



The US Particle Accelerator School: A cohesive force for Accelerator Education in America

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World-leading science/engineering education
is America's competitive advantage



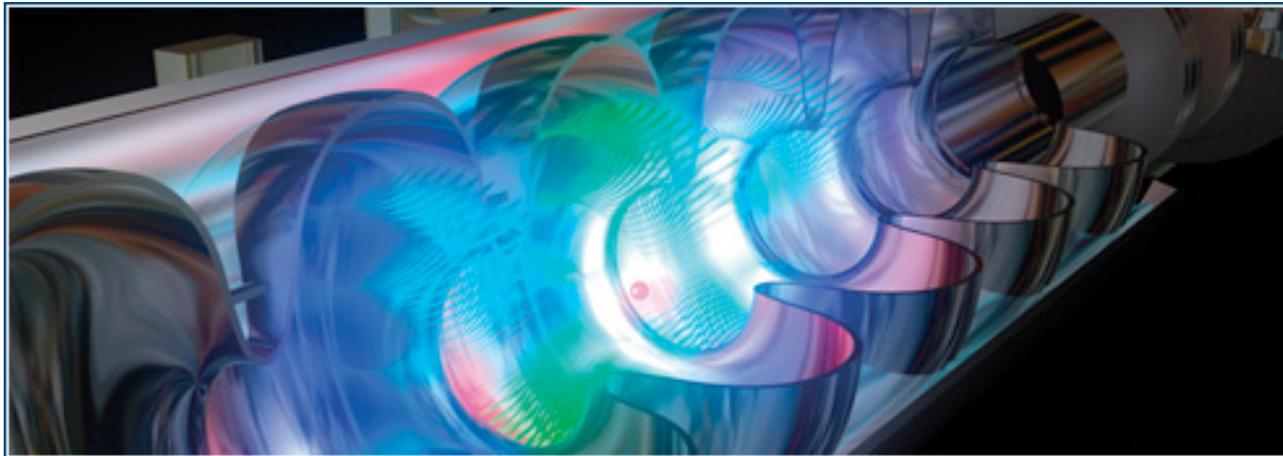
*America attracts & trains top talent from around the world
to attend US universities & use US scientific facilities*



Moreover, accelerators for future science...



- * ...Will be challenging to design & build
- * ...Will be challenging to operate



- * ...Will need outstanding physicists & engineers to realize

Yet only a handful of universities offer any formal graduate training in accelerator science & technology



Some root causes



- ✱ Accelerator science is inherently cross-disciplinary
- ✱ Prejudices:
 - ➔ Many physics departments view accelerator science as “just technology”
 - ➔ Electrical engineering departments have evolved toward micro- & nano-technology and computing science.
- ✱ Practicalities:
 - ➔ It is difficult to get the minimum number of students enrolled in a class for university approval
 - Even Cornell, UCLA, MSU, & Stanford only offer core courses
 - ➔ Interest at individual universities is not extensive enough to support a strong faculty line
 - ➔ Funding agency support of university-based accelerator research infrastructure is insufficient to develop new faculty lines



Group I: Universities with strong programs (alphabetic ordering)



- * Cornell University
- * Indiana University
- * Michigan State University
- * Stanford University
- * University of California at Los Angeles
- * University of Maryland (College Park)

*Even Group I universities offer only 2 or 3 regular courses
in accelerator physics and technology*

- * Also initiating structured Ph.D. programs
 - Massachusetts Institute of Technology
 - Old Dominion University (in affiliation with Jefferson Lab)
 - Stony Brook University (in affiliation with Brookhaven Lab)



Group II Universities: Some accelerator education activities



- * Colorado State University
- * Duke University
- * Illinois Institute of Technology
- * Texas A&M
- * Northern Illinois University
- * University of California at Berkeley
- * University of Chicago
- * University of Hawaii
- * University of Southern California
- * University of Texas at Austin
- * Vanderbilt University

A single interested faculty member cannot sustain a program



USPAS charter for educational stewardship Founded & nurtured under HEP auspices



- ✱ Constituted as a partnership of sponsoring institutions that fund all program costs
 - ➔ 7 SC laboratories (FNAL, ANL, BNL, JLAB, LBNL, ORNL, SLAC)
 - ➔ 2 NNSA laboratories (LANL, LLNL)
 - ➔ 2 NSF funded universities (Cornell, MSU)
 - ➔ 1 DHS office (DNDO/TARD)

- ✱ OHEP directly funds the USPAS Office at FNAL (Managing Institution)

- ✱ SC reaffirms commitment to USPAS governance formula (2010)
 - ➔ “we have reviewed the school's history, its successes, & promised benefits of its continuation... if the members of the *USPAS Board of Governors* ... *decide* that a given school is needed for training personnel, *we will support that decision.*”

 - ➔ “we will, as a consequence, *accept the Board of Governors' collective judgment* as adequate justification for funding the USPAS with the Federal funds that our programs provide to the respective laboratories.”



The USPAS office: The DOE view



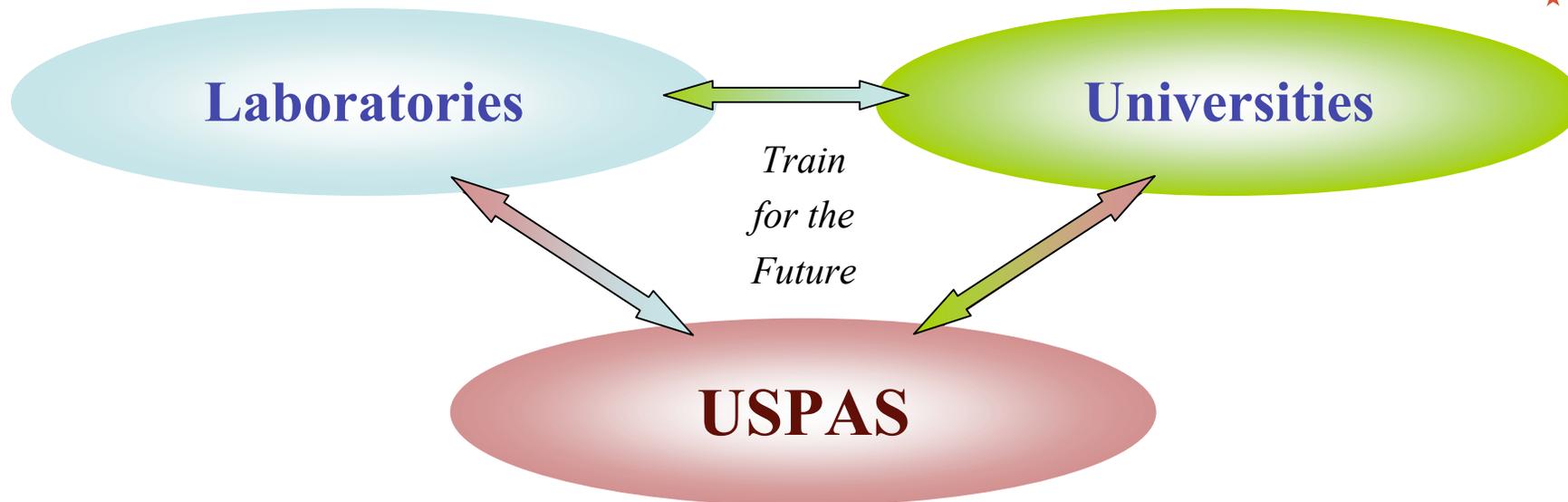
- ✱ “We reconfirm the principle that a single national laboratory is responsible for budgetary and business management oversight.”
- ✱ “We further reconfirm that Fermilab should continue to perform this function.”
- ✱ “We reconfirm that HEP will continue to provide funding support for the USPAS office at Fermilab including a full-time USPAS Director.”
- ✱ “The activities of the office appear well organized, the staff highly qualified, and the function essential to the schools.”



