NSF ERC for EUV Science and Technology

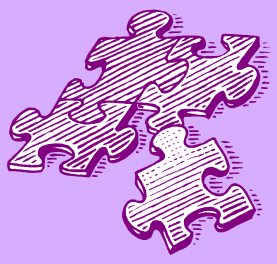
news from the EUV ERC

Volume 3 Issue 2 August, 2011

Sustainability Summit Planning for the Future

With two years to go on its 10-year ERC grant from the NSF, the Extreme Ultraviolet Engineering Research Center is building on its long range planning to insure that the important work of the Center continues past its graduation. Sustainability Planning brings stakeholders together from academia, state governments and, very importantly, industry to determine how the organization will build on the solid foundation begun by the NSF grant. The industry portion of that plan begins with the upcoming sustainability Summit. .

Meeting Goals The emerging work provides focus on two core areas.
First, how do we expand and deepen the collaborative engagements between industry and Center researchers? We will assess the various types of collaboration available, understand funding sources that we can jointly pursue and identify areas of mutual interest and benefit.



Second, what is the structure of the industry program after graduation? The team needs to examine the program's functions and benefits, determine what to keep, what to improve and what to add. Based on the outcome of that examination, we will establish the budget structure that will provide those benefits.

Based on the outcomes of these discussions, the meeting deliverables are to draft the industry portion of the overall Sustainability Plan, document a list of near term action items and deliverables and present the documented plan at the February IAB meeting for approval and inclusion in the NSF annual report.

Date and Location
This is an opportunity for the IAB to help set the future course of the Center and help determine the mutual benefit of industry and the Center working together. Participation in this summit meeting will insure success. The Center's Executive Committee recognizes the critical nature of IAB participation and, therefore, plans to hold this meeting on a date and at a location that is most convenient for the greatest number of IAB members. The Center will conduct a poll in the coming weeks to determine the final date and location.

Preparation
In order to begin the thought process and initiate strategic planning, members of the Center Executive Committee would like to schedule preliminary discussions with you and key decision makers within your companies. We will contact each IAB representative in the coming weeks in order to plan and schedule these discussions. Your support of this process will be greatly appreciated.

In this Issue

NSF Site Visit

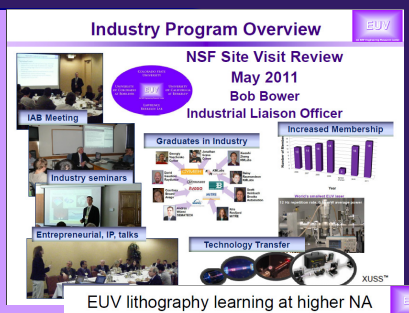
NSF EUV ERC 8th Year Site Visit
May 18th, 2011
University of California, Berkeley

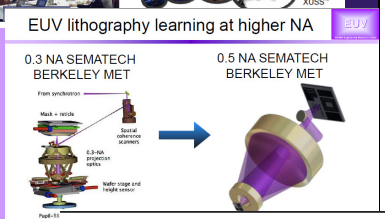
Industry support and attendance at this year's site visit contributed to making this event one of the best in the Center's history with 26 Industrial Advisory Board members and their guests joining the NSF review team, Principal Investigators, graduate students and Center staff. Attendees viewed presentations on

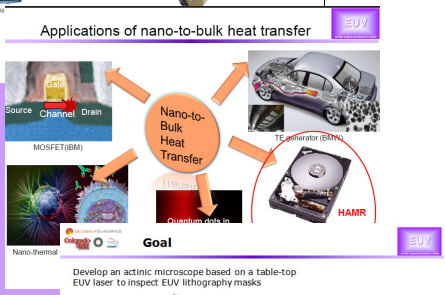
- Coherent High Harmonic sources
- Table-top EUV Sources
- Imaging, Patterning and Metrology
- Nanometer Resolution Imaging
- Nanoscale Materials Metrology
- Multilayer Reflective Optics
- Nanoscale Coherent Diffractive Imaging
- Education and Outreach Program Updates
- Industry Program Overview including presentations by three students collaborating on industry projects.

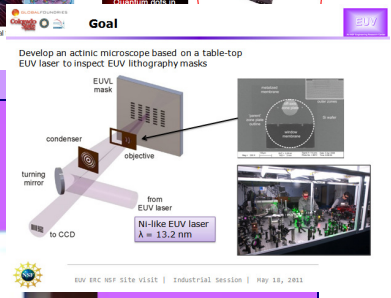
The meeting culminated with a student poster session and reception with approximately 30 students describing their research to attendees. The NSF review team was highly impressed by industry participation in this event. IAB support and input were key factors in making this year's review highly successful.

