2-Ton NaI array CC & CEvNS

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An unexpected windfall of detectors

- Many tons of NaI[Tl] detectors (7.7 kg each) became available to U.S. researchers when a DHS portal monitoring program was shuttered

- ~1.2 T of detectors are transferred to Duke and UW each

- Another 6.5 T available at ORNL

- The irony: these are not low-background crystals, but there is so much mass, it likely doesn't matter

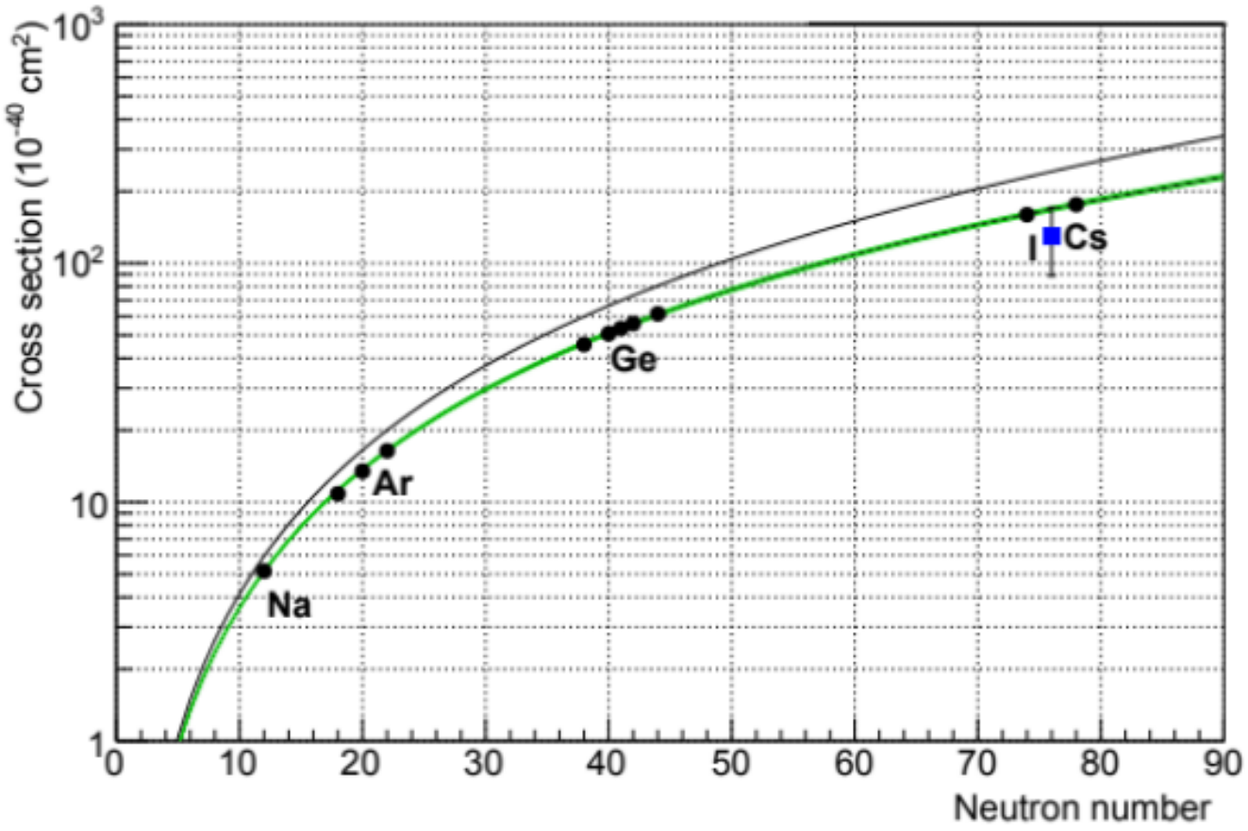
The Physics

- A CEvNS measurement with ^{23}Na will provide the largest lever arm in our program on N^2

- Due to low N and unpaired proton, measurement of axial currents possible

- Charged-Current measurement is a test of g_A renormalization

- We are aiming for a simultaneous measurement of these two cross sections with the same detectors



