Snowmass**2013**

(July 29-August 10, 2013)

High Energy Frontier

Michael Peskin
Chip Brock

TOC:

1. Snowmass status, overall
2. High Energy Frontier, in particular
3. What's next for the High Energy Frontier

1. Snowmass status, overall

Snowmass is a creature of your APS Division of Particles and Fields

Not of HEPAP or the agencies

a long-range, "taking-stock" exercise

Considering the whole field, to:

explore our collective physics goals among ourselves

correlate them, if appropriate and create a compelling narrative

to the broader scientific community and the government

Participation by European and Asian colleagues is encouraged

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“Snowmass” is a Particle Physics brand

A long tradition, covering both general and focused agendas:

Snowmass’82 DPF Summer Study On Elementary Particle Physics And Future Facilities

Snowmass ‘84 DPF Summer Study On The Design And Utilization Of The Superconducting Super Collider (SSC)

Snowmass '86 Summer Study On The Physics Of The Superconducting Supercollider

Snowmass ‘88 DPF Summer Study On High-Energy Physics In The 1990s

Snowmass ‘90 DPF Summer Study On High-Energy Physics: Research Directions For The Decade

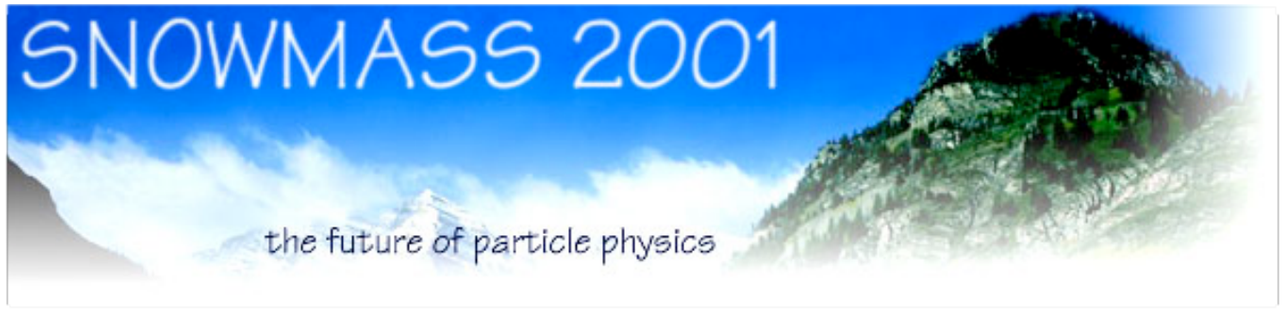
Snowmass ‘94 DPF Summer Study On High-Energy Physics: Particle And Nuclear Astrophysics And Cosmology In The Next Millenium

Snowmass ‘96 DPF/DPB Summer Study On New Directions For High-Energy Physics

Snowmass ’01 APS/DPF/DPB Summer Study On The Future Of Particle Physics

Snowmass ’05: DPF Toward an International Linear Collider.

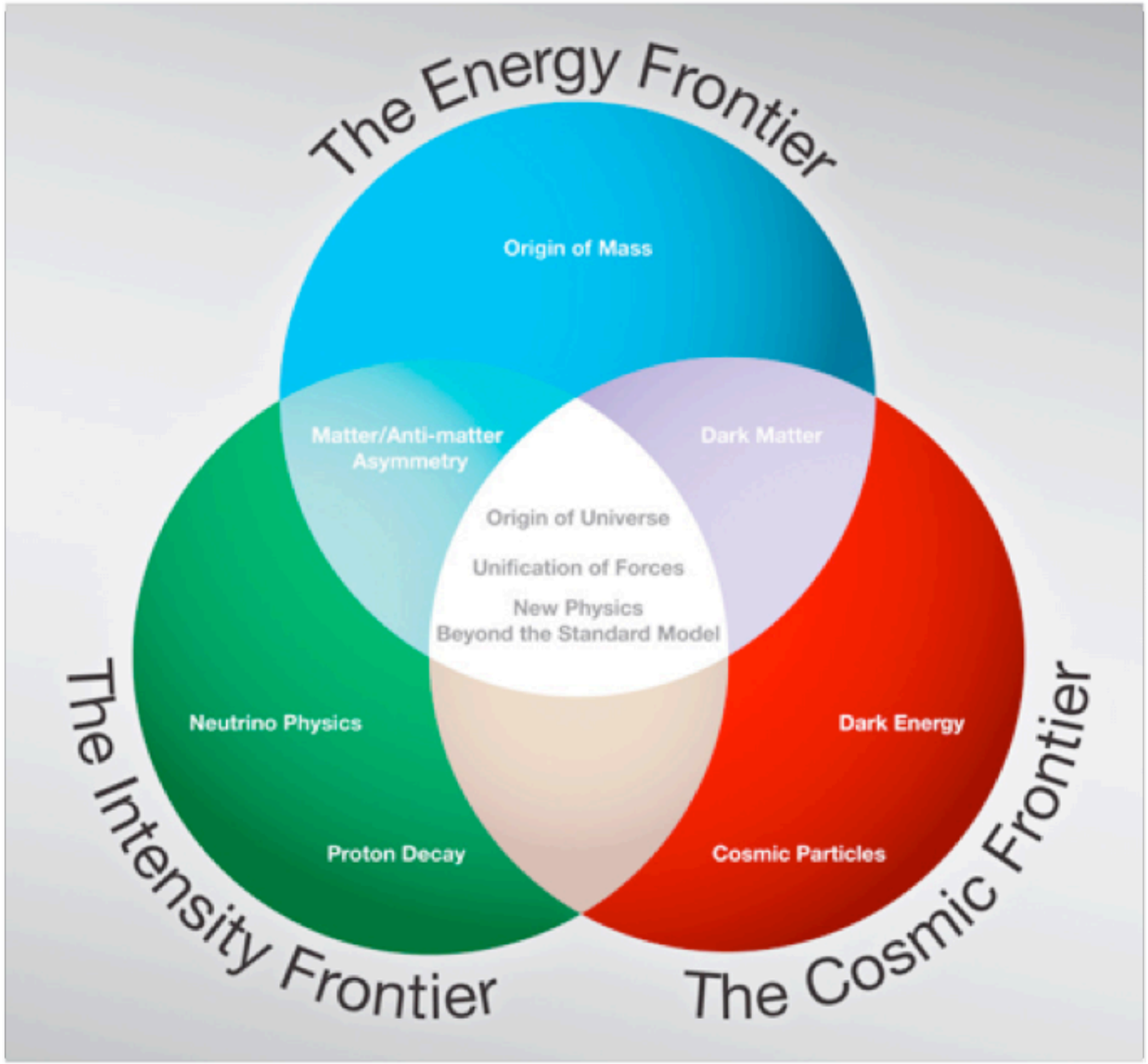
Most recent general meeting, 2001:

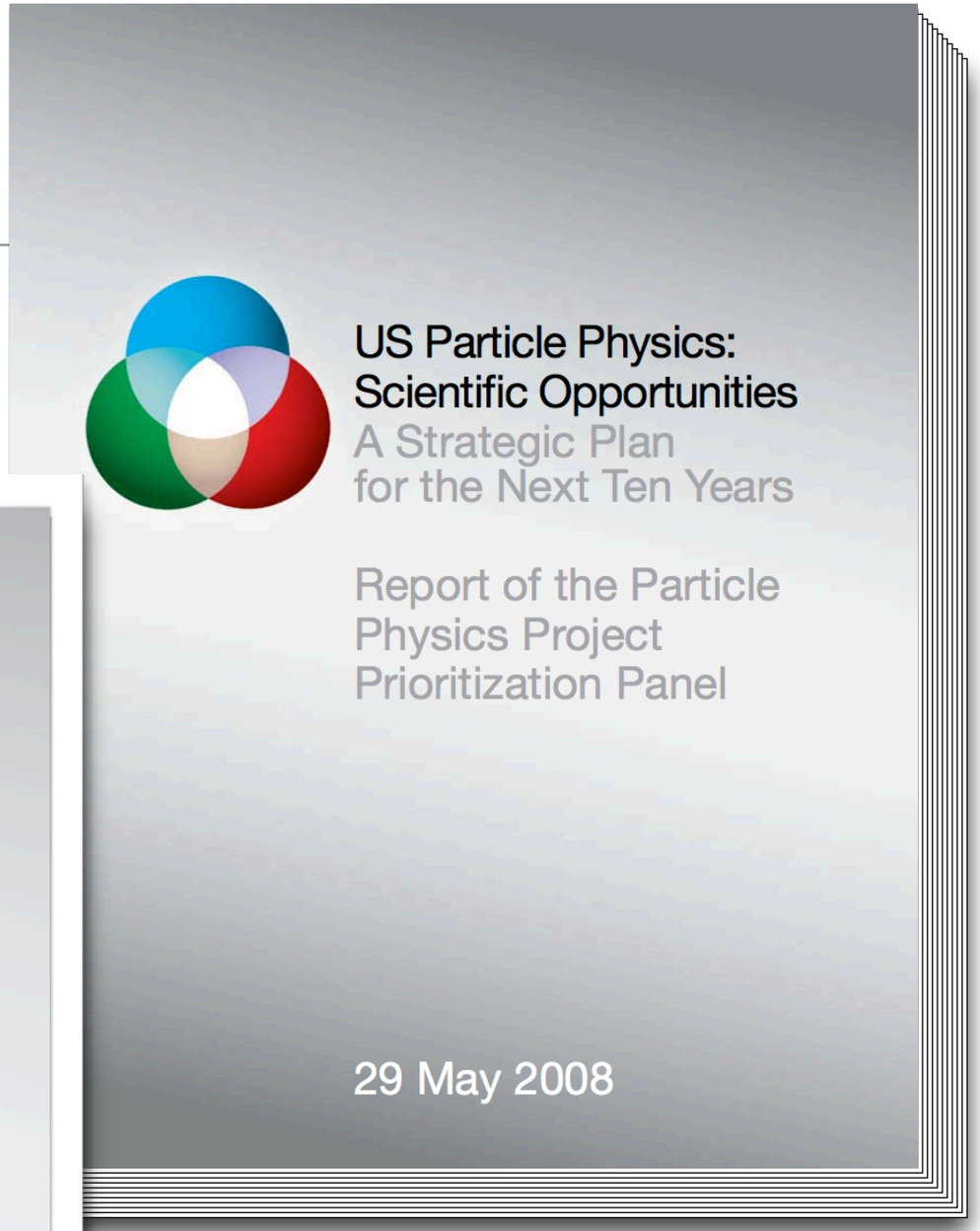


We have a theme

"the circles" were a gift from the 2008 P5

and we're organized around them





We have a wiki

http://www.snowmass2013.org

increasingly active

We have a set of Frontier Groups

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Brand new

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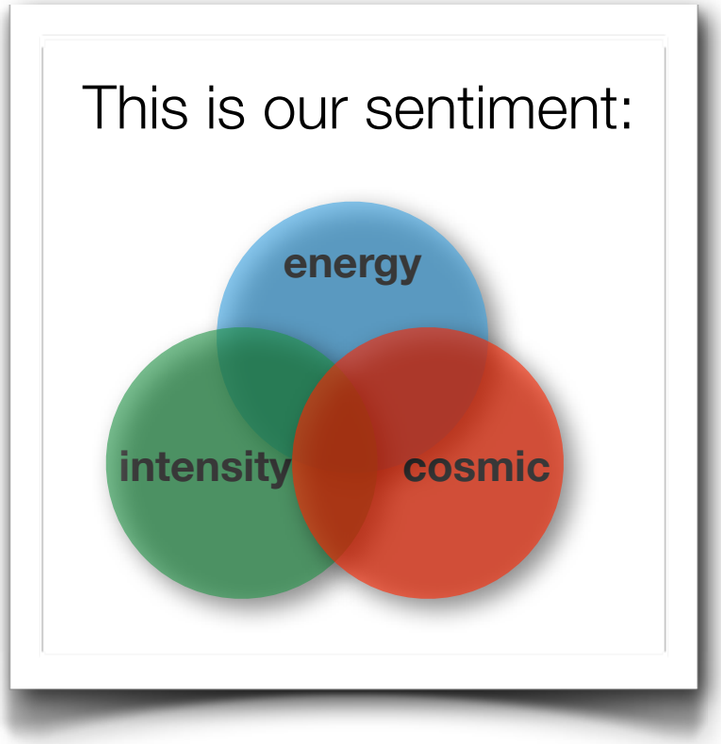
EO: **Education and Outreach** - Marge Bardeen & Dan Cronin- Hennessey

Ideas on Education and Outreach, events for the local community

We are bending the organization

to fit the circles, including overlaps



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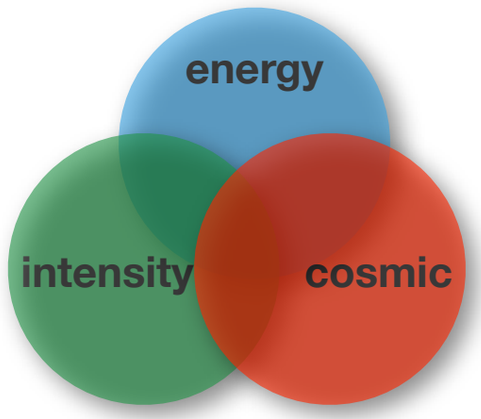
This is our sentiment:



This is our organizational reality:

We have a problem

GSA scandal fallout affects the venue

unknown ramifications

Two known consequences:

shortened from 3 weeks to 2 weeks

@ a university site

One big unknown consequence:

Unknown $ limits for DOE personnel

We have two proposals and a schedule

99% decided a few days ago.

