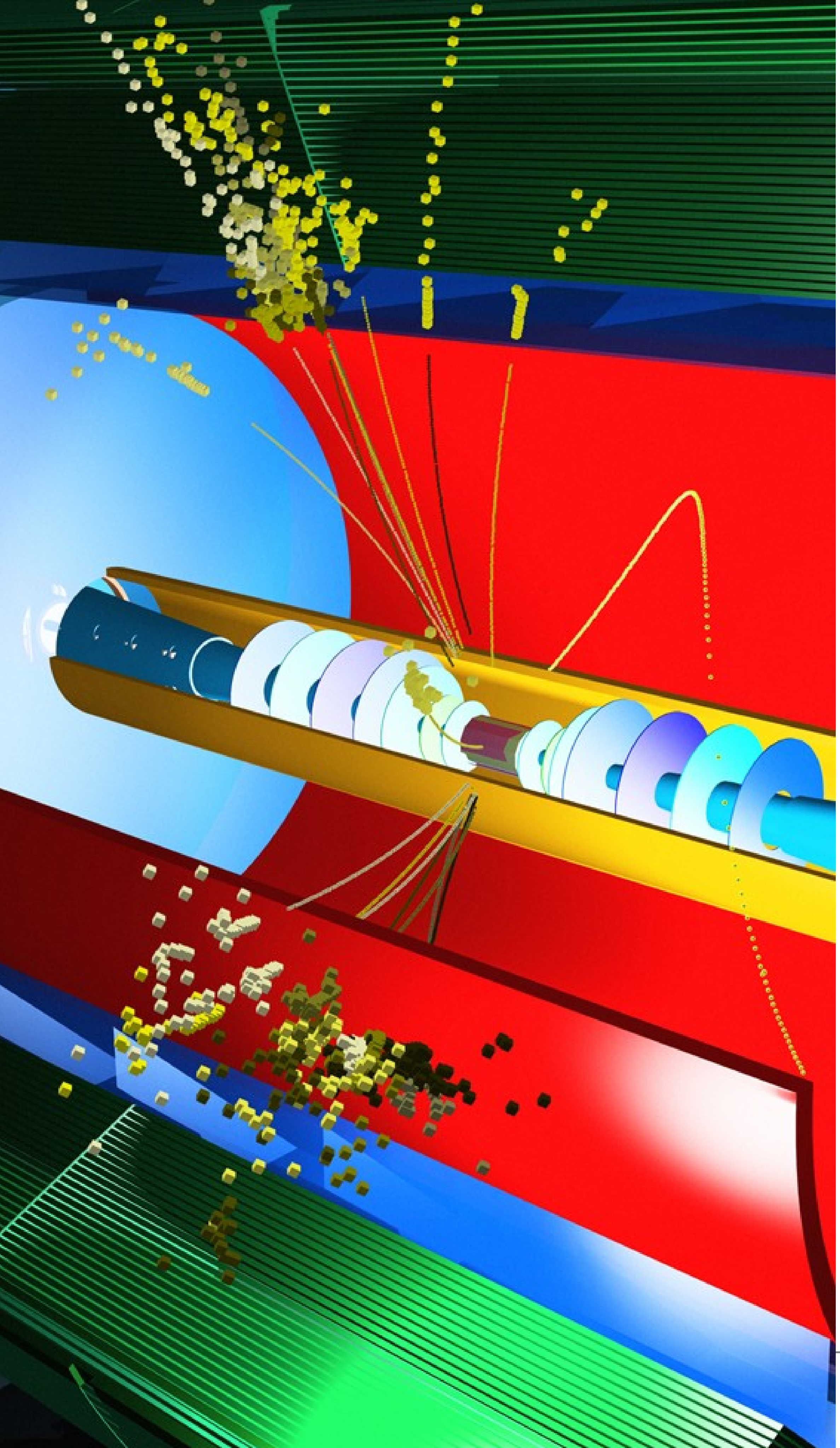
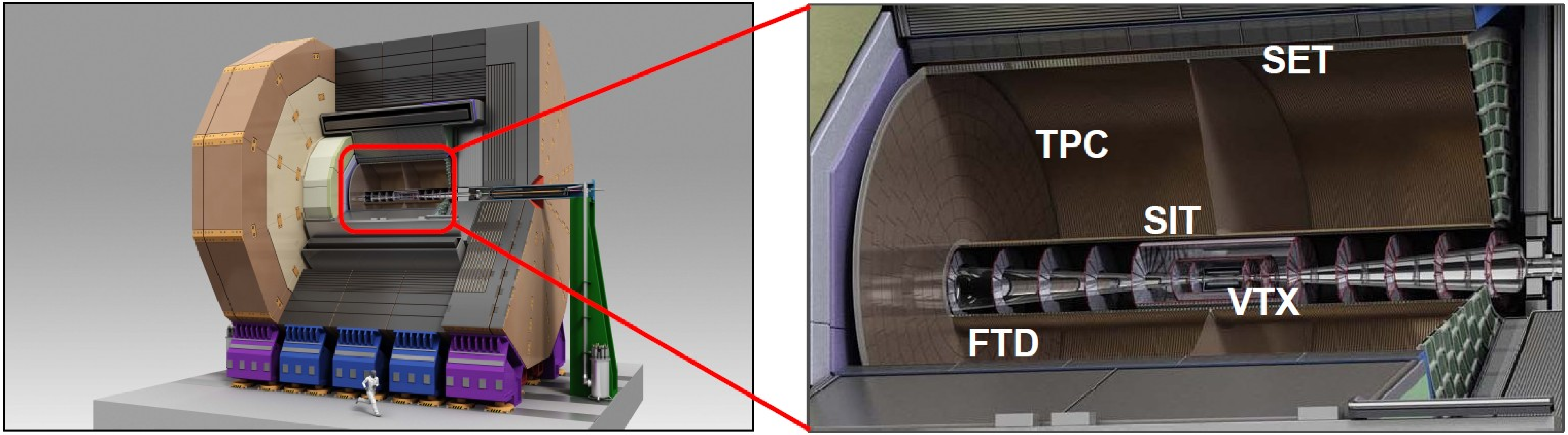


