RD51 mini week, 8 – 11 December 2014

Photon Detection in an MWPC

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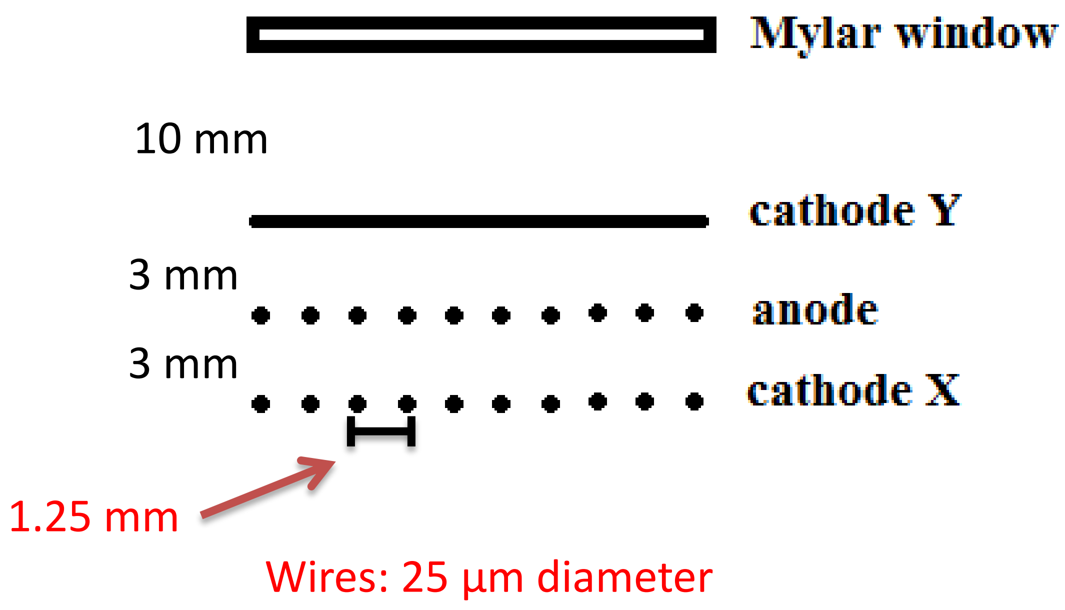
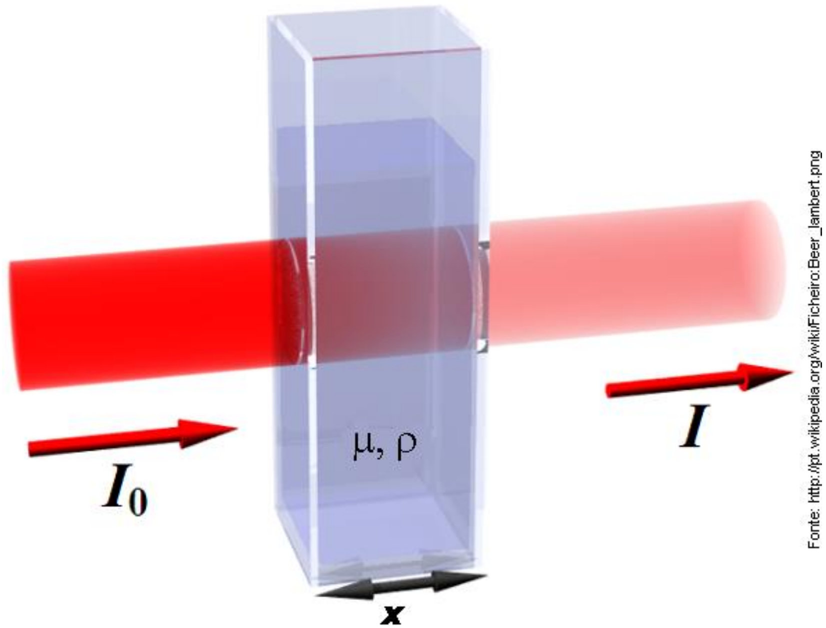
Sketch of Detector



X-rays Attenuation



$$I = I_0 e^{-\mu x}$$

μ is the linear attenuation coefficient;
x is the thickness of the absorber.

