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.C.a. 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: Maury Tigner

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.C.a. 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: Donald L Hartill

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.C.a. 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: Georg H Hoffstaetter

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.C.a. 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: Mark A Palmer

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.C.a. 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 Rubin

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).

DEVIATION AUTHORIZATION:

Dear Maury,

Your request for page limit waiver has been granted. Can you please upload into the proposal in the waiver section prior to submission. (Important otherwise it will be rejected by the front office before we get to see it)
Please make sure that the new limit is observed.

Regards, David.

From: Caldwell, C. Denise
Sent: Thu 8/6/2009 1:49 PM
To: Lissauer, David A
Cc: Muse, Trevin K.
Subject: FW: page limit waiver request - from Maury Tigner et al.

David:

This request for the page waiver has been approved by Morris on behalf of MPS/OAD. A copy of this e-mail should be uploaded into the proposal in the waiver section prior to submission. The PI should be advised that the page number is strictly limited to that number requested.

Denise

From: Aizenman, Morris L. [mailto:maizenman@nsf.gov]
Sent: Thursday, August 06, 2009 1:44 PM
To: Caldwell, C. Denise
Cc: Aizenman, Morris L.; Salau, Kamaria E.; Muse, Trevin K.; Goldberg, Marvin; Lissauer, David A
Subject: FW: page limit waiver request - from Maury Tigner et al.

Hi Denise,

Your request for a page limit waiver with respect to a proposal to be submitted by Maury Tigner and his associates (as described in the attachment) is granted.

Regards,

Morris

Subject: FW: page limit waiver request - from Maury Tigner et al.
Date: Wed, 29 Jul 2009 10:19:35 -0400
X-MS-Has-Attach: yes

Deviation Authorization contd...

X-MS-TNEF-Correlator:
Thread-Topic: page limit waiver request - from Maury Tigner et al.
Thread-Index: AcoQT3So5IwqlH5ERDWKMIpkxo3j8wABLvRAAAC1KJA=
From: "Caldwell, C. Denise" <dcaldwel@nsf.gov>
To: "Aizenman, Morris L." <maizenma@nsf.gov>
Cc: "Goldberg, Marvin" <mgoldber@nsf.gov>,
"Lissauer, David A" <dlissaue@nsf.gov>,
"Caldwell, C. Denise" <dcaldwel@nsf.gov>

Morris:

On behalf of the Physics Division I am requesting that this page waiver on the Project Description for the proposal be granted. This is indeed a very complex project, involving numerous technical and scientific issues. It is critical that the reviewers have a full and complete picture in order to provide informed input.

Thanks.

Denise

From: Lissauer, David A
Sent: Wednesday, July 29, 2009 10:14 AM
To: Caldwell, C. Denise
Cc: Goldberg, Marvin
Subject: FW: page limit waiver request - from Maury Tigner et al.

Hi Denise,

Attach is a request from Maury Tigner et al from Cornell to waive the page limit limitation on NSF proposal. They would like to get the NSF to allow them to submit a proposal with a maximum of 30 pages.

The proposal that the Cornell group is planning to submit includes R&D for Lepton Colliders which will need to cover:

i) Use of CESR as an R&D tool for understanding the limitation and possible mitigation of the electron cloud effects.

Deviation Authorization contd...

ii) Development of Superconducting radiofrequency rf technology.

They will have to explain how this work is integrated in to the overall US and international effort on electron colliders as well as the applicability to future Muon colliders.

The expected scope of the proposal is of the order of $5 Million Dollars per year.

I support this request as I believe it is needed in order to give the reviewers sufficient detailed information for a proposal of this complexity.

Thanks,

David.

****

David Lissauer
Tel: 703 292 7061 FAX: 703 292 9078
EPP/PHY/MPS
National Science Foundation Suite 1015
4201 Wilson Blvd.-Arlington VA 22230-USA
e-mail: dlissaue@nsf.gov

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 09-29 **NSF 09-29**	**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 - PHYSICS-OTHER**	

DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION
				872612445	

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?
150532082	☐ A RENEWAL ☐ AN ACCOMPLISHMENT-BASED RENEWAL	YES ☐ NO ☒ IF YES, LIST ACRONYM(S)

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE **Cornell University**	ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE **Cornell University** **373 Pine Tree Road** **Ithaca, NY. 148502820**
AWARDEE ORGANIZATION CODE (IF KNOWN) **0027110000**	
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 **Lepton Collider R&D**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ **15,750,000**	**0** months		

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.1.e)
☐ PROPRIETARY & PRIVILEGED INFORMATION (GPG I.D, II.C.1.d)
☐ HISTORIC PLACES (GPG II.C.2.j)
☐ EAGER* (GPG II.D.2) ☐ RAPID** (GPG II.D.1)
☐ VERTEBRATE ANIMALS (GPG II.D.6) IACUC App. Date ________
PHS Animal Welfare Assurance Number ________
☐ HUMAN SUBJECTS (GPG II.D.7) 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 **324 Newman Laboratory, Cornell Univ.** **Ithaca, NY 148535001** **United States**
PI/PD FAX NUMBER **607-255-8062**	

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address
PI/PD NAME **Maury Tigner**	**PhD**	**1964**	**607-255-4951**	**mt52@cornell.edu**
CO-PI/PD **Donald L Hartill**	**Ph.D.**	**1967**	**607-255-8787**	**dlh13@cornell.edu**
CO-PI/PD **Georg H Hoffstaetter**	**DPhil**	**1994**	**607-255-5014**	**gh77@cornell.edu**
CO-PI/PD **Mark A Palmer**	**DPhil**	**1993**	**607-255-5014**	**map36@cornell.edu**
CO-PI/PD **David Rubin**	**Ph.D**	**1983**		

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 09-29). 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

* EAGER - EArly-concept Grants for Exploratory Research
** RAPID - Grants for Rapid Response Research

Project Summary

Lepton Collider R&D

Electrons, positrons and muons are, as far as is known, elementary particles. Thus using them in collision with equal and opposite momenta in the laboratory provides the full center of mass energy for creation of new forms of matter with well defined energy and kinematics. For this reason studies such as EPP2010 and P5 have called for significant investment in the enabling accelerator science and technologies that might lead to lepton colliders with TeV scale center of mass energies. This proposal covers R&D of several of the accelerator science and technology components of lepton collider R&D.

The damping rings for linear colliders are particularly challenging, requiring unprecedented brightness of the beams with very short damping times to allow rapid pulsing of the collider for high luminosity. Damping ring R&D comprises: electron cloud physics and ion effects and their mitigation and establishment of high beam brightness in a semi-automatic way. Meeting the brightness and damping time criteria requires use of very strong wiggler magnets for enhancement of the synchrotron radiation needed for damping. The Cornell Electron Storage Ring (CESR) has been fitted with such superconducting wigglers, critically located to enhance the production of high brightness. In addition the machine, now dubbed CesrTA has been fitted with special instrumentation for measuring the properties of the cloud of electrons generated by synchrotron radiation together with the action of secondary electron emission from the chamber walls. Potential mitigation methods have been installed so that their effectiveness can be determined. Both electrons and positrons can be stored so that both electron cloud and ion effects can be separated. The special instrumentation mentioned together with precision bpm's and beam size monitors are used for the low emittance (high brightness) tuning noted above and will allow the study of the many emittance diluting effects that come into play in a damping ring. The intellectual merit of this work is that it explores basic accelerator science and advances the science and technology needed to build a linear collider for elementary particle physics. The broader impact is that other accelerators for elementary particle and materials science will benefit from the work.

Superconducting radiofrequency cavities are needed both for the colliders and damping rings. Achievement of the in principle achievable Q factors ($>10^{11)}$ and accelerating electric fields (> 50 MV/m) in cavities that will be useful for accelerators has proved illusive. There are science and technology issues in both cases. Detailed measurements of the limits found in practical accelerating cavities will be made in a very low magnetic field environment and with the capability of making detailed temperature maps of cavity surfaces for location of limiting areas that can be further analyzed and mitigations applied to determine effectiveness. The effect of other environmental factors such as presence of couplers and beamline higher order mode absorbers will also be studied. The intellectual merit of this component resides in the new knowledge of limiting phenomena that will be obtained. The broader impact will be the advance of accelerator science and technology that will be used in all the sciences based on accelerators.

Low frequency (~ 200 MHz) superconducting cavities will be needed for boosting the energy of muons in a muon collider of the future. This is a significant technology challenge since such cavities are of about 1.5 m diameter. Sputtering on spun copper forms has shown the great difficulty of achieving needed film quality and adhesion over such a large surface area. Explosion bonded niobium on copper appears to have significant advantages and will be put to the test by the work proposed herein. The intellectual merit of this lies in the exploration of a new approach to the manufacture of superconducting cavities that may improve yield and lower refrigeration costs. The broader impact will be in the potential for improving manufacture of all low frequency superconducting cavities for both nuclear and elementary particle science.

An extensive outreach program with both national and regional elements for the general public and K-12 students will draw on the personnel and activities of the proposed work. The laboratory's intellectual and physical resources are used to promote the adventure of science directly to young people as well as provide workshops and direct support for teachers of science in their own classrooms and in group settings on campus. In addition we have been working with underrepresented populations in both urban settings of New York City and rural areas here on the edge of Appalachia.

TABLE OF CONTENTS

For font size and page formatting specifications, see GPG section II.B.2.

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.

PROJECT DESCRIPTION

<u>CesrTA R&D Program</u>

1 Introduction

We summarize the status and goals of the CesrTA project and present a proposal for further experimental and theoretical investigation of damping ring (DR) phenomena. We describe our request for DOE support for direct contributions to the ILC DR design.

Over the course of the last 1.5 years, the Cornell Electron Storage Ring (CESR) has been reconfigured as the CESR Test Accelerator (CesrTA) [1,2]. It now serves as the principal instrument of the CesrTA collaboration for the investigation of the physics of low emittance damping rings. Nearly thirty multi-channel retarding field analyzers (RFAs) have been installed in the CESR vacuum system and used to measure the development of the electron cloud (EC) [3-5]. These electron detectors characterize the energy spectrum and spatial distribution of the cloud in dipole fields, quadrupoles, solenoids, and wigglers as well as in field free regions. Vacuum chambers with mitigating chemistry and geometry have been tested including grooved chambers, and chambers with TiN and amorphous carbon coatings, yielding direct comparisons with bare aluminum and copper chambers.

In order to achieve sufficiently low vertical emittance to test emittance diluting effects of the EC and intra-beam scattering, a new network of survey monuments has been installed that permits efficient alignment of the magnetic guide field elements. Emittance tuning software has been interfaced to the CESR control system for real-time optics analysis and correction [6].

An x-ray beam size monitor (xBSM) is being developed that provides single bunch/single pass measurement of vertical beam size at the level of a few microns [7-9]. An emittance of 10pm corresponds to a beam size of 8 microns at the xBSM source point. This device permits individual measurement of every bunch in a long train, thus illuminating emittance diluting effects of the EC and identification of EC-induced instabilities.

The collaboration has measured the tune shift of individual bunches to characterize the ring-wide dynamical effects of the cloud, as well as its growth and decay times [10]. The phase shift of TE waves transmitted from a BPM electrode and received at another BPM electrode several meters away is a sensitive measure of the density of the intervening EC. At CesrTA, TE wave measurements are being developed as a standard tool to characterize the growth of the EC [11].

The experimental program is accompanied by a collaborative effort to simulate and model EC-related phenomena. A principal goal of the CesrTA project is to validate simulation predictions with measurements, allowing one to build physics models of the cloud that can be used to predict with confidence its effects on the beam in the ILC damping rings [12, 13]. There has been significant progress in understanding the experimental results with physics models.

During the remainder of the original CesrTA program period, we expect to complete a definitive set of measurements of electron cloud development and of the dynamics of the interaction of the electron cloud with the circulating beams of electrons and positrons. We will validate EC models by detailed comparison with measurements and will complete tests of several EC mitigation techniques. We will demonstrate reliable algorithms for tuning vertical emittance at the level of a few tens of pm and exploit our capability for single pass beam size measurements with few micron resolution.

We expect to have achieved a reduction of the zero current vertical emittance to ~20 pm by the end of the current grant period. Further reduction to 5-10 pm will require an ongoing effort to exploit the enormous capability of the new beam position monitor electronics and to minimize systematic errors in beam position measurements. As we continue to reduce residual dispersion and coupling, our sensitivity to emittance diluting effects will be enhanced.

Coupled with the x-ray beam size monitors for electrons and positrons, and the flexibility to vary the beam energy over a broad range, we will measure the dependence of intrabeam scattering emittance growth and lifetime limiting Touschek scattering on bunch current and beam energy in various emittance coupling regimes.

We propose to develop non-destructive techniques for real-time monitoring of sources of emittance dilution including focusing errors, transverse coupling, and dispersion errors. Such techniques will be invaluable for the operation of future ultra low emittance damping and light source rings.

As regards the ILC Global Design Effort [14], we propose to contribute to the electron cloud modeling required for the design of the ILC damping ring. We will exploit the EC diagnostics in CESR to characterize existing and future mitigation methods and their relevant vacuum properties. We will participate in the development and qualification of the damping ring optics.

Section 2 summarizes the current status of the CesrTA program including machine layout, new instrumentation and results to date. Section 3 describes the measurements that we expect to complete during the current grant period. Section 4 details our proposal for new research. DOE funded ILC damping ring activities are discussed in Section 5. Budget, manpower and schedule issues are in Section 6.

2 Results of Prior NSF Support

The present effort is supported by NSF PHY-0734867, CESR Conversion, FY09-FY10. $10,245,000. Additional funding is being provided by the US DOE.

2.1 Machine Layout and Optics

The layout of the storage ring was reconfigured during the summer of 2008 for low emittance operation [1]. Damping wigglers were moved from the machine arcs to the 18m (L0) straight that became available with the removal of the CLEO detector. The low beta final focus insert was replaced with standard FODO optics. Vertical electrostatic separators were removed from the diametrically opposite straight (L3) to reduce longitudinal impedance and make space for instrumentation. The full complement of corrector magnets (56 vertical and 54 horizontal dipoles and 13 skew quadrupoles), essential for emittance tuning, has been preserved.

We have developed and tested optics for operation of the storage ring with beam energies of 1.8, 2.0, 2.3, 3.2, 4.0, 5.0 and 5.3 GeV. We achieve our lowest horizontal emittance of 2.5 nm at 2 GeV beam energy with 12 damping wigglers. At 5 GeV the minimum emittance is 40 nm with 6 wigglers. All of the optics are designed to be compatible with on energy injection of multiple bunches so that experimental measurements can be performed efficiently.

2.2 Instrumentation and Feedback Systems

The instrumentation requirements for the program fall into four principal categories: 1) beam instrumentation required to correct the machine optics for ultra low emittance operation; 2) beam instrumentation to characterize the beam emittance in these conditions; 3) local diagnostics to characterize the build-up of the electron cloud in the accelerator vacuum chambers; and 4) beam instrumentation to characterize the dynamics of the interaction between the beam and the cloud. A feedback system capable of stabilizing bunch trains with similar parameters to those needed for the ILC damping rings is also required. We have implemented hardware to meet all of the above requirements over the course of the first 1.5 years and are presently beginning to take full advantage of our enhanced measurement capabilities for the R&D program.

2.2.1 Instrumentation for Low Emittance Tuning and Measurement

The key piece of instrumentation for optics correction is the beam position monitor (BPM) system. A new digital BPM system has been designed for turn-by-turn orbit measurements in CESR. The system is capable of simultaneous multi-bunch measurements in both single beam and dual beam (as used for CHESS) operation of the machine. A 10 μm measurement resolution for successive measurements is necessary for our ability to correct the vertical dispersion around the machine at the <10 mm level (see

Section 2.4). At present, approximately 80% of the beam position monitors in CESR have been upgraded to multi-bunch, turn-by-turn readout capability. Approximately 20 additional readout modules with full multi-bunch capability will be deployed for correction of the entire ring during the December 2009 experimental run.

In order to characterize the emittance of damping-ring-like beams, a major focus of our efforts has been the development of an x-ray beam size monitor (xBSM) which is capable of single pass measurements [7,8]. The xBSM detector utilizes a 1-D InGaAs diode pixel array (50 μm x 500 μm pixels). With either Fresnel zone plate or coded aperture [9] x-ray imaging optics, this detector can resolve the ~10 μm vertical beam sizes that are expected when operating CESR in the damping ring configuration. With the Fresnel optics in place, rotation of the detector array by 90 degrees allows for beam characterization in both vertical and horizontal planes.

Two CHESS x-ray lines, one looking at the positron beam and the second at the electron beam, have now been modified as “all vacuum” lines for xBSM use. Each line has insertable optics assemblies for flexible testing of a range of x-ray optics. At beam energies around 2 GeV, the expected white beam flux on an xBSM detector, with no optics elements inserted, is approximately 550 photons/mA/pixel. With the coded aperture optics in place, this reduces to somewhat over 100 photons/mA/pixel in the 1 keV to 5 keV range, which is adequate for single-pass imaging. In the case of the Fresnel zone plate, a monochromator is typically inserted in the beam path to provide optimum measurement resolution. The monochromator, however, reduces the flux by roughly two orders of magnitude, and this method is used for high resolution measurements which integrate over multiple beam passages. Single-pass measurements, with similar flux to that of the coded aperture case, can be made by using a Fresnel zone plate without a monochromator, at the price of somewhat degraded resolution. In multi-bunch mode, this allows for detailed characterization of emittance growth along ILC-like bunch trains. Fig. 1 shows the results of some multi-turn averaged single-bunch measurements.

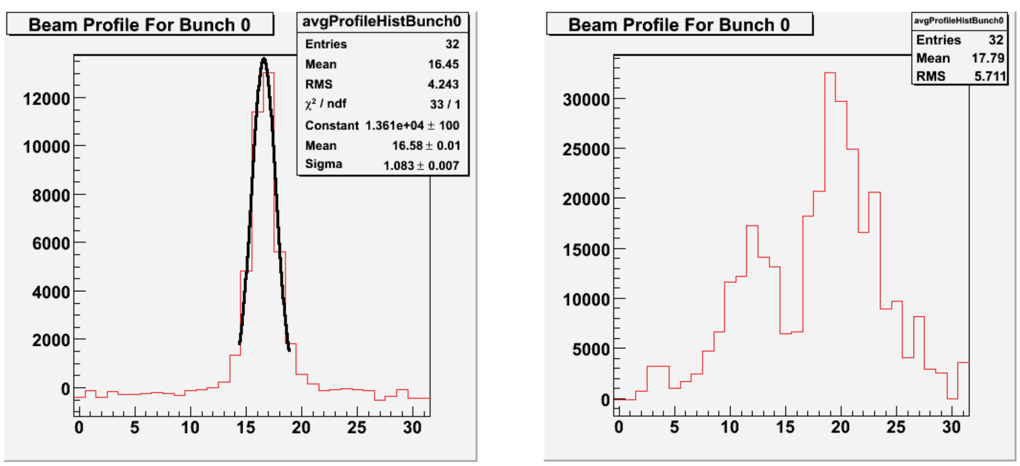

Figure 1. Single bunch beam profile measurements with the xBSM detector using the Fresnel zone plate optics (left) and coded aperture optics (right) for two different data runs. The horizontal axis shows the response of each pixel while the vertical axis is ADC counts for the bunch-by-bunch digitizer output. Both results are obtained in the 2.085GeV low emittance optics. The images correspond to measured vertical beam sizes of 19μm (left) and 17μm (right).

2.2.2 Feedback System

The ILC damping ring baseline design envisions operating the positron ring with bunch spacings of ~6 ns [16]. In order to characterize electron cloud build-up in the relevant regime, the CESR feedback system has been upgraded for operation with bunch trains with spacings as small as 4 ns. A feedback system from DIMTEL, Inc [17] was selected to provide the feedback in all 3 planes. A particular benefit of this system is its extensive diagnostics for characterization of the bunch trains [18]. This system has been in operation at CESR since mid-2009.

2.2.3 Electron Cloud Instrumentation

Instrumentation to characterize the electron cloud in CESR falls into two principal categories: local diagnostics to measure surface properties and cloud build-up and beam diagnostics to measure the impact of the cloud on the beam dynamics.

A major component of the CesrTA program has been to deploy retarding field analyzers in each of the major vacuum chamber types and magnetic field regions in CESR [3-5]. The CESR RFA design relies on a very thin detector structure, ~3mm thickness, which can be inserted in magnets with extreme aperture constraints such as dipoles, wigglers, and quadrupoles. In these regions, detectors with single retarding grids and collector electrode structures generated using photolithography techniques on thin (0.006”) polyimide substrates are employed. Fig. 2 shows a schematic and assembly photo for a set of 3 such RFAs in a wiggler vacuum chamber. These detectors offer transverse segmentation to characterize the geometric distribution of electrons striking the vacuum chamber walls. As of mid-2009, over 30 RFAs have been deployed in CESR.

In addition to the retarding field analyzers, we have deployed instrumentation to allow characterization of the local cloud build-up via TE wave transmission through the vacuum chambers [11,19]. In drift regions this method is sensitive to the density of the cloud in the center of the chamber. A major area of current effort is the application of this technique to magnetic field regions, particularly in the vacuum chambers of wigglers and dipoles.

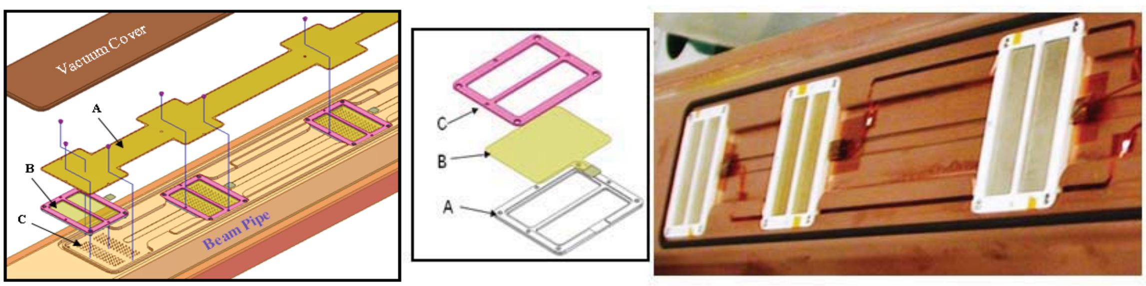

Figure 2. Retarding field analyzer structure utilized for the CesrTA wiggler vacuum chambers. The vacuum chamber assembly is shown on the left. The middle drawing shows the insulator and mesh layers that form the retarding grid. The right photo shows the 3 RFAs during assembly. One RFA is located at the center of a wiggler pole, one at the boundary between two poles, and one in the field roll-off region at the edge of a pole.

The integrated ring-wide impact of the EC on the beam is being studied with a variety of techniques. These include bunch-by-bunch measurements with the new BPM system, with the DIMTEL feedback system [17], with a gated spectrum analyzer, and with the xBSM.

Bunch-by-bunch tune information has been obtained in several ways. Turn-by-turn data with the new BPM system has been recorded for cases where: 1) trains have been excited by a single-turn kick where the induced oscillations are then allowed to freely decay; 2) the feedback is turned off and the bunches in a train are monitored without excitation; and 3) the bunches are excited by a drive source (from a spectrum analyzer or the feedback system). The DIMTEL feedback system and the gated spectrum analyzer measurements also provide bunch tune data.

Studies of multi-bunch instabilities are underway using mode spectra that are obtained via the BPM system as well as the DIMTEL feedback system [17]. The xBSM provides information on emittance growth along a train and experiments are underway to measure incoherent emittance growth effects as well as the onset of head-tail instabilities. A gated spectrum analyzer has also been configured to look for the presence of vertical synchro-betatron sidebands, a signature of the head-tail instability [20].

2.3 Electron Cloud Measurements and Analysis

Coherent tune shift and RFA measurements have been made with both positrons and electrons, at 2 and 5 GeV, with bunch trains of length varying from a few to 145 bunches, with bunch spacings as small as 4 ns, and with bunch currents from a few tenths to 5 mA/bunch.

The RFA's described in section 2.2.3 have been used to make measurements in CESR drift regions, dipoles, and wigglers, with aluminum, copper, TiN-coated, carbon-coated, and grooved vacuum chambers. In the PEP-II chicane dipoles, installed in L3, measurements have been made as a function of dipole field and clear evidence of cyclotron resonances [23] has been observed. This is shown in Fig. 3. The total RFA current in the central collector, and in edge collectors, is plotted as a function of the dipole field, measured in units of the cyclotron resonance field. The suppression of the total current in the chamber with a mitigation (TiN coating and grooves) is evident. The overall cloud current suppression from the uncoated aluminum chamber to the coated, grooved chamber is approximately a factor of 300 at the chamber center (where multipacting dominates) and about a factor of 5-20 at the edges. Similar resonance structure has also been observed during field scans of the CesrTA wiggler magnets.