I am grateful for DOE's confidence & support



The USPAS Partnership Vision

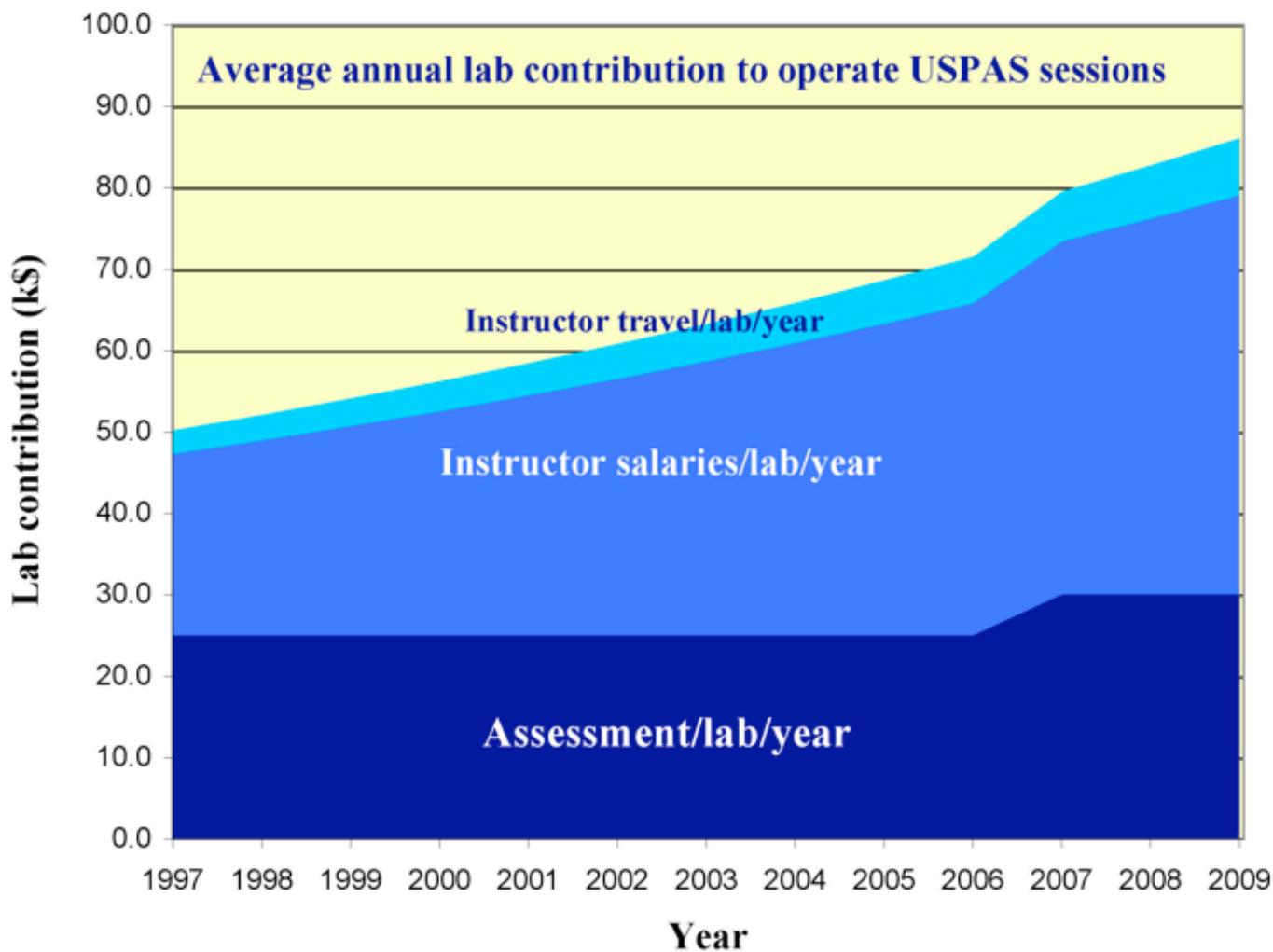


The US Particle Accelerator School provides graduate-level educational programs in the science of beams and their associated accelerator technologies

We grant more academic credit in accelerator science & technology than any university in the world

