Preliminary BIB study at $\sqrt{s}$=10 TeV

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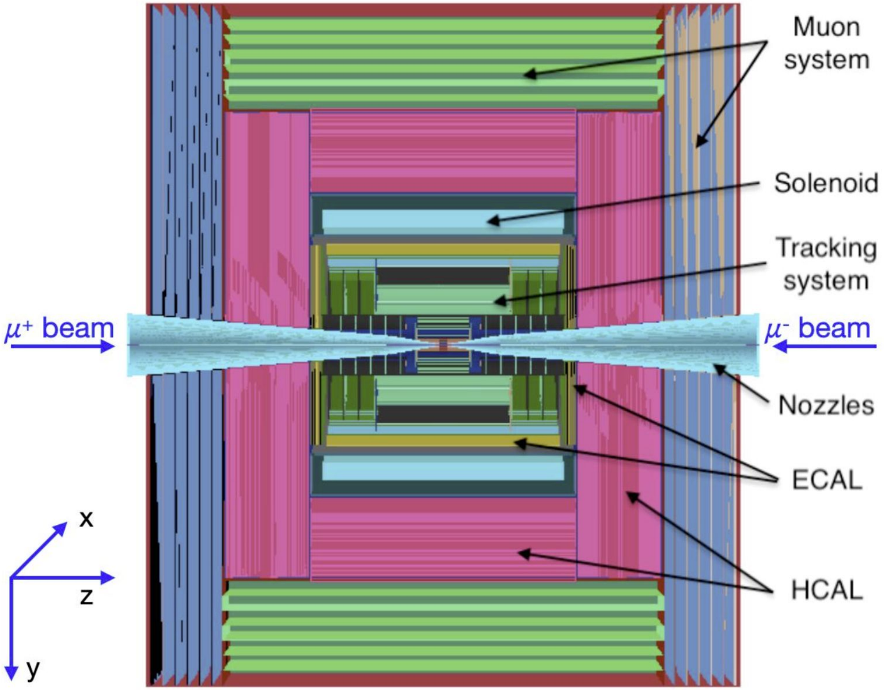
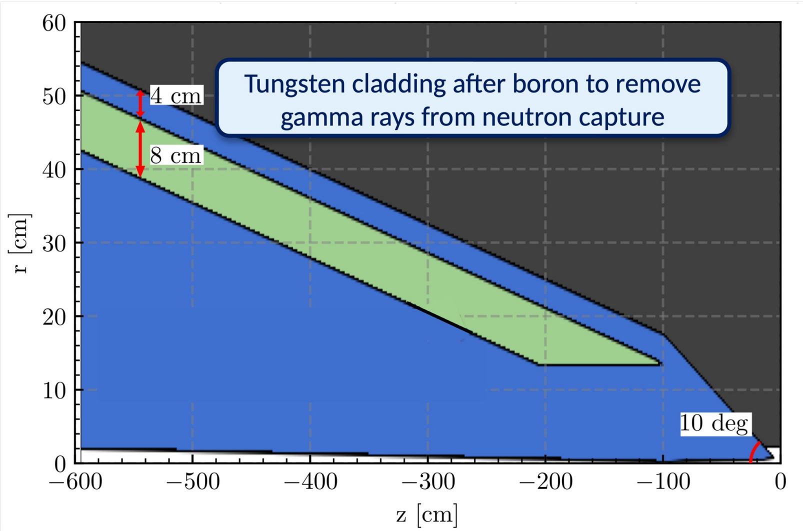
Introduction



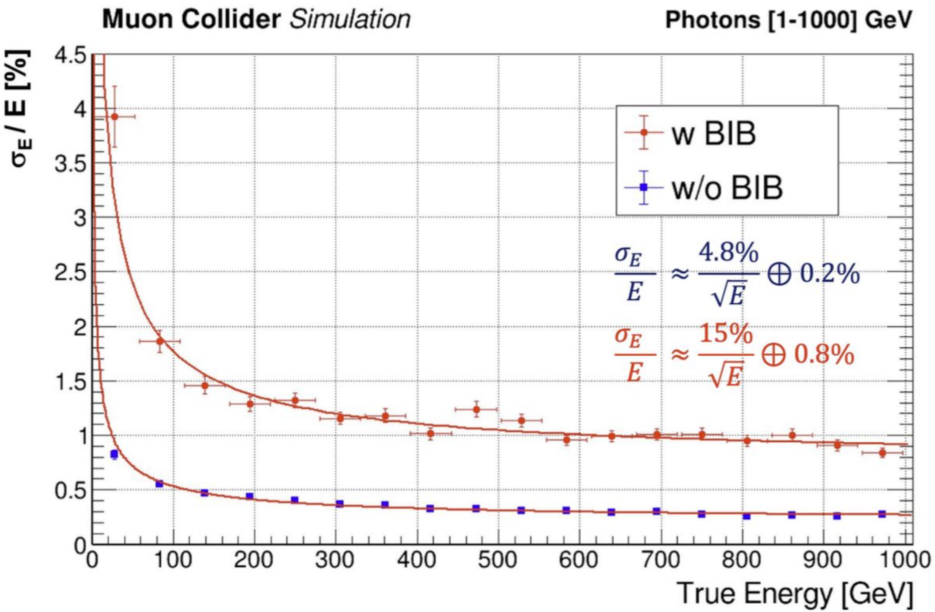
Detector geometry MUSIC_V1

BIB sample at √s =10 TeV with the new version of the **nozzles design** and **accelerator lattice**.



Goal of this study

- Characterize the electromagnetic calorimeter.
- Mitigate BIB effects and optimize the performance of the ECAL.



