Mass spectrometry

Discovery to validation at unprecedented scale

Stellar mass spectrometer

Benefits

- Expanded experimental scale with faster gradients due to higher ion utilization rates
- Expanded target capacity with fast and sensitive acquisition rates
- Higher quantitative sensitivity with the hyper-fast dual-pressure linear ion trap mass analyzer
- Greater specificity by acquiring full-scan MS^2 and MS^3
- Increased laboratory productivity with novel software solutions to create, implement, and manage highly multiplexed quantitative methods
- Simplified operations with common user interface to that used for current Thermo Scientific™ mass spectrometers

The Thermo Scientific™ Stellar™ mass spectrometer delivers breakthroughs in sensitivity, specificity, and throughput at scale to move biomarker candidates from discovery to validation more efficiently, confidently, and at a lower cost. The Stellar mass spectrometer combines revolutionary hardware and software advancements with robust quantitation. Enhance confidence with the specificity of hyper-fast full-scan MS^n acquisition from the quadrupole-linear ion trap technology and detector system, which delivers single-ion sensitivity. Streamline multi-analyte method creation and dynamic instrument control with automated and intelligent software for increased laboratory productivity.

Hardware features

Active Ion Management Plus technology

Active Ion Management Plus (AIM+) technology maximizes ion transmission, from injection to detection, with novel hardware designed to precisely manage electrical fields and remove sources of noise to achieve unprecedented levels of quantitative performance.

Thermo Scientific™ OptaMax™ Plus API source

The new heater and sprayer design improves the focus of desolvation gases, enhancing contact with the LC stream and concentrating heat on the probe. The improved thermal isolation increases electrospray stability at higher probe temperatures.

- Automatic connection of all gases and voltages on installation simplifies operation and improves reliability
- Automatic source recognition simplifies use and data logging
- Sweep gas reduces chemical noise
- Enhanced exhaust port efficiently removes solvent vapor, improving uptime and reducing chemical noise
- Flexible X, Y, and Z positioning for all ionization probes maximizes performance
- Optimal 60-degree spray angle
- Integrated APCI functionality with interchangeable heated electrospray ionization (HESI) and APCI ionization probes
- APPI compatibility

Optional ion sources

- Thermo Scientific™ EASY-Spray™ NG ion source is designed for maximum nanospray performance with no need for adjustments
- Thermo Scientific™ Nanospray Flex™ NG ion source is designed for ultimate nanospray performance with complete flexibility of column selection
- Thermo Scientific™ FAIMS Pro™ interface improves signal-to-noise ratio by reducing isobaric interferences

Auto-Ready ion source

- The integrated Thermo Scientific™ Auto-Ready™ ion source simplifies and automates mass calibration
- Mass calibrations can be automatically run according to a user-defined schedule, without disruption to LC-MS configuration or productivity
- Calibration and maintenance results are controlled and reported directly in the instrument control software interface
- Internal Thermo Scientific™ Pierce™ FlexMix™ Calibration solution consumable lasts ≥3 months with weekly mass calibration and monthly system calibration, plus intermittent checks

High-capacity transfer tube

The optimized high-capacity transfer tube (HCTT) transfers more ions into the vacuum system for improved sensitivity while maintaining robustness and ease of use.

Ion optics

Electrodynamic ion funnel RF lens

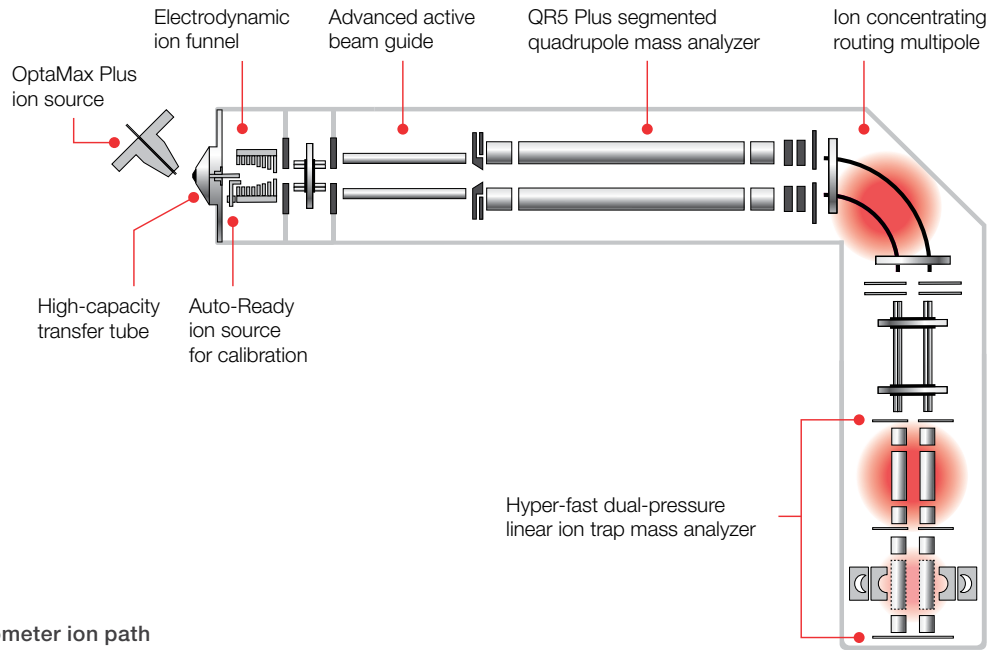
The electrodynamic ion funnel (EDIF) efficiently captures ions as they leave the transfer tube. Its broad transmission curve reduces ion losses, increasing sensitivity. By design, the EDIF gently moves ions from atmosphere to vacuum, reducing in-source fragmentation.

