Radio Frequency Magnetic Field Test Facility (RFMFTF)
An update fordiscussion in the Magnet WG

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*** CERN/EN-MME**

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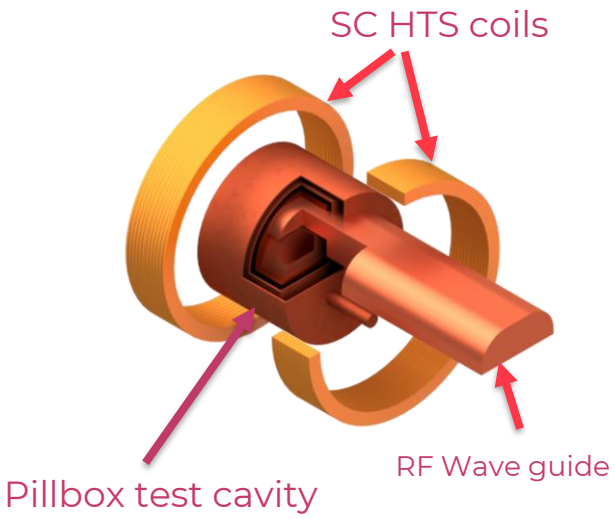
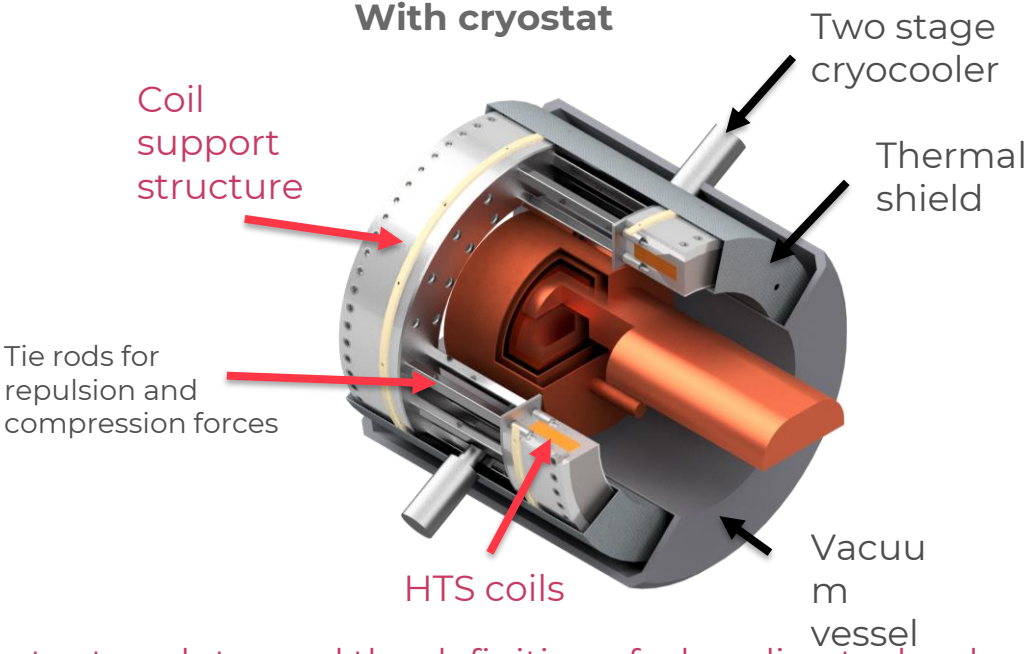
First sketch of RFMF test stand split coils, single cryostat 700 mm free bore

Bare coils and RF cavity



With cryostat



The construction of a test bed is an important push toward the definition of a baseline technology
Beside being a **key tool for RF tests**. However the first rough evaluation was in the **4 M€ range…**

Decion after Orsay Meeting (June 2023)

