Coincident Events in the Soudan Muon-Shielded Room

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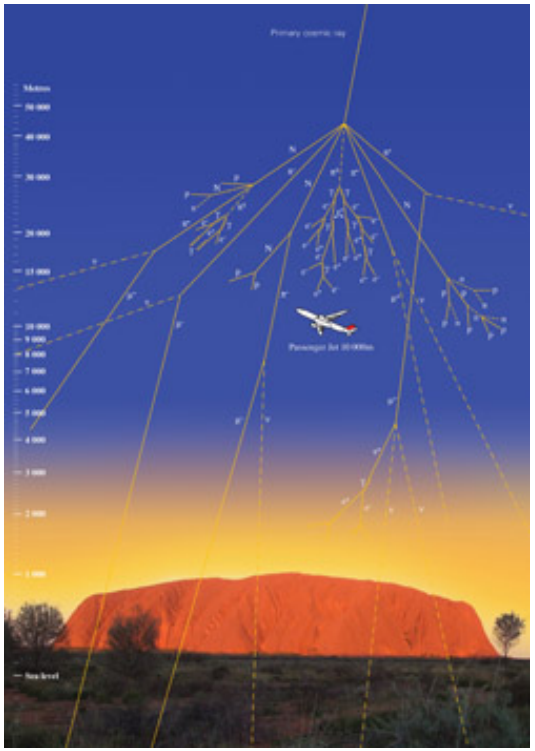
Radiogenic/Cosmogenic

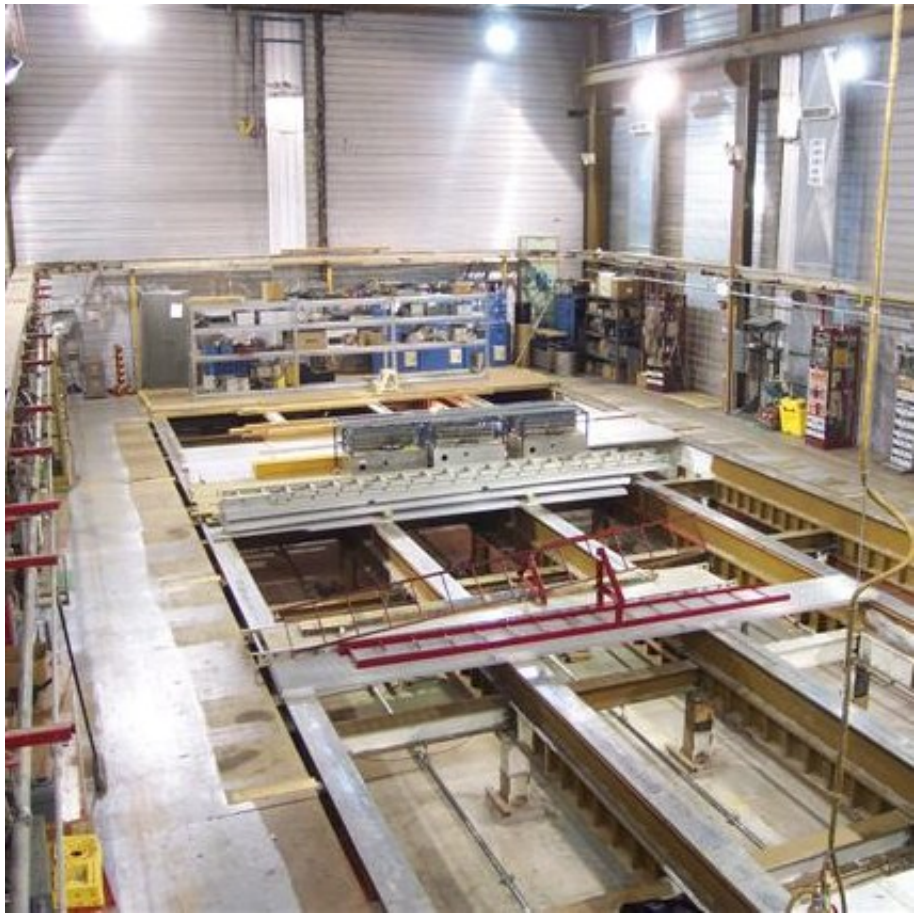
There are two broad categories of background for underground low background experiments

