The Center for BRIGHTBEAMS

A NATIONAL SCIENCE FOUNDATION SCIENCE & TECHNOLOGY CENTER

NEWSLETTER

2023

The Beam Team gathered at Cornell University for the 2023 annual meeting.

Dear Friends of CBB,

In this festive season, let's celebrate the togetherness that makes this time of year special. In the realm of science, where individual achievements often take precedence, it's crucial to recognize the profound impact of collaboration.

Collaborative teams are essential not only for scientific progress, but also for building science's appeal as a career path. Some young people, often including women and members of underrepresented groups, seek a communal spirit in choosing their careers and may be deterred by a perceived culture of individualism. By embracing community, we better attract this scientific talent and bring new strength to our teams.

As we celebrate togetherness, CBB stands out for its inclusivity and collaboration. Our diverse team is a testament to this commitment. In the holiday spirit, let's cherish our unity and the richness that community brings to our shared journey.

Wishing you joyous holidays!

Ritchie

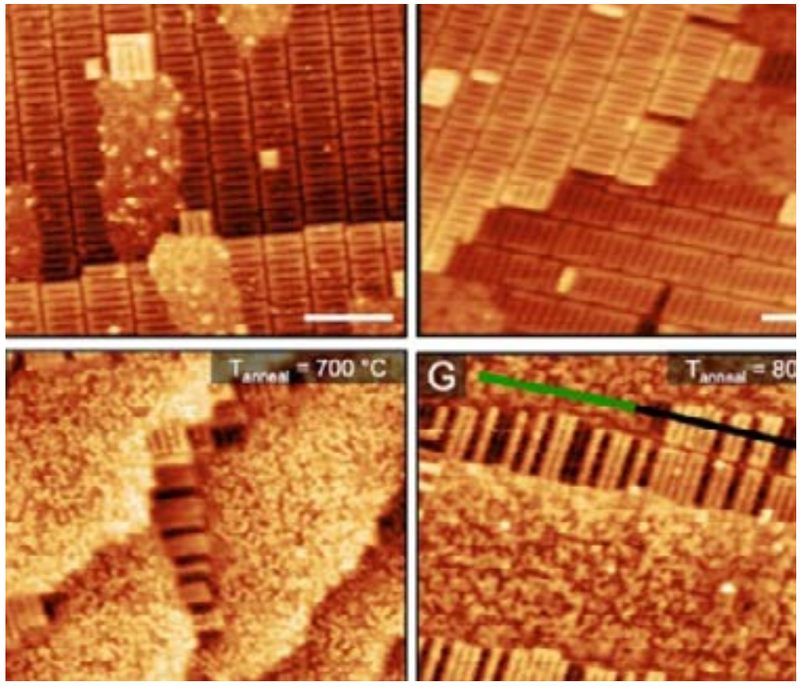
J. Ritchie Patterson
Director of the Center for Bright Beams

In This Issue

In the Press

Atomic-Scale Images Depict Particle Accelerator Film Formation

By: Rick Ryan
Original publication J. Phys. Chem. C 2023, 127, 6, 3339–3348



Researchers capture first atomic-scale images depicting early stages of particle accelerator film formation

New research from a team of scientists at the Center for Bright Beams has made significant strides in developing new techniques to guide the growth of materials used in next-generation particle accelerators.

The study, published in the Journal of Physical Chemistry C, reveals the potential for greater control over the growth of superconducting Nb_3Sn films, which could significantly reduce the cost and size of cryogenic infrastructure required for superconducting technology.

Superconducting accelerator facilities, such as those used for X-ray free-electron laser radiation, rely on niobium superconducting radio frequency (SRF) cavities to generate high-energy beams. However, the associated cryogenic infrastructure, energy consumption, and operating costs of niobium SRF cavities limit access to this technology.

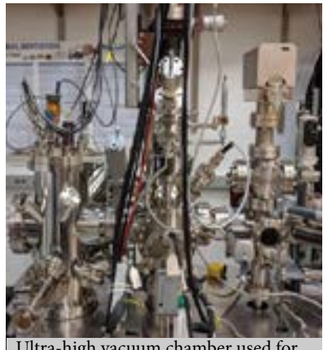
To address this issue, researchers have been working to identify superconducting materials that can operate at temperatures higher than 2 Kelvin with comparable quality factors to niobium (Nb) SRF cavities. One of the most promising materials is triniobium tin (Nb_3Sn), an alloy with an operating temperature of 18 Kelvin, thus reducing the need for expensive cryogenic infrastructure.

The theoretical and experimental advancements in the performance of Nb_3Sn-coated cavities make them a promising approach for future accelerators but there is still a need for a thorough understanding of how to grow higher quality Nb_3Sn alloy films.

