



# Snowmass Community Planning Meeting: Education, Outreach, and Diversity Session US Particle Accelerator School Needs



Slides ([Dropbox Link, pdf](#))

**Prof. Steven M. Lund**

Director, US Particle Accelerator School / Fermilab

Michigan State University / Physics & Astronomy / Facility for Rare Isotope Beams

SLAC

Monday, November 22, 2021



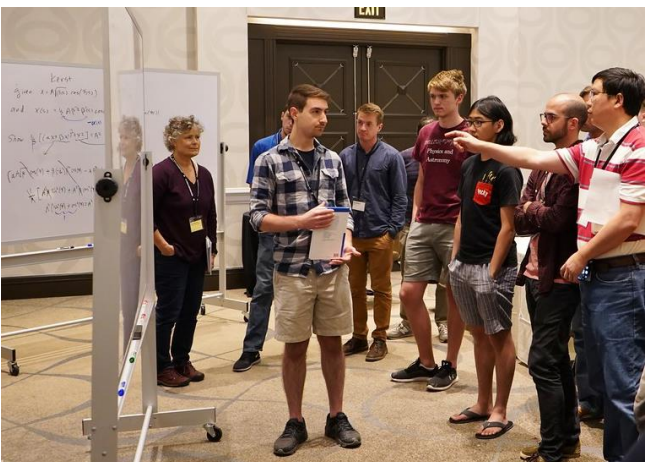
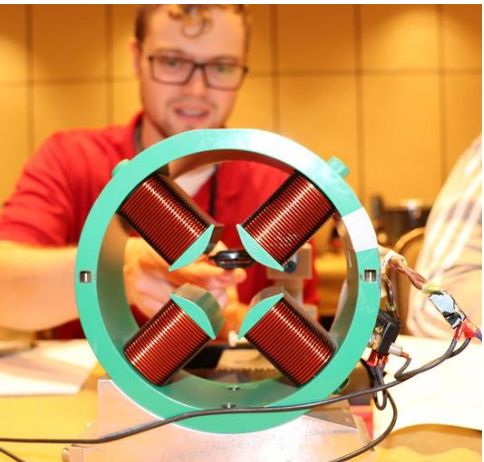
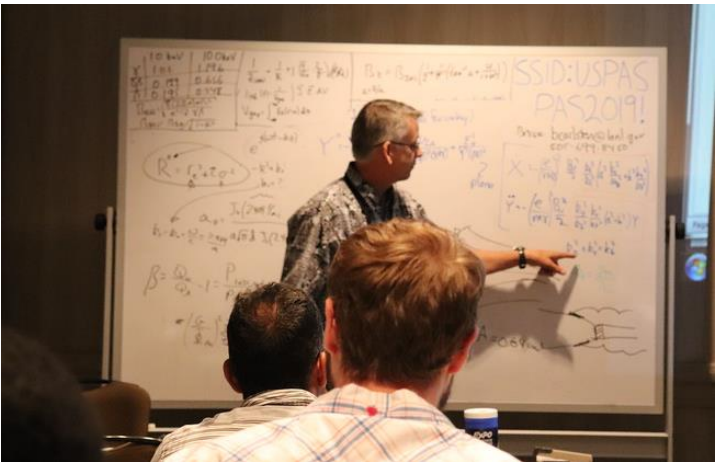
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# Outline

## 1. Overview of the US Particle Accelerator School (USPAS)

## 2. Discussion on USPAS Needs



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# Outline

1. Overview of the USPAS
2. Discussion on USPAS Needs

USPAS Web Site  
<http://uspas.fnal.gov/>



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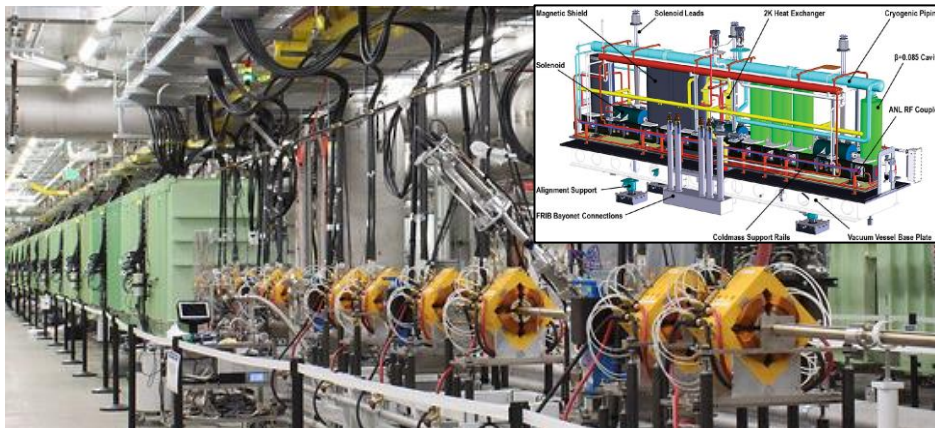
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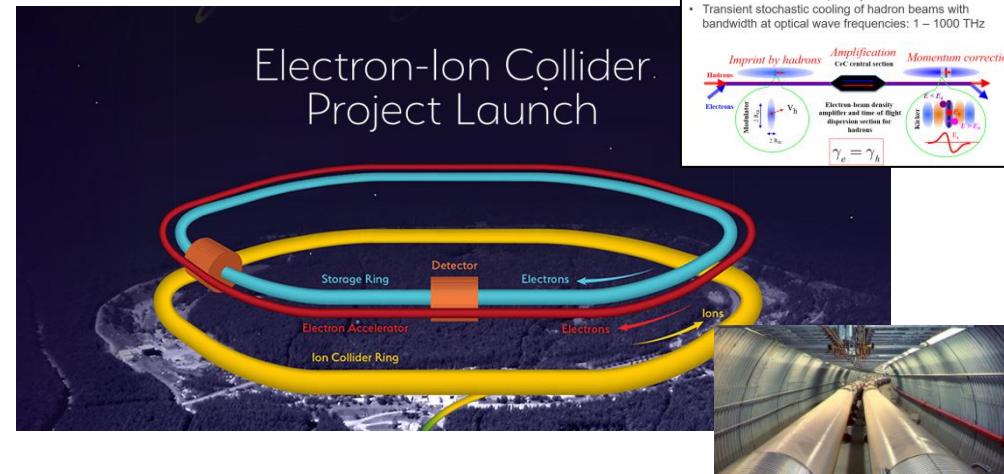
# Training the accelerator workforce is critical to USA technical leadership

- **Accelerator Workforce ~ 2,500 +**
  - DOE Labs have older workforce demographics
  - **Train ~ 5-10% workforce/year just to maintain level**

FRIB @ MSU



EIC @ BNL



- **Accelerators challenging to Design, Build & Operate**
  - Efficient, and cost-effective operation and extension key
  - Need workforce of world leading scientists & engineers with specialized training

*The USA must have an outstanding  
accelerator workforce development program*

# Core skills for the Accelerator Workforce

## Physicists

- Electromagnetism & Electrodynamics, Relativity, Hamiltonian Mechanics & Action-Angle Formulations of Dynamics, Applied Math, Numerical Methods

## Electrical Engineers

- RF (Resonant Cavities, Waveguides, Transmission Lines & Antennas), Electronics, Signal Processing, Power Electronics, Pulse Power

## Mechanical Engineers

- Structures, Alignment/Tolerances, Heat Transfer & Thermodynamics, Fluids, Vacuum

## Computer Scientists

- Software, Computer Controls, Data Science, Optimization & Machine Learning

## Safety & Management

- Radiation, Personnel & Machine Protection, Regulations, Project Management

## Operators

- Undergrad & Grad-Level Core Physics, Technology, Design, Accelerator Operations

## Technicians

- Basic Engineering & Physics Concepts, Hands-on Training

***+ All need specialized courses for effective training***

# University programs are insufficient to train accelerator workforce in specialized needs

Only small number of university basic accelerator courses

- Typically only limited students every few years even in larger centers and core topics like *Accelerator Physics* etc.
- **Situation worse for key specialty classes:**

Examples: *Photocathode Physics, Space-Charge Effects, RF Power Engineering, Cryogenic Engineering, ...*

Training in field can be provided by:

**Self-Study**

**Apprenticeship/On-Job**

**Regional / International Accelerator Schools**

**Mel Month,  
Founding Director**



*The USPAS was formulated to provide high-quality training for the community*



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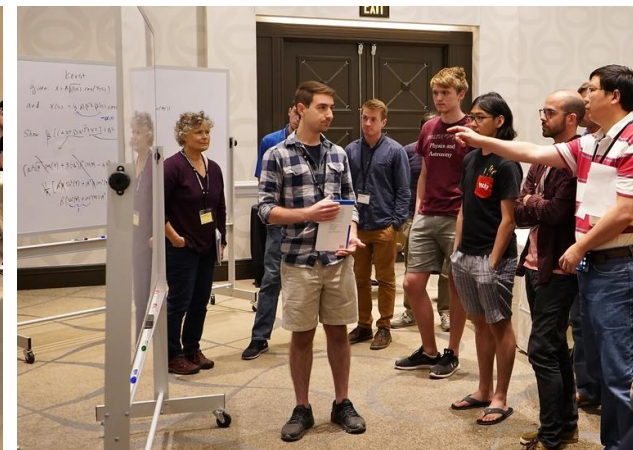
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# The US Particle Accelerator School (USPAS) trains specialists in Accelerator Science & Technology

