Helium tank comparison

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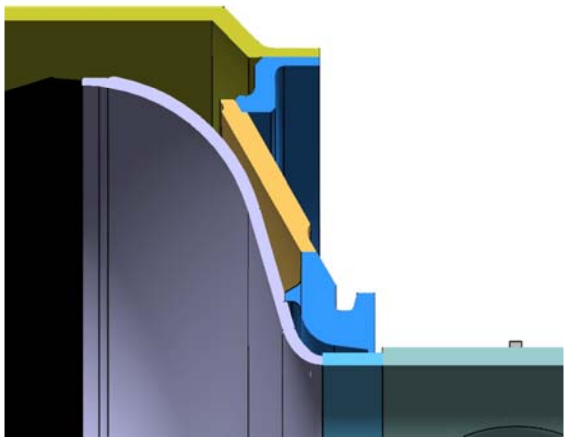
INFN – Mi

LASA

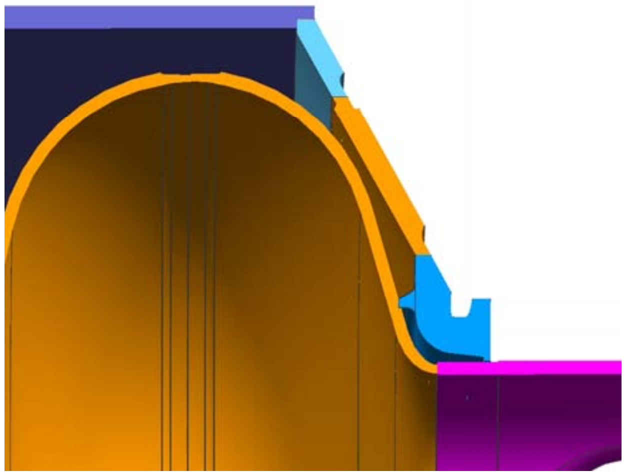
history - versions

HT Version	Cavity	Tuner	Pad distance	End cones
TTF type	Long	Saclay	750 mm	Old
ILC 1.0	Long/Short	Coaxial	600 mm	Old + ”L” adapting ring
ILC 1.3	Long/Short	Coaxial slim	750 mm	Old + straingt adapting ring
ILC 2.0	Long/Short	Coaxial slim	750 mm	New

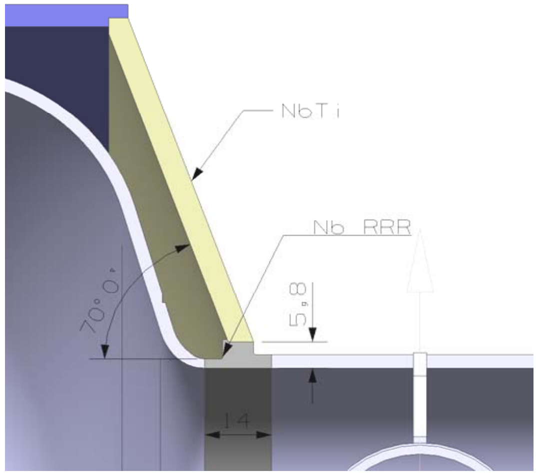
ILC 1.0



ILC 1.3



ILC 2.0



Materials

Ti Grade 1

ASME VIII, div 2, part AM, table ANF-1.4, density = 4500 kg/m^3

- Bellow: spec. no. SB265/UNSR50400

  f_t = 240 MPa; $f_{0.2}$ = 170 MPa; ε_t > 24% S_m = 80 MPa @ 20°C; E = 106870 MPa

Ti Grade 2

ASME VIII, div 2, part AM, table ANF-1.4, density = 4500 kg/m^3

- Vessel: spec. no. SB265/UNSR50250 Forged rings: spec. no. SB381/F2

  f_t = 345 MPa; $f_{0.2}$ = 275 MPa; ε_t > 20% S_m = 115 MPa @ 20°C E = 106870 MPa

NbTi

The niobium / titanium ally is not considered by the ASME pressure vessel code. The mechanical characteristics are taken from the literature, while the S_m value is assumed equal to $f_y/(1.5*1.6)$

f_t = 550 MPa; $f_{0.2}$ = 480 MPa; ε_t > 30% S_m = 200 MPa @ 20°C; E = 62000 MPa

density = 5700 kg/m^3

Nb RG

The niobium material is not considered by the ASME pressure vessel code. The mechanical characteristics are taken from the test performed by Myneni and Umezawa [1], while the S_m value is assumed equal to $f_y/(1.5*1.6)$. The heat treatment at 800°C has been taken into account.