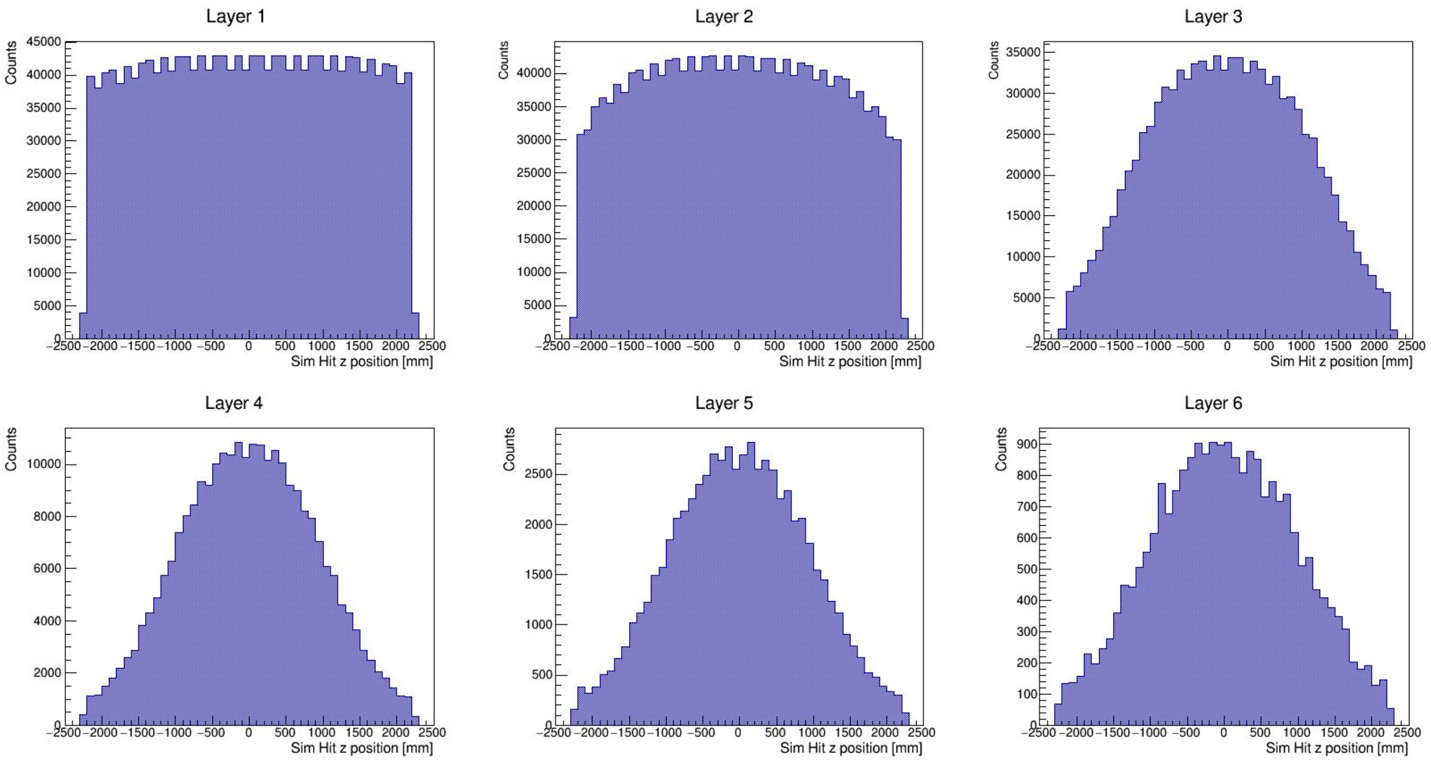
- Electromagnetic calorimeter: CRILIN (6 layer of PbF2 Cherenkov crystal read by SiPMs)
- With BIB at √s=1.5 TeV energy resolution ~15%/√E.

We currently focusing on studying the performance of CRILIN with the BIB at √s=10 TeV

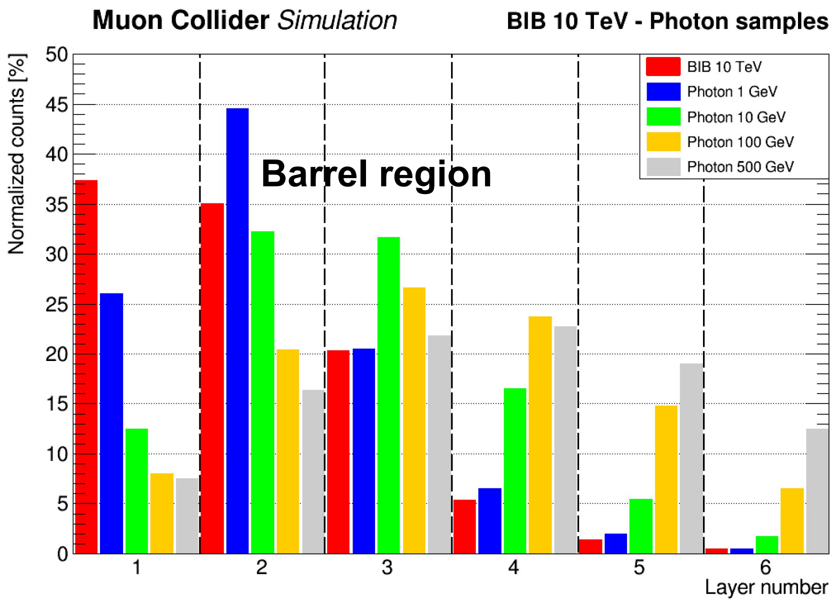
BIB distribution in z coordinate (barrel region)

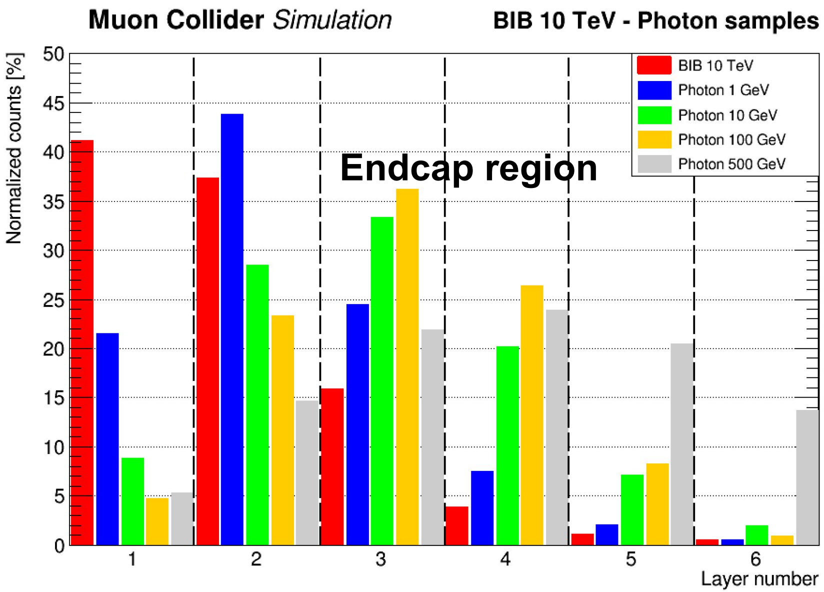
- In the **first two layers** the ECAL cells are affected by BIB hits

- In **deeper layers**, most hits are concentrated in the central region of the barrel.



