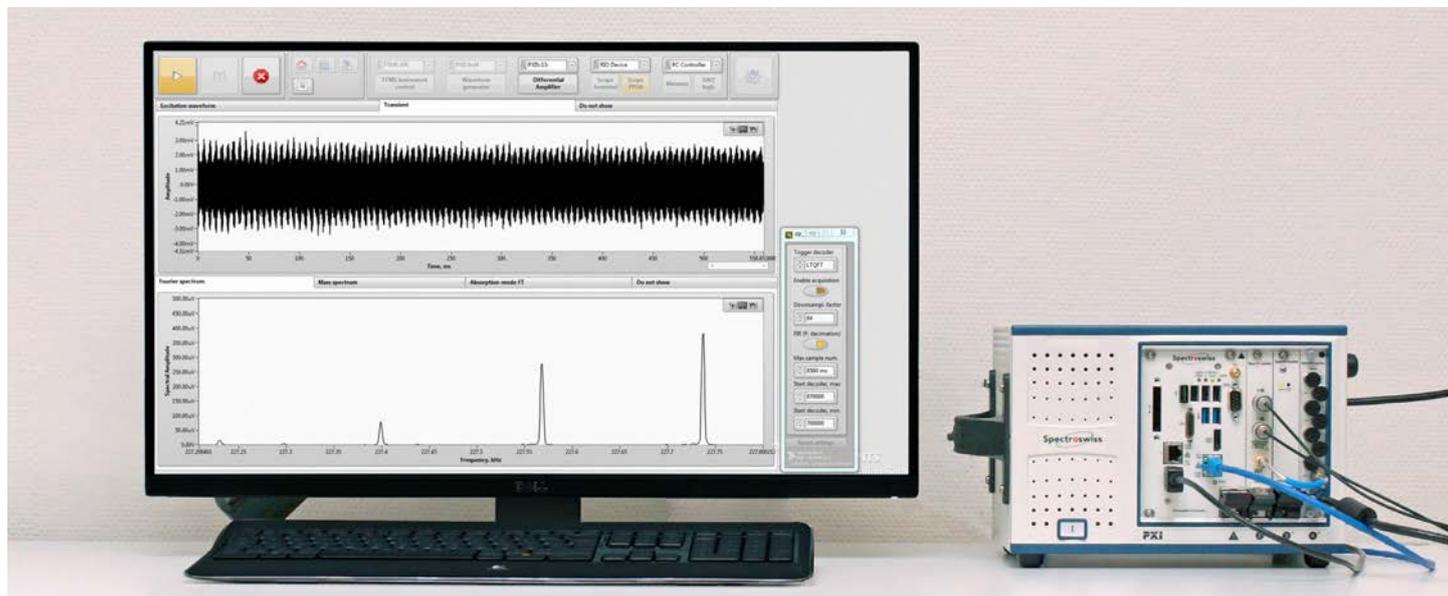


FTMS Booster X1

High-performance data acquisition system for FT-ICR MS

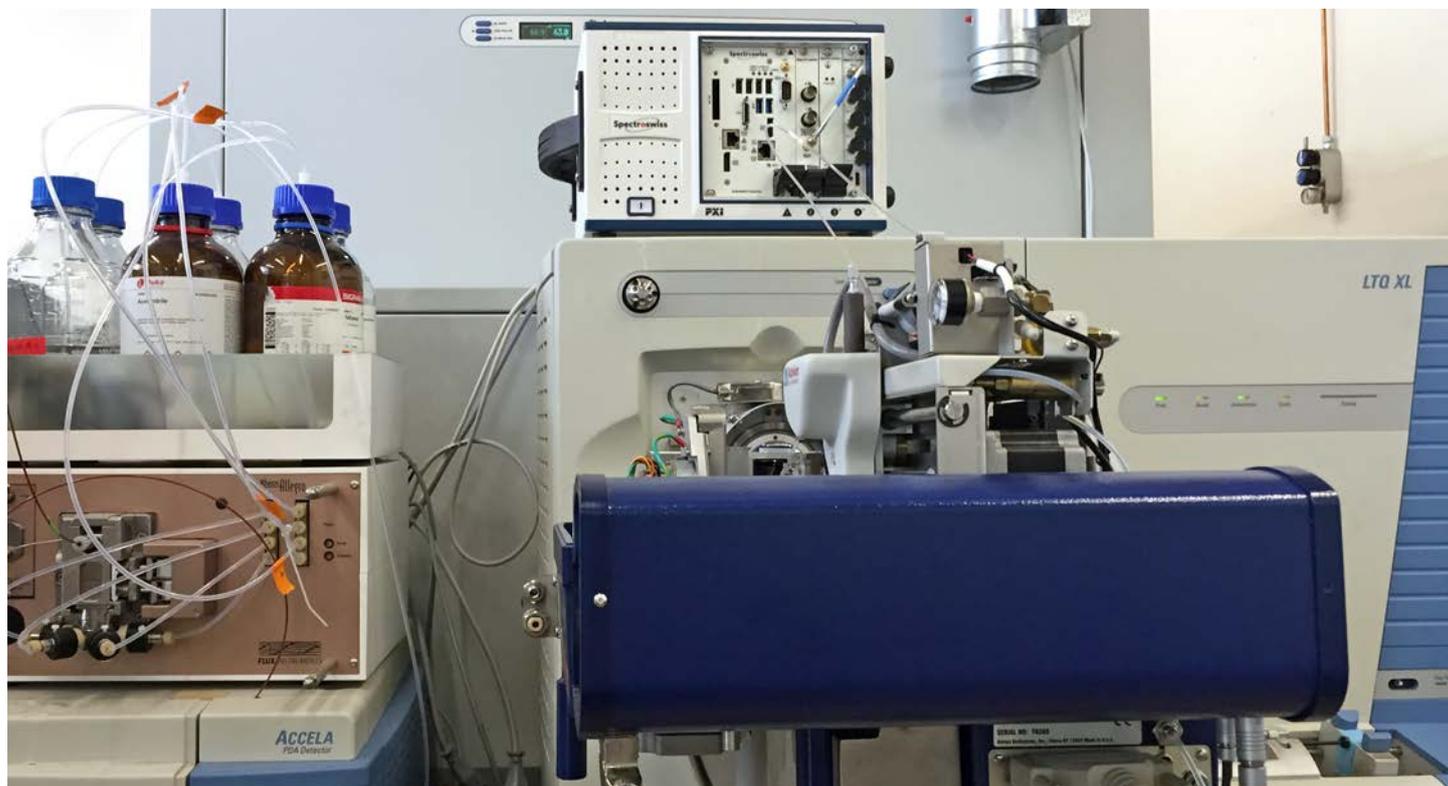


What is FTMS Booster?



The Spectroswiss FTMS Booster X1 is a high-performance **data acquisition and analysis system** based on state-of-the-art FPGA (field-programmable gate array) technology. Together with our Peak by Peak™ software, FTMS Booster X1 is a complete state-of-the-art solution for acquisition of time-domain signals (transients), real-time digital signal processing, trigger decoding, and off-line data visualization and processing.

Compatible with **any** FT-ICR MS, FTMS Booster X1 gives your existing instrument a quantum boost in data quality and processing sophistication, helping you to take on the most complex and challenging applications.



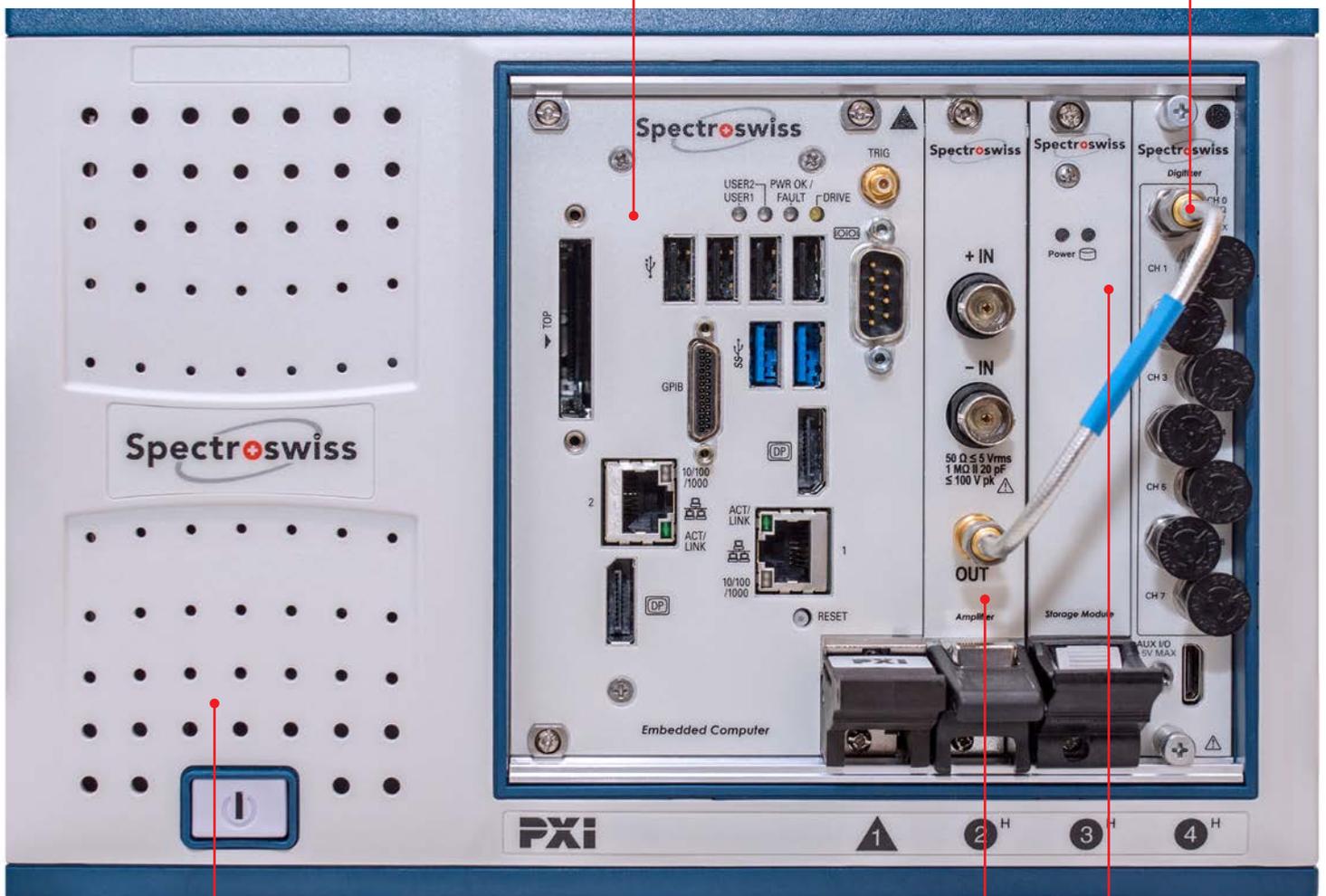
Data Acquisition Module

Embedded computer

Processing and visualization of time-domain signals and mass spectra.

