

Update on integration test S5-like Demo Cell

WP8: Lucio Rossi & Mattia Castoldi (U.Milan & INFN-Mi-LASA)

With inputs from:

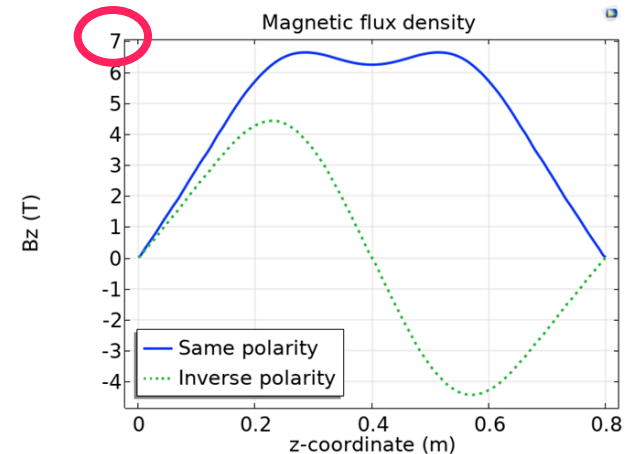
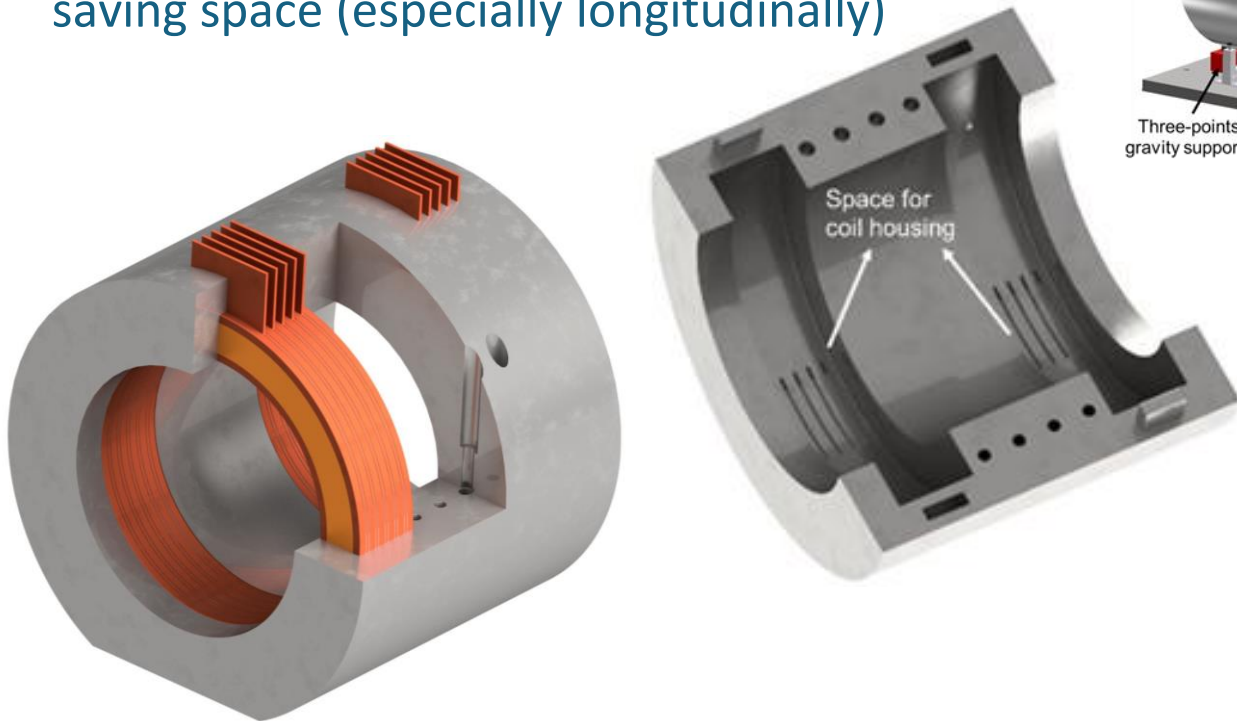
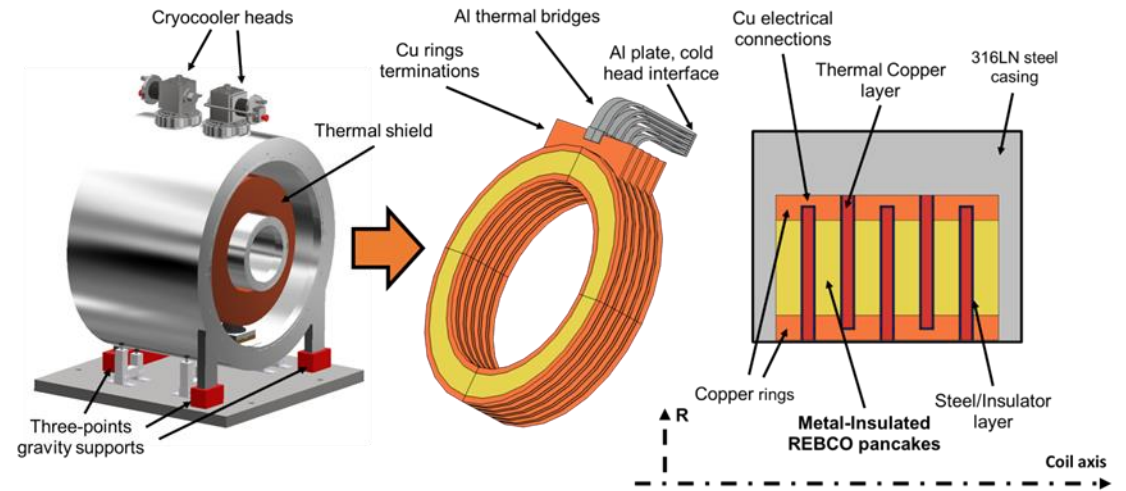
WP6 : RF, Dario Giove (INFN-LASA)

