https://indico.fnal.gov/event/22303/program


**Xinchou Lou**
**IHEP**

# SNOWMASS 2021
# 美国高能物理规划

① **Define the most important questions for HEP & related fields**
② **Identify the most promising opportunities to address these questions in a global context**

## U.S. Strategic Planning Process for Particle Physics

~year-long process
Snowmass Community-Wide "Science" Study
Organized by Division of Particles and Fields (DPF) of APS

Input to P5

~year-long process
P5 (Particle Physics Project Prioritization Panel)
formulate a 10-year plan (20 year vision) within funding constraints
Subpanel of HEPAP, High Energy Physics Advisory Panel for DOE/NSF funding agencies

# SNOWMASS 2022
# 美国高能物理规划

The **Snowmass community planning exercise -** the full activity from September.

**1. Snowmass Day:** To get on a new starting point, …., host of a half-day zoom meeting: the “Snowmass Day”, on **September 24, 2021**.
We envision a virtual meeting **recording available**

**Plenary:** 2 hours, 12:00pm - 2:00pm EDT. Short presentations from all on plans for the upcoming activities.

**Breakout sessions:** 2:30pm EDT. This is the opportunity to discuss frontier's status and future plans in details, to conduct cross-talk and interconnections between frontiers.

**2. CSS:** The dates for the Snowmass Community Summer Study (CSS) to be held the University of Washington-Seattle have been fixed at **July 17-27, 2022.**

https://snowmass21.org/start

# SNOWMASS 2021
# 美国高能物理规划

White Paper submission to arXiv: by March 15, 2022.

Late submissions and updates are likely not to be incorporated in the working group reports, but will be included in the Snowmass on-line archive documents.

- **Preliminary reports** by the Topical Groups due: no later than May 31, 2022.

- **Preliminary reports** by the Frontiers due: no later than June 30, 2022.

- **Snowmass Community Summer Study** (CSS)
  **July, 2022 at UW-Seattle**.

- All final reports by TGs and Frontiers due: no later than September 30, 2022.

- **Snowmass Book** and the on-line archive documents due: **October 31, 2022**.
  **Update of P5 will follow, to be coordinated by DOE, DPF and labs**

