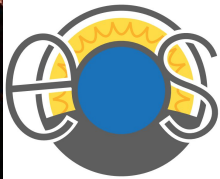


Performance of the Eos Detector



Lu Ren

On Behalf of the Eos Collaboration

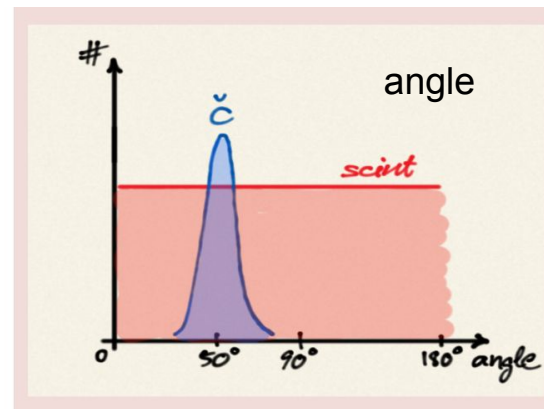
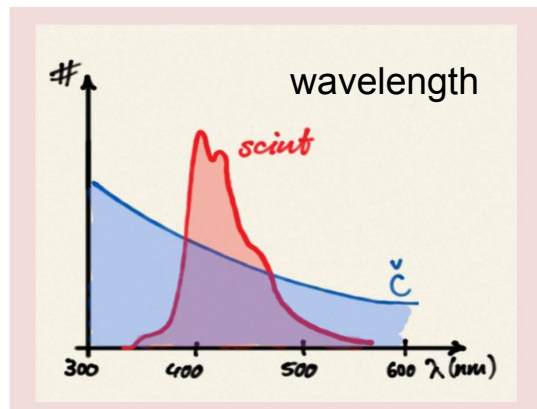
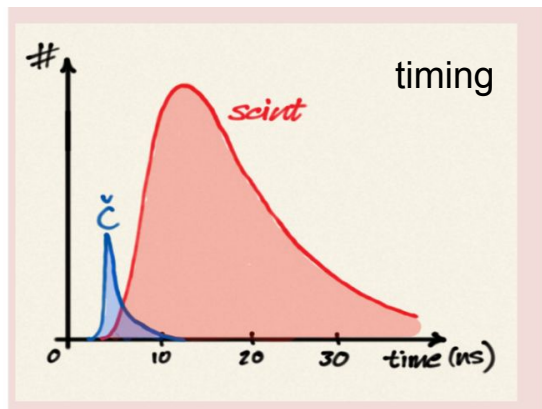
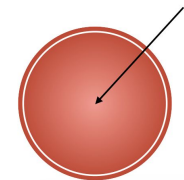


Hybrid Detector

- Cherenkov light **directional** sensitivity via ring imaging
- Scintillation light **energy and vertex resolution** and **low-threshold** particle detection
- **Particle ID** from the relative intensity of two signals

