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CERN

Calorimeter studies at a Muon Collider

Muon Collider Meeting

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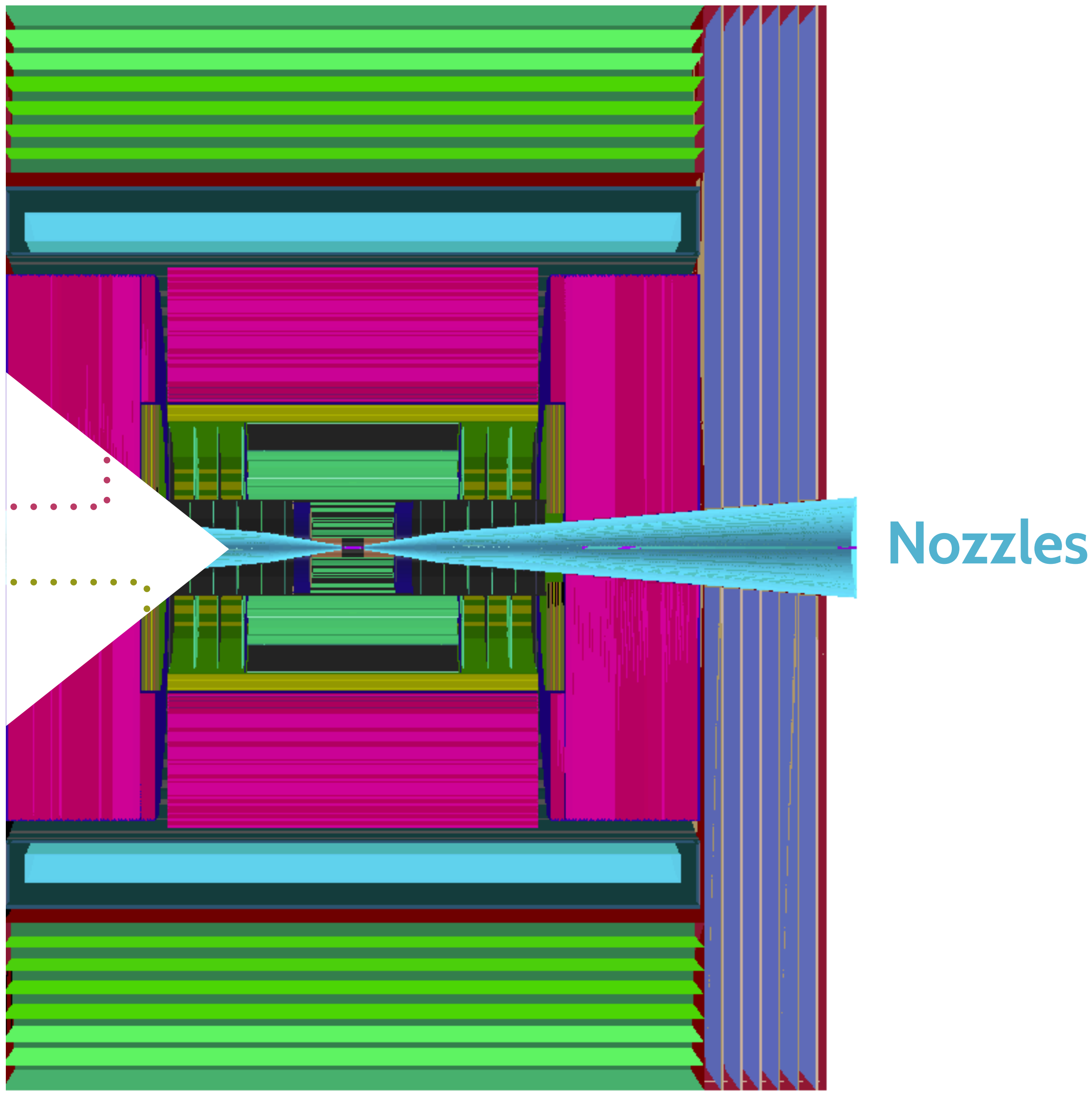
The studies are based on the CLICdet geometry for the time being

- **slightly adjusted to accommodate the larger nozzles**



Understanding the influence of BIB on the calorimeter performance is essential for the detector optimisation