Thank you to the IAB from the EUV ERC Executive Committed, Principal Investigators, Post docs, students and staff!









EUV ERC Calendar

SPIE Optical Engineering Applications Conference

August 21-25

(see page 4 for details of events involving members of the EUV ERC)

Scheduled Talks

Dr. Steve Leone will be delivering the following talks

September 9, 2011 at the University of Maryland, Distinguished Lecture Series in the Department of Chemistry and Biochemistry, "Attosecond Electron Dynamics".

November 15, 2011 at the 13th edition of the Instrumental Analysis Conference in Barcelona, Spain, "Advanced Light Sources For Analytical Spectroscopy: From X-Rays to Attoseconds".

November 2011 (Date TBD) will give two lectures (titles are TBD) at Technion - Israel Institute of Technology, and will be the recipient of their Distinguished Schulich Lectureship Award.

Upcoming Events, Schedules To Be Determined

Sustainability Summit

The date and location of the summit will be dependent on feedback from the members of the Industrial Advisory Board with the goal of maximizing participation. (See page 1 for a meeting overview).

Annual Retreat

Each winter, before the start of classes, the Center gathers the Principal Investigators, students and Center staff in one location to review the year's accomplishments and set the stage for the coming year. The event occurs at the Tamasag Events Center in the foothills northwest of Fort Collins, Colorado. Additional topics include intellectual property and patent process overviews and an entrepreneurial presentation. The 2012 retreat is tentatively scheduled for the second week of January. Members of the Industrial Advisory Board and invited guests are welcome and encouraged to attend this event. This is an excellent opportunity to spend time with the researchers in an informal setting.

Industrial Advisory Board Meeting

This meeting will occur during the SPIE Advanced Lithography Meeting that will be held February 12 – 16, 2012 at the San Jose Convention Center. As was the case last year, the specific day and time will be determined by a poll of IAB members . In addition to research updates, this year's meeting will include a review of the Sustainability Plan.

If you have further interest in any of these topics, please contact Robert.Bower@colostate.edu

Publications and Presentations

Tuesday 23 August 10:20
Spectral width of seeded and ASE XUV lasers: experiment and numerical simulations, Annie Klisnick, Limin Meng, Univ. Paris-Sud 11 (France); David Alessi, Colorado State Univ. (United States); Olivier A. Guilbaud, Univ. Paris-Sud 11 (France); Yon Wang, Mark Berrill, Bradley M. Luther, Scott Domingue, Lukasz Urbanski, Colorado State Univ. (United States); Djamel Benredjem, Univ. Paris-Sud 11 (France); Annette Calisti, Univ. de Provence (France); Sebastien M. de Rossi, Denis Joyeux, Institut d'Optique Graduate School (France); Mario C. Marconi, Jorge J. Rocca, Colorado State Univ. (United States). . . . [8140-07]

Wednesday 24 August
Soft x-ray laser-ablation mass spectrometry depth profiling of compound semiconductor heterostructures, Paper 8140-44Author(s): Ilya Kuznetsov, Feng Dong, Jorge Filevich, Elliot R. Bernstein, Dean C. Crick, Michael McNeil, Colorado State Univ. (United States); Weilun Chao, Erik H. Anderson, Anne Sakdinawat, Yanwei Liu, David T. Attwood, Univ. of California, Berkeley (United States); Jorge J. Rocca, Carmen S. Menoni, Colorado State Univ. (United States)

Wednesday 24 August 8:30
Advances in high repetition rate table-top soft x-ray lasers ***(Invited Paper)*** 8140-19
Author(s): Jorge J. Rocca, Yong Wang, David Alessi, Bradley M. Luther, Brendan A. Reagan, Dale H. Martz, Alden H. Curtis, Keith Wernsing, Mark Berrill, Vyacheslav N. Shlyaptsev, Federico J. A. Furch, Colorado State Univ. (United States)

