Benefits to the US from participation in accelerator experiments abroad

M. E. Peskin
Seattle EF meeting
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For those of us involved in LHC experiments, our lives are different from those of physicists in previous eras.

global organizations

many levels of supervision

much travel, constant phone/video meetings

When we discuss our roles, it is tempting to emphasize the differences.

and yet, there are key elements that remain the same.

Important among these are the benefits of supporting basic scientific research:

intellectual leadership in fundamental discoveries

development of beyond-the-state-of-the-art instrumentation and analysis techniques

training of students and postdocs in advanced technologies

transfer of expertise and people to US high-tech industry

How can a large international organization benefit all of the nations and even localities with which it is involved ?

This is not understood by the press, by Congress, even by the DOE.

We understand it, because we work in these organizations or work closely with them.

We need a language to explain this to others.
The purpose of this lecture is an attempt to provide a framework for this discussion, with useful language and illustrative stories.

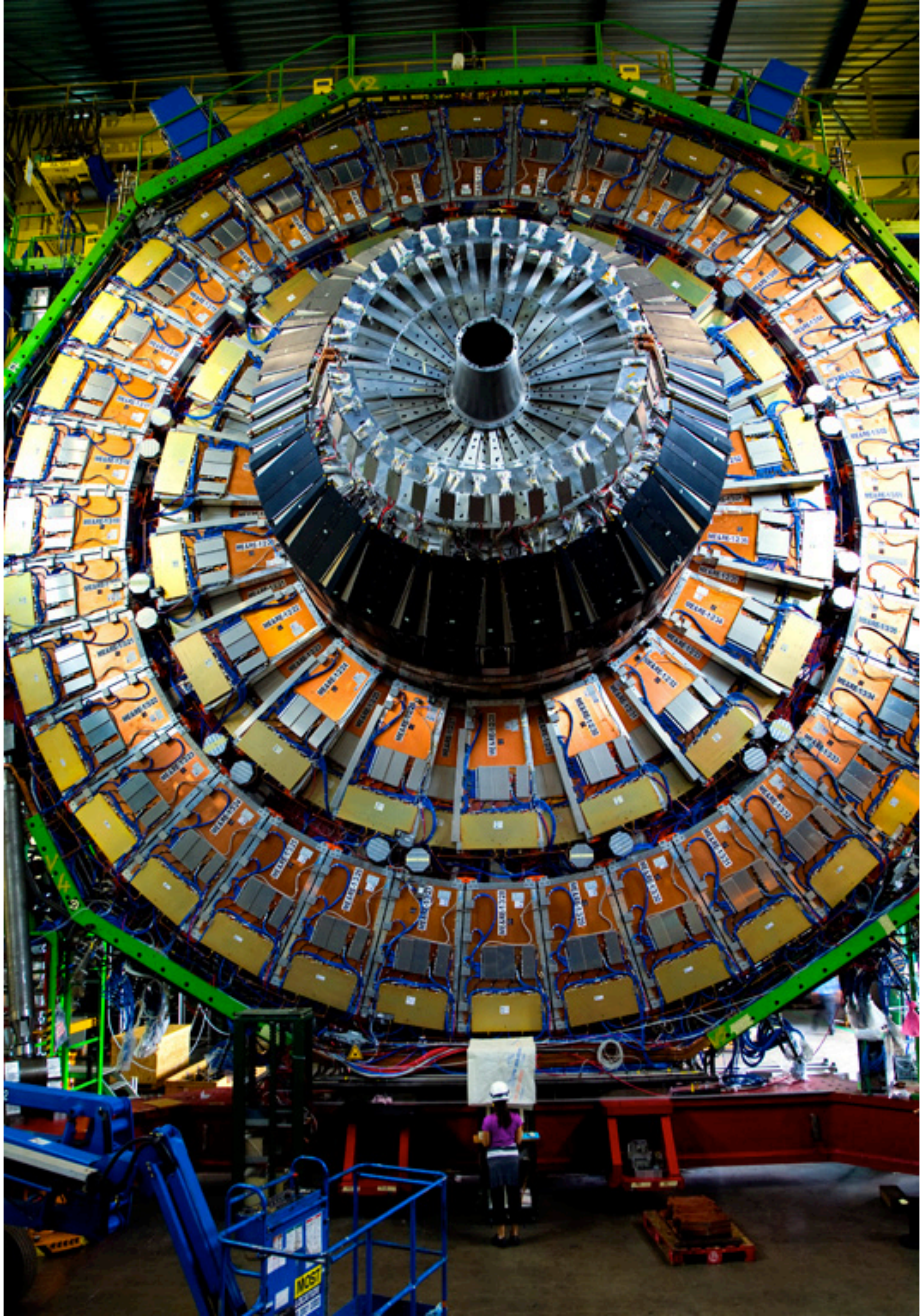
A central idea is: contributions in kind

The global organization makes high-level technology choices. This involves competition between solutions proposed by different groups in different regions.