f_t = 90 MPa; $f_{0.2}$ = 60 MPa; ε_t > 50% S_m = 25 MPa @ 20°C; E = 102700 MPa
density = 8700 kg/m^3

Nb RRR

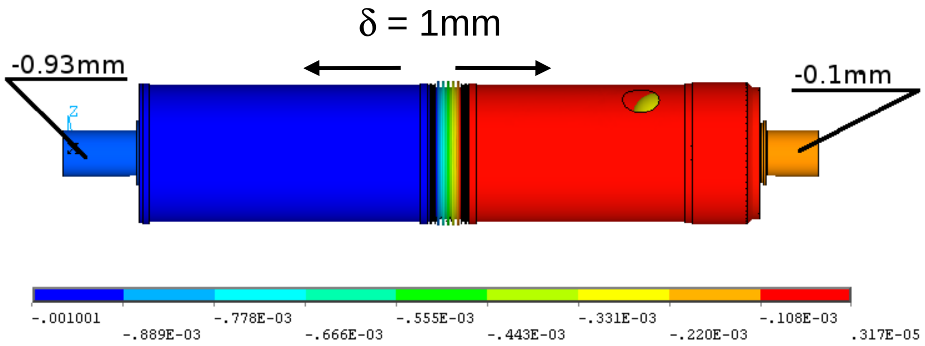
Like for the RG niobium, the mechanical characteristics are taken from the test performed by Myneni and Umezawa [1], while the S_m value is assumed equal to $f_y/(1.5*1.6)$. The heat treatment at 800°C has been taken into account.

f_t = 130 MPa; $f_{0.2}$ = 40 MPa; ε_t > 47% S_m = 16 MPa @ 20°C; E = 102700 MPa
density = 8700 kg/m^3

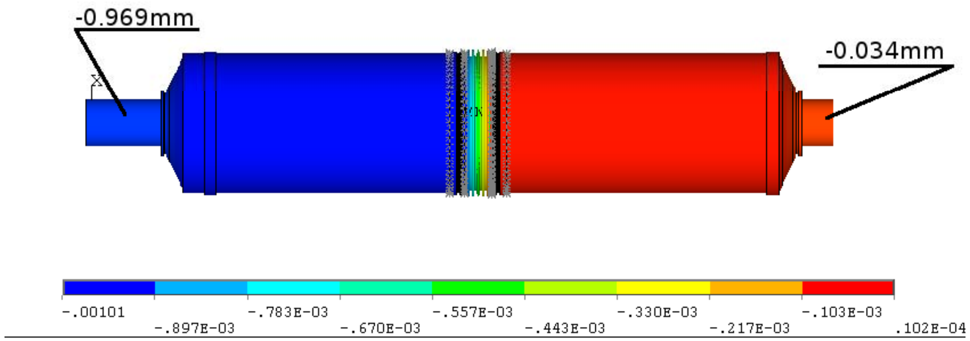
tuning efficiency

- **The elongation of the cavity due to the tuning, depends from the end-cones stiffness**

