



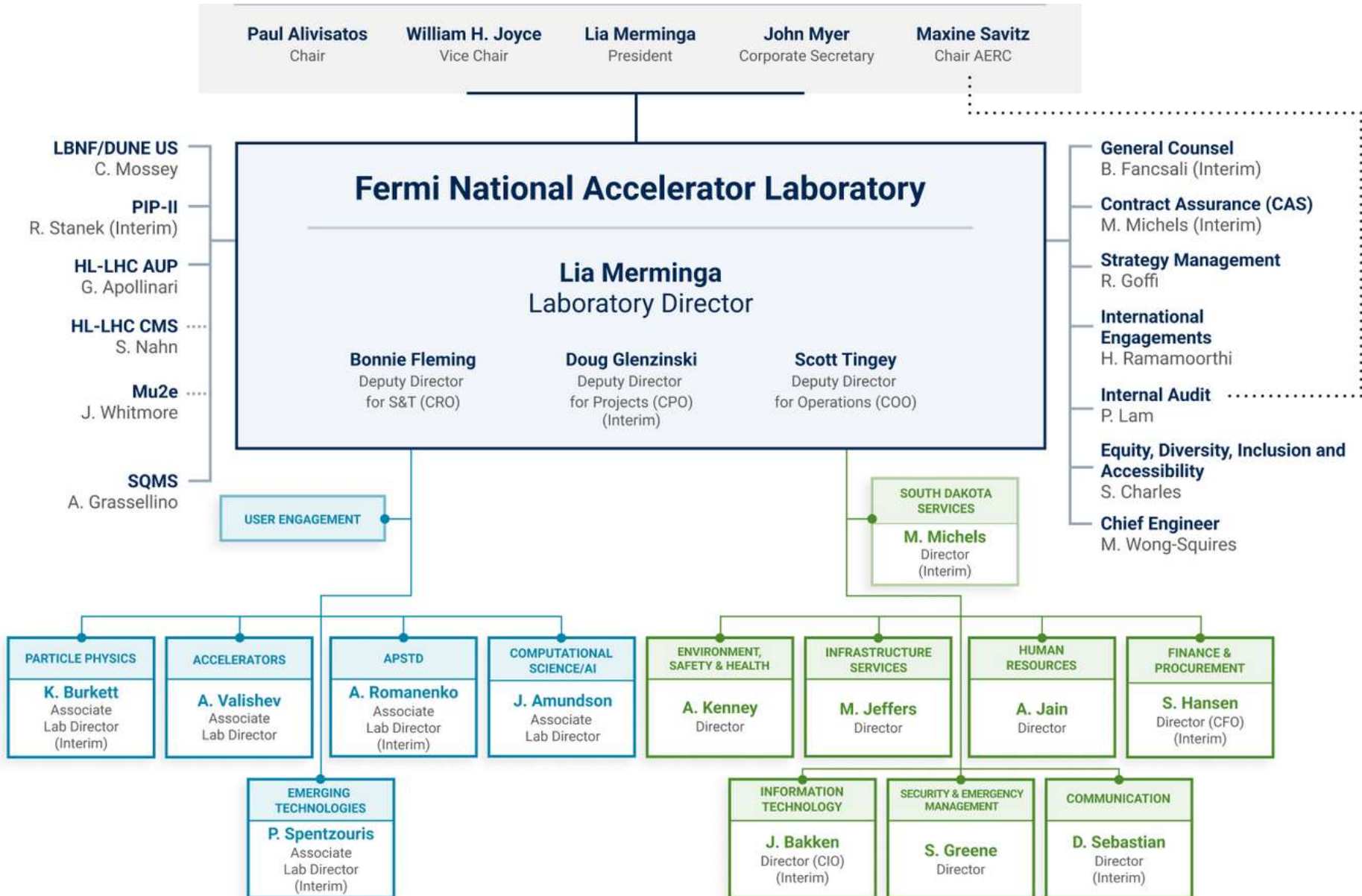
# **ACCELERATOR DIRECTORATE – ACCELERATOR RESEARCH DIVISION**

## **All-Hands Meeting**

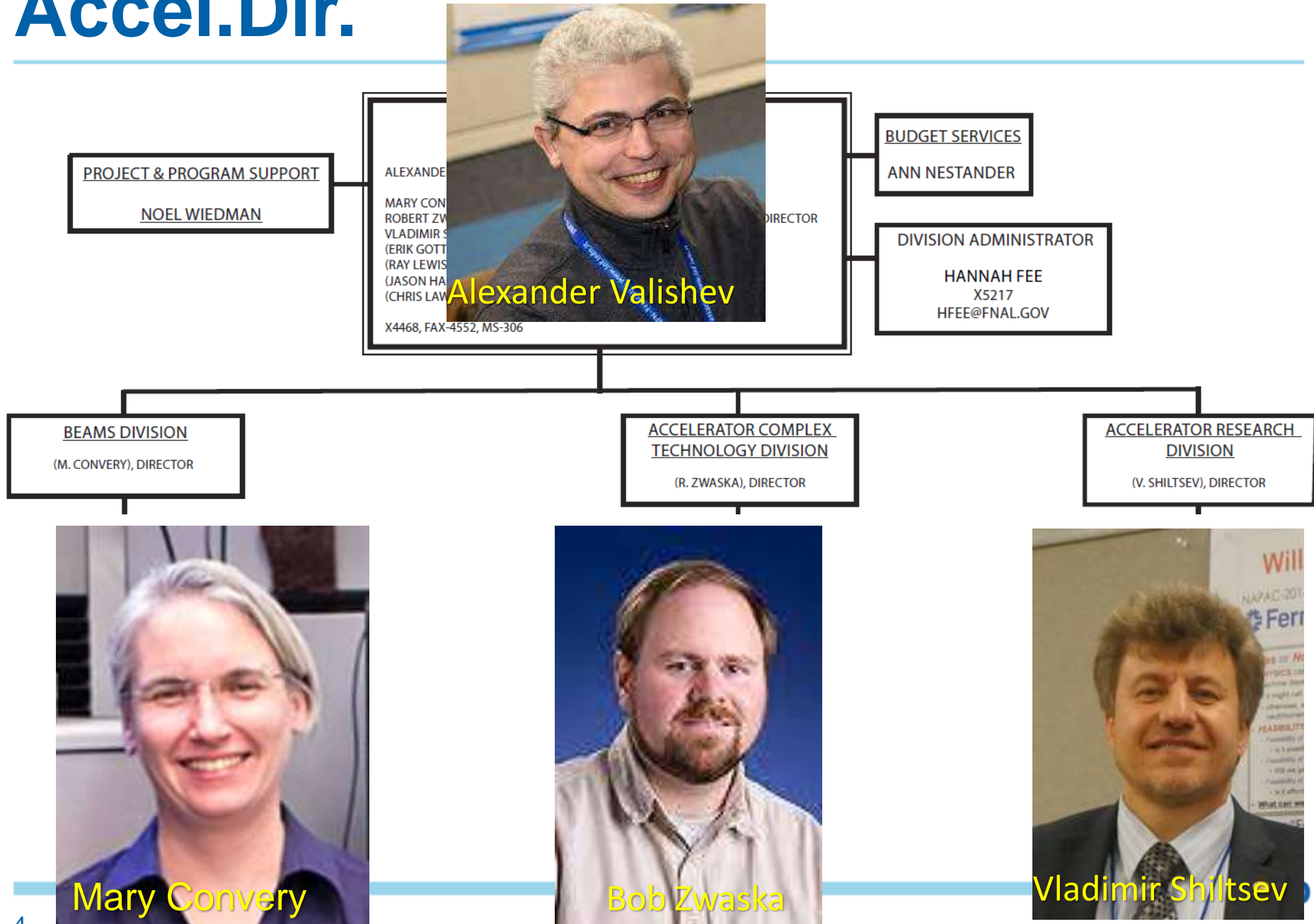
28 February 2023, 1 West, Fermilab

- **Welcome from ALD for Accelerators**
- **AD-ARD: vision and mission, organization**
- **Near-term priorities (high level)**
- **Departments and Groups:**
  - IOTA/FAST Operations – Dan Broemmelsiek
  - IOTA/FAST Physics – Jonathan Jarvis
  - USPAS – Susan Winchester
  - PhD Program – Bob Zwaska
  - Peoples Fellowship – C.Y.Tan
  - Helen Edwards Internship – Rob Ainsworth
  - Lee Teng Internship – Jonathan Jarvis
- **AOB/Q&A and Group Photo**