High-performance digitizer / FPGA

High sample rate analog-to-digital conversion, *in-line* digital signal processing and advanced triggering.



High-bandwidth chassis

PXI Express backplanes for high-speed data transfer. Low footprint and lightweight.

Differential amplifier

Low-noise, high-bandwidth amplification of transients.

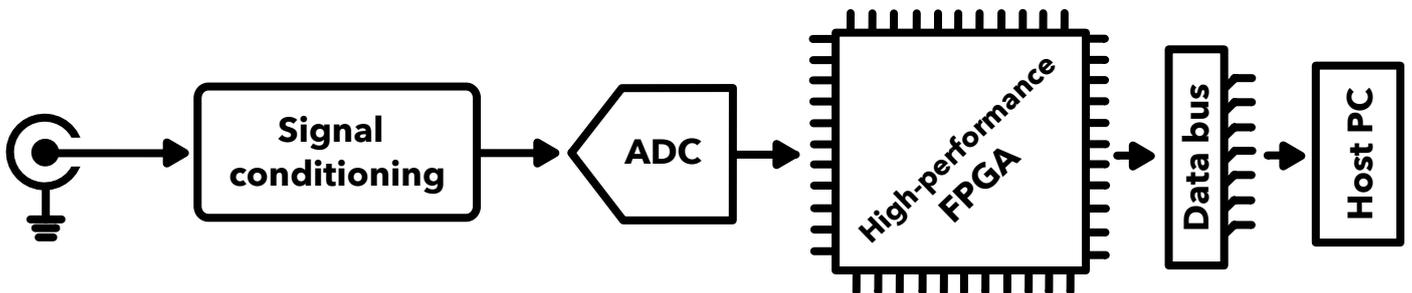
Data storage buffer

High-speed streaming and buffering of both transients and mass spectra.

New Generation Architecture

Reduced Noise for Improved Sensitivity, Dynamic Range
Full Transient Recording for Improved Resolution, Sensitivity
Reduced Phase Distortions for Improved Resolution, Mass Accuracy

High-throughput in-line FPGA technologies are the basis of the new architecture in FTMS Booster X1. Compared to traditional systems, the fidelity, accuracy and extent of the acquired time-domain data are substantially improved. This translates directly into improved analytical performance.



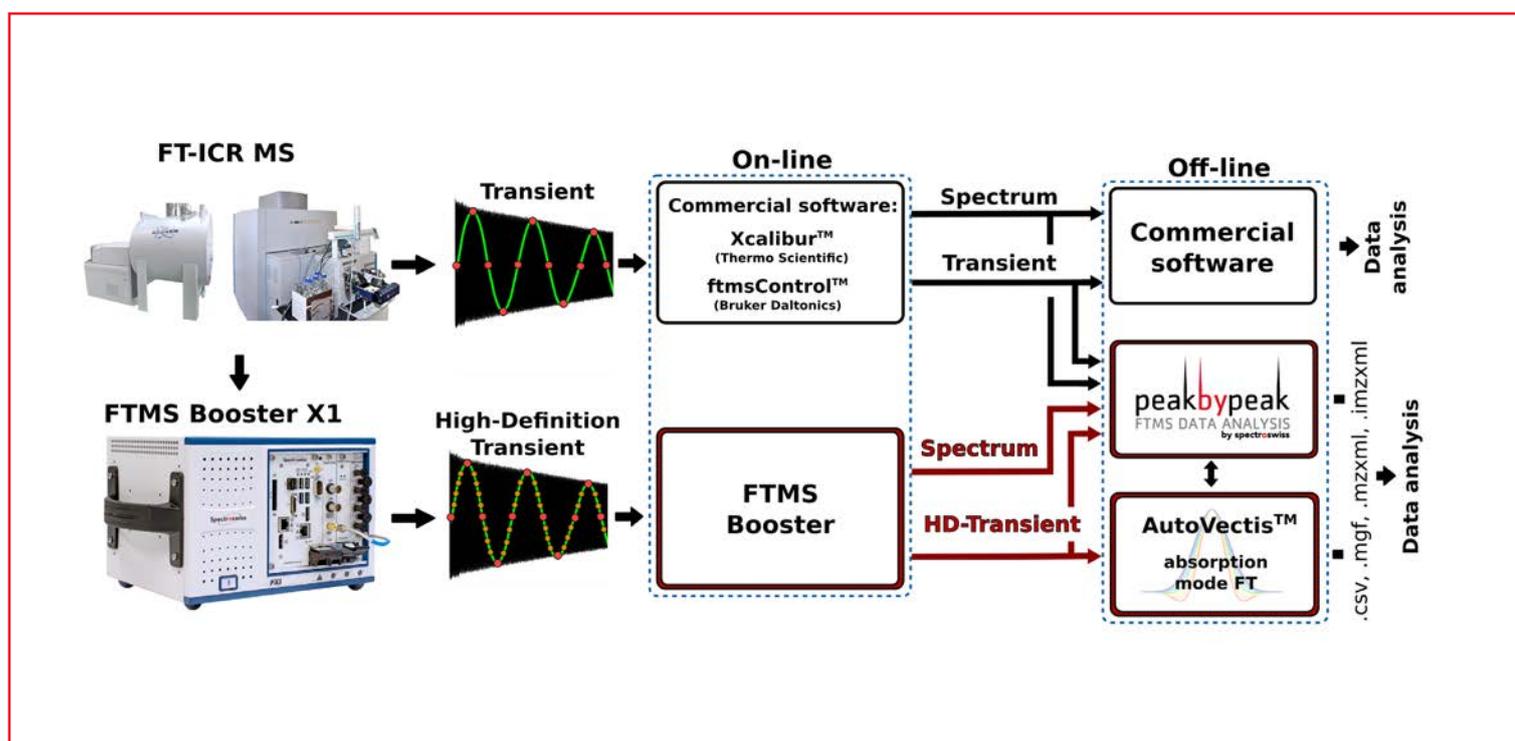
Block diagram of FTMS Booster X1. The analog signal from the FT-ICR passes through our signal conditioning sub-system, before digitization in the analog-to-digital converter (ADC). The digital data stream is continuously processed by a high-performance FPGA chip with proprietary firmware. The high definition but compact digitized transients are transferred to the embedded (host) computer for processing and visualization.

