



Attila Code-to-Code Comparison Gamma Scatter through a Labyrinth with a Bulk Shield

Introduction

A shielding calculation was performed with both Monte Carlo (MCNP) and Attila. An isotropic Co^{60} gamma point source was located at one end of a U-shaped labyrinth lined by iron walls on the outside. The dose was calculated at three points on the far side of the aluminum shield. Attila and Monte Carlo calculations generously provided by Richard Haley of Nuclear Technologies, Plc. (www.nuclear.co.uk).

Problem Summary

Figure 1 illustrates the model geometry. The model consists of a u-shaped labyrinth, with a 10 cm thick iron wall of density 7.6 g/cc bounding the $-x$ and $-y$ sides of the labyrinth. The overall size of a bounding box surrounding the labyrinth model is $100 \times 100 \times 50 \text{ cm}^3$. The interior of the labyrinth (red in Figure 1) is modeled as void. The labyrinth is 50 cm high in the z -direction (into the page in Figure 1), with a specular reflecting boundary condition applied at the $z = -50 \text{ cm}$ plane, effectively making the labyrinth 100 cm high. Vacuum (non-reentrant) boundary conditions are applied on all other external surfaces. An isotropic Co^{60} gamma source point source is located at coordinates of $x = -25$, $y = 30$, and $z = -50 \text{ cm}$ (on the specular reflecting boundary plane). The dose is calculated at 3 points on the opposite side of the labyrinth, having coordinates of $(x, 80, -50)$, where x was -30 , -20 , and -10 for points 1, 2, and 3, respectively. The dose throughout the entire void region behind the shield, which encompasses the 3 points, was also calculated.

The model geometry is such that particles can only reach the dose points by first scattering off the iron shield on both the $-x$ and $-y$ sides of the labyrinth, then passing through the aluminum shield. As such, contribution of the unscattered (primary) gammas to the dose is zero.

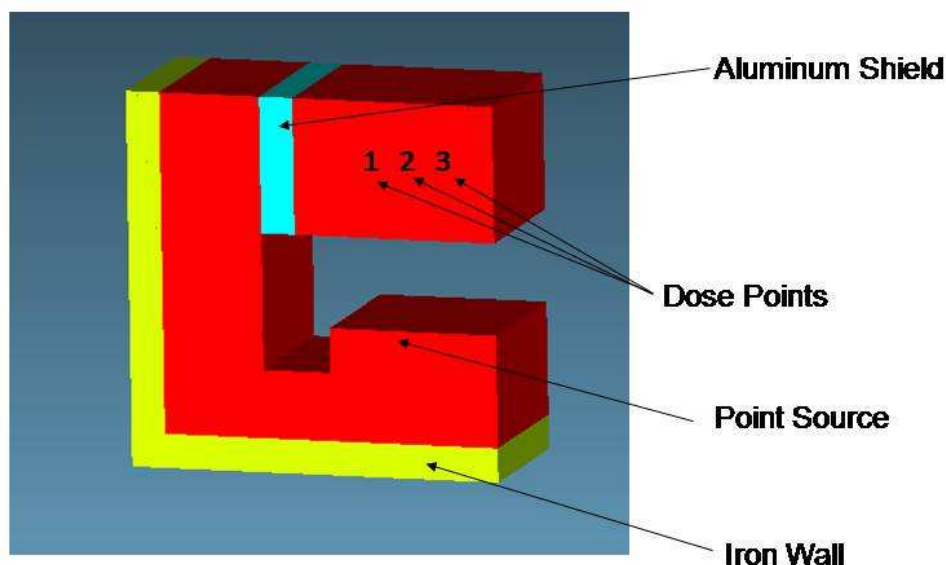


Figure 1: Model geometry.

The source is an isotropic volume source from Co^{60} gamma emission, with chi values of 0.99 and 1.0 for energies of 1.33 MeV and 1.17 MeV, respectively.

Attila Calculation Summary

The Attila computational mesh contained approximately 3,500 elements. Since four spatial unknowns are solved in each tetrahedral element, this equates to approximately 14,000 spatial degrees of freedom. Mesh layering was



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performed in both the iron and aluminum shields to provide a higher mesh resolution in the directions normal to the wall surfaces. The Transpire46g cross section set was used for the calculation, which is a 48 group gamma cross section set created using CEPXS. 25 energy groups were used in the calculation, which included all fine-groups below 1.35 MeV, the highest source energy. The Triangular Chebychev Legendre quadrature set was used with an S_{16} quadrature order. The scattering order for the calculation was P_4 .

The dose was obtained at the 3 points shown in Figure 1 using the ICRU-57 (ICRP74) flux-to-dose conversion factor for both Attila and MCNP. Attila results were calculated at points with the use of the last-collided method, which semi-analytically transports the last scattered flux to the associated edit points.

Since a point source was used, the Attila calculation was performed through the first scattered distributed source (FSDS) capability. Through the FSDS feature, the uncollided and collided (scattered) components of the solution are separately calculated, then merged to obtain the total flux solution. However, since only the collided component is of interest in this calculation, the merge step was deactivated and post processing was only performed on the collided component.

Results

A section plot of the scattered gamma flux is provided in Figure 2.

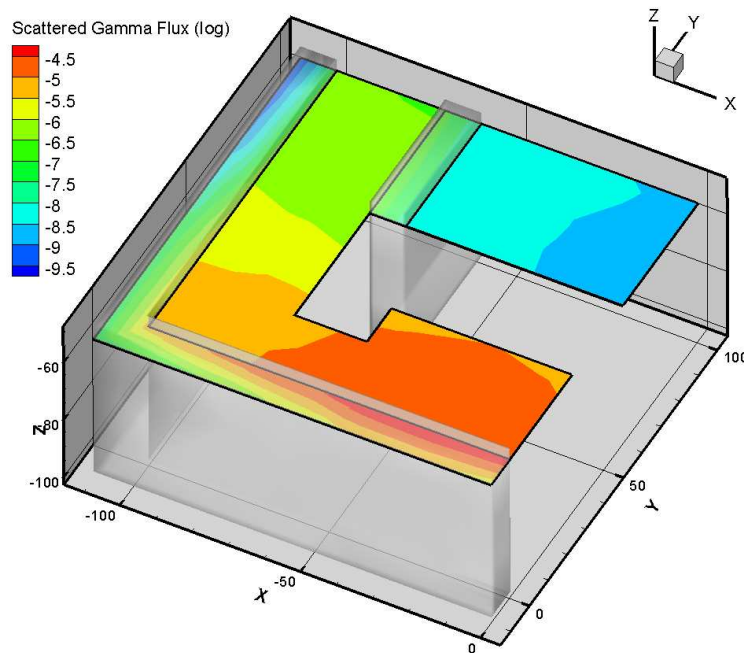


Figure 2: Scattered gamma flux (log).

Location	Results		
	MCNP	Attila	MC/Attila
Point 1	5.5e-12	5.69e-12	0.97
Point 2	4.10e-12	4.24e-12	0.97
Point 3	3.14e-12	3.26e-12	0.96

Table 1: Point dose results, including comparison between Attila and MCNP. Dose is in units of microSv/hr for a total source strength of 1 particle/second.