G. F. Knoll, Radiation Detection and Measurement, John Wiley and Sons, New York, Chicester, Brisbane, Toronto, Singapure, 3rd ed. (2000).

Mass Attenuation Coefficient

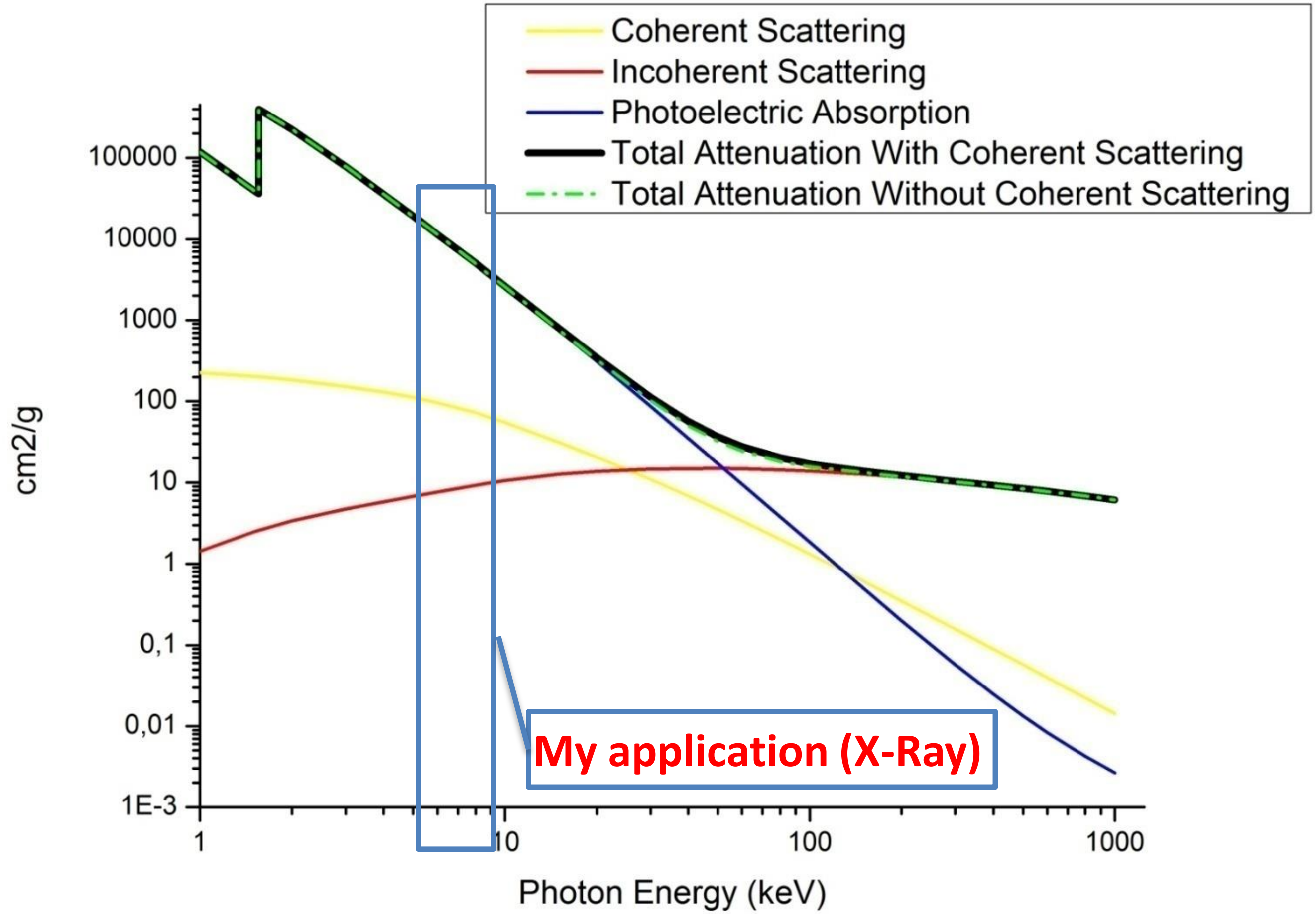
$$\mu = \mu(E, \rho) \longrightarrow \mu_m = \frac{\mu}{\rho} \longrightarrow \mu_m = \mu_m(E)$$

