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STATUS OF THE FAIR PROTON LINAC

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Abstract

For the production of Antiproton beams with sufficient intensities, a dedicated high-intensity 325 MHz Proton linac is currently under construction. The Proton linac shall deliver a beam current of up to 70 mA with an energy of 68 MeV for injection into SIS18. The source is designed for the generation of 100 mA beams. The Low-Energy Beam Transport line (LEBT) contains two magnetic solenoid lenses enclosing a diagnostics chamber, a beam chopper and a beam conus. A ladder 4-Rod RFQ and six normal conducting crossbar cavities of CCH and CH type arranged in two sections accelerate the beam to its final energy of 68 MeV. The technical design of the DTL CH cavities is given and the commissioning measurements of the ion source are described. The construction and the procurement progress, the design and testing results of the key hardware are presented.

OVERVIEW

Figure 1 and Tab 1. shows the main properties and the structure of the Proton Linac [1], [2], [3]. It will serve as injector into the existing Heavy Ion Synchrotron (SIS) 18 for the research program with cooled antiprotons at the facility of antiproton and ion research (FAIR) [4].

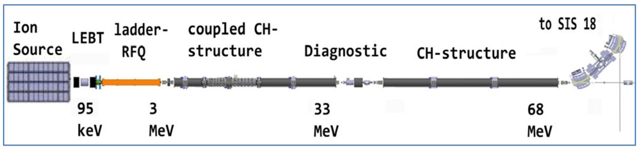

Figure 1: Layout of the FAIR Proton Linac.

Table 1: Main Parameters

Particle	Proton (H^+)
Ion source	95 keV
MEBT energy	3 MeV
CCH section	33 MeV
Final energy	68 MeV
Pulse current	70 mA
RF-frequency	325.224 MHz
Rep. rate	2,7 Hz

ION SOURCE AND LEBT

The commissioning of the Proton source is ongoing at CEA, Saclay [5] and will be completed by the end of this year. By means of AC current transformer, fast current transformer FC, Wien filter (beam proportion) and Alison Scanner (emittance measurements), the extracted Proton beam has been characterized with different setting of the LEBT solenoids and the ion source. An example measurement is shown in Fig. 2. Particle distributions drawn from measurements with the Allison scanner have been used for RFQ tracking simulations [6].

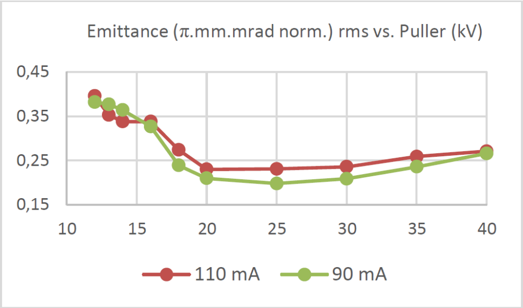

Figure 2: Ion source emittance scan at CEA.

LADDER RFQ

After assembly of the ring-electrode system and the assembly of the ladder structure inside the vacuum chamber last year (Fig. 3), the ladder structure was adjusted to the final frequency and flatness [7]. The RFQ design includes the compensation of longitudinal entrance gap field effects [8]. The final assembly of all parts in preparation of RF tests at GSI [9] will be performed during this year at IAP Frankfurt.

Figure 3: View on the full length ring-electrode structure (top) and the assembly of the ladder structure inside the RFQ vacuum chamber (bottom).

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CH STRUCTURES

To facilitate the assembly of the magnetic triplet lenses of the CCH cavities in future the design of the couple cells has been redesigned. A flange on the top (Fig. 4) will allow the assembly through the upper opening.

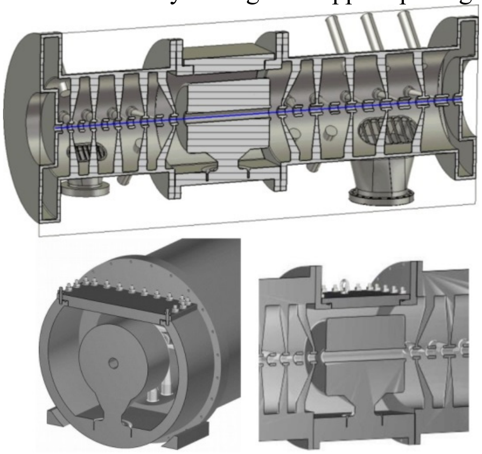

Figure 4: 3D sketch of the CCH1 geometry (top) with details of the new designed vertical flange opening of a couple cell (bottom).

In order to optimize the copper plating of the narrow structures of the first CCH cavity, several test runs with dedicated dummy structures will be carried out in advance. Examples results are shown in Fig. 5

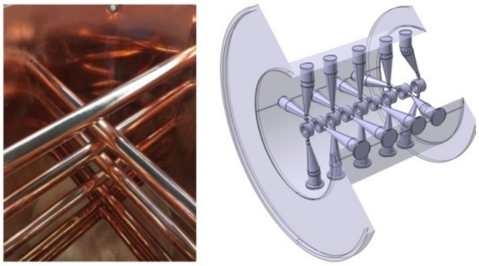

Figure 5: View on the surface after the first copper plating test for a CCH1 dummy (left) and 3D sketch of the dummy section for the final CCH1 copper plating test (right).

First welding tests for the joints of the stems to the CH tank were performed (Fig. 6). As the welding connection has to be carried out from outside for series production it is foreseen to test and compare several welding procedures.