- **USPAS is recognized as world leading**
  - Formed out of necessity
  - Present format since 1987 (63 Sessions, 642 Courses)
- Holds **two, two-week intensive sessions** per year:
  - Winter** (January)
  - Summer** (June)
- Sessions move around country near Accel facilities
- Linked to host universities providing graduate credit



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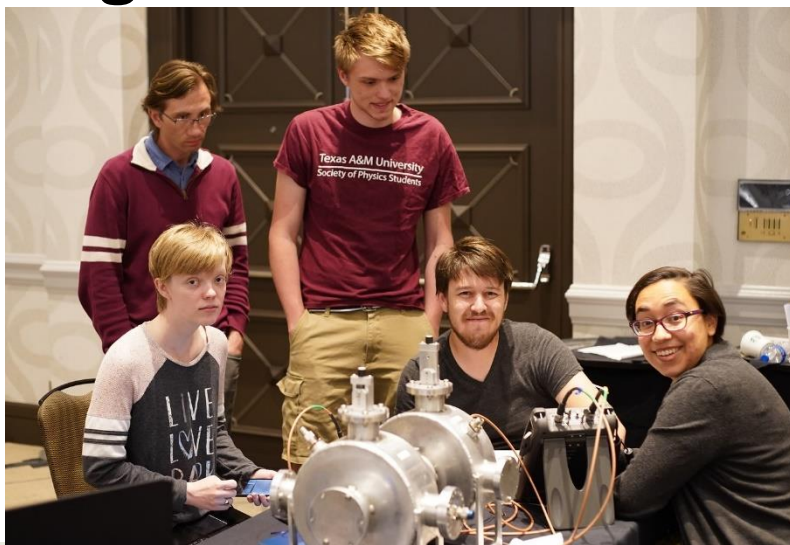
# Most USA specialists in Accelerator Science and Engineering pass through USPAS several times

- **Topics covered from basic to advanced specialized courses that cannot be regularly taught at Universities**

Microwave Measurements  
RF Cavities and Components  
Photocathode Physics  
Space-Charge Physics

Wakefield & Plasma Acceleration  
High Brightness e- Injectors  
Engineering for SRF Linacs  
Magnetic Systems

- **A “critical mass” of highly motivated students from all over gather to learn in academically rigorous classes**



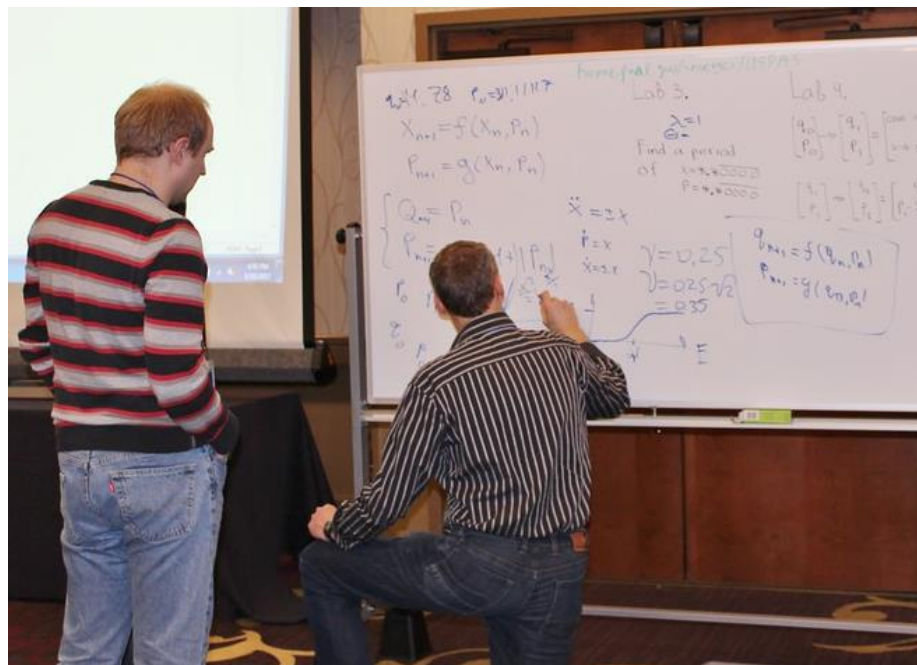
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# USPAS students study long hours in our 2-week intensive sessions – typically beyond hours in Universities



- **~45 hours instruction for 3 semester hours in Universities**
  - USPAS often ~ 65+ engagement hours
- **Intensive format does have issues:**
  - Rapid pace (2 weeks) relative to semester (~15 weeks) leaves little time for concepts to “sink in”
  - But abbreviated period enables Lab instructors to participate



# USPAS distinguished from a plethora of international AS&E schools by academic rigor

- **Many international accelerator schools** (primarily Europe)

  - CERN Accelerator School (CAS)

  - Joint Universities Accelerator School (JUAS)

  - International Accelerator School (IAS) ... USPAS linked

  - Nordic Particle Accelerator Project (NPAP)

    - + Massively Open Online Course (MOOC)

  - Korea Particle Accelerator School (KoPAC)

  - Accel Innovation and Research for European Society (AIRES)

  - ... + More and Growing ...

**Most closer to seminar series** (JUAS exception)

Contrast: **USPAS hours, homework & exams ~ University Format**

- **USPAS is a rigorous academic school**

  - **Grades motivate students** for max effort compressed into 2-week session with minimal time away from institute / university activities

  - **Major research universities** “host” session to **convey credit**

    - » 3 semester hour credit for full session is transferrable



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# The USPAS is funded by the DOE Office of High Energy Physics and administered by Fermilab

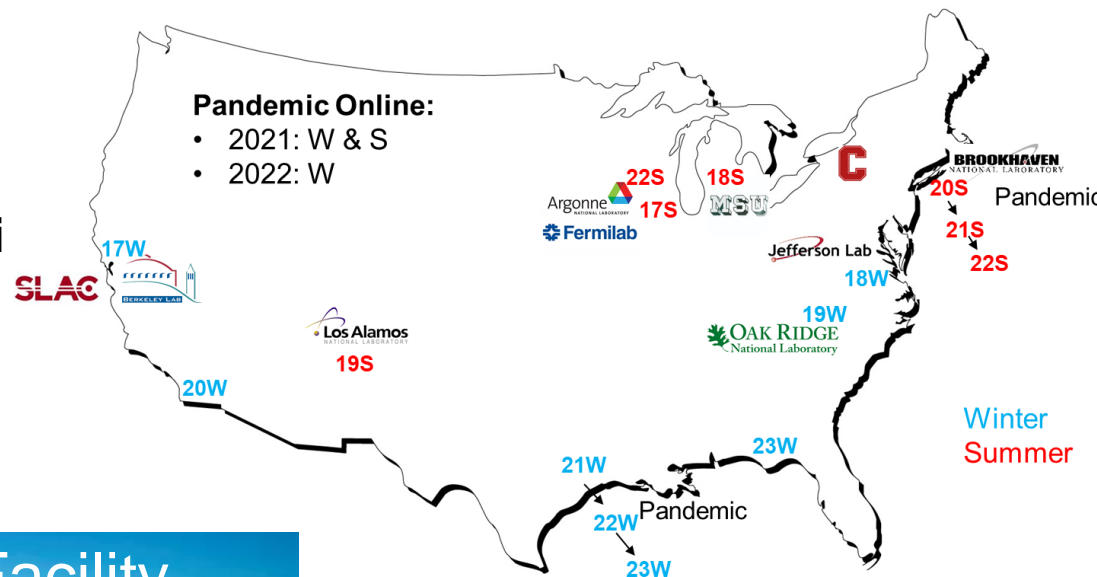
- **DOE High Energy Physics is steward of accelerator R&D**
  - USPAS funded to support Accelerator Science & Engineering
  - Stable \$1.014 M FWP since FY17
- **USPAS office at Fermilab, sessions near accelerator labs**

- Typically at Hotel/Conf Centers

- **Director (3/4-time) Steve Lund & Two (full time) Office Staff**

Susan Winchester

Irina Novitski



USPAS Office in IARC Facility

- DOE lab instructors benefit from teaching experience
- High fraction DOE workforce passes through our sessions



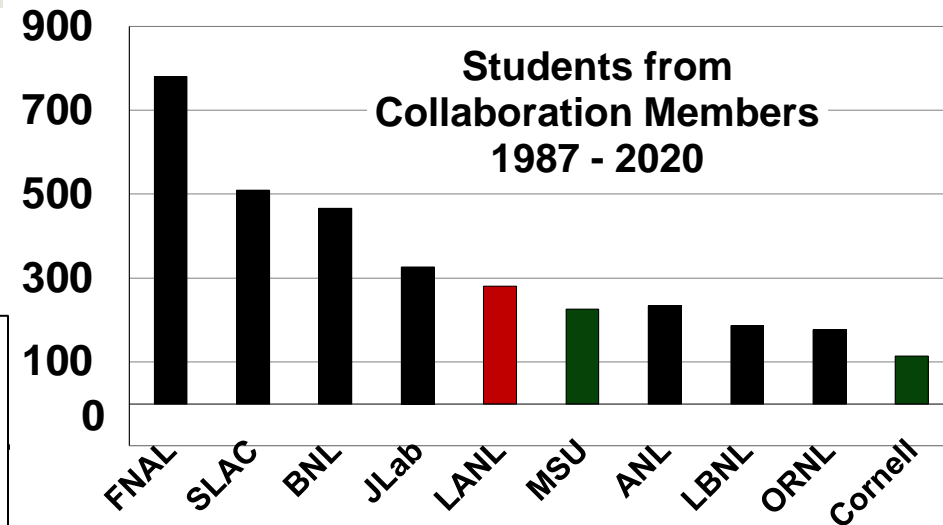
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# The USPAS is governed by a collaboration of labs/Universities via a signed MOA