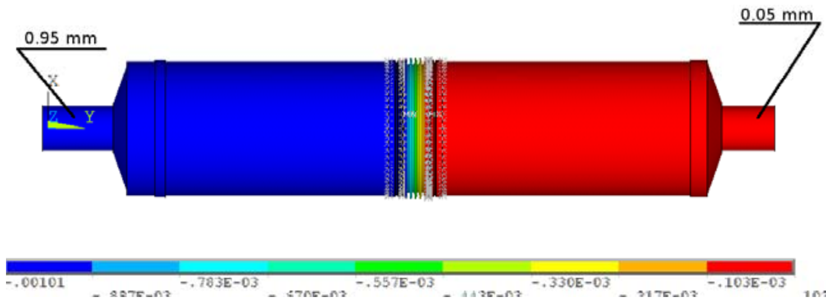
ILC 1.0: efficiency 83%



ILC 1.3: efficiency 93%

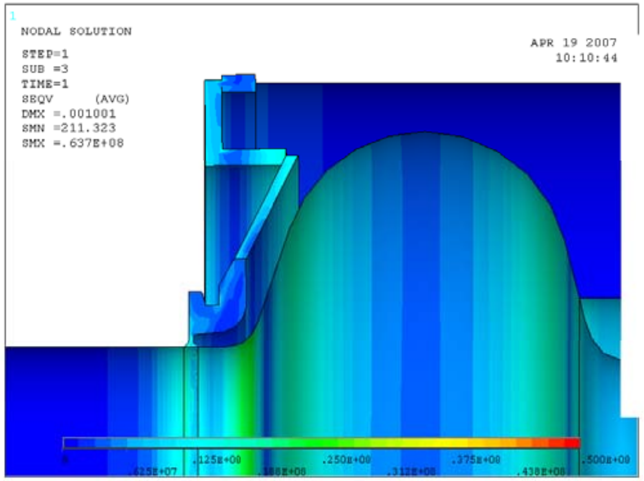


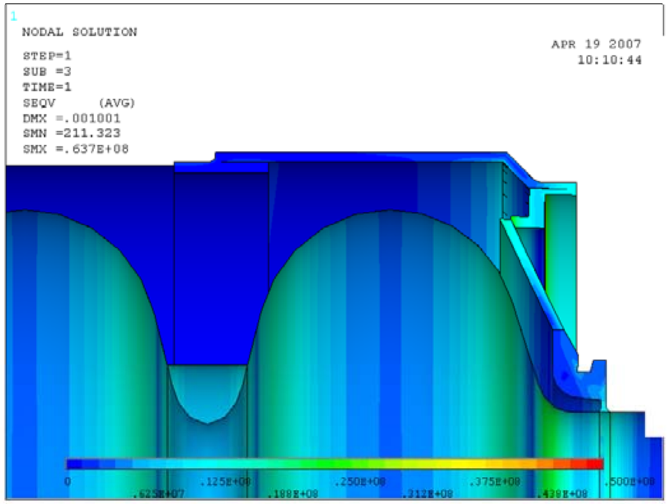
ILC 2.0: efficiency 90%



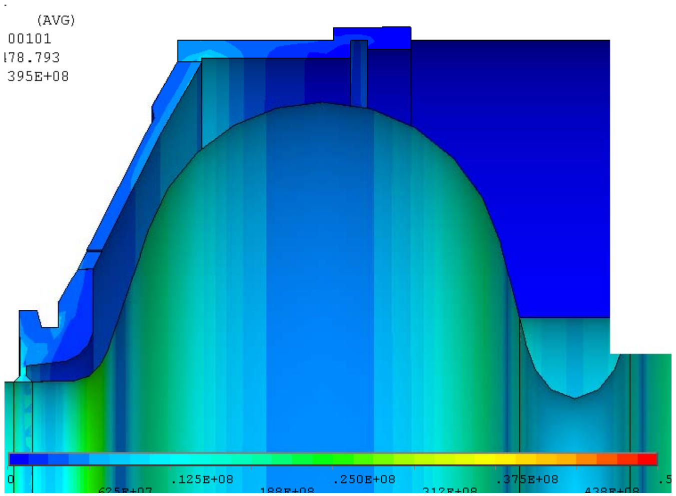
stress during tuning

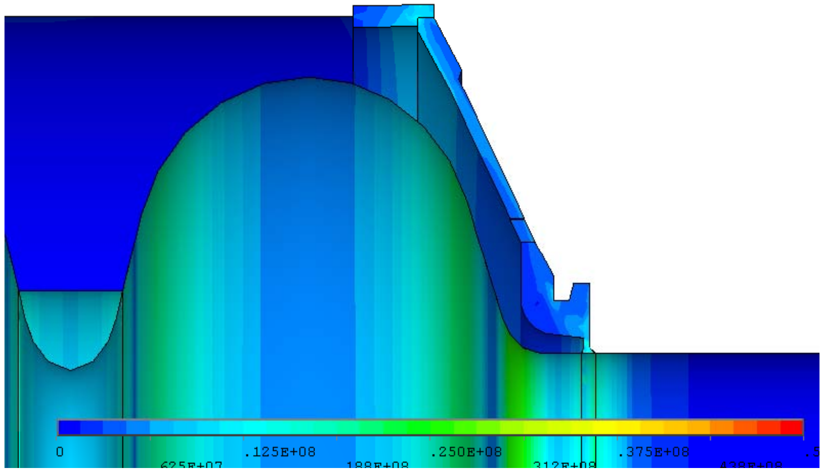
