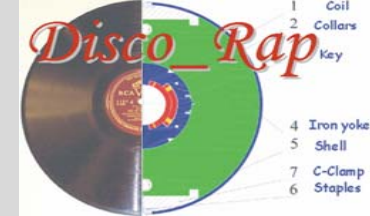


Cryostat design and procurement

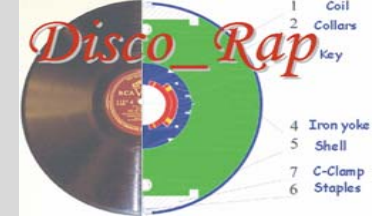
After the TDR in Genoa we worked on the review comments and suggestions. After further round meetings (CERN and GSI) we then come to decisions which lead to the actual design. The main decision concerned the plastic support: actually we only can use the LHC supports “as is”. Other important decisions where the thickness of the outer shell and of the main plate, the transport fixing pieces. Finally improvements on the integrations have been suggested.



Discussion warnings

- Three supporting POSTs have a non-isostatic behavior, and in addition for such a short and light mass it may be a complication. We are more worried of the cold mass curvature than of complexity of the structure;
- Outer shell has to support the cold mass weight also, as only three feet will support the whole system below the cryostat. To improve rigidity of the structure we increased the outer shell thickness to 10 mm.
- POSTs are to be placed in order to minimize cold mass deformations, and (luckly) this also matched the requirements for sliding sleeves clear space
- LHC POSTs can be used in our design with only slight increase of low temperature dissipations.

Modifying LHC POST



D:\Documenti\NTA_DISCO-RAP\Criostato e refrigerazione\POST LHC\lhcqbh_p0020-v0[1].pit

**Warm side
(lower)**

SECTION AA

Ø 232 H7 | HEIGHT : 151

Thickness 4.0 mm

TUBE Ø 17.2 X 1
⊕ ⊖ 0.6 A B C

Cross section
37 cm² total

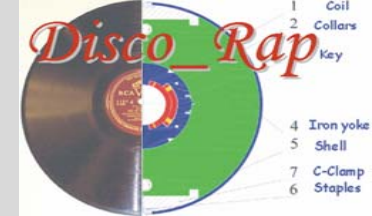
To be removed
in our case

GLUED (INTERFAC
TECHNICAL SPE)

Pins to hold the
load

**Cold side
(upper with holes)**

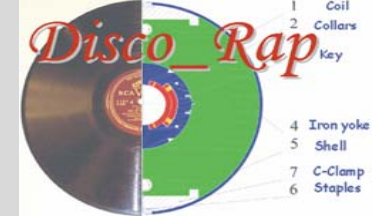
Sliding slit



We also pointed out the assembling sequences:

The LHC processes foresee the removal of the sliding sheet by lifting the cold mass from the bottom, once inserted into the cryostat. This saves space, but requires a more rigid cryostat structure (LHC outer shell is 12 mm thick).

In our design we would prefer to keep the slit below the cold mass to ease the integration process.

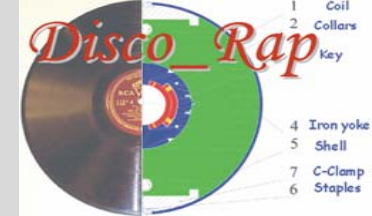


Cold Mass Mechanical behavior

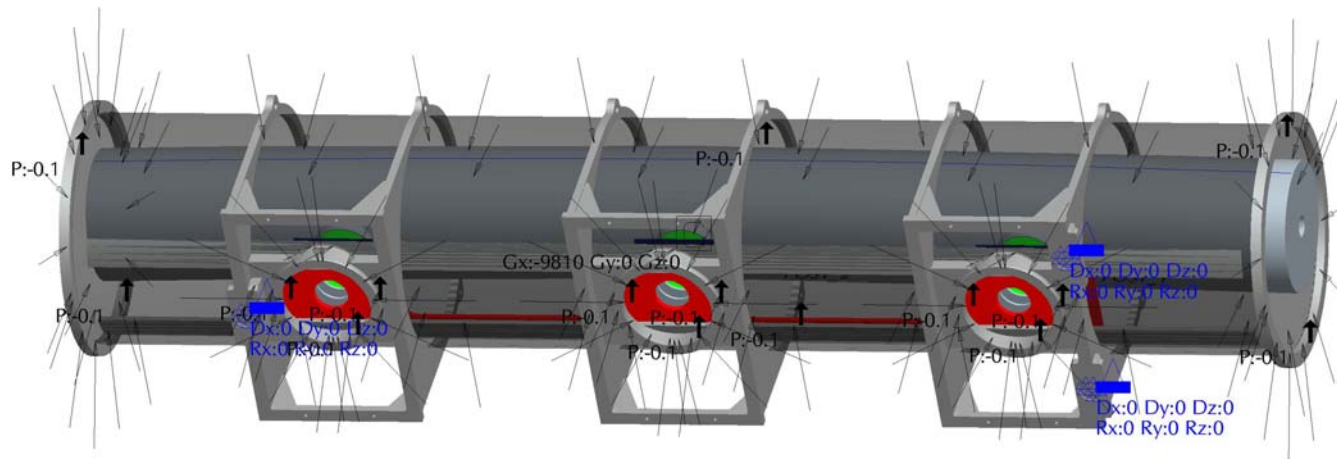
To have an idea of the cold mass mechanical behavior we were addressed to CERN results: we found a measured rigidity of LHC cold mass $EI=170 \text{ MN}\cdot\text{m}^2$

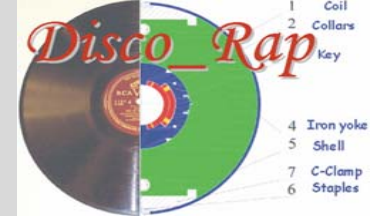
Being the geometrical inertia of a hollow cylinder
$$I = \frac{\pi}{4}(r_o^4 - r_i^4)$$

We obtained the Young modulus of LHC cold mass as $E \sim 60 \text{ GPa}$. We assumed that our cold mass has similar features as LHC cold mass, thus used the same Young modulus in the estimation of its mechanical behavior when supported by the POSTs.



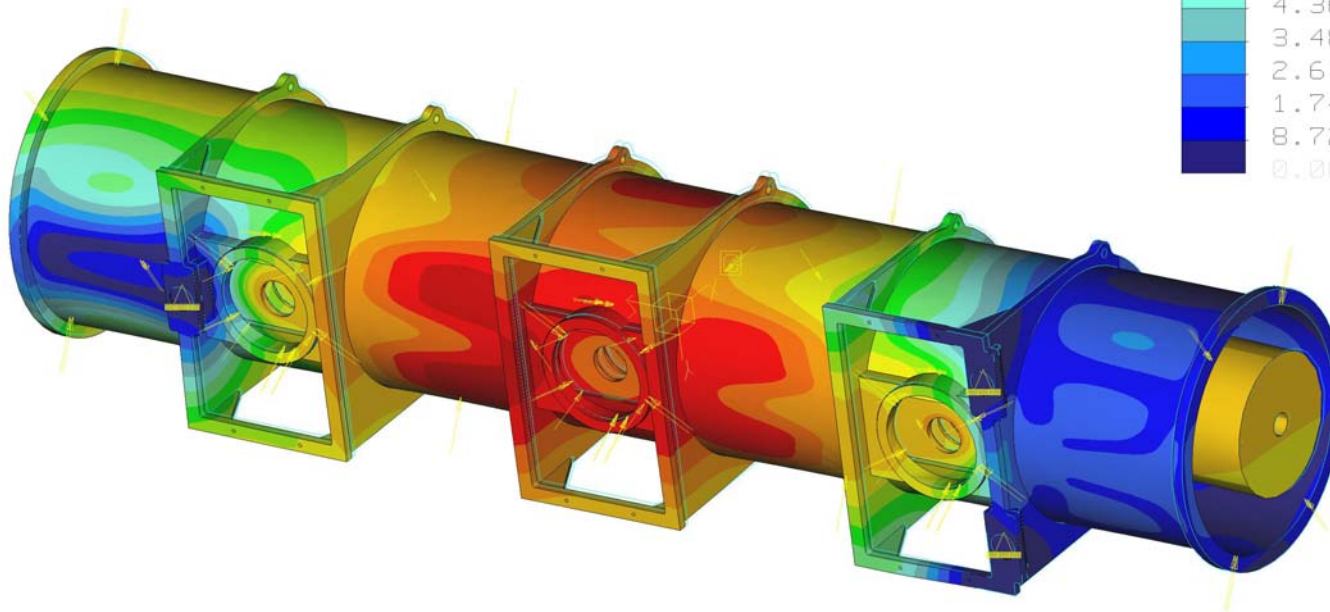
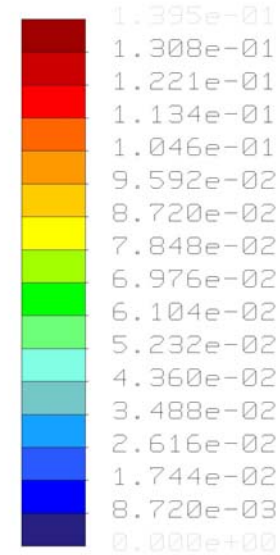
Static analysis: pressure and weight loads, fixed points at the three feet



