Snowmass and P5

Or how to match limited funds to the long list of future projects

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University of DZero October 10, 2013

What This Talk is NOT About

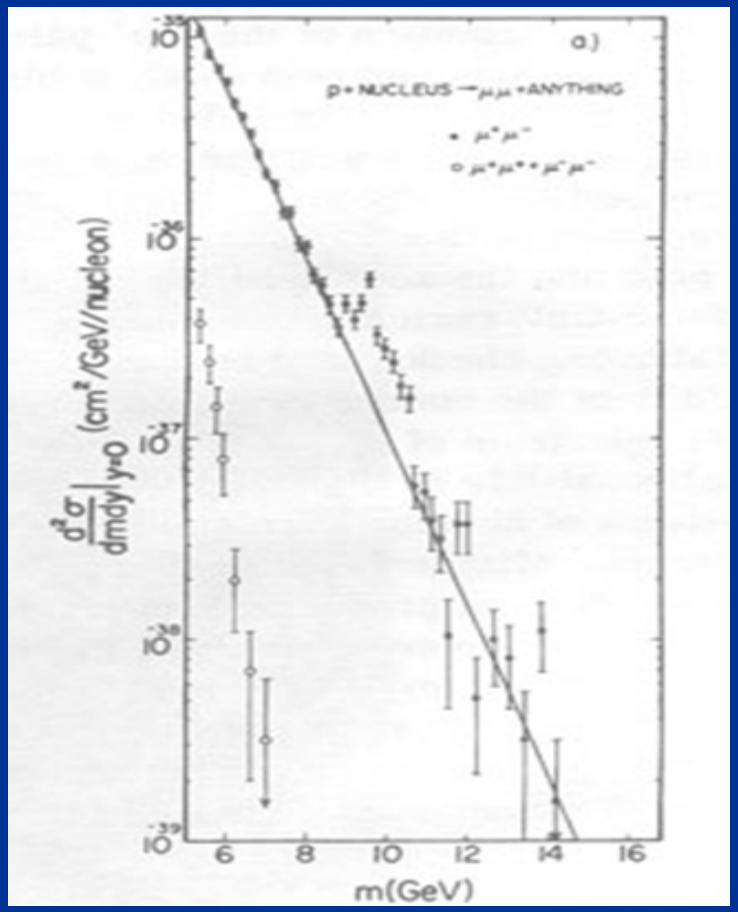
- **Not to describe details of the large number of exciting future projects / experiments in particle physics**
- **Not to prioritize future activities**
- **Rather to discuss how the process to prioritize future projects in US particle physics is expected to proceed**

"Good Old Times"

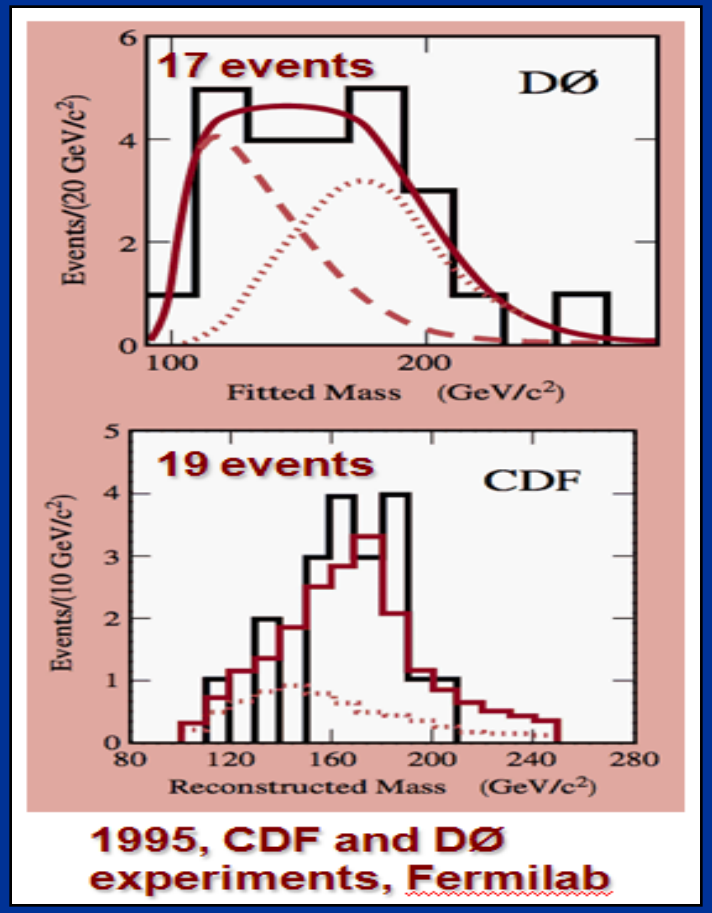
- How the process of funding new experiments progressed in 60's, 70's and 80's (somewhat simplified description)
  - Smart physicist(s) propose new experiment and send written proposal to the Laboratory
  - The Laboratory considered the proposal including recommendation of the Physics Advisory Committee (PAC)
    - Original DZero proposal was "E740" – proposal number 740 among experiments proposed at Fermilab accelerators
  - Director of the Laboratory decided to support (or not) the experiment in consultation with DOE with main construction funding provided via the Laboratory budget
    - Substantial flexibility, lack of excessive reviews/bureaucracy
  - Majority of the experiments were completed on schedule and produced fundamental physics results

