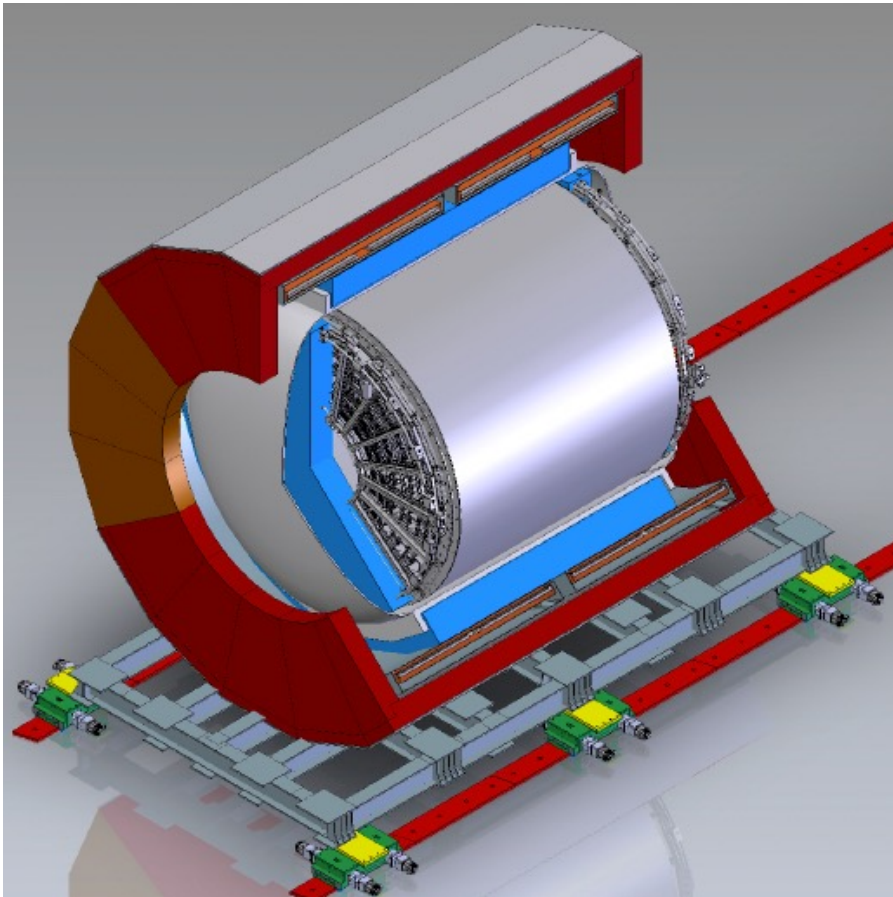


Update on optical simulation studies for interactions in ND- GAr

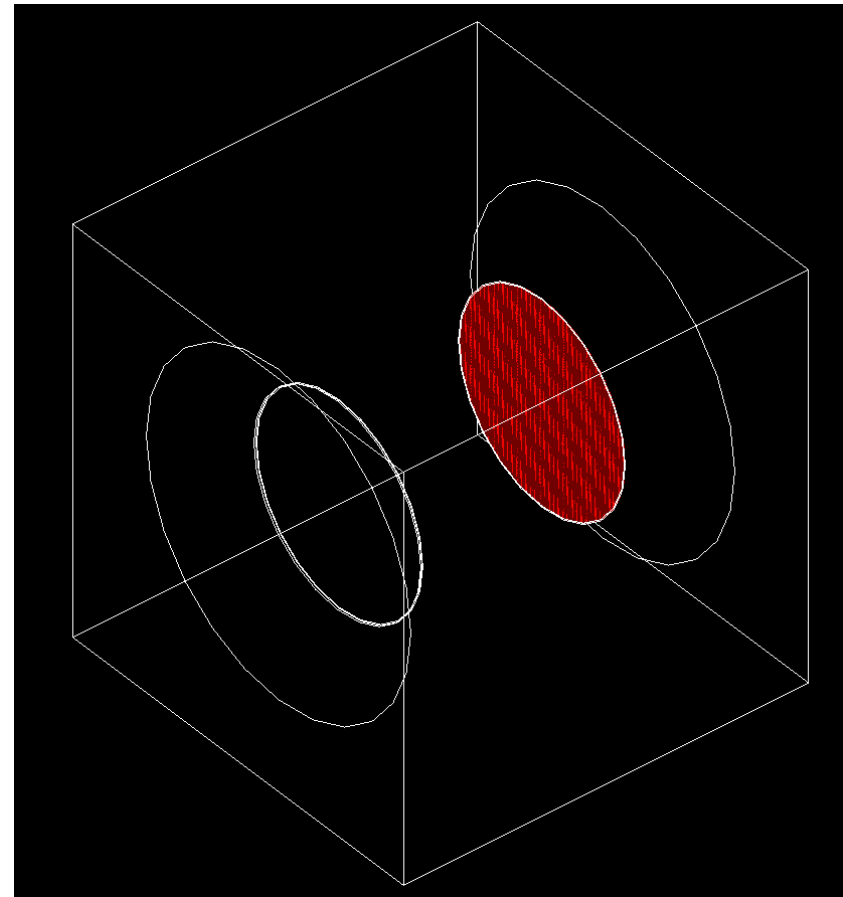
Justo Martín-Albo, Mirald Tuzi

Overview

- ND-GAr is a magnetised argon target system filled with high pressure gaseous argon and will be part of DUNE's Near Detector modules