https://snowmass21.org/start

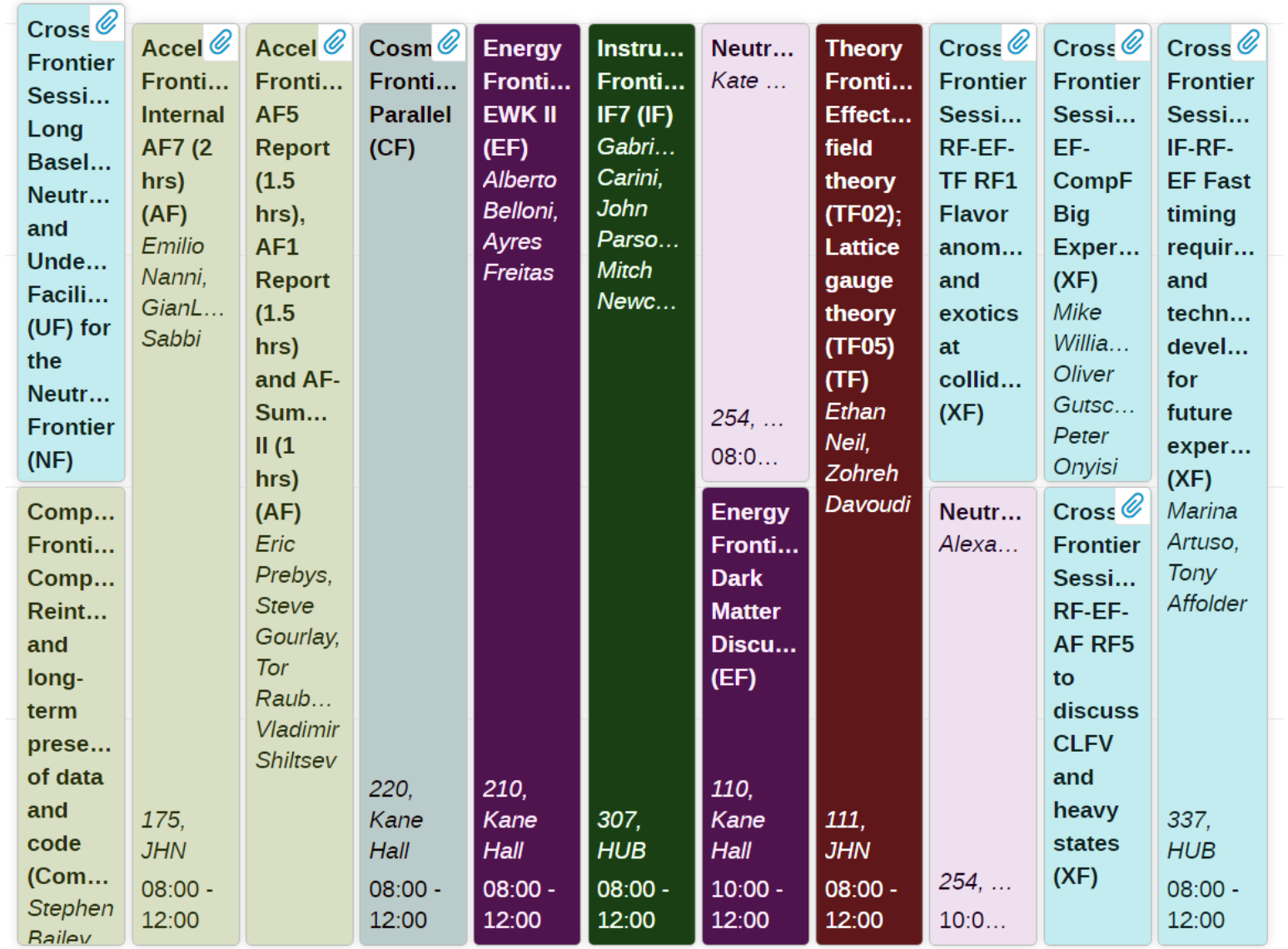
The Particle Physics Community Planning Exercise (a.k.a. "Snowmass") is organized by the Division of Particles and Fields of the American Physical Society.

**Snowmass is a scientific study**. It provides an opportunity for the entire particle physics community to come together to identify and document a scientific vision for the future of particle physics in the U.S. Snowmass will define the most important questions for the field of particle physics and identify promising opportunities to address them.

**The Snowmass Community Study has 10 frontiers addressing different aspects of the field.**

- **Energy Frontier,**
- **Neutrino Physics Frontier,**
- **Rare Processes and Precision Measurements Frontier,**
- **Cosmic Frontier,**
- **Theory Frontier,**
- **Accelerator Frontier,**
- **Instrumentation Frontier,**
- **Computational Frontier,**
- **Underground Facilities,**
- **Community Engagement.**

**Participants**
Number of in-person participants: 746
Number of virtual participants: 637
Local Organizing Committee/Volunteer/Press: 58
Total number of participants: 1383


