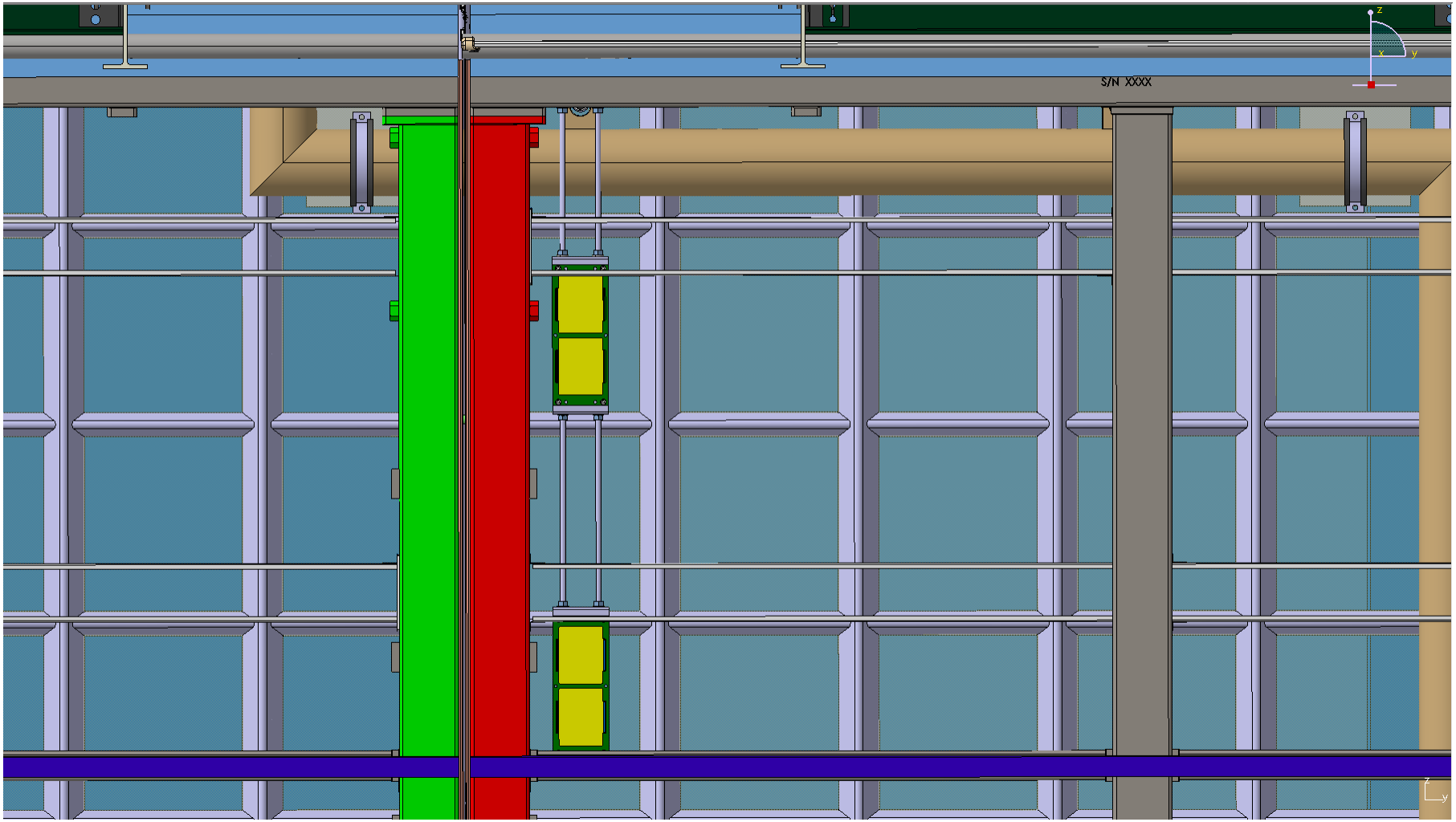
Xenon Doping

Niccolo' Gallice, Henrique Souza
04/09/2020

Monte Carlo Update

- LArTPC frames inserted
- PD modules inserted



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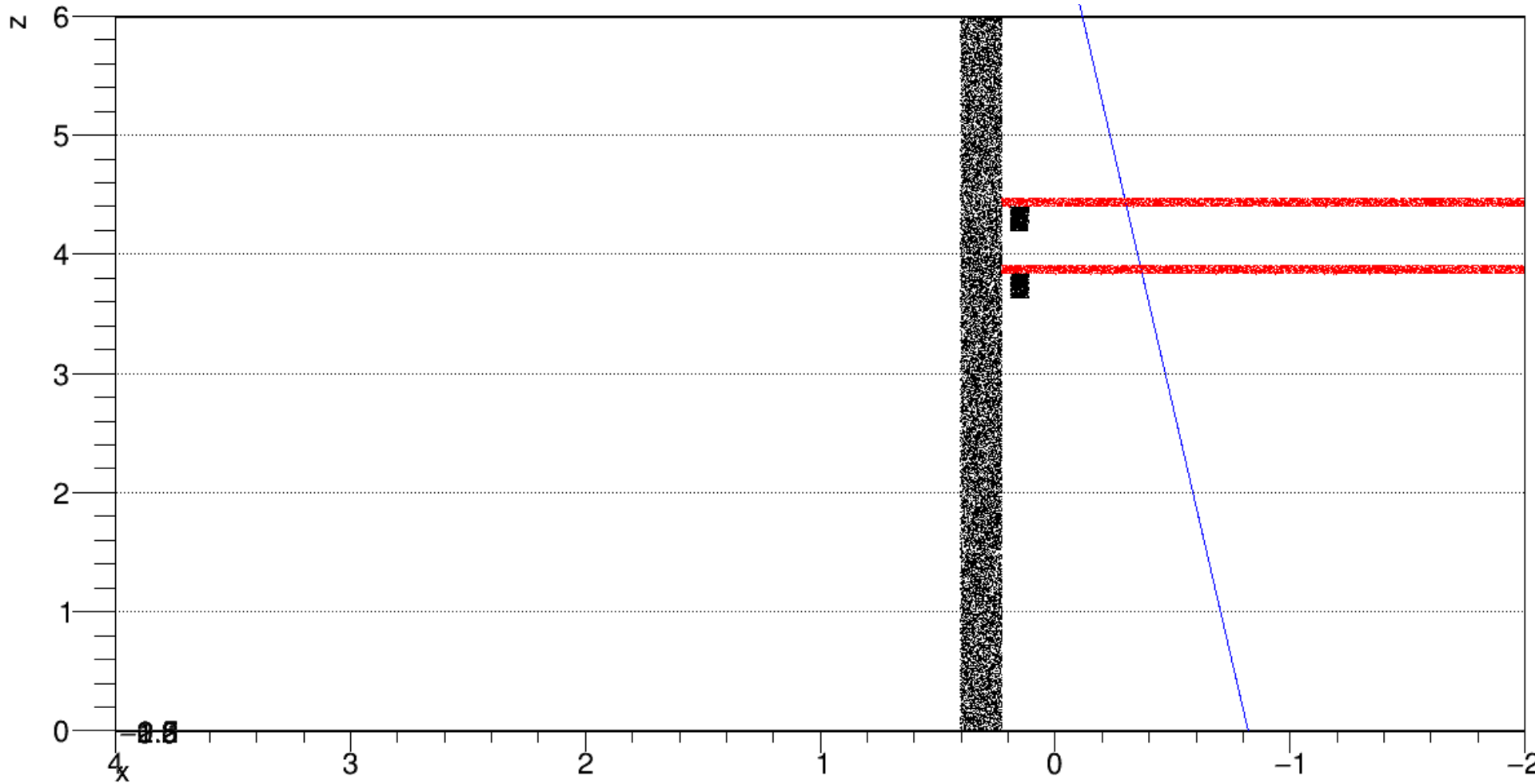

