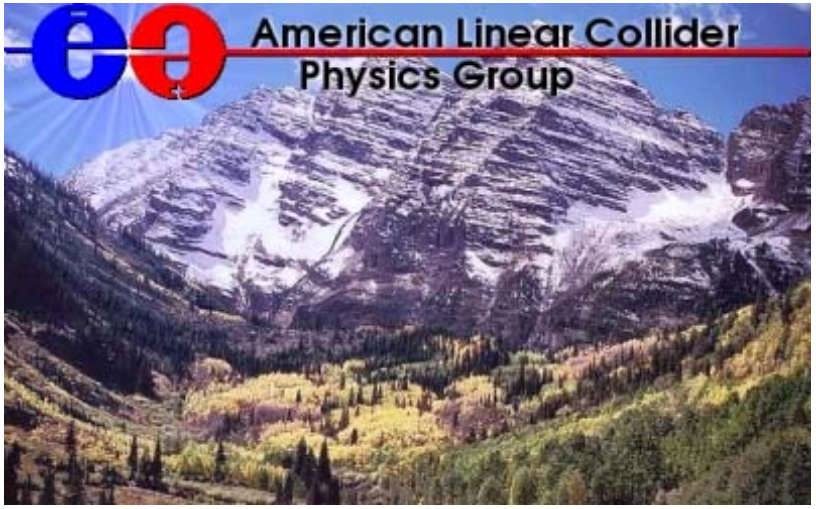


2005 International Linear Collider Physics and Detector Workshop
and Second ILC Accelerator Workshop
Snowmass, Colorado, August 14-27, 2005

