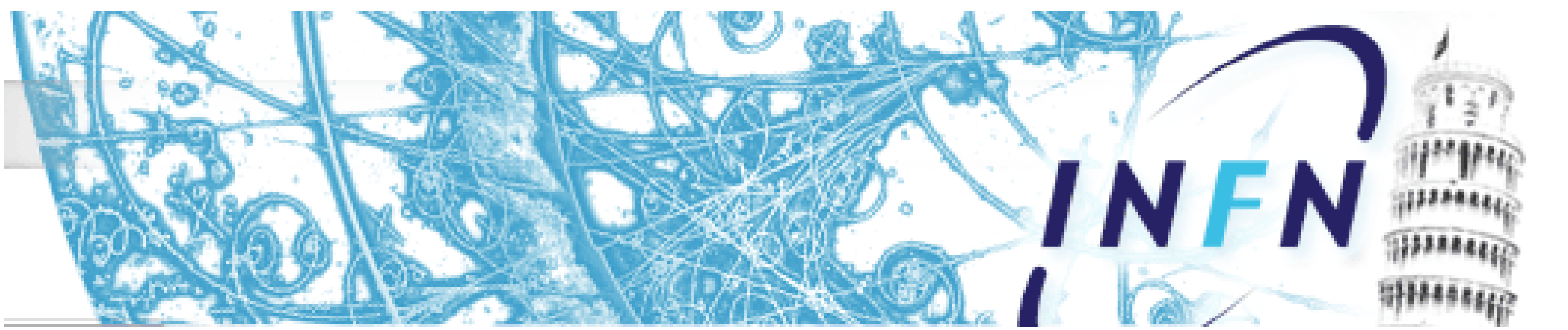
SVT Mechanics

F. Bosi, A.Bernardelli

INFN-Pisa

on behalf of the SuperB SVT Group



Outline

- SVT components design update
- Be pipe (L=390 mm)
- I.R. general layout update (cryostat flanges position)
- L0 pixel module support: micro-channel bidirectional flow
- SVT Quick Demounting
- Conclusion

SVT Components Update

1) Difference shift of the L2 and L3 modules position w.r.t. the I.P.

- Reason: better condition for clearance between L2 and L0

↓

Change for the fanout dimensions

2) Be pipe L=390 mm

- Reason -> better clearance Be beam-pipe flanges/L0 striplets cold flanges
-> more space for coolant feeding circuit Be beam-pipe

↓

Reduction of the C.F. semicone nose length

Cooling ring L1/2 forw/back moved outside from I.P. (3.5 mm)

Differente design for L0 striplets Cold flanges

SVT Module Master tablet

Layer Shift in Z direction

SVT - Dimensioni e copertura angolare sensori

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Layer	Radius piano y-z sensore barrel SuperB	Radius piano y-z punto estremo sensore wedge SuperB	Radius punto estremo laterale sensore SuperB	Lunghezza orizzontale sensore tangente cono 300 mrad SuperB	Lunghezza sensore barrel SuperB (tabella Londra)	Lunghezza totale sensore barrel SuperB	Lunghezza totale sensore totale SuperB	Lunghezza estensione sensore oltre 300 mrad SuperB column (G-E)/2	Lunghezza estensione sensore oltre 350 mrad BaBar	Angolo intercettato nel punto ingombro estremo sensore con piano y-z (rad)	Angolo intercettato nel punto ingombro estremo laterale sensore (rad)	Shift Layer asse Z (mm)	Angolo intercettato nel punto ingombro estremo sensore con piano y-z+shift (rad)	Angolo intercettato ingombro fisico sensore estremo laterale +shift (rad)
0	15,10	-	17,30	97,63	-	104,00	104,00	3,19	-	0,283	0,321	0	-	-
1	32,85	-	36,97	212.39	214,78	223,36	223,36	5,48	21.69	0,286	0,320	+2	0,284	0,325
2	39,85	-	44,26	257.65	262.78	265,78	265,78	4.06	2.51	0,291	0,322	-2	0,293	0,326
3	58,85	-	65,28	380.49	385,70	385,70	385,70	2,60	1.41	0,296	0,326	0	-	-
4A	119,85	87,91	90,54	574,60	457.95	457.95	578,23	2,05	1.96	0,295	0,303	+2	0,293	0,293
4B	123,85	91,91	94,42	597,69	479.42	479.42	599,70	1.14	1.07	0,297	0,305	+2	0,296	0,296
5A	139,85	112,18	114,25	732,47	613.04	613.04	737,46	2.72	2.58	0,295	0,300	-2	0,297	0,297
5B	143,85	116,18	118,18	756,53	635.84	635.84	760,26	2.05	1.93	0,297	0,301	-2	0,298	0,298

Modules have sensor in symmetric position but respect I.P. they are shifted along z direction to avoid middle dead space

SVT Module shift

New Layer Shift in Z direction

SVT - Dimensioni e copertura angolare sensori

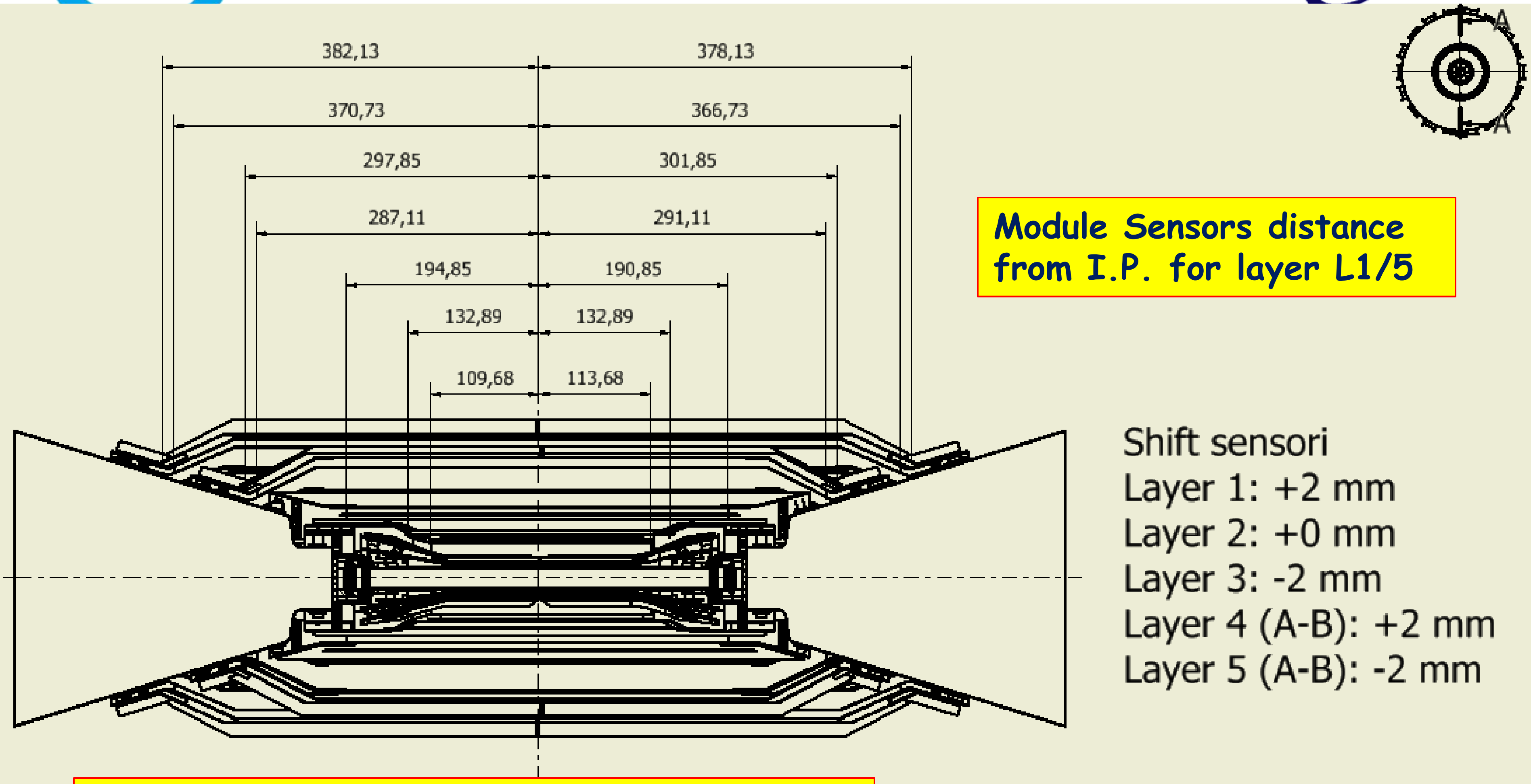
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Layer	Radius piano y-z sensore barrel SuperB	Radius piano y-z punto estremo sensore wedge SuperB	Radius punto estremo laterale sensore SuperB	Lunghezza orizzontale sensore tangente cono 300 mrad SuperB	Lunghezza sensore barrel SuperB (tabella Londra)	Lunghezza totale sensore barrel SuperB	Lunghezza totale sensore totale SuperB	Lunghezza estensione sensore oltre 300 mrad SuperB column (G-E)/2	Lunghezza estensione sensore oltre 350 mrad BaBar	Angolo intercettato nel punto ingombro estremo sensore con piano y-z (rad)	Angolo intercettato nel punto ingombro estremo laterale sensore (rad)	Shift Layer asse Z (mm)	Angolo intercettato nel punto ingombro estremo sensore con piano y-z+shift (rad)	Angolo intercettato ingombro fisico sensore estremo laterale +shift (rad)
0	15,10	-	17,30	97,63	-	104,00	104,00	3,19	-	0,283	0,321	0	-	-
1	32,85	-	36,97	212.39	214,78	223,36	223,36	5,48	21.69	0,286	0,320	+2	0,284	0,325
2	39,85	-	44,26	257.65	262.78	265,78	265,78	4.06	2.51	0,291	0,322	0	0,293	0,326
3	58,85	-	65,28	380.49	385,70	385,70	385,70	2,60	1.41	0,296	0,326	-2	-	-
4A	119,85	87,91	90,54	574,60	457.95	457.95	578,23	2,05	1.96	0,295	0,303	+2	0,293	0,293
4B	123,85	91,91	94,42	597,69	479.42	479.42	599,70	1.14	1.07	0,297	0,305	+2	0,296	0,296
5A	139,85	112,18	114,25	732,47	613.04	613.04	737,46	2.72	2.58	0,295	0,300	-2	0,297	0,297
5B	143,85	116,18	118,18	756,53	635.84	635.84	760,26	2.05	1.93	0,297	0,301	-2	0,298	0,298

New Layers shift

L3: shifted -2mm in Z direction .
L2: symmetric w.r.t. I.P. because this layout allow better clearance condition between L0/L2

Modules have sensor in symmetric position but respect I.P. Modules are shifted along z direction to avoid middle dead space

Modules Position Shift

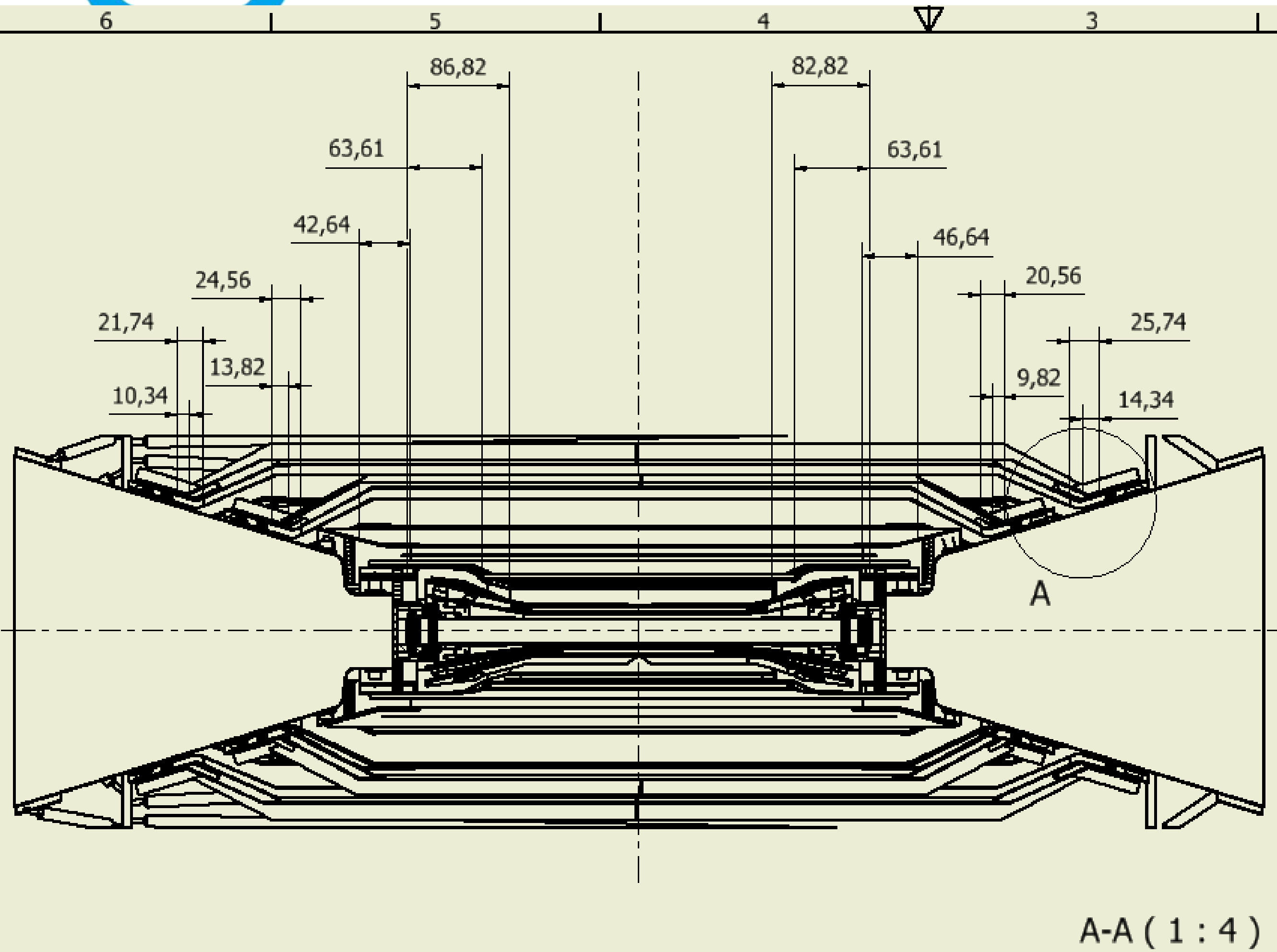


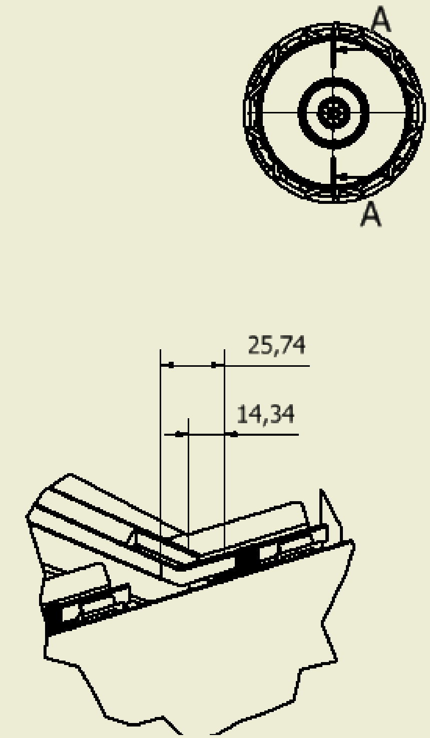
Module Sensors distance from I.P. for layer L1/5

Shift sensori
Layer 1: +2 mm
Layer 2: +0 mm
Layer 3: -2 mm
Layer 4 (A-B): +2 mm
Layer 5 (A-B): -2 mm

Reference drawing for module position shift from I.P.

Sensors/HDI distance





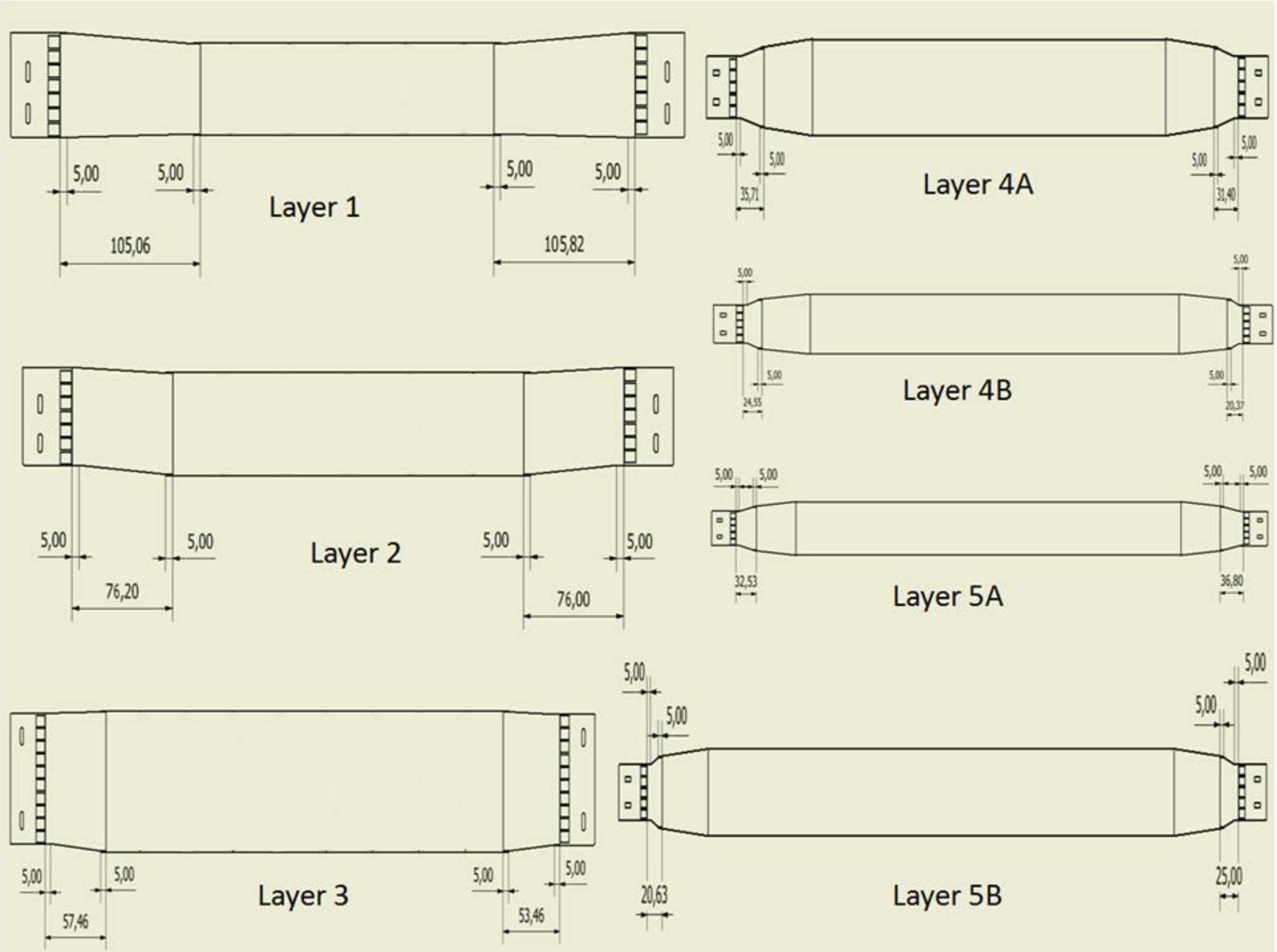
1 : 2)

