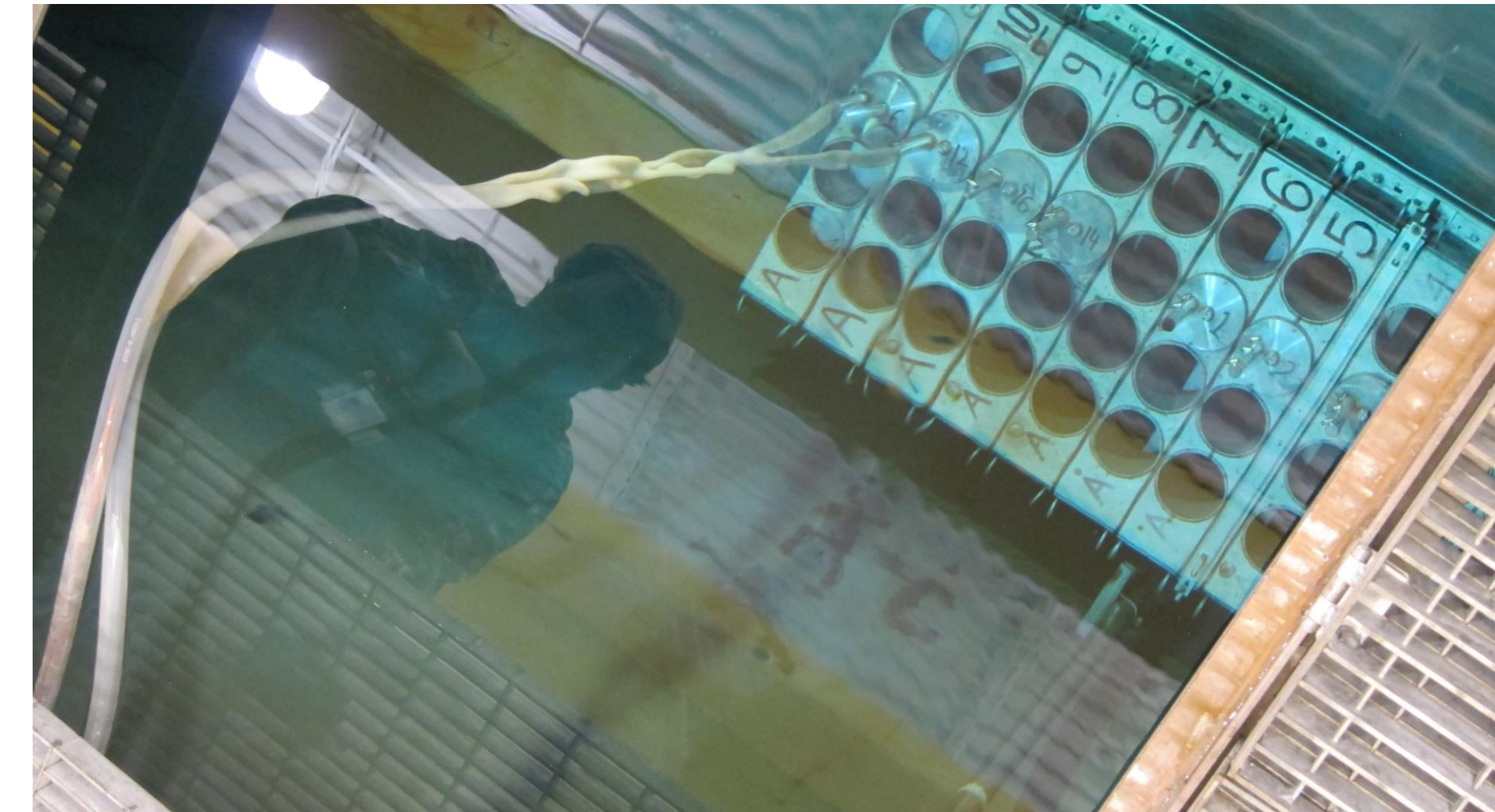
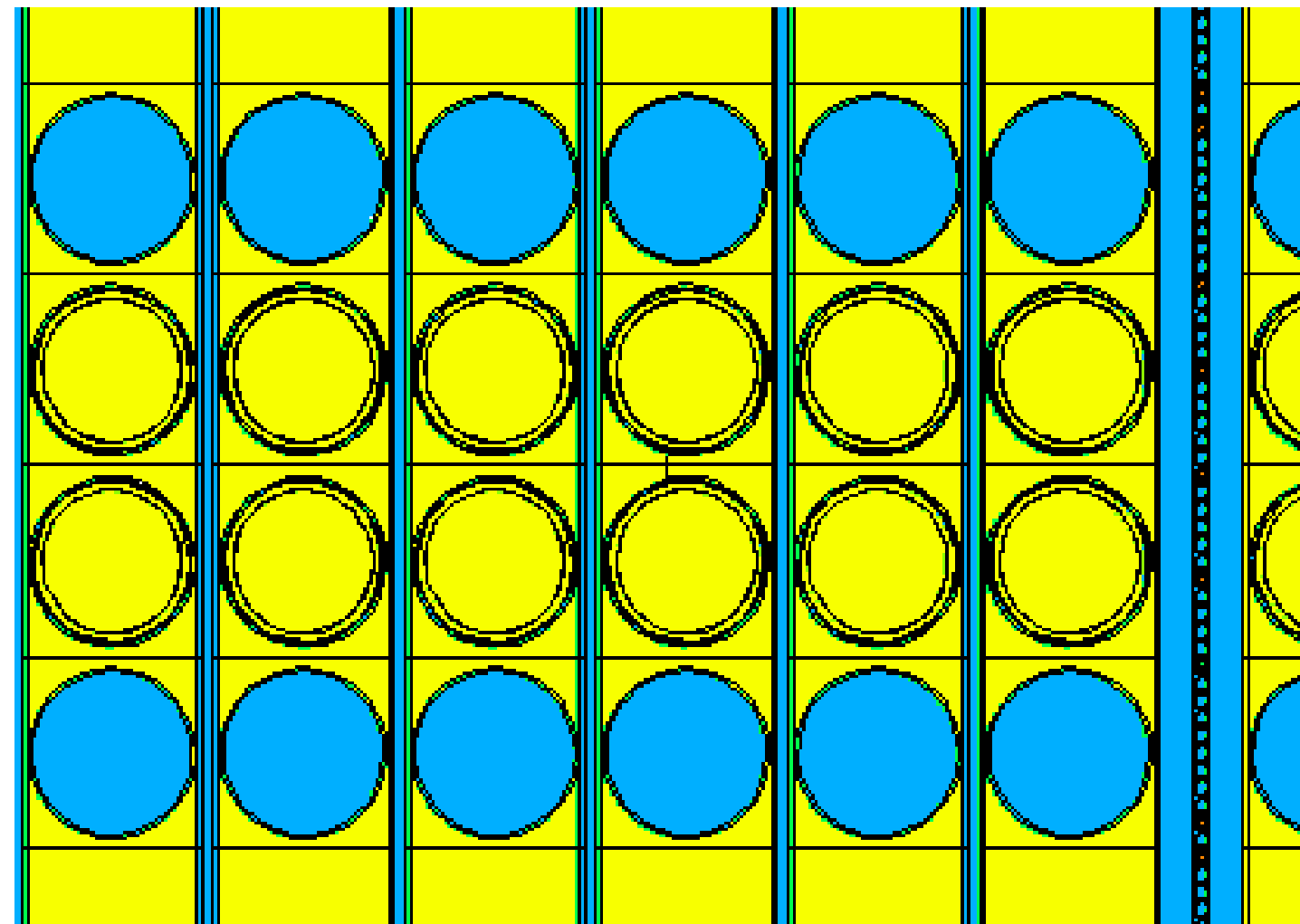
