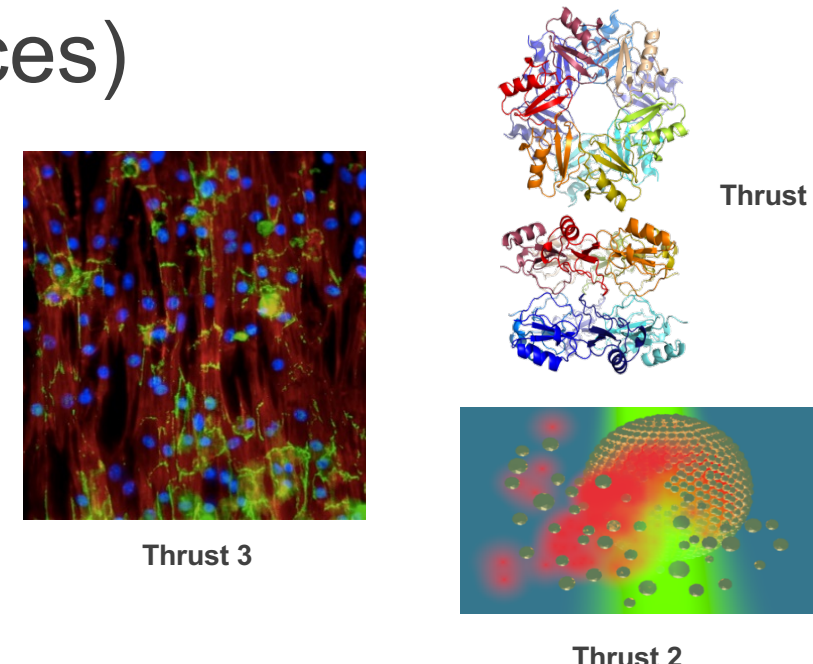


Research

Chemistry, physics, biology, and engineering fields—to study **how biological matter assembles to perform specific tasks**, in hopes of eventually being able to **engineer and develop innovations** (from designer cells and tissue to novel diagnostic and therapeutic devices)

Significance

- Nobel Prize, 2016—molecular machines
- Multi-scale biomolecular and cellular assemblies
- Control over Biological Systems and Designs
- Aligned with Strategic Academic Focusing Initiative



Thrust 1: Biomolecular Machines

Proteins are true cellular nanomachines that perform sophisticated biological functions by self-assembling into dynamic 3D structures that use thermal energy to change shape in response to specific stimuli. Amid their many functions, proteins make for excellent nanoscale instruments.

Circadian Molecular Clocks | Analogic Single-Molecule Biosensors

Victor Muñoz (lead), Michael Colvin, Ariel Escobar, Andy LiWang, Jing Xu

Thrust 2: Macromolecular Assemblies and Hybrid Devices

The high rate of discovery in nanotechnology is permitting us to realize nanomaterials with interesting new properties that can be used for building hybrid devices in conjunction with biomolecules. Here we focus on several of these applications.

Designer Vesicles for Transport | DNA Origami-Nanocomposites Graphene-based Biosensors

Ajay Gopinathan (lead), Wei-Chun Chin, Anand Gadre, Sayantani Ghosh, Linda Hirst, Anand Bala Subramanian, Lin Tian, Vincent Tung, Jing Xu, Tao Ye

Thrust 3: Cellular and Multicellular Systems

Large scale assemblies composed of multiple cells are ubiquitous, ranging from tissue to biofilms, and exhibit striking emergent behaviors controlled by cell mechanics and cell-cell interactions.

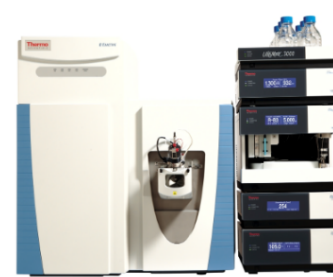
Differentiating Tissue | Bacterial Community Motility

Kara McCloskey (lead), Ajay Gopinathan, Jennifer Lu, Bin Liu, Arvind Gopinath

Increasing Research Capacity at UC Merced:

Fall 2016: Purchase of **Q Exactive Hybrid-Quadrupole-Orbitrap LC-MS/MS** (Mass Spectrometry for macromolecular CCBM research)

Spring 2018: Purchase of computational science equipment for collaborative research