$$[\mu_m] = \frac{cm^2}{g}$$

$$I = I_0 e^{-\mu x} \longrightarrow I = I_0 e^{-\mu_m \rho x}$$

$$\longrightarrow \quad \boxed{x = -\frac{\ln\left(I/I_0\right)}{\mu_m \rho}}$$

Mass Attenuation Coefficient for Mylar



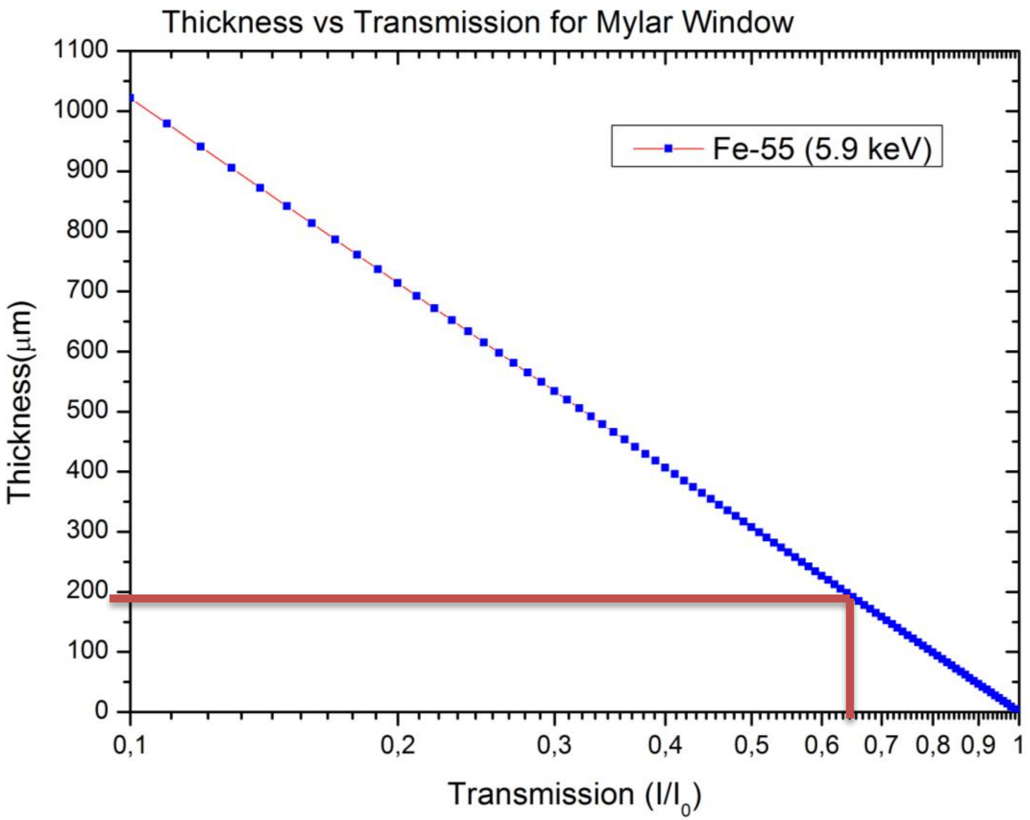
Obtained from NIST (National Institute of Standards and Technology)

