AWANOW 2023 SESSION SCHEDULE

AWA Overview (chair John Power): AWA presents a short overview of the AWA program and plans
THURSDAY 9 – 10:20 AM

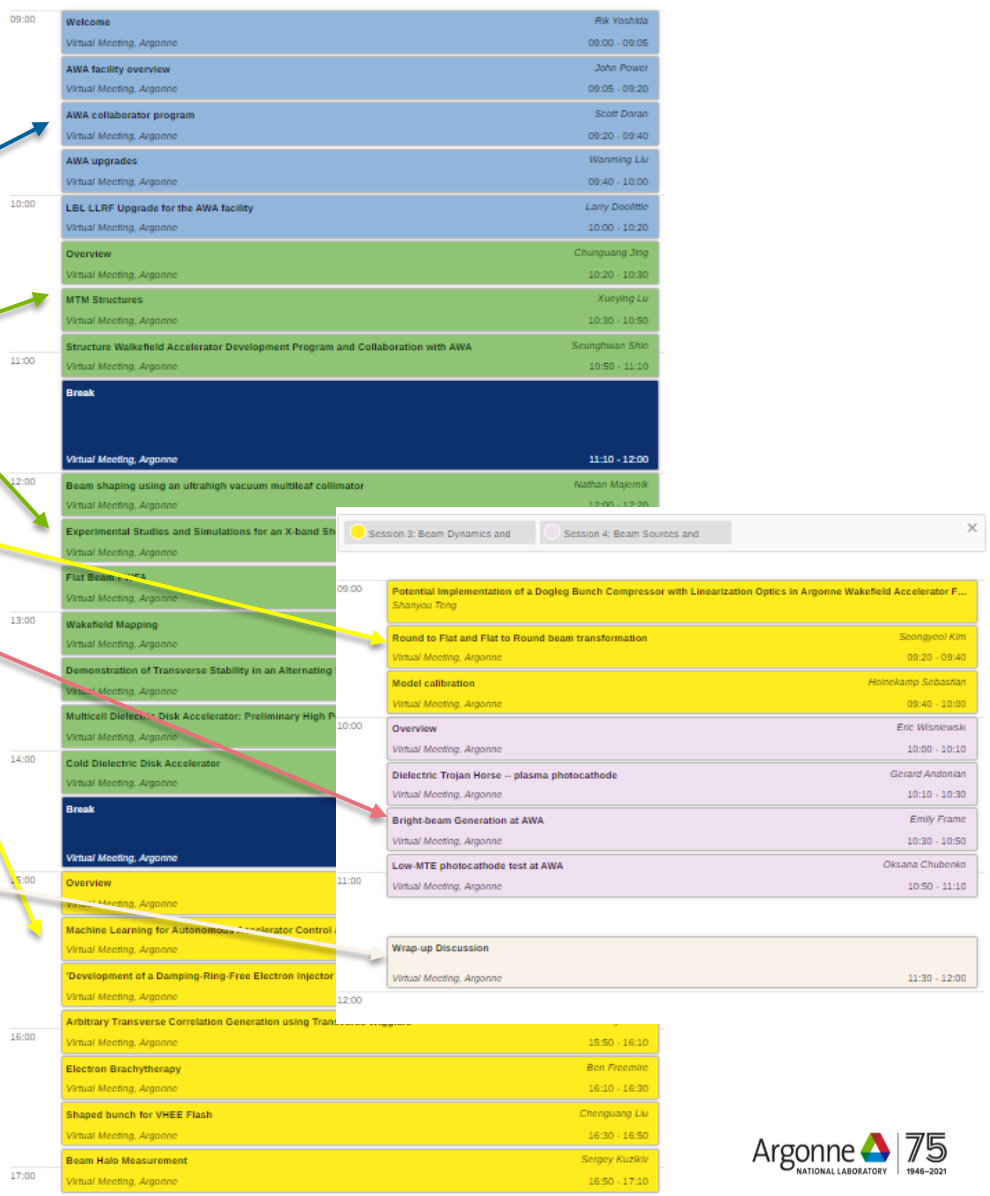
Advanced Acceleration Concepts (chair Chunguang Jing)
Presentations from researchers on AWA Theme 1
THURSDAY 10 AM – 2:20 PM

Beam Dynamics and Diagnostics (chair Philippe Piot)
THURSDAY 3 PM – 5:10 PM
Presentations from researchers on AWA Theme 2

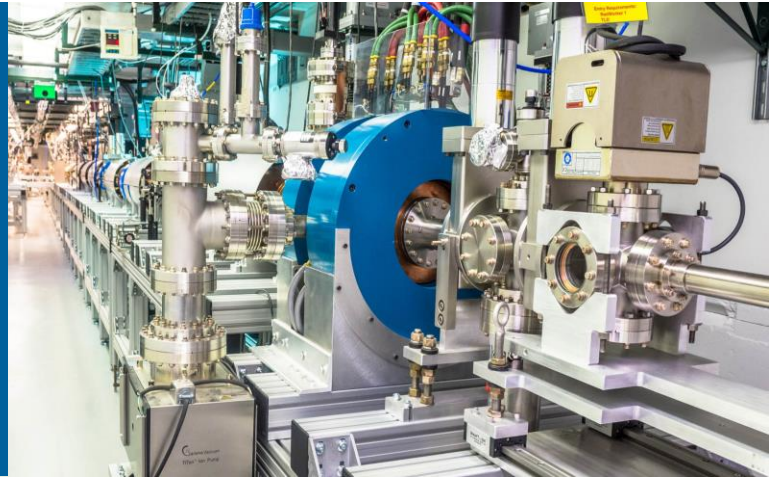
Beam Sources and Applications (chair Eric Wisniewski)
FRIDAY 9 – 11:10 AM
Presentations from researchers on AWA Theme 3

AWA Wrap-up
FRIDAY 11:30 AM – 12 noon
We want to hear what your priorities are for the AWA facility in Session 5.

