CMOS IN ILC AND CLIC

Joel Goldstein

UK CMOS Meeting

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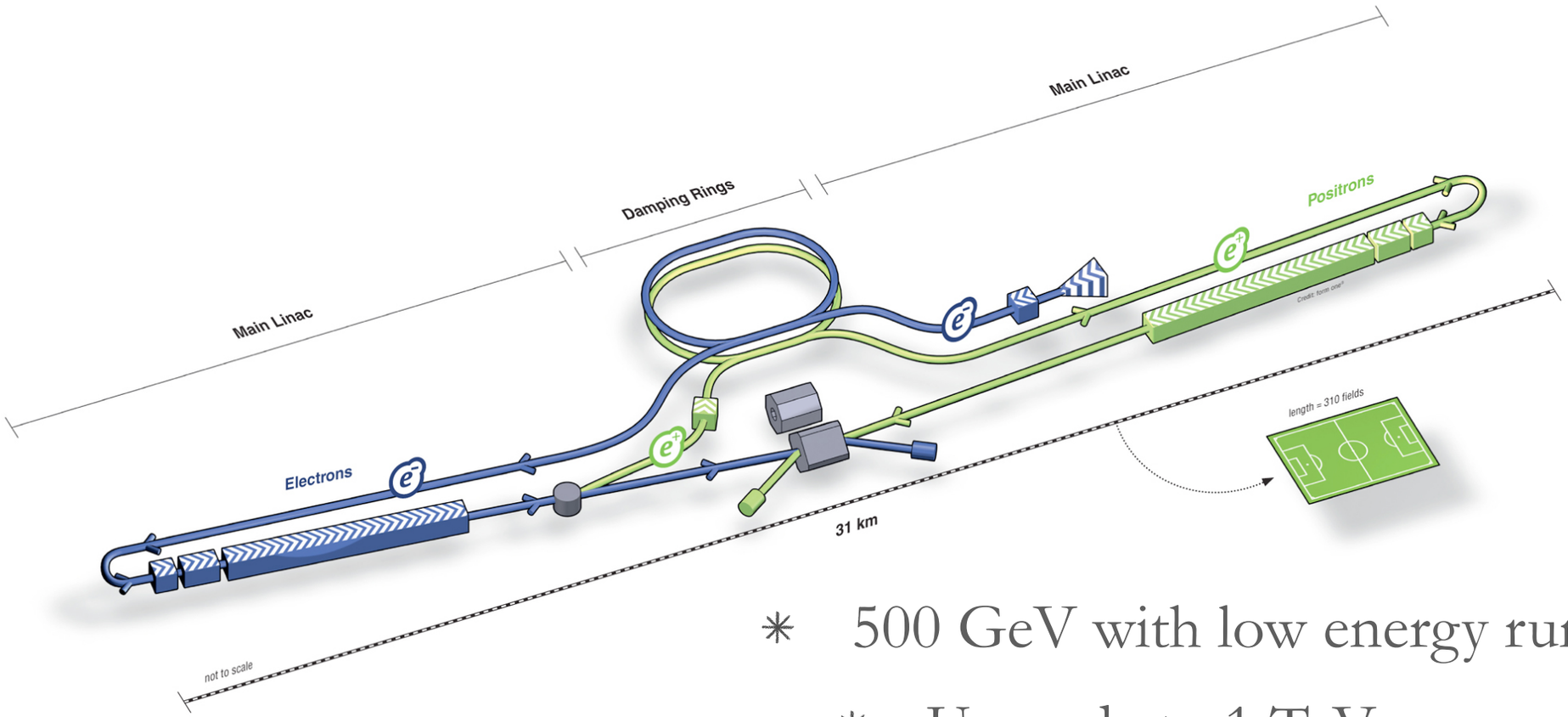
Overview

* Electron-positron colliders with L ≳ 10^{34} $cm^{-2}s^{-1}$:
  * ILC & CLIC
  * Circular - TLEP/FCC, China
* Clean and low-radiation compared to LHC
* Precision Higgs, top and BSM physics
  * Demanding physics requirements
  * Very low mass
  * Minimise sensor, mechanical and cooling material