Fundamental Discoveries

b-quark



t-quark

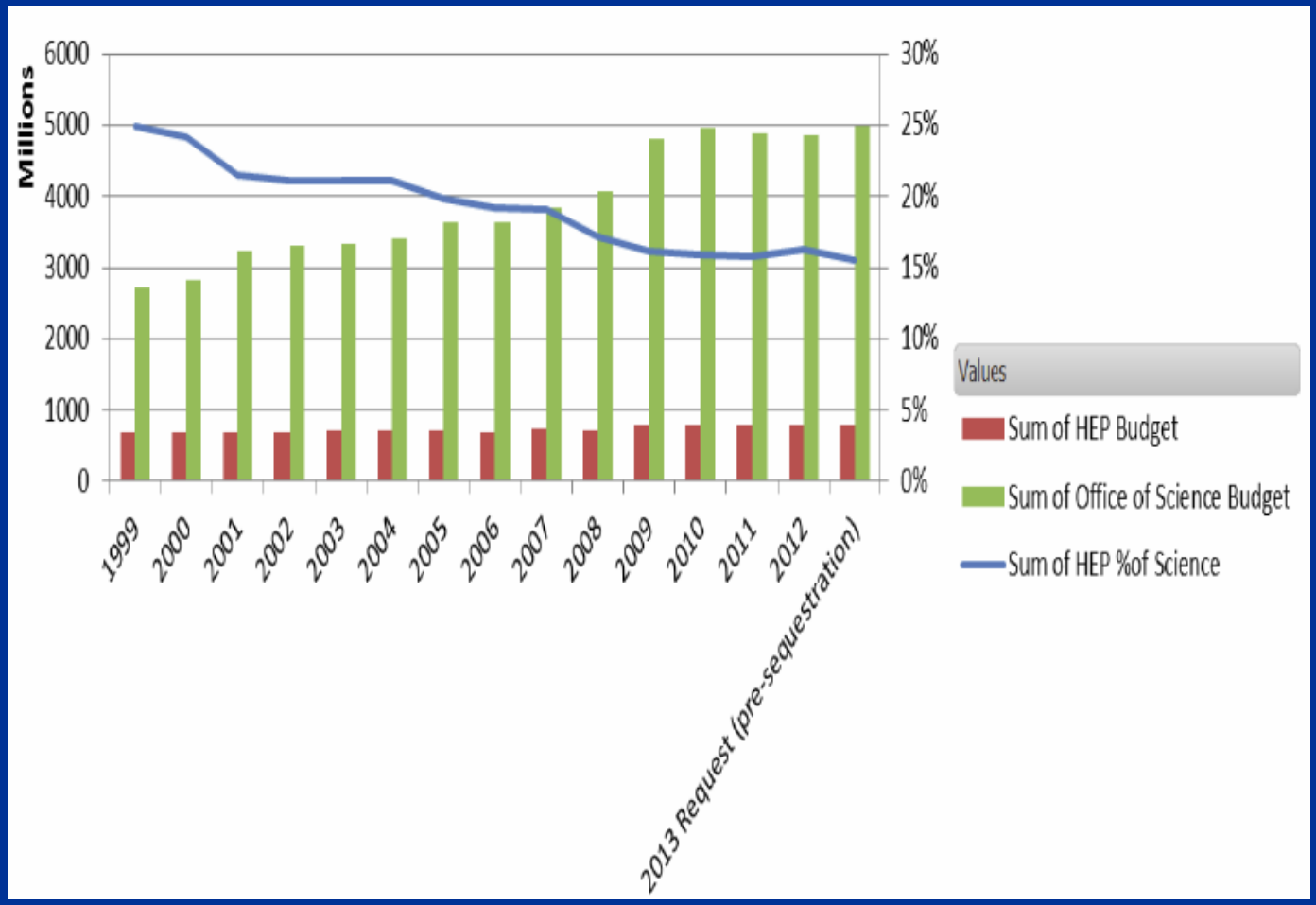


Many fundamental discoveries have been made at Fermilab

Why to Change Proven Model of Funding?

- Increase in the cost and duration of the experiments
  - What could have been studied "easily" already have been done
  - Only few large experiments progressing
- Experiments in most cases no longer "belong to a single Laboratory"
  - ATLAS experiment has many US national laboratories participating
- Funding agencies formalized approval/construction process and control the cost
  - From "get it done" to "do it by the rules"
  - Not just for particle physics
- Large number of interesting proposals available
  - With long time to construct and collect/analyze data
- Overall reduction in the funding for the field

Particle Physics (=HEP) DOE Funding



- **Funding is "flat" vs year at ~$760M per year over past 13 years**
- **But… everything is more expensive today vs 1999**
  - **Effective reduction in HEP budget is ~25% over past decade or about $170 millions per year**
    - **And there are no expectations for a change of the slope for now**

How to Proceed in the New Environment?

- The field, all of us together, have to develop approach how to decide “what projects to do”
- Final decision belongs to funding agencies
  - DOE and NSF need input from us to decide where to spend money!
- Important points in providing recommendations
  - The science has to be excellent, among best in the world
  - The selection process has to be community wide (and even world-wide)
  - We all have to agree to the process and support the outcome
    - If many of us will complain about outcome, funding agencies will have hard time implementing recommendations
  - The selected projects costs have to fit into “available envelope” and not only “total”, but “vs year”

5 Steps Process

- **Step 1**
  - Scientists or groups of scientists develop proposals for future projects/experiments
- **Step 2**
  - "Snowmass" community wide process discusses proposals, evaluates strong and weak points, physics reach and costs and summarizes outcome in a written form
  - Organized by Division of Particles and Fields (DPF) – professional organization, not Laboratory or NSF or DOE