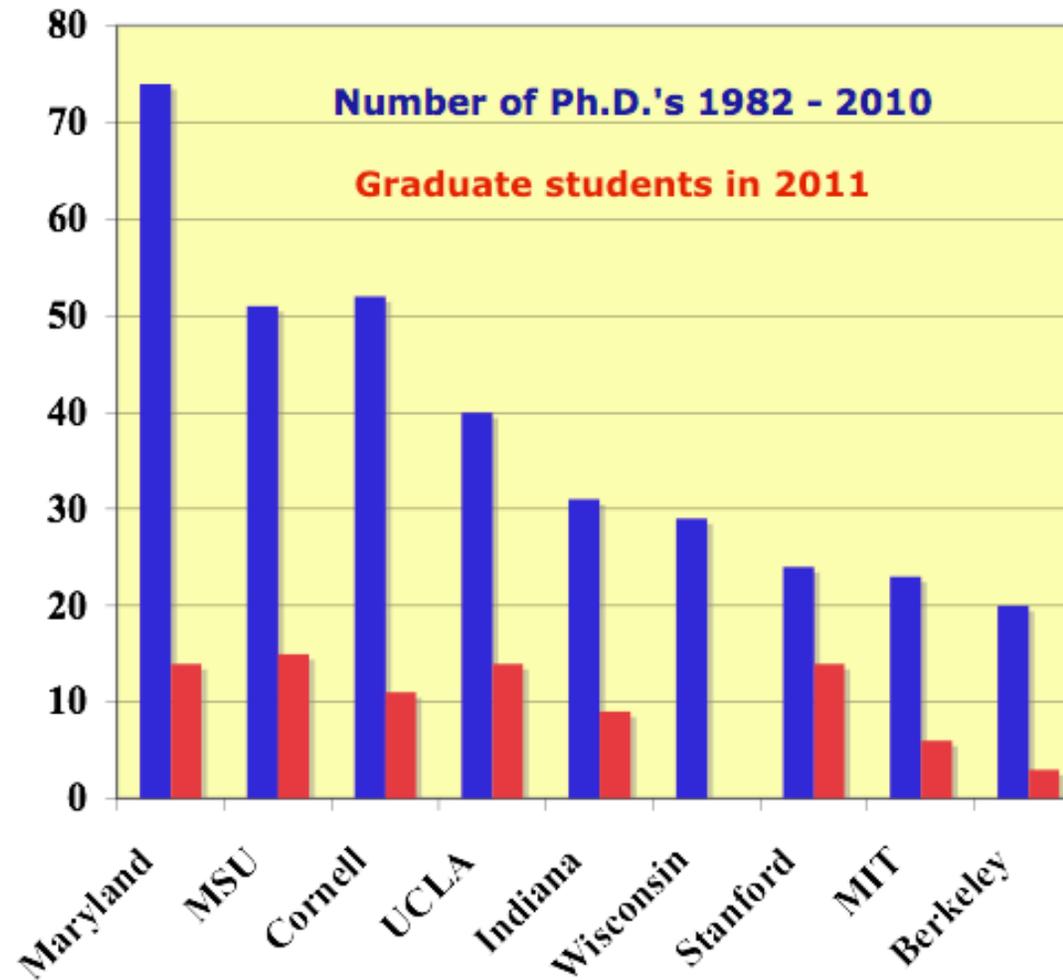


Consortium laboratories are strongly committed to our 3-way partnership





Historical context and present population





Major US universities rely on USPAS as an essential partner in education



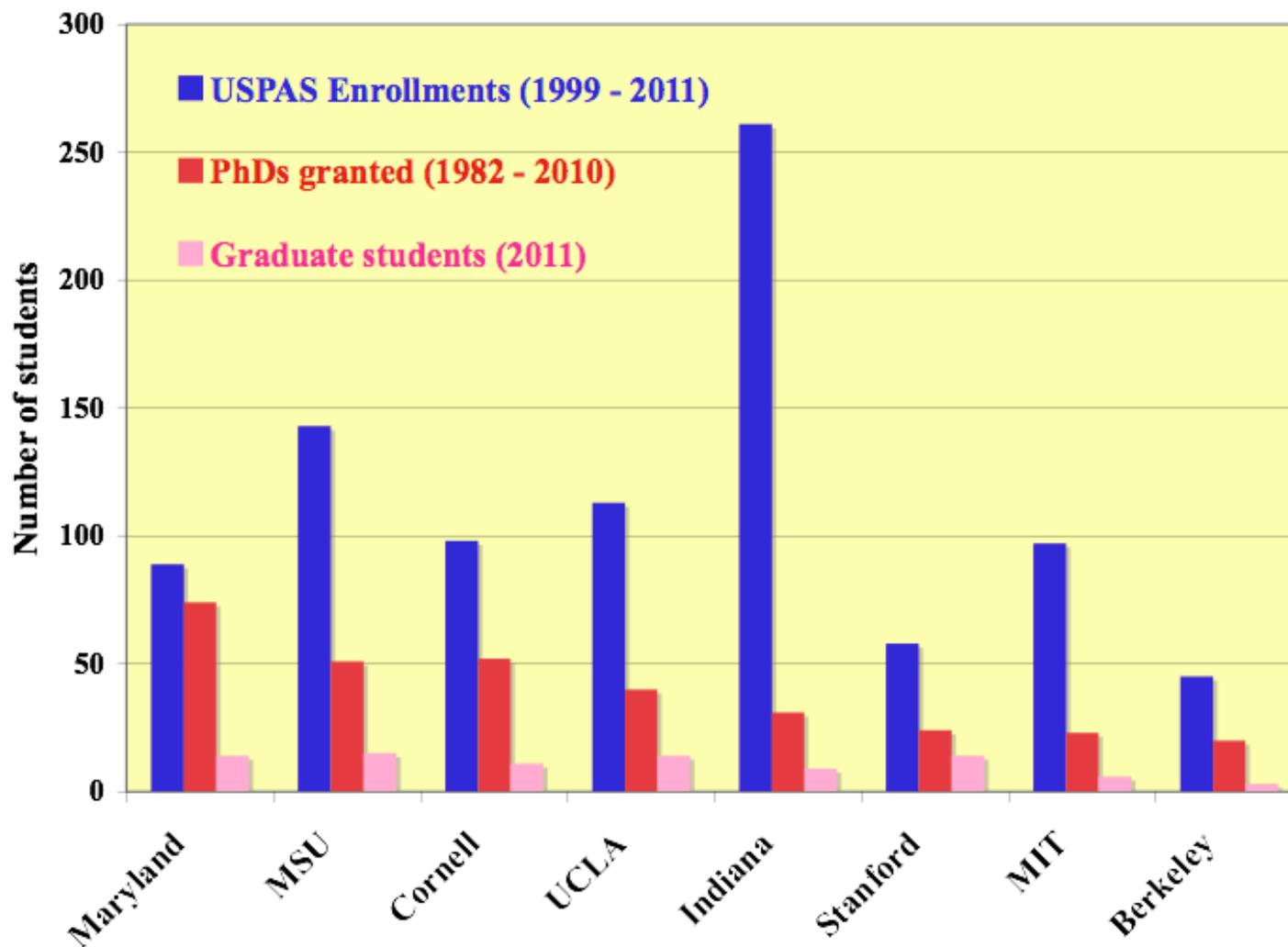
- ✱ Universities with strong graduate programs in accelerator physics provide the largest student attendance at USPAS
 - ➔ Only Maryland, Cornell, MSU, UCLA, & Stanford have strong faculty lines (>2 professors)

