Update on forward tracking from the Spanish future collider network

Pixel solution for forward region
(IFIC/DEPFET)

Micro-strip detectors with intrinsic gain
(IFCA/CNM-IMB)

FTD thermo-mechanical
(IFCA/IFIC Valencia)

ILD optimization workshop, DESY, February 2016

M. Vos, IFIC (UVEG/CSIC) Valencia

Forward tracking (is)

Important:

Forward tracking at the next e+e- collider.
Part I: the physics case,
JINST 4 (2009) P08002

Many processes are forward-peaked at $\sqrt{s} >> m_Z$

- Higgs boson through VBF
- Di-boson production
- Any t-channel with a light mediator
- Bread-and-butter $e^+e^- \rightarrow f\bar{f}\ (\gamma)$

Challenging:

Forward tracking at the next e+e- collider.
Part II: experimental challenges and detector design,
JINST 8 (2013) T06001

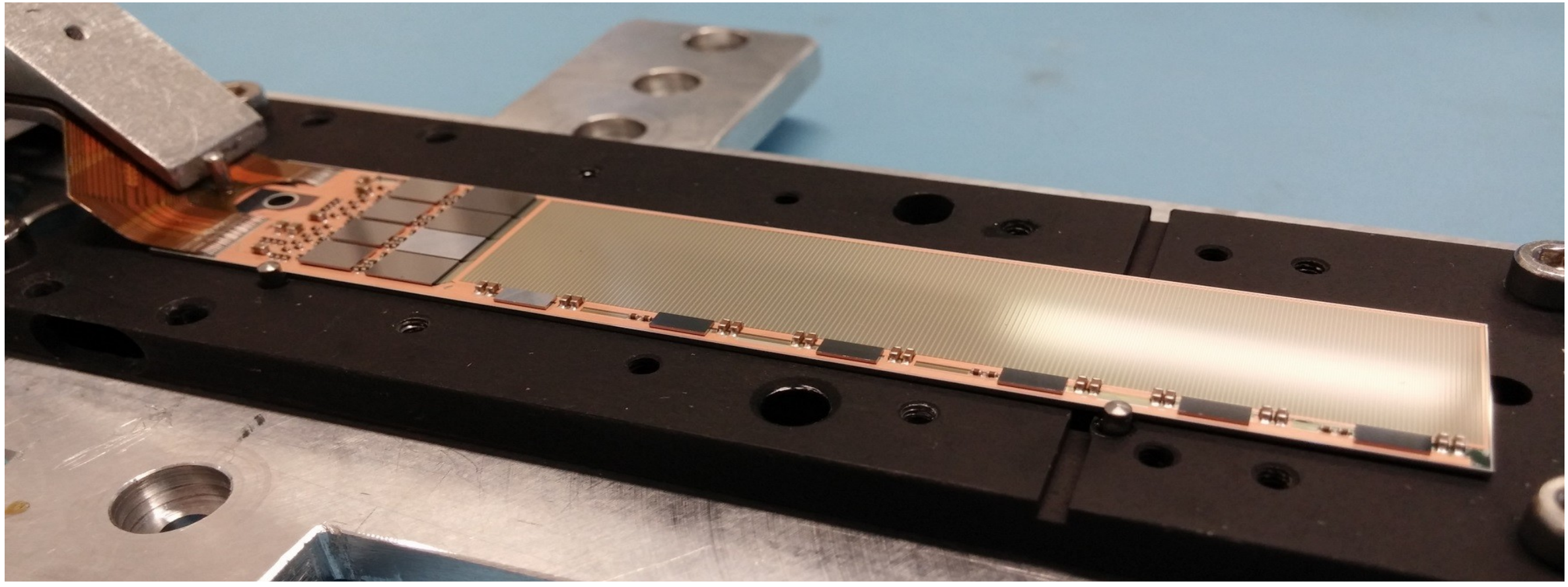
Hard to keep good performance vs. polar angle

- backgrounds ($\gamma\gamma \rightarrow$ hadrons)
- pattern recognition, low p_T tracks

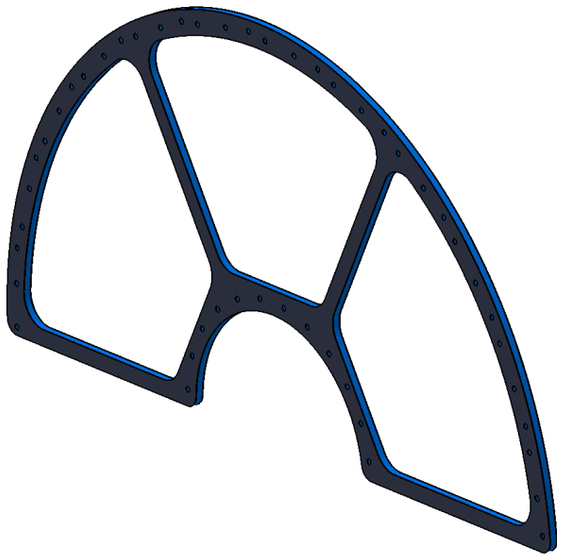
  (see previous talk)
- p_T resolution $\rightarrow$ orientation magnetic field
- vertexing $\rightarrow$ distance + material

Final DEPFET half-ladder

Fully functional.... major milestone for the Belle II project!

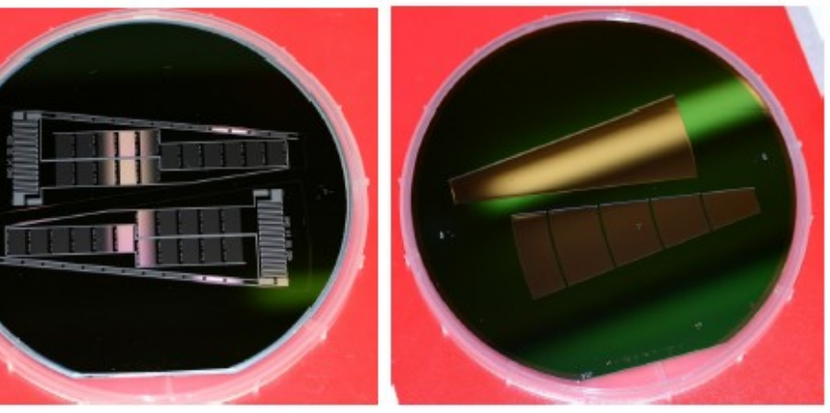


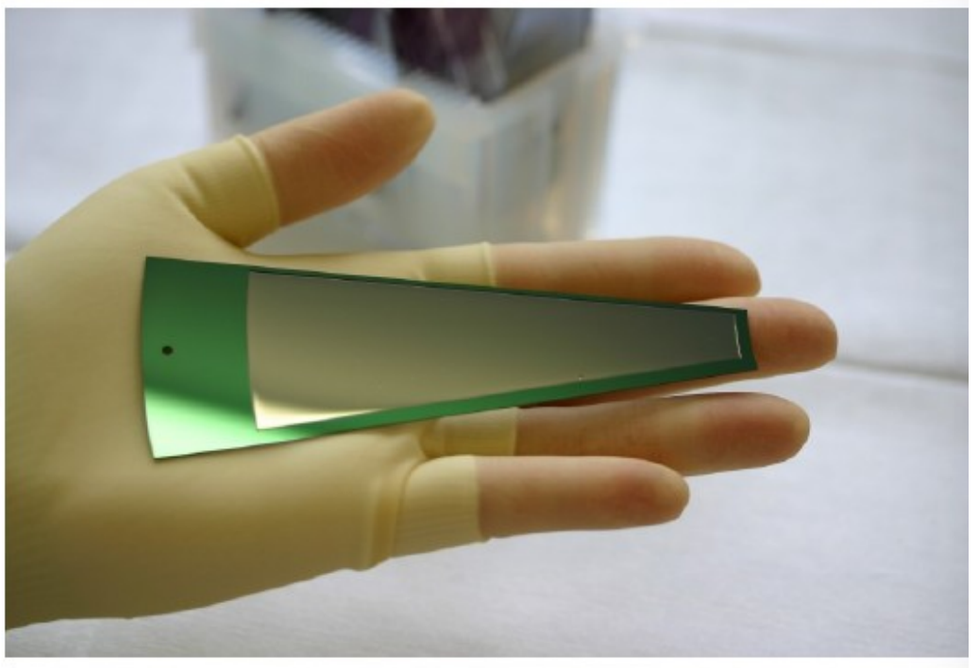
And it works... detailed electrical characterization + TB ongoing

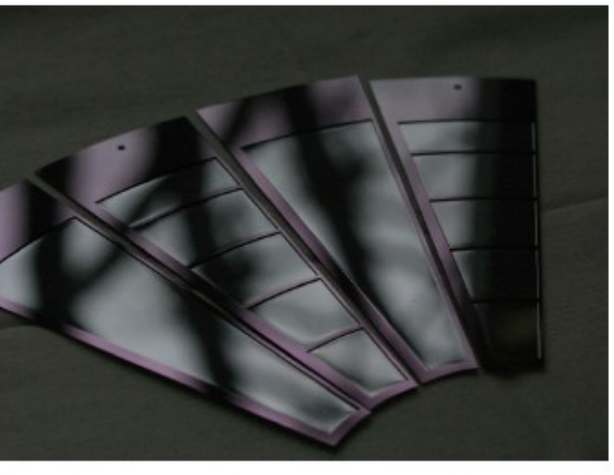


thermo-mechanical

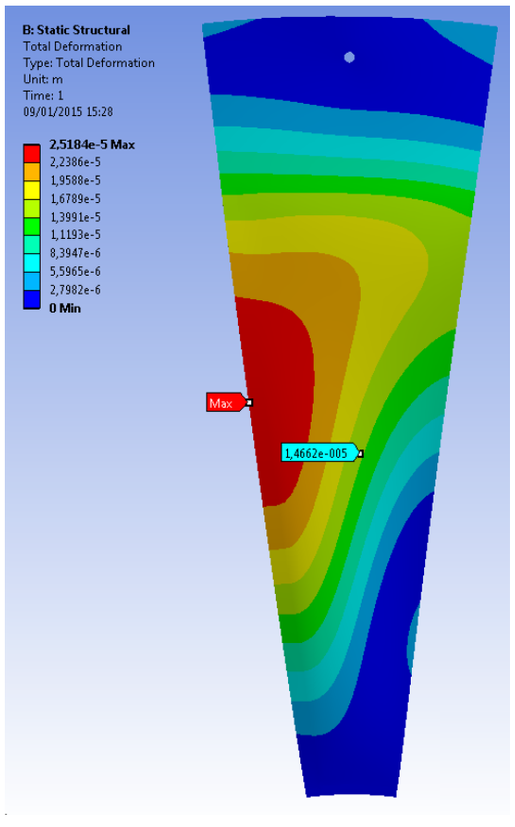
CF support disk for ILD-FTD1 in production in INTA, Madrid



