

**Report of the
United States Particle Accelerator School
(USPAS)
Review Subcommittee**

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Bottom-line First: Subcommittee Conclusions

- **USPAS of high quality.**
- **USPAS essential for maintenance and development of DOE's (and Nation's) accelerator workforce, and in doing so serves**
 - **the existing workforce,**
 - **those seeking professional transition into the workforce, and**
 - **undergraduate and graduate students.**
- **Partnership between USPAS, DOE and other laboratories, and universities essential.**

Process/Timeline

- Charged by DOE & NSF Feb. 12, 2015
- Requested preliminary comments April 2015
- Final report May 2015
- Numerous preparatory teleconferences prior to March 13-14, 2015 meeting in Chicago
- Since then drafting report with continued teleconferences and communication.

Committee Membership

- Roger Bailey, CERN
- Gerald C. Blazey, NIU
- Bruce Carlsten, LANL
- Tom Katsouleas, Duke
- Andy Lankford (Chair), UC Irvine
- Ritchie Patterson, Cornell

Charge Elements

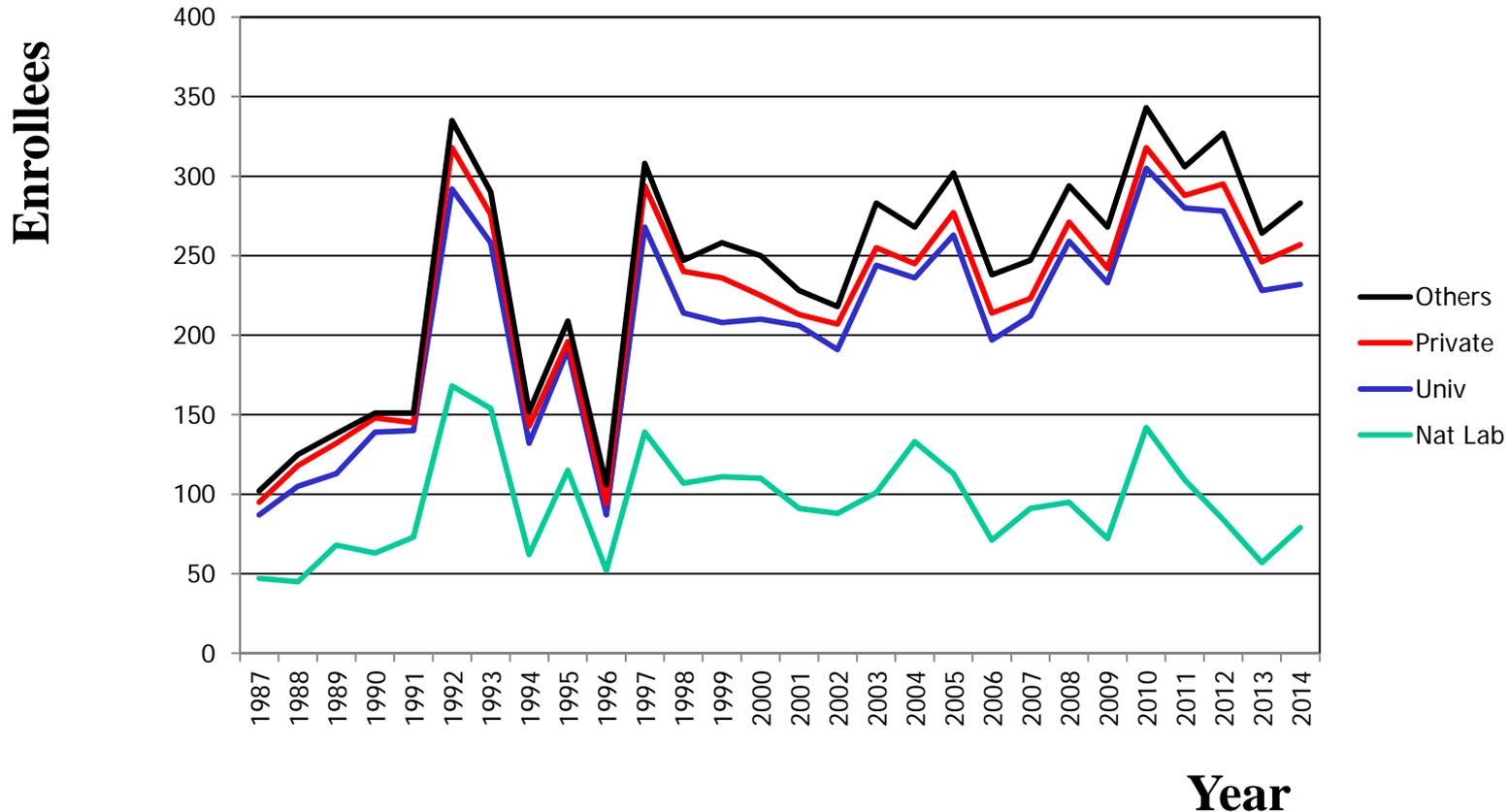
- **Effectiveness and impact**
- **Quality and breadth**
- **Need for program**
- **Unique and essential capabilities**
- **Efficacy of the management model**
- **Minority participation**
- **Projected need for scientists**

