HF May 7th

Notes from this week FCC week meetings

Caterina Vernieri, caterina@slac.stanford.edu

SLAC NATIONAL ACCELERATOR LABORATORY

Stanford University | U.S. DEPARTMENT OF ENERGY

MDI https://indico.cern.ch/event/1679640/

50 ns being evaluated to compensate electron cloud effects

New parameter table at 25 ns and 50 ns bunch spacing for LCC optics at Z, W, and Higgs energy

27-Apr-26	LCC Z 25 ns	LCC Z 50 ns
Emittance x (m)	1,22E-09	1,19E-09
Beta x (m)	0,09	0,09
sigma x at IP (microns)	1,05E+01	1,04E+01
Emittance y (m)	3,65E-12	5,21E-12
Beta y (m)	8,01E-04	8,01E-04
sigma y at IP (nm)	5,41E+01	6,46E+01
Np (bunch)	2,42E+11	4,84E+11
sigma z (mm)	1,49E+01	2,23E+01
sigma_delta	0,04%	0,19%

Given the lattice parameters, 50ns has **14% more luminosity** (as calculated by GuineaPig)
The 50 ns lattice produces **11 % more IPCs** due to the bunch dimensions and beam structure
The 50 ns has a **harder energy spectrum**, more IPCs reaching the first vertex layer - 20% more for IDEA, 35% more for CLD

Jan E.

Injection Background

G. Nigrello https://indico.cern.ch/event/1679640/contributions/7063725/attachments/3267850/5836829/MDI_04052026.pdf

The FCC-ee stores ~189 MJ of beam energy at the Z pole (orders of magnitude more than other lepton colliders), making beams highly destructive. The collimation system must protect the machine and minimize detector backgrounds using a multi-stage setup (SR collimators, tertiary collimators, local protection, and shower absorbers).

Beam lifetime is very short during collisions (<1 h), requiring continuous top-up injection with no ramp (direct injection into FCC-ee cycle). The Z-mode is the most critical: up to ~1% of full beam intensity is injected every 6 seconds per beam.

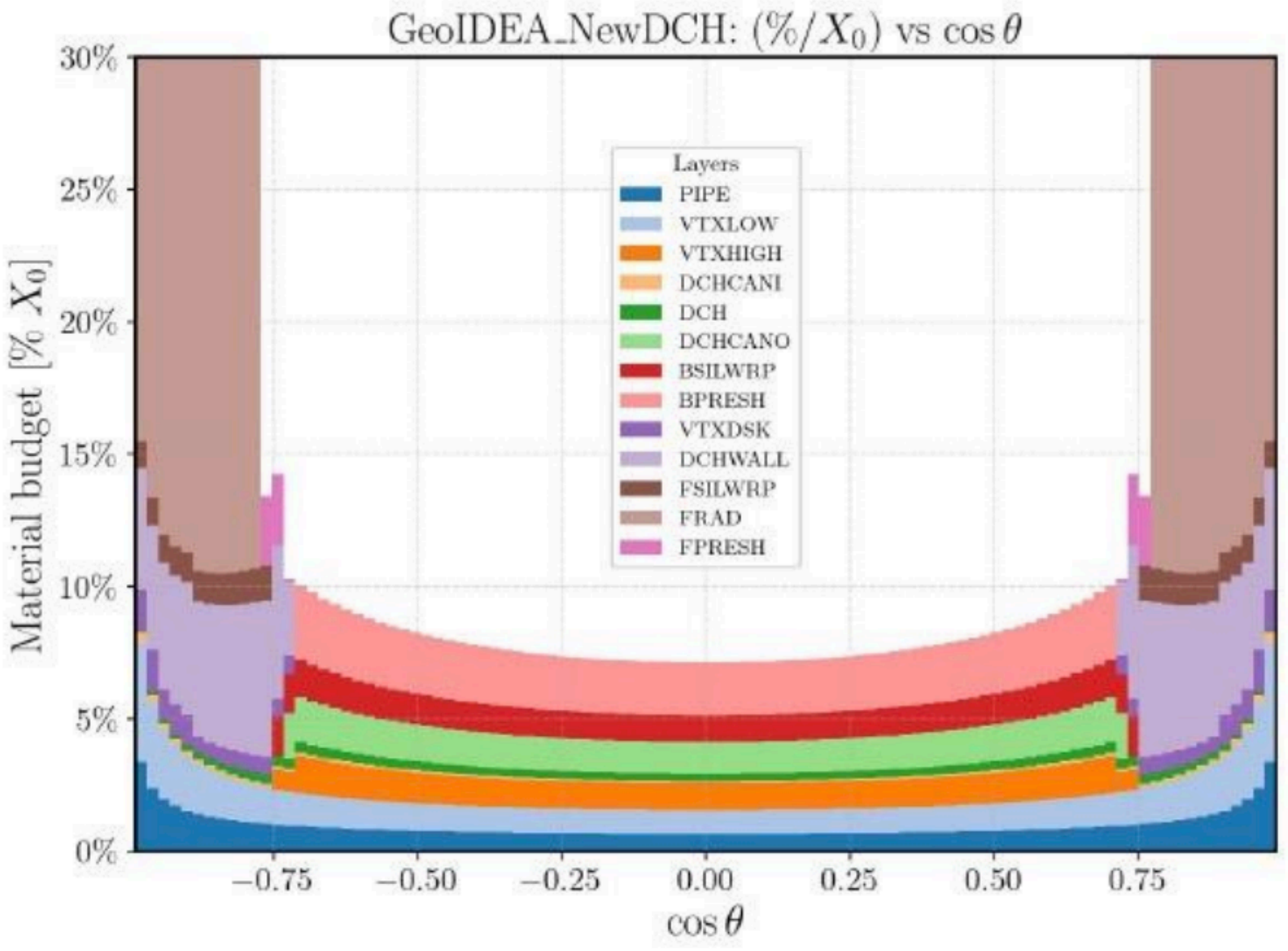
Simulations show ~88% injection efficiency in the presence of collimators (SR lattice). Beam-beam effects reduce efficiency by an additional factor, while the hybrid on-axis scheme can recover roughly 10% efficiency. About 12% of injected particles are lost around the ring, and ~50% of those are scraped at the injection point.

