# 2023-06-07: Issue report – GATE surface

Brief:

Do not observe reflection (following Snell's Law) at non-reflector surfaces in UNIFIED Optical Model

Config:

- G4.10.06.p03 and G4.10.06.p01
- GATE v9.0-Mod to enable scintillation (https://github.com/OpenGATE/Gate/pull/368)

Solution → work around

- Use PBP or GBP with reflectivity set to 0, and RI of the gap set similar to the other volume

# Issue

Geometry Setup

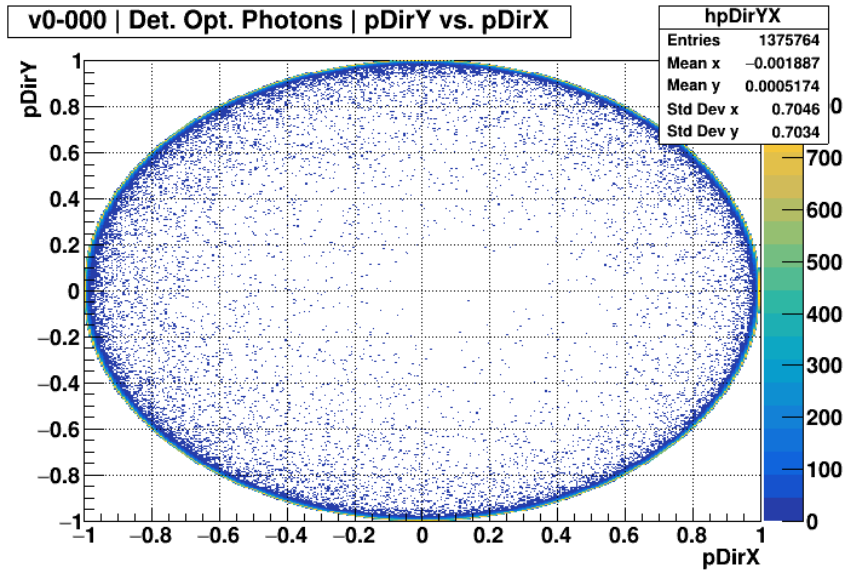
- cylindrical LYSO, r = 15 mm, t = 3 mm, RI = 1.82, 25 photons/keV for scintillation yield
- Sensor as tube shape, on the side surface of the crystal, RI = 1

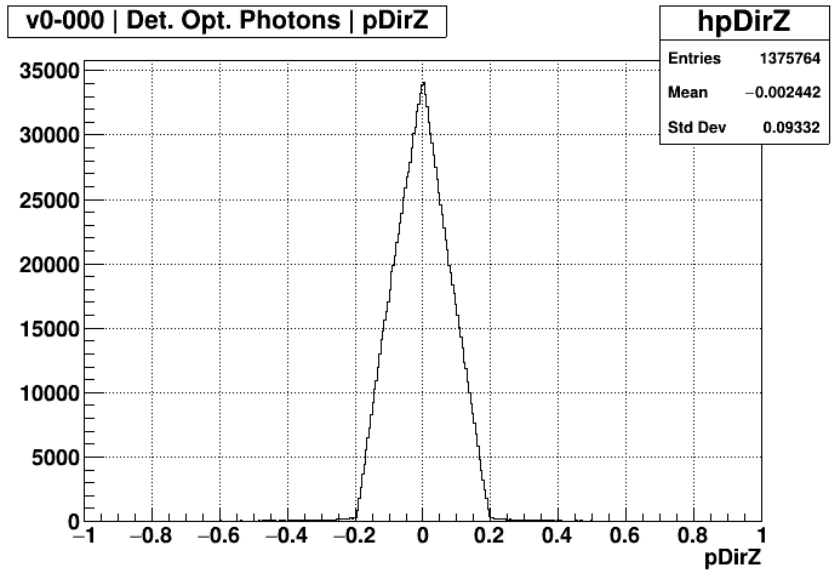
Surface Setup

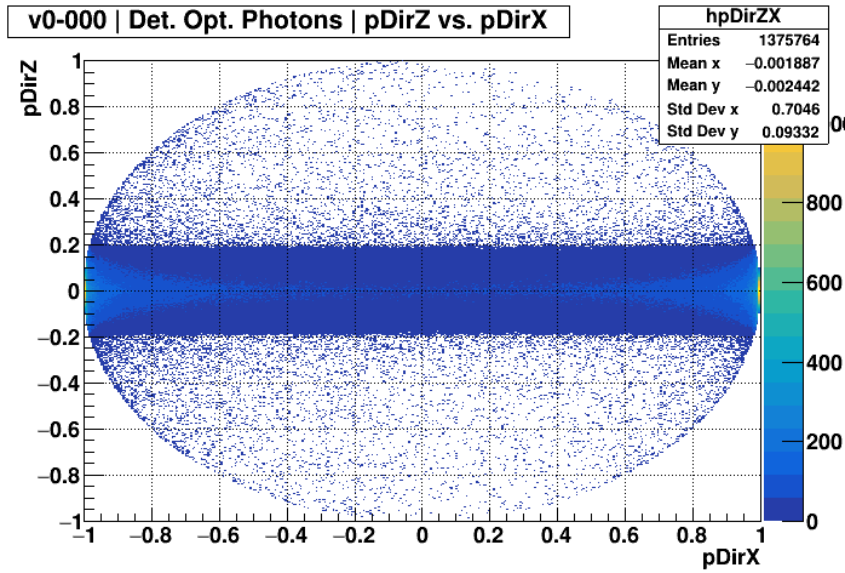
- Crystal to mother volume (scanner) → top and bottom surface: dielectric-dielectric, perfect polished (smooth), R = 1 (same issue for ground surface with σ_α = 0.01)
- Crystal to sensor: detection surface, dielectric-metal, smooth, R = 0, efficiency = 0.385

