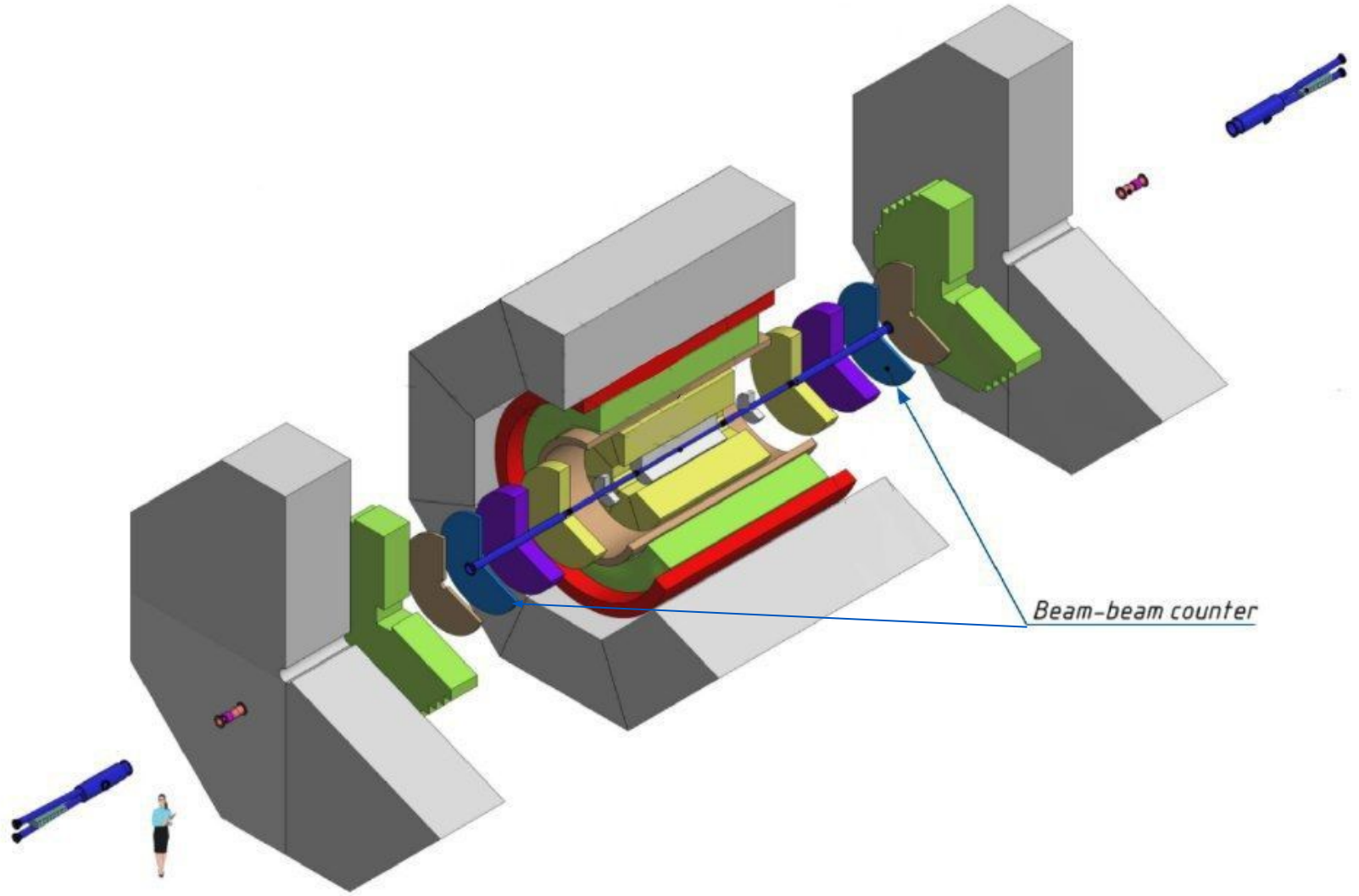
Status of Geant4 Simulation for the BBC Detector

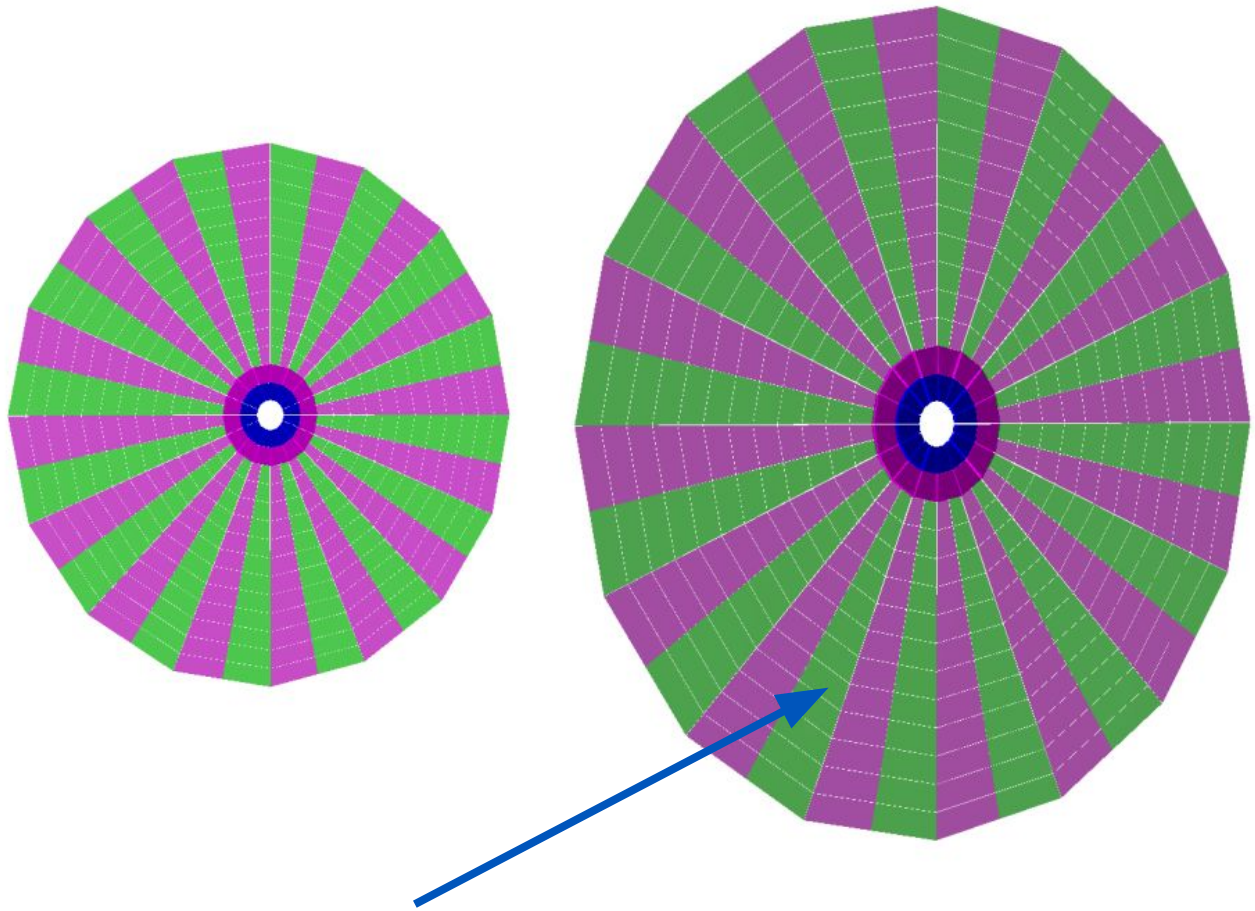
Prepared by: Zavidov E.N., Levkov A.A.

