Mechanical study of “AMANDA”

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Introduction

Material properties of Niobium (RRR~250)

- Density: 8.57 $g.m^{-3}$
- Young's Modulus: 107 GPa
- Poisson's ratio: 0.394
- Yield strength : ~70 MPa @ 300K
- Tensile strength : ~150 MPa @ 300K

Calculations performed with ACORD-CP

- Yield strength limit: 50 MPa
- Only linear ➔ Von Mises stress values > 70 MPa are wrong !

Under vacuum load @ 1 bar

Cavity without stiffeners

Thickness (mm)	Peak V.M stress (MPa)
2	372
3	175
4	102
5	67

Yield strength exceeded

Cost : 3600€/mm & 8 kg

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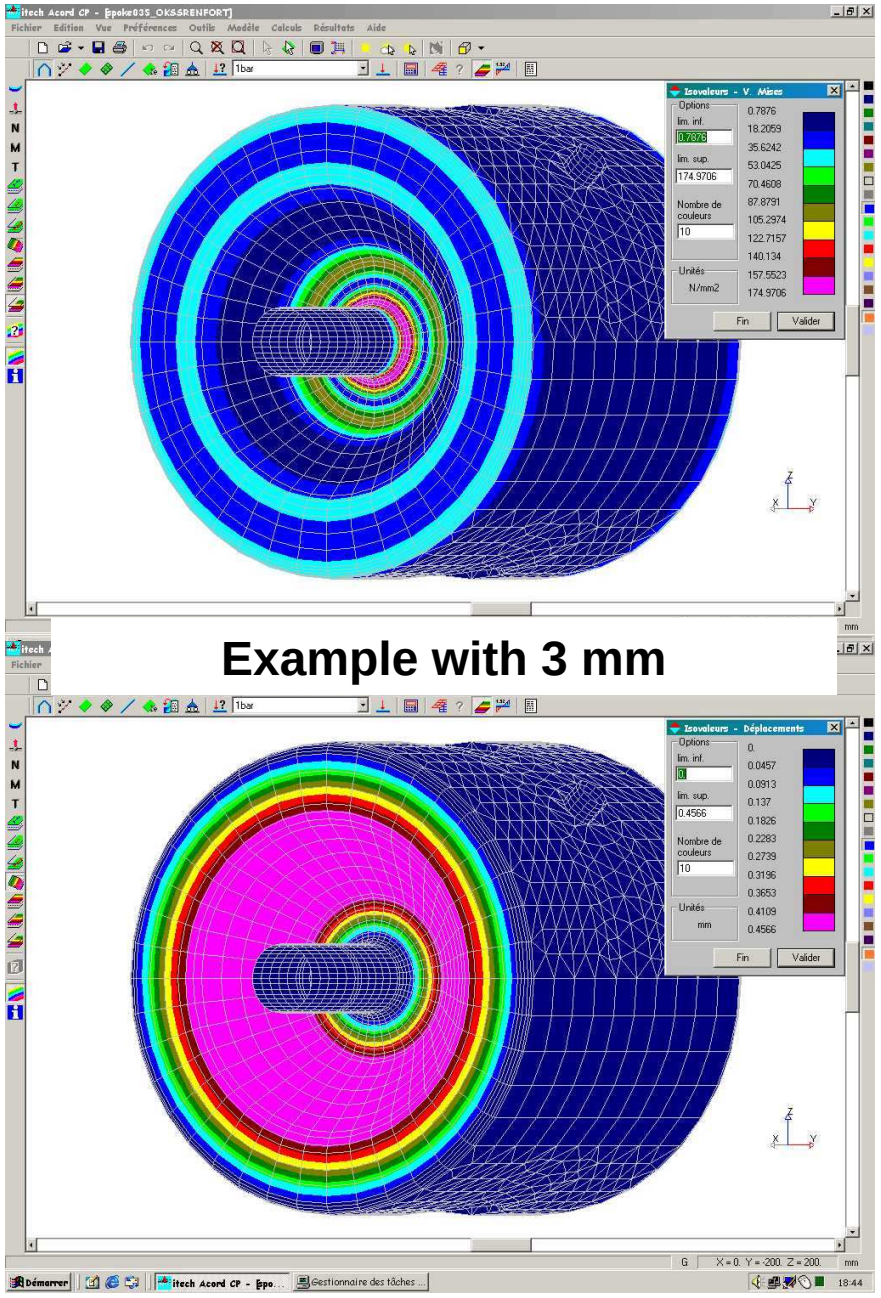
!!! Stiffeners !!!



