ν Scattering

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- Extensive experience searching in the Dark Matter, Coherent Neutrino Scattering efforts and other rare event searches

- CoGeNT, LUX, Zeplin, CAST, CosI, IGEX, Majorana Demonstrator, EXO, ULGen, Double Chooz, SK, T2K, SNO, COUPP/PICO…

- …and neutron measurement experience (think backgrounds) from the security sector

Large Mass, Low-Threshold, Low-Background Detectors

- A collaboration has recently formed from disparate but experienced groups, bringing together individually developed detector technologies with the goal of finally measuring the coherent neutrino-nucleus scattering cross-section at the Spallation Neutron Source in Oak Ridge.

- The collaboration's stated scientific goal is to measure coherent neutrino-nucleus scattering on numerous nuclei, and with several detector technologies with increasing precision on the total and differential rate.

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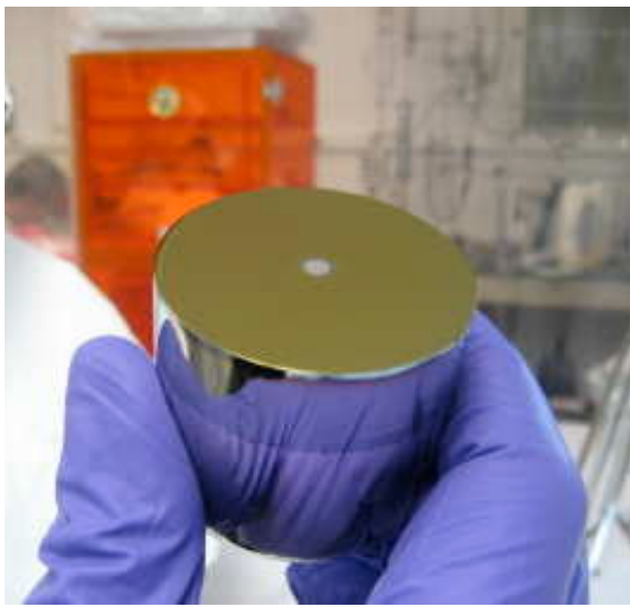

P-Type Point Contact HPGe

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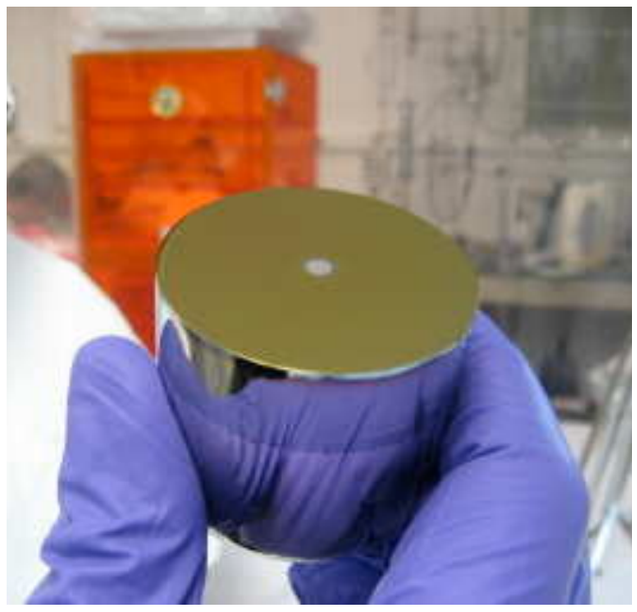

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Low-Background CsI(Na)

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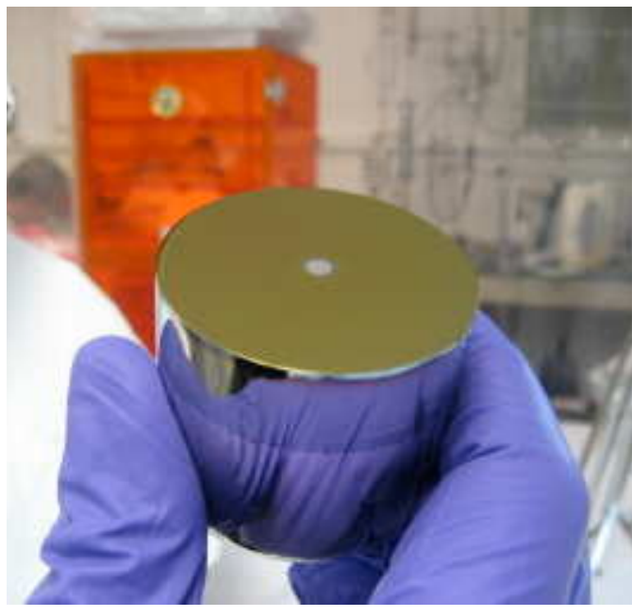

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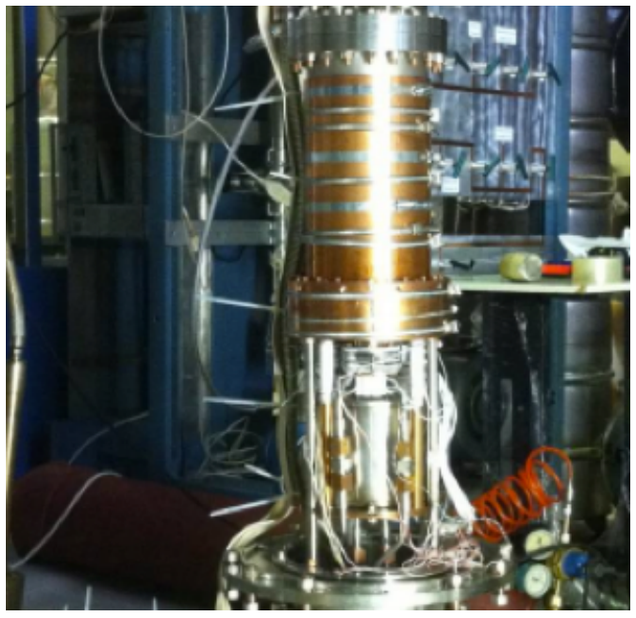

