



Simulazioni: detector e ricostruzione

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Outline

- Detector overview:
 - ▶ the tracking system;
 - ▶ the calorimeter system;
 - ▶ the muon system.
- status of low and high level event reconstruction;
- ongoing activities.

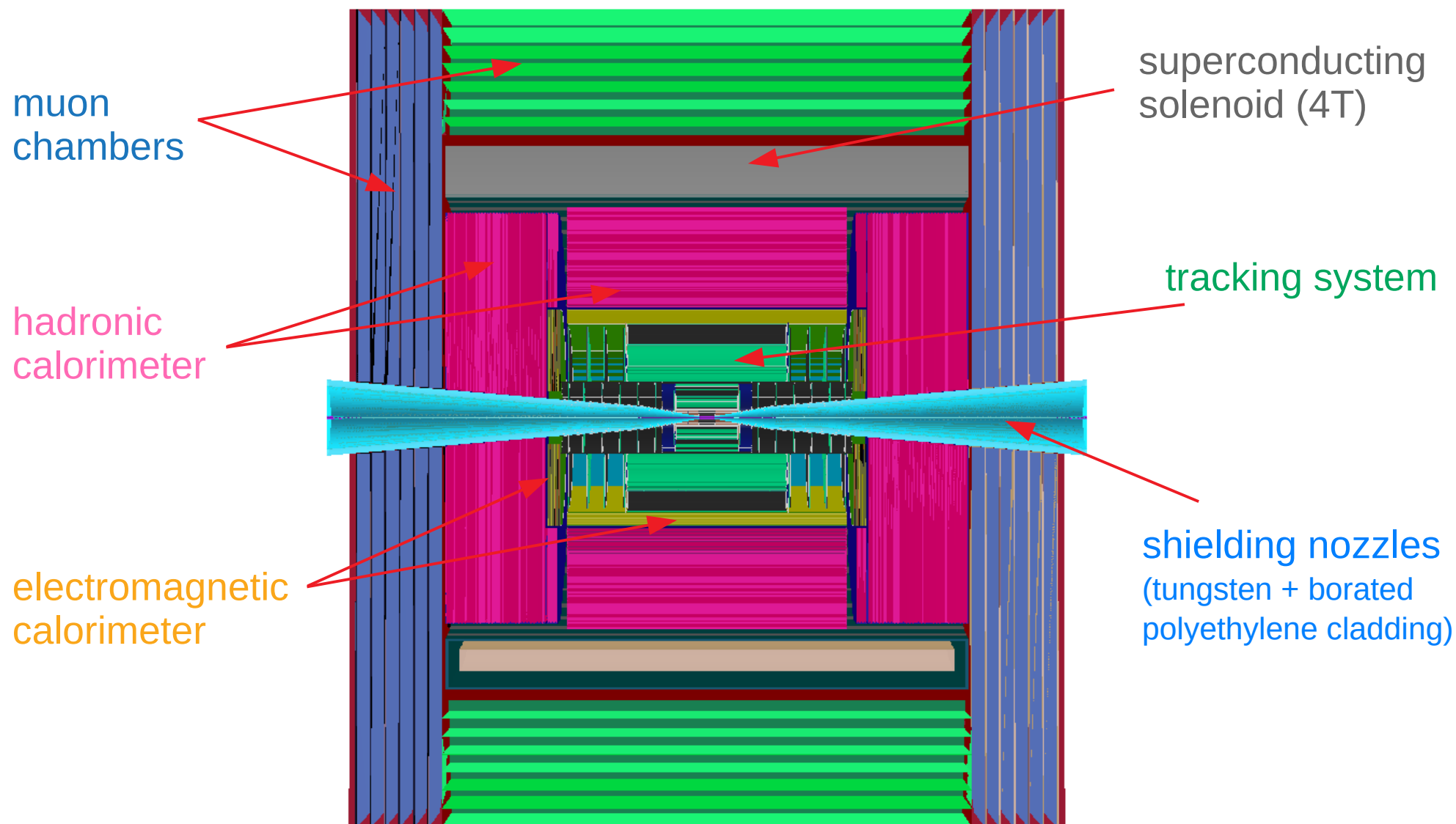


Master plan

- As a starting point, use CLIC detector model and reconstruction software, outcome of many years of tuning and optimization (for 3-TeV ee collisions, though):
 - ▶ <https://github.com/iLCSoft>.
- If needed, revisit both the detector and the reconstruction strategy to cope with:
 - ▶ much higher levels of background (beam-induced background);
 - ▶ higher $\mu\mu$ collision energies (6, 10 TeV).