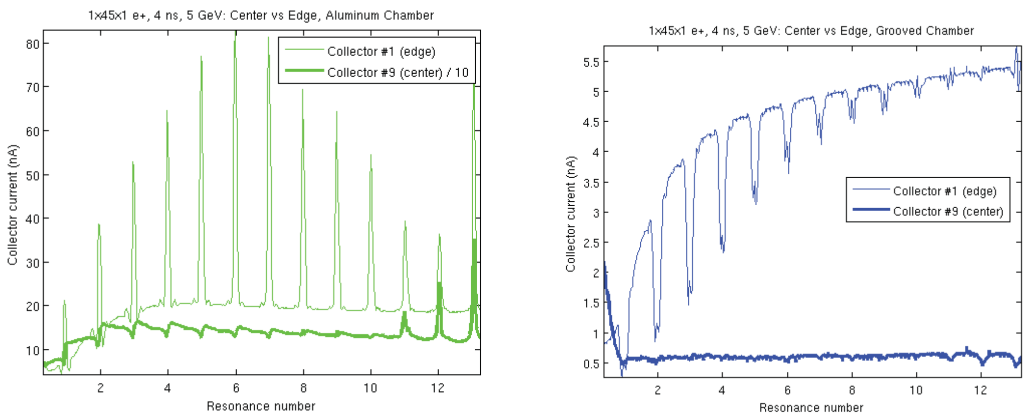

Figure 3. Total RFA current vs. chicane dipole field, as measured by the cyclotron resonance number: chamber with uncoated aluminum surface (left), and grooves plus TiN coating (right).

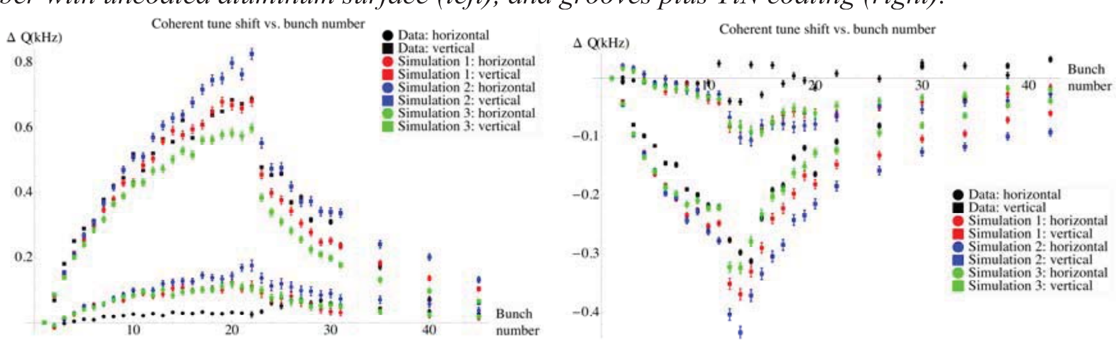

Figure 4. Left: measured and simulated coherent tune shifts for a 21 bunch train of positrons, with 0.5 mA/bunch and 14 ns spacing, at 2.1 GeV, followed by 11 witness bunches. Right: measured and simulated coherent tune shifts for a 10 bunch train of electrons with 0.75 mA/bunch and 14 ns spacing, at 1.9 GeV, followed by 13 witness bunches. The tunes were measured using a pinger to coherently excite the whole train. The simulation parameters in simulation 1 correspond to a peak SEY of 2.0 in an aluminum chamber; for simulation 2, SEY=2.2, and for simulation 3, SEY=1.8.

Measurements of the coherent tune shift of individual bunches in long trains, and of witness bunches following these trains, can probe the growth and decay of the ring-wide average electron cloud in CESR. In order to determine these tune shifts, cloud simulation runs with offset bunches and trains were used to compute effective field gradients. Runs were performed in both drifts and dipoles, in which the cloud was generated from photons with a flux distribution computed from the predicted radiation pattern in CESR.

Simulations with the same cloud model parameters give relatively good agreement with a wide range of data for both positrons and electrons. In Figure 4, plots of tune shift data and comparisons with simulations are shown.. The simulation parameters in the cloud physics model are, in all cases, appropriate for uncoated aluminum. The variation with one simulation parameter, the chamber peak secondary emission yield, is also shown. The agreement is good for the vertical tune, but poorer for the horizontal tune.

2.4 Low Emittance Tuning

Low emittance tuning is the beam based measurement and correction of sources of single particle vertical emittance, including vertical dispersion and transverse coupling. Transverse coupling is generated by tilted quadrupoles and vertically offset sextupoles. Vertical dispersion is generated by rolled bend magnets, vertically offset quadrupoles, and by any mechanism that couples horizontal dispersion into the vertical plane. We measure coupling by resonant excitation of the normal betatron modes and measurement of the relative phase and amplitude of horizontal and vertical motion at each of the 100 beam position monitors [21]. Dispersion is the measured change in position of closed orbits at two difference RF frequencies.

2.4.1 Machine Alignment and Beam Position Monitors

The coupling and dispersion that is generated by misaligned magnets is minimized with the help of dipole and skew quad correctors. A simulation study [22] shows that, using our upgraded tuning algorithm, the requirements for achieving 20 pm vertical emittance are: quadrupole vertical misalignments <150 μm; sextupole vertical misalignments <300 μm; quadrupole and diple rotations about the beam axis <100 μrad; beam position monitor accuracy for orbit differences <20 μm; and BPM rotations <15 mrad. We have reduced vertical misalignments to well below the required specification for both quadrupoles and sextupoles. The rms dipole roll is presently 150 μrad. We continue to measure and level dipoles as time and manpower permits.

One of the major components of the CesrTA upgrade is high bandwidth and high precision beam position monitor electronics. As of early September, 80% of the CESR BPMs were instrumented and commissioned with the new electronics. We anticipate that the new system will routinely be used for low emittance tuning during the next CesrTA running period that begins in November. Tests of individual modules indicate that the new system readily meets the targets for accuracy and reproducibility required to achieve ultra low emittance.

2.4.2 Low Emittance Tuning Procedure

The strategy for minimizing vertical emittance begins with a beam based alignment of the beam position monitors with the centers of the adjacent quadrupoles. Using closed orbit bumps, the trajectory of the beam is adjusted until the closed orbit is independent of a change in strength of the quadrupole. BPM resolution and systematic effects associated with the alignment of the quadrupole and BPM centers limit the precision of the offset measurement to 50-75 microns.

Having aligned the beam position monitors to the quadrupoles, the procedure is to:

1. Measure the closed orbit at each of 100 beam position monitors and correct (center in quadrupoles) using all 108 dipole correctors.
2. Measure betatron phase and transverse coupling at each BPM by resonant excitation of the normal modes, and correct using all 100 quadrupoles and 14 skew quadrupoles. We typically achieve an rms phase error of less than 1.5 degrees and an rms coupling error of less than 0.6% in two or three iterations, in about 10 minutes of machine time.
3. Re-measure coupling and measure dispersion by orbit difference. Simultaneously fit dispersion, coupling, and vertical orbit using skew quad and vertical dipole correctors.

At the conclusion of the low emittance tuning procedure we typically measure an rms residual dispersion of about 2.4 cm. According to our machine model, a residual dispersion of 2. 4cm rms will generate vertical emittance of 80 pm, assuming no coupling. Preliminary measurement of the vertical beam size with the xBSM indicates a vertical emittance of ~40 pm which corresponds better to a residual vertical dispersion of 1.7 cm. We believe the discrepancy is a result of systematic errors in our dispersion measurement associated with the analog BPM electronics (soon to be fully replaced). The dependence of the Touschek lifetime on bunch current is also consistent with a zero current vertical emittance of ~40 pm (see Sections 4.2 and 4.3) [1].

3 Ongoing Research During Current Grant Period

During the remainder of the current grant period, we will demonstrate that our low emittance tuning instrumentation and procedure reproducibly yields a zero current vertical emittance of ~20 pm. This will enable measurement of EC beam dynamics effects, including emittance dilution, at the 20 pm level. We will characterize several mitigation techniques and continue our study of electron cloud development in wigglers, dipoles, quadrupoles and field free regions. In Section 4 we propose to extend these studies to the 5-10 pm regime and to carry out further investigations of EC mitigations.

3.1 Electron Cloud Measurements and Analysis

3.1.1 Local Measurements of the Electron Cloud

The RFA data provide information on the differential current density of electrons which impact the chamber walls at the location of the RFAs. This information provides a direct measurement of the time-average electron cloud density generated in the associated magnetic and vacuum chamber environment as a function of the generating beam conditions.

In order to interpret the data in terms of the physics models of the formation of the electron cloud, it is necessary to compare the observed differential current densities with the results of a simulation. In drifts and dipoles, most of the RFA's are located in regions in which a two-dimensional description of the electron cloud dynamics is sufficient for an accurate simulation of the development of the cloud. However, in the wigglers, the inherently 3D nature of the field requires a 3D simulation code. In collaboration with LBNL, we are developing a 3D code (WARP-POSINST) to have the capability to model the cloud growth in wigglers. Several interesting features of the 3D wiggler results, such as trapping of electrons in the region of peak longitudinal fields, have been observed in the simulation, and work is underway to develop methods to observe this effect experimentally.

In dipoles, and particularly in the high-field wigglers, the confinement of the motion of the electrons to helical trajectories around the field lines, with cyclotron radii which are small compared to the holes in the vacuum chamber that define the RFA acceptance, means that the motion of the cloud electrons which are detected by the RFA is strongly influenced by the RFA electric fields, and by secondary emission processes occurring within the RFA itself. For an accurate simulation, it is therefore necessary to include the RFA structure and its effect on the cloud within the electron cloud simulation program itself. In collaboration with LBNL, we are working on developing a version of both POSINST [24] and ECLOUD [24] which includes the RFAs.

An example of a comparison between an RFA measurement and a simulation in development is shown in Fig. 5. This figure compares a POSINST simulation (using nominal cloud model parameters for Al, and an overall SEY of 1.8) with the measured currents on several collectors of the segmented RFA at 15E in CesrTA. This region is a drift with an uncoated Al chamber. The data was taken with a 45 bunch train of positrons at 2 GeV, with a bunch spacing of 14 ns. Collector 5 is in the middle of the vacuum chamber, while collectors 4 and 6 are adjacent on either side. A simple postprocessing script has been used to compute the RFA efficiency, supplemented with an empirical model to account for secondaries generated inside the beam pipe holes. The agreement with the simulation is satisfactory except at voltages below about 40 volts in collector 5. Lower voltages are more sensitive to the secondaries produced in the beam pipe holes and in the RFA, and further improvements to the model are in progress.

.

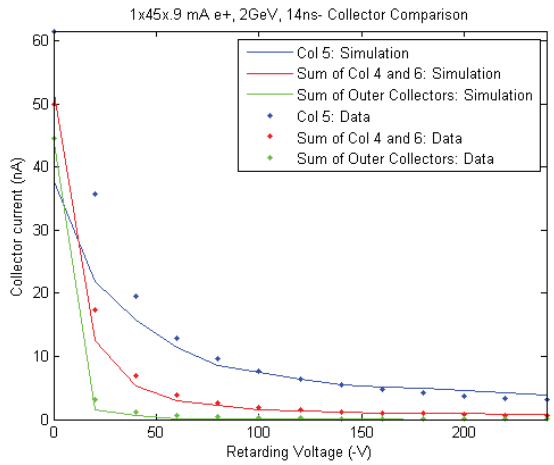

Figure 5. Comparison of an RFA at location 15E in CesrTA with POSINST simulation. This region is a drift with an uncoated Al chamber.

When code development is complete, we will generate simulations of the observable RFA differential current densities, and compare with the observations. These comparisons will be made for a range of magnetic environments, including the variable dipole field results from the PEP-II chicane in L3, and for a range of vacuum chamber environments including all the proposed mitigation techniques. The comparisons will allow us to tie the observations to cloud physics model parameters, which will establish confidence in our understanding of the cloud development in these environments, and the suppression of that development by the mitigation techniques.

Other elements of our local EC measurement program include ongoing R&D into obtaining direct measurements of EC build-up and decay via the RFA's, shielded pickups and TE wave measurements. We are also preparing to deploy an in-situ secondary electron yield measurement station which will allow us to characterize the SEY of various surface treatments before, during and after processing with synchrotron radiation. A companion (identical) setup is planned for the Main Injector at FNAL as part of a SLAC-FNAL-Cornell collaboration.

3.1.2 Beam Dynamics Measurements and Simulations

Ring-wide measurements of coherent tune shifts cannot differentiate between the drift and dipole contributions. To disentangle them, we have installed solenoids in a large fraction of the drift regions of the ring. We are planning on making ring-wide tune shift measurements with and without solenoids energized. Using our new BPM system, we will also attempt to measure betatron phase shifts as a function of bunch number over a dipole-dominated region of the ring.

The wide range of coherent tune shift data that we have taken and will take allow a comprehensive set of comparisons with cloud buildup simulations. These comparisons will allow us to characterize the cloud physics model parameters in a way that is complementary to the comparisons using the RFA data. For example, the time dependence of the cloud growth and decay, provided by the train and witness bunch-by-bunch tune measurements, provide access to information on the cloud dynamics not available from the RFA data. On the other hand, the RFA data provide a direct measurement of the cloud electron energy spectrum. The combination of tune shift and RFA data (in uncoated Al chambers), and the requirement of consistency between these data, over a wide range of beam parameters, allows one to identify systematic errors in both measurements that might otherwise evade detection. This provides further confidence in our understanding of the physics of the formation of the electron cloud. This understanding is essential for a convincing extrapolation to the conditions expected in the ILC damping rings.

The new DIMTEL feedback system [17] can be used to make grow-damp measurements of the growth time and mode spectrum of EC-driven multi-bunch instabilities. The mode spectra are sensitive to details of the EC growth. Measurements of the spectra over a wide range of beam conditions will provide both additional information on the buildup of the cloud and information on the interaction of the cloud with the beam. We plan to compare our observations of multi-bunch instability growth times and mode spectra with simulations. Although we do not have simulation capability for this at Cornell, our collaborators (from INFN and KEK) are very interested in this and have agreed to support these simulations using their well-developed codes.

The coherent tune shift measurements that we have made to date suggest that, at the highest bunch currents and with long trains, we can develop electron cloud densities which are sufficiently large to excite the single-bunch head-tail instability. We will use gated tune measurements to look for the excitation of synchro-betatron sidebands, a signature of this instability. If observed, we will measure the threshold for the onset of the instability, which can provide information about the high frequency dynamics of the cloud. We plan to compare our observations of single bunch instability thresholds with simulations. Again, we will rely on the simulation capability and tools of our collaborators (from SLAC and KEK).

In conjunction with the gated tune measurements described above, we will use our visible and x-ray beam size monitors to observe emittance growth associated with the onset of the head-tail instability. These beam size monitors will also be used to pursue a more elusive, but possibly more significant, effect: subthreshold incoherent emittance dilution. Such dilution is driven by nonlinear phase space diffusion, whose origin is the nonlinear terms in the electron cloud fields experienced by the beam. The sensitivity of searches for these effects will depend on the minimum vertical emittance which can be reached at CesrTA, and on the resolution of the beam size monitors.

Emittance dilution from coherent instabilities will be simulated using codes developed by our collaborators at SLAC and KEK. Sub-threshold emittance dilution due to nonlinear phase space dilution resulting from the electron cloud can be modeled using single particle tracking codes. There is interest in this work on the part of our collaborators at KEK. In addition, tracking codes available at Cornell may be used.

3.2 Low Emittance Tuning

As noted above, precision beam position measurement is essential to identifying and eliminating sources of residual vertical dispersion and transverse coupling. A vertical dispersion of 1cm corresponds to vertical emittance of about 10pm. We can change the beam energy by about 0.2% by varying the frequency of the storage ring RF. Then a vertical dispersion of 1cm corresponds to an orbit difference of $\Delta y = \eta \ \Delta E/E = 20\ \mu$m. Systematic errors such as BPM tilt, and button to button gain variation will contaminate the measurement of vertical dispersion. Typical horizontal dispersion in the CesrTA lattice is about 1m. Therefore we must determine BPM tilts (either physical or electronic) with 10mrad precision in order that the contribution of measured vertical dispersion due to BPM coupling be less than the 1cm target. We use beam based gain mapping techniques to identify button to button gain errors [6]. Measurement of relative amplitude and phase of resonantly excited vertical and horizontal motion at each BPM gives the coupling matrix elements $\overline{C}_{12}$, $\overline{C}_{22}$, and $\overline{C}_{11}$. While $\overline{C}_{11}$ and $\overline{C}_{22}$ are sensitive to BPM tilt, $\overline{C}_{12}$ is not. The true coupling of transverse motion can be eliminated by measurement and correction of $\overline{C}_{12}$. Then $\overline{C}_{22}$ is a direct measure of beam position monitor tilt. [2]. Reproducibility of measured coupling and dispersion shows that the intrinsic resolution of the digital BPM system is more than adequate to achieve our target emittance.

Recent measurements show that the intrinsic resolution of the dispersion measurement with the new digital BPM system is <5 mm. Coupling data taken during the same period also clearly shows the superior performance of the new system. The residual for the new system detectors in the measurement of $\overline{C}_{12}$ is much less than 0.1% (note that $\overline{C}_{12}$ =1% corresponds to an 0.01% emittance coupling). Both are well below the level required to achieve zero current vertical emittance less than 10 pm. We anticipate that, with the complete characterization of the digital BPM electronics, we will be able to understand these systematic effects (BPM tilt and button-to-button gain errors) at the requisite level.

In addition to the use of the xBSM for emittance measurements, we have explored ways to improve our visible light beam size monitor system (vBSM) in order to provide both a cross-check as well as an additional set of tuning tools for our low emittance operations. The vBSM system consists of direct imaging for beam sizes larger than the diffraction limit of the optics (~180 microns), a two slit interferometer with a slit spacing of 3 mm and 0.5 mm slit width (sensitive to vertical beam sizes between 50 and 200 microns), and a displaced imaging system for the vertically polarized component of the synchrotron light (sensitive to vertical beam sizes from 5 to 70 microns) [15]. We utilize two readout methods for the images: a conventional CCD TV camera feeding a frame grabber; and a 32 element linear photomultiplier with 1 mm photocathode spacing which is capable of resolving individual bunch passages. The vertical polarization method is well matched to the range of emittances covered by the CesrTA optics. The expected dip in the CCD image of the vertically polarized light was observed at the end of the last run and the observed light intensity should permit single turn single bunch (~1 mA) measurements using this system.

3.3 Role of Collaborators

Collaborators have played a crucial role in the progress of the CesrTA program, including the design and fabrication of hardware and instrumentation, loan of existing equipment, contribution to the development of modeling software, and participation in CesrTA machine studies. Physicists and engineers from KEK, LBNL and SLAC have collaborated in the design and fabrication of wiggler vacuum chambers with electron cloud mitigation and retarding field analyzers. Accelerator physicists from KEK and INFN-Frascati have participated in the experimental programs to characterize e-cloud induced instabilities, and to identify and correct sources of residual vertical emittance in CESR, Physicists from KEK have made very important contributions to the development of the CesrTA xBSM.

There is a close LBNL-Cornell collaboration to develop the electron-cloud simulation and modeling codes to interpret the data that is emerging from CesrTA. SLAC and Argonne are also contributing to e-cloud code development and investigation of e-cloud dynamics. Both FNAL and CERN are taking advantage of the Test Accelerator to characterize electron-cloud mitigating surface treatments, and physicists from CERN have been able to test aspects of the proposed CLIC magnet stabilization system in CesrTA. The use of TE microwaves to measure cloud density at CesrTA has benefited from the contributions of LBNL.

The instrumented dipole chicane, that was first implemented at PEP II and, on loan from SLAC, is now installed in CesrTA, is being used to measure the field dependence of electron cloud development. Also on loan from SLAC is equipment for in-situ measurement of secondary emission yield. CalPoly is collaborating on the visible light beam size monitor, on instrumentation for measurement of bunch by bunch tune shifts, and on streak camera instrumentation.

Accelerator physicists at the Cockroft Institute have contributed to the development of the low emittance tuning program, participated in LET machine studies, and analyzed the data that has come from those studies. Technion is helping to create phenomenological models of electron-cloud dynamics.

We anticipate the collaborators will continue to play an integral role in the CesrTA program.

4 Proposal for Further Investigation

Measurement of emittance diluting effects is a critical component of the CesrTA program. Our sensitivity to such effects depends on our ability to achieve ultra low zero current emittance. The digital BPM electronics that has recently been commissioned has the intrinsic measurement resolution necessary to identify guide field errors and to reach vertical emittance in the ILC damping ring regime. With further effort to understand systematic measurement errors, to develop our low emittance tuning algorithms, and to identify time dependent sources of emittance dilution (power supply ripple, magnet vibration, etc.), we expect to reproducibly achieve 5-10 pm zero current vertical emittance. This will permit us to measure emittance diluting effects with exquisite sensitivity. We will continue to advance our x-ray and visible beam size monitor designs to exploit this experimental regime.

4.1 Mitigation Methods and Vacuum System R&D

Ongoing R&D on mitigation methods forms a significant part of the proposed research program. The extended operations schedule will allow detailed evaluation of the aging effects of the mitigations proposed for the damping rings. The CESR operations model during this time frame, which includes two running periods per year with intervening downs, is well-suited to tests of new and refined mitigation methods as they are developed. The duration of the R&D program is also commensurate with the time required to design and test prototype ILC-like vacuum chambers incorporating EC mitigations. In regions such as the wigglers, these designs are challenging and such tests will ensure that a robust design exists. Details of the designs will then be incorporated into the overall impedance model for the damping rings.

4.2 Intra-Beam and Touschek Scattering

The fully instrumented CesrTA will be a unique laboratory for the investigation of intra-beam scattering. With the combination of the low emittance and the low beam energies accessible with CesrTA optics, effects of intrabeam scattering are evident. The range of beam energies accessible to CESR will permit detailed characterization of the energy dependence of IBS. Flexibility of the optics allows for straightforward variation of the zero current emittances. We will use the low emittance tuning techniques and instrumentation for real time measurement of vertical beam size (xBSM and vBSM) that are now being developed to minimize vertical emittance. Ultimately we will measure the current and energy dependence of horizontal and vertical emittance for both electron and positron beams, allowing a complete characterization of intra-beam scattering and electron cloud induced emittance dilution.

Calculations suggest that as we approach our design zero current vertical emittance we will observe a strong current dependent emittance growth [2]. In particular we find a strong dependence of horizontal emittance on bunch current. The sensitivity of horizontal emittance to intra beam scattering is due to the relatively large horizontal dispersion in the CesrTA optics. The dynamic range of the xBSM will permit measurements of bunch size from 0.4 mA to 5 mA. In order to measure the very significant energy dependence of the IBS emittance growth, we have developed and tested optics for operation from 1.8 GeV to 5.0 GeV beam energy, with a range of zero current horizontal emittances from 2.5 nm to 100 nm.

We plan to measure horizontal and vertical beam size, and beam lifetime as a function of bunch current over the range of energies from 1.8 GeV to 5.0 GeV. We will repeat the measurements for positrons and electrons. This data will provide a unique test of models of emittance growth and particle loss due to intra-beam scattering and interaction with the electron cloud.

4.3 Lifetime Measurements

Sensitivity of beam lifetime to emittance provides a powerful tool for studying collective effects. The Touschek effect is characterized by the dependence of lifetime on beam current. ($dI/dt = -I/\tau_0 - I^2/b$) If the Touschek b-parameter is small, Touschek scattering will significantly degrade the lifetime. The effect of Touschek scattering on lifetime depends on particle density (emittance) and the energy acceptance of the lattice.

Determination of the effective energy acceptance is non-trivial. If the energy acceptance is limited by the RF overvoltage, then the tolerance of a particle to an energy change due to scattering will be independent of where in the lattice that energy change occurs. However, if the limiting energy acceptance is dynamic, then that acceptance does depend on local lattice functions. In a lattice with strongly varying dispersion and beta functions, like the CesrTA optics, energy acceptance cannot be characterized by a single number. We are developing algorithms to locally compute dynamic acceptance and then to incorporate that information into the calculation of the Touschek lifetime.

4.4 Ion Effects

An electron beam is subject to the effect of the fast ion instability (FII). Ions are created by interaction of the beam with the residual gas molecules. The ions may dilute the emittance of the electron bunch in an electron beam by a mechanism similar to the effect of the electron cloud on the positron bunch in a positron beam [7]. Similarly, ions may couple bunches within a train. The instability threshold depends on the beam configuration, bunch charge density, and residual gas pressure. The FII can dilute the emittance of the electron beam and ultimately limit the bunch and current density of the electron damping ring if not controlled. For example, it is anticipated that the ion density will increase along the length of the train of bunches. We will measure individual bunch size, frequency, and tune shift to further characterize the effect. We will use the CesrTA to explore the fast ion instability in the emittance, charge density, and beam current regime that is characteristic of the ILC electron damping ring. Comparison of the data with the theoretical expectations and simulations can be used to benchmark the models used in the design of the ILC damping rings.

4.5 Cloud-Driven Emittance Dilution at Ultra Low Emittance

The single bunch instabilities which the electron cloud can generate, such as the head-tail instability, will lead to a growth in the emittance, and cannot in general be controlled by conventional feedback systems. While the density of the cloud generated by a beam is not expected to depend substantially on the emittance of the beam, the strong electric fields generated near a low emittance beam will cause rapid oscillations of the electrons in the cloud near the beam. These rapid oscillations are expected to drive the development of the head-tail instability. Thus, the threshold for the instability may be lower for low emittance beams, even for fixed cloud density. Since this phenomenon is not well understood, it is important to study it experimentally, which should be possible in CesrTA with ultra low emittance beams, using the extensive suite of beam-size-monitoring instrumentation which will be available.

Even at cloud densities well below the threshold for coherent single-bunch instabilities, emittance dilution may be driven by phase space diffusion from the nonlinear terms in the EC fields experienced by the beam. Given the very small design emittance of the ILC damping ring, there is not much headroom for such effects. Simulations at KEK have indicated that such growth can occur, but on very long time scales. Hence, it is important to look for such effects in long-term experiments carried out using the lowest possible emittance beams. Moreover, at CesrTA, the level of cloud density experienced by a particular bunch can be controlled by placing the bunch in a “witness” position at a variable distance from the end of a bunch train. Thus, carefully controlled studies of the effects of low levels of cloud density on the emittance of ultra low-emittance test bunches can be carried out. Such studies are needed to establish how important this effect may be for the ILC damping ring.