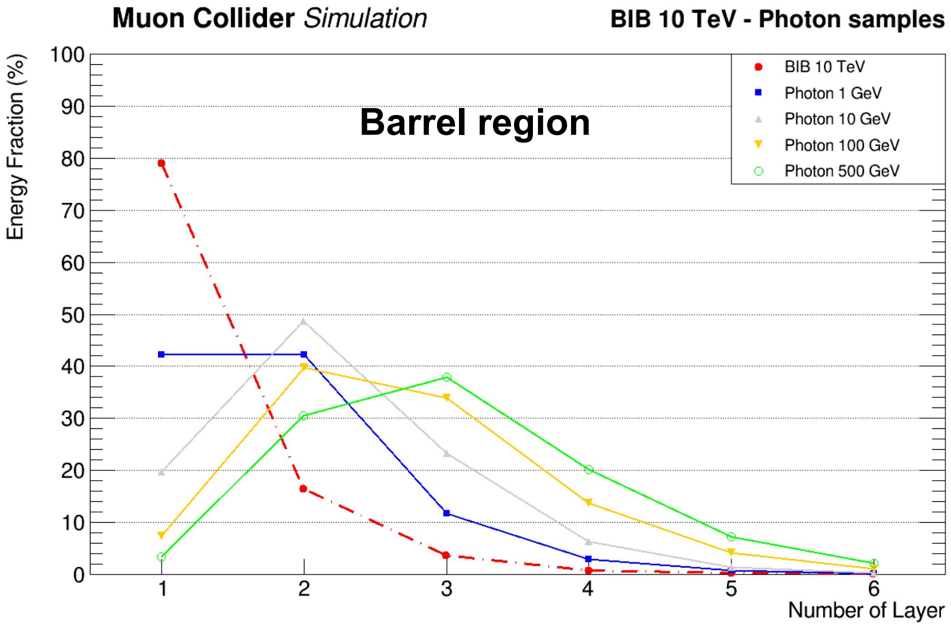
Normalized number of hit per layer

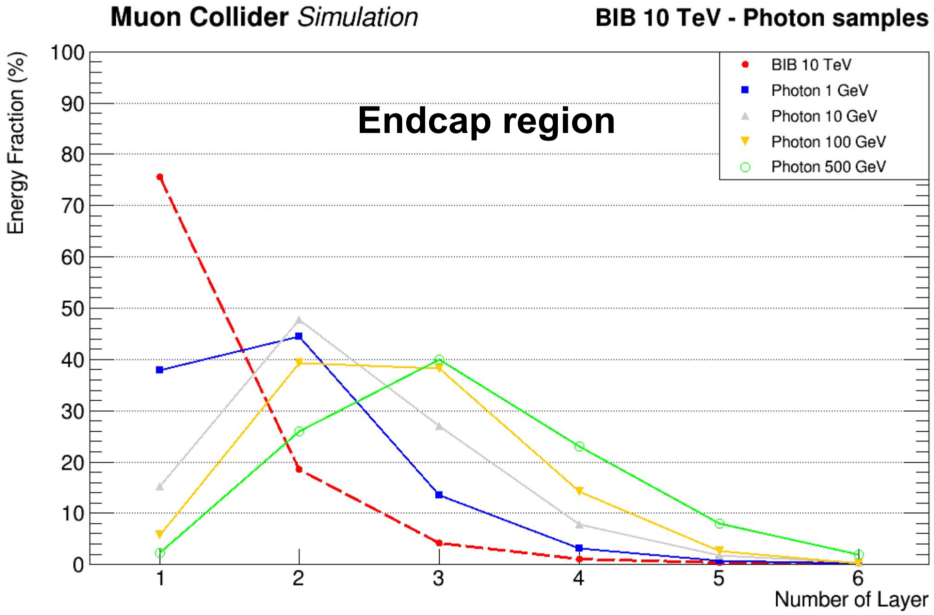




- Plots show normalized hits per layer for BIB (red) and photon samples (1, 10, 100, 500 GeV).
- **BIB Observation:** most hits are concentrated in the first two layers; significant drop from the third layer onward.
- **Photon Samples Observation:** maximum number of hits between the second and third layers, depending on the energy.

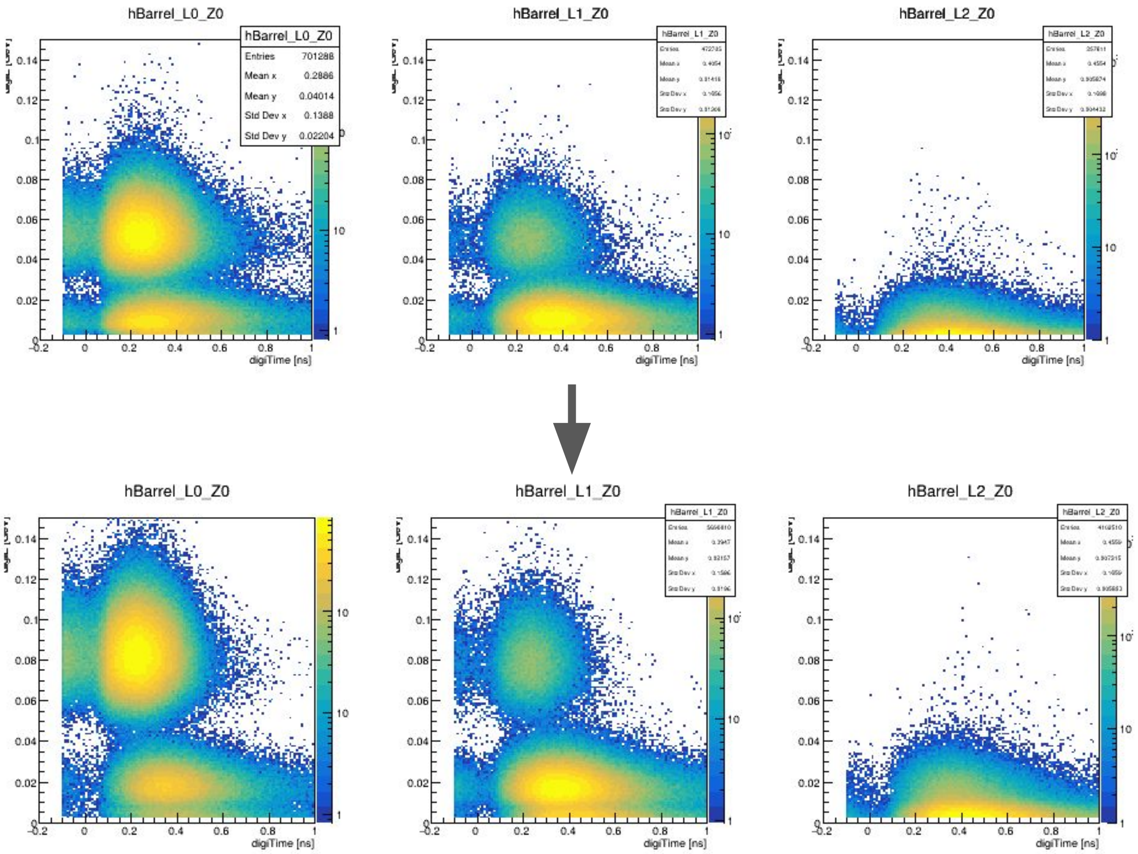
Energy fraction per layer: BIB vs photon sample





