Status of the proton injector for FAIR

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The microwave ion source and low energy beam transport (LEBT) for the injection into the proton linac have to deliver a 100 mA proton beam with an energy of 95 keV at the entrance of the RFQ within an acceptance of 0.3π mm mrad (normalized rms). The source SILHI (high intensity light ion source) at CEA/Saclay meets these requirements. It operates with a frequency of 3 GHz and allows high brightness ion beams with energies up to 100 keV and full beam currents of 130 mA [1].

The proton injector for the FAIR facility is presented in Fig.1. The microwave ion source runs in a pulsed mode by pulsing the rf generator. The RF power is produced by a magnetron and injected into the source via standard rectangular wave guides. The duty cycle is 4 Hz with a pulse length of 0.2 ms. The minimum pulse duration is 300 µs with a 100 µs rise and fall time. The source is able to run with a long time of operation (several months) with good performance as noise to beam fluctuation ≤5 % and pulse-to-pulse repetition ≤2.5 %.

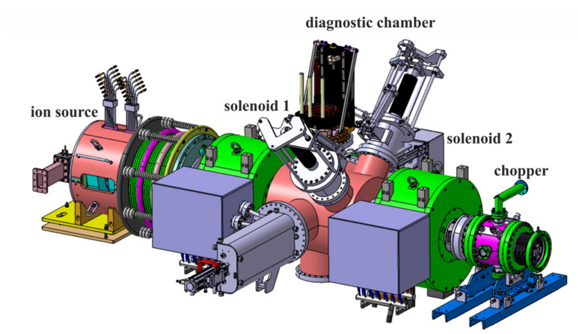

Figure 1: The proton injector for the FAIR (microwave ion source and LEBT)

The LEBT consists of two solenoids with a maximum magnetic field of 260 mT and two magnetic steerers to adjust the horizontal and vertical beam position [2]. The diagnostic chamber between both solenoids includes Iris (beam diaphragm), Allison scanner (emittance measurement), Secondary Emission (SEM)-Grid (beam profiler), beam stopper and a Wien filter (mass separator). The Iris is required for transverse beam limitation. The Wien filter composed of a 0.2 Tesla window frame and two electrodes inside with adjustable voltage allows the detection of different ion species (H^+, H_2^+, H_3^+) as a check of beam composition. For measuring ion beam intensity behind the pentode extraction system and at the end of the beam line a beam current transformer (ACCT) is installed. An electrostatic chopper right in front of the RFQ will shorten the beam pulse current to 36 µs [3].

The beam dynamics simulation in the proton injector is presented in Fig.2. The calculations were performed with TraceWin [3]. The simulations start at the plasma electrode of the ion source and ended at the entrance of RFQ. To simplify the calculations, the space charge compensation degree is considered constant in all the beam line and its value has been assumed to be 80 %. The compensation in the source extraction region and in the region between chopper and RFQ is less than 80 %. The estimated emittance and twiss parameters according to calculations are ε=0.18π mm mrad, α=0.48 and β=0.04 mm/mrad.

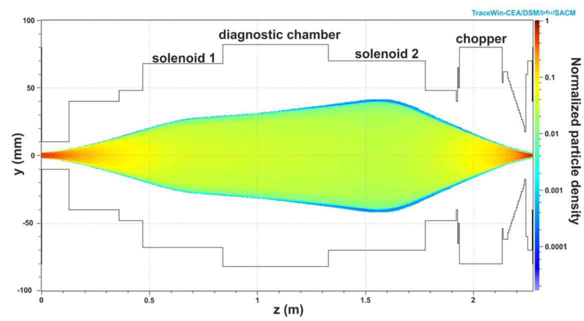

Figure 2: The beam particle distribution in the FAIR p-injector (performed by N. Chauvin)

At the end of 2013 it is planned to start the commissioning at CEA/Saclay, to perform the emittance measurements, space charge compensation measurements with a 4-grid-analyzer, current measurements and determination of the beam fractions as well as check for the reliability. The emittance measurements will be performed with a mobile emittance scanner [5] from GSI (MobEmi) that consists of two vacuum chambers including diagnostic components. The MobEmi will be installed at the end of the LEBT close to the later entrance of the RFQ.

After the commissioning the microwave ion source and LEBT will be transported to GSI for the commissioning and later operation of the proton linac. The installation into the tunnel is planned in the beginning of 2017.

References

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