> "Advancing this science is only made possible through diverse collaborations - an important focus at the heart of CBB. The expertise and close collaborations between all of our partner institutions are driving this research into the future."
>
> *Ritchie Patterson, Director of CBB*

This new CBB research, conducted by experimental materials chemists at the University of Chicago coupled with theoretical physicists at the University of Florida, delivers the first atomic-scale images of Sn on oxidized niobium, depicting the early stages of Nb_3Sn formation. This visualization of Sn adsorption and diffusion on oxidized niobium is an essential advancement in creating a mechanistic formula for optimizing the fabrication of next generation accelerator cavities.

"The quality and accelerating performance of Nb_3Sn depends on many convoluted variables at play during the growth procedure" says Sarah Willson, CBB graduate student at the University of Chicago and co-lead author of the paper along with postdoctoral scholar Rachael Farber. "We are aiming to look at the initial steps of a complicated growth process and isolate certain variables in a controlled setting." Their atomic-level growth experiments are supported by quantum theory from graduate student Ajinkya Hire.



Ultra-high vacuum chamber used for Nb_3Sn film growth studies.

As Nb_3Sn accelerator cavities are prepared, scientists aim to reduce impurities and contaminants from the niobium cavity to achieve a cleaner and more uniform surface. The cavity is then heated to high temperatures in the presence of an Sn vapor. This causes the Sn to diffuse into the Nb layer, forming Nb_3Sn. As careful measures are taken to grow a pristine Nb_3Sn film, looking closely across the cavity reveals a highly disordered, rough, polycrystalline surface - not the consistent single-crystal surface ideal for a highly controlled experiment.

Willson explains that in order to conduct this experiment, they recreate, in a way, the real-world process of cavity-making, but further surpass the temperature demands needed - heating the materials to 1630 degrees Celsius, and creating an atomically-flat niobium oxide surface to showcase the interactions of Sn, Nb, and O at the atomic level.

Observations of metal oxides are routinely performed using scanning tunneling microscopy, STM, revealing information at the atomic scale. However, the specific setup for studying Nb_3Sn growth with STM is not readily available. So, Willson and Farber created one.

They designed and built a custom metal deposition chamber to deposit the Sn on the niobium surface. This technique recreates the real-world environment in which accelerator cavities are developed – with the ability to prevent surface contamination – while allowing researchers to study the deposition using STM.

"We have taken a state-of-the-art STM setup, which was not really built to study high temperature metallic growth and alloy formation, but through the funds from CBB, have added the intermetallic growth chamber that allows us to do these experiments in-situ," says Willson, stating that using the intermetallic growth section reveals the individual Sn atoms integrating with the niobium subsurface.

"We see that even in our highly-controlled environment, the Nb surface serves as a major roadblock in preventing Sn diffusion required for Nb_3Sn formation," says Willson. "Improving Nb_3Sn growth is much more than just simply developing a uniform coating layer of tin on niobium."

This study was led by corresponding author Steven Sibener, Carl William Eisendrath Distinguished Service Professor at the University of Chicago, in collaboration with CBB faculty member Richard Hennig, Alumni Professor of Materials Science and Engineering at the University of Florida.

Sibener, a physical chemist, says that the collaboration between different areas of accelerator and non-accelerator sciences is unique in his experience, helping to lay the groundwork for advancing particle accelerators and looks forward to the promising developments of Nb_3Sn.

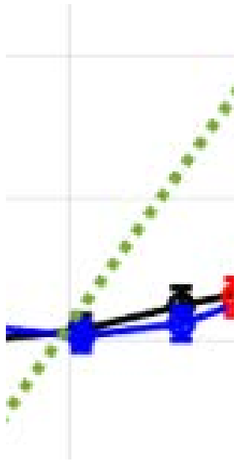
"The collaborations that CBB sparks, the ability for surface chemists, materials engineers, accelerator physicists, and theorists to interact in this way, has certainly empowered and strengthened this research," says Willson. "Personally, I gained a deeper understanding of how to properly navigate the challenges associated with the differing jargon, priorities, and research perspectives across scientific fields. Many chemists are interested in these types of interfacial metallic growth challenges that are encountered by engineers and physicists. This collaboration facilitated extensive interdisciplinary communication that has made conducting a study like this more comfortable and efficient."

Research Highlights

Learn more about CBB research at cbb.cornell.edu

Mean Transverse Energy at the Thermal Limit

A. Kachwala, P. Saha, P. Bhattacharyya, E. Montgomery, O. Chubenko, and S. Karkare



The Mean Transverse Energy (MTE) of Cs_3Sb has been shown to approach the thermal limit at room temperature when illuminated with light at the emission threshold. The emission threshold was observed to be lower than in previous studies.

MTE is the ultimate limit on the achievable brightness of an electron source. If this performance can be replicated in a full injector with a higher QE, it will enable hard X-ray operation of LCLS-II HE.