Input

- Extensive information from USPAS, particularly 2014 Report
- Letters:
 - DOE Laboratories
 - Former USPAS trainees
 - Universities with accelerator programs
 - Industry
 - USPAS Board of Governors
 - APS Division of Particle Beams.
- Presentations:
 - Report of Subpanel on Workforce Development
 - Overview of USPAS
 - Overview of European situation: CAS, TIARA, JUAS
 - Perspective from USPAS Board of Governors
 - Fermilab perspectives

A Bit about the USPAS: Format

- Two sessions / year: January and June
- Moves around U.S. near a lab and a university
- Session lasts 2 weeks
- Four 2-week courses + four 1-week courses



Organization

- Office has 3 FTE: Director and two administrative staff
- Consortium of ten labs contribute to session operating costs (7 DOE, 1 NNSA, 2 University)
- Labs have seat on Board of Governors which reviews course offerings, assists session planning, reviews and hires Director.
- Curriculum Advisor Committee helps with syllabi and instructor identification

Finance

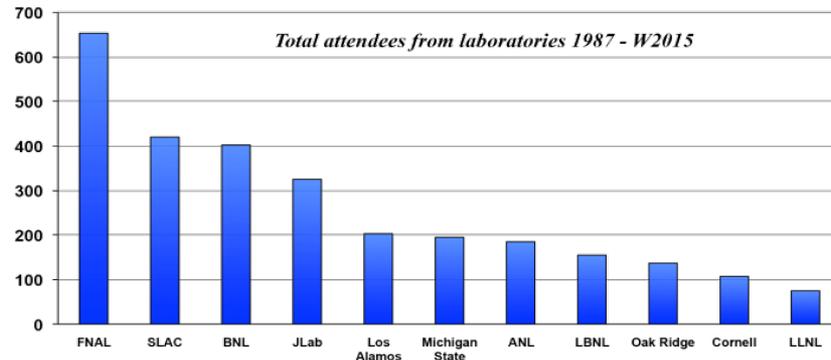
- Funded by OHEP, \$650k year
- Housed at Fermilab, overhead waived.
- Session operating costs, ~\$250k:
 - Consortium members contribute (through \$30k / year)
 - Registration fees collected from ~half the students cover remaining costs.
- Labs, universities, & private sector provide instructors

Program Need and Projected Need

- DOE workforce about 3000.
 - Wide skill set (accelerator science, RF engineering, magnets...)
 - Changing and increasing needs (consider the rise of XFELs)
 - GAO reports DOE attrition at 7%, for accelerator workforce corroborated by Lab letters reporting total need of ~150/yr.
- Including industry and academia, national workforce about 3800
- US university programs small in number and in faculty, produce 15-20 accelerator physicists/yr.
- To address current and projected needs a mechanism required for:
 - Professional development of mid-career accelerator scientists and engineers
 - Training of scientists new to accelerator science.
 - Courses for undergraduates and graduate students in accelerator science helping to ensure a pipeline

