mRICH Homework

mRICH Team, March 21, 2023

- **Provide transmission curves, clarity, radiation hardness, and any information on the properties of the fresnel lens and the aerogel from beam tests and optical bench tests.**

  The Fresnel lens for mRICH is from Edund Optics (`https://www.edmundoptics.com/p/67quot-x-67quot-6quot-focal-length-fresnel-lens/2434/`). The lens geometry and its transmission are shown in Fig. 1.

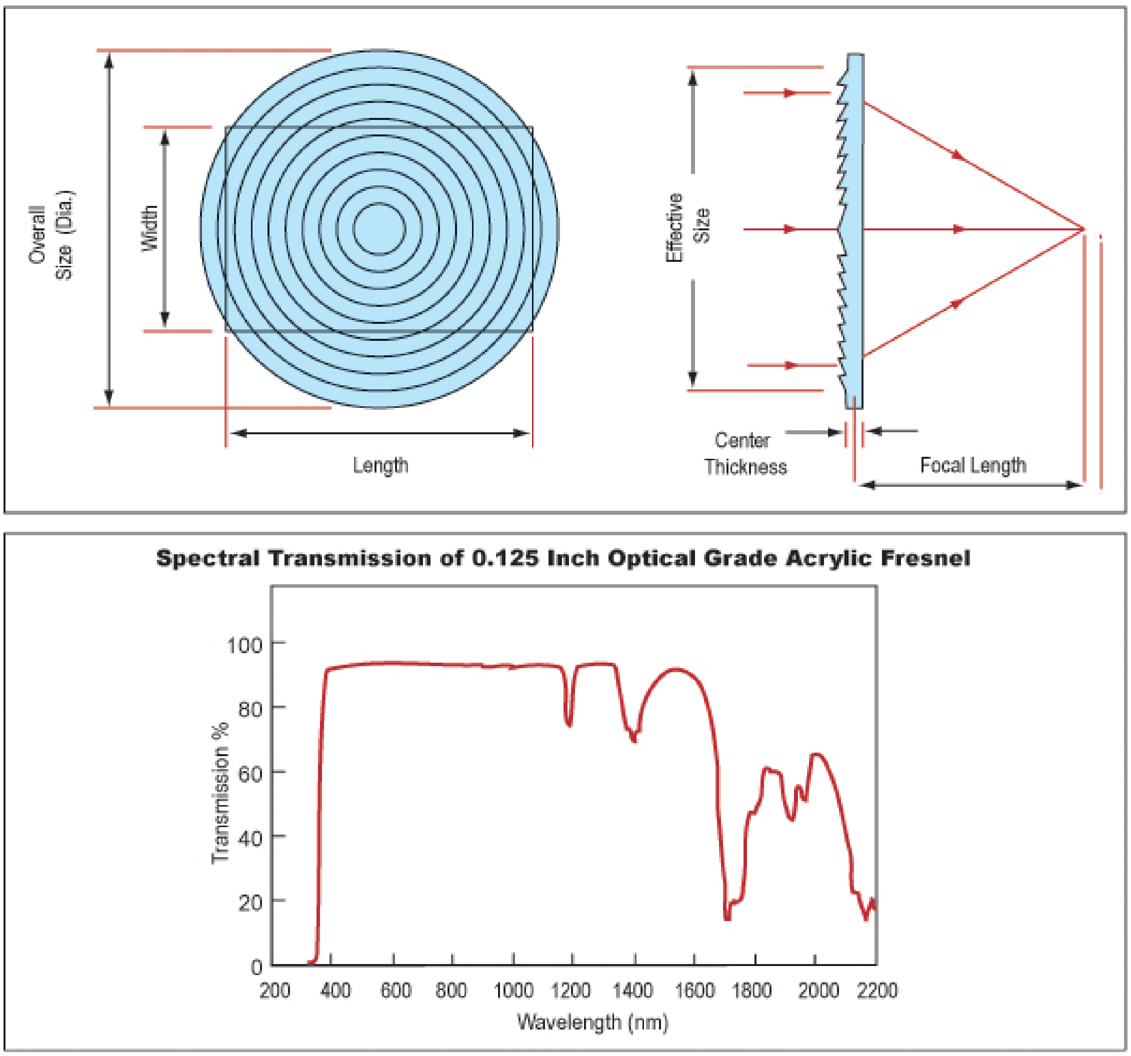

Figure 1: 6-inch Fresnel lens from Edmund Optics. The transmission plot also shows the UV-photon filtering, a design feature of mRICH.