Example with 3 mm

Under vacuum load @ 1 bar

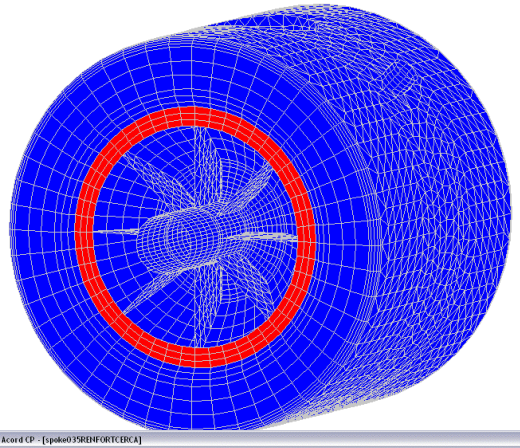
Thickness: 3 mm

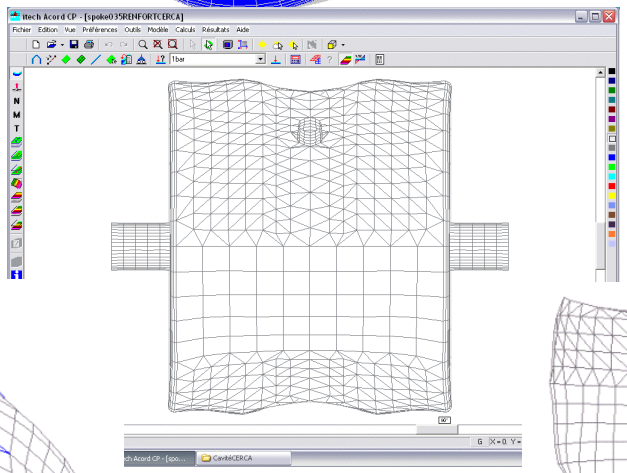
Cavity with 8 stiffeners & a ring (2 mm thick)

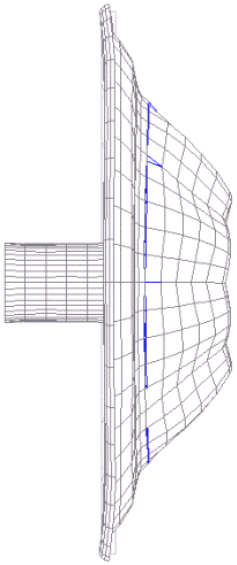
Peak V.M stress (MPa)	Peak displacement (mm)
37.3	0.057

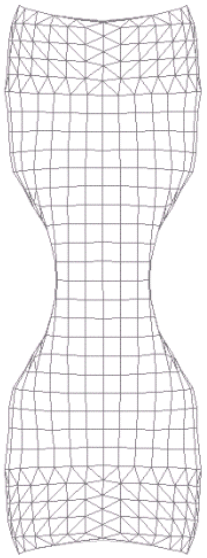
NB: Both beam tube ends fixed

No change with thicker stiffeners (3 mm to 5 mm)



