Layer0 support & SVT Mechanics Status

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on behalf of the SuperB SVT Group

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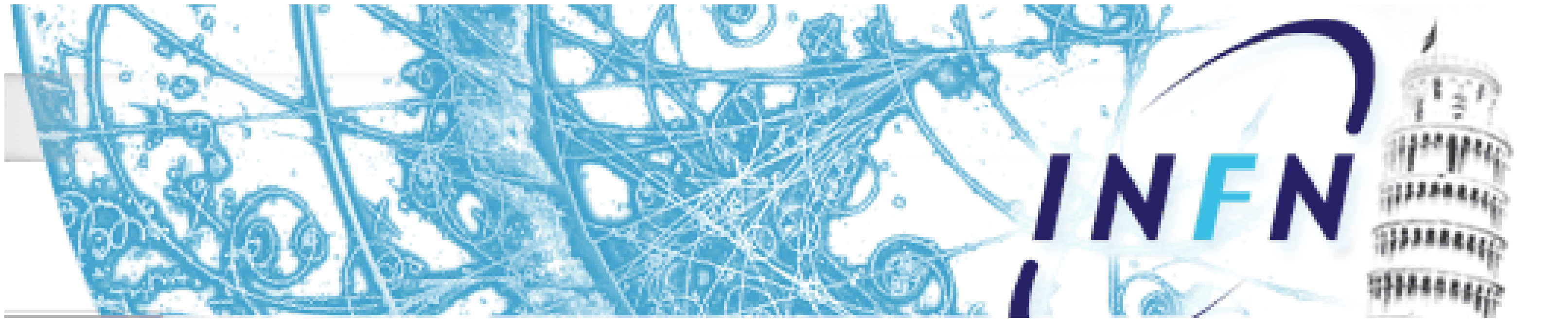


Outline

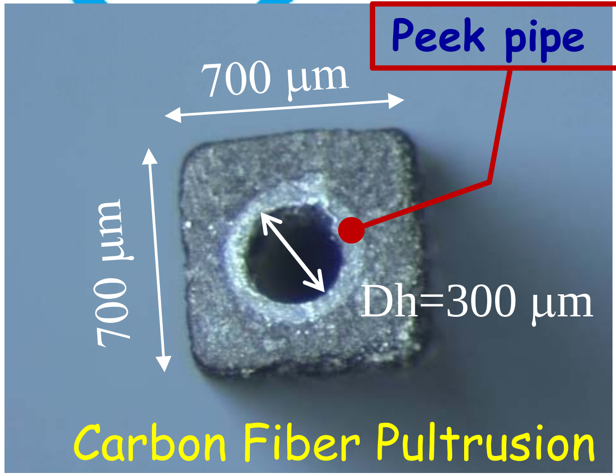
- Module supports summary :
  - Micro-channel Full and Net Module test results
  - Micro-channel Full and Net Long Modules test results

- Be Beam pipe

- Work in progress and to do

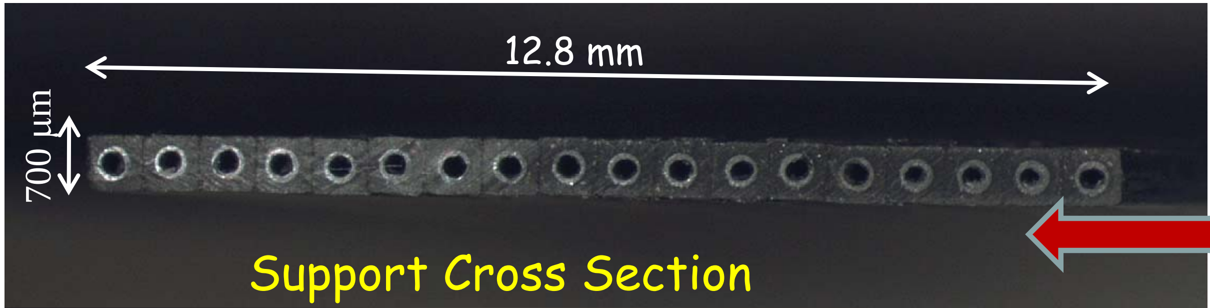
- Conclusions

Module supports summary



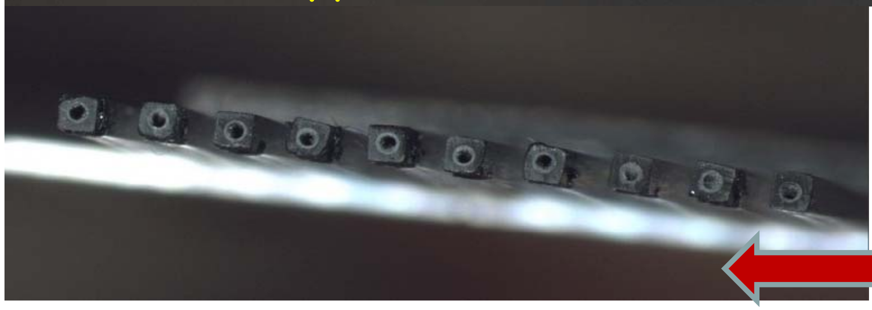
The single base microchannel unit

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 $\%X_0$



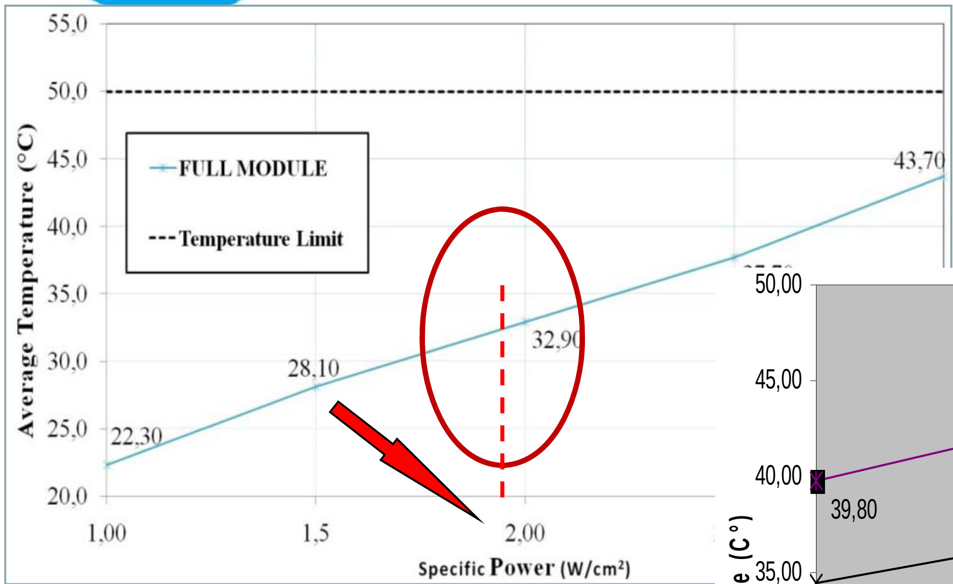
Net micro-channel module

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

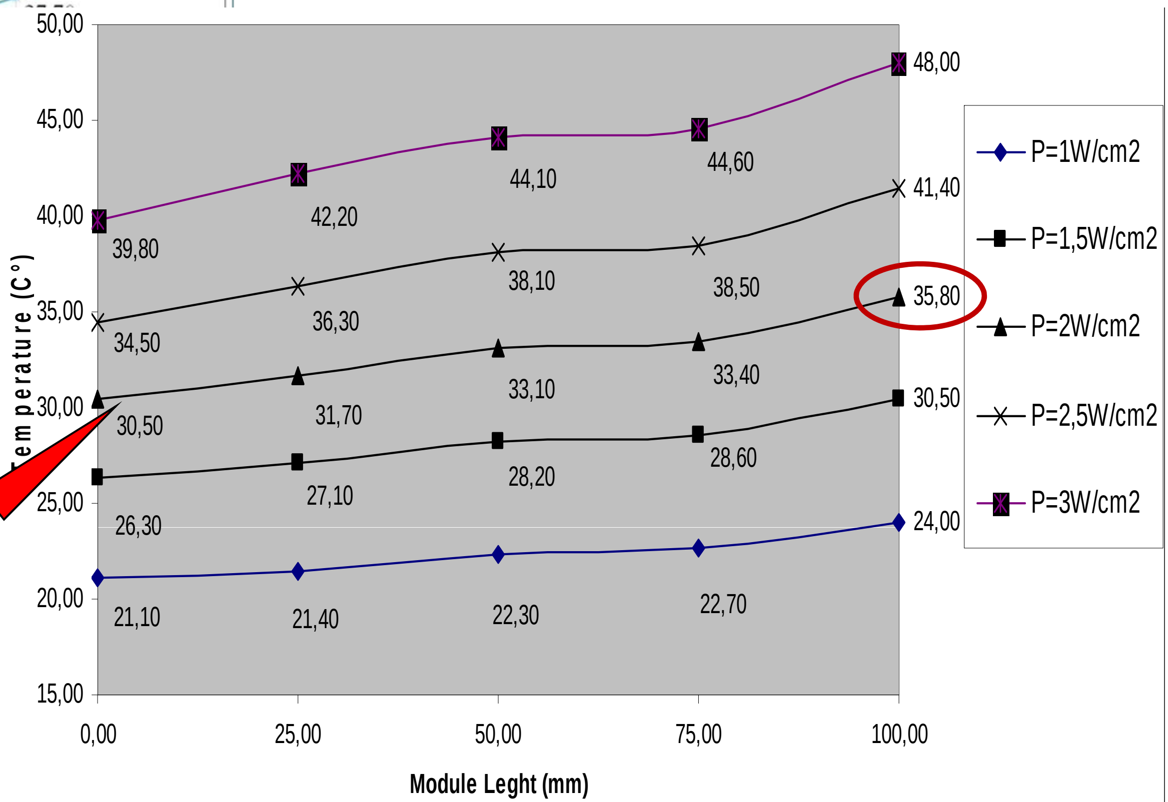
(*): Material of the support structure: (All C.F. material + peek tube + Water)

Full module test results

Tests performed on full module sample (length = 120 mm) at Δp =3.6 atm.



