Educating the next generation of accelerator scientists & engineers

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Why do we need accelerator schools

- Accelerators are **essential** tools for discovery in fundamental physics, biology, & chemistry
- > 14,000 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 UMd, Cornell, UCLA, & 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"

  Advanced Accelerator R&D Sub-panel Report, 2006

- This problem is not limited to the US; it is international in scope
- The need is not new

Our community needs a different paradigm

How can we design an effective school?

- Rigorous for-credit courses or seminars
  - Fundamentals or specialty courses
  - Laboratory courses available?
- Degree Program Available?
- Frequent, regular sessions or occasional
- Standing organization or ad hoc
- On campus or at hotel / conference center
- Duration (weeks)
- Scholarships available?
- Proceedings, books, or lecture notes on web

USPAS meets this challenge

Vision:
We are 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.

Mission: The US Particle Accelerator School provides
rigorous, graduate-level educational programs
in the science of beams & associated accelerator technologies

Origins of the USPAS

- Inspired by an Erice Symposium School in 1976 (K. Johnson)
- Founded in 1981 by Mel Month using symposium format

The original USPAS team: Mel Month with Marilyn Paul and Susan Winchester
June, 2005

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

USPAS charter: educational stewardship

- Founded & nurtured under HEP auspices
- Letter from the four Energy Research AD's *allows & encourages* national laboratory sponsorship & support (1992)
  - Discretion is expressly left to the Governing Board
  - 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)
  - 1 federal agency: DHS/DNDO/TARD
- Partner institutions fund all program costs
  - Partner support - $30 k/yr
- HEP directly funds USPAS Office at FNAL

USPAS Governance & Structure

- National Graduate Program
- Board of Governors with elected Chair
  - Organized under an MOU & By-laws
  - Curriculum Advisory Committee
  - Fiduciary oversight by Managing Institution, Fermilab
- USPAS Director
  - Appointed by BOG
  - Funded as full time position by DOE/HEP
- Curriculum Committee Chair
  - Selected by Director with consent of BOG

USPAS educational operations

- 2 schools annually hosted by a major research university
- Typical attendance per school ~ 130 students
  - → Scholarship support available for matriculated graduate students who take courses for credit
  - → Credit-student workload during course > 8 hr/day
- 39 university-style schools with >3100 individual students
  - → Attended more than >1x / >2x / 3x >570 / > 220/>100
- 10 Joint International Schools with CERN & KEK & INP

USPAS stresses academic rigor

- **Goal:**

  Educate & train in accelerator physics & technology

- **Method:**

  Intense 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 hardware)
- We provide textbooks as requested by instructors
- Pay hosting university ~$300 per credit-student
- Students may ask hosting university for transcript

