The Thermo Scientific™ Orbitrap Fusion™ Lumos™ Tribrid™ mass spectrometer is the industry-leading high-performance mass spectrometer with enhanced sensitivity facilitated by a new High Capacity Transfer Tube, Electrodynamic Ion Funnel, Advanced Quadrupole Technology, Advanced Vacuum Technology, and ETD HD.

**Novel Orbitrap Fusion Lumos MS Features**
- Novel high-sensitivity API interface combines a High Capacity Transfer Tube and an Electrodynamic Ion Funnel for increased ion flux and lower limits of detection
- Advanced Active Beam Guide (AABG) prevents neutrals and high velocity clusters from entering the resolving quadrupole
- Advanced Quadrupole Technology (AQT) combines high selectivity and efficiency of transfer for the selected ions symmetrically across the isolation window
- Advanced Vacuum Technology for improved transmission of high molecular weight ions to the Orbitrap analyzer
- Novel ETD HD—high dynamic range ETD providing significantly increased fragment ion coverage

**Established Tribrid Features**
- Tribrid architecture includes quadrupole mass filter, linear ion trap and Orbitrap mass analyzers
- Ultra high-field Orbitrap analyzer for ultra-high resolution and the fastest Orbitrap acquisition rates
- Resolving power up to 500,000 FWHM with isotopic fidelity up to 240,000 FWHM at m/z 200
- Large surface area ion trap detector for significantly improved robustness and life span
- Full parallelization of MS and MS^n analyses with intelligent ADAPT™ (All Dynamically Available Parallelizable Time) technology
- Synchronous Precursor Selection (SPS) for MS and MS^n experiments
- Multiple fragmentation techniques: CID, HCD and optional ETD and EThC-D available at any stage of MS^n with detection in either the Orbitrap or linear ion trap detector

**Unique Tribrid architecture allows for high acquisition rates in Orbitrap and linear ion trap analyzers and maximum flexibility for dissociation and detection of fragment ions**
- Compact ETD ion source based on Townsend discharge with extremely stable anion flux for improved usability and reagent longevity
- Acquisition rates of up to 20 Hz for both Orbitrap and linear ion trap MS^n analyses
- Universal Method provides maximal peptide identifications without method optimization for samples of unknown concentration, reducing sample and instrument time requirements for routine peptide identification experiments
- Intuitive and flexible drag-and-drop user interface simplifies method development and enables unique and complex workflows
Hardware Specifications

**Ion Source**

*Thermo Scientific™ Ion Max NG™ Ion Source*
- Adjustable heated electrospray ionization (HESI) probe for ultimate sensitivity
- Flow rates from 1 μL/min up to 2,000 μL/min
- Designed for maximum performance with no need for adjustments
- Enhanced ruggedness
- Sweep Gas™ reduces chemical noise
- Optional APCI probe compatible with liquid flow rates of 50 μL/min to 2,000 μL/min without splitting

**Generation IV Ion Optics**

- The new API interface consists of a High Capacity IV Ion Optics
  - Optional APCI probe compatible with liquid flow rates of 50 μL/min to 2,000 μL/min without splitting
  - New low noise detection pre-amplifier
  - Next-generation, ultra high-field Orbitrap analyzer
  - New low noise detection pre-amplifier

**Electrodynamic Ion Funnel**

- EDIF, a radio frequency (RF) device, efficiently captures ions as they leave the HCTT
- Automatic tuning results in broad transmission curves and reduces ion losses, increasing sensitivity

**High-Capacity Ion Transfer Tube**

- The HCTT increases ion flux into the vacuum system for improved sensitivity and desolvation
- Vent-free maintenance

**Eddy Current Mass Filter**

- EDIF, a radio frequency (RF) device, efficiently captures ions as they leave the HCTT
- Automatic tuning results in broad transmission curves and reduces ion losses, increasing sensitivity

**Advanced Active Beam Guide**

- Advanced Active Beam Guide with an axial field and low pass filtering reduces noise by preventing neutrals and high-velocity clusters from entering the quadrupole mass filter

**Advanced Quadrupole Technology**

- Segmented Quadrupole Mass Filter for precursor ion selection with variable precursor isolation width from 0.4 u to 1,200 u
- Superior ion transmission across isolation widths up to 1,200 u
- MS/MS precursor ion selection with high transmission from 50 to 3,000 m/z

**Ion-Routing Multipole**

- IRM for ion storage
- Higher-energy collisional dissociation (HCD) cell
- Efficient, reliable ion transfer between the ion-routing multipole and the Orbitrap and linear ion trap mass analyzers

**Orbitrap Mass Analyzer**

- Next-generation, ultra high-field Orbitrap analyzer
- New low noise detection pre-amplifier
- High-speed real-time data acquisition and instrument control system
- Automatic calibration of all ion transfer and analysis parameters via instrument control software

**Dual-Pressure Linear Ion Trap**

- High-pressure cell for MS+ precursor ion isolation from 0.2 u to 600 u
- Collision-induced dissociation (CID) and optional electron-transfer dissociation (ETD)
- Low-pressure cell for improved scan speed, resolving power, and mass accuracy
- Dual-dyne detector with high linear dynamic range for improved quantitation and a large surface area for increased lifespan and robustness

**Vacuum System**

- Split-flow turbomolecular pump controlling vacuum in three regions
- Aluminum high-vacuum analyzer chambers
- Advanced Vacuum Technology reducing the pressure in the ultra-high vacuum region to \(<2 \times 10^{-7}\) and enhancing transmission of the ions to the Orbitrap mass analyzer

