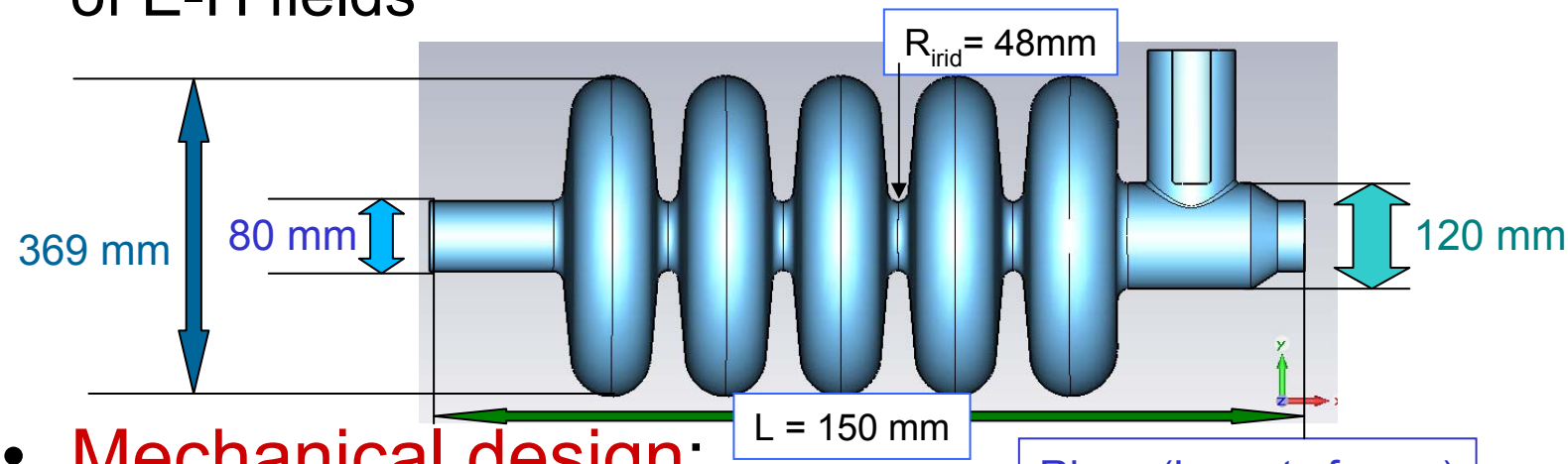
Mechanical design of SPL 704MHz β 0.65 cavity

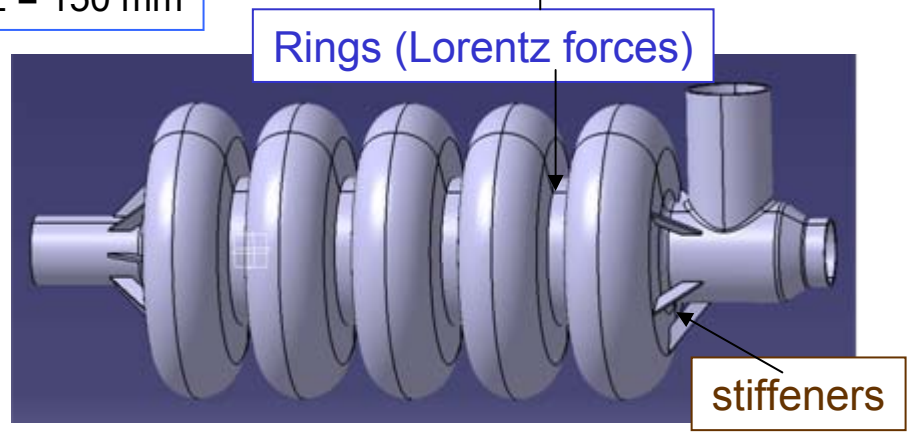
H. Gassot

From RF design to mechical design

- RF design: inner shape of cavity wall from optimization of E-H fields



- Mechanical design:
  - Cavity thickness
  - Pressure sensibility
    - > Stiffeners
  - Lorentz forces
    - > Stiffening rings and optimization of its location