- One of the aims is to detect particles that exit the liquid argon near detector (ND-LAr) and identify their momentum and charge in order to identify the parity and lepton family of neutrinos produced in interactions in the ND-LAr



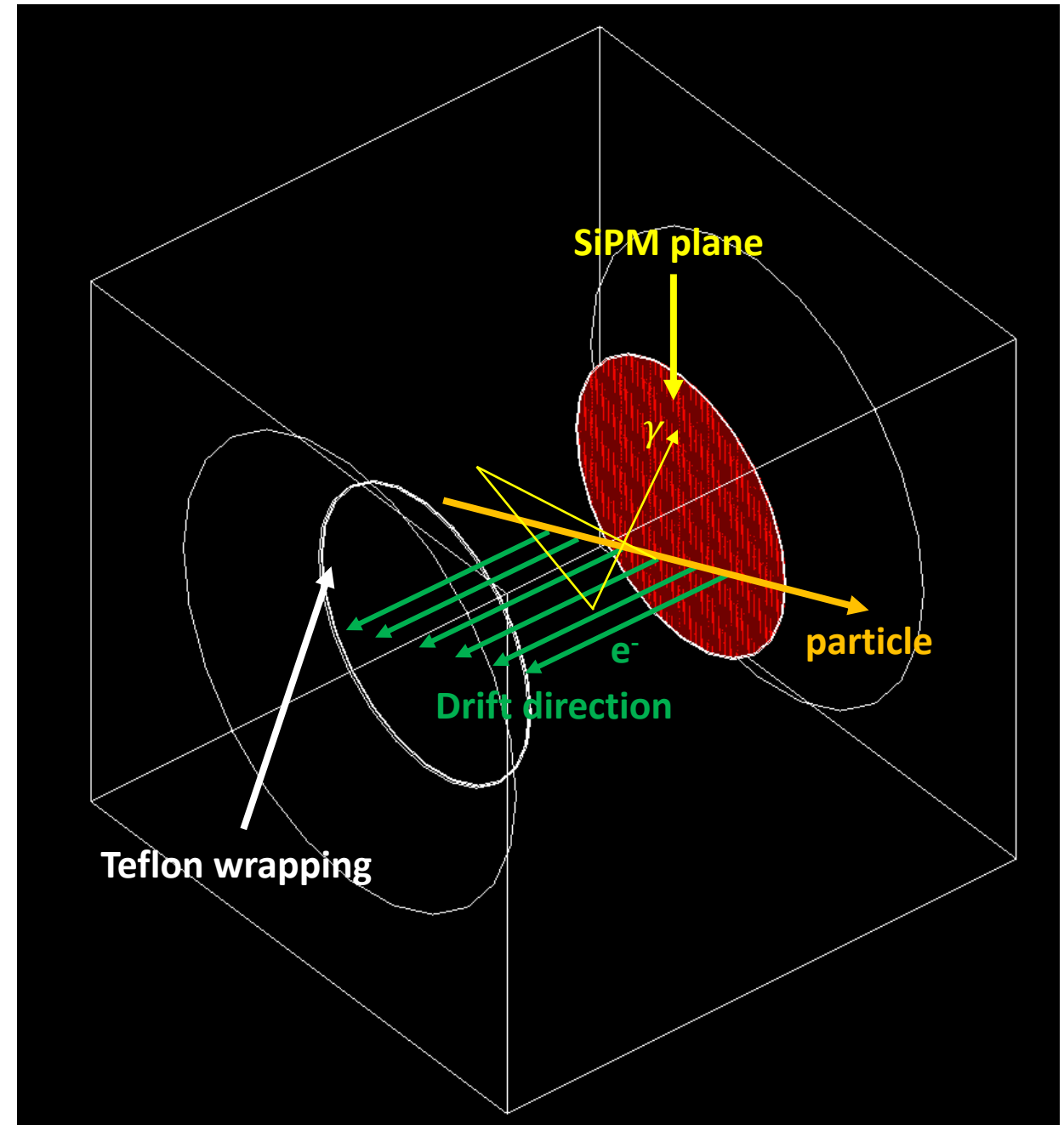
Source: DUNE ND conceptual design report