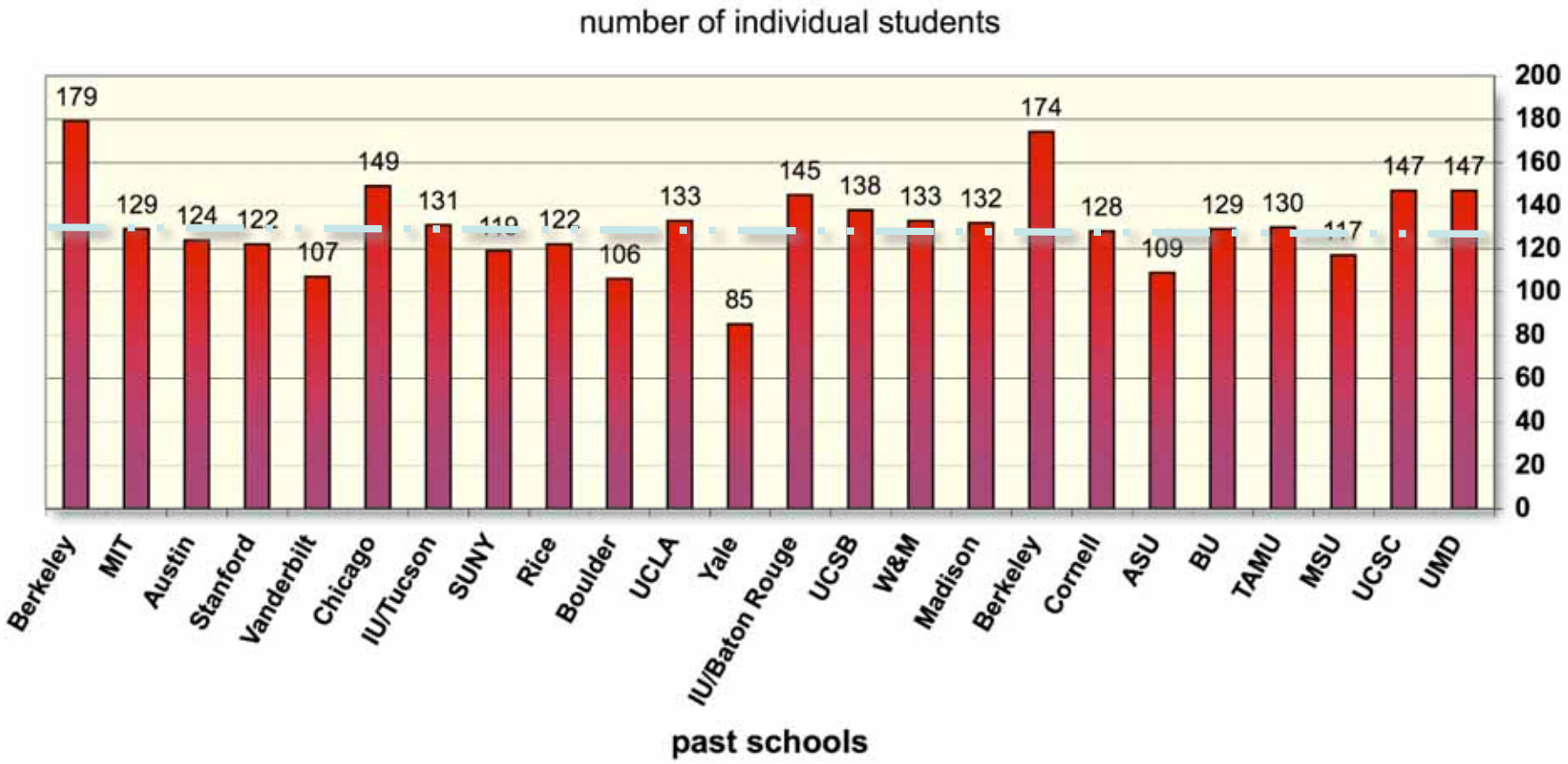
A special thank you

- Agilent provides expensive instrumentation (network analyzers etc.)

