ABSTRACT
EMPHATIC (Experiment to Measure the Production of Hadrons At a TestBeam in Chicagoland) is a low-cost, table-top-sized, hadron-production experiment located at the Fermilab Test Beam Facility (FTBF) that will measure hadron scattering and production cross sections that are relevant for neutrino flux predictions. High statistics data will be collected using a minimum bias trigger, enabling measurements of both interacting and non-interacting cross sections. Particle identification will be done using a commercial high gas hybrid ring imaging Cherenkov (RIC) detector, a time-of-flight (ToF) wall, and a lead glass calorimeter array. The ARICH focuses on the kaons, pions and protons separation with multi-track capability up to 8 GeV/c. Here we show the study of performance and implementation of optical reflectors in the ARICH system for phase 1 of the experiment to reflect Cherenkov light outside of the PMT array acceptance onto the PMT array increasing the angular acceptance of the experiment with a low-cost improvement.

INTRODUCTION
Neutrino experiments use realistic simulations of production beam lines to predict neutrino flows and spectra and a necessary component is modeling of hadron production and interactions in the production target and beam line material like magnetic horns, decay volume walls, etc. Uncertainties on hadron interaction modeling typically dominate the total error on the neutrino flux prediction, these measurements are also important for atmospheric neutrino flux calculations. EMPHATIC will focus on measurements with beam energies below ~15 GeV which are not currently accessible in NA61/SHINE. The geometry of the simulation is represented in the Figure 2. The particles are produced from a point source with a given direction and momentum. The first of two layers of aerogel radiator are 33 cm downstream from the particle source. Each layer consists of one piece of aerogel measuring 14 cm x 14 cm x 2 cm. An array of PMTs are placed 21 cm downstream from the front of the first layer of aerogel. The simulation will consist of a large sensitive volume. The section of the PMT volume matches the current design of PMTs array with 20 x 20 cm. The PMT Quantum efficiency was considered to correct the results to be realistic to what the hardware can detect.

RESULTS
As a first analysis we should look the wavelength distribution generated by the aerogel radiators. The distribution is shown in Figure 4. Characteristic of the Cherenkov radiation, we see that the spectrum generated by the aerogel tends towards the low wavelength (high energy) region. However, with the existence of the Rayleigh scattering effect that happens inside the aerogel we see how the distribution changes due to the scattering of the low wavelength photons being more prominent.

CONCLUSION
We note that the contribution of photons with short wavelength is more important for the choice of mirrors, we see that the Cherenkov radiation spectrum is more prominent in this range, which shows that the material that has greater reflectance in this region will have a better efficiency as evidenced in Figure 6. However, light scattering is an undesired effect since these photons do not have the correct momentum direction for the PID. When comparing the ratio between scattered and non-scattered light we see an inversion between the materials showed in Figure 7.

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