- **Step 3**
  - P5 committee (Particle Physics Projects Prioritization Panel) is formed consisting of ~25 scientists representing all areas of particle physics
  - The committee, within about 6 months, have to recommend priorities for DOE to follow based on available funding and expected cost of the projects
  - Recommendations will cover ~10 years time span
- **Step 4**
  - HEPAP (High Energy Physics Advisory Panel) reviews the proposal and recommends it to be considered by funding agencies
- **Step 5**
  - Recommended projects are funded by funding agencies

Snowmass 2013

The DPF Charge for Community Summer Study also called "Snowmass 2013"

To develop the community's long term physics aspirations. Its narrative will communicate the opportunities for discovery in high energy physics to the broader scientific community and to the government.

Organized around Frontiers

- **Energy, Intensity, Cosmic, Instrumentation, Facilities (mainly new accelerators), Education and Outreach, Theory**

- **Process continued for about a year (since late 2012) and culminated in ~10 days community meeting at the University of Minnesota late July 2013**
  - **"Snowmass" is the name of the village in Colorado where similar exercises have been done in the past (last time in 2001)**

Snowmass 2013

Snowmass on the Mississippi a.k.a CSS 2013

Log in

Quick Links

- TWiki registration
- Pre-meetings
  - Community Planning Meeting
  - All pre-Snowmass Meetings
- Colloquium questions
- Big Questions (Quantum Universe)

Groups

- Energy Frontier
- Intensity Frontier
- Cosmic Frontier
- Frontier Capabilities
- Instrumentation Frontier
- Computing Frontier
- Education and Outreach
- Theory Panel

Google Search

snowmass2013.org
WWW

Community Summer Study 2013

(Snowmass on the Mississippi) *Minneapolis, 7/29 - 8/6 2013*

The American Physical Society's Division of Particles and Fields is pursuing a long-term planning exercise for the high-energy physics community. Its goal is to develop the community's long-term physics aspirations. Its narrative will communicate the opportunities for discovery in high-energy physics to the broader scientific community and to the government.