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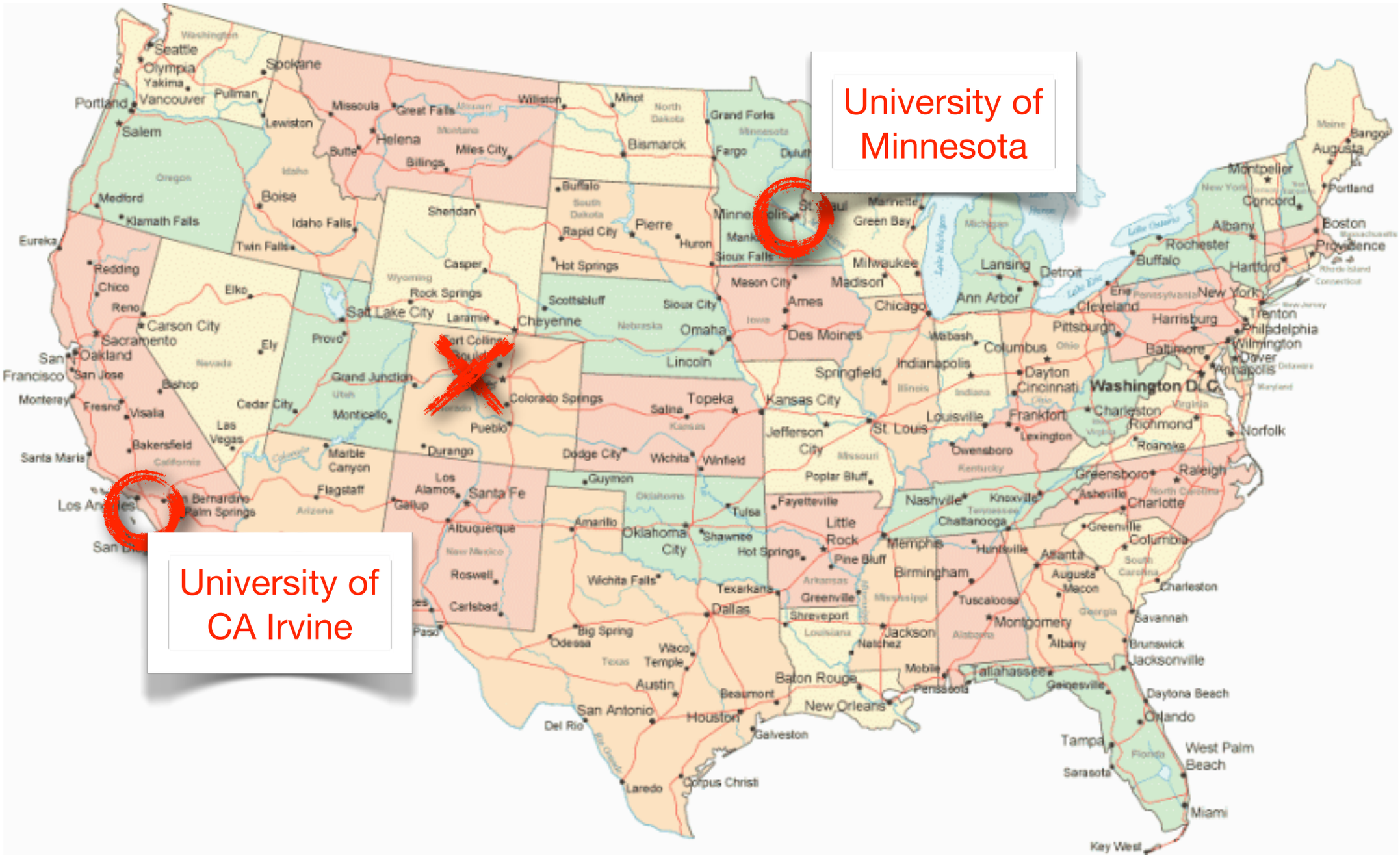

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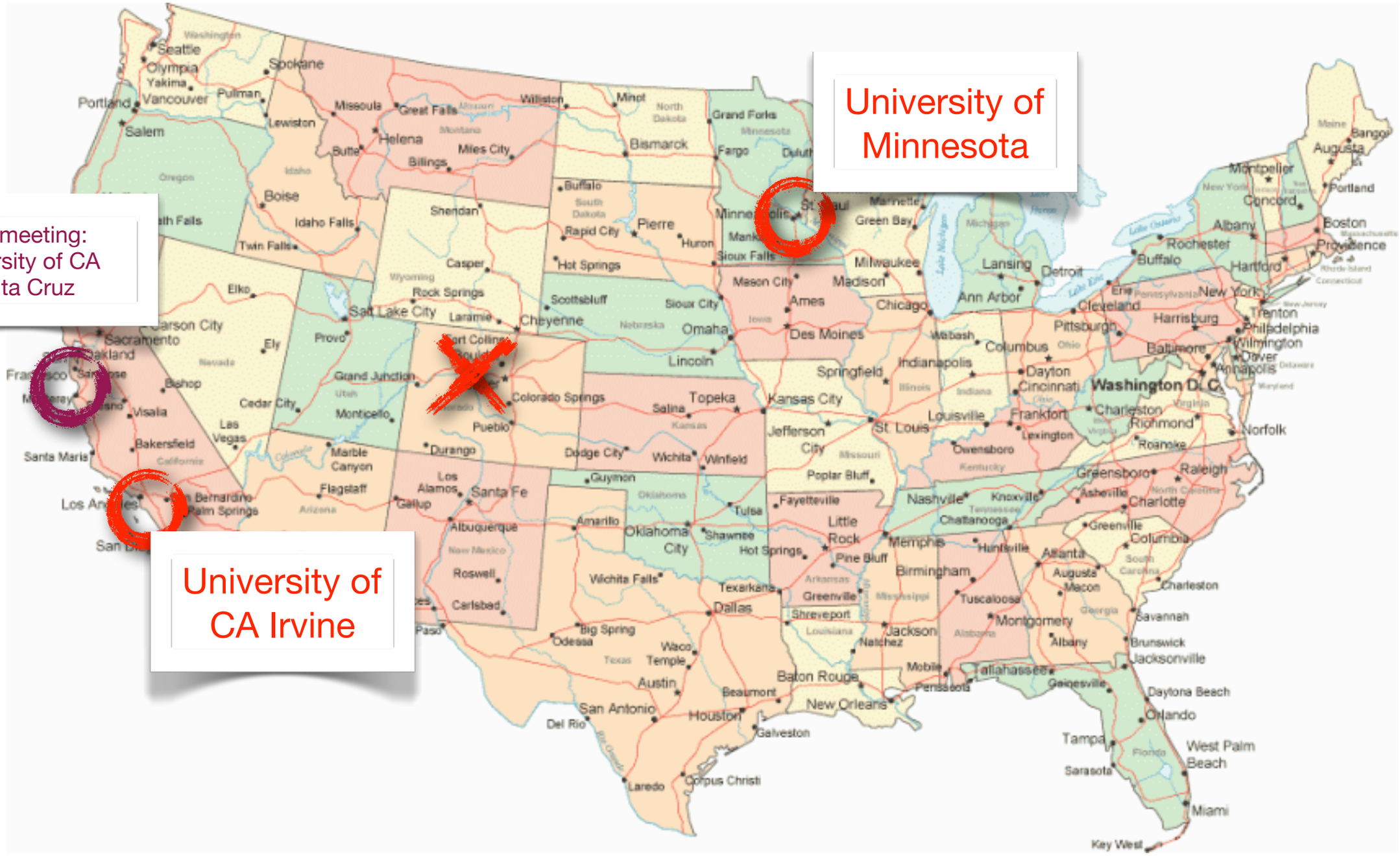

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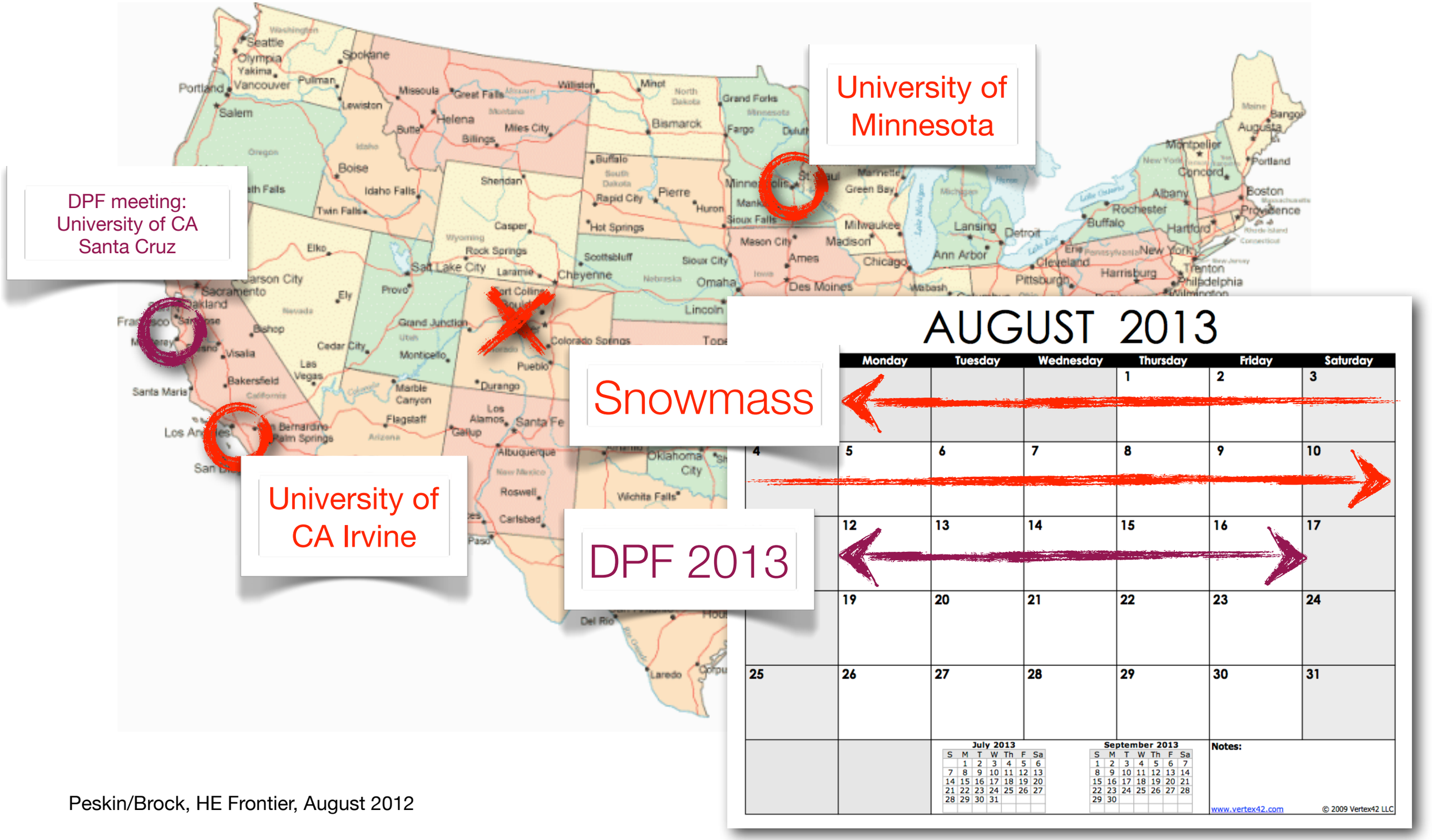

