US Particle Accelerator School:

Educating the next generation in the science & technology of accelerators, beams & plasmas

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The problem

- Accelerators are **essential** tools for discovery in fundamental physics, biology, & chemistry
- > 15,000 accelerators in medicine, industry & national security constitute a multi-billion dollar/year industry.
- > 55,000 peer-reviewed papers having accelerator as a keyword are available on the Web.
- **Yet…**

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

Reasons & excuses

- 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 universities such as Cornell, UCLA, MSU, & Stanford only offer core courses
  - → Interest at individual universities is not extensive enough to support a strong faculty line.

The challenge: HEPAP sub-panels

- "The education & the training of the next generation of accelerator scientists & engineers is a serious concern."
- "The limited number of educational opportunities at universities is insufficient to meet anticipated future needs."

AARD Sub-panel Report

- "The present University Grant Program level of effort shortfall is not consistent with US intentions to host the ILC."

UGP Sub-panel Report

The USPAS is dedicated to responding to this challenge

USPAS Vision & Mission

USPAS is an essential partner of U. S. universities & national laboratories in training the next generation of accelerator scientists & technologists for the challenging accelerators of the future.

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

Why USPAS is critical to SC & NSF

The next 10 years will see operation of challenging, new machines

Well-trained accelerator physicists & engineers are essential to a rich & productive future in accelerator-based science

USPAS grants more academic credit in accelerator science & technology than any university in the world

It is an opportunity to mentor and counsel not just teach

USPAS is a growing contributor to the education of accelerator scientists and technologists internationally

International outreach directly benefits DOE & NSF laboratories

USPAS charter for educational stewardship

- Founded & nurtured under HEP auspices
- Letter from the four Energy Research AD's allows & encourages national laboratory sponsorship & support (1992)
  - Re-confirmed by DOE/SC & NSF in 2008
- Constituted as a partnership of sponsoring institutions
  - 7 SC laboratories (FNAL, ANL, BNL, JLAB, LBNL, ORNL, SLAC)
  - 2 NNSA laboratories (LANL, LLNL)
  - 2 NSF funded universities (Cornell, MSU)
- Partner institutions fund all program costs
  - Partner support - $30 k/yr
- HEP directly funds USPAS Office at FNAL

USPAS Organization & Governance

- National Graduate School
- Board of Governors with elected Chair
  - Organized under an MOU & By-laws
  - Curriculum Advisory Committee
  - Administration provided by Managing Insititution
- USPAS Director
  - Appointed by BOG
  - Funded by DOE/HEP
- Curriculum Committee Chair
  - Selected by Director with consent of BoG

Fiduciary administration by Fermilab

- USPAS Office at Fermilab (Managing Institution)
  - → Directly funded by DOE/HEP by FY2000 agreement
  - → Office Manager, Susan Winchester
    - Over 20 years of service to USPAS

Susan Winchester, with student Julius Nfor

How USPAS started

- Founded in 1981 by Mel Month offering seminar style presentations

The original USPAS team M. Month with Marilyn Paul and Susan Winchester

- Since 1987 USPAS has been organized as a university course program (academic courses for credit)

USPAS educational operations

- 2 schools annually hosted at different US universities
- Typical attendance per school ~ 130 students
  - → Scholarship support available for matriculated graduate students
- 38 university-style schools with >3000 individual students
- Also 10 Joint Schools with CERN & KEK
  - → Assisted organizing ICFA/GDE LC School in 2008
  - → Joint Schools in China (2009) & Brazil (2010) in planning

USPAS approach stresses academic rigor

- **Goal:**

  Educate & train in accelerator physics & technology

- **Method:**

  University courses with homework, exams & academic credit from host universities

- **Means**:

  Lectures & “hands-on” laboratory courses & activities

- **Typical USPAS academic session:**

  ~ 4 two-week courses on core subjects (45 contact hours)

  ~ 8 one week courses, mostly technology & highly specialized subjects (23 contact hours)

