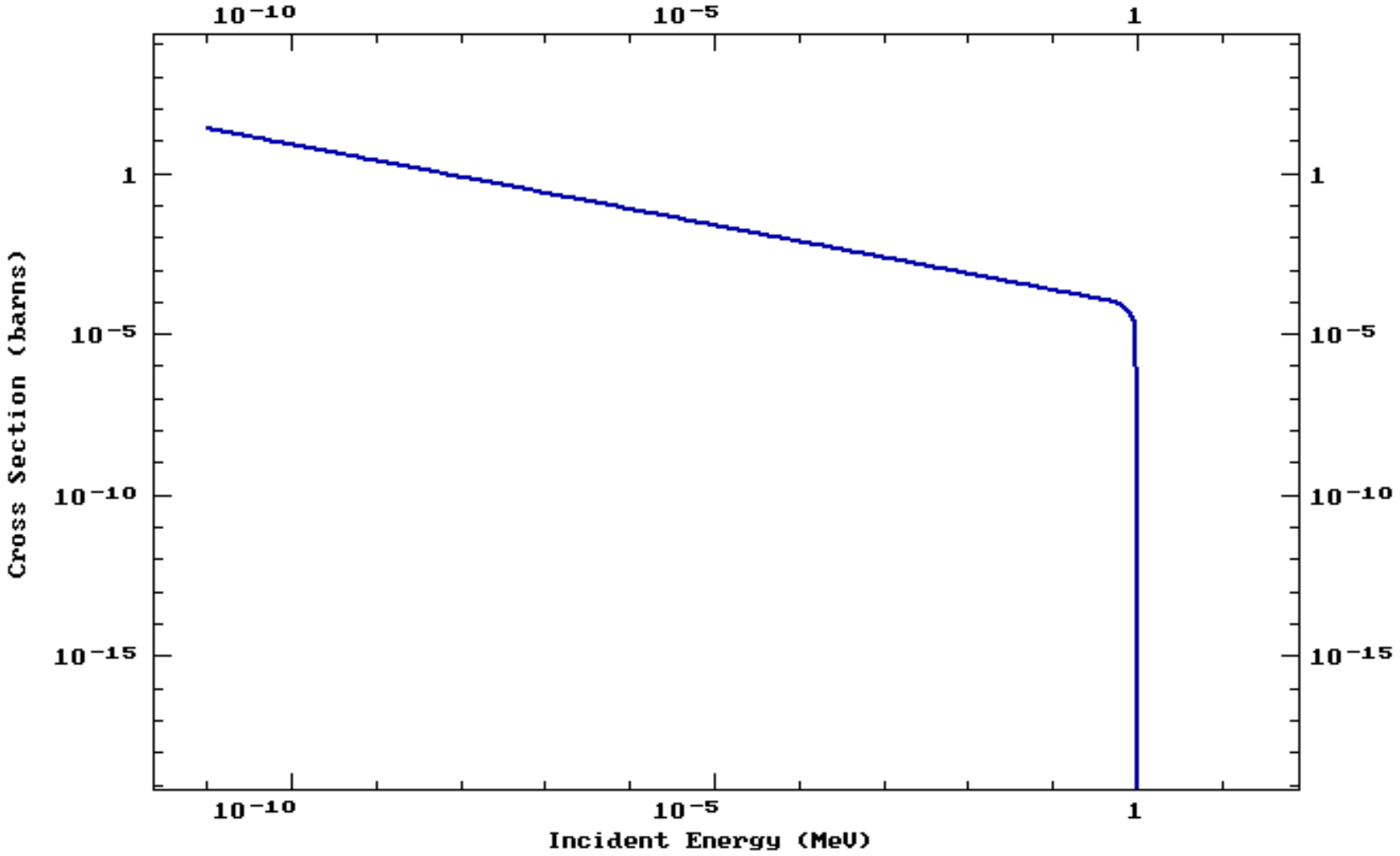
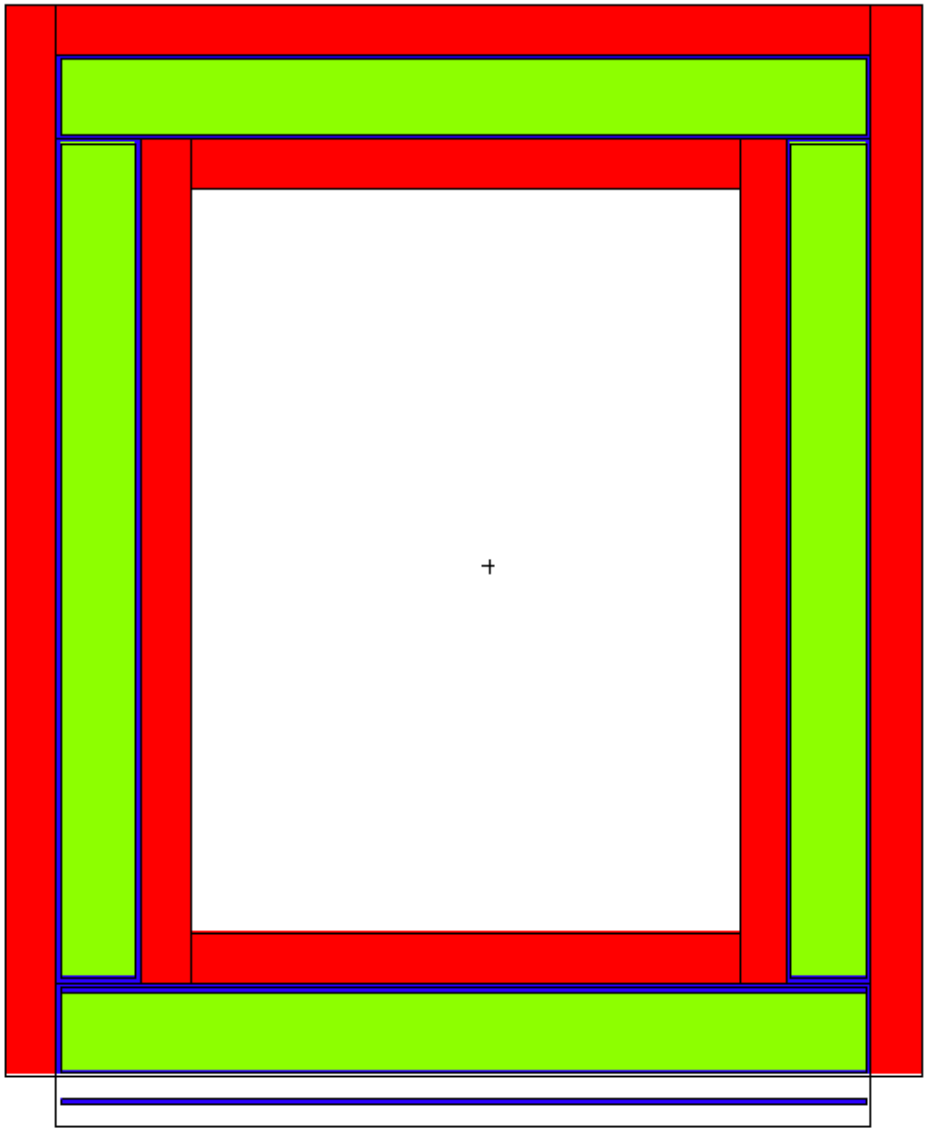
Monte Carlo Simulation for Reactor Anti-Neutrino Detector Shielding

