Spanish Network LoI contribution

SiD LoI preparation workshop, SLAC 3th March 2009

Iván Vila Álvarez
Instituto de Física de Cantabria [CSIC-UC]

IFCA

Centro Nacional de Microelectrónica

IMB

Caveat

- In this talk just the current Spanish contribution the LoI
- See tomorrow's R&D session for a complete review of Spanish consortium activities.

Members and R&D lines

IFCA (Santander)
TRACKING; mechanics alignment; uStrips.

USC (Santiago de Comp.)
VTX; TRACKING, 3D sensors, DEPFET

CNM, UB, URL (Barcelona)
VTX;TRACKING; sensors, R/O electronics; DEPFET

IFIC(Valencia)
ACCEL, VTX, TRACKING; BPM, mechanics, DEPFET

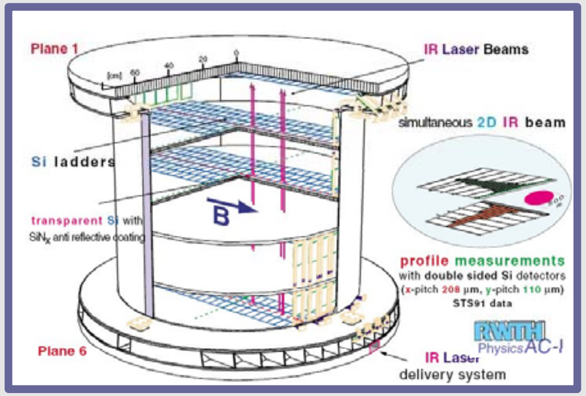
CIEMAT (Madrid)
ACCEL; CALO; mechanics, RPC R/O

RD on Sensors: IRuS for alignment

- Statement of the issue:
  - The ultimate alignment precision will be achieved by track-based alignment algorithms. BUT ...

    ....a real time monitoring of the vtx/tracker stability/deformation during detector normal operation (thermal, magnetic loads) and pull-push procedure is a MUST.
- Requirements:
  - Alignment resolution should be at least as good as the intrinsic hit resolution.
  - Avoid as much as possible the increase of material in the tracking volume.

RD on Sensors: IRuS for alignment (2)



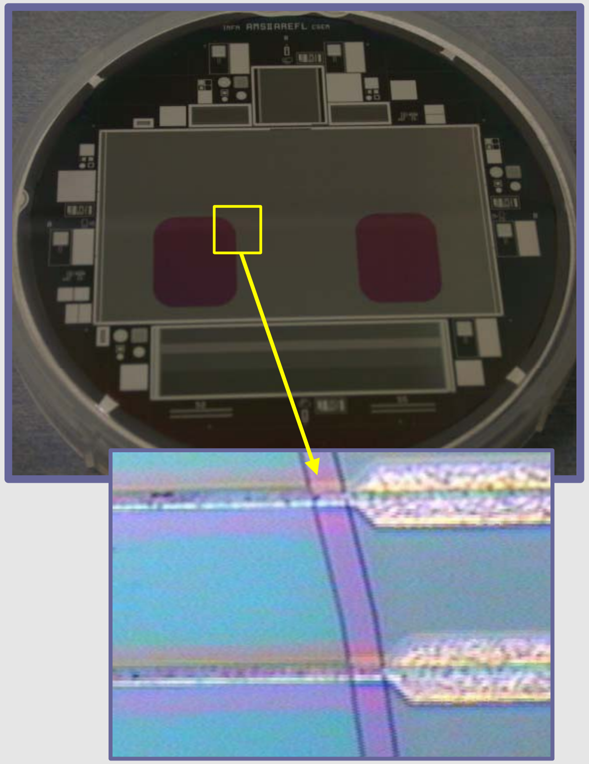
AMS-01 innovation (W. Wallraff)