Cosmogenic:

- muons very penetrating
- can produce neutrons in underground environments
- can produce radioactive secondaries which remain as contaminants
- mitigated by simulation and measurement efforts



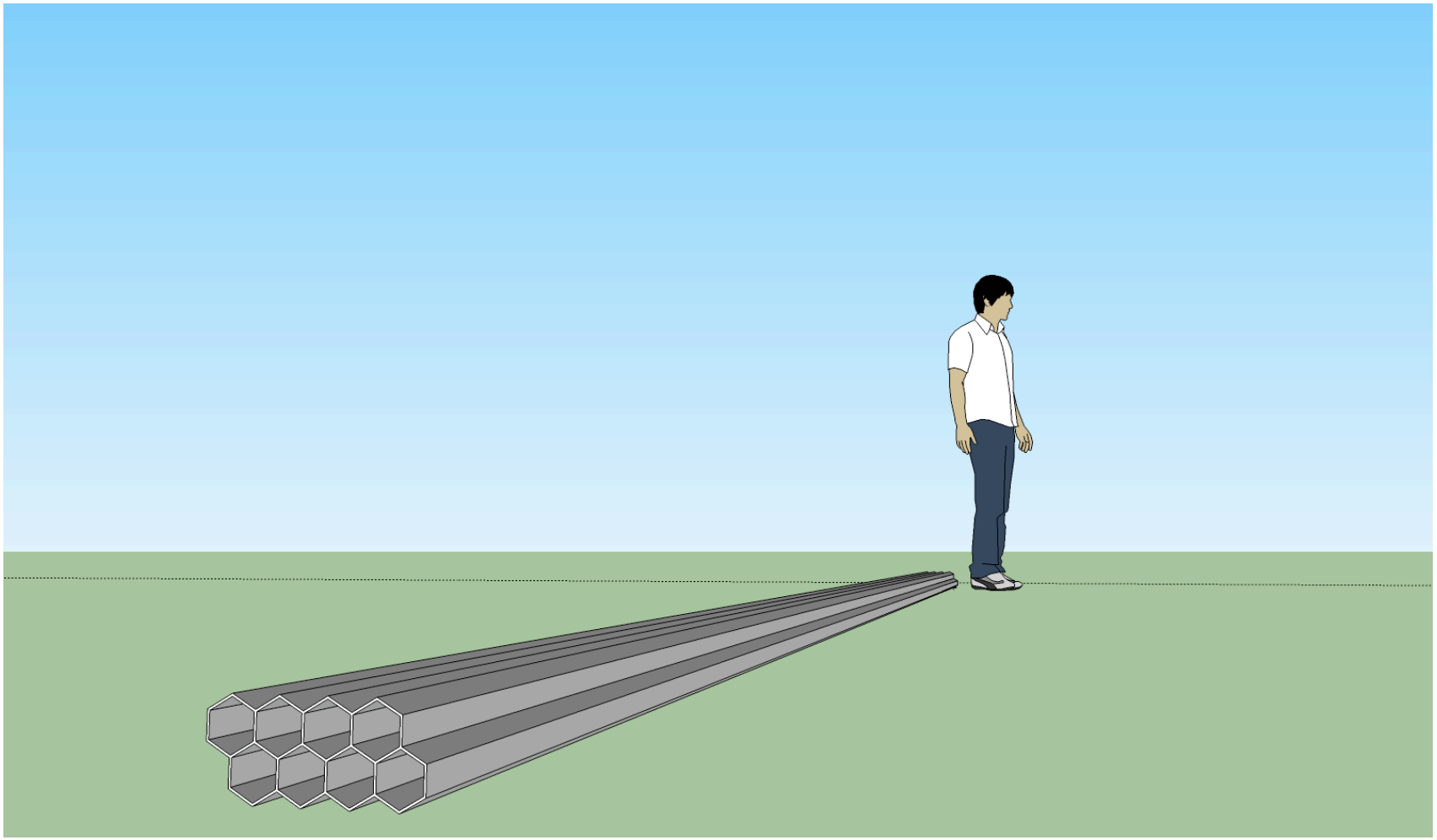
