Snowmass on the Mississippi

From the perspective of a young scientist

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Syracuse University

Outline

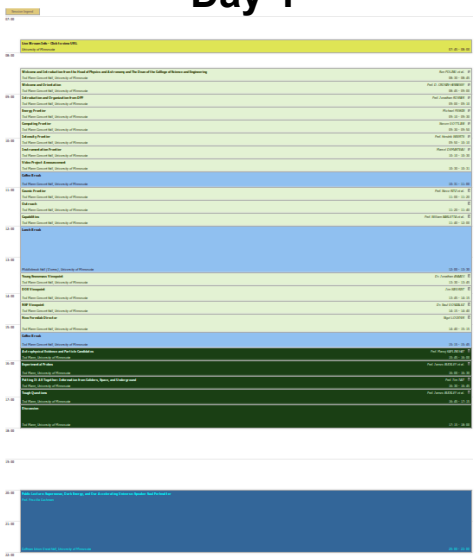
- **Overview of Snowmass**
  - *What was Snowmass?*
  - *Some thoughts from Snowmass*
- **Snowmass Young**
  - *Contributions I was part of*
- **Going Forward**
  - *What comes next*

Full Disclosure

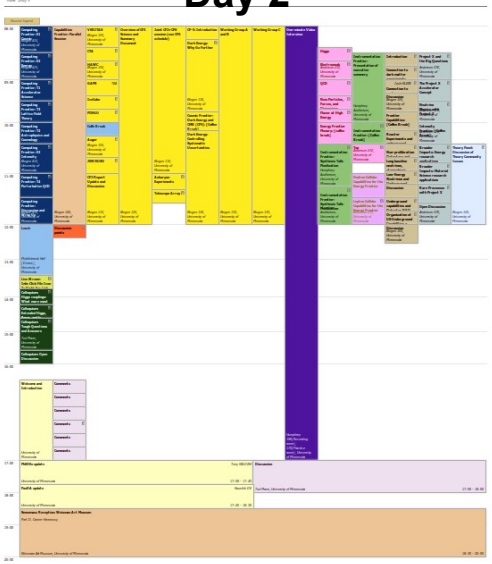
Snowmass on the Mississippi 2013

(Impossible to attend every session)

Day 1



Day 2



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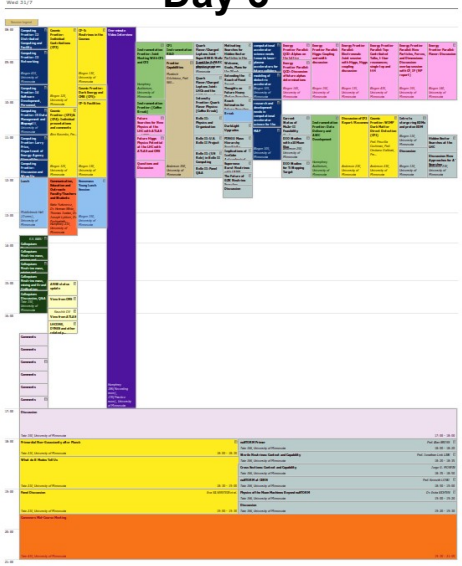

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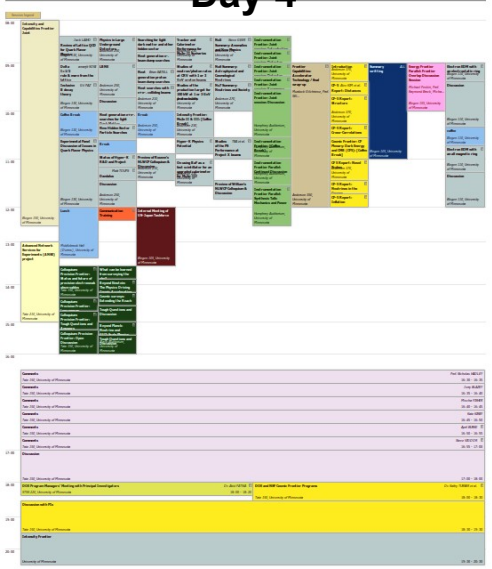

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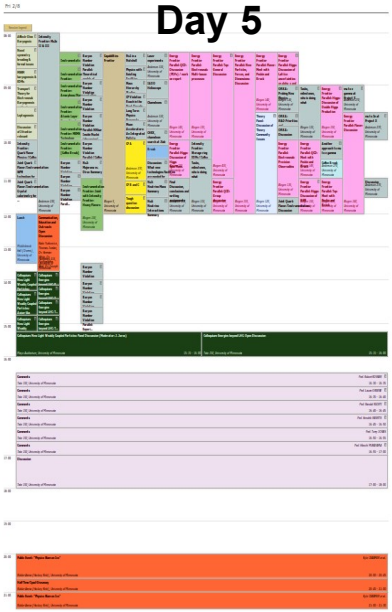

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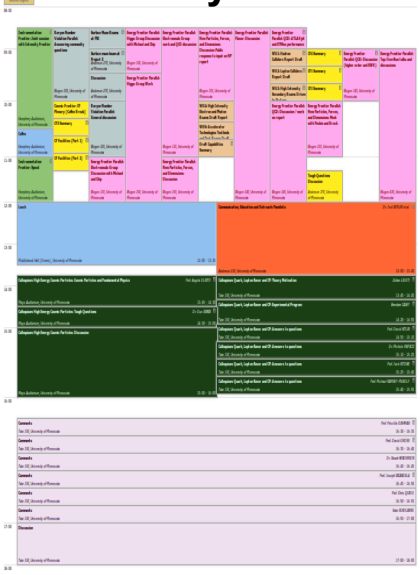
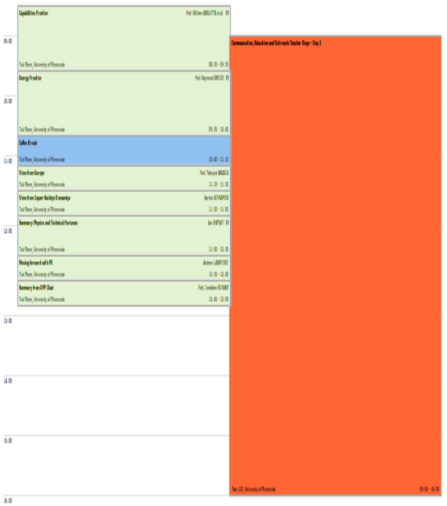


Day 7

Day 8

Day 9



More Disclosure

In 2001 Snowmass was 3 weeks long in Snowmass, Colorado

Snowmass 2001						
S	M	T	W	T	F	S
S	M	T	W	T	F	S
S	M	T	W	T	F	S

Snowmass 2013!

October 2012						
S	M	T	W	T	F	S
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November 2012						
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December 2012						
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January 2013						
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February 2013						
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March 2013						
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April 2013						
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May 2013						
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June 2013						
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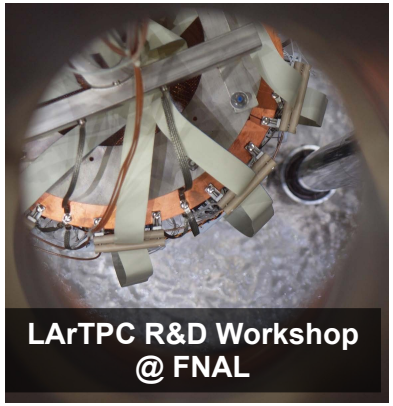
July 2013						
S	M	T	W	T	F	S
S	M	T	W	T	F	S
S	M	T	W	T	F	S
S	M	T	W	T	F	S

Became 8 months, > 50 meetings, more than 5 general workshops, lots of phone conferences and a summer school

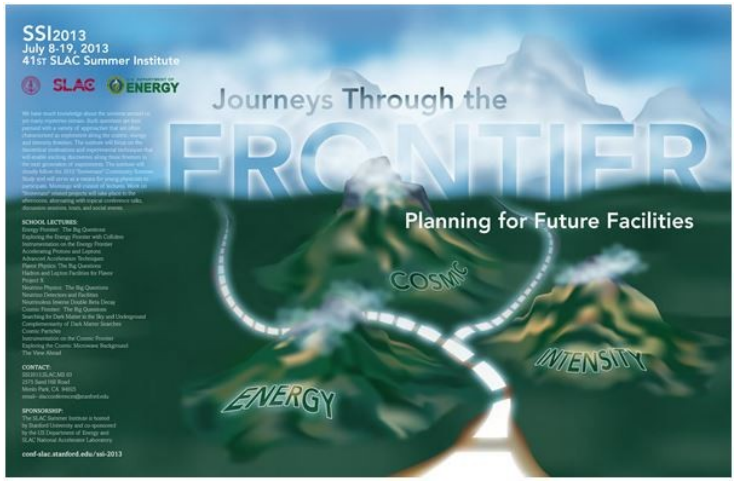
(I did not attend all these meetings)

More Disclosure

- However, I did attend a lot of Snowmass meetings!



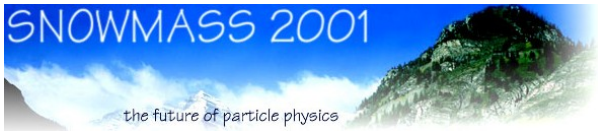
- Moreover, because of my involvement with Snowmass Young, I got to hear directly from many other people who attended lots of the other Snowmass meetings



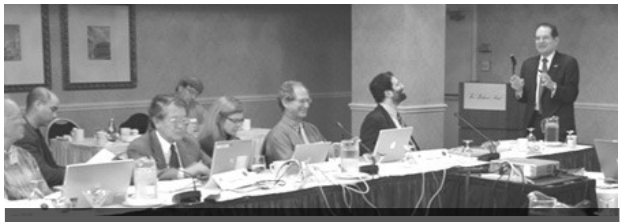
Overview

A little history...

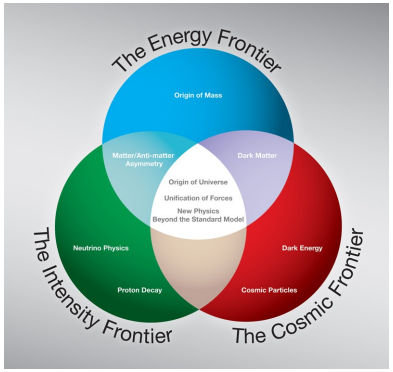
- **This isn't the first time we've done this exercise...**
  - In the past this was a many week long workshop done on the slopes in Snowmass, Colorado



- **This isn't the only planning we do as a field either...**
  - **HEPAP** (High Energy Physics Advisory Panel, **P5** (Particle Physics Project Prioritization Panel) process, etc...



From 2006 so I'm not sure why this is in black and white...

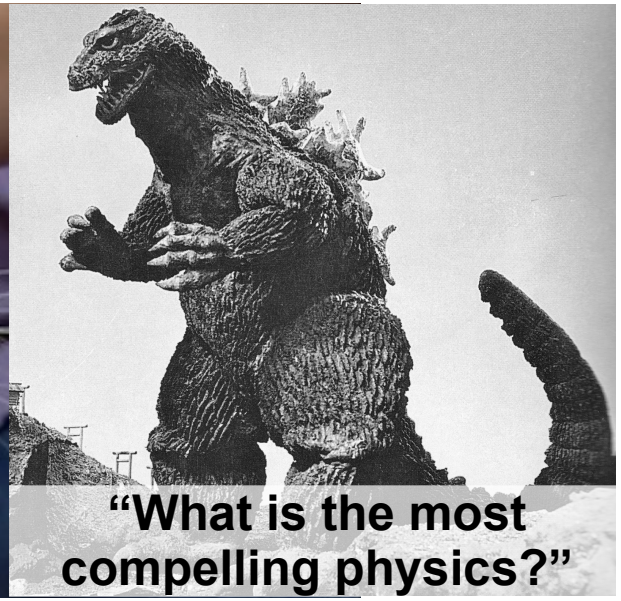


What were we doing at all those meetings?

- **From the Snowmass website**
  - *"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."*

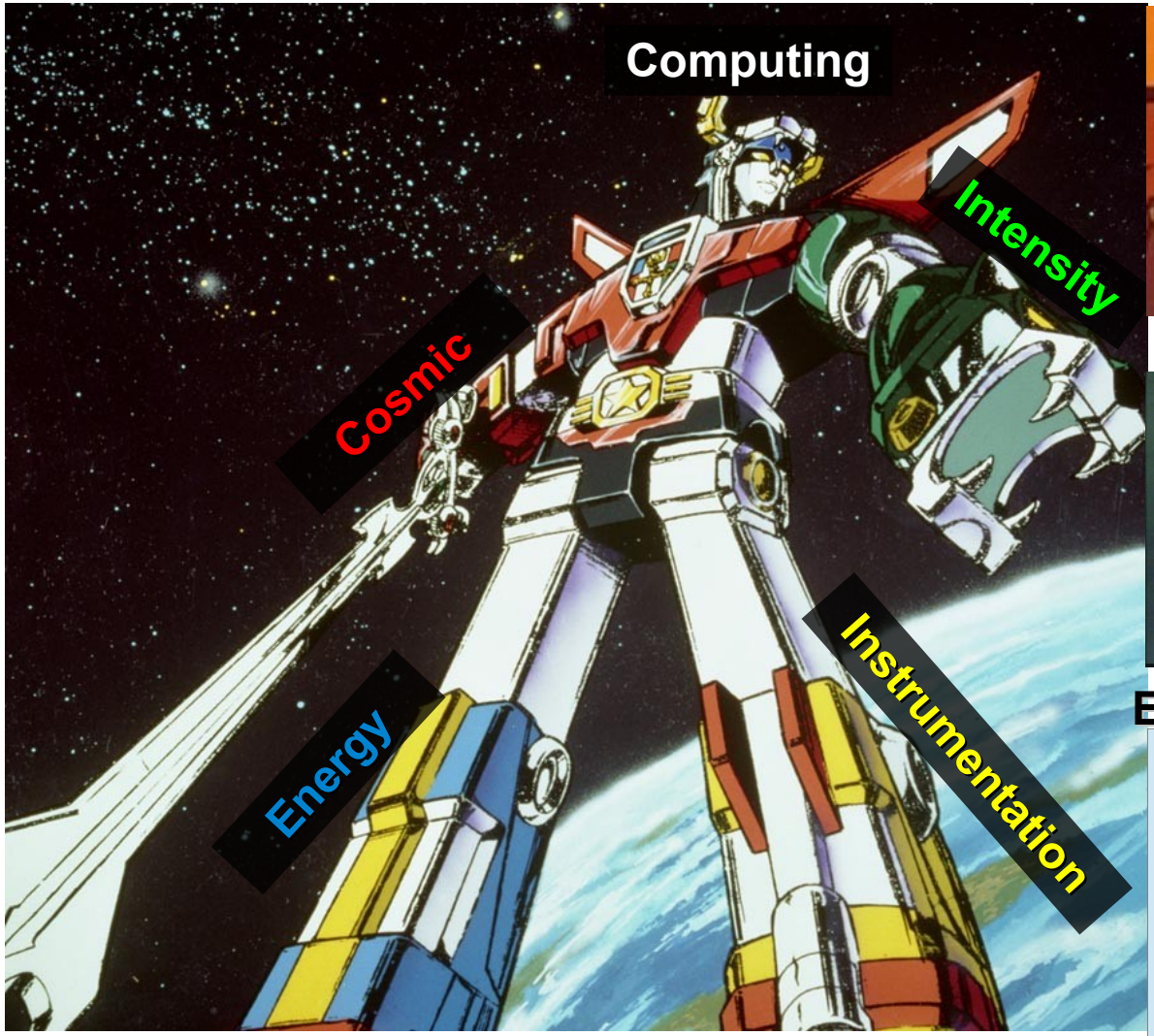
- **One way to translate**
  - Opportunity to "take a step back" and chart a course for HEP in the next decade
  - "What is the most compelling physics?"
  - "What facilities do we need to accomplish the physics"
  - Develop a unified message

How to attack the question?