λ = 1082 nm

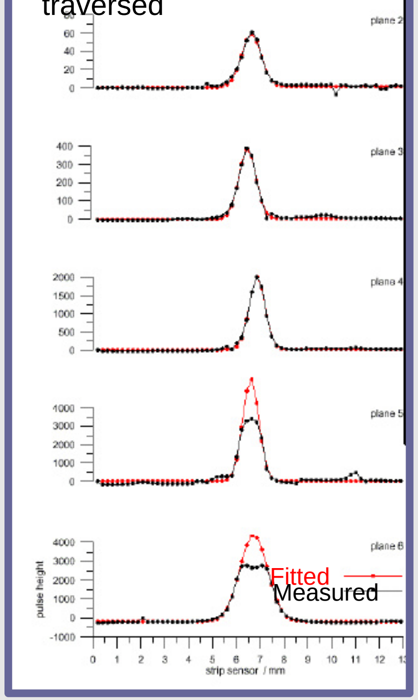
IR "pseudotracks"

1-2 µm accuracy obtained

Transmittance~ 50%

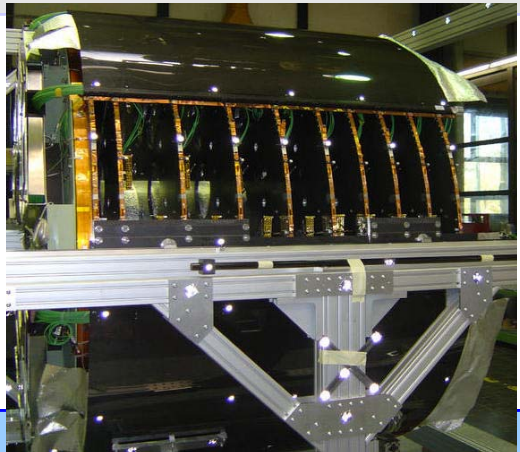


Up to 4 ladders traversed



CMS

TEC



λ = 1075 nm

- Optimization of sensors not included from beginning of sensor design ⇒ **lower transmittance** achieved~20%
- 180 deg **beam splitters** in the middle of the tracker produce back to back beams measured by modules
- Laser spot reconstructed with **10 µm resolution** (1st sensor)

9 TEC disks (18 petals) reconstructed using 2 beams with 50 µm accuracy (100 µm required in CMS)

RD on Sensors: IRuS for alignment (3)