The ILC



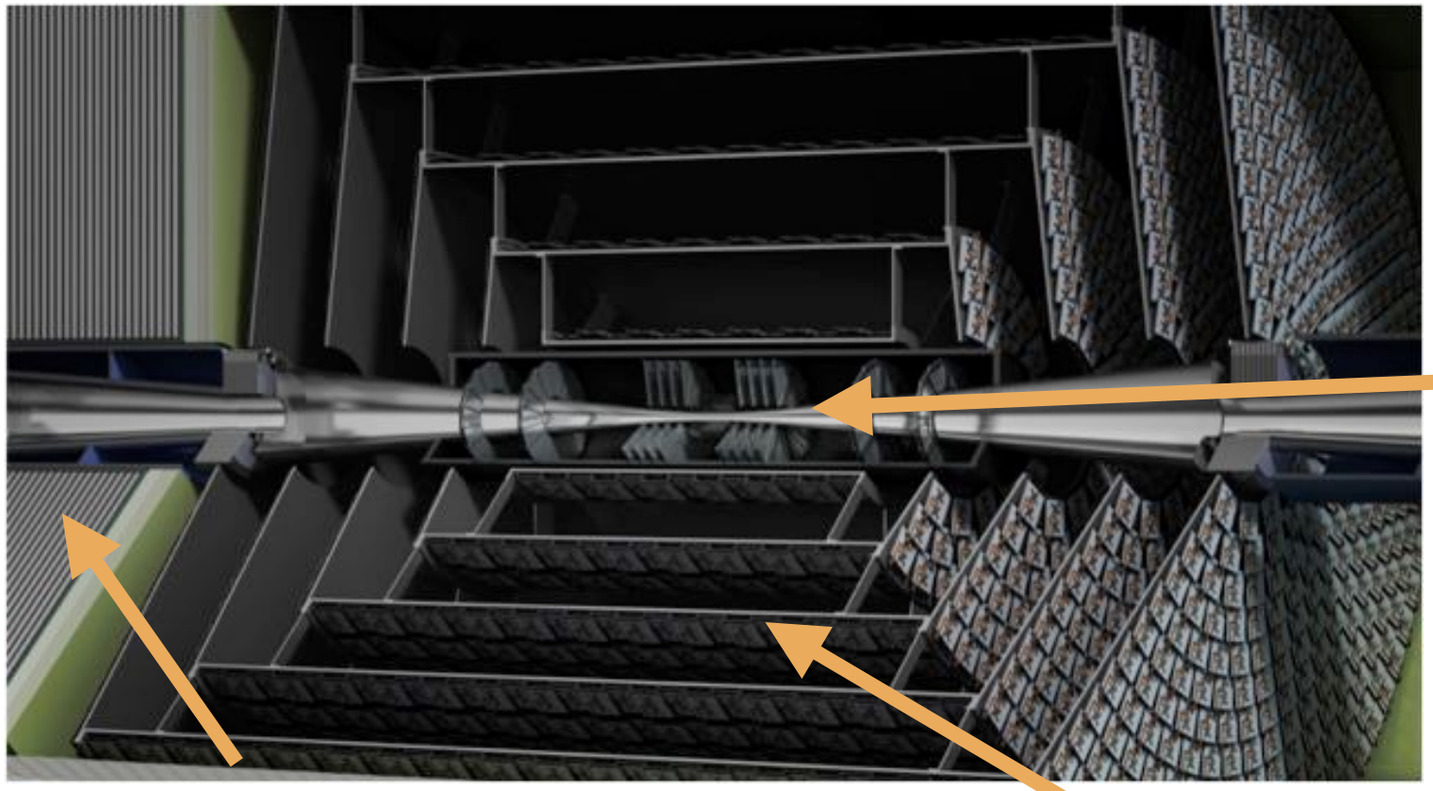
ILC Scheme | © www.form-one.de

* 500 GeV with low energy running
  * Upgrade to 1 TeV
* Two detectors (ILD & SiD) in push-pull
* Beam structure:
  * 1312 bunches with 554 ns spacing
  * 5 Hz repetition

CLIC

* High accelerating gradient achieved using drive beam
* 350 GeV to 3 TeV
* Beam structure:
  * 312 bunches with 0.5 ns spacing
  * 50 Hz repetition

