ARIS-ER at UC Davis

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Aaron Elersich

LAr Lab at UC Davis

Group
PI, 1 postdoc, 2 PhD students, local engineers on recharge, +1 more person to be hired

DarkSide-20k
TPC HHV system, reflector cage components, field cage components, offline working group contributions
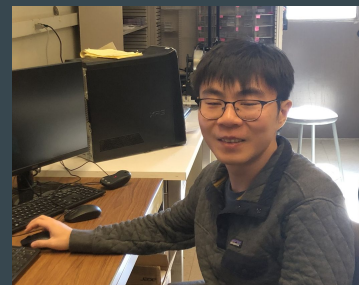
DUNE
Neutron calibration system (ARTIE)

ARIS-ER
Two-phase LAr TPC for precision calibration measurements

Dr. Emilija Pantic
PI

Dr. Tianyu Zhu
Postdoctoral researcher

Michael Poehlmann
5th year PhD student, graduating

Tyler Erjavec
5th year PhD student

Aaron Elersich
2nd year PhD student

ARIS-ER

Argon Recoil Ionization and Scintillation from Electron Recoils

Experiments like DarkSide-20k and ARGO need precise calibrations of LAr scintillation and ionization responses to nuclear and electron recoils

Background models at low energies have large uncertainties due to a lack of calibration data points

ARIS-ER will measure the response of LAr to electron recoils down to 1 keV using the Compton coincidence technique

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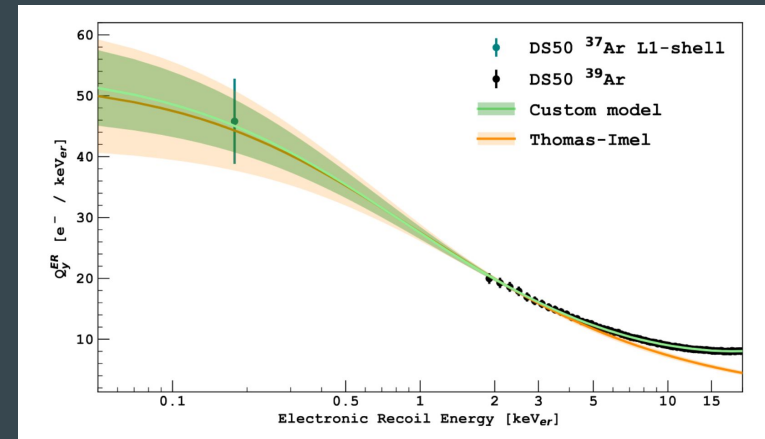
P. Agnes et al. (DarkSide Collaboration), Phys. Rev. D 104, 082005 (2021).

ARIS-ER Experimental Design

- Irradiate TPC with 511 keV γ's from a 100 μCi Na-22 source

- Select events where a γ Compton scatters in TPC and deposits remaining energy in germanium detector
  - Energy measured by BEGe detector is used to reconstruct energy deposited in TPC

- Trigger on coincidence between BaF_2 (back-to-back 511 keV γ) and BEGe detector (scattered γ)
  - Coincidence with another BaF_2 detector (1273 keV γ) can be required to further separate events from background


