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February 2020

CS Winding Pack and Support Structures

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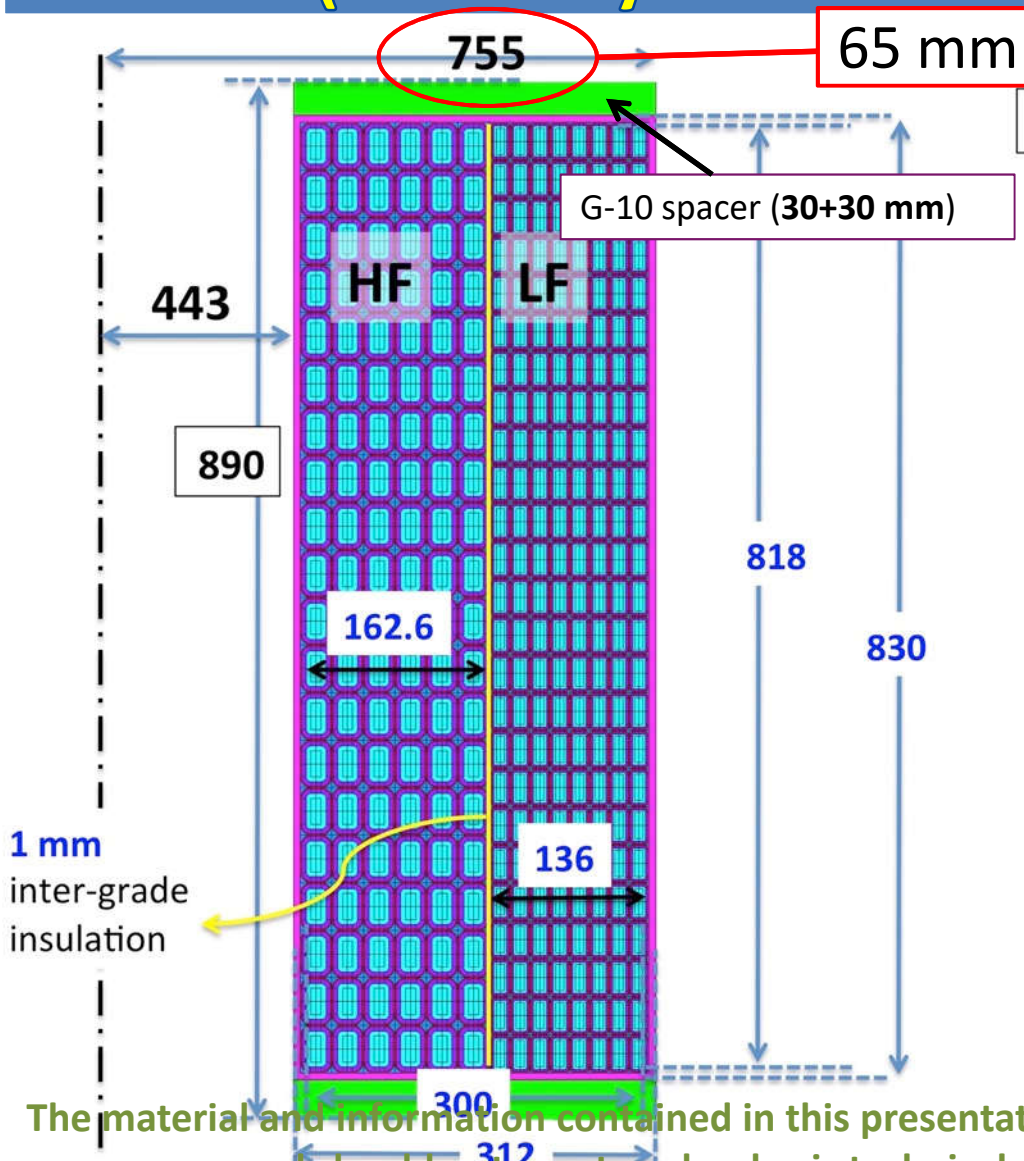
CS module: geometry (actually under revision)



DTT CS Coil_Layered_v50

HF:
6 x 20 = 120 turns

LF:
8 x 25 = 200 turns

I_op: 29.04 kA

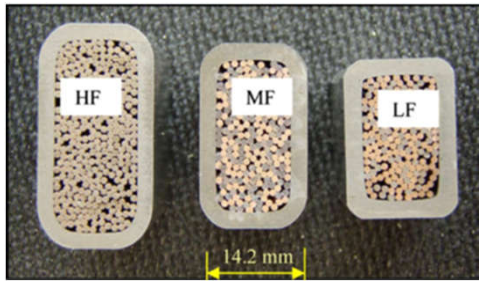
HF CICC (insulated):
40.9 x 27.1 mm^2
Jack. Thickness: 4.1 mm
Turn insulation: 1 mm

LF CICC (insulated):
32.7 x 17.0 mm^2
Jack. Thickness: 2.0 mm
Turn insulation: 1 mm

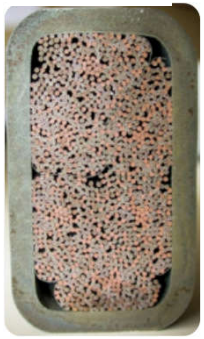
(All dimensions at 4 K)

