A Ton-Scale NaI Detector for Coherent Neutrino-Nucleus Scattering Studies
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**Coherent Elastic Neutrino-Nucleus Scattering (CEvNS) Experiment**

- A neutrino elastically scatters off a nucleus via exchange of a Z, and the nucleus recoils as a whole
- Coherent process up to $E_n \sim 50$ MeV
- Enhancement of elastic scattering cross section.
- Standard model prediction - $N^2$ cross section dependence
- Observable = nuclear recoil $< 50$ keV energy deposited

**Design and Development**

- NaI[Tl] paddle detectors being reused from Advanced Spectroscopic Portal Monitoring system
  - test detectors and characterize response
  - U Washington characterization and test procedure
- Detector location constraints (location in basement hallway of Spallation Neutron Source at ORNL)
  - maximum size 40'' (101 cm) from wall including shielding
- Shielding requirements
  - neutron shielding
  - $\gamma$-ray shielding (source from nearby pipes)
  - probably not need muon veto - inner detectors well shielded
- Low-energy recoil with high-efficiency requires high-gain refurbishment of bases for high-gain signals

**Simulations**

- MCNP and GEANT4 based simulations underway for optimizing shielding
- Use 185 kg NaI Detector to compare model to data

**Proposed Design**

- Propose modular design
- Initially 2 to 5 tons of NaI (less than 800 detectors)
- Stacks of $\sim$180 detectors
  - for $\sim$1.35 T per stack
- Pb (grey) and water (blue) shielding

**References**