*Accelerator-based science needs several more such universities
to assure an adequate, well trained professional workforce*

- ✱ Universities with research accelerators
 - ➔ Emphasize innovation in accelerator science
 - ➔ Promote undergraduate awareness
 - MSU - 50 UGs annually; Cornell - 60 UGs annually
 - ➔ Offer exciting opportunities to engineering students
 - ➔ Encourage student experimentalists to learn about accelerators
 - ➔ *Are a vanishing breed*

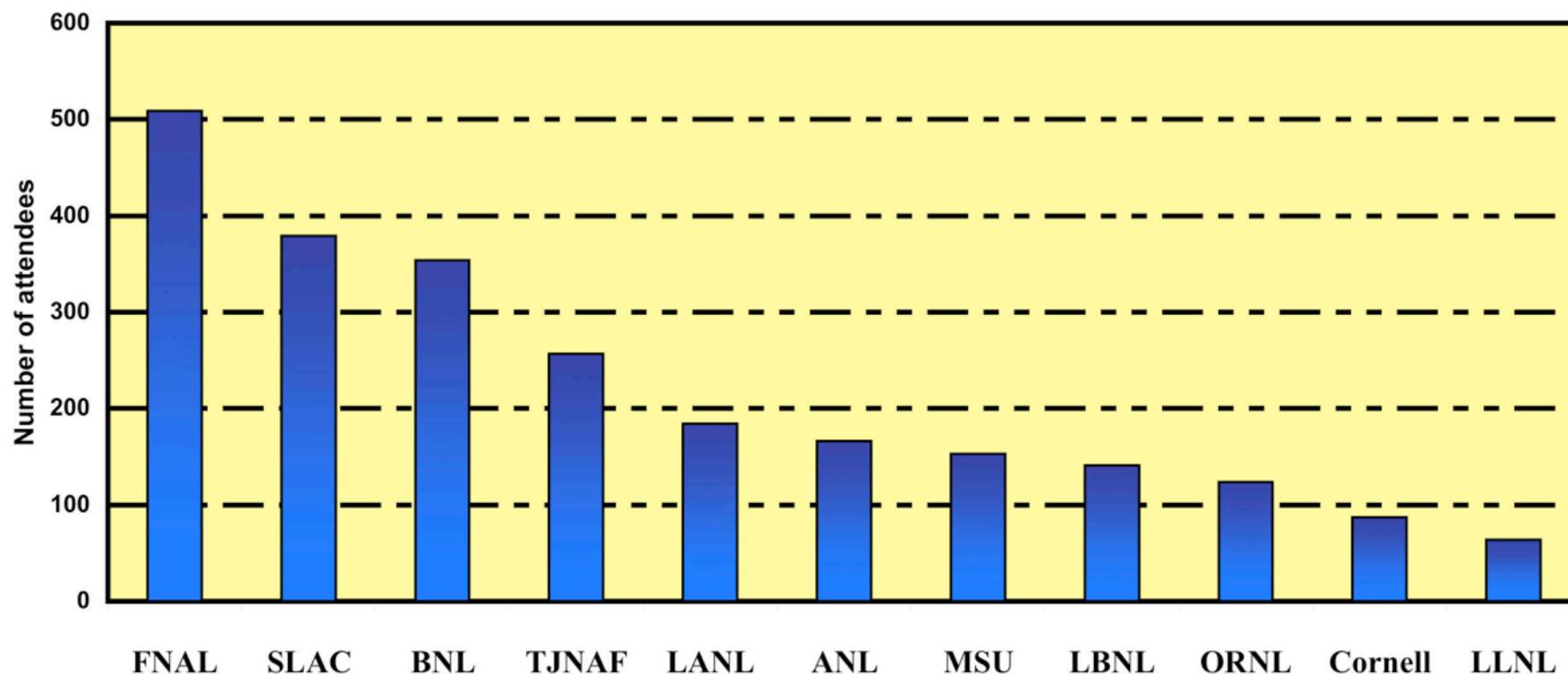


Universities with the strongest programs send the most students to USPAS sessions





USPAS is an unparalleled source of continuing education for the consortium



Attendance at USPAS sessions from sponsoring institutions from 1987 - 2011



As required by host universities USPAS stresses academic rigor



- ✱ 2 schools annually hosted by a major research university
 - ➔ 8 intense university, courses run in parallel (45 contact hours in 2 weeks)
 - ➔ Balance physics v. engineering, lectures v. hands-on
- ✱ Typical attendance per school ~ 130 students (recently ~150)
 - ➔ Scholarship support available for matriculated students who take courses for credit
 - ➔ Credit-student workload during course > 8 hr/day
 - ➔ Graded homework & exams
- ✱ 42 university-style schools with >3300 individual students
 - ➔ Attended more than >1x / >2x / 3x >1030 / > 450 / >200
 - ➔ >200 have become intellectual leaders in their field
 - ➔ >25 USPAS graduate students have become USPAS instructors
 - ➔ ~150 USPAS instructors have taken USPAS courses