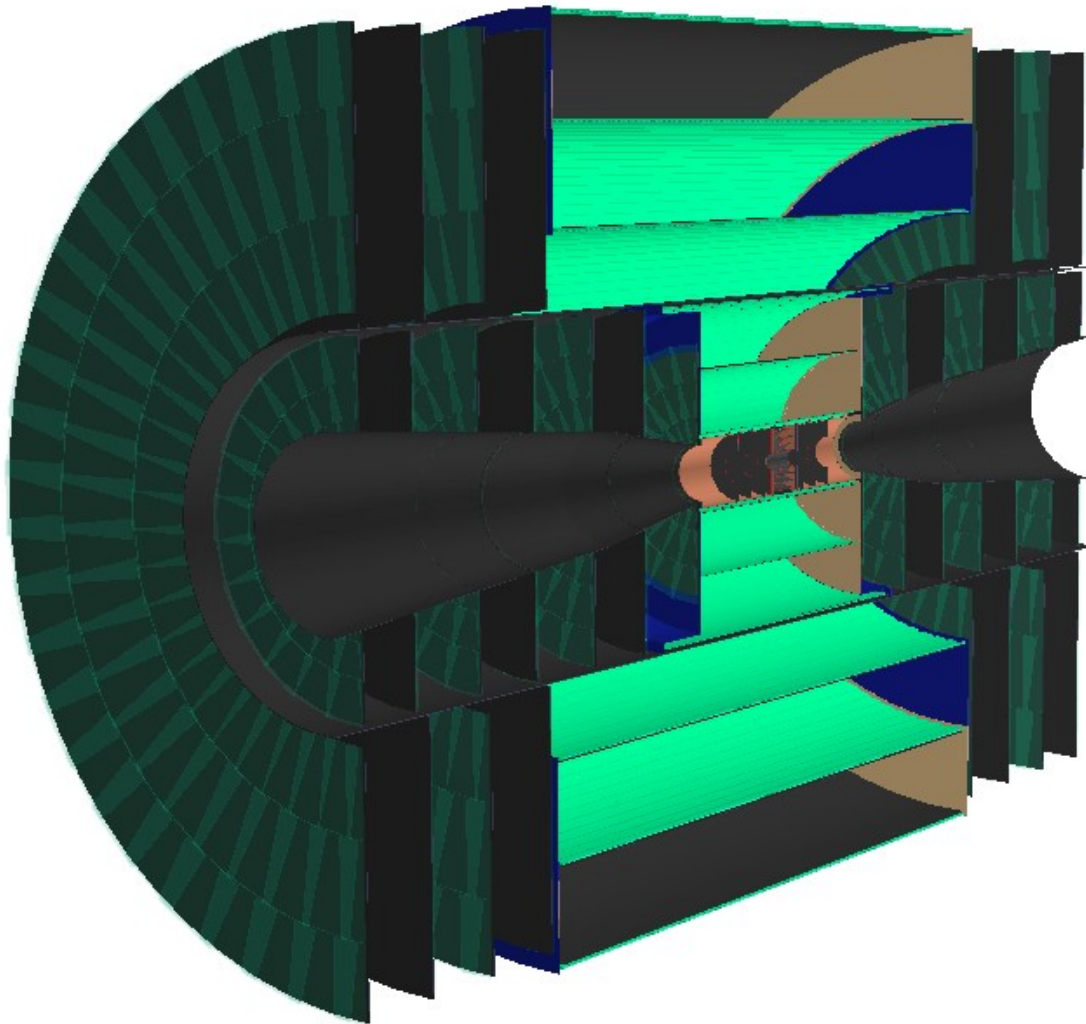


Detector overview





The tracking system



● Vertex Detector (VXD)

- ▶ 4 double-sensor barrel layers:
 - ◆ at $r = 3.1, 5.1, 7.4, 10.2$ cm;
 - ◆ 50- μm thick Si sensors;
- ▶ 4+4 double-sensor disks:
 - ◆ at $|\Delta z| = 8.0, 12.0, 20.0, 28.0$ cm;
 - ◆ 50- μm thick Si sensors.

● Inner Tracker (IT)

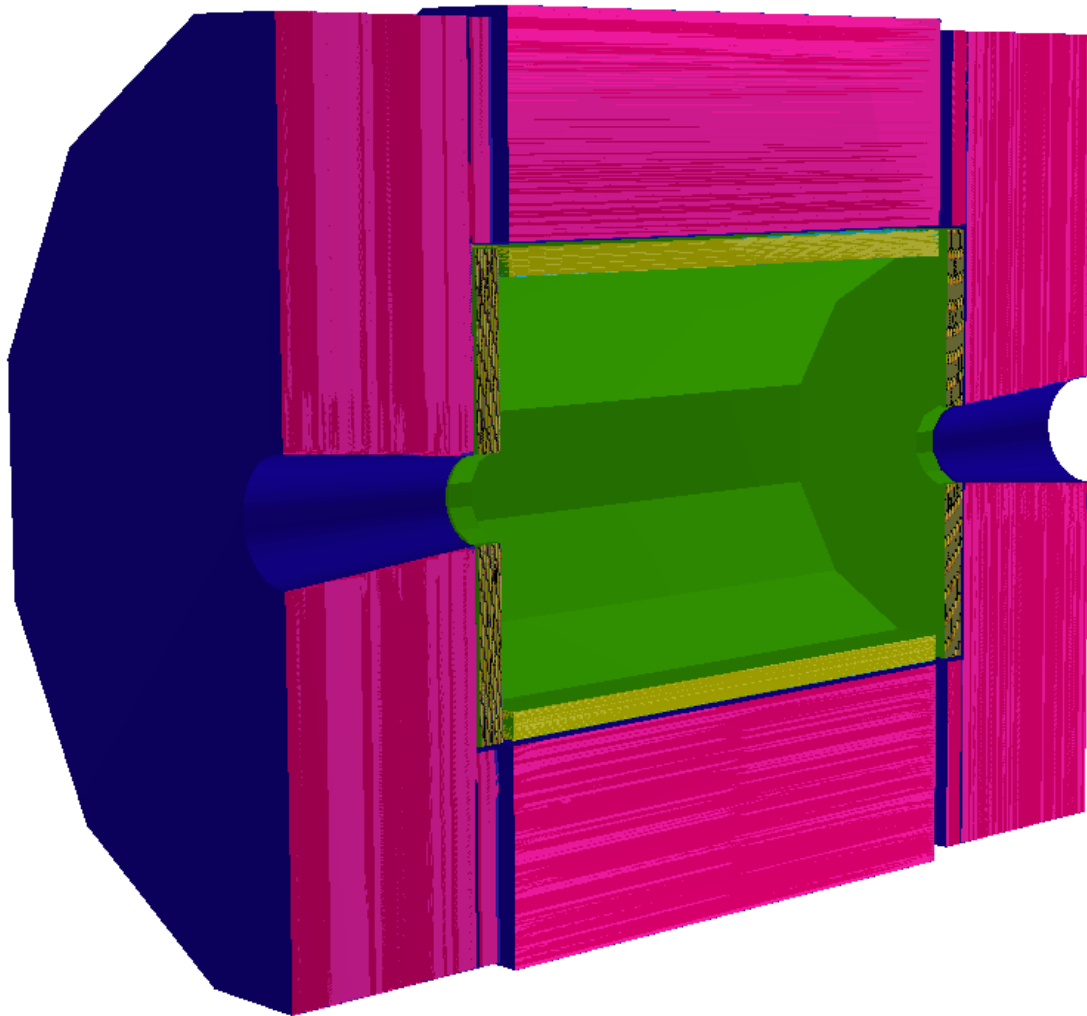
- ▶ 3 barrel layers (100- μm thick):
 - ◆ at $r = 12.7, 34.0, 55.4$ cm;
- ▶ 7+7 disks (100- μm thick):
 - ◆ at $|\Delta z| = 52.4, 80.8, 109.3, 137.7, 166.1, 194.6, 219.0$ cm;

● Outer Tracker (OT)

- ▶ 3 barrel layers (100- μm thick):
 - ◆ at $r = 81.9, 115.3, 148.6$
- ▶ 4+4 disks (100- μm thick):
 - ◆ at $|\Delta z| = 131, 161.7, 188.3, 219$ cm.



