SiLC sensors for the LP-TPC

Thomas Bergauer
Institute for High Energy Physics (HEPHY)
Austrian Academy of Sciences, Vienna

for the SiLC Collaboration

EUDET Annual Meeting 8. October 2007

Outline

- Design Considerations
  - Timescale
  - Requirements
- Current Status of
  - Sensors
  - Hybrids (& Readout electronics)
  - Pitch Adapter
  - Modules/Frames
  - Support
- Future design
- Open Questions

Design Considerations: Timescale

- Cosmic Tests (Jan until Aug 08)
  - With Hardware available in January 2008
  - Mostly CMS front-end and readout electronics
  - Only small readout area
  - Very low myon rate expected

- Beam test starting September 2008
  - New readout chip (LPNHE Paris) forseen
  - CMS Readout system as backup

Design Considerations: Resolution Requirements

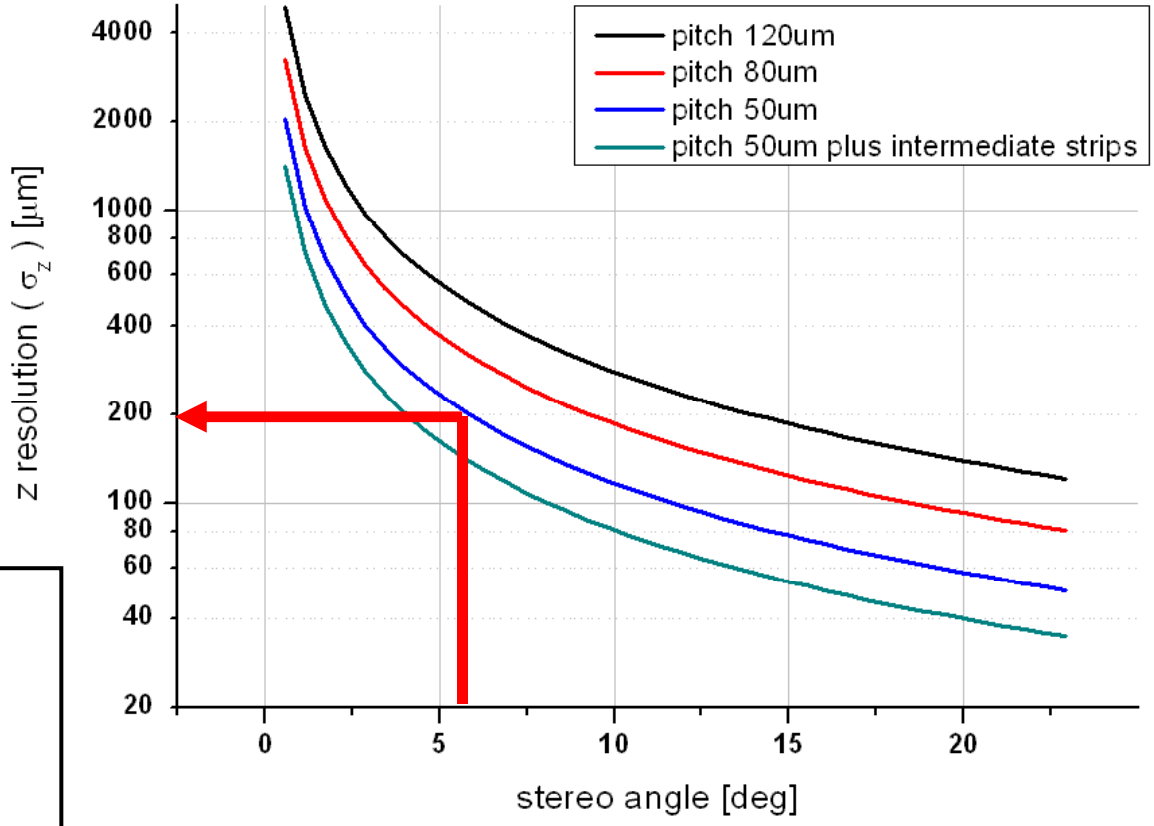
r-Phi resolution:

pitch [um]	resolution sigma [um]
120	35
80	23
50	14
50*	10

* with intermediate strips

Solution:
2 quadratic sensors perpendicular to each other

z resolution vs. stereo angle

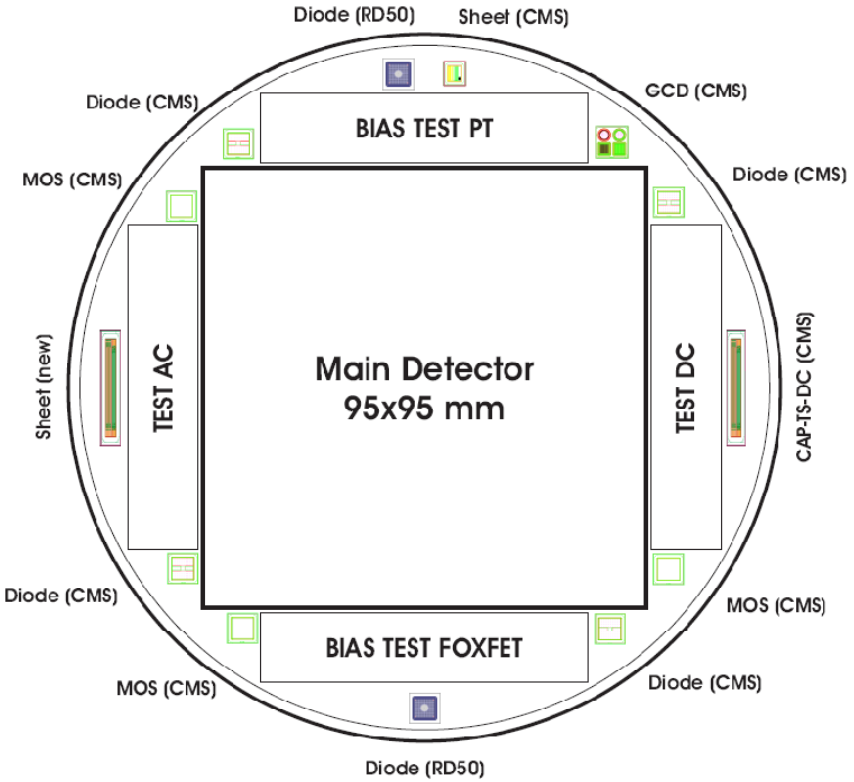


CMS: angle 6 deg already a lot!
σz<100 um hard to archive

Status of Sensors

- Single-sided AC coupled SSD
- **Sensor size:** 91,5 x 91,5 mm² (± 0,04 mm)
- **Wafer thickness**: approx. 320 µm
- **Resistivity**: such that depletion voltage: 50 V < Vdepl < 100 Volt
- **Leakage current**: < 10 µA per sensor
- **Biasing scheme**: poly-Silicon Resistor with 20 MΩ (± 5 MΩ)
- **Number of strips:** 1792 (= 14 x 128)
- **Strip pitch:** 50 um pitch, without intermediate strips
- **Strip width:** 12.5 um
- **Dielectric Structure:** Oxide (SiO_2) + Nitride (Si_3N_4) between p+ and aluminium strips.
- 2 **bond pads** on each side of the strip
  1 **probe pad** on each side of the strip (contact to p+)