Shift sensori
Layer 1: +2 mm
Layer 2: +0 mm
Layer 3: -2 mm
Layer 4 (A-B): +2 mm
Layer 5 (A-B): -2 mm

Reference drawing for sensor/HDI distance (on Z axis)

SVT Fanouts

Fanout dimension (not in scale)



SVT L1-5 Layout design

Modelling ribs for Layer 1-5

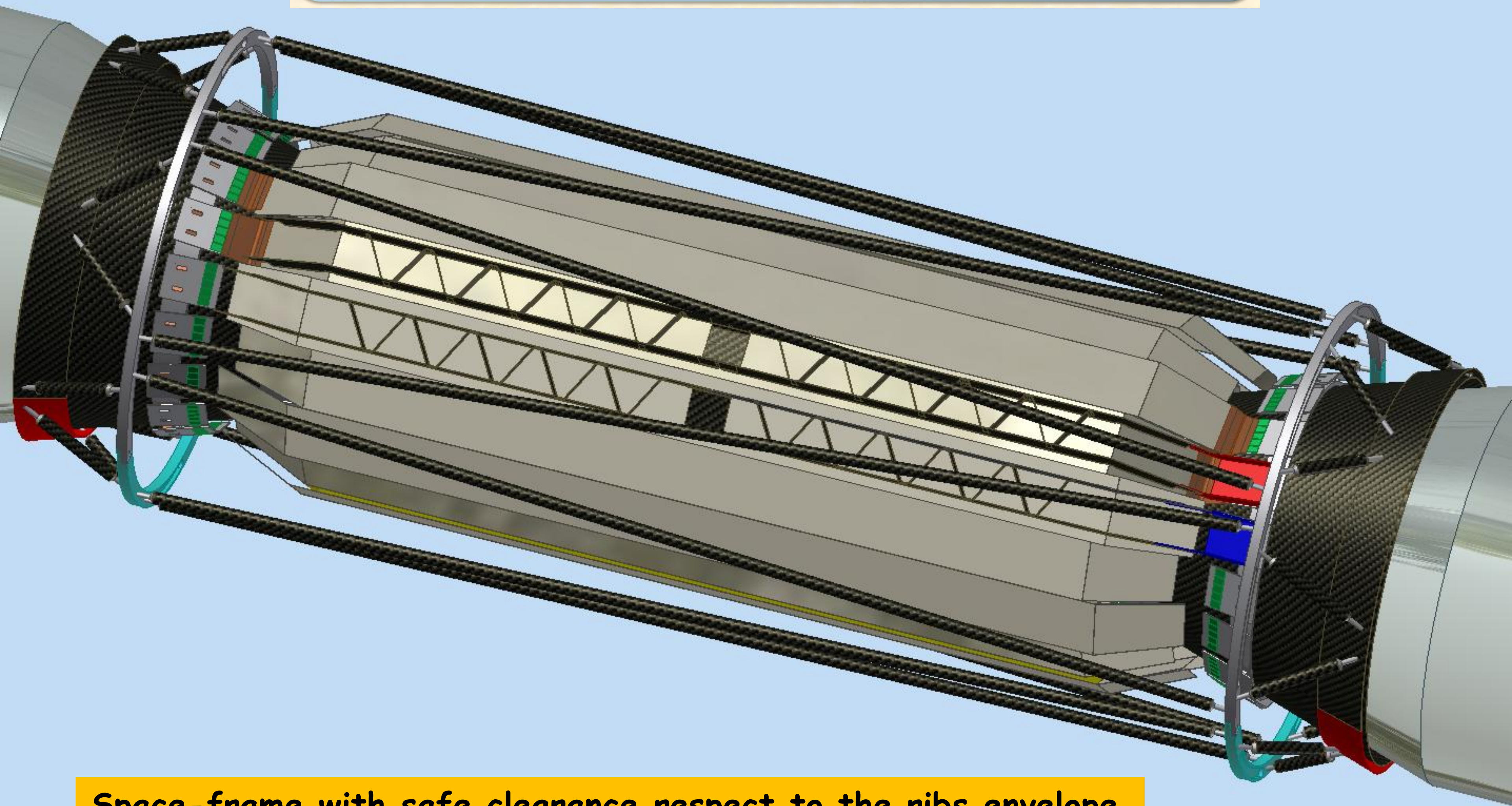
SuperB modules longer to respect Babar !

For L5B modules about 230 mm extra length respect Babar dimensions !

(L5B module total length about 760mm).

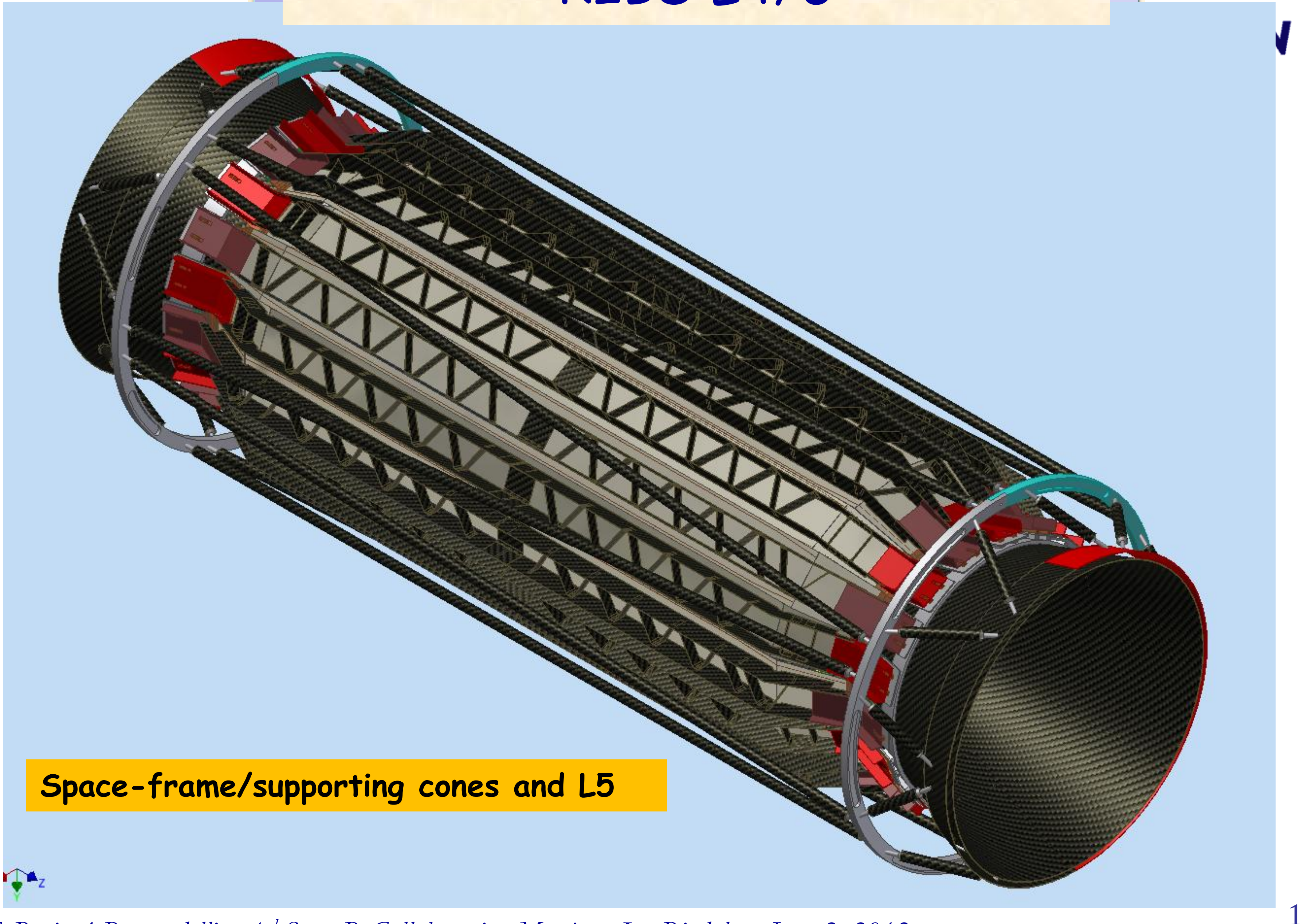
- Need ribs more height and a reinforced profile along the barrel sensors to be more rigid about flexion /torsion forces.
  - Snake Ribbon or lighter Reticular Structure to add to the ribs:
    - Snake Ribbon: N.1 equivalent rib/module
    - Reticular Structures: N.1/3 equivalent rib/module
- Work in progress for final dimensioning (thermo-structural simulation)

Ribs L5



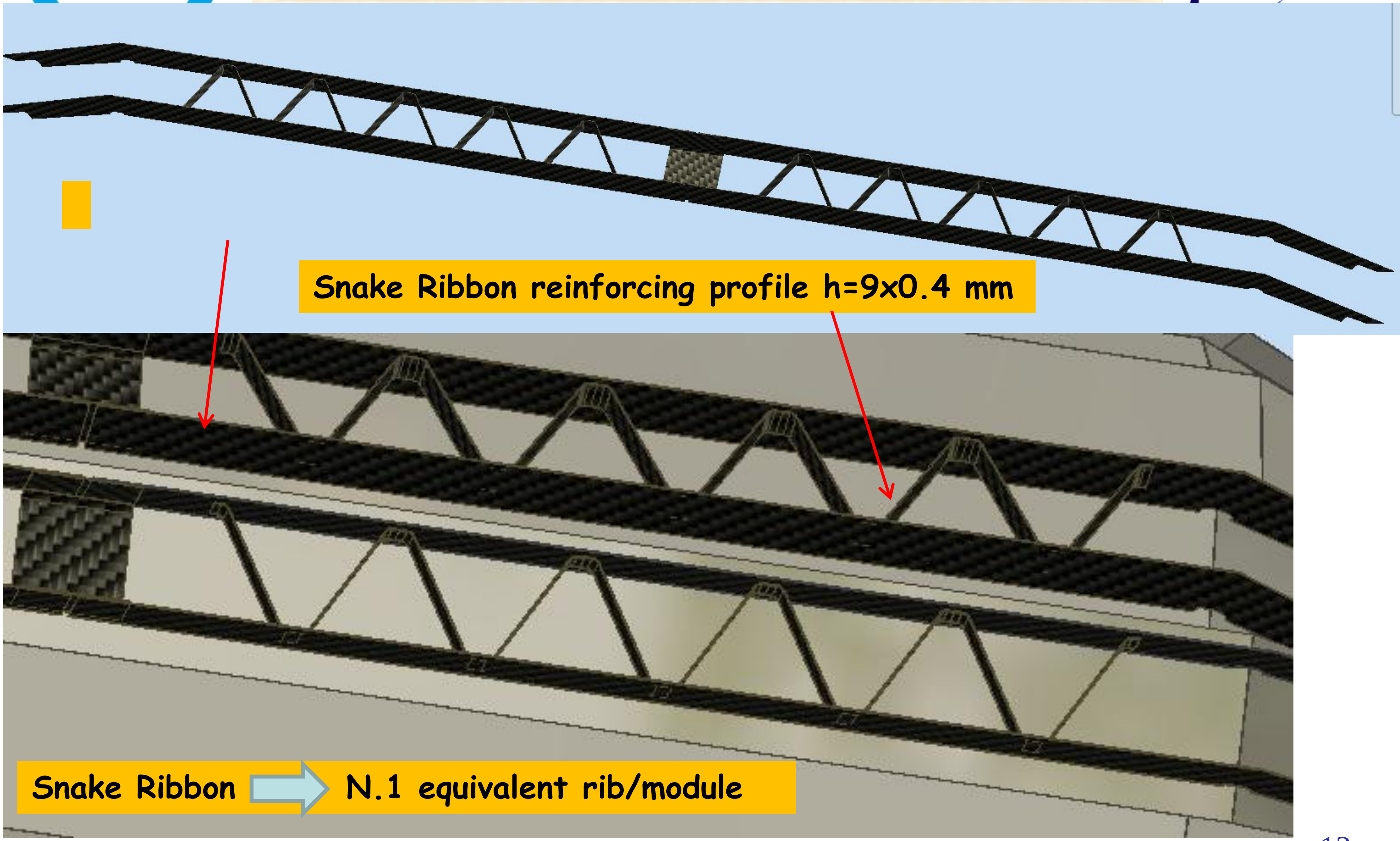
Space-frame with safe clearance respect to the ribs envelope

RIBS L4/5

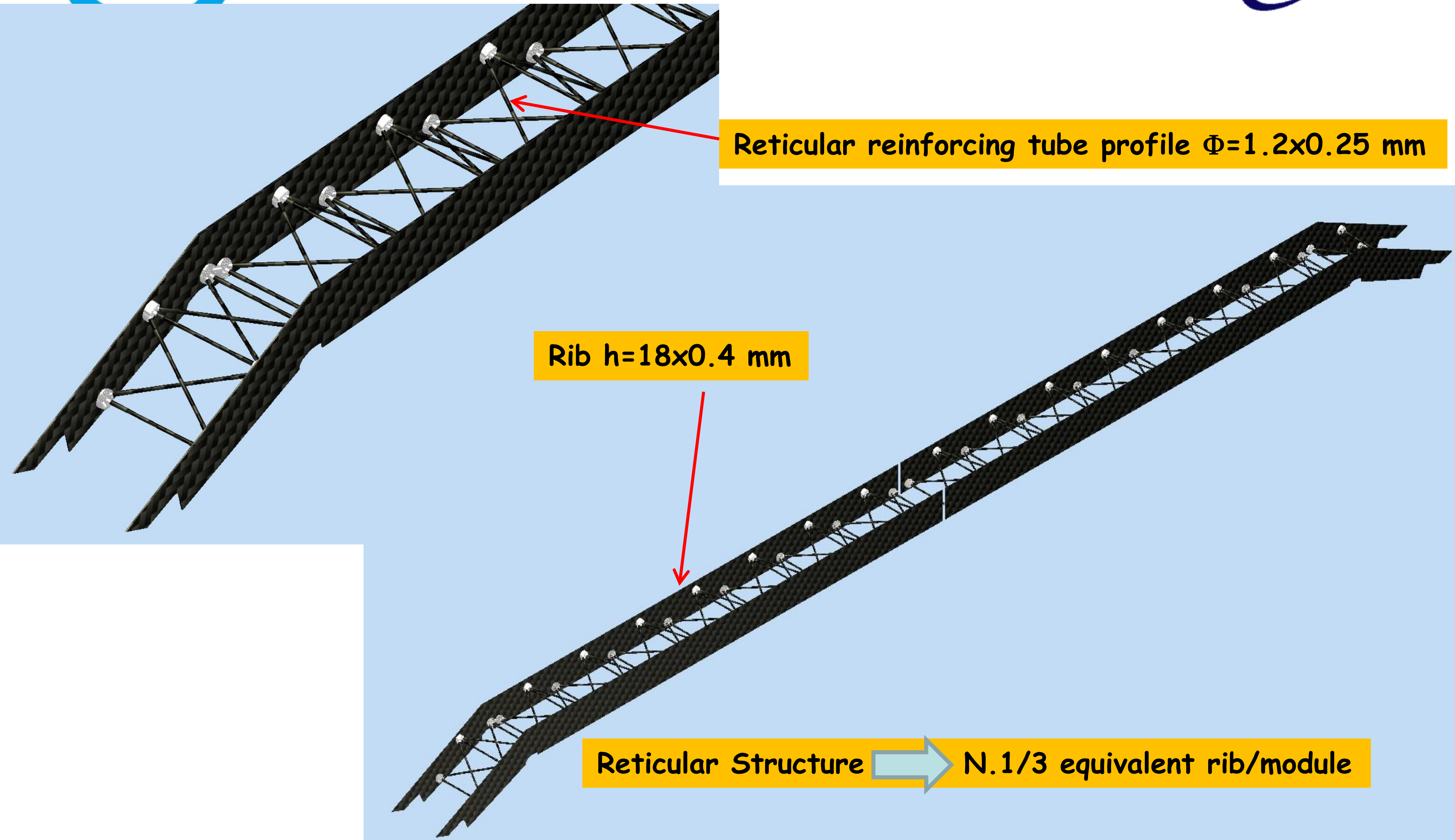


Space-frame/supporting cones and L5

RIBS L4/5

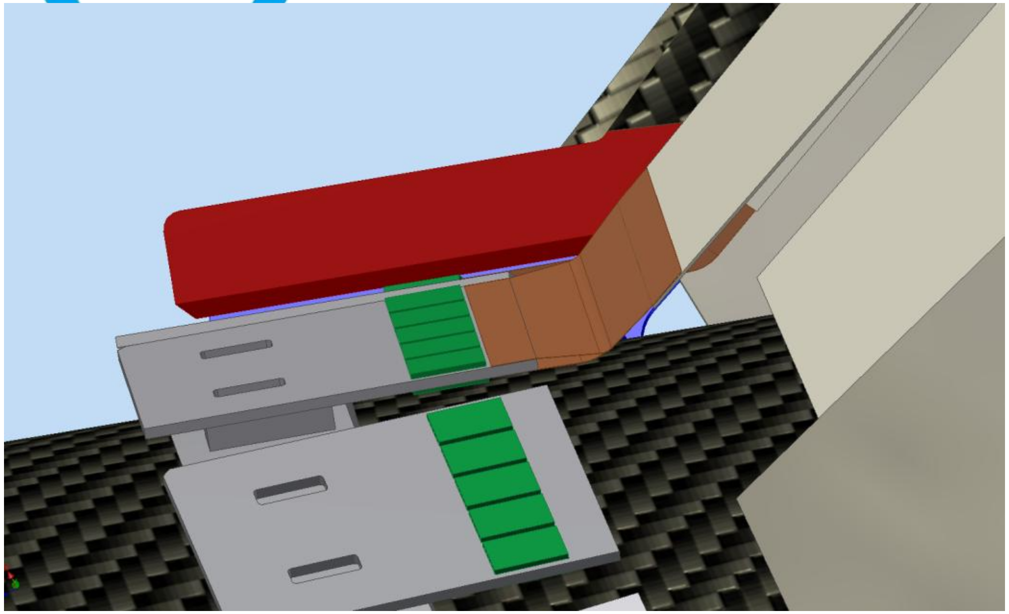

Snake Ribbon reinforcing profile h=9x0.4 mm
Snake Ribbon
N.1 equivalent rib/module

RIBS L4/5

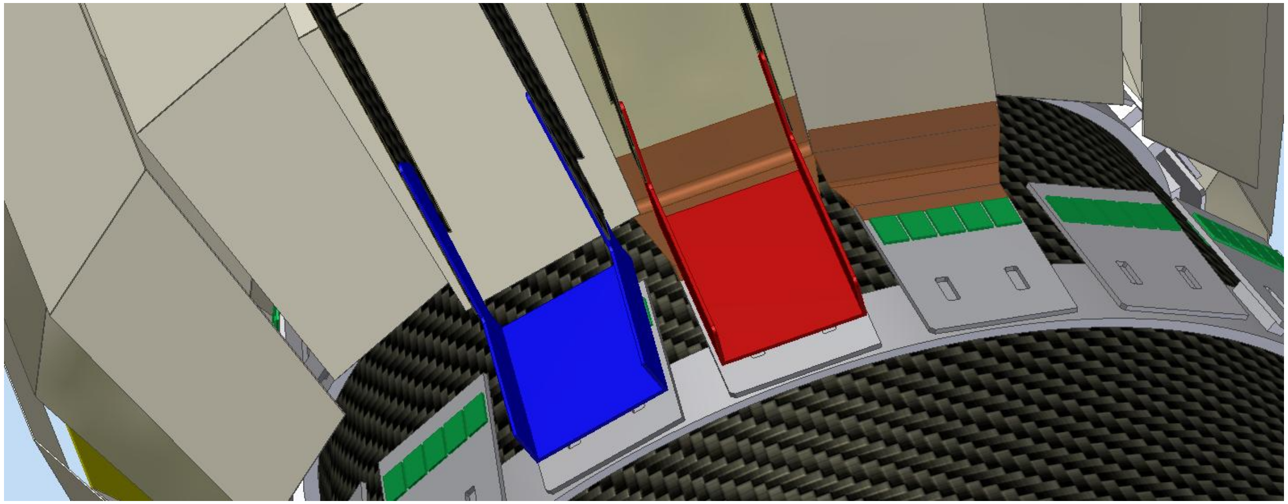


Reticular reinforcing tube profile Φ=1.2x0.25 mm
Rib h=18x0.4 mm
Reticular Structure
N.1/3 equivalent rib/module