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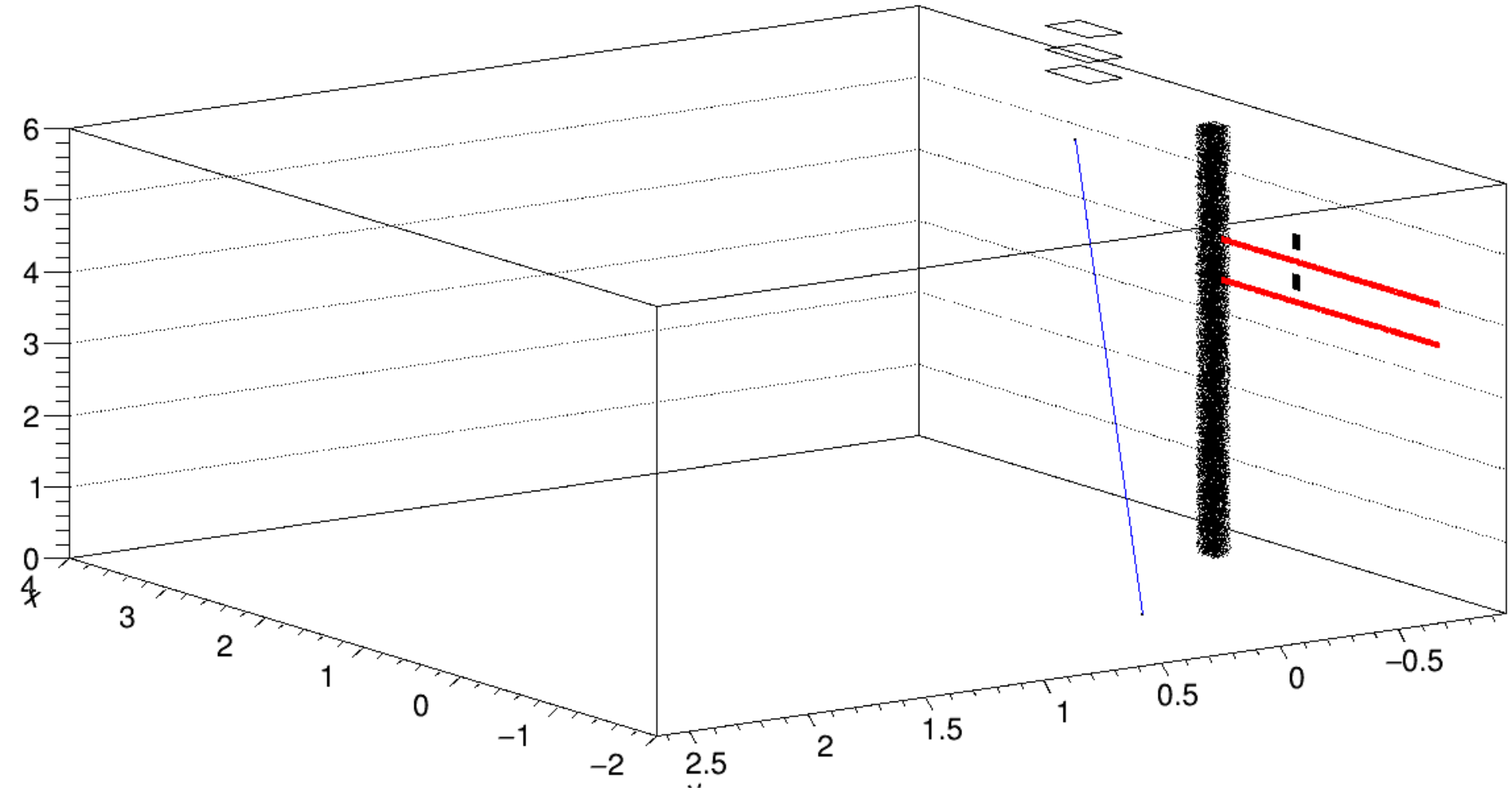
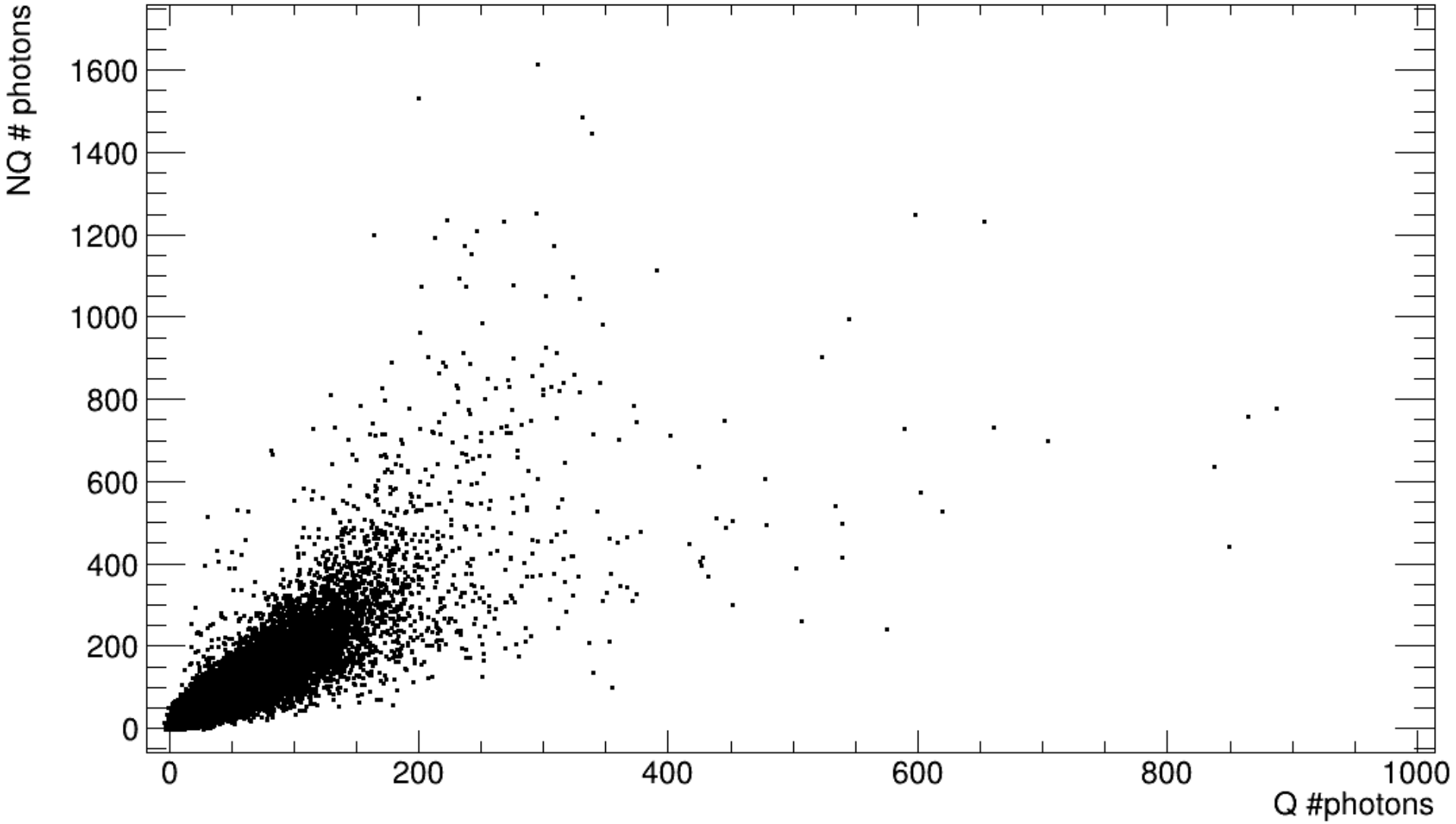
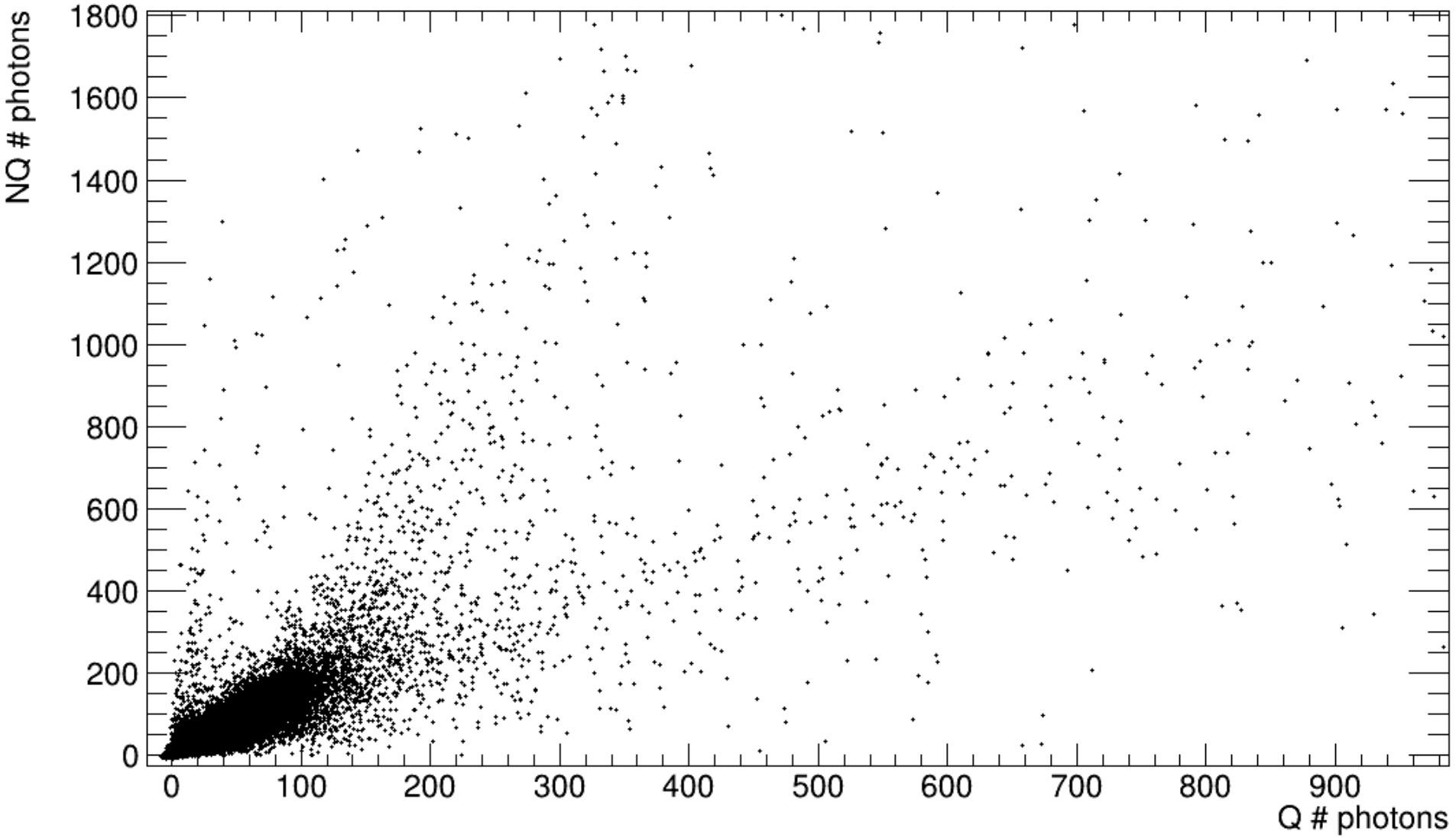


