Meeting Muon Collider
GEANT4 Calorimeter simulation

Status and plans - 4/7/2022

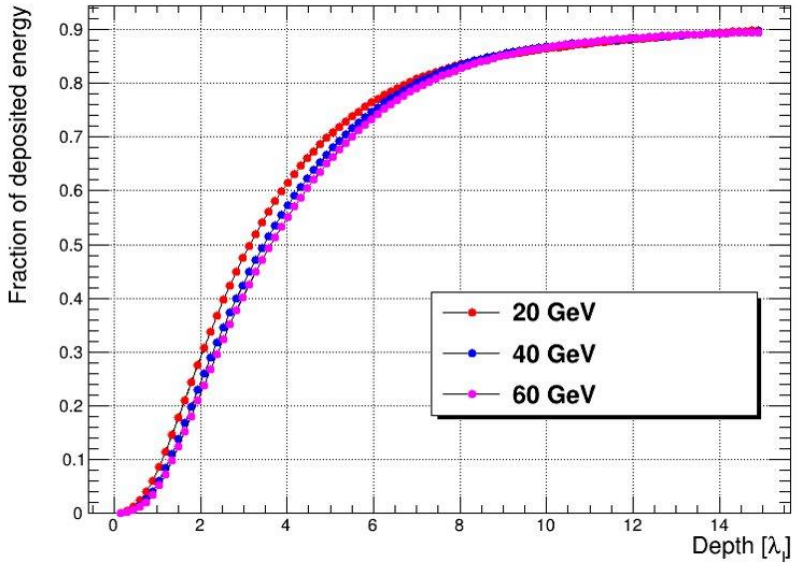
Latest results

- **Containment studies** with pions up to 60 GeV

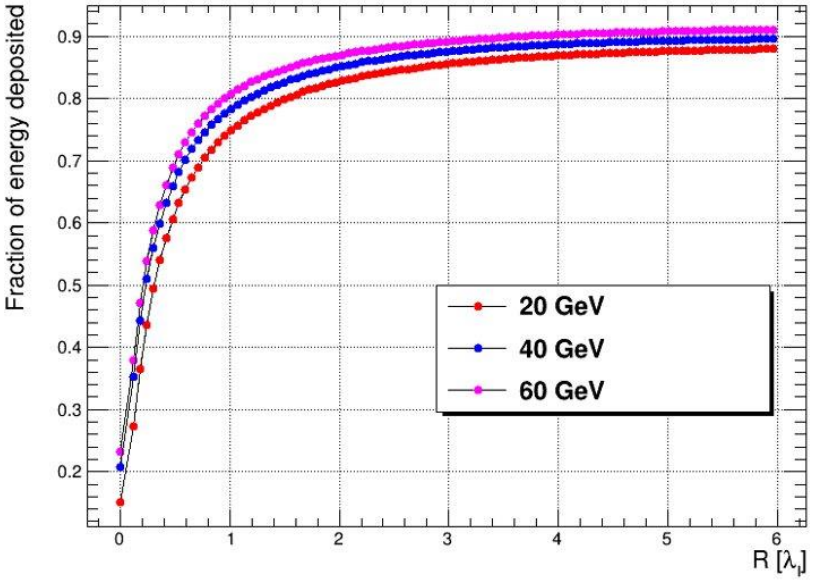
- Layers made of
  - 2 cm of Fe (**absorber**)
  - 5 mm of Ar (**active gap**)
- Granularity given by cell of 1x1 cm²

- Geometry optimized for shower containment
  - 3 λ_I for 90% lateral containment
  - 14 λ_I for 90% longitudinal containment