The study of the radiation hardness of Fresnel lens was carried out in spring 2019 at BNL using ^{60}Co source by Greg Kalicy (an expert on DIRC detector). The results are shown in Fig. 2.

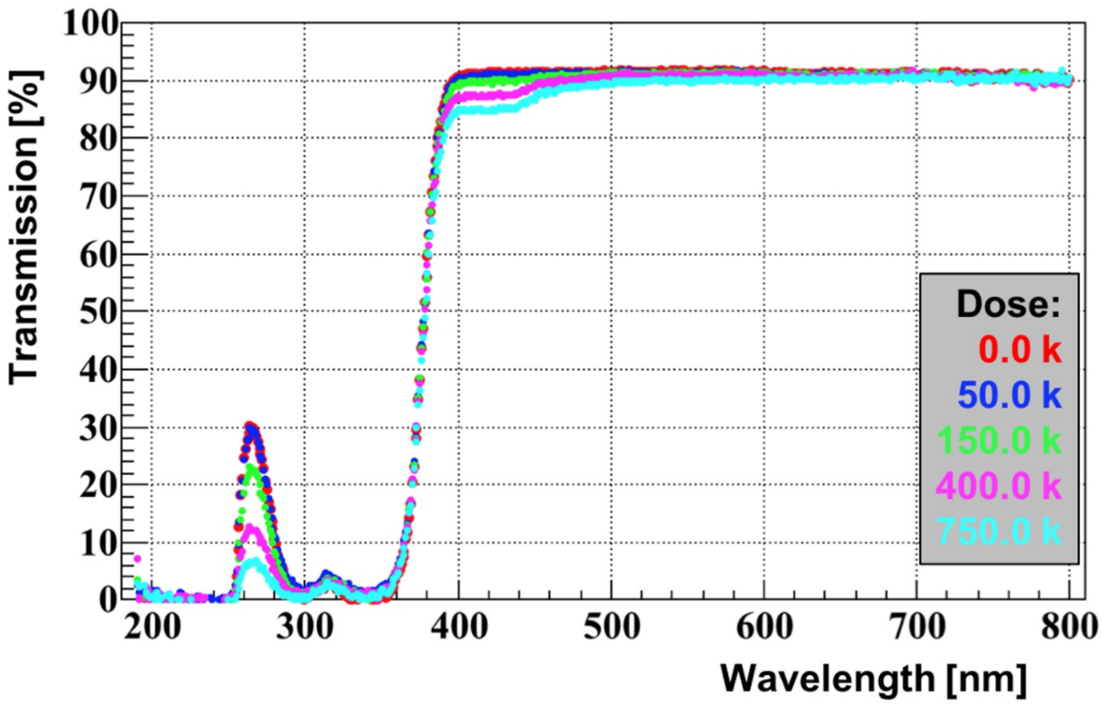

Figure 2: Radiation hardness test of 2 mm-thick acylic mRICH lens sample. A small drop of transmission was observed below 500 nm. This material seems surprisingly radiation hard even after a dose of 750 kRad.

The radiation damage to lens is simply not an issue. The ionization radiation dose and neutron flux from the EIC collisions have been documented in the Yellow Report. A screen capture of the report is shown in

- **Is there detailed or quantitative information about the effect that the photon's incident angle with respect to the fresnel lens has on its performance (e.g. focusing quality, photon losses)?**

  The lens optical properties were studied extensively in the early days (in 2015 and 2016) of the mRICH development. An example of its focusing property is shown in Fig. 4 from an early version of the mRICH GEANT4 simulation. It has been demonstrated in all three beam tests that our description of the lens properties has been properly implemented in GEANT4 simulation.

