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Neutron Imaging At Z In A Harsh Bremsstrahlung Environment

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Neutron Imaging At Z: Is It Even Possible

Model Must Include:

1. Imaging Slit Geometry

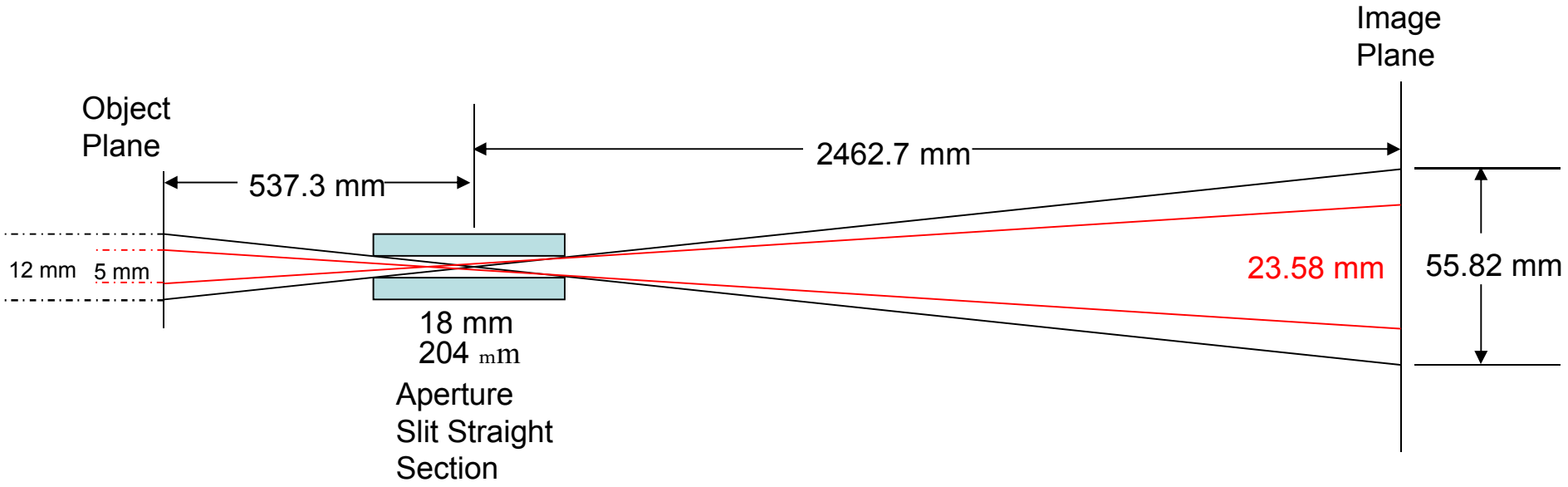
2. Perspective For Carrying Out Any Calculation
   i.e., Do Any Calculation With Respect To The Detector
   Or The Source