Detector R&D in the ILD Concept

Linear Collider Workshop 2021

Marcel Vos
IFIC (U. Valencia/CSIC), Spain
With inputs from many ILD colleagues

The ILD detector concept



Large high-field solenoid and yoke

Highly granular ECAL and HCAL optimized for particle flow

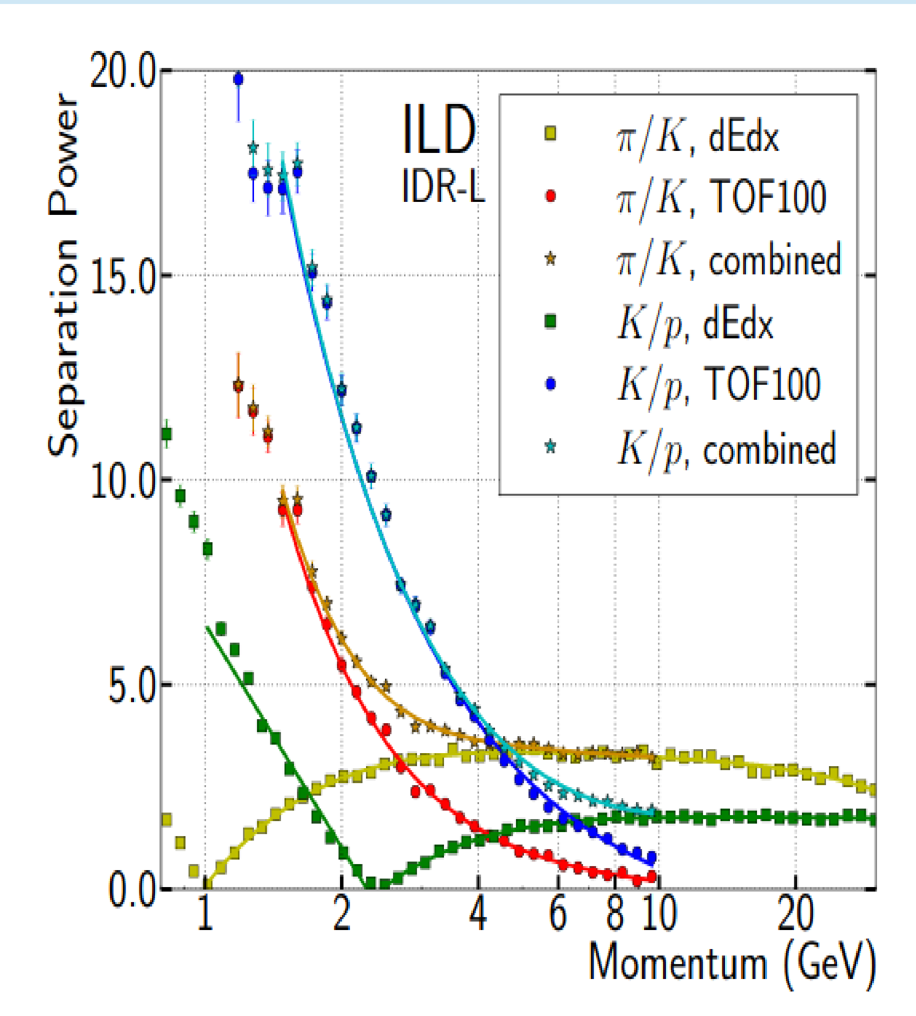
Time Projection Chamber as a transparent central tracker

