Soudan Veto Shield and Neutron Correlations & Public Data
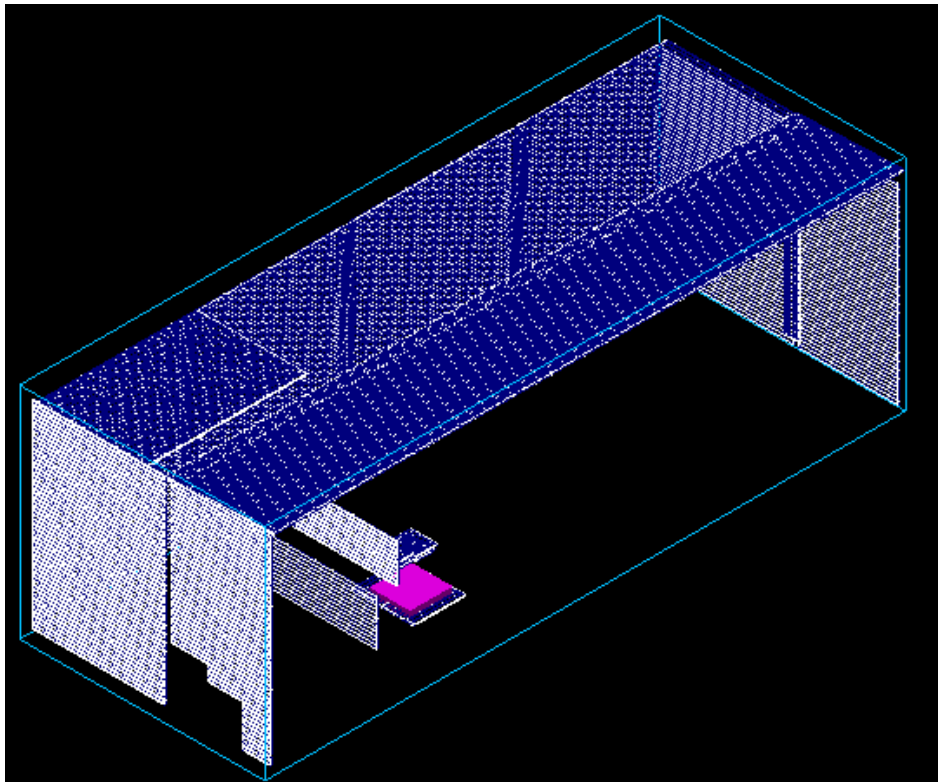
A.N. Villano

University of Minnesota
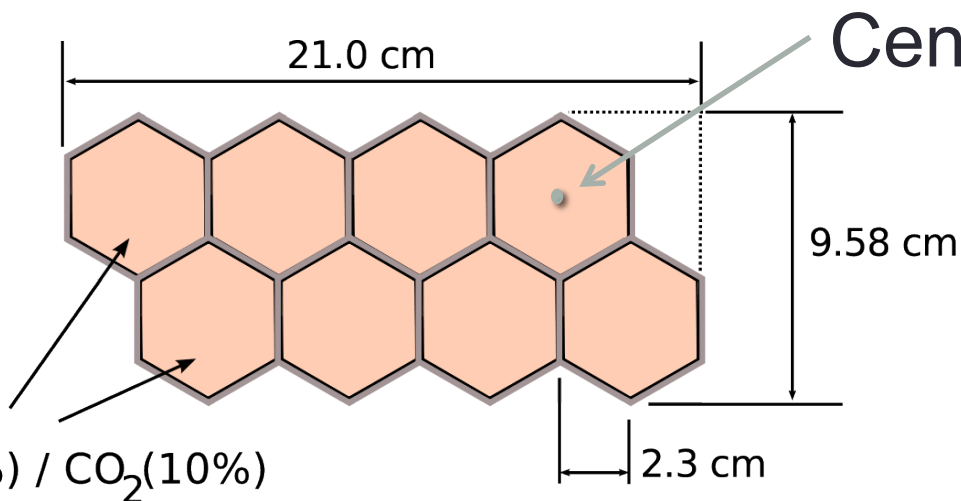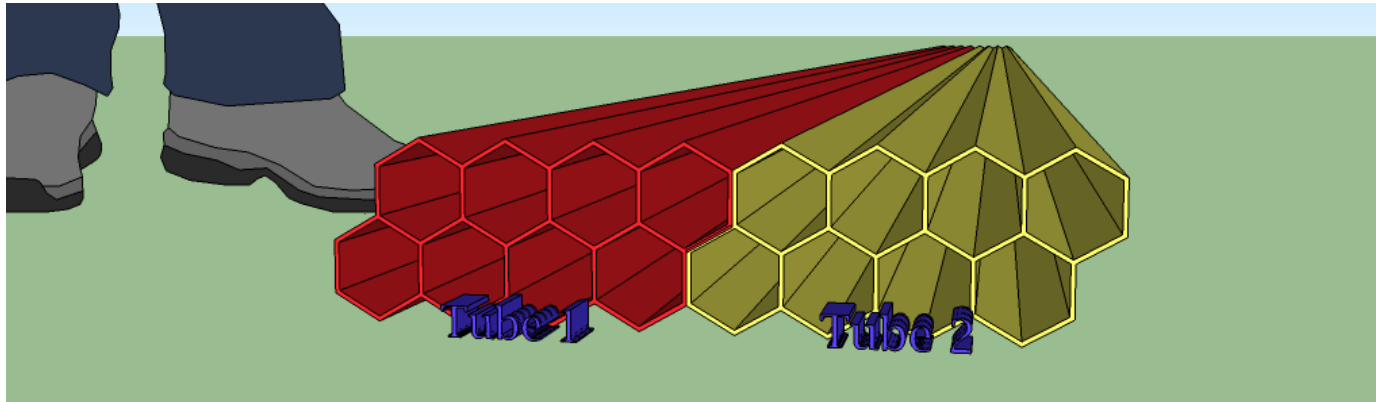
UNIVERSITY OF MINNESOTA
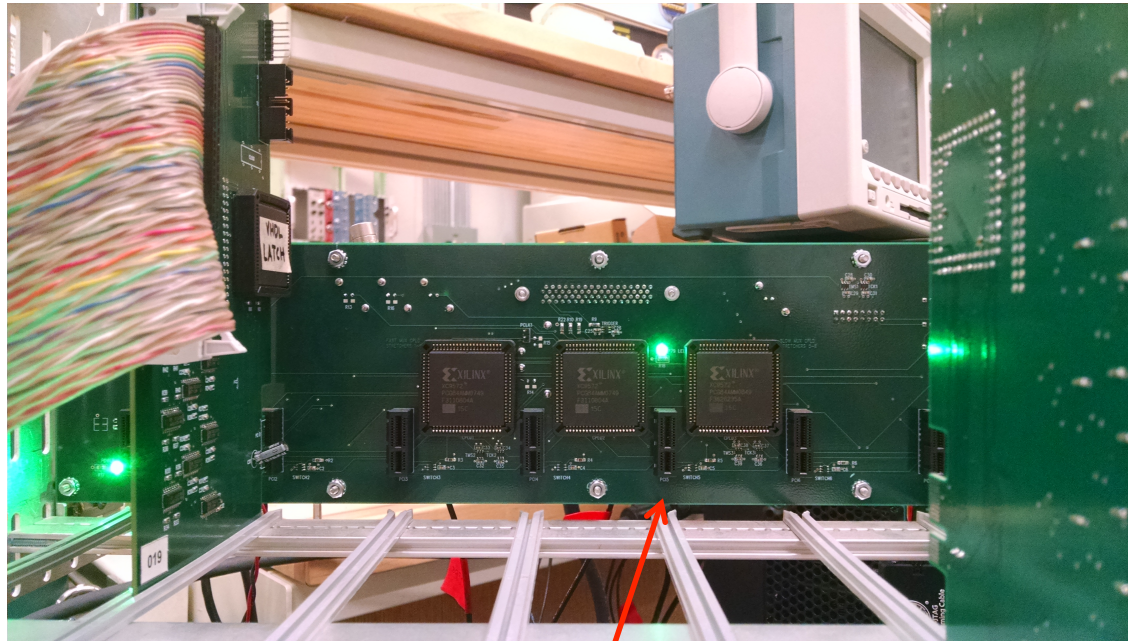
Soudan Cavern Veto-shield

