Application Materials For
Research Experience for Undergraduates/Summer 2006

A complete application for the EUV Center REU program consists of:

- A statement of purpose (guidelines below)
- A completed student information form
- A letter of recommendation (from a faculty member)
- Copy of official school transcripts (from all institutions attended)

Statement of Purpose
Describe (on 2-3 typed pages) your interest in the EUV Center REU program. Explain why you wish to participate in the program, what you hope to gain, and how this research experience will help you achieve your academic and career goals. Your statement should include a description of:

- Your specific research interests
- Any relevant research experience you have had in an academic or work setting
- Your goals beyond earning a baccalaureate degree
- A statement about how you would benefit both the program and its participants

Please note that the statement of purpose is one of the most important parts of your application. Successful applicants demonstrate a general understanding of research conducted at the Center and can express a particular interest in one or more particular areas of study. Please include your name on your statement of purpose.

Transcripts
Please submit a student copy of your transcripts with your application and have official transcripts from all institutions you attended sent directly to the EUV Center office.

Recommendation Letter
A faculty member familiar with your skills should write the recommendation form and send it directly to the EUV Center office. See link to recommendation form on EUV Center REU home page.

Application Deadline: March 17th, 2006. E-mail the completed student information form and statement of purpose to mcelaya@engr.colostate.edu. In addition, have your transcripts and recommendation letter sent to the following address:

Michael Celaya
University of Colorado
Campus Box 440
Boulder, CO 80309-0440

Fax: (303) 492-5235

Questions? Call (303)-492-2558 or write to mcelaya@engr.colostate.edu
Student Information Form

Name ____________________________________________________________________________

Last     First     Middle

Permanent Address
Street Address____________________________________________________________
City___________________________ State_____ Zip_____________________
Permanent Phone Number__________________________

Local Address
Street Address____________________________________________________________
City___________________________ State_____ Zip_____________________
Local Phone Number____________________________

E-mail______________________________________

U.S. Citizen_____   Permanent Resident_____   Not U.S. citizen______

Emergency Contact
Name________________________________________________
Phone Number____________________________________

NSF Diversity Reporting Information
The National Science Foundation requests such information simply to determine the diversity of students our program is attracting. It is strictly confidential and used only in aggregate form.

Gender   F____   M____
Are you disabled? Yes____   No____

Ethnicity:   Hispanic or Latino_____   Non-Hispanic or Latino____
Race:   Caucasian____   African American_____   Asian_____   Asian_____   Native American____   Pacific Islander_____   Other (please specify)___________________
I do not wish to provide this information____

College or University you attend
Institution____________________________________________________________
City___________________________ State_______
Major_________________________________ GPA________
Status: Senior_______________ Sophomore__________

Expected graduation date______________________________
Future Education Plans

Do you intend to apply to graduate school to pursue a higher degree in science or engineering?
_________________________________________________________________________________

If graduate school is **not** in your future plans, what type of careers are you considering?
_________________________________________________________________________________

Parent’s Education

Education of mother
Highest grade completed:  1  2  3  4  5  6  7  8  9  10  11  12  13  14  15  16
College degree earned, if any:  ☒ Bachelor’s  ☐ Master’s  ☐ Doctorate

Education of father
Highest grade completed:  1  2  3  4  5  6  7  8  9  10  11  12  13  14  15  16
College degree earned, if any:  ☐ Bachelor’s  ☒ Master’s  ☐ Doctorate

Previous participation in research programs
Have you previously participated in any program that offered a research experience?
If so, please provide the name of program(s)____________________________________________

Participation in Federally Funded Programs
Do you participate in any of the following programs (mark those with which you are affiliated)

- Louis Stokes Alliance for Minority Participation (LSAMP) _____
- Alliances for Graduate Education and the Professoriate (AGEP) _____
- Centers of Research Excellence in Science and Technology (CREST) ____
- Tribal Colleges and Universities Program (TCUP) ____

Research Project
Please indicate your first and second choices from the list below for the projects you wish to work on.

1st Choice ________________________________________________________________

2nd Choice ______________________________________________________________

I hereby certify to the best of my knowledge that the information furnished on this application is true and complete without evasion or misrepresentation. I understand that if found to be otherwise, it is sufficient cause for rejection or dismissal.

Signed (Applicant) ____________________________ Date ___________
Apply for any of the following projects

**Interferometry with EUV light.** One of the tasks of the Center is the development of interferometers that can be used with EUV light to make precision measurements of systems which are of interest for industrial as well as scientific purposes. At Colorado State University, the student will construct an interferometer using visible laser light from a helium-neon laser. Following this, the student will work in the development of an EUV interferometer.

**Development of multilayer mirrors using an ion beam sputtering system.** The development of new compact EUV lasers at the Center and their use in applications requires the use of a broad set of advanced optical coatings with high damage threshold. In this project at CSU, a student will design, fabricate and characterize multilayer coatings deposited using a state-of-the-art ion beam sputtering machine. The student will be able to install the finished product as a vital optical component in one of the lasers developed at the Center, and observe its performance as part of a system.