Point source, 662-keV γ, beam to the center of crystal's top surface

Same for pDirZ vs. pDirY



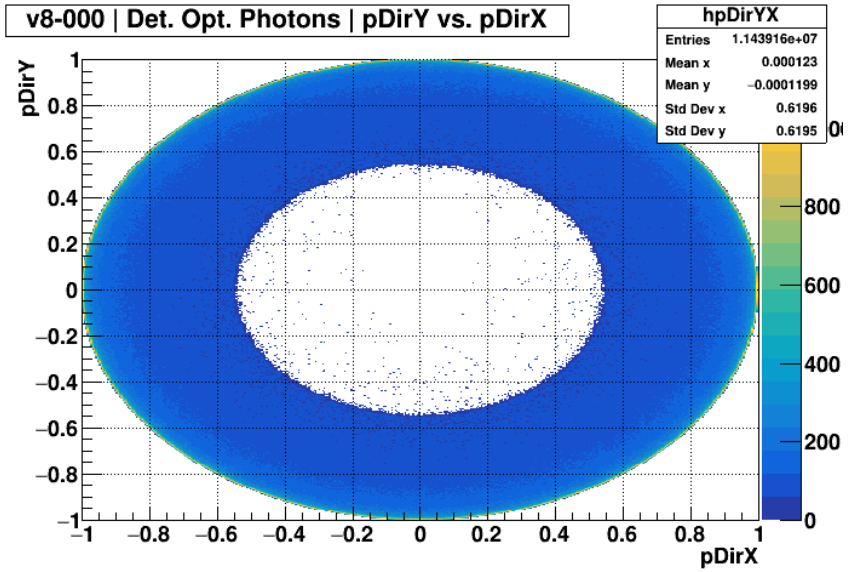



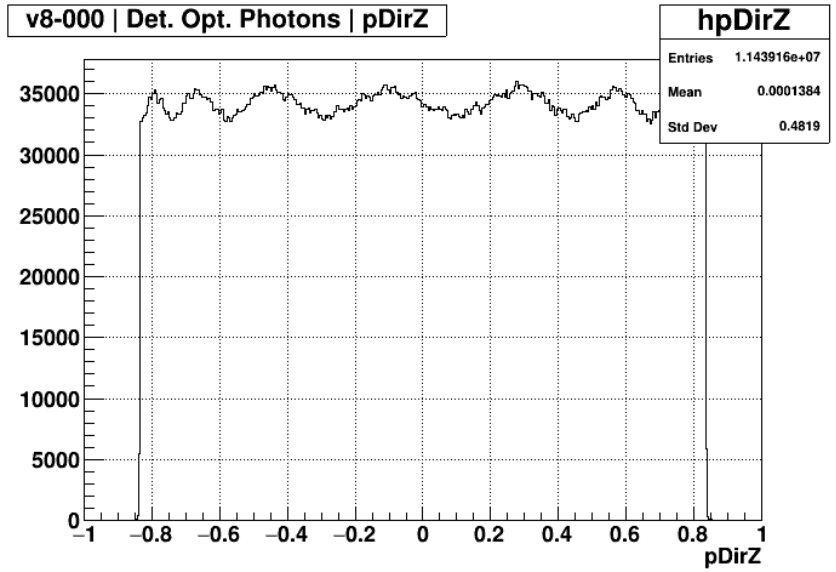



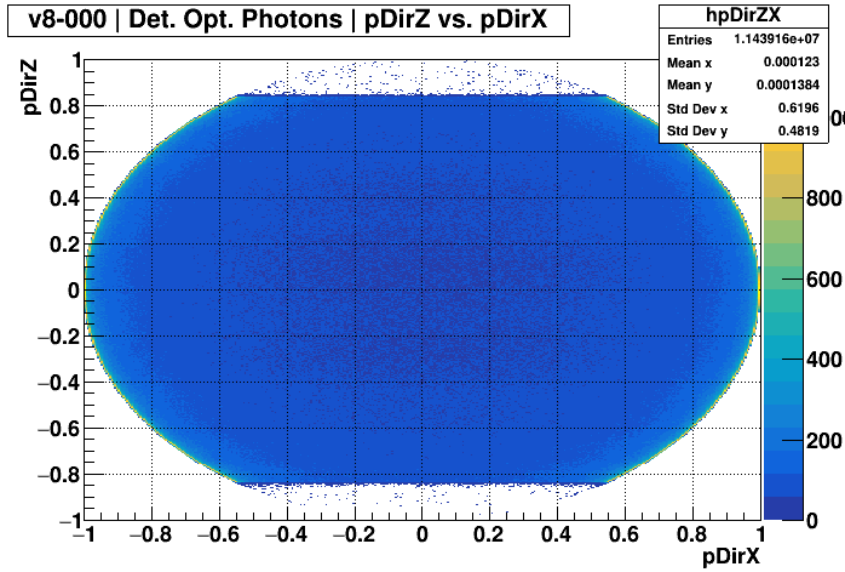

pDirZ is only in (-0.2, 0.2), where $\frac{3}{\sqrt{3^2+15^2}} \approx 0.196$ → it seems optical photons just go directly from interaction points in the center line to the side of the crystal with no reflections at top and bottom surfaces.

**Work around →** Change surface Setup

- Crystal to mother volume (scanner) → top and bottom surface: dielectric-dielectric, PBP, σ_α = 0, R = 0 (of the paint)