Adjourn



ARGONNE WAKEFIELD ACCELERATOR OVERVIEW



JOHN POWER

AWA Group Leader
HEP Division
Argonne National Laboratory

August 10, 2023
AWANOW Workshop
via ZOOM

CHARTING THE FUTURE:
AWA'S BLUEPRINT FOR NEXT-GENERATION ACCELERATORS

VISION

Creating tomorrow's accelerators.

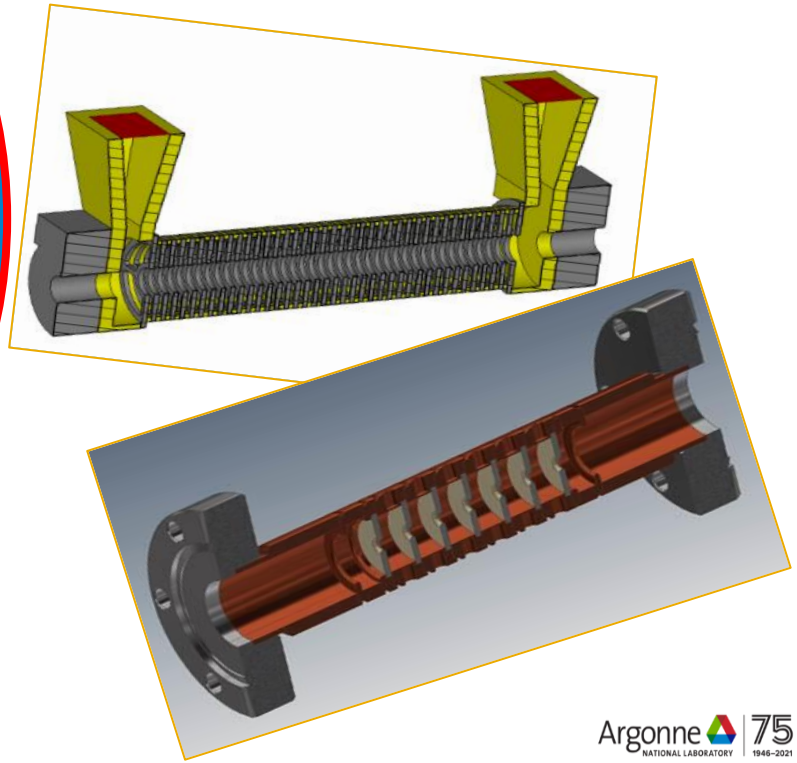
MISSION

Developing the Accelerator Science & Technology (AS&T) of electron beam generation, manipulation and acceleration for beam-driven wakefield acceleration for a future Energy Frontier Linear Collider (LC) and other applications