USPAS session format & logistics maximize instruction & study time

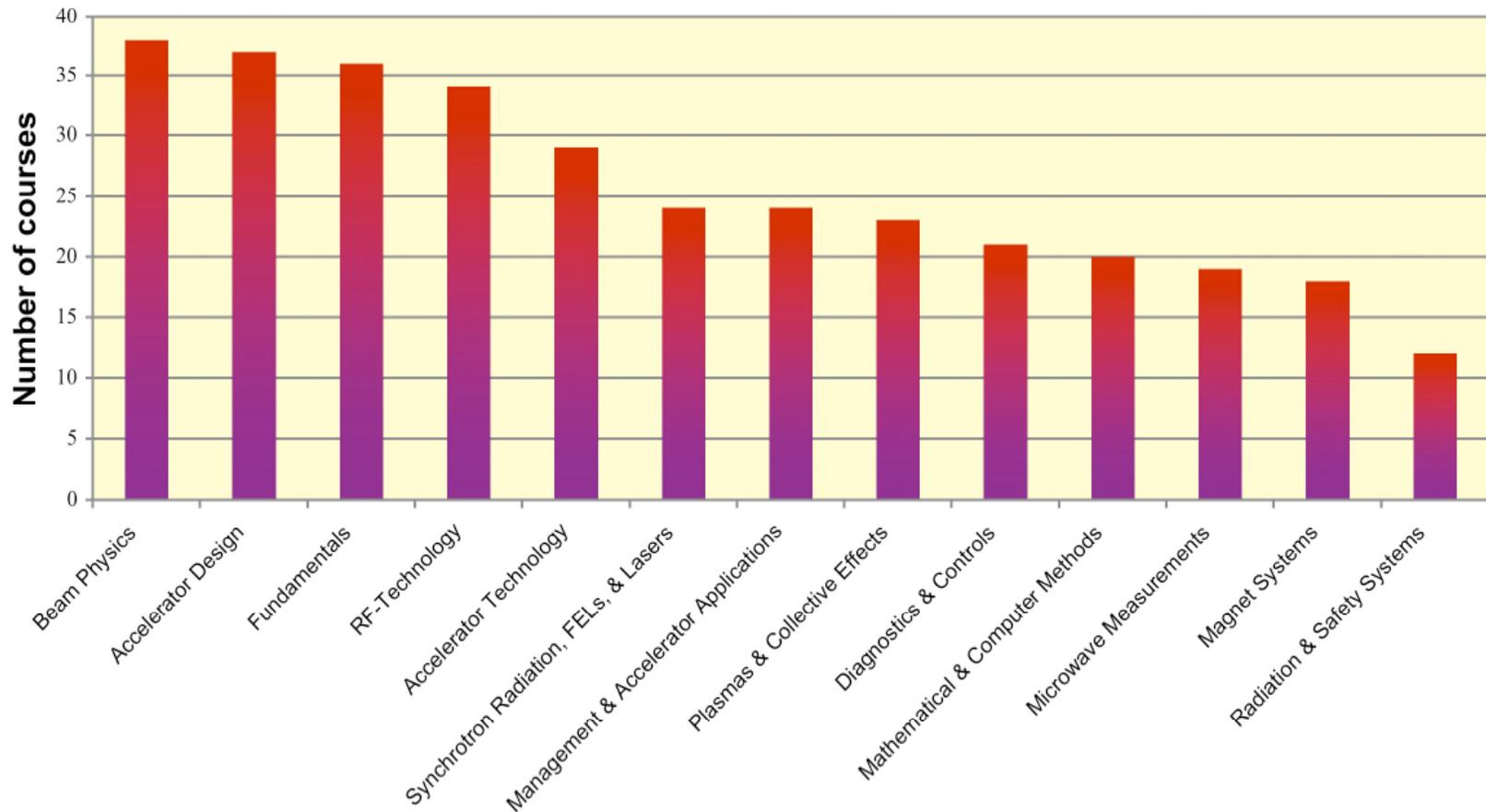


Typically:

- * School held at a hotel
- * We provide breakfast & dinner to students
- * Supported students share a room
- * We rent computers (PCs, printers, network)
- * We provide textbooks as requested by instructors
- * Pay hosting university ~\$300 per credit student
- * Students may ask hosting university for transcript

