Beam Characterization of the MYRRHA-RFQ

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Transport Mode and Ion Beam Scrubbing for a Helium Beam

Based on the measurements of [1], the ion beam scrubbing mode was numerically investigated with Bender [2]. First results show, that Helium is not accelerated in the RFQ and is very sharp at injection energy (120keV). The „transport mode“ is well suited for calibrating a momentum spectrometer and for the validation with the ion beam scrubbing technique.

Beam Dynamics of the Acceleration Mode for a Proton Beam

First results of the simulations with the 3D-PIC-code Bender are shown for the analysis of the beam transport within an RFQ. They also serve as expectation values for the planned measurements with the diagnostic train.

Calibration of the Momentum Spectrometer

The upcoming measurements at the MYRRHA injector are currently being prepared. The momentum spectrometer has already been calibrated. The corresponding measurements can be found in Figure 11.

Once calibrated, the diagnostic train is quickly ready for future measurements with high accuracy and short lead time.

Figure 1: Transmission and ratio of accelerated particles for a 1 mA Helium beam.

Figure 2: Energy spread for 120-kV Helium downstream the RFQ.

Figure 3: Diagnostic train in operation: Emittance meter (left), Beam Dump (center) and Momentum Spectrometer (right).

Figure 4: Simulation of the transport mode for a Helium beam of 120 keV and U_R=60kV. As also seen in Fig. 2, the particles stay unaccelerated.

Figure 5: Ion beam scrubbing with a 120 keV Helium beam, measurements of [1].

Figure 6: Simulation of a 50 mA proton beam of 120 keV and U_R=60kV. Clearly visible is the bunching as well as the accelerating region.

Figure 7: Comparison of several rod voltages. It can be seen that the optimal transmission does not necessarily coincide with the largest proportion of accelerated particles.

Figure 8: Momentum spectra for several rod voltages. It is expected to confirm these spectra with the momentum spectrometer of the diagnostic train (see Fig. 9).

Figure 9 (left): Phase space (U_R=60kV) of 50 mA protons. Left side is density distribution, right side is energy in color coded as in figure 6. Shown on top is the y-x-plane for both cases, below the x-k-plane for both cases.

Figure 10 (left): Longitudinal energy spread for 50 mA protons at 700 keV downstream the RFQ.

Figure 11: Momentum spectrum for different ion species at various energies. Calibration has been made with Helium and Argon at 6 keV. The estimated spectra for 120 keV Helium and 700 keV protons were calculated.

References

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