Minnesota Information and Registration webpage

Follow this link to a preliminary agenda

Conveners, to request room for parallel sessions use this link Request rooms

COLLOQUIUM QUESTIONS

BIG QUESTIONS FOR OUR UNIVERSE.

LATEST NEWS

- July 24 update: list of questions for the colloquia at CSS2013 are posted
- May 7 Update: The Snowmass Young Physicists Career and Science Aspirations Survey is now online. Please encourage students and postdocs to respond. http://tinyurl.com/snowmassyoung

By now Snowmass process is almost over with final reports expected shortly

Next Step is P5

- **DOE and NSF have charged the HEPAP Chair to**
  - **"constitute a new P5 panel to develop an updated strategic plan for U.S. high energy physics that can be executed over a 10-year timescale, in the context of a 20-year global vision for the field"**
- **The committee has been formed**

Steve Ritz (UCSC) - **chair**	**Lia Merminga** (TRIUMF)
Marty Briedenbach (SLAC)	**Toshinori Mori** (Tokyo)
Bob Cousins (UCLA)	**Tatsuya Nakada** (Lausanne)
Andre de Gouvea (Northwestern)	**Steve Peggs** (BNL)
Marcel Demarteau (ANL)	**Saul Perlmutter** (Berkeley)
Scott Dodelson (FNAL/Chicago)	**Kevin Pitts** (Illinois)
Bonnie Fleming (Yale)	**Kate Scholberg** (Duke)
Fabiola Gianotti (CERN)	**Rick van Kooten** (Indiana)
Francis Halzen (Wisconsin)	**Mark Wise** (Caltech)
JoAnne Hewett (SLAC)	**additional member - TBC**
Wim Leemans (LBNL)	**Andy Lankford** (UCI) – ***ex officio***
Joe Lykken (FNAL)	**possible additional *ex officio* members**
Dan McKinsey (Yale)	(*e.g.* writing assistance)

- **The committee is starting to work with first public meeting at Fermilab early November**

The P5 Process

- **P5 committee will base their recommendation on Snowmass outcome, but their opinion will affect what projects will get high priority**
  - **All of you should talk to P5 members, send them your input and participate in the meetings/discussions**
  - **Be sure your opinion/logic is taken into account**
    - **Even more important for all of us is to support P5 recommendations!**

- **P5 recommendations are expected early March 2014 – very soon**

- **After that funding of new experiments is expected to follow priorities set by P5, unless there are major changes in the field landscape**

P5 Web Page

Particle Physics Project Prioritization Panel (P5)

Login

Home Charge Membership Meetings Submissions Useful Links HEPAP

About The Particle Physics Project Prioritization Panel (P5)

NEWS

Please check the news panel on the right for the latest P5 developments.

ABOUT P5

The particle physics community is developing an updated strategic plan for the United States that can be executed over a ten-year timescale, in the context of a twenty-year global vision for the field. The Particle Physics Project Prioritization Panel (P5) is charged with developing this plan under various budget scenarios. P5 is a subpanel of the High Energy Physics Advisory Panel (HEPAP) that serves both the Department of Energy's Office of High Energy Physics and the National Science Foundation. The chair of P5 is Professor Steven Ritz from the University of California, Santa Cruz. The P5 process follows directly on the heels of the Snowmass process organized by the American Physical Society's Division of Particles and Fields. Through the Snowmass process the U.S. particle physics research community identified the most compelling scientific opportunities and the technologies required to seize those opportunities. The Snowmass process culminated in a nine-day-long meeting at the University of Minnesota in July and August of 2013. The final Snowmass reports, expected in November, will serve as input to P5. Please check this page regularly for news and information about P5 activities. There will also be mechanisms for the particle physics community to provide input, documents, and feedback to P5.

News

Indico Page for Meeting #1 (2-4 November at Fermilab)
10/08/2013
The indico page for the first meeting at Fermilab, 2-4 November, is now posted. The agenda details will be filled in soon. If you are planning to attend, to assist with logistical planning, please go to the indico

Meeting plans posted
10/02/2013
The meetings link above now has more information about upcoming P5 meetings, including the 2-4 November meeting at Fermilab. This page will be updated regularly as the plans develop. Please check back regularly or use the RSS feed.

