Neutrino-oxygen cross sections with EOS at the Spallation Neuron Source

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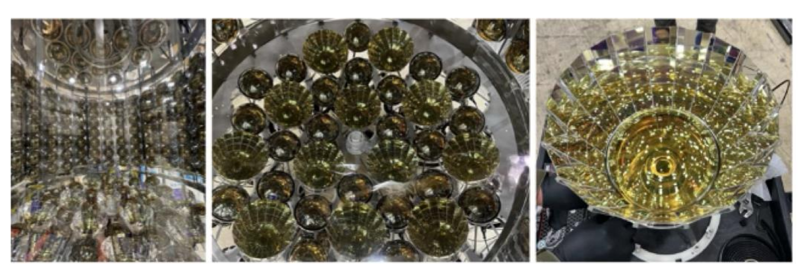
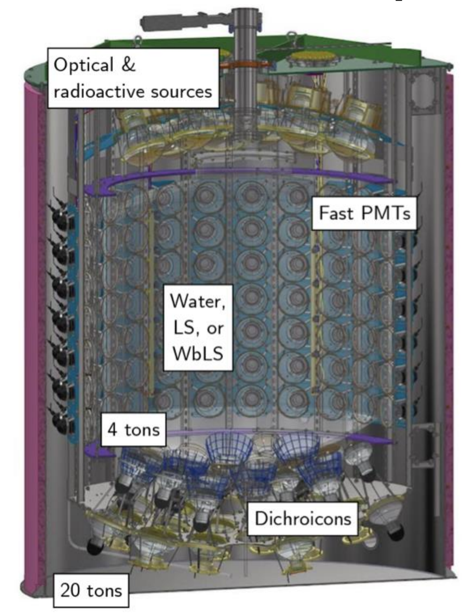
Hybrid Cherenkov / Scintillator Performance Demonstrator

A flexible, multi-ton scale integrated testbed to demonstrate the performance of novel technology

- Novelty / technology:
- 4-ton acrylic inner vessel — water, WbLS, novel LS
- High coverage (50%, 242 PMTs)
- Ultra-fast photon detectors — R14688-100, 900ps FWHM
- "Quantum chromatic sorting": dichroicons for spectrally sensitive photon detection
- Deployable sources (β, γ, tagged-γ, AmBe, PuBe, directional) for studies of vertex, energy, direction reconstruction & PID
- 36-fiber light injection system for optical calibration
- AI/ML-based analysis techniques



The Concept

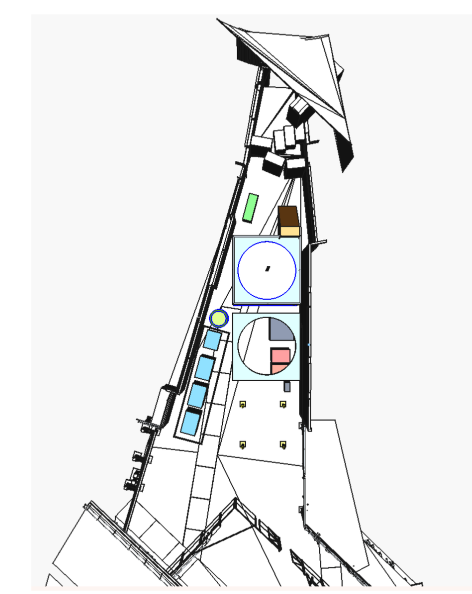


Fully deployed
Water data complete
1%, 2% WbLS data taking complete
Planned: Pure LS, slow LS, fast LS

