REAL TIME MOMENTUM SPREAD MEASUREMENT OF THE CERN ANTIPROTON DECELERATOR BEAM

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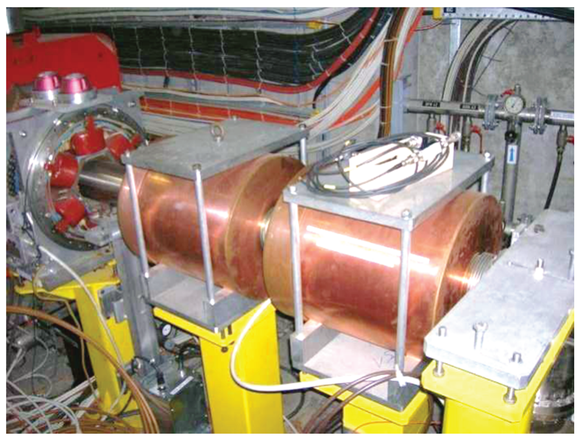
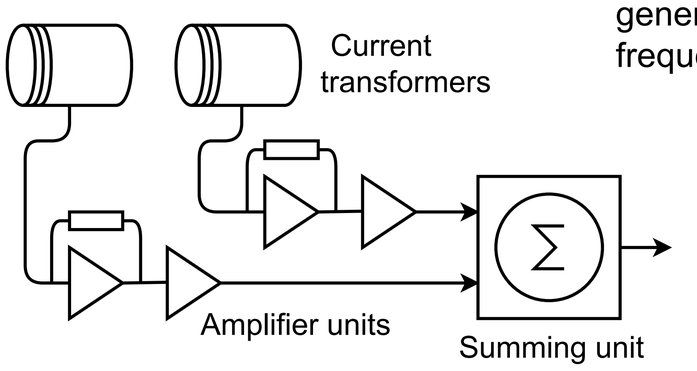
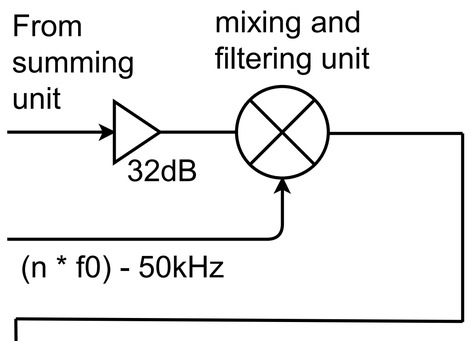
Constant optimisation and diagnostics of the cooling processes in the CERN antiproton decelerator (AD) relies on a de-bunched beam momentum spread real time measurement.

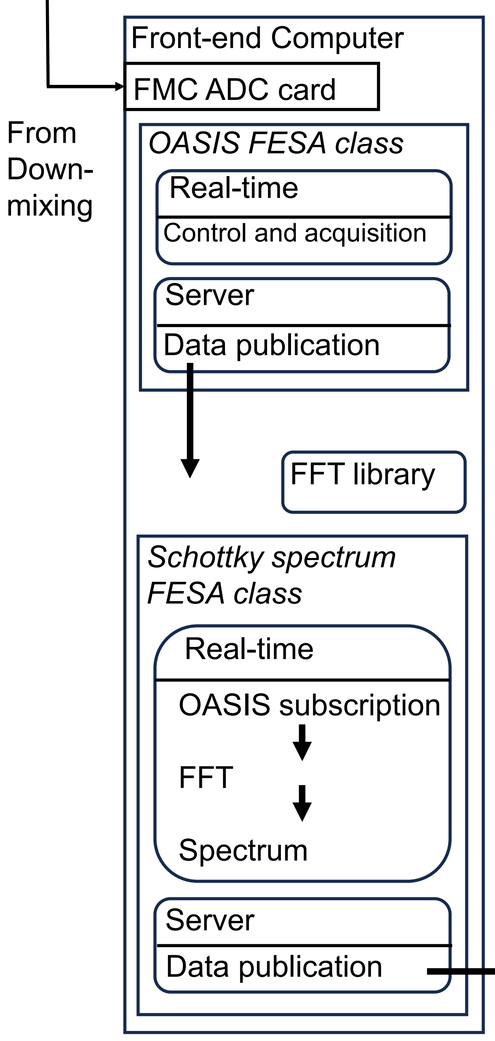
The AD longitudinal Schottky measurement for operation has been renovated and deployed with standard CERN hardware and software to maximize reliability and ease maintenance. It is used for day-to-day operation through several applications.