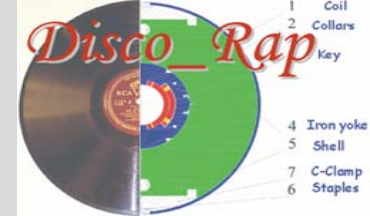


Outer shell absolute displacement

Displacement Mag (WCS)
 (mm)
 Deformed
 Max Disp +1.3952E-01
 Scale 2.0000E+02
 Combination



4 I
 5
 7
 6



Cold mass displacements: mainly due to POST compression

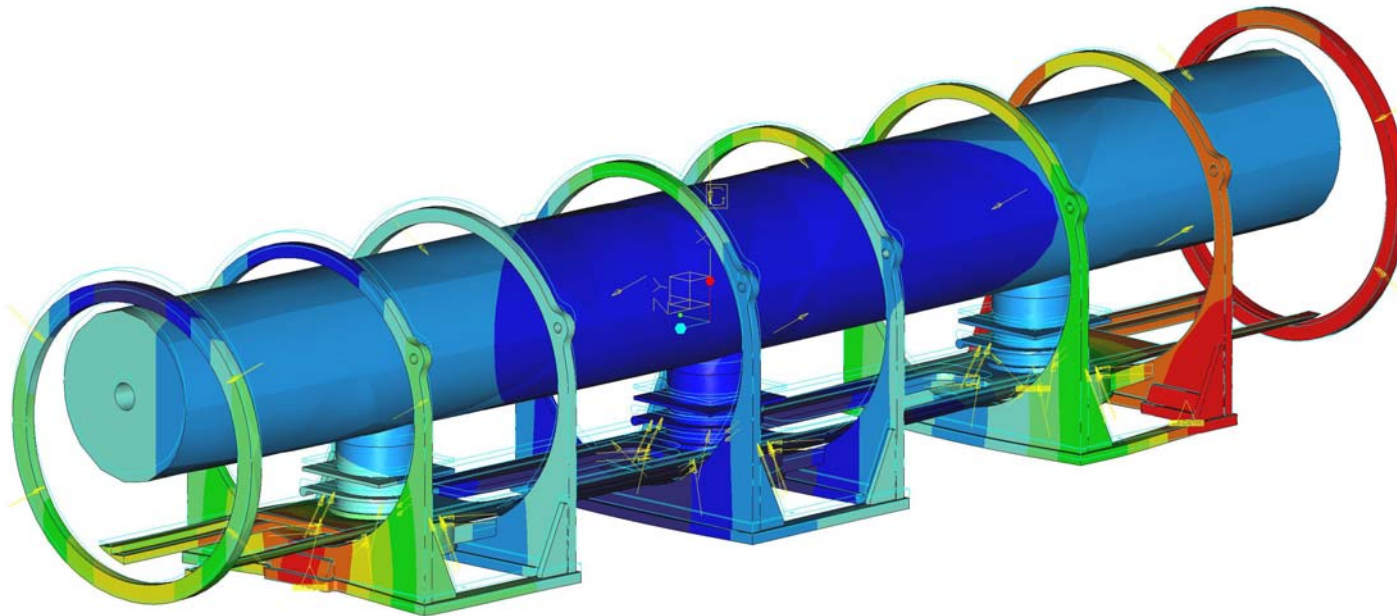
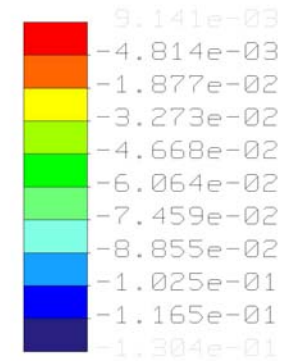
Displacement X (WCS)
(mm)