MC - Scatter plot

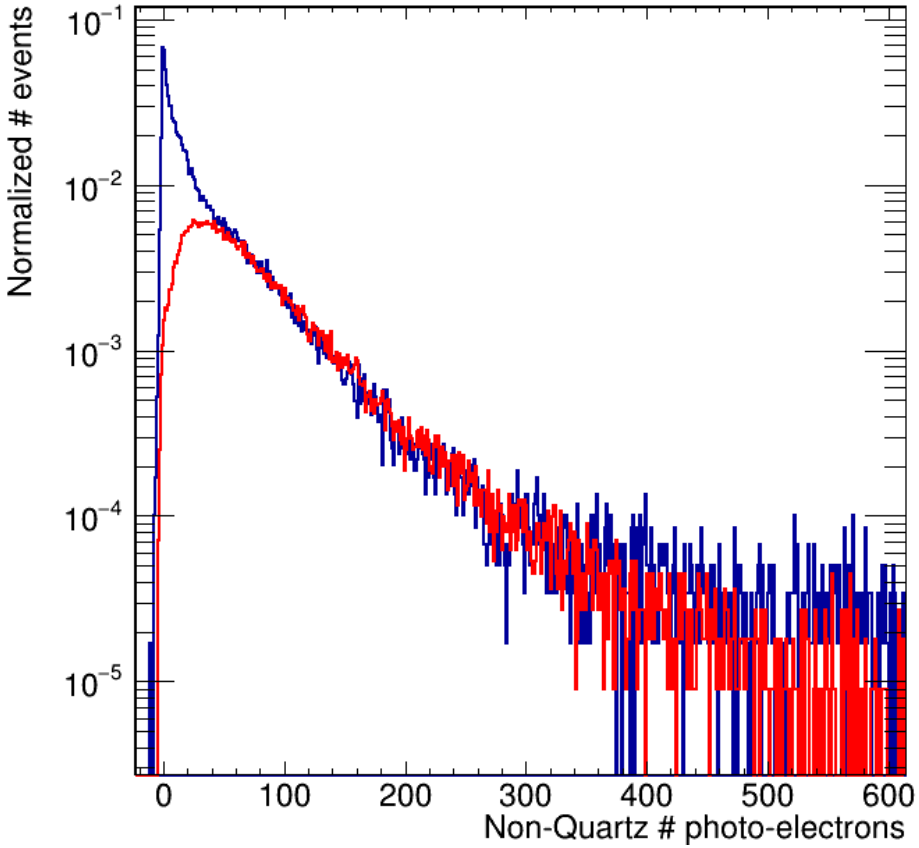


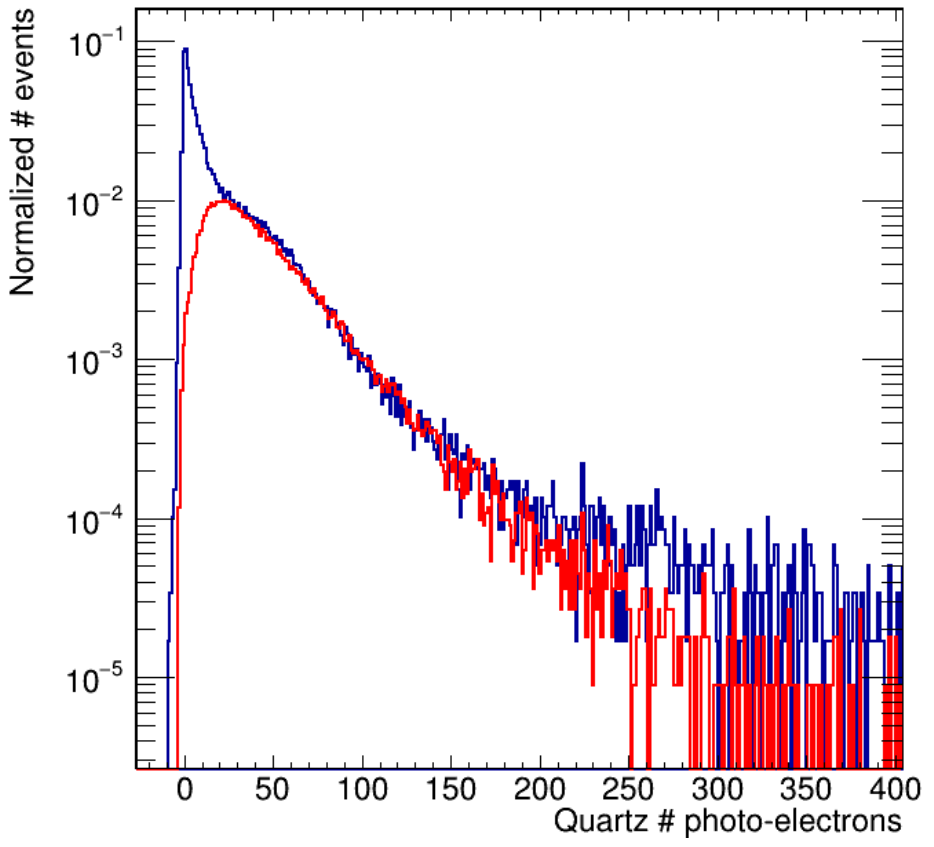
Doping 5 Scatter plot



Spectrum

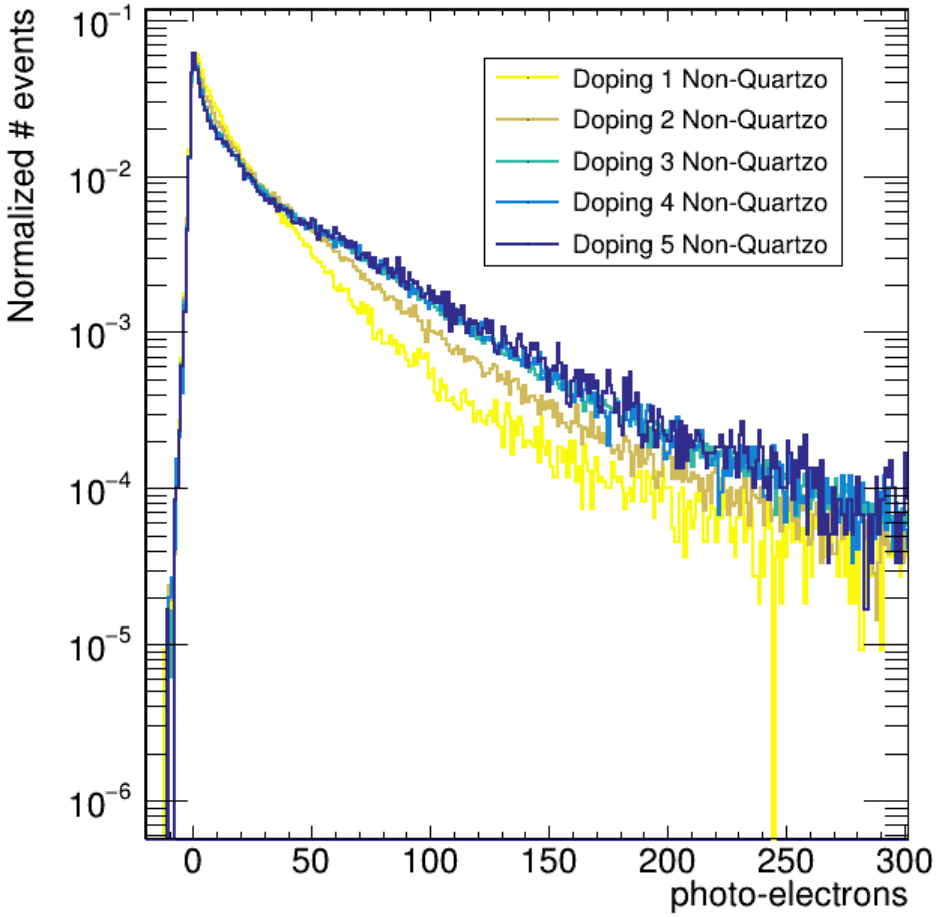
- X-ARAPUCA efficiency ~ 2%
- Quartz window transmittance ~ 80%
- MC output (RED) correspond to ~ 46% of the data

