FIRST MEASUREMENTS ON THE 325 MHz SUPERCONDUCTING CH CAVITY*

M. Busch[†,1], F. Dziuba[1], H. Podlech[1], U. Ratzinger[1], W. Barth[2,3], S. Mickat[2,3], M. Amberg[3], M. Pekeler[4]
[1]IAP Frankfurt University, 60438 Frankfurt am Main, Germany
[2]GSI Helmholtzzentrum, 64291 Darmstadt, Germany
[3]Helmholtz-Institut Mainz (HIM), 55099 Mainz, Germany
[4]RI Research Instruments, Bergisch Gladbach, Germany

Abstract

At the Institute for Applied Physics (IAP), Frankfurt University, a superconducting 325 MHz CH-Cavity has been designed and built. This 7-cell cavity has a geometrical β of 0.16 corresponding to a beam energy of 11.4 AMeV. The design gradient is 5 MV/m. Novel features of this resonator are a compact design, low peak fields, easy surface processing and power coupling. Furthermore a new tuning system based on bellow tuners inside the resonator will control the frequency during operation. After successful rf tests in Frankfurt the cavity will be tested with a 10 mA, 11.4 AMeV beam delivered by the GSI UNILAC. In this paper first measurements and corresponding simulations will be presented.

CAVITY LAYOUT

Worldwide there is a growing interest in applications demanding high beam power and quality (e.g. MYRRHA (**M**ulti Purpose **HY**brid **R**esearch **R**eactor for **H**igh-Tech **A**pplications) [1]). The superconducting CH-cavity is an appropiate structure for these specifications being characterized by a small number of drift spaces between adjacent cavities compared to conventional low-β ion linacs [2]. Applying KONUS beam dynamics, which decreases the transverse rf defocusing and allows the development of long lens free sections, this results in high real estate gradients with moderate electric and magnetic peak fields. In the past a 19-cell, superconducting 360 MHz CH-prototype has been developed and successfully tested [3]. For future operations a new design proposal for high power applications has been investigated. Presently a new cavity operating at 325.224 MHz, consisting of 7 cells, β = 0.16 and an effective length of 505 mm (see table 1) is undergoing first measurements. Referring to the previous structure this cavity utilizes some novel features (see fig. 1):

- inclined end stems
- additional flanges at the end caps for cleaning procedures
- two bellow tuners inside the cavity
- two ports for large power couplers through the girders

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† busch@iap.uni-frankfurt.de

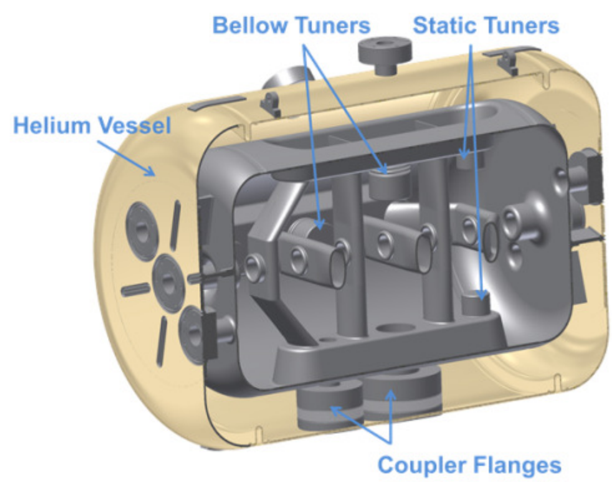

Figure 1: Layout of the superconducting 7-cell CH-Cavity (325.224 MHz, β = 0.16)[4].

Table 1: Specifications of the 325 MHz CH-Cavity.

β	0.16
frequency [MHz]	325.224
no. of cells	7
length ($\beta\lambda$-def.) [mm]	505
diameter [mm]	352
E_a [MV/m]	5
E_p/E_a	5
B_p/E_a [mT/(MV/m)]	13
G [Ω]	64
R_a/Q_0	1248
R_aR_s [$k\Omega^2$]	80

SCOPE FOR THE DYNAMIC BELLOW TUNERS

Rf, mechanical properties as well as Multipacting studies of the novel bellow tuner system can be reviewed in [5],[6], [7].