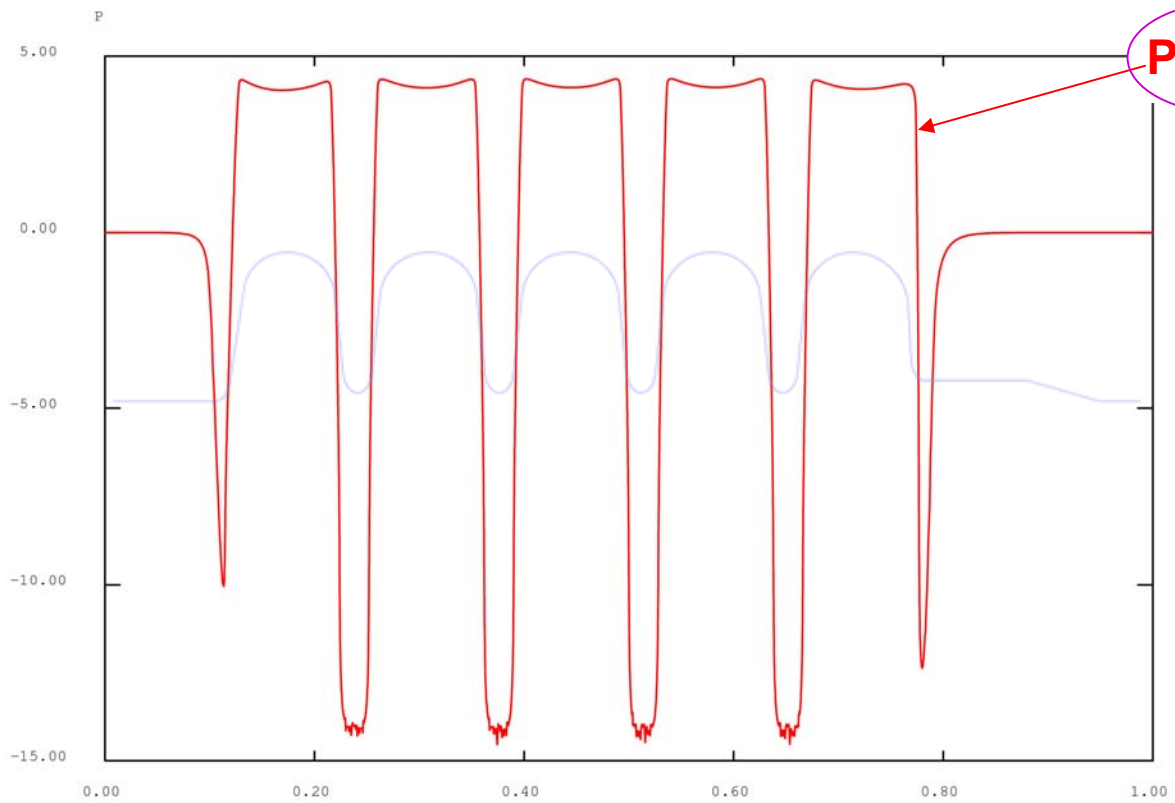
The Criterions

- Stress under 2 Bar at room temperature < 50 MPa
- Mechanical stability
- Frequency Shift due to Lorentz forces < bandwidth

  (Q_{ext}=1.e^6, Q_0=4.e^{10},

  $\Delta f_{1/2} = f_0(1/Q_0 + 1/Q_{ext})$ ~700Hz)