- 32 m x 14.5 m x 11 m cavern
- Covered top and sides with proportional tubes
- Neutron Multiplicity Meter (NMM) placed toward the north-west (lead stack visible at left)
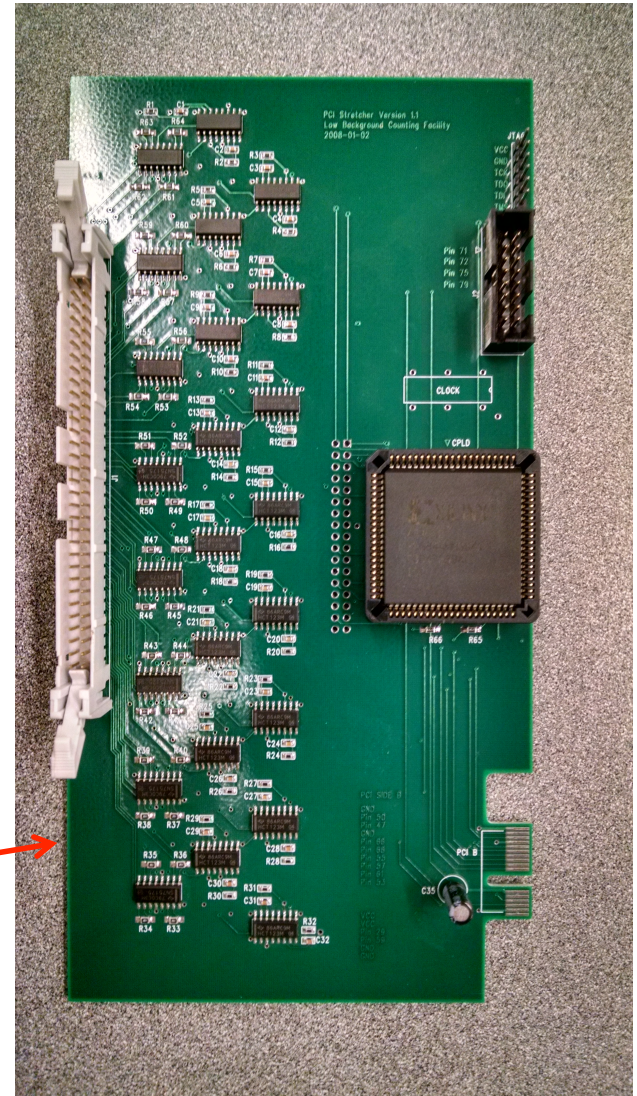
Veto-Shield Proportional Tubes

Center fed wires at 2350 V

21.0 cm

9.58 cm

2.3 cm

Ar (90%) / CO_2(10%)
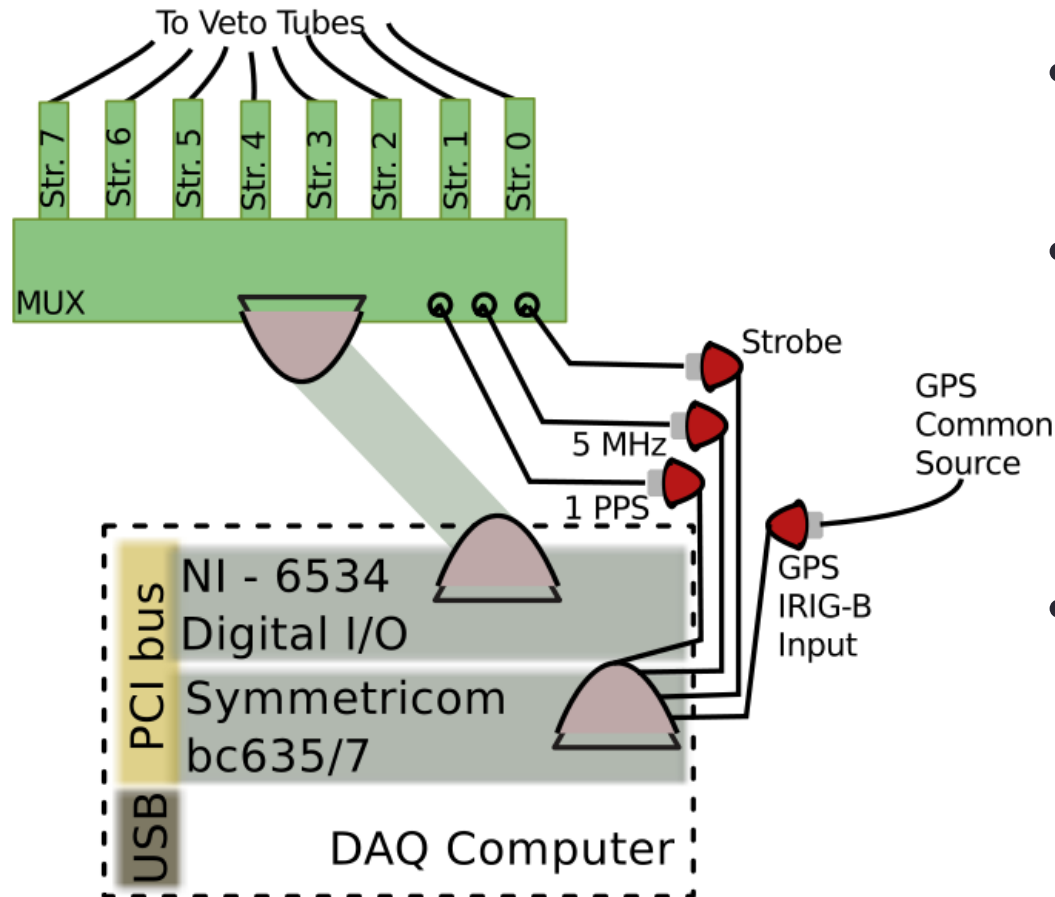
Veto-Shield Front-End

