

PMT Signal Simulation

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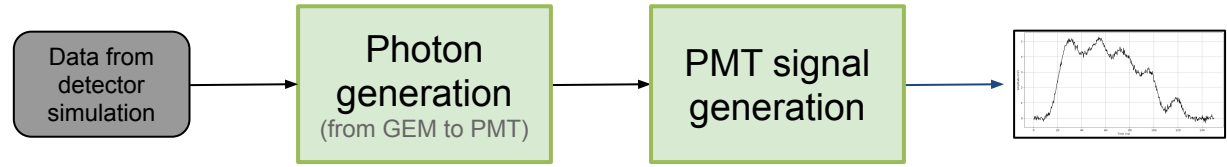
Mariana Migliorini with Davide Pinci (INFN-Roma I) and Rafael A. Nóbrega (UFJF)



September 27, 2022



Summary



- Photon Generation
 - Description
 - Scan Measurements
- PMT Signal Generation
 - Description
 - PMT Signal Characterization
- Next Steps

Photon Generation

Vector equation of a line

- Equation of a line in space:

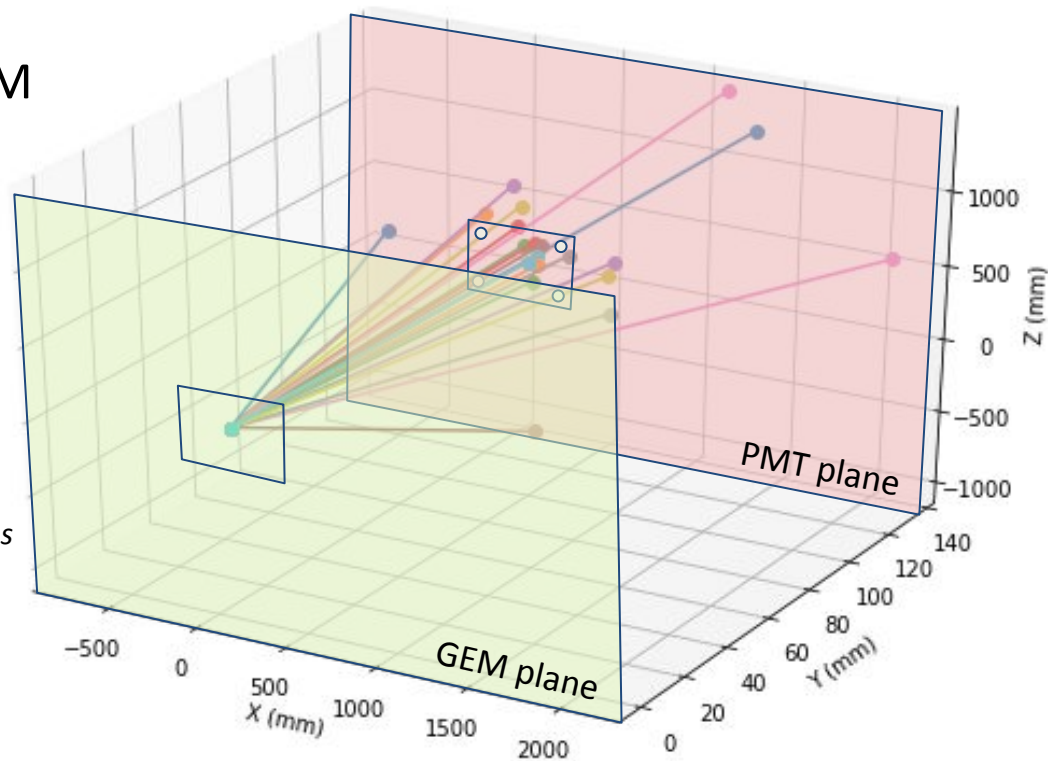
$$(x, y, z) = (x_0, y_0, z_0) + t(v_x, v_y, v_z)$$

- x_0, y_0 and z_0 define initial position of photon;
- t is a scalar parameter;
- v is the vector that describes the direction of the photon;
- The isotropic source is a 3D unit vector generated with a uniform spherical distribution.

Photon generation example *(center of the GEM)*

- N photons generated in the GEM plane throughout an uniform distribution (X, Y)

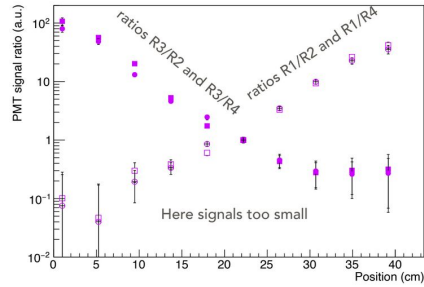
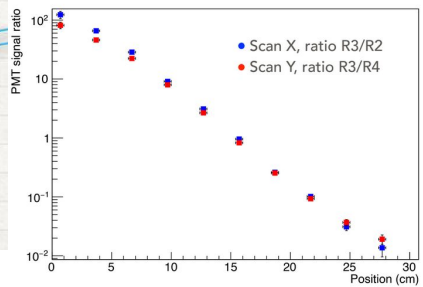
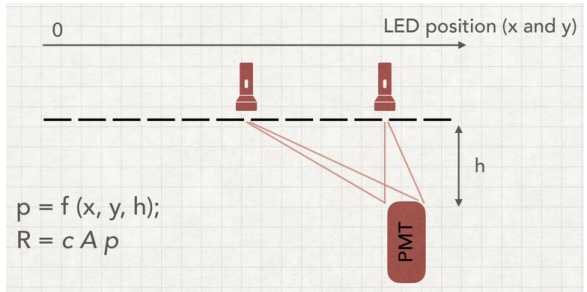
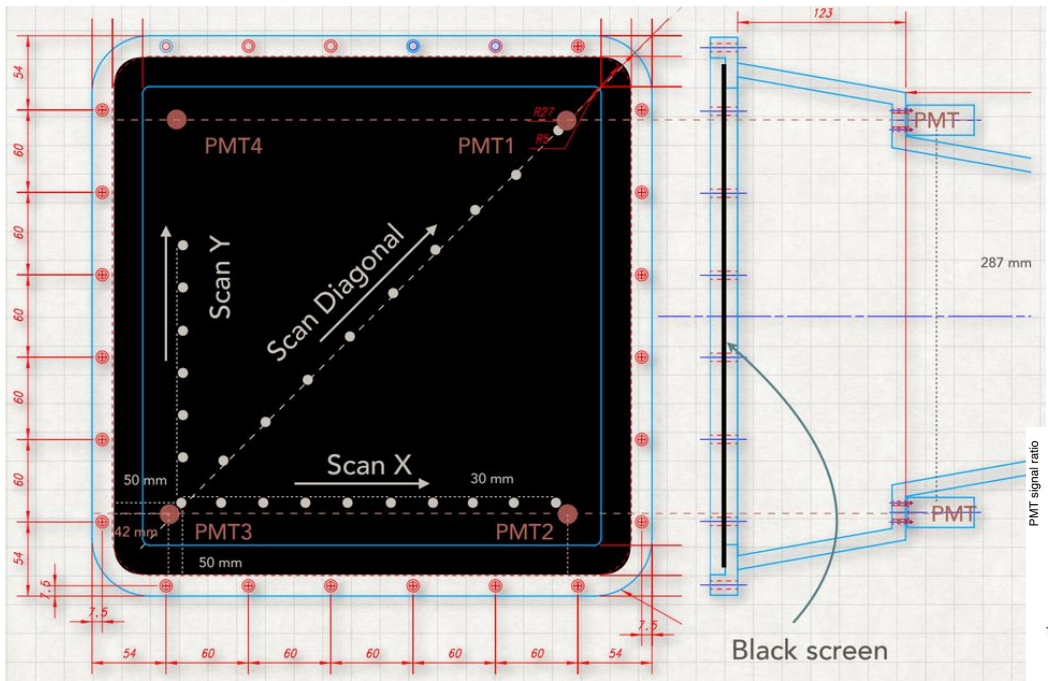
Visual example generating ~20 photons from a single GEM position