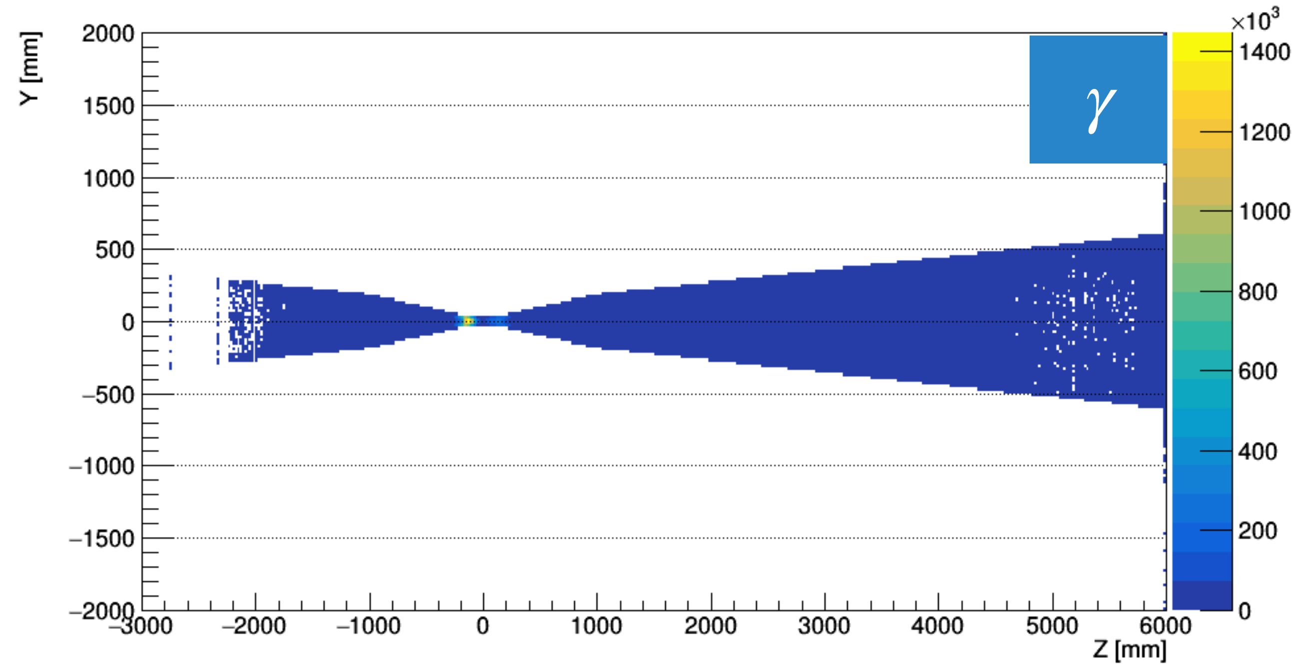
Background composition

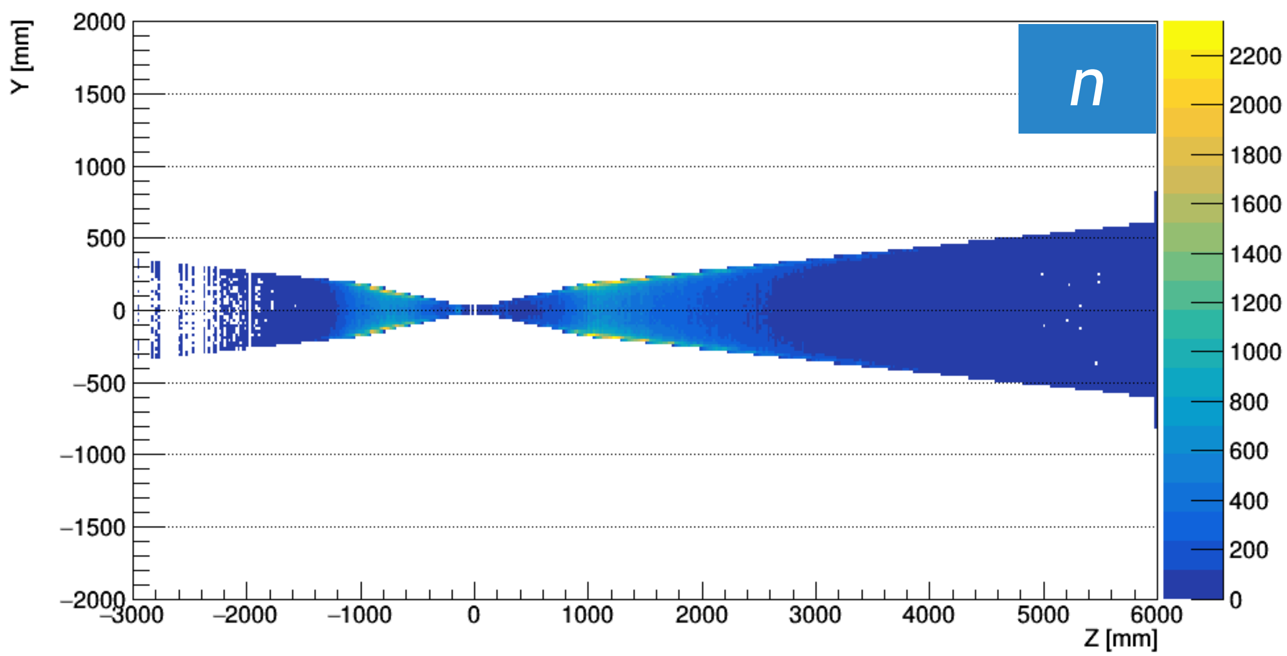
μ^- beam

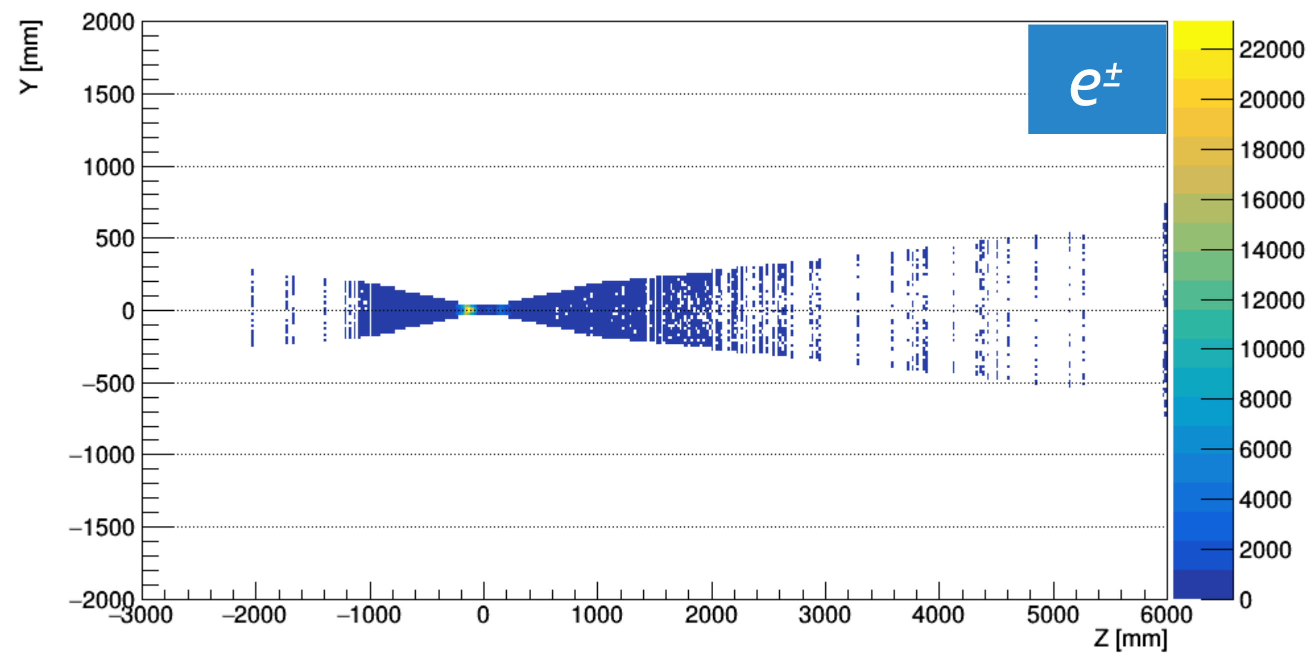
Dominant components of the beam induced background are:

photons	94%
neutrons	4%
electrons [e±]	1%
other	<1%

Looking at the BIB production vertex







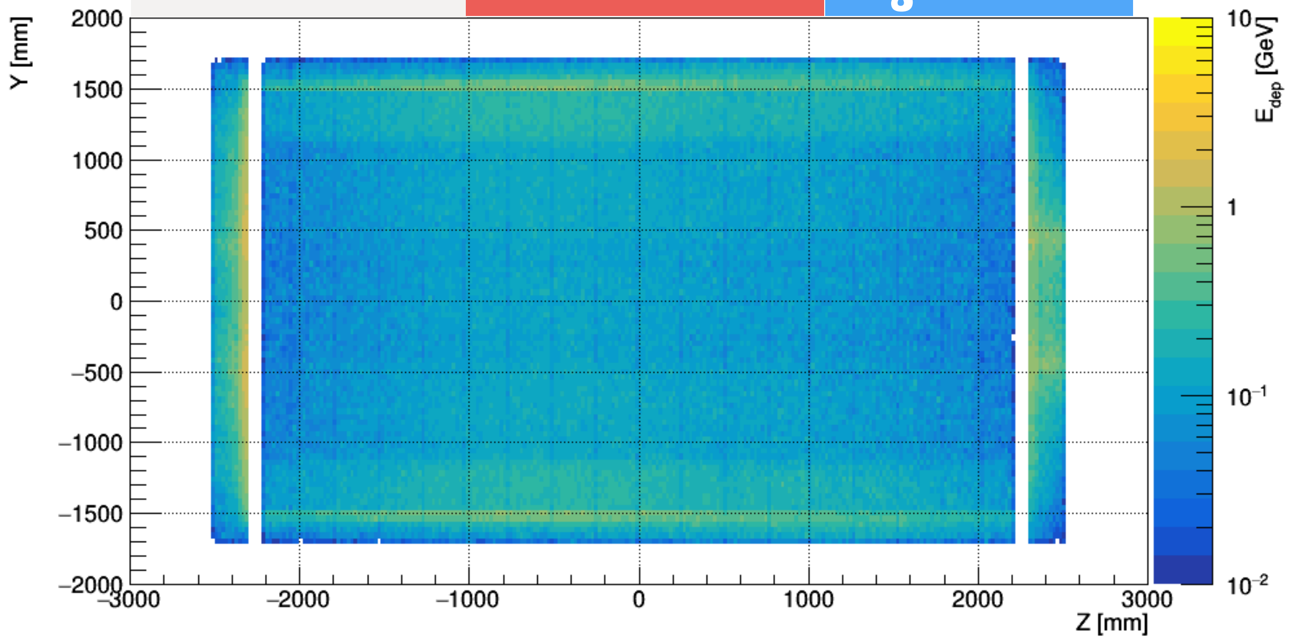
Impact on the calorimeter performance depends on the type of the particle