Thursday 25 August
8:30
Nano-scale imaging mass spectrometry of biological materials with soft x-ray lasers *(Invited Paper)*, Carmen S. Menoni, Jorge Filevich, Ilya Kuznetsov, Feng Dong, Elliot R. Bernstein, Dean C. Crick, Michael McNeil, Colorado State Univ. (United States); Anne Sakdinawat, Yanwei Liu, Univ. of California, Berkeley (United States); Weilun Chao, Erik H. Anderson, Lawrence Berkeley National Lab. (United States); David T. Attwood, Jr., Univ. of California, Berkeley (United States); Jorge J. Rocca, Colorado State Univ. (United States). . . . . [8140-28]
Table top nanopatterning by de-magnified Talbot Effect, Lukasz Urbanski, Colorado State Univ. (United States) and NSF Engineering Research Ctr. For Extreme Ultraviolet Science & Technology (United States); Przemyslaw W. Wachulak, Military Univ. of Technology (Poland); Artak Isoyan, Synopsys, Inc. (United States); Aaron G. Stein, Brookhaven National Lab. (United States); Carmen S. Menoni, Jorge Rocca, Mario C. Marconi, Colorado State Univ. (United States) and NSF Engineering Research Ctr. for Extreme Ultraviolet Science & Technology (United States) [8140-29]
Movies of nanoscale dynamics using soft x-ray laser illumination, Sergio Carbajo, Isela D. Howlett, Fernando Brizuela, Mario C. Marconi, Jorge J. Rocca, Carmen S. Menoni, Colorado State Univ. (United States); Weilun Chao, Erik H. Anderson, Lawrence Berkeley National Lab. (United States); Anne Sakdinawat, Yanwei Liu, David T. Attwood, Univ. of California, Berkeley (United States); Alexander V. Vinogradov, Igor A. Artioukov, P.N. Lebedev Physical Institute (Russian Federation) [8140-30]
10:50
Line width measurement of a capillary discharge soft x-ray laser, Mario C. Marconi, Lukasz Urbanski, Colorado State Univ. (United States) and NSF Engineering Research Ctr. for Extreme Ultraviolet Science & Technology (United States); Limin Meng, Univ. Paris-Sud 11 (France); Mark Berril, Colorado State Univ. (United States) and NSF Engineering Research Ctr. for Extreme Ultraviolet Science & Technology (United States); Olivier Guilbaud, Univ. Paris-Sud 11 (France); Jorge J. Rocca, Colorado State Univ. (United States) and NSF Engineering Research Ctr. for Extreme Ultraviolet Science & Technology (United States); Annie Klisnick, Univ. Paris-Sud 11 (France) [8140-34]

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Publications and Presentations

Temporal coherence and spectral linewidth of an injection-seeded transient collisional soft x-ray laser. Meng LM, Alessi D, Guilbaud O, Wang Y, Berrill M, Luther BM, Domingue SR, Martz DH, Joyeux D, De Rossi S, Rocca JJ, Klisnick A., 2011 Jun 20;19(13):12087-92. doi: 10.1364/OE.19.012087.

Demonstration of a compact 100 Hz, 0.1 J, diode-pumped picosecond laser, A. H. Curtis, B. A. Reagan, K. A. Wernsing, F. J. Furch, B. M. Luther, and J. J. Rocca, "Demonstration of a compact 100 Hz, 0.1 J, diode-pumped picosecond laser," Opt. Lett. **36**, 2164-2166 (2011)

Submicrometer spatial resolution EUV-laser ablation mass spectrometry imaging-Jorge Filevich[1,2], Ilya Kuznetsov[1,2], Feng Dong[1,3], Bryce Schroeder[1,4], Elliot Bernstein[1,3], Dean Crick[4], Michael McNeil[4], Anne Sakdinawat[1,6], Yanwei Liu[1,6], David T. Attwood[1,6], Jorge J. Rocca[1,2] and Carmen Menoni, 2011American Society of Mass Spectrometry: 59th Conference on Mass Spectrometry and Allied Topics

Demonstration of a compact 100 Hz, 0.1 J, diode-pumped picosecond laser, A. H. Curtis, B. A. Reagan, K. A. Wernsing, F. J. Furch, B. M. Luther, and J. J. Rocca, "Demonstration of a compact 100 Hz, 0.1 J, diode-pumped picosecond laser," Opt. Lett. **36**, 2164-2166 (2011)

Young-type Interferences in Photoionization of Dissociating H+2 Molecule, A. Pic´on, A. Bahabad, H.C. Kapteyn, M.M. Murnane, and A. Becker, Physical Review A **83**, 013414 (2011).