The Reality

Sited on UC Berkeley campus in Nuclear Engineering department

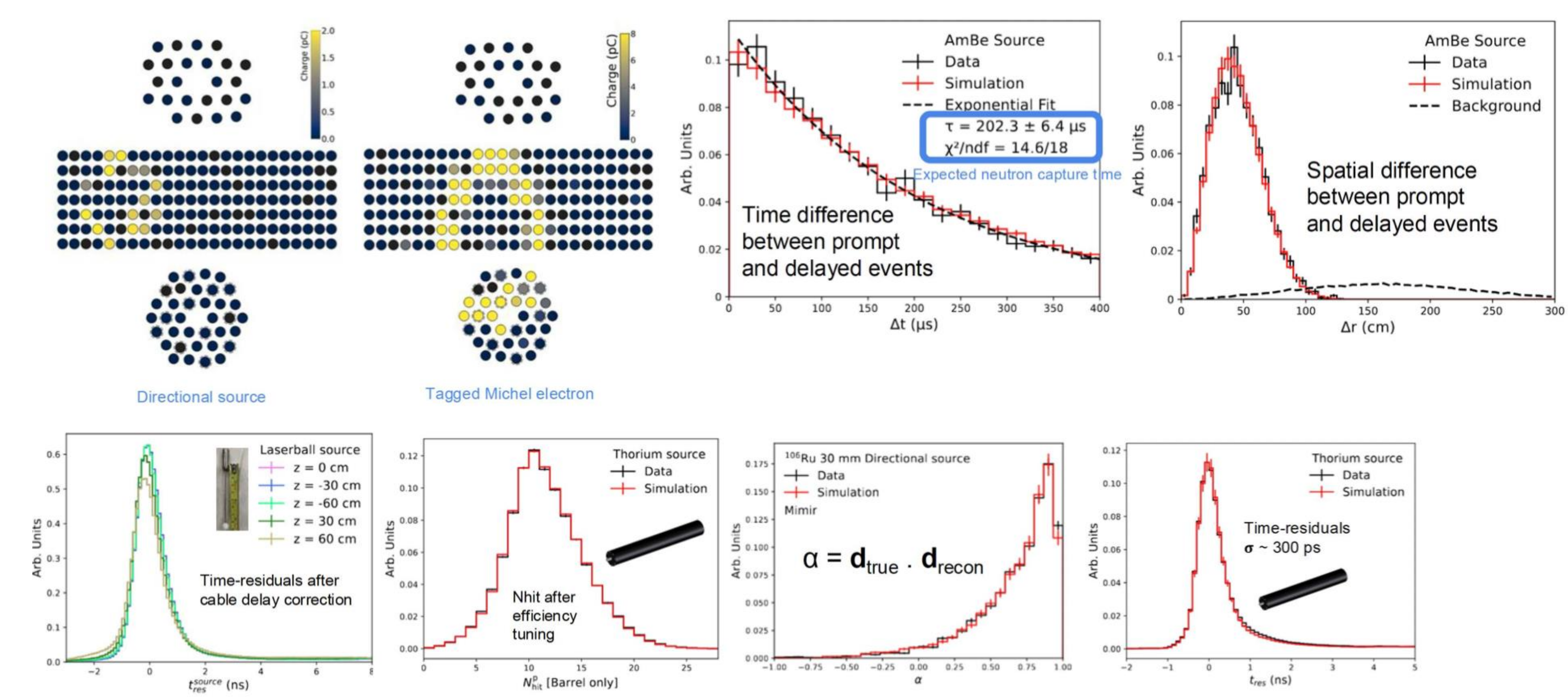
The Plan



Engineering studies underway for deployment at the SNS ~20 meters from the neutrino source.

Eos concept paper published: *JINST 18 P02009 (2023), https://doi.org/10.1088/1748-0221/18/02/P02009*

