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Accelerator & Underground Capabilities for High Energy Physics

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Accelerator Capabilities

What are long term "big questions" regarding accelerator-based HEP capabilities



- How can one build a collider at the 10 30 TeV constituent mass scale?
- What is the farthest practical energy reach of accelerator-based high-energy physics?
- How would one generate 10 MW or more of proton beam power?
- Can multi-megawatt targets survive and if so, for how long?
- Can plasma-based accelerators achieve energies & luminosities relevant to high-energy physics?
- ✤ Can accelerators be made 10x cheaper per GeV? or per MW?

These are issues for the long term future

Areas of inquiry included specific questions

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Energy Frontier

How high a luminosity is possible for the LHC?

- ➤ How high an energy is possible in the LHC tunnel?
- Could a Higgs factory be built in the LHC tunnel?

Can ILC and CLIC designs be improved using new technologies?

*Can one design a multi-TeV μ + μ - collider?

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Areas of inquiry included specific questions (cont'd)

Intensity Frontier:

- What secondary beams are needed for Intensity Frontier experiments?
 - ➢ What proton beams are needed to generate these secondary beams,
 - Can these be made by existing machines?
- What accelerator capabilities at heavy flavor factories are required to realize the full range of physics opportunities?
- What are new physics opportunities using high power electron & positron beams?

Accelerator test facilities

 What is broad range of test capabilities existing or needed for developing accelerator capabilities

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Summary conclusions – Energy Frontier

- To maximize exploration of the Energy Frontier, full exploitation of the LHC is the highest priority of the hadron-collider program
 - With renewed interest in a ~100 TeV scale collider, we recommend participation in the CERN-led international study
- As described in its Technical Design Report (TDR), the ILC is technically ready to proceed to construction
 - An experienced cadre of U.S. accelerator physicists & engineers is capable and ready to work on ILC
- Vigorous, integrated U.S. research toward demonstrating feasibility of a muon collider is highly desirable.
 - > The current funding level is inadequate to assure timely progress.

Summary conclusions – Intensity Frontier



- Next generation Intensity Frontier experiments require beam intensities & timing structures beyond capabilities of any existing accelerator
- Fermilab's proposed, multi-stage Project X would yield a world-leading capability
 - Could serve multiple experiments over an energy range 0.25 120 GeV
- ✤ DAE&ALUS / IsoDAR- Decay At Rest short baseline, anti-neutrino experiments based high power cyclotrons
 - Strong industrial & international laboratory connections

Intensity Frontier using electron beams



- Relevant technologies of super flavor-factories exploit strong synergy with light sources & damping rings for lepton colliders
 - Continuing U.S. involvement would maximize physics opportunities
- All electron-ion colliders studied recently would be based at an existing accelerator lab with center-of-momentum energies range from 14 GeV to 2000 GeV
 - Recirculating, energy recovery linacs (ERLs) are a key technology

Cross-cutting frontier-accelerator issues



- Understanding & controlling beam loss is a major challenge for frontier accelerators
- Superconducting RF technology Most modern high power proton facilities rely superconducting radio frequency (SRF) acceleration
 - Needs optimization for medium gradient, CW operation
- Isochronous ring cyclotrons are also good candidates for high continuous (CW) power at energy < 1 GeV
- Sustained, focused research into high-power (> 1 MW) target technology is essential to frontier accelerators
 - Conduct R&D in the context of a broad international collaboration of interested laboratories

Long range accelerator research



- Innovations in acceleration & beam transport techniques such as plasma and dielectric wakefield acceleration have significant potential to reduce the size of future facilities
- Long-term research including fundamental accelerator and beam physics theory & simulation will expand the technical options for any future accelerator-based facility
 - Personal option: this area is often underfunded in preference to project related research
- Focused engineering development is *no substitute* for innovative R&D.

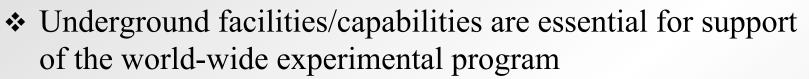
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Underground Detector Capabilities

On behalf of Gil Gilchriese

Relevance of underground capabilities



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- Direct dark matter experiments
- > Neutrinoless, double-beta decay ($0 \nu \beta \beta$) experiments
- Atmospheric, reactor, solar, supernova neutrino experiments
- Proton decay
- Connections to astrophysics, nuclear and earth science, & detectors for non-proliferation
- Roughly 1,000 US scientists now participate in underground experiments
 - Includes US-led Antarctica effort)
- May grow by 30 50% over next decade

Existing/Planned Facilities



- No technical showstoppers to create underground/ice space for planned activities for next 10-20 years
- World-wide "general purpose" space is expected to about double by end of decade
 - Assumes anticipated expansion in non-US underground capabilities
- Significant non-US underground capabilities for specific neutrino experiments is planned
- Plans for expansion of underground facilities in the United States are less developed.
 - Currently, there are no approved plans with federal funding for significant expansion of underground capabilities in the U.S.

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Key goals for the U.S. planning process

- It is critical that US scientists continue to be supported to take advantage of future international & domestic underground facilities
- Put LBNE underground to realize its full science potential!
 - Makes it an anchor of possible future domestic underground capabilities at SURF
- Maintain leading U.S. roles in many of the future dark matter, 0ΩΩΩ & a large variety of Ω experiments.
 - Improved coordination and planning of underground facilities (overseas & domestic) is required to maintain this leading role, including the use of US infrastructure
 - > Maintaining an underground facility that can be expanded to house the largest dark matter and $0 \nu \beta \beta$ experiments would guarantee a strong US to role in world-wide program of underground physics





Thank you

Questions?