Seamless Hardware and Software Integration

High-Throughput Data Streaming
Compatible with Any FT-ICR MS
Open File Formats for Greater Flexibility
Operates Parallel to Existing Data Acquisition

FTMS Booster X1 is compatible with any contemporary FT-ICR MS instrument and requires **no major modification or replacement** of existing components. Both on-line and off-line software operate parallel to installed products. Two complementary data sets are simultaneously and synchronously acquired.

Both Booster-produced and conventional transients or mass spectra can be processed by Peak by Peak™ and AutoVectis™ software tools. Booster data is synchronized with metadata produced by the existing software.

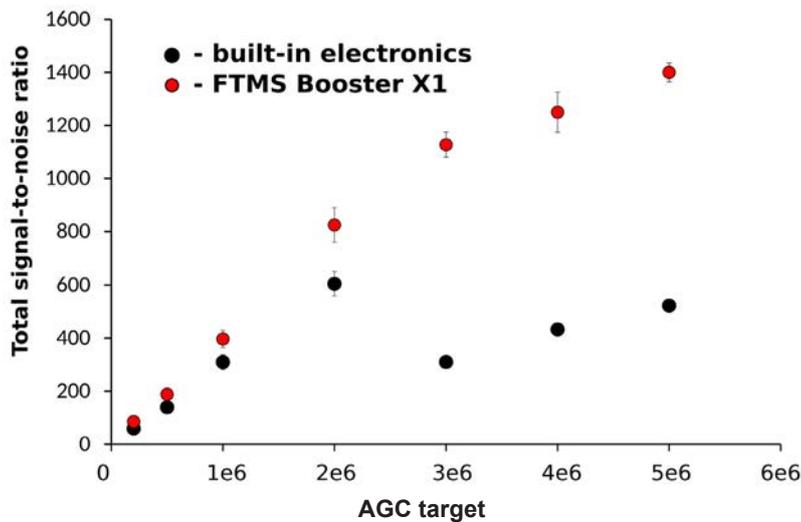


Parallel, simultaneous acquisition and processing paths maximize instrument and analysis flexibility.

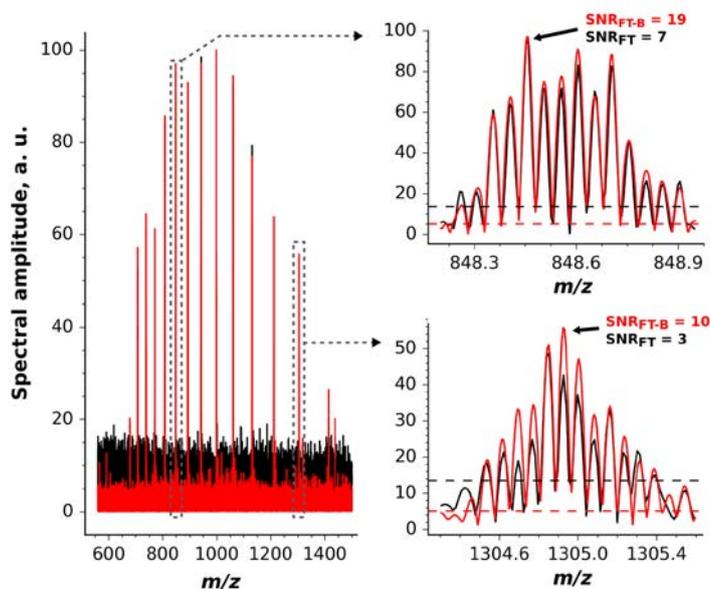
Improved Sensitivity Owing to...

Reduced Analog and Digital Noise
Full Profile Mode Mass Spectra
Full Transient Recording

FTMS Booster X1 reduces noise levels from 20% to as much as 300% compared to standard commercial data acquisition systems.



Signal-to-noise performance of a 10 T LTQ FT-ICR MS (Thermo Scientific) equipped with a 2X NADEL ICR cell for data acquired in parallel with a built-in electronics and FTMS Booster X1. The data were measured with myoglobin in a single scan as a function of target AGC setting. Total signal-to-noise ratio = sum of signal amplitudes divided by six standard deviations of the noise in mass range of 600 - 1500 m/z (preset $R=50,000$).