Deformed Location: Components and Layers

Max Disp +1.3041E-01

Scale 3.0000E+02

Combination

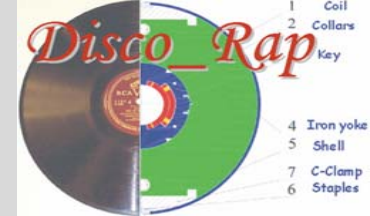


4 I

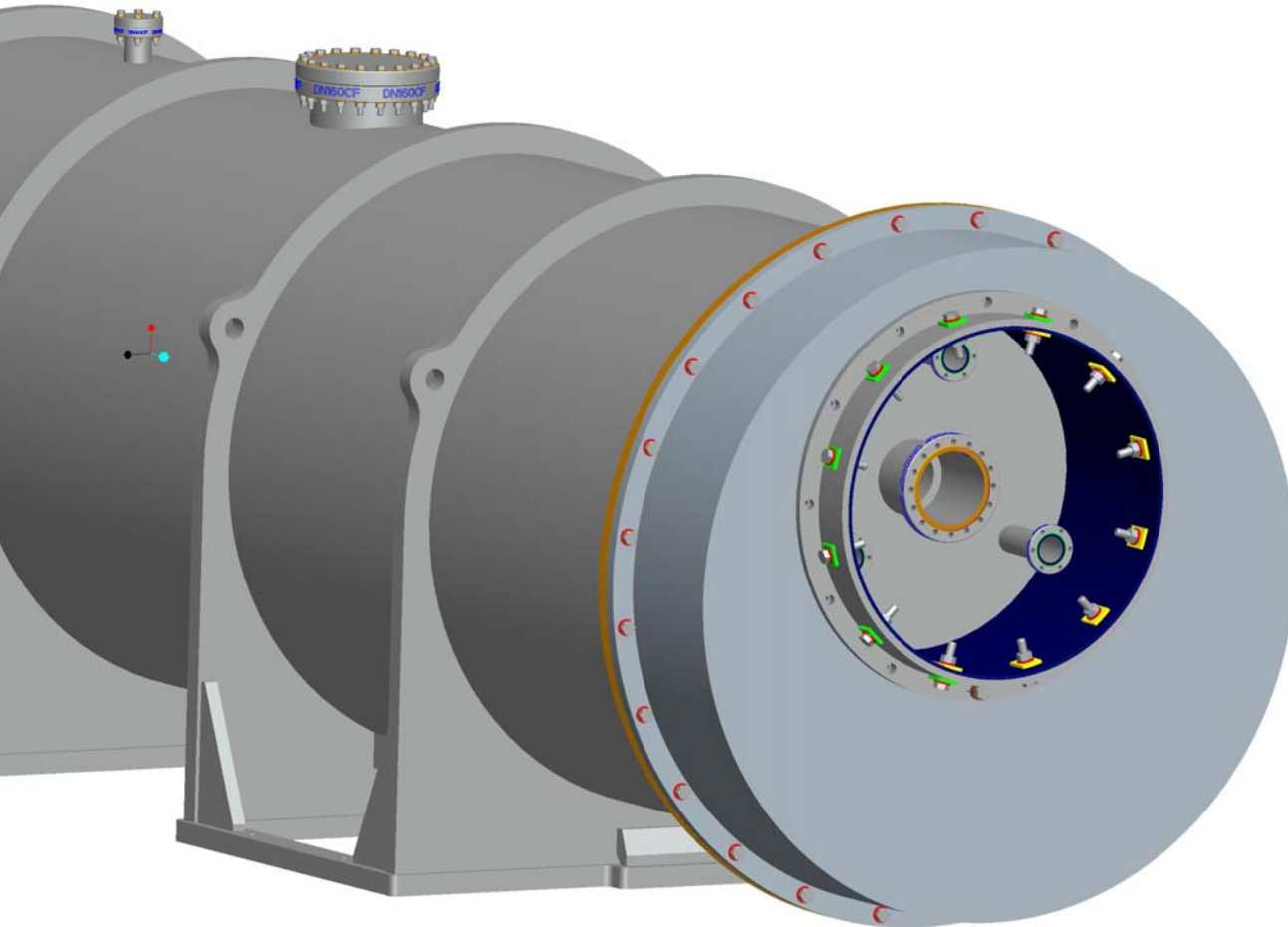
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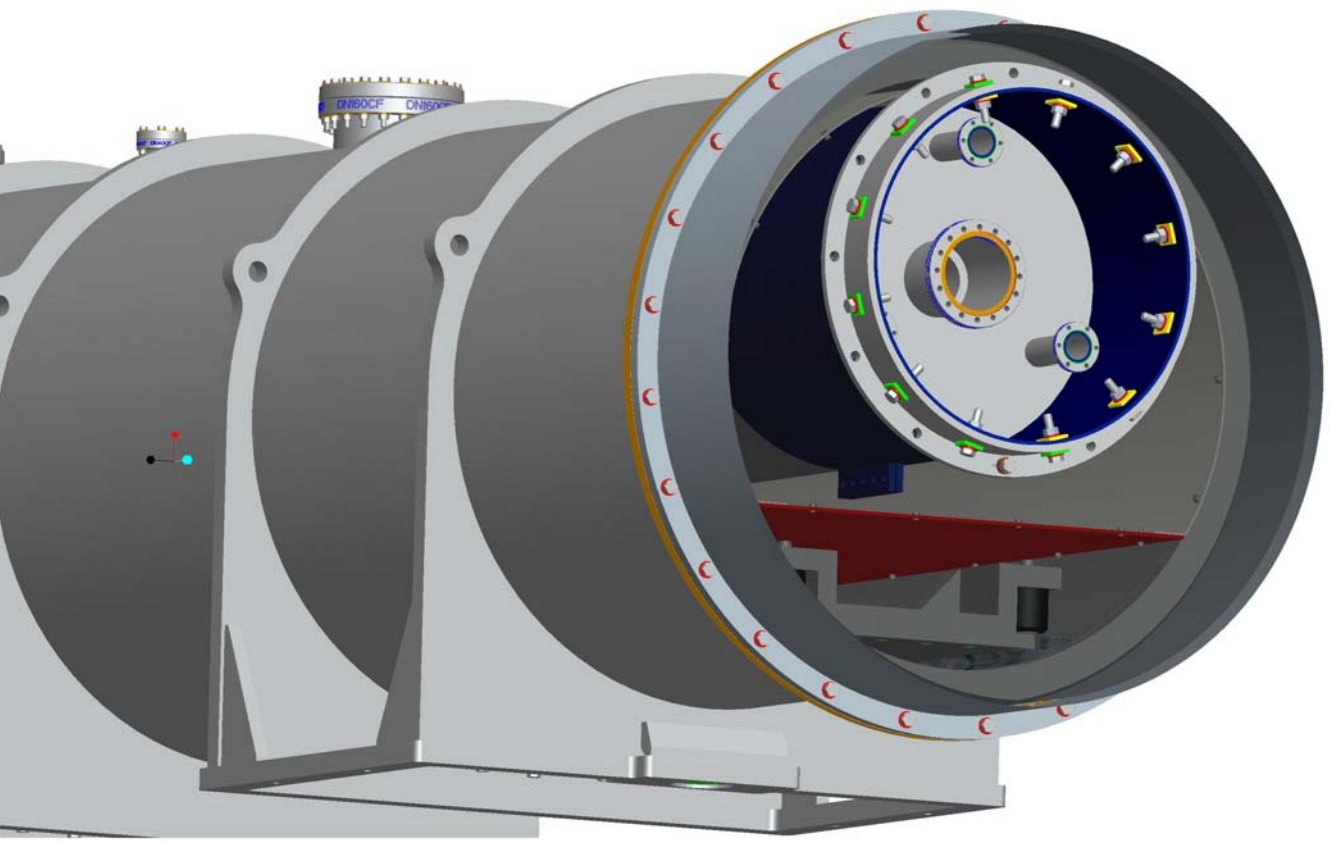
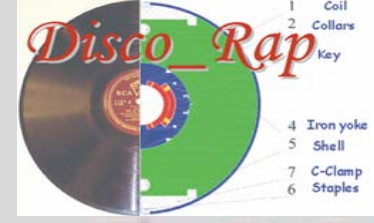
7

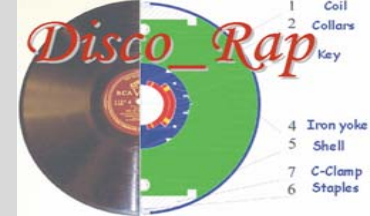
6



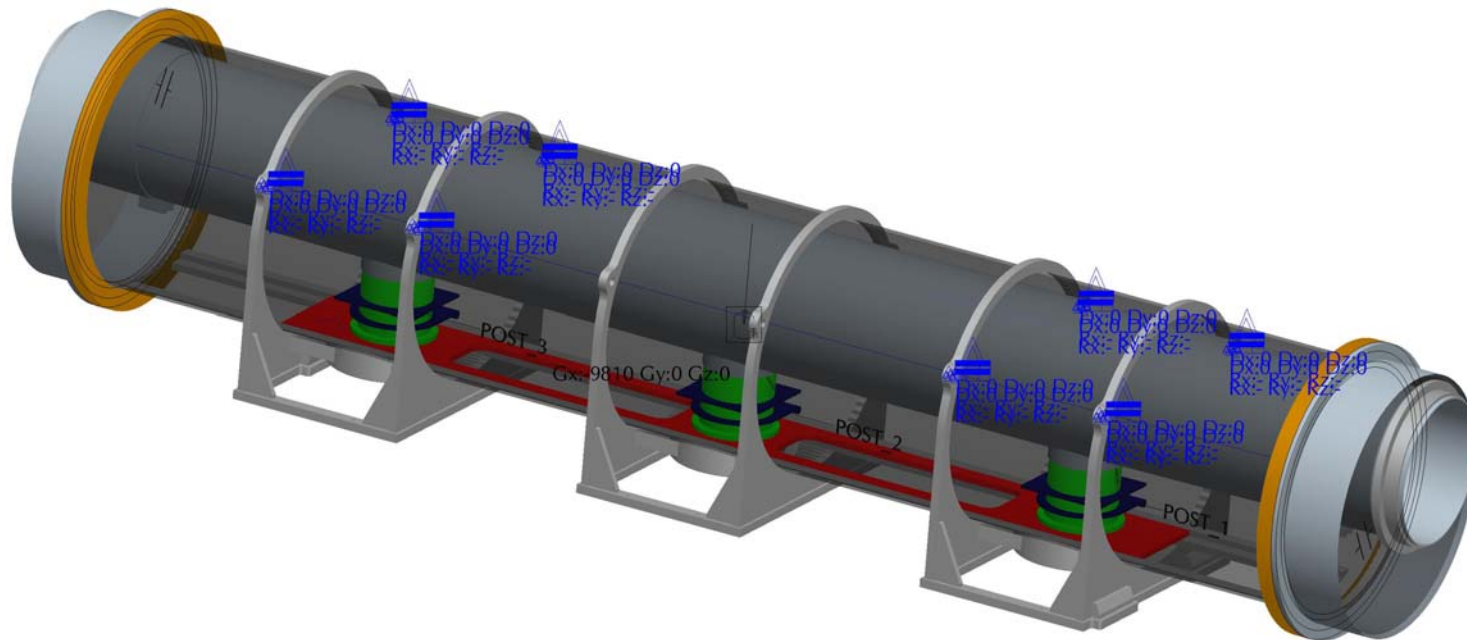
New ending transport support: rods cannot withstand compression, so we changed to collar