Calorimeter system



- Electromagnetic calorimeter (ECAL)

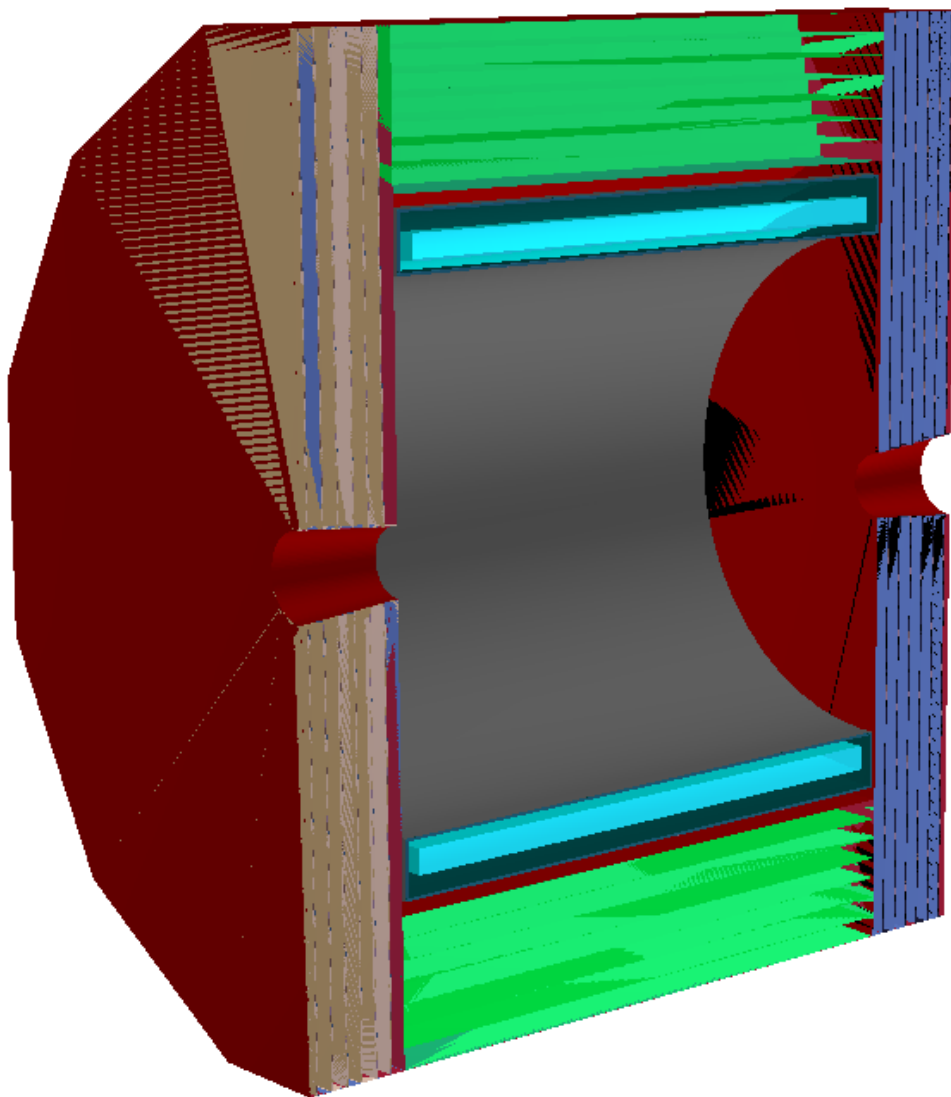
- ▶ 40 layers of 1.9-mm W absorber and silicon pad sensors;
- ▶ $5 \times 5 \text{ mm}^2$ cell granularity;
- ▶ $22 X_0 + 1 \lambda_I$.

- Hadron Calorimeter (HCAL)

- ▶ 60 layers of 19-mm steel absorber and plastic scintillating tiles;
- ▶ $30 \times 30 \text{ mm}^2$ cell granularity;
- ▶ $7.5 \lambda_I$.