## ■ Collaboration members (10):

ANL	LBNL	SLAC
BNL	LANL	JLab
Cornell	MSU	
Fermilab	ORNL	

DOE Lab  
University  
(NSF / DOE fund)  
NNSA Lab



## ■ Governing bodies ensure broad AS&T representation

- **Advisory Council (10):** *Advise director + collaboration interface*
- **Curriculum Committee (11):** *Input on school curriculum*
- **Institutional Board (5):** *Grade school performance*

## ■ Free to join collaboration (post FY16 DOE reorganization), **BUT:**

- **Expected to support staff (time + travel) who teach / study**
  - » USPAS budget insufficient to pay for teaching
  - » Augments USPAS student support
- **Take part in school governing bodies**
  - » Helps ensure representation of collaboration member needs

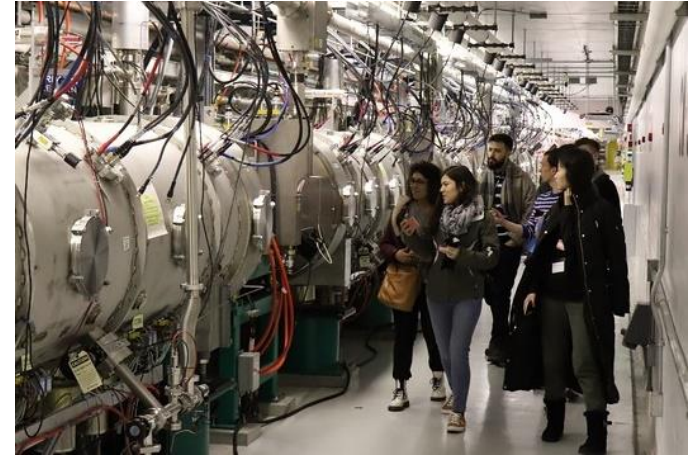
# Example: Winter 2019 Session: Knoxville, TN

## NIU+UT-Battelle Sponsor, Jan 21-Feb 1, 2019

[Link to Session Page \(USPAS Website\)](#)

[Link to Opening Session Talk \(Lund Dropbox pdf\)](#)

### SNS Tour



### ➤ 13 Courses:

- Two-week: 3
- One-week: 10

### ➤ 45 instructors, TA's, Graders

- Web site credit (mostly Instructors): 36
- Non-credited (mostly Graders, some TA's): 9

### ➤ 161 students: **6<sup>th</sup> Largest Session Ever:** Typical larger pre-pandemic size

- 78 (48%) Universities
- 62 (39%) National Labs
- 21 (13%) Industry (13), Foreign Labs (5), Military (2), Gov (1)
- 
- 21 (13%) International [Europe (10), Americas (8), Asia (1), Aus. (1), Middle East (1)]
- **38 (24%) Women**



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# Winter 2019, Knoxville

## Typical recent larger session

### Two-Week Courses

Expanded Team: **Fundamentals** (undergraduate level) [Students = 19]

Cousineau<sup>W</sup>, Holmes, Evans, Ruisard<sup>W</sup> (ORNL)

### **Accelerator Physics** [23]

Peggs (BNL); Satogata (Jlab)

Expanded Team: **Magnet & RF Cavity Design** [27]

Holzbauer, Badgley<sup>W</sup>, Berrutti (Fermilab)

### One-Week Half-Courses

### **NEW: High-Power Targets** [19]

Riemer; Winder; Iverson; Gallmeier (ORNL); Hurh, Ammigan (Fermilab)

### **NEW: Precision Storage Rings -- Muon g-2** [8]

Syphers (NIU/Fermilab); Stratakis (Fermilab); Rubin (Cornell)

### **NEW: Undulators for Storage Ring & FEL Light Sources** [11]

Gluskin, Sajaev (ANL)

### **Beam-Based Diagnostics** [20]

Steier (LBNL); Safranek, Huang (SLAC)

### **NEW: Wakefields & Collective Beam Instabilities** [13]

Stupakov, Baxevanis (SLAC)

### **NEW: Neutrino Beams** [13]

Zwaska, Fields<sup>W</sup> (Fermilab)

### **Integrable Particle Dynamics** [11]

Nagaitsev, Zolkin (Fermilab)

### **Principles of Superconducting Linear Accelerators** [11]

Kim, Doleans (ORNL)

### **NEW: Engineering of Beam Diagnostics** [14]

Wendt (CERN); Zorzetti<sup>W</sup>, Thurman-Keup (Fermilab)

Expanded Team: **EPICS Control Systems** [20]

Kasemir, Sinclair, Vodopivec (ORNL)

6 **NEW** Classes

3 Expanded Team

4 **Red**: ORNL led classes

13 **Red**: ORNL Instructors

13 ORNL-linked students

2 Industry Student Scholarships

RadiaBeam Technologies

Radiasoft

5 woman Instructors

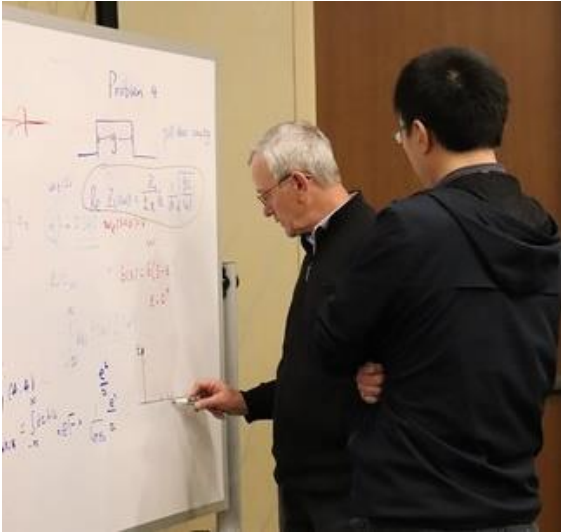
(<sup>W</sup> superscripts)

Tour to SNS

80+ Students

# Highlights of 2019W Knoxville Session

**Stupakov in *Wakefields*:**  
Domestic team in need area



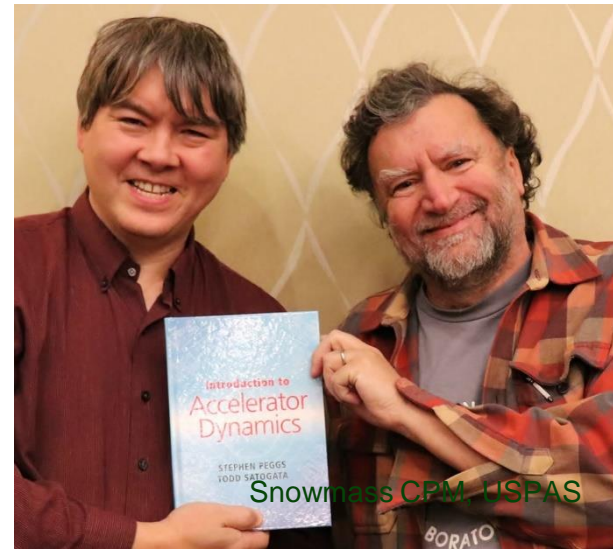
***Cavity & Electromagnet Design*:**  
large (25) engaged class