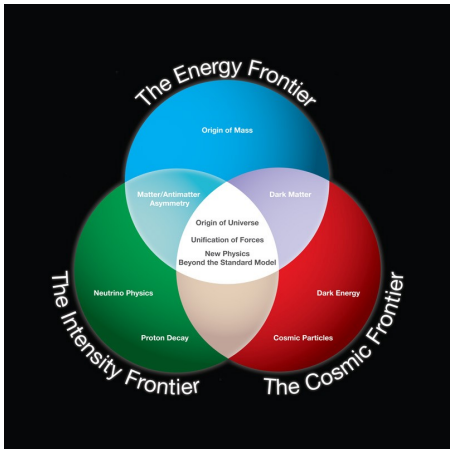
- **Tackle the difficult question of what is the most compelling physics to pursue for the next 10-20 years?!?**
  - Along with all the tangle of what facilities you need / budget questions / international partnerships / etc....
  - I think HEP took an approach from a superhero character from my childhood

Snowmass on the Mississippi
=
Voltron Defender of the Universe

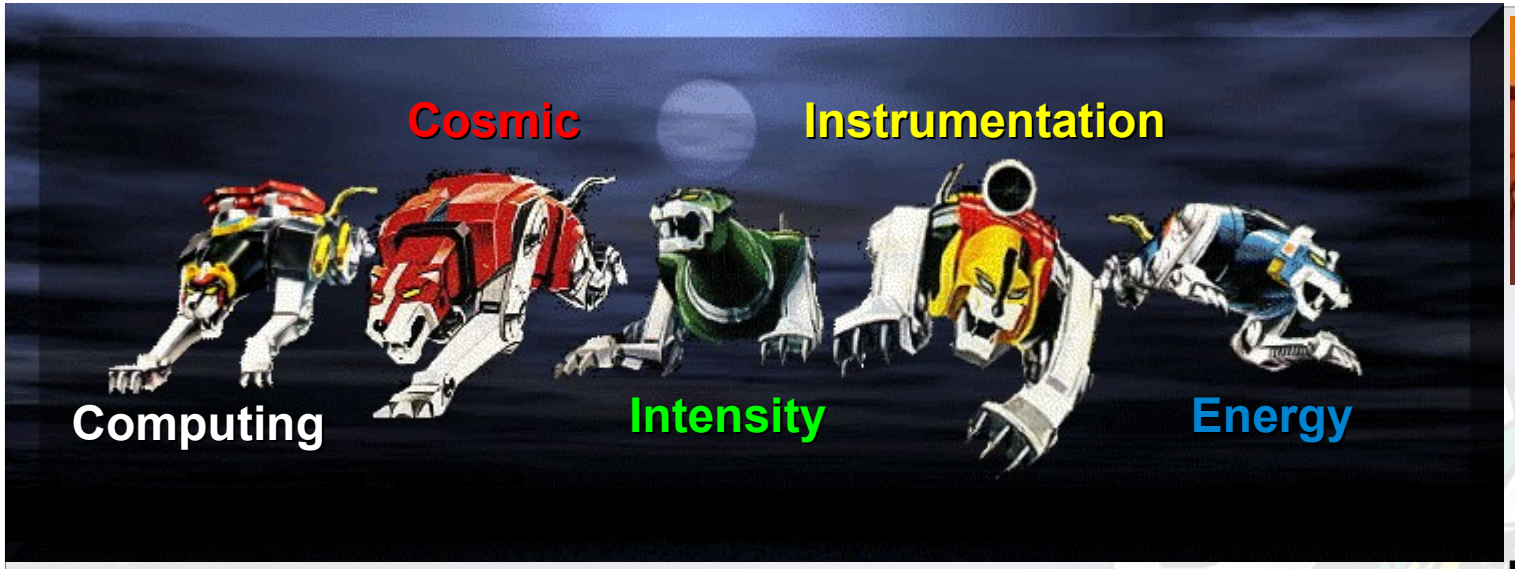


Theory

Education/Outreach

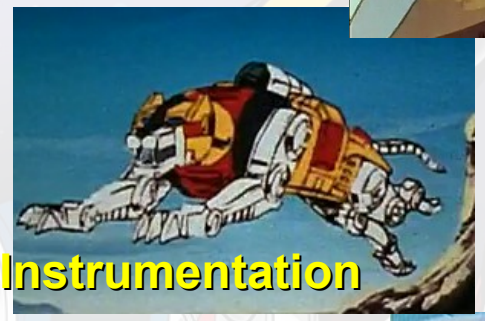


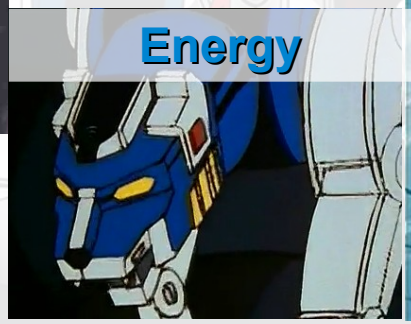
Don't worry if you've never seen the show...I will tell you why I think this is a better analogy than the three circles (in case you needed convincing)



Theory

Education/Outreach

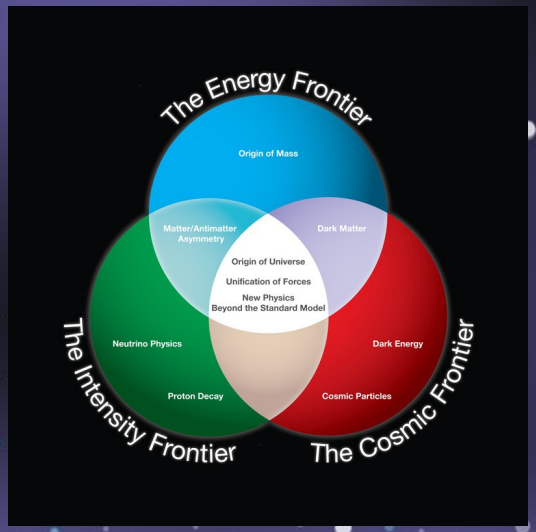


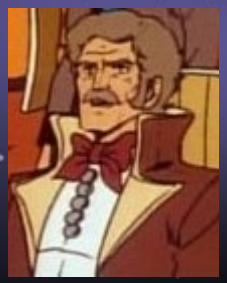


We set out attacking the question (what is the most important physics) separately in many Pre-Snowmass meetings

But just like in the show, we are better when we combine!

Snowmass on the Mississippi 2013





Theory

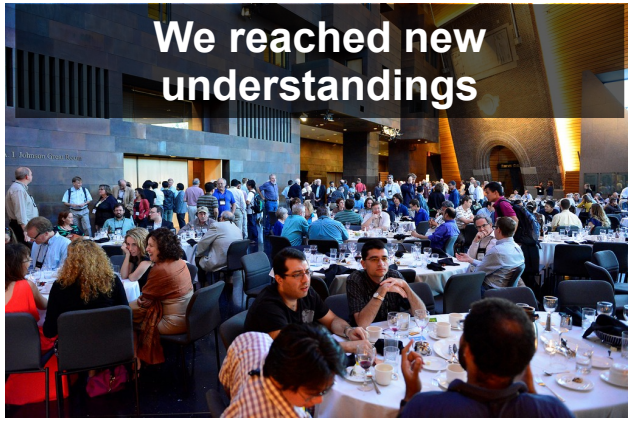
Education/Outreach

Energy Cosmic Computing Intensity Instrumentation

So what happens in every episode once they form Voltron?

So how did it go for Snowmass 2013?

Well....the “battle” is actually still going on...but we did make progress



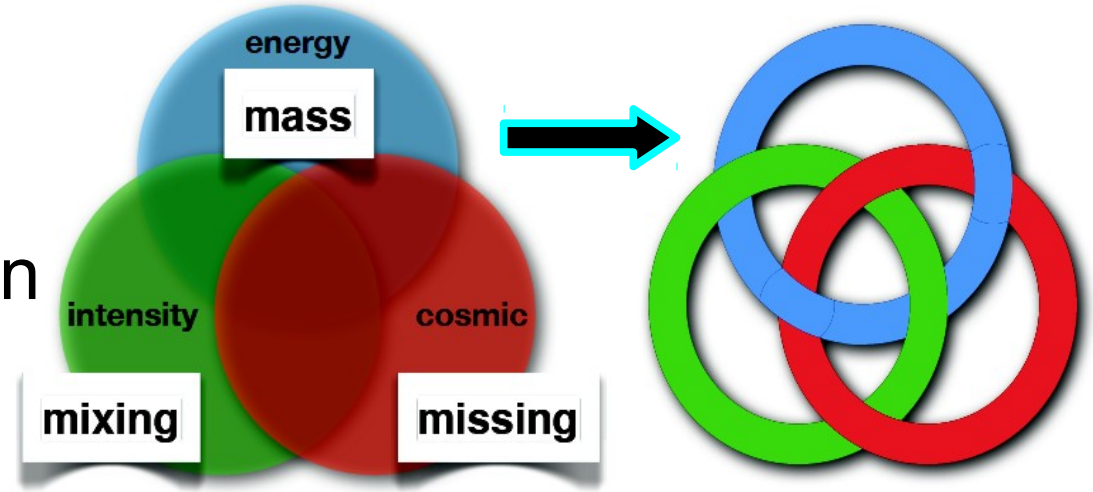
Snowmass 2013

Warning: What is coming next is a combination of my opinions and slides put together by others

- I was struck by the discussions at Snowmass that there is actually broad agreement on 3 major pieces physics that are agreed upon across frontiers and have good prospects in the next 10 years
  - **Dark Matter**
    - Direct/Indirect detection
  - **Neutrinos**
    - Properties and anomalies
  - **Higgs Boson**
    - Precise measurements on the nature of mass mechanism

And always keep an eye out for new physics!

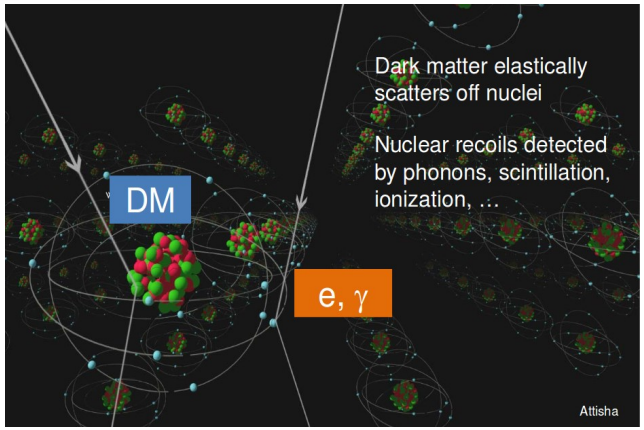
“Land, Air, Sea” Approach

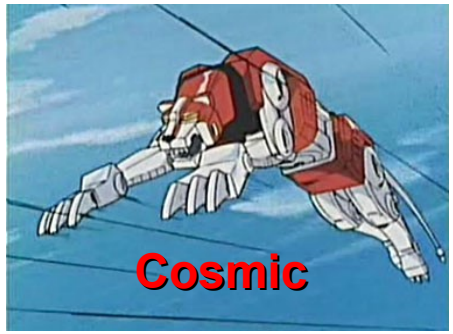


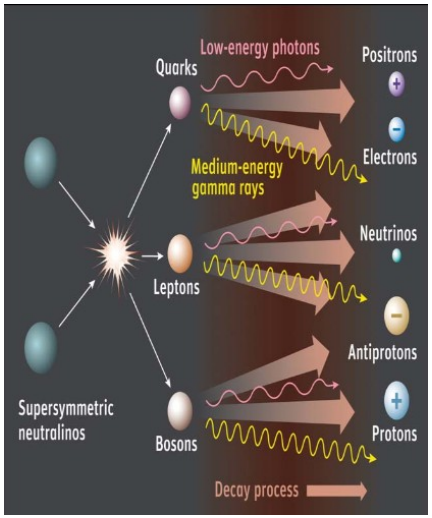
- **Dark Matter**
  - Direct/Indirect detection
- **Neutrinos**
  - Properties and anomalies
- **Higgs Boson**
  - Precise measurements on the nature of mass mechanism

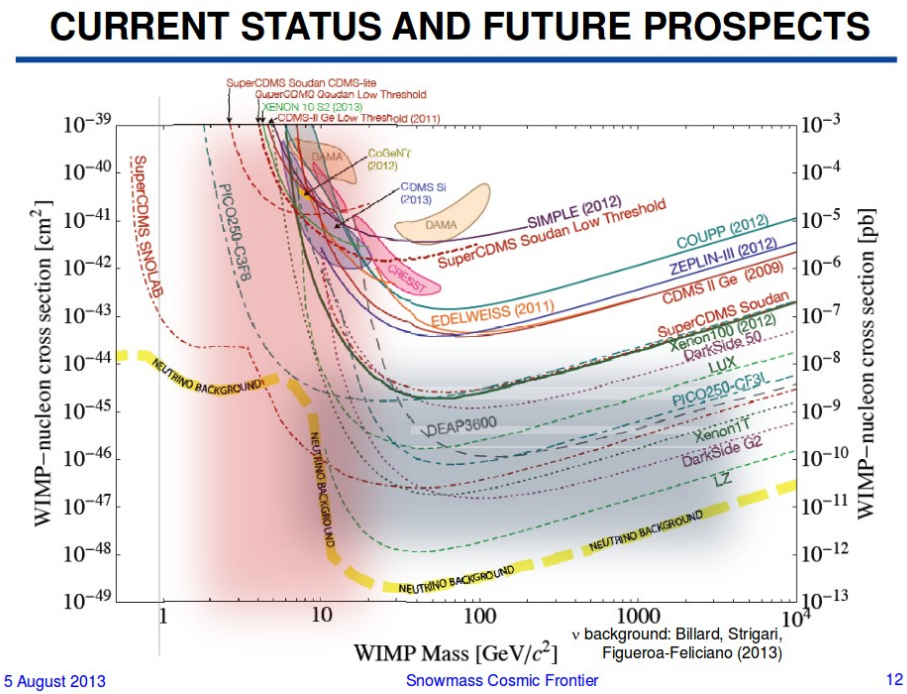
One compelling aspect to thinking about these pieces of physics is that our “frontiers” provide complimentary information too each other through a number of different experiments

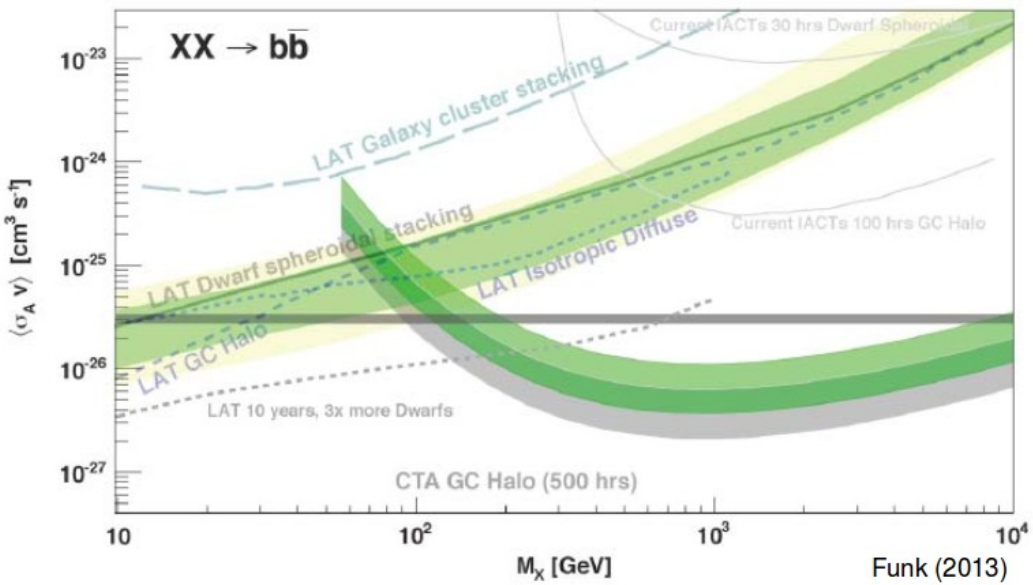
An example...Dark Matter











Direct Detection

Indirect Detection

An example...Dark Matter

New Light Weakly Coupled Particles

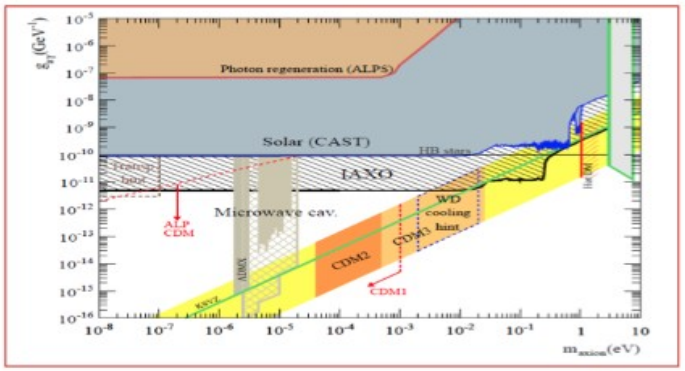
Portals

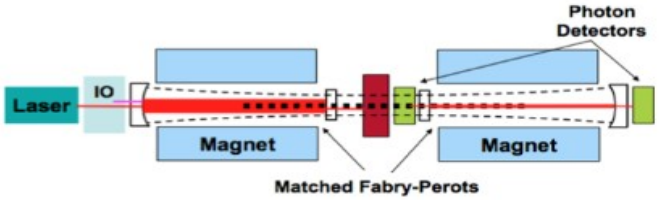
- "Axion" $\frac{1}{f_a} F_{\mu\nu}\tilde{F}^{\mu\nu} a$ — axions & axion-like particles (ALPs)
- "Vector" $\epsilon F^{Y,\mu\nu} F'_{\mu\nu}$ — dark photon A'
- "Higgs" $\lambda H^2 S^2 + \mu H^2 S$ — exotic Higgs decays?
- "Neutrino" $\kappa (HL) N$ — sterile neutrinos?