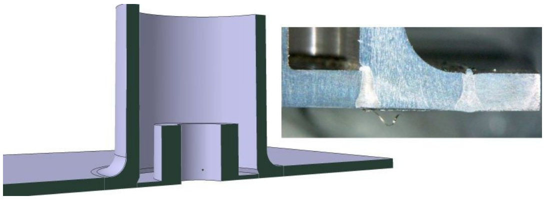

Figure 6: Detail of the CH stem geometry for the welding dummies (left) with grinding pattern of the welding joints after the first E-Beam welding test (right).

MECHANICAL INTEGRATION

The design of the cavities was finally tuned taking into account the plunger and the redesigned couple cells and intertank sections [10]. The length of the diagnostic section at 33 MeV (Fig. 7) has been extended to simplify mechanical integration. The installation of a 6-gap rebuncher cavity will be possible. This will significantly reduce the RF power requirements for this rebuncher.

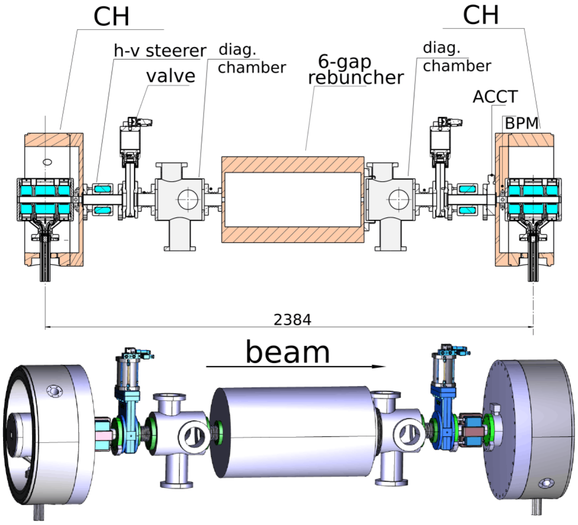

Figure 7: Layout (top) and 3D drawing (bottom) of the diagnostic section at 33 MeV with a 6-gap rebuncher.

Shortening intertank BPMs (Fig. 8) and elongated intertank sections between the cavities will allow the integration of the BPMs and the triplets.

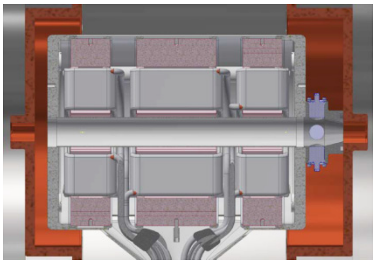

Figure 8: Cross section of the intertank section between two CH structures with integrated triplet and BPM.

Further investigations have been carried out on the CH prototype [11], [12]. On the one hand, RF shielding measurements for the BPMs located in the intertank section were carried out. On the other hand, bead pull measurements and CST simulations were systematically compared [13].

BEAM DYNAMICS

Within the final design of the cavities end-to-end beam dynamics simulations with error studies were performed [9]. They start from a thermal distribution in the ion source plasma chamber and end after the multi-turn injection into synchrotron SIS18. Particle distributions created

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from LEBT measurement during the ion source commissioning have also been examined for that purpose.

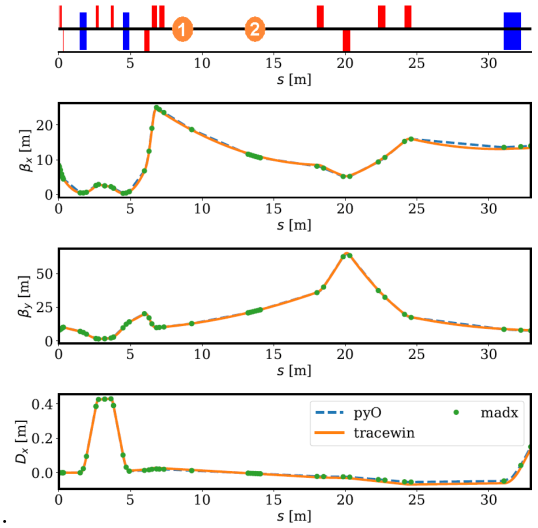

Figure 9: Beam optic layout of the transfer channel with two possible positions ① and ② for the debuncher.

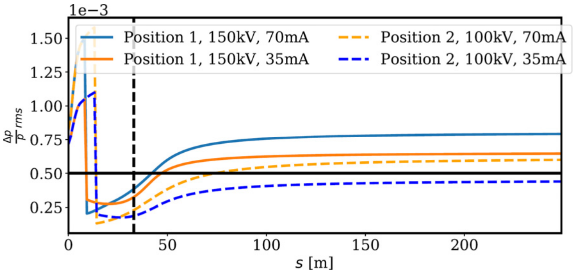

Figure 10: Evolution of the momentum spread along the transfer channel and the first turn in SIS18 for different beam currents and debuncher positions.

After an achromatic 90°-inflection into the existing transfer channel UNILAC-SIS18 a debuncher tilts the longitudinal phase space distribution in order to provide a minimized momentum spread at injection into the synchrotron SIS18. The final full momentum spread should be with the RF requirement of 10^{-3}. As shown in Fig. 9 and Fig. 10 a debuncher at position 2 and a beam current of 35 mA at SIS18 injection can provide a minimized momentum spread with fulfil the RF requirement [13].

ACKNOWLEDGEMENTS

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