# OHEP WORKFORCE DEVELOPMENT

Ritchie Patterson
for the Workforce Subcommittee

Ilan Ben-Zvi (BNL)
Tao Han (U Pittsburgh)
Andy Lankford (UCI), ex-officio
Patty McBride (FNAL)
Ritchie Patterson (Cornell)
Ian Shipsey (Oxford)

# Subcommittee

*At the last HEPAP meeting (March 13 &14), a subcommittee was formed to address an Office of Science charge regarding workforce shortages affecting the OS mission.*

- Subcommittee members:
  - Tao Han (U Pittsburgh)
  - Patty McBride (FNAL)
  - Ilan Ben-Zvi (BNL)
  - Ritchie Patterson (Cornell), chair
  - Ian Shipsey (Oxford)
  - Andy Lankford (UC Irvine) ex-officio

# Charge, part 1

## Charge letter from Pat Dehmer, Office of Science

Part 1:

"We are asking the assistance of each of the Office of Science Federal Advisory Committees to help us identify disciplines in which significantly greater emphasis in workforce training at the graduate student or postdoc levels is necessary to address gaps in current and future Office of Science mission needs."

Please consider:

- Disciplines not well represented in academic curricula;
- Disciplines in high demand, nationally and/or internationally, resulting in difficulties in recruitment and retention at U.S. universities and at the DOE national laboratories;

## Observations:

- It asks for fields with a *deficit of training* (different from a *deficit of jobs*)
- Specifically targets graduate student and post-doc level training

# Charge, part 2

After these disciplines are identified, the charge asks for consideration of remedies, and specifically,

- Disciplines identified in the previous two bullets for which the DOE national laboratories may play a role in providing the needed workforce development; and,

- Specific recommendations for programs at the graduate or postdoc levels that can address discipline-specific workforce development needs.

- Process
  - Initial HEPAP discussion
  - Questionnaire to DPF and DPB membership
    - Inquired about overlooked disciplines, courses offered at their home institution, possible remedies
    - Some of the responses are shown in boxed text on other slides
  - Request to DOE lab directors for hiring data
  - Four phone meetings

# Disciplines with a pipeline problem

- Initial HEPAP meeting suggested three disciplines with a training shortage
  - Accelerator Science
  - Instrumentation and Detector Development
  - Large-scale computing and “Big Data”

- The shortage has a different origin in each of these fields, and the severity and remedies vary.

- Phenomenology was also suggested as an affected discipline early on. It is crucial to the OHEP mission, and lean funding has made positions scarce. However, since training is available, it falls outside this charge.

## Findings:

- Presence in academic curricula — Bill Barletta
  - 5 US universities have more than 2 accelerator faculty
  - 6 US universities offer 2 or more courses
  - 10-12 US PhD's are awarded annually
    By contrast, Europe awards ~100 PhD's annually (est.)
- Difficulties in hiring and retention
  - At FNAL, job openings in aspects of accelerator science typically attract 2-3 applicants, mostly foreign.
  - At BNL,16 searches for accelerator physicists in the last 3 years turned up fewer than 10 qualified applicants, mostly foreign.
  - European study (TIARA): 60% of European institutes report problems in hiring accelerator physicists…
    even though Europe trains ~10x as many as the U.S.
  - TIARA: European institutes and industries anticipate a 10% annual growth in demand. F. Kircher et al., TIARA-REP-WP5-2012-006

# Accelerator Science Recommendation I

***Recognize accelerator science as a distinct academic discipline, and increase support for university investigators.***

- Better support will attract more university departments and faculty to the field. Graduate students will follow.

Recently, NSF has done exactly this, and has introduced a new program in accelerator science.

We are chronically short of people with a strong, formal background in accelerator physics.

We are very lacking in university faculty in accelerator physics.

# Accelerator Science Recommendation II

## *Support test accelerators, and enhance university access to those at national labs.*

- Test accelerators are rare and essential tools for research and graduate education.
  - Examples include ATF at BNL, FACET at SLAC, CESRTA at Cornell, UMER at U Maryland, and the MSU cyclotron.

- ATF at Brookhaven is a successful model for providing university access to a test accelerator at a national lab. Access is proposal-driven, with an independent review committee. Each year ~1.5 students (20 year average) are awarded a PhD for research there.

  ASTA at FNAL also plans proposal-driven university access.

> …interested/qualified students at a school without an accelerator physics program only have access to the USPAS classes and find it extremely hard to pursue study in the field without transfer of institution, a major sacrifice.

# Accelerator Science Recommendation III

***Support training grants for graduate students engaged in accelerator research.***

- The grants should provide support, and should be selective, recognizing past achievement and strong promise.

- The Joint University-Fermilab doctoral program in accelerator physics, graduates ~1.5 PhD's annually, with lab staff providing supervision. This should be continued.

