NNP - Non Neutral Plasma Physics Group

IAP - Institute for Applied Physics
Max-von-Laue-Straße 1
D-60438 Frankfurt am Main, Germany

NNP Non Neutral Plasma Physics Group
IAP Institut für Angewandte Physik Frankfurt am Main
GOETHE UNIVERSITÄT FRANKFURT AM MAIN

THPO 061
SPWR 017

Beam Characterization of the MYRRHA-RFQ

P. P. Schneider, M. Droba, O. Meusel, H. Podlech, A. Schempp *(IAP, Frankfurt/M.)*
D. Noll *(CERN, Geneva)*

Transport Mode and Ion Beam Scrubbing for a Helium Beam

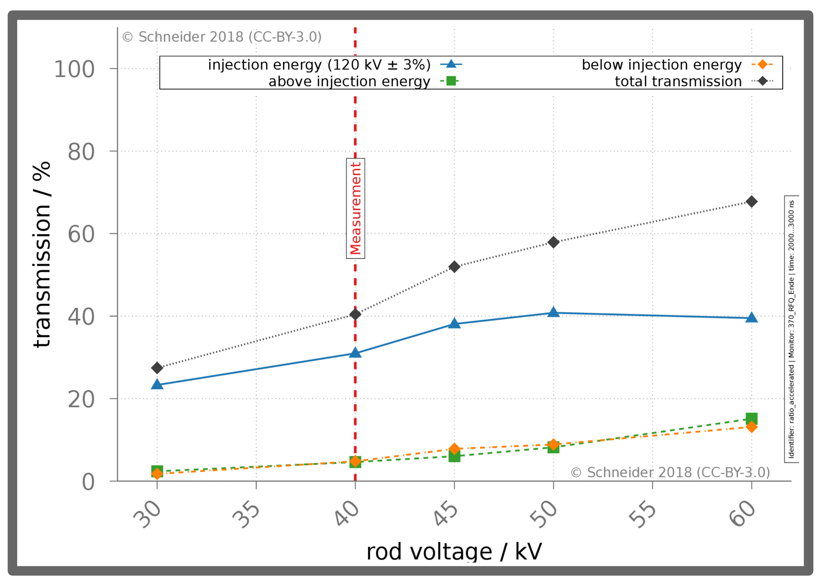


Figure 1: Transmission and ratio of accelerated particles for an 1 mA Helium beam.

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 the support of RFQ conditioning with the ion beam scrubbing technique.

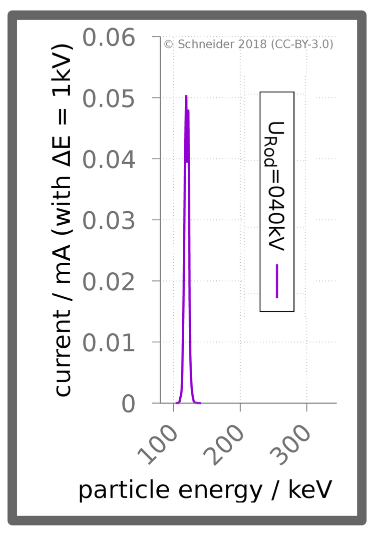


Figure 2: Energy spread for 120 keV Helium downstream the RFQ.

