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

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Snowmass 2022
AF1 Report, Thursday, 7/21
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 fills 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

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?

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

DOE Accelerator Traineeships:

- New FY22 Traineeship: Old Dominion U paired with HBUs Hampton U & Norfolk U with component to recruit URMs at undergrad level
Women teaching team members increasing consistent with fraction women students – hopefully drawing in more women
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