STRATEGY

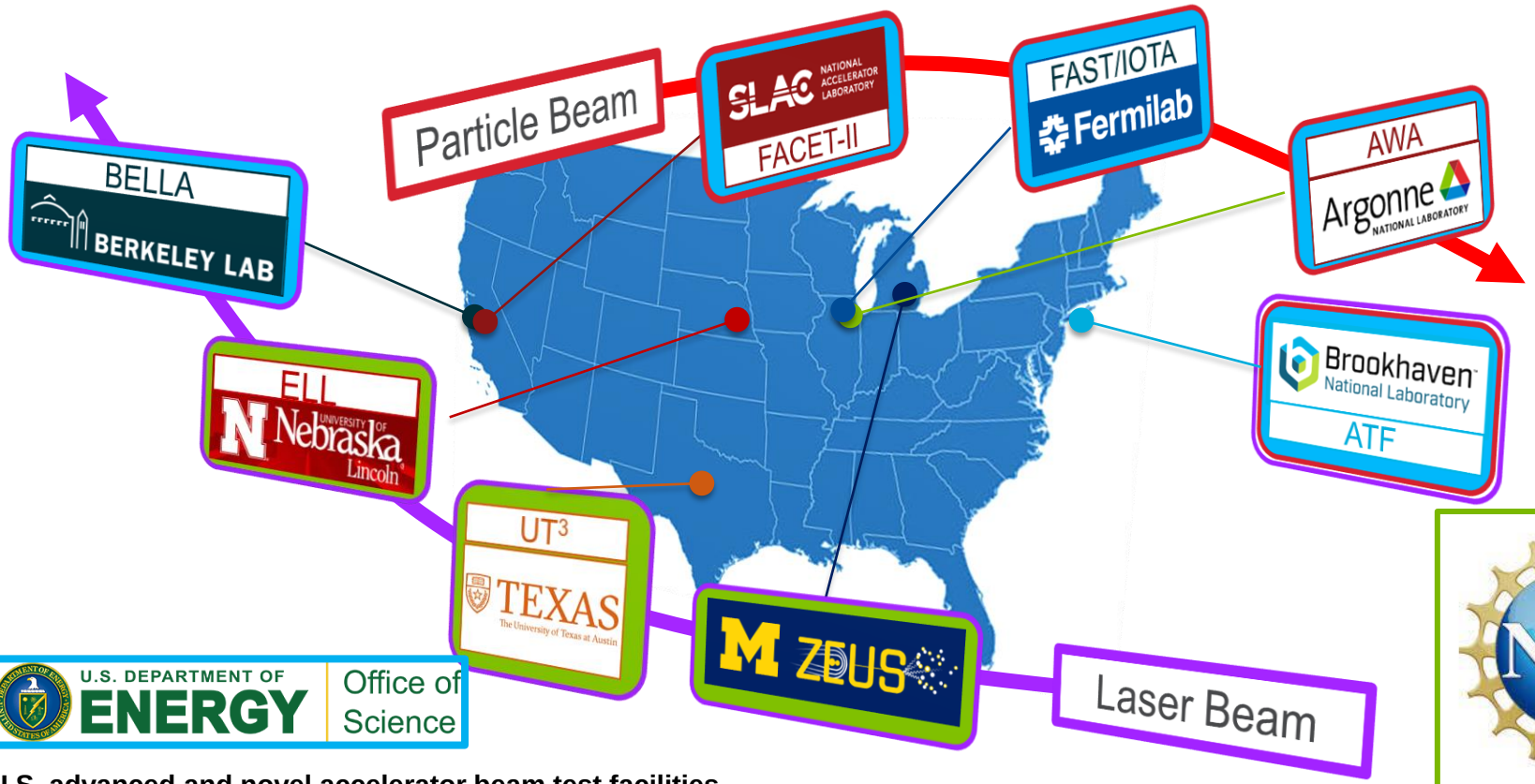
Basic research
&
developing near-term & mid-term applications as stepping-stones towards the long-term e+/e- LC through both in-house and collaborative research.

enabling
GV/m STRUCTURE WAKEFIELD ACCELERATION
to produce
BRIGHT GeV-class ELECTRON BEAMS
at the
ARGONNE WAKEFIELD ACCELERATOR



PREMIER AMERICAN BEAM TEST FACILITIES

Demonstrating the viability of emerging accelerator science ultimately relies on experimental validation.



U.S. advanced and novel accelerator beam test facilities
[C. Clarke et al 2022 JINST 17 T05009, https://iopscience.iop.org/article/10.1088/1748-0221/17/05/T05009]

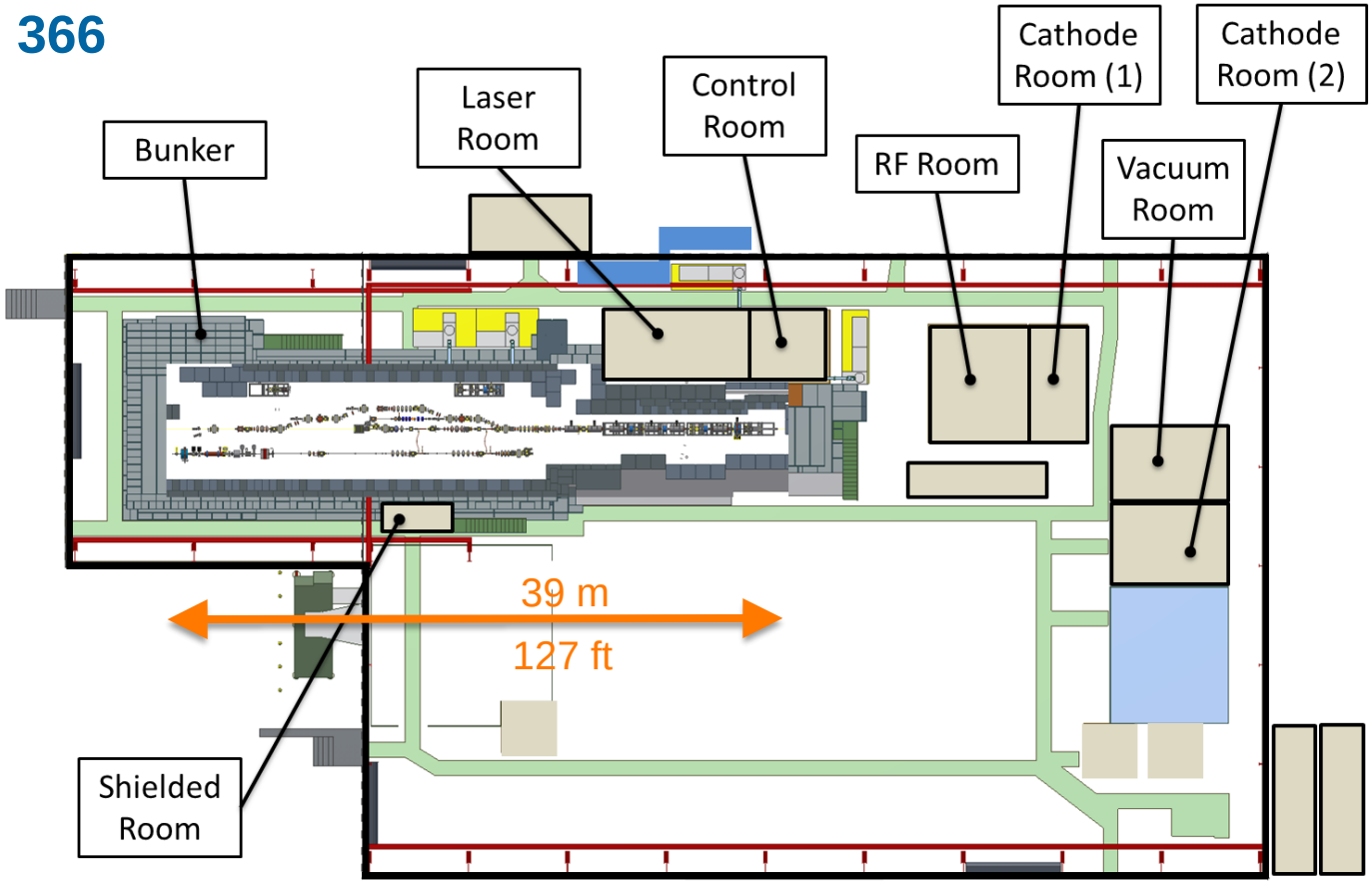
ARGONNE WAKEFIELD ACCELERATOR (AWA)