Frequency shift due to Lorentz forces



$P_{radiation} = \frac{1}{4} (\mu_0 H^2 - \varepsilon_0 E^2)$

Simulated by
F. Bouly
with Superfish

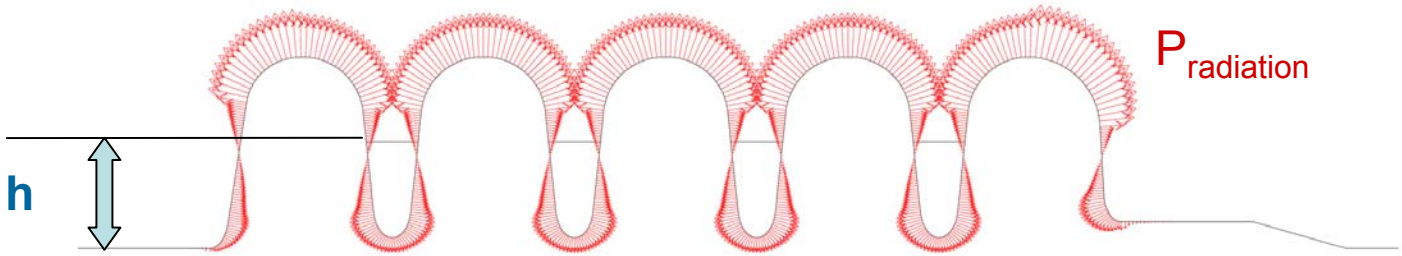
Calculated
with Cast3m

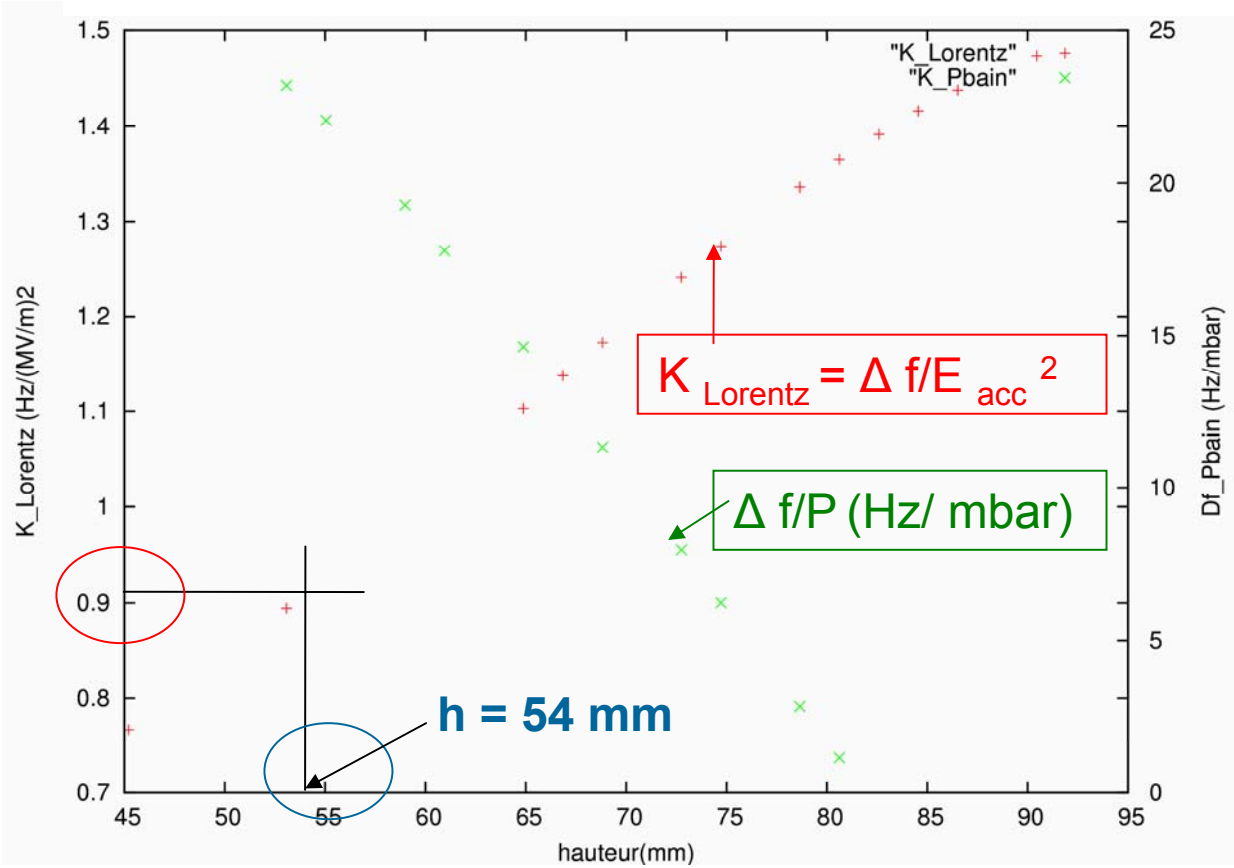
Mechanical deformation

$$\frac{\Delta f}{f_0} = -\frac{1}{4W} \int\int\int (\mu_0 H_s^2 - \epsilon_0 E_s^2) dV$$