Muon detectors

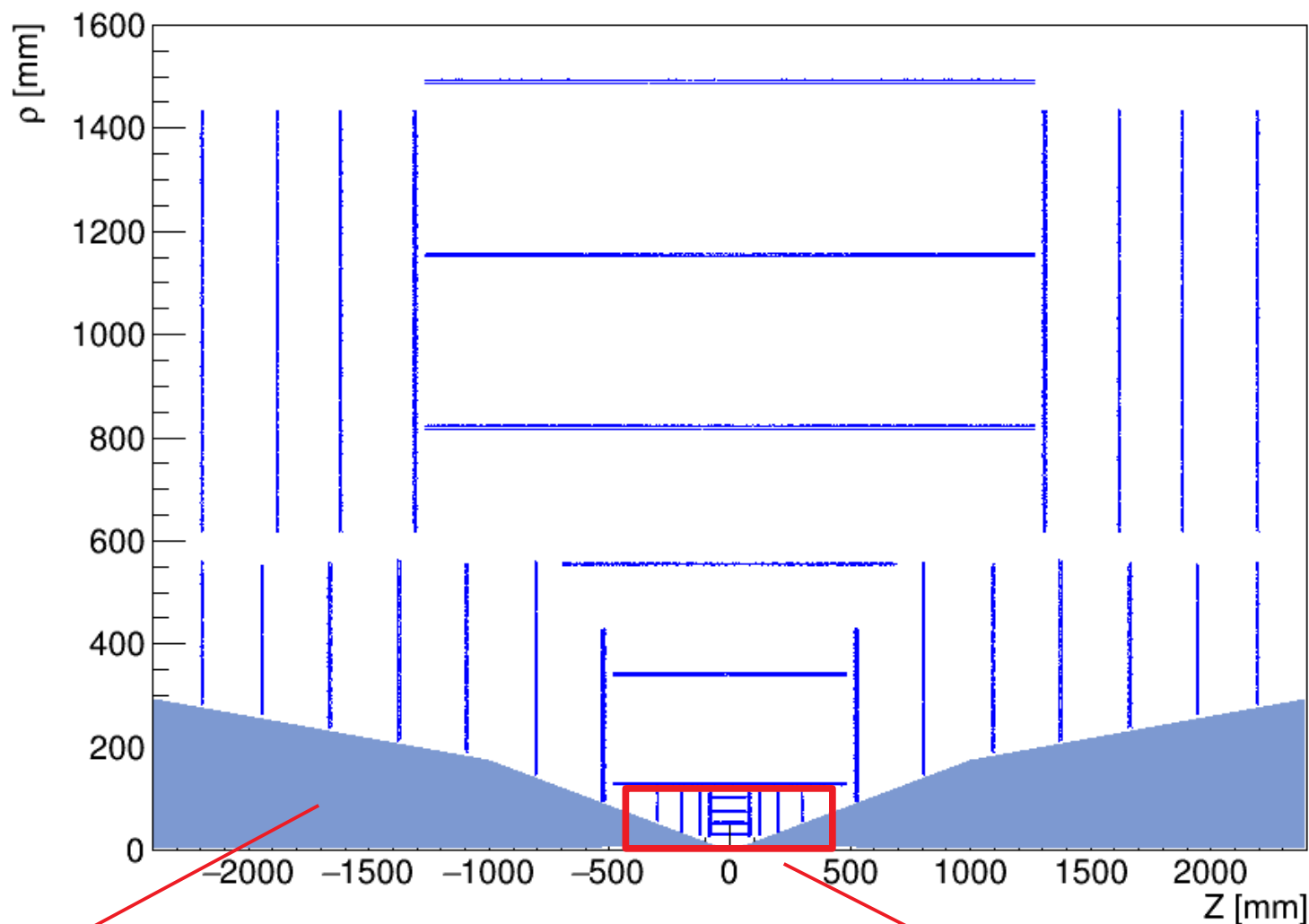


- Muon Detectors

- ▶ RPC sensor layers interleaved in the magnet's iron return yoke;
- ▶ 7 layers in the barrel and 6 layers in the endcaps;
- ▶ 30x30 mm² cell size.



First adjustments to ILCSoft



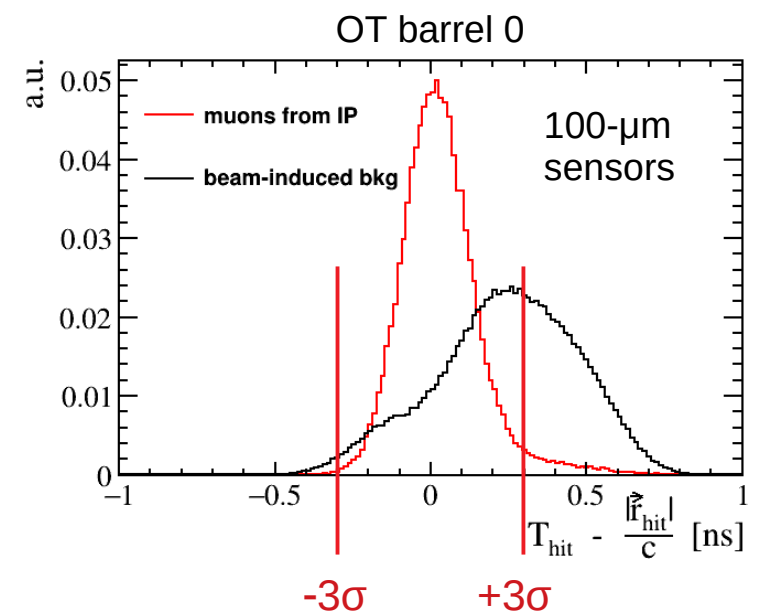
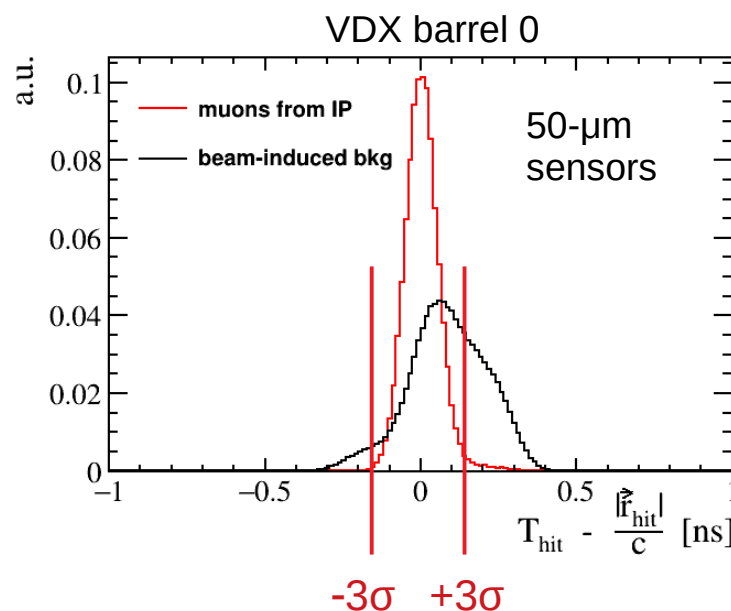
added shielding nozzles

