02 INFORMATION ABOUT PRINCIPAL INVESTIGATORS/PROJECT DIRECTORS(PI/PD) and co-PRINCIPAL INVESTIGATORS/co-PROJECT DIRECTORS

Submit only ONE copy of this form **for each PI/PD and co-PI/PD** identified on the proposal. The form(s) should be attached to the original proposal as specified in GPG Section II.B. Submission of this information is voluntary and is not a precondition of award. This information will not be disclosed to external peer reviewers. ***DO NOT INCLUDE THIS FORM WITH ANY OF THE OTHER COPIES OF YOUR PROPOSAL AS THIS MAY COMPROMISE THE CONFIDENTIALITY OF THE INFORMATION.***

PI/PD Name: Robert M Morse

Gender: ☒ Male ☐ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☒ Not Hispanic or Latino

Race:
(Select one or more)
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☒ White

Disability Status:
(Select one or more)
- ☐ Hearing Impairment
- ☐ Visual Impairment
- ☐ Mobility/Orthopedic Impairment
- ☐ Other
- ☒ None

Citizenship: (Choose one) ☒ U.S. Citizen ☐ Permanent Resident ☐ Other non-U.S. Citizen

Check here if you do not wish to provide any or all of the above information (excluding PI/PD name): ☐

REQUIRED: Check here if you are currently serving (or have previously served) as a PI, co-PI or PD on any federally funded project ☒

Ethnicity Definition:
Hispanic or Latino. A person of Mexican, Puerto Rican, Cuban, South or Central American, or other Spanish culture or origin, regardless of race.
Race Definitions:
American Indian or Alaska Native. A person having origins in any of the original peoples of North and South America (including Central America), and who maintains tribal affiliation or community attachment.
Asian. A person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam.
Black or African American. A person having origins in any of the black racial groups of Africa.
Native Hawaiian or Other Pacific Islander. A person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands.
White. A person having origins in any of the original peoples of Europe, the Middle East, or North Africa.

WHY THIS INFORMATION IS BEING REQUESTED:

The Federal Government has a continuing commitment to monitor the operation of its review and award processes to identify and address any inequities based on gender, race, ethnicity, or disability of its proposed PIs/PDs. To gather information needed for this important task, the proposer should submit a single copy of this form for each identified PI/PD with each proposal. Submission of the requested information is voluntary and will not affect the organization's eligibility for an award. However, information not submitted will seriously undermine the statistical validity, and therefore the usefulness, of information recieved from others. Any individual not wishing to submit some or all the information should check the box provided for this purpose. (The exceptions are the PI/PD name and the information about prior Federal support, the last question above.)

Collection of this information is authorized by the NSF Act of 1950, as amended, 42 U.S.C. 1861, et seq. Demographic data allows NSF to gauge whether our programs and other opportunities in science and technology are fairly reaching and benefiting everyone regardless of demographic category; to ensure that those in under-represented groups have the same knowledge of and access to programs and other research and educational oppurtunities; and to assess involvement of international investigators in work supported by NSF. The information may be disclosed to government contractors, experts, volunteers and researchers to complete assigned work; and to other government agencies in order to coordinate and assess programs. The information may be added to the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See Systems of Records, NSF-50, "Principal Investigator/Proposal File and Associated Records", 63 Federal Register 267 (January 5, 1998), and NSF-51, "Reviewer/Proposal File and Associated Records", 63 Federal Register 268 (January 5, 1998).

02 INFORMATION ABOUT PRINCIPAL INVESTIGATORS/PROJECT DIRECTORS(PI/PD) and co-PRINCIPAL INVESTIGATORS/co-PROJECT DIRECTORS

Submit only ONE copy of this form **for each PI/PD and co-PI/PD** identified on the proposal. The form(s) should be attached to the original proposal as specified in GPG Section II.B. Submission of this information is voluntary and is not a precondition of award. This information will not be disclosed to external peer reviewers. ***DO NOT INCLUDE THIS FORM WITH ANY OF THE OTHER COPIES OF YOUR PROPOSAL AS THIS MAY COMPROMISE THE CONFIDENTIALITY OF THE INFORMATION.***

PI/PD Name: James J Beatty

Gender: ☒ Male ☐ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☒ Not Hispanic or Latino

Race:
(Select one or more)
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☒ White

Disability Status:
(Select one or more)
- ☐ Hearing Impairment
- ☐ Visual Impairment
- ☐ Mobility/Orthopedic Impairment
- ☐ Other
- ☒ None

Citizenship: (Choose one) ☒ U.S. Citizen ☐ Permanent Resident ☐ Other non-U.S. Citizen

Check here if you do not wish to provide any or all of the above information (excluding PI/PD name): ☐

REQUIRED: Check here if you are currently serving (or have previously served) as a PI, co-PI or PD on any federally funded project ☒

Ethnicity Definition:
Hispanic or Latino. A person of Mexican, Puerto Rican, Cuban, South or Central American, or other Spanish culture or origin, regardless of race.
Race Definitions:
American Indian or Alaska Native. A person having origins in any of the original peoples of North and South America (including Central America), and who maintains tribal affiliation or community attachment.
Asian. A person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam.
Black or African American. A person having origins in any of the black racial groups of Africa.
Native Hawaiian or Other Pacific Islander. A person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands.
White. A person having origins in any of the original peoples of Europe, the Middle East, or North Africa.

WHY THIS INFORMATION IS BEING REQUESTED:

The Federal Government has a continuing commitment to monitor the operation of its review and award processes to identify and address any inequities based on gender, race, ethnicity, or disability of its proposed PIs/PDs. To gather information needed for this important task, the proposer should submit a single copy of this form for each identified PI/PD with each proposal. Submission of the requested information is voluntary and will not affect the organization's eligibility for an award. However, information not submitted will seriously undermine the statistical validity, and therefore the usefulness, of information recieved from others. Any individual not wishing to submit some or all the information should check the box provided for this purpose. (The exceptions are the PI/PD name and the information about prior Federal support, the last question above.)

Collection of this information is authorized by the NSF Act of 1950, as amended, 42 U.S.C. 1861, et seq. Demographic data allows NSF to gauge whether our programs and other opportunities in science and technology are fairly reaching and benefiting everyone regardless of demographic category; to ensure that those in under-represented groups have the same knowledge of and access to programs and other research and educational oppurtunities; and to assess involvement of international investigators in work supported by NSF. The information may be disclosed to government contractors, experts, volunteers and researchers to complete assigned work; and to other government agencies in order to coordinate and assess programs. The information may be added to the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See Systems of Records, NSF-50, "Principal Investigator/Proposal File and Associated Records", 63 Federal Register 267 (January 5, 1998), and NSF-51, "Reviewer/Proposal File and Associated Records", 63 Federal Register 268 (January 5, 1998).

02 INFORMATION ABOUT PRINCIPAL INVESTIGATORS/PROJECT DIRECTORS(PI/PD) and co-PRINCIPAL INVESTIGATORS/co-PROJECT DIRECTORS

Submit only ONE copy of this form **for each PI/PD and co-PI/PD** identified on the proposal. The form(s) should be attached to the original proposal as specified in GPG Section II.B. Submission of this information is voluntary and is not a precondition of award. This information will not be disclosed to external peer reviewers. ***DO NOT INCLUDE THIS FORM WITH ANY OF THE OTHER COPIES OF YOUR PROPOSAL AS THIS MAY COMPROMISE THE CONFIDENTIALITY OF THE INFORMATION.***

PI/PD Name: Kara D Hoffman

Gender: ☐ Male ☐ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☒ Not Hispanic or Latino

Race: (Select one or more)
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☒ White

Disability Status: (Select one or more)
- ☐ Hearing Impairment
- ☐ Visual Impairment
- ☐ Mobility/Orthopedic Impairment
- ☐ Other
- ☒ None

Citizenship: (Choose one) ☒ U.S. Citizen ☐ Permanent Resident ☐ Other non-U.S. Citizen

Check here if you do not wish to provide any or all of the above information (excluding PI/PD name): ☒

REQUIRED: Check here if you are currently serving (or have previously served) as a PI, co-PI or PD on any federally funded project ☒

Ethnicity Definition:
Hispanic or Latino. A person of Mexican, Puerto Rican, Cuban, South or Central American, or other Spanish culture or origin, regardless of race.
Race Definitions:
American Indian or Alaska Native. A person having origins in any of the original peoples of North and South America (including Central America), and who maintains tribal affiliation or community attachment.
Asian. A person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam.
Black or African American. A person having origins in any of the black racial groups of Africa.
Native Hawaiian or Other Pacific Islander. A person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands.
White. A person having origins in any of the original peoples of Europe, the Middle East, or North Africa.

WHY THIS INFORMATION IS BEING REQUESTED:

The Federal Government has a continuing commitment to monitor the operation of its review and award processes to identify and address any inequities based on gender, race, ethnicity, or disability of its proposed PIs/PDs. To gather information needed for this important task, the proposer should submit a single copy of this form for each identified PI/PD with each proposal. Submission of the requested information is voluntary and will not affect the organization's eligibility for an award. However, information not submitted will seriously undermine the statistical validity, and therefore the usefulness, of information recieved from others. Any individual not wishing to submit some or all the information should check the box provided for this purpose. (The exceptions are the PI/PD name and the information about prior Federal support, the last question above.)

Collection of this information is authorized by the NSF Act of 1950, as amended, 42 U.S.C. 1861, et seq. Demographic data allows NSF to gauge whether our programs and other opportunities in science and technology are fairly reaching and benefiting everyone regardless of demographic category; to ensure that those in under-represented groups have the same knowledge of and access to programs and other research and educational oppurtunities; and to assess involvement of international investigators in work supported by NSF. The information may be disclosed to government contractors, experts, volunteers and researchers to complete assigned work; and to other government agencies in order to coordinate and assess programs. The information may be added to the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See Systems of Records, NSF-50, "Principal Investigator/Proposal File and Associated Records", 63 Federal Register 267 (January 5, 1998), and NSF-51, "Reviewer/Proposal File and Associated Records", 63 Federal Register 268 (January 5, 1998).

02 INFORMATION ABOUT PRINCIPAL INVESTIGATORS/PROJECT DIRECTORS(PI/PD) and co-PRINCIPAL INVESTIGATORS/co-PROJECT DIRECTORS

Submit only ONE copy of this form **for each PI/PD and co-PI/PD** identified on the proposal. The form(s) should be attached to the original proposal as specified in GPG Section II.B. Submission of this information is voluntary and is not a precondition of award. This information will not be disclosed to external peer reviewers. ***DO NOT INCLUDE THIS FORM WITH ANY OF THE OTHER COPIES OF YOUR PROPOSAL AS THIS MAY COMPROMISE THE CONFIDENTIALITY OF THE INFORMATION.***

PI/PD Name: Ilya Kravchenko

Gender: ☐ Male ☐ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☐ Not Hispanic or Latino

Race:
(Select one or more)
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☐ White

Disability Status:
(Select one or more)
- ☐ Hearing Impairment
- ☐ Visual Impairment
- ☐ Mobility/Orthopedic Impairment
- ☐ Other
- ☐ None

Citizenship: (Choose one) ☐ U.S. Citizen ☐ Permanent Resident ☐ Other non-U.S. Citizen

Check here if you do not wish to provide any or all of the above information (excluding PI/PD name): ☒

REQUIRED: Check here if you are currently serving (or have previously served) as a PI, co-PI or PD on any federally funded project ☐

Ethnicity Definition:
Hispanic or Latino. A person of Mexican, Puerto Rican, Cuban, South or Central American, or other Spanish culture or origin, regardless of race.
Race Definitions:
American Indian or Alaska Native. A person having origins in any of the original peoples of North and South America (including Central America), and who maintains tribal affiliation or community attachment.
Asian. A person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam.
Black or African American. A person having origins in any of the black racial groups of Africa.
Native Hawaiian or Other Pacific Islander. A person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands.
White. A person having origins in any of the original peoples of Europe, the Middle East, or North Africa.

WHY THIS INFORMATION IS BEING REQUESTED:

The Federal Government has a continuing commitment to monitor the operation of its review and award processes to identify and address any inequities based on gender, race, ethnicity, or disability of its proposed PIs/PDs. To gather information needed for this important task, the proposer should submit a single copy of this form for each identified PI/PD with each proposal. Submission of the requested information is voluntary and will not affect the organization's eligibility for an award. However, information not submitted will seriously undermine the statistical validity, and therefore the usefulness, of information recieved from others. Any individual not wishing to submit some or all the information should check the box provided for this purpose. (The exceptions are the PI/PD name and the information about prior Federal support, the last question above.)

Collection of this information is authorized by the NSF Act of 1950, as amended, 42 U.S.C. 1861, et seq. Demographic data allows NSF to gauge whether our programs and other opportunities in science and technology are fairly reaching and benefiting everyone regardless of demographic category; to ensure that those in under-represented groups have the same knowledge of and access to programs and other research and educational oppurtunities; and to assess involvement of international investigators in work supported by NSF. The information may be disclosed to government contractors, experts, volunteers and researchers to complete assigned work; and to other government agencies in order to coordinate and assess programs. The information may be added to the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See Systems of Records, NSF-50, "Principal Investigator/Proposal File and Associated Records", 63 Federal Register 267 (January 5, 1998), and NSF-51, "Reviewer/Proposal File and Associated Records", 63 Federal Register 268 (January 5, 1998).

02 INFORMATION ABOUT PRINCIPAL INVESTIGATORS/PROJECT DIRECTORS(PI/PD) and co-PRINCIPAL INVESTIGATORS/co-PROJECT DIRECTORS

Submit only ONE copy of this form **for each PI/PD and co-PI/PD** identified on the proposal. The form(s) should be attached to the original proposal as specified in GPG Section II.B. Submission of this information is voluntary and is not a precondition of award. This information will not be disclosed to external peer reviewers. ***DO NOT INCLUDE THIS FORM WITH ANY OF THE OTHER COPIES OF YOUR PROPOSAL AS THIS MAY COMPROMISE THE CONFIDENTIALITY OF THE INFORMATION.***

PI/PD Name: David Seckel

Gender: ☒ Male ☐ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☒ Not Hispanic or Latino

Race:
(Select one or more)
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☒ White

Disability Status:
(Select one or more)
- ☐ Hearing Impairment
- ☐ Visual Impairment
- ☐ Mobility/Orthopedic Impairment
- ☐ Other
- ☐ None

Citizenship: (Choose one) ☒ U.S. Citizen ☐ Permanent Resident ☐ Other non-U.S. Citizen

Check here if you do not wish to provide any or all of the above information (excluding PI/PD name): ☒

REQUIRED: Check here if you are currently serving (or have previously served) as a PI, co-PI or PD on any federally funded project ☒

Ethnicity Definition:
Hispanic or Latino. A person of Mexican, Puerto Rican, Cuban, South or Central American, or other Spanish culture or origin, regardless of race.
Race Definitions:
American Indian or Alaska Native. A person having origins in any of the original peoples of North and South America (including Central America), and who maintains tribal affiliation or community attachment.
Asian. A person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam.
Black or African American. A person having origins in any of the black racial groups of Africa.
Native Hawaiian or Other Pacific Islander. A person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands.
White. A person having origins in any of the original peoples of Europe, the Middle East, or North Africa.

WHY THIS INFORMATION IS BEING REQUESTED:

The Federal Government has a continuing commitment to monitor the operation of its review and award processes to identify and address any inequities based on gender, race, ethnicity, or disability of its proposed PIs/PDs. To gather information needed for this important task, the proposer should submit a single copy of this form for each identified PI/PD with each proposal. Submission of the requested information is voluntary and will not affect the organization's eligibility for an award. However, information not submitted will seriously undermine the statistical validity, and therefore the usefulness, of information recieved from others. Any individual not wishing to submit some or all the information should check the box provided for this purpose. (The exceptions are the PI/PD name and the information about prior Federal support, the last question above.)

Collection of this information is authorized by the NSF Act of 1950, as amended, 42 U.S.C. 1861, et seq. Demographic data allows NSF to gauge whether our programs and other opportunities in science and technology are fairly reaching and benefiting everyone regardless of demographic category; to ensure that those in under-represented groups have the same knowledge of and access to programs and other research and educational oppurtunities; and to assess involvement of international investigators in work supported by NSF. The information may be disclosed to government contractors, experts, volunteers and researchers to complete assigned work; and to other government agencies in order to coordinate and assess programs. The information may be added to the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See Systems of Records, NSF-50, "Principal Investigator/Proposal File and Associated Records", 63 Federal Register 267 (January 5, 1998), and NSF-51, "Reviewer/Proposal File and Associated Records", 63 Federal Register 268 (January 5, 1998).

02 INFORMATION ABOUT PRINCIPAL INVESTIGATORS/PROJECT DIRECTORS(PI/PD) and co-PRINCIPAL INVESTIGATORS/co-PROJECT DIRECTORS

Submit only ONE copy of this form **for each PI/PD and co-PI/PD** identified on the proposal. The form(s) should be attached to the original proposal as specified in GPG Section II.B. Submission of this information is voluntary and is not a precondition of award. This information will not be disclosed to external peer reviewers. ***DO NOT INCLUDE THIS FORM WITH ANY OF THE OTHER COPIES OF YOUR PROPOSAL AS THIS MAY COMPROMISE THE CONFIDENTIALITY OF THE INFORMATION.***

PI/PD Name: David Z Besson

Gender: ☒ Male ☐ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☒ Not Hispanic or Latino

Race:
(Select one or more)
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☒ White

Disability Status:
(Select one or more)
- ☐ Hearing Impairment
- ☐ Visual Impairment
- ☐ Mobility/Orthopedic Impairment
- ☐ Other
- ☒ None

Citizenship: (Choose one) ☒ U.S. Citizen ☐ Permanent Resident ☐ Other non-U.S. Citizen

Check here if you do not wish to provide any or all of the above information (excluding PI/PD name): ☐

REQUIRED: Check here if you are currently serving (or have previously served) as a PI, co-PI or PD on any federally funded project ☒

Ethnicity Definition:
Hispanic or Latino. A person of Mexican, Puerto Rican, Cuban, South or Central American, or other Spanish culture or origin, regardless of race.
Race Definitions:
American Indian or Alaska Native. A person having origins in any of the original peoples of North and South America (including Central America), and who maintains tribal affiliation or community attachment.
Asian. A person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam.
Black or African American. A person having origins in any of the black racial groups of Africa.
Native Hawaiian or Other Pacific Islander. A person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands.
White. A person having origins in any of the original peoples of Europe, the Middle East, or North Africa.

WHY THIS INFORMATION IS BEING REQUESTED:

The Federal Government has a continuing commitment to monitor the operation of its review and award processes to identify and address any inequities based on gender, race, ethnicity, or disability of its proposed PIs/PDs. To gather information needed for this important task, the proposer should submit a single copy of this form for each identified PI/PD with each proposal. Submission of the requested information is voluntary and will not affect the organization's eligibility for an award. However, information not submitted will seriously undermine the statistical validity, and therefore the usefulness, of information recieved from others. Any individual not wishing to submit some or all the information should check the box provided for this purpose. (The exceptions are the PI/PD name and the information about prior Federal support, the last question above.)

Collection of this information is authorized by the NSF Act of 1950, as amended, 42 U.S.C. 1861, et seq. Demographic data allows NSF to gauge whether our programs and other opportunities in science and technology are fairly reaching and benefiting everyone regardless of demographic category; to ensure that those in under-represented groups have the same knowledge of and access to programs and other research and educational oppurtunities; and to assess involvement of international investigators in work supported by NSF. The information may be disclosed to government contractors, experts, volunteers and researchers to complete assigned work; and to other government agencies in order to coordinate and assess programs. The information may be added to the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See Systems of Records, NSF-50, "Principal Investigator/Proposal File and Associated Records", 63 Federal Register 267 (January 5, 1998), and NSF-51, "Reviewer/Proposal File and Associated Records", 63 Federal Register 268 (January 5, 1998).

02 INFORMATION ABOUT PRINCIPAL INVESTIGATORS/PROJECT DIRECTORS(PI/PD) and co-PRINCIPAL INVESTIGATORS/co-PROJECT DIRECTORS

Submit only ONE copy of this form **for each PI/PD and co-PI/PD** identified on the proposal. The form(s) should be attached to the original proposal as specified in GPG Section II.B. Submission of this information is voluntary and is not a precondition of award. This information will not be disclosed to external peer reviewers. ***DO NOT INCLUDE THIS FORM WITH ANY OF THE OTHER COPIES OF YOUR PROPOSAL AS THIS MAY COMPROMISE THE CONFIDENTIALITY OF THE INFORMATION.***

PI/PD Name: Albrecht Karle

Gender: ☒ Male ☐ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☒ Not Hispanic or Latino

Race:
(Select one or more)
☐ American Indian or Alaska Native
☐ Asian
☐ Black or African American
☐ Native Hawaiian or Other Pacific Islander
☒ White

Disability Status:
(Select one or more)
☐ Hearing Impairment
☐ Visual Impairment
☐ Mobility/Orthopedic Impairment
☐ Other
☐ None

Citizenship: (Choose one) ☐ U.S. Citizen ☒ Permanent Resident ☐ Other non-U.S. Citizen

Check here if you do not wish to provide any or all of the above information (excluding PI/PD name): ☒

REQUIRED: Check here if you are currently serving (or have previously served) as a PI, co-PI or PD on any federally funded project ☒

Ethnicity Definition:
Hispanic or Latino. A person of Mexican, Puerto Rican, Cuban, South or Central American, or other Spanish culture or origin, regardless of race.
Race Definitions:
American Indian or Alaska Native. A person having origins in any of the original peoples of North and South America (including Central America), and who maintains tribal affiliation or community attachment.
Asian. A person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam.
Black or African American. A person having origins in any of the black racial groups of Africa.
Native Hawaiian or Other Pacific Islander. A person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands.
White. A person having origins in any of the original peoples of Europe, the Middle East, or North Africa.

WHY THIS INFORMATION IS BEING REQUESTED:

The Federal Government has a continuing commitment to monitor the operation of its review and award processes to identify and address any inequities based on gender, race, ethnicity, or disability of its proposed PIs/PDs. To gather information needed for this important task, the proposer should submit a single copy of this form for each identified PI/PD with each proposal. Submission of the requested information is voluntary and will not affect the organization's eligibility for an award. However, information not submitted will seriously undermine the statistical validity, and therefore the usefulness, of information recieved from others. Any individual not wishing to submit some or all the information should check the box provided for this purpose. (The exceptions are the PI/PD name and the information about prior Federal support, the last question above.)

Collection of this information is authorized by the NSF Act of 1950, as amended, 42 U.S.C. 1861, et seq. Demographic data allows NSF to gauge whether our programs and other opportunities in science and technology are fairly reaching and benefiting everyone regardless of demographic category; to ensure that those in under-represented groups have the same knowledge of and access to programs and other research and educational oppurtunities; and to assess involvement of international investigators in work supported by NSF. The information may be disclosed to government contractors, experts, volunteers and researchers to complete assigned work; and to other government agencies in order to coordinate and assess programs. The information may be added to the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See Systems of Records, NSF-50, "Principal Investigator/Proposal File and Associated Records", 63 Federal Register 267 (January 5, 1998), and NSF-51, "Reviewer/Proposal File and Associated Records", 63 Federal Register 268 (January 5, 1998).

02 INFORMATION ABOUT PRINCIPAL INVESTIGATORS/PROJECT DIRECTORS(PI/PD) and co-PRINCIPAL INVESTIGATORS/co-PROJECT DIRECTORS

Submit only ONE copy of this form **for each PI/PD and co-PI/PD** identified on the proposal. The form(s) should be attached to the original proposal as specified in GPG Section II.B. Submission of this information is voluntary and is not a precondition of award. This information will not be disclosed to external peer reviewers. ***DO NOT INCLUDE THIS FORM WITH ANY OF THE OTHER COPIES OF YOUR PROPOSAL AS THIS MAY COMPROMISE THE CONFIDENTIALITY OF THE INFORMATION.***

PI/PD Name: Douglas F Cowen

Gender: ☒ Male ☐ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☒ Not Hispanic or Latino

Race:
(Select one or more)
☐ American Indian or Alaska Native
☐ Asian
☐ Black or African American
☐ Native Hawaiian or Other Pacific Islander
☒ White

Disability Status:
(Select one or more)
☐ Hearing Impairment
☐ Visual Impairment
☐ Mobility/Orthopedic Impairment
☐ Other
☐ None

Citizenship: (Choose one) ☒ U.S. Citizen ☐ Permanent Resident ☐ Other non-U.S. Citizen

Check here if you do not wish to provide any or all of the above information (excluding PI/PD name): ☒

REQUIRED: Check here if you are currently serving (or have previously served) as a PI, co-PI or PD on any federally funded project ☒

Ethnicity Definition:
Hispanic or Latino. A person of Mexican, Puerto Rican, Cuban, South or Central American, or other Spanish culture or origin, regardless of race.
Race Definitions:
American Indian or Alaska Native. A person having origins in any of the original peoples of North and South America (including Central America), and who maintains tribal affiliation or community attachment.
Asian. A person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam.
Black or African American. A person having origins in any of the black racial groups of Africa.
Native Hawaiian or Other Pacific Islander. A person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands.
White. A person having origins in any of the original peoples of Europe, the Middle East, or North Africa.

WHY THIS INFORMATION IS BEING REQUESTED:

The Federal Government has a continuing commitment to monitor the operation of its review and award processes to identify and address any inequities based on gender, race, ethnicity, or disability of its proposed PIs/PDs. To gather information needed for this important task, the proposer should submit a single copy of this form for each identified PI/PD with each proposal. Submission of the requested information is voluntary and will not affect the organization's eligibility for an award. However, information not submitted will seriously undermine the statistical validity, and therefore the usefulness, of information recieved from others. Any individual not wishing to submit some or all the information should check the box provided for this purpose. (The exceptions are the PI/PD name and the information about prior Federal support, the last question above.)

Collection of this information is authorized by the NSF Act of 1950, as amended, 42 U.S.C. 1861, et seq. Demographic data allows NSF to gauge whether our programs and other opportunities in science and technology are fairly reaching and benefiting everyone regardless of demographic category; to ensure that those in under-represented groups have the same knowledge of and access to programs and other research and educational oppurtunities; and to assess involvement of international investigators in work supported by NSF. The information may be disclosed to government contractors, experts, volunteers and researchers to complete assigned work; and to other government agencies in order to coordinate and assess programs. The information may be added to the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See Systems of Records, NSF-50, "Principal Investigator/Proposal File and Associated Records", 63 Federal Register 267 (January 5, 1998), and NSF-51, "Reviewer/Proposal File and Associated Records", 63 Federal Register 268 (January 5, 1998).

List of Suggested Reviewers or Reviewers Not To Include (optional)

SUGGESTED REVIEWERS:

Not Listed

REVIEWERS NOT TO INCLUDE:

Not Listed

List of Suggested Reviewers or Reviewers Not To Include (optional)

SUGGESTED REVIEWERS:
Not Listed

REVIEWERS NOT TO INCLUDE:
Not Listed

List of Suggested Reviewers or Reviewers Not To Include (optional)

SUGGESTED REVIEWERS:
Not Listed

REVIEWERS NOT TO INCLUDE:
Not Listed

List of Suggested Reviewers or Reviewers Not To Include (optional)

SUGGESTED REVIEWERS:
Not Listed

REVIEWERS NOT TO INCLUDE:
Not Listed

List of Suggested Reviewers or Reviewers Not To Include (optional)

SUGGESTED REVIEWERS:
Not Listed

REVIEWERS NOT TO INCLUDE:
Not Listed

List of Suggested Reviewers or Reviewers Not To Include (optional)

SUGGESTED REVIEWERS:
Not Listed

REVIEWERS NOT TO INCLUDE:
Not Listed

List of Suggested Reviewers or Reviewers Not To Include (optional)

SUGGESTED REVIEWERS:
Not Listed

REVIEWERS NOT TO INCLUDE:
Not Listed

List of Suggested Reviewers or Reviewers Not To Include (optional)

SUGGESTED REVIEWERS:
Not Listed

REVIEWERS NOT TO INCLUDE:
Not Listed

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/if not in response to a program announcement/solicitation enter NSF 07-140 **PD 06-1643** **09/26/07**	FOR NSF USE ONLY NSF PROPOSAL NUMBER
FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.) **PHY - PARTICLE ASTROPHYSICS, (continued)**	

DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION
				965088057	

EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)	SHOW PREVIOUS AWARD NO. IF THIS IS	IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES ☐ NO ☒ IF YES, LIST ACRONYM(S)
996000354	☐ A RENEWAL ☐ AN ACCOMPLISHMENT-BASED RENEWAL	

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE **University of Hawaii**	ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE **University of Hawaii** **2530 Dole Street** **Honolulu, HI. 968222303**
AWARDEE ORGANIZATION CODE (IF KNOWN) **0016105000**	
NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE **University of Hawaii Manoa**	ADDRESS OF PERFORMING ORGANIZATION, IF DIFFERENT, INCLUDING 9 DIGIT ZIP CODE **University of Hawaii Manoa** **2530 Dole Street** **Honolulu, HI 96822-2225**
PERFORMING ORGANIZATION CODE (IF KNOWN) **5300018145**	

IS AWARDEE ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions)	☐ SMALL BUSINESS ☐ FOR-PROFIT ORGANIZATION	☐ MINORITY BUSINESS ☐ WOMAN-OWNED BUSINESS	☐ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT **Collaborative Research: IceRay-36**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ **655,494**	**36** months	**03/01/08**	

CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW

☐ BEGINNING INVESTIGATOR (GPG I.G.2)
☐ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C)
☐ PROPRIETARY & PRIVILEGED INFORMATION (GPG I.D, II.C.1.d)
☐ HISTORIC PLACES (GPG II.C.2.j)
☐ SMALL GRANT FOR EXPLOR. RESEARCH (SGER) (GPG II.D.1)
☐ VERTEBRATE ANIMALS (GPG II.D.5) IACUC App. Date ________
PHS Animal Welfare Assurance Number ________
☐ HUMAN SUBJECTS (GPG II.D.6) Human Subjects Assurance Number ________
Exemption Subsection ______ or IRB App. Date ________
☐ INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j)
____
☐ HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.G.1)

PI/PD DEPARTMENT **Physics**	PI/PD POSTAL ADDRESS **2505 Correa Rd** **Honolulu, HI 96822** **United States**
PI/PD FAX NUMBER **808-956-2930**	

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address
PI/PD NAME **Robert M Morse**	**PhD**	**1969**	**808-956-7051**	**morse@phys.hawaii.edu**
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				

CERTIFICATION PAGE

Certification for Authorized Organizational Representative or Individual Applicant:

By signing and submitting this proposal, the Authorized Organizational Representative or Individual Applicant is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding debarment and suspension, drug-free workplace, and lobbying activities (see below), nondiscrimination, and flood hazard insurance (when applicable) as set forth in the NSF Proposal & Award Policies & Procedures Guide, Part I: the Grant Proposal Guide (GPG) (NSF 07-140). Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U. S. Code, Title 18, Section 1001).

Conflict of Interest Certification

In addition, if the applicant institution employs more than fifty persons, by electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative of the applicant institution is certifying that the institution has implemented a written and enforced conflict of interest policy that is consistent with the provisions of the NSF Proposal & Award Policies & Procedures Guide, Part II, Award & Administration Guide (AAG) Chapter IV.A; that to the best of his/her knowledge, all financial disclosures required by that conflict of interest policy have been made; and that all identified conflicts of interest will have been satisfactorily managed, reduced or eliminated prior to the institution's expenditure of any funds under the award, in accordance with the institution's conflict of interest policy. Conflicts which cannot be satisfactorily managed, reduced or eliminated must be disclosed to NSF.

Drug Free Work Place Certification

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Drug Free Work Place Certification contained in Exhibit II-3 of the Grant Proposal Guide.

Debarment and Suspension Certification

(If answer "yes", please provide explanation.)

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency? Yes ☐ No ☒

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Debarment and Suspension Certification contained in Exhibit II-4 of the Grant Proposal Guide.

Certification Regarding Lobbying

The following certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding $100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding $150,000.

Certification for Contracts, Grants, Loans and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, ''Disclosure of Lobbying Activities,'' in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

Certification Regarding Nondiscrimination

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative is providing the Certification Regarding Nondiscrimination contained in Exhibit II-6 of the Grant Proposal Guide.

Certification Regarding Flood Hazard Insurance

Two sections of the National Flood Insurance Act of 1968 (42 USC §4012a and §4106) bar Federal agencies from giving financial assistance for acquisition or construction purposes in any area identified by the Federal Emergency Management Agency (FEMA) as having special flood hazards unless the:

(1) community in which that area is located participates in the national flood insurance program; and
(2) building (and any related equipment) is covered by adequate flood insurance.

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant located in FEMA-designated special flood hazard areas is certifying that adequate flood insurance has been or will be obtained in the following situations:

(1) for NSF grants for the construction of a building or facility, regardless of the dollar amount of the grant; and
(2) for other NSF Grants when more than $25,000 has been budgeted in the proposal for repair, alteration or improvement (construction) of a building or facility.

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	SIGNATURE	DATE
NAME		

TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS	FAX NUMBER

*SUBMISSION OF SOCIAL SECURITY NUMBERS IS VOLUNTARY AND WILL NOT AFFECT THE ORGANIZATION'S ELIGIBILITY FOR AN AWARD. HOWEVER, THEY ARE AN INTEGRAL PART OF THE INFORMATION SYSTEM AND ASSIST IN PROCESSING THE PROPOSAL. SSN SOLICITED UNDER NSF ACT OF 1950, AS AMENDED.

