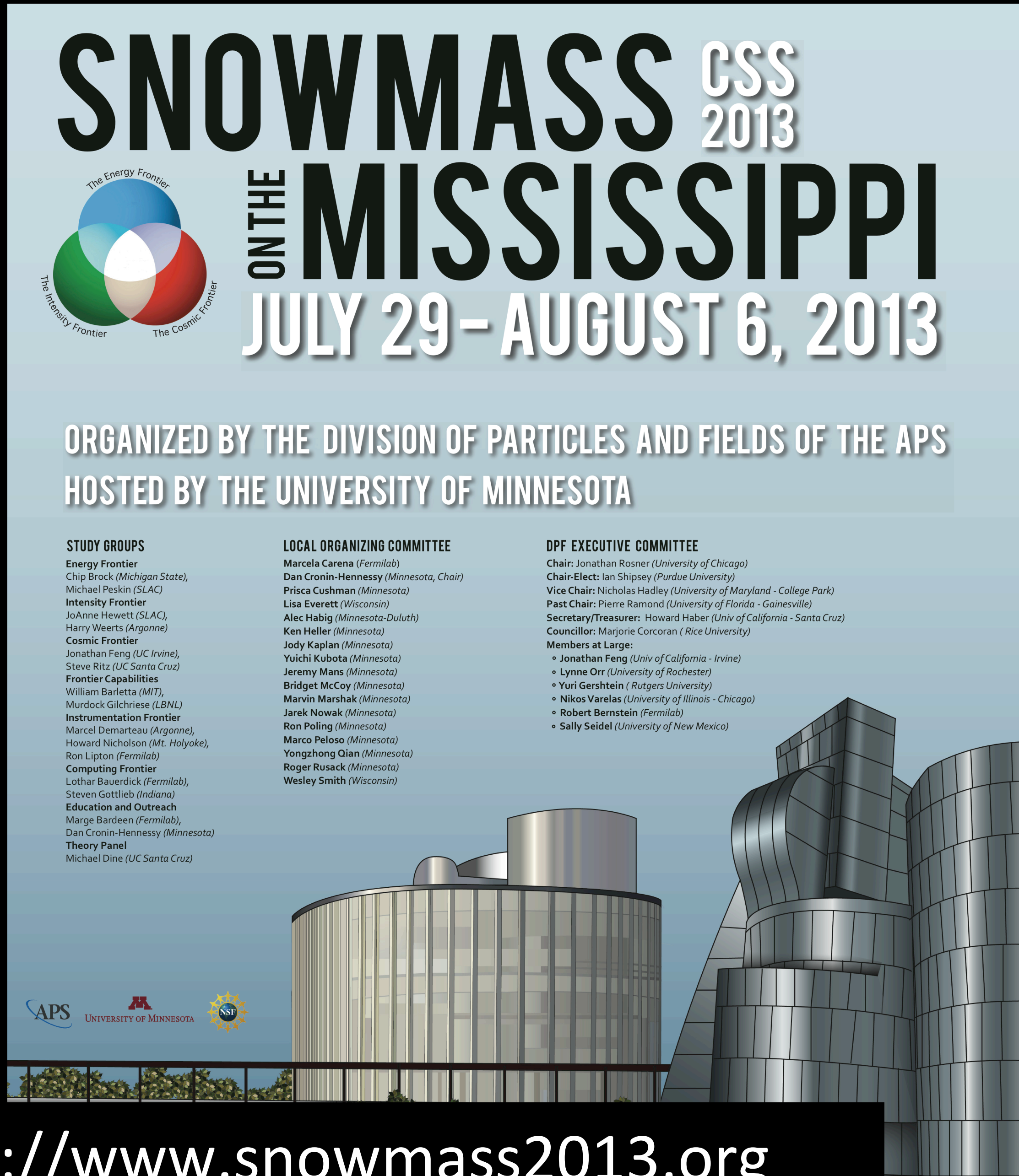
"The Snowmass Process"

Developing a US Strategy for Particle physics

Ian Shipsey
Chair-elect
DPF of APS



http://www.snowmass2013.org

The Snowmass Process

A community based study of the future of particle physics in the U.S. held roughly every ten years

Organized by the community i.e. American Physical Society Division of Particles and Fields (3,500 members)

The 1982, 1988, 1996, 2001 process culminated in a 3 week meeting at Snowmass, Colorado- hence the name

A "bottom-up" organization, contributions from individuals, experiments etc. it is not led by funding agencies

[redacted]

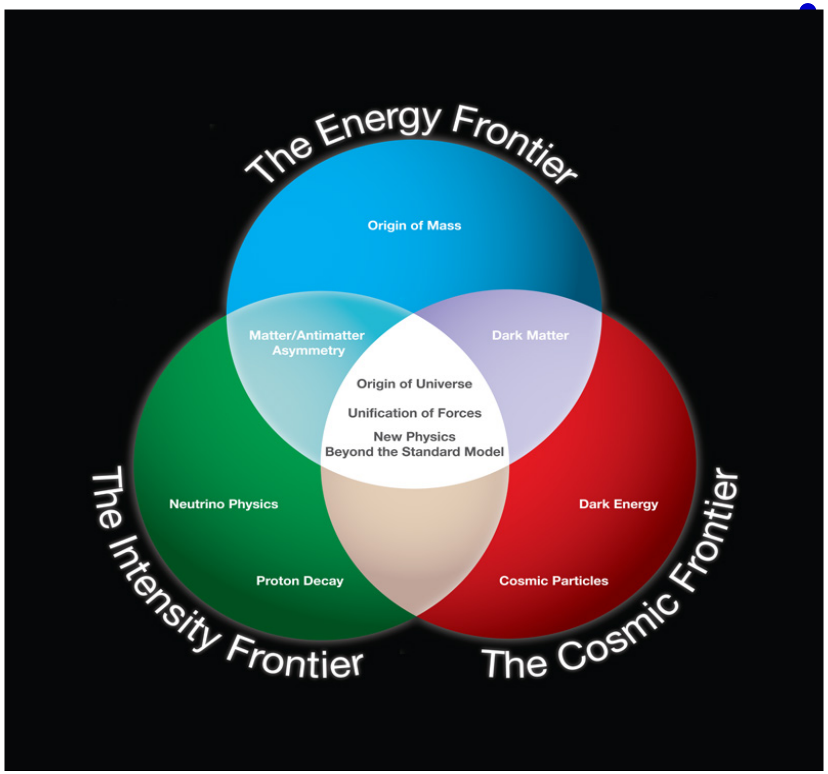
The Goal of Snowmass 2013

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

Particle Physics: what it includes (in the US)

DOE definition: particle physics is the science of matter, energy, space and time

Scope is broad : accelerator & non accelerator *& cosmological observations: Dark energy ex: LSST CMB ex: SPT & TeV astronomy*



- **Particle Physics organized by DOE by frontiers: reflecting multi-pronged approach to search for new physics**
  - **Direct Searches**
  - **Precision Measurements**
  - **Rare and Forbidden Processes**
  - **Fundamental Properties of Particles and Interactions**
  - **Cosmological observations**

The Snowmass process
uses the frontier-based organizing principle

SNOWMASS 2013 GROUPS

Conveners of seven "Frontiers"

- **Energy Frontier**
  - Chip Brock (Michigan State), Michael Peskin (SLAC)
- **Intensity Frontier**
  - JoAnne Hewett (SLAC), Harry Weerts (Argonne)
- **Cosmic Frontier**
  - Jonathan Feng (UC Irvine), Steve Ritz (UC Santa Cruz)
- **Frontier Capabilities**
  - William Barletta (MIT), Murdock Gilchriese (LBNL)
- **Instrumentation Frontier**
  - Marcel Demarteau (ANL), Howard Nicholson (Mt. Holyoke), Ron Lipton (Fermilab)
- **Computing Frontier**
  - Lothar Bauerdick (Fermilab) and Steven Gottlieb (Indiana)
- **Education and Outreach**
  - Marge Bardeen (Fermilab), Dan Cronin-Hennessy (U of M)

Each Frontier is organized in subgroups

what Snowmass is not

We don’t make recommendations

what Snowmass is

We evaluate by benchmarking

We speculate by calculating

We dream about following the physics

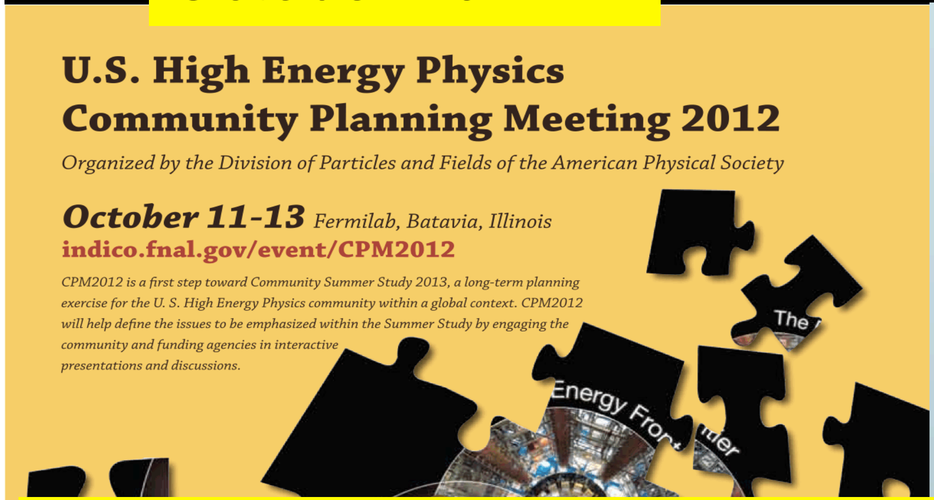
We imagine discovery

The Snowmass process is identifying, asking and answering key hard questions at the Energy, Intensity and Cosmic Frontiers and these will be summarized in a resource book that will be the primary input to the deliberations of the DOE/NSF Particle Physics Project Prioritization Panel (P5).

The purpose of P5 is to judge the questions and answers and place them within a realistic budgetary framework.

Kick Off meeting
October 2012

Concluding meeting
July 29 –August 6, 2013



Reflecting our era of high bandwidth communication, shared desktops & near effortless remote collaboration on a daily basis Snowmass 2013 is not a 3-week meeting in Snowmass but a 9 month study.

Face to face remains crucial: Kickoff Meeting October ’12@FNAL & culminating in a 9-day meeting in Minneapolis in July/August interspersed with multiple smaller Workshops (pre-meetings)

PRE-MEETING SCHEDULE

Group	When	Where	What
Energy	Jan 14-15	Princeton	Higgs
	Jan 14-16	UC Irvine	New Particles
	Feb 18-20	Duke Univ.	Electroweak
	Apr 3-6	BNL	General meeting
	May 13-15	Fla. State	QCD
	May 29-31	KITP (UCSB)	Theory; joint with IF/CF
	Jun 30-Jul 3	U. Wash.	General meeting
Intensity	Feb 13-15	Fermilab	EDM
	Mar 6-7	SLAC	Neutrino
	Apr 25-27	ANL	General; with Proj. X
Cosmic	Mar 6-8	SLAC	With Capabilities, AARM, DURA
	Mar 22-25	Snowbird	Non-WIMP dark matter
	May 29-31	KITP (UCSB)	Joint CF/EF/IF (see EF above)
Instrum.	Jan 9-11	ANL	CPAD Meeting
	Mar 20-21	Fermilab	LAr TPC R&D Workshop
	Apr 17-19	Boulder	Snowmass/CPAD

PRE-MEETINGS, CONTINUED

Group	When	Where	What
Capabilities	Feb 21-22	CERN	High energy hadron colliders
	Feb 25-26	U of Chicago	Accel. tech. testbeds, test beams
	Apr 9-11	MIT	High energy lepton colliders
	Apr 17-19	BNL	High intensity proton beams
	Jun 24-28	UC Santa Cruz	Writers' meeting
Computing	Jan-Jul	Various	With Energy/Intensity/Cosmic
	11/28/12	Washington	With NERSC (special hardware)
Ed., Comm., Outreach	Mar 16-17	Baltimore	Teachers and students
	Apr 12-13	Denver	Scientific, policy, general

23 pre-meetings planned, 21 have occurred

Progress and Status at the Snowmass Wiki: snowmass2013.org/tiki-index.php

Snowmass on the Mississippi a.k.a CSS 2013

Log In

Quick Links

- **TWiki registration**
- **Pre-meetings**
  - Community Planning Meeting
  - All pre-Snowmass Meetings

Groups

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

Google Search

www.snowmass2013.org

WWW

Community Summer Study 2013

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

Minnesota Information and Registration webpage

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

Full Calendar of Pre-Snowmass Meetings

LATEST NEWS

- March 19 Update: Web site for Contributed papers The site is now fully live; the submission form is working. Please submit your papers.
- March 2 Update: Web site for Contributed papers created (more details below on this page)
- November 9 Update: **changes to the twiki registration process**
- CPM2012/CSS2013 August 17 Update: Snowmass 2013 site is chosen
- CPM2012/CSS2013 July 30 Update: computing frontier conveners named
- CPM2012/CSS2013 June 29 Update: local org cmte for CPM2012
- CPM2012/CSS2013 June 28 Update

