RECENT MEASUREMENTS ON THE SC 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 and built and extensive tests have successfully been performed. The cavity is determined for a 11.4 AMeV, 10 mA ion beam at the GSI UNILAC. This cavity consists of 7 gaps and is envisaged to deliver a gradient of 5 MV/m. Novel features of this structure are a compact design, low peak fields, improved surface processing and power coupling. Furthermore a tuner system based on bellow tuners attached inside the resonator and driven by a stepping motor and a piezo actuator will control the frequency. In this contribution measurements performed at 4.2 K and 2.1 K at the cryo lab in Frankfurt will be presented.

INTRODUCTION

Currently planned projects like the sc cw Heavy Ion Linac at GSI/HIM [1] require compact and efficient cavities to deliver beams of high intensity, quality and availabilty. For those applications the superconducting CH-cavity has

Figure 1: Rendering of the cavity with welded helium vessel.

already proved to be an appropiate candidate being characterized by a small number of drift spaces between neighboring cavities compared to conventional low-β ion linacs [2]. Additionally the KONUS beam dynamics, which decreases the transverse rf defocusing and allows the development of long lens free sections, yields high real estate gradients with moderate electric and magnetic peak fields. At the Institute for Applied Physics, Frankfurt University, a new cavity operating at 325.224 MHz, consisting of 7 cells, $\beta = 0.16$ and an effective length of 505 mm (see Table 1) has been designed [3] and extensively measured after all fabrication

and processing steps at Research Instruments [4]. In the final stage the cavity is being welded to a helium vessel to provide a closed helium circulation (see Fig. 1).

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 (design) [MV/m]	5
E_p/E_a	5
B_p/E_a [mT/(MV/m)]	13
G [Ω]	66
R_a/Q_0	1260
$R_a R_s$ [$k\Omega^2$]	80

MEASUREMENT SETUP

At the cryo lab of the IAP a measurement setup comprising a vertical cryostat has been installed for various test purposes (see Fig. 2) allowing power measurements at 4.2 K and 2.1 K, respectively. In this system the spent Helium can be extracted to a recovery system or the cryostat can be evacuated by a roots pump to reach 2 K. The CH-cavity
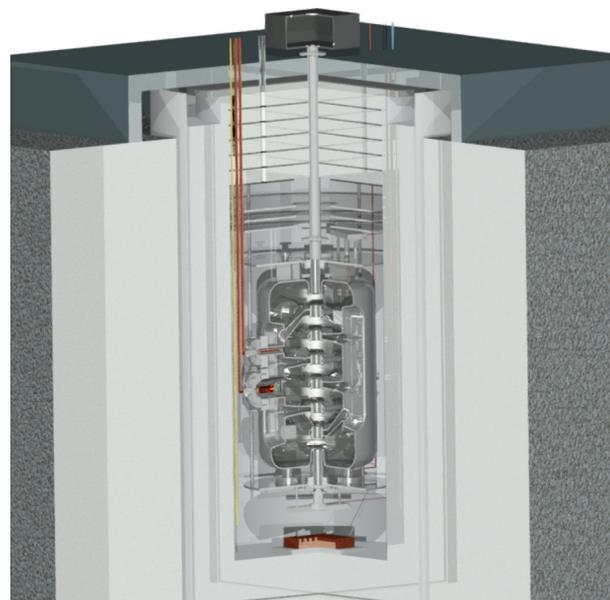

Figure 2: Schematic layout of the vertical test environment.

has been provided with four low-temperature probes, 40 **T**hermo-**L**uminescence-**D**osimeter (see Fig. 3) to record

field emission events and two piezos for microphonic excitation and detection.

Figure 3: Setup of the cavity with TLDs and temperature probes.