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) - continued from page 1
(Indicate the most specific unit known, i.e. program, division, etc.)

ANT - ANTARCTIC AERONOMY & ASTROPHYS

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/if not in response to a program announcement/solicitation enter NSF 07-140

NSF 07-140 09/26/07

FOR NSF USE ONLY

NSF PROPOSAL NUMBER

0757980

FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)

PHY - PARTICLE ASTROPHYSICS, (continued)

DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION
09/26/2007	2	03010000 PHY	1643	071650709	10/01/2007 8:20pm

EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN): 996000354

SHOW PREVIOUS AWARD NO. IF THIS IS
☐ A RENEWAL
☐ AN ACCOMPLISHMENT-BASED RENEWAL

IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES ☐ NO ☒ IF YES, LIST ACRONYM(S)

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE: Ohio State University Research Foundation

ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE:
Ohio State University Research Foundation
1960 Kenny Road
Columbus, OH. 432101016

AWARDEE ORGANIZATION CODE (IF KNOWN): 0030908001

NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE: Ohio State University

ADDRESS OF PERFORMING ORGANIZATION, IF DIFFERENT, INCLUDING 9 DIGIT ZIP CODE:
Ohio State University
190 N OVAL MALL
COLUMBUS, OH 43210-1321

PERFORMING ORGANIZATION CODE (IF KNOWN): 0030908000

IS AWARDEE ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions) ☐ SMALL BUSINESS ☐ MINORITY BUSINESS ☐ FOR-PROFIT ORGANIZATION ☐ WOMAN-OWNED BUSINESS

☐ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT: Collaborative Research: IceRay-2007

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ 391,366	36 months	06/01/08	

CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW

☐ BEGINNING INVESTIGATOR (GPG I.G.2)
☐ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C)
☐ PROPRIETARY & PRIVILEGED INFORMATION (GPG I.D, II.C.1.d)
☐ HISTORIC PLACES (GPG II.C.2.j)
☐ SMALL GRANT FOR EXPLOR. RESEARCH (SGER) (GPG II.D.1)
☐ VERTEBRATE ANIMALS (GPG II.D.5) IACUC App. Date ________
PHS Animal Welfare Assurance Number ________
☐ HUMAN SUBJECTS (GPG II.D.6) Human Subjects Assurance Number ________
Exemption Subsection ________ or IRB App. Date ________
☐ INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j)
____
☐ HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.G.1)

PI/PD DEPARTMENT: Department of Physics

PI/PD POSTAL ADDRESS:
191 W. Woodruff Avenue

Columbus, OH 43210
United States

PI/PD FAX NUMBER: 614-292-7557

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address
PI/PD NAME James J Beatty	PhD	1986	614-247-8413	beatty@mps.ohio-state.edu
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				

Electronic Signature

CERTIFICATION PAGE

Certification for Authorized Organizational Representative or Individual Applicant:

By signing and submitting this proposal, the Authorized Organizational Representative or Individual Applicant is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding debarment and suspension, drug-free workplace, and lobbying activities (see below), nondiscrimination, and flood hazard insurance (when applicable) as set forth in the NSF Proposal & Award Policies & Procedures Guide, Part I: the Grant Proposal Guide (GPG) (NSF 07-140). Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U. S. Code, Title 18, Section 1001).

Conflict of Interest Certification

In addition, if the applicant institution employs more than fifty persons, by electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative of the applicant institution is certifying that the institution has implemented a written and enforced conflict of interest policy that is consistent with the provisions of the NSF Proposal & Award Policies & Procedures Guide, Part II, Award & Administration Guide (AAG) Chapter IV.A; that to the best of his/her knowledge, all financial disclosures required by that conflict of interest policy have been made; and that all identified conflicts of interest will have been satisfactorily managed, reduced or eliminated prior to the institution's expenditure of any funds under the award, in accordance with the institution's conflict of interest policy. Conflicts which cannot be satisfactorily managed, reduced or eliminated must be dislosed to NSF.

Drug Free Work Place Certification

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Drug Free Work Place Certification contained in Exhibit II-3 of the Grant Proposal Guide.

Debarment and Suspension Certification

(If answer "yes", please provide explanation.)

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency? Yes ☐ No ☒

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Debarment and Suspension Certification contained in Exhibit II-4 of the Grant Proposal Guide.

Certification Regarding Lobbying

The following certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding $100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding $150,000.

Certification for Contracts, Grants, Loans and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, ''Disclosure of Lobbying Activities,'' in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

Certification Regarding Nondiscrimination

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative is providing the Certification Regarding Nondiscrimination contained in Exhibit II-6 of the Grant Proposal Guide.

Certification Regarding Flood Hazard Insurance

Two sections of the National Flood Insurance Act of 1968 (42 USC §4012a and §4106) bar Federal agencies from giving financial assistance for acquisition or construction purposes in any area identified by the Federal Emergency Management Agency (FEMA) as having special flood hazards unless the:

(1) community in which that area is located participates in the national flood insurance program; and
(2) building (and any related equipment) is covered by adequate flood insurance.

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant located in FEMA-designated special flood hazard areas is certifying that adequate flood insurance has been or will be obtained in the following situations:

(1) for NSF grants for the construction of a building or facility, regardless of the dollar amount of the grant; and
(2) for other NSF Grants when more than $25,000 has been budgeted in the proposal for repair, alteration or improvement (construction) of a building or facility.

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	SIGNATURE	DATE
NAME Lisa M Jones	Electronic Signature	Sep 26 2007 11:58AM

TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS	FAX NUMBER
614-247-8348	jones.2368@osu.edu	614-292-3639

*SUBMISSION OF SOCIAL SECURITY NUMBERS IS VOLUNTARY AND WILL NOT AFFECT THE ORGANIZATION'S ELIGIBILITY FOR AN AWARD. HOWEVER, THEY ARE AN INTEGRAL PART OF THE INFORMATION SYSTEM AND ASSIST IN PROCESSING THE PROPOSAL. SSN SOLICITED UNDER NSF ACT OF 1950, AS AMENDED.

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) - continued from page 1
(Indicate the most specific unit known, i.e. program, division, etc.)

ANT - ANTARCTIC AERONOMY & ASTROPHYS

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/if not in response to a program announcement/solicitation enter NSF 07-140	FOR NSF USE ONLY
PD 06-1643 09/26/07	NSF PROPOSAL NUMBER
FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.) PHY - PARTICLE ASTROPHYSICS, (continued)	0800462

DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION
10/01/2007	2	03010000 PHY	1643	790934285	10/01/2007 8:21pm

EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)	SHOW PREVIOUS AWARD NO. IF THIS IS	IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY?
526002033	☐ A RENEWAL ☐ AN ACCOMPLISHMENT-BASED RENEWAL	YES ☐ NO ☒ IF YES, LIST ACRONYM(S)

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE	ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE
University of Maryland College Park	University of Maryland College Park 3112 LEE BLDG COLLEGE PARK, MD. 207422510
AWARDEE ORGANIZATION CODE (IF KNOWN) 0021030000	
NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE	ADDRESS OF PERFORMING ORGANIZATION, IF DIFFERENT, INCLUDING 9 DIGIT ZIP CODE
PERFORMING ORGANIZATION CODE (IF KNOWN)	

IS AWARDEE ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions)
☐ SMALL BUSINESS ☐ MINORITY BUSINESS
☐ FOR-PROFIT ORGANIZATION ☐ WOMAN-OWNED BUSINESS
☐ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT **Collaborative Research: IceRay-36**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ 97,650	36 months	03/01/08	

CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW

- ☐ BEGINNING INVESTIGATOR (GPG I.G.2)
- ☐ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C)
- ☐ PROPRIETARY & PRIVILEGED INFORMATION (GPG I.D, II.C.1.d)
- ☐ HISTORIC PLACES (GPG II.C.2.j)
- ☐ SMALL GRANT FOR EXPLOR. RESEARCH (SGER) (GPG II.D.1)
- ☐ VERTEBRATE ANIMALS (GPG II.D.5) IACUC App. Date ________ PHS Animal Welfare Assurance Number ________
- ☐ HUMAN SUBJECTS (GPG II.D.6) Human Subjects Assurance Number ________ Exemption Subsection ________ or IRB App. Date ________
- ☐ INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j) ________
- ☐ HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.G.1)

PI/PD DEPARTMENT	PI/PD POSTAL ADDRESS
Physics	4336 John S. Toll Physics Building College Park, MD 207425141 United States
PI/PD FAX NUMBER 301-699-9195	

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address
PI/PD NAME Kara D Hoffman	PhD	1998	301-405-7263	kara@icecube.umd.edu
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				

Electronic Signature

CERTIFICATION PAGE

Certification for Authorized Organizational Representative or Individual Applicant:

By signing and submitting this proposal, the Authorized Organizational Representative or Individual Applicant is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding debarment and suspension, drug-free workplace, and lobbying activities (see below), nondiscrimination, and flood hazard insurance (when applicable) as set forth in the NSF Proposal & Award Policies & Procedures Guide, Part I: the Grant Proposal Guide (GPG) (NSF 07-140). Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U. S. Code, Title 18, Section 1001).

Conflict of Interest Certification

In addition, if the applicant institution employs more than fifty persons, by electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative of the applicant institution is certifying that the institution has implemented a written and enforced conflict of interest policy that is consistent with the provisions of the NSF Proposal & Award Policies & Procedures Guide, Part II, Award & Administration Guide (AAG) Chapter IV.A; that to the best of his/her knowledge, all financial disclosures required by that conflict of interest policy have been made; and that all identified conflicts of interest will have been satisfactorily managed, reduced or eliminated prior to the institution's expenditure of any funds under the award, in accordance with the institution's conflict of interest policy. Conflicts which cannot be satisfactorily managed, reduced or eliminated must be dislosed to NSF.

Drug Free Work Place Certification

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Drug Free Work Place Certification contained in Exhibit II-3 of the Grant Proposal Guide.

Debarment and Suspension Certification

(If answer "yes", please provide explanation.)

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency? Yes ☐ No ☒

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Debarment and Suspension Certification contained in Exhibit II-4 of the Grant Proposal Guide.

Certification Regarding Lobbying

The following certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding $100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding $150,000.

Certification for Contracts, Grants, Loans and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, ''Disclosure of Lobbying Activities,'' in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

Certification Regarding Nondiscrimination

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative is providing the Certification Regarding Nondiscrimination contained in Exhibit II-6 of the Grant Proposal Guide.

Certification Regarding Flood Hazard Insurance

Two sections of the National Flood Insurance Act of 1968 (42 USC §4012a and §4106) bar Federal agencies from giving financial assistance for acquisition or construction purposes in any area identified by the Federal Emergency Management Agency (FEMA) as having special flood hazards unless the:

(1) community in which that area is located participates in the national flood insurance program; and
(2) building (and any related equipment) is covered by adequate flood insurance.

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant located in FEMA-designated special flood hazard areas is certifying that adequate flood insurance has been or will be obtained in the following situations:

(1) for NSF grants for the construction of a building or facility, regardless of the dollar amount of the grant; and
(2) for other NSF Grants when more than $25,000 has been budgeted in the proposal for repair, alteration or improvement (construction) of a building or facility.

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	SIGNATURE	DATE
NAME **Wendy T Montgomery**	**Electronic Signature**	**Oct 1 2007 2:52PM**

TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS	FAX NUMBER
301-405-6279	**wmontgomery@umresearch.umd.edu**	**301-314-9569**

*SUBMISSION OF SOCIAL SECURITY NUMBERS IS VOLUNTARY AND WILL NOT AFFECT THE ORGANIZATION'S ELIGIBILITY FOR AN AWARD. HOWEVER, THEY ARE AN INTEGRAL PART OF THE INFORMATION SYSTEM AND ASSIST IN PROCESSING THE PROPOSAL. SSN SOLICITED UNDER NSF ACT OF 1950, AS AMENDED.

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) - continued from page 1
(Indicate the most specific unit known, i.e. program, division, etc.)

ANT - ANTARCTIC AERONOMY & ASTROPHYS

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/if not in response to a program announcement/solicitation enter NSF 07-140 PD 06-1643 09/26/07	FOR NSF USE ONLY NSF PROPOSAL NUMBER
FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.) PHY - PARTICLE ASTROPHYSICS, (continued)	

DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION
				001425594	

EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)	SHOW PREVIOUS AWARD NO. IF THIS IS	IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES ☐ NO ☒ IF YES, LIST ACRONYM(S)
042103594	☐ A RENEWAL ☐ AN ACCOMPLISHMENT-BASED RENEWAL	

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE **Massachusetts Institute of Technology**	ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE **Massachusetts Institute of Technology** **77 MASSACHUSETTS AVE** **Cambridge, MA. 021394307**
AWARDEE ORGANIZATION CODE (IF KNOWN) 0021782000	
NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE	ADDRESS OF PERFORMING ORGANIZATION, IF DIFFERENT, INCLUDING 9 DIGIT ZIP CODE
PERFORMING ORGANIZATION CODE (IF KNOWN)	

IS AWARDEE ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions)
☐ SMALL BUSINESS ☐ MINORITY BUSINESS
☐ FOR-PROFIT ORGANIZATION ☐ WOMAN-OWNED BUSINESS
☐ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT **Collaborative Space Research: IceRay-36**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ 0	36 months	03/01/08	

CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW
- ☐ BEGINNING INVESTIGATOR (GPG I.G.2)
- ☐ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C)
- ☐ PROPRIETARY & PRIVILEGED INFORMATION (GPG I.D, II.C.1.d)
- ☐ HISTORIC PLACES (GPG II.C.2.j)
- ☐ SMALL GRANT FOR EXPLOR. RESEARCH (SGER) (GPG II.D.1)
- ☐ VERTEBRATE ANIMALS (GPG II.D.5) IACUC App. Date ________ PHS Animal Welfare Assurance Number ________
- ☐ HUMAN SUBJECTS (GPG II.D.6) Human Subjects Assurance Number ________ Exemption Subsection ________ or IRB App. Date ________
- ☐ INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j) ________
- ☐ HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.G.1)

PI/PD DEPARTMENT LNS	PI/PD POSTAL ADDRESS 77 MASSACHUSETTS AVE Cambridge, MA 021394307 United States
PI/PD FAX NUMBER 617-253-1755	

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address
PI/PD NAME Ilya Kravchenko	PhD	1999	617-253-1000	ikrav@mit.edu
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				

CERTIFICATION PAGE

Certification for Authorized Organizational Representative or Individual Applicant:

By signing and submitting this proposal, the Authorized Organizational Representative or Individual Applicant is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding debarment and suspension, drug-free workplace, and lobbying activities (see below), nondiscrimination, and flood hazard insurance (when applicable) as set forth in the NSF Proposal & Award Policies & Procedures Guide, Part I: the Grant Proposal Guide (GPG) (NSF 07-140). Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U. S. Code, Title 18, Section 1001).

Conflict of Interest Certification

In addition, if the applicant institution employs more than fifty persons, by electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative of the applicant institution is certifying that the institution has implemented a written and enforced conflict of interest policy that is consistent with the provisions of the NSF Proposal & Award Policies & Procedures Guide, Part II, Award & Administration Guide (AAG) Chapter IV.A; that to the best of his/her knowledge, all financial disclosures required by that conflict of interest policy have been made; and that all identified conflicts of interest will have been satisfactorily managed, reduced or eliminated prior to the institution's expenditure of any funds under the award, in accordance with the institution's conflict of interest policy. Conflicts which cannot be satisfactorily managed, reduced or eliminated must be dislosed to NSF.

Drug Free Work Place Certification

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Drug Free Work Place Certification contained in Exhibit II-3 of the Grant Proposal Guide.

Debarment and Suspension Certification

(If answer "yes", please provide explanation.)

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency? Yes ☐ No ☒

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Debarment and Suspension Certification contained in Exhibit II-4 of the Grant Proposal Guide.

Certification Regarding Lobbying

The following certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding $100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding $150,000.

Certification for Contracts, Grants, Loans and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, ''Disclosure of Lobbying Activities,'' in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

Certification Regarding Nondiscrimination

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative is providing the Certification Regarding Nondiscrimination contained in Exhibit II-6 of the Grant Proposal Guide.

Certification Regarding Flood Hazard Insurance

Two sections of the National Flood Insurance Act of 1968 (42 USC §4012a and §4106) bar Federal agencies from giving financial assistance for acquisition or construction purposes in any area identified by the Federal Emergency Management Agency (FEMA) as having special flood hazards unless the:

(1) community in which that area is located participates in the national flood insurance program; and
(2) building (and any related equipment) is covered by adequate flood insurance.

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant located in FEMA-designated special flood hazard areas is certifying that adequate flood insurance has been or will be obtained in the following situations:

(1) for NSF grants for the construction of a building or facility, regardless of the dollar amount of the grant; and
(2) for other NSF Grants when more than $25,000 has been budgeted in the proposal for repair, alteration or improvement (construction) of a building or facility.

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	SIGNATURE	DATE
NAME		

TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS	FAX NUMBER

*SUBMISSION OF SOCIAL SECURITY NUMBERS IS VOLUNTARY AND WILL NOT AFFECT THE ORGANIZATION'S ELIGIBILITY FOR AN AWARD. HOWEVER, THEY ARE AN INTEGRAL PART OF THE INFORMATION SYSTEM AND ASSIST IN PROCESSING THE PROPOSAL. SSN SOLICITED UNDER NSF ACT OF 1950, AS AMENDED.

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) - continued from page 1
(Indicate the most specific unit known, i.e. program, division, etc.)

ANT - ANTARCTIC AERONOMY & ASTROPHYS

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/if not in response to a program announcement/solicitation enter NSF 07-140		FOR NSF USE ONLY
PD 06-1643	09/26/07	NSF PROPOSAL NUMBER
FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)		**0800430**
PHY - PARTICLE ASTROPHYSICS, (continued)		

DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION
10/01/2007	2	03010000 PHY	1643	059007500	10/01/2007 8:21pm

EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)	SHOW PREVIOUS AWARD NO. IF THIS IS	IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY?
516000297	☐ A RENEWAL ☐ AN ACCOMPLISHMENT-BASED RENEWAL	YES ☐ NO ☒ IF YES, LIST ACRONYM(S)

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE	ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE
University of Delaware	University of Delaware 210 Hullihen Hall Newark, DE. 197161551
AWARDEE ORGANIZATION CODE (IF KNOWN) 0014316000	
NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE	ADDRESS OF PERFORMING ORGANIZATION, IF DIFFERENT, INCLUDING 9 DIGIT ZIP CODE
PERFORMING ORGANIZATION CODE (IF KNOWN)	

IS AWARDEE ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions) ☐ SMALL BUSINESS ☐ FOR-PROFIT ORGANIZATION ☐ MINORITY BUSINESS ☐ WOMAN-OWNED BUSINESS ☐ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT **Collaborative Research: IceRay-36**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ 178,328	36 months	03/01/08	

CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW

- ☐ BEGINNING INVESTIGATOR (GPG I.G.2)
- ☐ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C)
- ☐ PROPRIETARY & PRIVILEGED INFORMATION (GPG I.D, II.C.1.d)
- ☐ HISTORIC PLACES (GPG II.C.2.j)
- ☐ SMALL GRANT FOR EXPLOR. RESEARCH (SGER) (GPG II.D.1)
- ☐ VERTEBRATE ANIMALS (GPG II.D.5) IACUC App. Date ________ PHS Animal Welfare Assurance Number ________
- ☐ HUMAN SUBJECTS (GPG II.D.6) Human Subjects Assurance Number ________ Exemption Subsection ________ or IRB App. Date ________
- ☐ INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j) ________
- ☐ HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.G.1)

PI/PD DEPARTMENT	PI/PD POSTAL ADDRESS
Physics and Astronomy	Newark, DE 19716 United States
PI/PD FAX NUMBER 302-831-1843	

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address
PI/PD NAME David Seckel	PhD	1983	302-831-1846	seckel@bartol.udel.edu
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				

Electronic Signature

CERTIFICATION PAGE

Certification for Authorized Organizational Representative or Individual Applicant:

By signing and submitting this proposal, the Authorized Organizational Representative or Individual Applicant is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding debarment and suspension, drug-free workplace, and lobbying activities (see below), nondiscrimination, and flood hazard insurance (when applicable) as set forth in the NSF Proposal & Award Policies & Procedures Guide, Part I: the Grant Proposal Guide (GPG) (NSF 07-140). Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U. S. Code, Title 18, Section 1001).

Conflict of Interest Certification

In addition, if the applicant institution employs more than fifty persons, by electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative of the applicant institution is certifying that the institution has implemented a written and enforced conflict of interest policy that is consistent with the provisions of the NSF Proposal & Award Policies & Procedures Guide, Part II, Award & Administration Guide (AAG) Chapter IV.A; that to the best of his/her knowledge, all financial disclosures required by that conflict of interest policy have been made; and that all identified conflicts of interest will have been satisfactorily managed, reduced or eliminated prior to the institution's expenditure of any funds under the award, in accordance with the institution's conflict of interest policy. Conflicts which cannot be satisfactorily managed, reduced or eliminated must be disolsed to NSF.

Drug Free Work Place Certification

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Drug Free Work Place Certification contained in Exhibit II-3 of the Grant Proposal Guide.

Debarment and Suspension Certification

(If answer "yes", please provide explanation.)

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency? Yes ☐ No ☒

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Debarment and Suspension Certification contained in Exhibit II-4 of the Grant Proposal Guide.

Certification Regarding Lobbying

The following certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding $100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding $150,000.

Certification for Contracts, Grants, Loans and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, ''Disclosure of Lobbying Activities,'' in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

Certification Regarding Nondiscrimination

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative is providing the Certification Regarding Nondiscrimination contained in Exhibit II-6 of the Grant Proposal Guide.

Certification Regarding Flood Hazard Insurance

Two sections of the National Flood Insurance Act of 1968 (42 USC §4012a and §4106) bar Federal agencies from giving financial assistance for acquisition or construction purposes in any area identified by the Federal Emergency Management Agency (FEMA) as having special flood hazards unless the:

(1) community in which that area is located participates in the national flood insurance program; and
(2) building (and any related equipment) is covered by adequate flood insurance.

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant located in FEMA-designated special flood hazard areas is certifying that adequate flood insurance has been or will be obtained in the following situations:

(1) for NSF grants for the construction of a building or facility, regardless of the dollar amount of the grant; and
(2) for other NSF Grants when more than $25,000 has been budgeted in the proposal for repair, alteration or improvement (construction) of a building or facility.

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	SIGNATURE	DATE
NAME Geraldine Hobbs	Electronic Signature	Oct 1 2007 2:38PM

TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS	FAX NUMBER
302-831-8618	geh@udel.edu	302-831-2828

*SUBMISSION OF SOCIAL SECURITY NUMBERS IS VOLUNTARY AND WILL NOT AFFECT THE ORGANIZATION'S ELIGIBILITY FOR AN AWARD. HOWEVER, THEY ARE AN INTEGRAL PART OF THE INFORMATION SYSTEM AND ASSIST IN PROCESSING THE PROPOSAL. SSN SOLICITED UNDER NSF ACT OF 1950, AS AMENDED.

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) - continued from page 1
(Indicate the most specific unit known, i.e. program, division, etc.)

ANT - ANTARCTIC AERONOMY & ASTROPHYS

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/if not in response to a program announcement/solicitation enter NSF 07-140 PD 06-1643 09/26/07	FOR NSF USE ONLY
FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.) PHY - PARTICLE ASTROPHYSICS, (continued)	NSF PROPOSAL NUMBER 0757863

DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION
09/25/2007	2	03010000 PHY	1643	076248616	10/01/2007 8:21pm

EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)	SHOW PREVIOUS AWARD NO. IF THIS IS	IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY?
480680117	☐ A RENEWAL ☐ AN ACCOMPLISHMENT-BASED RENEWAL	YES ☐ NO ☒ IF YES, LIST ACRONYM(S)

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE
University of Kansas Center for Research Inc

ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE
University of Kansas Center for Research Inc
2385 IRVING HILL RD
LAWRENCE, KS. 660457563

AWARDEE ORGANIZATION CODE (IF KNOWN)
0019489001

NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE

ADDRESS OF PERFORMING ORGANIZATION, IF DIFFERENT, INCLUDING 9 DIGIT ZIP CODE

PERFORMING ORGANIZATION CODE (IF KNOWN)

IS AWARDEE ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions)
☐ SMALL BUSINESS ☐ MINORITY BUSINESS
☐ FOR-PROFIT ORGANIZATION ☐ WOMAN-OWNED BUSINESS
☐ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT **Collaborative Research: IceRay-36**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ 149,210	36 months	03/01/08	

CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW

- ☐ BEGINNING INVESTIGATOR (GPG I.G.2)
- ☐ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C)
- ☐ PROPRIETARY & PRIVILEGED INFORMATION (GPG I.D, II.C.1.d)
- ☐ HISTORIC PLACES (GPG II.C.2.j)
- ☐ SMALL GRANT FOR EXPLOR. RESEARCH (SGER) (GPG II.D.1)
- ☐ VERTEBRATE ANIMALS (GPG II.D.5) IACUC App. Date ________ PHS Animal Welfare Assurance Number ________
- ☐ HUMAN SUBJECTS (GPG II.D.6) Human Subjects Assurance Number ________ Exemption Subsection ________ or IRB App. Date ________
- ☐ INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j) ________
- ☐ HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.G.1)

PI/PD DEPARTMENT
Physics

PI/PD POSTAL ADDRESS
University of Kansas Physics Dept
1082 Malott Hall
Lawrence, KS 660452151
United States

PI/PD FAX NUMBER
785-864-5262

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address
PI/PD NAME David Z Besson	PhD	1986	785-864-4741	dbesson@ku.edu
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				

Electronic Signature

CERTIFICATION PAGE

Certification for Authorized Organizational Representative or Individual Applicant:

By signing and submitting this proposal, the Authorized Organizational Representative or Individual Applicant is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding debarment and suspension, drug-free workplace, and lobbying activities (see below), nondiscrimination, and flood hazard insurance (when applicable) as set forth in the NSF Proposal & Award Policies & Procedures Guide, Part I: the Grant Proposal Guide (GPG) (NSF 07-140). Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U. S. Code, Title 18, Section 1001).

Conflict of Interest Certification

In addition, if the applicant institution employs more than fifty persons, by electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative of the applicant institution is certifying that the institution has implemented a written and enforced conflict of interest policy that is consistent with the provisions of the NSF Proposal & Award Policies & Procedures Guide, Part II, Award & Administration Guide (AAG) Chapter IV.A; that to the best of his/her knowledge, all financial disclosures required by that conflict of interest policy have been made; and that all identified conflicts of interest will have been satisfactorily managed, reduced or eliminated prior to the institution's expenditure of any funds under the award, in accordance with the institution's conflict of interest policy. Conflicts which cannot be satisfactorily managed, reduced or eliminated must be disclosed to NSF.

Drug Free Work Place Certification

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Drug Free Work Place Certification contained in Exhibit II-3 of the Grant Proposal Guide.

Debarment and Suspension Certification

(If answer "yes", please provide explanation.)

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency? Yes ☐ No ☒

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Debarment and Suspension Certification contained in Exhibit II-4 of the Grant Proposal Guide.

Certification Regarding Lobbying

The following certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding $100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding $150,000.

Certification for Contracts, Grants, Loans and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, ''Disclosure of Lobbying Activities,'' in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

Certification Regarding Nondiscrimination

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative is providing the Certification Regarding Nondiscrimination contained in Exhibit II-6 of the Grant Proposal Guide.

Certification Regarding Flood Hazard Insurance

Two sections of the National Flood Insurance Act of 1968 (42 USC §4012a and §4106) bar Federal agencies from giving financial assistance for acquisition or construction purposes in any area identified by the Federal Emergency Management Agency (FEMA) as having special flood hazards unless the:

(1) community in which that area is located participates in the national flood insurance program; and
(2) building (and any related equipment) is covered by adequate flood insurance.

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant located in FEMA-designated special flood hazard areas is certifying that adequate flood insurance has been or will be obtained in the following situations:

(1) for NSF grants for the construction of a building or facility, regardless of the dollar amount of the grant; and
(2) for other NSF Grants when more than $25,000 has been budgeted in the proposal for repair, alteration or improvement (construction) of a building or facility.

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	SIGNATURE	DATE
NAME **Barbara J Armbrister**	**Electronic Signature**	**Sep 25 2007 3:16PM**

TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS	FAX NUMBER
785-864-3441	**barmbris@ku.edu**	**785-864-5025**

*SUBMISSION OF SOCIAL SECURITY NUMBERS IS VOLUNTARY AND WILL NOT AFFECT THE ORGANIZATION'S ELIGIBILITY FOR AN AWARD. HOWEVER, THEY ARE AN INTEGRAL PART OF THE INFORMATION SYSTEM AND ASSIST IN PROCESSING THE PROPOSAL. SSN SOLICITED UNDER NSF ACT OF 1950, AS AMENDED.

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) - continued from page 1
(Indicate the most specific unit known, i.e. program, division, etc.)

ANT - ANTARCTIC AERONOMY & ASTROPHYS

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/if not in response to a program announcement/solicitation enter NSF 07-140

PD 06-1643 09/26/07

FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)

PHY - PARTICLE ASTROPHYSICS, (continued)

FOR NSF USE ONLY

NSF PROPOSAL NUMBER

0800351

DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION
10/01/2007	2	03010000 PHY	1643	161202122	10/01/2007 8:22pm

EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)

396006492

SHOW PREVIOUS AWARD NO. IF THIS IS
☐ A RENEWAL
☐ AN ACCOMPLISHMENT-BASED RENEWAL

IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES ☐ NO ☒ IF YES, LIST ACRONYM(S)

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE

University of Wisconsin-Madison

AWARDEE ORGANIZATION CODE (IF KNOWN)

0038950000

ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE

University of Wisconsin-Madison
21 North Park Street
MADISON, WI. 537151218

NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE

PERFORMING ORGANIZATION CODE (IF KNOWN)

ADDRESS OF PERFORMING ORGANIZATION, IF DIFFERENT, INCLUDING 9 DIGIT ZIP CODE

IS AWARDEE ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions)
☐ SMALL BUSINESS ☐ MINORITY BUSINESS
☐ FOR-PROFIT ORGANIZATION ☐ WOMAN-OWNED BUSINESS

☐ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT **Collaborative Research: IceRay-36**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ 396,741	36 months	03/01/08	

CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW

☐ BEGINNING INVESTIGATOR (GPG I.G.2)
☐ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C)
☐ PROPRIETARY & PRIVILEGED INFORMATION (GPG I.D, II.C.1.d)
☐ HISTORIC PLACES (GPG II.C.2.j)
☐ SMALL GRANT FOR EXPLOR. RESEARCH (SGER) (GPG II.D.1)
☐ VERTEBRATE ANIMALS (GPG II.D.5) IACUC App. Date ________
PHS Animal Welfare Assurance Number ________
☐ HUMAN SUBJECTS (GPG II.D.6) Human Subjects Assurance Number ________
Exemption Subsection ______ or IRB App. Date ________
☐ INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j)
____
☐ HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.G.1)

PI/PD DEPARTMENT

IceCube

PI/PD FAX NUMBER

608-262-2309

PI/PD POSTAL ADDRESS

222 W Washington Ave #500

Madison, WI 53703
United States

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address
PI/PD NAME Albrecht Karle	PhD	1994	608-262-3945	karle@icecube.wisc.edu
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				

Electronic Signature

CERTIFICATION PAGE

Certification for Authorized Organizational Representative or Individual Applicant:

By signing and submitting this proposal, the Authorized Organizational Representative or Individual Applicant is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding debarment and suspension, drug-free workplace, and lobbying activities (see below), nondiscrimination, and flood hazard insurance (when applicable) as set forth in the NSF Proposal & Award Policies & Procedures Guide, Part I: the Grant Proposal Guide (GPG) (NSF 07-140). Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U. S. Code, Title 18, Section 1001).

Conflict of Interest Certification

In addition, if the applicant institution employs more than fifty persons, by electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative of the applicant institution is certifying that the institution has implemented a written and enforced conflict of interest policy that is consistent with the provisions of the NSF Proposal & Award Policies & Procedures Guide, Part II, Award & Administration Guide (AAG) Chapter IV.A; that to the best of his/her knowledge, all financial disclosures required by that conflict of interest policy have been made; and that all identified conflicts of interest will have been satisfactorily managed, reduced or eliminated prior to the institution's expenditure of any funds under the award, in accordance with the institution's conflict of interest policy. Conflicts which cannot be satisfactorily managed, reduced or eliminated must be dislosed to NSF.

Drug Free Work Place Certification

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Drug Free Work Place Certification contained in Exhibit II-3 of the Grant Proposal Guide.

Debarment and Suspension Certification

(If answer "yes", please provide explanation.)

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency? Yes ☐ No ☒

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Debarment and Suspension Certification contained in Exhibit II-4 of the Grant Proposal Guide.

Certification Regarding Lobbying

The following certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding $100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding $150,000.

Certification for Contracts, Grants, Loans and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, ''Disclosure of Lobbying Activities,'' in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

Certification Regarding Nondiscrimination

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative is providing the Certification Regarding Nondiscrimination contained in Exhibit II-6 of the Grant Proposal Guide.

Certification Regarding Flood Hazard Insurance

Two sections of the National Flood Insurance Act of 1968 (42 USC §4012a and §4106) bar Federal agencies from giving financial assistance for acquisition or construction purposes in any area identified by the Federal Emergency Management Agency (FEMA) as having special flood hazards unless the:

(1) community in which that area is located participates in the national flood insurance program; and
(2) building (and any related equipment) is covered by adequate flood insurance.