2-Phase LXe

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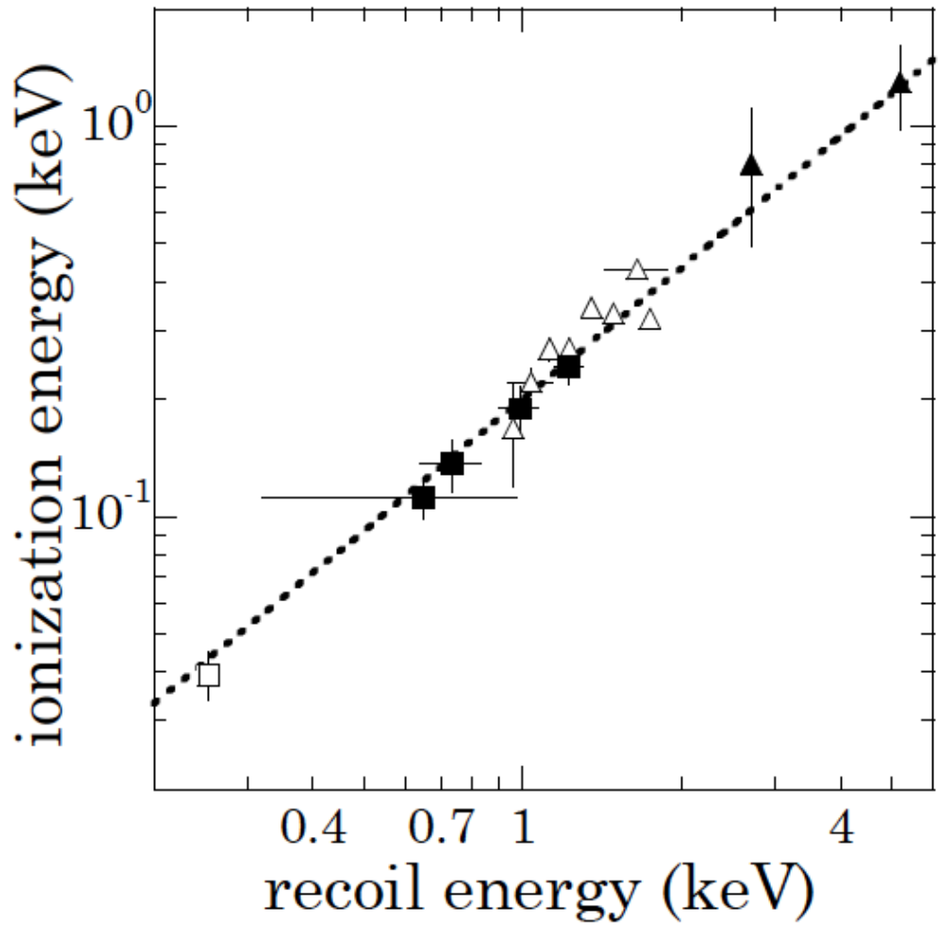
- Other targets people have been thinking about:
  - Na in NaI(Tl), ^{20}Ne, ^{22}Ne, ^{20}Ne/^{22}Ne, Ar…
  - …C, F, O, S…

Low energy nuclear recoils

- Lots of experience measuring low energy nuclear recoils within the collaboration (Chicago, Duke, ITEP)

- A facility has been developed at Duke/TUNL to enable the precision calibration of all of these detectors. *CsI(Na) and NaI(Tl) data in the can.*



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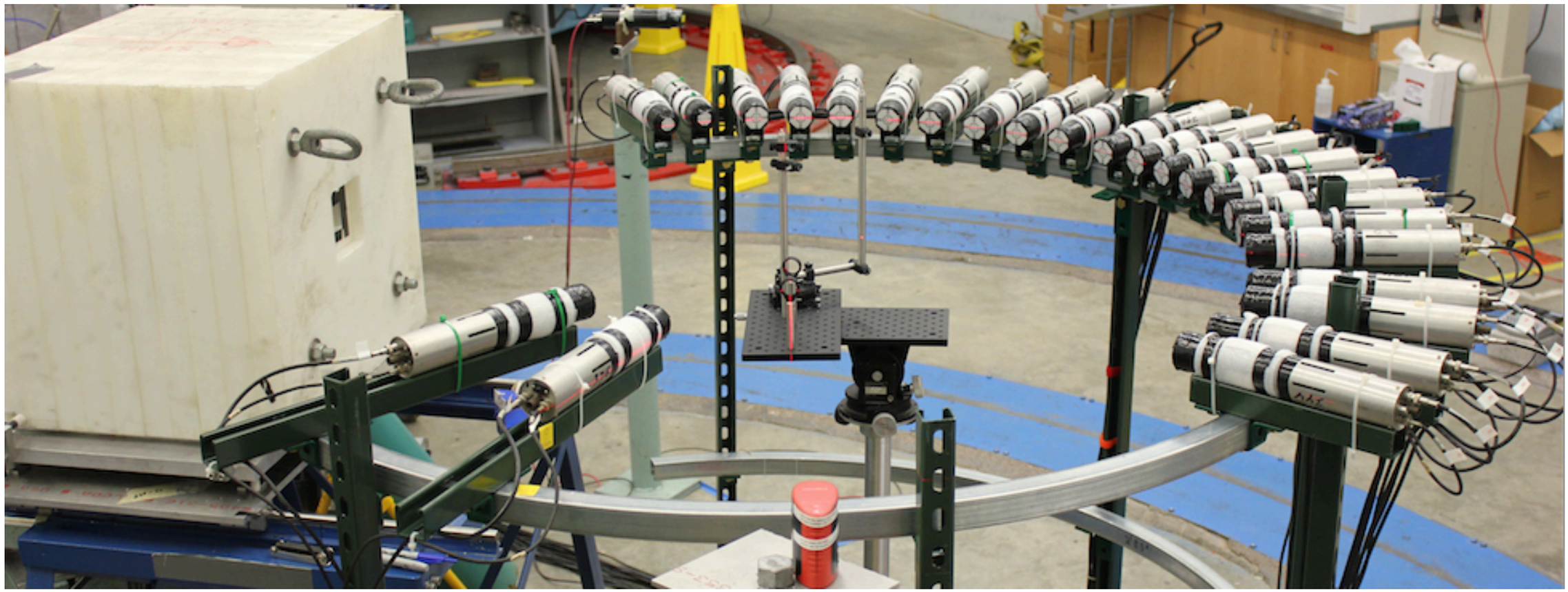