Located in Chicago Western Suburbs

- 5 accelerators at Argonne

THE AWA FACILITY

building 366



Top view of building 366

THE AWA GROUP

NATIONAL LABORATORY

~10 AWA STAFF
~5-10 AWA students

STRONG INDUSTRY CONNECTIONS

STRONG UNIVERSITY CONNECTIONS

Early Career Award

Advanced Accelerator Concepts

Chunguang Jing
Euclid/AWA

Group Leader

John Power

Beam Physics

Philippe Piot
NIU/APS/AWA

Advanced Accelerator Concepts

Xueying Lu
NIU/APS/AWA

Advanced Accelerator Concepts

Gongxiaohui Chen

Controls & RF Systems

Wanming Liu

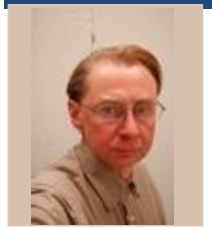
AWA Facility Manager

Eric Wisniewski

Mech. & Civil Engineering

Scott Doran

Making things work



Charles Whiteford

Beam Physics

Alex Ody

New Hire

Joint Appointment

Guest Scientist

AWA RESEARCH THEMES

Long lasting, timeless research themes

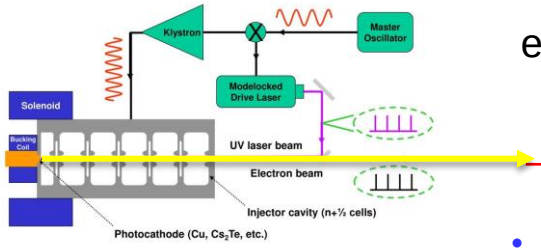
APPLICATION

THEME 3
Beam Production

THEME 2
Beam Manipulation

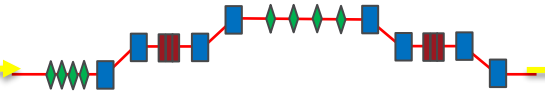
THEME 1
Advanced Accelerator

e.g. RF Photoinjector



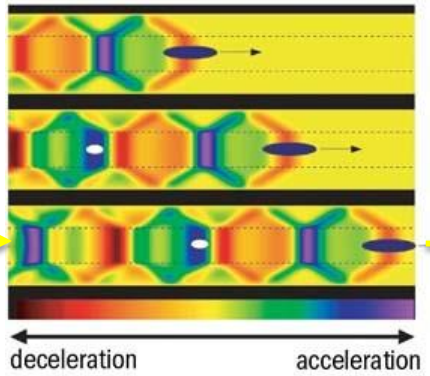
- High-brightness sources
- High-charge sources
- Novel cathodes

e.g. Double Emittance Exchange



- Beam manipulation and control.
- Beam Diagnostics.

e.g. SWFA



- High-gradient acceleration
- High-efficiency acceleration
- SWFA
- PWFA

AWA CAPABILITIES

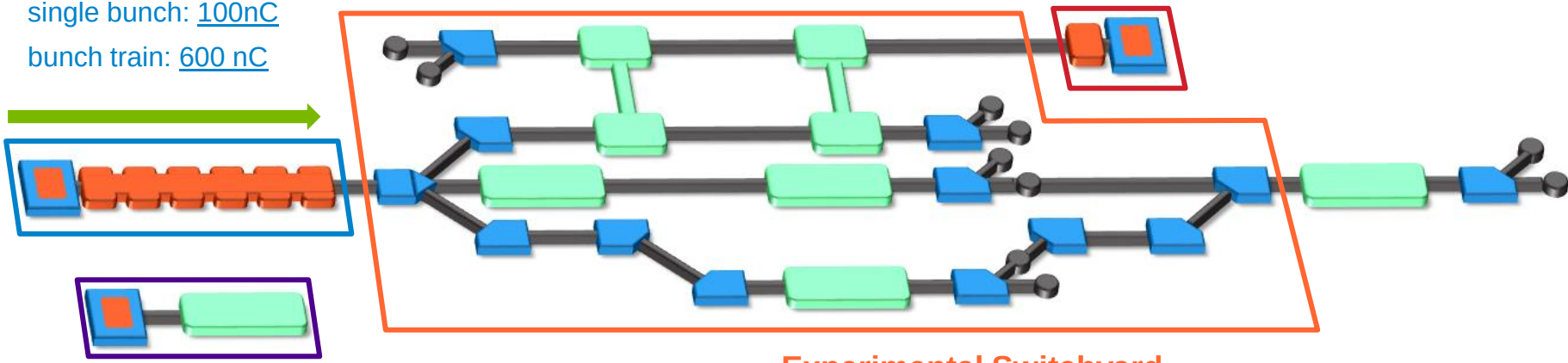
Beam Test Facility to enable novel acceleration