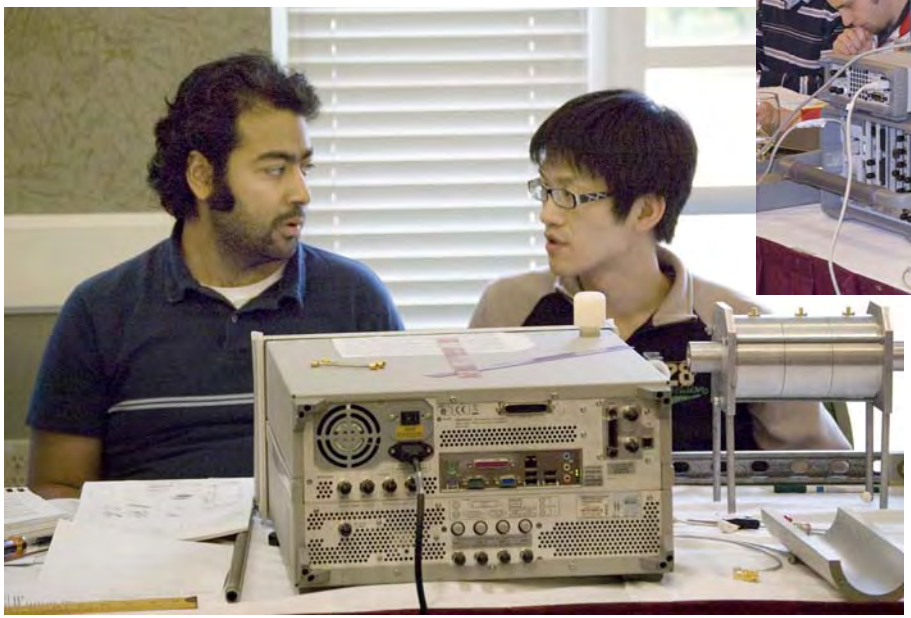
USPAS session format & logistics maximize instruction & study time