Similar CICC concepts

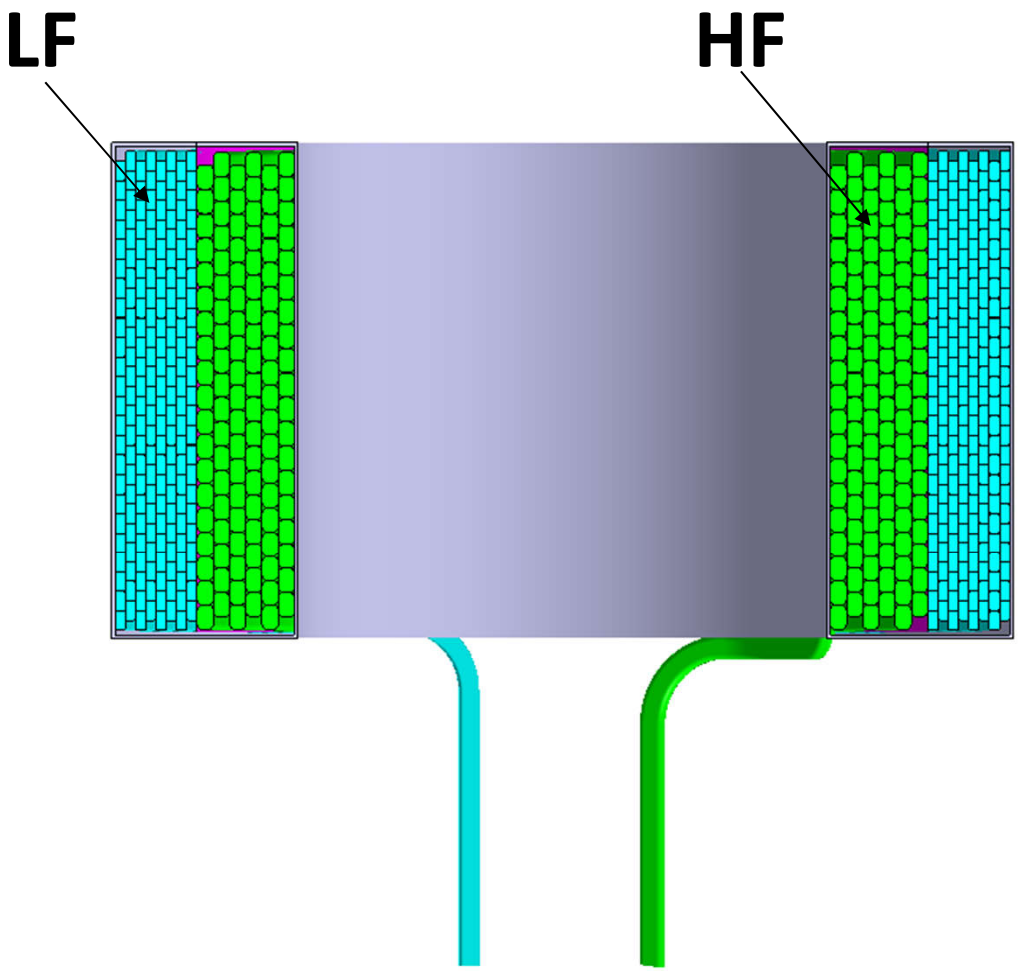
NHMFL



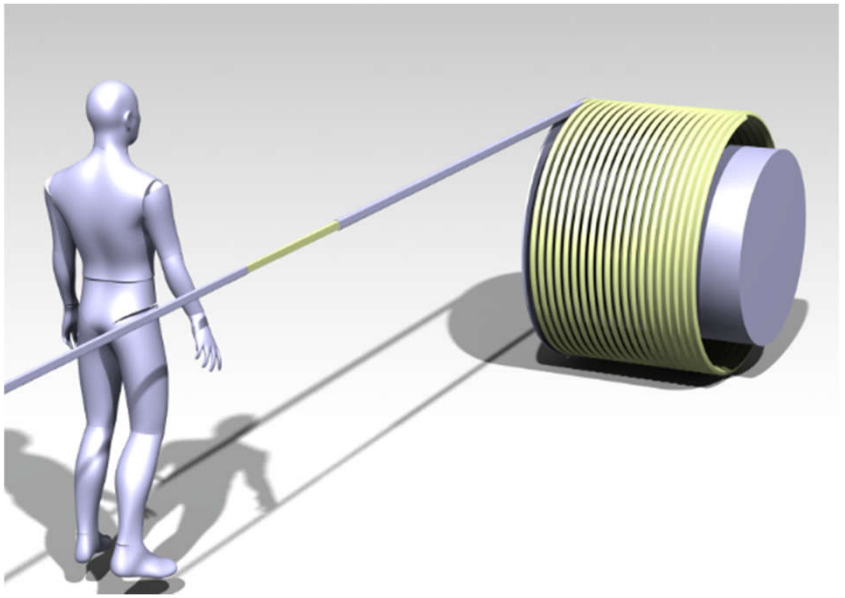
EU-Alt TF



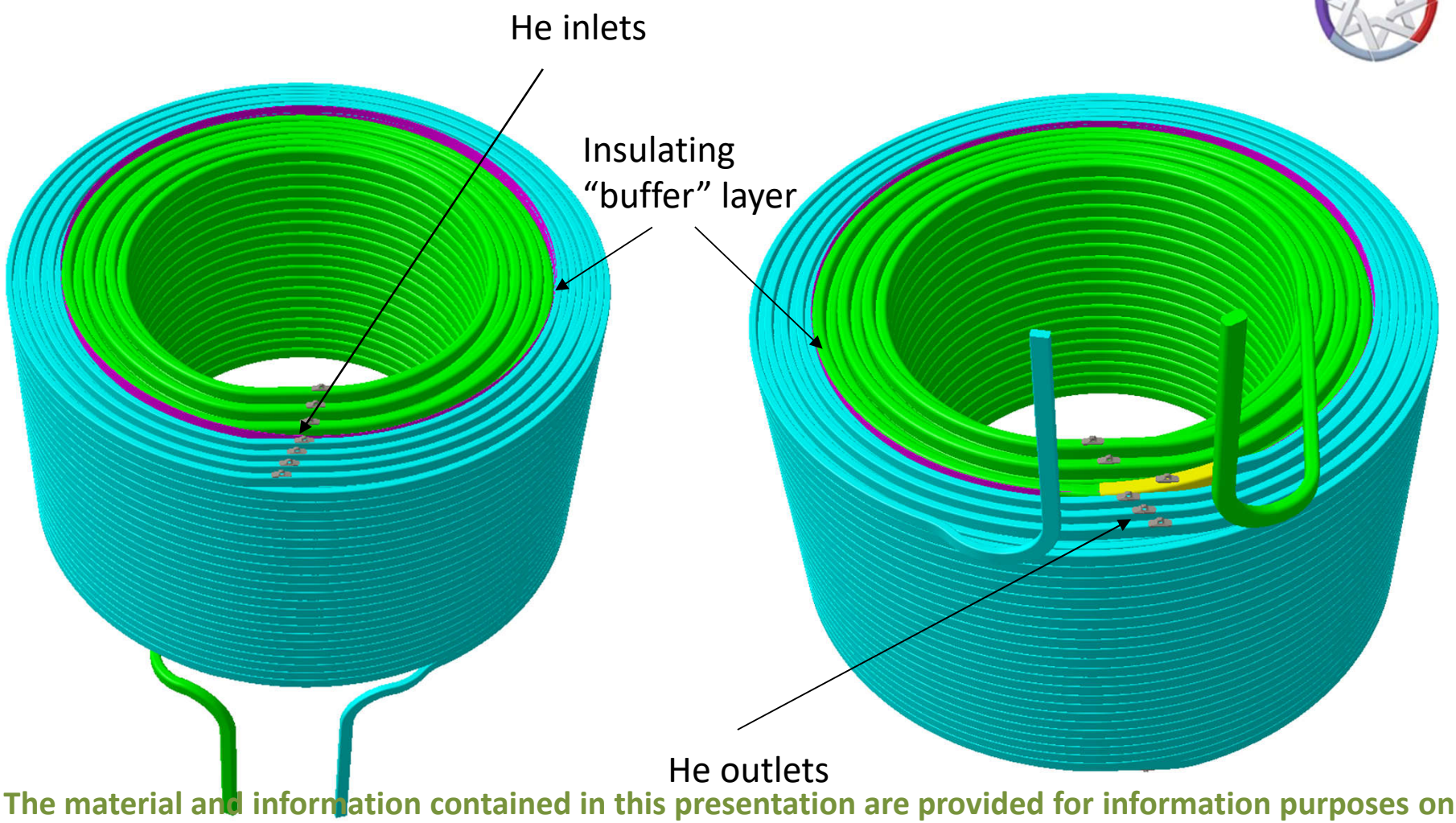
CS module: winding configuration



Presently under evaluation:
subdivide this LF section into a **MF** and a **LF** section.