Calorimeter hit distribution

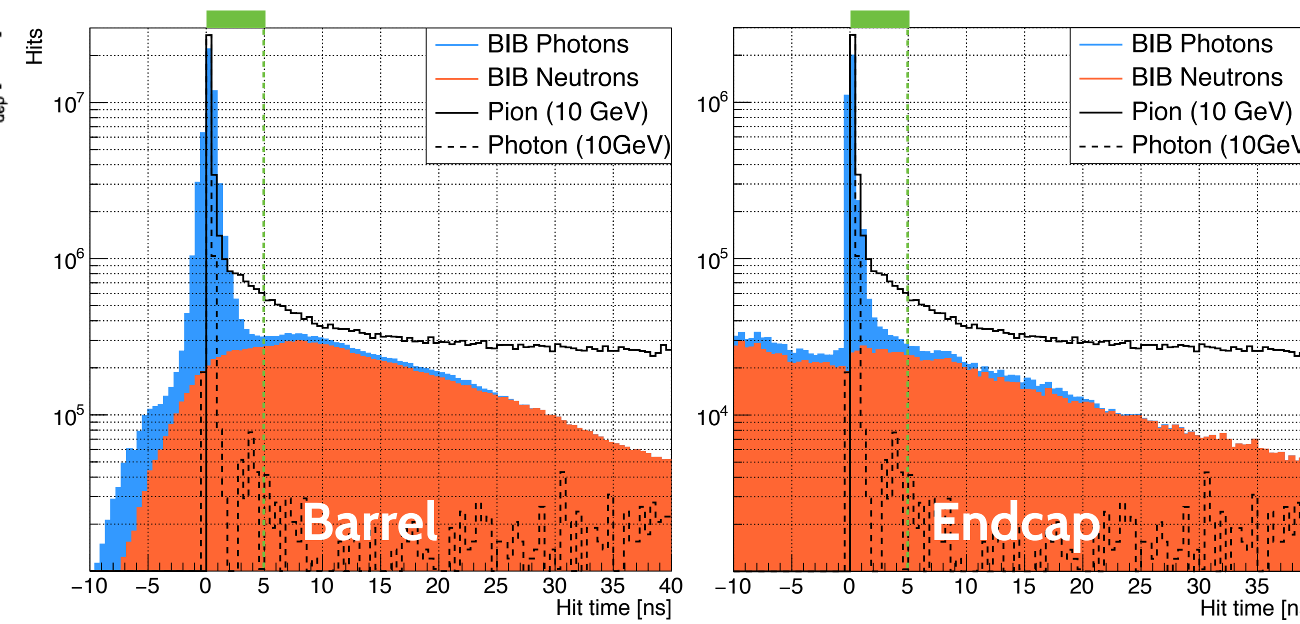
Calorimeter is almost uniformly lit by the BIB particles