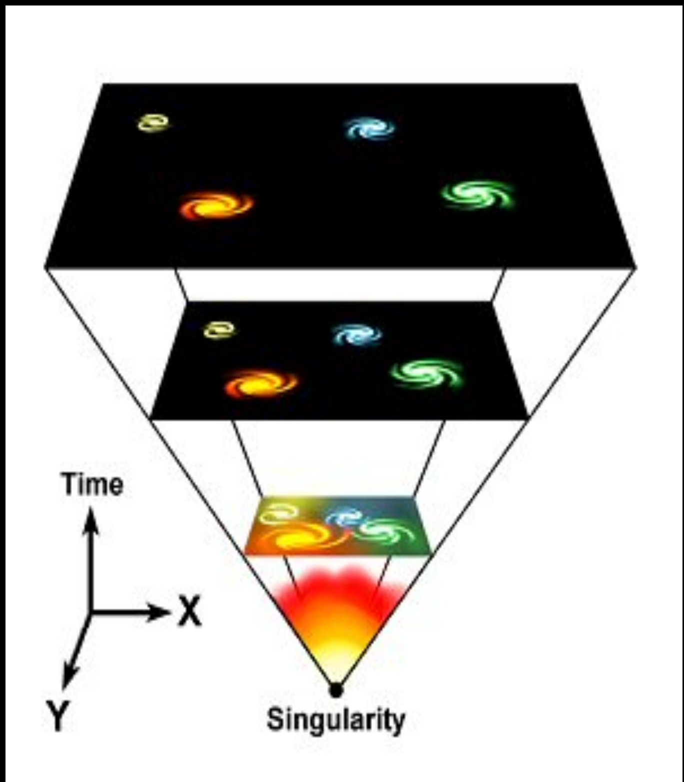
long process

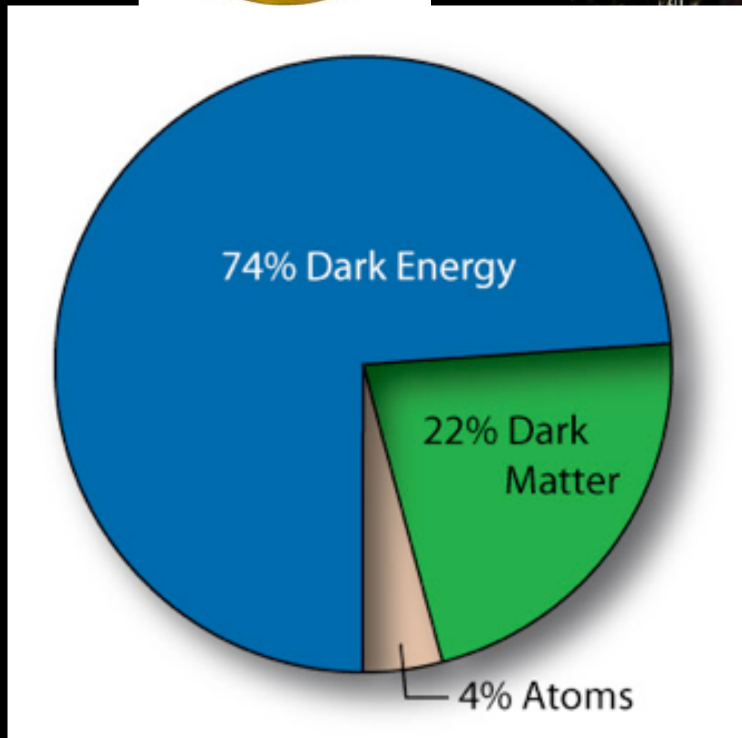
Snowmass is only one part of a lengthy planning process in the US.

However, it is the best chance to bring forward opportunities for new projects that could elict wide support.

A special time….

- October 2011: Nobel Prize for the discovery of dark energy

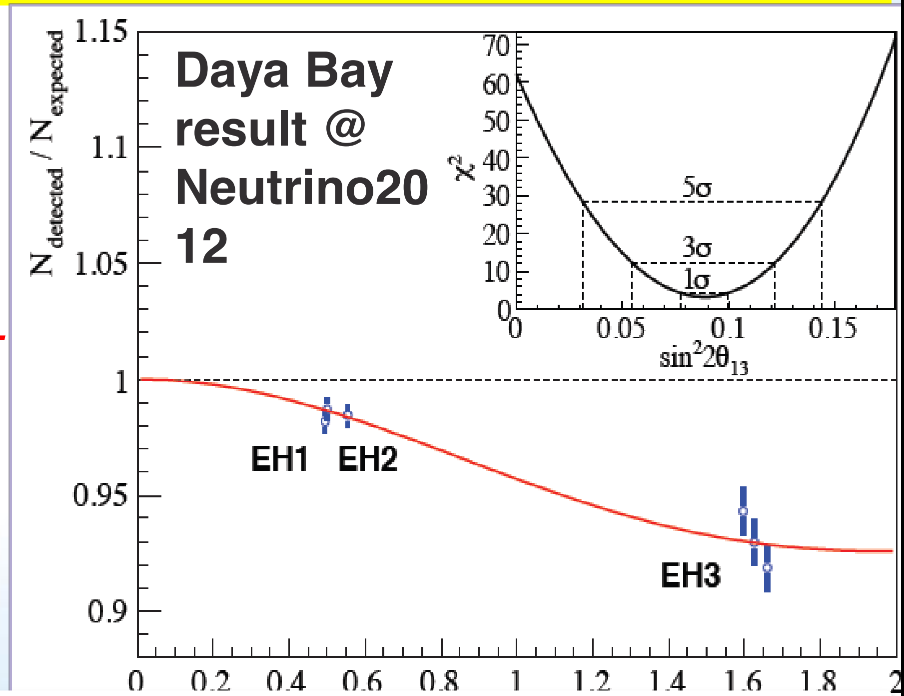




A special time….

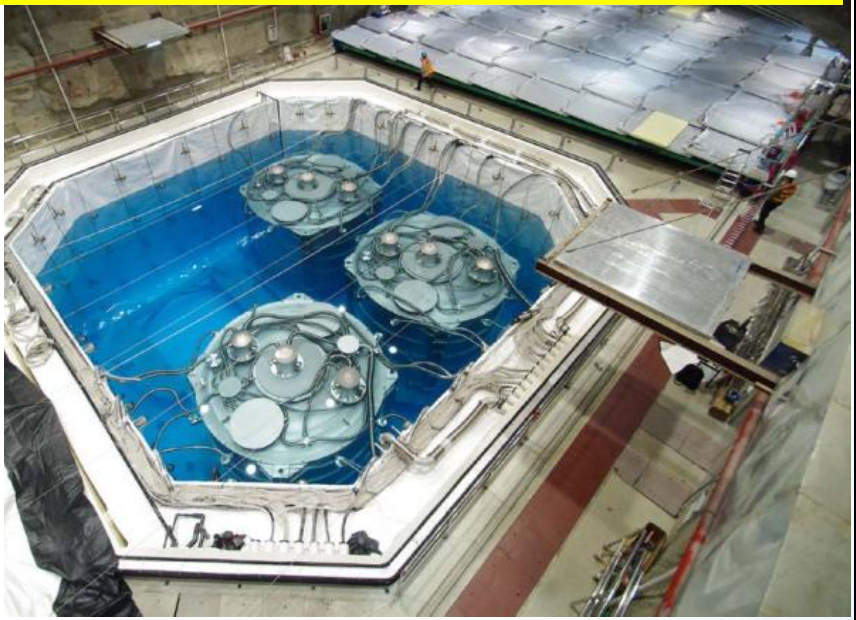
- March 2012: First results from Daya Bay:

Daya Bay - Large $Sin^2 2\theta_{13}$

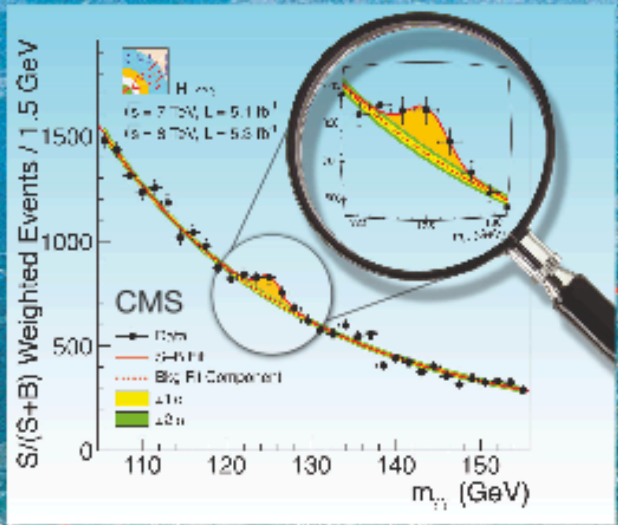


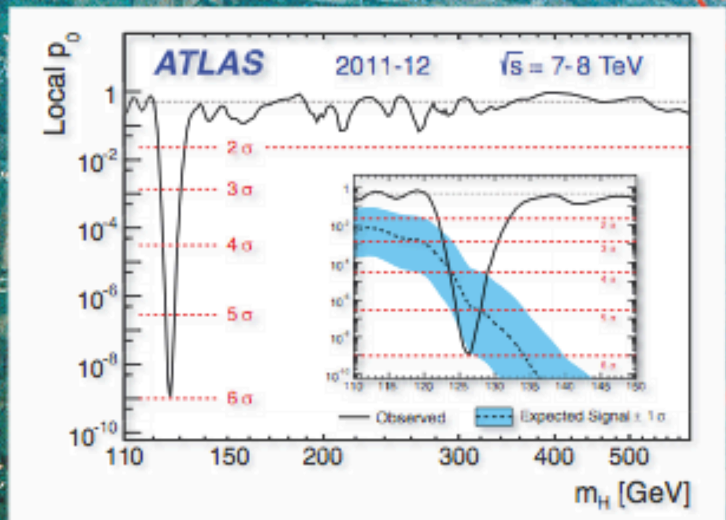
$\sin^2 2\theta_{13} = 0.089 \pm 0.010\ (stat) \pm 0.005\ (syst)$

Daya Bay - Far Det.



First observations of a new particle in the search for the Standard Model Higgs boson at the LHC





The LHC, the experiments and the observation of a Higgs boson is a global phenomena

PRESS COVERAGE

after July 4th seminars at CERN

CERN black board, Jul 2012

Shipsey ECF

"Higgs update" seminar, 4th July

CERN press conferences
Multiple interviews
Hundreds of repeats of the CERN events around the globe

55

media organizations at CERN (11 global news, 21 print, 20 TV)

496,000

Distinct (IP) connections to seminar webcast

EDITION: INTERNATIONAL | U.S. | MÉXICO | ARABIC
TV: CNNI | CNN en Español
Set edition preference
CNN
Home Video World U.S. Africa Asia Europe Latin America Middle East Business
Higgs and the holy grail of physics
By Lawrence M. Krauss, Special to CNN
July 6, 2012 -- Updated 1507 GMT (2307 HKT)
Higgs search update 04.07.2012
Searching for the 'God particle'
yle AREENA TV Radio
Hae ohjelmia
A-Ö
Kaikki ohjelmat
Sarjat ja elokuvat
Viihde ja kulttuuri
Dokumentit ja fakta
Urheilu
Lapset
HIGGSIN HIUKKANEN
Suomalaistutkijat mukana hiukkasen etsinnässä
> 1 billion
people saw TV footage from CERN
1,034
TV stations
5,016
Broadcasts
Открытие "частицы Бога" сделало Хиггса кандидатом на премию Нобеля
В ноутбуке.
Senior CERN researcher Albert de Roeck explains the Higgs
ECFA LC2013 DESY
26
Lucas Taylor, CMS Communications Group Report on July 4th Seminar

Convincing current & next generation voters
Influencing decision makers

The public are very interested
in science.
Combined with the
unprecedented global impact
of the Higgs discovery
this provides
an opportunity to
expand engagement
with the public
our colleagues
and the government.

To communicate what we have
learned and the opportunities for
discovery in particle physics

Education and Outreach Frontier

Why do we need a healthy particle physics program ?

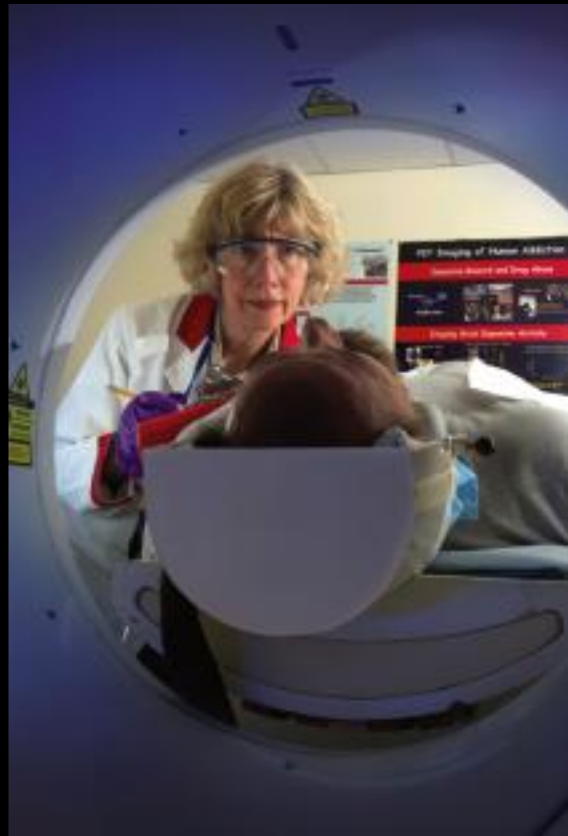
#1 Our science is important for our nations to pursue

What is the world made of?
What holds the world together?
How did the world begin?

For millenia all great societies have asked these questions

#2 The big questions we ask attract young talent to *all* of the sciences

#3 Particle physics is an essential part of the fabric of the physical sciences in developed nations



Contributing broadly to other physical sciences:

Accelerator Science

Detector development

Large Scale computing driven by large collaborations

It is a two-way process. We benefit from developments in Material science & Basic Energy Sciences.

Some of the essential ingredients of a healthy particle physics program are:

A program focused on the most compelling science

Infrastructure to support the development of our tools

A long term vision and strategy to guide the program for future decades.

The Snowmass process must identify opportunities for achieving "transformational or paradigm-altering" scientific advances: *great discoveries*.