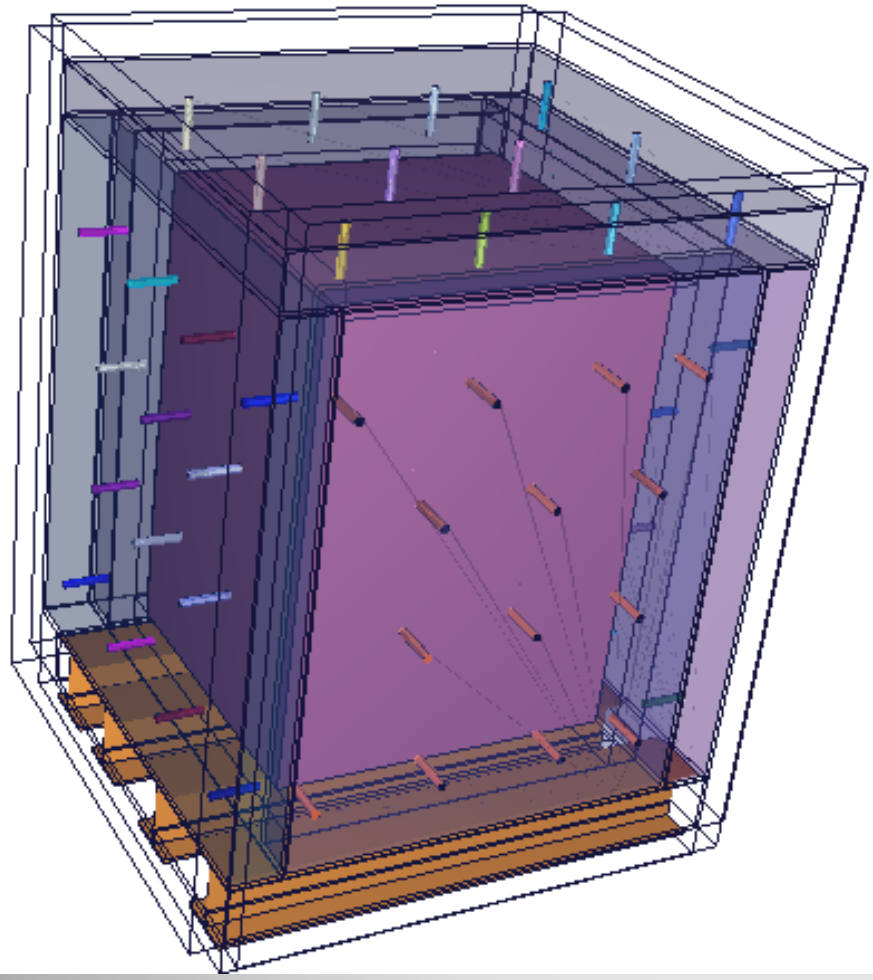
Jacob Siegel

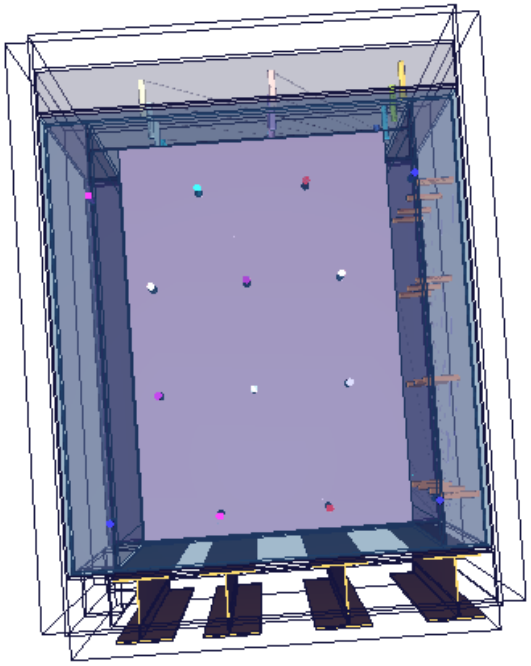


What is the Mini Time Cube



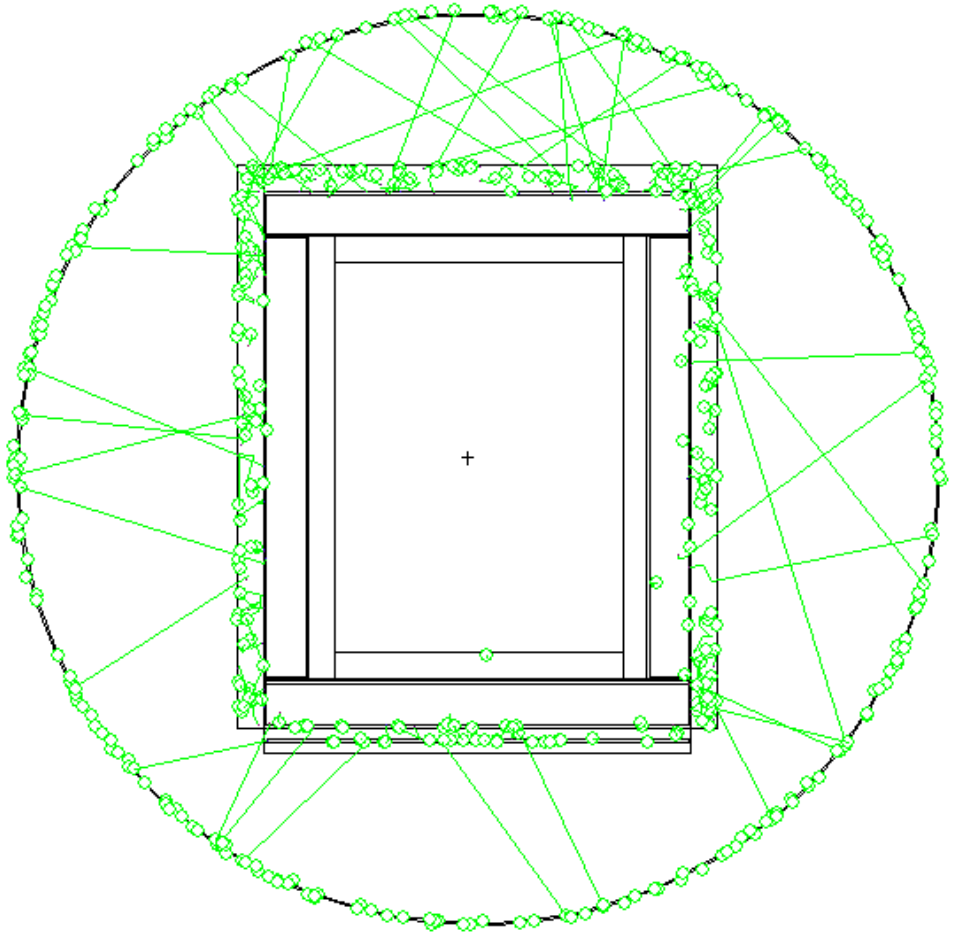
Red = Borated Poly
Green = Steel Shot in wax
Blue = A36 Steel