Bringing together physical and engineering approaches to understand biological machines and design and develop new functional machines:

Research Challenge: Understand

We are interested in investigating hierarchical assemblies of molecular, cellular and multicellular structures seeking to 1) understand how they perform remarkably robust functions in their highly noisy natural environments & 2) exhibit emergent properties unanticipated from just the sum of the components

Technological Goals: Exploit

1) Attain control of multi-scale biological assemblies potentially leading to therapeutic improvements in human health & 2) Implement design principles for building bio-inspired materials and machines

CCBM Leadership and Staff

Left to Right:
Drs. Ajay Gopinathan, Sayantani Ghosh, Kara McCloskey, Victor Muñoz
CCBM Executive Committee



Dr. David Quint
CCBM Project Scientist

Carrie Kouadio
CCBM Executive Director

Dr. Mourad Sadqi
CCBM Project Scientist

Nora M. Cole
CCBM Programs Manager

Communications

- Social media/web
- External Advisory Board
- UC Merced articles and local media
- UC Merced events and meetings

<http://ccbm.ucmerced.edu/>



Education

CCBM aims to:

- Increase pipeline for **highly qualified STEM workforce**
- Produce **high caliber, diverse trainees** at all levels
- **Spur growth** in California Central Valley



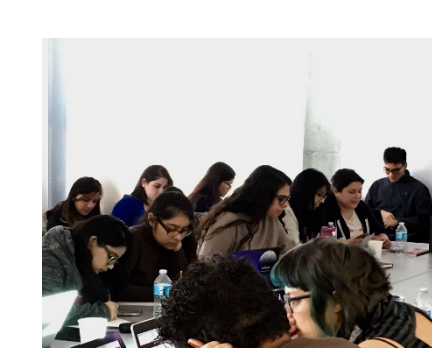
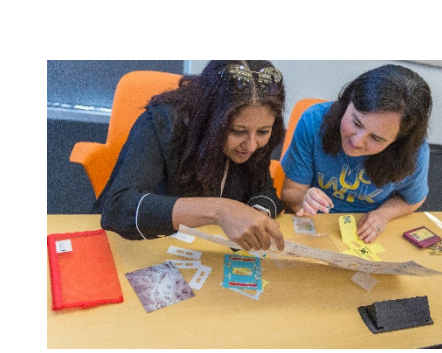
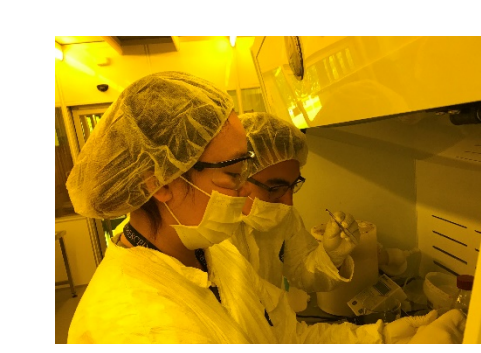
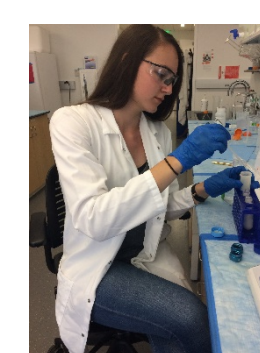
Thrust Meeting and Research Meeting, 2017

CCBM Fellows & Scholars

Our fully funded CCBM fellows are co-advised by two separate faculty mentors – promoting an interdisciplinary research agenda led by the graduate student. We have 6 fellows in Spring 2018, and will continue to increase these numbers until we have approximately 8-10 CCBM fellows a year. Each student also works leading a team with undergraduate students (both supported by CCBM & others), thus getting an opportunity to develop mentoring & supervision skills. Fellows and scholars have access to summer modules, thrust meetings, center activities, travel funds, special speakers, I-CORPS Site (opportunities to commercialize research), & more.



As stated by one 2017 STEP participant: "...my research experience has undoubtedly cemented my interest in the sciences and has enabled me to develop a more profound understanding of and respect for research."



Broadening Participation/Outreach

In all center programs and activities, we seek to increase the representation of women, underrepresented groups and students with disabilities, as well as others who are traditionally underrepresented in STEM fields.

STEP Science and Technology Enrichment Program for high school students: hands-on research in faculty labs for multiple weeks during summer & 3-day orientation with hands-on activities, trainings, lectures, & discussions, with prof. development, sharing research at CCBM Open House.