Peskin/Brock, HE Frontier, August 2012

We have a schedule

Group Convener Organization
Aug 1, 2012 – Aug 31, 2012

Community Planning Meeting (CPM) at Fermilab
Oct 11, 2012 – Oct 13, 2012

Topical workshops?
Jan 1, 2013 – Aug 1, 2013

LHC shutdown
Feb 10, 2013 – Dec 31, 2014

Snowmass2013
Jul 29, 2013 – Aug 10, 2013

DPF2013
Aug 11, 2013 – Aug 18, 2013

14 TeV Collisions
1/1/15 – 10/30/15

Jan 2013 Jul 2013 Jan 2014 Jul 2014 Jan 2015 Jul 2015

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Jan 2013 | Jul 2013 | Jan 2014 | Jul 2014 | Jan 2015 | Jul 2015

Group Convener Organization

This month, August

Most are nearly done–see the wiki

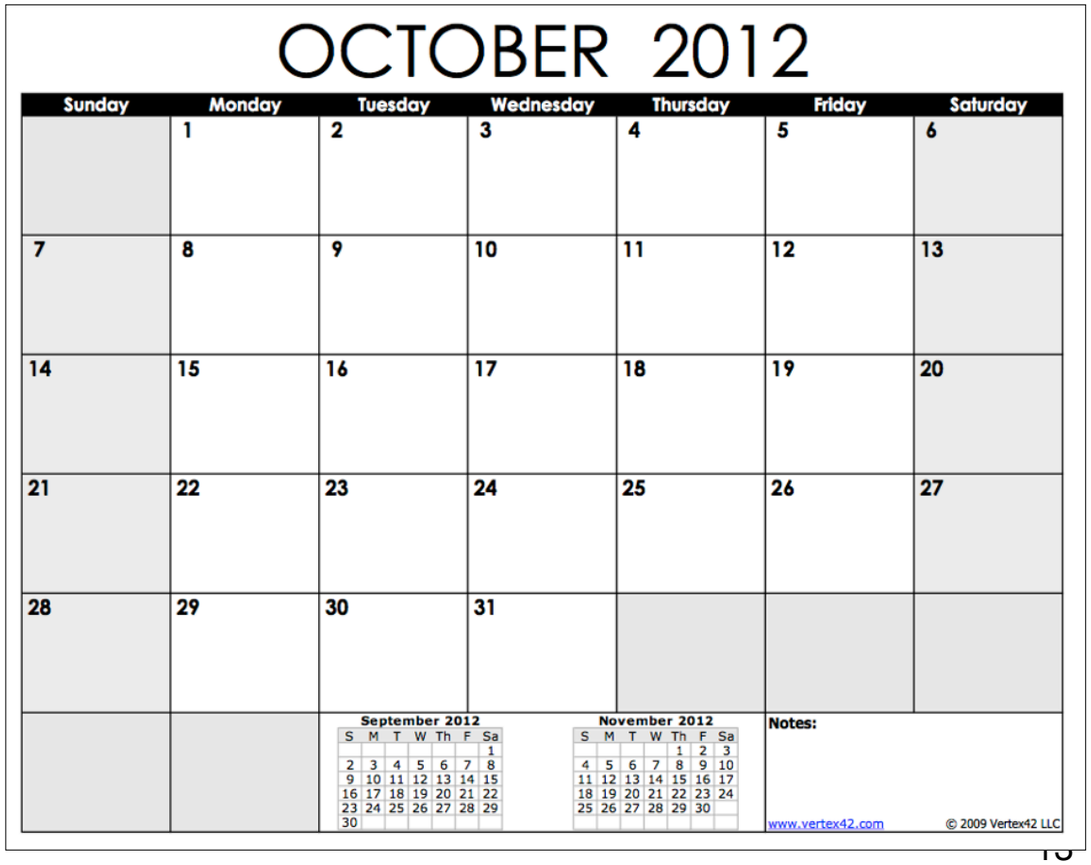
I'll talk about HEF in a minute

Community Planning Meeting, “CPM”

@ Fermilab

planning, normalization

working group meetings



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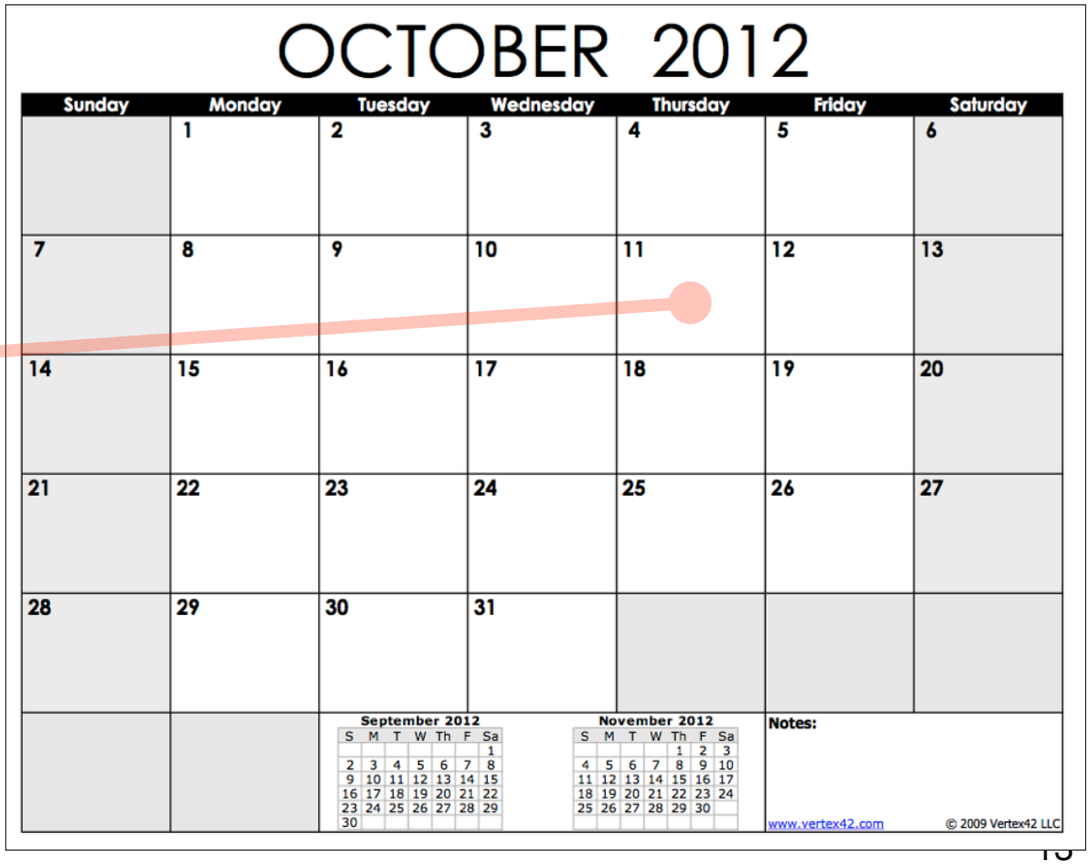

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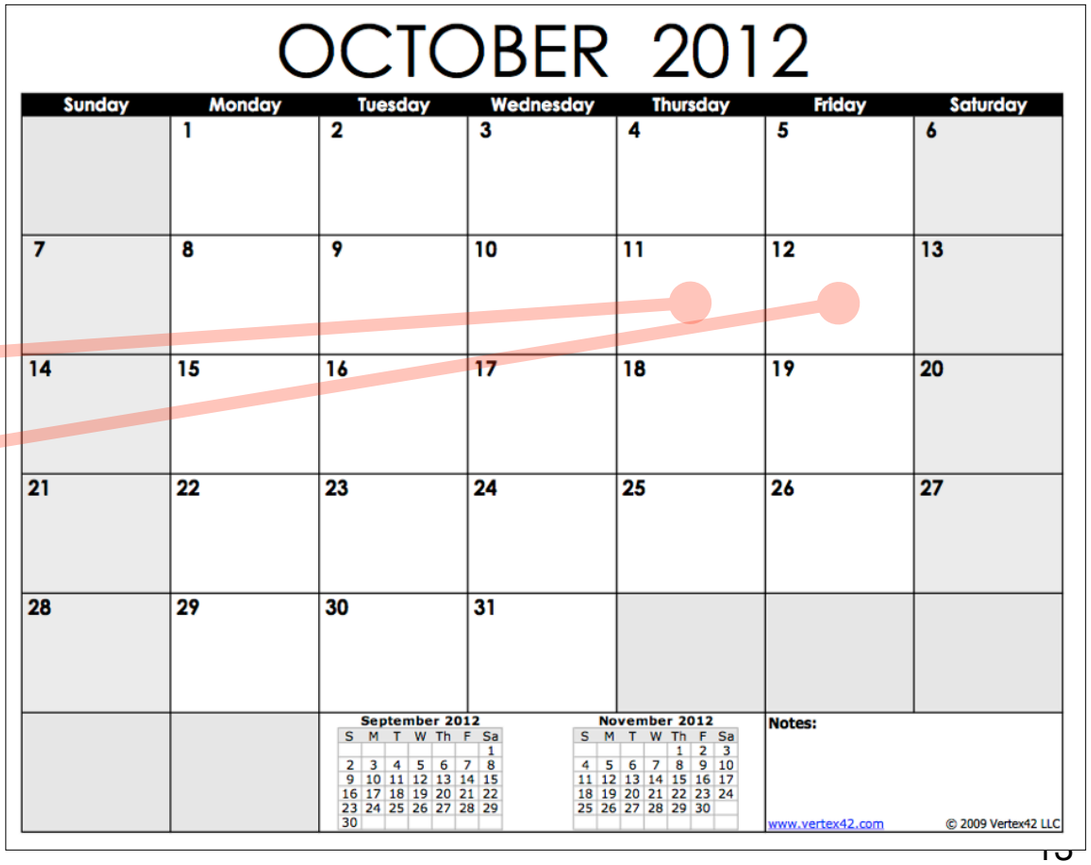

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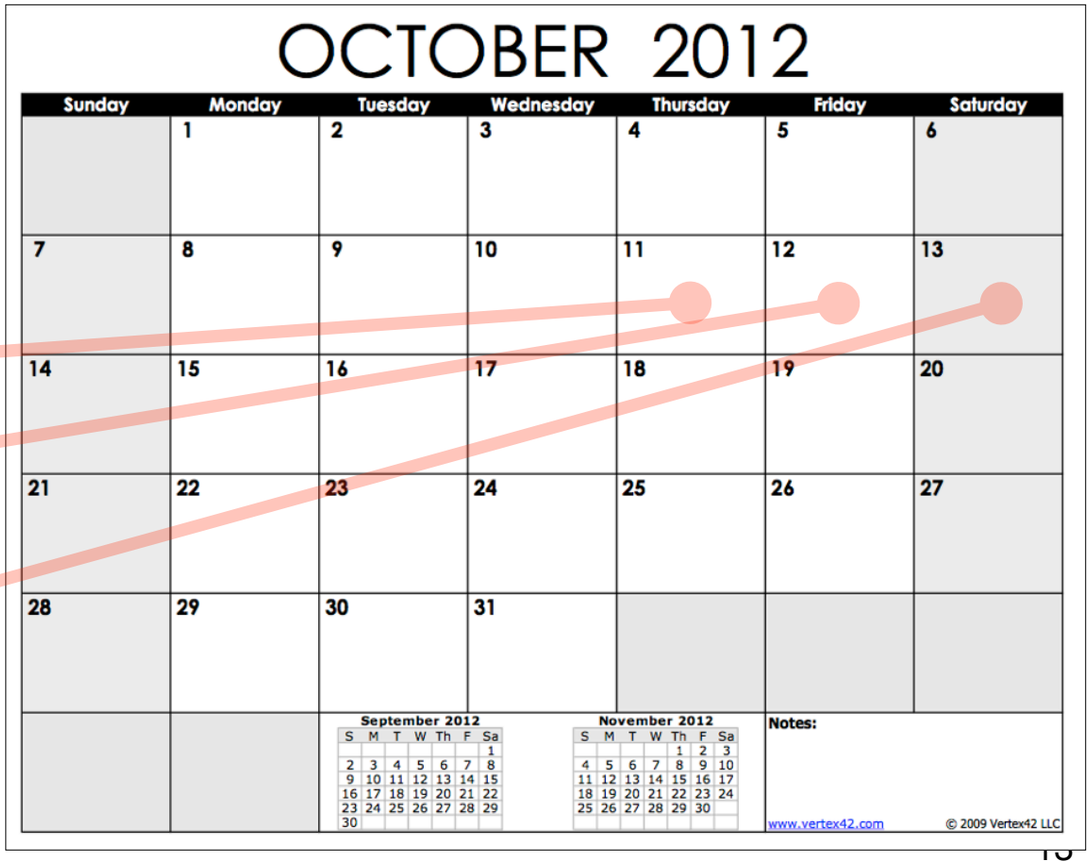
Plenary

