Activity of the Cuban group in SPD

Katherin Shtejer Díaz
on behalf of the Cuban group

SPD Collaboration Meeting
07.11.2024

Higher Institute of Technology and Applied Sciences (InSTEC)
of Havana University (UH)

MoU signed in 2024 under the leadership of Professor *Fernando Guzmán Martínez*

Ing. Mayvi Pedraza Monzón	junior researcher (master in 2025)
Ing. Thalia Rodríguez Martínez	junior researcher (master in 2026)
BSc. Eduardo Albert Fernández	junior researcher (master in 2026)
Alex M. Gaute Alvarez	student 3rd course Nuclear Physics
Juan F. Grillo Muñoz	student 3rd course Nuclear Physics
BSc. Oris Suárez	junior researcher (PhD in 2028)
Dr. César García Trápaga	senior researcher
Dr. Katherin Shtejer Díaz (CEADEN)	senior researcher

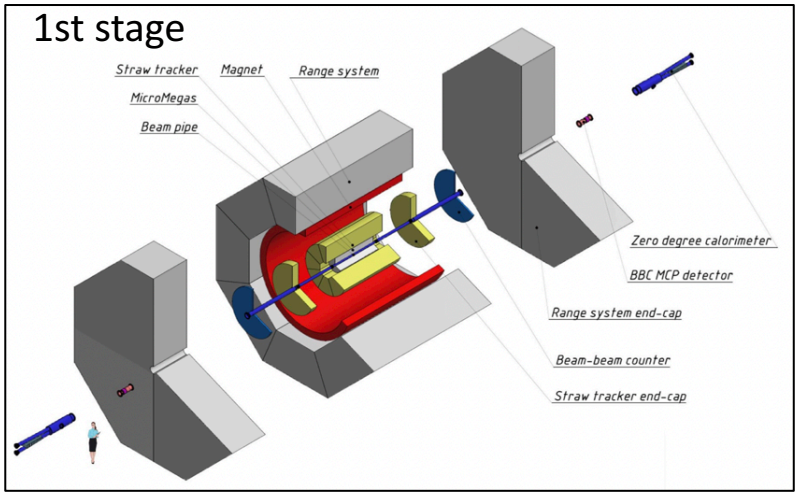
Current contribution of the InSTEC to the SPD

- To perform a GeoModel-based ZDC geometry of SPD.

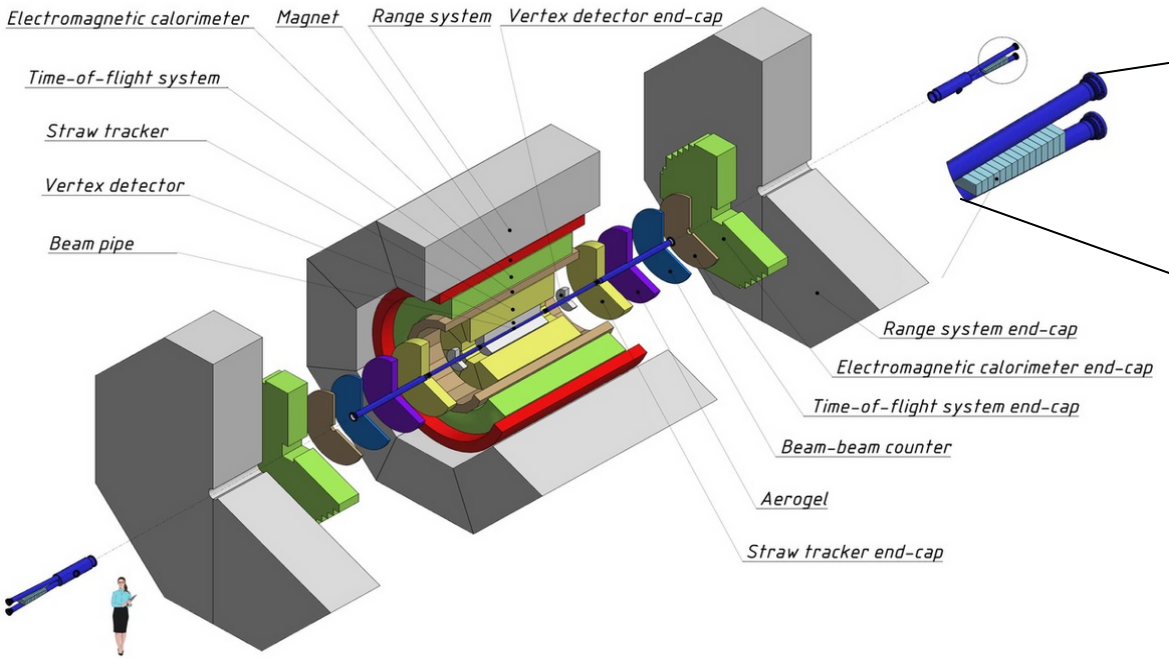
Description of the Zero Degree Calorimeter in the frame of GeoModel to ensure modularity and portability according to the general geometry description of SPD.