Technology

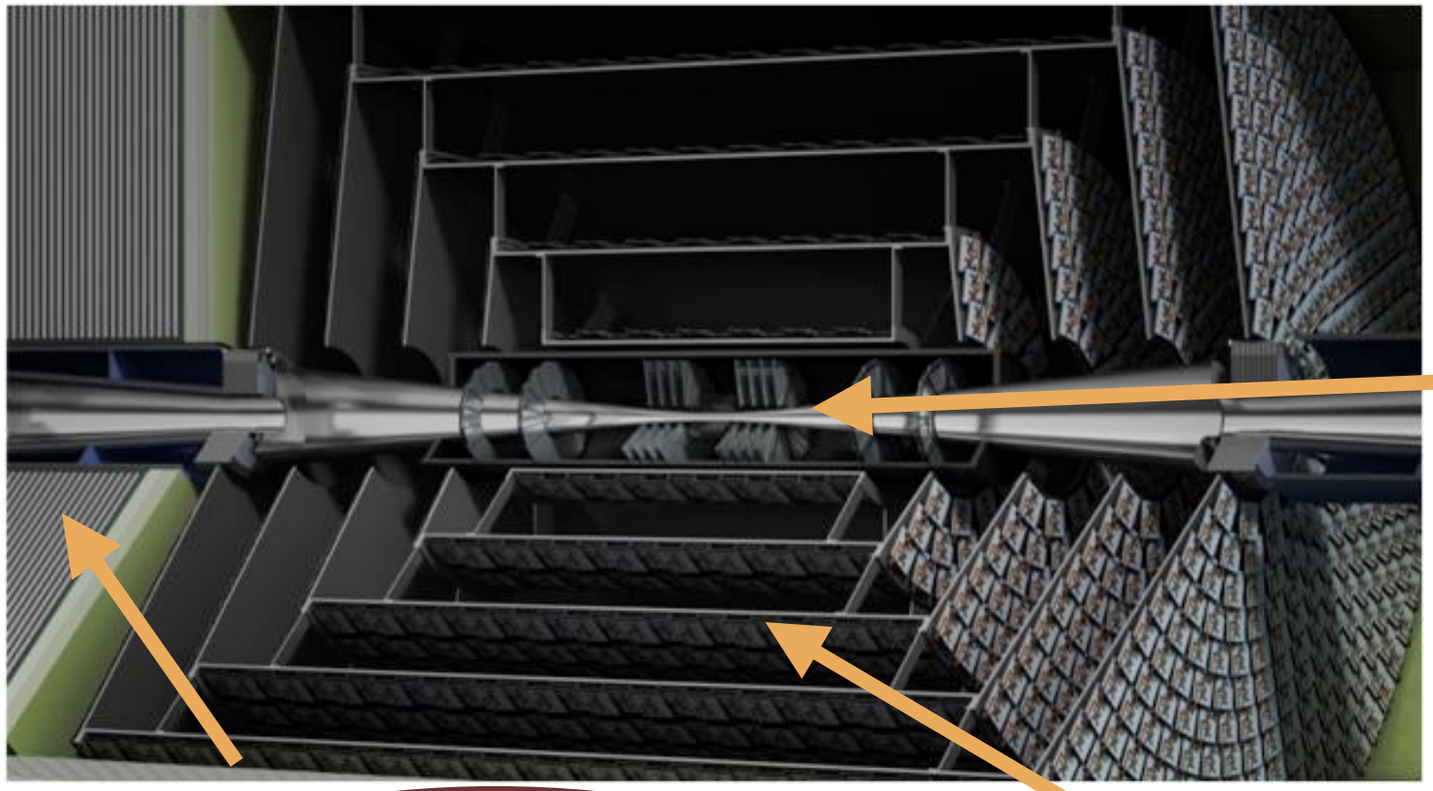


* **Vertex pixel detector**
  * Likely to be CMOS

* **EM Calorimeter**
  * Tungsten absorber
  * Analogue silicon pads

* **Tracker**
  * Silicon strips in SiD, CLIC
  * TPC (with silicon strips) in ILD

Technology



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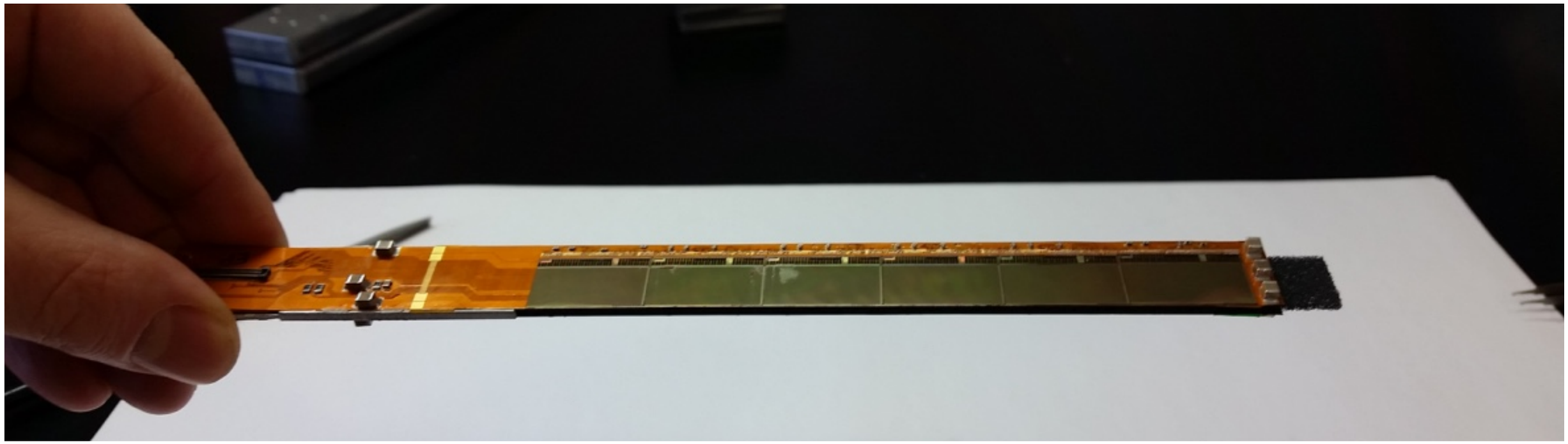
CMOS?