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

A special thank you

- Get expensive instrumentation (network analyzers etc.) from Agilent

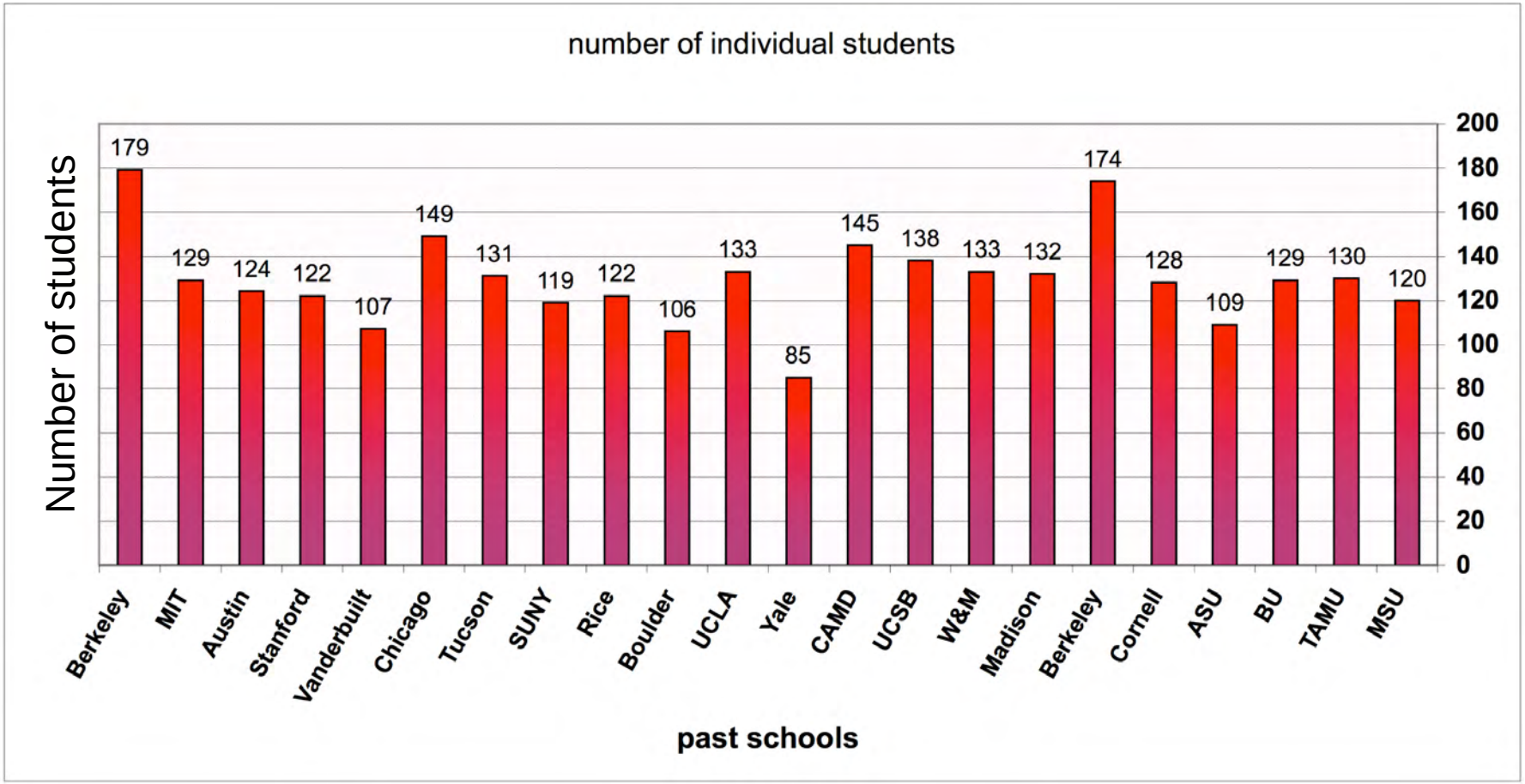


USPAS Academic Sessions:
Cumulative Statistics, 1987 - 2007

❖ **Total Number of Programs***	**38** (23)
➙ **Total Number of Courses***	**~ 360** (262)
➙ **Average Number of Courses /Program**	**8**
➙ **Number of Working Days/ Program**	**10**
➙ **Average Number of Teachers & Support / Course**	**2.1**
❖ **Total Number of Students***	~ **4350** (3000)
➙ **Total number of individual students**	**~2900**
➙ **Attended more than once / twice / 3x**	**>900 / >500 /277**
➙ **Average Attendance per Program**	**~130**
➙ **Current level of university students**	**~ 60 %**
❖ **Average Percentage of for-Credit Students**	**~ 60 %**
➙ **Credit Student Workload during Course**	**> 8 hr/day**

** Since 1997 in ( )*

Session attendance remains high



ASU & BU schools lost several students at the last minute due to visa problems

USPAS Degree Program

Master of Science

in

Beam Physics and Accelerator Technology

from

Indiana University & USPAS

4 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

Highlights of 2008

- Winter session sponsored by UC Santa Cruz (~150 students)
  - → Special offerings: Emphasis on light sources & FELs
  - → 2 new, *hands-on* courses introduced
    - Synchronization, timing & RF processing
    - Synchrotron light based beam diagnostics

Highlights of 2008

- **USPAS "Iron-man" recognition**
  - Mike Syphers - 408 students in 11 classes
  - New course introduced: "Optics of High Energy Accelerators"