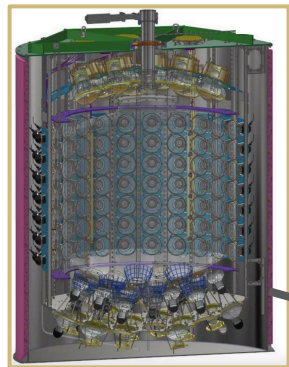


Scintillation

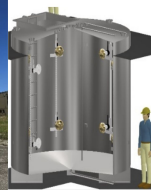


M. Wurm

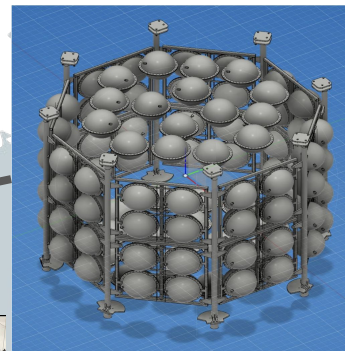
Hybrid Technique Demonstrators



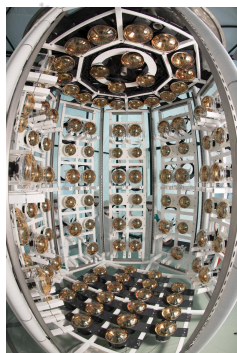
Eos at Berkeley



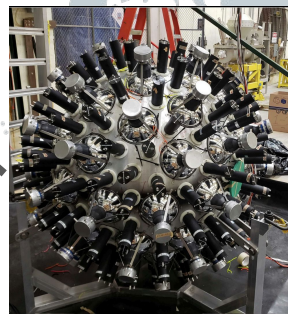
1-ton and
30-ton at BNL



BUTTON in the UK



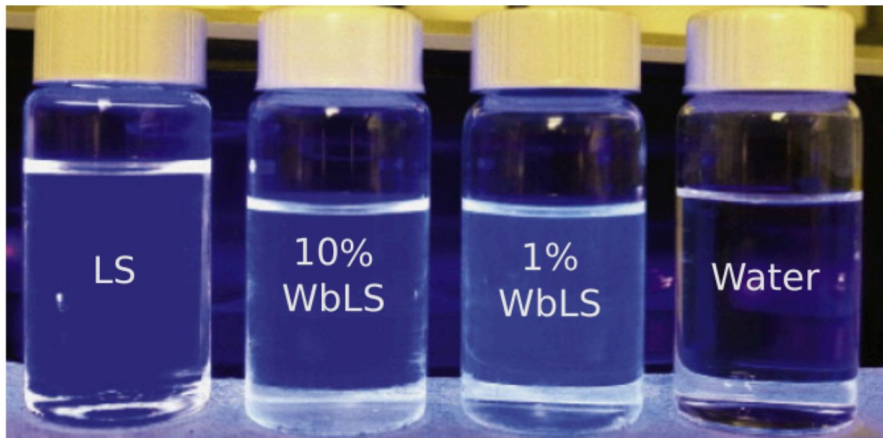
ANNIE at Fermilab



NuDot at Delaware

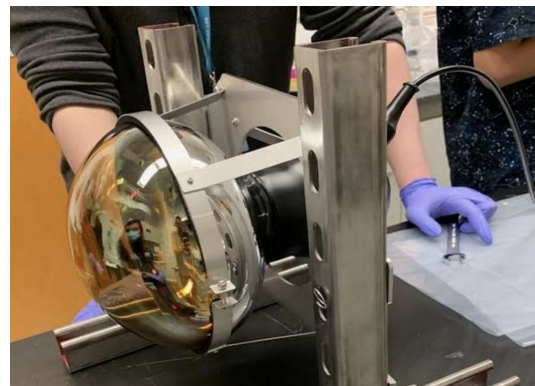
Eos as a Testbed of Novel Technology

- Novel target: Water-based liquid scintillator (WbLS), slow liquid scintillator (LS)
 - Enhance Cherenkov detection by modifying the scintillation signal



Eos as a Testbed of Novel Technology

- Novel target: WbLS, slow liquid scintillator
 - Enhance Cherenkov detection by modifying the scintillation signal
- Ultra-fast photon detectors
 - 204 8-inch Hamamatsu PMTs: R14688-100, 900ps FWHM



Eos as a Testbed of Novel Technology

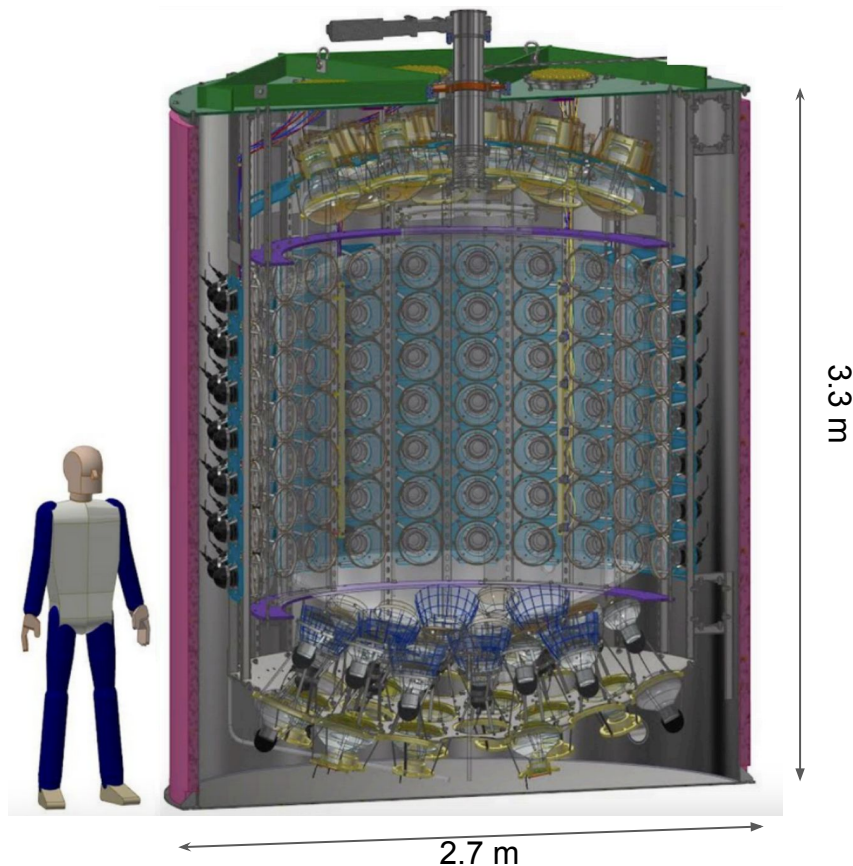
- Novel target: WbLS, slow liquid scintillator
 - Enhance Cherenkov detection by modifying the scintillation signal
- Ultra-fast photon detectors
 - 204 8-inch Hamamatsu PMTs: R14688-100, 900ps FWHM
- Dichroicon
 - Sorting Cherenkov-rich and scintillation-rich photons toward two PMTs using a parabolic concentrator built from dichroic filters

RDC 2: Spectral Photon Sorting with Dichroicons in Eos and Beyond by Samuel Naugle