Energy frontier
Cosmic frontier
Intensity Frontier
Enabled by instrumentation, facilities & computing
Supported by Education & Outreach

High Energy Frontier

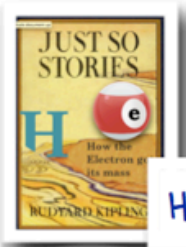
To figure out the best way to:

1. Study the Higgs-like state at 125 GeV

Higgs Top EW QCD NP Flav

Higgs
Top
EW
QCD
NP
Flav

2. Answer some troublesome questions



3. Write the story that encompasses the SM

Higgs Top EW QCD NP Flav

4. Be nimble & ready for surprises

Higgs Top EW QCD NP Flav

High Energy Frontier
HE1 The Higgs
HE2 Precision Study of Electroweak Interactions
HE3 Fully understand the top quark
HE4 The path beyond the Standard Model
HE5 QCD & the strong force
HE6 Flavor Mixing and CP Violation @ High Energy

The subgroups are led by expert experimentalists and theorists in each area. A "high-minded observer" may also be appointed to some subgroups. The linked subgroup webpages list relevant topics and experiments for each subgroup. In addition, many topics cut across more than one Frontier; overlaps requiring the collaboration of two or more working groups are also noted.

Chip Brock and Michael Peskin have asked the following as the major questions to be answered in the Energy Frontier study:

We need to articulate a scientific program and its motivation:

I. What scientific targets can be achieved before 2018 ?

II. What are the science cases that motivate the High Luminosity LHC ?

III. Is there a scientific necessity for a "Higgs Factory" ?

IV. Is there a scientific case today for experiments at higher energies beyond 2030 ?

For these issues, we must clarify in our own minds:

Where is the physics beyond the Standard Model ?

What did we learn from LHC 7/8 TeV ?

What does this tell us about the next step ?

The physics topics that we are studying are divided among 6 working groups:

1. The Higgs Boson

Conveners: Sally Dawson (BNL), Andrei Gritsan (Johns Hopkins), Heather Logan (Carleton), Jianming Qian (Michigan), Chris Tully (Princeton), Rick Van Kooten (Indiana)

2. Precision Study of Electroweak Interactions

Conveners: Ashutosh Kotwal (Duke), Michael Schmitt (Northwestern), Doreen Wackeroth (SUNY Buffalo)

3. Fully Understanding the Top Quark

Conveners: Kaustubh Agashe (Maryland), Robin Erbacher (UC Davis), Cecilia Gerber (Illinois-Chicago), Kirill Melnikov (Johns Hopkins), Reinhard Schwienhorst (Michigan State)

4. The Path Beyond the Standard Model - New Particles, Forces, and Dimensions

Conveners: Yuri Gershtein (Rutgers), Markus Luty (UC Davis), Meenakshi Narain (Brown), Liantao Wang (Chicago), Daniel Whiteson (UC Irvine)

5. Quantum Chromodynamics and the Strong Force

Conveners: John Campbell (Fermilab), Kenichi Hatakeyama (Baylor), Joey Huston (Michigan State), Frank Petriello (ANL/Northwestern)

6. Flavor Mixing and CP Violation at High Energy

Conveners: Marina Artuso (Syracuse), Michele Papucci (LBL), Soeren Prell (Iowa State)

Technical Advisors

detectors and experimentation: Jeff Berryhill (Fermilab), Tom LeCompte (ANL), Eric Torrence (Oregon), Sergei Chekanov (ANL), Sanjay Padhi (UC San Diego)

accelerators: Eric Prebys (Fermilab), Tor Raubenheimer (SLAC)

and thank you to: Markus Klute, Mark Palmer

We thank the ILC and CLIC communities for preparing White Papers on the capabilities of those machines. These will be valuable input to the working group reports. They will also be public documents available in full in the Snowmass 2013 electronic proceedings.

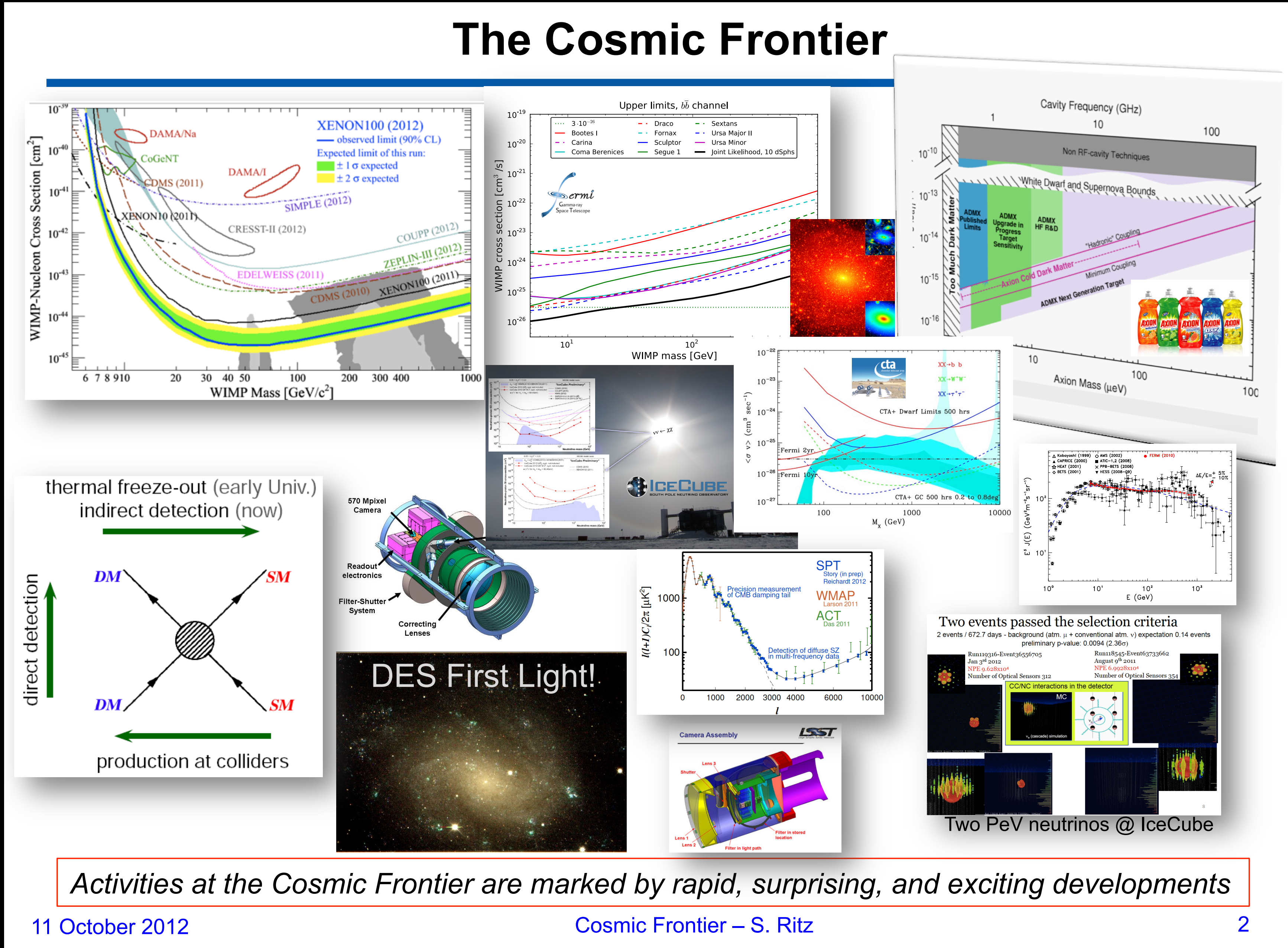
ATLAS, CMS, and the Muon Collider physics group are also writing White Papers. We welcome all contributed papers from other groups. To submit a paper, please visit

https://www-public.slac.stanford.edu/snowmass2013/

The best way to influence the study is to communicate directly with the working group conveners named on the previous slides.

The first-draft conclusions of the working groups will be presented at our Seattle meeting, June 30 - July 3,

https://sharepoint.washington.edu/phys/research/snowmass2013/Pages/


The Cosmic Frontier
XENON100 (2012)
observed limit (90% CL)
Expected limit of this run:
± 1 σ expected
± 2 σ expected
DAMA/Na
CoGeNT
CDMS (2011)
DAMA/I
SIMPLE (2012)
XENON10 (2011)
CRESST-II (2012)
COUPP (2012)
ZEPLIN-III (2012)
EDELWEISS (2011)
CDMS (2010)
XENON100 (2011)
WIMP-Nucleon Cross Section [cm²]
WIMP Mass [GeV/c²]
Upper limits, $b\bar{b}$ channel
WIMP cross section [cm³/s]
WIMP mass [GeV]
Cavity Frequency (GHz)
Non RF-cavity Techniques
White Dwarf and Supernova Bounds
Too Much Dark Matter
ADMX Published Limits
ADMX Upgrade in Progress Target Sensitivity
ADMX HF R&D
Axion Cold Dark Matter
ADMX Next Generation Target
Axion Mass (μeV)
thermal freeze-out (early Univ.)
indirect detection (now)
direct detection
DM
SM
DM
SM
production at colliders
570 Mpixel Camera
Readout electronics
Filter-Shutter System
Correcting Lenses
ICECUBE
CTA+ Dwarf Limits 500 hrs
Fermi 2yr
Fermi 10yr
CTA+ GC 500 hrs 0.2 to 0.8deg
DES First Light!
SPT
WMAP
ACT
Precision measurement of CMB damping tail
Detection of diffuse SZ in multi-frequency data
Camera Assembly
LSST
Two events passed the selection criteria
CC/NC interactions in the detector
Two PeV neutrinos @ IceCube
Activities at the Cosmic Frontier are marked by rapid, surprising, and exciting developments
11 October 2012
Cosmic Frontier – S. Ritz
2

Cosmic Frontier
CF1 WIMP Dark Matter direct detection
CF2 WIMP Dark matter indirect detection
CF3 Non-WIMP Dark Matter
CF4 Dark Matter Complementarity
CF5 Dark Energy & CMB
CF6 Cosmic Particles & fundamental physics

The Intensity Frontier

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

Heavy Quarks

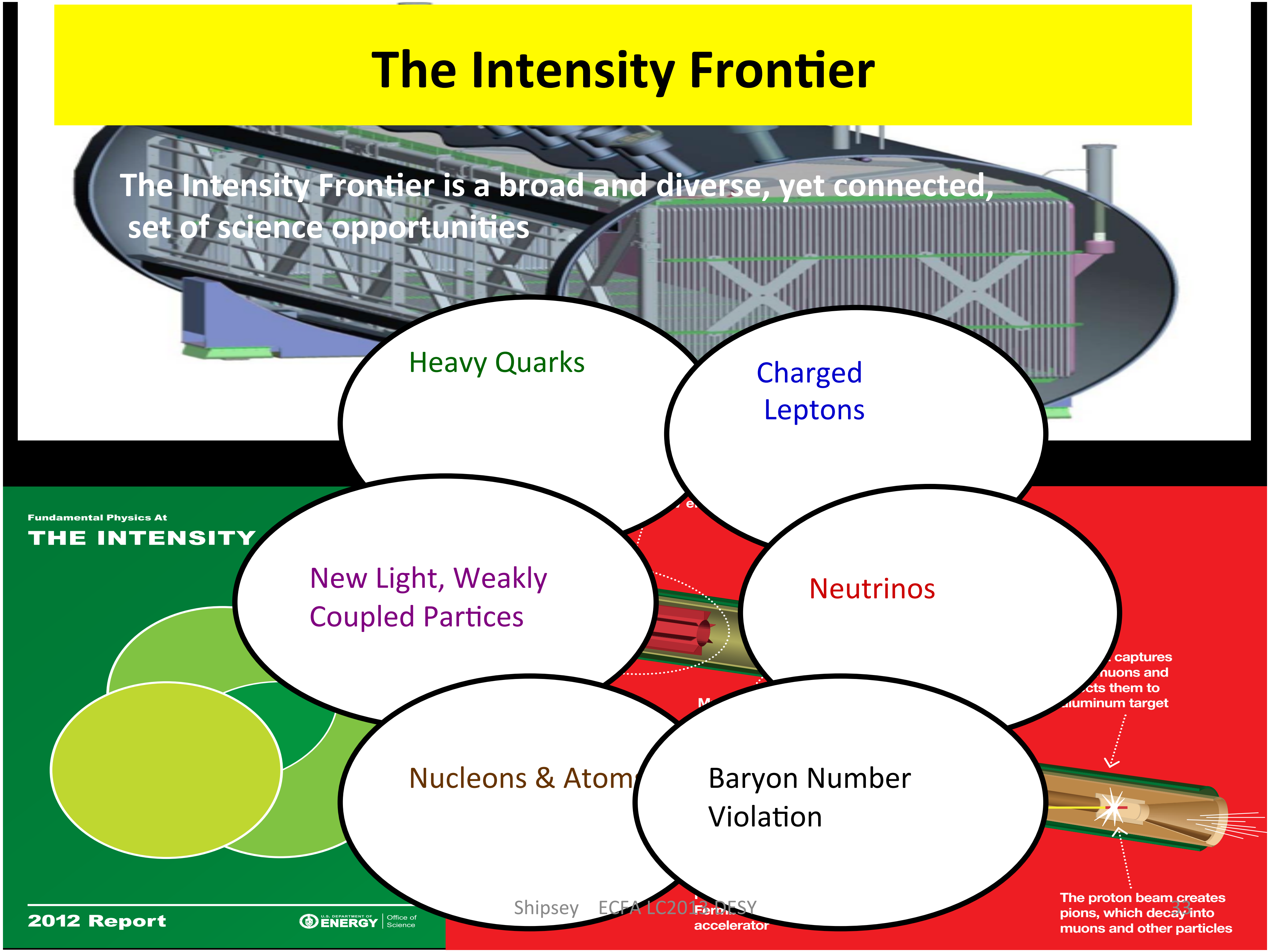
Charged Leptons

New Light, Weakly Coupled Partices

Neutrinos

Nucleons & Atoms

Baryon Number Violation



Intensity Frontier subgroups

- IF1: Quark Flavor Physics (Joel Butler, Zoltan Ligeti, Jack Ritchie)
- IF2: Charged Lepton Processes (Brendan Casey, Yuval Grossman, David Hitlin)
- IF3: Neutrinos (Andre deGouvea, Kevin Pitts, Kate Scholberg, Sam Zeller)
- IF4: Baryon Number Violation (K.S. Babu, Ed Kearns)
- IF5: New Light, Weakly Coupled particles (Rouven Essig, John Jaros, William Wester)
- IF6: Nucleons, Nuclei and Atoms (Krishna Kumar, Zheng-Tian Lu, Michael Ramsey-Musolf)
- IF/Capabilities liasons: Gil Gilchriese, Bob Tschirhart
- IF/Instrumentation liaisons see: Instrumentation Matrix
- IF/Computing liaisons see: Computing Frontier E3

