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University Program Concerns

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U. Wisconsin

Summary of the Report of the DOE/NSF HEPAP University Grants Program Subpanel

P5 Meeting at Brookhaven

March 7, 2008

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Purpose of Study

To examine the state of the NSF & DoE grant programs for university high energy physics research, to document their successes, challenges & promise, & to recommend steps to ensure their continued vitality.

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UGPS Subpanel Membership

Thomas Applequist

Jonathan Bagger

Keith Baker

Jim Brau

Chip Brock

Jordan Goodman

Paul Langacker

Kevin McFarland

Homer Neal, Chair

Steve Olsen

Ritchie Patterson

Natalie Roe

Randy Ruchti, ex officio

Michael Shaevitz

Elizabeth Simmons

Wesley Smith, Vice-Chair

Chris Stubbs

Andy White

P.K. Williams, ex officio

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Subpanel Data Collection Processes

- Eight subpanel meetings across US
- Two major surveys (PI survey, Anonymous survey)
- *More than a thousand* question-responses received
- Five Town Hall meetings:
  - DPF Honolulu, MIT, SLAC, CERN, Fermilab
- Multiple DPF mailings
- Interactions with UEC, SLUO, DPF, agency officials, EPP2010 members, CoV's, etc.
- Informal reviews from field leaders at universities & national laboratories; & individuals outside field
- Communications directly received by UGPS members

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The Changing Landscape
(or why was a study needed?)

NSF

Particle physics in the United States stands at a crossroads. … it is a time of great opportunity. The LHC & new experiments in astrophysics, cosmology & neutrino physics promise to revolutionize particle physics & quite possibly, our understanding of the universe itself.

But …when the LHC begins operation & the three U.S. collider programs close, a major focus of U.S. particle physics will move offshore…represents a substantial shift in the way particle physics is carried out in the United States.

This will challenge program management & force a new focus in the particle physics portfolio. In this new portfolio, the balance between large & small groups, old & new ones, infrastructure & research personnel, laboratories & universities must change to match the evolving scientific opportunities.

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Assumed Priorities

EPP2010 addressed why & how the US should maintain leadership in elementary particle physics. It highlighted the compelling science facing the field, together with its role in inspiring young scientists, attracting the best minds from around the world, & helping drive technological innovation in the US.

American physicists have played leading roles in advancing the field to the present threshold of discovery. The US program includes fulfilling the potential of the LHC, which includes a luminosity upgrade (SLHC), R&D on the International Linear Collider (ILC), & experiments in astrophysics, cosmology & neutrinos, together with a variety of smaller scale experiments.

The UGPS Subpanel endorsed these priorities. The opening up of multiple new scientific frontiers is exciting & provides the field with a wealth of new opportunities to explore.

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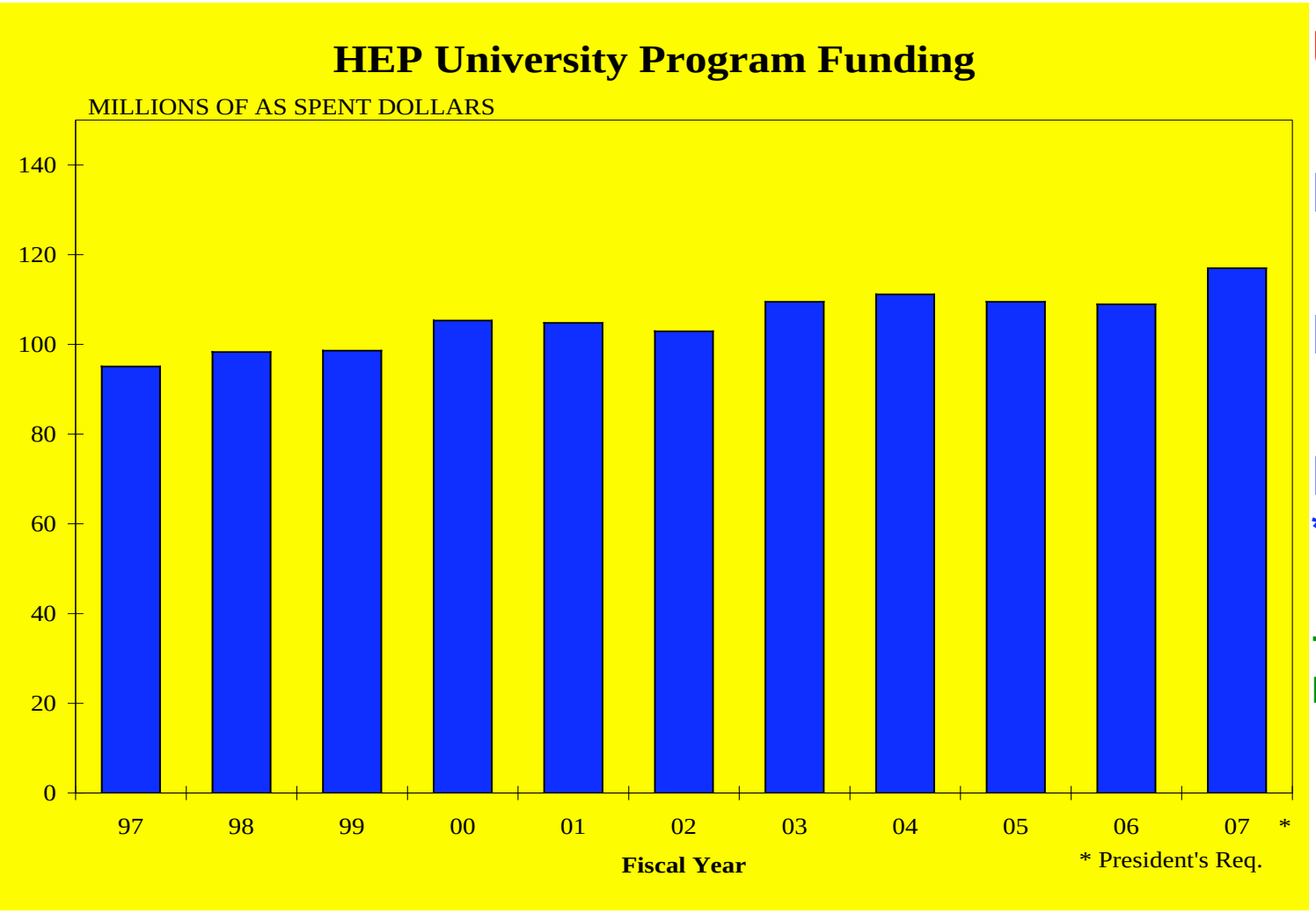
HEP DoE University Program—Budget History (as presented to Subpanel in 9/2006)