μ^- beam

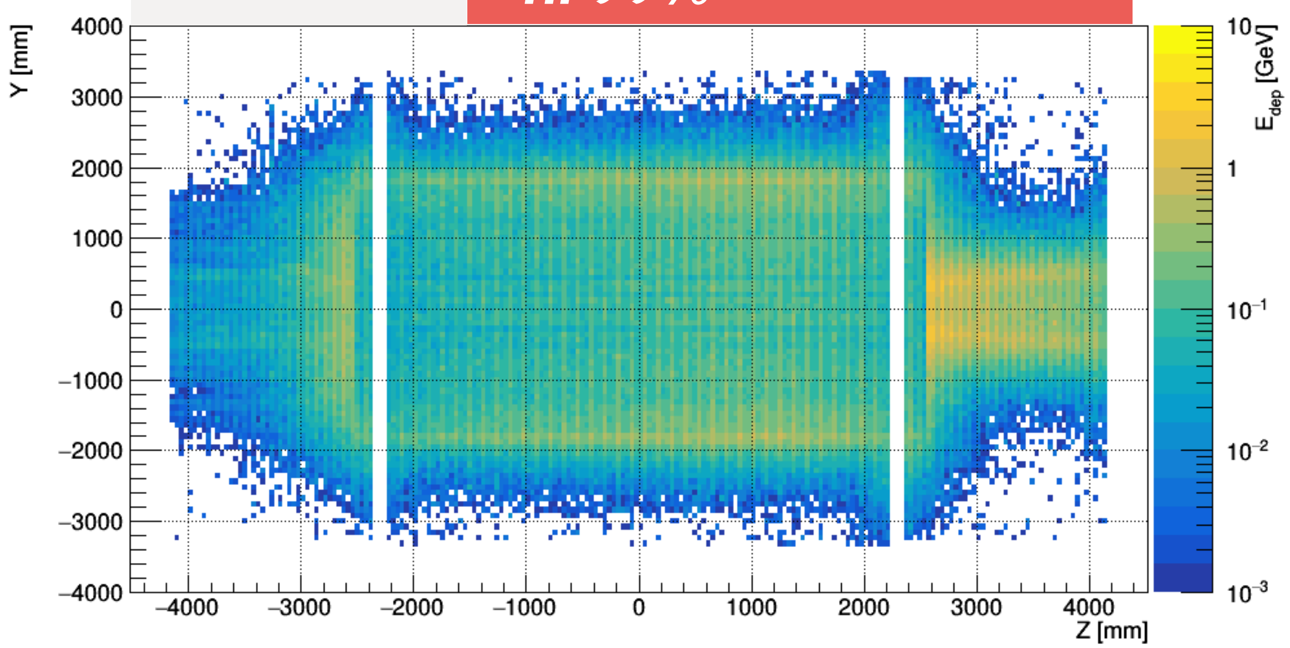
ECAL *n: 48%* *γ: 51%*



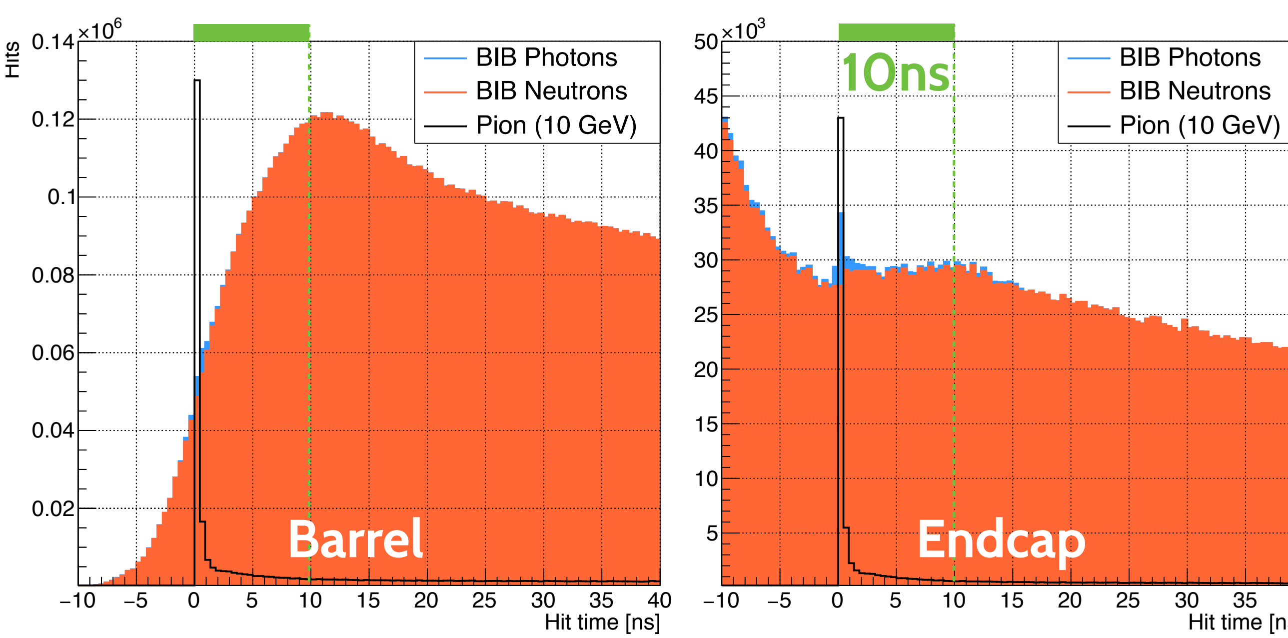
5ns



HCAL *n: 99%*



A short readout time window needed