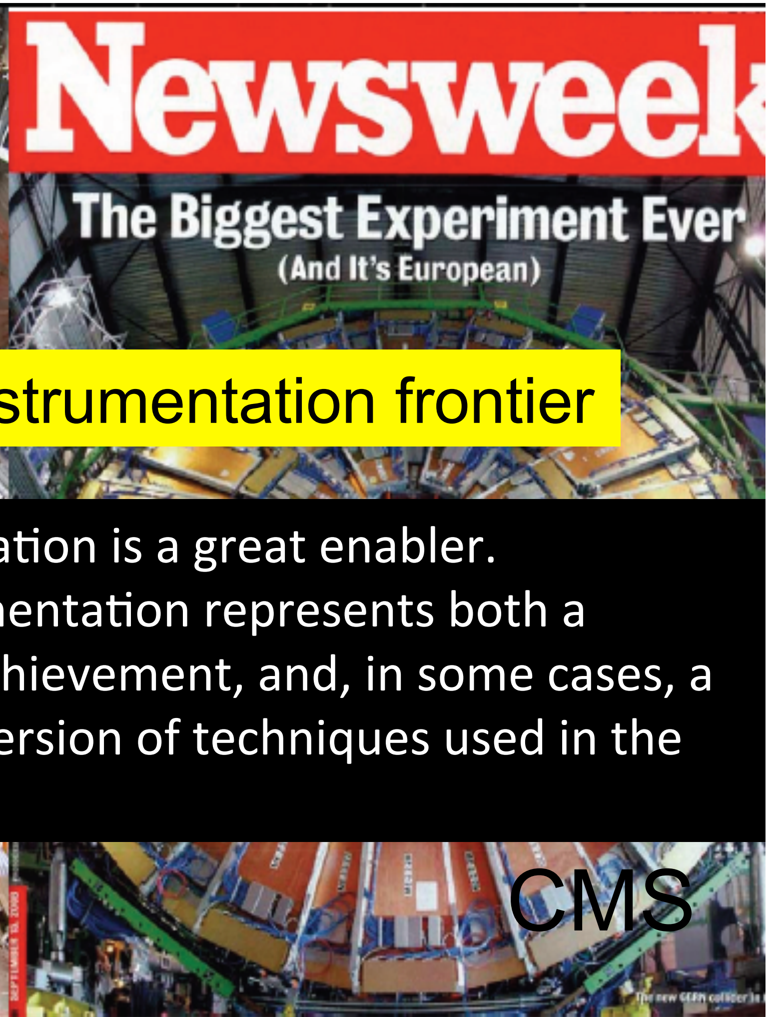
The Instrumentation Frontier

"New directions in science are launched by new tools much more often than by new concepts.

The effect of a concept-driven revolution is to explain old things in new ways. The effect of a tool-driven revolution is to discover new things that have to be explained"

Freeman Dyson

Object	Weight (tons)
Boeing 747 [fully loaded]	200
Endeavor space shuttle	368
ATLAS	7,000
Eiffel Tower	7,300
USS John McCain	8,300
CMS	12,500



Instrumentation frontier

Instrumentation is a great enabler.
Our instrumentation represents both a towering achievement, and, in some cases, a scaled-up version of techniques used in the past.

CMS

Instrumentation triumph

ATLAS

DIGITAL CAMERAS THE SIZE OF CATHEDRALS

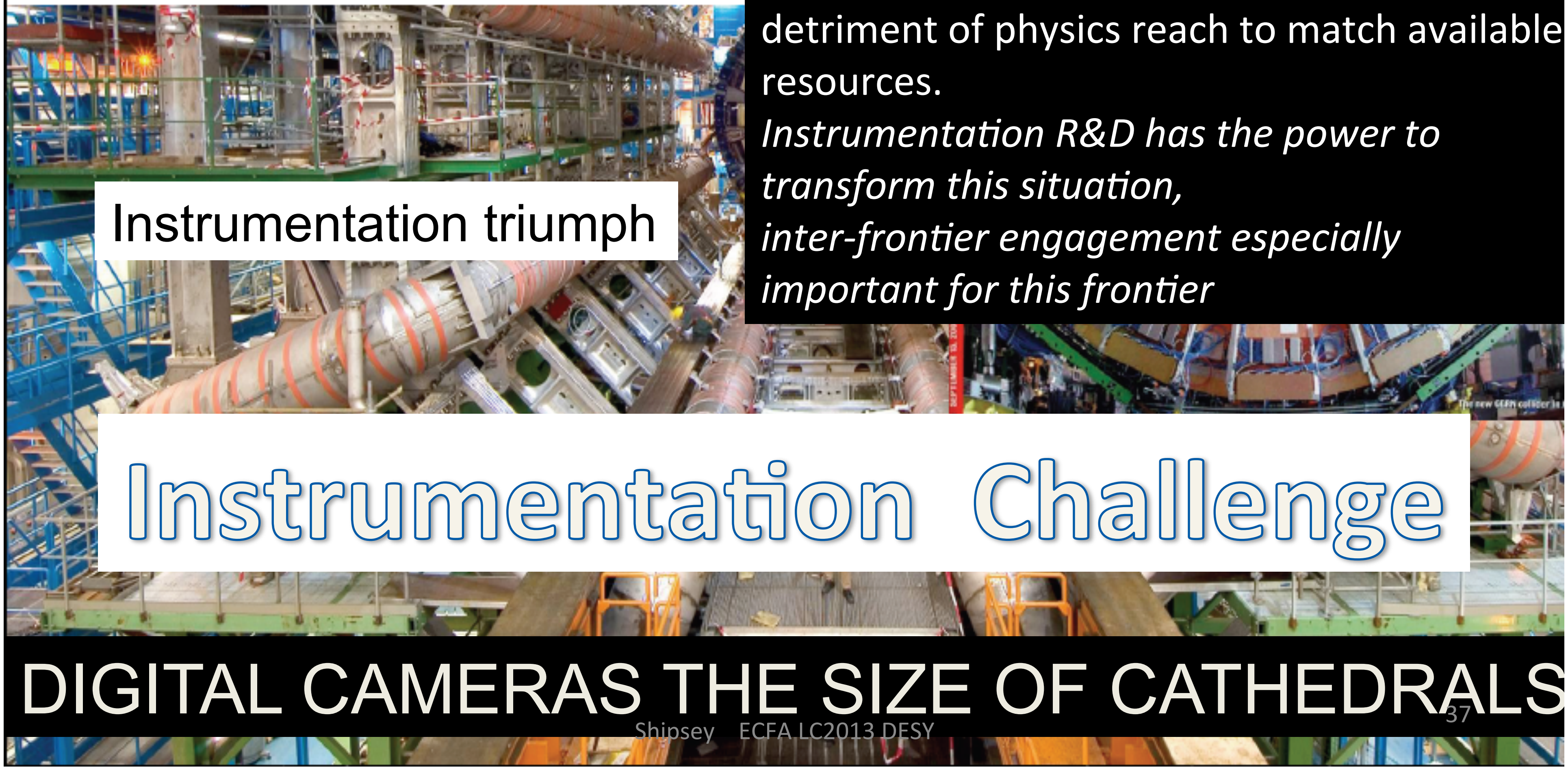
Object	Weight (tons)
Boeing 747 [fully loaded]	200
Endeavor space shuttle	368
ATLAS	7,000
Eiffel Tower	7,300
USS John McCain	8,300
CMS	12,500

CMS

Many experiments are large and have high costs resulting in major de-scoping of detectors and their capabilities to the detriment of physics reach to match available resources.

Instrumentation R&D has the power to transform this situation,

inter-frontier engagement especially important for this frontier



Instrumentation triumph

Instrumentation Challenge

DIGITAL CAMERAS THE SIZE OF CATHEDRALS

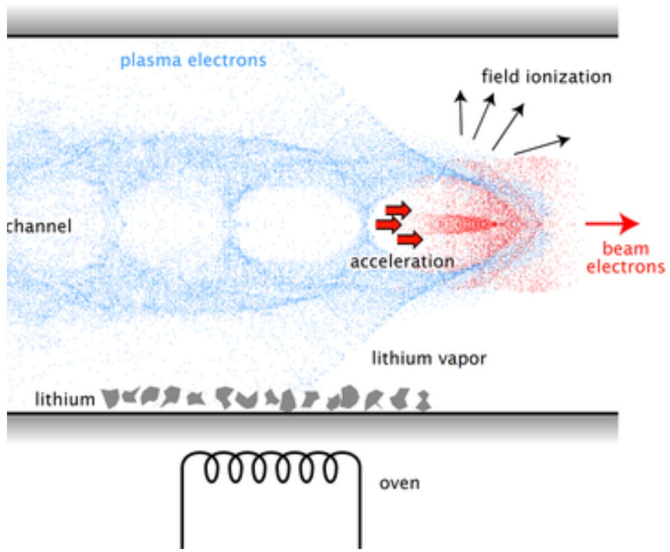
Instrumentation Frontier

In preparation for the Snowmass meeting, the Instrumentation Frontier has currently organized itself into a matrix of technologies and physics and facility frontiers. In order to facilitate the process and arrive at a complete overview of the field, liaisons have been identified for each intersection of technology and physics frontier. The current formulation of the matrix is given below.

Technologies	Energy Frontier	Intensity Frontier	Cosmic Frontier
	Ulrich Heintz	*David Lissauer*	*Juan Estrada*
Sensors *Marina Artuso* *Abe Seiden*	*Daniela Bortoletto (Purdue)* *Sally Seidel (New Mexico)* *Ren-yuan Zhu (Caltech)*	*Matt Wetstein (Chicago)* *Henry Frisch (Chicago)* *J. Va'vra (SLAC)*	*Andrei Nomerotksi (BNL)* *Clarence Chang (Chicago)* *Jim Fast (PNNL)*
Gaseous Detectors *Gil Gilchriese* *Bob Wagner*	*Andy White (UTA)* *Marcus Hohlmann (FIT)* *Vinnie Polychronakos (BNL)*	*James White (Texas A&M)* *Brendan Casey (FNAL)*	
Detector Systems *Ed Blucher* *David Lissauer*	*Roger Rusack (Minnesota)* *Adam Para (FNAL)*	*Bonnie Fleming (Yale)* *Bob Svoboda (UC Davis)*	*Karen Byrum (ANL)* *Peter Gorham (Hawaii)* *David Nygren (LBL)* *Dan Akerib (Case Western)* *Greg Tarle (Michigan)*
Electronics/DAQ/Trigger *Ulrich Heintz* *Ron Lipton*	*Dong Su (SLAC)* *Wesley Smith (Wisconsin)* *Maurice Garcia-Sciveres (LBNL)*	*Gary Varner (Hawaii)* *Yau Wah (Chicago)*	*Günther Haller (SLAC)* *Frank Krennrich (Iowa State)*
Novel/Emerging Technologies *Jim Alexander* *David MacFarlane*	*Ted Liu (FNAL)* *Julia Thom (Cornell)*	*Steve Ahlen (BU)*	*Juan Estrada (FNAL)*
Software *Norman Graf*	*Erich Varnes (Arizona)*	*Robert Kutschke (FNAL)*	*Salman Habib (ANL)*
Facilities	*Carsten Hast (SLAC)*	*Jae Yu (UTA)*	*Erik Ramberg (FNAL)*

Facilities and Capabilities: Accelerator frontier

- *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 accelerators be made 10x cheaper per GeV? Per MW?*
- *Can plasma accelerators deliver luminosity relevant to HEP?*



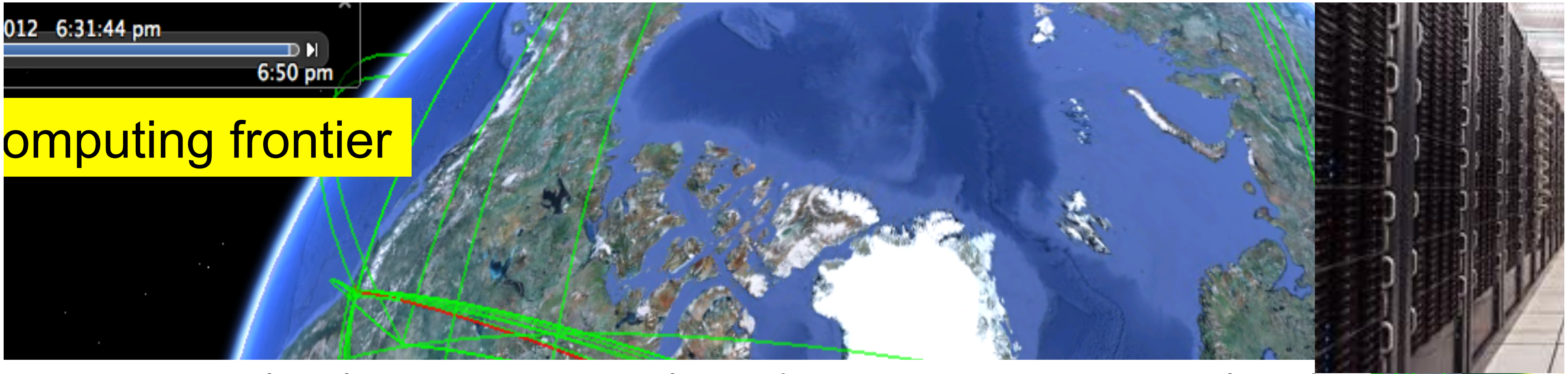
Facilities & Capabilities Frontier

THE SIX ACCELERATOR CAPABILITY AREAS:

1. Energy Frontier Hadron Colliders
2. Energy Frontier Lepton and Gamma Colliders
3. High Intensity Secondary Beams Driven by Protons
4. High Intensity Electron and Photon Beams
5. Electron-ion Colliders
6. Accelerator Technology Testbeds and Test Beams

THE NON-ACCELERATOR FACILITIES AREAS:

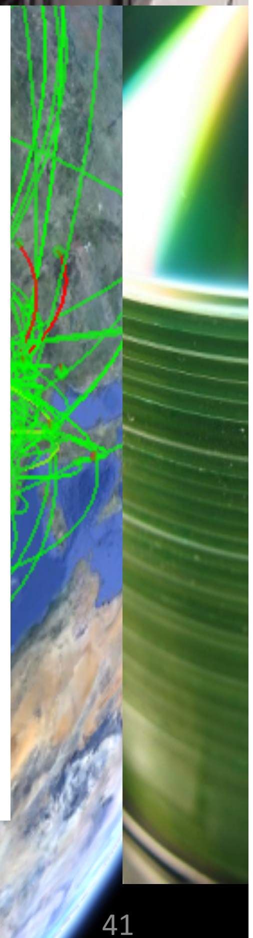
1. NAF1 – on underground facilities to support very large detectors for neutrino physics, proton decay and other science requiring detectors of the multi-kiloton scale.?
2. NAF2 – on underground facilities for dark matter experiments, neutrinoless double beta decay experiments, underground accelerators for nuclear astrophysics, low background assay of materials and related topics.?

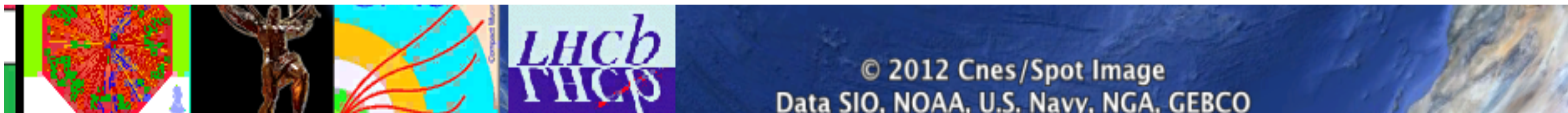


omputing frontier

Computing has become essential to advances in experimental and many areas of theoretical physics. Research requirements in these areas have led to advances in computational capabilities.

- What are the computational requirements for carrying out the experiments that will lead to advances in our physics understanding?
- What are the computational requirements for theoretical computations and simulations that will lead to advances in our physics understanding?
- What facility and software infrastructure must be in place in order to meet these requirements, and what research investments does it require in computing, storage, networking, application frameworks, algorithms, programming, etc. to provide that infrastructure?
- What are the training requirements to assure that personnel are available to meet the needs?



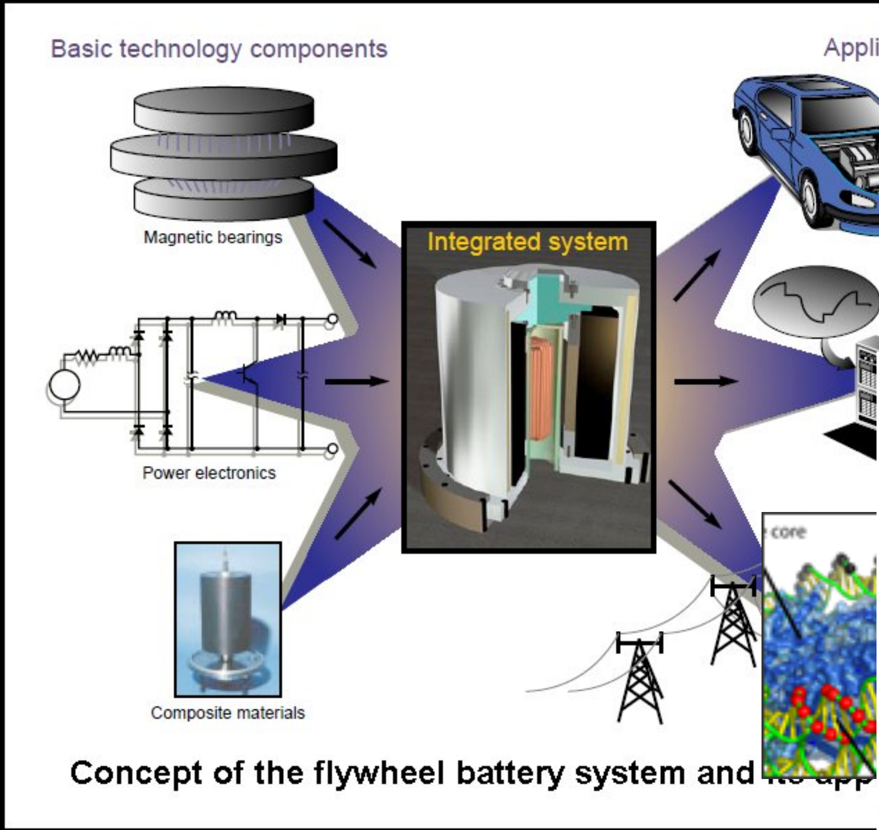


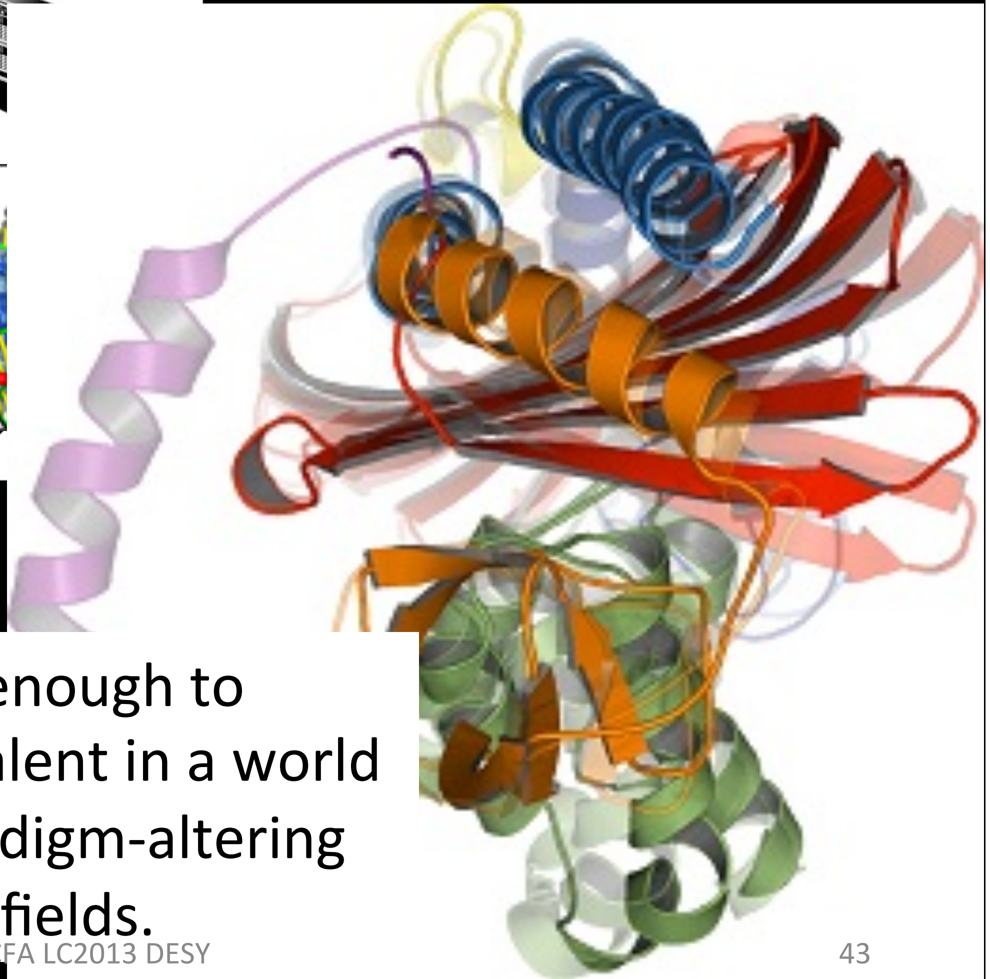
Computing Frontier

At the top level, the Computing Frontier is divide into User Needs and Infrastructure Issues. There are three experimental user needs subgroups and four for theory. Five subgroups are planned for infrastructure.

User needs:
CpF E1: Cosmic Frontier
CpF E2: Energy Frontier
CpF E3: Intensity Frontier
CpF T1: Accelerator Science
CpF T2: Astrophysics and Cosmology
CpF T3: Lattice Field Theory
CpF T4: Perturbative QCD

Infrastructure issues:
CpF I1: Computing, including special purpose hardware
CpF I2: Distributed Computing and Facility Infrastructures
CpF I3: Networking
CpF I4: Software Development, Personnel, Training
CpF I5: Data Management and Storage

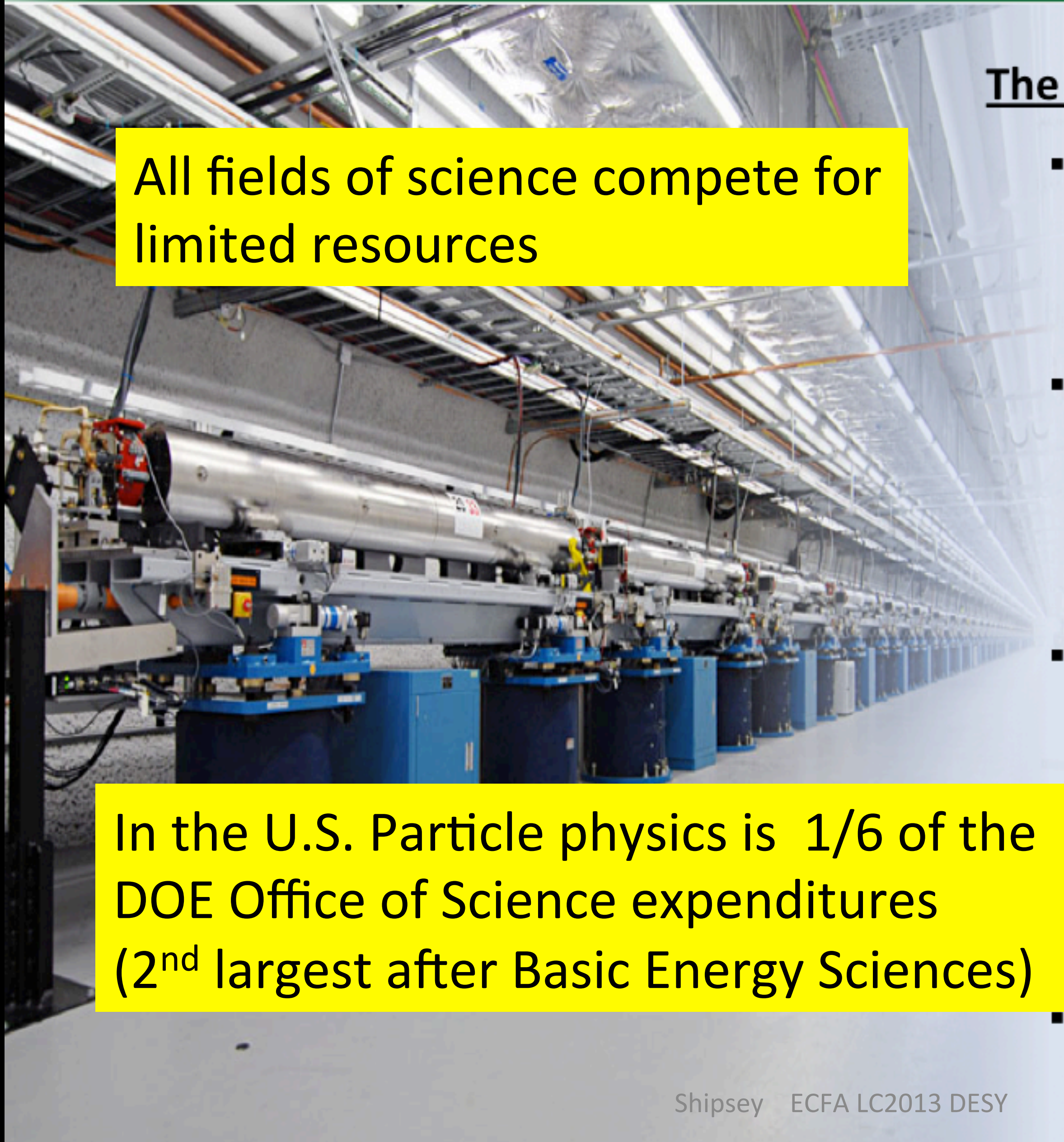




Our science must be compelling enough to compete favorably for the best talent in a world where transformational and paradigm-altering advances are happening in other fields.