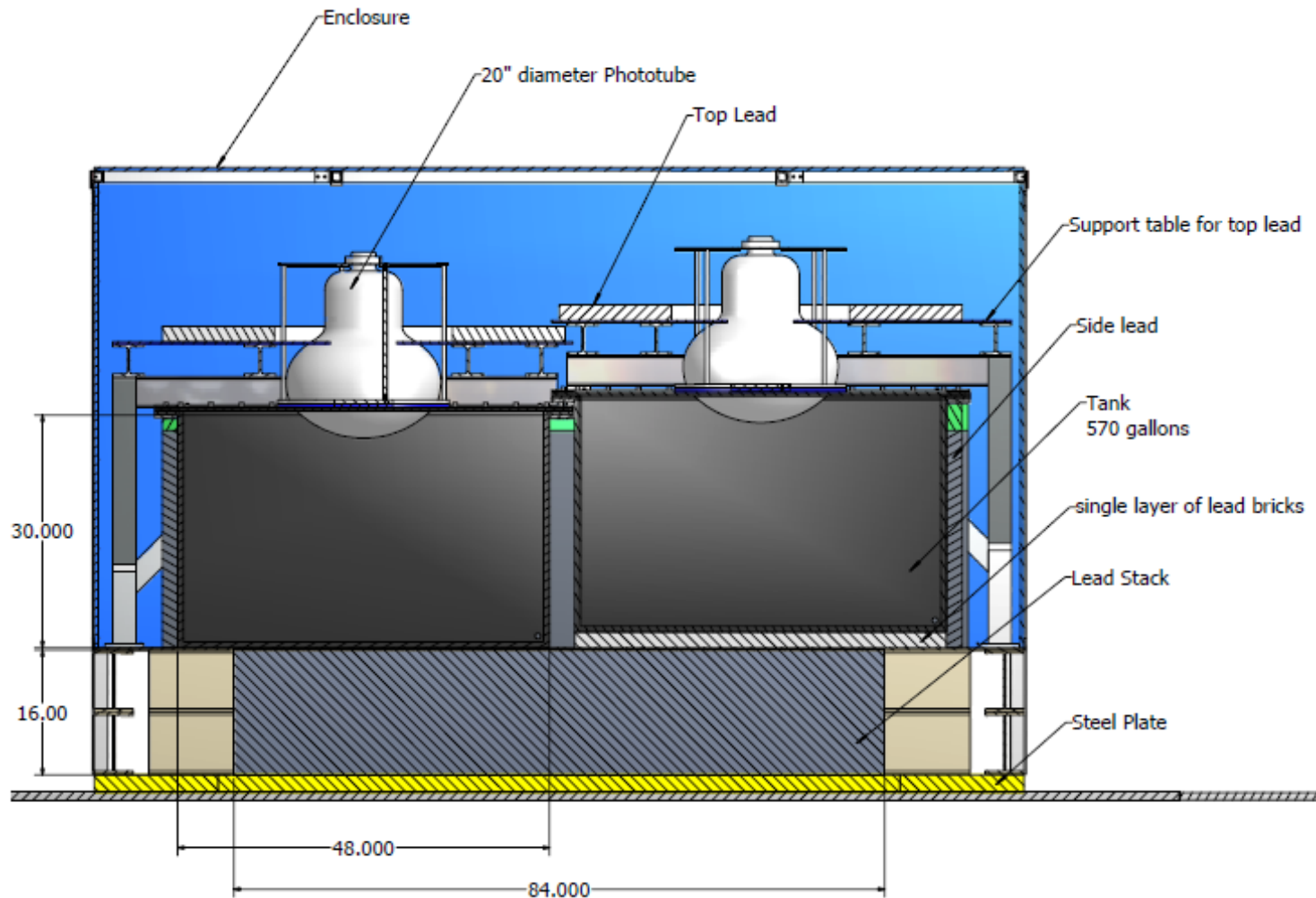MUX (3 Xilinx CPLDs), takes 8 stretchers

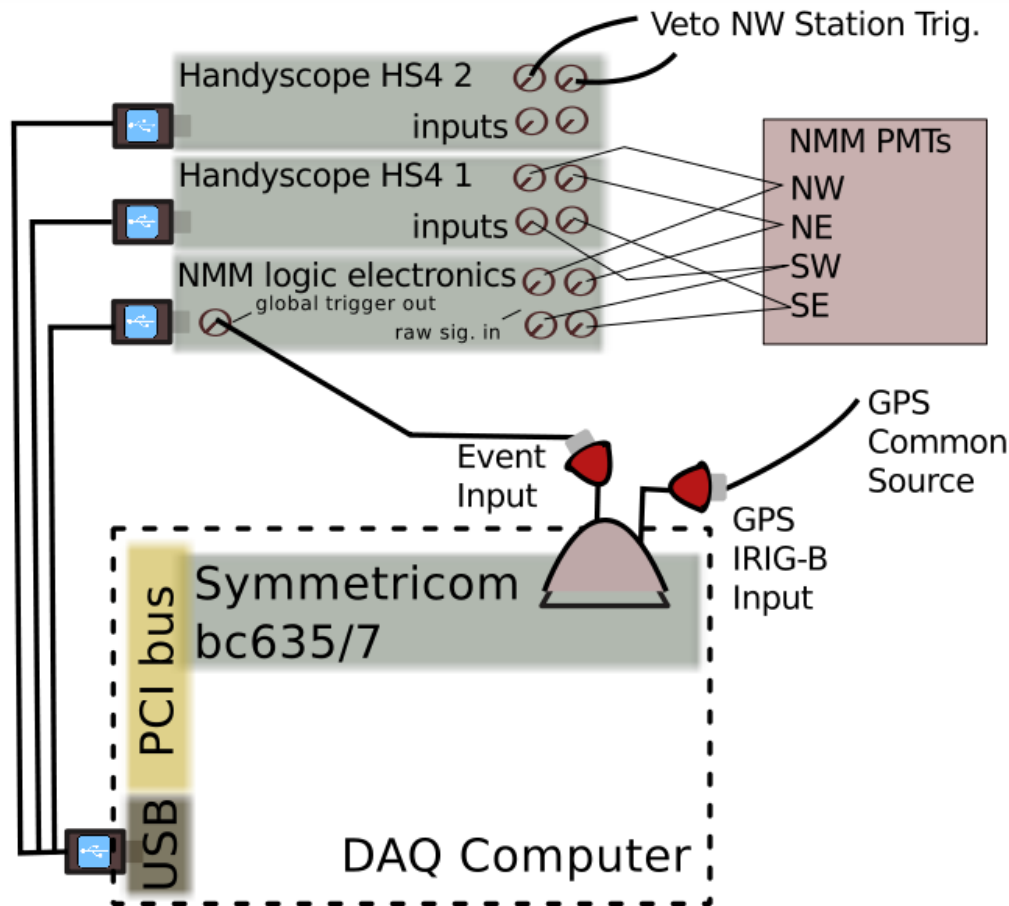Stretcher (1 Xilinx CPLD), controls triggering