4.6 Instrumentation for Real-time Monitoring of Machine Parameters

The high bandwidth beam position monitor electronics provide the capability of continuous and nondestructive measurement of machine parameters such as the betatron phase, coupling, dispersion and beam emittance. We propose to drive a witness bunch at the normal mode tunes (horizontal, vertical and longitudinal) and to measure phase and amplitude of horizontal and vertical motion at each BPM. From this data we can extract betatron phase and amplitude, transverse coupling parameters, and vertical and horizontal dispersion at each beam position monitor. Real time analysis of the measurements will drive the correction scheme.

4.7 Broader Impacts

While CesrTA is nominally a laboratory for investigation of ILC damping ring physics, many of our collaborators are motivated by other considerations. Electron cloud phenomena and mitigation techniques are relevant to the performance of high intensity proton accelerators, like Project X and the LHC injector and high intensity positron rings like Super B-Factories. The x-ray beam size monitor envisioned for Super KEKB is a close cousin to the instrument being developed for the test accelerator. Low emittance tuning techniques developed at CesrTA may find application in light sources, like NSLS-II, and studies of IBS dominated damping rings are of interest for the CLIC project. In addition, techniques for stabilizing CLIC linac and interaction region magnets are being tested at CesrTA.

4.8 Outreach (see outreach discussion at end of **Development of Low Frequency High Gradient Superconducting RF Cavities for Muon Acceleration**)

5 DOE-funded ILC Damping Ring Activities

A major component of the proposed effort will be continued participation in the ILC GDE Technical Design Phase. In particular, the CESR-based R&D program will allow important refinement and validation of the EC mitigation plan, and we intend to provide general support for the damping ring design activities. Key contributions will include:

1. EC simulations in support of the positron damping ring design and performance evaluation;
2. Participation in the development and characterization of the DR optics;
3. Development of real-time low emittance tuning and measurement tools including emittance feedbacks with application to both CesrTA and KEK-ATF;
4. Development of damping ring instrumentation (including R&D into a fast x-ray monitor with sufficient time resolution to measure longitudinal slices within individual bunches);
5. R&D into EC mitigation methods including: tests of the long-term durability of EC mitigation coatings, exploration of new EC mitigation techniques, and participation in the design and prototyping of ILC DR vacuum system elements;
6. A general program of experiments and device prototyping for linear collider R&D
    a. Support for collaborator experiments and device tests in the ultra low emittance and IBS dominated regimes
    b. Investigation of other beam physics of relevance to the linear collider damping rings (e.g., the fast ion instability)

We envision a total effort directed at ILC DR work packages of roughly 6 FTEs and propose to pursue the support for these personnel along with suitable M&S from DOE as part of the ILC ART program. An explicit breakdown is provided in the next section.

6 CesrTA Project Organization, Manpower and Budget

The proposed research program envisions two experimental runs per year during the funding period. This corresponds to approximately 20% of the CESR operations effort. Each run for accelerator R&D will have a nominal duration of 3 weeks.

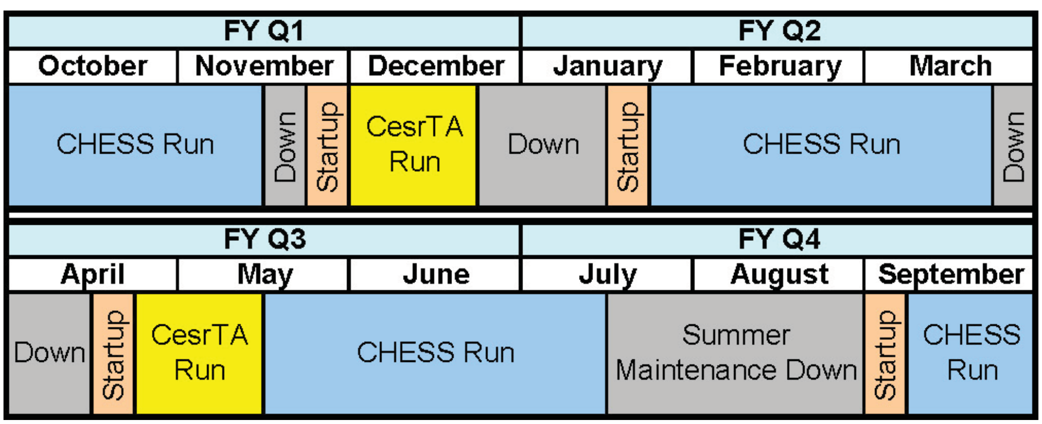

Figure 6. Strawman schedule showing CESR runs and downs for a single fiscal year.

The CesrTA project operates under the umbrella of the CLASSE Directorate. The overall research effort is coordinated by David Rubin (Principal Investigator), Gerald Dugan and Mark Palmer (Project Director). Technical coordination is handled by the project director and deputies.

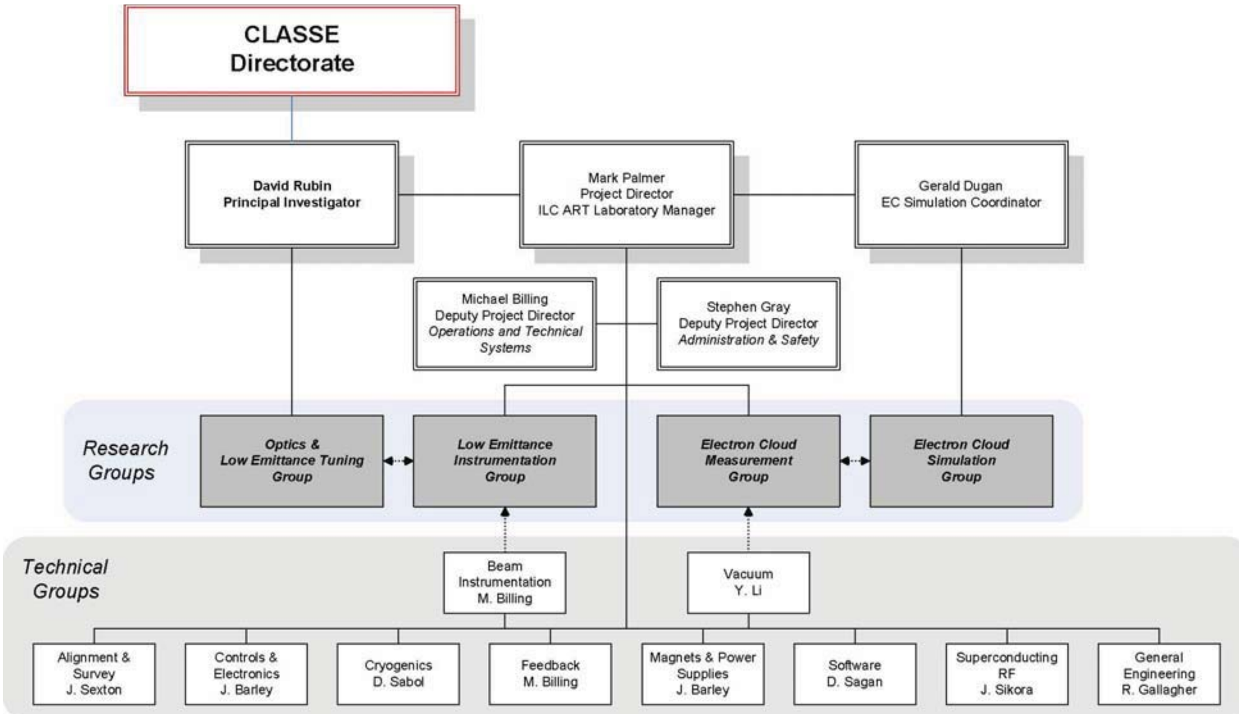

Figure 7. Organization Chart for the CesrTA Project.

The total manpower required for the CesrTA project is estimated at approximately 25 FTE staff members. In addition to laboratory staff we expect the direct involvement of at least 4 faculty members and are targeting the recruitment of 5 graduate students at any given time in the program. Just over 25% of the staff effort is directly associated with CESR operations. The ILC ART effort was described in the preceding section. The remaining effort will provide general support of the CESR-based R&D program. A manpower breakdown is provided with the proposed budget in Table 1. The proposed funding profile assumes that $1.5M in funding is available from the ILC ART for the first year and will continue, with annual adjustments for inflation, in the succeeding years.

Year	Funding Component	Staff FTE	GRA FTE	Salaries & Fringe (K$)	M&S (K$)	Travel M&S (K$)	Indirect (K$)	Total (K$)
1	NSF	20.5	3.5	1775	1112	70	1093	**4050**
	DOE	4.5	1.5	673	327	39	459	**1499**
2	NSF	20.5	3.5	1976	1382	74	1219	**4650**
	DOE	4.5	1.5	698	337	40	468	**1543**
3	NSF	20.5	3.5	2036	1310	76	1229	**4650**
	DOE	4.5	1.5	722	347	42	484	**1594**

Table 1. Staff and funding profile for the CesrTA Accelerator R&D program and ILC Damping Rings activities.

***References* (see References Section)**

PROJECT DESCRIPTION

Superconducting Radio Frequency Basic R&D

1. *Introduction*

Due to its many successes in science and applications, superconducting radiofrequency (SRF) has become an enabling technology for the accelerator based sciences such as particle physics, nuclear physics and the materials sciences. Nevertheless, there remain technical and scientific challenges in full realization of the potential of this technology. These challenges include but are not limited to achieving theoretical surface resistances and peak rf magnetic fields as well as discovery of new materials that may have properties superior to niobium used at present. While there have been outstanding examples of very high Q (low surface resistance) and peak magnetic field (accelerating gradients) repeatability at scales useful for practical devices has been poor. Input material quality, fabrication and processing procedures and materials and environmental factors all seem to play a role. Untangling these factors in needed applications and devising remedial measures are at the frontier of SRF R&D today. This proposal addresses issues related to achieving highest gradients and highest Q's.

The Cornell SRF group has the physical and intellectual infrastructure to attack several of these issues. We are currently seeking support to address three major areas:
(a) High-gradient performance variations with key surface processing techniques,
(b) Techniques for achieving the highest Q at mid level gradients, and
(c) Q degradation from environmental factors.

2. *High-Gradient Performance Variation with Key Surface Processing Techniques*

Electropolishing (EP) is accepted as one of the best chemical treatment procedures to prepare niobium cavity surfaces to reach high gradients [1]. EP provides a smooth surface with minimal grain boundary steps (less than 0.5 μm). This is important to avoid a strong Q degradation above 20 MV/m, normally referred to as the "high field Q-slope." For a review see reference [2].

The standard "horizontal electropolishing" method developed by KEK in the 1980's is now used at KEK, DESY, JLab, and ANL [3]. In this method a cavity is placed with its beam-axis in a horizontal orientation and is half filled with acid. The cavity rotates slowly around the axis to polish the whole surface. The acid circulates between the cavity and a large acid storage barrel where it is cooled with a heat exchanger. In the Cornell vertical EP (VEP) method [4], the cavity orientation is vertical with the cavity full of a relatively small volume of acid, gently stirred by propellers mounted from a coaxial shaft. Electrical connections are fixed. A water shower over the outside surface of the cavity cools the acid. See Fig. 1 (left) for the Vertical Electropolishing set up.

It has the following advantages:
(a) that the temperature of the cavity walls can be better regulated because the cavity inside is uniformly filled with acid and the outside is uniformly flushed with coolant. In horizontal setups, a rotating cavity in only partially filled with acid which is pumped through a heat exchanger.
(b) For VEP the acid is not pumped through the cavity multiple times so that removed acid has no further contact with the cavity.
(c) The technical complexity of the horizontal method is reduced by eliminating rotary acid seals, external acid plumbing, acid flow valves, acid circulating pumps, large storage barrels and heat exchangers. Such simplifications will result in lower cost for a large number of systems that will eventually be needed to electropolish tens of cavities per day for a large accelerator.

(d) The vertical EP method reduces the known risk for sulfur and oxide contamination build-up in the many plumbing parts and acid reservoir. These contaminants can eventually find their way to the cavity to cause field emission or rf losses.
(e) Soft cavities without stiffening rings sag in a horizontal EP system, but can be processed in a VEP system.

We propose to analyze our cavity preparation procedures including the critical VEP stage with an existing batch of 5-cell, 1.3 GHz cavities shown in Fig. 1 (right) using our already prepared 5-cell Temperature mapping system (T-map). We plan to map the detailed nature and frequency of defects that lead to quench and RF losses in general.

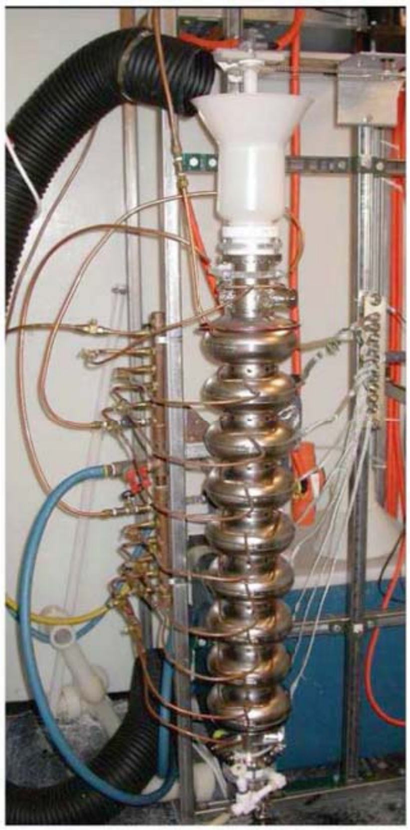

Figure 1: Left: Vertical electropolishing set up for 9-cell 1.3 GHz ILC cavity. Right: Several existing 5-cell 1.3 GHz cavities of similar shape.

We have applied VEP to single cell 1.3 GHz cavities to achieve gradients of more than 53 MV/m [5]. We have also applied vertical electropolishing to several 9-cell standard (ILC) shape cavities, and on one re-entrant shape cavity to demonstrate gradients between 25 – 30 MV/m with high Q's. The limit has generally been quench in the accelerating pi mode. We have also demonstrated that individual cells in some of these multi-cell cavity tests have reached 37 MV/m gradient, showing that the method is capable of yielding the high gradients needed [6]. We have also successfully applied VEP to a 5-cell 1.3 GHz cavity (described below) to reach 37 MV/m in the accelerating pi-mode [7].

One of the main goals of the proposed cavity treatment evaluation program will be to understand the underlying causes to address the high gradient yield problem for multi-cell 1.3 GHz cavities. Recent world data on 9-cell, 1.3 GHz, niobium cavities show that quench of superconductivity limits more than 50% of the tests from reaching the goal of 35 MV/m accelerating gradient [8]. After excluding field emission limitations, the 9-cell data show a large spread in quench fields. We need to understand the quench sources and the reasons for the large spread.

Our program will use three 5-cell niobium cavities at 1.3 GHz that we posses, one of which has already reached 37 MV/m after VEP [7].

To fully understand the reasons for gradient spread, each 5-cell test will be carried out with a high sensitivity, high spatial resolution thermometry based on a work-horse one-cell thermometry system [9] that has been successfully used at Cornell to reveal all types of gradient limitations, such as multipacting, field emission, and most importantly, quench. Multi-cell cavity work around the world suffers from a lack of understanding because there is no accompanying detailed thermometry data for the tests. This is one of the reasons for the protracted effort to improve the gradient yield in multi-cell cavities.

Routine temperature mapping will allow a detailed understanding of gradient spread and guide the program to improve procedures to achieve a high yield at 35 MV/m. We will study whether the quench field and location changes due to VEP treatment cycles, baking and other treatments regularly used for cavity preparation. Quench locations from the temperature map will be augmented by location found by our innovative second sound detection with Oscillating Super-leak Transducers (OSTs) [10]. We will be able to differentiate between quench occurring at the weld or from the material. We will also be able to map the overall loss distribution over the surface area of the cavity to understand the role of geometry in any of the treatment procedures. The loss distribution will be compared to that expected from surface field levels. And parameters of the preparation, e.g. the orientation of the cavity during VEP, will be correlated with the loss distribution. A detailed analysis of the quench field and the temperature map in the quench region allows determination of the resistivity and size of the defect that cased the quench, and allows distinguishing between those quenches caused by impurities and those caused by pits [11].

The use of 5-cell (instead of 9-cell) cavities will allow the program to carry out preparations and tests at a high rate (one per month) as compared to 9-cell cavities. The 5-cell units will fit into our high vacuum annealing furnace for hydrogen degassing so that we can reduce the total cycle time. As compared to previous test, we expect a significant cost reduction for testing using our new He recovery system presently under installation. The use of 5-cell cavities without end groups (for input and higher order mode couplers) will allow the program to focus attention on the gradient and yield issues in the main high field regions (the cells) and expedite the turn-around time for preparation and testing.

With previous NSF funding we have prepared most of the components necessary for the complete 5-cell thermometry system (see Fig. 2) based on 500 resistors per cell.

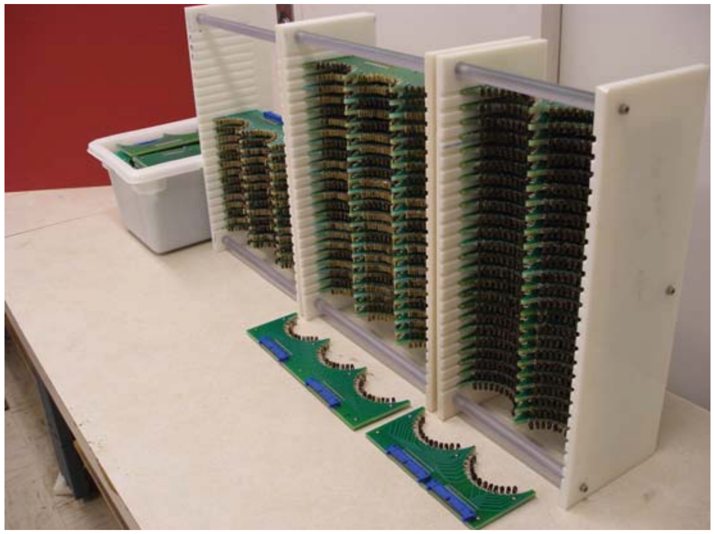

Figure 2: PC boards populated with thermometers ready for 5-cell cavity T-map system**.**

3. ***Techniques for achieving the highest Q at mid level gradients***

Whereas high gradients are paramount for high energy, low duty factor pulsed applications, such as ILC and XFEL, high Q's are important for high duty factor to CW applications at medium gradients due to the dominance of the refrigerator load and its impact on the operating cost of an SRF accelerator. The medium-field Q-slope can be quite strong dropping the Q by a factor of 2 - 3 from 2 MV/m to 25 MV/m. Understanding and controlling the medium-field Q-slope is important to future cw applications, such as the Energy Recovery Linacs (ERL) where cryogenics costs dominate due to cw operation at medium fields (< 20 MV/m). We propose to analyze how best to reliably produce Q values above 2 x 10^{10} at 1.8K.

According to the BCS theory, the surface resistance should fall exponentially with temperature as $e^{-\Delta/kT}$. However measurements at $T < 0.2\ T_c$ generally show that the surface resistance reaches a residual value, called the residual surface resistance (R_0). The lowest surface resistance measured in a superconducting cavity is less than 0.5 nΩ for a 1.3 GHz Nb cavity which reached a Q_0 of 2 x 10^{11} at 1.6 K (Fig. 3) [12]. More typically the residual resistance for Nb cavities is of the order of 5 – 10 nΩ.

Some of the familiar causes for residual resistance that can be treated by well-known methods are: insufficient shielding of the ambient dc magnetic field and the hydrogen-related Q-disease. The first can be reduced by improving the magnetic shielding in the test cryostat and the second by hydrogen degassing at 600 C or above.

Residual losses can also arise from several less understood sources. For example, residues from chemical etching, foreign material inclusions, or condensed gases are common. Therefore, cleanliness during forming, welding, and surface preparation and evacuation are essential. Successive reprocessing of the same cavity may show variations in residual losses, indicating that we do not yet know how to control all the important variables. Temperature mapping have proven an effective tool to locate regions of high loss on the cavity surface responsible for residual resistance, as for example Nb-H precipitates or trapping of the earth's dc magnetic field. For a review see [2].

We aim to investigate several important topics related to high Q using our existing 1.5 GHz single cell cavities and large-scale temperature mapping system [9]. We also have on hand one large grain cavity to explore the effect of grain size.

a) Is EP or BCP the best procedure for highest Qs at medium fields?
b) Does heat treatment give lower residual losses? If so what is the best temperature? The two high Q results shown above were both from heat treated cavities.

c) Do cavities from large grain Nb give higher ultimate Qs?

With increasing field level, the observed *Q* of a niobium cavity shows several interesting features (as shown in Fig. 3). For a review of Q-slope effects see [2]. In the low field region between a few mT and 20 mT, the *Q increases*, a surprising effect, named the "low field Q-slope". Mild baking (100 – 120 C for 48 hours) generally enhances the low field Q-slope. At medium fields (between 20 and 80 mT) the gradual *Q* fall is called the "medium-field Q-slope" and is a common feature of all niobium cavities. The medium-field Q-slope is generally attributed to a combination of rf surface heating and non-linear BCS resistance with varying degrees of success. Baking generally (but not always) decreases the medium-field Q-slope. Finally, there is a strong Q-drop at the highest field. This is not of concern for cavities operating below 20 MV/m (< 85mT) but for high-field applications that are a topic for the first part of this proposal.

We propose to investigate the importance of the medium-field Q slope out to 20 MV/m for cavities treated for field highest Q.

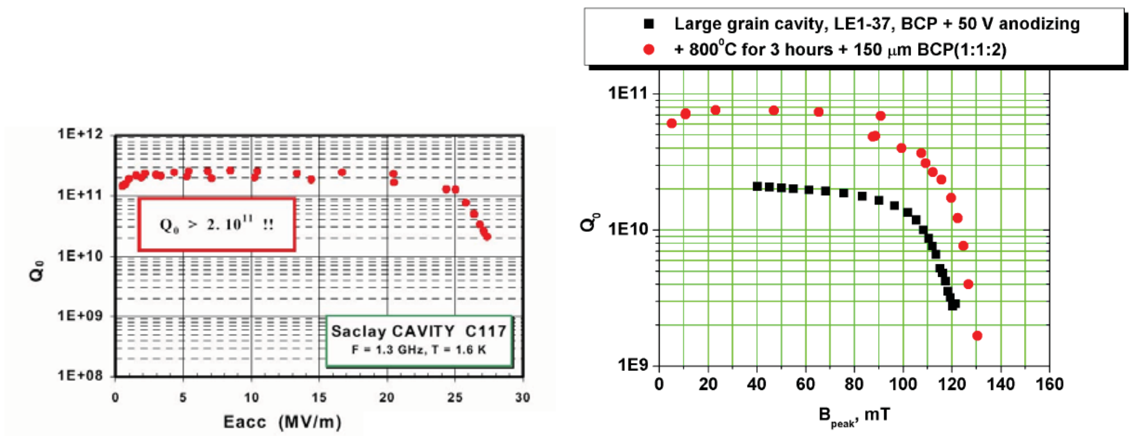

Figure 3: Left: World record Q value corresponding to record residual resistance of 0.5 nOhm [12]. 1.3 GHz at 1.6 K. Right: Example of the highest Q obtained at Cornell with a single cell 1.5 GHz cavity from large grain material after annealing at 800 C for 3 hours and chemical etching to clean the surface [13].

Analysis of temperature maps shows that the medium-field Q-slope is relatively uniform from spot to spot in contrast to the high field Q-drop, which has significant spatial variation [13]. The simplest explanation for the medium-field Q-slope is based on a thermal feedback model with pure BCS resistance. Thermal feedback provides a good account for high frequency (> 2.5 GHz) cavities, but otherwise yields a rather weak slope for 1.3 GHz cavities. Inclusion of the pair-breaking BCS resistance (the non-linear effect) predicts a strong medium-field Q-slope that often exceeds the observed slopes.

Some of these discrepancies may stem from the fact that the medium-field Q-slope and thermal feedback models which attempt to fit the data depend on a large number of physical parameters, some of which are not very well known for each cavity, or even for each test: thermal conductivity (especially the magnitude of the phonon peak), Kapitza resistance (which may be influenced by the mild baking conditions), electron mean free path (which also changes due to mild baking) and residual resistance. The trends for each parameter variation have been studied computationally [14]. For example computations predict that heat treatment > 800 C which increases the grain size and the phonon mean free path can decrease the medium-field Q-slope.

We propose to equip or test pits with additional magnetic shielding to reach Qs of more than 10^{11}, and guided by theoretical and numerical considerations to test the Q's dependence on preparation parameters.

4. *Q Degradation from Environmental Factors*

Although there have been several proof-of-principle examples of high Q operation of cavities inside cryomodules, there are many examples of variying degrees of Q-degradation due to a number of possible causes. These are Q-degradation and field emission from dust introduction, condensed gases, or insufficient magnetic shielding at particular regions of the cryostat. Several accelerators that use beam-pipe Higher Order Mode (HOM) absorbers have reported low Q values, and Q values that diminish with time. This problem has been reported for accelerators in the field of High Energy Physics, Nuclear Physics, and for light source applications. At Cornell it has been observed in the prototype ERL injector.

