

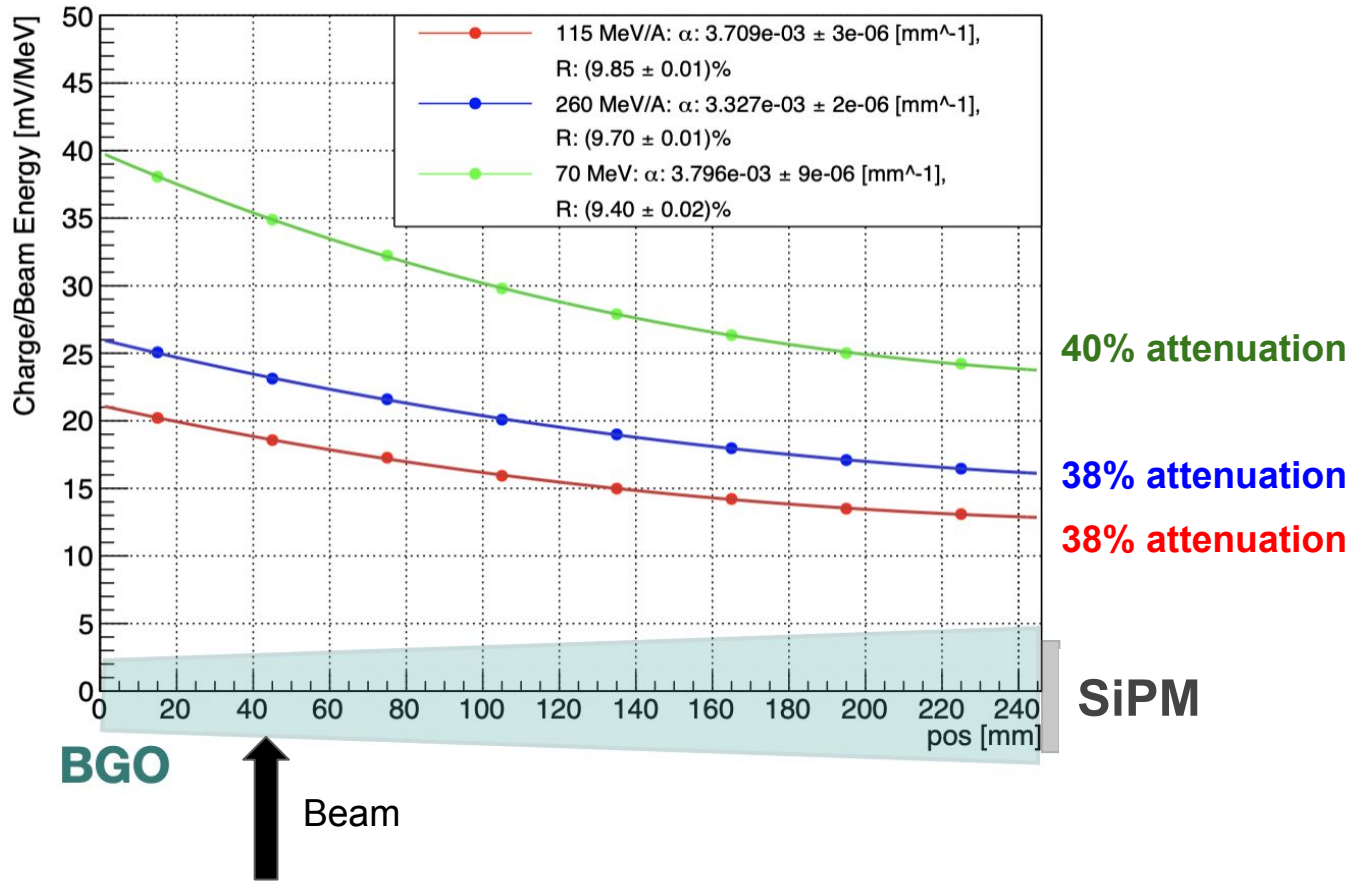
Simulation of the optical transport in the calorimeter