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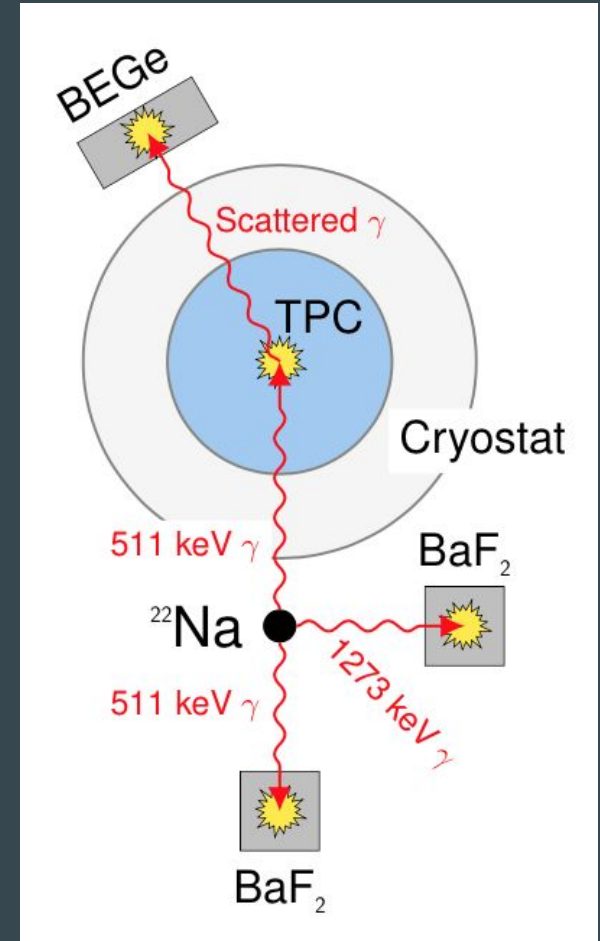
Two-phase LAr TPC

- 0.5 kg active LAr, originally built for the ARIS experiment
  - 7.6 x 7.6 cm PTFE cylinder, quartz window caps
  - Gas pocket needs to be tested

- Seven 1-inch R8520 PMTs in top array, which enable XY position reconstruction

- One 3-inch R11065 PMT below
  - Needs to be tested

- Drift field up to 1 kV/cm, extraction field up to 4 kV/cm

- Internal surfaces coated with TPB wavelength shifter
  - Converts LAr scintillation light (~128 nm) to visible range (~420 nm)

- Possible upgrade to SiPMs
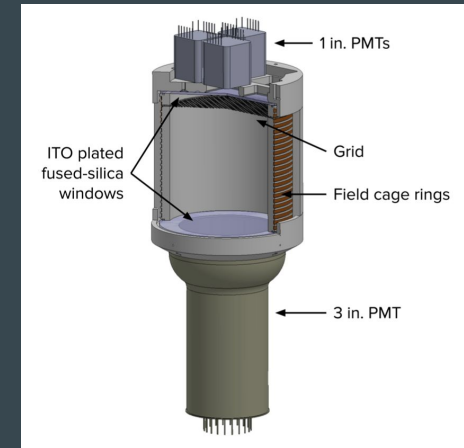
Germanium Detector
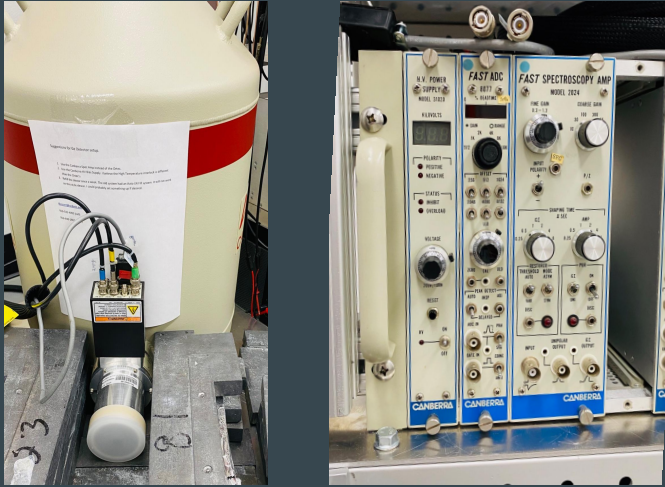
- Canberra BE2020 broad-energy germanium detector, used to precisely measure scattered γ energy
  - 5.13 cm crystal diameter, 2.17 cm thickness
  - Energy resolution: 0.65 keV FWHM at 122 keV
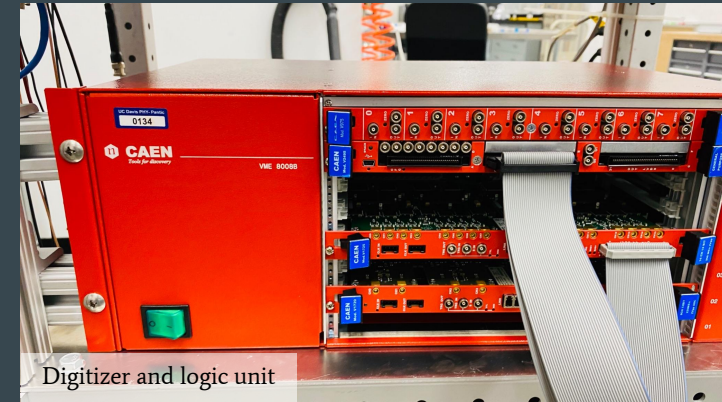- Canberra HV power supply and preamplifier modules

