FIRST RESULTS OF THE PROTON SOURCE FOR THE FUTURE P-LINAC AT FAIR

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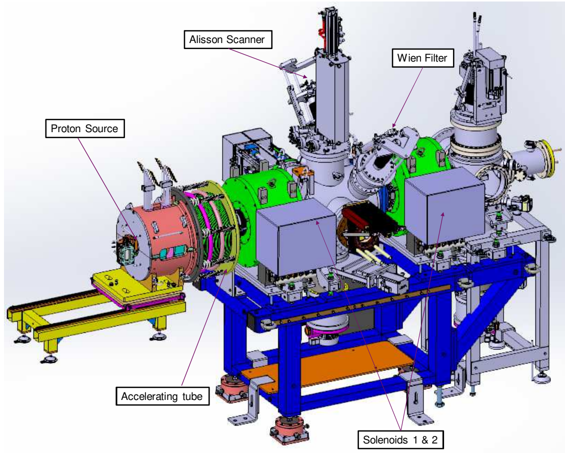
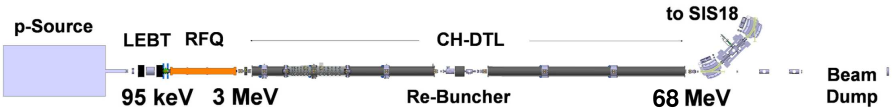
❑ Abstract

The construction of the source and Low Energy Beam Transport of the future Proton-Linac for the FAIR (Facility for Antiproton and Ion Research) facility in Darmstadt, Germany is going forward. The latest results of normalized emittance and of species repartition are shown at two different positions, firstly directly at the source exit and secondly behind the first solenoid. A new software separating the different species for emittance measurement was used to process data.
We present here the status of the project in summer 2018.

❑ Setup / Proton Source & Injector





Layout of the FAIR proton linac.

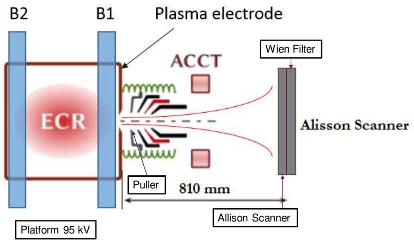
Beam Parameters of the P-Linac Injector	Value
Energy	95 keV
Intensity	100 mA (H^+)
Repetition rate	≤ 4 Hz
Energy spread	< 60 eV
Pulse length	≥ 36 µs
Final Emittance	≤ 0.33 π mm.mrad
α Twiss parameter	0.27 ≤ α ≤ 0.59 mm/π.mrad
β Twiss parameter	0.037 ≤ β ≤ 0.046 mm/π.mrad

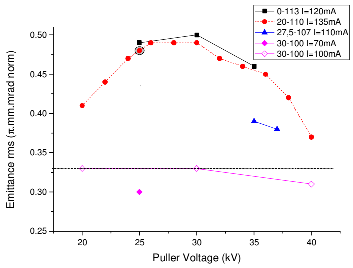
The P-Linac injector is composed of an Electron Cyclotron Resonance (ECR) ion source, a Low Energy Beam Transport (LEBT) line, a 3 MeV Radio-Frequency Quadrupole (RFQ) and a Drift Transport Line (DTL) using Cross-bar H-mode cavities (CH).

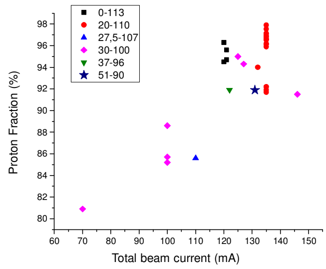
The ECR phenomenon needs, to occur, the presence of an axial magnetic field produced by two coils, independently power-supplied and tuned in order to reach a constant on-axis magnetic field value of 0.875 T, possibly as close as possible to the ridge output concentrating the 2.45 GHz RF-wave from the magnetron. Electron density is increased thanks to two boron nitride disks.

❑ Measurements

At the source exit





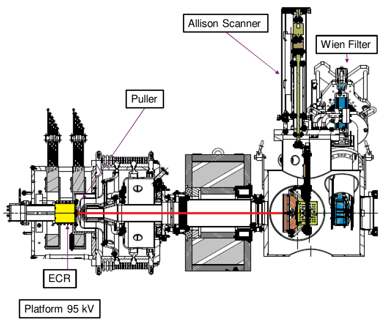


Measurements were performed for different B1/B2 current configuration (A), different total beam current (mA) and by varying puller voltage (kV).
Emittance was measured with an Allison Scanner, proportion with a Wien Filter.

The targeted rms emittance at the RFQ input is ≤ 0.33 π mm.mrad norm.
The higher the total intensity is, the higher the emittance, due to space charge.
The puller voltage concentrates more or less the beam, modifying the emittance (already seen on IFMIF).

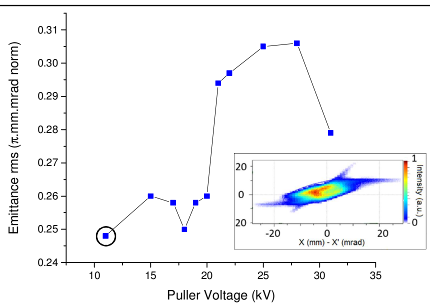
The higher the beam intensity is, the higher the proportion of H^+.
Data acquired with a Wien Filter (in the beam center) seem too optimistic.

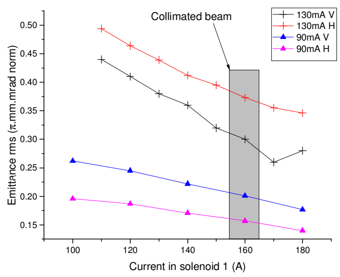
Behind 1st solenoid



The influence of total beam intensity in H^+ proportion is confirmed.
Results obtained by post-processing global emittance figures seem closer to reality.
The WF measures only in the beam center while analysis takes the whole beam.

Total beam intensity	H^+ proportion	
	WF	Analysis
130 mA	98.9 %	89.9 %
90 mA	93.5 %	84.9 %





Measurements were performed in 0/113 coils configuration vertically and horizontally.
Emittance was measured with an Allison Scanner, proportion both with a Wien Filter and by post-processing the total emittance figures.

The influence of puller voltage on the emittance was done with a collimated beam (sol.1 current at 160 A) after the 1st solenoid. The total beam current is equal to 90 mA.
The same pic around 29 kV is observed as at the source output.

The insert shows a concentrated emittance beam corresponding to the encircled data.

The higher the focusing is, the lower the emittance.
Vertical and horizontal measurements do not perfectly overlap. For high current, the horizontal one is higher, for lower current, the vertical one is higher.
Unfortunately, the beam line had to be opened to switch from V to H configuration.

❑ Conclusions

First results of emittance value, proton energy and beam current just at the source output and behind the 1st solenoid show that targeted parameters at the RFQ input are reachable. It has to be confirmed by direct measurements behind the 2nd solenoid in a next step.