$\Delta f = K \times E_{acc}^2$

Optimization of stiffening rings position

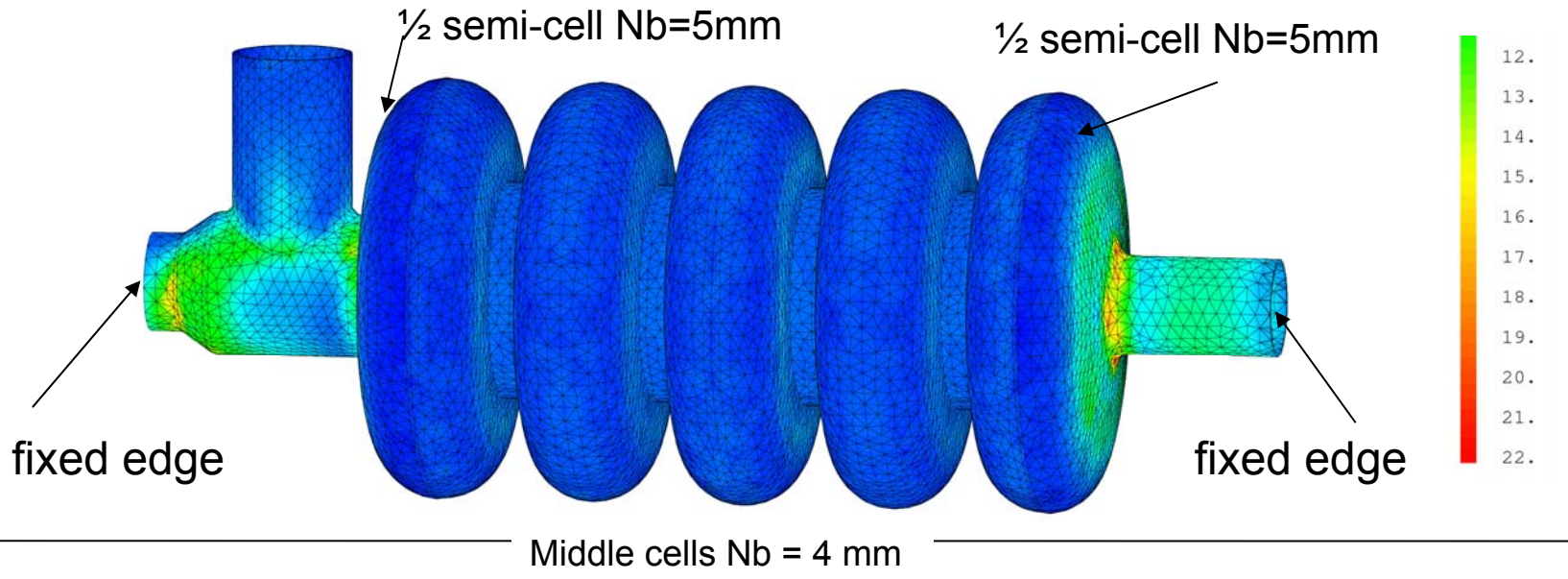




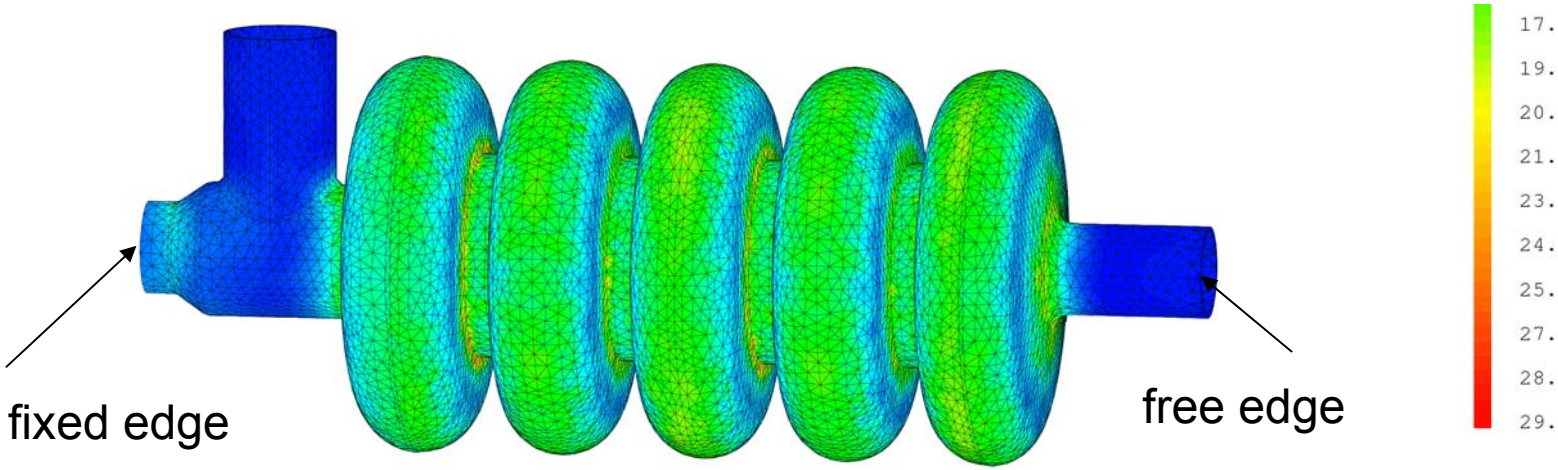
Results from optimization

Parameters	SPL	XADS	Tesla
thickness of cavity wall (mm)	4	4	2.5
Position of stiffening rings (mm) % axis	94		21.5
K_L (Hz/(MV/m) ^{2} without stiffening rings	1.9	2.2	1.53
K_L (Hz/(MV/m) ^{2} with stiffening rings (nb 4 mm)	0.9		0.8
K_p (Hz/mbar) with stiffening rings (nb 4mm)	23		9.5