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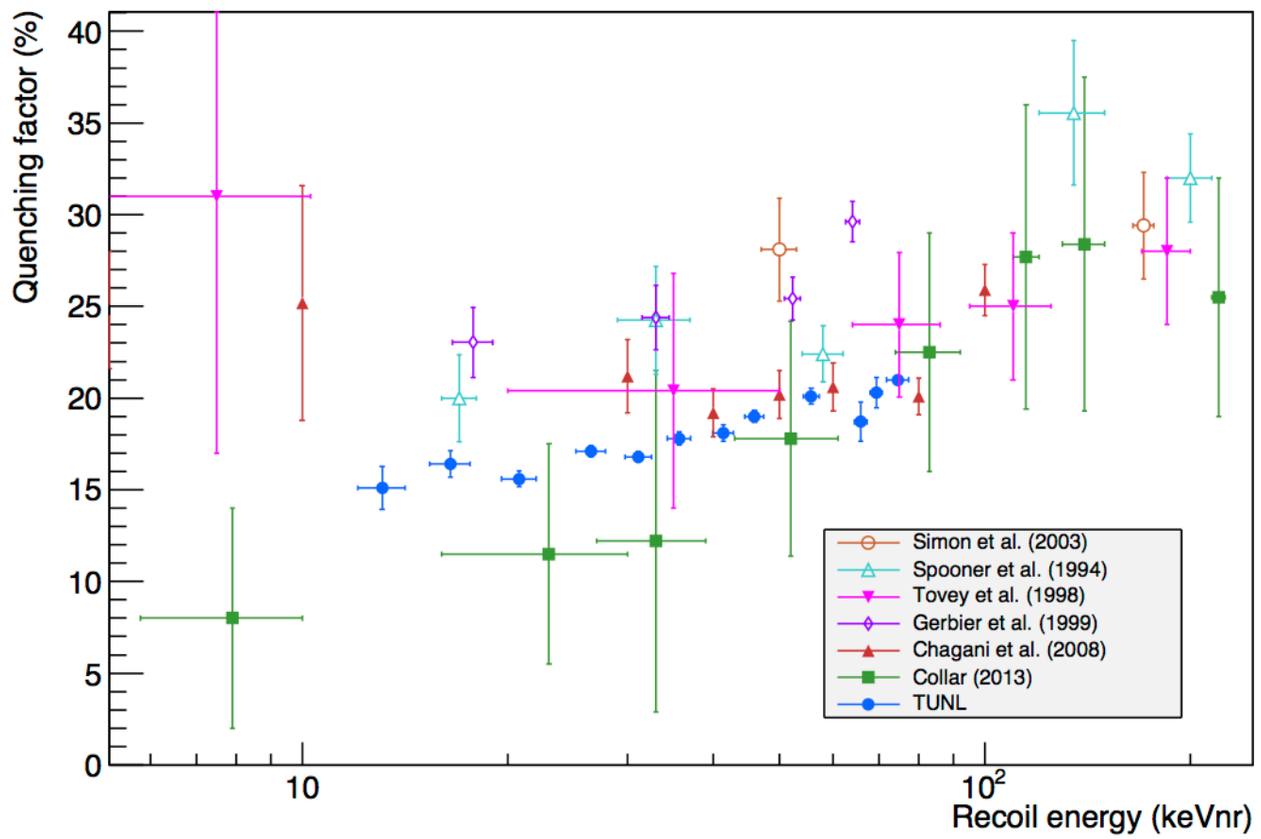
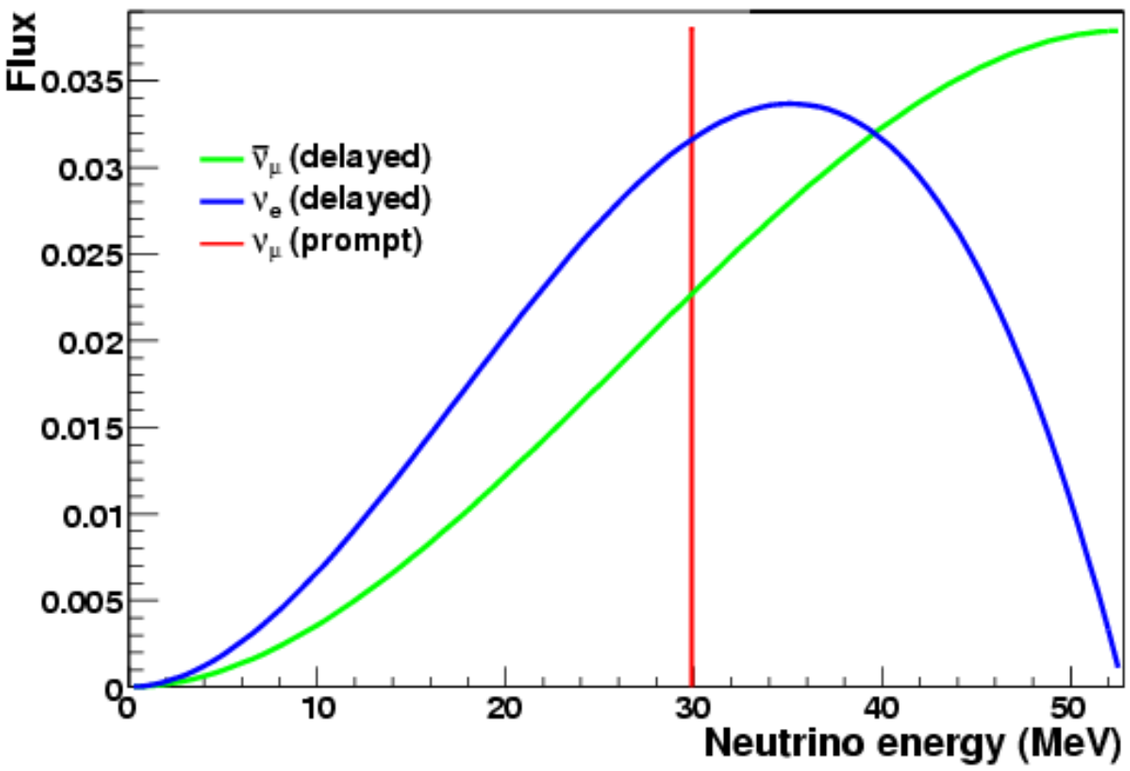