BaF$_2$ Detectors (x2)

- For triggering on 511 keV and 1273 keV γ's
- 3.8 cm diameter BaF$_2$ crystal
  - Decay time: 800 ps
  - Time resolution: 150 ps at 1 MeV

Data Acquisition System

Digitizer and logic unit

- CAEN V1725 16-channel digitizer
- CAEN V2495 logic unit used to combine discriminator signals
  - Custom cables to synchronize and propage trigger to digitizers
- Custom PMT front-end boards, based on what was used in DarkSide-50
- C++ DAQ software which uses MIDAS, based on DarkSide-Proto system
  - Scalable up to 64 channels (4 digitizers)

Front-end boards

Supporting Subsystems

Cryomech PT90 Cryocooler cold head

Cryomech CP2800 compressor
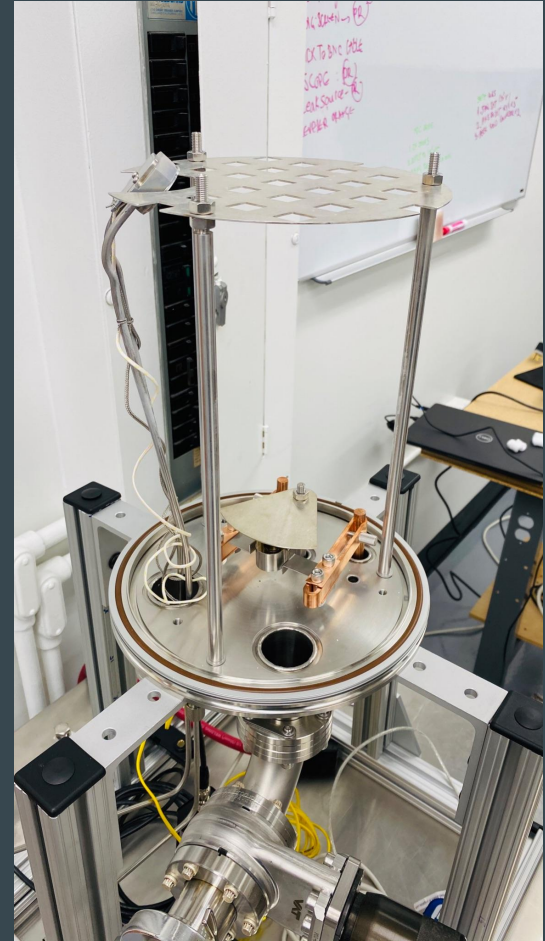
SAES MonoTorr getter to remove impurities in LAr

LabVIEW slow control system

Backup Slides

TPB Coating System

- Thermal evaporation chamber of TPB coating
- Can coat wafers up 15 cm in diameter
- Used for ARIS TPC

Simulations

Detailed TPC, BEGe, and BaF2 detector descriptions implemented in the DarkSide Geant4-based simulation package (G4DS)

Optimize angle of BEGe detector