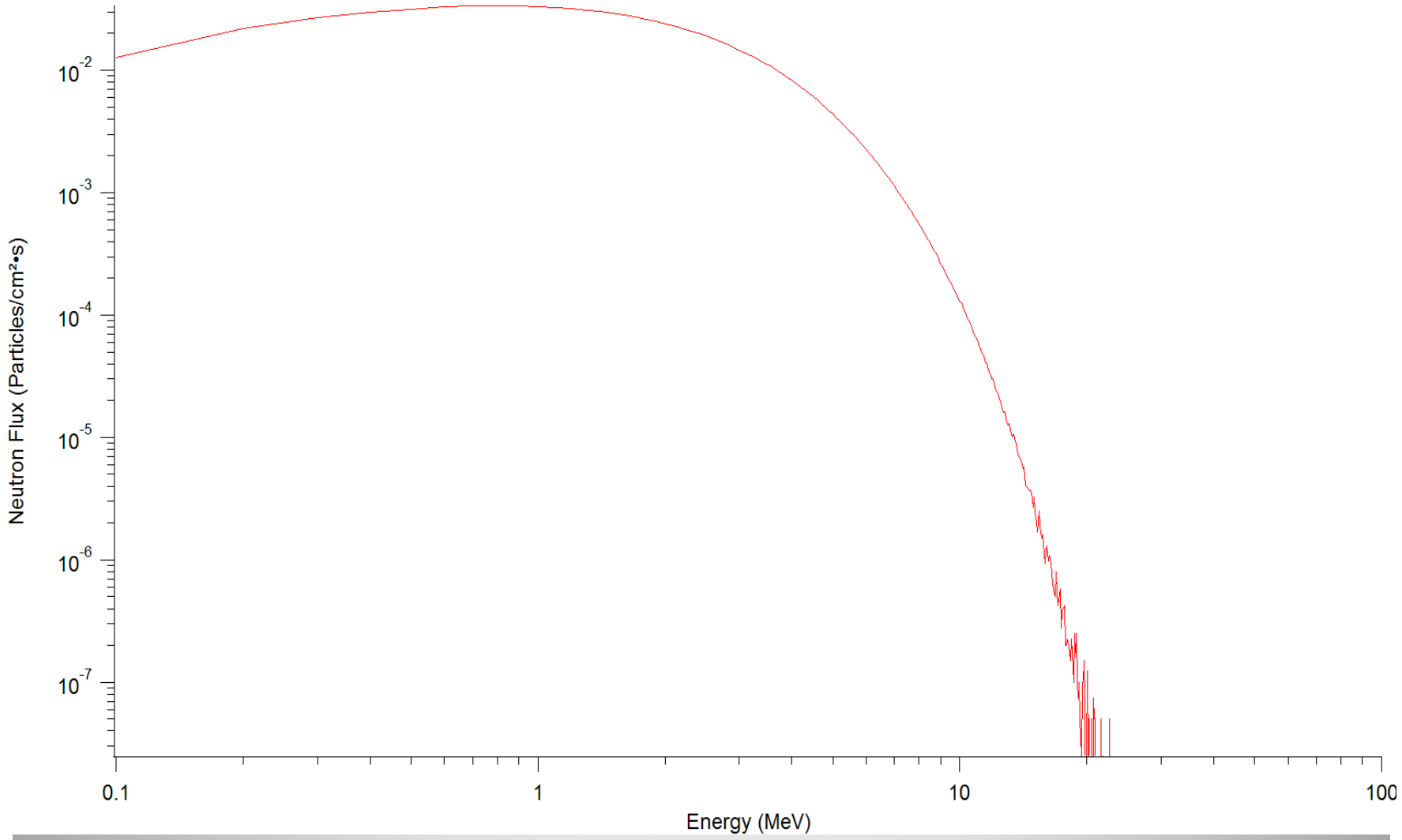


3D Model

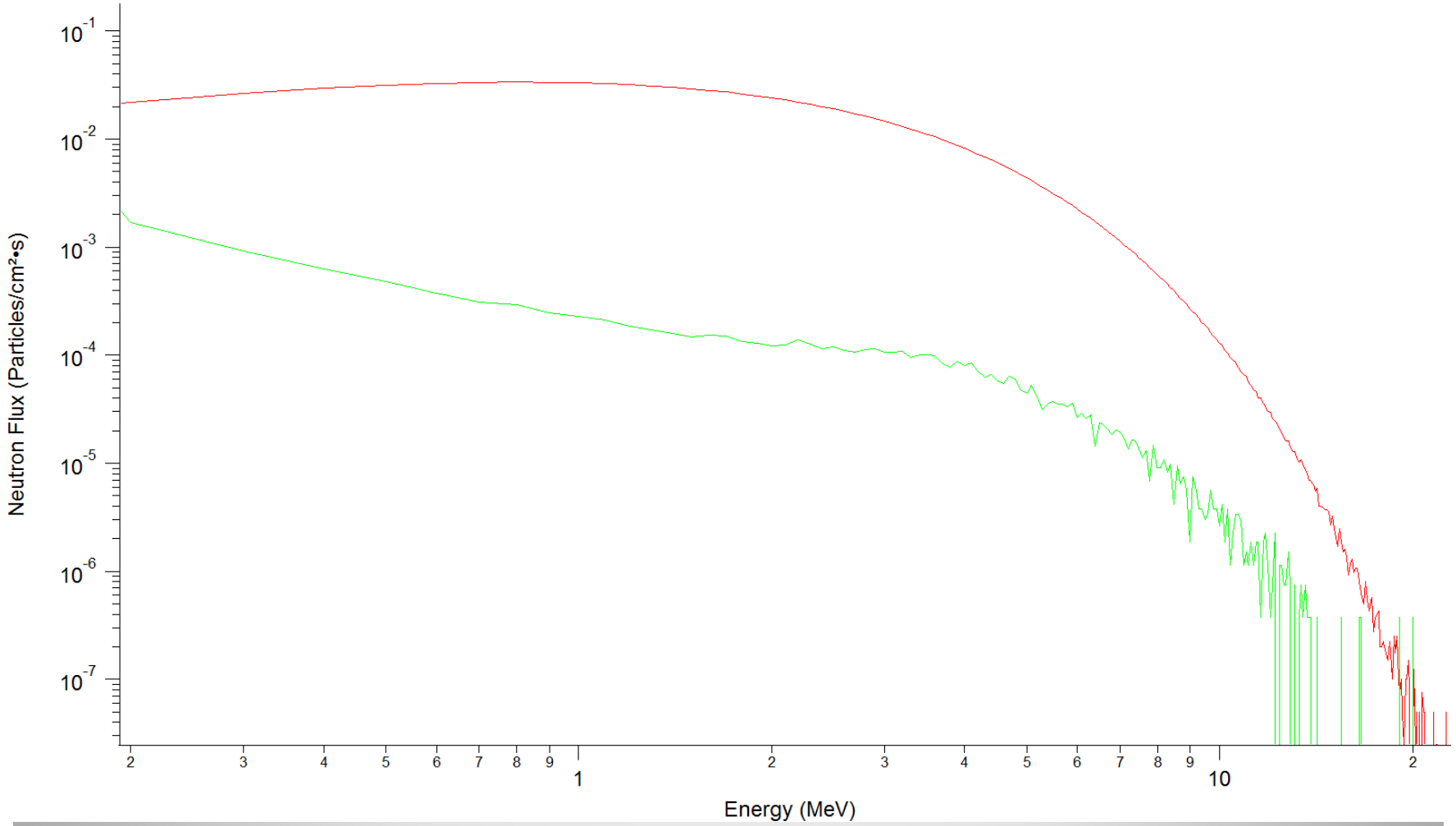
Construction



Source