Cross Frontier Sessi… Long Basel… Neutr… and Unde… Facili… (UF) for the Neutr… Frontier (NF)
Comp… Fronti… Comp… Reint… and long-term prese… of data and code (Com… Stephen Bailey
Accel Fronti… Internal AF7 (2 hrs) (AF) Emilio Nanni, GianL… Sabbi
175, JHN
08:00 - 12:00
Accel Fronti… AF5 Report (1.5 hrs), AF1 Report (1.5 hrs) and AF-Sum… II (1 hrs) (AF) Eric Prebys, Steve Gourlay, Tor Raub… Vladimir Shiltsev
Cosm Fronti… Parallel (CF)
220, Kane Hall
08:00 - 12:00
Energy Fronti… EWK II (EF) Alberto Belloni, Ayres Freitas
210, Kane Hall
08:00 - 12:00
Instru… Fronti… IF7 (IF) Gabri… Carini, John Parso… Mitch Newc…
307, HUB
08:00 - 12:00
Neutr… Kate …
254, …
08:0…
Energy Fronti… Dark Matter Discu… (EF)
110, Kane Hall
10:00 - 12:00
Theory Fronti… Effect… field theory (TF02); Lattice gauge theory (TF05) (TF) Ethan Neil, Zohreh Davoudi
111, JHN
08:00 - 12:00
Cross Frontier Sessi… RF-EF-TF RF1 Flavor anom… and exotics at collid… (XF)
Neutr… Alexa…
254, …
10:0…
Cross Frontier Sessi… EF-CompF Big Exper… (XF) Mike Willia… Oliver Gutsc… Peter Onyisi
Cross Frontier Sessi… RF-EF-AF RF5 to discuss CLFV and heavy states (XF)
Cross Frontier Sessi… IF-RF-EF Fast timing requir… and techn… devel… for future exper… (XF) Marina Artuso, Tony Affolder
337, HUB
08:00 - 12:00

# This actually matches well with the EF vision (Section 2.8.7)

**Resource needs and plan for the five year period starting 2025:**

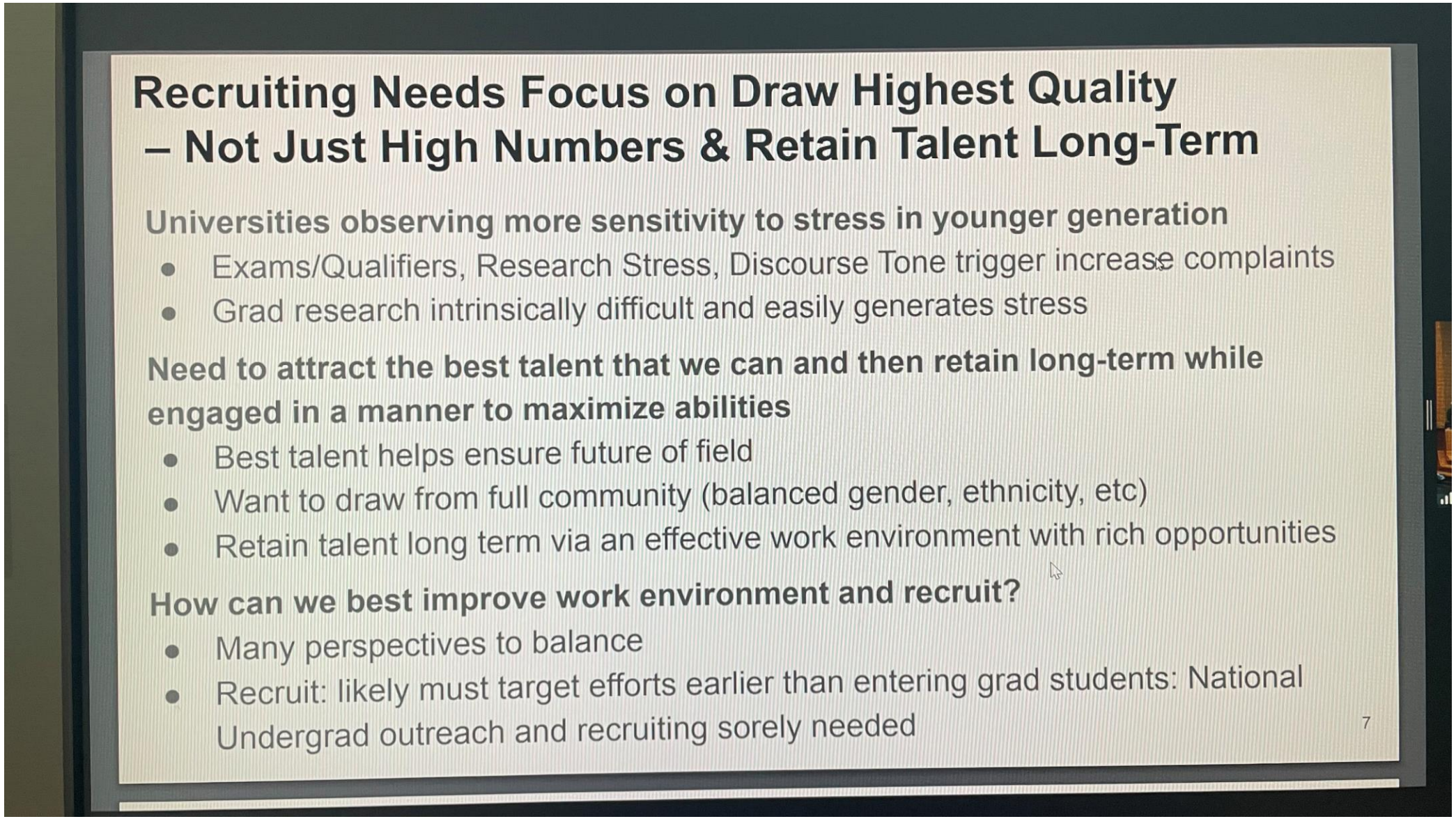
1. Prioritize HL-LHC physics program,
2. Establish a targeted $e^+e^-$ Higgs Factory detector R&D program for US participation in a global collider,
3. Develop an initial design for a first stage Tev-scale Muon Collider in the US, with pre-CDR document at the end of this period,
4. Support critical detector R&D towards EF multi-TeV Colliders.