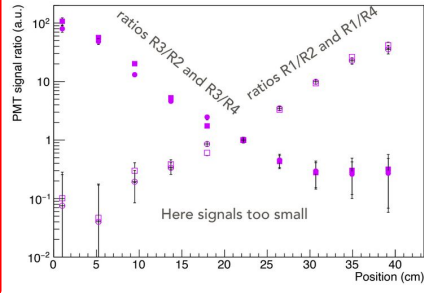
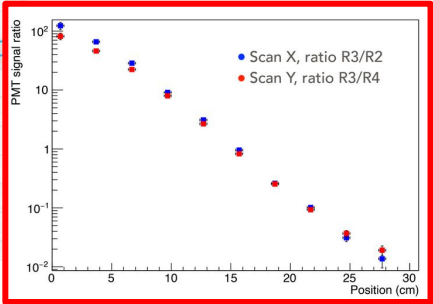
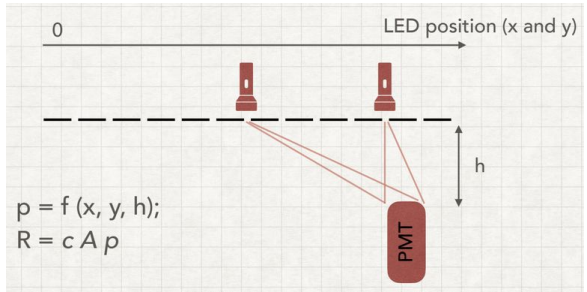
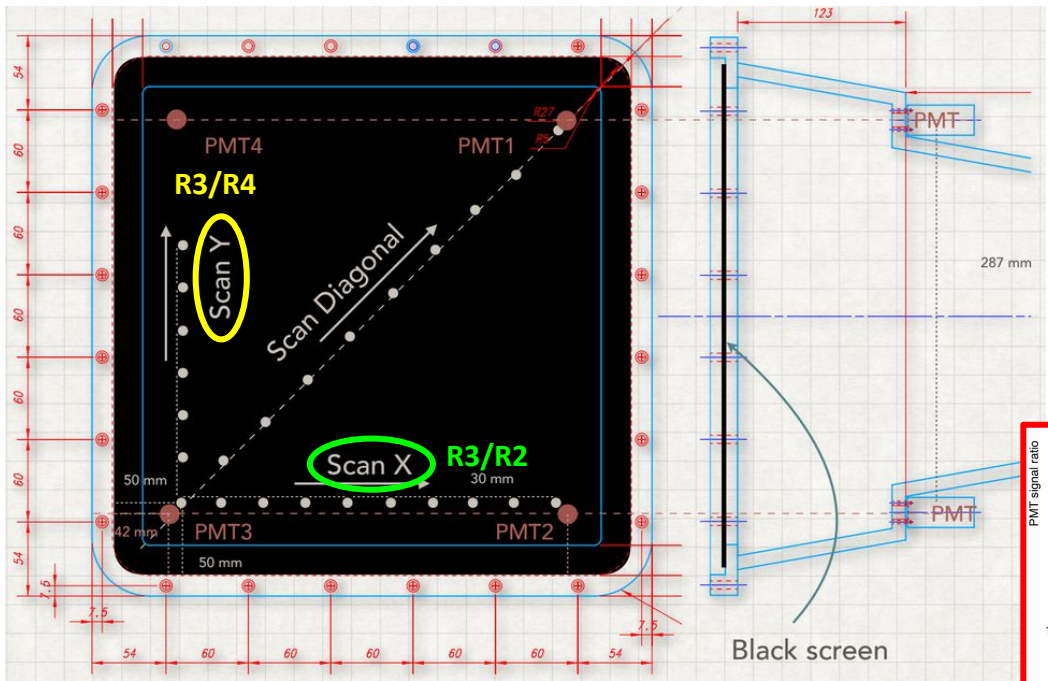
Scan Measurements

Real x Simulated data

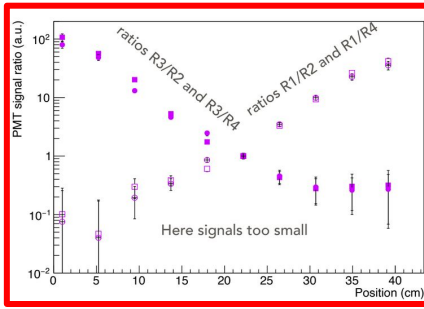
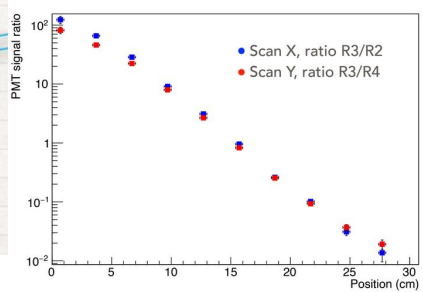
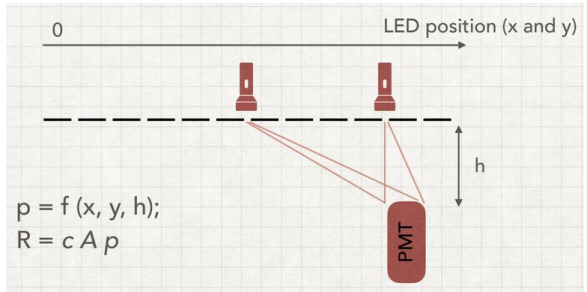
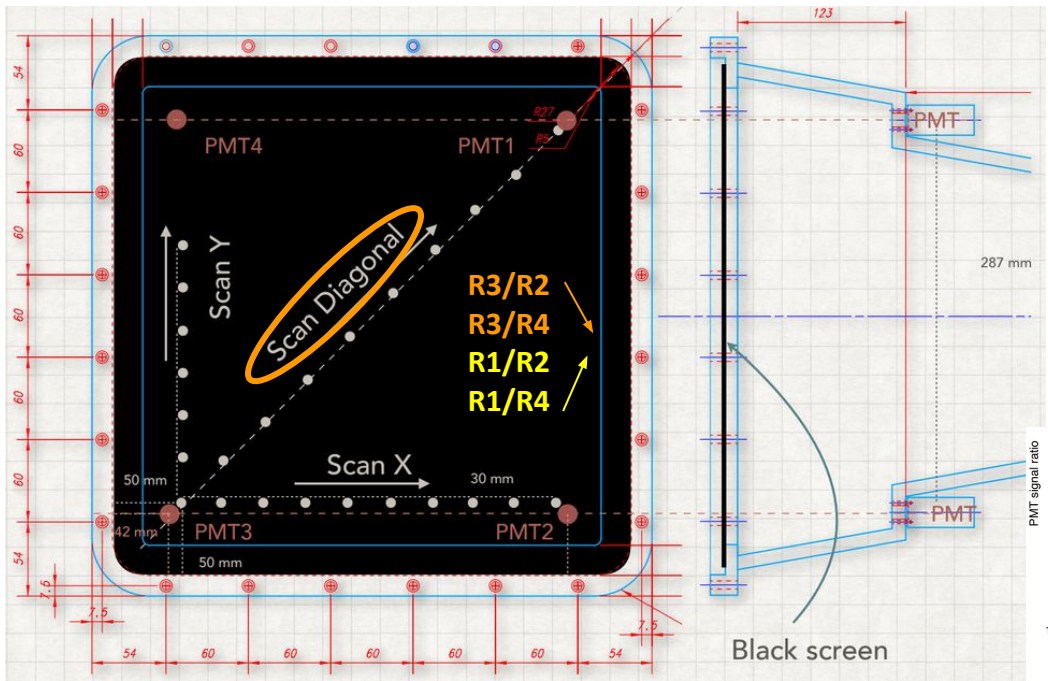
Real measurements — Francesco I. and Davide P.