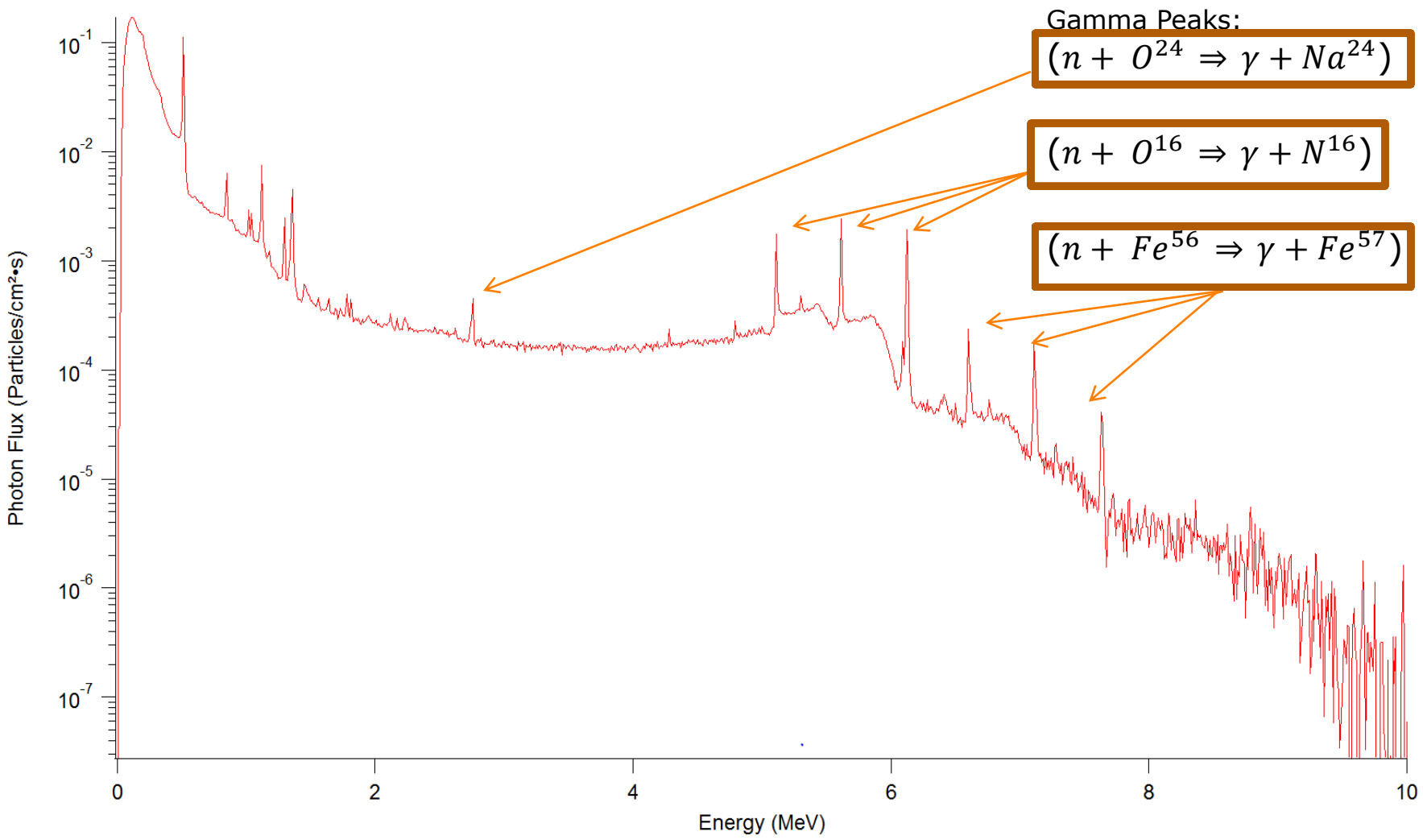


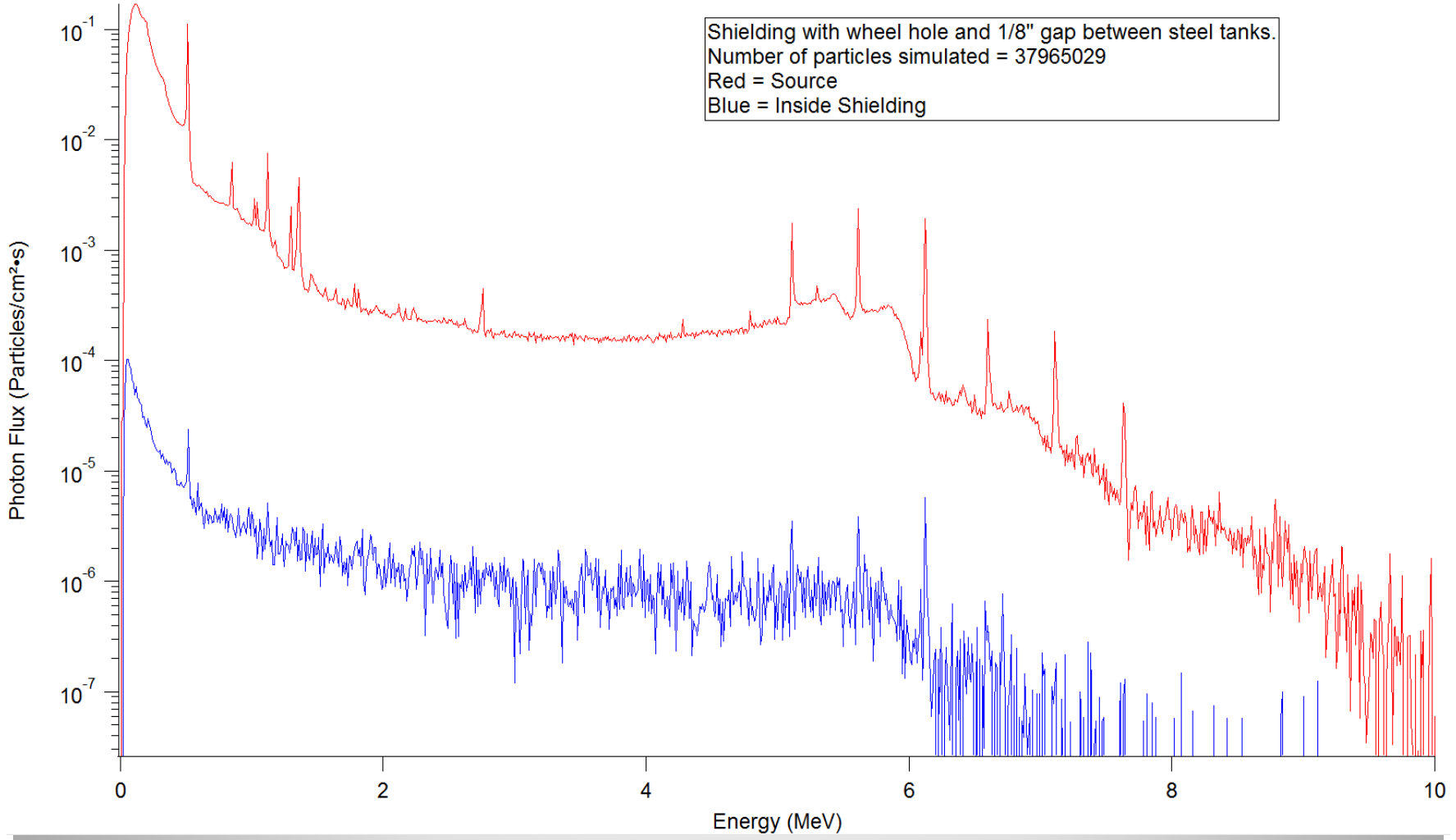
Source (Fission Spectrum)


Neutron Flux (Particles/cm²•s)
10^-1
10^-2
10^-3
10^-4
10^-5
10^-6
10^-7
2 3 4 5 6 7 8 9 1 2 3 4 5 6 7 8 9 10 2
Energy (MeV)

