Dear Friends of CBB,

Recent months have been exciting ones at CBB. First, NSF has selected CBB for a second 5-year award for 2021 - 2026, allowing us to further advance our research and education. This marvelous outcome recognizes CBB’s strong record of accomplishment in its first four years and its promise for the future. Go Beam Team!

To learn more about our research plan, see the graphic on page 6 of this Newsletter.

In another development, CBB is pleased to welcome SLAC as a new member. SLAC brings exceptional expertise and capabilities and we look forward to close collaboration. CBB also welcomes Professor Sandra Biedron of the University of New Mexico, the leader of a major initiative at Brookhaven National Lab in ultrafast electron diffraction.

Last but not least, CBB has launched a new mentoring initiative for its grad students and postdocs. Under the plan, which was inspired by a student suggestion, each of their research projects is assigned two co-mentors with relevant interdisciplinary expertise. This initiative strengthens our mentorship, builds communication across the center, and offers affiliates an important new opportunity to contribute. Above all, the new program recognizes that close collaboration is the spark for CBB’s greatest successes.

Stay well,

J. Ritchie Patterson
Director of the Center for Bright Beams

CBB Chicago students picnicking at a safe distance.

CBB is the only center in the world that brings together an interdisciplinary team to address critical challenges in accelerator science.

It is a synergistic complement to ongoing related activities at DOE multipurpose and accelerator labs. CBB’s knowledge generation and workforce development in concert with the development and implementation efforts at the national labs provide a winning strategy for ensuring continued U.S. leadership in this critical area of science and technology.

In This Issue

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Research Highlights

Learn More About Research Applications and Relation to CBB Goals at cbb.cornell.edu

**Optical Stochastic Cooling with an Arc-Bypass in CESR**

Advanced beam cooling techniques are being developed to address the challenge of luminosity degradation that occurs during a beam store in high brightness hadron and heavy-ion colliders. This paper explores a proposed test of a collider bypass design for one such technique — Optical Stochastic Cooling — in the Cornell Electron Storage Ring (CESR). Exploring methods of beam cooling with OSC to improve brightness in next generation particle colliders is a thrust of CBB and this paper is a good step forward towards our goal of demonstrating high-gain OSC in CESR.

**Ab Initio Many-body Photoemission Theory of Transverse Energy Distribution of Photoelectrons: PbTe(111) as a Case Study with Experimental Comparisons**
M. B. Andorf, V. A. Lebedev, and P. Piot

Previous works predict that the (111) surface of PbTe is capable of producing high-brightness photoelectron beam with very low mean transverse energy (MTE) ≤ 15 meV, but experiments show otherwise. We develop a new ab initio many-body photoemission theory to calculate the MTE of photoemitted electrons. Our results show that excited bulk electronic states and coherent electron-photon-phonon scattering, both of which the previous works ignore, play significant roles in photoemission from PbTe(111). Our work improves the understanding of fundamental processes governing photoemission and thus will help searching for next-generation high brightness photocathode materials (MTEs ≤ 10 meV).

**Ab Initio Theory of the Impact from Grain Boundaries and Substitutional Defects on Superconducting Nb₃Sn**
M. M. Kelley, N. S. Stolovitch, and T. A. Arias

Nb₃Sn offers the potential to significantly advance superconducting radio frequency (SRF) technology by improving the efficiency of accelerating cavities, but preserving the material’s performance requires special attention to its microstructural properties. This study provides the first ab initio investigation to predict the impact of grain boundaries on the superconducting performance of Nb₃Sn. The results of this study will inform CBB experimentalists on how to adjust cavity baking recipes to optimize Nb₃Sn performance.

**Grain-Boundary Structure and Segregation in Nb₃Sn Coatings on Nb for High-Performance Superconducting Radiofrequency Cavity Applications**

In this study we looked at Nb₃Sn grain boundaries made by Fermilab and by Cornell. We found that grain boundaries in samples from cavities that performed well have no compositional inhomogeneities within uncertainty. On the other hand, grain boundaries in samples from cavities with some performance degradation showed a small excess tin at the grain boundaries. Additional studies are planned to investigate if the excess tin could be a cause for the degradation. We also showed that this excess tin could be avoided by modification of the coating parameters.

**The Exit-Wave Power-Cepstrum Transform for Scanning Nanobeam Electron Diffraction: Robust Strain Mapping at Subnanometer Resolution and Subpicometer Precision**
E. Paletti, M. E. Holtz, P. Cueva, T. I. Man, L. Langenberg, D. G. Schlom, and D. A. Muller

Here, we present the EWPC (exit-wave power cepstrum) transform approach for robust strain mapping at sub-nm resolution and sub-pm precision. EWPC decouples the strain information from crystal mistilts and thickness variation artifacts. It provides a mapping to a good basis for performing machine learning of structure-property relationships, without being dominated by imaging artifacts that have plagued previous approaches. This project enhances the CBB’s capabilities for the SRF thrust, especially for studying the polycrystalline Nb₃Sn coatings used in the superconducting RF cavities. The EWPC method provides a robust way to study the local strain distribution in polycrystalline Nb₃Sn coatings, providing materials insights into designing better SRF cavities.
Welcome New CBB Members

We are delighted to welcome a number of new and returning members to CBB.