Essig

Other sources of Dark Matter

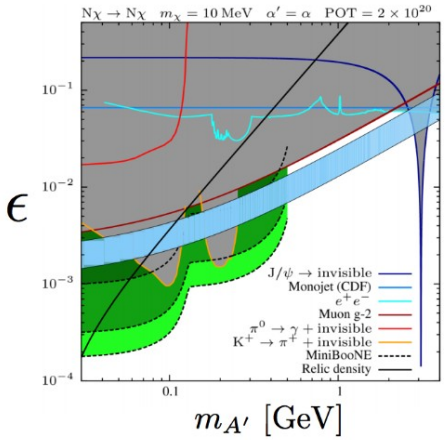
Axion coupling to γγ vs. Axion mass



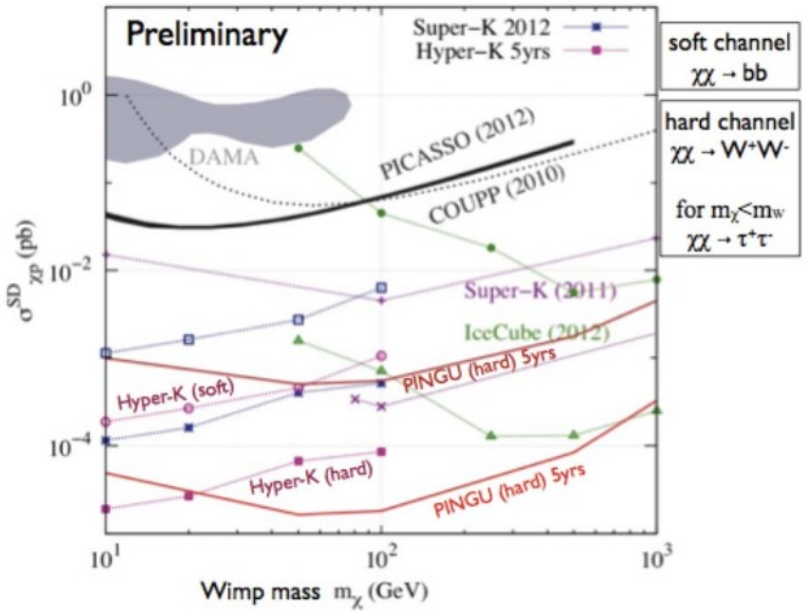


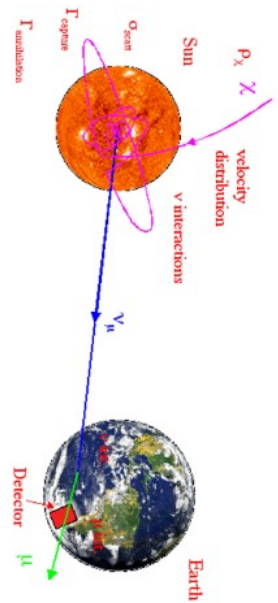
Proton-beam based searches

MiniBooNE proposal for sub-GeV DM search

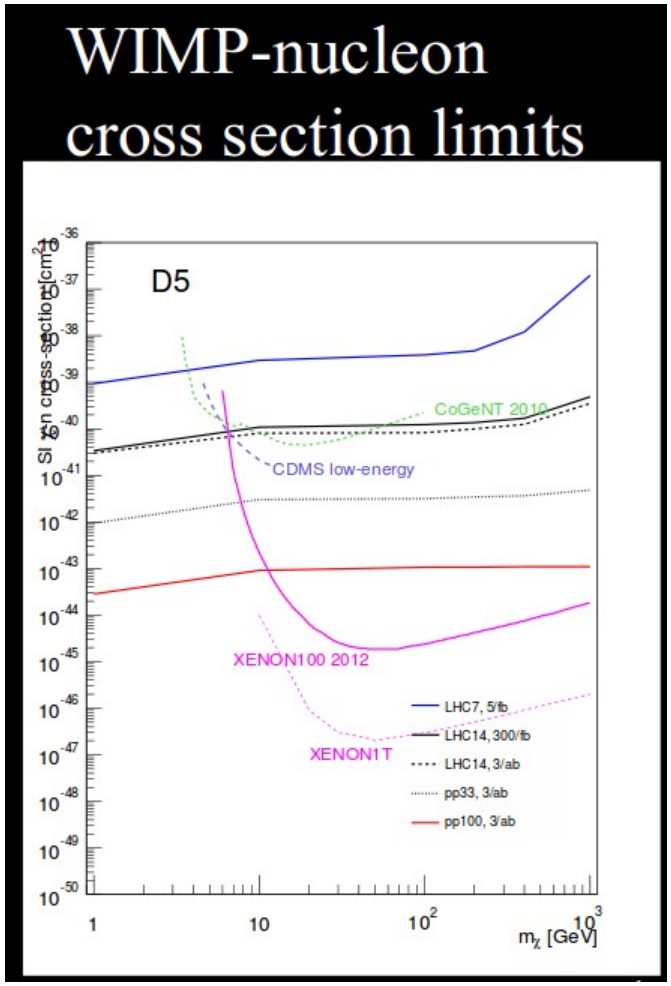


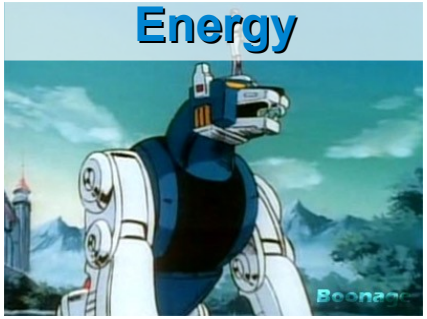
INDIRECT DETECTION: NEUTRINOS

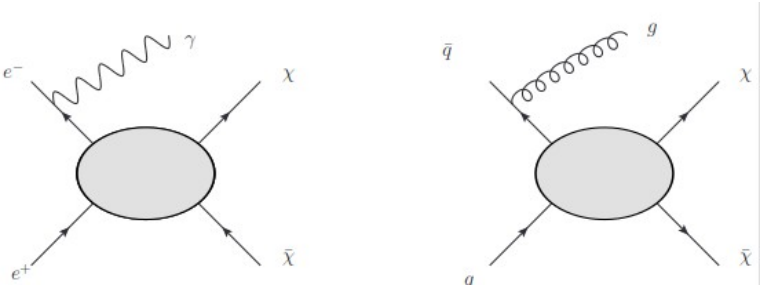




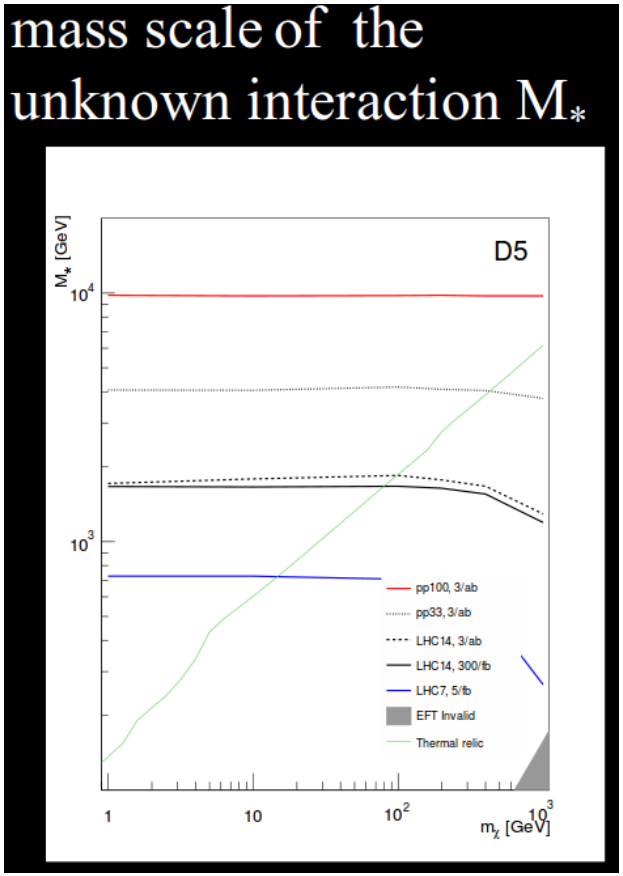
An example...Dark Matter







Direct Production of WIMP Dark Matter



Can be done with a dizzying array of sensitivities at various colliders

Cheating?!?!

<u>You might be sitting there saying:</u>

"No fair just saying that all frontiers should do everything! We live in a world of limited budgets and time and I thought Snowmass was going to tell me which of these approaches was the *<u>best</u>* one to pursue..."

<u>Then I would say:</u>

"Nope, that isn't what Snowmass was about...but don't worry because that is coming real soon"

Snowmass wasn't about picking the “best” experiment and going forward and funding that one thing....

Instead, I think Snowmass was about coming together (after spending much time apart debating with ourselves) and laying out what is the most compelling physics and how we (from the respective frontiers) would go about pursuing that!

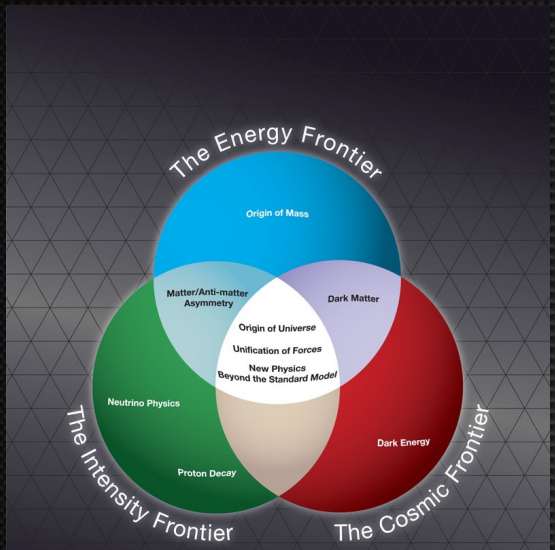
(And at least in my mind I have an idea of what and why that physics matters!)

What seems to emerge (at least for me) is a story that we can take to our funding agencies and to congress and say:

→ “Here is the physics that has us psyched! We have a lot of good ideas how to go about answering these really fundamental questions. We are now going to select the most compelling ones and find an answer that is complimentary across multiple fields and frontiers!”

Snowmass Young

Snowmass Young Physicist



Contributors

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Conveners

Find us on the internet

http://snowmassyoung.hep.net

Facebook

https://www.facebook.com/snowmass.young

Twitter

https://twitter.com/snowmass2013

Email to organizers

(Jonathan Asaadi and Roxanne Guenette)

snowmass2013young@gmail.com

Join the Email list

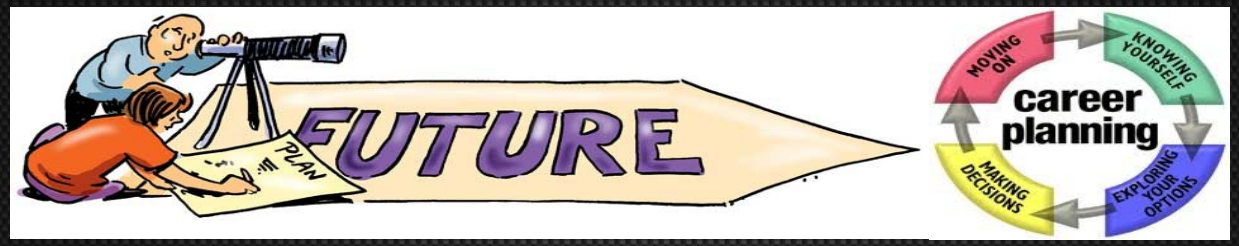
LISTSERV@LISTSERV.FNAL.GOV

with an empty subject line, and in the body:

subscribe SNOWMASS-YOUNG Your Name

Purpose of Snowmass Young

- **Get untenured (young) particle physicists to participate in the Community Summer Study.**



- **The truth is that the long-term planning of the field means that decisions which will effect your future are taking place right now!**

Future experiment planners are not the future experimenters!

You will be the one building, running, and staking your careers on these experiments!

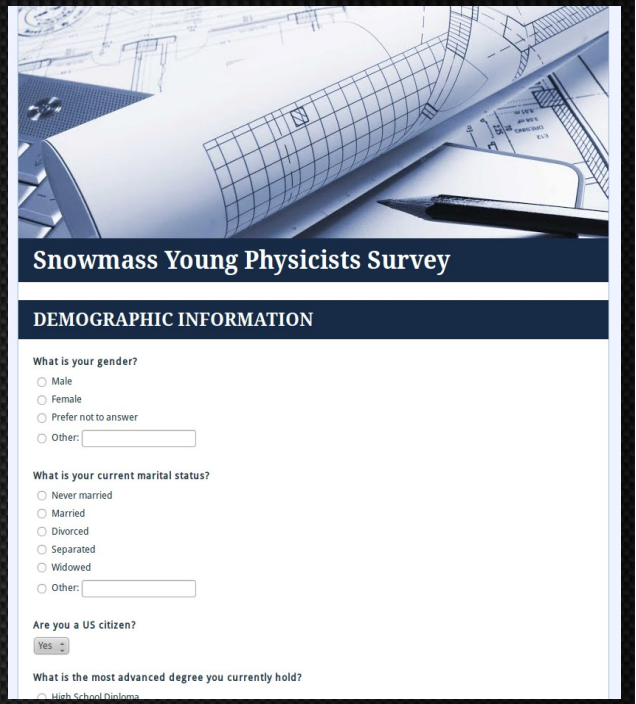
Story....