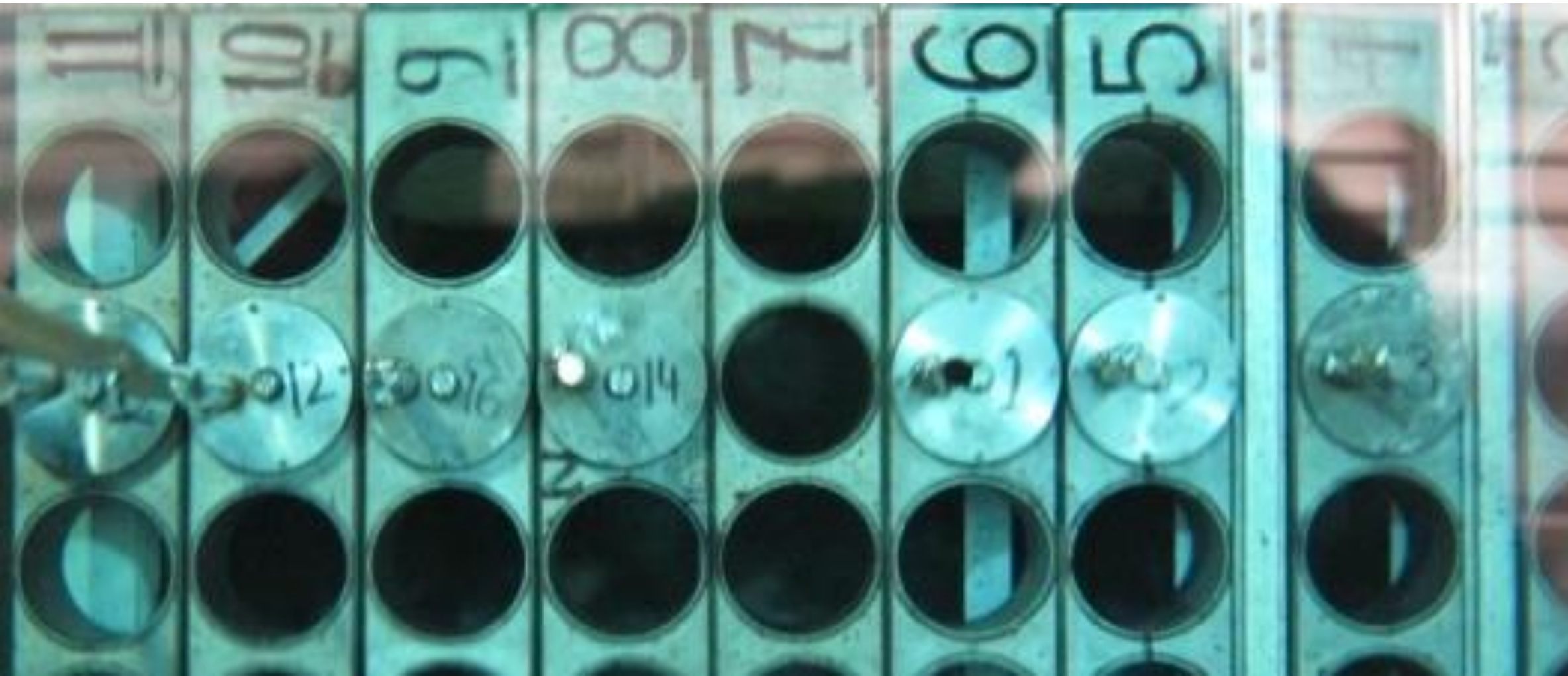