P5 Panel Membership
09/23/2013
The P5 Panel membership is now complete. Please see Membership.

Snowmass Aspirations - I

- **Probe the highest possible energies and smallest distance scales with the existing and upgraded Large Hadron Collider and reach for even higher precision with a lepton collider; study the properties of the Higgs boson in full detail**

- **Develop technologies for the long-term future to build multi-TeV lepton colliders and 100 TeV hadron colliders**

- **Execute a program with the U.S. as host that provides precision tests of the neutrino sector with an underground detector; search for new physics in quark and lepton decays in conjunction with precision measurements of electric dipole and anomalous magnetic moments**

- **Identify the particles that make up dark matter through complementary experiments deep underground, on the Earth's surface, and in space, and determine the properties of the dark sector**

- **Map the evolution of the universe to reveal the origin of cosmic inflation, unravel the mystery of dark energy, and determine the ultimate fate of the cosmos**

Snowmass Aspirations - II

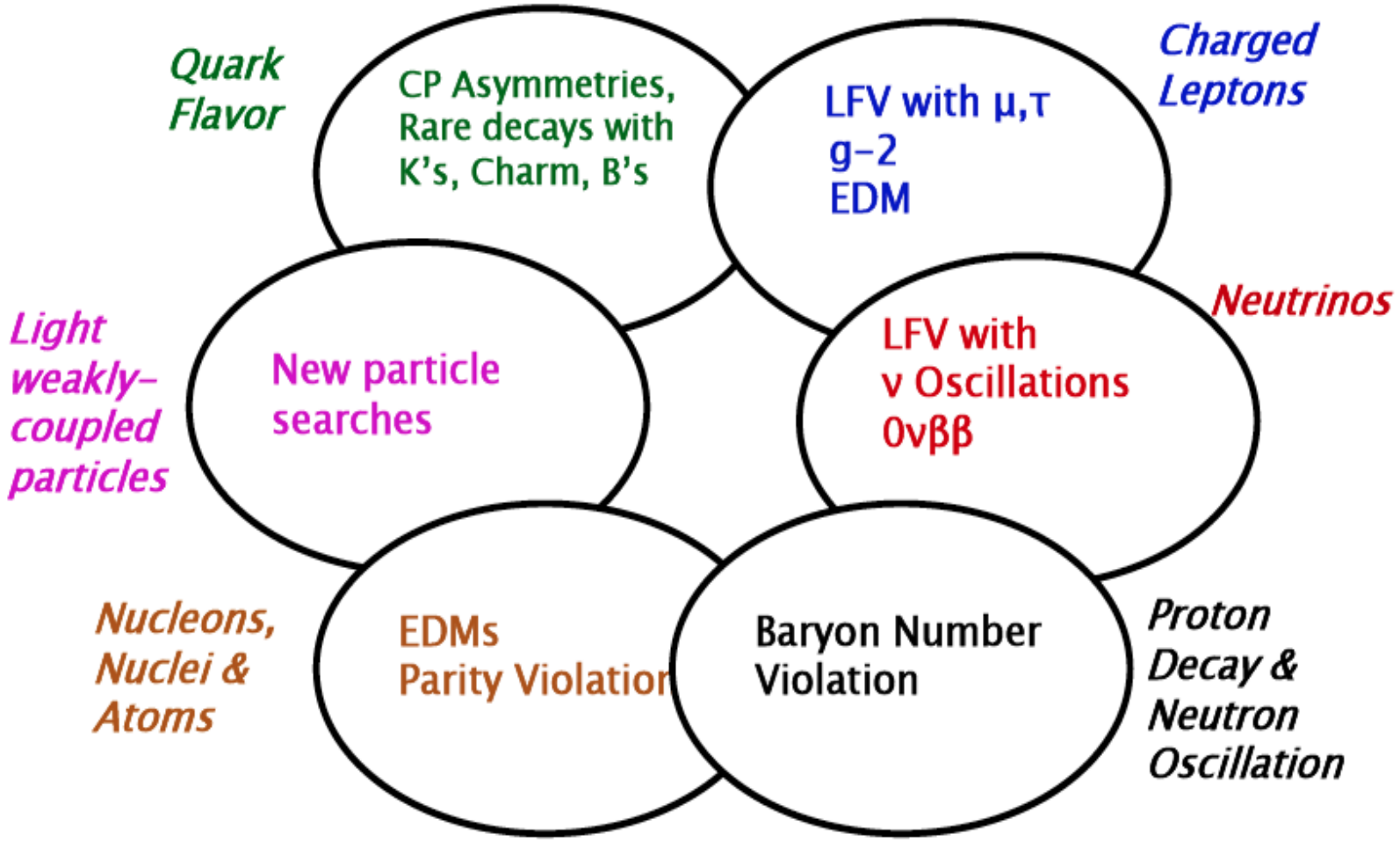
- Invest in the development of new, enabling instrumentation and accelerator technology
- Invest in advanced computing technology and programming expertise essential to both experiment and theory
- Carry on theoretical work in support of these projects and to explore new unifying frameworks
- Invest in the training of physicists to develop the most creative minds to generate new ideas in theory and experiment that advance science and benefit the broader society
- Increase our efforts to convey the excitement of our field to others