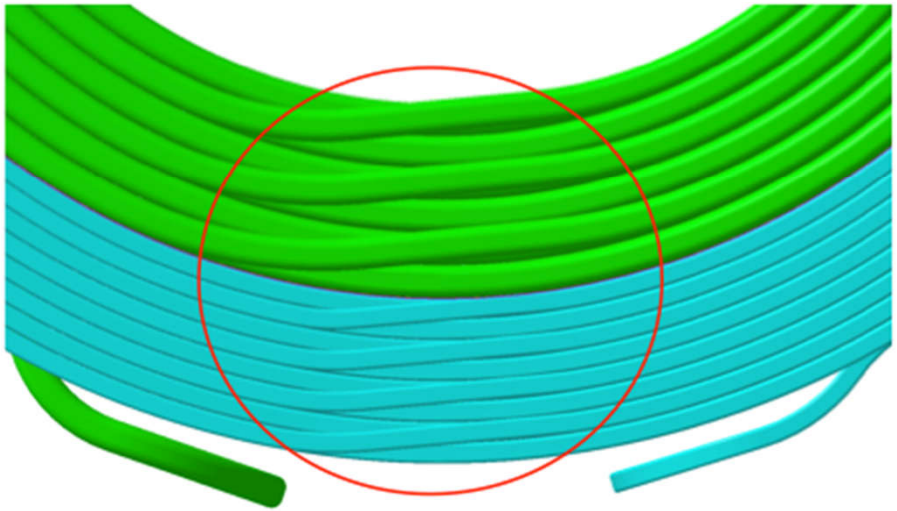
CS module: winding configuration



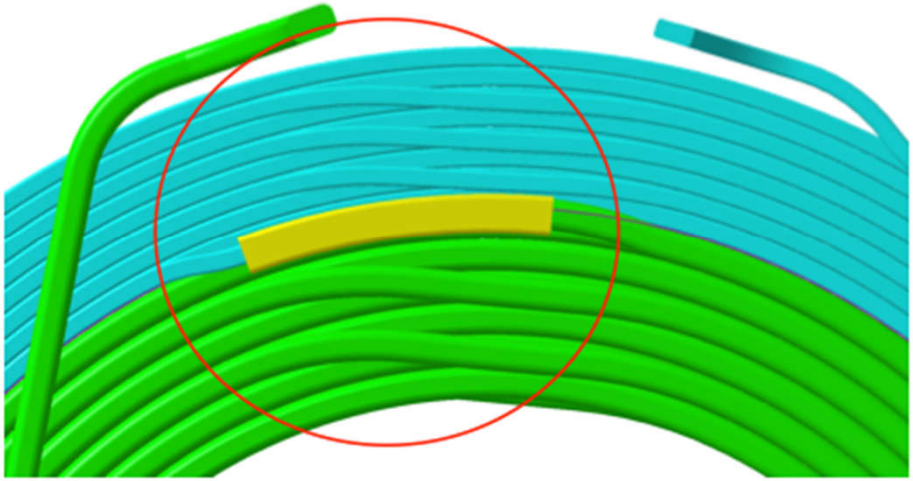
CS module: winding configuration

Possible winding configuration

Vista da sopra

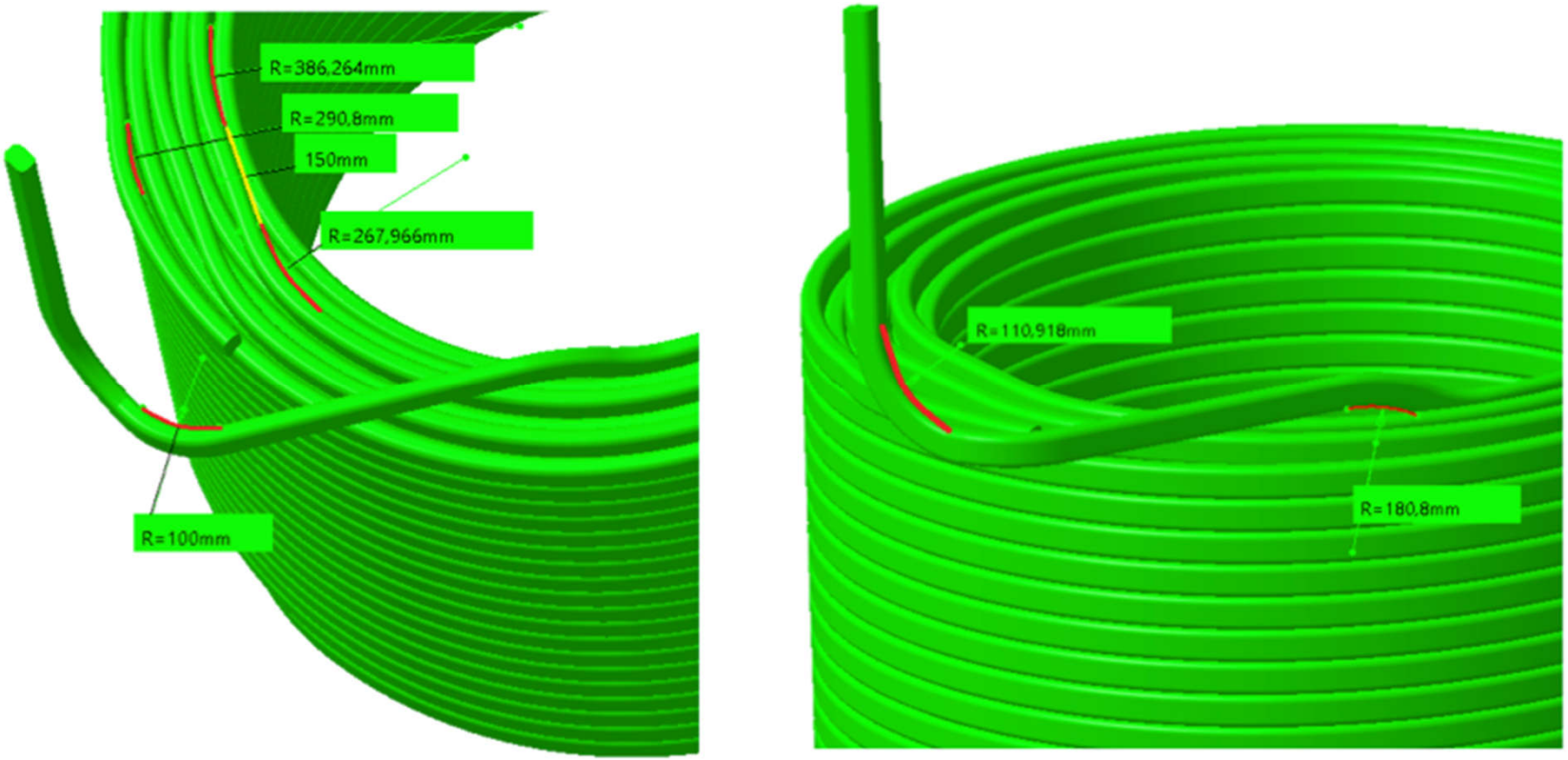


Vista da sotto



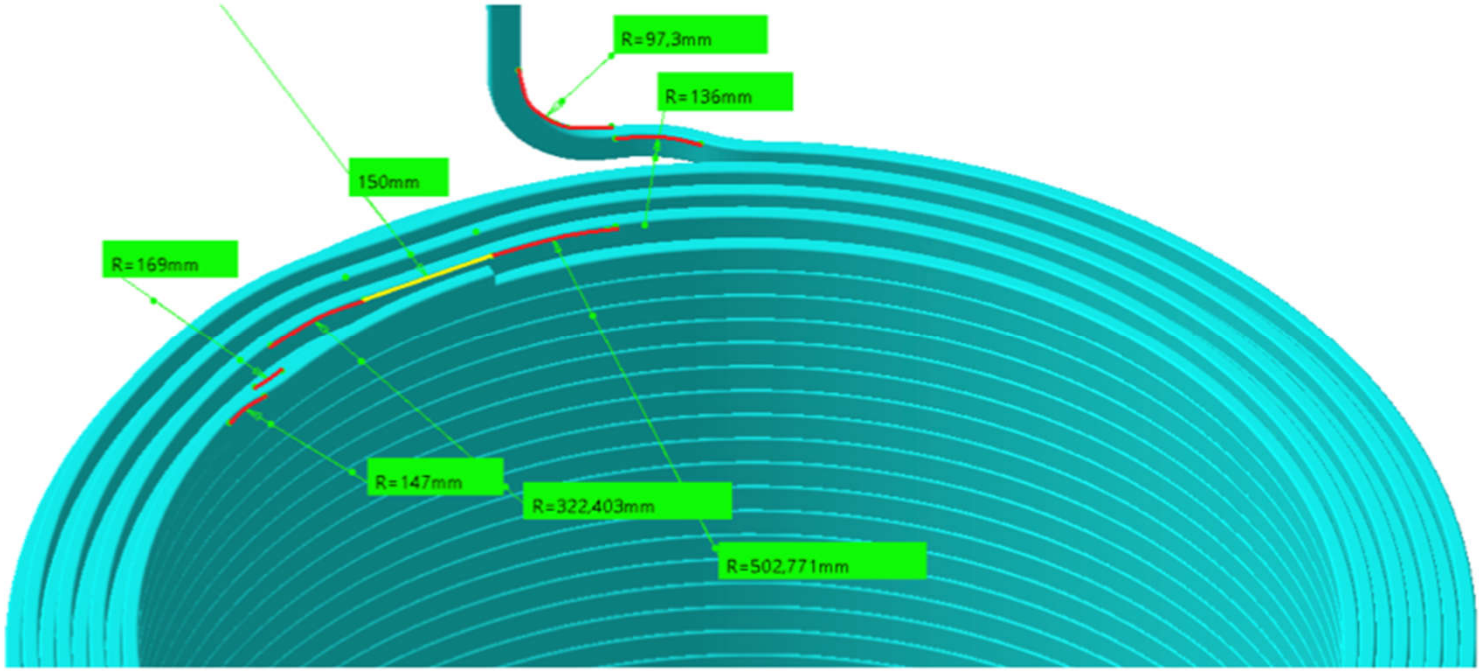
CS module: winding configuration

HF winding

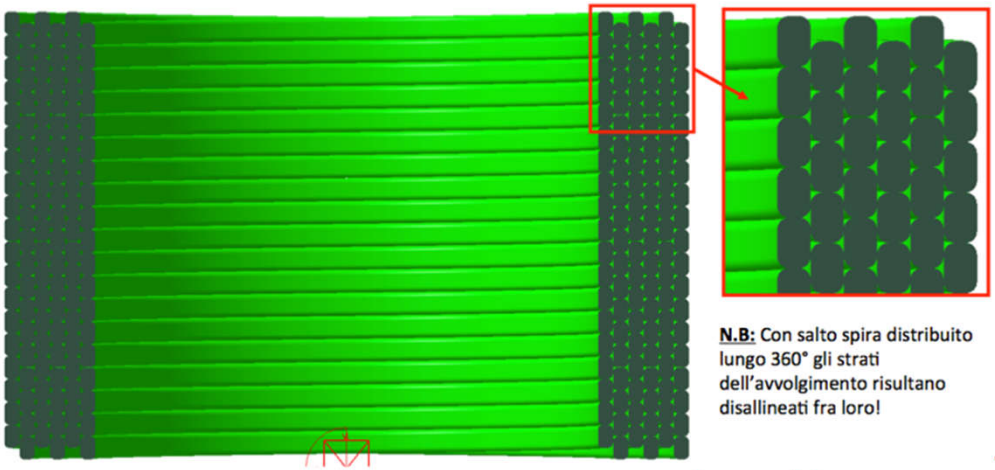


CS module: winding configuration

LF winding

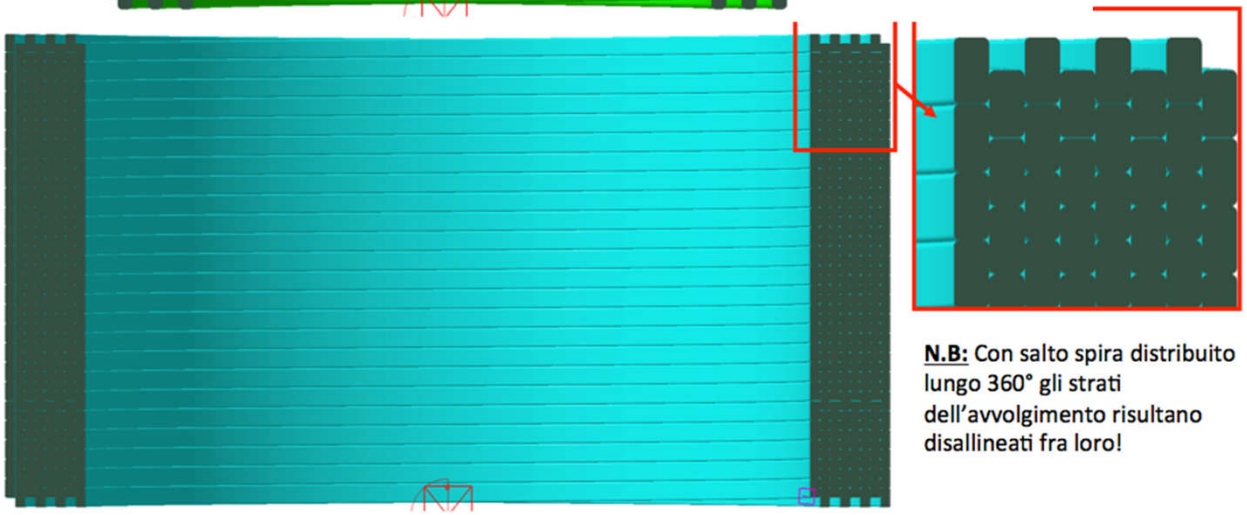


CS module: winding configuration



N.B: Con salto spira distribuito lungo 360° gli strati dell'avvolgimento risultano disallineati fra loro!

HF winding