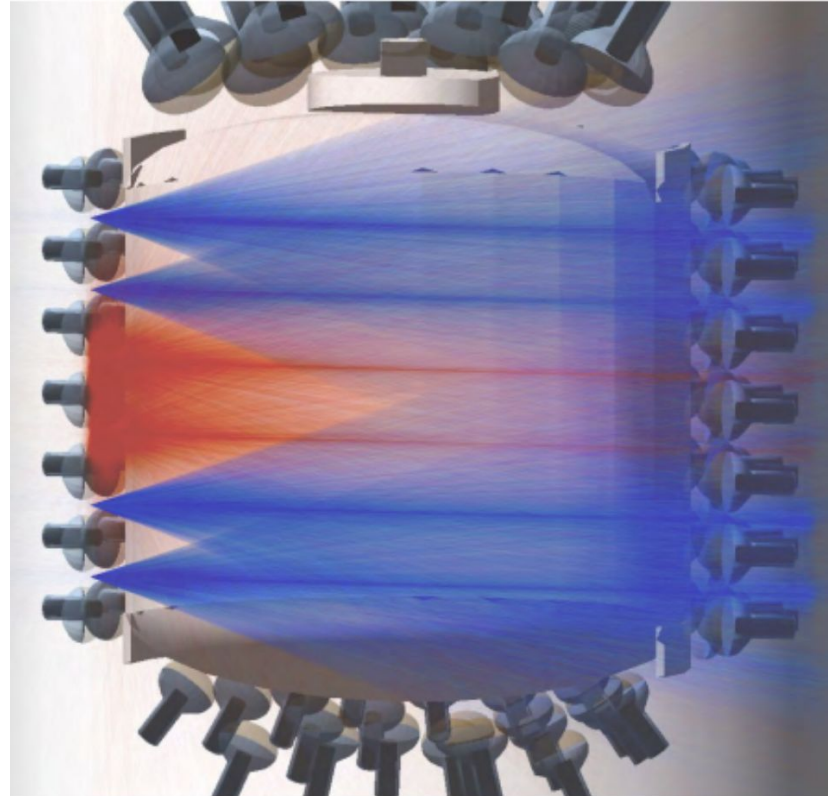
The Eos Detector

- 20-ton steel outer vessel
- 4-ton acrylic inner vessel
- 242 fast PMTs
- 12 dichroicons



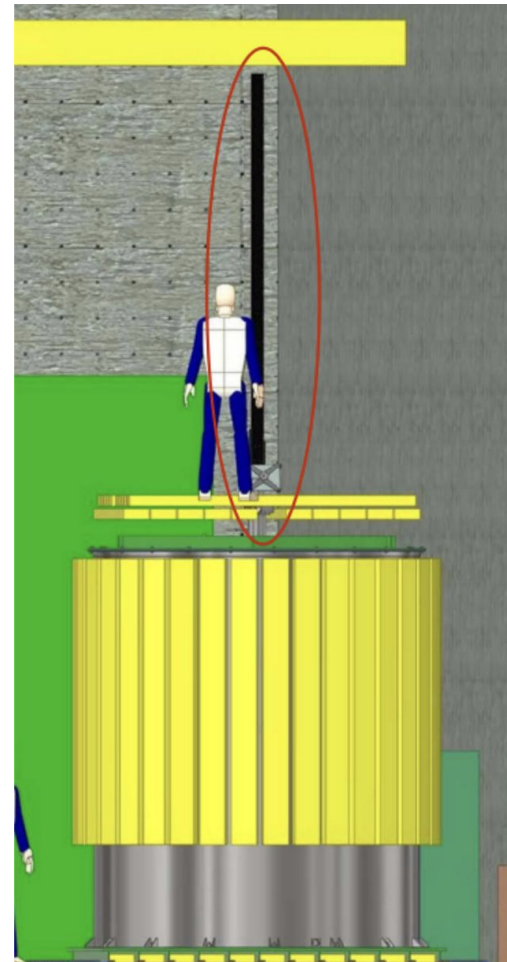
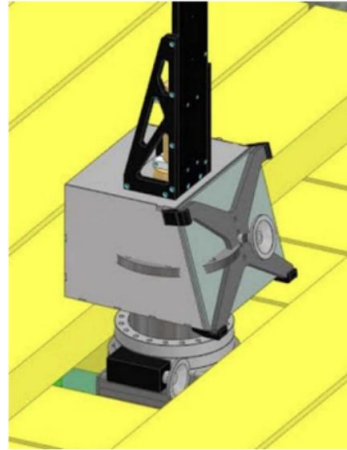
The Eos Detector

- 20-ton steel outer vessel
- 4-ton acrylic inner vessel
- 242 fast PMTs
- 12 dichroicons
- Light injection system
 - Central diffuser ball
 - 36 fibers installed on the barrel