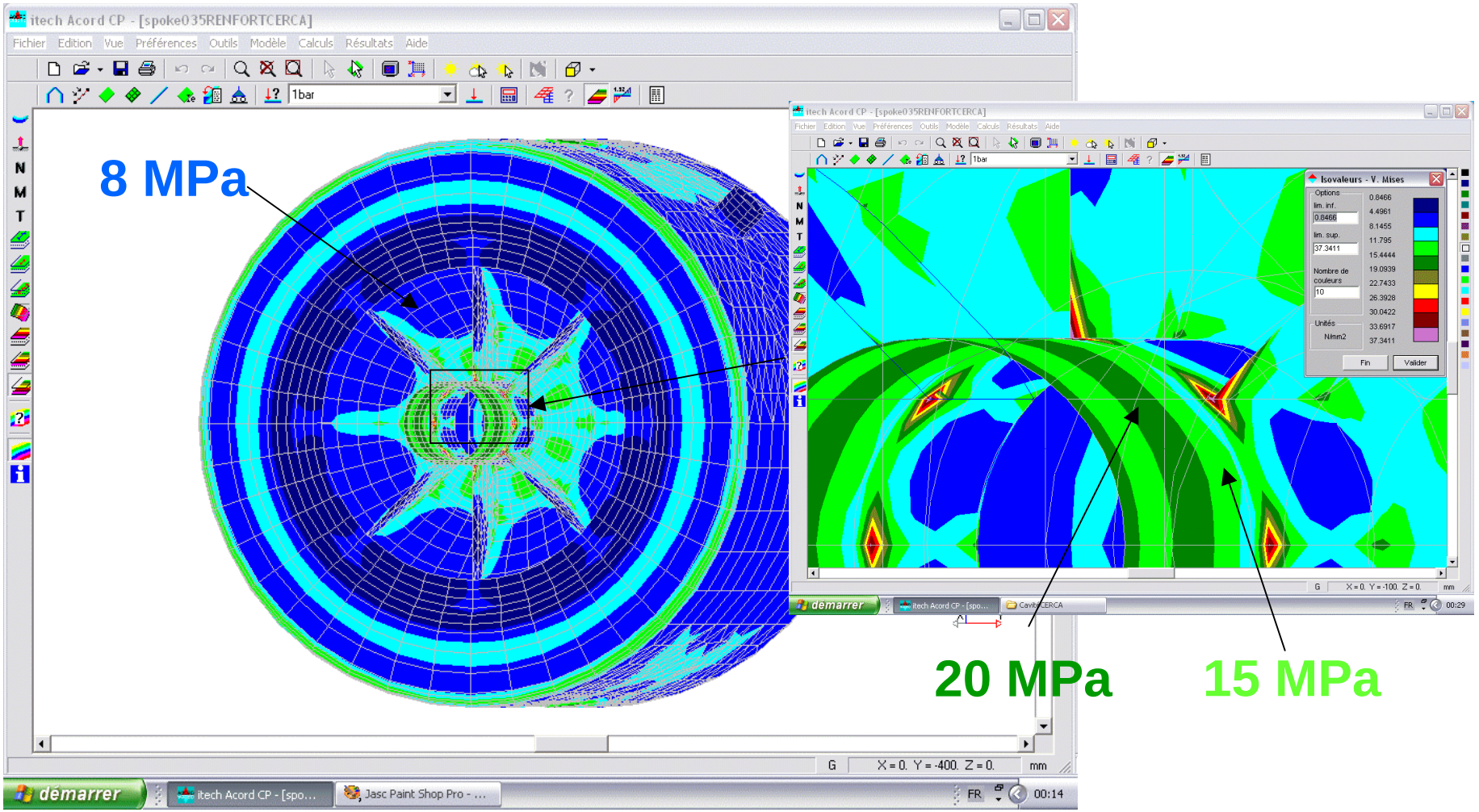






Under vacuum load @ 1 bar

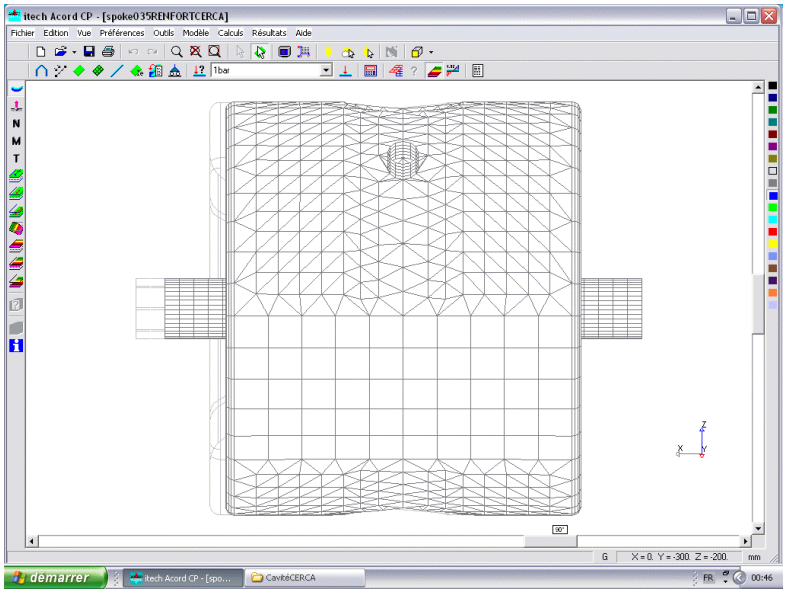
Location of stress



Under vacuum load @ 1 bar

Calculations with one end free

Peak V.M stress (MPa)	Peak displacement (mm)
139	2.38