Snowmass Energy Frontier

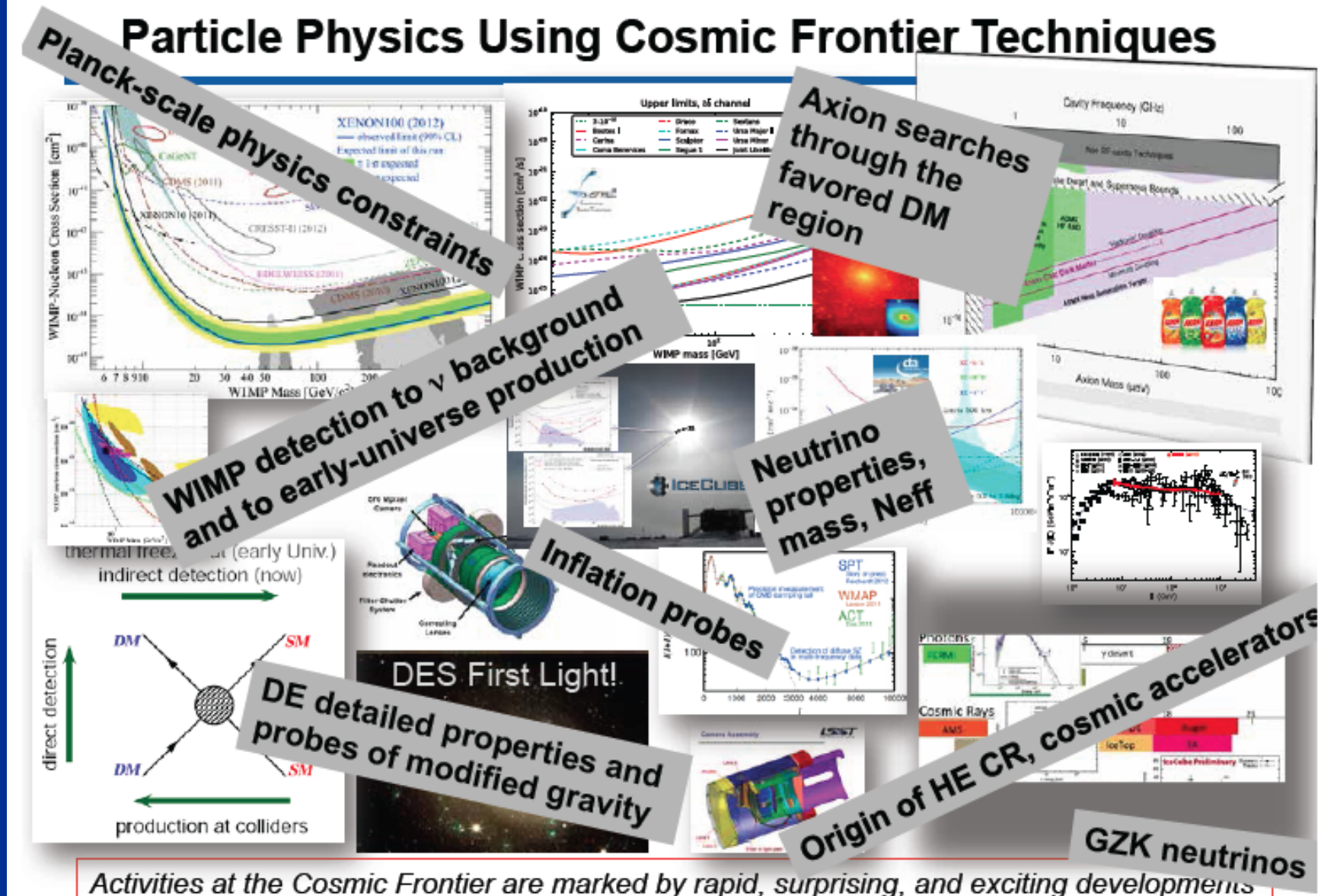
- **HL-LHC – Higgs couplings, VV scattering, new particle searches**
- **500 GeV ILC – Higgs couplings, top couplings, NP in LHC blind spots**
- **1 TeV ILC – Higgs self coupling (13%), precision NP**
- **350-3000 GeV CLIC - Higgs self coupling (10%), NP**
- **0.125, 3-6 TeV Muon Collider – s-channel Higgs, NP, measurements of Higgs self coupling + anything e^+e^- can do**
- **TLEP (350 GeV circular e^+e^-) - 10x higher luminosity than linear e^+e^- colliders**
- **100 TeV pp – NP search, electroweak WIMPs over the full allowed mass range, constraints on "naturalness" (see my February 2013 UD0 talk for details)**