Longitudinal containment



Lateral containment

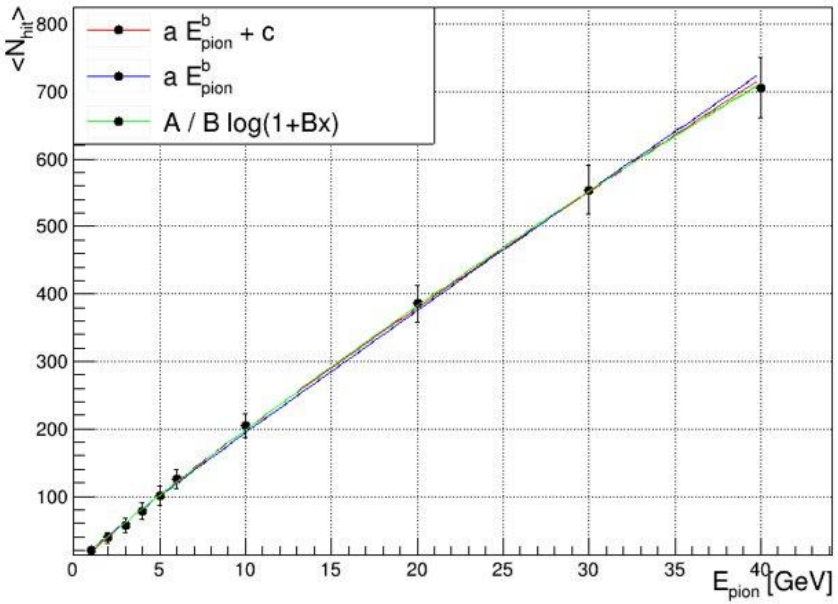


Latest results

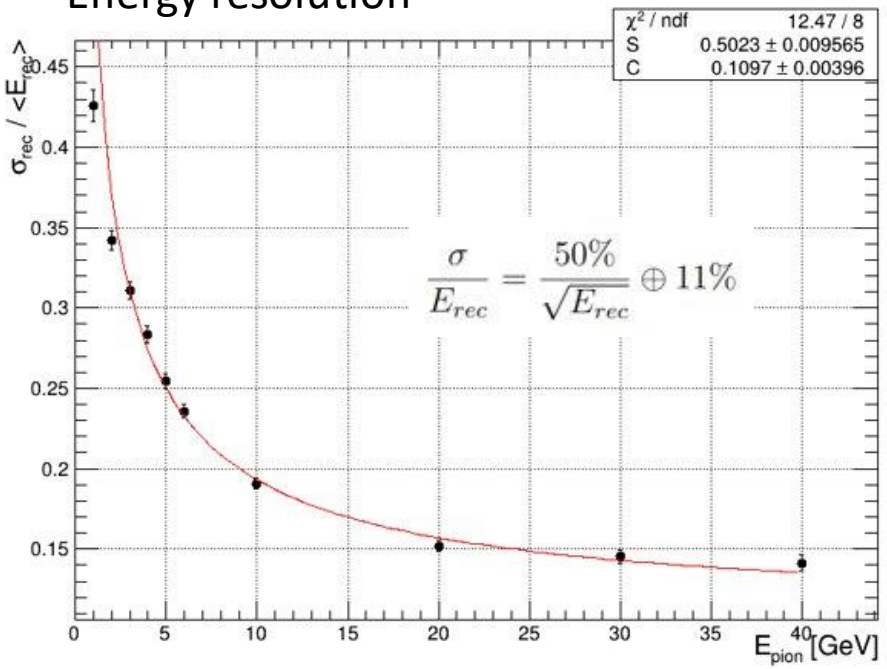
Energy resolution

- E_{pion} from 1 to 40 GeV
- Detector Geometry:
  - 50 layers, 1x1 m²
    total transverse size, 1x1 cm² cell
- **Digital RO** (single threshold)
  - 1 hit = 1 cell with deposited energy higher than 30 eV
- Response function $N_{hit} = f(E_{pion})$
- Reconstruct the energy from $E_{rec} = f^{-1}(N_{hit})$

Calorimeter response function



Energy resolution



Future plans

- Implement the realistic prototype materials and geometry – the one described on PRIN?

Preliminary containment plots with
- 12 layers, 50x50 cm^2 transver size
  - 4 cm of Fe for the absorber
  - 3 mm of Ar for the gap
- At the energies of the SPS test beam