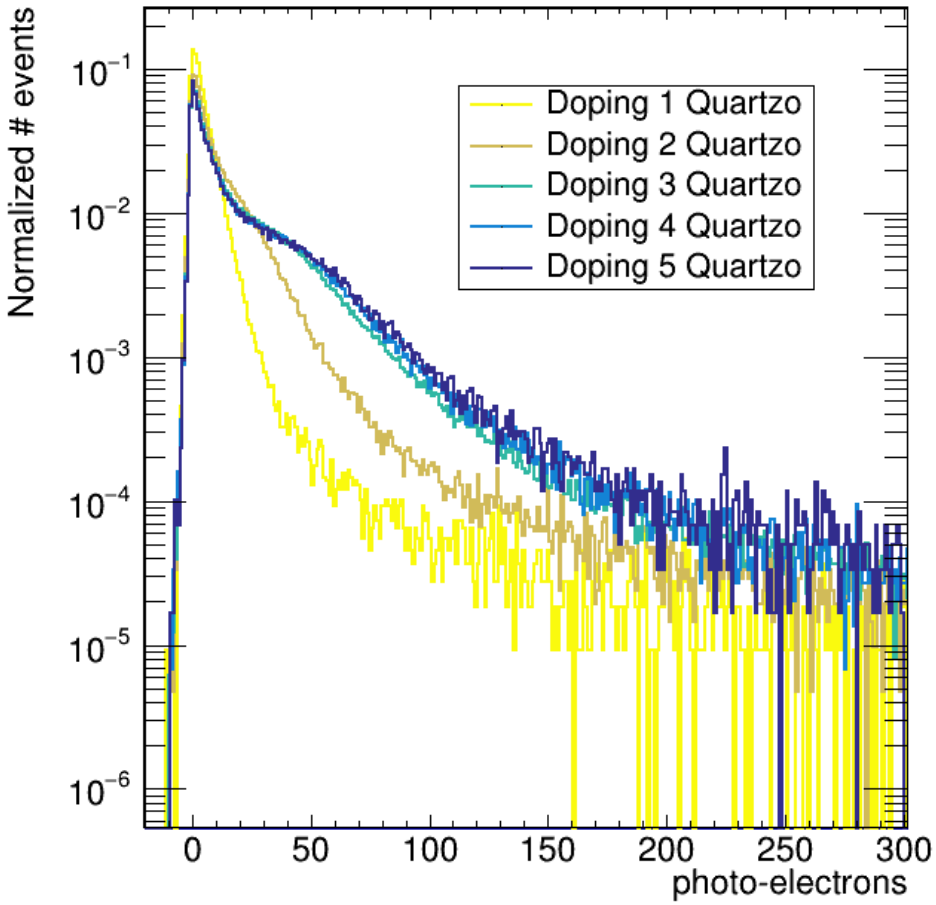




Backup slides

Light yield


Normalized # events
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
0
50
100
150
200
250
300
photo-electrons
Doping 1 Non-Quartzo
Doping 2 Non-Quartzo
Doping 3 Non-Quartzo
Doping 4 Non-Quartzo
Doping 5 Non-Quartzo

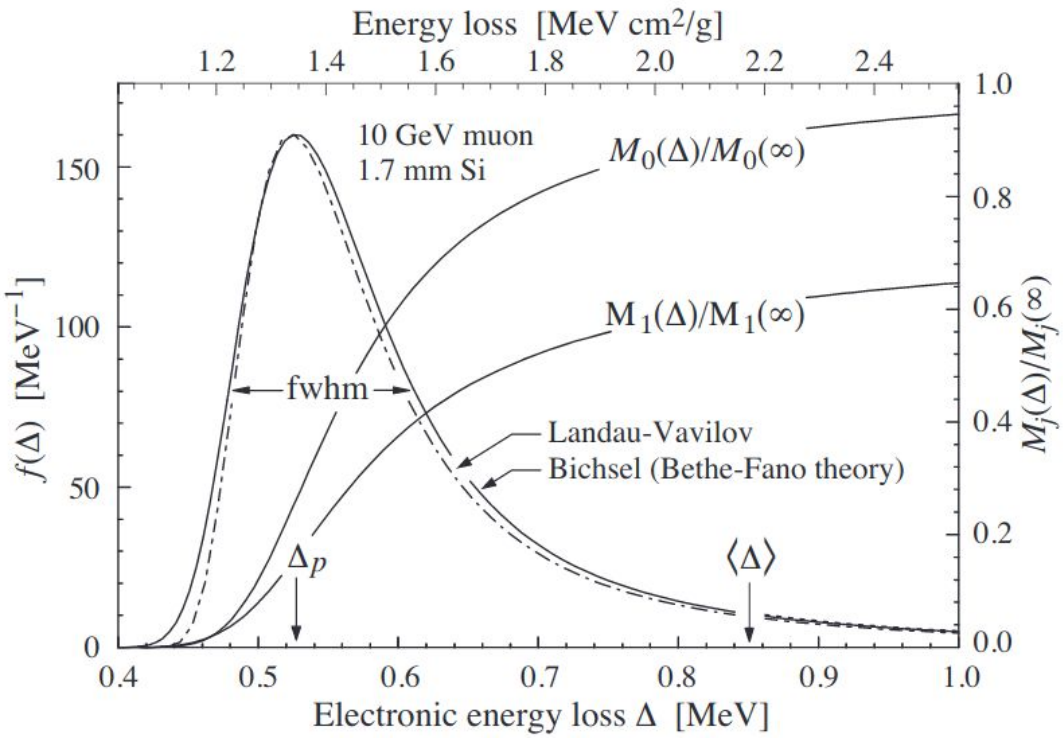

Normalized # events
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
0
50
100
150
200
250
300
photo-electrons
Doping 1 Quartzo
Doping 2 Quartzo
Doping 3 Quartzo
Doping 4 Quartzo
Doping 5 Quartzo

MC - implementation

Muon energy loss:

fwhm set as 4ξ,
were

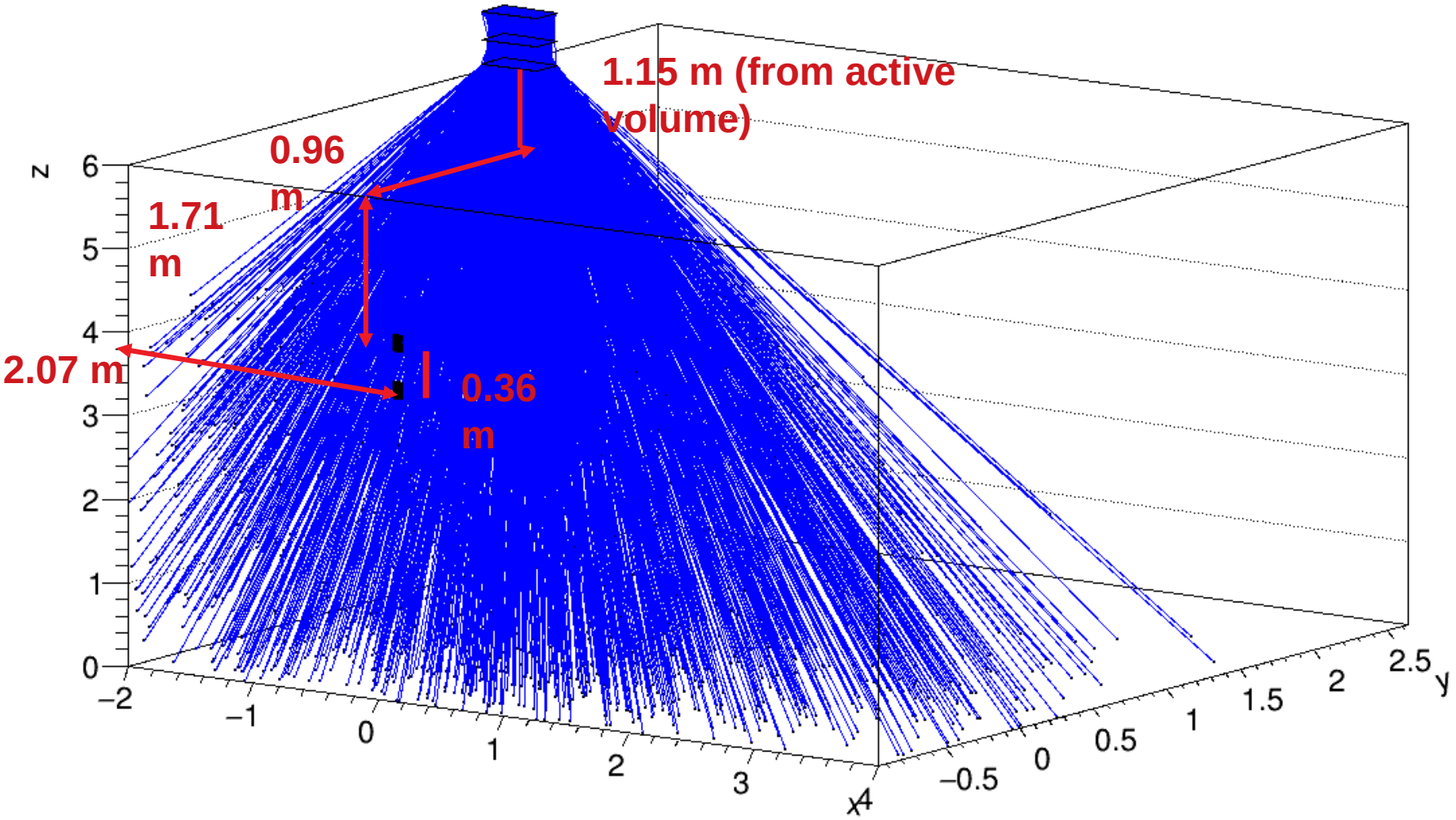
$$\xi = (K/2)\,\langle Z/A\rangle\, z^2 (x/\beta^2)\ \text{MeV}$$