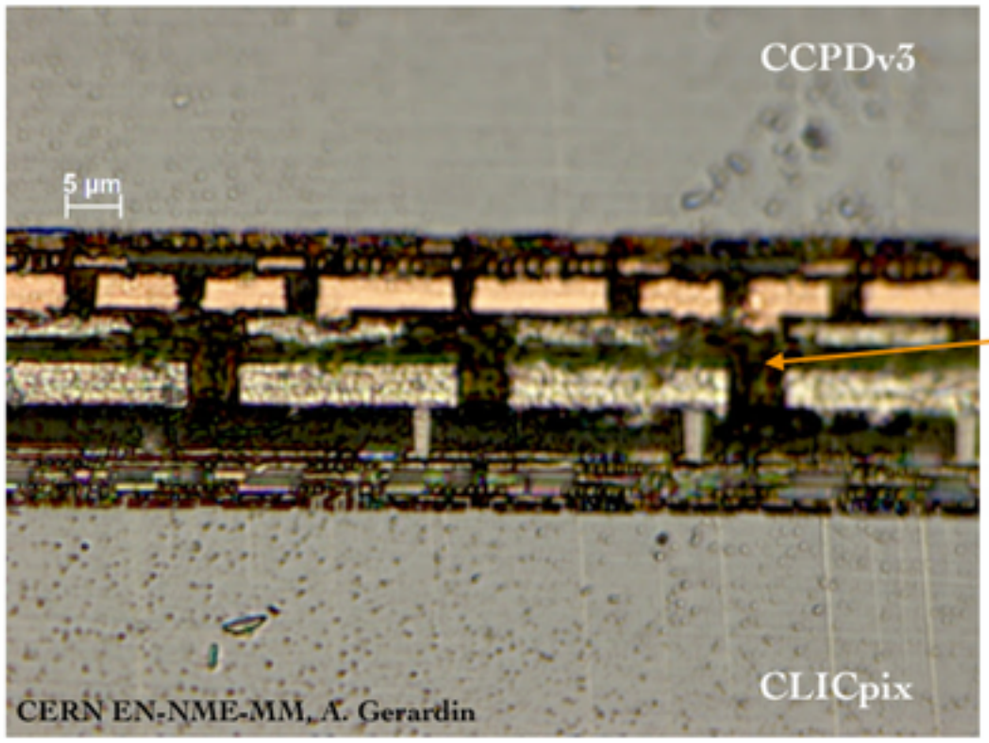
ILC Vertex

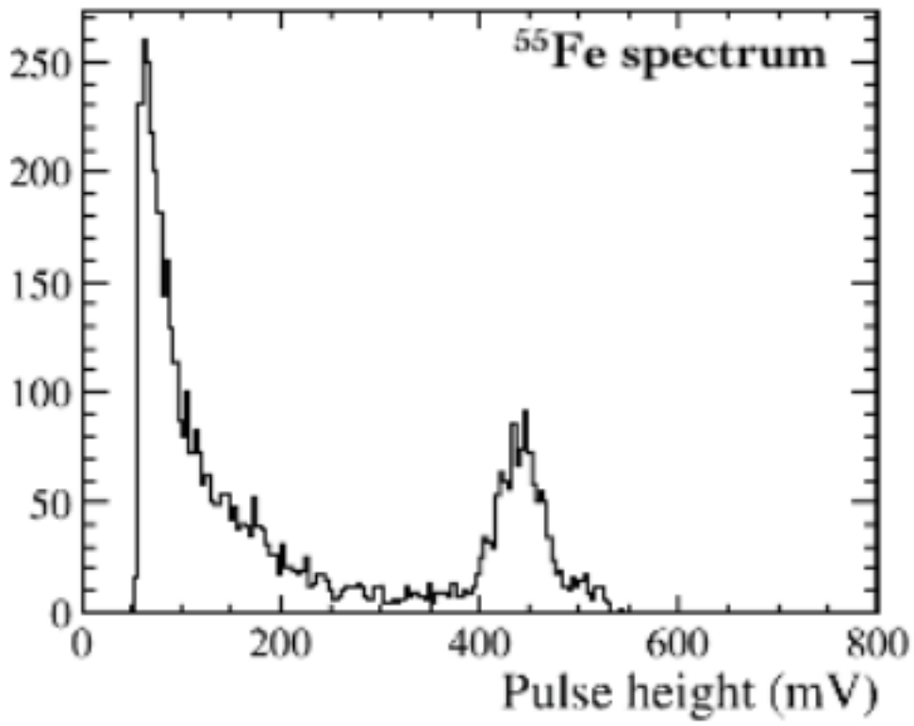
- Monolithic CMOS e.g.
  - Chronopixel (*Oregon/Yale*)
  - Mimosa (*Strasbourg*)