Particle losses are concentrated at the collimation insertion and around the Interaction Points (IPs). Notably, the tertiary collimators near the IPs absorb nearly as many losses as the main collimation section — a key concern for detector backgrounds.

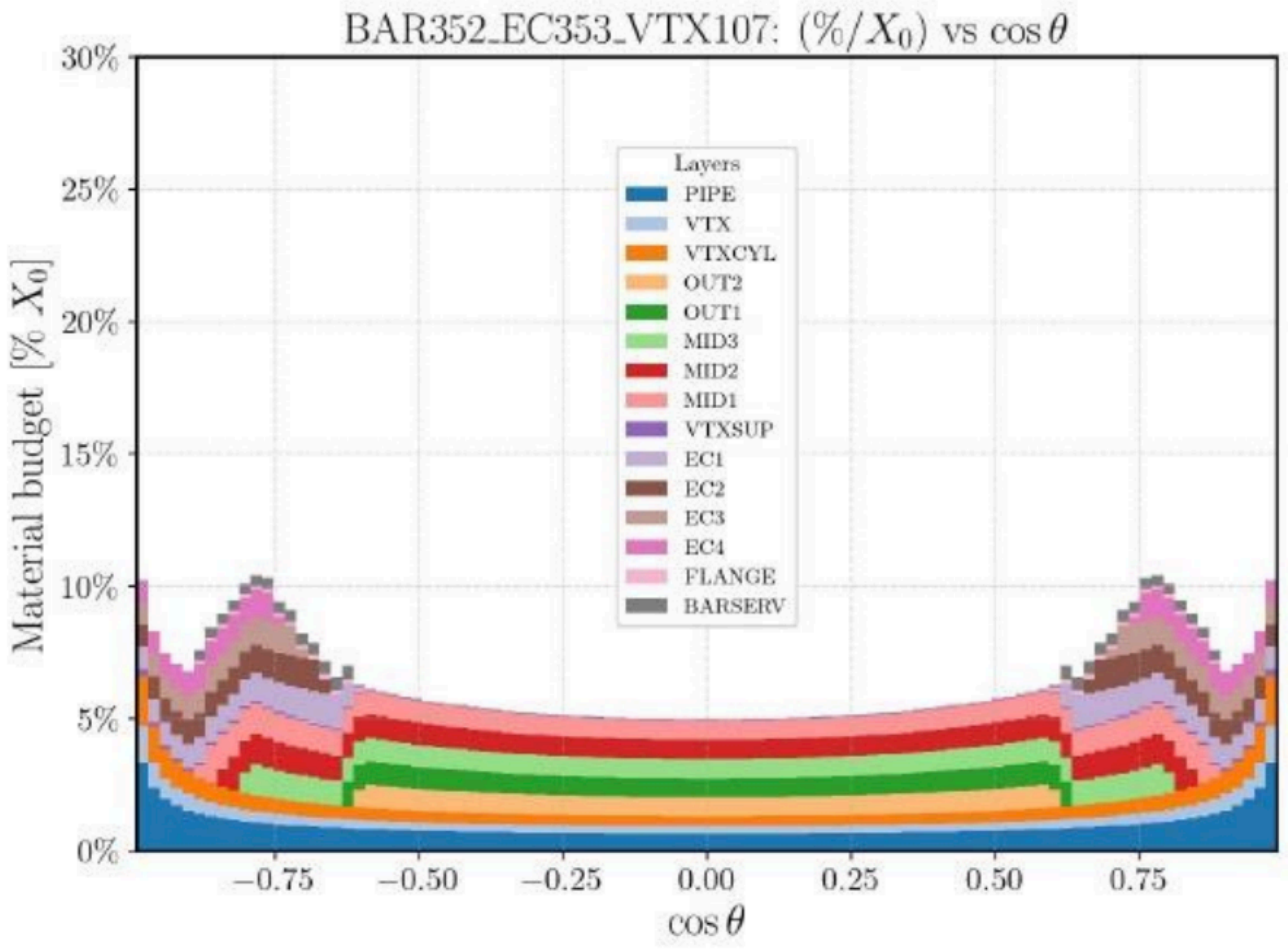
- **Hit rates well below IPC level in the Vertex Barrel but could be higher in the Disks.**