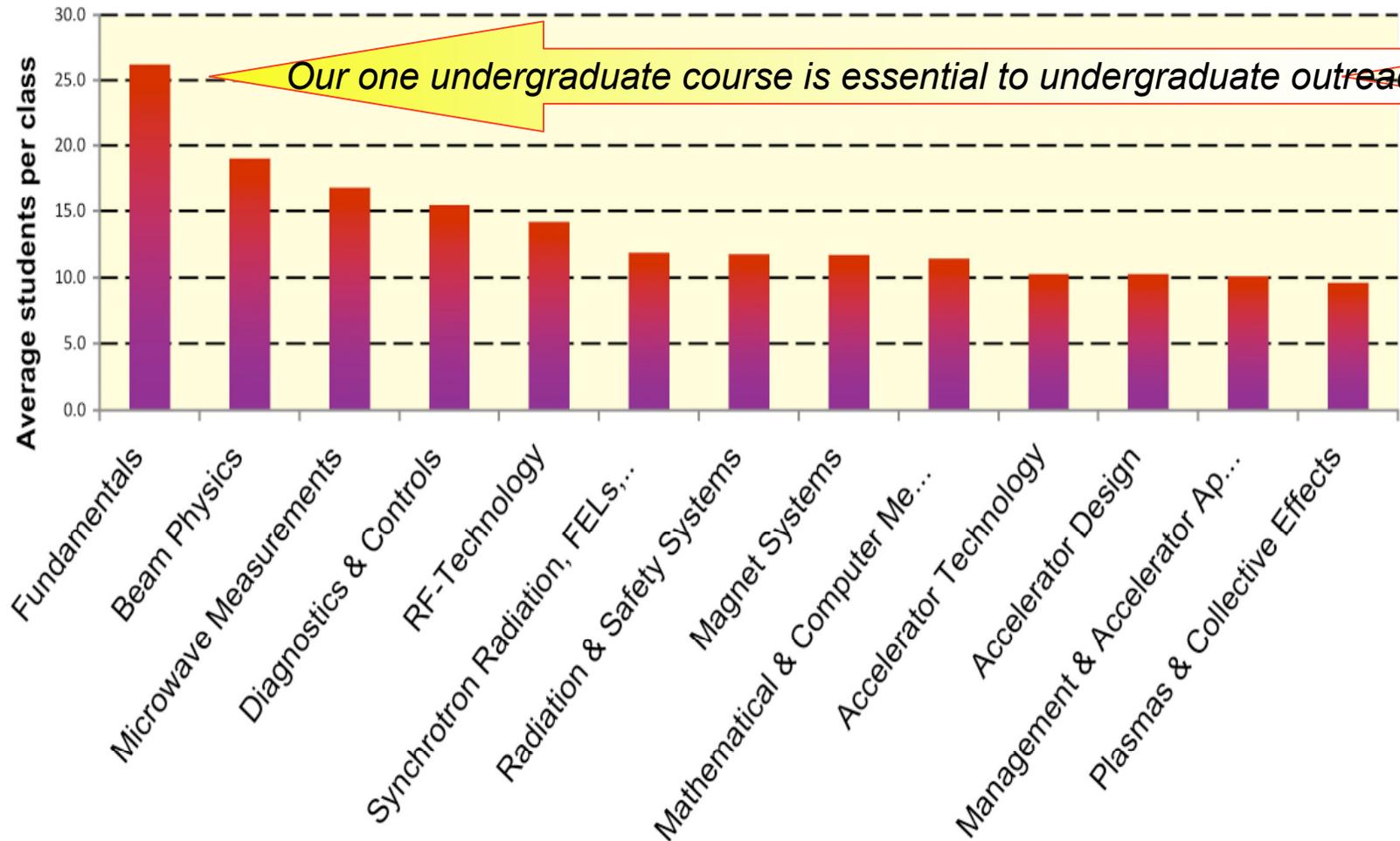


USPAS covers *all* areas of central interest for government, industry & medicine





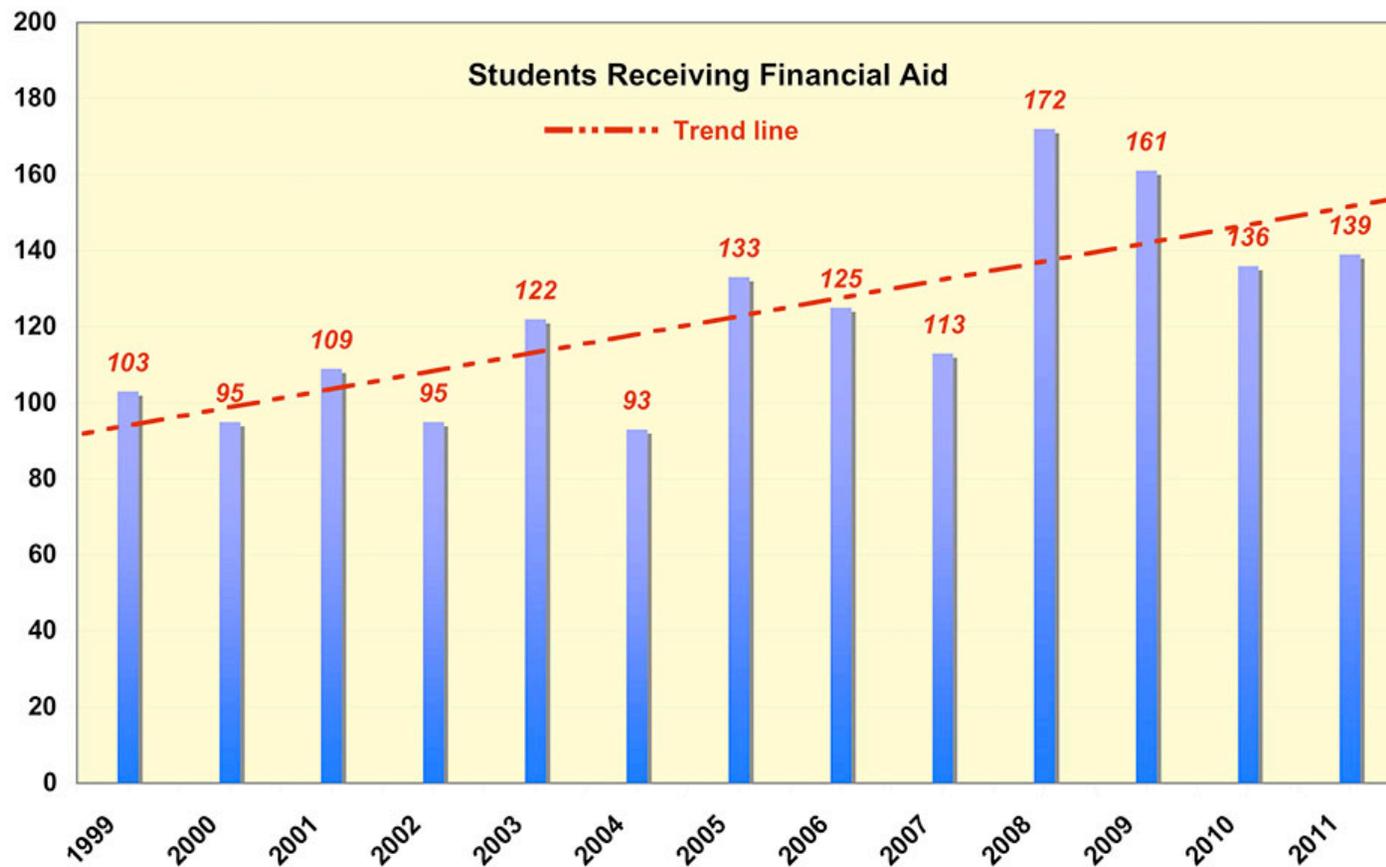
Introductory courses are the biggest draw



We use these data in planning curricula & in choosing venues



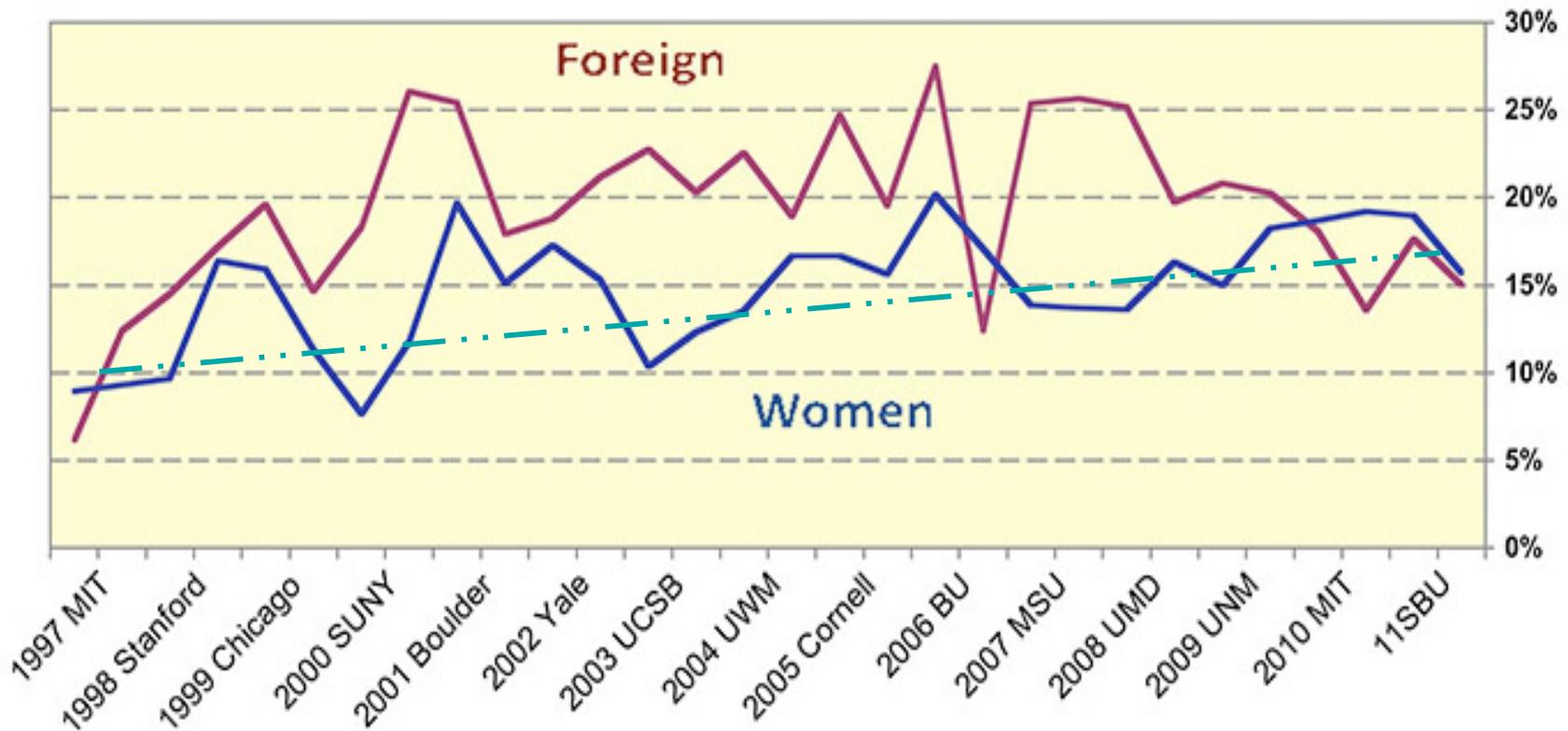
Many of our students receive financial aid