new vertex detector



Tracker hits timing

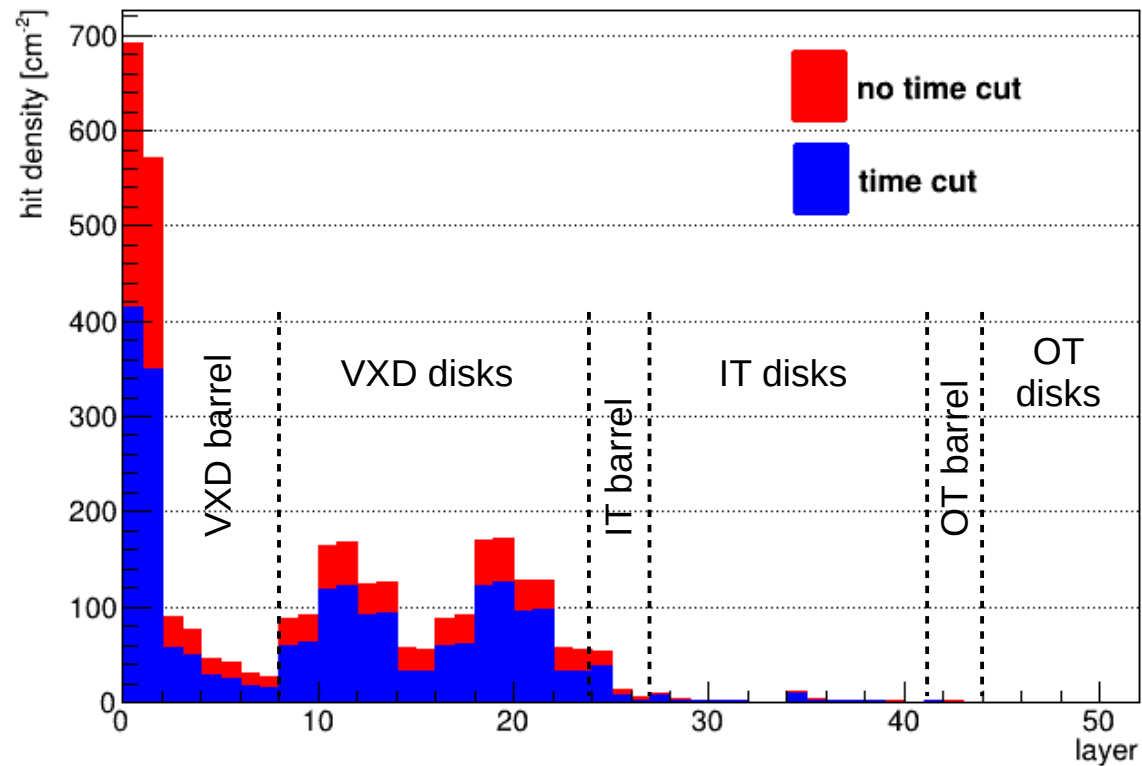
- The time-of-arrival spread of the hits from the beam-induced bkg provides a powerful handle to mitigate their number:
 - ▶ we assume a time resolution of 50 ps (100 ps) for the 50- μm (100- μm) thick Si sensors;
 - ▶ “read out” only hits compatible with particles coming from the interaction point.





Tracker occupancy

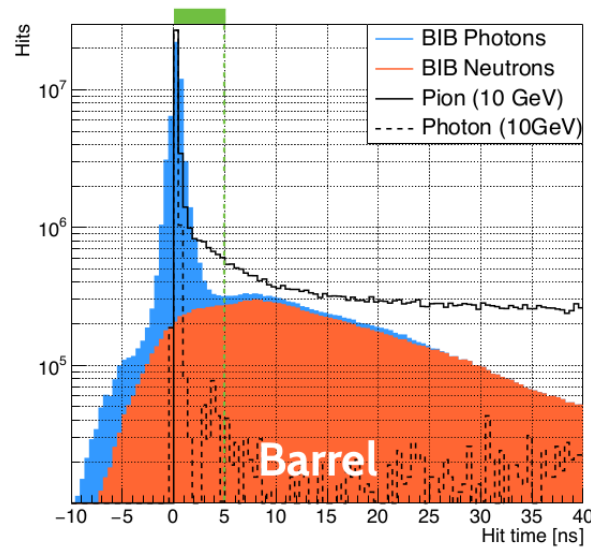
- Hit density due to the beam-induced background for one bunch crossing without and with the hit time window selection:



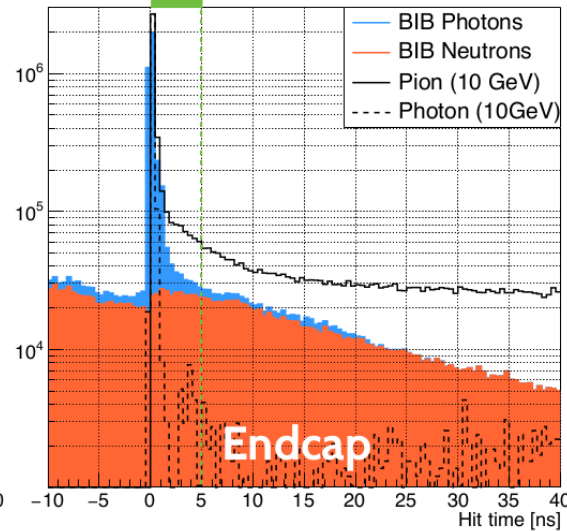


Calorimeter timing

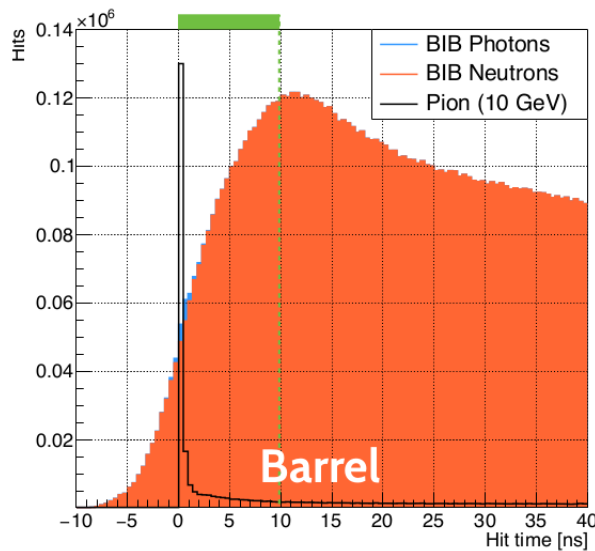
μ^- beam



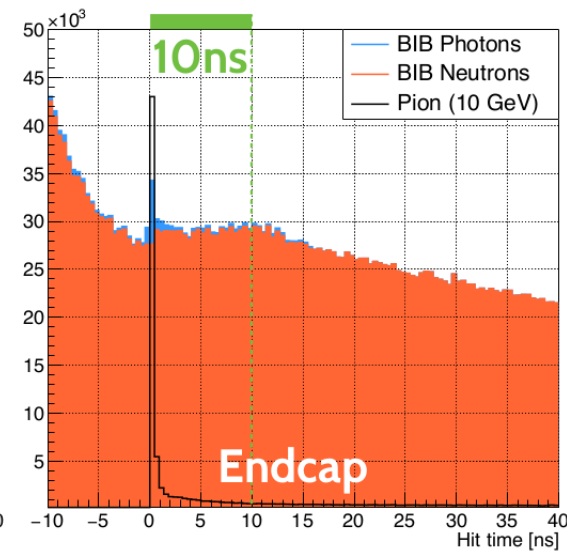
5ns



ECAL



10ns



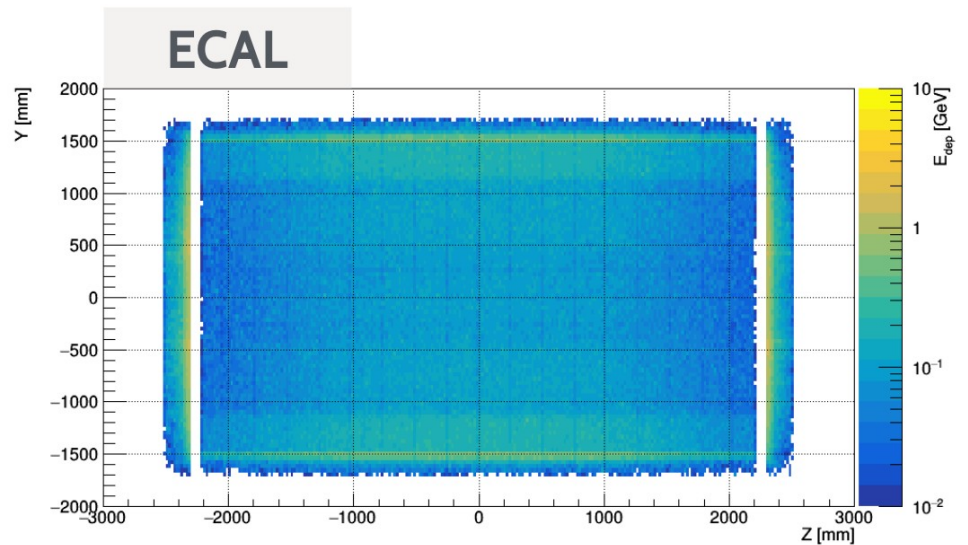
HCAL

N. Bartosik



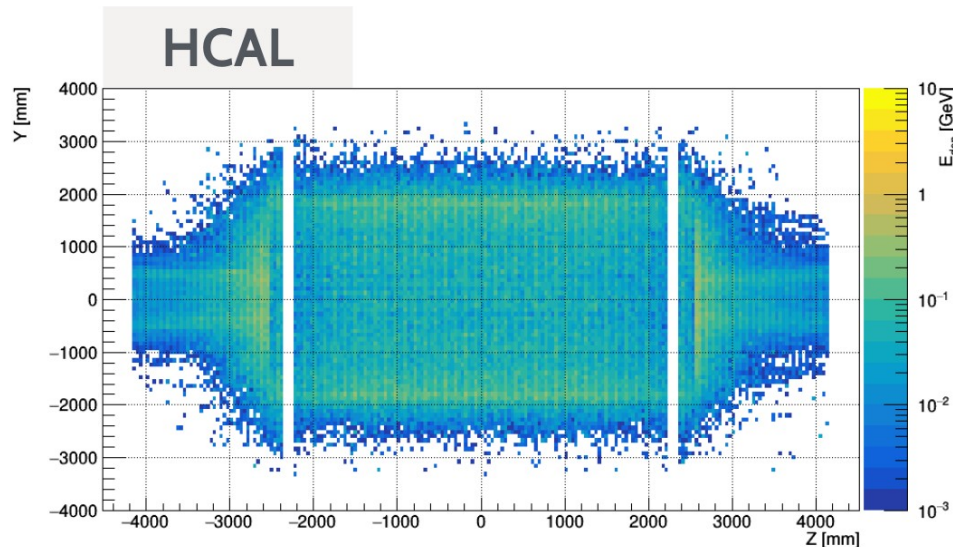
Calorimeter occupancy

$\mu^\pm$ beams



- Energy deposited in the calorimeters at each bunch-crossing:

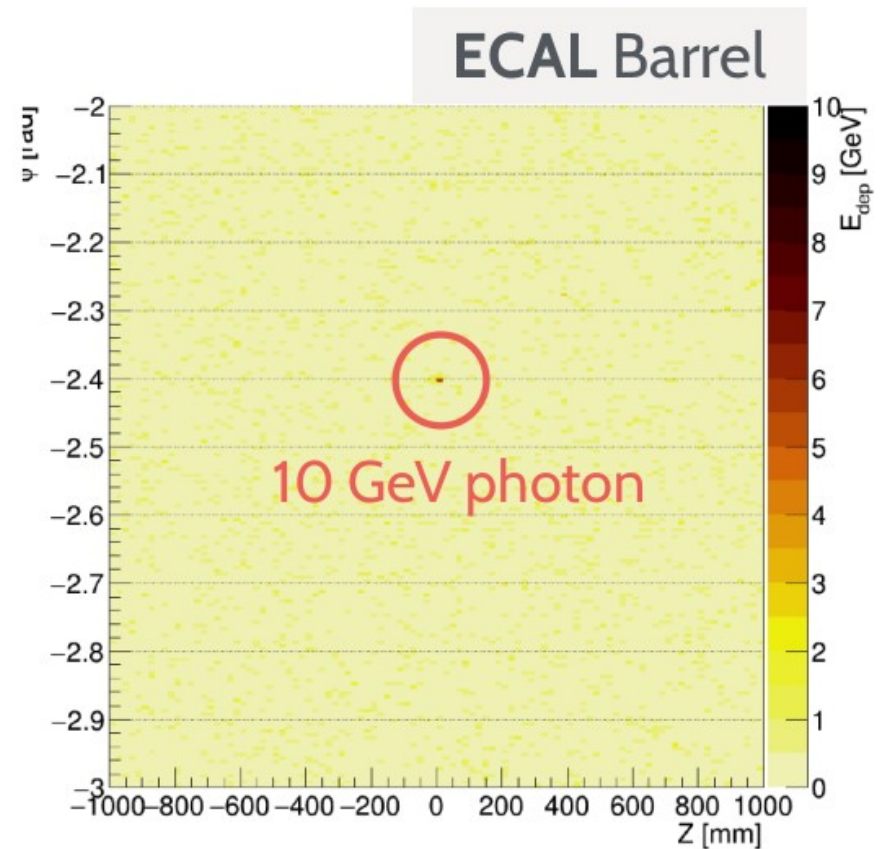
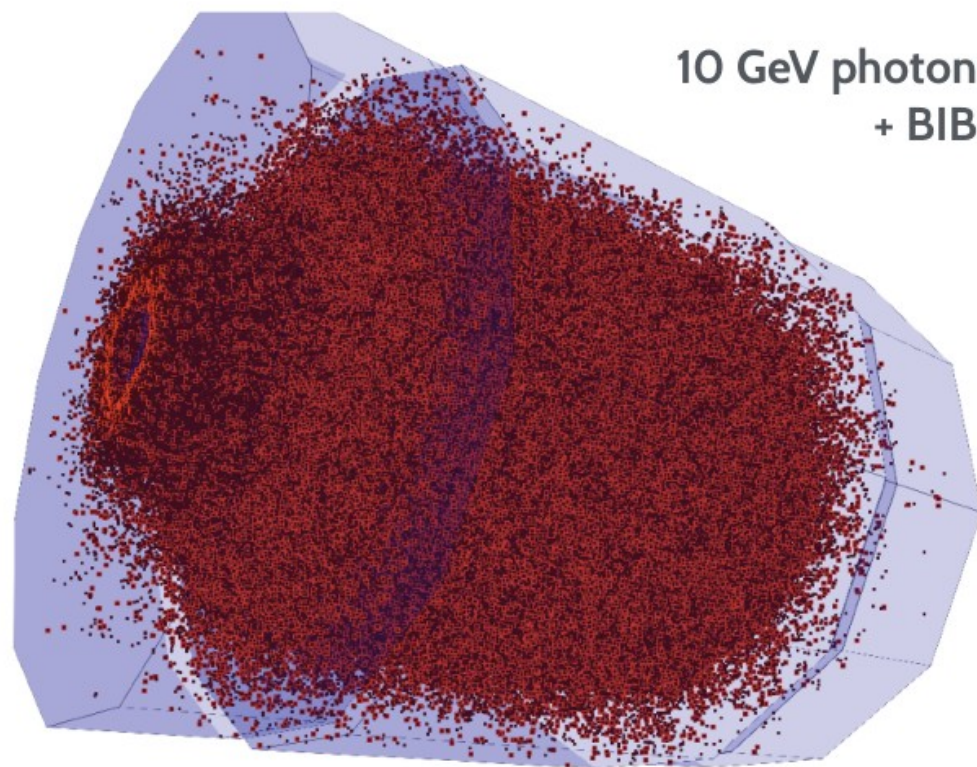
ECAL	HCAL
2.5 TeV	0.5 TeV



N. Bartosik



Single photon + beam-induced bkg

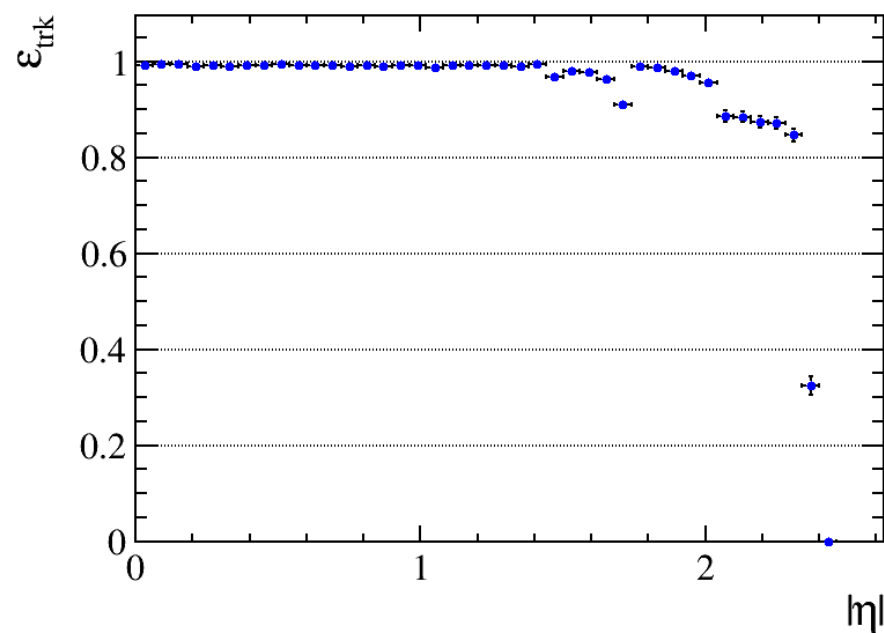
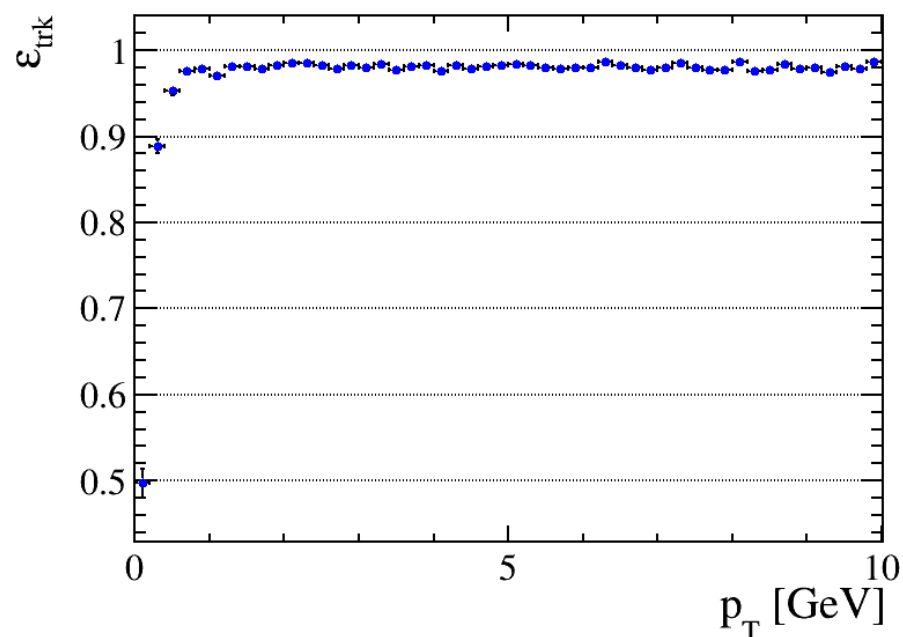