N.B: Con salto spira distribuito lungo 360° gli strati dell'avvolgimento risultano disallineati fra loro!

LF winding

CS module: manufacturing approach

Wind & Insulate → React → Impregnate manufacturing approach

- Insulation to be applied during coil winding, before the Nb_3Sn reaction heat treatment:

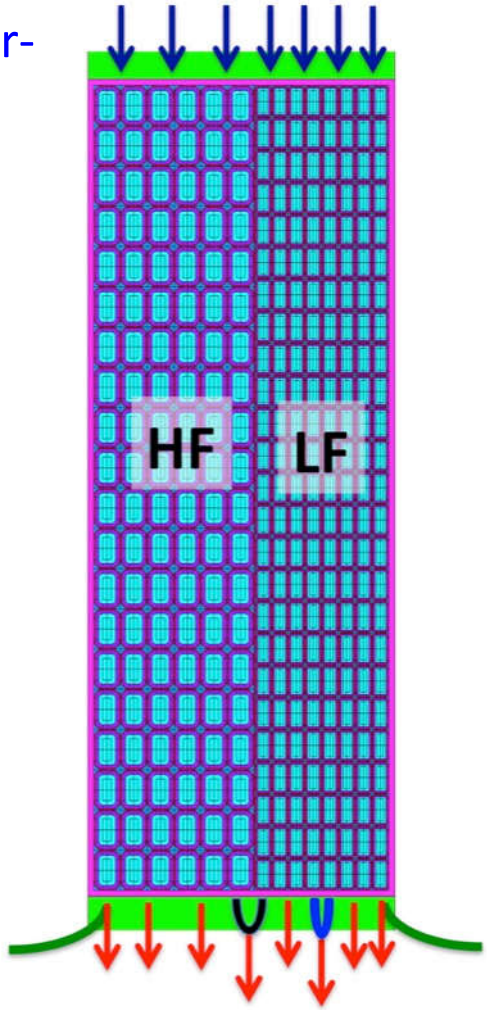
  → turn insulation will not rely on Kapton: but according to computations, it is not necessary for the expected voltage levels (*3.5 kV peak terminal-to-terminal Voltage at plasma breakdown*);

  → most appropriate choice of insulation material (S-glass ? / resin type ?) and manufacturing process?

