AF1: Education, Outreach & Diversity In Accelerator Science & Engineering

Steve Lund (USPAS & MSU/FRIB)

Snowmass 2022

AF1 Report, Thursday, 7/21

Snowmass 2021

Accelerator Frontier Topical Group AF1: Beam Physics, Education & Outreach

AF1 Covered within Accelerators:

1. Education, Outreach, and Diversity — Steve Lund (MSU & USPAS)
2. Research Centers & Facilities — Zhirong Huang (SLAC / Stanford U)
3. Physics Limits of Ultimate Beams — Mei Bai (SLAC)
4. (with Comp Frontier) Computational Tools and Machine Learning — Jean-Luc Vay & Ji Qiang (LBNL)

Here, Summarize AF1 Findings in Education, Outreach and Diversity covered in the White Paper:

Strategies in Education, Outreach, and Inclusion to Enhance the US Workforce in Accelerator Science and Engineering

https://arxiv.org/abs/2203.08919

Accelerator Education

US Particle Accelerator School (USPAS): Due to lack of critical mass in Universities, USPAS fillls specialty education role for Accelerators

- **Developed Format**: Since 1987 regularly holds two 2-week intensive sessions/year distributed near accelerator labs/facilities around country.
  - **Academic Format; credit & graded** NOT a workshop
  - **Yearly Impact:** 20-28 courses /year delivered by 45-70 scientists, engineers, & TA/graders to 240-350 students. Class notes commonly posted for resources to field
  - **Pandemic:** 2 years moved online, return to historical in-person format starting 2023
- **Topics Evolve:** Legacy HEP-centered, now diverse: teach topics NOT specific applications

Accelerator training typically for skill "Toolkit":

- Fungible skills (e.g. SRF Technology) vs application specific (e.g., SRF crab cavities for a HEP Colliders) so many workers can apply skills in spectrum of projects in the field whether in HEP or other fields employing accelerator technology
- Limited capacity at the USPAS forces this approach but works well

Accelerator Education

Universities have limited Accel faculty representation due to:

- Limited university-based facilities, projects, and grants
- Relatively poor representation in department colloquia series

Hinders Recruiting

DOE Accelerator Science & Engineering Traineeships: Four Traineeships now funded to start *domestic* (US Citizen or Permanent Resident) grad students in field

- **Present Traineeships**:

  1) Michigan State U (MSU)
  2) Stony Brook U & Cornell
  3) Illinois Inst Tech & Northern Illinois U
  4) Old Dominion U & Hampton U & Norfolk U

- **@ Steady State:** start/graduate 15-25 students/year: some focus MS (needed in Accel), others PhD & MS
- **Traineeships Emphasize 4 Need Areas of Large Accel Facilities:**

  1) Physics & Engineering of Large Accel Systems
  2) RF Power Engineering
  3) SRF Technology
  4) Large Cryogenic System

A Limited Overview of University-based Accelerator research

Barletta, Winklehner, Patterson

- Cave: No claim to completeness (e.g.: not including Van der Graaff accelerators and surely forgetting some university groups).
- Source: W.A. Barletta, D. Winklehner, R. Patterson
- DOE traineeship program should be combined with strong faculty research to be fully effective.
- An APS (and/or DOE/NSF)-driven effort to assess university research vs. national laboratory research across frontiers is needed!
  - Funding allocation?
  - Research?
  - Output?
- How to define these metrics?
- Goes beyond AF2, but could be led by AF2?

CBB = Center of Bright Beams (NSF)

University (alphabetical)	Funding	Project(s)
Arizona State University	CBB	compact X-ray sources
Brigham Young University	CBB	superconductor simulations
Cornell University	NSF, CBB	CBeta, CHESS, MEDUSA, technology facilities
Duke & Triangle Universities	DOE, NSF	TUNL facilities (FEL, HIGS, DFELL)
Florida State University	DOE, NSF	John D. Fox Laboratory (linac), high field magnet lab
Idaho State University	(?)	pulsed power driven accelerators
IIT	DOE, NSF	
Indiana University	(?)	CEEM, neutron scattering facility
LSU	NSF(?)	CAMD light source
MIT	NSF	cyclotrons, ion sources, polarized electron beams
MSU	DOE, NSF, DOE Traineeship	NSCL, FRIB
Northern Illinois University	CBB	
Old Dominion University	DOE	Center for Accelerator Science (CAS)
Rutgers University	DOE	
Stanford University	(?)	multiple facilities for compact accelerators
SUNY at Stony Brook	DOE, DOE Traineeship	CASE
Texas A&M	DOE	cyclotron & accelerator technology labs
Texas Tech University	(?)	pulsed power labs
UC Davis	(?)	cyclotron facility
UCLA	DARPA, DOE, CBB, NSF	multiple facilities, e.g.: Pegasus, XFEL development
UMD – College Park	DOE	UMER
University of Chicago	CBB	innovations in bright beam science
UNM	CBB	