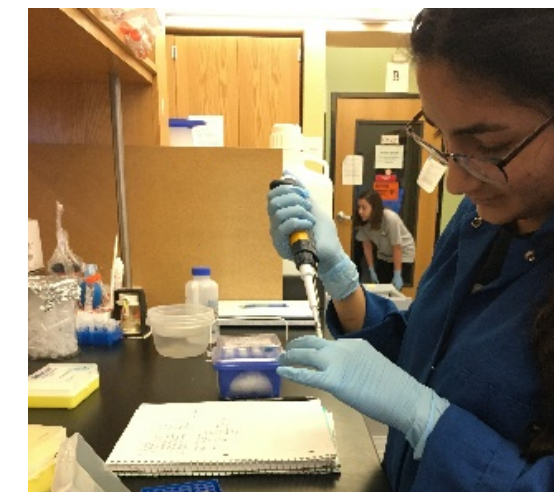
C-SIP CCBM Summer Internship Program brings external undergraduate students to UC Merced for 9 weeks (housed on campus), who are mentored in research, obtain professional development & networking opportunities, & are trained in hands-on cutting edge research instrumentation.

CREST Scholars UC Merced undergraduates engage in 10 hrs/week research during academic year in center faculty labs & participate in grad school prep workshops, presenting at end of academic year. Priority placement at partner institutions for summer internship opportunities.

Open House First CCBM Open House held on 9/22/17. Dr. Manu Prakash (Stanford University Bioengineer, 2016 MacArthur Genius Award recipient) gave memorable keynote lecture to attendees. Also, lab tours, poster session and judging, hands-on STEM demonstrations & awards reception.

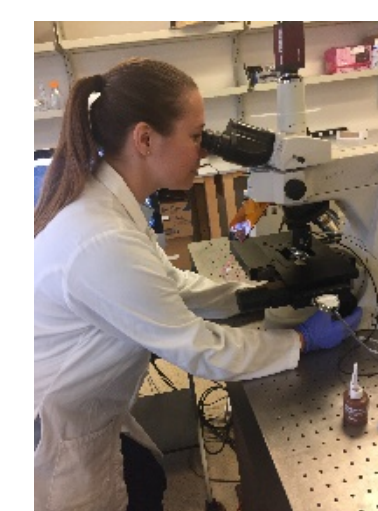
K-12 Outreach Science Day at CSU Stanislaus, Feb. 2017; CREST-led STEM Outreach Day, Apr. 2017; Lab tours/campus visits, Apr. 2017; Bobcat Summer STEM Academy, Jul. 2017; ACS SEED Symposium, Aug. 2017; UC Merced Homecoming, Oct. 2017

Synergy with STEM Resource Center, American Chemical Society (ACS) Summer Research Program, STEM summer camps for middle & high school students including Merced Nanomaterials Center for Energy and Sensing (MACES) & Bobcat STEM Academy, CalTeach/Science and Math Initiative: summer workshops for teachers & minor offered in Natural Sci Education, Central Valley Teacher Prep Partnership (CVTPP), Extension Education Programs (expanding UC Merced educational initiatives/developing Teacher Preparation Program)



Future Plans

- Refining programs at all levels based on evaluation results
- Exploring additional resources, collaborations, funding and partnerships
- Bringing activities under organized research unit eventually
- Expanding/creating further opportunities: K-12 students & teachers