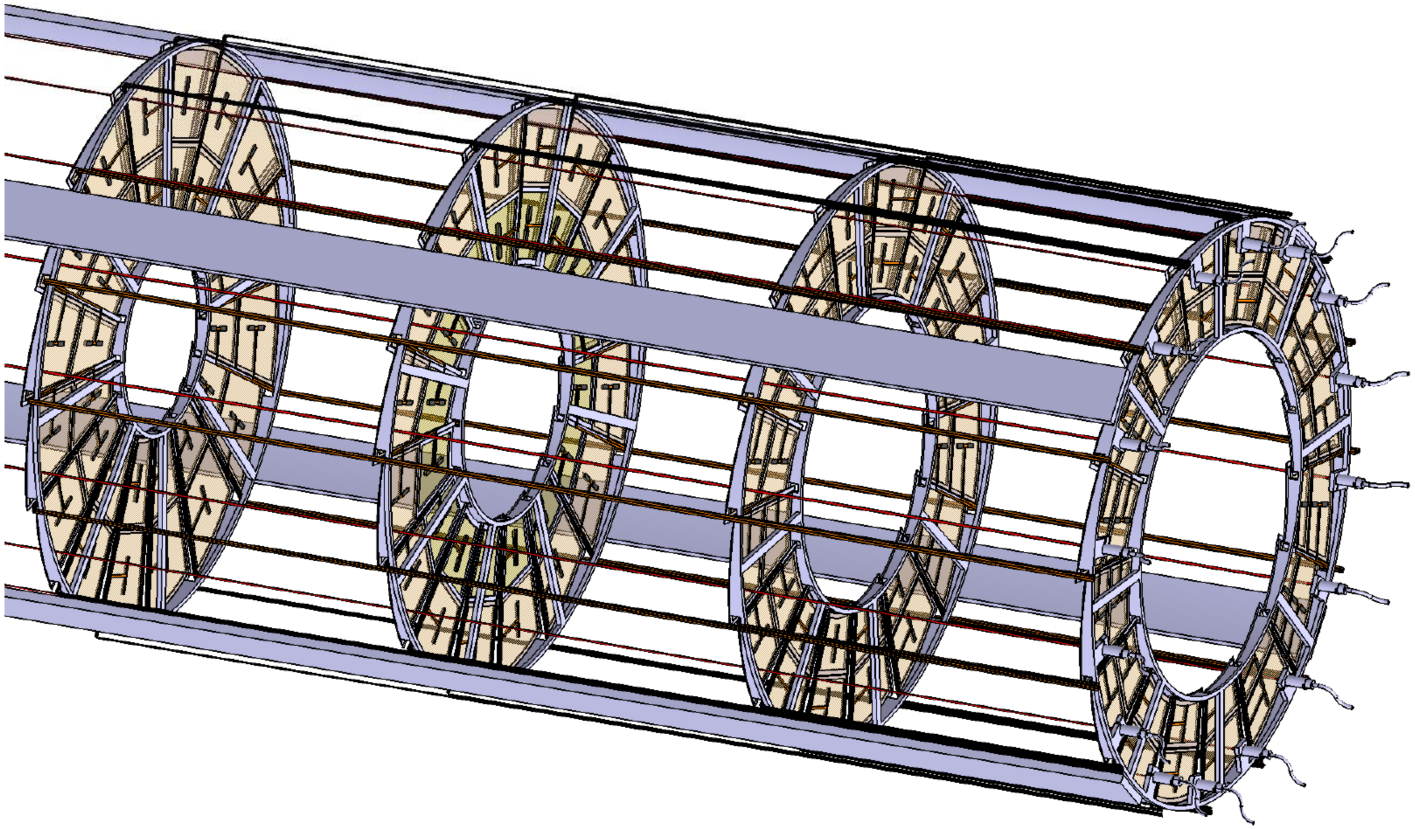
- Advantages:
  - Similar sensors for tracking and alignment.
  - Same r/o electronics.
  - Same code as for track alignment
  - No precision mechanics, mechanical transfer does not contribute to the error budget
  - Minimal material:
    - In CMS forced to put the lasers and optics within the tracking volume.
    - Al the lasers collimators could be put outside the tracker volume as long as the sensors are transparent enough in such a way that the same laser can go through multiple layers