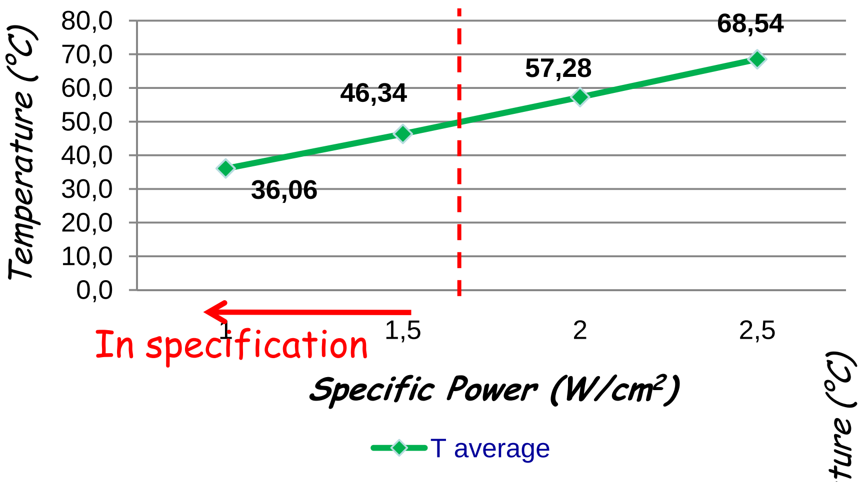
Average module Temperature vs Specific Power



Temperature along the module: ΔT = 5,3 °C at $2W/cm^2$ and Δp =3,6 atm

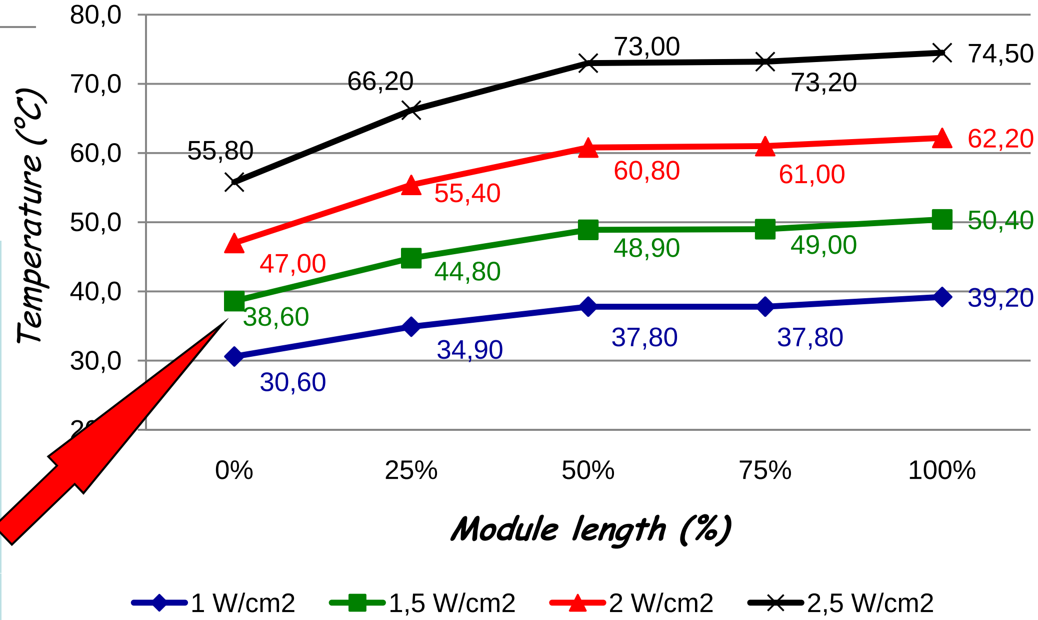
Net Module test results

Net module average Temperature Vs. Specific power density



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

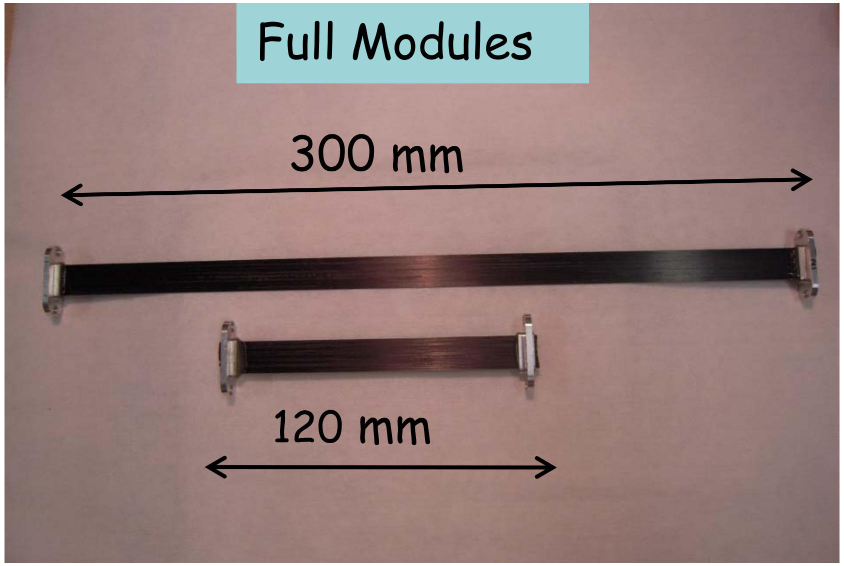
Net module, Sensor Temperature Power on Single Side

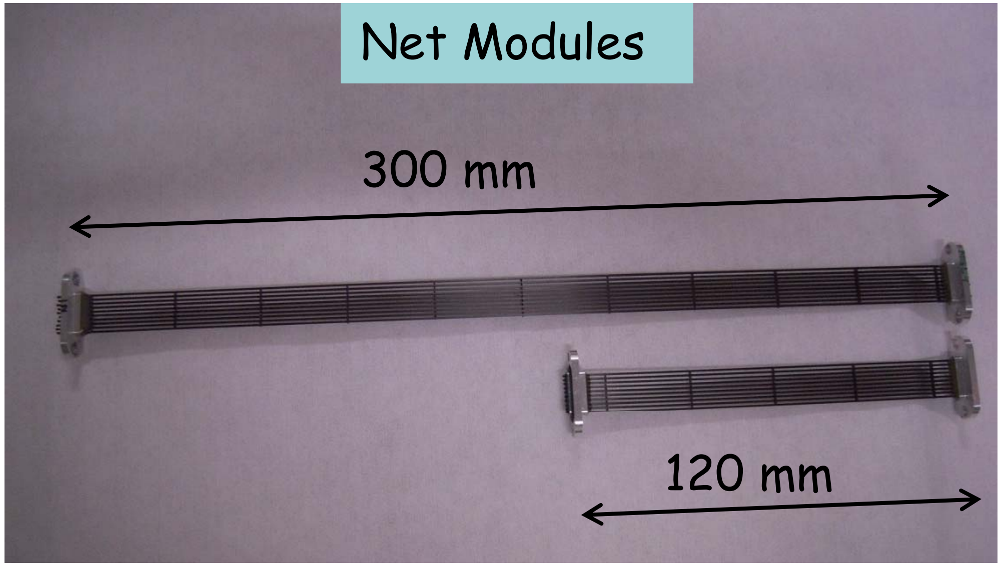


Data shown that Net Module is able to cool power up to about 1.5 W/cm² at the max required Temperature (50 °C).
This goal can also be achieved with a greater safety factor by reducing the inlet coolant temperature.