Our students are the bright future for our field

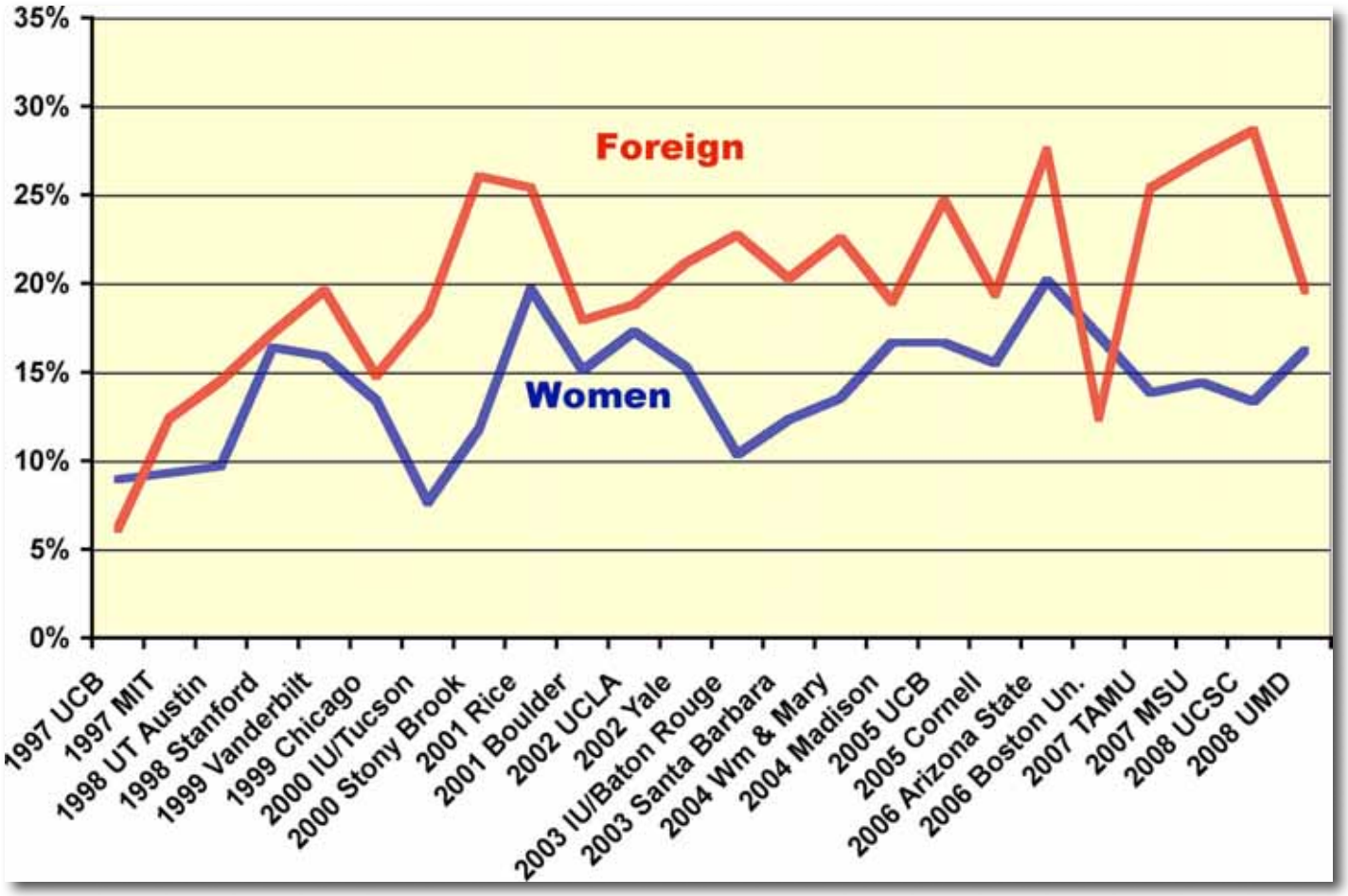
All four of the student poster prize winners are USPAS students