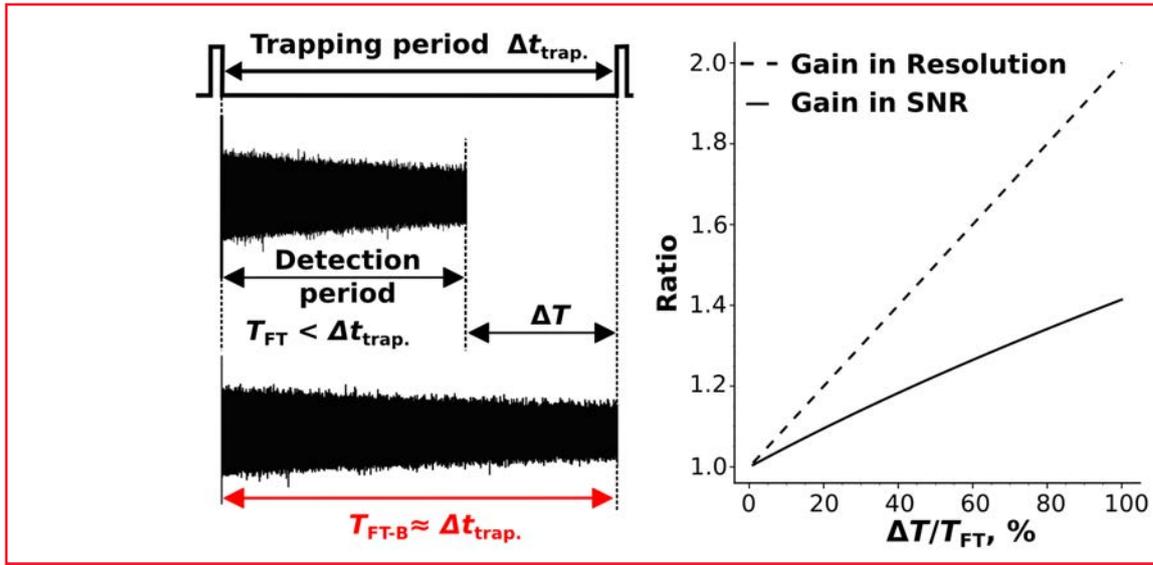


Single scan mass spectrum of myoglobin (AGC=3e6, preset $R=50,000$), acquired on a 10 T LTQ FT-ICR MS (Thermo Scientific) equipped with a 2X NADEL ICR cell with FTMS Booster X1 (red) and with the FT-ICR's built-in electronics (black). Total SNR = sum of signal amplitudes divided by six standard deviations of the noise. The latter is represented with dashed lines.

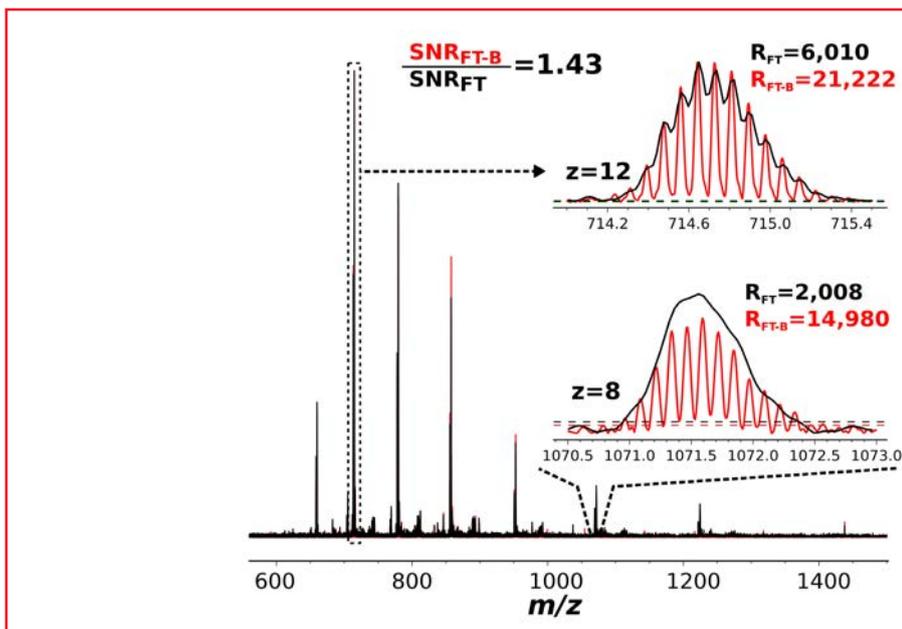
Improved Resolution Owing to...

Full Transient Recording

Conventional FT-ICR MS data acquisition systems typically can measure only part of the available transient. FTMS Booster X1 acquires complete transients, maximizing duty cycle. SNR obviously increases, but resolution benefits even more.



Increased length of FTMS Booster transient, %. Notably, ion detection is possible during ion accumulation in an external ion trap, e.g., in LTQ.