TTF Tuner Development: Saclay and INFN-Blade

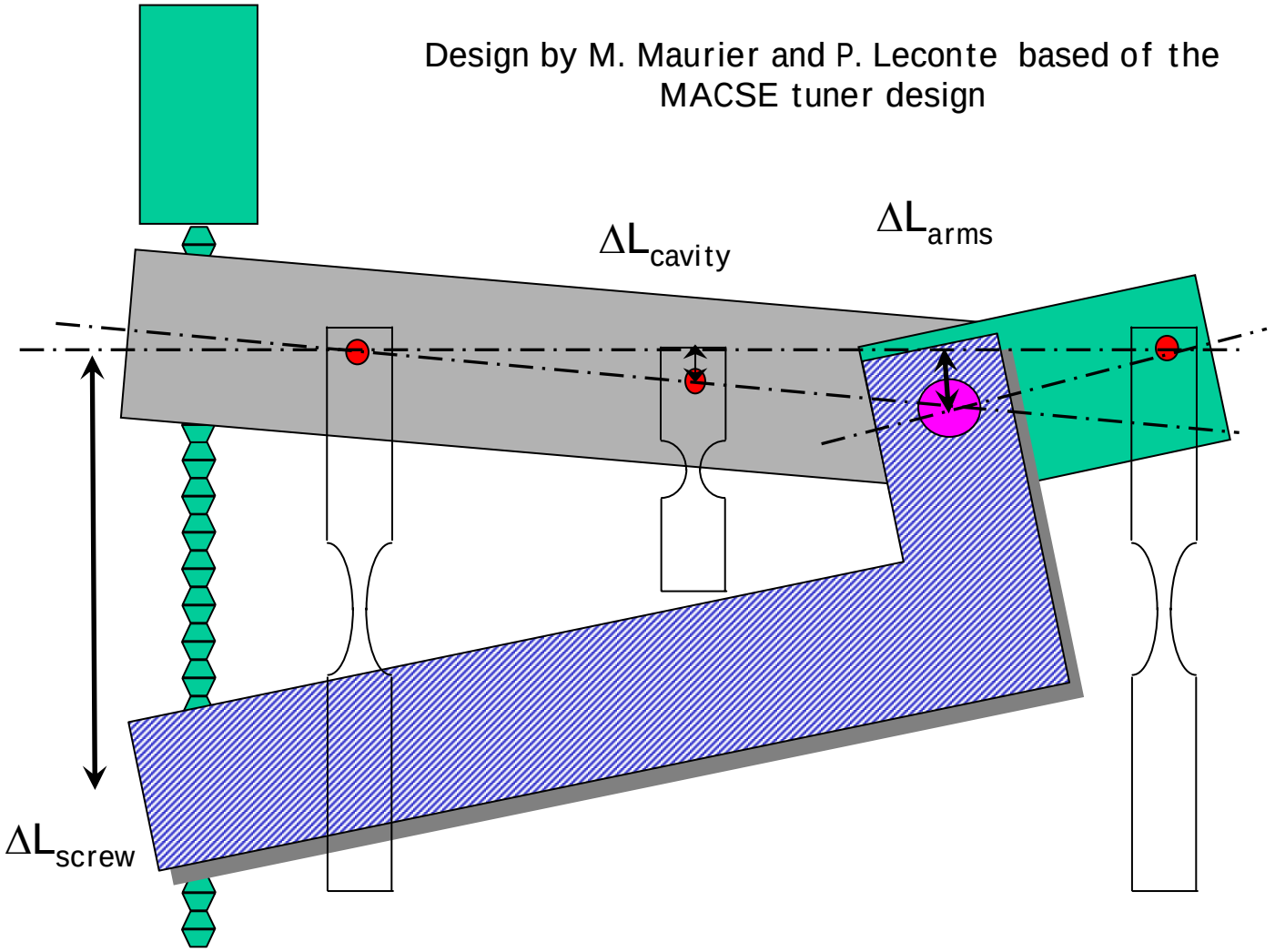
Carlo Pagani

INFN Milano and DESY

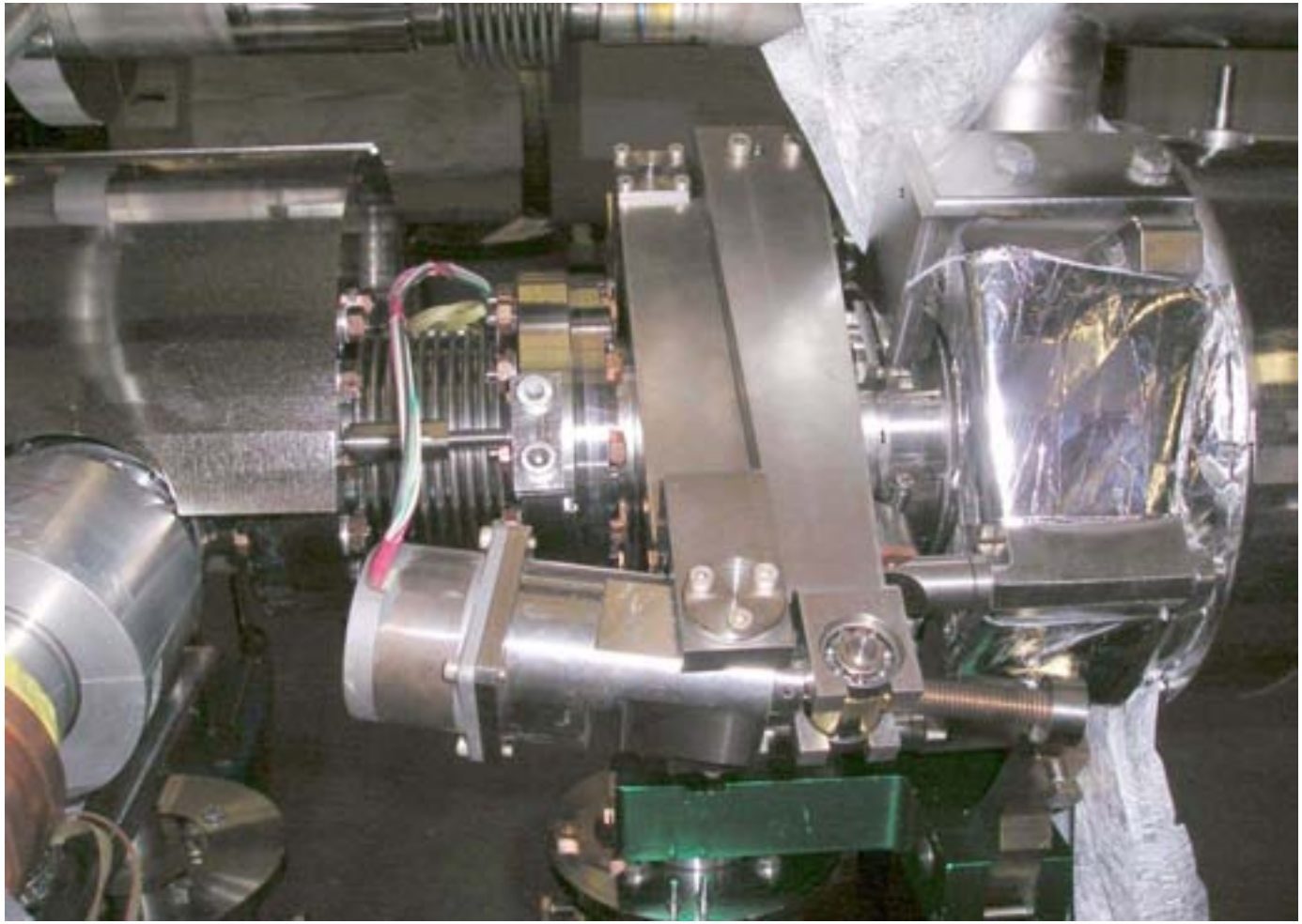
On leave from University of Milano

The TTF Saclay Tuner: Operation Principle

Design by M. Maurier and P. Leconte based of the MACSE tuner design



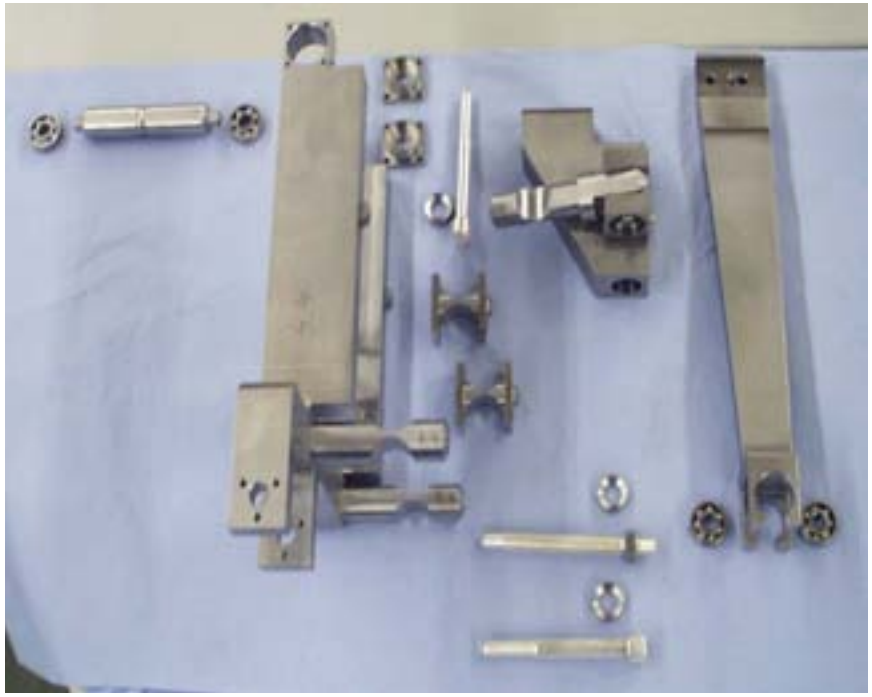
The TTF Saclay Tuner - 1



The TTF Saclay Tuner - 2

Tuner parameters and Details

- Double lever system: ratio ~ 1/25
- Stepping motor with Harmonic Drive gear box
- Screw – nut and gearbox system: surface coating (balzers Balinit C coating) for working at cold and in vacuum
- ball bearings with lubricant Lamcoat
- Δz_{max}= 2 mm
- ΔF_{max} = 830 kHz
- theoretical resolution: Δz = 1.5 nm or 0.74 Hz
- calculated stiffness: 180 kN/mm (measured : 100 kN/mm)