SPD Experiment and the BBC Detector

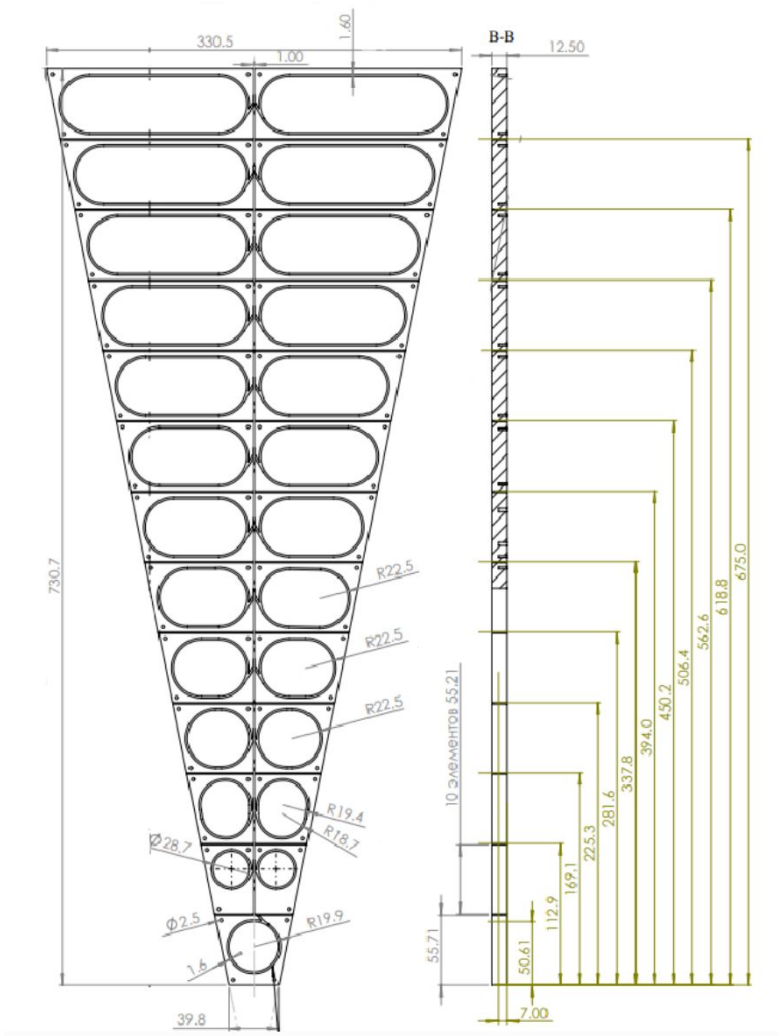


BBC Design and its Model

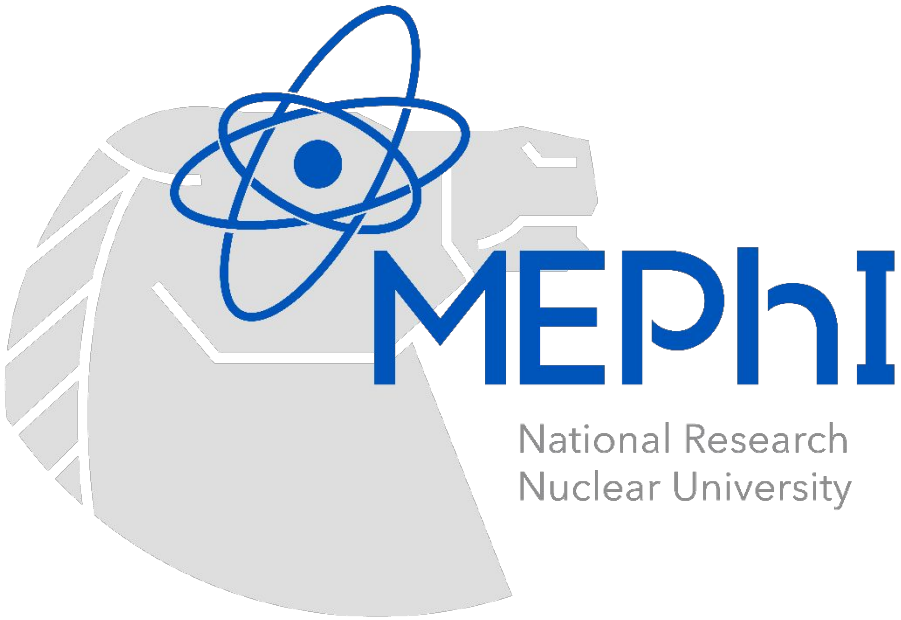
Existing Model



No grooves for wavelength-shifting fiber

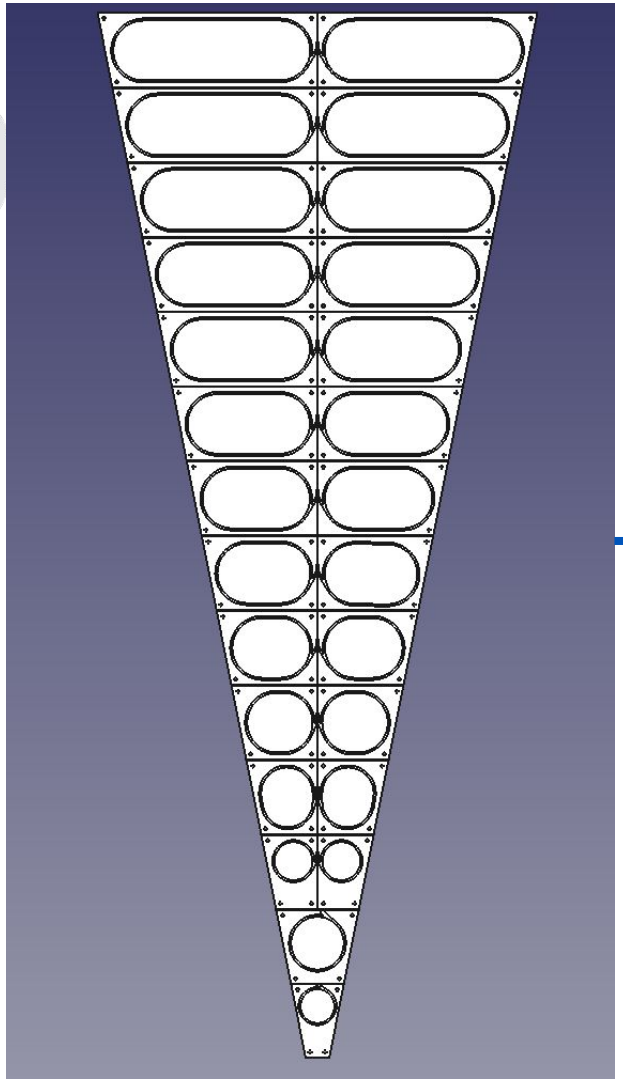


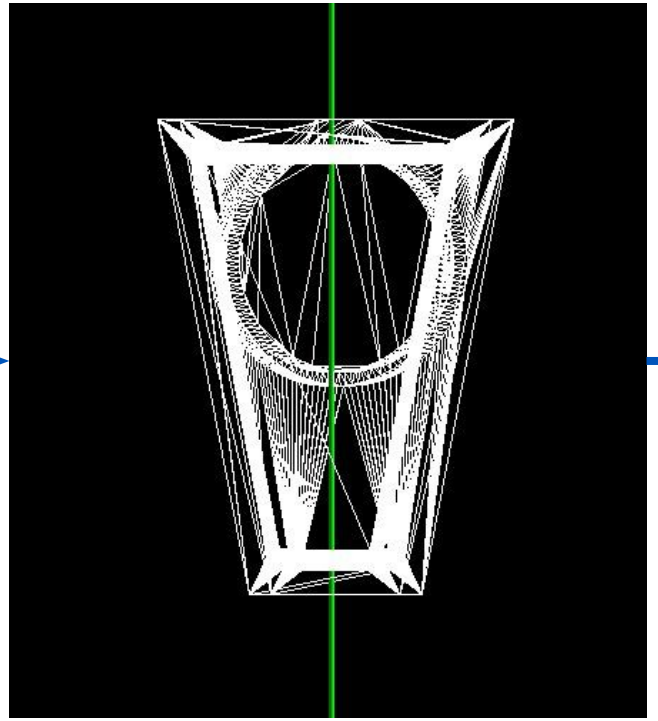
Sector drawing

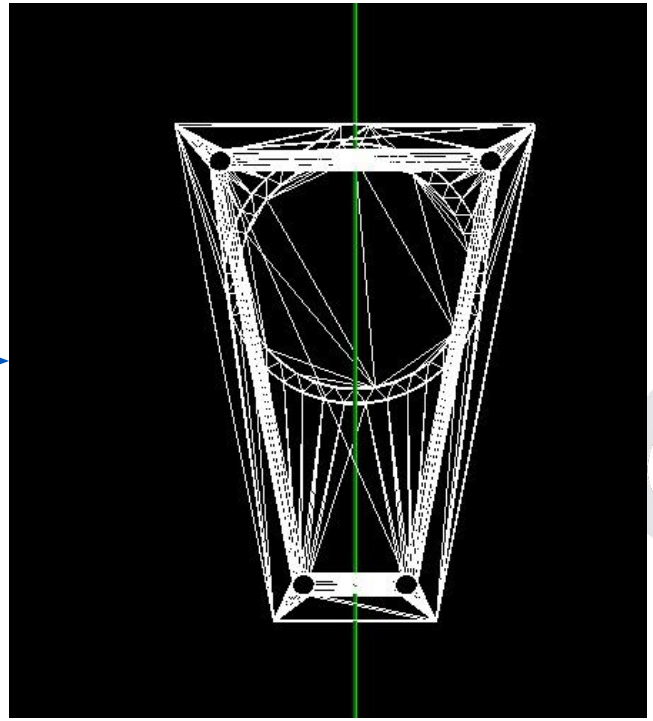


Part 1 - Tile

First idea - import .step file into Geant4

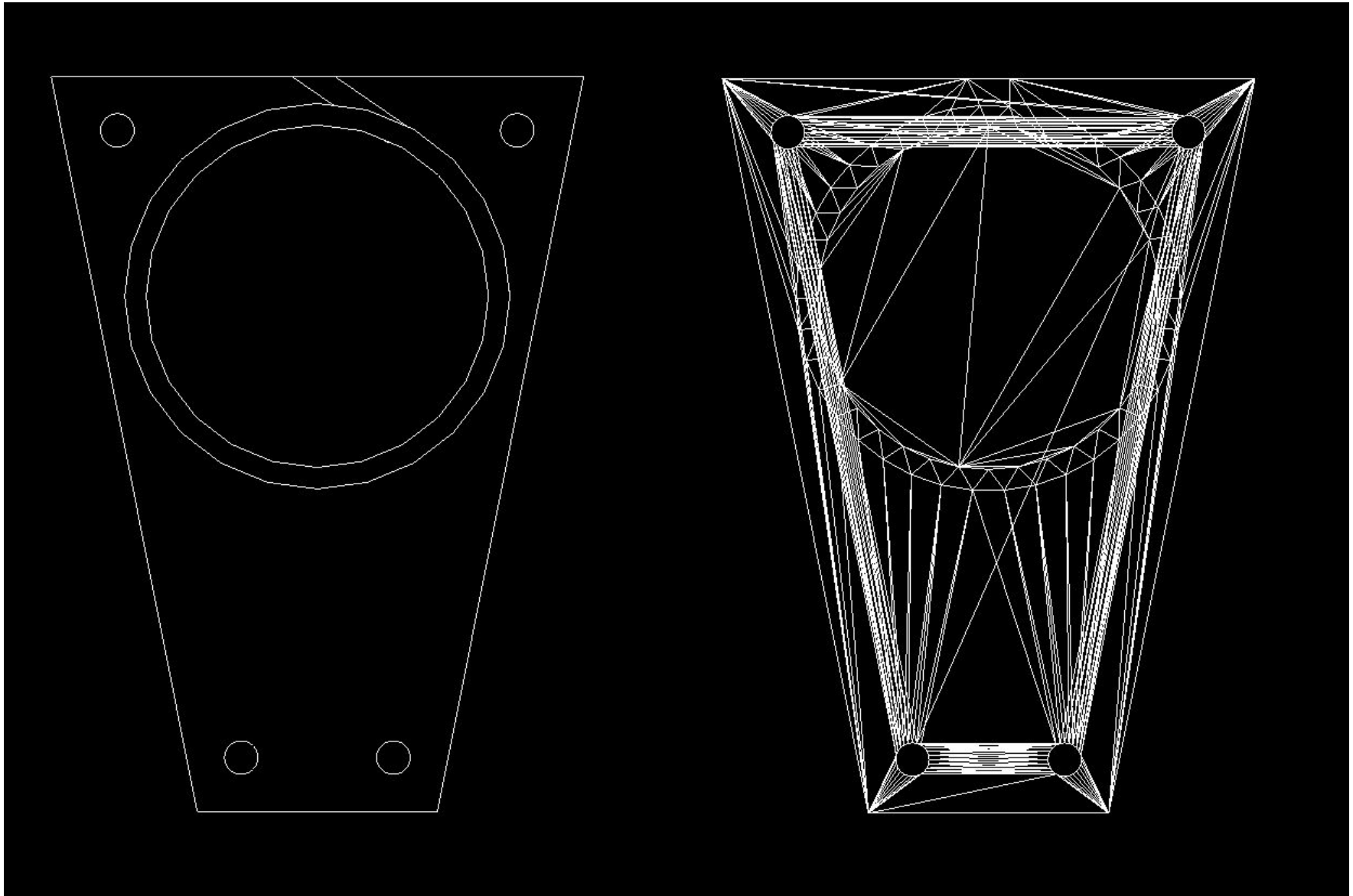






Comparison of Tile Models: Geant4 vs CAD

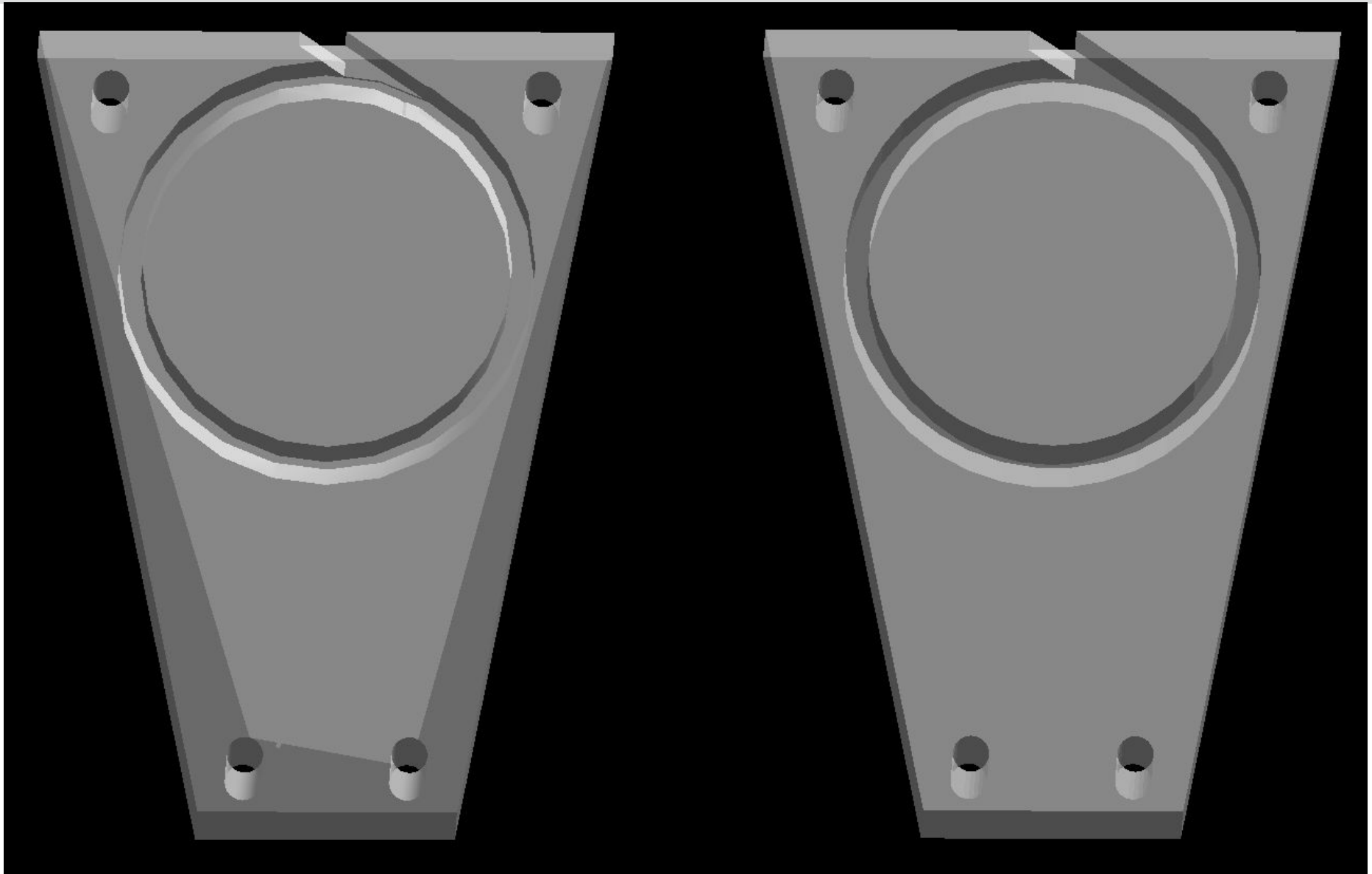
Geant4 primitives



CAD

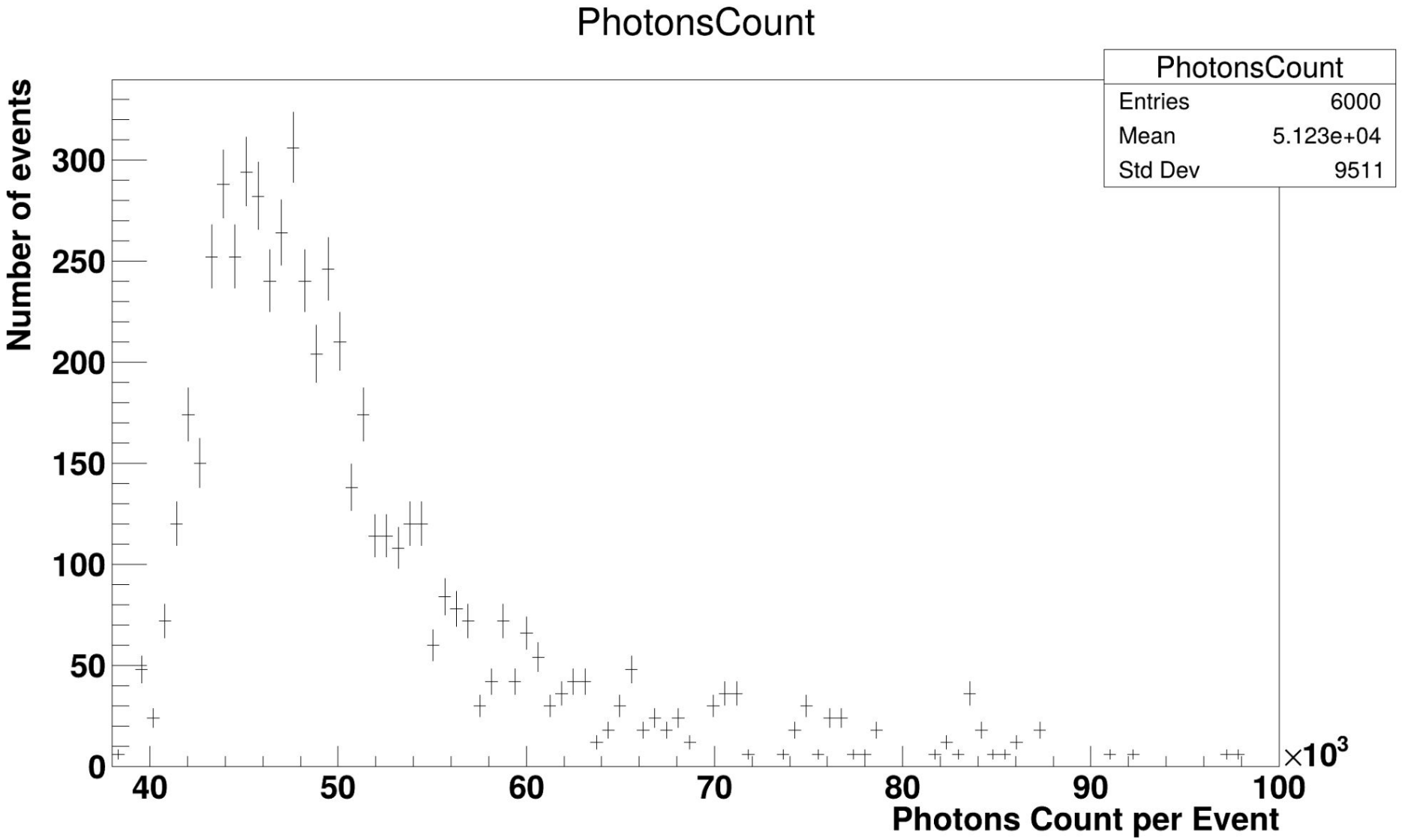
Comparison of Tile Models: Geant4 vs CAD