**Options**

- **Thermo Scientific™ NanoSpray Flex NG™ Ion Source**
  - Supports static and dynamic nanoelectrospray experiments
  - Compatible with liquid flow rates of 50 nL/min to 2 μL/min

- **Thermo Scientific™ EASY-Spray™ Ion Source**
  - Maximum nanoelectrospray performance with no need for adjustments
  - Generates fluoranthene anions for electron capture dissociation (ECD)
  - Generates internal calibrant ions for electron transfer dissociation (ETD)

- **Thermo Scientific™ EASY-IC™ Ion Source**
  - Provides <1 ppm RMS mass accuracy under defined conditions and minimizes effort

**Performance Characteristics**

**Mass Range**

- \(m/z\) 50–2,000
- \(m/z\) 200–4,000
- up to \(m/z\) 6,000 without precursor ion selection (OTMS only)

**Resolution OTMS**

- 15,000–500,000 (FWHM) at \(m/z\) 200

**Scan Rate**

- OTMS up to 20 Hz
- ITMS up to 20 Hz

**Mass Accuracy OTMS**

- <3 ppm RMS using external calibration
- <1 ppm RMS using internal calibration

**MS/MS Electrospray Ionization (ESI) Ion Trap sensitivity**

- 2 μL of a 50 fg/μL solution of reserpine (100 femtograms total) injected at a flow of 500 μL/min will produce a minimum signal-to-noise ratio of 200:1 for the transition of the isolated protonated molecular ions at \(m/z\) 609 to the largest two product ions, \(m/z\) 397 and \(m/z\) 448, when the mass spectrometer is operated at unit resolution in the full scan MS/MS mode, \(m/z\) 165–615. The test requires HESI III probe.

**Dynamic Range**

- >5,000 within a single OTMS spectrum

**MS Scan Power**

- MS+, for \(n = 1\) through 10

**Synchronous Precursor Isolation**

- Up to 20 precursors per MS+ scan

**Multiplexing Using the Ion Routing Multipole**

- Up to 10 precursors per scan using the quadrupole mass filter

**Polarity Switching**

- One full cycle in <1.1 sec (one full scan positive mode and one full scan negative mode at resolution setting of 30,000)

**ETD Efficiency**

- ETD fragmentation efficiency of >15%, (infusion of 1 pmol/μL angiotensin at 3 μL/min)

**Analog Inputs**

- Channel 1 analog input (0–10 V), Channel 2 analog (0–2 V)

*Under defined conditions*
Software Features

Data System
- High-performance PC with Intel® microprocessor
- High-resolution LCD color monitor
- Microsoft® Windows® 7 operating system
- Microsoft Office 2010 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 drag-and-drop user interface to facilitate method development

Operation Modes
- Top-speed mode maximizes the number of high-quality MS^n spectra from each cycle by intelligently scheduling MS and data-dependent MS^n scans based on a user-definable time between adjacent survey scans
- Dynamic parallelization using ADAPT™ technology maximizes the amount of high-quality data acquired by synchronizing operation of the quadrupole mass filter, Orbitrap and linear ion trap operations
- Automatic gain control (AGC) ensures that the ion routing multipole is always filled with the optimum number of ions for any acquisition type

Advanced Data-Dependent Experiments
- Universal Method powered by ADAPT technology always ensures the best results from the samples with unknown concentrations
- Fragment ion or neutral-loss-triggered MS^n experiments including at the same MS^n level
- Synchronous MS^n precursor selection significantly increases the number of peptides accurately quantified in isobaric mass tagging experiments
- Data-dependent neutral-loss experiment triggers an MS^n scans only for product ions with a predefined neutral loss
- Isolation offset allows for custom centering of the window when working with broad isotopic distributions
- Quanfirmation experiment uses synchronous HRAM SIM for quantitation with full-scan MS/MS in the linear ion trap for precursor identity confirmation

Optional Application-Specific Software
- Thermo Scientific™ Proteome Discoverer™ software—flexible, expandable platform for the analysis of qualitative and quantitative proteomics data
- Thermo Scientific™ Protein Deconvolution software—intact-protein analysis platform
- Thermo Scientific™ ProSightPC™ software—stand-alone software for analyzing top-down intact-protein data, as well as middle-down and bottom-up data
- Thermo Scientific™ Compound Discoverer™ software—integrated solution for small-molecule structural identification
- Thermo Scientific™ SIEVE™ software—label-free, semi-quantitative differential analysis of highly complex data sets

Figure 1. Orbitrap Fusion Lumos MS ion path.
Installation Requirements

Power
- 230 Vac ± 10% single phase, 15 Amp, 50/60 Hz, with earth ground for the instrument
- 120 or 230 Vac single phase with earth ground for the data system

Gas
- Ultra-high purity Helium (99.999%) with less than 1 ppm each of water, oxygen and total hydrocarbons
- High purity Nitrogen (99.5% pure, flow rate 15 L/min) gas supply for the API source and the ion routing multipole (IRM)

Size
1186 × 674 × 650 mm (w, d, h)

Weight
180 kg (400 pounds) without data system, vacuum rough pumps and optional items

Environment
- System averages 2,800 W (10,000 Btu/hr) output when considering air conditioning needs
- Operating environment must be 16–26 °C (59–78 °F) and relative humidity must be 50–80% with no condensation
- Optimum operating temperature is 18–21 °C (65–70 °F)

IC/ETD Options
Nitrogen supply for IC/ETD option: Ultra-high purity nitrogen (UHP, 99.999%) with less than one ppm each water and oxygen

Figure 2. Orbitrap Fusion Lumos MS dimensions.