EUROTRANS

- EUROPEAN RESEARCH PROGRAMME FOR THE TRANSMUTATION OF HIGH LEVEL - NUCLEAR WASTE IN AN ACCELERATOR DRIVEN SYSTEM

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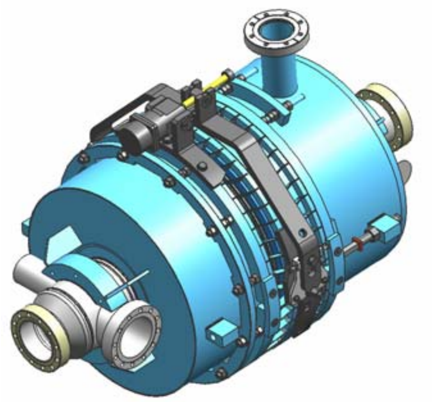

STATUS OF THE PREPARATION OF THE ELLIPTICAL CAVITY SYSTEM FOR THE EUROTRANS CRYOMODULE

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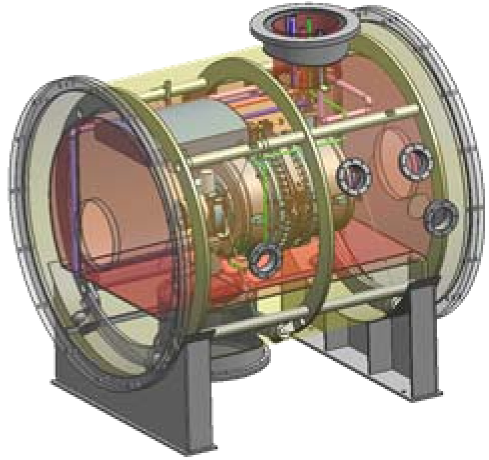
Outline

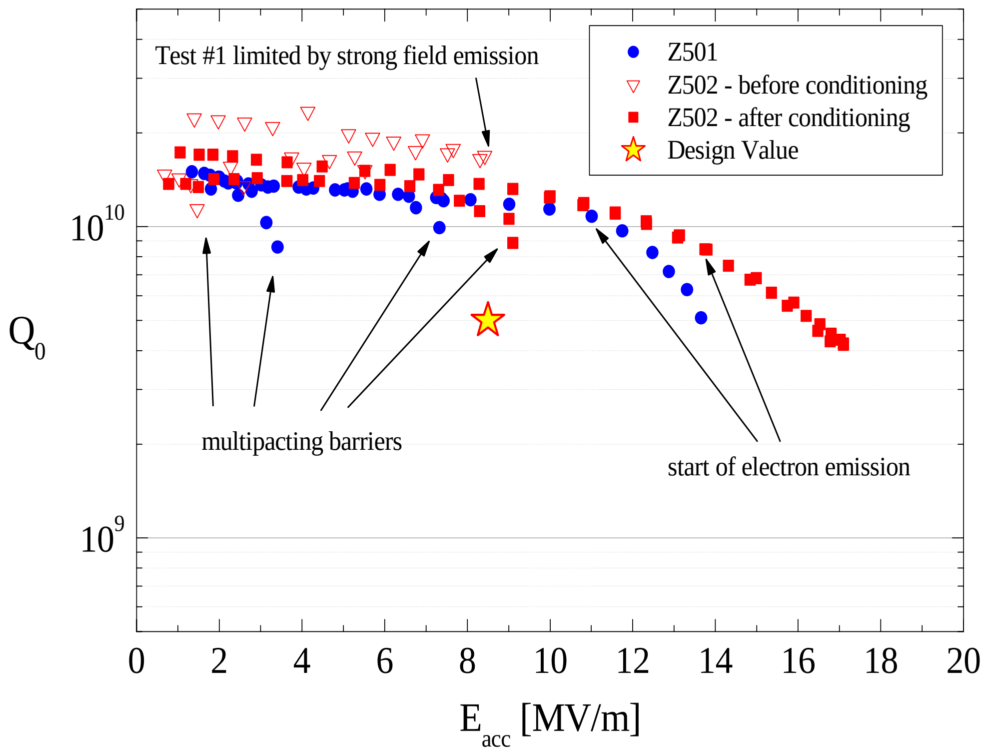
- TRASCO cavity
  - Experimental tests
  - Requirements for the external components
- Helium tank and tuner system
  - Design
  - Reliability
- Preparation for horizontal tests