**Developing of high damage threshold thin films for high power laser systems.** Some of the EUV lasers that will be developed at the Center will require the use of high power optical laser beams generated through successive amplification stages, and high damage threshold mirror and lenses to redirect and focus them. At CSU, students will design high damage threshold coatings that will be used to construct, polarizers, antireflection coatings and high reflectivity mirrors. These structures will then be fabricated using ion beam sputtering and tested for uniformity and thickness. Students will also measure the performance of the coatings in term of reflectivity and damage threshold.

**Design, fabrication and testing of EUV multilayer optics.** A thrust of the EUV ERC is to develop a test bed for nanocluster spectroscopy based on the 46.9 nm source. The implementation of this system requires high reflectivity Si/Sc optics. In this project at CSU, students will design and fabricate high quality Si/Sc multilayers utilizing ion beam sputtering. To evaluate the interface quality, the student will carry out x-ray diffraction and x-ray photoelectron emission experiments. The reflectivity will be tested using the EUV lasers available at the Center.

**Imaging and focusing with an EUV laser.** The Center has successfully developed compact EUV lasers that generate large average powers of light at a wavelength of 46.9 nm. These compact lasers offer very good opportunities for the development of high resolution imaging systems as well as to study the properties of materials with focused EUV light. This requires the development of focusing and imaging systems using diffractive and reflective optics. At CSU, the student will work in the implementation and optimization of these systems. The systems will be subsequently tested using a compact EUV laser source.

**Optimization of femtosecond lasers:** Students will learn how to operate a continuous-wave laser, and how to align and operate a femtosecond Titanium-doped-sapphire laser at the University of Colorado-Boulder. Students will then do original research on generating broader bandwidths and, therefore, shorter pulses from these lasers.

**Project #1.** Students will use specially-designed, dispersion-controlled, optics to generate broader bandwidths from a Titanium-doped-sapphire laser. By carefully measuring and testing the dispersion of laser mirrors, an optimum set can be chosen for broadest bandwidth operation of the laser.

**Project #2.** Students will use commercial optical design programs to design dispersion-controlled optics to generate broader bandwidths from the laser. These programs will then be replaced with a more accurate code developed by the student. The student will work with local optics manufacturers to fabricate the optics, and then test the mirrors in a laser.

**Project #3.** Students will design and construct a femtosecond laser using a different laser crystal than usual. The laser will be constructed using Li:SAF instead of Ti:sapphire.

**Development of laser pulse shapers:** From fourier transforms we know that a short pulse in time must have a broad frequency spectrum to support it. Therefore, by sending the femtosecond laser pulse through a grating-lens combination, the different colors making up the short pulse can be separated spatially. Any device that can selectively change the path length for different colors of the laser pulse will then change the laser pulse shape when the various colors are reassembled.
by a second lens-grating pair. At CU-Boulder, students will have opportunities to participate in the following projects.

**Project #1.** Students will construct and test a deformable mirror based laser pulse shaper. The design will be based on accurate, piezo-driven, mirror deformations. The piezo-driven design has the potential to have more accurate adjustments and higher values of the deformation than alternate designs currently being tested in our laboratories.

**Project #2.** Students will set-up and use a liquid-crystal-based laser pulse shaper. By adjusting the voltage on the liquid crystal, different frequency components of the laser can be adjusted both in amplitude and phase to construct a wide variety of pulse shapes.

**Design and testing of EUV generation and focusing set-ups:**

One goal of our EUV ERC is to use bright, short wavelength light for high resolution imaging, and/or to achieve very small focused spot sizes for a variety of applications. Many of the required optical set-ups can be optimized and tested using visible light. At the University of California-Berkeley, students will investigate the following:

**Project #1.** In this project, a student will optimize the set-ups used to generate short-wavelength high harmonic light efficiently. The student will work in testing the throughput and use of tapered fibers, multi-state fibers, fabricating modulated fibers, etc. This project uses concepts from fiber optics, and involves detailed comparison of theory and experiment.

**Project #2.** A student will design and test various focus arrangements based on reflective optics to generate tightly-focused EUV light. The student will calculate the expected focused laser spot size for visible and EUV illumination, and then test the set-up using visible light. The student can then test the set-up using EUV light.

**Project #3.** In this project, a student will work on applications of coherent EUV/soft x-rays using the undulator radiation beamline at the Advanced Light Source in Berkeley.

**Project #4.** Students will work on the development of a multilayer mirror for use as an EUV/SXR radiation beam monitor, coating mirrors of appropriate material combinations using the sputtering facility at Lawrence Berkeley National Laboratory’s Center for X-Ray Optics. The mirror is to be used for measurements of beam size and power of undulator radiation just upstream of a spatial filter. Students will learn to measure mirror reflectivity using the Berkeley EUV/SXR Reflectometry and Standards beamline at the Advanced Light Source.

**Project #5.** Students will work on the preparation of biological samples for imaging at high spatial resolution in the Berkeley soft x-ray microscope. They will learn to operate the microscope and obtain images to 20 nm spatial resolution.