But, then, local groups must produce the devices or analyses. This where invention, innovation, interaction with industry takes place. And, this is where students and postdocs make the technology function in practice.

“The highest technology resides at the lowest level.”

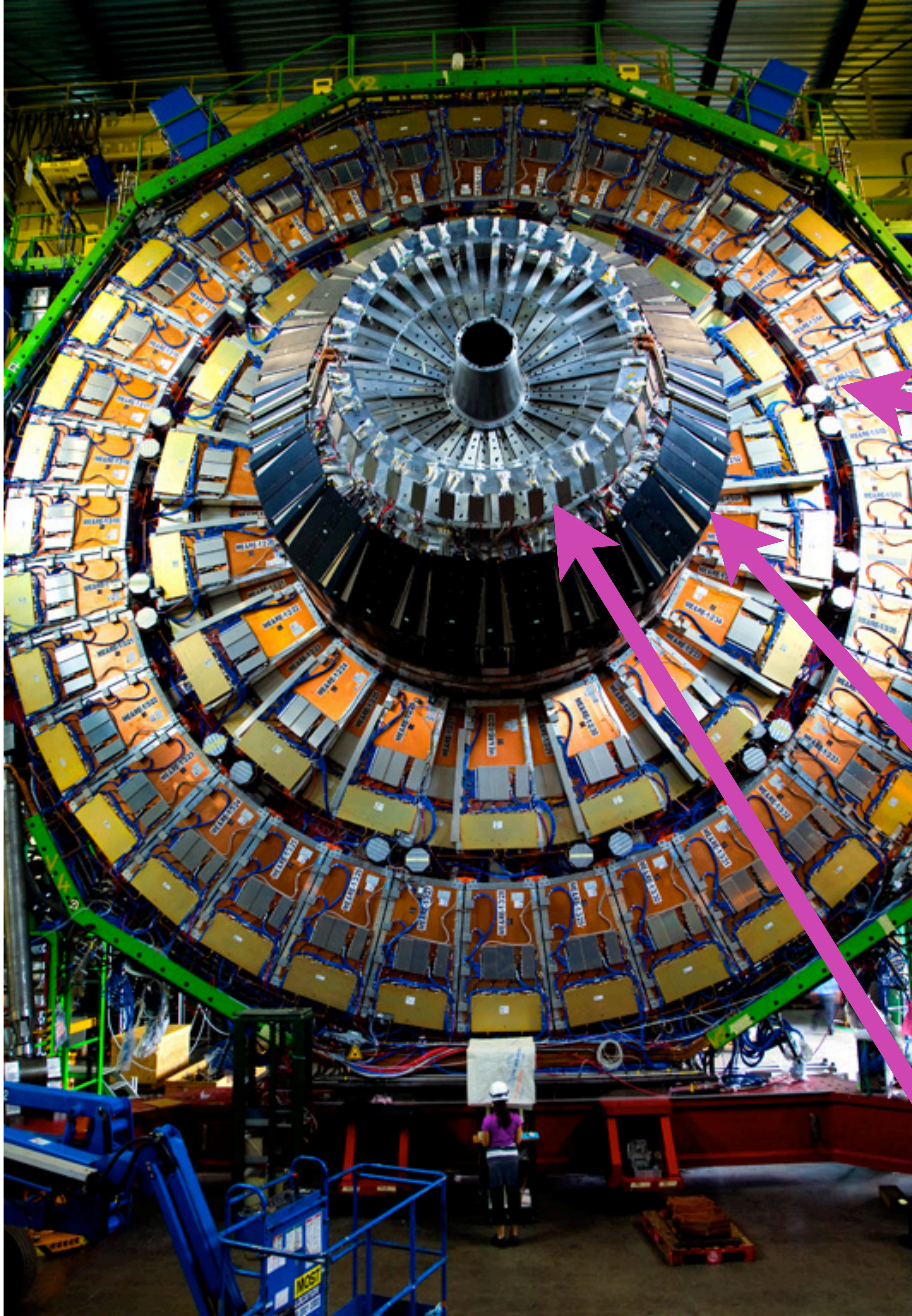
Examples: Detector contributions



N Y Times
March 5, 2013

The CMS detector construction was a global project with the largest contribution from Europe, but ...

thanks: Yuri Gershtein



Every detector that you see in this figure was built in the US with US technology

Cathode Strip Detectors
Florida/Fermilab
(technology developed for SSC)

Forward calorimeter
Fermilab
scintillator/
wave-shifting fiber

Laser calibration system for the central EMcal
Caltech

ATLAS pixel detector:

International project; US contribution managed by LBNL.