Laser Enabled Auger Decay in Rare Gas Atoms, P. Ranitovic, X. M. Tong, C. W. Hogle, X. Zhou, N. Toshima, M. M. Murnane and H. C. Kapteyn, Physical Review Letters **106**, 053002 (2011).

Collapse of long-range charge order tracked by time-resolved photoemission at high momenta, Timm Rohwer, Stefan Hellmann, MartinWiesenmayer, Christian Sohrt, Ankatrin Stange, Bartosz Slomski, Adra Carr, Yanwei Liu, Luis Miaja Avila, Matthias Kalla¨ne, Stefan Mathias, Lutz Kipp, Kai Rossnagel, Michael Bauer, Nature **471**, 490 (2011)

Photonics Spectra, May 2011 article, ***Imaging in the Ultrafast Lane***, article about the work being done by a team led by professors Henry Kapteyn and Margaret Murnane. See **http://www.photonics.com/Article.aspx?AID=46861**

Laser Enabled Sub-Shell Auger Decay of Rare Gas Atoms, X. M. Tong, C. Hogle, P. Ranitovic, M. M. Murnane, H. C. Kapteyn and N. Toshima, to be published in Physical Review A (2011).

Manipulating Nonlinear Optical Processes with Accelerating Light Beams, Alon Bahabad, Margaret. M. Murnane and Henry C. Kapteyn, to be published in PRA (2011).

Controlling the XUV Transparency of Helium using Two Pathway Quantum Interference, P. Ranitovic, X. M. Tong, C. W. Hogle, X. Zhou, Y. Liu, N. Toshima, M. M. Murnane, and H. C. Kapteyn, Physical Review Letters **106**, 193008 (2011).

90-GW Peak-Power Few-Cycle Mid-IR Pulses from an Optical Parametric Amplifier, G. Andriukaitis, T. Bal_i_nas, S. Ali_auskas, A. Pug_lys, A. Baltu_ka, T. Popmintchev, M.-C. Chen, M.M. Murnane, H.C. Kapteyn, Optics Letters 36, 2755 (2011).

Extreme Ultraviolet Photoionization of Aldoses and Ketoses, J. -W. Shin, F. Dong, M. E. Grisham, J. J. Rocca, and E. R. Bernstein, Chem. Phys. Lett. 506, 161 (2011)

Experimental and Theoretical Studies of Neutral $Mg_mC_nH_x$ and $Be_mC_nH_x$ Clusters, F. Dong, Y. Xie, and E. R. Bernstein, J. Chem. Phys. 135, 054307 (2011)

Summer Programs

Since 2003, almost 200 undergraduates have contributed to the EUV ERC's research through the Research Experience for Undergraduates (REU) program. As was the case in previous years, this summer, students from schools throughout the U.S. participated in a 10-week program at Center lab facilities. In addition to college students, several gifted high school students participated in this year's program. Center faculty and graduate students worked closely with these students providing a strong and focused undergraduate research and networking experience in EUV science. In a similar program, middle school teachers from Colorado and California participated in the Center's Research Experience for Teachers (RET) program. In addition to work in the labs, the students attend lectures presented by Principal Investigators from the Center. At the end of the 10 week period, both students and teachers delivered presentations describing the work done. These presentations were supported through web conferencing software so that participants from all three campuses could share in the experience.

The REU and RET programs are committed to attracting, developing, and training a new generation of engineers and scientists in the theory and practice of EUV science as well as in the art of interdisciplinary collaboration so that the important breakthroughs that are necessary for the advancement of the field can be made. The projects are designed to expediently familiarize the interns with concepts in optics, lasers, advanced light sources, and EUV technology. This program is an important tool in providing the future workforce necessary for the success of our industry partners.

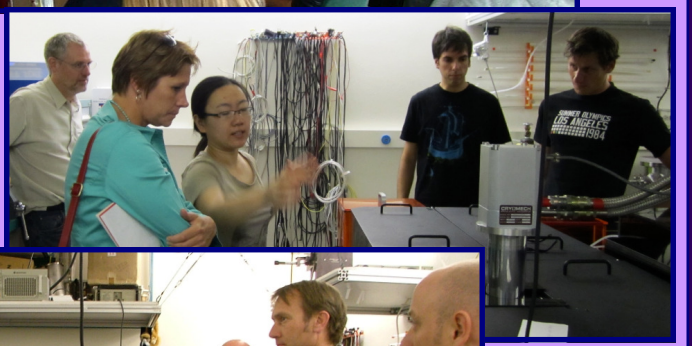
REU and RET participants with Center Researchers

Industry at the Center

Todd Jaeger of CVI Melles Griot deliverd a Student Leadership Council Industry seminar discussing his career path and the variety of industry options our graduates will face after graduation.