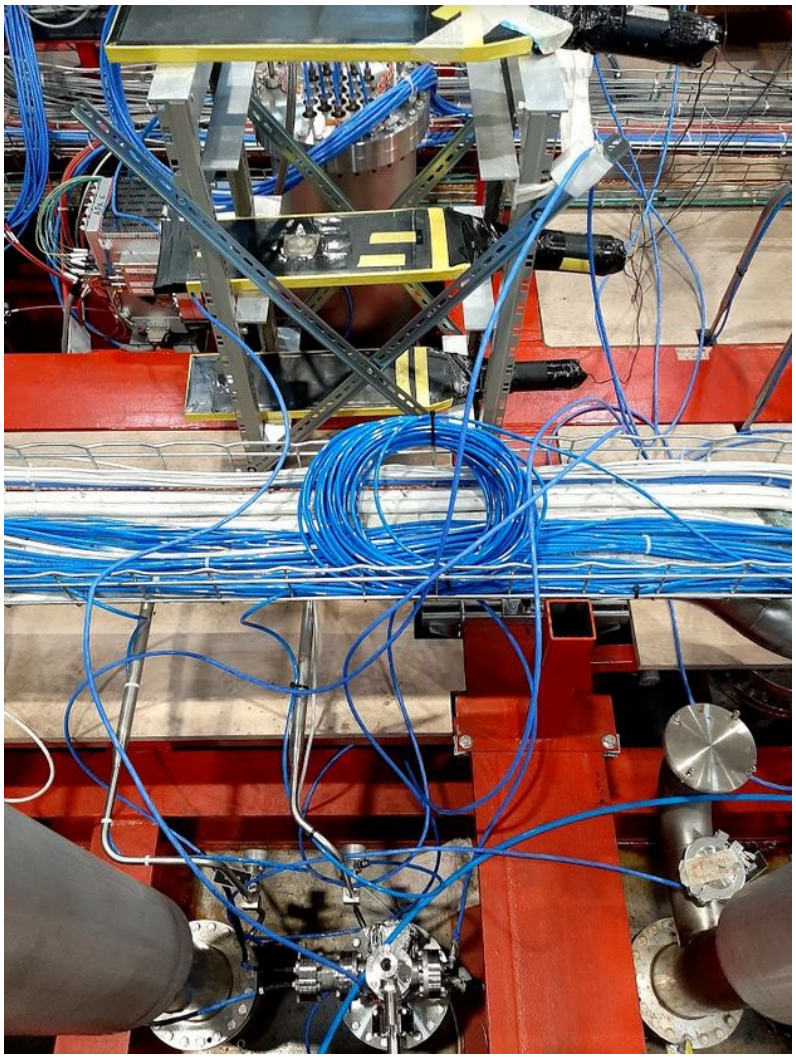
Not the best approximation, we still have many muons stopping inside the detector (this did not affect the results).

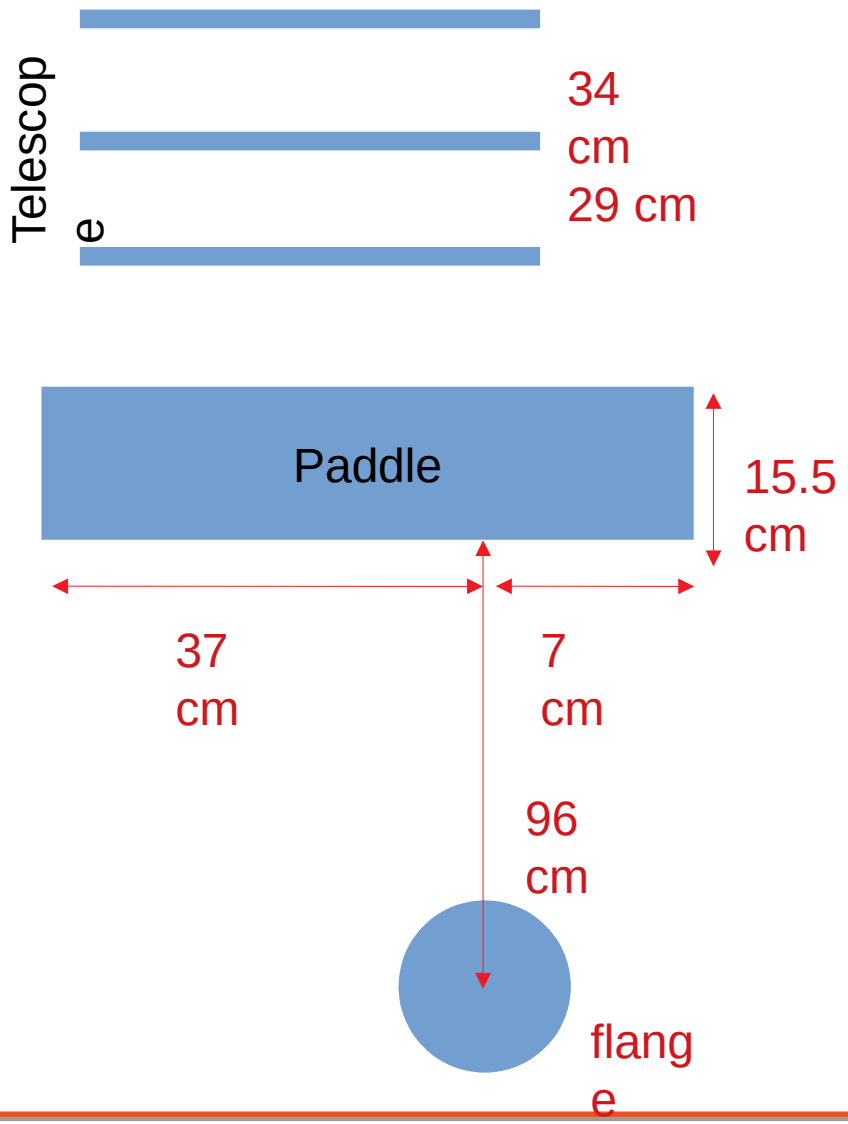
https://pdg.lbl.gov/2012/reviews/rpp2012-rev-passage-particles-matter.pdf

MC - implementation



MC - implementation





MC - implementation

Photon emission:

- Isotropic emission

- Light yield was set as 400 photons/MeV. This (roughly) correspond to a 1% efficiency of the x-arapuca.