Long Term Experience in TTF

total amount in million motor steps - averaged per module

Status: 15-Mar-05 R. Lange MKS

Module cycl. c/w months c	M1 5 17	M2 3 44	M3 1 35	MSS 3 14	M1* 2+(1) 8+(12)	M2* (1) (12)	M3* 1+(1) 3+(12)	M4 1+(1) 3+(12)	M5 1+(1) 3+(12)
add carry steps	0.0	0.0	0.0	0.0	9.9 M1	9.3	6.1	0.0	0.0
prepare at 300 K	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.2	0.2
CHECHIA 4K/2K	3.8	3.8	3.8	2.8	0.0	0.0	0.0	2.8	2.8
module assembly	0.2	0.2	0.2	0.5	0.2	0.2	0.2	0.2	0.2
TTFLinac 4K/2K	5.7	5.1	1.9	0.5	5.7	0.8	2.3	1.9	2.1
total steps	9.9	9.3	6.1	4.0	15.9	10.4	8.7	5.1	5.3

expected lifetime:> 48 million motor steps from long term tests

Summary of TTF Experience

By Rolf Lange

Tests , installations and operations with standard cold tuners from Saclay type have not caused problems and have worked fine from 1997 until autumn 2004.

But

Oct-04 Module 3* tuner cavity 4 after many years operation does't work!
Motor coils o.K. Problem not understood!

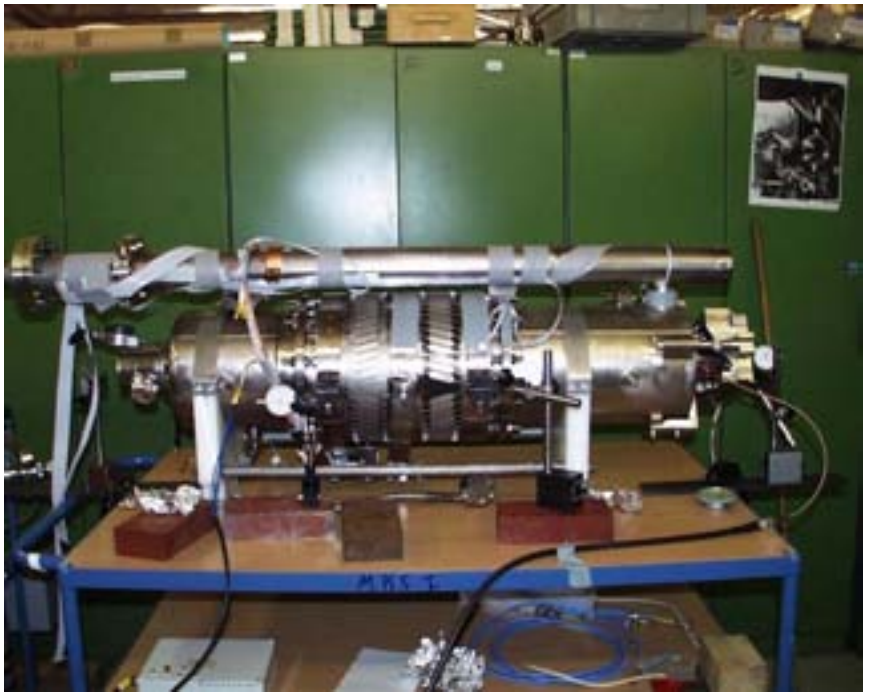
Nov-04 Module 5 tuner motors had been connected to other wrong old spare driver electronic components in a typical Friday afternoon/week-end action. The components had not been checked!!!

➔DC and holding current for 3 days
4 motor coils (C1-C4) destroyed, motor not working
4 motor coils (C5-C8) damaged, but motors still working

Although these problems the tuner itself is the most reliable component in the TTF Cryomodules during the last 8 years of TTF operation.