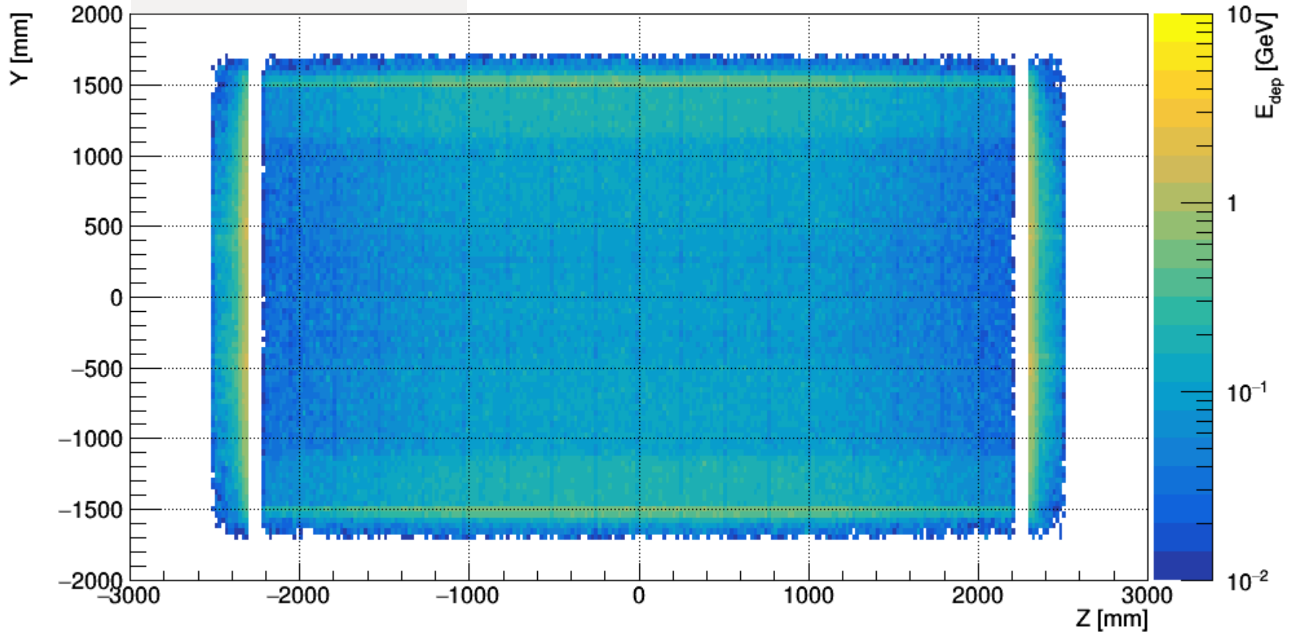


Calorimeter hit distribution

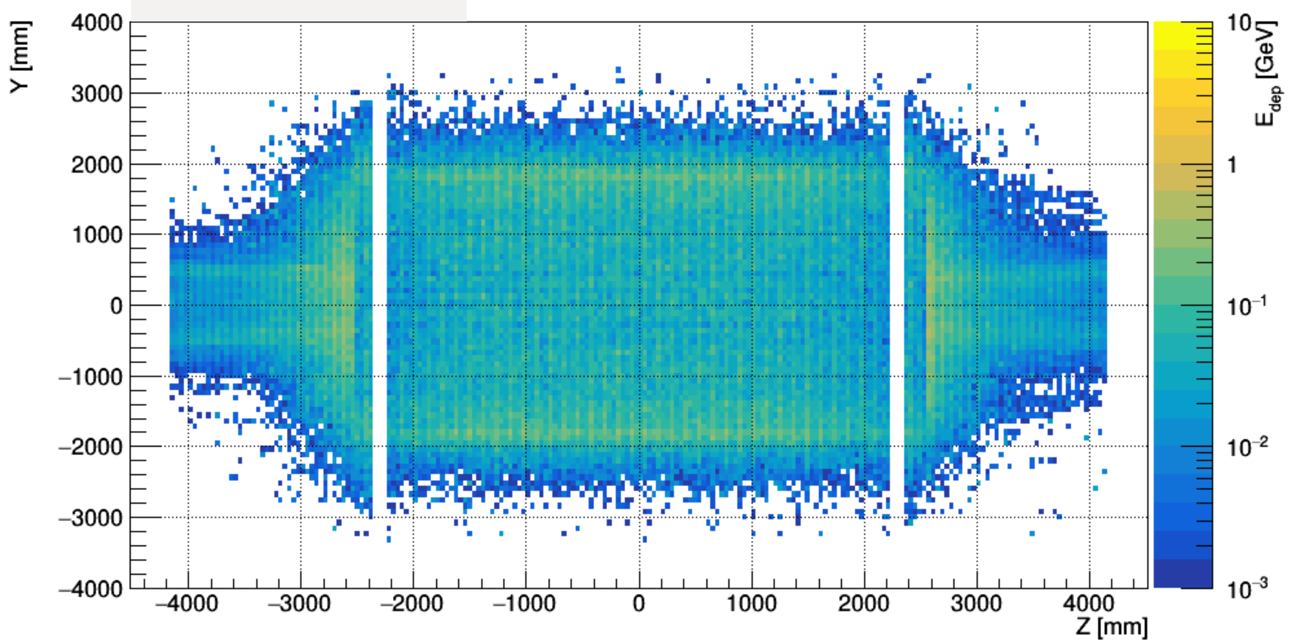
After applying the time selection + adding μ^+ beam

