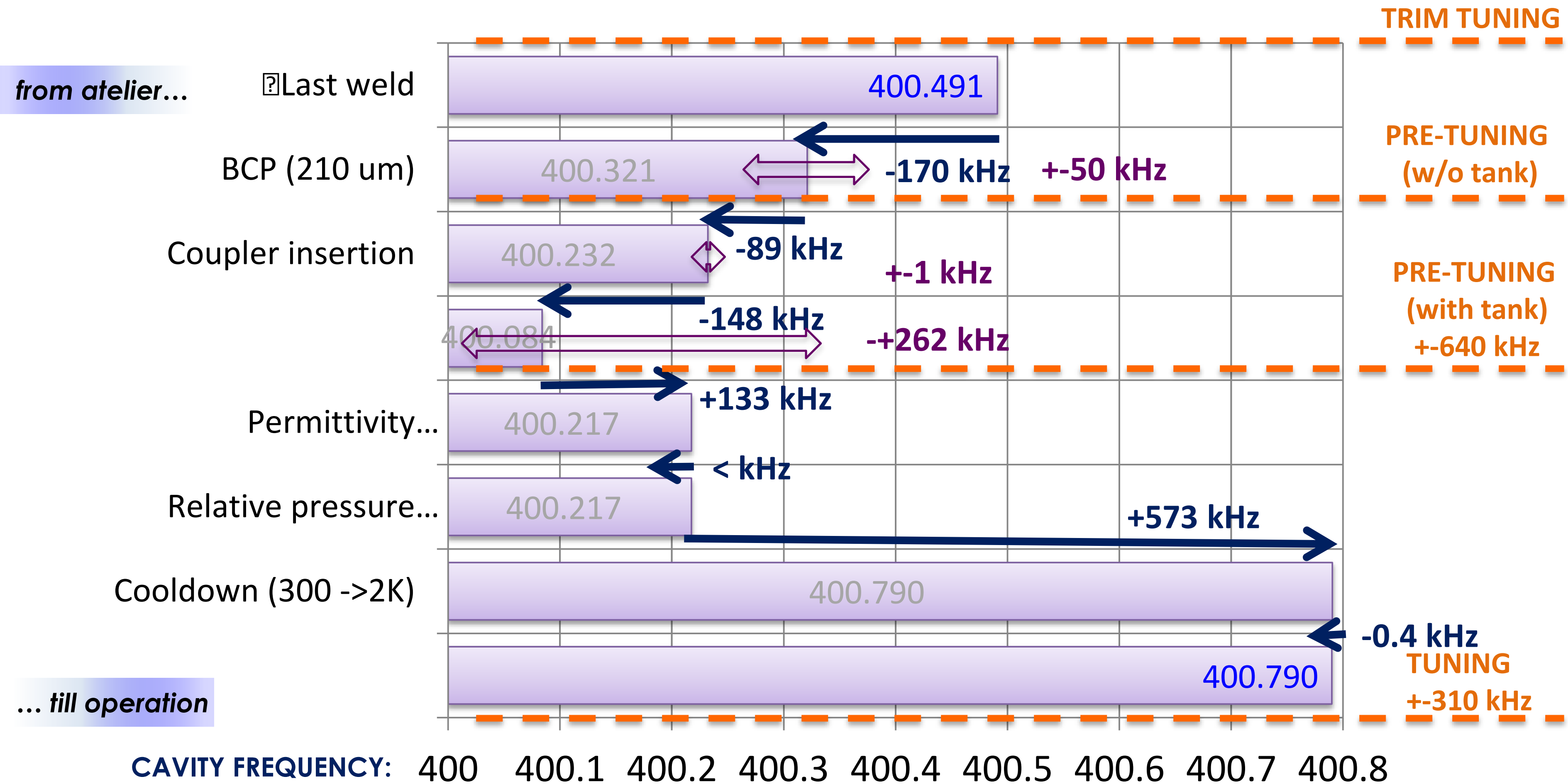
Alternative tuning methods for a DQW crab cavity

Expected frequency evolution – *from atelier till operation*



STUDY a) *Tuning by squeezing cavity waist*

Main characteristics:

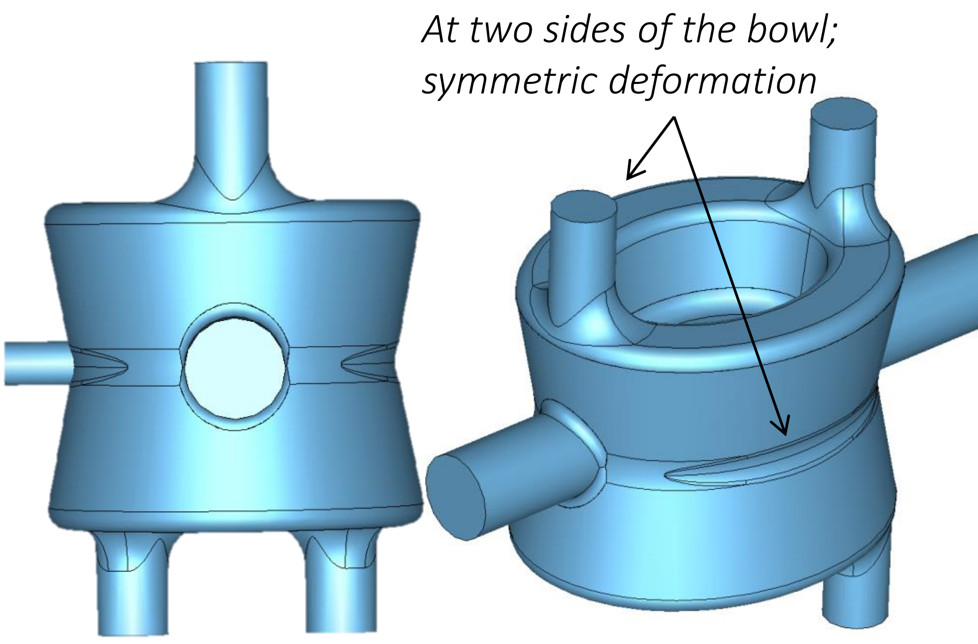
- Use of belt.
- Can be performed before welding the last wall of the helium vessel.

Body used to simulate deformation:

- Ring torus [r=Rmi-1 mm, R = Rma+30 mm, C=(0, 0, 0) mm] and scale factor of 1.28 in x on outer walls.
- Deformation max. depth 1 mm.

Tuning range: **0.11 MHz/mm**

- +115 kHz for max. deformation of 1 mm



STUDY b) *Tuning by pressing on internal walls of bowl*

<u>Main characteristics</u>:

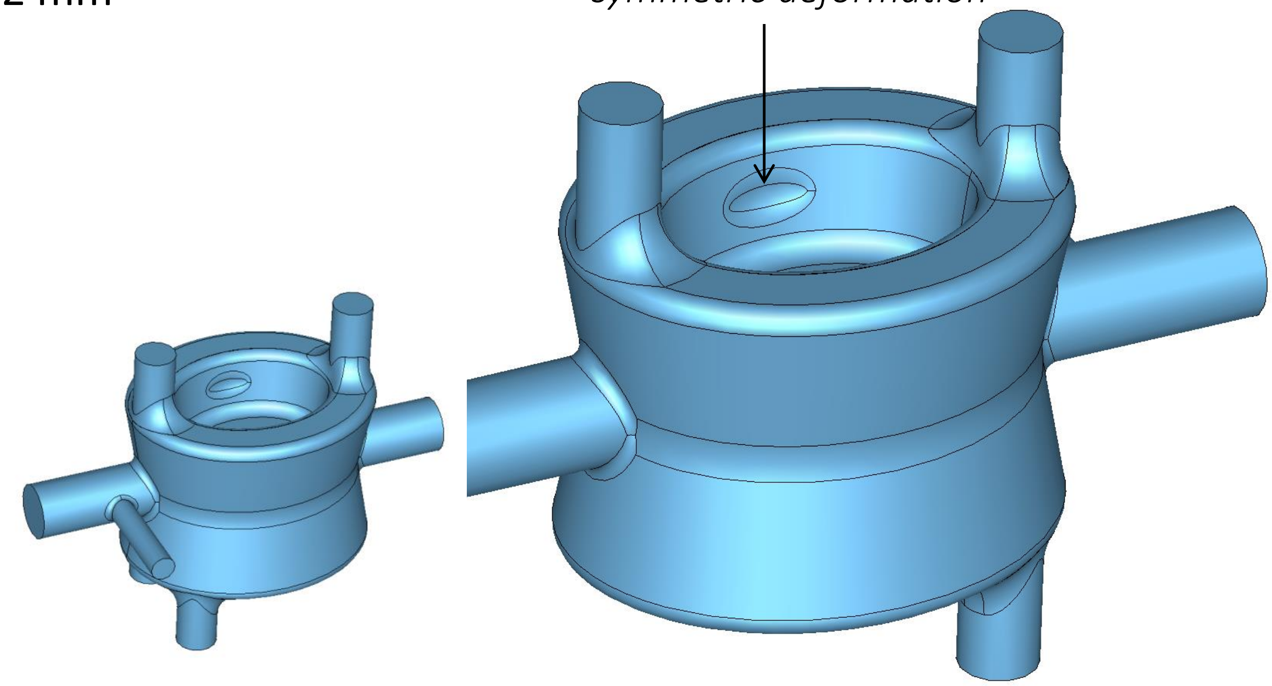
- Unidirectional tuning

Body used to simulate deformation:

- ring torus [r=25 mm, R = 88 mm, C=(0, 95, 0) mm] – deformation depth is 3.2 mm
- At two sides of the bowl; symmetric deformation

<u>Tuning range</u>: **0.03 MHz/mm**

- +81 kHz by pressing on (both) internal walls of bowl when deformation depth is 3.2 mm



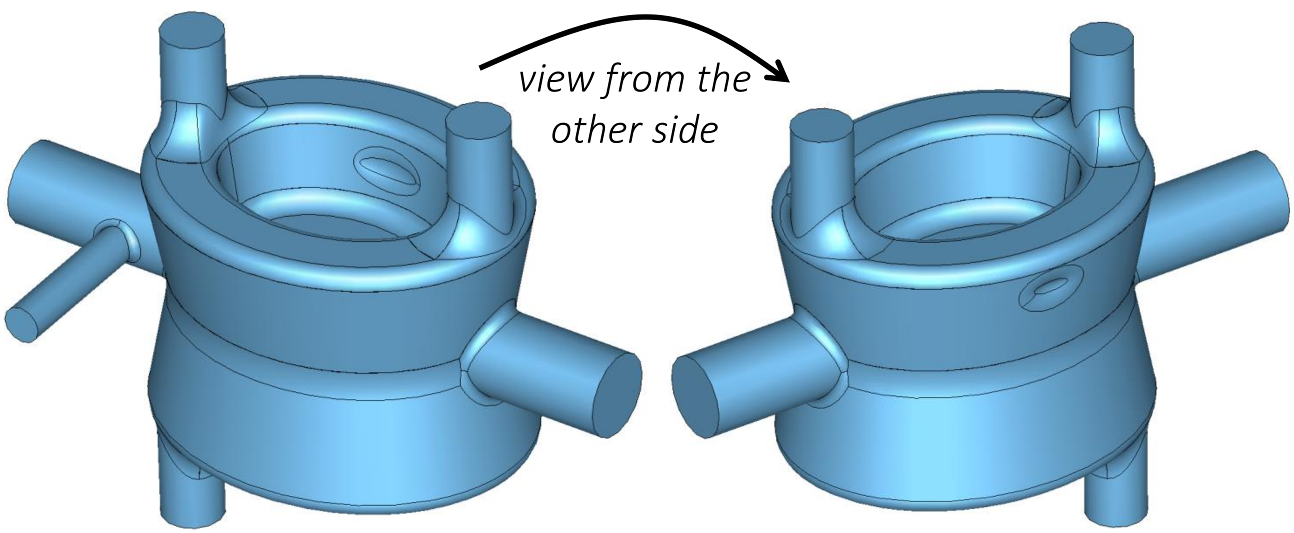
STUDY c) *Tuning by clamping inductive region*

Bodies used to simulate deformation:

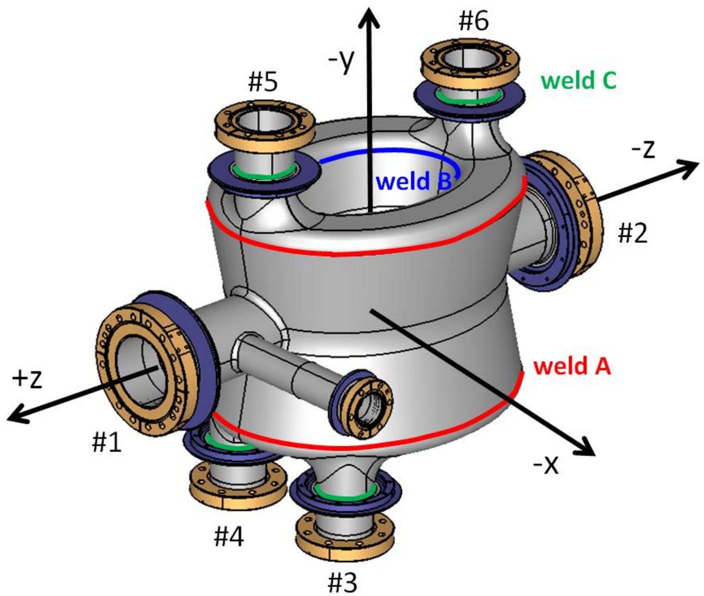
- INTERIOR BOWL : Ring torus [r=25 mm, R = 88 mm, C=(0, 95, 0) mm] – deformation max. depth 3.2 mm;
- OUTER WALL: Ring torus [r=60 mm, R = 95 mm, C=(0, 92, 245) mm] – deformation max. depth 5.4 mm

Tuning range: **0.03 MHz/mm**

- +85 kHz by clamping in inductive region for max. deformation depth of 3.2 mm in interior wall and max. deformation depth of 5.4 mm in outer wall.