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant located in FEMA-designated special flood hazard areas is certifying that adequate flood insurance has been or will be obtained in the following situations:

(1) for NSF grants for the construction of a building or facility, regardless of the dollar amount of the grant; and
(2) for other NSF Grants when more than $25,000 has been budgeted in the proposal for repair, alteration or improvement (construction) of a building or facility.

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	SIGNATURE	DATE
NAME **Petra Schroeder**	**Electronic Signature**	**Oct 1 2007 1:49PM**

TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS	FAX NUMBER
608-265-4868	**pschroeder@bascom.wisc.edu**	**608-262-5134**

*SUBMISSION OF SOCIAL SECURITY NUMBERS IS VOLUNTARY AND WILL NOT AFFECT THE ORGANIZATION'S ELIGIBILITY FOR AN AWARD. HOWEVER, THEY ARE AN INTEGRAL PART OF THE INFORMATION SYSTEM AND ASSIST IN PROCESSING THE PROPOSAL. SSN SOLICITED UNDER NSF ACT OF 1950, AS AMENDED.

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) - continued from page 1
(Indicate the most specific unit known, i.e. program, division, etc.)

ANT - ANTARCTIC AERONOMY & ASTROPHYS

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/if not in response to a program announcement/solicitation enter NSF 07-140 **NSF 07-140** **09/26/07**	FOR NSF USE ONLY NSF PROPOSAL NUMBER **0800512**
FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.) **PHY - PARTICLE ASTROPHYSICS, (continued)**	

DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION
10/01/2007	2	03010000 PHY	1643	003403953	10/01/2007 8:22pm

EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)	SHOW PREVIOUS AWARD NO. IF THIS IS	IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY?
246000376	☐ A RENEWAL ☐ AN ACCOMPLISHMENT-BASED RENEWAL	YES ☐ NO ☒ IF YES, LIST ACRONYM(S)

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE **Pennsylvania State Univ University Park**	ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE **Pennsylvania State Univ University Park** **110 Technology Center Building** **UNIVERSITY PARK, PA. 168027000**
AWARDEE ORGANIZATION CODE (IF KNOWN) **0033290000**	
NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE	ADDRESS OF PERFORMING ORGANIZATION, IF DIFFERENT, INCLUDING 9 DIGIT ZIP CODE
PERFORMING ORGANIZATION CODE (IF KNOWN)	

IS AWARDEE ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions)
☐ SMALL BUSINESS ☐ MINORITY BUSINESS
☐ FOR-PROFIT ORGANIZATION ☐ WOMAN-OWNED BUSINESS
☐ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT **COLLABORATIVE RESEARCH: IceRay-36**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ 43,896	36 months	03/01/08	

CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW

☐ BEGINNING INVESTIGATOR (GPG I.G.2)
☐ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C)
☐ PROPRIETARY & PRIVILEGED INFORMATION (GPG I.D, II.C.1.d)
☐ HISTORIC PLACES (GPG II.C.2.j)
☐ SMALL GRANT FOR EXPLOR. RESEARCH (SGER) (GPG II.D.1)
☐ VERTEBRATE ANIMALS (GPG II.D.5) IACUC App. Date ________
PHS Animal Welfare Assurance Number ________
☐ HUMAN SUBJECTS (GPG II.D.6) Human Subjects Assurance Number ________
Exemption Subsection ________ or IRB App. Date ________
☐ INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j)
____
☐ HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.G.1)

PI/PD DEPARTMENT **Department of Physics**	PI/PD POSTAL ADDRESS **104 Davey Laboratory** **University Park, PA 16802** **United States**
PI/PD FAX NUMBER **814-863-3297**	

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address
PI/PD NAME **Douglas F Cowen**	PhD	1990	814-863-5943	cowen@phys.psu.edu
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				

Electronic Signature

CERTIFICATION PAGE

Certification for Authorized Organizational Representative or Individual Applicant:

By signing and submitting this proposal, the Authorized Organizational Representative or Individual Applicant is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding debarment and suspension, drug-free workplace, and lobbying activities (see below), nondiscrimination, and flood hazard insurance (when applicable) as set forth in the NSF Proposal & Award Policies & Procedures Guide, Part I: the Grant Proposal Guide (GPG) (NSF 07-140). Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U. S. Code, Title 18, Section 1001).

Conflict of Interest Certification

In addition, if the applicant institution employs more than fifty persons, by electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative of the applicant institution is certifying that the institution has implemented a written and enforced conflict of interest policy that is consistent with the provisions of the NSF Proposal & Award Policies & Procedures Guide, Part II, Award & Administration Guide (AAG) Chapter IV.A; that to the best of his/her knowledge, all financial disclosures required by that conflict of interest policy have been made; and that all identified conflicts of interest will have been satisfactorily managed, reduced or eliminated prior to the institution's expenditure of any funds under the award, in accordance with the institution's conflict of interest policy. Conflicts which cannot be satisfactorily managed, reduced or eliminated must be dislosed to NSF.

Drug Free Work Place Certification

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Drug Free Work Place Certification contained in Exhibit II-3 of the Grant Proposal Guide.

Debarment and Suspension Certification

(If answer "yes", please provide explanation.)

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency? Yes ☐ No ☒

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Debarment and Suspension Certification contained in Exhibit II-4 of the Grant Proposal Guide.

Certification Regarding Lobbying

The following certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding $100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding $150,000.

Certification for Contracts, Grants, Loans and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, ''Disclosure of Lobbying Activities,'' in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

Certification Regarding Nondiscrimination

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative is providing the Certification Regarding Nondiscrimination contained in Exhibit II-6 of the Grant Proposal Guide.

Certification Regarding Flood Hazard Insurance

Two sections of the National Flood Insurance Act of 1968 (42 USC §4012a and §4106) bar Federal agencies from giving financial assistance for acquisition or construction purposes in any area identified by the Federal Emergency Management Agency (FEMA) as having special flood hazards unless the:

(1) community in which that area is located participates in the national flood insurance program; and
(2) building (and any related equipment) is covered by adequate flood insurance.

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant located in FEMA-designated special flood hazard areas is certifying that adequate flood insurance has been or will be obtained in the following situations:

(1) for NSF grants for the construction of a building or facility, regardless of the dollar amount of the grant; and
(2) for other NSF Grants when more than $25,000 has been budgeted in the proposal for repair, alteration or improvement (construction) of a building or facility.

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	SIGNATURE	DATE
NAME **Allyn Ditmer**	**Electronic Signature**	**Oct 1 2007 3:10PM**

TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS	FAX NUMBER
814-863-0301	**iod1@psu.edu**	**814-865-3634**

*SUBMISSION OF SOCIAL SECURITY NUMBERS IS VOLUNTARY AND WILL NOT AFFECT THE ORGANIZATION'S ELIGIBILITY FOR AN AWARD. HOWEVER, THEY ARE AN INTEGRAL PART OF THE INFORMATION SYSTEM AND ASSIST IN PROCESSING THE PROPOSAL. SSN SOLICITED UNDER NSF ACT OF 1950, AS AMENDED.

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) - continued from page 1
(Indicate the most specific unit known, i.e. program, division, etc.)

ANT - ANTARCTIC AERONOMY & ASTROPHYS

PROJECT SUMMARY

IceRay proposes to study the feasibility of constructing a 50 km2 GZK neutrino detector array working in concert with the IceCube detector at the South Pole. This detector will enhance the ultra high energy capabilities of IceCube and could serve as a prototype for larger arrays of 300 to 1000 km2 detecting up to 100 GZK neutrinos per year. We expect this small scale extension to detect 4-8 GZK neutrinos per year and to allow cross calibration on a subset of neutrino events detected by both optical and radio methods.

We propose in the next three years to study Shallow-ice (20-200 meters) detection schemes and check the South Pole suitability for large scale RF detectors. This will be achieved by deploying 4 sub surface stations and a surface listening station.

The proposed 50 km2 detector will consist of 18 to 36 stations. The depth and spacing between stations will be set to maximize GZK sensitivity while minimizing the cost: For example, deeper detectors sample a greater volume of ice, but require a more expensive and time consuming drilling of deeper bore hole.

The detectors are sensitive to the radio Cherenkov signal emitted when very-high-energy neutrinos interact and shower in the ice. Since cold Antarctic ice has an attenuation length greater than 1 km for radio emissions in the 60-to-1000-GHz range, it is possible to detect neutrino signals that are kilometers away, and cover large volumes with large spacing between detectors.

Events detected by both the IceCube and IceRay detectors would comprise a small but extremely useful part of the final IceCube neutrino event sample, because they would provide complete calorimetric energy measurement of the entire neutrino event, including both the primary vertex with radio measurements, and the secondary lepton via the optical array.

This proposal asks for support for 3 years:
In the first season at Pole (FY-09), we propose to install a surface listening post, to determine the strength and duration of radio emissions in the 60-to-1000-MHz region. This surface listening post also would provide continuous monitoring of the EMI environment at South Pole, providing not only frequency usage but also amplitude and duration measurements in a continuously logged fashion. Also in FY-09, plans call for installing two subsurface stations at ice depths between 50 and 80 meters or possibly deeper, if firn-drill techniques allow. These activities would serve as a prototyping of the full IceRay array, giving experience with drilling holes needed for detector installation.
In the second year (FY-10), we propose installing two more subsurface stations at ice depths of 50 to 100 meters or deeper. Also in FY-10, plans call for work to start in a modest fashion on design of the full IceRay array, when the depth-of-detectors question is resolved. This would be the subject of a proposal submitted to continue the project to its planned size.
In the third season (FY-11), IceCube work should be ramping down, so that a seamless transition from IceCube to IceRay installation might be achieved.

Finally, the opportunity to explore new techniques in scientific investigations, such as radio detection of neutrinos, provides a wonderful platform to reach out to students, educators and the general public. The universities involved in this proposed effort all have strong E & O programs in place. For instance, both the Universities of Hawaii and Maryland are involved in QuarkNet. Hawaii’s program is actively involved in developing cosmic-ray detectors for classroom use.

TABLE OF CONTENTS

For font size and page formatting specifications, see GPG section II.C.

*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.

TABLE OF CONTENTS

For font size and page formatting specifications, see GPG section II.C.

Appendix Items:

*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.

TABLE OF CONTENTS

For font size and page formatting specifications, see GPG section II.C.

Appendix Items:

*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.

TABLE OF CONTENTS

For font size and page formatting specifications, see GPG section II.C.

Appendix Items:

*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.

TABLE OF CONTENTS

For font size and page formatting specifications, see GPG section II.C.

*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.

TABLE OF CONTENTS

For font size and page formatting specifications, see GPG section II.C.

Appendix Items:

*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.

TABLE OF CONTENTS

For font size and page formatting specifications, see GPG section II.C.

*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.

TABLE OF CONTENTS

For font size and page formatting specifications, see GPG section II.C.

Appendix Items:

*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.

An IceCube-centered Radio-Cherenkov Ultra-high Energy Cosmogenic Neutrino Detector

R. Morse, P. Allison, M. DuVernois, P. Gorham, J. Learned, & G. Varner, *Dept. of Physics and Astronomy, Univ. of Hawaii, Manoa, HI 96822*; D. Besson, *Dept. of Physics, University of Kansas, Lawrence, KS 66045*; A. Karle, F. Halzen, & H. Landsman, *Dept. of Physics, University of Wisconsin, Madison, WI 53703*; J. Beatty, *Dept. of Physics, The Ohio State University, Columbus, OH 43210*; K. Hoffman, *Dept. of Physics, Univ. of Maryland, College Park, MD 20742*; D. Seckel, *Dept. of Physics and Astronomy, Univ. of Delaware, Newark, DE 19716*; D. Cowen, & D. Williams, *Dept. of Physics, Penn State Univ., University Park, PA 16802*; I. Kravchenko, *LNS, Massachusetts Institute of Technology, Cambridge, MA 02139*; P. Chen, *Dept. of Physics, National Taiwan Univ., Taipei 106, Taiwan.*; R. Nichol & A. Connolly, *Dept. Physics & Astronomy,Univ. College London, LONDON WC1E 6BT*.

I. SUMMARY OF SCIENCE GOALS

We propose here to begin phased development of a low-cost, high-value radio-Cherenkov augmentation to the IceCube detector which will seek the following scientific goals:

1. Extend IceCube energy sensitivity to ExaVolt energies, to yield substantial rates of cosmogenic neutrinos–the so-called "guaranteed" neutrinos.

2. Determine source directions for each neutrino to degree-scale precision, thus identifying directly the sources of the highest energy cosmic rays, which produce the cosmogenic ultra-high energy neutrinos.

3. Co-detect hybrid events with the main IceCube detector, yielding both primary vertex energy via radio-Cherenkov and secondary lepton energy via optical Cherenkov, for complete event calorimetry on a subset of the total neutrino events.

Our proposed system has the potential to significantly enhance the scientific reach of IceCube with regard to total ultra-high energy neutrino event calorimetry, an important and compelling scientific challenge. As we will argue here, a wide-scale radio-Cherenkov [1] detector is a natural and highly complementary addition to IceCube. Recent improvements in the understanding of the radio Cherenkov method [2–5], and its advancing technological maturity have greatly reduced both the risk of such systems and their costs. The time to consider such an augmentation is upon us: once IceCube construction nears completion and the infrastructure and human resources begin to dissipate, the costs for such a system will rise immeasurably.

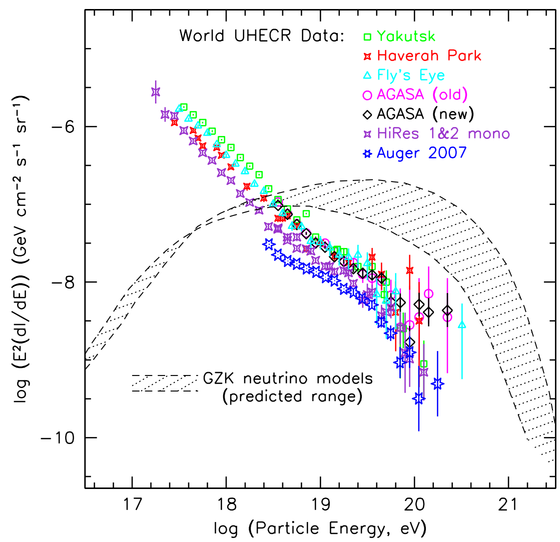

FIG. 1: *World ultra-high energy cosmic ray and predicted cosmogenic neutrino spectrum as of early 2007, including data from the Yakutsk [11], Haverah Park [12] the Fly's Eye [16], AGASA [13], HiRes [14], and Auger [15], collaborations. Data points represent differential flux $dI(E)/dE$, multiplied by E^2. Error bars are statistical only. GZK neutrino models are from Protheroe & Johnson [18] and Kalashev et al. [19].*

II. SCIENTIFIC MOTIVATION

The typical charged-current neutrino-nucleon deep-inelastic scattering event that leads to a detectable secondary muon (or potentially a tau lepton for tau neutrino primaries) in IceCube is $\nu + N \rightarrow \ell^{\pm} + X$ where the lepton $\ell^{\pm}$ may then propagate for 20-30 km or more before it is detected in the optical Cherenkov array [22]. This potentially long propagation distance leads to an unknown amount of lost energy, and the measurement of lepton energy in an array such as IceCube can thus only provide a lower limit on the energy of the original neutrino. The kinematics of the event is such that the lepton typically carries 75-80% of the primary neutrino energy, with the remainder dumped into a local hadronic cascade initiated by the hadronic debris X above. This cascade, while initiated by hadrons, rapidly develops into a characteristic $e^+e^-\gamma$ shower in ice. As has now been shown in a series of recent experiments at SLAC [10], such cascades produce a charge asymmetry as postulated by Askaryan in the early 1960's, and the net negative charge produces strong coherent Cherenkov radio emission, detectable at great distances in a radio-transparent medium such as Antarctic ice. Thus a suitably stationed array of antennas in a configuration surrounding IceCube on the scale of several km to several tens of km will observe the Cherenkov emission from the primary vertex of the same events that may produce detectable leptons in IceCube. Such a radio array is insensitive to the secondary lepton, but even a relatively coarse array with km-scale spacing between small-number antenna clusters, can coherently detect the strong radio impulses from the cascade vertex. The two methods are thus truly complementary in their physics reach.

One may ask why such a methodology was not adopted early in the design for IceCube. The answer is that the energy of the events that are detectable by a wide-scale radio array is well above the initial design scale for IceCube, intended to go to PeV scales but initially not above this scale. However, since construction of IceCube began, much work has been done on understanding the high-energy reach of the array beyond the original design scale, and it is now evident that IceCube does have significant reach [17] into the range where there is useful overlap between the techniques. In addition, work on understanding the properties of the Askaryan effect and the radiation it produces has proceeded steadily, and we are now in a position to make confident predictions regarding the sensitivity of radio arrays.

This has been facilitated to a large degree by renewed interest in a particular set of neutrino models sometimes called the "guaranteed neutrinos"– those that arise from the interactions of the highest energy cosmic rays with the microwave background radiation throughout the universe [8, 9]. Such cosmogenic neutrinos, as they are also known, are required by all standard model physics that we know of, and their fluxes are tied closely to the parent fluxes of the ultra-high energy cosmic rays which engender them.

Our design approach has been to require that any radio array that would provide hybrid detection with IceCube must be able to detect such neutrinos with confidence in a single year of operation, even at their lowest plausible fluxes. In addition, we expect that the economy of scale for radio technology, which has been greatly enhanced within the last two decades by the explosion in wireless, microwave, and satellite television device development, will lead to an array that is highly affordable on the scale of a small fraction of the costs for IceCube, operating within the scope of an enhancement to the original array. To this end, our choices for the arrays studied have strongly leaned toward giving up spatial and angular resolution in favor of high sensitivity, to maximize the probabolity for both overall UHE cosmogenic neutrino detection, and hybrid radio/IceCube detections, at minimum cost.

The Highest Energy Neutrinos. A proper evaluation of our approach requires an understanding of the distinct nature of the cosmogenic neutrino flux which provides the basis for our design. Figure 1 shows the ultra-high energy cosmic ray flux as of 2007, with a shaded band indicating the cosmogenic neutrino flux range that results from the interactions of these cosmic rays in intergalactic space. While current uncertainty in the observations of the Greisen-Zatsepin-Kuzmin (GZK) [6, 7] cutoff continue to allow for a relatively wide range of cosmogenic neutrino fluxes, the ongoing measurements of the UHECR fluxes by the Auger Observatory [15], as well as experiments such as ANITA [35], will soon lead to much better constraints on these "guaranteed" neutrino models. Thus we expect a significant narrowing of the allowed range of fluxes in the next several years.

It is important to note that UHE cosmogenic neutrinos peak at energies of order 10^{18} eV, well above the canonical range of IceCube, and in fact even well above the ~ 10 PeV threshold at which radio detection for an embedded or surface ice array becomes practical. Thus, as we will discuss more below, it is possible to design arrays that are much coarser-grained than would be required at the threshold energy for the technique, and to make use of far fewer detectors overall in reaching a given level of sensitivity for the cosmogenic neutrino fluxes. This has important implications for the economics of our studied detectors.

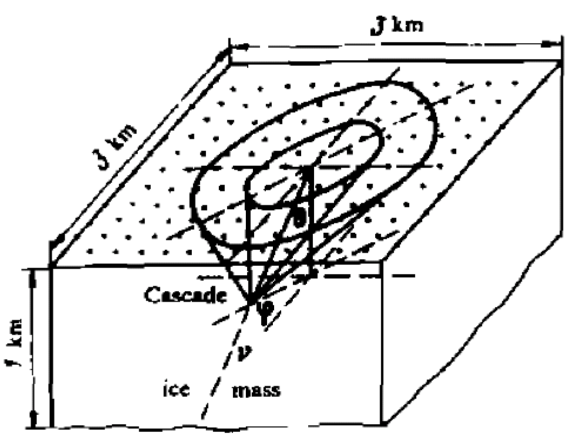

FIG. 2: Original figure from reference [24] in which a surface radio antenna array is used to detect high energy neutrino cascades.

Radio Detection History. It is surprising to find that proposals for multi-cubic-km radio Cherenkov detectors in ice are concurrent or perhaps even predate the earliest suggestions that an optical Cherenkov array in ice could engender neutrino astronomy, but that is in fact the case. In the early 1980's, several Russian investigators began to revisit Askaryan's suggestions [1] regarding coherent radio detection of high energy particles in dense media such as ice, and in 1984, Gusev and Zheleznykh described an array that utilized this methodology.

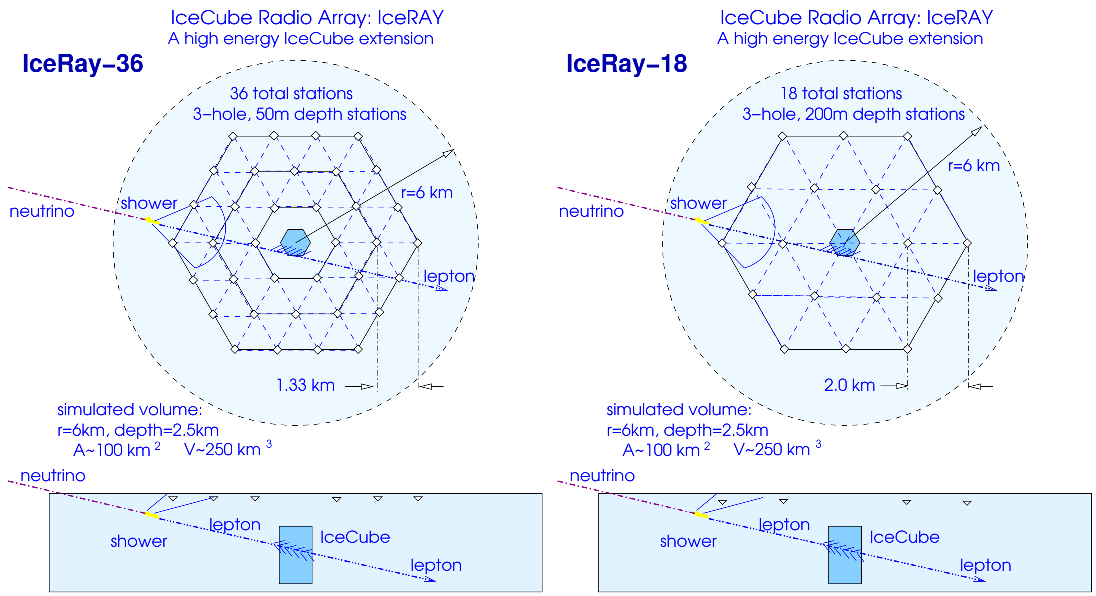

FIG. 3: Left: Baseline 36 station, 50-m depth array, in a plan view (top) and side view (bottom) showing the simulated interaction region around the detector. Right: Alternative 200 m depth, 18 station array.

Figure 2 shows the original figure from the paper by Gusev and Zheleznykh [24] in which a surface radio array with a ~ 10 km^2 footprint is proposed to detect of order 10 PeV neutrinos via antennas with grid spacing of several hundred m.

In the later 1980's and early 1990's further investigations were done on the feasibility of the technique, and a landmark paper was published in 1992 in which E. Zas, F. Halzen, and T. Stanev [26] first presented detailed shower simulations which included electrodynamics in a compelling and comprehensive way. This paper gave high credibility to Askaryan's predictions and made the first quantitative parameterization of the radio emission, both in its frequency dependence, and angular spectrum.

Since those results in the early 1990's, the field has grown steadily with the recognition that the relatively high neutrino energy threshold, 10 PeV or more in a reasonably scaled embedded detector in ice, and even higher for other geometries, is well-matched to a number of emerging models for high energy neutrino sources and production mechanisms such as the GZK process. Notable efforts are the RICE [28] array, which continues to pilot the study of embedded detector arrays with a small grid of submerged antennas above the AMANDA detector, the GLUE [29] and FORTE [23] experiments, which set the first limits at extremely high energies above 10^{20} eV, and more recently, the ANITA balloon payload [35], which completed a prototype flight in 2004 [31], and its first full-payload flight in early 2007.

III. ICERAY PROJECT OVERVIEW

We propose to perform a detailed design study, including development and deployment of prototype hardware, that will enable the construction GZK neutrino detector array covering a physical area of ~ 50 km^2 (Fig.3), working in concert with the IceCube detector at the South Pole. The full IceRay will be a discovery-class instrument designed to detect at least 4-8 GZK neutrinos per year based on current conservative models, and would serve as the core for expanding to larger precision-measurement arrays of 300 to 1000 km^2, capable of detecting at least 30-100 GZK neutrinos per year. The present challenge is to determine the number of individual detectors, their spacing and the depth at which these detectors should be buried in the Antarctic Ice. This depth question is paramount, since deeper detectors sample a greater volume of ice, and thus reduce the number of detectors needed to achieve a desired GZK sensitivity. But deeper detectors also require the drilling of deeper boreholes, which can be expensive and time-consuming. The quest is thus to find the optimum detector spacing-depth ratio that maximizes GZK sensitivity while minimizing the cost

Initial IceRay prototype stations will focus on a wide-scale, shallow detector scheme designed to investigate the radio detection properties from the ice surface down to about 50-80 meter depths, or possibly greater using the much cheaper firn-drill techniques, and to establish background levels several km out from the central part of the South Pole station. This will complement investigations using the IceCube boreholes as part of low-level ongoing study-phase efforts, which have already taken place under the acronym Askaryan Underice Radio Array (AURA). The AURA prototype efforts have allowed some of the current team to already begin investigation of deeper ice through deployments of radio detectors as elements of IceCube strings over the last several seasons, and these detectors and further ongoing efforts for AURA now already provide a first-order testbed for studies of a deep-ice detector. Although not a direct part of the activities proposed and costed here, we discuss AURA in some detail in a later section, since it provides an important facet of the investigation into the utility of deep antenna deployments, without requiring separate high-cost deep boreholes. Our investigations to date have strongly indicated that deeper detectors are more effective than shallow detectors, but now this is a quantitative question: what is the cost-benefit for deeper vs. shallower arrays, given that shallow detector deployments are easier and less costly than the deep deployments. Understanding these trade-offs is a fundamental question confronting the array designers.

The Plan. The ice-depth of the detectors and the spacing between them is of paramount importance, and is one of the primary objectives of this study. The detectors are sensitive to the radio Cherenkov signal emitted when these very high energy GZK neutrinos interact and shower in the ice. Since cold Antarctic ice has an attenuations length greater than 1 km for radio emissions in the 60-1000 GHz range, it is possible to detect neutrino signals from interactions that are kilometers away. The basic geometry is initially assumed to be like IceCube, that is, individual detectors are located at the apices of equilateral triangles, which then are formed up into series of expanding hexagons as is shown in Fig. 3.

We request support for three years, or from March 2008 to March 2011. In the first South Pole season (FY-09) we propose to install a surface listening post, IceRay-0, to determine the strength, and duration of radio emission in the 60-1000 MHz region. This surface listening-post also has SCOARA and the NSF interested in how it might be possible to get a continuous monitoring of the EMI situation at South Pole, that is providing not only frequency usage, but amplitude and duration measurements in a continuously logged fashion. Using the combination of ANITA and IceCube technology this installation of the IceRay surface listening-post should be a straight forward installation.

Also in FY-09 we propose installing IceRay-2, or two sub-surface stations at ice depths of between 50-80 meters, or possibly deeper if the firn-drill techniques allow.. These activities would serve as a prototyping of the IceRay-36 array, and give us experience of drilling the holes needed for detector installation. In the second season (FY-10) we would propose installing IceRay-3, or 2 more sub-surface stations of ice depths of 50-100 meters, or deeper if developments in firn-drill technology will allow such extensions.

In the third season (FY-11) our goal is to start work on the full IceRay array, whatever its form—deep or shallow. This would be engendered by a follow-on proposal submitted to continue the project to its planned full-size. In FY-11 the IceCube work should be ramping down so that a seamless transition from IceCube installation to IceRay installation might be achieved.

IceRay's Relationship to IceCube. IceRay's relationship to IceCube will be focused to minimize the cost and manpower levels associated with the proposed IceRay installations. IceRay, working through the Wisconsin group, can be scheduled into the IceCube deployment plan with minimum impact. AURA's prior use of the IceCube boreholes, along with IceRay's proposed use of the firn-drill and the deployment winches are examples of making use of equipment that is already on site because of IceCube's needs. In FY-11, after the successful installation of the IceRay equipment and analysis of the data, we could then, with approval, start the full IceRay installation work. FY-11 is also the season when the IceCube deployment will be ramping down, so the degree of coordination between IceCube and IceRay will be reduced.

Responsibilities and Oversight. It will be the primary responsibility of the IceRay effort not to slow down or in anyway impede the normal progress of the IceCube installation. A planning and oversight group consisting of members from both the IceCube and IceRay collaborations will be formed up to provide the necessary oversight. Of course, it is the primary mission of the IceRay effort to work as efficiently as possibly within the IceCube environment.

It will also be the responsibility of IceRay to propose the most effective and cost-efficient detector design. To guarantee that we are receiving and responding to responsible reviews we plan to form up an external review panel that can provide annual reviews of our designs and our progress. Such a committee would be formed up from the people that are in the radio-Cherenkov detection discipline

IV. ARRAY DESIGN DRIVERS

The field attenuation length for South Polar ice in the upper km is of order 1.3 km [32] at frequencies in the several hundred MHz regime. In finding the maximum spacing at which a Cherenkov array still has good sensitivity without regard for angular resolution, it is reasonable to adopt distances of order the attenuation length in the medium. If the expected signal is large compared to the threshold of the technique, as is the case for the cosmogenic neutrinos, then even larger spacings can be considered, giving up signal strength for physics reach at the expense of some resolution.

In one prior published study of a combined radio and acoustic detector coincident with IceCube[20], the goals were somewhat different, and the approach was to build the array initially as part of IceCube itself, making use of the upper portions of the IceCube boreholes and then extending it out to larger radii. Such an array preserved angular resolution and PeV-scale sensitivity while gradually extending its size up to the scale where it could begin to detect cosmogenic neutrinos. Our approach here is quite different; driven by the desire to combine with IceCube on the detection of the "guaranteed" cosmogenic neutrino fluxes, the radio array is designed only to maximize such detection as early as possible, at the lowest cost, and with the highest cross-section possible for hybrid detection with IceCube.

We note parenthetically that acoustic techniques [20] in South Polar ice may well be found to be competitive and complementary to the radio methods for a wide-scale array. It is too early to decide this question, since measurements of acoustic attenuation length and noise levels are at a rudimentary stage, but such methods tend to view portions the solid angle around a neutrino cascade event that are disfavored by radio emission, and acoustic methods could thus prove to fill in the gaps left by radio, at potentially even lower costs than radio methods. We thus keep open the possibility that a widescale array should remain flexible to additional sensor suites should such methods mature in the interim.

With such design choices defined, and based on the physics of the interactions as outlined above, the layout of the necessary array must extend out radially from IceCube far enough to begin covering a significant fraction of the range where neutrino vertices are located. At high energies, this favors lepton events coming from near the horizon for IceCube, since that is the direction with the largest probability for neutrino interactions within the 20-30 km range of the resulting muons. For purposes of this proposal, we have chosen to adopt spacings of 1 to 2 km, and grid which occupies an initial 4 km radius around IceCube. We have explored a range of cases, and we focus on two representative examples which capture the required sensitivity, and span a reasonable portion of the depth-spacing trade-space.

Figure 3 shows the two example full-scale IceRay arrays studied in the most detail here. On the left is a 36-station, 50 m deep version with 1.33 km spacing; and on the right, an array with 2 km spacing, 200 m depth, with 18 total stations. In each case a "station" is required to be able to produce standalone measurements of an event, including location of the vertex and a rough calibration of detected energy. The use of polarization information is also presumed to allow for first-order single-station measures of the event momentum vector. To this end we assume each station to consist of 12 antennas 6 of each polarization, horizontal and vertical. The antennas are assumed to have low directivity gain, equivalent to a dipole, with a dipole-like beam pattern. Directionality is attained by providing local, several-meter baselines within each station's array, either through a local-grid-positioning of antennas at the surface, or through use of multiple boreholes (of order 3 with 5-10 m spacing) at each submerged station.

Choice of frequency. In choosing a frequency range over which such an array will operate, we begin with the range of frequencies over which ice is transparent: from a practical lower limit of several MHz, where time resolution will already be an issue, and backgrounds potentially prohibitive, to of order 1 GHz, where the attenuation length of ice becomes a problem. Antenna designs will generally limit usable fractional bandwidths to no more than 5:1 for extreme broadband designs, and we therefore assume this as the working bandwidth ratio (5:1 indicates the ratio of the upper frequency to the lower frequency).

An antenna's effective collecting area A_e is related to its directivity gain G (the ratio of 4π to the antenna's main beam solid angle) by the standard equation

$$A_e = \frac{G\, c^2}{4\pi\, f^2} \tag{1}$$

where f is the radio frequency and c is the speed of light. Since the radiation that arrives at the antenna from an Askaryan radio impulse is often described in terms of it peak field strength $\vec{\mathcal{E}}_p$ in V/m, the resulting voltage induced at a matched-load receiver attached to an antenna is given by

$$V_{rcv} = \vec{\mathcal{E}}_p \cdot \vec{h}_e/2$$

where the vector effective height $\vec{h}_e$ has a magnitude given by

$$h_e = 2\sqrt{\frac{ZA_e}{Z_0}} \tag{2}$$

where Z is the antenna impedance, assumed matched to the receiver here and $Z_0 = 377\ \Omega$. The direction of the vector effective height is given by the direction of maximum response to an incident linearly-polarized electric field at a frequency where the antenna is responsive.