Mylar

Edge	(required) Photon Energy	Scattering		Photoelectric Absorption	Pair Production		Total Attenuation	
		Coherent	Incoherent		In Nuclear Field	In Electron Field	With Coherent Scattering	Without Coherent Scattering
	MeV	cm^2/g	cm^2/g	cm^2/g	cm^2/g	cm^2/g	cm^2/g	cm^2/g
	1.000E-03	1.189E+00	1.284E-02	2.909E+03	0.000E+00	0.000E+00	2.911E+03	2.909E+03
	1.500E-03	1.075E+00	2.570E-02	9.525E+02	0.000E+00	0.000E+00	9.536E+02	9.526E+02
	2.000E-03	9.509E-01	3.982E-02	4.196E+02	0.000E+00	0.000E+00	4.206E+02	4.196E+02
	3.000E-03	7.237E-01	6.658E-02	1.280E+02	0.000E+00	0.000E+00	1.288E+02	1.280E+02
	4.000E-03	5.532E-01	8.816E-02	5.401E+01	0.000E+00	0.000E+00	5.465E+01	5.410E+01
	5.000E-03	4.339E-01	1.043E-01	2.738E+01	0.000E+00	0.000E+00	2.792E+01	2.749E+01
	6.000E-03	3.507E-01	1.162E-01	1.561E+01	0.000E+00	0.000E+00	1.608E+01	1.573E+01
	8.000E-03	2.473E-01	1.322E-01	6.370E+00	0.000E+00	0.000E+00	6.750E+00	6.502E+00
	1.000E-02	1.877E-01	1.426E-01	3.151E+00	0.000E+00	0.000E+00	3.48[illegible]+00	3.294E+00
	1.500E-02	1.111E-01	1.581E-01	8.626E-01	0.000E+00	0.000E+00	1.13[illegible]+00	1.021E+00
	2.000E-02	7.370E-02	1.662E-01	3.400E-01	0.000E+00	0.000E+00	5.79[illegible]-01	5.062E-01
	3.000E-02	3.863E-02	1.720E-01	9.032E-02	0.000E+00	0.000E+00	3.009E-01	2.623E-01
	4.000E-02	2.356E-02	1.718E-01	3.500E-02	0.000E+00	0.000E+00	2.304E-01	2.068E-01
	5.000E-02	1.583E-02	1.695E-01	1.673E-02	0.000E+00	0.000E+00	2.020E-01	1.862E-01
	6.000E-02	1.135E-02	1.663E-01	9.141E-03	0.000E+00	0.000E+00	1.868E-01	1.754E-01