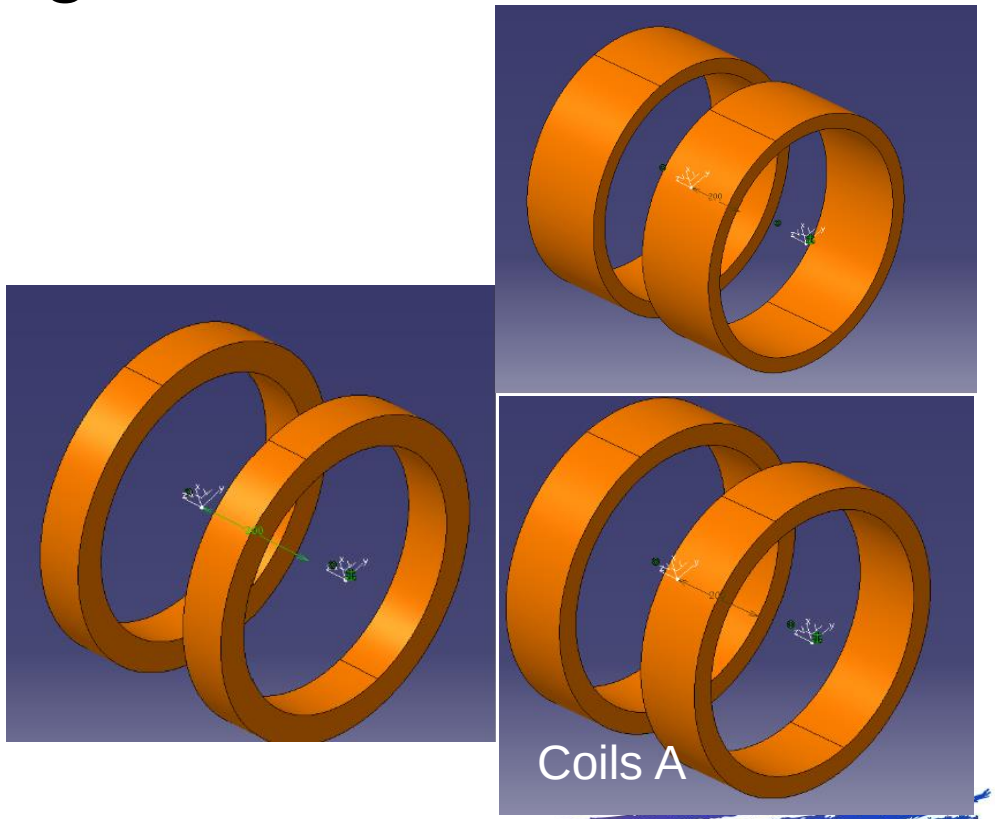
- Redesign to ≥ 300 mm free bore
  - → coil dia. ~ 400 mm
  - → good for 3 GHz test or higher frequency
  - 7 T, parallel and antiparallel coil excitation
- Try to optimize solution for cost saving
- Design at engineering level completed **by end of the year** → cost target < 2 M€
  - Effort to finish design also for 700 mm (beginning of 2024)

Redesign to 350 mm
3 coils configuration examined

- Used parameters

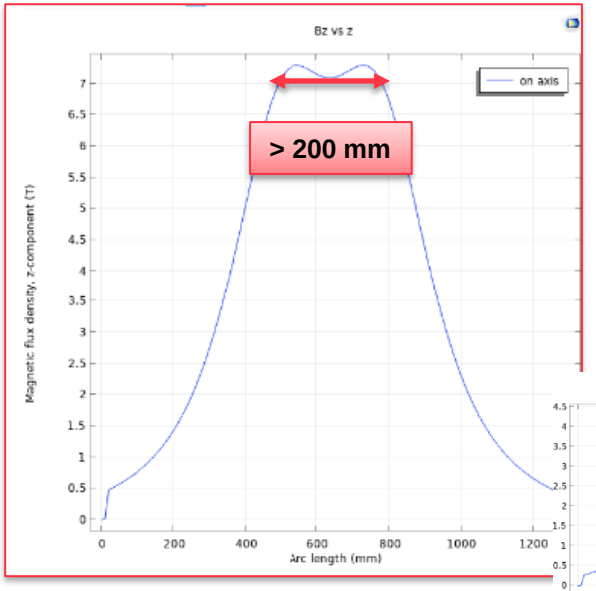
HYPOTHESIS		
Current density	J (A/mm^2)	621,8
Internal radius	R_i (mm)	200
Bulk lenght	L_bulk (mm)	200
Tape cross	T_cross (mm^2)	0,804
Tape lenght	L_tape (mm)	12
Tape thick	T_thick (mm)	0,067
Young's module	E (GPa)	126
Poisson rate	p	0,34