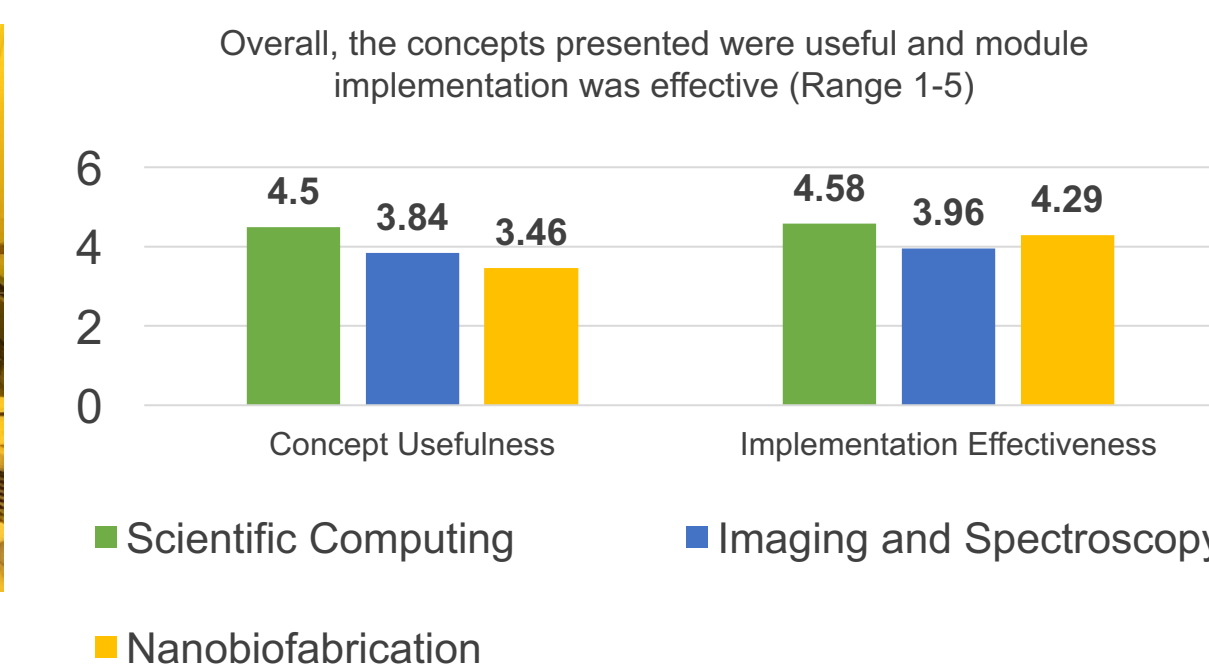


Courses The CCBM offers a training program in Interdisciplinary Biophysical Sciences, Biomaterials and Biotechnology (IB3) where graduate students enjoy a broadly interdepartmental curriculum. These specialized courses are offered via videoconferencing with the BMSE program at our institutional partner UCSB. We are exploring other options for courses.

Summer Modules: 2-week Intensive Training Modules on NanoBio Fabrication, Imaging and Spectroscopy and Computation and Modeling led by center faculty and project scientists. These modules will be offered as courses starting in summer 2018.



Computation/Modeling & NanoBiofabrication Summer Modules, Summer 2017



Evaluation

The external evaluation utilizes **Values-Engaged, Educative (VEE) evaluation approach** (Boyce, 2017; Greene, Boyce, & Ahn, 2011). The VEE approach, developed with NSF-EHR support, defines high quality STEM educational programming as that which effectively incorporates cutting edge scientific content, strong instructional pedagogy, and sensitivity to diversity and equity issues.

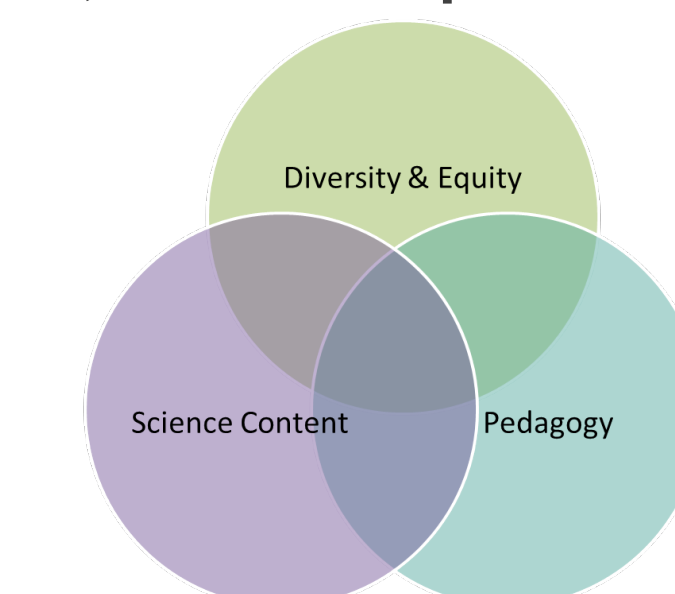
The evaluation is guided by questions about Program Theory, Implementation, Effectiveness, Diversity, Outcomes, and Sustainability.