Working Groups

Town Meeting, closeout



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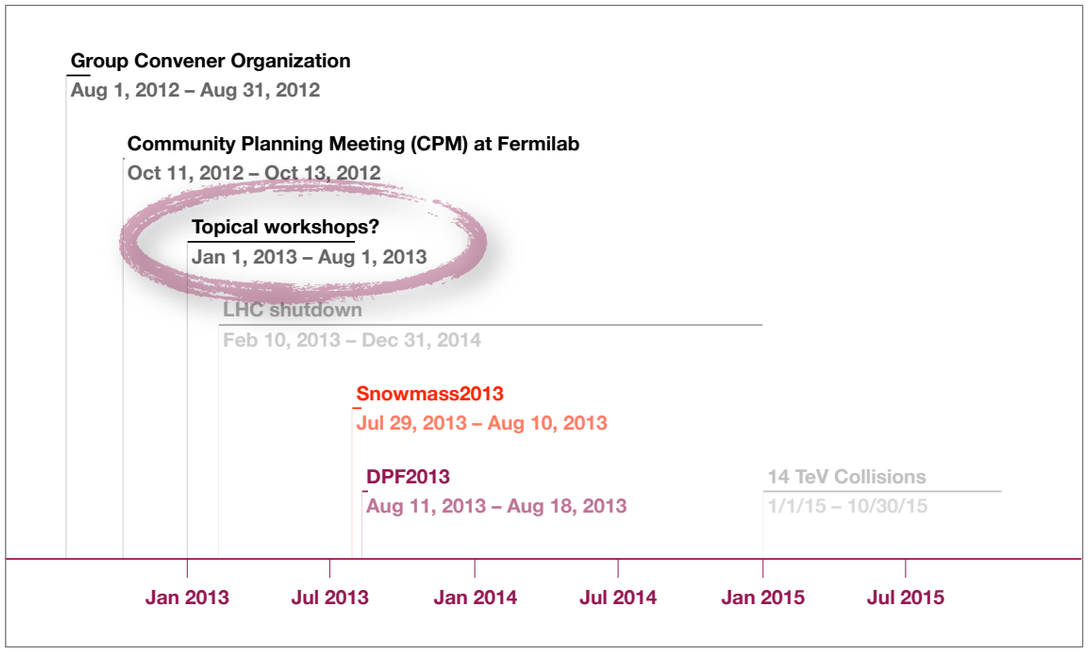
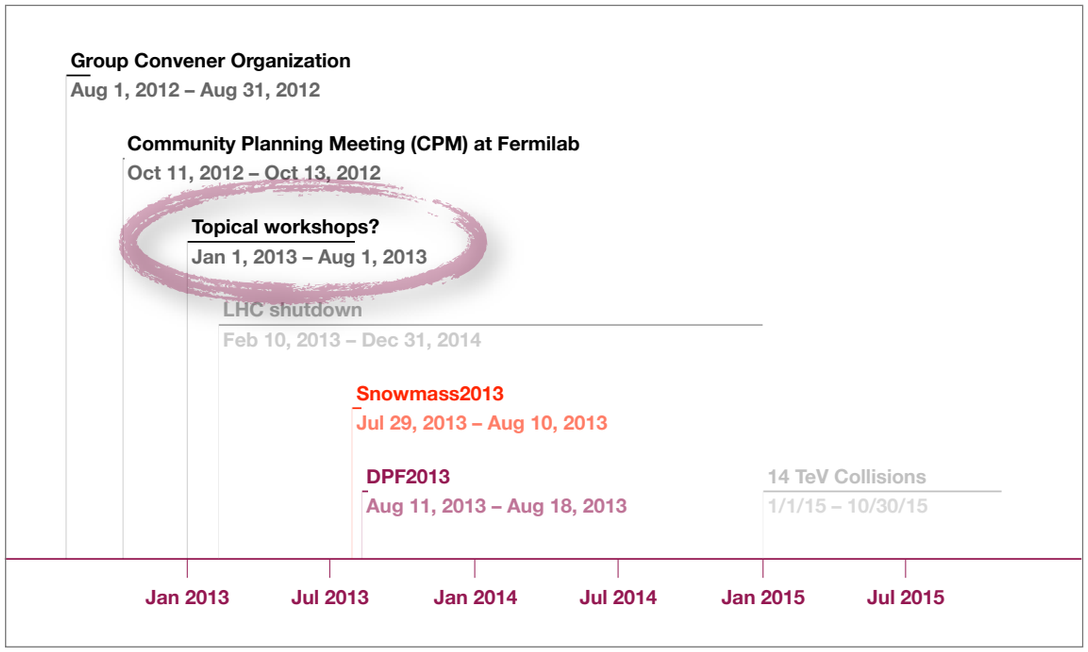


Topical Workshops?

After CPM: Finish Charges

Clarify the physics questions

Identify potential experimental scenarios



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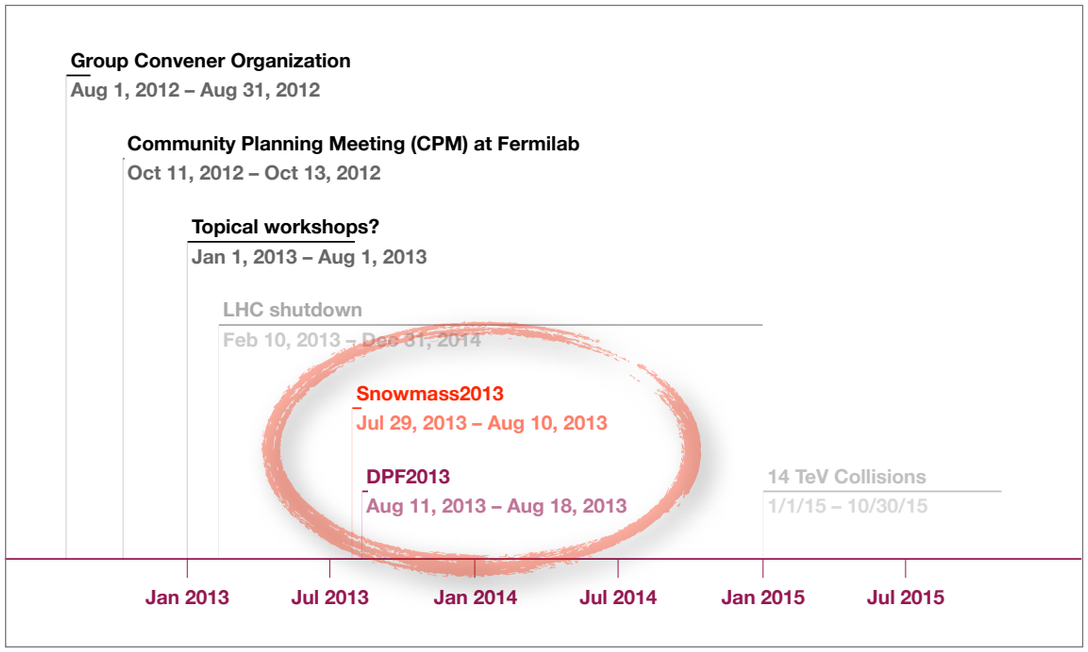
Identify potential experimental scenarios

Working groups prepare through the year

Initiate major projects to be concluded at Snowmass

Topical workshops?

Maybe a briefing from the European Strategy Planning?

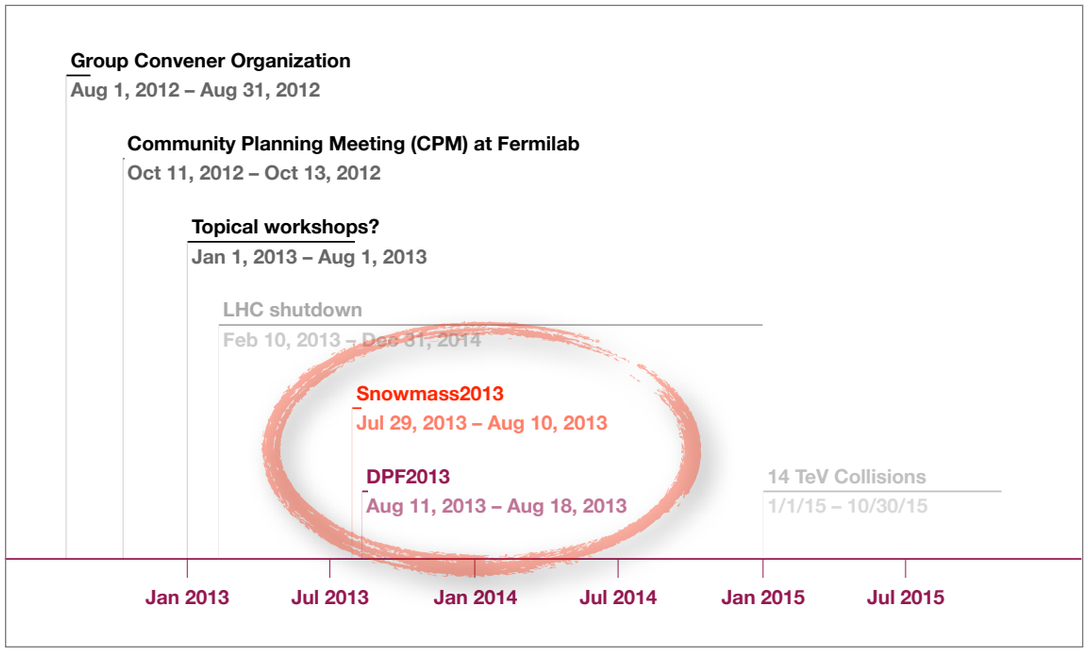


Snowmass2013 & DPF2013

Discussion, analysis, conclusions

executive summary @ the meeting

each subgroup writes a report



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Possibly a published account of the Workshop

electronic archive: all contributed papers and the subgroup summaries.

summaries may be published in a separate volume.

DPF2013 could continue the Snowmass Summaries Session

We anticipate a followup

An independent, P5 Strategic Planning Exercise

commissioned by HEPAP for DOE and NSF

during 2013-2014?

We have a blessing

Jim Siegrist, Director OHEP

In 2008 HEPAP through the work of its P5 subpanel laid out a compelling strategic vision for the future of High Energy Physics.

Given recent exciting results at all the HEP scientific frontiers, and the ongoing evolution of budget projections and project plans, it is prudent to revisit the HEPAP/P5 plan with an eye towards examining the science options that have been put forward as well as emerging opportunities.

As a first step in this process, we need a strong scientific case that covers the range of opinion in the community. We would like to understand if our opportunities enable programs that are capable of achieving most or all of the scientific goals as the program considered in the 2008 roadmap, or whether some modifications to those goals and plans are needed.

To that end, a planning process that carefully considers the science opportunities and trade-offs involved, and can clearly elucidate the pros and cons of the various options, would be extremely valuable input for updating the HEP strategic plan.