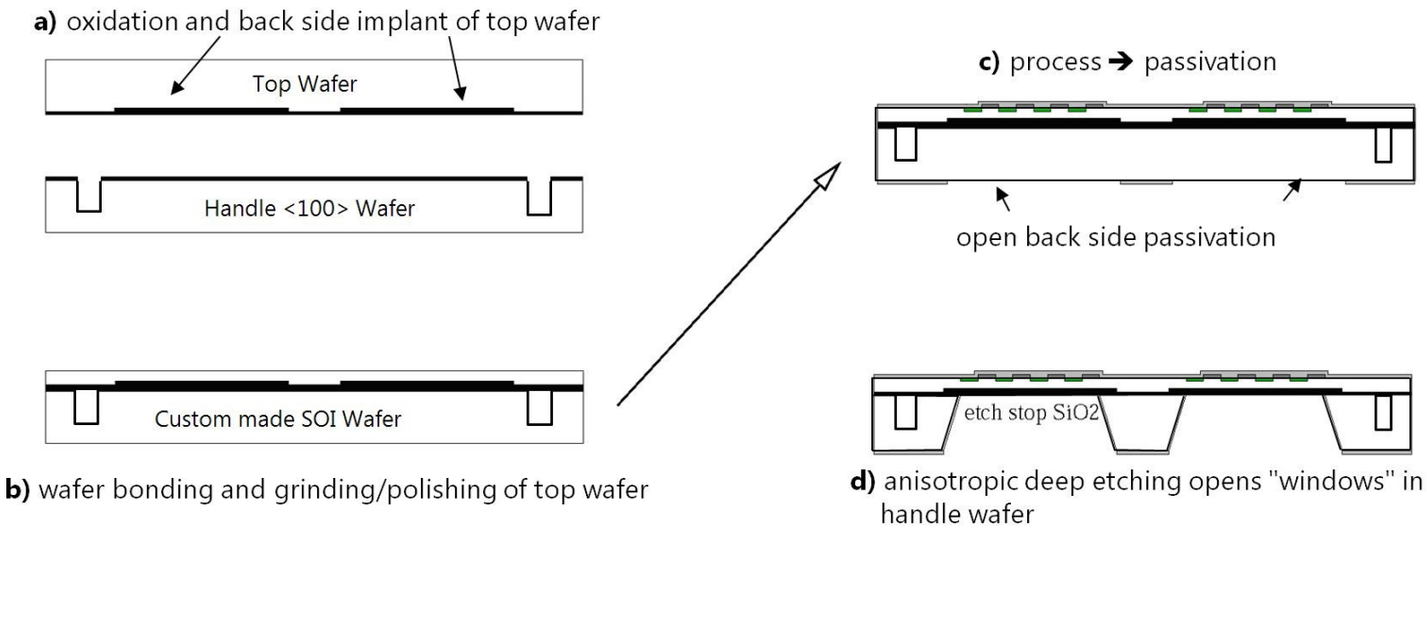


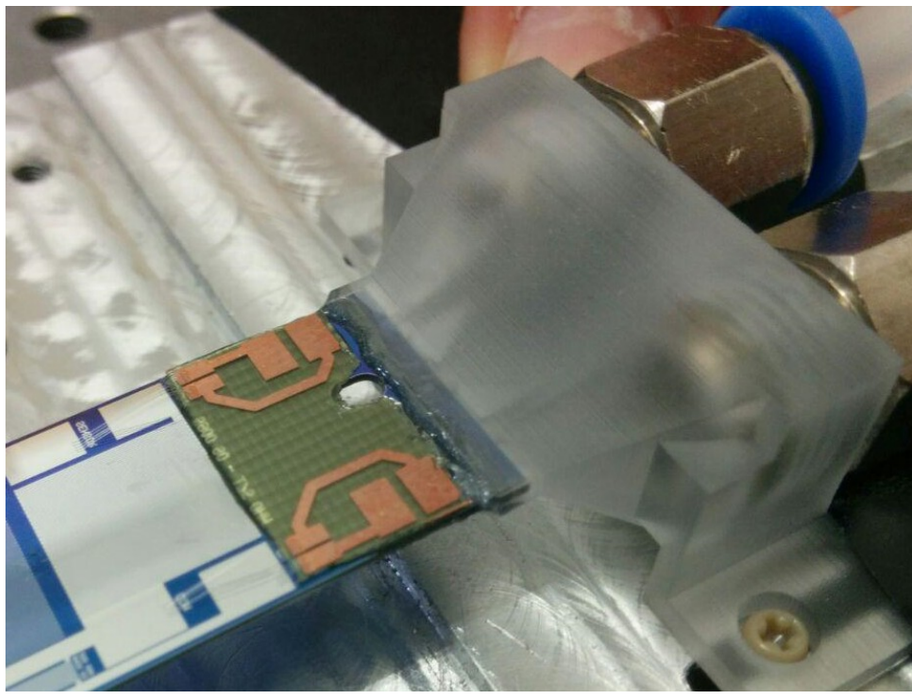


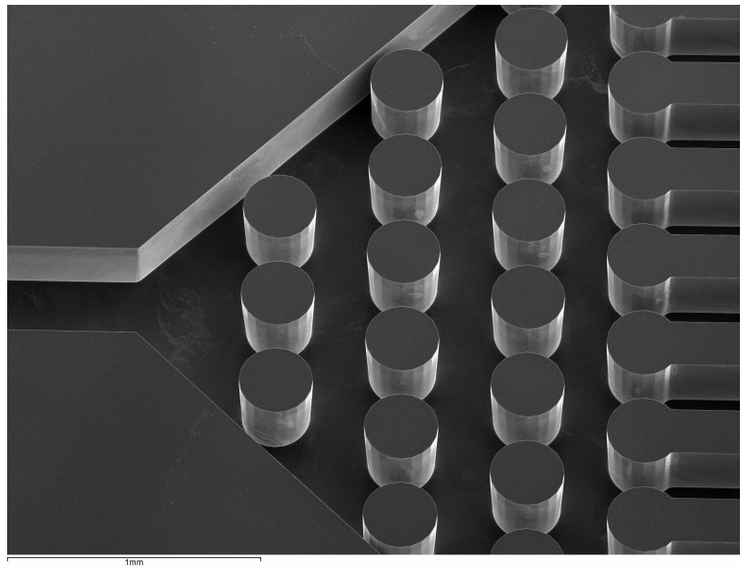
Laci Andricek, HLL Munich
Mechanical samples for all-silicon petals. Most of the area is thinned to 75 μm, resistor circuits emulate power consumption of sensor and ASICs following DEPFET pattern.