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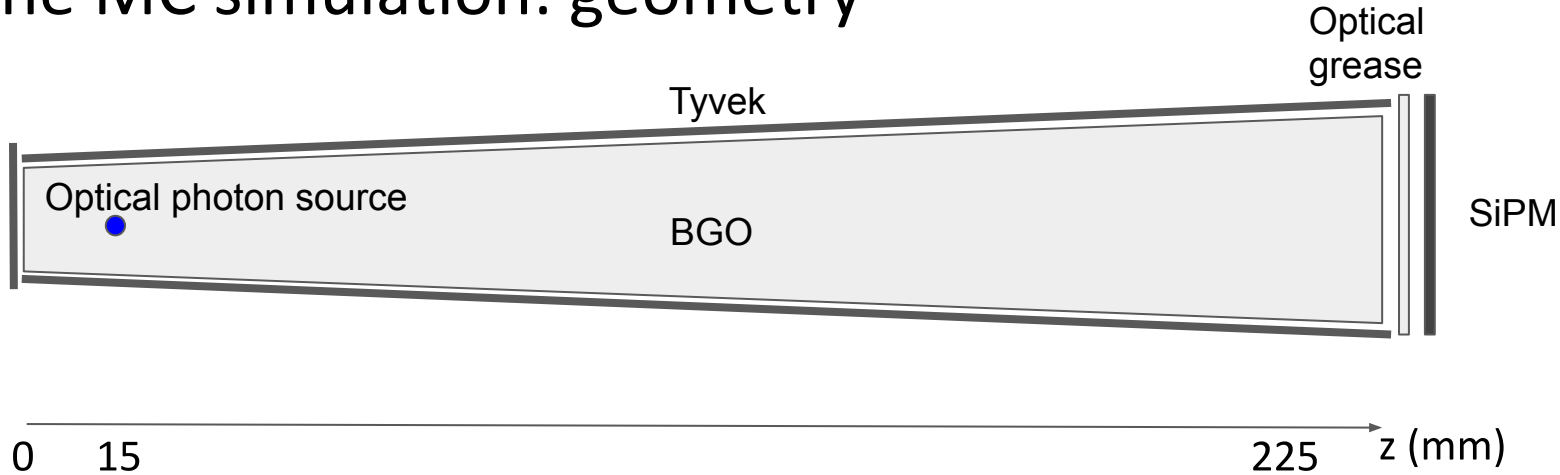
IX FOOT General Meeting, 10/12/2020



The calorimeter question



The MC simulation: geometry



- BGO trapezoid (20 mm x 20 mm ---> 30 mm x 30 mm, 240 mm length)
- Tyvek wrapping on 5 sides
- Layer of optical grease/glue between crystal and SiPM
- SiPM volume
- Scan along the crystal length with an optical isotropic point source (440 nm <-> 2.8 eV)

NOT TO SCALE

The MC simulation: physics and output

- **BGO:** $n = 2.15$, no optical absorption length (and no scattering)
- **Wrapping:** polished surface, air coupling with Tyvek -> G4 LUT “**polishedtyvekair**” (R=97%)
LUT description: <https://ieeexplore.ieee.org/document/5485130> (Janecek & Moses)
- **Optical coupling BGO+SiPM:** DOW CORNING 3145RTV, $n = 1.65$
https://cds.cern.ch/record/687343/files/note01_030.pdf
- No energy deposition, no scintillation, no SiPM response (100% PDE) - to be added
- **Simulation output:**
 - Nr. of detected photons out of 10^4 simulated
 - (x,y) position and time of arrival of each detected photon
 - 100 complete photon tracks