RESULTS

The initial conditioning of low multipacting barriers (s. Fig. 4, bottom, red dotted lines) took several days. Further barriers in the range between 2.5 MV/m and 5.7 MV/m
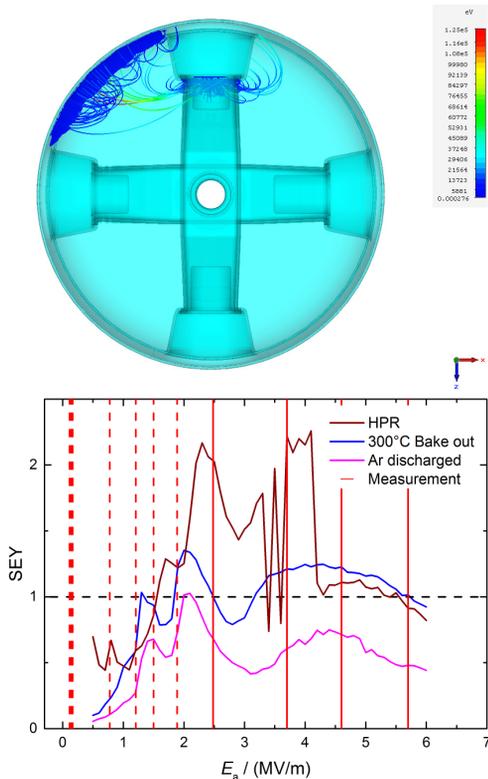

Figure 4: Multipacting simulations in the region of the cavity wall (top). Comparison between measured and simulated multipacting events (bottom).

could be crossed but still remained softly in repetitive measurements (s. Fig. 4, bottom, red straight lines). Simulations indicate that in the quarter sections of the tank (s. Fig. 4, top) multipacting is possible depending on the surface preparation. Also the simulated values match quite well with the measured ones between 2 MV/m and 6 MV/m. With a residual pressure of $6 \cdot 10^{-10}$ mbar measurements up to the quench of the cavity have been performed. Figure 5 depicts the Q vs E curves for three different temperatures.
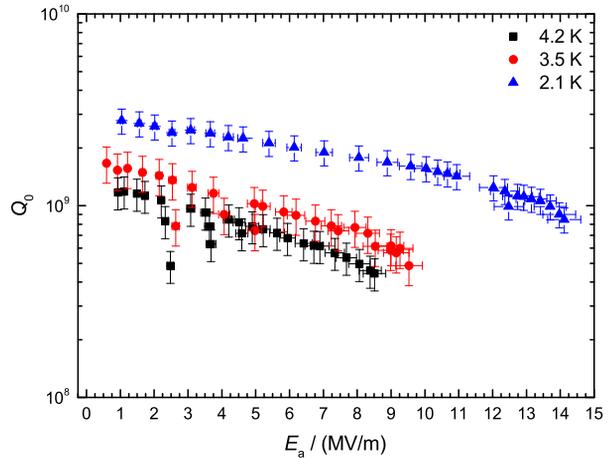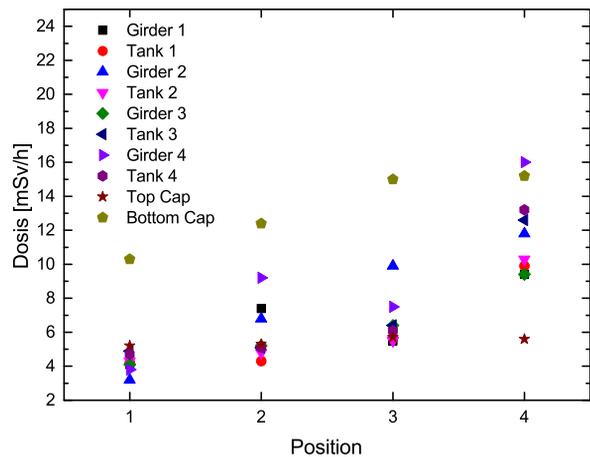

Figure 5: Q vs E curve for different temperatures.

Figure 6: Dosis distribution among the TLD.