- Rayleigh Scattering with $\lambda = 1$ m

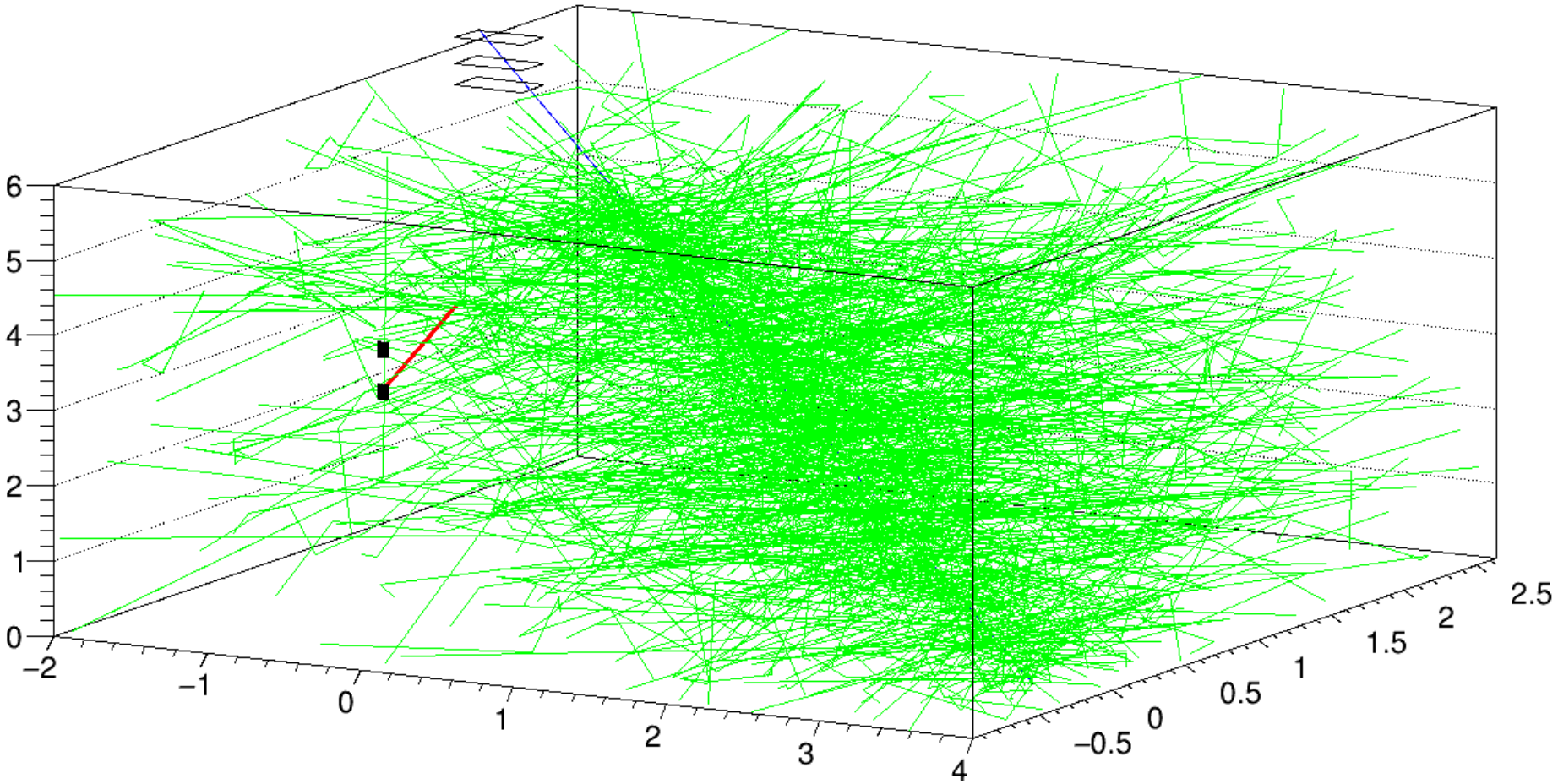
- Absorption with $\lambda = 20$ m

- The “type” (128 nm or 175 nm) of photon is decided in the emission, 70% for Xe and 30 % Argon.

- To speed up simulation, the type was also decided only if the photon hit the x-arapuca window. No change in the output was noticed.

MC - implementation

Photon emission:



MC - implementation

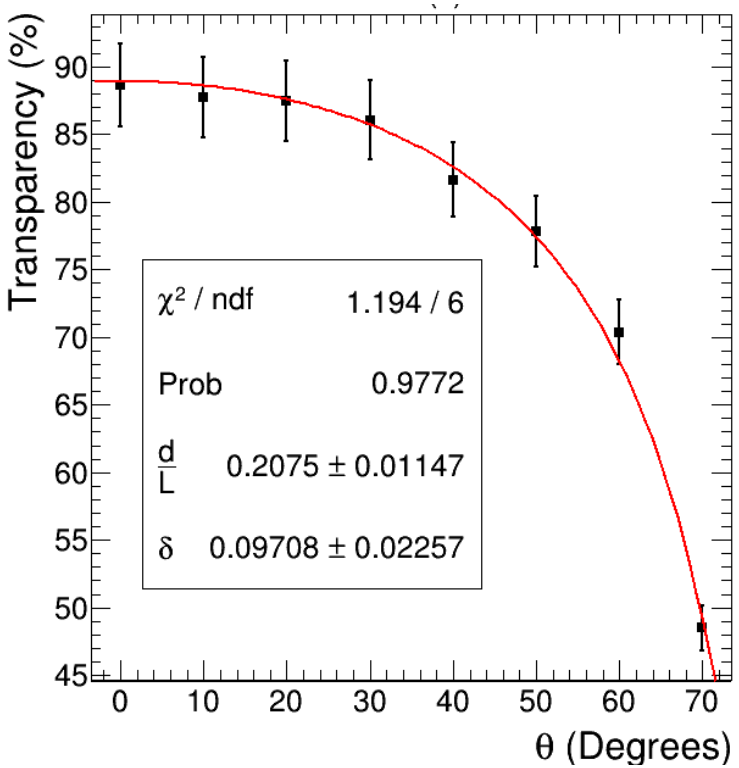
Shadow due to grids:

In front of the x-arapucas there are:

- 6 TPC wires (d = 0.15 mm (diameter) and L = 4.75 mm (pitch))
- Two sets of ground grids (transparency measured at Unicamp)

Fitting function

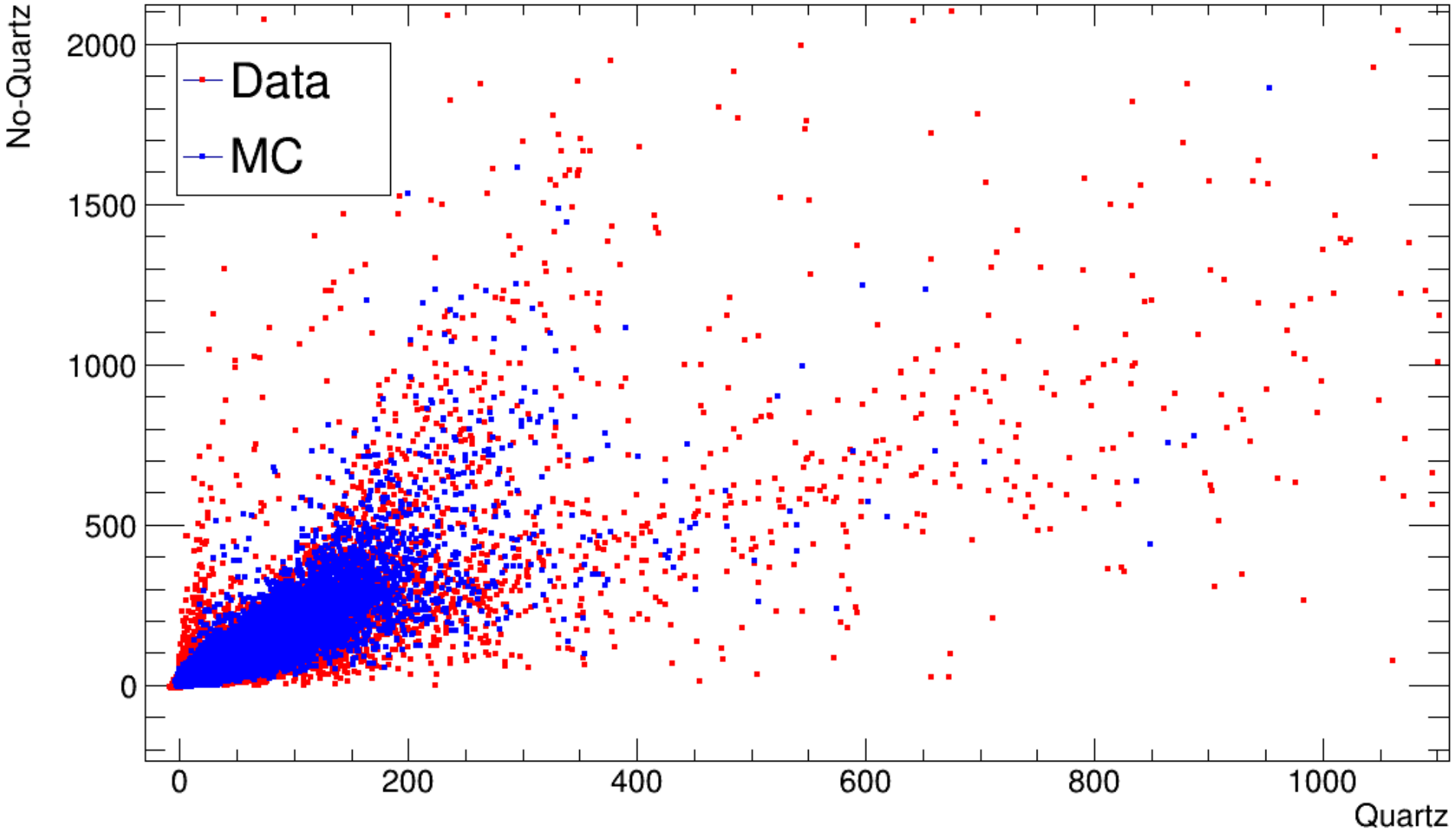
$$1 - \frac{d}{L}\frac{1}{\cos(\theta)} + \delta$$