We propose to use the existing 2-cell cavities of the ERL injector with input couplers and HOM absorbers to investigate how best to limit the Q-degradation from vertical test to cryomodule test results. Significant assembly steps that will be investigated are: (a) assembly with couplers but HOM absorbers, (b) assembly of HOM absorbers without ferrite and ceramic tiles, (c) assembly of HOM absorbers with such tiles, (d) full assembly after several cold shocks.

We plan to connect the existing Horizontal Test Cryostat (HTC) of Fig. 4 to a helium liquefier and measure the Q of the cavity after various assembly steps to determine which steps have the high vulnerability. Figure shows the 2-cell cavity string with HOM, input couplers and gate valves in our HTC.

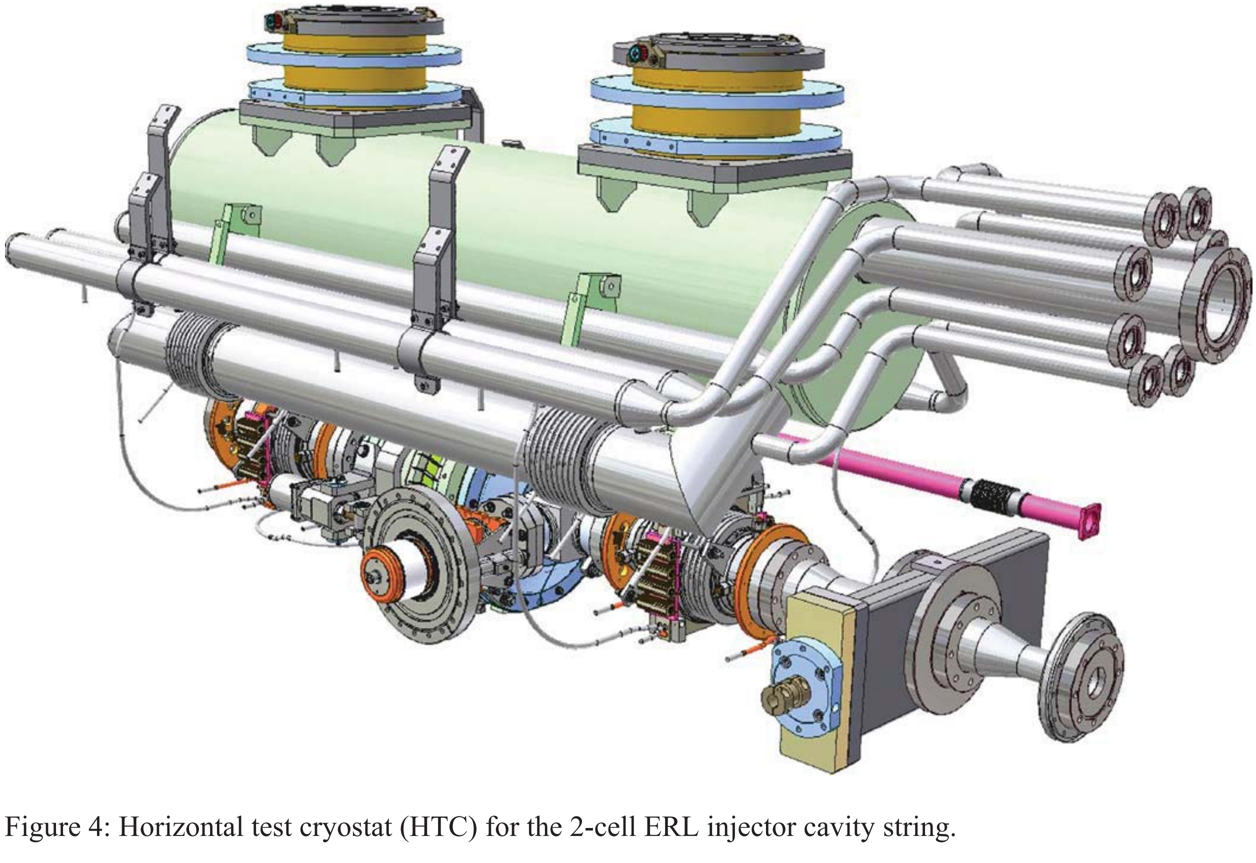

Figure 4: Horizontal test cryostat (HTC) for the 2-cell ERL injector cavity string.

5. ***Results of Prior NSF Support***

PHY – 0202078, **Support of the Cornell Electron Storage Ring (CESR) Facility, 04/01/03-03/31/10 $96,218,197**

Over more than four decades, research by the SRF group at Cornell has played a leading role in pushing cavity performance to high levels and in bringing many projects to realize the benefits of rf superconductivity. Among our successes, JLAB adopted the Cornell developed 5-cell, 1.5 GHz SRF technology to build CEBAF [15]. These cavities first operated successfully in CESR (Cornell Electron

Storage Ring) at 5 MV/m. 300 cavities now operate CEBAF at 7 MV/m. Since late 1997, CESR runs with a 500 MHz SRF system developed at Cornell [16]. Similar superconducting rf systems are now in use at several light sources around the world [17]. A major push for a one-percent duty factor, pulsed SRF-based linear collider came from the Cornell TESLA workshop held in 1990 [18]. Cornell has pushed the world record for gradients on many occasions. In 1993, a 2-cell 3 GHz cavity of "rounded equator geometry" (to lower the surface magnetic field) reached 35MV/m [19]. In 1994 a Cornell/DESY/Fermilab collaboration first reached 26 MV/m accelerating in several 5-cell 1.3 GHz structures [20] surpassing the 25 MV/m gradient goal for a SRF-based linear collider. After the ITRP technology decision to adopt the SRF approach for the linear collider the gradient goal increased to 35MV/m. In 2004 we tested the new idea of re-entrant shape cavity to further reduce the surface magnetic field to reach 47 MV/m in a single cell 1.3 GHz cavity [5]. Our KEK collaborators tested another re-entrant cavity built by Cornell and reached 53 MV/m [5]. Subsequent test after processing at Cornell reached the current world record of above 53 MV/m [5]. In 2007 the SRF group constructed the superconducting injector cavities and cryomodule for the ERL prototype [21].

The following references represent publications resulting from prior NSF support [2,4,5,6,7,8,9,10,11,16,17,18,19,20,21]

The Cornell SRF group has collaborated with many international laboratories to advance the state of the art of rf superconductivity. These include DESY, CERN, Fermilab, ANL, Jlab, the Muon Collaboration, the TESLA Technology Collaboration, and the Daresbury Laboratory.

Over these years of development, Cornell has installed extensive infrastructure for research and development in RF superconductivity as well as for production, preparation, and testing of superconducting cavities (see Facilities, Equipment and Other Resources section). Eight doctoral dissertations have been completed in the field.

6. *Broader Impact*

These activities will have an impact on all uses of SRF technology from low beta heavy ion accelerators through to the ILC where the highest practical gradients and Q's are important. The work will benefit both pulsed and cw applications where control of gradient capability and surface losses is of great importance.

7. Outreach (see outreach discussion at end of **Development of Low Frequency High Gradient Superconducting RF Cavities for Muon Acceleration**)

8. *Management*

This work will be managed by Prof. Hoffstaetter with the assistance of Prof's Liepe and Padamsee. Coordination with other Laboratory activities and resources will be managed by Prof. Tigner

9. *Timeline*

The timescale for the proposed program is 3 years.

First Year

- Complete and qualify thermometry systems for 5-cell cavities
- Prepare and test 5-cell cavities to qualify new thermometry system (2 tests)
- Carry out 12 single cell preparations and tests (one test per month) for high Q research varying BCP, EP and heat treatment
- Prepare 2-cell injector cavity for vertical test with its Higher-Order-Mode (HOM) absorber
- Improve magnetic shielding in one test pit
- Install Horizontal Test Cryostat and heat exchanger for 2K operation with 5K shield and 80K HOM absorber section.

Second Year

- Carry out 12 tests on 5-cell cavity with thermometry to explore variations in performance with treatment and cavity
- Carry out 12 single cell preparations and tests (one test per month) for high Q research varying BCP, EP and heat treatment
- Make improvements to cavities and treatments based on test results, guided by thermometry results.
- Assemble 2-cell injector cavity with couplers and HOM absorbers in Horizontal Test Cryostat (HTC) and test for environmental effects on performance after different assembly steps.

Third Year

- Make improvements to cavities and treatments based on test results, guided by thermometry results.
- Re-assemble 2-cell injector cavity with couplers and HOM absorbers for two more tests in the HTC.
- Carry out 12 single cell preparations and tests (one test per month) for high Q research varying BCP, EP and heat treatment

References **(see References Section)**

PROJECT DESCRIPTION

Development of Low Frequency High Gradient Superconducting RF Cavities for Muon Acceleration

1. *Overview*

An intense, well controlled, well characterized, narrow beam of muon (from the decay of μ^-'s) neutrinos and electron antineutrinos from the decay of muons in a storage ring (a "neutrino factory") can advance neutrino physics beyond the current round of approved and proposed experiments using conventional neutrino beams produced from a beam of decaying pions and kaons. There is no other comparable single clean source of electron neutrinos (from the decay of μ^+'s) or muon antineutrinos. A muon storage ring producing 10^{19} to 10^{21} muon decays per year should be feasible. These intense neutrino beams can be used to study neutrino oscillations and possible *CP* violation. An entry level muon storage ring that could provide 10^{19} decays per year would allow a determination of the sign of Δm_{31}^2 and a first measurement of $\sin^2\theta_{31}$ for favorable values of this parameter. An improved muon storage ring system that could provide 10^{20} muon decays per year would allow measurement of $\sin^2\theta_{31}$ at the lower limits suggested by present neutrino data. A high performance muon storage ring capable of providing more than 10^{20} muon decays per year would allow the exciting possibility of a measurement of *CP* violation in the leptonic sector.

Muons are fundamental particles like electrons, so muon colliders have the same advantages as electron-positron colliders. The energy of the interaction is the full center-of-mass energy of the colliding particles, not of the constituents. Synchrotron radiation by muons is less than that by electrons by $(m_e/m_\mu)^4 \approx 6 \times 10^{-10}$, which allows muon colliders to be much smaller than $e+$ $e-$ colliders of the same center-of-mass energy. Both of these effects allow $\mu+$ $\mu-$ colliders to be smaller than hadron colliders of the same effective center-of-mass energy. Also, because the amount of synchrotron radiation is very small, the muon beam can have a very narrow energy spread ($\sim 10^{-5}$). At a muon collider, the Higgs boson would be produced through the *s*-channel, so the production cross section is thousands of times that at an $e+$ $e-$ collider. A muon collider with center-of-mass energy equal to the mass of a Higgs boson could be used to measure the mass of the Higgs to a few hundred keV and make a direct measurement of the width to about 1 MeV. The *CP* properties of the Higgs bosons can be measured through asymmetries with transversely polarized $\mu+$ and $\mu-$ beams. The ultimate goal, however, is a multi-TeV $\mu+$ $\mu-$ collider. Because of beamstralung, electron positron colliders have limited capability for precision energy constraints for energies above 3 TeV. Because the muon is 200 times heavier than electrons, beamstralung is very much reduced and permits the use of precision energy contraints on the final state resulting from the collision.

The Neutrino Factory and Muon Collider Collaboration (NFMCC) has led the R&D program needed to realize these facilities that would be capable of carrying out the research program described above. The collaboration was formed in the late 1990's and manages the research program that is funded by the Department of Energy and the National Science Foundation along with support from both Fermilab and Brookhaven National Laboratory. The main areas of research are the development of the multi-megawatt target based on liquid Hg in an intense solenoidal magnetic field needed for the generation of the intense muon beams, the demonstration of ionization cooling, the development of high gradient, low frequency RF cavities needed for cooling the muon beam, the development of effective solenoid focusing to contain the muon beam during cooling, the development of a rapid acceleration system to accelerate the low energy cooled muon beam to high energy (based on high gradient low frequency superconducting cavities in a re-circulating linear accelerator configuration) and the design of storage ring optics for either a neutrino factory or a muon collider.

There has been excellent progress on the target feasibility with a successful test carried out at CERN (the MERIT experiment) this past year. The MuCool Test Area at Fermilab is about to begin tests with an intense proton beam from the linac on high pressure hydrogen filled RF cavities which promise to be effective for cooling the high intensity muon beam needed. The MICE experiment at Rutherford Appleton Laboratory is exploring the more conventional approach using liquid hydrogen with conventional RF cavities and superconducting solenoid focusing for cooling the muon beam. The beam line has been commissioned for the experiment and the rest of the experimental equipment is being assembled with the goal of demonstrating ionization cooling of the low energy muon beam within the next four years. MICE is an international experiment with funding coming from several European governments, Japan, China, the Department of Energy and the National Science Foundation. Detailed end-to-end simulations have been carried out on several concept designs for both a neutrino factory and a muon collider. There has been good progress on the development of high gradient low frequency superconducting cavities through the Cornell program.

The present spokepersons for the NFMCC are Dr. Harold Kirk from BNL and Dr. Alan Bross from Fermilab. Dr. Michael Zisman from LBNL is the project manager for the collaboration. A letter of endorsement from the NFMCC spokespersons and project manager is presented in the Special Information and Supplementary Documentation Section.

2. *Results of Prior Support*

PHY-0104619, $3.6 Million, 9/1/01 to 8/31/06, Supporting R&D for the Design of a Neutino Source Based on a Muon Storage Ring, a consortium of Cornell, Columbia,Illinois Institute of Technology, U. Mississippi, Michigan State, UC Riverside

A program of R&D on low frequency superconducting RF cavities has been carried out by the SRF group at Cornell and their collaborators over the last several years. The purpose of the program was to develop high accelerating gradient superconducting RF cavities to provide rapid acceleration of low energy muons to high energy for injection into a muon storage ring. The rapid acceleration is needed to overcome the loss due to decays of the muons because of their short lifetime (2.2 μsec in their rest frame). The storage ring could be configured either as a Neutrino Factory with long decay straight sections or as a collider with a very low beta interaction region. This R&D program was supported by a grant from the National Science Foundation from the fall of 2000 until the fall of 2006 (NSF PHY-0104619). The Cornell program was a key component of the NFMCC R&D program. Professor Hartill continues to serve on the NFMCCTechnical Board. [1, 2, 3, 4]

The primary focus of the superconducting RF R&D activities at Cornell was the development of a single cell superconducting cavity operating at 200 MHz with an accelerating gradient of at least 15 MV/m. Two cavities were manufactured by our collaborators at CERN by sputter coating electro-polished copper cavities with several micrometers of pure Nb. The copper cavities were made by spinning each half cell and then electron beam welding the two halves together at the equator and then electro-polishing the inner surface to provide a very smooth surface for better adhesion of the Nb film. The finished cavity was then high pressure rinsed with ultra-pure water. One of the 200 MHz cavities achieved an accelerating gradient of 11.4 MV/m but had a significant Q slope at higher gradients indicating poor Nb surface quality. The other cavity never reached more than 3 MV/m due to severe multipacting that could not be processed away again indicating poor surface quality of the Nb film. Because of the large physical size of the cavity, achieving a consistent high quality film of Nb has proved to be very difficult. [5, 6, 7, 8]

A program to develop other techniques for depositing a high quality Nb surface film on copper was carried out on small samples. This development program included DC bias sputtering, vacuum arc sputtering, and using electron cyclotron resonance to ionize a Nb vapor generated by electron beam melting of Nb. The surface quality of some of the samples was significantly better but transferring the techniques to actually coating a cavity was not done. As a result no large cavity was coated with any of these techniques. [9, 10, 11]

In parallel with the sputtering program, one square meter sheets of a 1 mm thick Nb sheet explosion bonded to a 3 mm thick sheet of Cu were manufactured in Japan. Similar sheets of 1 mm Nb bonded to 3 mm of Cu by another process, called hot isostatic pressure bonding (HIP), were also made in Japan. One sheet of explosion bonded material and one sheet of the HIP material were spun into single cell 500 MHz cavities by our collaborator, Prof. Enzo Palmieri, in Italy. The explosion bonded material produced a good cavity with a high quality Nb inner surface. The cavity made from the HIP material had areas on the inner surface where it was clear that de-lamination had occurred between the Nb and the Cu. The de-laminated areas would have very poor thermal conductivity and hence probably would not support large gradients. Both cavities were sent to ACCEL (now Research Instruments, GBH) in Germany to have beam tubes and flanges electron beam welded onto the cavities. The funding for the program ran out before the cavities could be completed and tested. The two cavities remain at Research Instruments.

The publications resulting from this work are given as references in the Reference section.

3. *Proposed Cavity Development Program*

From the experience with the sputter coated cavities, the poor quality Nb surface that is produced by sputtering is the main limitation to their performance. The thin coating is fragile and it is not possible to use the surface processing techniques that have been so successful in achieving high accelerating gradients (up to 59 MV/m) in solid Nb cavities. By using the bonded materials with ~ 1 mm thick Nb for the inner cavity surface, the solid Nb surface preparation techniques can be used. The typical surface processing consists of a buffered chemical polish to remove approximately 40 microns of Nb followed by an electropolish to remove an additional 30 to 40 microns of material and provide a very smooth surface. A high pressure ultra pure water rinse completes the surface preparation. This approach also preserves the excellent thermal conductivity provided by the Cu, producing a much more thermally stable cavity. By soldering copper tubing to the outer cavity surface, the cavity can be cooled by circulating LHe through the tubing instead of immersing the cavity in a LHe bath. Pure Nb cavities do not permit this type of cooling because of the much poorer thermal conductivity of Nb at 4 K. For the 200 MHz cavities needed for muon acceleration, the LHe inventory needed to cool the cavity is very much reduced, thereby simplifying the cryogenic system.

This proposal is for the support of a continuation of the program mentioned above to demonstrate the feasibility of producing high gradient superconducting low frequency RF cavities for efficient rapid acceleration of low energy muons to the high energies needed. The plan is to finish the assembly of the explosion bonded cavity presently at Research Instruments, to construct a second cavity using the remaining sheet of explosion bonded material, and procure a third sheet of explosion bonded material with slightly thicker Nb and produce a cavity from it. The HIP cavity will be scrapped.

The spinning of the two new cavities would be carried out by our collaborator, Prof. Enzo Palmieri, at INFN in Legnaro, Italy with the final assembly again being done by Research Instruments. These three explosion bonded cavities would then go through our standard chemistry and final high pressure water rinsing here at Cornell. The cavities would then be tested in our test facility. The resources needed in addition to the cavity fabrication to carry this out would be the technician labor for the chemistry, support for a post doctoral fellow for two and one half years to carry out the tests, and the liquid helium needed for six tests, two for each cavity.

Choosing to work at 500 MHz instead of the needed 201 MHz minimizes the cost compared with producing the much larger cavity. Still, 500 MHz is sufficiently low in frequency to require a cavity with surfaces of a similar scale as the 201 MHz cavities and will address all of the technical challenges in producing the larger single-cell RF cavities.

In more detail, year one will be devoted to finishing the cavity that is already at Research Instruments, interviewing and hiring a post doctoral fellow to begin mid year, performing the final surface preparation of the cavity, carrying out the initial testing of the finished cavity, procuring the materials for cavity number two and cavity number three, and arranging for the spinning and final fabrication of both of these cavities. Year two will see the finishing of cavity number two, its surface preparation, its initial testing, and the spinning of cavity number three. Year three will see the final testing of cavity number two, the finishing of cavity number three, its surface preparation, and its initial and final testing. With the three cavities, the variability of the production processes can be assessed, any production problems will be understood, and the feasibility of producing high gradient low frequency superconducting RF cavities will have been demonstrated.

4. ***Benefits to the Broader Community***

The demonstration of high gradient superconducting cavities produced from explosion bonded Nb Cu can lead to reduced costs and greater thermal stability compared to solid Nb cavities. The training of a post doctoral fellow in the testing and surface preparation of these cavities will provide a skilled scientist in a field that is in desperate need of more skilled people. Because the project is imbedded in a larger program to study superconducting RF in general, the graduate students in the larger program will have an opportunity to observe and perhaps work on this part of the program. The very successful REU program at CLASSE will also provide an excellent opportunity for interested undergraduates participating in this program to become involved. Involvement in exciting development programs such as low frequency high gradient superconducting cavities can lead to their choosing to pursue a PhD in accelerator physics. These new young researchers will be the ones to develop the new ideas for the accelerators that will benefit society in general.

5. Management

Professor Hartill will manage this work. Coordination with other Laboratory activities and resources will be managed by Prof. Tigner.

References **(see References Section)**

LABORATORY OUTREACH PROGRAM

1. ***Outreach to K-12 Students***

During the past three years, the laboratory has provided after-school enrichment programming for nearly 300 elementary school students. Most programs run one hour a week and are provided free of charge to any school within a sixty-mile radius of Ithaca. Many schools have children from disadvantaged backgrounds; their families live in remote, rural areas with a large percentage of the student population qualifying for free or reduced lunches. These programs are designed to inspire students and encourage them to ask questions and be comfortable with the process of “doing science”. During one program, students get to operate light microscopes, investigate crystal formation, study light spectra, and witness what happens to atoms inside of a bell jar.

The Laboratory also provides support needed to advertise, coordinate and host the Expanding Your Horizons conference held annually at Cornell University. This conference, designed to encourage middle school girls to pursue careers in math and science, drew 250 girls from the central New York region and allowed participants to spend a day on campus attending various science and math workshops as well as keynote presentations given by female Cornell staff and faculty. We also host three-day workshops for middle and high school students involved in the 4-H via Career Explorations, a program run out of the Cooperative Extension office at Cornell. The majority of the students attending Career Explorations come from remote, predominantly rural counties in NYS.

The laboratory works with a local non-profit organization to arrange research experiences for students who might not have an opportunity to do so. During the past year, a number of high school students have worked along side our laboratory's scientists, involved in projects of value to their mentors. In addition, the laboratory provides job-shadowing opportunities for regional high school students who spend anywhere from two hours to the entire day along side our staff scientists.

2. *Outreach to K-12 Educators*

The outreach program at Wilson lab has taken an active role in helping to provide science teachers with the professional development training they need by hosting summer institutes. During the summer of 2007, CLASSE collaborated with the Cornell Center for Radiophysics and Space Research to host the Cornell Physical and Space Science Summer Institute for Middle School Science Teachers. Funding for this one-week institute was provided by a grant from the New York State Education Department, the Space Grant Consortium, and individual contributions from each outreach program. In 2008, CLASSE hosted the Cornell Physical Science Summer Institute for Middle School Science Teachers. The theme for the week-long institute was "Making Connections: What Science Research and Your Middle School Curriculum Have in Common". The Institute was partially funded through grant money received from the New York State Education Department, the other funding came from money devoted to Outreach at CLASSE. Each Institute, held at Cornell for a week in July, provided eleven middle school science teachers from New York City with the opportunity to gain content knowledge aligned with NY State learning standards. It also provided teachers with the chance to interact with scientists who are conducting cutting-edge research and allowed participants to learn about state-of-the-art technology in the unique stetting of a world-class research university. All participants in the 2008 Institute earned one unit of graduate credit in Physics for the five days they spent on campus.

Each summer, CLASSE hosts two out of ten days of the CNS sponsored Cornell Institute for Physics Teachers (CIPT) workshop. Agenda items during these two days included presentations given by scientists on particle physics, accelerator technology, and x-ray science and its applications. Participants engaged in hands-on activities modeling lesson plans for use in their classrooms and received resource materials for teaching the Standard Model. All twenty-two teachers received a guided tour of Wilson Lab where they spent time visiting the facility and interacting with staff.

During the 2008-2009 academic year, the Director of Educational Programs along with graduate students and other representatives from Cornell University traveled to New York City to present science workshops to a cohort of middle school teachers as part of the Cornell University Science Leadership Academy. This academy, funded by New York City's Department of Education's Teacher Centers, is working with the Associate Provost for Outreach at Cornell to provide educators with quality STEM-related professional development. Academy participants, who visited Cornell's campus during the summer and met with scientists and toured laboratory facilities, attend a series of five workshops throughout year, of which CLASSE was participated in three of the workshops. CLASSE will continue this collaboration during the 2009-2010 school year.

During the past year, nearly 200 elementary and secondary school teachers (grades 4-12) have participated in one-on-one professional development training provided by LEPP staff, faculty and graduate students. In addition, almost 150 elementary and secondary school students (grades 3-12) have participated in hands-on, inquiry-based science programming provided by LEPP personnel.

3. ***Lay Community Outreach***

The synchrotron facility, with its impressive scale and sophisticated hardware, is a popular venue for visits by K-12, local high-school and college classes and the public throughout the central NY region, and serves as an inspiration for future young scientists and for educating the public. In 2003-2009, an estimated 10,000 people visited the laboratory to see an educational video introduction to the science at Wilson Laboratory and to tour the facilities. In 2005, 2007 and 2009, CLASSE has organized three Open House events that brought over 2000 visitor to Wilson Synchrotron laboratory. To distribute information abroad via the web, CLASSE produced a brochures describing "The Science at Wilson Laboratory." Staffs also spend considerable time at outside venues to give demonstrations in K-12 classrooms, shopping malls, and museums.

Every year in August, CLASSE sponsors a science booth at the New York State Fair. Over 500 people the booth to participate in hands-on activities involving such topics as the conversion of heat energy, electrical energy, light and color, and properties of matter. A similar booth is run each year by CLASSE at the National Chemistry Fair during the month of October. The booths are run by Lab volunteers and allow approximately 200 children and accompanying adults to experience some wonders of physics.