Full and Net Long Modules

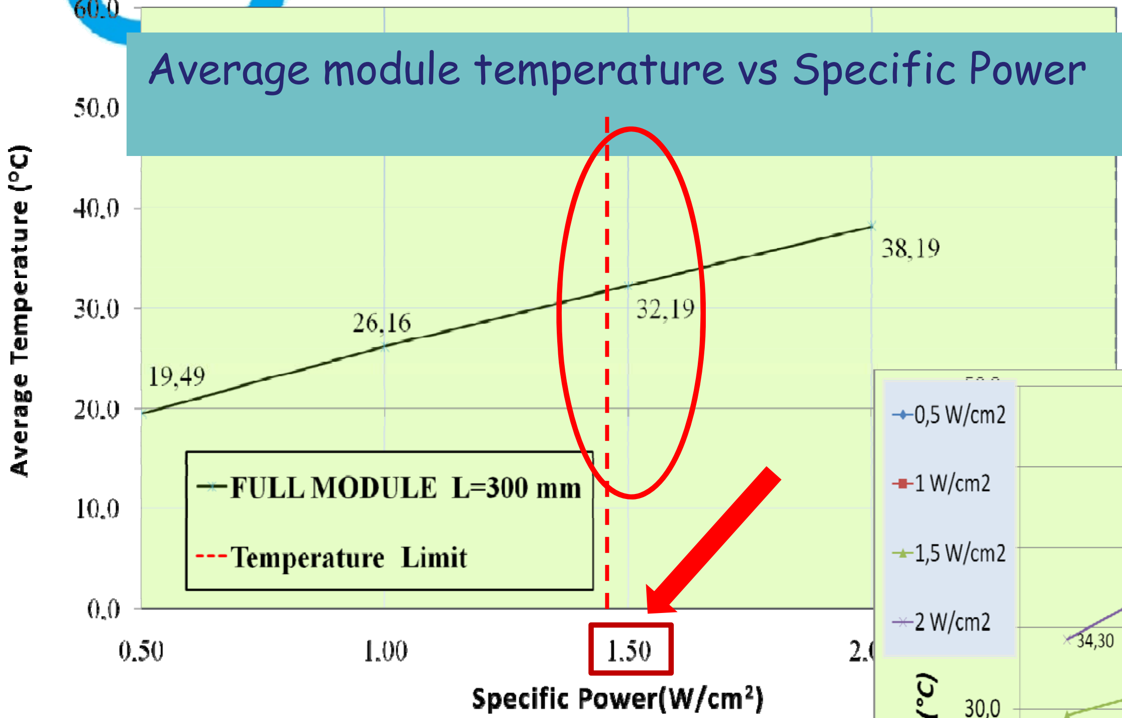
In order to test longer microchannel support structures useful for different experimental layout, two new supports structure have been assembled and tested . Both structure have been realized with the same pultruded micro-channel technology in full and net Microchannel version. They have the same cross sections of short modules but the length is 300 mm instead 120 mm.



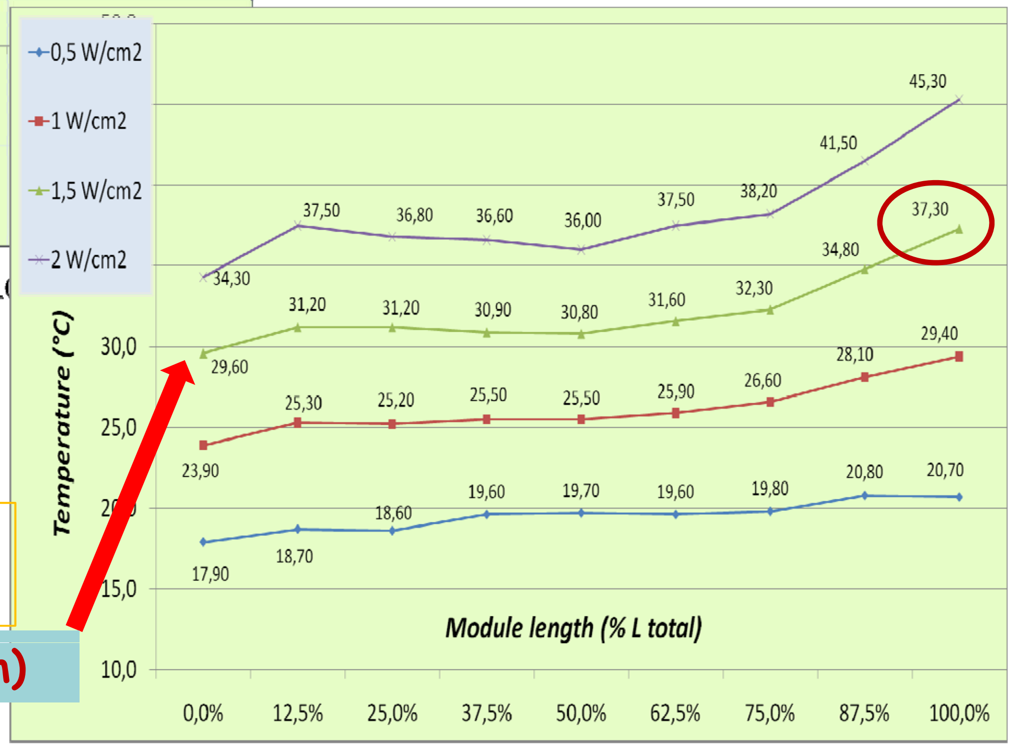


Full Long Modules test results

Average module temperature vs Specific Power



Tests performed on full module sample (length = 300 mm).

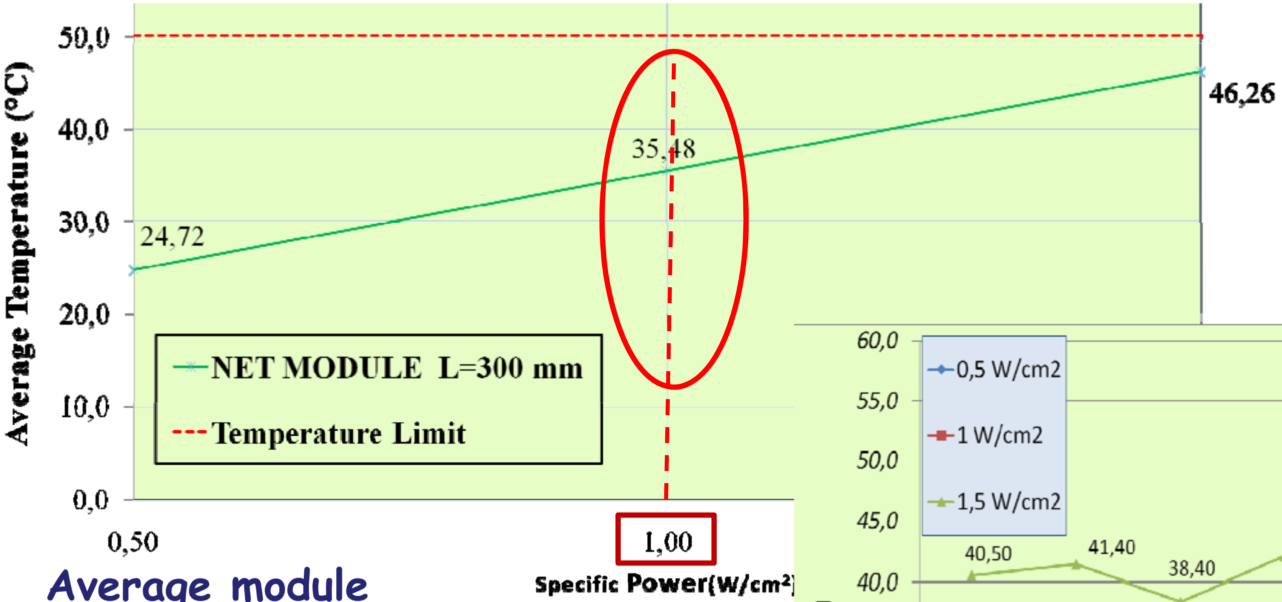


Temperature along the module: (ΔT = 7.7 °C at 1.5W/cm^2, Δp =3,5 atm)

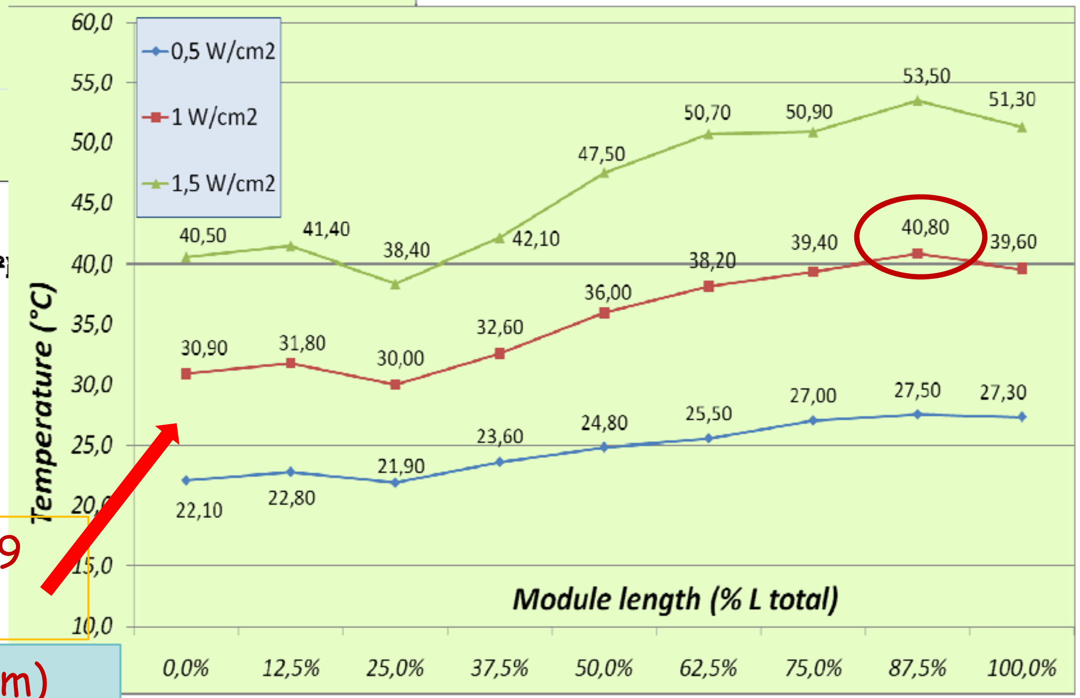
(ΔT = 4,8 °C at 1.5W/cm^2, Δp =7,0 atm)

Net Long Modules test results

Tests performed on Net Module sample (length = 300 mm).