Results

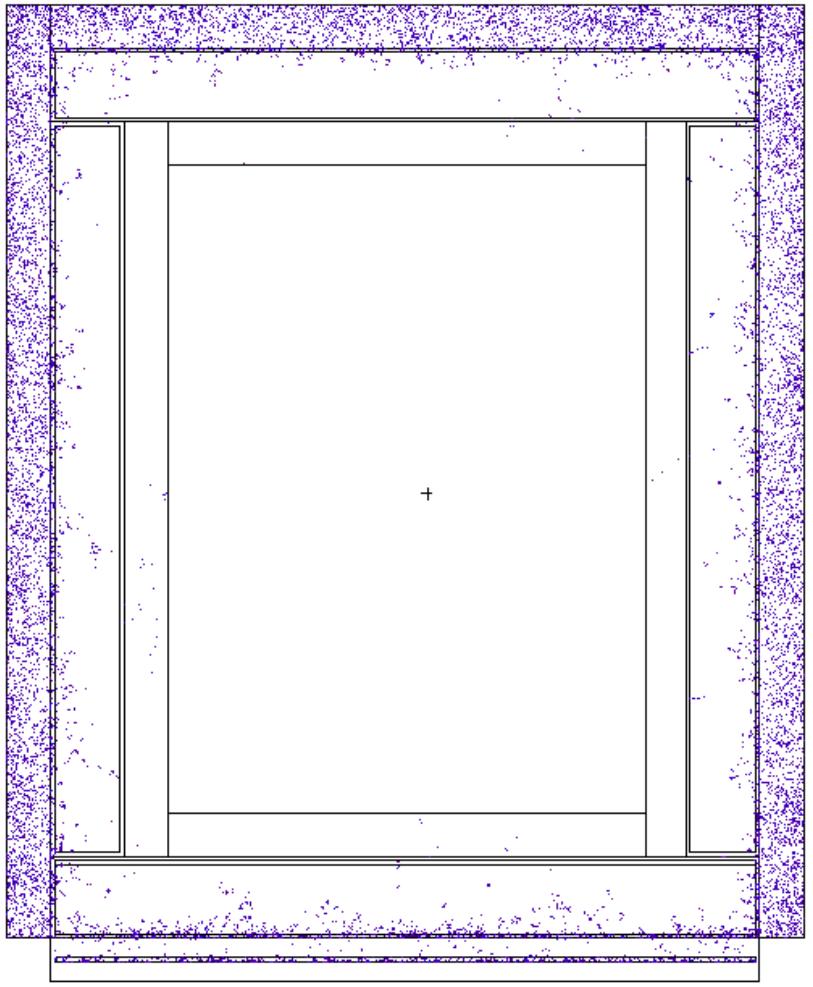
- Measured source for photons:




Shielding with wheel hole and 1/8" gap between steel tanks.
Number of particles simulated = 37965029
Red = Source
Blue = Inside Shielding
Photon Flux (Particles/cm²•s)
10^-1
10^-2
10^-3
10^-4
10^-5
10^-6
10^-7
0
2
4
6
8
10
Energy (MeV)

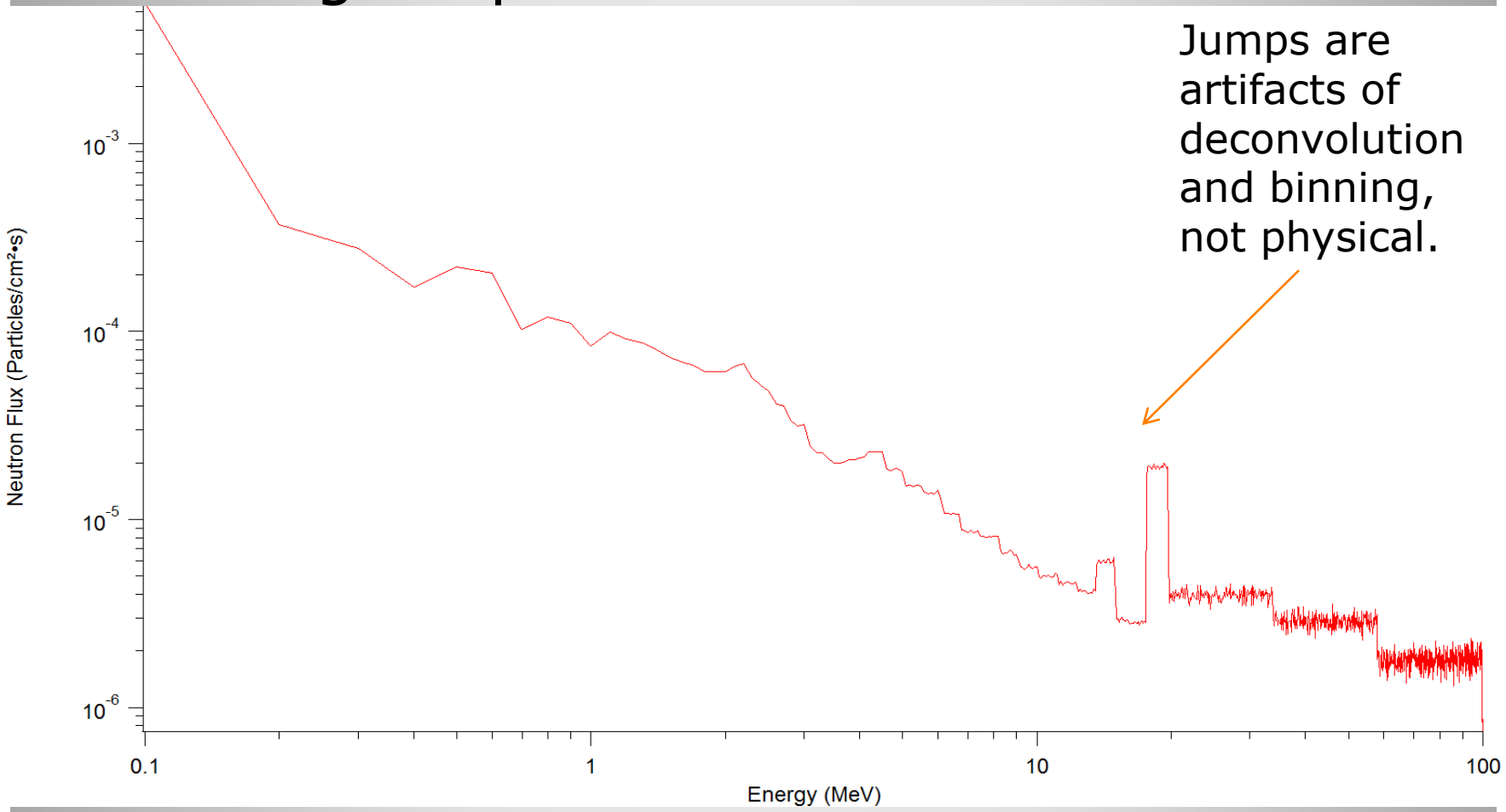
Results

Compton Scattering scales with more electrons, which is why steel (Fe) stops gammas.

