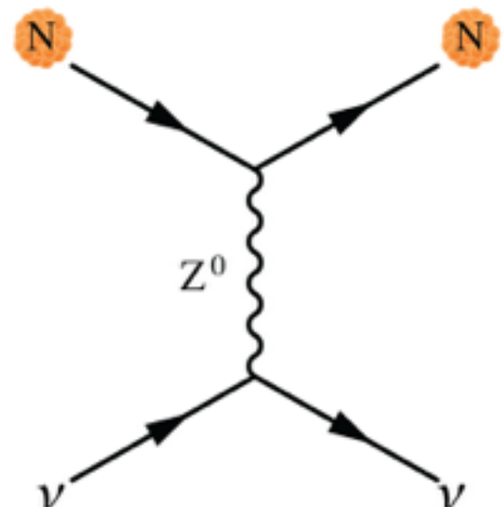
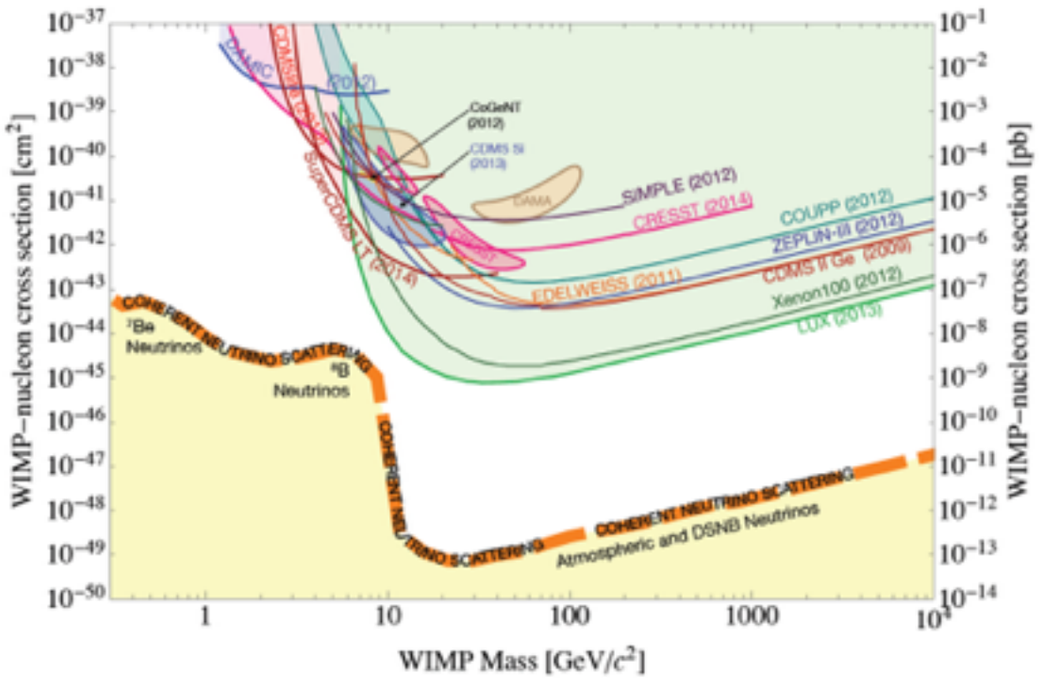
Ricochet