- **BIB**: release most of the energy in the **first layer**.
- **Signal**: except for the **low energy photon**, release only a **small fraction** of energy in the first layer.

t-E spectra: old vs new MDI at 10 TeV



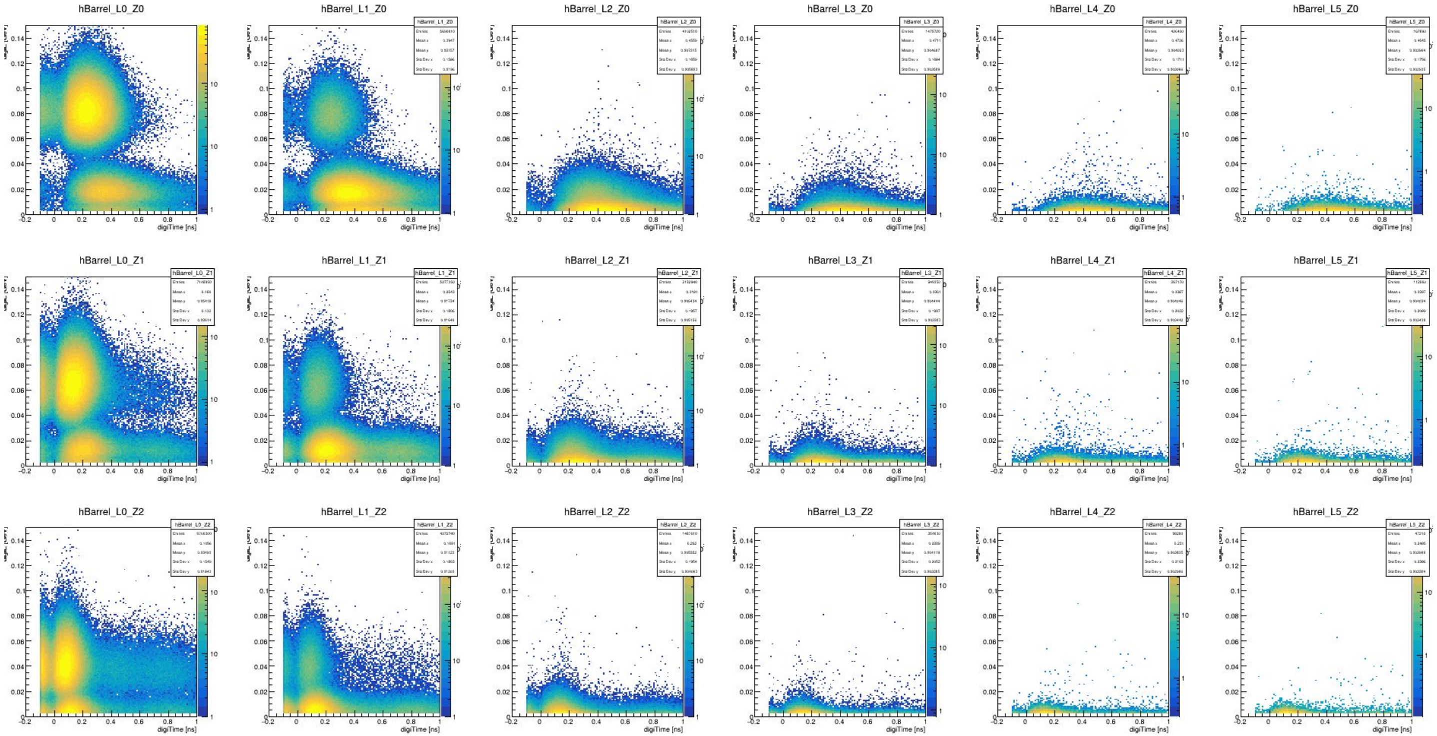
Barrel **+25%** Nhits
Endcap **+30%** Nhits