Average module Temperature vs Specific Power



Temperature along the module: (ΔT = 9,9 °C at 1.0 W/cm^2 , Δp =3,5 atm)

(ΔT = 6,2 °C at 1.0 W/cm^2 , Δp =7.0 atm)

Hydraulic parameters

The hydraulic parameters show that for the **micro-channel** geometry there is a laminar flow and a good thermal film coefficient.

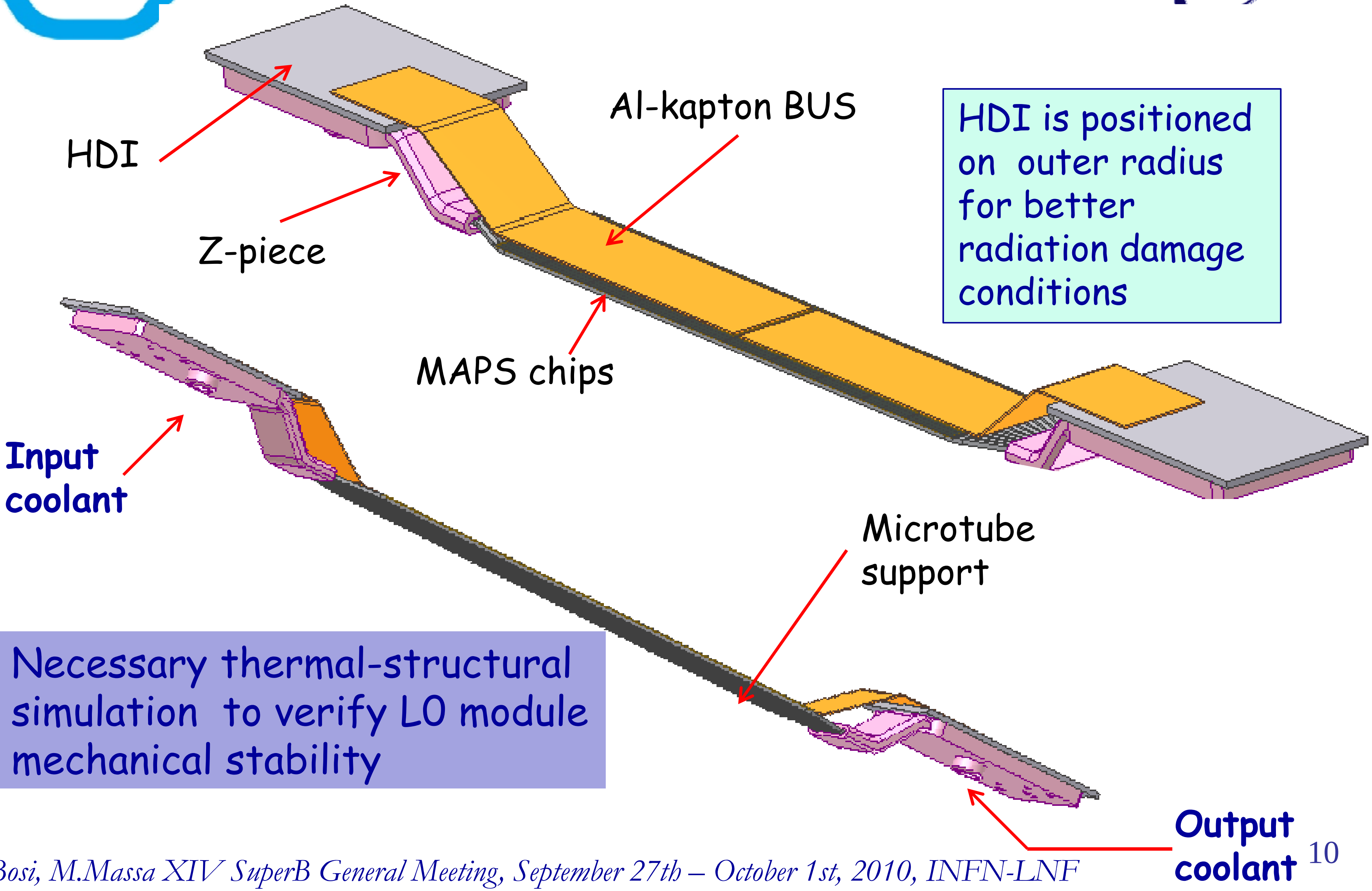
	Total Section	D_h	Total flow	Pressure drop	Flow characteristic	Fluid velocity	Re	h
	mm^2	mm	kg/min	atm	-	m/sec		W/m^{2}K
Net Module *Micro-channel (10 micro-tubes)*	0,7	03	0,128	~ 3,6	laminar	3,37	267	3275
Full Module *Micro-channel (18 micro-tubes)*	1,272	0.3	0,244	~ 3,6	Laminar	3,37	267	3275

It's important to find a balance between pressure drops and *h* value because minimize D_h means to go towards greater pressure drops.

The laminar flow inside the cooling tube minimizes the pressure drops. (Reynolds number < 2300).