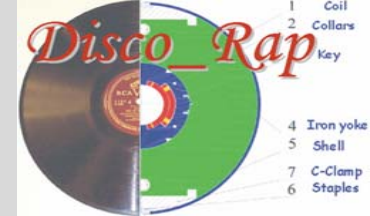






Lifting analysis: with transport fixing pieces





It seems a quite rigid structure

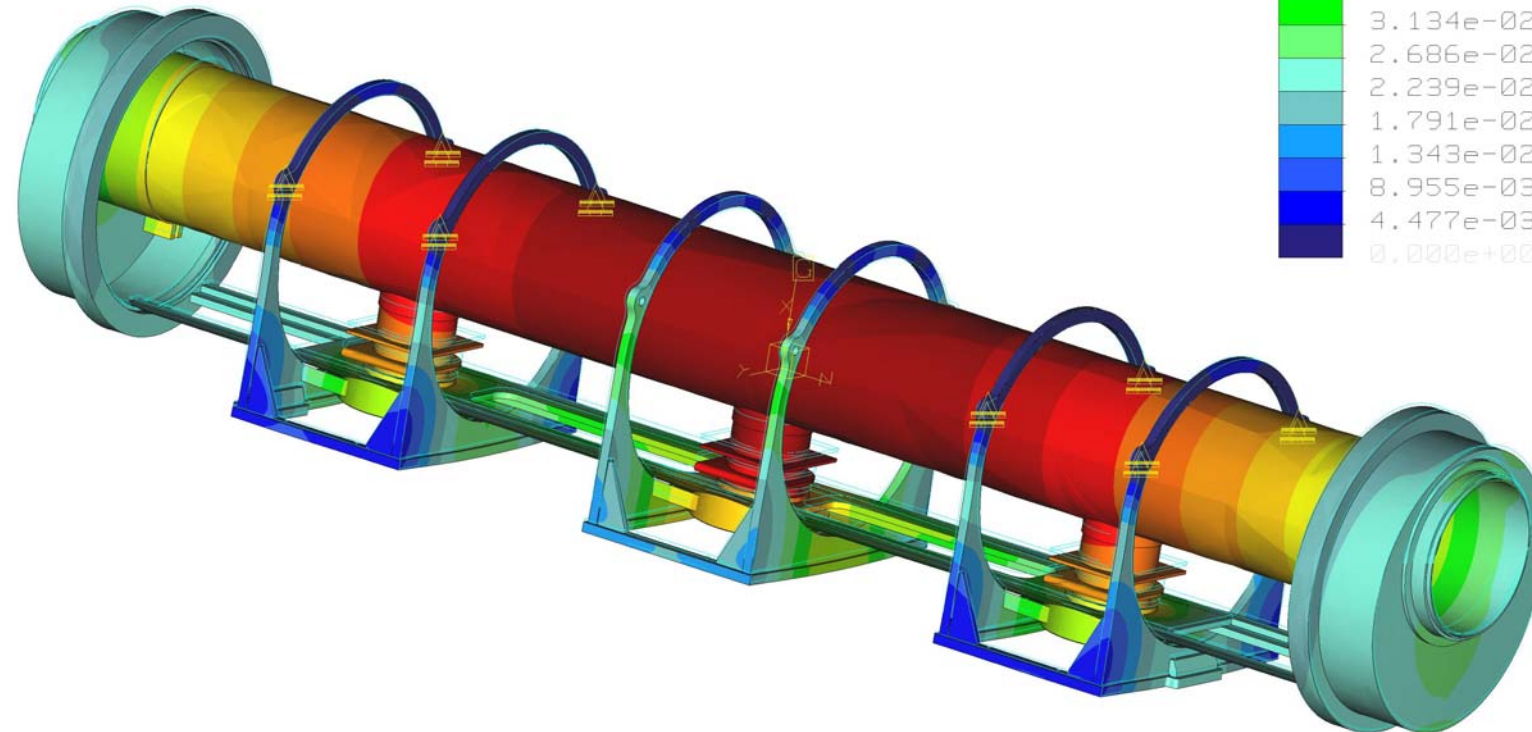
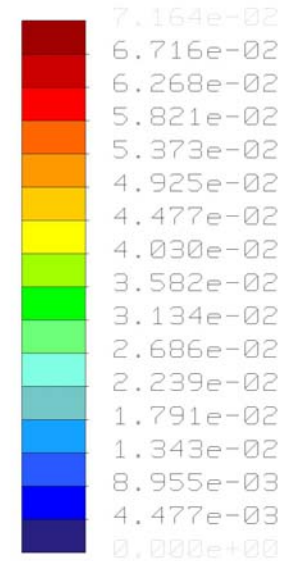
Displacement Mag (WCS)
(mm)

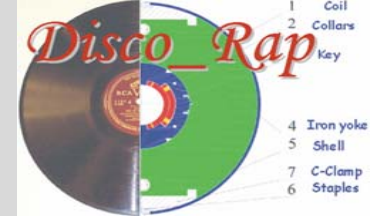
Deformed Location: Components and Layers

Max Disp +7.1638E-02

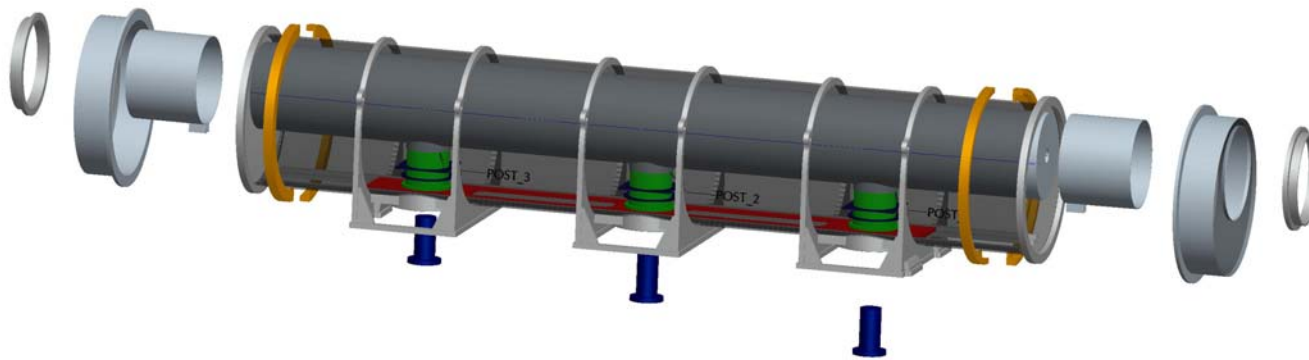
Scale 5.0000E+02

Loadset:IG_VERTICALE

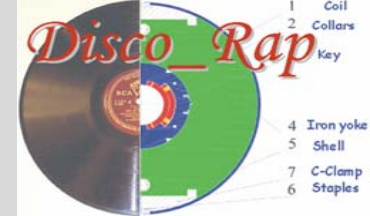




Transport analysis: 1g axial and lateral, plus weight

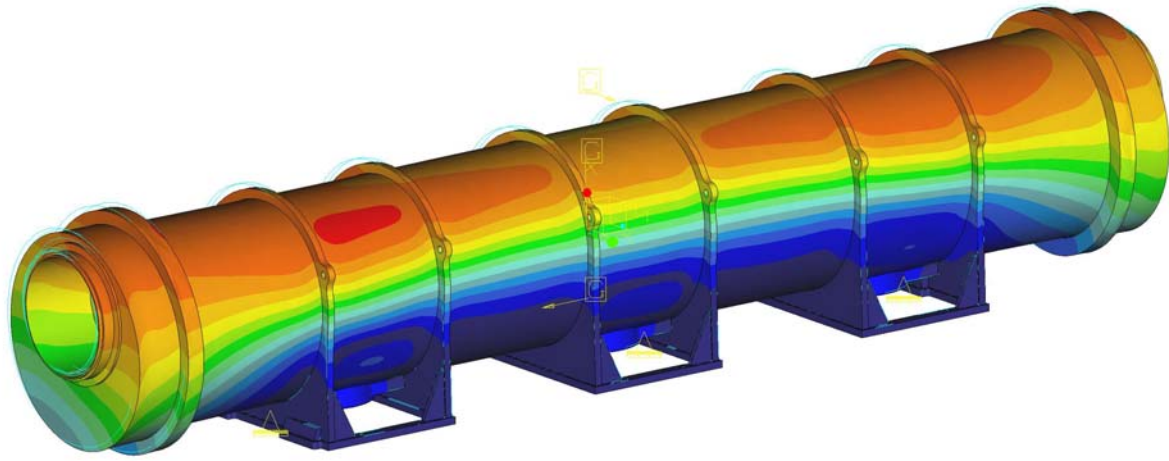
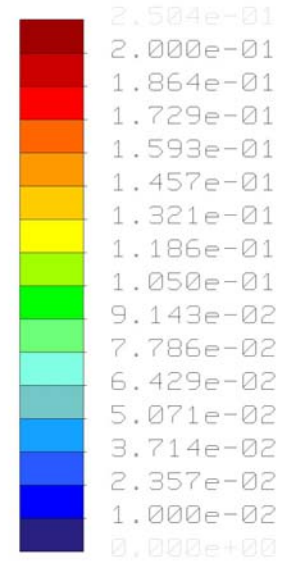


