MASS SPECTROMETRY

Thermo Scientific MAT 253

The Gold Standard for Isotope Ratio MS

Thermo Fisher MAT 253
Stable Isotope Ratio Mass Spectrometer

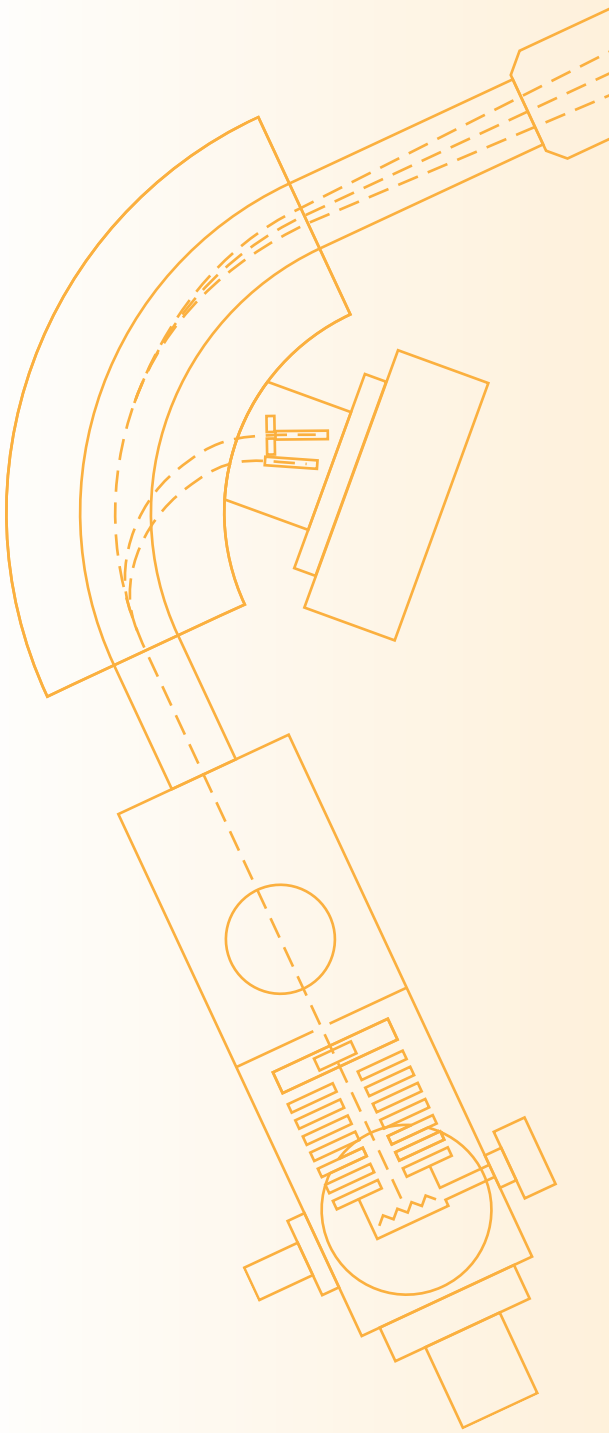
The Gold Standard for Isotope Ratio MS

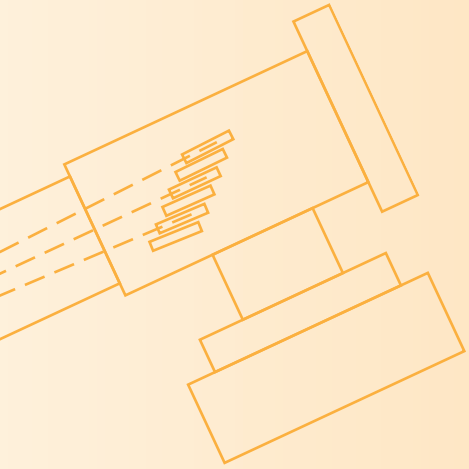
Features of the MAT 253

- Highest sensitivity and linearity
- Amplifiers register up to 50 V
- Computer switchable amplifier gain
- Hydrogen continuous flow capability
- "Fast bellows" system
- Computer-controlled ion source potentials and parameters
- Up to eight simultaneous acquisition channels
- "Plug and measure" peripheral recognition
- Total Isodat software suite integration
- Small footprint

All the Features of the Established Standard, the Thermo Scientific MAT 252

- 10 kV acceleration voltage
- Ion source with variable conductivity
- All-metal sealed ion source and analyzer
- Monolithic all-metal valves with gold gaskets
- 100% analyzer transmission
- 460 mm mass dispersion
- Mass range *m/z* 1-150 at full acceleration voltage
- Mass resolution 200 (C,N,O,S)
- The only system for e.g. SF_6, SiF_4, Xe...
- Proven robustness





The Thermo Scientific MAT 253 stable isotope ratio mass spectrometer system delivers the highest precision for the determination of D/H, $^{13}C/^{12}C$, $^{15}N/^{14}N$, $^{18}O/^{16}O$, $^{34}S/^{32}S$ (from SO_2 and SF_6), $^{28}Si/^{29}Si$ as well as Ar, Kr and Xe isotope ratios.

It is unique in its capability to achieve precision measurements from the smallest amounts of sample. The MAT 253 provides a flexible and open platform for the connection of inlet systems and preparation devices. Thermo Fisher Scientific-supplied inlet systems are automatically recognized by a ***"plug and measure"*** concept. In addition, the system is open for easy connection and control of custom inlet/preparation systems.

Full integration of Isodat software suite, the dedicated gas isotope data system, enables the MAT 253 to be easily set up, tuned, and run – fully automatically.

The powerful Isodat Script Language (ISL) provides access to all processes and allows modification of supplied scripts as well as development of entirely new measurement and evaluation protocols.