Kimberly Palladino
2/28/17

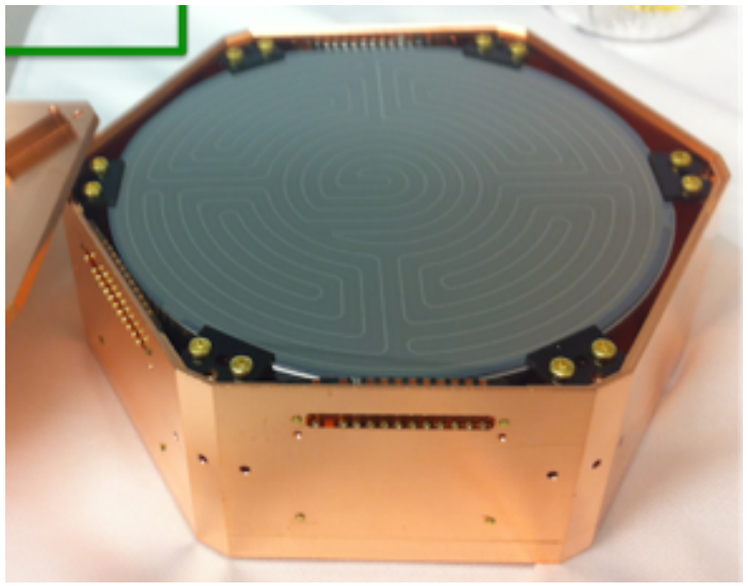
Coherent Neutrino Scattering

- Standard model process that hasn't been measured
  - Once measured can probe nuclear physics and neutrino physics
- Neutral Current iteration same for all flavored neutrinos
- Characterized by low energy recoils: more in the realm of dark matter physicists than neutrino physicists
- Background for Dark Matter Experiments
- Future of: Nuclear monitoring? Sterile Neutrino searches?





RICOCHET
A Coherent Neutrino Scattering Program



- Initial thoughts in arXiv: 1107.3512
- Operate a CDMS iZIP at lower temperatures to get <50 eV threshold, and look at phonon signals only (limited discrimination)
- Essentially the same way you'd look for a low mass WIMP, but focussing on neutrinos since CDMS-lite (iZIP at high voltage and enhanced Luke Phonons) is current path forward in WIMPs
- Mono-energetic neutrino sources like Ar-37 to do a sterile neutrino search (like SOX experiment evolving from

New Ricochet Idea

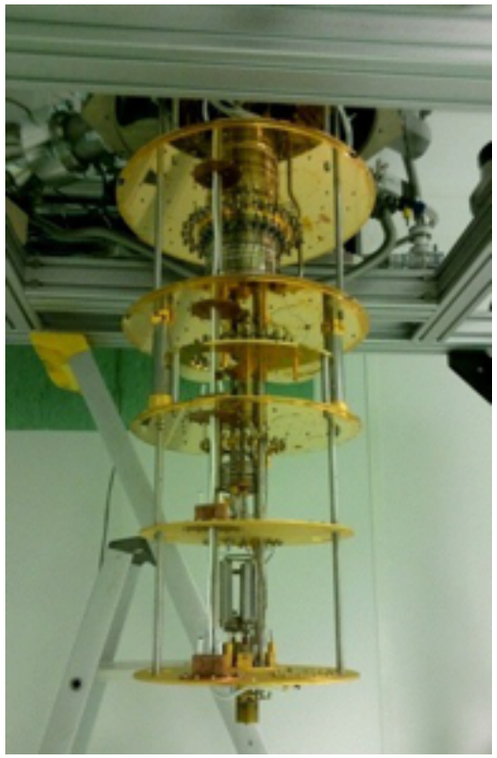
- With **J. Formaggio** at MIT, T. Figueroa at Northwestern/ FNAL, J. Billard in France, + a few others

- Instead of just looking at semiconductors (Si, Ge) as in CDMS, look to superconducting metals, especially Os, Zr, Sn, and Zn

- Less loss of signal if superconducting

- Very new detector style; new R&D

Ricochet Plans



- New dilution refrigerator arrived at MIT this winter: Desperaux, should be turning on in the next few weeks

- Start with a Si or Ge crystal from Edelweiss and a Zn crystal (not single crystal) from MIT

  - Zn needs Si then Au deposited then Au wire bonded to bolometer chip that will actually measure the phonons