Witness RF photoinjector (15 MeV)

- Provides two-beam capability
- Bright beams for low-energy experiments

Drive RF Photoinjector (65 MeV)

- single bunch: 100nC
- bunch train: 600 nC



Argonne Cathode Test Stand (2-4 MeV)

- Cathode research and diagnostics
- Physics of high-gradient breakdown

Experimental Switchyard

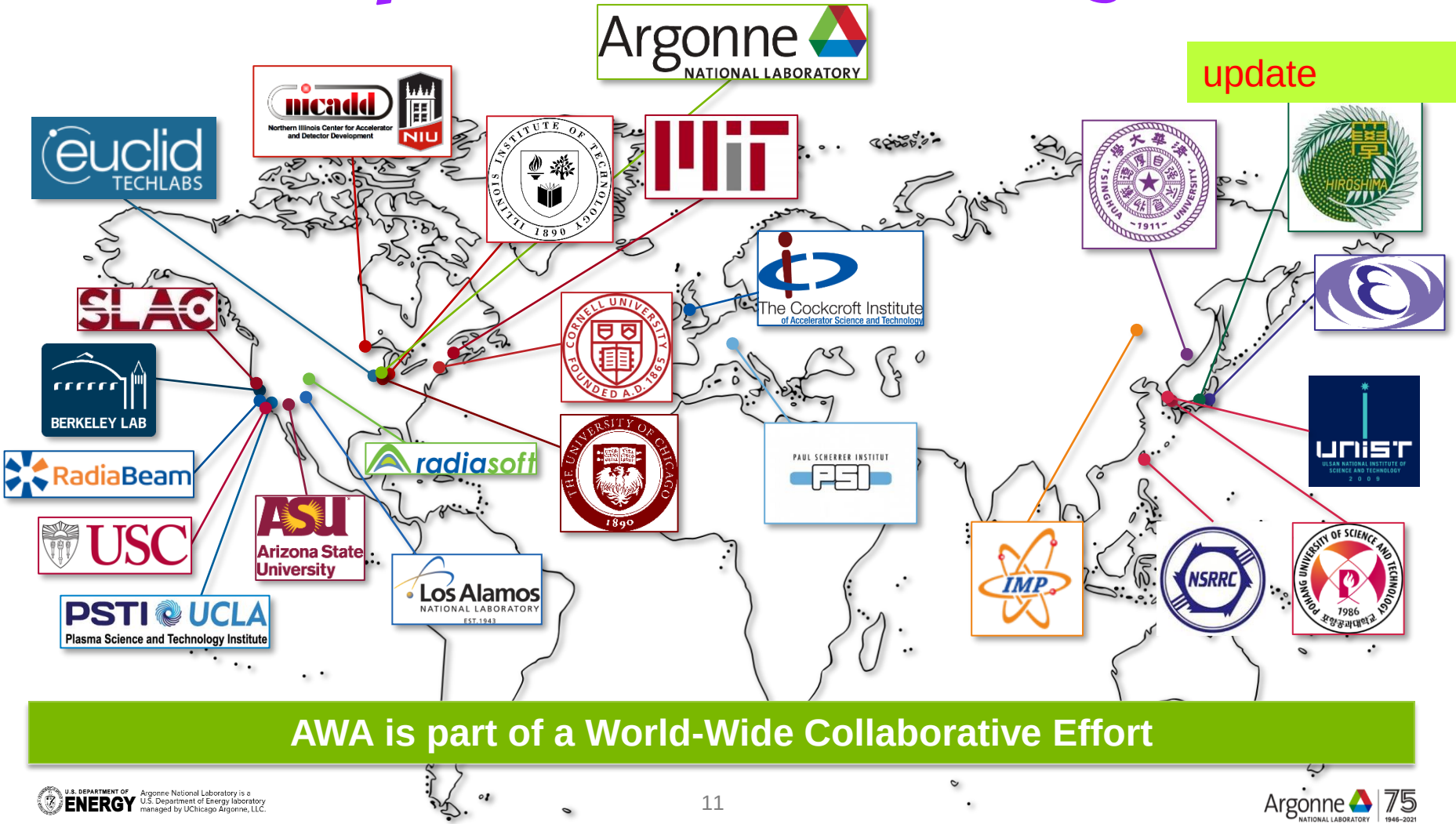
- Highly reconfigurable
- 6D phase space manipulation