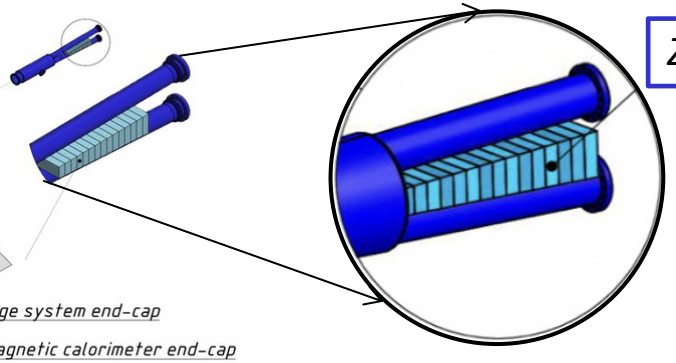
- ✓ Verification of the ZDC geometry description using Monte Carlo simulation (Geant4) to control and to optimize the main parameters of the ZDC detector
- ✓ Check the reliability of the obtained results (using information from TDR)
- ✓ Prove that the proposed detector geometry is optimal
- ✓ To modeling the proposed ZDC geometry GeoModel
- ✓ Create a program code within the GeoModel package
- ✓ Check the compatibility of the code with the SpdRoot package

The Zero Degree Calorimeter will be present in the 1st stage of the SPD installation