Coherent Cherenkov radiation arising from the Askaryan effect has a frequency spectrum for which the incident field strength at the peak of the Cherenkov cone rises linearly with frequency, thus

$$R\mathcal{E}_p \simeq A_0 \frac{E_{shower}}{E_0} f \quad \mathrm{V\ m^{-1}\ MHz^{-1}} \tag{3}$$

where R is the distance to the shower from the observation point, A_0 is a medium-dependent scale factor, E_{shower} is the shower energy, and E_0 a reference energy. This dependence will obtain up to frequencies where loss of coherence due to the size of the shower begins to set in,

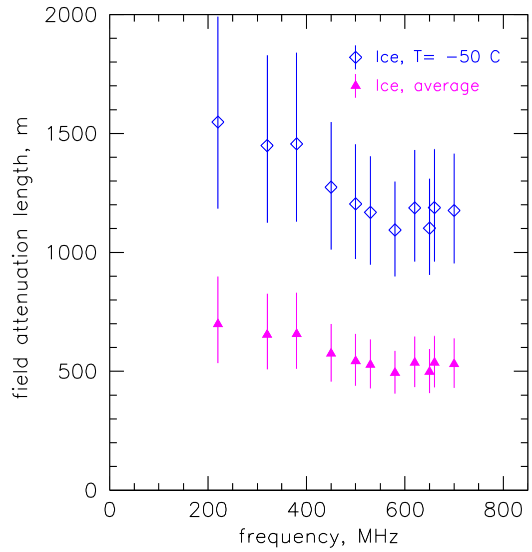

FIG. 4: South pole ice attenuation measurements made in 2004.

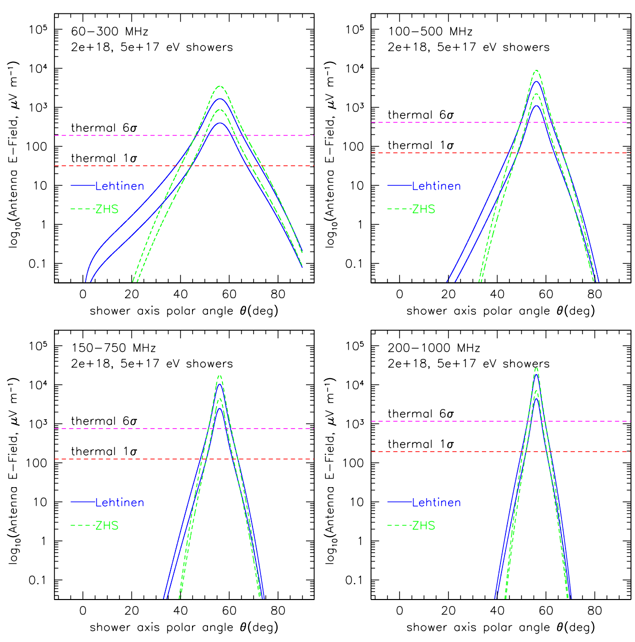

FIG. 5: Angular widths for various frequency ranges and two cascade energies in the heart of the cosmogenic neutrino spectrum. See text for details.

typically near 1 GHz for showers in ice. Thus, solving the equations above, we find the induced signal voltage at the receiver is given by

$$V_{rcv} = cA_0 \left(\frac{E_{shower}}{E_0} \right) \sqrt{\frac{ZG}{Z_0}}\, \Delta f \tag{4}$$

which no longer contains any explicit dependence on *frequency*, though a bandwidth dependence remains in the term Δf. If there is also no implicit dependence of the gain G on frequency, which is often the case with many antennas, then the signal is proportional to bandwidth only, independent of the center frequency.

The system noise is also a consideration, and for a receiver which sees a total system noise (from both the antenna and any intrinsic receiver noise or cable noise) $T_{sys} = T_{ant} + TLNA + Tcable + ...$, the RMS induced voltage noise referenced to the input of the receiver is $V_n = \sqrt{kT_{sys}\, Z\, \Delta f}$ where k is Boltzmann's constant, Z the receiver impedance, and Δf the bandwidth. Thus the signal-to-noise ratio (SNR) is

$$SNR = \frac{V_{rcv}}{V_n} = cA_0 \left(\frac{E_{shower}}{E_0} \right) \sqrt{\frac{G\Delta f}{kT_{sys} Z_0}} \tag{5}$$

showing that for Askaryan impulse detection, SNR grows with the square-root of bandwidth, but is independent of the center frequency over which this bandwidth is obtained, as long as the antenna gain is approximately independent of frequency. Since it is generally easier to observe larger total bandwidths around higher center frequencies, this appears to favor a higher center frequency for observations, all else being equal.

However, this is not the whole story. Since a neutrino detector depends not only on threshold energy for detection, but also on the total acceptance for events at that energy, we must also consider the dependence of acceptance on radio frequency. There are two terms that contribute to acceptance, one dependent on observable volume of ice, and another on the effective solid angle over which events can arrive and still produce detectable emission.

Effective volume depends generally on the attenuation length of the surrounding ice. Figure 4 shows recent measurements [32] of ice attenuation at the South Pole, based on bottom reflection data. It is evident that there is some frequency dependent increase in losses over the range 200-700 MHz, of order 25-30%. Since the reduction in volume is to first order cubic in the attenuation length, this implies a loss of as much as a factor of 2 in available volume at the two extremes of frequencies here.

The solid-angle for acceptance for any isotropic source, as the cosmogenic neutrinos are expected to be, scales linearly with the solid angle of emission for the Cherenkov cone. The polar angle θ of emission around the direction of the shower momentum peaks at the Cherenkov angle.

The angular spectrum of radio Cherenkov emission can be approximated with [23]:

$$F(\theta; f) = \sin\theta \; e^{-(2\pi c L/f)^2 (\cos\theta - 1/n)^2/2} \qquad (6)$$

where n is the index of refraction of the medium, and L is a parameter describing the characteristic shower length. The resulting solid angle is

$$\Omega(f) = \int_0^{\pi} F(\theta; f) sin\theta d\theta d\phi \ .$$

Clearly, frequency plays an important role in the total solid angle, entering quadratically in the exponential: However, this integral is not analytic, and analysis of the solid angle as a function of frequency is best done numerically.

To understand the behavior of the solid angle terms, we thus refer to actual simulations of the expected signal, based on semi-analytic parameterizations such as that given in equation 6. Figure 5 shows a comparison of the expected signal at a distance of 1.5 km for ice with characteristics of the South Pole. The parameterizations for the radio emission used are those of Zas, Halzen, and Stanev [26] and that given by Lehtinen et al. [23]. The same fractional bandwidth is used in each case, and the noise is scaled assuming an antenna the same directivity gain, constant with frequency, is used for each band considered. There are two important considerations here: first, the strength of the signal on the peak of the Cherenkov cone, which grows with frequency; and second, the width of the Cherenkov cone at the detection threshold, here given as 6σ above the thermal noise. The former consideration determines the minimum detectable neutrino energy, while the latter determines the total acceptance by the angular width of the cone where it exceeds detection threshold.

Since the cosmogenic ultra-high energy neutrino spectrum peaks above several times 10^{17} eV, we conclude from this comparison that lower frequencies gain more acceptance and still retain adequate signal-to-noise ratios for detection, as compared to higher frequencies. To put it another way, lowering the energy threshold below the peak of the cosmogenic neutrino flux gains no increase in event rate unless one can preserve the solid angle for acceptance; in this case that does not occur, and a lower frequency array is preferable.

Refraction effects. The density of Antarctic deep ice is relatively constant at about 0.9 gm cm^{-3}, but near the surface the density rapidly decreases, eventually terminating in the density of the hard-packed snow surface that is common to most of the ice sheet. This has a similar effect on the radio index of refraction and is thus important for relatively shallow embedded arrays such as we consider here. Figure 6 shows this behavior in the index of refraction, which is dependent primarily on the density.

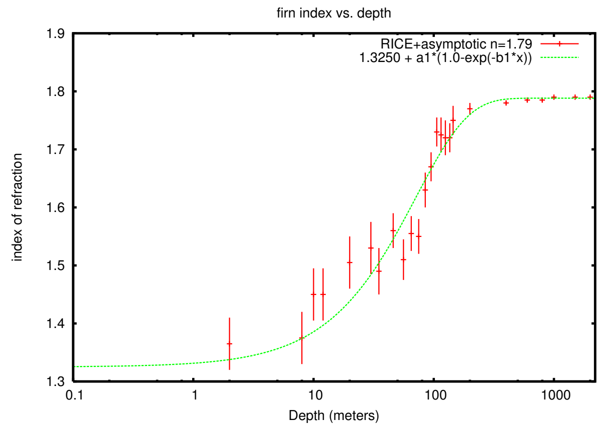

FIG. 6: *Index of refraction in firn at South Pole station, based on data from the RICE experiment [28].*

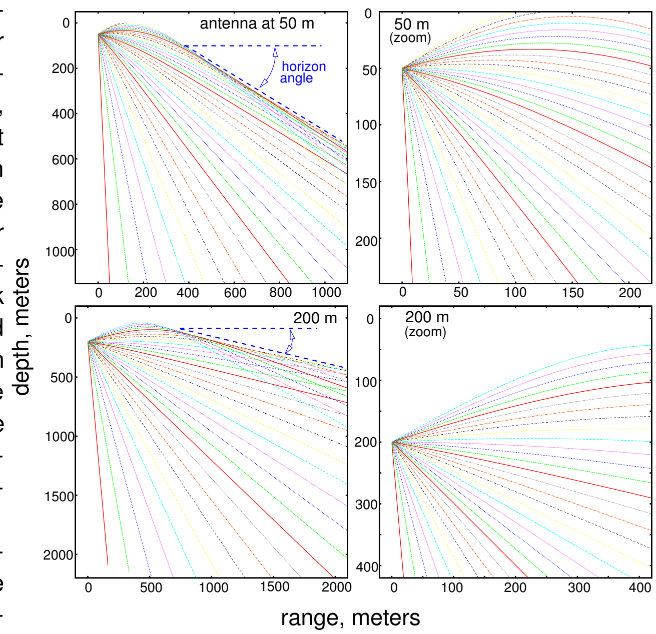

FIG. 7: *Example of refraction effects for shallower antenna locations. Both 50 m (upper) and 200 m (lower) deep antenna locations are shown. On the left are the wide-scale ray geometries, showing the terminal horizon angle in each case, and on the right the details of the ray bending in the near zone are shown.*

This behavior in the index of refraction must be accounted for in any simulation, and we show here some representative results giving the ray-trace behavior near the surface. This is of particular concern for a relatively shallow subsurface array, and Figure 7 shows a series of rays traced from deep source directions to the near-surface, illustrating the tendency for a near-surface array to see an inverted horizon below the ice, precluding detec-

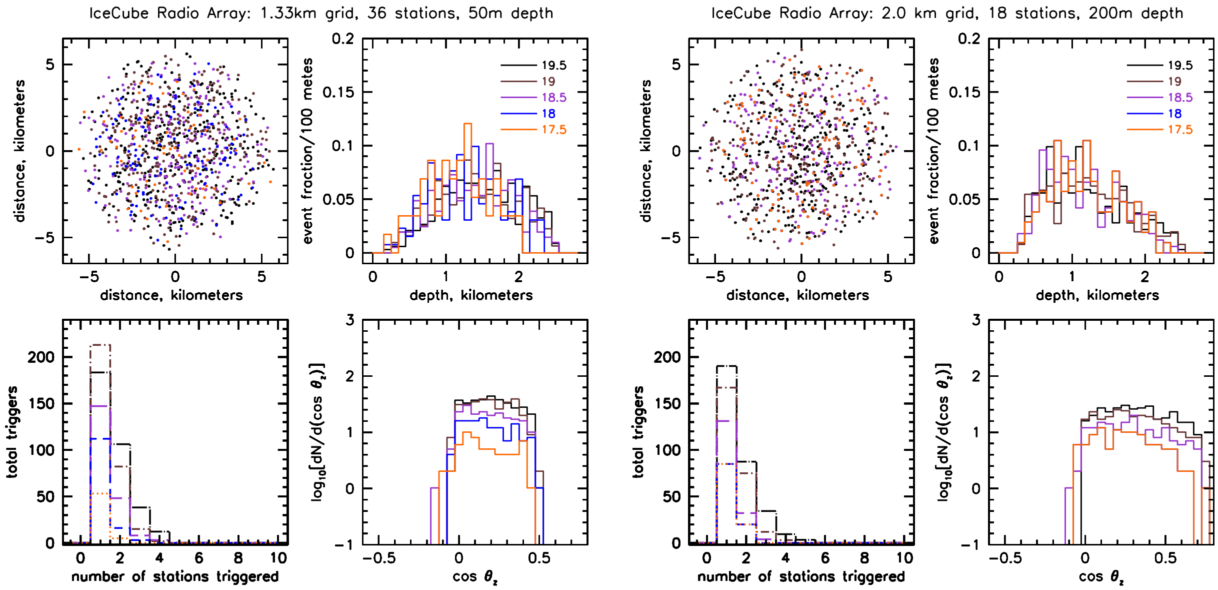

FIG. 8: *Histograms of various distributions from the Monte Carlo results for the two configurations studied. Left: distribtions for the 36 station array at 50 m depth with 1.33 km spacing; clockwise from upper left: a) the vertex locations in plan view (color coded by energy according to the legend in the next pane to the right); b) the depth distributions of events with energy, with shape governed in part by the refractive horizon; c) the angular distribution of detected neutrino interactions, most events from above the physical horizon, but cut off by the underice refraction at low zenith angles; d) the multi-station hit distribution with energy. Right: similar distributions for the 18-station array with 200 m depth and 2 km spacing with effects of the less restrictive underice refraction horizon evident in the shift of the peaks of the depth distribution, and the wider angular acceptance. However, the coarser station spacing yields fewer multi-station hits.*

tion of source above a conical region below the detector. Such concerns limit both the effective volume for a near-surface detector, and the solid angle above the horizon over which events can be seen, and the effect, while significantly less for more deeply submerged antennas, cannot be neglected in either the 50 m or 200 m array depths we studied here.

V. MONTE CARLO RESULTS

We have studied these arrays with three completely independent Monte Carlo codes (MCCs), and find good agreement with all of them. In addition, the Univ. of Delaware has done MCC studies of some of the specifics of the underice detection, and has independently validated several important aspects of the investigations. The most detailed studies to date were done with the UH Monte Carlo (developed for ANITA and SalSA) from which most of the plots here are derived, but IceRay-36 and -18 studies have also been done with both the Kansas MCC under the direction of D. Besson, modified from the RICE code, and from the UC London MCC under the direction of A. Connolly, which has been developed both for ANITA project and for studies of the ice-surface array ARIANNA. Thus we have considerable confidence that our basic approach has been validated to the highest degree currently possible in simulations, and the simulations themselves have been validated with a variety of experimental efforts.

Figure 8 shows results for some standard distributions for both of the studied arrays, as a function of neutrino energy, over a range of energies important to cosmogenic neutrino detection. Detections are allowed up to 2 km beyond the outer perimeter of the arrays in each case, and this additional volume is important in both cases at higher energies, as seen in the upper left panes of each plot. Distributions of detected events (upper right in each set) with depth show the distinct behavior for the 50 m deep array due to the effective "exclusion zone," or horizon, caused by the firn shadowing of events, whereas the deeper 200 m array shows more uniform range for detection. On the lower right a plot of the angular distribution of events shows the cutoffs imposed by firn shadowing for both arrays, although much less restrictive for the submerged array. Finally, on the lower left the multi-station hit distributions are shown–the denser array has a clear advantage here, and will as a result give a larger fraction of events with high-precision measurements of the event geometry and kinematics.

Figure 9 shows the volumetric acceptance of several of the arrays studied, including a surface-array with 60 sta-

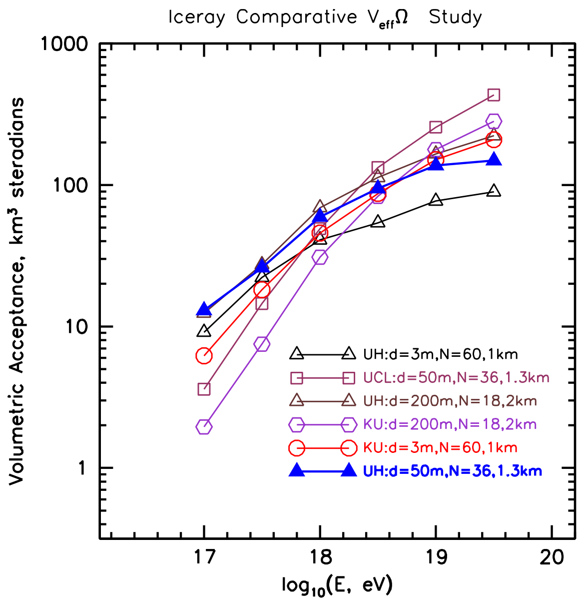

FIG. 9: *Volumetric acceptance, in km^3 steradians, of several arrays studied here, including results from the three independent Monte Carlos within our collaboration: UH indicates Univ. of Hawaii, KU the Univ. of Kansas, and UCL the Univ. College London.*

tions, 1 km spacing, and 3 m depth, which was found to be constrained by the losses in the firn refraction, and helps to indicate the importance of getting at least part-way below the firn. Each curve shows the volumetric acceptance, in water-equivalent km^3 times steradians plotted as a function of energy over the range of interest for cosmogenic neutrinos. IceRay-18 generally gives somewhat higher acceptance than IceRay-36 at the highest energies, but at the cost of slower turn-on at the lowest energies of interest, where it is has a smaller net acceptance, attributable to the coarser spacing of this array.

It is evident also that, although the three independent Monte Carlos indicate a generally different energy dependence, and vary widely at the extrema of the energy range, they agree to of order a factor of 2 near 10^{18} eV, the heart of the GZK neutrino spectrum, and as a result give very similar integrated event rates. We stress that these codes evolved and are maintained competely independently, and that the production runs for these results involved no use of any common data other than the detector configuration. It is thus encouraging to see this level of convergence at an early stage, and we assert that we can proceed in our design study with good confidence that the scale of the detector we propose is correct to first order. The IceRay proposal concept is robust and sound, and we can achieve the levels of sensitivity we describe here.

Table I shows the results for the IceRay-36 and IceRay-18 arrays in tabular form, and also approximately factors out the solid angle, to give some additional insight into the differences: the 18-station version gains considerably in solid angle because of its 200 m depth, which reduces the horizon losses under the ice, while the 36 station array makes up for this in the better sampling of the volume that the higher-number-density array affords.

TABLE I: *Acceptance and its factors as a function of energy for the two primary example arrays considered here.*

$\log_{10}$(Neutrino Energy)	17	17.5	18	18.5	19	19.5
Interaction Length, kmwe	2650	1744	1148	756	498	328
Iceray-36 $V_{eff}\Omega$ (km^3 sr)	13	26	60	94	137	149
Iceray-36 Ω (sr)	2.4	2.4	2.1	1.8	1.7	1.6
IceRay-18 $V_{eff}\Omega$ (km^3 sr)	11.6	38	63	115	137	185
IceRay-18 Ω (sr)	3	4.4	4.2	4.1	3.8	3.8

TABLE II: *Event rates per year for several classes of UHE cosmogenic neutrino models. The lowest two models are in direct conflict with observations, which do not favor a strong iron content for the UHECR; and the next model assumes no evolution of the cosmic ray sources, which is also a scenario that is improbable for known UHECR source candidates.*

Cosmogenic neutrino model	36sta/50m events/yr	18sta/200m events/yr
Fe UHECR, std. evolution	0.50	0.60
Fe UHECR strong src. evol.	1.6	1.8
ESS 2001,$\Omega_m = 0.3$, $\Omega_\Lambda = 0.7$	3.5	4.4
Waxman-Bahcall-based GZK-ν flux	4.2	4.8
Protheroe and other standard models	4.2-7.8	5.5-9.1
Strong-source evolution (ESS,others)	12-21	13.8-28
Maximal, saturate all bounds	24-40	32-47

The most important results come after the acceptance has been integrated over various current cosmogenic neutrino models, and the results of such an integration are shown in table II. The lowest two models [30] are in direct conflict with observations [14], which do not favor a strong iron content for the UHECR since models cannot reproduce the observed UHECR spectral endpoint. Such models are detectable on a several-year timescale, but would yield very few hybrid events and are not considered further. The next three "standard model" cosmogenic fluxes give 4-9 events per year. Such events would be dramatic in general, and we expect no irreducible physics background, so detection of even a few events is statistically plausible here. If stronger source evolution obtains, or cosmogenic neutrinos experience other enhancements still allowed by the current limits, these arrays would go beyond detection in a single year, and would begin to provide statistics adequate to develop differential energy spectra on single-year timescales.

Both of the arrays that we have explored in this study have sensitivity for detection of cosmogenic neutrinos on single-year timescales. We thus have developed the basic outline of a design that can achieve the first two of our science goals. It thus remains still to understand the fraction of such events that will provide hybrid event detection with IceCube.

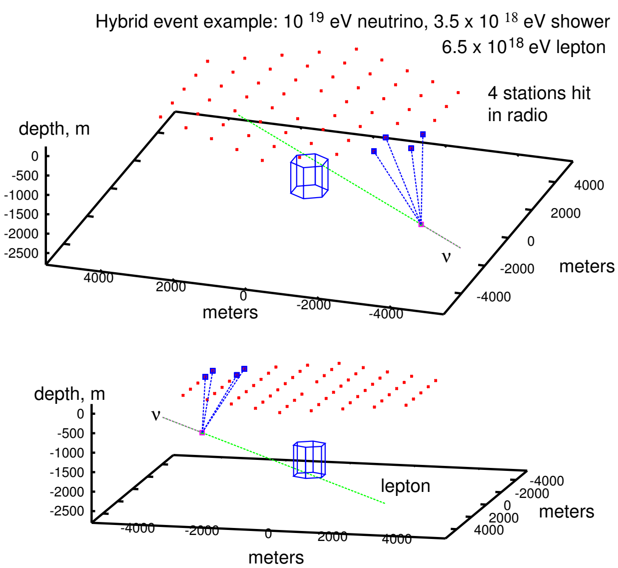

FIG. 10: Example of a hybrid event where the vertex is seen by 4 surface radio detectors and the resulting lepton passes near enough to IceCube to make a detection

Hybrid Events.

Not all three neutrino flavors, nor all neutrino-initiated showers can yield hybrid IceCube detections. Neutral current events produce no secondary charged lepton, and will comprise about 20% of all events. In the remaining 80% of charged-current interactions, electron neutrinos undergoing yield a secondary high energy electron which interacts very quickly to produce a secondary electromagnetic shower. Muon and tau neutrinos do produce secondary penetrating leptons which can be detectable at IceCube.

At EeV energies in the heart of the cosmogenic neutrino spectrum, the secondary leptons deposit large amounts on energy quasi-continuously along their tracks, and are detectable optically from several hundred meters distance. Secondary EeV muons yield strong electromagnetic subshowers primarily through hard bremsstrahlung and pair production. Secondary tau neutrinos at these energies give their largest secondary showers through photohadronic interactions, and may also produce a strong shower upon their decay, although they typically must fall below 0.1 EeV through energy loss prior to this. in our

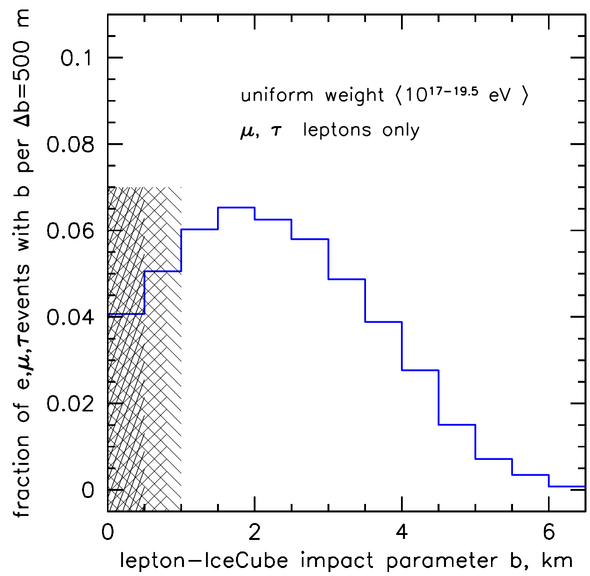

FIG. 11: The distribution of impact parameters relative to the center of IceCube for the outgoing leptons for both muon and tau neutrino events.

simulation we have assumed that all three neutrino flavors are equally mixed, and thus the hybrid event fractions reported here apply to 2/3 of the total events, except at the lowest energies where electron-neutrino events comprise a larger fraction than $1/3$ of the total.

TABLE III: *Hybrid event rates for the baseline IceCube, and IceCube-plus (1.5 km guard ring), per 10 years of operation, for several classes of UHE cosmogenic neutrino models, assuming the IceRay-36, 50m-deep radio array.*

Cosmogenic neutrino model	IceCube 10 yrs	IceCube+ 10 yrs
ESS 2001$\Omega_m = 0.3$, $\Omega_\Lambda = 0.7$	3.2	6.4
Waxman-Bahcall-based GZK-ν flux	3.8	7.6
Protheroe and other standard models	3.8-7.1	5.0-8.2
Strong-source evolution (ESS,others)	10-19	13-25
Maximal fluxes, saturate all bounds	22-36	30-44

An example of the overall event geometry for one example is shown in Figure 10. Here we show an event detected by the surface array in which an incident 10^{19} eV neutrino put 35% of its energy into a shower which was seen by 4 of the surface radio detectors, and the secondary lepton passed just outside the IceCube array with initial energy of 6.5×10^{18} eV. At this energy either a muon or tau lepton is losing of order 0.1 EeV per km of track–this level of emission would produce a huge signal at IceCube, even with an impact parameter several hundred meters distance outside the array.

In Figure 11 we quantify the hybrid event detection fractions for the IceRay-36 array, indicating the distribution of all neutrino events vs. their impact parameter b for 500 m increments, using a graded hatching to denote the regions over which there is a direct detection within the fiducial volume of the IceCube detector, or a detection within a 500 m annular region around the array, as expected for these very high energy (and thus very bright) leptons. We have included electron neutrino events and neutral current events in the total count, even though they do not produce an outgoing long-range lepton, so that the hybrid fractions are with respect to total neutrino events, not just charged-current muon or tau neutrino events.

For the standard IceCube geometry, the total hybrid event fraction of is of order 10% in these two regions. Recent studies of "guard-ring" extensions to IceCube [17] have shown the utility of one or more outer rings of strings 500-1000m outside the standard array. If we assume a single ring at a radius of 1 km from the center of IceCube, with itself an additional 500 m of reach for secondary lepton detection, the hybrid fraction extends to 15% of all neutrino events, and a 1.5 km guard ring could yield a hybrid fraction reaching 20%.

Table III gives the resulting total hybrid events expected for the IceRay-36 detector, for two different IceCube configurations, the baseline design, and one that includes a 1.5 km guard ring, known as IceCube-plus. The totals are for ten years of operation, and although they are relatively small totals, they will represent the first set of UHE neutrino events where the complete event topology can be constrained, and calorimetric information can be extracted. In addition, these events should be free of any known physics backgrounds.

Further enhancement of the hybrid subsample can be achieved using sub-threshold cross-triggering techniques, whereby events detected in either IceCube or the radio array would provide a trigger to the other array, allowing the data stream to be searched for contemporaneous signals that might not have been otherwise detectable. For example, IceCube can only observe events that arrive from above the horizon if their energies are very high, far above the atmospheric muon background. However, an apparent atmospheric muon event that was coincident with a radio event with the right geometry could be promoted into the hybrid event subsample. We propose here to quantify the detector requirements to take advantage of such possibilities.

We have also investigated the converse of the IceRay→IceCube hybrid detection scheme we detail above: that is, what fraction of GZK neutrino events detected by IceCube will also be seen by the radio array? For this we estimate a minimum of between 30-50%, but if a core AURA-type array is included within the IceCube central array, then this fraction will grow to of order 100%. There is thus a strong argument from the point-of-view of hybrid events for continuing the AURA efforts.

VI. THE ICERAY-36 DETECTOR

The IceRay-36 detector, which we have currently adopted in preference to the 18-station, 200 m deep detector, consists of 36 stations buried 50-80 meters deep in the ice, based on current or projected firn-drill capability. The basic geometry consists of 1.3 km equilateral triangles which form a series of three concentric hexagons with IceCube in their center. While we have adopted the 50 m depth version of IceRay as the baseline, we propose to study the cost-benefit of deeper detectors. Ray-tracing studies do show a steady improvement fiducial volume in with increasing depth up to about 400-500 meters, however drilling cost certainly do increase. One can compensate for the reduced volume sampled by shallow depth detectors by employing more of them. The present IceRay schemes also calls for three boreholes per detector station, most probably arranged on the apices of an 8-10 meter equilateral triangle. Such an arrangement will provide not only multi-fold coincidence information, but timing-phase information will allow directions to be determine to 1-2 degrees or better depending on signal power.

Design. Each detection station consists of an array of 12-16 wideband antennas, each instrumented with band-pass filters and amplifiers adjacent to each antenna down hole. Considerable effort has already gone into antenna design and optimization and this topic will certainly be further addressed as part of our study, although for brevity we do not detail these here. The amplified RF signal is transmitted via coaxial cable to trigger and digitization electronics located on the surface. Amplification of approximately 76 dB is needed to boost the signal from thermal noise levels to an amplitude large enough for direct triggering and digitization. The trigger scheme [34] has been successfully flown on the ANITA payload [35]. Each detector station is connected via fiber optic and a number of station inter-trigger and readout topologies have been considered, one such study has been published [36]. The first year prototype has been based upon the LABRADOR3 ASIC [37], used by both ANITA and AURA. However, for being able to store an entire array transit time for sub-threshold event reconstruction, a next generation trip based upon the BLAB chip [38] will be used. First generation prototypes are 64k samples deep, permitting 64us of buffering at 1GSa/s. Local station triggers are formed based upon temporal and spatial coincidences in the antenna signals and broadcast to the central recording station to force complete array readout.

Construction. Antennas will be designed, constructed, and tested at both Kansas and Hawaii. Both institutions have had extensive experience in this area with their pursuits of RICE and ANITA. Both institutions have Anechoic

Chambers and equipment required to completely characterize antennas, such as measuring complex impedance and VSWR in both the frequency and time-domain. For short-pulse work, the time-domain is the proper domain in which to characterize the antennas. Since the antennas are physically small protecting them is not a major problem. The antenna arrangement will be back-filled with snow, so that in time, the antennas will see an almost uniform environment of snow and a constant index of refraction.

The signals detected by the antennas are fed to the LNAs and then run to the surface via coaxial cables to a data collection box (DCBs) on the surface. In addition, this shielded DCB accepts the power to run all the devices from the station DC power supply and cable system. The DCBs also provides additional amplification of each of the antenna channels. The various antenna signals are then routed to discriminators to determine that we have a signal of interest, and if they trigger, the signals are then run to the BLAB digitizers, where their full time-amplitude development is digitized, and the data is routed via the power-signal cable to the Central DAQ in the ICL. We are also going to investigate possibly sending the data over a fiber-optic line.

IceRay Integration. Present planning calls for IceRay components to be shipped to Wisconsin's Physical Sciences Lab (PSL) for final testing and integration. This is, and has been, standard prodecure for all IceCube equipment and AURA equipment that will be installed at South Pole. Specifically for IceRay, we plan to use PSL's 24 x 25 ft anechoic chamber which is capable of being cooled to -50C to provide test conditions that are quite similar to austral winter situations at South Pole, where the ice temperatures a few meters below the surface generally average about -50C. We plan to conduct full system tests, from antennas to DAQ read-outs before we would certify the system as ready for shipment. PSL has all of the standard electronic equipment needed to conduct most of these tests, and has the technical people needed to conduct them.

Ice Drilling and Deployments. Each station requires three holes 50-80 meter deep, and 60 cm in diameter to accommodate the antennas. Present plans are to use the IceCube "firn" drill, a "hotpoint" style drill that specializes in drilling through the firn: that porous ice that makes up the first 50-70 meters of low-density ice just below the surface. We also will investigate what is needed to extend the reach of the firn drill to depths of 100-200 meters. The present IceCube firn-drill uses about 150 kW and can drill at a rate of about 4 m/hour. The whole setup is about 24 ft long by 8 ft wide. It circulates about 15-20 gpm of hot fluid (60-40 mix of propylene glycol and water) to the head at about 75 deg. C. (returning 15 to 30 C cooler depending on drill rate). The heaters come on and off as needed to maintain the fluid tank at 75C. The total available power is 150 kW but we rarely used it all. We usually had about 3 or 4 heaters on (@ 30kW) at a time so we probably averaged about 100 kW for most of the hole. We drilled about 6 meters/minute near the top of the hole and at about 3 meters/minute at the bottom (around 38-40 m deep). The system would start to slow down somewhat below where we start to get in to pooling water. This could slow down drill progress. That remains to be seen but we did find we were drilling with all 5 heaters running more of the time.