Stato esploso:1(+)

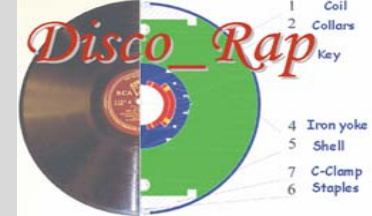


Displacements are within 0.2 mm and stresses are below 50 MPa

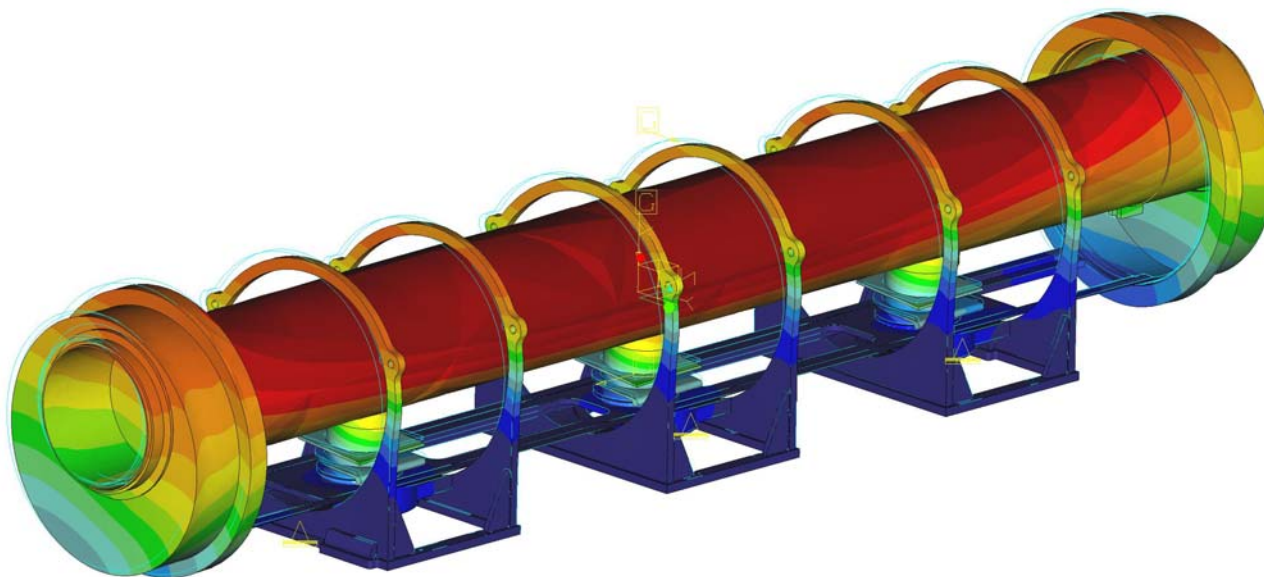
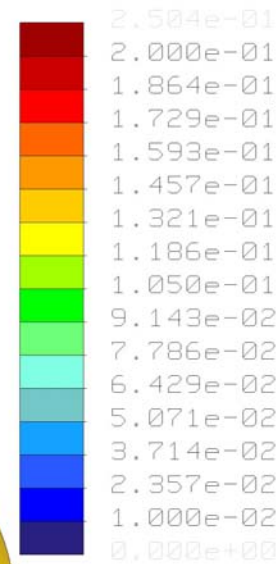
Displacement Mag (WCS)
(mm)
Deformed
Max Disp +2.5037E-01
Scale 3.0000E+02
Combination



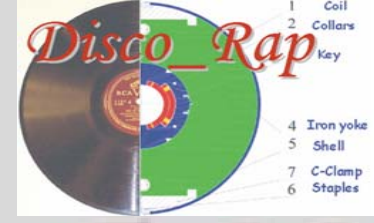
4 I
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7
6 S



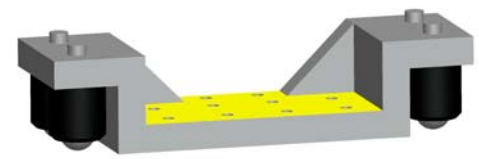
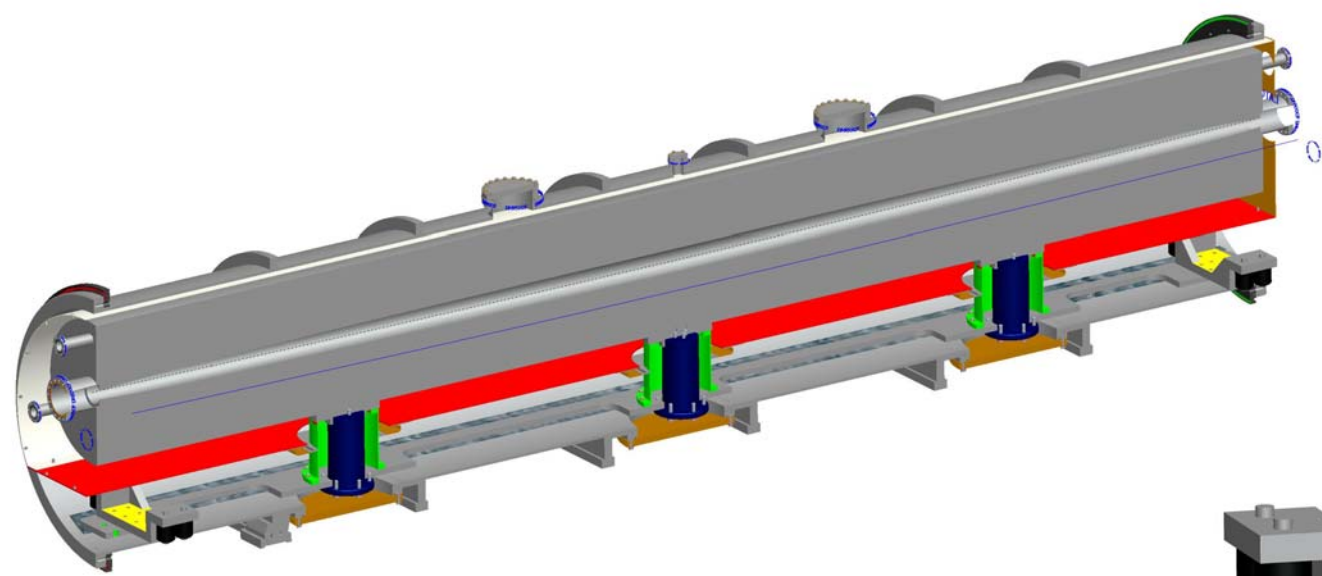
Displacement Mag (WCS)
 (mm)
 Deformed Location: Components and Layers
 Max Disp +2.5037E-01
 Scale 3.0000E+02
 Combination