Coaxial tuner prototypes at DESY

H. Kaiser



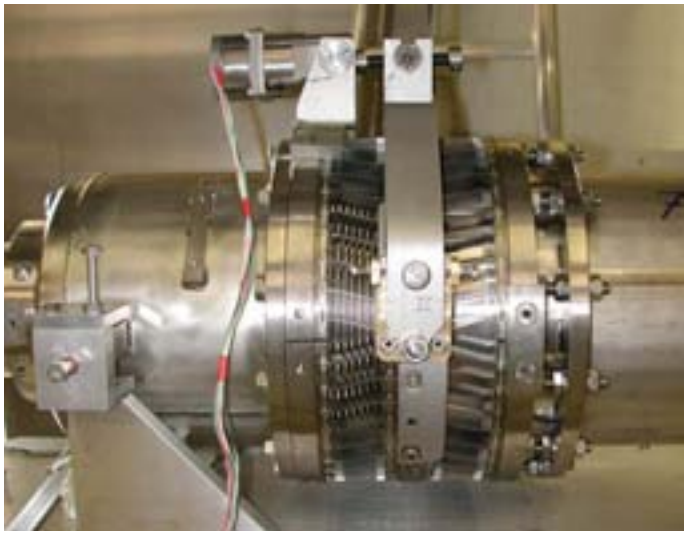
H.-B. Peters

INFN Blade-Tuners on Superstructures

References for the New Tuner Designs

The Saclay Tuner in TTF

The INFN Blade-Tuner

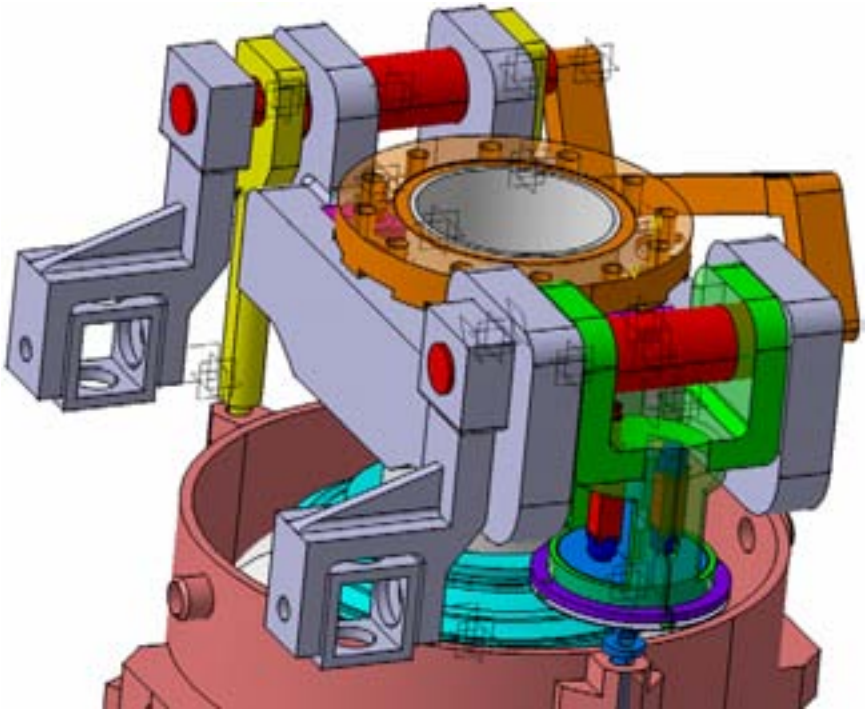


Successfully operated with superstructures

The New Saclay Tuner for XFEL

New design with piezos

- **CARE/JRA-SRF**
- **SOLEIL upgrades**
- **larger rigidity**



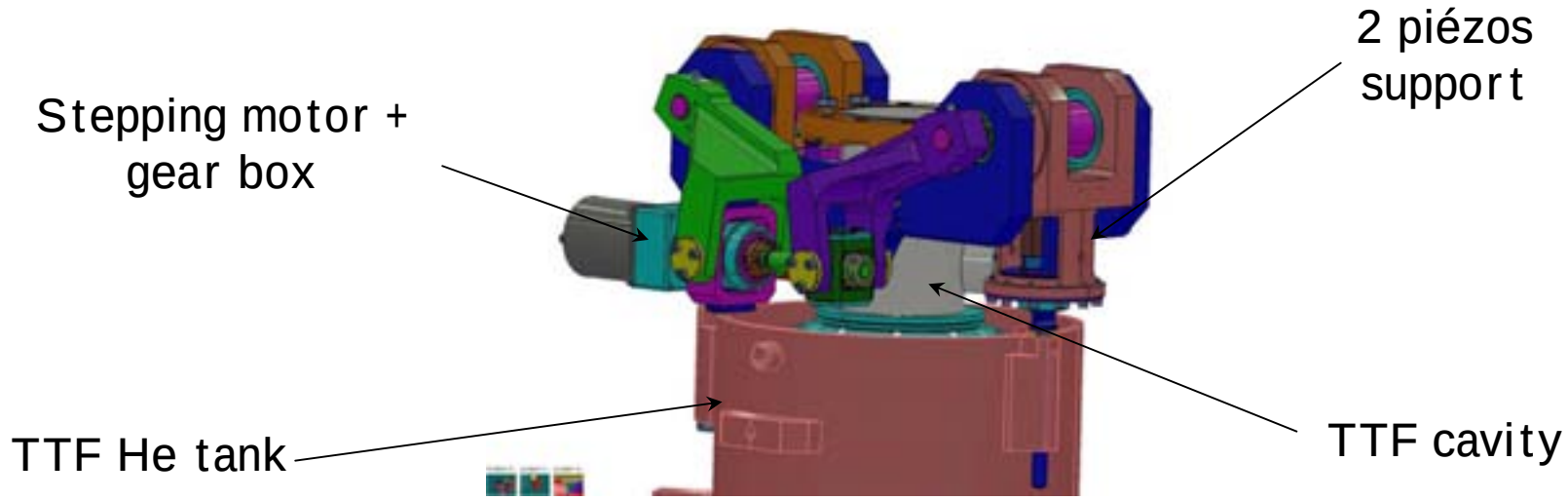
- Fabrication of 2 tuners since beginning of 2005
- 12 NOLIAC piezos, 2 PHYTRON stepping motors ordered
- Coll. with IPN Orsay: CEA send NOLIAC piezos to IPN for characterization, and IPN send P.I. piezos for tests on tuners
- Coll. with INFN-Milano for measurement with stress sensors @ 2K

The New Piezo assisted Saclay Tuner

Principle of the Super-3HC tuner with 3 fixations on the TTF helium tank

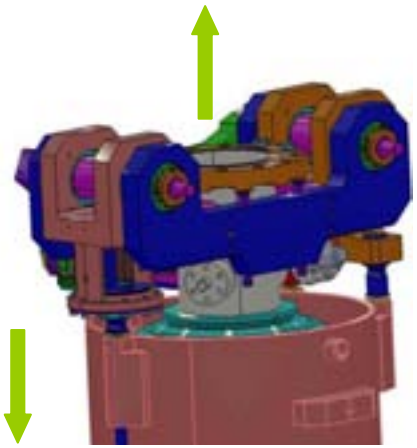
Full tuning range: ± 460 kHz

Resolution ~ present TTF tuner (~ 4 nm)