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Estimating Dose Rates and Photon Energy Spectra In Sandia's Low Intensity Cobalt Array

Introduction

The Gamma Irradiation Facility (GIF) and Sandia National Laboratories uses the underwater irradiation structure called the Low Intensity Cobalt Array (LICA) for irradiations of various experiments. The goal of this research was to determine energy-dependent photon flux densities and corresponding dose rates at various possible experiment locations within the LICA. Due to the array's position on the bottom of an 18-foot pool of water, measurements are impractical outside of TLD dosimetry. By modeling the LICA using Monte Carlo N-Particle code (MCNP6) and comparing it to measured TLD absorbed dose values, the dose rates and energy spectra can be estimated within the LICA.

Modeling the LICA

Using drawings and measurements of the LICA, the geometry of the structure was created using transformations of rectangular parallelepipeds (RPPs) and corresponding transformation cards. Two rows of Co-60 source pins were modeled as separate rectangular arrays with two universes designated as empty pins and source pins. The same was true for the cans (designed to hold the samples being irradiated), which currently have two universes, empty spaces and empty cans. The empty can universe can be altered to include different materials in the future. With the exception of cobalt and water, all the materials in the array are steel or an aluminum alloy. The dose rate tallies were done by modeling a CaF₂:Mn TLD and using F6 energy heating tallies. The dose rate can be time corrected easily by using the exponential decay equation. The energy spectra were obtained by taking F5 volume flux tallies in the innermost cell of the can (the actual 'inside' of the empty can) and normalizing them over the net flux in the can.