1 μs Timing

- Symmetricom card synced to GPS
- Front end electronics count a disciplined 5 MHz signal
- DAQ computer records the absolute time of every event – best accuracy about ~ 1 μs
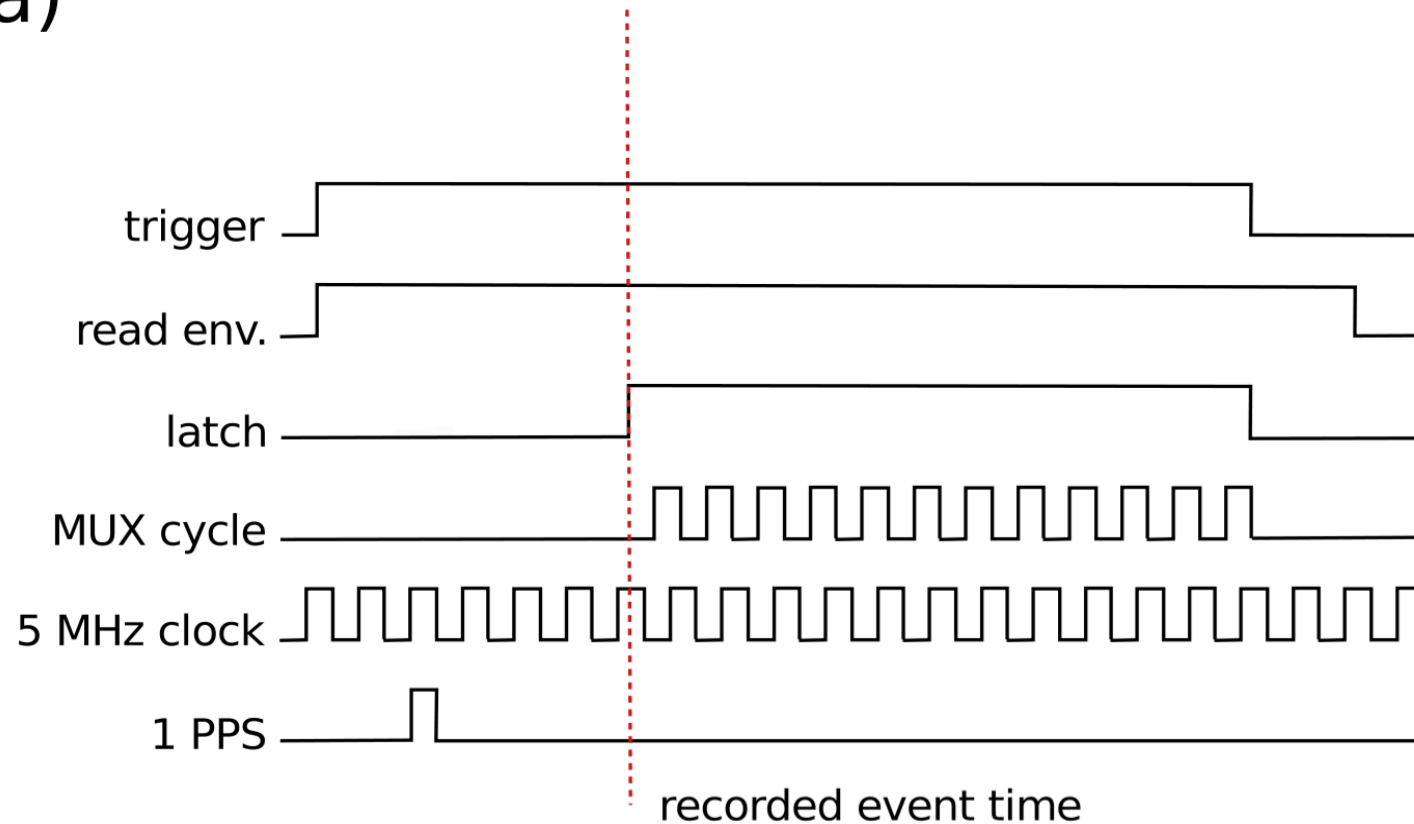
Systems In Place (NMM)