3. Model For Gamma Production At Z

4. Attenuation Model For Any Shield
   a. Gamma Attenuation
   b. Neutron Attenuation

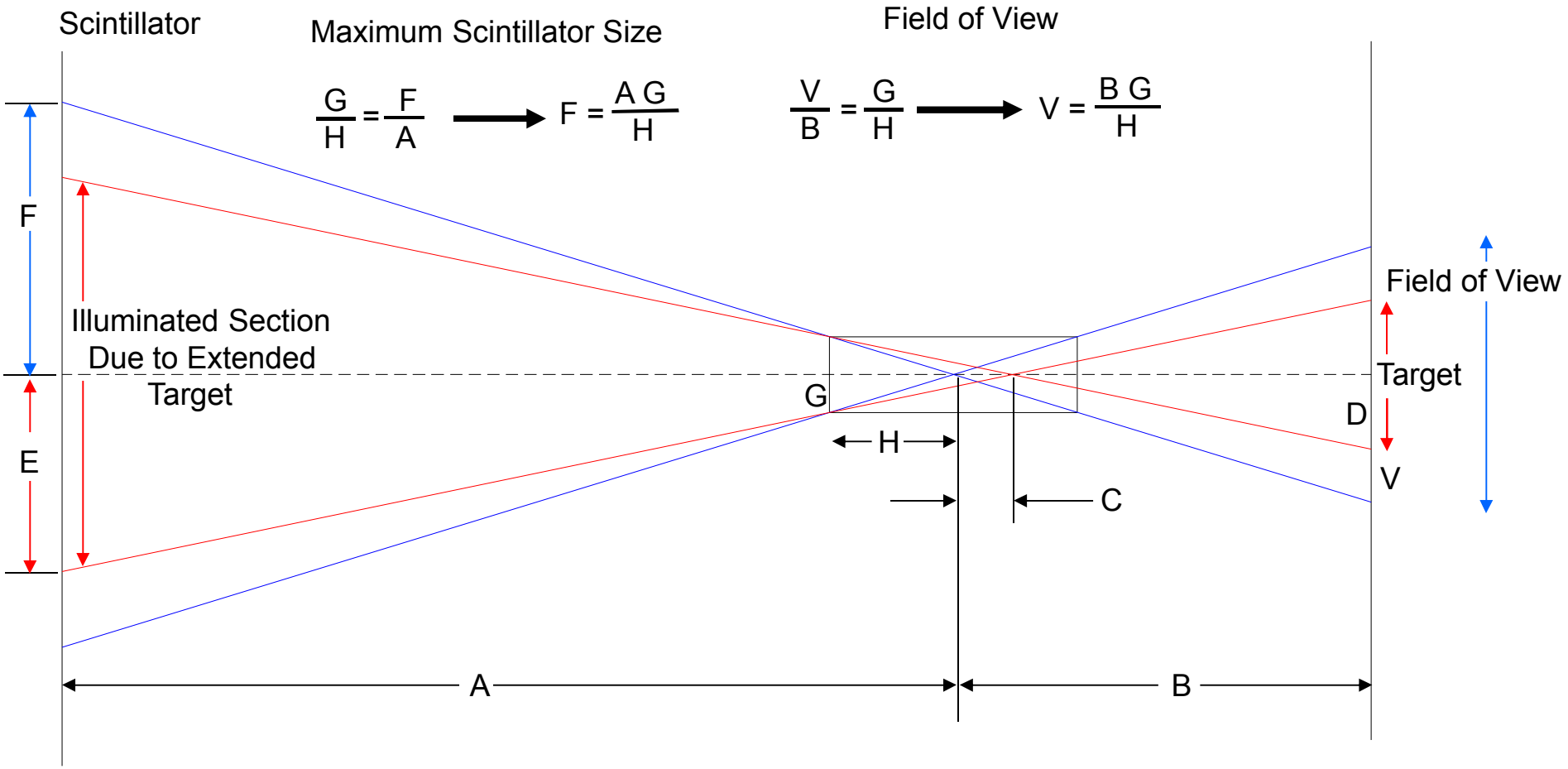
5. Results
   a. Is The Model Believable
   b. What Has Been Left Out Of The Model

Neutron Imaging Geometry



Note: The Slit Dimensions Into/Out Of The Plane Of The Board Are Such That The Full Object Width Is Viewed By Every Horizontal Detector Pixel.

Relationship Between Illuminated Section of Detector Due To Extended Source and Full Field of View of the Detector