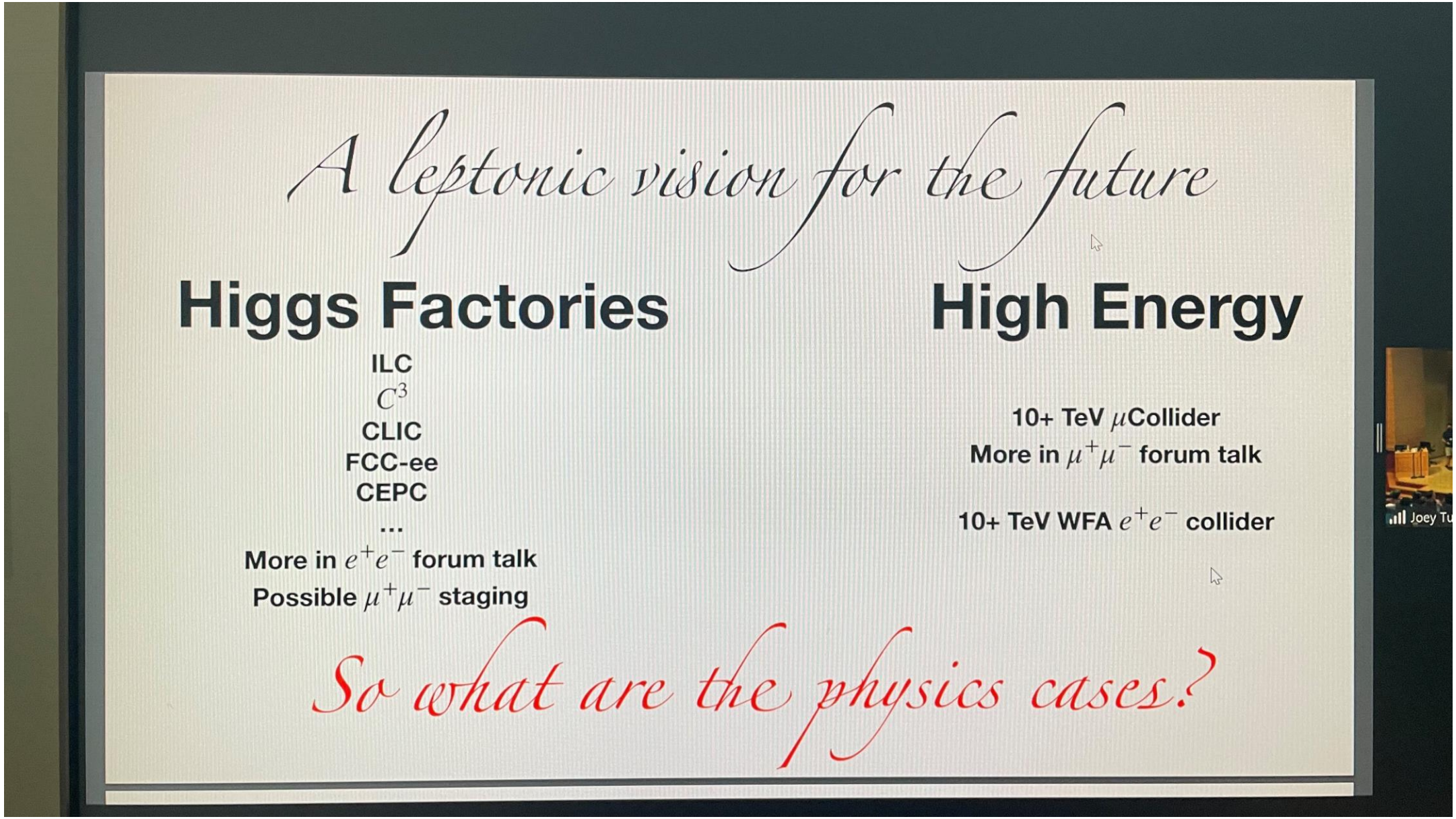
**Resource needs and plan for the five year period starting 2030:**