**ORNL SNS Tour** well attended & Cousineau  
Later announces **APS DPB Scholarships**

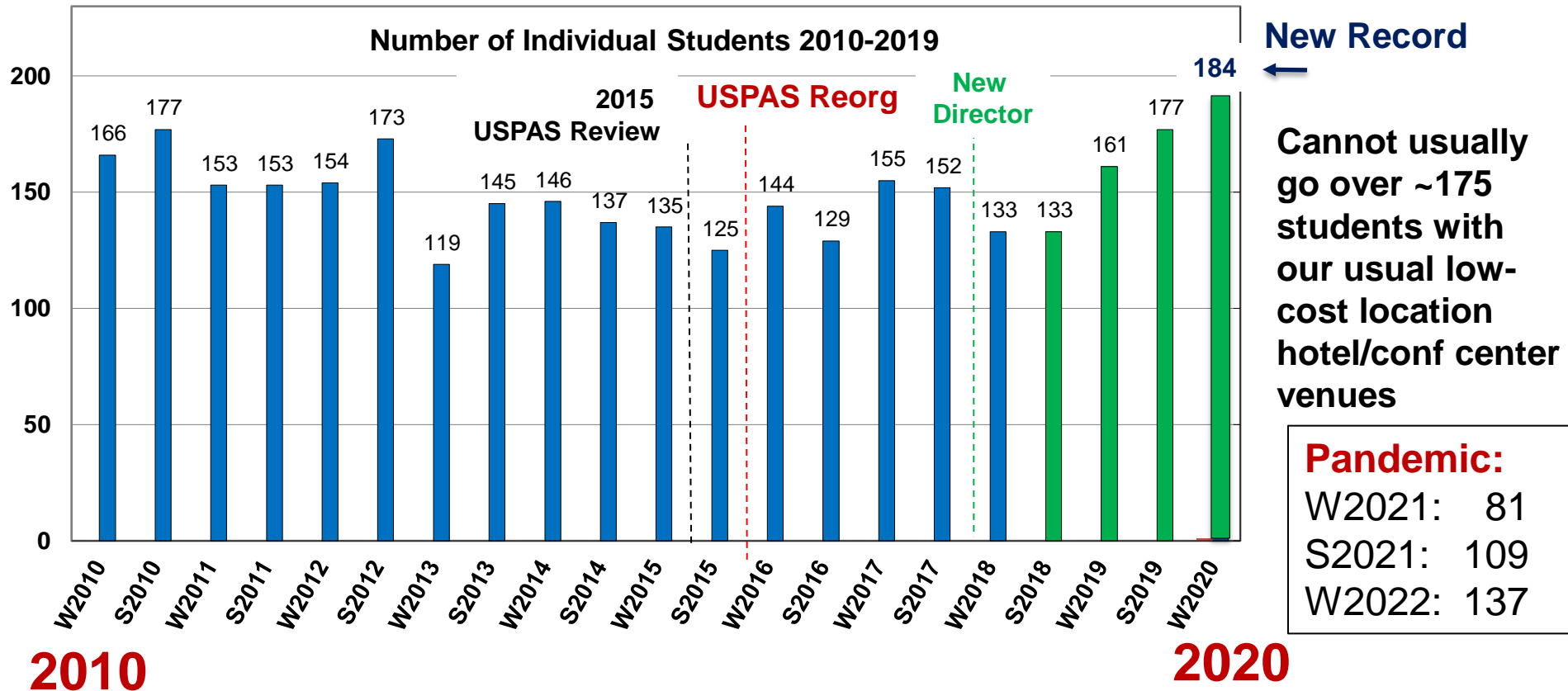


**Peggs & Satogata, *Accel Physics***  
use new book: ultra-high rated class



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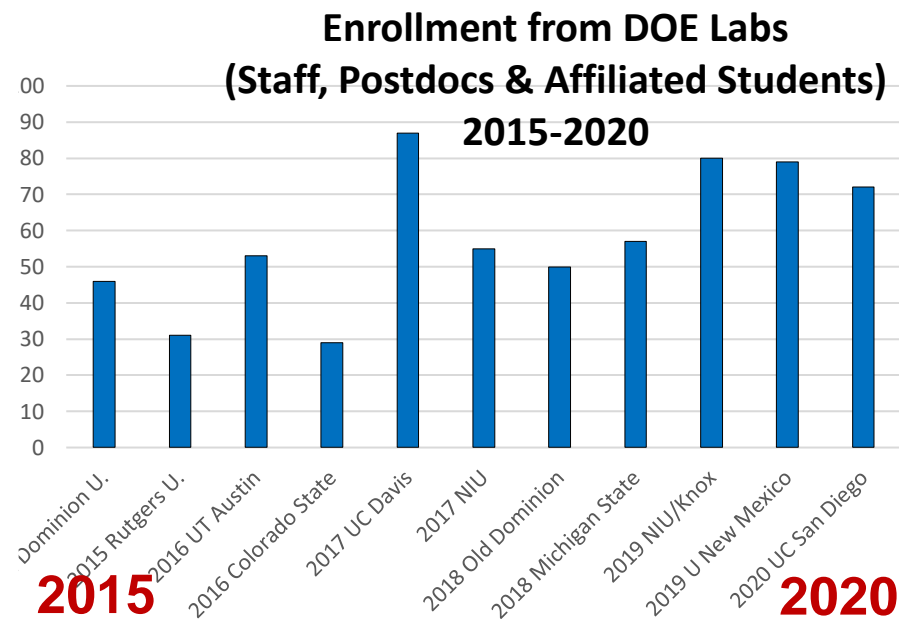
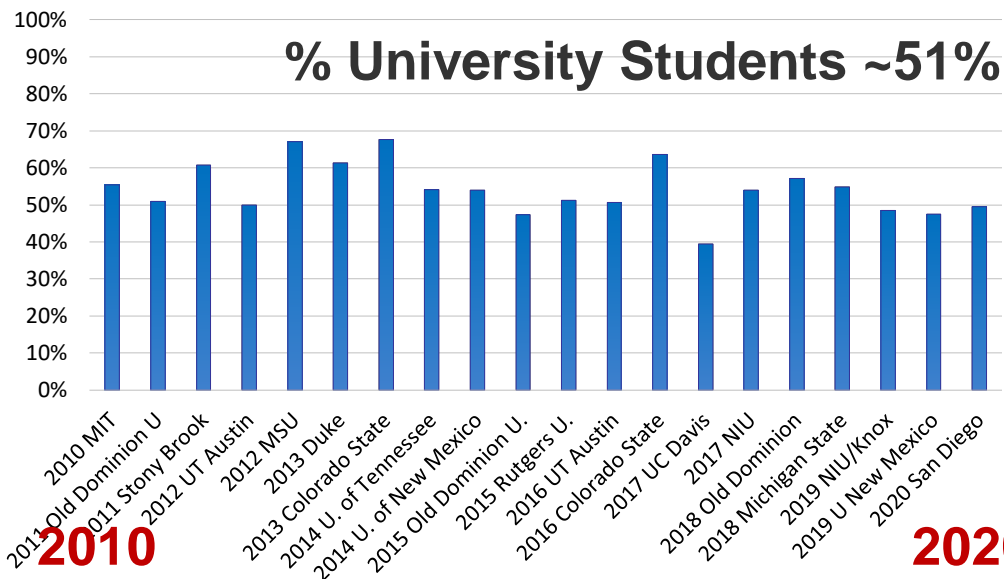
# Pre-Pandemic USPAS Sessions Large which serves DOE workforce training needs



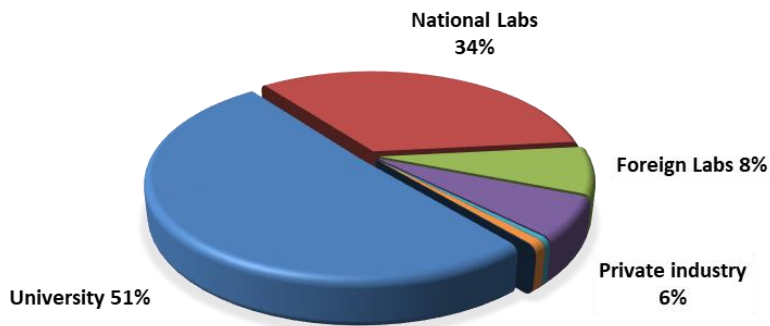
- High demand for AS&E training + USPAS** driven by
- Lab Accel Projects + Lab Workforce Demographics
  - 4 DOE Traineeships (MSU / NIU-IIT / SBU-Cornell, ODU)
  - IU-USPAS MS program + Center Bright Beams



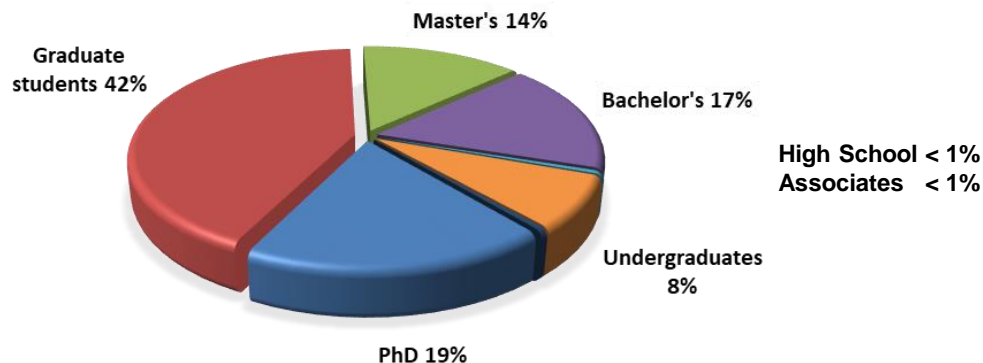
# Students are primarily drawn from universities and national labs with a range of preparation