Impact: Labs

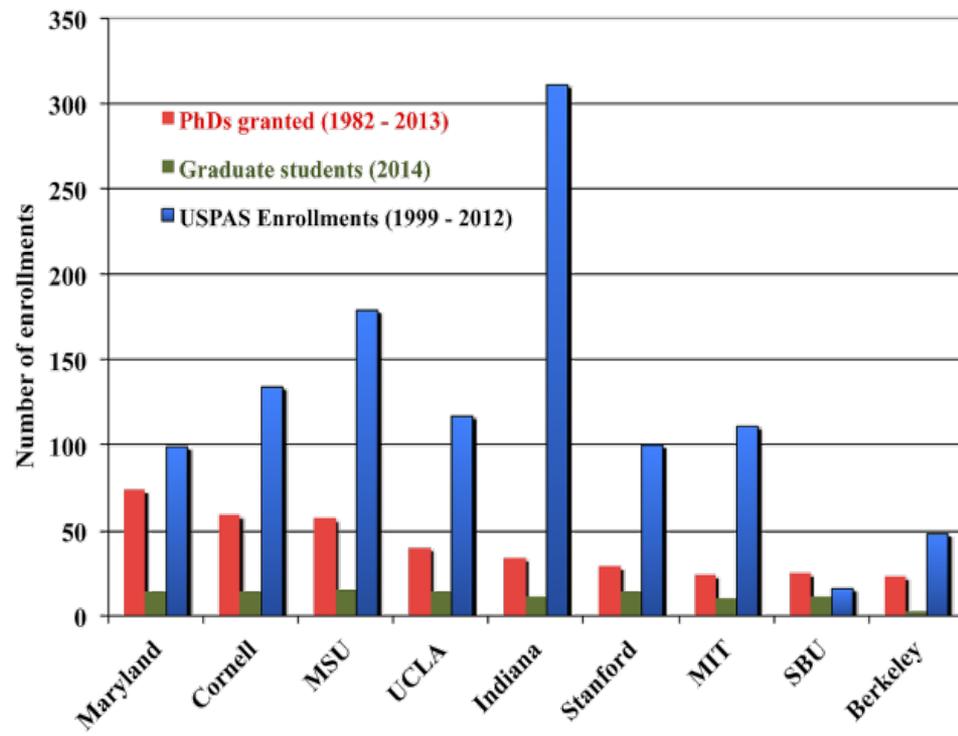
- Lab staff members have enrolled in USPAS courses two thousand six hundred times, ~100 lab employees attend per year. Includes retraining, operators, and transitioning professionals



- 150 university students attend USPAS per year, with approximately thirty percent of these university students going to work at a national laboratory upon graduation. This helps ensure a pipeline.
- USPAS specialty courses are essential for laboratory scientific and technical staff, and are available nowhere else:
 - *Such topics are not taught anywhere else but are absolutely needed for the development and operation of particle accelerators. – BNL*
- Provides training for those entering workforce:
 - *USPAS provides fundamental accelerator physics training for early-career LANL staff that are transitioning into accelerator science from another field, helping to fill a nationwide hiring gap due to the limited number of US university programs offering courses in accelerator science and technology. – LANL*
- All labs attest that USPAS is vital for development and training of workforce.

