



# 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 Cornell, UCLA, and 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
  - Administration provided by Managing Institution
- ❖ USPAS Director
  - Appointed by BOG
  - Funded as full time position 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
- Now part of FNAL O&M Contract
- Office Manager, Susan Winchester
  - > 20 years of service to USPAS





## 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 once / twice / 3x >950 / >500 / 280
- ❖ 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**



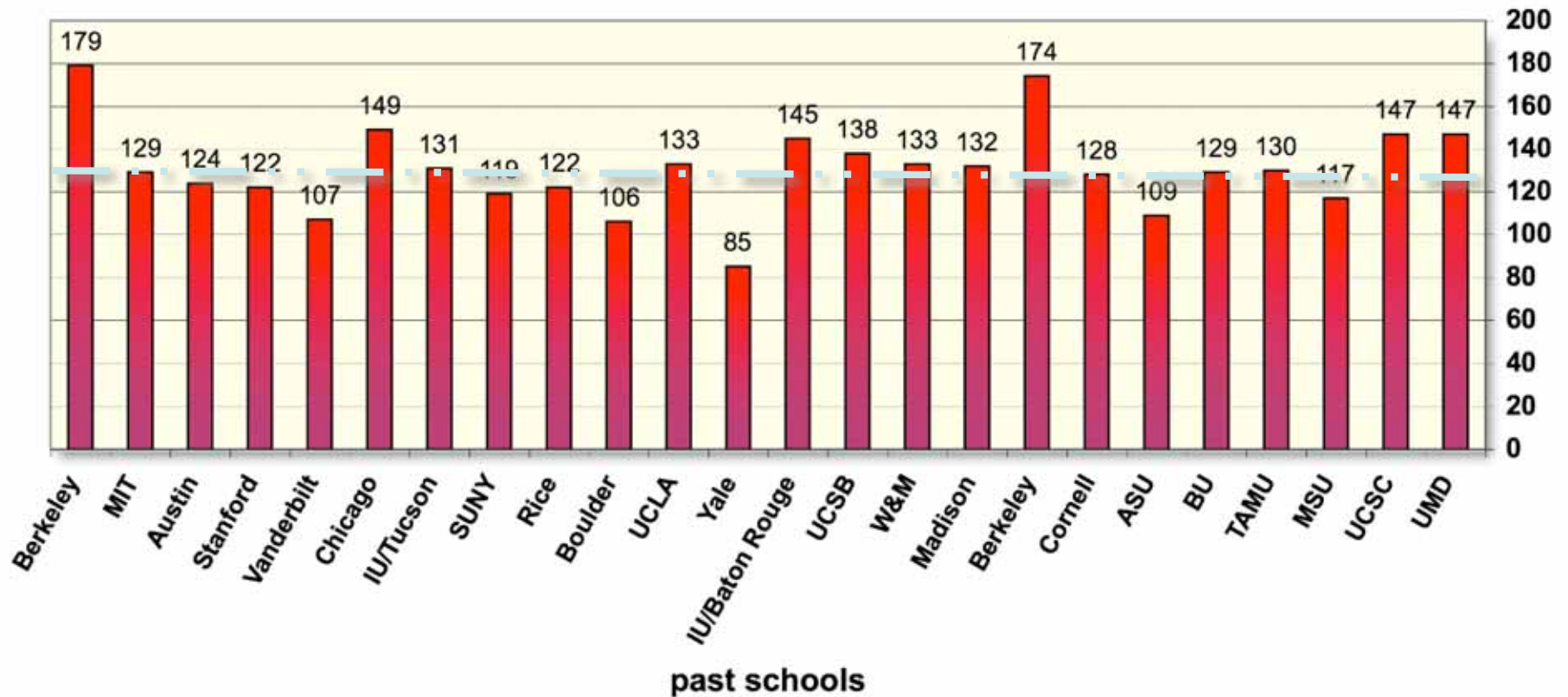
*>150 have gone from USPAS graduate student to intellectual leader in our field*