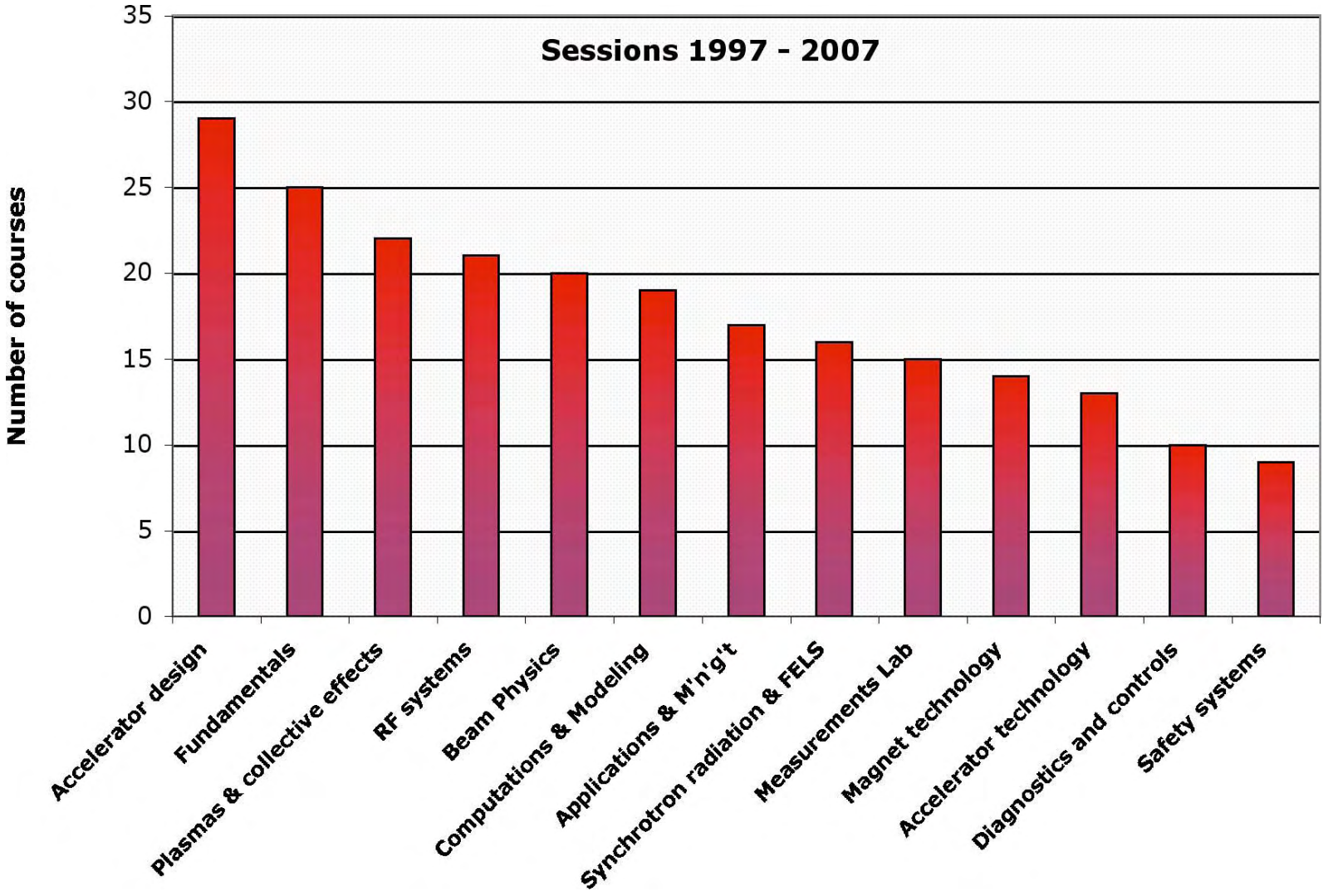
Highlights of 2008: More "hands-on" training for students

- Lee Teng Undergraduate Internships at FNAL & ANL
  - → USPAS course followed by 8 weeks at Lab
  - → Focus on juniors in physics & engineering
  - → More such programs to follow
- Summer session sponsored by U. Md.
  - → Hands-on course "Beam dynamics experiments
  - → New course introduced: Vacuum tube design

We develop the USPAS curriculum to meet SC & NSF needs

- USPAS Curriculum Committee meets annually
  - Timely: Align curriculum with evolving accelerator-based science
  - Responsive: Align curriculum with needs of sponsors
- Members from sponsors plus universities & USPAS Director
- The agenda is simple:
  - Review past schools and successes
  - Recommend courses & possible instructors for *next four schools*.
- Final program & instructors are set by USPAS Director
  - Approval of the Governing Board
- Host university approves courses & instructors