Power and Signal Transport. Each detector station will consume of order 50 watts of power. The present plan is to run both the power and the signals over copper lines, though we will be looking into a combo-cable that carries both power and fiber optics. This design will require an optimization scheme that depends on the total number of detectors planned. For example, the designs as to wire-sizes and wire paths might be quite different for IceRay-36 as opposed to an IceRay-300 design. The present cable design has been supplied by Ericsson, who also makes the IceCube cables. It consists of three twisted-quads or 12 0.9mm wires (#19 AWG). Two of the quads carry 100 watts of 120 VDC power, while the third quad carries the signals from the detector location approximately 2 km to the ICL. The voltage drop is about 25 volts over 2 km, so it represent about a 25% power-loss in the cables. It is expected that we will supply about 125 VDC at the ICL to obtain about 100 volts and 1 amp at the detector to supply power to the various DC to DC converters. The signal transmission over 2 km is not that challenging at the expected data bandwidths required. This is quite similar to the IceCube data transfer requirements from 2.4 km depths, using the same type of cables.

Control & Data Handling. The IceCube infrastructure is used for communication, control, timing, data handling and data transfer to the northern hemisphere. Once a multiple bands and antenna triggers occurs, the digitized waveforms are read from all the antennas, packed and sent to a special designated host machine located in the IceCube Counting house on a special crate. A surface cable from the surface junction box runs to the central counting house. The South Pole host machines (hubs) are standard industrial Single Board Computers. The communication is done through a customized PCI cards developed for IceCube (DOm Readout card). The hub is also equipped with a special service board distributing the GPS time string to all PCI cards. Each hub is customized with +48 Volt and -48 Volt switching regulated AC-DC single output power supplies, to supply 96 Volts to the main boards. Each DOR card can connect to two power and communication wire pairs. For IceCube, they were used to connect two adjacent DOMs on a string. We will use one of the wires to connect to the main board, and the other to supply additional power to the RF amplifiers using an external power supply. Timing with an accuracy of a few ns is achieved by using the RAPCAL method as used by IceCube. Offline processing looking for time coincidenced between several stations and with IceCube, will further filter the data.

Analysis–Pass One Early verification analysis include vertex reconstruction using an in ice RF source or a surface transmitter. This will verify the expected time resolution, waveform reconstruction and vertexing. Such a measurements will also allow Linearity and Amplitude calibration. Ambient and transient background measurements will be used to study the EMI background around the South Pole, and the environment suitability for RF detection. Since the detector is buried in shallow snow, and not in water (like IceCube) data can be taken as soon as the detector is plugged in. Not only will this allow EMI measurements during the summer period where the South Pole station is busy, it will also allow trouble shooting of the detector and cables before season ends, and experts are still on ice. Events times will be compared to IceCube's trigger times looking for coincidental events in both directions: looking for RF event when strong IceCube triggers occurred, and also looking for IceCube events when strong RF events were detected (This will require some tuning of the IceCube trigger scheme, to keep this data from being filtered out).

Linked Assets: AURA

RICE (the Radio Ice Cerenkov Experiment) was the first array in the Antarctic to employ the Askaryan effect in the search for neutrinos and other high energy phenomena. Since it began operations, RICE has mapped out the South Pole RF noise environment, studied the RF properties of the cold South Polar ice, and developed techniques for radio analysis, eventually setting limits on low scale gravity and other high-energy phenomena. Following on the success of RICE, which was largely deployed parasitically to the AMANDA installation, the AURA collaboration was formed to exploit the unique opportunity created by IceCube operations to deploy radio antennas over a larger footprint and at greater depths. Further, the electronics and infrastructure developed by IceCube to provide power, time synchronization, and data readout across large distances, along with radio specific hardware developed for ANITA, have been used as a spring board to quickly develop radio instrumentation that could be scaled up to a large englacial array for GZK neutrino studies.

AURA currently consists of a set of radio detectors buried between 250-1400 meters in the Antarctic ice. These detectors are designed to measure the radio characteristics of the deep ice. Selected IceCube boreholes have radio receivers installed in them to measure the radio spectrum from about 200-1000 MHz. In the austral summer of 2006-2007, the first AURA instrumentation was deployed: two clusters consisting of four receivers and one transmitter, and one cluster with a transmitter only. A schematic of a cluster is shown in Figure 12. The electronics which provide the power, data acquisition, trigger logic and communications are located inside of an IceCube pressure vessel, so that the mechanical mounting and connection of the digital radio module (DRM) could proceed exactly as it does for IceCube digital optical modules, with zero impact on IceCube operations. Present plans call for installing three shallow detectors (250 m depth), and one deep detector (1400 m) in January 2008.

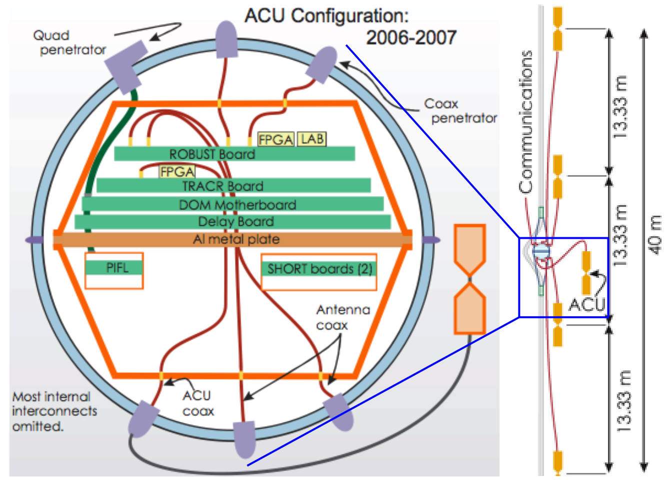

FIG. 12: Left: A schematic of the DRM. Right: its location along an IceCube string.

A schematic of the DRM is shown on the right in Figure 12. It holds the TRACR board(Trigger Reduction And Communication for RICE) that controls the calibration signal and the high triggering level, the SHORT board (SURF High Occupancy RF Trigger) that provides frequency banding of the trigger source, the ROBUST card (Read Out Board UHF Sampling and Trigger) that provides band trigger development, high speed digitization and second level trigger discrimination, the LABRADOR (Large Analog Bandwidth Recorder And Digitizer with Ordered Readout) digitization chip, the PIFL supplies the power, and a Motherboard that controls the communication and timing. The sampling speed is 2 GSPS, with a 1.3 GHz bandwidth and 256 ns buffer depth. The simple RICE-style dipole antennas have been used. Located near each antenna are pressure vessels containing front end electronics for amplification and filtering. The digitized data is sent to the surface using the IceCube in-ice and surface cables where it is being processed and analyzed.

The DRM with the single transmitter and one of the transmitter-receiver clusters were deployed in holes drilled 500m apart at a depth of 1450 m with unused connectors in the IceCube cable. This allows a survey of the noise environment in the deep ice, as well as studies of the effects of the proximity of the IceCube DOMs. The remaining receiver-transmitter cluster was installed at a depth of 250m in a hole near the existing RICE array to allow cross calibration of the two instruments. Since February 2007, when the clusters were first frozen in, they have been operated in both self trigger and forced trigger mode, and to date, a large quantity of data has been transmitted north for analysis. The data being taken consists of ambient and transient background studies, calibration runs using the AURA transmitter and the in-ice RICE transmitters. The first unambiguous confirmation of our ability to receive and digitize radio signals was achieved shortly after deployment with a series of special calibration runs using the RICE continuous waveform transmitter. The effect of IceCube electronics has been studied using the deep transmitter cluster by taking special runs with IceCube turned on and off.

This AURA work has been and will continue to be benficial and complementary to IceRay in our efforts to learn just how deep in the ice we have to locate the detectors in order to develop a credible GZK neutrino array. Deep access is provided as a result of the IceCube string deployments, and from the point-of-view of the current IceRay proposal, the utilization of these resources with minimal impact on IceCube provides important added-value to the decision process for a wide-scale radio array.

VII. PRIOR & ONGOING NSF SUPPORT RESULTS

The proposal members have contributed to a variety of successful NSF supported research programs, including AMANDA, Auger, IceCube, and RICE.

AMANDA (Antarctic Muon And Neutrino Detector Array). UW (including R. Morse, AMANDA Principal Investigator, now at UH) has been the lead US institution in the AMANDA collaboration. AMANDA pioneered the use of an array of photo-multiplier tubes in deep clear polar ice to gather Cerenkov light from neutrino generated muons. AMANDA served as a testbed for deployment, DAQ, calibration and analysis techniques that have been vital for development of the IceCube detector. Late in life AMANDA is operating as a high density low threshold component of IceCube. Data from earlier years is producing a steady output of scientific papers on virtually all subjects of high energy neutrino Astronomy, from atmospheric neutrinos to constraints on AGN models with neutrino energies above a PeV.

Auger. J. Beatty (OSU) is a leading member of the Auger collaboration, and serves as Task Leader for the Auger Surface Detector Electronics. The OSU group is involved in work on data acquisition, calibration, and data analysis focusing on the surface detector. The southern Auger detector is nearly complete, and results concerning the spectrum, anisotropy, and composition of the highest energy cosmic rays are being released.

IceCube. Members of this IceRay/AURA proposal from UW, UMd, UD, and KU are all collaborating members of the IceCube collaboration. This includes NSF support for the construction of IceCube managed through UW and disbursed to US collaborators, as well as 'Physics analysis' grants to the individual institutions. The main component of IceCube is a 1 km^3 neutrino detector, deployed at a mean depth of 2 km at South Pole. The detector consists of an array of PMTs for detecting optical Cerenkov signals - ultimately due to neutrino interactions in deep ice, or in bedrock below the detector. The detector is approximately 1/4 finished. It has an operational live time of better than 95%, and is transmitting ~ 30 GB of filtered data per day to the northern hemisphere. Using data from the first year of physics operation ($\sim 12\%$ of full array), the collaboration has already produced its first scientific paper on the atmospheric neutrino flux. The experiment also includes IceTop, an array of frozen water tanks, reminiscent of Auger tanks, for detecting cosmic ray induced air showers. In coincidence with the in-ice detector, such events are useful for cosmic ray science, calibration, and vetoing a background of large cosmic ray events which may masquerade as UHE neutrino events in and near the deep detector.

RICE (Radio Ice Cerenkov Experiment). D. Besson (KU) is the PI of the RICE experiment. D. Seckel (UD) and I. Kravchenko (MIT) have been collaboration members since its inception in 1995. RICE is a prototype for an englacial neutrino detector utilizing the Askaryan radio technique. RICE has deployed over 20 receivers in the Antarctic ice at South Pole and has collected physics quality data since 2000. RICE data is responsible for the strongest limit on UHE neutrino fluxes in the energy range of $10^{17} - 10^{18}$ eV. RICE data has been used to place limits on neutrino nucleon cross-sections in low scale gravity models, the flux of ultra relativistic magnetic monopoles, and the flux of UHE neutrinos from gamma ray bursts.

ANITA (Antarctic Impulsive Transient Antenna). While ANITA does not receive direct NSF support, it does receive substantial indirect support through NSF's strong support for the NASA Long Duration Balloon (LDB) Program. Collaborators P. Gorham (PI for ANITA), G. Varner, M. Duvernois, P. Allison, J. Learned, P. Chen, R. Nichol, and A. Connolly have all played important roles in bringing ANITA to the forefront of current UHE neutrino detectors. Without NSF support for LDB and the infrastructure necessary to sustain it, ANITA and similar projects would not be possible.

VIII. BROADER IMPACTS

As IceRay is intended as an augmentation to IceCube capabilities, we propose to augment IceCube's Education and Public Outreach (EPO) programs with material and avtivities that will widen the understanding that Cherenkov radiation, the electromagnetic analog to the more familiar acoustic shock-wave, can have effects across the whole electromagnetic spectrum, including radio. The huge increase in public consumption of radio and wireless-based devices–cell-phones, networks, radio-frequency identification tags, wireless car locks and toll-roads creates an excellent opportunity for public impact as we incorporate the IceRay/AURA methodology into existing IceCube EPO venues. These augmentations are essentially no-cost extensions since the EPO activities are ongoing and can admit new curricular elements at any time.

The IceCube EPO program at the UW Madison has focused on three main areas: providing quality K - 12 teacher professional development, and producing new inquiry-based learning materials that showcase ongoing research; increasing the diversity of the science and technology workforce by partnering with minority institutions and programs that serve underrepresented groups; and enhancing the general public appreciation and understanding of science through informal learning opportunities, including broadcast media and museums. These efforts have been supported by the University of Wisconsin since 2001, and we propose to expand the curriculum with a distinct radio component.

In addition to IceCube's formal EPO program, many efforts to share the excitement of science with students and the public at-large take place at the institutional level as well. Kara Hoffman frequently visits local high schools to talk to students about her life as a scientist and Polar traveler. Within the last year, Dave Besson at the University of Kansas has been giving classes to senior citizens on the subject of astrophysics, with a particular emphasis on his own experience with RICE and AURA. These classes are typically attended by $\sim$50 persons from the Lawrence-Topeka-Kansas City area.

The primary science mission of this proposal lends itself to active undergraduate involvement. RICE has benefited from the efforts of previous physics majors – seven KU undergrads, including Adrienne Juett (Goldwater Scholar, 1998, and MIT, Ph.D., 2005), Dave Schmitz (Goldwater Scholar, 2001, now finishing his Ph.D. at Columbia), Josh Meyers (Goldwater Scholar, 2003, now a grad student with the Perlmutter group at LBL), and Hannah Swift (Goldwater Scholar, 2005, also a grad student with the Perlmutter group at LBL) performed initial work on data analysis and both the attenuation length and index-of-refraction measurements at the South Pole. Current undergrad, and Rhodes Scholar nominee Daniel Hogan is currently finishing an analysis of the sensitivity of RICE to monopoles. The University of Maryland has also involved three undergraduate physics majors to produce simulations to determine the optimal placement of the AURA hardware. We expect to continue this heavy reliance on undergraduates as the radio effort moves forward in the future.

Several of our institutions also have formal partnerships with local high school teachers as well. The OSU group is working with teacher Doug Forrest at Pickerington North High School in suburban Columbus to incorporate simple cosmic ray experiments into the honors physics high school curriculum. They helped him secure $11,000 form a local educational foundation for laboratory equipment, and are working with him to design appropriate experiments and educational materials and conduct classroom visits from time to time. We propose that additional radio-based curricular materials will be integrated into this program, and we will seek further funds to adapt a modest radio-detector extension to the current systems.

Both the University of Maryland and the University of Hawaii are heavily involved in the QuarkNet program. Through UH's QuarkNet program, established in 2003, Gorham, Varner, and Learned have been actively involved in developing cosmic ray detectors for classroom use. Morse will take on a contributing role for the UH Quarknet efforts, providing seminar and mentoring contributions to the local Quarknet curriculum. The UH Quarknet program involves both teachers and students from underserved outer-island districts, and a radio-based augmentation to this will have accordingly greater impact. W

UM's QuarkNet chapter was established in 2002, and since her arrival at UM in 2004, Hoffman has been the main organizer and mentor for this group. In the past summer, she ran her third summer teacher institute, and she has been instrumental in increasing participation from ethnically diverse communities. She has also helped secure cosmic ray detectors for several of the teachers she mentors.

[1] G. A. Askaryan, 1962, JETP 14, 441; 1965, JETP 21, 658.
[2] P. W. Gorham, D. P. Saltzberg, P. Schoessow, *et al.*, Phys. Rev. E. **62**, 8590 (2000).
[3] D. Saltzberg, P. Gorham, D. Walz, *et al.* Phys. Rev. Lett., **86**, 2802 (2001).
[4] P. W. Gorham, D. Saltzberg, R. C. Field, *et al.*, Phys. Rev. D 72, 023002 (2005).
[5] P. Miočinović, R. C. Field, P. W. Gorham, *et al.*, Phys. Rev. D 74, 043002 (2006).
[6] K. Greisen, "End To The Cosmic Ray Spectrum?," Phys. Rev. Lett. **16**, 748 (1966).
[7] G. T. Zatsepin and V. A. Kuzmin, "Upper Limit Of The Spectrum Of Cosmic Rays," JETP Lett. **4**, 78 (1966) [Pisma Zh. Eksp. Teor. Fiz. **4**, 114 (1966)].
[8] V. S. Berezinsky and G. T. Zatsepin, Phys. Lett. B 28, 423 (1969)
[9] R. Engel, D. Seckel, and T. Stanev, Phys. Rev. D 64, 093010 (2001).
[10] P. W. Gorham, *et al.*, [ANITA Collaboration], "Observations of the Askaryan Effect in Ice," (2007), Phys. Rev. Lett. in press; arXiv:hep-ex/0611008.
[11] A.V.Glushkov et al., Astropart. Phys. 4 (1995) 15.
[12] M.A. Lawrence, R.J.O. Reid, A.A. Watson. J. Phys. G. 17 (1991) 733.
[13] S.Yoshida et al., Astropart. Phys. 3 (1995) 105; also Shigeru Yoshida, Hongyue Dai, (astro-ph/9802294). Journal of Physics G 24 (1998) 905.
[14] R. U. Abbasi, *et al.*, The HiRes Collaboration, (2007) submitted to Phys. Rev. Lett., astro-ph/0703099.
[15] M. Roth, for the Auger Collaboration, "Measurement of the UHECR energy spectrum using data from the Surface Detector of the Pierre Auger Observatory," Contribution to the 30th International Cosmic Ray Conference, Merida, Mexico, http://arxiv.org/abs/0706.2096, 2007.
[16] D.J.Bird et al., Astrophys. J. 441 (1995) 144. J.W.Elbert, P.Sommers, Astrophys. J. 441 (1995) 151; Baltrusaitas, R.M., Cassiday, G.L., Elbert, J.W., et al., *Phys. Rev. D* **31**, 2192 (1985).
[17] F. Halzen, and D. Hooper, JCAP 0401 (2004) 002; astro-ph/0310152.
[18] R. J. Protheroe & P. A. Johnson, Astropart. Phys. 4, 253 (1996).
[19] O. E. Kalashev, V. A. Kuzmin, D. V. Semikoz and G. Sigl, "Ultra-high energy neutrino fluxes and their constraints," Phys. Rev. D **66**, 063004 (2002).
[20] D. Besson, S. Boeser, R. Nahnhauer, P.B. Price, and J. A. Vandenbroucke, for the IceCube Collaboration, 29th International Cosmic Ray Conference, Pune, India (2005) 00, 101.
[21] The AMANDA Collaboration: J. Ahrens, et. al., Nucl. Instrum. Meth. A524 (2004) 169.
[22] The IceCube Collaboration: M. Ackermann et al., Nucl. Instrum. Meth. A556 (2006) 169.
[23] N. Lehtinen, P. Gorham, A. Jacobson, & R. Roussel-Dupŕe, Phys. Rev. D 69 (2004) 013008; astro-ph/030965.
[24] G. A. Gusev, I. M. Zheleznykh, "On the possibility of detection of neutrinos and muons on the basis of radio radiation of cascades in natural dielectric media (antarctic ice sheet and so forth)," SOV PHYS USPEKHI, 1984, 27 (7), 550-552.
[25] M. A. Markov, I. M. Zheleznykh, Nucl. Instr. Meth. A 248 (1986) 242.
[26] E. Zas, F. Halzen, & T. Stanev, 1992, Phys Rev D 45, 362.
[27] I. M. Zheleznykh, 1988, Proc. Neutrino '88, 528; R. D. Dagkesamanskii, & I. M. Zheleznyk, 1989, JETP 50, 233.
[28] I. Kravchenko et al., Astropart.Phys. 20 195-213 (2003).
[29] P. W. Gorham, C. L. Hebert, K. M. Liewer, C. J. Naudet, D. Saltzberg, D. Williams, Phys. Rev. Lett. 93 (2004) 041101.
[30] M. Ave, N. Busca, A. V. Olinto, A. A. Watson, T. Yamamoto, Astropart. Phys. 23 (2005) 19.
[31] The ANITA Collaboration: S. W. Barwick *et al.*, Phys. Rev. Lett. 96 (2006) 171101.
[32] S. Barwick, D. Besson, P. Gorham, D. Saltzberg, J. Glaciol. 51 (2005) 231.
[33] J. Alvarez–Muñiz & E. Zas, 1997, Phys. Lett. B, 411, 218.
[34] G. Varner, "The Modern FPGA as Discriminator, TDC and ADC," Journal of Instrumentation, Volume 1, P07001 (2006).
[35] The ANITA Collaboration, presented by G. Varner, "Detection of Ultra High Energy Neutrinos via Coherent Radio Emission," Presented at 9th International Symposium on Detector Development for Particle, Astroparticle and Synchrotron Radiation Experiments (SNIC 2006), Menlo Park, California, 3-6 April 2006, SLAC-PUB-11872, 6pp. May 2006.
[36] G. Varner *et al.*, "A Giga-bit Ethernet Instrument for SalSA Experiment Readout," Nucl. Instr. Meth. A554 (2005) 437-443.
[37] G. Varner *et al.*, "Development of a Low-Power Multi-GSa/s TranThe Large Analog Bandwidth Recorder And Digitizer with Ordered Readout (LABRADOR) ASIC," arXiv:physics/0509023v2, accepted for publication by Nucl. Instr. Meth. A Sept. 2007 (in press).
[38] G. Varner and L. Ruckman, "The Buffered LABRADOR ASIC version 1 (BLAB1)," submitted to Nucl. Instr. Meth. A; initial test results presented SLAC Advanced Instrumentation Seminar, July 11, 2007. `www-group.slac.stanford.edu/ais/`

BIOGRAPHICAL SKETCH

Robert M. Morse

Professional Preparation

1969 Doctorate in Physics, University of Wisconsin
1965 Masters Degree, University of Wisconsin
1963 Bachelors Degree, San Jose State University

Appointments

Affiliate Graduate Faculty, Physics, University of Hawaii-Manoa, 9/2006 ? present
Professor Emeritus, Physics, University of Wisconsin-Madison
Qualifier committee, 2004 - 2005
Physics Council 2003
Prinicipal Investigator of the AMANDA NSF grant from 1991 ? present
South Pole Users Committee, 1995 - 2005
Advisory committee to NSF and Raytheon Polar Programs, the NSF contractor for Polar Operations
IceCube Collaboration, Executive Committee 2003 - 2005
IceCube Level 2 manager for Implementation (Technical and Budget responsibility), 2003 ? 2005
IceCube funding for Phase II: Construction (PI F. Halzen) awarded by NSF (2003: $25M; 2004: $40M; 2005: $48M; 2006: $52M)

Publications

Detection of atmospheric muon neutrinos with the IceCube 9-string detector, IceCube collaboration; astro-ph/07051781; Phys. Rev. D 76 027101 (2007).

Search for neutrino-induced cascades from gamma-ray bursts with AMANDA, IceCube collaboration, (to be published in Astrophys. Jour., 10.1086 / 518596, 2007); astro-ph/0702265v2.

Five years of searches for point sources of astrophysical neutrinos with the AMANDA-II neutrino telescope, IceCube collaboration, Phys. Review D 75 102001 (2007); astro-ph/0611063.
Optical properties of deep glacial ice at the South Pole, AMANDA collaboration, J. Geophys. Res. 111 D13203 DOI:10 1029 / 2005JD006687 (2006).
On the selection of AGN neutrino source candidates for a source stacking analysis with neutrino telescopes, IceCube collaboration, Astropart. Phys. 26 282-300 (2006).

Limits on the high-energy gamma and neutrino fluxes from the SGR 1806-20 giant flare of 27 December 2004 with the AMANDA-II detector, Ice Cube collaboration, Phys. Rev. Lett. 97 221101 (2006); astro-ph/0607233.

First year performance of the IceCube Neutrino Telescope, IceCube collaboration, Astropart. Phys. 26
155-173 (2006); astro-ph/0604450.

Search for Extraterrestrial Point Sources of High Energy Neutrinos with AMANDA-II Using Data Collected in 2000-2002, AMANDA collaboration, Phys. Rev. D 71, 077102 (2005); astro-ph/0503122.

BIOGRAPHICAL SKETCH

(This is a continuation page)

Flux Limits on Ultra High Energy Neutrinos with AMANDA-B10, AMANDA collaboration, Astropart. Phys. 22, 339 (2005).

Search for Neutrino Induced Cascades with AMANDA, AMANDA collaboration, Astropart. Phys. 22, 127 (2004).

Synergistic Activities

? Participated in Physics in the Arts: a hands-on laboratory course for non-science majors covering acoustics and musical instruments, optics and color.

? Created the Antarctic Center for Education at the University of Wisconsin, Madison, home of education and outreach programs for the AMANDA and IceCube projects.

? Presented lectures reaching students and the general public.

List of Collaborators

The IceCube Collaboration
The AMANDA Collaboration

JAMES J. BEATTY
Professor of Physics and of Astronomy. The Ohio State University
174 West 18th Avenue, Columbus, OH 43210-1106

Professional Preparation

University of Chicago	Chemistry	A.B. 1982
University of Chicago	Physics	S.M. 1984
University of Chicago	Physics	Ph.D. 1986

Appointments

July, 2004-	Professor of Physics and Professor of Astronomy The Ohio State University, Columbus, Ohio
1995-2004	Professor (2001-2004), Associate Professor (1995-2001) Departments of Physics and of Astronomy and Astrophysics The Pennsylvania State University, University Park, Pennsylvania
2001-2002	Visiting Scientist, Bartol Research Institute, The University of Delaware and Fellow, John Simon Guggenheim Memorial Foundation
1991-1995	Associate Professor (1994-1995), Assistant Professor (1991-1994) Department of Physics and McDonnell Center for the Space Sciences Washington University, St. Louis, Missouri
1986-1992	Assistant Professor of Astronomy and Physics (1989-1991) Assistant Research Professor of Physics (1986-1989) Boston University, Boston, Massachusetts
1982-1986	Research Associate (1986), Research Assistant (1982-1985) Laboratory for Astrophysics and Space Research, Enrico Fermi Institute and Department of Physics University of Chicago, Chicago, Illinois

Publications

An Upper Limit to the Photon Fraction in Cosmic Rays above 10^{19} eV from the Pierre Auger Observatory. The Pierre Auger Collaboration. 2006. *Astroparticle Physics* **27**, 155. (astro-ph/0606619)

Anisotropy studies around the Galactic Centre at EeV Energies with the Auger Observatory. The Pierre Auger Collaboration. 2007. *Astroparticle Physics* **27**, 244. (astro-ph/0607382)

Observations of the Askaryan Effect in Ice. The ANITA Collaboration. 2007. Submitted to *Phys Rev. Lett.* (hep-ex/0611008)

Constraints on Cosmic Neutrino Fluxes from the ANITA Experiment. The ANITA Collaboration.. 2007. *Phys Rev. Lett.* **96,** 171101.

Calibration of the surface array of the Pierre Auger Observatory. X. Bertou, P. Allison, C. Bonifazi, P. Bauleo, C.M. Grunfeld, M. Agelitta, F. Arneodo, D. Barnhill, J.J. Beatty, N.G. Busca, A. Creusot, D. Dornic, A. Etchegoyen, A. Filevitch, P.L. Ghia, I. Lhenry-Yvon, M.C. Medina, E. Moreno, D. Nitz, T. Ohnuki, S. Ranchon, H. Salazar, T. Suomijärvi, D. Supanitsky, A. Tripathi, M. Urban and L. Villasenor. 2006. *Nucl. Instr. and Meth. A* **568**, 839.

Properties and Performance of the Prototype Instrument for the Pierre Auger Observatory. The Auger Collaboration. 2004. *Nucl. Instr. and Meth* **A523**, 50-95.

Synergistic Activities

Development of materials for the enhanced teaching of freshman mechanics to engineering students. These efforts centered on active and collaborative learning were recognized at Penn State by the award of the 1997 Provost's Award for Collaborative Instruction Curricular Innovation, and continued until my departure. I have been applying the same principles to the teaching of introductory electromagnetism at Ohio State, and am presently reengineering the laboratory component of this course.

Successful advocacy for the establishment of additional faculty positions in particle astrophysics. This includes work to generate the positions now held by Stéphane Coutu and Doug Cowen at Penn State, as well as my former positon now held by Paul Sommers. This effort is continuing at Ohio State in the context of our new Center for Cosmology and Astro-Particle Physics.

Mentoring of students from groups underrepresented in physics. Our group continues to foster a welcoming environment, and we have been particularly successful in recruiting women to work with us at the postdoctoral, graduate, and undergraduate level.

Collaborators and Other Affiliations

Collaborators

Only US Auger Collaborators are included due to space limitations. The full list is at http://www.auger.org/admin. Affiliations indicated are the last known affiliation.

S.P. Ahlen(Boston U.), H.S. Ahn(U.Md.), P. Allison(Ohio State), L. Anchordoqui (Northeastern), R. Andrews(FNAL), K. Arisaka(UCLA), S. Atulugama(Penn State), M. Ave(Chicago), L.M. Barbier(NASA/GSFC), D. Barnhill(UCLA), S. Barwick(UC-Irvine), P. Bauleo(Colo. State), A.S. Beach(Penn State), X. Bertou(Chicago), D. Besson(Kansas), A. Bhattacharyya(Indiana), W.R. Binns(Wash. U.), C.R. Bower(Indiana), J. Brack (Colorado), B. Cai(Minnesota), C.J. Chaput(SLAC), J. Chirinos Diaz(Michigan Tech), A. Chou(FNAL), E.R. Christian(NASA/HQ), J. Chye(Michigan Tech), D. Claes(Nebraska), J. Clem(Bartol), S. Coutu(Penn State), C. Covault(Case Western), D. Cowen(Penn State), D.J. Crary(Wash. U.), J. Cronin(Chicago), J. Darling(Michigan Tech), G.A. deNolfo (USRA/GSFC), A.V. Dorofeev(Michigan Tech), M. DuVernois (Minnesota), D.J. Ficenec(Millenium Pharm.), B. Fick (Michigan Tech), O. Ganel(U.Md.), G. Gelmini (UCLA), H. Glass(FNAL), M.S. Gold(UNM), J. Gonzalez (Northeastern), A. Goodwin (LSU), P. Gorham(Hawaii), N.R. Greene(Bloomsburg U.), T.G. Guzik(LSU), Y.J. Han (Korea), J. Harton(Colo. State), T. Hebert(Hawaii), R.M. Heinz(Indiana), P.L. Hink(Burle Industries), C. Hojvat(FNAL), S. Jaminion(Penn State), J. Jarrell(UNM), M. Kaducak (FNAL), H.J. Kim(U.Md.), S.K. Kim(U.Md.), J. Klarmann(Wash. U.), S. Kleinfelder(UC-Irvine), K.E. Krombel(Chicago), A. Kusenko(UCLA), A. Labrador(Caltech), D.J. Lawrence(LANL), J. Learned(Hawaii), M.H. Lee(U.Md.), K. Liewer(JPL), M. Lijowski (Bartol), J. Link(Hawaii), D. Loomba(UNM), D.M. Lowder (Montavista Software), L. Lutz (U.Md.), P. Mantsch(FNAL), S. Matsuno(Hawaii), J.M. Matthews(LSU), J.A.J. Matthews (UNM), P. Mazur(FNAL), T. McCauley(Northeastern), M. McEwen(LSU), S.P. McKee (Michigan), R. McNeil(LSU), R. Meyhandan(LSU), R. Milincic(Hawaii), W. Miller(UNM), S.A. Minnick(Kent State), P. Miocinovic (Hawaii), J.W. Mitchell(NASA/GSFC), M. Mostafa(UNM), S.L. Mufson(Indiana), D. Muller(Chicago), J.A. Musser(Indiana), J. Nam (UC-Irvine), C. Naudet(JPL), C. Newman-Holmes(FNAL), R. Nichol(Ohio State), D. Nitz (Michigan Tech), S.L. Nutter(Northern KY), T. Ohnuki(UCLA), A. Olinto(Chicago), K. Palladino (Ohio State), T. Paul(Northeastern), N. Peshman (Minnesota), J.J. Pitts(LSU), T. Porter(LSU), B. Rafert (Michigan Tech), B.F. Rauch(Wash. U.), S. Reucroft (Northeastern), M. Roberts(Utah), M. Rosen(Hawaii), D. Saltzberg(UCLA), E. Schneider (UC-Irvine), M. Schubnell (Michigan), D. Seckel (Bartol), D. Semikoz (UCLA), E.S. Seo (U.Md.), W. Slater (UCLA), K. Smith(Colo. State), G. Snow (Nebraska), P. Sokolsky (Utah), P. Sommers(Utah), C. Song (Minnesota), G.M. Spiczak(UW-River Falls), H. Spinka(ANL), S.H. Sposato(Wash. U.), R.E. Streitmatter(NASA/GSFC), J. Swain (Northeastern), S.P. Swordy(Chicago), G. Tarlé(Michigan), S. Tobias(Wash. U.), A.D. Tomasch (Michigan), E. Torbet(UCSB), A. Tripathi(UCLA), G. Varner(Hawaii), L. Voyvodic(FNAL), C.J. Waddington (Minnesota), J.Z. Wang(U.Md.), D. Warner(Colo. State), J.P. Wefel (LSU), L. Wiencke(Utah), D. Williams(UCLA), T. Yamamoto(Chicago).