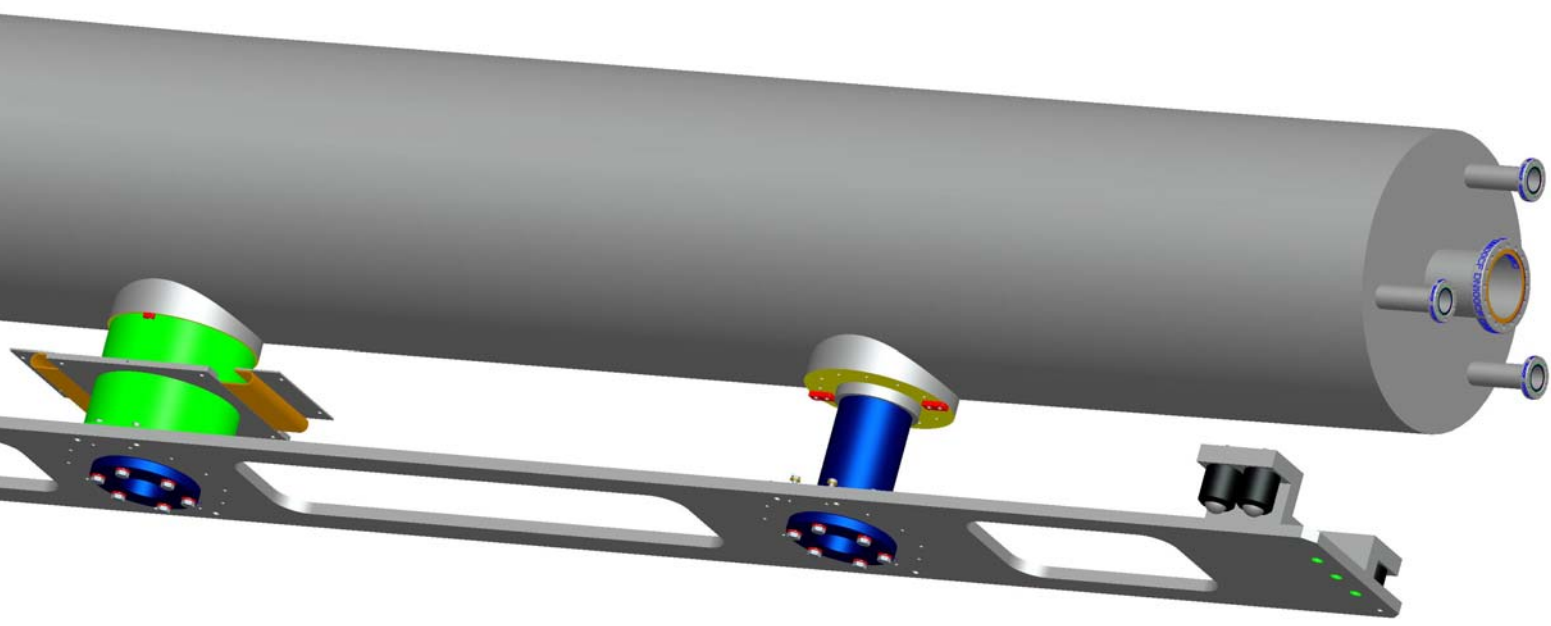
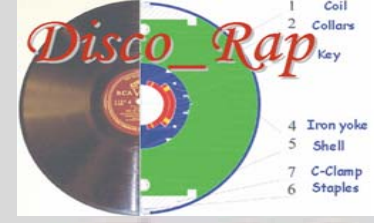


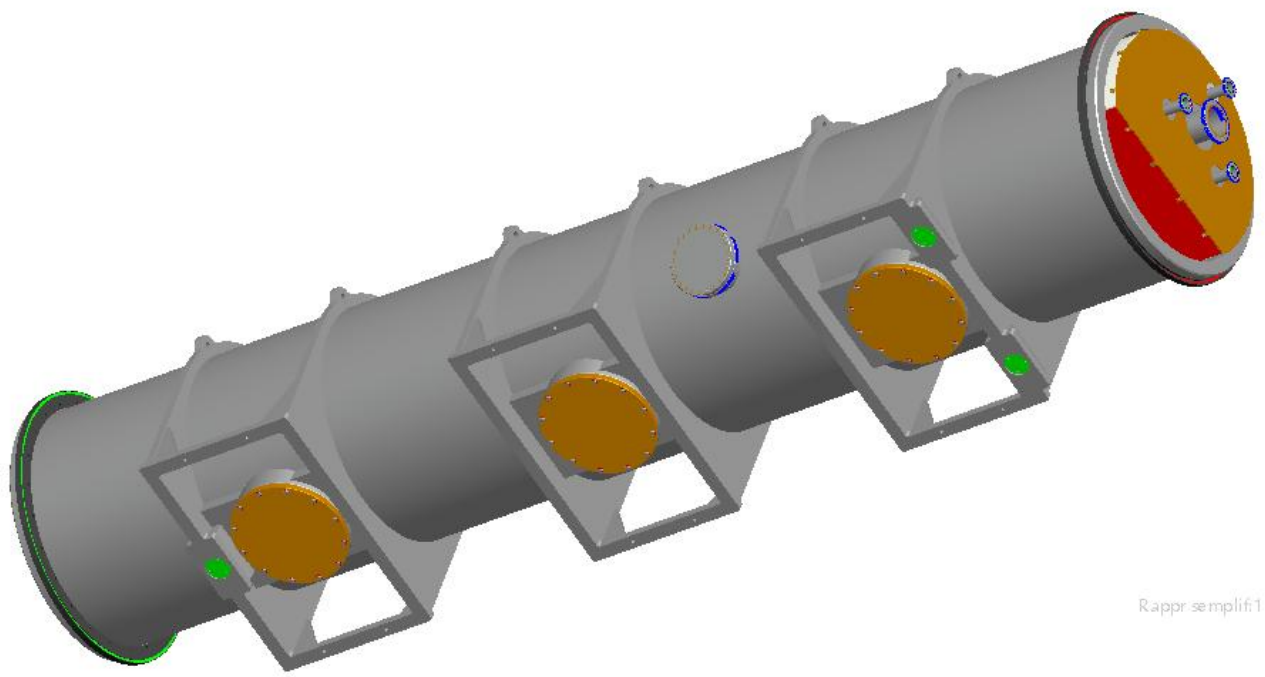
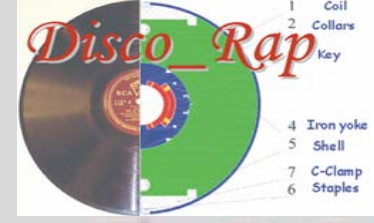
4 I
 5
 7
 6



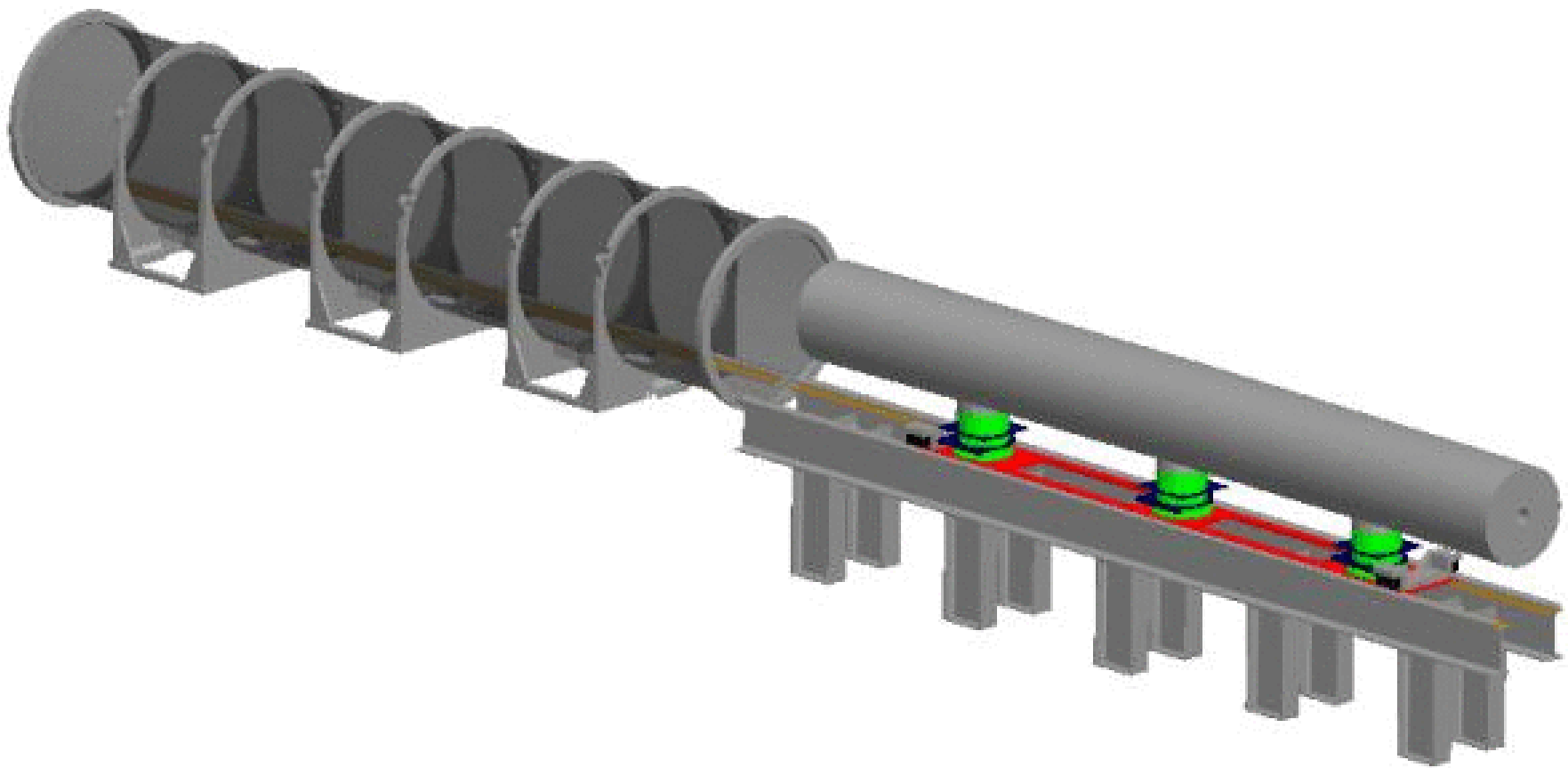
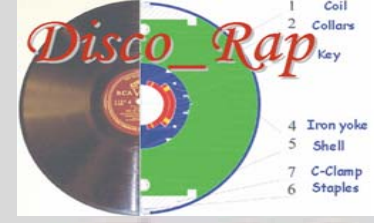
Other improvements: moving cart for assembling