GEANT4 model

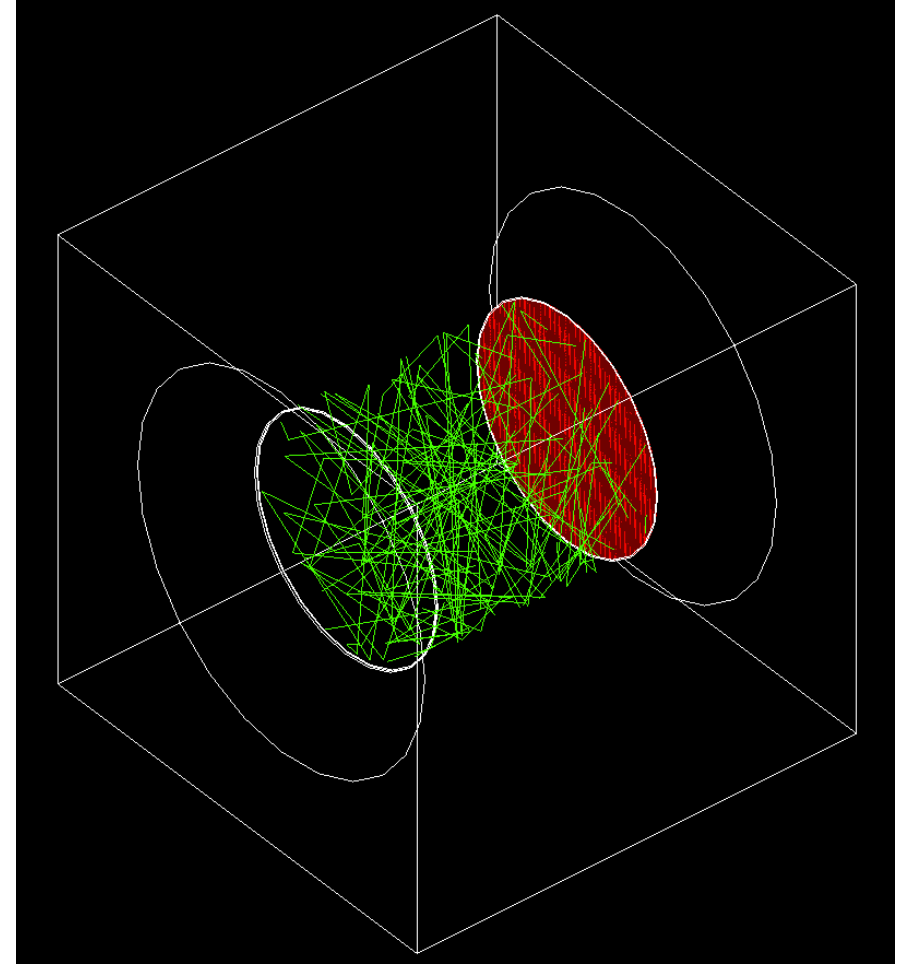
Simulation setup

- Volumes
 - cylinder of gaseous argon (D, Z = 5 m)
 - wrapped with thin layer of Teflon (thickness 5cm)
 - SiPM plane on one end (24mmx24mm, ~40k sensors)
- Fields
 - electric drift field
 - linear magnetic field (0.5 T)
- Principle: A passing particle ionises the gas which also produces scintillation light. The electrons coming from ionisation are guided along a drift field and read out at the anode like in a classical TPC while the scintillation light provides the t_0 of the measurement