Sample output: photon tracks

Photon interaction counters

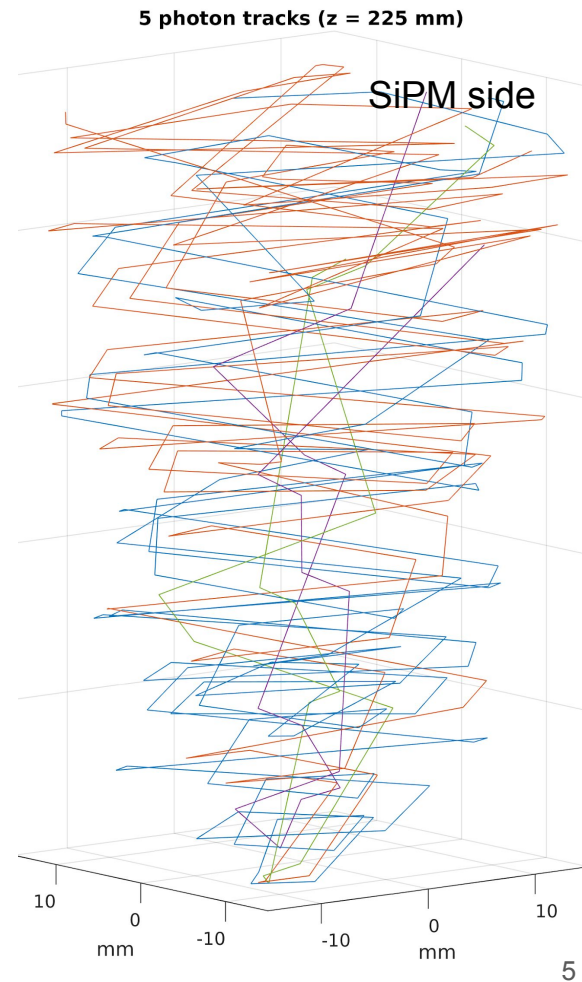
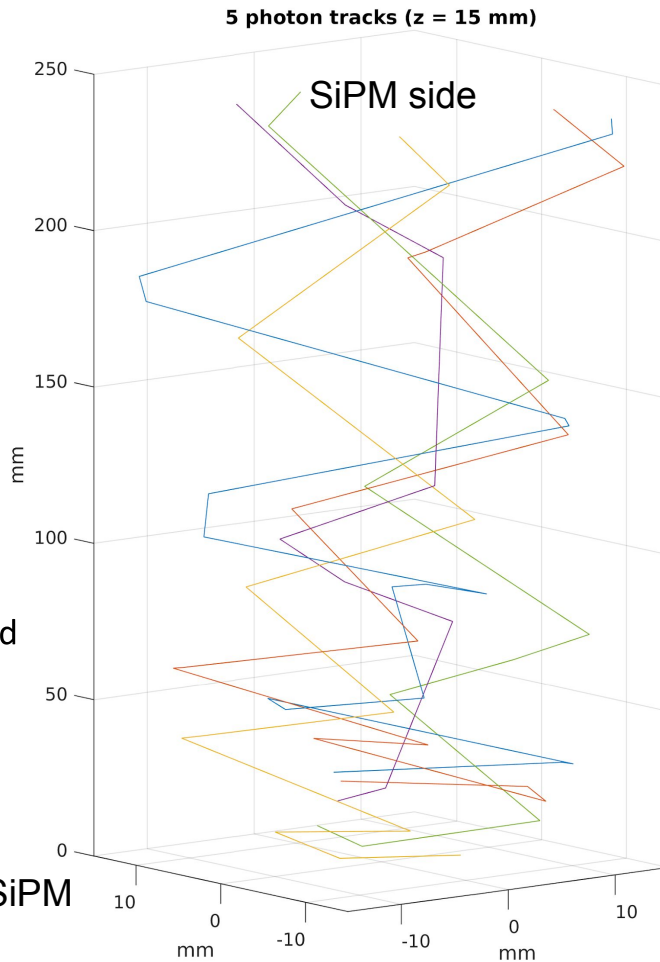
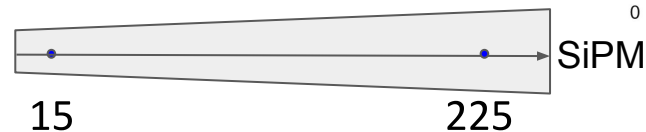
PolishedTyvekAirReflection: 321692