Office of Science

Science to Meet the Nation's Challenges Today and into the 21st Century



All fields of science compete for limited resources

In the U.S. Particle physics is 1/6 of the DOE Office of Science expenditures (2nd largest after Basic Energy Sciences)

The Frontiers of Science

- Supporting research that led to over **100** Nobel Prizes during the past **6** decades—more than **20** in the past **10** years
- Providing **45%** of Federal support of basic research in the physical and energy related sciences and key components of the Nation's basic research in biology and computing
- Supporting over **25,000** Ph.D. scientists, graduate students, undergraduates, engineers, and support staff at more than **300** institutions

Century Tools of Science

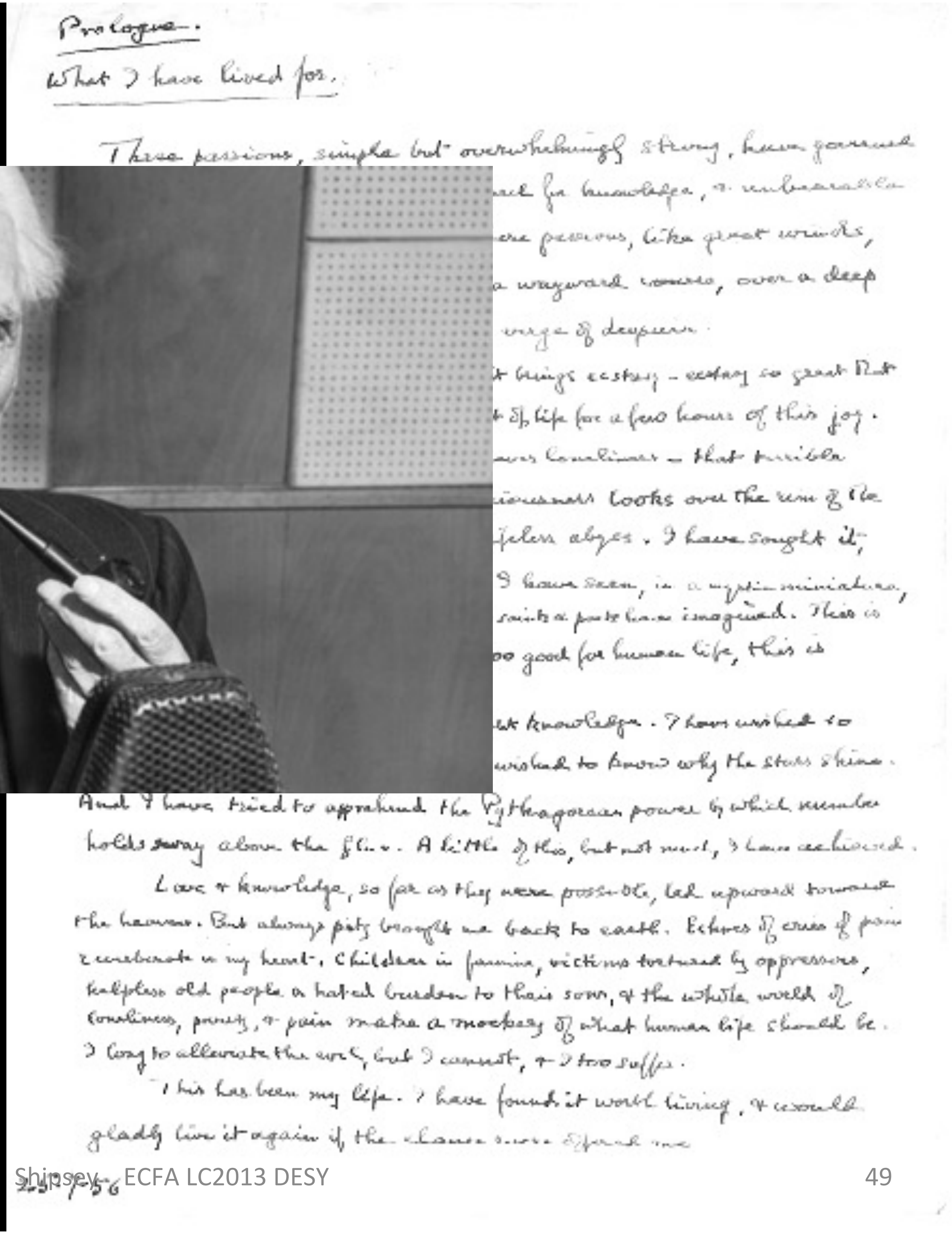
- Providing the world's largest collection of scientific user facilities to over **26,500** users each year

There is no entitlement for particle physics funding.

We must compete favorably with other opportunities on all the playing fields: in the agencies in Congress

and in academia.

We need to see our science as compelling and we need to convince others it is compelling as well.



Prologue.

What I have lived for.

Three passions, simple but overwhelmingly strong, have governed

for knowledge, & unbearable

passions, like great winds,

a wayward course, over a deep

verge of despair.

brings ecstasy – ecstasy so great that

of life for a few hours of this joy.

loneliness – that terrible

ciousness looks over the rim of the

feless abyss. I have sought it,

I have seen, in a mystic miniature,

saints & poets have imagined. This is

oo good for human life, this is

knowledge. I have wished to

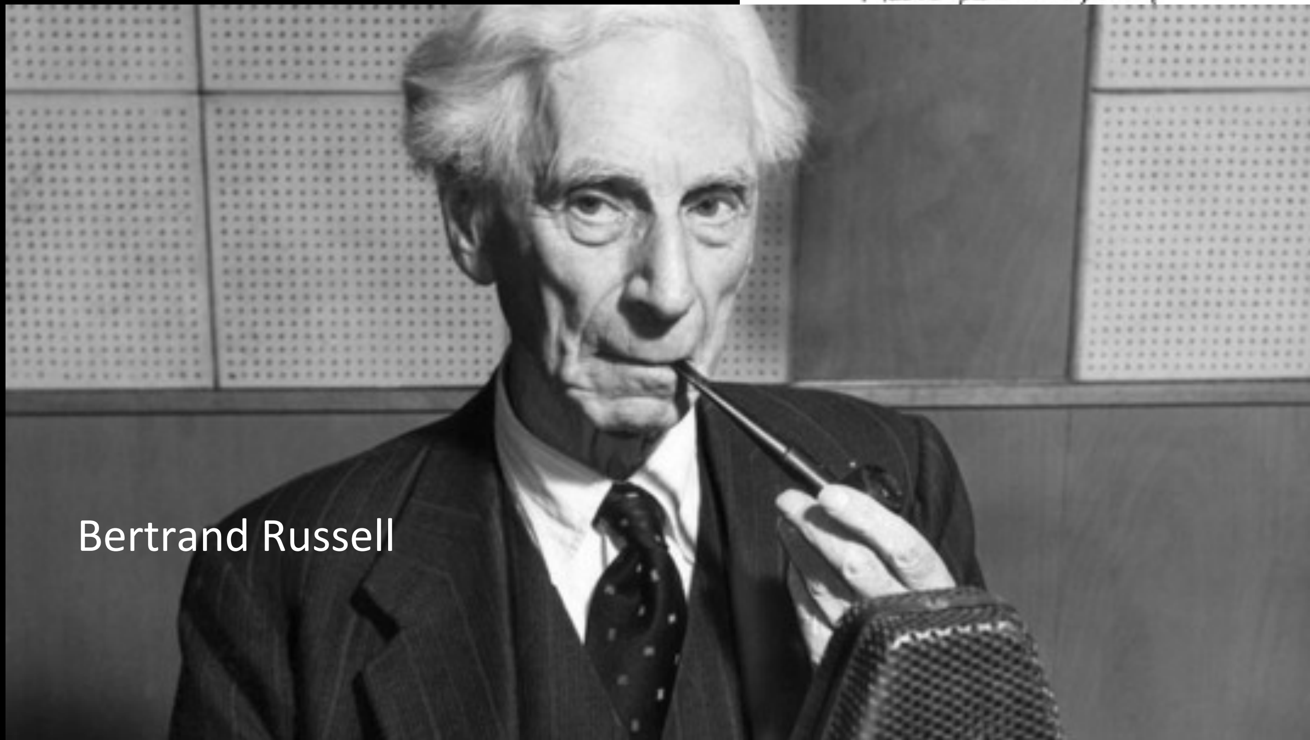
wished to know why the stars shine.

And I have tried to apprehend the Pythagorean power by which number holds sway above the flux. A little of this, but not much, I have achieved.

Love & knowledge, so far as they were possible, led upward towards the heavens. But always pity brought me back to earth. Echoes of cries of pain reverberate in my heart. Children in famine, victims tortured by oppressors, helpless old people a hated burden to their sons, & the whole world of loneliness, poverty, & pain make a mockery of what human life should be. I long to alleviate the evil, but I cannot, & I too suffer.

This has been my life. I have found it worth living, & would gladly live it again if the chance were offered me

25.7.56



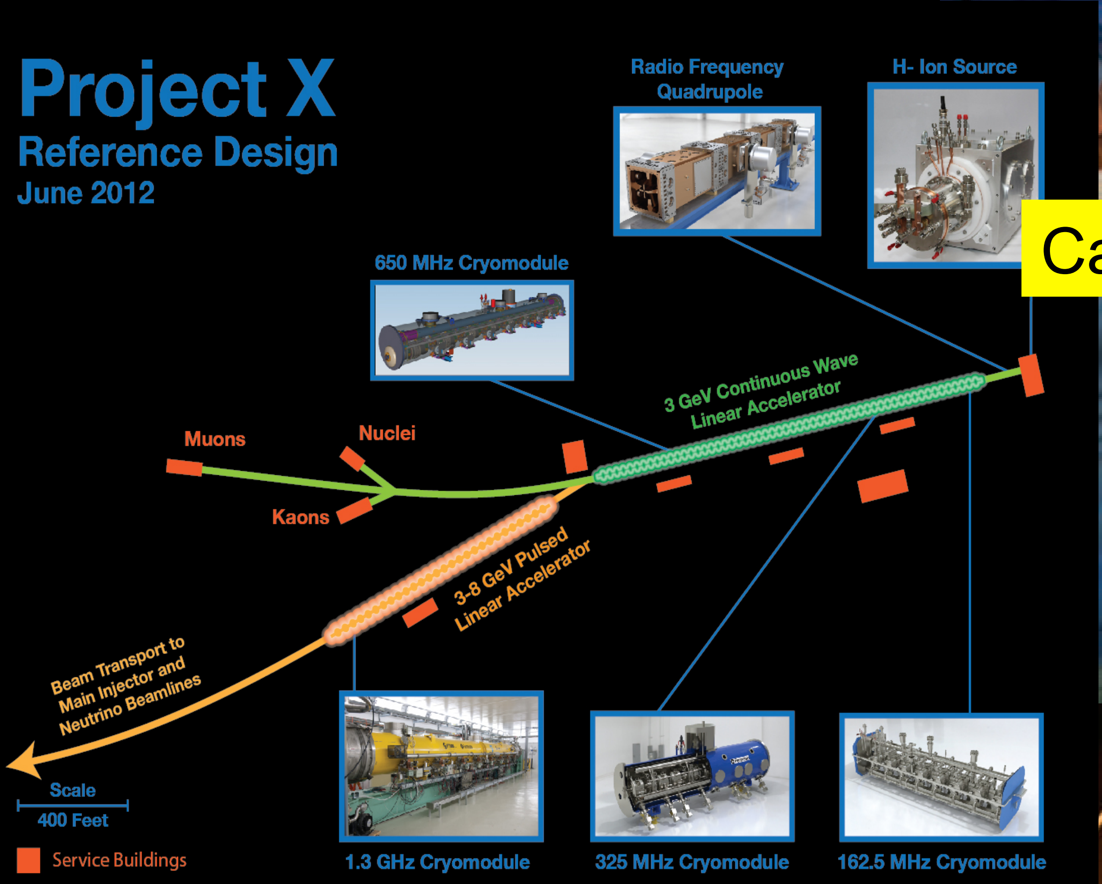
We need to do that clearly, and articulately.