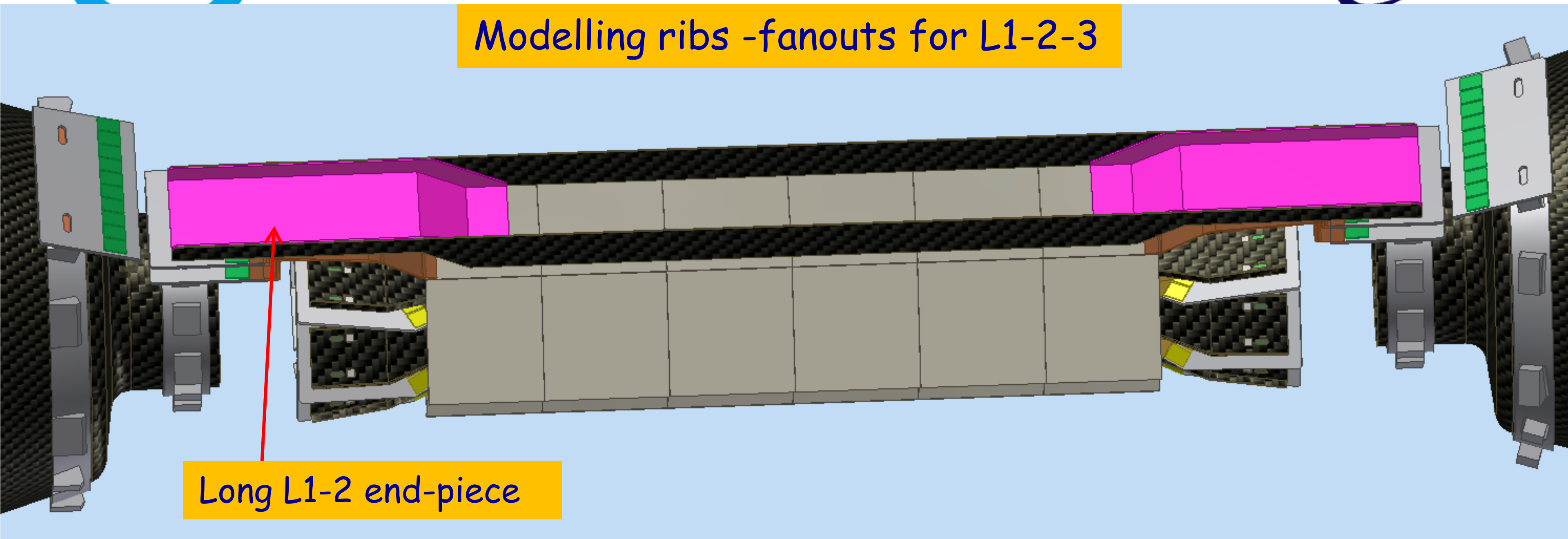
Fanout L4/5

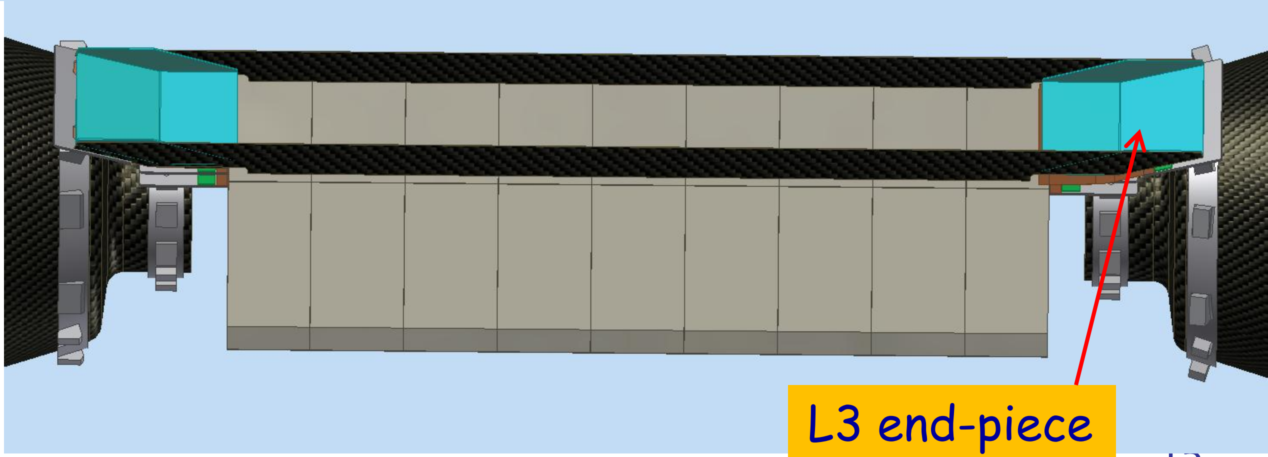


No particular problem to model fanout layer 4-5



SVT L1-5 design





SVT L1-5 Layout design

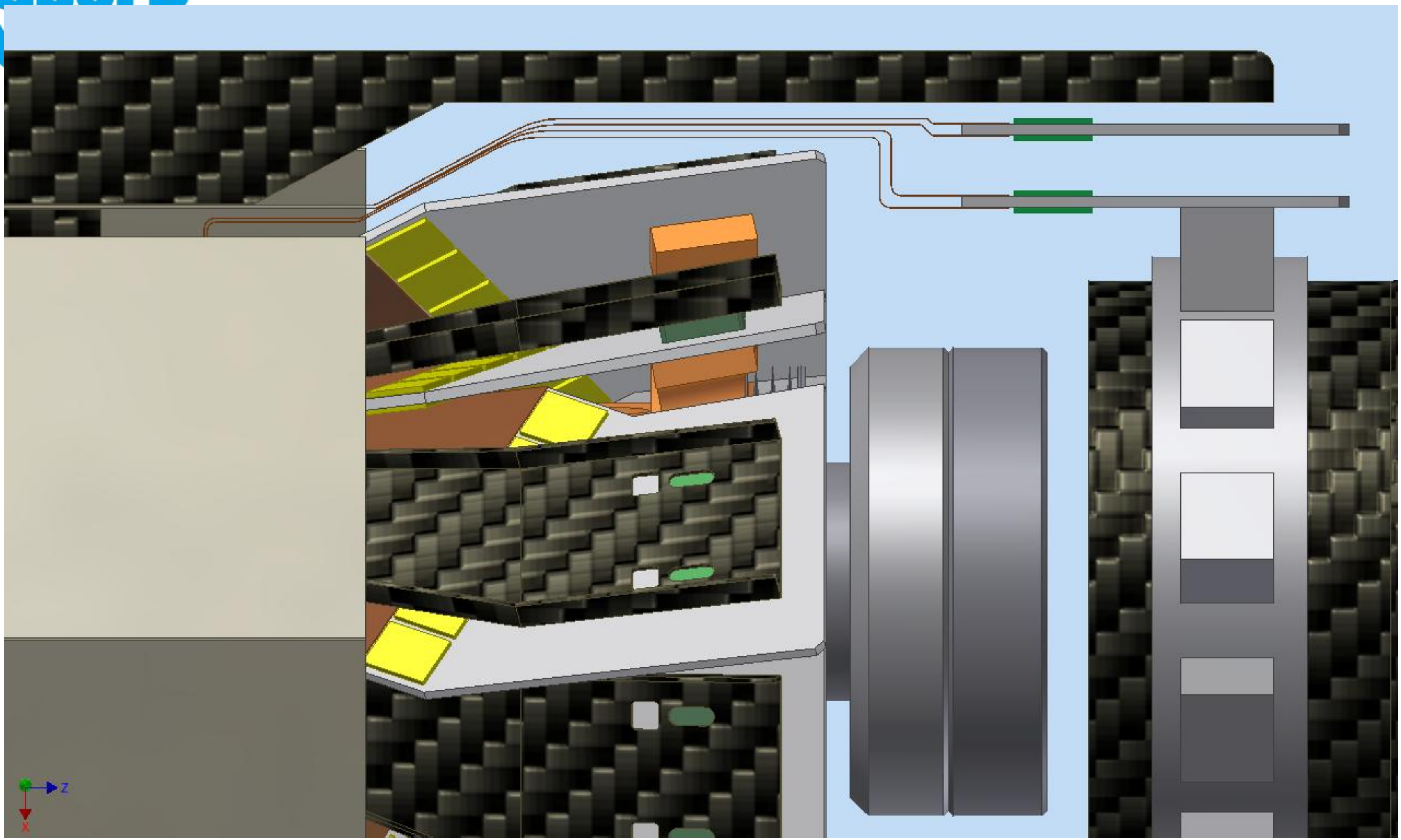
Modelling ribs -fanouts for L1-2 in update models

1) L1-2-L3 fanouts shape very peculiar :

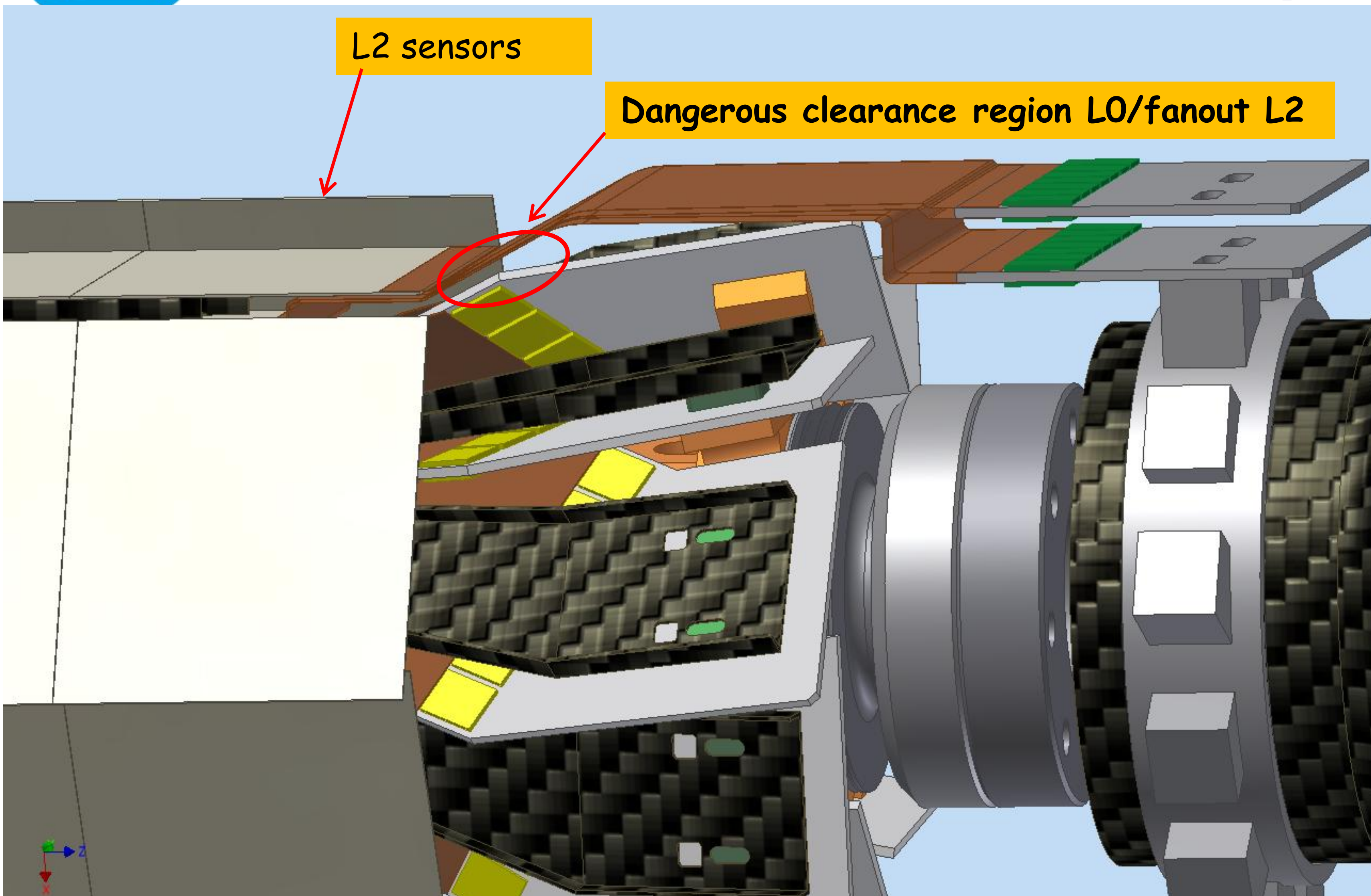
   -They need to round around the L0 Hybrid :ribs will be used like constrain to hold the fanout on the right shape

   - Region very crowded with small clearance between components!