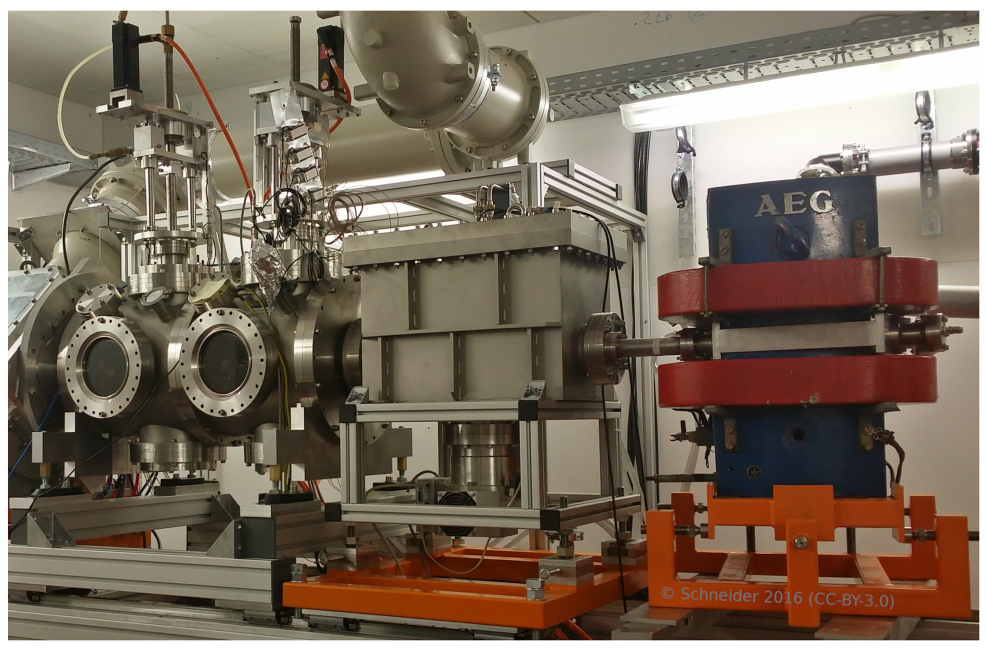


Figure 3: Diagnostic train in operation: Emittance meter (left), Beam Dump (center) and Momentum Spectrometer (right).

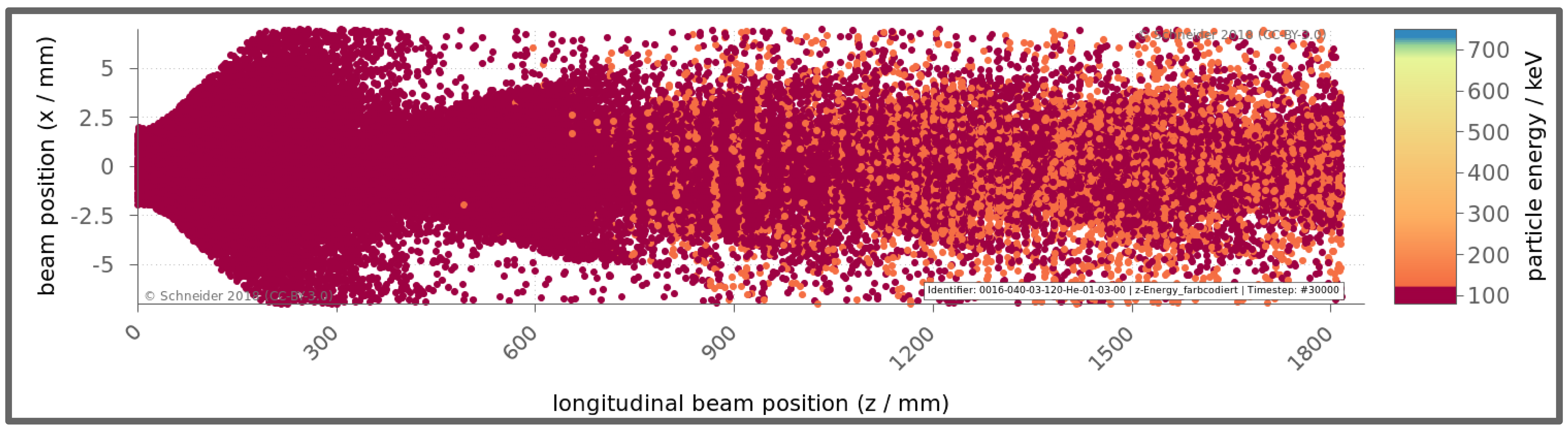


Figure 4: Simulation of the transport mode for a Helium beam of 120 keV and U_{Rod}=40kV. As also seen in fig. 2, the particles stay unaccelerated.