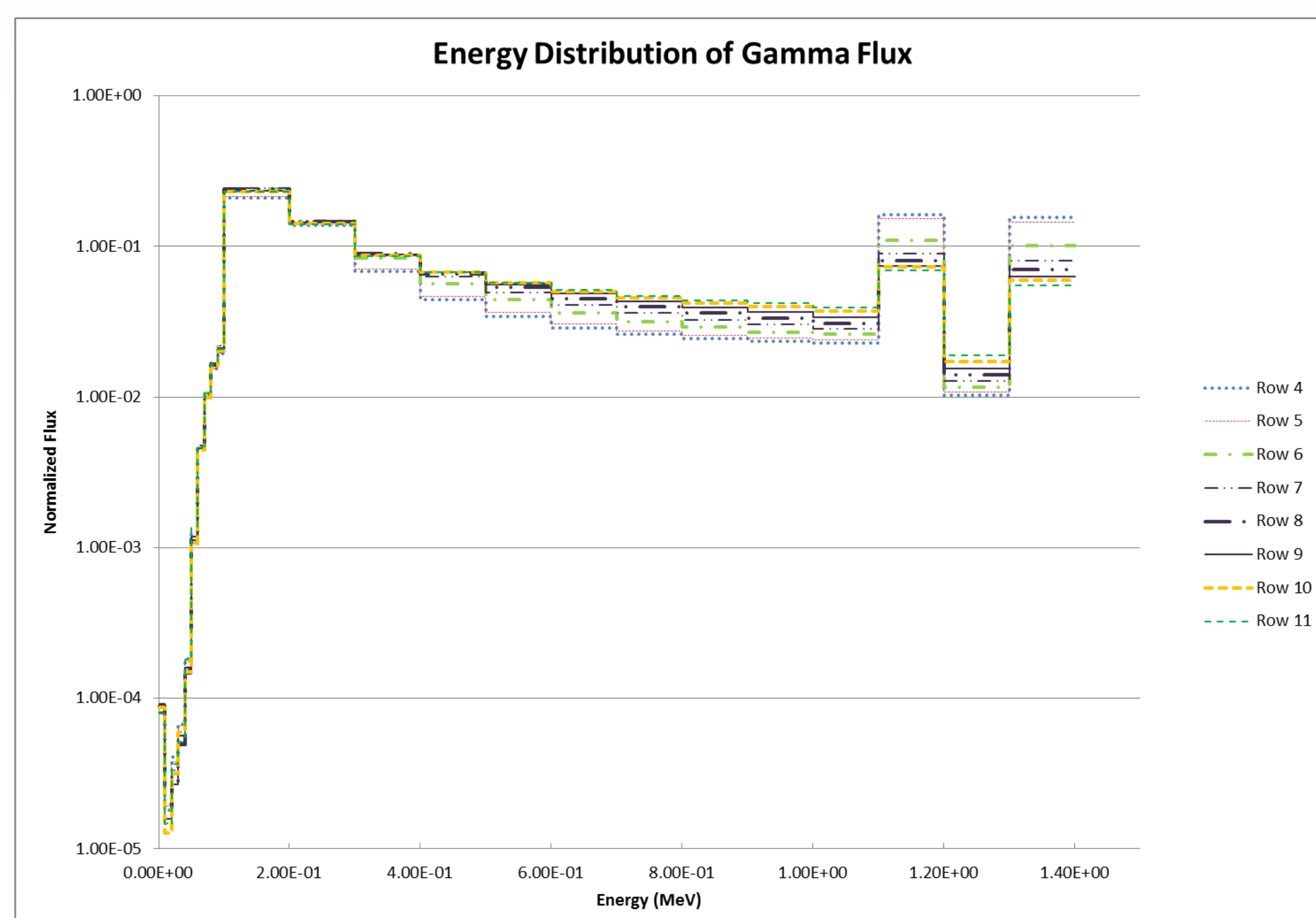


Figure 1: Energy Spectra in Can B of each row

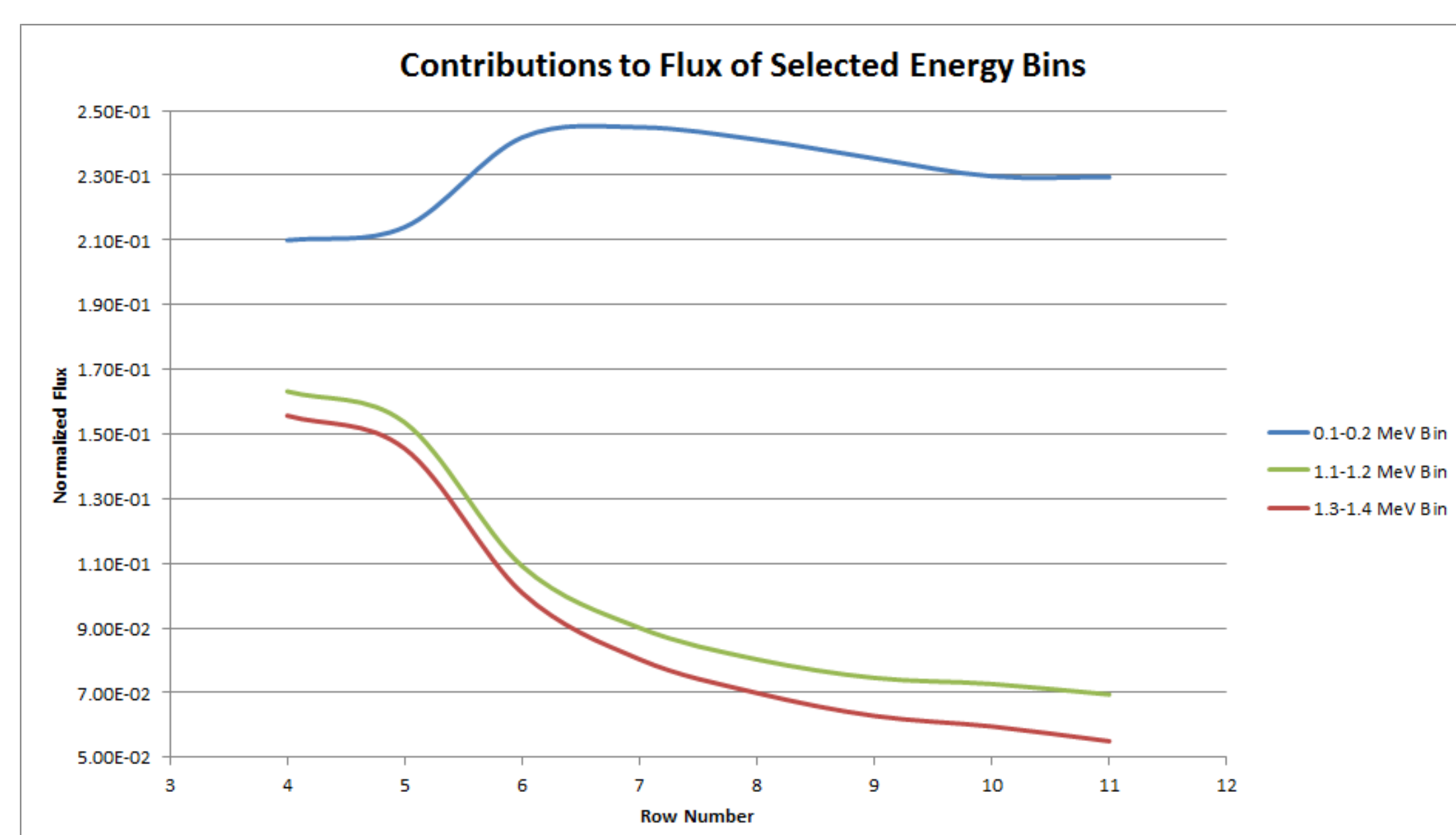


Figure 2: Normalized Flux in selected energy bins

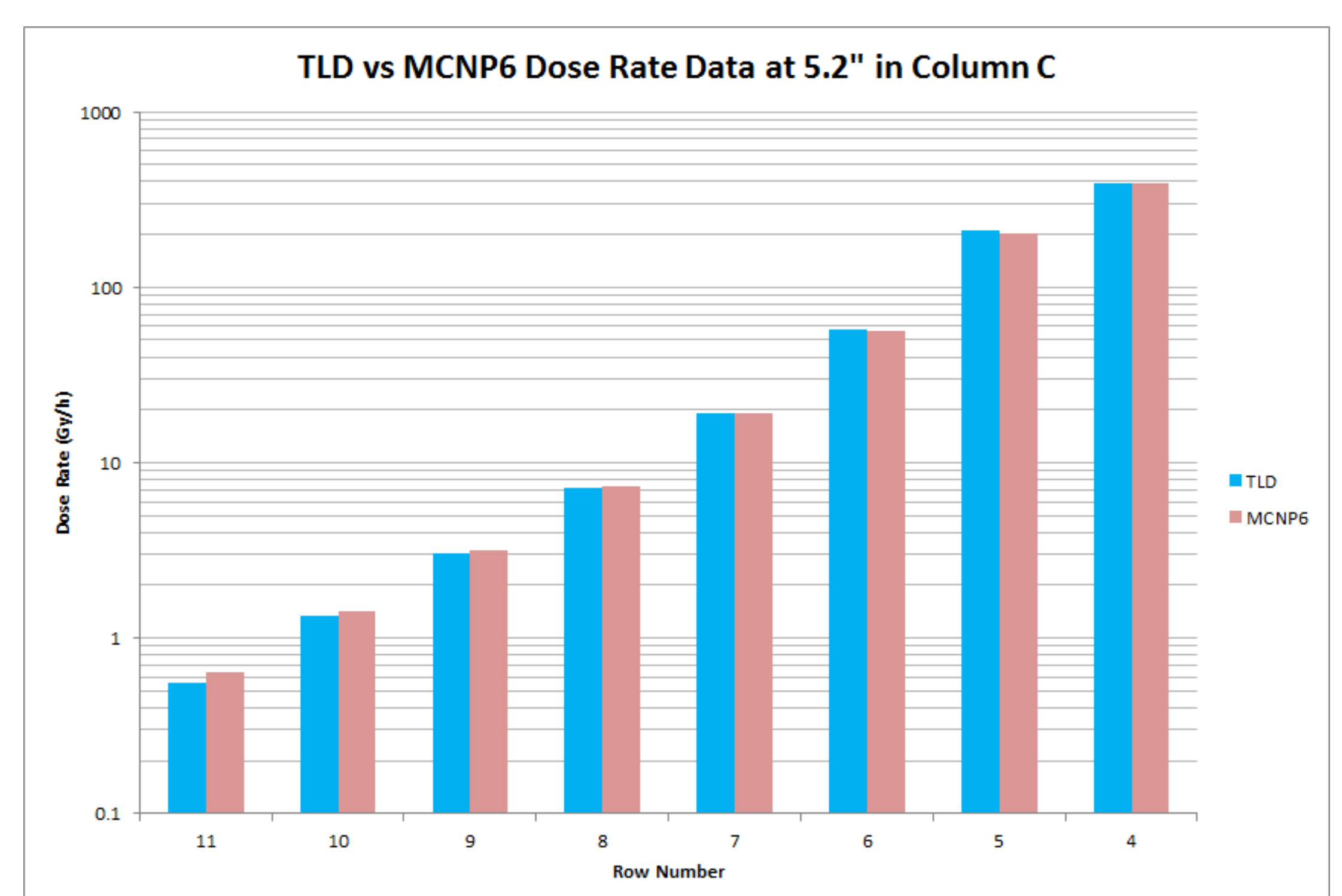


Figure 3: Dose Rate data

Results

Figure 1 was generated using the flux tallies in discretized energy bins. Most of the contribution to flux comes from the initial energy gammas (1.1732 and 1.3325 MeV) and scattered gammas down to about 100 keV, as expected. Low energy gammas (1-100 keV) provide relatively little contribution to the gamma flux. This figure shows that the positions that receive lower dose rates still receive most of their dose from higher energy photons. Figure 2 shows how the contribution to the net flux of gammas in certain energy ranges changes with distance from the sources. The MCNP6 dose rate data closely mirror the data from CaF₂ TLDs as shown in Figure 3, meaning the model is accurate and can be expanded to include other materials.

Nathan H Hart - nhart@sandia.gov