$\mu^+ + \mu^-$ beams

ECAL



HCAL



Energy deposited by BIB reduced from

ECAL	HCAL
6 TeV	2.5 TeV

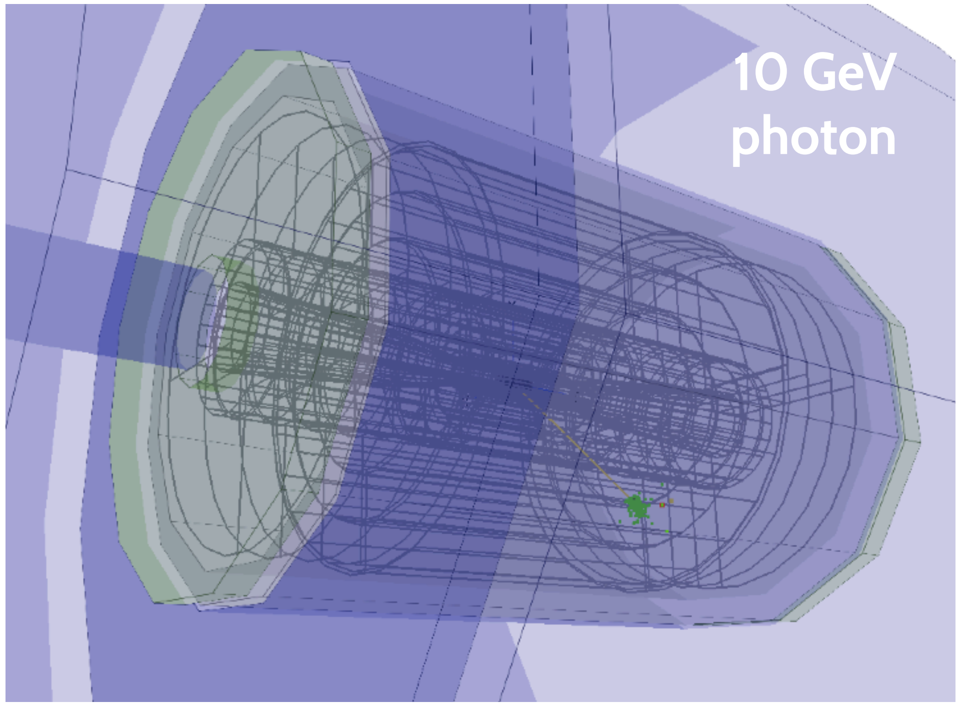
to

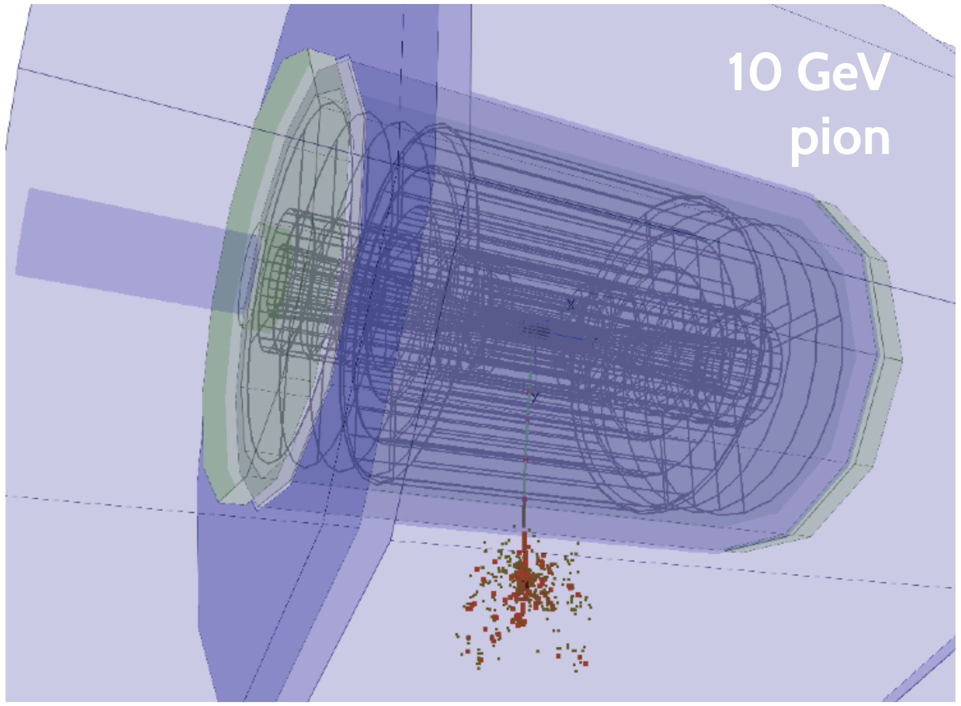
ECAL	HCAL
2.5 TeV	0.5 TeV

Energy resolution

Having a look at the effect of timing cuts on the reconstructed energy resolution

- using the Pandora particle flow algorithm [arXiv: 0907.3577]
  - relies on reconstructed tracks and calorimeter hit clusters, which are not yet appropriately handled with the full BIB included in the event
  - no BIB included at the reconstruction step yet





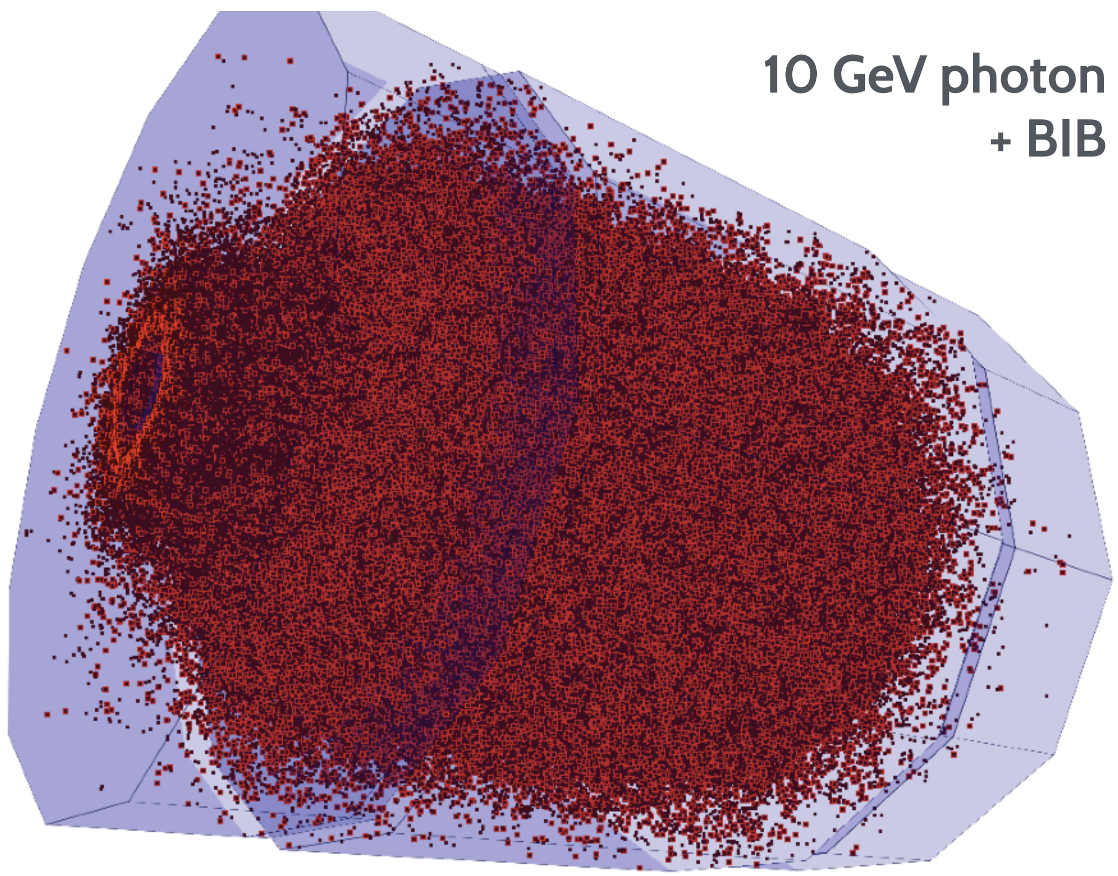
100 ns	10 GeV	100 GeV
photon	5%	1.6%
pion	19%	6%