Organization of the 7 Frontiers

High Energy Frontier

HE1: The Higgs Boson

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

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HE6: Quark Flavor and Mixing at High Energy

Soeren Prell (ISU), Michele Papucci (LBNL), Marina Artuso (Syracuse)

High Intensity Frontier

HIF1: Heavy Quarks

HIF2: Charged Leptons

HIF3: Neutrinos

HIF4: Baryon Number Violation

HIF5: New Light, Weakly Coupled particles

HIF6: Nucleons, Nuclei and Atoms

HIF7: Hadronic Structure

Cosmic Frontier

CF1: WIMP Dark Matter Direct Detection

P. Cushman (Minnesota), C. Galbiati (Princeton), D. McKinsey (Yale),
H. Robertson (U. Washington), T. Tait (UC Irvine)

CF2: WIMP Dark Matter Indirect Detection

J. Buckley (Washington U.), D. Cowen (Penn State),
S. Profumo (UC Santa Cruz)

CF3: Non-WIMP Dark Matter

A. Kusenko (UCLA), L. Rosenberg (U. Washington)

CF4: Dark Matter Complementarity

D. Hooper (FNAL), M. Kaplinghat (UC Irvine), K. Matchev (Florida)

CF5: Dark Energy and CMB

S. Church (Stanford/SLAC), S. Dodelson (FNAL/Chicago), + TBA

CF6: Cosmic Particle Probes of Fundamental Physics

J. Beatty (Ohio State), A. Nelson (U. Washington), A. Olinto (Chicago)

Frontier Facilities

FF1: Energy Frontier Hadron Colliders

Marco Battaglia (UCSC), Vladimir Shiltsev (FNAL), Soren Prestemon (LBNL)

FF2: Energy Frontier Lepton and Gamma Colliders

Markus Klute (MIT), Kaoru Yokoya (KEK), John Byrd (LBNL)

FF3: High Intensity Proton Beams

TBA, Sergei Nagaitsev (FNAL), TBA

FF4: Electron-ion Colliders

TBA, John Flanagan (KEK), TBA

FF5: Heavy Flavor Facilities, Muons, and Hidden Sector

Rolf Ent (JLAB), Thomas Roser (BNL), TBA

FF6: Technology Test Facilities and Test Beams

Georg Hoffstaetter (Cornell), Mark Hogan (SLAC), Wei Gai (ANL)

Instrumentation Frontier

IF1: Sensors

Marina Artuso (Syracuse University), Abe Seiden, (UC Santa Cruz)

IF2: Gaseous Detectors

Gil Gilchriese (LBNL), Bob Wagner (ANL)

IF3: Detector Systems

Ed Blucher (University of Chicago), David Lissauer (BNL)

IF4: Data Acquisition and Electronics

Ulrich Heintz (Brown University), Ron Lipton (Fermilab)

IF5: Software

Norman Graf (SLAC), TBD

IF6: Emerging Technologies

Jim Alexander (Cornell), David MacFarlane (SLAC)

Computing Frontier

User Needs

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

Infrastructure issues:

CpF I1:	Computing, including special purpose hardware
CpF I2:	Computing Facility Infrastructures
CpF I3:	Networking
CpF I4:	Personnel/Training/ Software development
CpF I5:	Storage

Education and Outreach

EO1: General Public

Michael Barnett (LBNL)

EO2: Policy Makers and Opinion Leaders

Katie Yurkewicz (Fermilab) & Herman White (Fermilab)

EO3: The Science Community

TBA

EO4: Teachers - grades 5-16

Tom Jordan (Florida)

EO5: Students - grades 5-16

Inga Karlinger (Illinois)

2. High Energy Frontier, in particular

what we've done:

Identifying subgroup conveners

emails to and conversations with:

U.S. experiments' representatives/spokespeople asking for convener ideas

this spawned internal requests for convener names within experiments

multiple times, many private and random queries

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Additional group "infrastructure"

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contacted all international spokespeople of ATLAS, CMS, LHCb, SiD, ILD, CLIC, Muon Collider asking for names of "contacts and consultants"

They are: ATLAS: *Paul Tipton; CMS: TBD; LHCb: Sheldon Stone; ILD: Graham Wilson; SiD: Andy White;CLIC: Mark Thomson; Muon Collider: Ron Lipton*

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create necessary correlations among groups

decided on technical "connective tissue" groups

explicit liaisons between HEF and other frontiers

HEF Goals:

What can be accomplished before ~2021 (~400 fb^{-1})?

In light of the results, circa 2013: what are recalibrated physics goals for the LHC?

How do the Phase 1 upgrades inform those goals?

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What are the Physics needs for accelerators beyond 2025?

A high energy LHC?

A high energy lepton collider?

A VLHC?

For each, what do we need to learn in order to make these cases?

Candidate scenarios for all groups:

A. The LHC with E = 14 TeV and L = 10^{34} cm^{-2} sec^{-1}

B. A luminosity upgraded LHC with: E_{cm} = 14 TeV, L = ~10^{35} $cm^{-2}s^{-1}$

C. An energy upgraded LHC

D. e+e- lepton colliders E_{cm} < ~1 TeV

E. A circular e+e- collider operating as a Higgs factory.

F. e+e- or gamma-gamma collider E_{cm} > ~1 TeV

G. A mu+mu- collider.

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- It is especially important to point out critical points in energy or luminosity that are essential to realize physics goals.
- For experiments at hadron colliders, a specific question is the effect of the machine environment for high-luminosity running. Do high-luminosity conditions compromise the needed measurements? Are there detector designs or experimental strategies that can ameliorate these problems?

Common template Charge to each HEF Group:

A. Please provide a compact summary of the state of the search for the SM Higgs Boson, including information from LEP, the Tevatron, and the LHC.

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...tailored list of questions follow

see them in the additional slides in the Appendix, or on the wiki

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C. Please guide your exploration of the above goals with the following scenarios/caveats:

i) Evaluate the above goals in the context of Candidate Facilities A-J. (Collaboration with the Facilities Frontier is expected.)

ii) Are new theoretical or simulation tools (for signal or backgrounds) required in order to achieve the goals?

iii) What are the detector and computing challenges that the above goals imply? (Collaboration with the Instrumentation and Computing Frontiers is expected.)

Preliminary Charge to the group, **The Higgs Boson**

for example:

A. Please provide a compact summary of the state of the search for the SM Higgs Boson, including information from LEP, the Tevatron, and the LHC.

B. Please address the following goals for Higgs Boson physics in the future:

1. *What measurements are required to prove that a candidate scalar boson is indeed THE SM Higgs boson? If this boson has small admixtures of other isoscalar, -doublet, or -triplet states, to what accuracy can this be determined?*
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whole collection: appendix to this talk

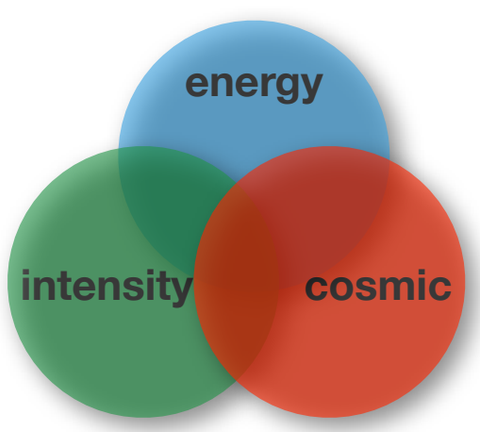
the overlaps

2 kinds of overlaps

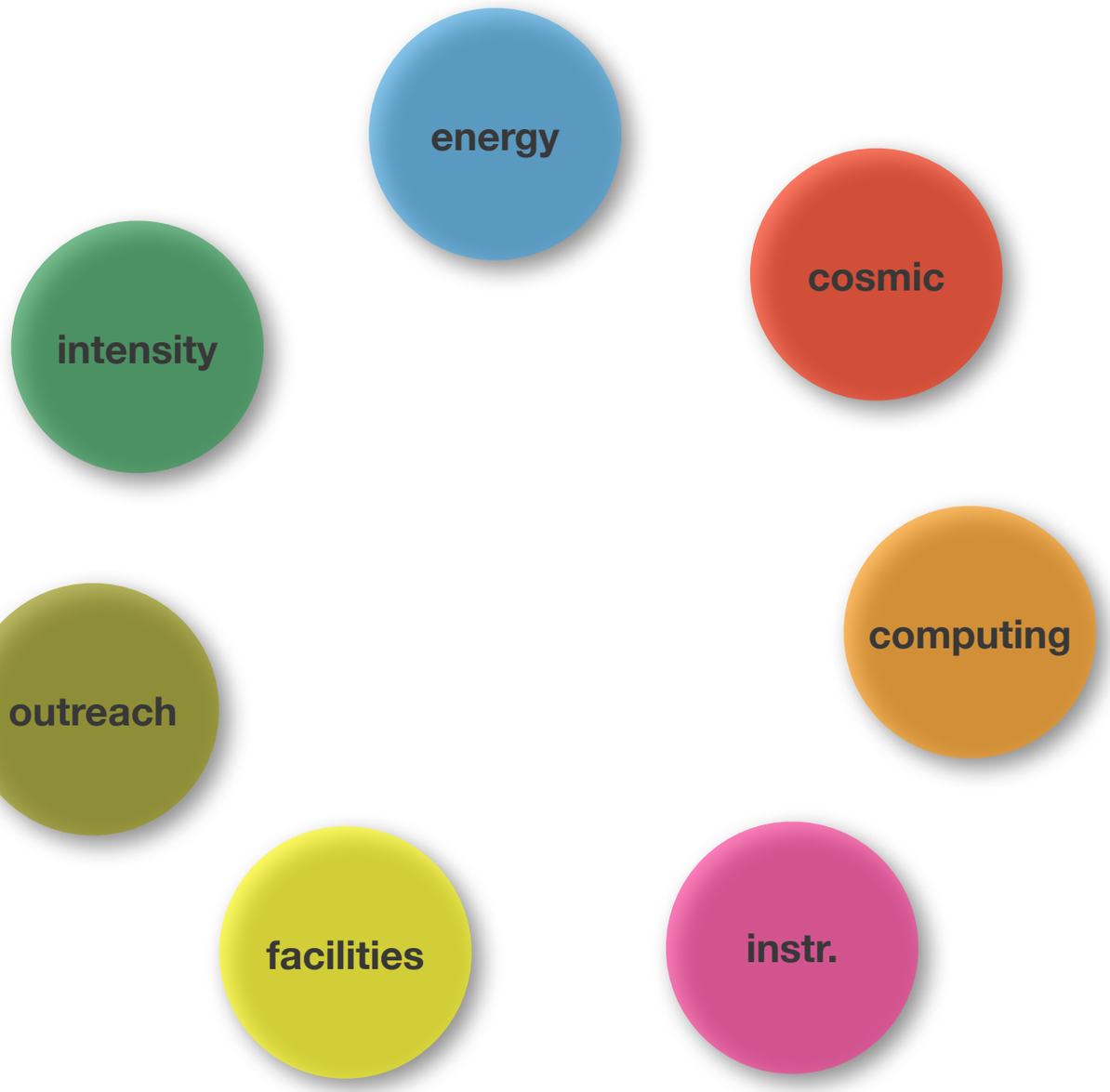
Facilities, Instrumentation, and Computing Frontiers

Other Physics Frontiers groups

This is our sentiment:



This is our organizational reality:



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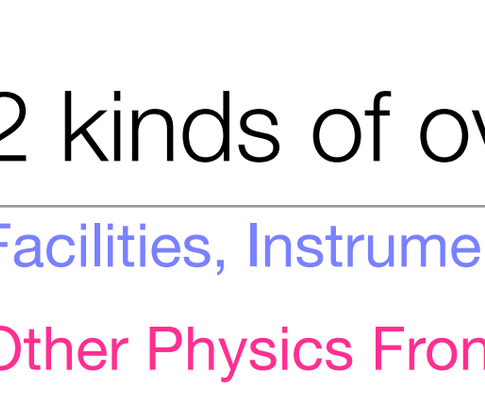

