# Characterization of an elliptical low beta multicell structure for pulsed operation

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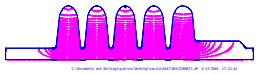
## Abstract

The five cell TRASCO cavities, with a geometrical beta of 0.47, have been equipped with a stiffening system in a position close to the nominal optimal for Lorentz force detuning minimization, even if they have been designed for CW operation.
Due to this feature, in the context of the CARE HIPPI EC program, the cavities are being equipped with a piezo assisted tuner of the "blade" type, in order to test them under pulsed operation in the future high power test facility that will be available at CRYHOLAB in Saclay.
In this paper we report the ongoing experimental characterization of the cavities at low power levels in vertical cryostats.

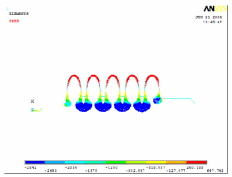

## Static KL Characterization

| | |
|---|---|
| $K_{cav}$ | 1.248 kN/mm |
| $\partial f/\partial z$ | -353.4 kHz/mm |

Mechanical characterization

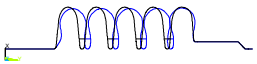


Field pattern



Lorentz Pressure Load

Slater coefficients



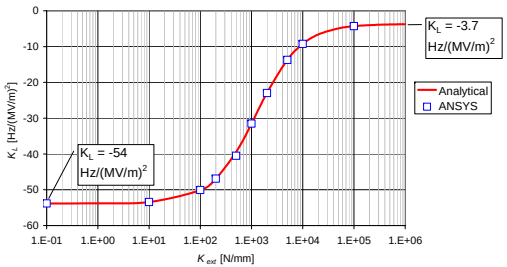
Geometrical Displacement with fixed B.C.

| | |
|---|---|
| Static $K_L^{\infty}$, with fixed boundary | -3.71 Hz/(MV/m)$^2$ |
| Reaction force at boundary, $F^{\infty}$ | -17.7 N |

General case for an external stiffness

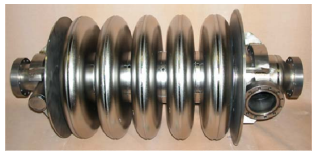
$$K_L = K_L^{\infty} + \frac{\partial f}{\partial z}\frac{F^{\infty}/E_{acc}^2}{K_{ext} + K_{cav}}$$

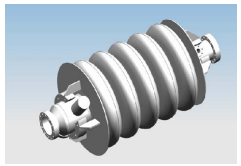
Lorentz Force Detuning Coefficient



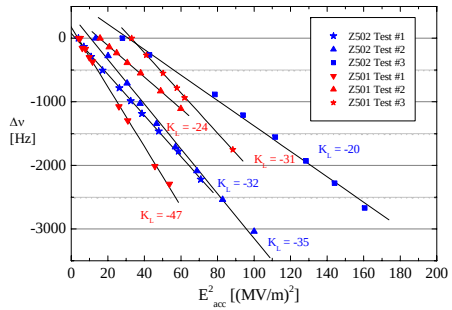

## Main cavity parameters

| Parameter | Value |
|---|---|
| Design Frequency | 704.4 MHz |
| Geometrical β | 0.47 |
| Iris radius | 40 mm |
| Cell to cell coupling | 1.34 % |
| R/Q | 180 Ohm |
| G | 160 Ohm |
| $E_{peak}/E_{acc}$ | 3.57 |
| $B_{peak}/E_{acc}$ | 5.88 mT/(MV/m) |
| Stiffening ring radial position | 70 mm |
| Lorentz Force Coefficient (estimated) | -3.7 Hz/(MV/m)$^2$ |