Geant4 primitives

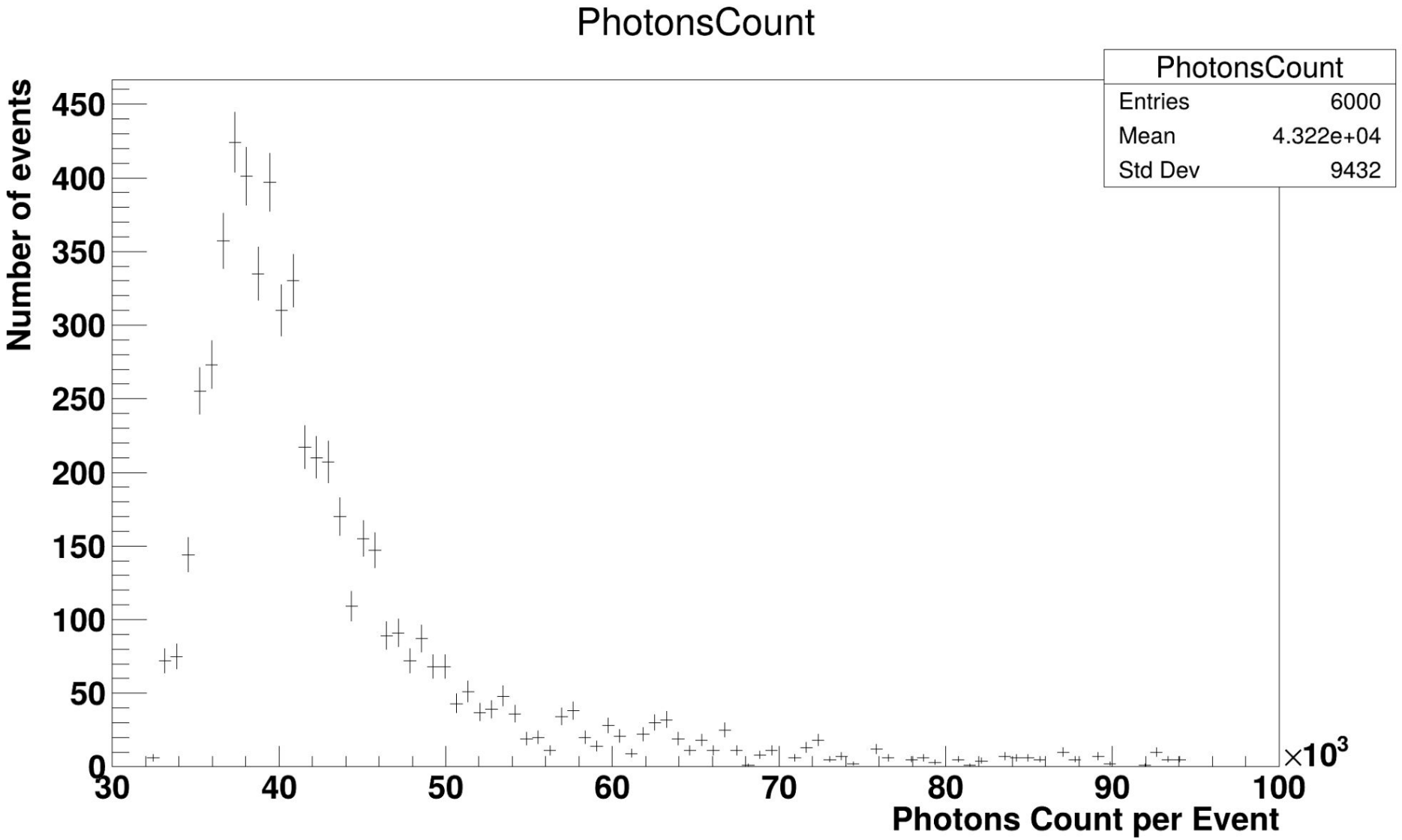


CAD

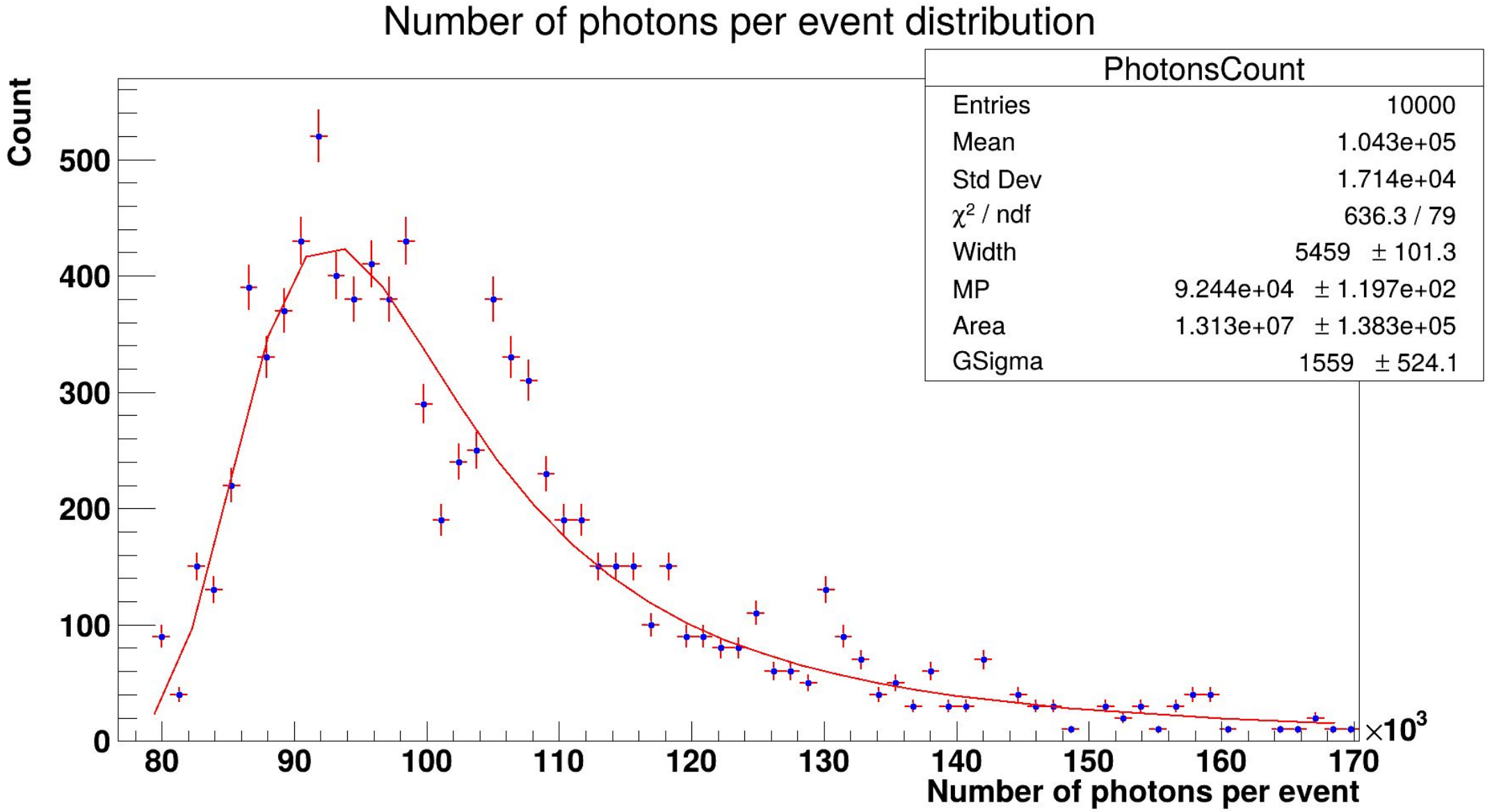
Model Comparison: Number of Photons Geant4 Primitives



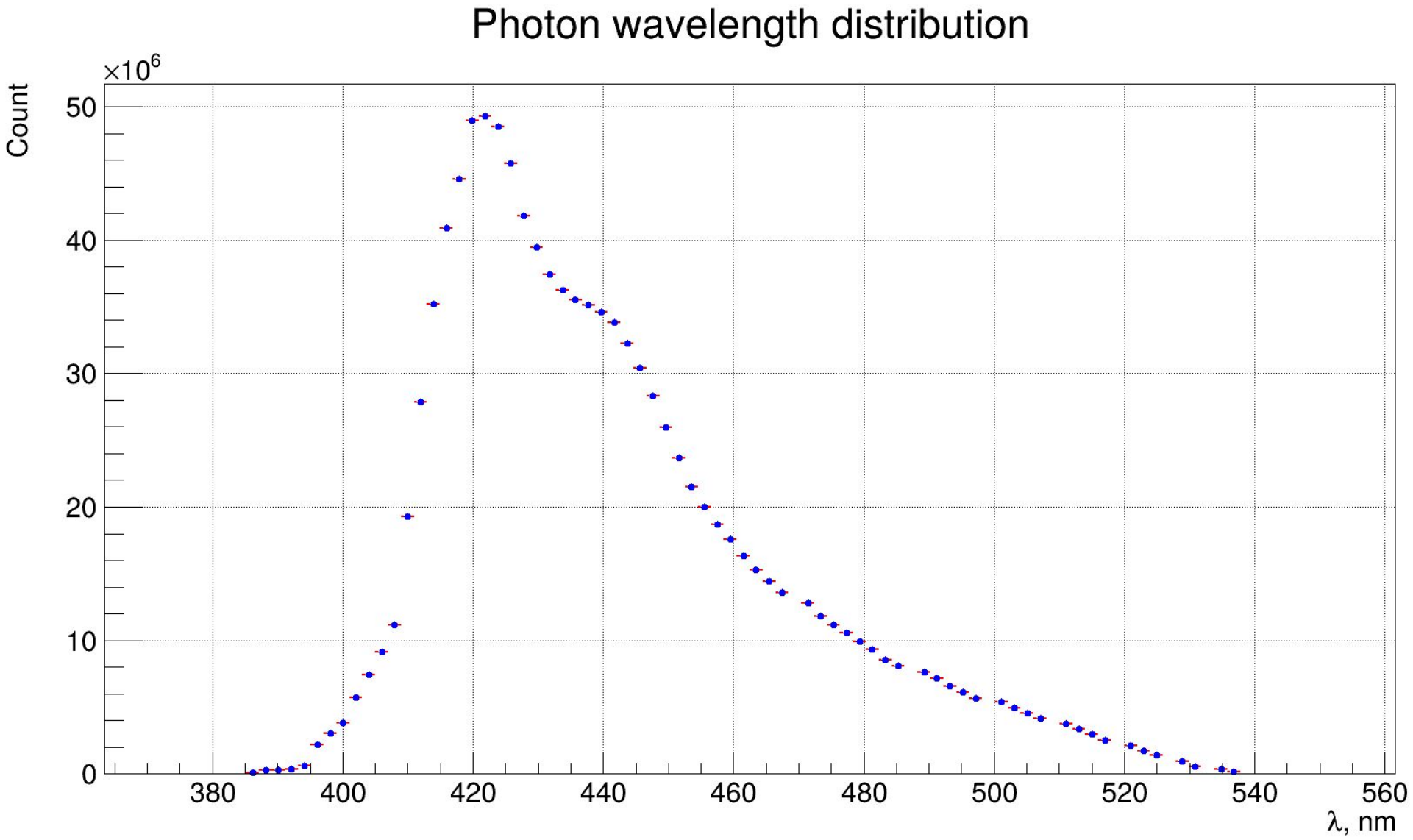
Model Comparison: Number of Photons CADMesh



