COLD MEASUREMENTS ON THE 325 MHz CH-CAVITY*

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Abstract

At the Institute for Applied Physics (IAP), Frankfurt University, a superconducting 325 MHz CH-Cavity has been designed, built and first tests were performed. The cavity is determined for a 11.4 AMeV, 10 mA ion beam at the GSI UNILAC. Consisting of 7 gaps this resonator is envisaged to deliver a gradient of up to 5 MV/m. Novel features of this structure are a compact design, low peak fields, improved surface processing and power coupling. Furthermore bellow tuners attached inside the resonator will control the frequency during operation. In this contribution first measurements executed at 4 K at the cryo lab in Frankfurt will be presented.

CAVITY KEY DATA

For several years there has been an ongoing process of CH-Cavity development at IAP in Frankfurt. After successful tests of the 360 MHz prototype a new 325 MHz cavity has been designed at IAP and has been built at Research Instruments (RI) [1]. CH-Cavities only need a small number of drift spaces between adjoining cavities compared to conventional low-β ion linacs [2] and by applying KONUS beam dynamics, which decreases the transverse rf defocusing and allows the usage of long lens free sections, this results in high real estate gradients with moderate electric and magnetic peak fields. The new cavity is operating at 325.224 MHz, consisting of 7 cells, $\beta = 0.16$ and has an effective length of 505 mm (see table 1). The main changes in geometry comprise (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

FIRST COLD TESTS AT 4 K

After successful preliminary tests at room temperature and at LN_2 temperature, defining the bellow tuner range, pressure sensitivity and shrinking behaviour [4], the cavity was delivered to the cryo lab in Frankfurt for further tests. At the time of delivery the quality of the surface was not optimal. It has only been chemically processed and ultra sonic cleaned because the HPR installation was not yet ready for use.

Nevertheless the cavity was equipped with ten temperature probes alongside the fixing rod and on the tank shell (see fig. 2). Subsequently the cavity was cooled down to liquid nitrogen temperature at first and in a second step to 4 K. The frequency shift for the whole temperature range was 430 kHz while the simulated value is 465 kHz (see fig. 3).

At LN_2 temperature the cryostat has been evacuated with a rotary vane pump. The pressure difference could be measured roughly down to 500 mbar yielding to an according pressure sensitivity of 89 Hz/mbar (see fig. 4), which

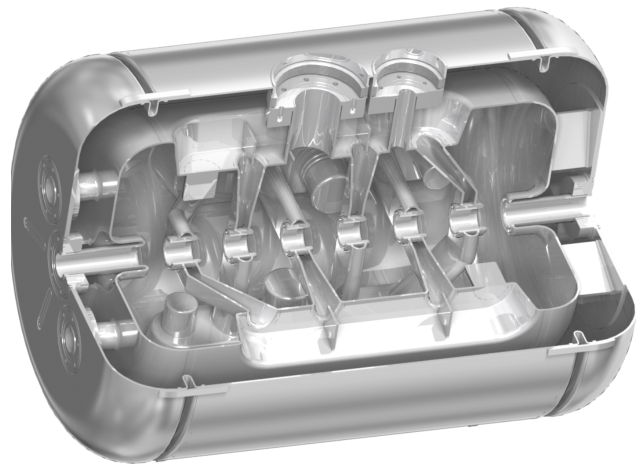

Figure 1: Layout of the superconducting 7-cell CH-Cavity (325.224 MHz, $\beta = 0.16$)[3].

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

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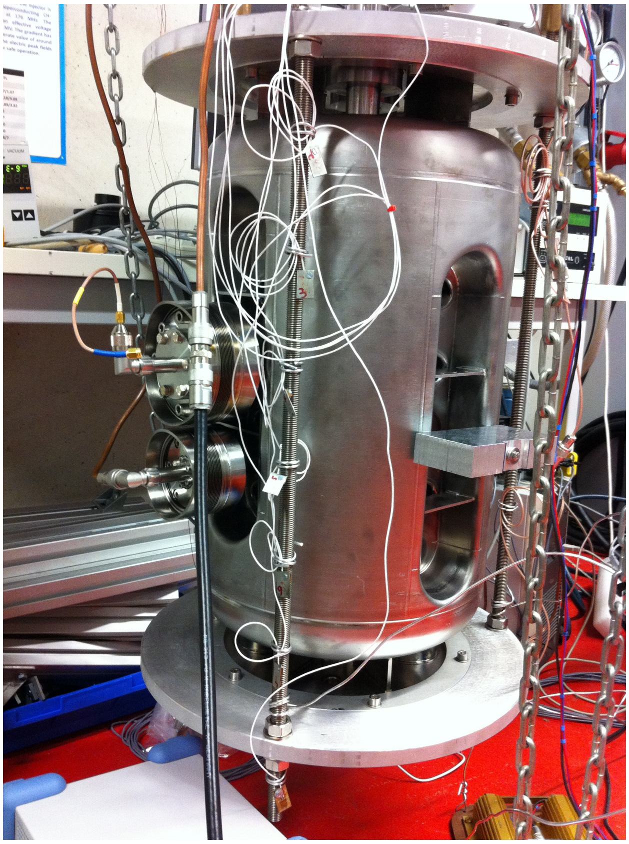

Figure 2: Preparation for the cold test.