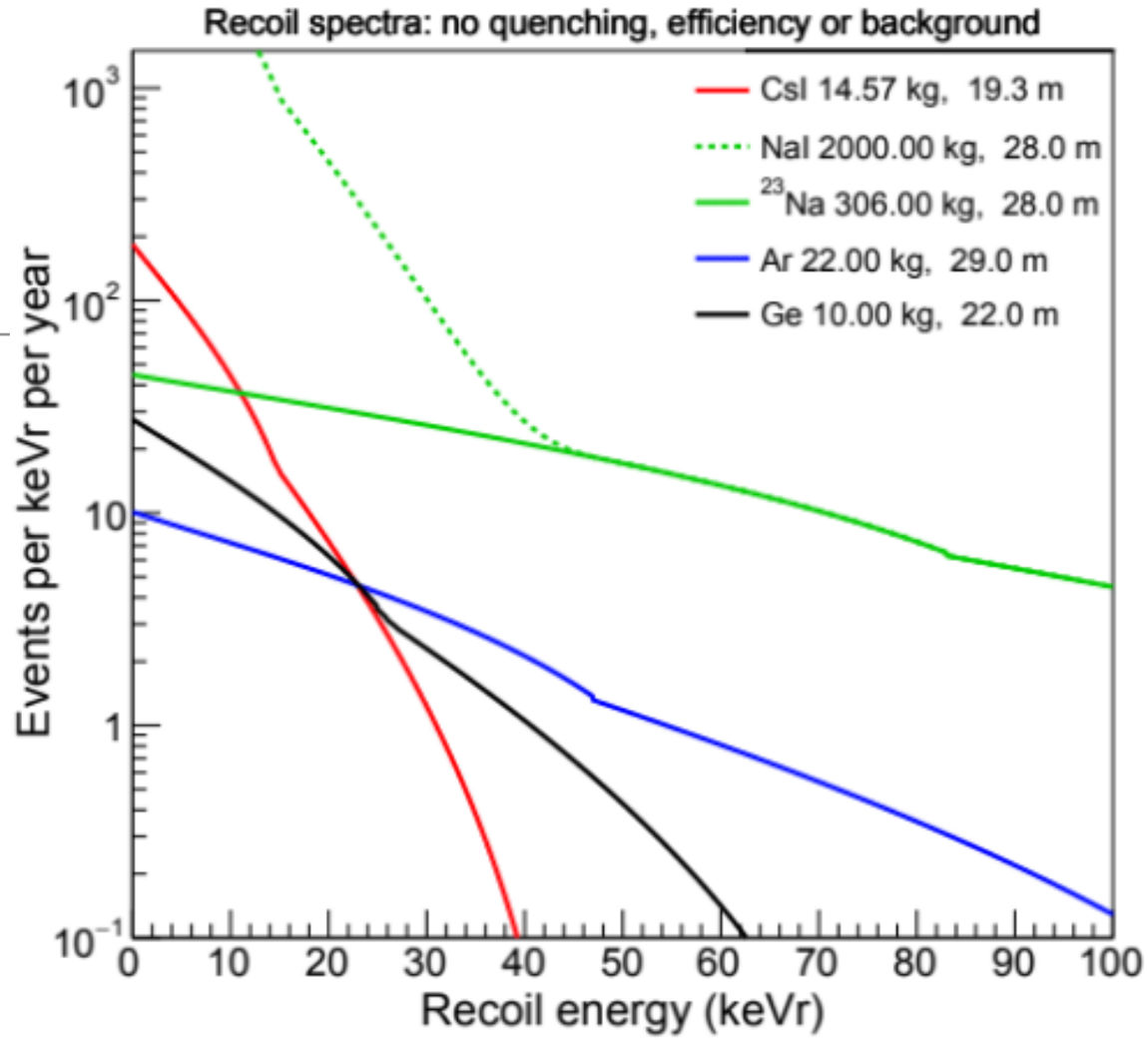
CEvNS Observation

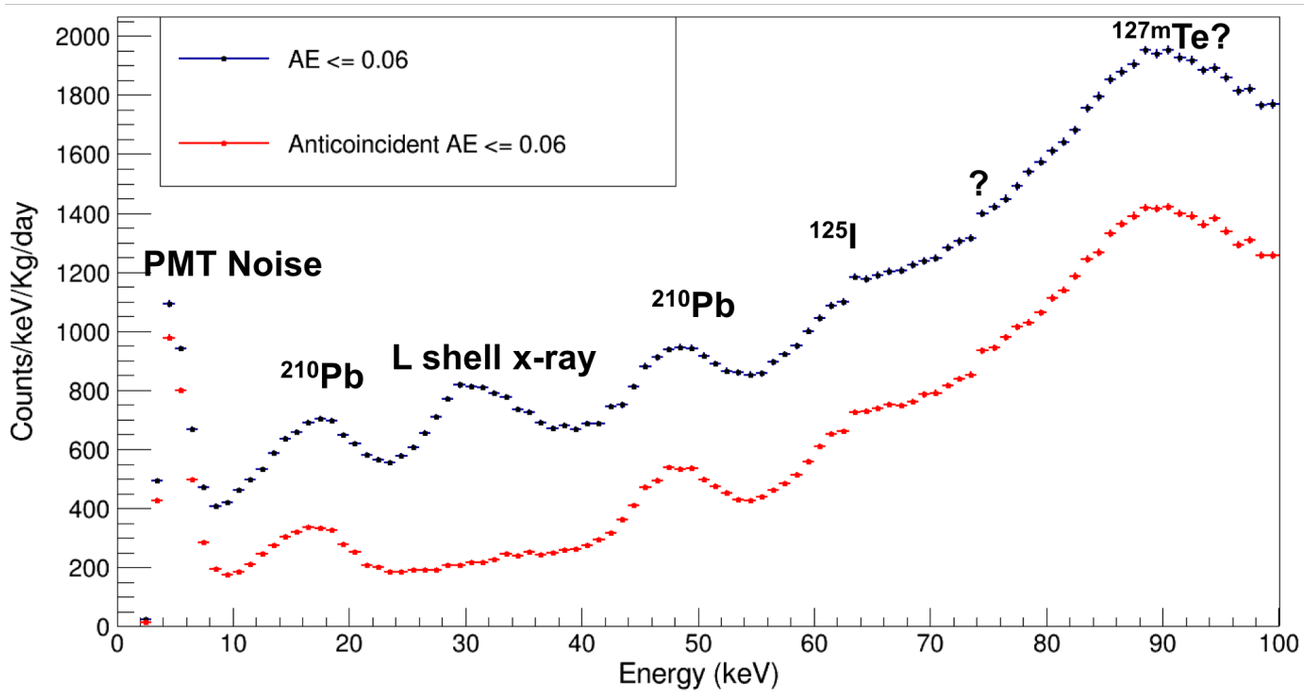
- The large mass of Na results in a very high count rate—1700 ^{23}Na recoils/yr above 13 keV$_{nr}$ threshold