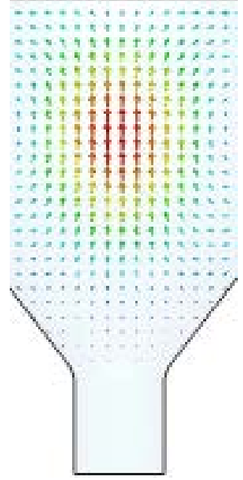
Unlocking the Potential of CsSb Thin Films for High-Brightness Electron Beams

C. T. Parzyck, C. A. Pennington, W. J. I. DeBenedetti, J. Balajka, E. Echeverria, H. Paik, L. Moreschini, B. D. Faeth, C. Hu, J. K. Nangoi, V. Anil, T. A. Arias, M. A. Hines, D. G. Schlom, A. Galdi, K. M. Shen, and J. M. Maxson

Here, we investigate the growth of CsxSb photocathodes over a variety of compositions, 1in situ electron diffraction, we identify the growth conditions for atomically smooth CsSb films on substrates including 3C-SiC (100) and graphene-coated TiO_2 (110). A variety of in situ probes including XPS, ARPES, and STM provide a comprehensive picture of the structural, morphological, and electronic properties of the resulting films.

Studies of Au/Nb bilayers for improving and understanding superconducting RF cavities

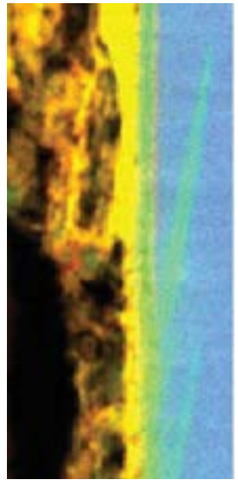
T. Oseroff, Z. Sun, and M. Liepe



This study has explored the significance of normal conducting inclusions on niobium surfaces, which are thought to be introduced by the presence of a niobium oxide layer. It considered the effects of rinsing the niobium surface with hydrofluoric acid, which removes the oxide, in a nitrogen atmosphere before depositing very small amounts of gold onto the surface. Such a procedure is expected to modify the properties of normal conducting materials at the niobium surface.

ZrNb(CO) RF Superconducting Thin Film with High Critical Temperature in the Theoretical Limit

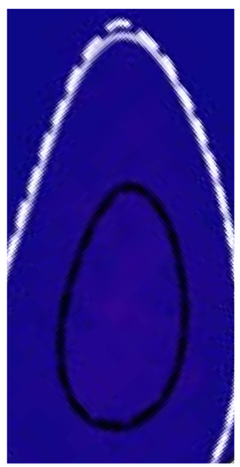
T. Oseroff, Z. Sun, and M. Liepe



Based on a new theoretical analysis of the niobium-zirconium system, we show that the beneficial effect of zirconium is much greater than previously thought, and the recipes we have developed produce niobium-zirconium surfaces with record-breaking superconducting critical temperatures.

Detailed four-dimensional transverse phase space reconstruction using neural networks and differentiable simulations

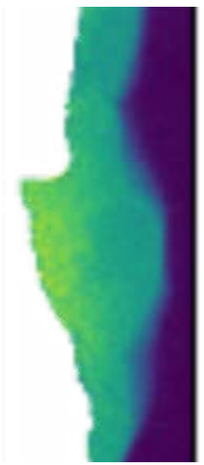
R. Roussel, A. Edelen, C. Mayes, D. Ratner, J. P. Gonzalez-Aguilera, S. Kim, E. Wisniewski, and J. Power



In this work, we present a new algorithm that makes use of neural networks and differentiable particle tracking simulations to efficiently reconstruct 4D transverse phase space distributions. The reconstruction only needs a single focusing quadrupole, a diagnostic screen and a limited number of measurements. We demonstrate an unprecedented level of reconstruction detail in both experimental and simulated examples.

Smooth, homogenous Nb_3Sn

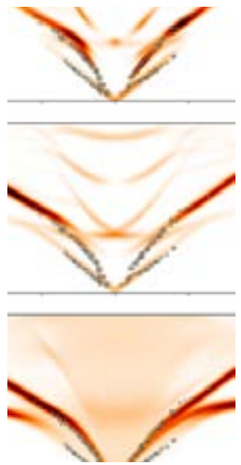
Z. Sun, G. Gaitan, M. Ge, K. Howard, M. U. Liepe, R. D. Porter, T. Oseroff, T. A. Arias, Z. Baraissov, M. Kelley, D. A. Muller, J. Sethna, N. Sitamaran, and K. D. Dobson



Superconducting thin films, e.g., Nb_3Sn, are the next-generation materials for RF accelerator cavities. However, the large surface roughness and non-stoichiometry of Nb_3Sn are two critical issues that limit their RF performance. Here, we achieved smooth, homogenous Nb_3Sn through our novel electrochemical recipes. The resultant surface roughness is five time smaller than the values from conventional vapor diffusion.

