STATUS OF THE 325 MHz SC CH-CAVITY AT IAP FRANKFURT*

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Abstract

At the Institute for Applied Physics (IAP), University of Frankfurt, a s.c. 325 MHz CH-Cavity is under development for future beam tests at GSI UNILAC, Darmstadt. The cavity with 7 accelerating cells has a geometrical beta of 0.15 corresponding to 11.4 AMeV. The design gradient is 5 MV/m. The geometry of this resonator was optimized with respect to a compact design, low peak fields surface processing, power coupling and tuning. Furthermore a new tuning system based on bellow tuners inside the resonator will control the frequency during operation. After 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 rf simulations, multipacting analysis as well as preliminary coupler simulations will be presented.

THE 325 MHZ CH-CAVITY

Presently many projects with high requirements regarding beam power and quality (e.g. MYRRHA (**M**ulti Purpose H**Y**brid **R**esearch **R**eactor for **H**igh-Tech **A**pplications) [1]) and spallation neutron sources ask for new linac concepts. The superconducting CH-cavity fulfill these specification because it reduces the number of drift spaces between cavities significantl compared to conventional low-β ion linacs [2]. Along with KONUS beam dynamics, which decreases the transverse rf defocusing and allows the development of long lens free sections, this yields high real estate gradients with moderate electric and magnetic peak fields So far a 19-cell, superconducting 360 MHz CH-prototype has been developed and successfully tested. Gradients of up to 7 MV/m, corresponding to an effective voltage gain of 5.6 MV were reached [3]. For future operations a new design proposal for high power applications has been investigated. The new cavity will be operated at 325.224 MHz, consists of 7 cells, β = 0.1545 and has an effective length of 505 mm (see Fig. 1).

Novel components compared to the CH-prototype are:

- inclined end stems
- additional flange at the end caps for cleaning procedures

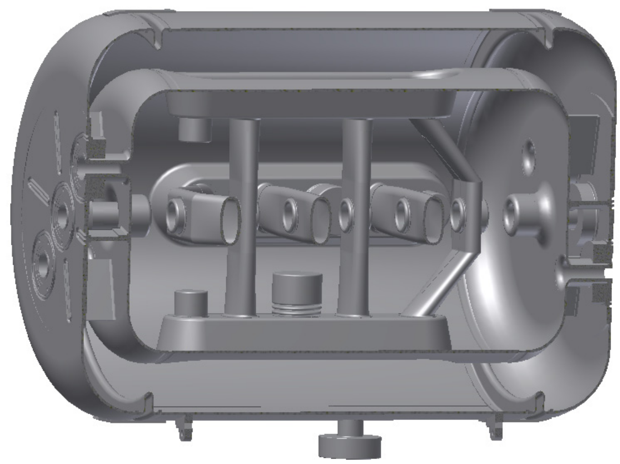

Figure 1: Layout of the superconducting 7-cell CH-Cavity (325.224 MHz, β = 0.1545) [4].

- two bellow tuners inside the cavity
- two ports for large power couplers through the girders

Table 1: Specification of the 325 MHz CH-cavity.

β	0.1545
frequency [MHz]	325.224
no. of cells	7
length ($\beta\lambda$-def.) [mm]	505
diameter [mm]	347.4
E_a [MV/m]	5
E_p/E_a	5.1
B_p/E_a [mT/(MV/m)]	13
G [Ω]	64
R_a/Q_0	1248
R_aR_s [$k\Omega^2$]	80

Inclined end stems yield a more homogeneous fiel distribution along the beam axis compared to straight stems because the magnetic high fiel volume and therefore the inductance is increased [5]. At the same time the longitudinal dimensions of the cavity can be reduced by about 20%-25% since an extended end cell is not needed for

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fiel flattening Flanges at the tank end caps provide an additional way to process the cavity surface with BCP (**B**uffered **C**hemical **P**olishing) and HPR (**H**igh **P**ressure **R**insing). In Table 1 the main parameters of this cavity are summarized.

MULTIPACTING SIMULATIONS FOR THE BELLOW TUNER

The rf and mechanical properties of the novel bellow tuner system have been discussed in [6],[7].

The original tuner design consisted of a six cell bellow

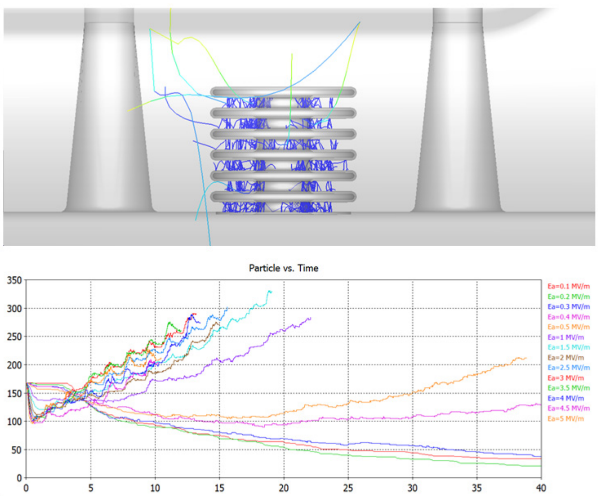

Figure 2: Top: Electron trajectories for multipacting simulations with the original six cell bellow tuner. Bottom: Number of Particles versus Time (ns).

with a height of 51 mm. Multipacting simulations [8] show an increasement of generated particles for low and medium f eld levels (see Fig. 2).