# The demand for USPAS is strong



number of individual students

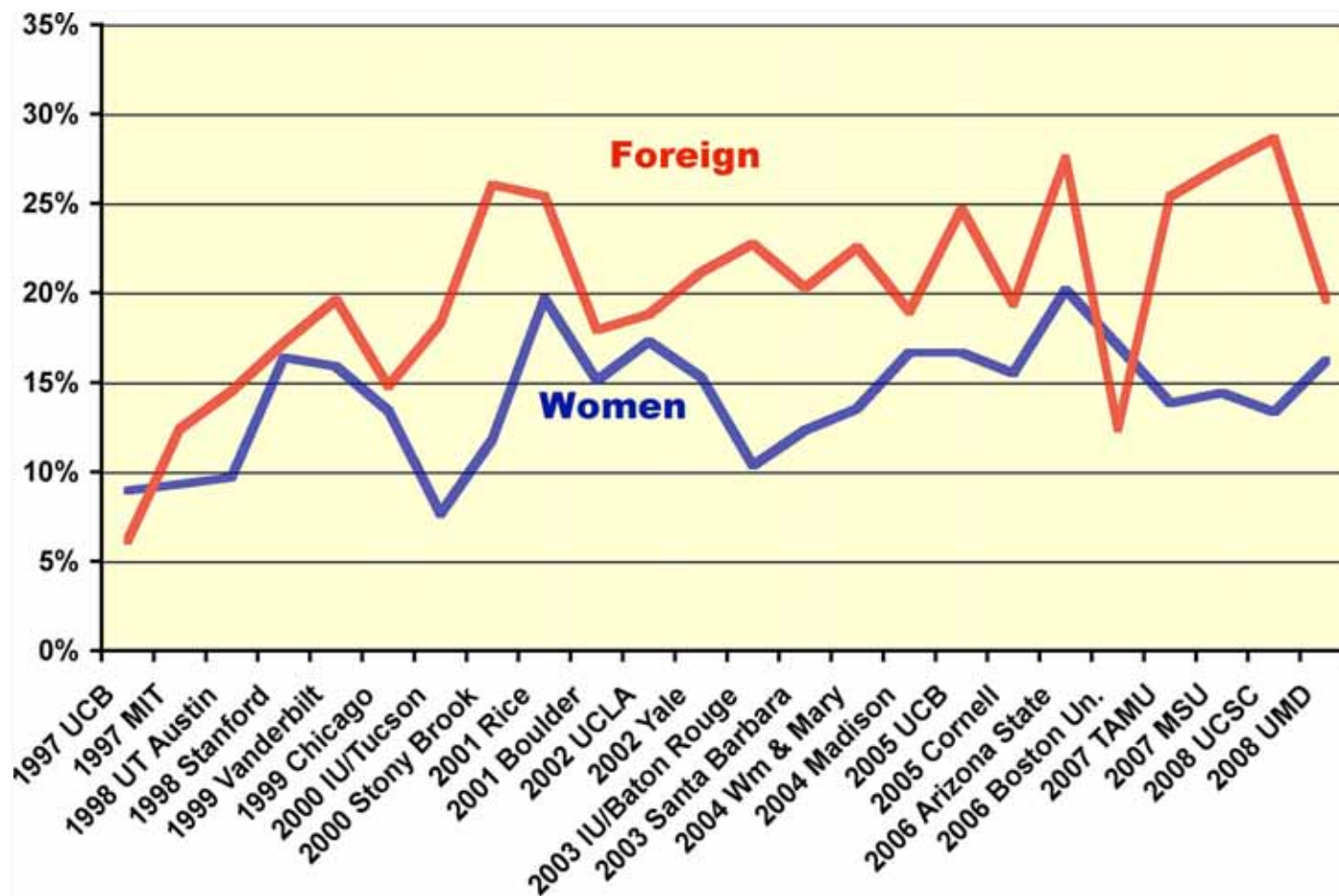


*~ 60% of the students take courses for credit*





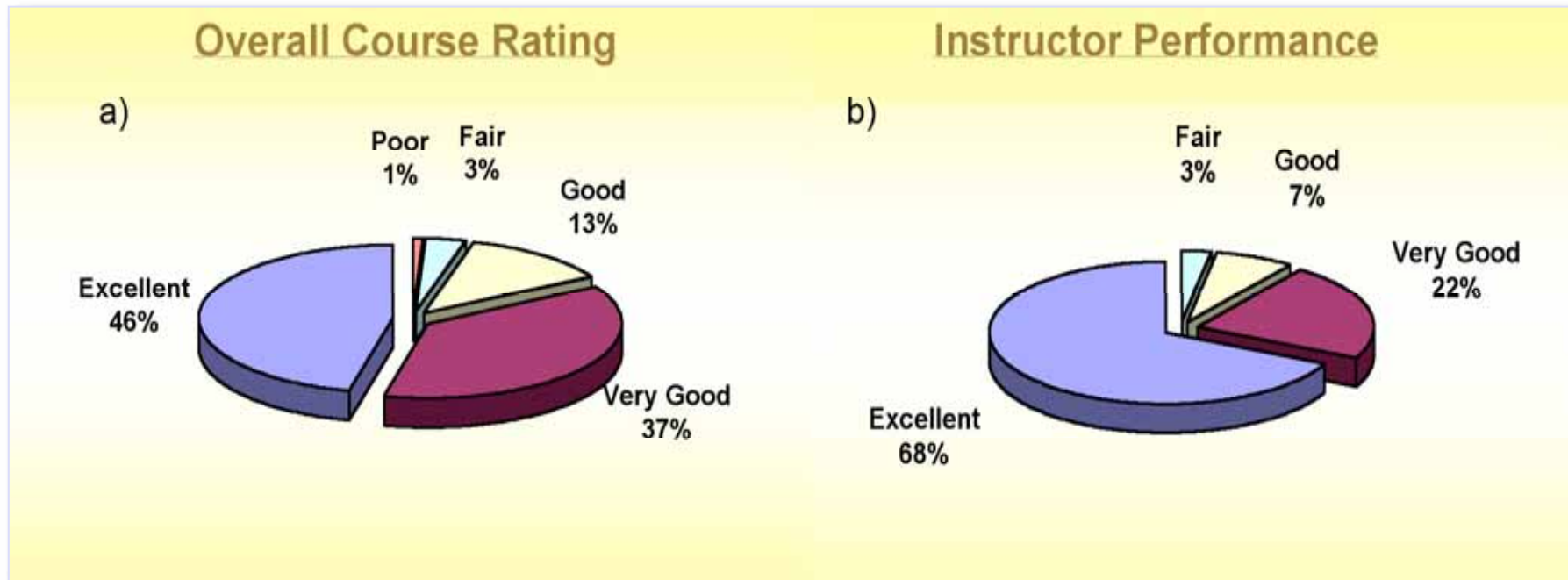
## Attendance by women & foreign students