- **Snowmass Young in 2001**
  - Self organize to give input
  - Took a survey to get the opinions of the field as input to Snowmass
  - Formed the YPP (Young Particle Physicists) to act on behalf of “young” people after Snowmass

- **Snowmass Young in 2013**
  - Organized during the Community Planning Meeting at FNAL in October 2012
  - Formed the Snowmass Young Physicists to help organize efforts both during and after Snowmass
  - Decided to administer another survey to build on the success of the last effort

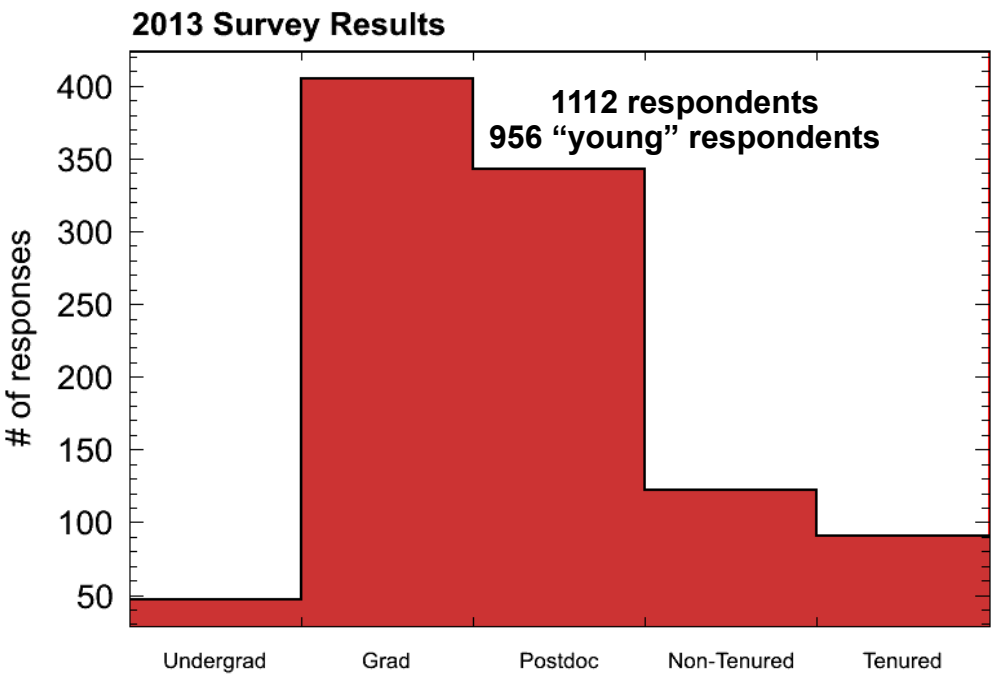
Survey Methodology

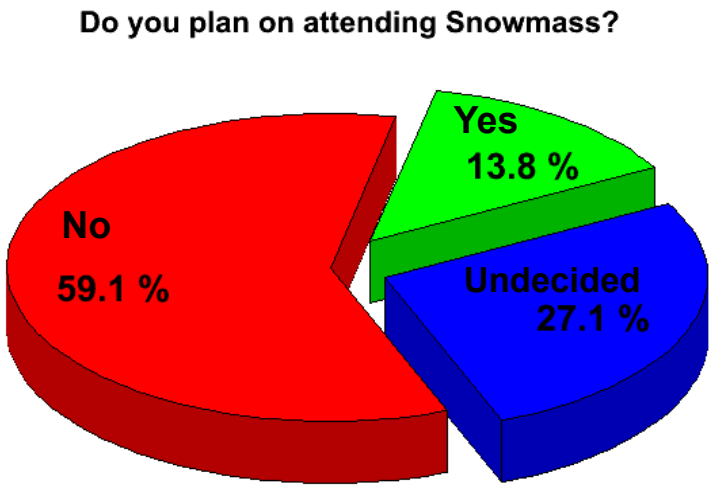
- **Collect a broad range of opinions that reflect both the physics interests and career concerns of HEP**
  - Allow us to look for trends across frontiers and at different stages in their career
  - Attempt to figure out what physics people are excited about ("vote with their feet")
  - Additionally, collect the opinions and work experience of those who have left HEP for jobs outside the field
- **Survey broken into 4 sections**
  - Demographic
  - Career Outlook
  - Physics Outlook
  - Non-academic career paths

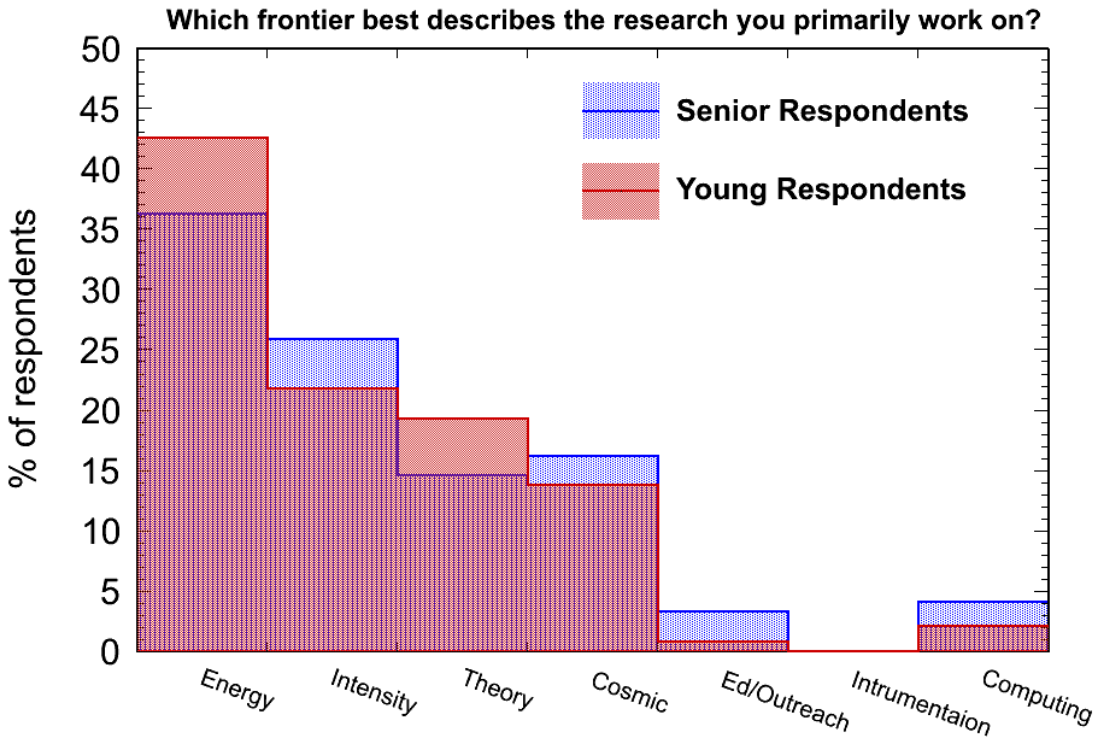


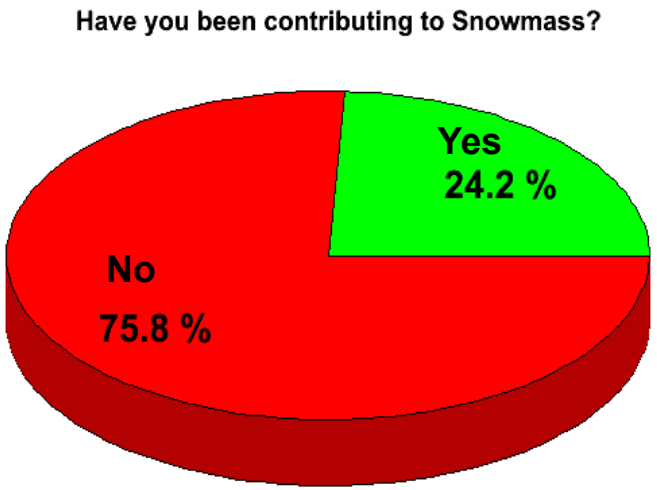
Today I am going to share some of the interesting things we found

Much more detail in our paper on the arxiv 1307.8080





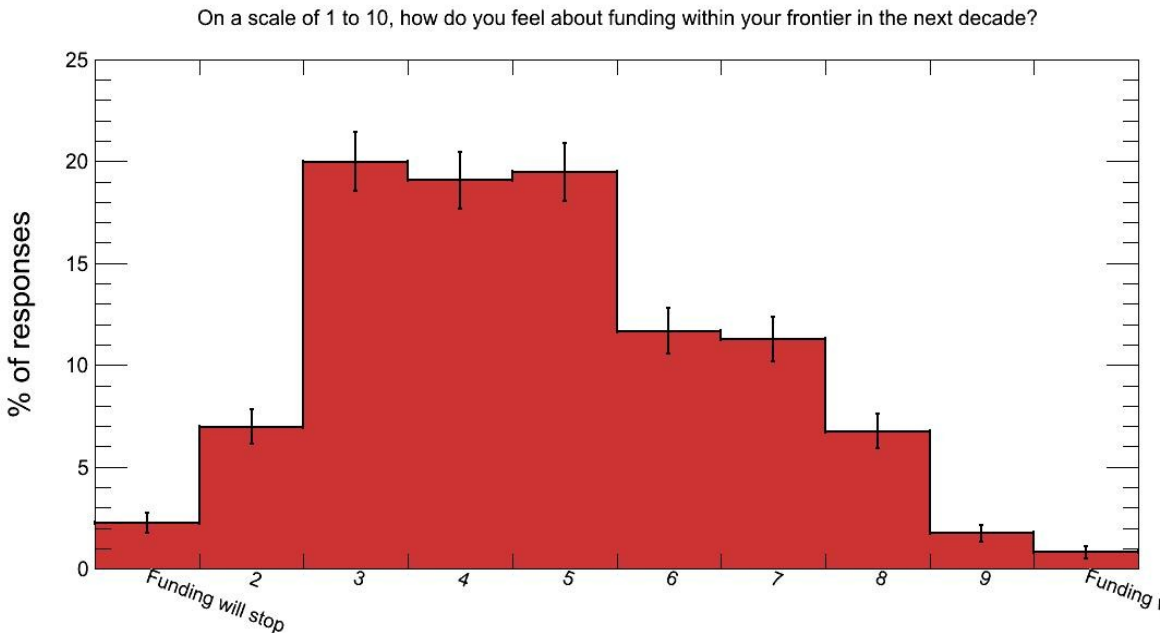


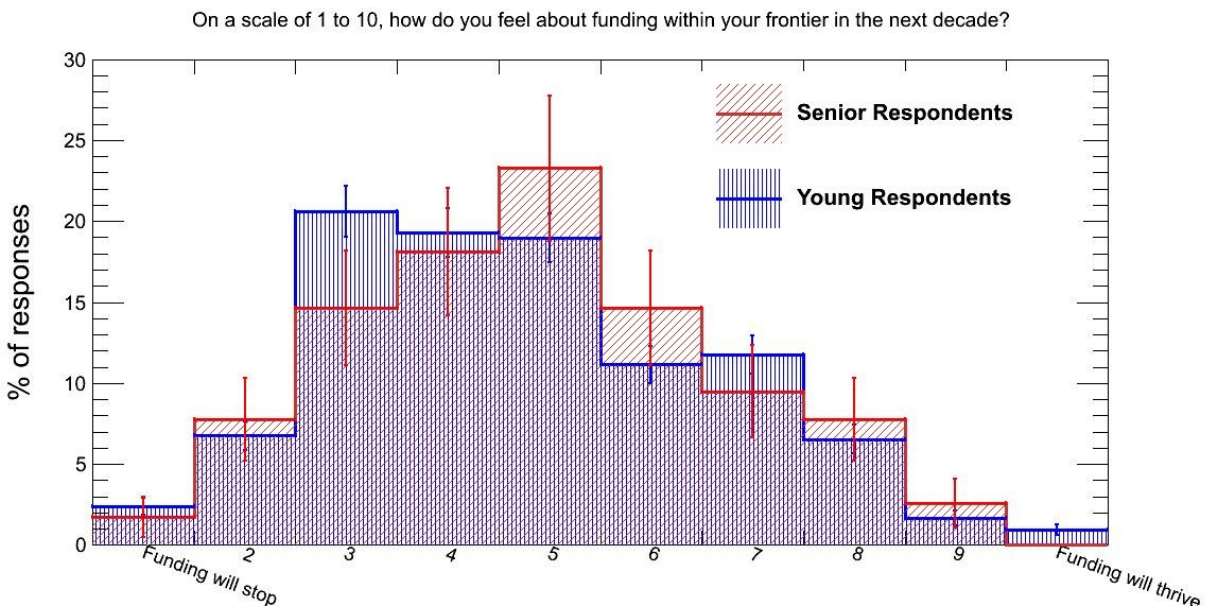


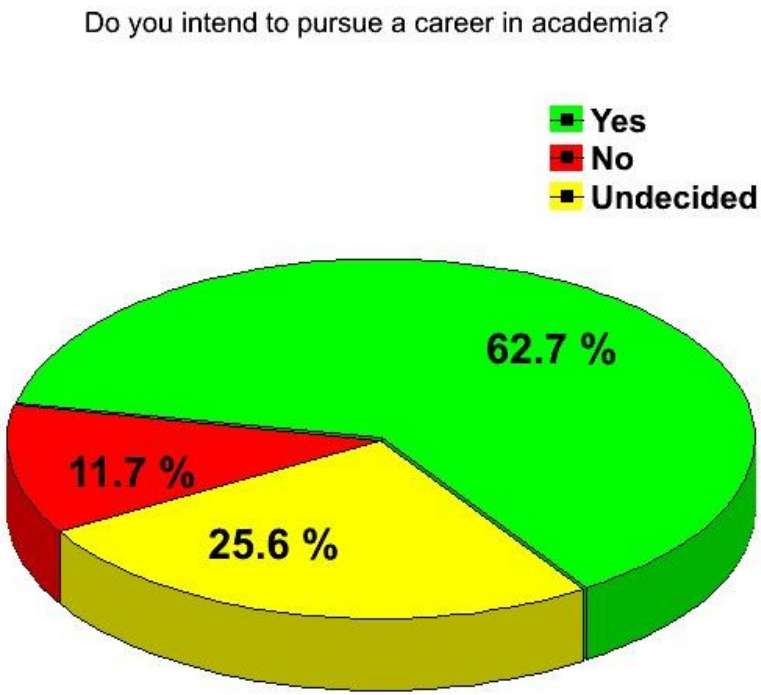
This makes the opinions heard in the survey all the more important!

1. **On a scale of 1 to 10 (1 = Funding will stop, 10 = Funding will thrive) how do you feel about the funding within your frontier within the next decade?**

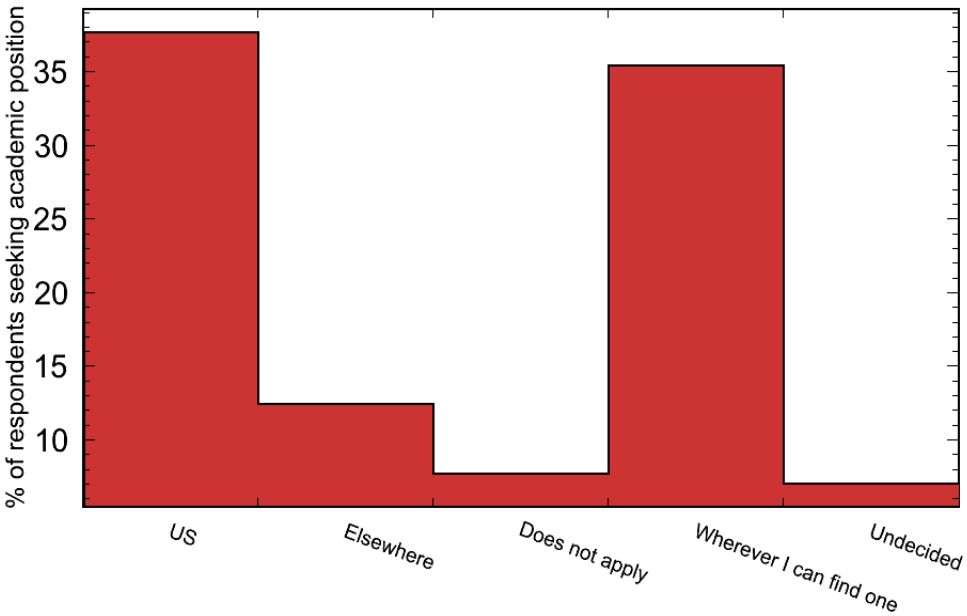
Nearly 60% of the respondents believed that funding was more likely to decline (giving an answer less than or equal to 5) in the future.