Tracking & PID   https://indico.cern.ch/event/1679102/

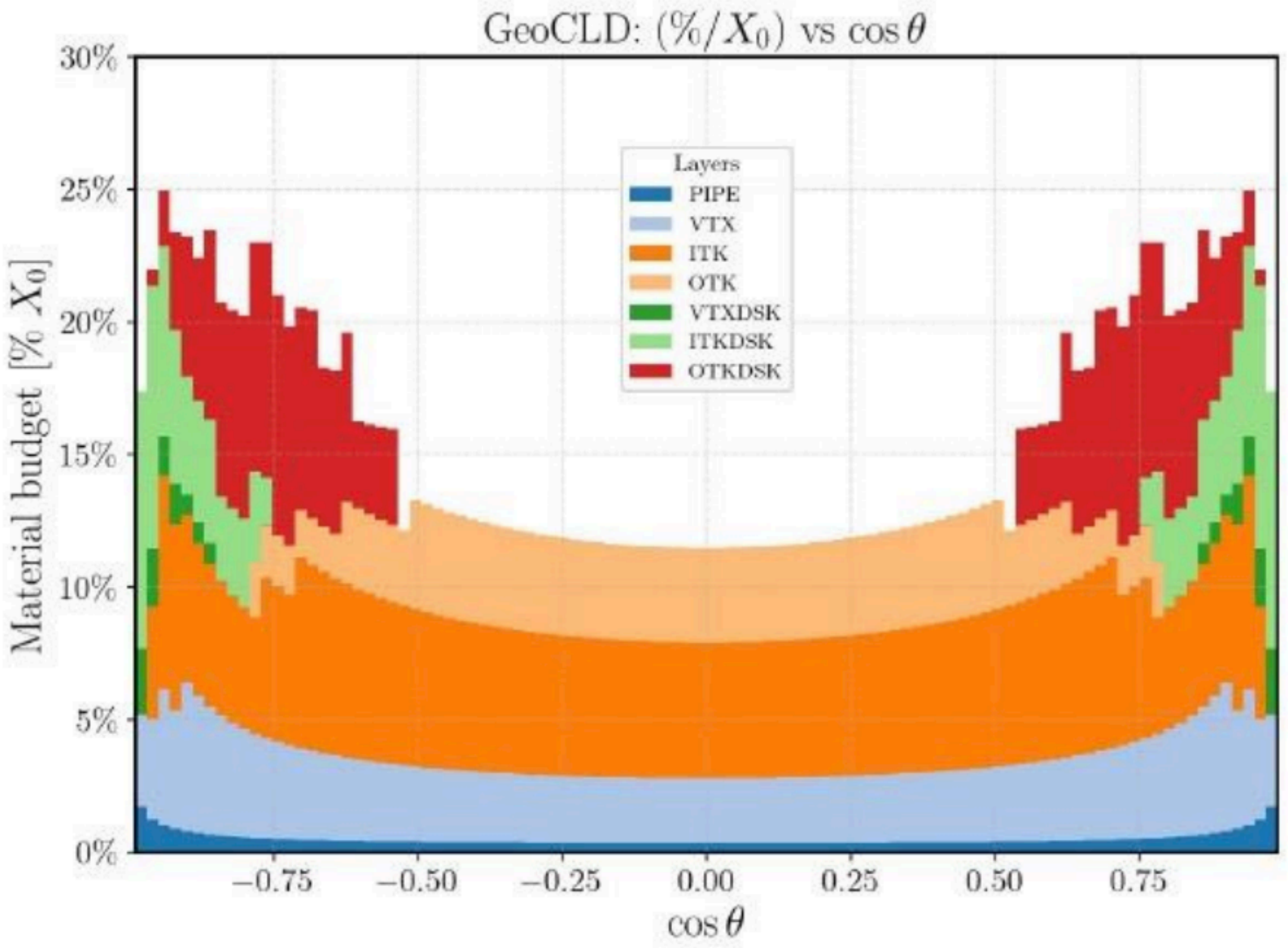
ALFA - an all MAPS detector - but light(er) weight than CLD