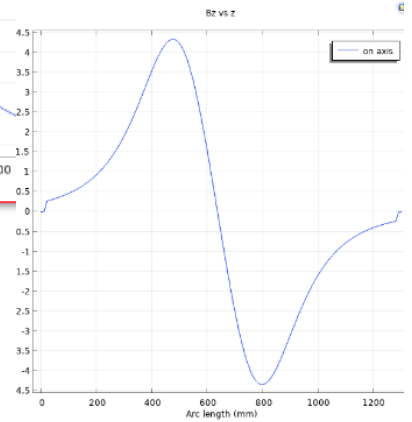
DIMENSIONI E NUMERO DI TURNS		
Diametro bore (interno)	d (mm)	400
Distanza tra le coil	L_bulk (mm)	200
Spessore coil (lungo r)	S_coil (mm)	45,56
Lunghezza coil (lungo z)	L_coil (mm)	72
Numero Turns (per ciascuna coil)	N_turn	4080



Coils A case (preferred)

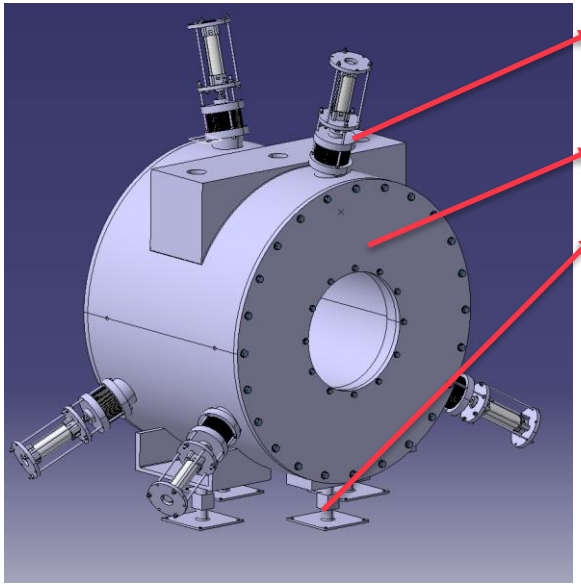
ANALISI FORZE E STATO TENSIONALE		
Verso corrente	Concorde	Inversa
B_z al centro (T)	7,09	4,34
B_max (T) (sulla coil)	16,28	14,69
Forza radiale F_r (MN)	10,2	6,37
Forza assiale F_z (MN)	2,06	2,08
Von Mises stress Max (MPa)	649,11	413,62
Von Mises stress Min (MPa)	460,11	295,65
sigma_t max (GPa)	0,62	0,42
sigma_t min (GPa)	0,44	0,27
sigma_r max (MPa)	0	0
sigma_r min (MPa)	-79,74	-80,47
sigma_z max (MPa)	0	45,05
sigma_z min (MPa)	-144,19	115,17