Total energy: **+85%**

More and more energetic hits in the whole ECal

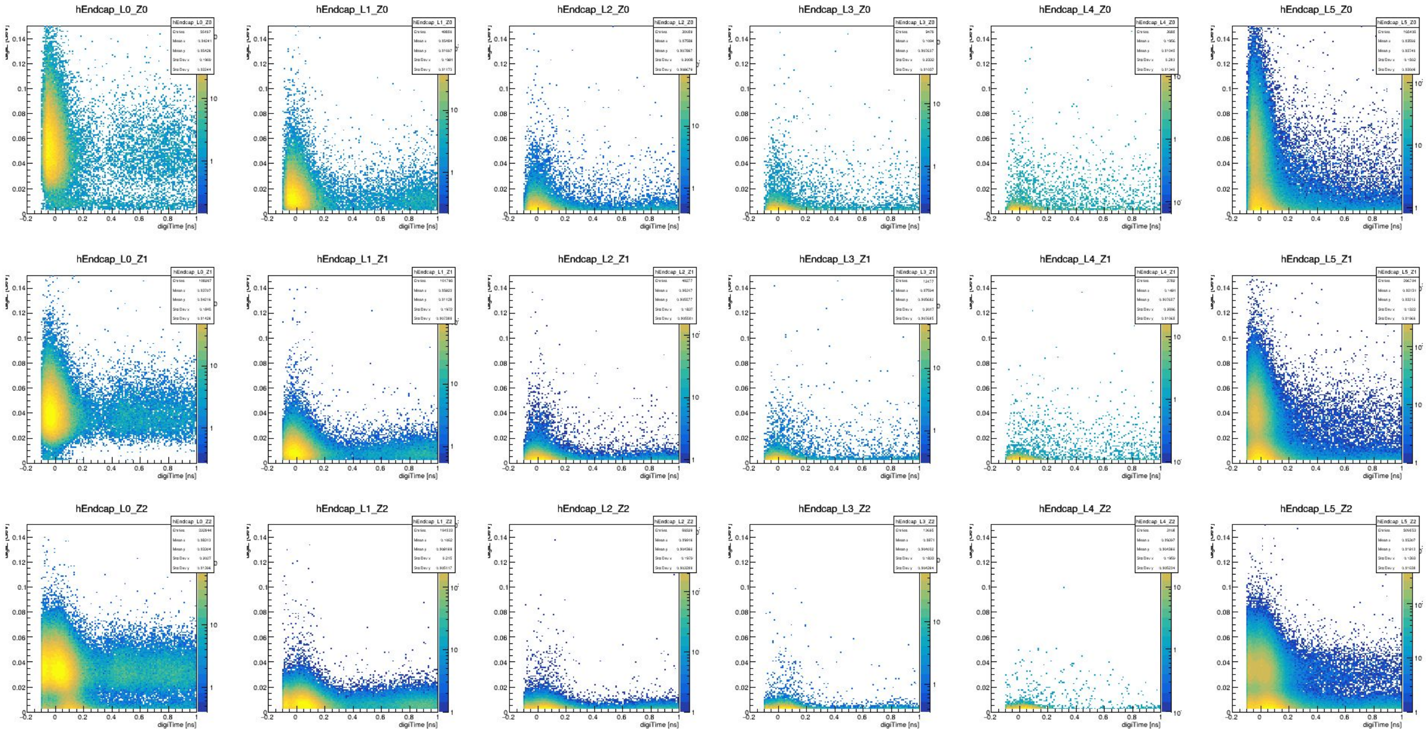
Plot: first three layer of the central barrel region

t-E spectra by ECal region (barrel)



Plot: time-energy plots for the barrel, with 6 layer (horizontally) and 3 z-regions (vertically)

t-E spectra by ECal region (endcap)



Plot: time-energy plots for the endcap, with 6 layer (horizontally) and 3 r-regions (vertically)

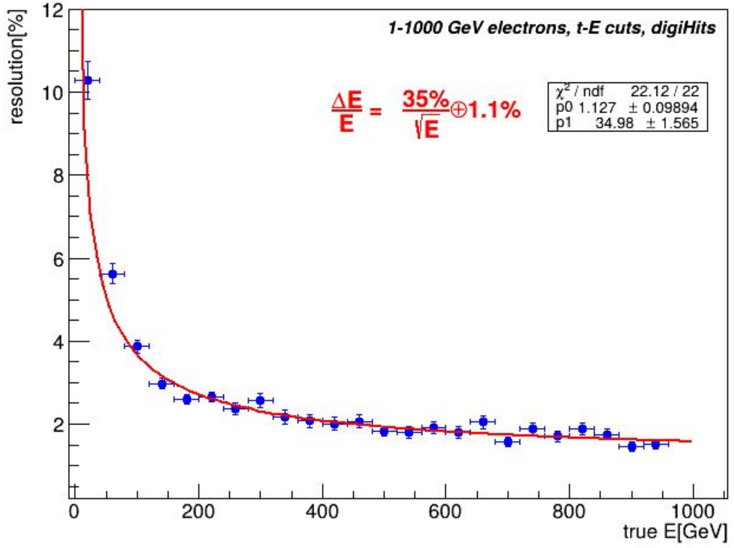
t-E cuts approach: lower limits

The usual approach consists in time+energy selections, recently improved to be zone-specific.

Such an approach is reaching its limits:

- too large cuts kill the signal

On the right: in order to reach a final BIB hit number of ~40K the energy resolution without overlay reaches 35%/√E (lower limit!)

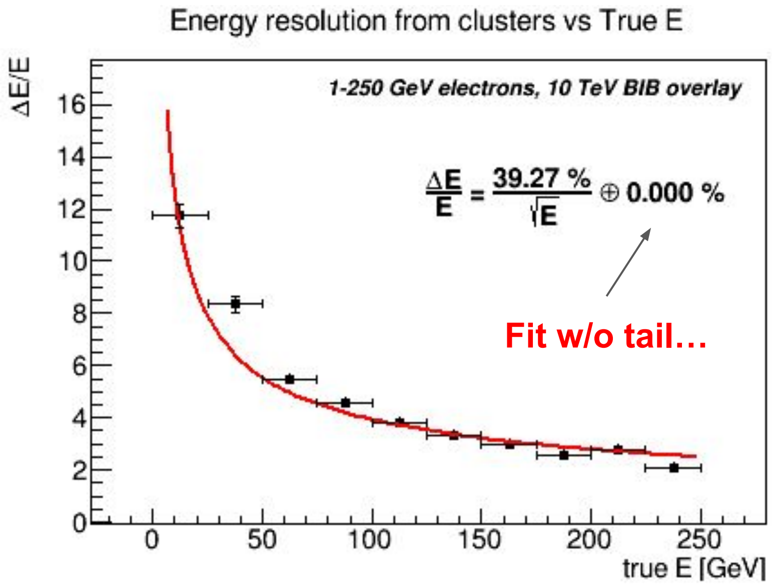


The energy is reconstructed summing the selected hits in a R=0.15 cone from the track. No clustering is used.