Stiffness (N/mm) without stiffening rings	1111		1700
Stiffness (N/mm) with stiffening rings (nb 4 mm)	3396		3418

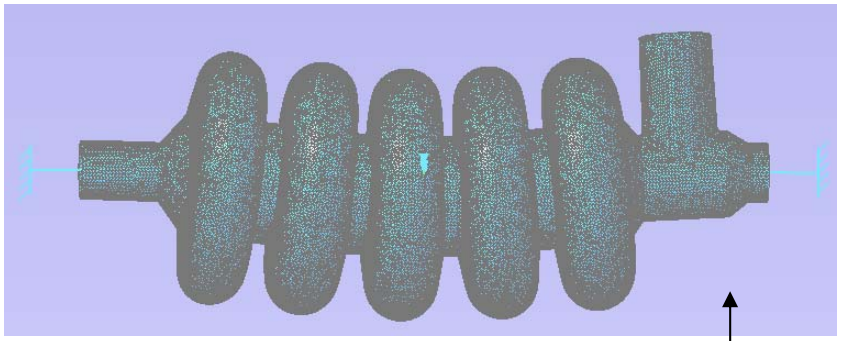
Cavity under 2 Bar at T_{300k}

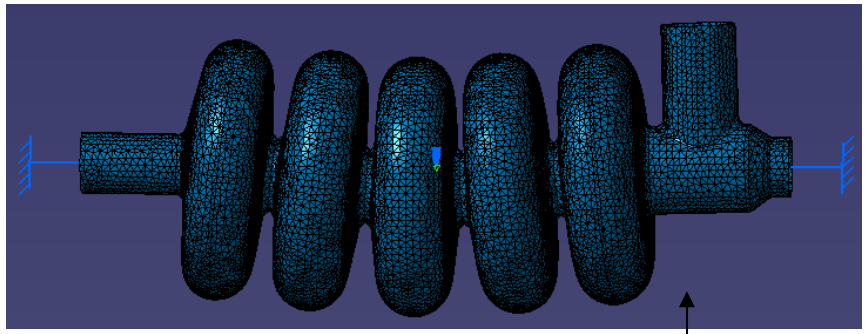


Middle cells Nb = 4 mm



Mechanical vibration modes





Mode (Nb 4 mm)	with rings	without rings
1	77 Hz	61 Hz
2	79 Hz	62 Hz
3	146 Hz	118 Hz
4	148 Hz	125 Hz
5	168 Hz	126 Hz
6	172 Hz	143 Hz

Next

- Integration of cavity into helium tank
  --> presentation of G. Olry and S. Rousselot