WP7: Magnets, M. Statera & G. Scarantino (INFN-LASA & U.Roma1)

17/September/2024
MuCol-WP8 integration meeting

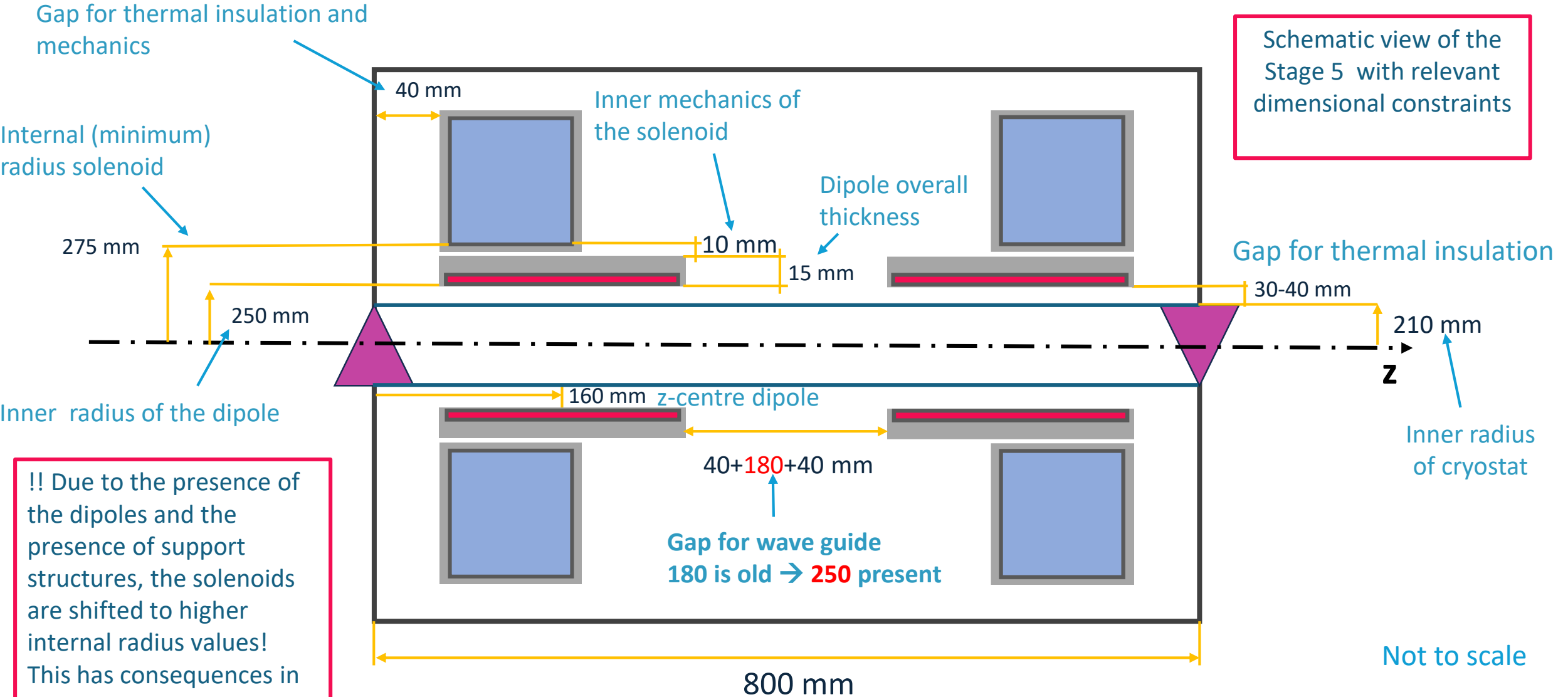
Concept for the test facility for RF cavities: unique support structure form the entire split coil

- Proposed unique restraining cylinder shell, **50 mm thick AISI 316 LN steel** structure.
- This allows a much greater compactness of the Coil Support System
- Eliminates various cold-to-warm interfaces saving space (especially longitudinally)



Field requirements, two operational modes.
«++» and «+-»