  A dedicated lab for detailed optical characterization of Aerogel and lens was recently made available for the Nuclear Physics Group at Georgia State University.

- **Are the proponents open to using a different aerogel?**

  There will be a detailed discussion of the Aerogel options that mRICH is considering. Our baseline choice is 10cm x 10cm x 4cm with $n \sim 1.03$.

10.4.1 Ionization radiation dose and neutron flux from the EIC collisions

The ionization radiation dose and neutron flux from the e+p collisions are studied using EICROOT and a generic EIC detector model in the RHIC IP6 experimental hall. The simulation is generated with the EIC tune of PYTHIA6 with 20×250 GeV beam energy and is based on the GEANT3 package with the $HADR = 5$ option. As shown in Figure 10.7, the near-beam-line regions experience relatively high ionizing radiation. For example, the crystal calorimeters in the backward arm show approximately 2.5 kRad/year max ionizing radiation dose from the e+p collisions at the top luminosity (10^{34} cm^{-2}s^{-1}). The above-100 keV neutron flux is shown in Figure 10.8. The near-beam-line regions, in particular the vertex tracker and the forward-backward calorimeters also experience relatively high neutron flux, exceeding 10^{10} neutrons/cm^2 per year from the e+p collisions at the top luminosity (10^{34} cm^{-2}s^{-1}).

Figure 3: Ionizing radiation dose and neutron flux from EIC collision.

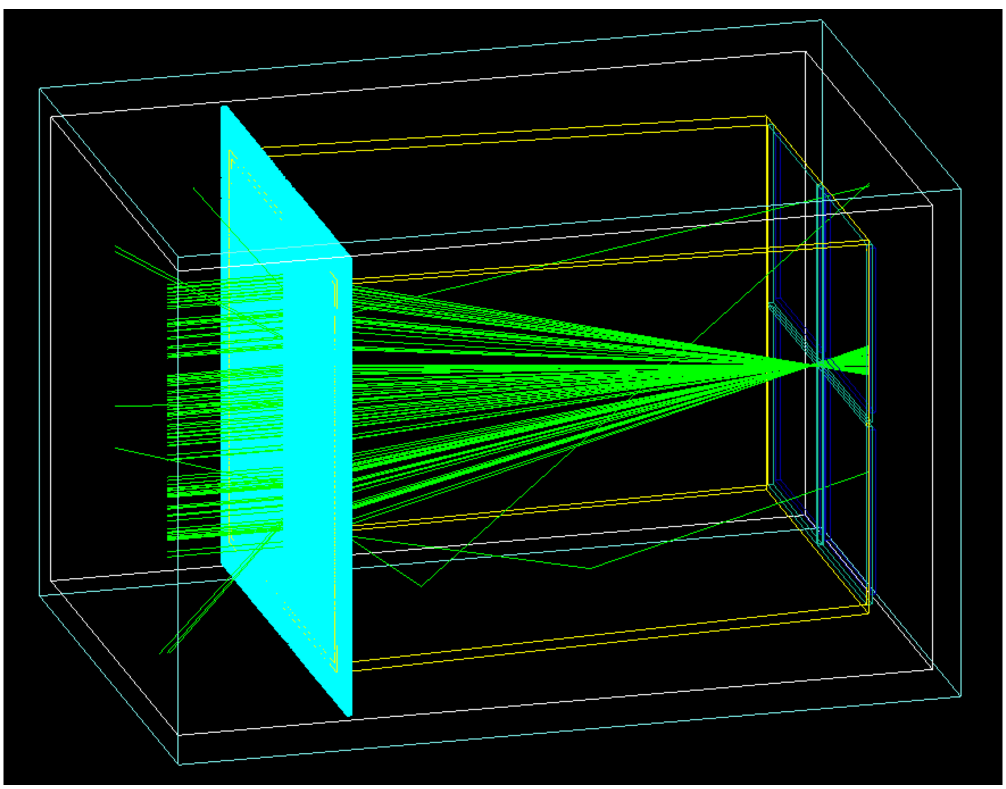

Figure 4: Focusing property of the lens (6-inch). A parallel array of optical photons get focused at the focal plane.

