**Introduction**

The Coherent Elastic Neutrino-Nucleus Scattering has been observed by the COHERENT collaboration using a 14.6-kg CsI(Tl) scintillator at Oak Ridge National Laboratory [5]. This indicates a new way to build a compact neutrino detector and unlock new channels to test the Standard Model. The main challenge is to understand the neutrino-induced low energy nuclear recoils. It is commonly known that the signals from nuclear recoils can be quenched in many types of detector, resulting in less light or ionization. This phenomenon is referred to as the “quenching factor”. It is defined as the ratio of the signal yield from the nuclear recoils to the signal yield from equivalent electron recoils with the same energy. The quenching factor highly depends on the detector materials, so different detectors require their own quenching factor measurements. The next step for the COHERENT experiment[7] is to use different nuclear targets e.g. Ar and Ge. Aside from the COHERENT experiment, many dark matter experiments (LZ[1], SuperCDMS[2], and etc.) trying to directly detect weakly interacting massive particles (WIMPs) also attempt to observe elastic scatterings between WIMPs and nuclei. In order to calibrate these detectors, a neutron beam is usually used to generate nuclear recoil signals; A new beam line has been built at TUNL in order to provide systematic and precise quenching factor measurements.

**Facilities**

The new beam line is located in the Target Room 4 and several experiments have been successfully done on this beam line with different neutron energies. The room has enough space for semi-permanent experiment installations.

**Experimental Set Up**

Low energy nuclear recoils can be mimicked by elastic scatterings with neutrons. The recoil energy is determined once the incident neutron energy and the scattering angle of the outgoing neutron are known [4]:

\[ E_{\text{recoil}} = 2E_n \left( \frac{M_n^2}{M_n + M_A} + \frac{M_A}{M_n} \right) \sin^2 \theta - \cos \theta \left( \frac{M_A}{M_n} \right) \sin 2\theta \]

Here \( E_n \) is the incident neutron energy, \( M_n \) and \( M_A \) are the neutron mass and target nucleus mass, and \( \theta \) is the scattering angle of the outgoing neutron.

**Preliminary Results**

In this measurement, we used two different neutron energies and five different frame positions to achieve ten data points in the final result. The lowest recoil energy we measured is only 0.8 keV.

**References**