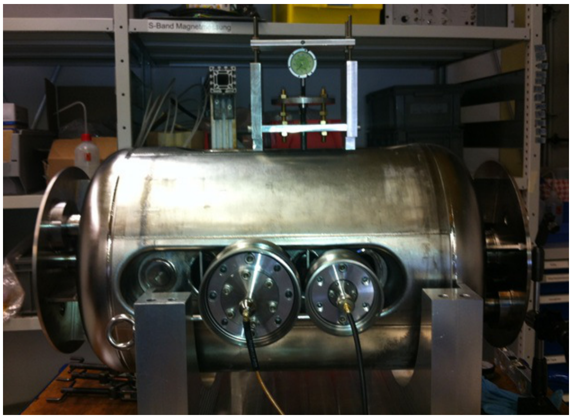

Figure 2: Setup for the test of the dynamic bellow tuners.

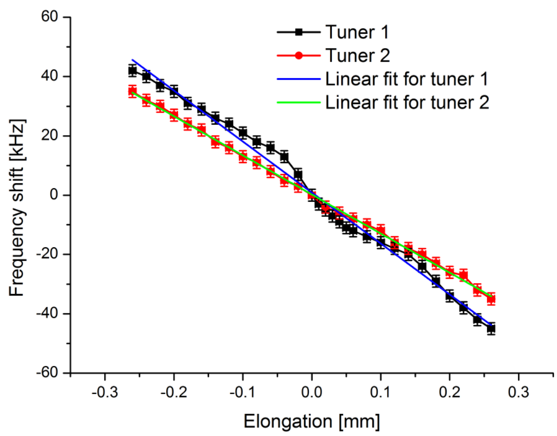

Figure 3: Frequency shift caused by elongation of tuner 1 and tuner 2.

First mechanical and rf tests regarding the scope of the dynamic bellow tuners have been performed at RI (Research Instruments GmbH [8]). The measuring configuration consisted of a framework housing a probe indicator and three spindles applying force via a metal plate on the rod of the tuners in each case (see fig. 2). Proceeding at room temperature the mechanical range of the bellow tuners was limited to $\Delta x = -0.3\ mm..0.3\ mm$ preventively. The measured frequency shift averaged $\Delta f = -172\ kHz/mm$ for tuner 1 and $\Delta f = -132\ kHz/mm$ for tuner 2. The simulated shift for the tuners is ($\Delta f = -150\ kHz/mm$) (see fig. 3).

PRELIMINARY COLD TEST

Prior to the final assembly of the cavity a preliminary cold test was arranged cooling down the cavity to LN_2 temperature. For this purpose the structure has been evacuated and inserted into an insulated metal box (see fig. 4). Three thermal sensors were attached to the top, alongside and bottom of the end caps. The cavity was leak-proof and the last remaining tuner hole was sealed with a Viton plug. This setup allowed a measurement down to an average temperature of roughly -120 °C (see fig. 5). Showing good agreement to the expected shrinkage the frequency shift at LHe should total up to 450 kHz corresponding to a shrinkage of 0.14 %.

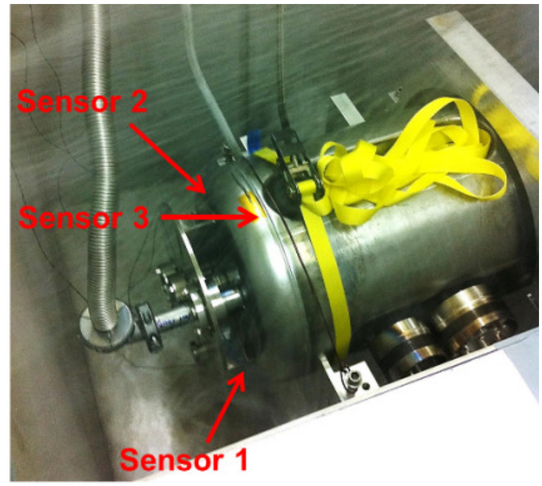

Figure 4: Setup for the preliminary cold test. Thermal sensors on top, alongside and bottom of the end cap.