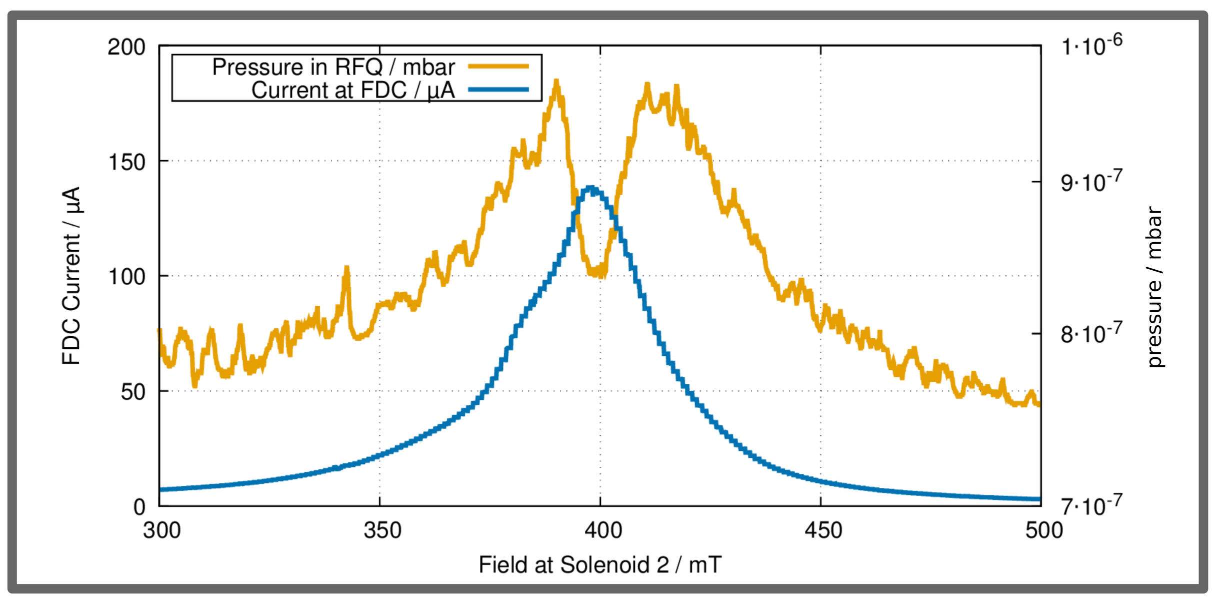


Figure 5: Ion beam scrubbing with a 120 keV Helium beam, measurements of [1].