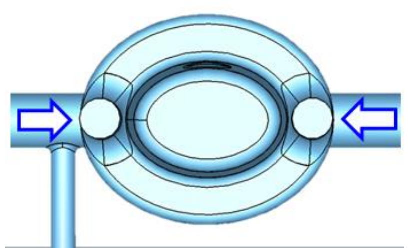


STUDY #4 - *Tuning by pulling/pushing beam pipes*



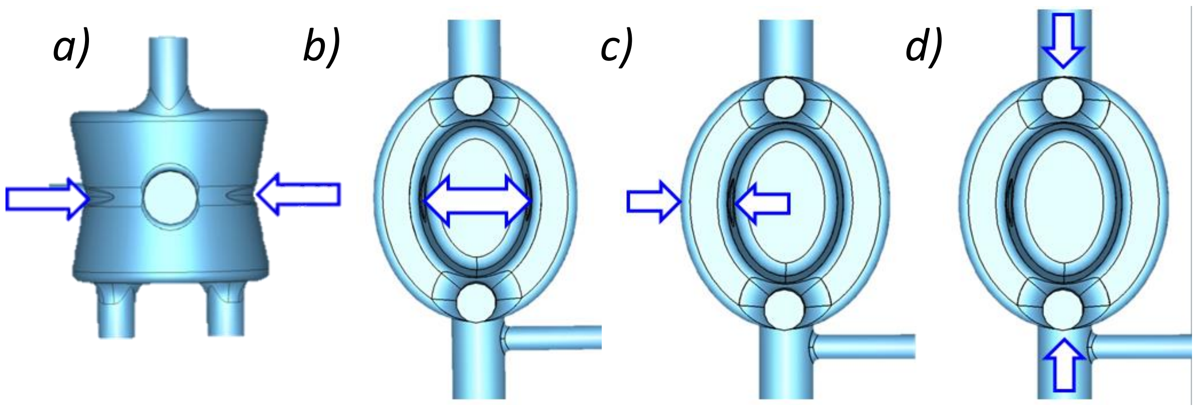
Applied displacement [mm] *to cavity ports and calculated new frequency* [kHz] (ACE3P):

$$\Delta f = 140(d_1 - d_2) + 580(d_3 + d_4) - 800d_5 - 380d_6$$



0.14 MHz/mm

Summary I



0.11 MHz/mm **0.03 MHz/mm** **0.03 MHz/mm** **0.14 MHz/mm**

e) re-weld

Any other method that I did not mention?

Summary II

- Further studies needed to:
    1) evaluate feasibility of deformation given the stiffness of the cavity and
    2) determine how other regions will deform in basis of the method used to cause the required deformation and the support points chosen.

- The tuning range should be re-evaluated for a cavity model with a realistic deformation.

- Additional RF simulations need to be performed to analyze electric field offset, multipoles, HOMs, etc.

- Need to define the characteristics of a tool capable of performing such kind of deformations.

Others - MIP

- Need CERN to review (removed steps about tooling, added resonator frequency controls): https://edms.cern.ch/document/1569808/3

  → In parallel, construction of “Niowave cavity parts MIP”

Back-up

#4 – Modify FPC

Penetration and rotation of FPC coupler

One of the optimization goals for the FPC hook design was to provide a FPC hook shape with reduced sensitivity of the coupling to assembly tolerances. In consequence, the frequency shifts associated to the assembly of the FPC are small: a penetration change of +-0.5mm, or a displacement of +-1mm in x or z direction or a rotation of up to +-15 degrees only shifts the cavity frequency by 1 kHz at most. These parameters are shown in Fig. ##. The coupling and the dissipated power are however pretty sensitive to some of these parameters, being particularly sensitive to the hook penetration, the displacement of the coupler in x direction and the hook rotation. The dissipated power increases by about 6 Watts for a penetration variation of +-0.5 mm, about 1.6 Watts for a displacement of +-1 mm in the x direction and about 0.8 Watts for a rotation of +-15 degrees. Table ## summarizes these values. The variation of the FPC assembly parameters is therefore not recommended for tuning the cavity frequency, as it provides a very small tuning range at expenses of increasing the dissipated power in the coupler, a critical aspect due to the heat load limitations for this project.

#5 – Rotation of HOM filters (from B. P. Xiao)

The rotation of HOM couplers by 5 degrees only changes the fundamental frequency by 1 kHz. The tuning sensitivity is low and the rotation may have an undesired impact on the impedance spectrum. Therefore this tuning method is not recommended.