2nd stage

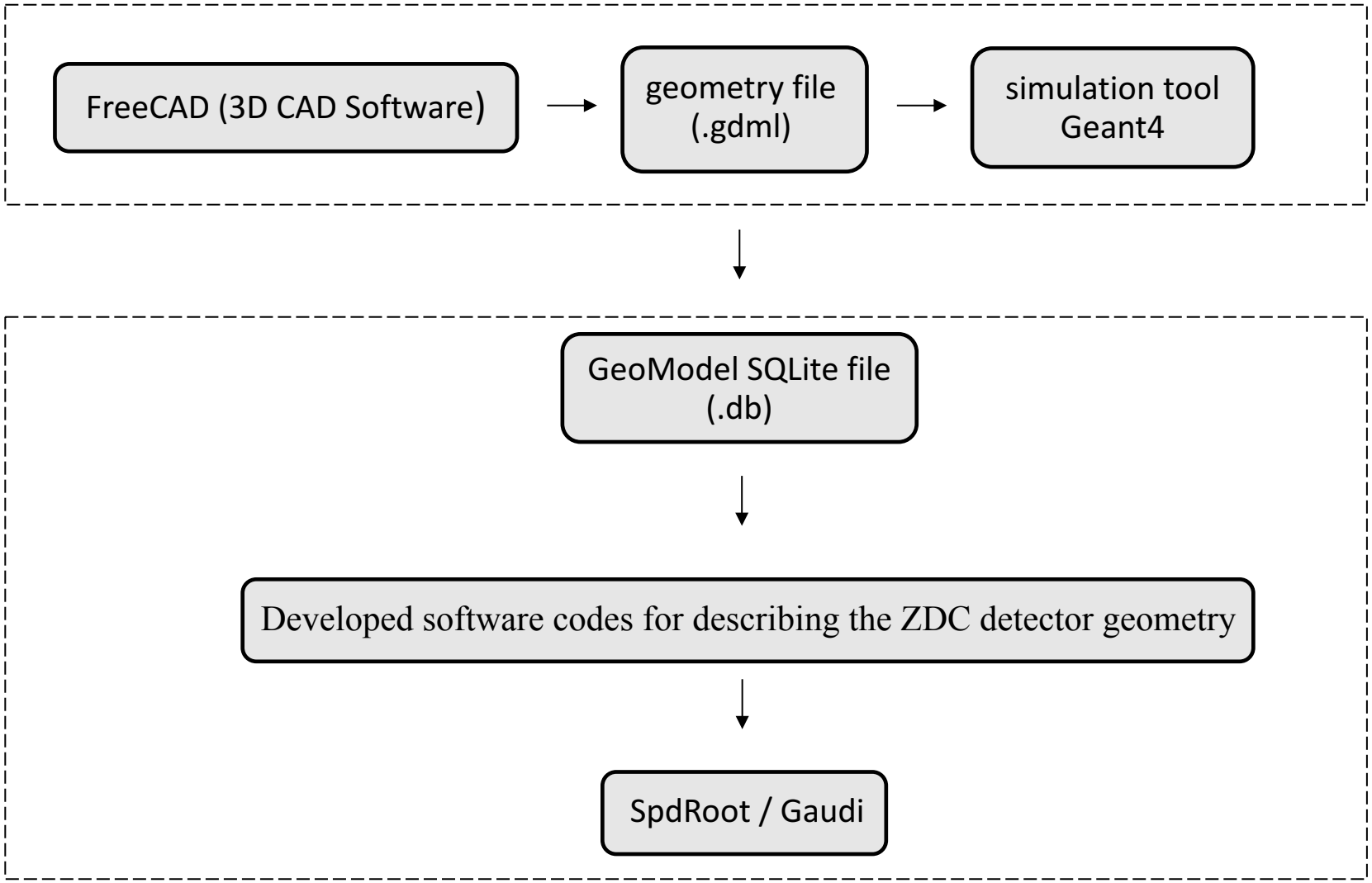




Zero Degree Calorimeter

- Main tasks
  - ✓ Luminosity measurements
  - ✓ Local polarimetry with forward neutrons
  - ✓ Time stamp of the events
  - ✓ Spectator neutron tagging