Beam Dynamics of the Acceleration Mode for a Proton Beam

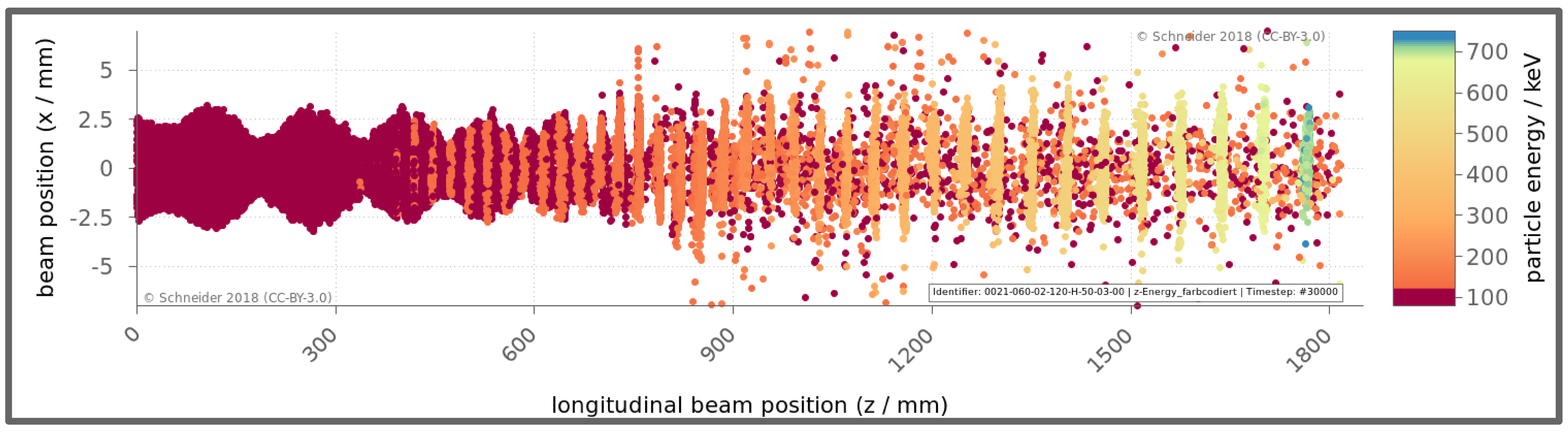


Figure 6: Simulation of a 50 mA proton beam of 120 keV and U_{Rod}=60kV. Clearly visible is the bunching as well as the accelerating region.

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.

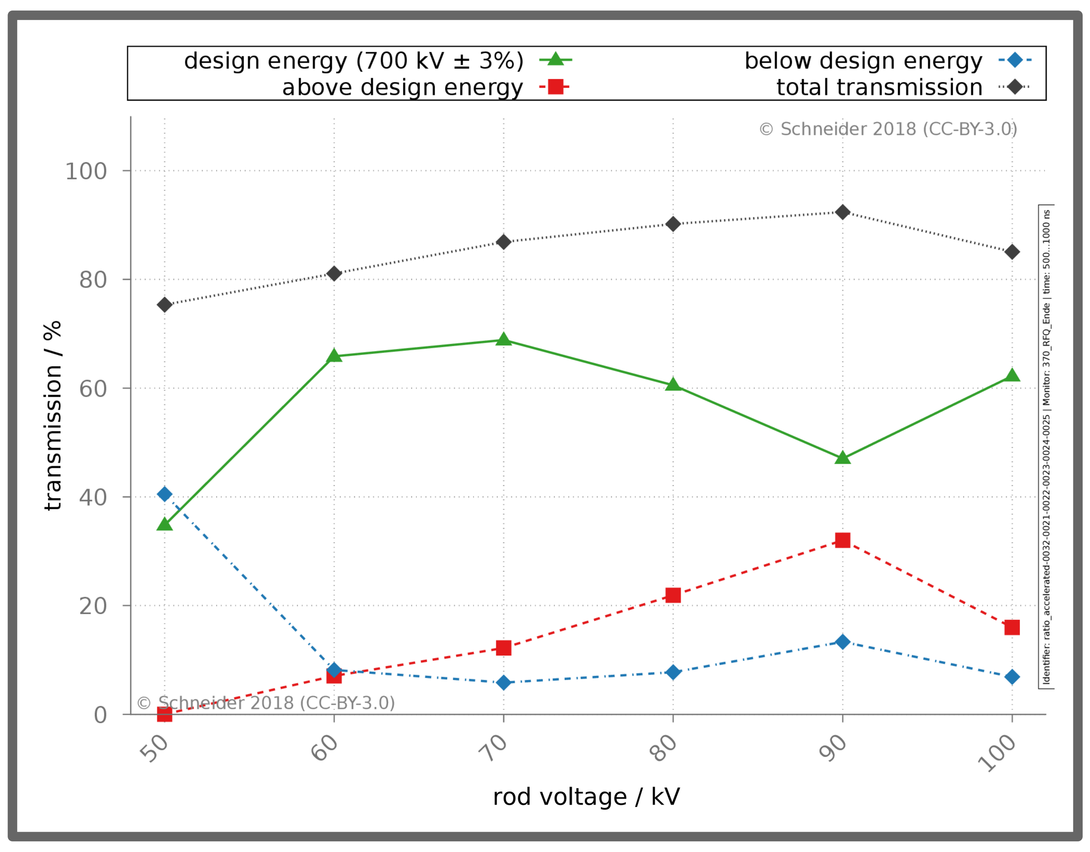


Figure 7: Comparison of several rod voltages. It can be seen that the optimal transmission does not necessarily coincide with the largest proportion of accelerated particles.