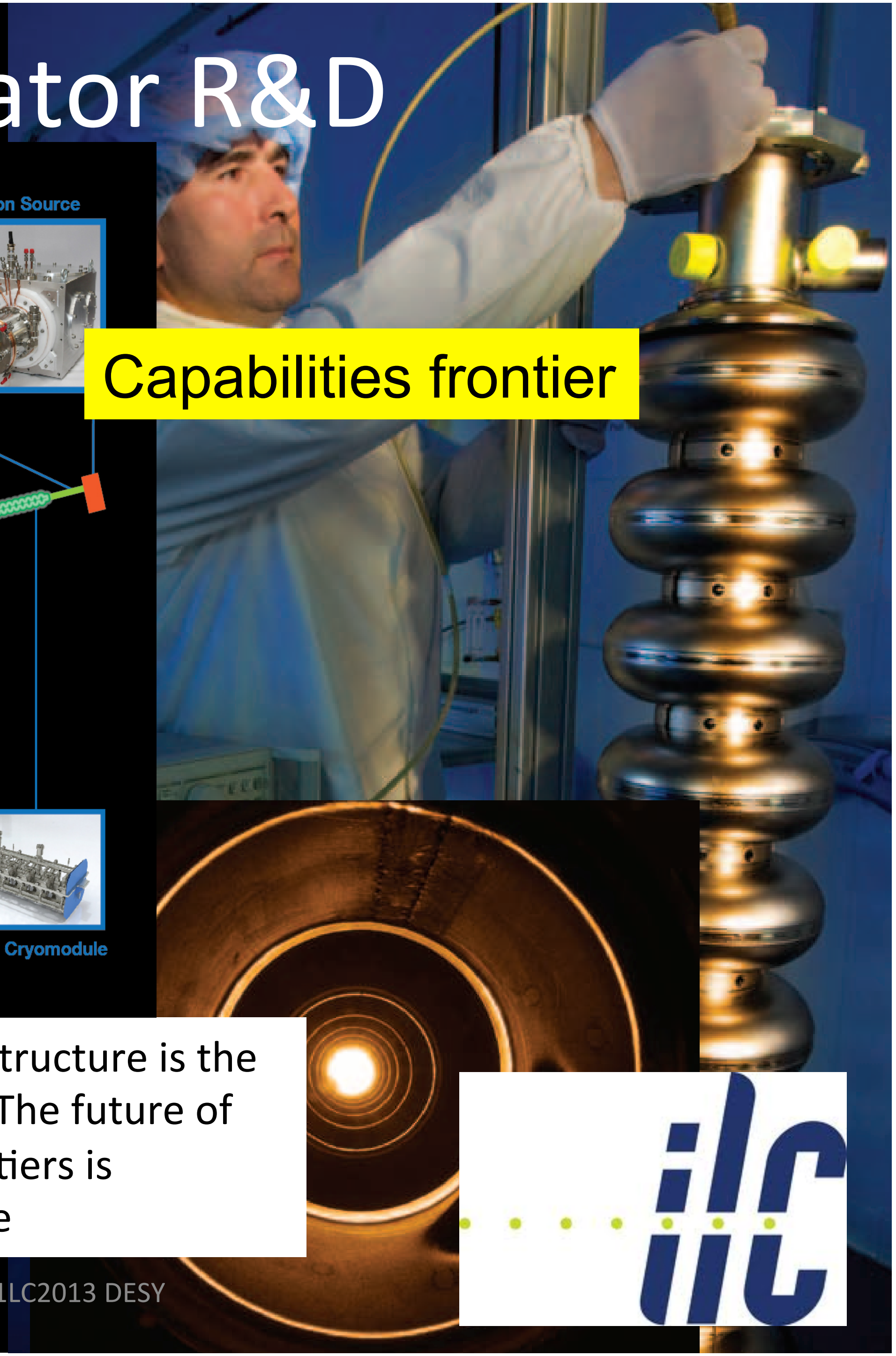

Wilson Hall, inspired by a Gothic cathedral in Beauvais, France, is the focal point for administrative and scientific activity at Fermilab.

Our big science with big tools requires the infrastructure to support the development of those tools for today and for the future in the US and to contribute to international projects

In the U.S. FNAL, ANL, BNL, LBNL, SLAC.

Accelerator R&D

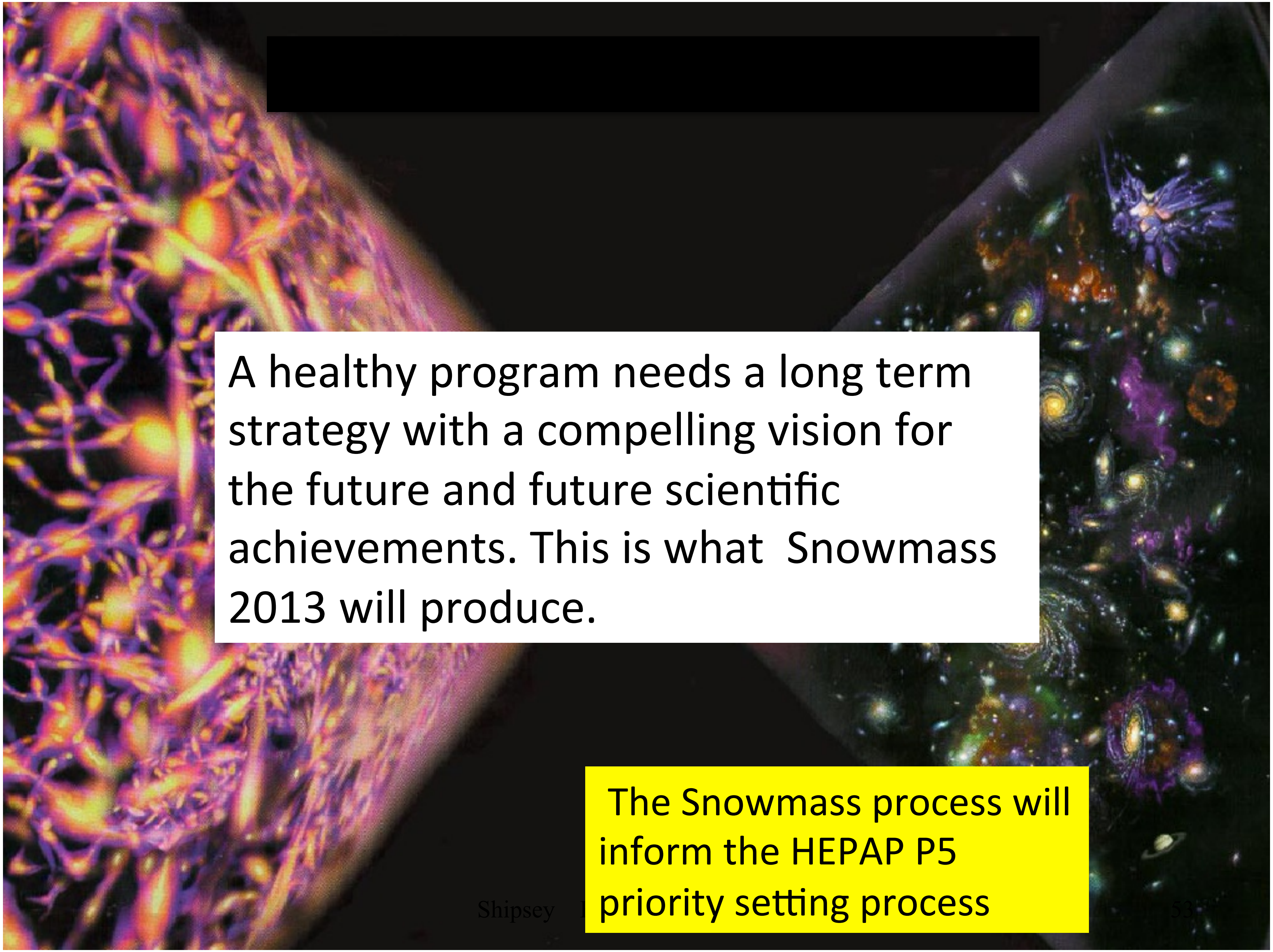




Intimately related to the need for healthy infrastructure is the need for a strong program in accelerator R&D. The future of particle physics at the energy and intensity frontiers is dependent on innovations in accelerator science

Given the global nature of our field, our long term strategy has to maintain an international perspective, and strong international partnerships will be crucial to our future health.

[redacted]



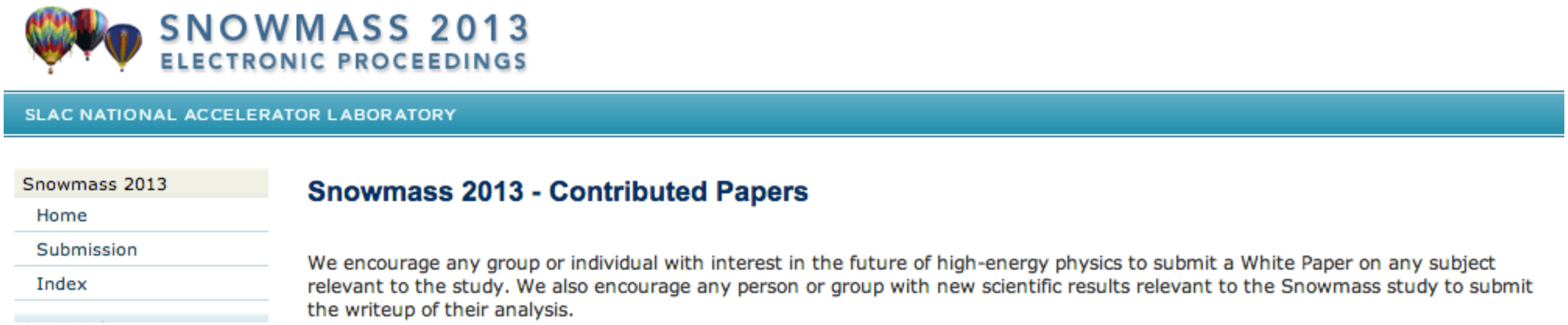
A healthy program needs a long term strategy with a compelling vision for the future and future scientific achievements. This is what Snowmass 2013 will produce.

The Snowmass process will inform the HEPAP P5 priority setting process

Snowmass proceedings

Snowmass proceedings consist of two parts the contributions from the community (white papers on the arXiv) this slide
& summaries of frontiers and subgroups written by conveners next slide

- https://www-public.slac.stanford.edu/snowmass2013/



- Submit to the arXiv
- Register @ Snowmass proceedings site and link arXiv number
- Revisions handled through the arXiv
- Deadline for contributions: 30 Sep, 2013

Summaries of Frontiers & subgroups written by conveners

Time line

Each subgroup in each frontier will produce 30-50 page subgroup write-up — Draft by July 1

Each subgroup in each frontier will also produce a 5-6 page subgroup summary — Draft by start of Snowmass

Each frontier will combine subgroup summaries into ~30 page frontier write-up — Draft by start of Snowmass

Each frontier will also produce a 5-6 page frontier summary – base for final summary — Draft by end of Snowmass

The "Snowmass book" will consist of:

The 7 frontier summaries (~7x30 pages)
Overall summary (based on frontier summaries) — Draft by end of Snowmass + few days

Present at DPF2013 August Conference

Frontier summaries in final from Nov 30
Snowmass Book end 2013

Draft Block Program for the 9 days of Snowmass

Time	29 July	30 July	31 July	1 Aug	2 Aug	3 Aug	4 Aug	5 Aug	6 Aug
morning	Grand Plenaries	**Subgroup Parallel Sessions and Joint Parallel Sessions**						Grand Plenaries	
early afternoon		**Subgroup Parallel Sessions and Joint Parallel Sessions**							
late afternoon		Grand Plenary Sessions and Discussions							
evening		**Parallel DISCUSSIONS**							

Detailed Schedule is under development

1st Day (July 29)

Plenary Sessions in Mann Hall

Start Time	Topic
8:30 AM	Welcome from U Minn.
8:40 AM	Introduction, Welcome, and Organization from DPF
8:50 AM	Energy Frontier
9:50 AM	Computing Frontier
10:25 AM	Coffee
10:55 AM	Intensity Frontier
12:00 PM	Lunch
2:00 PM	Instrumentation Frontier
2:35 PM	Cosmic Frontier
3:35 PM	Coffee
4:05 PM	Outreach
4:40 PM	Capabilities Frontier
5:30 PM	View from DOE
6:00 PM	View from NSF
6:30 PM	Adjourn

Status of the frontiers after 9 months of work

Days 2-7

To facilitate inter-frontier dialogue each frontier has prepared questions for other frontiers, these require significant work to answer they are a topic for joint frontier meetings at Minnesota some examples from the dozens of questions:

EF-IF: It is especially interesting in studies of rare processes for a discovery of a new physics effect beyond the Standard Model to point to a mass scale that would be the basis for a future accelerator search for new particles. What are the most important rare processes that have the potential to point to a specific mass scale, and how specific can their information be?

EF-IF: What is the impact of measurements of direct CP violation in charm decay on the search for new physics? In what processes is the Standard Model prediction sufficiently well understood, including perturbative and nonperturbative effects, to allow a strong conclusion of a deviation from the Standard Model?

EF-InstF: In the context of proposals of large tunnels that could host both pp and e+e- colliders, it is interesting to ask whether it is possible to design 4 pi detectors that can be used both for pp and e+e- experiments (perhaps with some interchangable inner tracking layers). Is there an optimal design of such a multi-purpose detector? What are the most important compromises required?

EF-CF: Suppose there is a 10 GeV WIMP or a 100 GeV WIMP with direct detection cross section just below current limits. This is the best case for understanding the particle nature of the dark matter. What is the full set of measurements that we are likely to make on such a particle from Cosmic Frontier probes alone?

Days 2-7

Proposed inter-frontier sessions for days 2 -7

Naturalness Dark Matter Lepton Flavour Violation

1. Naturalness -- The strongest argument for new particles at the TeV scale is that they are needed to provide a "natural" explanation for electroweak symmetry breaking. But some people are now saying that LHC exclusions or flavor bounds are inconsistent with naturalness. What is the real situation? To what extent have we excluded naturalness of the electroweak scale? Is it possible to fully exclude naturalness by proposed experiments and, if so, how? Is there an alternative to naturalness to estimate the scale of new physics? (needs input from IF and CF)

2. Dark Matter -- Review the various approaches to dark matter particle detection, including direct searches for new particles at colliders. Compare the advantages, disadvantages, and complementarity of the various methods. How does the sensitivity to models of new physics from astrophysical dark matter searches compare to that from direct searches at colliders? Do the times scales for discovery match? What can each method tell us about the quantum numbers and interactions of the dark matter particle? (needs to be organized with CF).

3. Lepton Flavor Violation -- what new physics models will be accessed by mu-e conversion, mu-> e gamma, and tau-> ell gamma experiments now being planned? How does the sensitivity to these models compare to that from direct collider searches? Do the times scales for discovery match? Are there collider observables sensitive to the neutrino mixing angles? (needs to be organized with IF)

Days 2-7

The Energy Frontier has proposed sessions for days 4 -9

Quark mixing and flavour violation   Future of the Higgs
Future fo the top quark

4. Quark Mixing and Quark Flavor -- What new physics models will be accessed by future measurements of B, D, and K weak decays, either from improved precision or from new observables? How does the sensitivity to these models compare to that from direct collider searches? Do the times scales for discovery match? Are there new sources of flavor mixing beyond the CKM angles that might show up either in low-energy or in high-energy measurements? (needs to be organized with IF)

5. Future of the Higgs -- What are examples of models that predict deviations from the Standard Model in the Higgs couplings, and at what levels? How far have current measurements constrained this model space? What is the interplay between Higgs coupling measurement and searches for new particles? What should be the goal in precision Higgs measurement?