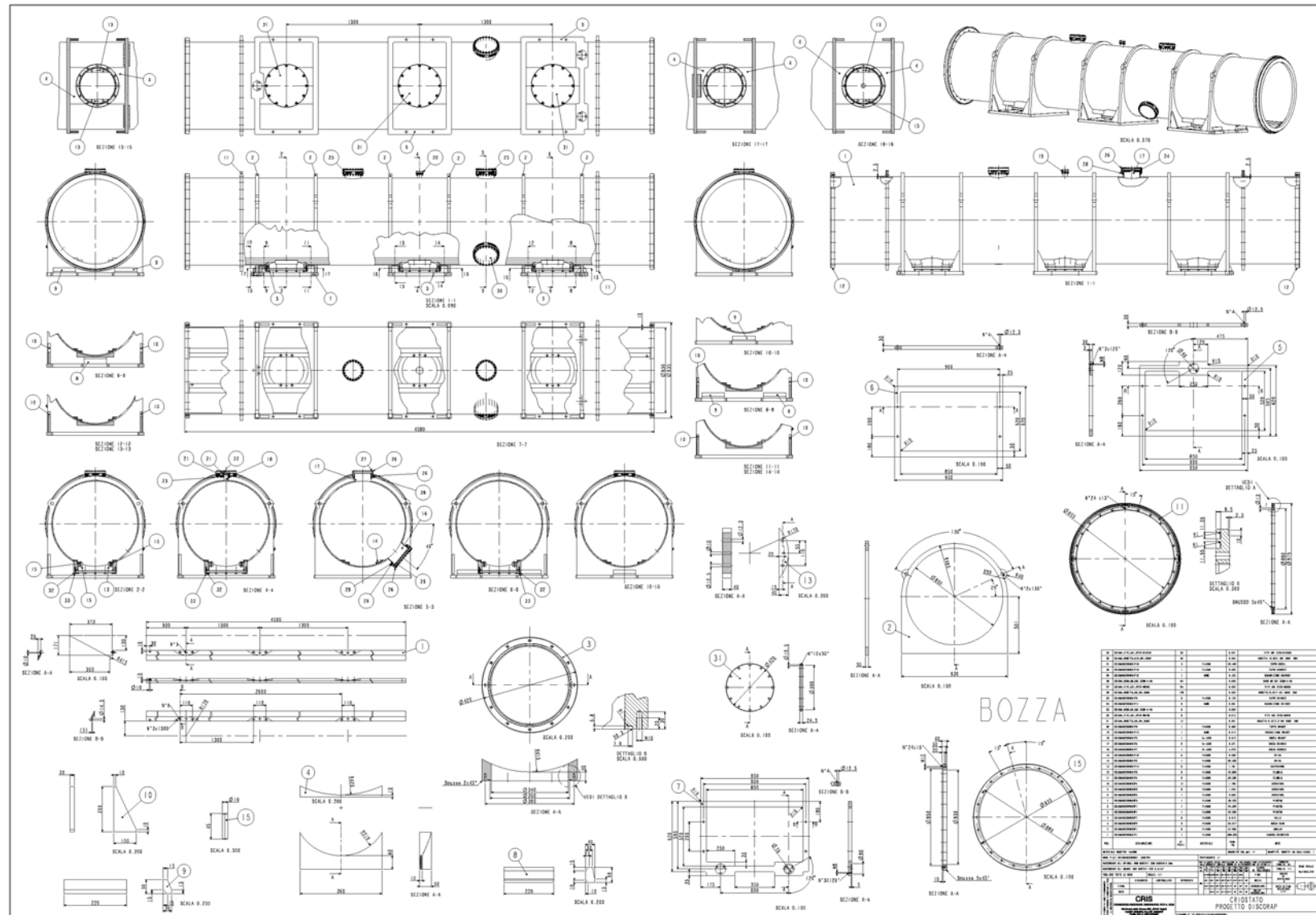


Rappr_semplif.1



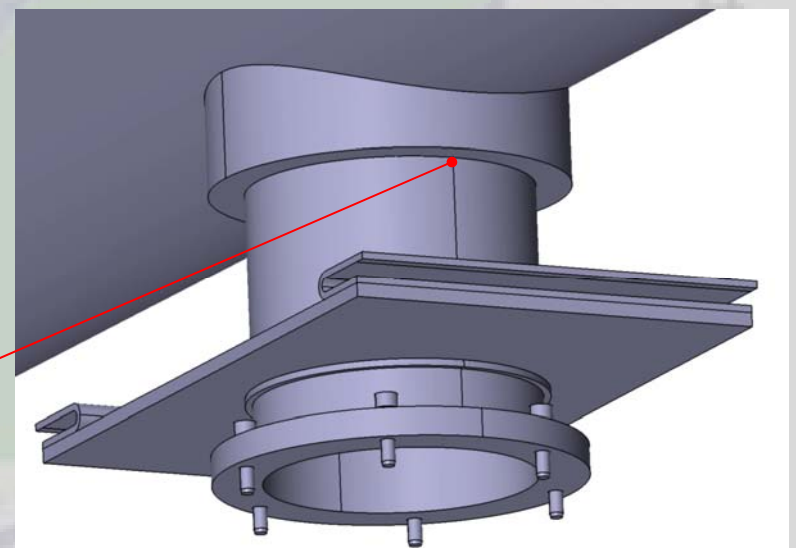
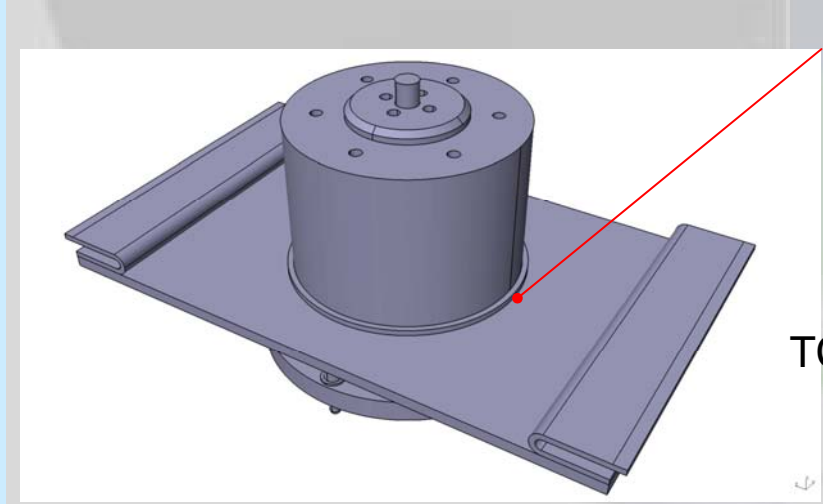
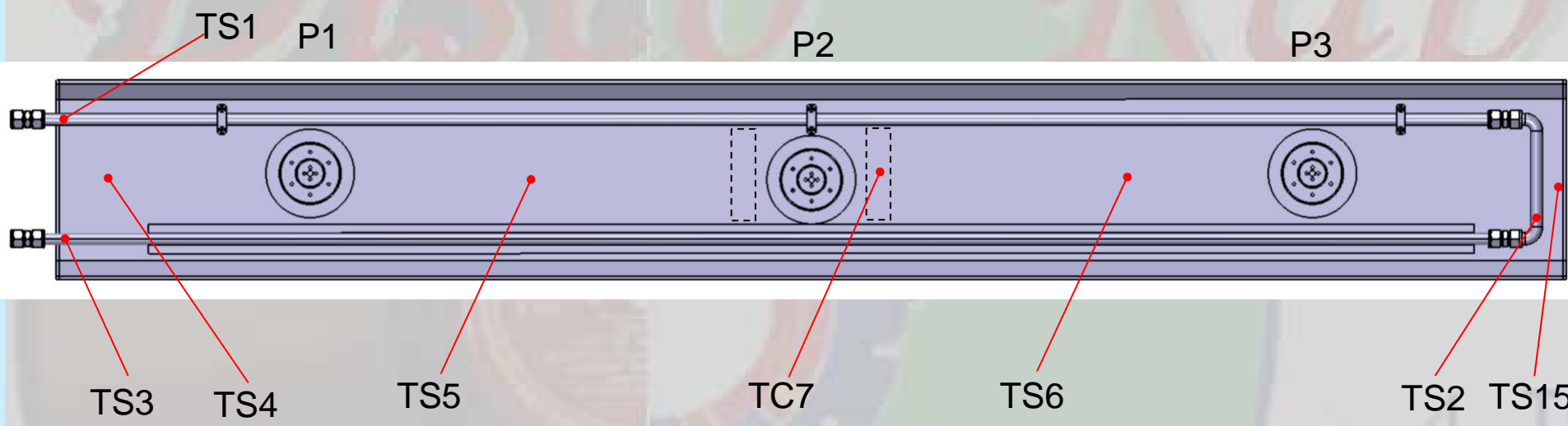