4. ***Undergraduate Involvement***

In each of the programs of this proposal, undergraduates have been involved for academic credit or part time employment during the school year and full time in the summer. In addition the laboratory annually hosts an REU program which has emphasized recruitment of students from small colleges across the US is which there is little or no opportunity to be involved in research.

Reference Section

References: CesrTA R&D Program

1. M.A. Palmer, *et. al*., The Conversion and Operation of the Cornell Electron Storage Ring as a Test Accelerator (CesrTA) for Damping Rings Research and Development, Proceedings of 2009 Particle Accelerator Conference, 2009 http://www.lns.cornell.edu/~dlr/papers/pac09/FR1RAI02.pdf.
2. D. Rubin. et. al., CesrTA Layout and Optics, Proceedings of 2009 Particle Accelerator Conference, http://www.lns.cornell.edu/~dlr/papers/pac09/WE6PFP103.pdf.
3. Y. Li, *et. al*., CesrTA Vacuum System Modifications, Proceedings of 2009 Particle Accelerator Conference, http://www.lns.cornell.edu/~dlr/papers/pac09/MO6RFP005.pdf.
4. Y. Li, *et. al*., Design and Implementation of CesrTA Superconducting Wiggler Beampipes with Thin Retarding Field Analyzers, Proceedings of 2009 Particle Accelerator Conference.
5. M.A. Palmer, *et. al.,* Design, Implementation and First Results of Retarding Field Analyzers Developed for the CesrTA Program, Proceedings of 2009 Particle Accelerator Conference.
6. J. Shanks, *et. al*., CesrTA Low-Emittance Tuning -- First Results, Proceedings of 2009 Particle Accelerator Conference, http://www.lns.cornell.edu/~dlr/papers/pac09/ PAC09 - LET first results.pdf.
7. J.Alexander, *et. al*., CesrTA X-Ray Beam Size Monitor Design, Proceedings of 2009 Particle Accelerator Conference.
8. J. Alexander, *et al.*, First Results from the CesrTA x-Ray Beam Size Monitor, Proceedings of 2009 Particle Accelerator Conference.
9. J. Flanagan, *et. al.,* Performance of Coded Aperture X-Ray Optics with Low Emittance Beam at CesrTA, Proceedings of 2009 Particle Accelerator Conference.
10. J.A.Crittenden, *et. al*., Studies of the Effects of Electron Cloud Formation on Beam Dynamics at CesrTA, Proceedings of 2009 Particle Accelerator Conference, http://www.lns.cornell.edu/~dlr/papers/pac09/FR5RFP044.pdf.
11. S. De Santis, *et. al*., The TE Wave Transmission Method for Electron Cloud Measurements at CesrTA, Proceedings of the 2009 Particle Accelerator Conference.
12. J. Calvey, *et. al*., Electron Cloud Modeling Considerations at CesrTA, proceedings of 2009 Particle Accelerator Conference.
13. J. Calvey, *et. al.*, Simulations of Electron-Cloud Current Density Measurements in Dipoles, Drifts and Wigglers at CesrTA, proceedings of 2009 Particle Accelerator Conference http://www.lns.cornell.edu/~dlr/papers/pac09/FR5RFP043_RFA_Simulations.pdf.
14. ILC Project Managers Report: ILC Research and Development Plan for the Technical Design Phase, July 2009, http://ilc-edmsdirect.desy.de/ilc-edmsdirect/file.jsp?edmsid=D0000000*813385.
15. A. Andersson, *et. al*., Determination of a small vertical electron beam profile and emittance at the Swiss Light Source, Nuclear Instruments and Methods A, March, 2008, http://www.sciencedirect.com/science?_ob=MImg&_imagekey=B6TJM-4S0PK3J-2-16&_cdi=5314&_user=492137&_orig=search&_coverDate=07%2F01%2F2008&_sk=994089996&view=c&wchp=dGLzVzz-zSkzV&md5=dd871c1062b5b71ff7a9dfc0a4f145d3&ie=/sdarticle.pdf.
16. ILC Reference Design Report http://ilcdoc.linearcollider.org/getfile.py?docid=182&name=ILC_RDR_Volume_3-Accelerator&format=pdf.
17. DIMTEL, Inc. http://www.dimtel.com/.
18. A. Drago, *et. al.,* Commissioning of the IGP Feedback System at DAFNE, Proceedings of the 2008 European Particle Accelerator Conferernce, Genoa, Italy, http://cern.ch/AccelConf/e08/papers/thpc116.pdf.
19. S. De Santis, *et al*., Measurement of Electron Clouds in Large Accelerators by Microwave Dispersion, PRL 100, 094801 (2008).
20. J.W.Flanagan, et. al., Vertical synchro-betatron sideband measurement at KEKB,PRL 94, 054801 (2005), http://prola.aps.org/pdf/PRL/v94/i5/e054801.
21. D.Sagan, *et al.*, Betatron Phase and Coupling Measurements at the Cornell Electron/positron Storage Ring, Phys.Rev. ST Accel.Beams 3, 059901 (2000).
22. R. Helms, Studies for Cesr-TA: A Low-Emittance Test Accelerator at the Cornell Electron Storage Ring, PhD thesis, Cornell, January 2008.

23. C.M. Celata, M.A. Furman, J.-L. Vay, and J.W. Yu, Electron cloud cyclotron resonances in the presence of a short-bunch-length relativistic beam , Phys. Rev. ST Accel. Beams 11, 091002 (2008).
24. F. Zimmermann and G. Rumolo, Electron Cloud Effects in Accelerators, ICFA Beam Dynamics Newsletter No. 33, eds, K. Ohmi and M.A. Furman (2004).

References: <u>Superconducting Radio Frequency Basic R&D</u>

1. L. Lilje et al, "Improved Surface Treatment of the Superconducting TESLA Cavities," Nucl. Instr. Meth. Phys. Res.A 516, p. 213 (2004).
2. H. Padamsee, "RF Superconductivity, Science Technology and Applications," Wiley-VCH, 2009.
3. Saito, et al, "Electropolishing of L-band cavities, Proc. 4th Workshop on RF Superconductivity, KEK, Tsukuba, Japan, pp. 635 (1989).
4. C. Crawford et al, "A Procedure for Electropolishing Vertically Oriented Muticell Niobium Radiofrequency Cavities," Proceedings of 2009 Particle Accelerator Conference, TU5PFP050 (2009).
5. R.L. Geng, et al., "World Record Accelerating Gradient Achieved In A Superconducting Niobium RF Cavity," Proceedings of 2005 Particle Accelerator Conference, Knoxville, Tennessee, p. 653 (2005), and R.L. Geng et al, "High Gradient Studies For ILC With Single-Cell Re-Entrant Shape and Elliptical Shape Cavities Made of Fine-Grain and Large-Grain Niobium," Proc. PAC 2007, Particle Accelerator Conference, Albuquerque, New Mexico, USA, p. 2337 (2007).
6. Z. Conway et al, ILC Testing Program at Cornell University," Proceedings of 2009 Particle Accelerator Conference, TU5PFP046 and "Multi-Cell Reentrant Cavity Development and Testing at Cornell," TU5PFP047
7. D. Meidlinger et al, Vertical Test Results for Vertically Electropolished 1.3GHz 5-Cell Superconducting Cavities, Proceedings of 2009 Particle Accelerator Conference, TU5PFP049.
8. J. Wiener and H. Padamsee, "Improvements in Field Emission:
An Updated Statistical Model for Electropolished Baked Cavities," TESLA Report 2008-2; and J. Wiener and H. Padamsee, "Thermal and Statistical Models for Quench in Superconducting Cavities," TESLA Report 2008-8.
9. J. Knobloch, "Advanced Thermometry Studies of Superconducting Radio-Frequency Cavities," PhD Thesis Cornell University (1997).
10. Z. Conway et al, "Defect Location in Superconducting Cavities Cooled with He-II Using Oscillating Superleak Transducers," Proceedings of 2009 Particle Accelerator Conference, TU5PFP044
11. Yi Xi, et al, "Relationship Between Defect Pre-Heating and Defect, Size, TUPP0049, Proceedings of the SRF 09 Conference, Berlin (2009).
12. "High Field Behavior of SCRF cavities," H. Safa, Proc. 10th Workshop on RF Superconductivity, Tsukuba, Japan, p. 279 (2001).

13. G. Eremeev, PhD Thesis, Cornell University (2008)

14. J. Vines et al, "Systematic Trends for the Medium Field Q-Slope," Proceedings of SRF2007, Peking Univ., Beijing, China, TUP27.
15. H. A. Grunder, et al, "The Continuous Electron Beam Accelerator Facility", Proceedings of the 1987 Particle Accelerator Conference, p. 13 (1987).
16. S. Belomestnykh, et al, **"**Commissioning of the Superconducting RF Cavities for the CESR Luminosity Upgrade"**,** Proceedings of the 1999 Particle Accelerator Conference, New York, p. 980 (1999).
17. S. Belomestnykh, et al, "Commissioning and Operations Results of the Industry-Produced CESR-Type SRF Cryomodules", Proceedings of 2005 Particle Accelerator Conference, Knoxville, Tennessee p. 4233 (2005).
18. H. Padamsee, ed. Proceedings of the 1st TESLA Workshop*,* Cornell University, CLNS 90-1029 (1990).
19. J. Graber, "Reduction of Field Emission in Superconducting Cavities with High Power Pulsed RF", Nucl. Instrum. Methods Phys. Research, **350**, p. 572 (1994).
20. C. Crawford, et al, "High Gradients in Linear Collider Superconducting Accelerator Cavities by High Pulsed Power to Suppress Field Emission", Particle Accel. **49, p.** 1 (1995).

21. M. Liepe, "The Cornell ERL Superconducting 2-Cell Injector Cavity String and Test Cryomodule," Proceedings of PAC07, Albuquerque, New Mexico, USA, p.2572 (2007).

References: **<u>Development of Low Frequency High Gradient Superconducting RF Cavities for Muon Acceleration</u>**

1. Niobium-Copper Cavity Development for Muon Collider, R.L. Geng, P. Barnes, D. Hartill, J. Kaufman, H. Padamsee, J. Sears, M. Pekeler, R. Losito, G. Wu, 12th Workshop on RF Superconductivity, Ithaca, NY to be published paper TuP30 (2005).
2. Feasibility study 2 of a muon based neutrino source, with S. Ozaki et al, BNL-5263 (2001
3. SRF for Neutrino Factories, H. Padamsee, The 10th Workshop on RF Superconductivity, p. 327, Tsukuba, Japan (2001)
4. SRF for the Muon Collider, H. Padamsee, The 9th Workshop on RF Superconductivity, p. 587, Santa Fe, New Mexico (1999)
5. 200-MHz Superconducting RF Cavity Development for RLAs, with R.L. Geng, et al., 5th Intnl Workshop on Neutrino Factories and Superbeams (NuFact03), NY, NY, AIP Conf Proc., 721:p. 445 (2004)
6. First Test of Superconducting 200 MHz Nb-Cu Cavity, with Rongli-Geng et al, 2003 Particle Accelerator Conference Proceedings, p.1309 (2003)
7. Recent Progress in Neutrino Factory and Muon Collider Research within the Muon Collaboration, with M.M. Alsharo'a et al, Physical Review, Special Topics – Accelerators and Beams, v. 6(2003)
8. 200 MHz Nb-Cu Cavities for Muon Acceleration, R.L. Geng, P. Barnes, D. Hartill, H. Padamsee, J. Sears, S. Calatroni, E. Chiaveri, R. Losito, H. Preis, in The 11th Workshop on RF Superconductivity, paper WeO06, Travemünde, Germany (2003)
9. New Magnetron Configuration for Nb onto Cu G. Lanza, A. Frigo, H. Padamsee, V. Palmieri, D. Tonini, 12th Workshop on RF Superconductivity, Ithaca, NY to be published, paper TuA12, (2005)
10. RF Properties at 6 GHz of Cathodic Arc Films up to 300 Oe, in A. Romanenko, H. Padamsee, 12th Workshop on RF Superconductivity, paper TuP63, Ithaca, NY to be published, paper ThP63 (2005)
11. A prototype of 500 MHz Cavity Coating System by ECR Plasma" G. Wu, L. Phillips, R. Rimmer, A-M. Valente, H. Wang, A. Wu, H. Padamsee, 12th Workshop on RF Superconductivity, Ithaca, NY to be published, paper TuP64 (2005)

Maury Tigner
Director,
Laboratory of Elementary-Particle Physics (LEPP)
Cornell University

130 Newman Laboratory
Cornell University
Ithaca, NY 14853
maury.tigner@cornell.edu

A. Professional Preparation

Webb Institute of Naval Architecture	Marine Engineering		1954-1956
Rensselaer Polytechnic Institute	Physics	B.S.	1958
Cornell University	Physics & E.E.	Ph.D.	1964

B. Appointments

Cornell University, Director, CLASSE	2006
Cornell University, Director of LEPP	2000-2006
Chinese Academy of Sciences, Senior Advisor	1994-2002
Cornell University, Professor Emeritus	1994
Cornell University, Professor	1977-1994
Cornell University, Senior Research Associate	1968-1977
Cornell University, Research Associate	1964-1968

C. Publications

(i) *Publications Most Closely Related to the Project*
None

(ii) *List of Significant Related Publications*
Feasibility Study for a Neutrino Factory, N. Holtkamp, D. Finley eds, http://www.fnal.gov/projects/muon_collider/nu/sutdy/report/machine_report/00_fermilab_study_title+author rev8.PDF

Handbook of Accelerator Physics and Engineering, A. Chao and M. Tigner, eds, World Scientific 1998, 2006

Superconducting TESLA Cavities, with B. Aune et al, Physical Review Special Topics - Accelerators and beams, vol 3, 092001 (2000)

Lectures on Superconductivity Fundamentals in Proceedings of the Asian Accelerator School, Beijing China, 1999, World Scientific to be published.

First Observation of Self-Amplified Spontaneous Emission in a Free Electron Laser at 109 mm Wavelength, J. Andruzkow et al, Phys. Rev. Let. 85, p. 3825 Oct. 2000

D. Synergistic Activities

Accelerators are now used in many branches of science including life sciences, physical sciences and engineering. The Handbook of Accelerator Physics and Engineering cited above makes accessible the findings and technologies developed in high energy physics for workers in the wider scientific community. Students of accelerator physics at Cornell have traditionally gone into many fields besides accelerator work where their broad training is of great advantage. Recent graduates work in bio physics, electronics, photocopies development, electric lamp development, etc.

E. Collaborators and Other Affiliations

Collaborators and Co-Editors

Current or recent collaborators include CLEO, TESLA, TESLA Technology Collaboration, BES and Neutrino Factory and Muon Collider Collaboration (MC) as well as the Magnet Oversight Board for ATLAS 2006, LHC Machine Advisory Committee.

D.K. Barton (Hanover, NH), A Chao (SLAC), R. Falcone (Berkeley), D. Kleppner (MIT), FK Lamb (U. Ill.), MK Lau (Sandia), HL Lynch (SLAC), K.H. Mess (CERN), D. Moncton (MIT), D. Montague (LDM Assoc.) DE Mosher (RAND Corp.), W. Priedhorsky (LANL), DR Vaughan (RAND Corp), F. Zimmerman (CERN)

Graduate Advisors and Post Doctoral Sponsors
R.R. Wilson (deceased), B.D. McDaniel (deceased)

Thesis Advisor and Postgraduate-Scholar Sponsor
None in last 5 years

Donald L. Hartill
Professor of Physics,
Laboratory of Elementary-Particle Physics (LEPP)
Cornell University

234 Newman Laboratory
Cornell University
Ithaca, NY 14853
dlh13@cornell.edu

A. Professional Preparation

Massachusetts Institute of Technology	Physics	B.S.	1961
California Institute of Technology	Physics	Ph.D.	1967

B. Appointments

Cornell University, Professor, LEPP Dept.	1980
Cornell University, Associate Professor	1974-1980
Cornell University, Assistant Professor	1968-1974
Stanford Linear Accelerator Center, Visiting Scientist	1975
Osservatoria Astrofisico di Arcetri, Florence, Italy, Visiting Scientist	1981-1982
SSC Central Design Group, Visiting Scientist	1985
CERN, Geneva, Research Associate	1967-1968

C. Publications

(i) *Publications Most Closely Related to the Project*

First rf Test at 4.2 K of a 200 MHz Superconducting Nb-Cu Cavity
Geng, R.L., Barnes P., Hartill, D., Padamsee, H., Sears, J., Calatroni, S., Chiaveri, E., Losito, R., Preis, H., Proceedings of the 2003 Particle Accelerator Conference (PAC2003), 12-16 May 2003, Vol 2, pg 1309-1311 (2003).
http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=1289688&isnumber=28710

Progress in Neutrino Factory and Muon Collider Research within the Muon Collaboration
D. Hartill, et al, Recent Accelerators and Beams, 6, 081001 (2003).
http://bt.pa.msu.edu/pub/papers/MuSRIIPRSTAB02/MuSRIIPRSTAB02.pdf

SSC Control System
D. Hartill, Proceedings of Europhysics Conference on Control Systems for Experimental Physics, Sept. 28 – Oct. 2, 1987 Villars-sur-Ollon, Switzerland, ed. B. Kuiper, CERN, Geneva, Switzerland, CERN Pub. CERN 90-08 pg. 8

The CESR Magnet Power Supply System
D. Hartill and D. Rice, IEEE NS-26 4078 (1979)

Running CESR at High Luminosity and Beam Current with Superconducting RF System
CESR RF Operations Group, S. Belomestnykh *et al.,* Proceedings of the 7th European Particle Accelerator Conference, Vienna, Austria, 26-30 June, 2000

(ii) *List of Significant Related Publications*

Design and Implementation of an Electron and Positron Multibunch Turn by Turn Vertical Beam Profile Monitor in CESR
Cerio, B.; Holtzapple, Robert L.; Kern, J. S.; Palmer, Mark A.; Tanke, E.; Dobbins, John; Hartill, D. L.; Strohman, Charles R.; Watkins, Michael E.; Proceedings of the 2007 IEEE Particle Accelerator Conference (PAC07). 25-29 June 2007, Albuquerque, New Mexico. 22nd IEEE Particle Accelerator Conference, p. 4081 (2007) https://accelconf.web.cern.ch/accelconf/p07/PAPERS/FRPMS047.PDF

Observation of $B_d{}^0 \rightarrow D^0\pi^0$ and $B_d{}^0 \rightarrow D^{*0}\pi^0$
T. E. Coan et al., (CLEO Collaboration), Phys. Rev. Lett., 88, 062001 (2002)

Muon Lifetime Experiment
D. Hartill , Proceedings of the III ICFA School on Instrumentation in Elementary Particle Physics, Rio de Janeiro, Brazil 16-28 July 1990, Edited with J. C. Anjos, F. Sauli, and M. Sheaff – World Scientific

Absolute Measurement of Hadronic Branching Fractions of the D_s^+ Meson
Alexander, J. P., Berkelman, K., Cassel, D. G., Duboscq, J. E., Ehrlich, R., Fields, L., Gibbons, L., Gray, R., Gray, S. W., Hartill, D. L., Heltsley, B. K., Hertz, D., Jones, C. D., Kandaswamy, J., Kreinick, D. L., Kuznetsov, V. E., Mahlke-Krueger, H., Mohapatra, D., Onyisi, P. U. E., Patterson, J. R,, Phys. Rev Lett, 100(16) 100.161804 (2008).

D. Synergistic Activities

NSF Review Panel for IceCube – Chair	2000-present
Member LIGO Program Advisory Committee	2009-present
Member NFMCC Technical Board	2005-present
Member CERN Scientific Policy Committee	2005-present
Member ILC Program Advisory Committee	2008-present

E. Collaborators and Other Affiliations

Collaborators and Co-Editors

(**NOTE:** This list has been truncated due to space limitations, a complete list of authors can be found at http://www.chess.cornell.edu/hartill.pdf)

Graduate Advisors and Post Doctoral Sponsors
Thesis Advisor: Alvin Tollestrup

Thesis Advisor and Postgraduate-Scholar Sponsor
Thesis Advisees: Bill Francis, Eric Blum, Dave Perticone, Eliott Treadwell, and others
Postgraduate Scholars sponsored in last 5 years: None
Total Graduate Students Advised: 9
Total Postgraduate Scholars Sponsored: 2

Georg Hoffstaetter
Professor of Physics
Cornell University

118 Newman Laboratory
Cornell University
Ithaca, NY 14853
Gh77@cornell.edu

A. Professional Preparation

Darmstadt University of Technology	Physics	Diploma	1991
Michigan State University (MSU)	Physics	PhD	1994
Deutsches Elektronen-Synchrotron (DESY)	Accelerator Physics		1994-1996
Darmstadt University of Technology	Physics	Habilitation	2000

B. Appointments

Cornell University	Professor of Physics	2008-present
Cornell University	Associate Professor of Physics	2002-2008
DESY	Accelerator Physicist	1998-2002
Darmstadt University of Technology	Faculty	1996-1998

C. Publications

*(i) Publications Most Closely Related to the Project (undergraduate indicated by *):*

Exact 1D model for coherent synchrotron radiation with shielding and bunch compression,
C.E. Mayes, G.H. Hoffstaetter, Phys. Rev. ST-AB 12, 024401 (2009)

Equilibrium Extended 1D method for Coherent Synchrotron Radiation including Shielding,
D.C. Sagan, G.H. Hoffstaetter, C.E. Mayes, U. Sae-Ueng*, submitted to Phys. Rev. ST-AB and arXiv 0806.2893v1 (2008)

Compensation of wake-field-driven energy spread in Energy Recovery Linacs,
G.H. Hoffstaetter, Y.H. Lau*, submitted to Phys. Rev. ST-AB and arXiv:0805.2637v1 (2008)

Ion distribution in the presence of clearing electrodes and its influence on electron dynamics,
G.H. Hoffstaetter, C. Spethmann, Physical Review ST-AB 11, 014001 (2008)

Transverse Emittance Dilution due to Coupler Kicks in Linear Accelerators,
B. Buckley*, G.H. Hoffstaetter, Physical Review ST-AB, 10, 111002 (2007)

(ii) List of Significant Related Publications

Optics issues in ongoing ERL projects,
S. Smith, B.D. Muratori, H.I. Owen, G.H. Hoffstaetter, V.N. Litvinenko, I. Ben-Zvi, M. Bai, J. Beebe-Wang, M. Blaskiewicz, R. Calaga, W. fischer, X.Y. Chang, D. Kayran, J. Kewisch, W.W. MacKay, C. Montag, B. Parker, V. Ptitsyn, T. Roser, A. Ruggiero, T. Satagata, B. Surrow, S. Tepikian, D. Trbojevic, V. Yakimenko, S.Y. Zhang, Ph. Piot, Nuclear Instruments and Methods in Physics Research A 557, 145-164 (2006)

Adiabatic invariance of spin-orbit motion in accelerators,
G.H. Hoffstaetter, H.S. Dumas, J.A. Ellison, Physical Review ST-AB 8, 014001 (2006)

Orbit and Optics Improvement by Evaluating the Nonlinear BPM Response in the Cornell Electron Storage Ring,
R.W. Helms, G.H. Hoffstaetter, Physical Review ST-AB 8, 062802 (2005)

Coherent beam-beam tune shift of unsymmetrical beam-beam interactions with large beam-beam parameter,
L. Jin, J. Shi, G. H. Hoffstaetter, Physical Review E 71, 036501 (2005)

Beam-Breakup Instability Theory for Energy Recovery Linacs,
G. H. Hoffstaetter, I. Bazarov, Physical Review ST-AB, Volume 7, 54401 (May 2004)

D. Synergistic Activities

Head, SRF group of CLASSE	
Co-PI/PI for the NSF REU program of CLASSE	2009-2011
Advisor for several undergraduate summer students	2003, 2004, 2005, 2006, 2008, 2009
Advisor for high-school interns for the Learning Web of Ithaca	2003, 2004, 2006
College of Arts and Science Educational Policy Committee	2003-2006

E. Collaborators and Other Affiliations:

Collaborators in last 48 months
Agapov (univ. of London/Royal Holloway), M. Bai (BNL), D. Barber (DESY), I. V. Bazarov (Cornell), J. Beebe-Wang (BNL), S. Belomestnykh (Cornell), I. Ben-Zvi (BNL), D. H. Bilderback (Cornell), M. G. Billing (Cornell), M. Blaskiewicz (BNL), J.D. Brock (Cornell), B. Buckley (UCLA), R. Calaga (BNL), X.Y. Chang (BNL), A. Chao (Stanford), H.S-H. Choi (Cornell), J. Codner (Cornell), J.S-H. Choi (unknown), D. Dale (Cornell), W. Decking (DESY), M. Dohlus (DESY), D. Douglas (TJNAF),S. Dumas (Univ. of Cincinnati/OH), B. Dunham (Cornell), J. A. Ellison (Univ. of New Mexico), K. Finkelstein (Cornell), W. Fischer (BNL), E. Fontes (Cornell), M. Forster (Cornell), S. Greenwald (Cornell), Z. Greenwald (unknown), S. M. Gruner (Cornell). R. W. Helms (Cornell), H. Huang (BNL), N. Iqbal (unknown), L. Jin (unknown), K. Jordan (TJNAF), A. Kaimirov (BNL), D. Kayran (BNL), J. Kewisch (BNL), K.J. Kim (ANL), C. Koupparis (unknown), G. Krafft (TJNAF), S. Y. Lee (U-Indiana/Bloomington), Y. Li (Cornell), M. Liepe (Cornell), T. Limberg (DESY), F. Lin (BNL), V. Litvinenko (BNL), M. Lomperski (DESY), W. MacKay (BNL), C. Mayes (Cornell), B. Meredith (unknown), L. Merminga (TNJAF), M. Minty (BNL), C. Montag (BNL), D. Muratori (BNL), H. Owen (Daresbury), H. Padamsee (Cornell), B. Parker (BNL), Ph. Piot (Univ. of Northern Illinois/FNAL), V. Ptitsin (BNL), E. Pozdeyev (TJNAF), J.T. Rogers (Cornell), H. Rose (LBL), T. Roser (BNL), D. Sagan (Cornell), T. Satagata (BNL), B. S. Schmekel (UC/Berkeley), V. Shemelin (Cornell), Q. Shen (ANL), J. Shi (U-Kansas), S. Simrock (DESY), C. K. Sinclair (Cornell), S. Smith (Daresbury), T. I. Smith (Stanford), K. W. Smolenski (Cornell), C. Song (Cornell), C. Spethmann (Cornell), B. Surrow (MIT), R. M. Talman (Cornell), T. Tanabe (UC/Berkeley), A. Temnykh (Cornell), C. Tennant (TJNAF), S. Tepikian (BNL), M. Tigner (Cornell), D. Trbojevic (BNL), J. Urban (unknown), V. Veshcherevich (Cornell), E. Vogel (DESY), M. Vogt (DESY), H. Wang (TJNAF), R. Wanzanberg (DESY), F. Willeke (DESY), Y. Xie (Cornell), V. Yakimenko (BNL), S.Y. Zhang (BNL), F. Zimmermann (CERN)

Graduate Advisors and Post Doctoral Sponsors:
Martin Berz (MSU), Ferdinand Willeke (DESY), Desmond Barber (DESY), Harald Rose (Darmstadt Univ. of Tech.)