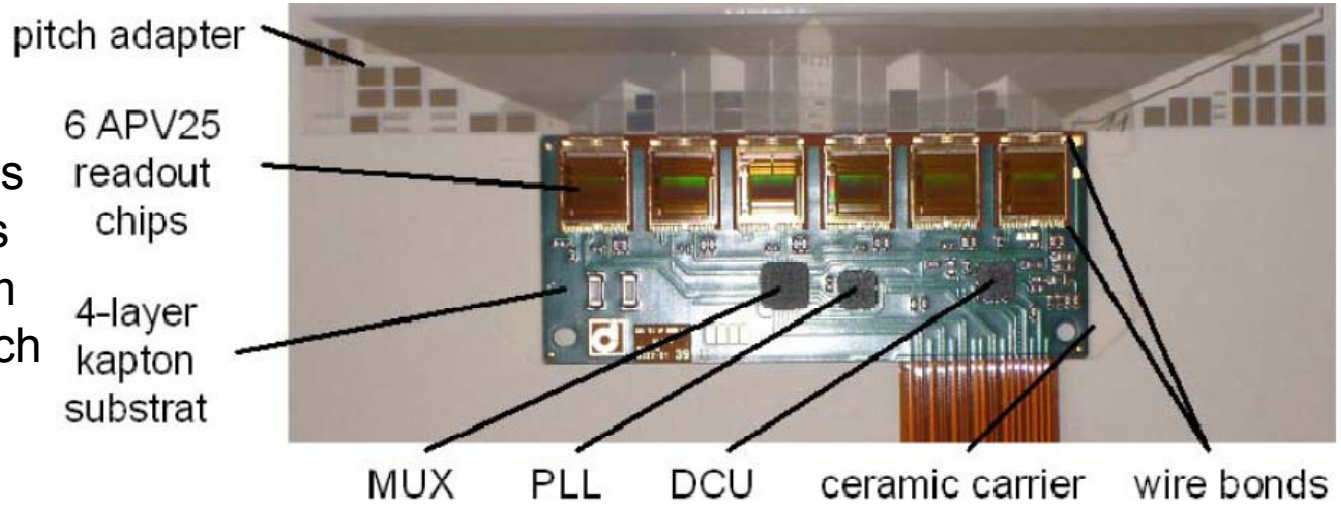
- We ordered 35 HPK Sensors
  - 6 will needed for this setup
- Have been delivered last week



Status of Hybrids & FE electronics

CMS Ring 2 Hybrid:

- 6 APVs = 768 channels
- pitch adapter connects the APV pitch of 44 μm with the R2-sensor pitch of 143 μm



Intermediate Pitch Adapter:

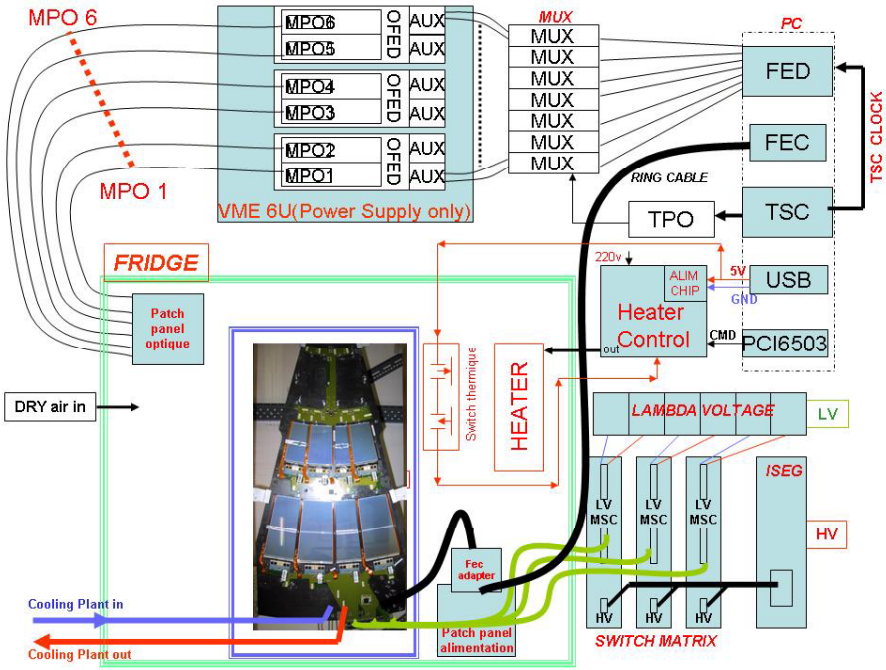
Connects a pitch of 143 μm (CMS R2 PA) with a pitch of 50 μm (new HPK sensor)