Graduate and Postdoctoral Advisors

Graduate Advisor: Prof. John A. Simpson, University of Chicago (deceased)

Postdoctoral Advisors: Prof. John A. Simpson, University of Chicago (deceased)
Prof. Steven P. Ahlen, Boston University

Thesis Students Advised and Postgraduate Scholars Sponsored

Thesis Students: Georgia A. DeNolfo (USRA/Goddard Space Flight Center)
Steven Beach (M.S., now teaching at the secondary level in Wisconsin)
Patrick Allison (Ph.D., now a postdoc at Hawaii)

Current Thesis Students: Patrick Allison, Teresa Brandt, Brian Mercurio, Chad Morris, Kimberley Palladino, Michael Sutherland, and Thomas Weisgarber

Current Postgraduate Scholar: Brian Baughman

Postgraduate Scholars within the Last Five Years: Stephanie Jaminion (industry), Matthias Leuthold (Aachen), Ryan Nichol (University College-London), Kara D. Hoffman

Personal Information:

Address:	University of Maryland, Department of Physics, College Park, MD 20742 phone: 301 405-7263 email: kara@icecube.umd.edu

Education

B.S. (Physics), University of Kentucky – 1992
M.S. (Physics), Purdue University – 1994
Ph.D. (Physics), Purdue University – 1998
Adviser: D. Bortoletto

Employment

2004 – present	Assistant Professor of Physics, Univ. of Maryland
2001 -- 2004	Research Associate, Univ. of Chicago
1998 – 2001	CERN Fellow

Research Activities

Neutrino Astronomy with the South Pole IceCube Detector
Detection of ultra high energy neutrinos using the Askaryan effect
Top quark physics with the Collider Detector at Fermilab (CDF)
Generation of high energy muon and neutrino beams
Higgs and charged Higgs searches at LEP
LEP Higgs working group (statistical methods for combining Higgs limits)
Searches for new physics (CDF)
Development of double sided silicon vertex detectors (CDF)

Selected Publications

1. Detection of Atmospheric Muon Neutrinos with the IceCube 9-String Detector. The IceCube Collaboration, Phys. Rev. D *76*, 027101 (2007).

2. IceCube: Initial Performance and Physics Potential. K. D. Hoffman for the IceCube Collaboration, Proceedings of the 6th Rencontres du Vietnam, 2006.

3. AURA: the Askaryan UnderIce Radio Array, K. D. Hoffman on behalf of the AURA Collaboration Proceedings of the International Conference on Acoustic and Radio EeV Neutrino detection Activities (ARENA 2006).

4. Muon colliders: from science fiction to real science, K.D. Hoffman on behalf of the Muon Collaboration, Eur.Phys.J.C33:S1059-S1063,2004.

5. Recent progress in neutrino factory and muon collider research within the Muon collaboration, By Muon Collider/Neutrino Factory Collaboration (Mohammad M. Alsharoa et al.), Phys.Rev.ST Accel.Beams 6:081001,2003.

6. Search for the Standard Model Higgs at LEP, the LEP Higgs Working Group, Phys.Lett.B565:61-75,2003

7. News from the year 2000: Update on OPAL searches for new phenomena and Higgs and combined LEP Higgs results, K. Hoffman on behalf of the OPAL Collaboration and the LEP Higgs Working Group, proceedings of ICHEP 2000, Osaka 2000, High energy physics, vol. 2* 1197-1200.

8. Search for new particles decaying to b anti-b in p anti-p collisions at S**(1/2) = 1.8-TeV, the CDF Collaboration, Phys.Rev.Lett.82:2038-2043,1999.

9. Charge collection efficiency in double-sided silicon microstrip detectors, K. D. Hoffman, et. al., Nucl.Instrum.Meth.A379:237-242,1996.

Ilya Kravchenko

24-522, 77 Massachusetts Ave
Massachusetts Institute of Technology
Cambridge, MA 02139

Phone: (617) 253-7596
Fax: (617) 253-1755
email: ikrav@mit.edu

Professional Preparation

Moscow Institute of Physics and Technology	Physics	B.S., 1991
Moscow Institute of Physics and Technology	Particle Physics	M.S., 1993
University of Kansas	Physics	Ph.D., 1999

Appointments

09/2003-present	Research Scientist, Laboratory for Nuclear Science, MIT
09/2001-09/2003	Senior Post-Doc, Laboratory for Nuclear Science, MIT
02/1999-09/2001	Post-Doc, Laboratory for Nuclear Science, MIT
09/1993-02/1999	Research Assistant, Physics Department, University of Kansas
05/1993-08/1993	Junior Scientist, Joint Institute for Nuclear Research (Russia)
09/1990-05/1993	Research Assistant, Joint Institute for Nuclear Research (Russia)

Publications

Publications most closely related

1. I. Kravchenko et al., "RICE limits on the Diffuse Ultra-High Energy Neutrino Flux", Phys. Rev. D73, (2006), 082002
2. I. Kravchenko et al., "In situ index of refraction measurements of the South Polar firn with the RICE dectector", J. Glac., vol. 50, 171 (2004).
3. I. Kravchenko et al., "Limits on the ultra-high energy electron neutrino flux from the RICE experiment," Astroparticle Physics 20(2003) 195-213
4. I. Kravchenko et al., "Performace and simulation of the RICE detector," Astroparticle Physics 19(2003) 15-36
5. C. Allen et al., "Status of the Radio Ice Cherenkov Experiment (RICE)," New Astronomy Reviews 42(1998) 319

Other significant publications

1. A. Abulencia et al., "Observation of $B_s^0 \bar{B}_s^0$ Oscillations", Phys. Rev. Lett. 97(2006) 242006
2. A. Abulencia et al., "Measurement of the $B_s^0 \bar{B}_s^0$ Oscillation Frequency," Phys. Rev. Lett. 97(2006) 062003
3. D. Acosta et al., "B Hadron Mass Measurements,", Phys. Rev. Lett. 96(2006) 202001

4. D. Acosta et al., "A time-of-flight detector in CDF-II," Nucl. Instrum. Meth A518(2004) 605-608

5. G. Gomez-Ceballos et al., "Event Builder and Level3 at the CDF experiment," Nucl. Instrum. Meth A518(2004) 522-524

Collaborators and Other Affiliations

Collaborators and Co-Editors
The RICE Collaboration: D.Besson (U. Kansas), K.Ratzlaff (U.Kansas), D.Seckel (U. Delaware), S.Seunarine (U. Canterbury) and others. The CMS Collaboration.

Graduate and Postdoctoral Advisors
Georgi Chelkov (JINR,Russia), David Besson (Univ. of Kansas), Christoph Paus (MIT)

Thesis Advisor and Postgraduate-Scholar Sponsor
Not applicable for current and previous job titles.

David Seckel

(a) Professional Preparation:

Brown University	Physics	B.A. 1976
University of Washington	Physics	M.Sc. 1981
University of Washington	Physics	Ph.D. 1983
Fermilab	Physics	1983-85
CERN	Physics	1986
Univ. California, Santa Cruz	Physics	1985-1988

(b) Appointments: Professor, University of Delaware, 2005-present; Associate Professor, University of Delaware, 2000-present; Associate Professor, Bartol Research Institute 1993-2000; Assistant Professor, Bartol Research Institute, 1988-1993; Post Docotral Research Associate, University of California at Santa Cruz, 1985 and 1987-1988; Paid Associate, Theory Division, CERN, 1986; Post Doctoral Research Associate, Theoretical Astrophysics Group, Fermilab, 1983-1985.

(c1) Five publications relevant to research proposal:
1. "The IceCube Collaboration: Contributions to the 29th Interntional Cosmic Ray Conference", A. Achterberg et al. (IceCube Collaboration), Pune India, Aug, 2005.
2. "Limits on the Ultra-High Energy Electron Neutrino Flux from the RICE Experiment", I. Kravchenko, et al. (RICE Collaboration), Astroparticle Physics, 20, 195-213 (2003)
3. "Propagation of Muons and Taus at High Energies", S. Iyer Dutta, M. H. Reno, I. Sarcevic and D. Seckel, Phys Rev D63, 094020 (2001).
4. "Neutrinos from propagation of ultra-high energy protons", R. Engel, D. Seckel and T. Stanev, Phys Rev D64, 093010 (2001).
5. "Detecting UHE neutrinos ($E > 10^{18}$eV) with a large radio array", D. Seckel and G. Frichter, HE 6.3.12, Proc. XXVI Int. Cosmic Ray Conf. Salt Lake City, Utah (1999).

(c2) Five additional publications:
1. "Coherent Radio Pulses From GEANT Generated Electromagnetic Showers In Ice", S. Razzaque, S. Seunarine, D.Z. Besson, D.W. McKay, J.P. Ralston, and D. Seckel, Phys Rev D65, 103002 (2002).
2. "Neutrino-photon reactions in astrophysics and cosmology", D. Seckel, Phys. Rev. Lett. 80, 900 (1998).
3. "Three Exceptions to the Calculation of Relic Abundances", K. Griest and D. Seckel, Phys. Rev. D 43, 3191 (1991).
4. "Detection of Cosmic Dark Matter", J. Primack, D. Seckel, and B. Sadoulet, Ann. Rev. Nuc. Part. Sci. 38, 751 (1988).
5. "Bounds on Exotic Particle Interactions from SN 1987a", G. Raffelt and D. Seckel, Phys. Rev. Lett. 60, 1793 (1988).

(d) Synergistic Activities: Local Outreach: presentations at "High School Physics Day", "Space Day", local elementary schools, Center for Lifelong Learning; Judge for Science Olympics.

(e) Collaborators and Other Affiliations:
(i) Collaborators: J. Adams (Christchurch), S. Barr (Delaware), S. Barwick (Irvine), A. Bean (Kansas), J. Beatty (Ohio State), D. Besson (Kansas, RICE), B. Binns (Washington Univ.), J. Clem (Delaware), M. Duvernois (Minnesota), R. Engel (Karlsruhe), P. Evenson (Delaware), T. Gaisser (Delaware), P. Gorham (Hawaii, ANITA), F. Halzen (IceCube), J. Learned (Hawaii), W. Matthaeus (Delaware), D. McKay (Kansas),

J. Ralston (Kansas), Soebur Razzaque (Penn State), M.H. Reno (Iowa), I. Sarcevic (Arizona), D. Saltzberg (UCLA), Suruj Seunarine (Christchurch), G. Spiczak (Wisconsin, River Falls), T. Stanev (Delaware), G. Varner (Hawaii).

(ii) Graduate and Post-Doctoral Advisors: A. Zee, ITP Santa Barbara (thesis). E. Kolb, Fermilab; J. Ellis, CERN; J. Primack, UCSC (postdoctoral).

(iii) Thesis Advisor and Postgraduate Scholar Sponsor: Five years: Shahid Hussain (postdoctoral scholar); Student Total 2; Postdoctoral Total 2.

DAVID Z. BESSON

Department of Physics and Astronomy	Telephone: 785-864-4741
Unversity of Kansas	Fax: 785-864-5262
Lawrence, KS 66045	Email: dbesson@ku.edu

Professional Preparation

Columbia University	Physics	B.S. 1979
Rutgers University	Physics	Ph.D. 1986

Appointments

3/02 -	Professor of Physics, University of Kansas, Dept. of Physics
5/06 - 8/06	Fulbright Fellow, Institute Nuclear Research, Moscow
1/97 -	Associate Professor, University of Kansas, Dept. of Physics
8/93 - 12/96	Assistant Professor, University of Kansas, Dept. of Physics
9/90 - 8/93	Postdoctoral Research Associate, Cornell U., Dept. of Physics, (CLEO Collaboration "Analysis Coordinator" during that time)
1/87 - 8/90	Postdoctoral Research Associate, University of Florida, Dept. of Physics
9/88 - 12/88	Visiting Scientist, Institute of Nuclear Physics, Novosibirsk, Siberia (Russia)
6/83 - 1/87	Research Assistant, Rutgers University, Physics Dept.
9/79 - 6/83	Teaching Assistant, Rutgers University, Physics Dept.

Publications

Publications Most Closely Related

1. D. Besson *et al.*, *In situ radioglaciological measurements near Taylor Dome, Antarctica and implications for UHE neutrino astronomy*, arXiv:astro-ph/0703413, submitted to Astropart. Phys. (2007).

2. D. Besson *et al.*, *Limits on the Transient Ultra-High Energy Neutrino Flux from Gamma-Ray Bursts (GRB) Derived from RICE Data*, Astropart. Phys. **26**, 367–377 (2007).

3. I. Kravchenko it et al., *RICE Limits on the Diffuse Ultra-High Energy Neutrino Flux*, Phys. Rev. **D73**, 082002 (2006)

4. S. Barwick *et al.*, *South Polar in situ Radio Frequency Ice Attenuation*, J. Glac., **51**, 173, 231-238 (2005)

5. I. Kravchenko *et al.*, *In situ index of refraction measurements of the South Polar firn with the RICE detector*, J. Glac., **50**, 171 (2004).

Other Significant Publications

1. S. Barwick *et al.*, *Constraints on cosmic neutrino fluxes from the Antarctic Impulsive Transient Antenna experiment*, Phys. Rev. Lett., **96**, 17, 171101 (2006).

2. R. A. Briere *et al.* *Comparison of particle production in quark and gluon fragmentation at* $sqrts$ *∼10 GeV*, accepted by Phys. Rev. D. (2007).

3. J. L. Rosner *et al.*, *Measurement of Upper Limits for* $\Upsilon \to \gamma + \mathcal{R}$ *Decays*, submitted to Phys. Rev. D. (2007).

4. D. Besson *et al.*, *Measurement of the Direct Photon Momentum Spectrum in $\Upsilon(1S)$, $\Upsilon(2S)$, and $\Upsilon(3S)$ decays*, Phys. Rev. **D74**, (2006) 012003.

5. N. Brambilla *et al.*, *Heavy Quarkonium Physics*, CERN Yellow Report (2005)

Synergistic Activities

1. Reviewer, Journal of Women and Minorities in Science and Engineering, (1995–)

2. Instructor, Osher Continuing Education Institute, 2007-.

3. Primary instructor for Kansas Regents High Academy (KRHA190), summer 2002. Duties included teaching 140-person class of high school juniors and seniors selected from throughout the state of Kansas to attend special summer class on cosmology at the University of Kansas (June 10, 2002 – July 5)

Collaborators and Other Current Affiliations
<u>Collaborators and Co-Editors</u>

1. CLEO Collaboration (1983-present, author list at http://www.lns.cornell.edu/perl/people)

2. RICE Collaboration (1996-present, http://kuhep4.phsx.ku.edu/ iceman)

3. ANITA Collaboration (2002-present, http://www.phys.hawaii.edu/ anita/web)

4. ICECUBE Collaboration (2002-present, http://www.icecube.wisc.edu/collaboration)

Co-Editors: None

<u>Graduate and Postdoctoral Advisors</u>
Felix Sannes (Rutgers U.), Paul Avery (U. of Florida), Karl Berkelman (Cornell U.)

<u>Thesis Advisor and Postgraduate-Scholar Sponsor:</u>
Ned Hancock, Ilya Kravchenko, Sergei Kotov, Soebur Razzaque, Surujhedo Seunarine

<u>Total number of graduate students advised:</u> 11
<u>Total number of postdoctoral scholars sponsored:</u> 1

BIOGRAPHICAL SKETCH

Albrecht Karle

Professional Preparation
1990 M.Sc., Physics, University of Munich, Germany
1994 Ph.D., Physics, University of Munich, Germany

Appointments
Professor, Physics, University of Wisconsin-Madison

Publications
First year performance of the IceCube Neutrino Telescope, IceCube collaboration, submitted to Astroparticle Physics, March 2006.
Muon Flux at the Geographical South Pole, X.Bai, T.K.Gaisser, A.Karle, K.Rawlins, G.M.Spiczak, T. Stanev, in press, Astroparticle Physics, 2006, e-print archive: astro-ph/0602381.
Search for Extraterrestrial Point Sources of High Energy Neutrinos with AMANDA-II Using Data Collected in 2000-2002 (with AMANDA collaboration), Phys. Rev. D 71, 077102 (2005), e-print archive: astro-ph/0503122.
Flux Limits on Ultra High Energy Neutrinos with AMANDA-B10 (with M. Ackermann et al.), Astropart. Phys. 22, 339 (2005).
The IceCube Project (with the IceCube collaboration, C. Spiering et al.), arXiv: astro-ph/0404090.
Observations of high energy neutrinos with water/ice neutrino telescopes, Talk at the 9th International Conference on Topics in Astroparticle and Underground Physics, TAUP 2005, Zaragoza, September 2005, astro-ph/0602025
Search for Neutrino Induced Cascades with AMANDA (with AMANDA collaboration), Astropart. Phys. 22, 127 (2004).
Search for Extraterrestrial Point Sources of Neutrinos with AMANDA-II (with AMANDA collaboration), Phys. Rev. Lett. 92, 071102 (2004).
Measurement of the Cosmic Ray Composition at the Knee with the SPASE-2/AMANDA-B10 Detectors (with AMANDA collaboration), Astropart. Phys. 21, 565 (2004).
Calibration and Survey of AMANDA with the SPASE Detectors (with AMANDA/SPASE Collaboration), Nucl. Instr. Meth. A 522, 347 (2004).
Muon Track Reconstruction and Data Selection Techniques in AMANDA (with AMANDA collaboration), Nucl. Instr. Meth. A 524, 169 (2004).

Sensitivity of the IceCube Detector to Astrophysical Sources of High Energy Muon Neutrinos (with IceCube collaboration), Astropart. Phys. 20, 507 (2004).

Synergistic Activities
? URA Visiting Committee to Fermilab ? assessment of overall Fermilab Research Program
? South Pole Users Committee ? Advisory committee to the NSF and Raytheon Polar Programs
? Presented numerous lectures reaching scientists, students and the general public

List of Collaborators
The IceCube Collaboration
The AMANDA Collaboration

BIOGRAPHICAL SKETCH

Hagar Landsman

Professional Preparation

2004 Doctorate in Physics, Technion, Haifa, Israel
2000 Masters Degree, Technion, Haifa, Israel
1997 Bachelors Degree, Technion, Haifa, Israel

Appointments

Postdoctoral Research Associate, University of Wisconsin-Madison 2004 ? present
Graduate Student, Physics, OPAL and ATLAS collaborations, Technion, Haifa, Israel 1997 - 2004

Publications

Detection of atmospheric muon neutrinos with the IceCube 9-string detector, IceCube collaboration; astro-ph/07051781; Phys. Rev. D 76 027101 (2007).

Search for neutrino-induced cascades from gamma-ray bursts with AMANDA, IceCube collaboration, (to be published in Astrophys. Jour. 664 397-410 (2007); astro-ph/0702265v2.

Five years of searches for point sources of astrophysical neutrinos with the AMANDA-II neutrino telescope, IceCube collaboration, Phys. Review D 75 102001 (2007); astro-ph/0611063.

Optical properties of deep glacial ice at the South Pole, AMANDA collaboration, J. Geophys. Res. 111 D13203 DOI:10 1029 / 2005JD006687 (2006).

On the selection of AGN neutrino source candidates for a source stacking analysis with neutrino telescopes, IceCube collaboration, Astropart. Phys. 26 282-300 (2006).

Limits on the high-energy gamma and neutrino fluxes from the SGR 1806-20 giant flare of 27 December 2004 with the AMANDA-II detector, Ice Cube collaboration, Phys. Rev. Lett. 97 221101 (2006); astro-ph/0607233.

First year performance of the IceCube Neutrino Telescope, IceCube collaboration, Astropart. Phys. 26
155-173 (2006); astro-ph/0604450.

TeV photons and neutrinos from giant soft-gamma repeater flares (with F. Halzen and T. Montaruli), astro-ph/0503348 (2005).

Search for extraterrestrial point sources of high energy neutrinos with AMANDA-II using data collected in 2000-2002, AMANDA collaboration, Phys. Rev. D 71, 077102 (2005); astro-ph/0503122.

Flux Limits on Ultra High Energy Neutrinos with AMANDA-B10, AMANDA collaboration, Astropart. Phys. 22, 339 (2005).

BIOGRAPHICAL SKETCH

(This is a continuation page)

Synergistic Activities

? Participated in interviews and lectures reaching students and the general public, including one on IceCube recently on Wisconsin Public Radio.

? Represented IceCube at the Coalition for National Science Funding exhibition and reception in Washington, DC in June 2007.

? Designed, programmed and maintained ?Physweb,? a large-scale, web-based homework system used at Technion since 2000 to handle thousands of physics students each semester (perl, cgi programming).

? Videotaped classes for the Technion?s video libraray, the Center of Promotion of Teaching.

List of Collaborators

The IceCube Collaboration
The AMANDA Collaboration

Biographical Sketch
D.F. Cowen, Pennsylvania State University

Education

Dartmouth College	Physics	B.A. 1983
University of Wisconsin--Madison	Physics	M.S. 1985, Ph.D. 1990
California Institute of Technology	High Energy Physics	1990-1994

Appointments

2002-	Associate Professor of Physics and of Astronomy and Astrophysics The Pennsylvania State University, University Park, PA
1994-2002	Assistant Professor of Physics The University of Pennsylvania, Philadelphia, PA
1993-1994	Senior Research Fellow in Physics California Institute of Technology, Pasadena, CA
1990-1993	Research Fellow in Physics California Institute of Technology, Pasadena, CA

Publications Directly Related to Neutrino Astrophysics

- *Constraints on Cosmic Neutrino Fluxes from the ANITA Experiment*, S. Barwick, et al. (ANITA Collaboration), Phys. Rev. Lett. **96** (2006) 171101
- *Limits to the muon flux from neutralino annihilations in the Sun with the AMANDA detector*, M. Ackermann, et al. (ICECUBE Collaboration), Astropart. Phys. **24** (2006) 459 – 466.
- *Flux limits on ultra high energy neutrinos with AMANDA-B10*, M. Ackermann, et al. (AMANDA Collaboration), Astropart. Phys. **22** (2005) 339–353.
- *Search for extraterrestrial point sources of high energy neutrinos with AMANDA-II using data collected in 2000-2002*, M. Ackermann, et al. (AMANDA Collaboration), Phys. Rev. **D71** (2005) 077102.
- *Observation of high energy neutrinos with Cherenkov detectors embedded in deep Antarctic ice*, E. Andres, et al. (AMANDA Collaboration), Nature **410**, (2001) 441–443.

Other Publications

- *Search for neutrino-induced cascades with AMANDA*, M. Ackermann, et al. (AMANDA Collaboration), Astropart. Phys. **22** (2004) 127–138.
- *Search for Neutrino-Induced Cascades with the AMANDA Detector*, J. Ahrens, et al. (AMANDA Collaboration), Phys. Rev. **D67** (2003) 012003.
- *Solar and Reactor Neutrinos* and *Detectors and Data Acquisition*, D.F. Cowen in Proc. 7th School on Non-Accelerator Astroparticle Physics, Trieste, Italy, Carrigan, Giacomelli, Paver Eds., World Scientific 2005.
- *Results from the AMANDA Neutrino Telescope at the South Pole*, D.F. Cowen for the AMANDA Collaboration, Proc. XXth International Conference on Neutrino Physics and Astrophysics (Neutrino 2002), Nucl. Phys. B Proc. Suppl., 2002.

- *First Physics Results from the AMANDA Neutrino Telescope*, D.F. Cowen for the AMANDA Collaboration, Proc. International Conference High Energy Physics (ICHEP 2000), Osaka, Japan, 2000.

Synergistic Activities

- Initiated and currently oversee the Physics and Astronomy for Women (PAW) group at Penn State, providing mentoring for women taking introductory Physics and Astronomy courses, inviting prominent female scientists for seminars and colloquia, performing outreach activities in local elementary schools, 2002-present. With five particle astrophysics colleagues, taught a 1-week for-credit summer course in particle astrophysics for high school teachers. Will continue offering this course through 2009.

Collaborators (last 5 years)

- Members of the IceCube Collaboration (Ch. Spiering, DESY-Zeuthen, Spokesperson)
- Members of the SNO Collaboration (A. MacDonald, Queens University, Spokesperson)

Graduate and Postdoctoral Advisors

- Graduate Advisor: Prof. Sau Lan Wu, University of Wisconsin-Madison
- Postdoctoral Advisors: Profs. Barry Barish and Alan Weinstein, Caltech

Undergraduate, Graduate and Postdoctoral Advisees

- Ex-graduate students and Postdoctoral advisees (with present location):
  - Dr. Toni Coarasa (MPI-Munich)
  - Dr. Kael Hanson (Scientist, UW-Madison)
  - Dr. Martin Kestel (German software industry)
  - Dr. Doug McDonald (ETS), Dr. Mark Neubauer (MIT) and Dr. Peter Wittich (Asst. Prof., Cornell) [with Prof. Gene Beier at U. of Pennsylvania]
  - Dr. Seon-Hee Seo (University of Stockholm)
  - Dr. Ignacio Taboada (UC-Berkeley)
  - Ms. Laura Voicu (University of Zuerich)
- Undergraduate Students (2003-present only)
  - Mr. David Atlee (OSU Astronomy Department)
  - Mr. Mark Foerster
  - Ms. Jessie Hart
  - Mr. Vincent Viscomi
- Graduate Students
  - Mr. Chang-Hyon Ha
  - Mr. Steven Movit
  - Mr. Douglas Rutledge
  - Mr. William Robbins
- Research Associates and Postdoctoral Advisees:
  - Dr. Brendan Fox
  - Dr. Darren Grant
  - Dr. Carsten Rott
  - Dr. Patrick Toale
  - Dr. Dawn Williams

SUMMARY PROPOSAL BUDGET

YEAR 1

ORGANIZATION **University of Hawaii**					**FOR NSF USE ONLY** PROPOSAL NO. / DURATION (months): Proposed / Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR **Robert M Morse**					AWARD NO.

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Robert M Morse - Professor - PI**	2.00	0.00	0.00	$ **20,000**	$
2.					
3.					
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**1**) TOTAL SENIOR PERSONNEL (1 - 6)	2.00	0.00	0.00	**20,000**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**1**) POST DOCTORAL SCHOLARS	12.00	0.00	0.00	**47,000**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**1**) GRADUATE STUDENTS				**21,343**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**88,343**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**1,780**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**90,123**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.) **detector electronics--unit 1** $ **70,000** **detector electronics-unit 2** **70,000**					
TOTAL EQUIPMENT				**140,000**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**6,000**	
2. FOREIGN				**4,000**	
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ **0** 2. TRAVEL **0** 3. SUBSISTENCE **0** 4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**5,000**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**5,000**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**245,123**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **salaries and fringes (Rate: 20.6000, Base: 43123) (Cont. on Comments Page)**					
TOTAL INDIRECT COSTS (F&A)				**11,973**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**257,096**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **257,096**	$
M. COST SHARING PROPOSED LEVEL $ **0**	AGREED LEVEL IF DIFFERENT $				

PI/PD NAME **Robert M Morse**	**FOR NSF USE ONLY** INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME*	Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET COMMENTS - Year 1

**** I- Indirect Costs**
services (Rate: 20.6000, Base 5000)
travel (Rate: 20.6000, Base 10000)

SUMMARY PROPOSAL BUDGET

YEAR 2

ORGANIZATION **University of Hawaii**	FOR NSF USE ONLY PROPOSAL NO.	DURATION (months) Proposed / Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR **Robert M Morse**	AWARD NO.	

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Robert M Morse - Professor - PI**	2.00	0.00	0.00	$ **20,000**	$
2.					
3.					
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**1**) TOTAL SENIOR PERSONNEL (1 - 6)	2.00	0.00	0.00	**20,000**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**1**) POST DOCTORAL SCHOLARS	12.00	0.00	0.00	**48,000**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**1**) GRADUATE STUDENTS				**21,343**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**89,343**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**1,780**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**91,123**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.) **detector unit - 3** $ **70,000** **detector unit-4** **70,000**					
TOTAL EQUIPMENT				**140,000**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**6,000**	
2. FOREIGN				**4,000**	
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ **0** 2. TRAVEL **0** 3. SUBSISTENCE **0** 4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**5,000**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**1,000**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**6,000**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**247,123**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **salaries and fringes (Rate: 20.6000, Base: 43123) (Cont. on Comments Page)**					
TOTAL INDIRECT COSTS (F&A)				**12,179**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**259,302**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **259,302**	$

M. COST SHARING PROPOSED LEVEL $ **0**	AGREED LEVEL IF DIFFERENT $
PI/PD NAME **Robert M Morse**	FOR NSF USE ONLY INDIRECT COST RATE VERIFICATION
ORG. REP. NAME*	Date Checked / Date Of Rate Sheet / Initials - ORG

 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET COMMENTS - Year 2

** I- Indirect Costs
services (Rate: 20.6000, Base 6000)
travel (Rate: 20.6000, Base 10000)

SUMMARY PROPOSAL BUDGET

YEAR 3

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months)	
	Proposed	Granted
AWARD NO.		

ORGANIZATION
University of Hawaii

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Robert M Morse

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. Robert M Morse - Professor - PI	2.00	0.00	0.00	$ 20,000	$
2.					
3.					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	2.00	0.00	0.00	20,000	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (1) POST DOCTORAL SCHOLARS	12.00	0.00	0.00	49,000	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (1) GRADUATE STUDENTS				21,343	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				90,343	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				1,780	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				92,123	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.) detector electronics--unit 5 $ 20,000					
TOTAL EQUIPMENT				20,000	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				5,000	
2. FOREIGN				4,000	
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ 0 2. TRAVEL 0 3. SUBSISTENCE 0 4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				5,000	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				1,000	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				0	
TOTAL OTHER DIRECT COSTS				6,000	
H. TOTAL DIRECT COSTS (A THROUGH G)				127,123	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) salaries and fringes (Rate: 20.6000, Base: 43123) (Cont. on Comments Page)					
TOTAL INDIRECT COSTS (F&A)				11,973	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				139,096	
K. RESIDUAL FUNDS				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 139,096	$

M. COST SHARING PROPOSED LEVEL $ 0 AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Robert M Morse

ORG. REP. NAME*

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET COMMENTS - Year 3

** I- Indirect Costs
services (Rate: 20.6000, Base 6000)
travel (Rate: 20.6000, Base 9000)

SUMMARY PROPOSAL BUDGET

Cumulative

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months)	
	Proposed	Granted
AWARD NO.		

ORGANIZATION
University of Hawaii

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Robert M Morse

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. Robert M Morse - Professor - PI	6.00	0.00	0.00	$ 60,000	$
2.					
3.					
4.					
5.					
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	6.00	0.00	0.00	60,000	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (3) POST DOCTORAL SCHOLARS	36.00	0.00	0.00	144,000	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (3) GRADUATE STUDENTS				64,029	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				268,029	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				5,340	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				273,369	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.) $ 300,000					
TOTAL EQUIPMENT				300,000	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				17,000	
2. FOREIGN				12,000	
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ 0 2. TRAVEL 0 3. SUBSISTENCE 0 4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				15,000	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				2,000	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				0	
TOTAL OTHER DIRECT COSTS				17,000	
H. TOTAL DIRECT COSTS (A THROUGH G)				619,369	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				36,125	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				655,494	
K. RESIDUAL FUNDS				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 655,494	$

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Robert M Morse

ORG. REP. NAME*

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

C *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

Budget Justification

Scope and Phasing of the IceRay Task. IceRay is scheduled as a three-year multi-university investigation. In the first year season at South Pole (FY-09) we plan to install two remote radio-detectors in proximity to the IceCube detector. These detectors will make almost exclusive use of ANITA technology so that little R&D work is required beyond making them deployable in the deep Antarctic Ice. Getting two detectors into the ice is important since it will allow us to study radio correlations between detectors as well as correlations with the IceCube detector.

In the second season at South Pole (FY-10), we plan to install two more radio-detectors near IceCube. These four detectors will yield more detailed information on the correlations between detectors, trigger formation schemes(using electronic pulses), radio propagation through the ice as well as possible IceCube-radio correlations (so-called reverse triggers)

In the third year of the proposal we plan to concentrate fully on the data analysis and the development of more detailed simulations, and the reconciliation of simulation results with the actual harvested data. To this end, we hope in the third year to cap our efforts by proposing for the actual construction of IceRay-36, a 50 square-kilometer GZK neutrino detector, starting in the FY-11 season.

Direct Labor Costs. The University of Hawaii-Manoa (H) budget includes a full-time post-doctoral fellow, a graduate student fully devoted to the project, and two months of ”casual-hire” for the PI, Professor Morse, since he is not an employee, but is ”Affiliate Graduate Faculty” at UH. As such, he pays nominal fringe benefits, and normal overhead is charged on his compensation. Post-doctoral fellows at UH are supported via stipends, since they are involved in ”post-doctoral training”. They do not receive fringe benefits, and their stipend is not subject to overhead. Graduate students are subject to fringe benefits charges at 8.34and normal university overhead.

The post-doc and graduate student will be responsible for the assembly, and integration of ANITA components into the IceRay detector units. Testing will include operating the units in the UH anechoic chamber and transferring the data to the Central DAQ. Analysis Software to run the Central-DAQ will be provided by our colleagues at OSU and Wisconsin. The post-doc and graduate student will also serve as daily liaisons between our IceRay collaborators as well as the IceCube experiment. The PI will work with the cognizant IceCube task leaders to ensure that IceRay works within the guidelines of ”no-interference” to normal operations of the IceCube detector, and to coordinate between the various IceRay university groups, and to participate in the deployment, analysis, and modeling of IceRay.

Travel. Travel includes support for three to four domestic person trips per year to work with our colleagues, mostly at OSU and Madison (IceCube headquarters), and also to attend the semi-annual IceCube meetings. We also include support for two to three foreign trips to attend the annual IceCube meeting hosted by our European Collaborators, and to consult with our European IceCube collaborators that will also be analyzing the IceRay data.

Other Direct Costs. We include in the budget incidental materials and supplies based on our experience with similar projects.