Too high : need to add an external banding

Mechanical design
General view



Coil support system

Vacuum vessel

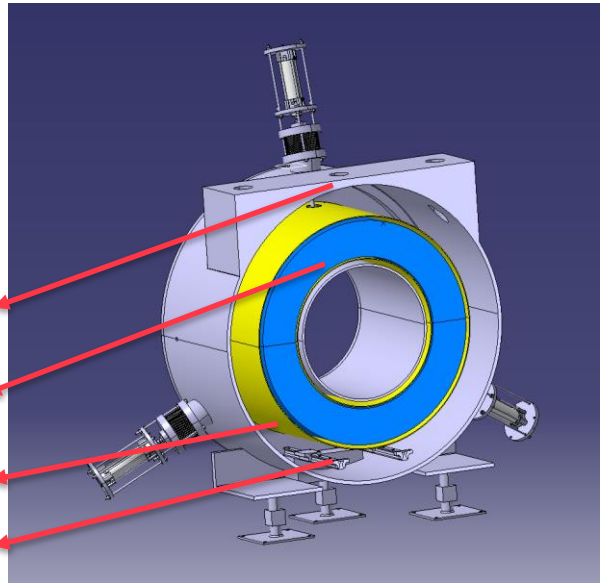
Ground support

Cryogenic system

Magnet support

Thermal screen

Guide system



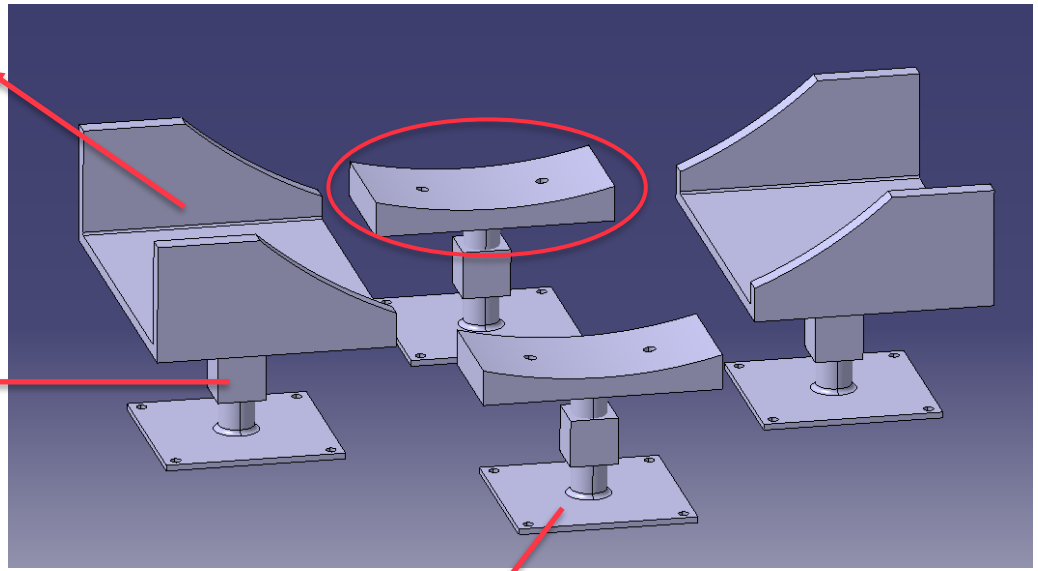
Support system

temperature
300 K

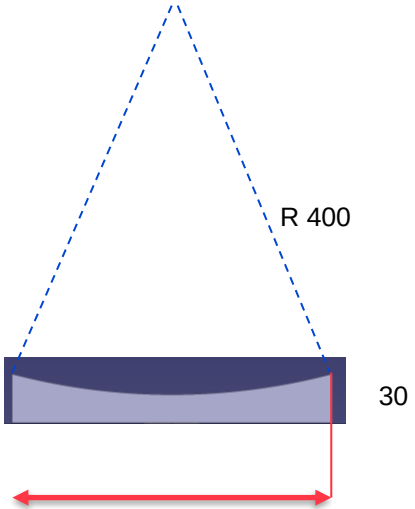
Work condition
Static load

(2x) Ss 304L UPN 300
L 200

(4x) norelem nlm 27701
M30 inox +
(8x) Ss 304L spacer
80x80x10



(4x) Ss 304L
150x150x15



Thermal screen

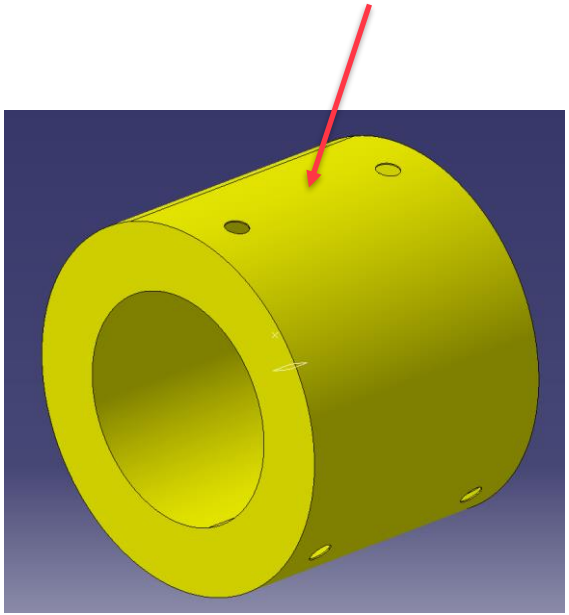
Work condition
Static load /Static Temperature