- Possible Producers for this pitch adapter:
  - ILFA (Germany) - 2 layer copper on PCB
  - CERN – 2 layer copper on Kapton foil
  - Reinhardt Microtech (Switzerland) – aluminium on glass PA
  - HIP (Finland)

Status of FE electronics

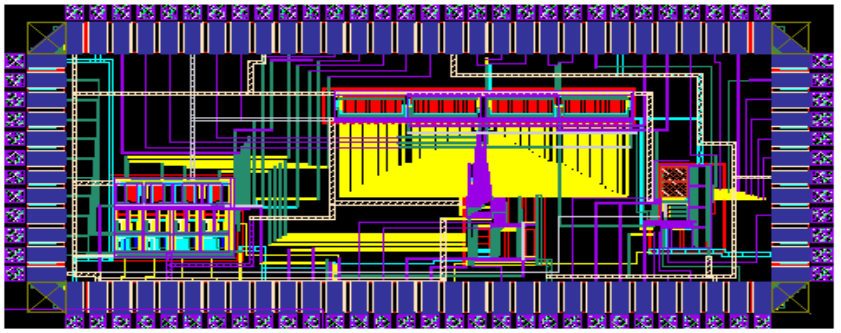
Short term solution:

- CMS front-end requires CMS readout system
- XDAQ system with PCI FED und PCI FEC
- Available in Karlsruhe



Long term solution:

- New readout chip developed by LPNHE Paris together with readout electronics

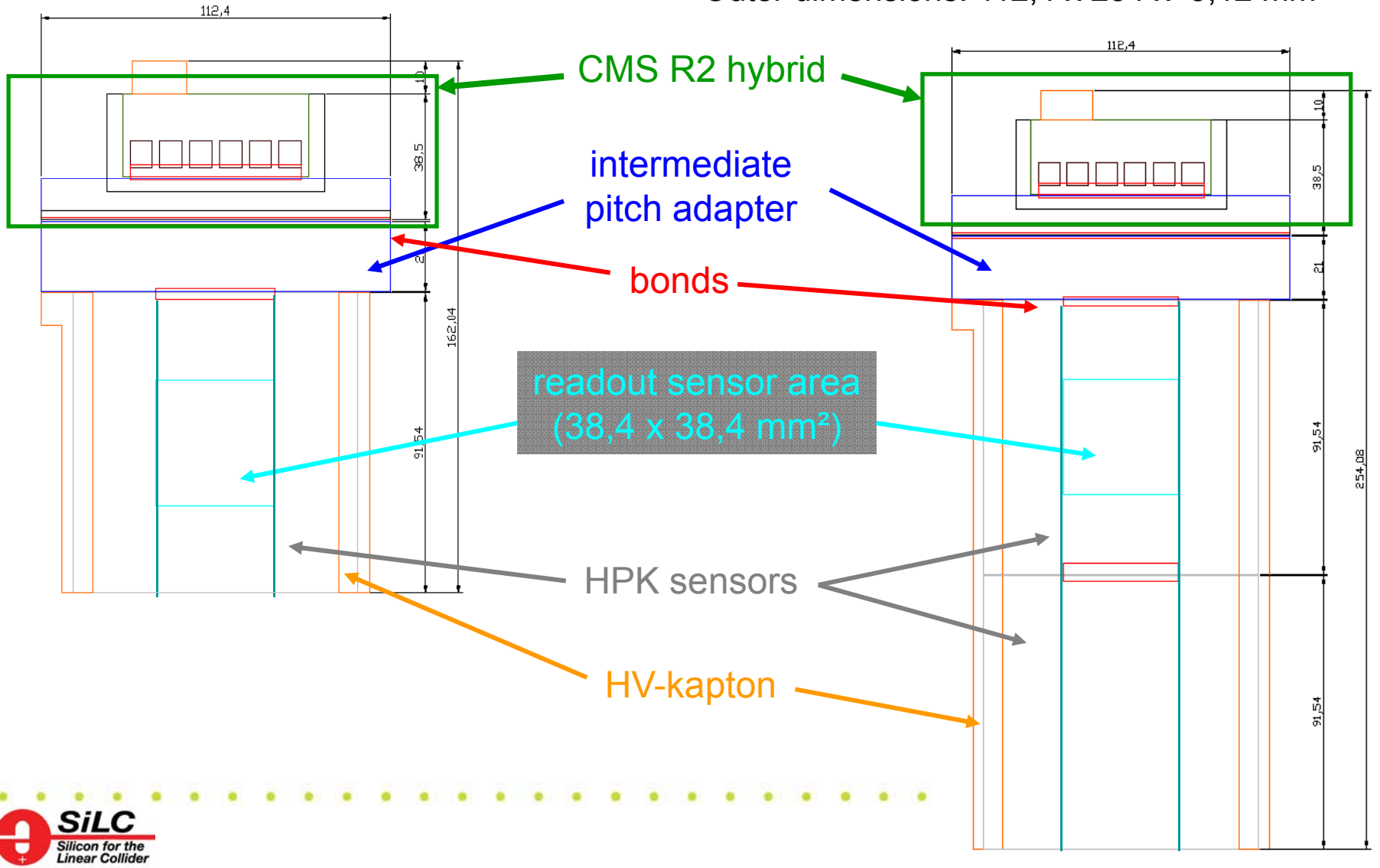


Layout of the 130nm chip including