Strategy flow



GeoModel: Detector description toolkit for HEP experiments

A single ZDC module

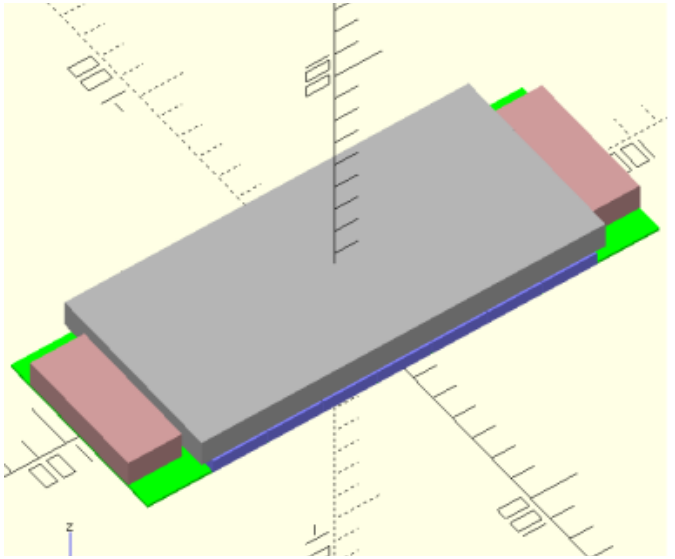
Electromagnetic part

Number of layers 8

Scintillator thickness, mm 5

Absorber thickness, mm 5

PCB thickness, mm 1



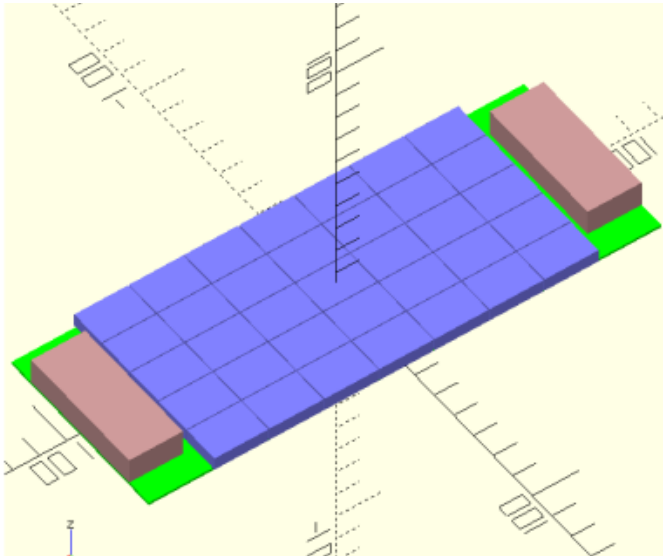
Hadronic part

Number of layers 22

Scintillator thickness, mm 10

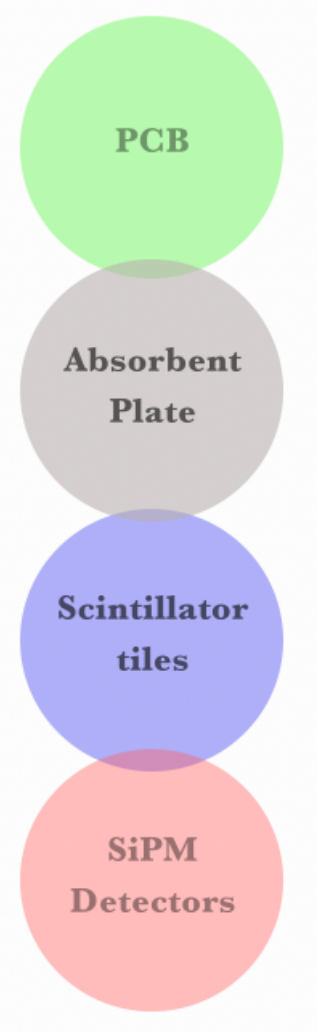