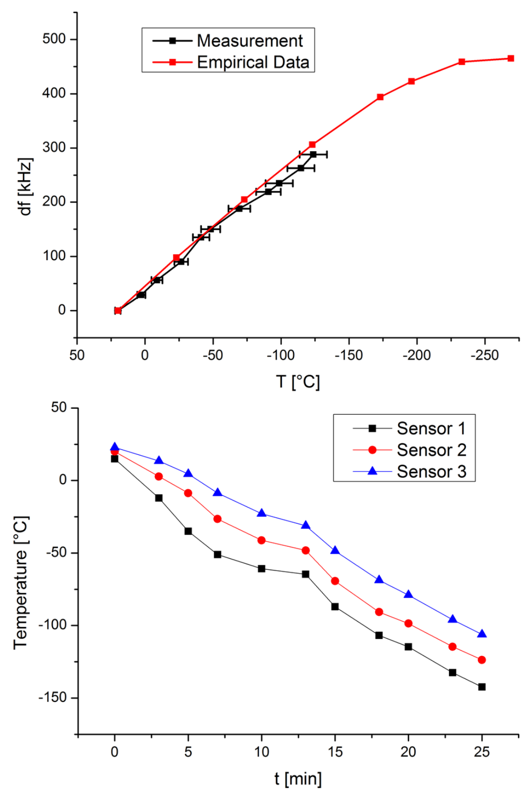

Figure 5: Top: Measured and expected frequency shift due to thermal shrinkage (Empirical data taken from: A.F. Clark, Materials at Low Temperatures). Bottom: Temperature behaviour for all three sensors.

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PRESSURE SENSITIVITY

Furthermore pressure sensitivity measurements have been performed. Therefore three probe indicators were positioned on both end caps and on one cavity quarter shell (see fig. 6) to measure the deformation at the according spots. Then the cavity has been evacuated with a rotary vane pump down to 100 mbar and 1 mbar in another measurement, respectively. The frequency shift according to the measurements added up to ≈190 kHz and ≈180 kHz, respectively. According to simulations the shift is 205 kHz. The deformation on the cavity quarter shell was 0.22 mm at 100 mbar residual pressure while the simulated reference value amounts to 0.19 mm (see fig. 7).

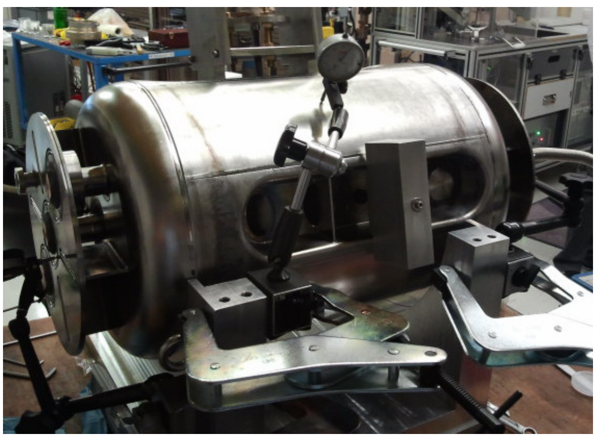

Figure 6: Setup for pressure sensitivity measurement.

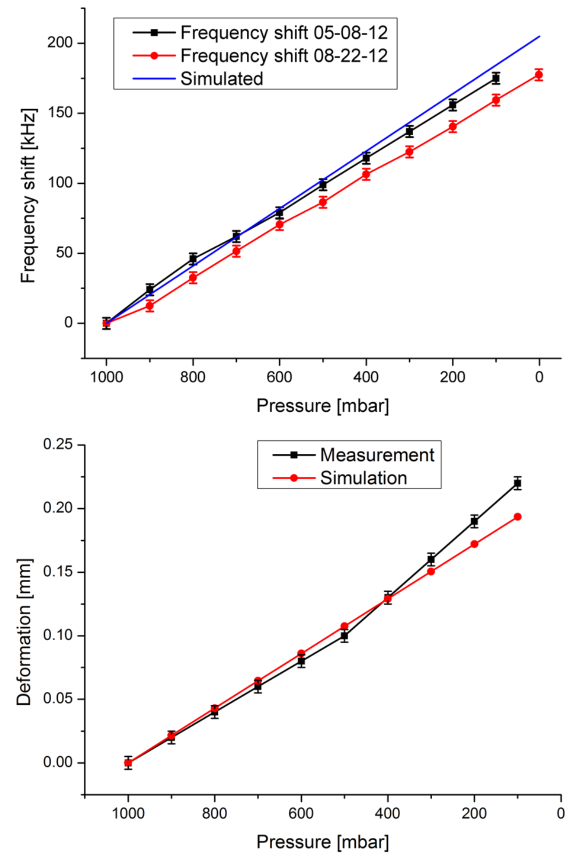

Figure 7: Top: Frequency shift due to evacuation. Bottom: Deformation of the cavity quarter shell versus residual pressure.

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