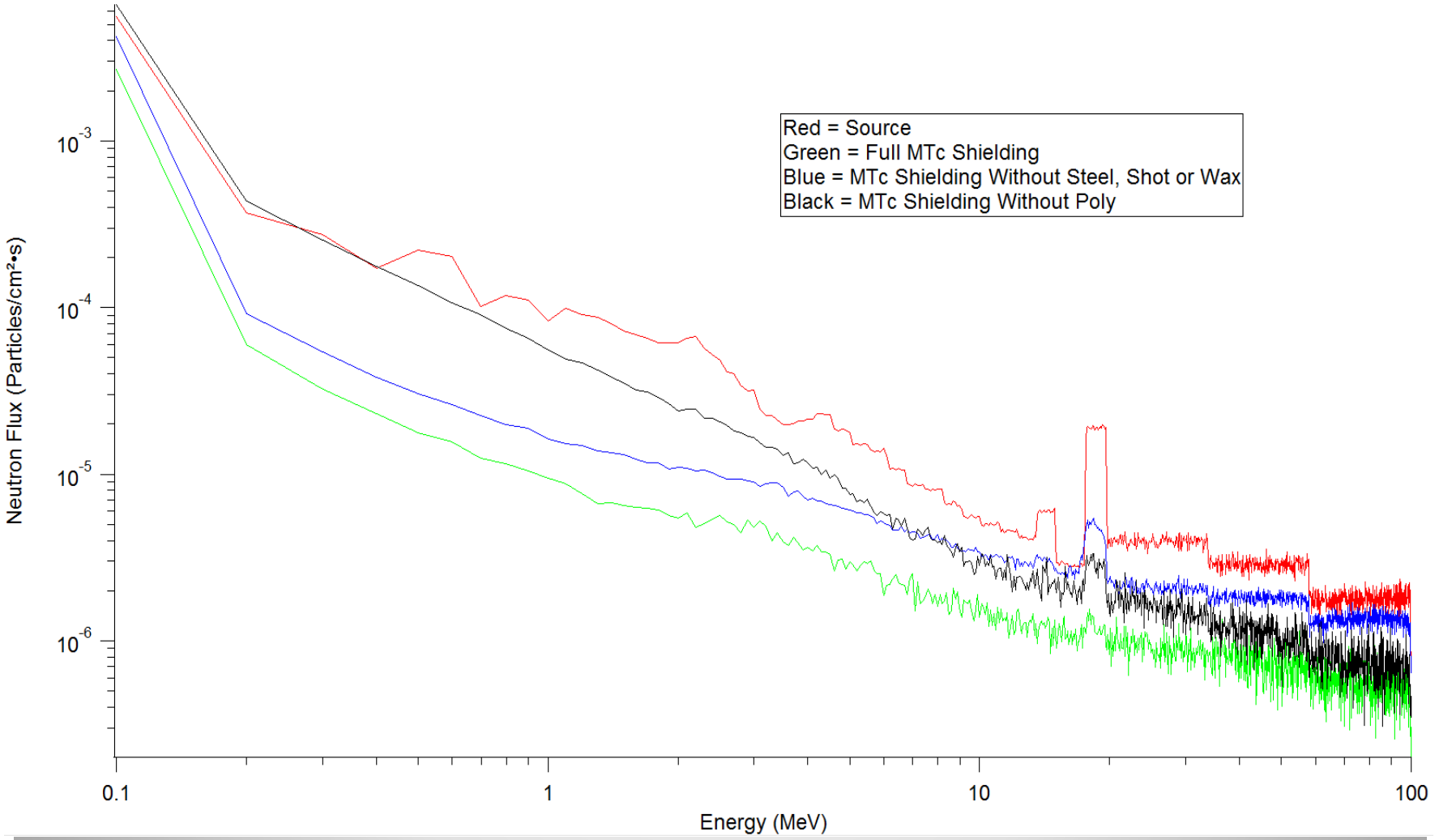


Photon Tracks

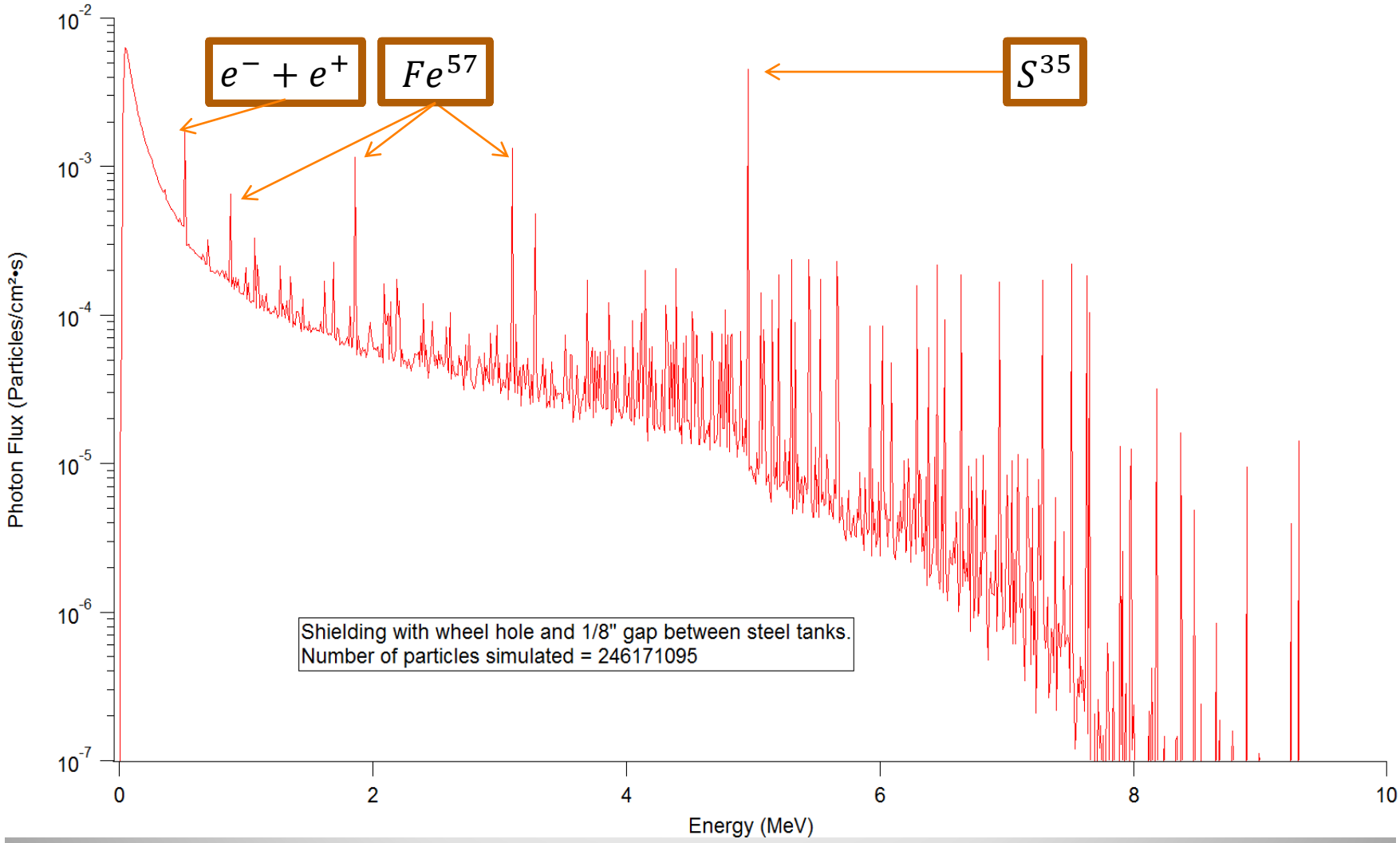
- Goldhagen spectrum for neutrons:



Source (Goldhagen)

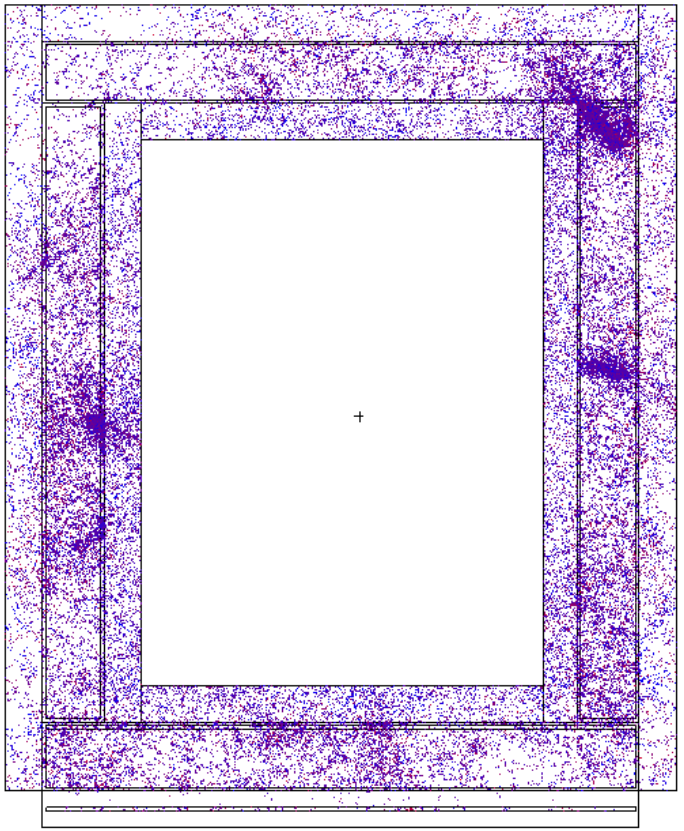

Red = Source
Green = Full MTc Shielding
Blue = MTc Shielding Without Steel, Shot or Wax
Black = MTc Shielding Without Poly
Neutron Flux (Particles/cm²•s)
10-3
10-4
10-5
10-6
0.1
1
10
100
Energy (MeV)

Results


$e^- + e^+$
Fe^{57}
S^{35}
Photon Flux (Particles/cm²•s)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
0
2
4
6
8
10
Energy (MeV)
Shielding with wheel hole and 1/8" gap between steel tanks.
Number of particles simulated = 246171095

Results

1. Little interaction with outer Boron, only absorbs low energy neutrons.
2. Lots of neutron scattering happens in the steel and wax which lowers neutron energy.
3. High interaction with inner Boron, neutrons are low enough energy to be absorbed.



Neutron Tracks

- Thank You

Questions?

Borated Poly:

Isotope	Percentage
H^1	12.1%
$Natural\ Carbon$	71.8%
O^{16}	11.1%
B^{10}	0.995%
B^{11}	4.005%

Densities:

Steel Shot in Wax $5.87\ \frac{grams}{cm^3}$

A36 Steel $7.85\ \frac{grams}{cm^3}$

Borated Poly $1.06\ \frac{grams}{cm^3}$

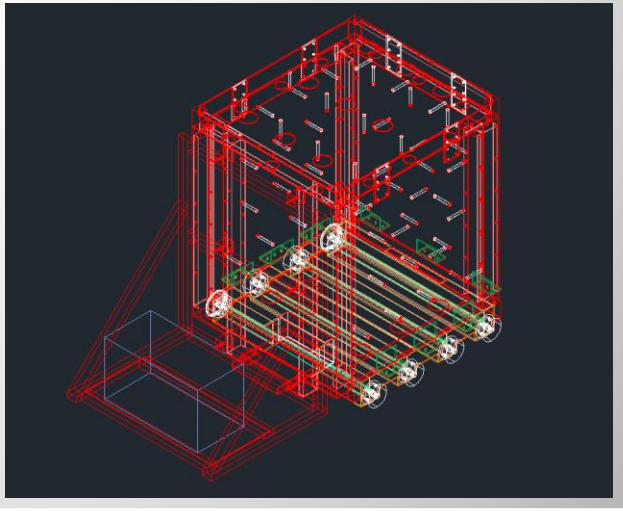
Steel Shot in Wax (by mass):
65% A36 Steel
35% Paraffin Wax

Watt fission spectrum:

$$p(E) = C^{-E/1.028}\sinh(2.084E)^{1/2}$$

Based off of a 14 MeV neutron induced fission of a U^{235} nucleus.

AutoCAD Model (without poly):



Extras