Indicators include, linkages between resources, activities, outputs, & outcomes, themes across stakeholders, fidelity of implementation, participant/PI satisfaction, number & type of activities offered, participant mastery of STEM concepts, participant attitudes, motivation, & self-efficacy about STEM, presentations/publications, scientific communications skills, trainee demographics & achievement information, curricular changes, etc.

Data collection includes existing program data & documents, multiple surveys of all participants, pre/post assessments of participant knowledge, selected observations of center activities, a logic model completed with program leadership, & interviews and focus groups with CREST CCBM leadership and participants.

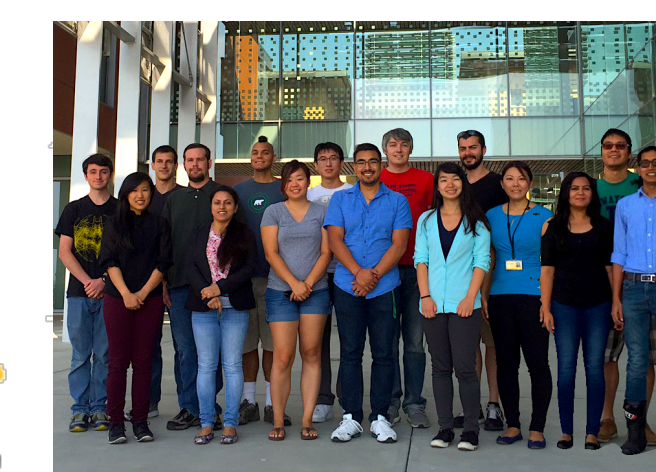
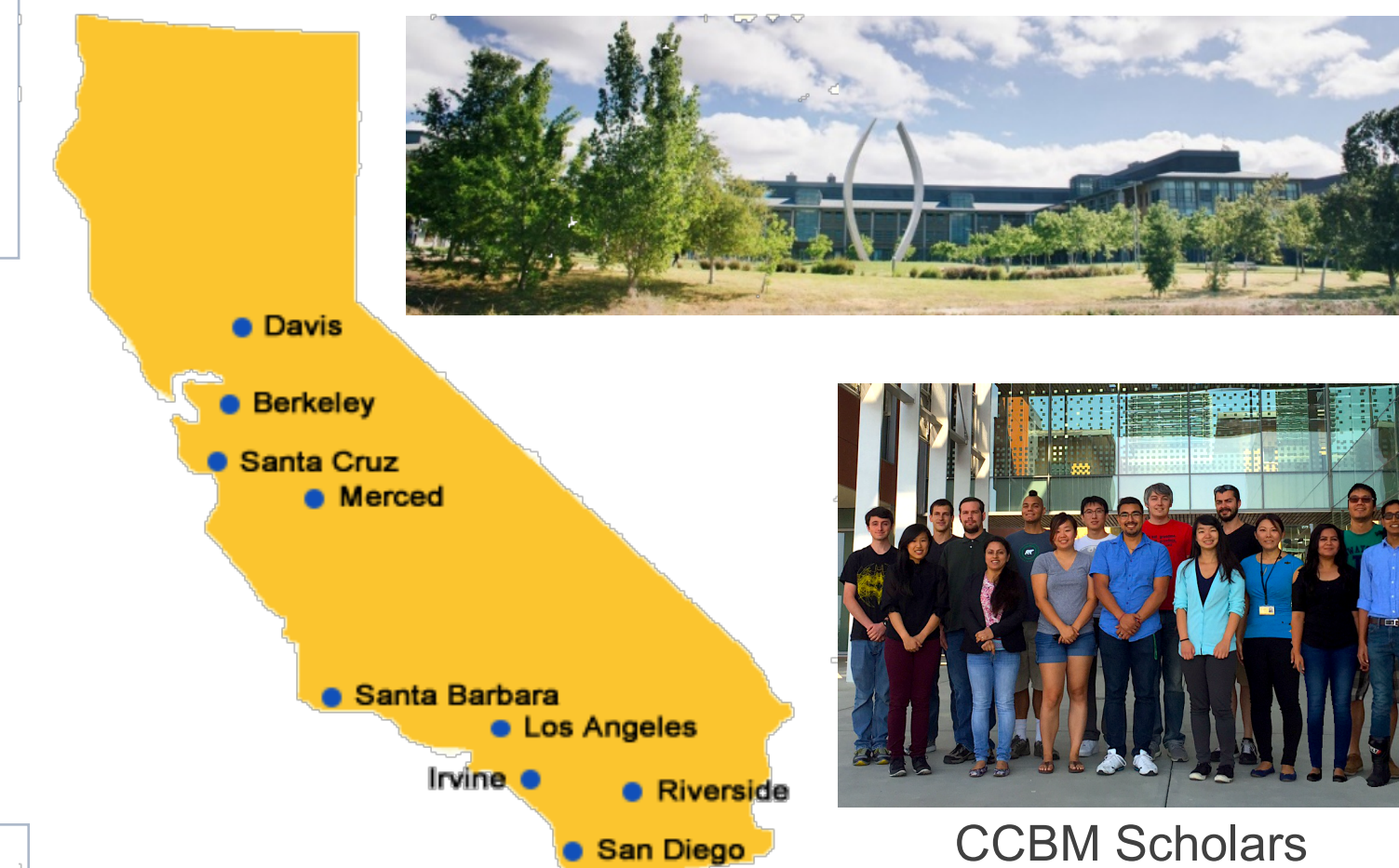
Selected Findings: Center program organization, structure, and communication is generally well-received by participants. Overall, Center programming is well-organized, fulfilled expectations, and valuable to participants.