Equipment and Fabrication. The IceRay array will consists of 4 remote radio-Cherenkov detector stations and a Central-DAQ data collecting station located in the IceCube Laboratory (ICL) at the South Pole. The remote stations basically consist of a suite of antennas connected to low-noise 50 kb amplifiers (LNAs), further amplified with secondary amplifiers (SSAs)). Coincidences between antennas provide the local trigger and the resulting signals are time-digitized and sent back to the ICL for integration with other detectors signals and analysis. The UH is concentrating of the remote stations, while Wisconsin and OSU are constructing the ICL Central-DAQ. The detector unit cost is about 70 k$ per station (without cables), and the detailed Central DAQ cost is about 30 K$ to operate the four detectors. The table also includes the projected costs for the entire IceRay-36 structure.

Indirect Costs. F&A costs are included at the Universities negotiated rate with the cognizant agency.

Estimated Costs for the Full IceRay.

TABLE IV: *Estimated hardware construction and deployment costs for the two arrays considered here, along with the cost basis.*

item	IceRay-36 $K	AURA-18 $K
Engineering design	250	250
Station costs	3000	1620
Cable costs	600	450
Drilling (3 holes/station)	...	1600
Surface deployment	600	300
Central DAQ/power system	300	300
TOTAL	4750	4520

Costs for these arrays scale according to the number of stations. In each case the common elements for the arrays are a set of order 12-16 antennas which comprise the standalone detector, receiver and digitizer blocks for each antenna, local trigger detection electronics and signal transmission electronics for an electro-optical cable. We assume that the central Data Acquisition (DAQ) system can rely on IceCube infrastructure for housing of the system and power distribution.

TABLE V: Grassroots costs for IceRay-36, along with cost basis.

IceRay-36 Equipment Cost Estimate				
			Rev. 2.0	GSV + PG, 09/01/2007
		Unit Cost	TOTAL	
Detector Station	**Qty.**	**k$**	**k$**	**Comment, cost basis**
Upper Ground shield	1	2.0	2.0	flexible EMI mesh screen, as built costs
Antennas	16	0.75	12.0	discones (V), batwings (H), as built costs
LNA/receiver	4	7.00	28.0	Miteq LNA, ANITA rcvr design, as built costs
RF cables	16	0.05	0.8	incl. Connectors, as built costs
Power cables/connectors	6	0.20	1.2	shielded D38999 with backshells, as built
Station DAQ EMI housing	1	2.00	2.0	Machined RF-shielded encl., as built
Readout Board	1	5.00	5.0	8 layer boards, as built costs incl. labor
Trigger/FPGA	1	1.00	1.0	Virtex 4/5, RF fan-out, incl. Firmware costs
Digitizer ASIC	2	0.50	1.0	BLAB3 (TSMC 0.25um)
Trigger/discrete components	16	0.40	6.4	filters+square-laws, as built costs
Gbsp transceiver	1	0.80	0.8	OKI Semiconductor, eng. Estimate
Station data cable	1	9.00	9.0	average 3km, Corning ALTOS 24 fiber,$3/m
Station power cable	1	18.00	18.0	3km LDF-5 heliax (for EMI), $6/m
Power Reg/misc.	1	1.20	1.2	DC-DC, housekeeping, as built costs
drilling costs, 24" holes, 50m	3	6.60	19.8	from IceCube firn drill estimate
Single station costs			**108.2**	**$K**
reserves 15%			**16.23**	
Total # of stations	**36**			
Station Subtotal			**4479**	**$K**
Central DAQ			*General Infrastructure not included--use IceCube*	
Gbsp transceiver	60	0.80	48.0	matching links, engineering estimate
Interface Boards	10	3.50	35.0	5 stations/board, engineering estimate
cPCI DAQ crate	2	6.00	12.0	1 + spare, std. Commercial costs
cPCI CPU	2	4.00	8.0	1 + spare "
Processor farm	10	2.50	25.0	event reduction/correlation
Storage media	2	20.00	40.0	RAID systems
Network/comms	1	12.00	12.0	routers, hubs, ICL link
GPS/global clock	2	7.50	15.0	1 system + 1 spare
Power gen/regul.	1	30.00	30.0	mainframe power supply, commercial
Power pods	40	1.00	40.0	modular+spares
Central DAQ Subtotal, incl 15% reserves			**304.8**	**$K**
GRAND TOTAL ESTIMATE			**4784**	**$K**

For IceRay-18 we assume that 3 holes per station will be required for minimal reconstruction of vertex directions, and that the stations will have some additional complexity to accommodate the borehole geometry, including more stringent antenna construction requirements as well as embedded amplifier modules. Thus the single station costs assumed here are about $90K for IceRay-18, and $50K for the IceRay-36. These costs are based on pricing of a station prototype currently under development and are probably good to 15% accuracy based on current and prior vendor prices from almost all of the equipment. Cable costs are assumed to be $10/meter based on conservative costs for a custom electro-optical cable. Drilling costs are based on estimates from other shallow holes drilled on the plateau, and assume that three holes per station will be required for effective direction reconstruction and triggering with a single station.

Table IV give a summary estimate; more detailed costs were developed in a spreadsheet that is reproduced in Table V. The estimated base costs for the hardware and deployment here do not include scientific or professional salaries except for a single line item we include for the engineering design of the arrays. In that case we assume a single engineering man-year, estimated here at $250K. We also do not include here the logistics costs for transport of the hardware and personnel necessary for the construction or deployment to the South Pole.

In both cases, initial estimates give hardware construction and direct deployment costs under $5M. These systems do not require development of any new technology, thus a realistic contingency on these costs is probably well under 30%.

SUMMARY PROPOSAL BUDGET

YEAR 1

ORGANIZATION **Ohio State University Research Foundation**	FOR NSF USE ONLY PROPOSAL NO.	DURATION (months) Proposed	Granted		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR **James J Beatty**	AWARD NO.				

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. James J Beatty - Professor	0.00	0.00	0.00	$ 0	$
2.					
3.					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	0	
2. (1) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	6.00	0.00	0.00	24,000	
3. (1) GRADUATE STUDENTS				22,090	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				46,090	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				9,385	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				55,475	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.) Data Acquisition System-Part I $ 10,000					
TOTAL EQUIPMENT				10,000	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				8,000	
2. FOREIGN				3,000	
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ 0 2. TRAVEL 0 3. SUBSISTENCE 0 4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				5,000	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				13,296	
TOTAL OTHER DIRECT COSTS				18,296	
H. TOTAL DIRECT COSTS (A THROUGH G)				94,771	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) Ohio State-On Campus 50% of MTDC (Rate: 50.0000, Base: 71475)					
TOTAL INDIRECT COSTS (F&A)				35,738	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				130,509	
K. RESIDUAL FUNDS				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 130,509	$
M. COST SHARING PROPOSED LEVEL $ 0	AGREED LEVEL IF DIFFERENT $				

PI/PD NAME **James J Beatty**	FOR NSF USE ONLY INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME* **Lisa Jones**	Date Checked	Date Of Rate Sheet	Initials - ORG

1 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET

YEAR 2

ORGANIZATION: **Ohio State University Research Foundation**				FOR NSF USE ONLY — PROPOSAL NO.	DURATION (months): Proposed / Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **James J Beatty**				AWARD NO.	

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. James J Beatty - Professor	0.00	0.00	0.00	$ 0	$
2.					
3.					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	0	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	6.00	0.00	0.00	24,960	
3. (1) GRADUATE STUDENTS				22,974	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				47,934	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				10,594	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				58,528	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.) Data Acquisition System-Part II $ 5,000					
TOTAL EQUIPMENT				5,000	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				8,000	
2. FOREIGN				3,000	
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ 0 2. TRAVEL 0 3. SUBSISTENCE 0 4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				5,000	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				13,600	
TOTAL OTHER DIRECT COSTS				18,600	
H. TOTAL DIRECT COSTS (A THROUGH G)				93,128	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) Ohio State-On Campus 50% of MTDC (Rate: 50.0000, Base: 74528)					
TOTAL INDIRECT COSTS (F&A)				37,264	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				130,392	
K. RESIDUAL FUNDS				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 130,392	$
M. COST SHARING PROPOSED LEVEL $ 0	AGREED LEVEL IF DIFFERENT $				

PI/PD NAME: **James J Beatty**	FOR NSF USE ONLY — INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME*: **Lisa Jones**	Date Checked	Date Of Rate Sheet	Initials - ORG

 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET

YEAR 3

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months)	
	Proposed	Granted
AWARD NO.		

ORGANIZATION
Ohio State University Research Foundation

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
James J Beatty

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. James J Beatty - Professor	0.00	0.00	0.00	$ 0	$
2.					
3.					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	0	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	6.00	0.00	0.00	25,958	
3. (1) GRADUATE STUDENTS				23,893	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				49,851	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				11,515	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				61,366	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				8,000	
2. FOREIGN				3,000	
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ 0 2. TRAVEL 0 3. SUBSISTENCE 0 4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				5,000	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				14,416	
TOTAL OTHER DIRECT COSTS				19,416	
H. TOTAL DIRECT COSTS (A THROUGH G)				91,782	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) Ohio State-On Campus 50% of MTDC (Rate: 50.0000, Base: 77366)					
TOTAL INDIRECT COSTS (F&A)				38,683	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				130,465	
K. RESIDUAL FUNDS				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 130,465	$

M. COST SHARING PROPOSED LEVEL $ 0 AGREED LEVEL IF DIFFERENT $

PI/PD NAME
James J Beatty

ORG. REP. NAME*
Lisa Jones

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET

Cumulative

ORGANIZATION Ohio State University Research Foundation				FOR NSF USE ONLY PROPOSAL NO.	DURATION (months) Proposed / Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR James J Beatty				AWARD NO.	
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. James J Beatty - Professor	0.00	0.00	0.00	$ 0	$
2.					
3.					
4.					
5.					
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	0	
2. (1) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	18.00	0.00	0.00	74,918	
3. (3) GRADUATE STUDENTS				68,957	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				143,875	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				31,494	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				175,369	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.) $ 15,000					
TOTAL EQUIPMENT				15,000	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				24,000	
2. FOREIGN				9,000	
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ 0 2. TRAVEL 0 3. SUBSISTENCE 0 4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				15,000	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				41,312	
TOTAL OTHER DIRECT COSTS				56,312	
H. TOTAL DIRECT COSTS (A THROUGH G)				279,681	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				111,685	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				391,366	
K. RESIDUAL FUNDS				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 391,366	$
M. COST SHARING PROPOSED LEVEL $ 0	AGREED LEVEL IF DIFFERENT $				
PI/PD NAME James J Beatty		FOR NSF USE ONLY INDIRECT COST RATE VERIFICATION			
ORG. REP. NAME* Lisa Jones		Date Checked	Date Of Rate Sheet	Initials - ORG	

C *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

Notes to the Budget

Our budget was prepared to cover our IceRay tasks, which include design and programming of the central data acquisition (DAQ) and trigger in collaboration with the Wisconsin group, and participation in data analysis.

We include one-half FTE of an information technology professional (programmer/analyst). This person will be drawn from our excellent computing support group, and may well be a composite of a few staff members with complementary areas of expertise. Associating this position with the computing support group will facilitate continuity in what is likely to be a long term project. We also include one graduate student. The graduate student will participate in DAQ and trigger development and in data analysis. No salary support is requested for the PI, who will be involved in both DAQ development and analysis activities. Fringe benefits are included at the applicable rates as direct charges.

Equipment includes $15K for the data acquisition system, which we will design and implement in collaboration with the Wisconsin group. Our focus will be on the central trigger, event building, and event selection.

We include $8K travel each year to support participation in project meetings, which we anticipate might be held at the University of Hawaii, University of Wisconsin, and other collaborating institutions. $3K per is budgeted for participation in European IceCube meetings, because of the close coupling between IceRay and IceCube. $5K is budgeted for materials and supplies, based on our experience with similar projects.

F&A costs are included at the University's negotiated rate with the cognizant agency, the Department of Health and Human Services.

SUMMARY PROPOSAL BUDGET

YEAR 1

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months)	
	Proposed	Granted
AWARD NO.		

ORGANIZATION
University of Maryland College Park

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Kara D Hoffman

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Kara D Hoffman - none**	0.00	0.00	0.00	$ **0**	$
2.					
3.					
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**1**) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	**0**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**1**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	1.20	0.00	0.00	**12,000**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**12,000**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**3,600**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**15,600**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**0**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ **0** 2. TRAVEL **0** 3. SUBSISTENCE **0** 4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**0**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**0**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**15,600**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **Indirect at 50% (Rate: 50.0000, Base: 15600)**					
TOTAL INDIRECT COSTS (F&A)				**7,800**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**23,400**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **23,400**	$

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Kara D Hoffman

ORG. REP. NAME*
Wendy Montgomery

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

1 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

YEAR 2

ORGANIZATION **University of Maryland College Park**			FOR NSF USE ONLY PROPOSAL NO.	DURATION (months) Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR **Kara D Hoffman**			AWARD NO.		

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Kara D Hoffman - none**	0.00	0.00	0.00	$ **0**	$
2.					
3.					
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**1**) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	**0**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**1**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	1.20	0.00	0.00	**12,000**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**12,000**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**3,600**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**15,600**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**0**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ **0** 2. TRAVEL **0** 3. SUBSISTENCE **0** 4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**0**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**0**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**15,600**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **Indirect at 50% (Rate: 50.0000, Base: 15600)**					
TOTAL INDIRECT COSTS (F&A)				**7,800**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**23,400**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **23,400**	$
M. COST SHARING PROPOSED LEVEL $ **0**	AGREED LEVEL IF DIFFERENT $				

PI/PD NAME **Kara D Hoffman**	FOR NSF USE ONLY INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME* **Wendy Montgomery**	Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

YEAR 3

FOR NSF USE ONLY					
PROPOSAL NO.	DURATION (months)				
	Proposed	Granted			
AWARD NO.					

ORGANIZATION
University of Maryland College Park

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Kara D Hoffman

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. Kara D Hoffman - none	0.00	0.00	0.00	$ 0	$
2.					
3.					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	0	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (1) GRADUATE STUDENTS				23,000	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				23,000	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				6,900	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				29,900	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				0	
2. FOREIGN				0	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ 0					
2. TRAVEL 0					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				0	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				6,000	
TOTAL OTHER DIRECT COSTS				6,000	
H. TOTAL DIRECT COSTS (A THROUGH G)				35,900	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) Indirect on total - Other(tuition remission) (Rate: 50.0000, Base: 29900)					
TOTAL INDIRECT COSTS (F&A)				14,950	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				50,850	
K. RESIDUAL FUNDS				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 50,850	$

M. COST SHARING PROPOSED LEVEL $ 0 AGREED LEVEL IF DIFFERENT $

PI/PD NAME	FOR NSF USE ONLY		
Kara D Hoffman	INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME*	Date Checked	Date Of Rate Sheet	Initials - ORG
Wendy Montgomery			

 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET
Cumulative

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months)	
	Proposed	Granted
AWARD NO.		

ORGANIZATION
University of Maryland College Park

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Kara D Hoffman

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. Kara D Hoffman - none	0.00	0.00	0.00	$ 0	$
2.					
3.					
4.					
5.					
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	0	
2. (2) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	2.40	0.00	0.00	24,000	
3. (1) GRADUATE STUDENTS				23,000	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				47,000	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				14,100	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				61,100	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				0	
2. FOREIGN				0	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ 0					
2. TRAVEL 0					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				0	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				6,000	
TOTAL OTHER DIRECT COSTS				6,000	
H. TOTAL DIRECT COSTS (A THROUGH G)				67,100	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				30,550	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				97,650	
K. RESIDUAL FUNDS				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 97,650	$

M. COST SHARING PROPOSED LEVEL $ 0 — AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Kara D Hoffman

ORG. REP. NAME*
Wendy Montgomery

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

C *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

Budget Justification

A. Senior Personnel

No support is requested for the Co-Pi Hoffman.

B. Other Salaries

Years 1 and 2 request 10% FTE of an electrical engineer for development and testing of front-end-electronics. In year 3 we request support for one graduate student.

C. Fringe Benefits

30% of salary for fringe benefits.

D. Equipment

No equipment funds are requested in this proposal. Electrical parts for development and deployment work are requested in Hoffman's pending CAREER proposal (0748595).

E. Travel

No travel support requested

G. Other Direct Costs

$6,000 in year 3 for tuition remission of one graduate student.

I. Indirect Costs

Indirect costs of 50% on base. Tuition remission in year 3 has no indirect added.

Additional Info:

The bulk of funding for this work, including all equipment cost, was requested in Hoffman's pending CAREER proposal (0748595) of $481,000 for 60 months with a requested starting date of 1 Jan 2008.

SUMMARY PROPOSAL BUDGET

YEAR 1

ORGANIZATION **Massachusetts Institute of Technology**				FOR NSF USE ONLY PROPOSAL NO.	DURATION (months) Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR **Ilya Kravchenko**				AWARD NO.		
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)	
1. **Ilya Kravchenko - none**	0.00	0.00	0.00	$ 0	$	
2.						
3.						
4.						
5.						
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0		
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0		
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)						
1. (0) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	0		
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0		
3. (0) GRADUATE STUDENTS				0		
4. (0) UNDERGRADUATE STUDENTS				0		
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0		
6. (0) OTHER				0		
TOTAL SALARIES AND WAGES (A + B)				0		
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				0		
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				0		
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)						
TOTAL EQUIPMENT				0		
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				0		
2. FOREIGN				0		
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ 0 2. TRAVEL 0 3. SUBSISTENCE 0 4. OTHER 0						
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0		
G. OTHER DIRECT COSTS						
1. MATERIALS AND SUPPLIES				0		
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0		
3. CONSULTANT SERVICES				0		
4. COMPUTER SERVICES				0		
5. SUBAWARDS				0		
6. OTHER				0		
TOTAL OTHER DIRECT COSTS				0		
H. TOTAL DIRECT COSTS (A THROUGH G)				0		
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **(Rate: , Base:)**						
TOTAL INDIRECT COSTS (F&A)				0		
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				0		
K. RESIDUAL FUNDS				0		
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 0	$	
M. COST SHARING PROPOSED LEVEL $ 0	AGREED LEVEL IF DIFFERENT $					
PI/PD NAME **Ilya Kravchenko**				FOR NSF USE ONLY INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME*				Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

YEAR 2

	FOR NSF USE ONLY		
ORGANIZATION **Massachusetts Institute of Technology**	PROPOSAL NO.	DURATION (months)	
		Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR **Ilya Kravchenko**	AWARD NO.		

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Ilya Kravchenko - none**	0.00	0.00	0.00	$ 0	$
2.					
3.					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	0	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (0) GRADUATE STUDENTS				0	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				0	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				0	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				0	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				0	
2. FOREIGN				0	
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ 0 2. TRAVEL 0 3. SUBSISTENCE 0 4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				0	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				0	
TOTAL OTHER DIRECT COSTS				0	
H. TOTAL DIRECT COSTS (A THROUGH G)				0	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **(Rate: , Base:)**					
TOTAL INDIRECT COSTS (F&A)				0	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				0	
K. RESIDUAL FUNDS				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 0	$

M. COST SHARING PROPOSED LEVEL $ 0	AGREED LEVEL IF DIFFERENT $

	FOR NSF USE ONLY		
PI/PD NAME **Ilya Kravchenko**	INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME*	Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

YEAR 3

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months)	
	Proposed	Granted
AWARD NO.		

ORGANIZATION
Massachusetts Institute of Technology

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Ilya Kravchenko

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Ilya Kravchenko - none**	0.00	0.00	0.00	$ **0**	$
2.					
3.					
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**1**) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	**0**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**0**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**0**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**0**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**0**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**0**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**0**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**0**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **(Rate: , Base:)**					
TOTAL INDIRECT COSTS (F&A)				**0**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**0**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **0**	$
M. COST SHARING PROPOSED LEVEL $ **0**	AGREED LEVEL IF DIFFERENT $				

PI/PD NAME
Ilya Kravchenko

ORG. REP. NAME*

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

Cumulative

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months)	
	Proposed	Granted
AWARD NO.		

ORGANIZATION
Massachusetts Institute of Technology

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Ilya Kravchenko

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. Ilya Kravchenko - none	0.00	0.00	0.00	$ 0	$
2.					
3.					
4.					
5.					
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	0	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (0) GRADUATE STUDENTS				0	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				0	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				0	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				0	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				0	
2. FOREIGN				0	
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ 0 2. TRAVEL 0 3. SUBSISTENCE 0 4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				0	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				0	
TOTAL OTHER DIRECT COSTS				0	
H. TOTAL DIRECT COSTS (A THROUGH G)				0	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				0	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				0	
K. RESIDUAL FUNDS				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 0	$

M. COST SHARING PROPOSED LEVEL $ 0 AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Ilya Kravchenko

ORG. REP. NAME*

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

C *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET

YEAR 1

ORGANIZATION **University of Delaware**				FOR NSF USE ONLY PROPOSAL NO.	DURATION (months) Proposed / Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR **David Seckel**				AWARD NO.	

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **David Seckel - Professor**	0.00	0.00	0.00	$ 0	$
2.					
3.					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (1) POST DOCTORAL SCHOLARS	6.00	0.00	0.00	21,091	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (0) GRADUATE STUDENTS				0	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				21,091	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				7,171	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				28,262	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				2,000	
2. FOREIGN				0	
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ 0 2. TRAVEL 0 3. SUBSISTENCE 0 4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				3,000	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				0	
TOTAL OTHER DIRECT COSTS				3,000	
H. TOTAL DIRECT COSTS (A THROUGH G)				33,262	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **MTDC (Rate: 53.0000, Base: 33262)**					
TOTAL INDIRECT COSTS (F&A)				17,629	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				50,891	
K. RESIDUAL FUNDS				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 50,891	$
M. COST SHARING PROPOSED LEVEL $ 0	AGREED LEVEL IF DIFFERENT $				

PI/PD NAME **David Seckel**	FOR NSF USE ONLY INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME* **Geraldine Hobbs**	Date Checked	Date Of Rate Sheet	Initials - ORG

1 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY YEAR 2
PROPOSAL BUDGET

	FOR NSF USE ONLY		
ORGANIZATION: **University of Delaware**	PROPOSAL NO.	DURATION (months)	
		Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **David Seckel**	AWARD NO.		

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **David Seckel - Professor**	0.00	0.00	0.00	$ 0	$
2.					
3.					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (1) POST DOCTORAL SCHOLARS	10.00	0.00	0.00	36,470	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (0) GRADUATE STUDENTS				0	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				36,470	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				12,400	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				48,870	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				2,000	
2. FOREIGN				0	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ 0					
2. TRAVEL 0					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				0	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				0	
TOTAL OTHER DIRECT COSTS				0	
H. TOTAL DIRECT COSTS (A THROUGH G)				50,870	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **MTDC (Rate: 53.0000, Base: 50870)**					
TOTAL INDIRECT COSTS (F&A)				26,961	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				77,831	
K. RESIDUAL FUNDS				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 77,831	$
M. COST SHARING PROPOSED LEVEL $ 0	AGREED LEVEL IF DIFFERENT $				

	FOR NSF USE ONLY		
PI/PD NAME: **David Seckel**	INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME*: **Geraldine Hobbs**	Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET YEAR 3

	FOR NSF USE ONLY		
ORGANIZATION **University of Delaware**	PROPOSAL NO.	DURATION (months)	
		Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR **David Seckel**	AWARD NO.		

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **David Seckel - Professor**	0.00	0.00	0.00	$ **0**	$
2.					
3.					
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**1**) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	**0**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**1**) POST DOCTORAL SCHOLARS	6.00	0.00	0.00	**22,703**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**22,703**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**7,719**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**30,422**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**2,000**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ **0** 2. TRAVEL **0** 3. SUBSISTENCE **0** 4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**0**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**0**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**32,422**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **MTDC (Rate: 53.0000, Base: 32422)**					
TOTAL INDIRECT COSTS (F&A)				**17,184**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**49,606**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **49,606**	$
M. COST SHARING PROPOSED LEVEL $ **0**	AGREED LEVEL IF DIFFERENT $				

PI/PD NAME **David Seckel**	FOR NSF USE ONLY INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME* **Geraldine Hobbs**	Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

Cumulative

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months)	
	Proposed	Granted
AWARD NO.		

ORGANIZATION
University of Delaware

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
David Seckel

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **David Seckel - Professor**	0.00	0.00	0.00	$ **0**	$
2.					
3.					
4.					
5.					
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**1**) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	**0**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**3**) POST DOCTORAL SCHOLARS	22.00	0.00	0.00	**80,264**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**80,264**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**27,290**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**107,554**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**6,000**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**3,000**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**3,000**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**116,554**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				**61,774**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**178,328**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **178,328**	$

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
David Seckel

ORG. REP. NAME*
Geraldine Hobbs

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

C ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

Budget Justification – Collaborative Research: IceRay-36

The budget provides support for 22 months of a post doctoral scientist. The main duties of this person will be to a) design and maintain simulation code in support of the IceRay-36 project, b) write significant parts of the code, and c) perform analysis of different detector designs using the code. A critical part of tasks a) and b) is that simulation is usable by all members of the collaboration, allowing for efficient and consistent study of detector options. At that moment we target post doctoral scientist Shahid Hussain for this position. He has significant experience with the RICE and AURA simulation codes, having designed and written the latter. The University of Delaware's fringe benefits rate for faculty and professionals is 34%.

We budget travel for two collaboration meetings assuming domestic travel, per yr. A workstation is budgeted for year 1, to be used in code development and small analysis tasks.

The University of Delaware's negotiated facilities and administrative cost rate for federal research is 53% based on modified total direct costs.

SUMMARY PROPOSAL BUDGET

YEAR 1

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months)	
	Proposed	Granted
AWARD NO.		

ORGANIZATION
University of Kansas Center for Research Inc

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
David Z Besson

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. David Z Besson - PI	0.00	0.00	0.09	$ 825	$
2.					
3.					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.09	825	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	0	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (1) GRADUATE STUDENTS				23,250	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				24,075	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				1,938	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				26,013	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				1,850	
2. FOREIGN				0	
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ 0 2. TRAVEL 0 3. SUBSISTENCE 0 4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				2,185	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				6,129	
TOTAL OTHER DIRECT COSTS				8,314	
H. TOTAL DIRECT COSTS (A THROUGH G)				36,177	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) MTDC (Rate: 46.0000, Base: 30048)					
TOTAL INDIRECT COSTS (F&A)				13,822	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				49,999	
K. RESIDUAL FUNDS				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 49,999	$

M. COST SHARING PROPOSED LEVEL $ 0 AGREED LEVEL IF DIFFERENT $

PI/PD NAME
David Z Besson

ORG. REP. NAME*
Barbara Armbrister

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET

YEAR 2

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months)	
	Proposed	Granted
AWARD NO.		

ORGANIZATION
University of Kansas Center for Research Inc

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
David Z Besson

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. David Z Besson - PI	0.00	0.00	0.09	$ 866	$
2.					
3.					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.09	866	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	0	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (1) GRADUATE STUDENTS				24,413	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				25,279	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				2,035	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				27,314	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				1,600	
2. FOREIGN				0	
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ 0 2. TRAVEL 0 3. SUBSISTENCE 0 4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				922	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				6,439	
TOTAL OTHER DIRECT COSTS				7,361	
H. TOTAL DIRECT COSTS (A THROUGH G)				36,275	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) MTDC (Rate: 46.0000, Base: 29836)					
TOTAL INDIRECT COSTS (F&A)				13,725	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				50,000	
K. RESIDUAL FUNDS				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 50,000	$

M. COST SHARING PROPOSED LEVEL $ 0 AGREED LEVEL IF DIFFERENT $

PI/PD NAME
David Z Besson

ORG. REP. NAME*
Barbara Armbrister

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET

YEAR 3

ORGANIZATION	FOR NSF USE ONLY		
University of Kansas Center for Research Inc	PROPOSAL NO.	DURATION (months) Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR David Z Besson	AWARD NO.		

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. David Z Besson - PI	0.00	0.00	0.09	$ 909	$
2.					
3.					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.09	909	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	0	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (1) GRADUATE STUDENTS				23,072	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				23,981	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				1,214	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				25,195	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				1,850	
2. FOREIGN				0	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ 0					
2. TRAVEL 0					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				0	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				9,725	
TOTAL OTHER DIRECT COSTS				9,725	
H. TOTAL DIRECT COSTS (A THROUGH G)				36,770	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) MTDC (Rate: 46.0000, Base: 27045)					
TOTAL INDIRECT COSTS (F&A)				12,441	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				49,211	
K. RESIDUAL FUNDS				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 49,211	$
M. COST SHARING PROPOSED LEVEL $ 0	AGREED LEVEL IF DIFFERENT $				

PI/PD NAME	FOR NSF USE ONLY		
David Z Besson	INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME*	Date Checked	Date Of Rate Sheet	Initials - ORG
Barbara Armbrister			

 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET

Cumulative

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months)	
	Proposed	Granted
AWARD NO.		

ORGANIZATION

University of Kansas Center for Research Inc

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR

David Z Besson

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. David Z Besson - PI	0.00	0.00	0.27	$ 2,600	$
2.					
3.					
4.					
5.					
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.27	2,600	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	0	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (3) GRADUATE STUDENTS				70,735	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				73,335	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				5,187	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				78,522	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				5,300	
2. FOREIGN				0	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ 0					
2. TRAVEL 0					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				3,107	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				22,293	
TOTAL OTHER DIRECT COSTS				25,400	
H. TOTAL DIRECT COSTS (A THROUGH G)				109,222	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				39,988	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				149,210	
K. RESIDUAL FUNDS				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 149,210	$
M. COST SHARING PROPOSED LEVEL $ 0	AGREED LEVEL IF DIFFERENT $				

PI/PD NAME

David Z Besson

ORG. REP. NAME*

Barbara Armbrister

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

C *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

Budget Justification

Personnel

David Besson will serve as the PI of the proposed project for the University of Kansas. The KUCR policy requires the PI to request effort annually. The PI is budgeted at 0.09 summer months. Salary cost is adjusted for inflation in years 2 and 3.

A full-time GRA will work with the PI to conduct data analysis, run and develop the existing software simulation framework, and assist with antenna testing and development. Salary cost is adjusted for inflation in years 2 and 3.

Fringe Benefits

Fringe benefit rates for faculty/staff are 32% and 12% for graduate student researchers working 76% or more and 4% for those working 75% or less. Fringe benefit rates for undergraduate student researchers working hourly are 4% regardless of full or part-time status.

Travel

Funding is requested for David Besson for $1,850 in year 1 and 3, and $1600 in year 2 to travel to professional meetings throughout the duration of the project.

Other

The amount of $2,185 in year 1, and $922 in year 2 is being requested to cover associated cost with research materials and supplies.

Tuition

Tuition – Yr 1-$6,129; Yr 2-$6,439; Yr 3-$9,725. Tuition for the GRAs is listed at the rates approved by the University of Kansas Registrar's Office. This includes full year support for each GRA.

Indirect Cost

The University of Kansas on campus direct cost rate is 46% on all direct costs excluding equipment costs, tuition, participant support costs and subcontracts after the first $25,000.

SUMMARY PROPOSAL BUDGET

YEAR 1

ORGANIZATION **University of Wisconsin-Madison**				FOR NSF USE ONLY PROPOSAL NO.	DURATION (months) Proposed / Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR **Albrecht Karle**				AWARD NO.	

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Albrecht Karle - Principal Investigator**	0.00	0.00	0.00	$ **0**	$
2.					
3.					
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**1**) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	**0**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**1**) POST DOCTORAL SCHOLARS	9.50	0.00	0.00	**39,330**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**1**) UNDERGRADUATE STUDENTS				**11,000**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**50,330**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**10,296**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**60,626**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
Cables / Fiber Optic			$ **40,000**		
Central DAQ HW			**6,000**		
TOTAL EQUIPMENT				**46,000**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**5,000**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**3,000**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**3,000**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**114,626**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **Other Direct Costs (Rate: 47.0000, Base: 3000) (Cont. on Comments Page)**					
TOTAL INDIRECT COSTS (F&A)				**32,254**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**146,880**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **146,880**	$
M. COST SHARING PROPOSED LEVEL $ **0**	AGREED LEVEL IF DIFFERENT $				

PI/PD NAME **Albrecht Karle**	FOR NSF USE ONLY INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME* **Petra Schroeder**	Date Checked	Date Of Rate Sheet	Initials - ORG

1 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET COMMENTS - Year 1

**** I- Indirect Costs**
Travel (Rate: 47.0000, Base 5000)
Wages / Benefits (Rate: 47.0000, Base 60626)

SUMMARY PROPOSAL BUDGET

YEAR 2

FOR NSF USE ONLY	
PROPOSAL NO.	DURATION (months): Proposed / Granted
AWARD NO.	

ORGANIZATION
University of Wisconsin-Madison

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Albrecht Karle

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Albrecht Karle - none**	0.00	0.00	0.00	$ **0**	$
2.					
3.					
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**1**) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	**0**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**1**) POST DOCTORAL SCHOLARS	9.50	0.00	0.00	**40,510**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**1**) UNDERGRADUATE STUDENTS				**11,330**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**51,840**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**10,605**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**62,445**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.) **Cable / Fiber Optic** **$ 40,000**					
TOTAL EQUIPMENT				**40,000**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**5,000**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ **0** 2. TRAVEL **0** 3. SUBSISTENCE **0** 4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**3,000**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**3,000**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**110,445**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **Other Direct Costs (Rate: 47.0000, Base: 3000) (Cont. on Comments Page)**					
TOTAL INDIRECT COSTS (F&A)				**33,109**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**143,554**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **143,554**	$

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI/PD NAME	FOR NSF USE ONLY		
Albrecht Karle	INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME*	Date Checked	Date Of Rate Sheet	Initials - ORG
Petra Schroeder			

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET COMMENTS - Year 2

**** I- Indirect Costs**
Travel (Rate: 47.0000, Base 5000)
Wages and Benefits (Rate: 47.0000, Base 62445)

SUMMARY PROPOSAL BUDGET YEAR 3

ORGANIZATION **University of Wisconsin-Madison**				FOR NSF USE ONLY PROPOSAL NO.	DURATION (months) Proposed / Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR **Albrecht Karle**				AWARD NO.	