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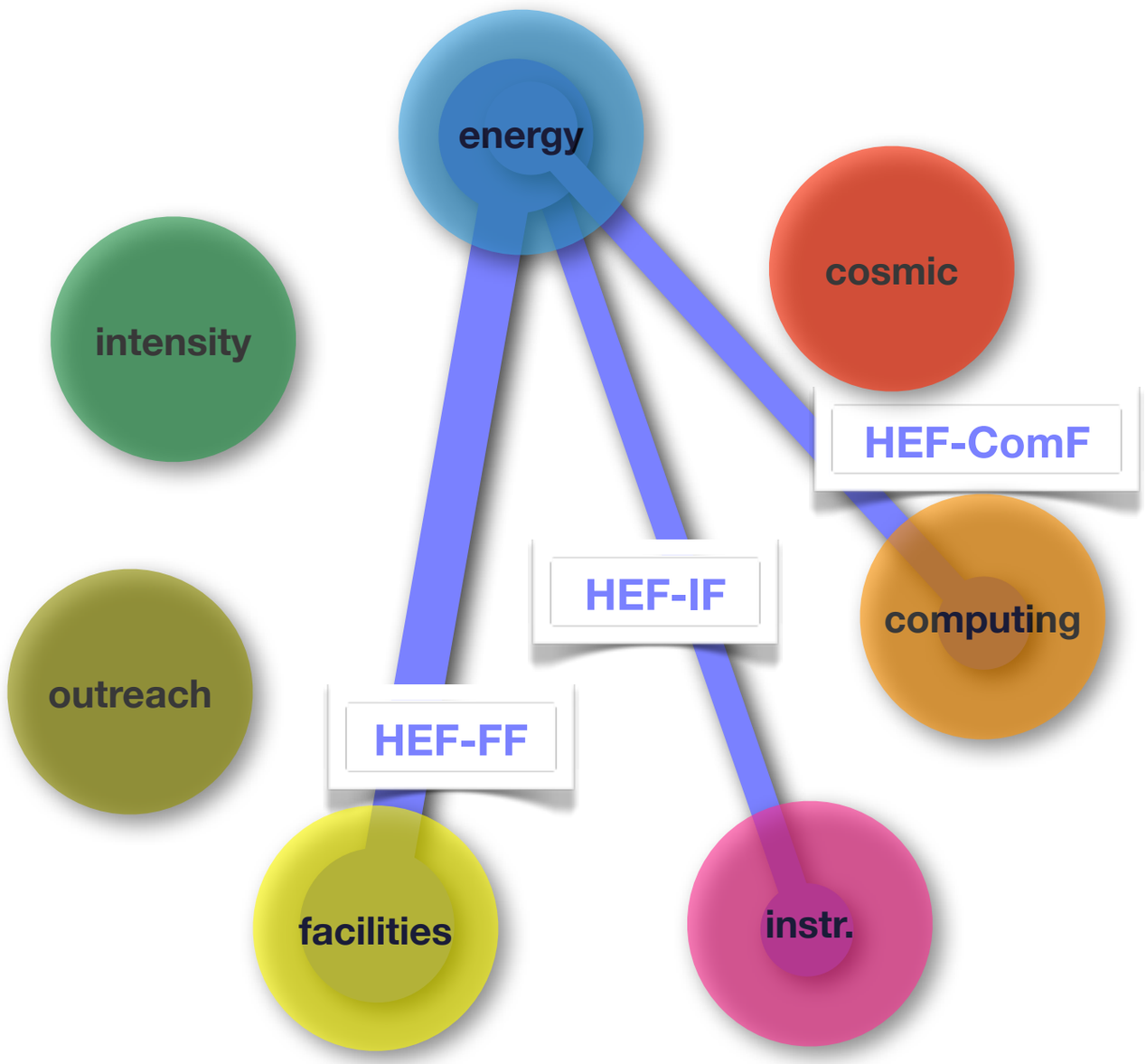

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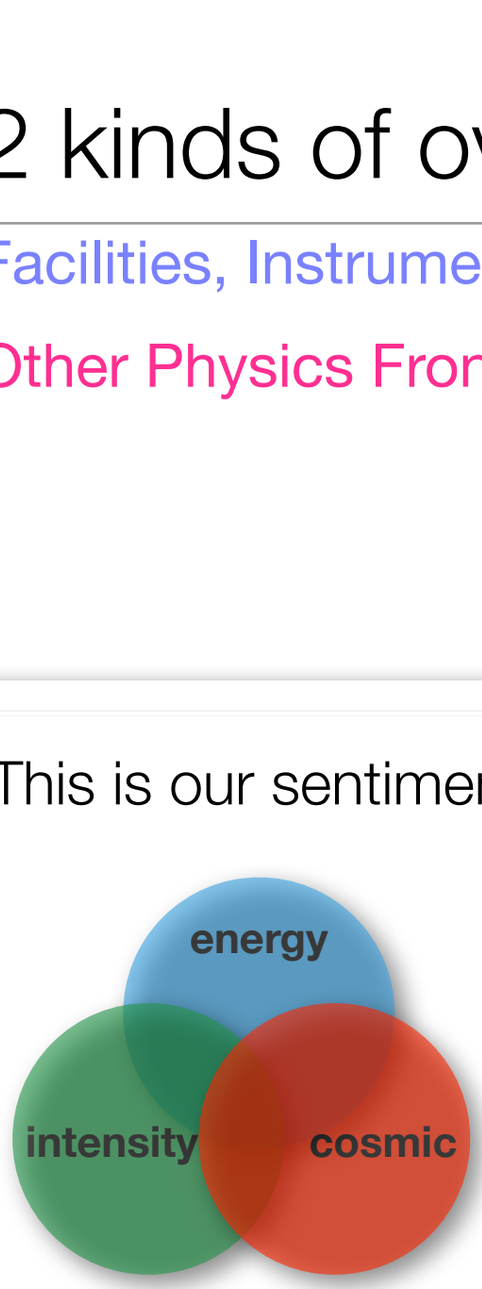

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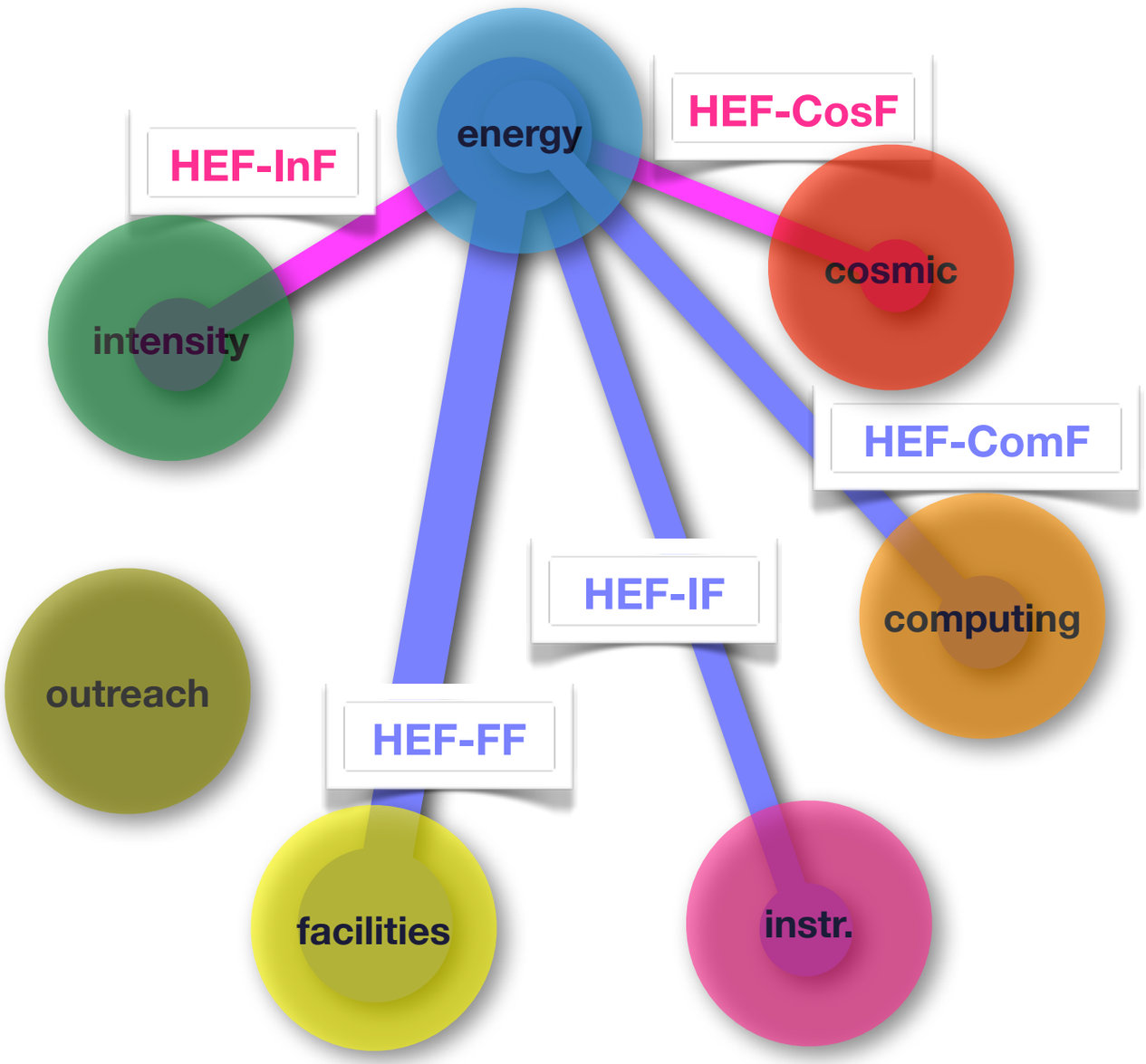

“technical group”

An explicit interface between the HEF physics groups and the FF, IF, and CF groups

Technical Group:

Beate Heinemann (Cal), Jeff Berryhill (FNAL), Eric Torrence (Oregon),
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Establishing common benchmark parameters for each Candidate Facility
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Throughout the spring and workshop:

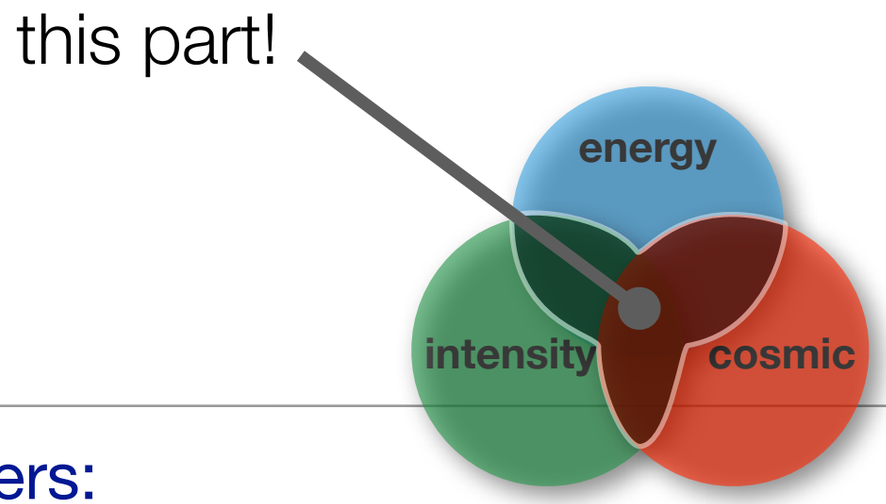
Liaison with the Facilities, Instrumentation and Computing Frontier Groups

the Instrumentation Frontier

has gone another level deep with their overlap responsibilities:

	Energy	Intensity	Cosmic	Computing
Sensors				
Marina Artuso	Daniela Bortoletto (Purdue)	Prisca Cushman (Minnesota)	Andrei Nomerotksi (BNL)	Morris Swartz (JHU)
Abe Seiden	Sally Seidel (New Mexico)	Matt Wetstein (Chicago)	Clarence Chang (Chicago)	
		Jerry Va'vra (SLAC)	Jim Fast (PNNL)	
Gaseous Detectors				
Gil Gilchriese	Andy White (UTA)	James White (Texas A&M)	David Nygren (LBL)	
Bob Wagner	Marcus Hohlmann (FIT)	Brendan Casey (FNAL)	Dan Akerib (Case Western)	
	Vinnie Polychronakos (BNL)		Greg Tarle (Michigan)	
Detector Systems				
Ed Blucher	Roger Rusack (Minnesota)	Bonnie Fleming (Yale)	Karen Byrum (ANL)	Erik Gottschalk (FNAL)
David Lissauer	Adam Para (FNAL)	Giorgio Gratta (Stanford)	Peter Gorham (Hawaii)	
	Joel Butler (FNAL)	Bob Svoboda (UC Davis)		
Electronics/DAQ/Trigger				
Ulrich Heintz	Dong Su (SLAC)	Gary Varner (Hawaii)	Günther Haller (SLAC)	Torre Wenaus (BNL)
Ron Lipton	Wesley Smith (Wisconsin)	George Gollin (Illinois)	Frank Krennrich (Iowa State)	
	Maurice Garcia-Sciveres (LBNL)	Yau Wah (Chicago)		
Novel/Emerging Technologies				
Jim Alexander	Ted Liu (FNAL)	Steve Ahlen (BU)	Juan Estrada (FNAL)	
David MacFarlane	Julia Thom (Cornell)	Jack Ritchie (Texas)	Ben Monreal (UCSB)	
Software				
Norman Graf	Erich Varnes (Arizona)	Robert Kutschke (FNAL)	Salman Habib (ANL)	
NN				