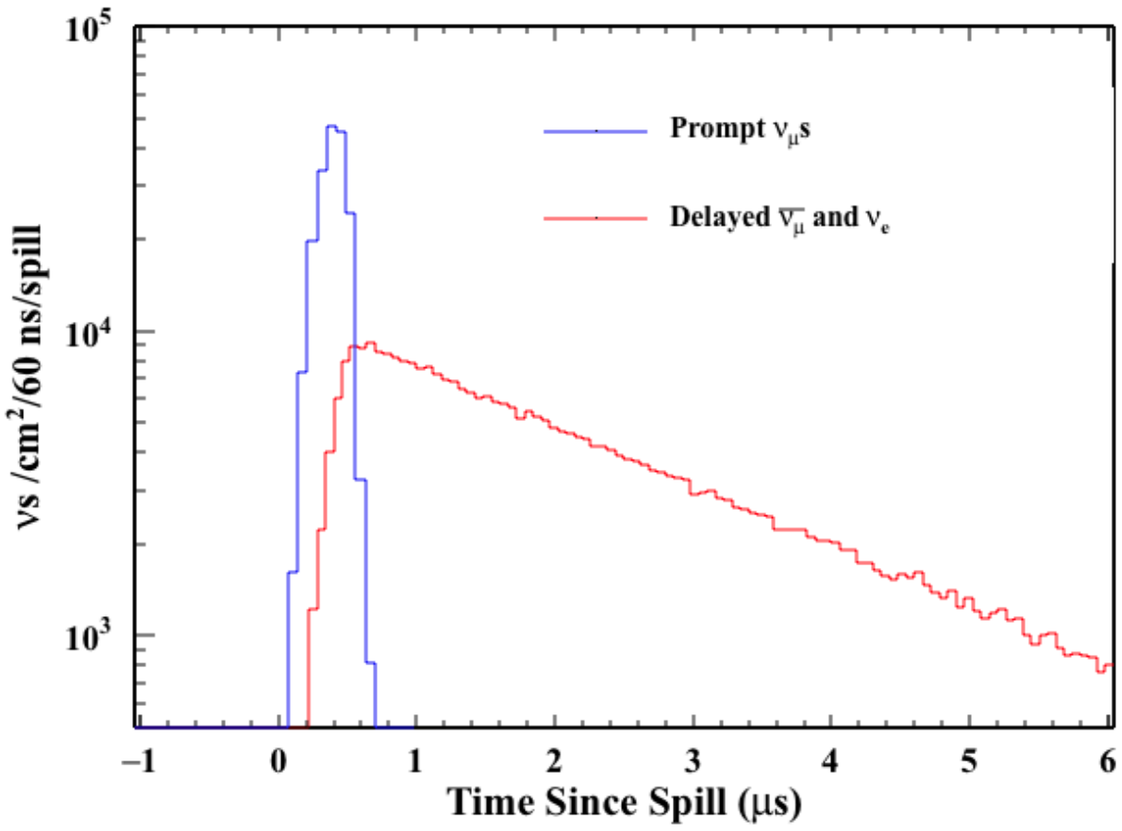
The Spallation Neutron Source

- Decay-at-Rest Neutrino Source
  - DIF is neglibible
- Current **ν** flux calculations -> 1.1×10^{7} **ν** cm^{-1} s^{-1} at 20 m for 1.2 MW operation



The Spallation Neutron Source

- Pulsed: 700 ns width at 60 Hz (background reduction)
- Depending on detector characteristics -> $6x10^{-5}$ to $2x10^{-4}$ background rejection



Backgrounds

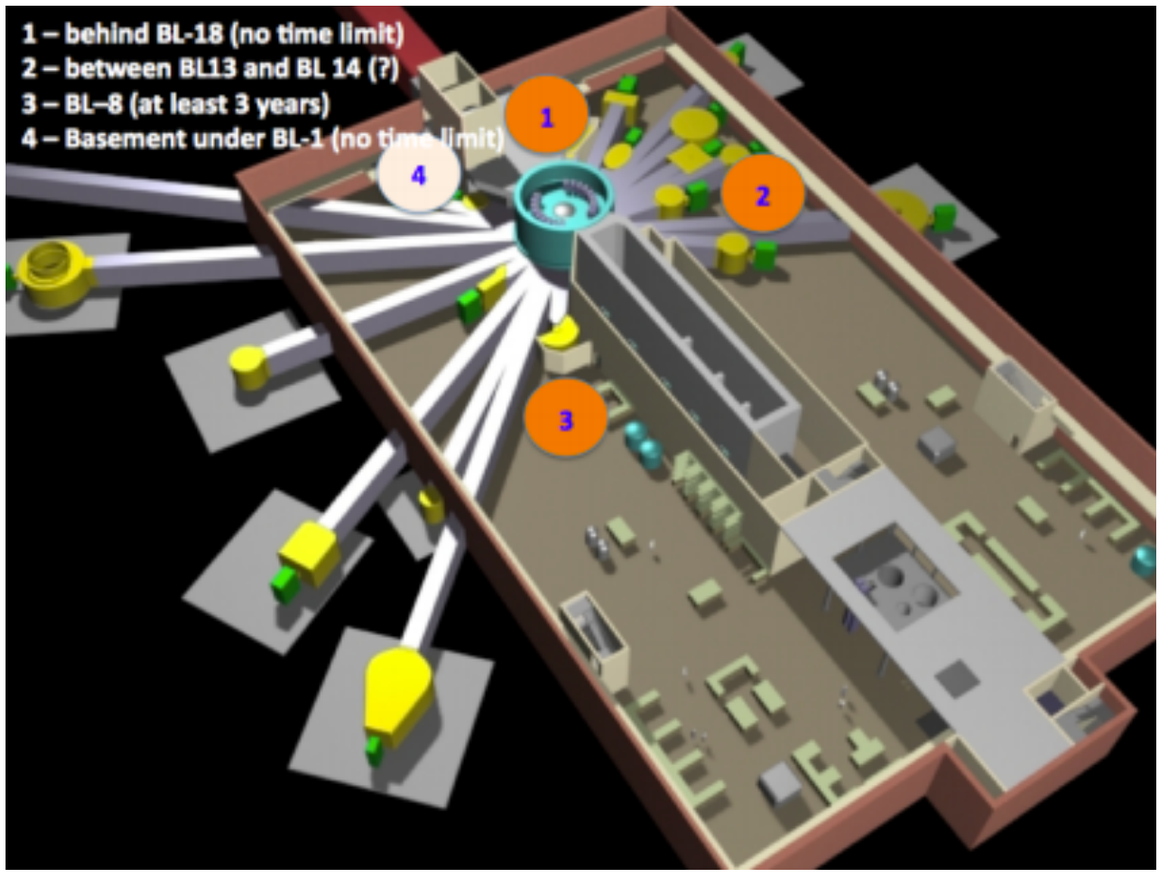
But let us not forget that this is a facility designed to produce neutrons, and that those neutrons are pulsed with the same time structure of the neutrinos (**with the exception of the characteristic decay time of the muon**).