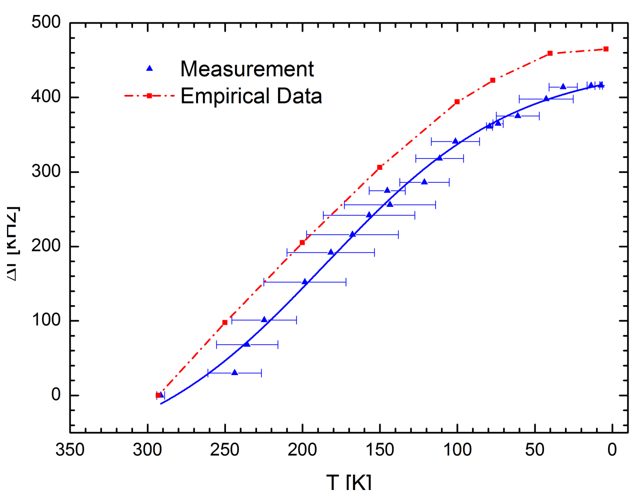

Figure 3: Frequency shift due to cavity shrinkage.

matches the previous measurements at room temperature of 80 Hz/mbar and 90 Hz/mbar, respectively.

POWER TESTS

Due to the surface quality many levels of multipacting were experienced (see fig. 5 top). All thresholds could be conditioned after several hours, in some cases after a few days (see fig. 5 bottom). The coupling factor at low

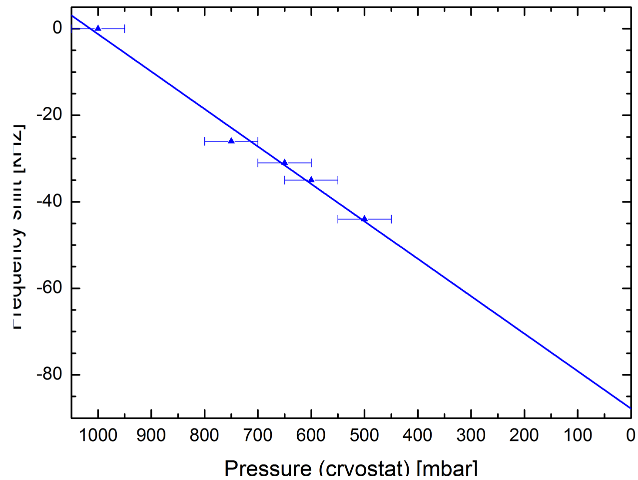

Figure 4: Frequency shift due to cryostat evacuation.

fields was 0.8. For tests at high electric fields the X-Ray spectrum was recorded with three probes. In figure 6 the measured curve and the noise curve are put on top of each other. The maximum electron energy gained by field emission was ≈230 keV hence yielding a total effectivce voltage of 1.06 MV. Increasing the power up to the Q-drop the final achieved field gradient was 2.1 MV/m (see fig. 7).

FABRICATION PROGRESS

For each fabrication step the frequency has been measured. Since the cavity will be tested with beam it is of high importance to hit the frequency after the final processing step. Initially the frequency was designed higher than the operating frequency (see fig. 8). By changing the geometry (reducing the end cap length) or inserting tuners the frequency is lowered. Chemical processing, however, leads to an increase of the freqency. Thus BCP can be utilized to tune the cavity after all mechanical actions are depleted. Finally the frequency has to be in the range of the dynamic bellow tuners of ±300 kHz.