Muon Veto Shield Overview



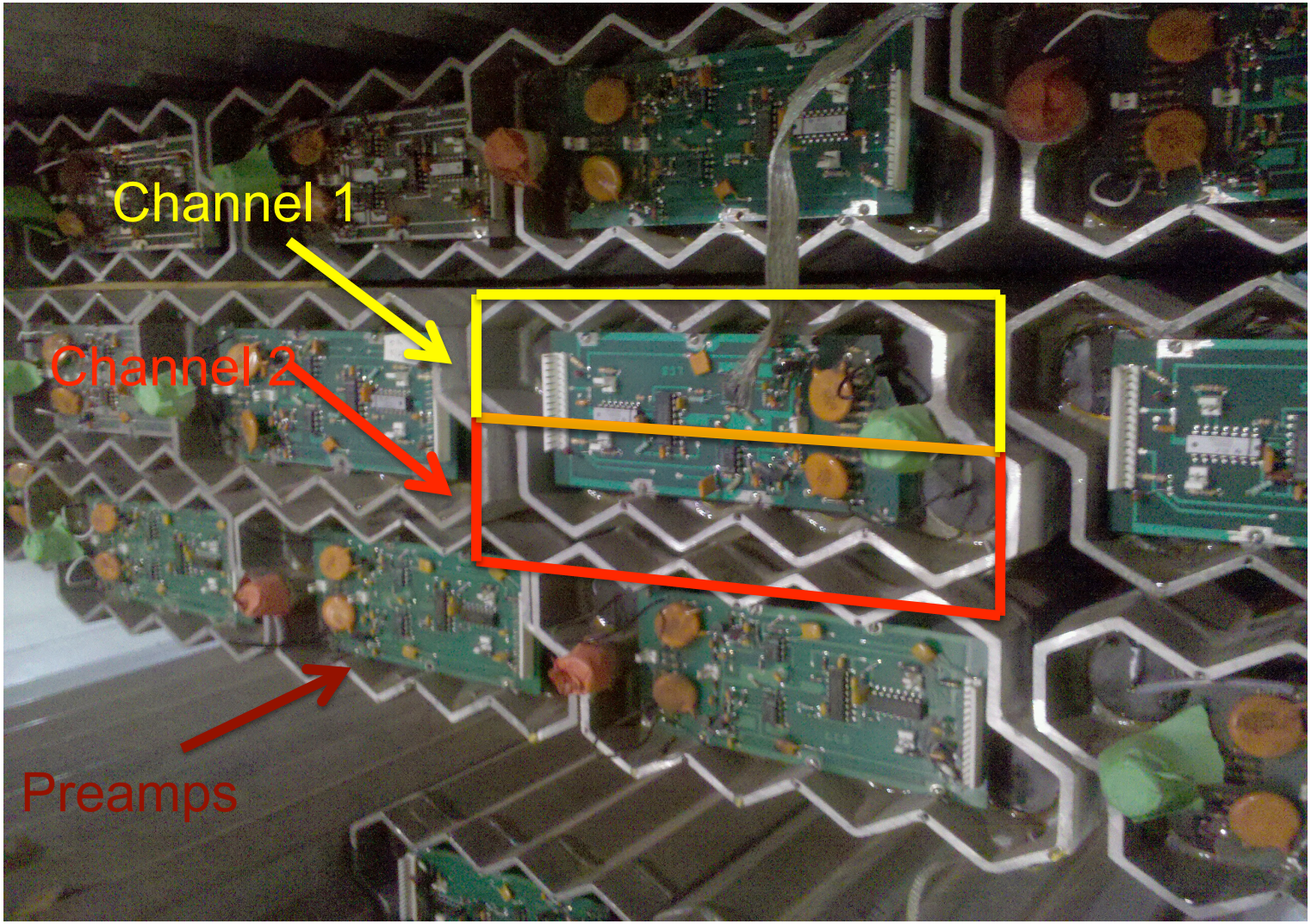
- 32m X 17 m X 10 m cavern (old Soudan-II experiment shield)
- about 1000 tubes
- two channels each
- very segmented
- C10 gas proportional tubes
- about 2400 V on single coaxial sense wires