CLICpix

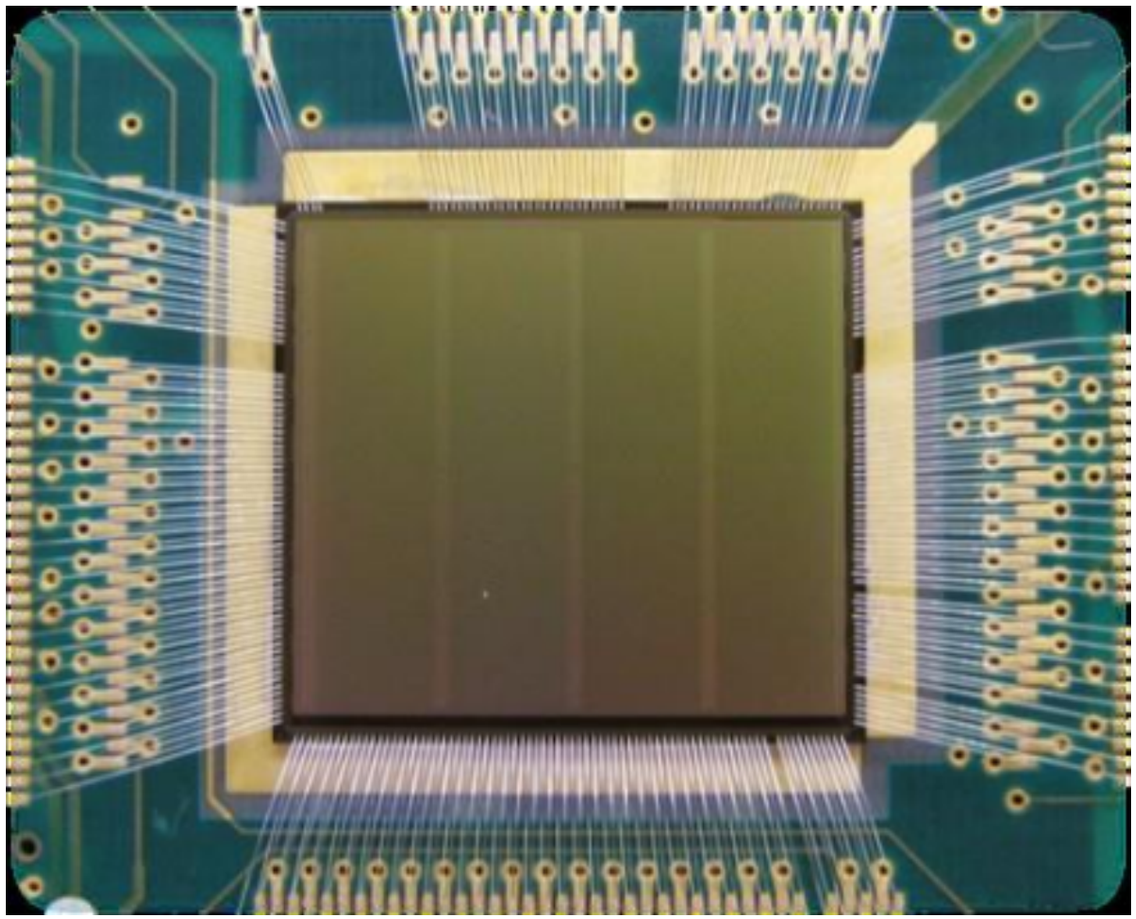
- Development of Timepix family
- Bunch stamping (5 ns)
  - Hybrid sensor/ASIC
  - Tested with capacitive coupling