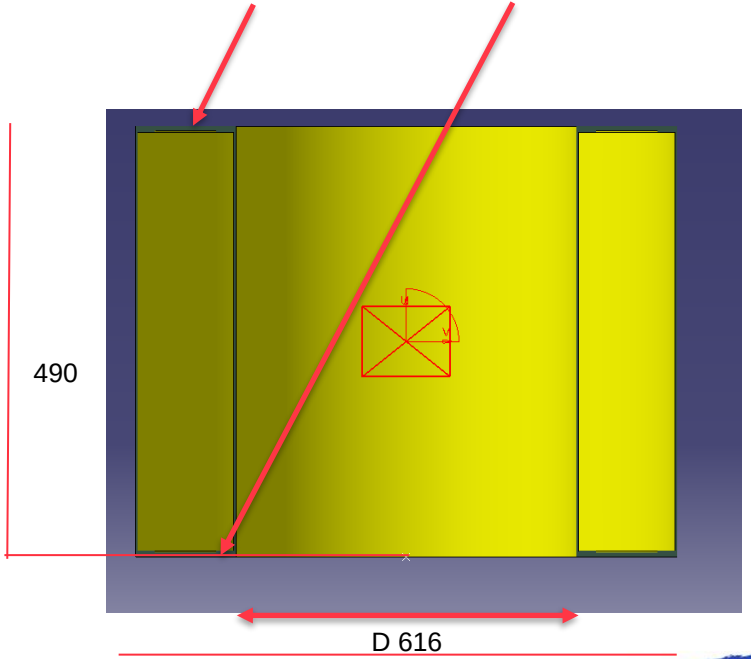
temperature
50/60 K

Copper
20/25-layer Mli outer
3/5-layer Mli inner

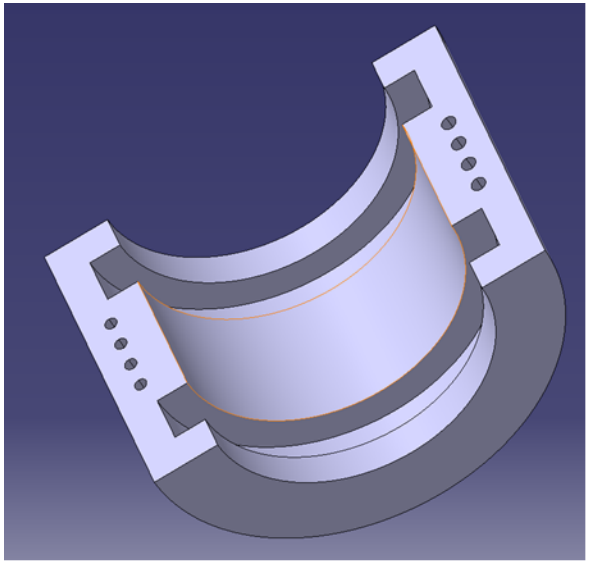
Thickness of the body 2 mm