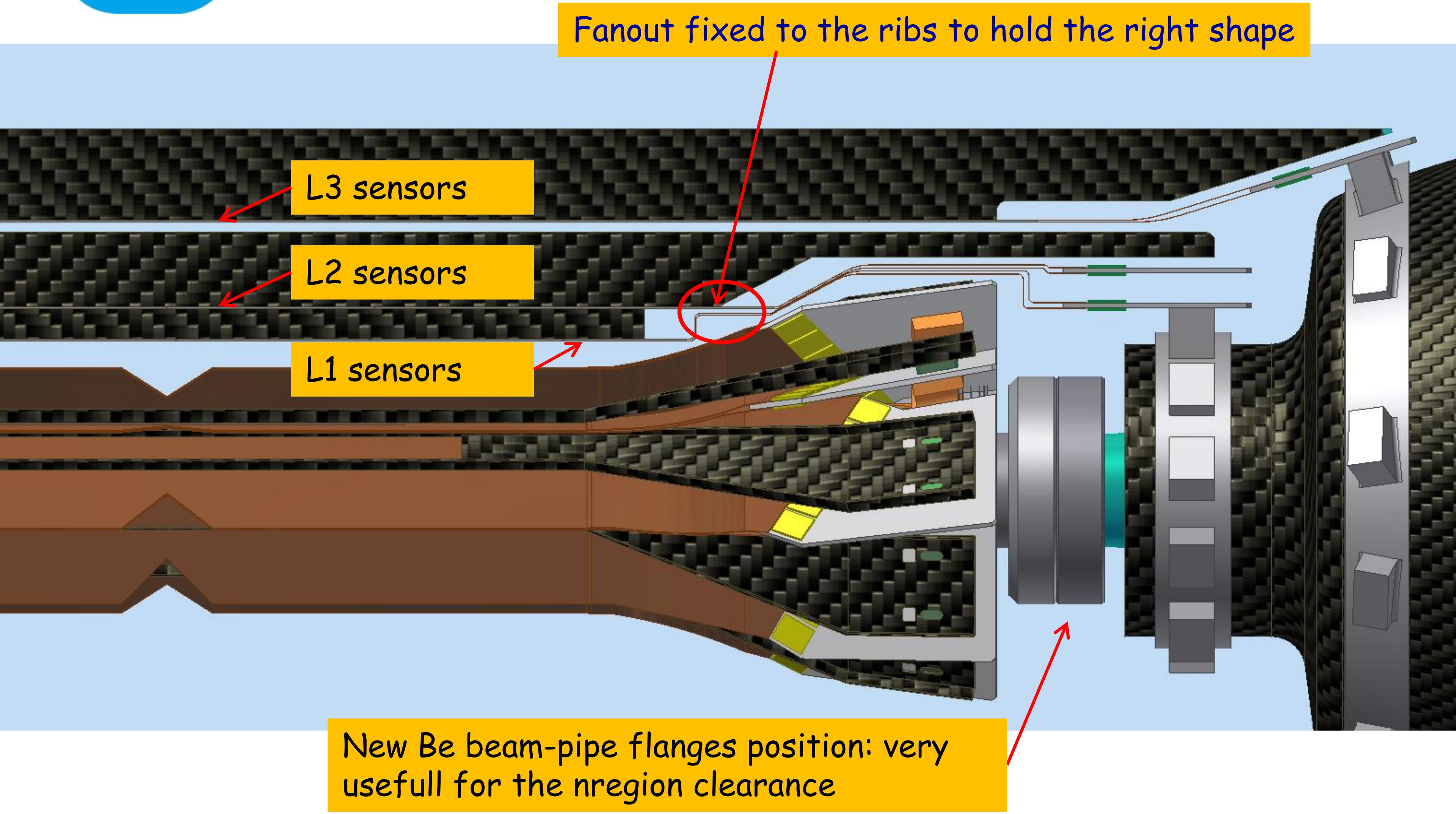
L0/L1-2 fanouts routing



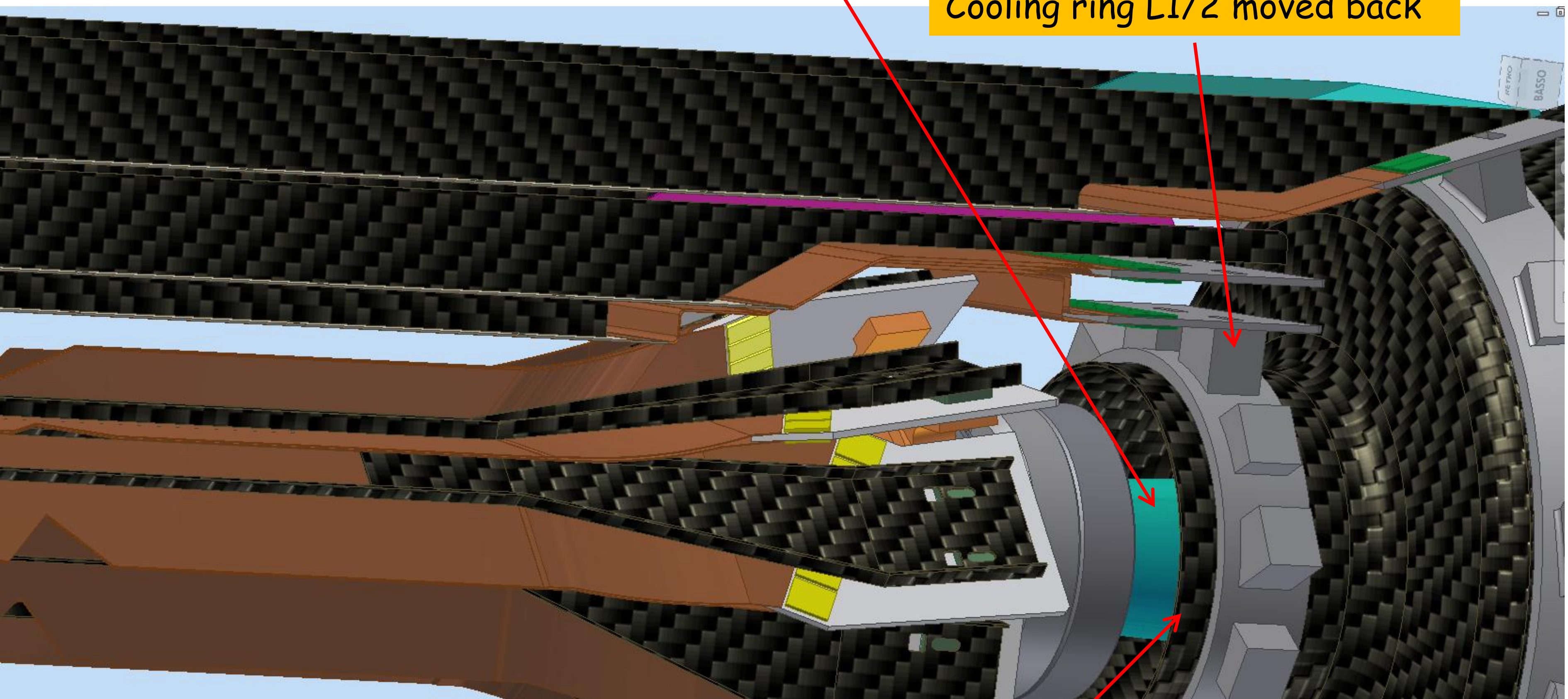
L0/L1-2 fanouts routing



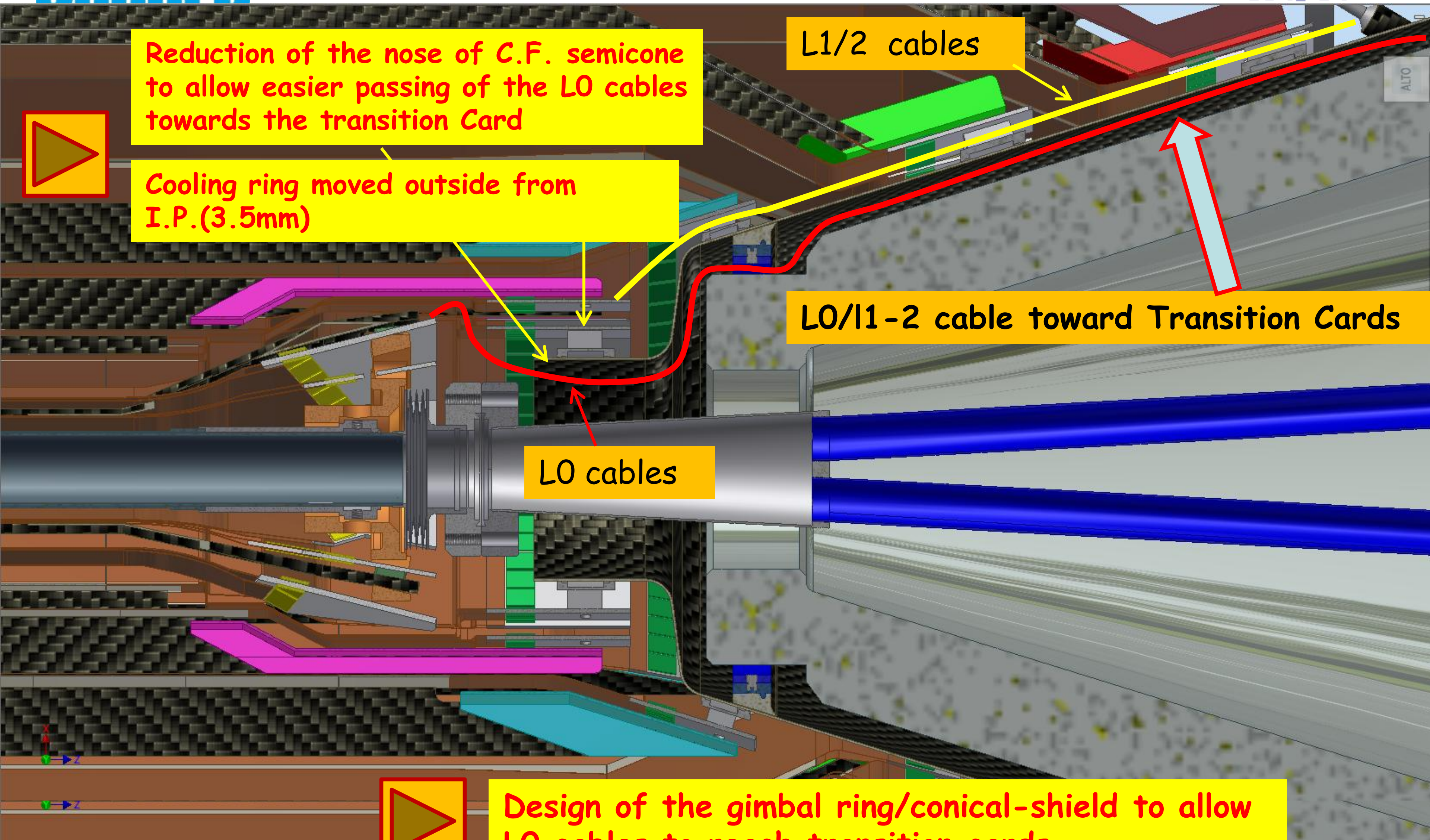
L0/L1-2-3 fanouts routing



L0/L1-2-3 fanouts routing

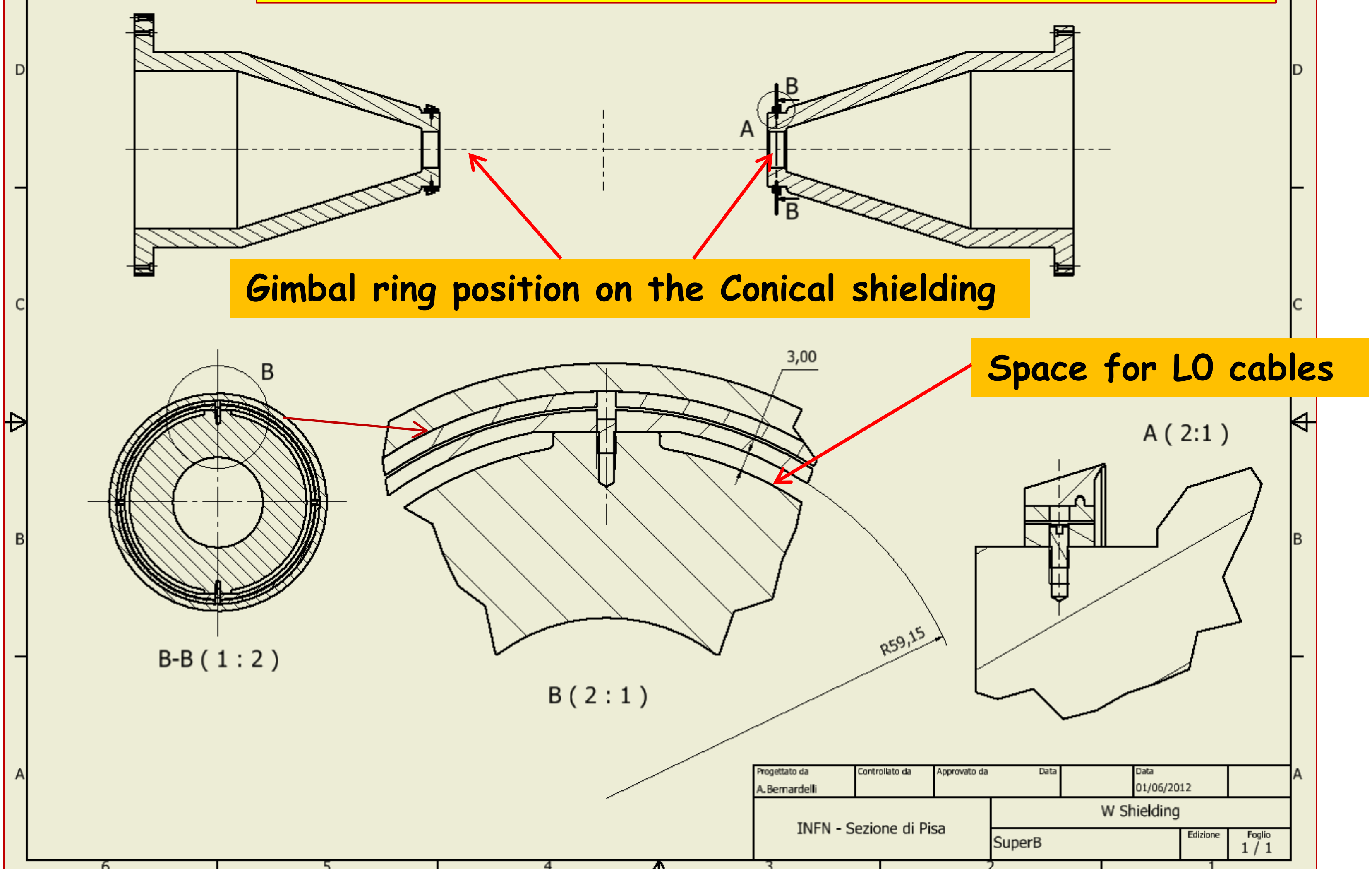


L0/L1-2 cables routing

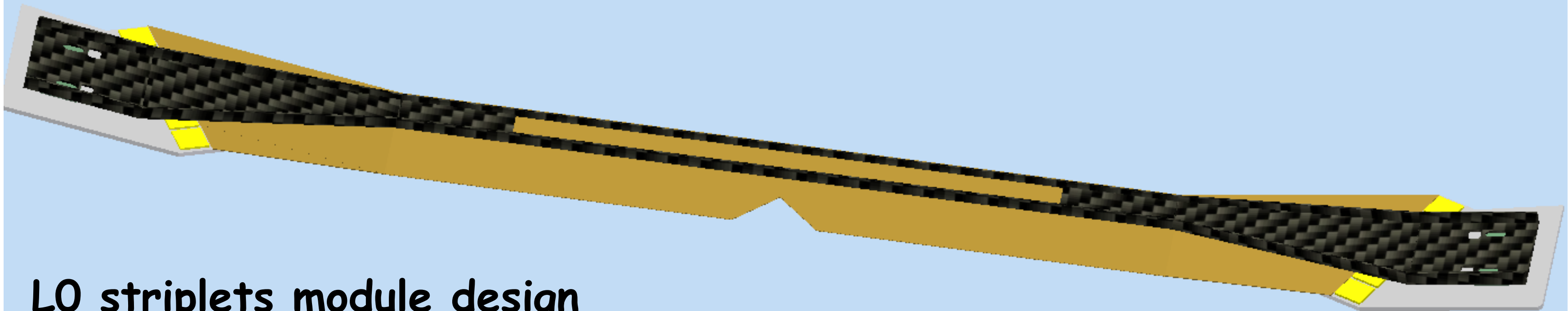


L0/L1-2 cable routing

Design to allow L0 cables to pass-through gimbal-ring/conical-shield to reach transition cards region.

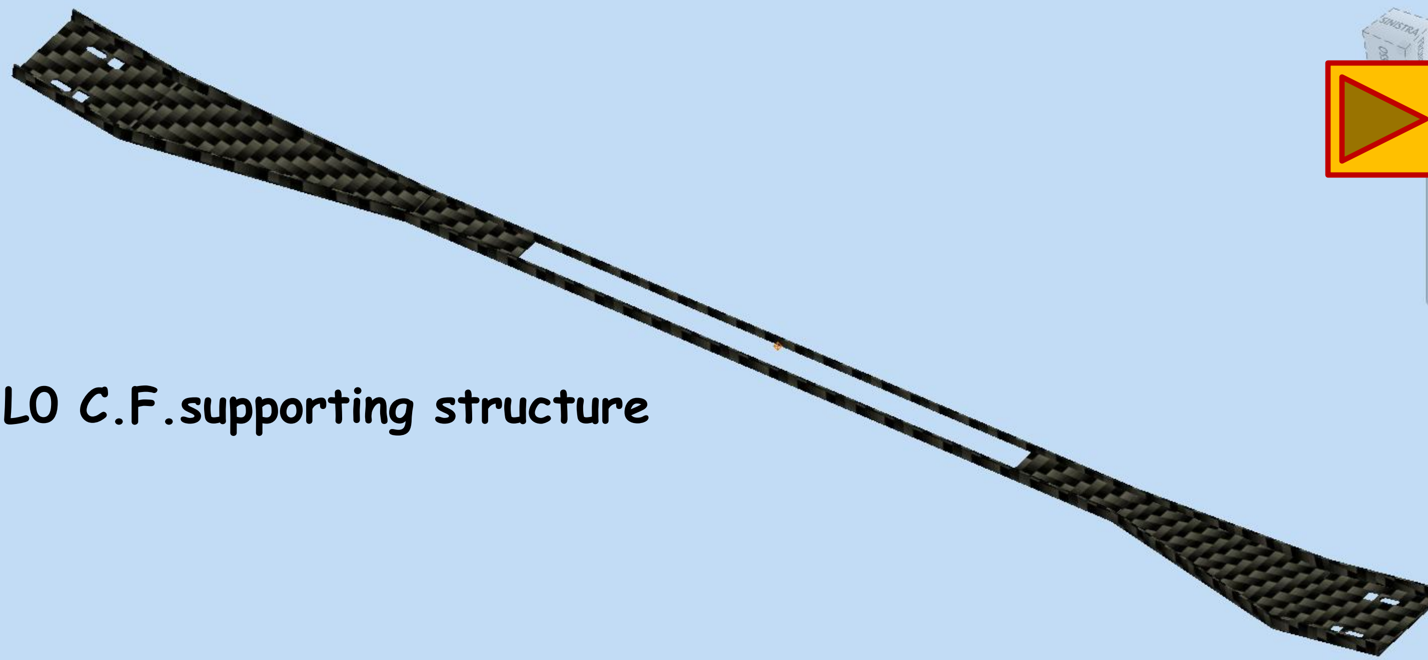


Striplets L0 module design



L0 striplets module design

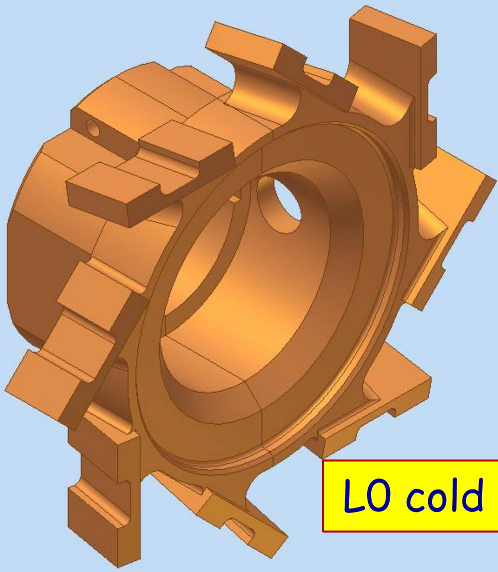
HDI/kapton inclinated 10°

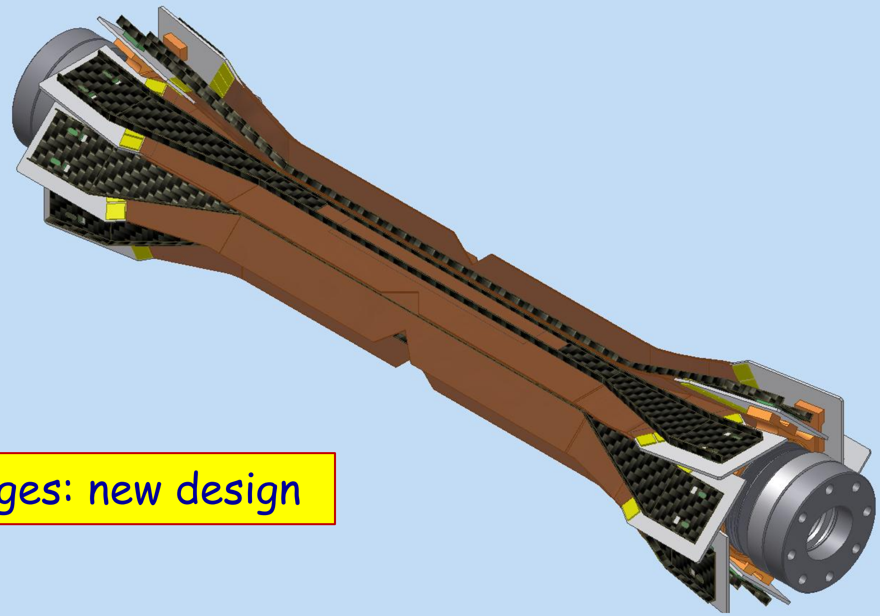


L0 C.F.supporting structure

Si sensor :
W=15.1 mm
L=104 mm
R=15.1 mm

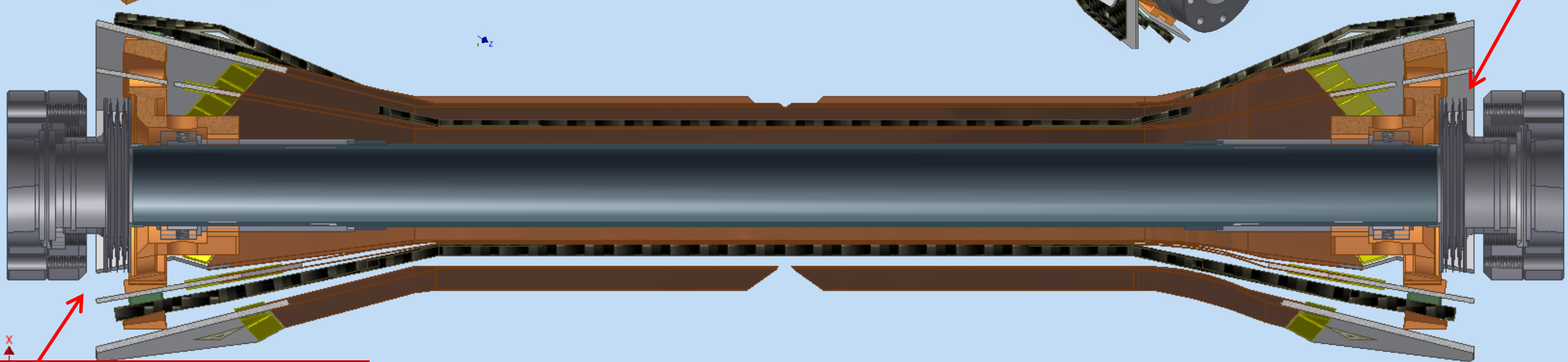
Be beam-pipe





L0 cold flanges: new design

more space for feeding Be beam-pipe circuit coolant

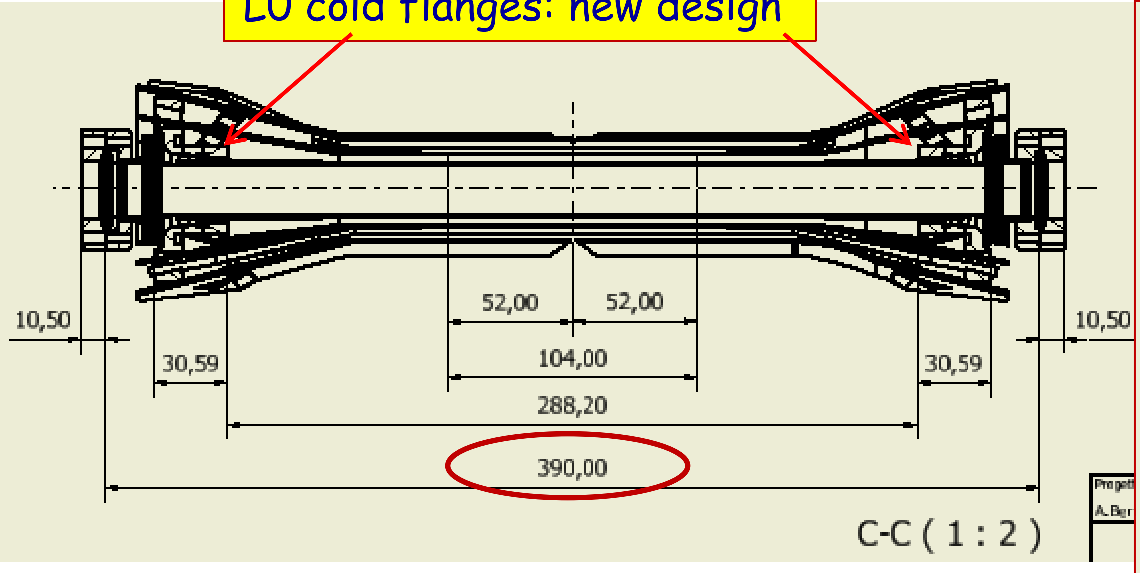


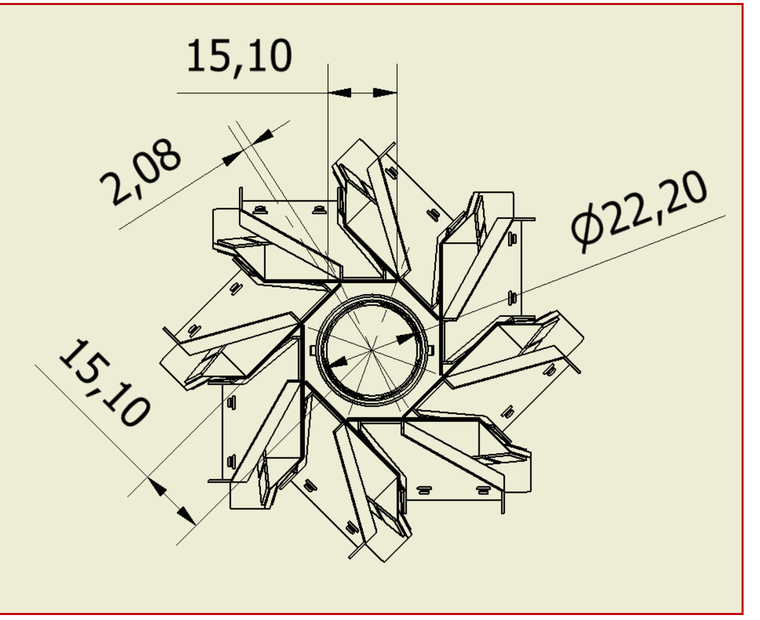
better clearance Be beam-pipe flanges/L0 striplets cold flanges

