Photon Calibration Working Group

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Goals and Boundaries

- Why this WG is needed?
  - We already have a Photon-Detector Calibration and Monitoring System.
  - It is based on 275nm LEDs, light-guided by quartz optical fibers.
  - From the 60% TDR presentation (June 2019), on page 7:

➤ Operation done with 275 nm light; does not operate at 128 nm (LAr wavelength).
  - Not intended to measure absolute detection efficiency at 128 nm
  - "Does everything else" quickly and efficiently.

➤ Complementary to ionization laser and radioactive sources.
  - One of the topics to be addressed by calibration groups.   this is us
  - Develop optimal calibration plan for DUNE Far Detector   (but we are not alone)

Synergies

- DUNE (Physics) Calibration WG
  - Conveners: Michael Mooney (Colorado State University) and David Caratelli (Fermilab)
  - https://indico.fnal.gov/category/1057

- JT Calibration and Cryogenic Instrumentation Consortium (CISC)
  - Convener: Jose Maneira (LIP - Portugal)
  - https://indico.fnal.gov/category/702 (consortium)
  - https://indico.fnal.gov/category/936 (IoLase WG - Sowjanya Gollapinni)

- SP Photon Detection System
  - Convener: Ettore Segreto
  - https://indico.fnal.gov/category/1031 (consortium)
  - Calibration and Monitoring System: Zelimir Djurcic (ANL) and David Martinez (South Dakota School of Mines and Technology)
  - https://indico.fnal.gov/category/1309 (⬅this is us)

Objectives

- How could we continuously measure the absolute detection efficiency of the PDS at the 128nm LAr wavelength?
  - What standard candles do we have available?
  - What do we know about the recombination?

- How could we use the planned charge calibration systems in a complementary manner to the UV-system?
  - Ionization Laser
  - Pulsed neutron source
  - Natural sources (muons, pions, ^{39}Ar, etc)

- What is the optimal strategy for achieving full calibration of the PDS?
  - Full energy and efficiency calibration
  - Cross-calibration between different systems
  - Possible tests for ProtoDUNE run 2.

Deliverables

- Comprehensive PDS calibration strategy
- Simulation tools for photon calibration related studies.

Boundaries

- This is not an instrumentation WG (which there are several).

- As previously mentioned, this is not the only group looking at the physics calibration:
  - (Physics) Calibration WG:
    https://indico.fnal.gov/event/24155/contributions/75510/attachments/128652/155780/DUNE_CALCIWorkshop_20_05_26.pdf
  - Calibration Consortium:
    https://indico.fnal.gov/event/24155/contributions/75509/attachments/128642/155775/CalibrationPlans_May2020_v3.pdf

- There is the obvious need to work in tandem with the these groups, but we should strive to not overlap with their work.

- Ideally, we should have at least one collaborator from other groups (not only the PDS monitoring system). But even if that doesn't happen, it is my job to keep others informed about what we are doing.

- We should work closely with the Physics and Simulation WG.

First steps and topics we should be looking at

- Review the relevant materials and topics already addressed by other groups.

- Study the limits of our knowledge on the recombination of electron-ion pairs in liquid argon.

- Search for possible standard candles, including but not limited to the already planned calibration devices.

- Start working on relevant base simulations.
  - There has been a recent development on ionization simulation: LArQL
    https://cdcvs.fnal.gov/redmine/attachments/download/63475/LArQLDetails.pdf
  - LIP group is working on IoLase simulation.

Summary

- Setting the goals and boundaries: we are filling an existing gap.
- Synergies: working in parallel, not in overlapping.
- Objectives and Deliverables: physics must translate to a calibration plan.
- Planning activities: who does what?

How to join

- There is a lot of interesting work here for students to engage in DUNE activities.
- DUNE Slack: **#hd-photon-calibration**
- Indico agenda: https://indico.fnal.gov/category/1309
- Zoom room: https://fnal.zoom.us/j/7904002300

Backup

- About recombination

  George Jaffé on Recombination https://doi.org/10.1103/PhysRev.58.968

  J. Thomas and D. A. Imel on Recombination in LAr https://doi.org/10.1103/PhysRevA.36.614

  Recombination with ICARUS https://doi.org/10.1016/j.nima.2003.11.423

  Recombination with ArgoNeuT https://doi.org/10.1088/1748-0221/8/08/P08005