Relevance: Course offerings cover all areas of interest to DOE & NSF



Balance special topics with fundamentals
Balance physics with technology

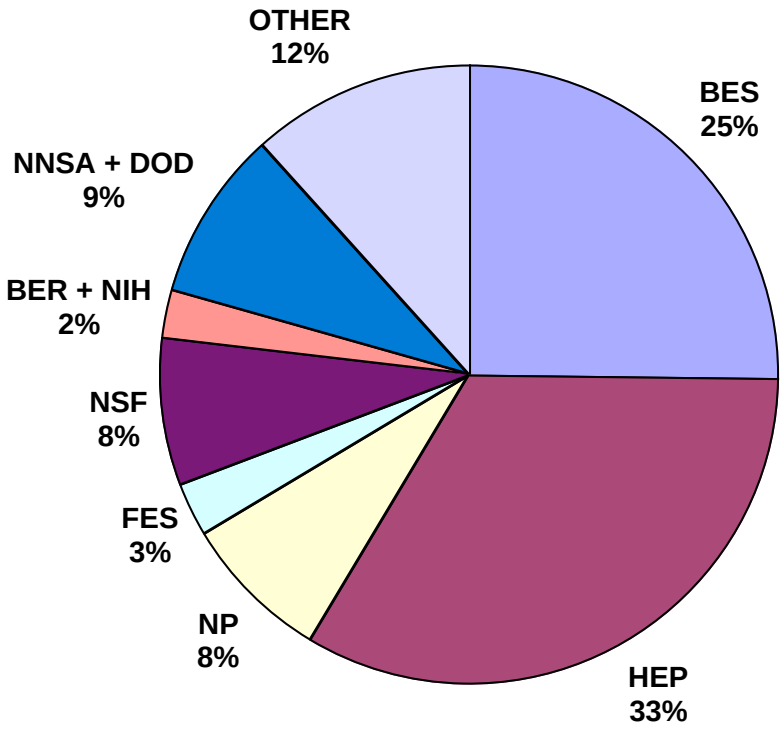
S-2008 USPAS at the University of Maryland				
Guest Lecture: Frontiers of Accelerator Technology				
Two Weeks				
Accelerator Fundamentals	Y. Wu & S. Mikhailov (Duke), J. Wu (SLAC)			
Accelerator Physics	W. MacKay & T. Satogata (BNL)			
Beam Dynamics Experiments at UMD	R. Kishek (Univ. of Md.) & UMd Team			
RF Superconductivity	J. Delayen (JLAB)			
Beam Physics with Intense Space Charge	J. Barnard & S. Lund (LLNL)			
One Week				
Applications of Accelerators in Medicine (include treatment planning if possible)	J. Flanz (Mass Gen)		Radiation Detection & Imaging for Medicine & Security	T. Budinger (LBL)
Laser Plasma Accelerators	C. Schroeder & E. Esarey (LBL)		Applications of Lasers in Accelerators	Y. Li (ANL)
Vacuum Tube Engineering	Lecturer from Thales Components Corp		Microwave Sources	B. Carlsten & S. Russell (LANL)
Beam-Based Diagnostics	C. Steier & G. Portmann (LBNL) & J. Safranek, SLAC		Control Room Physics Application Programs	J. Galambos & C. Allen (ORNL)