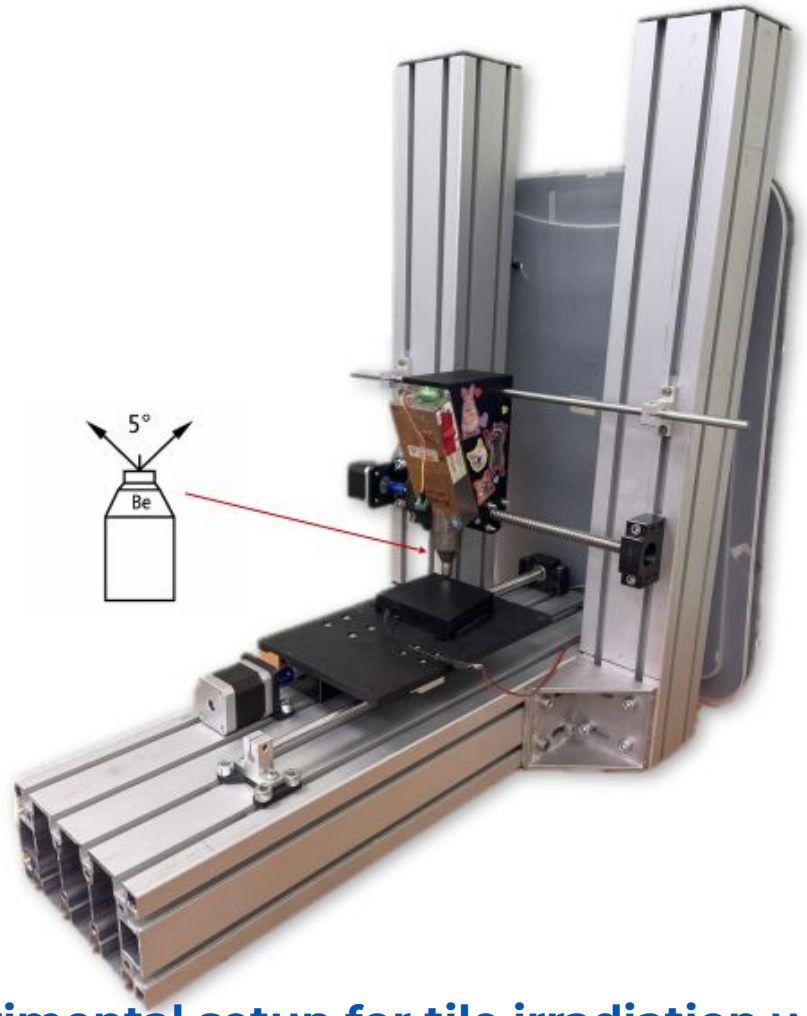
Final Choice - Geant4 Primitives



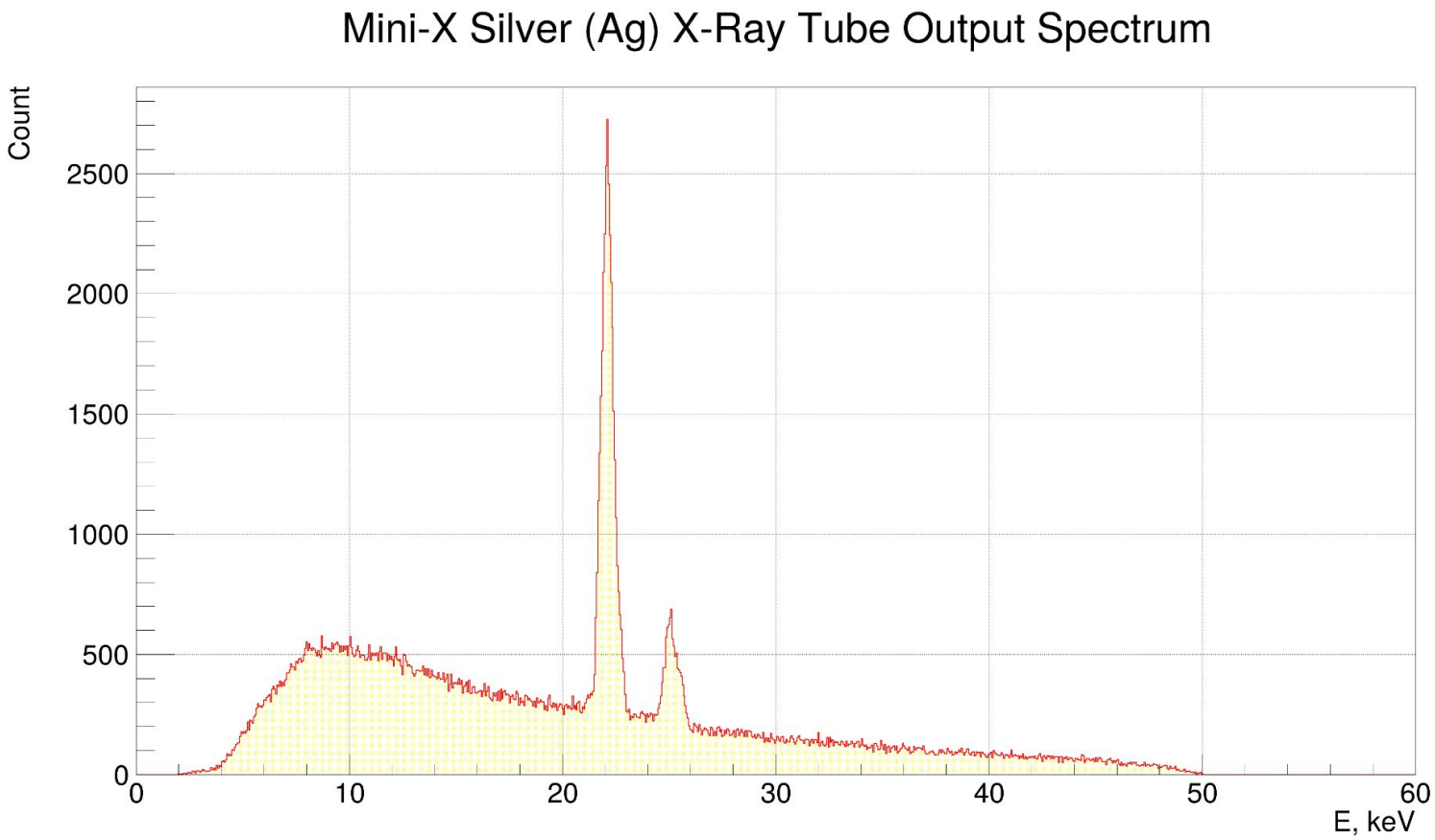
Photon spectrum by wavelength



Model and Experiment Comparison: Experimental Setup Configuration



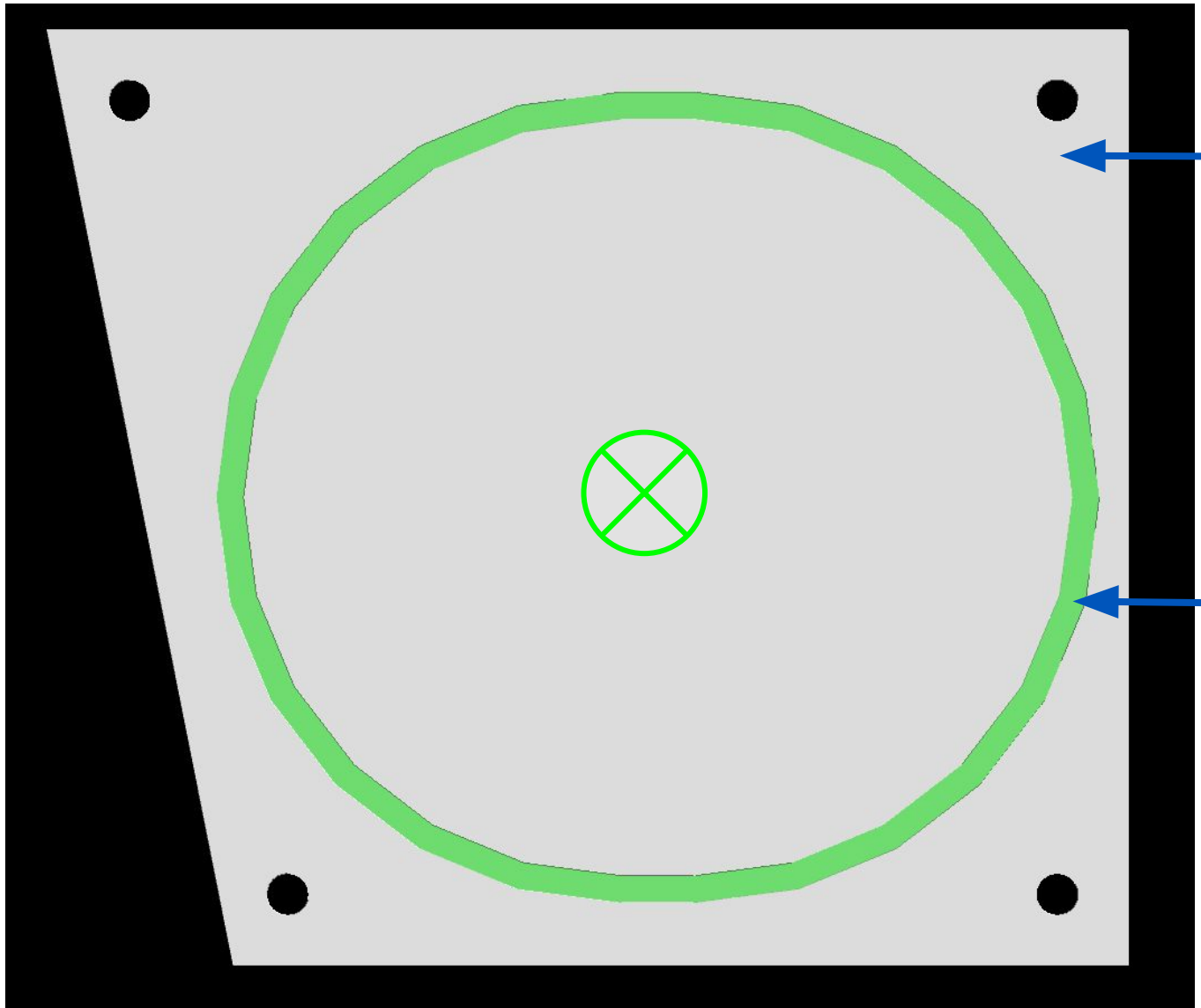
Experimental setup for tile irradiation with X-rays