Fellowship opportunities are few and far between

# Accelerator Science Recommendation IV

## *Sustain support for the US Particle Accelerator School.*

- 300 students participate annually in courses ranging from undergraduate to advanced topics.
- Courses are formal, with homework and exams, and some universities award academic credit.
- Even schools with strong accelerator science programs rely on USPAS training. Lab staff also take USPAS courses.
- There is some concern that USPAS will be designated as a conference, making participation difficult for lab staff.

> Increased funding for USPAS seems to me to be an excellent use of money.

## Findings:

Instrumentation is essential for particle physics, yet the number of students with significant experience has declined rapidly.

- The erosion of university infrastructure and support staff is an important impediment.
- The long time-scale of experiments makes projects sporadic, so consistent training requires support for R&D that is not project specific.
- The 2011 DPF Task Force on Instrumentation in Particle Physics (co-chairs: Shipsey, Demarteau) and, more recently, the Coordinating Panel for Advanced Detectors (CPAD) have studied the problem in detail.

HEP must invest in its future. The current trend of LHC students and postdocs that actively avoid participation in instrumentation and in general have little or no connection with the detector experts is a recipe for a future collapse of the field.

# Instrumentation Recommendation I

***Make targeted resources at the national labs, including equipment, services and expertise, available to members of the university community, and invest in instrumentation at universities.***

- The Physics Research Equipment Pool (PREP) at FNAL provides equipment and some services to university researchers, and is a valuable resource.
- Updated equipment and access to engineering, design, and technical support would increase university opportunities.
- Requests for resources should be evaluated through independent merit review.

The most cost-effective step to build a cadre would be to increase the involvement of undergrads, graduate students, and postdocs in innovative projects that use modern infrastructure at their home institutions, working closely with / faculty and professional staff.

# Instrumentation Recommendation II

## *Support training grants for graduate students engaged in instrumentation research.*

– The grants should provide support, and should be selective, recognizing past achievement and strong potential.

> …a big drawback is the perception (which I think is valid) that doing instrumentation at the grad student or postdoc level is a detriment to career advancement in particle physics.

> Reason will not convince US physics departments -- money will. Provide a fellowship for physics thesis work on instrumentation.

> The most important component is real experience in test beams, detector design and fabrication, and experiment development.

# Instrumentation Recommendation III

***Continue to support national instrumentation schools offering introductory courses, and support new courses in advanced topics.***

- EDIT and the CERN Instrumentation School provide valuable introductory training.
- Courses with a formal academic structure, including homework and exams, enable universities to offer academic credit.
- Potential hosts for national schools include USPAS and consortia of universities and labs.
- DOE labs could provide national schools with instrumentation, retired detectors, and, when appropriate, beam time.

# Large-scale Computing and Big Data

## Findings:

Scientists with strong computing skills are essential for HEP, but high demand in industry makes retention difficult.

- Affected areas include physics algorithm and method development and validation; scientific computing framework; workflow data management and distributed system development; advanced computing hardware and software architecture and engineering; and production system deployment, integration, and support.

- Some universities have created computational science courses in conjunction with their research programs, and a few offer PhD minors in Scientific Computing.

- NSF has a new program: National Research Traineeships in Data-Enabled Science and Engineering, supporting the development of new university programs in this area.

> I am finding it difficult to hire good people in software & computing for particle physics, especially at the entry level.

## *Support national schools and workshops offering advanced training in Computing.*

- Schools with a formal structure, with homework and exams, similar to the excellent, but oversubscribed, CERN School of Computing.
- Workshops with online follow-up to initial training.
- Collaboration hands-on training sessions and interactive online software documentation.

# Summary

- Three disciplines have a workforce pipeline gap affecting OS mission: Accelerator science, Instrumentation, and Large-scale Computing & Big Data.
- For Accelerator Science and Instrumentation, university engagement is essential, and requires support. Accelerator science needs to be established as a new university discipline. Students will follow.
- Lab-university partnerships can provide necessary research infrastructure, expert support, and direct training. Some mechanisms are in place; additional ones are needed.
- Training grants can provide support and build visibility.
- National schools, whether USPAS or organized via lab-university consortia, already provide essential training in introductory and advanced topics, and more is needed.

- Letter is due June 30. Draft will be circulated to HEPAP in 1-2 weeks.

# Survey questions

- What mechanisms would increase graduate student and post-doc participation in instrumentation, accelerator physics, or large-scale computing?
- Does your institution offer formal instruction in instrumentation, accelerator physics, or large-scale computing as it is applied to particle physics? If so, please describe.
- Are there disciplines other than these (instrumentation, accelerator science, and large-scale computing) that are important to the success of HEP, and that are not represented in academic curricula...
- Do you directly participate in a discipline with a workforce training shortage as defined above? If so, which one?
- If you are an accelerator physicist, please indicate your primary focus (HEP, NP, BES, other)
- If you work in a discipline with a workforce training shortage, what is the total number of PhD scientists in this discipline at your institution?
- Which best describes your status? (student, faculty, lab staff, etc.)
- Name of institution where you are studying or employed (optional)
- Please share additional comments, if any.
- If you are willing to be contacted, please give your name and contact information.