FFT-Signal Analyzer for Schottky Mass Measurements at the ESR ◇

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High accuracy mass measurements were performed at the experimental storage ring ESR at GSI using the novel technique of Schottky spectrometry [1]. Projectile fragments produced by ^{197}Au and ^{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.

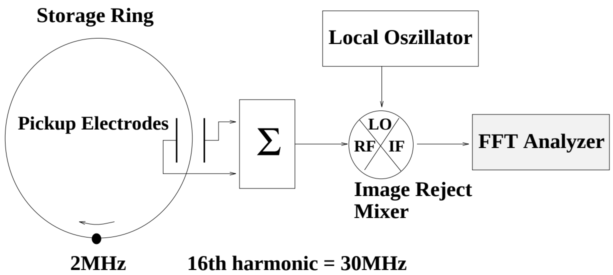

Fig. 1: Schematic view of the Schottky setup with the storage ring ESR. The revolution frequency of the ions is about 2MHz. For a better peak resolution we look at the 16th harmonic.

For a description of the experimental setup see [2]. The detector signals are frequency analyzed by a Tektronix Fast-Fourier-Transform analyzer. With this tool spectra of 10 kHz bandwidth and a frequency resolution of 6.25 Hz/channel can be calculated in real time. The whole bandwidth of the circulating ions in the storage ring is 100-150 kHz. In order to scan the full bandwidth, about 20 small band spectra have to be taken. This can be done within 30 minutes.
The masses of the ions can be determined by calculating the momentum compaction factor α_p in each spectrum with reference nuclides [3]. To calculate the non linear behavior of α_p, 100 kHz broadband spectra with the high frequency resolution of 6.25 Hz/channel of the 10 kHz spectra are needed. This can be obtained with the new data recording system.

The FFT-Signal Analyzer and Data Recording System

Fig. 2 gives a schematic view of the system. The VXI mainframe contains a 13 slot VXI backplane. All devices are controlled by a 100 MHz HP-workstation and transfer data over the VXI backplane and the high-speed local bus. The Schottky noise is digitized by an ADC-unit (digitizer) with 18 bit linear operating range and a sampling rate of 10 MSa/s. The input signals go through multi stage digital filters. A high-speed 8MB FIFO allows continuous digitizing. The SCSI-2 interface provides on-line recording of the digital raw data. These data are transfered to external SCSI devices with a sustained rate of 16 MB/s. The Digital Signal Prozessor DSP is controlled by a 32-bit CPU running at 40 MHz. This device provides on-line monitoring of the digital data during the measurement.

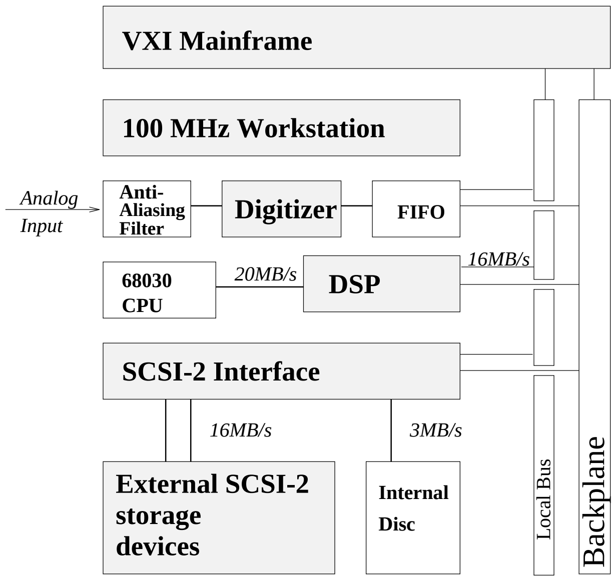

Fig. 2: Schematic view of the new FFT-Signal Analyzer. This equipment replaces the Tektronix-FFT-Analyzer in the Schottky setup. It writes continuously transient time-capture data to deep memory. The FFT-spectra are calculated offline.

The continuously writing of the raw data (time captures) has a lot of advantages and possibilities:

- more efficient use of the beam time by a factor of 10-20
- the new spectra contain enough reference nuclides to calculate the deviations from linearity of the momentum compaction factor α_p
- off-line optimization of the FFT parameters
- off-line corrections of short-time frequency jumps

References

[1] B. Franzke *et al.*, Phys.Scripta **T59** (1995) 176
[2] Th. Beha, Ph.D. thesis, LMU München, 1995, p. 27
[3] Th. Kerscher, Ph.D. thesis, LMU München, 1996, p. 73

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