  - Test in lab? With neutron calibration sources

- Move to “far” CHOOZ reactor location for the experiment

CvNS Signals

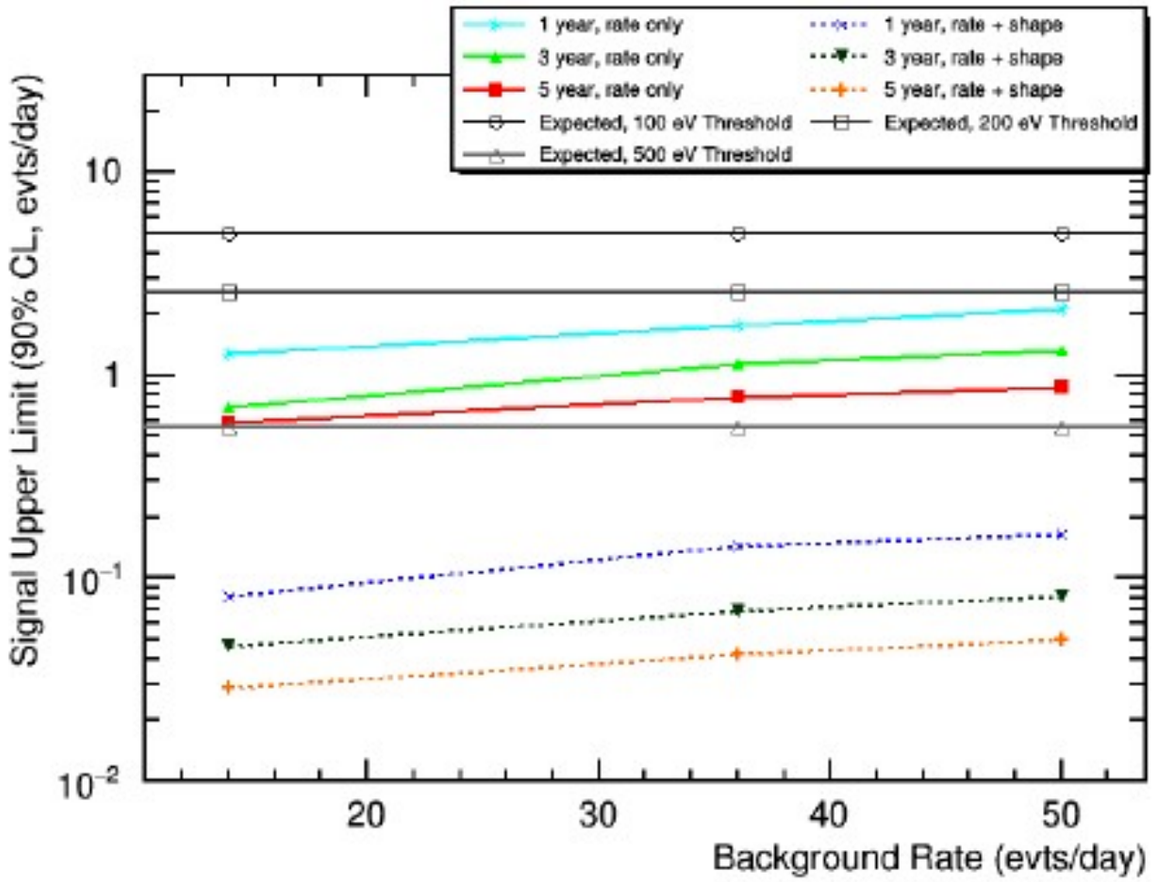
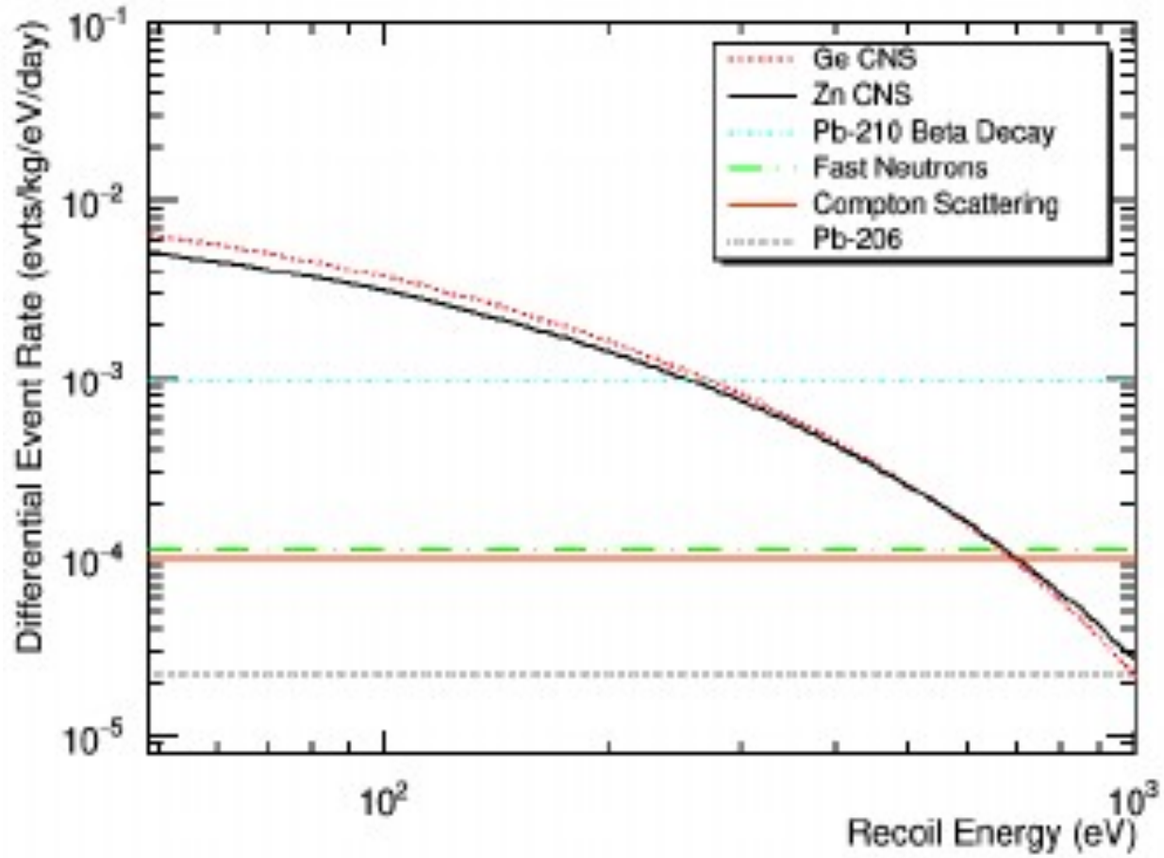