The demand for USPAS is strong



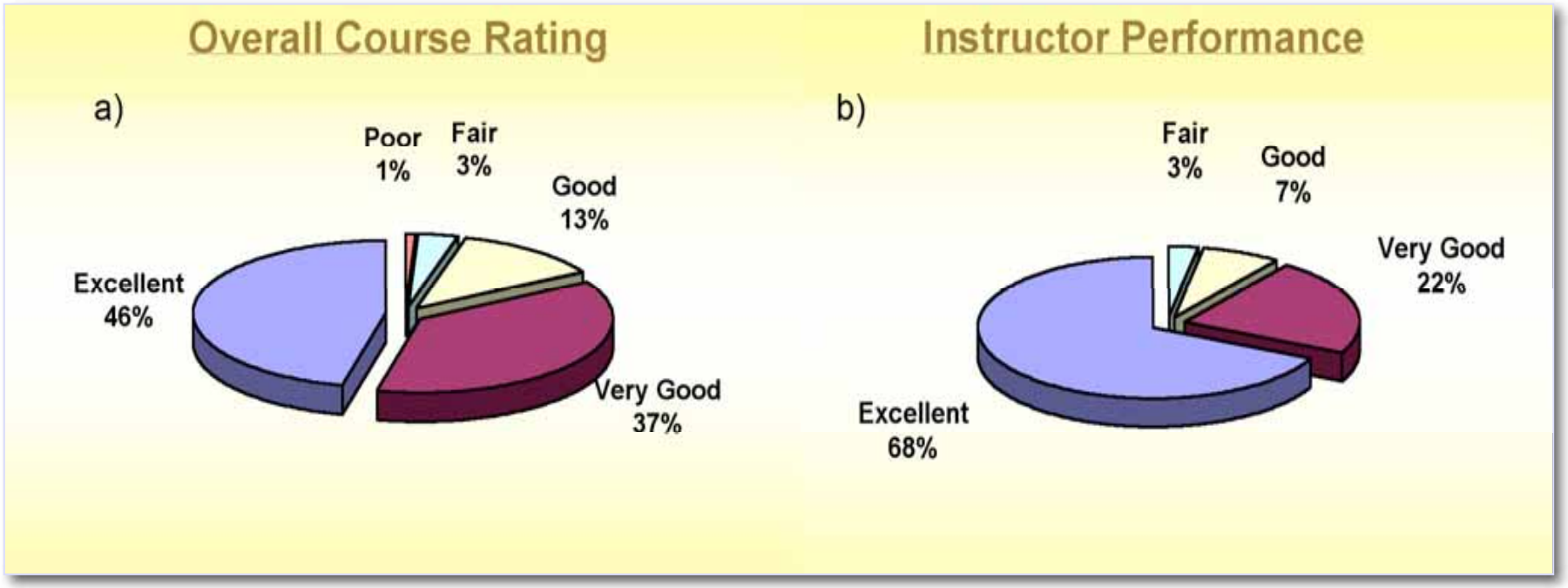
~ 60% of the students take courses for credit