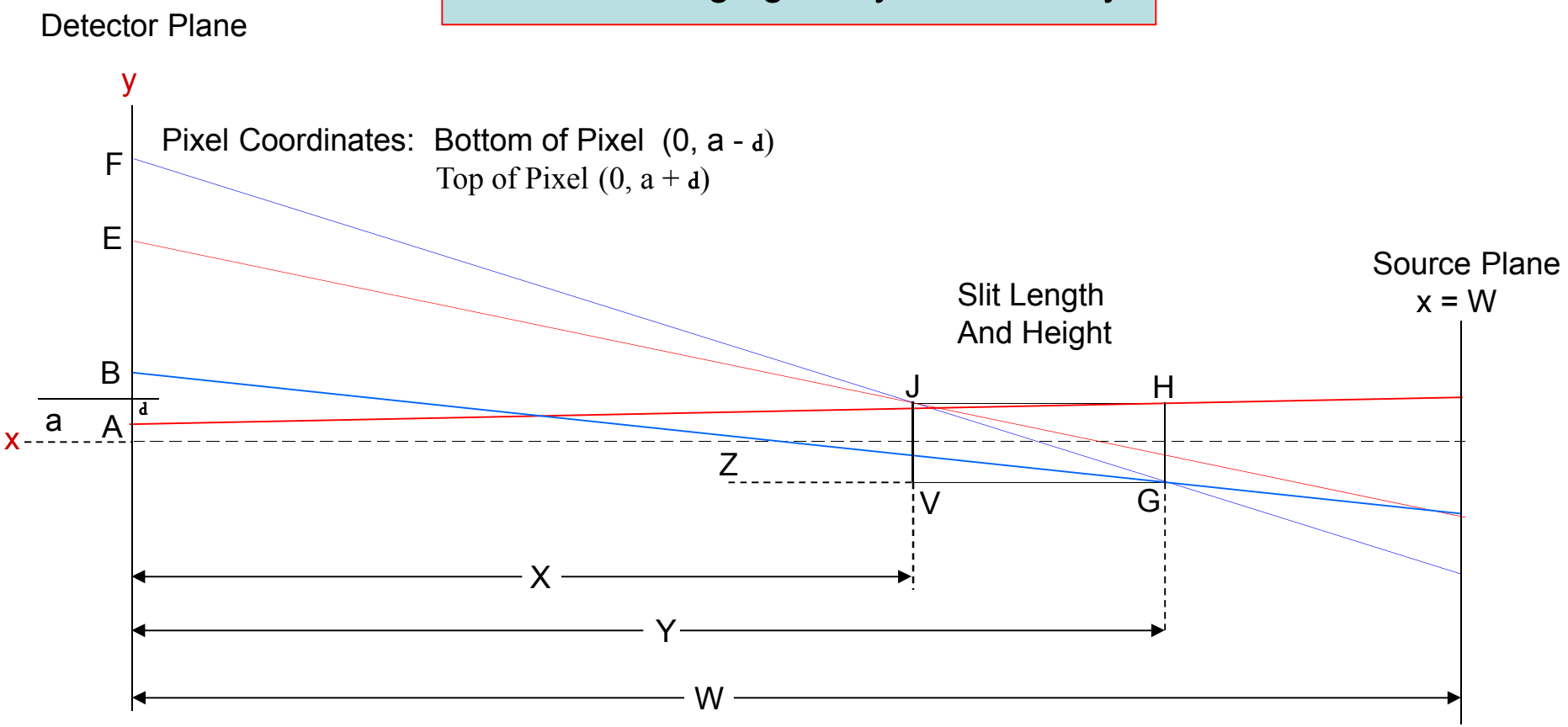
Crossing Point

$$\frac{G}{H + C} = \frac{D}{B - C} \rightarrow C = \frac{GB - DH}{D + G}$$

Scintillator Illuminated Size