Great courses require great teachers

A small selection of recent faculty

Our faculty are drawn from national labs, universities, & industry

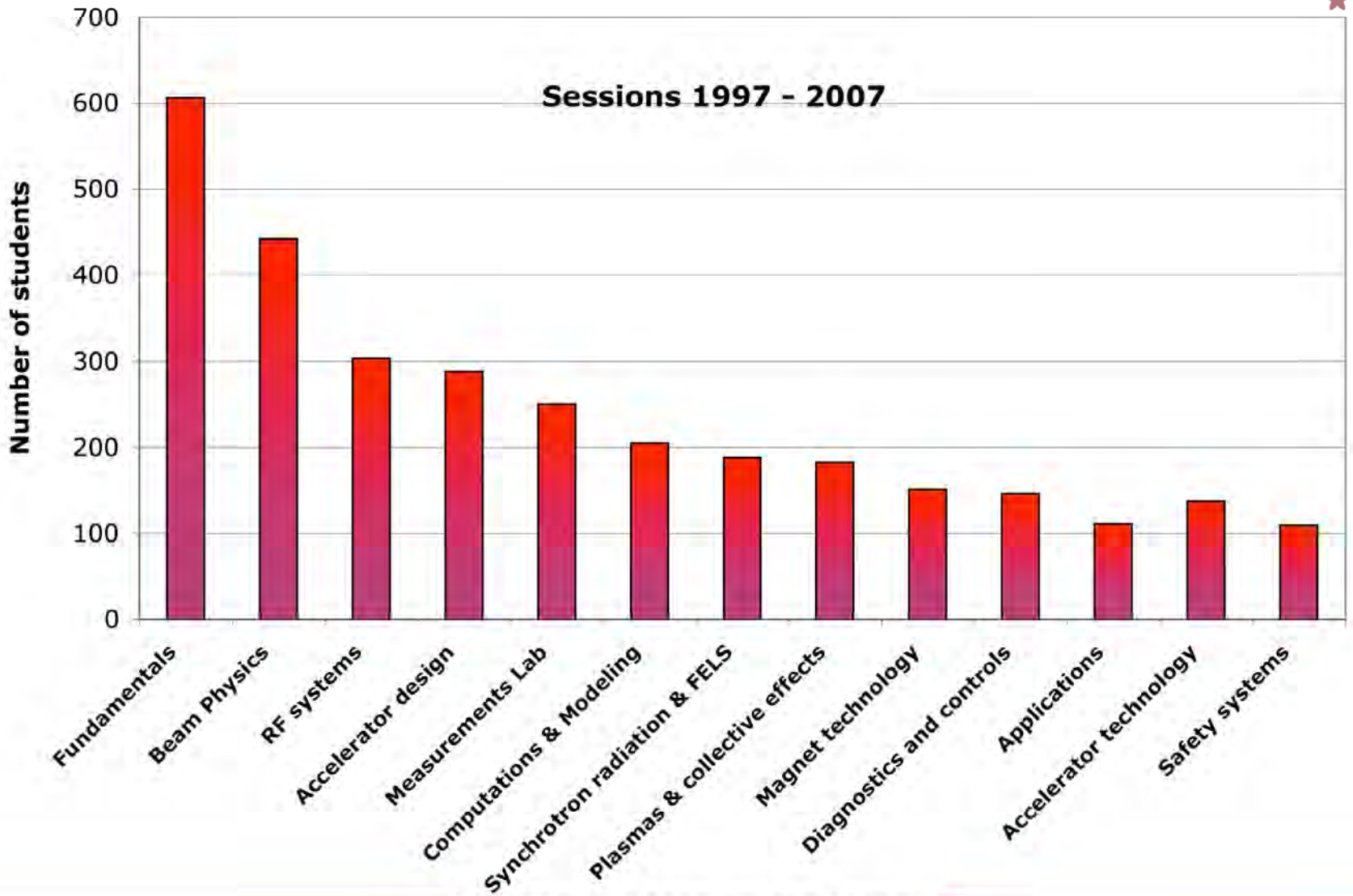
Faculty from the sponsoring labs teach as part of their work assignment