The TRASCO cavities



2 cavities TRASCO β=0.47 for proton (90 a 200 MeV)

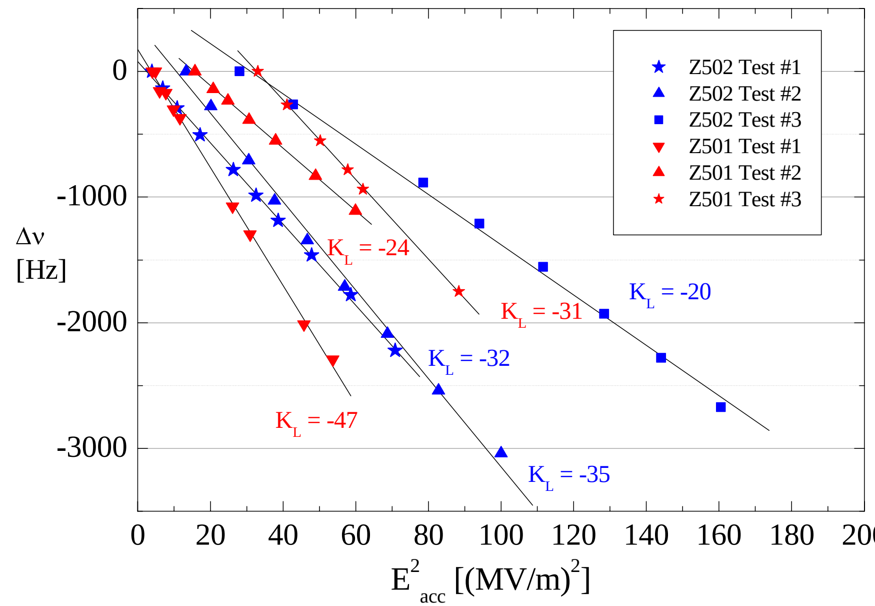
Successfully tested up to 17 MV/m (design requirement 8.5 MV/m)



Cavity requirements

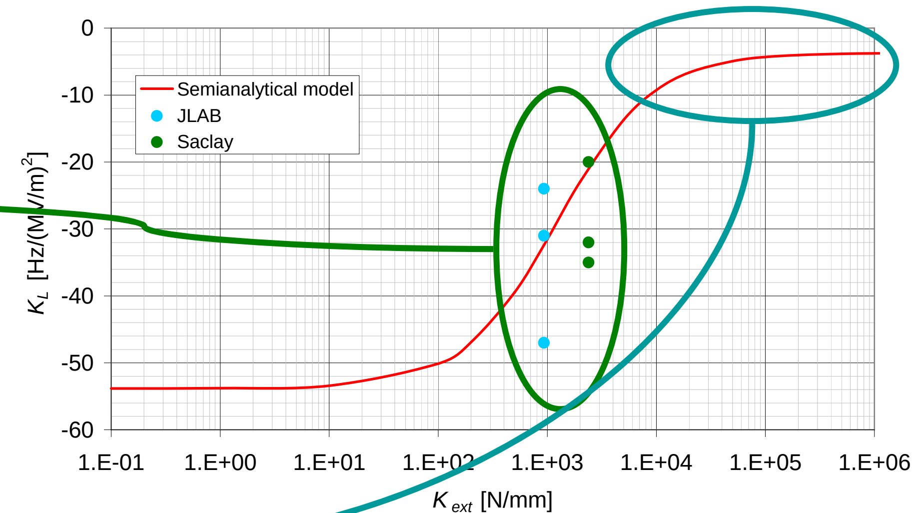
$$K_L = K_L^{\infty} + \frac{\partial f}{\partial z} \frac{F^{\infty}/E_{acc}^2}{K_{ext} + K_{cav}}$$