FresnelRefraction: 9821

FresnelReflection: 855

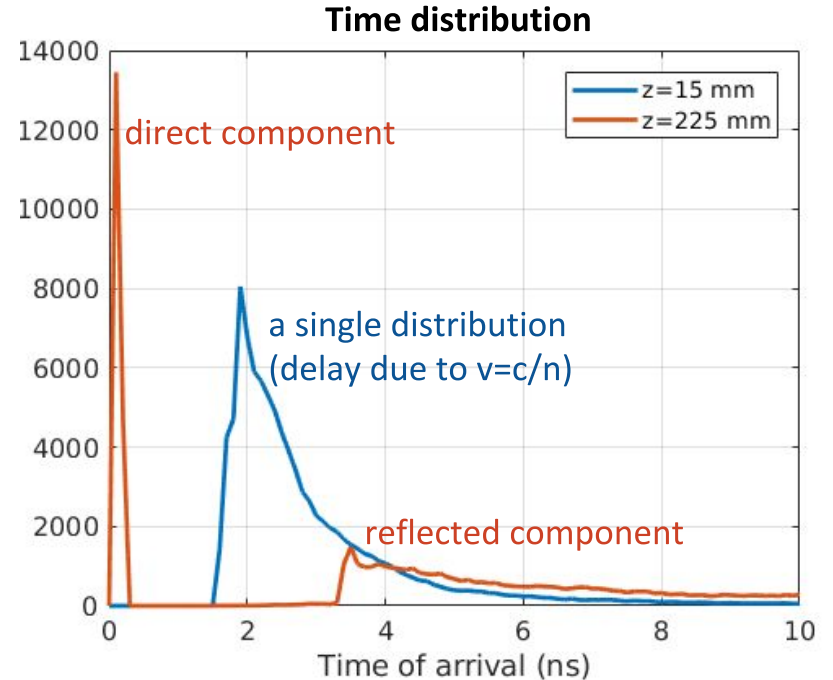
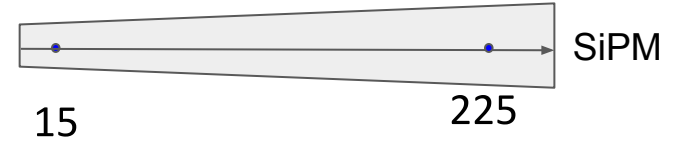
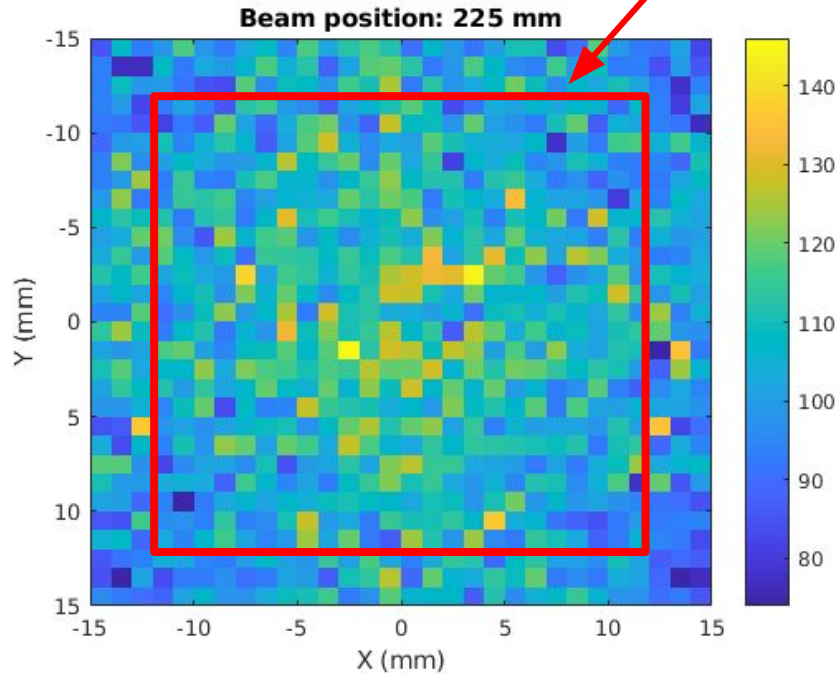
TotalInternalReflection: 3123

There seem to be many more reflections when the BGO is irradiated close to the SiPM