sampling and A/D conversion

Status of modules/frames

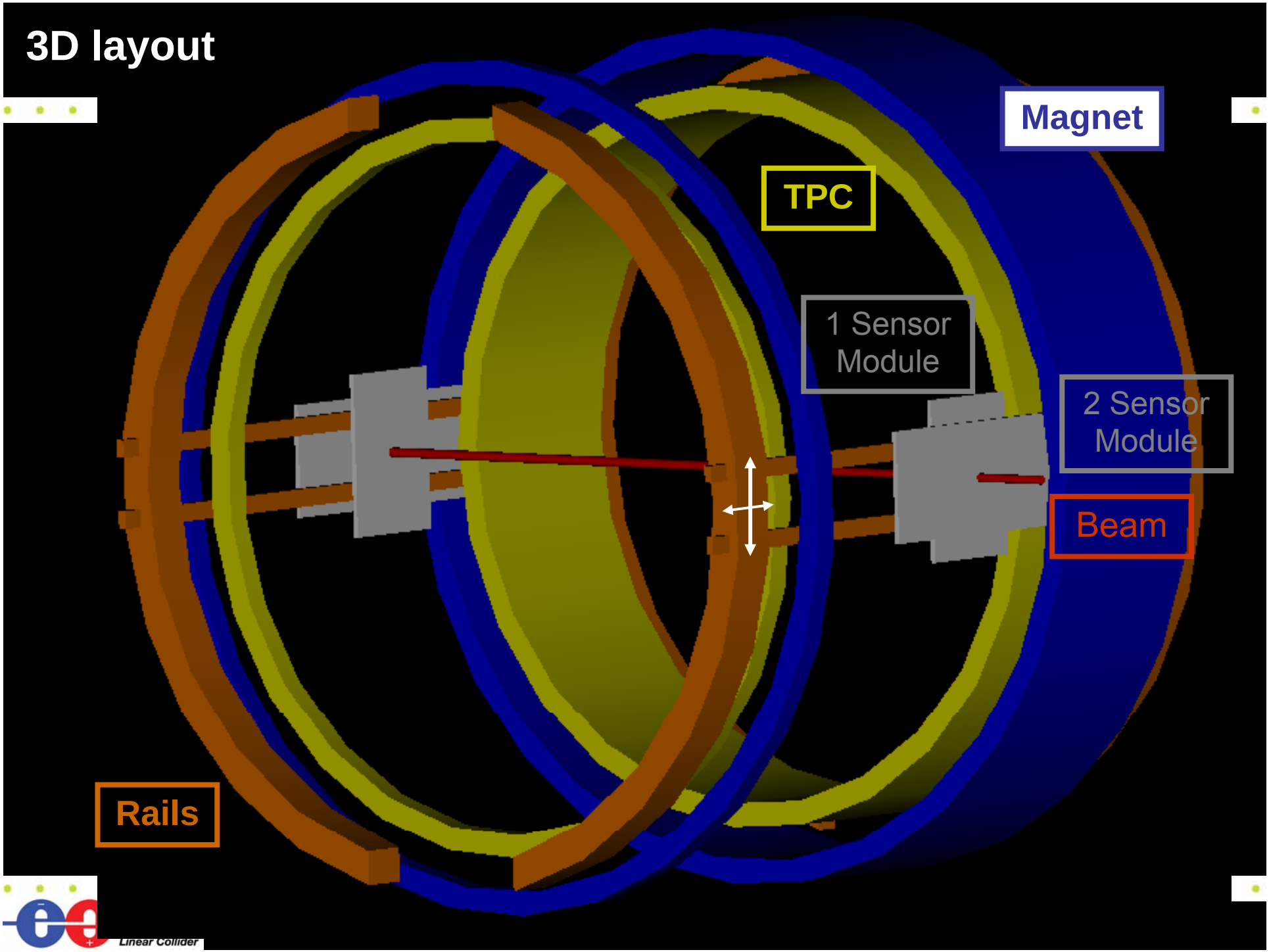
one sensor module
Outer dimensions: 112,4 x 162,04 x 5,12 mm³