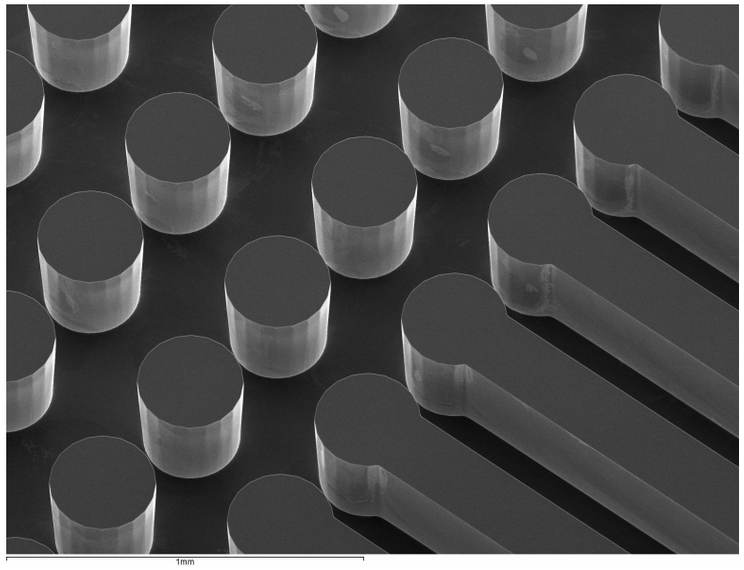


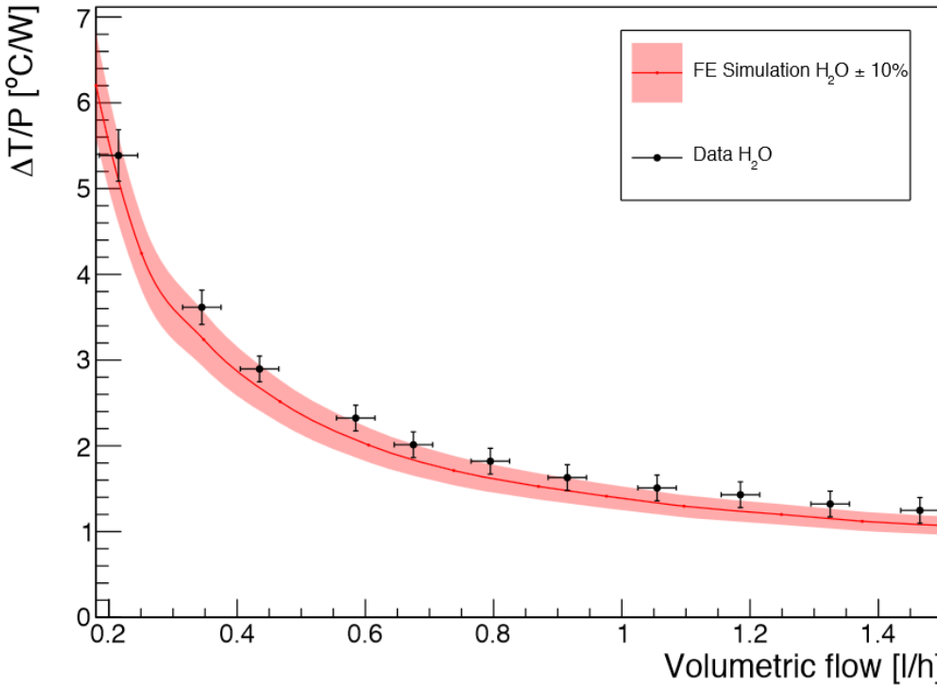
Integrated cooling!











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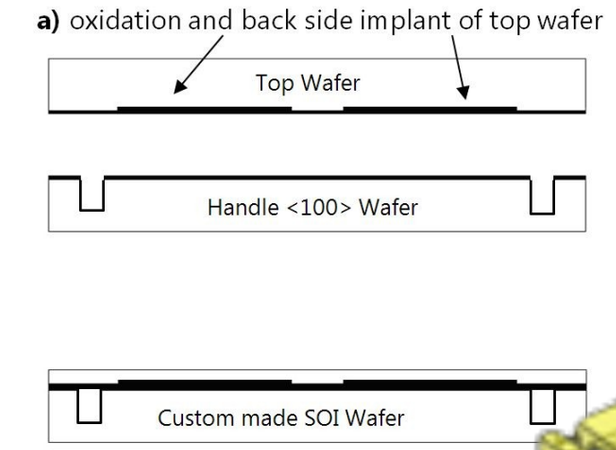
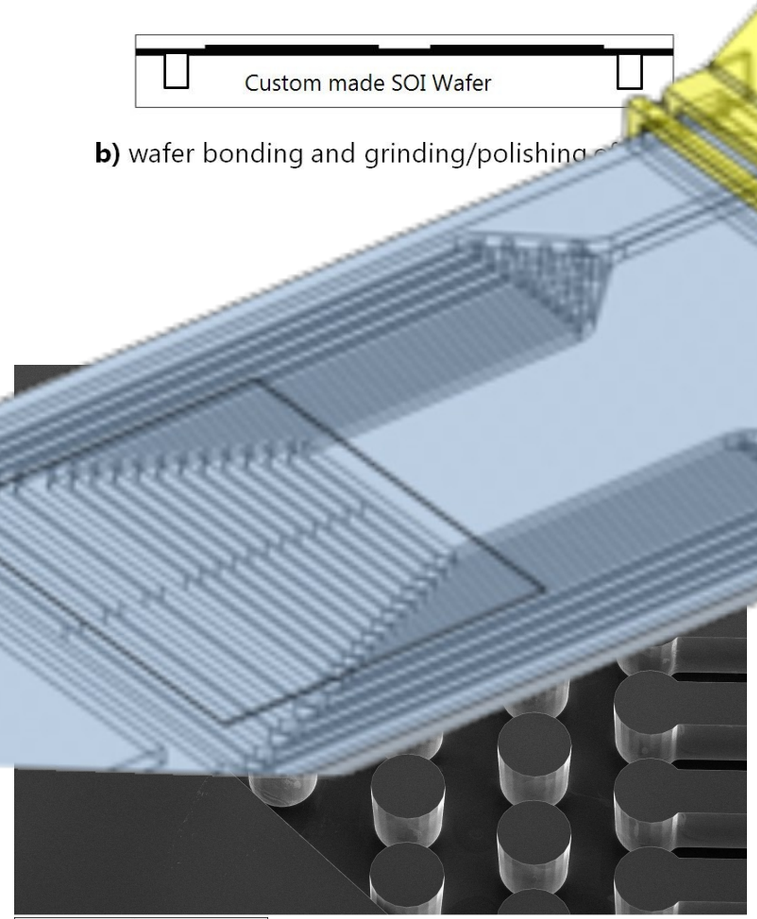
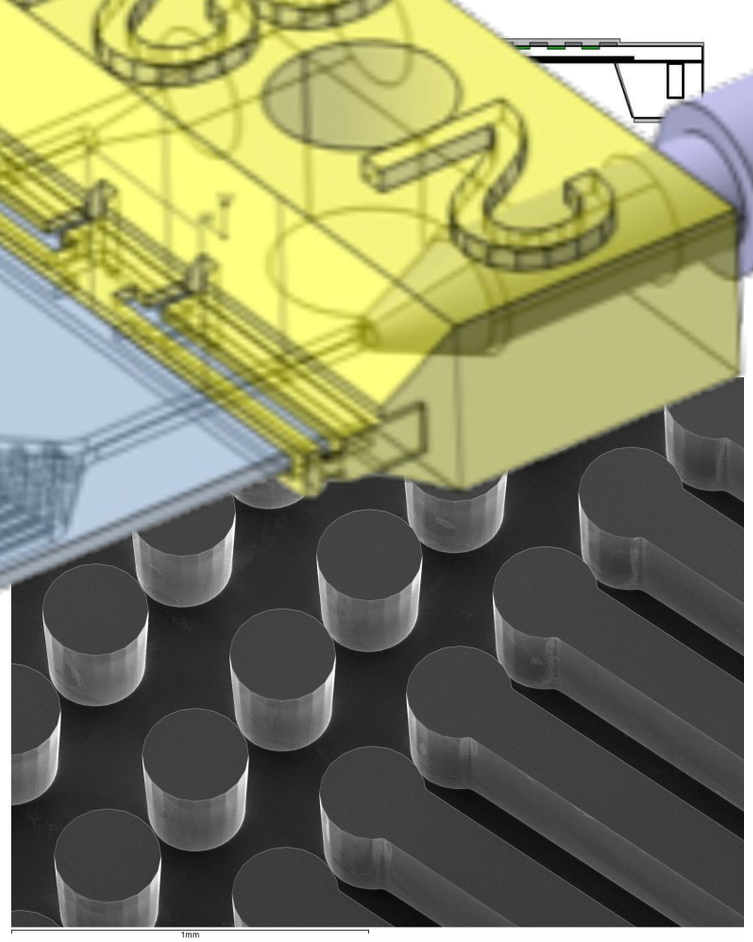
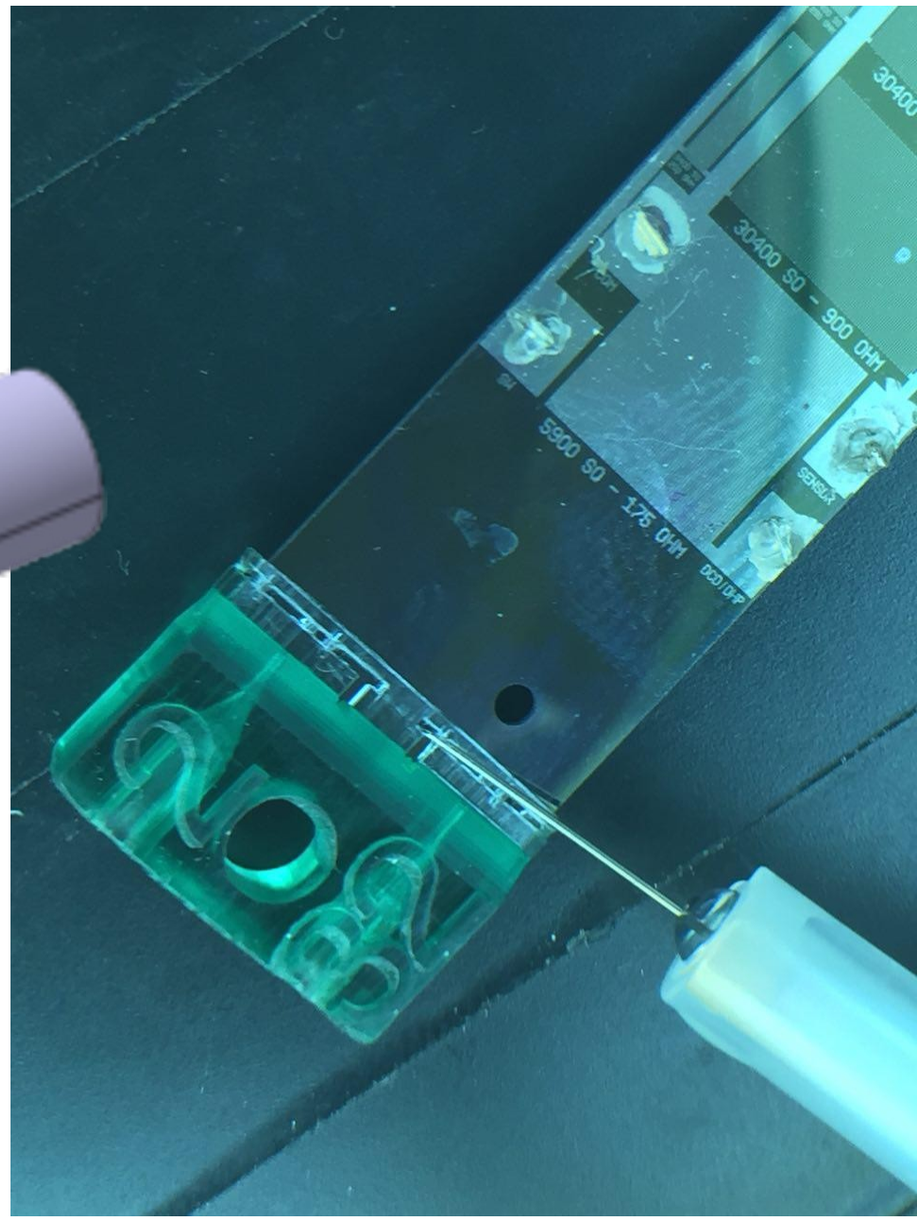