Real measurements — Francesco I. and Davide P.

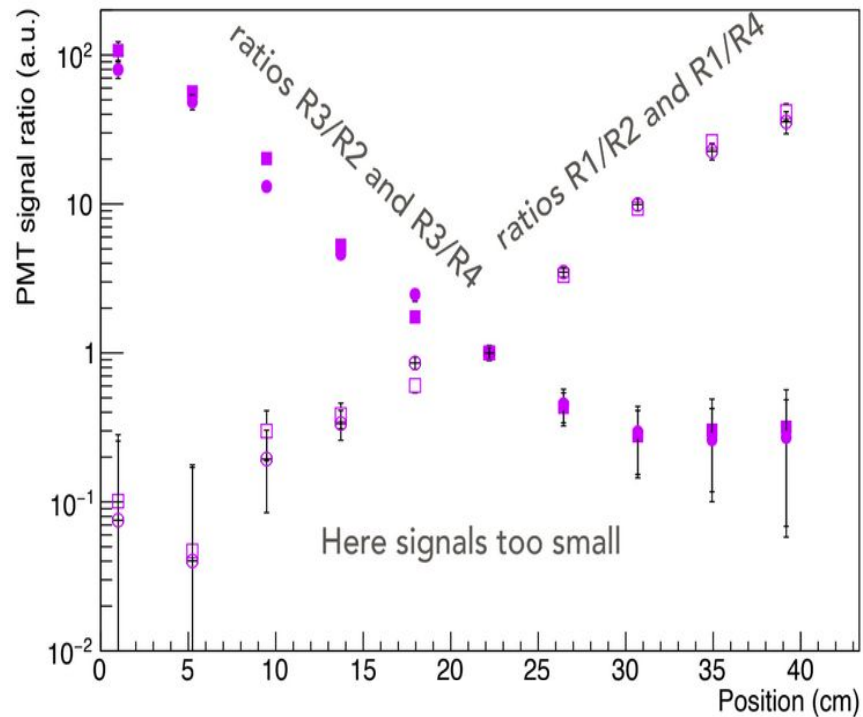


Real measurements — Francesco I. and Davide P.

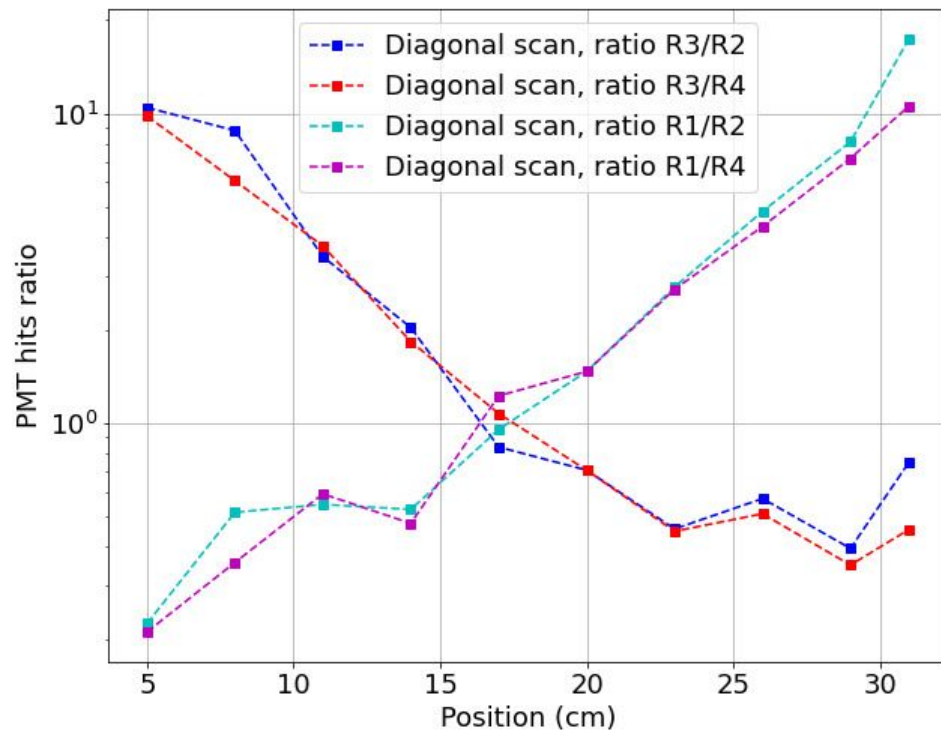


Simulation vs. Real data

Real data

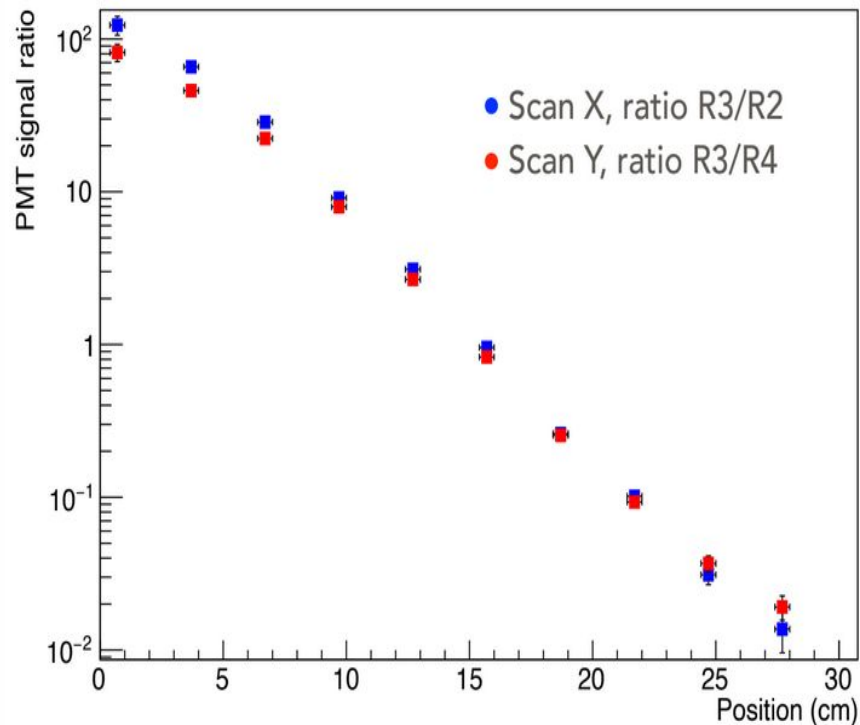


Simulation data (using N=100k photons)