Sample output: spatial and time distribution of detected photons

$N = 10^5$

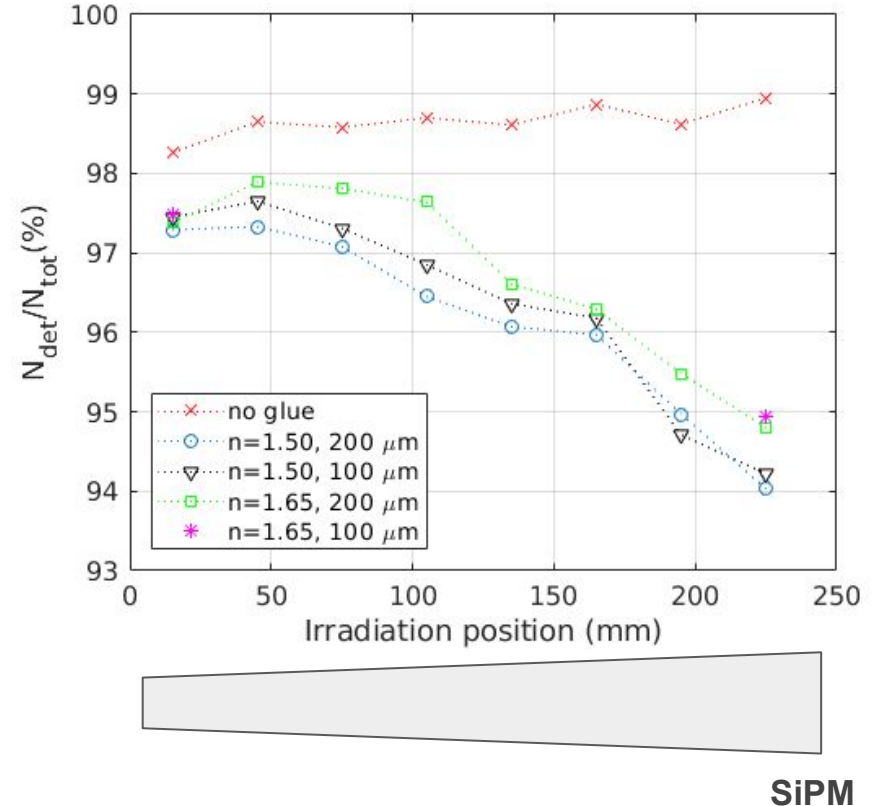


Tests done

- No optical grease between BGO and SiPM: no attenuation along the crystal observed
- Thickness of optical grease: 100 μm , 200 μm
- Refractive index of optical grease: $n=1.5$, 1.65
- BGO+Tyvek LUTs

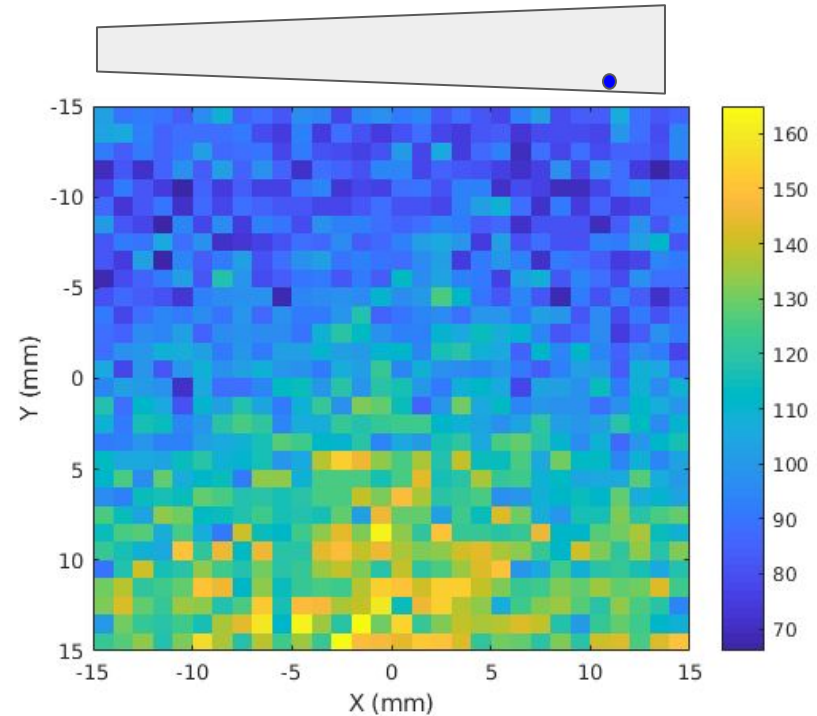
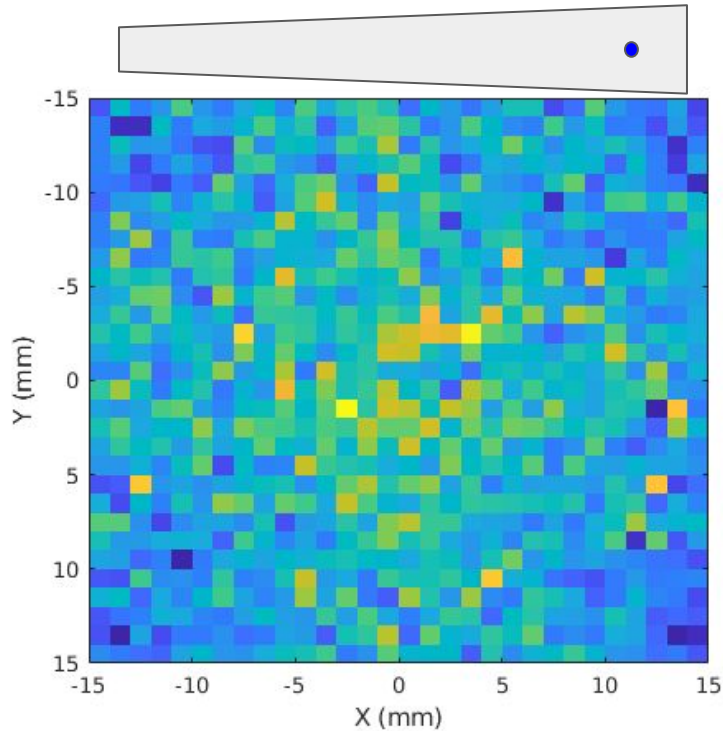
4% attenuation at most