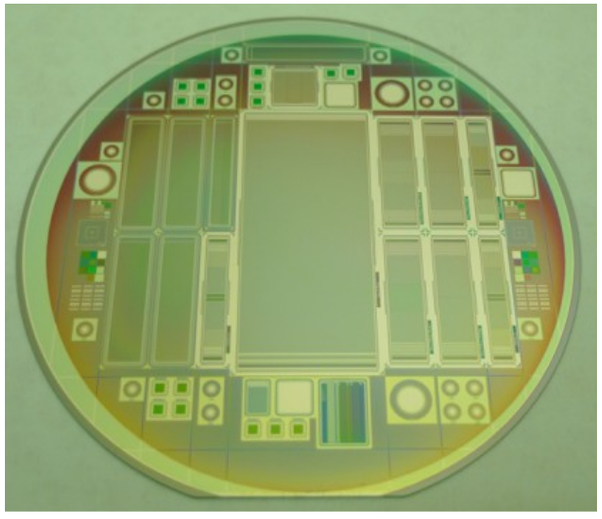
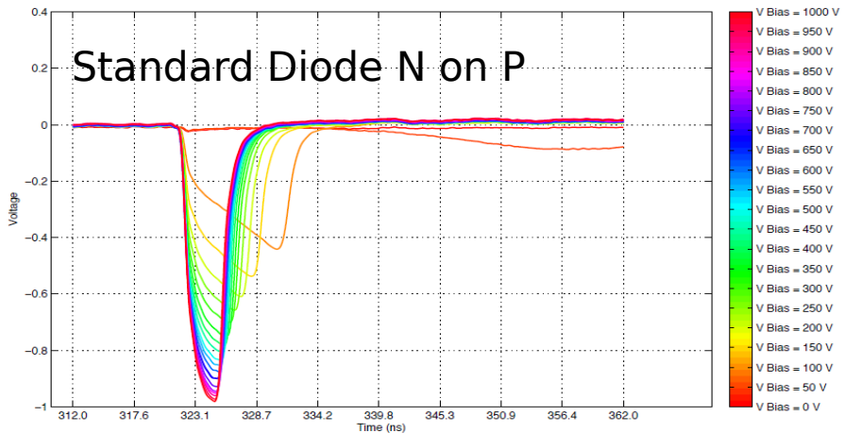
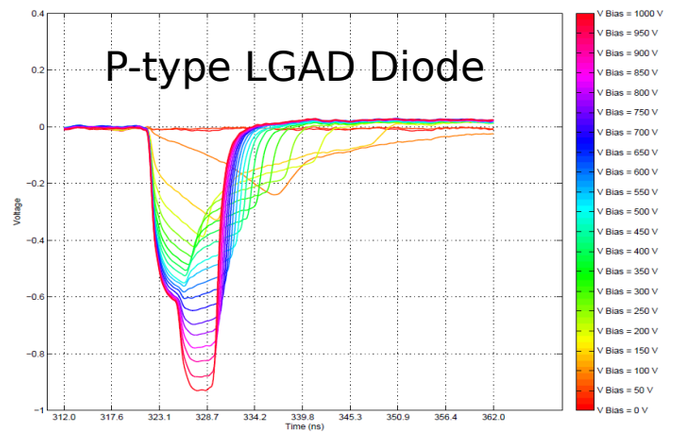
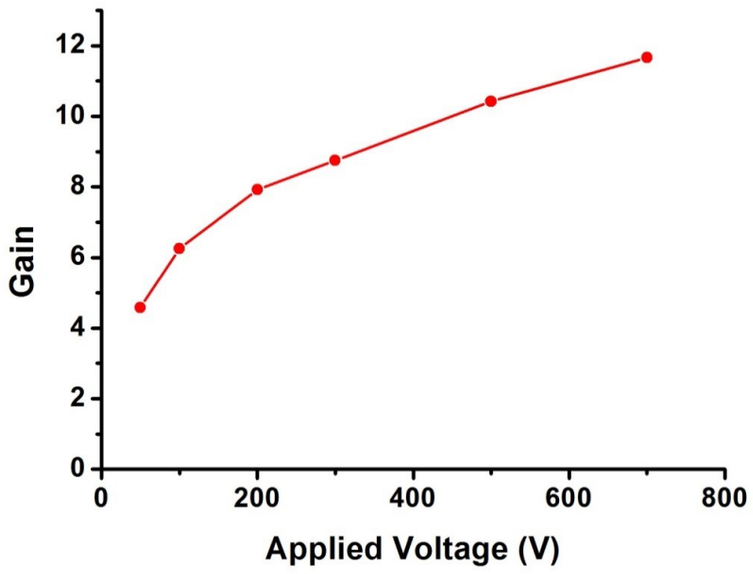


Figure 1. General view of a wafer with the new **resistive microstrip** detectors fabricated at IMB-CNM clean room

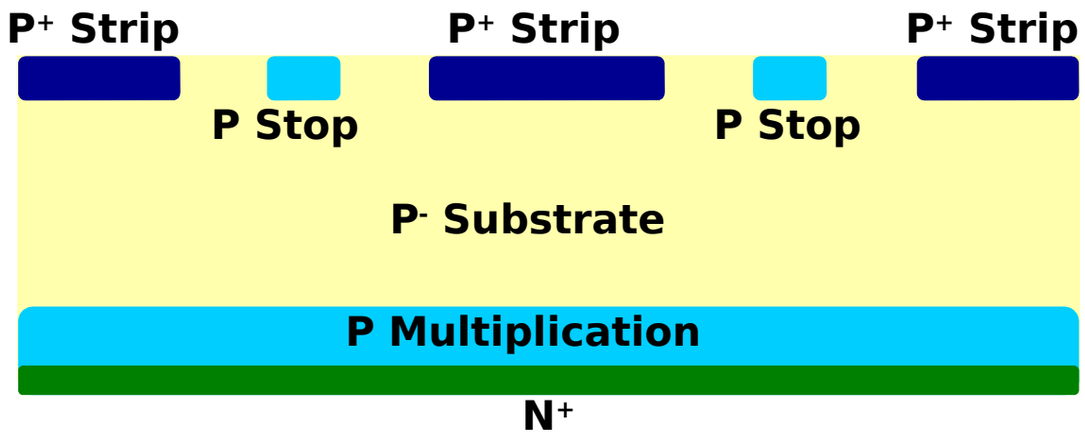
Use CNM in-house processes: capability for thin 6” wafers, full custom implants and segmentation (pixel/strips)







Signal multipllication in the sensor
→ higher S/N or thinner silicon sensor



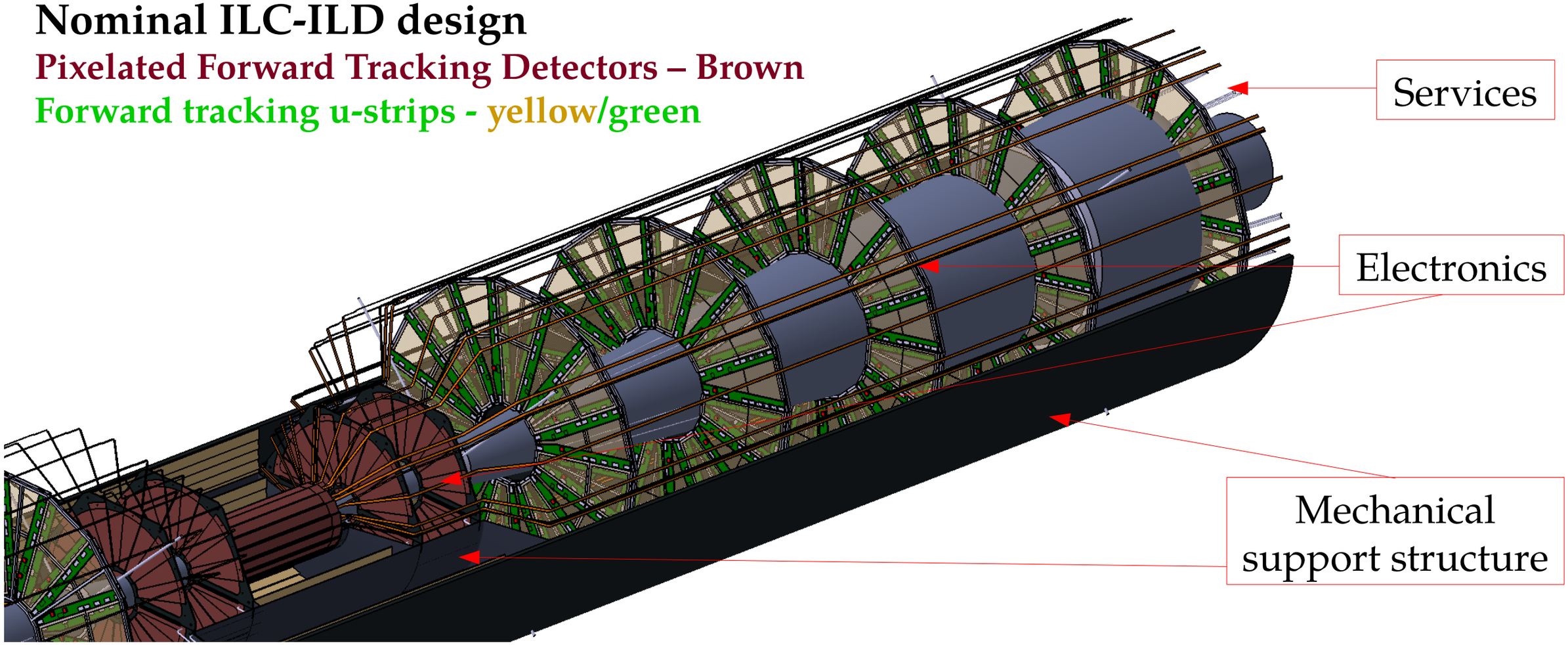
Next stop: segmented LGAD detector (iLGAD)