$$\frac{E}{A + C} = \frac{D}{B - C} \rightarrow E = \frac{D\,(A + C)}{B - C}$$

Neutron Imaging Analytic Geometry



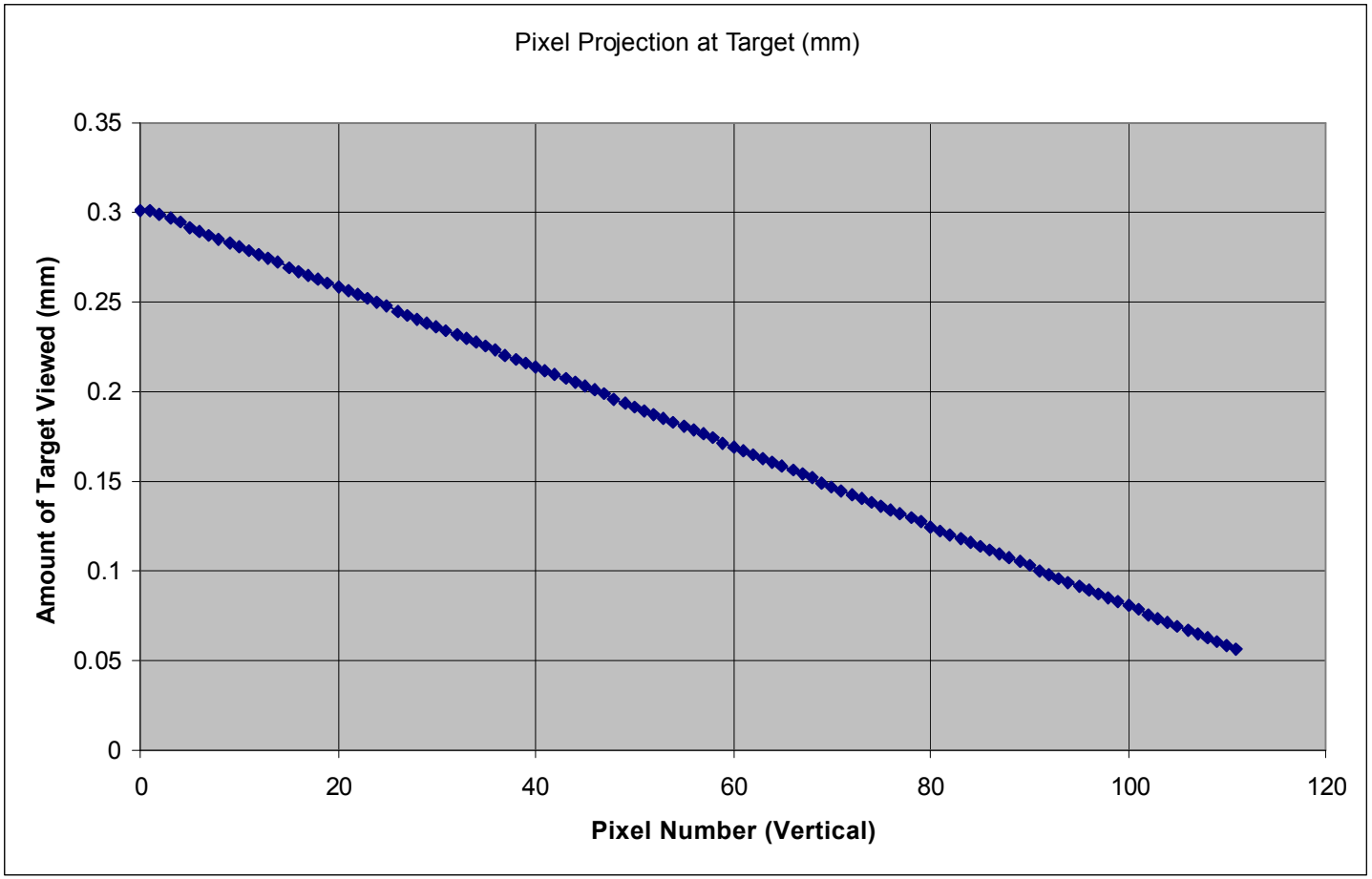
Equation of Line AH: $y = a - d + ((z - a + d)/Y)\,x$