Update:

FY07: 108.4

FY08: 109.9

FY09: 115.1*

***President's Req**

-- D. Kovar, HEPAP, 2/14/08

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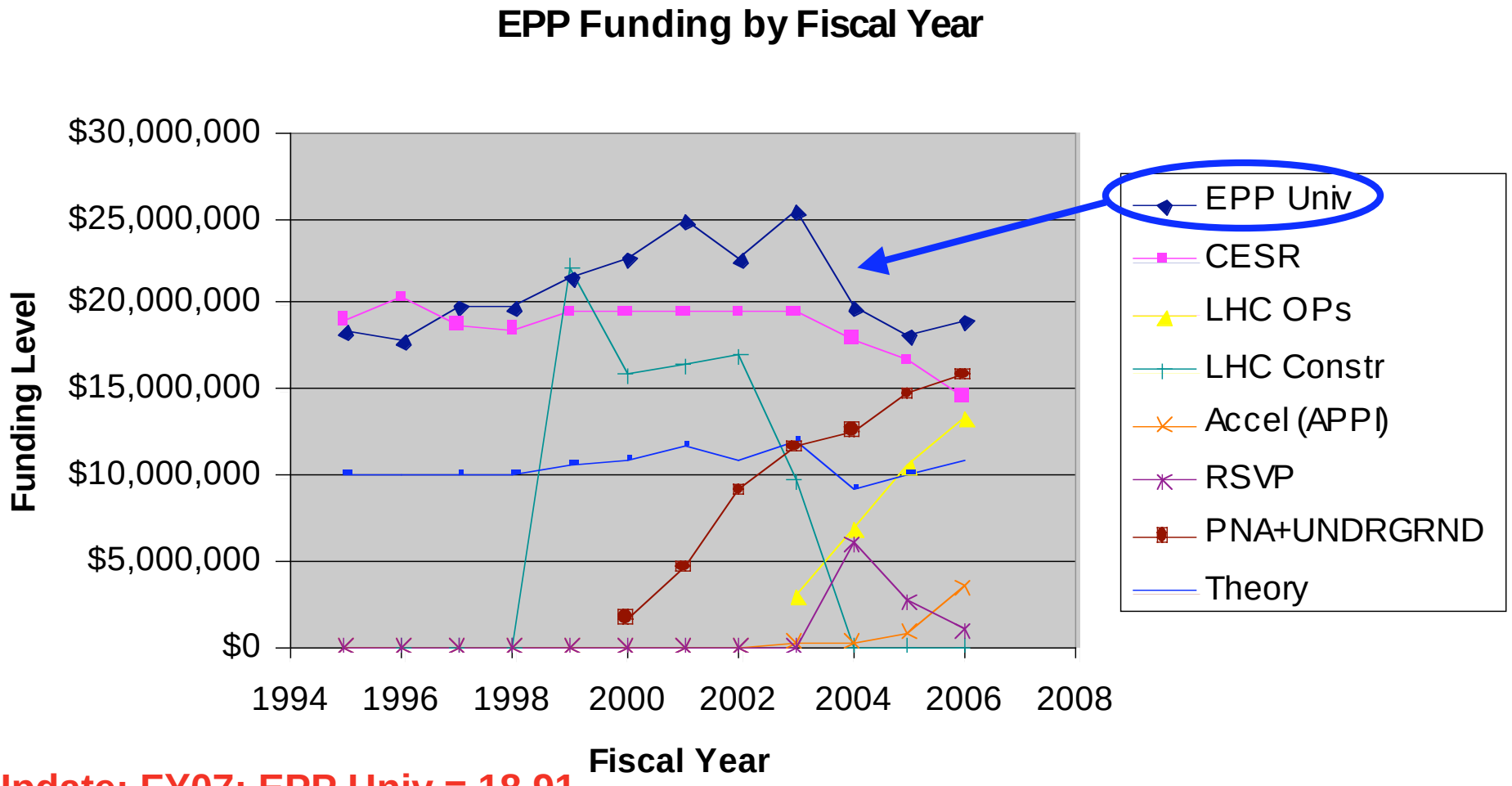
HEP NSF University Program—Budget History (as presented to Subpanel in 9/2006)