# Fermilab Organization Structure



# Accel.Dir.



# AD-ARD Includes

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- IOTA-FAST Accelerator research department (J. Jarvis)
- IOTA-FAST Operations department (D. Broemmelsiek)
- [Future Accelerators and Colliders group (V. Shiltsev)]
- US Particle Accelerator School office (S. Winchester)
- Accelerator Training Programs
  - Joint Fermilab-University PhD program and students
  - Peoples Fellowship
  - Lee Teng Internship
  - Helen Edwards Internship
  - [Accelerator Joint Appointments]

# AD-ARD : Vision and Mission

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- ARD vision is to carry out research and development to keep Fermilab at the forefront of accelerator science, technology and facility operation in support of the Laboratory's high-energy physics research mission.
- The ARD mission is to engage in General Accelerator Research and Development along the Accelerator Beam Physics (ABP) and Advanced Accelerator Concepts (AAC) thrusts; and to lead Fermilab's efforts toward future accelerator facilities by:
  - Carrying out experimental ABP studies at and operation of **the IOTA-FAST facility**;
  - Leading and coordinating the R&D, design and pre-project planning towards **future frontier accelerator facilities** in the US and internationally;
  - Providing accelerator physics support for **existing operational programs** and the evolution thereof;
  - Providing the **platform** for establishment of closer cooperation ties and collaborations of Fermilab staff with other National Labs, the US Universities and international HEP research community;
  - Hosting the **US Particle Accelerator School** office;
  - Hosting the Laboratory's programs for **training accelerator scientists and engineers**;
  - 6 Contributing to the AD efforts towards **DEIA**.

# DOE OHEP: General Accelerator R&D Thrusts

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## - Accelerator and Beam Physics

- Integrated machine design, codes, instrumentation and controls, beam facilities (AD-ARD and IOTA/FAST)

## - Superconducting magnets and materials (MDP)

- High-field SC magnets, new SC materials, test facilities (APSTD)...minor at AD-ARD (fast cycle HTS)

## - RF Acceleration Technology

- High performance NC and RF cavities, RF sources, test facilities, ... (APSTD)

## - Particle Sources and Targets

- Multi-MW targets, e<sup>+</sup> sources, test facilities (AD-ACT)

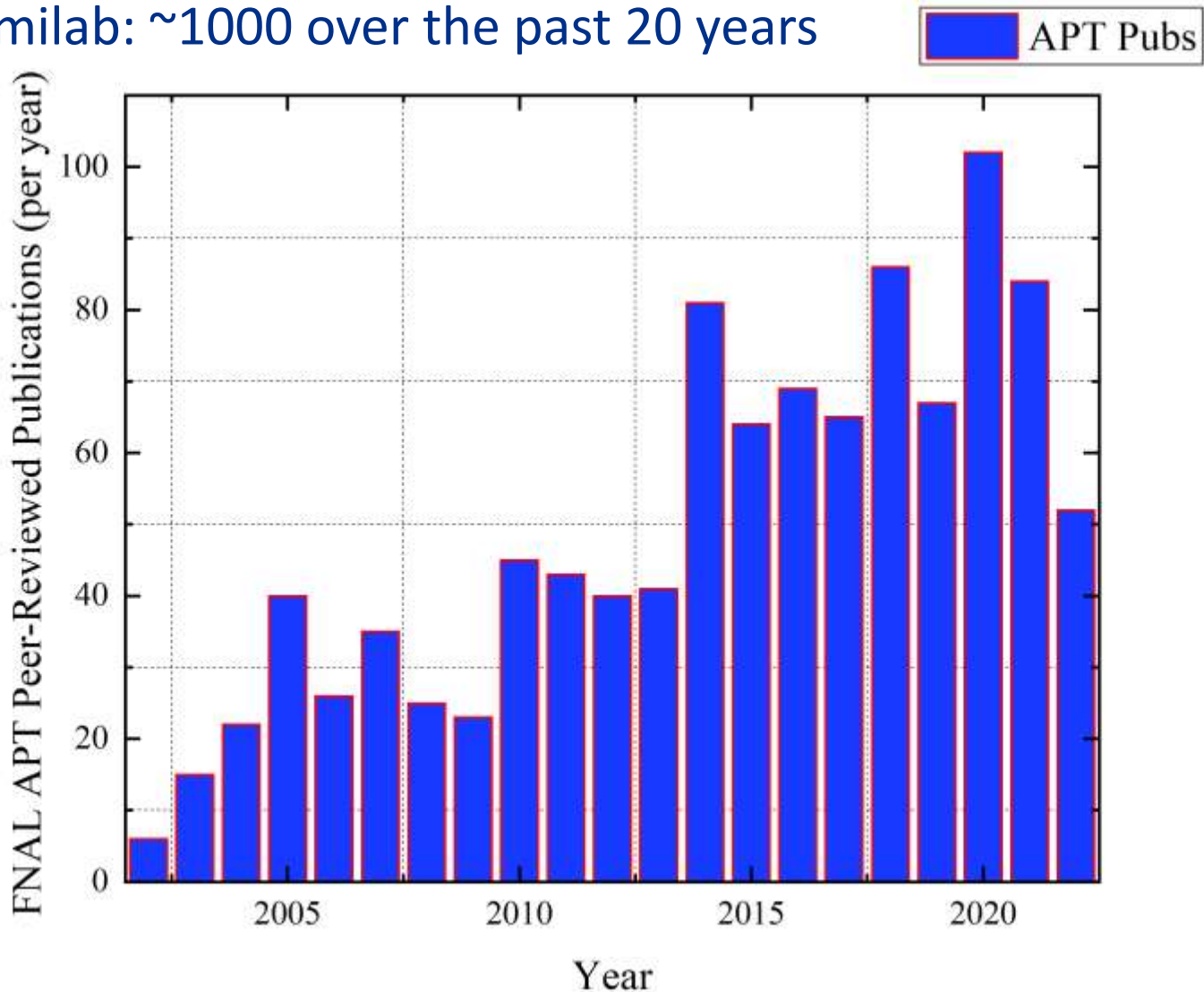
## - Advanced Acceleration Methods

- Wakefield experiments, modeling, etc (AD-ARD: E336)