The name of the game is to increase the sensor transmittance

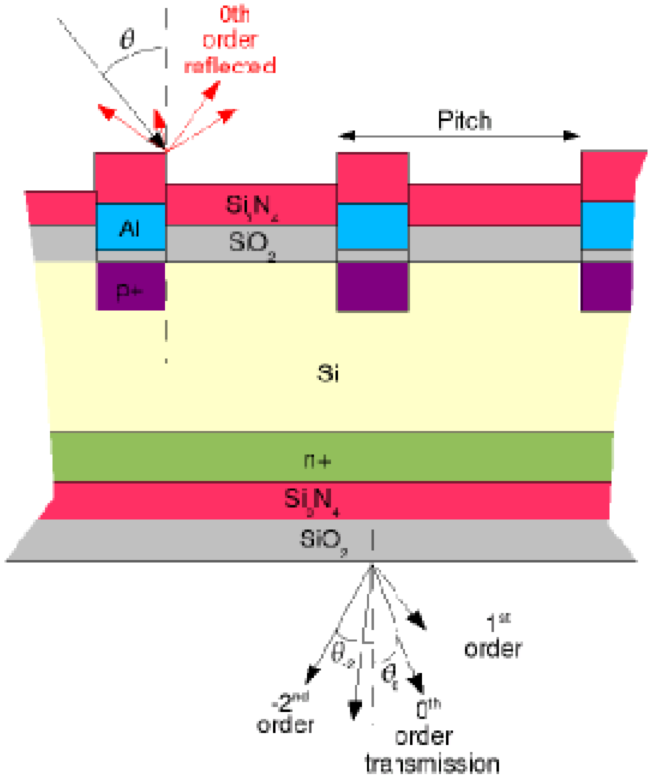
R&D program

- Starting with a conventional microstrip desing baseline design (p on n; AC coupling, 50 um pitch) introduce minimal design modifications to boost sensor IR transmittance.
- 1st - Validation of optical simulation software with material samples. (done)
- 2nd - Production of IR baby sensors. (on progress)
- 3th - Bench and beam testing of sensors

Current proposal for ILD’s FTD



Detector simulation



- Strips produce diffraction.

Interferences still present. So, both effects present at the same time.

- Even with normal incidence, we have diffraction orders propagating in directions away from the normal
- We use Rigorous Coupled Wave Analysis (RCWA) theory (there are others available):
  - Fields expanded as Fourier Series (FS)
  - Boundary conditions matched at each interface.
  - Truncation of FS $\Rightarrow$ "n" diffraction orders retained
  - Matrix inversion with very small numbers. Solution of the matrix system is now built in the theory and makes it more complicated to understand.

- Hopefully, we could use RODIS simulation package:

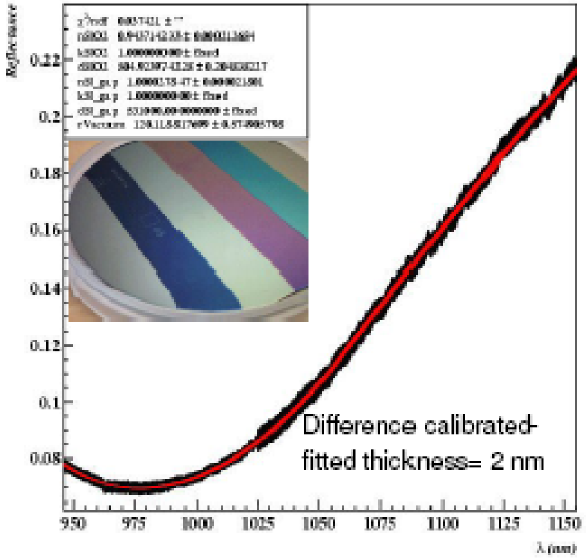
Advantages: We saved A LOT of time coding the solution of the Maxwell equations

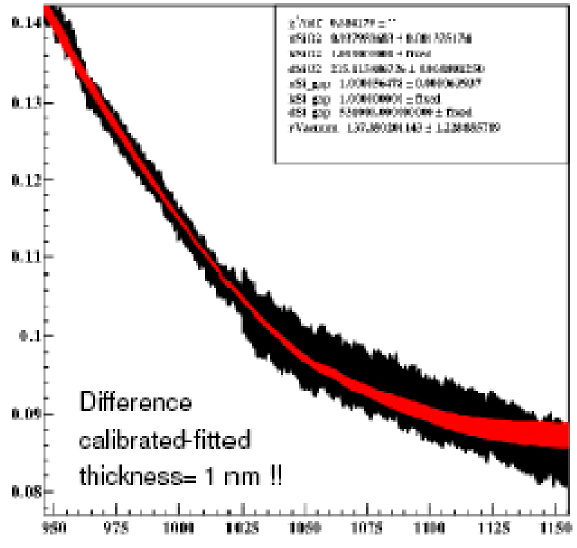
Disadvantages: Unsupported. Making any change in the source (available) obliged us to study the code. It took time (still less than writing it from scracth)