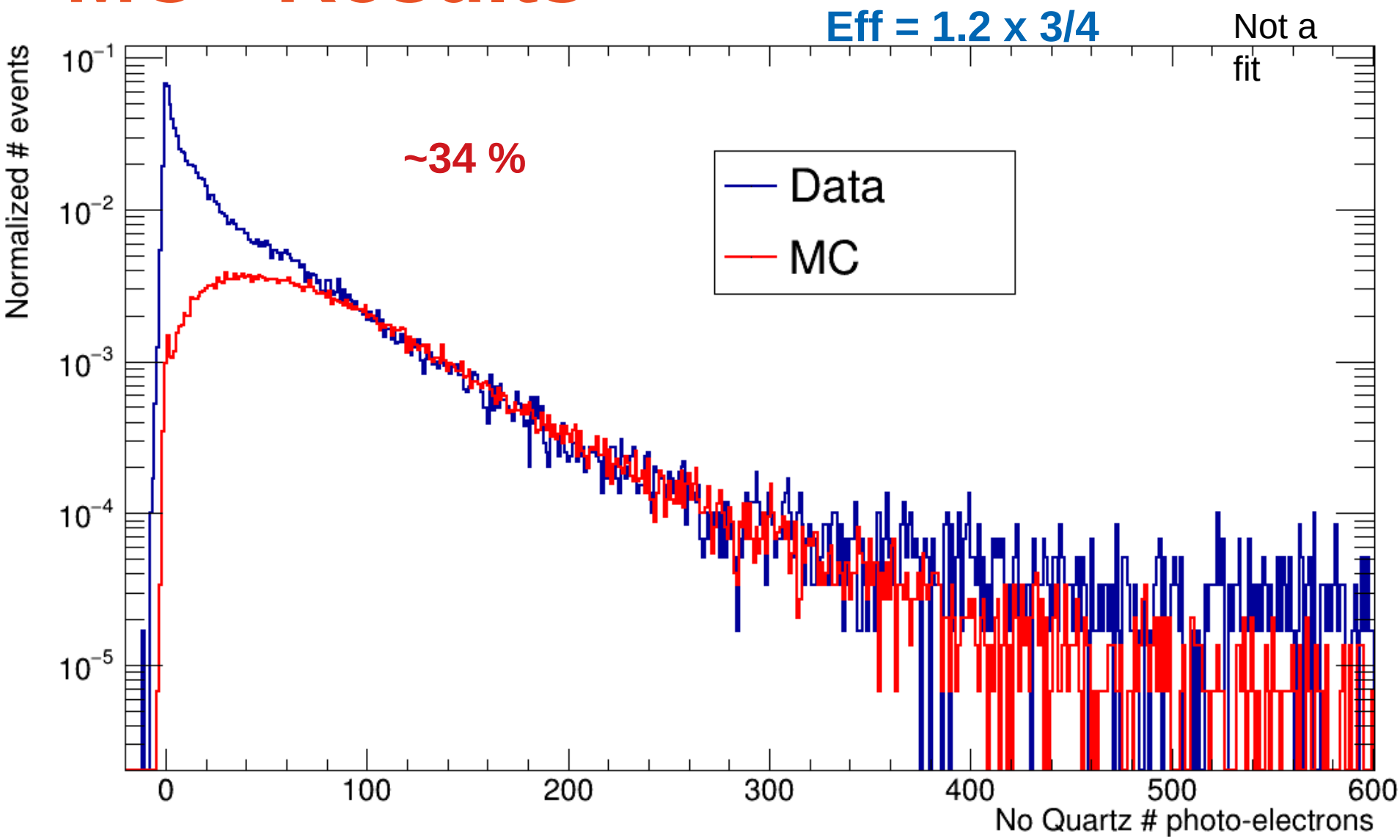
For each photon, we save the angle relative to the normal of the x-arapuca.

The photon must go through all the 6 + 2 grids with a survival probability given by the formula.

MC - Results

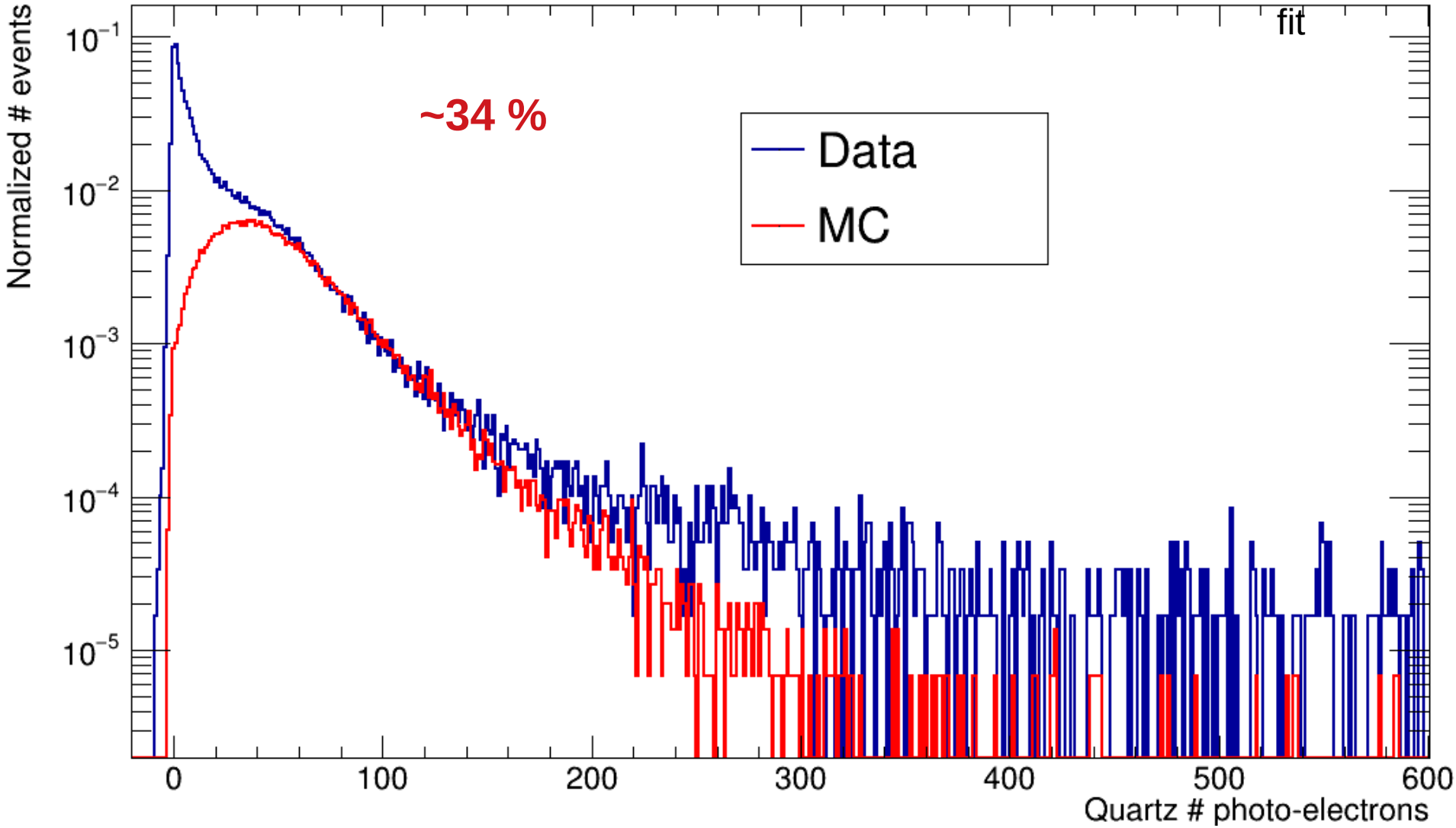

Data
MC
No-Quartz
Quartz
2000
1500
1000
500
0
0
200
400
600
800
1000

MC - Results

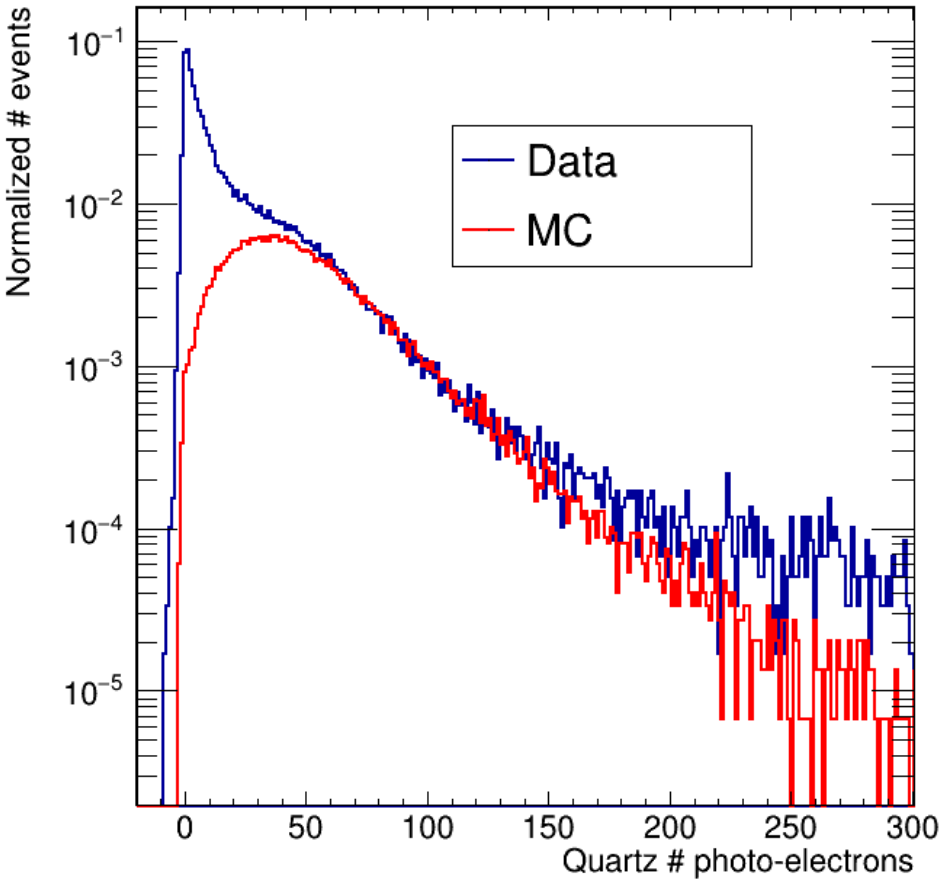

Eff = 1.2 x 3/4
Not a fit
~34 %
Data
MC
Normalized # events
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
0
100
200
300
400
500
600
No Quartz # photo-electrons