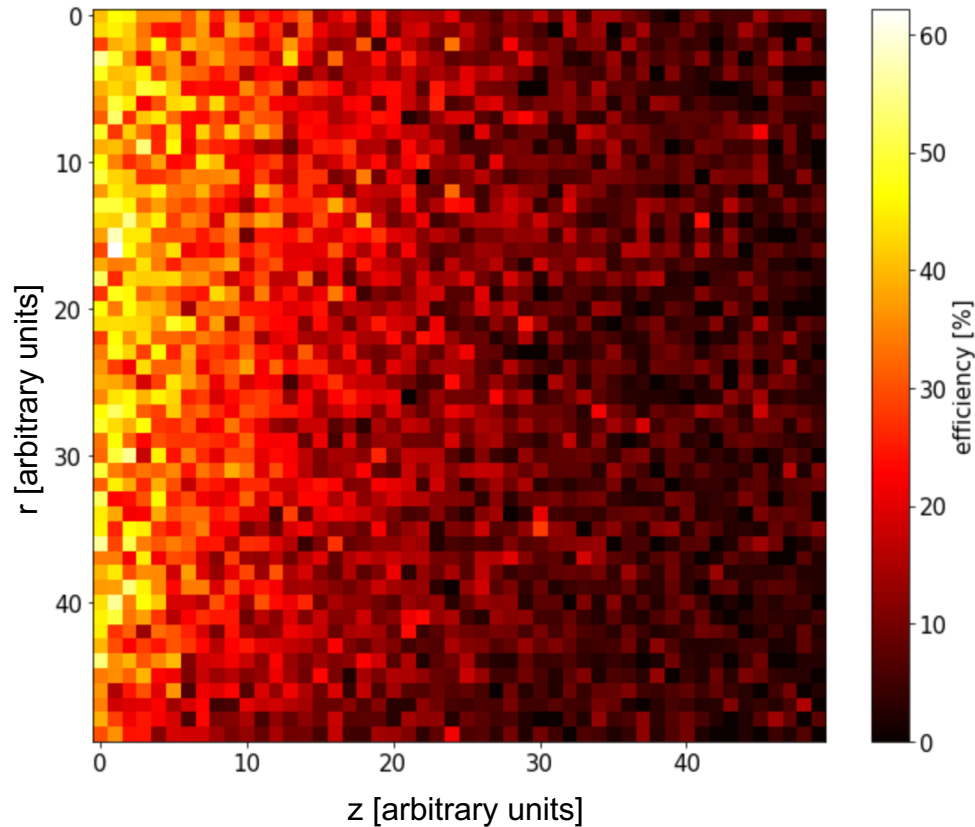


Light collection efficiency

- Goal: study light collection efficiency as a function of position (r, z) of scintillation source (no angular dependency) for different reflectivities of teflon