Physics overlaps



Explicit dual-coverage conveners:

HEF & CF (Dark Matter): Lian-Tao Wang & Konstantin Matchev

HEF & CF (Baryogenesis): Michele Papucci & Ann Nelson

HEF & HIF (b physics): Michele Papucci & Zoltan Ligeti

3. What's next for the High Energy Frontier

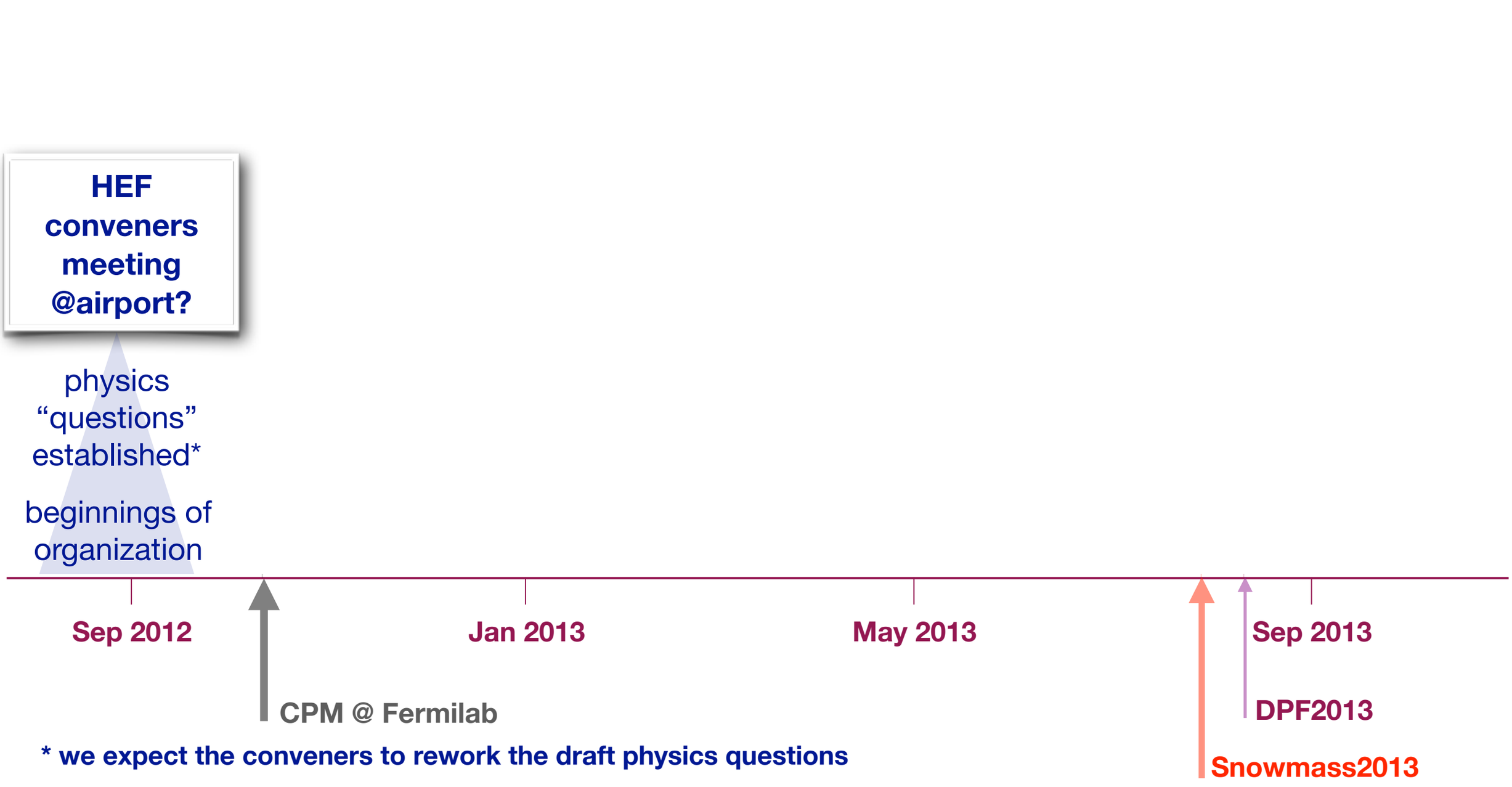
our to-do list

1. Complete the convener leadership
2. Facilitate the year

HEF conveners meeting @airport?

physics "questions" established*

beginnings of organization



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Final Charges

working group condensation

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Sep 2012

Jan 2013

May 2013

Sep 2013

CPM @ Fermilab

DPF2013

Snowmass2013

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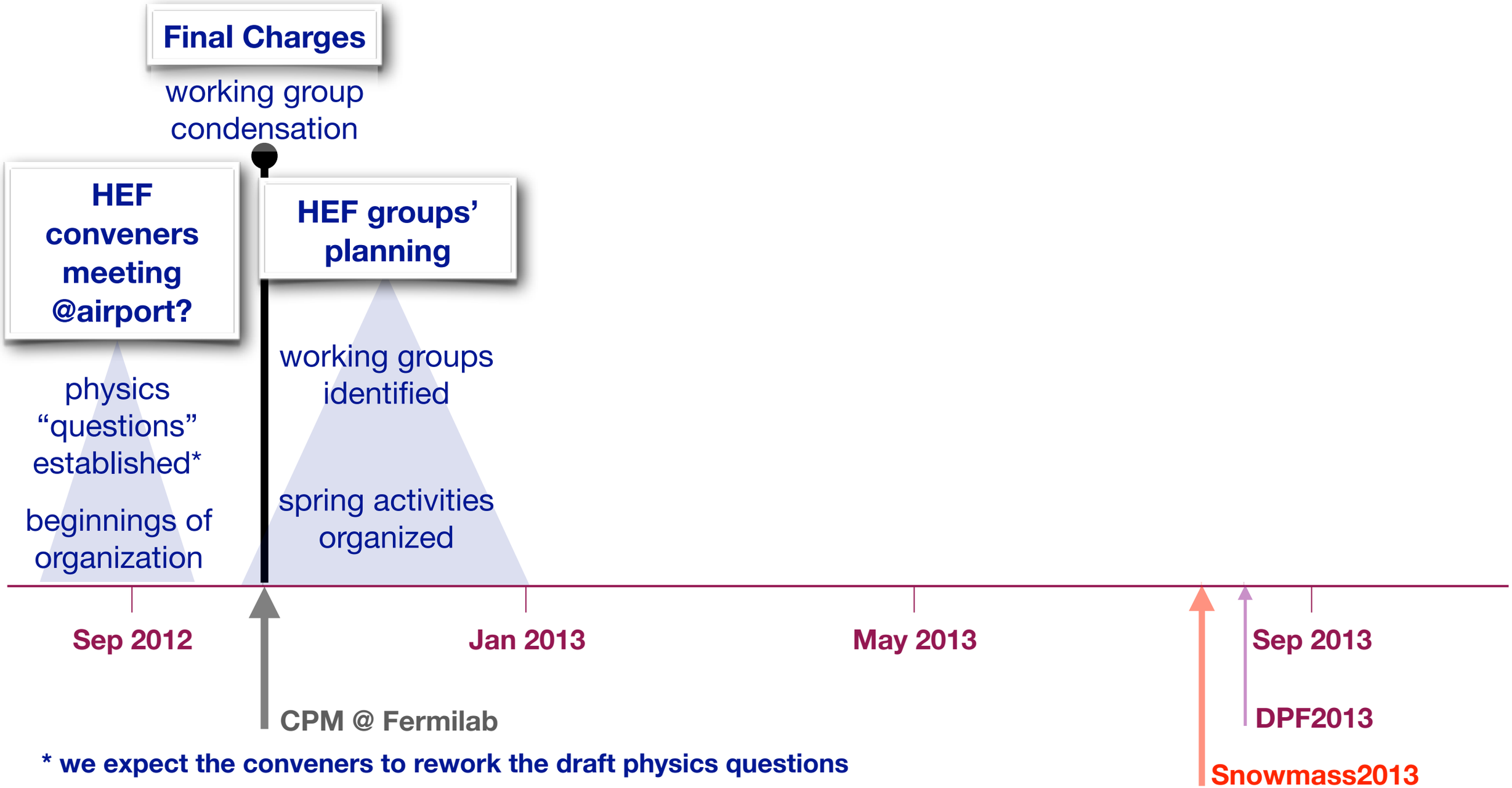

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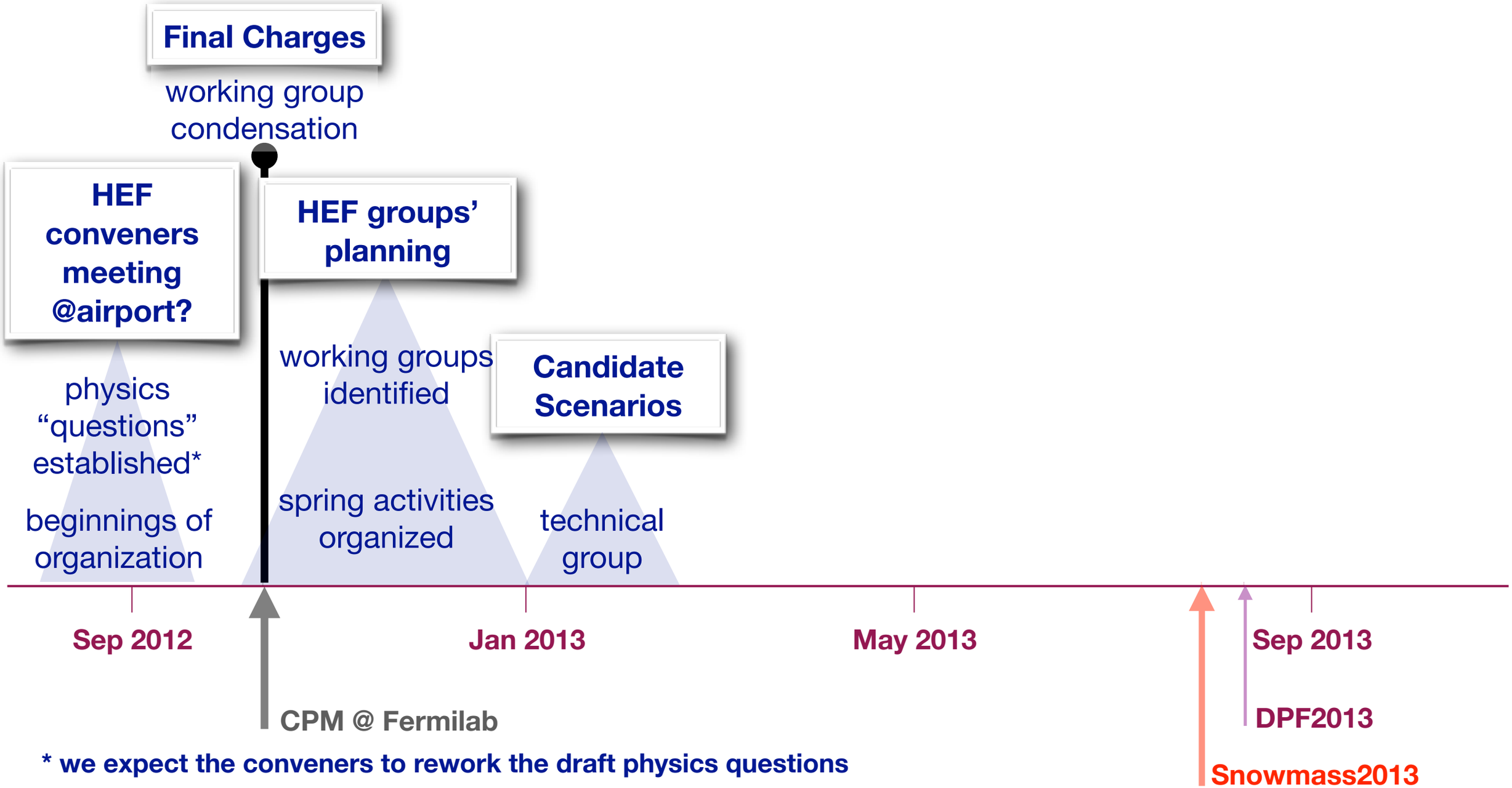

