Progress of Schottky Mass Measurements Using New Signal-Analyzer at the ESR ◊

M. Falch, Th. Kerscher, K.E.G. Löbner, F. Attallah [a], F. Bosch [a], B. Franzke [a], H. Geissel [a], M. Hausmann [a], O. Klepper [a], H. J. Kluge [a], C. Kozhuharov [a], G. Münzenberg [a], F. Nolden [a], Z. Patyk [a], W. Quint [a], T. Radon [a], C. Scheidenberger [a], M. Steck [a], L. Vermeeren [a], M. Winkler [a], Th. Winkler [a], H. Wollnik [b], and Yu. Novikov [c]

[a] GSI, Darmstadt [b] Justus-Liebig University, Giessen
[c] St. Petersburg Nuclear Physics Institute, Gatchina

Systematic determination of the mass surface for neutron deficient Bi-fragments between Rh and Po has been done using Schottky Mass Spectrometry [3] at the ESR at GSI. For the first time the newly developed data acquisition system [1] [2] was used which yields a new quality of raw data by storing the digitized Schottky-noise signal with 16 bits of resolution and a sampling rate of 640kHz. About 15000 frequency spectra with a frequency resolution of 1.2Hz/channel were calculated offline out of 1TB of raw data stored during the experiment. The storing of time-captures compared to online-Fourier-transformation of former experiments represents a decisive progress as it allows several new possibilities in the data analysis. The evaluation of the data is now nearly finished. The masses of more than 350 isotopes were measured directly with errors between 30 and 170keV. About half of them were previously unknown. Nuclei with half-lives down to 10 seconds could be identified in the spectra. In addition about 100 nuclei are linked to the region of measured masses as members of α-chains with well known Q_α-values. This allows the indirect determination of all masses between Au and U on the proton-rich side of the valley of stability.

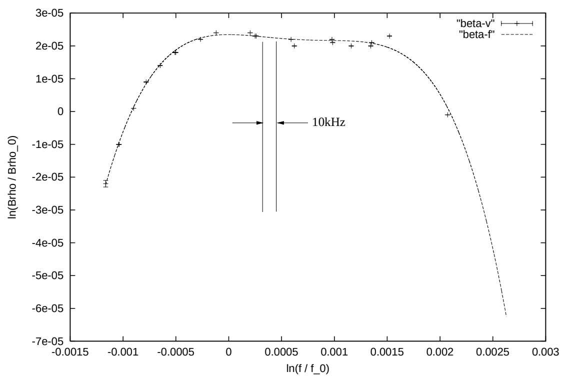

Fig. 1: Deviations from linearity of magnetic rigidity of ions identified in one 320kHz frequency spectrum as function of frequency.

In former experiments [4,5,6,7] spectra with a bandwidth of 10kHz and a frequency resolution of 6.25Hz/channel were used for mass measurements. The offline Fourier-transformation of the stored time captures allows now the calculation of high resolution frequency spectra (1.19Hz/ch) with a bandwidth of 320kHz covering the whole momentum acceptance of the storage ring. These spectra allow the determination of the deviations from linearity of the magnetic rigidity $B\rho$ as a function of frequency. Fig.1 shows the $B\rho$-function as a polynomial fit to the ions identified in one frequency spectrum and the bandwidth of the frequency spectra of 10kHz of the former measurements. The Momentum-Compaction-factor α_p in fig.2 is obtained by deviating this $B\rho$-function with $ln(f/f_0)$. This is the major improvement of the method as it ensures the process of identification of the peaks in the frequency spectra and leads to a reduction of the systematic error. In combination with the stabilization of power supplies and improvements in the field homogenities of the ESR dipole magnets done in the last years, the systematic error decreased from $100\mu u$ in former measurements to $37\mu u$ (preliminary value).

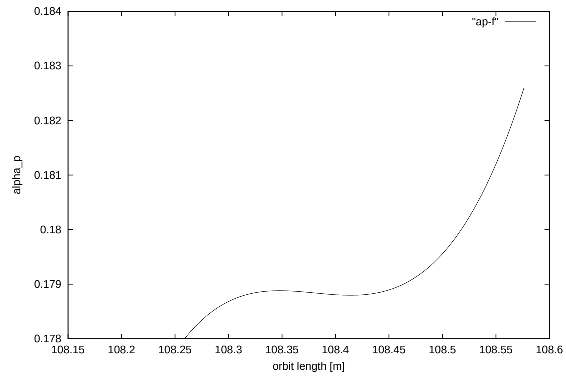

Fig. 2: Momentum-Compaction-Factor α_p in the ESR as a function of the orbit length.

As the data are stored as time captures the evolution of the frequency peaks can be studied and give additional informations to ensure the identification of the frequency peaks. Another possibility is the so-called software cooling. It allows offline correction of frequency shifts and leads to a reduction of the width of the frequency peaks. Due to the improved stability of the ESR magnets the average decreas of peak-width by oftware cooling is below 5%. With the achieved frequency resolution of $\Delta f/f = 3.3 * 10^{-7}$ it is now possible to separate isomeric states in the frequency spectra. This shows in combination with the reduction of the systematic error the new dimension in the quality of the measured Schottky spectra.

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◊ This work is supported by the BMBF under contract number 06 LM 868 I(2) and the GSI under contract number LMLÖK