ILC 1.0





ILC 1.3

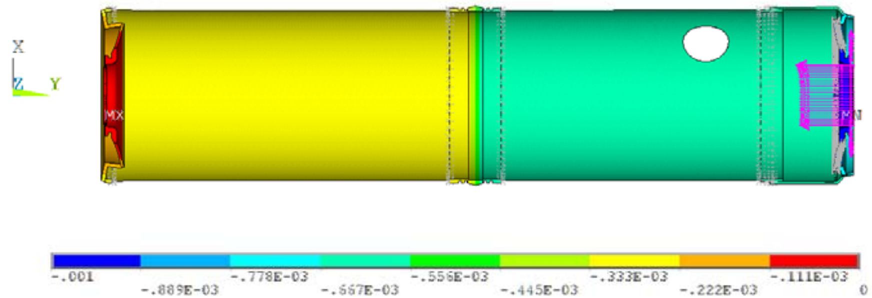




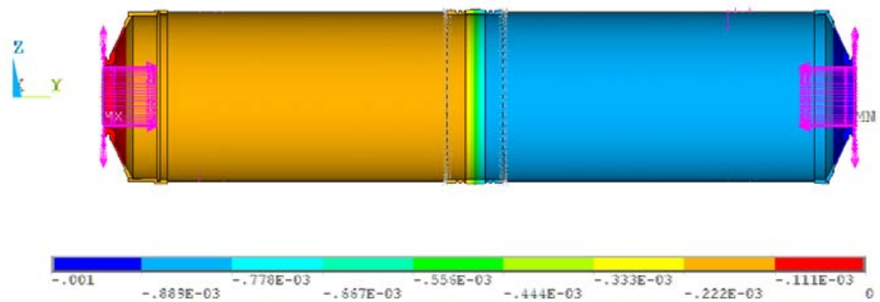
Lorentz force detuning

- **The helium tank + tuner represents the external constraint to the cavity length**
- **The piezo+tuner has been replaced by 3D elements with the same stiffness (22.3 kN/mm)**