Advanced active ion beam guide

The active ion beam guide improves instrument robustness for increased throughput and high-quality data acquisition by both performing ion filtering and blocking neutrals.

QR5 Plus segmented quadrupole mass filter with hyperbolic surfaces (Q1)

Segmented hyperbolic-surface quadrupole mass filter with 5.25 mm field radius provide increased stability and transmission efficiency across a wide *m/z* range with filtering resolution capabilities down to 0.4Th.



Stellar mass spectrometer ion path

Transmission shutter gate

The transmission shutter gate (TSG) is a set of ion gates that manage ion populations into downstream components. Ion gating times are reduced to about 1–2 microseconds to extend linearity at the ULOQ for high ion flux target analytes.

Ion concentrating routing multipole

The ion concentrating routing multipole (ICRM) is a collision cell for beam-type HCD fragmentation and precursor/product ion trapping capabilities from both the quadrupole mass filter and the dual-pressure linear ion trap. Ion packet manipulations are synchronized with the linear ion trap for maximum ion beam utilization rates, extending the fast analytical capabilities.

Hyper-fast dual-pressure linear ion trap mass analyzer

The hyper-fast dual-pressure linear ion trap mass analyzer enables additional ion packet manipulations, on-resonance isolation and CID, and radial ion ejection for sensitive detection with scan rates up to 140 Hz.

- Dual-pressure configuration expands analytical capabilities while maximizing fast and confident data acquisition
- The high-pressure linear ion trap operates with a static helium pressure for optimized trapping
- The high-pressure linear ion trap can apply on-resonance RF for CID
- The low-pressure linear ion trap operates at a lower pressure, in radial ion ejection mode using scan rates of 33, 67, 125, and 200 kDa/sec
- Linear ion trap can be used in single ion isolation or Synchronous Precursor Selection (SPS) modes using on-resonance RF
- MS^n capabilities, up to MS^{10}
- Traps and manipulates ions while the ICRM is simultaneously filled with the next batch of ions for increased ion utilization rates

Detector

- Dual conversion dynode and photomultiplier tube (PMT) systems for sensitive detection and long lifetimes
- Five orders of dynamic range provide high-confidence quantitation

Vacuum system

- Four-stage differentially pumped vacuum manifold
- Advanced triple-inlet turbomolecular pump integrated with the vacuum manifold
- A single Edwards nXR120i dry-pump

Syringe pump and optional divert valve

The system features an independent syringe pump (included) and a divert valve (optional) fully controlled via data station for maximum flexibility. Automated control of the optional divert valve enables switching the solvent front, gradient end point, or any portion of the HPLC run to waste.

Software features

Data system

- High-performance PC with Intel® microprocessor
- High-resolution LCD color monitor
- Microsoft® Windows® 10 operating system (64-bit)

Standard MS software

- Thermo Scientific™ Xcalibur™ processing and instrument control software
- Tune editor for system calibration, diagnostics, and manual data acquisition
- Method editor with comprehensive application-specific template library and intuitive user interface to facilitate method development, and includes:
  - Adaptive RT feature—Automated on-the-fly adjustment of retention time windows to accommodate chromatographic fluctuations
- Direct control of multiple vendors' LC systems and autosampler configurations through SII for Xcalibur software

Optional application-specific software

- Thermo Scientific™ Proteome Discoverer™ software
- Flexible, expandable platform for the qualitative and quantitative analysis of proteomics data
- Supports the use of Skyline software (MacCoss Lab Software, University of Washington) for method development and data analysis in peptide applications
- PRM Conductor—A Skyline plugin tool that automates method development from discovery work to targeted assays
- Thermo Scientific™ Mass Frontier™ spectral interpretation and classification software for the identification of unknowns
- Thermo Scientific™ TraceFinder™ software simplifies method development and routine analysis in food safety, environmental, clinical research, and forensic toxicology laboratories