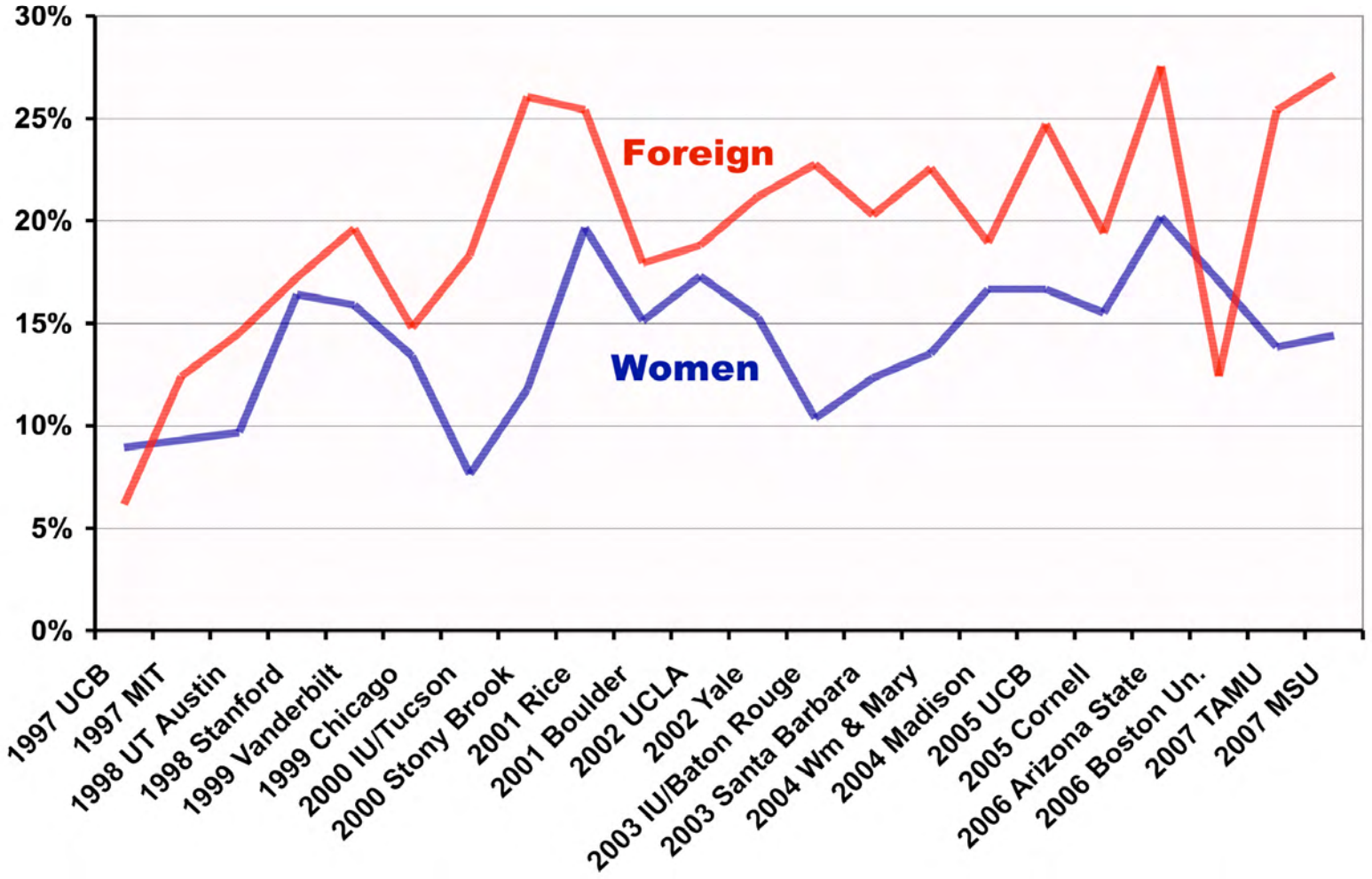
Source of support of USPAS faculty

Instructors also benefit from their teaching experience

Our students favor fundamentals



Attendance by women & foreign students



Student & University feedback improves our planning of future sessions

Course Name:

Student Survey

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	◯	◯	◯	◯	◯
-student material provided	◯	◯	◯	◯	◯
-homework problems	◯	◯	◯	◯	◯
-computer simulations (if applicable)	◯	◯	◯	◯	◯

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	◯	◯	◯	◯	◯
-classroom performance	◯	◯	◯	◯	◯
-attitude toward students	◯	◯	◯	◯	◯

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
◯	◯	◯	◯	◯

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

Unimportant	Slightly Important	Will have no Impact	Somewhat Important	Very Important
◯	◯	◯	◯	◯

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

Unimportant	Slightly Important	Will have no Impact	Somewhat Important	Very Important
◯	◯	◯	◯	◯

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

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

USPAS Office Evaluation Form

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	◯	◯	◯	◯	◯
- Response	◯	◯	◯	◯	◯
- Attitude	◯	◯	◯	◯	◯