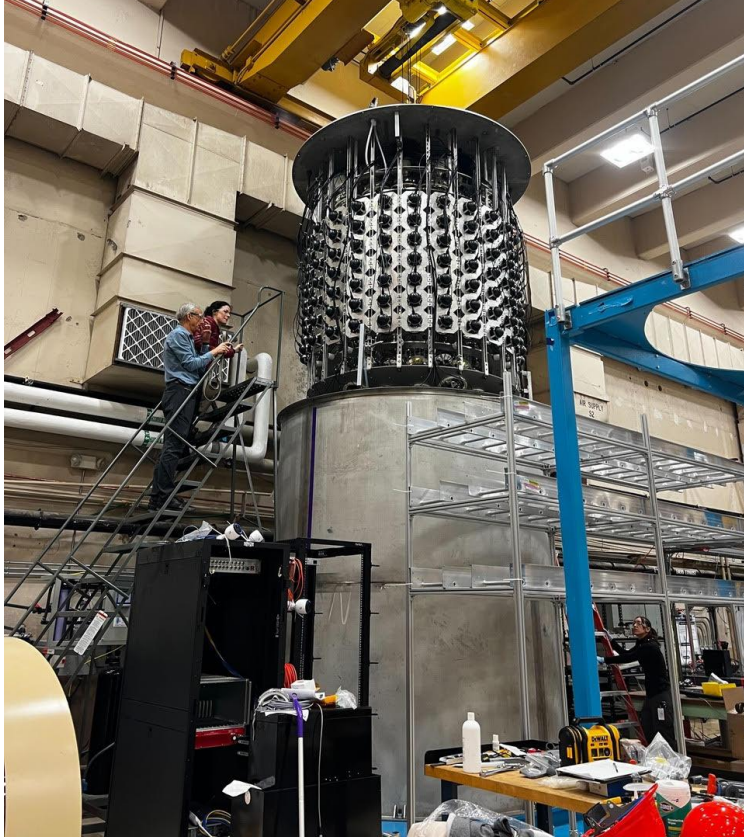


The Eos Detector

- 20-ton steel outer vessel
- 4-ton acrylic inner vessel
- 242 fast PMTs
- 12 dichroicons
- Light injection system
- Central calibration source deployment system
- Muon-veto system

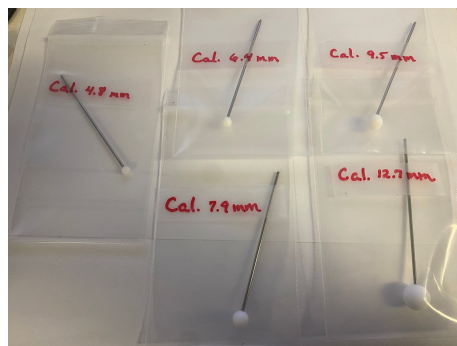


Eos Timeline

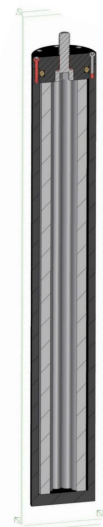
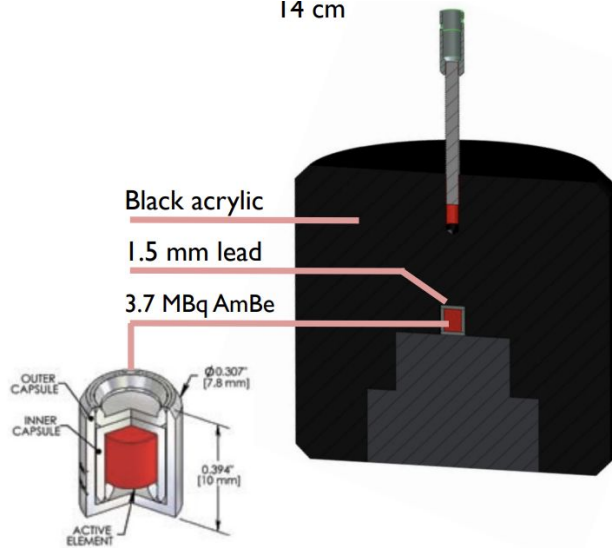
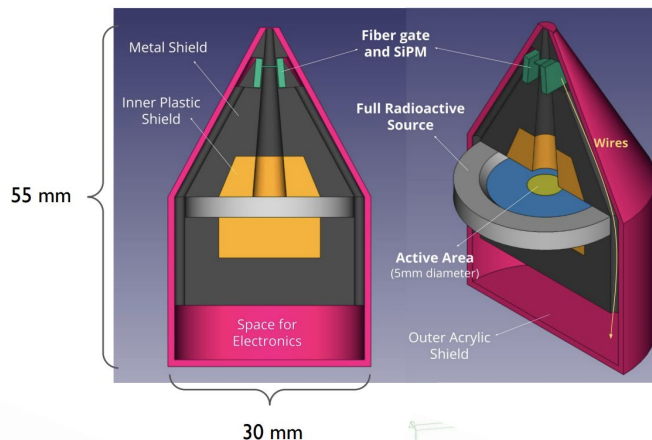


Water Data-taking

- Central diffuser balls
 - 374, 408, 442, 510 nm
- Novel directional source
 - Ru-106
 - Sr-90
- Ambe source
- Thorium source
- Cosmic muons
- ...