Attendance by women & foreign students



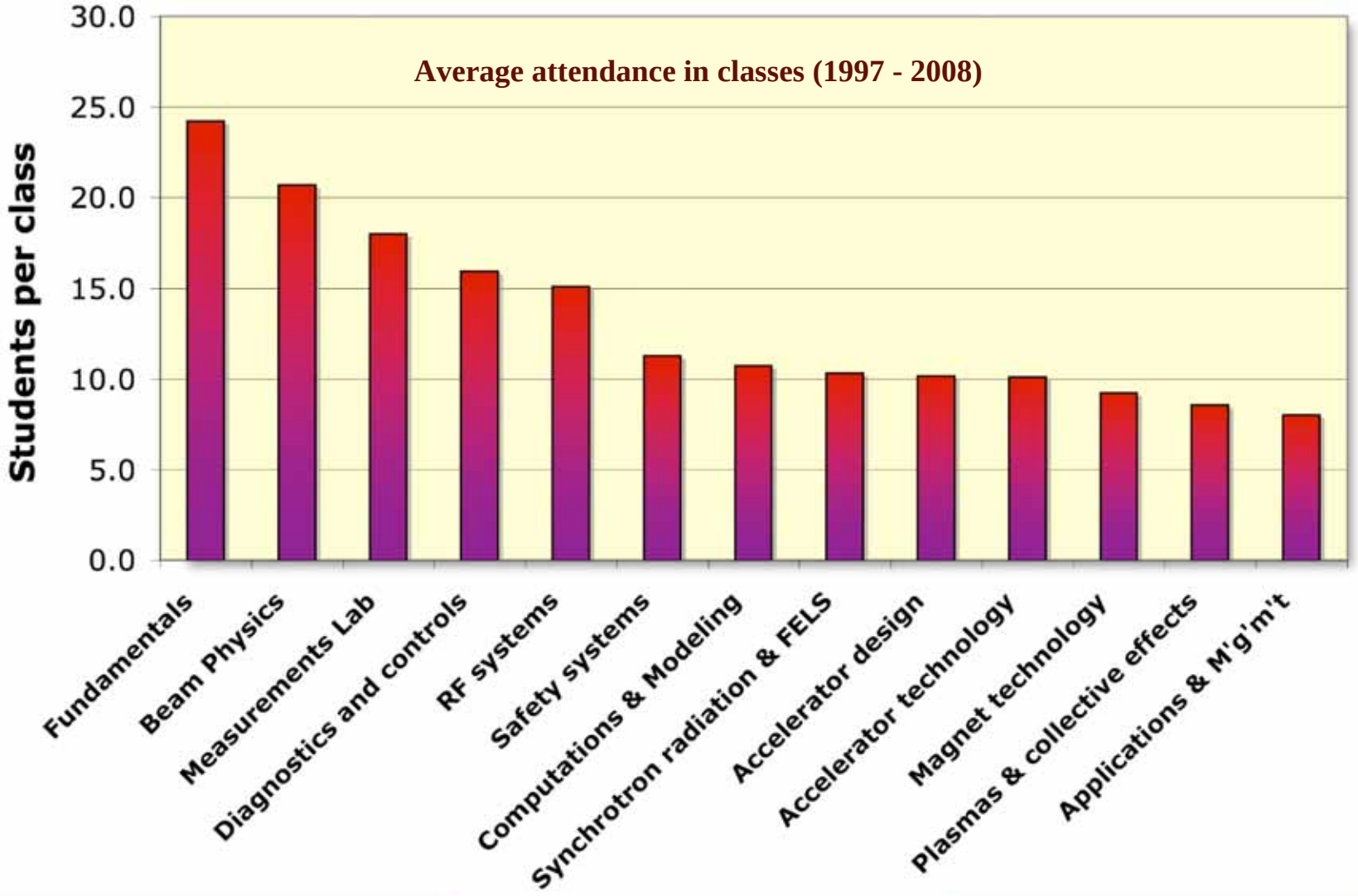
We will add more women instructors

Student satisfaction is high



All courses are evaluated as in most universities

The strongest demand is for fundamentals



Degree Programs

&

Academic Outreach

USPAS Degree Program

Master of Science

in

Beam Physics and Accelerator Technology

from

Indiana University & USPAS

5 degrees awarded

7 Students currently enrolled in program

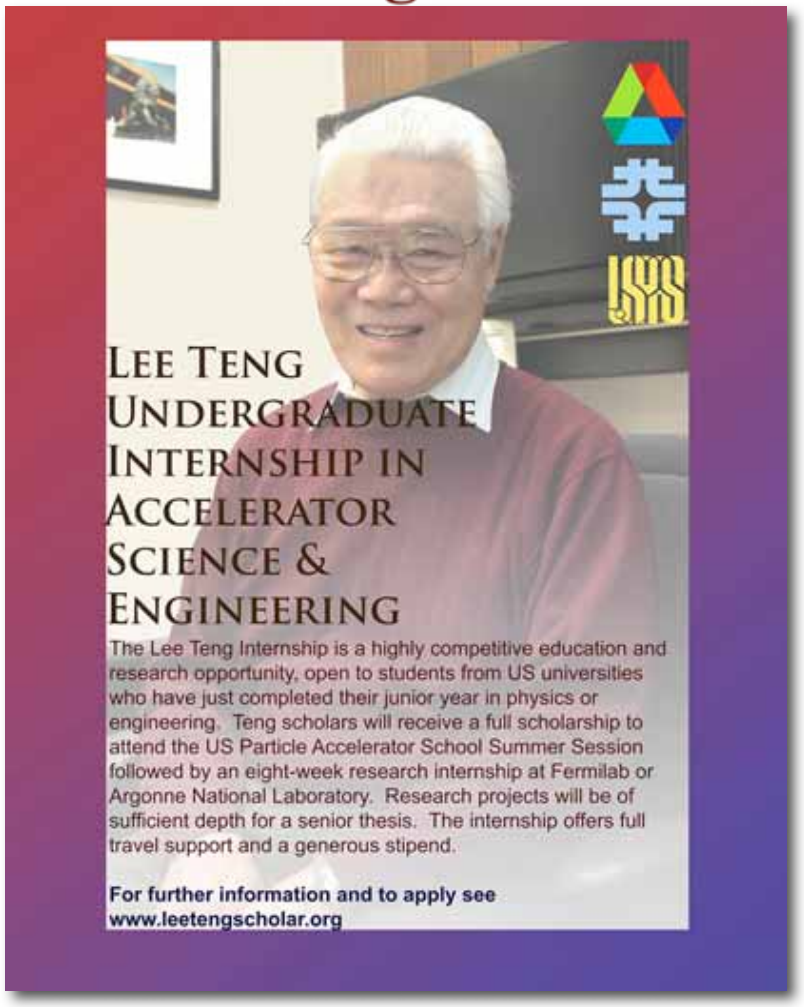
Requirements: 30 Credit Hours: with grade point average of B or above