These neutrons can have very high energies (>100 MeV)

This heat map image of the high energy neutron flux in the SNS bay was produced using a coded aperture neutron detector array.

Hunting for a Background Free Location

- There is an ongoing campaign of overburden and neutron background measurements



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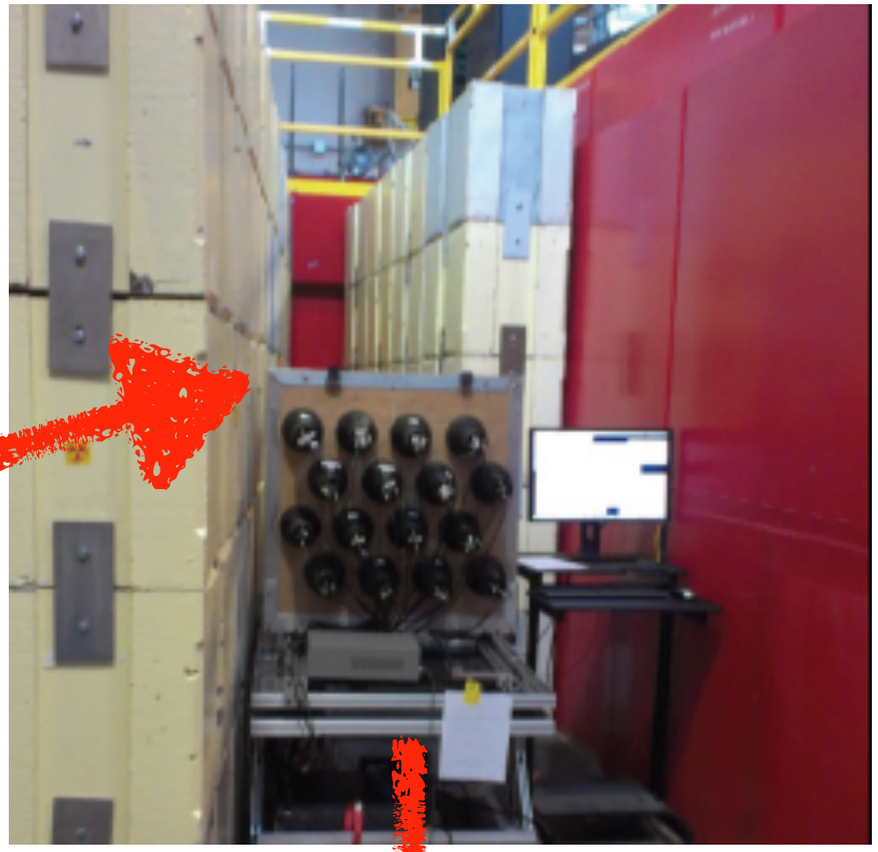
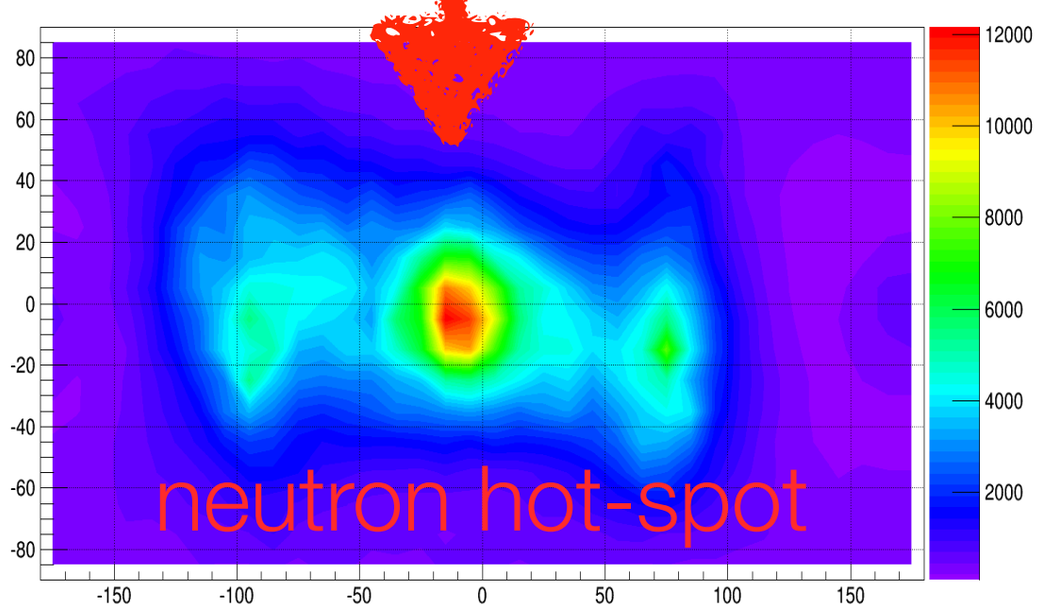
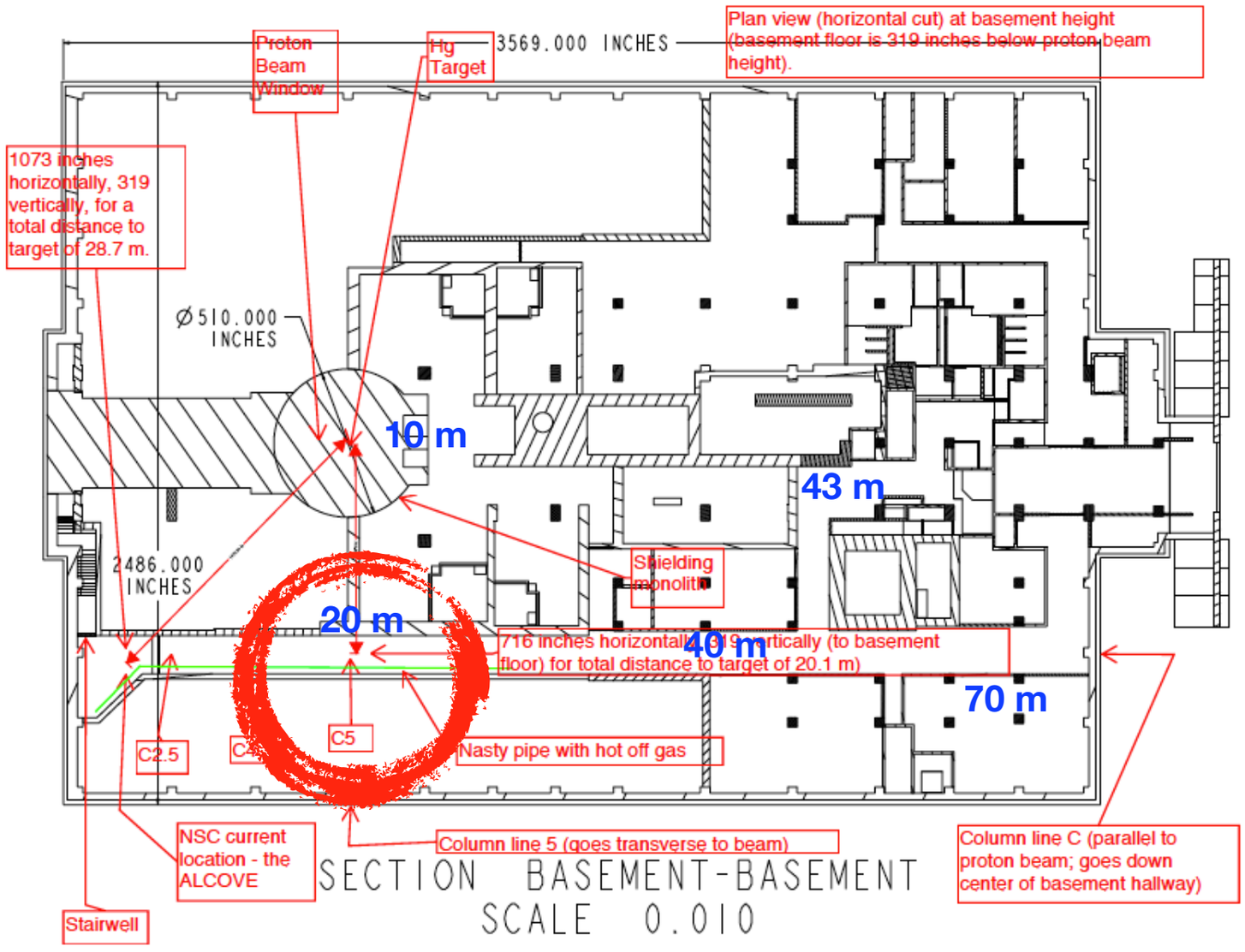




Hunting for a Background Free Location

- So far, the basement is the most promising location.
- Presence of some easily shielded 511 keV γ's from an air cooling loop.