Thesis advisors:
Mike Saelim (PhD anticipated 2013), Mike Ehrlichman (PhD anticipated 2012), Chris Mayes, PhD 2009, Yi Xie (PhD anticipated 2010), Joe Choi, MS in 2006, Changsheng Song, MS in 2006 (Univ. of Michigan), Bjoern Schmekel, PhD 2005 (Hamburg), Mathias Vogt, PhD 2000 (DESY), Christoph Weissbaecker, Diploma 2000 (Porsche), Achim Hohl, Diploma 1998 (unknown)

Mark A. Palmer

Research Associate	Telephone:	(607) 255-4240
222 Wilson Laboratory	FAX:	(607) 255-8062
Cornell University	E-mail:	map36@cornell.edu
Ithaca, NY 14853		

Professional Preparation:

Princeton University	Physics	AB	1986
Princeton University	Physics	MA	1989
Princeton University	Physics	PhD	1993
Univ of Illinois at Urbana-Champaign	Particle Physics		1993-1996

Appointments:

Cornell University	Research Associate, Accelerator Physics	2000-
Univ of Illinois at Urbana-Champaign	Research Assistant Prof	1999-2000
Cornell University	Wilson Fellow	1994-2000
Univ of Illinois at Urbana-Champaign	Visiting Research Asst Professor	1996-1999
University of Illinois at Urbana-Champaign	Research Associate	1993-1996
Princeton University	National Science Foundation Fellow	1987-1989
Rijksuniversiteit Groningen, Netherlands	Fulbright Fellow	1986-1987

Publications (closely related to this proposal):

The Conversion and Operation of the Cornell Electron Storage Ring as a Test Accelerator (CesrTA) for Damping Rings Research and Development, M. A. Palmer *et al.*, Proc. of PAC09, Vancouver, British Columbia, Canada (2009).

Design, Implementation and First Results of Retarding Field Analyzers Developed for the CesrTA Program, M. A. Palmer *et al.*, Proc. of PAC09, Vancouver, British Columbia, Canada (2009).

Plans for Utilizing the Cornell Electron Storage Ring as a Test Accelerator for ILC Damping Rings Research and Development, M. A. Palmer *et al.*, Proc. of PAC07, Albuquerque, New Mexico, USA (2007), pp. 42-44.

Electron Cloud Studies at CESR-c and CESR-TA, M. A. Palmer *et al.*, Proc. of ECLOUD07, Daegu, South Korea (2007), pp. 108-112.

The Proposed Conversion of CESR to an ILC Damping Ring Test Facility, M. A. Palmer *et al.*, Proc. of EPAC06, Edinburgh, Scotland (2006), pp. 891-893.

Other Significant Publications:

X-ray Monitor Based on Coded-Aperture Imaging for KEKB Upgrade and ILC Damping Ring, J.W. Flanagan *et al.*, Proc. of EPAC08, Genoa, Italy (2008), pp. 1029-1031.

Tests of a High Voltage Pulser for ILC Damping Ring Kickers, M. A. Palmer *et al.,* Proc. of EPAC06, Edinburgh, Scotland (2006), pp. 3137-3139.

Design and Operation of a Radiative Bhabha Luminosity Monitor for CESR-c, M. A. Palmer *et al*., Proc. of PAC05, Knoxville, Tennessee, (2005), pp. 3564-3566.

Measurement of $D^+ \rightarrow K^{*0} l^+ \nu_l$ *Branching Fraction*
G. Brandenburg *et al*., Physical Review Letters **89,** 222001(2002).

Improved Measurement of $|V_{cb}|$ *using* $B \rightarrow D^* l \nu$ *Decays*
R.A. Briere *et al*., Physical Review Letters **89**, 081803(2002).

Synergistic Activities:

Lecturer, Third International Accelerator School for Linear Colliders, October 19-29, 2008.
Contributor, Wilson Lab Outreach Programs, 1997-present.
Co-convener of the ILC-CLIC Damping Rings Working Group, October 2008-present.
LEPP Research Experience for Undergraduates program mentor, 1999-present.
Member, ILC Americas Regional Team (ART), April 2006-present.

Collaborators and Other Affiliations:

Graduate advisor:
Val Fitch, Princeton University.
Post-doctoral sponsors:
Profs. Jon Thaler, Mats Selen, George Gollin, Gary Gladding and Bob Eisenstein, University of Illinois at Urbana-Champaign.

David L. Rubin
Boyce D. McDaniel Professor of Physics
Laboratory of Elementary-Particle Physics (LEPP)
Cornell University

220 Wilson Laboratory
Cornell University
Ithaca, NY 14853
drubin@physics.cornell.edu

A. Professional Preparation

University of Pennsylvania	Physics	B.S.	1976
University of Michigan	Physics	Ph.D.	1983

B. Appointments

Cornell University, Boyce D. McDaniel Professor	2000
Cornell University, Professor for LEPP	1998
Cornell University, Director of Accelerator Physics for LNS	1994
Cornell University, Associate Professor	1992
Cornell University, Assistant Professor	1986
Cornell University, Research Associate	1983

C. Publications

(i) *Publications Most Closely Related to the Project*

D. Sagan and D. Rubin, *Linear Analysis of Coupled Lattices*, Physical Review Special Topics, Accelerators and Beams, Volume **2,** 074001 (1999) http://prst-ab.aps.org/pdf/PRSTAB/v2/i7/e074001

D.L. Rubin, D. Sagan, *CESR Lattice Design*, Proceedings of the 2001 Particle Accelerator Conference, p.3517-3519, Chicago, June 2001 http://epaper.kek.jp/p01/PAPERS/RPPH121.PDF

D. L. Rubin, *CesrTA Layout and Optics*, Proceedings of the 2009 Particle Accelerator Conference, Vancouver, 2009, http://www.lns.cornell.edu/~dlr/papers/pac09/WE6PFP103.pdf

M. Palmer, et. al., *The Conversion and Operation of the Cornell Electron Storage Ring as a Test Accelerator (CESRTA) for Damping Rings Research and Development*, Proceedings of the 2009 Particle Accelerator Conference, Vancouver, 2009, http://www.lns.cornell.edu/~dlr/papers/pac09/FR1RAI02.pdf

D.Sagan, R.Meller, R.Littauer, D.Rubin, *Betatron Phase and Coupling Measurements at the Cornell Electron/Positron Storage Ring*, Phys. Rev. St Accel. Beams 3, 092801 (2000) http://prst-ab.aps.org/pdf/PRSTAB/v3/i9/e092801

(ii) *List of Significant Related Publications*

D.L.Rubin, S.Belomestnykh, M.Billing, G.Codner, M.Forster, S.Greenwald, Z.Greenwald, D.Hartill, Y.He, S.Henderson, R.Holtzapple, J.Hylas, Y.Li, R.Littauer, R.Meller, A. Mikhailichenko, M.Palmer, S.Peck, D.Rice, D.Sagan, J.Sikora, A.Temnykh, V.Veshcherevich, D.Wang, J.Welch,*CESR Status and Performance*, Proceedings of the 2001 Particle Accelerator Conference, Chicago, June 2001**,** pp 3520-3522, http://epaper.kek.jp/p01/PAPERS/RPPH122.PDF

D.L. Rubin, *Magnetic separation of multiple bunch beams*, CON 90-2, January 10, 1990, http://www.lns.cornell.edu/~dlr/papers/twoeng.pdf

Rubin, D.L.,;Billing, M.; Byrd, J.; Chen, T.; Greenwald,Z.; Hartill,D.; Hylas,J.; Kaplan,J.; Krasnykh,A.; Meller,R.; Peck,S.; Pelaia,T.; Rice,D.; Sagan,D.; Schick,L.A.; Sikora,J.; Welch,J., *Beam-beam interaction with a horizontal crossing angle,* Nuclear Instruments andMethods in Physics Research Section A, Volume 330, Issue 1-2, p. 12-20 (1993) http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TJM-473FMP8-1F5&_user=492137&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000022719&_version=1&_urlVersion=0&_userid=492137&md5=e774823627f288ed5e96a0c0578f8451

D.L.Rubin, S.Isaacman, A.Long, *Modeling colliding beams with an element by element representation of the storage ring guide field*, Phys. Rev. ST Accel. Beams **9**, (2006), pp. 011002(15), http://prst-ab.aps.org/pdf/PRSTAB/v9/i1/e011002

J.C.Smith, L.Gibbons, R.Patterson, D.Rubin, D.Sagan, P.T.Tenenbaum, *Comparison of Beam-based alignment algorithms for the ILC*, Proceedings of the 2005 Particle Accelerator Conference, Knoxville, http://www.lns.cornell.edu/~dlr/papers/pac05/RPPP024.pdf

D. Synergistic Activities

Chairman, Muon Collaboration Technical Advisory Committee
Member, Board of Governors, US Particle Accelerator School
Member, NSLSII Accelerator Systems Advisory Committee
Member, Brookhaven Science Associates, Science and Technology Steering Committee
Member APS DPB Publications Committee

E. Collaborators and Other Affiliations

Collaborators and Co-Editors

J. Alexander, M. Billing, D. Cassel, G. Codner, R. Galik, L. Gibbons, S. Greenwald, Y. Li, A. Mikhailichenko, H. Padamsee, R. Patterson, D. Rice, A.Temnykh, M. Tigner, M. Palmer, D.Sagan, D. Hartill, J. Crittenden, R. Meller, E. Smith, G. Dugan, D. Kreinick, D. Peterson, S. Gray (all Cornell).

D. Munson, D. Plate, F. Caspers, G. Penn, A. Molvik, C. Celata, J. Byrd, J. Corlett, M. Venturini , S. DeSantis (LBL), K. Harkay (Argonne) , G. Rumolo, Y. Papaphillipopou (CERN), A. Wolski, J. Jones (Cockroft Institute) , J. Flanagan, J. Urakawa, K. Ohmi, K. Kanazawa, K. Kubo, K. Shibata, M. Tobiyama, Y. Suetsugu (KEK), M. Pivi, L. Wan, Y. Yan (SLAC), R. Holtzapple (California Polytechnic Institute)

Graduate Advisors and Post Doctoral Sponsors

Thesis Advisor: Rudi Thun, University of Michigan
Post-doctoral Supervisor: Robert Siemann, Cornell University

Thesis Advisor and Postgraduate-Scholar Sponsor

Thesis Advisees: Peter Bagley, Tom Pelaia, Walter Hartung, Joel Graber, Daniel Fromowitz, Richard Helms, Jeff Smith, Jim Shanks, Joe Calvey (all Cornell University)
Postgraduate Scholars Sponsored in last 5 years: David Sagan, Alexander Mikailichenko, Shlomo Greenwald, Yulin Li, Mark Palmer, Jim Crittenden, Sergey Belomestnykh, Xianghong Liu, Robert Meller, David Rice, Sasha Temnykh, J. Crittenden, Belomestnykh (all Cornell University)

Total Graduate Students Advised: 9
Total Postgraduate Scholars Sponsored: 13

James P. Alexander
Professor of Physics
Newman Laboratory
Cornell University
Ithaca, NY 14853-5001

Telephone: (607) 255-5259
FAX: (607) 254-4552
E-mail: Jim.Alexander@cornell.edu

Professional Preparation

Carleton College	Physics	B.A.	1976
University of Chicago	Physics	M.S	1979
University of Chicago	Physics	Ph.D	1985
SLAC	Elementary Particle Physics		1985-1988

Appointments

Director, Laboratory for Elementary Particle Physics. Cornell Univ.		2006-
Professor	Cornell University	1998-
Visiting Foreign Researcher	KEK	1997-1998
Associate Professor	Cornell University	1993-1998
Assistant Professor	Cornell University	1988-1993
Research Associate	SLAC	1985-1988

Publications most closely related to the proposed project:

1. *The CMS Experiment at the LHC*
   CMS Collaboration, R. Adolphi *et al.,*
   JINST 0803:S08004,2008, JINST 3:S08004,2008.
2. *CMS technical design report, volume II: Physics performance*
   CMS Collaboration (G.L. Bayatian et al.),
   J.Phys.G34:995-1579,2007
3. *Testing Cosmology at the ILC*
   A. Birkedahl, *et al,* Proceedings of 2005 International Linear Collider Workshop
   hep-ph/0507214
4. *Measuring mass and cross section parameters at a focus point regions*
   R. Gray, *et al*, Proceedings of 2005 International Linear Collider Workshop,
   hep-ph/0507008
5. *Design and Performance of the Silicon Detectors for CLEO III,*
   C.W. Ward, J.P. Alexander, *et al,*
   EEE Trans. Nucl. Sci. **44**, 606, (1997).

Other significant publications:

1. *Fluid particle accelerations in fully developed turbulence*
   A. La Porta, Greg A. Voth, Alice M. Crawford, Jim Alexander and Eberhard Bodenschatz,
   Nature **409**, 1017 (2001).
2. *Observation of* $B \rightarrow K^{\pm}\pi^{0}$ *and* $B \rightarrow K^{0}\pi^{0}$ *and Evidence for* $B \rightarrow \pi^{+}\pi^{-}$
   CLEO Collaboration, D. Cronin-Hennessy, *et al,* Phys. Rev. Lett., **85**, 515 (2000). arXiv:hep-ex/9908039v1
3. *Search for Exclusive Charmless Hadronic B Decays*
   CLEO Collaboration, D.M. Asner *et al.,* Phys. Rev. D **53**, 1039 (1996).
4. *Observation of* B^{0} *Decays to Two Charmless Hadrons*
   CLEO Collaboration, M. Battle *et al,*, Phys. Rev. Lett. **71**, 3922 (1993).
5. *Initial Measurement of the Z-Boson Resonance Parameters in e+e- Annihilation*
   MARK II Collaboration, Phys. Rev. Lett., **63**, 724, (1989).

Synergistic Activities

1. *Studies of Turbulence*: Spent 3 years working part time with Cornell physicists who study highly turbulent fluid motion. Main contribution was to introduce high energy physics technology (silicon strip detectors for light detection) and techniques (e.g., Monte Carlo simulations).
2. *K12 Outreach:* Developed "Atoms for Kids!" program for elementary schools, consisting of six one-hour units of demonstrations and hands-on exercises to illustrate various aspects of the atomic nature of matter that can be seen with simple, macroscopic observations.
3. *ILC detector development:* Currently applying solid state detector experience to develop fast GaAs based pixel camera for bunch-by-bunch imaging of beams in the damping rings of the International Linear Collider.
4. *Service to HEP Community:* Have served on HEPAP, the SLAC EPAC, and FNAL PAC (2 years as chair), P5 (twice), as well as numerous DOE and NSF reviews and review panels.

Collaborators and Other Affiliations

Collaborators: Members of the CLEO Collaboration (the list includes over 150 names and over 10 institutions); CMS Collaboration (over 2000 collaborators from 155 Institutes spanning 37 countries; http://cms.web.cern.ch/cms/Collaboration/Institutes/index.html)

Graduate and Postdoctoral Advisors:
Thesis advisor: Jim Pilcher, University of Chicago;
Postdoctoral Advisor: John Jaros, SLAC.

Thesis Advisor and Postgraduate Scholar Sponsor*:*
Graduate students (last 5 years):
Gregg Thayer, Daniel Hertz, Michael Weinberger, Xin Shi, Nicholas Eggert
Postdocs (last 5 years):
Karl Ecklund, Werner Sun, Jean Duboscq, Hanna Mahlke-Krueger, David Urner

Gerald F. Dugan
Professor of Physics
Newman Laboratory
Cornell University
Ithaca, NY 14853

Telephone: (607) 255-5744
Fax: (607) 254-4552
E-mail: gfd1@cornell.edu

Professional Preparation:

Undergraduate:	Iona College	Physics	B.S.	1967
Graduate:	Columbia University	Physics	Ph.D.	1973
Postdoctoral:	Columbia University	Nuclear Physics		1972-76

Appointments:

Professor	Cornell University	1995-
Associate Director	SSC Laboratory	1991-94
Head, Accelerator Division	Fermilab	1989-91
Scientist	Fermilab	1982-91
Assistant Professor	Columbia University	1976-82
Research Associate	Columbia University	1972-76

Publications closely related to the proposed project:

1. J. A. Crittenden,J. R. Calvey, G. Dugan, J. A. Livezey, M. A. Palmer, D. L. Rubin, M. A. Furman, G. Penn, M. Venturini, K. C. Harkay, R. Holtzapple, K. Ohmi, M. T.F. Pivi, L. Wang, *Studies of the Effects of Electron Cloud Formation on Beam Dynamics at CesrTA*, in **Proceedings of the 2009 Particle Accelerator Conference**, to be published, (Vancouver, BC, Canada, May 2009)
2. J. R. Calvey, J. A. Crittenden, G. Dugan, S. Greenwald, J. A. Livezey, M. A. Palmer, D. L. Rubin, C. M. Celata, M. A. Furman, H. Fukuma, P. Jain, K. Kanazawa, Y. Suetsugu, K. C. Harkay, R. Holtzapple, M. T.F. Pivi, L. Wang, *Simulations of Electron-Cloud Current Density Measurements in Dipoles, Drifts and Wigglers at CesrTA*, **in Proceedings of the 2009 Particle Accelerator Conference**, to be published, (Vancouver, BC, Canada, May 2009)
3. M. A. Palmer, J. P. Alexander, M. G. Billing, J. R. Calvey, S. S. Chapman, G. W. Codner, J. A. Crittenden, J. Dobbins, G. Dugan, M. J. Forster, R. E. Gallagher, S. W. Gray, S. Greenwald, D. L. Hartill, W. H. Hopkins, D. L. Kreinick, Y. Li, X. Liu, J. A. Livezey, V. Medjidzade, R. Meller, S. B. Peck, D. P. Peterson, M. C. Rendina, D. H. Rice, N. T. Rider, D. L. Rubin, D. Sagan, J. W. Sex- ton, J. P. Shanks, J. P. Sikora, E. N. Smith, K. W. Smolenski, C. R. Strohman, A. B. Temnykh, M. Tigner, S. Vishniakou, W. S. Whit- ney, T. Wilksen, H. A. Williams, J. M. Byrd, C. M. Celata, J. N. Corlett, S. De Santis, M. A. Furman, A. Jackson, R. Kraft, D. V. Munson, G. Penn, D. W. Plate, A. W. Rawlins, M. Venturini, M. S. Zisman J. W. Flanagan, P. Jain, K. Kanazawa, K. Ohmi, Y. Suetsugu K. C. Harkay Y. He, M. C. Ross, C.-Y. Tan, R. M. Zwaska R. Holtzapple J. K. Jones J. Kandaswamy D. Kharakh, M. T.F. Pivi, L. Wang A. Wolski , *The Conversion and Operation of the Cornell Electron Storage Ring as a Test Accelerator (CesrTA) for Damping Rings Research and Development*, in **Proceedings of the 2009 Particle Accelerator Conference**, to be published, (Vancouver, BC, Canada, May 2009)
4. J. Urban, G. Dugan, *CESR-c Wiggler Studies in the Context of the International Linear Collider Damping Rings,* in **Proceedings of the 2005 Particle Accelerator Conference,** RPPP025, (Knoxville, TN, May 2005)
5. G. Dugan, *Localized Multibunch Modes in Accelerators*, **Phys. Rev. ST Accel. Beams 2,** 094401 (1999)

Other significant publications:

1. G. Dugan, *Status of the SSC*, **Proc. of the 15th International Conference on High Energy Accelerators**, pg. 100 (Hamburg, Germany, July 1992).
2. G. Dugan, *Very Large Hadron Collider R&D* , in **Proceedings of the 1999 Particle Accelerator Conference,** p. 48 (New York, 1999)
3. G. Dugan, *Transverse Linear Dynamics in an Axisymmetric Ionization Cooling Channel*, **Phys. Rev. ST Accel. Beams 4**, 104001 (2001)
4. G. Dugan. *Linear Damping Systems for the International Linear Collider,* in **Proceedings of the 2005 Particle Accelerator Conference,** RPPP020, (Knoxville, TN, May 2005)
5. G. Dugan, *Advanced Accelerator System Requirements for Future Linear Colliders,* in **Advanced Accelerator Concepts,** (Stony Brook, 2004), AIP Conf. Proceedings 737, p. 29

Synergistic Activities:

1. Development of graduate courses in accelerator physics using distance-learning technologies.
2. Chair, Executive Committee, American Physical Society Division of Physics of Beams 2005-06
3. Director, Americas Region, International Linear Collider Global Design Effort 2005-07
4. Member, Linear Collider Steering Group of the Americas 2001-09
5. Chair, Spallation Neutron Source Accelerator Advisory Committee 2008-

Collaborators and Other Affiliations

Cornell University: M. Billing, S. Greenwald, D. Rubin, M. Palmer, J. Crittenden, J. Calvey, M. Palmer, D. Rubin
Lawrence Berkeley National Lab: C. Celata, M. Furman, M. Venturini, G. Penn
SLAC: M. Pivi, L. Wang
ANL: K. Harkay
KEK: K. Ohmi, J. Flanagan, K. Kanazawa, Y. Suetsugu
CalPoly: R. Holtzapple

Graduate and Postdoctoral Advisors:

Thesis Advisor: L.M. Lederman (Illinois Institute of Technology)
Postdoctoral supervisor: C.S. Wu (Deceased)

Thesis Advisees or Postgraduate Scholars Sponsored:

Thesis Advisees: Hisashi Hirada, Mitsubishi Heavy Industries
Jeremy Urban, Cornell University
Postgraduate Scholars sponsored in last 5 years: None

Total Graduate students advised: 2
Total Postgraduate Scholars sponsored: 0

Matthias Liepe
Assistant Professor of Physics
Cornell University

Newman Laboratory
Cornell University
Ithaca, NY 14853
mul2@cornell.edu

A. Professional Preparation

Universität Hamburg	Physics	B.S.	1994
Universität Hamburg	Physics	M.S.	1998
Universität Hamburg	Physics	Ph.D.	2001

B. Appointments

Assistant Professor of Physics, Cornell University	2006-present
Lecturer, Cornell University	2004
Research Associate, Cornell University	2001-2006
Particle Accelerator School Lectures	2002
Research Assistant, DESY, Germany	1998-2001
Visiting Scientist, Cornell University	1998-1999
Teaching Assistant	1995, 1997

C. Publications

(i) Publications Most Closely Related to the Project

Superconducting Multicell Cavities for Linear Colliders, M. Liepe, PhD. thesis, Universität Hamburg, DESY-THESIS-2001-045, http://www-library.desy.de/preparch/desy/thesis/desy-thesis-01-045.pdf 2001).

Superconducting RF for Energy-Recovery Linacs, M. Liepe, J. Knobloch, Nuclear Instruments and Methods in Physics Research A 557, 354-369, http://erl.chess.cornell.edu/papers/2006/Liepe.pdf (2006).

First Test Results from the Cornell ERL Injector Cryomodule, M. Liepe et al., in Proc. of the 2008 EPAC, Genoa, p. 883-885, http://accelconf.web.cern.ch/AccelConf/e08/papers/mopp138.pdf (2008).

Pushing the Limits: RF Field Control at High Loaded Q, M. Liepe, S. Belomestnykh, J. Dobbins, R. Kaplan, C. Strohman, B. Stuhl, in Proc. of the 2005 Particle Accelerator Conference, Knoxville, TA, p 2642-2644, http://ieeexplore.ieee.org/iel5/10603/33511/01591213.pdf?arnumber=1591213 (2005).

Dynamic Lorentz Force Compensation with a Fast Piezoelectric Tuner, M. Liepe, W.D.-Moeller, S.N. Simrock, Proceedings of the 2001 Particle Accelerator Conference, Chicago, IL, p. 1074-1076, http://ieeexplore.ieee.org/iel5/7745/21261/00986582.pdf (2001).