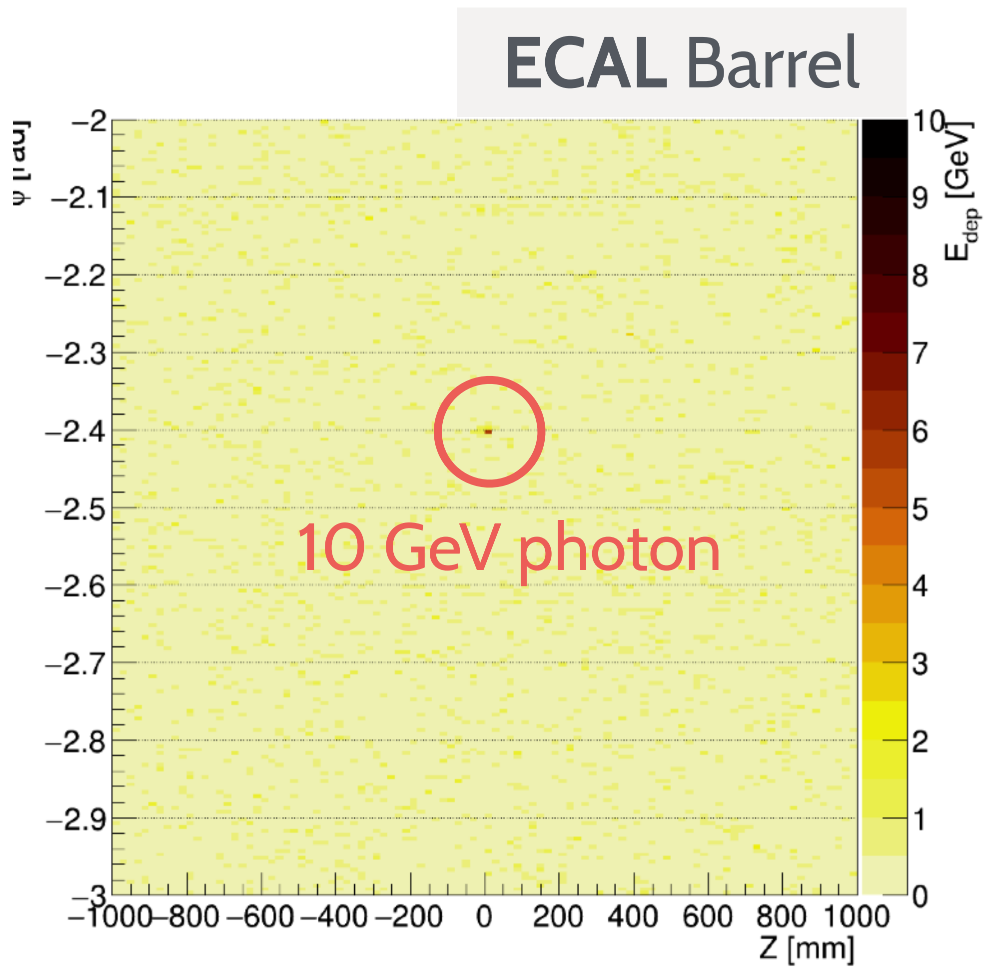
→

5/10 ns	10 GeV	100 GeV
photon	5%	1.7%
pion	20%	7%

Reconstruction with BIB

Things get very busy once energy deposits from BIB are added





Traditional calorimeter hit clustering algorithms are not applicable in such a busy environment

Proper subtraction of energy deposited by the BIB has to be implemented at the clustering stage of the particle flow algorithm

Next steps

Proper treatment of energy deposited by the BIB, which was proved to be effective in the previous MAP framework

- select regions of interest with energy deposits above the expected background level *(by 2.5σ)*
- subtract the Θ-dependent mean expected energy deposited by the BIB

Improve computational performance of the detector simulation

- order of 10M calorimeter hits from the BIB have to be added to each signal event, with minimal statistical variations
- overlaying at the level of simulated hits and digitizing them altogether is very time consuming
- overlaying at the level of digitized hits should be much more efficient