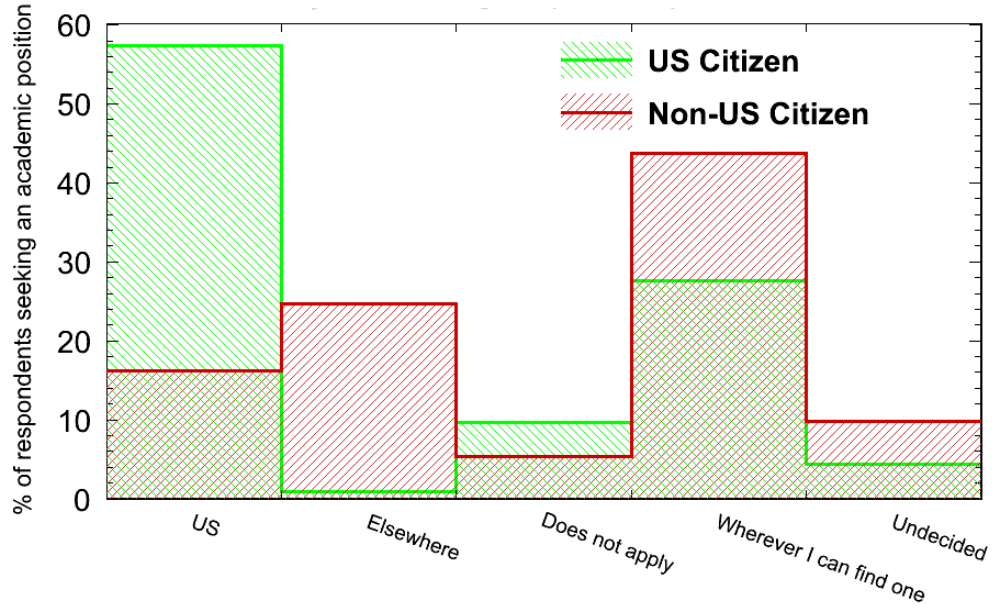


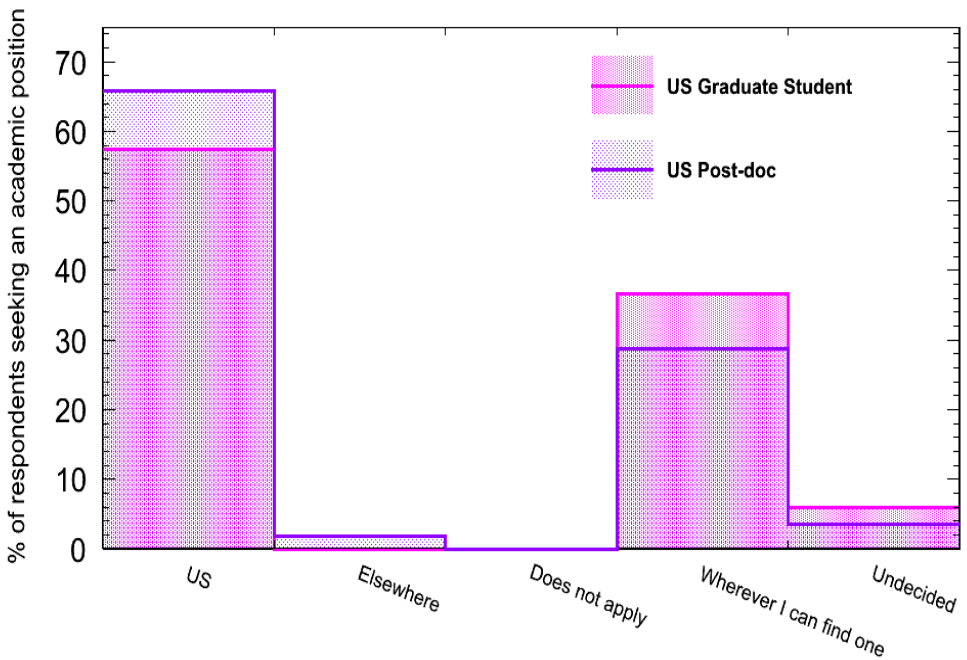


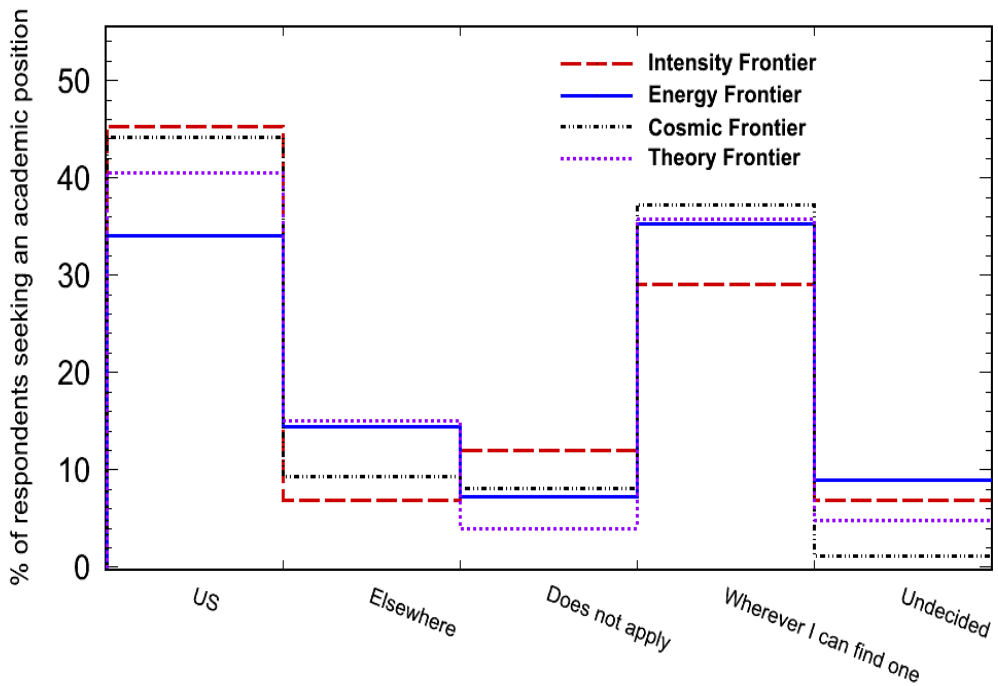


In the future will you be searching for a permanent academic position in the US or abroad?

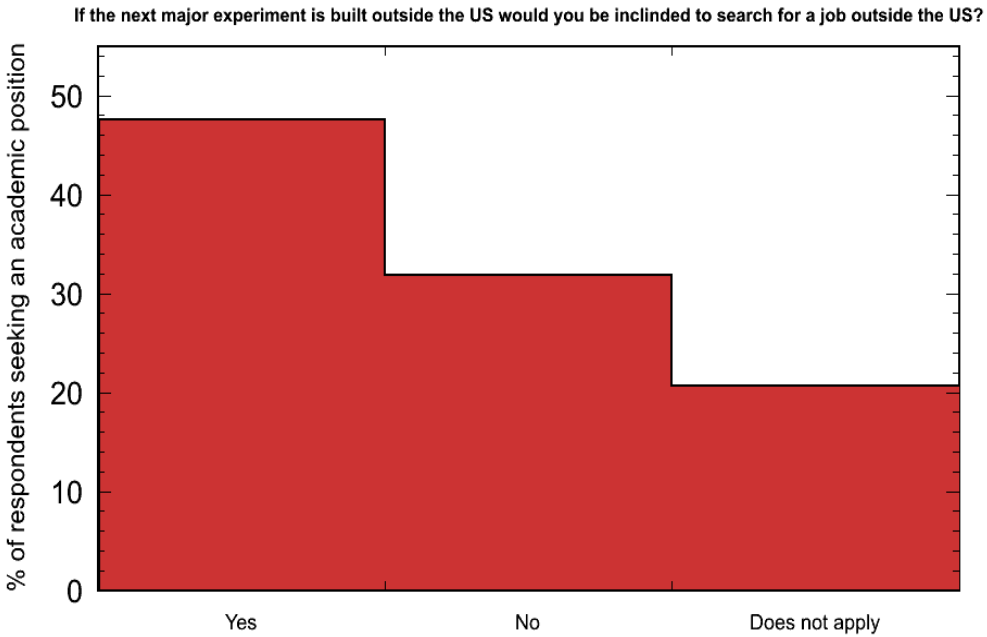


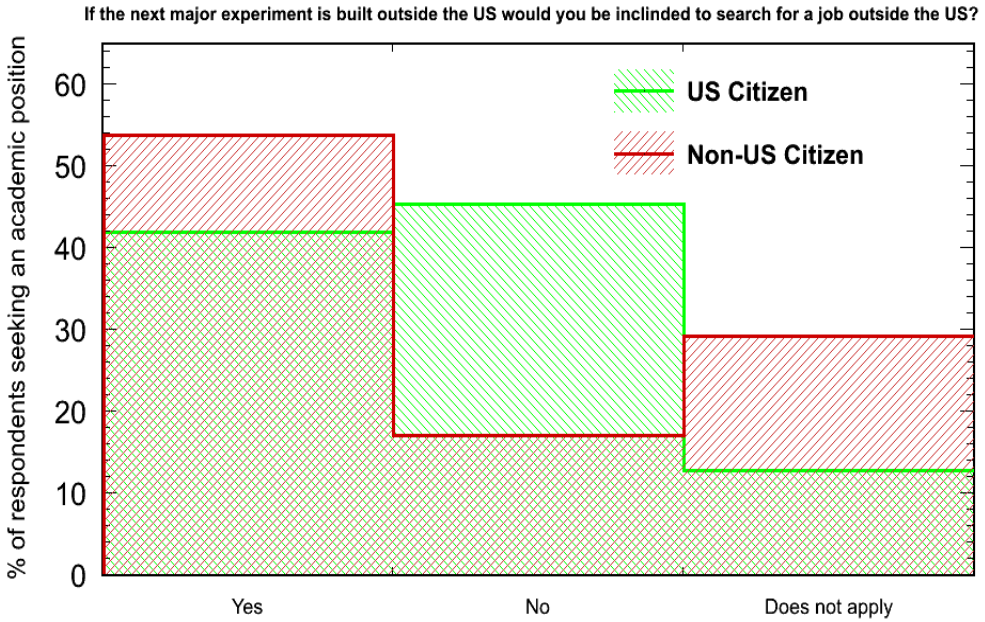


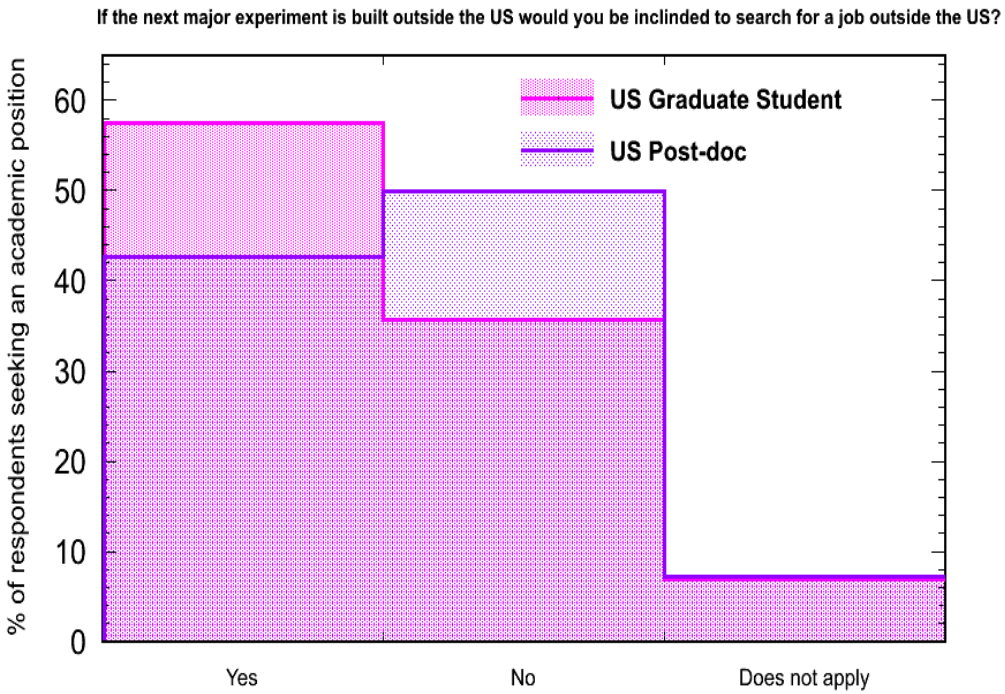


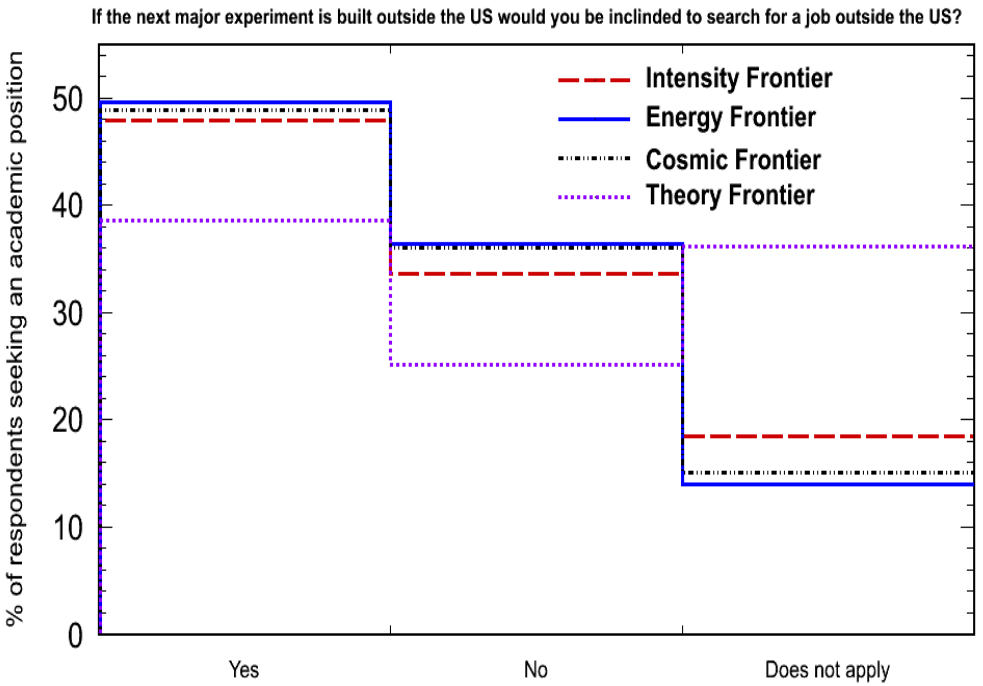


If the next major experiment in your frontier is built outside the US would you be inclined to search for a job outside the US?