Accelerator Education: Summary Recommendations

- **USPAS:** +1 FTE Enhance Office to:
  - Run national undergrad recruit class (see **Outreach**)
  - Gather community statistics on jobs, needs, diversity, etc to drive education and recruiting strategies with sound data
  - IT enhancements for community resources: augmentations, tutorials cloud tools, …,
  - Long-range planning
- **Universities:**
  - More funding for university based programs and facilities
  - More research grants
  - Involve professors in DOE lab projects
- **DOE Traineeships:**
  - Clear expectations on labs to support placement of traineeship students
  - Relax severe cap limits per student (Support Cap: 2 years, $110k Total)
  - Allow international students to participate (Pledge work in USA for interval post grad?)
  - Expectations for renewal on performance for long-range continuity

Accelerator Outreach

Plethora of Jobs: in recent years & foreseeable future (decade + ?) due to a broad spectrum of facilities and projects (largely outside of HEP) with an active suite of new facilities, upgrades, etc.

High Energy Physics (PIP-II/LBNF/DUNE, GARD, …) **Nuclear Physics** (EIC & FRIB)
Light Sources (LCLS-II, ALS-U, NSLS-II, APS-U, …) **& Spallation Neutron Sources** (SNS)
Serving Materials Science, Biology & Medicine
Medical (for Radioisotopes, Tumor Therapy, …) **& Industrial** (Materials Processing)
& NNSA (DARHT, Scorpius, Marie) **+ More as Time Advances** (Energy Production, …)

- **Training Usually for Skill "Toolkit"**: Fungible skills (e.g. SRF Technology) vs application specific (e.g., SRF for a HEP Collider) so many workers can apply skills in spectrum of projects
- **Most Recent Grads Find Work in Field:** within National Labs, Academia, Industry, Medicine

Difficult to recruit grad students to Accelerators: in spite of job situation and the field being diverse with broad physics driving areas with high impact

- **Few undergrads enter grad School seeming themselves as Accelerator Scientists & Engineers:** so it is difficult to rapidly reach/recruit those entering graduate programs
- **Accelerators Lower Profile:** Faculty representation weak, field has less awards & high profile publications, field struggles to capture public imagination

Recruiting Needs Focus on Draw Highest Quality – Not Just High Numbers & Retain Talent Long-Term

Universities observing more sensitivity to stress in younger generation

- Exams/Qualifiers, Research Stress, Discourse Tone trigger increase complaints
- Grad research intrinsically difficult and easily generates stress

Need to attract the best talent that we can and then retain long-term while engaged in a manner to maximize abilities

- Best talent helps ensure future of field
- Want to draw from full community (balanced gender, ethnicity, etc)
- Retain talent long term via an effective work environment with rich opportunities

How can we best improve work environment and recruit?

- Many perspectives to balance
- Recruit: likely must target efforts earlier than entering grad students: National Undergrad outreach and recruiting sorely needed

Accelerator Outreach: Recommendations

Enhance recruiting with a yearly national undergrad class designed to draw in talent:

- **Not USPAS Rigor:** Fun & Light survey on rich physics and opportunities of full field, employing dynamic lecturer(s): record materials for broad distribution
- **National:** Hold at accelerator center for tours and contacts. Rotate locations?
- **USPAS Organize:** *IF* FWP budget/effort enhanced consistently
- **Run to Enhance Underserved:** Emphasize drawing in women & URMs to boost efforts on equity and inclusion
- **Fully Fund:** Registration, Housing, and Travel paid for qualified applicants to maximize impact

Lab programs to support colloquia in universities to boost profile:

- **Reward Outreach:** Include in lab program performance evaluations
    - Enhances effectiveness of increased University efforts to boost profile