CCBM External Evaluator
Dr. Ayesha Boyce
University of North Carolina, Greensboro



University of California, Merced

UC Merced opened 9/5/05, as the newest campus in the University of California system & the first American research university of the 21st century. Situated near Yosemite National Park, the campus significantly expands access to the UC system for students throughout the state, with a special mission to increase college-going rates among students in the San Joaquin Valley. It also serves as a major base of advanced research, a model of sustainable design and construction, & a stimulus to economic growth & diversification throughout the region; the Horizon 2020 Project is a \$1.3 billion effort currently in progress to duplicate campus size and number of faculty. As of Fall 2017, UC Merced has nearly 8,000 undergraduate and graduate students making up the Bobcat community. The San Joaquin Valley region of the Central California is an underserved region with a relatively young population, low economic indicators, a high school dropout rate double the national average, a severe teacher shortage, & one of the fastest growing & most diverse population cohorts in the state.



CCBM Scholars

NSF CREST

"The Centers of Research Excellence in Science and Technology (CREST) program [at the National Science Foundation] provides support to enhance the research capabilities of minority-serving institutions (MSI) through the establishment of centers that effectively integrate education and research. MSIs of higher education denote institutions that have undergraduate enrollments of 50% or more (based on total student enrollment) of members of minority groups underrepresented among those holding advanced degrees in science and engineering fields: African Americans, Alaska Natives, American Indians, Hispanic Americans, Native Hawaiians, and Native Pacific Islanders. CREST promotes the development of new knowledge, enhancements of the research productivity of individual faculty, and an expanded presence of students historically underrepresented in science, technology, engineering, and mathematics (STEM) disciplines." https://www.nsf.gov/funding/pgm_summ.jsp?psims_id=6668

Acknowledgements

This work was supported by funding from the National Science Foundation: NSF-CREST: Center for Cellular and Biomolecular Machines (CCBM) at the University of California, Merced: NSF-HRD-1547848

We would like to thank the following for their ongoing support: Dr. Tom Peterson, Provost and Executive Vice Chancellor, UC Merced. Dr. Sam Traina, Vice Chancellor for Research and Economic Development, UC Merced. Dr. Marjorie Zatz, Dean, Graduate Division, UC Merced. Dr. Betsy Dumont, Dean, School of Natural Sciences, UC Merced. Dr. Mark Matsumoto, Dean, School of Engineering, UC Merced. Center faculty, project scientists, staff, graduate students, and undergraduate students at UC Merced. Dr. Eva Nogales (UC Berkeley), Dr. Kent Carey (Keysight Technologies, Inc.), Dr. Daniel Cox (UC Davis), Dr. Angel Garcia (Los Alamos National Lab), Dr. Martin Gruebele (University of Illinois), External Advisory Board Members. Dr. Philip Pincus, UCSB, Steering Committee. Dr. Ayesha Boyce, Univ. of North Carolina at Greensboro, External Evaluator. Staff in the Schools of Engineering and Natural Sciences. Dr. Lynn Reimer, Director of Education Programs, UC Merced Extension. And other UC Merced and community affiliates.