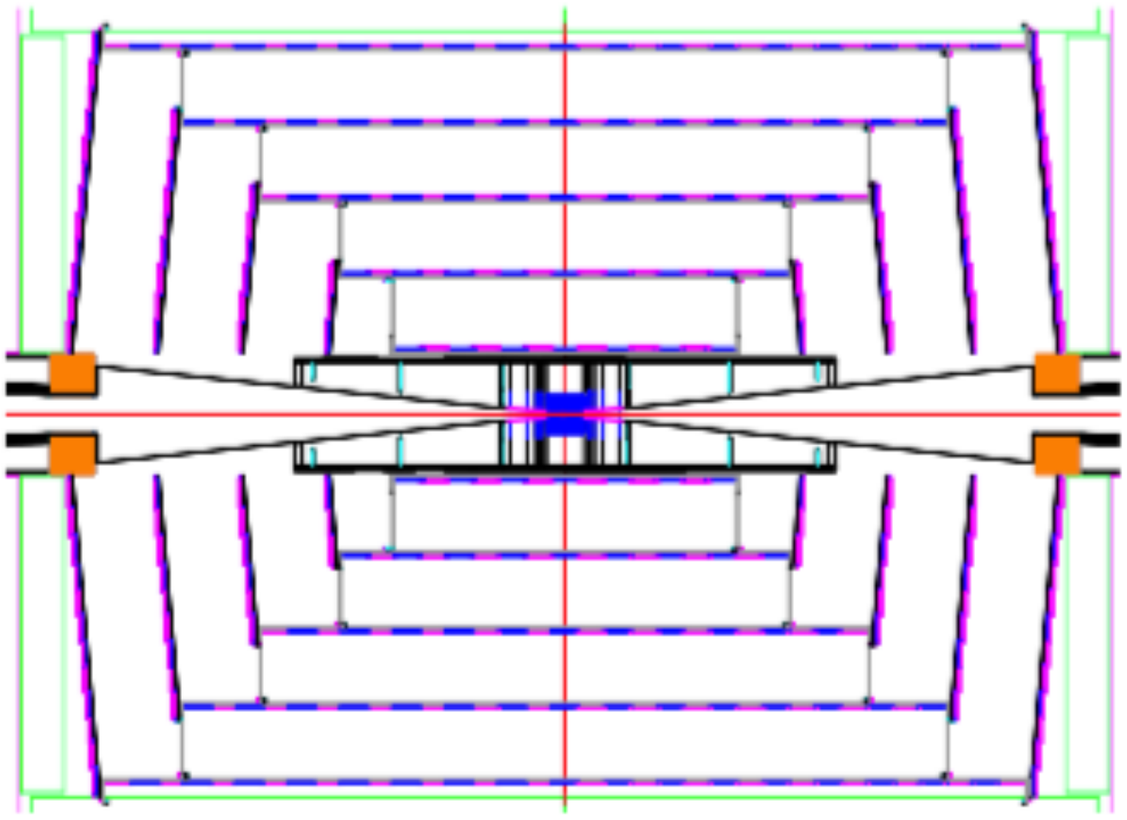
ECAL

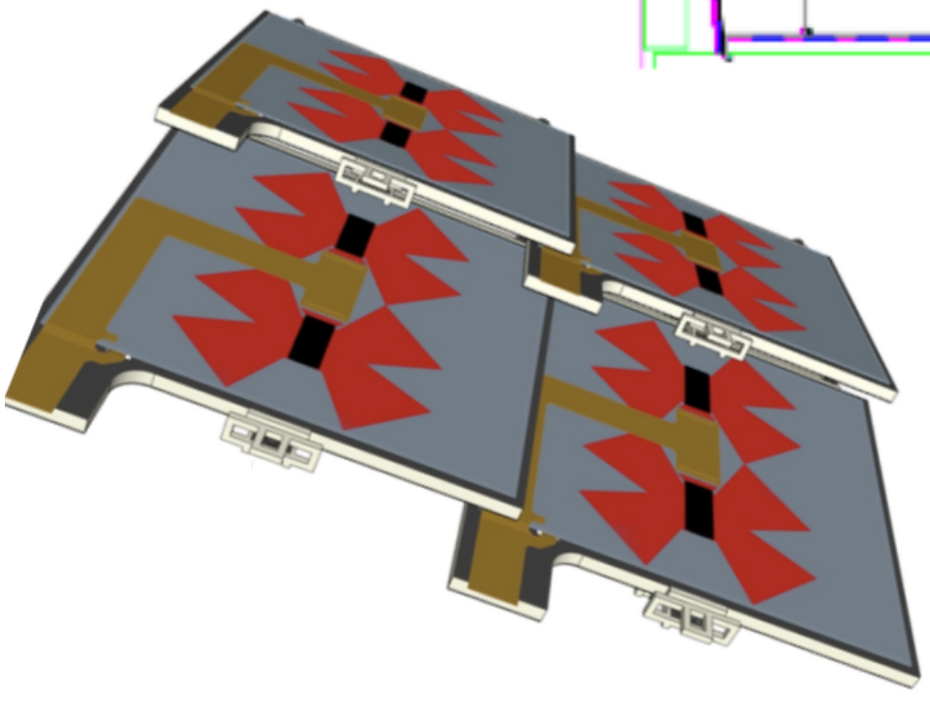
- Analogue pads → CMOS pixels with digital readout
  - Directly count particles
  - "Tracking" calorimeter
- TPAC series of chips (*UK*)
  - Digital logic in pixel
  - Deep p-well



Strip Tracker

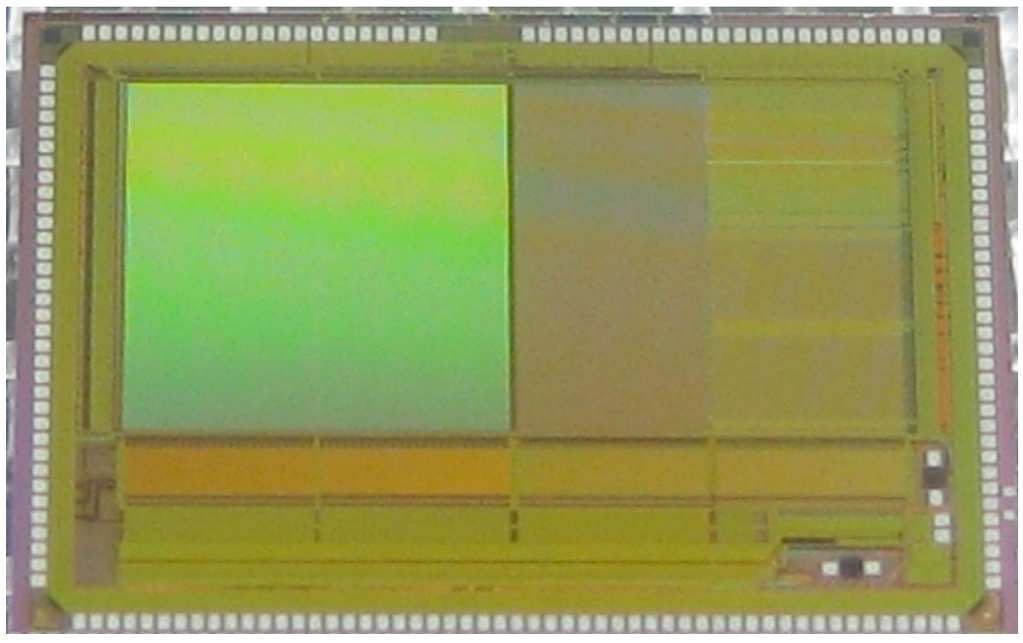
- SiD and CLIC very similar
  - 25μm strips
  - Readout each bunch at ILC
  - Approx 5 layers