The AD Longitudinal pick-up







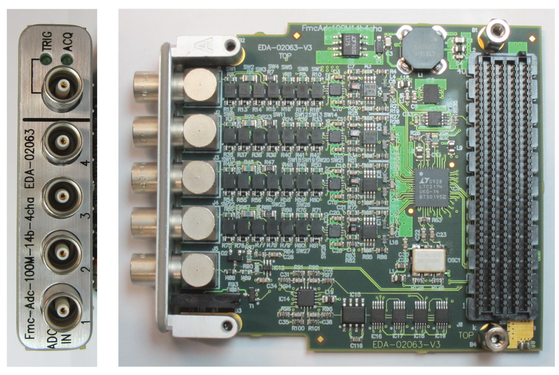
Overview of the acquisition and processing system

The AD longitudinal pick-up (LPU) consists of two specially designed ultra-low noise ferrite-loaded beam current transformers and amplifiers [1].

The longitudinal Schottky spectrum of a de-bunched beam consists of bands of frequencies (Schottky bands), located around harmonics of the average revolution frequency. [2]

To accommodate the different revolution frequencies of the AD cooling plateaus, the signal from the LPU is mixed with a signal generated from a harmonic of the revolution frequency minus 50 kHz.

The result is a transposition of the signal to a fixed centre frequency of 50 kHz, enabling fixed parameters for different cooling plateau energies.

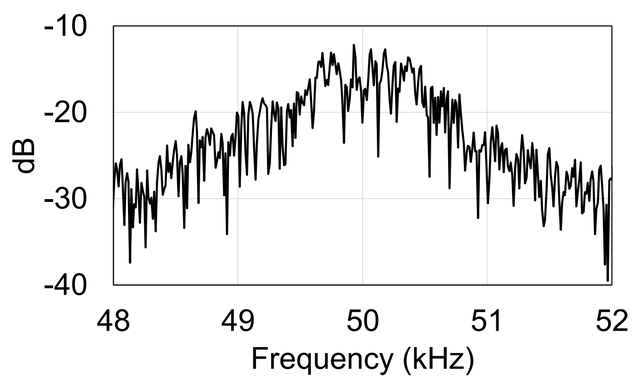


The ADC FMC card

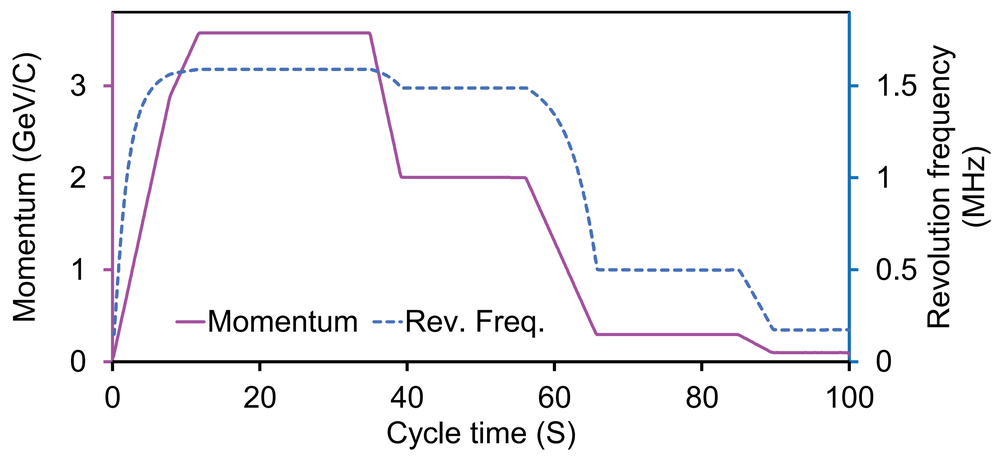
The signal acquisition is performed by a 4 channel 100 Msps 14-bit ADC card. Typical settings are a sampling rate of 3 Msps during a 100 ms segment, for a total of 3E5 samples per segment. The acquisition segment is repeated and published continuously at 5 Hz. The voltage range is set to the maximum sensitivity at +/- 50 mV.