## Measured KL for the TRASCO cavities




## Cavity treatments

Before the first test, the cavity has been tuned, degreased in a solution of water and micro with ultrasonic agitation for 30 min, followed by a buffered chemical polish (BCP) of the internal surface with a mixture of HF, $HNO_3$ and $H_2PO_3$ in ratio 1:1:2 in volume at ~ 10 C, removing nominally about 150 µm, followed by thorough rinsing with ultrapure water. Subsequently, the cavity has been heat treated at 600 °C for 10 h to desorb hydrogen generated during the chemical treatment . The vacuum in the furnace at 600 °C was ~$10^{-7}$ mbar.
After a retuning the cavity was degreased again and a surface layer of about 100 µm was removed by BCP, followed by thorough high pressure rinsing (HPR) with ultrapure water and subsequent four hours of high pressure rinsing in two "sweeps", each 2 h long. The cavity was then dried overnight in the class 10 clean room and assembled with an input antenna placed in the power coupler port and a shorter antenna placed in the pick-up probe. The beam pipe ports were closed by stainless steel blanks with one of them having a pump-out port. All gaskets were made from $AlMg_3$. The cavity was evacuated with a turbo-pump/scroll pump system overnight; prior to sealing the cavity off hermetically with an all-metal valve, the pressure at room temperature was 3*$10^{-8}$ mbar.

No further treatments were performed before the second test.

The third test was preceded by a short BCP treatment for 20 µm removal, followed by 2 stages of HPR (2 h each) and the same drying, assembling and pumping procedure of the first test.

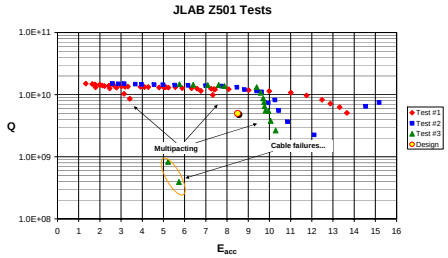
## RF Tests at JLAB

Three tests have been performed at JLAB on the cavity

The first one after a deep BCP etch and HPR

The second after one year of stationary vacuum and no further treatmens

The third after a 20 um BCP etch and 2 HPR stages



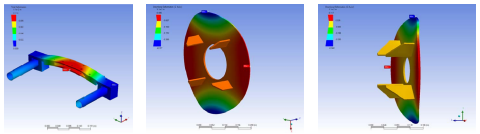

In **Test #1** the cavity showed a easily conditioned multipacting level at low field and a barrier at 7-8 MV/m which needed long RF conditioning times.
The ultimate field reached by the cavity was **13.7 MV/m** ($E_p$=49 MV/m, $B_p$=81 mT)

In **Test #2** the barrier started showing signs of electron activity from 9.4 MV/m, it needed over 30 minutes of RF processing, after which the cavity reached **15.2 MV/m** ($E_p$=54 MV/m, $B_p$=89 mT) before the RF cable feeding the incident power failed (at a power level of > 200 W)

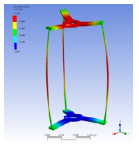
In **Test #3** again the cavity showed heavy electron activity from 7.8 MV/m, but this time the cable failed during the conditioning of the multipacting barrier, at a power level > 200 W

## Interpretations of the tests at JLAB

$$\frac{1}{K_{jlab}} = \frac{1}{K_{frame}} + \frac{1}{K_{Dbig}} + \frac{1}{K_{Dsmall}} \approx 0.93\ \text{kN/mm}$$

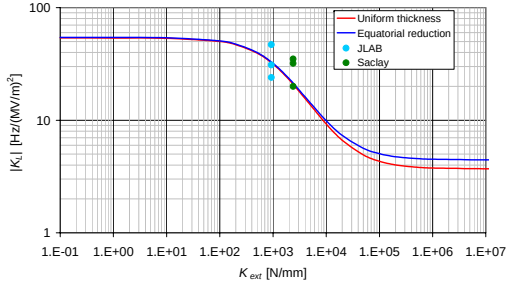


## Interpretations of the tests at Saclay



| Average frame stiffness | |
|---|---|
| $k_{frame}$ | 2.39 kN/mm |

Lorentz Force Detuning Coefficient




*We acknowledge the partial support of the European Community-Research Infrastructure Activity under the FP6 "Structuring the European Research Area" program (CARE, contract number RII3-CT-2003-506395).*