ACKNOWLEDGEMENT

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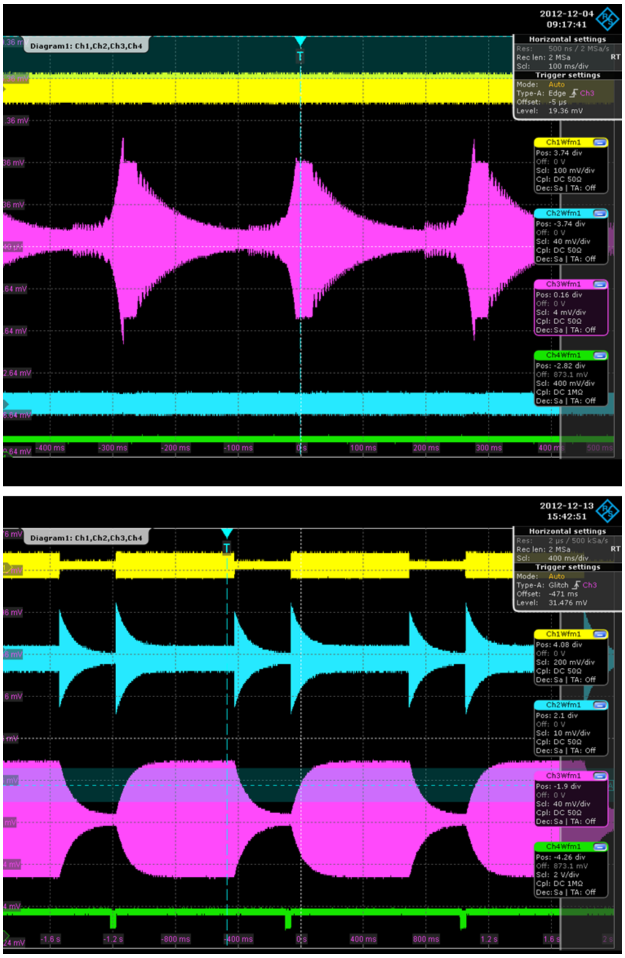

Figure 5: Top: Multipacting thresholds at ≈80 W forwarded power. Bottom: Scope signals after conditioning.

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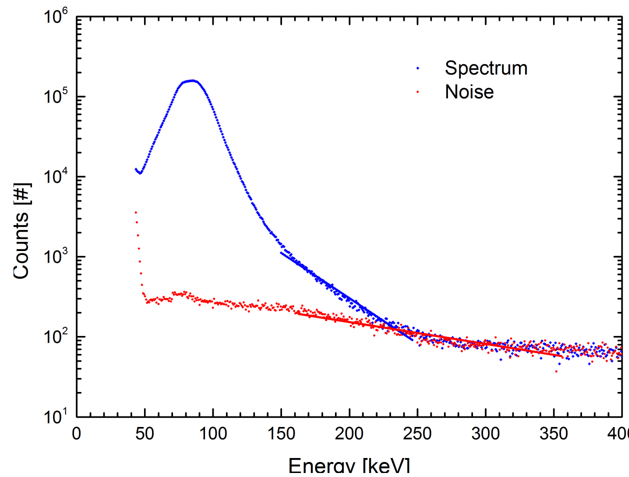

Figure 6: X-Ray spectrum for E≤2.1 MV/m.

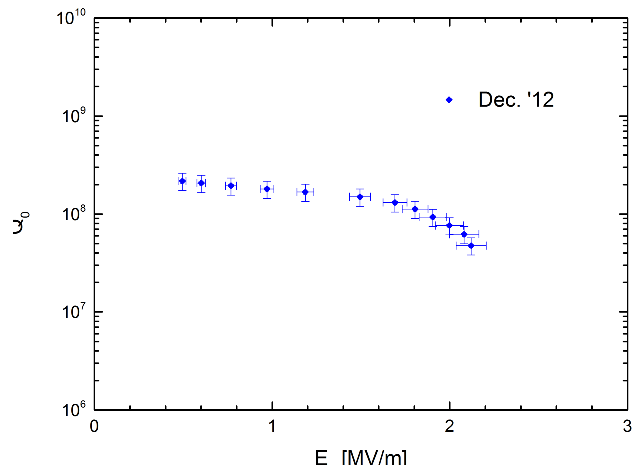

Figure 7: Q versus E curve.

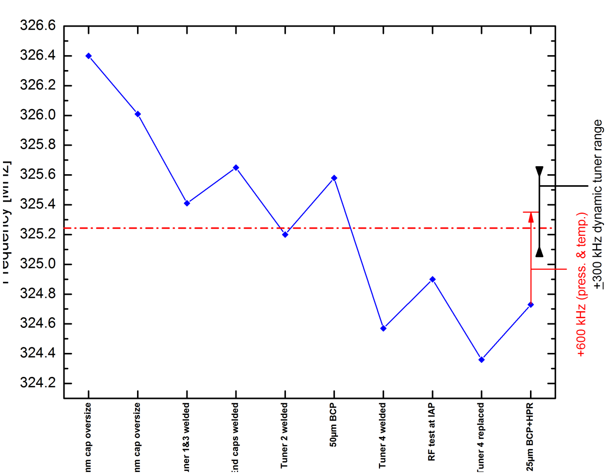

Figure 8: Top: Frequency shift due to evacuation. Bottom: Deformation of the cavity quarter shell versus residual pressure.

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