Simulation and material validation

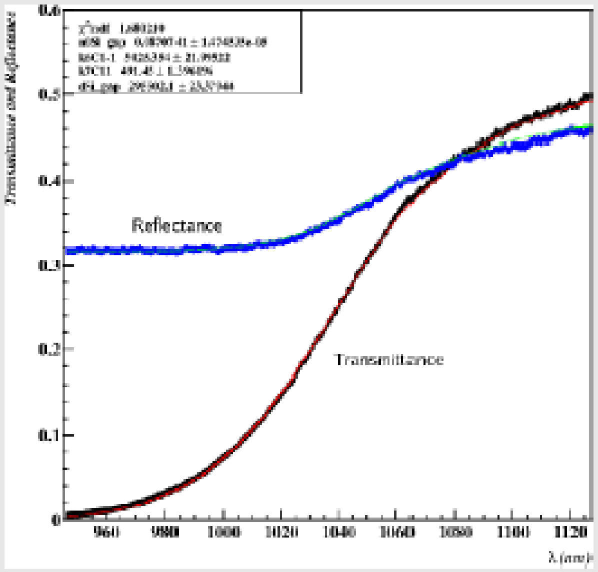
Reference wafer

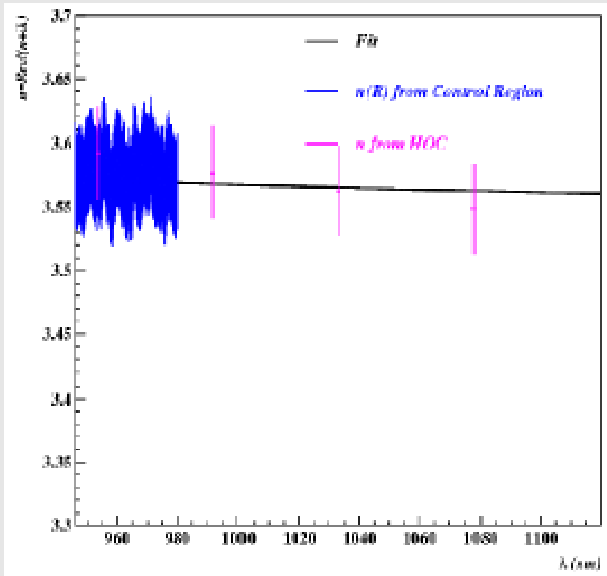
(SiO2 on Si)