Panels

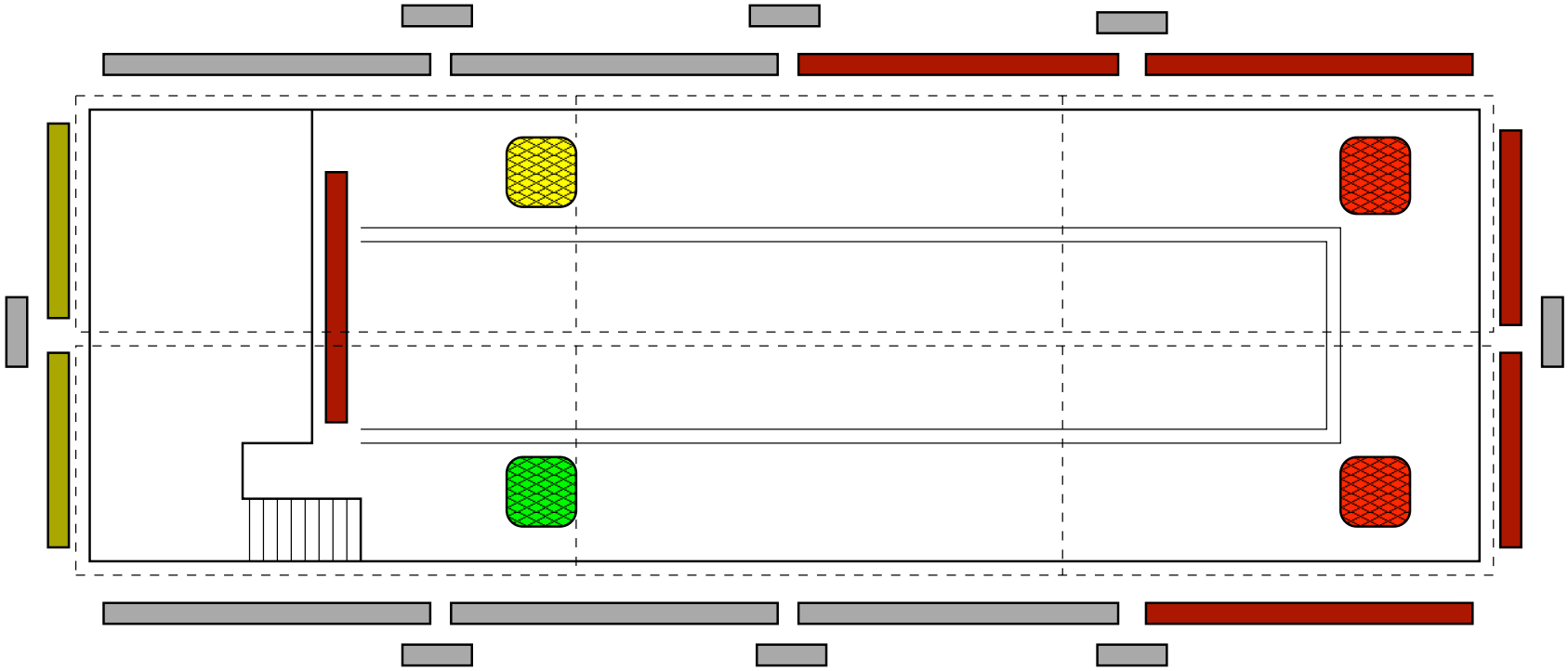
Tubes



Channels

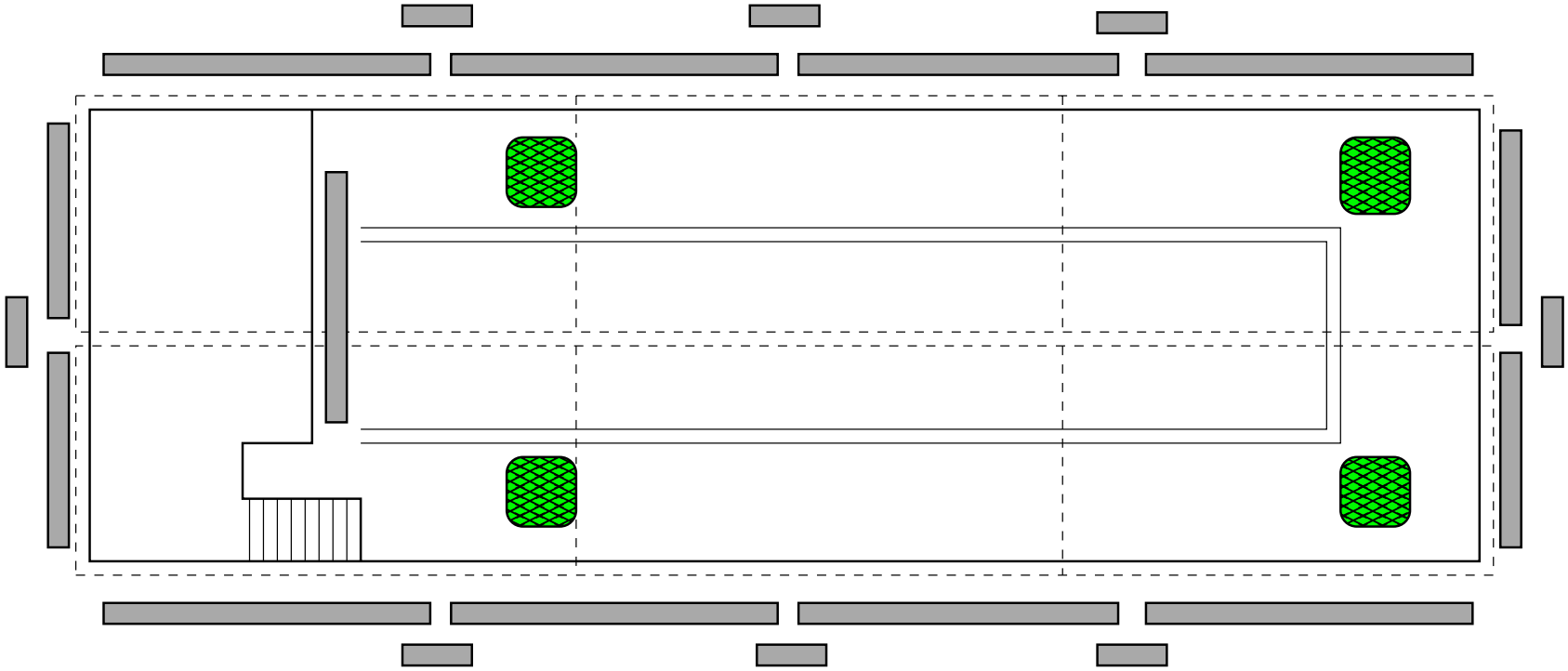


DAQ Layout



- Top view of the cavern
- Cross-hatched squares are DAQ “stations”
- Red indicated items which needed repair, all but one panel fixed now