BIB rejection considerations

Studies with old 10 TeV BIB show that the signal loss due to t-E selection is the largest contribution to the resolution degradation.
➡ need to explore new approaches

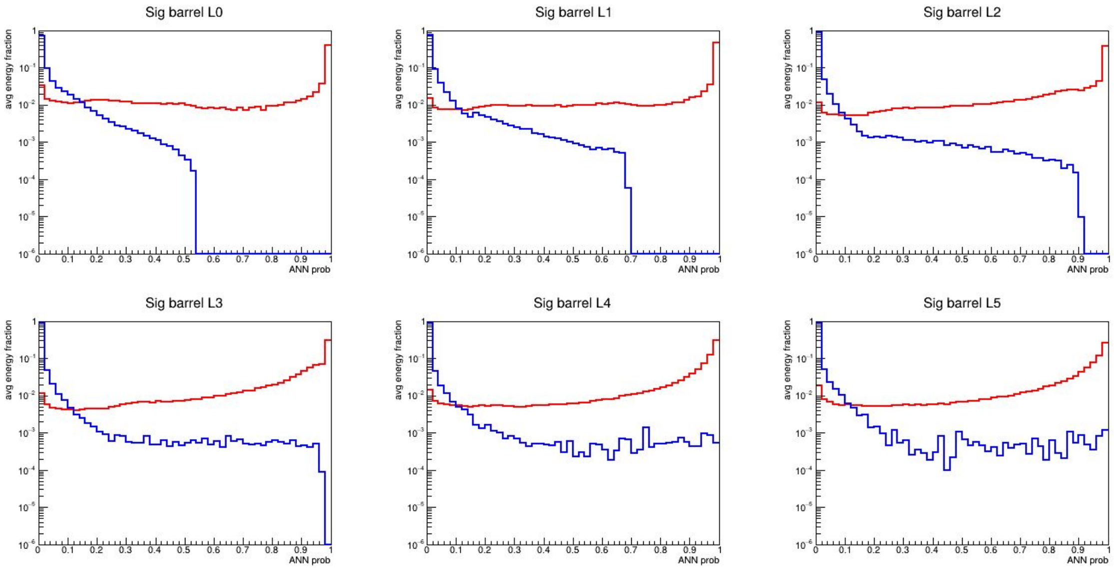
Exploit BIB's spectral features
➡ ML hit-level classification?
➡ ML cluster-level regression?
➡ other ideas?



Resolution from complete reconstruction with overlay, 1-250 GeV

First steps with a ML hit-level filter

Tentative exploration of a BIB-signal hit classifier, based on scikit's MLP. One classifier per layer, 3 features: (z or r, E, t), trained on a randomized sample of BIB+electrons. Optimization of depth/neurons/regularization still to do.

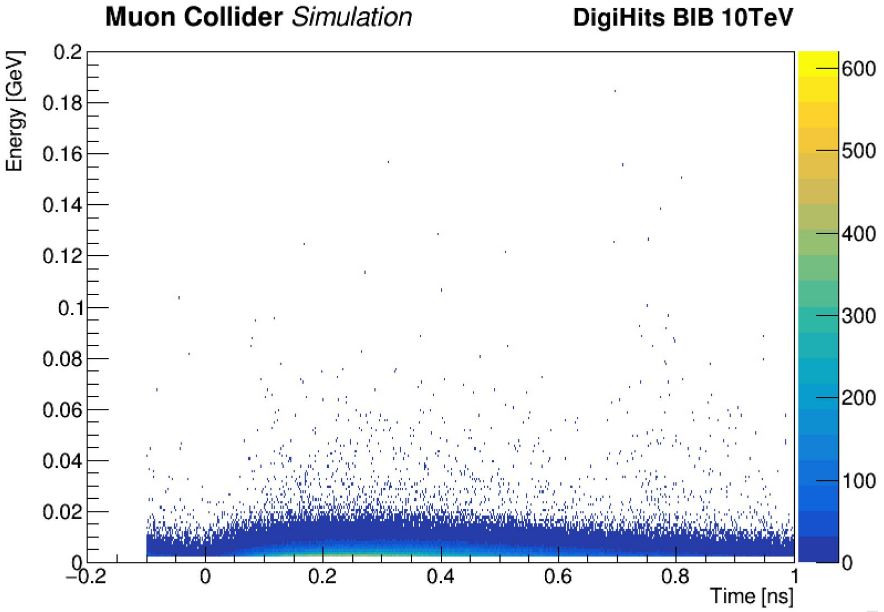


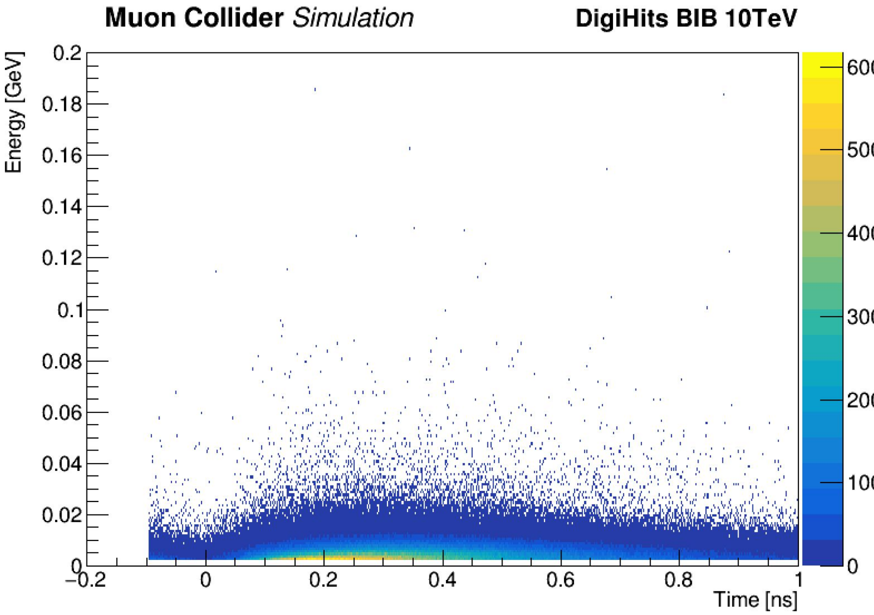
BIB vs **SIGNAL** MLP probability estimate in the barrel layers, weighted by the hit energy. The separation looks good, however the probability "regions" must be understood. At present, no advantage wrt the cut-approach.

