RECENT SUPERCONDUCTING CH-CAVITY DEVELOPMENT

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Abstract

The superconducting CH-Cavity (**C**rossbar **H**-Mode) is the first multi-cell drift tube cavity for the low and medium energy range of proton and ion linacs. A 19 cell, beta=0.1 cavity has been developed and tested successfully with gradients of up to 7 MV/m.The construction of a new superconducting 325 MHz 7-gap CH-cavity has started. This cavity has an optimized geometry with respect to tuning possibilities, high power RF coupling and minimized end cell lengths. After low power tests it is planned to test this cavity with a 11.4 MeV/u beam delivered by the Unilac at GSI.

THE 7-CELL 325 MHZ CH-CAVITY

Actual international projects with ambitious requirements regarding beam power and quality (e.g. IFMIF (**I**nternational **F**usion **M**aterial **I**rradiation **F**acility) / EUROTRANS (**EURO**pean Research Programme for the **TRANS**mutation of High Level Nuclear Waste in an Accelerator Driven System)) ask for new linac developments. The superconducting CH-cavity is an attractive candidate for those requirements because it reduces the number of drift spaces between cavities significantly compared to conventional low-β ion linacs [1]. Together with the KONUS beam dynamics which decreases the transverse rf defocusing and allows the development of long lens free sections this leads to high real estate gradients with moderate peak fields. A 19-cell, superconducting 352 MHz CH-cavity

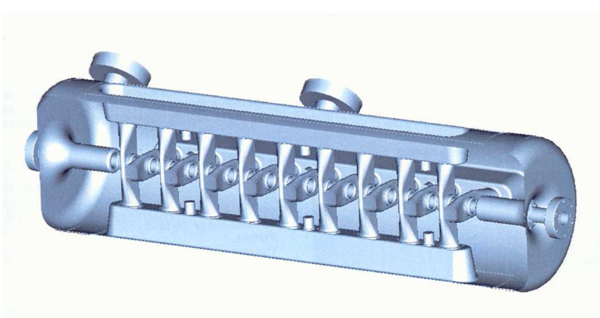

Figure 1: Sideview of the 19-cell, $\beta = 0.1$, 352 MHz CH-Prototype.

(see figure 1) has been developed and successfully tested in the past years. Gradients of up to 7 MV/m, corresponding to an effective voltage gain of 5.6 MV could be reached [2]. These results led to the design proposal of a new resonator laid out for high power applications (see figure 2). It operates at 325 MHz, consists of 7 cells, β = 0.1565 and has a length of 505 mm.

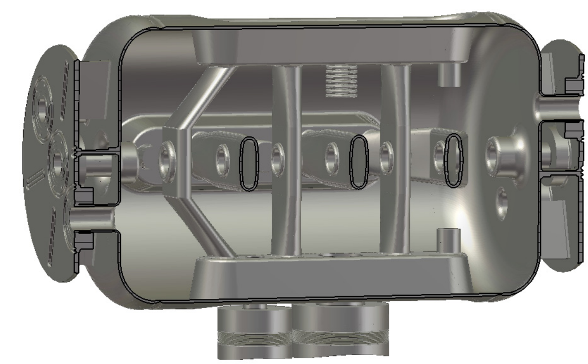

Figure 2: Design of the superconducting 7-cell CH-Cavity (325 MHz, β = 0.16).

The most important changes in comparison to the CH-prototype are:

- inclined stems at the ends of the cavity
- additional flanges at the tank caps for cleaning procedures
- membrane tuner

These elements can be seen in figure 2.

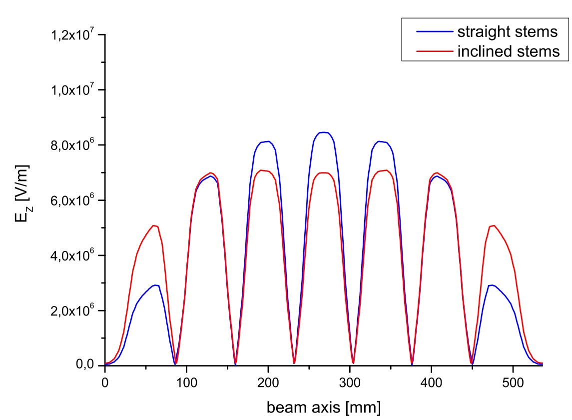

Figure 3: Field distribution for different stem / girder geometries.

The usage of inclined stems leads to a more homogeneous field distribution along the beam axis (see figure 3) compared with straight stems because the volume for the

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magnetic field is increased. At the same time the longitudinal dimensions of the cavity can be reduced by about 20% because a long end cell is no longer needed for field flattening. Flanges at the tank caps provide a pleasant 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 the new cavity are summarized.

Table 1: Specifications of the 325 MHz CH-cavity

β	0.1565
frequency [MHz]	325.224
no. of cells	7
length ($\beta\lambda$-def.) [mm]	505
diameter [mm]	356
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 [Ω^2]	80000

Furthermore a new way to tune the frequency during beam operation will be tested. While the CH-prototype was tuned by pushing the tank caps and varying the end cell of the resonator, the new cavity will use membrane tuners inside the structure. Two tuners (a fast and a slow one) will be placed on the girder and driven by a piezo. The slow tuner adjusts the frequency after cooling the cavity down, while the fast one regulates the frequency during beam operation. A prototype of the membrane tuner (see figure 4) has already been tested at room temperature. By applying different forces the spring constant could be determined (see figure 5). Further tests at 4 K and with piezo tuners will demonstrate if the needed frequency lift can be met.

Figure 4: Prototype of the membrane tuner.

