Report from the Neutrino Group

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Brief Introduction

- **The Physics associated with Neutrino mass**

  Neutrino oscillation (CP violation, Mass ordering, Steriles) and astrophysical neutrinos

- **We split the Neutrino Science with "*Explore the Unknown*" session (Nature and Mass of neutrinos)**

- **We covered:**

Oscillation physics with accelerators *50'*
Speaker: Andrzej Szelc
Material: **Slides**

Near detectors for oscillation experiments *35'*
Speaker: Mr. hirohisa tanaka (University of Toronto/Institute of Particle Physics/TRIUMF)
Material: **Slides**

Coffee Break *30'* (Dabney Hall & Gardens)

Oscillation physics with radioactive sources and reactors *35'*
Speaker: Karsten Heeger
Material: **Slides**

Cosmology and neutrinos *25'*
Speaker: Joaquin Vieira

Astrophysics with neutrinos *35'*
Speaker: Kael Hanson
Material: **Slides**

Findings (I)

- Large effort with Liquid Argon detectors for the Short-Baseline program at FNAL and long-baseline DUNE project
  - Great physics potential (oscillation and interactions)
  - Several technical challenges
- Continued effort on Water Cherenkov detectors with HyperK
  - Established technology
  - Crucial complementarity to DUNE
- Near Detectors options are now being explored seriously
  - DUNE/HyperK are looking at many options (segmented and tracking detectors, LAr modules, HPG TPC, tunable energy detectors)
  - Serious investigations of the exact needs
  - Identifying the physics needs is the main concern over technological challenges

Findings (II)

- Reactor experiments
  - Searches for sterile neutrinos and of reactor spectrum models
  - Many different efforts with different technologies
- Cosmology has a completely different handle on neutrino property measurements
  - Highly complementary to HEP experiments
  - Technology in place for large deployment
- Astrophysical neutrinos
  - Large energy span requires adapted technologies
  - Existing technologies can be used if cost is reduced
  - Diverse scientific potential

Comments

- Diverse experimental landscape offering essential scientific complementary
- Significant ongoing R&D for the LAr neutrino experiments, but some challenges remain:
  - Robust and reliable High voltage systems
  - Light detection system
  - Complex event reconstruction
- Experiments are being designed with “no scientific contingency”, putting high pressure on the experimental community
- We did not discuss R&D for neutrino “beams”

Identification of Risks and Opportunities

- Risks:
  - Communication/collaboration between the LAr efforts is crucial
  - Designing experiment that only reach the “minimum desired science reach” puts a lot of pressure on the community
  - Lack of future R&D in neutrino beams could hurt us later

- Opportunities:
  - Exploiting the combination of scintillation light to the charge collection could be very powerful to expand the scientific reach of LAr detectors
  - Many technical challenges common to other fields (e.g. photon detectors, HV, …)
  - Staged approach of large projects allows ongoing R&D

Recommendations

- Continue to take the LAr technical challenges seriously
  - High voltage (delivery system and operation stability)
  - Cold electronics
  - Event reconstruction techniques
  - Consider magnetisation
- Continue to push the R&D in light/charge detection in LAr detectors to enhance the physics capabilities
- Ensure complementary scientific approaches (i.e DUNE/ HyperK or/and SBL accelerator/reactor)
- Continue exploration of cost reduction for large photodetectors
- Take advantage of synergies between fields and projects
- Keep investigating alternatives for neutrino beams

Possible Grand Challenge Ideas

- Overlap with Instrumentation sessions and Neutrino Physics encloses many existing challenges (photo sensors, trigger and DAQ)
- Globally, many projects are reaching the limits of the detector scalabilities (HyperK, DUNE, IceCube, JUNO), we need strategies for the further future
- We must be ready to react to new discoveries! (e.g. Sterile neutrinos, large CP violation and need for precision measurements)