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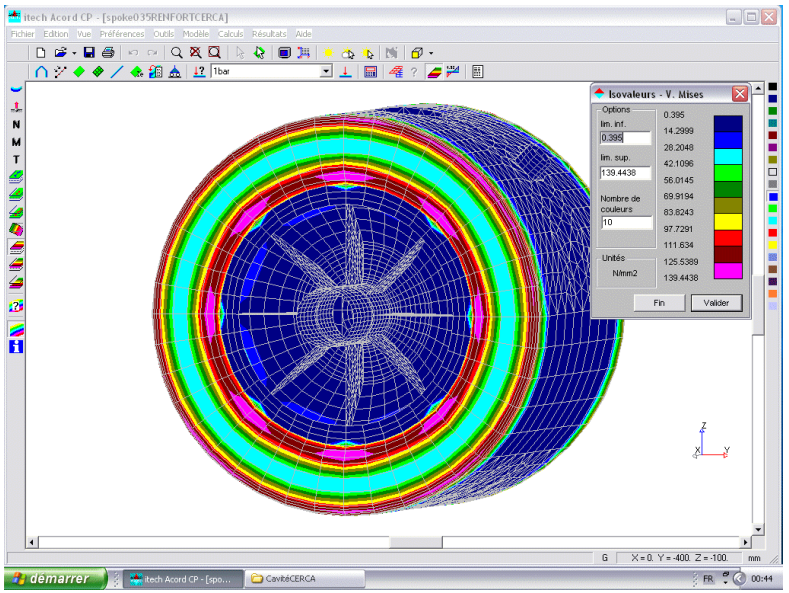
We need to fix the cavity under vacuum load

So we used the test bench designed for the 5-cell cavity



Tuning

Cavity stiffness value

- 50 MPa reached for 0.86 mm
- 3500 N/mm

measurements

~2500 N/mm (error: 40%)