L0 Striplets + cold flanges + Be pipe 390 mm

L0 module design

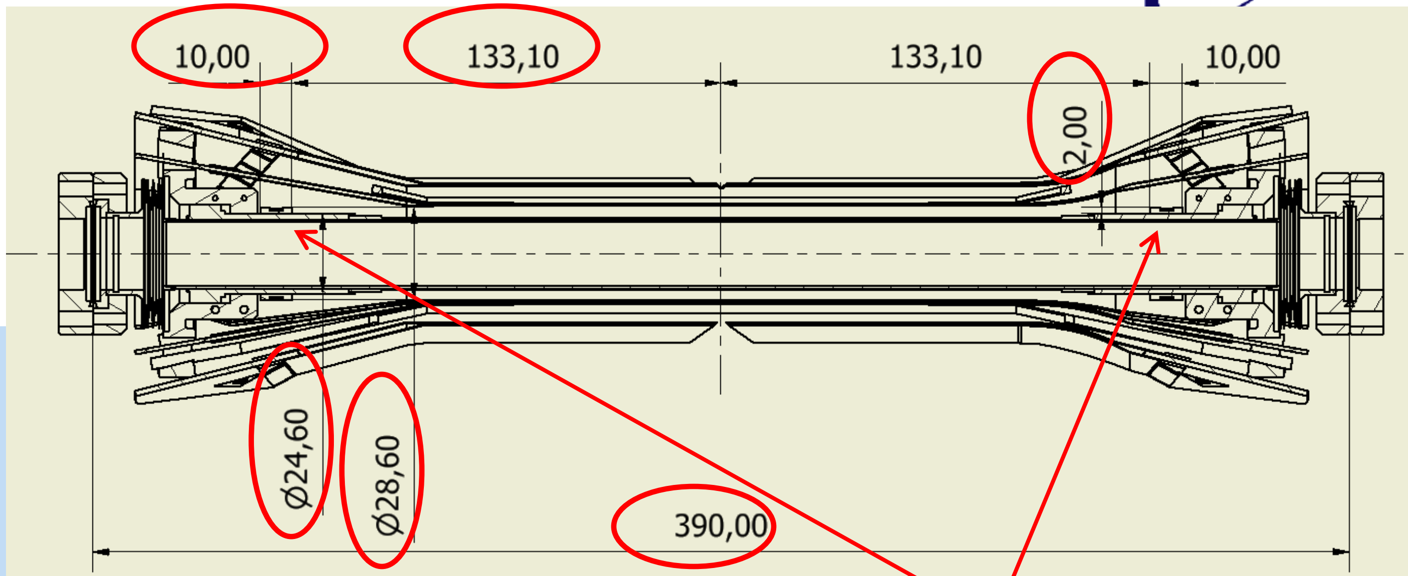
L0 cold flanges: new design



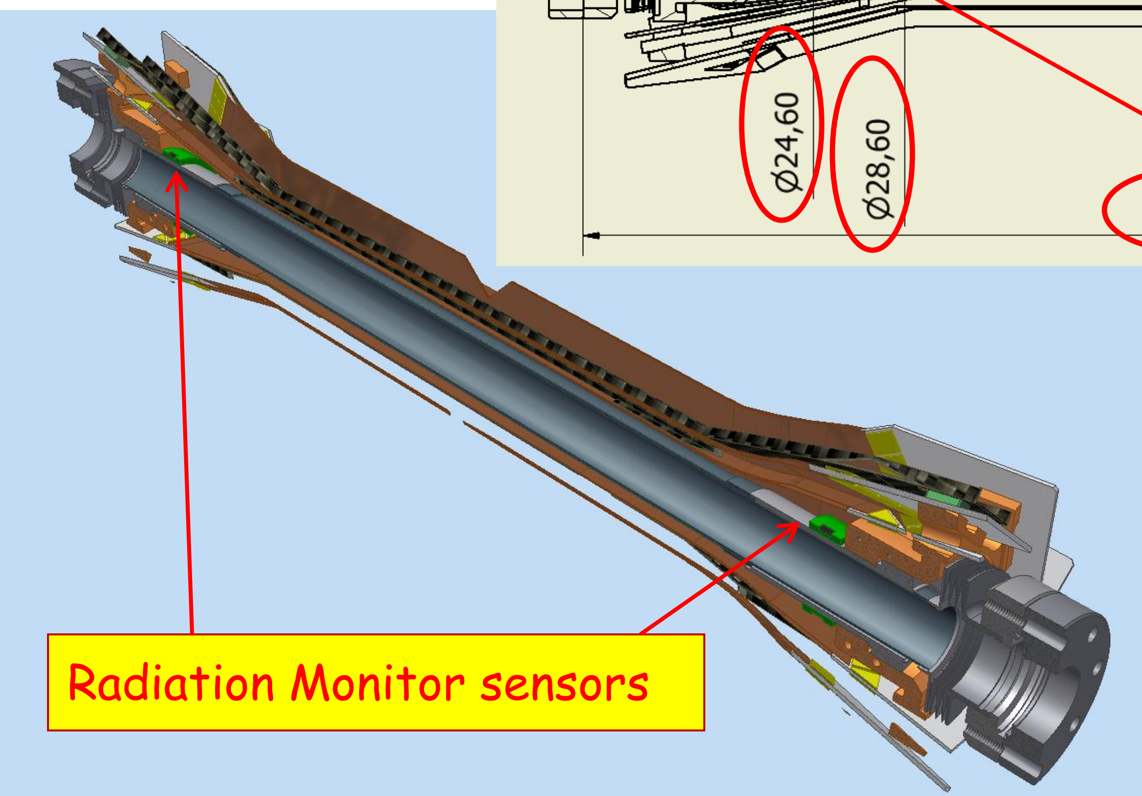


L0 Striplets + cold flanges + Be pipe 390 mm

Radiation Monitor

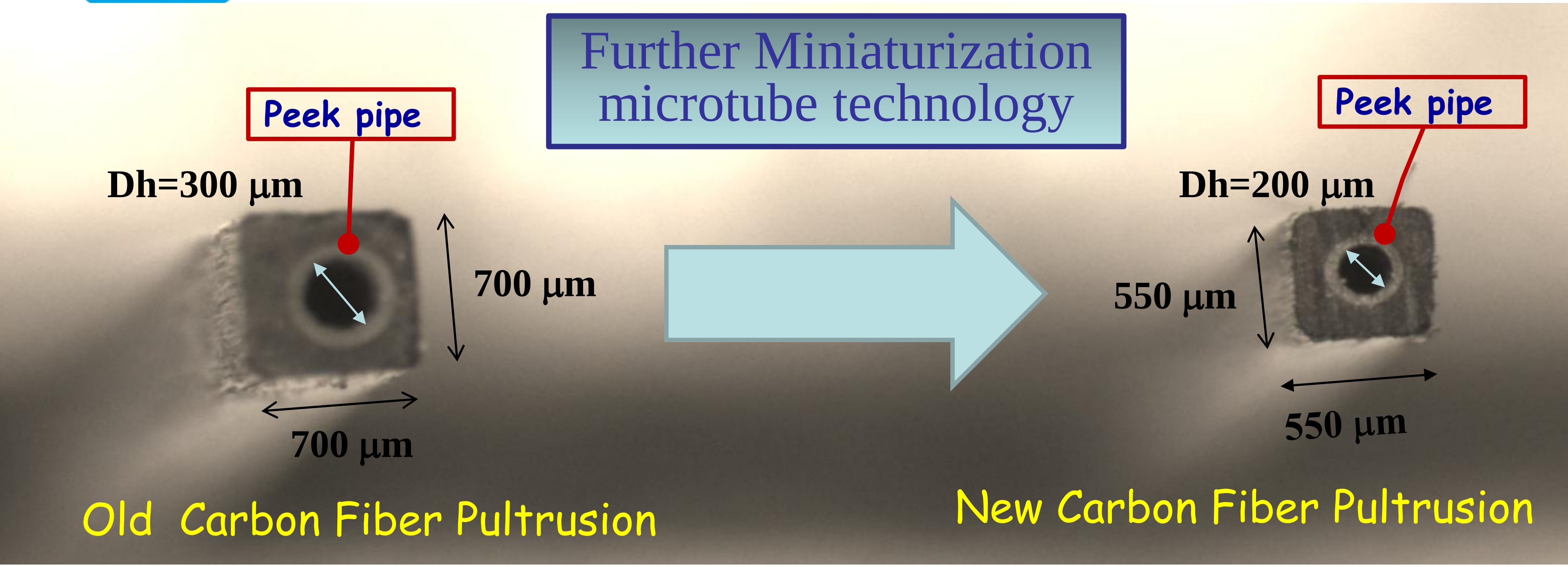


Radiation Monitor fixed on Be pipe L=390mm



Radiation Monitor sensors

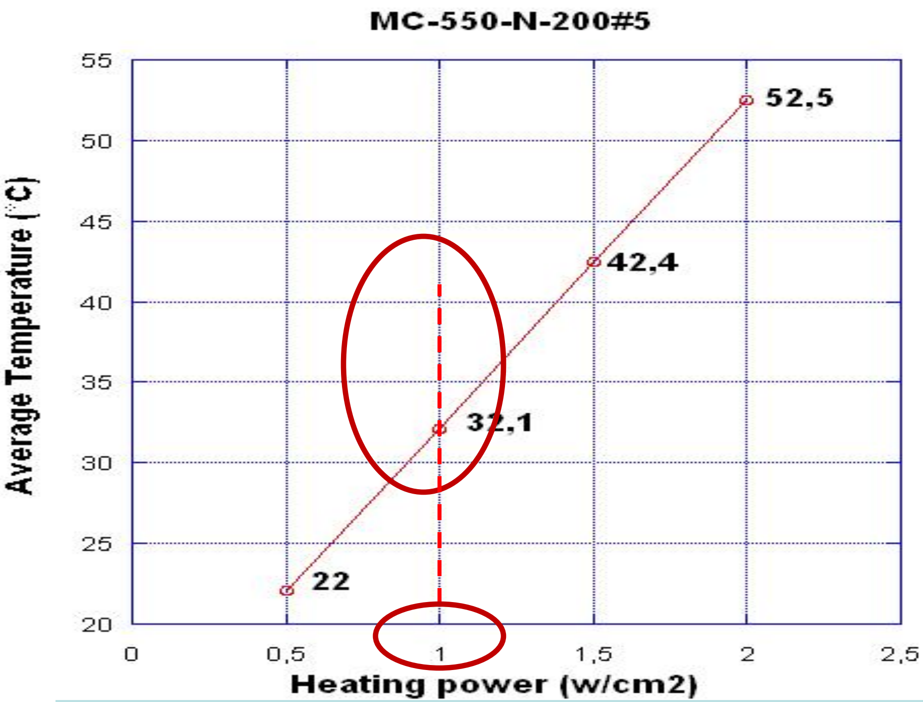
L0 Pixel module support



Old		New	
Full Module	$X = 0{,}28\ \%\ X_0$	Full Module	$X = 0{,}22\ \%\ X_0$
Net Module	$X = 0{,}15\ \%\ X_0$	Net Module	$X = 0{,}11\ \%\ X_0$

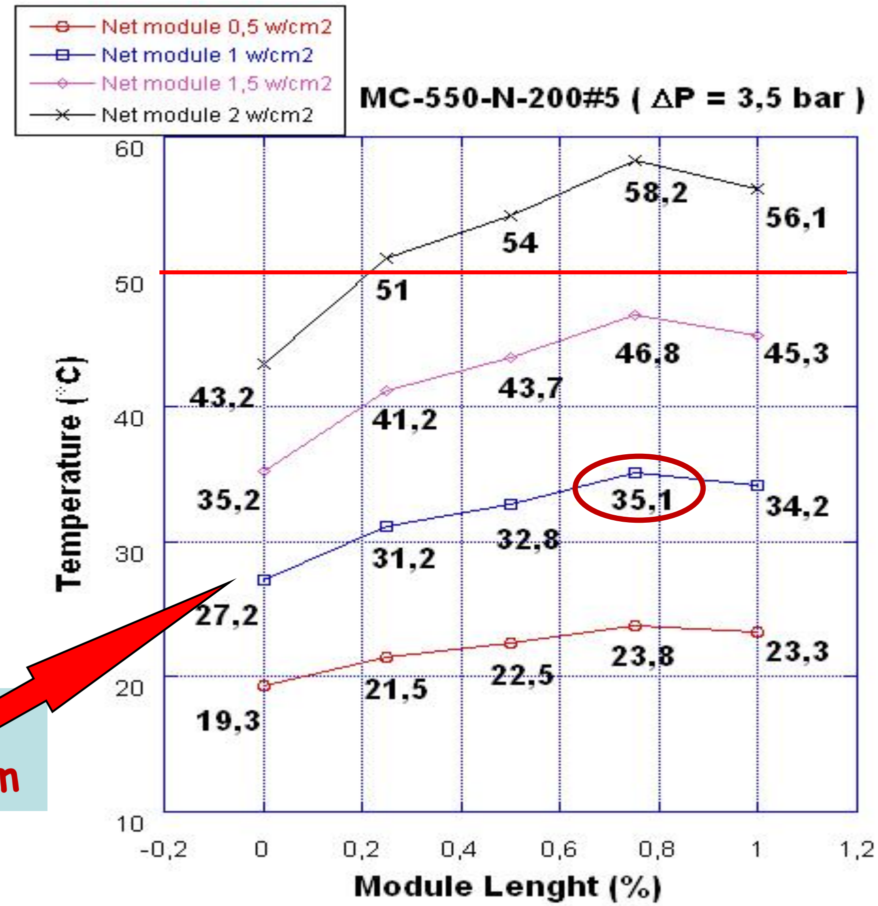
Microchannel support 550 μm th, Full and Net version tested at the TFD lab

Net Module H=550μm test results



Average module Temperature vs Specific Power

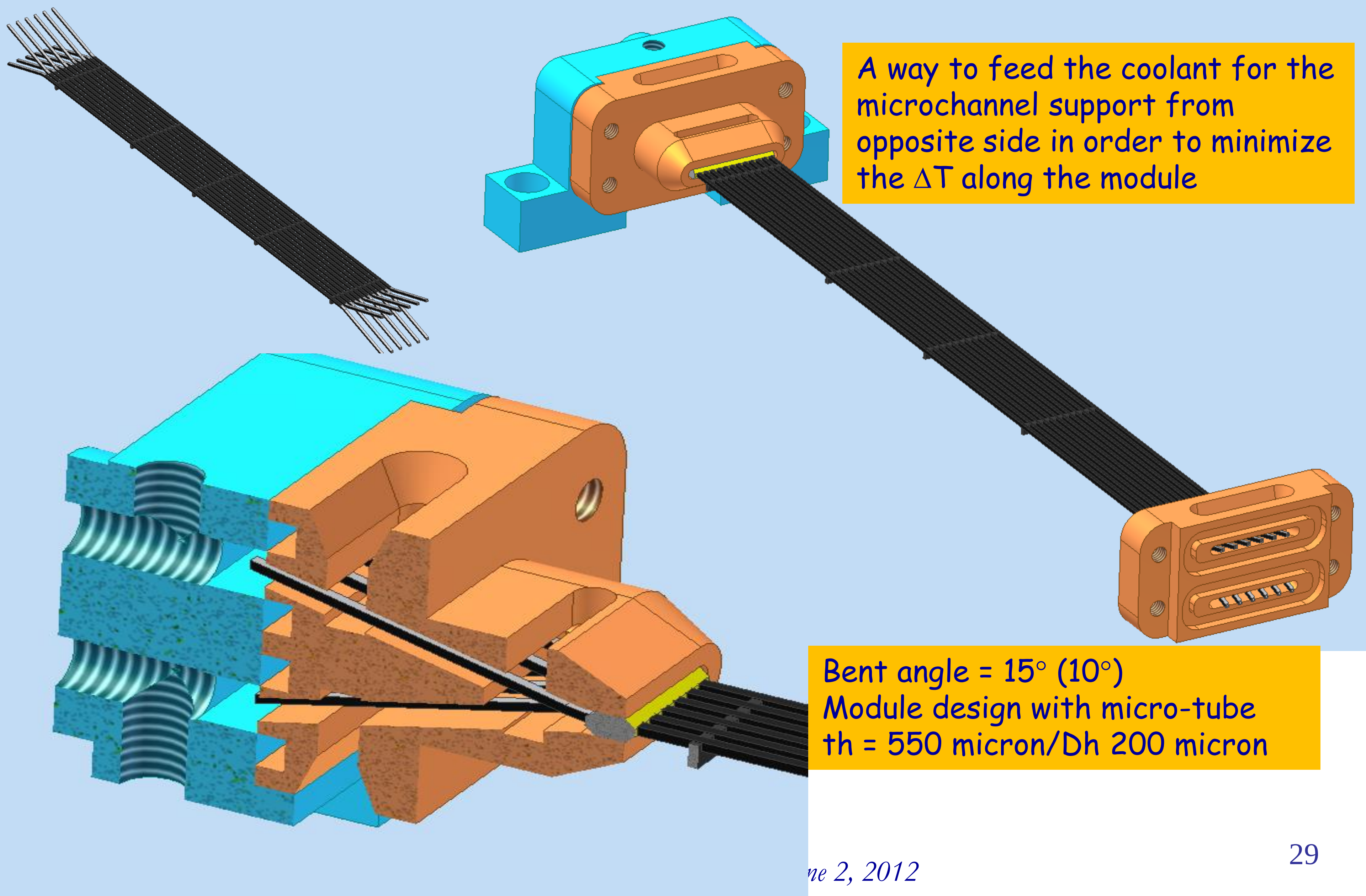
Tests performed on net module sample (length = 120 mm) with water-glycol @ 10 °C as coolant (Δp =3,5 atm).