1. Continue strong support for the HL-LHC physics program,
2. Support construction of a $e^+e^-$ Higgs Factory,
3. Demonstrate principal risk mitigation and deliver CDR for a first stage TeV-scale muon collider.

**Resource needs and plan after 2035:**

1. Evaluate continuing HL-LHC physics program to the conclusion of archival measurements,
2. Begin and support the physics program of the Higgs Factories,
3. Demonstrate readiness to construct and deliver TDR for a first-stage TeV-scale muon collider, 4. Ramp up funding support for detector R&D for EF multi-TeV Colliders.


Recruiting Needs Focus on Draw Highest Quality – Not Just High Numbers & Retain Talent Long-Term
Universities observing more sensitivity to stress in younger generation
Exams/Qualifiers, Research Stress, Discourse Tone trigger increase complaints
Grad research intrinsically difficult and easily generates stress
Need to attract the best talent that we can and then retain long-term while engaged in a manner to maximize abilities
Best talent helps ensure future of field
Want to draw from full community (balanced gender, ethnicity, etc)
Retain talent long term via an effective work environment with rich opportunities
How can we best improve work environment and recruit?
Many perspectives to balance
Recruit: likely must target efforts earlier than entering grad students: National Undergrad outreach and recruiting sorely needed
7


A leptonic vision for the future
Higgs Factories
ILC
$C^3$
CLIC
FCC-ee
CEPC
...
More in $e^+e^-$ forum talk
Possible $\mu^+\mu^-$ staging
High Energy
10+ TeV $\mu$Collider
More in $\mu^+\mu^-$ forum talk
10+ TeV WFA $e^+e^-$ collider
So what are the physics cases?

# Higgs Factories - Well known physics case

Higgs is Really New Physics!