CS module: HF to LF joint

- Two terminations and two inter-layer joints per module.

- Inter-layer joints:



DTT CS Coil_Layered_v50
Layout 1

Joint 1: HF-LF

Joint 2: LF-LF

Internal termination

External termination

He outlet

He inlet

2 terminations
2 intermediate joints
7 He inlets
8 He outlets

	HF	LF
Hydr. Length (m)	72	108

CS module: HF to LF joint

- Two terminations and two inter-layer joints per module.

- Inter-layer joints: use “internal” joint, manufactured in-line during winding, thus embedded within the winding pack (*EDIPO / NAFASSY / ITER CS – like*).

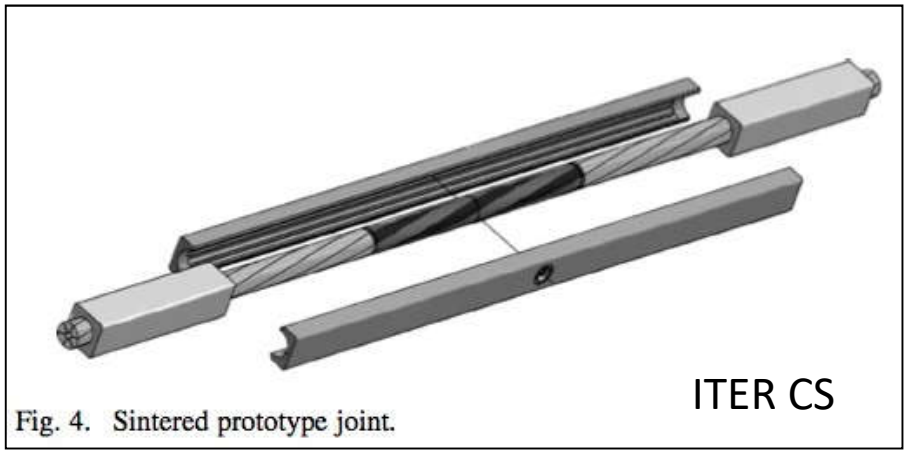
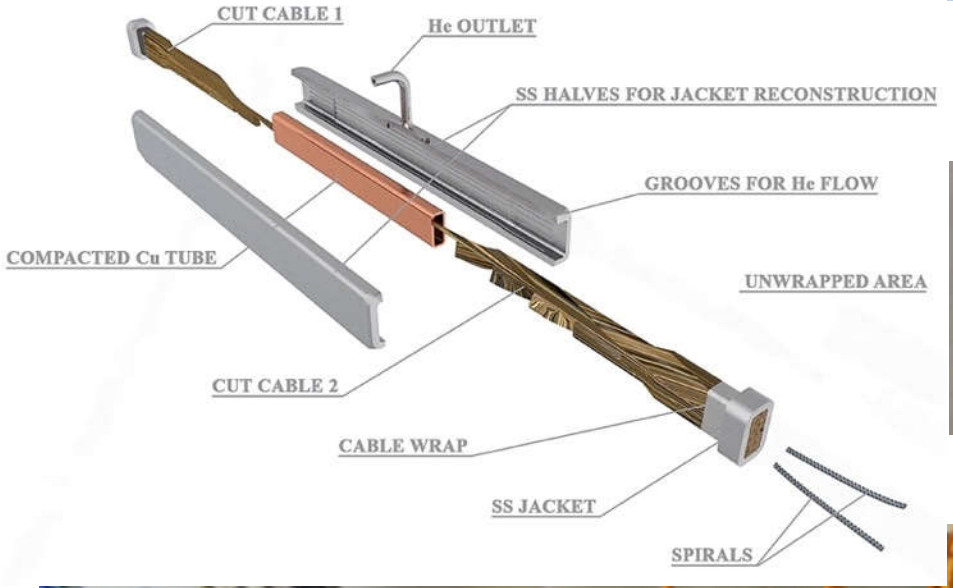


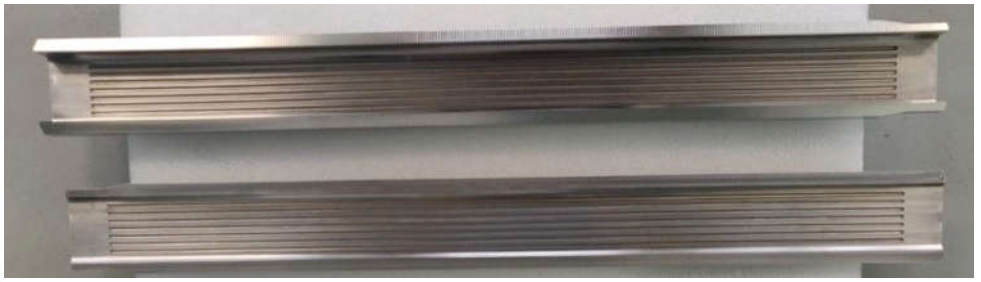
Fig. 4. Sintered prototype joint.