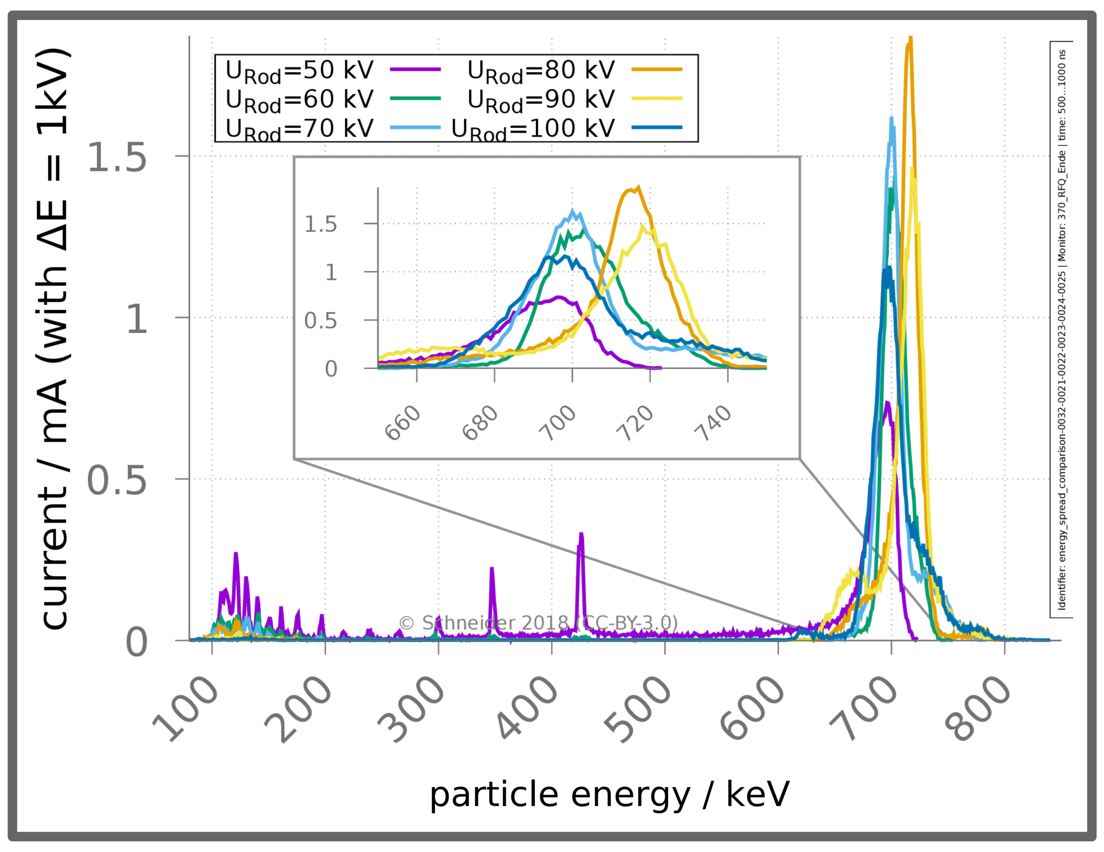


Figure 8: Momentum spectra for several rod voltages. It is expected to confirm these spectra with the momentum spectrometer of the diagnostic train (see fig. 3).