During the tests the Lorentz force detuning (LFD) coefficient was derived: the values obtained were larger than expected and with a relevant spread



This is mainly due to the uncertainty of the external constraints applied to the cavities during the tests

Big sensitivity of the cavity to the external constraint stiffness

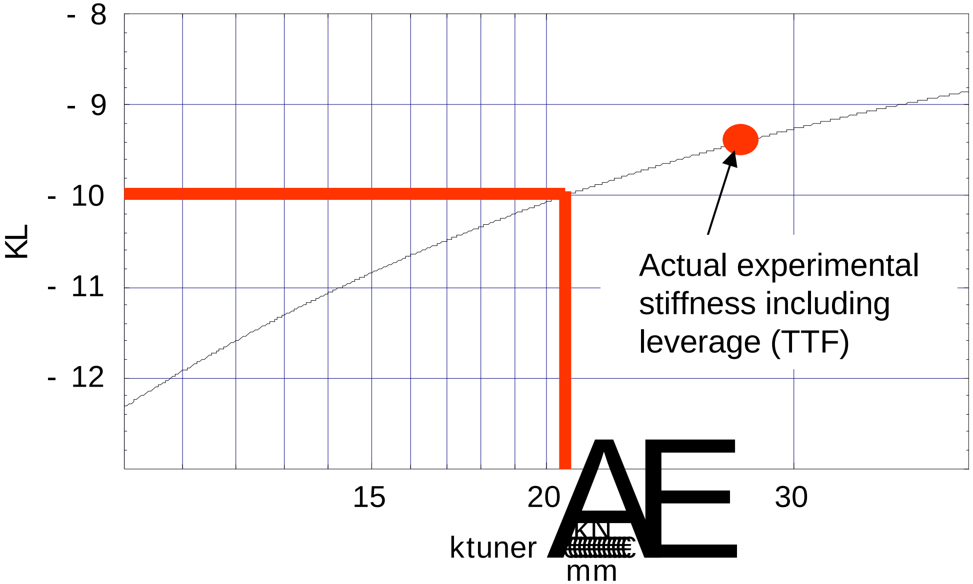


We should operate here:
$|K_L|<10$ Hz/(MV/m)$^2 \Rightarrow K_{ext} > 9$ kN/mm

Tuner and helium tank design

- Tuner and HT have been designed with this goal in mind:
  - Fulfill the cavity requirements in terms of external stiffness and tuning range
  - Reliable
  - Simple (assembly and preparation)
  - As cheap as possible

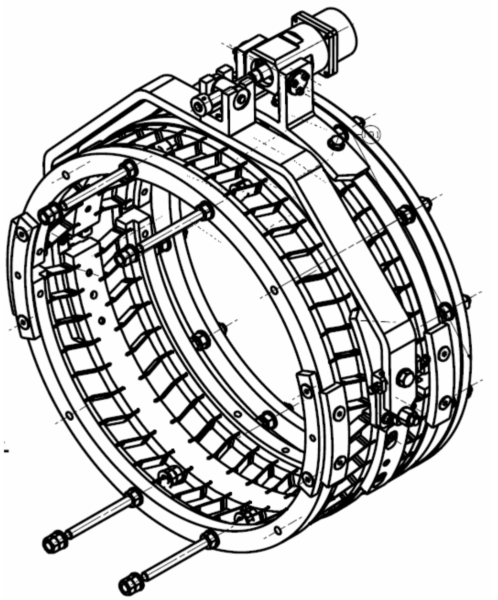
- Our starting point from the experience in TTF
  - The HT is simpler than the HT in TTF
  - Assembly easier
  - The tuner has the same components as the TTF blade tuner already tested