Figure 4. The 90% C.L. limit extracted in the case of zero input signal using a rate only (solid) and rate+shape (dashed) analyses. The extracted limits are well below the expected 5 events/day expected from the Ricochet 10 kg target, assuming a 100 eV recoil energy threshold.

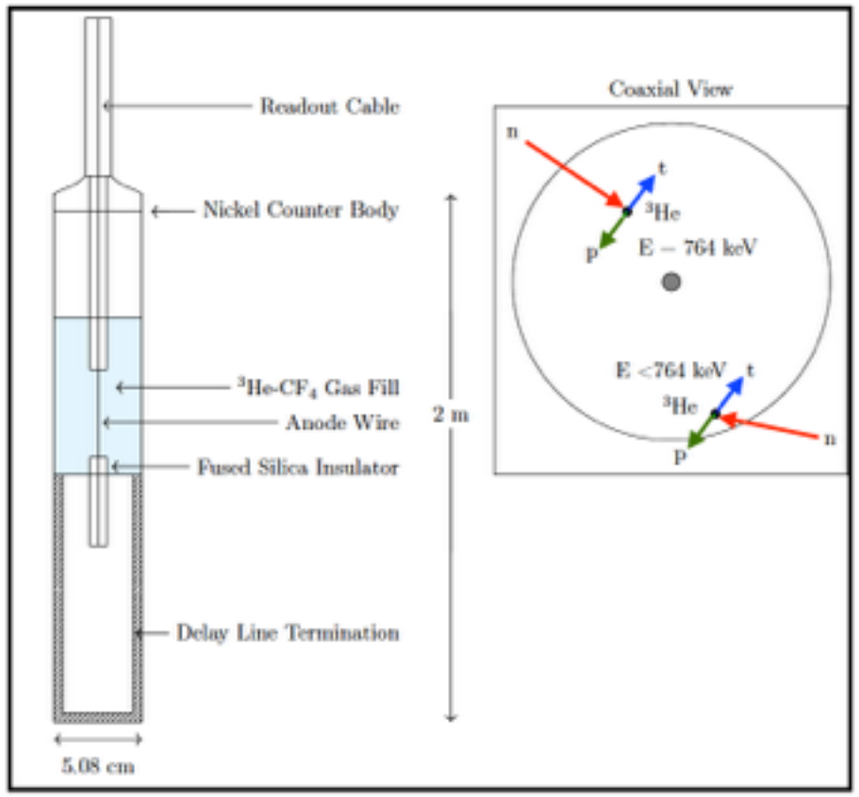


Detector Threshold	Rate (per kg per day) Si	Zn	Ge	Os
50 eV	0.32	0.66	0.76	1.25
100 eV	0.26	0.46	0.51	0.55
200 eV	0.19	0.25	0.26	0.14