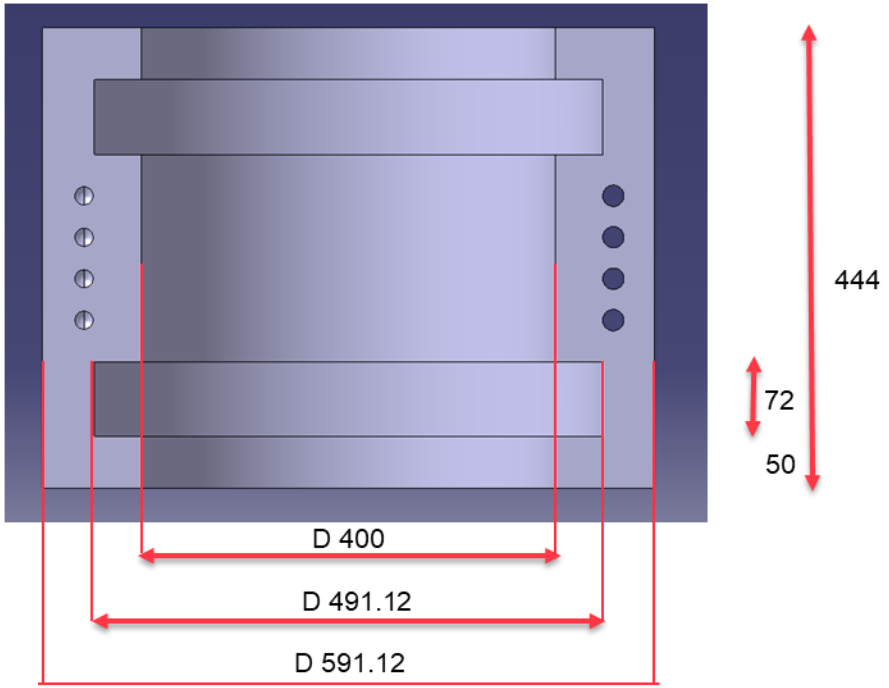
Thickness of the head flanges 5 mm





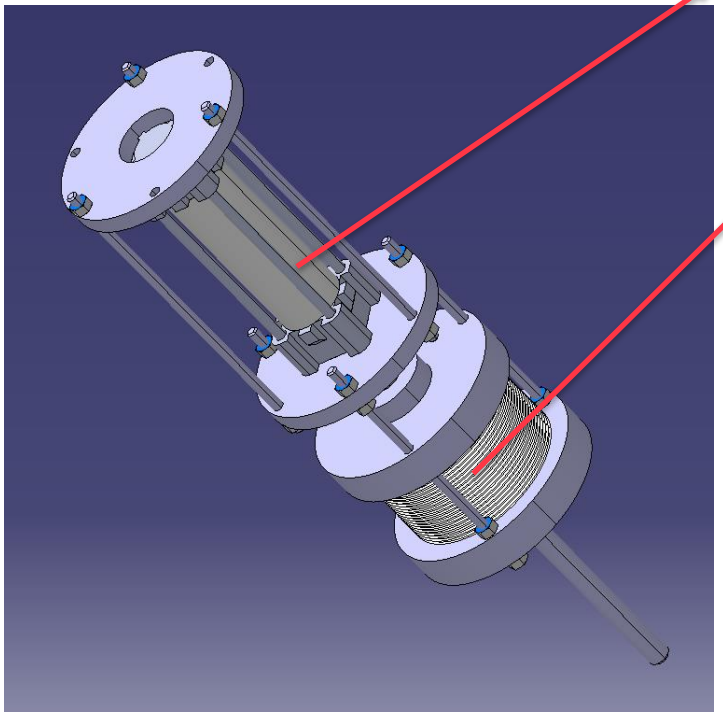
First design for coil banding… high precision half shells