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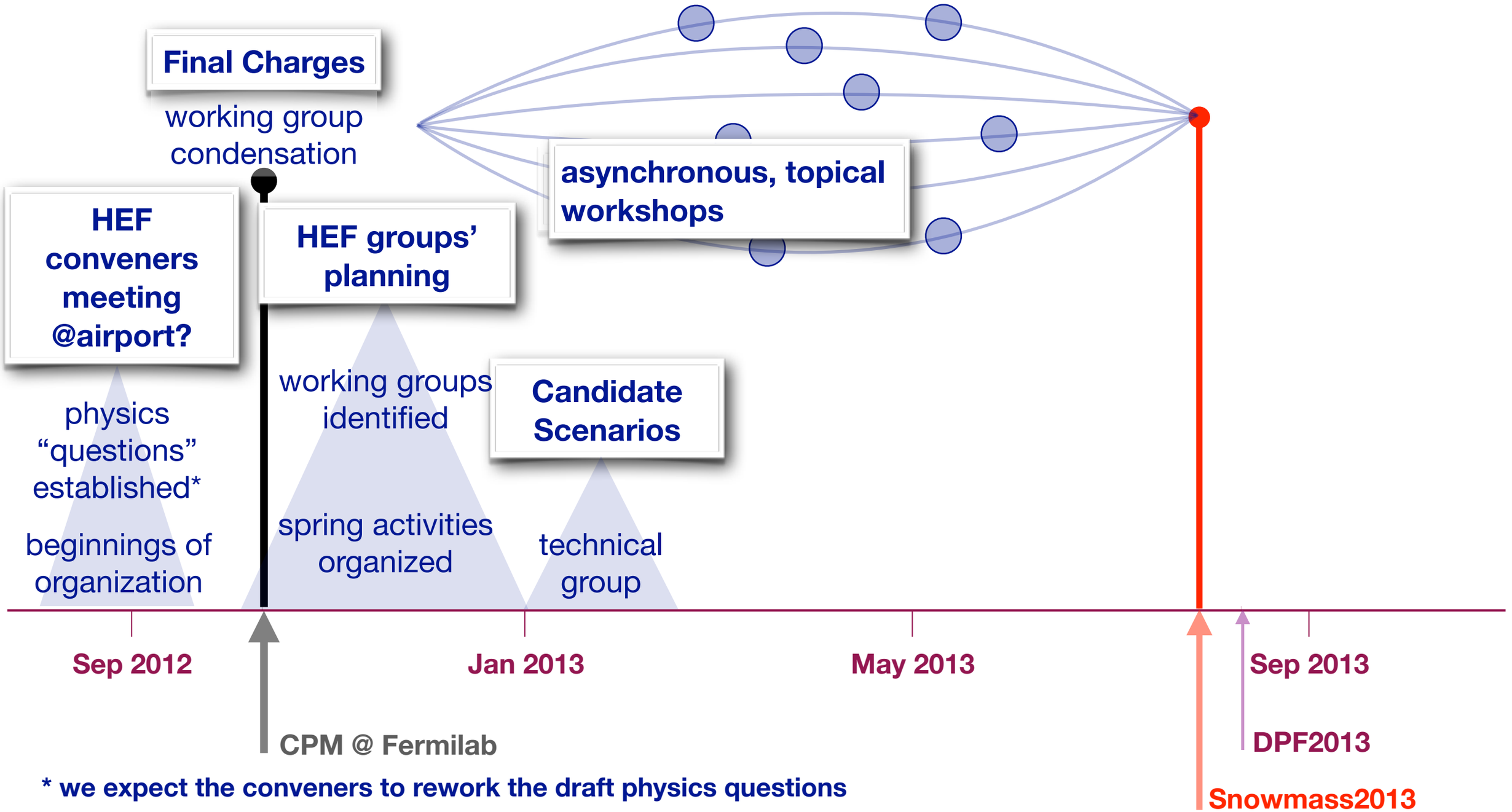

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Appendices

Links:

CPM2012 - Community Planning Meeting https://indico.fnal.gov/conferenceDisplay.py?confId=5323

“Snowmass” wiki http://snowmass2013.org

European Strategy Open Session 2012 http://indico.cern.ch/conferenceDisplay.py?confId=175067

Full HEF Charges follow:

Conclusions$_1$

Summer 2013 is the right time for a Snowmass

1st LHC run, complete; ILC Design Study, complete; neutrino program on a path

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The “European Strategy for Particle Physics” timing is useful...

`http://europeanstrategygroup.web.cern.ch/europeanstrategygroup/timeline.htm`

Inputs by end of October, and final report to CERN Council, March 2013

Jim, again:

Using the Plan

- **The program plan will be valuable in helping to describe, plan, defend and execute our program, both internally at DOE and with other government offices and the community.**
- **Even if we have funds available and all project-related requirements met, we still have to "sell" projects up the chain at DOE. We also have to articulate and defend our program to all the stakeholders**
- **We're in competition with other SC offices, so we need to be able to have a strong case for why HEP project/facility/plan is important to our field**
- **A clear plan leads to support within DOE and other government offices.**
- **Selling the plan takes time – all bases need to be covered. This is a continuing process**
- **Plans have a shelf-life. We try to push through what we can at the time. A few years later, the plans may need to be updated due to a changing landscape of activity, new discoveries, geo-politics, etc.**

- **Take the DPF planning process seriously, and participate!**

U.S. DEPARTMENT OF ENERGY | Office of Science

from presentation byJ. Siegrist - Fermilab 2012 Users Meeting

20

Wednesday, June 20, 2012

Conclusions$_2$

Yes. Snowmass is a big deal

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Thanks. Questions?

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Preliminary Charge to the group, **Precision Study of Electroweak Interactions**:

A. Please provide a compact summary of the state of Electroweak Physics, in particular precision measurements.

B. Please address the following goals for Electroweak physics in the future:

1. *What accuracies can be achieved on precision electroweak observables such as mW and sin^2theta_w? For experiments at hadron colliders, what information about QCD is needed to achieve the goals for these precision measurements? It is interesting to improve the Z pole measurements using a "giga-Z" facility?*
2. *How sensitive a test of the Standard Model can be achieved by comparing electroweak observables to the measured values of the Higgs boson and top quark masses? How sensitive will future measurements be to deviations from the Standard Model expected in models of new physics? What is the prospect for combining W Boson masses from the Tevatron, LEP, and LHC?*
3. *What accuracies can be achieved in measuring the parameters of W and Z 3- and 4-boson interactions?*
4. *If there is a strongly interacting Higgs sector with a spectrum of resonances in the TeV energy region, how well might the spectrum be measured, in particular, at a high energy hadron collider?*

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Preliminary Charge to the group, **Fully Understanding the Top Quark**:

A. Please provide a compact summary of the state of knowledge about the Top Quark.

B. Please address the following goals for Top Quark physics in the future:

1. *What accuracies can be obtained in the measurement of the top quark mass? What is the best convention for the definition of m_T, in particular, for hadron collider measurements, and, at what level of precision is such a specification needed? What are the implications of a high-precision m_T measurement?*
2. *To what accuracy can one measure the top quark cross section at hadron colliders?*
3. *To what accuracy can one measure the electroweak and magnetic moment couplings of the top quark? Which of these coupling are expected to most important for discovering new physics associated with the top quark?*
4. *Are there TeV-scale resonances that decay preferentially to top quarks? How can they be discovered? What are the predictions for the spectra of such resonances in possible models of new physics?*
5. *Are there new particles at the TeV scale that are partners or excited states of the top quark? What are the prospects for searches for such particles? What are the predictions for such particles in models of new physics?*
6. *What are the prospects for improving the QCD predictions for the multijet QCD reactions involving the top quark? What are the prospects for developing methods to specifically tag top quarks in hadron collisions?*
7. *What are the prospects for combining measurements of m_T from the Tevatron and LHC?*

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Preliminary Charge to the group, **The Path Beyond the Standard Model - New Particles, Forces, and Dimensions**:

A. Please provide a compact summary of the state of knowledge about searches beyond the Standard Model.

B. Please address the following goals for searches Beyond the Standard Model in the future:

1. *What are the future prospects for direct searches for production of new particles that decay to jets plus missing energy? What classes of models for the dark matter particle can be discovered or excluded?*
2. *What classes of supersymmetric models escape the searches at the LHC at 8 TeV? In these models, what strategies are needed to discover supersymmetric particles in future collider experiments? What are the prospects for direct experimental discovery of or constraints on the color-singlet particles of supersymmetry -- sleptons, gauginos, and Higgsinos?*
3. *To what extent do the LHC searches at 8 TeV winnow models of electroweak symmetry breaking based on Higgs composite structure or extra dimensions? Are new experimental strategies needed to discover the new physics that these models imply? How can the color-singlet particles in these models be discovered and studied?*
4. *What classes of models with very long-lived particles of 100 GeV - TeV mass are still allowed by the data from the 8 TeV LHC? Are there important theoretical schemes that are not yet significantly tested? How can these particles be discovered?*

We anticipate a dialogue between this group and the Dark Matter subgroup of the Cosmic Frontier study group.

C. Please guide your exploration of the above goals with the following scenarios/caveats:

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Preliminary Charge to the group, **Quantum Chromodynamics and the Strong Interactions**:

A. Please provide a compact summary of the state of knowledge of perturbative QCD calculations and the Strong Interactions, including the state of modeling in hadron physics.

B. Please address the following goals for Quantum Chromodynamics and the Strong Interactions in the future:

1. *What are the NLO and NNLO calculations required in order to pursue precision SM and BSM measurements? A list would be useful.*
2. *Are current jet algorithms robust for future high-energy and/or high luminosity experiments at hadron colliders? What are the prospects for modeling jet sub-structure modeling? Can we measure the color charge of the parton that initiated a jet?*
3. *Critically evaluate the prospects for parton distribution determinations in the future. Are new data or analyses of existing data missing? Are heavy quark effects reliably included in pdf determinations?*
4. *What are the prospects for resummation of low-x gluon effects to high precision? What strong interaction physics measurements will require high-precision resummation? Will BFKL effects be measurable?*
5. *Are there gaps in our understanding of diffractive and hard diffractive physics?*
6. *What is the state of non-perturbative methods for QCD at high energy? Are there measurements for which nonperturbative QCD theory is required? Can nonperturbative or all-orders results in model field theories such as N=4 Supersymmetric QCD contribute to the understanding of QCD at colliders?*

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Preliminary Charge to the group, **Quark Flavor and Mixing at High Energy**:

A. Please provide a compact summary of the state of knowledge of Heavy Flavor and Quark Mixing, in particular, for systems that go beyond the K and B mesons.

B. Please address the following goals for Heavy Flavor and Quark Mixing in the future:

1. *Given the present constraints on CP violation in B_d decays, what forms of new CP violation physics might be present that are best seen in the B_s or B baryon systems? What are the prospects for discovering these effects?*
2. *What are the prospects for discovery of exotic muti-quark states?*
3. *How can we test models of CP violation specifically associated with the top quark or the Higgs sector? How can we test models of CP violation specifically associated with new particles of TeV mass?*
4. *What types of flavor violation could we find in models of new physics? What effects at high energy colliders could reveal these new couplings?*
5. *Are there models with baryon number violation at TeV energies that could be tested at the next generation of accelerators?*

We anticipate a dialogue between this group and the Heavy Quark subgroup of the Intensity Frontier study group.

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