Tracking studies

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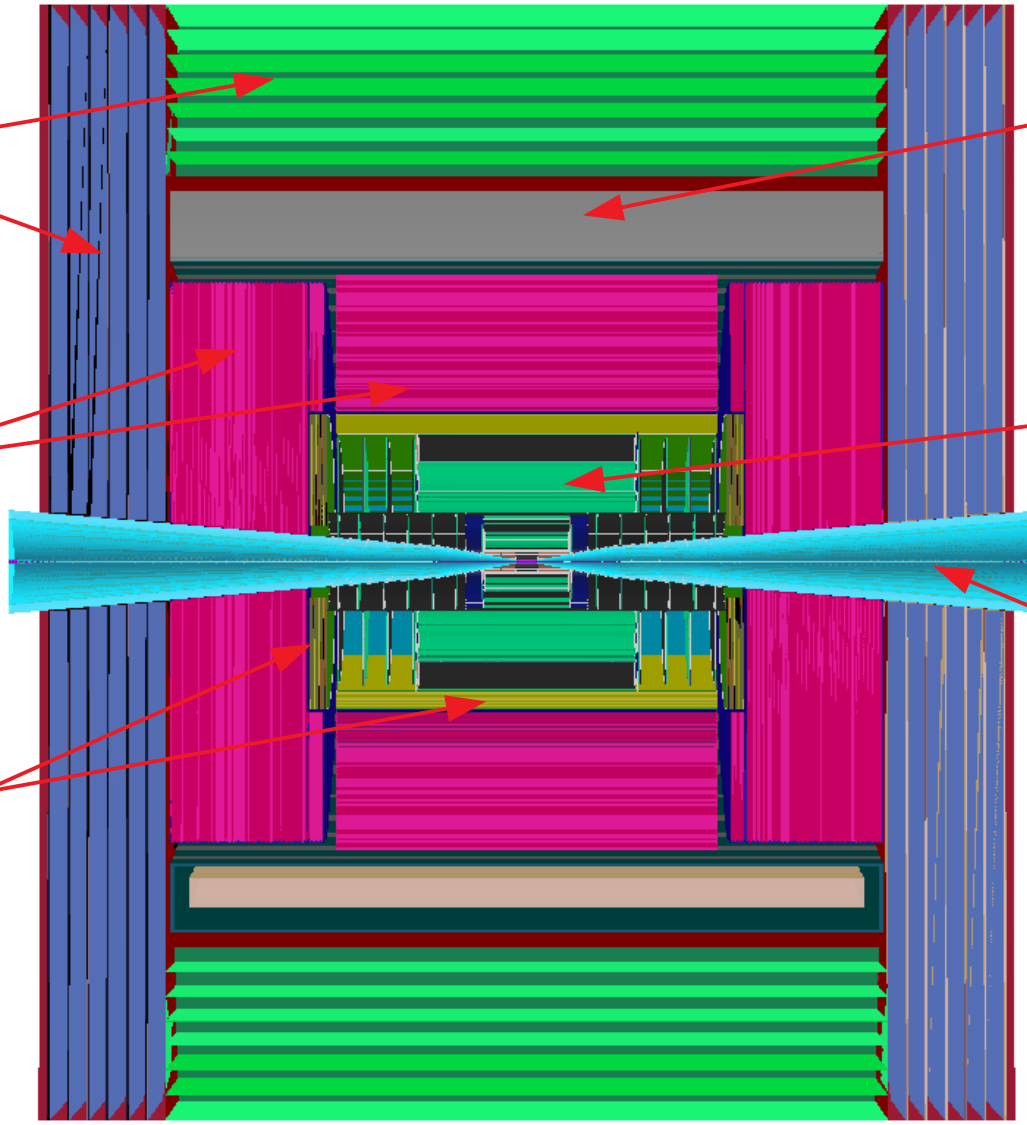
Outline

- Brief introduction to set the context;
- overview of the detector;
- the tracking system;
- first studies towards a full event tracking with beam-induced background overlaid:
  - tracker hit occupancy from the beam-induced background;
  - tracking efficiency for muons from the interaction region;
- next steps.