Update: FY07: EPP Univ = 18.91

FY08: Cut most core programs 5%

- **Since grants are 3 years, cut this year's renewals ~ 15%**

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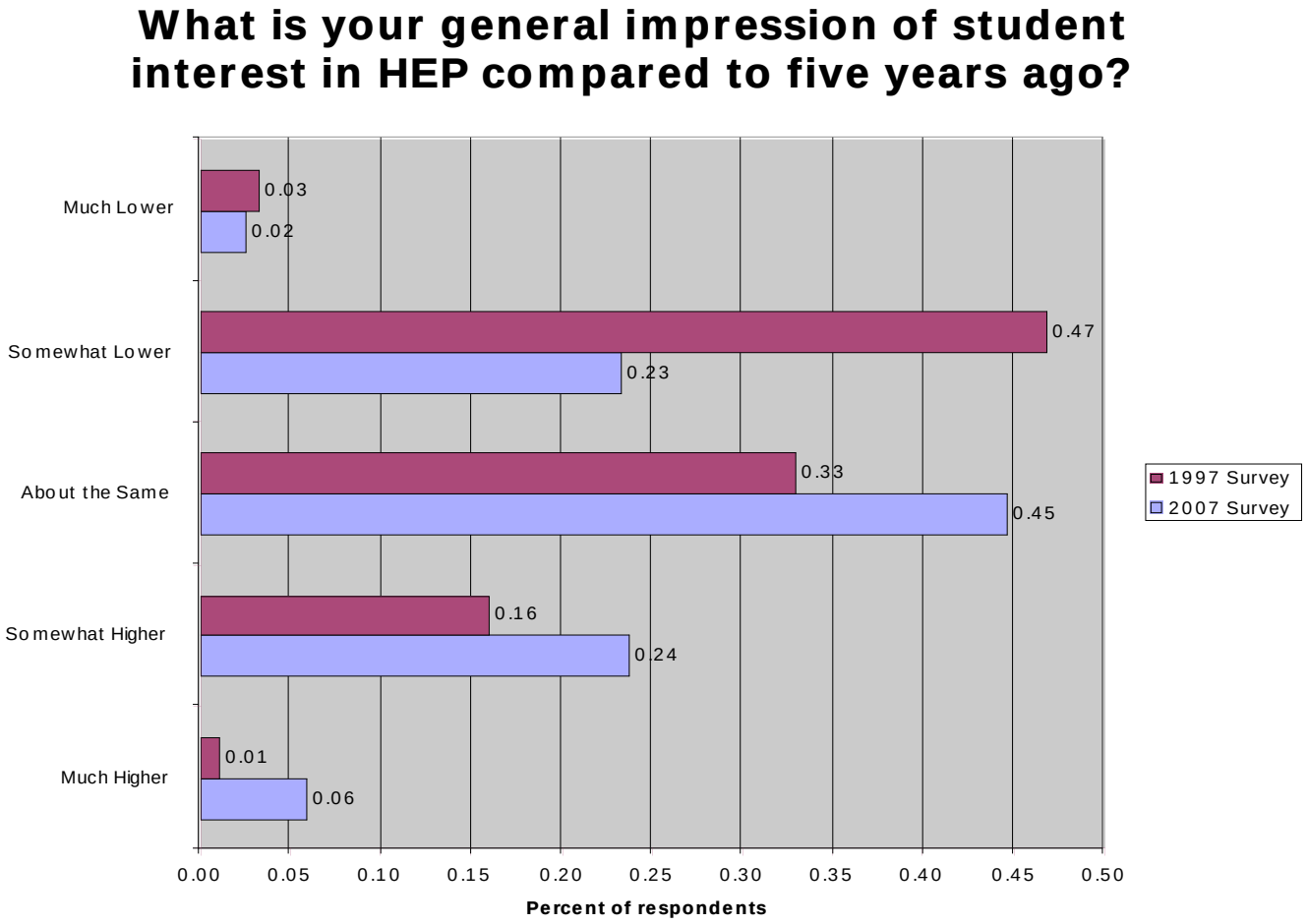
Example of Data Collected



Student interest in HEP has increased since ten years ago.

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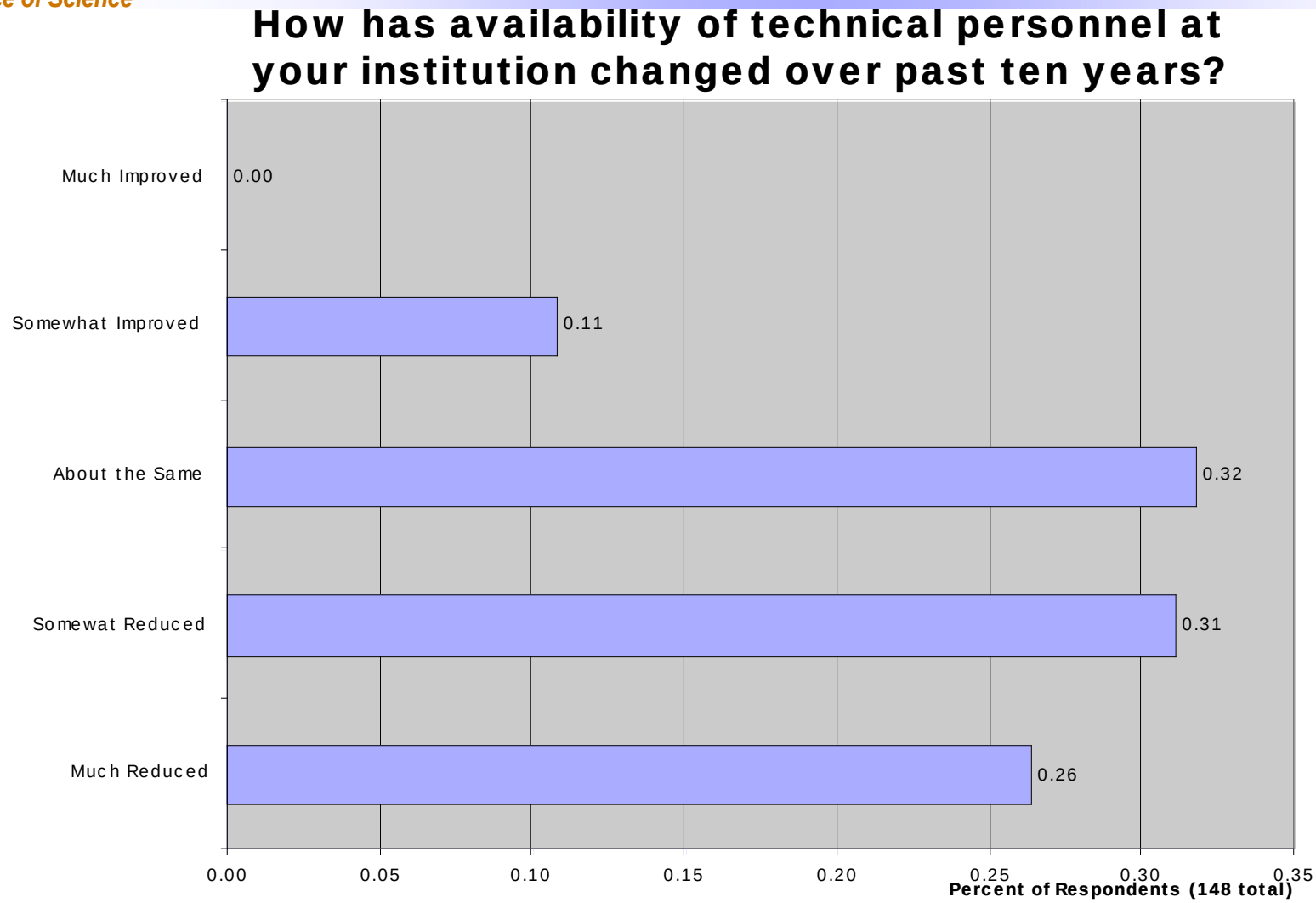
Survey results: Technical Personnel