AWA COLLABORATOR PROGRAM

see talk by Scott Doran (ANL) next

AWA Collaborators

update



AWA is part of a World-Wide Collaborative Effort

AWA Traineeship Program

Unique student experience due to AWA's small group size

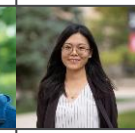
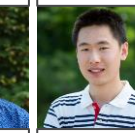
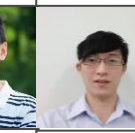
- *Provides a hands-on experience.*
- *Well prepared for research at universities, laboratories and industry.*

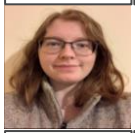
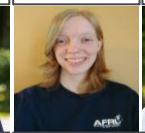
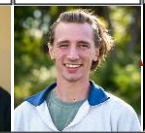
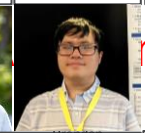
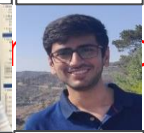
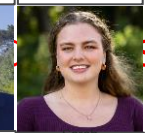
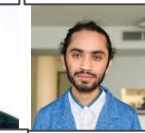
On-going educational support

- Education at all levels: graduate (MS & PhD), undergraduate students, summer interns.
- A yearly average of graduating <u>three Ph.D.'s per year</u>

Chicagoland Accelerator Science Traineeship (CAST)

- Program established between IIT-NIU to train MS students.
- AWA is actively participating in CAST

LBL	IASF	NIU	SLAC	SLAC	Tsinghua	SLAC	NIU	SLAC	Private Sector	AWA	SpaceX	SLAC	SLAC	POSTECH
Tsinghua	Tsinghua	Pohang	NIU	IIT	Tsinghua	UCLA	MIT	MSU	Tsinghua	IIT	MIT	NIU	NIU	UNIST
														
Dan Wang	Jiahang Shao	Gwanghui Ha	Alex Halavanau	Nicole Neveu	Lianming Zheng	Ryan Roussel	Xueying Lu	Mitchell Schneider	Maomao Peng	Chen Gongxiaohui	Julian Picard	Tianzhe Xx	Wei Hou Tan	Jimin Seok
2016	2016	2017	2017	2018	2018	2019	2019	2019	2020	2020	2022	2022	2022	2022

NIU	NIU	UCLA	NIU	NIU	NIU	UCLA	IIT	NIU	PSI	NIU	NIU	U Chicago	NIU
													
Emily Frame	Spencer Kelham	Walter Lynn	Cassie Phillips	Dillon Merenich	Brendan	Pratik Manwani	Sarah	Ian Sugrue	Sebastian Heinekamp	Gaurab Rijal	Tariqul Hasan	Juan Pablo Gonzalez Aguilera	Marc Crowell
Current	Current	Current	Current	Current	Current	Current	Current	Current	Current	Current	Current	Current	Current

ANL community

Scientific collaboration inside ANL (multipurpose lab)

- **Argonne Accelerator Institute** (John Byrd)
  1. **APS** (Advanced Photon Source): https://www.aps.anl.gov/
  2. **ATLAS** (Argonne Tandem Linac Accelerator System) in PHYS: https://www.anl.gov/atlas
  3. **AWA** (Argonne Wakefield Accelerator) in HEP: https://www.anl.gov/awa
  4. **LEAF** (Low Energy Accelerator Facility) in Nuclear Engineering: https://www.ne.anl.gov/facilities/leaf/
  5. **EXM** (Electron and X-ray Microscopy) in CNM: https://www.anl.gov/cnm/electron-and-xray-microscopy
- **Math & Computer Science:** efficient optimization, machine learning, …
- **"User" Applications:** MSD (beam irradiation of samples), APS **(**radiation for medical therapy studies)

Technical expertise inside ANL (multipurpose lab)

- **HEP:** Electronics Group, Mechanical Group, Safety
- **ANL Central Shops:** machining, brazing, welding, metrology
- **APS:** Vacuum Shop (UHV cleaning), Ju Wang (high-voltage test of beam kicker, and bipolar supplies), Alex Cours (klystron modulator circuits), Jeff Dooling (laser diagnostics),
- **PHY:** (radiation shielding calculations for AWA bunker);
- **Other ANL divisions:** CNM (Ultrananocrystalline Diamond for cathodes); ES and CSE: (atomic layer deposition (ALD) to prevent multipacting); ES (tribology and metrology for ILC positron source) CNM (SEM for surface inspection)

AWA UPGRADES

AWA'S PHILOSOPHY OF CONTINUOUS IMPROVEMENTS

see talks by

Wanming Liu (ANL) and Larry Doolittle (LBL)

next

ONGOING UPGRADES

Opportunities for collaborations

Beam Reliability	Beam Quality	Beam Stability	Beam Capabilities

START | PROJECT ---------- FINISH

- FY2018 | Photocathode laser (Vitara oscillator) ---------- **completed 2020**
- FY2019 | RF Photocathode Gun: ---------- winter 2023
- FY2019 | RF Accelerating Cavity: ---------- ---------- winter 2024
- FY2020 | Photocathode Laser Room Temp Ctrl: ---------- **completed 2022**
- FY2020 | Digital LLRF hardware: ---------- spring 2023
- FY2021 | Digital LLRF controls w/ APS and w/ LBL ---------- winter 2023
- FY2021 | EPICS control system w/ APS controls group ------- ---------- **completed 2023**
- FY2021 | High Power RF system w/ APS RF group (Klsytron1) ---------- 2024
- FY2021 | High Power RF system w/ APS RF group (Klsytron2) ---------- 2025
- FY2022 | Photocathode laser (Amplitude Continuum MPA pump) ---------- **completed 2023**
- FY2022 | Multileaf Collimator w/ UCLA ---------- spring 2024