For the 2 RI values of 1 and 1.82 → critical angle θ ≈ 33.3 deg. → sinθ ≈ 0.55 and cosθ ≈ 0.84

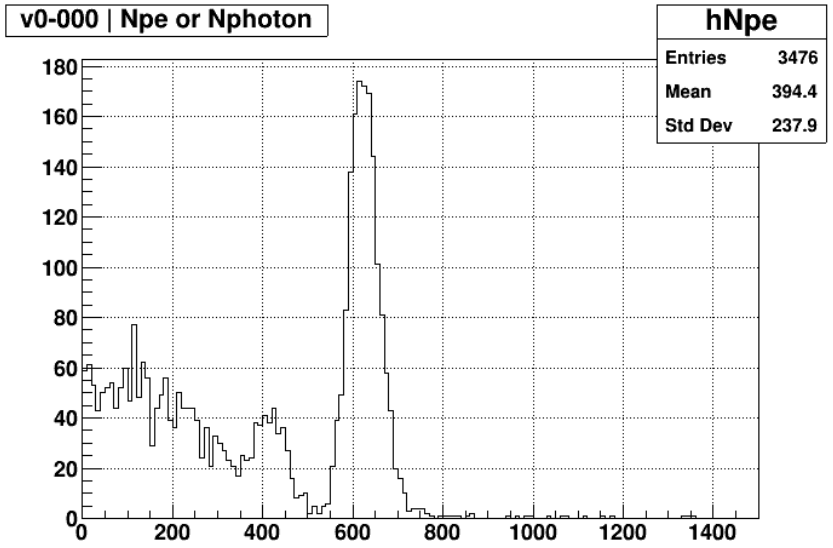
The lower limit of pDirρ ($p\mathrm{Dir}\rho = \sqrt{p\mathrm{Dir}x^2 + p\mathrm{Dir}y^2}$) and upper/lower limits of pDirZ indicate the reflection above θ at the top and bottom surfaces of the crystal.

Eight “peaks” in the pDirZ distribution indicate the number of reflections at the top and bottom of a photons before detected by the side.

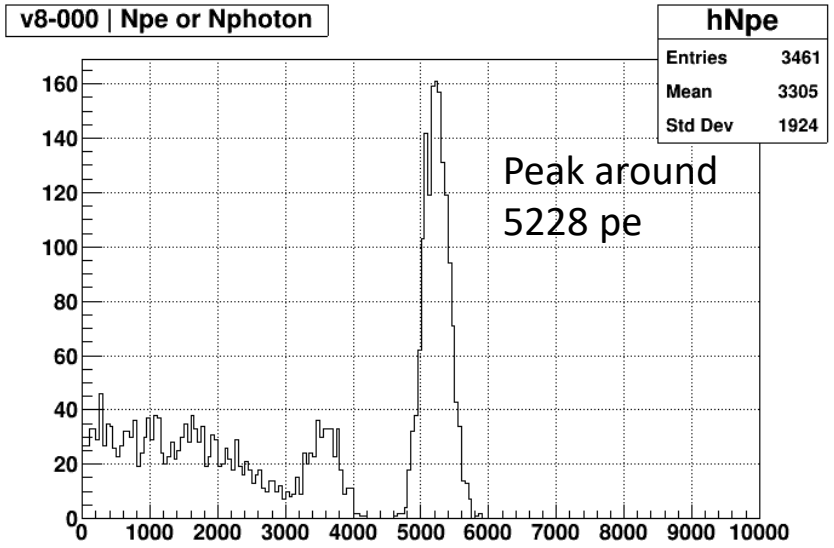
**Work around →** Change surface Setup

Npe histograms

Issue




Work around




Expect 25*662*0.836*0.385 = 5324 pe → the work around seems good