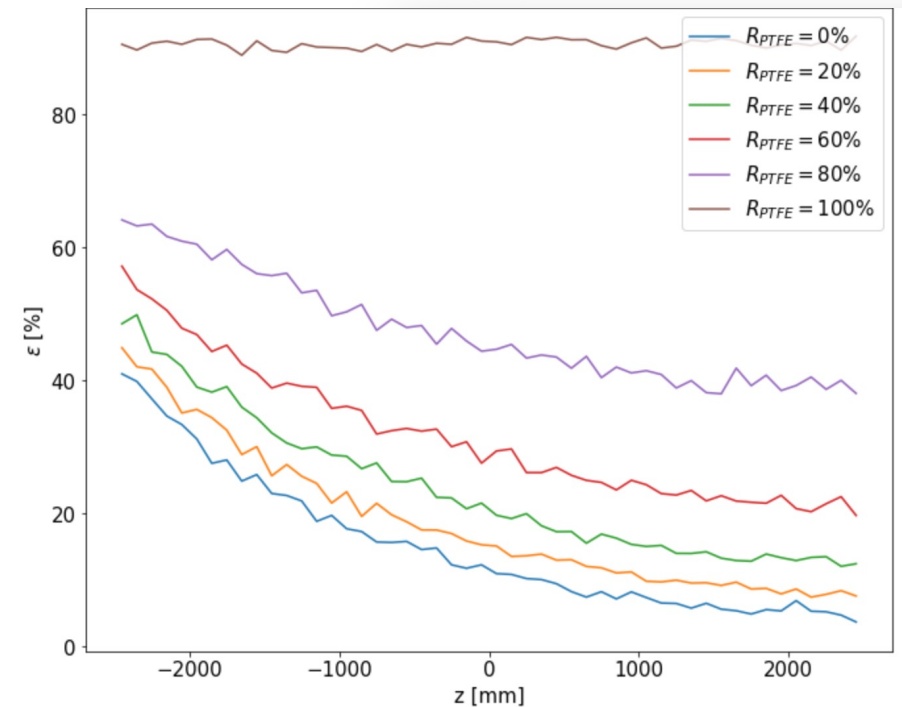
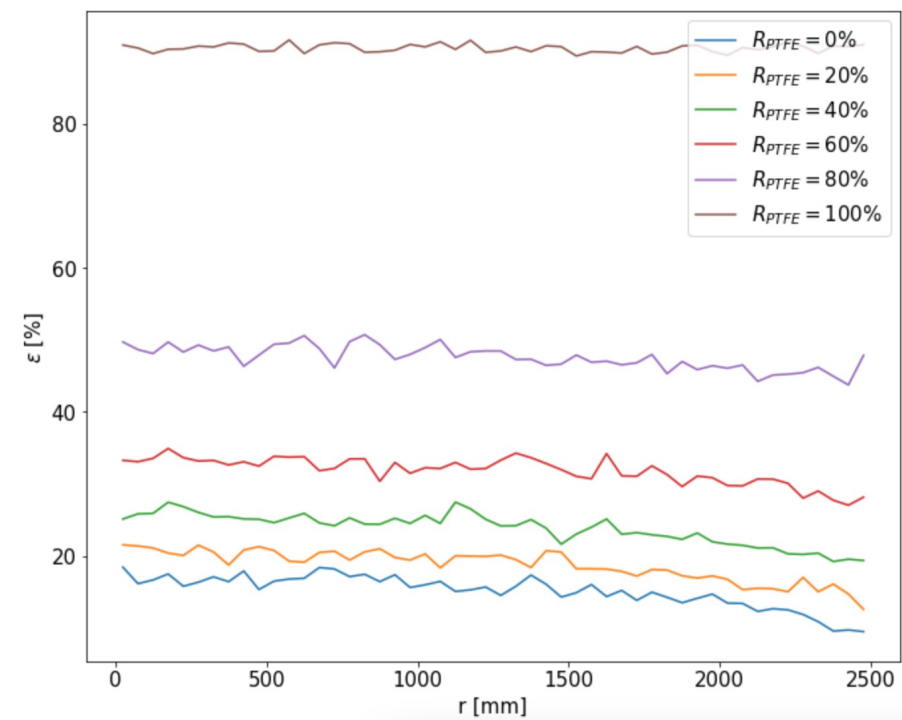