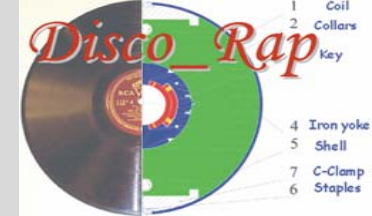
Status of drawing: tables are in progress, and will require 2 weeks to be completed



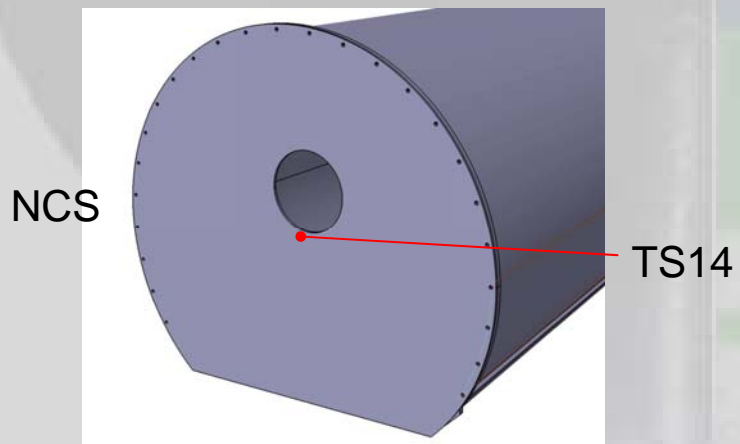
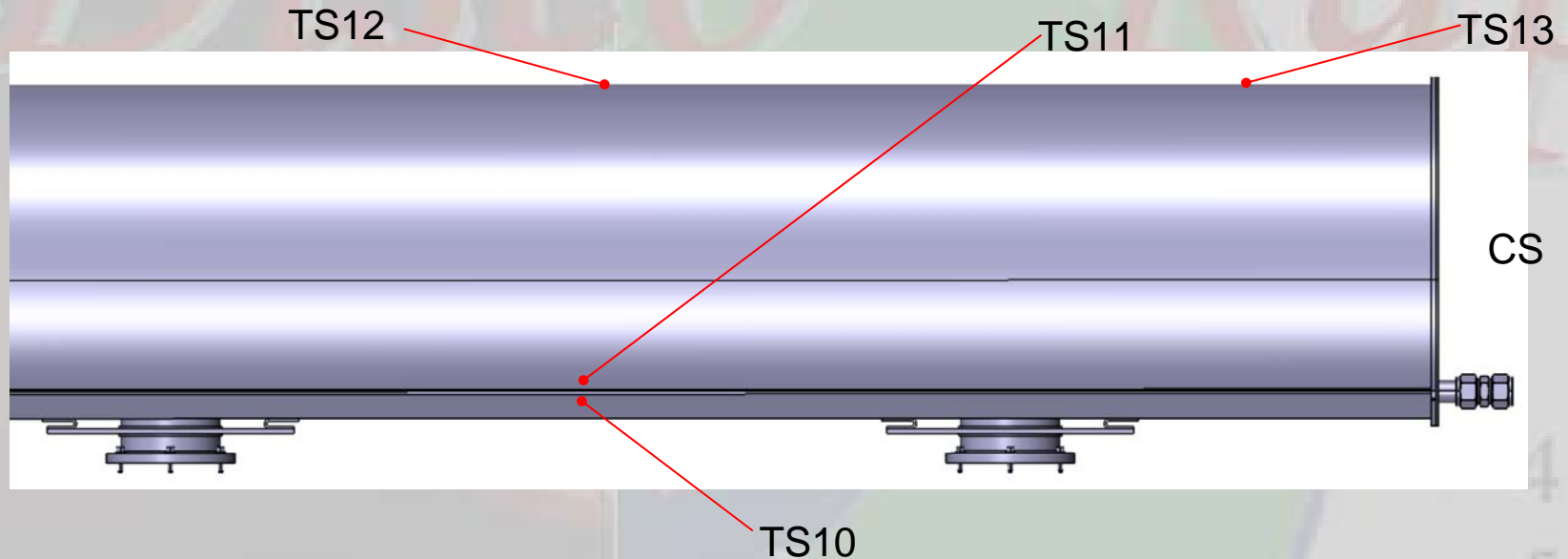


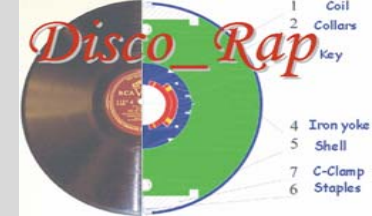
Temperature sensor positions at Shield cooling tube, bottom tray and Post:





Temperature sensor positions at Shell, End Cap and bolting flange position:

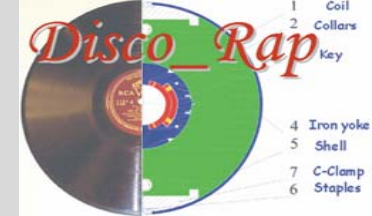




Cryostat procurement actions

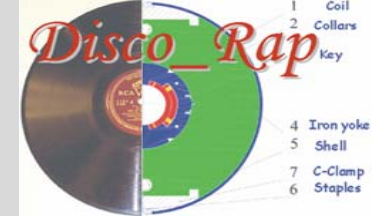
- **Define specifications for the bid by March 20th, to be approved by INFN executive board on Apr 17th.**
- **Letter of invitation to 3-4 companies, by end of April;**
- **Receive quotations in 45 days**
- **Evaluation and placement of order 1 month**
- **Manufacturing time (6-8 month ??)**

In parallel we have to get at least 5 LHC supports, either fully equipped or to be assembled/processed by us (depending on manufacturer availability)



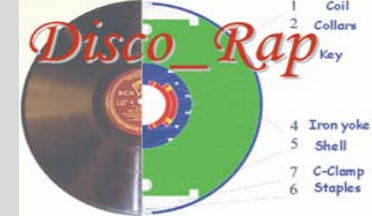
Cryostat specification will include GSI requirements

- A set of drawings showing all welded assemblies, including the welding specification
- The complete documentation of the calculations for the dimensioning and calculations during the design of any pressurised and evacuated container as well for the LHe containing components
- A collection of all material certificates of the used materials for the LHe, GHe and vacuum containing parts of the assembly
- A collection of all material certificates of the used welding fillers (additional welding materials)
- Documentation and certificates about the x-ray testing of the welding seams of all LHe related weldings and cryostat weldings
- Certificates of the used safety valves and / or Burst disks
- Welder certificates of the welders which participated in the production
- Certificates of the performed pressure tests
- Cryostat should have a CE - Label including the corresponding certificate and documentation



Further items to be fixed:

- **Fiducials anchors on the outer shell**
- **Safety valve (under design for the max flow rate)**
- **Kind of electrical feedthrough to manufacture suitable holes on the 200CF blind flange**
- **Transport basement, lifting tools**
- **End flanges for vacuum test**



CONCLUSION

- **The design of the cryostat is completed.**
- **The analyses suggest it will be safe to operate the dipole into the cryostat as well as to move it by truck**
- **We hope to have the parts ordered by July 2009 and ready for assembling at the beginning of 2010**