# UPDATE ON THE SC 325 MHz CH-CAVITY AND POWER COUPLER PROCESSING*

M. Busch†, M. Amberg, M. Basten, F. Dziuba, P. Mundine, H. Podlech, U. Ratzinger
Institute for Applied Physics, Frankfurt am Main, Germany

*Abstract*

The 325 MHz CH-cavity which has been developed and successfully vertically tested at the Institute for Applied Physics, Frankfurt, has reached the final production stage. The helium vessel has been welded to the frontal joints of the cavity and further tests in a horizontal environment are in preparation. The corresponding 325 MHz power couplers have been conditioned and tested at a dedicated test stand up to the power level of 40 kW (pulsed) for the targeted beam operation. The final step of the whole prototype development is a beam test with a 11.4 AMeV, 10 mA ion beam at GSI, Darmstadt. Furthermore a new developed test stand for the 217 MHz power couplers is in preparation for the cavities of the sc cw-LINAC project at GSI.

## STATUS UPDATE ON THE 325 MHz CH-CAVITY

After successful tests with gradients up to 14.1 MV/m at 2 K [1] the 325 MHz CH-cavity was sent back to Research Instruments for final weldings of the helium vessel and surface treatment. However the final leak tests discovered a

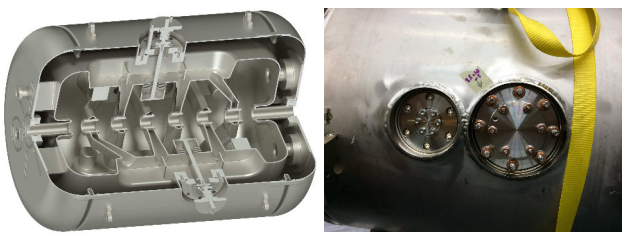

Figure 1: Left: Cross section of the 325 MHz CH-Cavity. Right: Position of the leak (power coupler port).

small leak inside the membrane bellow within the port for the power coupler (s. Fig. 1). Due to the complex and sensitive position of the leak it was decided to cut out a race track

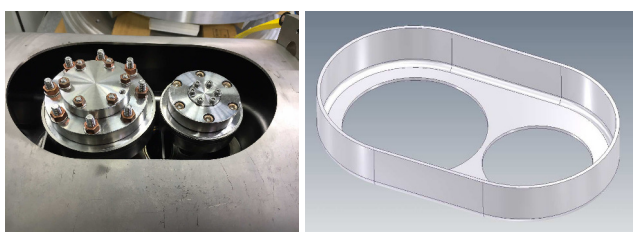

Figure 2: Left: Separated helium vessel comprising membrane bellows. Right: Replacement component.

profile around the coupler ports comprising the membrane bellows. A replacement structure is now being produced and will be installed within the next weeks (s. Fig. 2).

## 325 MHz POWER COUPLER TEST SETUP

For the tests of the 325 MHz power couplers a dedicated test stand has been arranged [2]. This setup consists of a

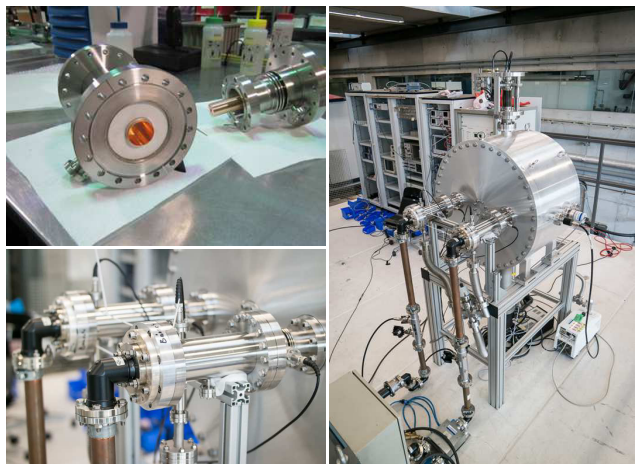

Figure 3: Pictures of the coupler's cold and warm parts (top left) and the assembly with the pill box cavity.

tuneable pillbox cavity and enables two power couplers to be conditioned up to 40 kW pulsed power (s. Fig. 3). The couplers were equipped with two Langmuir probes each which were biased with 50 V, four Peltier elements for temperature measurement and a vacuum port. Besides the measurement of $P_f$ and $P_r$ the current of the Langmuir probes (only the current at the warm end of the input coupler is displayed) as well as the pressure between the alumina windows has been recorded to detect Multipacting events (Fig. 4 to 6).

## CONDITIONING PHASE

In a first step the couplers were preconditioned with 200 W cw power until the pressure reached a sufficient level ($10^{-6}$ mbar). Then 5 Hz, 1 ms pulses were applied with progressive power from 200 W to 40 kW. The conditioning steps are presented in three parts. In the range from 200 W to 2200 W small pressure variations occured at 1.1 kW to 1.5 kW without any rise in current (s. Fig. 4). This effect is due to degassing and cleaning of the surface. Then several multipacting barriers emerged up to 2.2 kW. The conditioning time for this part was 10 h. The range from 5 kW to 11 kW took 80 min and showed only few and single barriers (s. Fig. 5). The final part from 30 kW to 40 kW took 180 min.