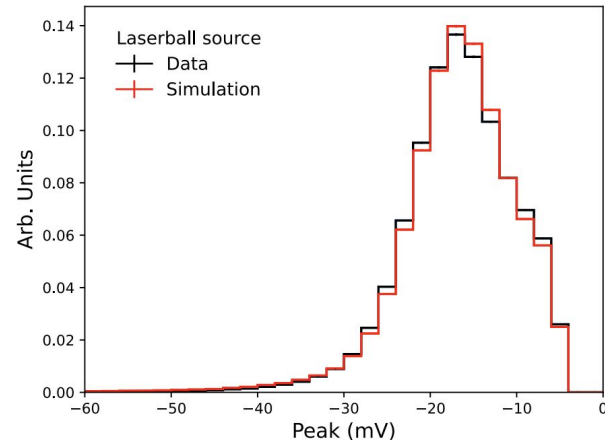
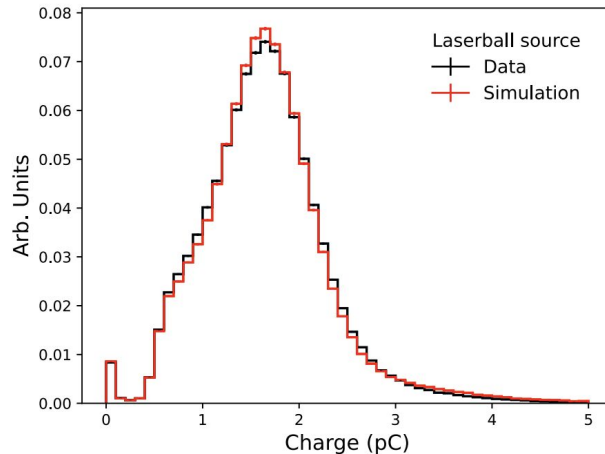
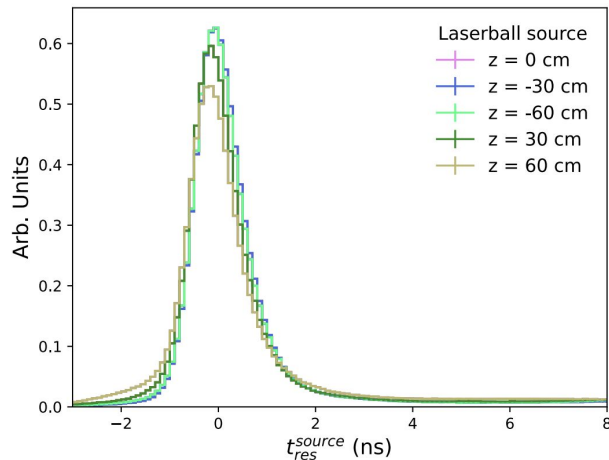


14 cm



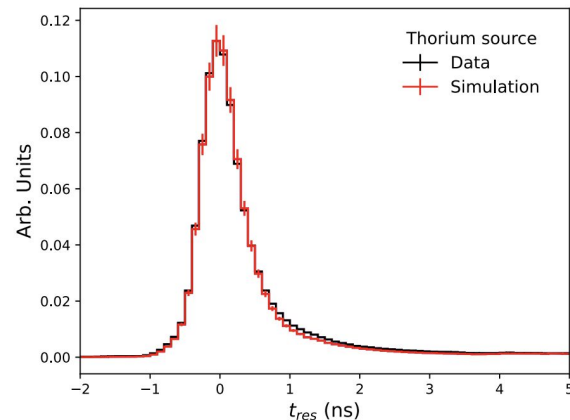
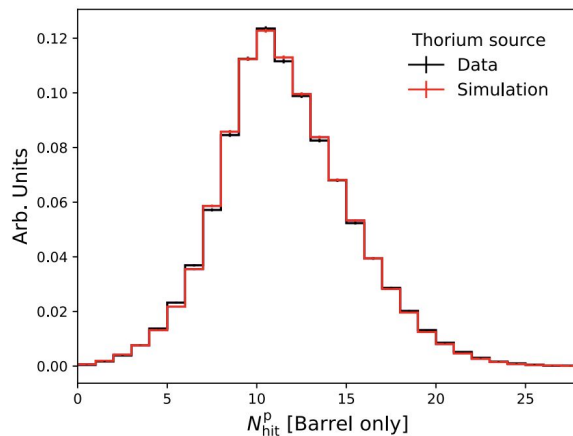
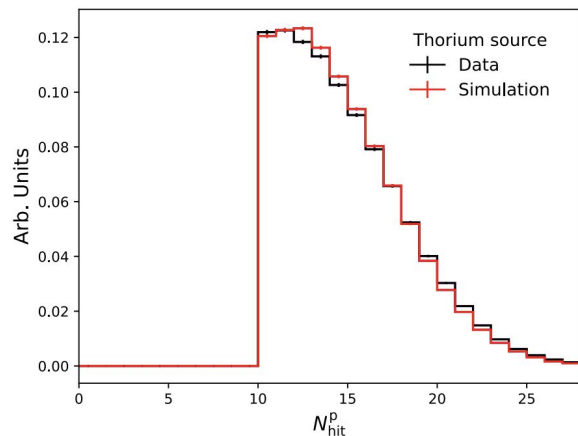
PMT Calibrations

- Central laser ball data: isotropic light from picosecond 408/515 nm laser
- Time residuals, pulse shapes, charge, dark noise, etc.