BG: $y = a + d + ((-z - a - d)/Y)\,x$

EJ: $y = a - d + ((z - a + d)/X)\,x$

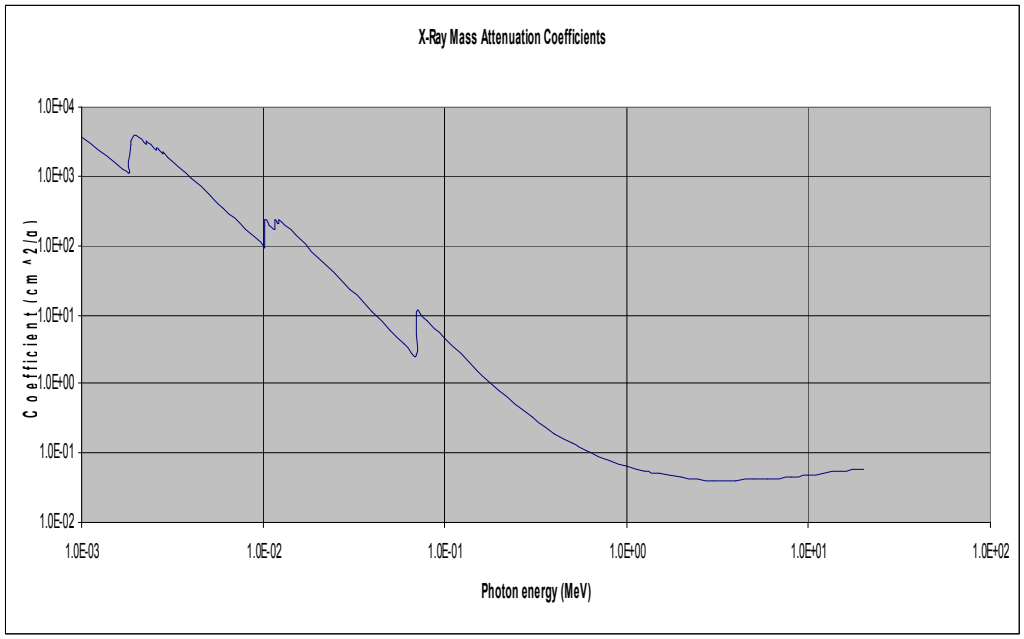
FG: $y = a + d + ((-z - a - d)/Y)\,x$

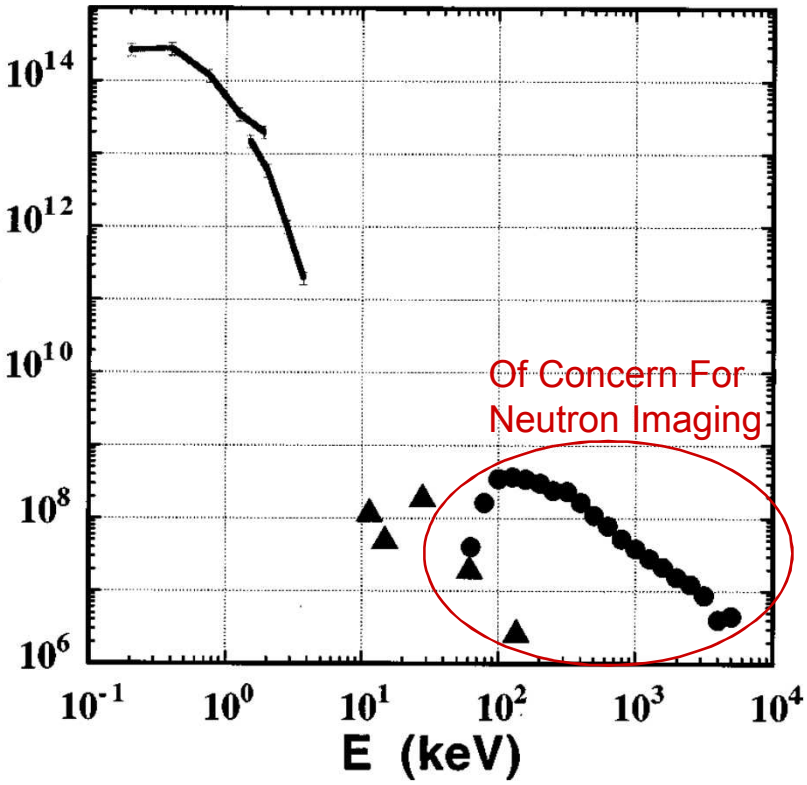
Amount of Target Viewed By Each Vertical Pixel



Some Numeric Models Used In This Presentation

Tungsten





Derzon et. al., Rev. Sci. Inst., 70, p566, (1999).