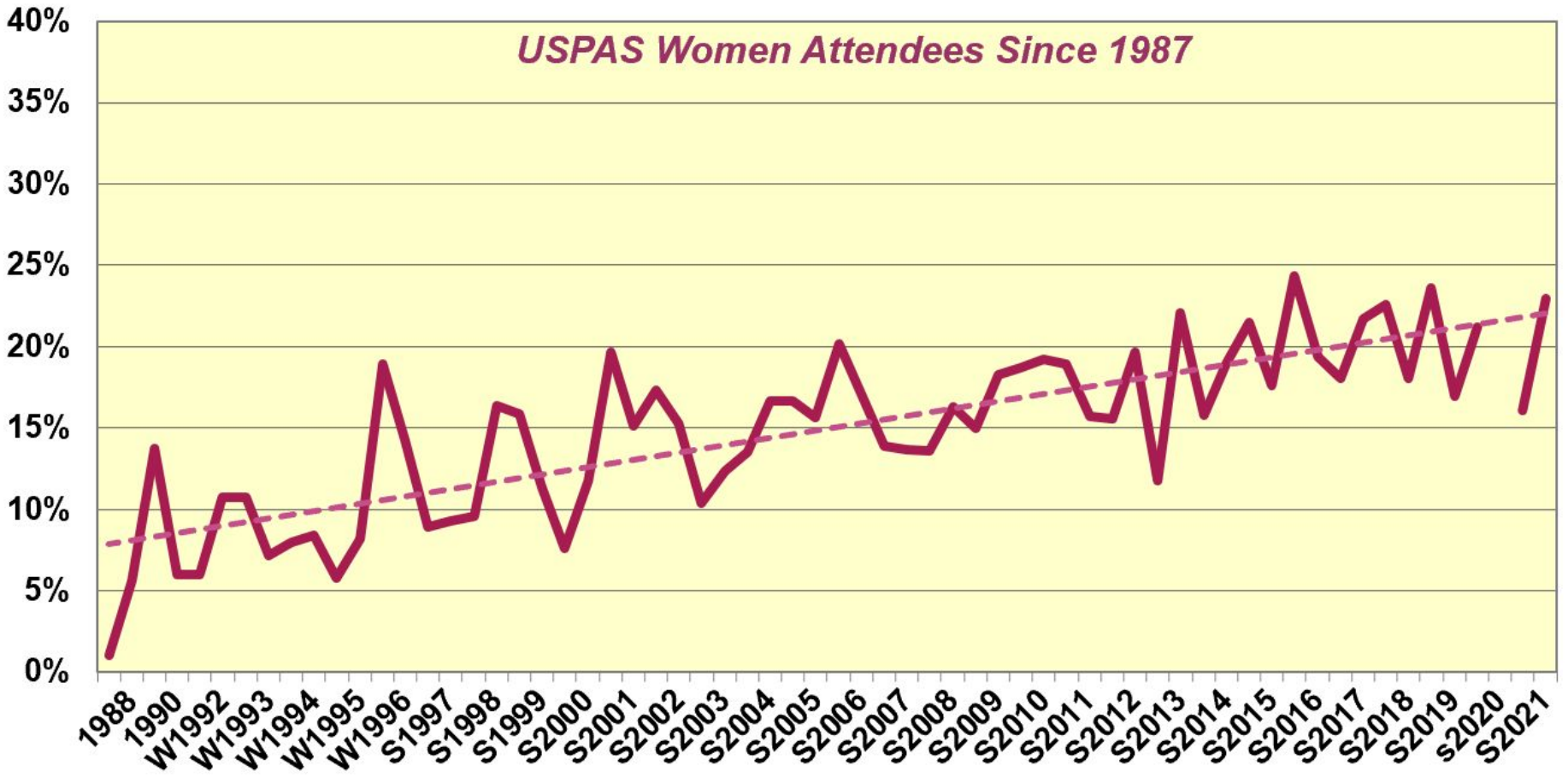
Diversity Equity & Inclusion in Accelerators

US Particle Accelerator School (USPAS):