Takeaway messages

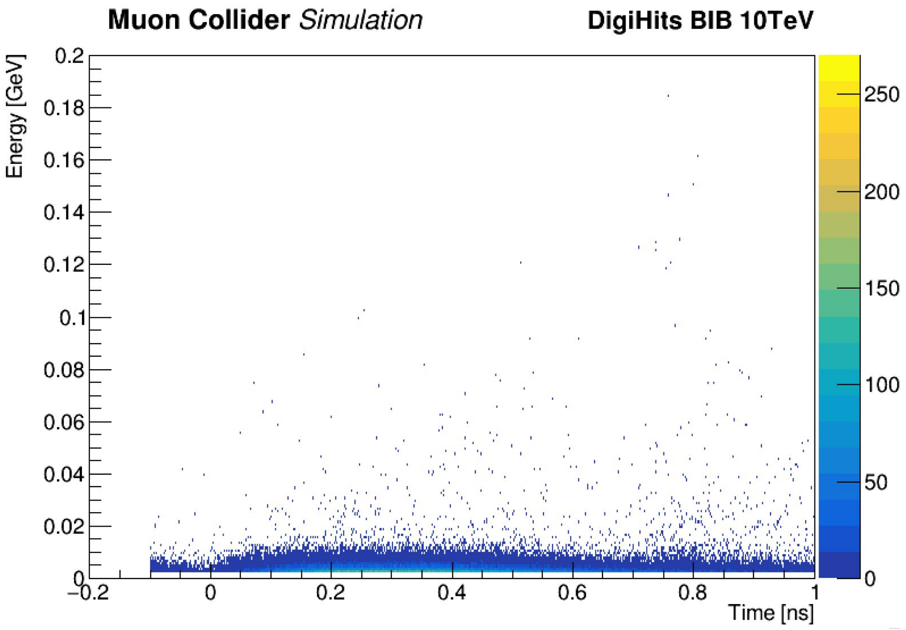
- The new BIB look significantly harder than in previous geometry
- The time-energy distributions share a similar shape, though with higher E
- Usual t-E selection, even with local optimization, looks insufficient for our performance goals
- Possible improvements may come from an (extensive?) use of ML

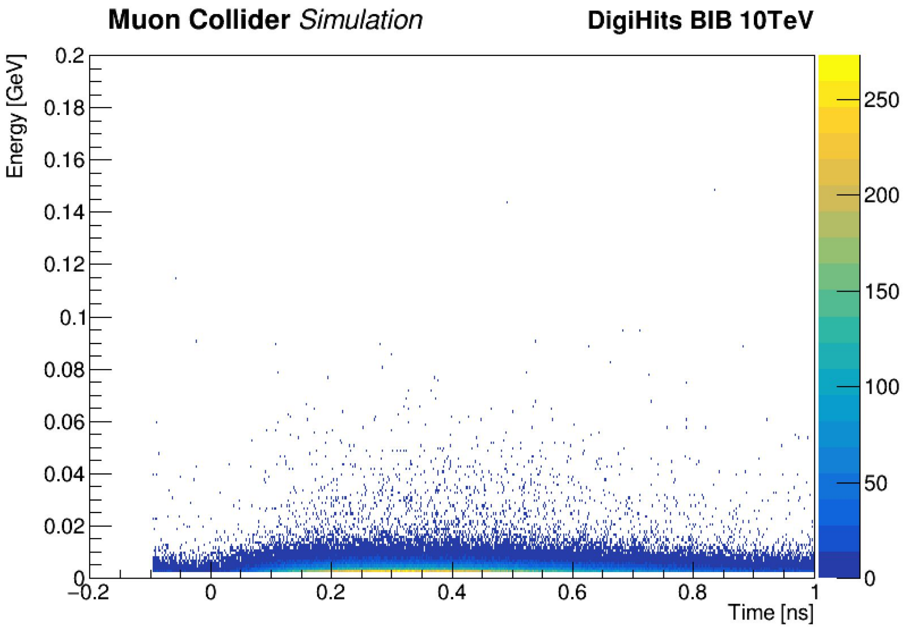
Backup





commento plot





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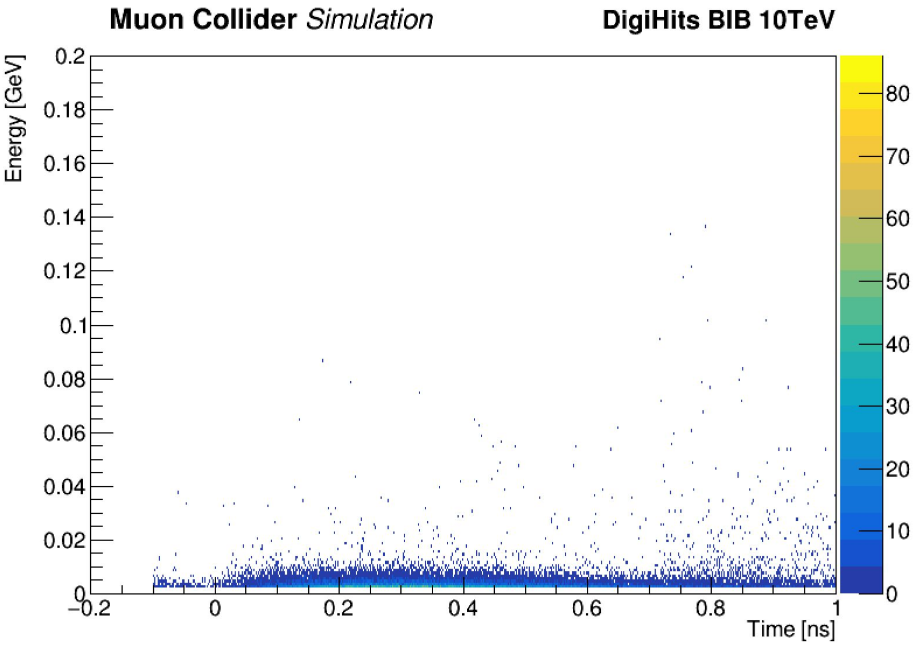