(see W. Liu and L. Doolittle talks)

POTENTIAL UPGRADES

Beam Quality | Reliability | Beam Stability | Capabilities

Near term

Diagnostics and Equipment

- BPM electronics & BPM vacuum hardware
- Online bunch length diagnostic, and Bunch arrival monitor
- 33 GHz oscilloscope
- Laser diagnostics

Beam control

- Beam shaping with multileaf collimator
- Laser shaping with SLM

ACT Gun

- Solid state cathode compatibility (improve vacuum, add load-lock)
- Upgrade energy from 2 MeV → 6 MeV
- Upgrade beamline linac, add TDC for bunch length, add WiFEL spectrometer

Witness Gun

- Solid state cathode compatibility (add load-lock)
- Relocation for TBA

Moderate funding and effort required

Mid term

- Collinear Wakefield Accelerator based energy doubler
- 500 MeV Two Beam demonstrator beamline **(AWA top research priority)**

Far term

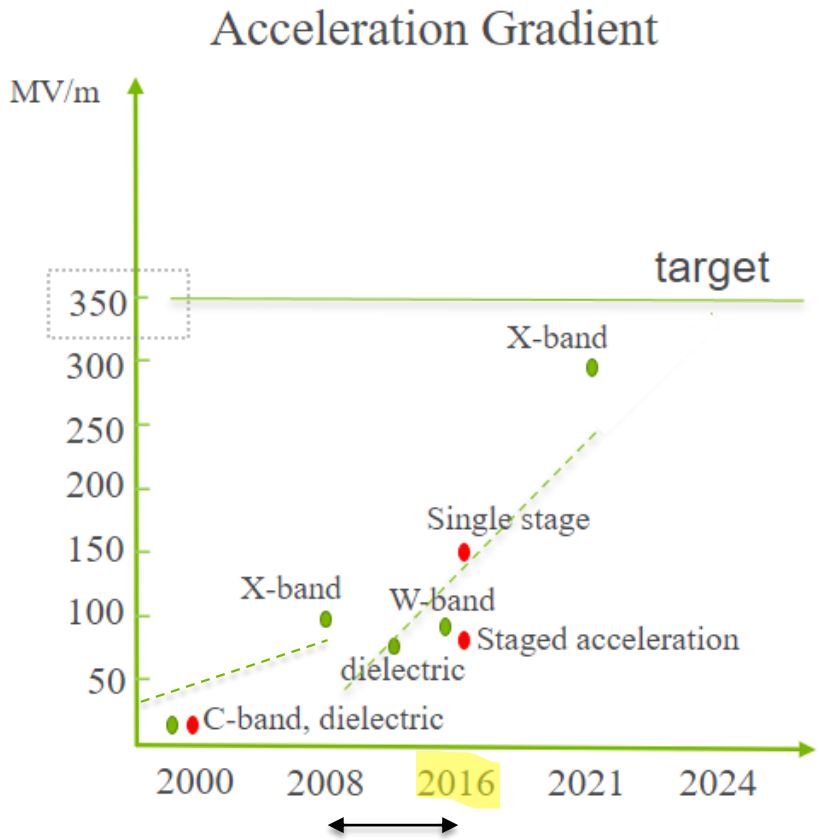
- AWA-II energy upgrade **(AWA top operations priority)**

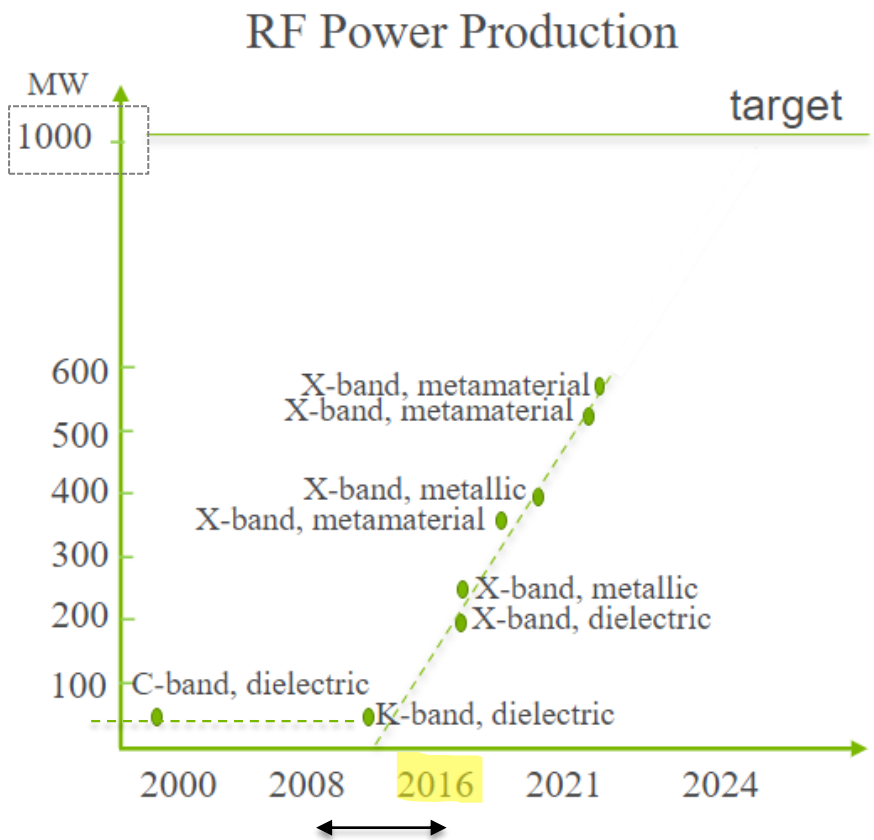
Substantial funding and effort required

WHY DOES AWA NEED AWA-II?