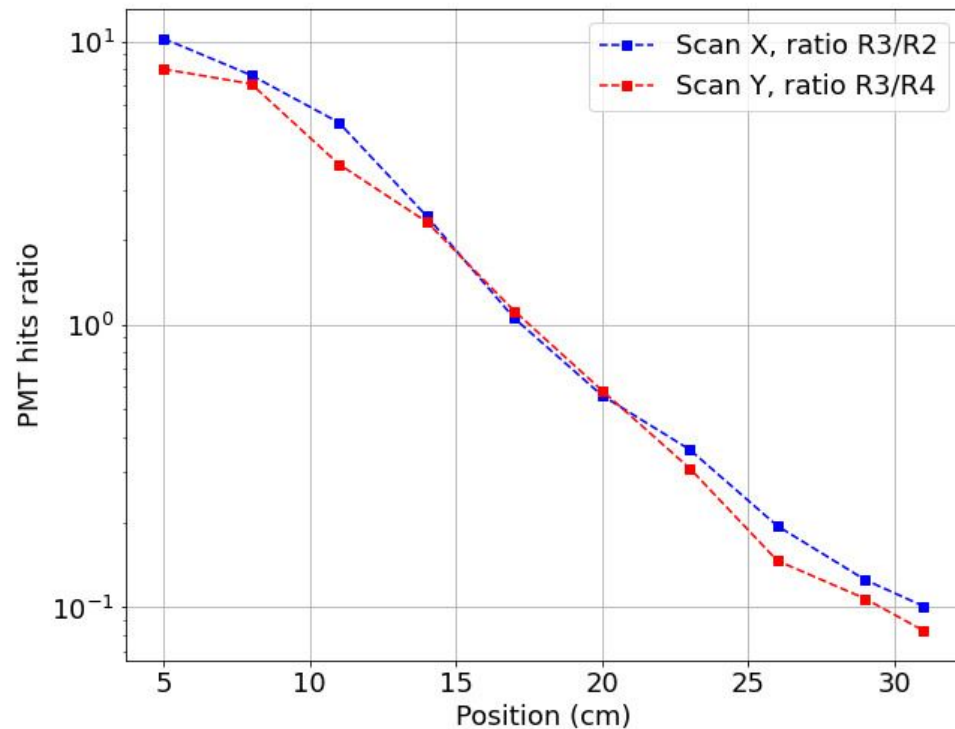


Simulation vs. Real data

Real data

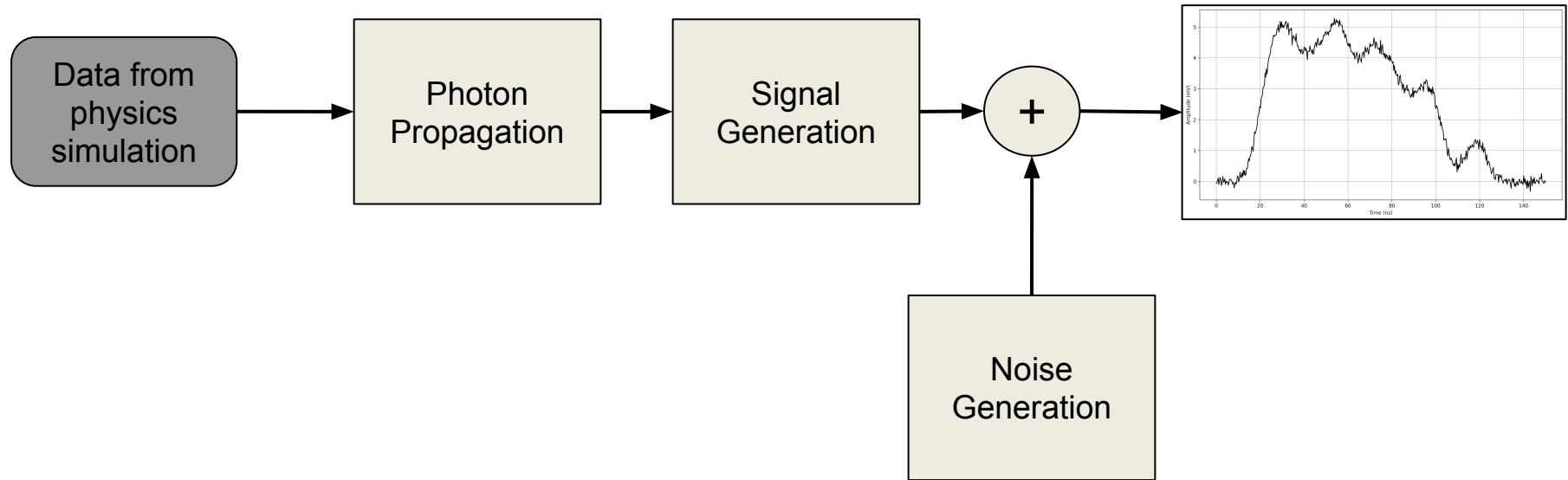


Simulation data (using N=100k photons)