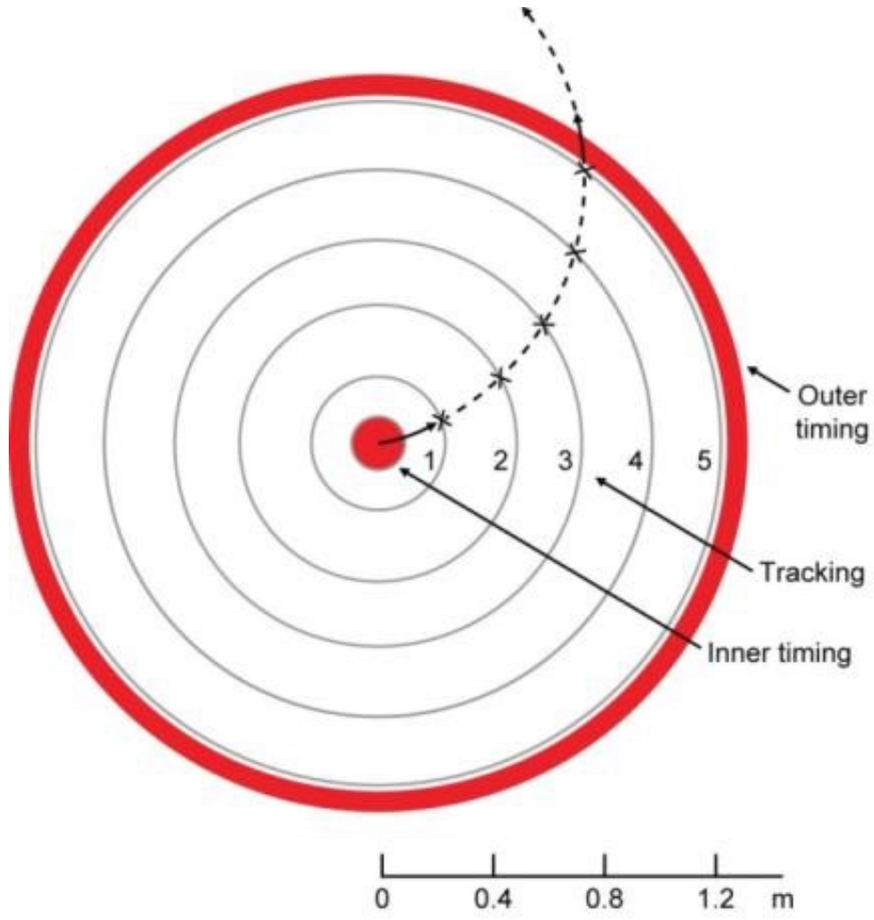




Pixel Tracking

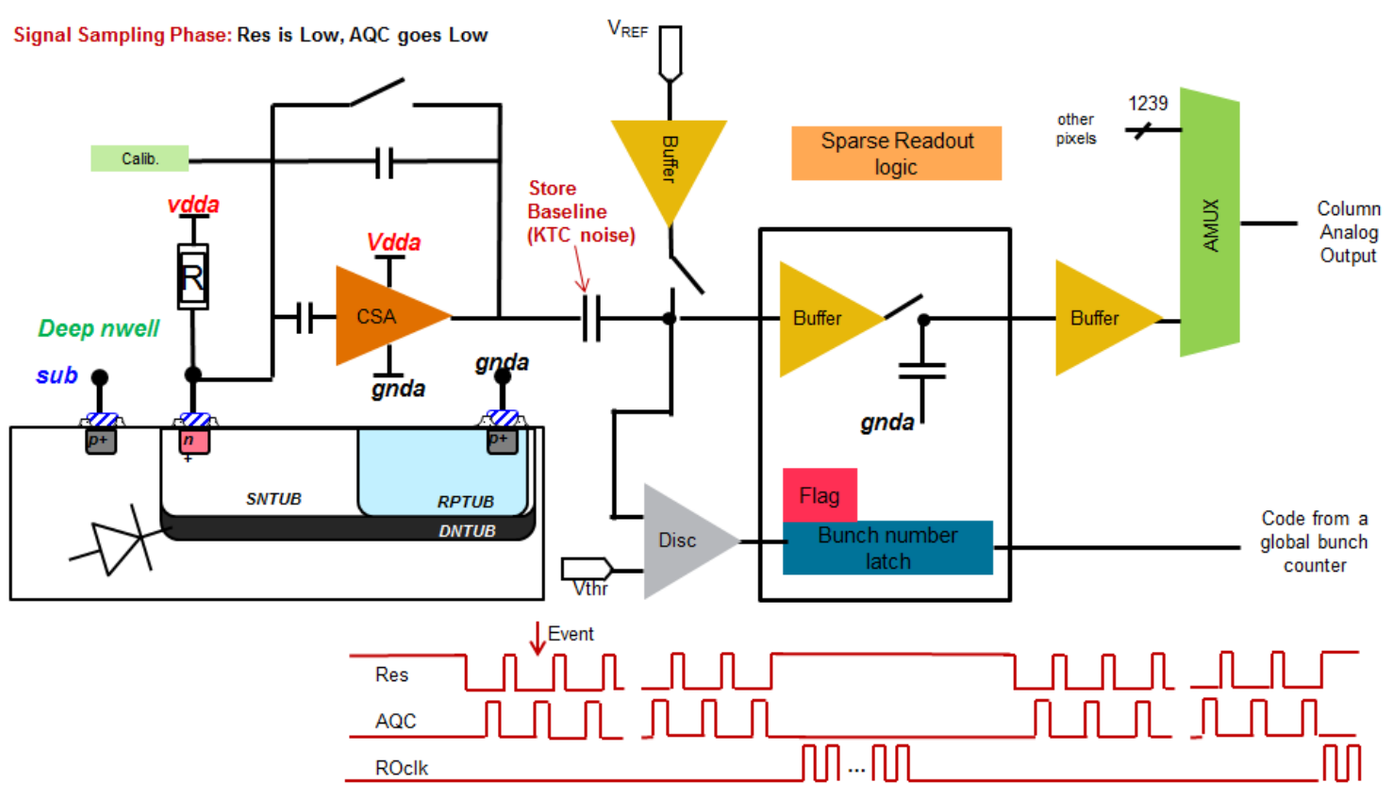
* Obvious attraction of CMOS pixels
* Cherwell included tracking features
* SPT Concept study
* ...