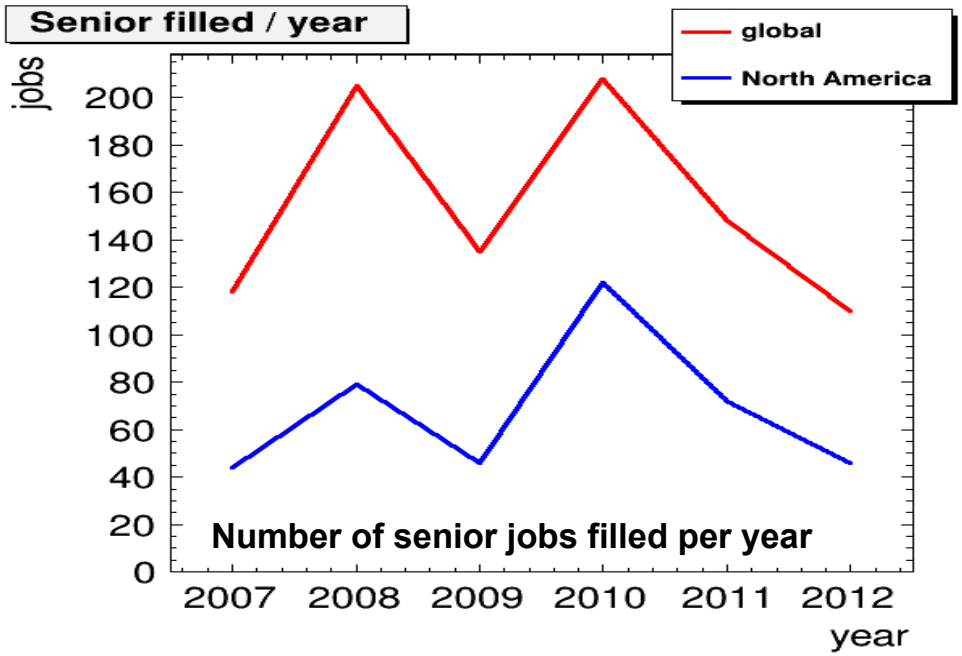


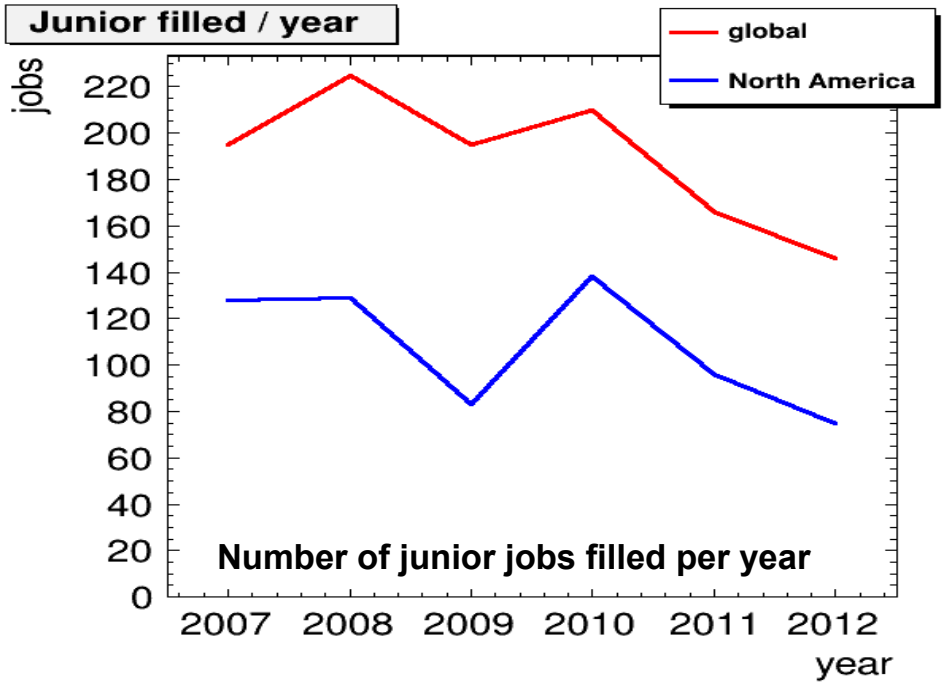


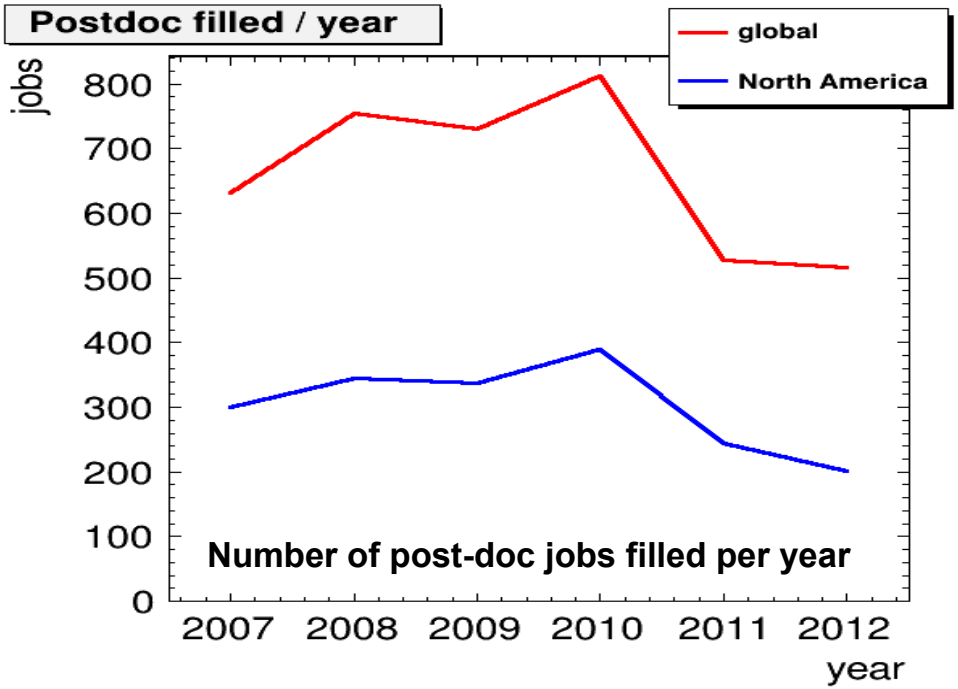


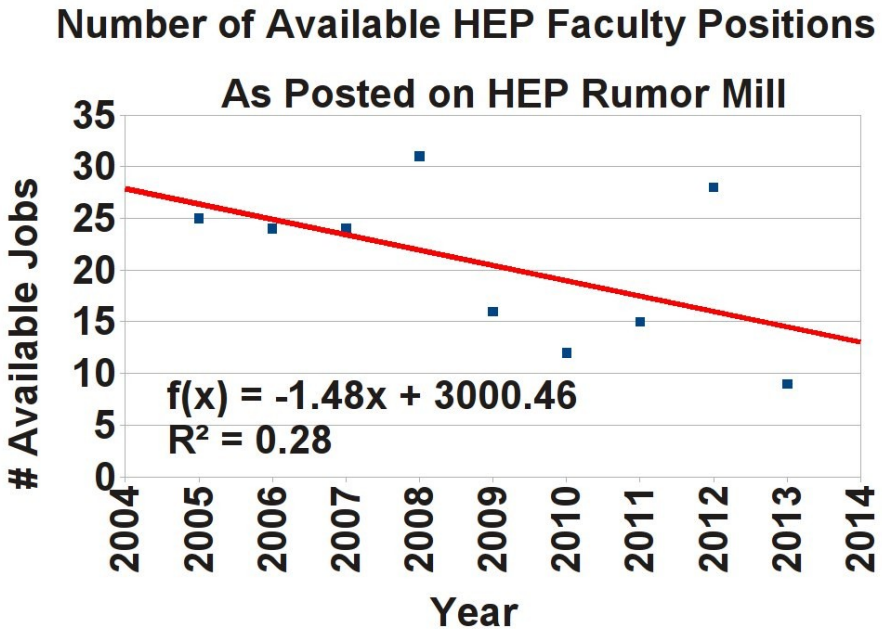


Preliminary Data from Spires



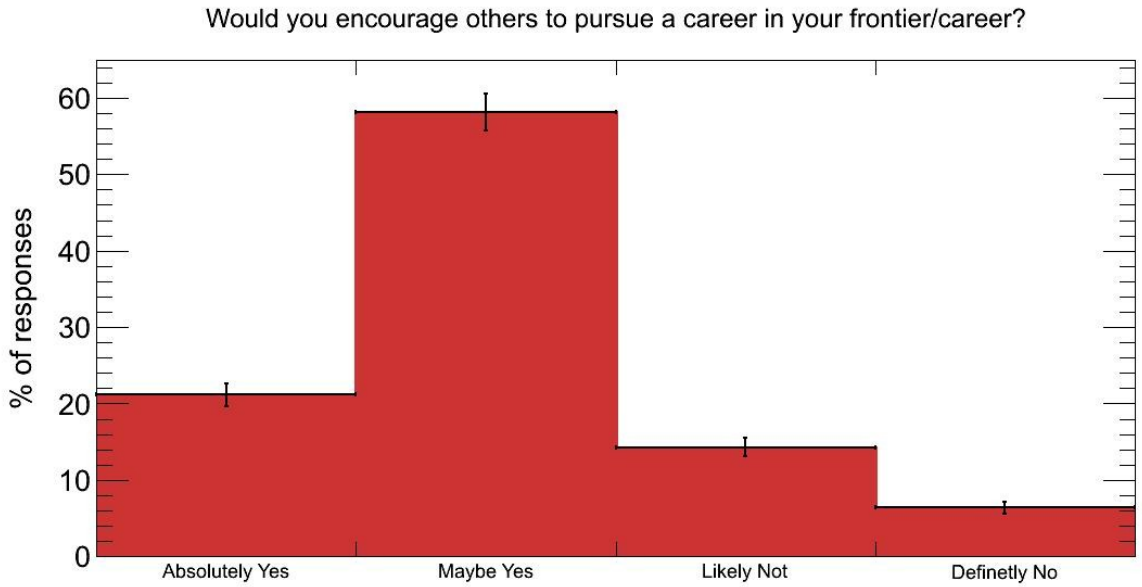


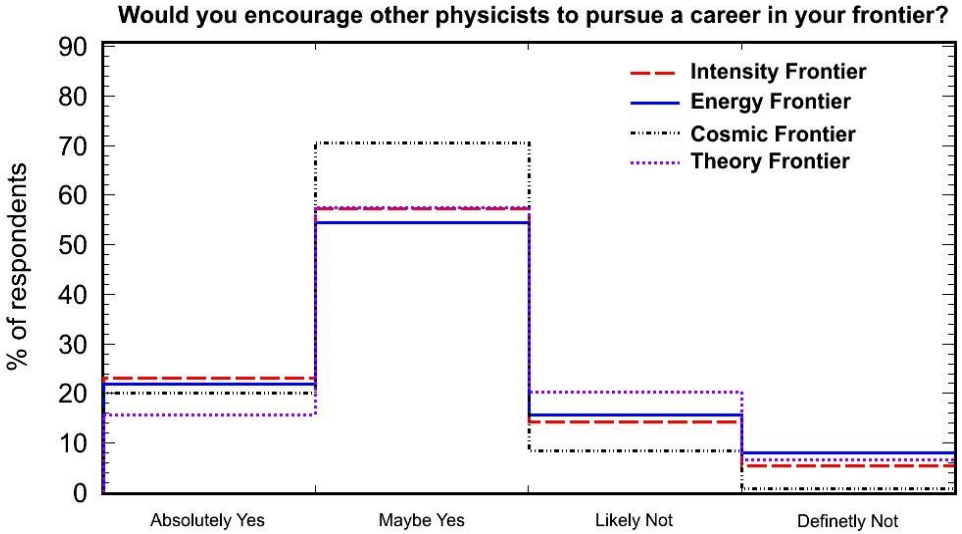


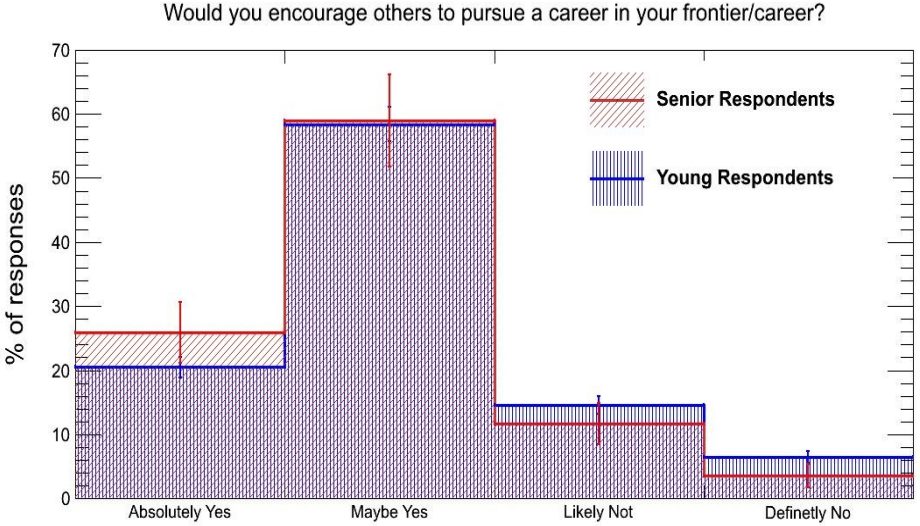


1. **Would you encourage other young physicist to pursue a career in your frontier?**

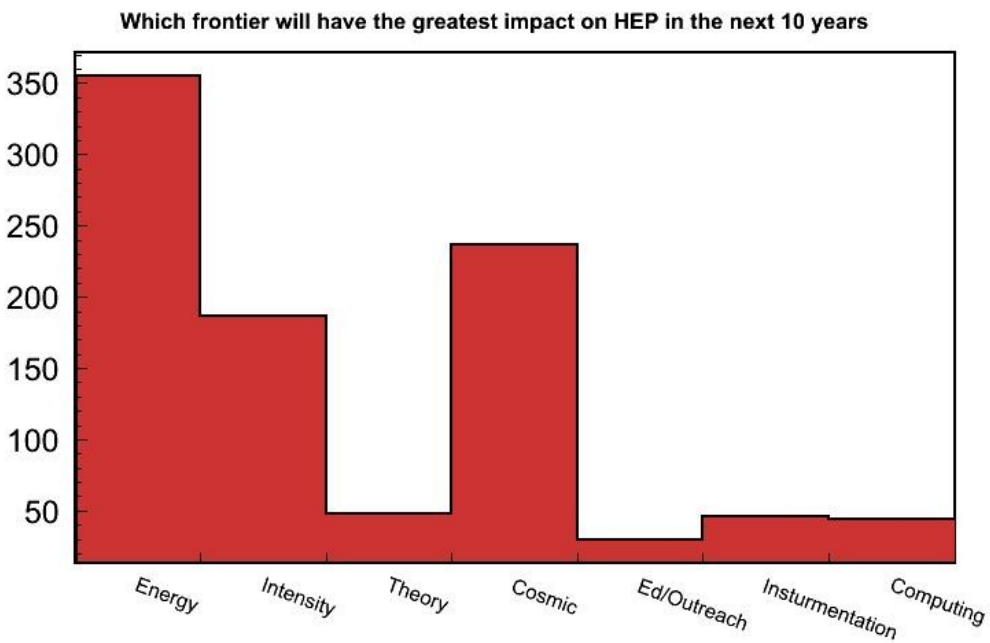
More than 75% of the respondents would recommend other talented young physicists to pursue a career in their frontier. This is a trend that is shown to be true across all the frontiers and for both young and senior members of HEP. This particular fact is remarkable given the rather pessimistic outlook for funding and jobs and demonstrates that the science is found to be very complelling.

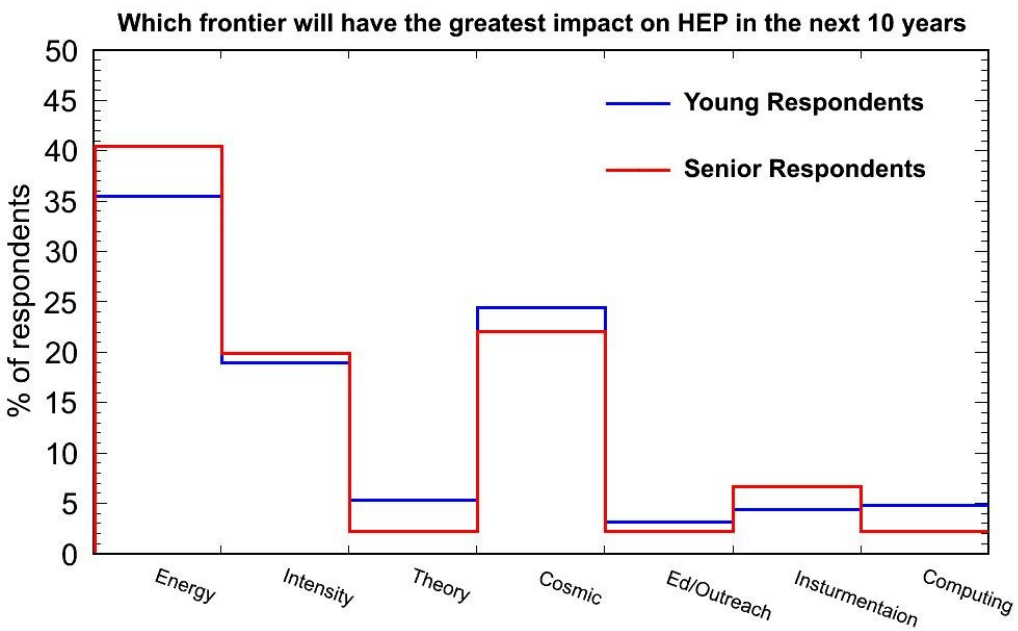






2. Which of the following frontiers as defined by the Snowmass process will have the greatest impact on the landscape of High Energy Physics in the next 10 years?