Basic Models of Shield Transmission And Gamma Production At Z

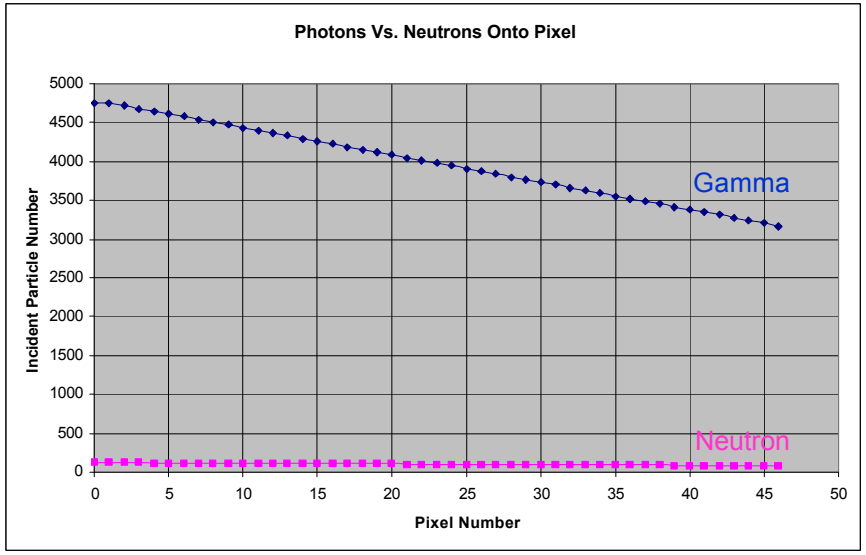
Photon Energy (MeV)	Atten Coeff (cm^2/g)	Transmission Through 4" W
1.00000E-01	4.438E+00	0
1.50000E-01	1.581E+00	2.3022E-135
2.00000E-01	7.844E-01	1.58689E-67
3.00000E-01	3.238E-01	2.66203E-28
4.00000E-01	1.925E-01	4.04308E-17
5.00000E-01	1.378E-01	1.84061E-12
6.00000E-01	1.093E-01	4.92061E-10
8.00000E-01	8.066E-02	1.35207E-07
1.00000E+00	6.618E-02	2.31268E-06
1.25000E+00	5.577E-02	1.78086E-05
1.50000E+00	5.000E-02	5.52081E-05
2.00000E+00	4.433E-02	0.000167826
3.00000E+00	4.075E-02	0.000338636
4.00000E+00	4.038E-02	0.000364118
5.00000E+00	4.103E-02	0.000320544
6.00000E+00	4.210E-02	0.000259876
8.00000E+00	4.472E-02	0.00015547
1.00000E+01	4.747E-02	9.06688E-05
1.50000E+01	5.384E-02	2.60009E-05
2.00000E+01	5.893E-02	9.58352E-06

Gamma Model For Z

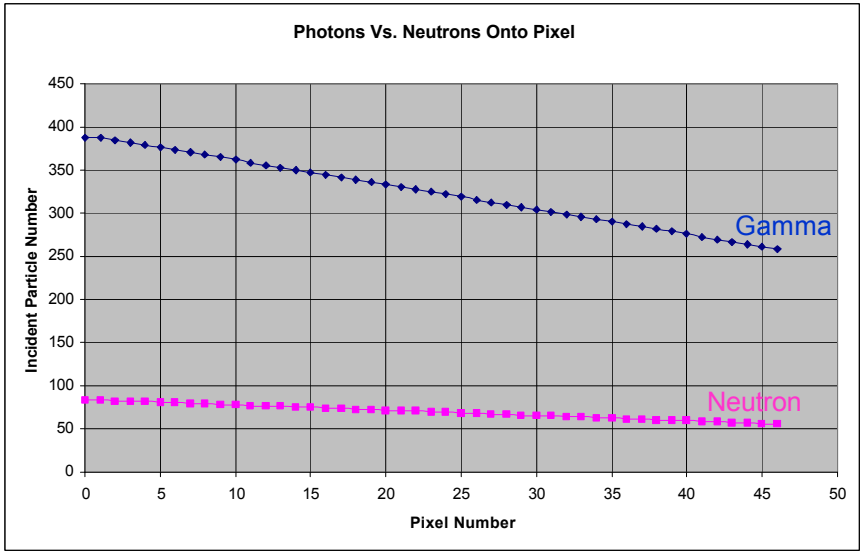
Photon Energy (keV)	Energy (J/keV/s)	Transmission Through 4" W In 20 ns Pulse (J)	Photons
100	3.50E+08	0.00E+00	0.00E+00
200	3.00E+08	9.52E-65	2.97E-51
300	2.20E+08	1.17E-25	2.44E-12
400	1.60E+08	1.29E-14	2.02E-01
500	1.10E+08	4.05E-10	5.05E+03
600	8.00E+07	7.87E-08	8.19E+05
700	6.00E+07	8.14E-06	7.26E+07
800	5.50E+07	1.49E-05	1.16E+08
900	4.50E+07	1.10E-04	7.64E+08
1000	4.00E+07	9.25E-04	5.77E+09
2000	1.50E+07	5.03E-02	1.57E+11
3000	8.50E+06	5.76E-02	1.20E+11
4000	4.00E+06	2.91E-02	4.55E+10
5000	4.50E+06	2.88E-02	3.60E+10
	Sum		3.65E+11