6. Future of the Top Quark -- To what extent have we tested the statement that the couplings of the top quark agree with the Standard Model? What models of new physics predict variations in the top quark couplings that will be visible when we achieve a higher level of precision? What is the interplay between measurement of top quark couplings and searches for new particles? The top quark mass is an important parameter for many purposes; how accurately must it be measured, and how can that be accomplished? (need input from IF)

Days 2-7

The Energy Frontier has proposed sessions for days 2 -7

Future Precision Electroweak Instrumentation (Hadron Colliders)

7. Future of Precision Electroweak -- How will the precision tests of the electroweak interactions improve in the coming generation of experiments, both from improved measurements at high energy and from lower energy probes such as Moller scattering and Atomic Parity Violation? What are the achievable accuracies on mW, mZ, alpha, alpha_s, sin2thetaw, etc.? What accuracies are needed to test predictions of new physics models? What is the interplay of precision measurement with measurements of W boson scattering? What is the interplay between precision electroweak measurements and precision Higgs boson measurements?

8. Instrumentation for High-Luminosity Hadron Colliders -- High energy hadron colliders face serious experimental problems, especially in event reconstruction in the presence of high pileup. What new technologies are emerging to confront the problems of triggering, heavy flavor ID, and precision tracking and calorimetry in this environment. How do the specifications of these technologies align with the requirements for physics measurements? (needs to be organized with InstF)

Days 2-7

The Energy Frontier has proposed sessions for days 2 -7

Instrumentation (Lepton Colliders)   Beyond the Terascale

9. Instrumentation for Future Lepton Colliders -- Future lepton colliders present a mixture of opportunities and challenges for particle experimentation. At large angles, ILC offers a very low-background experimental environment, while linear colliders detectors at small angles and muon collider detectors must deal with very large background rates. These features of future lepton colliders have spurred the development of new technologies, including, on the one hand, silicon detectors with minimal material and energy flow calorimetry at the level of single particle sensitivity and, on the other hand, trackers and calorimeters with nanosecond time windows. What is the range of such future detector technologies, and how do the proposed solutions match the needs from the physics? (needs to be organized with InstF)

10. Beyond the Terascale -- What are the most important elements of the case for hadron colliders at 30-100 TeV and lepton colliders at 3-10 TeV? What sorts of particles or phenomena will we be searching for at such energies? What are the requirements from the physics on collider parameters and on experimental design? (needs to be organized with Capabilities, and with input from InstF)

8th Day (August 5)

Start Time	Topic
8:30 AM	Introduction, Welcome, and Organization
8:40 AM	Intensity Frontier
9:45 AM	Computing Frontier
10:35 AM	Coffee
11:05 AM	Cosmic Frontier
12:10 PM	Lunch
2:10 PM	Outreach
3:00 PM	Instrumentation Frontier
3:50 PM	Coffee
4:20 PM	DPF and DNP Overlap
5:00 PM	Capabilties Frontier
5:50 PM	Adjourn

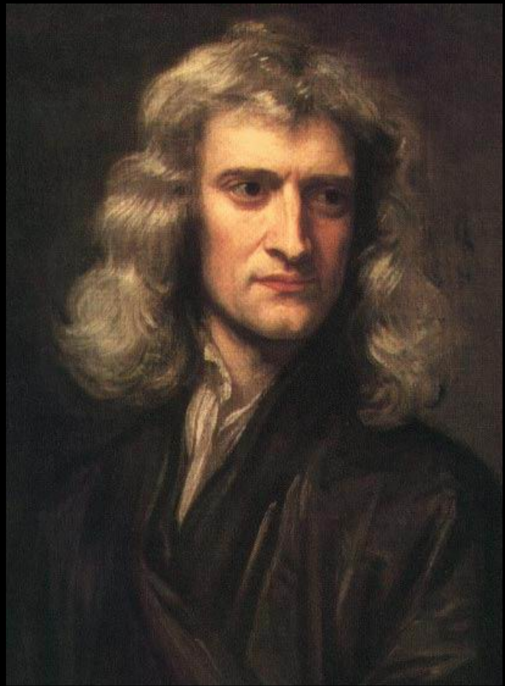
Summary by frontier
of findings and conclusions
for Snowmass Proceedings

9th Day (August 6)

Start Time	Topic
9:00 AM	Energy Frontier
10:05 AM	View from Europe
10:40 AM	View from Japan
11:15 AM	Coffee
11:45 AM	Panel: Physics Horizons
12:15 PM	Panel: Technical Horizons
12:45 PM	Summary from DPF Chair
1:00 PM	Adjourn

Findings & conclusions in bullet form are presented
To the wider community at the first two days of DPF2013
August 13-17 2013 @ Santa Cruz

Registration is open
http://www.hep.umn.edu/css2013/



“What we know is a droplet, what we don’t know is an Ocean”

Sir Isaac Newton (1643-1727)

Courtesy T. Virdee

The Division of Particles and Fields of the American Physical Society would like to thank

Conveners

Energy Frontier: Chip Brock, Michael Peskin

Intensity Frontier: JoAnne Hewett, Harry Weerts

Cosmic Frontier: Jonathan Feng, Steve Ritz

Capabilities: William Barletta, Murdock Gilchriese

Instrumentation: Marcel Demarteau, Ron Lipton, Howard Nicholson

Computing: Lothar Bauerdick, Steve Gottlieb

Education and Outreach: Marge Bardeen, Dan Cronin-Hennessy

And a cast of >1,000
Colleagues in the U.S. and around the globe
making the studies
making the calculations
and daring to dream

Additional Material

Customized Implementation Strategies

- **Energy Frontier**
  - US has a leading role in LHC physics collaborations but is not the **driver**
    - The issue is the scope and scale of US involvement. Requires US-CERN negotiation.
    - Could also be true for JILC but requires *deus ex machina*
- **Intensity Frontier**
  - US is a (the?) world leader and needs new facilities and/or upgrades of existing facilities to maintain its position
    - Has the potential to attract new partners to US-led projects if we can get going
    - Portfolio of experiments and science case is diverse. This is not a plus.
    - The scale of the projected investments is a big challenge
- **Cosmic Frontier**
  - US HEP has a leading role in a competitive, multidisciplinary environment
    - Technologies are diverse but HEP physics case is simple and compelling. Only question is how far one needs to go in precision/setting limits.
    - DOE is a technology enabler, not a facilities provider (see NSF, NASA)
      - Analogous to LHC but the HEP physics goals are not those of the facility owners
    - DOE supports particle physics goals and HEP-style collaborations
      - Astronomy and astrophysics is not in our mission nor our *modus operandi*

CSS2013 Outcomes and Boundary Conditions

Siegrist & DPF

- In general, we would like from the study process a community consensus on a 'situation analysis' for each major subsection of our field.
  - What are our current strengths and capabilities, and what are the opportunities we face.
- The 'situation analysis' can be accompanied by a 'decision tree' that summarizes a range of future options, depending on what current experiments do or do not find.
  - This is very helpful to understand what we need to do in order to be able to make certain decisions (e.g., await some new physics results? Technology demonstration? Etc.)
  - The analysis also needs to quantify how accurately various measurements need to made in order to advance the field ("more precise is better" is not good enough)
- Some opportunities may be too poorly defined to allow a major investment at this time, but need further exploration.
  - We refer to 'pilot studies' being needed to explore these areas in advance of approval of DOE Mission Need.

Boundary Conditions

Siegrist & DPF

- Note that a 'brute force' approach that seeks to spend vast sums in order to build some facility/physics capability simply will not work in today's fiscal environment. This has been empirically demonstrated.
  - Most recently, via our discussions on LBNE, we have confirmed that single domestic project expenditures must be somewhat smaller than $1B per stage.
- CSS2013 participants are encouraged to think about whatever physics you think is most relevant and important to progress in HEP, but the effort you put in should be tempered with a realistic assessment of funding possibilities.
  - Many ideas can be staged to provide new physics capability at each step, but some cannot.
- Stringing together projects that build upon previous investments either scientifically or through recycling of infrastructure is generally well received.

High Energy Frontier

In addition, we have to be aware of the community goals:

I. Present our case to our HEP colleagues

II. Justify our ambitions to government

III. Explain our goals to scientists in other fields and to the general public

These require:

A clear expression of why we do what we do.

"Discovery stories" :

Concrete illustrations of discoveries that could take place before 2020,
and the experiments that would pursue the new direction that is opened

White paper on US participation in global projects

Instrumentation Challenge

LHC data
October, 2011

Instrumentation is the great enabler of science both pure and applied. Instrumentation is critical to the mission of High Energy Physics, which is to explore the fundamental nature of energy, matter, space and time. Our field is embarking on a new golden age of discovery with the recent turn-on of the LHC, and with new experiments being planned at proposed new accelerators, deep underground, at the South Pole, and in space that together have the potential to reveal the origin of mass, explain the matter anti-matter asymmetry of the universe, search for extra spatial dimensions, determine the nature of dark matter and dark energy, and may probe the Planck scale. For the very first time we may come to know how our universe was born, how it will evolve, and how it will end. its ultimate fate.

Education and Outreach Frontier

- EO1: The General Public
- EO2: Policy Makers and Opinion Leaders
- EO3: The Science Community
- EO4: Teachers - grades 5-16
- EO5: Students - grades 5-16

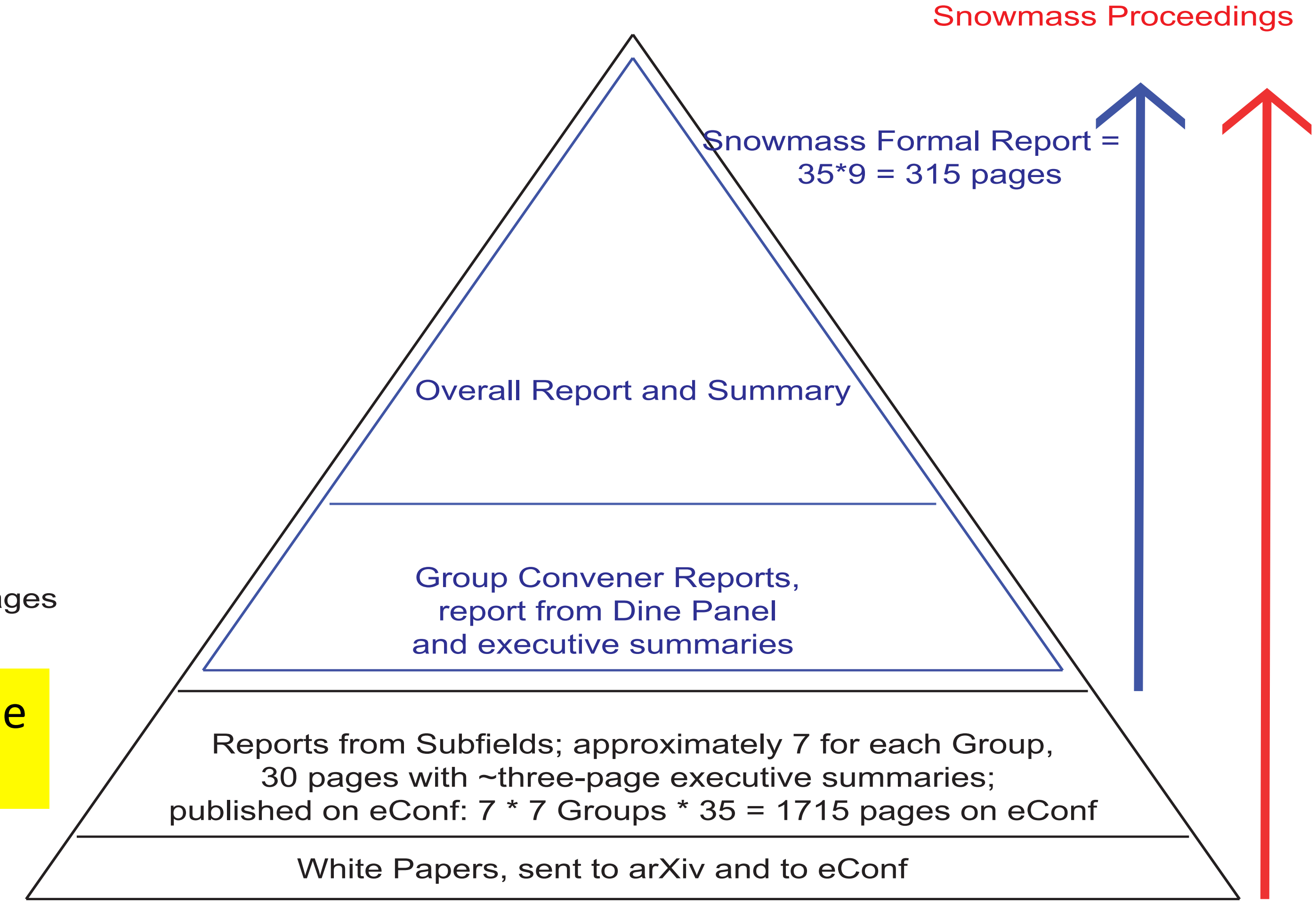
Snowmass Report Structure

Page Length:

35 pages

35 pages*8 = 280 pages

Same as last slide in pictoral form



Material in the Snowmass Formal Report will go to the Reading Committee and to editors at SLAC

Groups: Capabilties, Computing, Cosmic, Energy, Instrumentation, Intensity, Outreach

(30 pages report + 3 page summary = 35 pages by def'n)

No guarantees on the ice fishing!