N. Bartosik



Track reconstruction

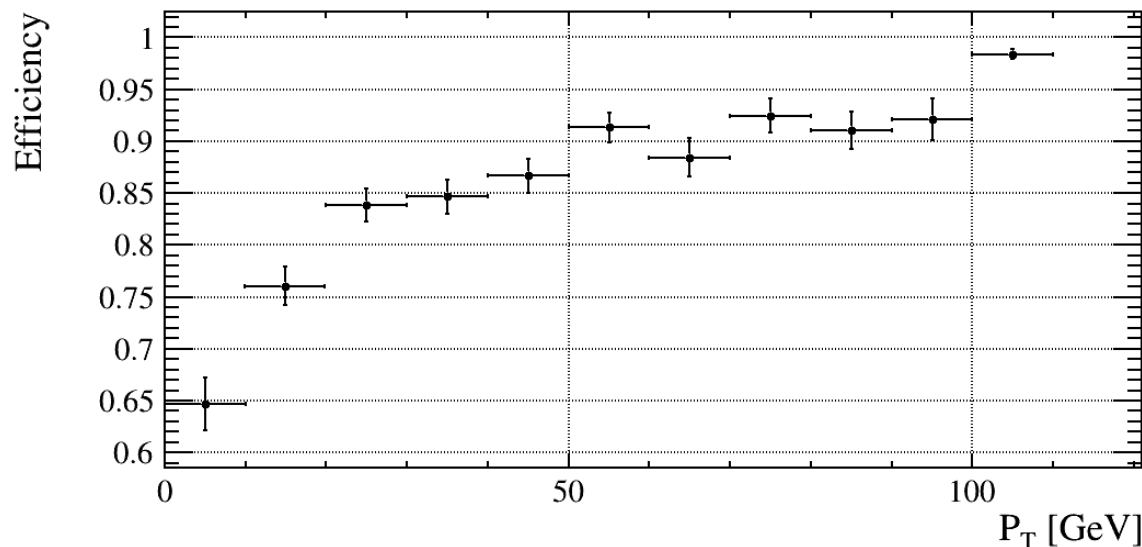
- Track reconstruction in a muon gun sample with:
 - ▶ $0.1 \text{ GeV} < p_T < 10 \text{ GeV}$, $0^\circ < \varphi < 360^\circ$, $8^\circ < \vartheta < 172^\circ$.



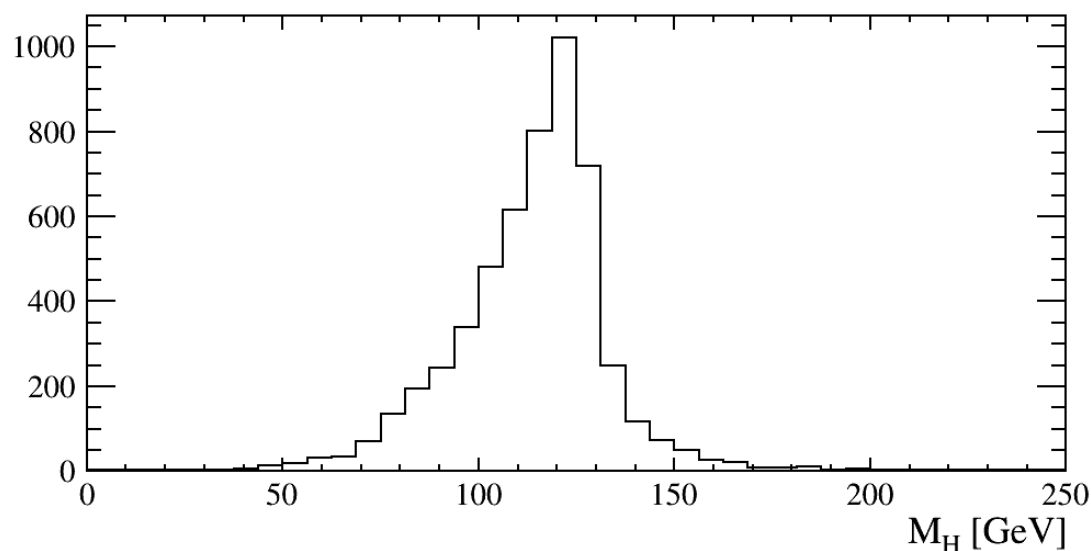
NB: Tracking algorithm not yet optimized for new vertex detector.



Jet reconstruction



- Jet reconstruction efficiency in a sample of $HH \rightarrow b\bar{b}b\bar{b}$ events at 3 TeV.



- $b\bar{b}$ invariant mass (in $HH \rightarrow b\bar{b}b\bar{b}$ events at 3 TeV).

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Ongoing activities

- Ongoing activities:
 - ▶ implementation of a more realistic simulation of the tracker readout that includes:
 - ◆ a segmentation of the Si sensors into pixels;
 - ◆ digitization of the pixel signals;
 - ◆ pixel clusterization and hit reconstruction.
 - ▶ rejection of tracker spurious hits exploiting double layer correlations;
 - ▶ tuning of pattern recognition and track finding to cope with the beam-induced background;
 - ▶ inclusion of muon detectors in event reconstruction.