* IU/USPAS Courses & Master's Thesis (3 - 9 credits)

* Final Examination or oral defense of thesis

Nearly all are lab employees who get a promotion as a result

Undergraduate outreach: Teng Internship at Argonne & Fermilab



- 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 and FNAL selected 11 Teng interns in 2008

We encourage other consortium laboratories to offer similar internships

USPAS outreach to developing countries

- Partnership with the American Physical Society (APS) International Programs Office to secure a travel grant for a deserving student from a developing country
- Julius Nfor from Cameroon is selected for the Winter 2009
- We expect a second grant in the near future
- We are working with the APS to secure continuing funding for the travel grant awards

Susan Winchester, with graduate student, Julius Nfor

Great courses require great teachers

We thank our instructors for their dedicated work

We continually develop new offerings for our constituency

- New lecture courses in 2008
  - → Optics of High Energy Accelerators
  - → Radiation Imaging for Medicine & Homeland Security
  - → Special opportunity: "Vacuum Electron Devices"
- 2 new, *hands-on* courses introduced in 2008
  - → Synchronization, Timing & RF Processing
  - → Synchrotron Light-based Beam Biagnostics

Schools across the Sea

CERN Accelerator School

- Training courses for accelerator physicists & engineers twice a year
  - Began in 1983
  - The courses take place in different member states of CERN
  - Consist of lectures & tutorials spread over a period of one or two weeks.
    - Participants from CERN member states & other countries world-wide
  - Director: Daniel Brandt
- Pattern of courses
  - Spring course on a specialist topic
  - Autumn course on accelerator physics
    - at the introductory level in even years
    - at the intermediate level in odd years
  - In even years an autumn course in the framework of the Joint Accelerator School (JAS) program
    - JAS is a collaboration between US, CERN, Russia and Asia
- Sessions lead to high quality, written proceedings
  - See http://cas.web.cern.ch/cas/Proceedings.html

The Joint Universities Accelerator School

- Intensive program for students & modular courses for professionals
- The full program covers many subjects during 10 weeks from January to March
  - Two five-week courses taught by Europe's accelerator specialists
  - Whole program includes about 180 hours of lectures, tutorials, guided studies & seminars
  - Lectures and tutorials are backed up by site visits / demonstrations
- Organized by European Scientific Institute
  - With support of CERN Accelerator School & several major European Universities
  - Examinations under the control of one of the partner universities validate the courses
    - Successful candidates may obtain credits at their home university through the European Credit Transfer System (ECTS)
    - It is recommended that all students take the examinations, which are *mandatory* for those students who receive a grant

New initiative: African School of Physics

- Proposal: establish a biennial school of physics in Africa
  - Topics: fundamental subatomic physics and its applications
- Purposes:
  - Build capacity to harvest, interpret, & exploit results of current & future physics experiments with particle accelerators
  - Increase proficiency in related applications and technologies
- Format: 3 weeks of lectures
  - Week one: Theoretical physics
  - Week two: Experimental techniques
  - Week three: Accelerator science & technology
- http://africanschoolofphysics.web.cern.ch/africanschoolofphysics/