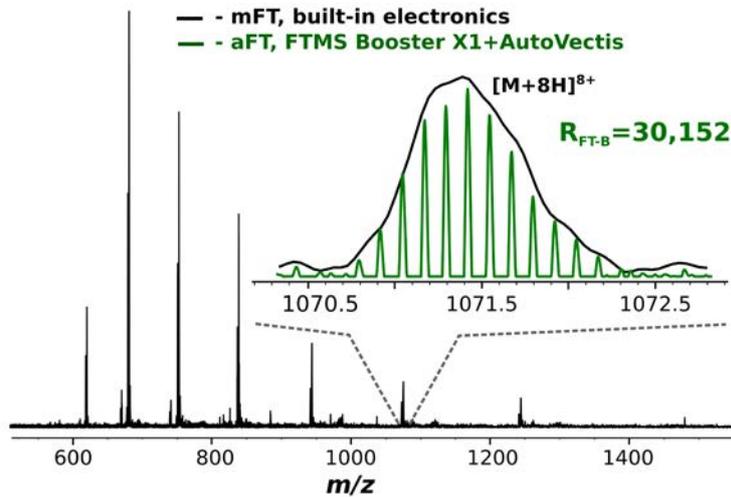


Broadband mass spectra of ubiquitin acquired with built-in acquisition system (black, FT) and with FTMS Booster X1 (red, FT-B) and processed in magnitude mode FT. Both mass spectra are normalized to the base peak of the former mass spectrum. Dashed lines represent six standard deviations of noise. 10 T LTQ FT-ICR MS (Thermo Scientific) equipped with 2X NADEL ICR cell, preset $R=12,500$, AGC is off, $IT=100$ ms.

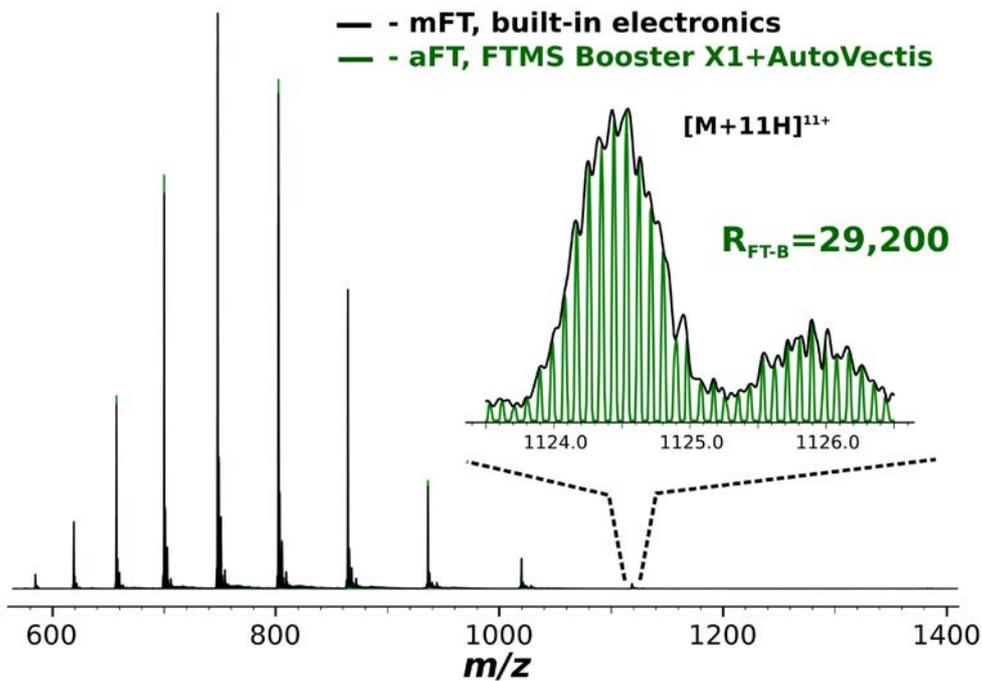
Improved Resolution Owing to...

Reduced Phase Distortion / Absorption Mode FT
Data Compatibility with the AutoVectis™ Software

The accurate, high-definition FTMS Booster X1 transients can be transformed in absorption mode to further increase the resolution using the AutoVectis™ software.