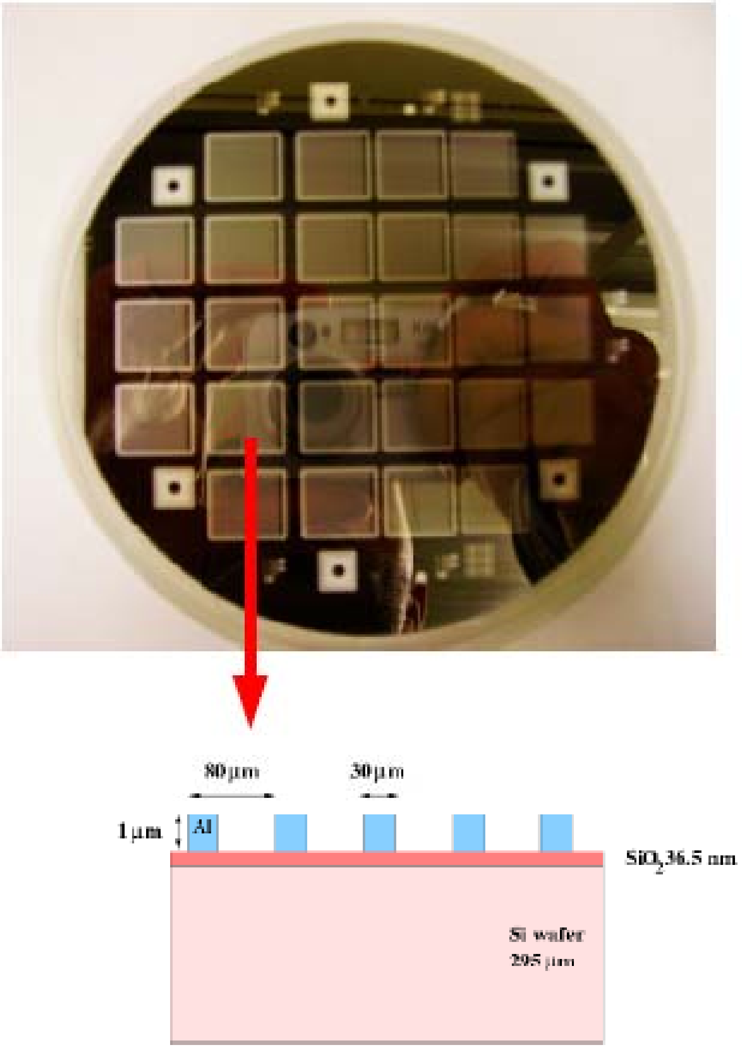


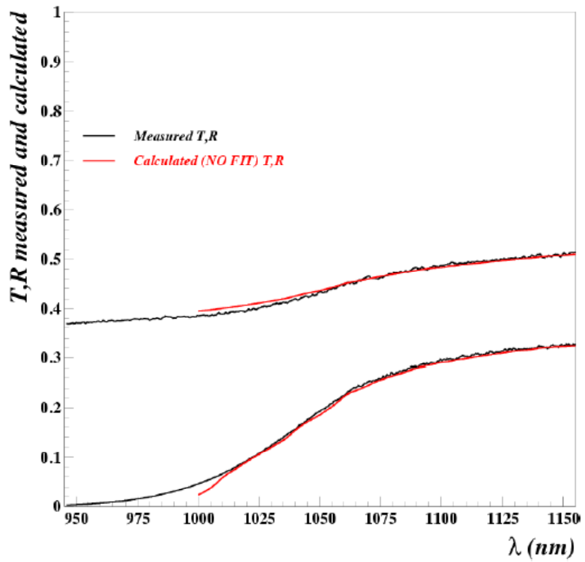
Silicon slab





Simulation and material validation(2)





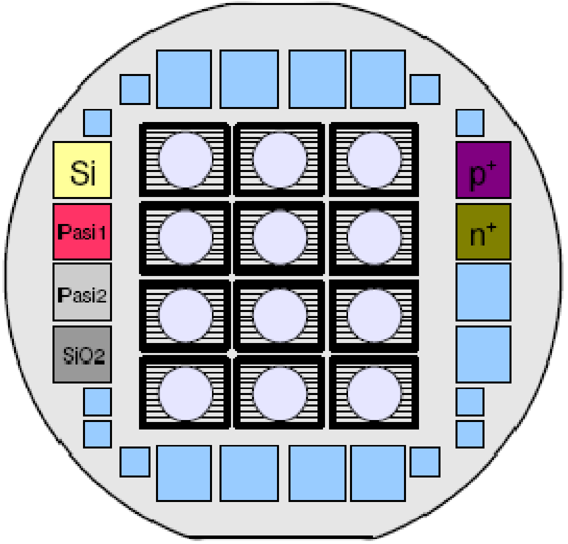
Reflectance and transmittance of wafer 5 matched. No fits involved!!

Compatible with 45 nm roughness of Al surface

Is this real? We need to measure the wafer roughness. I think it is possible to be done at CERN.