- Backgrounds measured in multiple locations & configurations, consistently show ~ 200 c keV^{-1}kg^{-1}d^{-1}

- conservatively: 3.6 sigma in 2 yr

- The quenching factors have been (and continue to be) well measured

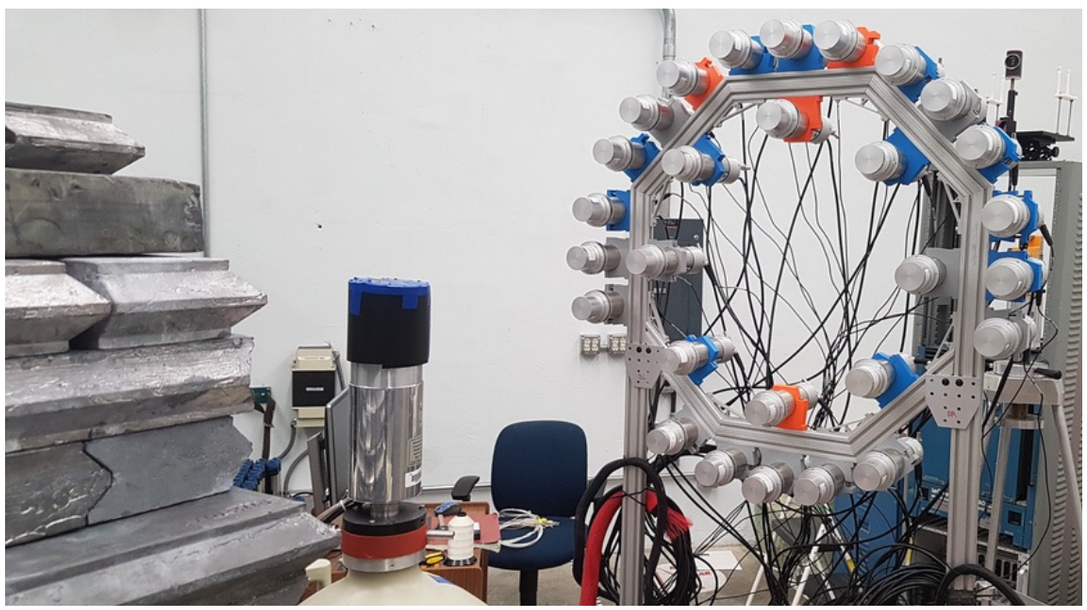


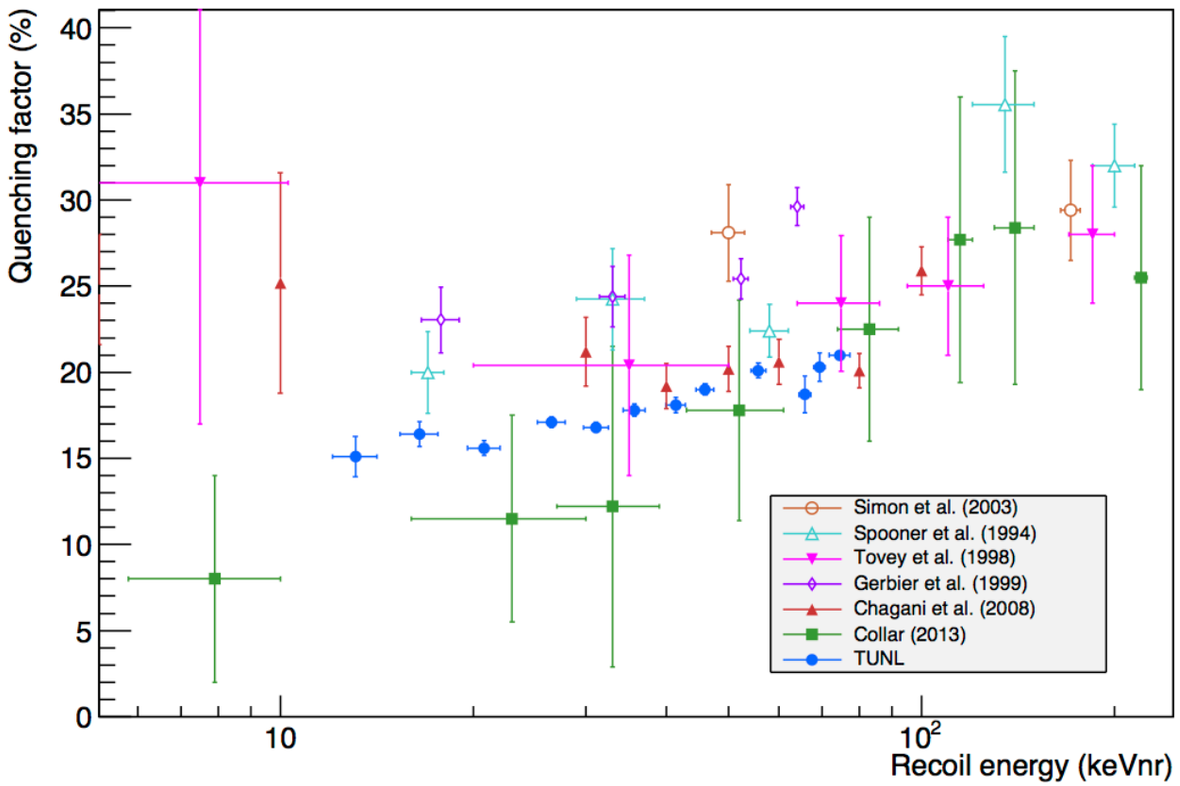