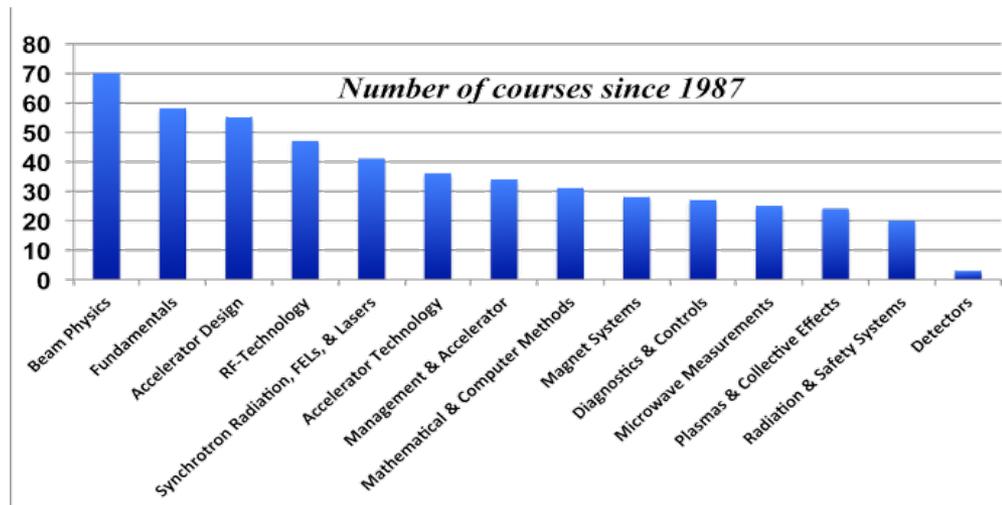
Private Sector and Universities

- **Private Sector:** Historically attendance has been about 6% with medical 60%, programmatic needs 20%, components 10%, operators 10%.
 - “I think USPAS offers a unique and rare opportunity for continuing education in the accelerator field and has contributed directly to the strengthening of my group’s technical understanding in our technology.” Varian
- **University students have enrolled in USPAS courses over 3000 times since inception.**
- **Graduate programs tend to be small, usually with enrollments of a dozen students or fewer, and few have more than two faculty in accelerator science. All rely on USPAS, usually students take 2 or more courses.**



Quality and Breadth

- The USPAS program is of high quality and remarkable breadth as indicated by curriculum, instructors, enrollment, surveys, and testimony.
- Curriculum is broad with both basic and technical or topical courses that serves the full accelerator community. Since 2000, 65 distinct course titles have been offered.



- Instructors are recruited from the deep and broad pool of talent available in the United States.
 - “A primary benefit is the exposure to a world-class community of experts represented by USPAS instructors.” Fermilab

- Enrollment has been steady or increasing over the past fifteen years and is now near capacity.
- Trainee assessments show good, very good, or excellent ratings by 95% or more of the trainees.
- Letters from trainees and from the DOE labs shows very high regard for USPAS.

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- “The expertise of hands-on national ...laboratory scientists is invaluable.”
 - “What makes USPAS courses even more applicable is the fact that they are not taught by academics, but rather by scientists actively engaged in the research related to the content of each course.”



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- “Such topics are not taught anywhere else but are absolutely needed ...”
 - “The broad curriculum and session format make it an ideal mechanism ...”
 - “USPAS provides depth and breadth beyond the reach of a single university”

Efficacy of Management Model

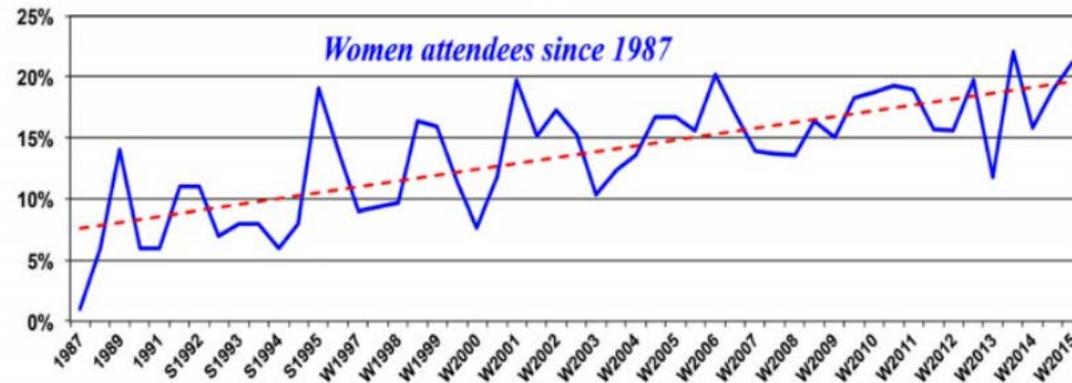
- The structure of USPAS (Board, Curriculum Advisory Committee, Director and staff) appropriate and effective.
- Management is accomplished with three FTEs, matched to the size of the program, and comparable to the CERN Accelerator School.
- The Director does and must have USPAS as primary focus, have gravitas in the community, and exceptional ability to cultivate collaboration and teamwork.
- Two features of the management structure are essential:
 - The Board, as a governing body rather than advisory, ensures close association between DOE laboratories and USPAS.
 - Hosting USPAS management at a stable facility committed to accelerators provides economies of scale in operations and minimizes budgetary requirements.