By Frontier

60% of people in the Energy Frontier believe their frontier will have the most impact
55% of people in the Intensity Frontier believe their frontier will have the most impact
70% of people in the Cosmic Frontier believe their frontier will have the most impact

Snowmass Young

- **We covered a lot more information in the survey**
  - Concerns of young people
  - Future experiments people are excited about
  - People pursuing non-academic jobs
  - # of hours people work per week
- **Complete version:**
  - **http://arxiv.org/abs/1307.8080**

Snowmass 2013 Young Physicists Science and Career Survey Report

J. Anderson[a], J. Asaadi *[b], B. Carls[a], R. Cotta[c], R. Guenette[d], B. Kiburg[a], A. Kobach[e], H. Lippincott[a], B. Littlejohn[f], J. Love[g], B. Penning[a,h], M. Soares Santos[a], T.Strauss[†i], A. Szelc[d], E. Worcester[j] and F. Yu[a]

[a]Fermilab, Batavia, IL
[b]Syracuse University, Syracuse, NY
[c]University of California, Irvine, CA
[d]Yale University, New Haven, CT
[e]Northwestern University, Evanston, IL
[f]University of Cincinnati, Cincinnati, OH
[g]Argonne National Laboratory, Argonne, IL
[h]University of Chicago, Chicago, IL
[i]University of Bern, Bern, Switzerland
[j]Brookhaven National Lab, Upton, NY

Snowmass 2013

Other important take home messages

Stronger advocacy from HEP in congress is a must

"If you aren't writing two letters per year to your congressman, you aren't even doing the minimum!"

We have no opposition!

No opposing lobby!

We have a product people want

Fundamental research
Skilled labor force
Innovation and jobs

I'm too busy is a terrible excuse!

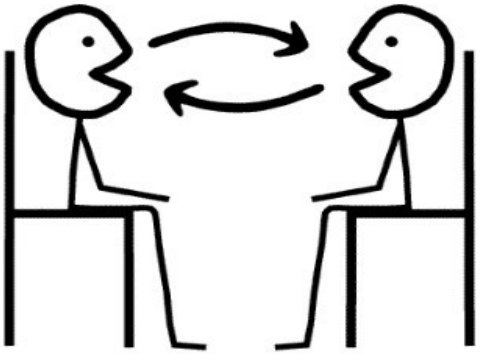
We are all busy...but people who don't depend on federal funding find time to write their congressman, so should we

http://www.house.gov/representatives/find/

Use the link
Find your congressman
Write your congressman
Invite him to your house
Invite him to tour Fermilab
Stay involved

What comes next

- **HEPAP Panel met September 5-6 and gave the charge to P5**
  - Read the charge here: www.interactions.org/p5
  - Portal to interact with P5: http://www.usparticlephysics.org/p5/form
- **First "Face-to-Face" meeting was at Fermilab November 2nd & 3rd (last week)**
  - ~ 200 people showed up to listen and give input
  - Focused on Intensity Froniter at this meeting



- **P5 process** ***(Steve Ritz will have more to say about this)***
  - SLAC Meeting December 2nd – 4th
    - Focused on Cosmic Frontier
  - Brookhaven Meeting December 15th – 18th
    - Focused on Energy Frontier

P5 and the young community

- **You should be involved!**

Letter from Steve Ritz to Young Scientists (I added bold face for emphasis)

Dear Colleague:

As you know, the P5 process has started. **The purpose of this note is to reaffirm that engagement by everyone in our community, including Snowmass Young Physicists, is needed.** There is a public website (http://interactions.org/p5) that I keep up to date with news and information about P5. I encourage you to check it regularly. In particular,

1) Please have a look at the meetings link. Each of the upcoming meetings (our first face-to-face meeting on 2-4 November at Fermilab, then 2-4 December at SLAC, and 15-18 December at Brookhaven) has a Town Hall, and all sessions except the executive sessions are completely open. **I encourage you to attend and participate.** The Town Halls are deliberately unstructured: most of the time will be devoted to open-mike statements and discussions. **If there is something you want to say, just come up to one of the microphone stations in the aisles.**

2) Please have a look at the charge and member list, also linked to the public page. **Feel free to contact me, or any member, to discuss any aspect of P5**. Also, please note the Submissions link on the P5 public page. You are welcome to submit your thoughts there, if you prefer.

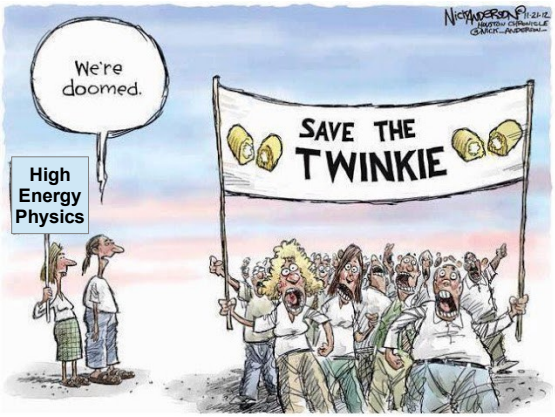
3) **Don't be subtle!** Let us hear from you about your concerns, advice, and input.

Best regards,

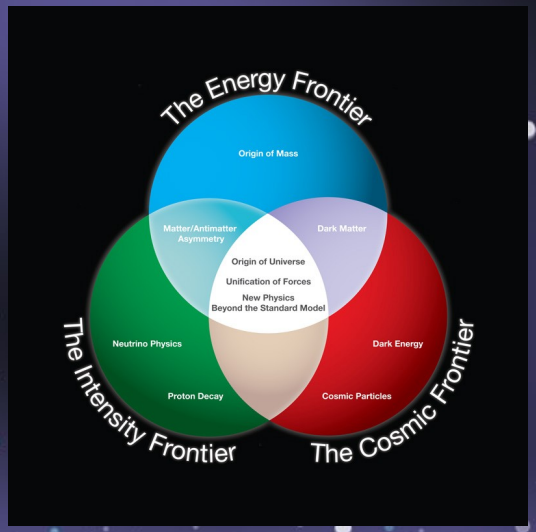
Steve

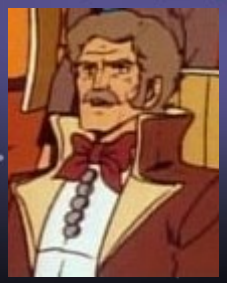
How to become informed

- **Look through the Snowmass Talks**
  - Drinking from a sprinkler
  - https://indico.fnal.gov/conferenceTimeTable.py?confId=6890#all.detailed
- **Read some Snowmass white papers**
  - More like drinking from a fire hose
  - http://www-public.slac.stanford.edu/snowmass2013/SnowmassWorkingGroupReports.html
- **Start writing to your congressman**
  - They are already thinking about the next election cycle and need to hear from their constituents!
- **Stay aware of the coming P5 meetings and attend them if possible**
  - http://www.interactions.org/p5



Thank you for your attention





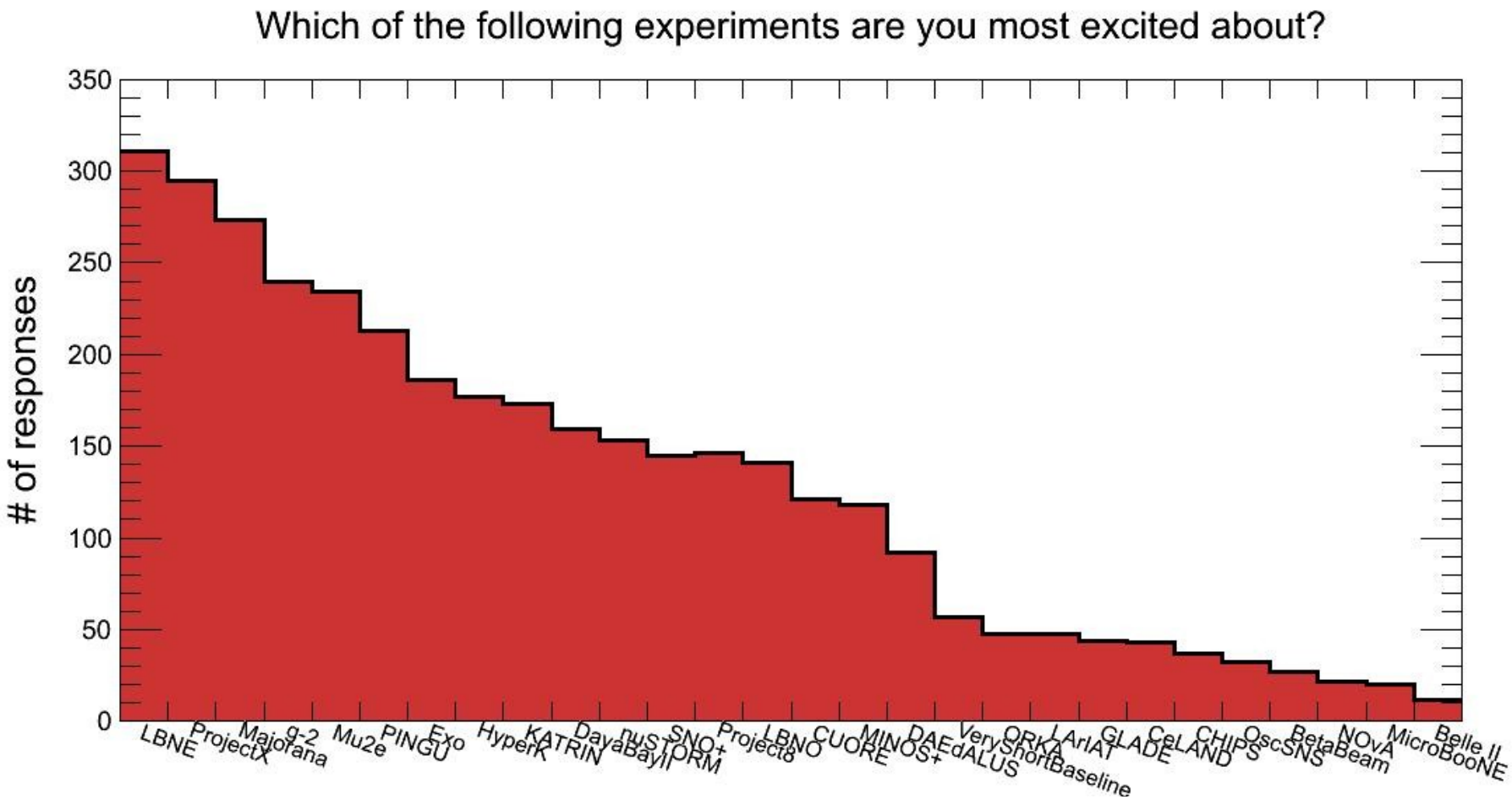
Theory

Education/Outreach

Energy Cosmic Computing Intensity Instrumentation

Backup slides

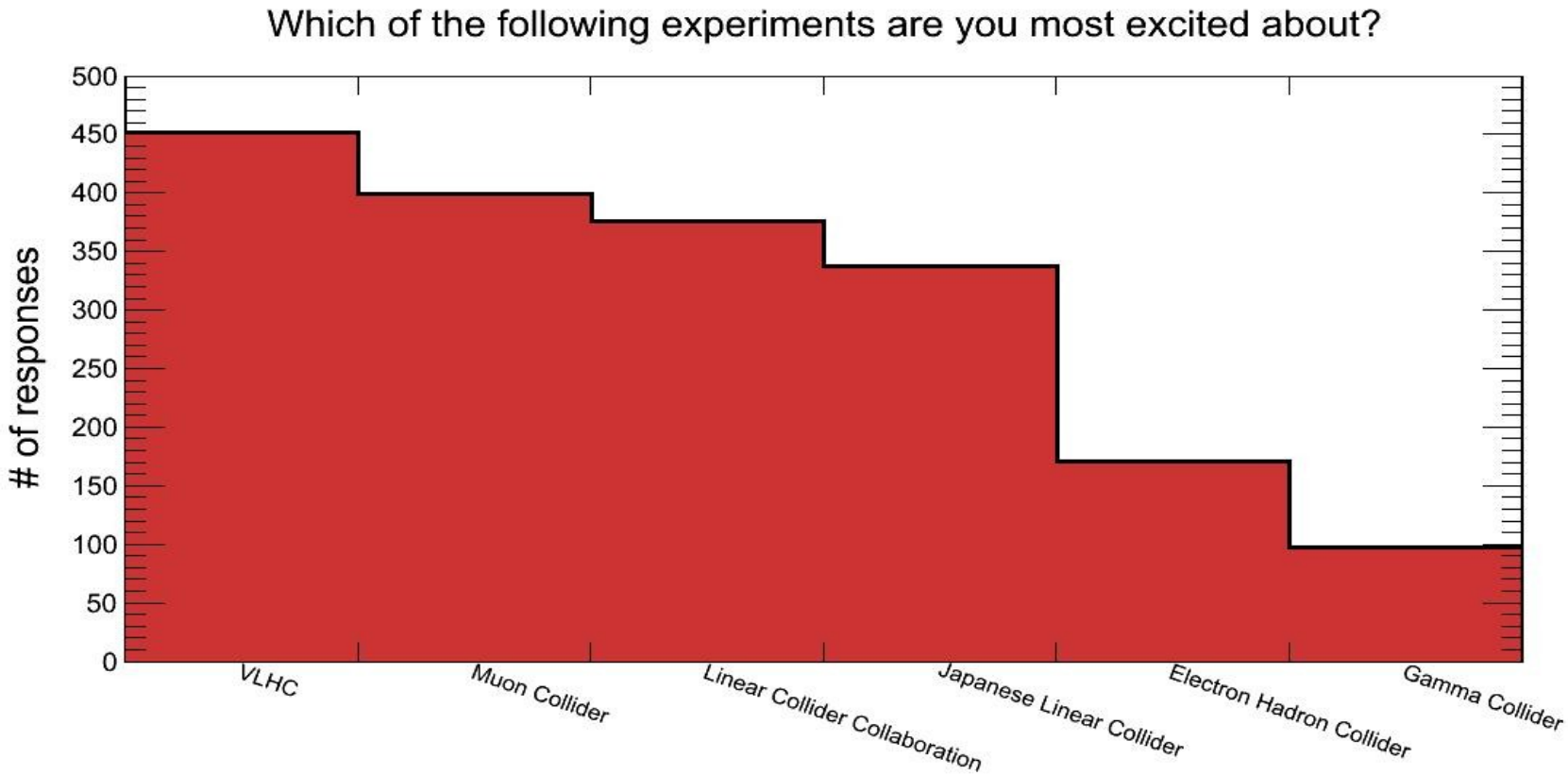
Intensity Frontier



	Cosmic Frontier	Theory Frontier	Energy Frontier	Intensity Frontier
1	PINGU	Majorana	Project X	LBNE
2	Majorana	g-2	LBNE	Project X
3	Exo	Mu2e	g-2	nuStorm
4	Sno+	LBNE	Mu2e	PINGU
5	Katrin	HyperK	Majorana	HyperK
6	LBNE	Exo	Exo	Majorana

Table 1: The top six Intensity Frontier experiments respondents were excited about, broken down by their current frontier.