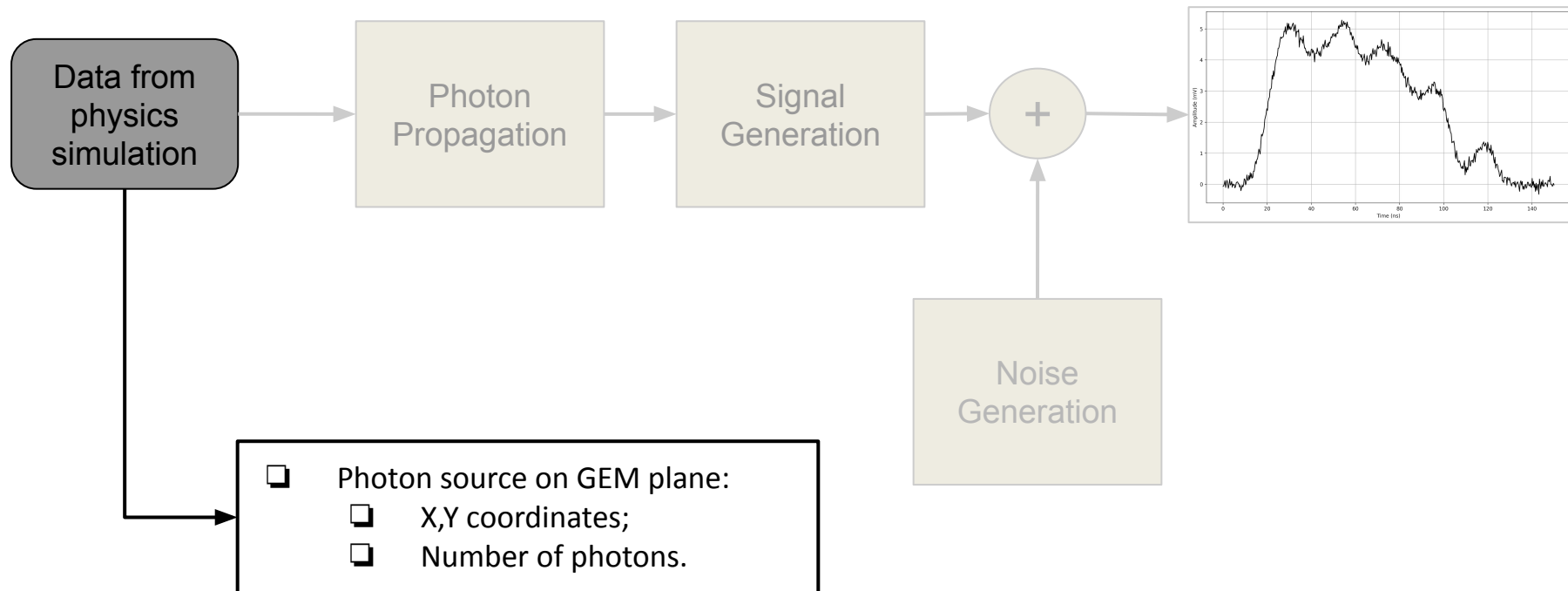


PMT signal generation

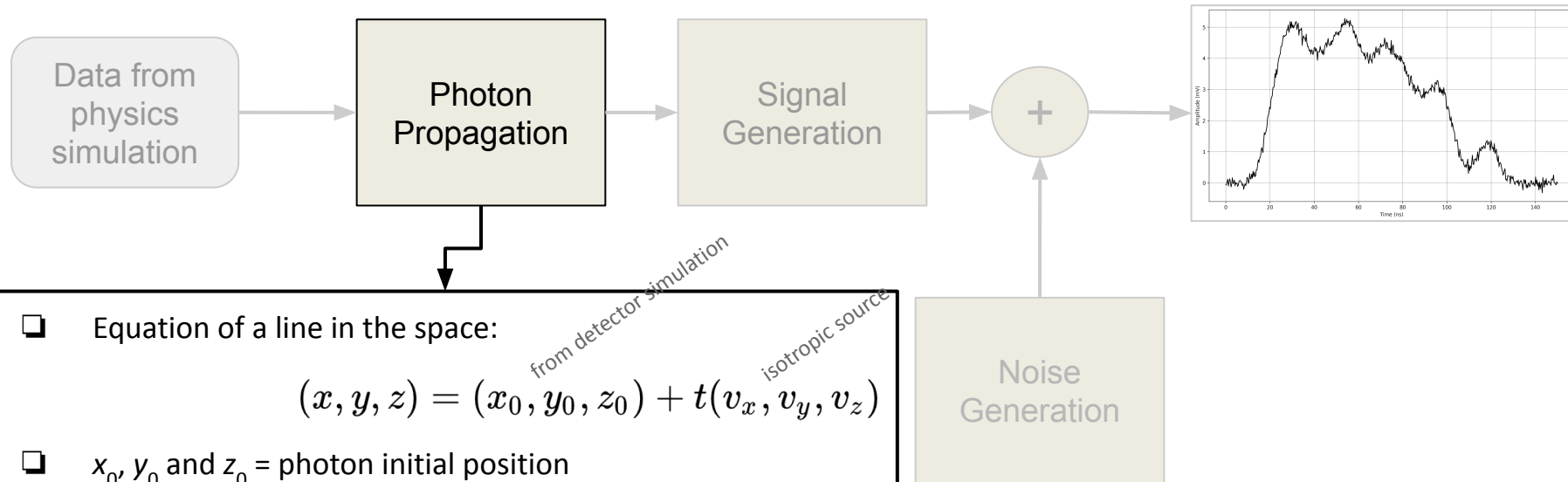
Simulation block diagram



Simulation block diagram



Simulation block diagram

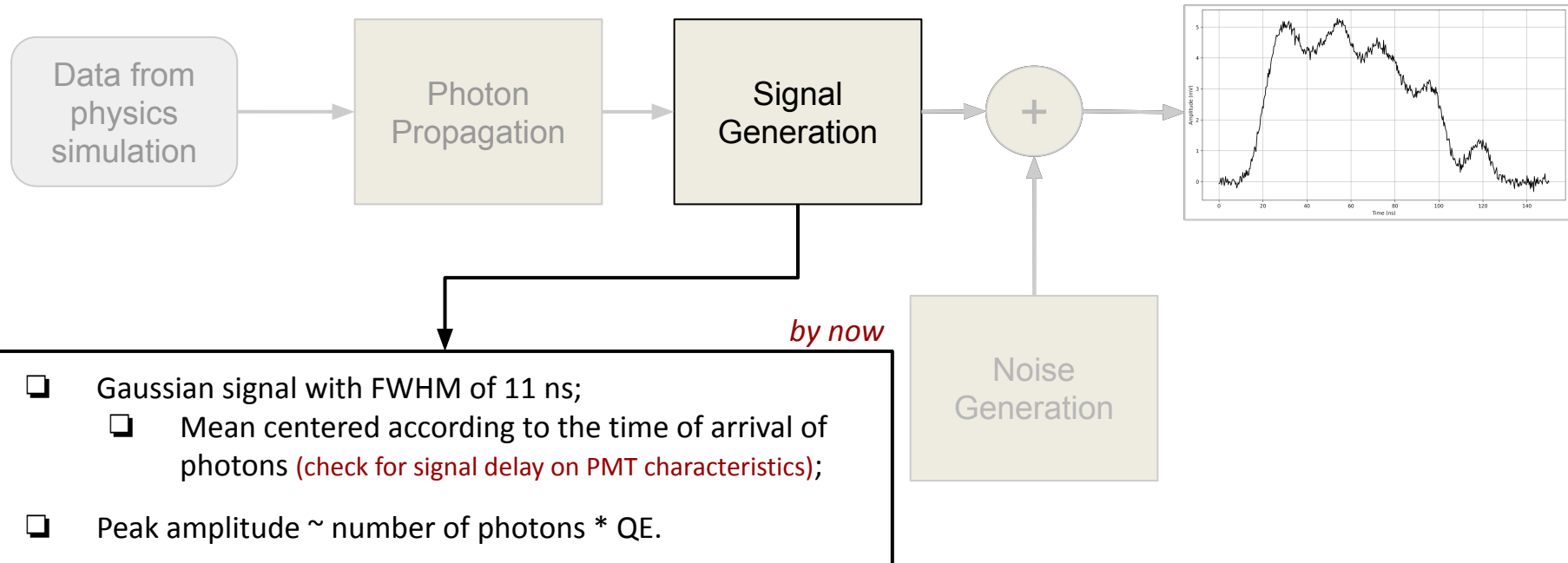


- Equation of a line in the space:

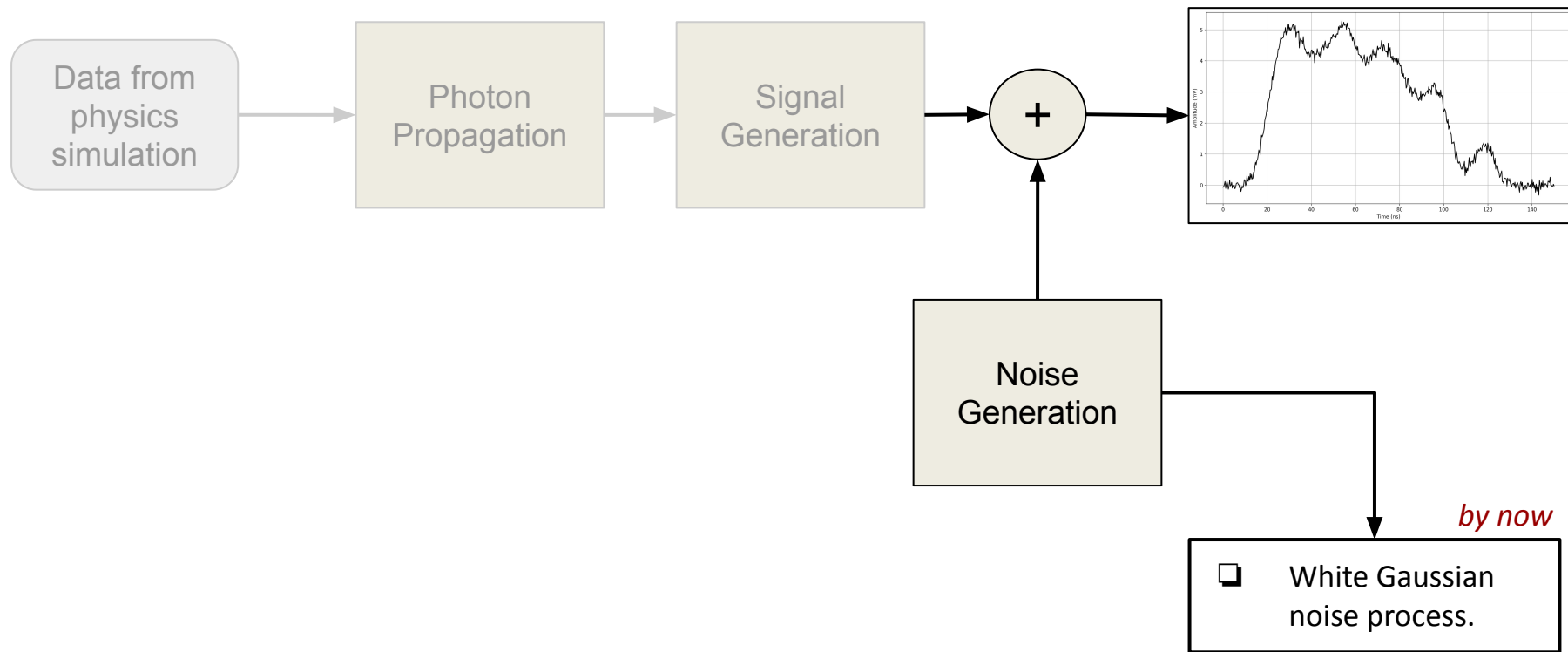
$$(x, y, z) = (x_0, y_0, z_0) + t(v_x, v_y, v_z)$$

- x_0, y_0 and z_0 = photon initial position
- t is a scalar parameter;
- v is the vector that describes the direction of the photon;
 - generated with a uniform spherical distribution (isotropic source).

Simulation block diagram



Simulation block diagram

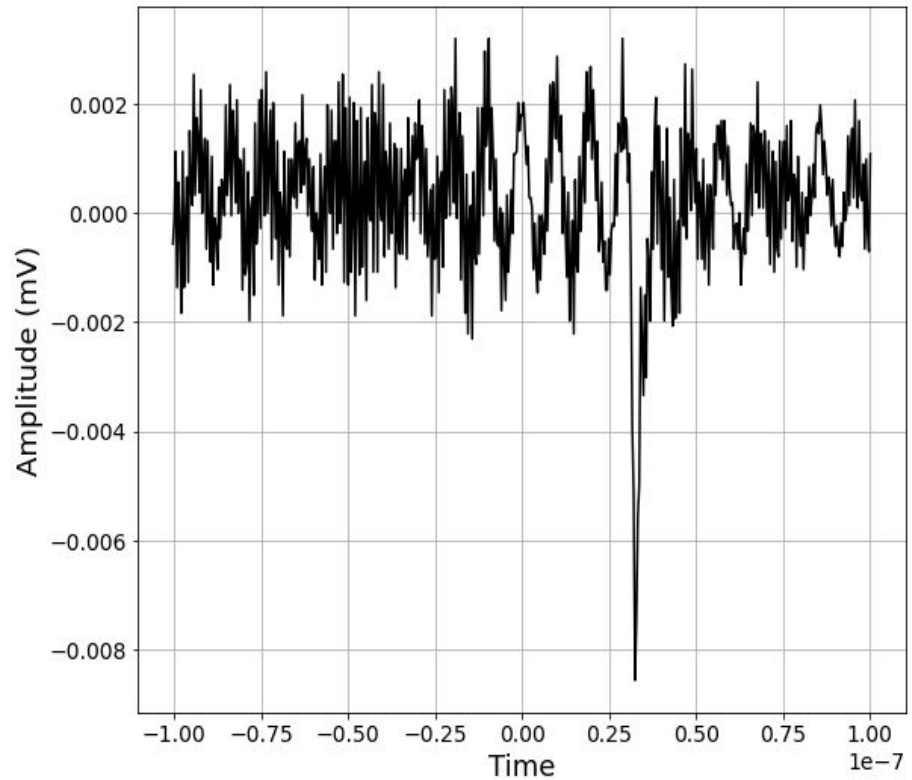
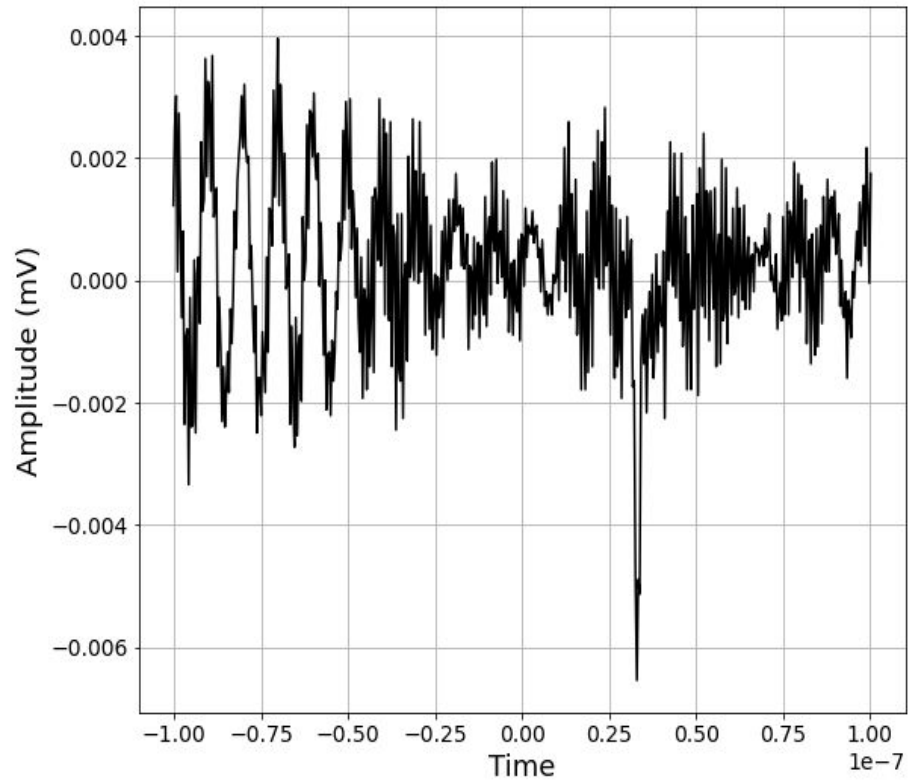