IDEA



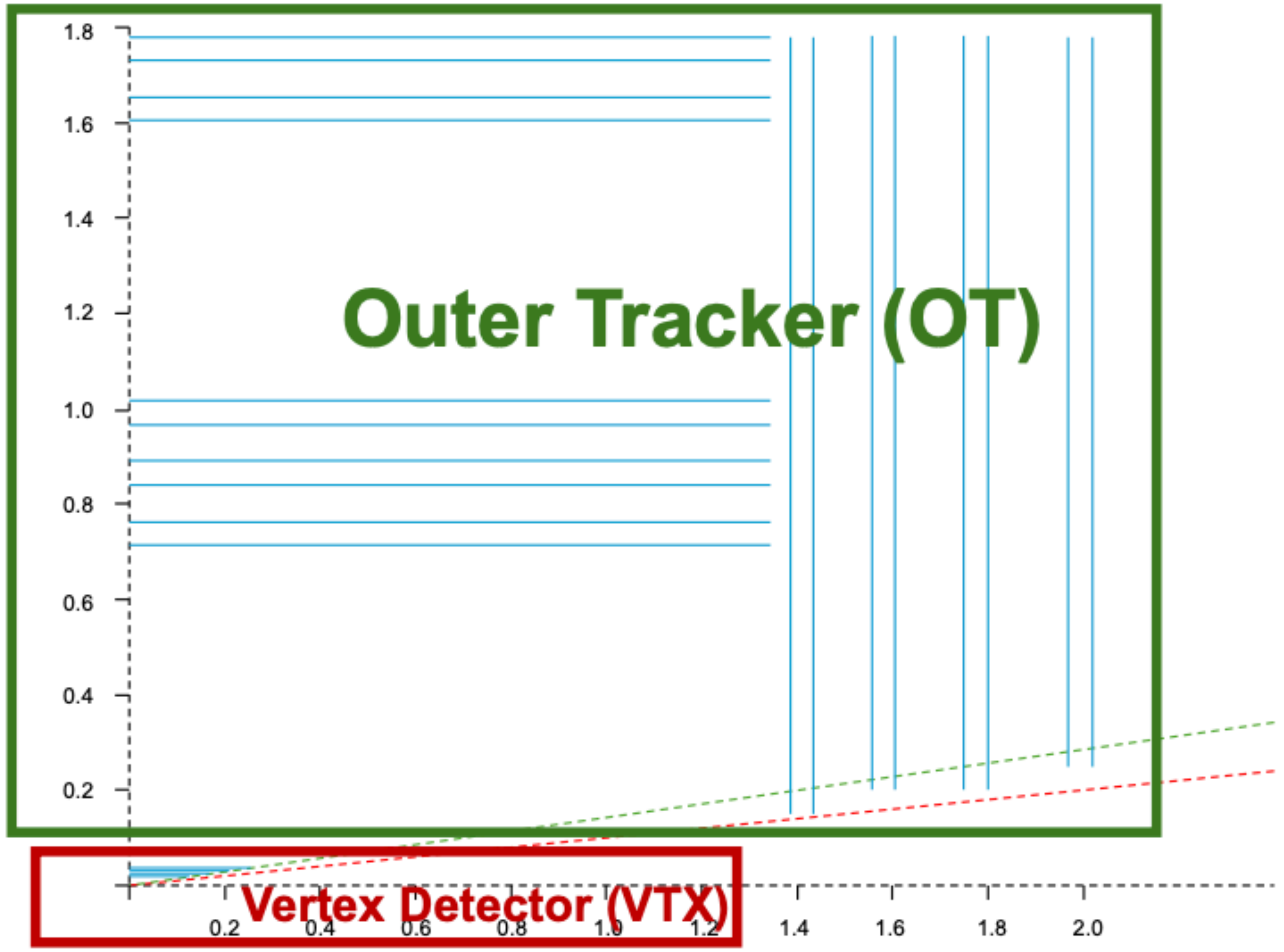
ALFA

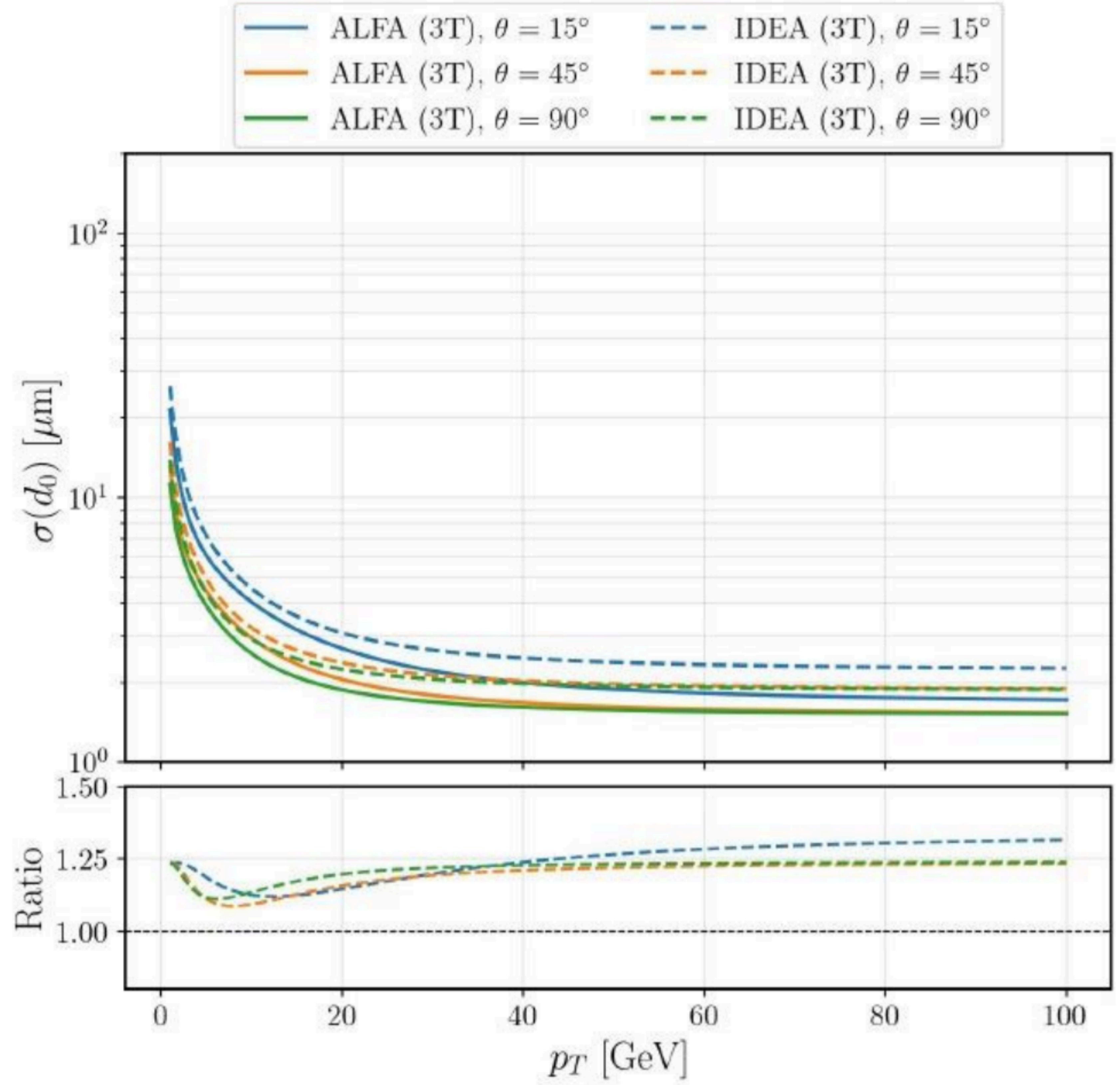


CLD

Tracking & PID https://indico.cern.ch/event/1679102/

ALFA - an all MAPS detector - but light(er) weight than CLD





Performance significantly better than CLD

Compared to IDEA , p_T res is better at high p_T/fwd region for alfa

