ISBN: 978-3-95450-184-7 doi:10.18429/JACoW-IPAC2018-WEPML040

FURTHER TESTS ON THE FINAL STATE OF THE SC 325 MHz CH-CAVITY AND COUPLER TEST BENCH UPDATE*

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Abstract

At the Institute of Applied Physics, Goethe-University Frankfurt, a sc 325 MHz CH-cavity has been developed and successfully tested up to 14.1 MV/m and has now reached the final production stage with the helium vessel made of titanium welded to the frontal joints of the cavity and final surface processing steps being performed. Further tests in a vertical test environment are being prepared for intensive studies. This cavity is a prototype for envisaged beam tests with a pulsed ion beam at 11.4 AMeV. Furthermore, first measurements of the recently installed coupler test bench at GSI, Darmstadt, are shown. This test bench has been designed to process power couplers at 217 MHz within a broad frequency range. The coupler for CH0 of the cw LINAC has already been processed successfully up to 2.5 kW in cw operation with the test bench setup.

STATUS AND FURTHER PLANNED MEASUREMENTS ON THE SC 325 MHz CH-CAVITY

The superconducting 325 MHz CH-cavity has been designed and built as a successor to the 360 MHz CH-prototype [1] utilizing a multicell geometry yet featuring compact and short dimensions with only few drift spaces (Fig. 1). In previous measurements this cavity reached gradients up to 8.5 MV/m (at 4 K) and 14.1 MV/m (at 2 K) while maintaining a high Q-value and only be limited by a thermal quench at high field levels [2]. Further specs of the cavity are shown in Table 1.

Table 1: Specifications of the 325 MHz CH-Cavity

Parameter [unit]	Value
β	0.16
frequency [MHz]	325.224
no. of cells	7
length ($\beta\lambda$-def.) [mm]	505
diameter [mm]	347
E_a [MV/m] (4 K / 2 K)	8.5 / 14.1
E_p/E_a	5
B_p/E_a [mT/(MV/m)]	13
G [Ω]	66
R_a/Q_0	1260

Figure 1: Left: Rendered cross section of the 325 MHz CH-Cavity. Right: Cavity with fixed helium vessel.

Figure 2: Left: Separated helium vessel comprising membrane bellows. Right: Replacement component.

After successful mounting of the helium vessel (leakage found inside one of the membrane bellow cells of the coupler flange led to a long delay of completion (Fig. 2)) and repeated surface processing (HPR) the cavity can now be prepared for further tests inside a large vertical cryostat at IAP, Frankfurt (Fig. 3).

TEST BENCH UPDATE FOR THE 217 MHz POWER COUPLERS

In order to achieve the goal of a future super-heavy element (SHE) production at GSI [3] a first step is the realisation of a cw-LINAC Demonstrator [4]. For the sc CH-cavities dedicated power couplers have been developed to fulfill the design requirements of up to 5 kW input power [5]. In order to test the upcoming 217 MHz power couplers for the cw LINAC at GSI, Darmstadt, a newly developed dedicated test bench has been built and installed at GSI. The main part of

* Work supported by GSI, HIC for FAIR, BMBF Contr. No. 05P15RFRBA, EU Framework Programme H2020 MYRTE Contr. No. 662186
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Figure 3: Vertical test environment for further measurements of the cavity.

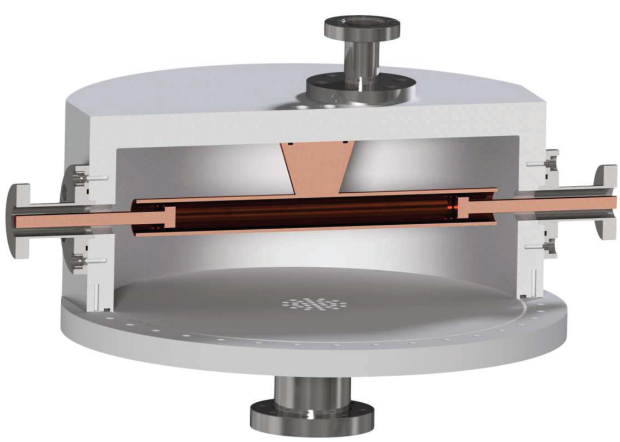
Figure 4: Rendering of the quarter-wave resonator alike structure.

the test bench consists of a compact, cylindric wave guide structure with a quarter-wave resonator alike interior but with a long center tube allowing to use different coupler configurations (Fig. 4). Using this type of geometry it is possible to transmit power from one coupler to another with a very high transmission rate over a broad frequency bandwith of ±10 MHz around the target frequency of 217 MHz (Fig. 5). The test bench construction allowed a conditioning process for two couplers simultaneously which were equipped with two Langmuir probes and pressure gauges each to detect multipacting events/ degassing. Additionally, the probes

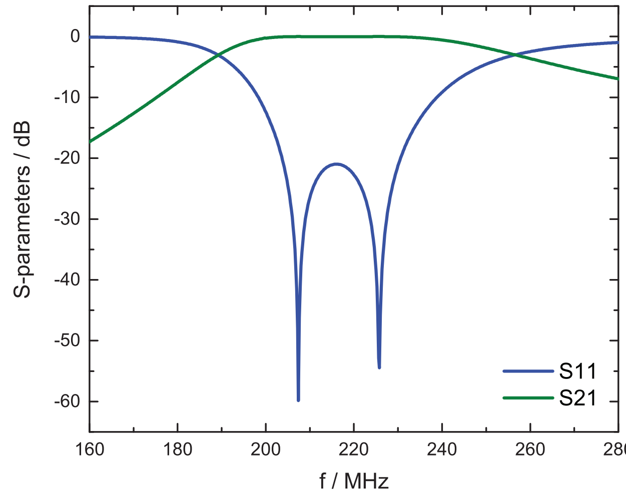

Figure 5: Transmission and reflection parameters for the test bench structure.

were biased with 50 V to suppress/ absorb possible electron avalanches. The input coupler was connected to a 5 kW solid state amplifier and a pulse generator. Furthermore, the forwarded and reflected power of the input coupler and the transmitted power of the output coupler have been recorded, too (Fig 6). The output coupler was mainly connected to a water cooled load but could also be terminated by a short or open cable end.