PMT Signal Characterization

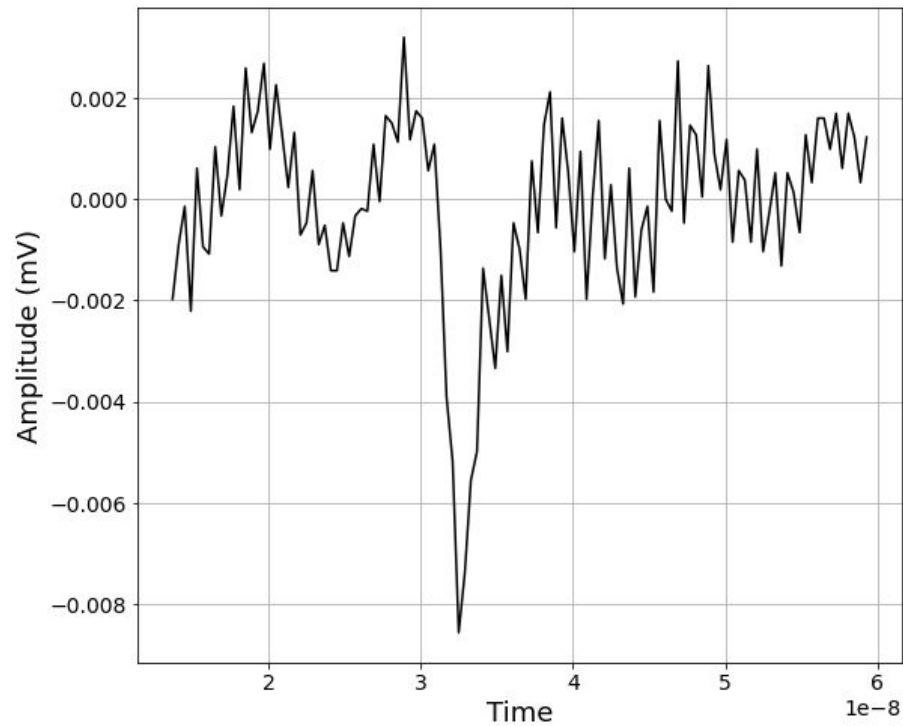
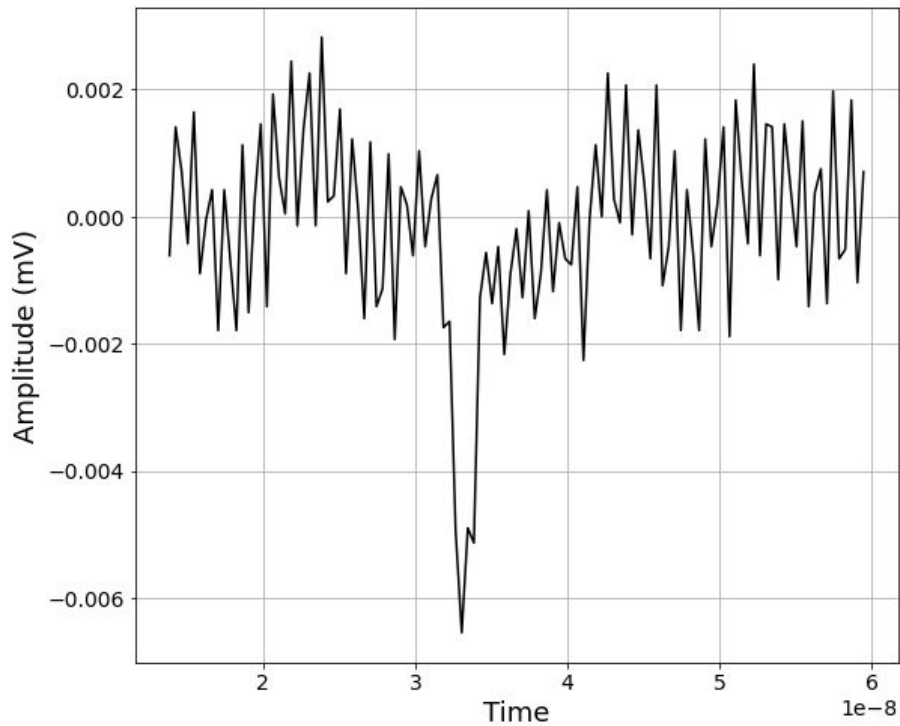
SPE signal shape and noise