Snowmass Intensity Frontier

The Intensity Frontier is a broad and diverse, yet connected, set of science opportunities



Snowmass Cosmic Frontier



Snowmass Accelerators Frontier

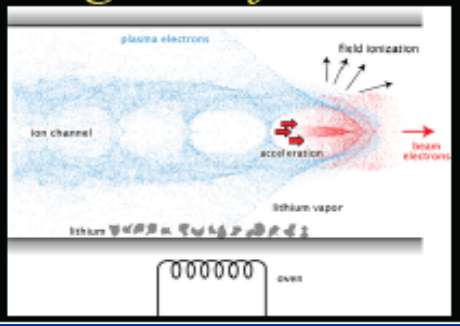
Capabilities: Accelerator frontier

What are long term "big questions"?

regarding accelerator-based HEP capabilities

- *How would one build a 100 TeV scale hadron collider?*
- *How would one build a lepton collider at >1 TeV?*
- *How would one generate 10 MW of proton beam power?*
- *Can multi-MW targets survive? If so, for how long?*
- *Can plasma-based accelerators achieve energies & luminosities relevant to HEP?*
- *Can accelerators be made 10x cheaper per GeV? Per MW?*

These are issues for the long term future



Instrumentation, Computing, Outreach

Instrumentation

- As experiments continue to reach for rarer processes, more precise measurements, higher energies and luminosities, and more inclusive observations how do we achieve the finer granularity, larger volume, more radiation hard, lower cost, and higher speed detectors that will in large part determine our experimental reach?

Computing

- What technologies will be needed to acquire, analyze and store the enormous amounts of data from future experiments? Can local intelligence be incorporated to manage data flow? How will we fully and efficiently utilize data stored in large databases?

Outreach

- How do we engage particle physicists in communication, education and outreach activities so as to convince policy makers and the public that particle physics is exciting and worth supporting?
- How do we develop a talented and diverse group of students that enter particle physics and other careers, including science teaching?

Excellent set of proposals developed at Snowmass in all areas!

Why are we concerned?

Let's take a look how much $s we need to implement the full program over next ~10 years

Funding Required

- **Summing over all projects of all frontiers proposed / discussed at Snowmass we come to the number of about $6 billion**
  - **Required over 10 years to accomplish the projects**