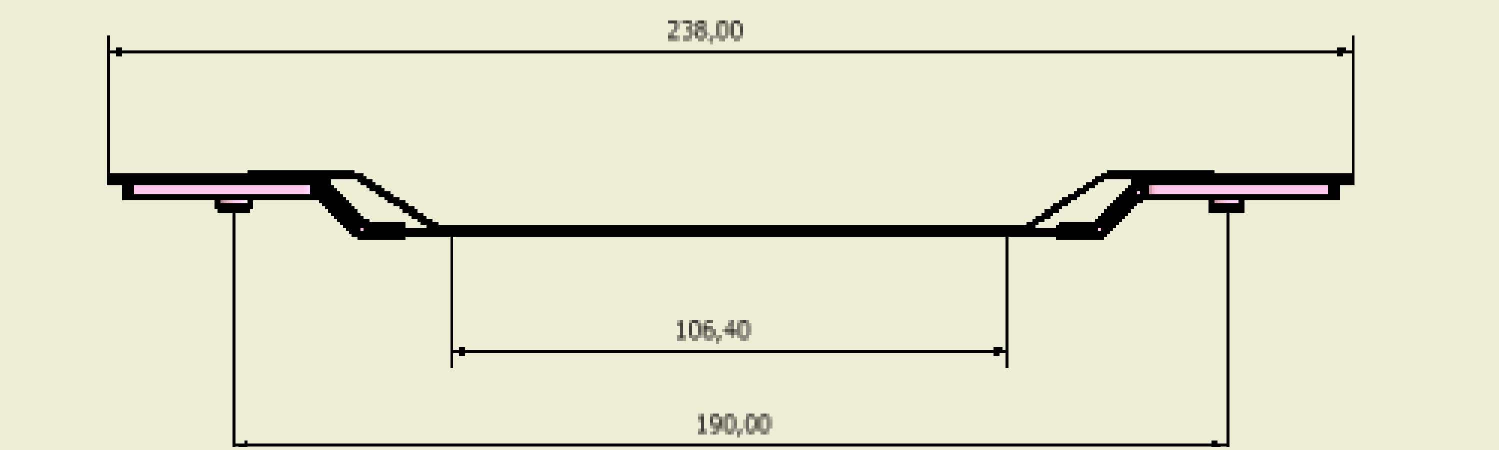
MAPS L0 module Design

HDI is positioned on outer radius for better radiation damage conditions

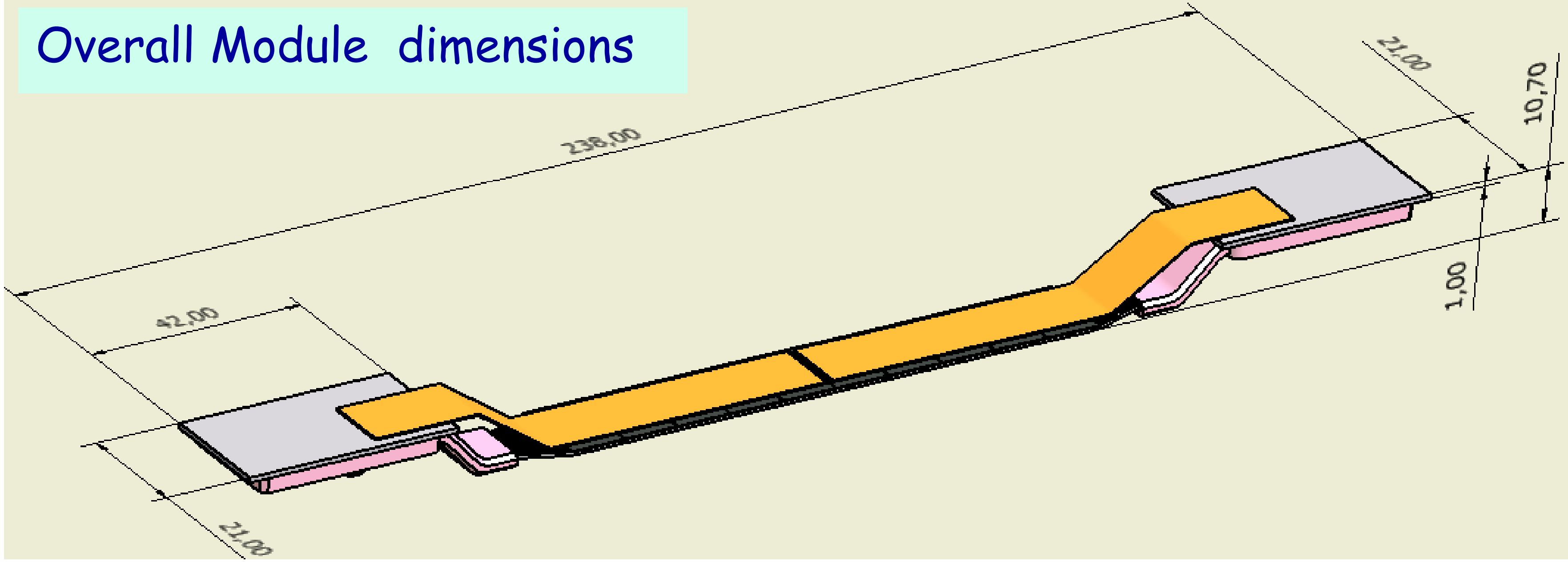


Necessary thermal-structural simulation to verify L0 module mechanical stability

MAPS L0 module Design

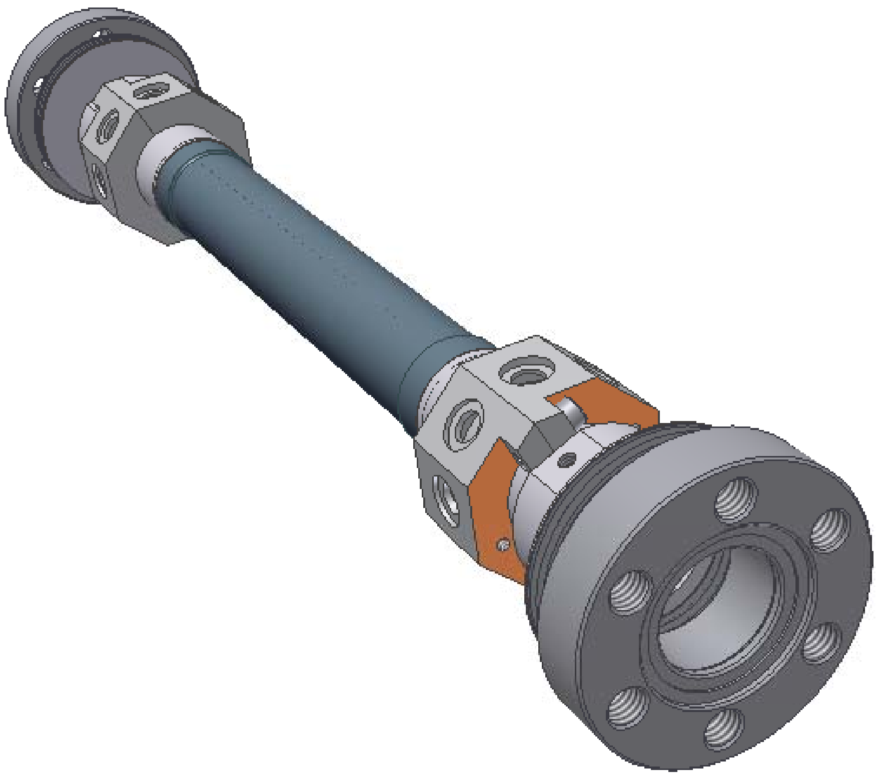


Overall Module dimensions



Beam Pipe

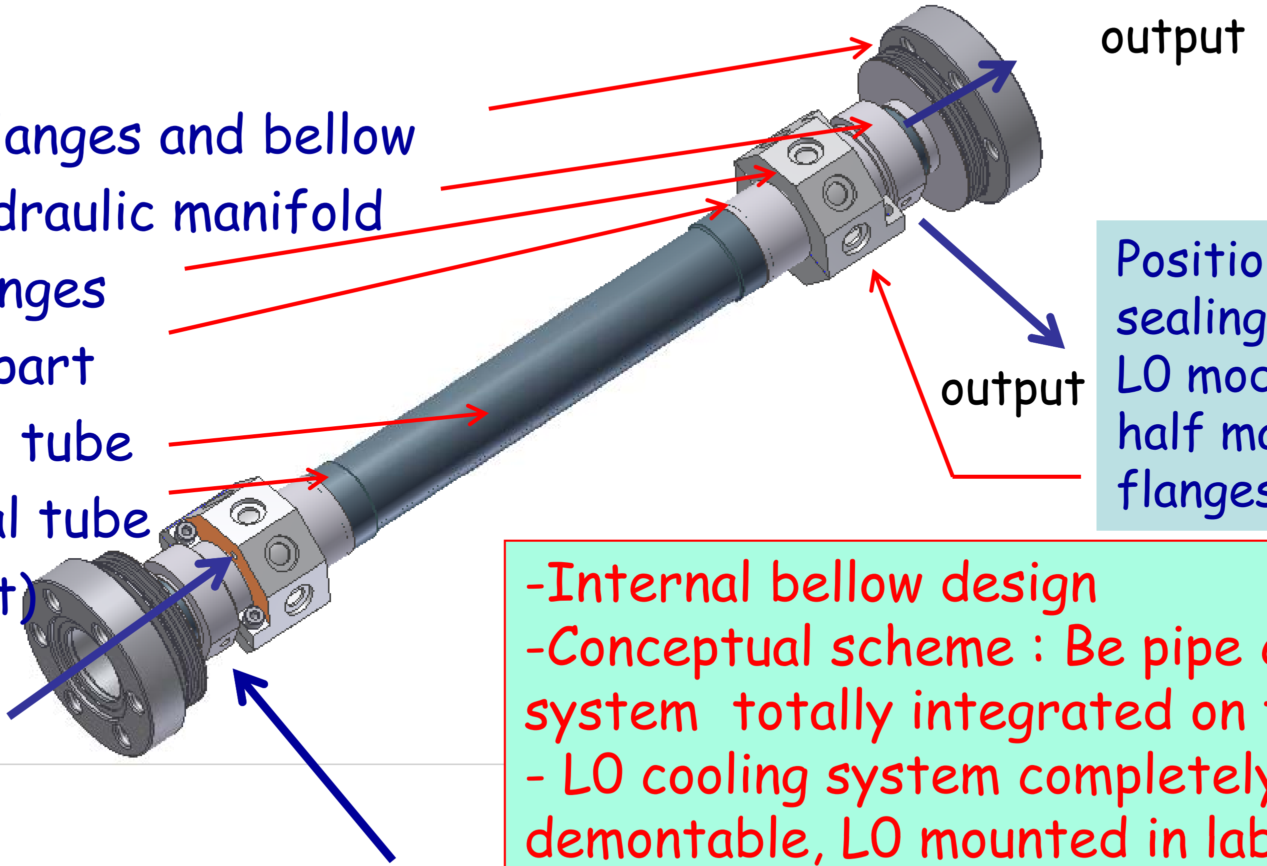
In order to resume: The beampipe consists of two Be cylinders with a layer of cooling water in beetwen. The inner cylinder is the beam pipe and the outer is the water jacket (Babar Style). The outer surface of the beam pipe must be machined in order to obtain a microchannels structure.



to protect from water corrosion the outer surface of beam pipe and the inner surface of water jacket must be nickel-plated (7÷10 μm). The oxidation of the outer surface of water jacket must be prevent using a corrosion inhibiting primer (~15 μm). Gold must have to be sputtered onto the inside surface of the beam pipe (3÷6 μm).