(ii) List of Significant Related Publications

The Cornell ERL Superconducting 2-Cell Injector Cavity String and Test Cryomodule, M. Liepe , S. Belomestnykh, E. Chojnacki, V. Medjidzade, H. Padamsee, P. Quigley, J. Sears, V. Shemelin, V. Veshcherevich, Proc. of the 2007 Particle Accelerator Conference, Albuquerque, NM, http://pac07.org/proceedings/PAPERS/THOAKI02.PDF (2007).

Pulsed Superconductivity Acceleration, M. Liepe, invited talk, in Proc. of the XX Linac Conference, SLAC-R-561, Monterey, CA, p. 678-682, http://www.slac.stanford.edu/econf/C000821/WE204.pdf (2000).

Superconducting TESLA Cavities, B. Aune et al., Phys. Rev. ST Accel. Beams, Vol. 3, 092001, http://prst-ab.aps.org/abstract/PRSTAB/v3/i9/e092001 (2000).

Characterization of Ferrites at Low Temperature and High Frequency, V. Shemelin, M. Liepe, H. Padamsee, Nuclear Instruments and Methods in Physics Research A 557, 268-271 http://erl.chess.cornell.edu/papers/2006/Shemelin.pdf (2006).

Test of two Nb superstructure prototypes, J. Sekutowicz, P. Castro, A. Gössel, G. Kreps, R. Lange, A. Matheisen, W.-D. Möller, H.-B. Peters, D. Proch, H. Schlarb, S. Schreiber, S. Simrock, M. Wendt, N. Baboi, M. Ferrario, M. Huening, M. Liepe, C. Pagani, and S. Zheng, Phys. Rev. ST Accel. Beams 7, 012002, http://prst-ab.aps.org/abstract/PRSTAB/v7/i1/e012002 (2004).

D. Synergistic Activities

- Faculty Innovation in Teaching Program Award 2007
- Research Experiences for Undergraduates Mentor and Lecturer 2001-present
- Particle Accelerator School Lecturer 2002
- Online physics video demonstration database: http://courses2.cit.cornell.edu/physicsdemos/
- Member of Particle Accelerator Conference Program Committee, of the Linear Accelerator Conference Program Committee, and of LLRF Workshop Program Committee

E. Collaborators and Other Affiliations

Collaborators and Co-Editors

CCLRC Daresbury Laboratory; DESY, Hamburg; FZR Rossendorf ; HEPL Stanford University; TESLA-Technology Collaboration; TJNAF; LBNL Berkeley; University of Pennsylvania; P. Barnes (Cornell University), I. Bazarov (Cornell University), S. Belomestnykh (Cornell University), D. Bilderback (CHESS, Ithaca, New York), A. Buechner (FZR Rossendorf), C. D. Beard (CCLRC Daresbury Laboratory), J. Byrd (LBNL, Berkeley), Eric Chojnacki (Cornell University), G. Codner (Cornell University), J. N. Corlett (LBNL, Berkeley), D. Dale (CHESS, Ithaca, New York), D. M. Dykes (CCLRC Daresbury Laboratory), K. Finkelstein (CHESS, Ithaca, New York), M. Forster (Cornell University), Rong-Li Geng (TJNAF), S. Greenwald (Cornell University), S. Gruner (CHESS, Ithaca, New York), G. H. Hoffstaetter (Cornell University), R. Kaplan (Cornell University), T. Kimura (HEPL Stanford University), D. Li (LBNL, Berkeley), Y. Li (Cornell University), C. Mayes (Cornell University), P. A. McIntosh (CCLRC Daresbury Laboratory), V. Medjidzade (Cornell University), David Meidlinger (Cornell University), P. Michel (FZR Rossendorf), H. Padamsee (Cornell University) , D. Proch (DESY, Hamburg), P. Quigley (Cornell University), J. Reilly (Cornell University), J. Sears (Cornell University), V. D. Shemelin (Cornell University), T. I. Smith (HEPL Stanford University), C. Song (Cornell University), J. Teichert (FZR Rossendorf), A. Temnykh (Cornell University), M. Tigner (Cornell University), B. Todd (CCLRC Daresbury Laboratory), N. Valles (Cornell University), V. Veshcherevich (Cornell University), Y. Xie (Cornell University)

Graduate Advisors and Post Doctoral Sponsors
Graduate Advisor: Peter Schmueser, Universität Hamburg, Germany

Thesis Advisor and Postgraduate-Scholar Sponsor
Thesis Advisor: Yi Xie

SUMMARY PROPOSAL BUDGET

YEAR 1

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

ORGANIZATION
Cornell University

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Maury Tigner

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. **Maury Tigner - PI**	0.00	0.00	0.00	$ **0**	$
2. **Donald L Hartill - co-PI**	0.00	0.00	0.00	**0**	
3. **Georg H Hoffstaetter - co-PI**	0.00	0.00	0.00	**0**	
4. **Mark A Palmer - co-PD**	6.00	0.00	0.00	**0**	
5. **David Rubin - co-PI**	0.00	0.00	0.00	**0**	
6. (**1**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	8.00	**140,140**	
7. (**6**) TOTAL SENIOR PERSONNEL (1 - 6)	6.00	0.00	8.00	**140,140**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**81**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	256.00	0.00	0.00	**1,433,935**	
3. (**4**) GRADUATE STUDENTS				**124,621**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**6**) OTHER				**48,553**	
TOTAL SALARIES AND WAGES (A + B)				**1,747,249**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**551,693**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**2,298,942**	

D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)

CESR capital improvements	$ **52,000**
Ecloud computing	**22,000**
Ecloud vacuum system upgrade	**101,000**
Others (See Budget Comments Page...)	**534,830**

	Funds Requested By proposer	Funds granted by NSF (if different)
TOTAL EQUIPMENT	**709,830**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)	**70,000**	
2. FOREIGN	**10,000**	

F. PARTICIPANT SUPPORT COSTS

1. STIPENDS $ **0**
2. TRAVEL **0**
3. SUBSISTENCE **0**
4. OTHER **0**

	Funds Requested By proposer	Funds granted by NSF (if different)
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS	**0**	
G. OTHER DIRECT COSTS		
1. MATERIALS AND SUPPLIES	**447,095**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION	**0**	
3. CONSULTANT SERVICES	**0**	
4. COMPUTER SERVICES	**0**	
5. SUBAWARDS	**0**	
6. OTHER	**440,680**	
TOTAL OTHER DIRECT COSTS	**887,775**	
H. TOTAL DIRECT COSTS (A THROUGH G)	**3,976,547**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **MTDC (Rate: 59.0000, Base: 2158395)**		
TOTAL INDIRECT COSTS (F&A)	**1,273,453**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)	**5,250,000**	
K. RESIDUAL FUNDS	**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)	$ **5,250,000**	$

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

PI/PD NAME
Maury Tigner

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 1

Other Senior Personnel

Name - Title	Cal	Acad	Sumr	Funds Requested
salaries, aggregated -	0.00	0.00	8.00	140140

**** D- Equipment**
Heat exchanger and pumps (Amount: $ 247880)
Low emittance tuning (Amount: $ 34000)
spun cavities (Amount: $ 132950)
X-ray beam size monitor (Amount: $ 120000)

SUMMARY PROPOSAL BUDGET

YEAR 2

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

ORGANIZATION
Cornell University

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Maury Tigner

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. Maury Tigner - PI	0.00	0.00	0.00	$ 0	$
2. Donald L Hartill - co-PI	0.00	0.00	0.00	0	
3. Georg H Hoffstaetter - co-PI	0.00	0.00	0.00	0	
4. Mark A Palmer - co-PD	6.00	0.00	0.00	0	
5. David Rubin - co-PI	0.00	0.00	0.00	0	
6. (1) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	5.00	108,432	
7. (6) TOTAL SENIOR PERSONNEL (1 - 6)	6.00	0.00	5.00	108,432	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	0	
2. (82) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	241.60	0.00	0.00	1,443,530	
3. (4) GRADUATE STUDENTS				114,491	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (6) OTHER				50,010	
TOTAL SALARIES AND WAGES (A + B)				1,716,463	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				544,670	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				2,261,133	

D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)

CESR capital improvements	$ 60,000
Ecloud computing	43,000
Ecloud vacuum system upgrade	140,000
Others (See Budget Comments Page...)	319,520

	Funds Requested By proposer	Funds granted by NSF (if different)
TOTAL EQUIPMENT	562,520	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)	72,100	
2. FOREIGN	11,700	

F. PARTICIPANT SUPPORT COSTS

1. STIPENDS $ 0
2. TRAVEL 0
3. SUBSISTENCE 0
4. OTHER 0

	Funds Requested By proposer	Funds granted by NSF (if different)
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS	0	
G. OTHER DIRECT COSTS		
1. MATERIALS AND SUPPLIES	529,864	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION	0	
3. CONSULTANT SERVICES	0	
4. COMPUTER SERVICES	0	
5. SUBAWARDS	0	
6. OTHER	474,110	
TOTAL OTHER DIRECT COSTS	1,003,974	
H. TOTAL DIRECT COSTS (A THROUGH G)	3,911,427	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) MTDC (Rate: 59.0000, Base: 2268768)		
TOTAL INDIRECT COSTS (F&A)	1,338,573	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)	5,250,000	
K. RESIDUAL FUNDS	0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)	$ 5,250,000	$

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

PI/PD NAME
Maury Tigner

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 2

Other Senior Personnel

Name - Title	Cal	Acad	Sumr	Funds Requested
salaries, aggregated -	0.00	0.00	5.00	108432

**** D- Equipment**
Low emittance tuning (Amount: $ 103000)
RF test gear (Amount: $ 20520)
spun cavities (Amount: $ 60000)
X-ray beam size monitor (Amount: $ 136000)

SUMMARY PROPOSAL BUDGET

YEAR 3

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

ORGANIZATION
Cornell University

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Maury Tigner

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. Maury Tigner - PI	0.00	0.00	0.00	$ 0	$
2. Donald L Hartill - co-PI	0.00	0.00	0.00	0	
3. Georg H Hoffstaetter - co-PI	0.00	0.00	0.00	0	
4. Mark A Palmer - co-PD	6.00	0.00	0.00	0	
5. David Rubin - co-PI	0.00	0.00	0.00	0	
6. (1) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	5.50	116,541	
7. (6) TOTAL SENIOR PERSONNEL (1 - 6)	6.00	0.00	5.50	116,541	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	0	
2. (82) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	238.00	0.00	0.00	1,462,356	
3. (4) GRADUATE STUDENTS				120,213	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (6) OTHER				51,510	
TOTAL SALARIES AND WAGES (A + B)				1,750,620	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				554,338	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				2,304,958	

D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)

CESR capital improvements	$ 60,000
Ecloud computing	39,000
Ecloud vacuum system upgrade	95,000
Others (See Budget Comments Page...)	280,572

	Funds Requested By proposer	Funds granted by NSF (if different)
TOTAL EQUIPMENT	474,572	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)	73,400	
2. FOREIGN	12,914	

F. PARTICIPANT SUPPORT COSTS
1. STIPENDS $ 0
2. TRAVEL 0
3. SUBSISTENCE 0
4. OTHER 0

	Funds Requested By proposer	Funds granted by NSF (if different)
TOTAL NUMBER OF PARTICIPANTS (0) TOTAL PARTICIPANT COSTS	0	
G. OTHER DIRECT COSTS		
1. MATERIALS AND SUPPLIES	540,842	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION	0	
3. CONSULTANT SERVICES	0	
4. COMPUTER SERVICES	0	
5. SUBAWARDS	0	
6. OTHER	481,735	
TOTAL OTHER DIRECT COSTS	1,022,577	
H. TOTAL DIRECT COSTS (A THROUGH G)	3,888,421	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) MTDC (Rate: 59.0000, Base: 2307761)		
TOTAL INDIRECT COSTS (F&A)	1,361,579	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)	5,250,000	
K. RESIDUAL FUNDS	0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)	$ 5,250,000	$

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

PI/PD NAME
Maury Tigner

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

Other Senior Personnel

Name - Title	Cal	Acad	Sumr	Funds Requested
salaries, aggregated -	0.00	0.00	5.50	116541

**** D- Equipment**
Low emittance tuning (Amount: $ 79000)
RF test gear (Amount: $ 26072)
spun cavities (Amount: $ 60000)
X-ray beam size monitor (Amount: $ 115500)

SUMMARY PROPOSAL BUDGET

Cumulative

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

ORGANIZATION
Cornell University

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Maury Tigner

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. Maury Tigner - PI	0.00	0.00	0.00	$ 0	$
2. Donald L Hartill - co-PI	0.00	0.00	0.00	0	
3. Georg H Hoffstaetter - co-PI	0.00	0.00	0.00	0	
4. Mark A Palmer - co-PD	18.00	0.00	0.00	0	
5. David Rubin - co-PI	0.00	0.00	0.00	0	
6. (1) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	18.50	365,113	
7. (6) TOTAL SENIOR PERSONNEL (1 - 6)	18.00	0.00	18.50	365,113	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	0	
2. (245) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	735.60	0.00	0.00	4,339,821	
3. (12) GRADUATE STUDENTS				359,325	
4. (0) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (18) OTHER				150,073	
TOTAL SALARIES AND WAGES (A + B)				5,214,332	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				1,650,701	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				6,865,033	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.) $ 1,746,922					
TOTAL EQUIPMENT				1,746,922	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				215,500	
2. FOREIGN				34,614	
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				1,517,801	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				1,396,525	
TOTAL OTHER DIRECT COSTS				2,914,326	
H. TOTAL DIRECT COSTS (A THROUGH G)				11,776,395	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				3,973,605	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				15,750,000	
K. RESIDUAL FUNDS				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 15,750,000	$

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

PI/PD NAME
Maury Tigner

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

CesrTA

CesrTA	Year 1	Year 2	Year 3
Personnel	1,748,573	1,933,438	1,976,716
Equipment	329,000	482,520	388,500
Power	345,000	398,480	405,400
Travel	70,000	73,500	75,705
M&S	407,590	483,410	497,341
Other	87,470	75,630	76,335
Indirect costs	1,062,367	1,203,022	1,230,003
Total	**4,050,000**	**4,650,000**	**4,650,000**

Conference support

exclusion:

Cap equip	329,000	482,520	388,500
Power	345,000	398,480	405,400
Labor	455,539	469,205	483,281
GRA tuition			
Health ins.	57,470	57,750	58,065

Personnel expenses include personnel for operation of the accelerator, carrying out of measurements for the CTA program as described in the proposal and for the construction of capital equipment (see labor exclusion)

Electric Power

These costs are based on operating experience and projections about the unit cost of power from the supplier and are included in the "other" budget line in Fastlane.

Equipment

Included in this category are such major items as:

Item	Year 1	Year 2	Year 3
CESR capital equipment	52 k$	60 k$	60 k$
x-ray beam size monitor	120	136	115
Ecloud vac sys upgrade	101	140	95
Ecloud computing	22	43	39
Low emittance tuning R&D	34	103	79

Travel

This being a very collaborative enterprise with many meetings held at collaborating institutions considerable travel is required both domestic and foreign

M&S - maintenance

Item	Year 1	Year 2	Year 3
CESR operations -cryogens+general maint.	287 k$	330 k$	330 k$
Computing maintenance	28	30	31
x-ray beam size monitor	15	16	17
Ecloud vac sys	40	42	44
LET instr. Maint.	21	32	22
Miscellaneous	17	33	53

Other

There are collaboration meetings each year. In year 1 ECloud 2010 will be held at Cornell. This also includes graduate student tuition, fees and health insurance.

SRF

SRF	Year 1	Year 2	Year 3
Personnel	442,986	152,101	147,380
Equipment	247,880	20,000	26,072
M&S	19,505	24,000	24,902
Other	8,210	0	0
Indirect costs	181,419	103,899	101,646
Total	900,000	300,000	300,000

exclusion:	Cap equip	247,880	20,000	26,072
	Labor	155,000	0	0
	GRA tuition			
	Health ins	8,210	0	0

Personnel
The personnel in the first year will be employed in creating the capital equipment and carrying out the R&D scheduled for that year. In subsequent years they will primarily be employed in carrying out the cavity tests and analyses as described in the proposal.
Equipment
In the first year the equipment expenditure will be largely the design and construction of the heat exchanger and pump lines needed to connect the existing horizontal test cryostat to the helium liquifier for continuous refrigeration. In the second and third years the equipment will be rf test gear needed for carrying out the tests described.
M&S
M&S is largely cryogens and replacement vacuum equipment associated with operating the cavity tests.

Muon Acceleration

Muon Acceleration	Year 1	Year 2	Year 3
Personnel	107,383	175,595	180,862
Equipment	132,950	60,000	60,000
Travel	10,000	10,300	10,609
M&S	20,000	22,454	18,600
Indirect costs	29,667	31,651	29,929
Total	300,000	300,000	300,000

exclusion:	Cap equip	132,950	60,000	60,000
	Labor	87,100	154,703	159,344

Personnel
The personnel are employed to carry out the cavity tests described and analyze the data from these tests.
Equipment
Equipment is largely purchases for the spun cavities and their outfitting by INFN and Research Instruments respectively.
Travel
Domestic travel to the NFMCC meetings and foreign travel to monitor progress at INFN and Research Instruments will be required
M&S
M&S will be mostly cryogens and replacement vacuum and helium transfer equipment

Indirect Costs - Costs have been proposed at a rate of 59% for Modified Total Direct Cost (MTDC) as approved in Cornell's rate agreement with the Department of Health and Human Services as 6/19/08. MTDC exclusions include capital equipment, GRA tuition and health insurance, power costs and capitalized labor costs.

Fringe Benefits – The fringe rate is 34% on all salaries, excluding student salaries.

Current and Pending Support

(See GPG Section II.D.8 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: **Maury Tigner**	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: **Support of the Cornell Electron Storage Ring (CESR) Facility**

Source of Support: **NSF PHY-0202078**
Total Award Amount: **$96,218,197** Total Award Period Covered: **04/01/03-03/31/10**
Location of Project: **Cornell University**
Person-months Per Year Committed to the Project: Cal: **0.00** Acad: **0.5** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: **Support of the Cornell Electron Storage Ring (CESR) Facility**

Source of Support: **NSF**
Total Award Amount: **$6,500,000** Total Award Period Covered: **04/01/09-03/31/10**
Location of Project: **Cornell University**
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: **Support of the Cornell Electron Storage Ring (CESR) Facility**

Source of Support: **NSF**
Total Award Amount: **$1,285,000** Total Award Period Covered: **04/01/09-03/31/10**
Location of Project: **Cornell University**
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: **Phase 1 Energy Recovery Linac (ERL) Synchrotron Light Source at Cornell**
Source of Support: **NSF (PHY-0131509)**
Total Award Amount: **$18,430,000** Total Award Period Covered: **02/15/05-01/31/10**
Location of Project: **Cornell University**
Person-months Per Year Committed to the Project: Cal: Acad: **0.5** Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: **Energy Recovery Linac at Cornell University Project #U316**
Source of Support: **NYS (ESDC)**
Total Award Amount: **$12,000,000** Total Award Period Covered: **07/18/06-09/30/10**
Location of Project: **Cornell University**
Person-months Per Year Committed to the Project: Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.D.8 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: **Maury Tigner**

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: **Operation of the Cornell High Energy Synchrotron Source (CHESS)**

Source of Support: **NSF-DMR**

Total Award Amount: **$86,258,138** Total Award Period Covered: **04/01/10-03/31/14**

Location of Project: **Cornell University**

Person-months Per Year Committed to the Project: Cal: **0.00** Acad: **0** Sumr: **0.00**

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Superconducting RF (SRF) Development for the Project X Neutrino Beam to DUSEL**

Source of Support: **NSF**

Total Award Amount: **$2,250,001** Total Award Period Covered: **04/01/10-03/31/13**

Location of Project: **Cornell University**

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: **Lepton Collider R&D**

Source of Support: **NSF**

Total Award Amount: **$15,750,000** Total Award Period Covered: **04/01/10-03/31/13**

Location of Project: **Cornell University**

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:

---

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.D.8 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: **Hartill, Donald**	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: **CESR Conversion**

Source of Support: **NSF/DOE**
Total Award Amount: $ **42,494,948** Total Award Period Covered: **10/01/07 – 09/30/11**
Location of Project: **Cornell University**
Person-months Per Year Committed to the Project: Cal: **0.00** Acad: 0**.5** Sumr: **0.00**

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: **Phase Ib Energy Recovery Linac (ERL) Technology R&D**

Source of Support: **NSF**
Total Award Amount: **$38,334,451** Total Award Period Covered: **10/01/08 – 09/31/13**
Location of Project: **Cornell University**
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: **REU Site: Accelerator Physics and Synchrotron Radiation Science**

Source of Support: **NSF**
Total Award Amount: **$422,224** Total Award Period Covered: **03/01/09-02/28/12**
Location of Project: **Cornell 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: **Operations of Cornell High Energy Synchrotron Source (CHESS)**

Source of Support: **NSF - DMR**
Total Award Amount: **$ 86,258,138** Total Award Period Covered: **04/01/10 – 03/31/14**
Location of Project: **Cornell University**
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: **Energy Recovery Linac R&D 2/1/09 - 3/31/10**

Source of Support: **NSF**
Total Award Amount: $ **10,381,368** Total Award Period Covered: **02/01/09 - 03/31/10**
Location of Project: **Cornell University**
Person-months Per Year Committed to the Project: Cal: Acad: Sumr:

*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.D.8 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: **Donald Hartill**	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: **Lepton Collider R&D**
Source of Support: **NSF**
Total Award Amount: **$15,750,000** Total Award Period Covered: **04/01/10-03/31/13**
Location of Project: **Cornell University**
Person-months Per Year Committed to the Project: Cal: **0.00** Acad: **0** 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: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.D.8 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: **Georg Hoffstaetter**	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: **Support of the Cornell Electron Storage Ring (CESR) Facility**

Source of Support: **NSF (PHY-0202078)**
Total Award Amount: **$96,218,197** Total Award Period Covered: **04/01/03-03/31/10**
Location of Project: Cornell University
Person-months Per Year Committed to the Project: Cal: **0.00** Acad:**0.25** Sumr: 0**.25**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: **Beam Pipe HOM Absorber for 750 MHZ RF Cavity System**

Source of Support: **Muons, Inc. (60104)**
Total Award Amount: **$30,000** Total Award Period Covered: **07/02/09-07/19/10**
Location of Project: **Cornell University**
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: **Development of Next Generation High Gradient Superconducting RF Cavity**
Source of Support: **AES**
Total Award Amount: **$30,003** Total Award Period Covered: **10/01/09-09/30/10**
Location of Project: Cornell University
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: **Energy Recovery Linac (ERL) R&D 2-1-09 to 3-31-10**

Source of Support: **NSF (DMR-0937466)**
Total Award Amount: **$5,200,000** Total Award Period Covered: **09/01/09-08/31/10**
Location of Project: **Cornell University**
Person-months Per Year Committed to the Project: Cal: Acad: **0.25** Sumr: **0.25**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: **Fundamental Research in Superconducting RF Cavity Design**
Source of Support: **DOE**
Total Award Amount: **$1,208,006** Total Award Period Covered: **07/01/09-06/30/12**
Location of Project: **Cornell University**
Person-months Per Year Committed to the Project: Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.D.8 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: **Georg Hoffstaetter**	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: **REU Site: Accelerator Physics and Synchrotron Radiation Science**

Source of Support: **NSF (PHY-0849885)**
Total Award Amount: **$303,000** Total Award Period Covered: **03/01/09-02/28/12**
Location of Project: Cornell University
Person-months Per Year Committed to the Project: Cal: **0.00** Acad: **0** Sumr: **0.00**

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: **Phase 1B Energy Recovery Linac (ERL) Technology R&D**

Source of Support: **NSF**
Total Award Amount: **$38,334,451** Total Award Period Covered: **04/01/10-03/31/13**
Location of Project: **Cornell University**
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: **Pushing the Gradient Frontier in Superconducting RF**

Source of Support: **NSF (PHY-0752663)**
Total Award Amount: **$936,000** Total Award Period Covered: **07/01/08-06/30/11**
Location of Project: **Cornell University**
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: **ILC SRF R&D for ART 2009**

Source of Support: **ART (143858)**
Total Award Amount: **$550,000** Total Award Period Covered: **05/07/09-12/31/09**
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: **Research in Superconducting Radiofrequency Systems**

Source of Support: **DOE (DE-FG02-04ER41354)**
Total Award Amount: **$592,400** Total Award Period Covered: **09/01/04-08/31/10**
Location of Project: **Cornell University**
Person-months Per Year Committed to the Project: Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.D.8 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: **Georg Hoffstaetter**	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 in Superconducting Radiofrequency Systems**

Source of Support: **DOE**
Total Award Amount: **$227,500** Total Award Period Covered: **09/01/09-08/31/10**
Location of Project: **Cornell University**
Person-months Per Year Committed to the Project: Cal: **0.00** Acad: **0** Sumr: **0.00**

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: **Superconducting RF (SRF) Development for the Project X Neutrino Beam to DUSEL**

Source of Support: **NSF**
Total Award Amount: **$2,250,000** Total Award Period Covered: **04/01/10-03/31/13**
Location of Project: **Cornell University**
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: **Lepton Collider R&D**

Source of Support: **NSF**
Total Award Amount: **$15,750,000** Total Award Period Covered: **04/10/10-03/31/13**
Location of Project: **Cornell University**
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:

*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

NSF Form 1239 (10/99)

Current and Pending Support

(See GPG Section II.D.8 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: **Mark Palmer**	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: **Support of the Cornell Electron Storage Ring (CESR) Facility**