S5- like for Demo cell integration

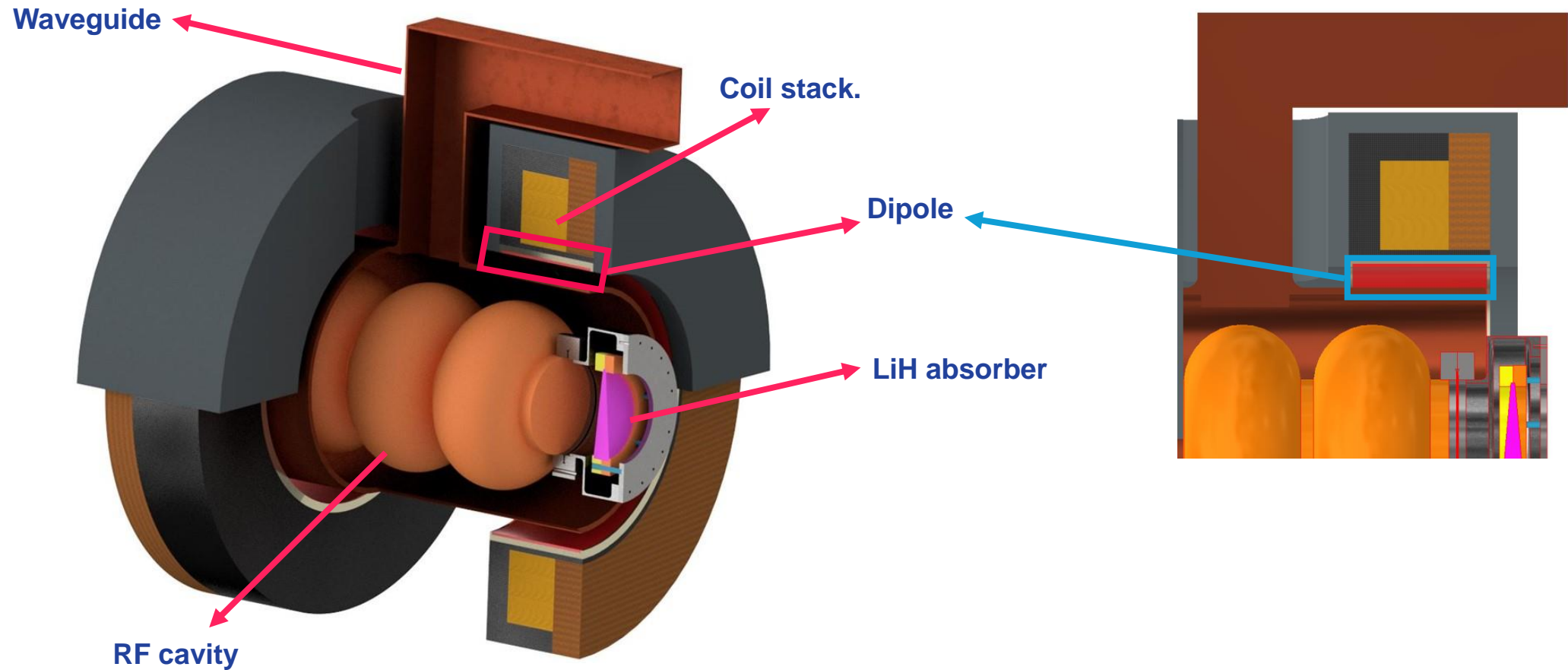


!! Due to the presence of the dipoles and the presence of support structures, the solenoids are shifted to higher internal radius values! This has consequences in the design...

Single coil structure not possible for the MC CC

Need of the space for power coupler

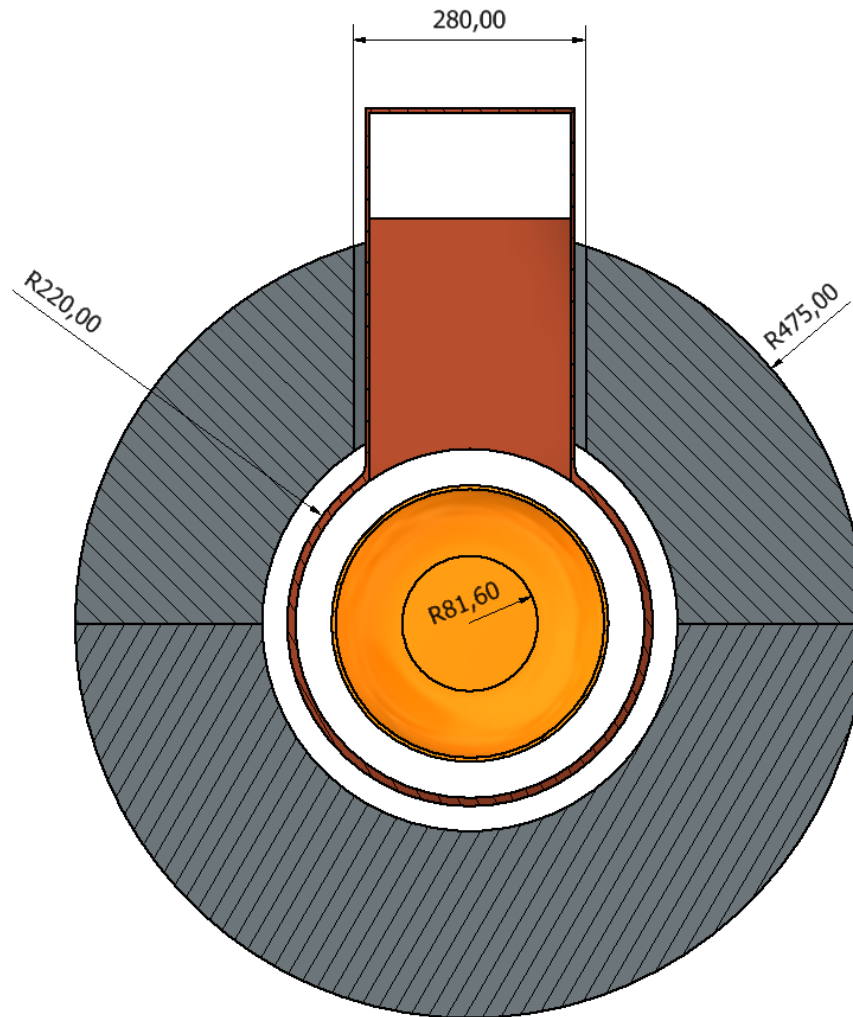
→ Status of the conceptual design of the S5 demonstrator, with separated cryostat