-> there must be other causes in the exp. data



Tests done

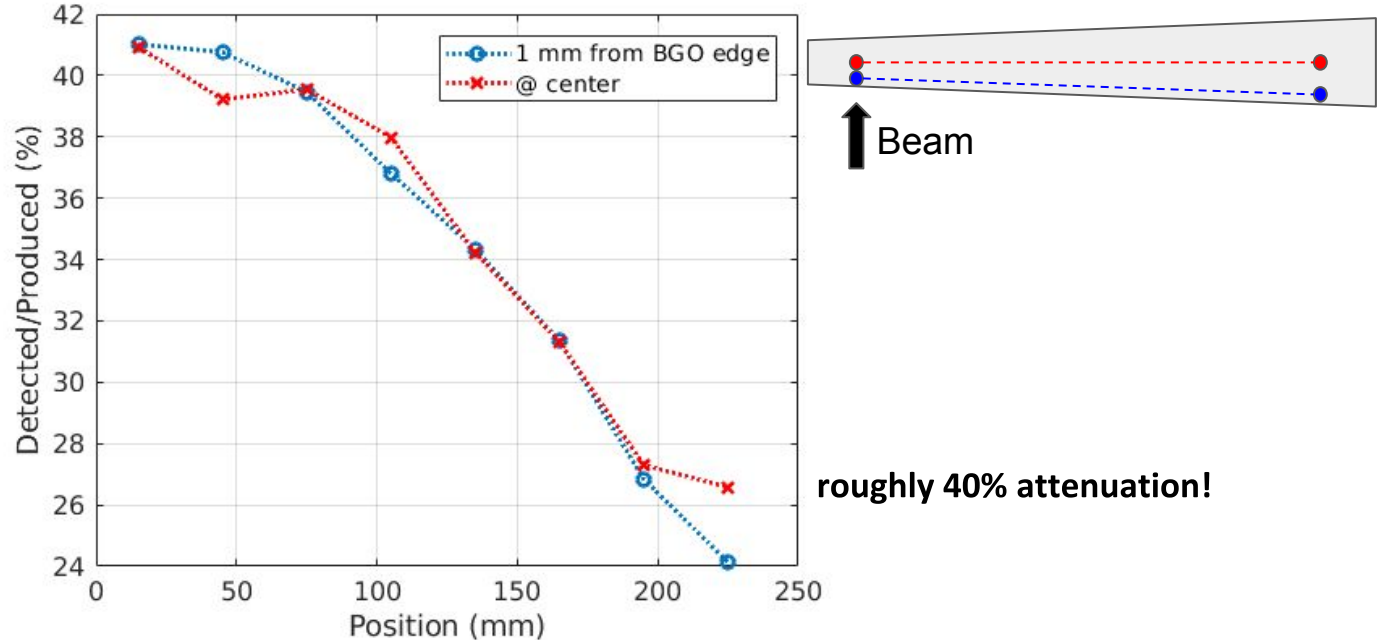
- Source position (off-center): the total number of detected photons does not vary



Add-ons

With the addition of:

1. optical absorption length (1 m, as suggested in the paper by Janecek and Moses, <https://ieeexplore.ieee.org/document/5485130>)
2. SiPM active area (central 24 mm x 24 mm)



Work in progress

- The addition of:
 - primary proton/carbon ion beam + energy deposition and fluctuations
 - scintillation

-> should give a better match between MC and experimental data

- The estimation of the SiPM response (PDE) could tell the actual number of photons per SiPM microcell and confirm the absence of SiPM saturation