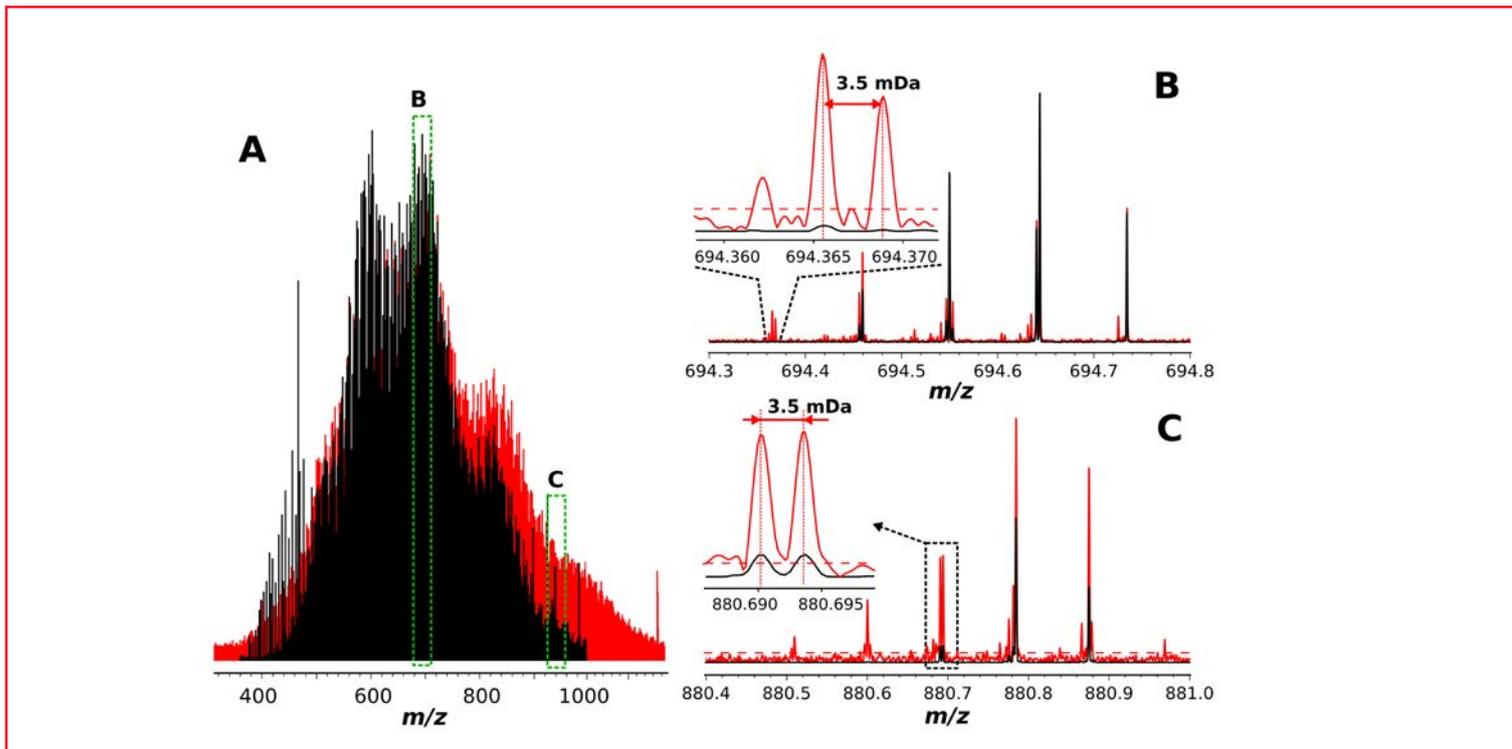
Broadband mass spectra of ubiquitin. Black: built-in electronics and magnitude mode FT. Green: FTMS Booster X1 and off-line absorption mode FT. Both mass spectra are normalized to the base peak of the former mass spectrum. The full transient length (see page 7) was used for calculations with FTMS Booster X1. 10 T LTQ FT-ICR MS (Thermo Scientific) equipped with 2X NADEL ICR cell, preset R=12,500, AGC is off, IT=100 ms.



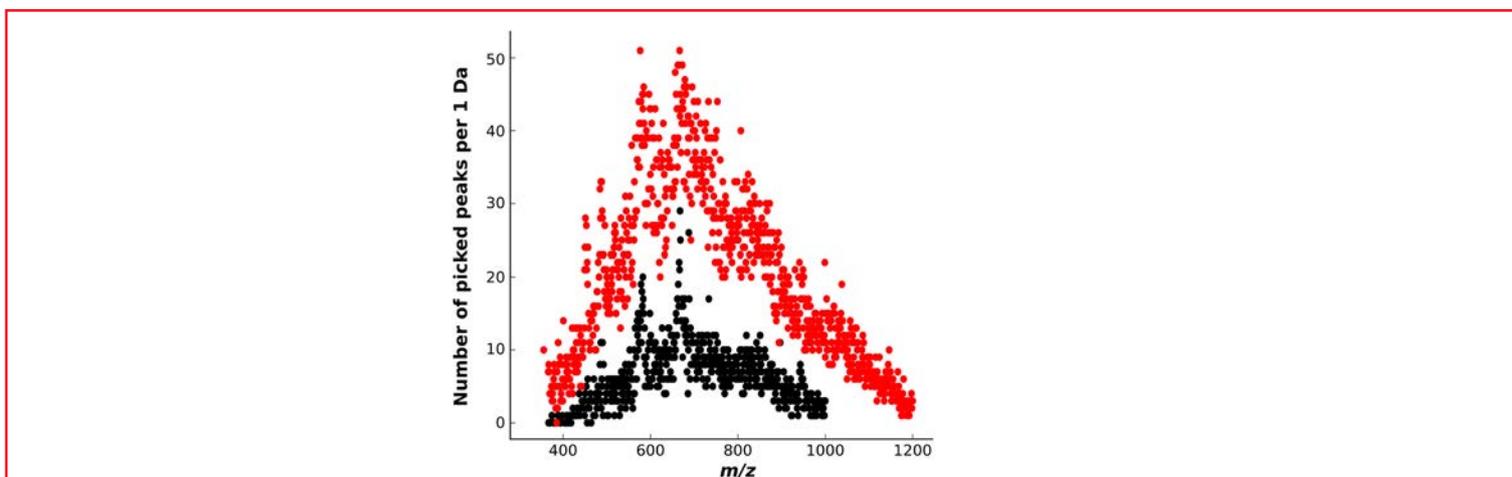
Broadband mass spectra of myoglobin. Black: built-in electronics and magnitude mode FT. Green: FTMS Booster X1 and off-line absorption mode FT. Both mass spectra are normalized to the base peak of the former mass spectrum. The transient lengths were the same in both calculations. 7 T LTQ FT Ultra™ (Thermo Scientific), preset R=50,000, AGC=4e6.

Petroleomics Applications

FTMS Booster X1 delivers better sensitivity, speed, accuracy, resolution and dynamic range. Everything needed for the most difficult applications, such as petroleomics.



Broadband mass spectra of a crude oil fraction. Black : built-in electronics (.raw, reduced profile mode). Red : FTMS Booster X1. Both mass spectra are normalized to the base peak of the former mass spectrum and represented in magnitude mode FT. 10 T LTQ FT-ICR MS (Thermo Scientific) equipped with 2X NADEL ICR cell, preset R=750,000, AGC is off, IT=100 ms .