Tracking & PID   https://indico.cern.ch/event/1679102/

Sci-Fi tracker based on SiPMs and evaluated as part of ALLEGRO

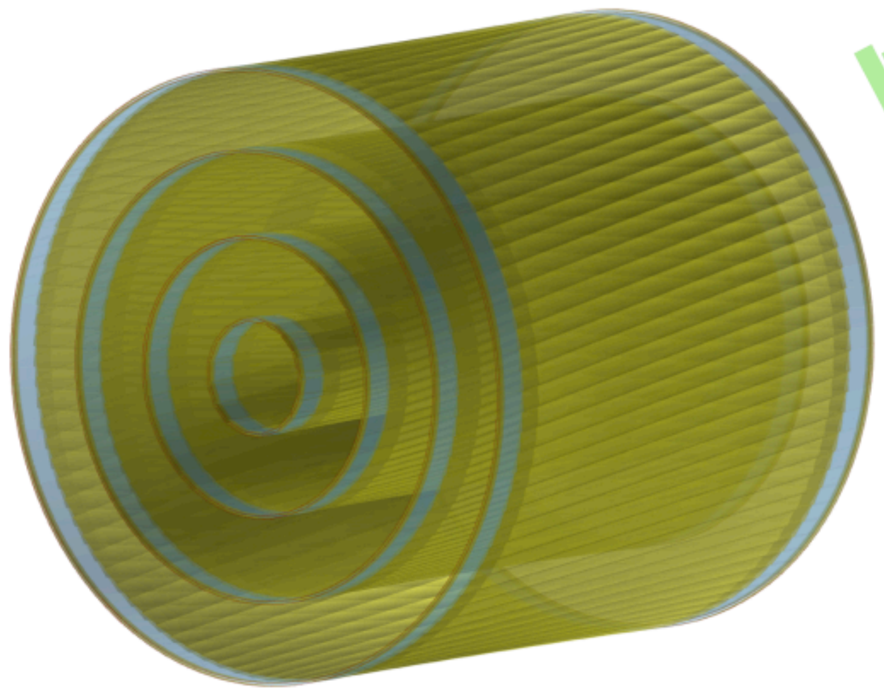
A full Geant4 simulation is already operational

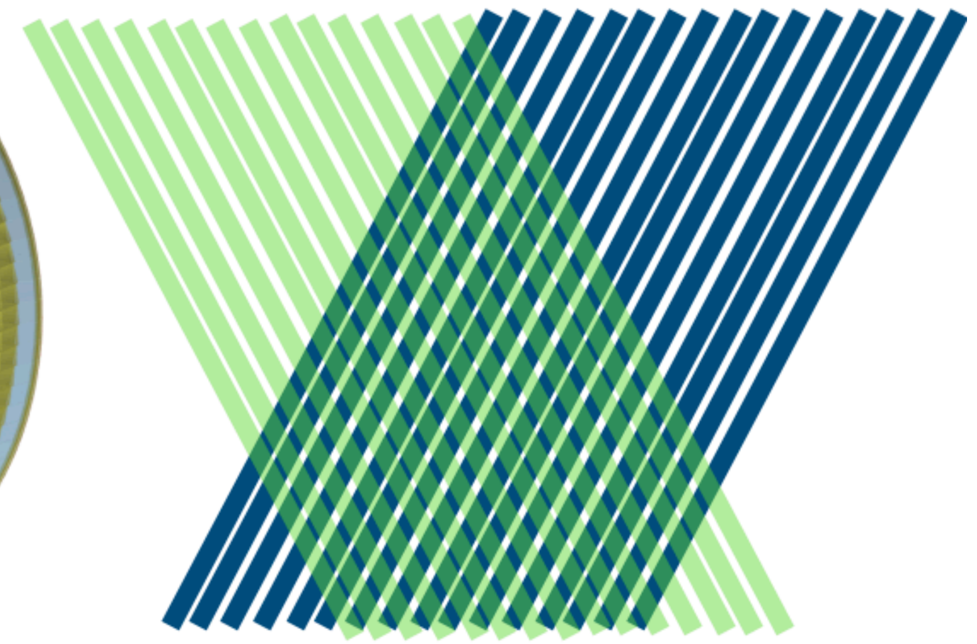
Spatial Resolution:

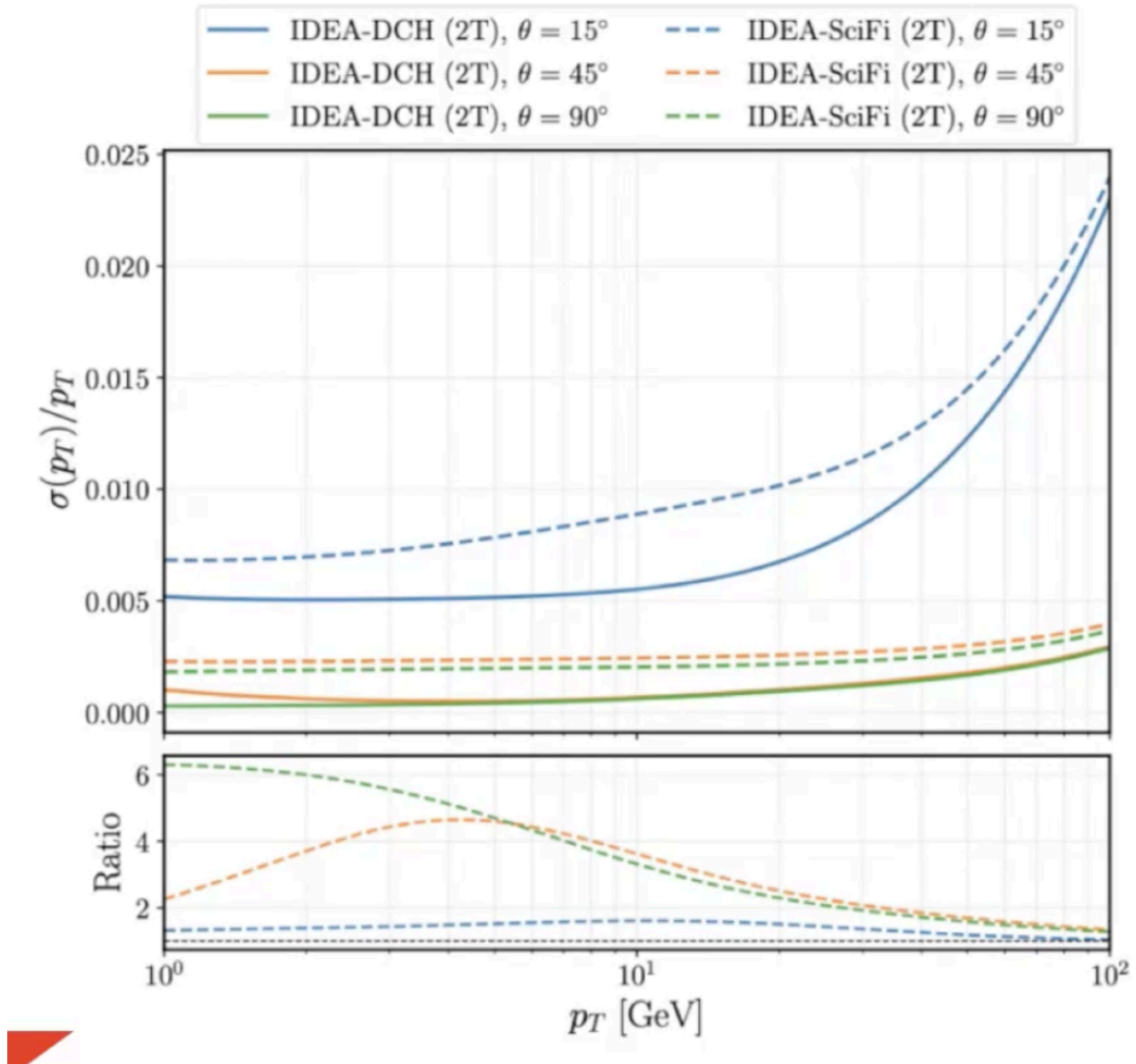
- Estimated at ~30 μm in X and ~200 μm in Z for a 3-station geometry;
- ~ 21 μm/R and Z ~ 200 μm.

Ongoing R&D areas:

- **Digital SiPMs**: Moving from LHC-style multi-pixel readout to Digital SiPMs to resolve individual fibers, targeting ~30 μm precision per mat layer.
- **Dual Readout**: Investigating cross-talk and dual-readout configurations with different fiber arrangements.
- **Timing Resolution**: Studying timing capabilities of the SciFi tracker.
- Radiation-Hard Fibers: Exploring newer, radiation-harder SciFi fiber materials.