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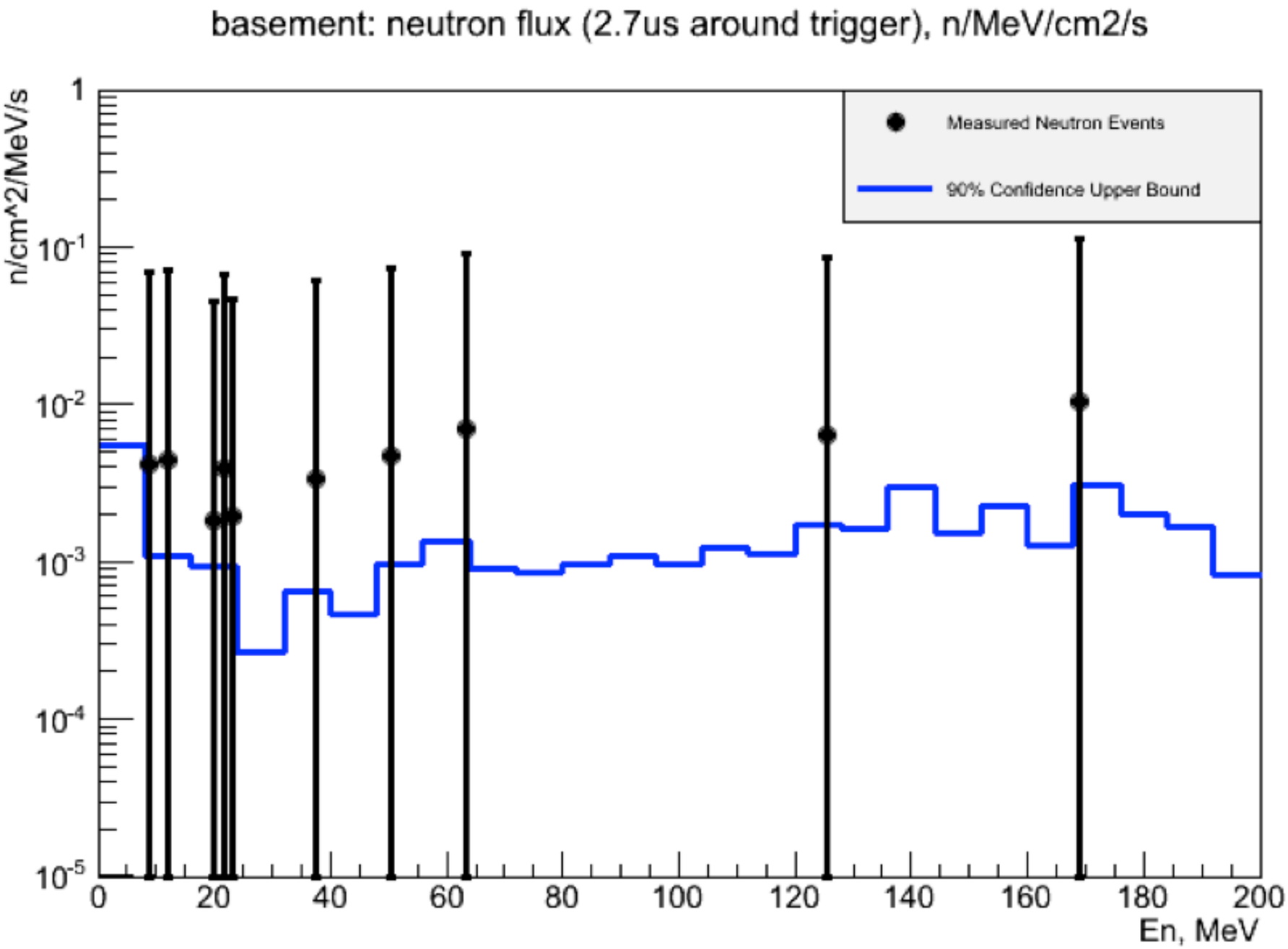

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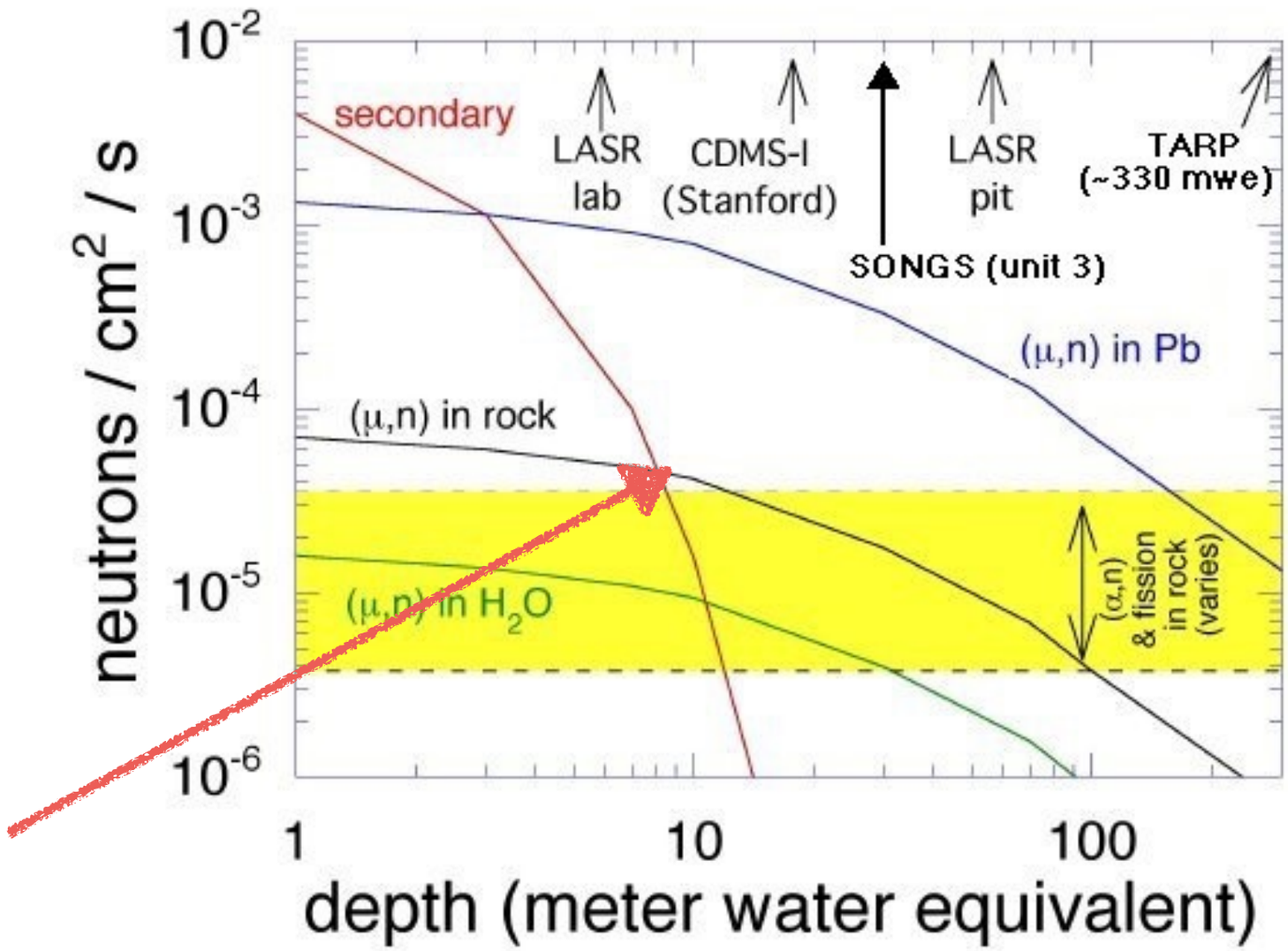
- 8 m.w.e. overburden