Temperature along the module:

ΔT = 7.9 °C at 1.0 W/cm^2 Δp =3.5 atm

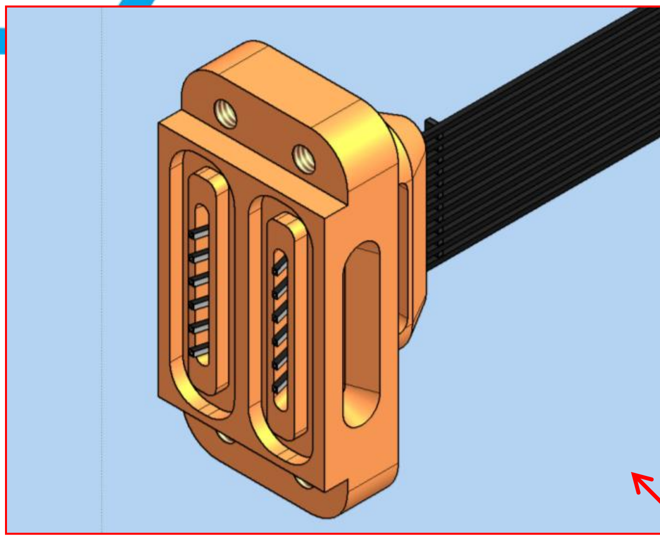
Bidirectional flow module support

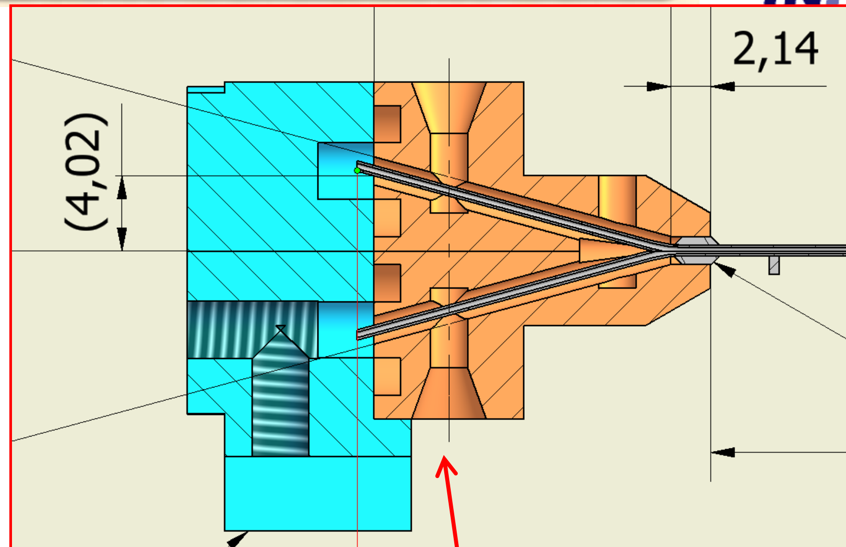


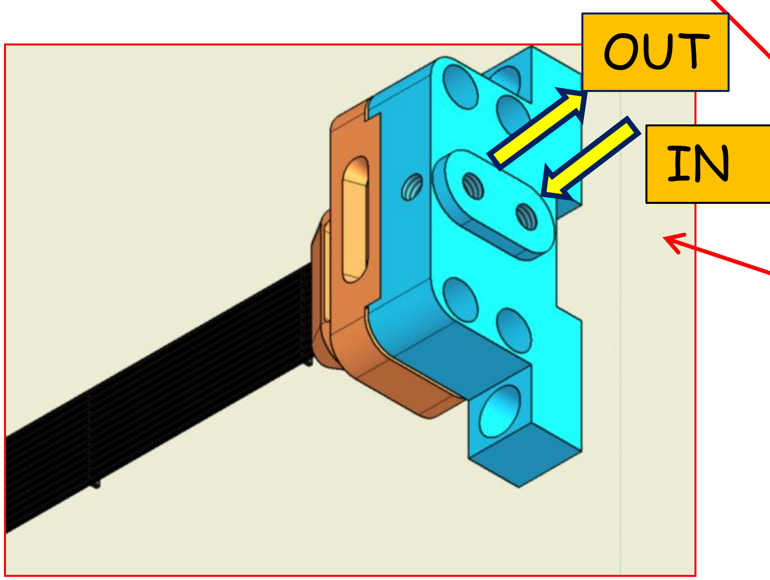
A way to feed the coolant for the microchannel support from opposite side in order to minimize the ΔT along the module

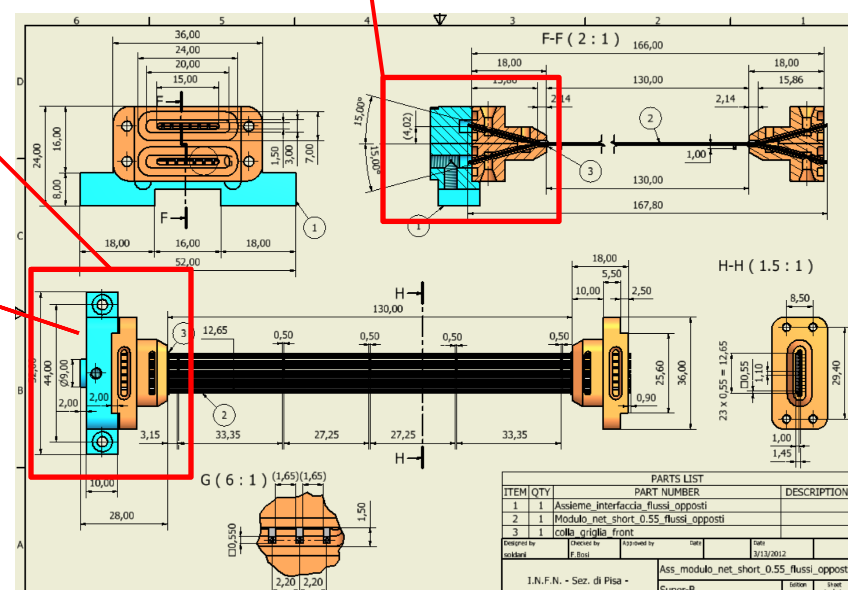
Bent angle = 15° (10°)
Module design with micro-tube th = 550 micron/Dh 200 micron

Opposite flow bent module

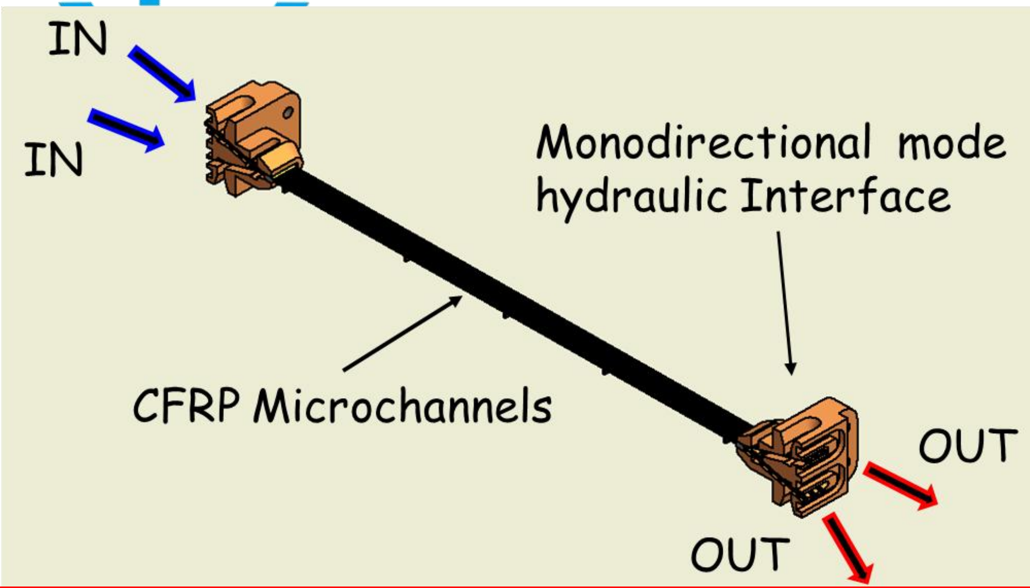


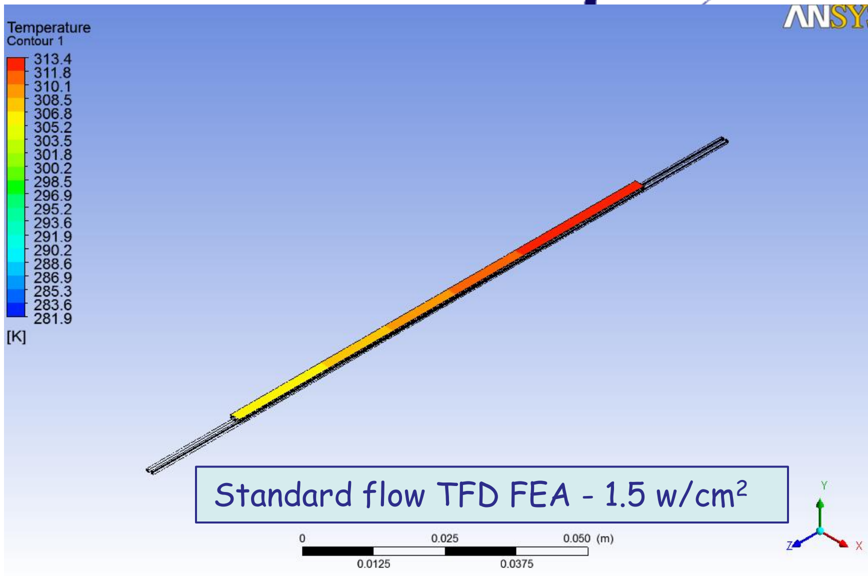


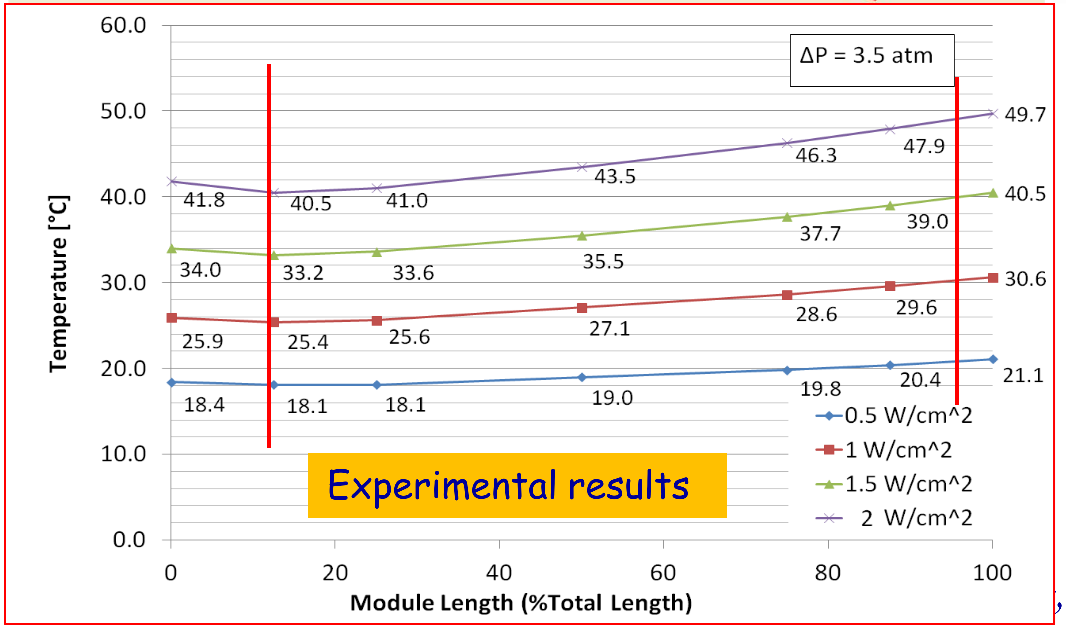




Monodirectional flow module

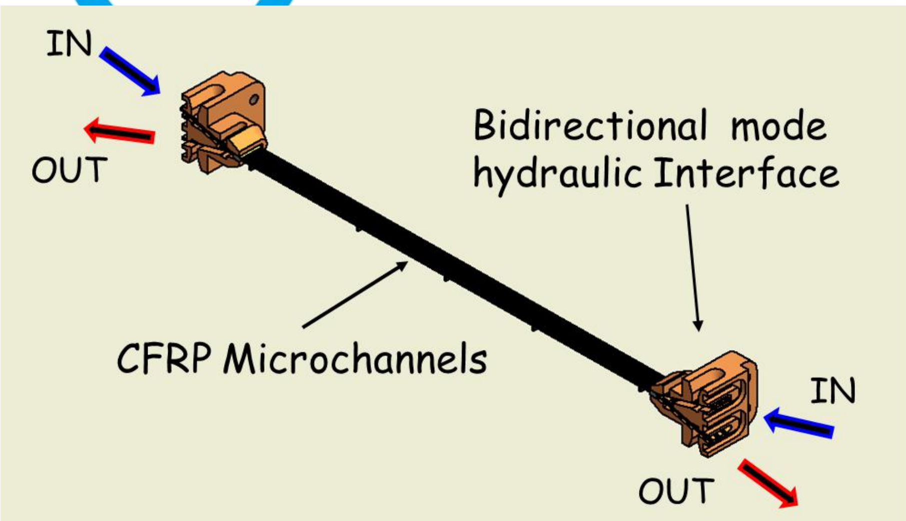


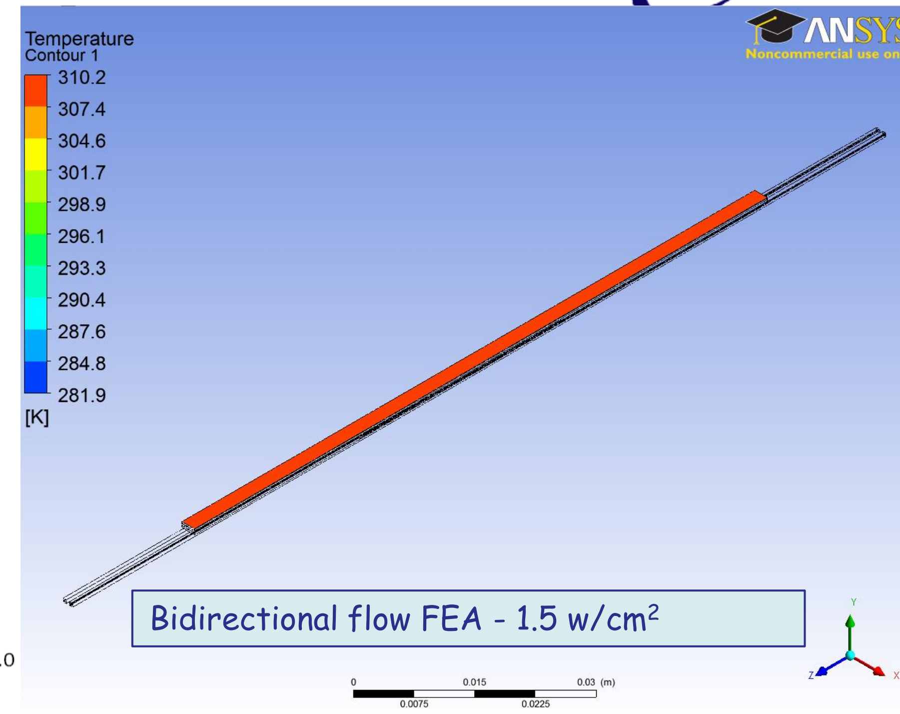


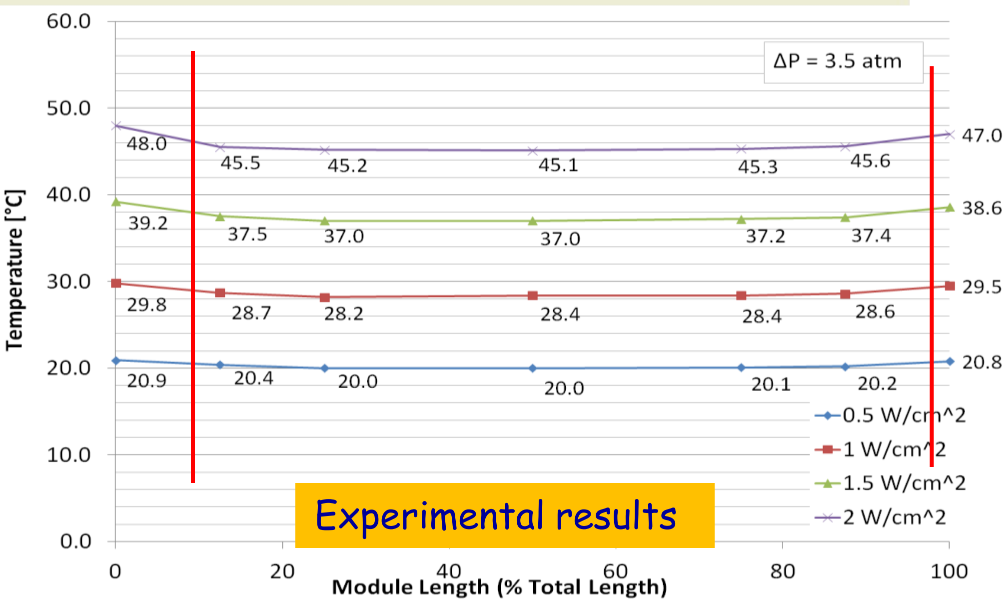


- Concordance results
FEA study/test at TFD lab

Bidirectional flow module

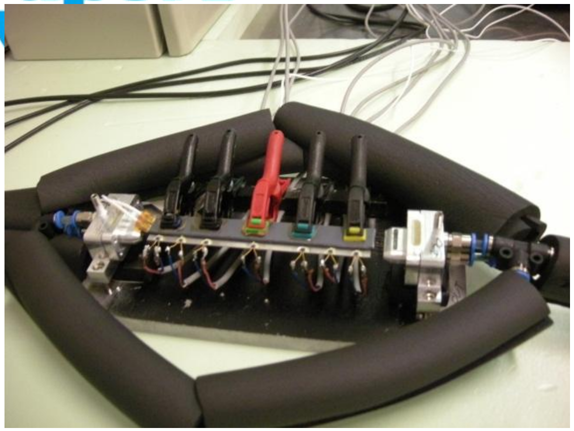


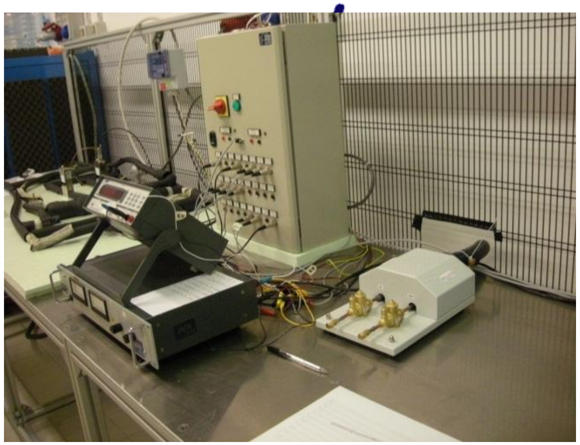




- Concordance results
FEA study/test at TFD lab

Bidirectional flow module





-Micro-channel support prototypes match the Layer 0 pixel detector requirements on material thickness (X_0). Efficient heat evacuation has been achieved by micro-channel technology through liquid forced convection.