Beam Pipe component

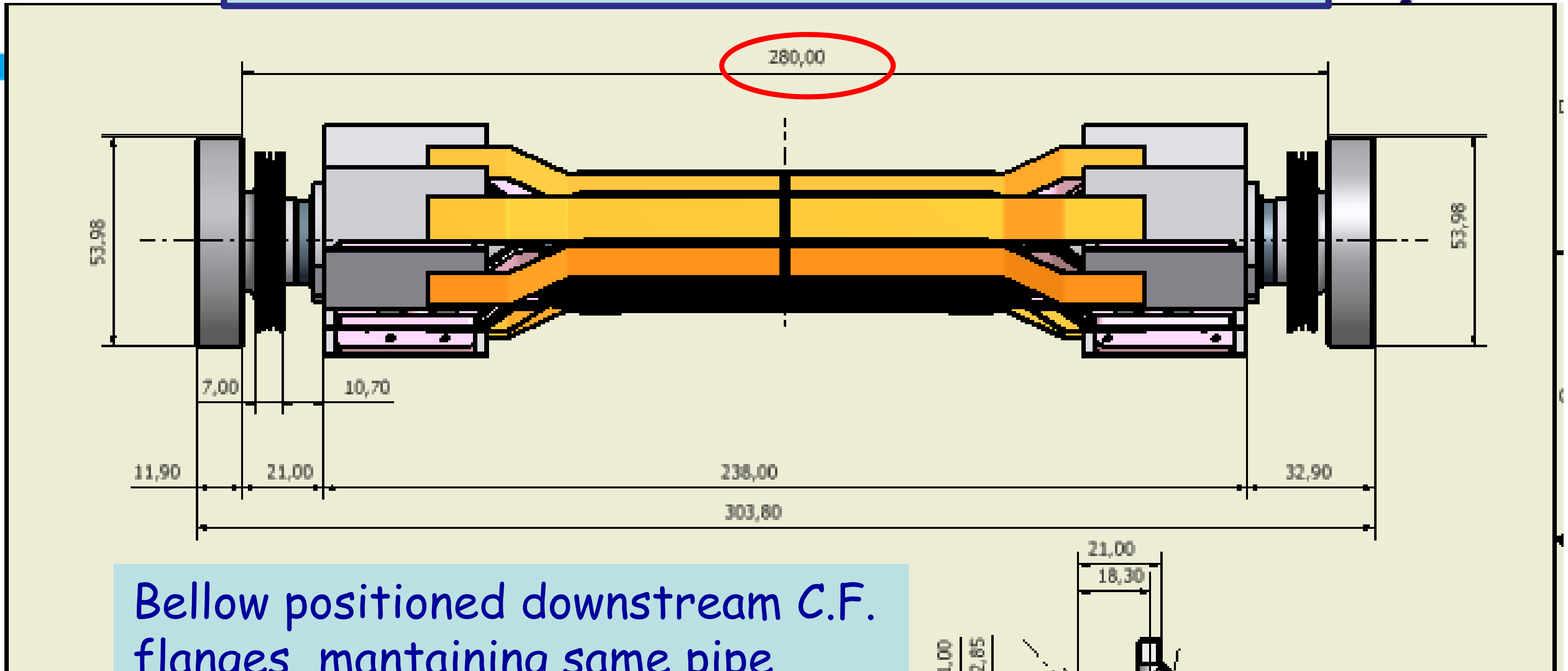
- External flanges and bellow
- Be pipe hydraulic manifold
- L0 cold flanges
- SS vessel part
- Be internal tube
- Be external tube (Water jacket)



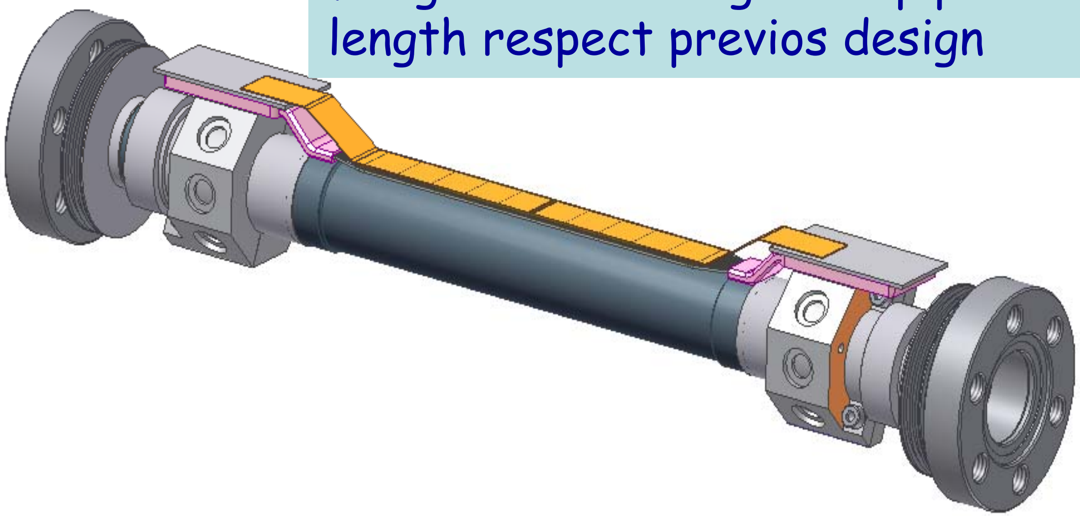
Positioning and sealing of Z-piece L0 modules on the half manifold cold flanges

-Internal bellow design
-Conceptual scheme : Be pipe cooling system totally integrated on the B.P.
- L0 cooling system completely demontable, L0 mounted in lab on two half manifold cold-flanges, positioned and fixed on rigid SS part of B.P.

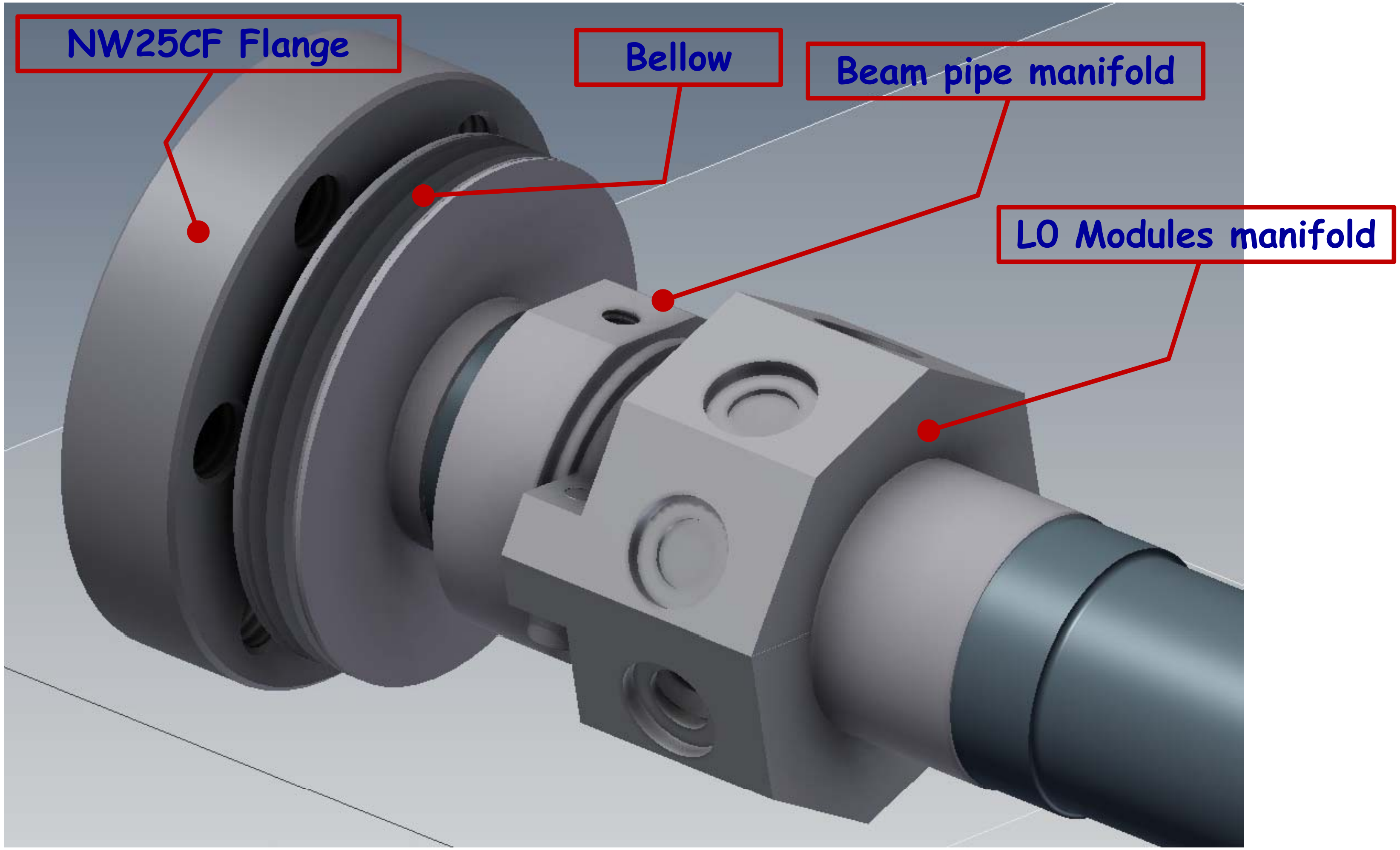
Beam Pipe with L0



Bellow positioned downstream C.F. flanges mantaining same pipe length respect previos design