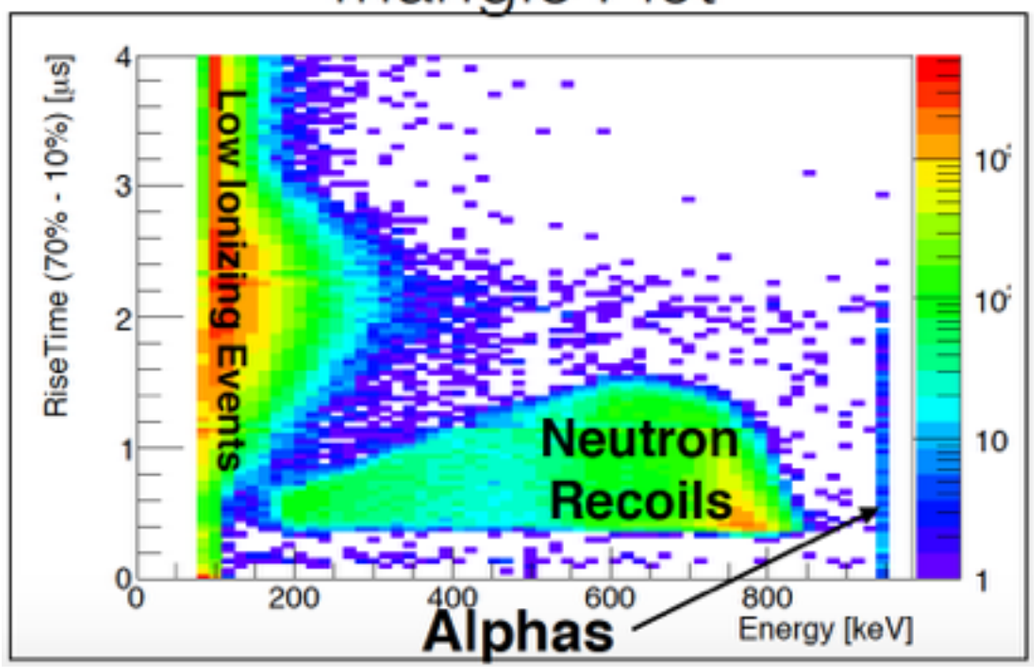
Table 2. The predicted CEνNS event rate for various detector materials and re threshold energies. Rates are calculated for a reactor power of 8.54 GW, a dete distance of 400 m, and fission fractions ^{235}U = 55.6%, ^{239}Pu= 32.6%,^{241}Pu = 7. and ^{238}U = 4.7%.