material	temperature
316ln	20 K

Coil support system

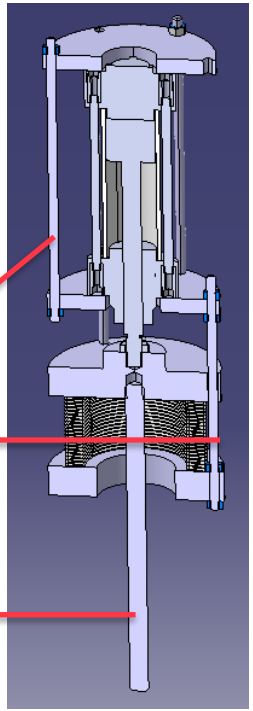


Festo ISO 21287
AND -A-P-A –PPS D80 +
(2x) Ss 304L spacer
D110*10

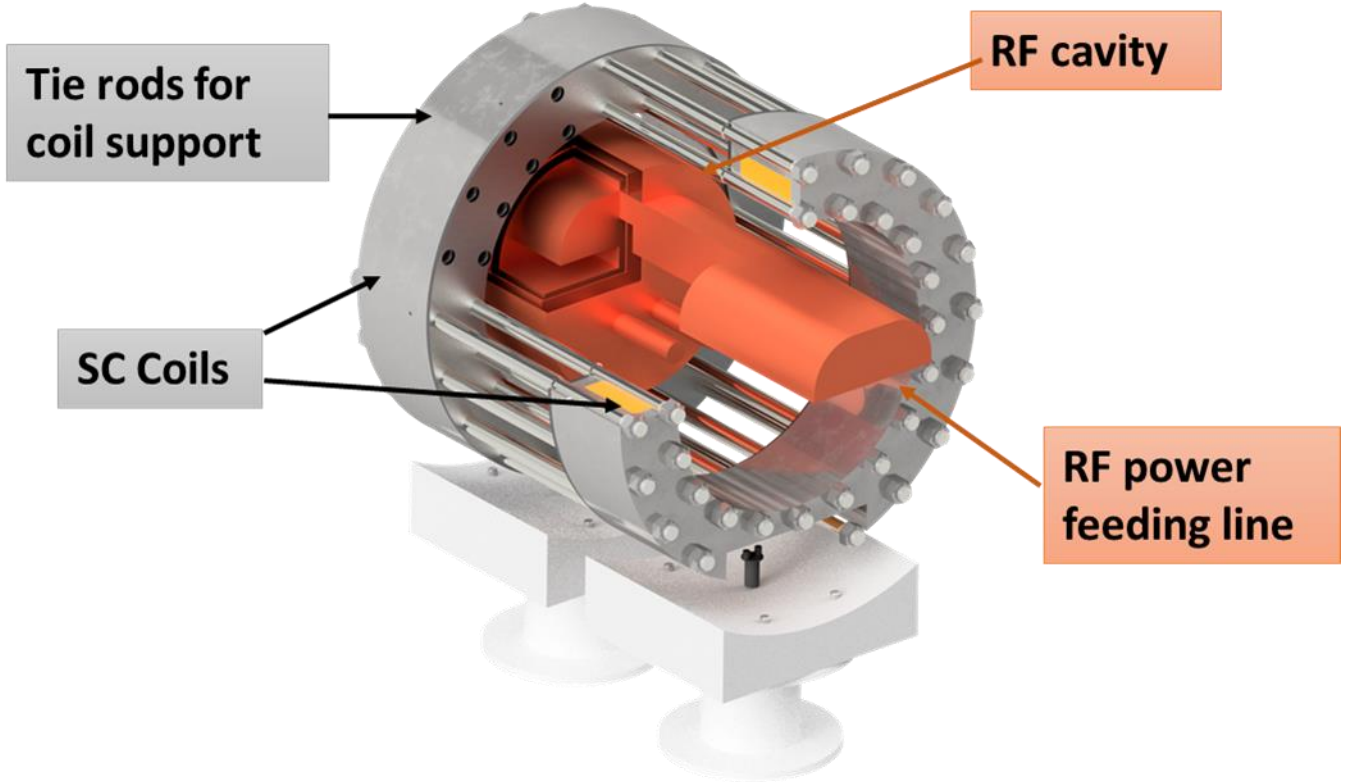
WITZENMANN HYDRA
LBR 06.0065.050 +
(1x) Ss 304L spacer
D110*10