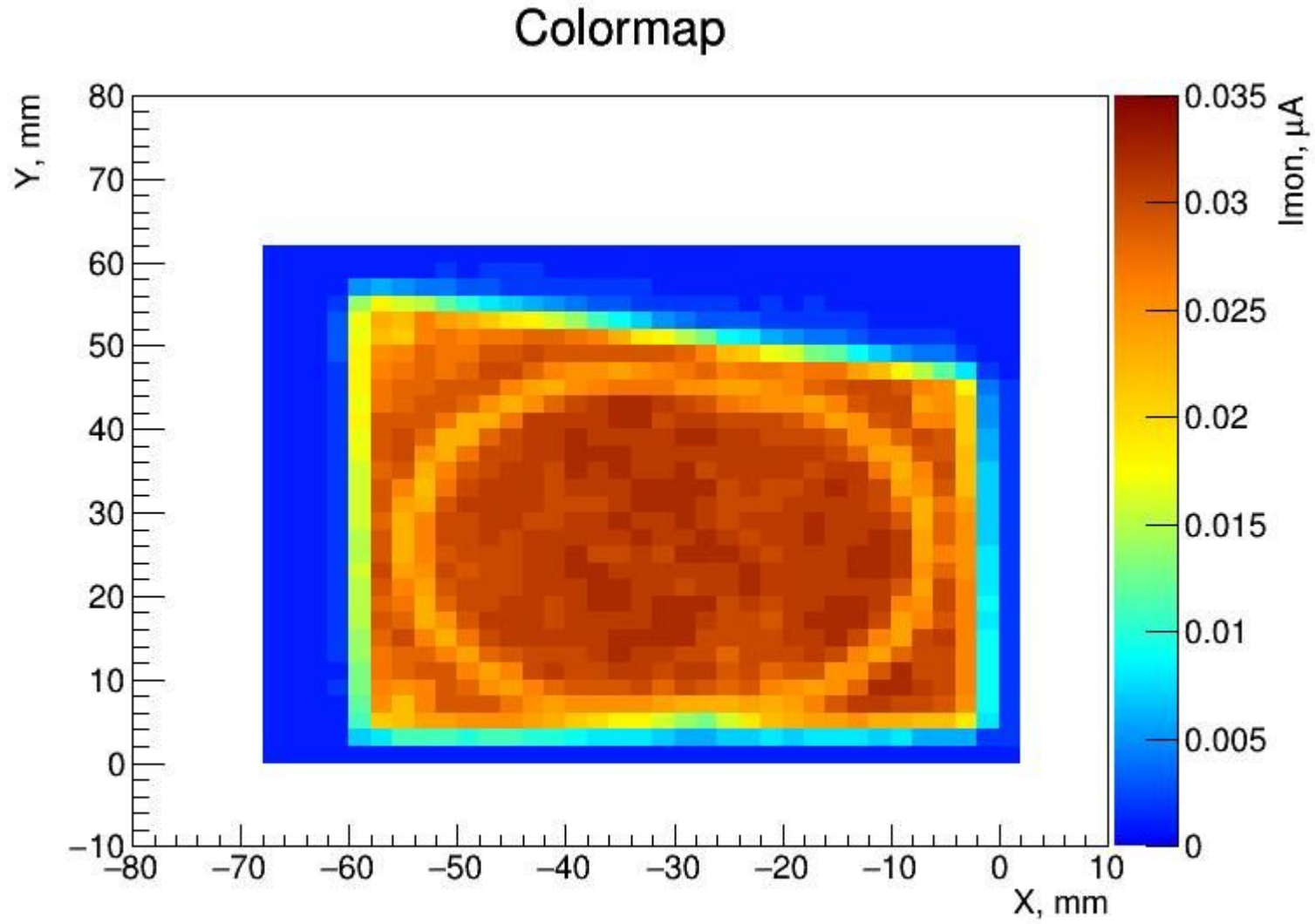
Digitized tube spectrum

Model and Experiment Comparison:
Model Configuration

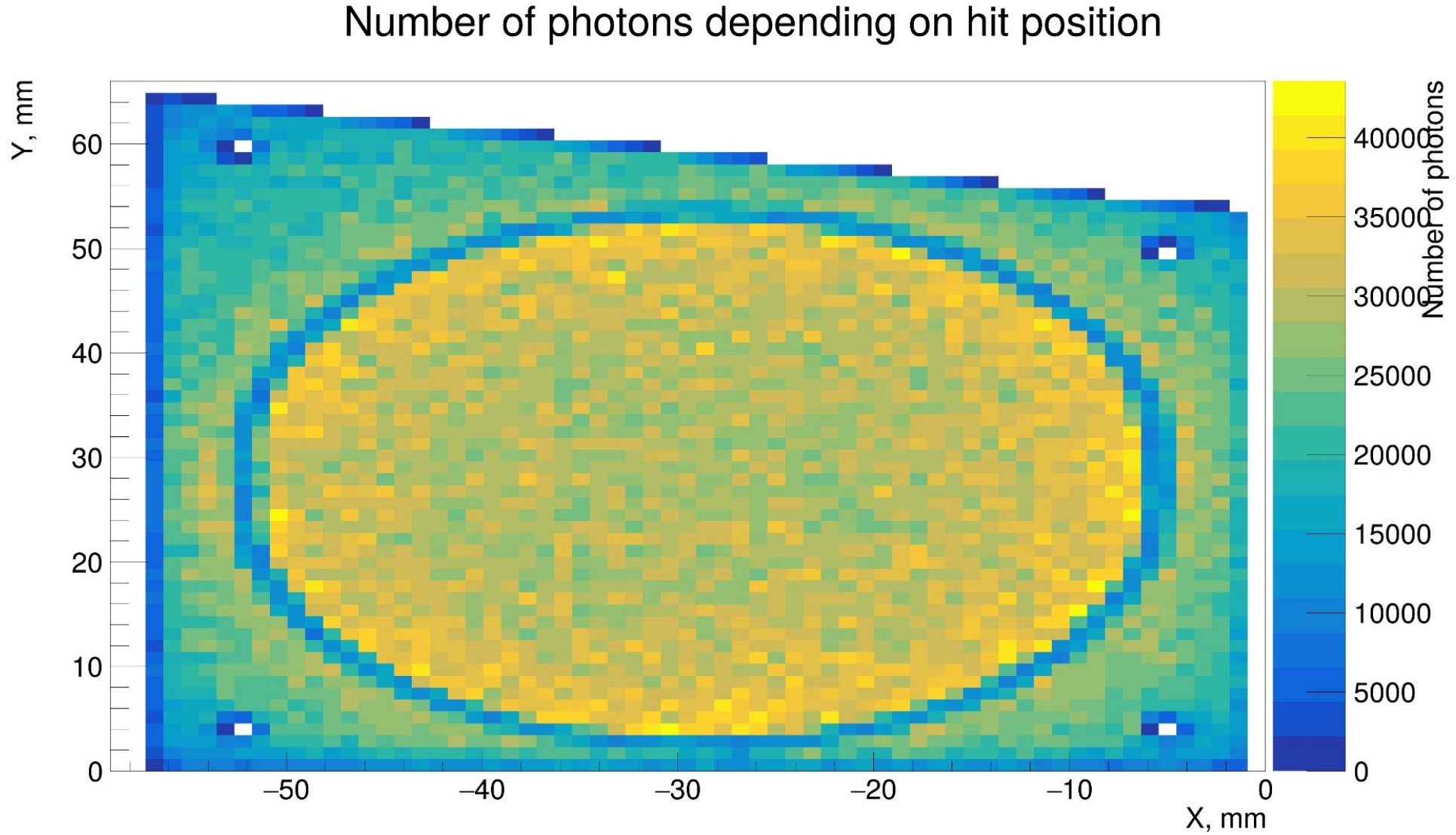
- direction of gamma quantum momentum



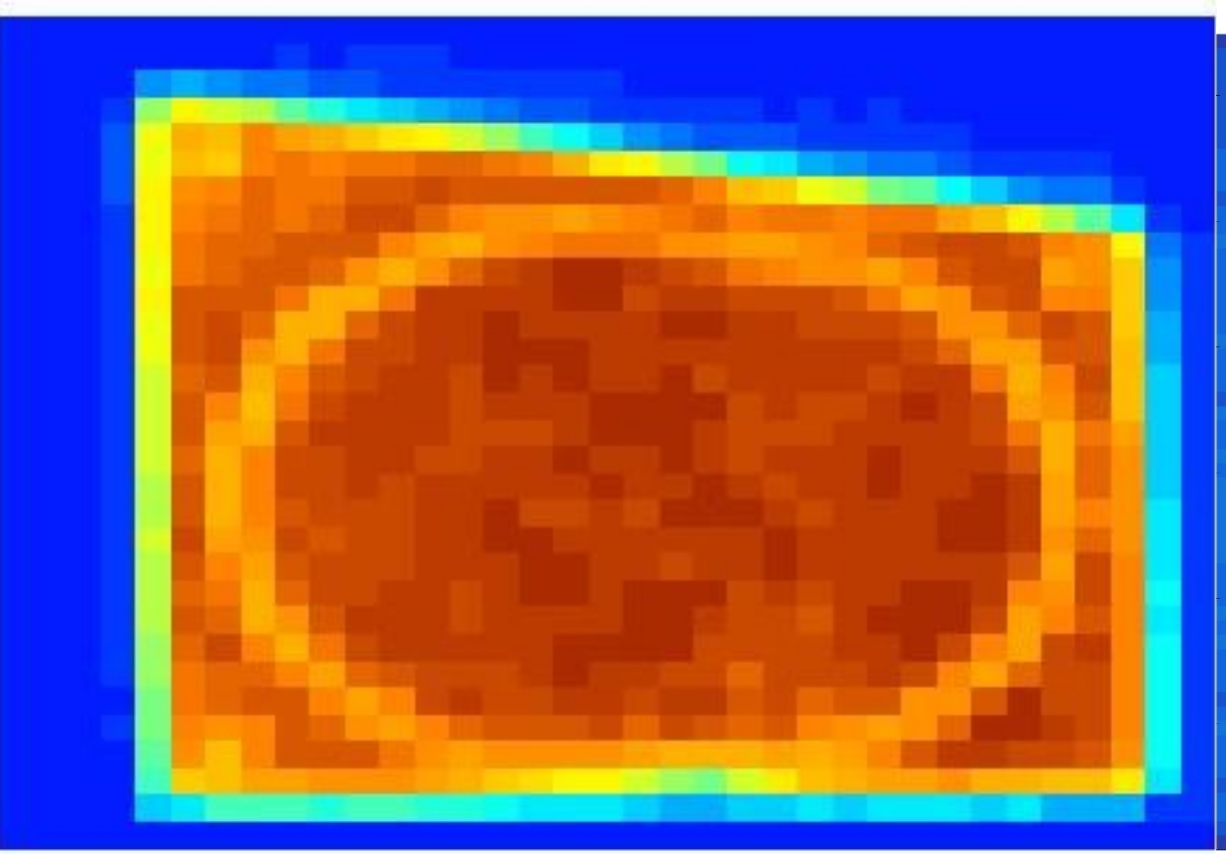
Experimental Data

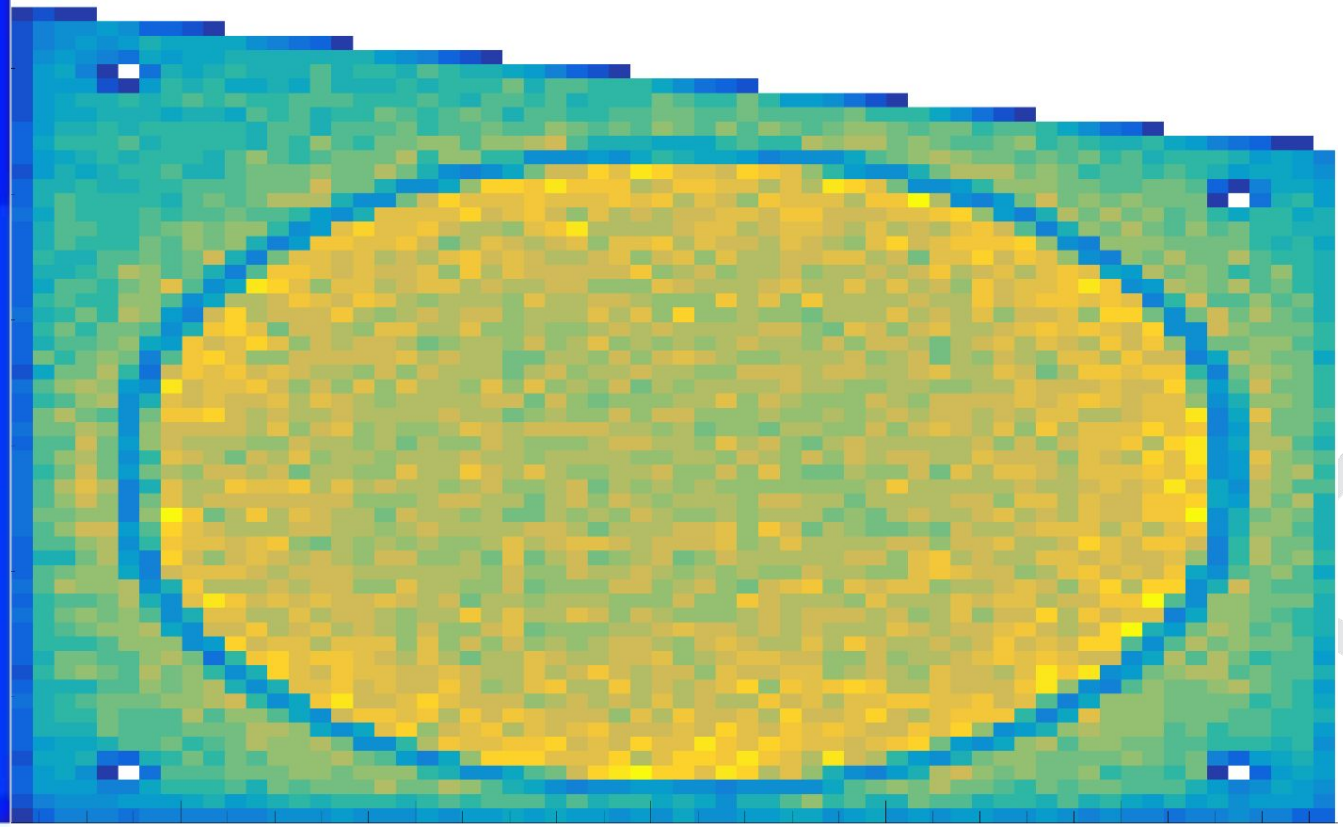


Simulation Data



Comparison

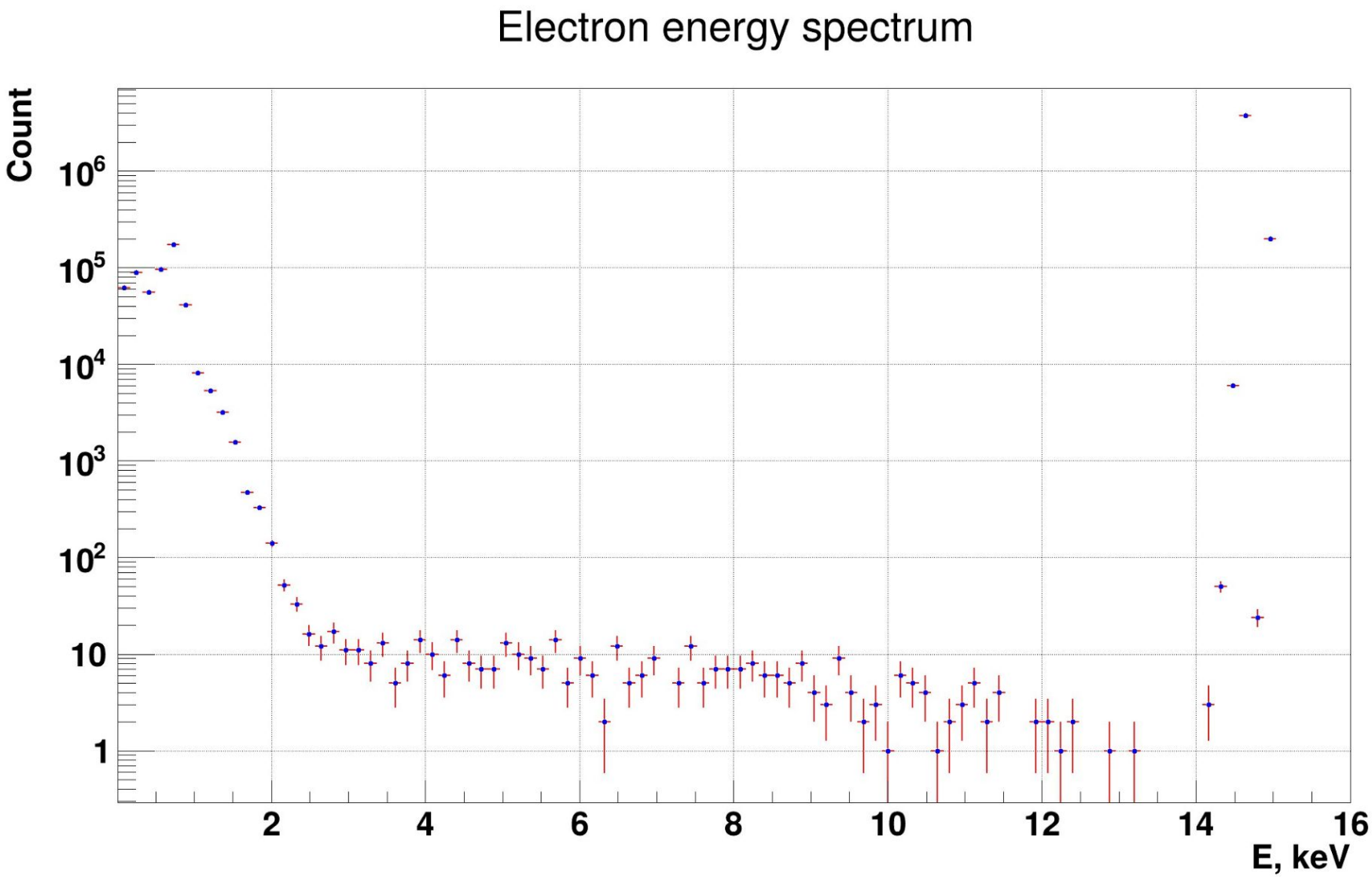




Experiment

Simulation

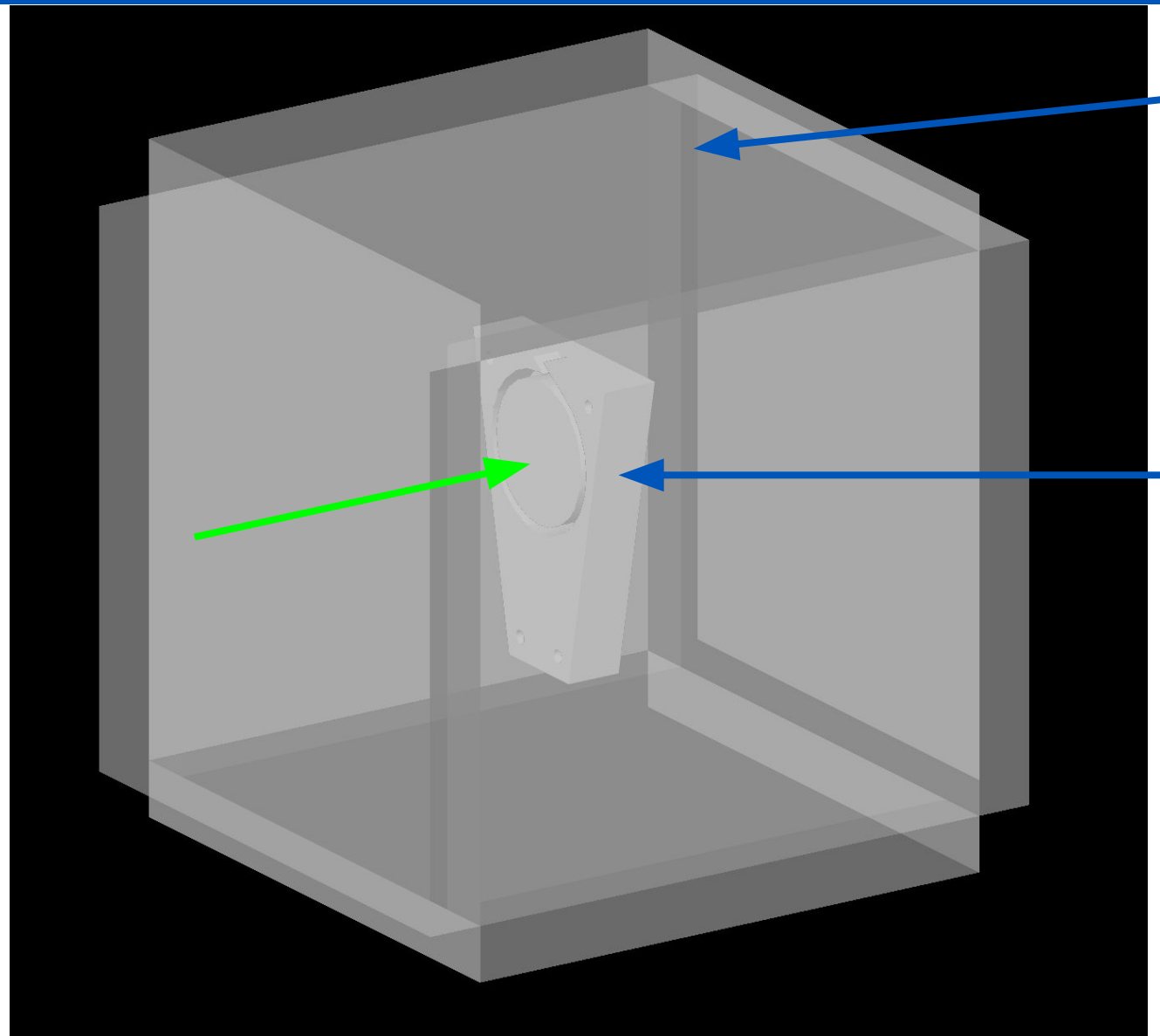