DAQ Layout

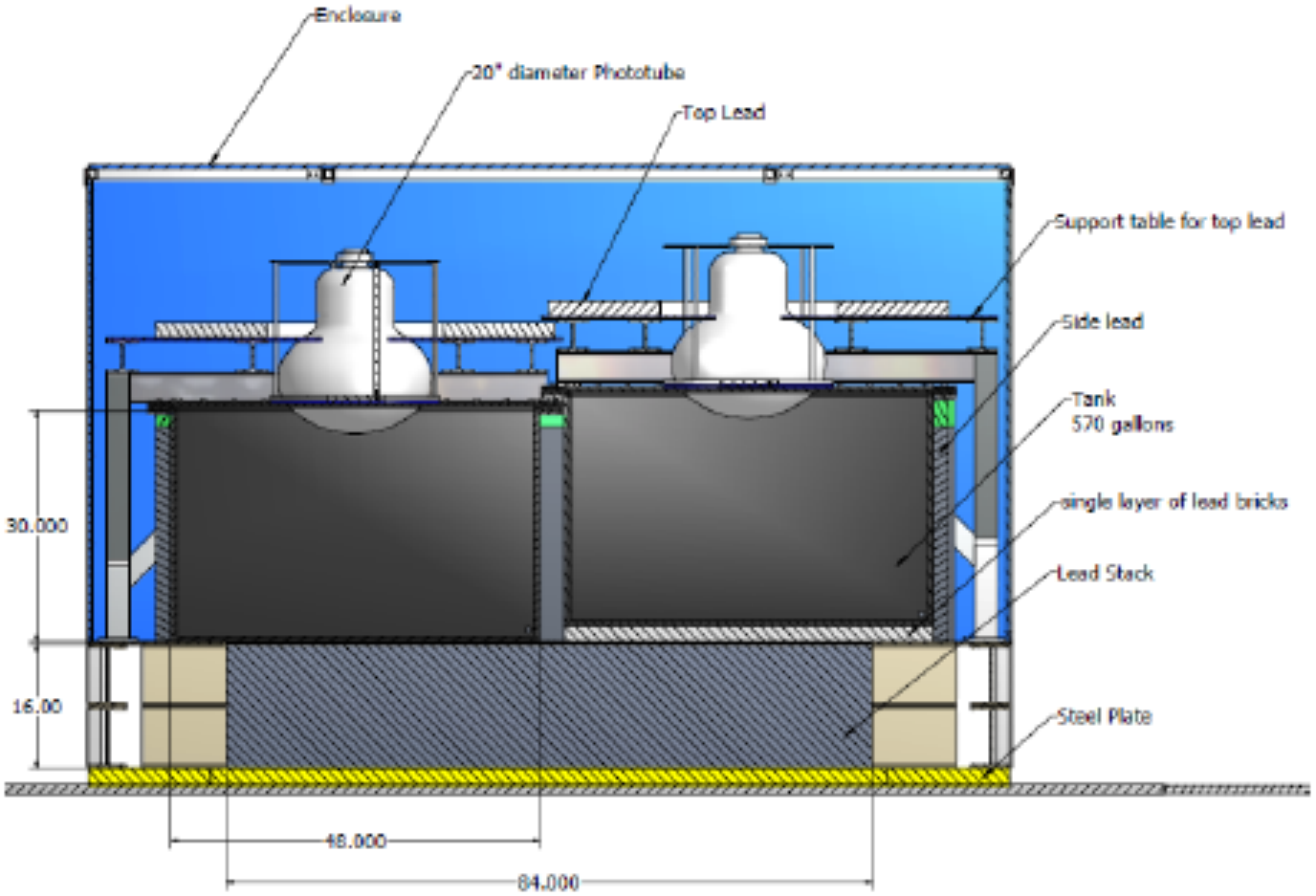


- Top view of the cavern
- Cross-hatched squares are DAQ “stations”
- All stations taking continuous 24/7 data from tubes
- Minor repairs continuously done on tubes