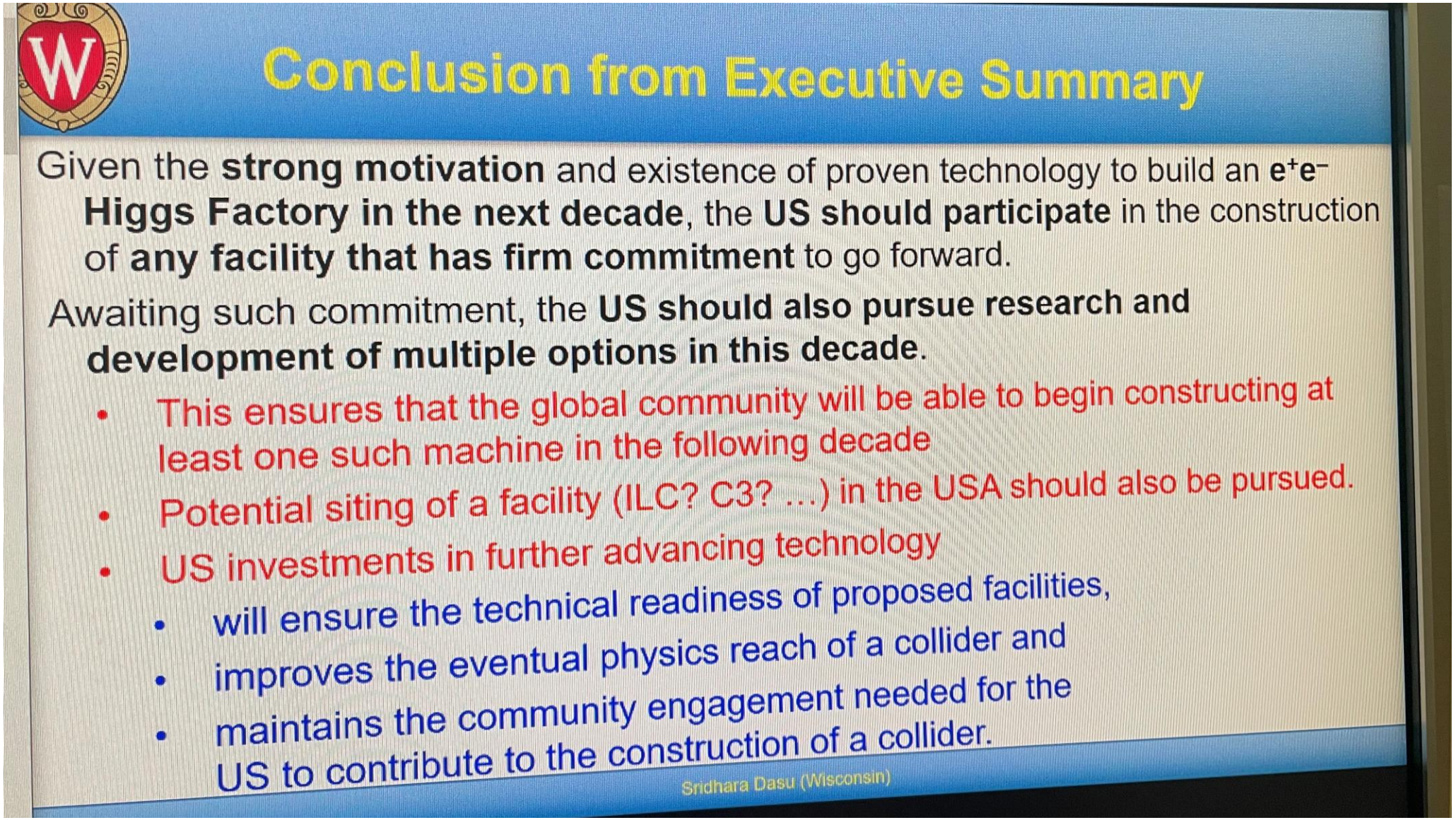
* We've never seen anything like it
* Harbinger of Profound New Principles at work in quantum vacuum

PUT IT UNDER MICROSCOPE

STUDY IT TO DEATH

Nima Arkani-Hamed Conclusions from Higgs 10th Anniversary CERN talk

**Also see Sally Dawson's colloquium this Saturday Afternoon!**


Conclusion from Executive Summary
Given the strong motivation and existence of proven technology to build an $e^+e^-$ Higgs Factory in the next decade, the US should participate in the construction of any facility that has firm commitment to go forward.
Awaiting such commitment, the US should also pursue research and development of multiple options in this decade.
This ensures that the global community will be able to begin constructing at least one such machine in the following decade
Potential siting of a facility (ILC? C3? …) in the USA should also be pursued.
US investments in further advancing technology
will ensure the technical readiness of proposed facilities,
improves the eventual physics reach of a collider and
maintains the community engagement needed for the US to contribute to the construction of a collider.
Sridhara Dasu (Wisconsin)