Recent Results at UC Berkeley Etcheverry Hall

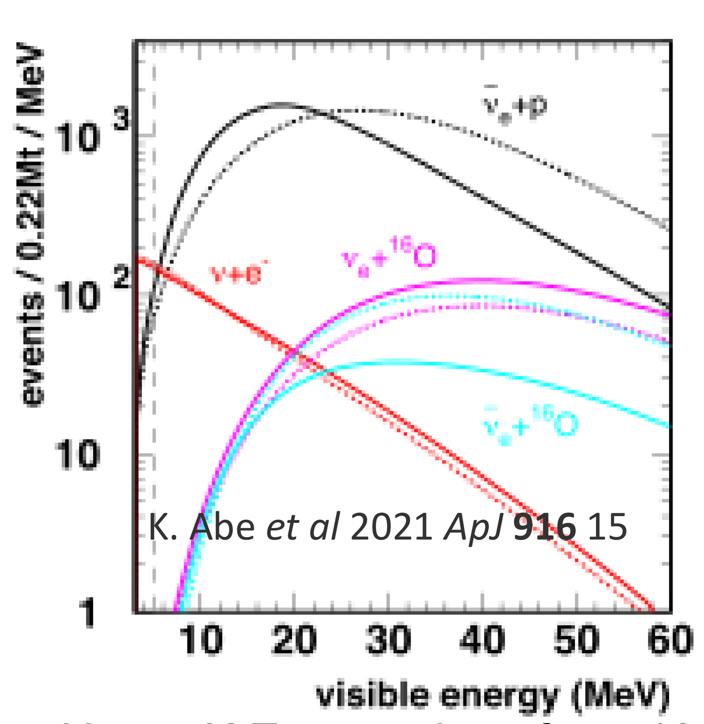


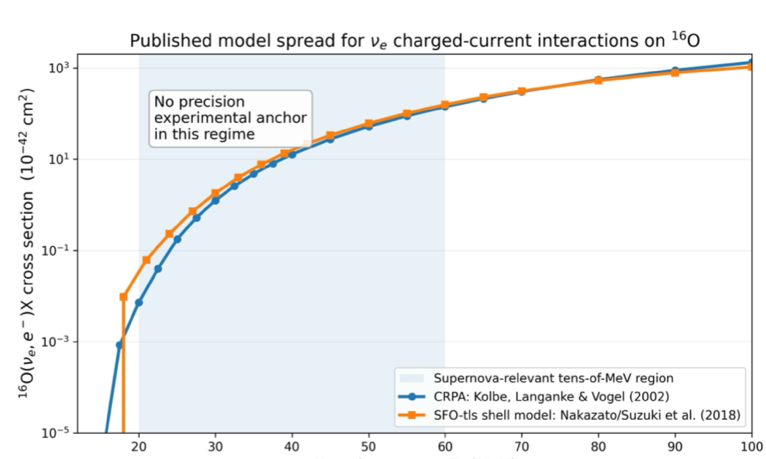
Event Reconstruction that takes full advantage of EOS instrumentation critical to reject external backgrounds: direction, energy, vertex, fiducialization.

Interpreting Supernova Neutrino Data

Neutrinos are key to understanding supernova dynamic evolution

Hyper-K Supernova Sensitivity: High Statistics, critical flavor gaps



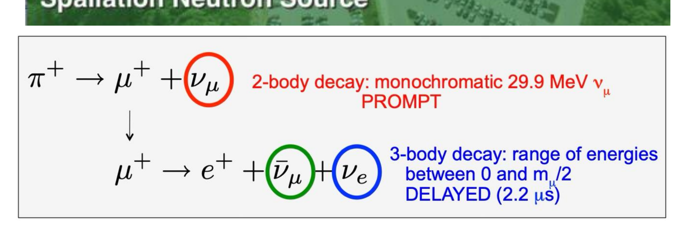


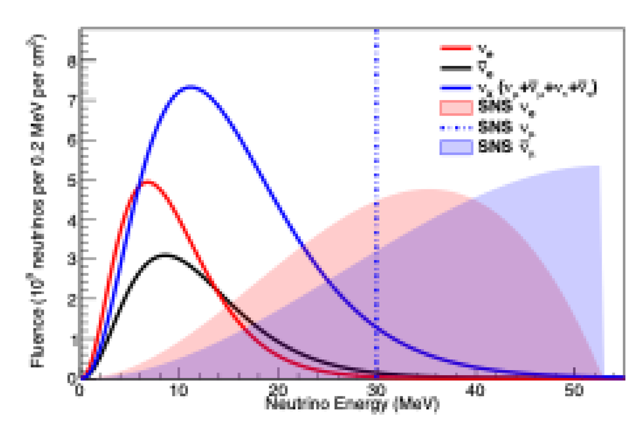
- Hyper-K Expectations for a 10 kpc Supernova
  - ~50,000 – 80,000 total events
  - ~1000-3000 events from ν_e-^{16}O CC
- Channels
  - $\overline{\nu}_e$(IBD): dominant
  - ν-e scattering: direction
  - ν_e: primarily from oxygen

- No precision experimental data at 1 - 50 MeV
  - Hyper-K relies on nuclear models
- Differences between models:
  - normalization
  - Energy dependent cross-section
  - final states

Oxygen interactions are the gateway to ν_e physics!