PMT Calibrations

- Central thorium data: 2.6 MeV gammas
- PMT efficiency calibration



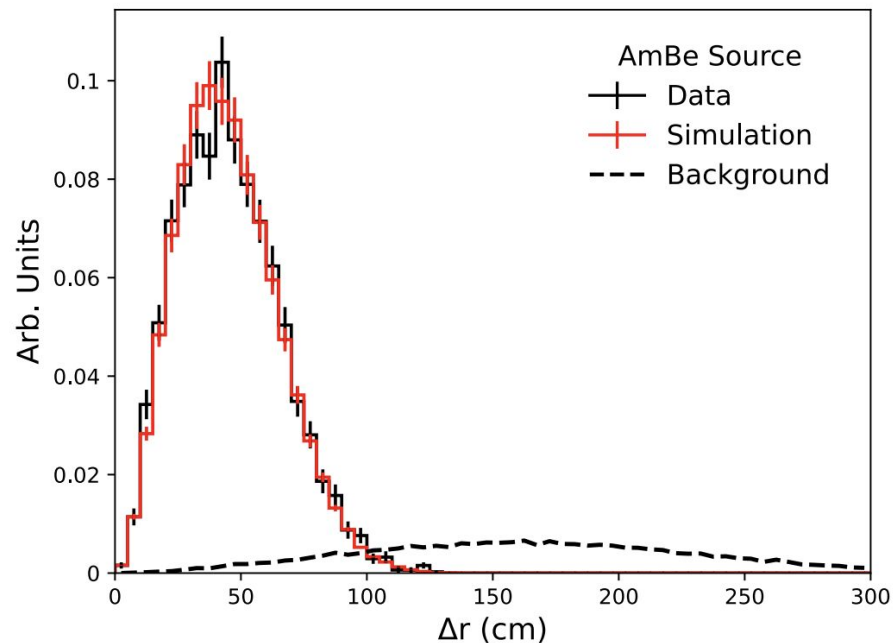
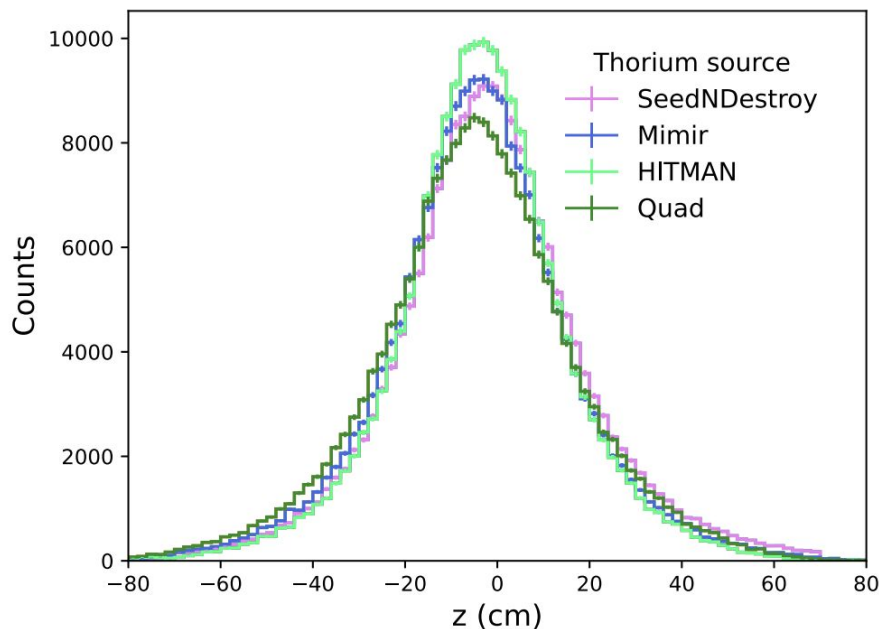
Event Reconstruction

- Common MC inputs for multiple reconstruction methods

	Quad	SeedNDestroy	AERO	MIMIR	HITMAN
Reconstructed variables	vertex	vertex	direction	vertex, direction	vertex, direction
approach	Simple average	Likelihood	Likelihood	Likelihood	Machine learning