Table obtained from http://physics.nist.gov/cgi-bin/Xcom/xcom3_1

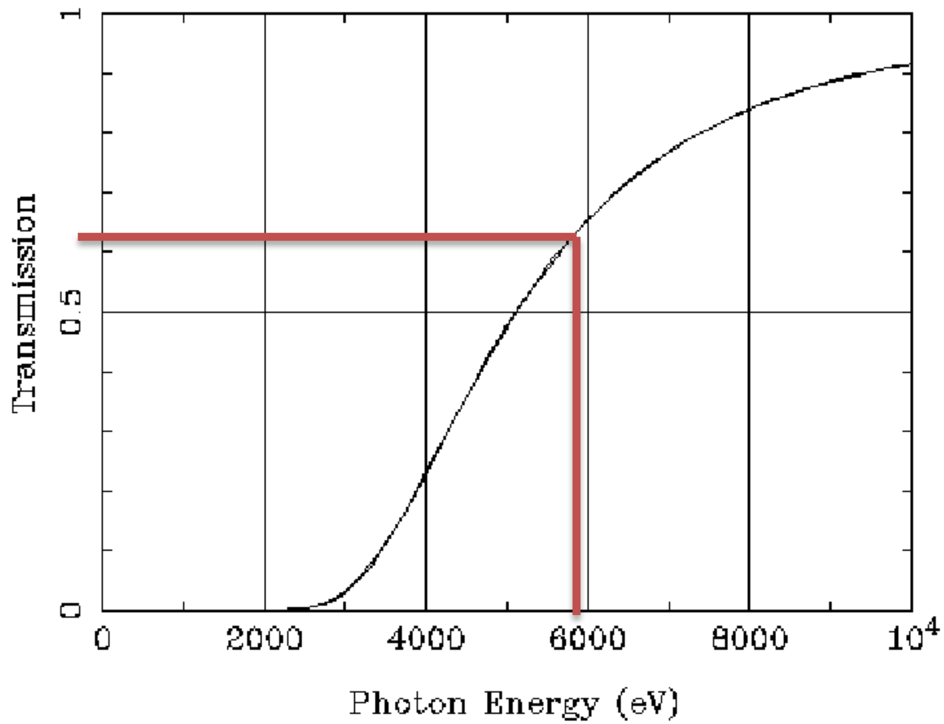
Transmission in Mylar Window



For our Mylar window (190 μm) a transmission about 63% to ^{55}Fe source is expected.

Transmission on Entrance Window

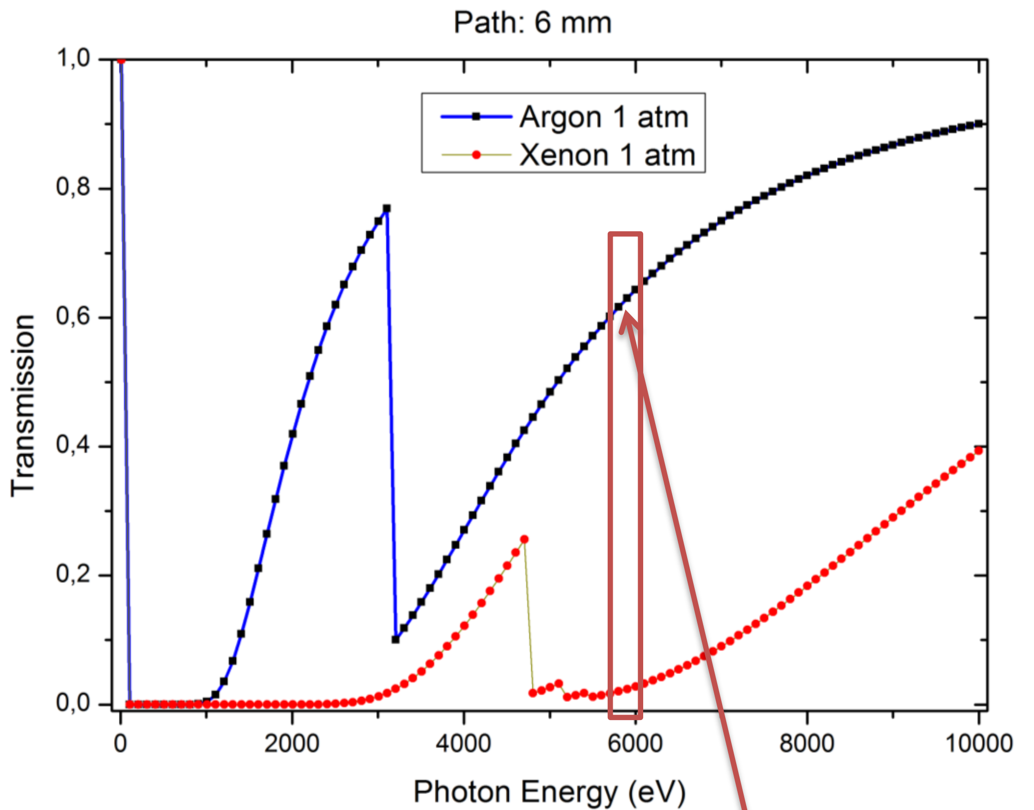
Mylar: Density=1.4 g/cm^3, Thickness=190 microns



Data from Henke: http://henke.lbl.gov/optical_constants/gastrn2.html

From Henke, the transmission is basically the same (~62%).