ILD-FTD design

Nominal ILC-ILD design

Pixelated Forward Tracking Detectors – Brown

Forward tracking u-strips - yellow/green



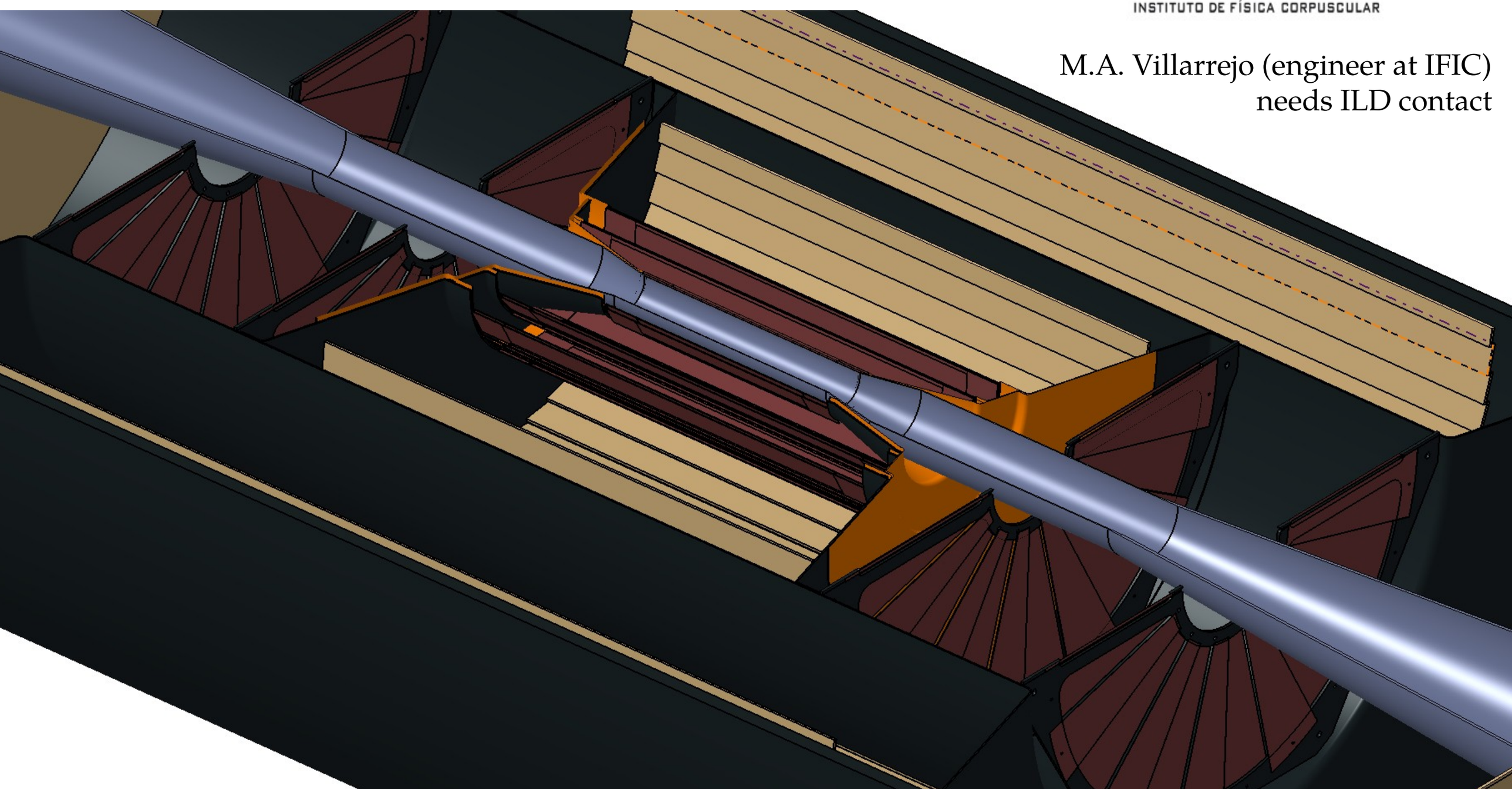
FTD: detailed design

A detailed design for innermost Forward Tracking Disks (and VXD)

→ end-of-ladder material (technology-specific)
→ cables & services (generic, inner-tracker level problem)

IFIC
INSTITUTO DE FÍSICA CORPUSCULAR

M.A. Villarrejo (engineer at IFIC)
needs ILD contact



Assembly procedure

Assembly strategy

7

8

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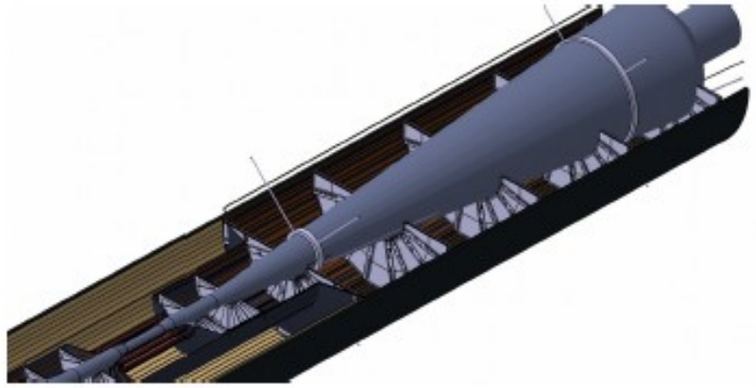

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Steps:

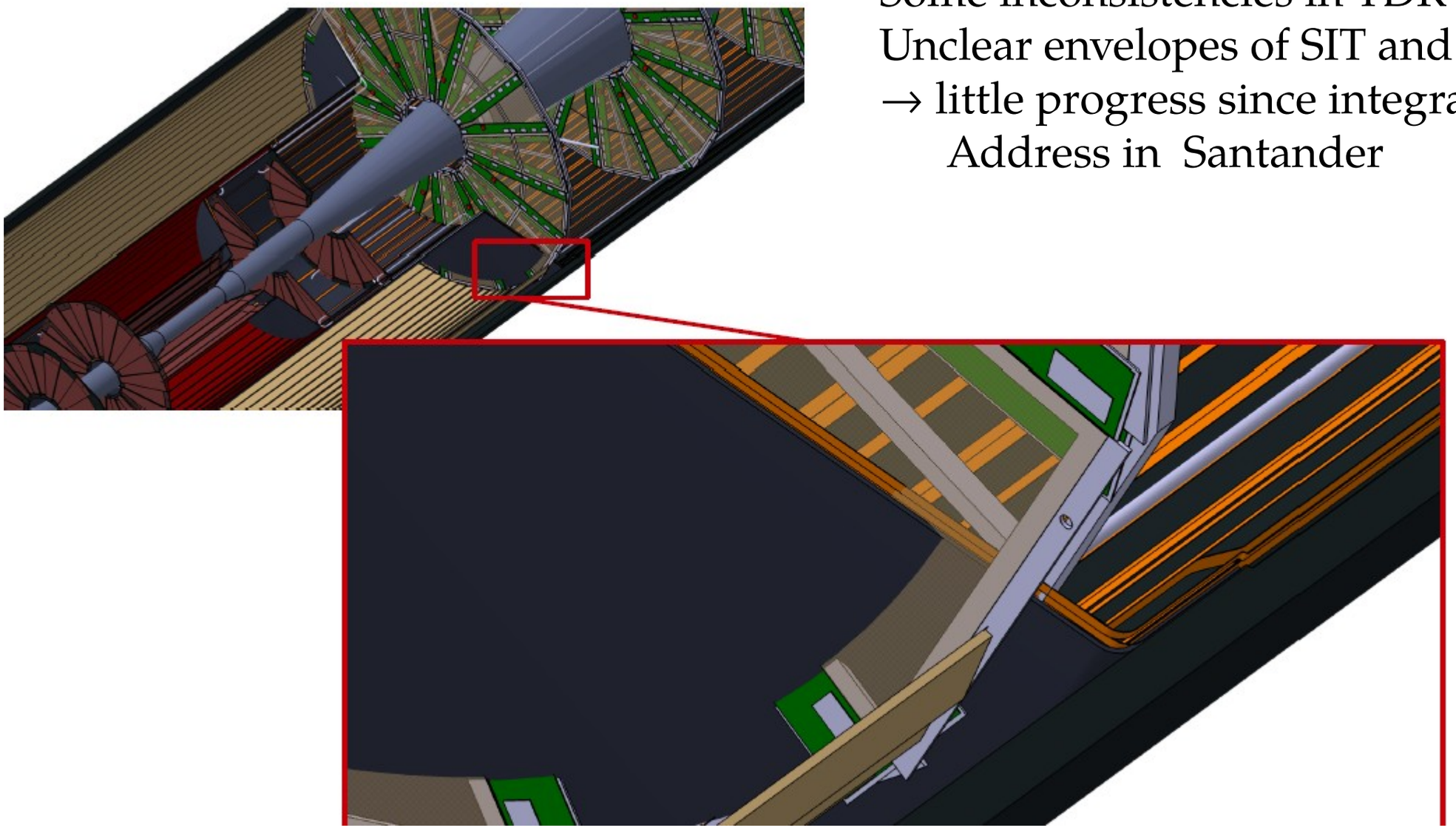
6 → 7 VXBD 1-2 & CFRP

7 → 8 FTD1-2 & CFRP

8 → 9 FTD 3-7 & CFRP (x2)