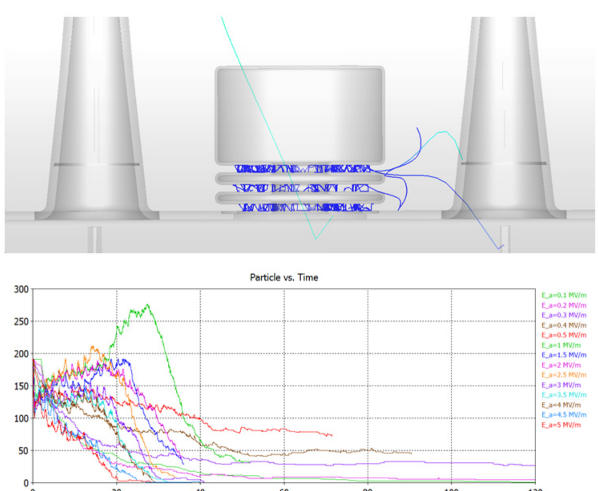

Figure 3: Top: Electron trajectories for multipacting simulations with the revised three cell bellow tuner. Bottom: Number of Particles versus Time (ns).

A revised geometry of the bellow with three cells reduces the risk of multipacting signif cantly (see Fig. 3). The mechanical stress for this type is higher but still tolerable for the planned tuning range.

POWER COUPLER DESIGN

For beam tests at GSI Unilac, Darmstadt, Germany, a dedicated power coupler has to be developed and fabricated. The existing power coupler for the SSR1 cavities at Fermilab meets the design goals for those beam tests and hence is appropiate as a reference model [9]. The requirements and boundary conditions are:

- 325 MHz
- 60 kW pulsed power
- up to 10 mA beam current
- 1% duty cycle
- 1-2 ms

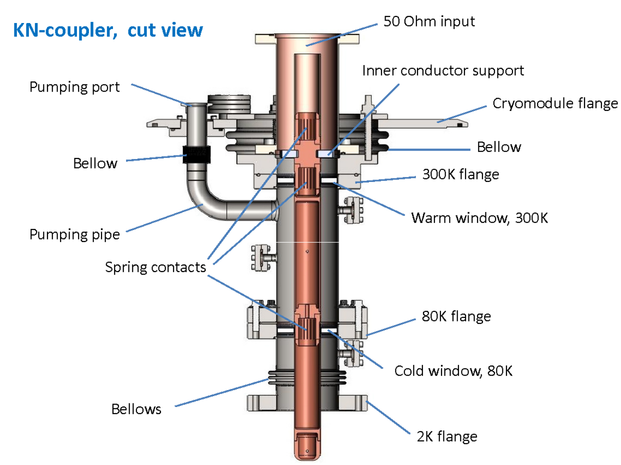

Figure 4: Schematic view of the power coupler design for SSR1 cavities by Fermilab.

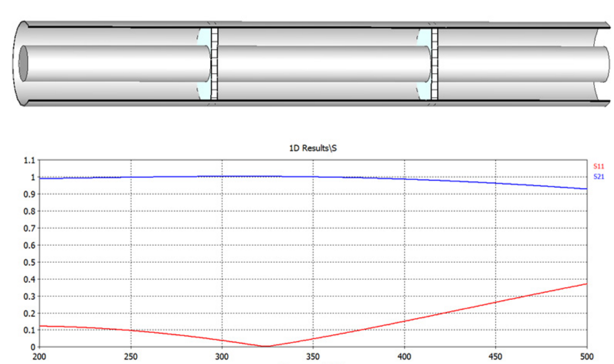

Figure 5: S-curves for the alumina positioning.

The required frequency of 325 MHz was already adjusted in the Fermilab design (see Fig. 5).

The diameter of the coupler flang on the helium vessel is smaller than that of the designed ”2 K flange from Fermilab. Therefore a matching section has to be inserted to ensure non-reflect ve operation: The smaller inner conductor is prolonged into the section of the larger diameter, which leads to a minimum for the reflectio (see Fig. 6).

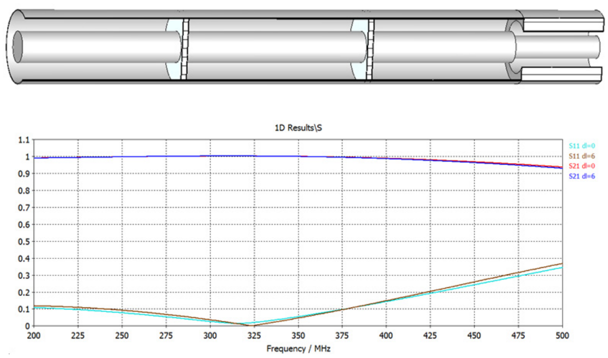

Figure 6: S-curves for the matching section.

FABRICATION STATUS

The construction of the cavity is in progress at Research Instruments, Bergisch-Gladbach, Germany. Most of the essential components are fabricated (e.g. girders, end caps (see Fig. 7), stems, drift tubes (see Fig. 8). The bellow tuners are currently in process of construction and the assembly of the cavity is about to start. First tests at 4 K are scheduled for the end of 2011 and beam tests are planned for mid 2012.

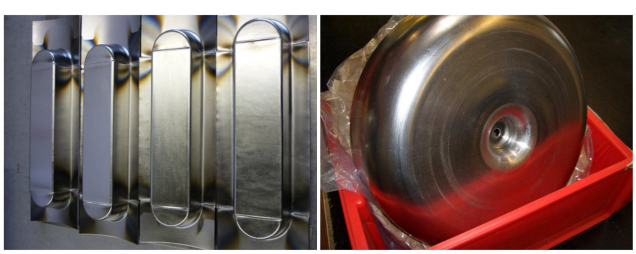

Figure 7: Pictures of the welded girders (left) and end caps of the cavity tank (right). Property of RI.

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Figure 8: Pictures of the inclined (left) and straight stem (right). Property of RI.

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