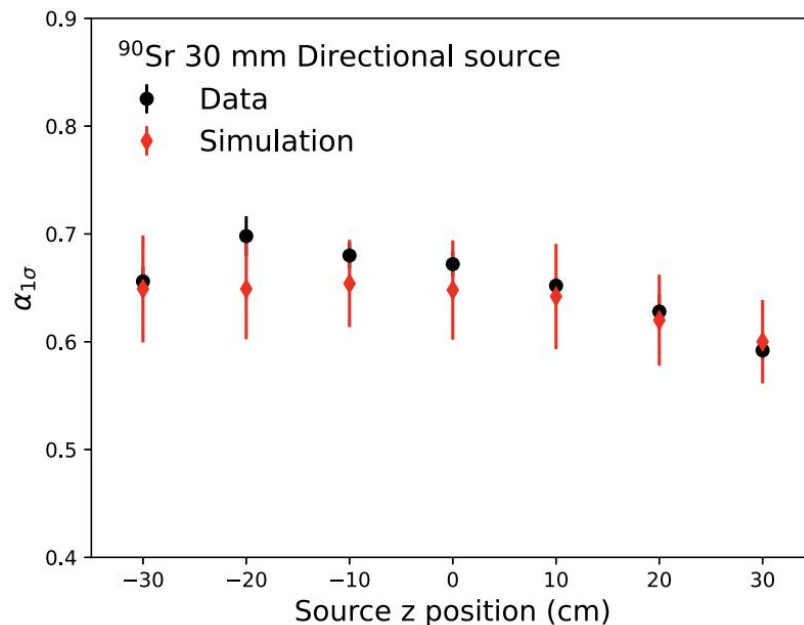
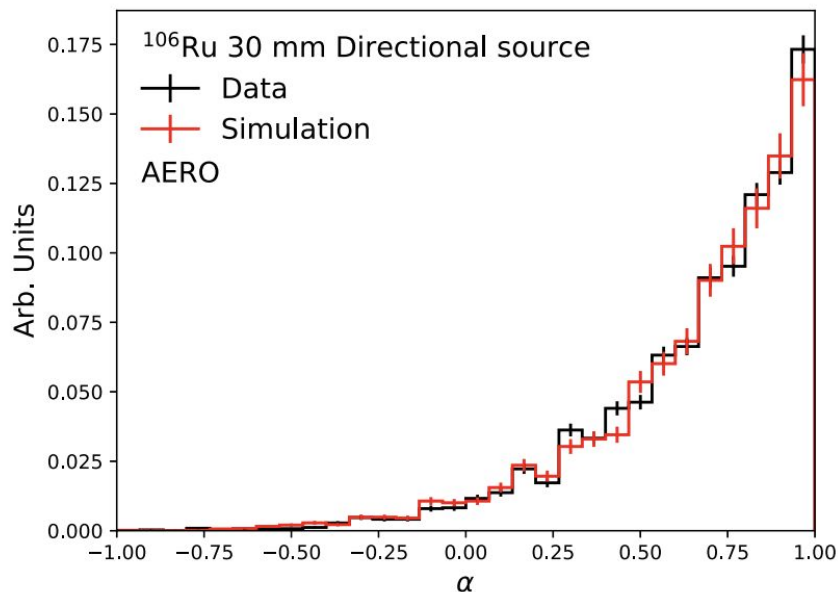
Vertex Reconstruction

- Performance of vertex reconstruction is evaluated using central thorium and AmBe data



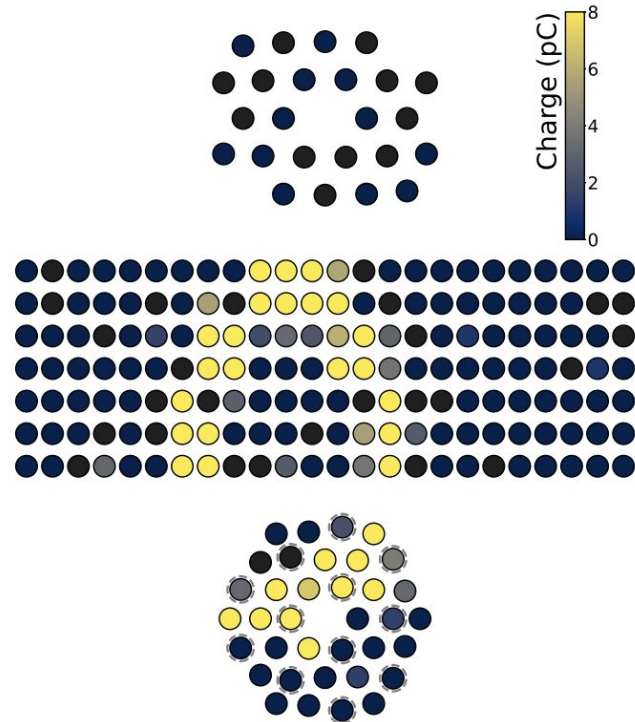
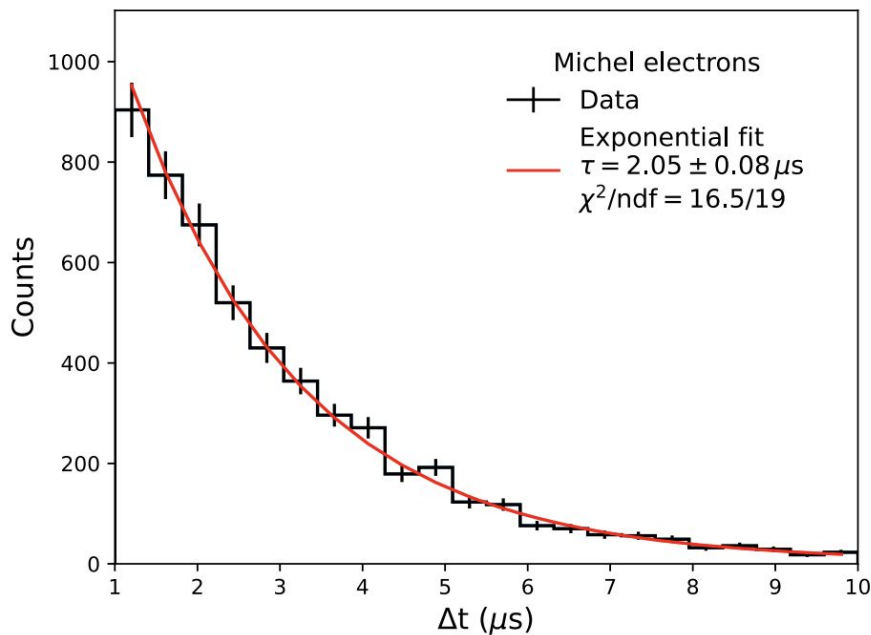
Direction Reconstruction