Lab Tours

Our IAB members are welcome at the Center for Tours of EUV ERC facilities and opportunities to meet with Principal Investigators and students to discuss ongoing research in EUV science and technology.



Lynore Abbott (Center), Marketing Director at CVI Melles Griot, recently toured labs in Boulder and Fort Collins.
(Right) Todd Jaeger and Wayne Stoner of CVI Melles Griot joined RET Program members for a tour of the Boulder labs.

Honors and Awards

OSA Advancing the Science and Technology of Light

Nonlinear Optics Meeting, Kauai, July 2011, Plenary Talk
Nonlinear Optics at the Timescale of the Electron - Ultra Broadband Coherent X-Rays and Applications, Margaret Murnane, *JILA, Univ. of Colorado, USA*

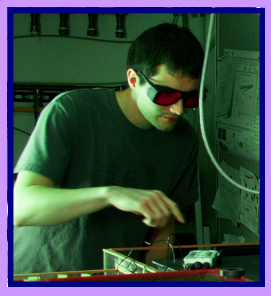
XXVII ICPEAC BELFAST 2011

XXVII International Conference on Photonic, Electronic and Atomic Collisions
27 July - 2 August 2011, Belfast, Northern Ireland, UK
Plenary Speaker, Margaret Murnane, Ultrafast Processes in Atomic Dynamics

NSF Graduate Research Fellowship awarded to Dennis Gardner
Research field: Optics and Optoelectronics
developing coherent x-ray microscopes for 3D imaging of biological samples

Piotr Matyba received a Postdoctoral Fellowship awarded by the Swedish Research Council. Award Proposal Title: Time- and Angle-Resolved Photoemission Spectroscopy of Electron and Molecular Dynamics at Surfaces Using High Harmonic Beams. Piotr is a member of the KM Group at the University of Colorado, Boulder

Graduating, Seeking a Position in Industry



Paul Arpin joined the NSF Center in 2007 after receiving a B. S. in Physics from Harvey Mudd College and is completing his Ph.D. in Physics at the University of Colorado. His research has focused on the development and characterization of high harmonic generation as a source of bright, coherent radiation in the 2 – 4 nm region of the spectrum. Paul has worked to develop this source for applications in imaging and spectroscopy. He has gained broad experience working with and designing optical systems and lasers. Paul will complete his Ph.D. in December 2011 and is interested in pursuing a career in industry involving laser systems and optics.

Center Graduate Seeking a Position in Industry

Jorge Filevich received his Ph.D. from the Center in 2007 and has continued working in the center leading two different projects as a Post Doc. Jorge is now interested in working in industry in the Portland, Oregon area. His work at the center spanned laser and discharge plasma generation, plasma electron density measurements, plasma spectroscopy, and EUV laser nano-ablation for bio imaging with mass spectrometry among others. Through his work at the Center, Jorge has gained experience in the design, construction, trouble shooting and conduction of experiments. He is skilled in data analysis, interpretation of results and reporting. Other experience includes optical system design in particular interferometers, laser focus, imaging systems, spectrometers, vacuum systems and mass spectrometers, with both visible and EUV light. Jorge is a highly organized multi-tasker and problem-solver who is comfortable working in collaboration within groups and with other groups throughout organizations.

The Extreme Ultraviolet (EUV) Engineering Research Center is one of 15 centers established in the United States through the National Science Foundation and supplemented by industry funding. Colorado State University (CSU) is the host institution with partner sites at the University of Colorado (CU), UC Berkeley and Lawrence Berkeley National Laboratory. The Center research mission is the development of compact coherent EUV sources and EUV-engineered systems that provide solutions to challenging scientific and industrial problems, including the development of new tools for nanotechnology and nanoscience. The Center has an important educational mission providing a unique environment for the training of students, young engineers and scientists. An Industry Advisory Board (IAB) with members, ranging from large- to small- capitalized companies, spanning instrumentation, semiconductor, lasers and optics, nanotechnology and the biological and chemical sciences actively participate in early access to technologies, joint research projects, directed research projects and the hiring of the some of the best students in the world in these areas.

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