Quenching Factors well studied

- We have regularly returned to measuring the quenching factors for nuclear recoils in NaI[Tl], due to the controversy surrounding previous measurements

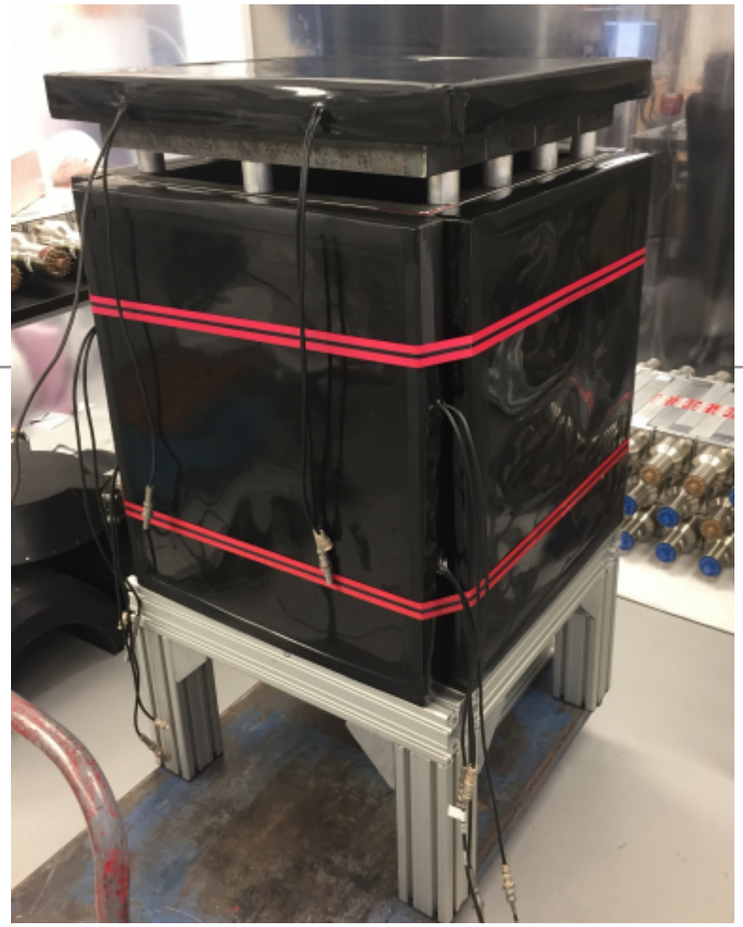
- We even have a measurement ongoing this week at TUNL with the ANAIS and COSINE collaborations