Reactor Neutrons

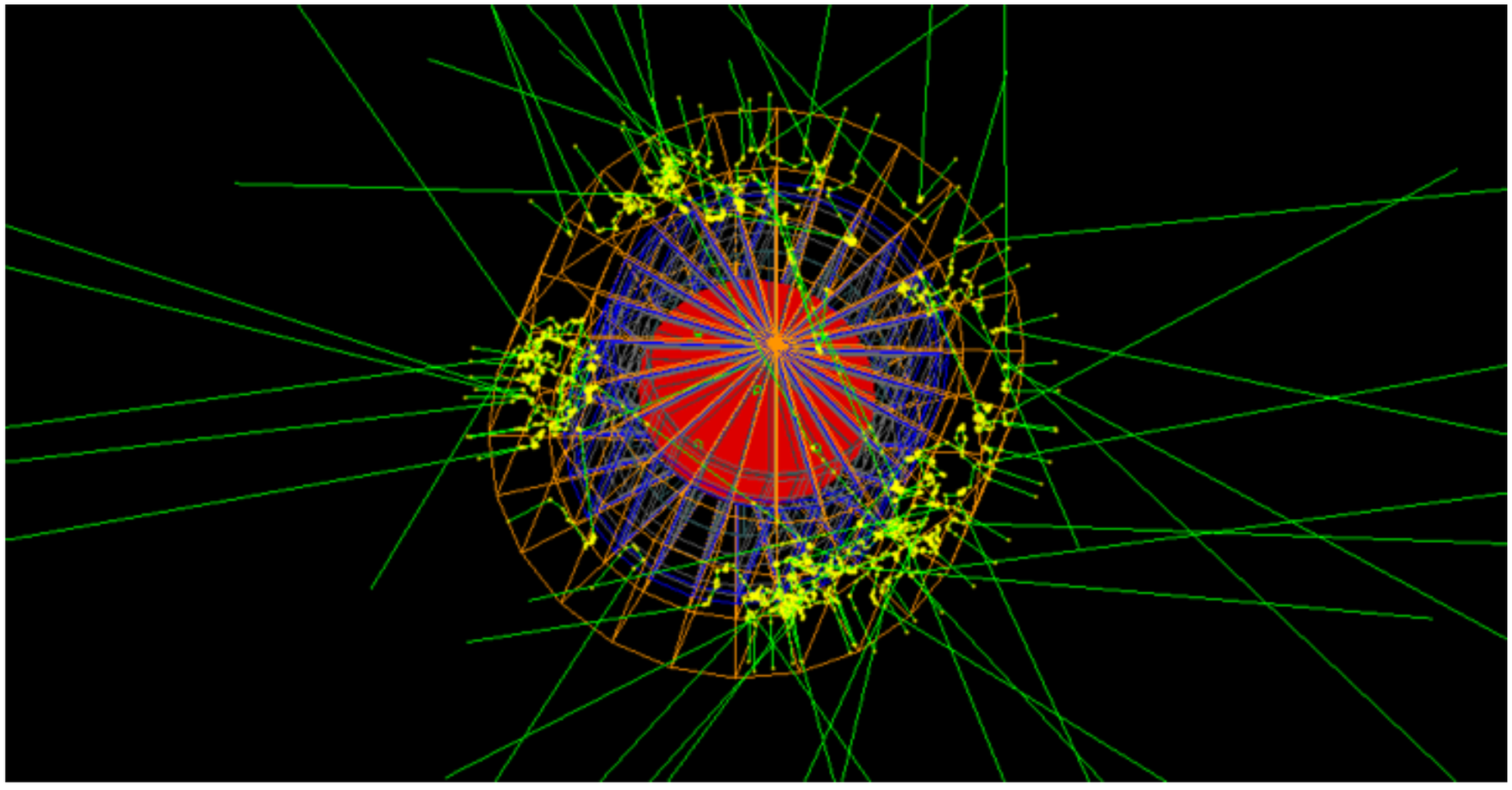
- Studied with a SNO NCD He3 neutron detector in the room near the reactor
- Need to convert data to a predict spectrum by matching to Monte Carlo simulations
- MIT ones off by factor of 50!