# The $e^+e^-$ Community Asks from EF & AF Reports

**We hope Snowmass Community Leaders & Eventually P5 support:**

Higgs Factories (from EF draft report)

- Starting 2025: Establish a targeted $e^+e^-$ Higgs Factory detector R&D progress for US participation in a global collider
- Starting 2030: Support construction of an $e^+e^-$ Higgs Factory
- After 2035: Begin and support the physics program of the Higgs Factories
- Ramp up funding support for detector R&D for EF multi-TeV Colliders

Wake Field Accelerators (Presently, GARD funded) (from AF draft report)

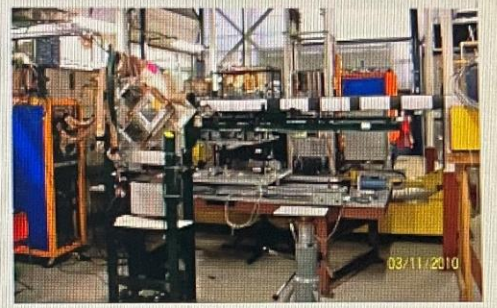
- Advanced wake field accelerator concepts should strive toward feasibility studies and integrated design reports for an O(10 TeV c.m.e.) collider and experimentally demonstrate collider-quality **emittances, efficiencies and energy spreads**, staging, **final focusing** schemes and **positron acceleration**. Targeting 10 $ab^{-1}$ or above for 10-TeV $e^+e^-$
- Reduction of power consumption is one of the main challenges of future colliders. ERLs

Sridhara Dasu (Wisconsin)

# U.S. Funding for Detector R&D – institution/PI rather than collaboration focus

- U.S. DOE HEP funds generic detector R&D through the *Advanced Technology R&D* (KA-25) program which funds Accelerator and Detector R&D programs
  - A significant fraction of that funding goes to support national laboratory capabilities, particularly FNAL
    - Test beam (FNAL FTBF, SLAC ESTB*)
    - ASIC design software (FNAL**)
    - SiDet and Noble Liquid Test Facility (FNAL)
    - Microsystems Lab (LBNL)
  - **No analogue in DOE Nuclear Physics at this time**
  - NSF funding through PI grants
- Project-specific R&D funding through "pre-project" programs and early phase of construction projects within DOE
  - This is where more significant funding may be available
  - **Primary funding mechanism in NP**
  - NSF Mid-Scale projects

Fermilab Test Beam Facility




LBNL Microsystem Lab

*SLAC ESTB will not operate again until the LCLS-II upgrade is completed

**Charged 100% to indirects at all labs except FNAL where it is 40% indirects



Jefferson Lab

Joey Tu

## Importance of Blue Skies R&D

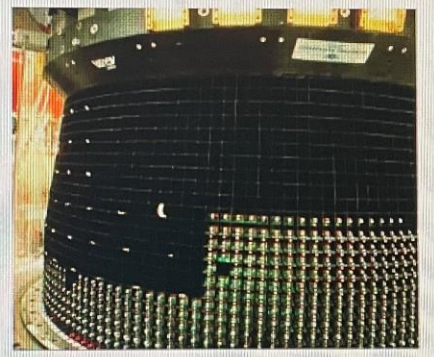
"Blue-sky" developments in particle physics have often been of broader application and had immense societal benefit.

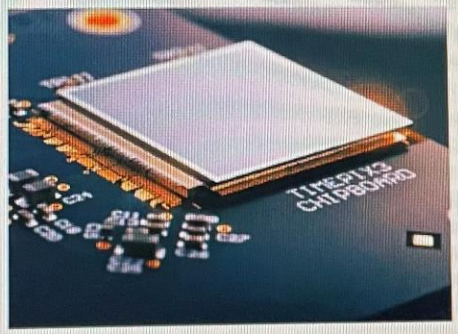
Examples include:

- Development of the World Wide Web
- Magnetic Resonance Imaging, Positron Emission Tomography
- X-ray imaging for photon science.