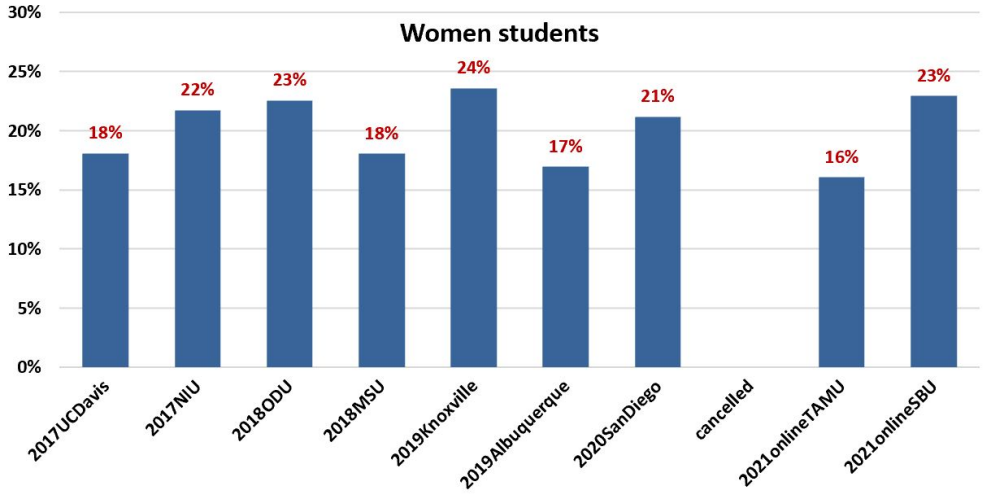
- **Recruit Women & Underrep Minority (URM) Instructors** – especially early career to be more welcoming
- **Sekazi Mtingwa URM Scholarships:** available with full support, every session, to remove possible barriers
- **Performance:**
  - **Women Students**: 18-25% recent sessions … slowly increasing year-by-year (see plot)
  - **URM Students:** ~15% Last few sessions (Mostly Hispanic/Latin-X)
    African Ancestry was often zero, now 3-5 students/session
  - **Instructors:** Women: Prior very small now ~20% but variable
    Non-Hispanic URM very poor representation

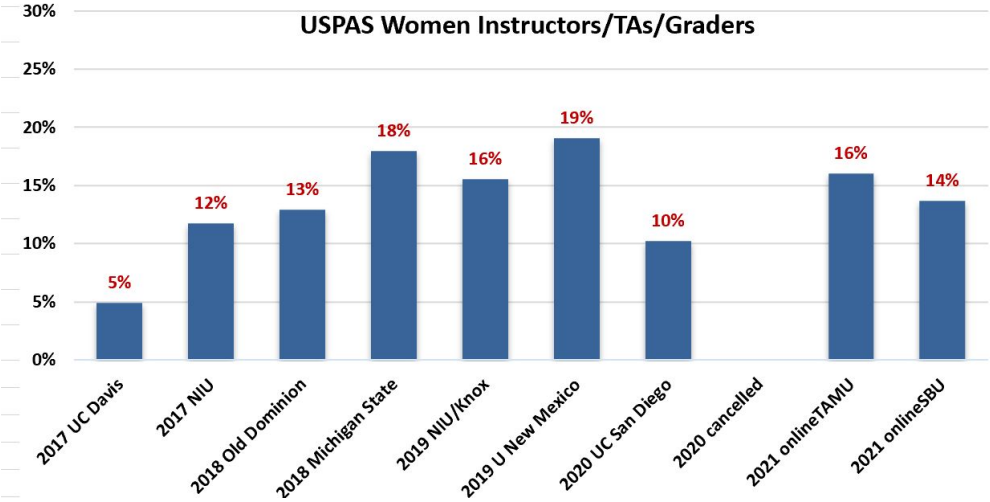
DOE Accelerator Traineeships:

- **New FY22 Traineeship: Old Dominion U paired with HBUs Hampton U & Norfolk U** with component to recruit URMs at undergrad level



1987 ← 34 Years → 2021





Women teaching team members increasing consistent with fraction women students – hopefully drawing in more women

Accelerator Diversity Equity & Inclusion: Recommendations

Supplement yearly national undergrad recruiting class (see Outreach Recommendations**) to boost underserved groups:**

- **URM & Women:** enhance recruiting; enlist prominent URM & Women in field to deliver colloquia to advertise
- **Fund via FWP:** vs grant for long term stability

Initiate programs to address quality of life issues in the labs:

- **Lab Programs for Quality of Life:** Family/Child stress help, Daycare, …
- **Professional Discourse:** Clarify and reenforce expectations for behavior and coach support of colleagues. Prevention of issues much better than discipline!

AF1 Summary Recs: Education, Outreach & Diversity

- **Education:**
  - **USPAS:** +1 FTE Enhanced Effort to: Run national undergrad recruit class; Gather community statistics on jobs, needs, diversity, etc; IT enhancements for community resources; Long-range planning
  - **Universities:** More research grants and programs to involve professors in DOE lab facilities & projects
  - **DOE Traineeships:** Clear expectations on labs to support placement of traineeship students; Relax severe cap limits per student; Allow international students to participate
- **Outreach:**
  - Yearly national undergrad-oriented recruiting class to draw talent: USPAS run if budgeted
  - Lab programs and expectations to deliver colloquia at universities
- **Diversity Equity & Inclusion:**
  - Enhance support to national undergrad recruiting class to bring in women & URM talent
  - Lab Programs to Address: Quality of life issues & family support;
    Tone of professional discourse