Energy upgrade II

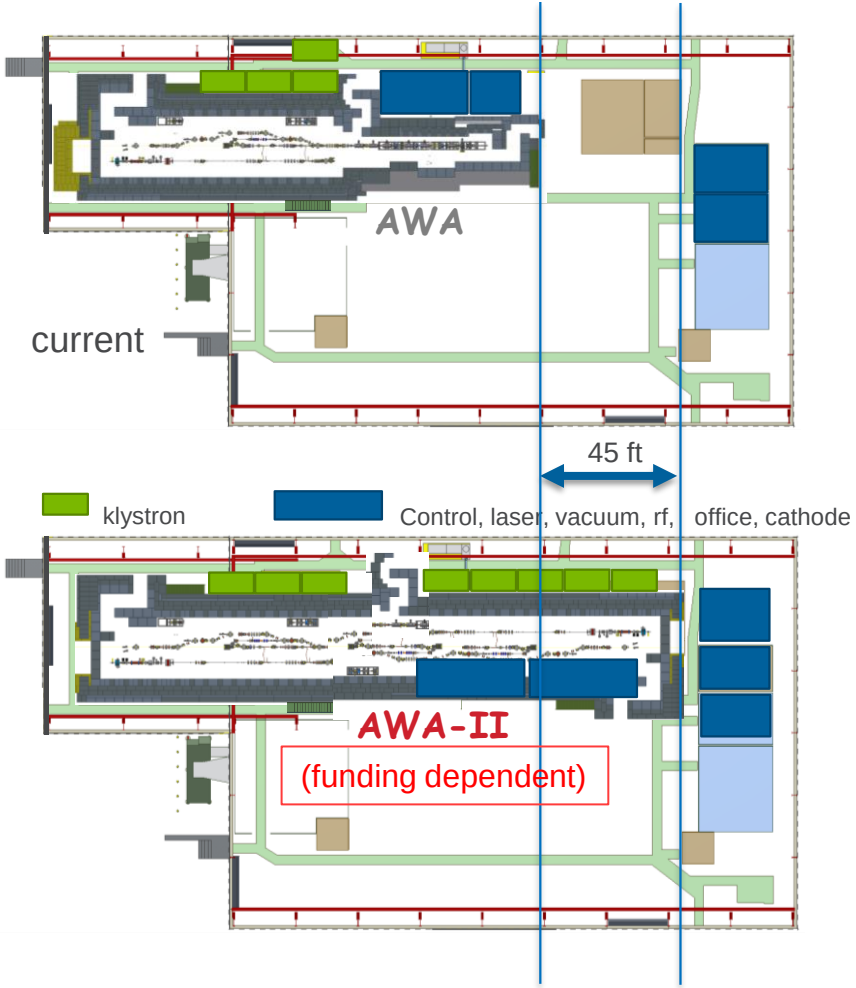
Rapid progress with short pulse TBA since 2016 upgrade (started 2008)





Energy upgrade I

UPGRADES: FAR TERM → AWA-II (funding dependent)



UPGRADE PATH

FY21-26

AWA: Ongoing upgrades

Quality upgrades

- Brightness. Emittance improvement by RF symmetrized gun (AWA) & RF symmetrized cavities (LBNL)
- Stability. New RF synchronization system (LBNL BACI), RF Station stability project (APS RF group)

Capabilities upgrades

- Extended Bunch shaping. (SLM based Laser shaping, TDC shaping, EEX multi-leaf Collimator, etc.)
- Machine Learning. For machine control, virtual diagnostics and physics (EPICS upgrade w/ APS Controls group)

>FY26

AWA-II: High energy version of AWA

- 65 MeV → ~150 MeV
- Tighter focus for acceleration research
  - **High-quality ~1 GeV TBA demonstrator (roadmap)**
  - **Allows SWFA to enter GV/m regime**
  - **High beam density needed for PWFA**
- Increase the size the experimental switchyard

SUMMARY: WE WANT YOUR FEEDBACK

Collaborations

- A mix of in-house and collaborative research towards future accelerators

Traineeship

- AWA welcomes and supports students

Upgrades

Beam Reliability	Beam Quality	Beam Stability	Beam Capabilities

The 10,000-foot view of AWANOW

STEP 1: AWA updates you on facility (Session 1, this one)
STEP 2: You tell AWA how your concept or project could be tested at the AWA (Sessions 2,3,4)
STEP 3: wrap up discussion (close-out on Friday)

- Give us comments on ELD, computer support, mechanical support, traineeship, upgrades, equipment, etc.