Light collection efficiency



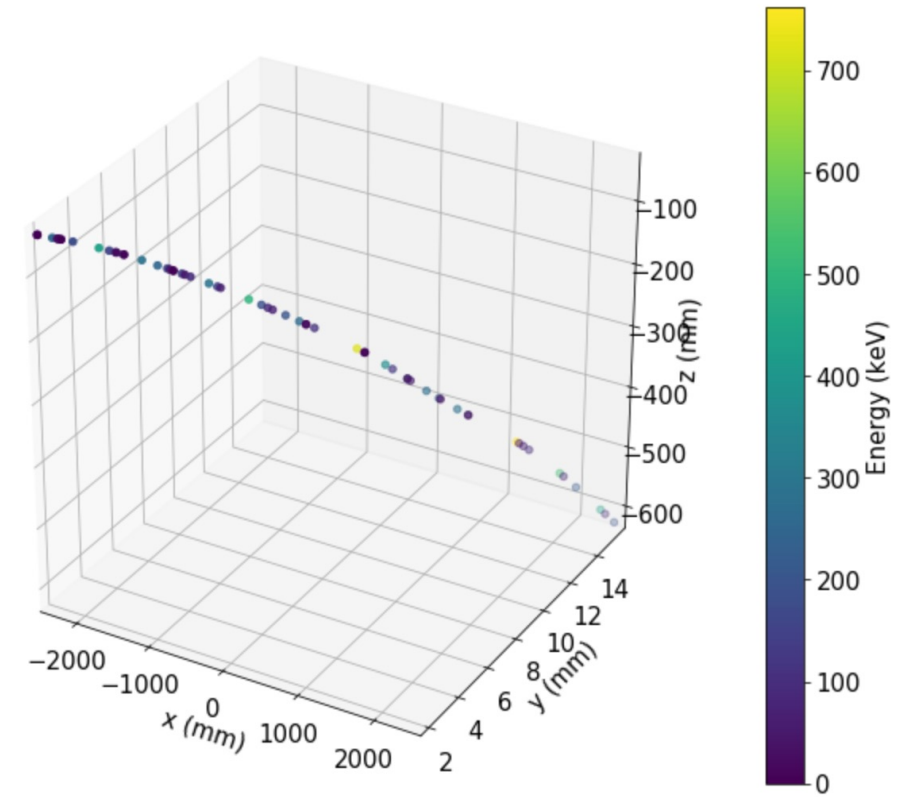
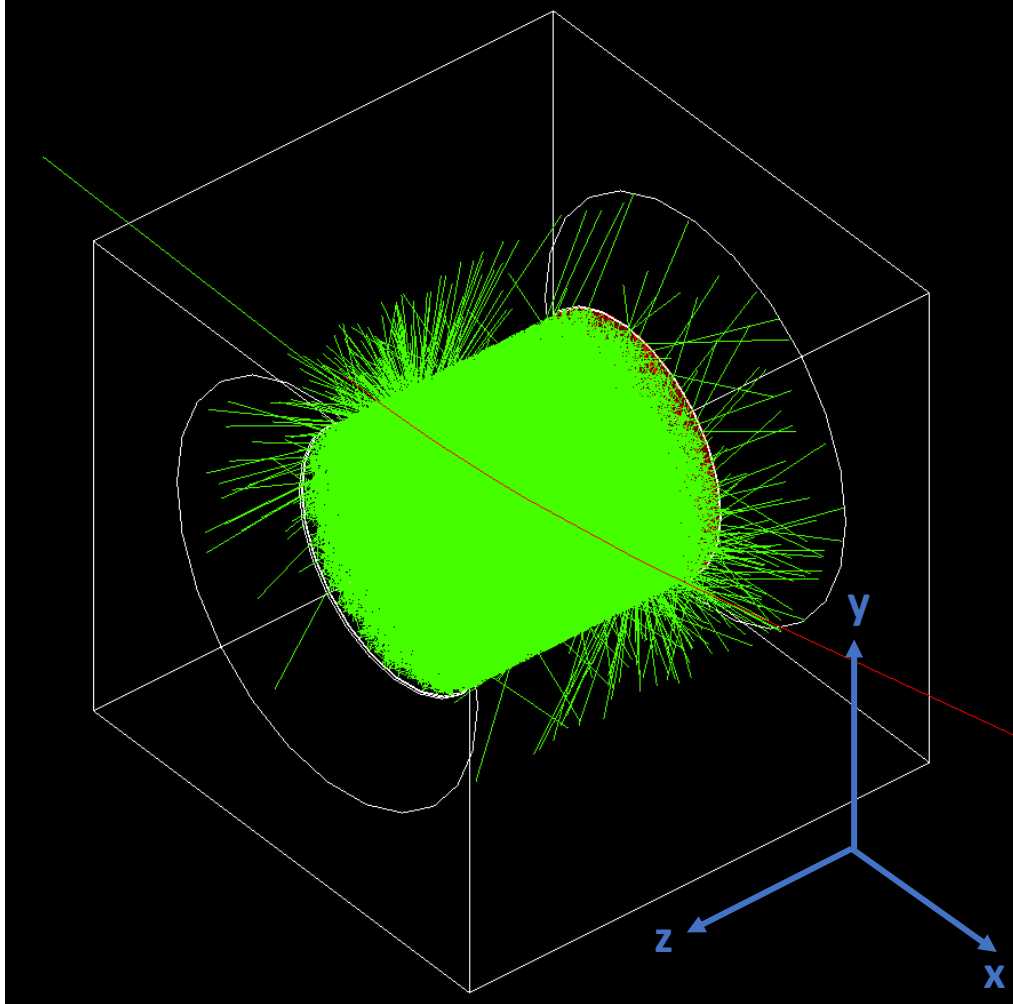
$$R_{PTFE} \approx 70\%$$