**AFFILIATION STATUS 2015-2020**



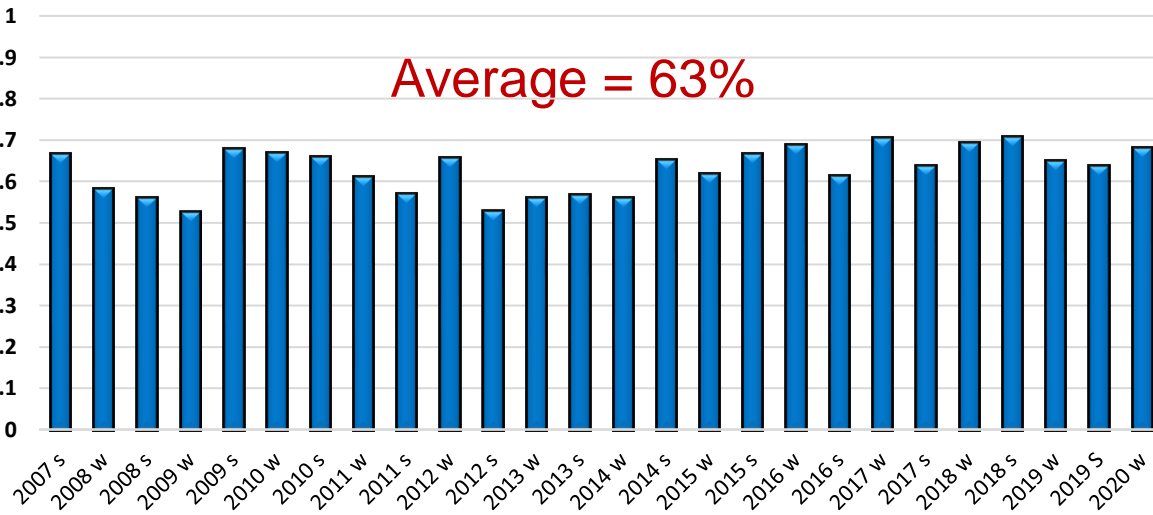
**EDUCATION LEVEL 2015-2020**



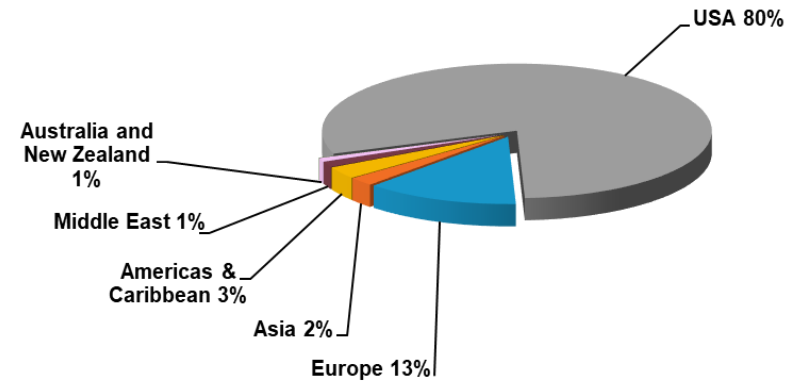
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# USPAS students are primarily domestic or domestic-University enrolled

## Domestic students with USA citizenship



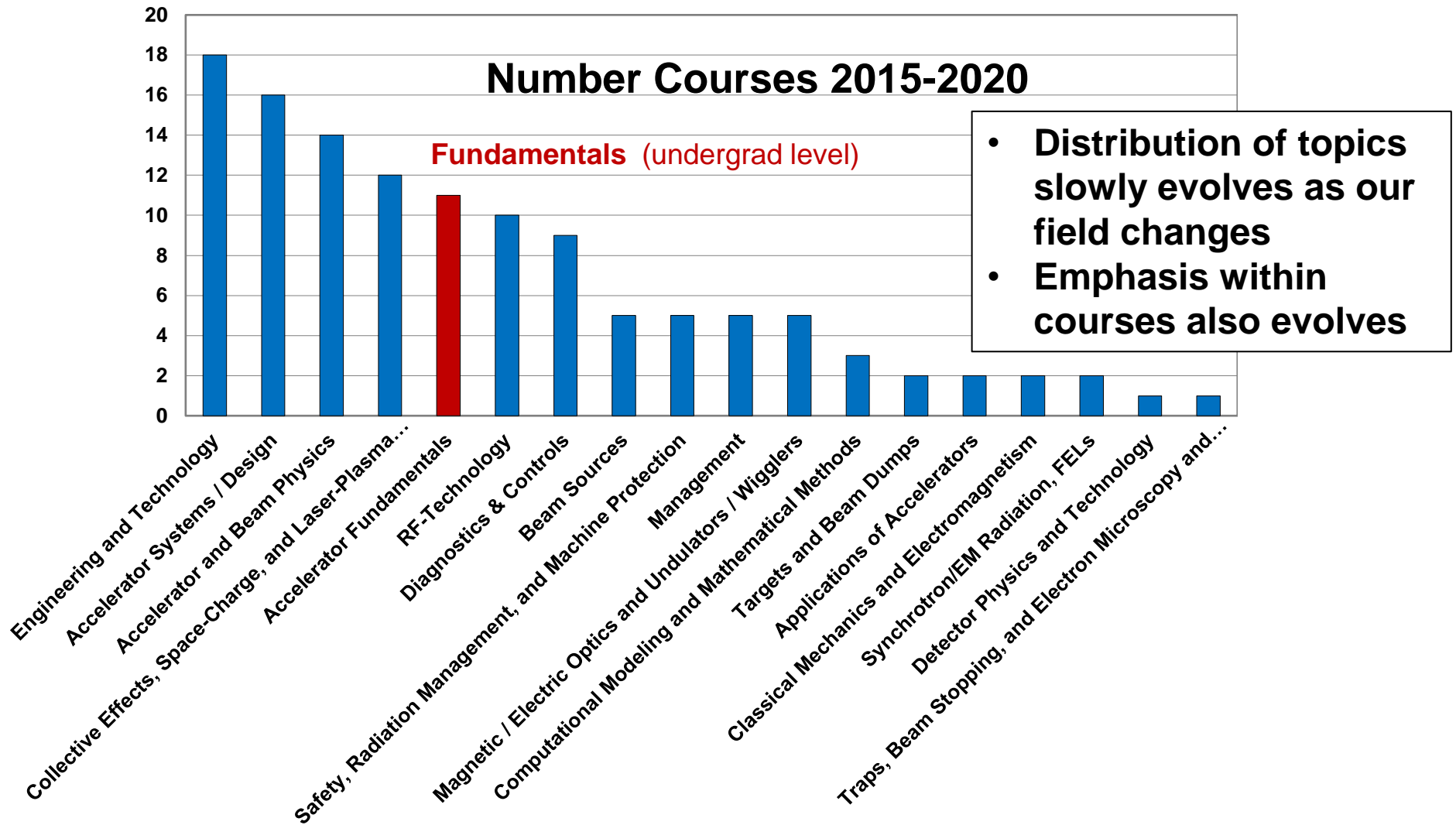
## All Attendees 2015-2020



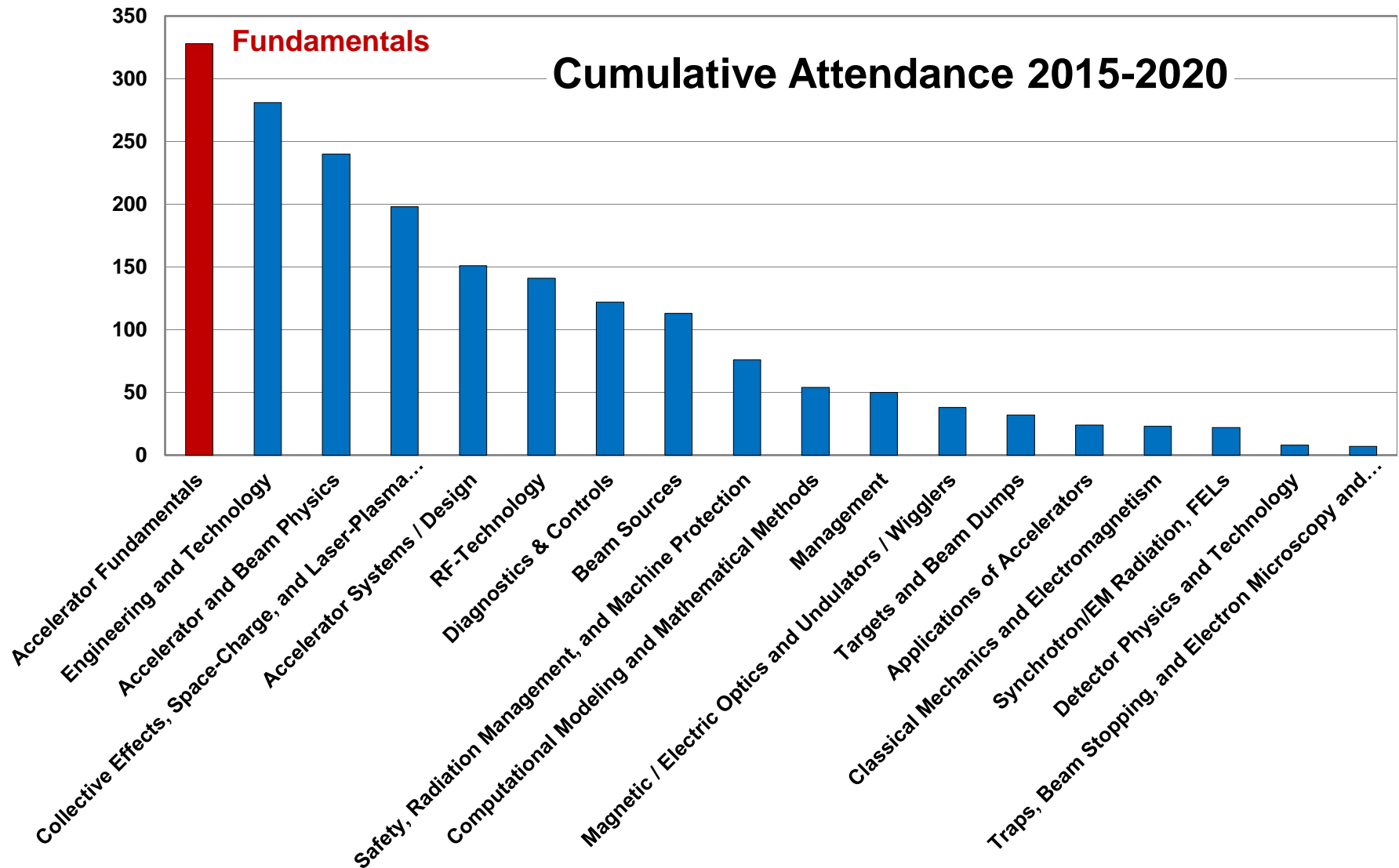
**USA 80%** includes international students enrolled in USA Universities