Introduction

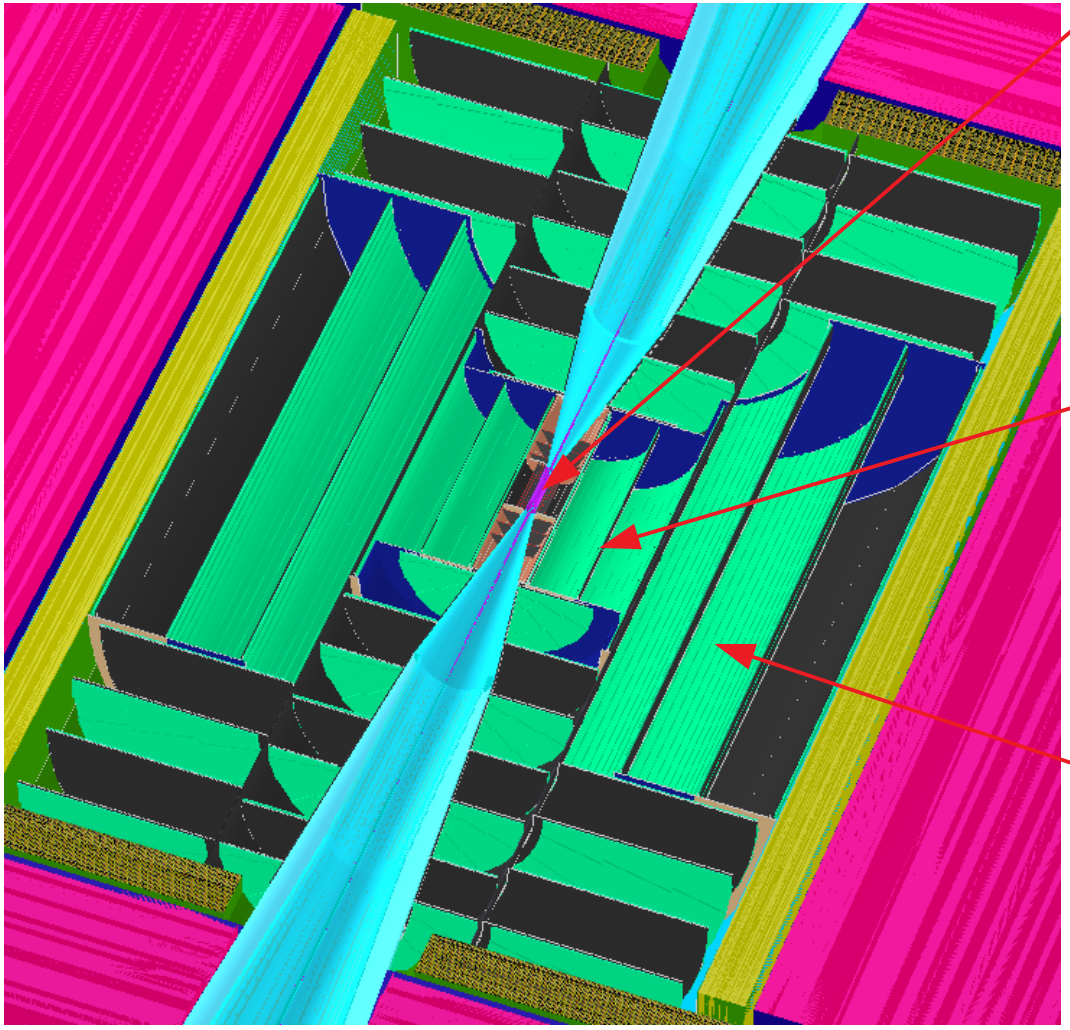
- In the past months we have migrated from MAP's simulation-reconstruction framework to CLIC's ILCsoft (and to CLIC's detector model).
- We are still using MAP's beam-induced background, produced with MARS15 by N. Mokhov:
  - one bunch crossing of 750-GeV $\mu^{\pm}$ beams with 2×10^{12} μ/bunch.
- We have updated the CLIC detector geometry to accommodate MAP's machine-detector interface: the interaction region and two shielding cones in the forward regions optimized for a 1.5-TeV collider.