The SNS is ideal for Neutrino Interactions



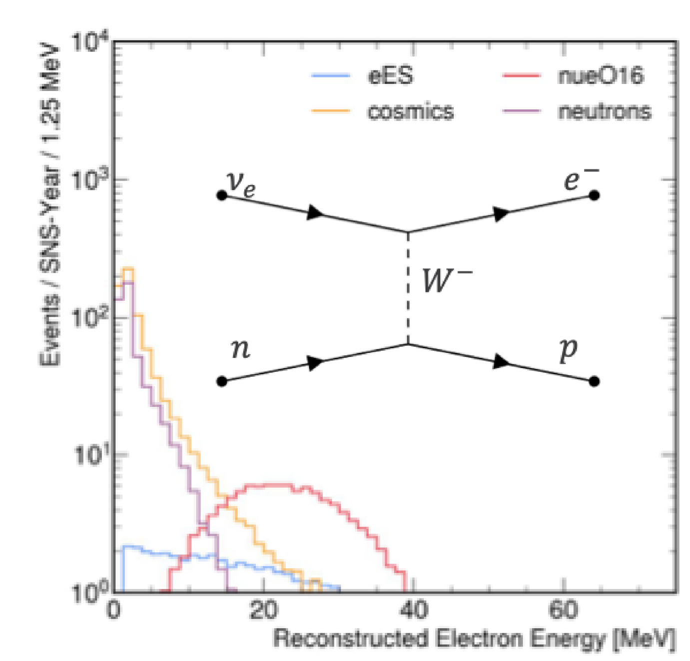


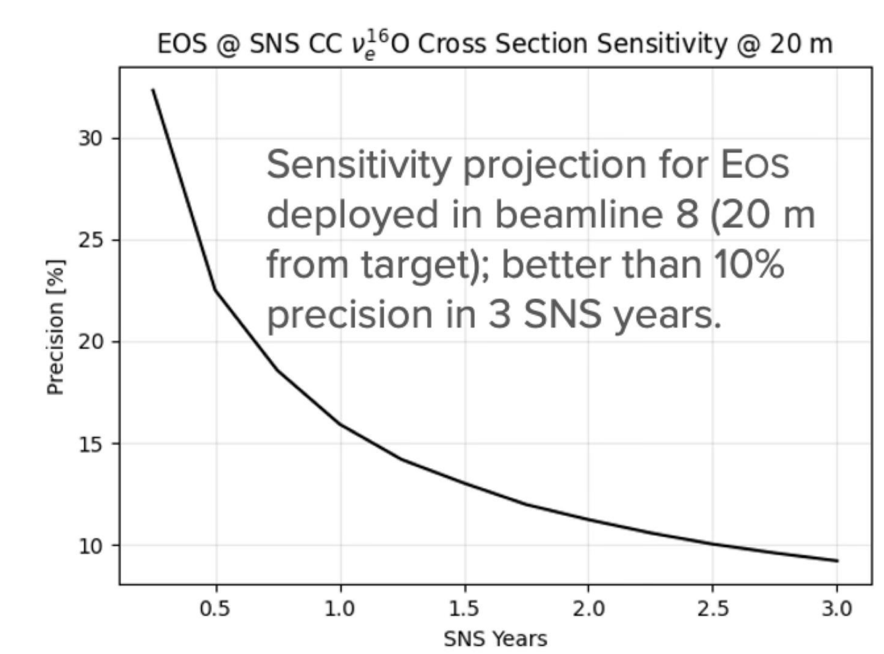
- High Intensity (4.3×10^{14} /cm^2/flavor/SNS-Year @ 20m)
- Excellent time structure (short pulses < 350 ns FWHM)
- Neutrino energy well-matched to supernova
- Multiple Neutrino Flavors: ν_e, (anti) ν_μ
- Prompt & delayed neutrinos provide additional handle for NC,CC systematic errors
- **The SNS is the world's cleanest, most intense neutrino source for low energy neutrino interactions.**

EOS Posters at Neutrino 2026

Neutrino applications within nonproliferation – L. Pickard
Performance of the Eos demonstrator with a water target – T. Kaptanoglu
Water-based liquid scintillator deployment at Eos – Y. Bezawada
Developing the Optical Model for WbLS Using the Eos Detector – P. Englezos
PuBe deployment at Eos – S. Gadamsetty
Machine Learning to Constrain Optical Parameters at Liquid Scintillator Detectors – S Arora
Background rejection for Eos@SNS – H. Song

Anticipated Neutrino Results at SNS





Precision of 10% cross-section achievable in 3 years.

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