However, we can no longer give as many full scholarships



We have increased participation by women





A first step: More women instructors



Prof. Linda Spentzouris mentoring students in Fundamentals of Accelerators.



Even a great product can be improved



- ✱ Sessions are planned through Summer 2013
 - Tentative locations for W2013 (Duke) & S2013 (CSU)
 - W2013 will concentrate on engineering for accelerators

- ✱ We are working to establish more continuing, formal relationships with major research universities

- ✱ We are adding courses in detector physics & technology
 - The goal is to work toward a Fall session concentrating on detectors & instrumentation if interest & new funds sources allow

- ✱ We have reestablished the Joint International Accelerator School sessions with CERN, KEK & BINP



Student & Instructor feedback improves our planning of future sessions



Course Name: _____

Student Survey

USPAS Office Evaluation Form

1) Are you taking this course for credit? Y or N

2) On the basis of the following characteristics, how do you rate this course?

	Poor	Fair	Good	Very Good	Excellent
-content, emphasis	<input type="radio"/>				
-student material provided	<input type="radio"/>				
-homework problems	<input type="radio"/>				
-computer simulations (if applicable)	<input type="radio"/>				

3) Compare the level of difficulty of this course with other university courses you have taken:

More difficult _____ Equal difficulty _____ Less difficult _____

Effectiveness of Instructors

4) On the basis of the following characteristics, how do you rate the performance of the instructors for this course?

	Poor	Fair	Good	Very Good	Excellent
-teaching effectiveness	<input type="radio"/>				
-classroom performance	<input type="radio"/>				
-attitude towards students	<input type="radio"/>				

5) Compare the quality of instructors for this course with other university instructors:

Better _____ Equal _____ Worse _____

6) Did your background adequately prepare you for this course?

Not at all	Only Slightly	Somewhat	For the Most Part	Very Much So
<input type="radio"/>				

7) Rate the value of this course for your current job:

Unimportant	Slightly Important	Will have no Impact	Somewhat Important	Very Important
<input type="radio"/>				

8) Rate the value of this course for your future career:

Unimportant	Slightly Important	Will have no Impact	Somewhat Important	Very Important
<input type="radio"/>				

9) What courses would you like to see in the future?

10) Suggestions or comments on this course or on the USPAS in general

As part of an ongoing assessment of the USPAS organization, please complete the following evaluation. Be frank in your answers and your comments. Your honesty is essential to our success. If you need more space for comments and suggestions please use the reverse side.

1) In your direct contact with USPAS staff, and in your general observations, how would you rate overall performance.

	Poor	Fair	Good	Very Good	Excellent
- Support	<input type="radio"/>				
- Response	<input type="radio"/>				
- Attitude	<input type="radio"/>				

2) How would you rate the USPAS Office performance compared with other such organizations?

Unfavorably Comparable Superior

3) Please provide brief comments on USPAS strengths and deficiencies. Include suggestions for improvement.

4) How would you rate the teaching conditions? (audio-visual, computer equipment/software, lab equipment, etc)

5) Additional comments:



USPAS Faculty & Degree Programs



USPAS partners provide 2/3 of our faculty



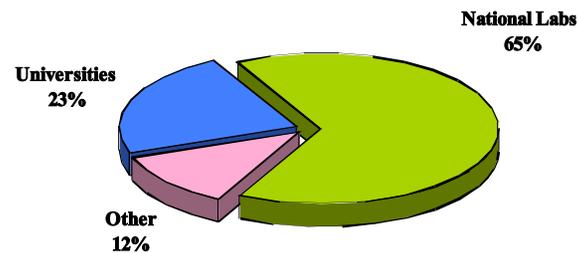
We thank our instructors for their dedicated work



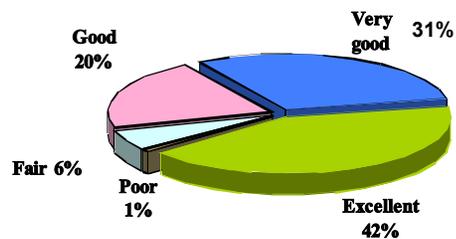
Instructor performance measures up to that at major universities



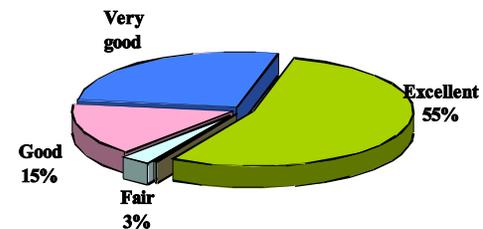
Lecturer Distribution



Overall Course Rating



Instructor Performance





USPAS Masters Program



Master of Science
in
Beam Physics and Accelerator Technology
from
Indiana University & USPAS

8 degrees awarded

7 Students currently enrolled in program

Requirements: 30 Credit Hours with grade point average of B or above

- * IU/USPAS Courses
- * Master's Thesis (3 - 9 credits)
- * Final Examination or oral defense of thesis