# Publications

INSPIRE HEP Search AD/APC/TD/CD

From Fermilab: ~1000 over the past 20 years

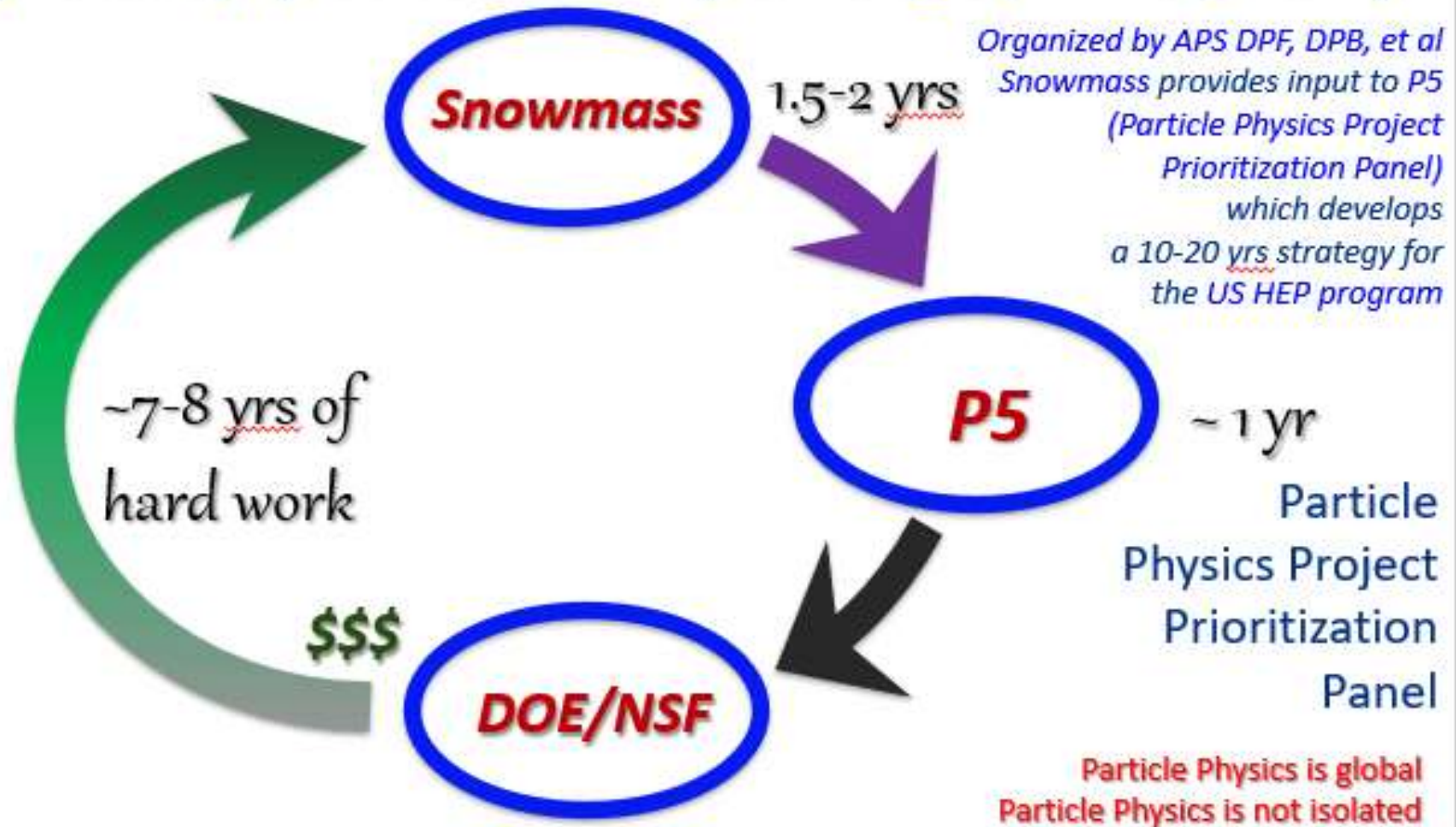


Ideally, research should lead to projects



# Snowmass'21

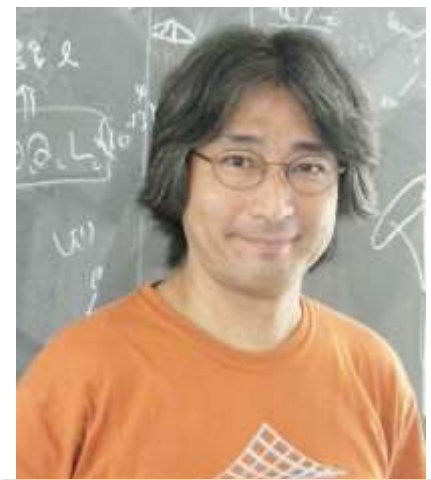
"a particle physics community strategic planning study"



<https://www.snowmass21.org/>

# ...and Now It's All to P5

- Chaired by Hitoshi Murayama
- Web site: <http://hitoshi.berkeley.edu/P5/>
- Charge... final report by October 2023
- Composition: 29 total, 4 from accelerators



Hitoshi Murayama



Cameron Geddes



Mark Palmer



Tor Raubenheimer

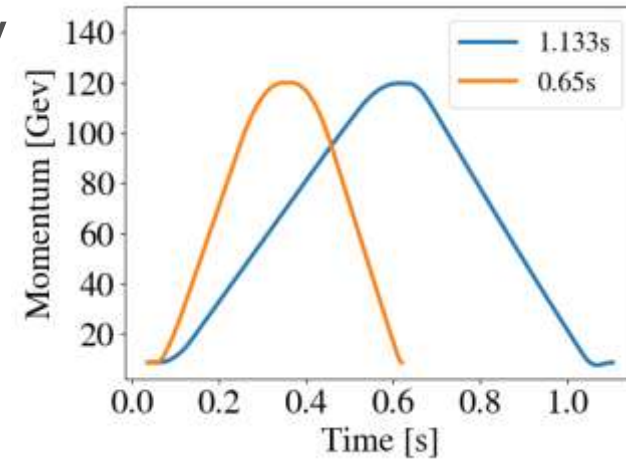


Bob Zwaska

- **Four “Town Halls”, including:**
  - February 22-23, 2023 : LBNL, *Cosmic Frontier*
  - March 21-24, 2023 : FNAL/ANL, *Neutrino and Rare Processes*
  - April 12-14, 2023 : BNL, *Energy Frontier, Instrumentation*
  - May 3-5, 2023 : SLAC, *Accelerator Frontier, Theory Frontier*

# Accelerator Initiatives/Proposals/Projects

- **For Neutrino Physics:** PIP-II followed by
  - ACE (Accelerator Capability Enhancement)
  - 0.65s cycle  $\rightarrow$  2.2MW; ASAP(ca 2031)
- **For Rare Processes (DM, CLFV, etc):**
  - 0.8 GeV PAR (Accumulator Ring)  $\sim$ 100kW
  - AMF (Advanced Muon Facility) two rings
- **For Energy Frontier (colliders) – design and R&D on:**
  - e+e- Higgs Factories: FCCee at CERN, C<sup>3</sup>, ILC/HELEN
  - Muon Colliders (6-10-14 TeV c.m.e.)
  - In collaboration with international partners
  - In coordination with corresponding physics/detectors teams