* Work supported by GSI, BMBF Contr. No. 05P15RFRBA
† busch@iap.uni-frankfurt.de


ISBN 978-3-95450-169-4

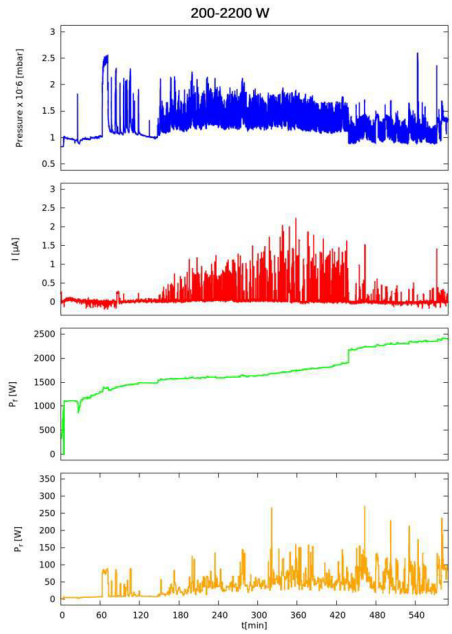


Figure 4: Measurement data for the power range 200 W to 2200 W.

In this range only one strong Multipactor occurred at 36 kW but could easily be surmounted (s. Fig. 6).

For temperature measurement four Pt100 elements were attached to the coupler parts (s. Fig. 7). The measurements were started at constant temperature of 21°C without power and then the power level was ramped up to maximum within 20 min. At equilibrium the maximum deviation to the initial temperature was 4.3°C at the cold window (T3) and 3.3°C at the warm window (T1).

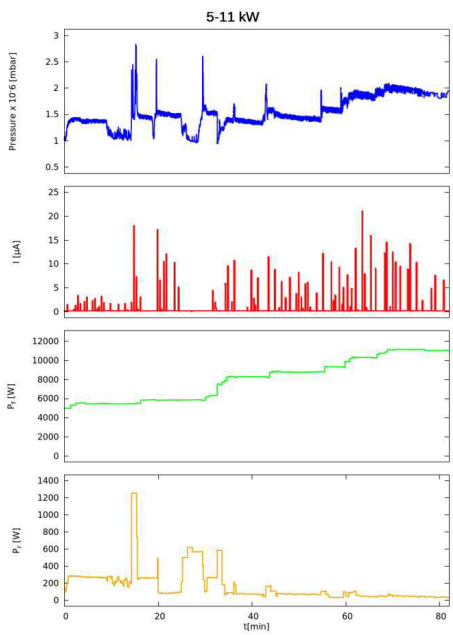


Figure 5: Measurement data for the power range 5 kW to 11 kW.

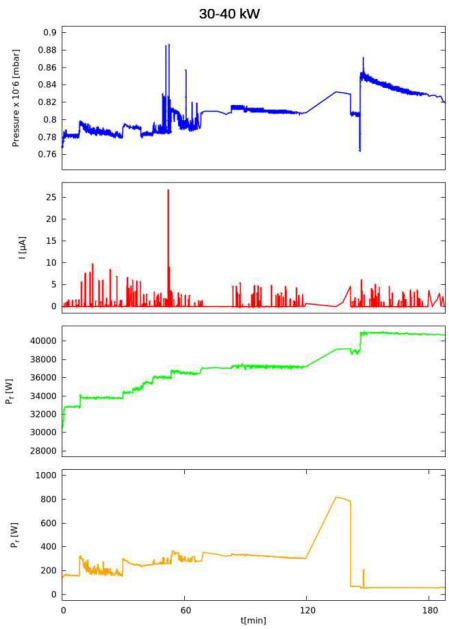


Figure 6: Measurement data for the power range 30 kW to 40 kW.

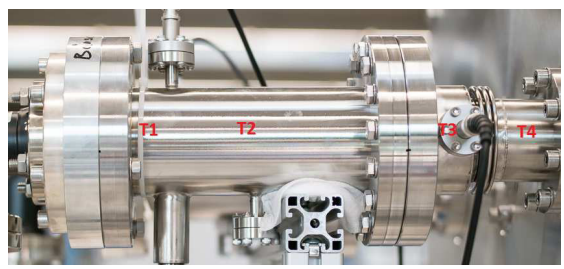


Figure 7: Temperature probes at the coupler surface.