S5 like demo cell

Sketch of September 17, 2024

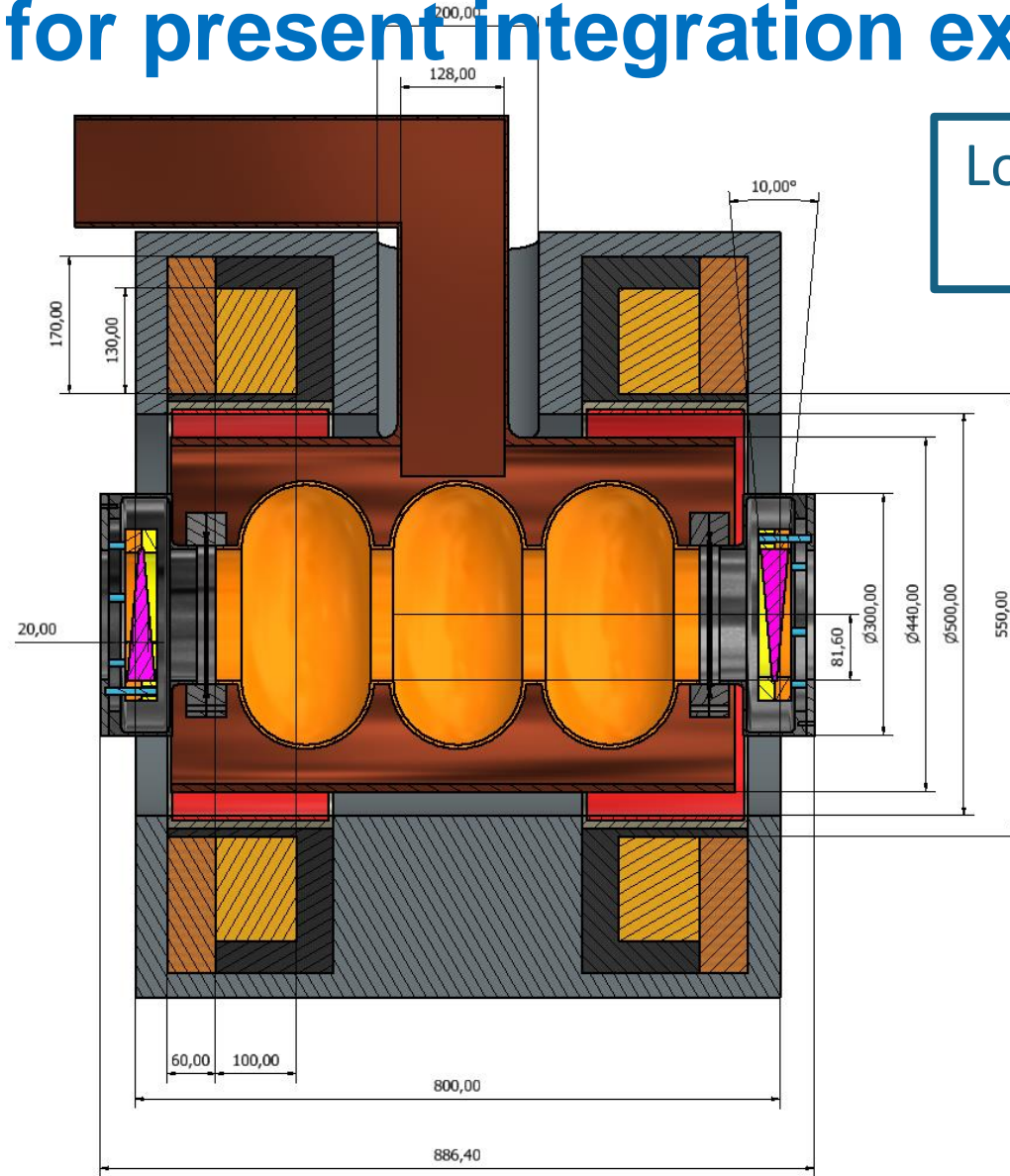
Transverse cut, in the center of
the S5_like Demo Cell



The 280 mm is generous
(260 mm required).
No similar cut under the
horizontal midplane

Courtesy of M. Castoldi,
INFN-LASA and UMIL

S5 like demo cell, Sketch of September 17, 2024: base for present integration exercise



Longitudinal cut of the S5-like Demo Cell

RF shown for information only ,
not in scale/size

Courtesy of M. Castoldi,
INFN-LASA and UMIL

Since then:

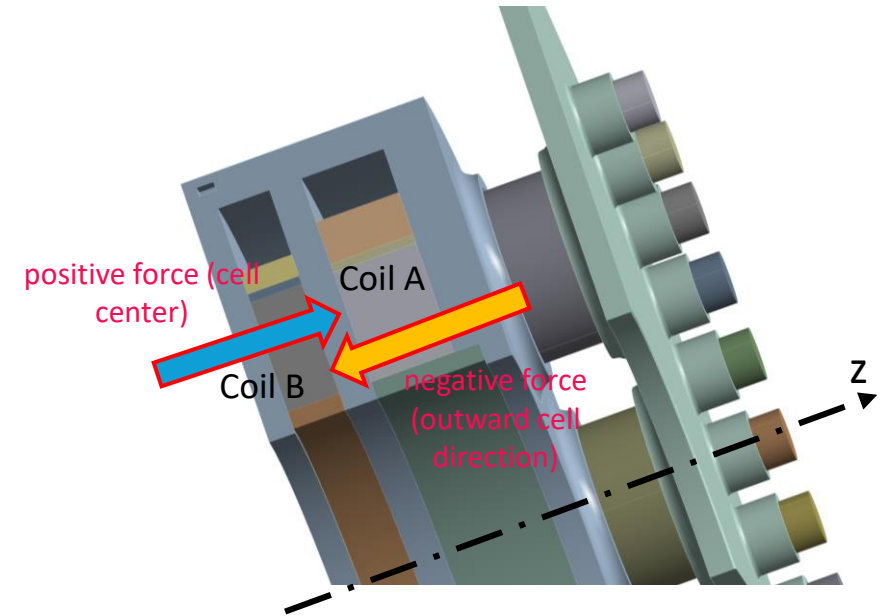
Optimization of the coil and computation of structure