9 → 10 Beam Pipe

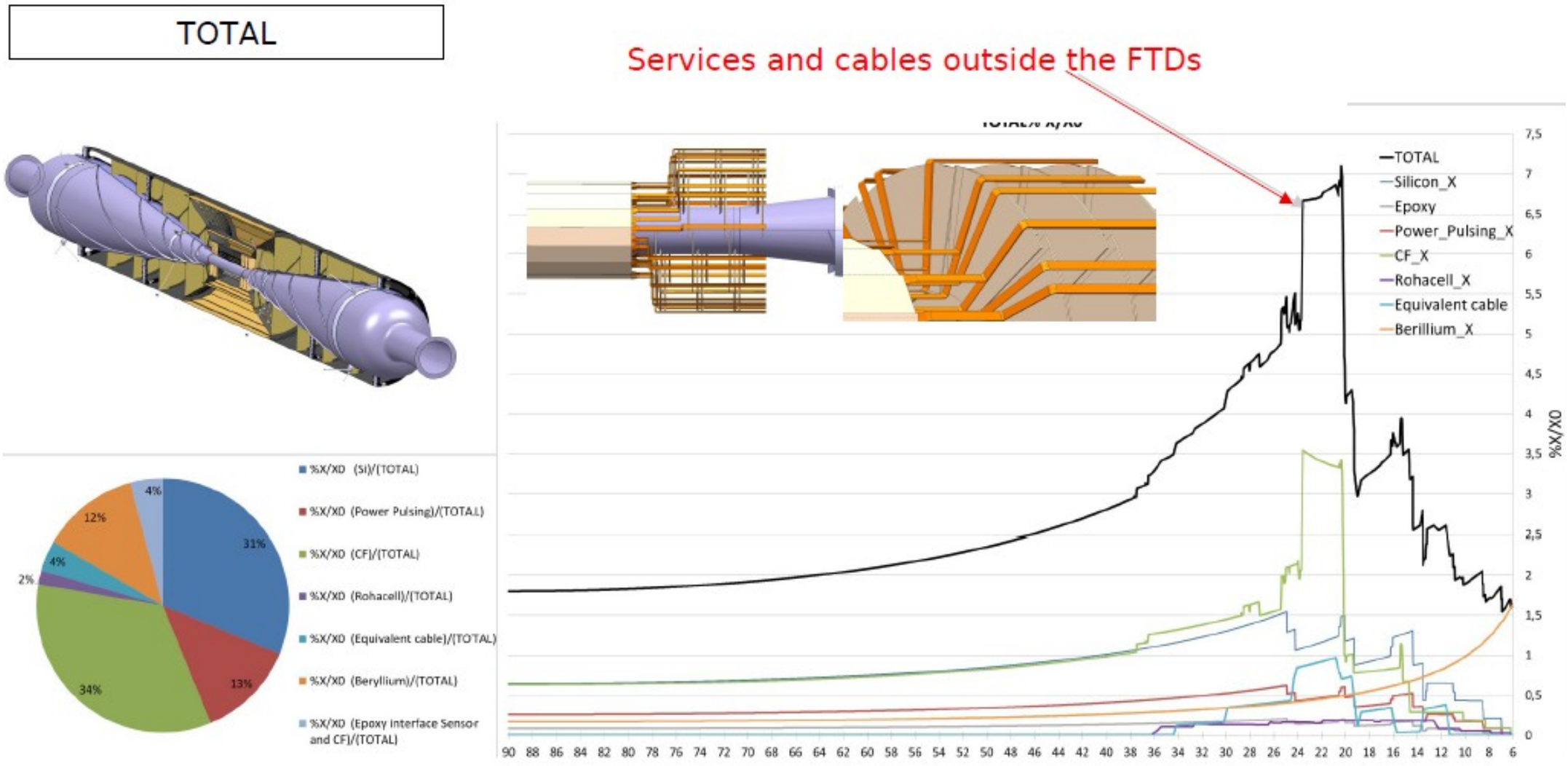
Envelopes



Some inconsistencies in TDR
Unclear envelopes of SIT and FTD
→ little progress since integration workshop,
Address in Santander