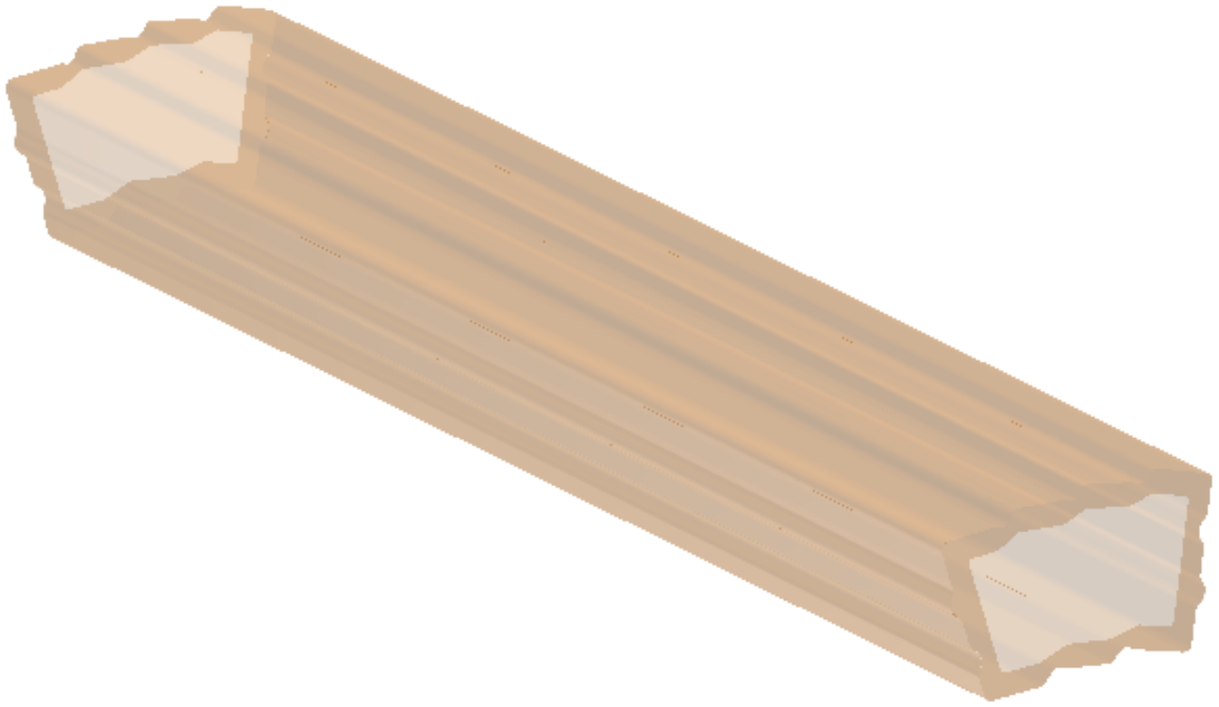


Tracking Sensors

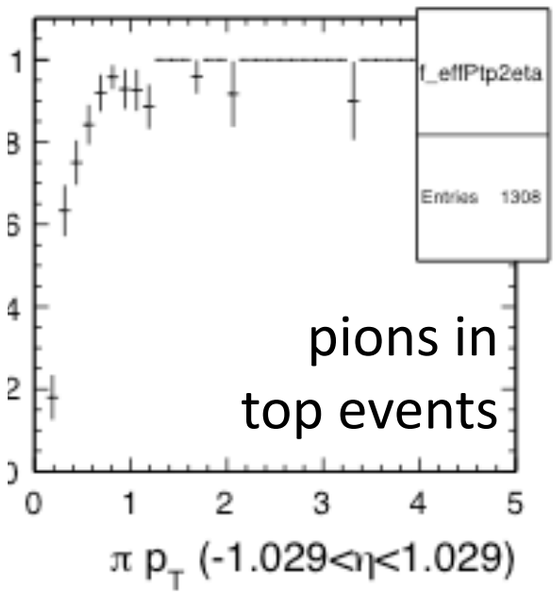
- Interest and effort in CMOS increasing
- Technology development largely piggy-backing
  - HL-LHC, vertex detector, space science etc.
- SLAC developing dedicated KPIX-M chip



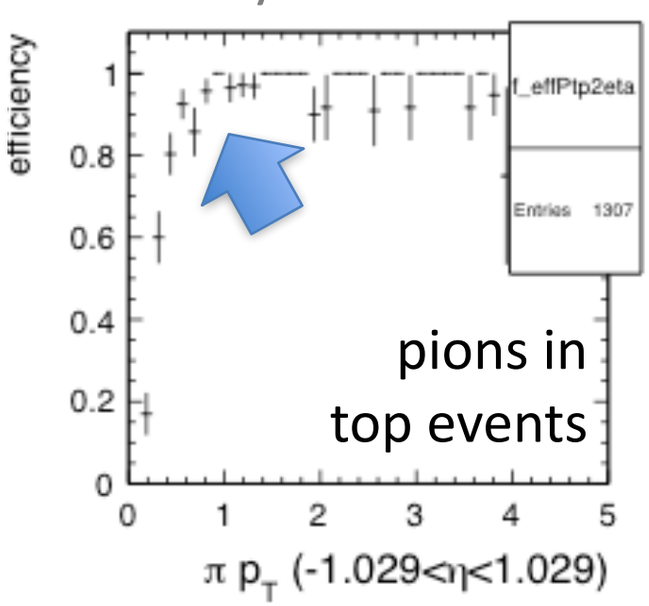
Tracking Studies



original layout



high granularity
layers 3 & 5



- UK (ILC) and CERN (CLIC) looking at mechanics/systems
- Spatial and temporal resolution require detailed study
  - **Need results to define sensor and layout parameters**

Summary

- CMOS will play major role in ILC/CLIC experiments
  - Strong contender for vertex detector
  - Possibility of tracking calorimeter
- Increasing interest in all-CMOS tracker
  - Little dedicated sensor design
  - Studies needed to define parameters