

## 8/21 Snowmass Frontier Introduction Series

### **Intro**

Tiffany: Welcome to the 3rd & final installment of the Frontier Introductions Series, featuring the Accelerator, Underground, Rare Processes & Precision, and Theory Frontiers. This series is brought to you by the snowmass Early Career Inreach Key Initiative, lead by Cindy Lin & Christian Herwig. Special Thanks to Josh Barrow for hosting the zoom connection. My name is Tiffany Lewis & I will be moderating today's discussion.

Each Frontier will present for 15 min, followed by a 5 min Q&A (for each), during which you are encouraged to use the zoom "raise hand" feature to bring up a question or comment.

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### **Accelerator Frontier**

Tiffany: We begin with the Accelerator Frontier, represented by Tor Raubenheimer. Tor is a Frontier Convener for Accelerator Science. He is also a Professor of Particle Physics and Astrophysics at Stanford University, as well as a Physicist at SLAC, having received his PhD from Stanford in 1991. Dr. Raubenheimer for the Accelerator Frontier.

Tor Raubenheimer (slides provided):

Introduced each of the topical groups

Both fixed target and more esoteric ideas

Identify promising opportunities, and tools to address them

Another frontier meeting beginning of September, date tbd

Large, mid, small scale projects

Large projects in the many \$B range need staged approaches, R&D

Spin off technologies

Accelerators likely key to HEP advances

Broad applications

AF07: focus on What technology limits accelerators

Snowmass should develop and idea of cost scale (not dollar amounts)

Emphasize the importance of stages & achievability

Q&A:

Josh: Wakefield acceleration prospects

Response:

Berkeley, SLAC have plasma wakefield acceleration facilities

Europe DESY and CERN have wakefield groups

World wide effort

Plasma interesting for many reasons

Immediate step for FEL with plasma  
multiple ways to engage

Marlene

Heard that acc physics is getting out of fashion  
interest seems to be decreasing

Opinion on how to address?

Response:

Haven't seen drop, but change in focus

Focus going towards immediate application things

Opportunities to develop ideas in FEL, elsewhere, because Tor can work on FEL now

Same with plasma acceleration

Key for next step to plasma collider, handle emittance, etc

As experimentalist, that element may not be of immediate interest

Berkley and SLAC, people working on plasmas, Fermilab strong on acc physics too

HEP interest in acc physics has decreased, funding big reason

much centered in Fermilab

Marlene:

Reference to plumbing??

Response:

have to know water flow, how to cool things, energy density in components

Cryogenics

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Underground Facilities frontier

Next up, we hear from the Underground Frontier, represented by Jeter Hall. Jeter is a Frontier Convener for Undergraouns Facilities. He is also the Director of Research at SNOLAB. He previously worked at Fermilab on dark matter searches after receiving his PhD from the University of Utah in 2007. Dr. Hall for the Underground Frontier.

Jeter Hall:

Why is a hole in the ground an exciting thing?

Focus on neutrino and DM

ties with these frontiers

atmospheric, solar neutrinos, accelerators as well

DUNE interesting challenge, something to target:

Getting tonnes of LAr underground, and cooling power there, is a big challenge

cold gas, condensing underground

$0\nu\beta\beta$

All experiments with different requirements

GeV neutrinos don't need understanding of Ar39, but need to understand for supernovae

Cosmic frontier, searches for DM have their own challenges  
neutralino likely DM candidate  
competing and synergistic efforts to look for candidates  
new technologies to reach very low masses, accelerators, cryogenic detectors deep underground  
SC electronics, lower densities for particles on SC film  
vibration, IR radiation, many new interesting requirements on instrumentation and detectors  
gravitational waves developing their concepts  
see black hole mergers  
infrastructure, understanding radon, mitigation, noble gases difficult to control, radon 4 days lifetime gets everywhere, turns to Pb210, Po with sticks to everything  
cleanliness, dust, keep detectors clean  
synergistic, quantum science, microbiology, origins of earth and life  
bring it together in integrated strategy  
Underground facility report and recommendations  
2013 report and recommendations linked  
LBNF realized with DUNE infrastructure  
SURF has leading role in DM and neutrino physics  
diversity in location is important, international partners  
especially with nationalistic politics, internationalization of science is important to promote

Q&A

Tiffany:

Opinion on value of EC people spending time on Snowmass, as opposed to usual current science

Response:

In general or specific to underground facilities?

In general, have worked in government R&D

scientific enterprise exists and is funded in connection with Congress and appropriations

people have priorities ask government to impose

remember that connection between research community, public, government

this is critical part of it

find topic that you can contribute a few pages, great way to network

all this work and people in Snowmass, get people working together, talking together, so that you know each other and expertise and what they do

communicate between senior, mid-career, and EC, in developing these connections, great way to find next job

Josh:

Next big hole beyond Dune?