1 μs Correlated Timing

- Symmetricom card synced to GPS
- Time latched in response to hardware trigger from NMM
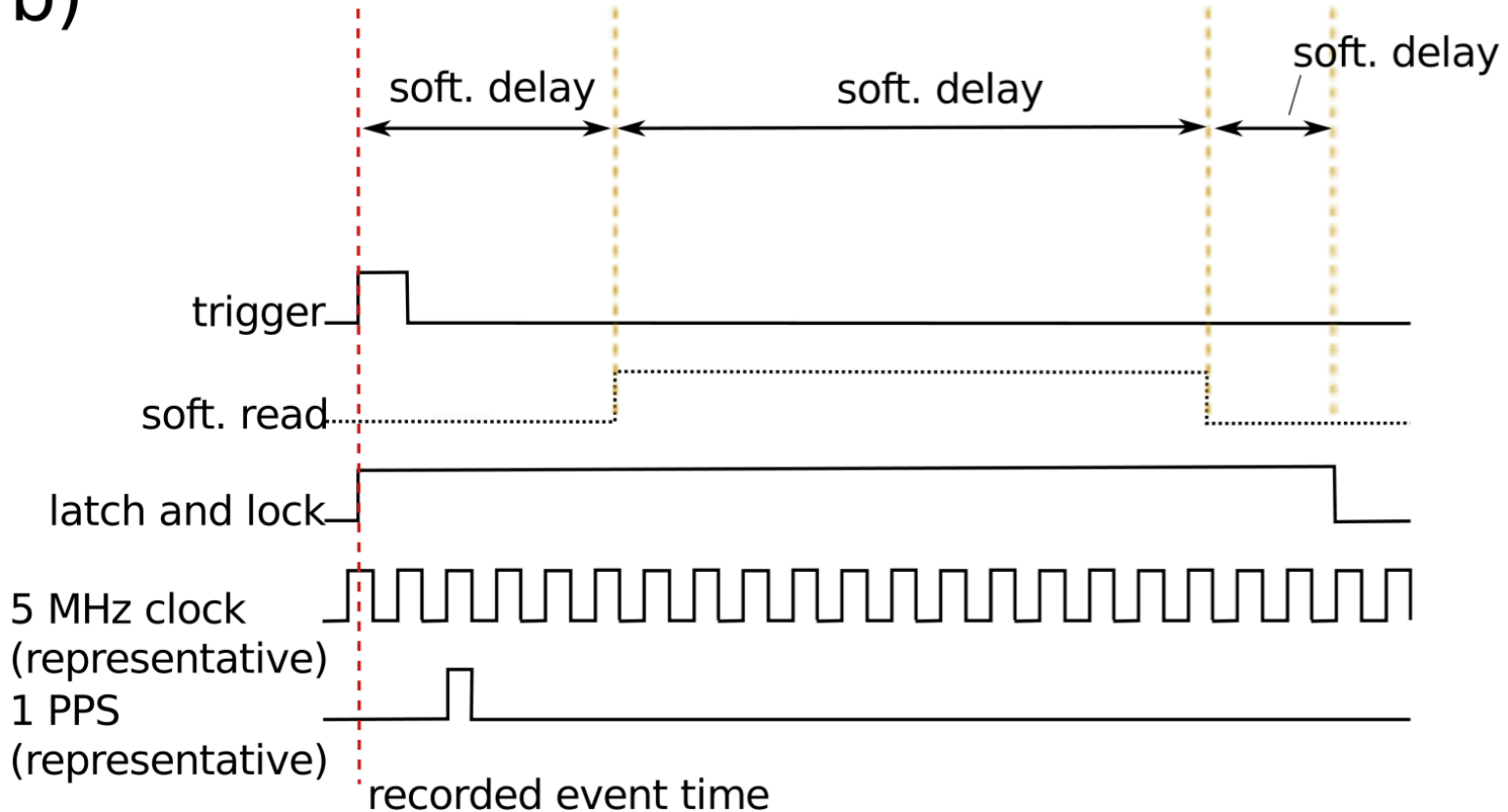- DAQ computer records the absolute time of every event – best accuracy about ~ 1 μs

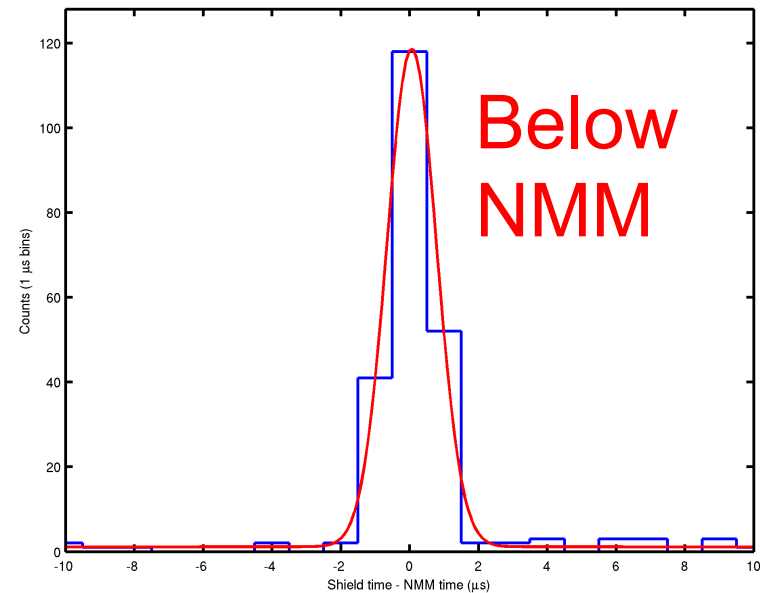# 1 µs Correlated Timing

a)

1 μs Correlated Timing

Coincident Events
Muons with NMM (special NMM run)
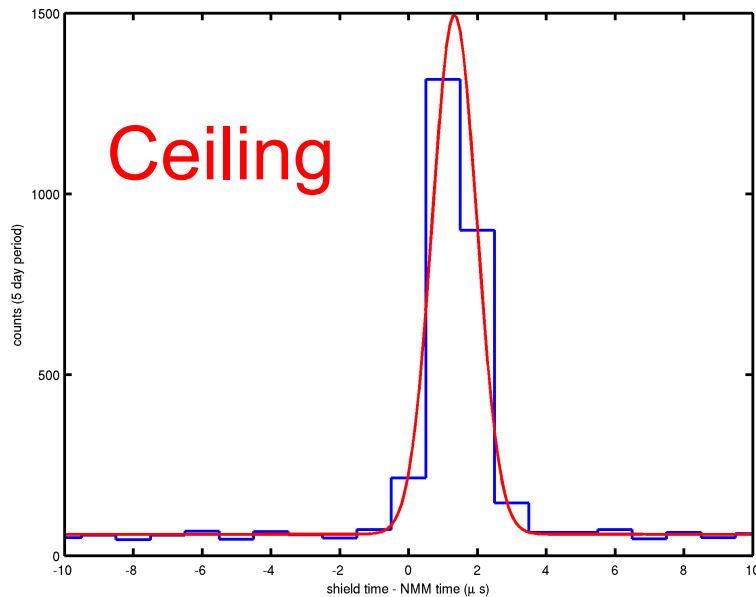
- Track these muons across the shield
- Use the muon NMM data to help with muon-bundle analysis
- Have about ~ 2 months of good correlated muon-triggered NMM data