Electron Energy Deposition in the Tile



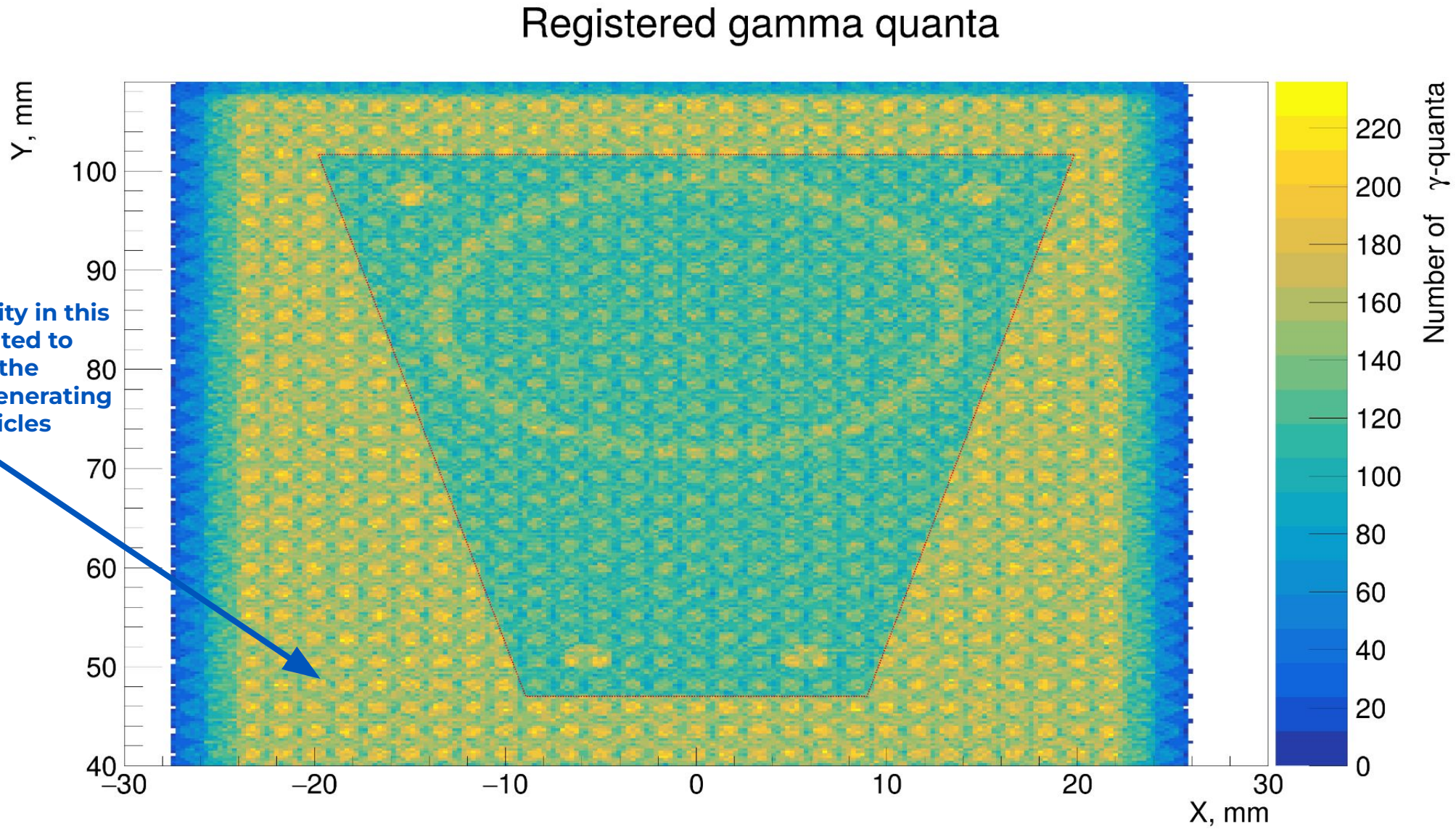
measurements were performed for gamma quanta with energy 15 keV

Checking Gamma Quantum Spread: Setup

green arrow - direction of gamma quantum movement

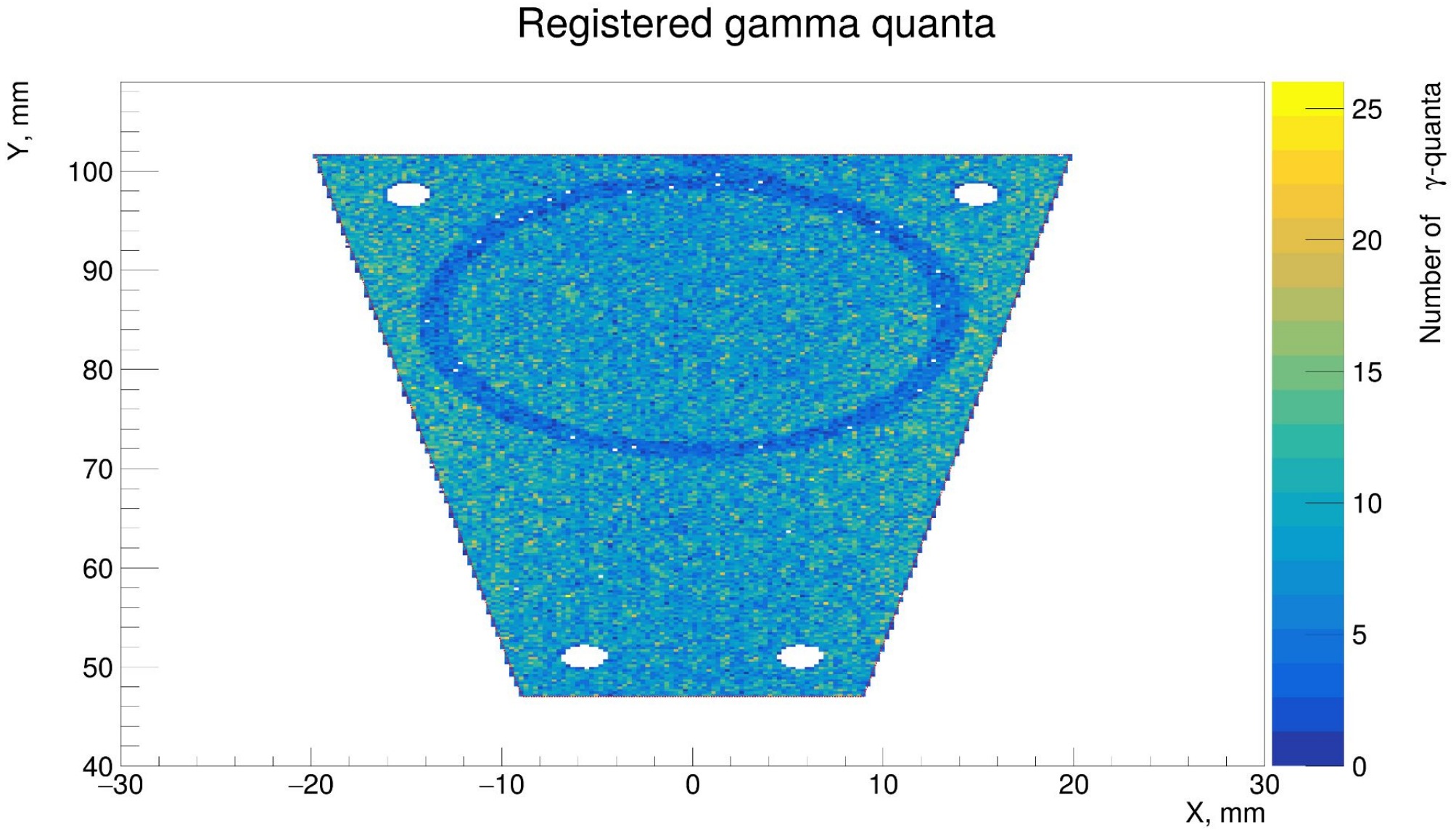


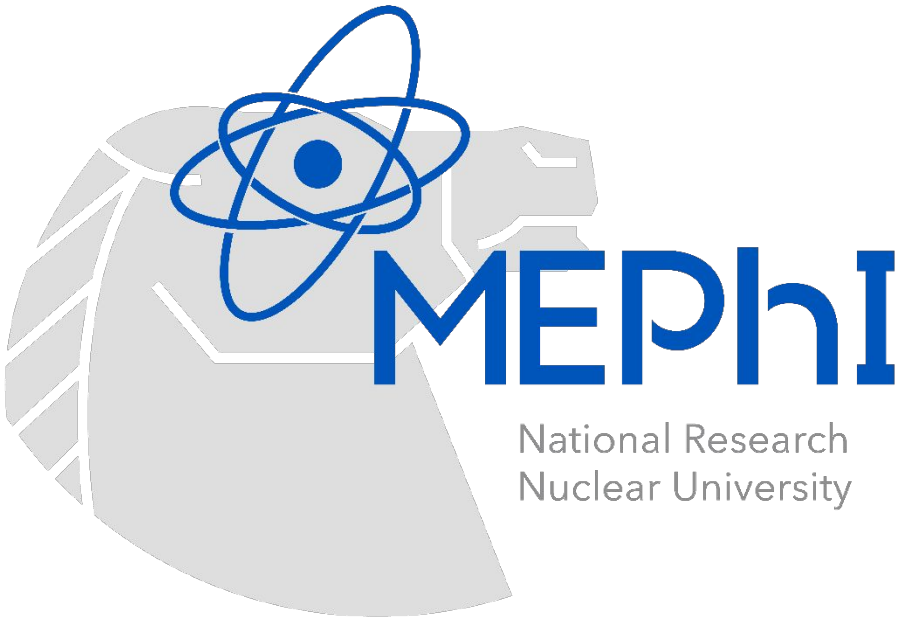
Gamma Quanta in the Front and Rear Detectors



non-uniformity in this region is related to binning and the method of generating primary particles