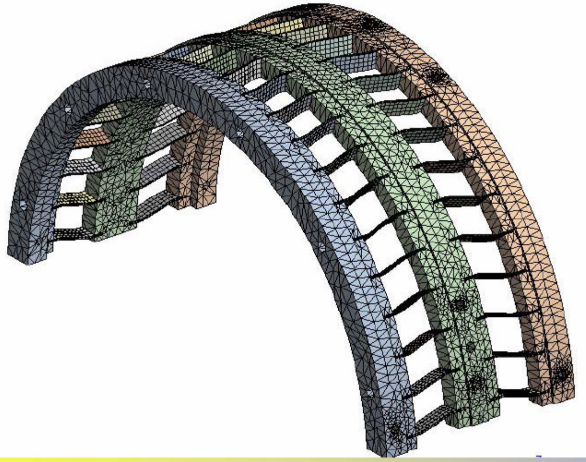
Tuner and helium tank design

The tuner consists of three main components:

- the rings-blades assembly, made of titanium;
- the leverage mechanism, in stainless steel 316L and brass MS58, that drives the rings-blade assembly movements;
- the piezo actuator part, that provides the fast tuning action necessary for compensation under pulsed operation.



- Design by Finite Element Method:
  - Rings and mechanism considered separately
  - Stiffness in different boundary conditions



Tuner design: stiffness

Finite element results:

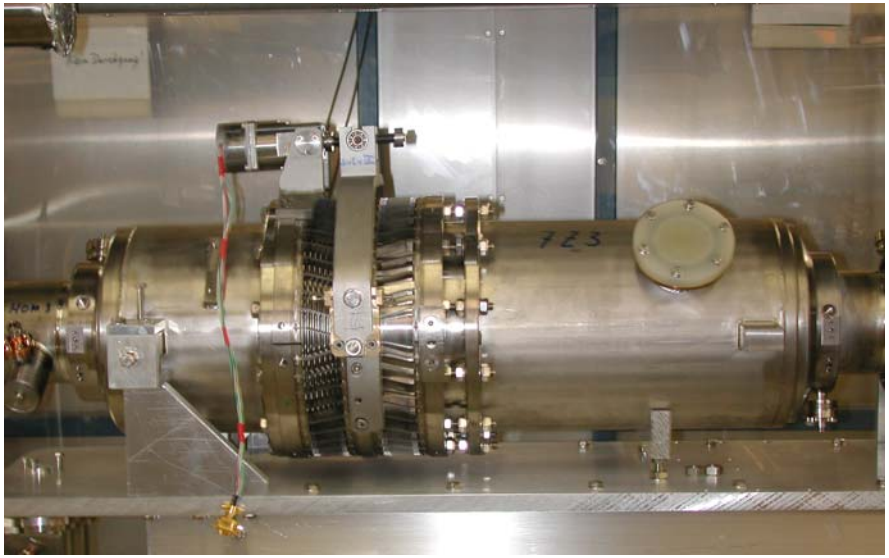
- central ring free (without leverage): K_T = 2.4 kN/mm
- central ring with leverage (working condition): K_T = 52.3 kN/mm

- Compliance of the motor and of the bearings was not considered
- Lacks and slack joints can not be included consistently in the FE analysis

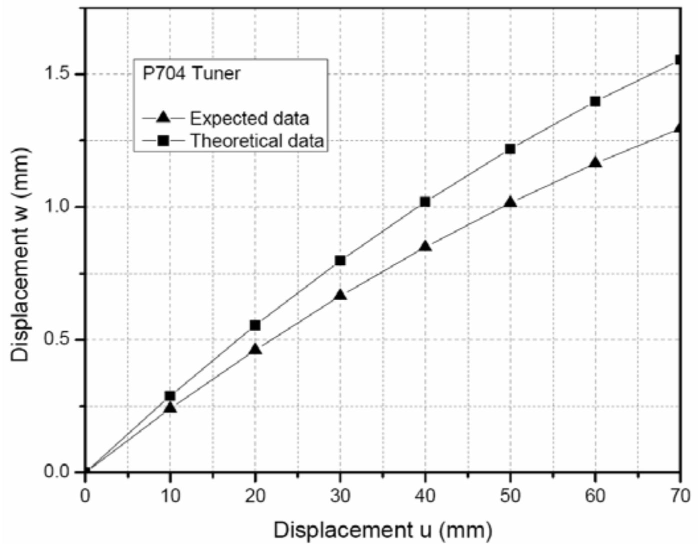
It seems convenient to use as reference for the whole tuner stiffness the value which has been measured experimentally (25 kN/mm) on the proven TTF tuner.