Unveiling the Secrets of Atomic Surface Scattering: A Universal Approach from First Principles

M. M. Kelley, R. Sundararaman, and T. A. Arias



This revolutionary study fills that void by introducing a new, fully first-principles framework by explicitly evaluating the interactions between the scattering atom and the surface electrons. By doing so, this new method corrects misleading results from previous theories and overall provides a more accurate approach for understanding atom–surface interactions.

More Research Highlights:

cbb.cornell.edu/research/research-highlights.

New Partnership with Morgan State University

Dr. Willie Rockward, Professor of Physics & Engineering at Morgan State University.

We are excited to announce a new partnership with Morgan State University and Dr. Willie Rockward, the Chair and Professor of Physics & Engineering Physics. Morgan State is Maryland's preeminent public urban research university and an HBCU. Their Department of Physics holds a vision to be a leader in producing the best and the brightest in Physics and we are thrilled to have them join the CBB team.

Through the Advancing sCientific exCELlence by Empowering Research in Accelerators Through Education (ACCELERATE) program, students from Morgan State will participate in CBB research. Projects may include developing photocathode materials or studying the impact of defects or surface roughness on the superconducting properties of RF accelerating cavities.

MORGAN STATE UNIVERSITY
GROWING THE FUTURE LEADING THE WORLD

Welcome Morgan State!

Collaboration and Global Research

Young-Kee Kim, the Louis Block Distinguished Service Professor at University of Chicago, and CBB theme leader gave a keynote speech at the World Congress of Korean Scientists & Engineers emphasizing the importance of forging more research connections.

By Baek Byung-yeul as seen in The Korea Times

Korean scientists and researchers from around the world gathered in Seoul, Wednesday, to interact with scholars and researchers at the inaugural World Congress of Korean Scientists & Engineers. To advance, Korea's science and technology, they also emphasized the importance of forging more connections with global researchers.

"It is important for Korean researchers to collaborate with international research organizations and pursue diverse kinds of human resource exchange," Young-Kee Kim, a physics professor at the University of Chicago, said during the event, introducing research about particle accelerator conducted in collaboration with countries around the world.

"We are very grateful to the president for fulfilling his promise to invite Korean researchers from around the world for exchanges. We have already laid the foundation for cooperation as 'world Koreans' and will continue to provide systematic cooperation and support for 'global Korea' as leaders in science and technology," Kim said.

To read the full press release: (The Korea Times)

CBB at the National Society of Black Physicists Conference

The National Society of Black Physicists (NSBP) is the leading professional organization for the African-American physics community. It creates and supports initiatives that broaden opportunities for African Americans in physics, striving to increase their representation in the field. CBB joined this year's meeting on November 9 – 12 in Knoxville, TN.

CBB postdoctoral fellow, Elena Echeverria, and Michigan State University Professor, Paul Guèye, organized a "Science Hour" to raise awareness about Accelerator Sciences and its applications. CBB Director, Ritchie Patterson, presented "Bright Electron Beams for Science and Society." Other speakers were Thomas Glasmacher, Director of Michigan State University's Facility for Rare Isotope Beams, and Julianne Pollard-Larkin of the MD Anderson Cancer Center.

CBB postdoctoral fellow, Elena Echeverria in a panel discussion on Opportunities in Accelerator Physics and Engineering.

Ritchie Patterson, Director CBB with Michigan State University Professor Paul Guèye.

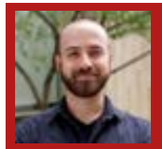
Dr. Willie Rockward, NSBP Conference Chair, is the Chair and Professor of Physics and Engineering Physics at Morgan State University.

NSBP Science Hour attendees, including (from front row, second from left) Ritchie Patterson, Julianne Pollard-Larkin, Elena Echeverria, distinguished accelerator scientist Sekazi Mtingwa, and behind him, Paul Guèye.

Recent Alumni

Graduate Students

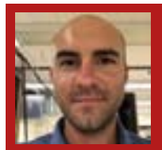
Eric Cropp
Postdoctoral Fellow
SLAC National Accelerator Lab
Thesis: High-Performance Accelerator Modeling: Toward Improving Controls and Diagnostics for High-Brightness Beams in Experiment



AJ Dick
Postdoctoral Fellow
Argonne National Lab
Thesis: Computational Modeling and Simulation of Optical Stochastic Cooling

Gevork Gevorkyan
Postdoctoral Fellow
Mayo Clinic
Thesis: Brightness, Spin Polarization, and Lifetime of Photocathodes for a High Current Electron Beam

Michelle Kelley
Postdoctoral Fellow
Rensselaer Polytechnic Institute
Thesis: Effective Quantum Many-Body Theories: Studies of Electronic Structure & Electron–Phonon Coupled Properties Near Interfaces in Superconductors