The most complex element was the readout chip, a US project. The LBNL group realized that this chip could be manufactured with an off-the-shelf IBM technology, 0.25 micron CMOS. Properties tested by an international group from ATLAS and CMS.

The sensors were produced by a vendor in Germany, IZM. Interactions with this vendor were managed by a local German group.

thanks: Abe Seiden

Globalization is not unique to HEP.

Jimmie Johnson:
(interview in SF Chronicle)

“I don't know if I've ever had a foreign car. Then again, a lot of the Chevys are built outside the U.S. these days. I think the only NASCAR race car built in the U.S. is the Toyota.”

Examples: Analysis contributions

Here again, we have global coordination of a variety of projects done by local groups, building on their unique talents.

Typical local projects are at the scale of CMP one-PI-lab investigations. This is not reflected in the journal publications, which amalgamate large numbers of these projects. To see the individual projects, we need to look deeper.

To develop these projects and have them influence physics results takes not only creativity but also the ability to communicate the innovation and how it fits into the bigger picture.

Example student trajectory: Ryan Rios (SMU)

Commissioning of ATLAS Liquid Ar EM calorimeter: wrote EMCal TDAQ monitoring panel for the ATLAS control room, interfaces to Relational Database; expert shifter

Thesis project: how to get maximum efficiency for e+/e- detection for the Higgs to 4 lepton analysis.

Organized an ATLAS workshop to develop the 4-lepton selection criteria.

Ph.D. May 2012; stayed on to contribute to the Higgs discovery paper.

Now working at Lockheed-Martin in Houston, on communication with the International Space Station.

What's wrong with this picture ?

Nothing !

All criteria given earlier are fulfilled. There is a specific benefit to Texas high-tech industry. And a bonus: experience in communication within a global organization.

thanks: Ryszard Stroynowski

All of you have stories like this, both in physics analysis and in detector technology development.

Please write a paragraph and sent it to me:

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Analysis leadership:
an example at the level of physics topical coordinator

Jeff Richman, with Alan Tapper of U College London, convened the CMS SUSY group in 2009-10.

Global coordination of projects that had developed earlier in many directions. To this theorist's eye, sharp scientific focus enabling robust discovery/exclusion.

Richman spent these two years in residence at UC Santa Barbara. He travelled to CERN once/month and spent one summer at CERN, but the bulk of the organization was done in almost daily video meetings beginning at 5am - 8am Pacific time.

CERN's support for global networking played a crucial role in enabling this.

This is the application for which the World Wide Web was invented 20 years ago. We remain a model for global connectivity and collaboration.

thanks: Jeff Richman

University Global Outreach:

Many universities are now interested in providing experience for their students in international projects. They recognize that the world is increasingly interconnect. Students want to learn how to navigate this new world in social and business contexts.

Brown University has a formal Internationalization Initiative. Experience working in CMS in Geneva is a high-visibility component, highlighted by Brown's president Christina Paxton.

thanks: Meenakshi Narain

Examples: Accelerator contributions

Key enabling technologies for the future of HEP are high-field superconducting magnets and high-gradient superconducting RF. Both are being developed in global collaborations. Each technology has developed through insight from and synergies with the other.

thanks: Mike Harrison, Eric Prebys, Marc Ross

High field magnets are needed for the HL-LHC high luminosity focusing quadrupoles.

The available solution is based on Nb_3Sn. The cold masses are being designed by LARP and fabricated by LARP and CERN (50/50).

Nb_3Sn is a US technology; other regions are several years behind. The overseas accelerator provides a rationale for its development and application.

Superconducting RF was originally developed at Cornell and JLab. However, by the 1990's, their R&D programs were poorly supported. DESY became the global leader.

The ILC GDE called for 35 MeV/m cavities as the core of the ILC design. This was beyond the state of the art at the time. The ILC, an intrinsically global project, required qualified industrial vendors in Asia, Europe, and North America.

Based on models from DESY, US labs jump-started R&D programs and US industrialization. There is now one qualified vendor in the US, another in the certification process.

This is an enabling technology for many scientific applications, including neutron sources, recirculating linacs for X-ray sources and FELs, and Project X at Fermilab.

Conclusions:

Globalization is the new reality. It challenges our lives, but it offers tremendous opportunity in terms of pooling of resources and intellectual power.