- Relatively constant in r
- In z decreases with increasing distance from SiPM plane (decrease of solid angle)
- Higher reflectivity improves collection efficiency



Simulating a muon passing through ND-GAr

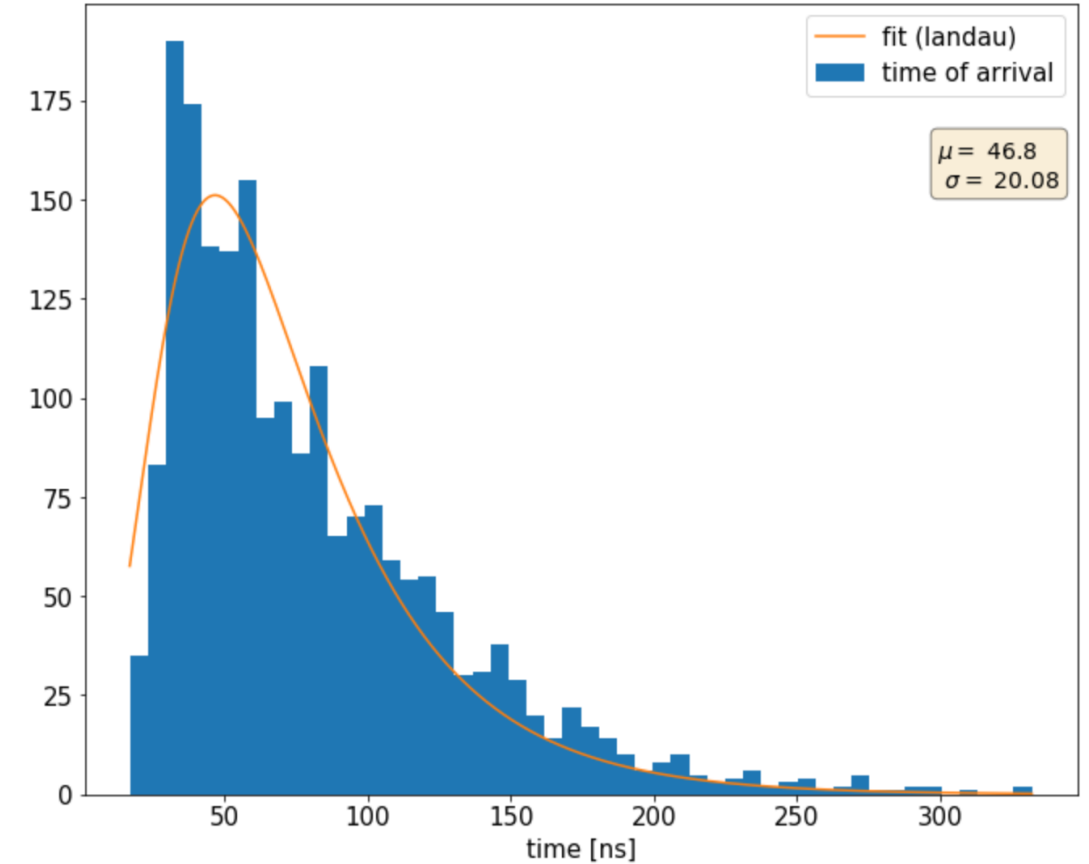
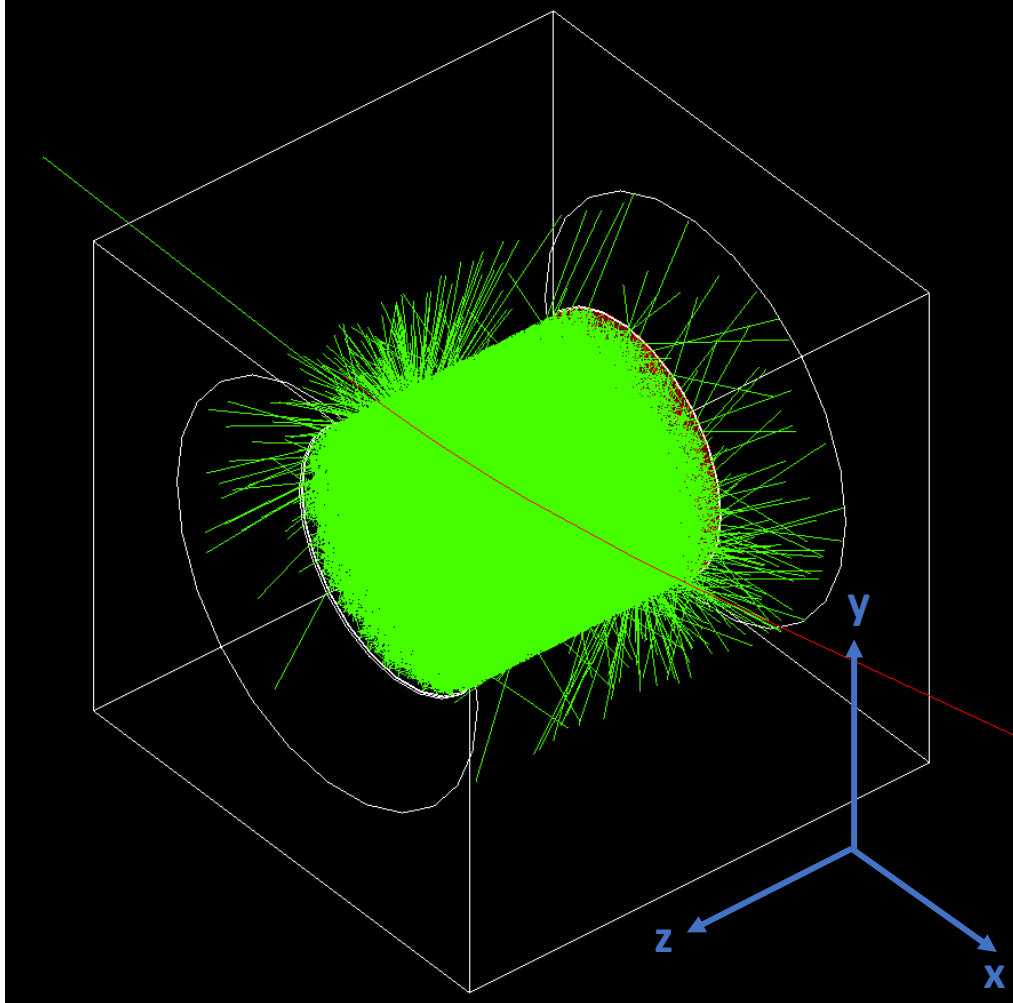
- 5 GeV muon passing the volume and magnetic field (slightly deflected)
- Muon ionises the gas
- Scintillation photons arrive with a time distribution on the SiPM plane



Muon trajectory

Simulating a muon passing through ND-GAr

- 5 GeV muon passing the volume and magnetic field (slightly deflected)
- Muon ionises the gas
- Scintillation photons arrive with a time distribution on the SiPM plane



- Timing values preliminary, simulation may not have the proper timing of emission set
- Secondary scintillation (electroluminescence) not simulated yet

Summary

- Simple simulation of NDGAr ready for first interaction studies
- Light collection efficiency depends on position along z axis and reflectivity of teflon
- First preliminary results of timing distribution of photons arriving on SiPM plane

Next steps:

- Update timing of emission in simulation
- Modify simulation in order to simulate electroluminescence

Long term goals:

- Study and understand the limits of the reconstruction of the scintillation signal
- Identify interaction channels that could profit from the scintillation signal