Baby sensors being produced at CNM

(Pictorial view)



Granted by GICSERV08

AC sensors

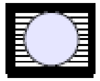
– Al strips (3 wafers)

– Al strips&Al backside (1 wafer)

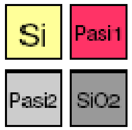
– Polysilicon strips (2 wafers)

– Low doping (2 wafers)

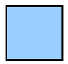
THINNED WAFERS [250, 200(?) µm]



- Alignment sensor 1.5×1.28 cm^2 (256 strips⇔ 2 Alibava)
- (Likely to become 1.5×1.5 cm^2 with guard rings...)
- Al hole in the back ∅~1 cm
- Strip width is the same along the full strip
- Slightly larger area to mount on PCB



- Optical test structure (TS)
- **No Al in the back**
- 1 per layer of material
- Ellipsometry?



- Electrical TS
- See poster by M. Dragicevic at INSTR08, Novosibirsk
- **All SILC TS are valid here**

Pitch (P), electrode width (w) and intermediate strips:

P=50µm w=3 µm	P=50µm w=5 µm	P=50µm w=10 µm
P=50µm w=3 µm 1 intermediate strip	P=50µm w=5 µm 1 intermediate strip	P=50µm w=10 µm 1 intermediate strip
P=50µm w=3 µm 1 intermediate strip	P=50µm w=5 µm 1 intermediate strip	P=50µm w=10 µm 1 intermediate strip
P=50µm w=3 µm 2 intermediate strips	P=50µm w=5 µm 2 intermediate strips	P=50µm w=10 µm 2 intermediate strips

About the LoI content on aligment

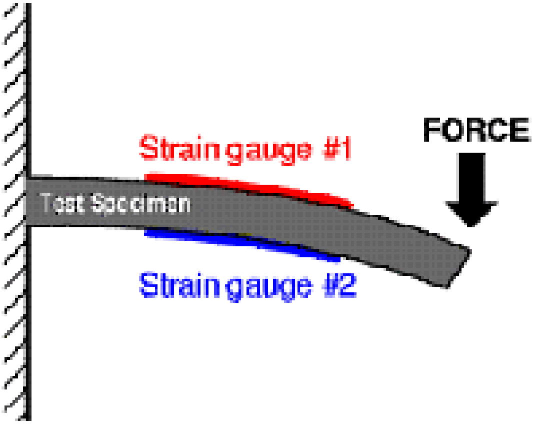
- Concerning the tracker alignment there is a 1.5 page on the current LoI draft proposing "two methods" FSI a IR laser alignment.
- The two technics are very complimentary: IR laser system strong on measuring transverse displacement while FSI strong measuring linear displacements.
- A smart combination of both monitoring technologies would be the optimal solution

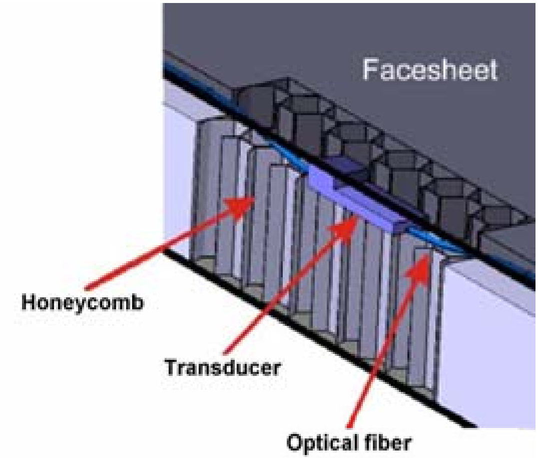
Final remark

- During the pull-push procedure beyond rigid desplacements deformations and vibrations may be an issue.
- We should consider introducing well know monitoring technologies in aeronatics and civil works based on fiber optics sensors. (accelaration, strain, temperature)
- Those sensors should be integrated on the composite layout of the FC support they add zero material

INTEGRATED FOS

- For the Track structure would be interesting to use a embedded fiber optic sensor.
  - more precise and reliable data
- It could be use 2 side solution
  - Better understanding of the results
  - Useful to quantify the termical strain





Integrated FOS in a FC strut