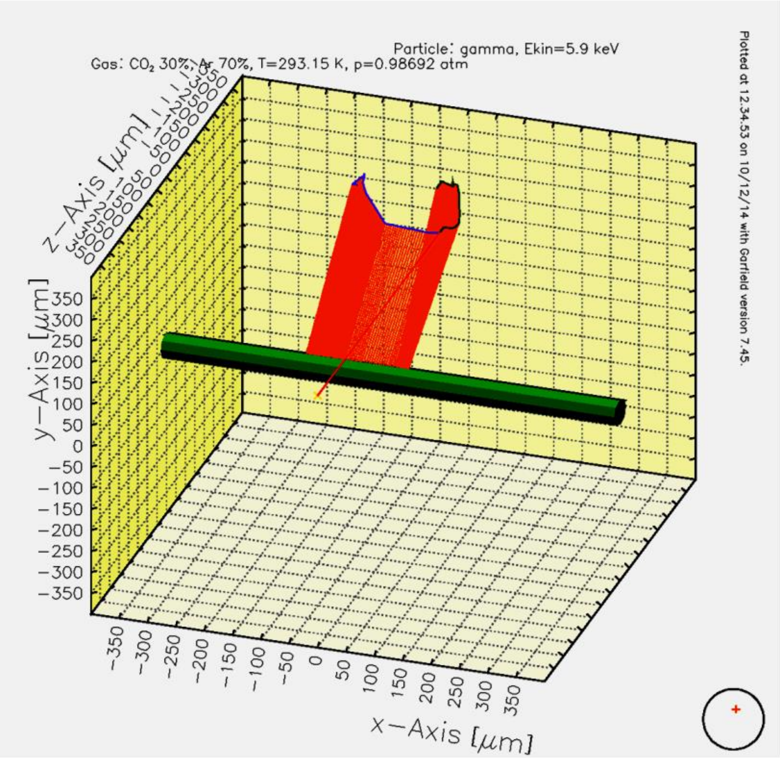
Photo-absorption in Gases



Data from Henke: http://henke.lbl.gov/optical_constants/index.html

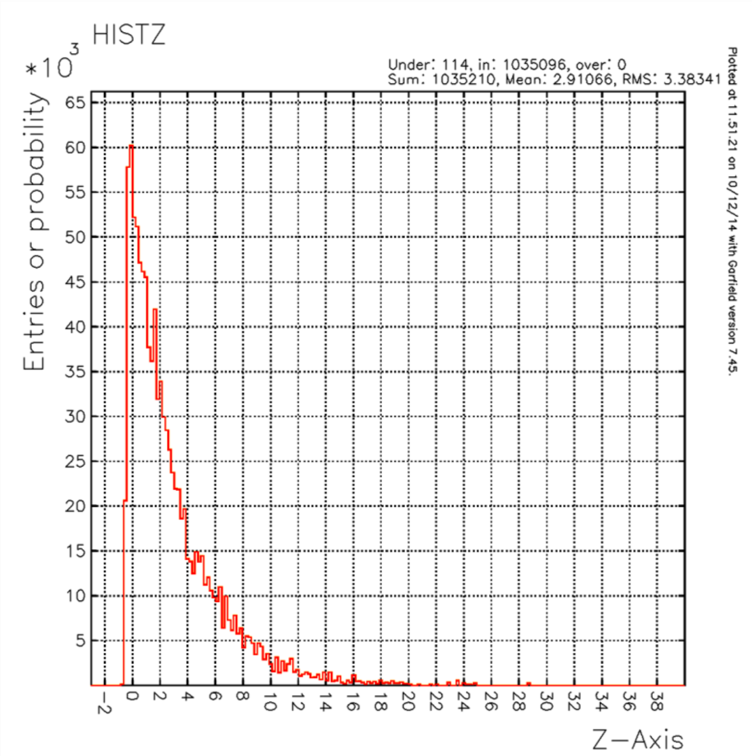
For ^{55}Fe source the absorption in argon is about 40%.

