Neutrino Sources for Coherent Neutrino Scattering

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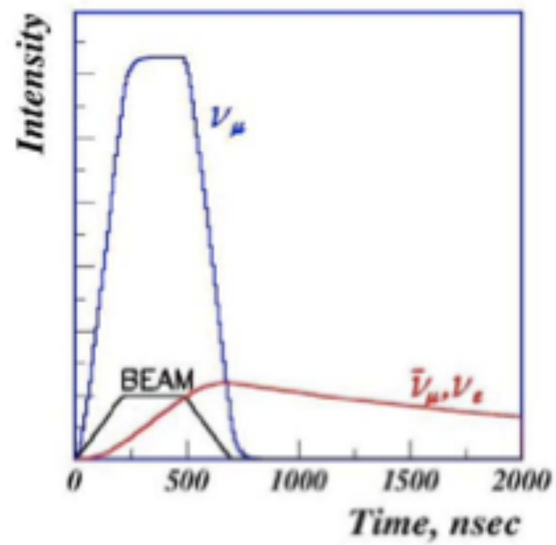
- Large cross-section, but signature is low energy nuclear recoils
  - Dark-Matter detector technology
- Important in Supernovas
- Sin ϑ_W
- Z’
- Oscillations to sterile neutrinos
- NSI

Near-term Possibility: MI-12

- Also known as BooNE target area, and a free source of neutrinos from stopped pions
- 20 kW proton power
- Small effort led by Jonghee Yoo
- Trying to understand backgrounds and shielding:
  - Would like to be close to target for neutrino flux
  - Lots of neutrons and gammas. Cause dead-time even if we can identify them as background.
  - Neutrons with K.E. > 10 MeV are hard to stop
    - Advice from Tennessee colleagues at this workshop:
      - at least 10m of shielding, may need 30m
      - Often counterintuitive need for different layers
      - Geant gives OK first approximation
    - How often do these leave only a low E nuclear recoil?
    - Experiment doesn't have to be zero-background. How do we optimize trade-offs between neutrino flux, background rate, and live-time.