*We will add more women instructors*



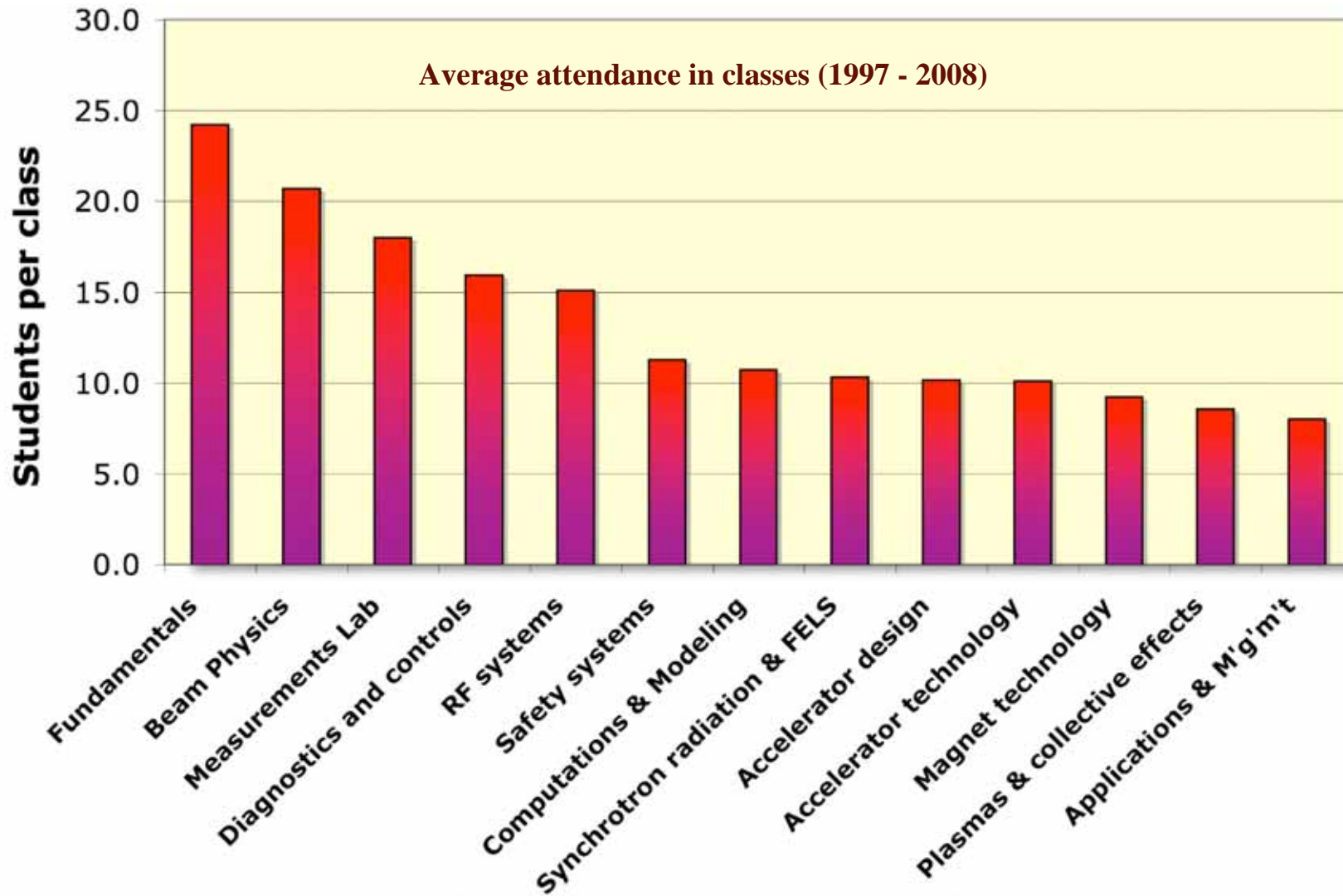
## Student satisfaction is high



*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



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.leetenscholar.org](http://www.leetenscholar.org)

- ❖ 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 diagnostics





# 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

UNIVERSITY OF NEW MEXICO  
ALBUQUERQUE