GPS Timing

- Real events of interest will typically be inter-station coincidences
- DAQs on stations are totally independent so accurate absolute timestamps are used (accurate to 1 μs; Symmetricom PCIe card)
- Neutron Multiplicity Meter is planned to test the same time stamping for obtaining coincidences with the shield
- Plan to make timing hardware generic so any setup placed in the cavern can have coincidence power

Novel Detectors -NMM



Coincidence Events: First Cut

- Feed trigger out signal to NMM
- Can only do for small number of panels
- Coincident events are clearly seen with small background
- Timing width is 1-2μs

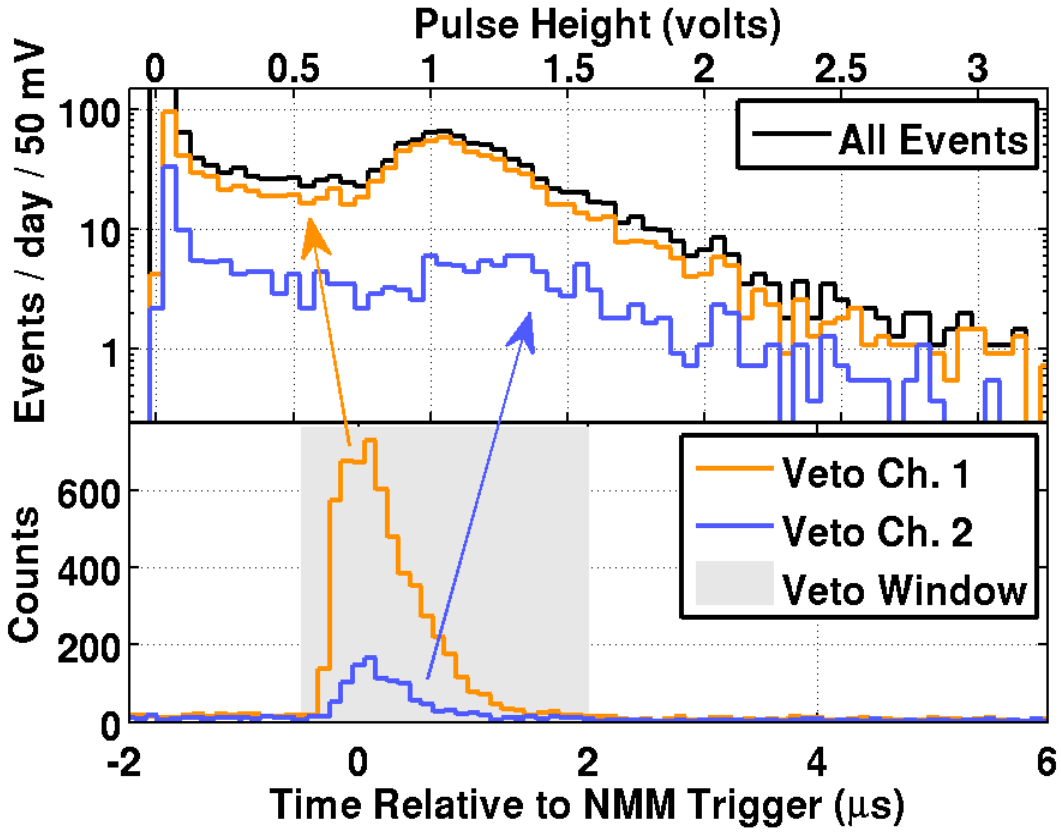
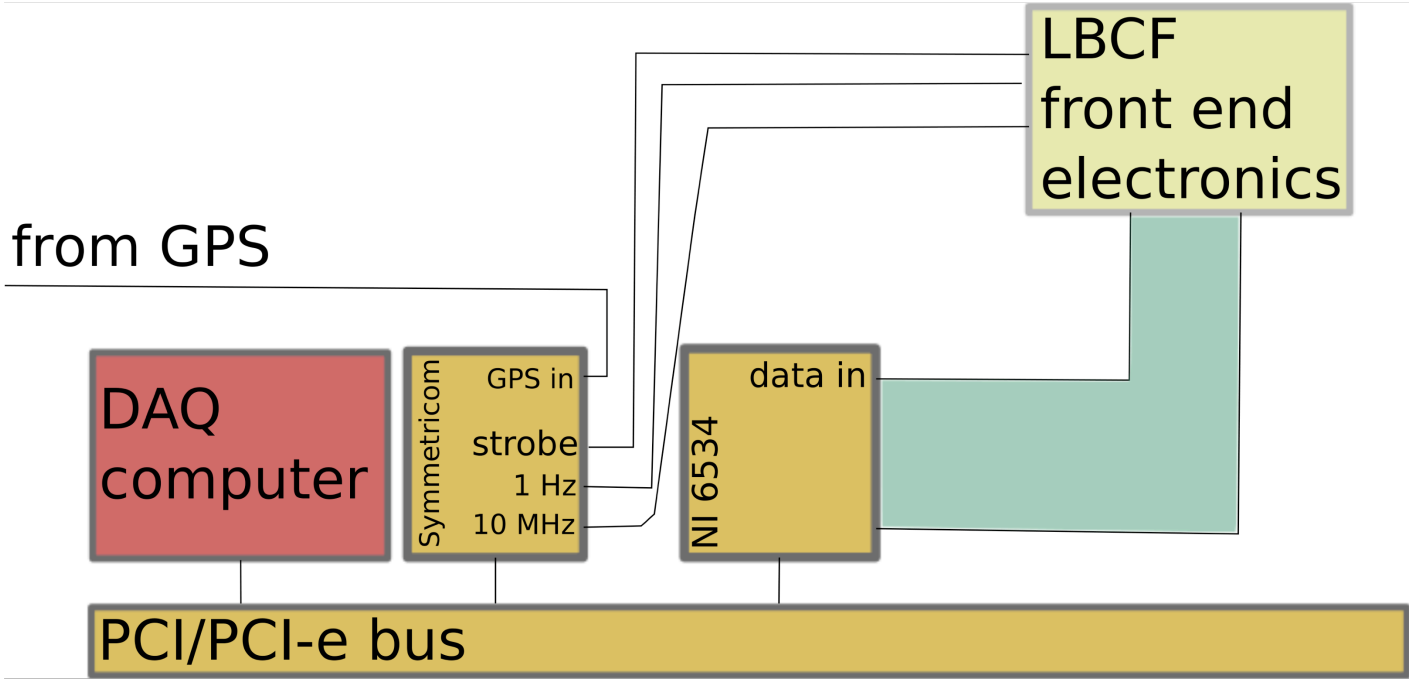


Figure: Ray Bunker

“Active” Cavern Environment



- (above) LBCF scheme for timing correlation
- use global ~μs stamp to correlate NMM or other events to muons
- possible to extend to NMM in a generic user-oriented way

Built in Symmetricom Function

- The Symmetricom cards which are installed on a PCI/ PCIe bus have event input
- This input latches the major and minor time values to a readable register
- This allows read out of seconds and microseconds after event input
- Looking into this method coupled with a software read of above registers in the NMM DAQ
- This read should be robust with respect to double triggers and be tied to the NMM trigger

Status/Summary

- Measurements which constrain cosmogenic physics are sparse
- The Soudan veto shield is taking data with the ability to tag cross-cavern muons with tracking and timestamp (1 μs resolution)
- The NMM has demonstrated shield-correlated events with close veto panels
- Upgrade to independent timing - give ability to correlate events across the whole shield
- This ability should come online spring ‘13