Coincident Events

Neutrons with NMM

**Delayed structure
from mult. trigger**
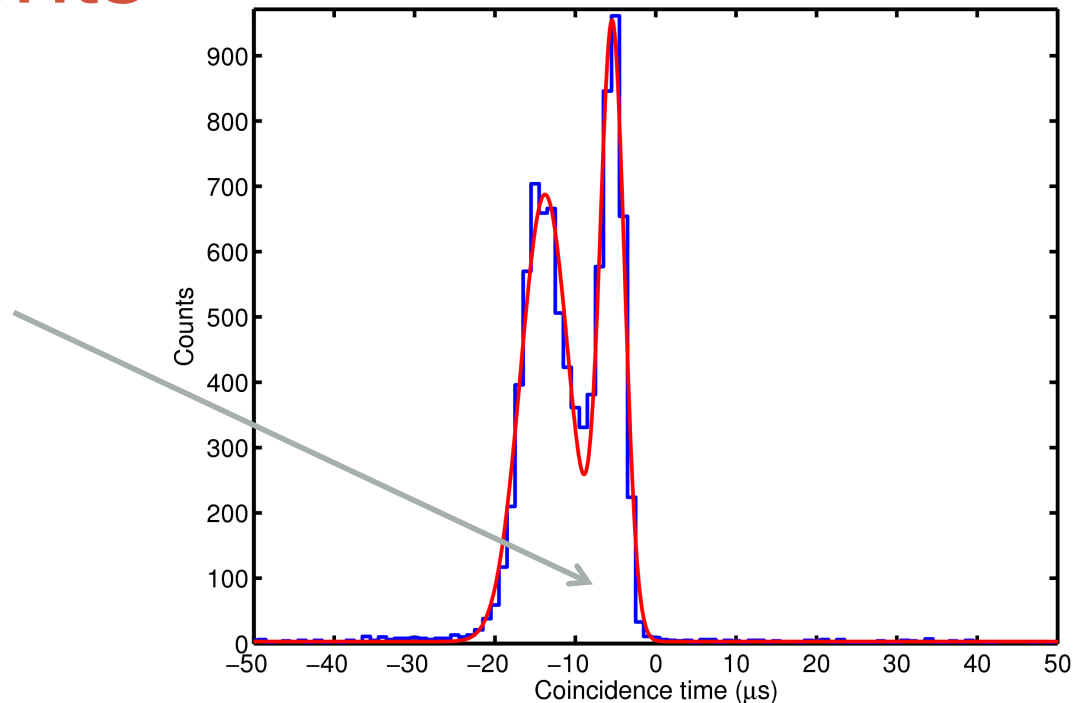
- Structure in the timing spectrum provides into about corr. activity
- This effort will extend and improve the NMM's primary goal, by answering questions about the parent muons related to the HE neutrons
- Have about ~ 1 year of good correlated muon data

Coincident HE Neutrons

Neutrons with NMM

1V Mult 4 cut t0s-timediffs (combined series and combined muxes)

- Structure in the timing spectrum is indication of neutrons
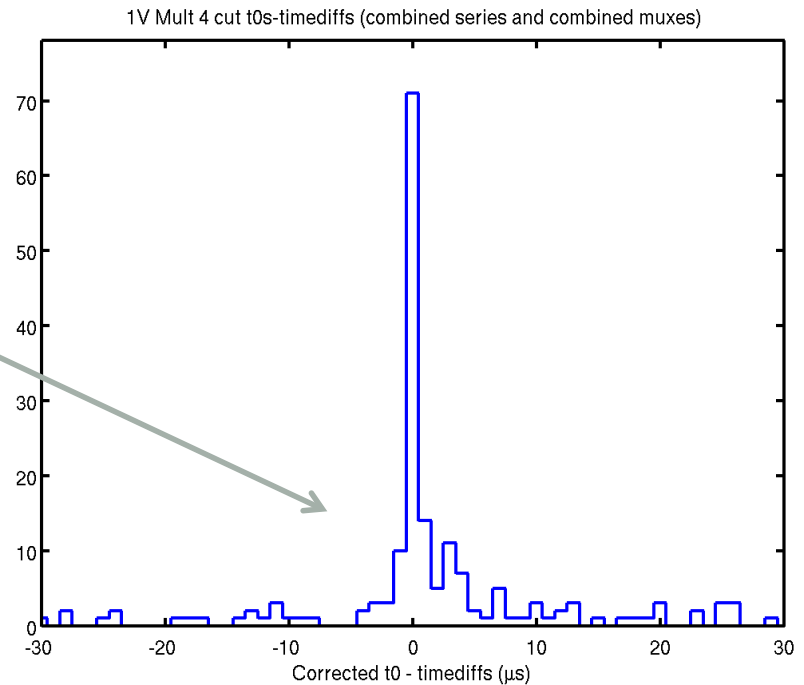- This data corresponds to about 139 live days, and we have about twice this amount of data taken and still going…
- Interesting thing is the detailed mapping of the topology of the coincident muon hits

Making a Facility
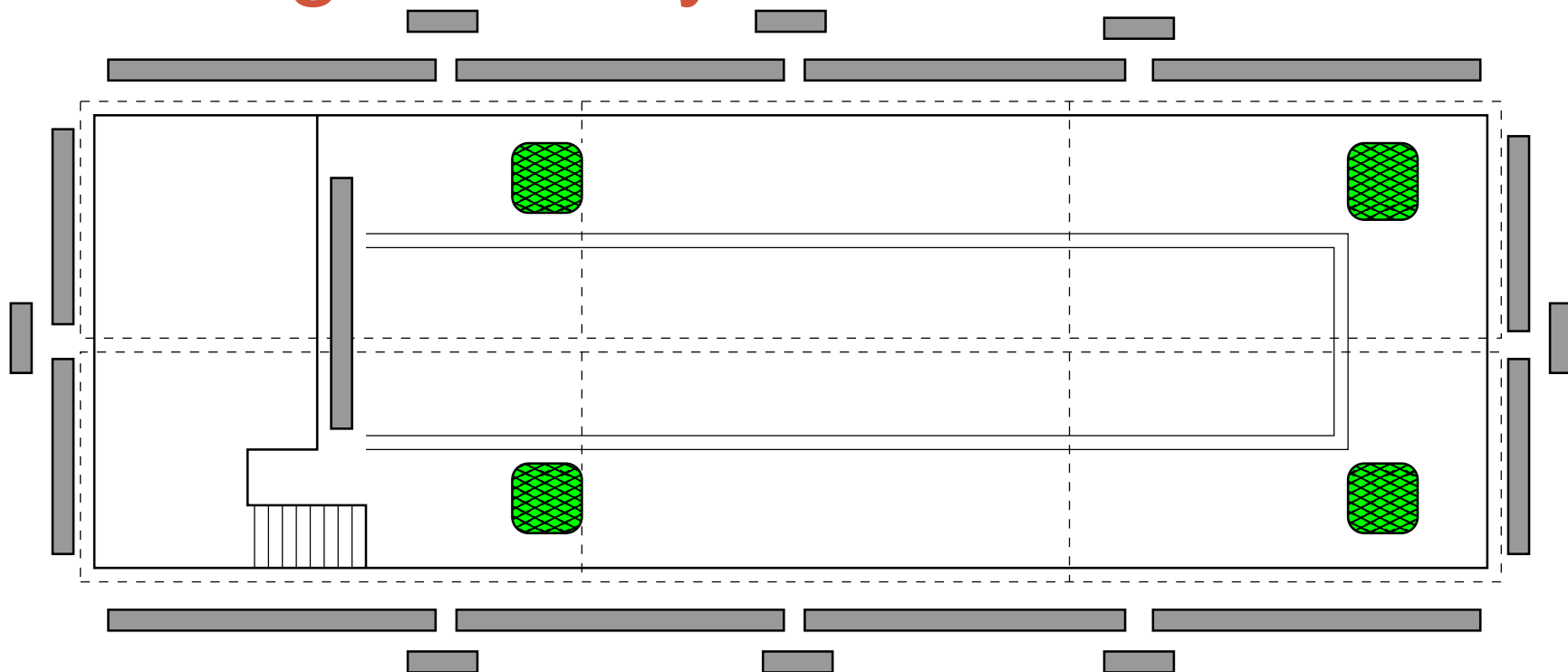
- Each quadrant (approx.) of the shield read out by an independent DAQ
- Other detectors inside the shield can be synced (like the NMM) to record coincident events