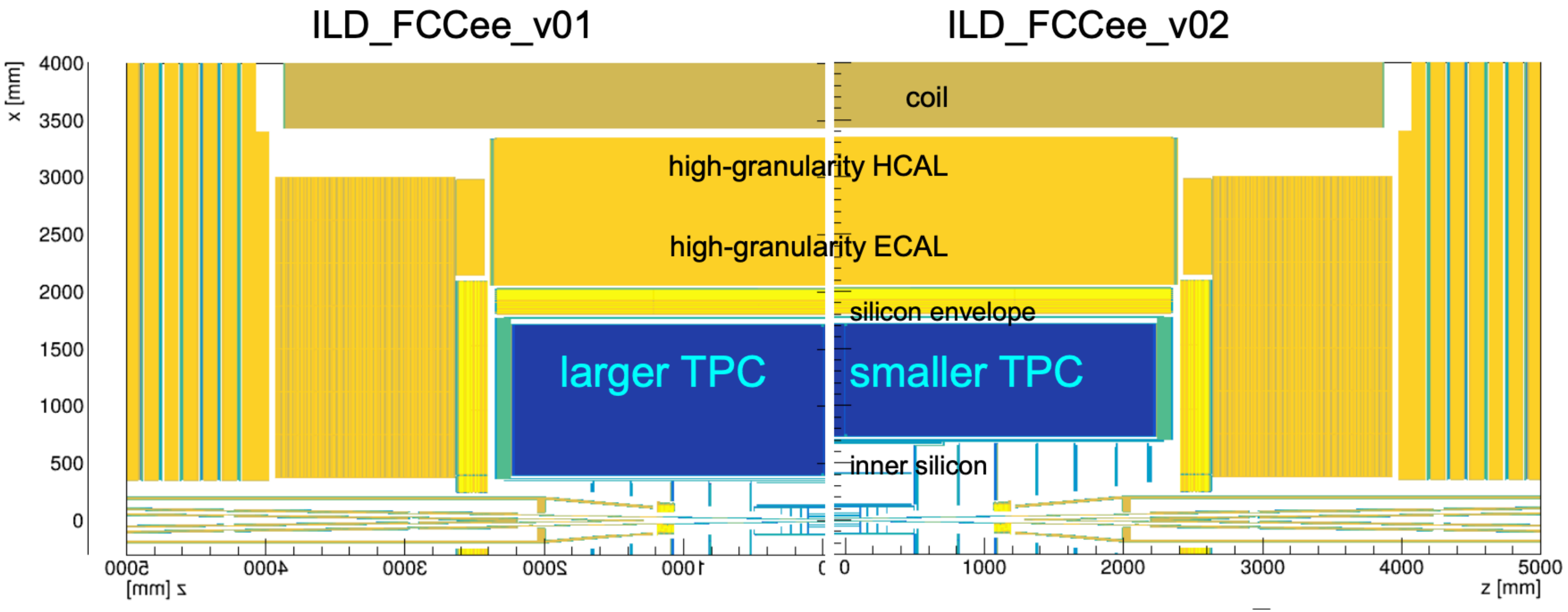




Detector concepts meeting https://indico.cern.ch/event/1664040/

ILD @ FCC

Two versions of ILD are still under consideration - mainly differ in the inner region
Final design choice can only be done once the backgrounds are understood