two sensor module
Outer dimensions: 112,4 x 254 x 5,12 mm³



SiLC
Silicon for the Linear Collider

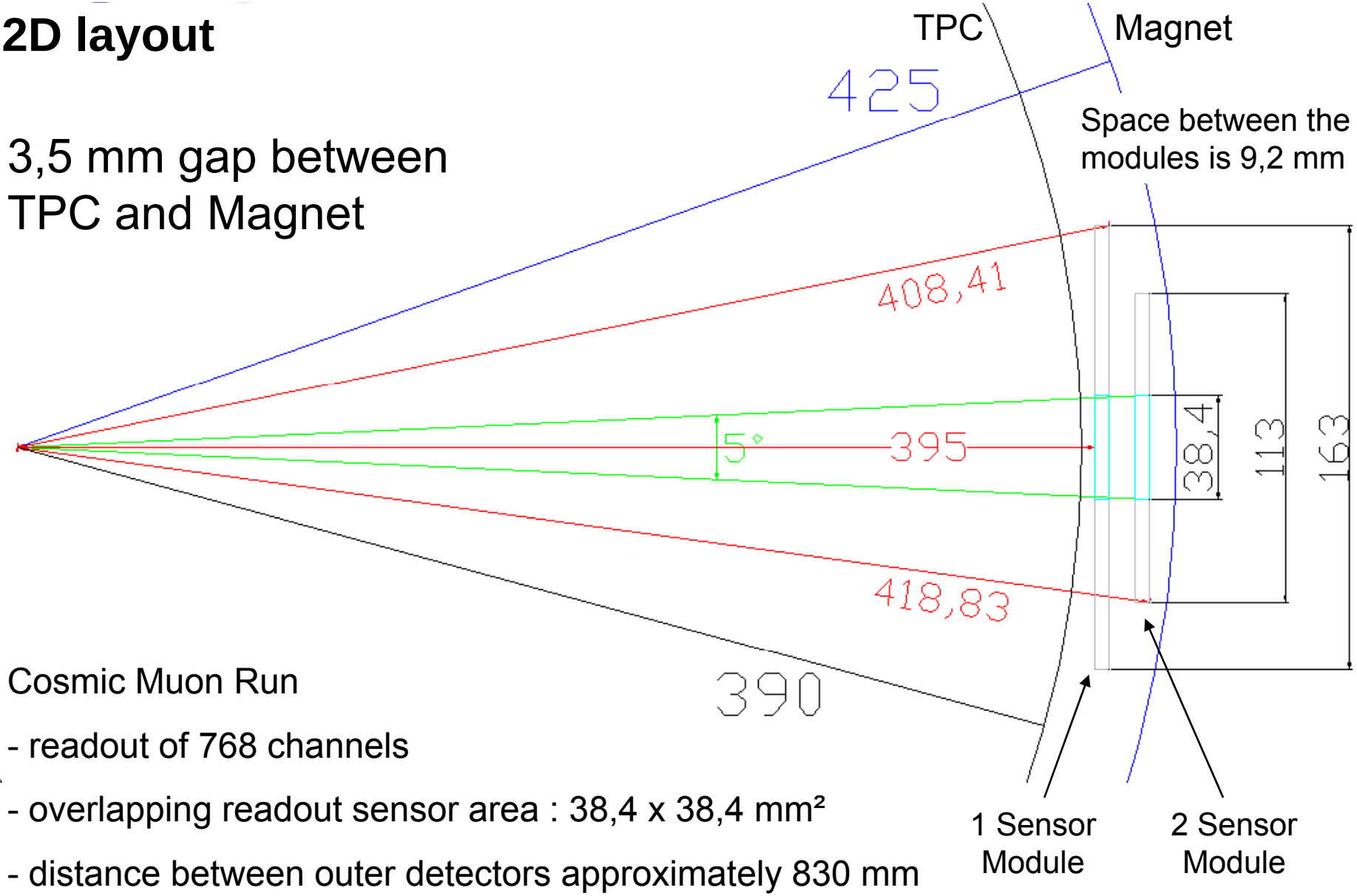
3D layout



Linear Collider

2D layout

- 3,5 mm gap between TPC and Magnet



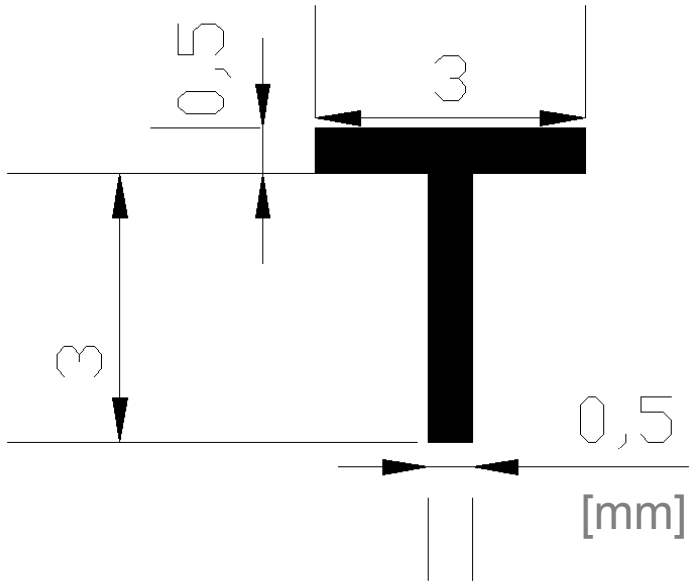
Cosmic Muon Run

- readout of 768 channels
- overlapping readout sensor area : 38,4 x 38,4 mm²
- distance between outer detectors approximately 830 mm

➢ **number of muon coincidences per day ~ 18**

Status of mechanical Support

- Two carbon fiber bars (3 x 0,5 mm^2) glued together forming a T-profile
- Two profiles are used as module support structure
- Very fragile, but necessary to
  - Keep material budget low
  - Don't waste little space between Magnet and TPC
- Stability tests were ok



Not defined yet:

How the modules will be fixed to the moveable support structure

SiLC
Silicon for the Linear Collider

Summary/Open questions

- Cosmic Run:
  - Time constrains only allow CMS front-end and readout electronics
  - Limited readout area: 38,4 cm^2
  - 18 muon coincidences expected per day
  - Too much effort for this? No, because first system test of TPC+Si readout systems
- Support structure for Cosmic Run
  - has to be rotated by 90°
  - Problem of space with field cage support (half-shells), which are in this region (top/bottom of TPC)
  - Half-shells have been/will be replaced by array of round bars
- Beam test (after August 08)
  - Eventually with new hardware from LPNHE Paris
  - Mechanics under development