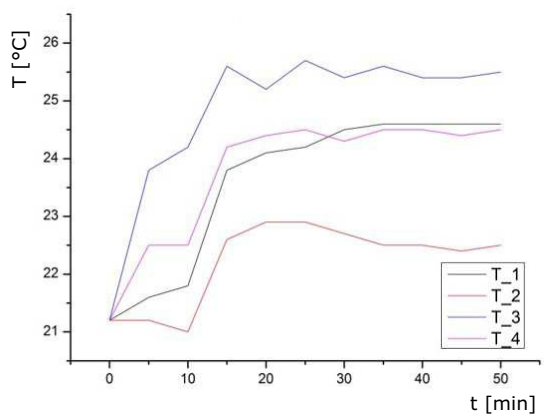


Figure 8: Measured temperature rise during power ramp up.

## TEST BENCH FOR 217 MHz FPCs

Pursuing 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 5 kW input power [5] (s. Fig. 9). As a test

Figure 9: Sectional view of the developed power coupler connected to a 217 MHz CH-cavity.

environment for the FPCs a new, dedicated test bench has to be set up due to the low frequency of the cw-LINAC (s. Fig. 10).

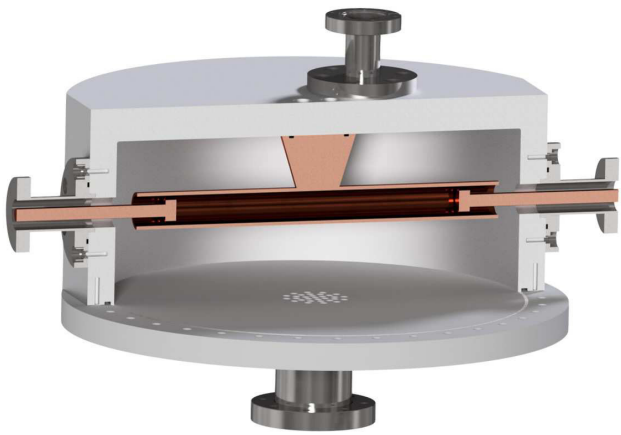

Figure 10: Cut-view of the proposed test bench cavity.

Utilizing a QWR-like cavity with an extended center tube to connect two couplers a broadband design (±10 MHz) could be found with a compact geometry and variable coupler configurations (s. Fig. 11).

## ACKNOWLEDGEMENT

This work has been supported by GSI, BMBF contr. No. 05P15RFRBA. We acknowledge also the support of the European Community-Research Infrastructure Activity under the FP6 Structuring the European Research Area program (CARE, contract number RII3-CT- 2003-506395). This work was (financially) supported by BMBF 06FY161I, 06FY7102 and by 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 for the close collaboration.

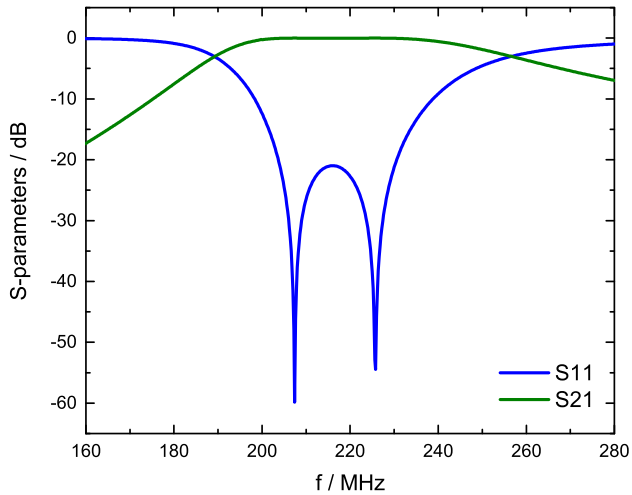


Figure 11: S-parameter properties of the QWR-like cavity.

## REFERENCES

[1] M. Busch, M. Amberg, M. Basten, F. Dziuba, H. Podlech, U. Ratzinger, "Recent Measurements on the sc 325 MHz CH-Cavity", Proceedings of SRF 2015, Whistler, BC, Canada, Sep. 2015, pp. 255-257.

[2] P. Mundine, "Design und Durchführung eines HF-Konditionierungsverfahrens für den fundamentalen Leistungskoppler der 325 MHz CH-Struktur", Master Thesis, Institute for Applied Physics (IAP), Goethe University Frankfurt, Germany, 2016.

[3] M. Schwarz *et. al.*, "Further Steps Towards the Superconducting cw-LINAC for Heavy Ions at GSI", Proceedings of IPAC 2016, Busan, Korea, May 2016, pp. 896-898.

[4] M. Miski-Oglu *et al.*, "Steps Towards Superconducting cw-LINAC for Heavy Ions at GSI", Proceedings of SRF 2015, Whistler, BC, Canada, Sep. 2015, pp. 262-264.

[5] R. Blank, "Entwicklung eines 217 MHz Hochleistungskopplers für das cw-LINAC-Demonstrator Projekt", Master Thesis, Institute for Applied Physics (IAP), Goethe University Frankfurt, Germany, 2015.




ISBN 978-3-95450-169-4