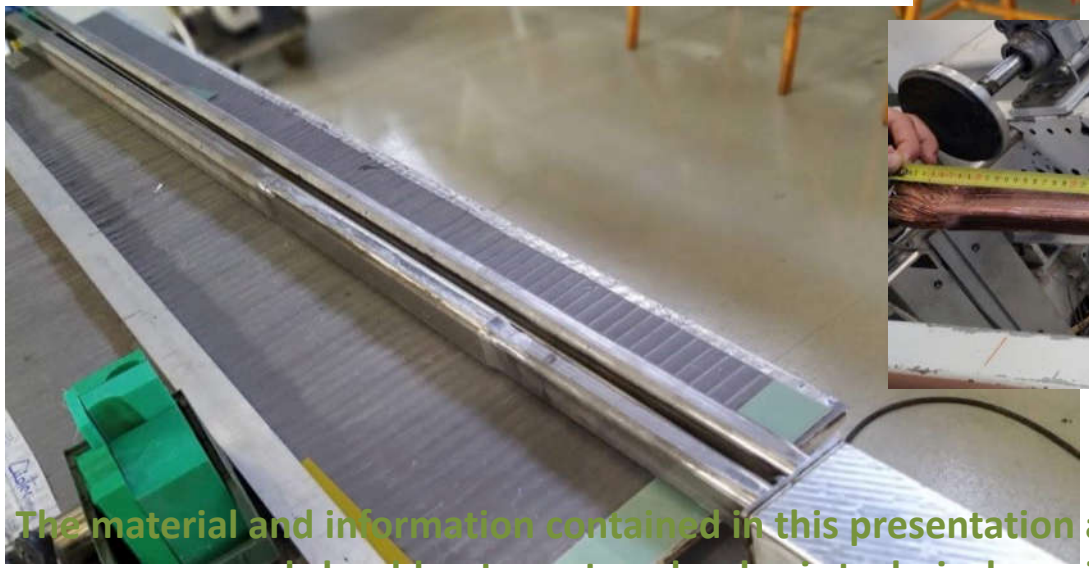
ITER CS

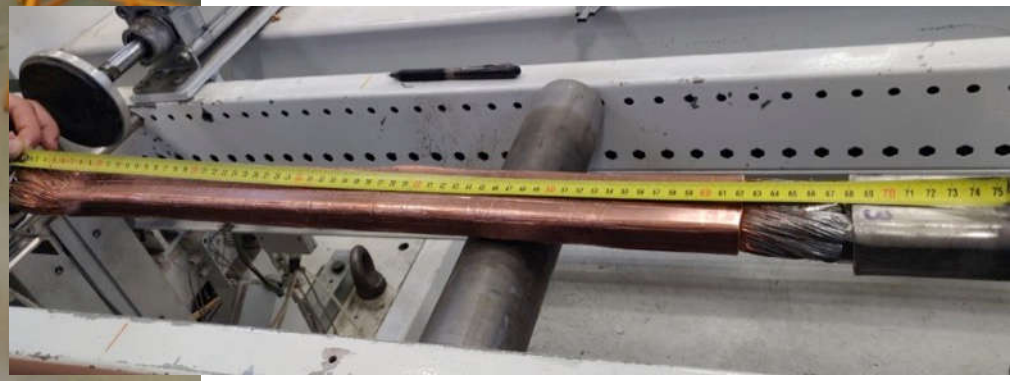
NAFASSY

DEMO TF Interlayer Joint





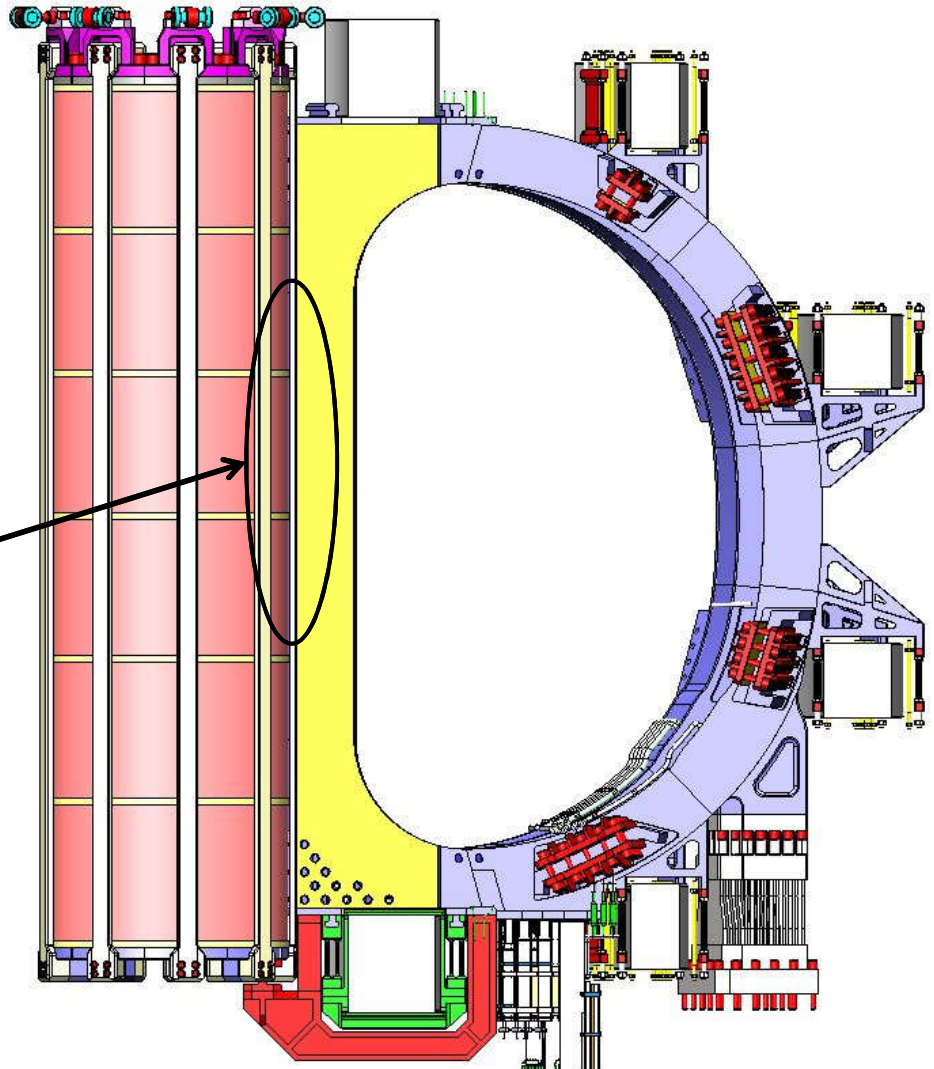




CS module: termination box

Still to be designed.

Space constraints are extremely demanding!