Absorber thickness, mm 13

PCB thickness, mm 1

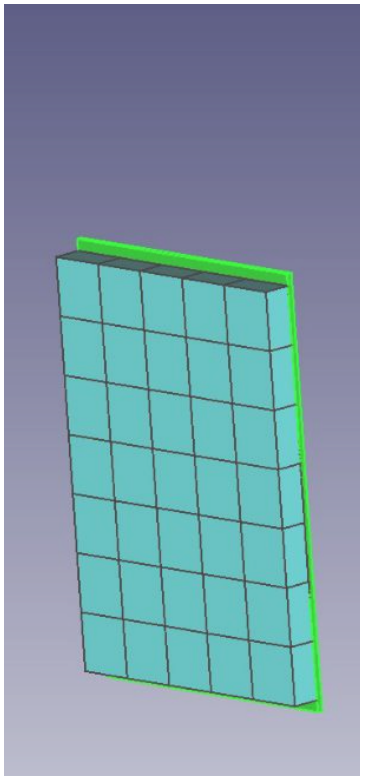


Total

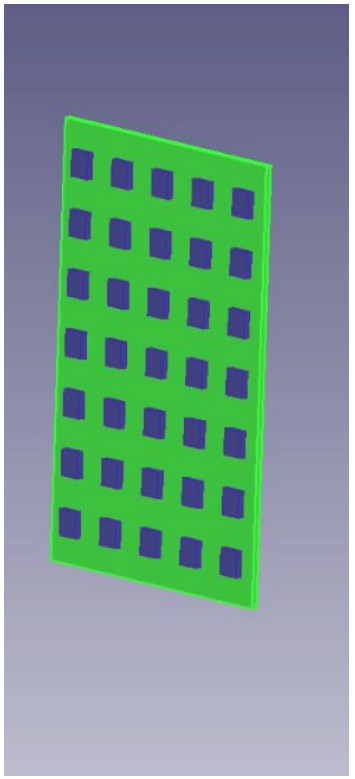
Thickness, mm 611



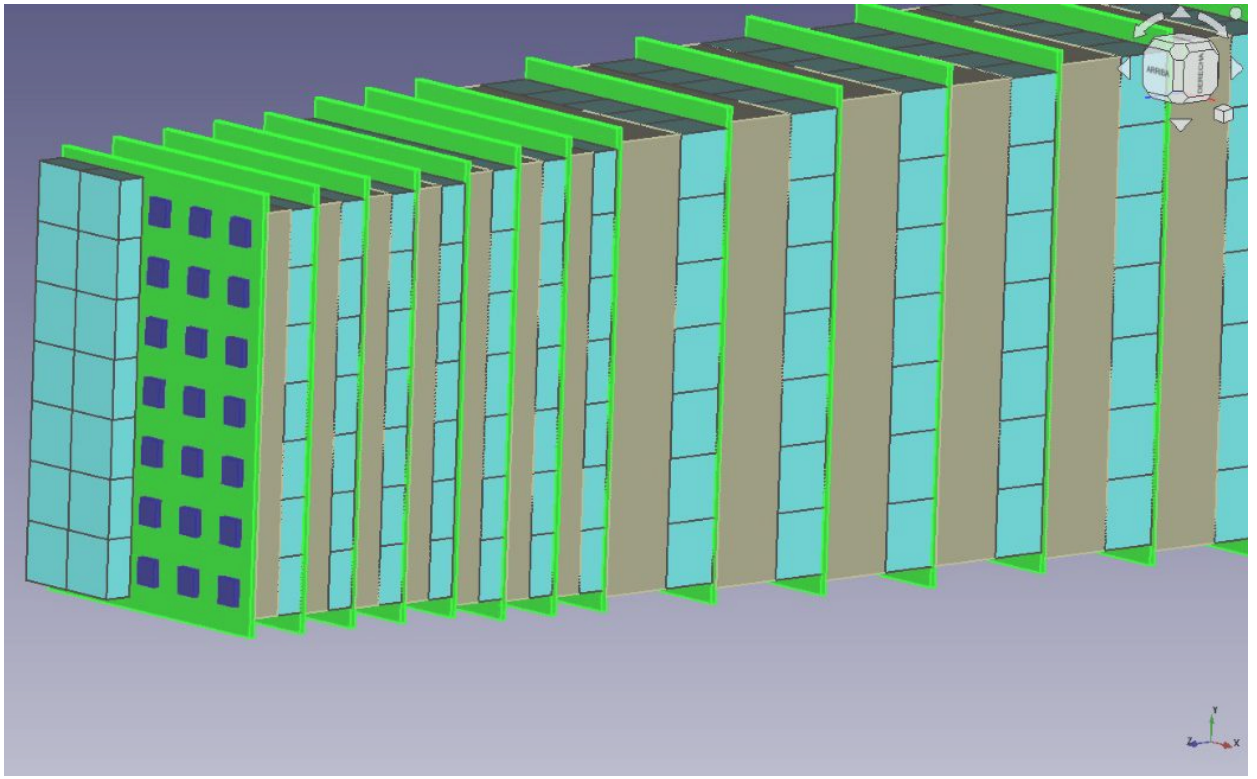
FreeCAD geometry design



Scintillator plate with PBC frame



PBC with SiPM detectors



Assembly of individual planes: 3D model in FreeCAD

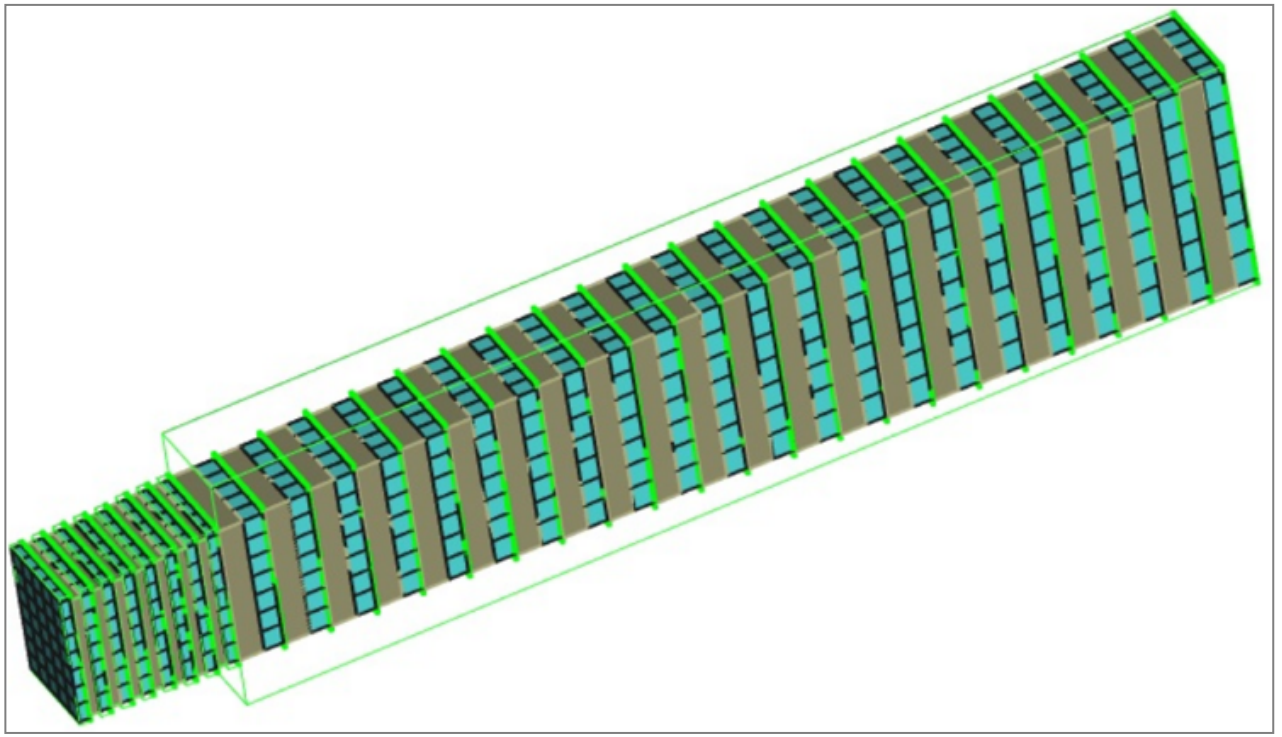
FreeCAD geometry design

Number of layers:

EM section: 8 layers
HAD section: 22 layers

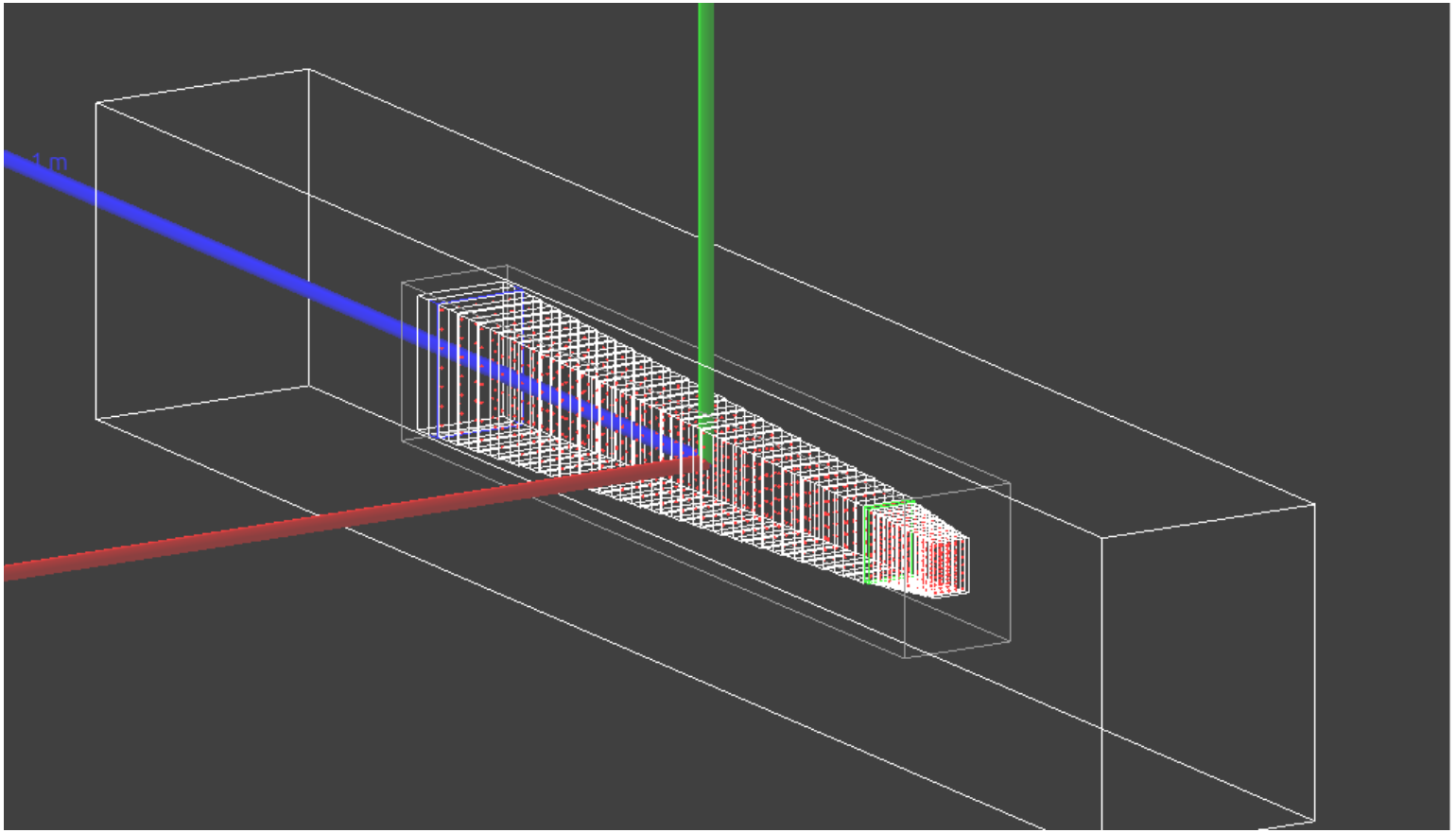
Absorber plates:

EM section: 7 absorbers
HAD section: 22 absorbers



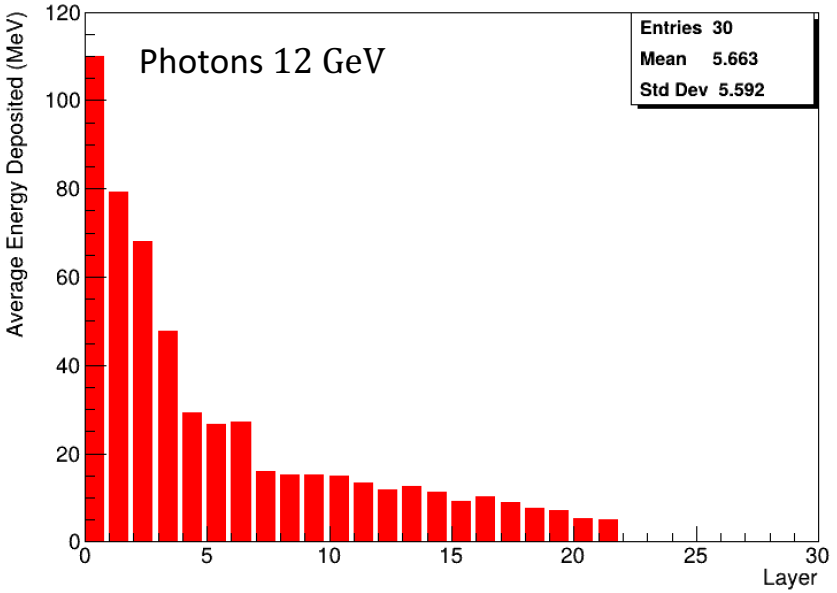
Integration of the calorimeter sections

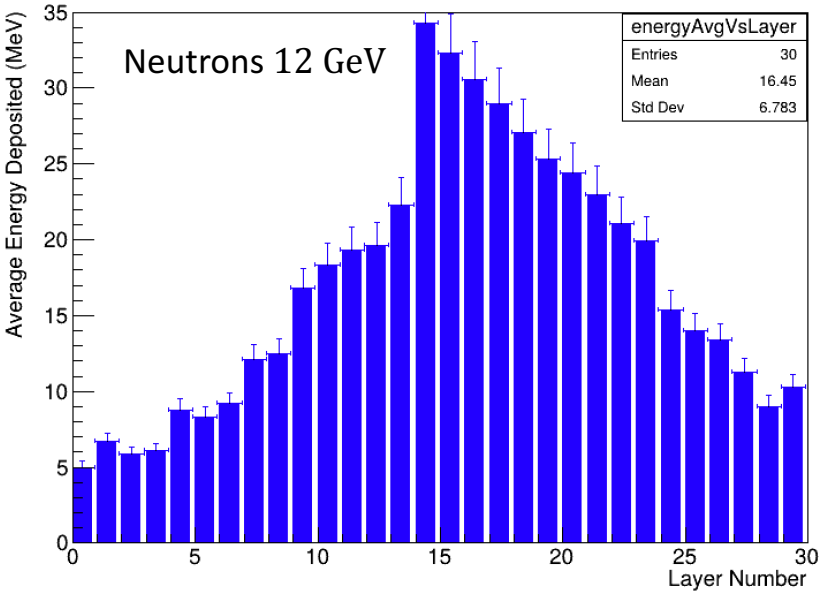
Geometry overview from Geant4

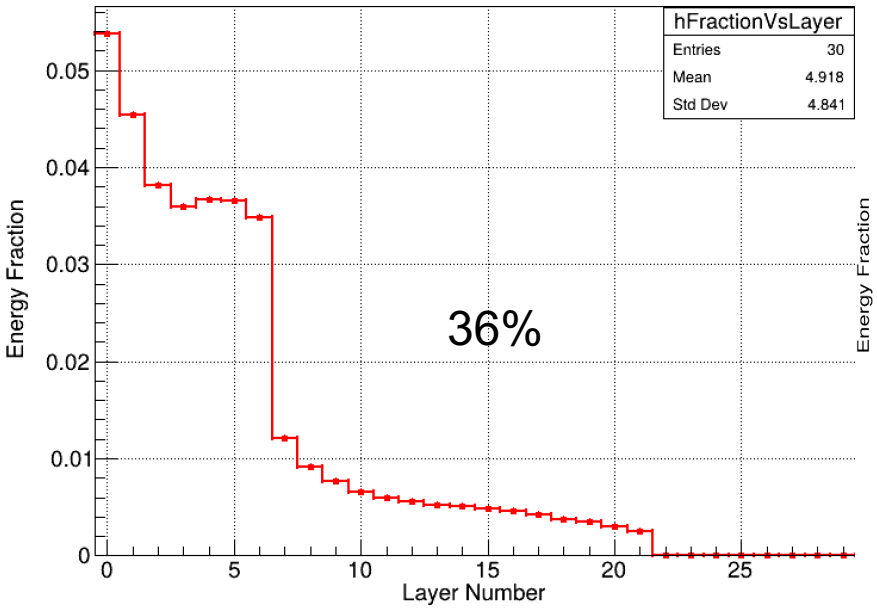


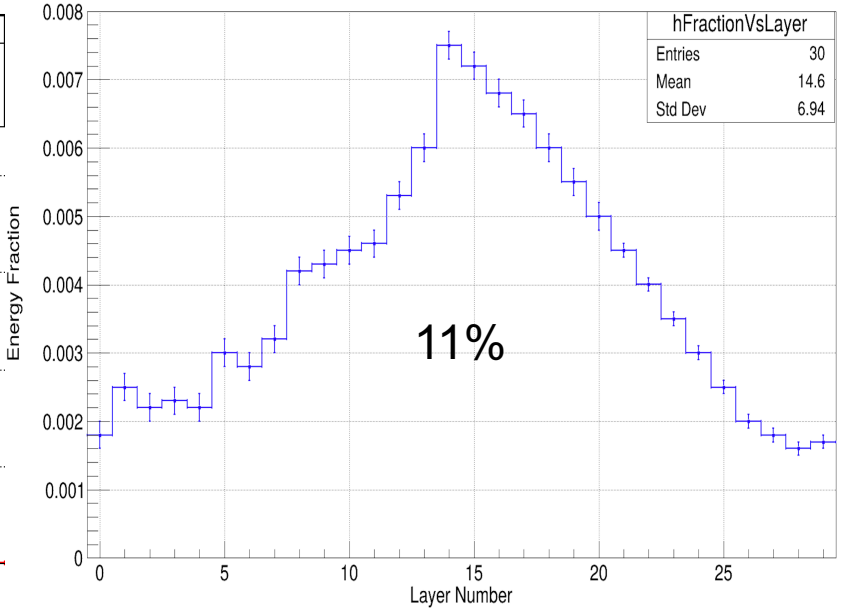
Scintillating Plastic **Composition:** 97.49% C, 2.5% H, 0.01% O **Density:** 1.05 g/cm³ **Function:** Conversion of energy into light signals	***Tungsten (W)*** **Function:** Primary absorber **Properties:** Z=74, ρ=19.3 g/cm³ **Advantage:** Excellent for initiating particle cascades	***FR-4 (PCB)*** **Composition: 43% C, 3% H, 54% O** **Density: 1.85 g/cm³** **Function:** Structural support and electrical connections	***SiPM*** **Simplified composition:** 95% Si, 3% O, 2% Al **Density:** 2.33 g/cm³ **Function:** Detection of light signals