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Albrecht Karle - none**	0.00	0.00	0.00	$ **0**	$
2.					
3.					
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**1**) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	**0**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**1**) POST DOCTORAL SCHOLARS	9.50	0.00	0.00	**41,725**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**1**) UNDERGRADUATE STUDENTS				**11,670**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**53,395**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**10,923**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**64,318**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**5,000**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ **0** 2. TRAVEL **0** 3. SUBSISTENCE **0** 4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**3,000**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**3,000**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**72,318**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **Other Direct Costs (Rate: 47.0000, Base: 3000) (Cont. on Comments Page)**					
TOTAL INDIRECT COSTS (F&A)				**33,989**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**106,307**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **106,307**	$

M. COST SHARING PROPOSED LEVEL $ **0**	AGREED LEVEL IF DIFFERENT $		
PI/PD NAME **Albrecht Karle**	FOR NSF USE ONLY INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME* **Petra Schroeder**	Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET COMMENTS - Year 3

**** I- Indirect Costs**
Travel (Rate: 47.0000, Base 5000)
Wages / Benefits (Rate: 47.0000, Base 64318)

SUMMARY PROPOSAL BUDGET

Cumulative

ORGANIZATION **University of Wisconsin-Madison**					FOR NSF USE ONLY PROPOSAL NO. / DURATION (months): Proposed, Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR **Albrecht Karle**					AWARD NO.
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Albrecht Karle - none**	0.00	0.00	0.00	$ **0**	$
2.					
3.					
4.					
5.					
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**1**) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	**0**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**3**) POST DOCTORAL SCHOLARS	28.50	0.00	0.00	**121,565**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**3**) UNDERGRADUATE STUDENTS				**34,000**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**155,565**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**31,824**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**187,389**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.) **$ 86,000**					
TOTAL EQUIPMENT				**86,000**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**15,000**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ **0** 2. TRAVEL **0** 3. SUBSISTENCE **0** 4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**9,000**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**9,000**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**297,389**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				**99,352**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**396,741**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **396,741**	$
M. COST SHARING PROPOSED LEVEL $ **0**	AGREED LEVEL IF DIFFERENT $				

PI/PD NAME **Albrecht Karle**	FOR NSF USE ONLY INDIRECT COST RATE VERIFICATION
ORG. REP. NAME* **Petra Schroeder**	Date Checked / Date Of Rate Sheet / Initials - ORG

C ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

Budget Justification Page

The scope of work at the University of Wisconsin-Madison includes two main tasks. The first one is the power and communication system:

a) the data communication between the remote detector station and the central counting house

b) the power distribution to the remote detectors

c) the global nanosecond precision timing system, required to trigger and build events.

The second task is integration and testing of instrument hardware prior to shipping to the South Pole.

A post-doc (Hagar Landsman) is leading the effort on both tasks with 9.5 months per year.

An experienced undergraduate student is budgeted at 3 months in the summer and 10h/week for the rest of the year to assist the post-doc and the PI in all tasks.

The power and communication system relies highly on technology that was developed by IceCube and we can utilize this technology for the proposed IceRay detectors.

The hardware costs are budgeted at $80k for cables for 4 stations at a distance of about 2 km from the centrral counting house. On the central DAQ side, there will be some collaborative effort on the triggering. We will require a computer with specialized boards which is included in this budget at a cost of $6000.

The effort includes testing of components prior to shipping and verification and calibration of the deployed detectors.

A smaller fraction (2 FTE months/year)of the post-doc time will be devoted to data analysis.

We include $5k/year for travel to allow participation in 1 meeting for the postdoc at the University of Hawaii, and one trip for developmental work at a collaborating institution.

$3k/year are budgeted for materials and supplies, based on experience with previous projects of this scale.

No salary or travel support is requested for the PI.

Funding requested for travel is for 3 trips per year to travel to professional meetings at a cost of $1,666 per year.

The University of Wisconsin-Madison on-campus indirect cost rate is 47% of MTDC.

SUMMARY PROPOSAL BUDGET

YEAR 1

FOR NSF USE ONLY					
ORGANIZATION: **Pennsylvania State Univ University Park**	PROPOSAL NO.	DURATION (months) Proposed	Granted		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **Douglas F Cowen**	AWARD NO.				

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Douglas F Cowen - Principal Inv.**	0.00	0.00	0.00	$ 0	$
2.					
3.					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (1) POST DOCTORAL SCHOLARS	2.00	0.00	0.00	7,745	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (0) GRADUATE STUDENTS				0	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				7,745	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				635	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				8,380	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				1,250	
2. FOREIGN				0	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ 0					
2. TRAVEL 0					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				0	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				0	
TOTAL OTHER DIRECT COSTS				0	
H. TOTAL DIRECT COSTS (A THROUGH G)				9,630	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **Modified Total Direct Costs (Rate: 47.4000, Base: 9630)**					
TOTAL INDIRECT COSTS (F&A)				4,565	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				14,195	
K. RESIDUAL FUNDS				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 14,195	$
M. COST SHARING PROPOSED LEVEL $ 0	AGREED LEVEL IF DIFFERENT $				

PI/PD NAME: **Douglas F Cowen**	FOR NSF USE ONLY		
	INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME*: **Allyn Ditmer**	Date Checked	Date Of Rate Sheet	Initials - ORG

 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET

YEAR 2

	FOR NSF USE ONLY		
ORGANIZATION **Pennsylvania State Univ University Park**	PROPOSAL NO.	DURATION (months)	
		Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR **Douglas F Cowen**	AWARD NO.		

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Douglas F Cowen - Principal Inv.**	0.00	0.00	0.00	$ 0	$
2.					
3.					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (1) POST DOCTORAL SCHOLARS	2.00	0.00	0.00	8,016	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (0) GRADUATE STUDENTS				0	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				8,016	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				657	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				8,673	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				1,250	
2. FOREIGN				0	
F. PARTICIPANT SUPPORT COSTS 1. STIPENDS $ 0 2. TRAVEL 0 3. SUBSISTENCE 0 4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				0	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				0	
TOTAL OTHER DIRECT COSTS				0	
H. TOTAL DIRECT COSTS (A THROUGH G)				9,923	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **Modified Total Direct Costs (Rate: 47.4000, Base: 9923)**					
TOTAL INDIRECT COSTS (F&A)				4,704	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				14,627	
K. RESIDUAL FUNDS				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 14,627	$
M. COST SHARING PROPOSED LEVEL $ 0	AGREED LEVEL IF DIFFERENT $				

	FOR NSF USE ONLY		
PI/PD NAME **Douglas F Cowen**	INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME* **Allyn Ditmer**	Date Checked	Date Of Rate Sheet	Initials - ORG

 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET

YEAR 3

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months)	
	Proposed	Granted
AWARD NO.		

ORGANIZATION
Pennsylvania State Univ University Park

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Douglas F Cowen

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. Douglas F Cowen - Principal Inv.	0.00	0.00	0.00	$ 0	$
2.					
3.					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (1) POST DOCTORAL SCHOLARS	2.00	0.00	0.00	8,296	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (0) GRADUATE STUDENTS				0	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				8,296	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				680	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				8,976	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				1,250	
2. FOREIGN				0	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ 0					
2. TRAVEL 0					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				0	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				0	
TOTAL OTHER DIRECT COSTS				0	
H. TOTAL DIRECT COSTS (A THROUGH G)				10,226	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) Modified Total Direct Costs (Rate: 47.4000, Base: 10227)					
TOTAL INDIRECT COSTS (F&A)				4,848	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				15,074	
K. RESIDUAL FUNDS				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 15,074	$

M. COST SHARING PROPOSED LEVEL $ 0 AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Douglas F Cowen

ORG. REP. NAME*
Allyn Ditmer

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY PROPOSAL BUDGET

Cumulative

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months)	
	Proposed	Granted
AWARD NO.		

ORGANIZATION
Pennsylvania State Univ University Park

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Douglas F Cowen

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. Douglas F Cowen - Principal Inv.	0.00	0.00	0.00	$ 0	$
2.					
3.					
4.					
5.					
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (3) POST DOCTORAL SCHOLARS	6.00	0.00	0.00	24,057	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (0) GRADUATE STUDENTS				0	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				24,057	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				1,972	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				26,029	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				3,750	
2. FOREIGN				0	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ 0					
2. TRAVEL 0					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				0	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				0	
TOTAL OTHER DIRECT COSTS				0	
H. TOTAL DIRECT COSTS (A THROUGH G)				29,779	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				14,117	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				43,896	
K. RESIDUAL FUNDS				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 43,896	$

M. COST SHARING PROPOSED LEVEL $ 0 AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Douglas F Cowen

ORG. REP. NAME*
Allyn Ditmer

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

C *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

Budget Justification

D.F. Cowen, Pennsylvania State University

The P.I and postdoctoral researcher have experience in FPGA programming and in radio work. The P.I. has worked on ANITA, and the postdoctoral researcher obtained her Ph.D. on Goldstone and has since worked in FPGA programming for IceCube. The P.I. has advised two other postdocs in the design and implementation of the trigger for IceCube. The time estimate for the work we will do, described below, is thus based on our experience doing similar work on similar experiments.

We will help develop the high-level triggers that trigger at the cluster and multi-cluster level, respectively. We will help build the software that will enable physicists to analyze the data produced by the deployed modules, and analyze the data that comes from the deployed modules, evaluating the noise response and the calibration data to understand the baseline behavior of the detector.

Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Robert Morse

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: AMANDA 2004

Source of Support: NSF
Total Award Amount: $ 1,246,027 Total Award Period Covered: 09/01/04 - 08/31/08
Location of Project: UW-Madison
Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 1.00 Sumr: 0.00

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: Science Coordination Office for Astrophysical Research in Antarctica - Phase 2

Source of Support: NSF
Total Award Amount: $ 1,238,988 Total Award Period Covered: 09/01/08 - 08/31/11
Location of Project: University of Chicago
Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 1.00 Sumr: 0.00

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: Initial Analysis of IceCube Data at UW-Madison

Source of Support: NSF
Total Award Amount: $ 4,821,238 Total Award Period Covered: 01/01/07 - 12/31/09
Location of Project: UW-Madison
Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 0.50

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: Current Proposal - Collaborative Research: IceRay-36

Source of Support: NSF
Total Award Amount: $ 1,912,685 Total Award Period Covered: 03/01/08 - 02/28/11
Location of Project: Collaborative Institutions and South Pole Station
Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

 USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: James Beatty

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Antarctic Impulsive Transient Antenna (ANITA)

Source of Support: NASA

Total Award Amount: $ 520,450 Total Award Period Covered: 11/03/04 - 09/30/08

Location of Project: Ohio State University; Collaborating Institutions; McMurdo.

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 1.00

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Studies of the Highest Energy Cosmic Rays with the Auger Observatory

Source of Support: NSF

Total Award Amount: $ 470,000 Total Award Period Covered: 06/01/05 - 05/31/08

Location of Project: Ohio State University and Malargue, Argentina.

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 0.50

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Cosmic Ray Energetics and Mass (CREAM)

Source of Support: NASA

Total Award Amount: $ 195,000 Total Award Period Covered: 12/01/04 - 11/30/07

Location of Project: Ohio State University and collaborating institutions

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 0.50

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Development of a low-power, low-cost front-end elecronics module for large-scale distributed neutrino detectors

Source of Support: Department of Energy

Total Award Amount: $ 50,000 Total Award Period Covered: 09/01/06 - 08/31/08

Location of Project: Ohio State University

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 0.00

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Pierre Auger Project Construction Funds

Source of Support: NSF & DOE (via Universities Research Foundation)

Total Award Amount: $ 85,760 Total Award Period Covered: 08/01/04 - 12/31/06

Location of Project: Ohio State University and Malargue, Argentina

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Summ: 0.00

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: James Beatty

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Characterization of Microwave Continuum Emission from Ultra-High Energy Cosmic Ray Extensive Air Showers

Source of Support: NSF Particle Astrophysics Program

Total Award Amount: $ 254,759 Total Award Period Covered: 09/01/07 - 08/31/10

Location of Project: OSU, U of Hawaii, and the Argentine Auger Observatory site

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 0.50

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: ANITA: Antarctic Impulsive Transient Antenna

Source of Support: NASA

Total Award Amount: $ 724,317 Total Award Period Covered: 10/01/07 - 09/30/10

Location of Project: OSU, collaborating universities, and McMurdo, Antarctica

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 1.00

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: CREAM:Cosmic Ray Energetics and Mass

Source of Support: NASA

Total Award Amount: $ 232,466 Total Award Period Covered: 12/01/07 - 11/30/10

Location of Project: OSU, collaborating universities, and McMurdo, Antarctica

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 0.50

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Collaborative Research:IceRay-2007

Source of Support: NSF Particle and Nuclear Astrophysics and Polar Programs

Total Award Amount: $ 391,366 Total Award Period Covered: 03/01/08 - 02/28/11

Location of Project: Collaborating Institutions and South Pole Station

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Particle Astrophysics at the Energy Frontier with the Auger Observatory

Source of Support: NSF Particle and Nuclear Astrophysics

Total Award Amount: $ 639,076 Total Award Period Covered: 06/01/08 - 05/31/11

Location of Project:

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Summ: 1.00

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Kara Hoffman

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: Particle Astrophysics with the IceCube Neutrino Telescope

Source of Support: NSF
Total Award Amount: $ 751,610 Total Award Period Covered: 09/15/05 - 09/14/08
Location of Project: University of Maryland
Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: CAREER Towards a GZK Neutrino Detector at the South Pole

Source of Support: NSF
Total Award Amount: $ 481,000 Total Award Period Covered: 01/01/00 - 01/01/00
Location of Project: South Pole, Antarctica
Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Ilya Kravchenko

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: US CMS Operations at the LHC

Source of Support: National Science Foundation -- via subcontract from UCLA
Total Award Amount: $ 795,972 Total Award Period Covered: 01/01/07 - 10/31/07
Location of Project: MIT
Person-Months Per Year Committed to the Project. Cal: 11.10 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

CURRENT AND PENDING SUPPORT

Dr. David Seckel

A. Current Support

(1) a. Supporting Agency: NSF ANT-0602679
b. Title: Air Showers in IceCube, T. Gaisser, PI
c. Award Amount: $500,000
d. Period: 06/01/2006 – 05/31/2008
e. Percent of Effort: 0.50 month
f. Location: University of Delaware, Newark, DE

(2) a. Supporting Agency: NASA NAG5-5390
b. Title: NAG5-5390
c. Award Amount: $483,892
d. Period: 04/04/2003 – 09/30/2008
e. Percent of Effort: no salary
f. Location: University of Delaware, Newark, DE

(3) a. Supporting Agency: NSF flow through Univ. WI G067830
b. Title: IceCube, T. Gaisser, PI
c. Award Amount: $8,378,302
d. Period: 08/01/2002 – 03/31/2008
e. Percent of Effort: 3 months
f. Location: University of Delaware, Newark, DE

B. Pending Support

(1) a. Supporting Agency: NASA
b. Title: ANITA: Antarctic Impulsive Transient Antenna
J. Clem, PI
c. Award Amount: $271,775
d. Period: Submitted for 3 Years: 10/01/2007 – 09/30/2010
e. Percent of Effort: 0.50 month
f. Location: University of Delaware, Newark, DE

(2) a. Supporting Agency: NSF - Current Proposal
b. Title: Collaborative Research: IceRay-36
c. Award Amount: $238,176
d. Period: 03/01/2008 – 02/28/2011
e. Percent of Effort: no salary
f. Location: University of Delaware, Newark, DE

Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: David Besson

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: This Proposal: Collaborative Research: IceRay-36

Source of Support: National Science Foundation/University of Hawaii
Total Award Amount: $ 149,226 Total Award Period Covered: 03/01/08 - 02/28/11
Location of Project: The University of Kansas, Lawrence, KS
Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 0.09

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: RICE-Radio Ice Cherenkov Experiment

Source of Support: National Science Foundation
Total Award Amount: $ 97,979 Total Award Period Covered: 12/07/07 - 12/06/10
Location of Project: The University of Kansas, Lawrence, KS
Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.09 Sumr: 0.00

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: Collaborative Research: Radar characterization of deep ice close to the WAIS Divide bedrock

Source of Support: National Science Foundation
Total Award Amount: $ 167,357 Total Award Period Covered: 04/01/08 - 03/31/11
Location of Project: The University of Kansas, Lawrence, KS
Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 0.12

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: RICE: Radio Ice Cherenkov Experiment

Source of Support: National Science Foundation
Total Award Amount: $ 97,979 Total Award Period Covered: 12/01/07 - 11/30/10
Location of Project: The University of Kansas, Lawrence, KS
Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 0.50

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: ANITA - Antarctic Impulsive Transient Antenna

Source of Support: NASA (ROSES-2007)
Total Award Amount: $ 96,766 Total Award Period Covered: 10/01/07 - 09/30/10
Location of Project: The University of Kansas, Lawrence, KS
Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Summ: 0.01

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

 USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: David Besson

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Research program in emperimental elementary particle physics

Source of Support: National Science Foundation

Total Award Amount: $ 1,341,000 Total Award Period Covered: 06/01/07 - 05/31/10

Location of Project: The University of Kansas, Lawrence, KS

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 2.00

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: ICECUBE

Source of Support: National Science Foundation/Wisconsin University

Total Award Amount: $ 5,000 Total Award Period Covered: 04/01/07 - 03/31/08

Location of Project: The University of Kansas, Lawrence, KS

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 0.00

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: RICE-Radio Ice Cherenkov Experiment

Source of Support: National Science Foundation

Total Award Amount: $ 454,144 Total Award Period Covered: 09/01/04 - 08/31/08

Location of Project: The University of Kansas, Lawrence, KS

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 0.00

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: In Situ Radiofrequency Ice Properties Measurements in support of ANITA Neutrino Detection

Source of Support: NASA

Total Award Amount: $ 120,000 Total Award Period Covered: 01/01/06 - 12/31/07

Location of Project: The Unviersity of Kansas, Lawrence, KS

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 0.09

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Albrecht Karle

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: AMANDA 2004

Source of Support: NSF
Total Award Amount: $ 1,246,027 Total Award Period Covered: 09/01/04 - 08/31/08
Location of Project: UW-Madison
Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.00 Sumr: 0.00

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: Initial Analysis of IceCube Data at UW-Madson

Source of Support: NSF
Total Award Amount: $ 4,821,238 Total Award Period Covered: 08/01/07 - 12/31/09
Location of Project: UW-Madson
Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: IceRay-2007 - Current Proposal

Source of Support: NSF
Total Award Amount: $ 1,592,801 Total Award Period Covered: 03/01/08 - 02/28/11
Location of Project: UW-Madison
Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

 USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Douglas Cowen

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: IceCube MREFC Construction Sub-Award (with Asst. Prof. Tyce DeYoung)

Source of Support: NSF via UW-Madison

Total Award Amount: $ 420,190 Total Award Period Covered: 04/01/07 - 03/31/08

Location of Project: South Pole, Antarctica

Person-Months Per Year Committed to the Project. Cal:4.00 Acad: 0.00 Sumr: 0.00

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Searches for Ultrahigh Energy Neutrinos with AMANDA

Source of Support: NSF

Total Award Amount: $ 450,000 Total Award Period Covered: 08/15/03 - 08/31/08

Location of Project: Pennsylvania State University and South Pole, Antarctica

Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 0.00 Sumr: 0.00

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Analysis of IceCube Data

Source of Support: NSF

Total Award Amount: $ 750,000 Total Award Period Covered: 08/01/06 - 07/31/09

Location of Project: Pennsylvania State University and South Pole, Antarctica

Person-Months Per Year Committed to the Project. Cal:2.50 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Collaborative Research: Ice-Ray-36

Source of Support: NSF

Total Award Amount: $ 43,896 Total Award Period Covered: 03/01/08 - 02/28/11

Location of Project: South Pole, Antarctica

Person-Months Per Year Committed to the Project. Cal:0.50 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

FACILITIES, EQUIPMENT & OTHER RESOURCES

FACILITIES: Identify the facilities to be used at each performance site listed and, as appropriate, indicate their capacities, pertinent capabilities, relative proximity, and extent of availability to the project. Use "Other" to describe the facilities at any other performance sites listed and at sites for field studies. USE additional pages as necessary.

Laboratory: University of Hawaii-Manoa Laboratory assets include:
1. 1600 sq-ft of test and equipment integration space, which includes an RF/Microwave Anechoic chamber laboratory. Chamber is 14x25x10 double skinned copper anechoic chamber rated for operation from 100 MHz to 20

Clinical:

Animal:

Computer: The University of Hawaii-Manoa computing facilities include two dual-processor Dell Poweredge servers with 1.3 Tbyte RAID; numerous desktop systems for specialized DAQ applications and computer-aided design. Commercial "Xfdtd" license for finite-difference time-domain

Office: Standard office space provided for Morse, Gorham, and Varner by UH Manoa. Office space for the yet to be named post-doc and grad-student will be obtained when needed.

Other:

MAJOR EQUIPMENT: List the most important items available for this project and, as appropriate identifying the location and pertinent capabilities of each.

1. HP54121T time-domain 20 GHz sampling oscilloscope, capable of time-domain impulse analysis.
2. TDS694C 3GHz bandwidth real-time oscilloscope, capable of real-time time-domain and spectral analysis of transients responses
3. HP8560E 3 GHz spectrum analyzer, capable of Fourier analysis and two-port S-parameter analysis
4.Picosecond Pulse Labs ultra-broadband impulse generator, spectral power

OTHER RESOURCES: Provide any information describing the other resources available for the project. Identify support services such as consultant, secretarial, machine shop, and electronics shop, and the extent to which they will be available for the project. Include an explanation of any consortium/contractual arrangements with other organizations.

State of Hawaii subsidized machine shop and two machinists on staff for UH Dept. of Physics and Astronomy projects. Shop services include CNC machining. Available on notice on a continuous basis, first-served queueing, wiht priority override by dept chairman if required. UH Astrophysics group supported by an administrator and two full-time secretaries.

FACILITIES, EQUIPMENT & OTHER RESOURCES

Continuation Page:

LABORATORY FACILITIES (continued):

GHz. Time-domain inpulse analysis system in place for antenna testing and characterization.
2. Radio detection laboratory. 1080 sq-ft including RF.microwave test bench,electronics assembly test station, test benches, and CAD stations.
3. Hawaii’s Instrument Design Laboratory includes 1200 sq-ft electronic design and development laboratory. Extensive solder stations and PC board testing workstations; wire-bondng capabilities, a 150 sp-ft class-1000 clean room. Chip design and development software; firmware design and development capabilities

COMPUTER FACILITIES (continued):

electromagnetic pulse analysis. The group has a 6 machine Linux server cluster, 20 processor cores and 7 TB of RAID storage. Group members have access to a variety of portable and desktop workstations to support data analysis, detector development and engineering tasks. The ANITA group has a specially equipped computing laboratory configured for group work, meetings, and remote conferencing.

MAJOR EQUIPMENT (continued):

to 20 GHz for time-domain characterization of RF systems.
5. Systron-Donner 2-8 GHz sweep generator/synthesizer, and standard gain horns for microwave testing.
6.Agilent Vector Network Analyzer
7.Agilent spectrum analyzer
8.Rohde and Schwarz portable specturm analyzer
9.Rohde and Schwarz signal generators.
10. Textronix fast time-domain oscilloscopes

FACILITIES, EQUIPMENT & OTHER RESOURCES

FACILITIES: Identify the facilities to be used at each performance site listed and, as appropriate, indicate their capacities, pertinent capabilities, relative proximity, and extent of availability to the project. Use "Other" to describe the facilities at any other performance sites listed and at sites for field studies. USE additional pages as necessary.

Laboratory: 1600 square-foot laboratory in the newly constructed Physics Research Building. Access to a 1500 square foot electronics shop and other specialized facilities and shops.

Clinical:

Animal:

Computer: The group has a six-machine Linux server cluster 20 processor cores and 7 TB of RAID storage. Group members have access to a variety of portable and desktop workstations to support data analysis, detector development, and engineering tasks. Our group also has a specially equipped computing

Office: Group members are allocated office space in the Physics Research Building near our laboratory.

Other:

MAJOR EQUIPMENT: List the most important items available for this project and, as appropriate identifying the location and pertinent capabilities of each.

Agilent vector network analyzer
Agilent spectrum analyzer
Rohde and Schwarz portable spectrum analyzer
Rohde and Schwarz signal generators
Tektronix fast oscilloscopes
Circuit board layout software
Rework, inspection, and environmental test facility.

OTHER RESOURCES: Provide any information describing the other resources available for the project. Identify support services such as consultant, secretarial, machine shop, and electronics shop, and the extent to which they will be available for the project. Include an explanation of any consortium/contractual arrangements with other organizations.

Our group is supported by the high energy physics secretary and by the program coordinator for the Center for Cosmology and Astro-Particle Physics. Machine shop services including CNC machining are readily available.

FACILITIES, EQUIPMENT & OTHER RESOURCES

Continuation Page:

COMPUTER FACILITIES (continued):

laboratory configured for group work, meetings, and remote conferencing.

MAJOR EQUIPMENT (continued):

FACILITIES, EQUIPMENT & OTHER RESOURCES

FACILITIES: Identify the facilities to be used at each performance site listed and, as appropriate, indicate their capacities, pertinent capabilities, relative proximity, and extent of availability to the project. Use "Other" to describe the facilities at any other performance sites listed and at sites for field studies. USE additional pages as necessary.

Laboratory: This research is being carried out at the South Pole Station, and at the University of Maryland. Laboratory and office space is provided at all facilities.

Clinical:

Animal:

Computer: Maryland maintains a medium size unix rack based computing system and distributed network workstations on a private network. The rack based farm is comprised of 10 racks, with more then 250 64-bit cores and online disk storage of more then 130 terabytes.

Office: Maryland provides office space for all personnel.

Other:

MAJOR EQUIPMENT: List the most important items available for this project and, as appropriate identifying the location and pertinent capabilities of each.

OTHER RESOURCES: Provide any information describing the other resources available for the project. Identify support services such as consultant, secretarial, machine shop, and electronics shop, and the extent to which they will be available for the project. Include an explanation of any consortium/contractual arrangements with other organizations.

High quality machine and electronics shops are available at the University of Maryland.

FACILITIES, EQUIPMENT & OTHER RESOURCES

FACILITIES: Identify the facilities to be used at each performance site listed and, as appropriate, indicate their capacities, pertinent capabilities, relative proximity, and extent of availability to the project. Use "Other" to describe the facilities at any other performance sites listed and at sites for field studies. USE additional pages as necessary.

Laboratory:

Clinical:

Animal:

Computer: Proposer has access to 3 modest size clusters for simulation studies. Two clusters (16 nodes each, AMD Athlon) reside within the Bartol Research Institute. One cluster 32 node, (dual core Xeons) is operated by the Department of Physics. Bartol Research Institute maintains a computer

Office:

Other:

MAJOR EQUIPMENT: List the most important items available for this project and, as appropriate identifying the location and pertinent capabilities of each.

OTHER RESOURCES: Provide any information describing the other resources available for the project. Identify support services such as consultant, secretarial, machine shop, and electronics shop, and the extent to which they will be available for the project. Include an explanation of any consortium/contractual arrangements with other organizations.

FACILITIES, EQUIPMENT & OTHER RESOURCES

Continuation Page:

COMPUTER FACILITIES (continued):

support person, skilled in scientific cluster management.

FACILITIES, EQUIPMENT & OTHER RESOURCES

FACILITIES: Identify the facilities to be used at each performance site listed and, as appropriate, indicate their capacities, pertinent capabilities, relative proximity, and extent of availability to the project. Use "Other" to describe the facilities at any other performance sites listed and at sites for field studies. USE additional pages as necessary.

Laboratory: The KU high-energy group currently occupies 3500 sq. ft. of floor space in the Physics Building at the University of Kansas. In addition, we have been granted access to the roof of Malott Hall, where an open-air "antenna testing range" is used for calibration of the RICE antennas.

Clinical: None

Animal: None

Computer: Five 3 GHz Linux PC's (Linux 7.3) are used for primary data analysis; several Window PC's have local versions of LabView and are used for code development and hardware interfacing. We also have accounts on both the KU Remote Sensing Lab Linux cluster (~30 Linux PC's) and the a

Office: The Physics Dept. front office is staffed by 3 full-time support staff, in addition to two accountants.

Other: (Previously listed access outside institutions' PC cluster).

MAJOR EQUIPMENT: List the most important items available for this project and, as appropriate identifying the location and pertinent capabilities of each.

In addition to the hardware at the South Pole for the current PICE experiment, local KU personnel currently have in-house access to a 4-channel, 10 GSa/sec, 1GHz bandwidth Tektronix digital scope (unfortunately, it cannot be taken to Antarctica), as well as a 500 ns. signal generator (HP8133A), and a 166 MHz HP8131 for testing and measurement. Two additional digital scopes (Tektronix and Hewlett-Packard) are also used for testing, measurement and data

OTHER RESOURCES: Provide any information describing the other resources available for the project. Identify support services such as consultant, secretarial, machine shop, and electronics shop, and the extent to which they will be available for the project. Include an explanation of any consortium/contractual arrangements with other organizations.

The University of Kansas Dept. of Physics maintains two full-time machinists (Allan Hase and Zach Kessler), who have, to date, built all of the RICE antennas. By arrangement with the University of Kansas, shop time is charged to the department at a nominal (and well-subsidised) price ($5/hr.). The Instrumentation Design Lab (IDL), who did the board layout for the CAMAC-based Hardware Surface Beto (installed at Pole in Dec., 2003) is staffed with on full-time Electrical Engineer (Robert Young) on

FACILITIES, EQUIPMENT & OTHER RESOURCES

Continuation Page:

LABORATORY FACILITIES (continued):

COMPUTER FACILITIES (continued):

similarly-sized Linux cluster (25 Gigaflops) at the Bartol Research Institute. Accounts are also maintained on the AMANDA/IceCube computers at the University of Wisconsin.

MAJOR EQUIPMENT (continued):

acquisition. In addition to the HP8712C Network Analyzer on the roof of Malott used for antenna characterization, There are also two research groups within the Department (Condensed Matter)which both have network analyzers (up to 40GHz) which are available for RICE use, as well. Within the last year we have acquired an Anritsu-Wiltron SiteMaster network-analyzer + spectrum-analyzer (100MHz-6GHz).

OTHER RESOURCES (continued):

the 6th floor of Malott Hall (Physics Building). The Electrical Engineering and Computer Science Departments at KU also maintain the "KU Antenna Testing Range" (a more sophisticated version of the range we have used on the roof of Malott Hall)on the roof of Nichols Hall, both for its own use, as well as for use by the RICE group. An anechoic antenna testing chamber is also planned for installation by the ITTC group at KU beginning in 2007; thus far, we have used (on four occasions) the anechoic testing chamber facilities available nearby in Overland Park, KS on the Sprint, Inc. campus.

FACILITIES, EQUIPMENT & OTHER RESOURCES

FACILITIES: Identify the facilities to be used at each performance site listed and, as appropriate, indicate their capacities, pertinent capabilities, relative proximity, and extent of availability to the project. Use "Other" to describe the facilities at any other performance sites listed and at sites for field studies. USE additional pages as necessary.

Laboratory: None

Clinical: None

Animal: None

Computer: None

Office: University of Wisconsin-Madison, 222 W. Washington Avenue #500, Madison, WI 53703

Other: None

MAJOR EQUIPMENT: List the most important items available for this project and, as appropriate identifying the location and pertinent capabilities of each.

None

OTHER RESOURCES: Provide any information describing the other resources available for the project. Identify support services such as consultant, secretarial, machine shop, and electronics shop, and the extent to which they will be available for the project. Include an explanation of any consortium/contractual arrangements with other organizations.

All constructed equipment activity will be accomplished at the University of Wisconsin Physical Service Laboratory. This unit, within the University of Wisconsin, has a machine and electronics shop. The University of Wisconsin - Antarctic Astronomy & Astrophysics Research Institute (A3RI) will provide any secretarial support required for this activity.

FACILITIES, EQUIPMENT & OTHER RESOURCES

FACILITIES: Identify the facilities to be used at each performance site listed and, as appropriate, indicate their capacities, pertinent capabilities, relative proximity, and extent of availability to the project. Use "Other" to describe the facilities at any other performance sites listed and at sites for field studies. USE additional pages as necessary.

Laboratory:

Clinical:

Animal:

Computer: A local physics-department-based computer group resolves local networking and emailing issues as they arise.

Office: Penn State has already provided us with sufficient office space to accommodate all the individuals in this grant proposal.

Other:

MAJOR EQUIPMENT: List the most important items available for this project and, as appropriate identifying the location and pertinent capabilities of each.

Penn State maintains and runs a High Pressure Test Facility that can subject objects to pressures of up to 20,000 psi in a water-filled volume large enough to hold any individual component of the detector. Electrical feed-throughs are supported for performing measurements in situ. The overhead on the charge for this facility would come from this proposal (i.e., HPTF does not charge overhead on campus-related work).

OTHER RESOURCES: Provide any information describing the other resources available for the project. Identify support services such as consultant, secretarial, machine shop, and electronics shop, and the extent to which they will be available for the project. Include an explanation of any consortium/contractual arrangements with other organizations.