on going

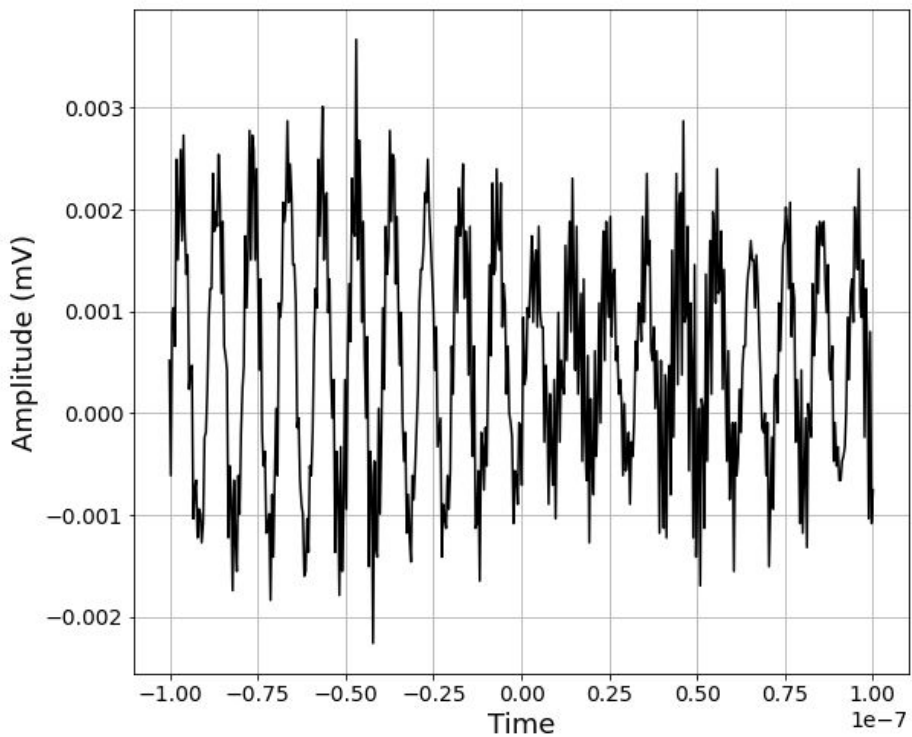
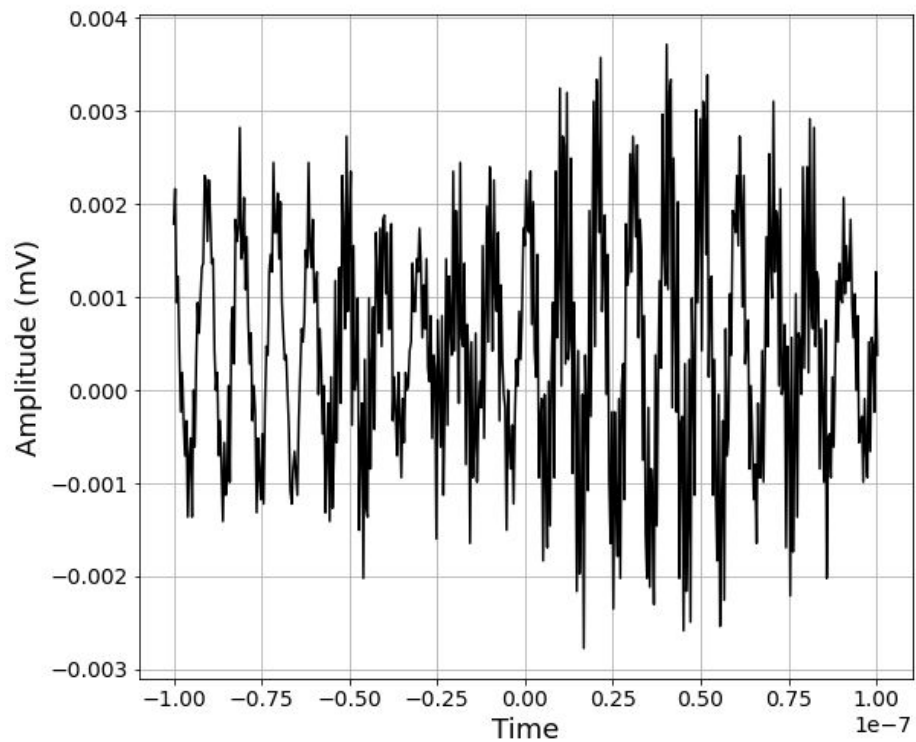
First look at the signal



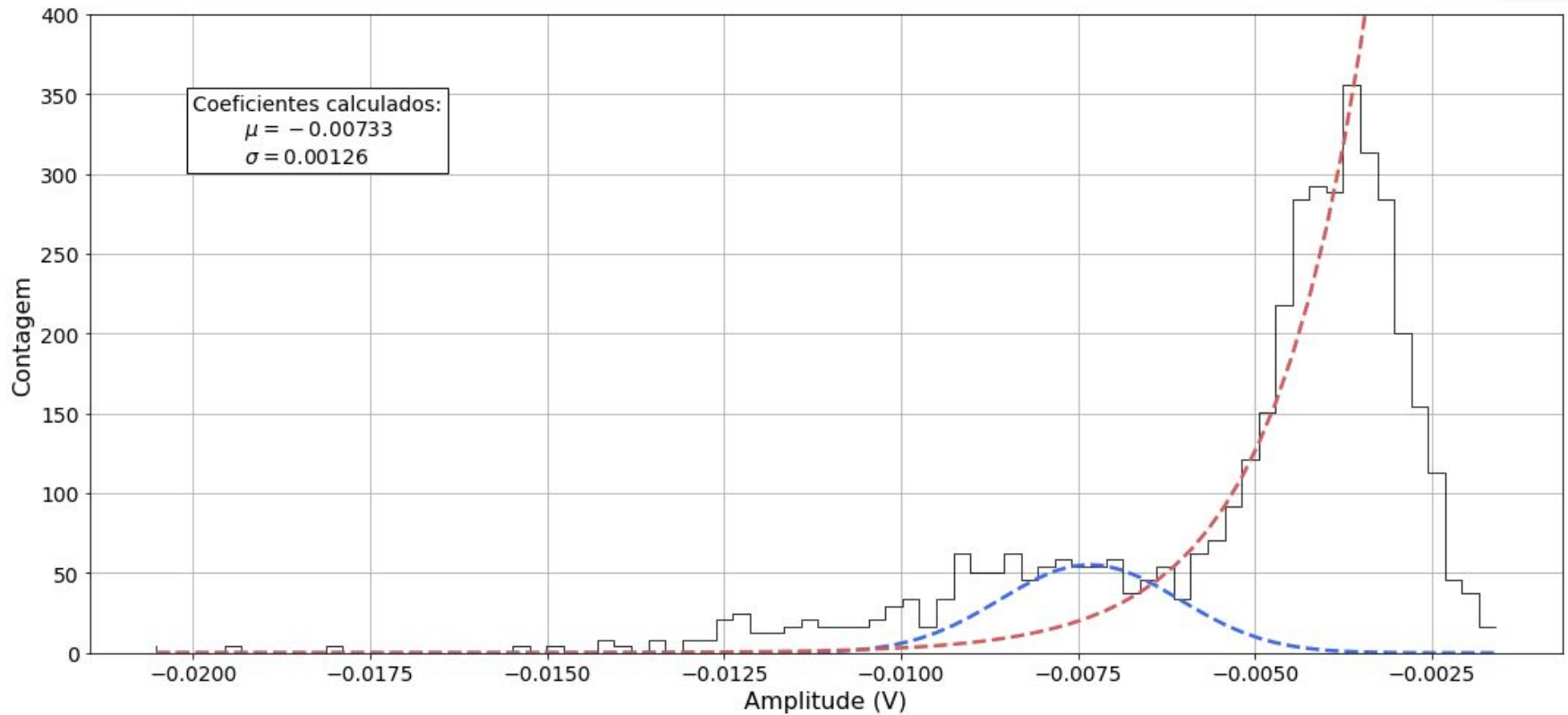
First look at the signal



First look at the noise



Peak amplitude distribution



Next Steps

Next steps

- ❑ Understand the noise oscillation of the SPE acquisition;
- ❑ Generate a better estimation of the PMT SPE shape and noise;
- ❑ Investigate for other PMT characteristics that might be important for the simulation to improve its signal generation algorithm;
- ❑ Integrate photon generation with the signal generation code;
- ❑ Integrate all with detector simulation output

Thank you!