Consideration:

- 1) The coils must be stable in “lattice” configuration (infinite sinusoid, i.e. left-right mirror), which is the normal operating mode.
- 2) **The coils must be stable in stand-alone powering-mode**
 - The first cell is alone
 - Need of testing single cell
 - Possibility of loss of powering in a single cell
→ UNBALANCED CASE STILL TO BE STUDIED

Reduced-current design: support structure design

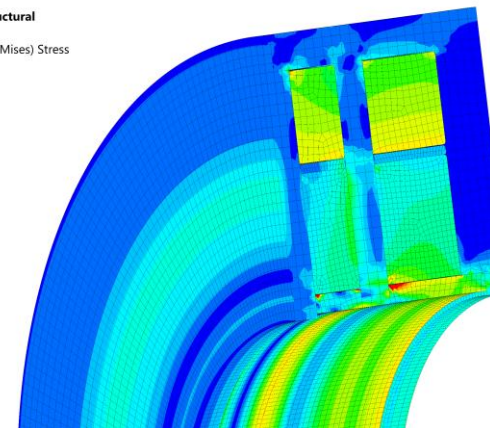
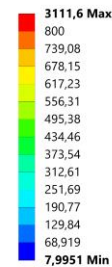
- The coil support structure has been designed to sustain the coil axial forces in the two configurations: *stand-alone*, *lattice*.
- Thick AISI 316LN shell is needed to sustain the axial forces in normal out-of-cell direction.
- Even in the reduced-current configuration, **the mechanical design of the support structure is not trivial.**



Coil Axial Forces	Coil A/Coil B Value [MN]	Net Force Value [MN]
Lattice configuration	-27 / +67	+50
Stand-alone configuration	-55 / +35	-20

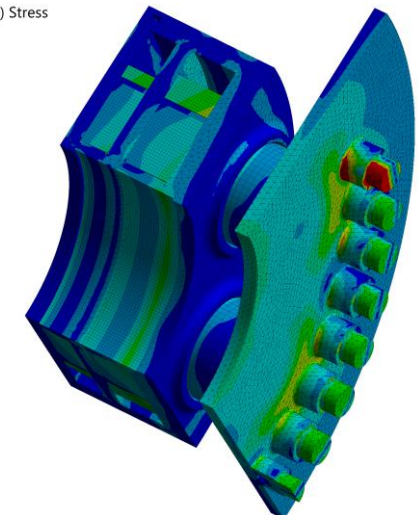
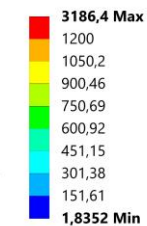
Stand-alone configuration: Von Mises Stress [Mpa]

C: Copy of Static Structural
Equivalent Stress
Type: Equivalent (von-Mises) Stress
Unit: MPa
Time: 1 s
11/10/2024 13:37



Lattice configuration: Von Mises Stress [Mpa]

D: Static Structural
Equivalent Stress
Type: Equivalent (von-Mises) Stress
Unit: MPa
Time: 1 s
11/10/2024 13:40

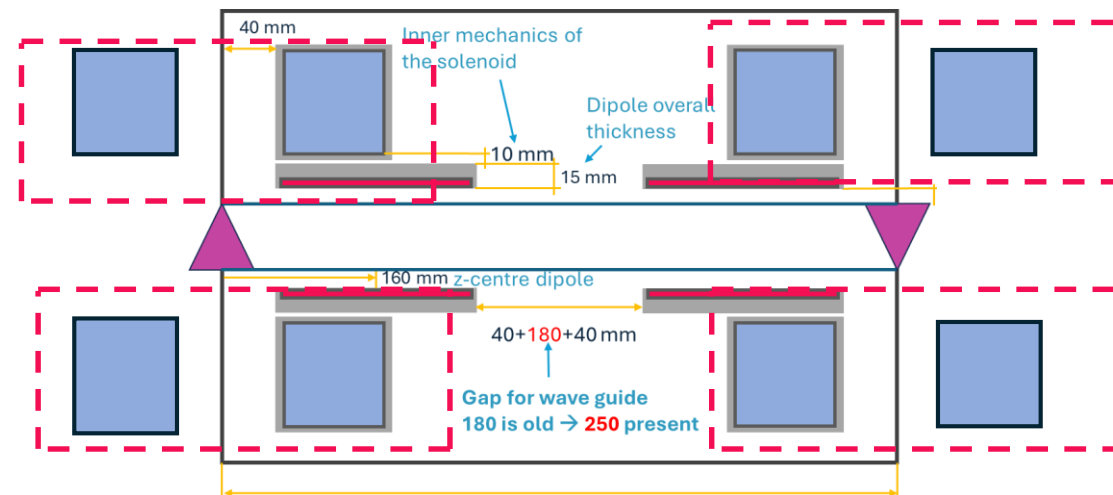


Since then: Optimization of the coil and computation of structure

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- 3) A further optimization would be to make a unique cryostat for adjacent coils (**intercell cryostat**)