Detector overview



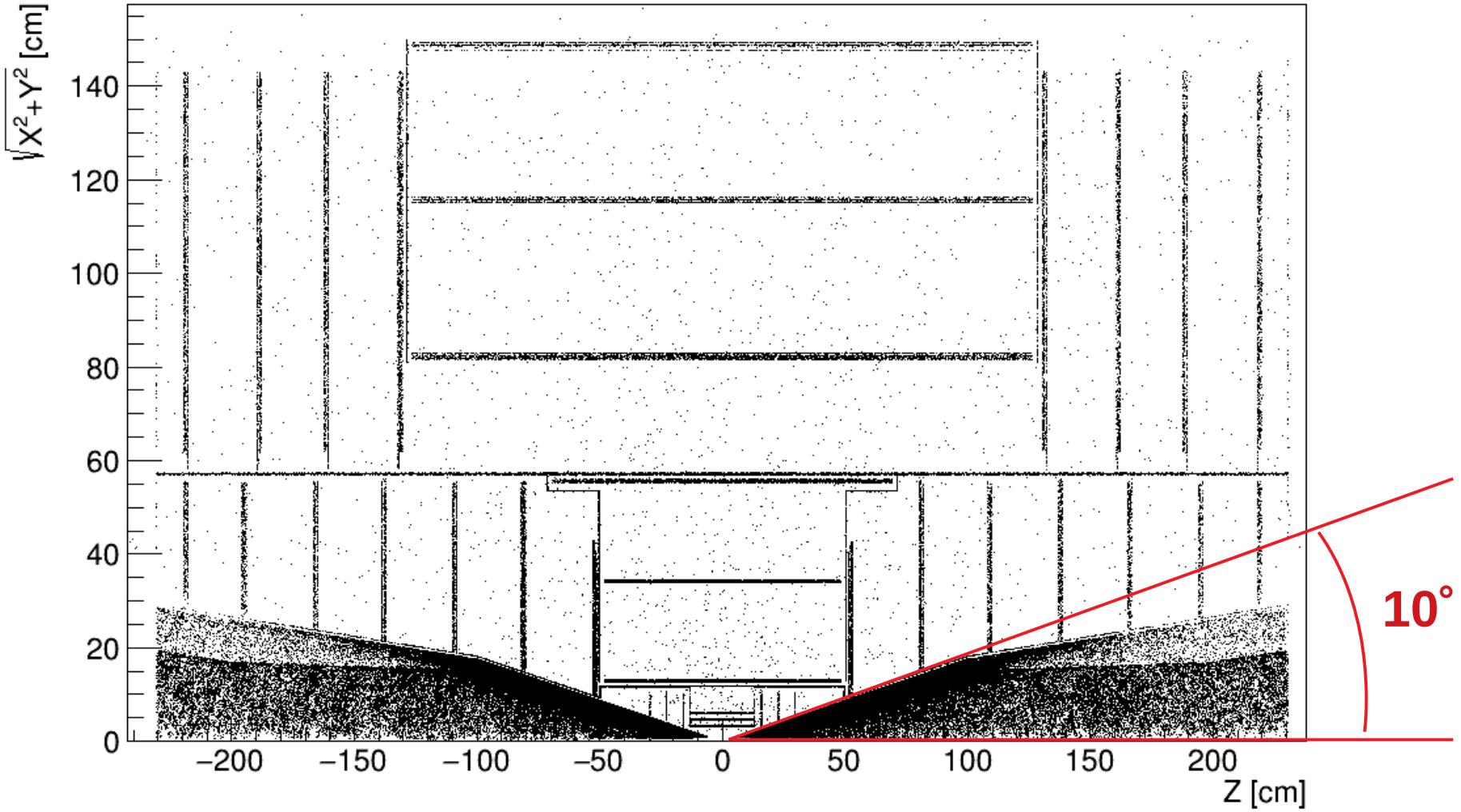
- This is basically CLIC's detector + the shielding nozzles.