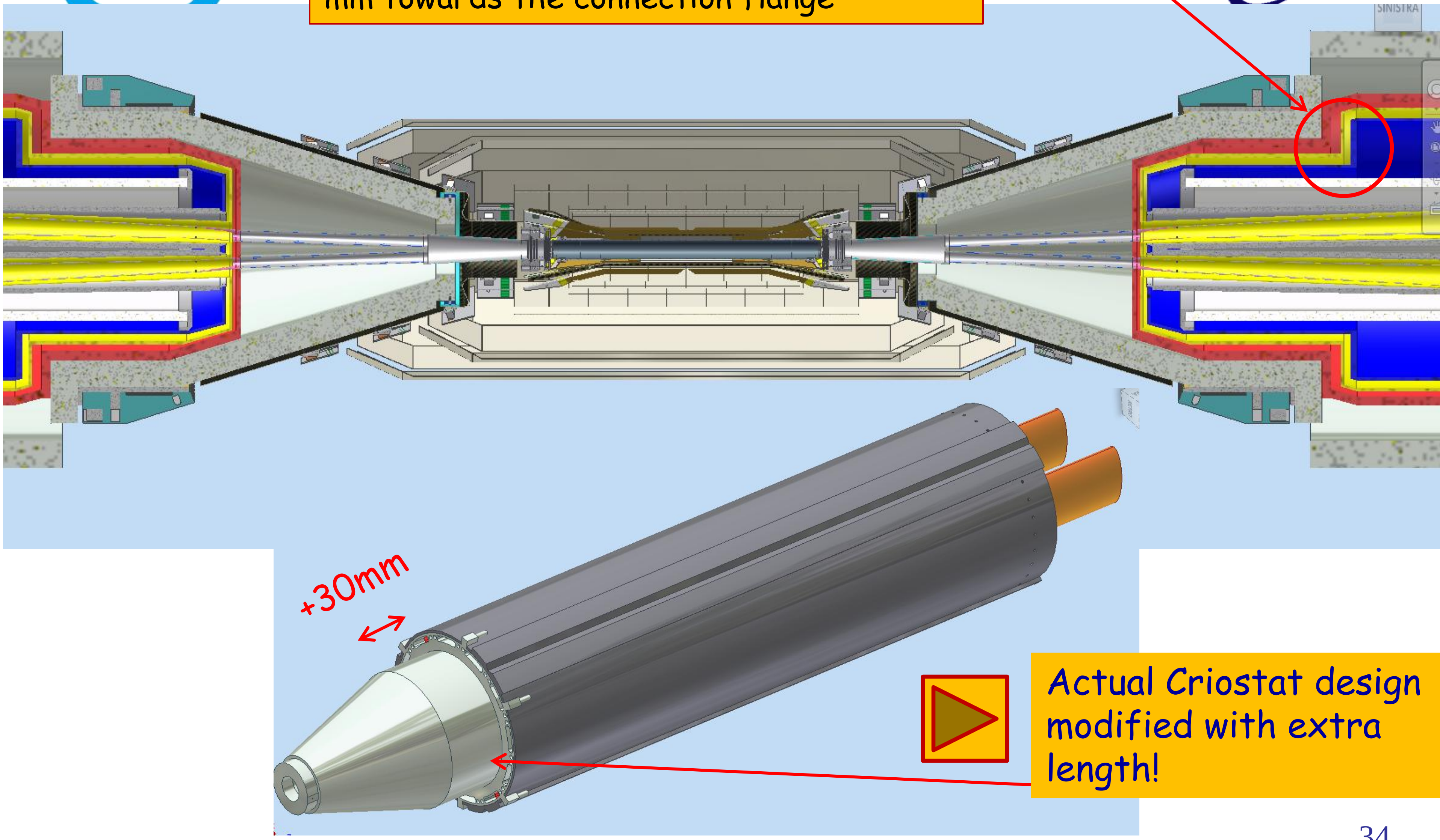
- The experimental results show that Net Module th=550micro and Dh=200 micron is able to cool sensors with a power density up to 1.5 W/cm^2 with a X_0 value of 0.11 % (mechanical support/cooling budget) and keep the sensor below 50 °C ; with bidirectional coolant flow mode, it is possible to reduce the ΔT along the sensor below 2°C.

- Thermo-structural simulation and experimental test are still needed to check geometry sensor variations at the operational cooling conditions. Endurance cooling test are also in planning.

-Next step : proceed to the engineering of the hydraulic interface and the support flanges manifolds according to the experimental layout condition.

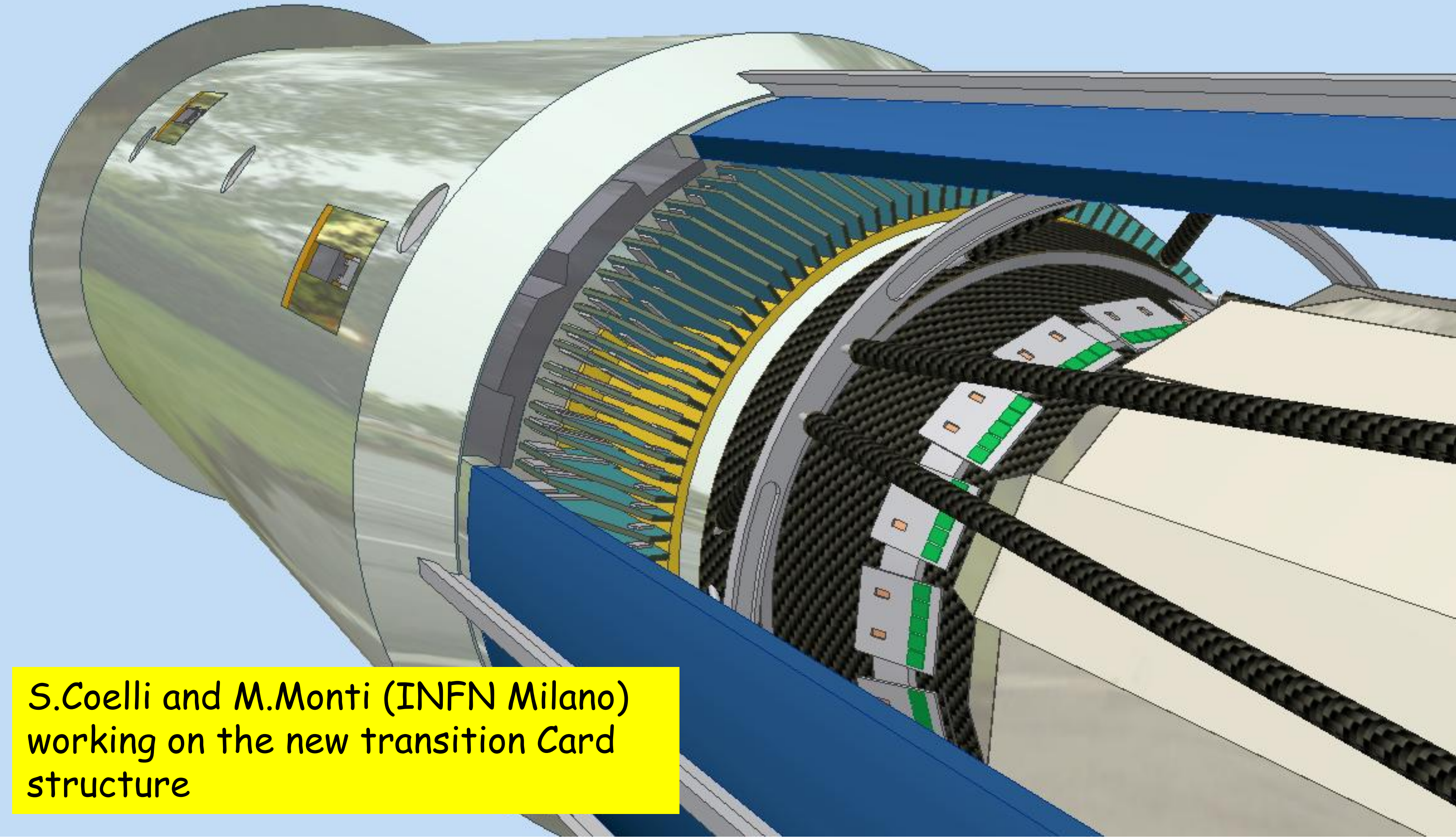
Transition Card

- Transition Card board 30 mm longer 30 mm towards the connection flange



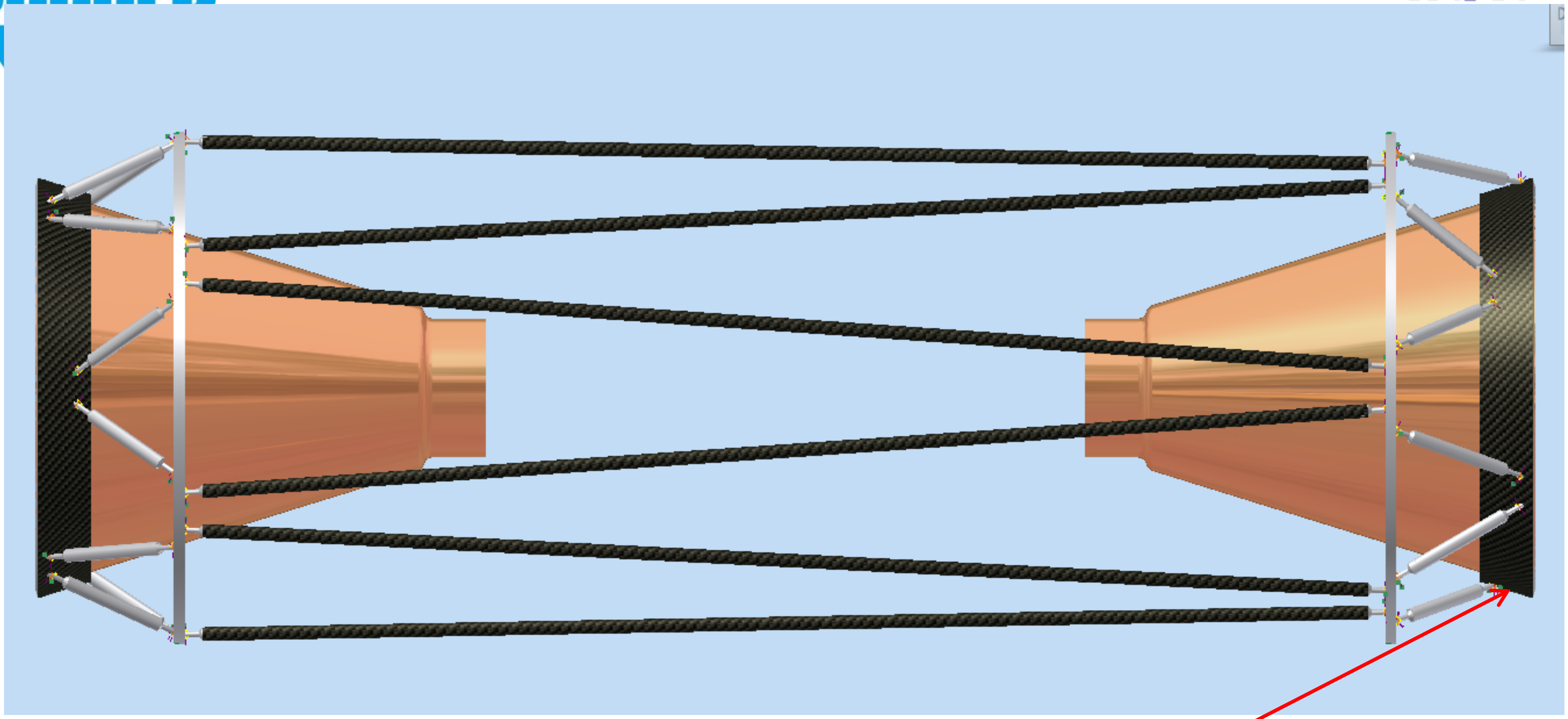
Actual Criostat design modified with extra length!

Transition Card



S.Coelli and M.Monti (INFN Milano) working on the new transition Card structure

Space Frame/Supporting Cones



J. Morris and F. Gannaway are working on the technological aspect of C.F. Space-frame flanges :

- sandwich structure/full C.F. section
- choice of the best C.F tube
- …….

Space Frame, version 2

I.R. Architecture/quick demounting

- Present I.R. design has the goal to assume W conical shield independent from cylindrical shield to move less mass for quick demounting operation (all SVT components have minor diameter respect to W conical shield int.diam.) .

-In this configuration, criostat forw/back+SVT+L0+Be pipe+conical shield forw/back are one body (like in BaBar) but, in SuperB, to gain in X0, is not present the C.F. BaBar supporting tube and the Be pipe and SVT are the weak part of the mechanical chain .

-Quick demounting plans to insert-remove a temporary cage to make rigid SVT /Be pipe during sliding operation to replace L0 in short time.

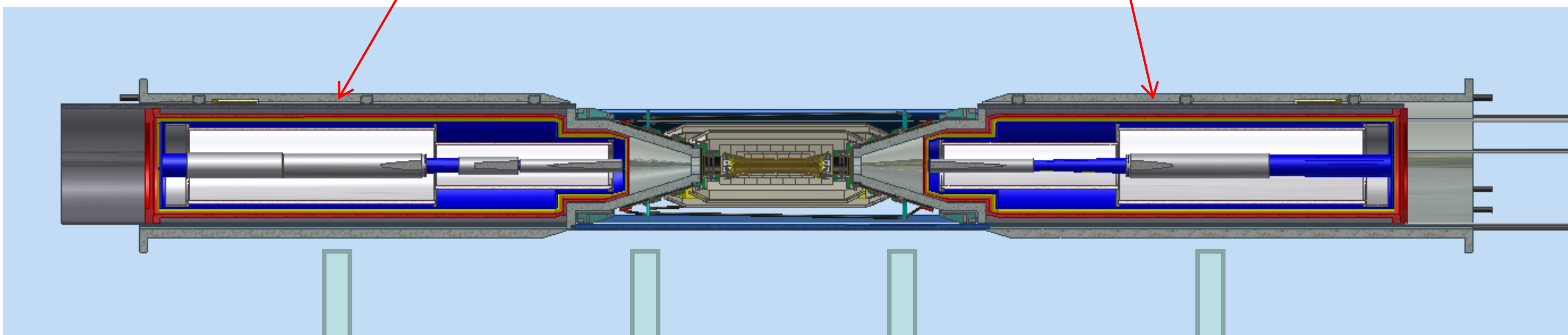
-Has been asked to assume R=255 (+10 mm respect now) as ext interface of D.C. in order to have minimum radial space to design the mechanics of operation.

-The temporary cage should put together the two opposite W conical shield from a remote region (FCAL) previous blocking the external tube forw/back to the internal part of cylindrical W shield.

I.R. Assembly

Cylindrical Shielding 1300 Kg

Cylindrical Shielding 1300 Kg



350Kg+150Kg+50Kg=550Kg
Cryostate+External tube+Cables

200 Kg
Conical Shielding

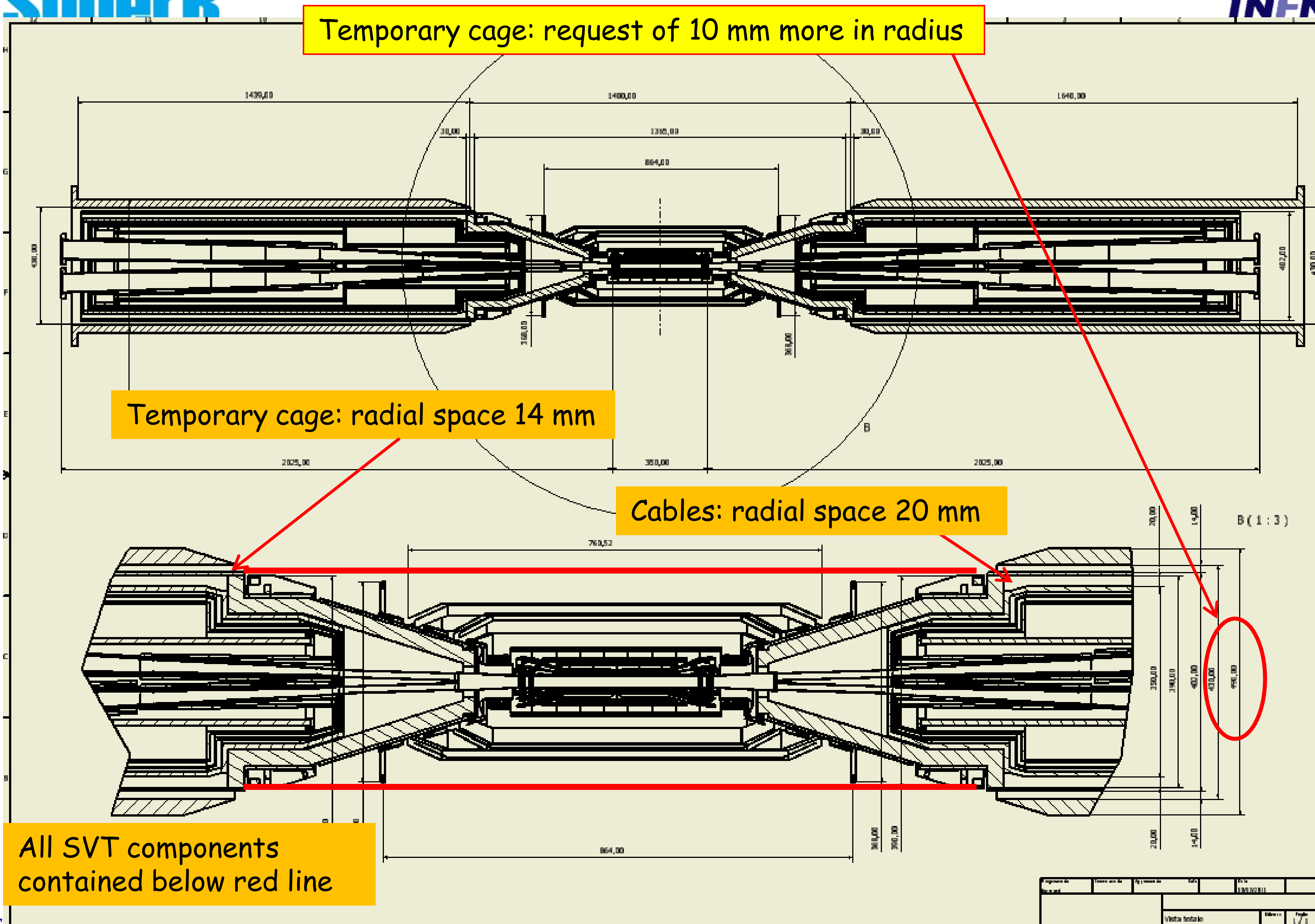
50 Kg + 80 Kg =100Kg
SVT + Temporary Cage

200 Kg
Conical Shielding

350 Kg+150 Kg+50Kg=550Kg
Cryostate+External tube+Cables

Total weight to move for quick demounting ≈ 1630 Kg

Quick demounting



Conclusion

1) Some update realized on Ribs/fanouts SVT models.