Yet another background: $\boldsymbol{\nu}$-induced neutrons

- The detector designs tend to utilize several tons of lead in their environmental shields

- Neutrinos can interact with the lead and produce a large flux of pulsed neutrons very near to the detectors

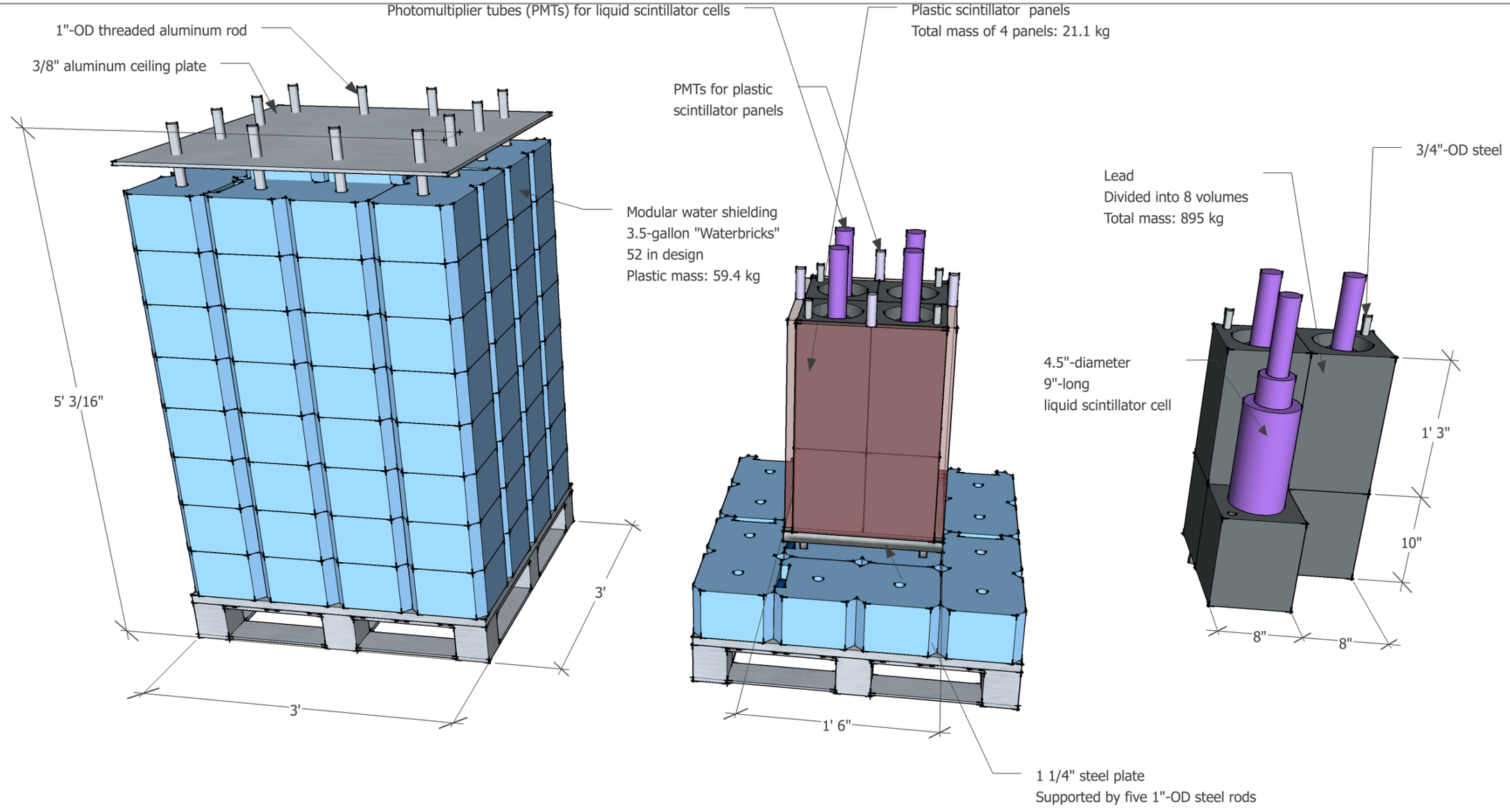
- For a convincing CE$\boldsymbol{\nu}$NS measurement, this cross-section needs to be measured, and the neutrons need to be dealt with.

CsI(Na) detector and shield

$$\nu_e + {}^{208}Pb \Rightarrow {}^{208}Bi^* + e^- \quad (CC)$$
$$\Downarrow$$
$${}^{208-y}Bi + x\gamma + yn$$

$$\nu_x + {}^{208}Pb \Rightarrow {}^{208}Pb^* + \nu_x' \quad (NC)$$
$$\Downarrow$$
$${}^{208-y}Pb + x\gamma + yn.$$

Measuring the ν-induced neutrons



- Several palletized (mobile) lead targets with LS neutron detectors are to be delivered to the SNS position c5 next week.

- As will the CsI(Na)-shield, with a LS in place of the CsI(Na) crystal, in order to measure the neutron background in situ.

COHERENT deployment at SNS

Deployment of neutrino cubes and CsI(Na) shielding assembly took place mid-September 2014. Located in basement, ~20 m from target, with ~8 m.w.e. overburden

- CsI(Na)-detector cavity occupied by liquid scintillator cells for *in situ* background measurement
  - Following background assessment, **CsI(Na) crystal can be installed and CEvNS data can be taken**
- **neutrino cubes can be occupied with Target of choice (Pb, Fe, W…**
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Wrapping up

- You will hear more details about CsI(Na), Ge and NINs in Coherent
- “First neutrino” is just around the corner
- First Coherent neutrino may come just after
- Phased approach to a systematically clean, higher precision measurement of the cross-section versus N
- While trying to remain focused on CEvNS, the collaboration is well positioned to take a look at other interactions
  - e.g. NINs
  - perhaps (ν, ɣ)
  - maybe neutrino induced fission (NIFs?)