57% say tech. personnel is somewhat or much reduced.

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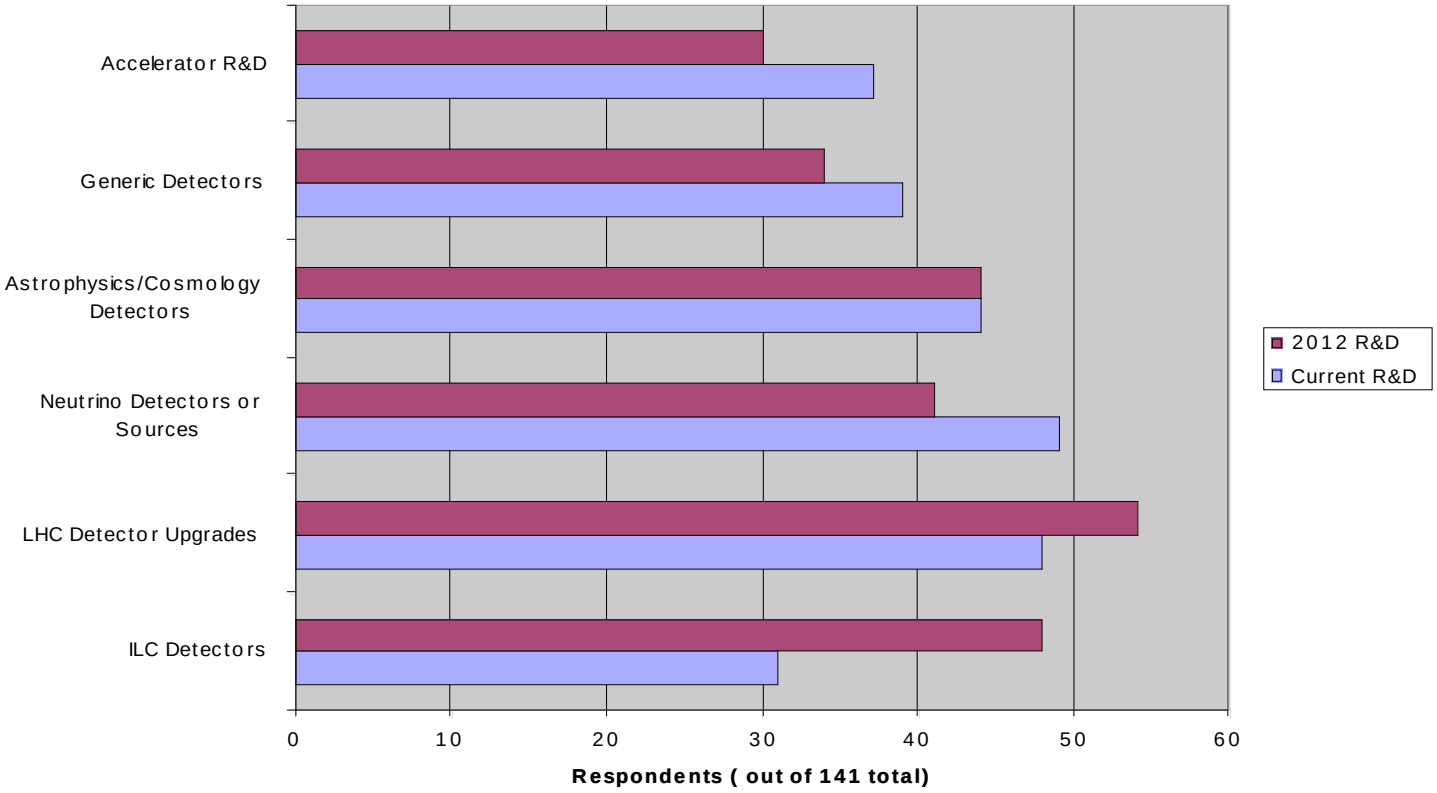
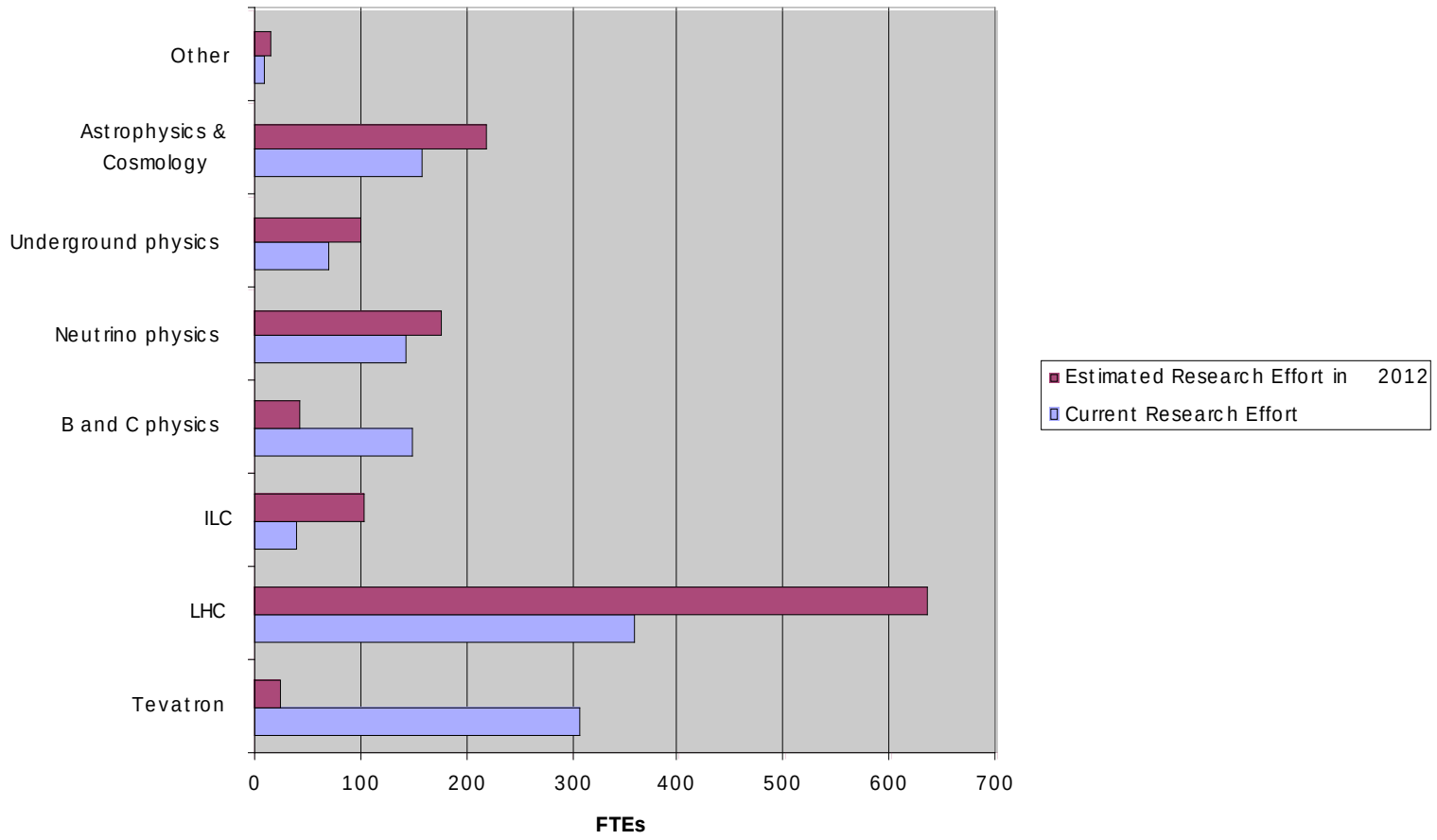
Survey results: R&D areas