**ALL THAT NEEDS P5 APPROVAL** – some of us are working on that



# FAST Facility Operations

Dan Broemmelsiek

ARD All Hands

28 Feb 2023

# Location

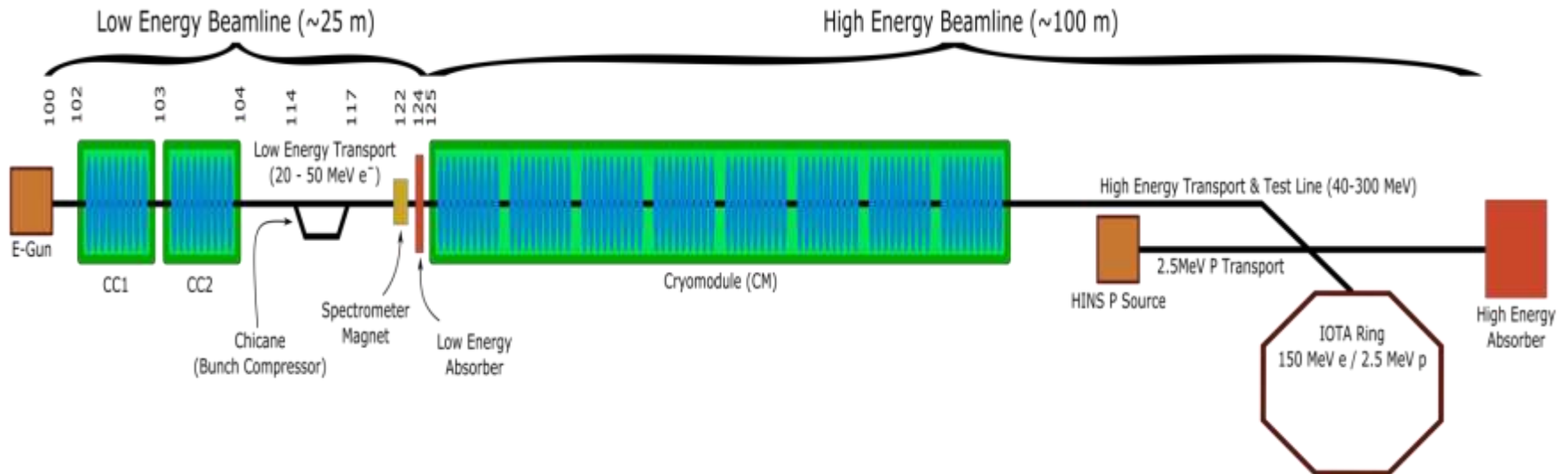


- NML
  - Northern Most Lab
  - No Man's Land
  - No More Letters
  - Ninety Meters Long
- Lab 7
  - Cathode Prep

Abbreviations: NML=New Muon Lab,  
FAST=Fermilab Accelerator Science and Technology (facility),  
Includes SRF linac and IOTA=Intergtable Optiocs Test Accelerator (ring)

# IOTA/FAST Facility: A Center for Accelerator and Beam Physics

- IOTA/FAST establishes a capability at FNAL, unique in the world, to address frontier topics in Accelerator and Beam Physics



- **The only dedicated facility for intensity-frontier accelerator R&D; ranked as top facility (“Tier 1”) for acc. & beam physics thrust by recent GARD review (Jul 2018)**
- ~30 Collaborating institutions
- Nat. Lab Partnerships:
- Many opportunities for R&D with cross-office benefit in DOE/SC

# FAST Facility Operations – Our Purpose

- Safely operate the facility and accelerators
- Maintain accelerator components
- Expand capabilities – proton source and injector, instrumentation development
- Experiment integration

# Milestones

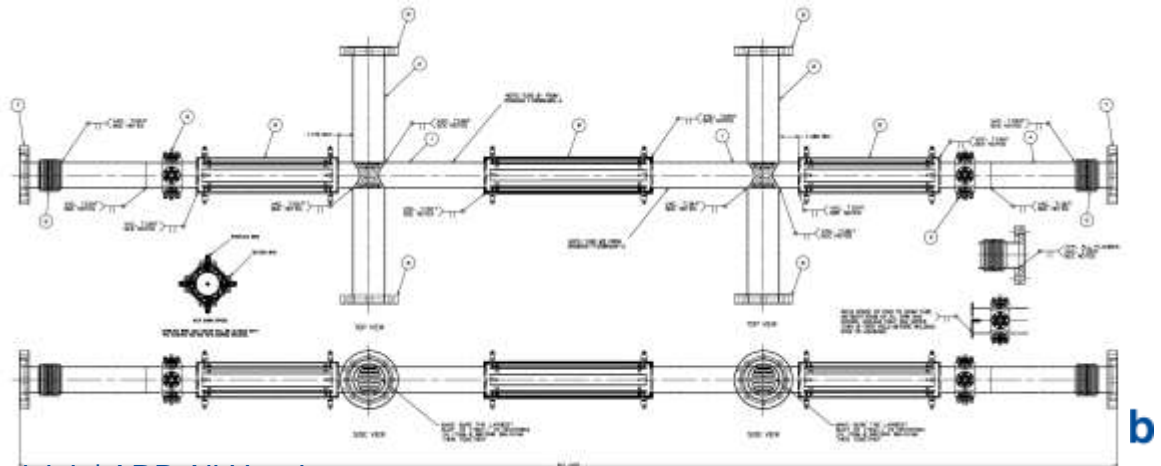
- Commissioned to full design energy of 300 MeV
- World-record beam acc. by ILC-type CM:  $>31.5\text{MV/m}$  ( $\sim 250\text{MeV}$  gain)
- Integrable optics
- Optical stochastic cooling
- Electron/Photon statistics
- **Need to demonstrate ILC bunch parameters  $\leq$  high brightness**





# Recent Operations

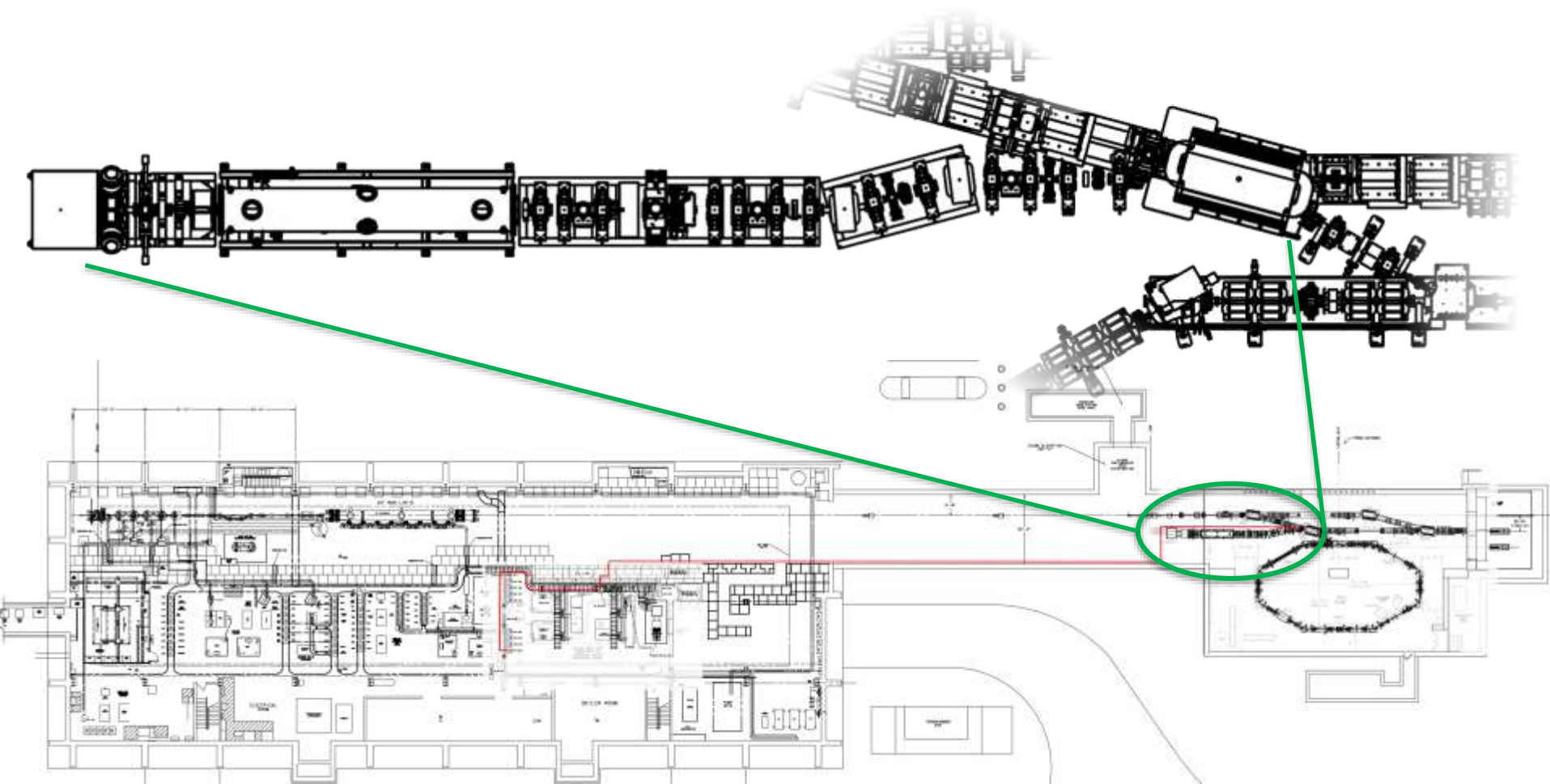
- What works, what doesn't?
  - CC2 ???
  - Usual suspects, Cryo, RF, EE, LCW, power supplies of all kinds...
- Near future expectations
  - We are incredibly close to starting science shifts. Approved experiments are scheduled 55 shifts.
  - Meanwhile, back at the ranch...