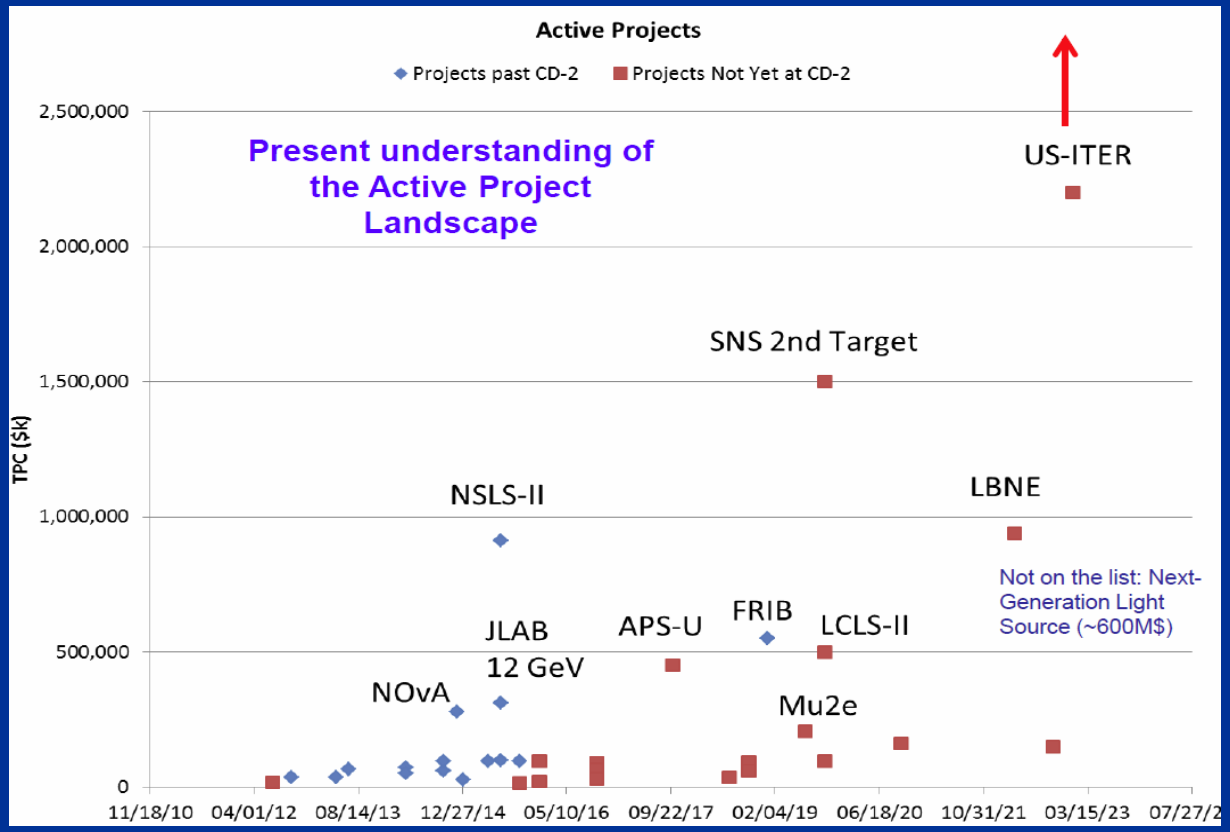
- **Some projects might continue beyond 10 years, while at the same time new projects could appear in the next few years**

Available and Required Funding

- Estimates that total funding we can expect for projects in the coming 10 years is $100 to $200 millions per year
  - Total over a decade, even if optimistic, is $2 billion
  - And we need $6 billion…
- Our “appetite” is well above what we can afford (factor of ~3)
  - And this is where P5 prioritization will be critical
- What we can expect from P5 recommendations
  - Some projects will be de-scoped (means less complex/ambitious detectors)
  - Some projects will have to wait to be constructed (if relevant at that time) for beyond 10 years
  - Some (even ongoing) projects might have to be cancelled
  - Above will affect majority of the projects as mismatch between currently available funding and funding needed for all projects is substantial

And What About "Super" Projects

- Any new large accelerator has price tag of "many billions"
- Even large detectors, like ATLAS/CMS/LBNE , cost in excess of a billion dollars
- Such projects were affordable in the past
  - Cost of the first Fermilab accelerator in today's dollars is ~$4 billions and it was constructed over ~4 years
- Recent history shows that "any project has to be below ~$1 billion"



Concluding Remarks

- **Snowmass**
  - Developed a list of interesting experiments/projects for the coming ~10 years
- **P5 panel**
  - Will provide DOE and NSF with priorities on the above list
- **During P5 process from October 2013 to about March 2014**
  - Important to provide P5 with opinions/feedback
  - Provide P5 numbers of projects physics reach, cost and manpower estimates
- **Very important for all of us to understand P5 recommendations well and be able to stay behind them**
  - Even if "your own" project is not high on the priorities list
- **Even more important is to address issue of declining high energy physics budgets**
  - We should convince public and the Government to fund us well
  - Can only be done if we demonstrate that we are contributing strongly to the society outstanding needs