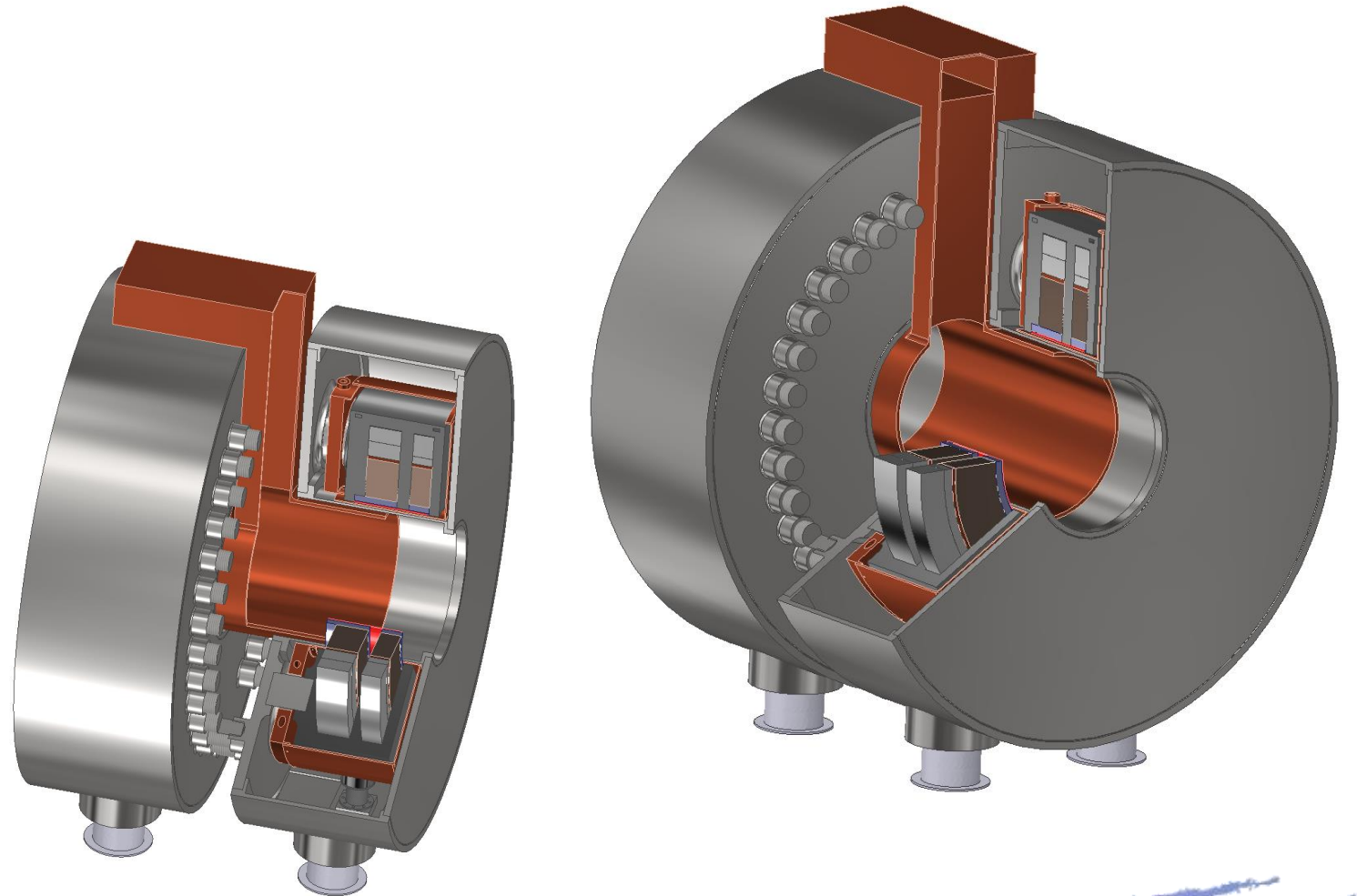
cellN-1/rightcoil and cellN/leftcoil
cellN rightcoil and cellN+1/leftcoil