Source of Support: **NSF: PHY-0202078**
Total Award Amount: **$96,218,197** Total Award Period Covered: **04/01/03-03/31/10**
Location of Project: Cornell University
Person-months Per Year Committed to the Project: Cal: **2** Acad: **0** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: **REU Site: Accelerator Physics and Synchrotron Radiaton Science**

Source of Support: **NSF**
Total Award Amount: **$422,224** Total Award Period Covered: **03/01/09-02/28/12**
Location of Project: **Cornell University**
Person-months Per Year Committed to the Project: Cal: **0.5** Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: **CESR TA Conversion**

Source of Support: **NSF**
Total Award Amount: **$15,570,631** Total Award Period Covered: **03/15/08-02/28/11**
Location of Project: **Cornell University**
Person-months Per Year Committed to the Project: Cal: **6.5** Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: **CESR TA Conversion**

Source of Support: **DOE**
Total Award Amount: **$5,284,000** Total Award Period Covered: **05/01/08-04/30/11**
Location of Project: **Cornell University**
Person-months Per Year Committed to the Project: Cal: **2** Acad: Sumr:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: **Lepton Collider R&D**
Source of Support: **NSF**
Total Award Amount: $**15,750,000** Total Award Period Covered: **04/01/10-03/31/13**
Location of Project: **Cornell University**
Person-months Per Year Committed to the Project: Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.D.8 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 Rubin**

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: **Support of the Cornell Electron Storage Ring (CESR) Facility**

Source of Support: **NSF: PHY-0202078**
Total Award Amount: **$96,218,197** Total Award Period Covered: **04/01/03-03/31/10**
Location of Project: Cornell University
Person-months Per Year Committed to the Project: Cal: **6** Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: **REU Site: Accelerator Physics and Synchrotron Radiation Science**

Source of Support: **NSF**
Total Award Amount: **$422,224** Total Award Period Covered: **03/01/09 – 02/28/12**
Location of Project: **Cornell University**
Person-months Per Year Committed to the Project: Cal: Acad: Sumr: **1**

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: **Lepton Collider R&D**

Source of Support: **NSF**
Total Award Amount: **$15,750,000** Total Award Period Covered: **04/01/10-03/31/13**
Location of Project: **Cornell University**
Person-months Per Year Committed to the Project: Cal: **1** Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: **CESR TA Conversion**

Source of Support: **NSF**
Total Award Amount: **$15,570,631** Total Award Period Covered: **03/15/08 – 02/28/11**
Location of Project: **Cornell University**
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: **CESR TA Conversion**

Source of Support: **DOE**
Total Award Amount: **$5,245,000** Total Award Period Covered: **05/01/08-04/30/11**
Location of Project: **Cornell University**
Person-months Per Year Committed to the Project: Cal: Acad: Sumr: **2.0**

*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.D.8 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 Rubin**	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: **Operation of the Cornell High Energy Synchrotron Source (CHESS)**

Source of Support: **NSF-DMR**
Total Award Amount: **$** Total Award Period Covered: **04/01/08 – 03/31/11**
Location of Project: **Cornell University**
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: **Conceptual and Engineering Design of a Brilliant X-ray Source Upgrade to the Cornell High Energy Synchrotron Source**
Source of Support: **NSF**
Total Award Amount: **$1,093,836** Total Award Period Covered: **10/01/09-09/30/10**
Location of Project:
Person-months Per Year Committed to the Project: Cal: Acad: 1 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: Sumr:

*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.D.8 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 Alexander**	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: **Collaborative Research: University Program of Detector Research for the ILC Detector Concept at the ILD (T-TPC)**
Source of Support: **NSF-MPS**
Total Award Amount: **225,00** Total Award Period Covered: **09/01/09-08/31/12**
Location of Project: **Cornell University**
Person-months Per Year Committed to the Project: Cal: Acad: **0.1** Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: **CESR TA Conversion**
Source of Support: **DOE**
Total Award Amount: **$5,284,000** Total Award Period Covered: **03/15/08-4/30/11**
Location of Project: **Cornell University**
Person-months Per Year Committed to the Project: Cal: Acad: **1** Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: **US CMS Software and Computing User Facilities Sub-Project**
Source of Support: **U of CAL (UCLA)**
Total Award Amount: **$971,518** Total Award Period Covered: **10/01/06-12/31/11**
Location of Project: **Cornell University**
Person-months Per Year Committed to the Project: Cal: Acad: **0.4** Sumr:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: **Particle Physics at the Energy and Luminosity Frontiers**
Source of Support: **NSF**
Total Award Amount: **$6,547,621** Total Award Period Covered: **04/01/10-03/31/13**
Location of Project: **Cornell University**
Person-months Per Year Committed to the Project: Cal: Acad: 2.5 Sumr: **2**

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: **Lepton Collider R&D**
Source of Support: **NSF**
Total Award Amount: **$15,750,000** Total Award Period Covered: **04/01/10-03/31/13**
Location of Project: **Cornell University**
Person-months Per Year Committed to the Project: Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.D.8 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 Alexander**	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 Physics at the Energy Frontier with CMS**

Source of Support: **NSF PHY-0757894**
Total Award Amount: **$2,289,175** Total Award Period Covered: **04/14/08-03/31/11**
Location of Project: **Cornell University**
Person-months Per Year Committed to the Project: Cal: **0.00** Acad: **0** 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: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.D.8 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: **Gerald Dugan**

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: **Support of the Cornell Electron Storage Ring (CESR) Facility**

Source of Support: **NSF**

Total Award Amount: **$96,218,197** Total Award Period Covered: **04/01/03-03/31/10**

Location of Project: **Cornell University**

Person-months Per Year Committed to the Project: Cal: Acad: **1.0** Sumr: **1.0**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **CESR TA Conversion**

Source of Support: **DOE**

Total Award Amount: **$5,284,000** Total Award Period Covered: **05/01/08-03/31/10**

Location of Project: **Cornell University**

Person-months Per Year Committed to the Project: Cal: Acad: Sumr: **2.0**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **CESR TA Conversion**

Source of Support: **NSF**

Total Award Amount: **$15,570,631** Total Award Period Covered: **04/01/08-03/31/10**

Location of Project:

Person-months Per Year Committed to the Project: Cal: Acad: **1.0** Sumr: **1.0**

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Lepton Collider R&D**

Source of Support: **NSF**

Total Award Amount: **$15,750,000** Total Award Period Covered: **04/01/10-03/31/13**

Location of Project: **Cornell University**

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:

---

*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.D.8 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: **Liepe, Matthias**	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: **Sloan Foundation – Sloan Fellowship**

Source of Support: **Sloan Foundation**
Total Award Amount: **$50,000** Total Award Period Covered: **09/16/08-09/15/10**
Location of Project: **Cornell University**
Person-months Per Year Committed to the Project: Cal: **0.00** Acad: **0.0** Sumr: **0.00**

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: **Phase 1b Energy Recovery Linac (ERL) Technology R&D**

Source of Support: **NSF**
Total Award Amount: **$38,334,451** Total Award Period Covered: **04/01/10-03/31/13**
Location of Project: **Cornell University**
Person-months Per Year Committed to the Project: Cal: **0.00** Acad: 0.**5** Sumr: **2.0**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: **CAREER: An Integrated Research/Educational Plan for Advancing RF Superconductivity for Particle Accelerators**
Source of Support: **NSF**
Total Award Amount: **$800,000** Total Award Period Covered: **04/15/09-03/31/14**
Location of Project: **Cornell University**
Person-months Per Year Committed to the Project: Cal: Acad: Sumr: **0.5**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: **Phase I Energy Recovery Linac (ERL) Synchrotron Light Source at Cornell University**
Source of Support: **NSF**
Total Award Amount: $ **17,980,000** Total Award Period Covered: **02/15/05 – 01/31/10**
Cornell University
Person-months Per Year Committed to the Project: Cal: Acad: 0.**5** Sumr: **2.0**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: **Pushing the Gradient Frontier in Superconducting RF**
Source of Support: **NSF**
Total Award Amount: $ **936,000** Total Award Period Covered: **07/01/08 – 06/30/11**
Location of Project: **Cornell University**
Person-months Per Year Committed to the Project: Cal: Acad: **0.50** Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.D.8 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: **Liepe, Matthias**	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: **REU Site: Accelerator Physics and Synchrotron Radiation Science**

Source of Support: **NSF**
Total Award Amount: **$ 422,224** Total Award Period Covered: **03/01/09-02/28/12**
Location of Project: **Cornell University**
Person-months Per Year Committed to the Project: Cal: **0.00** Acad: **0.50** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: **Fundamental Research in Superconducting RF Cavity Design**

Source of Support: **DOE**
Total Award Amount: **$1,208,006** Total Award Period Covered: **07/01/09-06/30/12**
Location of Project: **Cornell University**
Person-months Per Year Committed to the Project: Cal: **0.00** Acad: **0.00** Sumr: **0.5**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: **Support of the Cornell Electron Storage Ring (CESR) Facility**

Source of Support: **NSF**
Total Award Amount: **$96,218,197** Total Award Period Covered: **04/01/07 – 03/31/10**
Location of Project: **Cornell University**
Person-months Per Year Committed to the Project: Cal: Acad: Sumr: **0**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: **Energy Recovery Linac R&D 2/1/09 - 3/31/10**

Source of Support: **NSF**
Total Award Amount: $ **5,200,000** Total Award Period Covered: **09/01/09-08/31/10**
Location of Project: **Cornell University**
Person-months Per Year Committed to the Project: Cal: Acad: **0.5** Sumr: **1.0**

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: **Superconducting RF (SRF) Development for the Project X Neutrino Beam to DUSEL**
Source of Support: **NSF**
Total Award Amount: **$2,250,000** Total Award Period Covered: **04/01/10-03/31/13**
Location of Project: **Cornell University**
Person-months Per Year Committed to the Project: Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.D.8 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: **Liepe, Matthias**

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: **Lepton Collider R&D**

Source of Support: **NSF**
Total Award Amount: **$15,750,000** Total Award Period Covered: **04/01/10-03/31/13**
Location of Project: **Cornell University**
Person-months Per Year Committed to the Project: Cal: **0.00** Acad: **0** 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: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99)

USE ADDITIONAL SHEETS AS NECESSARY

Facilities, Equipment and Other Resources

CesrTA

The central facility for this work is the Cornell Electron Storage Ring, CESR, with it's injector linac and synchrotron. Facilitating the work are machine and electronics shops and helium refrigeration for the superconducting technological components of CESR.

Attached to CESR in the Cornell High Energy Synchrotron Source, CHESS, which provides facilities for using x-ray monitoring of the CESR electron and positron beams.

Technical services including engineering, material handling and stockroom service are available

SRF Basic R&D and Low Frequency Cavities for Muon Acceleration

Cornell has extensive infrastructure for research and development in rf superconductivity as well as for production, preparation, and testing of superconducting cavities. These facilities have been used to build the prototype SRF cavities for CEBAF and early prototypes for ILC, as well as all the cavities that power the present storage ring, CESR. ACCEL Corporation uses our facilities to test cavities and windows. Cavity production facilities include a 100 ton press for deep drawing niobium cavity cells, digital control milling machines for precise die machining, CMM for dimensional inspection and control, an electron beam welder, and a large UHV furnace to purify cavity half cells at 1300 C. Cleaning facilities include open and closed cavity etching systems that can handle a variety of cavity sizes, high purity water rinsing systems, and high pressure (100 atmospheres) water rinsing. There is a new 1100 sq ft Class 100 clean room for cavity assembly and a smaller Class 100 area for preparing test cavities. There are several portable clean room set ups for critical assembly.

Test setups include three radiation shielded pits, two of which can accommodate 1300 MHz cavities. We have several cryostats, and cryostat inserts to test cavities from 200 MHz to 3000 MHz.

We are in the process of installing a new helium liquefaction and recovery system. The liquefier and gas storage tanks are in house. We anticipate the rest of the system to be operational by the end of 2009.

For RF power we have several 200 Watt CW power sources and a 2 MW pulsed klystron for high pulsed power processing 1300 MHz cavities. High power testing capabilities exist for windows at 500 MHz and HOM loads at 2450 MHz. Research facilities include a rapid thermometry system for studying single cell 1500 MHz cavities, field emission apparatus, and dedicated scanning electron microscope with energy dispersive analysis for element identification and an Auger System with SIMS Analysis capabilities augments our surface analysis capabilities, installed in a class 1000 clean room.

HIGH ENERGY ACCELERATOR RESEARCH ORGANIZATION

KEK

Katsunobu Oide
Director, Accelerator Laboratory,
High Energy Accelerator Research Organization (KEK)
1-1 Oho, Tsukuba, Ibaraki 305-0801, Japan

October 1, 2009

Prof. Maury Tigner
Cornell University,
Floyd R. Newman Laboratory for Elementary-Particle Physics
Garden Avenue,
Ithaca, NY 14853-5001
U. S. A.

Dear Prof. Tigner,

It is with great interest that we receive news of the proposal to extend the CesrTA project to 2013. Collaborators from KEK have participated in the study of low-emittance tuning techniques, electron cloud measurement and mitigation methods, bunch-by-bunch beam size measurements and feedback, and electron cloud induced beam instability studies. All of these areas are of great interest to us for our own current and planned machines, as well as for the International Linear Collider and other future machines. In addition to the obvious benefits of collaboration between the ATF/ATF2 and CesrTA for ILC R&D, the success of the planned upgrade to KEKB, SuperKEKB, will depend on low-emittance tuning and measurement techniques, electron cloud diagnostic and mitigation techniques, and a deepened understanding of electron cloud instability thresholds and mechanisms, which are all the subjects of ongoing studies at CesrTA. As a result the collaborative efforts thus far have been very beneficially mutual from an inter-laboratory standpoint as well as for the development of future high-performance accelerators generally.

As much remains to be learned from future collaborative efforts at CesrTA, we strongly urge the continuation of this program, and look forward to continued participation as collaborators.

Sincerely,

Katsunobu Oide

Katsunobu Oide
Director, Accelerator Laboratory,
KEK

The Cockcroft Institute
Daresbury Science and Innovation Campus,
Daresbury, Warrington, WA4 4AD, United Kingdom
Telephone: +44 (0)1925 603820 Fax: +44 (0)1925 864303

30 September 2009

Prof. Maury Tigner
Director, CLASSE
Newman Laboratory
Cornell University
Ithaca, NY 14853-5001
USA

Dear Prof. Tigner,

Accelerator R&D at CesrTA

I would like to express my strong support for the continuation of the accelerator R&D program at CesrTA. As you know, at the time of the original proposal I was Area System Leader for the Damping Rings within the International Linear Collider Global Design Effort, and served also on the ILC Global R&D Board; it was clear that CesrTA offered a unique opportunity for accelerator studies that would not only address critical issues for the ILC damping rings, but would prove valuable for a range of future accelerator facilities. The achievements at CesrTA over the past couple of years have more than justified the support given to the facility, and there is every reason to believe that an extension of the program to 2013 will lead to many more important results.

As a faculty member in the Physics Department at the University of Liverpool, leading a small group in beam dynamics studies at the Cockcroft Institute, I have valued the opportunity to participate in the research program at CesrTA over the past few years. I have been impressed by the progress that has been made: first, in the reconfiguration of CESR to operate in the challenging, low-emittance parameter regime of linear collider damping rings; then, in the development and installation of advanced beam instrumentation to allow detailed measurements of beam behaviour over a wide range of conditions; and finally, in the systematic measurements and comparison with models of key dynamical effects. On the last point, I would cite in particular the studies of electron cloud build-up in the wigglers, using retarding field analysers. As recently as one or two years ago, there was still considerable discrepancy between experimental data and computer models of electron cloud build up, particularly in the strong magnetic fields of damping wigglers. However, after considerable effort by the collaboration centred on CesrTA, both measurements and models have been refined to the point where agreement between the two is starting to look convincing. It appears likely that in the very near future, we shall be able to claim the ability to predict, with confidence, levels of electron cloud that can be expected under a variety of conditions in the ILC damping rings. This represents considerable progress in our understanding of an effect that threatened to limit the performance of a number of future accelerators.

Of course, there remains a considerable amount of work to do. Interaction between the beam and the cloud is a complex effect with many subtleties that make the impact of electron cloud hard to predict, especially in the ultra-low emittance regime of linear collider damping rings. Great progress has been made at CesrTA with novel instrumentation for precision beam measurements, and this sets the necessary foundation for studies leading to a proper understanding of the interaction between the beam and the electron cloud. It has always been a concern that the compressed timescale of the CesrTA program would limit the opportunity to develop a proper understanding of key dynamical effects. An extension of the program would allow studies of sufficient rigour and completeness, for the development of reliable models for the prediction of electron cloud effects over a wide range of machine environments.

I would particularly wish to express my appreciation for the considerable efforts made by the team at CLASSE, for the inclusion and participation of researchers from around the world in the CesrTA program. I believe that this has done a great deal to strengthen links between a number of laboratories in the US, Asia and Europe, and there is no doubt that, if the CesrTA program can be extended, that the international collaboration will continue to strengthen, with lasting benefit for accelerator R&D worldwide.

CesrTA is a world-leading facility offering unique opportunities for accelerator research. The program has already made significant achievements, and there is every reason to believe that an extension of the program will allow further progress in important areas. At the Cockcroft Institute, our plans include continued participation in the CesrTA collaboration, especially in the area of low-emittance tuning and beam dynamics at ultra-low emittance; and I would like to express once again, my strong support for a continuation of this important program.

Yours sincerely,

A. Wolski

Andrzej Wolski

Lecturer in Accelerator Science,
University of Liverpool and the Cockcroft Institute.
Telephone: +44 (0)1925 603538
e-mail: andy.wolski@stfc.ac.uk

INTER-UNIVERSITY RESEARCH INSTITUTE CORPORATION
HIGH ENERGY ACCELERATOR RESEARCH ORGANIZATION

KEK

1 October 2009

Professor Maury Tigner
Cornell University, Floyd R. Newman Laboratory for Elementary-Particle Physics
Garden Avenue, Ithaca, NY 14853-5001 USA

Dear Prof. Tigner:

In addition to Prof. Oide's expression of intent, we the undersigned would also like to express our support for the continuation of the CesrTA project, and our interest in continuing to participate in R&D and machine studies there. Areas of interest are indicated with our names.

Sincerely,

Junji Urakawa, Leader, ATF and ATF2

Kazuhito Ohmi, Electron-cloud instability simulation and studies

Ken-ichi Kanazawa, Electron cloud density measurements and mitigation methods

Kiyoshi Kubo, Low-emittance tuning

Yusuke Suetsugu, Electron cloud density measurements and mitigation methods

Makoto Tobiyama, Beam instrumentation and bunch-by-bunch feedback

John W. Flanagan, X-ray beam size monitor and electron-cloud instability studies

Kyo Shibata, Electron-cloud density measurements and mitigation methods

CAL POLY

California Polytechnic State University
San Luis Obispo, CA 93407

Department of Physics
Dept: (805) 756-2448 • Fax: (805) 756-2435 • physics@calpoly.edu
Holtzapple: (805) 756-2602 • rholtzap@calpoly.edu

October 3, 2009

To Whom It May Concern:

I am writing to express my support and commitment for the Cornell Laboratory for Accelerator-based Sciences and Education to receive continued funding for the Cornell Electron-Positron Storage Ring Test Accelerator (CesrTA).

Since receiving my PhD from Stanford University in 1996, I have been associated with the Cornell Laboratory for Accelerator-based Sciences and Education (CLASSE) in three different capacities: first as a research associate at CLASSE; second as an Associate Professor of Physics at Alfred University; and third as an Associate Professor of Physics at Cal Poly. It has been my experience, in these three capacities, that the faculty and staff at CLASSE are outstanding in the field of accelerator physics.

In 2004, I was awarded a National Science Foundation CAREER grant entitled "Remote Operation of a Synchrotron Radiation Beam Dynamics Laboratory," which enables me to direct undergraduate research projects in accelerator physics, by remote operation of a beam dynamics laboratory, on CESR. This has allowed me to expose undergraduate students to accelerator physics research; an opportunity not available at most undergraduate institutions. Since 2004, over ten undergraduate students have worked on this project; three have written honors theses in accelerator physics. In addition, several conference papers have been published in conjunction with the accelerator physics research on CESR. This fall I plan to submit another research grant to continue to provide undergraduate students at Cal Poly the research opportunities available in beam physics at Cornell University.

My research interest is in accelerator beam diagnostics operated remotely at Cal Poly. Presently, I have been participating in the development of several devices capable of quantifying single bunch turn-by-turn beam dynamics in CesrTA. They are i) a photomultiplier-based device to measure the single bunch vertical beam size from vertically polarized light or an interferometer on a turn-by-turn basis, ii) a digital beam position monitor system capable of measuring the tunes for 4-ns spaced bunches, and iii) two visible synchrotron light transport lines which deliver synchrotron light to a streak camera capable of quantifying the longitudinal dynamics of 4-ns spaced bunches. These devices have been or are being installed in CesrTA to study beam dynamics, such as the electron cloud instability, that are important for the International Linear Collider damping ring.

Now that CesrTA is transitioning from an installation and commissioning phase to the measurement and analysis phase of beam physics I am excited about the beam physics research potential at CesrTA.

I am fully committed to continuing my participation on CESR-TA and I look forward to working with the faculty and staff at CLASSE on the CESR-TA.

Sincerely,

Robert L. Holtzapple
Associate Professor of Physics

Berkeley Lab

Accelerator & Fusion Research Division

September 25, 2009

To Whom It May Concern:

Re: NSF Proposal Supporting Development of Low-Frequency High-Gradient Superconducting RF Cavities for Muon Acceleration (Prof. Maury Tigner, PI)

We the undersigned, the Project Manager and Co-Spokespersons for the U.S. Neutrino Factory and Muon Collider Collaboration, NFMCC, hereby certify that the R&D program referred to above, which has been proposed to the National Science Foundation by Cornell University, is in accordance with the approved NFMCC R&D plan, and that the performers put forward in the proposal are highly qualified to carry out the proposed R&D activities.

The proposed work addresses a key aspect of the design of a muon-based facility—the development of low-frequency superconducting RF (SRF) cavities for the acceleration system. The acceleration system is the most expensive portion of the facility and its performance is critically important to the overall scientific capability of the accelerator complex. All present designs for a Muon Collider or muon-based Neutrino Factory assume the existence of suitable high-gradient SRF cavities for their performance. Cornell staff are world experts in the SRF field, and are uniquely qualified to carry out this development program.

The proposed program will fabricate and test several 500 MHz SRF cavities using explosion-bonded niobium on copper. If successful, the cost of fabricating such cavities will be markedly reduced, and their thermal stability will be markedly improved due to the properties of the copper backing. Moreover, the volume of increasingly expensive liquid helium needed to cool the cavity will be substantially reduced. All of these features are of great benefit to the entire SRF community. Finally, the ability to prepare a cavity that appears as "bulk" niobium on the inside with copper on the outside permits the use of relatively well understood niobium processing techniques, which should result in much better control of the quality factor.

Those activities, along with the rest of the NFMCC's R&D program, are reviewed annually by the Muon Technical Advisory Committee (MUTAC), which reports to the management of Brookhaven National Laboratory, Fermi National Accelerator Laboratory, and Lawrence Berkeley National Laboratory. Past MUTAC reviews indicate that the Cornell SRF R&D program has been very successful and should be strongly supported. We are confident that the R&D activities in this proposal will be of similar high quality and will be similarly successful. We strongly encourage NSF to fund this proposal, which plays an important role in the national R&D program aimed at developing a muon-based Neutrino Factory and/or a Muon Collider.

Michael S. Zisman	Alan Bross	Harold G. Kirk
Project Manager	Co-Spokesperson	Co-Spokesperson

Ernest Orlando Lawrence Berkeley National Laboratory
One Cyclotron Road | Berkeley, California 94720 | Tel: 510.486.5501 | Fax: 510.486.6003

Fermilab

Stephen D. Holmes
Director's Office

630.840.3988 (phone)
630.840.2900 (fax)
holmes@fnal.gov

October 6, 2009

Professor Maury Tigner
Laboratory for Elementary Particle Physics
Cornell University
Ithaca, NY 14850

Dear Professor Tigner,

This letter is written in support of your proposal seeking continuing funding support for the operations of the CESR Test Accelerator (CesrTA) through 2013. CesrTA provides a unique facility for the study of a variety of accelerator physics issues that are directly related to facilities of potential interest in the future of both U.S. High Energy Physics in general, and Fermilab in particular. It is fairly well known that the exploration of limitations in damping rings is of direct relevance to the ILC. What is less well known, but nonetheless true, is that the capabilities of CesrTA in terms of exploring multiple aspects of electron cloud effects is not only of great importance to ILC, but also to the development of high intensity proton facilities.

The facilities provided by CesrTA for e-cloud studies, including advanced instrumentation, control of bunch formats, and the ability to swap in vacuum tube test sections are unique. In recognition, Fermilab has been participating in the development of the experimental e-cloud program at CesrTA as part of our multi-MW Proton Facility (Project X) R&D program. Now that the ring is very well instrumented, we expect CesrTA to play a crucial role in advancing our understanding of the development and mitigation of e-cloud within the Project X facility. Continued operations over the next few years will allow us to successfully complete this program, with a strong impact on the design of Project X.

Cornell is a very strong collaborator with Fermilab, already on ILC and potentially on Project X. Continued operations of CesrTA is a critical element to the development of both these facilities.

Sincerely,

Stephen D. Holmes

Stephen D. Holmes
Associate Director for Accelerators
Fermi National Accelerator Laboratory