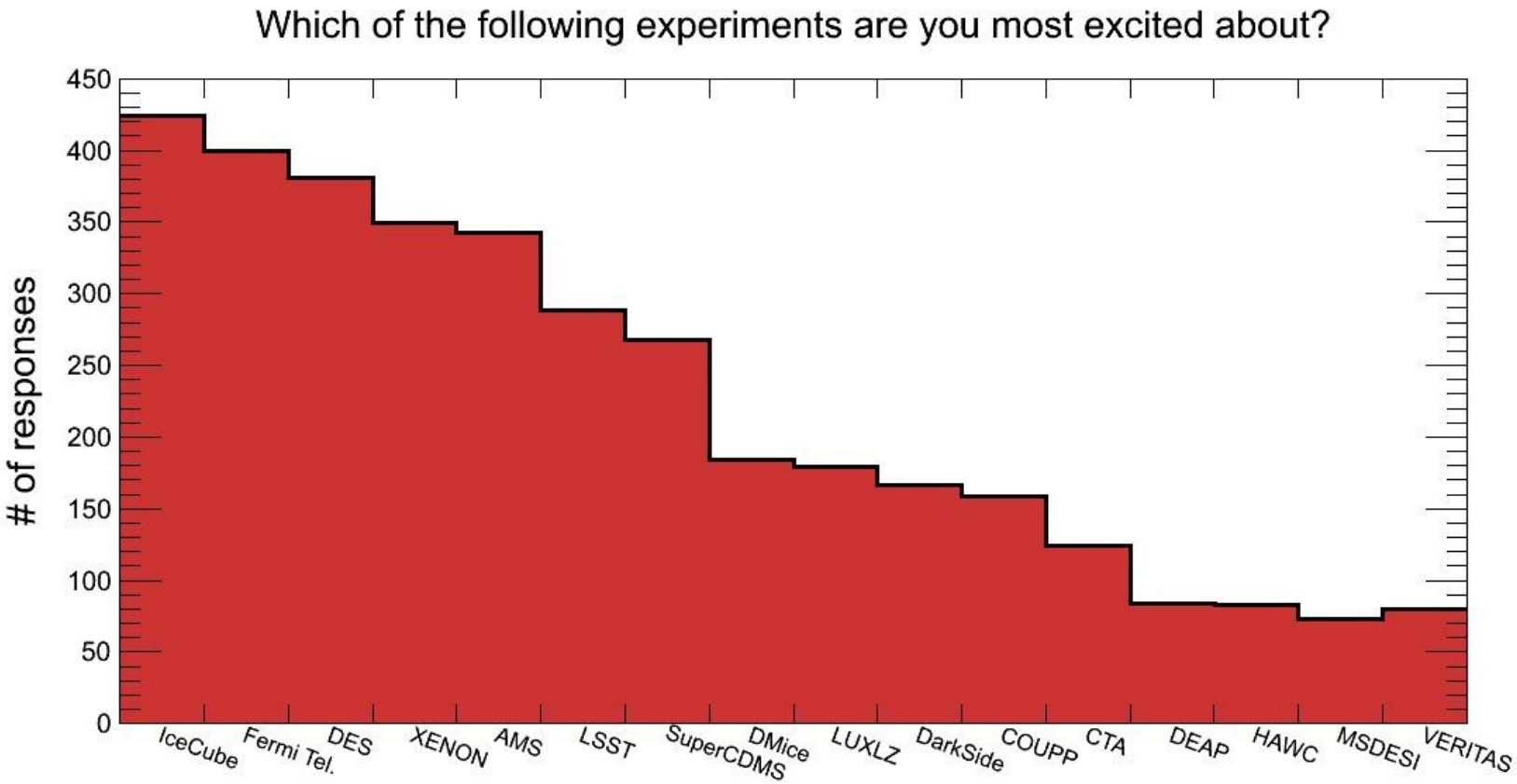
Energy Frontier



	Cosmic Frontier	Theory Frontier	Energy Frontier	Intensity Frontier
1	VLHC	VLHC	VLHC	Muon Collider
2	Linear Collider Collaboration	Japanese Linear Collider	Linear Collider Collaboration	Japanese Linear Collider
3	Muon Collider	Linear Collider Collaboration	Muon Collider	Linear Collider Collaboration
4	Japanese Linear Collider	Muon Collider	Japanese Linear Collider	VLHC
5	Electron Hadron Collider	Electron Hadron Collider	Electron Hadron Collider	Electron Hadron Collider
6	Gamma Collider	Gamma Collider	Gamma Collider	Gamma Collider

Table 2: The top six Energy Frontier experiments respondents were excited about, broken down by their current frontier.

Cosmic Frontier



	Cosmic Frontier	Theory Frontier	Energy Frontier	Intensity Frontier
1	LSST	Fermi Telescope	AMS	IceCube
2	Dark Energy Survey	XENON	IceCube	Fermi Telescope
3	Fermi Telescope	IceCube	Fermi Telescope	Dark Energy Survey
4	IceCube	AMS	Dark Energy Survey	XENON
5	SuperCDMS	Dark Energy Survey	XENON	AMS
6	XENON	SuperCDMS	LSST	SuperCDMS

Table 3: The top six Cosmic Frontier experiments respondents were excited about, broken down by their current frontier.

Changed others perspective

From the Energy Frontier

On Electroweak Symmetry Breaking

The LHC has revealed that the minimum SM prescription for electroweak symmetry breaking — the one Higgs double model — is at least approximately correct. What does that have to do with neutrinos?

The tiny neutrino masses point to three different possibilities.

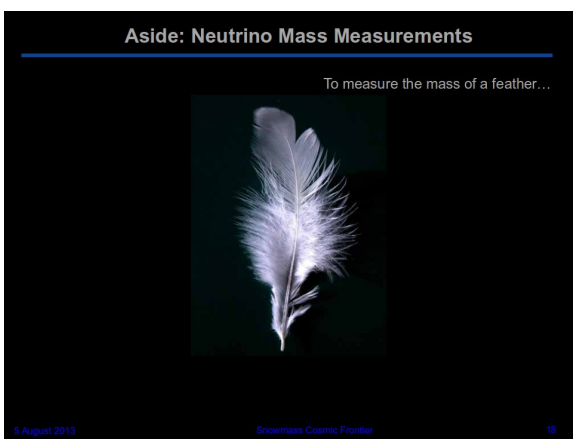
1. Neutrinos talk to the Higgs boson very, very **weakly** (Dirac neutrinos);
2. Neutrinos talk to a **different Higgs** boson – there is a new source of electroweak symmetry breaking! (Majorana neutrinos);
3. Neutrino masses are small because there is **another source of mass** out there — a new energy scale indirectly responsible for the tiny neutrino masses, a la the seesaw mechanism (Majorana neutrinos).

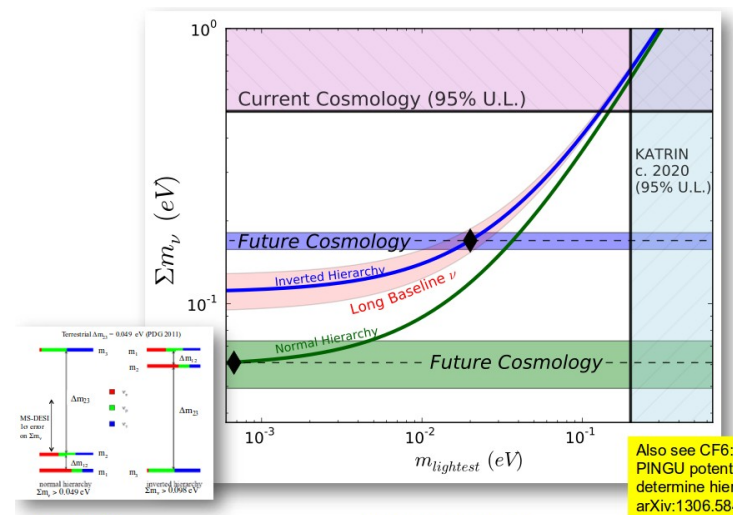
Searches for $0\nu\beta\beta$ help tell (1) from (2) and (3), the LHC and charged-lepton flavor violation may provide more information.

Searches for nucleon decay provide the only handle on a new energy scale (3) if

Beautiful NOvA and LBNE programs might very well influence the Higgs Program.

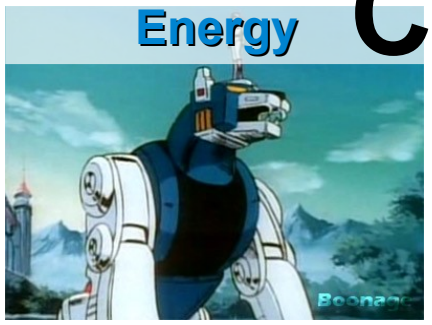
From the Cosmic Frontier



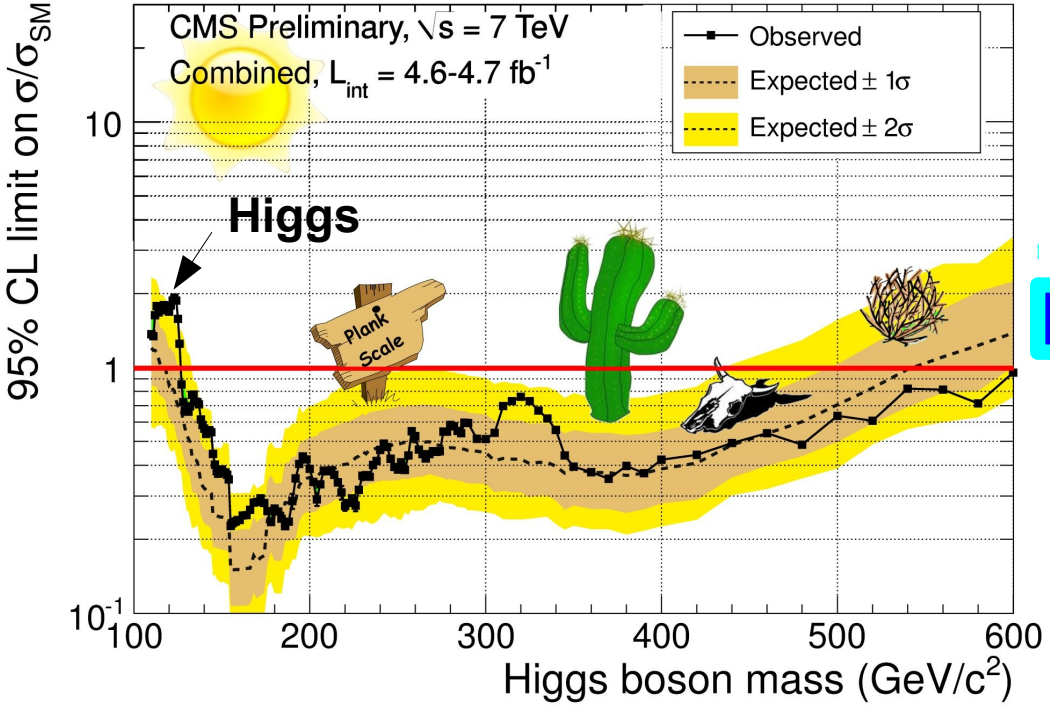


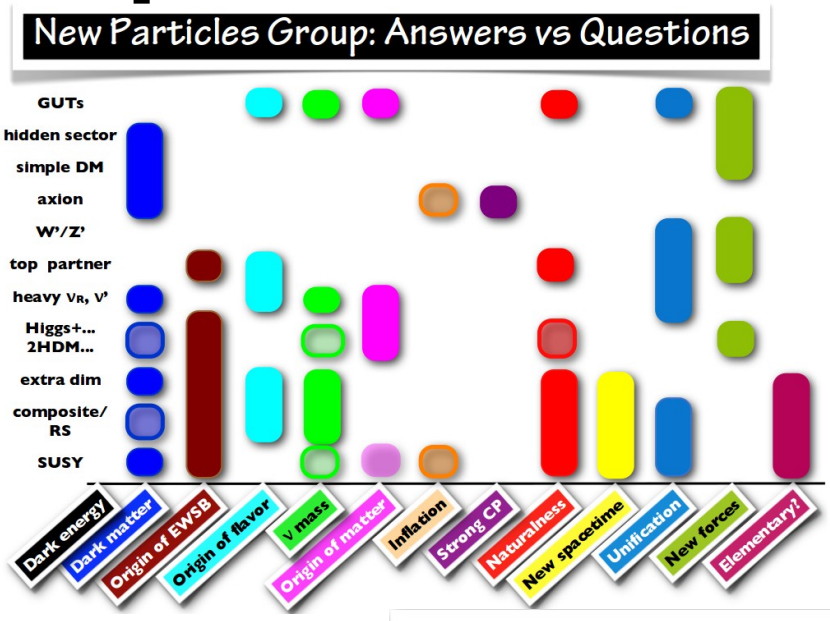
Also see CF6: PINGU potential to determine hierarchy arXiv:1306.5846v1

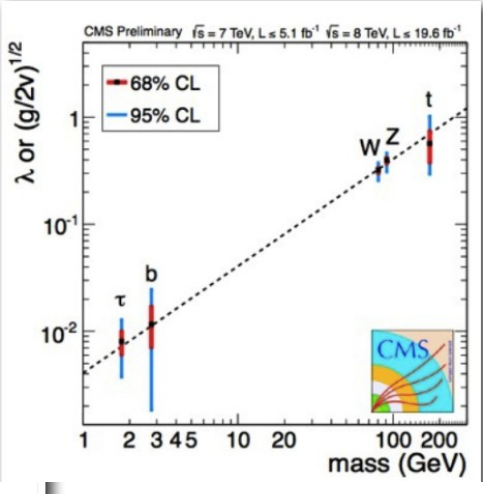
Changed my perspective

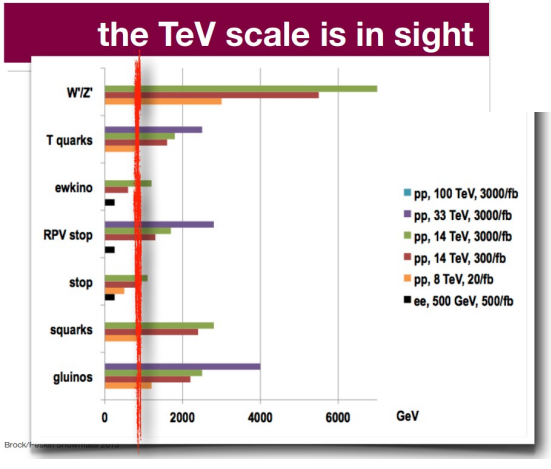


A friend made this plot in early 2012









Changed my perspective

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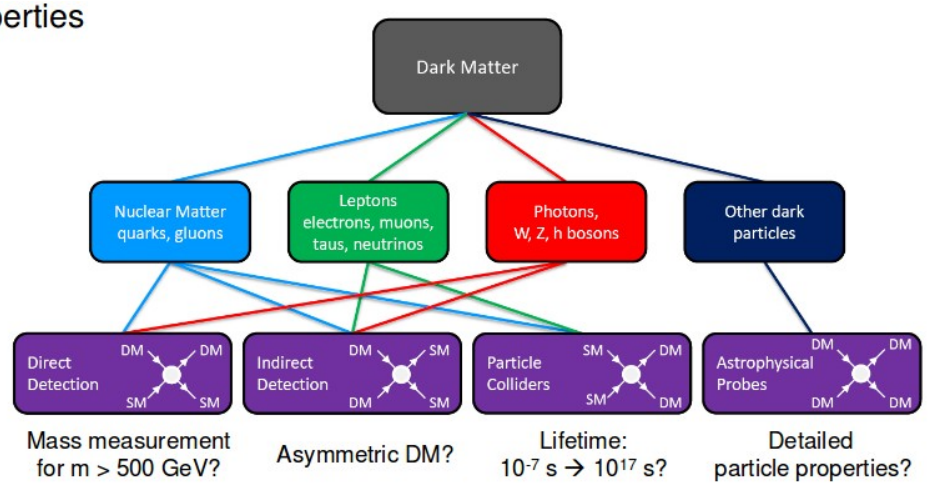
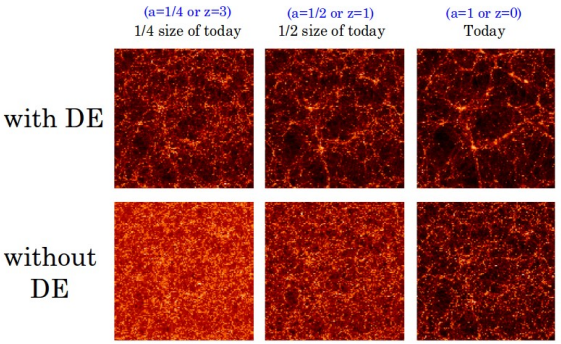


Current: Veritas, Fermi-LAT, HAWC, and others

Dark Energy suppresses
the growth of density fluctuations



The Virgo Consortium (1996)

Michael Levi
Saul Perlmutter

Precision Cosmology