The Physics Case

- Generally the facility has the ability to examine the *topology* of events of cosmogenic origin deep underground

- Specific analyses can constrain simulations (2 ex.)
    - In conjunction with NMM can discover how HE neutrons correlate to *remote* cavern muons
    - Tagging vertical-going single muons will be used to study multiple-muon (muon bundle) events

- Use with existing experiments as active 'veto' or as tagger for background-type events

The CDMS Experiment
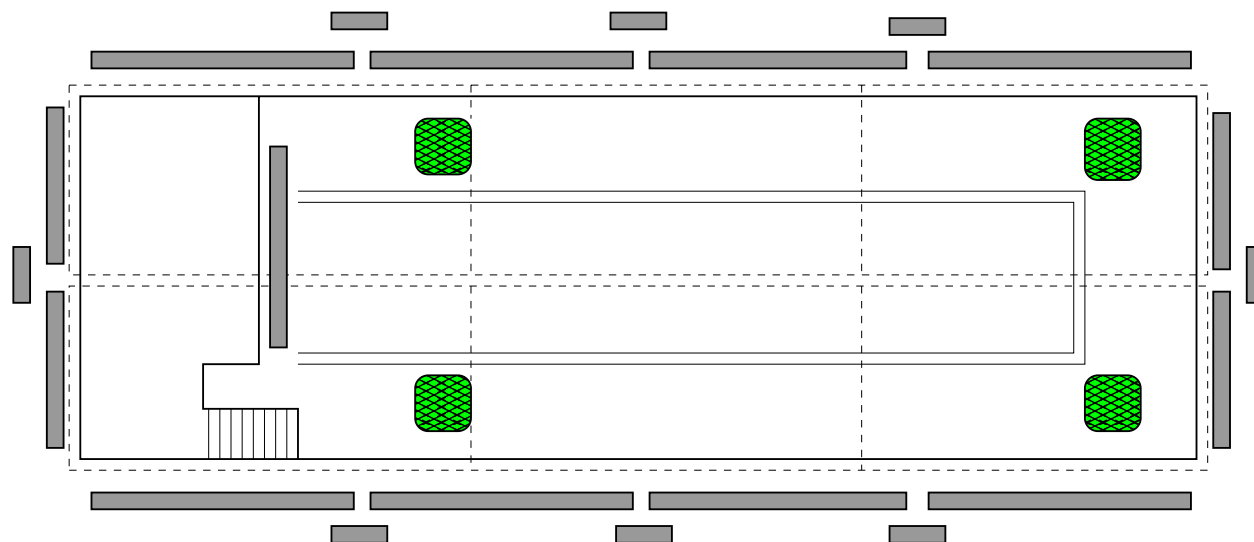
- CDMS detector located outside the shield, searching for rare WIMP scatter events
- Does have instrumentation with a GPS signal and Symmetricom readout
- Also equipped with an outer scintillator veto

CDMS Coincidences and Data Period
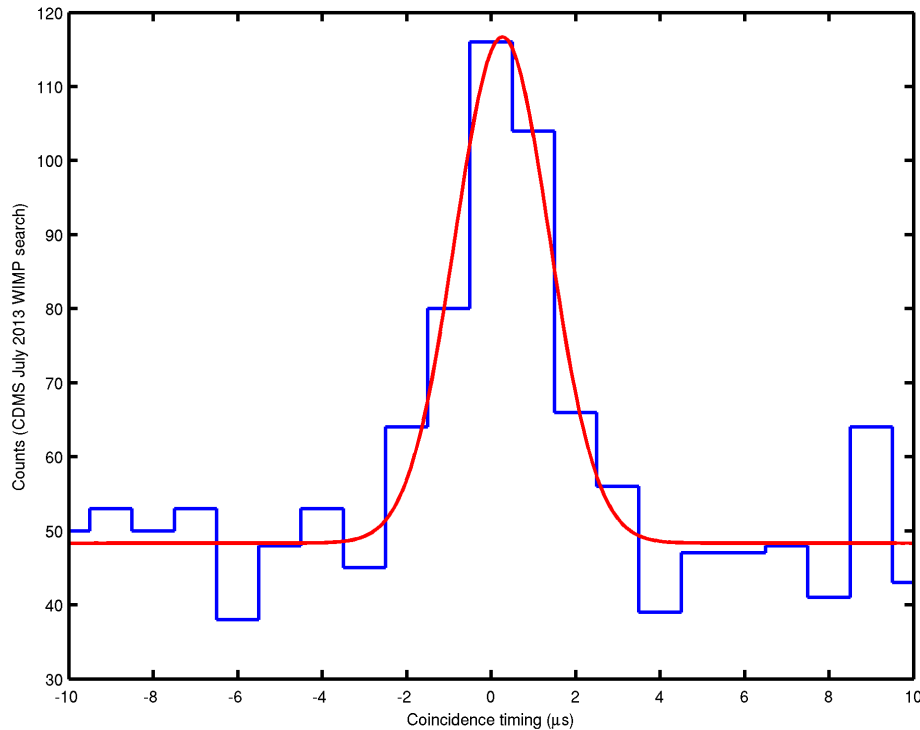
- Left is a sample correlating with only CDMS events with CDMS-veto activity
- The Veto-shield activity period spans from about June 2012 to present, overlapping with the SuperCDMS-Soudan runs