Best Practices

- **Economy of scale by conducting a shared program rather than individual training programs at each laboratory.**
- **Cross-pollination of knowledge and expertise across the labs, through participation of trainees and instructors.**
- **University involvement is a differentiating advantage for USPAS over CAS, and enhances the role of USPAS.**
 - **The primary role for both programs is the preservation and transmission of accumulated knowledge in accelerators.**
 - **The inclusion of universities also enables USPAS to develop the next generation of scientists and engineers who will expand that knowledge.**
- **The USPAS is a model for breaking silos between DOE offices, enabling collaboration and dissemination that benefits DOE and the Nation.**

Minority Participation

- A good record regarding diversity.
- USPAS has made efforts to increase the percentages of women engaged as instructors and as enrollees.
- Both percentages have grown,
 - Women instructors now at 10%
 - The percentage of woman enrollees now in line with national trends in the field.



- USPAS has also appointed a Minority Research Coordinator
- Notably: The labs credit USPAS with helping to building representation.

Unique and Essential Capabilities

- The essential capability of USPAS is the development and maintenance of the accelerator workforce required for the Nation's scientific and technological enterprise. Serves three groups:
 - the existing accelerator workforce,
 - those seeking professional transition into the workforce,
 - undergraduate and graduate students.
- The USPAS has two major curricular features, basic courses and technical and topical courses both essential for transmitting and maintaining accelerator science and technology.
- The close alignment and relationship between the labs and universities is essential and unique; this alignment provides three essential capabilities:
 - university instruction,
 - a workforce pipeline, and
 - visibility of the discipline.

Unique and Essential Capabilities

- **The close association between USPAS and the DOE laboratories is absolutely essential to the development of the accelerator workforce and has led to very effective delivery of information.**
 - **Through the Board, highly responsive to lab needs.**
 - **As the largest cohort of accelerator scientists in the country, DOE provides two-thirds of the instructors. The deep expertise provided by DOE laboratory staff is another essential aspect of USPAS, particularly with respect to presentation of technical and topical courses.**
 - **USPAS offers a mechanism for the DOE labs to share and leverage their knowledge with one another, and with the larger accelerator community.**
 - **To ensure a complete and well-structured curriculum, USPAS must also have access to laboratory facilities and equipment.**

Closing Comments

- **Committee worked hard with a very compressed schedule.**
- **Thanks to the very responsive community and the USPAS for rapid and helpful response.**
- **Conclusions:**
 - **High quality.**
 - **Essential for training of Nation's and DOE's accelerator workforce.**
 - **USPAS, laboratory, and university partnership essential.**
- **To quote a lab letter: "...if USPAS didn't exist it would have to be created."**

Charge

With this letter, we are charging HEPAP to assemble a sub-committee to examine, for DOE only, the effectiveness and cumulative impact of the USPAS over the past two and a half decades, in the context of both workforce development and training; as well as to assess the overall quality and breadth of the program. The sub-committee should take into account the unique qualifications and skills of accelerator scientists and their role in the public and private sectors, and how USPAS training prepares participants for careers in accelerator physics and accelerator R&D. It should evaluate the need for this kind of program, given the available academic resources and worldwide competition for a skilled technical workforce; and address which unique and essential capabilities are provided to the program via the involvement of the DOE laboratories. It should also address the efficacy of the current USPAS management model, the participation of women and under-represented minorities in this area, and the projected need for trained accelerator scientists to support both DOE science missions and continued U.S. leadership in accelerator science.