SLAC

ILD @ FCC https://indico.cern.ch/event/1664040/

TPC @ FCC → see Charlie's presentation

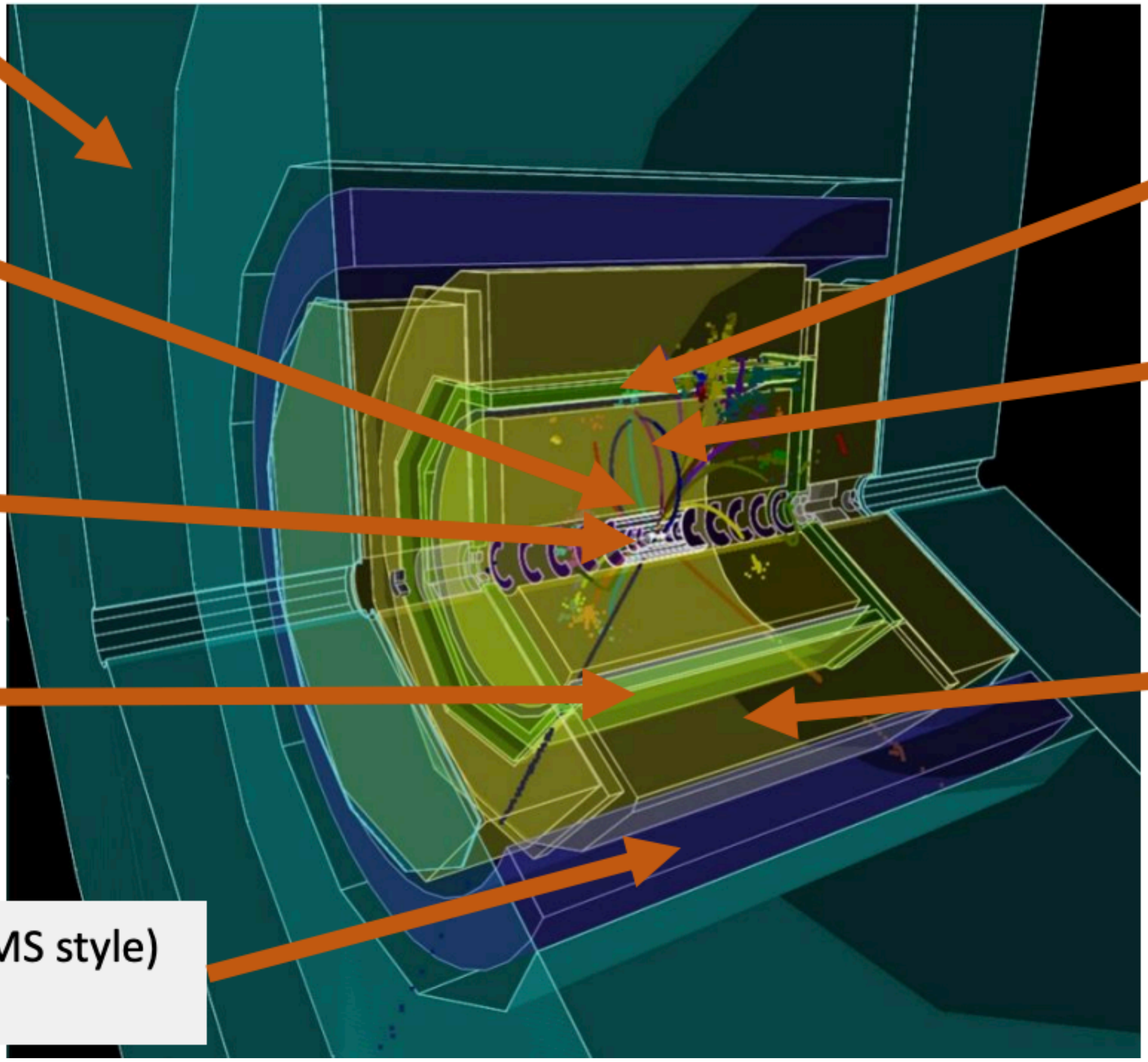
Muon tracking

Silicon inner tracker: Si strips, maybe pixel

Vertex: Silicon Pixel (MAPS?) low material, low power

Silicon outer layer/ timing layer

Superconducting Coil (CMS style) outside of HCAL



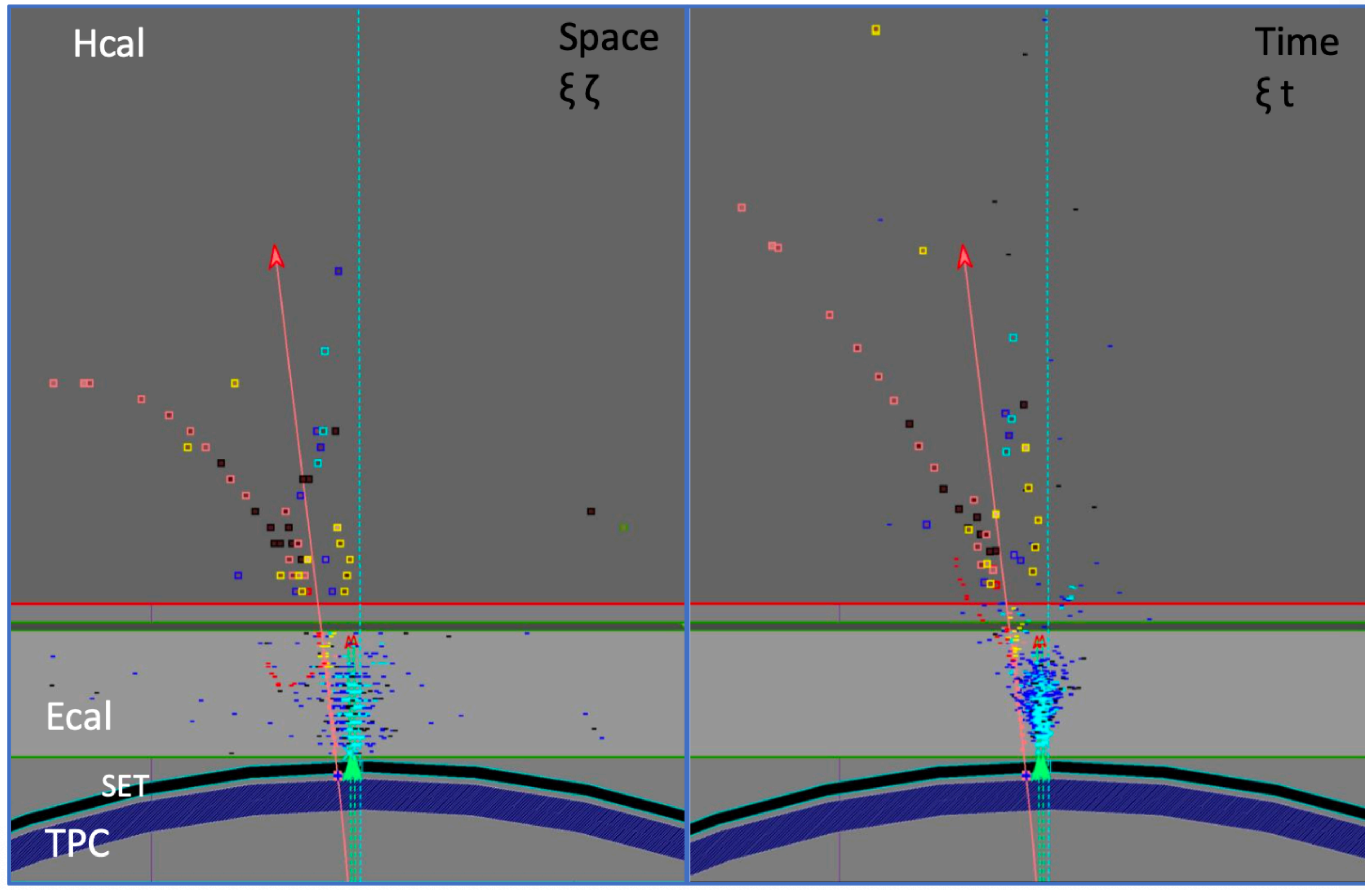
Si-W or Sc-W pixelated electromagnetic calorimeter

Large volume time projection chamber

Pixelated hadronic calorimeter Sc-SiPM analogue or gas-RPC semi-digital technology

4D calorimeter reconstruction https://indico.cern.ch/event/1664040/

- Treat the ILD calorimeter as 4D Minkowski space-time - add **~30 ps timing** to each cell so time and space are measured in commensurate units (~10 mm vs ~6 mm cells), enabling causality-based reconstruction.
- Each shower = a "start" cell (earliest hit) + its causal future ($\Delta t - \Delta d > \varepsilon$). Events are decomposed iteratively: find earliest start, collect domain, repeat on the complement.
- Photon efficiency at low energy: ~76% at 50 MeV, ~98.5% at 100 MeV, 100% at 250 MeV (≥2 hits, ≥2 layers); beam-synchronous timing makes fakes negligible.
  - Combining precise start-cell localization (~2 mm) with causality-constrained shower barycentres (~1.5 mm at 2 GeV) yields angular resolutions of order ~0.5 mrad, well below the ~10 mrad opening angle of a 10 GeV π^0.
    - Causality resolves a second photon start at ~18 mm distance with ~86% probability (20 ps timing).
- Strong gains with good timing → motivates detector redesign (sampling pitch matched to time precision, LGAD sensors). "Arbor-4D" extension of the arbor algorithm.



taking the ζ direction along the shower - a photon in this pic
ξ and η directions to form with ζ an orthonormal system