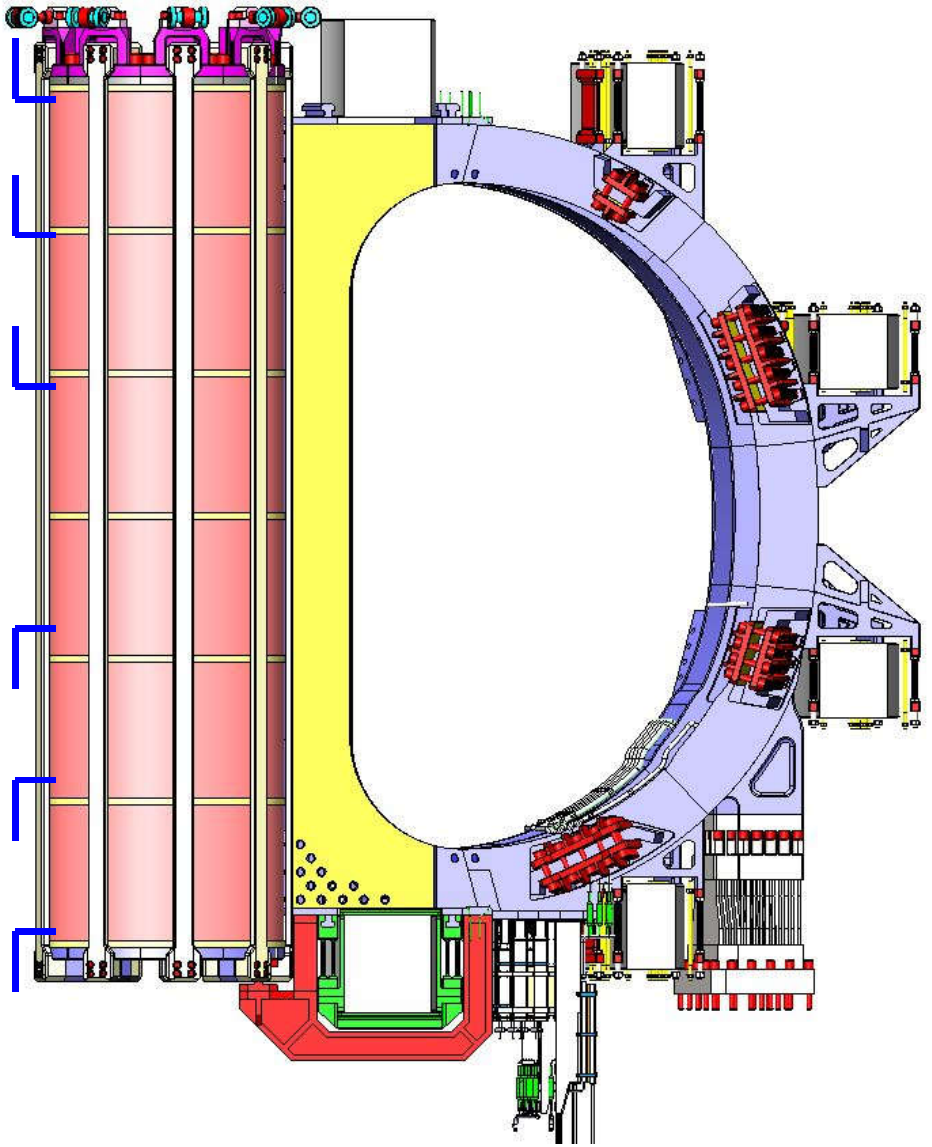


CS module: termination box

Still to be designed.

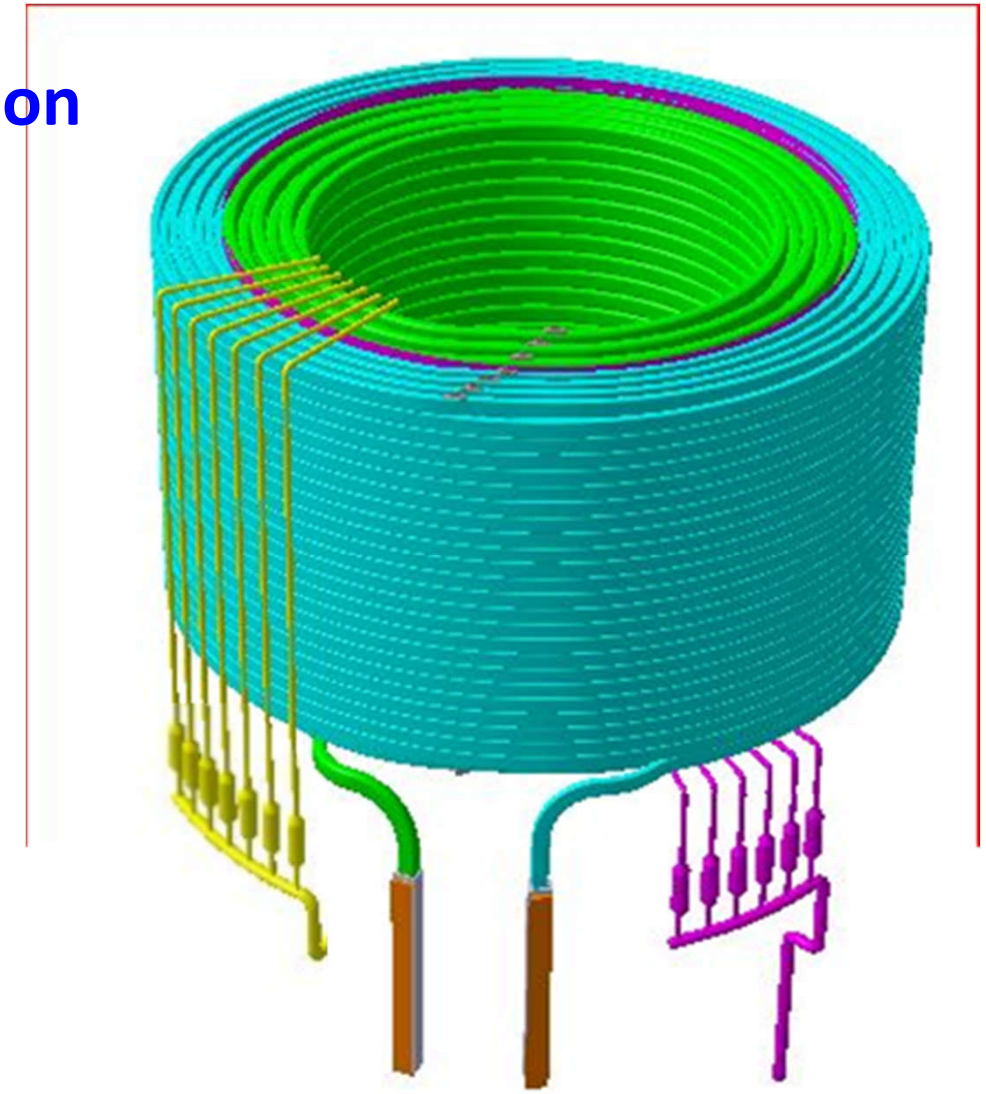
Space constraints are extremely demanding!

Terminal lengths will extend outside the module height, to allow easier termination manufacture.



CS module: termination and manifolds

Possible coil configuration



CS module: additional issues

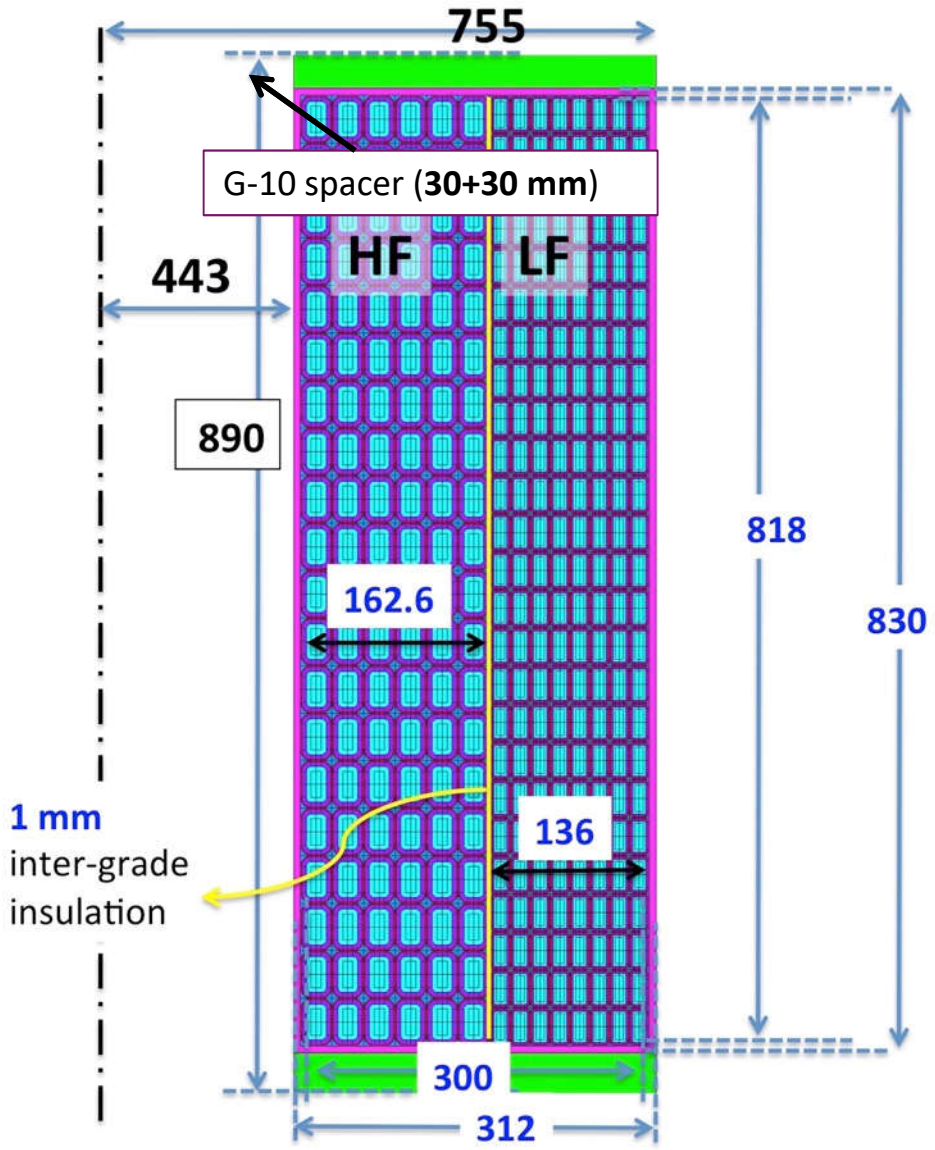
Corner regions:

- Glass insulated steel wire (useful also for co-wound V tap)

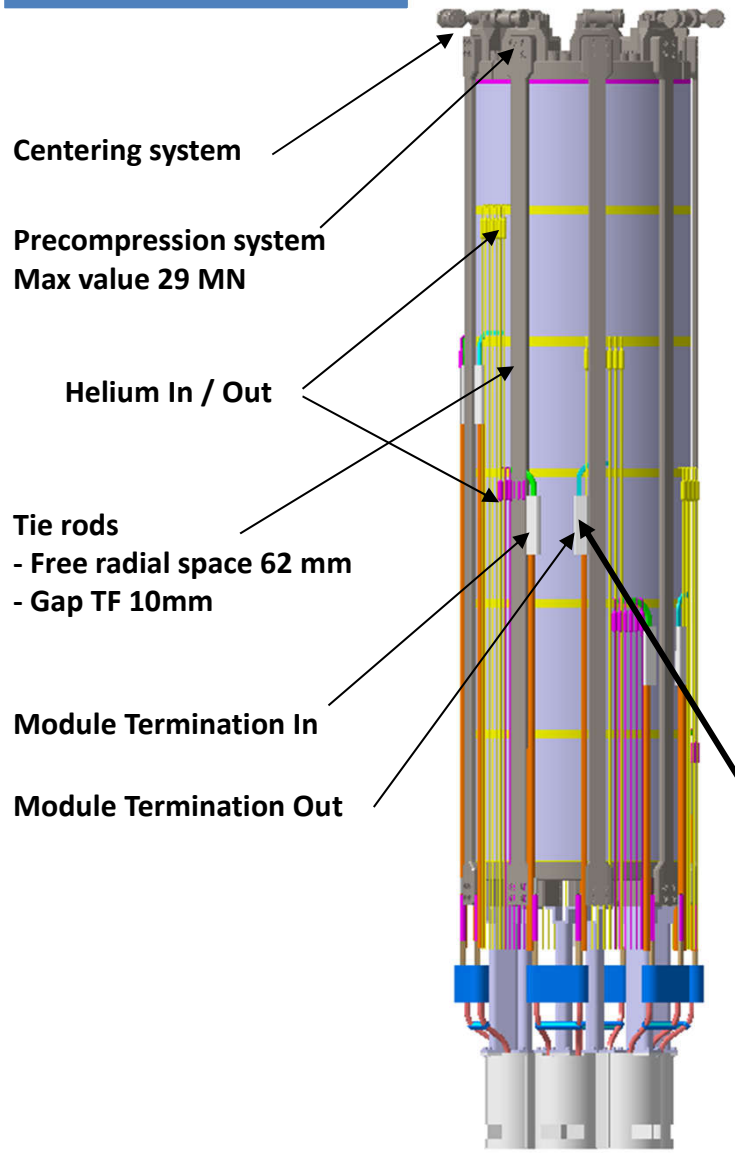
Still under evaluation: co-wound tape for quench detection:

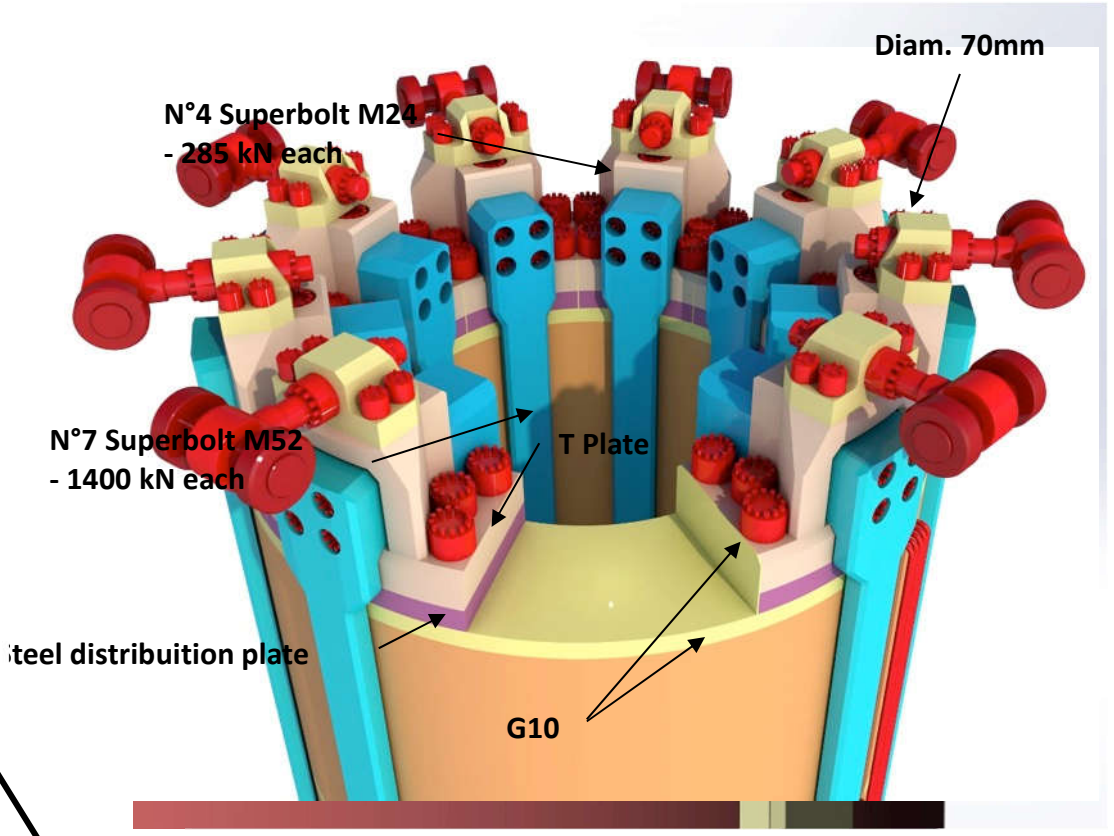
- fabric tape wrapped around the conductor (e.g. KSTAR CS)

CS module: additional issues



CS: structures and assembly





Coil assembly outdated layout

Presently: 3 upper modules exiting from the upper side; 3 lower ones from the lower side

CS: structures and assembly