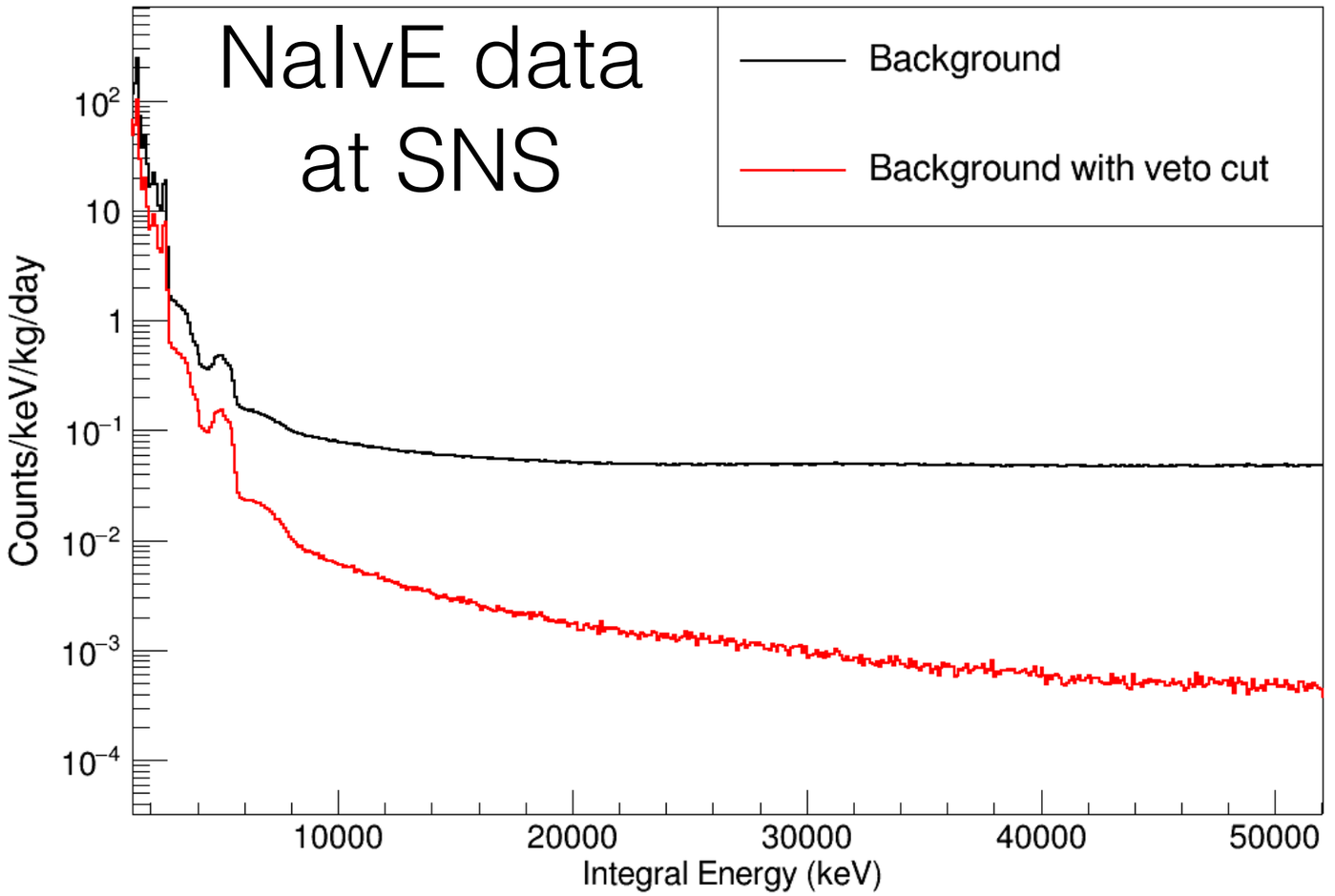




^{127}I CC Observation

- The large mass of ^{127}I results in ~370 *exclusive* events /yr, estimate ~ x2.7 more for *inclusive*
- Conservatively 5 sigma in 2 months
- High energy calibrations well-understood with internal gamma lines and muon tracks
- Background measured at SNS with NaIvE detector



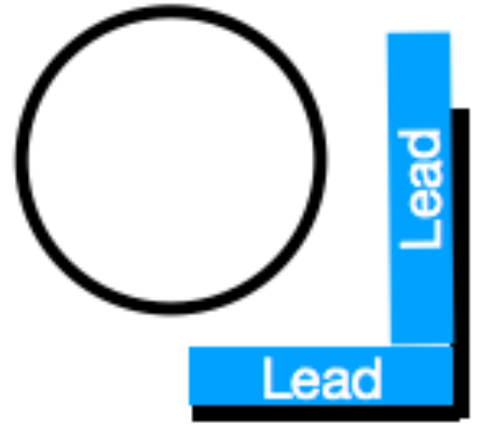


Simulation and Analysis Efforts Maturing

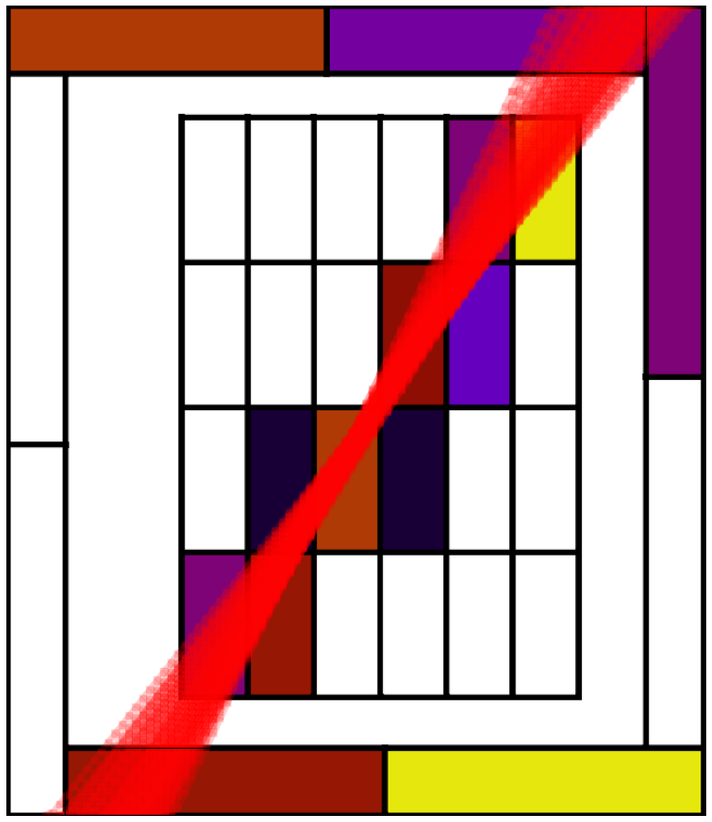
- Most of the concern at the moment is about shielding the Hot Off-Gas Pipe during SNS operations. Need factor ~ 1000 reduction of 511 keV gammas from the pipe.