Using a fast cool-down scheme to 4 K ($> 1\,K/min$) gradients of up to 8.5 MV/m corresponding to voltages of 4.2 MV could be achieved. Utilizing a roots pump Helium temperatures of 3.5 K and 2.1 K, respectively, could be attained. The respective curves yield a gradient of up to 9.5 MV/m in case of 3.5 K and 14.1 MV/m at 2.1 K. The quench at the highest field levels is supposedly due to a thermal defect since the degradation of the Q-value is still quite low. Also the evaluation of the TLD (see Fig. 6) shows only a small, potential field emitting site located somewhere near the bottom area of the cavity. To illustrate the enhancement factor of the emitting sites a Fowler-Nordheim plot is shown in Fig.
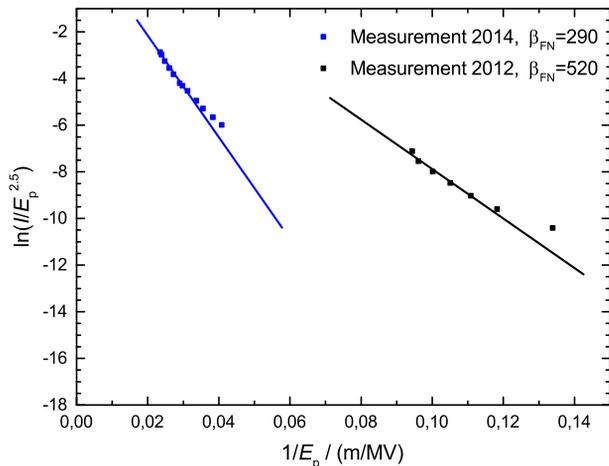
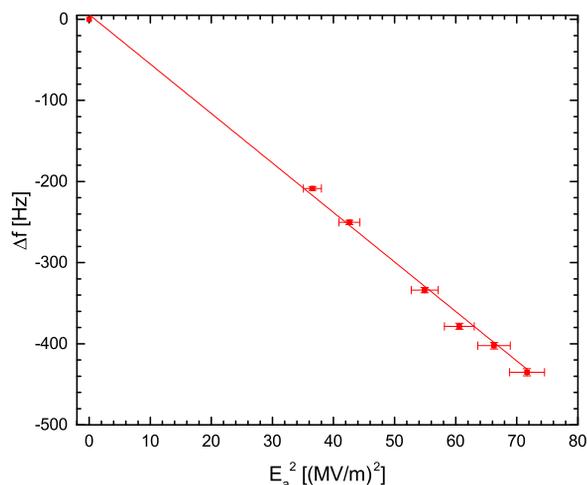Figure 7: Fowler-Nordheim plot for two different surface qualities.

Figure 9: Measurement of the LFD effect.

7. The two curves refer to different surface qualities. The black curve belongs to a measurement without HPR, the blue one with extensive HPR treatment showing a distinct difference in emitter activity.
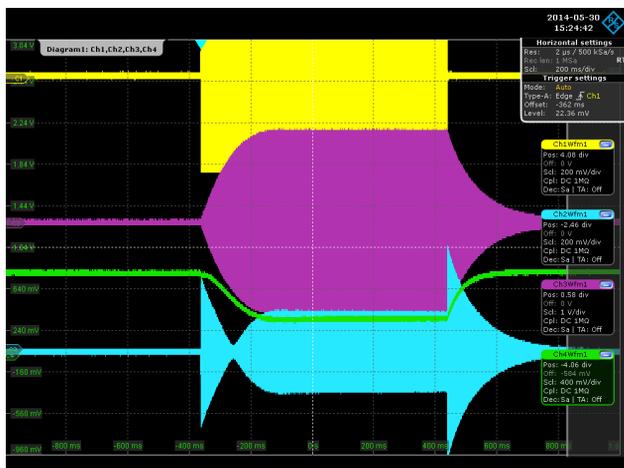
ACKNOWLEDGEMENT

Figure 8: LFD-signature on the VCO-signal (green curve) at 8.5 MV/m gradient pulsed operation.

Furthermore measurements in pulsed mode have been conducted to study Lorentz-Force-Detuning behaviour. Figure 8 shows an example of the VCO response at a field level of 8.5 MV/m. The according frequency shift compensated by the control system is -435 Hz yielding a LFD factor of -6.1 $Hz/(MV/m)^2$ (s. Fig. 9).

CONCLUSION AND OUTLOOK

The cold measurements showed a very promising performance of the CH-cavity with gradients of 8.5 MV/m at 4 K and 14.1 MV/m at 2 K for a Q of $1 \cdot 10^9$ and $3 \cdot 10^9$, respectively. Next steps are the welding of the helium vessel to the cavity, a final HPR treatment and tests in a large vertical cryostat at the new cryo-bunker at IAP.

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