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Development of Superconducting CH Cavities*

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Abstract:

At present, two superconducting (sc) CH cavities are under development at the Institute for Applied Physics (IAP) of Frankfurt University. The construction of a sc 325 MHz CH cavity with 7 cells and an envisaged design gradient of 5 MV/m is almost finished. It is planned to test this cavity with beam at GSI Universal Linear Accelerator (UNILAC), Darmstadt to show its performance as a candidate for the UNILAC upgrade. Furthermore, the 217 MHz CH structure with 15 accelerating cells and a real estate gradient of 5.1 MV/m will be the first cavity of the new sc continuous wave (cw) LINAC at GSI. This proposed cw LINAC is highly requested to fulfil the requirements of nuclear chemistry and especially for a competitive production of new Super Heavy Elements (SHE). To demonstrate the cavity capabilities under a realistic accelerator environment, a full performance test by injecting and accelerating a beam from the GSI High Charge Injector (HLI) is planned in 2013/14.

The 217 MHz CH Cavity for the new sc cw LINAC at GSI

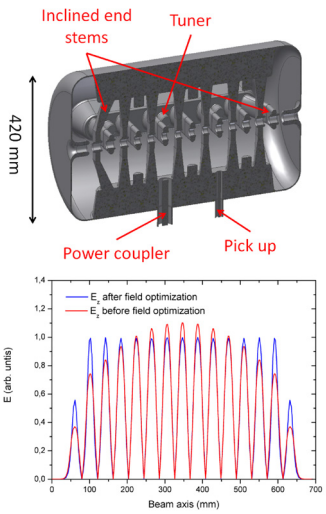

Figure 2: Layout of the sc 217 MHz CH cavity for the cw LINAC at GSI (top) and E_z along the beam axis before and after field optimization (bottom).

Cavity properties:

- EQUidistant mUlti-gap Structure (EQUUS beam dynamics)
- Inclined end stems
- 9 static tuners
- 1 slow bellow tuner
- 2 fast bellow tuners
- 10 kW power coupler
- Pick up

Table 2: Main parameters of the sc 217 MHz CH cavity.

Parameter	Unit	
β		0.059
Frequency	MHz	217
Gap number		15
Total length	mm	690
Cavity diameter	mm	420
Cell length	mm	40.82
Aperture	mm	20
Effective gap voltage	kV	225
Accelerating gradient	MV/ m	5.1
E_p/ E_a		6.5
B_p/ E_a	mT/ (MV/m)	5.9
R_a/ Q_0	Ω	3540

→ The rf design of the first CH cavity for the new sc cw LINAC at GSI is completed.

Current Status of the 325 MHz CH Cavity Fabrication

Figure 4: Deep-drawing of a grider component and an end cap of the cavity (top), final welded inclined end stem and a straight stem without drift tube (bottom).

The sc 325 MHz CH Cavity

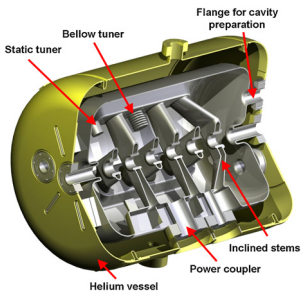

Figure 1: Design of the sc 325 MHz CH cavity for the GSI UNILAC upgrade.

Table 1: Specifications of the sc 325 MHz CH cavity.

Parameter	Unit	
β		0.16
RRR		>250
Frequency	MHz	325
Accelerating cells		7
Length (βλ-definition)	mm	505
Cavity diameter	mm	353
Accelerating gradient	MV/ m	5
E_p/ E_a		5.1
B_p/ E_a	mT/ (MV/m)	13
G	Ω	64
R_a/ Q_0	Ω	1248
R_aR_s	kΩ²	80

Cavity features:

- Inclined end stems
- Flanges at the end caps for cleaning procedures
- 4 static tuners inside the cavity
- 1 slow bellow tuner driven by a stepping motor
- 1 fast tuner driven by a stepping motor and by piezo element
- 60 kW power coupler, pulsed, 1% duty cycle
- Pick up
- Helium vessel from titanium

→ The construction of the sc 325 MHz CH cavity at Research Instruments (RI) GmbH, Bergisch Gladbach, Germany is almost finished.

Tuning Concept of sc CH Cavities

Matching the design frequency during the fabrication process of a sc CH cavity is one major challenge:

→ The cavity tuning will be done by several static and dynamic capacative tuners placed on the girders between the stems.

- Static tuners are used to reach the design frequency during fabrication procress
- Slow bellow tuners driven by stepping motors adjust the frequency after cooling down
- Fast bellow tuners driven by stepping motors and piezo elements regulate small frequency shifts during operation

→ Mechanical simulations have been performed to analyze the mechanical behaviour of the dynamic bellow tuners (see MOPO035).

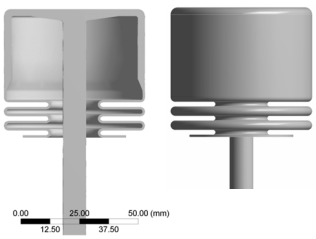

Figure 3: Schematic overview of an dynamic bellow tuner.

Table 3: Required frequency gain of the different tuner types for both cavities.

Tuner typ	Unit	Δf
Static tuners	MHz	±2
Fast tuners	Hz/ µm	±150
Slow tuners	kHz/ mm	±150

Summary & Outlook

The construction process of the sc 325 Mhz CH cavity is almost finished. It is planned to test the cavity with beam at the GSI UNILAC, Darmstadt in 2012.

The rf design of the 217 MHz cavity for the new sc cw LINAC at GSI is completed. Further rf, mechanical and multipacting simulations concerning the cavity tuning are in progress at the moment. The fabrication process of the cavity will start within this year. A full performance test with beam at the HLI is foreseen to demonstrate the cavity capabilities in 2013/14.