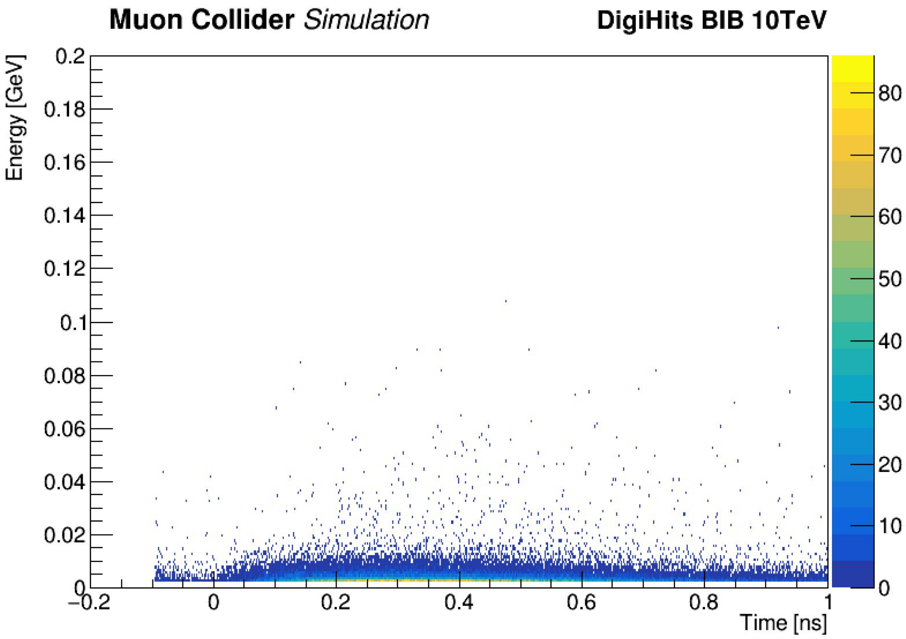

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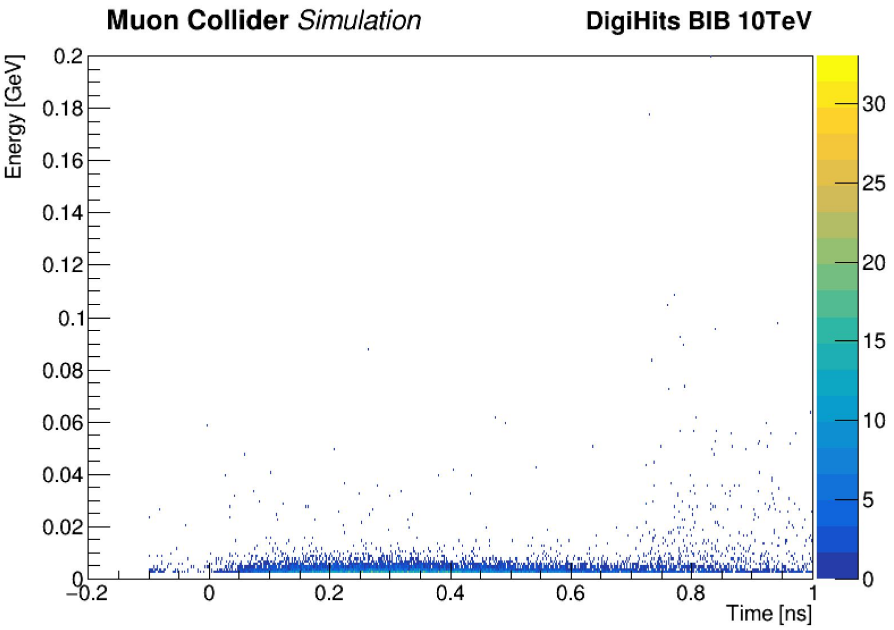

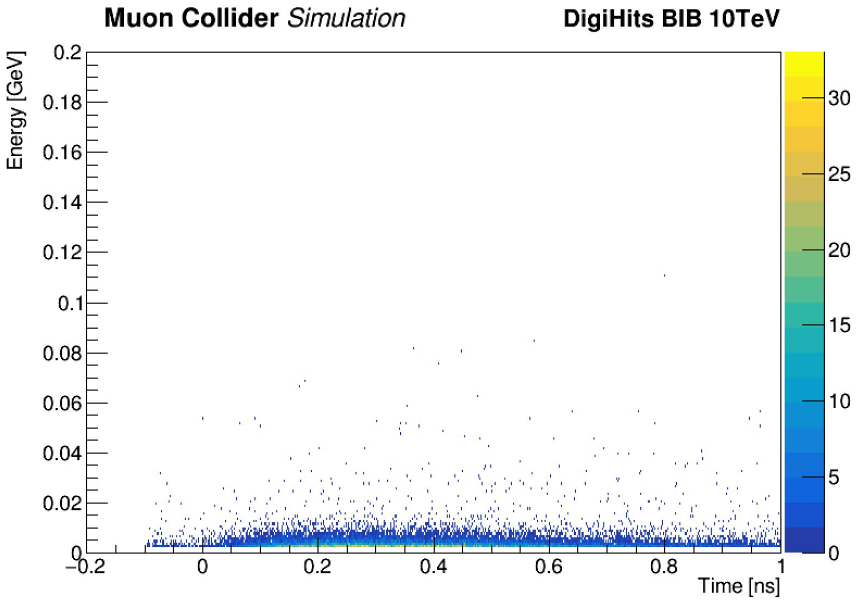

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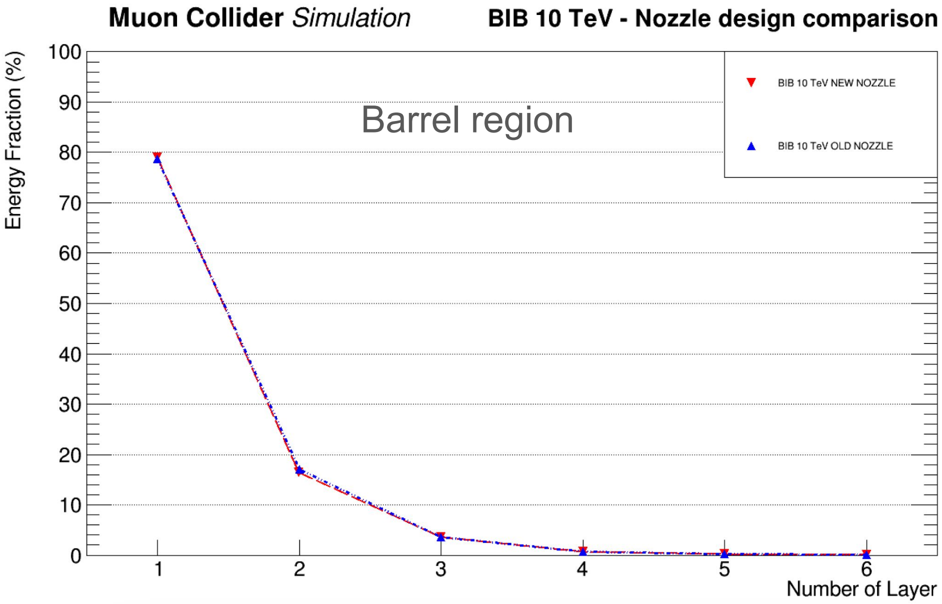

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