(6X) M6 filet bar Ss 304L

M12 filet bar Ss 304L



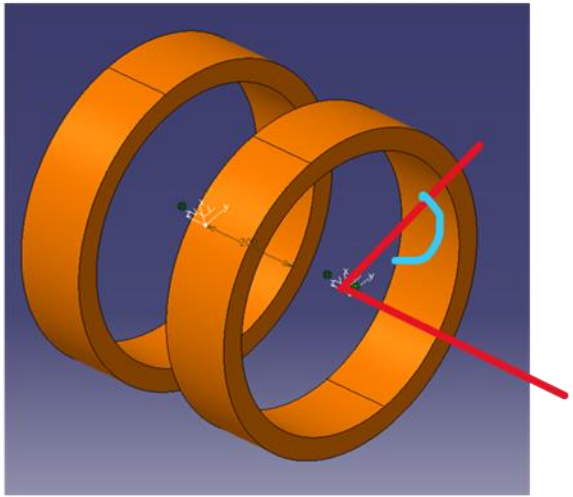
Recent change of support post



Assembly tolerances are not critical: 0.2-0.3 mm

Not aligned coils		
Current polarity	Same	
Total Radial Force/mm (N/mm)	-7840	Attractive
Total Momentum/mm (Nm/mm)	-831	destabilizing
Current polarity	Opposite	
Total Radial Force/mm (N/mm)	7840	Repulsive
Total Momentum/mm (Nm/mm)	831	Stabilizing

Tilted coil faces		
Current polarity	Same	
Total Radial Force/mrad (N/mrad)	-27	Attractive
Total Momentum/mrad (Nm/mrad)	165	Stabilizing
Current polarity	Opposite	
Total Radial Force/mrad (N/mrad)	27	Repulsive
Total Momentum/mrad (Nm/mrad)	-165	Destabilizing



Step for next months

- Magnet:
  - Refine magnetic design and freeze it. → **under way**
  - Calculation of field error and forces/torques due to assembly tolerances → **done! (thesist)**
  - Decide with WP7 (magnets) the acceptable stress level and the banding technology for stress reduction → **more critical item (depend on coil design)**
  - More detailed mechanical design
  - Make crude thermal model → **under way with thesist**
  - **Order of 150 k€ (+VAT) for HTS tape by INFN-Mi under way: about 6 km of 4mm tape by SST (170 A @15T, 20K)**
  - **Period of 6 weeks od 1 staff (F. Broggi) at CERN to compute heat depo on Magnet and other elements of CC.**
- Integrate RF cavity in the design: services and insertion devices → **Started**
- Cost evaluation (already launched by INFN/CERN) → **under way , outlook very positive** (< 2 M€ for the magnet system, with resource also from other projects (PNRR_IRIS, CERN-HFM, EU call hopefully…)

Urgent decisions

- Space to leave to the coil for force retaining and joints
- Other technology choice that requires space…
- Structure
- Single layers of 15 mm tape (or 4 mm ?) with inner/outer copper ring and outer steel banding? How thick?

International
MUON Collider
Collaboration

Thank you
for your attention