**It is essential that adequate resources be provided to support more speculative "Blue-Sky" R&D**

- This includes supporting the careers of junior scientists pursuing high risk, high reward ideas



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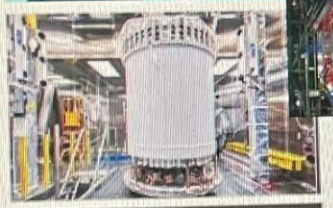
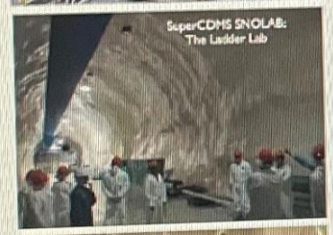
## Detector Development takes a village – Collaborations, Partnerships and Stewards






Research Collaborations

Advanced Detector Development

Facility Stewards

Industry Partnerships

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ADVANCING DETECTOR TECHNOLOGY OVER THE NEXT DECADE 4

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Joey Turnb

## Advancing detector technology relies on a broad, highly skilled workforce

Many areas require expertise and multi-disciplinary work electronics, CS, DAQ, mechanical engineering, cryogenic systems, composites design and fabrication, microfabrication and assembly, analytic chemistry, radiochemistry, materials science, ...

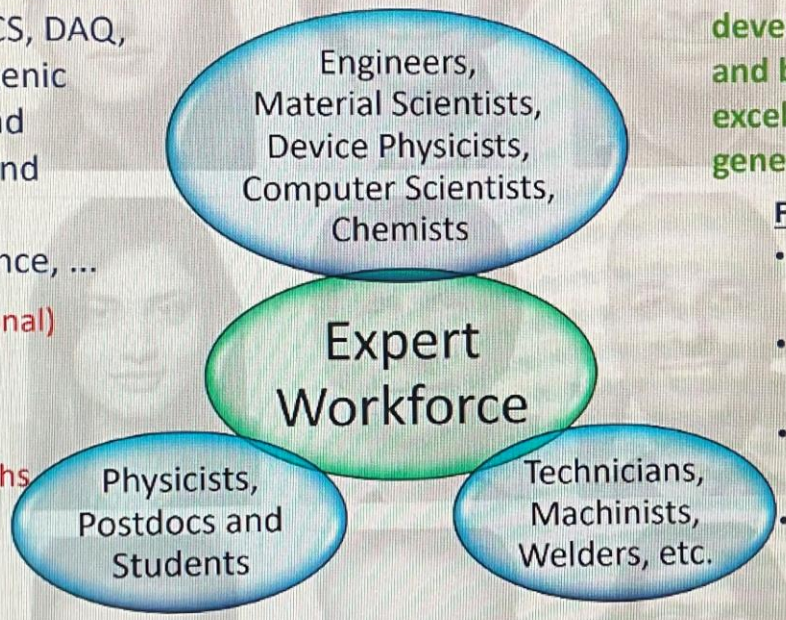
Diverse pipeline (in US, international)

University/lab partnerships

Connections to other disciplines

Supporting alternative career paths including multi-disciplinary

**Appropriate recognition across all of the workforce**




**To succeed in advanced detector development in the next decade and beyond, we need to succeed in excellence in the current and next generation of people**

**Fostering careers in instrumentation**

- Historically challenging career path for particle physicists in the U.S.
- CPAD has spearheaded some changes in recent years
- Physics faculty jobs focused on instrumentation are uncommon
- Several Nuclear Engineering departments have strong support for instrumentation experts

***These experts, in turn, educate the next generation in advanced HEP instrumentation techniques and development transforming not only HEP but other fields too.***

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ADVANCING DETECTOR TECHNOLOGY OVER THE NEXT DECADE 9

Joey


## Questions and Discussion