Transmission measurements of metal foils for ultracold neutron applications with a monochromatic neutron beam

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The TRIUMF Ultracold Advanced Neutron (TUCAN) collaboration has been formed to build a high-intensity UCN source at TRIUMF and to perform a measurement of the neutron electric dipole moment (nEDM) [1]. The nEDM is closely related to CP (charge-parity) symmetry and is a crucial observable for understanding the origin of the matter-antimatter asymmetry of the universe. Some of the key components of the nEDM spectrometer, such as UCN detectors and spin analyzers, require thin metal foils that UCNs must traverse. Measurements of the transmission of the metal foils planned for use in these components are therefore of interest.

During FY2024 and FY2025, experiments were conducted to measure the transmission of some of these foils using monochromatic cold neutrons from the JRR3 MINE2 port at a wavelength of 0.88 nm. The experiment used a simple setup, as shown in Figure 1. By varying the incident angle θ of the beam relative to the foil surface, the effective thickness ($\propto 1/\sin\theta$) was controlled. Prior to the measurement, the incident angle was calibrated using a multilayer supermirror.

The results are presented in Figure 2. The transmission T was fitted to a theoretical model

$$T = T_0 \exp(-\alpha t)\,.$$

The measured samples include 0.1 mm thick Al foils that are planned to be used for UCN spin analyzers, and a 0.1 mm thick $AlMg_3$ (Al: 97%, Mg: 3%) foil for UCN detectors. The Ni foils and Si wafer were also measured as references. This setup can be used for further testing of other nEDM spectrometer components.

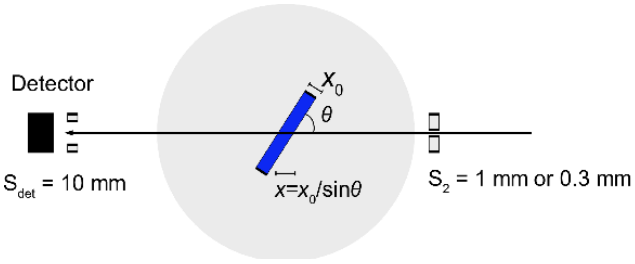

Figure 1 Setup of the transmission measurement. Using the θ-2θ stages at MINE2 beamline for neutron reflectometry, the incident angle of monochromatic neutrons to the foil surface was set.

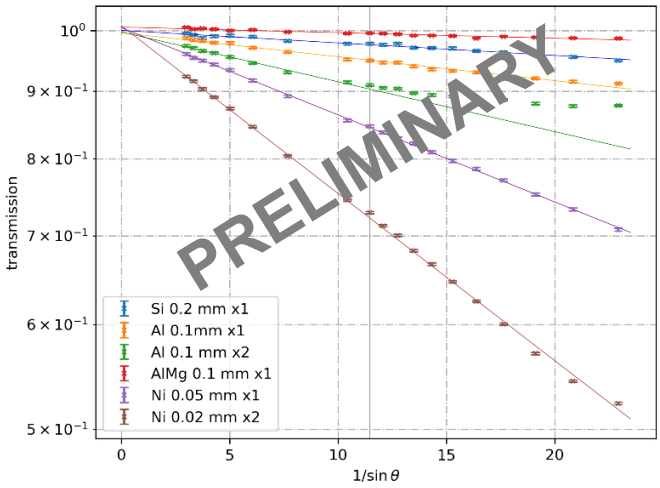

Figure 2 Results of the transmission measurements of different metal foils samples. For the data of two 0.1-mm thick Al foils stacked together, the data was fitted to the model in a range of θ > 5° because the second layer of the Al foil was suspected not to be aligned to the first one.

[1] B. Algohi et al., Phys. Rev. C **114**, L012501 (2026).

[2] T. Higuchi et al., J. Phys. Soc. Jpn. **93**, 091009 (2024)