Response:

Interesting question,

will be defined by the science

gravitational waves is amazing science and well motivated to build these large GW detectors

10s of kms for these systems, very large holes in teh ground  
accelerator side, FCC and other proposed colliders,  
CERN wants to start digging for next-gen colliders

Maria

Facilities and infrastructure

postdocs, grad students working in these facilities  
safety and working conditions is important to them  
will it be addressed by this group

Response

Health and safety is #1 priority for this group, for people working in these facilities  
often near old mines, build tunnels

air quality, basic survivability

most countries have basic rules

typically labs exceed those

SURF has flush toilets, most of these facilities don't, also microwave and coffee  
extra effort to improve quality and safety in the new facilities

very safe and low risk environment

but problem with access, cage lowered down, people can get cramped there  
number of people has been reduced for safety, less efficient for work but necessary  
claustrophobic, pressure changes, these are things that can be challenging for people  
working there

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Rare Processes and Precision frontier

Next, we hear from Joshua Barrow & Robert Bernstein, representing the Rare Processes & Precision Frontier. Joshua is a PhD Candidate at the University of Tennessee, Knoxville and visiting scientist at Fermilab. Bob is a Frontier Convener for Rare Processes and Precision Measurements. He is a Scientist at Fermilab, working on muon to electron conversion experiment, having received his PhD from the University of Chicago in 1984. He returned to earn his MBA in 2006. Dr. Bernstein & Josh Barrow for the Rare Processes & Precision Frontier.

Josh Barrow and Bob Bernstein

Bob:

The person who does all the email lists and slack

Could everybody working in neutrinos raise their hands? About 4 I see  
(because he already knows the muon people)

Cosmic? ~3

Collider? 0!

Snowmass: Look across entire field  
Maybe do something different next  
EC: learning skills and ways to think, don't be limited to domain knowledge  
credit people who switch fields  
Get big picture and see what sparks your interest  
RPPF: intense beams, specific goals  
interlinked, multiple measurements  
bigger intellectual picture  
EDMs whole new subfield that Snowmass can push  
EDMs not just tabletop but accelerators  
If you're curious about anything, email or slack the conveners  
extensive system of liaisons  
PIP-II at FNAL  
Bring ideas! Make YOUR future happen!  
Learn, communicate, participate  
Josh:  
Low-energy observables with high-energy implications  
Extensive group of EC representatives, liaisons

#### Q&A

Tiffany: best way to get in touch with EC?  
Slack channel, reach out to Josh and Jake  
open listserv  
Jake:  
open channel for Snowmass-Young

#### Manolis:

interlinked frontiers, involvement in Snowmass and looking outside your own field not necessarily bad for career.

also generally good to change fields as you mentioned, but after grad school may be the best time to do it. how to do it later in career, eg postdoc to junior, and Snowmass offers opportunity to find new relevant and interesting opportunities?

#### Bob:

My history: did thesis CP violation, super precise experiment  
next wanted to do something sloppy

QCD neutrinos, DIS

then precise, because tired of doing sloppy

did NuTeV, measurement of precision weak mixing angle

then neutrino oscillations, MINOS, NOVA

then tired of neutrinos, want something else

DES, but then Mu2e came up

really important physics, terrifically hard

overall changed subfields like 4 times

for about a year or so you don't know anything, then you know way more than before

changed fields in every career stage  
Tevatron shut down, many people went to DES, neutrino oscillations  
people changed subfields and did very well  
find something interesting, take a look  
don't be afraid that you won't be able to make that step

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## Theory frontier

Finally, we will hear from the Theory Frontier, represented by Samuel Homiller. Sam is a postdoc at Harvard University having received his PhD From Stony Brook University in 2020. He is a theoretical particle physicist interested in the Higgs boson and dark matter. Dr. Homiller for the Theory Frontier.

## Samuel

New frontier in Snowmass  
unique opportunity for EC theorists to make a difference  
(Nice slides with lots of explanatory text)  
get involved, define what to make of the theory frontier  
you can make a big difference  
Theory LOIs don't have the August deadline  
Get involved!

## Q&A

Tiffany:

Cosmic frontier and cosmic neutrinos in different subgroups, how are they separated/  
connected

Response:

Not necessarily separated, working together/in parallel

Josh: TF11 was spawned out of the neutrino frontier

YuDai: Thank you for the beautiful slides!

YuDai got a haircut by his partner, it's not good

Josh:

LOIs developing with rare processes, a lot of theoretical questions and interest coming  
out of it

how does the theory frontier connect with this

Response:

If theory not understood correctly, or if new questions coming out, certainly interesting to  
their frontier

Josh:

if papers in last years made interesting transformations in the field, information may not have percolated completely

Response: yes theory frontier would definitely be interested

Thank you to everyone in attendance and all the speakers

All meetings recorded, anyone interested you can point to them

Thanks to Tiffany and Inreach for the 3-week miniseries

After LOIs submitted, more in reach educational activities may be considered

Bob: No more Taco Bell for Josh