Scan functions

- Highly sensitive full-scan MS
- Selected-ion monitoring (SIM)
- Selected-reaction monitoring (SRM)
- Targeted-MSn
  - Targeted-MS2 with speeds up to 140 Hz
  - Targeted-MS3 with speeds up to 40 Hz
- Data-independent analysis (DIA)
- Data-dependent MS^n (dd-MS^2 up to dd-MS^{10})
- Polarity switching capabilities with 5 millisecond switching time
- Dissociation modes: in-source CID, HCD, CID. For MS^n, any dissociation combination can be used.
- Management of multiple experiments in same instrument method

Performance specifications

Sensitivity

Targeted-MS2 mode, positive HESI

10 fg of reserpine on column will produce a minimum signal-to-noise ratio of 600:1 for the sum of the targeted-MS2 products of the protonated molecular ion at *m/z* 609.3 when operated in targeted-MS2 mode with Q1 set to a resolution 0.7 Th FWHM. The ion trap is operated at a scan rate of 33 kDa/sec.

Targeted-MS3 mode, positive HESI

10 fg of reserpine on column will produce a minimum signal-to-noise ratio of 1000:1 for the sum of the targeted-MS3 products *m/z* 174, 195, and 236. The MS^3 ions are generated from the MS^2 ions *m/z* 448 and 397. The system is operated in targeted-MS3 mode with Q1 set to a resolution 2.0 Th FWHM. The ion trap is operated at a scan rate of 67 kDa/sec.

MS^n capabilities

Using a 500 pg/µL standard of Tris(2,4-di-tert-butylphenyl) phosphate infused at flow rate of 10 µL/min via a syringe pump, the instrument will perform multiple-stage MS^n experiments from MS to MS^{10} when operating in data-dependent mode.

Mass range

- *m/z* 5–2,000 in full-scan mode
- *m/z* 20–2,000 in MS^n mode

Resolution

- 0.4 Th filtering capabilities for the quadrupole mass filter
- The ion trap operates at various peak widths depending on scan rate:
  - 0.50 at 33 kDa/sec
  - 0.60 at 67 kDa/sec
  - 0.80 at 125 kDa/sec
  - 2.00 at 200 kDa/sec

Scan rate

- The linear ion trap operates at scan rates of 33, 67, 125, or 200 kDa/sec
- Polarity Switching: 5 msec total including signal stabilization time

Acquisition speed

- Up to 140 Hz for small molecules
- Up to 75 Hz for peptides

Mass stability

Mass accuracy will be within ±0.1 Da at *m/z* 524 over a 24-hour period for the 33 kDa/s scan rate. The laboratory room temperature must be maintained between 18–27 °C (65–81 °F). The room temperature may not change by more than 5 °C (9 °F) during this period.

Installation requirements

Power

- Two 230 Vac ±10%, 50/60 Hz at 16 A minimum
- Four 120 Vac ±6–10%, 50/60 Hz at 20 A or four 230 Vac ±10%, 50/60 Hz at 13 A
- Earth ground hardwired to main panel
- Free from voltage variations above or below the recommended operating range

Gas

- ICRM Collision gas: 99.995% pure Nitrogen
- ICRM Collision gas supply pressure: 345 ± 70 kPa (50 ± 10 psig)
- High-pressure linear ion trap gas: 99.995% pure Helium
- Low-pressure linear ion trap gas supply pressure: 275 ± 70 kPa (40 ± 10 psig)
- Sheath/aux/sweep gas: 99% pure Nitrogen
- Sheath/aux/sweep gas supply pressure: 690 ± 140 kPa (100 ± 20 psig)
- Sheath/aux/sweep gas consumption: ~20 L/min under normal operating conditions (~35 L/min at maximum gas flow conditions)

Environment

- Functional temperature range: 15–27 °C (59–81 °F)
- Optimal temperature range: 18–21 °C (65–70 °F)
- Maximum Heat output: 1,002 W (3,416 Btu/h)
- Total system heat output: 1,550 W (5,300 Btu/h)
- System noise levels: 69 dB at 1 meter distance
- Particulate matter: <3,500,000 particles per cubic meter of air (<100,000 particles of >5 µm diameter per cubic foot of air)
- Relative humidity: 20% to 80%, without condensation
- Floors must be free of vibration

Dimensions (h × w × d)

710 × 760 × 840 mm (28 × 30 × 33 in)

Weight

142 kg (314 lb)

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