Internal Bellows



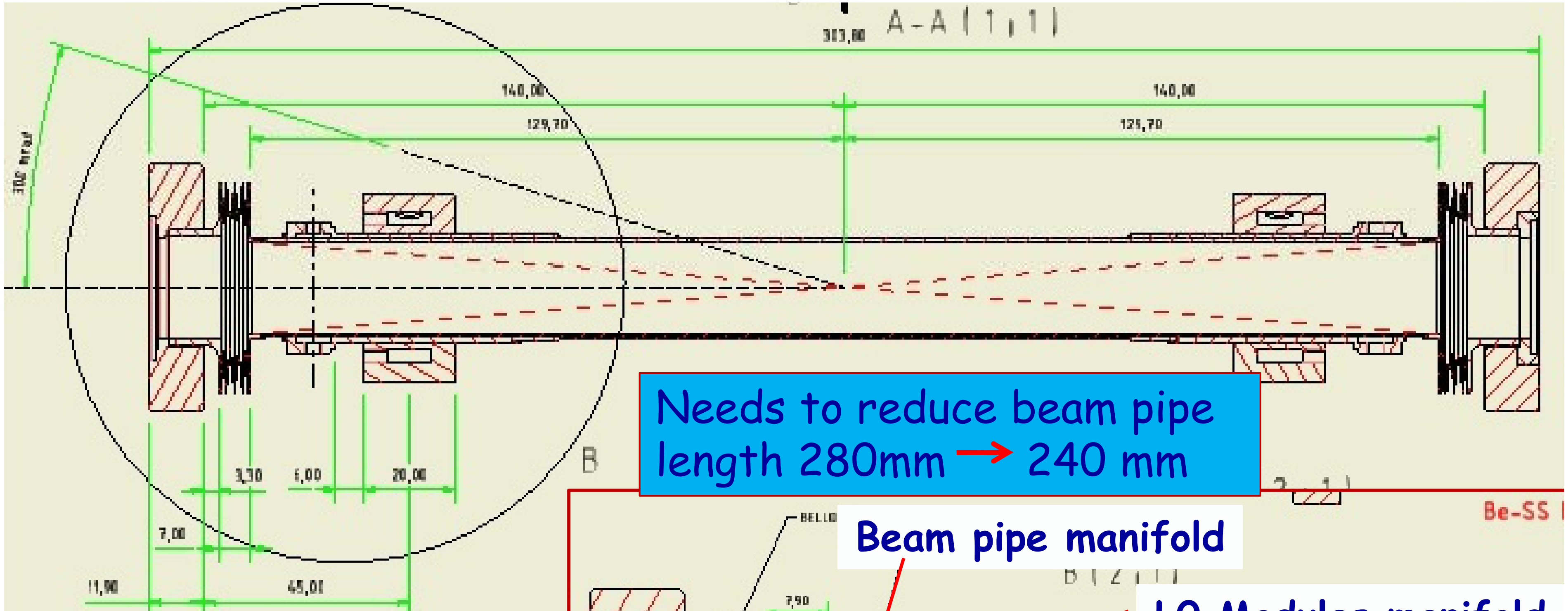
Beam Pipe Design

Dimension constrain and engineering issue:

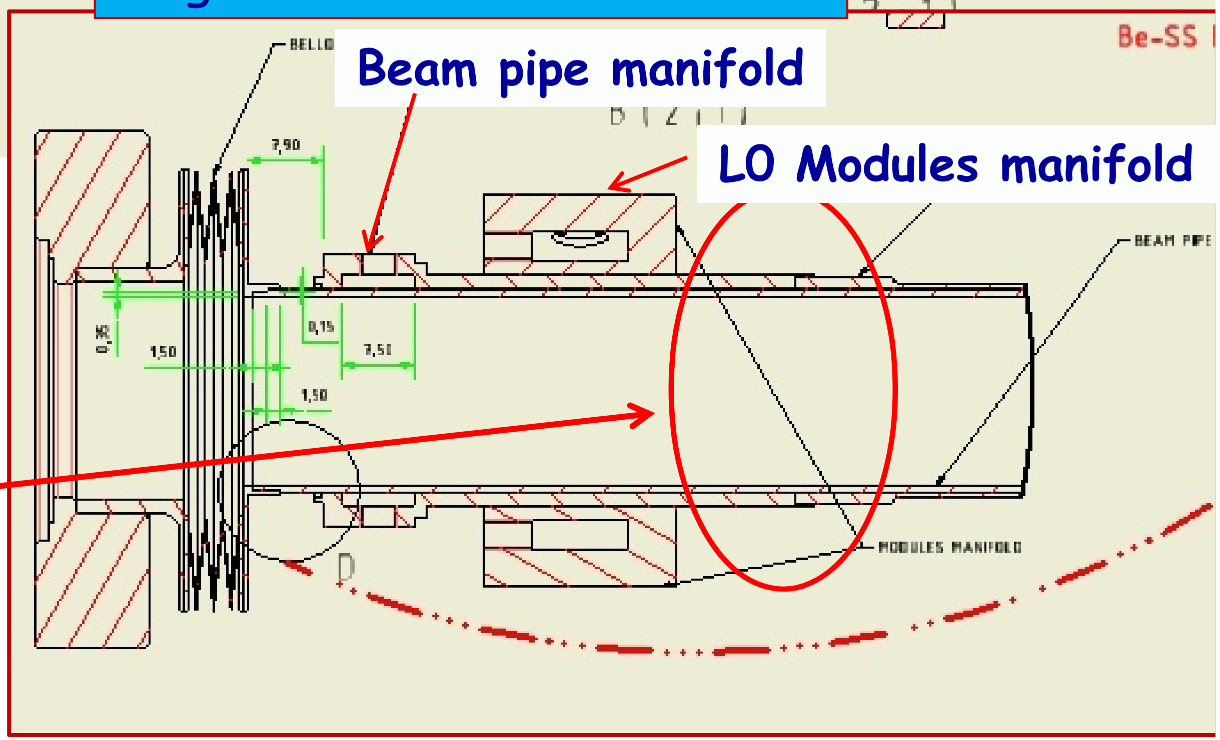
- All components is positioned below 300 mrad
- Specification by M.Sullivan: L=240 mm between the internal side of external flanges otherwise the cylindrical B.P. shape becomes elliptical

  Not respected at the moment (40mm longer)
- flanges with threaded hole (no nuts) to gain space in z
- Technological design for each weldable joint to be confirmed by specialized companies

  (TIG for SS-SS and Brazing for Be-SS)



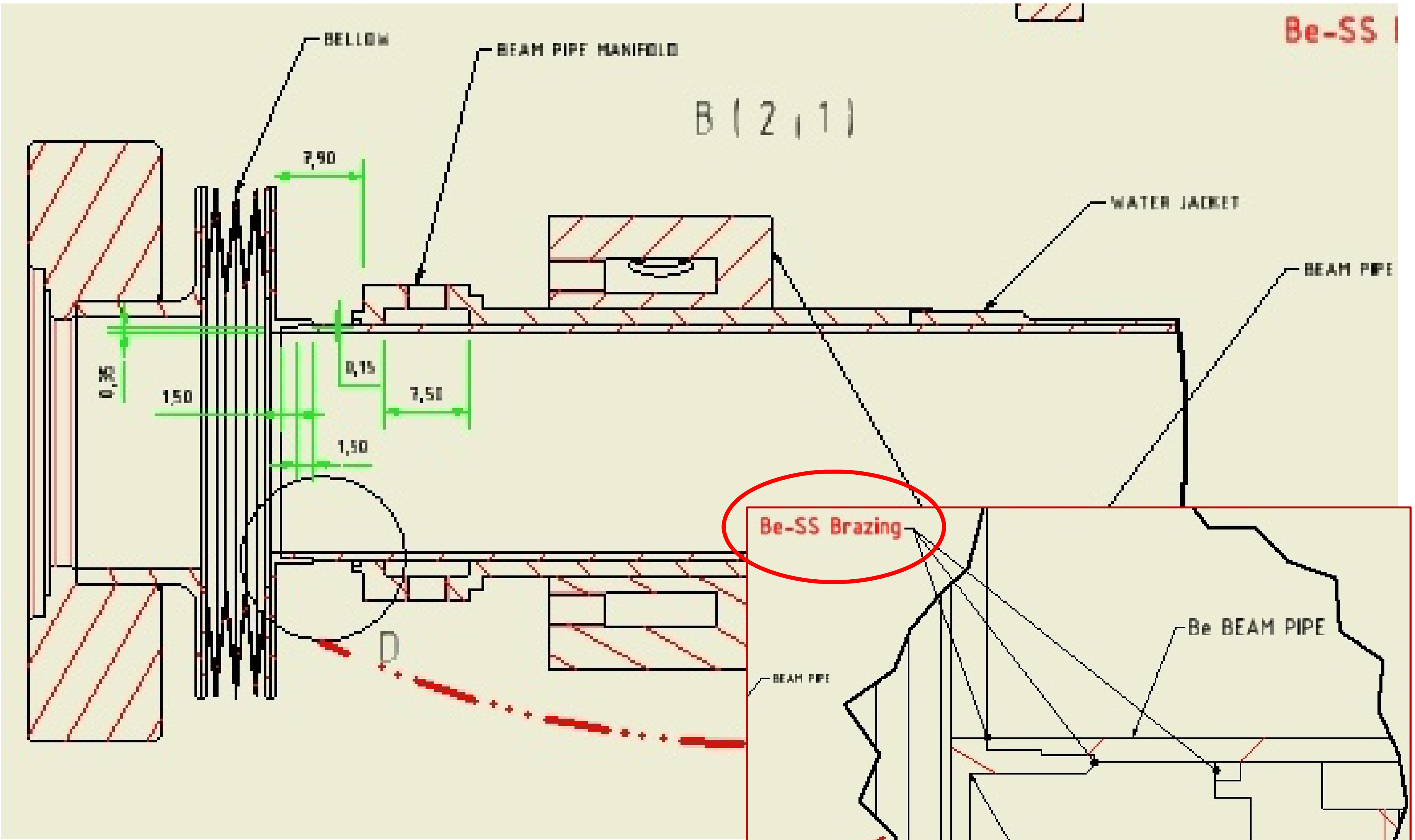
Needs to reduce beam pipe length 280mm → 240 mm

