Measuring Electron Recoils in Liquid Argon: Progress on ARIS-ER

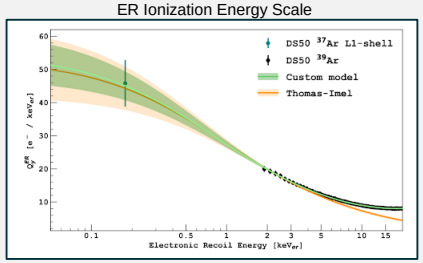
Aaron Elersich[1], Emilija Pantic[1]
[1]University of California, Davis

Nuclear Science & Security Consortium

Background

- Future experiments like Darkside-20k and ARGO require precise calibration of liquid argon electron recoil response
- Existing background models have larger uncertainties at low energies, due to a lack of calibration data points

ER Ionization Energy Scale



P. Agnes et al. (DarkSide Collaboration), Phys. Rev. D 104, 082005 (2021).

- Previous work measured LAr electron recoil response:
  - Darkside-50: Calibration using ^{37}Ar and ^{39}Ar
  - ARIS (Argon Recoil Ionization and Scintillation): Measured LAr nuclear and electron recoils
- The Argon Recoil Ionization and Scintillation from Electron Recoils (ARIS-ER) experiment will measure LAr electron recoil response down to 1 keV using Compton coincidence technique

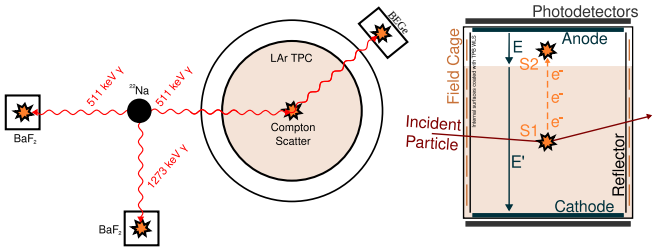
Experimental Setup

Liquid Argon Two-phase Time Projection Chamber

- Incident particles ionize argon atoms
- Electric field drifts free electrons
- Event detected as two pulses of light:
  - S1: Primary scintillation
    - Produces scintillation photons and drift elections
    - Calorimetry
  - S2: Secondary scintillation
    - Electroluminescent light from electrons in gas pocket
    - Position reconstruction, calorimetry

Compton Coincidence

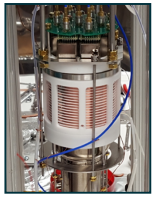
- Na-22 source emits two back-to-back 511 keV γs
  - One γ enters TPC and Compton scatters
- Scattered γ energy measured by broad-energy germanium detector (BEGe)
- Second 511 keV γ detected by a BaF_2 detector
  - Trigger on coincidence between BaF_2 and BEGe
- Na-22 decay also emits 1273 keV γ, may also be used for triggering



Status and Plans

Detector Specifications

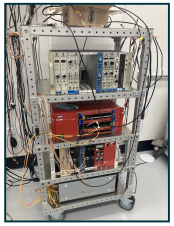
- 0.5 kg active LAr
- Array of 7 PMTs above, one below
- Drift field up to 1 kV/cm, extraction field up to 4 kV/cm
- Internal surfaces will be coated with a TPB wavelength shifter
- Reuses ARIS components



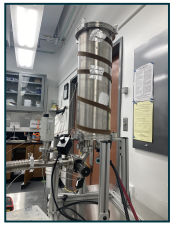
ARIS TPC

Progress

- Constructed DAQ using CAEN digitizers
- Currently testing a TPB deposition chamber for applying the wavelength shifter



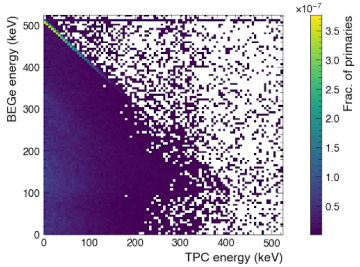
DAQ Cart



TPB Evaporation Chamber

Future Plans

- GEANT4 simulations to determine optimal source activity, positions of BaF_2 and BEGe detectors
- Investigate using SIPMs in place of PMTs



This material is based upon work supported in part by the Department of Energy National Nuclear Security Administration through the Nuclear Science and Security Consortium under Award Number DE-NA0003996.