- Muon tracking algorithms may allow more efficient muon rejection and more sophisticated analysis of CC tracks

Possible HOG pipe shield

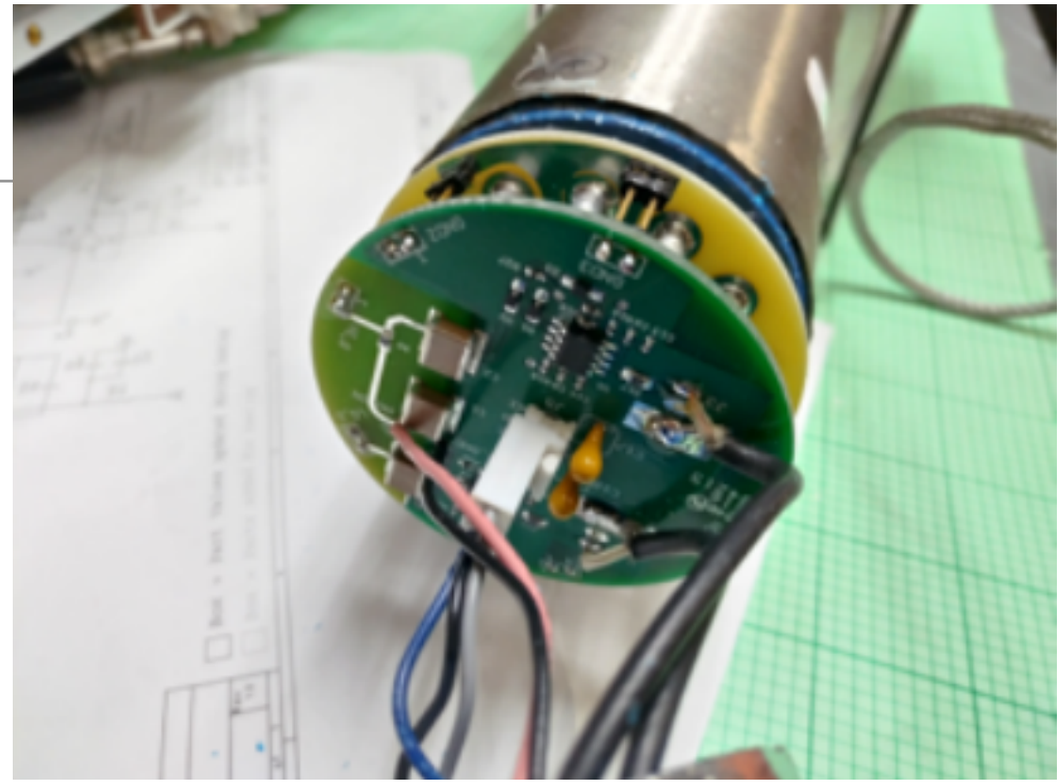


BG muon track from data



The Detector is *Cheap & Easy*

- We have the detectors
- Scaling up channel count can be an issue, but Lorenzo Fabris at ORNL has developed a low-cost (~$50 ea) dual gain base that is low-profile
- The digitizer, HV and LV costs are covered
- We just have to design & construct the shield

