Energy Frontier: Introduction

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Welcome to Snowmass 2013.

The purpose of this meeting is to survey the goals of continued exploration in high energy physics and the opportunities that will become available over the next two decades.

The purpose of this talk is to survey the activities at this meeting associated with Energy Frontier.

The goals and opportunities for our field involve large scientific questions. The term “frontier” refers to a specific method for addressing these questions experimentally. Great scientific problems must be approached from multiple perspectives and techniques. Thus, our ambitions transcend the frontiers.

We are at a pivotal moment in the history of high energy physics.

The discovery of the Higgs boson completes the particle spectrum of the Standard Model. This gives a theory that can be self-consistently extended to very high energies. For years, we have tested and verified the Standard Model. It is time for a new set of questions.

Many phenomena are known whose explanations are clearly outside the Standard Model:

dark matter
baryogenesis
quantum numbers of quarks and leptons
neutrino mass
dark energy and cosmic inflation
...

These all call for new particles and forces in nature.

Some of these forces (e.g. grand unification) lie outside the direct reach of foreseeable accelerators.

One of the mysteries concerns the Higgs boson itself.

Theorists and experimenters have been uncomfortable about the Higgs for a long time. Now it is reality.

Who gave us the Higgs field ? Why does it permeate the universe ? Is there one Higgs, or this the first element of a larger structure ?

Shouldn’t the answers be found by direct exploration of the Higgs field energy scale ?

Theoretical models of the Higgs field suggest answers to other mysteries -- dark matter, unification, ...

Big ideas are proposed: supersymmetry, higher dimensions, Higgs compositeness. These give new -- perhaps essential -- building blocks of nature.

For me, this is the great question of our age in physics:

Is there a new particle spectroscopy at the Higgs field energy scale -- the TeV scale ?

We will explore this spectroscopy with multiple techniques. But it is compelling to actually go there, hold the particles in our hands, and tease out their properties.

This is the philosophy of the "Energy Frontier" approach to high energy physics.

Powerful accelerators and detectors - now running and proposed - will give us the opportunity for a thorough exploration of the TeV energy scale.

Our goal in the Energy Frontier study is to survey and document their capabilities in relation to the physics goals.

Chip Brock and I have given this outline to the working groups:

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 steps ?

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

1. The Higgs Boson

Conveners: Sally Dawson , Andrei Gritsan , Heather Logan, Jianming Qian , Chris Tully , Rick Van Kooten

2. Precision Study of Electroweak Interactions

Conveners: Ashutosh Kotwal, Michael Schmitt, Doreen Wackeroth

3. Fully Understanding the Top Quark

Conveners: Kaustubh Agashe, Robin Erbacher, Cecilia Gerber, Kirill Melnikov, Reinhard Schwienhorst

4. The Path Beyond the Standard Model - New Particles, Forces, and Dimensions
Conveners: Yuri Gershtein, Markus Luty, Meenakshi Narain, Liantao Wang, Daniel Whiteson

5. Quantum Chromodynamics and the Strong Force
Conveners: John Campbell, Kenichi Hatakayama, Joey Huston, Frank Petriello

6. Flavor Mixing and CP Violation at High Energy
Conveners: Marina Artuso, Michele Papucci, Soeren Prell

thanks also to: Jeff Berryhill, Tom LeCompte, Eric Torrence, Sergei Chekanov, Sanjay Padhi, Markus Klute, Eric Prebys, Mark Palmer, Tor Raubenheimer

Over the past nine months, we have held two large meetings - at BNL and the University of Washington - plus single-group meetings at Princeton, Irvine, Duke, and Florida State - plus numerous phone and Vidyo meetings.

The people named on the previous slides have been working nonstop and deserve your appreciation.

We are now in the final assembly stage of the working group reports. We welcome your input.

The current stage of the contributions and reports can be found on the Energy Frontier pages of the Snowmass wiki.

Our morning sessions at this meeting are devoted to completion of the working group reports.

EF Plenaries: (Anderson 210)

Tuesday:

Highlights of the working group reports

Joint session with Capabilities Frontier on LHC and ILC

Wednesday:

White papers from the ATLAS and CMS collaborations

Thursday:

Joint session with Instrumentation and Computing

EF Parallels (6 parallel session in Blegen)

Wednesday, Friday, Saturday 8:30am

discussion by working group issue;

see the indico program for details

Afternoons are devoted to semi-plenary Colloquia
1:45 pm - 4 pm

introductory lectures / panel discussion /
open discussion and questions

Energy Frontier is organizing three of these:

Higgs	-	Tuesday afternoon
Precision Frontier	-	Thursday afternoon
Energies beyond LHC	-	Friday afternoon

We will also contribute to the colloquia on Dark Matter and Quark and Lepton Flavor.

An important topic for all of these subjects is:

Where are the new particles ?

that modify the Higgs, t, W couplings ..
that interact with the Higgs ...
that comprise the dark matter ...
that mediate flavor and CP mixing ...

and, can we nail down the properties of these particles - and find their complete spectrum - in collider experiments ?

We in the Energy Frontier study have great optimism for the discovery of a next set of particles and interactions.

High-energy colliders will be a key part of the story.

We hope that you will find the capabilities of collider experiments proposed for the next two decades fascinating and enabling for fundamental science.