Chris Knill
Advanced R&D Scientist
Honeywell ACST
Thesis: Practical Limitations of Low Mean Transverse Energy Metallic Photocathodes

Pallavi Saha
Postdoctoral Fellow
Brookhaven National Lab
Thesis: Growth and Characterization of Cesium-antimonide Photocathodes

Nathan Sitaraman
Postdoctoral Fellow
Cornell University
Thesis: SRF Theory Work on SRF Materials

More Alumni and Where they are now:

cbb.cornell.edu/about/cbb-alumni

Postdocs

Nathan Majernik
Staff Scientist
SLAC National Accelerator Lab

Zeming Sun
Research Assistant
Bruker Biotechnology Research

New Partner

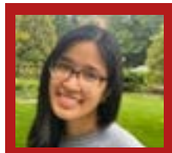
Prof. Willie Rockward
Chair of Physics and Engineering Physics
Morgan State University

MORGAN STATE UNIVERSITY
GROWING THE FUTURE LEADING THE WORLD

Welcome New CBB Members

Priyadarshini Bhattacharyya
Graduate Student
Arizona State University
Beam Production

Fabio Bosco
Postdoctoral Fellow
UCLA
Beam Dynamics and Control

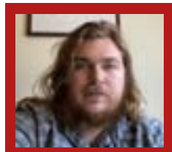


Van Do
Graduate Student
University of Chicago
Beam Acceleration

Sam Dong
Graduate Student
University of Florida
Beam Acceleration

Azriel Finsterer
Graduate Student
Cornell University
Beam Production

Emily Frame
Graduate Student
Northern Illinois University
Beam Dynamics and Control



Daniel Franklin
Graduate Student
Northern Illinois University
Beam Production

Tariqul Hasan
Graduate Student
Northern Illinois University
Beam Production

Sergei Kladov
Graduate Student
University of Chicago
Beam Dynamics and Control

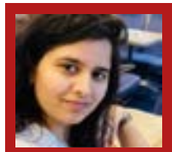
Atharva Kulkarni
Graduate Student
UCLA
Beam Dynamics and Control

Cristobal Mendez
Graduate Student
Cornell University
Beam Acceleration

Mansoure Moeini Rizi
Postdoctoral Fellow
Arizona State University
Beam Production

Peter Prah Owusu
Graduate Student
Arizona State University
Beam Production

Sadie Seddon-Stettler
Graduate Student
Cornell University
Beam Acceleration



Monika Yadav
Postdoctoral Fellow
UCLA
Beam Dynamics & Control

Charles Zhang
Graduate Student
Cornell University
Beam Production

2023 Annual Meeting and Symposium

The 2023 Annual Collaboration Meeting and Symposium was held at Cornell University in July. This is the one time each year when we meet in person. In addition to research-centric talks, presentations, learning 3-D design with Fusion360, and poster sessions, we spent time in real life (IRL) hiking, bowling, rock climbing, and even competing in a team-based scavenger hunt.

Watch on our YouTube Channel!

Professor David Muller gave a fascinating ethics talk from his experience at Stanford "Fundamental principles of scientific research and the rise and fall of Jan Hendrik Schön"

Postdoctoral Fellow Elena Echeveria taught our team the Basics of Photocathode Characterization Techniques

Hobbes! The Pawsitive Vibe Generator at CBB.

Congratulations to Poster Session Winners!

Juan Pablo Gonzalez Aguilera:
"Towards fully differentiable accelerator modeling"

Fabio Bosco:
"Fast Models for the Evaluation of Self-induced Field Effects in Linear Accelerators"

Chad Pennington:
"Ultra-thin Cs3Sb Photocathodes with Anomalously High Quantum Efficiency"

Liana Shpani:
"Optimizing Growth of Niobium-3 Tin Through Pre-nucleation Chemical Treatments"

CBB graduate student, Sarah Willson, presents a 60-second research blitz.

Research Experiences for Undergraduates

Contribute to cutting-edge research at world leading institutions.

Experience interdisciplinary research, working side-by-side with material scientists, chemists, condensed matter physicists and accelerator scientists.

Learn alongside individuals from a wide range of nationalities, cultures and educational backgrounds. CBB continuously works toward the inclusion of underrepresented minorities, women, and first-generation students.

Explore high demand career opportunities.

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, Cornell University, and Northern Illinois University regularly host CBB REU programs each summer. **We are currently accepting applications for the 2024 REU Program.**

Map of Past REU Student Home Institutions and Host Institutions

Check out what a few of our past students had to say.

Taylor Ray '23
Northern Arizona University
"This experience really made me realize that this is what I want to do. I saw how collaborative science research can be, and how amazing it is to be surrounded by people who are as passionate as you about a subject. I also realized, however, that being a researcher is very draining at times.I feel motivated to develop some self-care techniques in order to work hard without burning out at the end of the day."