Gamma Quanta in the Left and Right Detectors

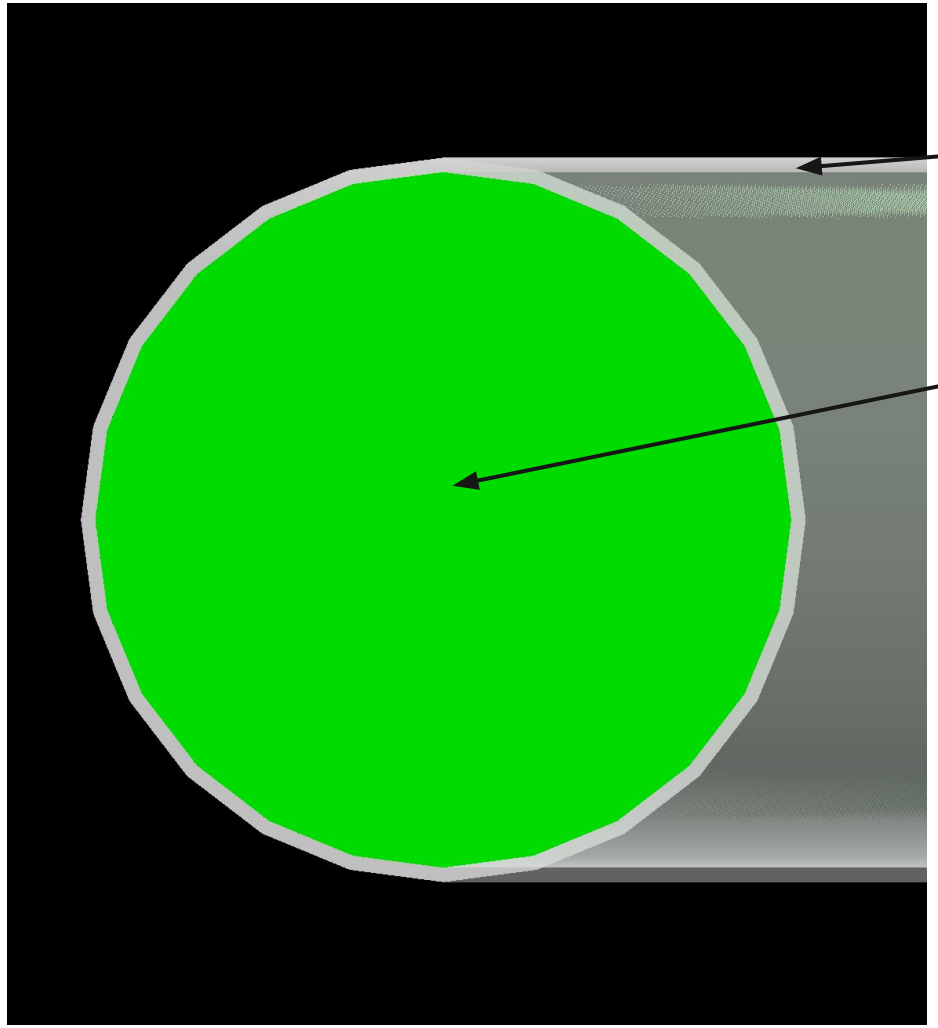




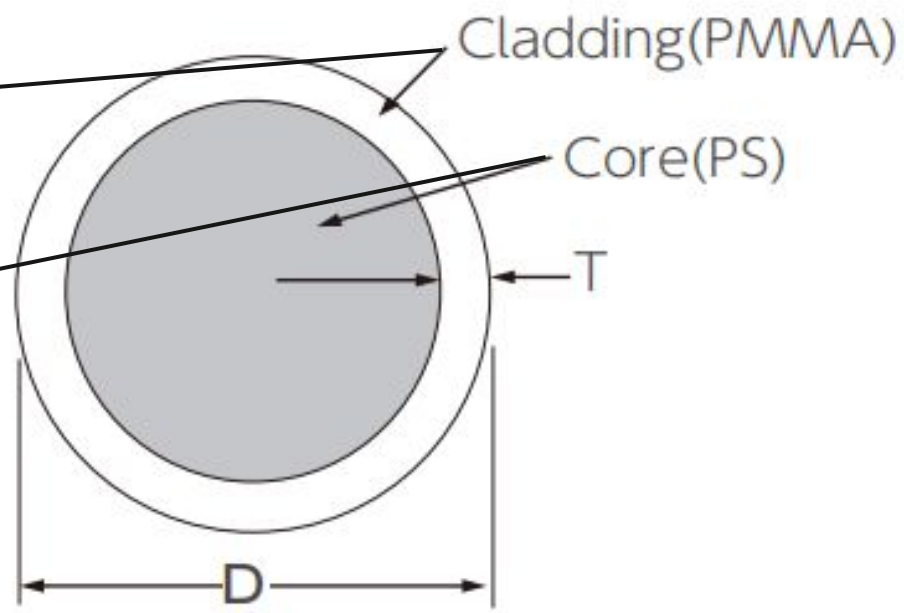
Part 2 - Fiber

Optical Fiber Structure and its Model

Geant4 Model



Structure from specification



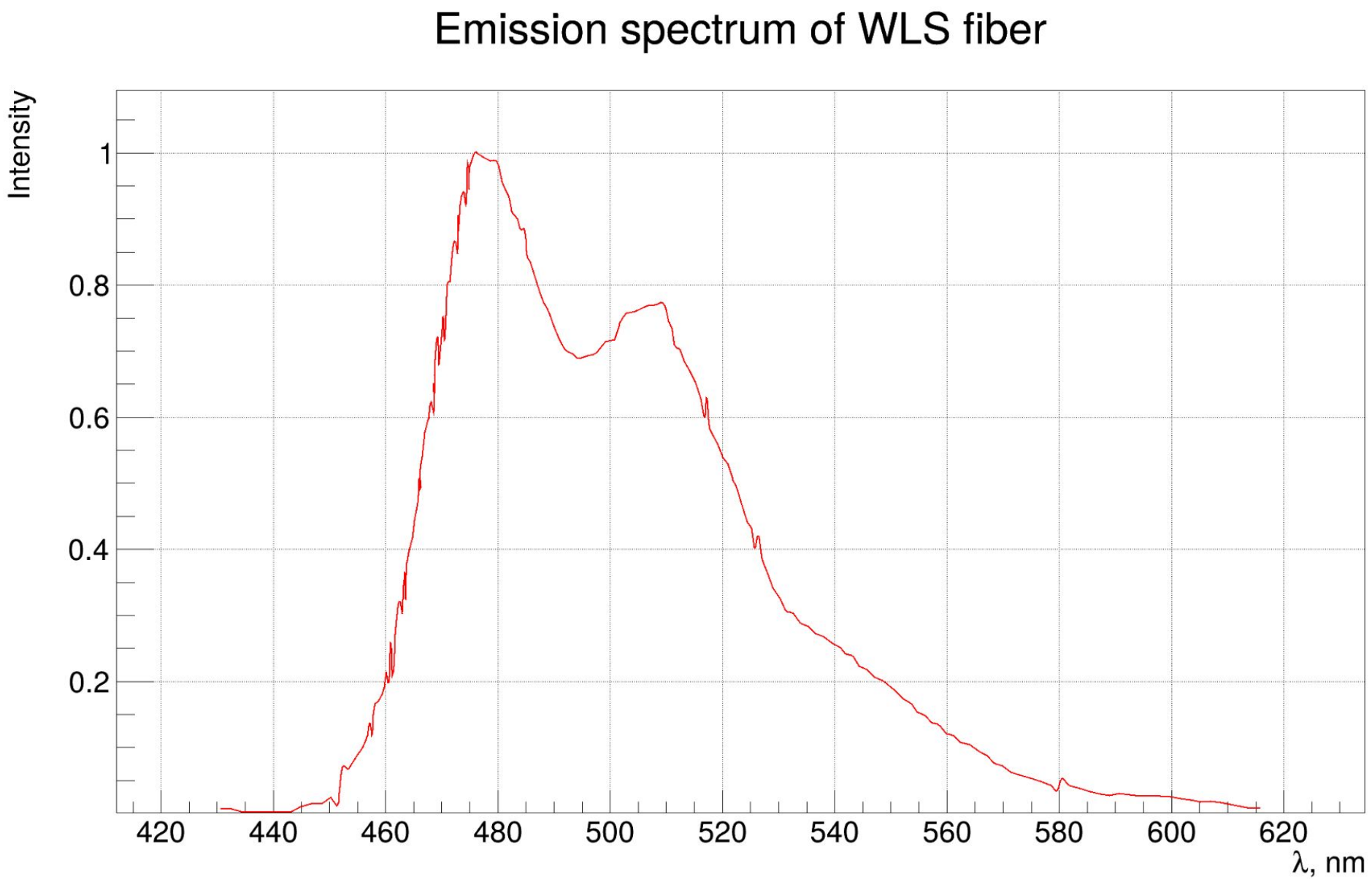
Cladding Thickness[1]: T=2% of D
Numerical Aperture: NA=0.55
Trapping Efficiency : 3.1%

Main Characteristics of the Optical Fiber

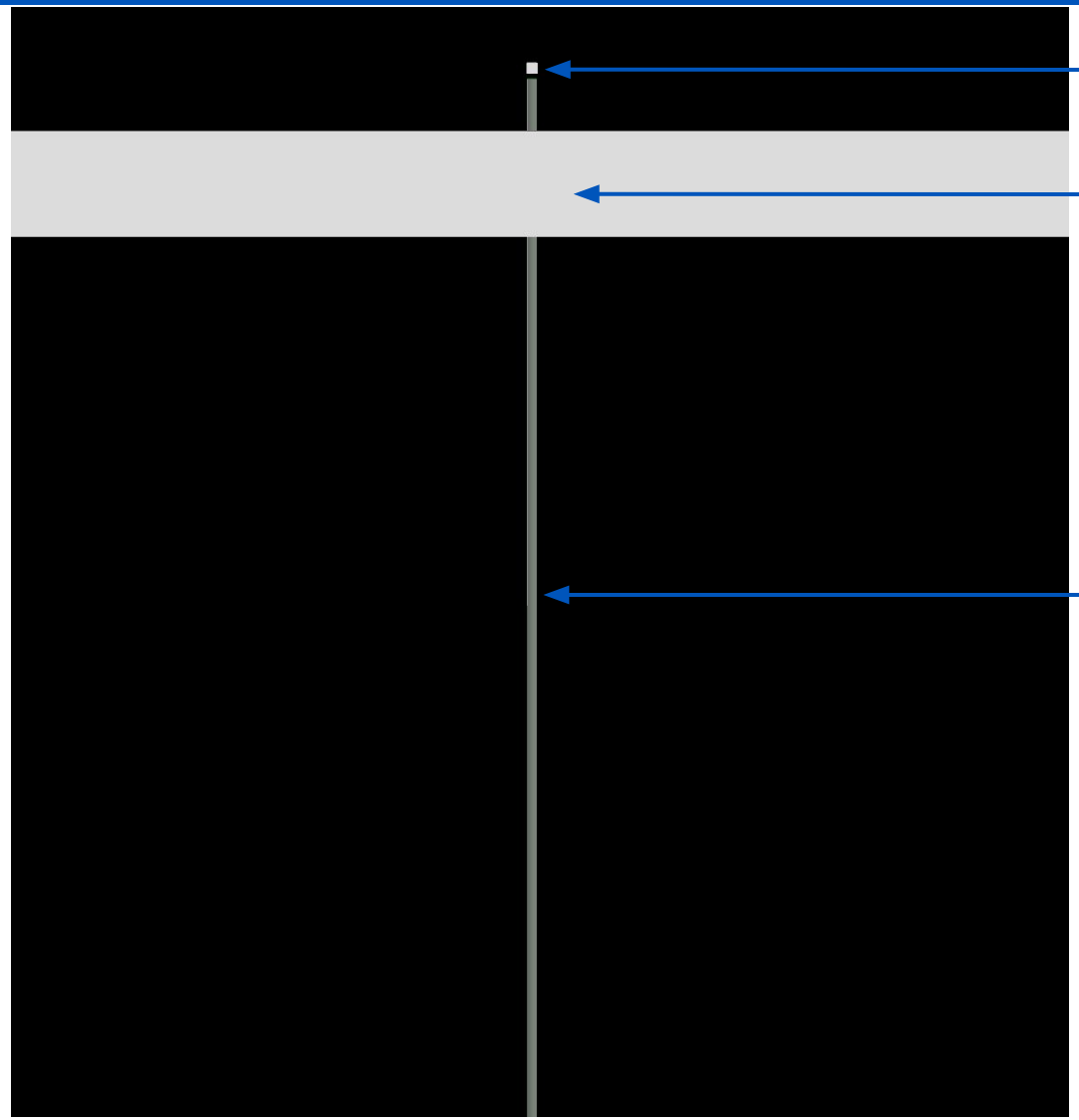
Wavelength Shifting Fibers (WLS Fibers)[4]

Description	Color	Emission Peak [nm]	Spectra	Att. Leng.[5] [m]	Characteristics
Y-7 (100), Y-7 (100)M	green	490		>3.0	Green Shifter
Y-8 (100), Y-8 (100)M	green	511	See the following figure	>2.8	Green Shifter
Y-11(200),Y-11(200)M	green	476		>3.5	Green Shifter (K-27 formulation)
O-2 (100), O-2(100)M	orange	538		>1.5	Green to Orange Shifter

Emission Spectrum: Fiber (Kuraray Y-11)