2) L0 striplets: cold flanges and Be pipe 390 new design

3) Some change in the SVT layout design : cryostat flange position-layer2/Layer3 module shift- L1/2 cooling ring/HDI – Conical Shield (below gimbal ring) for L0 cables transit…

4) L0 pixel: micro-channel bidirectional flow module support match the X_0 and operational temperature requested

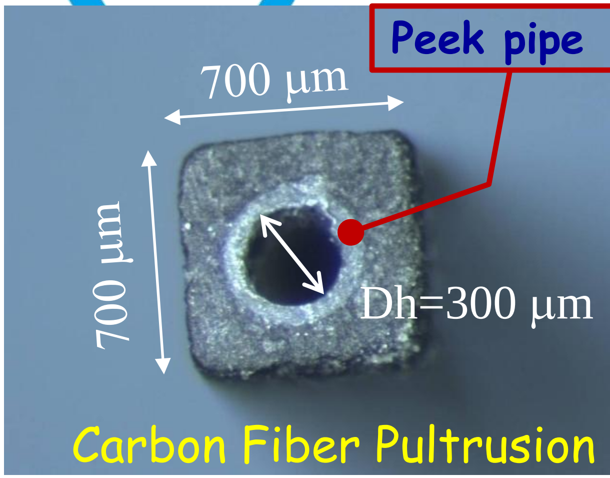
5) Quick Demounting: solution proposed to be confirmed from Integration/Tech. Board (request more space in radius for temporary cage: 10 mm)

6) Start work on writing TDR, expected time to complete mechanics issue : end of June

7) Need to start to design jig and features to make mechanical prototype layer 5B

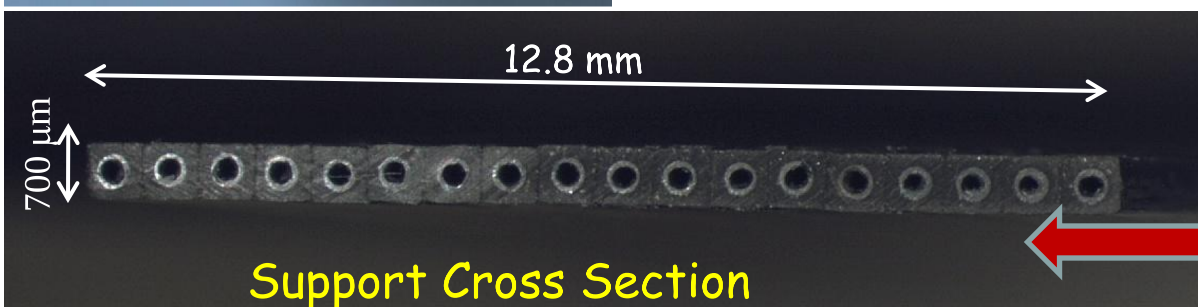
BACKUP

Work on Module MAPS supports



The single base microchannel unit

A square CF micro-tube with an internal peek tube 50 µm thick used to avoid moisture on carbon fiber



Full micro-channel module

The total radiation length (*) of this support is 0.28 $\%X_0$

Net micro-channel module

Same dimensions of full micro-channel but vacancies of tubes in the structure.
The total radiation length (*) is 0.15 $\%X_0$

(*): Material of the support structure: (All C.F. material + peek tube + Water)

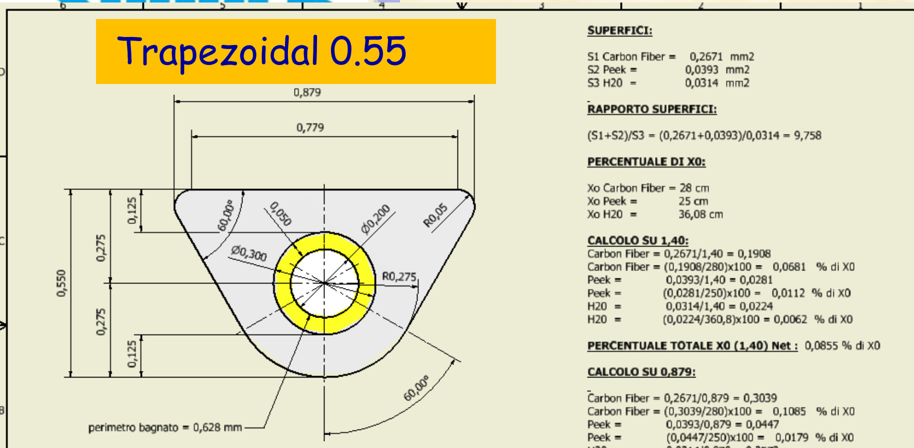
Microchannel Module Comparison Data

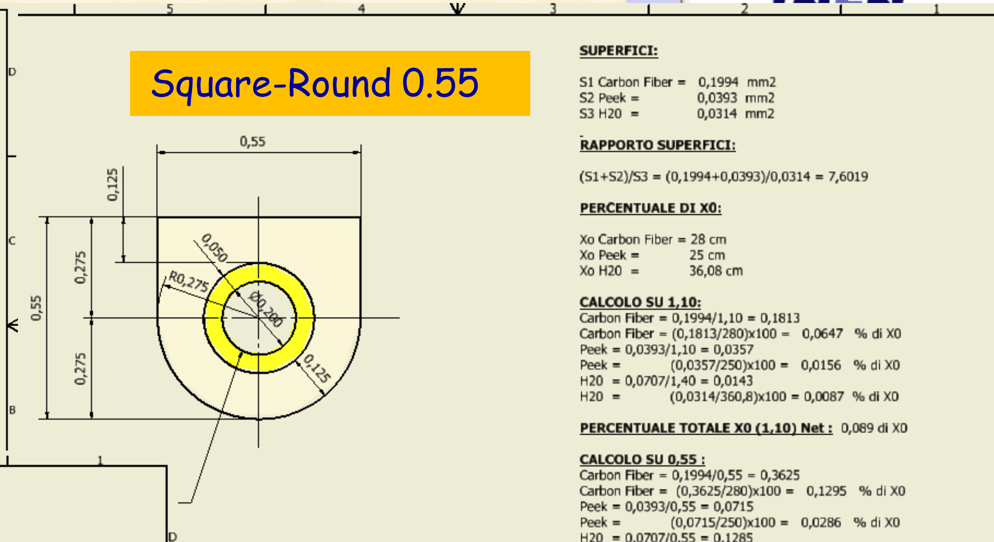
Comparison List

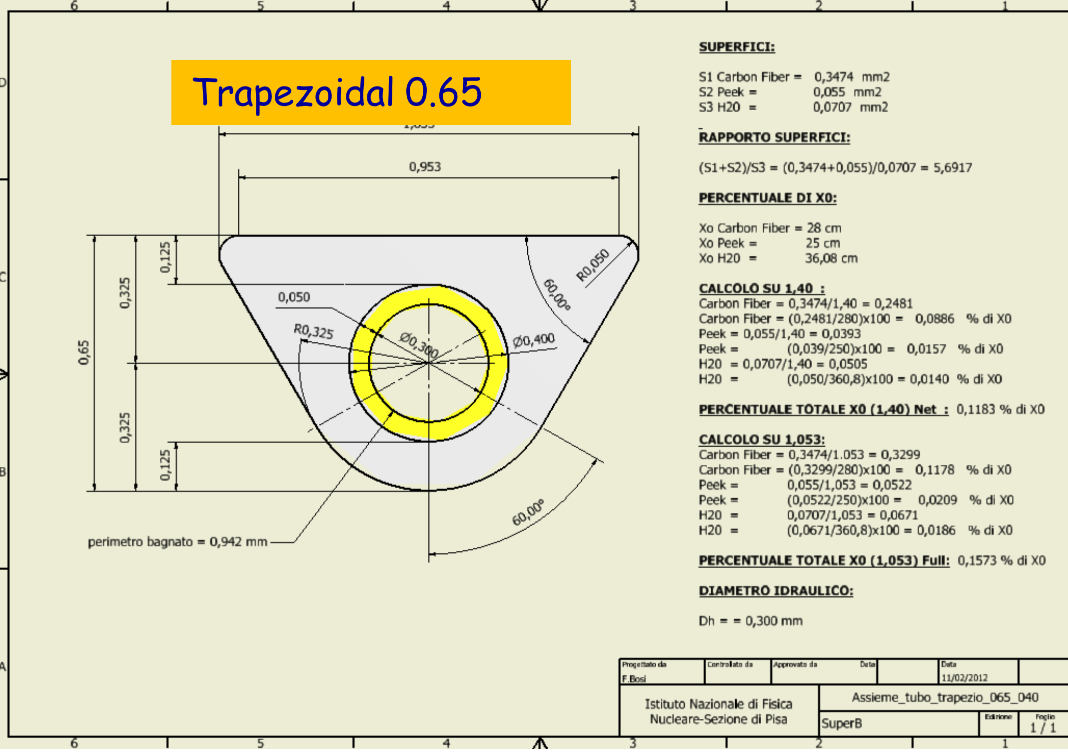
		% X0	T max °C	Specific Power W/cm2	Hydraulic. Diam. μm	Flow rate g/min	Δ Temperature °C
1	Microchannel FULL Module support H=700 μm		35.8	2.0	300	244	5.3
2	Microchannel NET Module support H=700 μm	0.15	38.3	1.5	300	128	6,7
3	Microchannel Full Module support H=550 μm	0.22	34.3	1.5	200	33*	7.1*
4	Microchannel NET Module support H=550 μm	0.11	34.2	1.0	200	24	7.0

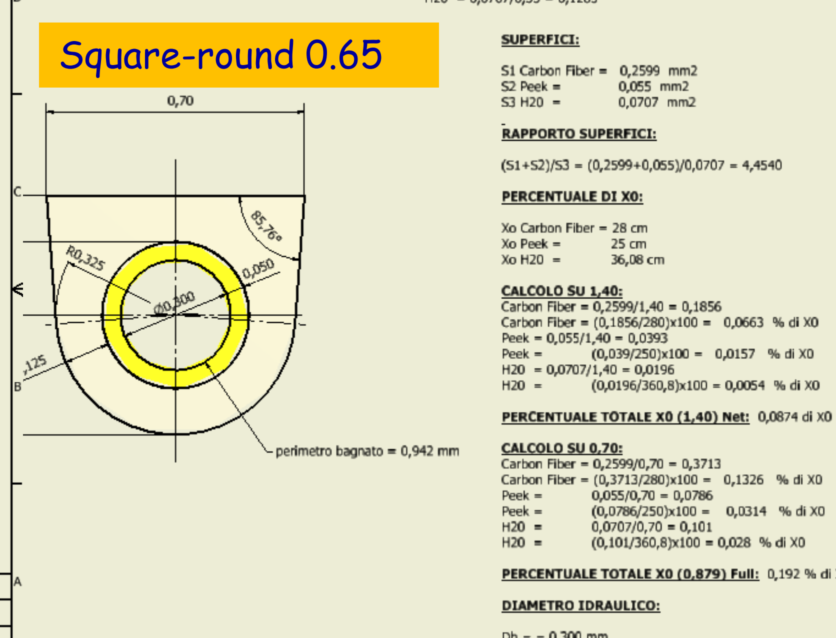
Tests performed on net module sample (length = 120 mm) with water-glycol @ 10 °C as coolant at Δp =3,5 atm (Δp not valid for value *).

Micro-tube development



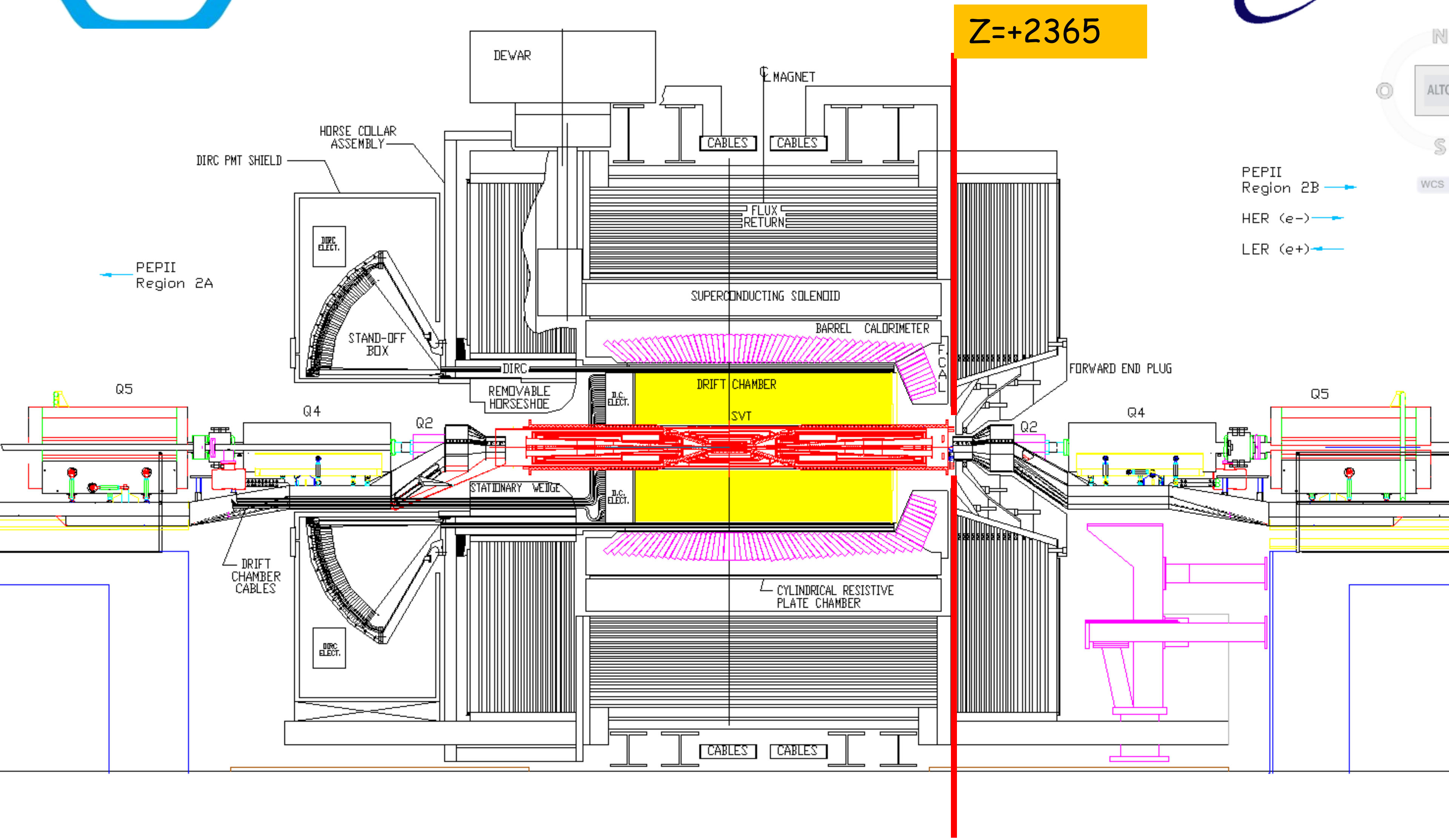






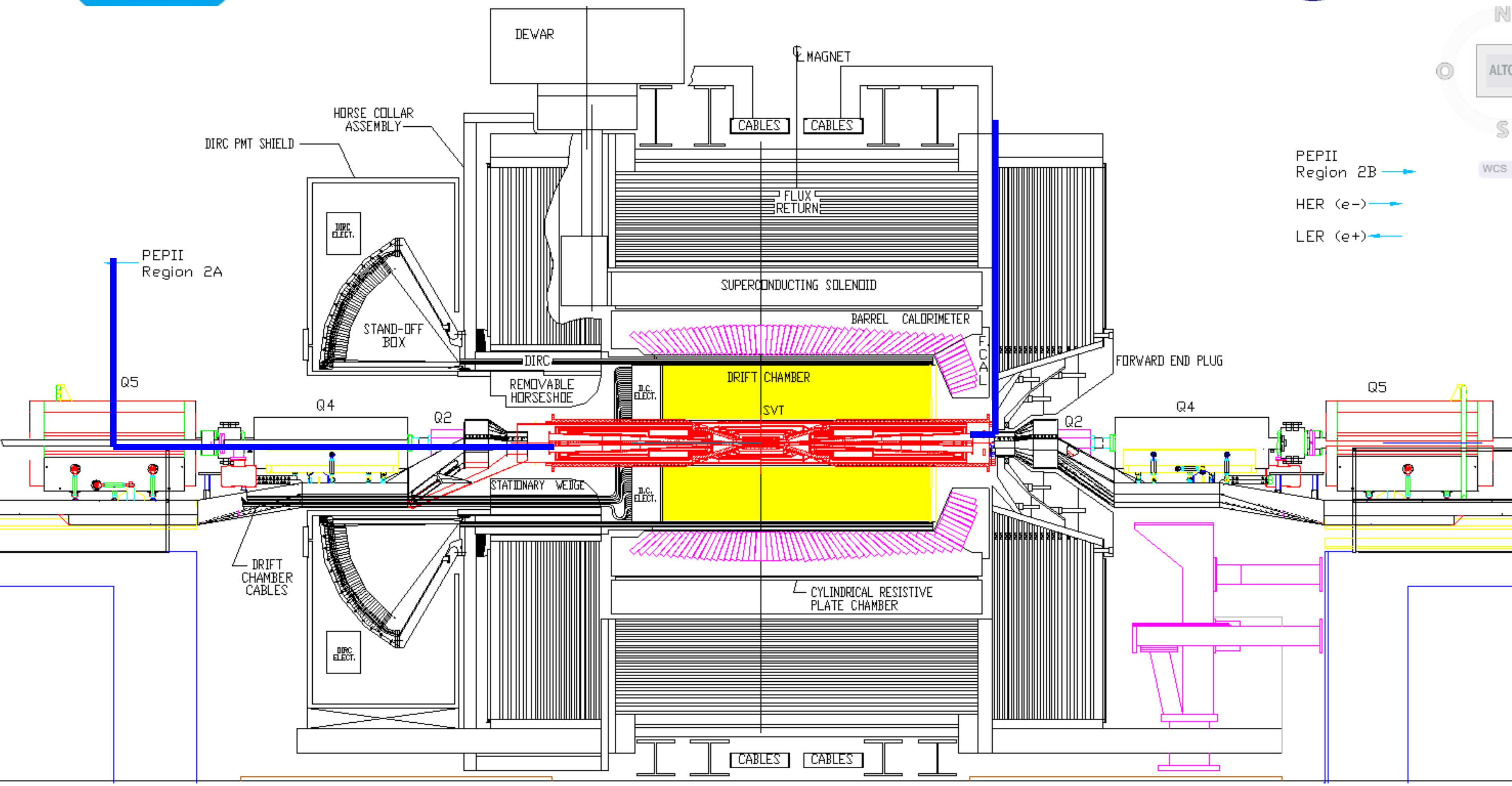
Thermal simulation / X_0

			% X0 tot		W/cm^2	0,5	1	1,5	2
		N° MC							
Quadrato 0,7 mm (full)		18	0,241300431		T [°C]		22,03	28,08	34,12
Quadrato 0,7 mm (net)		10	0,134055795		T [°C]	20,26	30,38	40,51	50,63
Quadrato 0,55 mm (full)		23	0,192561102		T [°C]	16,1	22,18	28,29	34,41
Quadrato 0,55 mm (net)		12	0,100466662		T [°C]	20,9	31,64	42,37	53,11
Trapezio 065_40 (net)		10	0,129312491		T [°C]	18,38	26,69	35,01	43,33
Trapezio 065_40 (full)		12	0,15517499		T [°C]	17,19	24,3	31,43	38,55
Trapezio 0,55 mm (full)		14	0,130882981		T [°C]	17,76	25,42	33,09	40,76
Trapezio 0,55 mm (net)		12	0,112185412		T [°C]	18,87	27,63	36,41	45,18
Quadrato tondo 0,7 mm (full)		18	0,189068288		T [°C]	16,08	22,13	28,2	34,28
Quadrato tondo 0,55 mm (full)		23	0,171383647		T [°C]	16,14	22,26	28,41	34,56
Quadrato tondo 0,55 mm (net)		12	0,089417555		T [°C]	20,91	31,67	42,42	53,18



Z=+2365
DEWAR
MAGNET
CABLES
CABLES
HORSE COLLAR ASSEMBLY
DIRC PMT SHIELD
FLUX RETURN
PEPII Region 2B
HER (e-)
LER (e+)
PEPII Region 2A
DIRC ELECT.
SUPERCONDUCTING SOLENOID
BARREL CALORIMETER
STAND-OFF BOX
DIRC
FCAL
FORWARD END PLUG
REMOVABLE HORSESHOE
DRIFT CHAMBER
D.C. ELECT.
SVT
Q5
Q4
Q2
STATIONARY WEDGE
DRIFT CHAMBER CABLES
CYLINDRICAL RESISTIVE PLATE CHAMBER

Cryogenic transfer line



Cryogenic transfer line