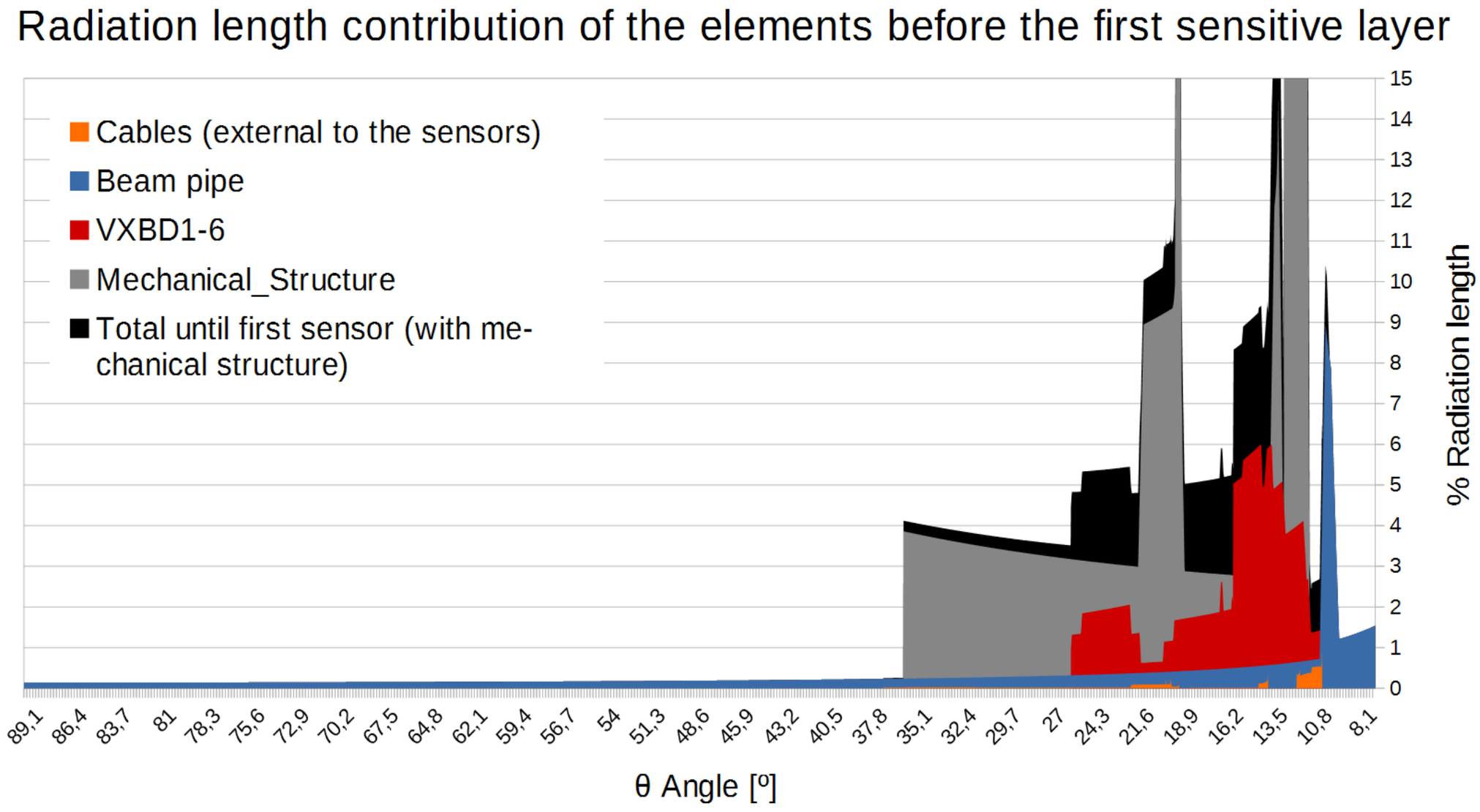
Engineered design

→ feed back into simulation for increased realism



Impact on physics

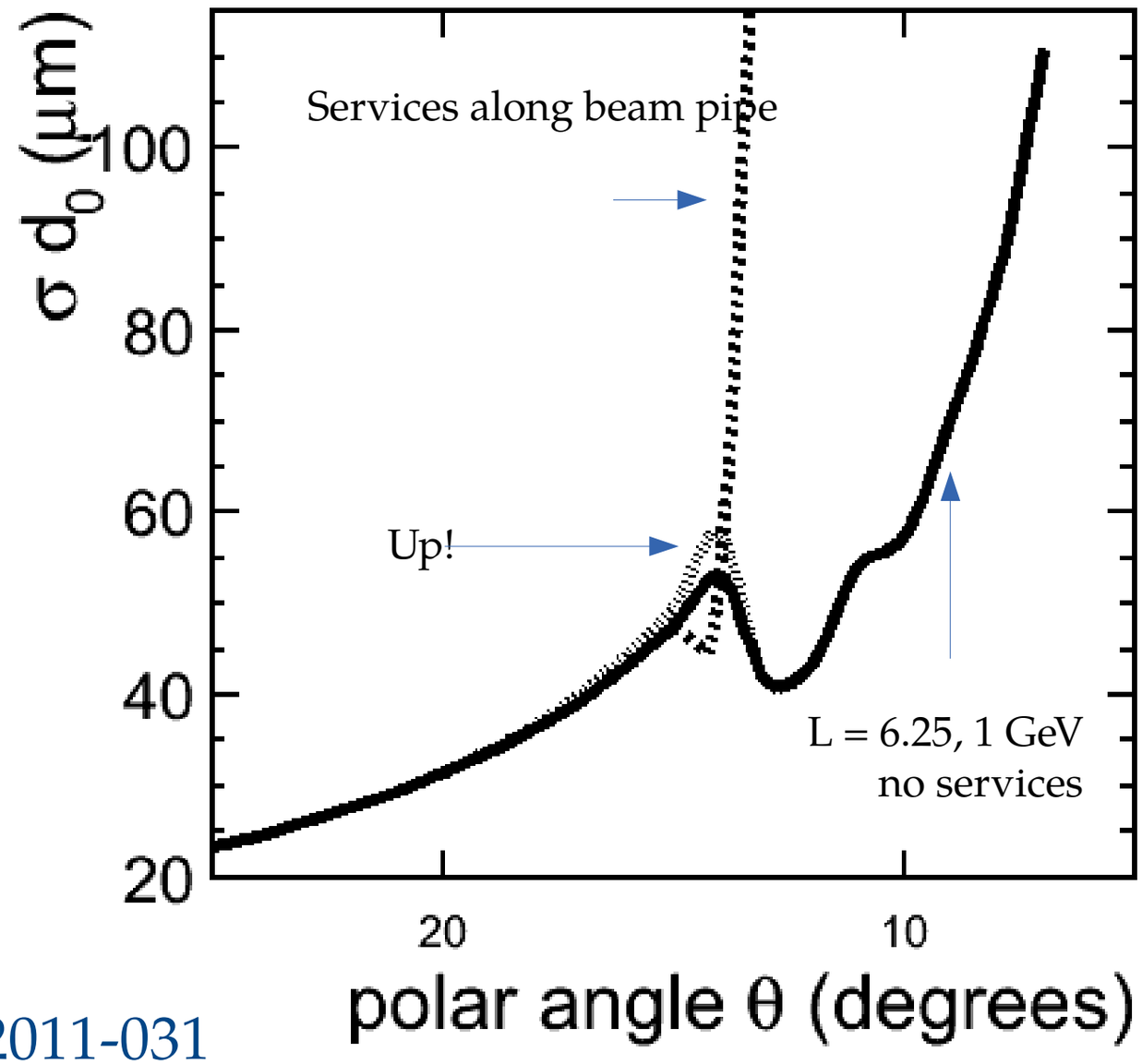
Minimize the impact on physics of service material
Vertexing at low angle with FTD requires no material in front of silicon, but VTX barrel services must go out...
Requires inner-detector-wide solutions!



A decision that needs to be taken...

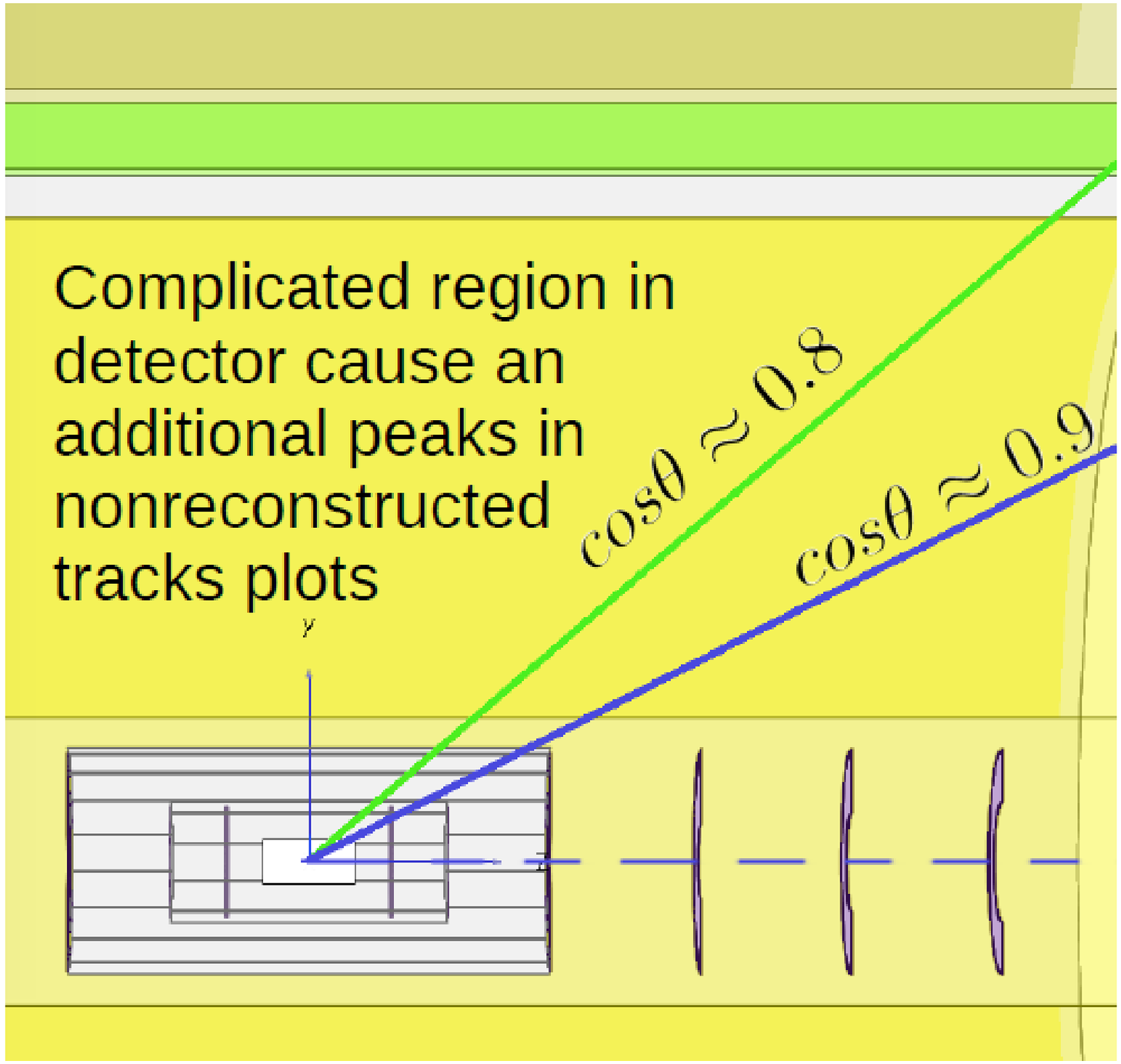
The forward region clearly does NOT like the services routed along the beam pipe

If anything close to a radiation length comes in the way between endcap and interaction point we can forget about forward vertexing



See also CLIC study LCD note 2011-031

Forward Pattern Recognition is a problem



Reconstruction of low-momentum forward tracks has never worked well in ILD

Too few layers, too much space in between....

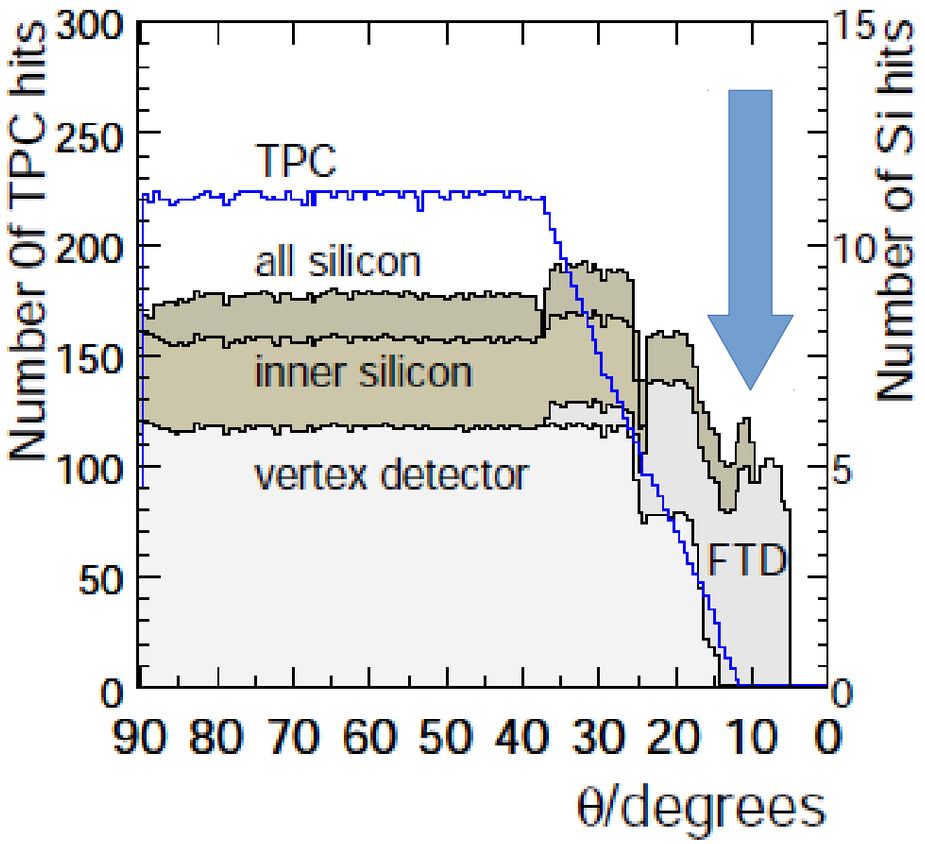
Algorithms have improved, but problem seems to remain

Need good efficiency AND low fake rate!