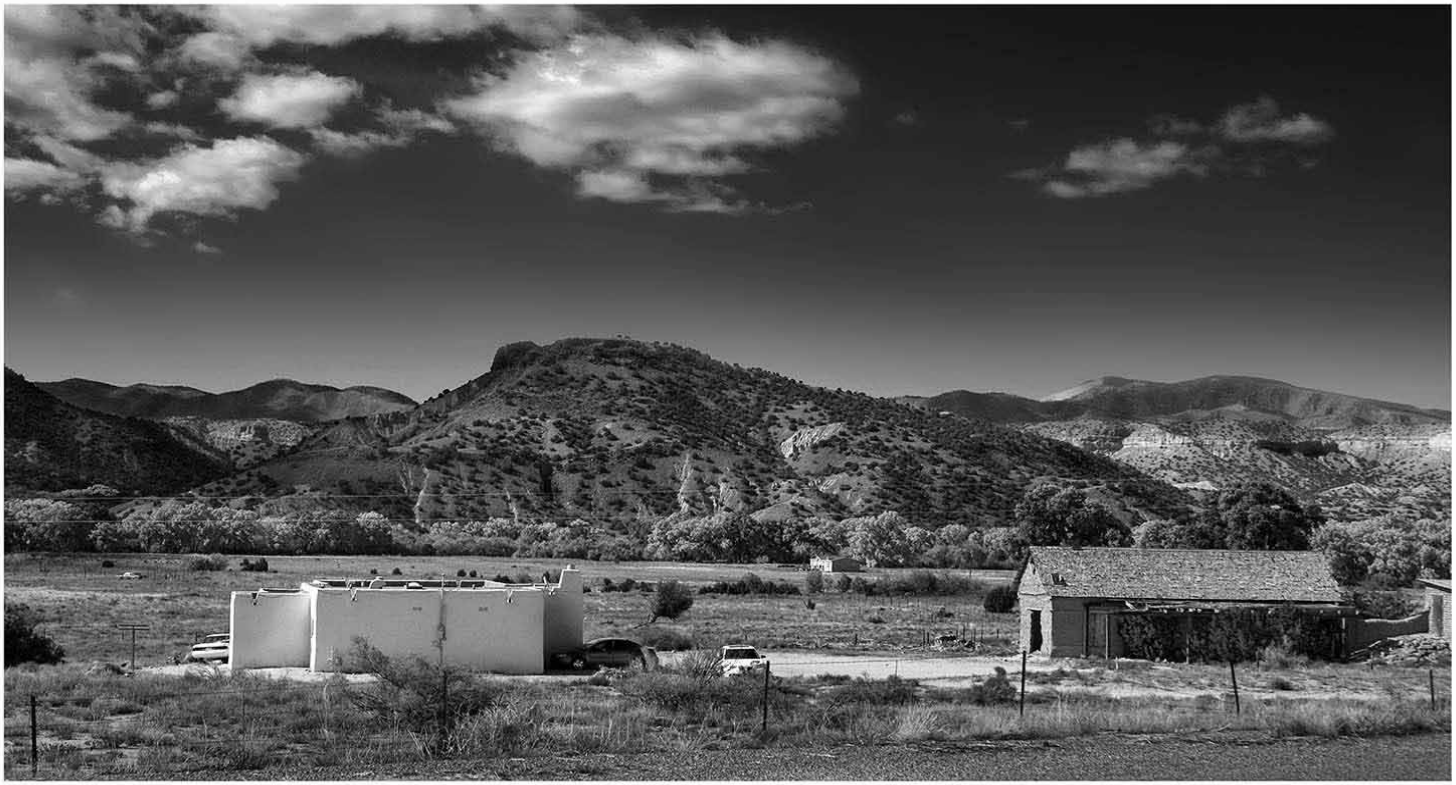
We wish them success

We make different choices to serve different needs

	USPAS	CAS	JUAS	JIAS
Rigorous for-credit courses	Y	N	Y	N
Degree program available	Y	N	N	N
Frequent regular sessions	2/yr	2/yr	1/yr	N
Standing organization w. staff	Y	Y	Y	N
Duration (weeks)	2	1.5 -2	10	1.5 -2
On campus	N	N	N	N
Conference center/ hotel	Y	Y	Y	Y
Scholarships available	Y	Y	Y	Y
Specialty courses	Y	Y	Y	Y
Fundamental courses	Y	Y	Y	N
Hands-on courses	Y	N	N	N
Proceedings	N	Y	N	N
Lecture notes on web	Y	Y	N?	Y?

There are also specialty schools such as the recent Linear Collider Schools

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



UNITED STATES PARTICLE ACCELERATOR SCHOOL

SUMMER SESSION 2009 ~ JUNE 15-26

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