Absorption of Photons from ^{55}Fe Source

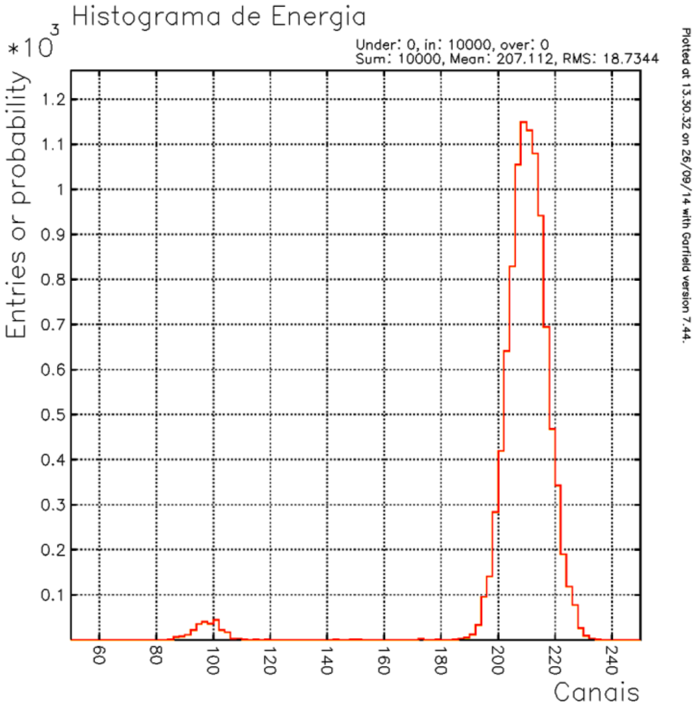


X-Ray starts at (0, 0.02, 0.04) and goes to (0, 0.02, 10) [cm].

Absorption of Photons from ^{55}Fe Source



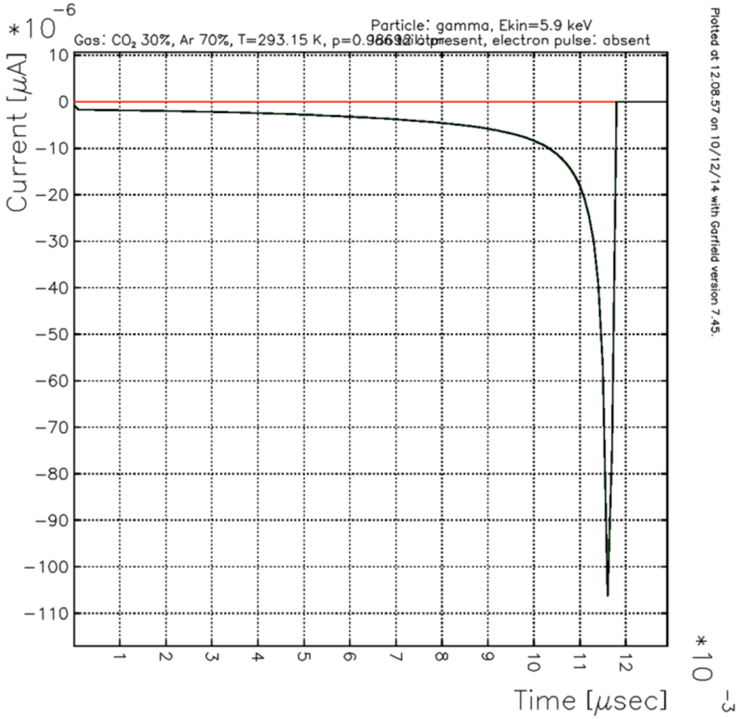
Probability of interaction in Z-axis.



Probability of absorption as a function of channel.

Signals

Ar 70%, CO_2 30%.