The tracking system



- Vertex Detector (VDX)
  - 3 double-sensor barrel layers:
    - at r = 3.1, 4.4, 5.8 cm;
    - 50-μm thick Si sensors;
  - 3+3 double-sensor disks:
    - at $|\Delta z|$ = 16.0, 22.8, 29.6 cm;
    - 25-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.

Tracker muography

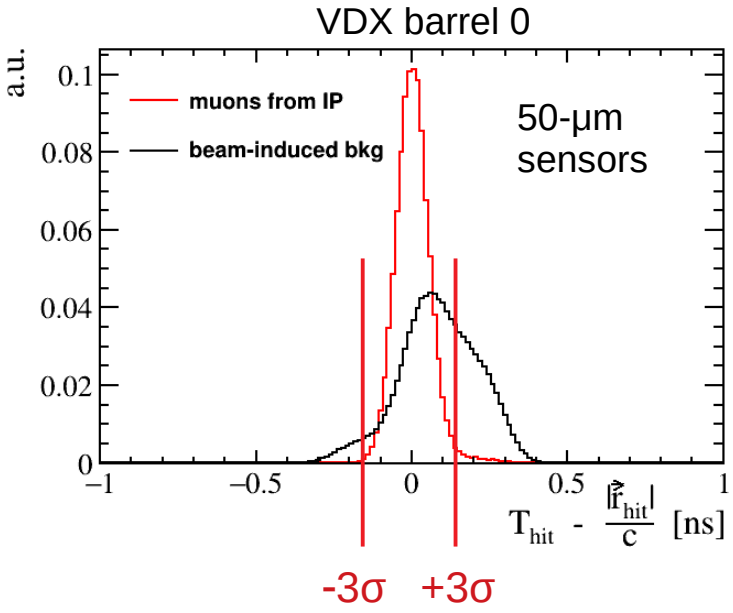


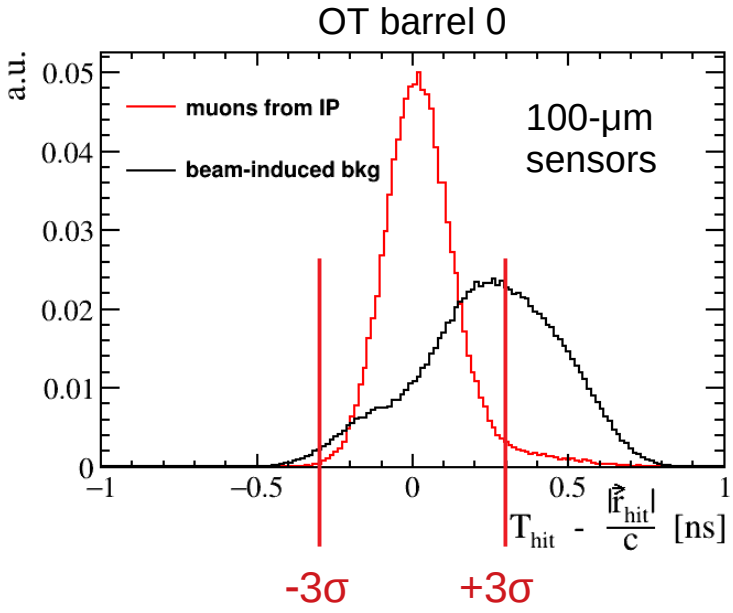
Tracker's sim-reco software

- Detector response:
  - full simulated with GEANT4.
- Hit reconstruction:
  - simple Gaussian smearing of the hit positions with different resolutions, assuming 25x25-μm^2 pixels in VDX and 50-μm pitch strips of various lengths in IT and OT.
- Pattern recognition and track finding:
  - conformal transformation of hit positions + inside-out Kalman-filter fit.
- As the closest detector to the beamline, the tracker is affected the most by the beam-induced background. The hit reconstruction and the tracking strategy need to be tuned to the muon collider conditions in order to preserve the tracker performance.

Timing of the tracker hits

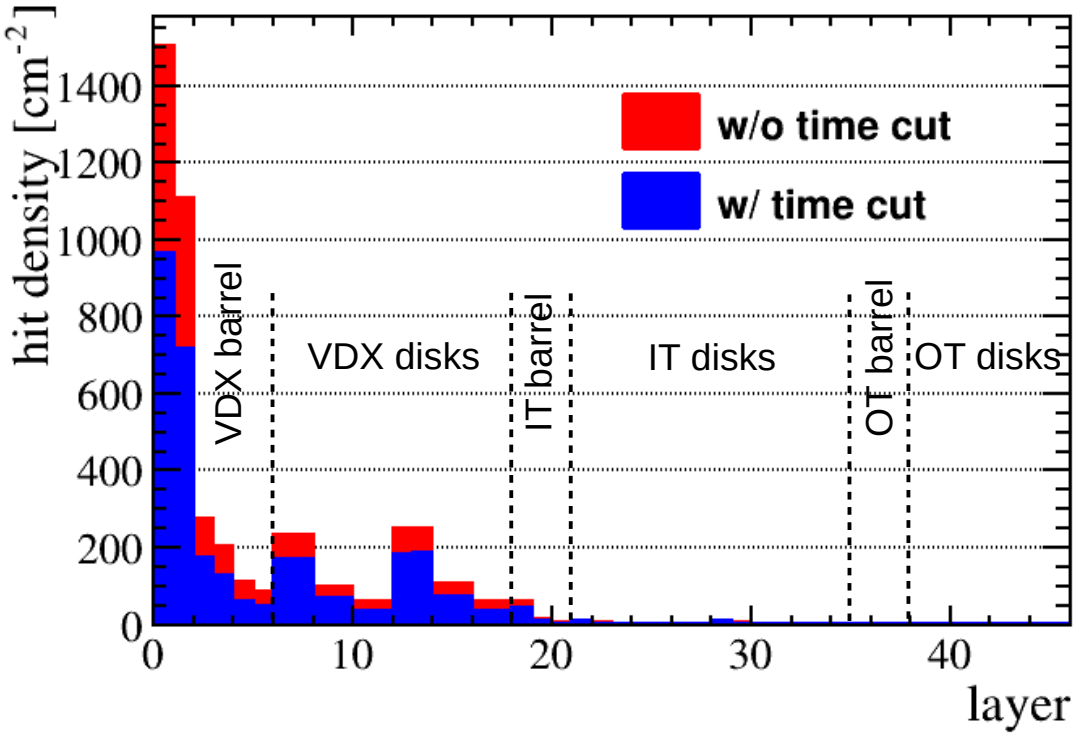
- The time-of-arrival spread of the hits from the beam-induced bkg provides a powerful handle to mitigate their number:
  - we assume a time resolution of 50 ps (100 ps) for the 50-μm (100-μm) thick Si sensors;
  - "read out" only hits compatible with particles coming from the interaction point.





