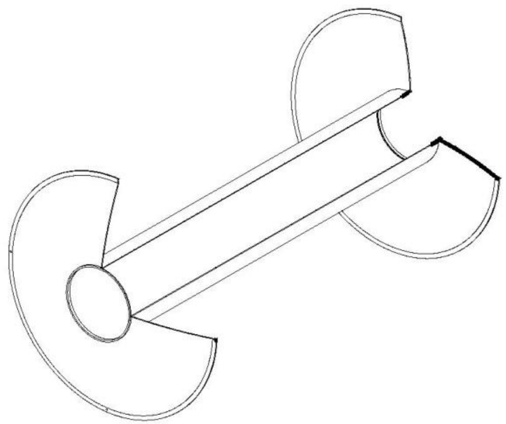
Preliminary studies on the SuperB DCH Mechanical Structure

13 Sep 2011

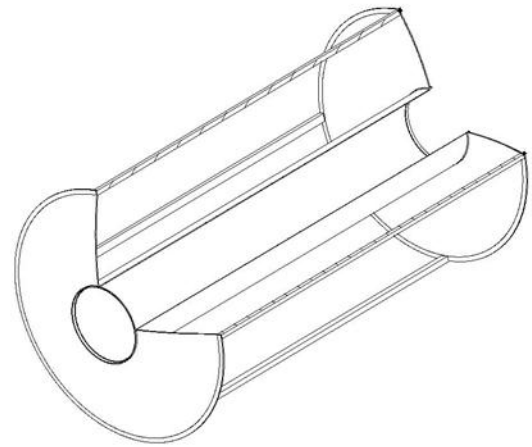
Specifications

- Total load on endplates ~2ton
  - “Tolerable” endplate deformations (to be defined)
- Possibly non-load-bearing inner cylinder
  - less material
- During stringing the two endplates must be mechanically coupled

Analyzed configurations



Load-bearing inner cylinder



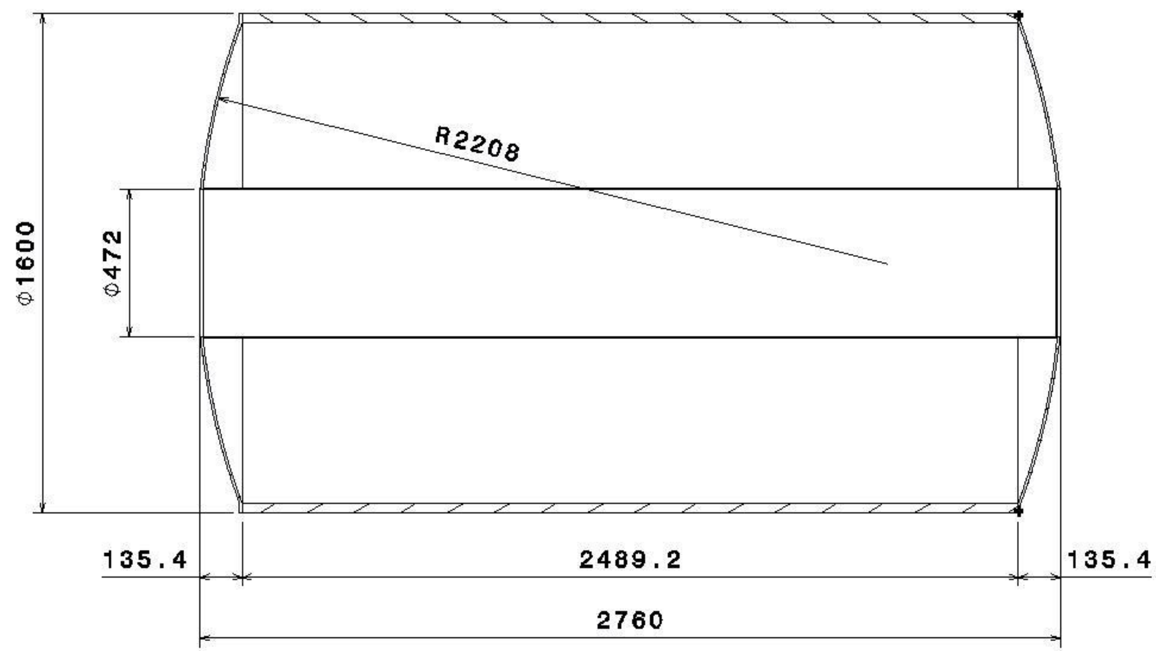
Load bearing structure on outer diameter(e.g. struts as in KLOE)