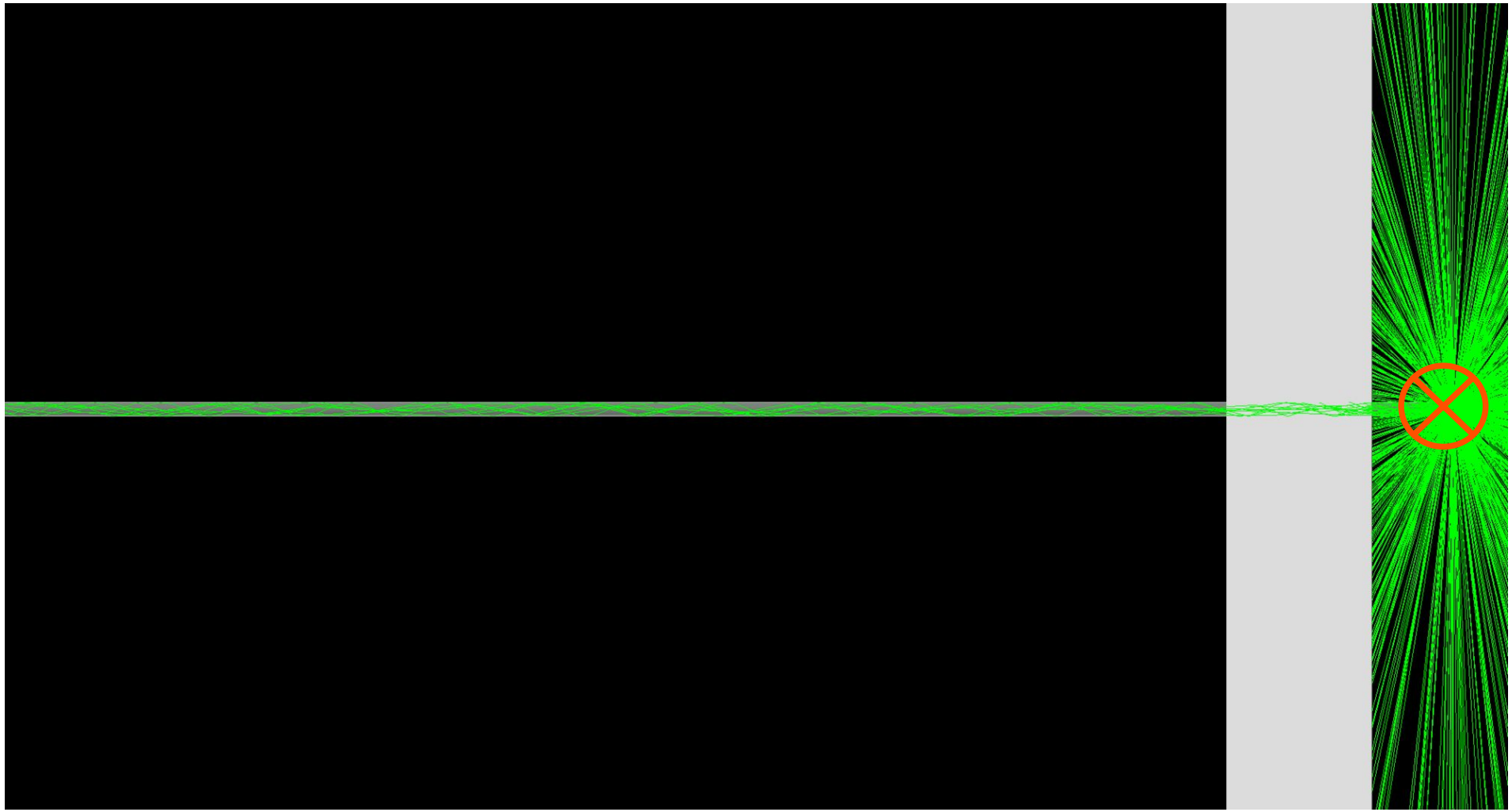


Experimental Setup: General View

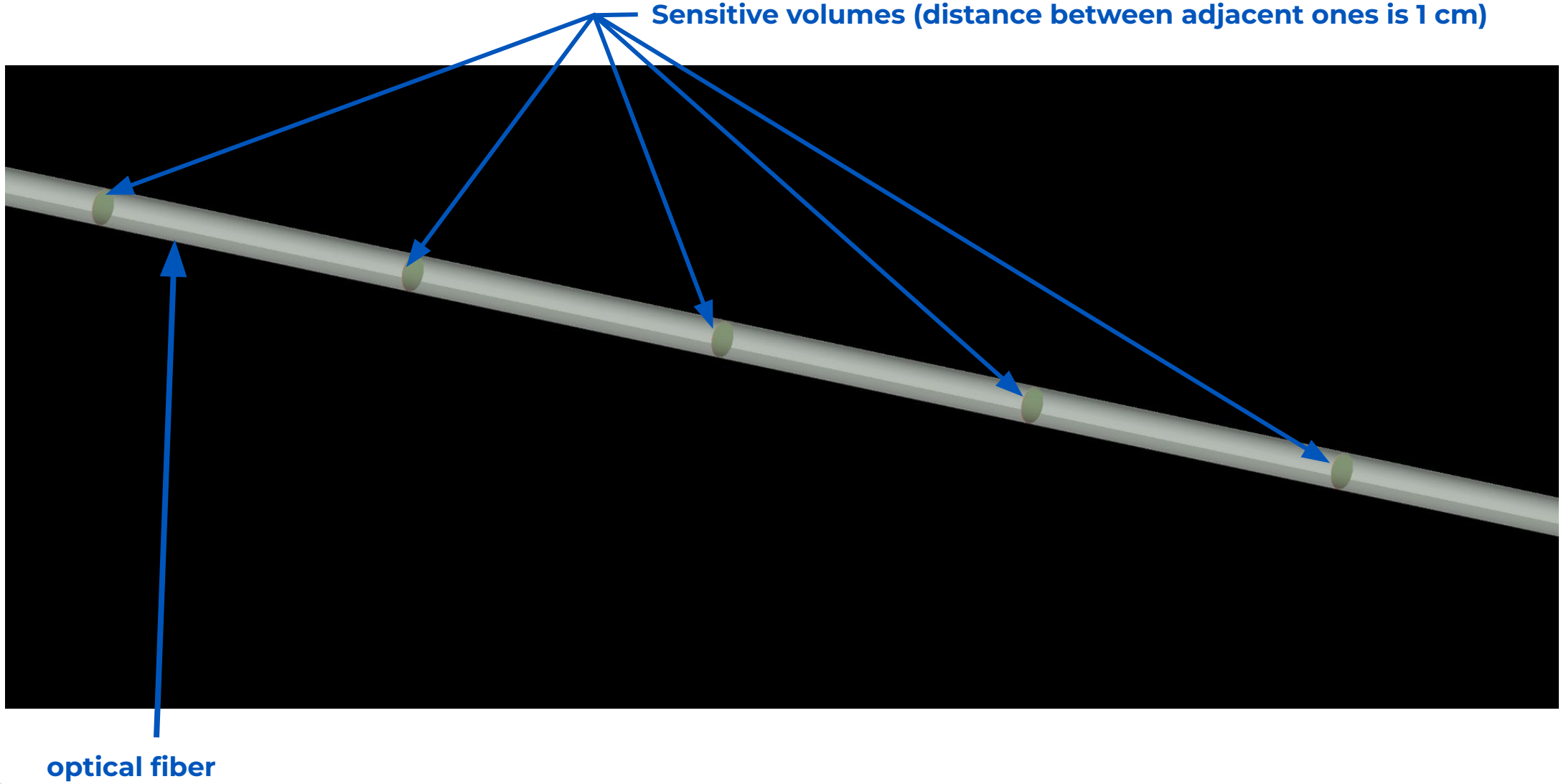


Experimental Setup: Photon Generation

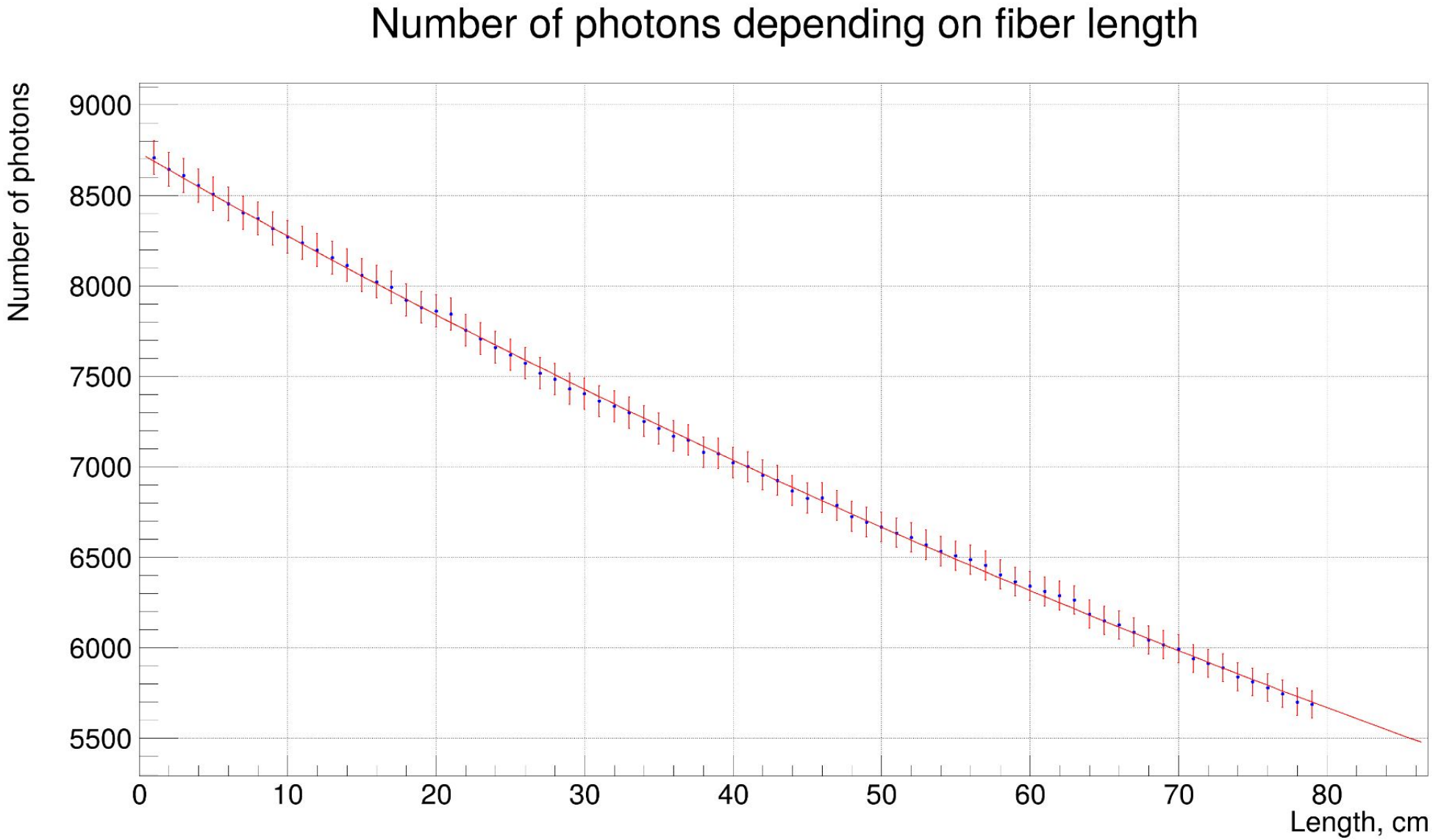
⊗ - direction of the proton momentum arriving at the scintillator



Experimental Setup: Sensitive Volumes

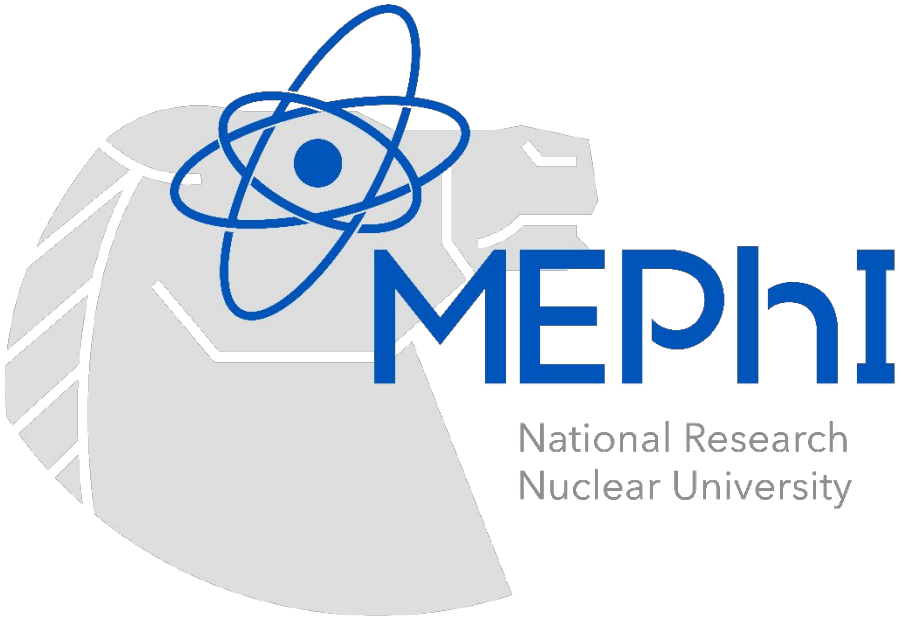


Dependence of the Number of Photons on the Fiber Length



The value at a point is the total number of photons from all runs that passed through this section of the fiber.

There are issues with the WLSABSLENGTH parameter.



Thank you for your attention!

20.10.2025

Appendix 1: Tile Emission Spectrum

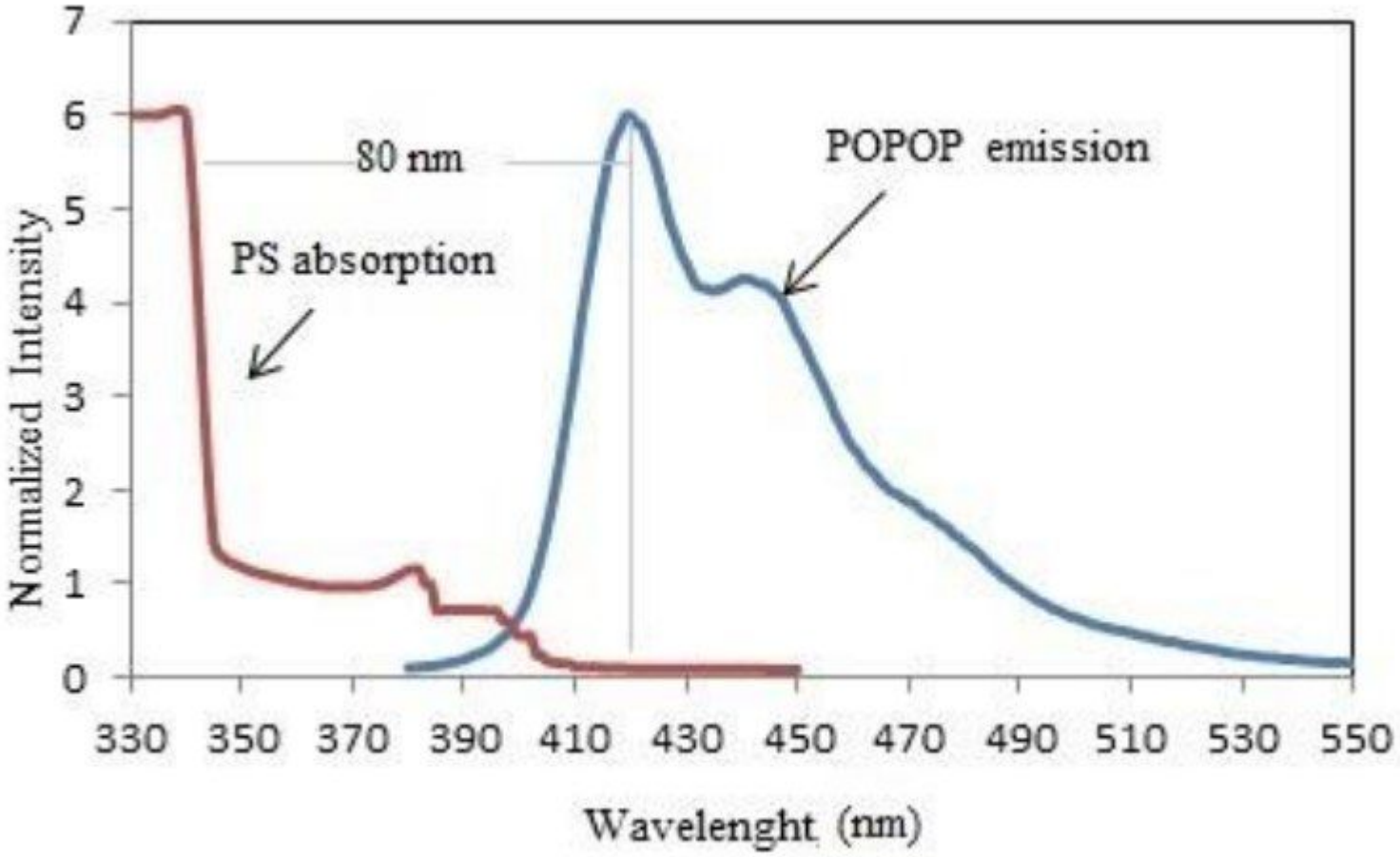


Figure 7. Stokes shift of PS-based scintillator sample

Appendix 2: Fiber Emission Spectrum