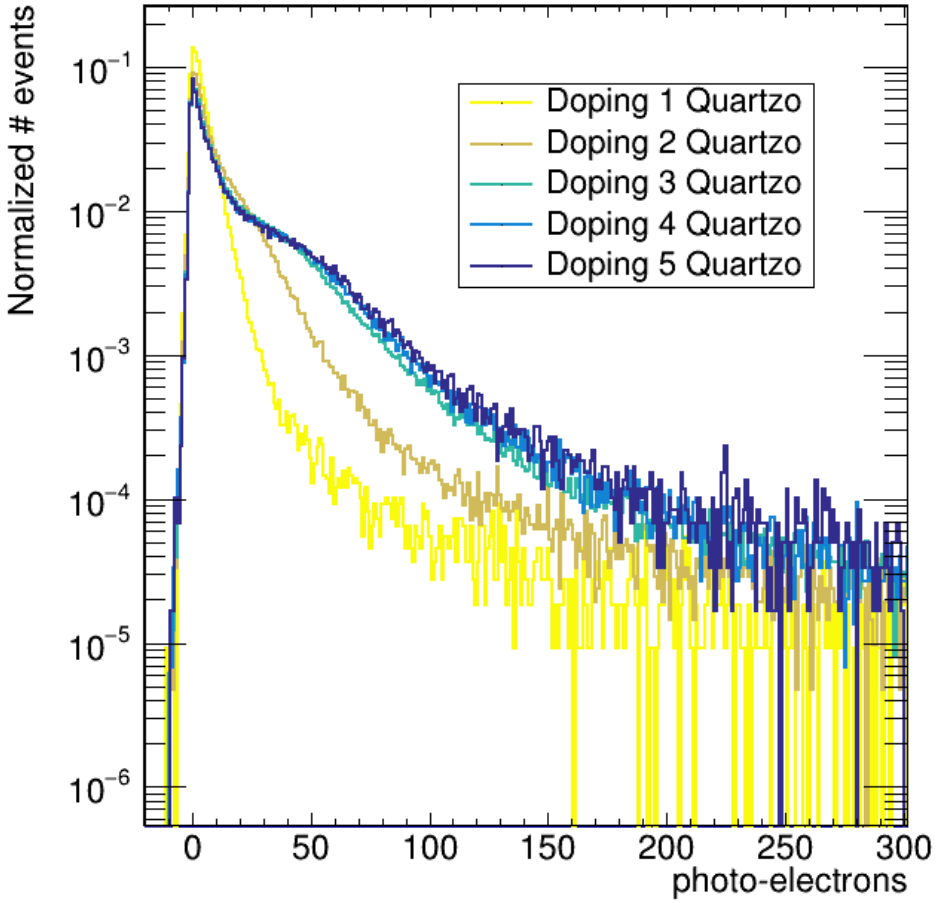
MC - Results

Eff = 1.2 x 3/4 x 0.8 Not a fit

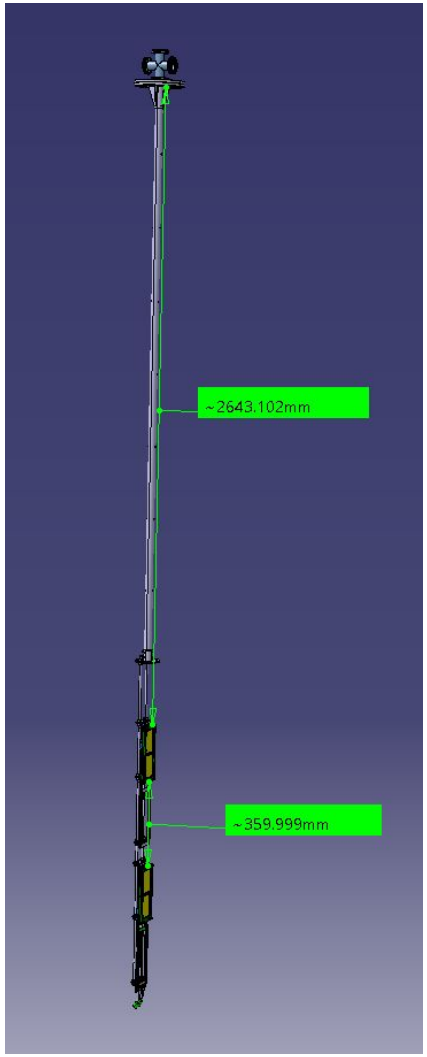


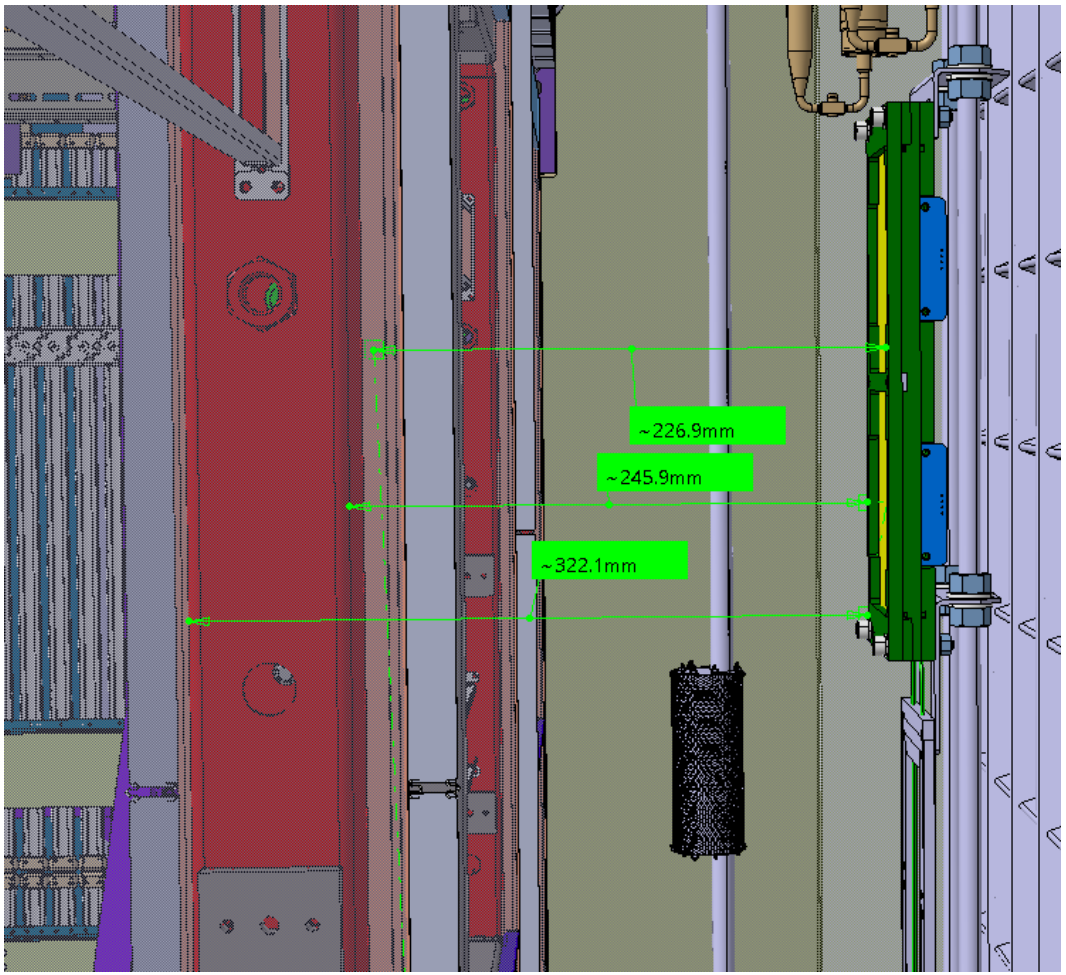
MC vs Data


Normalized # events
Data
MC
Quartz # photo-electrons


Normalized # events
Doping 1 Quartzo
Doping 2 Quartzo
Doping 3 Quartzo
Doping 4 Quartzo
Doping 5 Quartzo
photo-electrons

Backup slides





Backup slides