What areas(s) of R&D does your group work on currently and what areas do you expect to be working on in 2012?



R&D effort is broadly distributed across all fields.

Survey result: R&D RTE



LHC effort will almost double in next five years.

Open-ended survey

1238 responses

Representative snapshots follow….

Infrastructure

Respondents had great concern for university infrastructure

"Obviously, support for research infrastructure at universities is under severe pressure."

"The DOE should continue to support the technical infrastructure at HEP universities. Universities provide several advantages … the availability of graduate & undergraduate students, the dedication of junior faculty working hard to establish a track record in their quest to attain tenure, & the efforts of senior faculty who have tenure & thus are free to apply all their creativity to a problem, perhaps finding an unconventional solution. It is no accident that many advances in particle physics (both detector & analysis methods) have come from researchers working at Universities."

Research Scientists

Respondents were unanimous in their deploring the growing lack of funds for research scientists.

At our institution, we have gone from 2 to 1 research faculty members. The remaining research faculty member plays an important role in the viability of the group."

"I see repeatedly the critical role filled by the research faculty of the university groups. They provide the glue that holds together the efforts of the larger groups at the accelerator centers. They mentor the students. They are responsible for many detector subsystems. Their effort balances out the loss of faculty effort due to teaching. The DOE HEP office seems intent on eliminating this part of the community. I fear this will be to the detriment of the HEP community as a whole, and to the university program in particular."

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Use of Student TA Support

Vast majority of theory respondents suggest partial or full time TA support increasingly is the norm,

A few noted that experimental students are being asked to teach at an increased rate (problem for overseas exp'ts.)

Many noted that teaching puts HEP at a competitive disadvantage and lengthens the time to degree.

All regret a shrinking RA budget, especially with an increased interest in HEP with LHC starting up.

"We routinely have to bridge students on TAs, even though they are doing experimental work. This is demoralizing, and students talk to each other about it. Students in other areas are not having to do this (of course with the exception of theory, where such is the norm)."