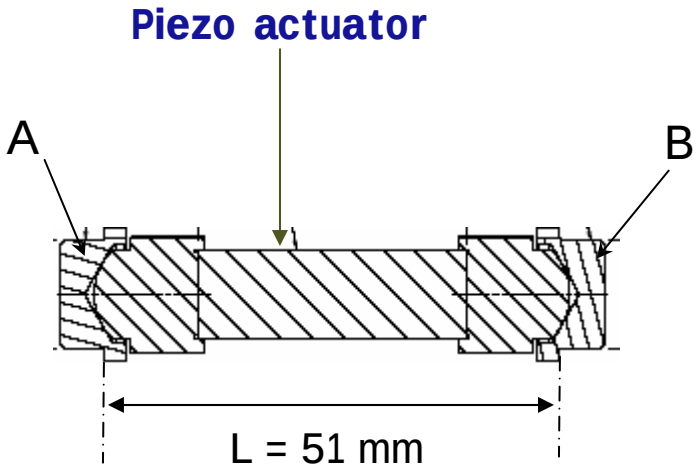


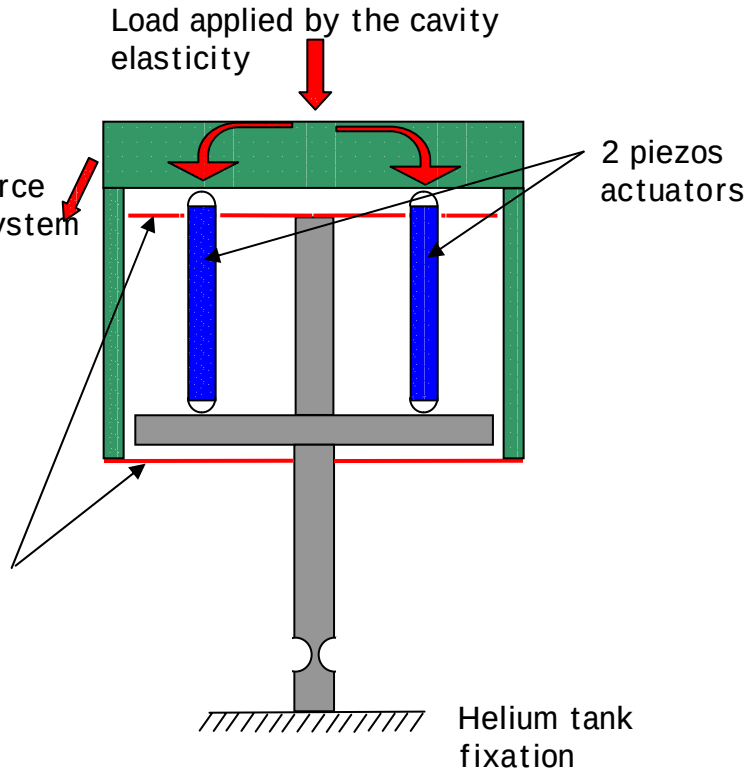
Piezo Support Principle

The cavity is stretched



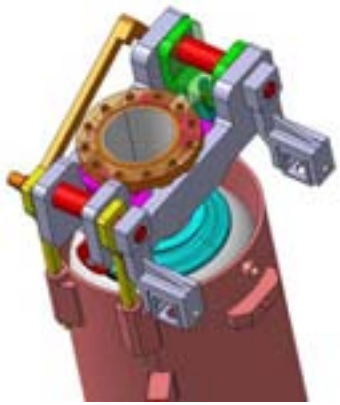
Piezo support is compressed by the cavity elasticity

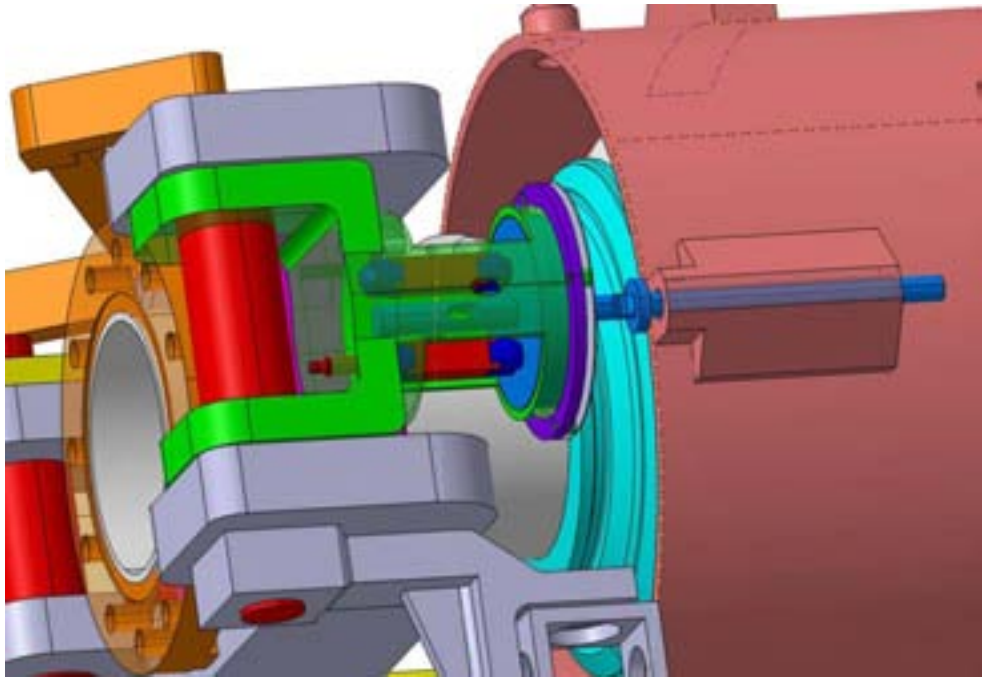


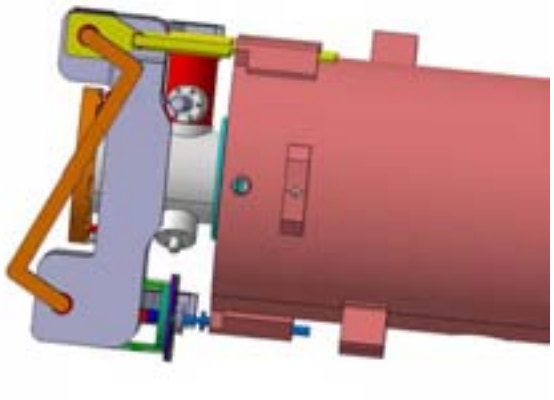


A and B pieces have to be machined in order to adjust the length L for the 2 piezos