S5-like demo cell Version 0

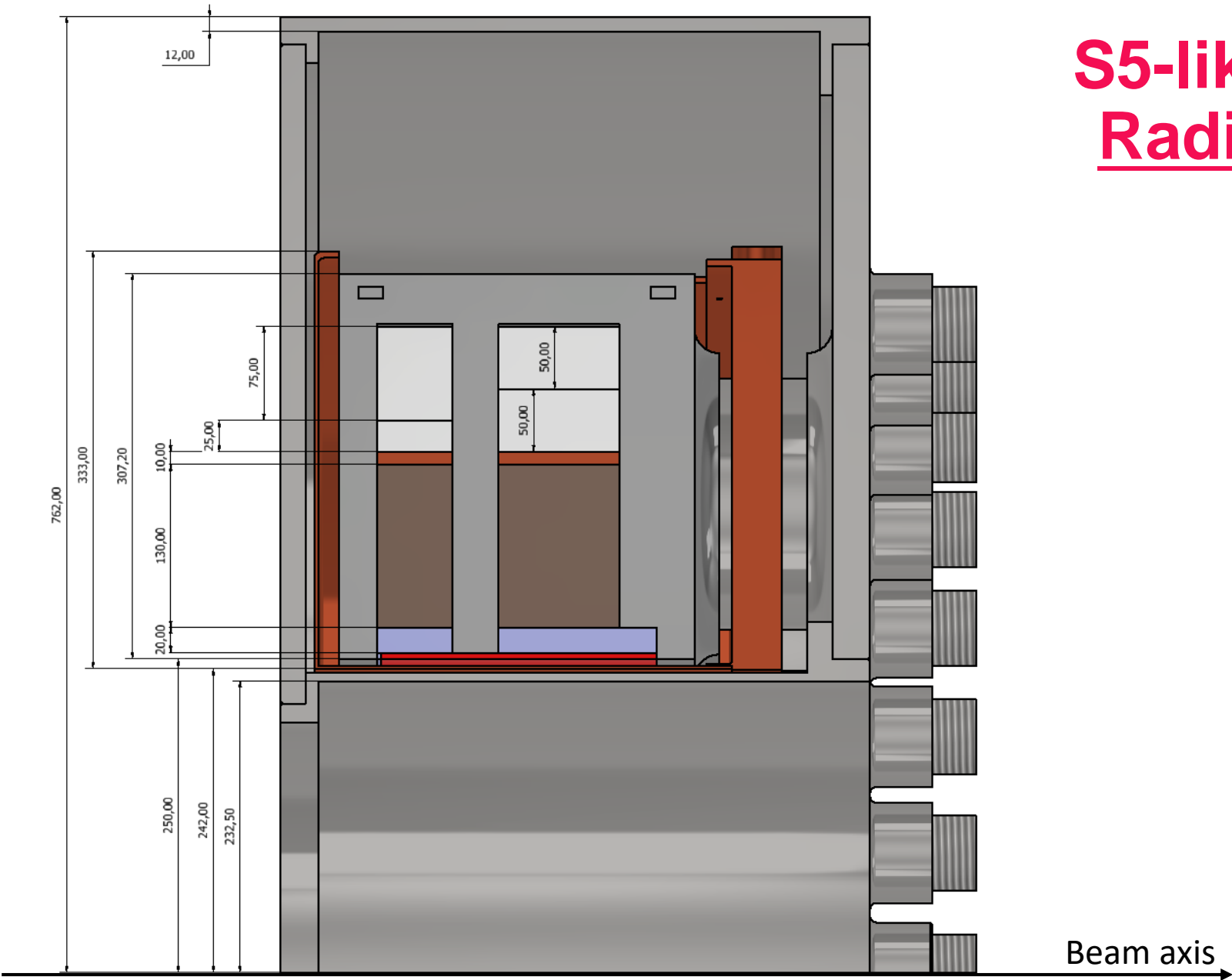
Consideration:

- 1) The stress are at highest value compatible with a 1.5 safety factor (to yield point)
- 2) The most difficult case is in stand alone operating mode
- 3) Bolting system in "INCONEL" cope with 800 MPa stress
- 4) Field is reduced "arbitrarily" by 25%
- 5) Size do not fitr the envelope (see next)