Shaped endplates result in much smaller deformations for fixed thickness

- e.g. almost 2 orders of magnitude (flat plates)

Spherical convex endplates used in the following

Dimensions



Max. diameter of DCH (mm)	1600
Min. diameter of DCH (mm)	472
Total max length (mm)	2760
Radius of endplate (mm)	2208

Analysis of endplates

- A *preliminary* FEM analisys was performed on the endplates for both configurations
- A CF (intermediate modulus) laminate was chosen (Tab.1) to have ad idea of the material properties
- For the sake of simplicty the material was considered isotropic (Tab.2)
- Plates thickness: 8mm (A total of eight composite laminates)

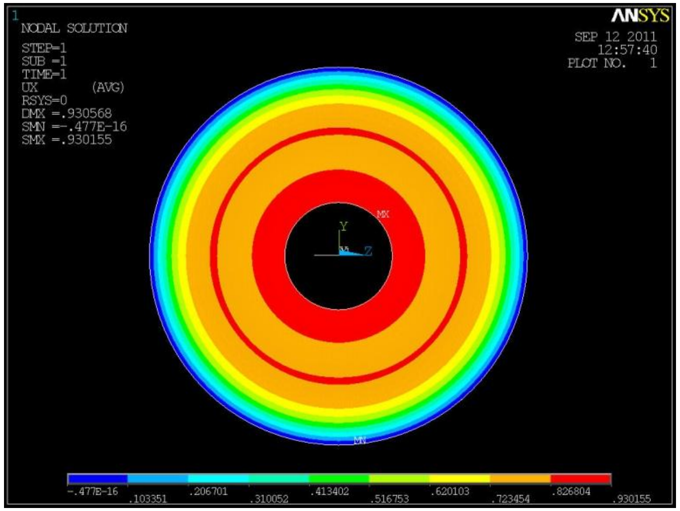
Ply#	Lamina Type	Thickness(m)	Angle (deg)
1	Graphite/Epoxy	1,27 E-04	0
2	Graphite/Epoxy	1,27 E-04	90
3	Graphite/Epoxy	1,27 E-04	45
4	Graphite/Epoxy	1,27 E-04	-45
5	Graphite/Epoxy	1,27 E-04	-45
6	Graphite/Epoxy	1,27 E-04	45
7	Graphite/Epoxy	1,27 E-04	90
8	Graphite/Epoxy	1,27 E-04	0

Tab.1

Properties	
Ex(MPa)	56300
Ey(MPa)	56300
Nuyx	0,2962
Nuxy	0,2962
Gxy (MPa)	21820

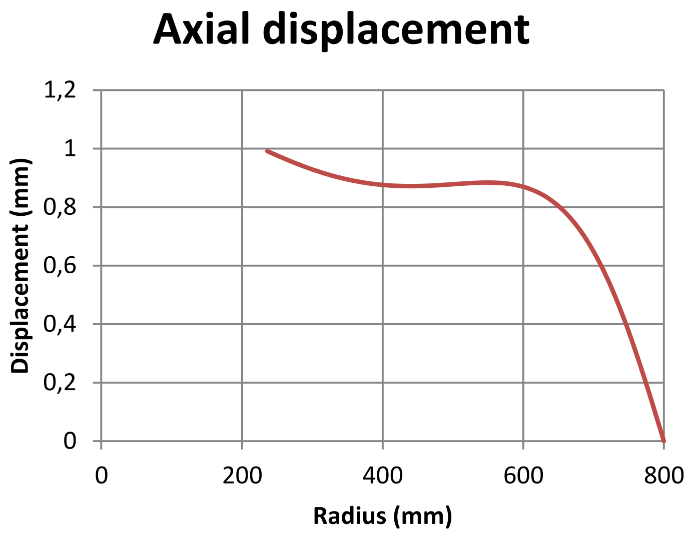
Tab.2

Case 1: Endplate supported on outer radius (simply supported edge)