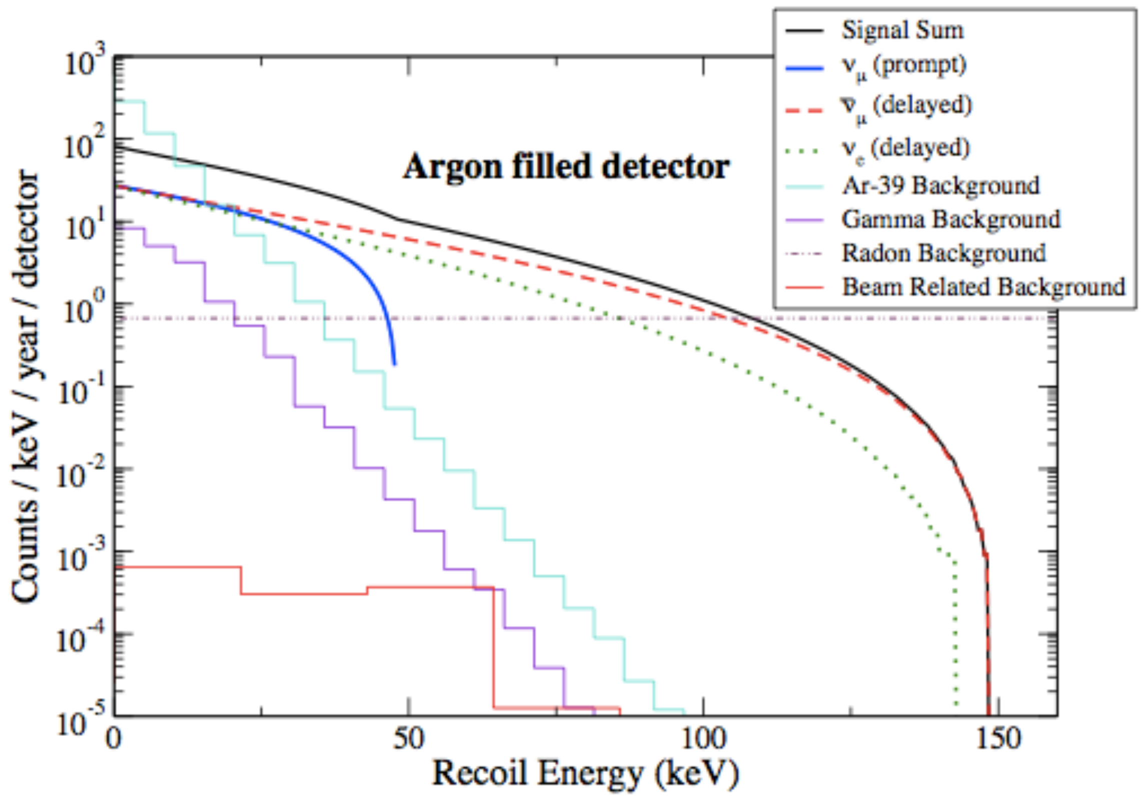
SNS

- 1 GeV proton beam, 1 MW
- 60 Hz, 0.5 μsec pulse,
  - ~10^{-4} duty cycle
- Target: π^- aborbed, π^+ stopped, μ^+ stopped
- 0.13 ν/flavor/proton
- Orland proposal: bunker near target
  - 30m H2O equivalent overburden
  - 3m of steel overburden
    - Reduces cosmics x4,
    - eliminates cosmics hadronic component



Estimates from CLEAR for SNS (Scholberg et al)

http://arxiv.org/abs/arXiv:0910.1989



46m from target

Detector has excellent n/γ discrimination if you collect enough scintillation light.

- Reject β from Ar-39
- Determines threshold

Project X Campaign

Program:	Onset of NOvA operations in 2013	Stage-1: 1 GeV CW Linac driving Booster & Muon, n/edm programs	Stage-2: Upgrade to 3 GeV CW Linac	Stage-3: Project X RDR	Stage-4: Beyond RDR: 8 GeV power upgrade to 4MW
MI neutrinos	470-700 kW**	515-1200 kW**	1200 kW	2450 kW	2450-4000 kW
8 GeV Neutrinos	15 kW + 0-50 kW**	0-42 kW* + 0-90 kW**	0-84 kW*	0-172 kW*	3000 kW
8 GeV Muon program e.g, (g-2), Mu2e-1	20 kW	0-20 kW*	0-20 kW*	0-172 kW*	1000 kW
1-3 GeV Muon program, e.g. Mu2e-2	-----	80 kW	1000 kW	1000 kW	1000 kW
Kaon Program	0-30 kW** (<30% df from MI)	0-75 kW** (<45% df from MI)	1100 kW	1870 kW	1870 kW
Nuclear edm ISOL program	none	0-900 kW	0-900 kW	0-1000 kW	0-1000 kW
Ultra-cold neutron program	none	0-900 kW	0-900 kW	0-1000 kW	0-1000 kW
Nuclear technology applications	none	0-900 kW	0-900 kW	0-1000 kW	0-1000 kW
# Programs:	4	8	8	8	8
Total max power:	735 kW	2222 kW	4284 kW	6492 kW	11870kW

* Operating point in range depends on MI energy for neutrinos.
** Operating point in range depends on MI injector slow-spill duty factor (df) for kaon program.

Project X targets

- A chance to design for detector close in?
- 1 MW, 1 GeV
- 1 MHz, 10 nsec beam width
- Can reduce duty cycle only by removing pulses, proportionally reducing power
- If enough motivation to justify expense:
  - Compressor ring
  - Full absorption target
    - More advice from Tennessee colleagues: Target is cheaper if it doesn't have to be a spallation source.
- As we improve our understanding, we can look at targets being build for other uses and see if any are suitable.

Parasitic possibilities

- Few percent duty cycle for neutrinos from pions
  - Ar-39 background: reduce x100 with depleted Argon
  - Could we deal with cosmics?
- 100% duty cycle for neutrinos from muons
- Not full absorption target. Less neutrinos/ proton, π^- not all absorbed