It is time to renew the MOU with Indiana



Movement toward an affiliated PhD



- ✱ Under the leadership Prof. Jean Delayen, Old Dominion University (ODU) is establishing a USPAS-affiliated Ph.D.
 - First step: all USPAS courses will be co-listed as ODU courses
 - USPAS Director is an Adjunct ODU Physics faculty
- ✱ At MIT, Dept. of Physics & Nuclear Engineering are exploring a similar possibility
 - Graduate & undergraduate accelerator physics are “on the books”
- ✱ Cornell is also exploring co-listing all USPAS courses
- ✱ Un. of Chicago is considering co-listing undergraduate “Fundamentals” & graduate “Accelerator Physics”

I am exploring co-listing with other universities



Internships & Undergraduate Outreach



USPAS attendance trends suggest that student interest has never been higher



- ✱ Seizing opportunity represented by these students requires
 - *Expanded DOE investment* in university-based accelerator research
 - A *new generation of hands-on training instruments*
- ✱ A *focused program of student internships* could attract
 - talented undergraduate physics & engineering students into graduate study in accelerator science & technology



Small, instructional cyclotrons can kindle undergraduate interest



Rutgers The State University of New Jersey



INSTITUTE FOR RESEARCH IN
ELECTRONICS
& **APPLIED PHYSICS**



The Rutgers 12-Inch Cyclotron is a research-grade accelerator dedicated to undergraduate instruction.

By Timothy Koeth (cyclotron educational director)

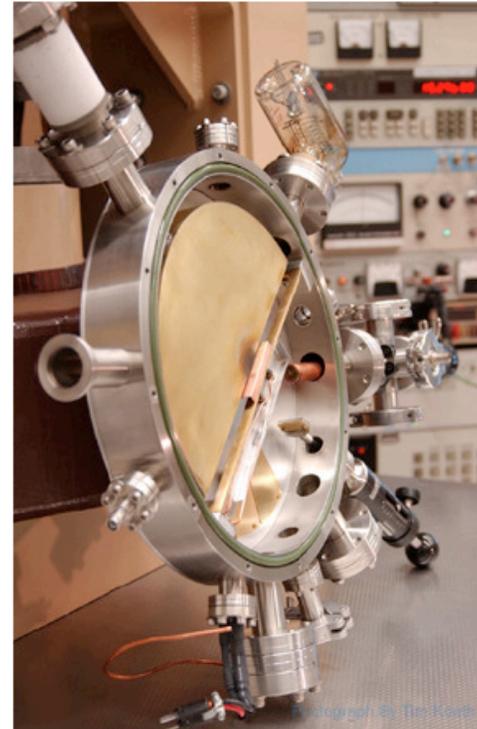
This machine was built on a low budget (< 100 k\$) by eleven generations of undergraduate students. Project continuity is provided by dedicated volunteer staff whose professional passion is particle accelerator science.

A Unique Educational Opportunity

- Beam physics & associated accelerator components
- Accelerator and E&M Simulations
- Mechanical design & machine shop interface
- RF, HV, & Electronics Experience
- Learn High Vacuum Techniques
- Diplomacy: Radiation Safety
- Pulling it all together: research

Goal: recruit accelerator physicists

Success: 5/14 physics students have decided to pursue careers in accelerator physics !



I will propose with Tim Koeth to built an electron model machine for USPAS



Undergraduate outreach: Teng Internship at Argonne & Fermilab



LEE TENG UNDERGRADUATE INTERNSHIP IN ACCELERATOR SCIENCE & ENGINEERING

The Lee Teng Internship is a highly competitive education and research opportunity, open to students from US universities who have just completed their junior year in physics or engineering. Teng scholars will receive a full scholarship to attend the US Particle Accelerator School Summer Session followed by an eight-week research internship at Fermilab or Argonne National Laboratory. Research projects will be of sufficient depth for a senior thesis. The internship offers full travel support and a generous stipend.

For further information and to apply see
www.leetengscholar.org

- ✧ Goal: Engage highly promising post-junior undergrads to study accelerator science & technology
- ✧ Encourage them to pursue graduate research & education in these fields
- ✧ Interns study Fundamentals at USPAS
- ✧ During remainder of summer, students undertake research project at the labs
- ✧ ANL & FNAL selected 11 Teng interns in 2008 - 2011
- ✧ We provide advice on graduate programs



Proposal to OHEP for accelerator stewardship program



- ✱ Establish annual USPAS Accelerator Internship Program
 - Makes students competitive for SC graduate fellowships
 - Encourages students to enter accelerator PhD programs

- ✱ Support 30 interns/yr at accelerator labs & 4 universities
 - Students selected & placed by 3 regional committees
 - Regional committees find mentors
 - Host institution provides logistics (as for SULI or REU students)

- ✱ Modeled after Lee Teng Program
 - Students take USPAS course followed by research internship
 - Open to pre-graduate school students
 - Stipend is \$1600/month plus housing allowance + transportation

Annual cost ~350k\$



The labs cannot supplant the principal role of research universities



- ✱ Talented undergraduates must be aware of the intellectual challenge & excitement of accelerator science
- ✱ Top undergraduates expect to study at a great university
- ✱ Students should spend a large fraction of time on campus
 - ➔ An education at a great lab is not an education at a great university



Universities do & can provide cutting-edge accelerator research for students



A few examples:

- ✱ Pioneering development of rf-superconductivity (Cornell & Stanford)
 - SCRF cavity optimization is done by students at Cornell & MSU
- ✱ Development of superconducting cyclotrons (MSU)
 - High current ion sources (MSU)
- ✱ Pioneering studies of plasma-based accelerators (UCLA)
- ✱ Experimental studies of space-charge dominated transport (UMER at UMd)

DOE investment in a few more small research machines at universities would pay large dividends to large accelerator-based science programs



Conclusions & recommendations



- ✱ Education in accelerator science *must continue* as a partnership among universities, national labs & USPAS
- ✱ USPAS attendance trends suggest that student interest has never been higher
- ✱ Taking advantage of the opportunity these students represent requires expanded DOE investment in university-based accelerator research & in a new generation of hands-on training instruments
- ✱ A focused program of student internships could attract talented undergraduate physics & engineering students into graduate study in accelerator science & technology

I encourage you

- 1) to take a USPAS course**
- 2) to teach a USPAS course**

Both are hard work

Both are highly rewarding

<http://uspas.fnal.gov>



**Our students are the bright future
for our field**



US PARTICLE ACCELERATOR SCHOOL