Silicon envelope and inner tracker + vertex detector

Forward calorimetry system

ILD at the ILC, arXiv:1912.04601, Interim Design Report, arXiv:2003.01116

The ILD tracker: novel avenues in silicon



The added value of time information is recognized

- 4D tracking, cf. CMS and ATLAS timing detectors
- Time-of-Flight particle ID complements dE/dX at ILC

Relatively mature solution exists:

Low Gain Avalanche Detectors

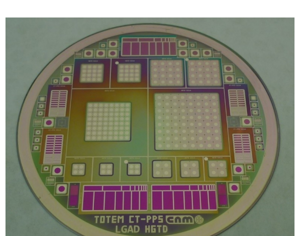
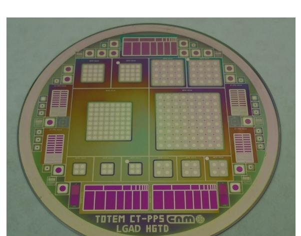
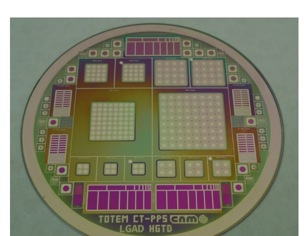
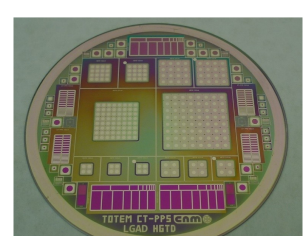
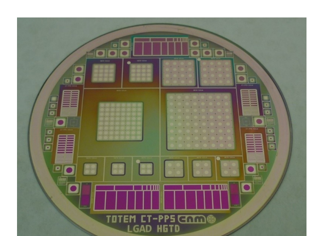
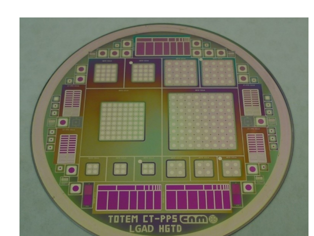
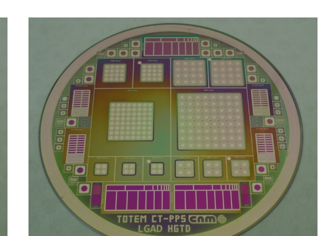
- time resolution of several 10s of ps
- reasonable spatial segmentation

Incipient effort in ILD, but, quite naturally, the key players are currently busy elsewhere