"Theory students require about 5 years to complete the Ph.D. requirements. In the past, we have kept students for two years as an RA and 3 years as a TA. We are now under extreme pressure to limit TA positions to 2 years. This is having a negative effect on our ability to attract graduate students."

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Major Findings

The EPP2010 report articulated the scientific priorities for the coming decade. Realizing that vision requires a partnership between the universities & the national laboratories. They are each components of a robust investment portfolio in particle physics.

University groups make theoretical breakthroughs, develop innovative detector technologies & initiate novel experimental approaches. In addition, they perform most of the analysis of the data from high-energy physics experiments. These university strengths draw undergraduates to science & bring some of the world's best minds to our graduate programs.

A thriving university research program advances science & nourishes the technical strength of our nation.

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Major Findings (cont'd)

University groups are sources of innovation. They are competitive & entrepreneurial, & diverse in their strengths, their students, & their science. Successful groups require:

- **Compelling scientific questions**
- **Outstanding personnel**
- **Freedom to innovate**
- **Sufficient infrastructure**
- **A clear & timely review path**

University researchers are helping lead the LHC, developing the SLHC & ILC detectors, initiating new experiments in astrophysics, cosmology & neutrino research, & inventing new strategies for exploring particle physics. Many of these experiments expand the boundaries of the field.

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Major Recommendations

The university program must be strengthened in order to achieve the goals of the national high-energy physics program as articulated by EPP2010. This requires increased investment & careful attention to building & sustaining the levels of personnel & infrastructure necessary for successful university research groups.

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Commentary on Previous Funding Recommendation

While this strengthening does require some additional funding, as documented in this report, the scale of this funding is at about a percent of the HEP budget.

This sum should be accessible from a part of the re-directions when the labs cease operating their colliders.

Now that the landscape of particle physics is evolving its support strategy needs to evolve as well.

H. Neal, BPA, 3 November 2007

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Major Recommendations (cont'd)

Group sizes should be sustained, and increased where appropriate and supported by peer review. The agencies should make a special effort to support long-term research scientists as an integral part of this group structure, particularly when they provide expertise essential to the experimental program or leadership at a remote laboratory.

A higher priority in the overall HEP program should be given to funding directed at university-based theoretical particle physics for the purpose of increasing the number of HEP-grant supported graduate students. Support for students & postdocs doing calculations related to upcoming experiments is particularly urgent.

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Major Recommendations (cont'd)

University-based technical development should be funded at a level commensurate with its great importance. The investment should be adequate to provide the necessary equipment and technical and engineering support.

The university grants program should fund the development and mounting of small and mid-scale university-based experiments that are highly rated by peer-review, and where appropriate, by the SAGs and P5. This may require supplements to the university grants program.

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Major Recommendations (cont'd)

A University Grants Program Committee (UGPC) should be formed to consult with university program managers of both agencies on the issues facing the university program. The chair of this committee should be chosen cooperatively by both agencies & the chairs of HEPAP, DPF & DPB, & should serve as a spokesperson for the university community.

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Major Recommendations (cont'd)

The agencies should support university technical infrastructure as part of grants including hardware development. In addition, project managers should utilize university resources because they are economical and effective, and they should report on this optimization at major project reviews.

The agencies should continue their efforts to ensure that the vision for LHC computing is realized. This includes working across and within agencies to ensure sufficient network and computing capacity.

The agencies should support efforts to ensure that both U.S. sites and key sites abroad are equipped with remote conferencing that is reliable, robust and readily available.

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Comment on Recommendation on University Infrastructure

Univ. Construction of Detector Apparatus is cost effective

- Leverage University facilities
- Use of students
- Supervision by University-supported faculty

Univ. Detector design & construction provides innovation

- Collaboration between Faculty & Engineers
- University leadership in development of new HEP detector technology

Univ. Detector design & construction provides training

- Students, Postdocs, Research Scientists & Faculty together
- Training the next generation in experimental HEP

Univ. Detector design & construction is a portal for new scientists into the field

- Many faculty started in HEP as undergrads working in labs
- Accessible method for beginning students to contribute

Univ. Infrastructure is now mostly supported by HEP detector construction projects and M&O

Funding Profiles

With the Present Profile – Can we staff the future research efforts?