NuMI Timing Correlations
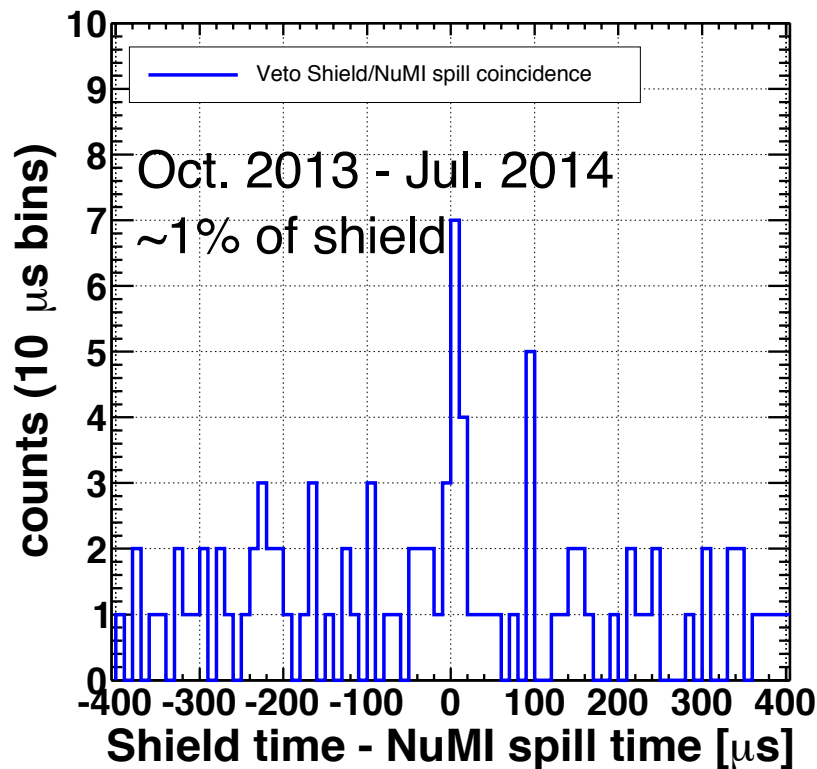
- Used about 1% of the shield to get a quick tag on rock-converted muons

- Interested in shield calibrations using these somewhat "rare" calibrations

Discussion: People Can Participate!

- We have about 2 years of data in hand of correlated data from the Soudan Veto Shield and the NMM
  - Doing a NMM neutron-correlated measurement for cosmogenically created neutrons
  - Possibility of probing multiple-muon events across the shield
- We can give others access to the data for any studies they like (contact me villaa@physics.umn.edu)
- We can correlate with SuperCDMS data as well, this is an analysis in the works
- We can correlate with any detector in the cavern at Soudan – so people can come with a detector to make measurements

The Soudan Simulation (LBCF Sim.)
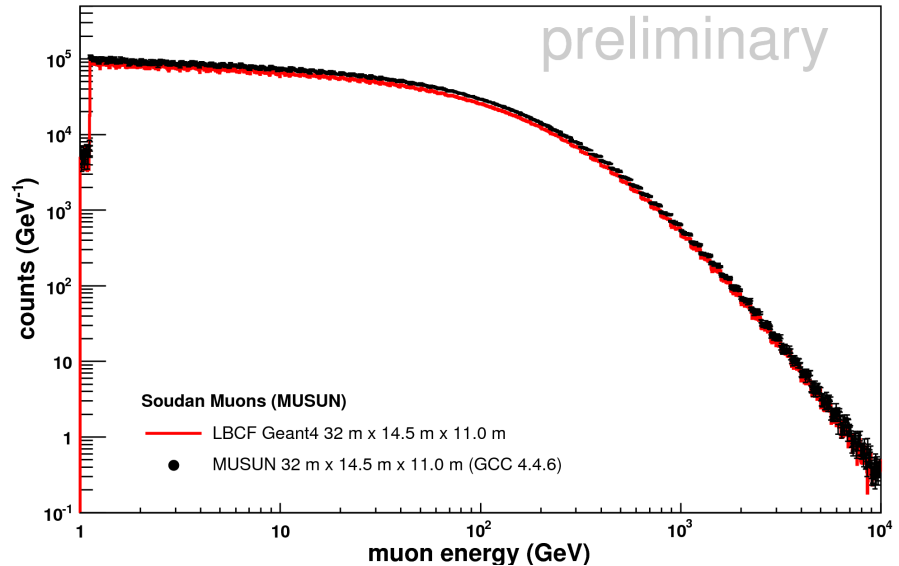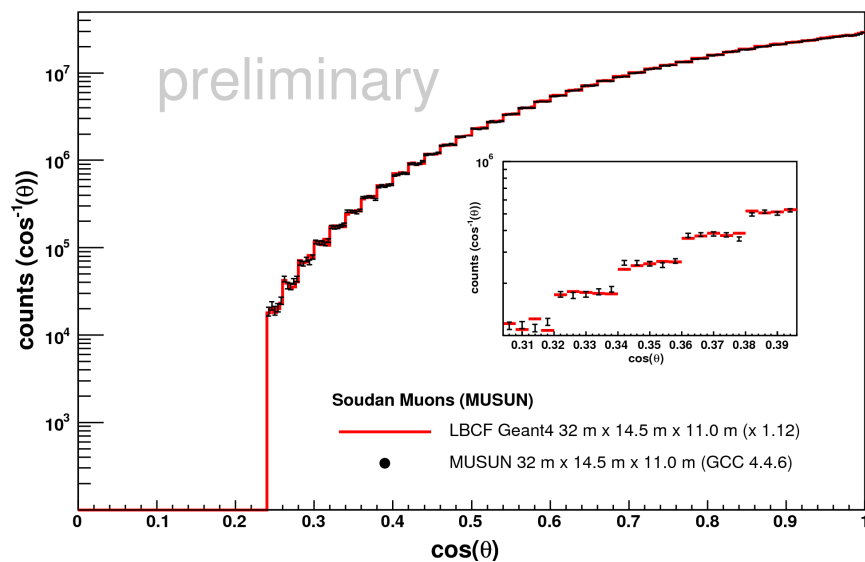
- Aside from experimental vetoing or monitoring, independent physics requires efficiencies
- We have a Geant4 simulation of the whole cavern and are updating this with *all* detector structures in the mine to get full information
- Since the muon distributions at Soudan are known, can throw many properly distributed primaries and *muon bundles*