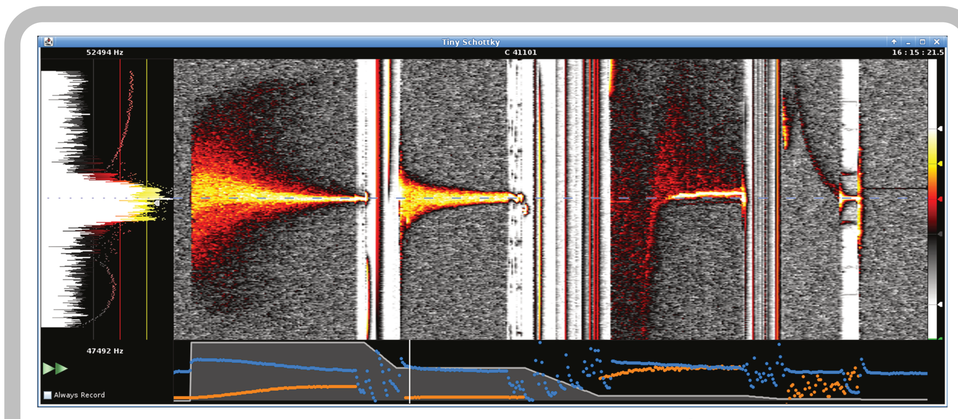
A raw data segment

The computation of the Schottky spectrum is performed and the data from frequencies around 5kHz are published to clients.

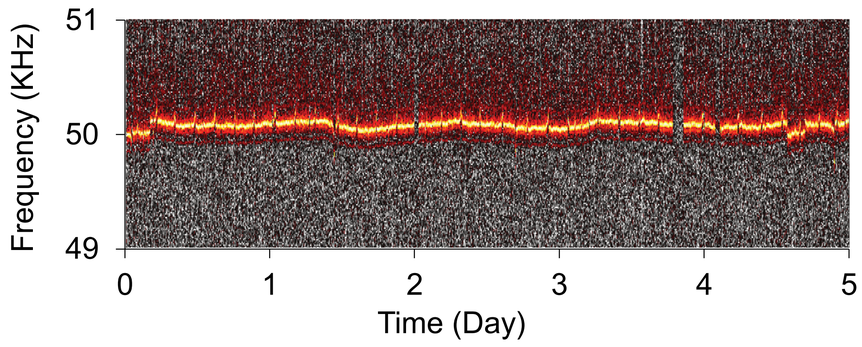


The AD decelerating cycle



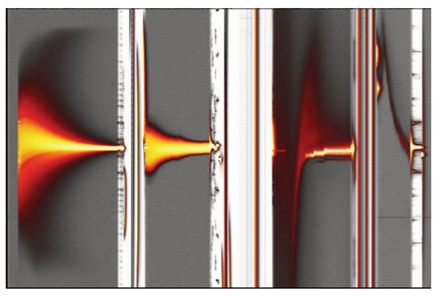


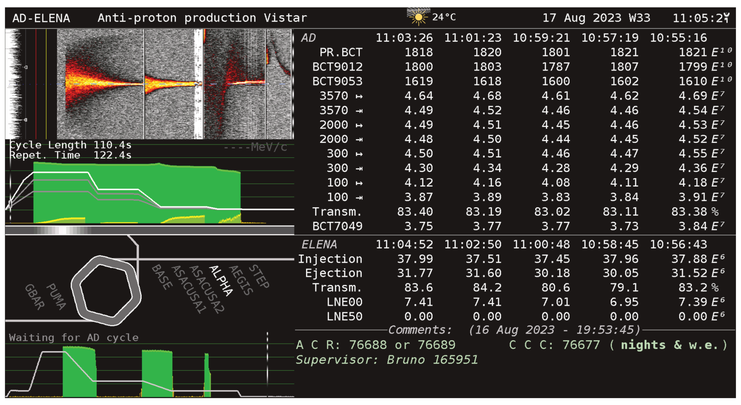
A java application has been developed for the operators, available on control rooms computers. Schottky spectra are displayed in a three-dimensions chart. The time axis is kept horizontal to be synchronised with other two dimensions time charts. The power spectrum value is colour coded, and the vertical axis represents the frequency.



Snapshots of Schottky spectrum at key moments along the AD deceleration cycle are logged, it allows machine stability analysis over several days and observation of any drifts of the cooling systems.

One can enhance the details of the envelop of the longitudinal cooling processes performance by averaging several cycles during stable operation.





Displayed on large screens in control rooms and published worldwide via a CERN webpage, the status screen of the AD/ELENA now integrates the AD real time animated Schottky spectrum.

[1] C. Gonzalez and F. Pedersen, “An ultra-low noise ac beam transformer for deceleration and diagnostics of low intensity beams.”, in *1999 Particle Accelerator Conference, New York, USA, 29 March - 2 April 1999*. doi: 10.1109/PAC.1999.795736
[2] D. Boussard, “Schottky noise and beam transfer function diagnostics 1995 ed.”, in *CAS - CERN Accelerator School: 5th Advanced Accelerator Physics Course*, pp.749-782. doi: 10.5170/CERN-1995-006.749

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