In order to calculate the influence of the tuners rf simulations have been performed. The height of the static tuners was kept constant while increasing continuosly the height

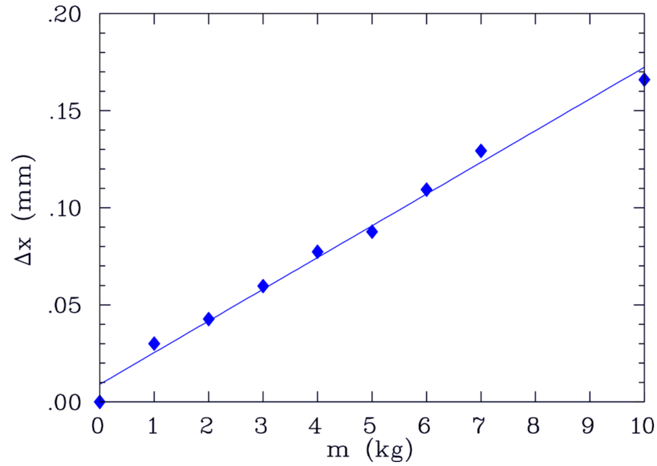

Figure 5: Determination of spring constant for the membrane tuner ($D = 654N/mm$).

of the membrane tuner. Figure 6 shows that at a working point of approximately 50 mm tuner height a shift of 150 kHz/mm is possible, which is sufficient for fast tuning during beam operation.

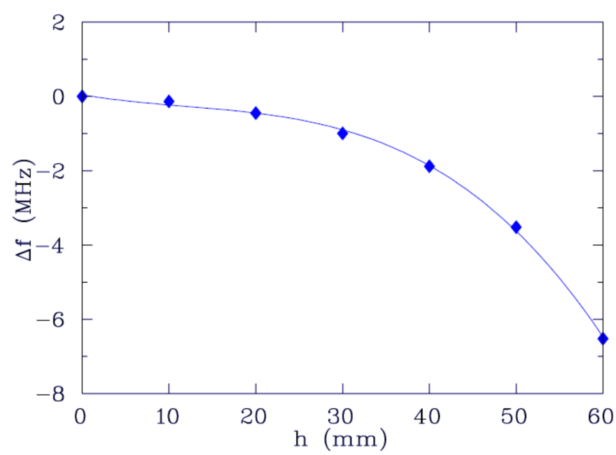

Figure 6: Tuning range of the membrane tuner.

It is intended to test the cavity with beam at the GSI UNILAC at the exit energy of 11.4 MeV. The frequency of 325 MHz is the third harmonic of the UNILAC.

THE COPPER MODEL

A room temperature copper model has been built to validate the electromagnetic simulations in the run-up to the fabrication of the superconducting structure (see figure 7) [3]. The design is very modular in order to modify the geometry for future purposes. Possible modifications include:

- cell number
- cell length
- cavity length

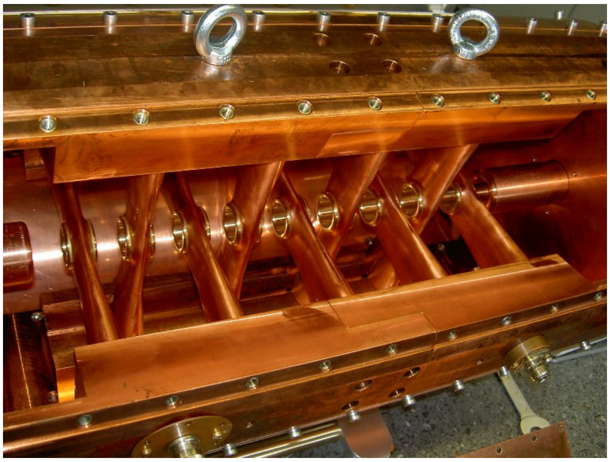

Figure 7: Photograph of the r.t. copper model.

- coupler size /position
- stem shape
- tuner position
- tuner size and shape

Bead pull measurements with an applied β-profile show an unflat field distribution at a constant gap to cell length ratio of 0.5 (see figure 8).

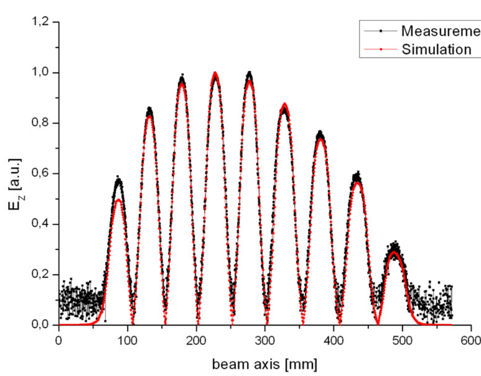

Figure 8: Longitudinal electric field distribution with β-profile.

By adjusting the gap to cell-length ratios, i.e. varying the drift tube lengths, the field distribution can be flattened (see figure 9).

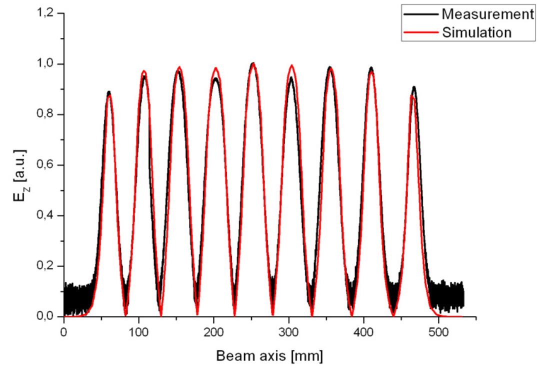

Figure 9: Longitudinal electric field distribution with flattened β-profile by variation of the gap to cell length ratio

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