G. Pellegrini et al., NIMA 765 (2014),

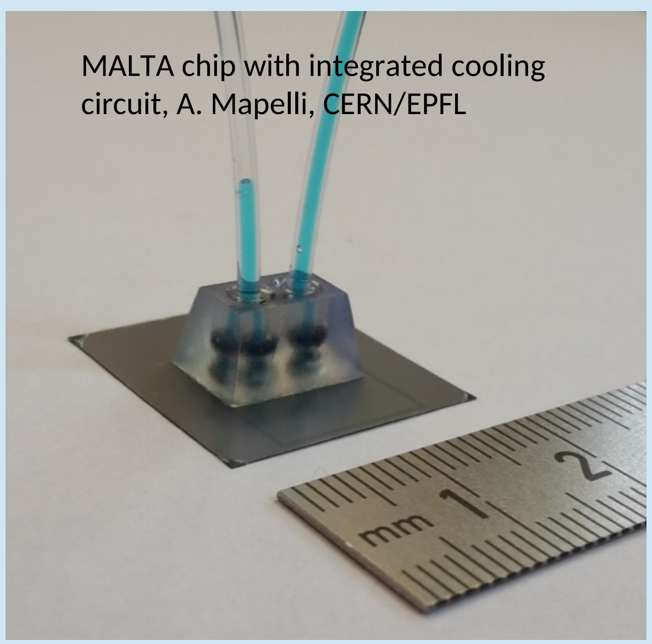
H. Sadrozinski et al., RPP 81 (2018)

See Schumm, Apresyan, Videau, Doblas, Cartiglia, Lastovicka,...

The ILD tracker: novel avenues in silicon

Depleted CMOS recognized as the next-generation technology for pixel sensors
- Long pioneered by the ILC community (esp. Strasbourg)
- Development fueled by STAR, ALICE, (ATLAS), CBM, RD50...
- Alternatives remain viable for niche applications like the VXD; CMOS can scale to O(1m^2), O(10m^2), O(100m^2)….



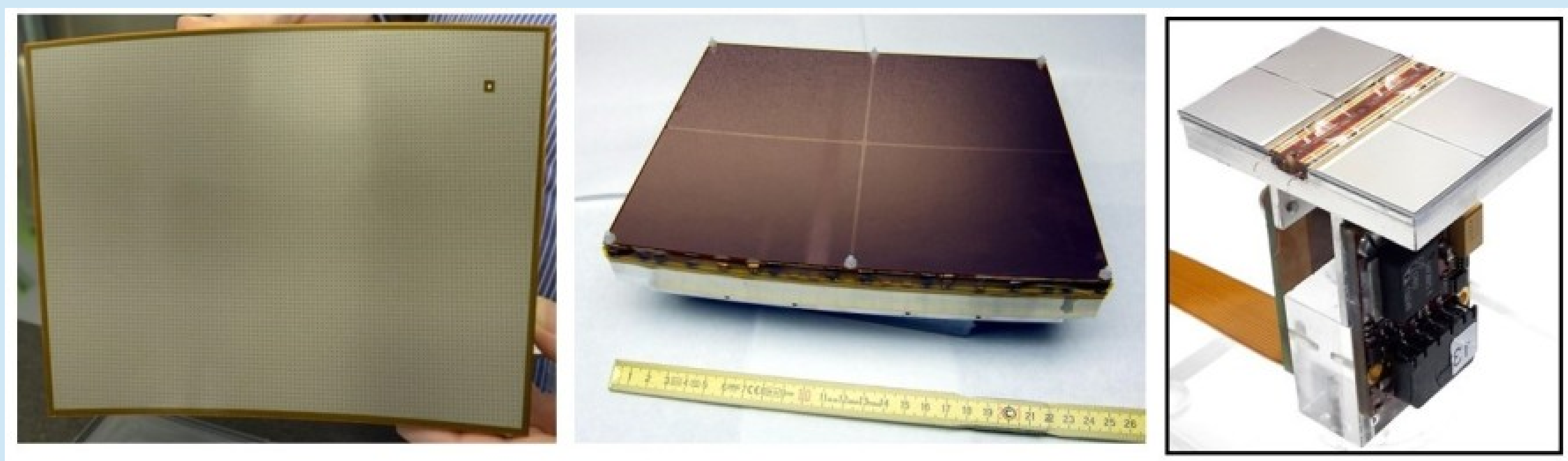
Key area for R&D: integration Silicon processing can yield large-area integrated all-silicon ladders (power/signal lines, support, even cooling channels)

See A. Besson, M. Mager, S. Mägdefessel

The ILD tracker: gaseous tracking

Time Projection Chamber

- A central tracker made out of thin air!
- Pixelated end-plate scaling up from stamp-sized prototypes to ~100 cm²
- Tracking and dE/dX performance of different read-out options are ~ clear



Key area for R&D: stability of operation and ion gating

Calorimetry

ILD calorimeter system:

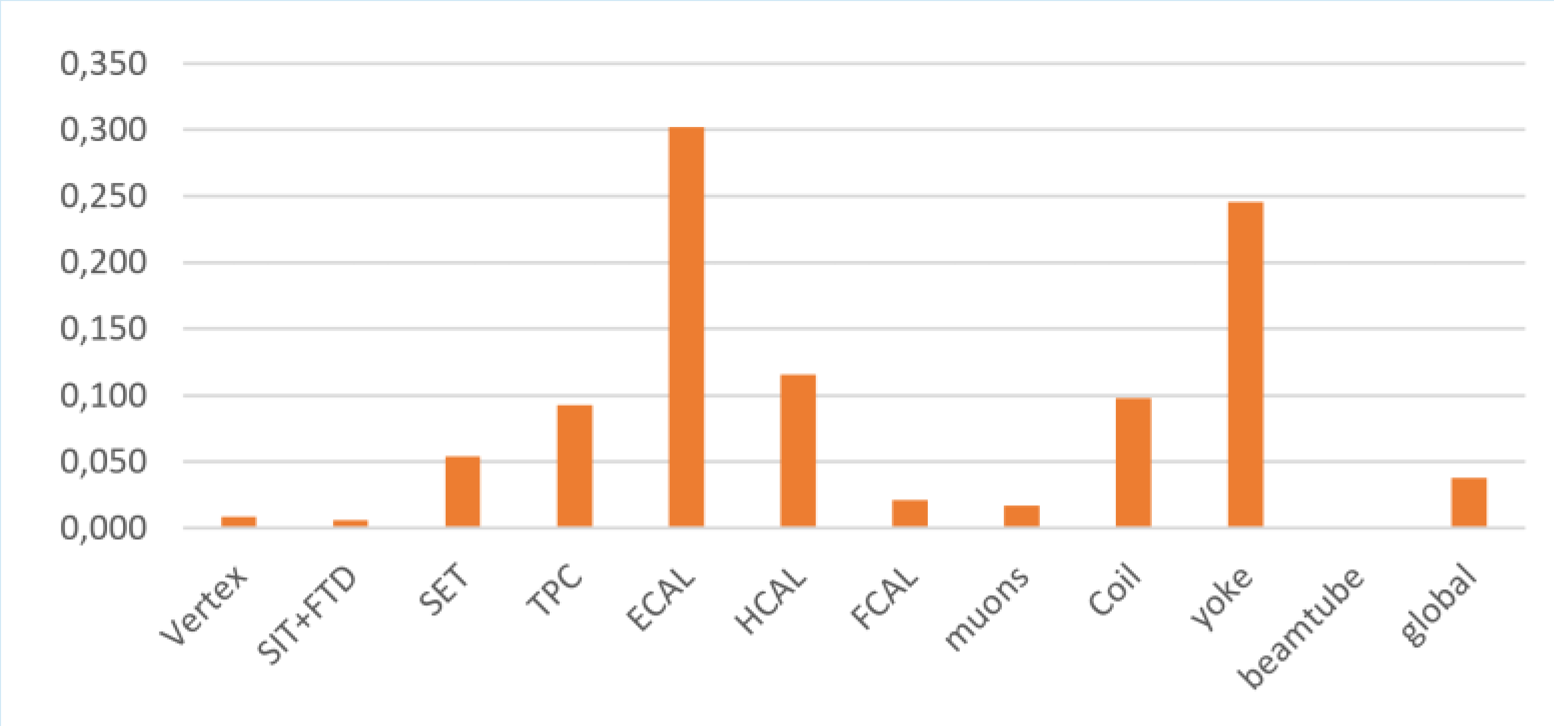
- CALICE has developed multiple highly granular solutions for ECAL & HCAL
- Highly granular calorimeter concept adopted by LHC experiments
  → adding funding & validation of large scale production
- Keep the stack compact and uniform (thin PCBs, minimal dead material)
- CMOS pixels may be a cost-effective alternative, see F. Pliquett, F. Wilson

Key challenge for ILD calorimeters is the sheer scale, channel count and cost

- Cost reduction R&D
- Ensure multiple vendors
- Automatization
- Industrialization

And only as a last resort:

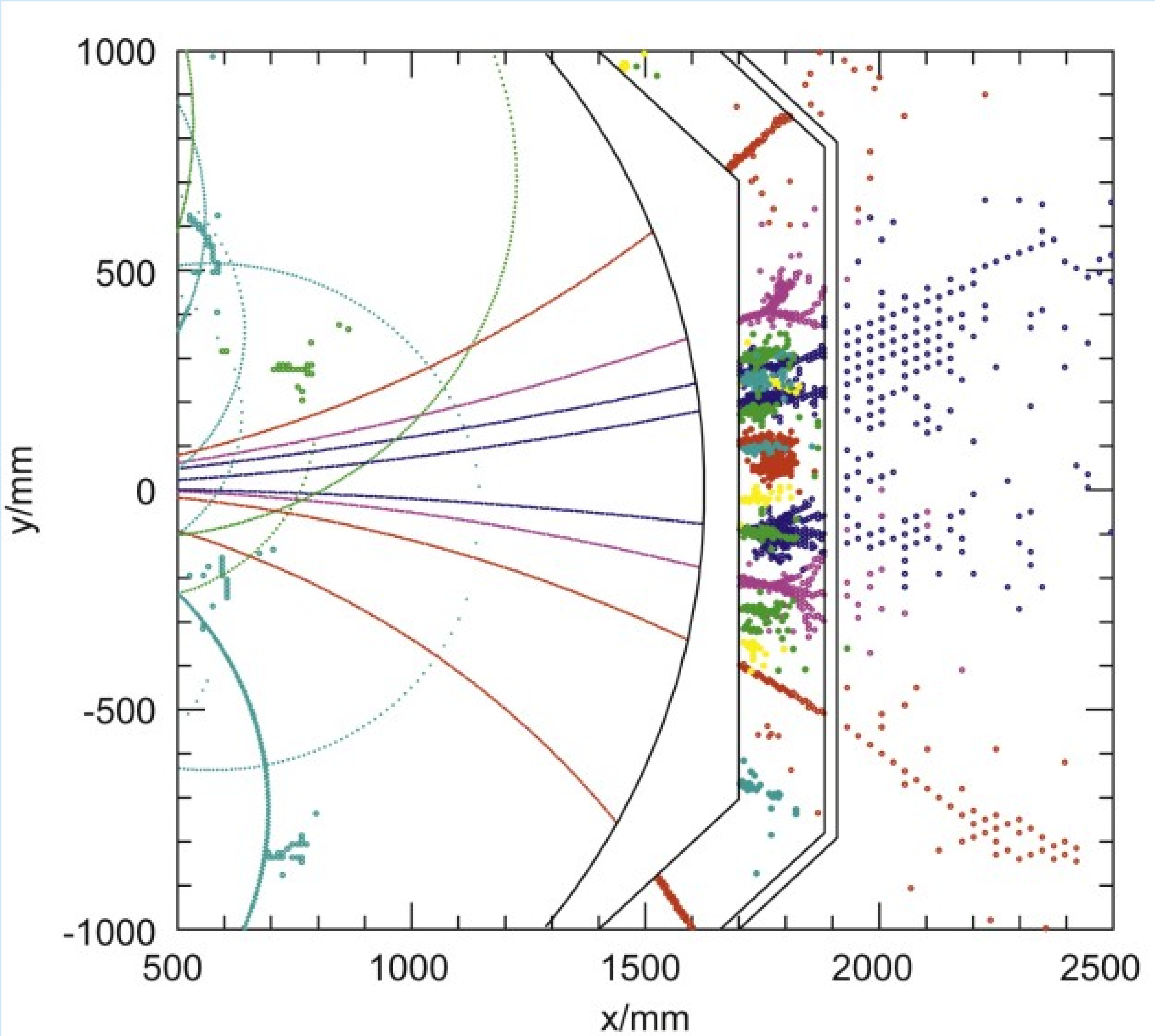
- negotiate size & granularity



Calibration & understanding

Key area for R&D: calibration & understanding of the detector system

- Particle-flow philosophy works best if all elements are carefully integrated and optimized to yield the best performance "as a team"
- Reconstruction software and Monte Carlo models are integral parts of the detector *(local compensation, hadronic shower models in GEANT4, advanced pat.rec./PFA)*
- Design for "understanding": a uniform and understood response may ultimately be a more important figure of merit for many measurements than the ultimate resolution



arXiv:1507.05893