*Most USPAS students are interested in employment in USA National Labs & Universities*

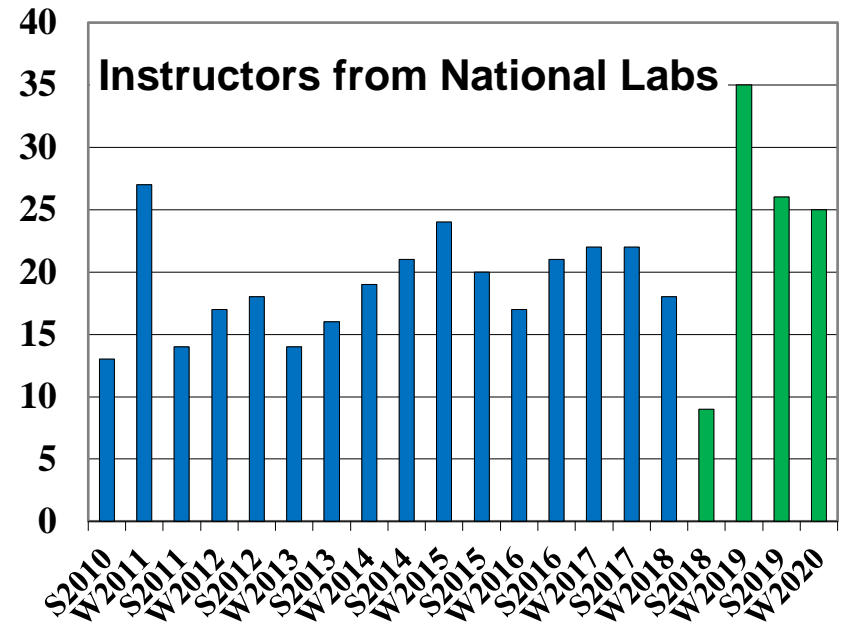
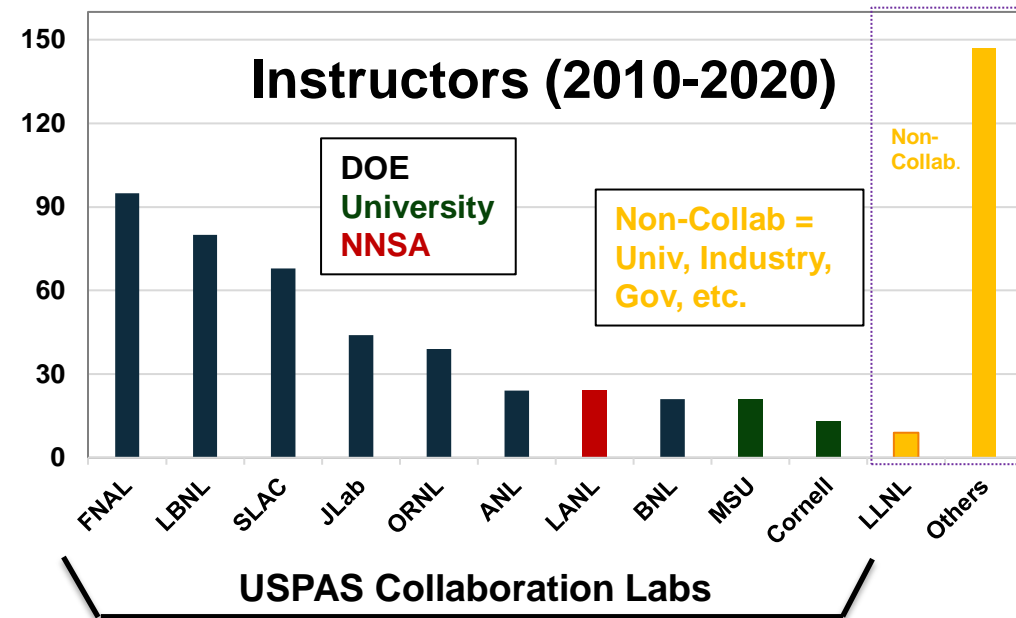
# Distribution of course topics evolves



# with corresponding attendance ...



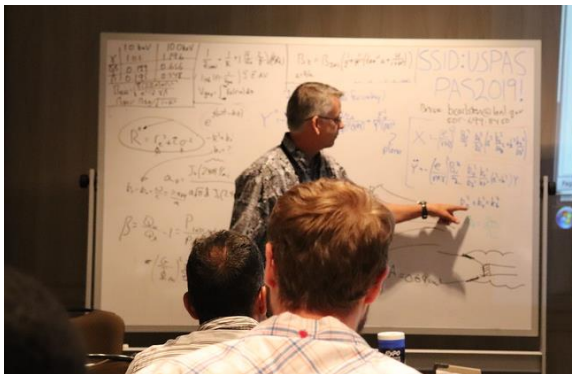
# Instructors are primarily drawn from the USPAS collaboration institutes



2010

2020

Bruce Carlsten, Summer 2019



## Lab employees benefit from teaching

- Enhances understanding
- Makes valuable contacts
- Recruiting & Prestige

## USPAS cannot pay our Lab instructors

- Academic field, instructors still want to teach
- Prestige, community service, etc

# The USPAS sessions are economical and students are supported

## In-Person session cost ~\$2800 economical

**\$1500 Registration:** Course Fee, Food (breakfast & dinner), Credit, Book

**\$ 700 Hotel** (shared room)

**\$ 600 Travel + Per-diem** (lunch)

- Universities 40-60% higher without hotel, food, book
- Professional training in Tech, Medicine Business typically much more costly

*The USPAS is economical while setting the standard for quality*

## Financial aid available for students enrolled for credit

- **USPAS Scholarships covering Registration Fee + Hotel + Food**
  - Travel *NOT* included
  - High rate of award for qualified students with proper status
- **APS Division of Physics of Beams Travel Awards**
  - Cover travel to and from session & enc
  - ~12 expected per session post pandemic
- **New Sekazi Mtingwa Underrepresented Minority Scholarships**
  - USPAS Scholarship + Travel for full coverage to attend

*Low cost covered for most students*



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# Pandemic Disrupts USPAS starting Summer 2020: Summer & Winter 2021 Online

- **Winter 2020 Session in San Diego ended Jan 24**
  - **School Successful:** all-time record (184) student enrollment
- **Pandemic rapidly escalates culminating in the Summer 2020 session (Melville, Long Island) being canceled**
  - **Insufficient time to transition online**
  - **Limited fill in** (only no credit *Fundamentals* without labs)
- **Online Strategy**
  - **Zoom: double duration** (2 weeks -> 4 weeks) & **half daily intensity**
    - » Necessary for online tolerance
  - **Extra teaching team help**
    - » Challenge to reach students with online homework help
  - **Keep format close to in person as possible**
    - » Retain fostering of professional contacts USPAS is well known for
  - **Exploit technology**
    - » Cloud computing, Slack channels, Software Tools, ...
    - » Derive long-term benefits when we return to in-person sessions
  - **Stress: Credit Classes that transition online Domestic Students**
    - » Retain usual community composition and avoid online apathy

# Qualified Online Success: Smaller but viable online sessions keep USPAS training going

## Online 2021 Sessions

**Winter:** 6 classes 81 students

**Summer:** 9 classes 109 students

- **Both had core *Fundamentals* and grad *Accelerator Physics***
- **Mix of specialty classes that transition online**
  - » Lab classes outside of Fundamentals deferred
- **Student reviews strong:** in-line with usual high school performance
  - » USPAS reputation & identity for academic seriousness maintained

## Qualifiers

- **Very hard to line up teaching teams for online**
  - »  $\frac{3}{4}$  opt out of teaching online longer duration problematic with lab jobs
  - » Needed lab classes do not transition well online
- **Student hesitancy to enroll**
  - » Pandemic online burn-out inhibits desire for online electives
- **Despite Effort: Stress expands Large class performance spread**
  - » Top students do well online, but bottom  $\sim 1/3$  performance drops strongly
  - » Hard to juggle longer intense online format with other tasks
- **Winter 2022 now online as pandemic persists**
  - » Can pull off Summer 2022 online but likely not sustainable beyond



# Outline

- 1. Overview of the USPAS
- 2. Discussion on USPAS Needs



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# Needs to Improve USPAS (1)

**½ FTE additional office help for increasingly technical needs of sessions, long-range planning and stability, and expanded directions to benefit community**

- **Technical IT Skills Needed:** Cloud Computing, Web Sites, SharePoint, Videos, ...
  - » Person also needs to contribute to management (people person)
- **Load Balance & Contingency:** 2 FTEs + ¾ Director is marginal for pre-pandemic levels we expect to return to. USPAS session setup effort may be than for two large conferences/year
  - » Pandemic highlighted load stress and little margin for when things go wrong
  - » All in office same career phase: need early career person for contingency & long-term stability
- **Justify via expanded roles giving community benefit** (see following points):
  - » **Gather community statistics** on hires to drive course decisions, support traineeships, monitor diversity progress, etc.
    - USPAS correct place to consistently evaluate long-term for max usefulness
  - » **Tutorials for community training**
  - » **Recruiting to maintain quality & Possible undergrad-level course**
- **FWP funding needed long-range for ½ FTE: Estimate ~\$88 k/year**

# Needs to Improve USPAS (2)

## Recruiting with emphasis on quality

- **DOE Traineeships (4) emphasize numbers:** Need top quality recruits for future R&D difference makers
  - » Broad spectrum of students, but recent lower range has been troubling: possibly exacerbated by pandemic
- **USPAS emphasizes educating grad students & early career workers *NOT* recruiting. Should we become more active in recruiting into the field ? If so, how ?**
  - » Fits expanded role (previous point)
  - » Likely need an intro course at lower undergrad level below *Fundamentals*
    - Limited class slots in venues we can afford: 3<sup>rd</sup> small session?
- **Diversity focused recruiting:** efforts underway, but improvements welcome!
  - » Enrollment statistics now accurately reflect ethnicities etc for use to measure
  - » New: Mtingwa Scholarship for Underrep Minorities started Winter 2022
  - » Plans to pair with HBCU *Florida A&M U* for Winter 2024 Session
    - Has large plasma group for sister field recruiting: diagnostics, modeling, etc.