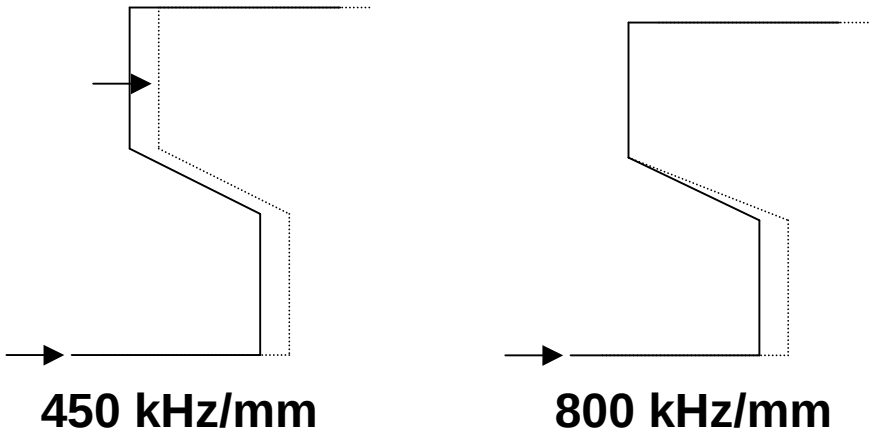
Sensitivity

- between 450 and 800 kHz/mm

(estimation with MAFIA)

measurements

~550 kHz/mm



Vibration modes

Frequencies in Hz of the first modes

Mode 1	97
Mode 2	149
Mode 3	287
Mode 4	303
Mode 5	336

→ **Torsion/beam axis**

→ **Oscillation along the beam axis**

Deformations

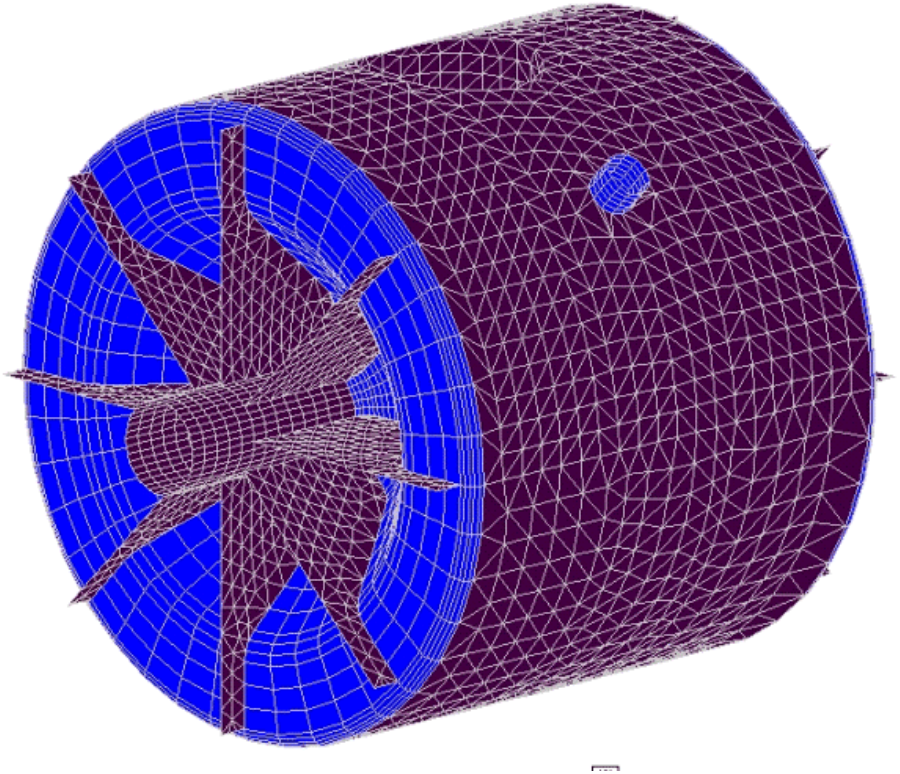
NB: Both beam tube ends fixed

→ **NO DANGER ?**

Conclusion

- Cavity is OK for cryogenic test (P~1 bar in cryostat)

- Cavity is probably not OK in an “accelerator” configuration (P up to 2 bars during cool down)
→ New stiffeners (in study)

Discussion

- Advantages & Drawbacks in comparison with the stiffening ring option ?