Tuner design: tuning range

TTF blade tuner

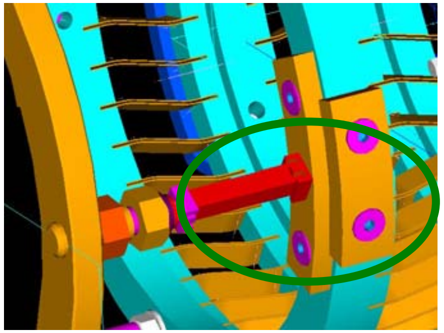


Slow tuning action



maximum elongation of approximately 1.3 mm that corresponds to a cavity stretching of 1.2 mm (≅400 kHz)

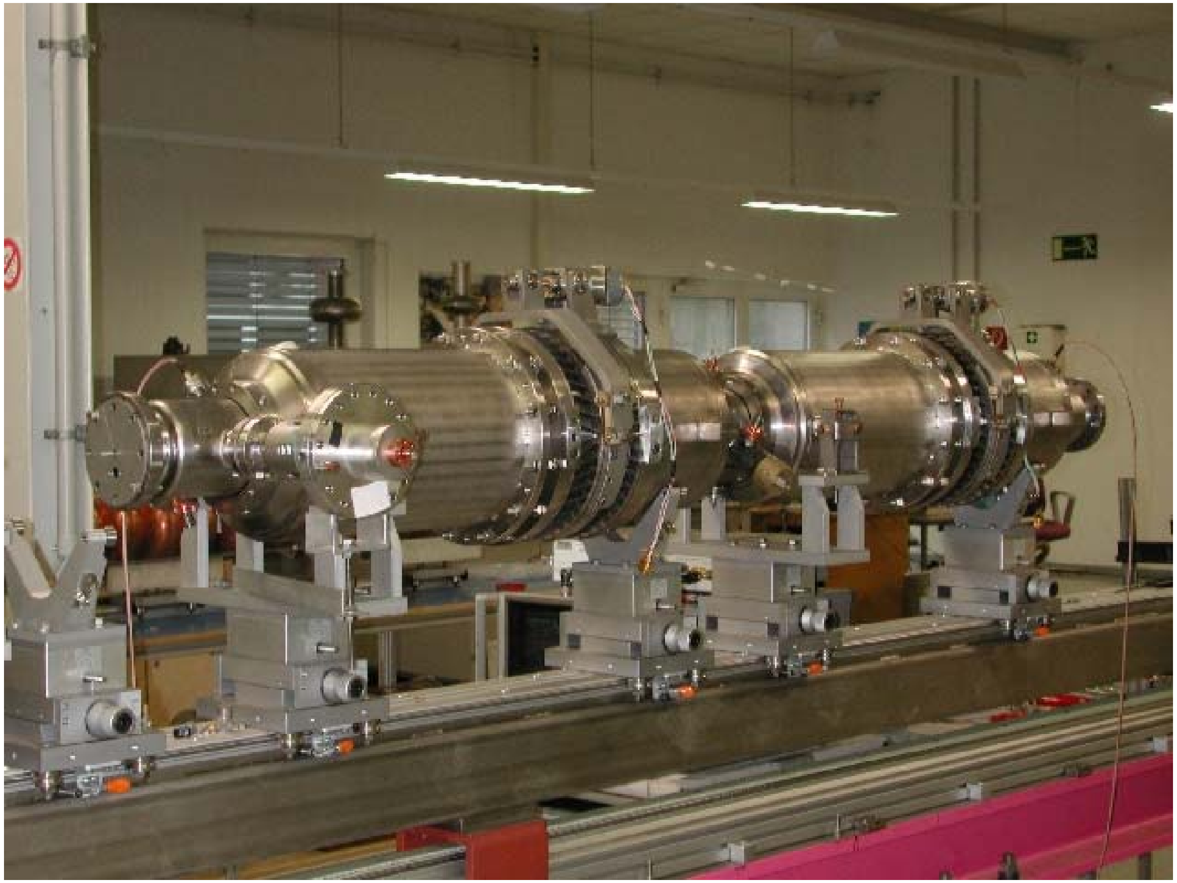
Fast tuning action



2 piezo elements, stroke depends on their length.
For L = 40 mm we expect more than 2μm of displacement (> 700 Hz)