CEA Tuner Details

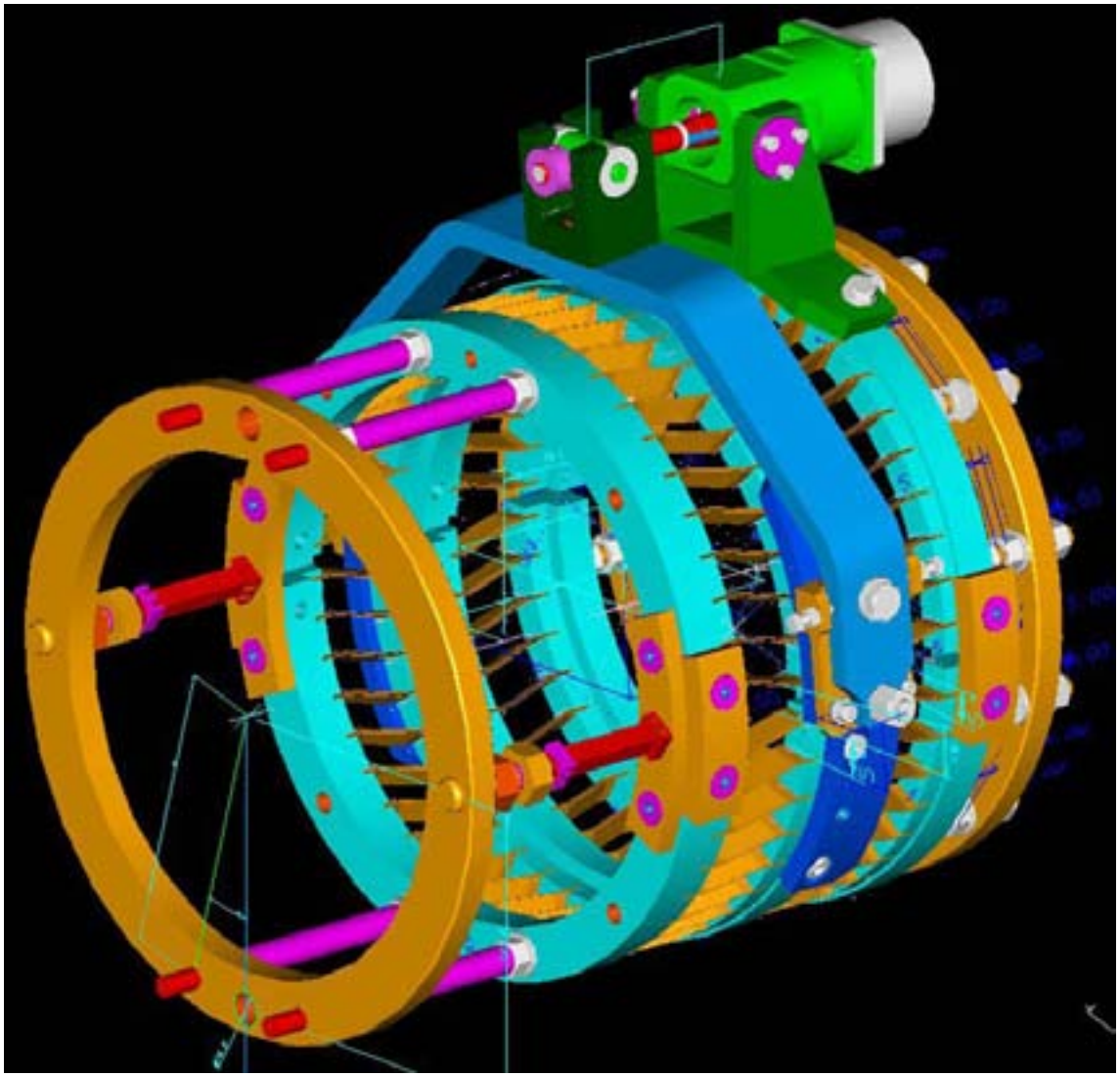




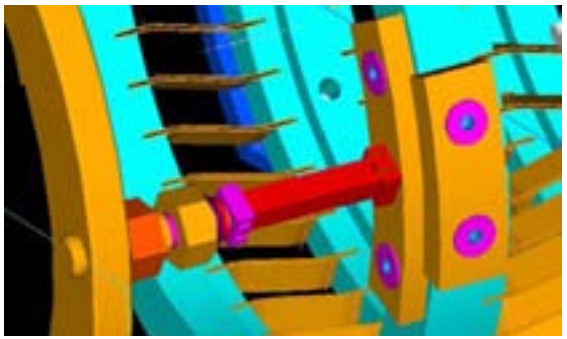


This tuner will be available in autumn 2005

The New INFN Blade-Tuner

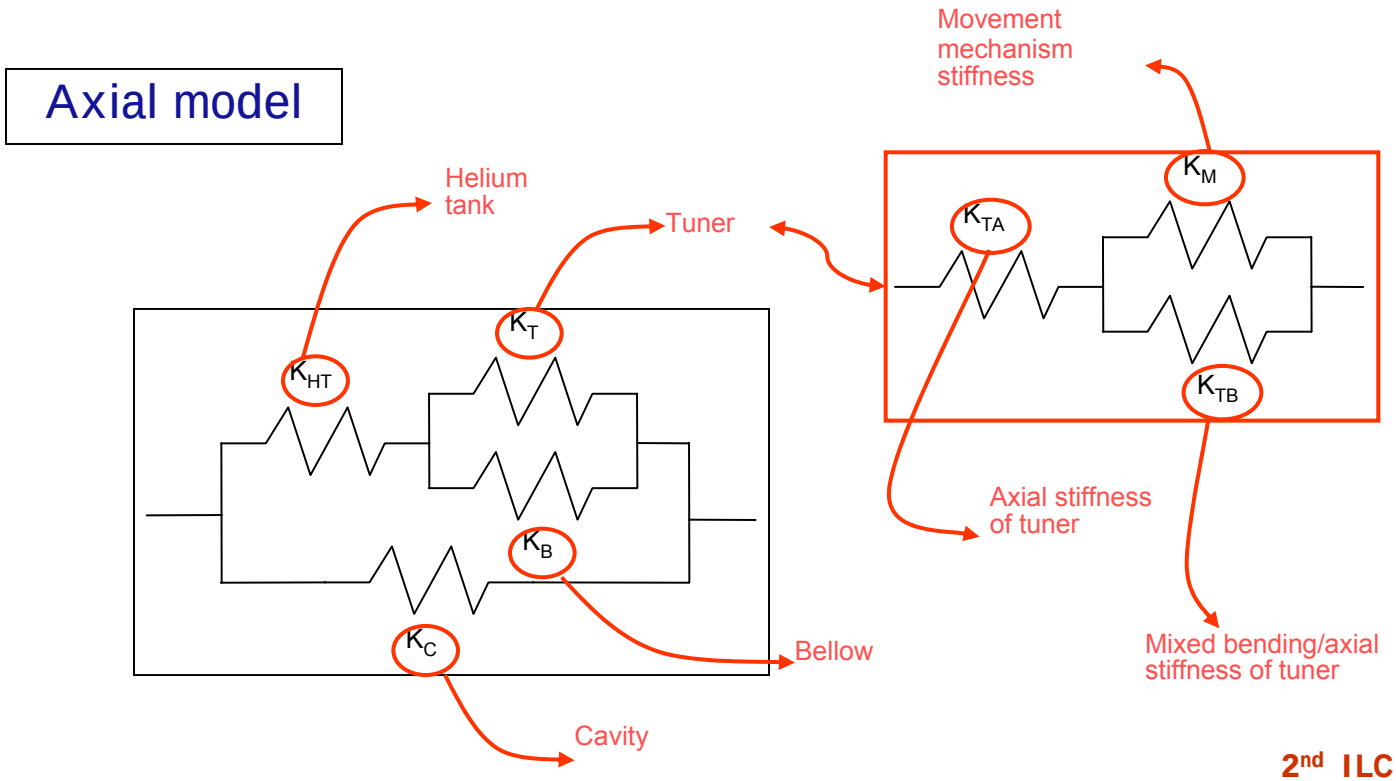


- Integration of piezos for Lorentz forces and microphonics completed.
- Final Drawing delivered for fabrication.
- Two prototype, including the modified helium tank, expected by end of October 2005
- Cold tests results by fall 2005 (DESY, BESSY, Cornell?)



Simplified structural model

- Tuner – Cavity – Helium tank system:
  - Axial behavior has been investigated in quasi static conditions