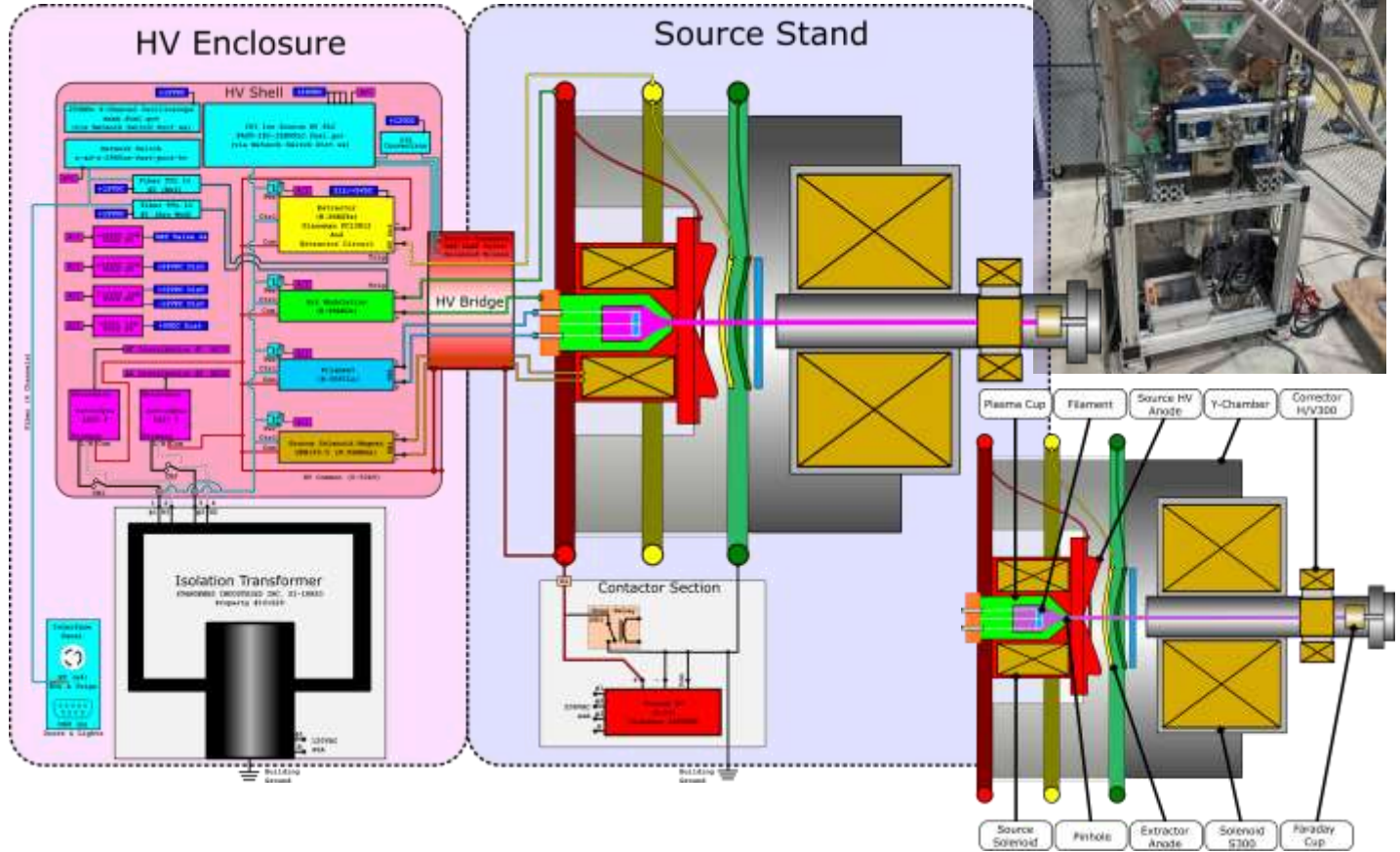
# Experiment Integration

- **NIO – Nonlinear Integrable Optics**
  - Ready to go when the electron linac is available.
- **NEB – Noise in Electron Bunches**
  - Desperately trying not to lose too many photons.
- **NIOLD – NIO Landau Damping**
  - Whole new IOTA section instrumented with striplines to be installed next week.
- **FAST-GREENS – Tapered undulators**
  - Next Week - Undulator installation, begin vacuum system integration
- **In near future – PROTONS**
  - e-lens, SC experiments, IPM and other diagnostics

# Proton Source/Injector



# IPI 50kV Proton Source



# SAFETY

- **Communication!**
- Safety issues anywhere affect everyone everywhere
- Where we need to be more mindful
  - Procedures and Lore do not replace Critical Thinking



# IOTA/FAST Research

Jonathan Jarvis

AD-ARD All Hands

28 Feb 2023

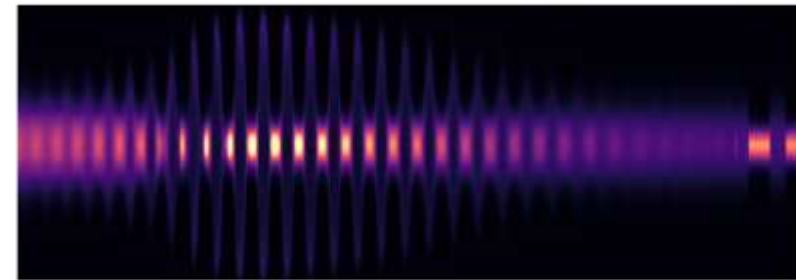
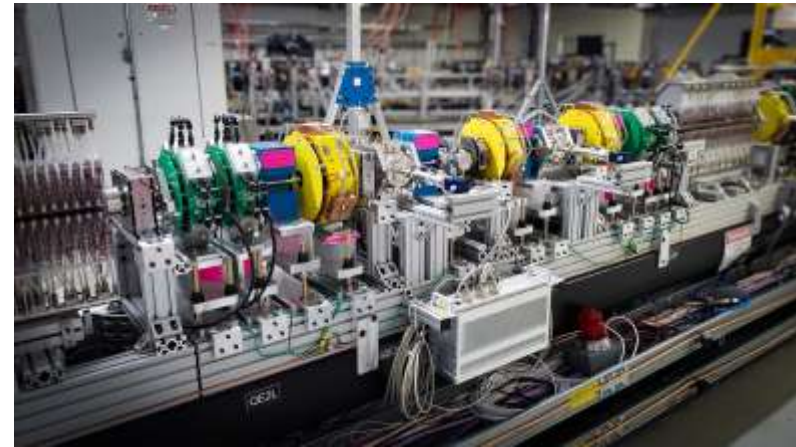
# Acc. Research Dept. focuses on frontier topics in Acc. Sci. & Tech