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

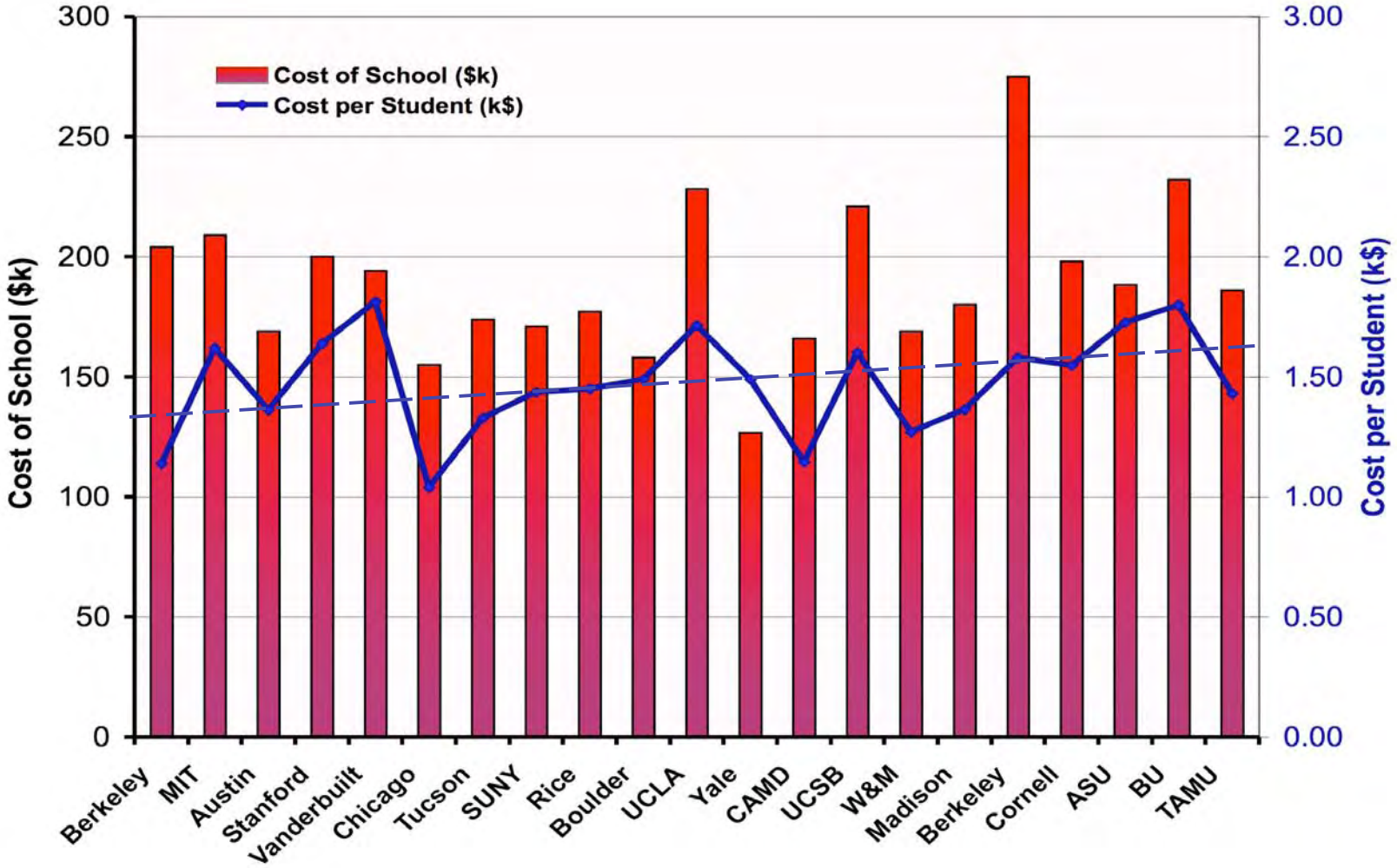
Unfavorably ◯ Comparable ◯ Superior ◯

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

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

5) Additional comments:

The cost: We have managed USPAS session economics within inflation



Meals & student support are major driver of cost increases (<2%/year)

USPAS Initiative: Provide more “hands-on” training

- Present practice
  - Experimental component of Accelerator Fundamentals course
  - Experimental course in Microwave Measurements
  - Periodic schools where there is a machine with a flexible schedule
- Initiative: New experimental courses
- Initiative: USPAS associated interdisciplinary Ph.D. at MIT
  - Establish a faculty line in accelerator science
  - Core physics & engineering courses at MIT campus
  - Summer training internships at national labs (BNL & JLab mentors

Our students are the bright future for our field

USPAS Initiative: Improved experiments for Fundamentals course

- Joint USPAS/MIT/UCLA proposal

Cookie tin rf-cavities

Registration is still open
http://uspas.fnal.gov/

UNITED STATES PARTICLE ACCELERATOR SCHOOL

SUMMER SESSION 2008 – ANNAPOLIS, MD

UNIVERSITY OF MARYLAND