  - Bending behavior is being investigated
  - The most complicated part is the tuner: axial, bending and shear stiffness have to be considered

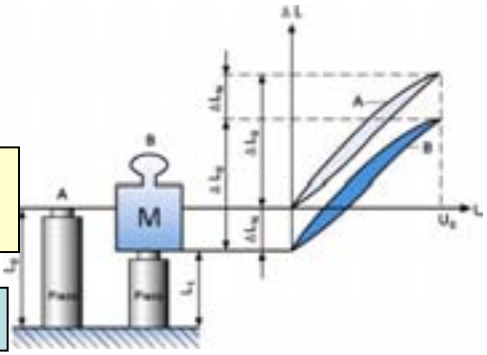


Blade Tuner Details

Requirements from the cavity point of view

± 1 mm fine tuning (on cavity) → ΔF on all piezo (sum) ≈ 3.5 kN

This value has to be considered as a preload variation and, if lower than the maximum characteristic force of piezo, acts as an offset

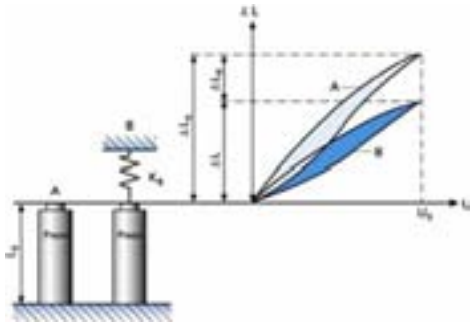


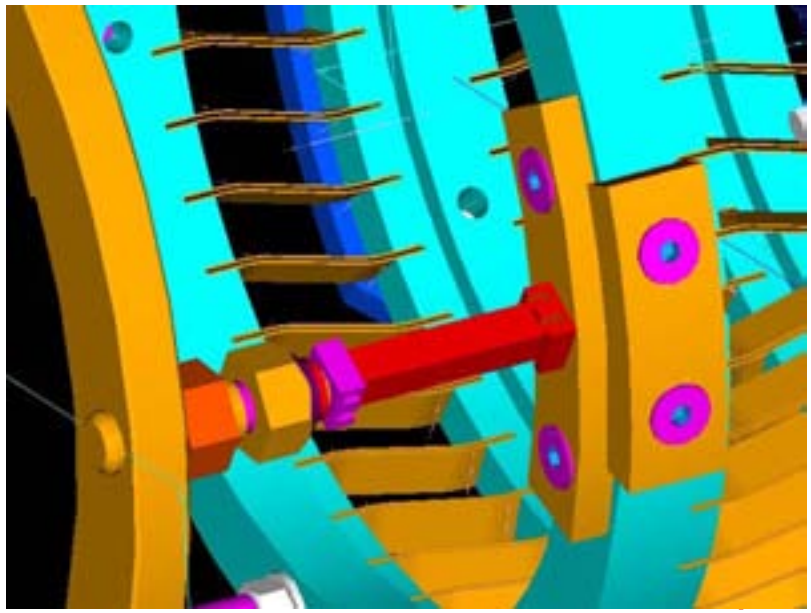
1 kHz fast tuning → ≈ 3 μm cavity displacement → ≈ 4 μm piezo displacement