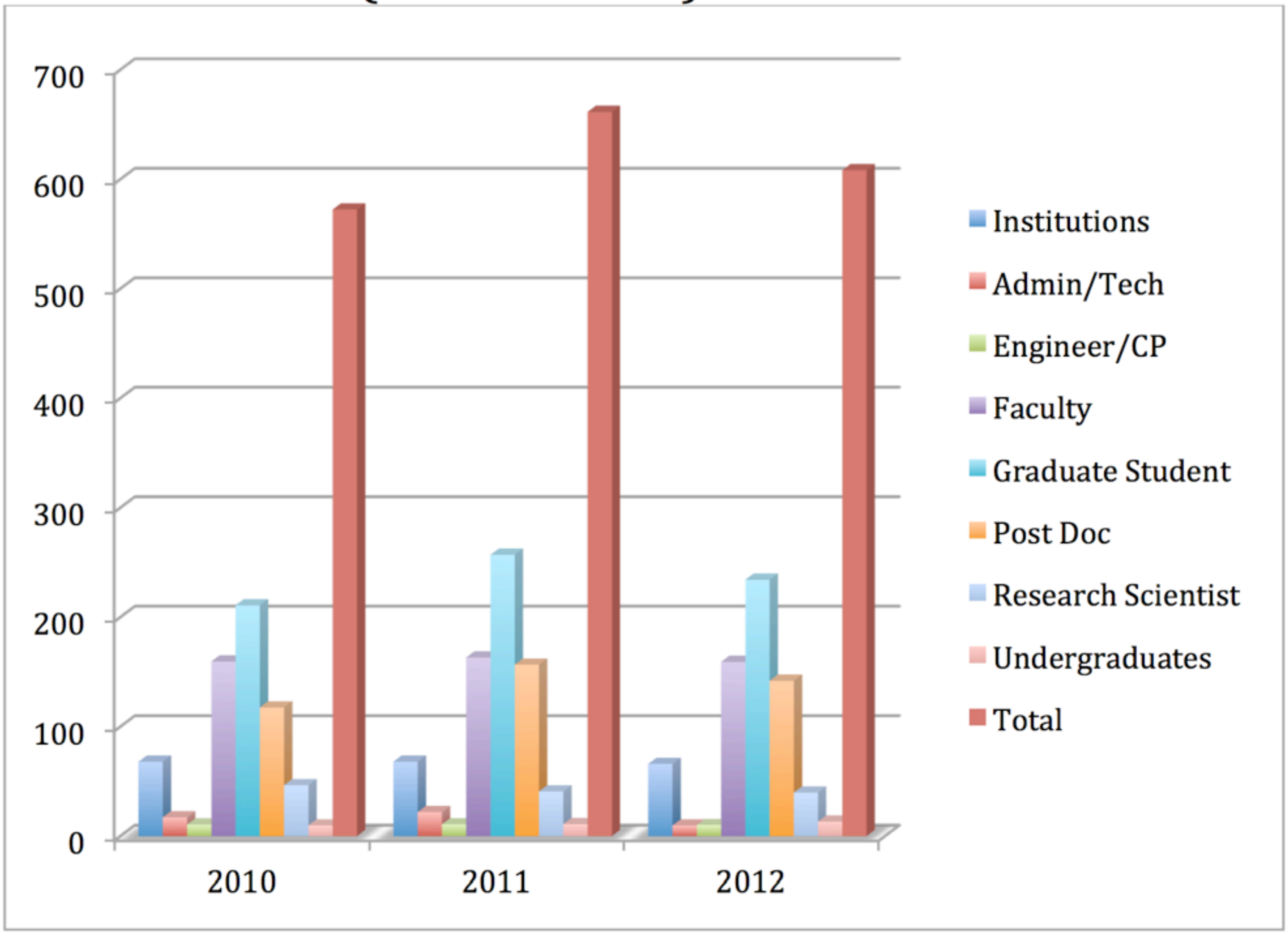
Global HEP collaborations are organized around in-kind contributions. Thus, the highest technology resides at the lowest level. This insures that the science supported in the US develops technology in the US and trains young people locally.

On the time scale of Snowmass, Chip and I will promote this through a write-up that describes these issues anecdotally, along the lines of this talk.

It is important also to get hard data. We hope this can be gathered in the P5 process.

For the moment, we need your stories. Please write a paragraph with yours and email them to me.

LHC Stats (data source: DOE via A. Patwa)
Raw numbers (ATLAS+CMS):



thanks: Abid Patwa and Meenakshi Narain

Why do innovations come from fundamental physics research ? It is because we are driven to solve "impossible" problems whose solutions are beyond the state of the art.

The passion to find these solutions comes from our drive to confront the most important problems in science. The most brilliant students seek the most high-profile scientific problems.

We have to put great science first. Wherever the accelerator is, the benefits to the US will follow.