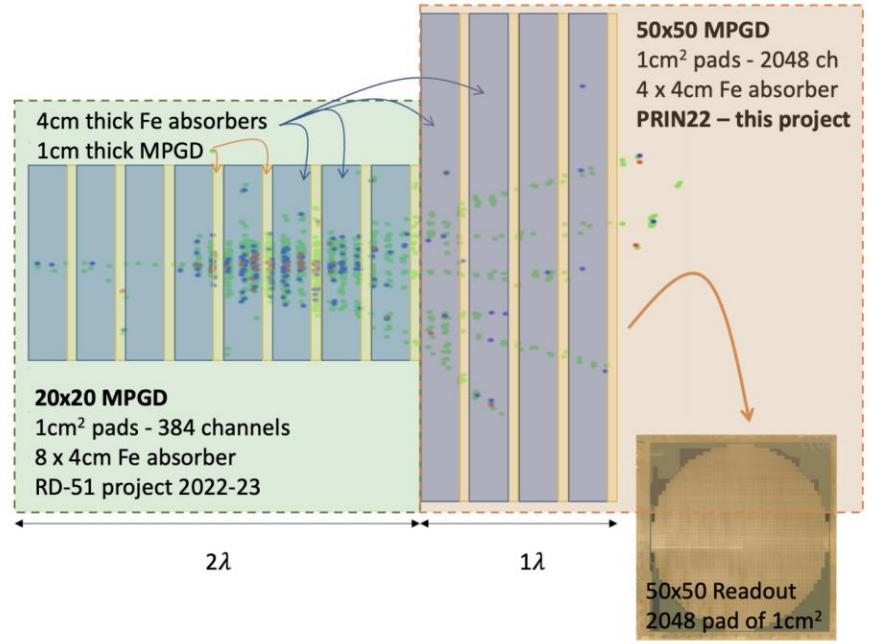
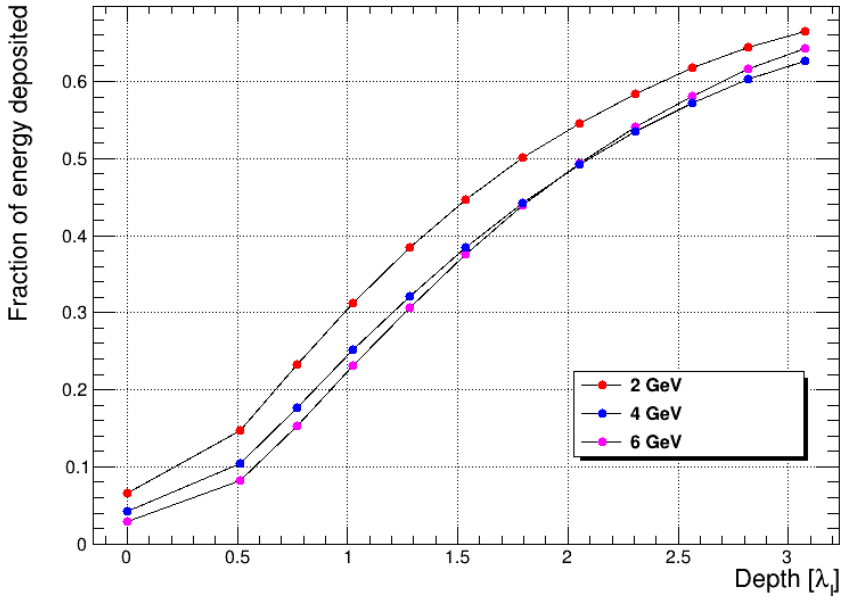
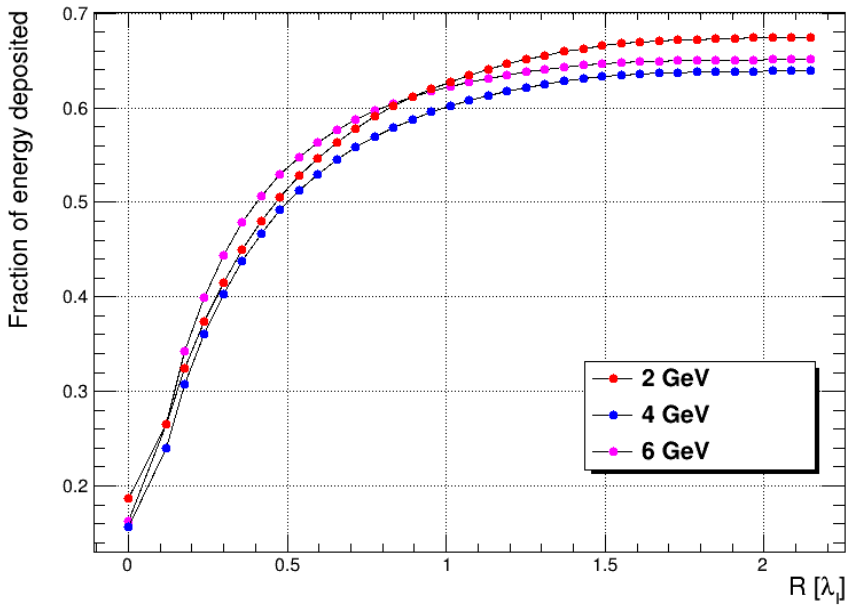


Fig. 2.4: Layout of the HCAL prototype with 3λ depth. The first 2λ is made of the 20x20cm^2 prototype developed in the RD-51 project in 2022, while the last λ necessary to contain longitudinally (95%) protons and pions of 1-6 GeV is made of 50x50cm^2 detectors developed in this project.

Longitudinal containment



Lateral containment



Future plans

- Implement semi-digital RO
  - Using multiple threshold
  - Need to optimize threshold values th_i and weight c_i

$$N_{hit,i} = \sum_j h_j \ where \begin{cases} i = 1 & th_1 \leq E_{dep} < th_2 \\ i = 2 & th_2 \leq E_{dep} < th_3 \\ i = 3 & th_3 \leq E_{dep} \end{cases}$$

$$E_{rec} = \sum_i c_i \cdot f^{-1}(N_{hit,i})$$

- Implement analogic RO
  - Need to find a different approach for the energy reconstruction
- Implement a dead time for the hit response
- Implement time resolution (detector + RO)
- Add background flux to simulate BIB
  - Flat distribution with rate and energies to be extracted from simulations with MuCol SW