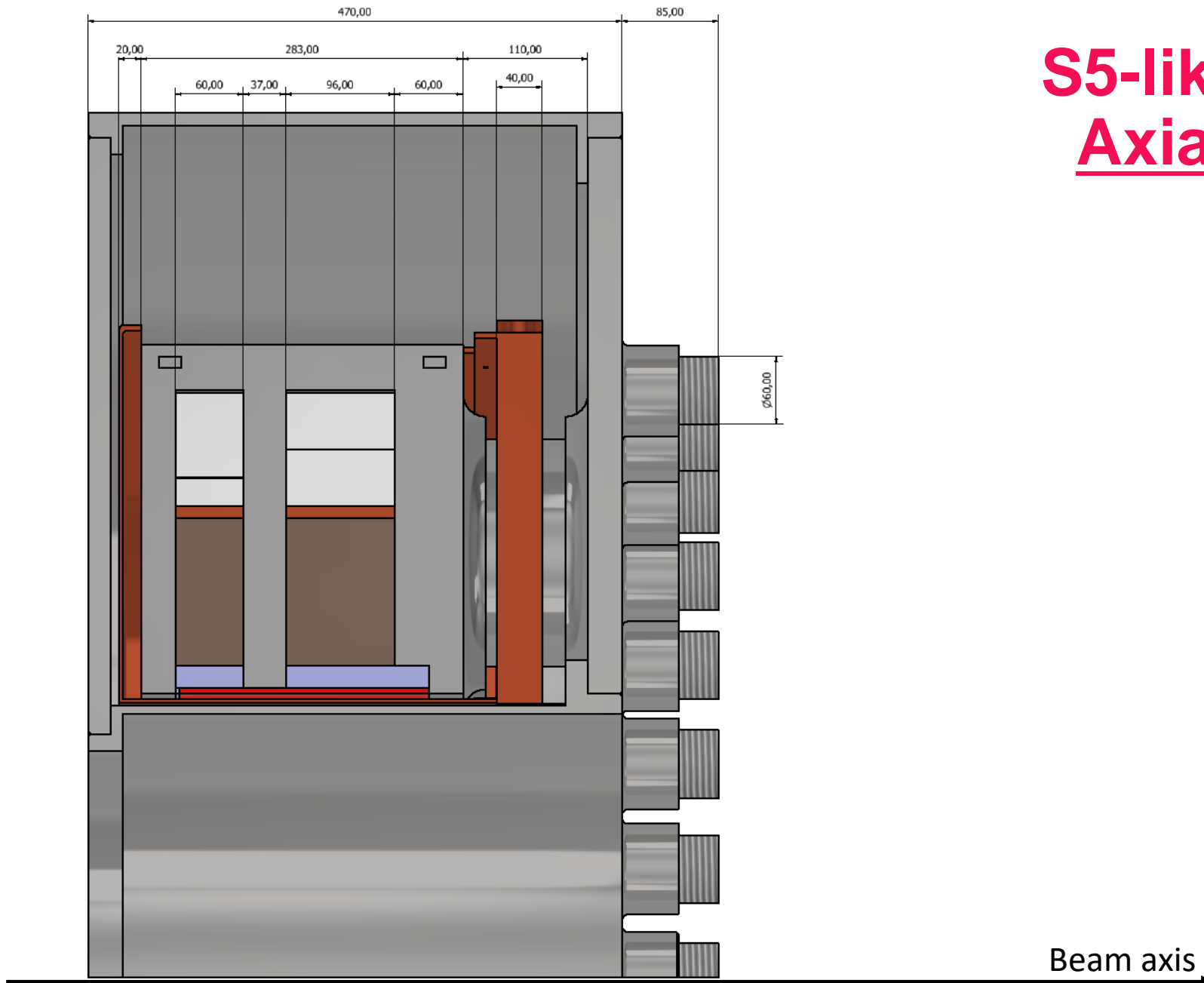
S5-like demo cell V0

Radial dimensions

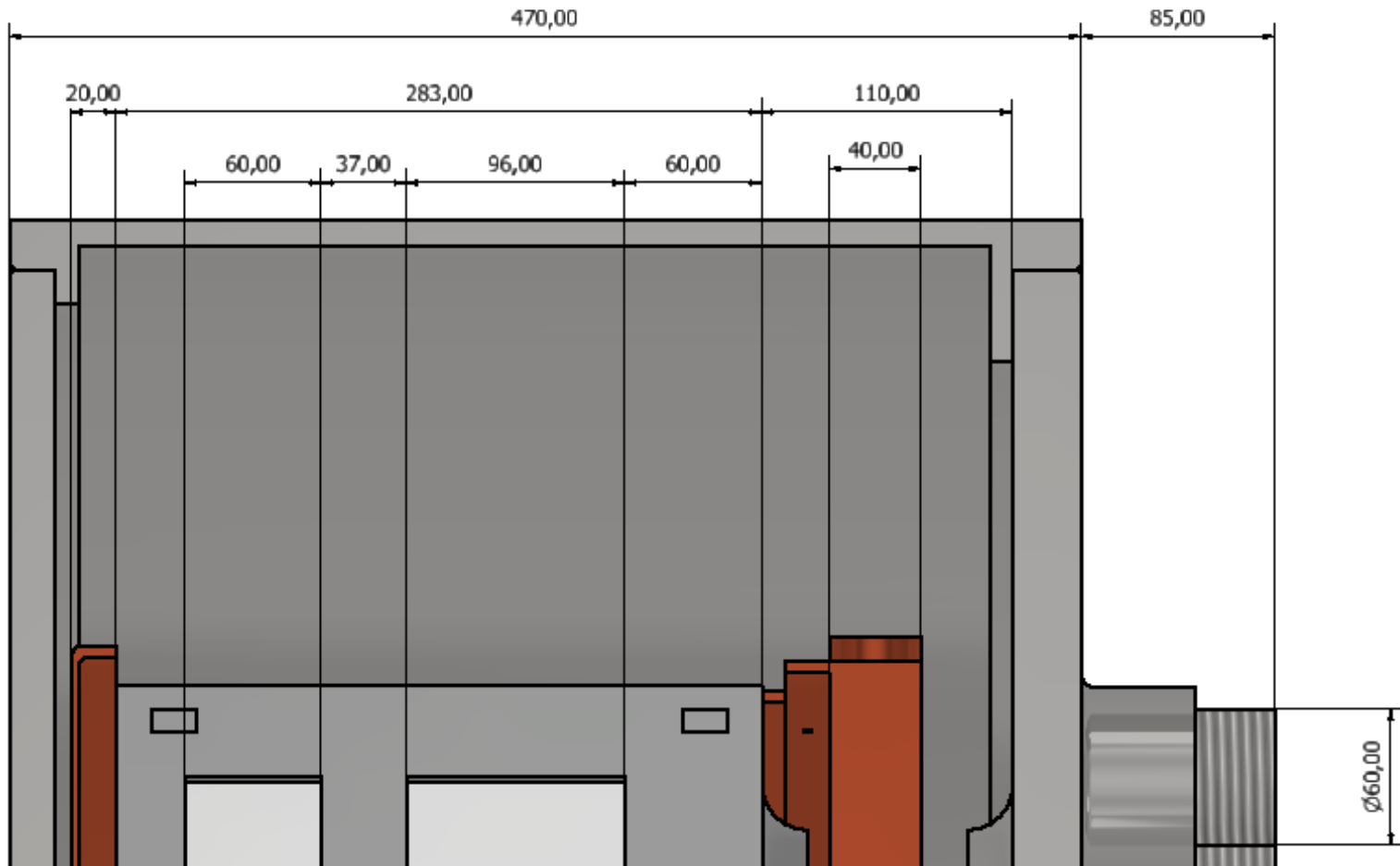


S5-like demo cell V0

Axial dimensions



S5-like demo cell V0 Axial dimensions



The bottom line is that
 $L_{\text{cell}} = 555 \times 2 = 1110$ mm
Instead of 800 mm as the target.
Optimization is possible but we
already have reduced from 1170 mm
to 1110 mm, no much room unless
different structure concept.

So we have:

25% less field

37% longer cell.

Intercell cryostat can gain some 100
mm but still too little...

To do...

- Assess carefully in Magnet WP the limit and the coil design
- Discuss with WP4 other possible configurations (putting coil outside the RF such as reducing the coil radius by a factor 2 or more?)
- See if a coil configuration with larger radial thickness (radial split) can reduce the longitudinal length

- Review the mechanical structure of the present configuration (different, more compact support... → MME hel is needed)