Learn more about our research projects on our CBB Research web pages by clicking on each theme. Themes: Beam Production (PHC), Beam Acceleration (SRF), and Beam Dynamics and Control (BDC).

FACULTY
Sandra Biedron
University of New Mexico
BDC theme

GRADUATE STUDENT
Amy Zhu
Cornell University
PHC theme

GRADUATE STUDENT
Lucy Lin
Cornell University
BDC theme

GRADUATE STUDENT
Chris Parzyck
Cornell University
PHC theme

GRADUATE STUDENT
Jason Gibson
University of Florida
PHC theme

GRADUATE STUDENT
Aiden Harbick
Brigham Young University
SRF theme

GRADUATE STUDENT
Aasma Aslam
University of New Mexico
BDC theme

GRADUATE STUDENT
Nilanjan Banerjee
Cornell University
SRF theme

POSTDOC
Benjamin Francis
Brigham Young University
SRF theme

POSTDOC
Dulanga Somaratne
Cornell University
PHC theme

POSTDOC
Chenyu Zhang
Cornell University
BDC theme

POSTDOC
Nathan Majernik
UCLA
PHC theme

NEW PARTNER INSTITUTION
CBB welcomes SLAC National Accelerator Laboratory. SLAC scientists (left to right) Zhirong Huang, who is also a CBB External Advisory Board member, Bruce Dunham, Auralee Edelen, and Adi Hanuka collaborate on photoinjector optimization and Machine Learning.
CBB strives to broaden the pipeline of accelerator scientists by increasing awareness of the discipline beyond the walls of national accelerator laboratories and by actively seeking out the participation of students and senior researchers from underrepresented groups. The Research Experience for Undergraduates (REU) has been a key component of this goal. Brigham Young University, University of Chicago, and Cornell University hosted CBB REU programs again this summer.

Contribute to cutting edge discovery.

Experience interdisciplinary research.

Learn alongside individuals from a wide range of nationalities, cultures, and educational backgrounds.

Explore unique areas of science.

Check out what a few REU students had to say!

Jeanne Garriz
Louisiana State University
“This experience has taught me a lot about accelerator physics research and about the complexities of research in general. My area of research was just one tiny part of accelerator research, and most areas of research are very specialized like that. It's taught me that even the most seemingly simple tasks can be extremely complicated.”
(more)

Jack Isen
UCLA
“Even though my project was largely independent, I made use of the guidance and assistance of many others. I think that this experience has shown me that all of research is collaborative to some extent and has emphasized the importance of being able to present research clearly.”
(more)

Menaka Kumar
North Carolina State University
“Over the summer, I worked with Dr. Alice Galdi and Chris Pierce to investigate the effect of space charge on solenoid scan measurements in the Cornell MTE meter through particle tracking simulations in General Particle Tracer (GPT) and Python. I was able to quantify the effect of space charge on MTE measurements at various pulse lengths and voltages.”
(more)

Emilie LaVoie-Ingram
Jacksonville University
“Although I am disappointed I couldn’t be in Ithaca this summer, I have enjoyed making virtual friends. We all get together and talk for hours about our hobbies, engaging topics, anything! It is a nice, refreshing break after long days of research.”
(more)

Pedro Rivera-Cardona
University of Puerto Rico, Mayagüez Campus
“The thing I enjoyed most about this experience was being able to interact with interns from different states, and communicating with experienced faculty about my future career goals.”
(more)
Awards

Auralee Edelen named the 2020 Panofsky Fellows

Auralee Edelen (CBB Faculty at SLAC) named the 2020 Panofsky Fellow at the Department of Energy’s SLAC National Accelerator Laboratory

Full Article here:

This award recognizes exceptional early-career scientists who would most benefit from the opportunity to do their research at the lab, providing generous funding for five years of research and an opportunity for continuing appointment at SLAC.

Recent Graduations

Will DeBenedetti
Ph.D. Recipient
Cornell University
Thesis: Atomic-Scale Control of TiO$_2$ in Air and Solution

Joshua Paul
Ph.D. Recipient
University of Florida
Thesis: Computational Discovery and Characterization of Low-Dimensional Materials

Happenings

CBB regularly hosts seminars and conferences. Stay up to date @ cbb.cornell.edu/

November 10 - 13, 2020

Nb$_3$SnSRF'20 International Workshop
Niobium-3-Tin Superconducting Radio Frequency Science, Technology, and Applications

Held virtually - Poster

CBB MISSION:
Transform the reach of electron beams by advancing fundamental knowledge and applying it to increase beam brightness x100 and reduce the cost and size of key enabling technologies. Ensure that these new approaches are realized in operating accelerators by transferring the best of them to national labs and industry. Educate and inspire a diverse generation of students to prepare them for a broad set of career paths including leadership in interdisciplinary team science.
Convergence Research & How We’re Connected

CBB’s brighter beams will advance the frontiers of physics, chemistry, materials science, biology, industry, and medicine.

CBB partners work together in project areas from theory to application, driven by the Center’s objectives. This convergence research benefits a wide range of accelerator applications.

Current projects are listed on page 7.
### CURRENT PROJECTS

Each year CBB reviews and updates its strategic plan and carefully selects projects that move it towards research objectives.

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Recent Publications