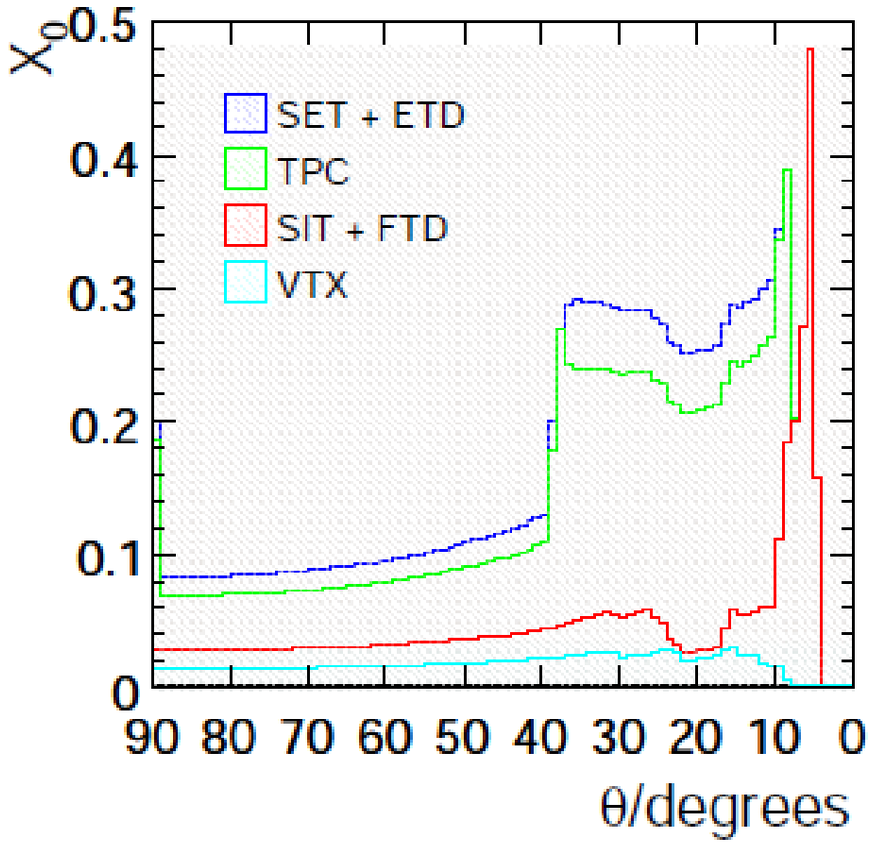
This affects physics analyses!

V. Bilokin, TopLC15

Forward tracking



Number of hits in the different subsystems of the ILD detector



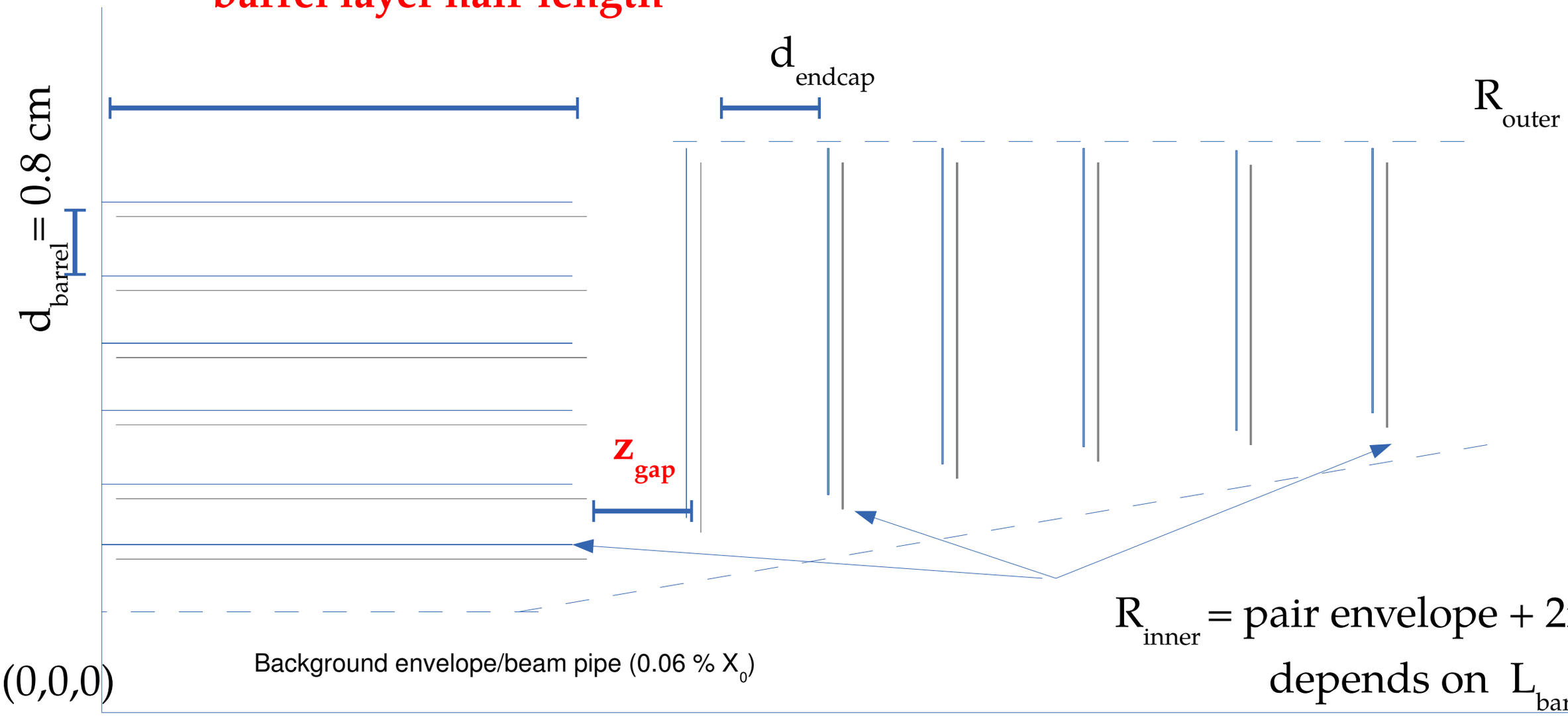
Radiation length

ILD DBD.
arXiv:1006.3396

The forward tracker has to cover a dense region, with very few measurements. **Do we need to reinforce the FTD?**
SiD has complete VXD end-cap and also CLIC opted for this design,
M. Vos, D. Dannheim et al, arXiv:1203.0942

Slide from AWLC14

A simplified view

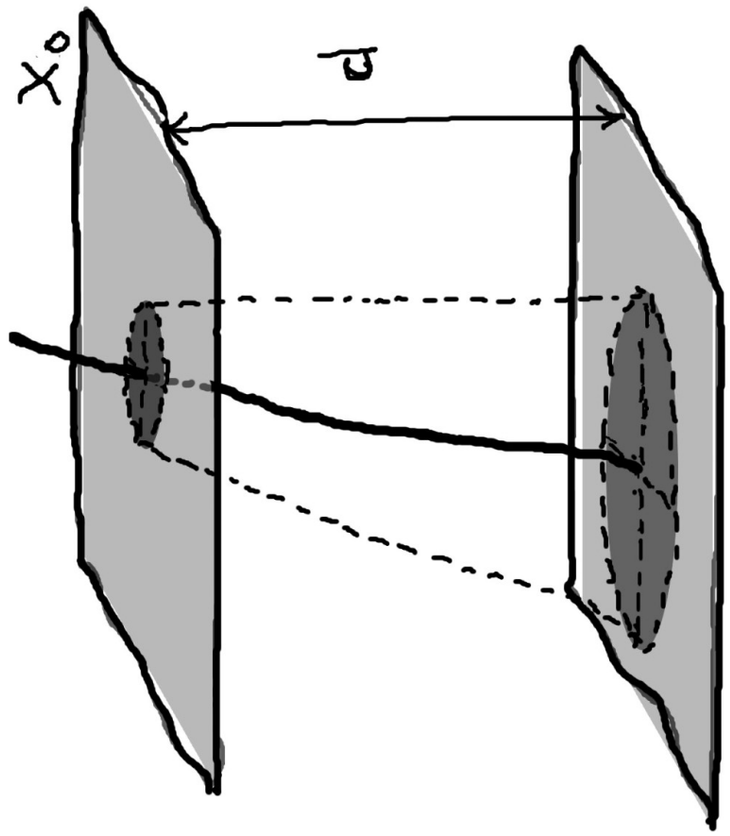


ILC-SiD: L_{barrel} ~ 6.25 cm, z_{gap} ~ 1 cm, d ~ 2 cm

ILC-ILD: L_{barrel} ~ 12.5 cm, z_{gap} ~ 10 cm, d > 10 cm

CLIC-iLD: L_{barrel} ~ 12.5 cm, z_{gap} = 2 cm, d ~ 3 cm

A concrete proposal



Alternative geometry to be tested for tracking (especially pattern recognition) performance:

- A real compact VXD end-cap, with five closely spaced disks, instead of two large pixelated disks far away
- Reduced gap between barrel and first FTD disks (include disks in cryostat if needed)

Summary

R&D programme progressing steadily

- measurements on thermo-mechanical performance of ultra-transparent detectors
- complete mechanical solution + integrated cooling
- micro-strip detectors with internal gain

FTD design

- engineering design for services exists
- important design choices pending since a few years
- reinforce FTD pixels for pattern recognition for low momentum forward tracks