Relative Particle Number Incident Onto Pixel

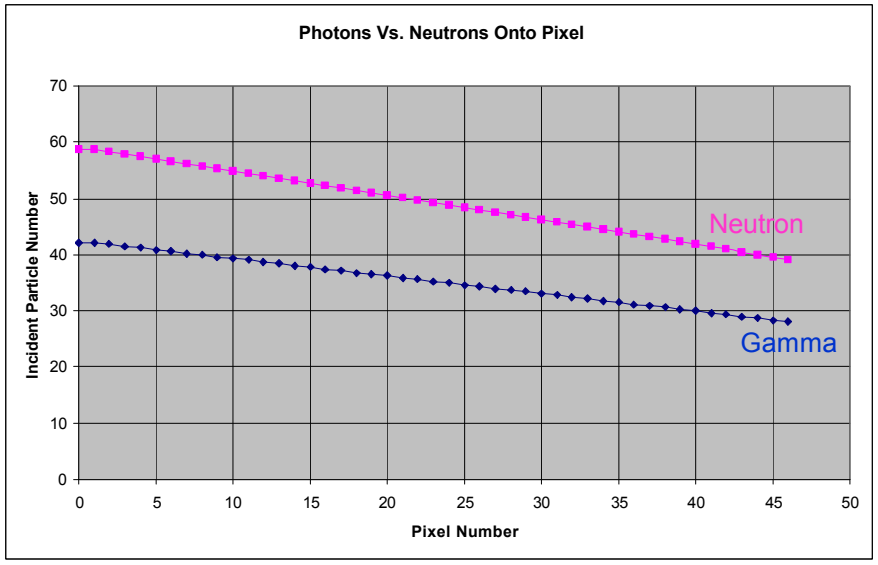
1” W Shielding



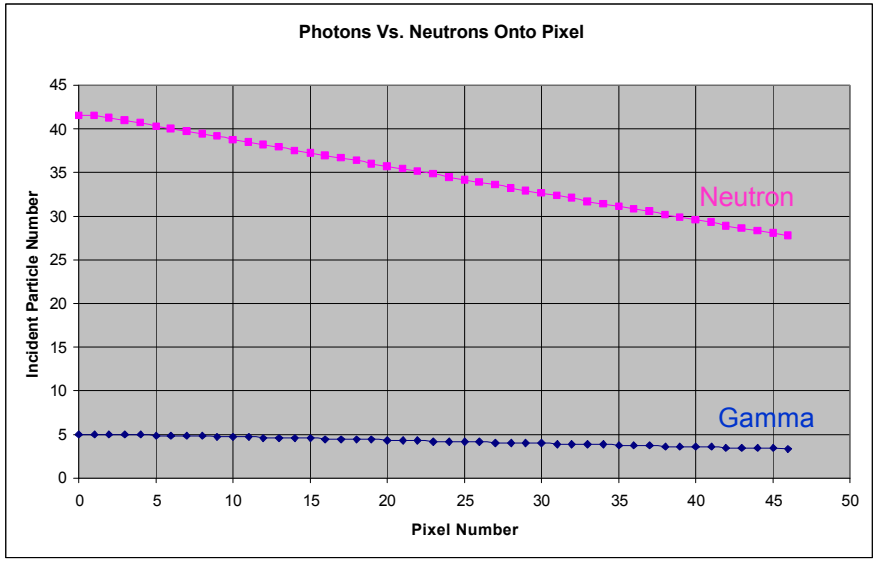
2” W Shielding



3” W Shielding



4” W Shielding



Examples of What Has Been Left Out Of The Model

1. Interaction of Particle With Scintillator
   a. Only 40% of the Neutrons Interact With Scintillator
   b. Interaction of Gammas With Scintillator Is Via Compton Scattering

2. Amount of Countable (Visible) Light Produced By Each Incident Particle

3. Losses In The Detector System

4. Scattered Gammas or Neutrons (sky shine)

5. Signal To Noise (Contrast) In The Final Detected Signal