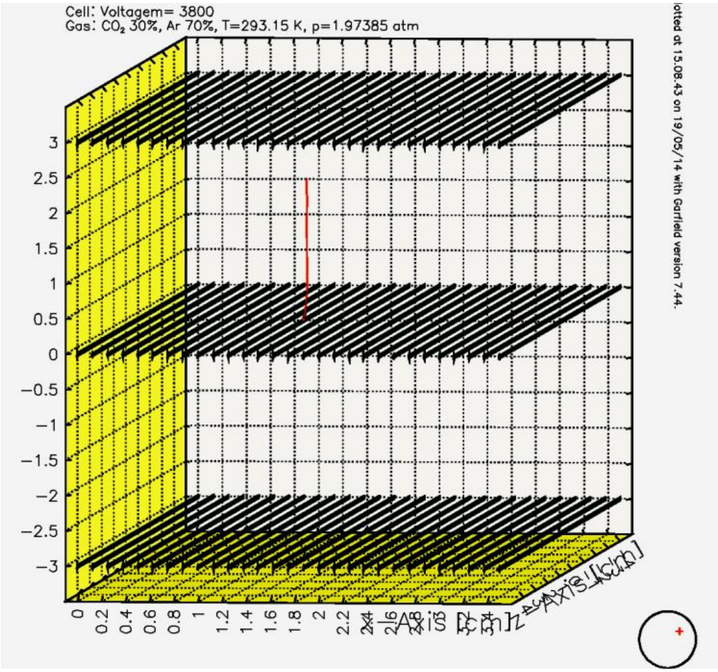


Induced signal by drift of just one electron.

Grids on Garfield

Before coming to CERN (and discuss with Rob)...

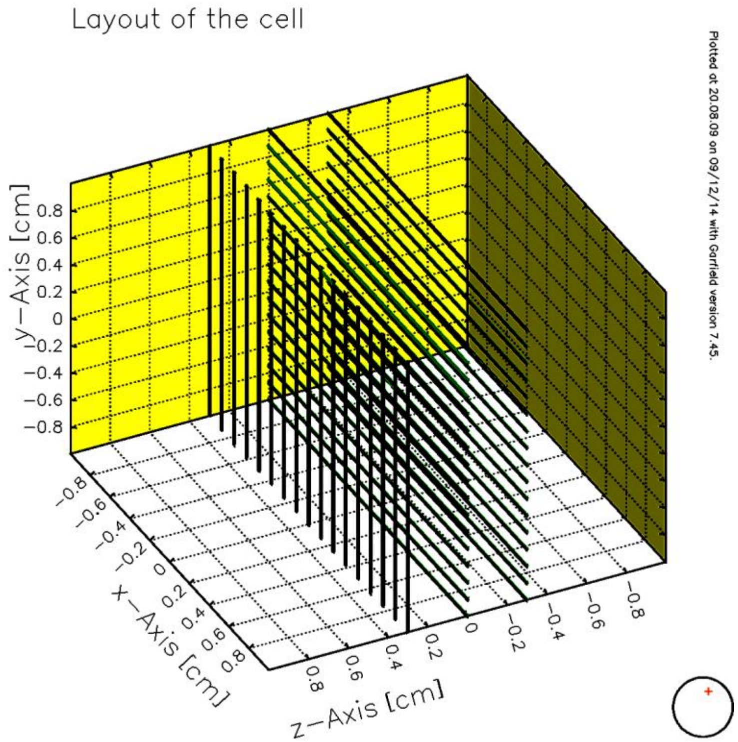
- I used the function *rows* to create the wires of the detector:



This function is not able to calculate electric field for perpendicular wires!

Grids on Garfield

- Now...



Periodic Copies using NEBEM.

Summary

- We estimate the transmission of photons in gas and entrance window using data from NIST and Henke;
- Simulated absorption of photons from a ^{55}Fe source in gas;
- We were able to get induced signals by drift charges in MWPC.

Many thanks to Rob Veenhof (Garfield support), Leszek Ropelewski (trainee stage opportunity), Eraldo Oliveri and Filippo Resnati for help.

Thank you for attention!