ARD is supported primarily by HEP's General Accelerator R&D (GARD) program

## Primary Goals:

- Take novel Accelerator Science and Technology (AST) from concept, to demonstration, to practice
- Capture high-impact science opportunities in AST
- Extend the discovery potential of current and future accelerators for HEP and beyond
- Expand FNAL capabilities and expertise in AST
- Workforce development for the accelerator community - a core element of all activities

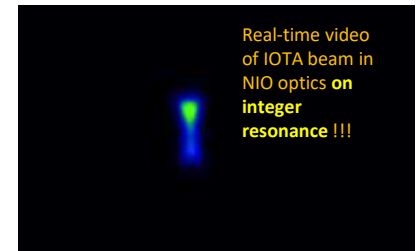
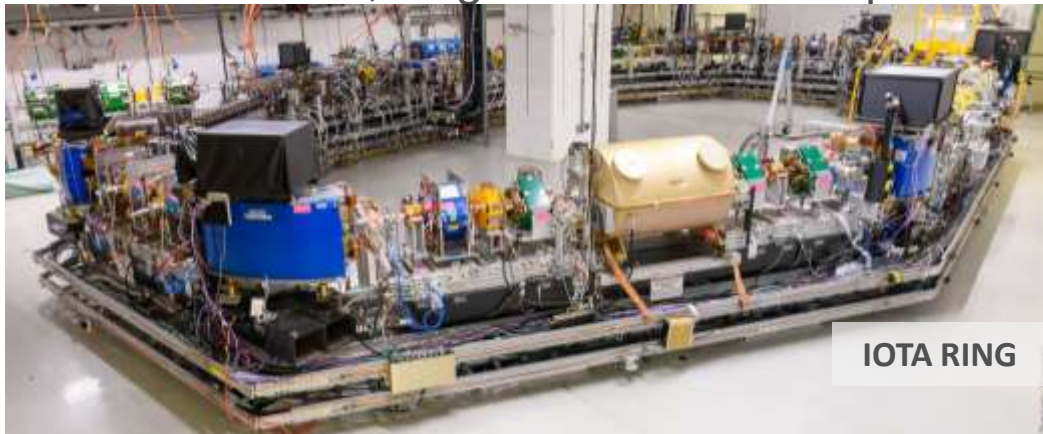
**We build broad AST collaborations across academia, industry and the national lab system**



# A growing portfolio of ARD R&D @ IOTA/FAST

## The Integrable Optics Test Accelerator (IOTA) at FAST

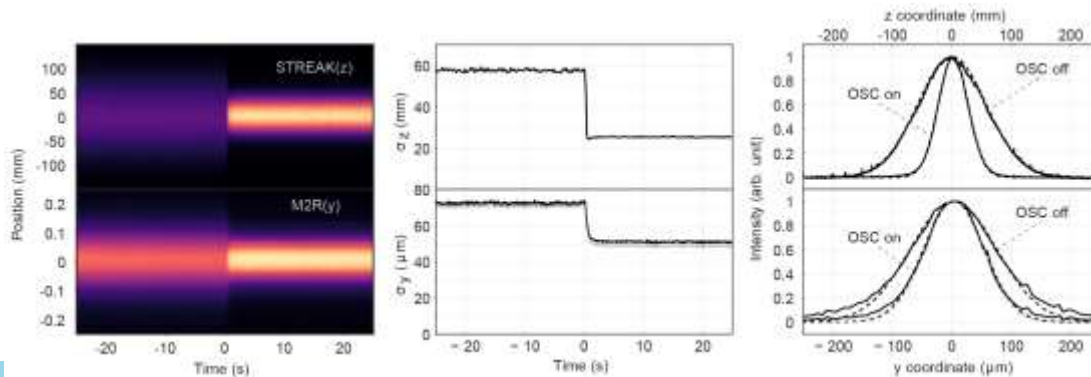
- Suppression of coherent instabilities via Landau damping through novel beam focusing techniques
- Advanced beam cooling; Optical Stochastic Cooling, ion crystals...
- Mitigation of space-charge effects
- Photon and Quantum Science with a single electron
- Development of novel instrumentation and methods, echo..
- AI/ML for controls, diagnostics and conceptual design ...





# Recent example of ARD model: Optical Stochastic Cooling @ IOTA

- **Optical Stochastic Cooling:** first successful realization of stochastic cooling (Nobel '84) in the optical regime; *Nature* 08/11/22
- 100-MeV electrons in IOTA with an optical wavelength of 950 nm
- Demonstrated bandwidth **>2000x higher** than state-of-the-art microwave SC; flexible, strong cooling for **1D, 2D and 3D**
- **Excellent example of ARD model/goals:** 1) high-impact science; 2) novel concept to demonstration to... \* 3) Training and education
- **Amplified OSC** now under development; 30-40dB of power gain; ~30x stronger rate; advanced beam control w/OSC hardware
- \*... to mature technology with broad benefits for acc.-based sciences



## Experimental demonstration of optical stochastic cooling

<https://doi.org/10.1038/s41586-022-02888-1> J. Jarvis<sup>1</sup>, V. Lebedev<sup>1,2</sup>, A. Bruehse<sup>1</sup>, D. Brice<sup>1,2</sup>, K. Calvert<sup>1</sup>, E. Chertkovskiy<sup>1,2</sup>, A. Dolz<sup>1</sup>, D. Edstrom<sup>1</sup>, J. Lobeth<sup>1</sup>, S. Nagaiwa<sup>1,2</sup>, H. Pokarr<sup>1</sup>, N. Poon<sup>1</sup>, J. Ruan<sup>1</sup>, J. Santucci<sup>1</sup>, B. Stawiec<sup>1,2</sup>, K.A. Vahleken<sup>1</sup>  
 Received: 18 March 2022  
 Accepted: 13 June 2022



# Flexibility and a broad community are key to ARD's success

- Demonstrated need for **dedicated R&D facilities**
- The success of the ARD science program has depended on many supporters and collaborators, both inside and outside of FNAL
- ARD program will adapt/align to the new P5 recommendations
- Fermilab likely a core entity in future national strategies and centers for AST development
- The unique and expanding infrastructure of IOTA/FAST will be central to future lab efforts in AST R&D



**CM2023 in Fall'23!!**



# U.S. Particle Accelerator School

Susan Winchester

Accelerator Research Division All-Hands

February 28, 2023



# USPAS – Recent Activities



## 4 online sessions due to Covid

- Fewer hours per day, doubled number of days, smaller classes, no hands-on classes except for Fundamentals labs
- Kept school going and ushered in positive changes: cloud computing, recorded lectures
- Was successful but significant # of drops, grades lower with amplified performance spread, difficult to find instructors, many national lab workers could not enroll due to work duties