# Enhanced diversity efforts

- **Continues to do better than community level with respect to participation of women**
  - Percentage in sessions remains strong ~ 21%
  - Involvement in teaching teams as part of larger group emphasis
  - Personal Experience: 2 of top 4 students women in Summer 2021 *Accel Physics*
- **Find better than expected underrep minority counts in 2021 (~14%)**
  - Due to: Hispanic & Mixed
    - » Better collection of ethnicity data
    - » Texas A&M U academic host
  - African American remains poor (~1-2/session)
- **Effort to increase African American rep**
  - Sekazi Mtingwa Scholarship:
    - Reg Fee + Room/Board + Travel
    - » Full support, named after prominent African Am Wilson Award winner who will help recruit
  - Post Pandemic targeting HBCU academic host
    - » Florida A&M has sister plasma physics program

Mtingwa Scholarship ([USPAS Link](#))



**U.S. Particle Accelerator School**  
Education in Beam Physics and Accelerator Technology

ns Courses, Materials & Instructors Resources Opportunities

### Sekazi K. Mtingwa Scholarship

  
Sekazi K. Mtingwa

The Sekazi K. Mtingwa Scholarship supports the increased participation of African/Black, Hispanic/Latinx, and Indigenous students in the study and workforce of Accelerator Science and Engineering (AS&E) who are historically underrepresented in AS&E. The scholarship is named in honor of Professor Sekazi Mtingwa. Prof. Mtingwa, a prominent physicist, received the 2017 Robert R. Wilson Prize for Achievement in the field of Accelerators for his innovative work on the theory of intrabeam scattering. In his illustrious career he has actively sought to broaden participation in the field. A biography of Prof. Mtingwa is given below.

Multiple awards may be given in a session. Eligible scholarship recipients are students in the fields of Accelerator Science, Technology, Engineering or Mathematics (STEM) who are historically underrepresented in AS&E. To indicate interest, the Mtingwa Scholarship must be checked on the application form.

In addition to covering items included in our full financial aid package (tuition, travel, and lodging) we will also cover per-diem lunch and dinner, shared housing, textbooks & course materials, host university course fees) as well as travel to and from the session. In addition to these items, we will also cover per-diem lunch and dinner from the USPAS session.



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# Needs to Improve USPAS (3)

## Extended Roles for enhanced value

- **Tutorials:** Use prominent conferences: NAPAC, IPAC, CAARI, etc to generate tutorials to advertise USPAS courses, attract students, and generate fresh materials for review to update skills
  - » Pre-pandemic experiment with NAPAC 2019 successful
  - » Increases load: had to be put on hold during the pandemic
  - » Best methods to ensure steady production and dissemination of needed materials?
- **Community Statistics:** Community Hires in Areas in Labs, Academia, & Industry to support USPAS course decisions and DOE Traineeships, and track diversity & gender balance
  - » Pre-pandemic experiment collecting 2020 hire intent from USPAS labs was very useful
  - » Must be done long term with consistency for max usefulness
  - » May be attractive to exploit software tools like *Qualtrics*
  - » Enhances load, had to be put on hold during pandemic
- **Disseminate course materials & augmentations for community**
  - » Pandemic shows video record streams useful for courses & likely enhances impact from teaching when posted. Need more effort to package and maintain.
    - Couples to ongoing efforts in cloud computing, Fermilab SharePoint, etc. Need help!
- **Instructor “Library” resources to ease creating classes**
  - » LaTeX problem library in development for *Accelerator Physics*
  - » Standard course materials to share: *Fundamentals* Labs provide model

# Initial iteration of workforce evaluation find large lab hire plans and motivates specific training needs

- **Idea: Poll US Particle Accelerator School Advisory Council (AC) yearly to sample field needs**
  - 10 AC members: 8 DOE labs and 2 Universities
- **Repeating & refine trial in 2020** in process (pandemic slowdown)
  - **Categories** Refined
  - **Timing** Previous Year Only
  - **Degree/Gender** Extra info

▪ **Findings 2019: 224 Jobs**

[Link \(dropbox, pdf\) to full report](#)

**Degree Breakdown (approx)**

➤ PhD	95
➤ PhD/MS	21
➤ MS	20
➤ MS/BS	52
➤ BS	36 (operators)

**188 jobs open to MS/PhD grad degrees in 2019 fitting DOE Traineeships needing USPAS training**

**DOE Traineeship “Need Area” breakdown (including BS deg)**

1) Large Accel Systems	180
2) SRF Phys/Eng	16
3) RF Eng	19
4) Cryogenic Systems	9

# Workforce Data, 2019 Cal Year

shows strong hiring desire in USPAS collaboration labs

DOE Need Area Topic	ANL	BNL	Cornell/CBB	Fermi	FRIB/NSCL	JLAB	LANL	LBNL	ORNL	SLAC	
Accel Phys <b>1</b>	0	10	2	4	5	6	6	15	1	8	<b>57</b>
Operations <b>1</b>	2	5	0	7	1	2	5	12	1	12	<b>47</b>
Diagnostics <b>1</b>	1	2	0	1	0	0	2	2	1	2	<b>11</b>
Software Controls <b>1</b>	1	1	0	2	2	1	9	4	2	2	<b>24</b>
RF Eng/Phys <b>3</b>	0	1	0	3	1	1	4	4	4	1	<b>19</b>
SRF Eng/Phys <b>2</b>	0	1	1	7	0	2	0	0	0	5	<b>16</b>
Cryo Eng <b>4</b>	2	1	0	1	1	2	1	1	0	0	<b>9</b>
Manage <b>1</b>	0	0	1	0	0	1	2	0	1	5	<b>10</b>
Other <b>Part 1</b>	2	10	1	3	2	0	0	0	6	7	<b>31</b>
	<b>8</b>	<b>31</b>	<b>5</b>	<b>28</b>	<b>12</b>	<b>15</b>	<b>29</b>	<b>38</b>	<b>16</b>	<b>42</b>	<b>224</b>

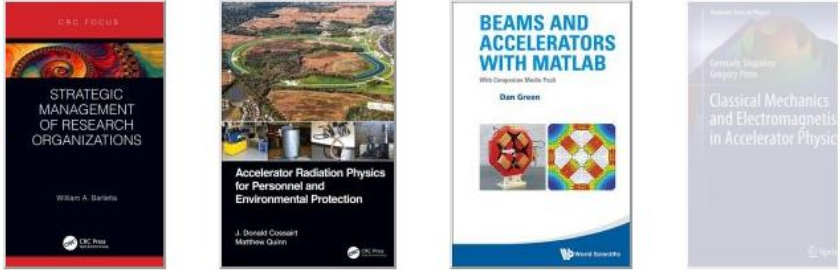
# USPAS web site continues refinements to maintain status as a primary education portal in the field

- Integrated & searchable course/session/instructor information
- Books linked to USPAS courses
- Educational and Career Opportunities
- IU / USPAS MS Program Info
- USPAS Committees and Roles

▪ ..... [USPAS Web Site Link: Books](#)

**Books Used in USPAS Courses**

**Highlight: Books based on and inspired by USPAS courses**



Reset Filters

Subject	Author	Book Title
Accelerator Physics	S.Y. Lee	Accelerator Physics - fourth edition (World Scientific 2019)
Accelerator Physics	Valery Lebedev and Vladimir Shiltsev	Accelerator Physics at the Tevatron Collider (Springer 2014)
Accelerator Physics	Edmund Wilson	An Introduction to Particle Accelerators (Oxford University Press 2001)



# Cloud Storage coming online to enhance course augmentations for community

- **Fermilab MS SharePoint based cloud storage**

- Almost unlimited long-term storage
  - » Avoids web server limits and allows archiving video records of lecture streams

- **Tools promise increased efficiency**

- Backed up and accessible any time by teaching teams w/o Fermilab accounts
- Well suited to class web-sites under control of instructors
  - » Updateable even outside of teaching cycles

- **Avoids valuable course materials disappearing for community**

Present Course Materials Postings (USPAS Link)

Links to:

- private server (can disappear)
- USPAS domain pdf (limited store)

New: large cloud storage archive in teaching team control to update etc.

The screenshot shows the website header for the U.S. Particle Accelerator School. Below the navigation bar, there is a section titled 'Courses, Materials & Instructors' with a search filter. The filter is set to 'Materials' and is circled in red. An arrow points from this filter to the right-hand side of the slide.