- Performance of direction reconstruction is evaluated using directional sources with two different isotopes



Cosmic muon data

- Independent validation using Michel electrons from the cosmic muon data



Current Focus and Future Plan

- Calibration and modeling for data from WbLS and pure LS phases
- Completing pure LS data-taking
- Decommissioning at UC Berkeley
- Exploring the possibility of re-deploying Eos at Spallation Neutron Source (SNS)



Spallation Neutron Source at Oak Ridge National Laboratory

RDC 11: Eos at the SNS by Tanner Kaptanoglu

Summary

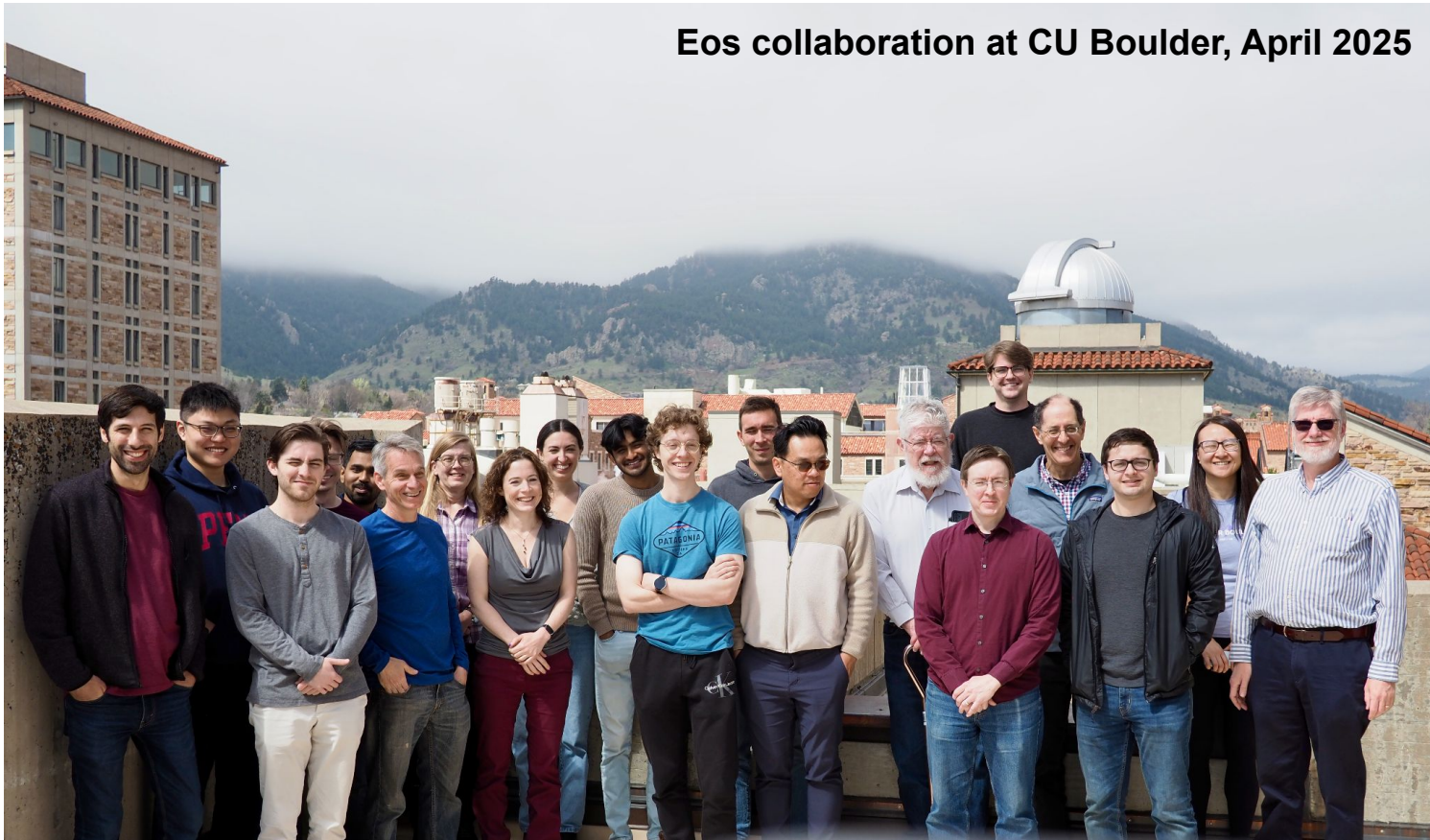
- Eos is a performance demonstrator of the hybrid neutrino detection concept
- Performance of the Eos detector with water published ([Phys. Rev. D 114, 052012](#))
- Work ongoing to calibrate and model WbLS/LS phase data
- Possible re-deployment Eos at SNS at ORNL in 2027

EOS talks

RDC 11: Eos at the SNS by Tanner Kaptanoglu

RDC 2: Spectral Photon Sorting with Dichroicons in Eos and Beyond by Samuel Naugle

Eos collaboration at CU Boulder, April 2025



Thank you!



U.S. DEPARTMENT OF
ENERGY

Office of
Science

NNSA
National Nuclear Security Administration