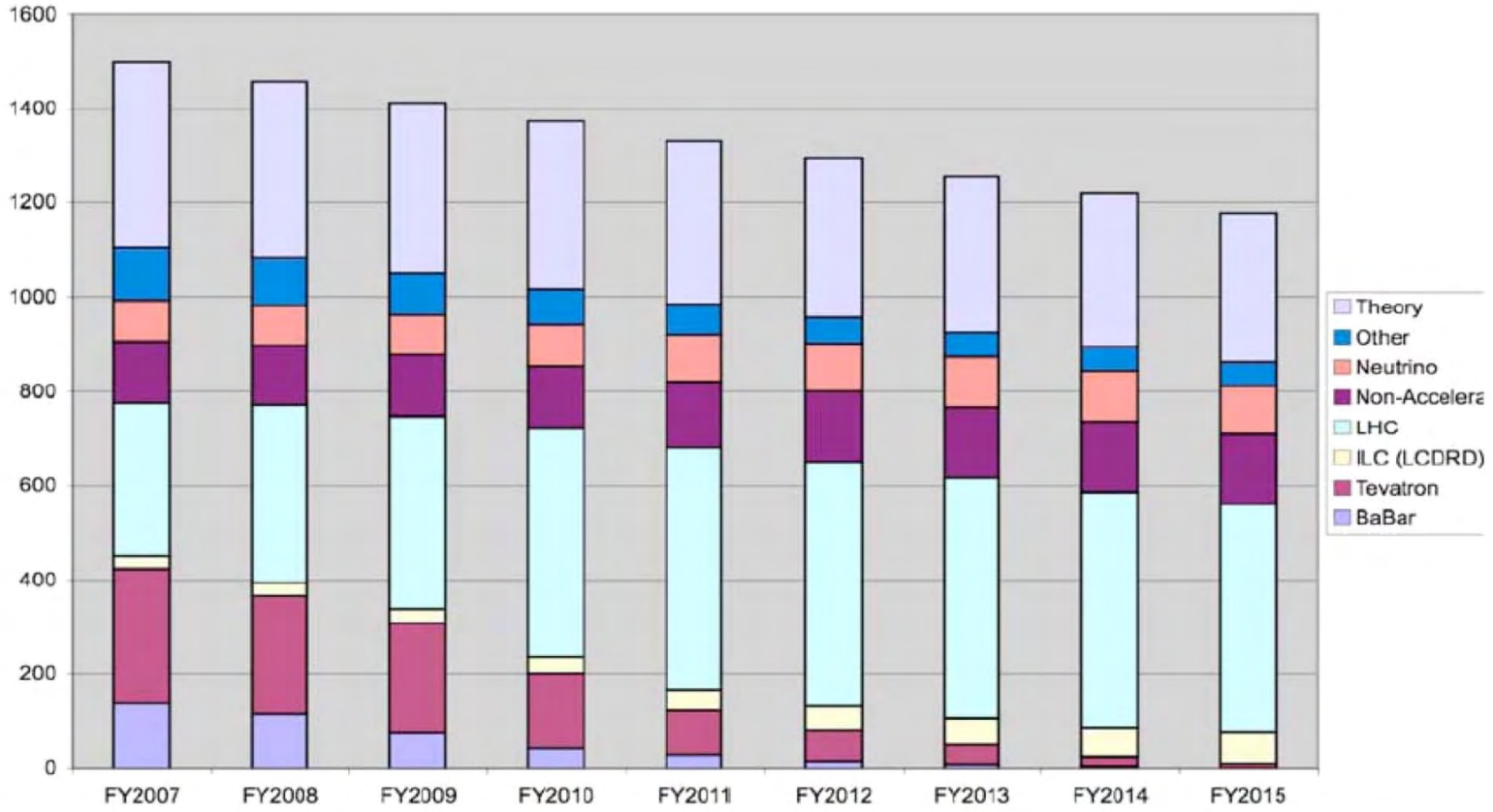

Figure 4. DOE University Grants Program activities by FTE, assuming "flat-flat" funding and 3% inflation.

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A Better Profile – Though Probably Still Not Optimum

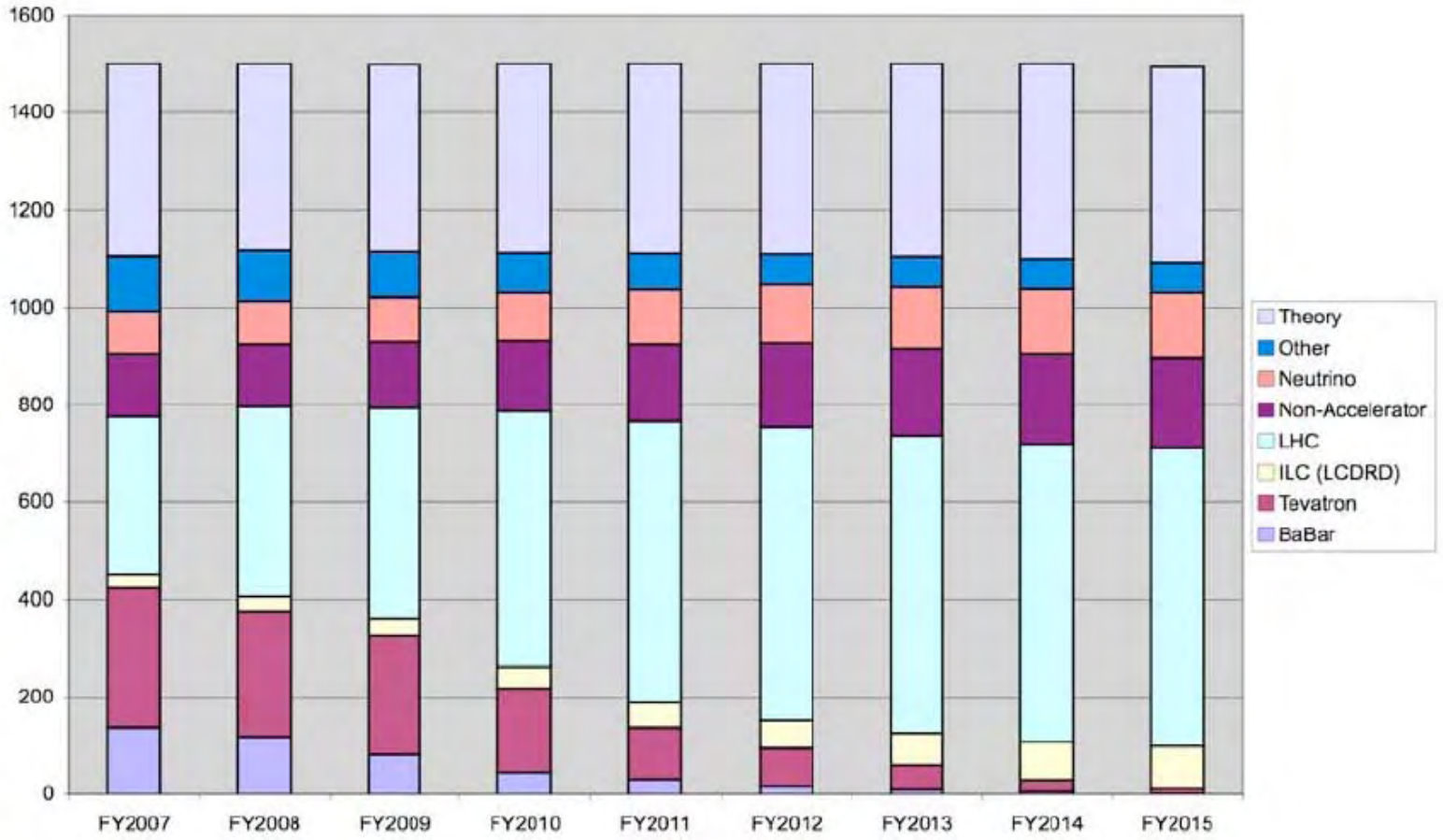

Figure 5. DOE University Grants Program activities by FTE, assuming constant level of effort, with 3% inflation and 3% increases in annual funding (from DOE OHEP planning documents).

