Measurements at the IH-cavity of REX-ISOLDE ◊

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For the REX-ISOLDE-project at CERN an IH-accelerator was designed, serving as booster accelerator for radioactive ions from an energy of 300 keV/u to an extraction energy, which can be varied from 1.1 MeV/u to 1.2 MeV/u using capacitive pistons [1]. In 2003 the tuning of the IH-cavity has been finalized.

With all high resolution phase shifters installed and tested the amplitude and phase regulation was set up to be working full automatically. As the overall beam quality is mostly determined in the matching section in front of the IH-cavity one focussed mainly on that region. To get best results beams of the highest current possible were produced by the EBIS as ion-source. By enriching the residual gas with helium one was able to produce a total average current of $1 \cdot 10^{-8}$ to $1 \cdot 10^{-9}$A instead of $1 \cdot 10^{-11}$A at the cups. Only with this high current one was able to measure with 1mm slits at the beginning and end of the separator magnet giving an energy resolution of 0.6%.

After some module changes at the low level rf-system and some cable lengths changed the RFQ's amplitude had to be readjusted as well as the buncher's amplitude and phase. The optimal setting for the RFQ tank amplitude was found at a pickup level of 1.865V for a mass to charge [m/u] ratio of 4. The energy spread was measured to 1.41% in agreement to PARMTEQ calculations and measurements in Munich [2]. The RFQ is the reference of the system, hence its phase is set to zero and doesn't need to be set up. The buncher was set on the buncher phase of $-90°$ degree, its effective shunt impedance was measured to 19.9 MΩ/m by accelerating the beam at 0 degree phase. This value was also verified by measuring the energy spread of the beam and comparing the result to theory. The effective shunt impedance is in good agreement to results from low level measurements [3].

The main goal for the IH-drift-tube-cavity was to set the proper phase and amplitude. Therefore simulation calculations with different phases and amplitude levels for the IH were done using the LoraSR computer code [4]. The results have been compared to measurements of energy spectra from the IH-cavity. The proper IH amplitude was mainly set by reducing the tank-loop voltage until the energy of the beam was at the expected value. The upper edge of this curve had to be in good agreement with the LORASR calculations at a defined amplitude. With those measurement it could be proved that 1.95V of tank loop amplitude is the proper operation mode for the IH at a mass to charge ratio of 4. This level is reached with 43kW rf-power. The resulting absolute shunt impedance was calculated to a value of 330 MΩ/m and is in exact agreement with results from X-ray measurements of the gap-voltages and low level measurements, where one obtained 300 to 330 MΩ/m [5]. With this amplitude energy-distributions at different phase settings were measured and compared to theoretical ones. The proper phase was identified. The energy-spectra and the calculated spectra at the optimal phase are shown in figure 1.

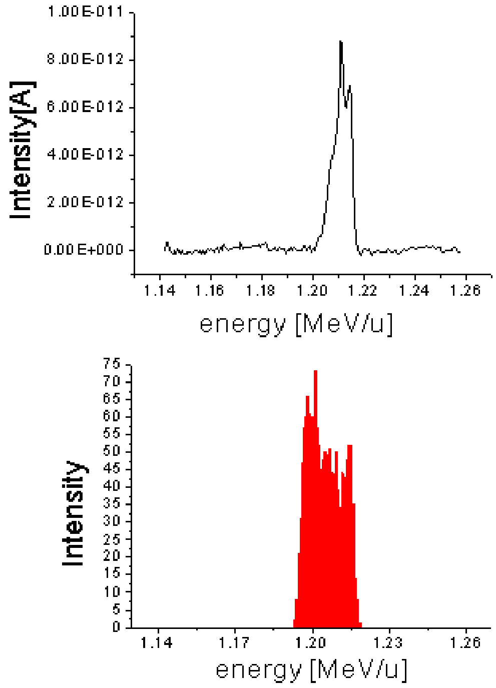

Fig. 1: The upper picture shows the energy distribution obtained from measurement. The lower shows the energy distribution as a result of LORASR simulations.

They agree very well in width and in the overall shape. At the proper phase the measured energy spread is 0.8% while from calculations it was expected to be 1.0%. The energy spreads at different phases agree well over the full measurable range of 40° degree. Small differences are due to the fact that the beam injected into the IH in reality does not fulfil a waterbag-distribution in the phase energy-space as assumed in the LORASR calculations. Calculations with the real distributions are in progress and will be compared to the measurements. The measurements done in 2003 already proved that the system is working, fulfilling its specifications.

References

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