Full Interview.

Ritee Zahin '23
Adelphi University
"What I'm enjoying most of all is the knowledge that I'm getting, it's a big thing for me. I love physics and I have never learned like this before in my normal classes. That's most important to me. And the other thing is the group we have here and the connection we have."

Full Interview.

Watch Ritee's full interview about the 2023 Summer Program here →

Outreach Updates

Exciting Physics Workshop Empowers Arizona Educators!

In collaboration with the Arizona Teachers Association, the Center for Bright Beams recently hosted an engaging physics workshop for 23 dedicated K-12 teachers hailing from various corners of Arizona.

The event, led by Professor Karkare along with CBB graduate students and postdocs, immersed the educators in a series of hands-on activities designed for seamless integration into their K-12 classroom curricula.

Among the highlights were innovative experiments crafted by CBB's scientists, such as "What is a Wave?" These experiments enable teachers to captivate their students' imaginations through immersive experiences involving sound, water, and a wave machine, fostering an understanding of the fascinating world of waves.

Additionally, teachers delved into the mysteries of Newton's Laws of Motion by constructing airboats and investigating how various variables influence their motion.

An inspiring visit to ASU's groundbreaking Compact X-ray Free Electron Laser (CXFEL), the world's first of its kind, added a touch of cutting-edge science to the workshop.

"I left feeling happy and energized and ready to share what I have learned with other teaching peers and of course to teach my students."

We invite you to explore and share the comprehensive guides & Lending Kits available on CBB's Resources for Teachers webpage.

Expanding Your Horizons

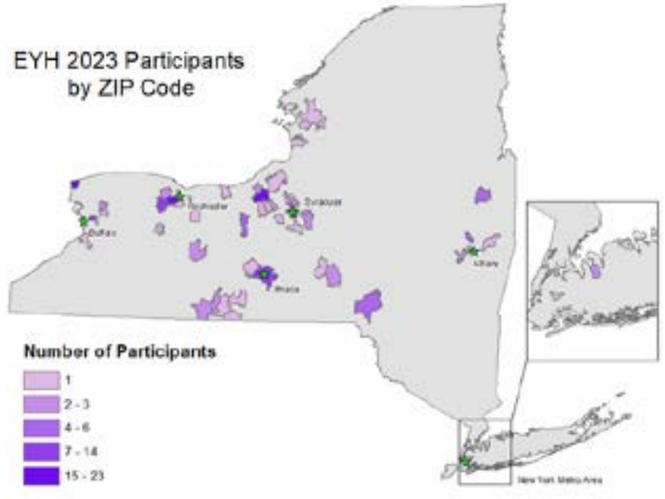
The Center for Bright Beams is an annual sponsor of Expanding Your Horizons at Cornell University. In April 2023, 28 workshops were offered to over 230 middle-school students. These hands-on activities led by scientist role models help young students learn that anyone with a curious mind has what it takes to pursue a future in STEM!

2023 EYH student evaluations noted:

"It brought me interest in a type of science I didn't know about before."

"It has taught me that there is a lot more to science than I thought. I learned about a lot more topics that I never knew about."

"My favorite part of the conference was learning about the people and how they got to where they are."