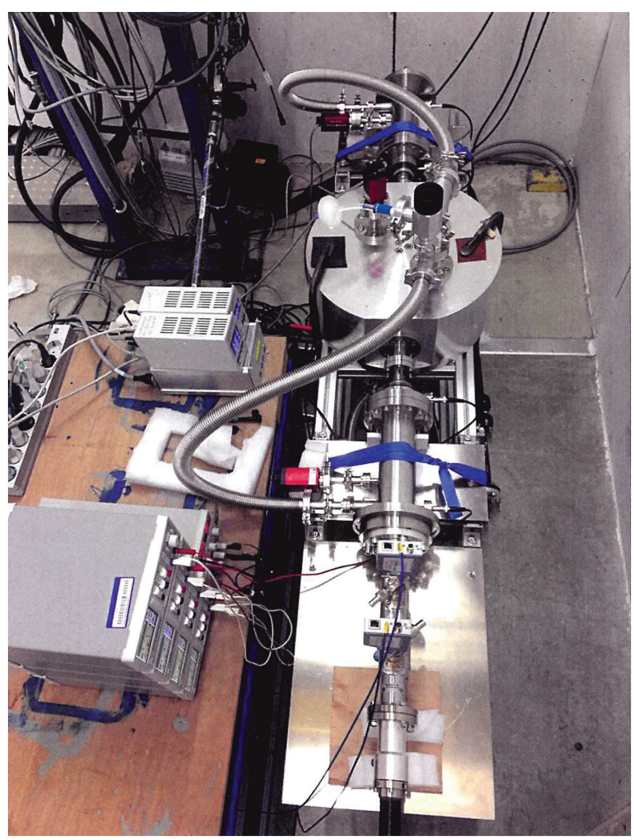
Figure 6: Transmission and reflection parameters for the test bench structure.

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TEST AND CONDITIONING PROCESS

Initially the couplers were preconditioned with 2 ms, 5 Hz pulsed power. Stepwise the duty factor has been increased to 100%.

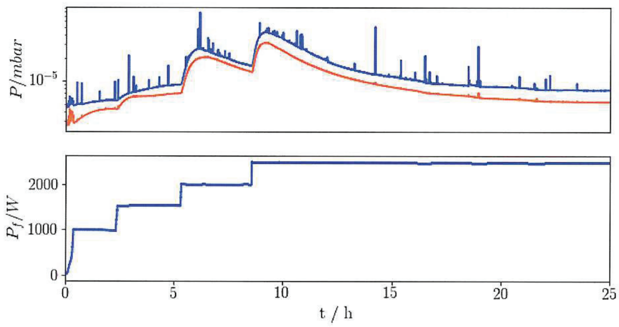

Figure 7: First phase of conditioning process with several degassing events at the input coupler.

In Fig. 7 the first conditioning campaign is shown. Within the first 25 h several degassing events occurred mainly in the input coupler (input coupler - blue curve, output coupler - orange curve). In the final phase of the conditioning process some multipacting events were detected within the Langmuir probes (Fig. 8, top). These scenarios occurred while changing the input power in differently large steps. Finally no more current from the Langmuir probes was noticed and the pressure inside the couplers remained on a constant level. Since the power coupler design is based on a non-cooled geometry it was only possible to process the couplers up to 2.5 kW cw power due to thermal issues at the ceramic windows. Finally, one of the processed couplers could be applied to successfully accelerate a heavy ion beam coming from the High Charge State Injector at GSI with different mass to charge ratios with the usage of a superconducting multigap CH-cavity for the very first time [6].

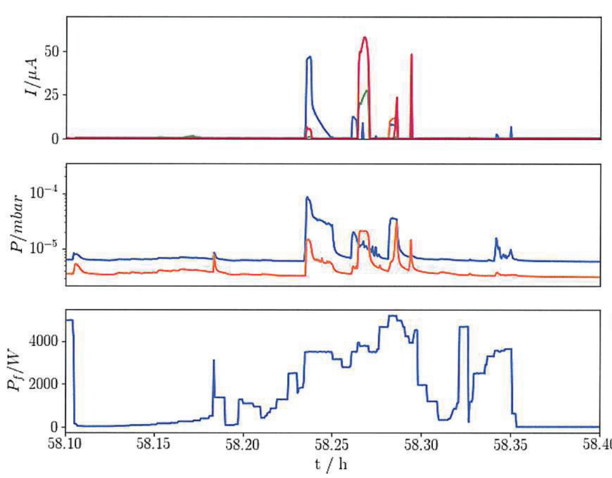

Figure 8: Final phase of conditioning process.

ACKNOWLEDGEMENT

This work has been supported by GSI, BMBF contr. No. 05P15RFRBA. We also acknowledge the support of the European Framework Programme H2020 MYRTE Contr. No. 662186 and of the Helmholtz International Center for FAIR within the framework of the LOEWE program (Landesoffensive zur Entwicklung Wissenschaftlich-Ökonomischer Exzellenz) launched by the State of Hesse. We'd also like to thank our partners at GSI/HIM for the close and kind collaboration.

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