Tuner reliability

- The components of the blade tuner (motor, ball bearings, harmonic drive) are continuously tested in TTF
- Used also for the Saclay tuner, we can get all the experience of the last 10 years.
- 4 TTF blade tuner installed on superstructure were tested at Desy
- We have 2 TTF blade tuner and 2 HPPA blade tuner ready for test



TTF Cavity Tuner Life Time Tests at 2K (courtesy R. Lange)

Results of 3 performed tuner long term(lifetime) tests **Status:May-1998 R. Lange –MKS-**

After 23 000 000 motorsteps warm up and cool down

System Nr. 1 **90 000 000 motor-steps**
==>Tests performed without problems
Inspection:No damages on the system

System Nr. 2 **50 000 000 motor-steps**
==>Test stopped because uneven run (fr, Video)
Inspection:Slight damages on the motor ball bearings

System Nr. 3 **70 000 000 Motor-Steps**
==>Test stopped because blocked drive(fr, Video)
Inspection:Strong damages on the motor ball bearings
Strong damages on the wave generator

Summary: **After these long term tests we knew, the motor ball bearings are the weakest parts of the tuner!**

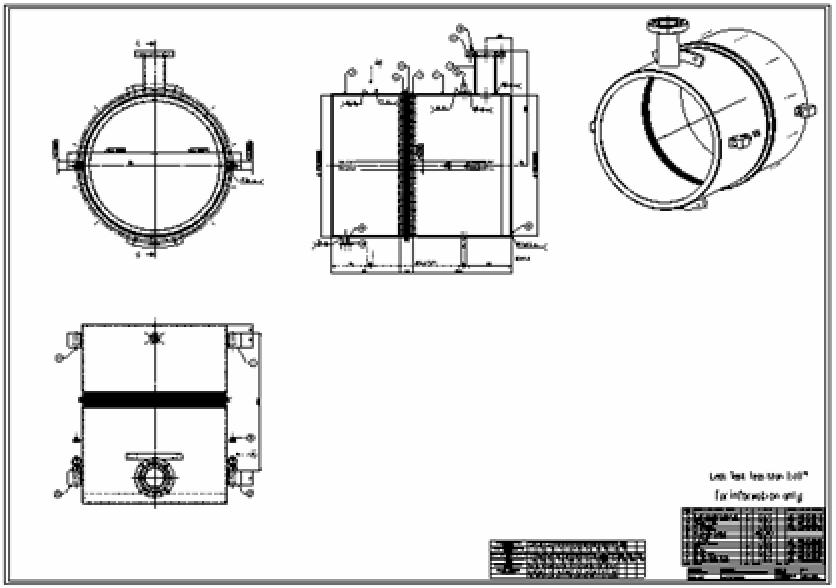
But:Assuming the linac will be cooled down and warmed up 2/year, we can do the following life time estimation:

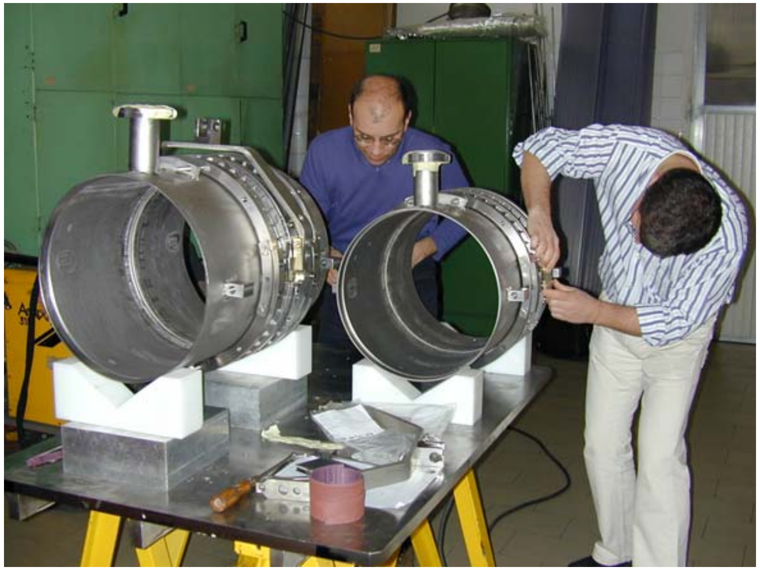
-Tuning to 2K-resonance(ca.340 kHz)	450 000 motor-steps
-Fine tuning at 2K (total)	300 000 motor-steps
-Tuning to 300K-position(ca.340kHz)	450 000 motor-steps
==>Amount for 1 cold/warm cycle	1 200 000 motor-steps
==>Amount for 1 year	2 400 000 motor-steps
==>Expectation life time 20 years	**48 000 000 motor-steps**

Tuner and helium tank construction

Status of tuner and HT construction

- Construction finished
- Delivery in time
- Assembled in our lab for test at RT

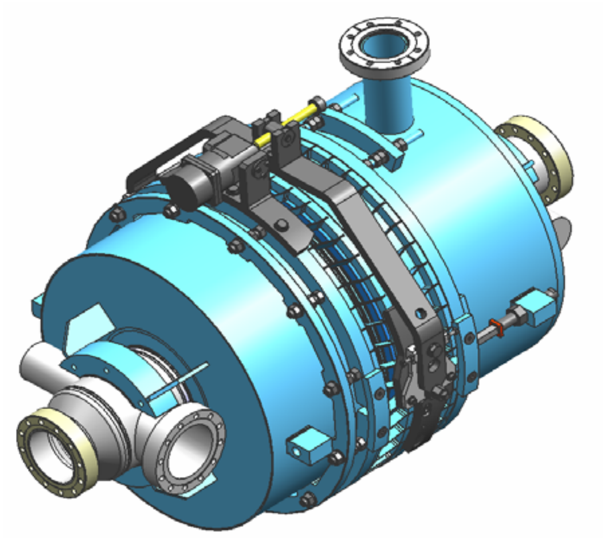


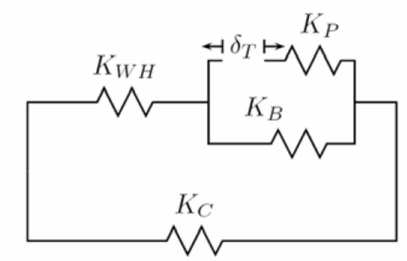


Dressed cavity

Part	Axial stiffness	c (µm/kN)	k (kN/mm)
Helium tank	K_H	1.17	856
End dishes	K_W	63.4	15.7
Bellow	K_B	3205	0.312
Blade tuner	K_T	40.0	25.0
Piezo PIC255	K_P	4.176	2x105

From the mechanical point of view, the dressed cavity can be described as a spring system





$$1/K_{ext} = 1/K_H + 1/K_T + 1/K_W + 1/(2K_P) \rightarrow K_{ext} = 9.2 > 9 \text{ kN/mm}$$

The external stiffness satisfies the cavity requirement

Cavity preparation for test

- The cavity frequency at room temperature should be 702.8 MHz in order to have 704.4 MHz at cold
- Cavity stretched from 699.9 to 702.1 Mhz
- Field flatness not so bad: final stretching and field flatness adjustment after the heat treatment in a vacuum furnace at CERN
- Leak rate test performed after the cavity tuning. No leaks observed.
- The cavity will be shipped in the next days to CERN
- A chemical treatment is foreseen at Saclay after the last tuning

Conclusions

Conclusions/Scheduling

- The tuner and helium tank have been designed to fulfill the cavity requirements in term of stiffness and tuning range;
- Reliability based on test performed on the TTF blade tuner, which share the same design
- The tuner and helium tank are ready
- Low power test foreseen beginning 2008, after cavity preparation and assembly in the HT