Average energy deposited per layer





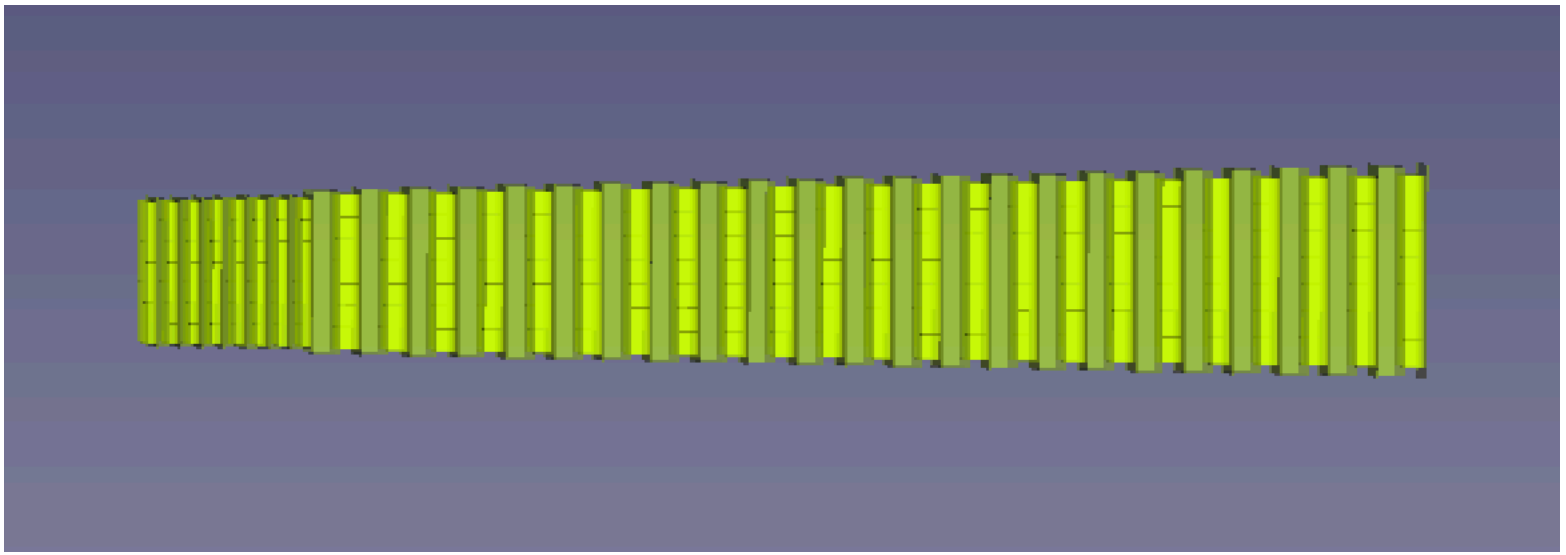




Low energy deposition fraction due to leakage, which reduces the chances of precisely tag incoming particles.

Different longitudinal energy distribution for photons and neutrons can be used for n/γ separation.

GeoModel geometry design



Writing the geometry description in SQLite self-contained database

ZDC geometry.db

FullSimLight

Easily run G4 simulations with minimal set of observables

Supports generators: G4 particle gun, Pythia, HEPMC3 formats

Plans

- Update our information about geometry, beyond the TDR, in coordination with the team from Kurchatov institute, ITEP
- To help with the simulations to test optimal parameters of ZDC both, for 1^{rt} and 2nd stage SPD
- Finnish the geometry description in GeoModel and testing it
- Integrate the GeoModel geometry in SpdRoot / Gaudi