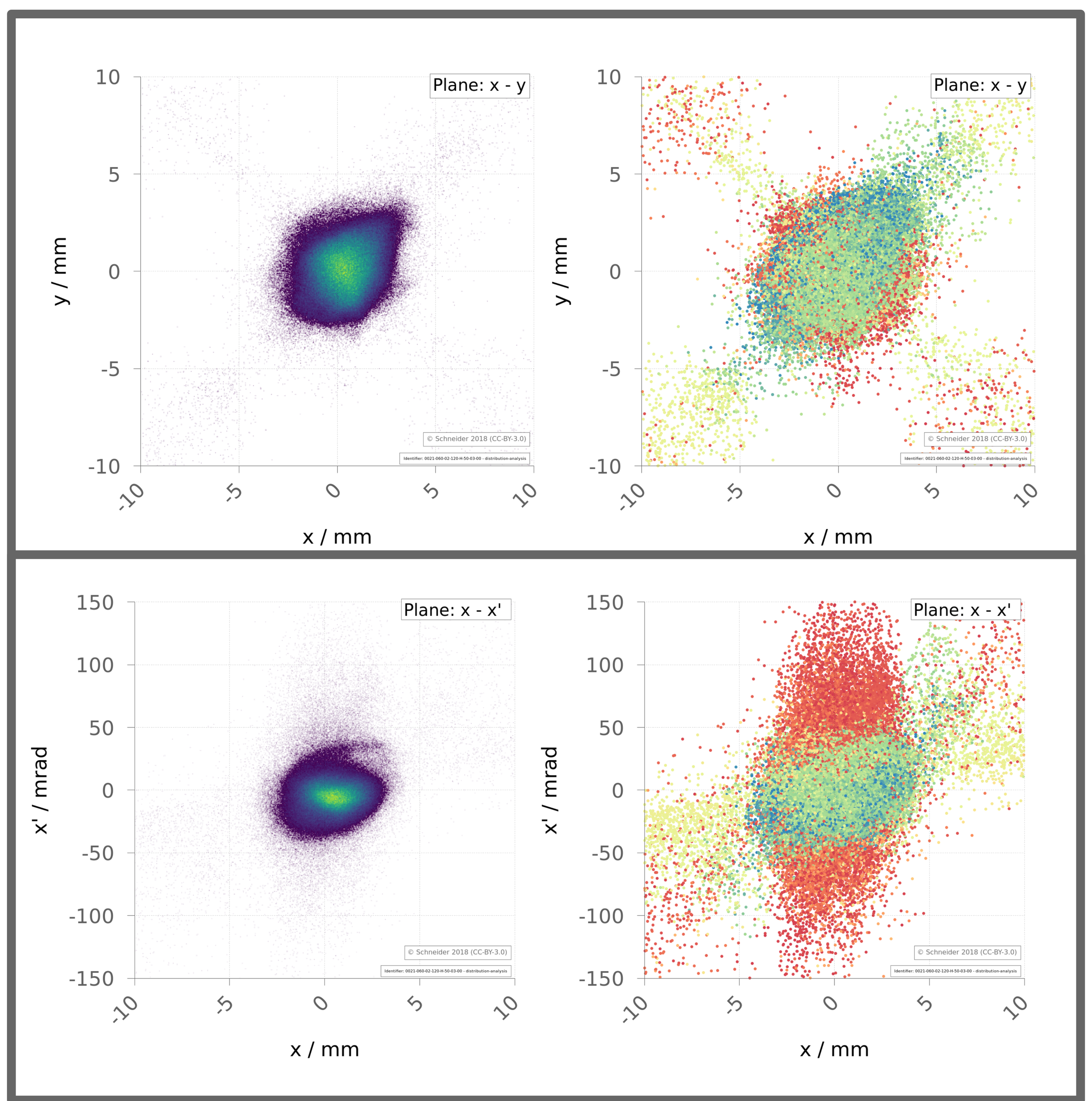
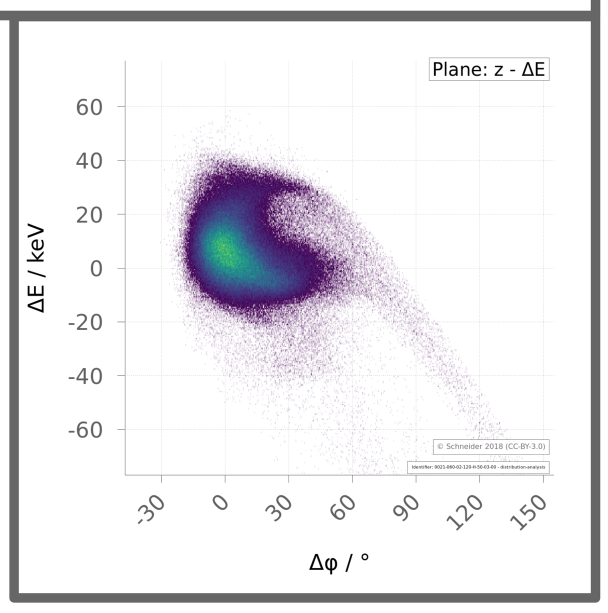


Figure 9 (↑): Phase space distribution downstream the RFQ (U_{rod}=60kV) of 50 mA protons. Left side is density distribution, right side is energy in color coded as in figure 6. Shown on top is the x-y-plane for both cases, below the x-x'-plane for both cases.