Triangle Plot

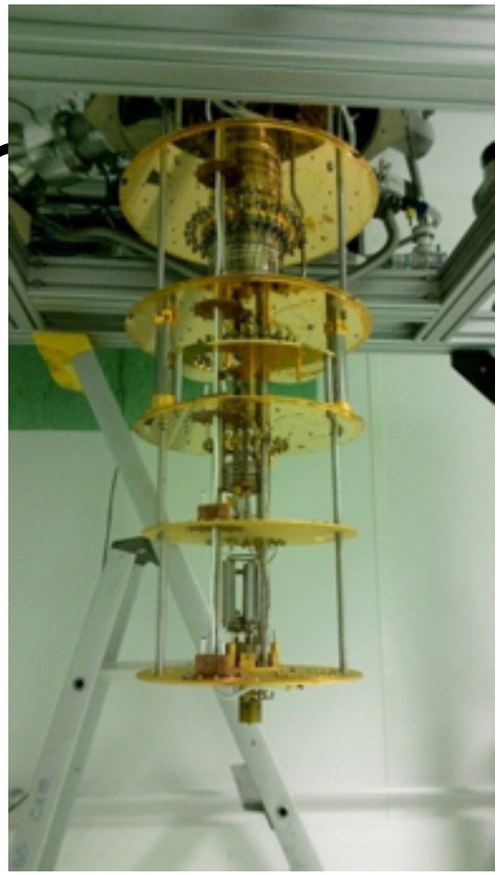


Other Backgrounds



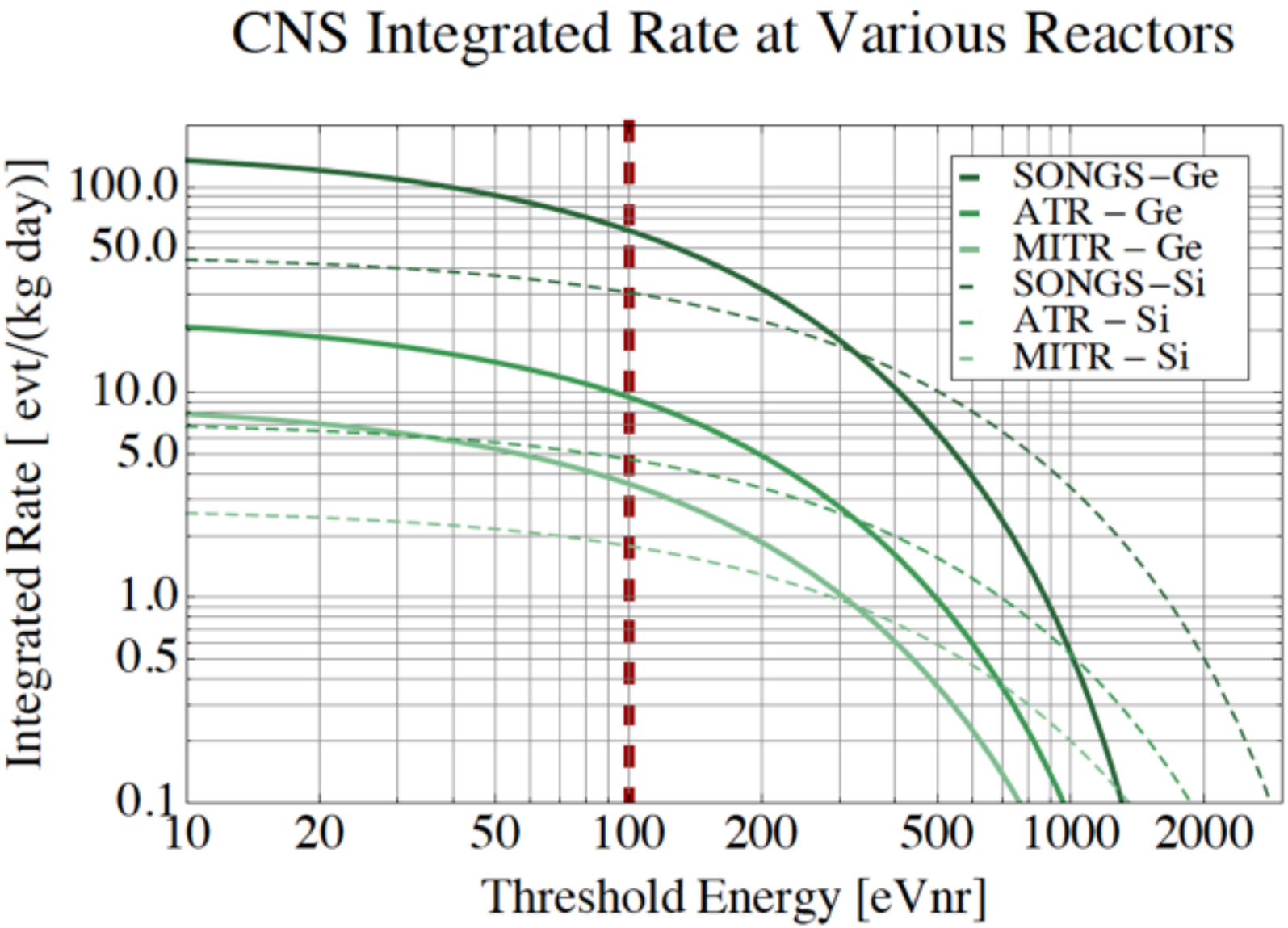
- Study in Geant4 simulation with the Ricochet detectors
- Currently expect neutron backgrounds of ~200 /kg/day at MITR

Old Ricochet Plan



- New dilution refrigerator arriving at MIT this winter
- Start with a Si or Ge crystal from Edelweiss and a Zn crystal (not single crystal) from MIT
    - Zn needs Si then Au deposited then Au wire bonded to bolometer chip that will actually measure the phonons
    - Test in lab? With neutron calibration sources
- Move to room in MIT test reactor location to run with neutrinos
    - Need to understand reactor neutron backgrounds, as well as cosmic/ radioactive backgrounds

CvNS Signals



MITR

Power MW	5.5
Baseline m	7
Ge evt/kg/day	3.6
Si evt/kg/day	1.8