2023 – 2024 Projects

PI Name	Projects	Theme	Students & Post-docs
Arias	Ab initio theory of many-body photoemission and of photomaterials	PHC	Tyler Chun Wai Wu (GRA)
Arias	Ab initio exploration of beyond-Nb SRF materials for low cooling power and high field performance	SRF	Cristobal Mendez (GRA)
Biedron	Applications of Machine Learning in Photoinjectors	BDC	Aasma Aslam (GRA)
Chubenko	Photocathodes under realistic accelerator conditions	PHC	Tariqul Hasan (GRA)
Chubenko	Monte Carlo modeling of photoemission from semiconductors	PHC	Daniel Franklin (GRA)
Hennig	Quantum machine learning for the synthesis of photocathodes by epitaxial growth	SRF	Sam Dong (GRA)
Hennig	Thermodynamics and Superconducting Properties of Novel SRF Superconductors	PHC	Ajinkya Hire (GRA)/Sam Dong (GRA)
Hines	Air-stable, high performance photocathodes	PHC	Amy Qingyuan Zhu (GRA)
Hoffstaetter	ML/AI preparation of polarized proton beams for electron cooling.	BDC	Lucy Lin (GRA)
Karkare	Sub-100 nm sources and High field testing of Alkali-antimonide	PHC	Mansoure Moeini Rizi (PD)
Karkare	Photoemission and surface characterization of Alkali-antimonides	PHC	Priyadarshini Bhattacharyya (GRA)
Karkare	Cathode characterization in PEEM	PHC	Alimohammed Kachwala (GRA)
Karkare	Measurements of low energy electron distributions and cryogenic MTE	BDC	Peter Owusu (GRA)
Kim	Auto-differentiable Accelerator Modeling	BDC	JP Gonzalez Aguilera (GRA)
Kim	Noise in Intense Electron Bunches	BDC	Sergei Kladov (GRA)
Liepe	High-performance Nb_3Sn	SRF	Liana Shpani (GRA)
Liepe	CVD Growth of Nb_3Sn Films	SRF	Gabriel Gaitan (GRA)
Liepe	Advanced Material Systems for Enhanced SRF Performance	SRF	Nathan Sitaraman (PD)
Liepe	Advancing RF Performance via Au Layering and Oxide Passivation	SRF	Sadie Seddon-Stettler (GRA)
Maxson	Optimizing alkali antimonides for high QE, low MTE performance in low and high field electron guns	PHC	Chad Pennington (GRA)
Maxson	MTE measurement of epitaxial alkali antimonides	PHC	Charles Zhang (GRA)
Maxson	Measurement of photocathode performance at high average current	PHC	Sam Levenson (GRA)
Maxson	Molecular beam epitaxy growth and characterization of bialkali antimonides	PHC	Elena Echeverria (PD)
Muller	Machine Learning for precise phase space control of electron microscopes	BDC	Desheng Ma (GRA)
Muller	Electron Microscopy characterization of the microstructure of materials for SRF cavities	SRF	Zhaslan Baraissov (GRA)
Musumeci	Demonstration of 100 nm transverse emittance with 100 pC beam charge	BDC	Atharva Kulkarni (GRA)
Musumeci	Testing of advanced photocathodes at UCLA Pegasus photoinjector	PHC	David Garcia (GRA)
Piot	Conserving 4-D brightness and enhancing 5-D brightness in integrated photoinjector beamlines	BDC	Afnan Al Marzouk (PD)
Rosenzweig	Optimization of ultra-compact free-electron laser performance with very low MTE photocathodes	BDC	Fabio Bosco (PD)
Rosenzweig	Extreme High Brightness Electron Source from Intense Laser Illumination of Nano-Blades	PHC	Monika Yadav(PD) Gerald Lawler (GRA)
Shen	Atomically Ordered & Engineered Materials for Photocathodes	PHC	Vivek Anil (GRA)
Sibener	Investigating the Atomic and Micron-Scale Morphological Development of Nb_3Sn Leading to Smooth Homogeneous Thin Films	SRF	Sarah Willson (GRA)
Sibener	In Situ Measurements of High Temperature Surface Structure, Bonding, and Dynamics of Alloying Sn, Nb, and Zr from Initial Behavior to Resulting Film Growth	SRF	Michael Van Duinen (GRA)
Sibener	Investigating the Effect of Atomic Scale Surface Structural Changes from Alloying, Doping, and Defects on the Superconductivity of Nb, Nb_3Sn and Zr with Simultaneous In Situ High Temperature Atomic-Scale Surface Structure and Surface Electron-Phonon Coupling Constant Measurements	SRF	Caleb Thompson (GRA)
Sibener	Optimization of Nb SRF Surfaces: Atomic Visualization of Alloy Growth and Oxide Suppression	SRF	Van Do (GRA)
Transtrum	Mesoscopic models of superconductivity for realistic materials and surfaces	SRF	Aiden Harbick (GRA)

Awards and Honors

Recipient	Award name or sponsor	Reason for award	Date
Juan Pablo Gonzalez Aguilera	Physical Sciences Division Quarterly Fellowship, U. Chicago	For strong academic potential	2023
Afnan Al Marzouk	Graduate School, Northern Illinois U.	Outstanding Dissertation Award of 2021-2022 in STEM and health sciences	2022
Zhaslan Baraissov	2023 Student Scholar Award, Microscopy & Microanalysis	Best Paper	2023
AJ Dick	Graduate School, Dept. of Physics, Northern Illinois U.	Outstanding Graduate Student	2022
Gevork Gevorkyan	Innovation Fellowship, Grad Student and Professional Student Association, Arizona State U.	Forming and hosting an interdisciplinary graduate colloquium series	2022
Alimohammed Kachwala	Graduate and Professional Student Association, Arizona State U.	Outstanding Research Award	2022
Alimohammed Kachwala	Graduate and Professional Student Association, Arizona State U.	Outstanding Mentor Award	2022
Alimohammed Kachwala	William J. and Carol M. Motil Scholarship	For Experimental Research	2022
Michelle Kelley	Psi-k conference	Poster commendation	2022
Jared Maxson	Stephen and Margery Russell Distinguished Teaching Award	Devotion to teaching	2023
David Muller	2023 John Cowley Medal, International Microscopy Congress	Lifetime achievement	2023
David Muller	American Association for the Advancement of Science	Fellow	2023
James Rosenzweig	2023 Hannes Alfven Prize in Plasma Physics, European Physical Society	Career achievement in plasma acceleration	2023
Kyle Shen	APS, Division of Materials Physics	Fellow	2022
Liana Shpani	Early Career Investigator Award, 21st International Conference on Radio-Frequency Superconductivity	Best Oral Presentation	2023
Steve Sibener	Remsen Award, American Chemical Society	Lifetime achievement	2023
Mark Transtrum	Edward and Betty Seppi Endowed Chair of Physical and Mathematical Sciences.	Demonstrated potential for future research excellence.	2022