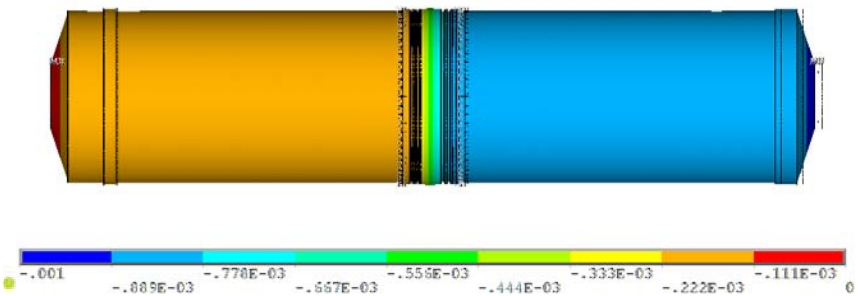
ILC 1.0: K_{ext} = 9700 N/mm



ILC 1.3: K_{ext} = 17500 N/mm



ILC 2.0: K_{ext} = 15300 N/mm

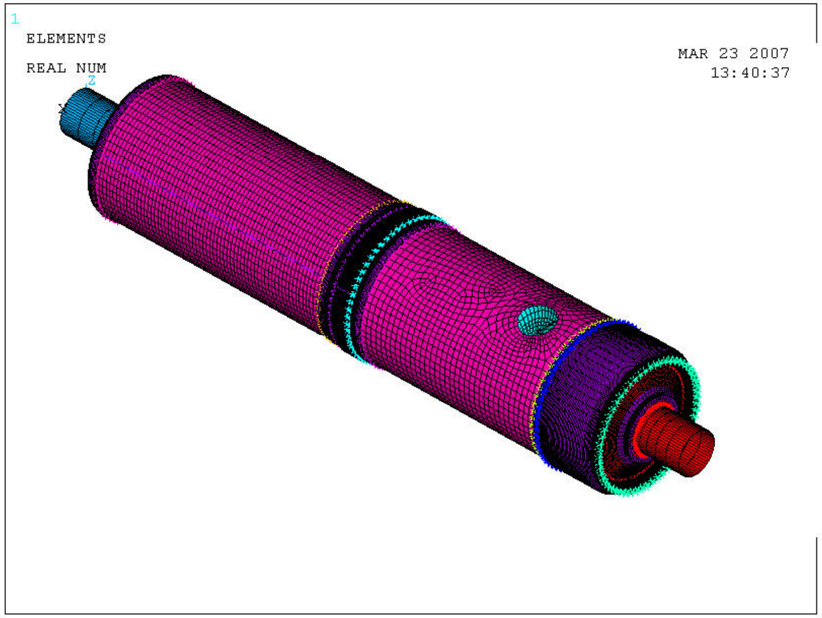


ASME check

- 3D FE model with brick and shell elements
- connections/welds with contact elements

ASME requirements:

- Materials: Ti is considered by ASME, Nb not.
  - for this first check I would use the material characteristics of Nb RRR as obtained by Myneni and Umezawa
- For check at cryogenic temperature, structural properties higher than that at room temperature can not be considered



Load cases:

- From T.P. january presentation:
  - 2bar at warm (only during filling)
  - 4bar at cold (emergency case)
  - 20mar working pressure
- The bellow is tested at 3bar

check of helium tank (Ti Gr2 parts)

- p = 2 bar @ RT
- S_m = 115 MPa; joint efficiency = 0.9→max stress = 1.5*.9*115 = 155MPa

ILC 1.0

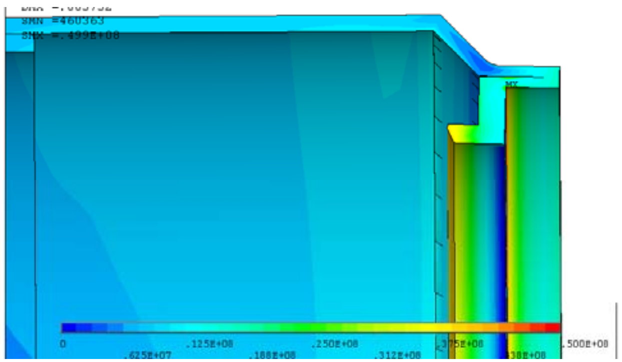
σ_{max} = 47 MPa

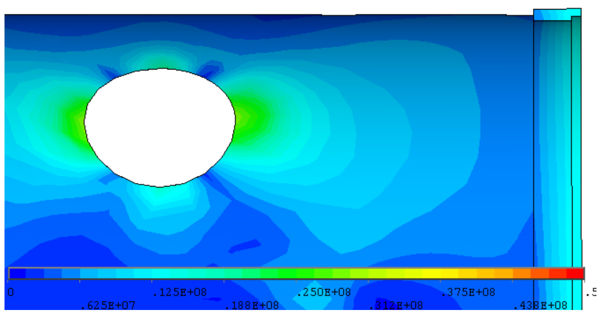
ILC 1.3

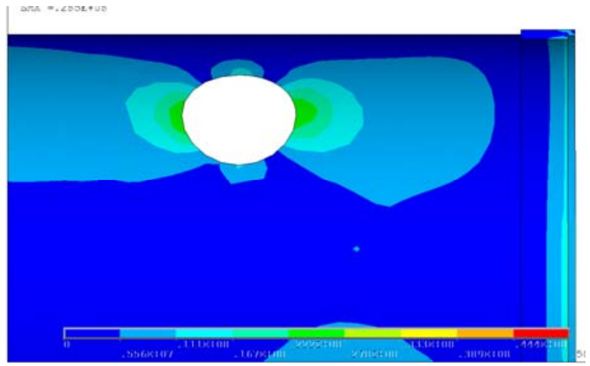
σ_{max} = 30 MPa

ILC 2.0

σ_{max} = 28 MPa







check of end cones (NbTi parts)

- S_m = 200 MPa; joint efficiency = 0.9→max stress = 1.5*.9*200 = 270MPa

ILC 1.0	ILC 1.3	ILC 2.0
σ_{max} = 30.9 MPa	σ_{max} = 21.3 MPa	σ_{max} = 11.6 MPa