This value has to be guaranteed at the temperature of 2 K, we expect to need a 40 mm long piezo

4μm piezo displacement → ≈ ΔF on all piezo ≈ 11.0 N

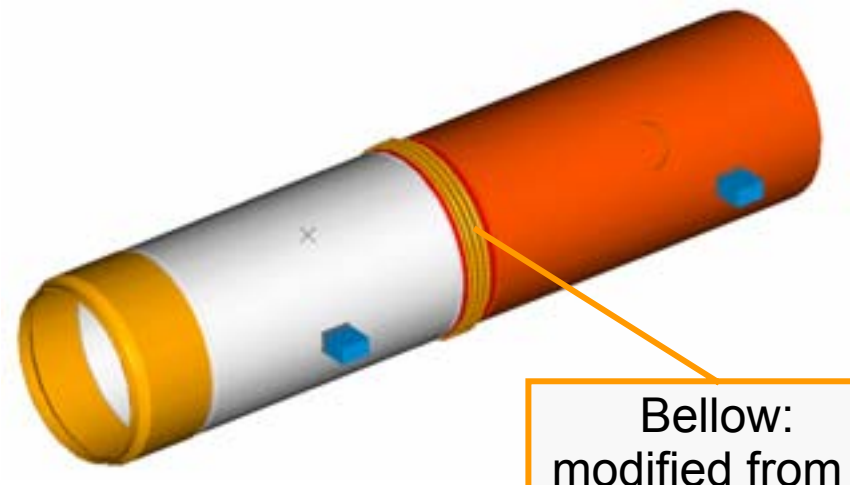
This value has been obtained in quasi-static conditions: no dynamic forces were considered



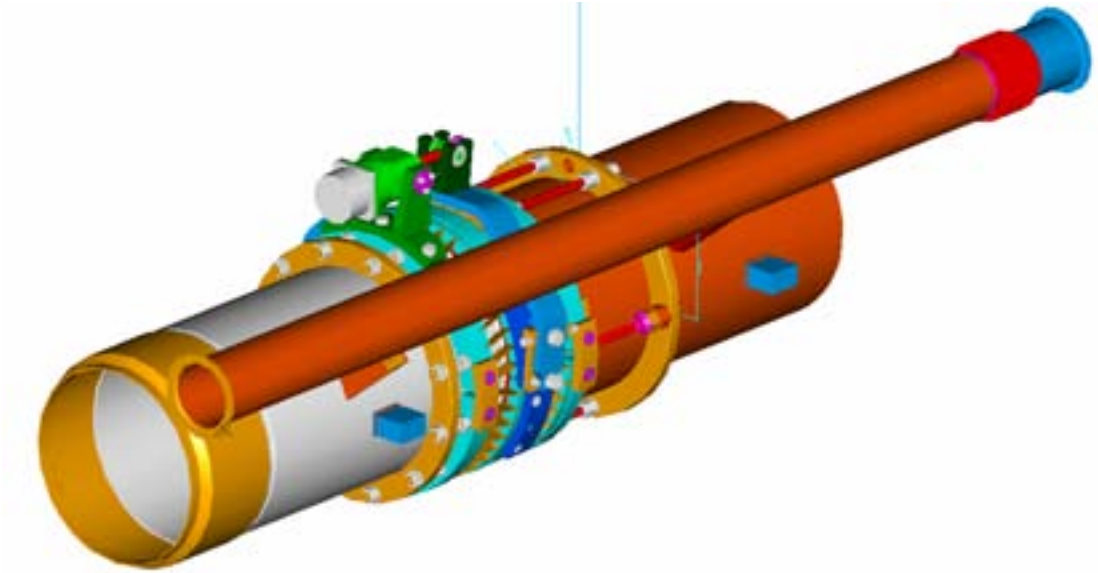


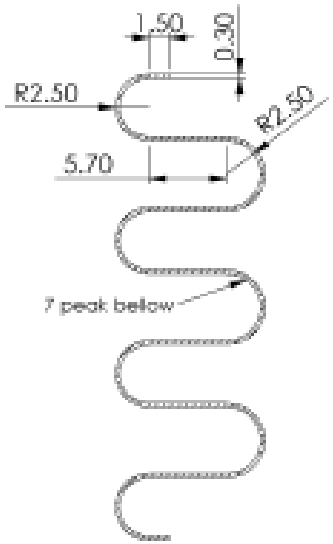
Revised He Tank

- Now the He tank needs to be split in two parts, with a bellow in between to allow the cavity elongation
- Magnetic shield assembly should probably be modified



Bellow: modified from 4 to 7 peaks





Comments on the Blade-Tuner

- It is a simple configuration;
- Low part number;
- The cavity elasticity is used to provide the piezo preload;
- Piezo capabilities seem to satisfy the requirements;
- Different piezo with different lengths and cross sections can be used (up to 72 mm length)
- Open possibility to use one piezo as actuator and the other one as measurement device. Is the stroke sufficient in this case?
- Piezo cannot sustain shear or bending forces, the system should avoid these excitation;
- With respect to the superstructure configuration, the tuner has no bending and shear stiffness due to the presence of the piezo actuators;
- Equilibrium and continuity of the helium tank has to be guaranteed by the cavity and the bellow;
- The assembling procedures are being revised in order to minimize the forces on the piezo.

Conclusions

- Two piezo assisted tuner designs are in the fabrication stage to be extensively tested in fall this year.
- Both should work reliably being based on established experience
- Cold motorization and annexed ball-bearing components are the ones extensively qualified on TTF.
- Comparative unity tuner cost will be performed
- For ILC the evaluation of the cost impact of the reduction of the cavity filling factor (real estate gradient) will possibly be the driving criteria for the tuner choice.