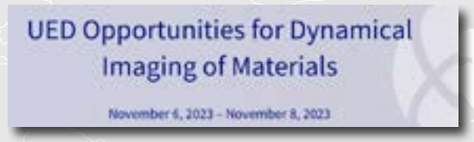
CBB Impact in the Global Accelerator Community

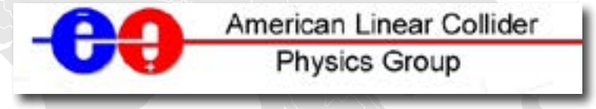
CBB participated broadly in conferences, workshops, and events around the world reaching audiences in not only the accelerator community but also in the broader scientific community.

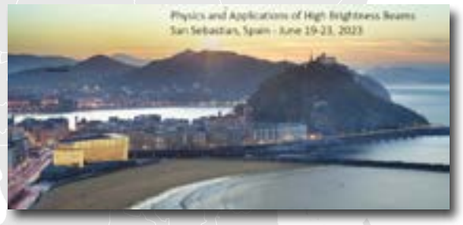
<u>CBB Students and Postdocs presented</u>
25 Research talks
36 Scientific Posters

<u>CBB Faculty served on</u>
16 Conference and Workshop Organizing Committees
8 Advisory Committees
3 Review Committees
4 Community Planning Committees

<u>CBB Accelerator Research Training Videos received</u>
Over 15k views from 12 Pedagogical videos
Over 4k views from 8 Professional Development videos







Recent Publications

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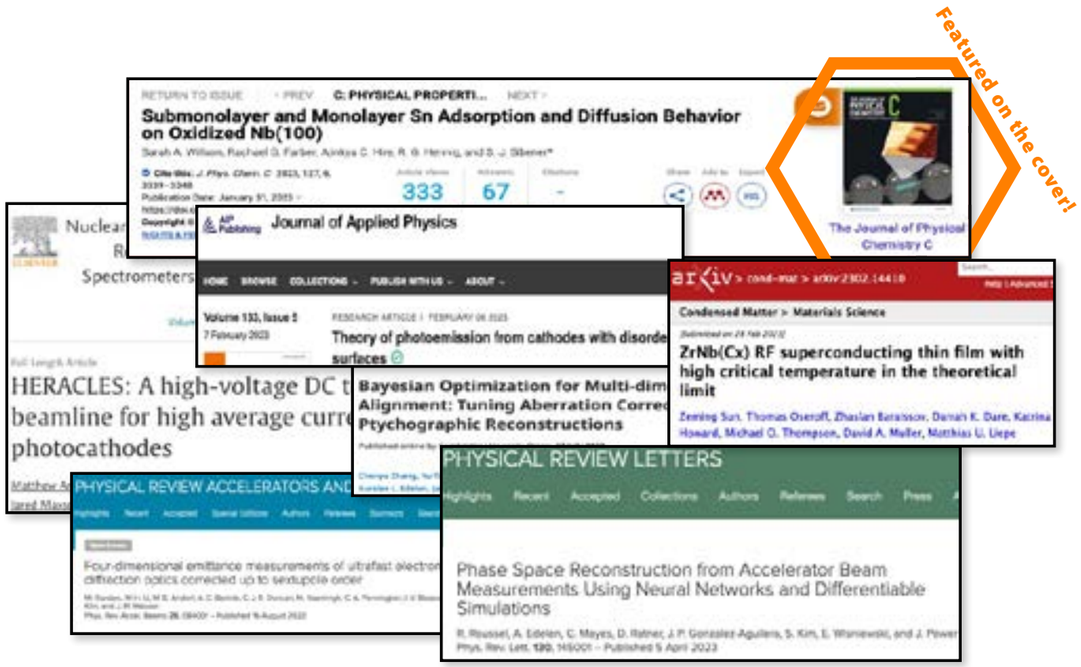

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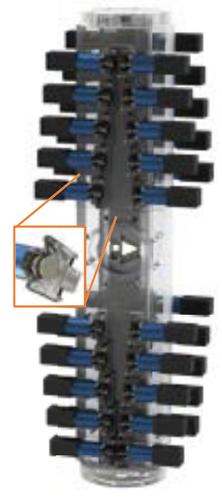

A render of the multileaf collimator with the vacuum chamber and some support structures made translucent for clarity, shown here creating a mask for a ramped drive beam and witness beam.