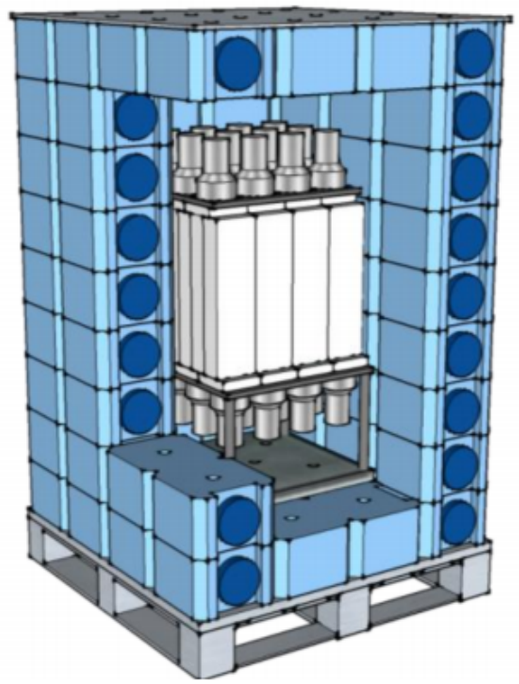


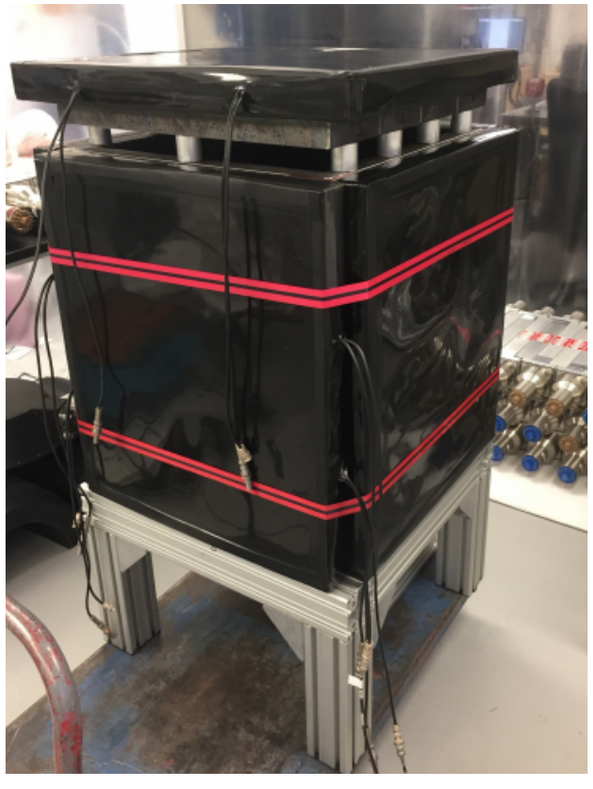
NaIvE Detector is a prototype for shield studies

- The deployment of the NaIvE detector has allowed us to verify background rates on site

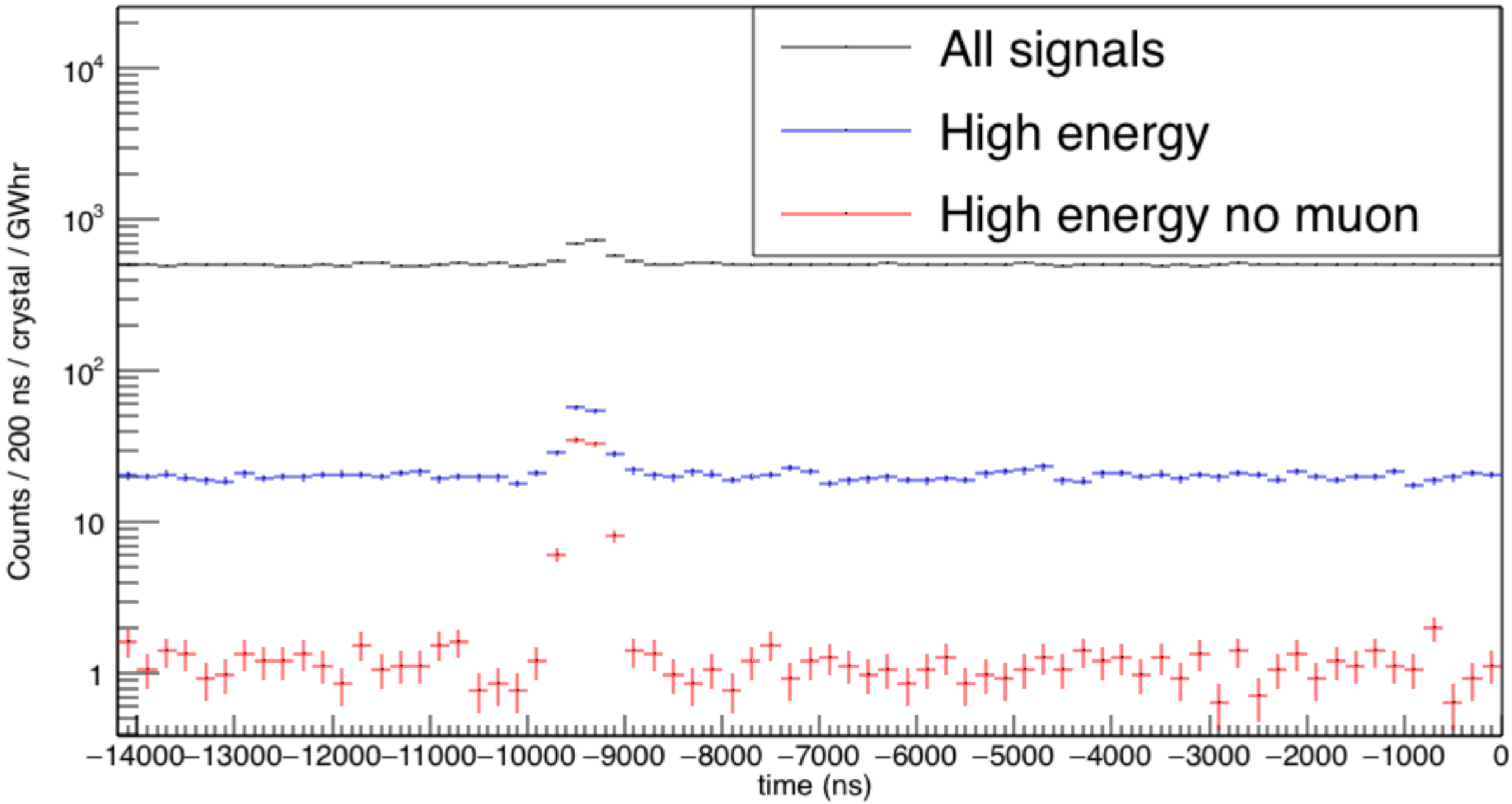
- Deployed in a water-only, and steel-only shield (both with muon vetos)