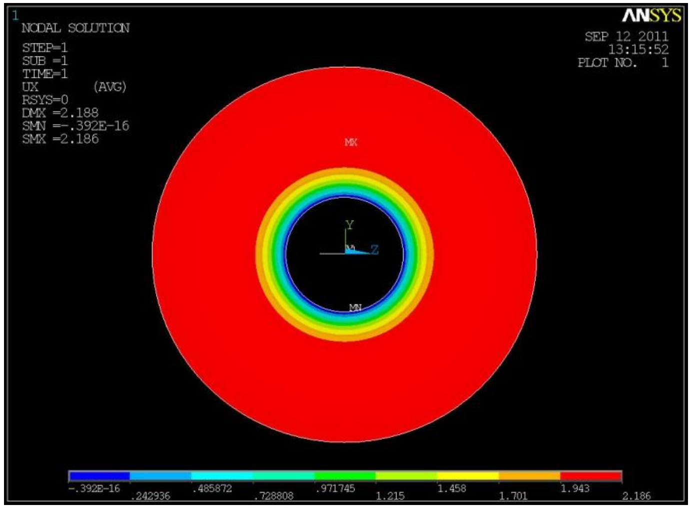
Hypothesis on boundary conditions:

- Outer rims of endplates contrained
- Radial displacement allowed
- Rotation on the tangential direction allowed



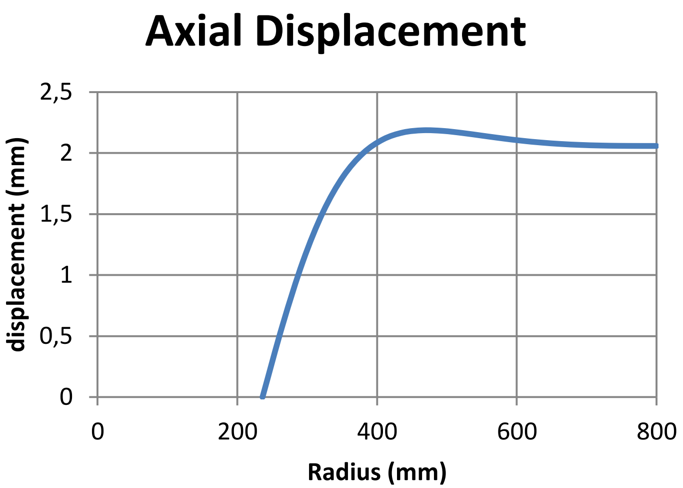
Maximum displacement is: 1 mm

Case 2: Endplate supported on inner radius (simply supported edge)



Hypothesis on boundary conditions:

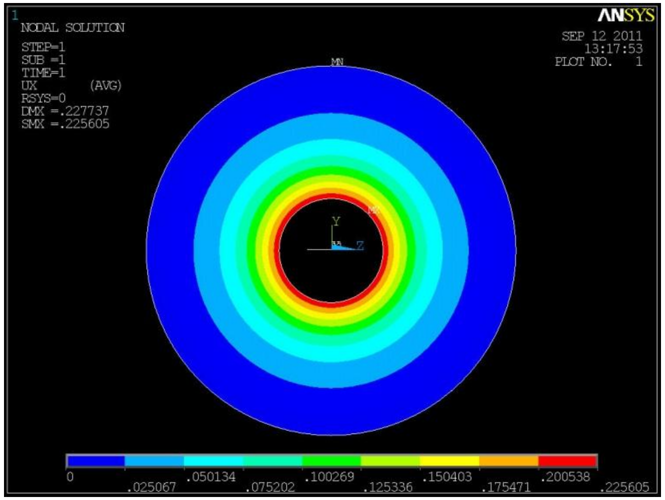
- Inner rims of endplates contrained
- Radial displacement allowed
- Rotation on the tangential direction allowed



Maximum displacement is: 2,2 mm

Axial displacement is 2,2 times larger than previous solution

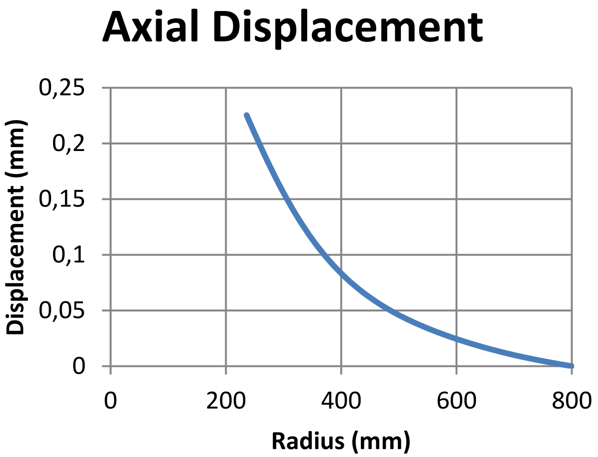
Case 3: Endplate supported on outer radius (fixed edge)



Hypothesis on boundary conditions:

- Outer rim of endplates contrained
- *Radial displacement fixed*
- Rotation on the tangential allowed

Using a CF flange on outer radius to improve stiffness



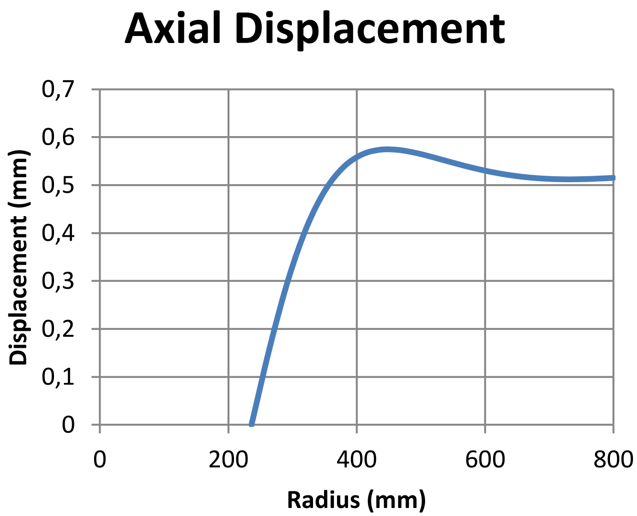
Maximum displacement decrease to: 0,22 mm

Case 4: Endplate supported on inner radius (fixed edge)

Hypothesis on boundary conditions:

- Inner rim of endplates contrained
- *Radial displacement fixed*
- Rotation on the tangential allowed

CF flange on our radius to improve stiffness



Maximum displacement decrease to: 0,57 mm

Axial displacement is still larger than the configuration with the outer rim constrained

Load bearing structures

Load bearing structure on inner diameter

Analytical and FEM analysis show that a inner cylinder with a thickness of 500 µm (CF) is enough for 2 tons

Considering a Safety Factor of 10, a thickness of 1,5mm could support all the load

However, it should be considered that:

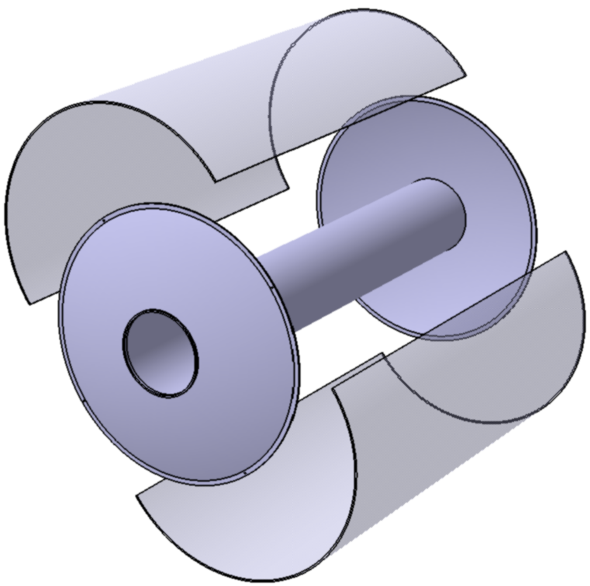
- Thin walled cylindrical structure is extremely sensitive to imperfections under axial compression
- FEM analysis is only about the eigenvalue buckling that is non-conservative
- Deformations on the enplates modify the boundary conditions of the cylinder, so the two elements should be considered at the same time

Load bearing structure on outer diameter

An idea is to use struts (like in KLOE), this solution is still under study and actually number or the cross section is not known

In KLOE, there are 12 struts for about 3ton

In SuperB DCH we would use only 4 struts to allow wires stringing



An alternative is to pretension the endplates, couple them to the stringing machine and then use cylindrical shells as a load bearing structure

Summary and plans

- Convex endplate configuration strongly reduce the axial displacement in comparison with flat plate
- It’s feasible to use only one load bearing structure (struts or inner/outer cylinder)
- Optimization of the CF laminate (High mododululs, sandwich structure, different orientation of fibers)
- Effect of the feed-through holes
- Improve the endplate geometry in order to realistically model the fixed edge conditions (Case 3,4)
- Improve FEM model to take into account the orthotropic material and understand the behaviour on the CF plies

Summary and plans (continued)

- Deformation analysis shoud be performed on whole structure
- A stability (buckling) analysis is needed on all elements (struts, cylinder, plate)
- Need to know if struts are acceptable for DIRC
- Fix some dimensions, I used arbitrary dimension (decreasing the radius of the spherical endplate has an important effect on displacement)