**We are indebted to our instructors for reformatting their courses and presenting online. Fermilab instructors & TAs :** Sergei Belomestnykh, Ram Dhuley, Jeff Eldred, Mike Geelhoed, Dan Green, Elvin Harms, Valeri Lebedev, Nikolai Mokhov, Sam Posen, Vladimir Shiltsev, Diktys Stratakis, Greg Tatkowski, Adam Watts

**Relied heavily on AD Networks staff:** virtual Fundamentals labs, cloud computing, website

**Started new enhanced financial aid with Sekazi Mtingwa Scholarships for underrepresented students:** 7 awards in 2022

**Awarded 3 USPAS Achievement Prizes:** Rama Calaga, Geoff Krafft, Gennady Stupakov

**2 new textbooks based on USPAS courses published:**

“Particle Therapy Technology for Safe Treatment” by Jay Flanz

“Polarized Beam Dynamics and Instrumentation in Particle Accelerators” by Francois Meot et al



# USPAS - Happily back to in-person!

## Winter 2023 with NIU in Houston TX

- 54 instructors + 11 courses
- 131 students



**AD:** 4 instructors & TAs + 9 students + 2 IT coordinators + 2 staff

**APSTD:** 3 instructors + 3 students

**CS&AI:** 1 instructor

**ES&H:** 2 instructors + 2 students

**PPD:** 1 instructor

**Awarded:** 53 regular scholarships + 4 Mtingwa scholarships  
+ 12 APS DPB travel awards





# USPAS – Next up:

- **Expect 3 graduates in our master’s degree program with Indiana University**

- 13 currently enrolled, 5 from AD
- 6 AD employee degrees already awarded



- **Summer session in Melville, NY – June 5-16 with MSU credit**

- 4 Fermilab instructors + 17 applicants + Lee Teng interns + teaching assistants?
- Applications for non-scholarship students due March 14
- USPAS scholarships + Mtingwa scholarships + DPB travel awards available

- **International Accelerator School on “Superconducting Science and Technology for Particle Accelerators” this July in Saskatoon**

- In-person, similar format to CERN Accelerator School, open for registration

- **Winter 2024 in Hampton, Virginia**



# Joint Fermilab-University PhD program

Bob Zwaska

AD-ARD All Hands

28 Feb 2023

# Fermilab Accelerator PhD Program

- Started in 1985 by Leon Lederman in response to diminishing number of students going into the field.
- A student works with an advisor at his or her home institution and a local advisor at Fermilab.
  - Students complete the formal course requirements at the home institution.
  - Students develop a research program in cooperation with a lab research group, and receives initial *training*.
    - Traineeships, SCGSR, lab support, university support, fellowships
  - The student comes to the lab to work on thesis research.
- PhD Program can support tuition, stipend, and overhead during research for at most three years.
  - Research costs are supported by the research group or university
- Degree is granted by home institution.
- Students participate in laboratory events (seminars, etc.).
- USPAS participation is encouraged.



# Graduates

- Aakaash Narayanan (NIU) 2022
- Nikita Kuklev (Chicago) 2021
- Crsipin Contreras (MSU)
- David Tarazona (MSU) 2021
- Ihar Lobach (Chicago) 2021
- Darren Veit (Chicago) 2020
- Yichen Ji (IIT) 2019
- Alexei Halavanau (NIU) 2018
- Alexey Kochemirovskiy (Chicago) 2018
- Sergey Antipov (Chicago) 2017
- Liyang Ye (NCSU) 2015
- Jeffrey Eldred (Indiana) 2015
- Ao Liu (Indiana) 2014
- Yulia Trenikhina (IIT) 2014
- Gene Kafka (IIT) 2014
- Timofey Zolkin (Chicago) 2014
- Meghan McAteer (UT – Austin) 2014
- Sergey Koshelev (Bauman Moscow State) 2013
- Denise Ford (Northwestern) 2013
- Arun Saini (Delhi) 2012
- Tim Maxwell (NIU) 2012
- W-M. Tam (Indiana) 2010
- Dan McCarron (IIT) 2010
- Uros Mavric (Ljubljana) 2009
- Tim Koeth (Rutgers) 2009
- Ryoichi Miyamoto (UT Austin) 2008
- Alexi Poklonsky (Michigan State) 2008
- Phill Yoon (Rochester) 2007
- Pavel Snopok (Michigan State) 2007
- Barbardo Bordini (Pisa) 2006
- Xiaobiao Huang (Indiana) 2005
- Robert Zwaska (UT Austin) 2005
- Kip Bishofberger (UCLA) 2005
- Sergey Seletskiy (Rochester) 2005
- Ludovic Nicolas (Glasgow) 2005
- Mohammad Alsharoa (IIT) 2005
- Linda Imbasciati (Vienna) 2003
- Vadim Kashikhin (SRIEA, Russia) 2002
- Vincent Wu (Cincinnati) 2001
- Jean-Paul Carneiro (U. of Paris) 2001
- Michael Fitch (Rochester) 2000
- Oleg Krivosheev (TPU, Russia) 1998
- Katya Langen (Wisconsin) 1997
- Eric Colby (UCLA) 1997
- Linda Spentzouris (Northwestern) 1996
- David Olivieri (Massachusetts) 1996
- Ping Jung Chou (Northwestern) 1995
- Donna Siergiej (New Mexico) 1995
- Xianping Lu (Colorado) 1994
- Bill Graves (Wisconsin) 1994
- Kathy Harkay (Purdue) 1993
- Ping Zhou (Northwestern) 1993
- Todd Satogata (Northwestern) 1993
- John Palkovic (Wisconsin) 1991
- Pilei Zhang (Houston) 1991
- Xiao-qing Wang (IIT) 1991
- Mark Stahl (Northwestern) 1991
- Leonid Sagalofsky (Illinois) 1989
- **Lia Meringa (Michigan) 1989**
- Mike Syphers (Illinois - Chicago) 1987

# Current Program and More Information

Expect new student solicitation in summer:

- Proposal
- Support Letters
- CV

Email list for announcements:

[acceleratorphd\\_info@listserv.fnal.gov](mailto:acceleratorphd_info@listserv.fnal.gov)

Budker seminars to resume later this year

## Present Students:

- William Asztalos (IIT)
- Abe Burleigh (IIT)
- Cristhian Gonzalez-Ortiz (MSU)
- Keegan Harrig (UC-Davis)
- Kellen McGee (MSU)
- Eric Viklund (Northwestern)
- John Wieland (MSU)



# Peoples Fellowship

C.Y. Tan

ARD All hands

28 Feb 2023

# What is the Peoples Fellowship?



- The Peoples Fellows was named in honor of Fermilab's 3<sup>rd</sup> director John Peoples
- The goal is to attract outstanding accelerator scientists early in their careers, both to enhance Fermilab's capabilities in accelerator science and related technologies, and to train and develop the accelerator scientists and technologists who will carry our field forward in the future.
- Who is eligible?
  - program targets entry-level accelerator physicists, specialists in accelerator technologies, and high energy physics post-doctoral researchers who wish to embark on a new career in accelerator physics or technology
  - Candidates must either:
    - Have received within the prior three years a Ph.D. in accelerator physics or accelerator-related technology. Post-doctoral experience is not required.
    - OR
    - Have received within the prior five years a Ph.D. in high energy physics or a related field. Candidates are normally expected to have at least three years of post-doctoral experience in high energy physics or a related field.
    - Note: committee has discretion to add +1 year to eligibility requirement.