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True Costs of Leadership

Examine previous profile for actual costs, taking migration from Tevatron to LHC as an example

- **Leadership in LHC Physics requires presence at CERN**
  - Either residence or large percentage of time
- **US Research Program funds only pay for M&O personnel**
- **University Core program supports physicist travel & COLA**
- **These costs are much higher for a program at CERN than FNAL**
  - e.g. COLA ~ $ 20K per physicist, 2 week trip ~ $3K
  - Declining dollar is exacerbating this

Additional cost to University program for each migrating physicist

- **Not included in profile on previous page nor in agency financial planning up to now.**

Our teams are now playing “away games” and need resources to compete with the “home teams”

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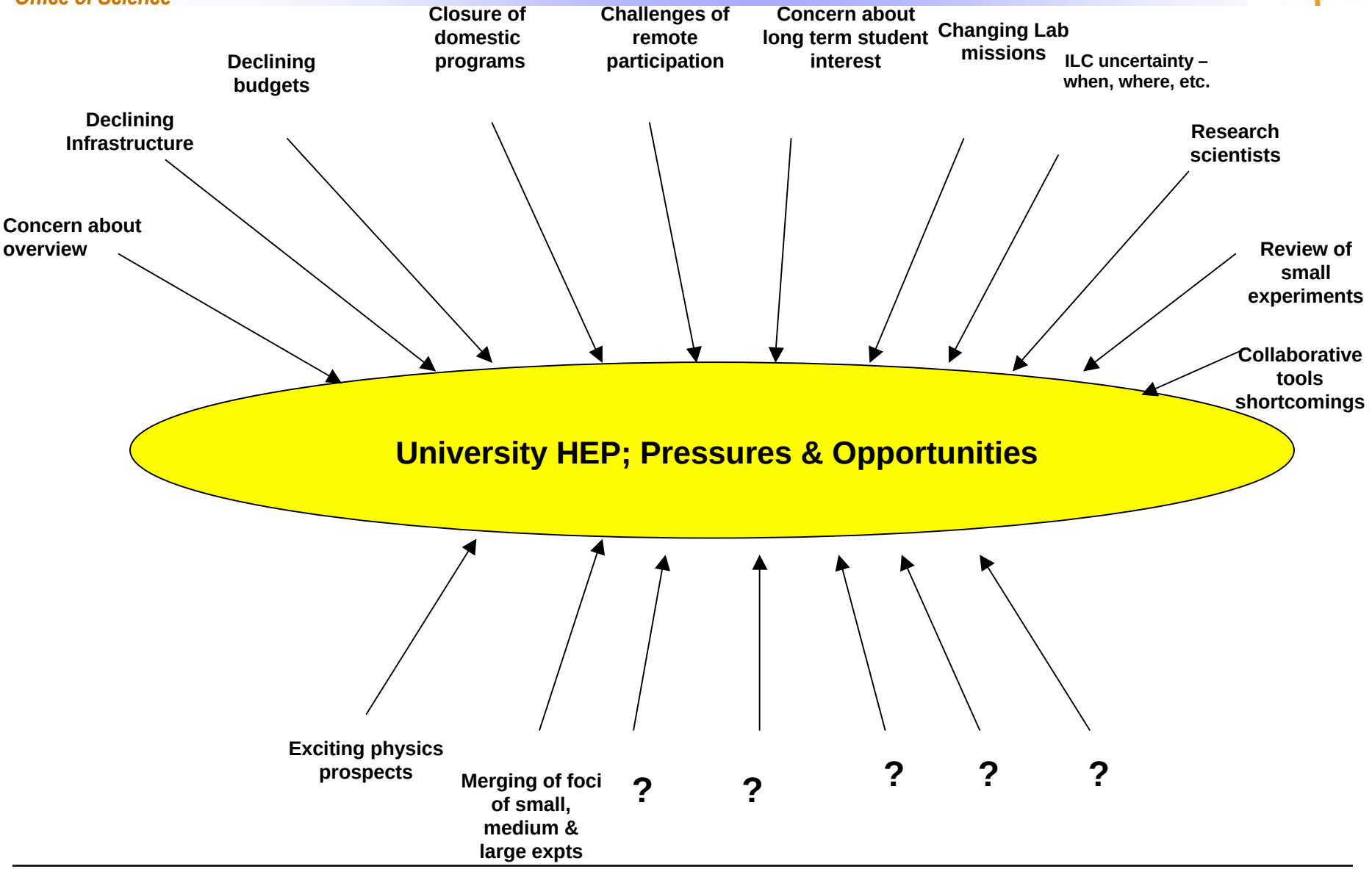
A Graphical Summary



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Summary

- We are approaching a very different era in U.S. high energy physics research in our universities – one that is full of promise as well as potential risks
- Actions are required to address organizational challenges, pipeline issues & funding needs
- Continuing our role as a leader in high energy physics should be stressed as a national priority
- All parties should recognize the critical role universities play in driving the field & in ensuring its future.