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



Calibration of the Momentum Spectrometer

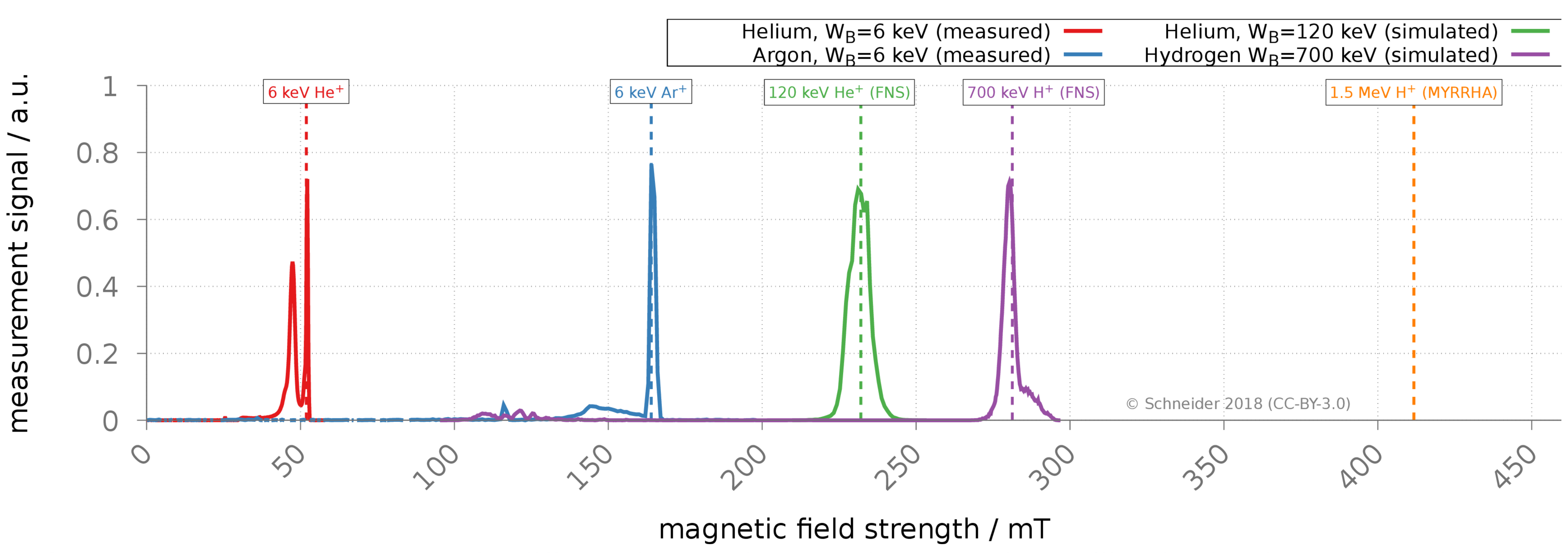


Figure 11: Momentum spectrum for different ion species at various energies. Calibration has been made with Helium and Argon at 6 keV. The estimated spectra for 120 keV Helium and 700 keV protons were simulated.

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.

References

[1] Schneider, P.P. et al., **„First Experiments at the CW-Operated RFQ for Intense Proton Beams"**, TUOP05, Proceedings of LINAC'16, East Lansing, MI, USA,

[2] Noll, D. et al., **"The Particle-in-Cell Code Bender and Its Application to Non-Relativistic Beam Transport"**, WEO4LR02, Proceedings of HB2014, East-Lansing, MI, USA

Funding

This work is supported by the German Federal Ministry of Education and Research (BMBF) #05P15RFRBA and by HORIZON 2020 for the MYRRHA project #662186.