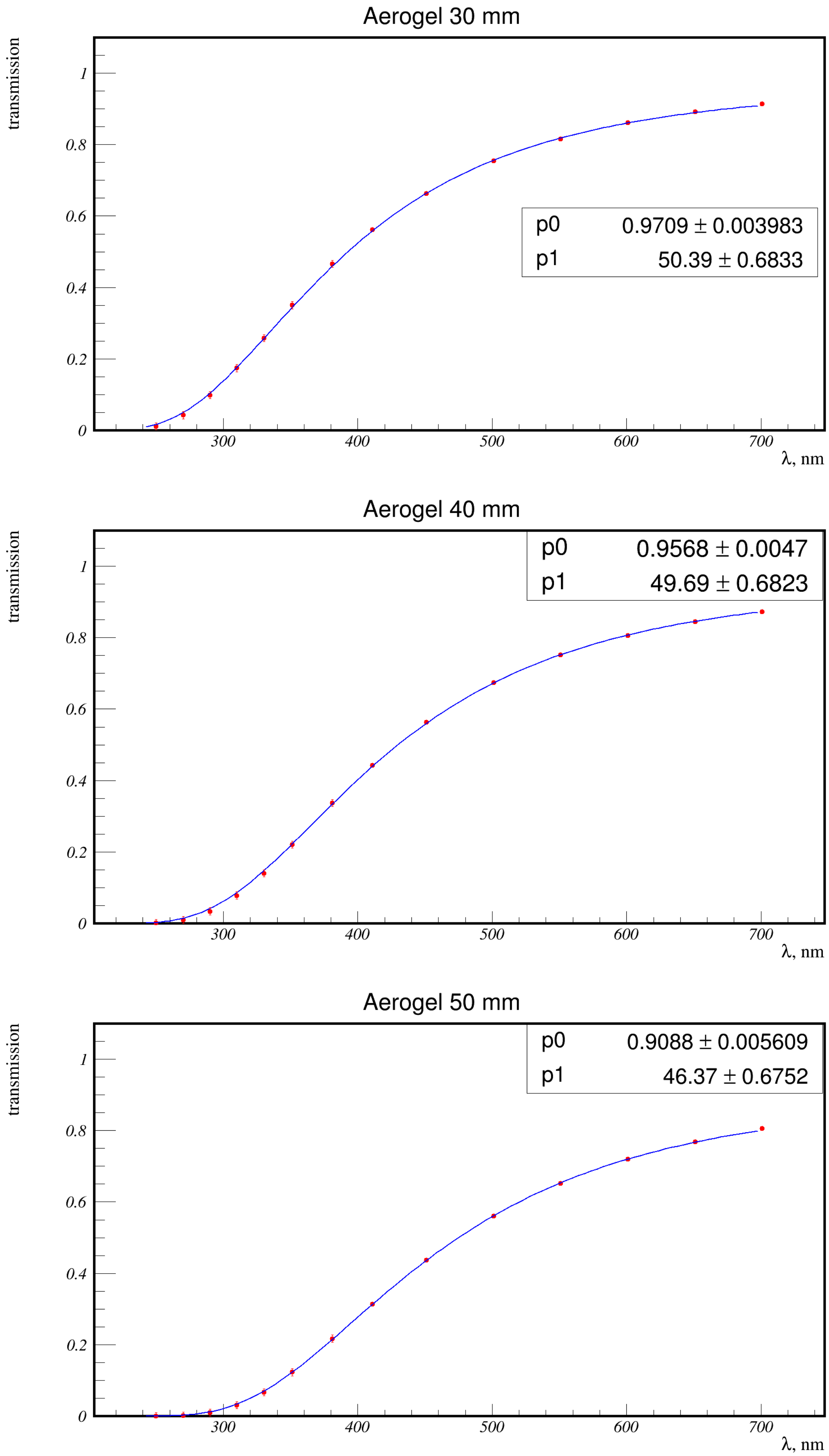

Figure 5: Raleigh scattering length measurement for Aertogel tiles of 3cm, 4cm, and 5cm thickness.