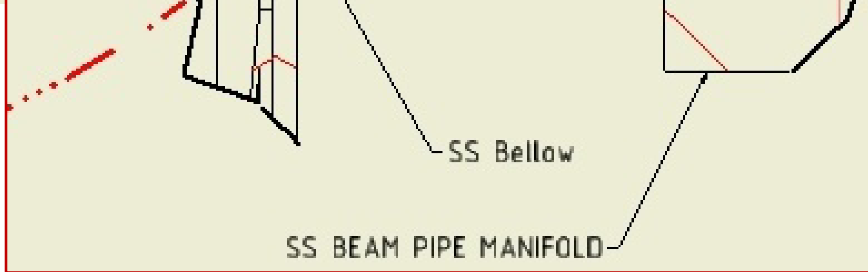


Beam pipe manifold

L0 Modules manifold

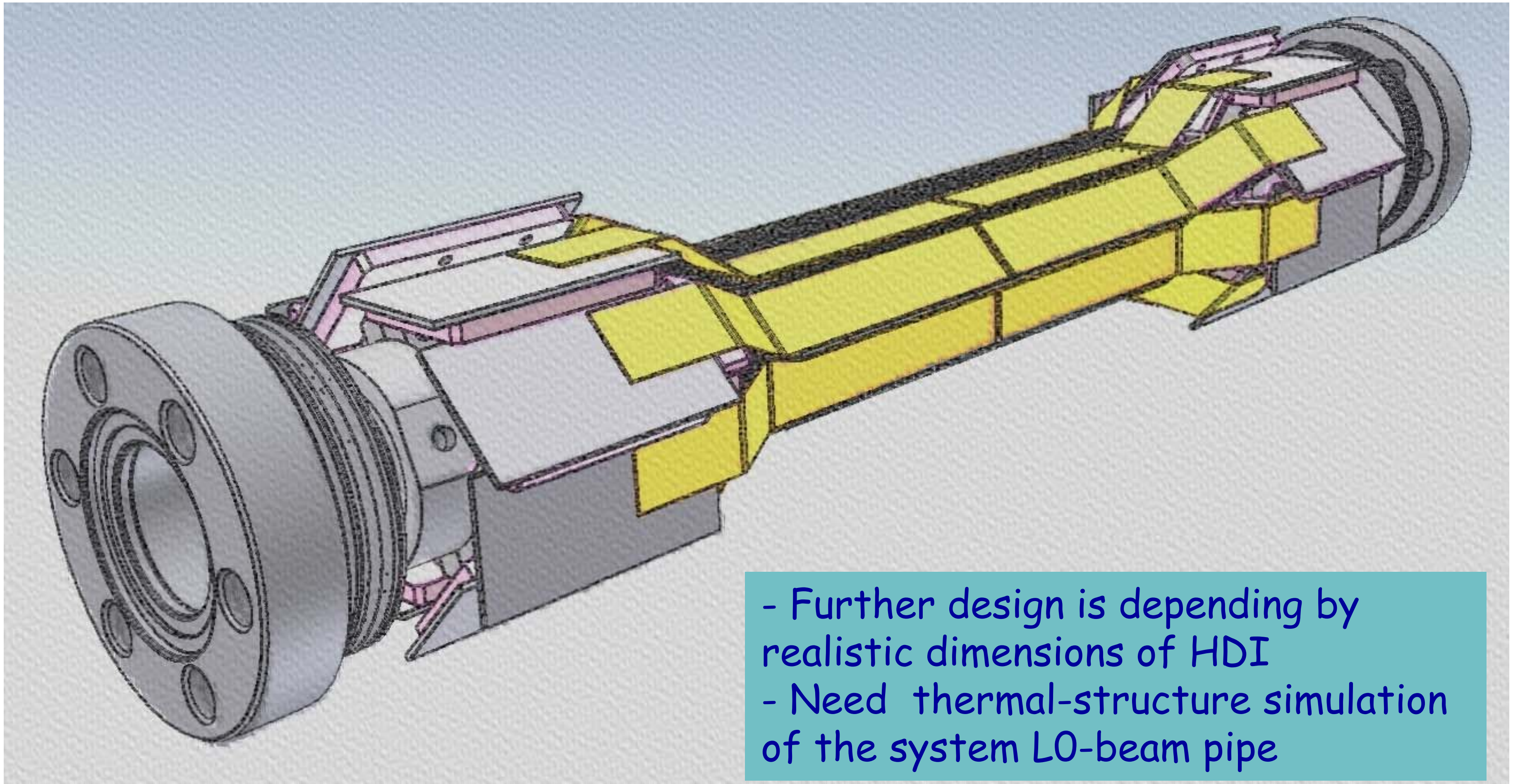
Possible further gain in reducing pipe length but need to check technological feasibility of weldeable joints





Weldable joint TIG in SS-SS
and brazing Be-SS transition

L0 on Beam Pipe



- Further design is depending by realistic dimensions of HDI
- Need thermal-structure simulation of the system L0-beam pipe

Work actually in progress

1) Design for CFRP mask and process.

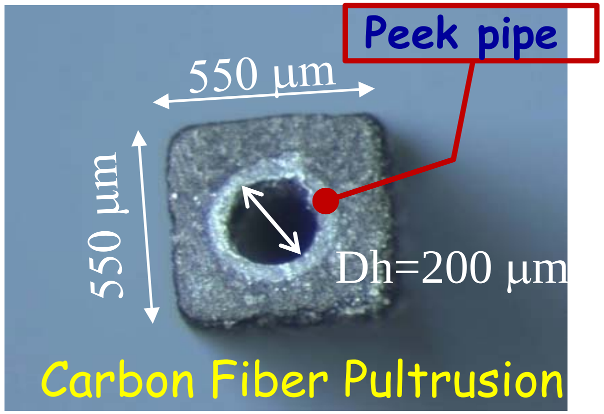
Started collaboration with italian company for first microchannel structure prototype (L=700 μm and Dh=300 μm)

2) Z-piece prototype

In construnction phase, with rapid prototyping technology (ABS material)

3) Development of microchannel base structure with L=550 μm and Dh=200 μm

In construction phase, first prototype, ready in 5 weeks (further reduction of X_0)

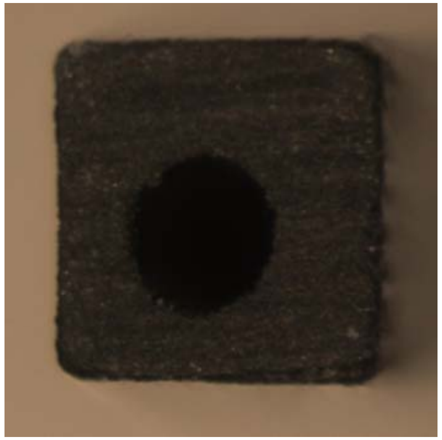


Work actually in progress

4) Hydraulic test circuit

In set-up phase, components able to test structural limit of the microtube up to 100 atm

5) Prototypes construction of Full and Net module support, with base microchannel tube without Peek internal tube:



Almost ready, N.2 prototypes to measure :

- wettability of Carbon fiber

-friction factor differences (not expected for laminar flow)

6) Circuit and group refrigerator for change phase thermal exchange with CO_2 fluid:

- Design started in contact with specialized companies

Work to do

1) Fine engineering design of Be pipe, contact with Electrofusion company for appropriate brazing technology and weldeable joint feasibility.

3) Further study to reduce dimensions for L0 module and beam pipe, to gain space in z direction (expected 240 mm at flanges limit)

5) Start with engineering work to design the mechanics for quick demounting of the SVT +L0 from the I.R.

Conclusions

1) Test on long full and net microchannel module have been performed with good results

2) In progress work to improve thermal exchange and X_0 of the microchannel support in pultrusion process (base tube L=550 μm , Dh= 200 μm)

2) In progress work to improve thermal exchange of the microchannel support with high th. conduct. Mat. in CFRP process.

3) Our Goal is to construct a full scale system L0+Al. beam-pipe model to test by thermal point of view at the TFD lab.

4) Reduction of Be beam pipe length is possible to match the request of 240 mm

5) Need adding work and effort to proceed in to the design of a quick demounting of the L0 in the SuperB experiments

BACKUP