Number of analyte peaks of crude oil fraction with the abundance higher than six standard deviations of noise for (red) FTMS Booster X1 and (black) built-in electronics (.raw, reduced profile mode) picked in the 1 Da mass windows spreading the mass range of 300-1200 m/z. Data correspond to the mass spectra shown above.

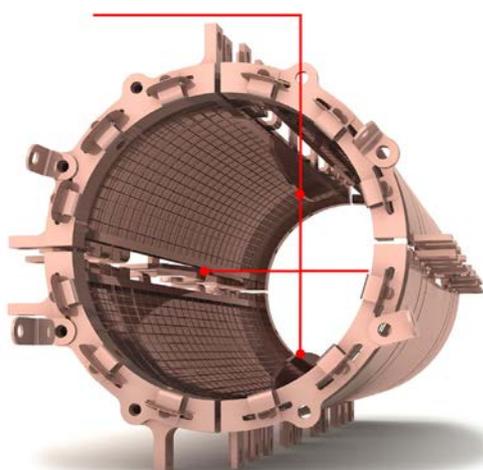
High-Precision Fourier Transform Ion Cyclotron Resonance Mass Spectrometry at Cyclotron Frequency

The **2X NADEL ICR cell** uniquely enables FT-ICR MS at the (true) cyclotron frequency by operating in the quadrupolar ion detection mode. It can be implemented on any FT-ICR MS instrument, including LTQ FT-ICR MS from Thermo Scientific and Solarix™ FT-ICR MS from Bruker Daltonics. Standard hardware and control software are required.

Four Narrow Aperture Detection Electrodes: radially inserted close to ion trajectories for increased sensitivity.

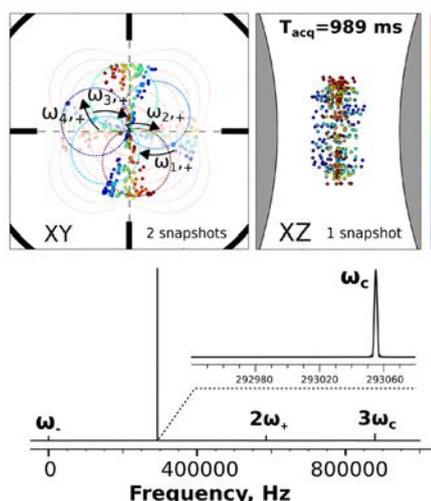
2X NADEL ICR cell for rear flange implementation (e. g., for Bruker Daltonics FT-ICR MS)

2X NADEL ICR cell for front flange implementation (e. g., for Thermo Scientific FT-ICR MS)

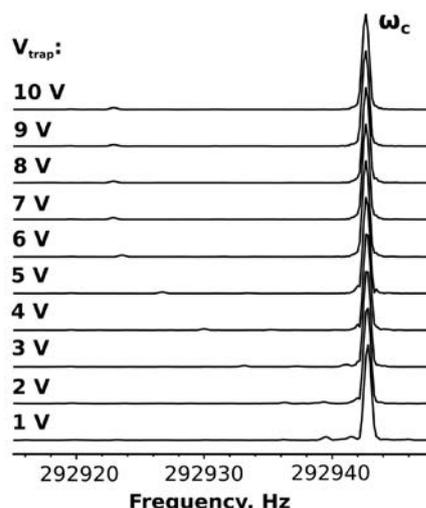


2X NADEL ICR cell design is based on the open-ended cylindrical cell (Ultra™ ICR cell from Thermo Scientific). The patented 2X NADEL ICR cell consists of four wide aperture excitation grid-electrodes and four narrow aperture detection electrodes, thus NADEL ICR cell [1].

Simulations



Experiment



Ion motion simulations of the 2X NADEL ICR cell revealed that a collective motion of a group of ions with a certain initial energy spread is responsible for generation of a new frequency resonance at the (near) **true cyclotron frequency**. The electric field influence (trapping and space charge fields) on the measured frequency is substantially diminished in comparison with standard ICR cells measuring **reduced cyclotron frequency**.

[1] Tsybin Y. O., et al., Patent application PCT/IB2014/060709

Technical Data

Content of delivery	High-performance data acquisition system for commercial FT-ICR MS instruments
System integration	Data acquisition in parallel and synchronously with built-in commercial data acquisition systems
Data file formats	On-demand file formats of output data, including: HDF5, MGF, mzXML, and imzXML
System installation	Trigger wire installation (1 x SMB connector): connection with the instrument's computer; Signal wire installation (1 or 2 x SMB connectors): connection with the instrument's preamplifier
System	Large data sets (e.g., mass spectra in full profile); High duty cycles (fast measurements, e.g. < 1 ms); Continuous recording of long transients (e.g. > 1 h)
Embedded computer	Intel® Core™ i7 CPU 2.6 GHz, 8 GB RAM, USB 2.0 and 3.0, Ethernet OS: Windows® 7 Professional™
Data visualization	On-line and off-line representation of individual or summed transients, frequency or mass spectra
Data storage buffer	User-defined, e.g., 1-2 TB
Analog bandwidth	DC - 100 MHz
Differential input impedance	1 MΩ, 50 Ω
Hardware inputs	3 x SMB connectors
Dimensions	185 x 300 x 210 mm
Weight	8.2 kg
Power supply	100 - 230 VAC, 50 - 60 Hz, Max. 200 W
Warranty	3 years



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