Schottky Mass Measurements with a New Signal-Analyzer at the ESR ◇

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First mass measurements have been performed in November 1997 for a period of two weeks with the ESR at the GSI using an improved Schottky method. The new developed Signal Analyzer and Data Recording System [1] was used. Projectile fragments produced by ^{209}Bi ions at 930MeV/u in a Be target were separated with the magnetic spectrometer FRS and stored and cooled in the storage ring ESR. For a description of the experimental setup see [1].

In contrast to former measurements [3–5], where only online Fourier transformation was possible, the Schottky signal is now digitized with a sampling rate of 625 kHz using 16 bits of resolution and stored as time captures. Due to this high sampling rate the measured frequency span is 244 kHz covering the whole momentum acceptance of the storage ring. With a continuous data rate of 1.2 MB/s nearly 1 TB of raw data were stored during this beamtime corresponding to roughly 15000 frequency spectra.

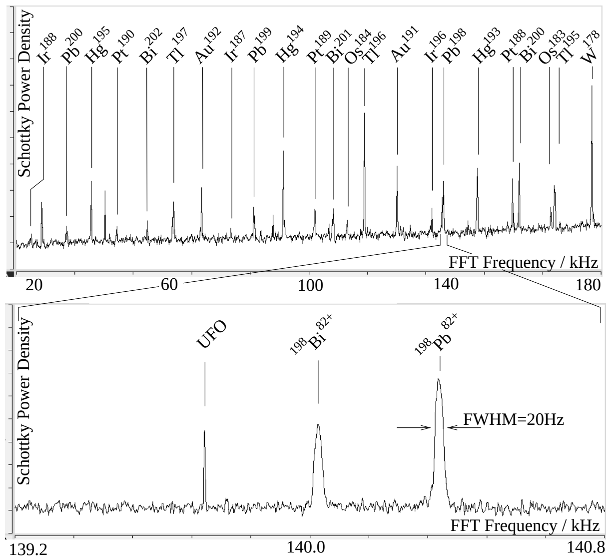

Fig. 1: Measured Schottky spectrum of stored and cooled nuclear fragments produced by projectile fragmentation of ^{209}Bi with an 8g/cm^2 Be target. In the upper part the 244 kHz broadband spectrum is shown. The spectrum recorded in 83 s is averaged over 100 single spectra. The FFT is calculated over 2^{19} data points for each single spectrum. This leads to a frequency resolution of 1.19 Hz/channel. The lower part of the figure shows two real peaks (FWHM of about 20 Hz, which means a frequency resolution of $\Delta f/f = 3.3 * 10^{-7}$), and one UFO (unidentified frequency object), its FWHM is much smaller ($\sim$ 4 Hz).

The aim of the experiment was a systematical mass measurement of proton rich isotopes in the Sn to Bi region including new α-chain endpoint nuclei (^{163}Hf(44 s), ^{164}Ta(14 s), ^{150}Er(18 s), ...) as well as unknown masses in the Z=60 area (^{160}Lu, ^{152}Tm,^{144,145}Dy, ...). In addition we succeeded for the first time during this beamtime to apply the Schottky-Method [2] to measure masses on the n-rich side between Ir and Hg. The data evaluation is right at the beginning. Fig. 1 gives a first impression: The frequency resolution of the spectrum is $\Delta f/f \approx 3.3 * 10^{-7}$. This is equivalent to a mass resolution of $\Delta m/m \approx 1.8 * 10^{-6}$ and compares to a mass resolution of $\Delta m/m \approx 5 * 10^{-6}$ which was achieved (only in the 10 kHz spectra !) in the last beamtime.

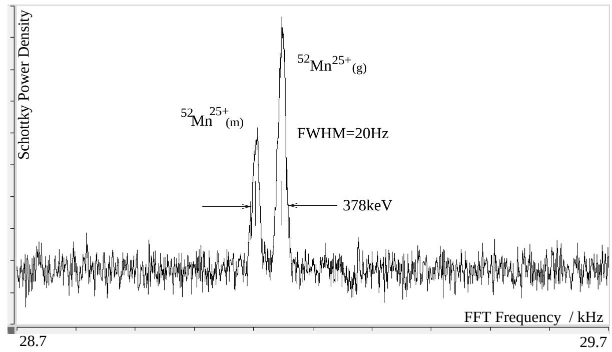

Fig. 2: Measured Schottky spectrum of the massresolved ground and isomeric states of ^{52}Mn($E^* = 378\,keV$) measured at the 30^{th} harmonic of the ion revolution frequencies of about 2 MHz. For this measurement nuclear fragments were produced using a ^{58}Ni primary beam on a 8g/cm^2 Be target. This spectrum is a 1 kHz part out of a 244 kHz spectrum. The FFT was calculated with 2^{19} data points and averaged over 83 s. The mass resolution of $\Delta m/m \approx 1.8 * 10^{-6}$ is for ^{52}Mn equivalent to 90 keV/c^2, which can be compared with the Δm/m=4*10^{-6} in a former measurement [6].

Up to now lots of nuclei on the proton rich side between Y and Po with half-lives $\leq$ 30 s could be identified. The FFT offline analysis allows additional things like the study of the dynamical behavior including cooling forces and decay. Because the digitized Schottky noise is stored, offline optimization of the FFT parameters is possible and the frequency resolution of the spectra is limited only by the measuring time. For the same reason offline corrections of short-time frequency jumps should be possible in principle. This so called 'Software-Cooling' is under development.

References

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