# Many interesting topics and the selection/appointment process



- Many interesting topics from previous years
  - Beam dynamics (theory, experiment, computational)
  - Superconducting RF, superconducting magnets
  - Quantum systems
- Proposals are expected to propose a scope of research activities aligned with Fermilab mission.
- In general, the selection Committee is expected to search for and recommend for hire one candidate per year, but multiple candidates can be recommended.
  - The initial appointment is typically for three (3) years.
  - Appointments may be renewed for a maximum of six (6) years in this job classification.
  - This position is roughly equivalent to the position of an Assistant Professor, and is usually the initial appointment in the scientist track.
  - These appointments are made by the Director.
- Application website:  
[https://www.fnal.gov/pub/forphysicists/fellowships/john\\_peoples/procedure.html](https://www.fnal.gov/pub/forphysicists/fellowships/john_peoples/procedure.html)
- Applications have just opened for FY23.

# Past and Present Fellows

Name	Current Institutions
Tiziana Spina	Fermilab
Robert Ainsworth	Fermilab
Mattia Checchin	Fermilab
Martina Martinello	Fermilab
Jonathan Jarvis	Fermilab
Xingchen Xu	Fermilab
Daniel Bowring	Fermilab
Moses Chung	UNIST Korea
Anna Grasselino	Fermilab
Pierre Bauer	European Fusion Development Agreement (ITER)
Markus Huening	DESY
Andreas Jansson	ESS
Andrea Latina	CERN
Philippe Piot	Northern Illinois University
Lionel Prost	Fermilab
Alex Romanenko	Fermilab
Tengming Shen	Lawrence Berkeley National Laboratory
Yin-e Sun	Argonne National Lab
Charles Tobin Thangaraj	Fermilab
Katsuya Yonehara	Fermilab
Robert Zwaska	Fermilab

Present fellows	Year
Jeff Eldred – AD/PS	2019
Timofey Zolkin – CD	2019
Nilanjan Banerjee – AD/ARD	2022/23

# Helen Edwards Internship

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- The Helen Edwards Summer Internship program is a **10-week opportunity** for students majoring in physics and engineering at **universities in Europe**.
- Projects related to science and technology of particle accelerators
- Committee members
  - Rob Ainsworth, AD (Chair)
  - Nino Chelidze, AD
  - Alexander Shemyakin, AD
  - Andrei Lunin, APS-TD
  - Stoyan Stoynev, APS-TD



# Helen Edwards Internship

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- Projects are split between AD & APS-TD
- Dates are June 26 – September 1, 2023
- Looking for potential projects/supervisors
  - Can commit some time, i.e. not traveling all summer
- Deliverable
  - Oral presentation





# Lee Teng Internship

Jonathan Jarvis

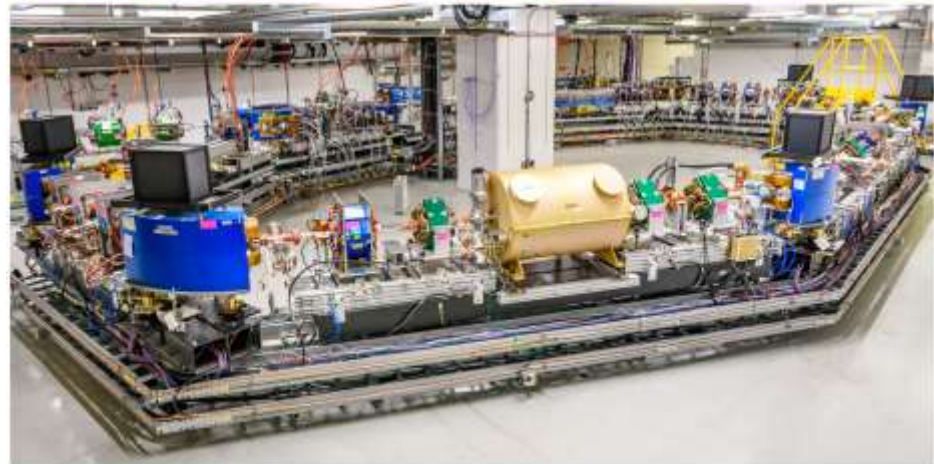
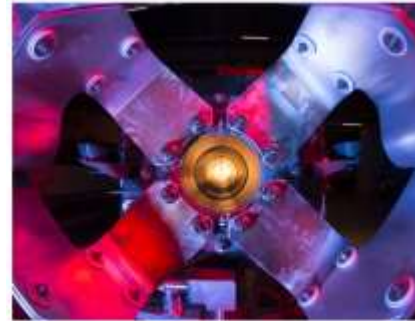
AD-ARD All Hands

28 Feb 2023

# LTI: a unique experience in Accelerator Science and Technology

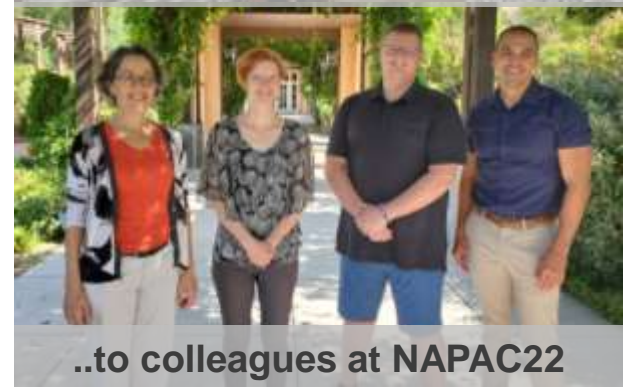
The Lee Teng Internship is a 10-week joint program between Fermilab and Argonne National Lab

1. 2-week course in accelerator fundamentals at the US Particle Accelerator School with academic credit
2. 8-week project in accelerator science and technology with a dedicated mentor at either Fermilab or Argonne
3. Joint tours of facilities at Fermilab, Argonne and University of Chicago
4. Mentorship on graduate-school applications, AST career planning, etc...



# Increased focus on “workforce conversion rate” for LTI

- Emphasis on interest in accelerators as a career
- Focus on outstanding mentors and projects that target near-term achievement and long-term integration into FNAL AST R&D
- Outreach campaign in the “off season” to build direct pipelines for AST with more institutions
- Contact us to find out how you can support the program and its goals!  
[jjarvis@fnal.gov](mailto:jjarvis@fnal.gov)
- <https://internships.fnal.gov/lee-teng-undergraduate-internship/>



# Thank you for your attention!

## Questions?

## (Group Photo)

# AD/ARD All-Hands Meeting



Tuesday Feb 28, 2023, 4:00 PM → 5:00 PM US/Central

1 West (Wilson Hall)

## Description

- Welcome from ALD for Accelerators
- AD-ARD: Vision and Mission
- Near-term priorities (high level)
- Departments and Groups:
  - IOTA/FAST Operations – Dan Broemmelsiek
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- AOB/Q&A and Group Photo

Lisa Lopez [llopez@fnal.gov](mailto:llopez@fnal.gov)  
 [shiltsev@fnal.gov](mailto:shiltsev@fnal.gov)

**4:00 PM** → 5:00 PM **AD-ARD All Hands slides**



**Conveners:** Daniel Broemmelsiek (FNAL/AD/ARD/FAST Facility Department), Jonathan Jarvis (Fermilab), Lisa Lopez (Fermilab), Vladimir Shiltsev (FNAL)

AD-ARD-AllHands02...