Accelerator Physics  
 Winter 2019 US Particle Accelerator School, Knoxville, Tennessee  
 Sponsored by [UT Batelle](#) and [Northern Illinois University](#)  
 Dr. Steve Peggs / Brookhaven National Laboratory / [peggs@bnl.gov](mailto:peggs@bnl.gov)  
 Dr. Todd Satogata / Jefferson Lab and Old Dominion University / [satogata@jlab.org](mailto:satogata@jlab.org)  
 TA's: Bhawin Dhital ([bdhiti001@odun.edu](mailto:bdhiti001@odun.edu)) and Kiel Hock ([khock@bnl.gov](mailto:khock@bnl.gov))

- Class Information
  - [Class Syllabus and Information](#) [last updated 30 Jan 2019]
  - [Textbook: introduction to Accelerator Dynamics \(1st Ed\)](#), Stephen Peggs and Todd Satogata
  - [Some handy computer tools](#). [Todd, Last updated Jan 2017]
  - [Handouts and interesting reading material](#) [Steve, Last updated Jan 2019]
  - [Annotated class photo](#) and [USPAS Winter 2019 photos](#)
- Class Materials
 

Date	Who	Chapter	Slides [pptx/pdf]	Topic	Homework/Lab
M Jan 21 AM	Both	1	<a href="#">[26 Mb pdf, Todd]</a> <a href="#">[1 Mb pdf, Steve]</a>	Introduction, Relativity Refresher	
M Jan 21 PM	Steve	2, 3	<a href="#">[1.5 Mb pdf, Steve]</a>	Linear Motion and Stability	<a href="#">Homework</a>

# Needs to Improve USPAS (4)

## Mitigate detrimental pandemic impact

~ $\frac{3}{4}$  teaching teams refuse to take rotation online due to:

*Lab Courses*

*Load*

*Incompatible Styles*

*Regarding connections key & online incompatible*

With one canceled session + 3 (possibly 4 if Summer 2022 not in person) online sessions this has created a large backlog of specialty courses. I am concerned that teaching cycles of 2-3 years are now dilated to 3-5 years with negative impact and potential course losses. The USPAS *Curriculum Committee* is ranking priorities on 27 pandemic deferred courses.

- **Schedule 3<sup>rd</sup> smaller session to “catch up” teaching rotations in 2023 & 2024 to get back on cycle**
  - » 2-3 class rooms (2-6 courses) for ease in finding (small) venue
- **Topical Themes, Where, and Timing?**
- **Small size helps office load, but worries persist**
  - » Further motivation for increased help

**Ideas Welcome!**

# Online opens additional challenges

**USPAS well known for fostering technical relationships in in-person sessions: continue online**



- Meet online with fellow students, instructors, TAs to discuss lectures, homeworks, etc
- Teaching teams enhanced and adapted for online



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Slide 35

# Extras



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# Outline

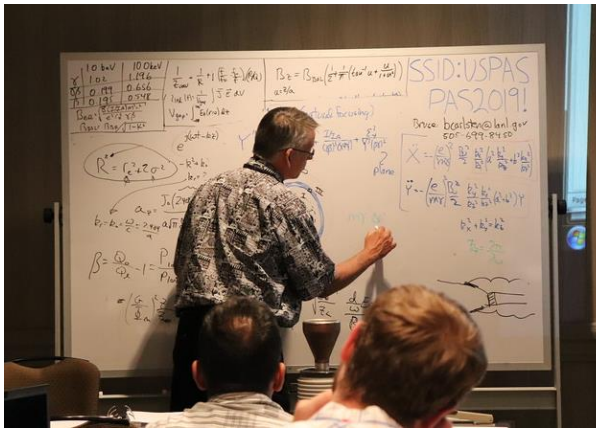
1. AC Roles & Composition
2. Pandemic & Online Strategy
3. Overview of Online Sessions
4. School Status & Issues
5. Discussion

Edwards

$$\begin{bmatrix} \beta_2 \\ \alpha_2 \\ \gamma_2 \end{bmatrix} = \begin{bmatrix} m_{11}^2 & -2m_{11}m_{12} & m_{12}^2 \\ -m_{11}m_{21} & 1+2m_{12}m_{21} & -m_{12}m_{22} \\ m_{21}^2 & -2m_{21}m_{22} & m_{22}^2 \end{bmatrix} \begin{bmatrix} \beta_1 \\ \alpha_1 \\ \gamma_1 \end{bmatrix}$$

Drift Matrix

$$M_D = \begin{bmatrix} m_{11} & m_{12} \\ m_{21} & m_{22} \end{bmatrix}$$
$$\alpha_2 = -\frac{1}{\beta_2} \frac{d\beta_2}{ds}$$
$$\frac{1+\beta_2^2}{\beta_2} = \frac{1+\alpha_2^2}{\beta_2}$$
$$d_2 = \frac{\beta_2}{\beta_1} (\alpha_2^2 - 1)$$
$$-E = \frac{\alpha_2^2}{\beta_2} = \frac{E_2^2}{P_2} \quad \sigma_1 = 2.5 \text{ mm} \quad \sigma_2 = 3.0 \text{ mm}$$
$$\epsilon = E \left( \frac{\beta_2}{\beta_1} \right) \frac{m_{12} \beta_1 \gamma_1}{(m_{11}^2 - \beta_1^2)}$$
$$\gamma \beta \cdot \sigma_1^2 \beta_2 = a \beta_1 \gamma \quad \left( \frac{E_{\text{beam}}}{E_{\text{err}}} \right) = \frac{c \beta_1}{E_{\text{err}}}$$
$$\beta_2 = \beta_1 - 2L\alpha_1 + \frac{(1+\alpha_1^2)L^2}{\beta_1}$$
$$d_2 = \alpha_1 - L\alpha_2$$



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# Post-Pandemic: Expect sustained high demand for USPAS training

- **Pent up demand: Many students avoided enrollment during pandemic and expect will return to in-person sessions due to**
  - Adverse to take online classes electives
  - Appreciation for connections made with students & faculty with in-person
  - Topical Delay: Most lab classes impractical to schedule
  - Topical Delay: ~3/4 teaching teams opted not to teach online (reschedule ASAP)
- **Student programs relying on USPAS training increasing**
  - **4 DOE Traineeships:**
    1. **MSU**                      **ASET**                      PhD/MS, any national lab 21 students now
    2. **SBU / Cornell**        **Courant**                      MS/PhD linked to BNL
    3. **IIT/NIU**                      **CAST**                      MS/PhD linked to Chicago Area Labs / Industry
    4. **New: ODU/Hampton/Norfolk**      MS/PhD linked to Jlab, underrep minority emphasis
  - **IU/USPAS MS Program**      ~10 students current
  - **New: Fermilab Aspire**      ~5 students, undergrad engineers; women and underrep minorities
- **Field hiring is strong**
  - Community has a healthy set of accelerator projects
  - Many upgrade projects + EIC Looming
  - Increasing medical/industry opportunities



# Four DOE Funded Traineeships are now bringing in new talent to field

**Format: DOE pays up to 2 years @ university then students placed in Labs to complete training/thesis research**

- 1<sup>st</sup> year typically TA-centered + University core courses
- 3 of 4 programs focus on MS with select students progressing to PhD
- Programs rely on USPAS for specialized training

## Programs

1. **MSU ASET** (2017 start)
  - PhD centered, any DOE lab, 21 students (~ steady limit)
2. **IIT/NIU CAST** (2020 start)
  - MS centered, Fermilab and ANL linked
3. **SBU/Cornell Courant** (2020 start)
  - MS centered, BNL linked
4. **New: ODU VITA** (2021 start)
  - MS/PhD, Underrep Minority recruitment emphasis



# Indiana Univ / USPAS MS Program

growing and improves DOE operator training



Mike Snow

- **Program healthy:** Prof. Mike Snow took over from SY Lee
  - **11 students** at present: 2-3 historic average

## Graduates of Program

2021	2021	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010
1	0	1	2	1	0	2	1	1	1	1	0

Expect increase near future

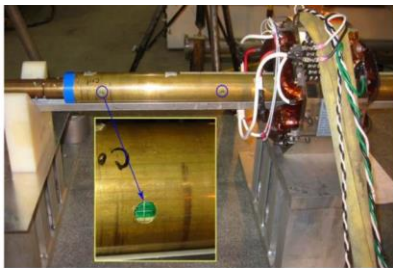


Figure 2.2: BNL 5-Tangential coil during calibration. [3]

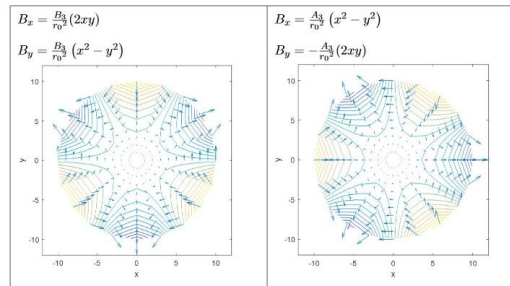


Figure 3.4: Field plot of upright sextupole (left) and skew sextupole (right)

**Yung-Chuan Chen, Conceptual Design of Rotating Wire System with Bucking Using Multichannel Lock-In Amplifier, 2018**

## ▪ Program based on USPAS courses + Thesis

- Unique & low-cost (~\$150/credit-hr + USPAS fees; most theses at work)
- Improved descriptions on [USPAS web site](#)

## ▪ IU wants more students & USPAS recruiting

- [Handouts](#) at: Sessions & Accel Conferences [Overviews at Sessions](#)



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