- Backgrounds look as expected





NaIvE Detector Observes Beam Neutrons

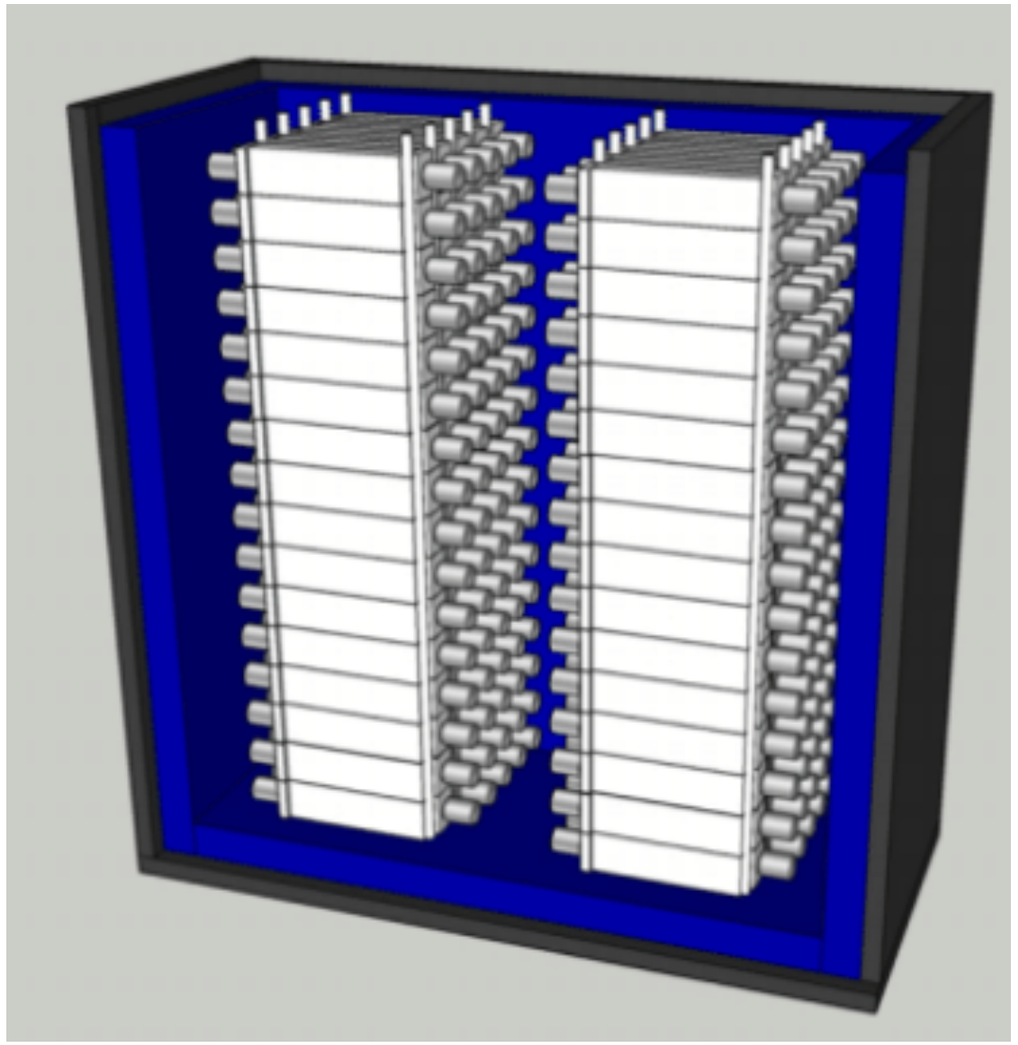


NalvE Detector is a prototype for shield studies

- The challenge is in fitting a shield that is optimized for both measurements into the tight space.

- For the CC measurement, we need a muon veto and a 5-10 cm of high-Z material to stop the electron from triggering the veto

- For CEvNS measurement we need hydrogenated material to shield neutrons, and high-Z material to shield environmental gammas



Moving forward

- Leadership team of Jason Detwiler (UW) & Sam Hedges (Duke)
- Overall, the plan is well formulated and ready to go
- Backgrounds well understood
- DAQ scheme is well designed
- Low-cost electronics system ready to be purchased
- We look before we leap: Quenching Factors well studied
- We are finalizing the shield design and integration into Neutrino Alley