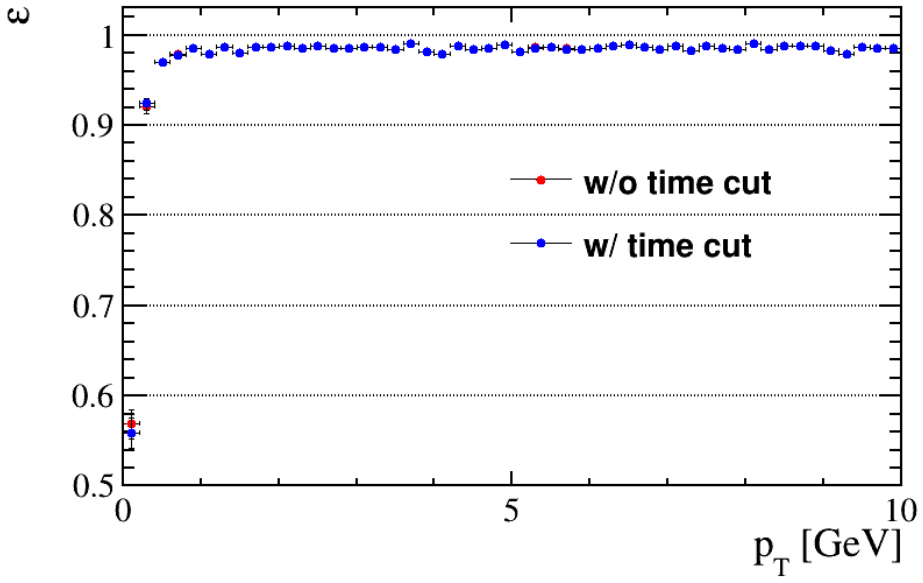
Tracker occupancy

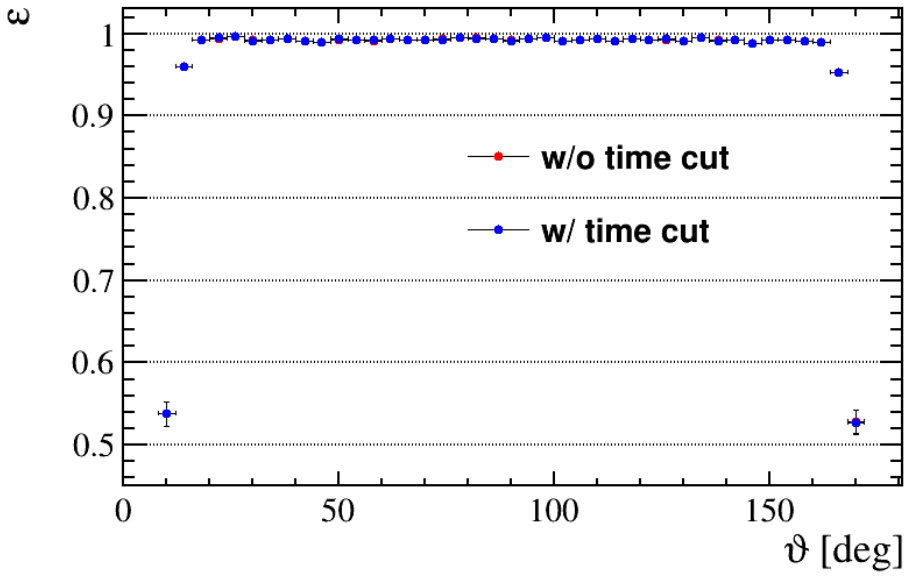
- Hit density due to the beam-induced background for one bunch crossing without and with the hit time window selection:



Tracking efficiency for IP muons

- The effect of the hit selection time window is negligible for muons coming from the nominal interaction point.
- Tracking efficiency for a muon gun sample with:
  - 0.1 GeV < p_T < 10 GeV, 0˚ < φ < 360˚, 8˚ < ϑ < 172˚.





Next steps

- Ongoing developments to:
  - implement 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.
  - find the most suitable tracking strategy for the high-occupancy environment at a muon collider.
- We are in contact with E. Brondolin, M. Petrič, and A. Sailer of the CLIC Collaboration, who we thank for their support and advice.