Highest Sensitivity in Isotope Ratio MS

The 10 kV Mass Analyzer

The Ion Source

The electron impact ionization source, held at 10 kV acceleration voltage, delivers the ***highest sensitivity*** while giving the tightest and most comprehensive specifications for linearity. The variable ion source conductance window allows source conductance to be optimized for the specific application.

The ion source is pumped with a hybrid two-stage turbo molecular pump, giving high pumping capacity for H_2 and He, while guaranteeing the lowest background and a low and stable H_3^+ factor.

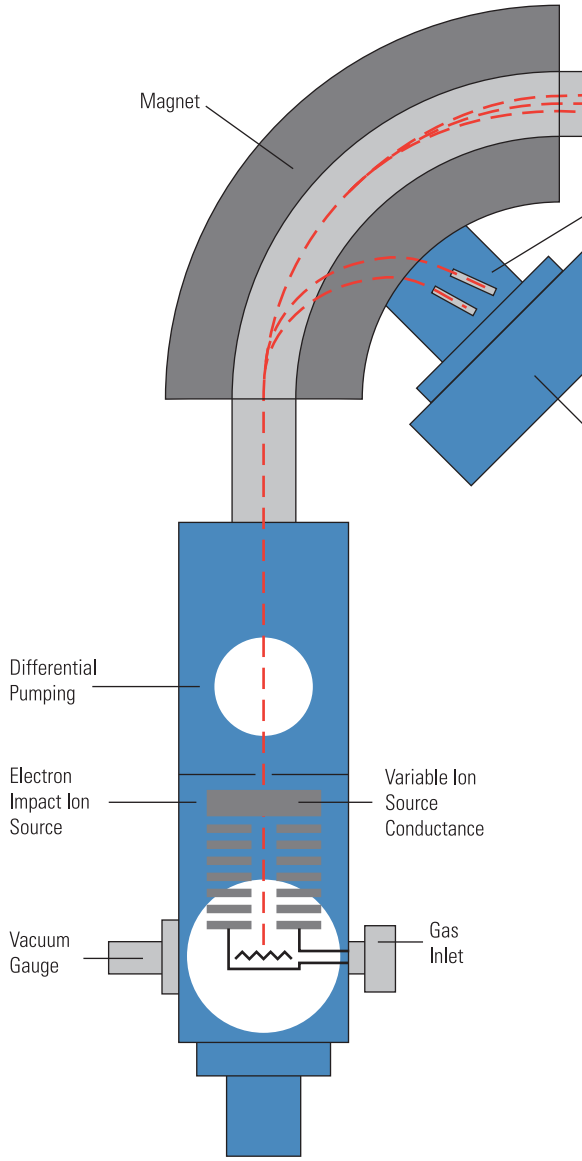
Ion source parameters are set by the data system. Tuning can be manual or automatic. Ion source parameters can be stored and retrieved. The ion source manifold is weldfree, machined from a single piece of stainless steel, and all-metal sealed.

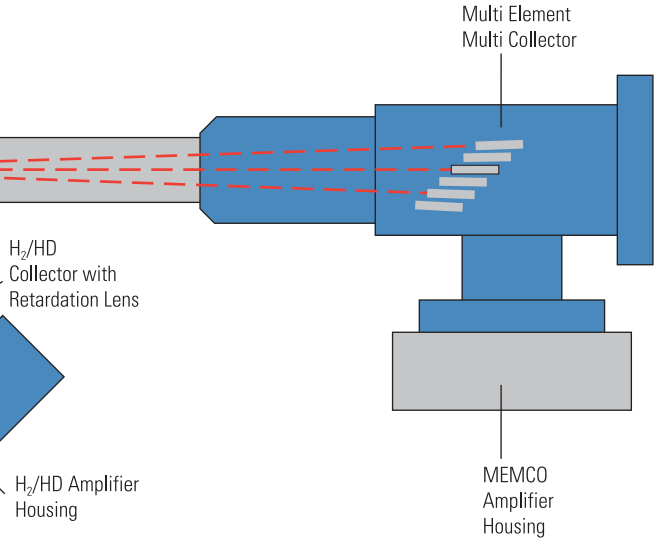
The Analyzer

The analyzer geometry with stigmatic focusing and the largest dispersion by far of any gas IRMS (460 mm), is the foundation of the MAT 253's analytical performance and ruggedness. Perfect peak shapes, unrivaled mass resolution, and a mass range which covers all stable isotope ratio applications translate directly into precision, accuracy, sensitivity, versatility, and reliability.

All gas species except H_2 are measured using the full deflection radius. H_2 is measured on a smaller radius with an effective dispersion of 180 mm. The magnetic sector field is generated by an electromagnet. The field strength is controlled by a high precision current regulator which is under full data system control.

The analyzer can be equipped with an optional differential pumping module, ensuring optimum vacuum conditions even with a high He load on the ion source.





The Collectors

Collectors for C, N, O, S, Si, Ar, Kr, and Xe are located at the focal plane of the full deflection radius. They use deep, individually shielded Faraday cups with secondary electron suppression. Up to eight individual cups can be present, depending on the application. ***Data can be acquired from any number of these cups simultaneously.***

The collectors for D/H are located at a smaller deflection radius. The cup for *m/z* 3 (DH) is equipped with a retardation lens. ***This enables the MAT 253 to determine the D/H ratio by continuous flow, in excess of He.***

Both sets of collectors are connected individually to evacuated amplifier housings with ***new amplifiers***. The amplifiers have a ***linear dynamic range*** of 50 V, and each channel can be equipped with computer switchable gain, implemented by switchable feedback resistors. This new design allows easier measurement of wide ratio swings, e.g. enriched samples.

Dual Inlet System

The optional Dual Inlet System uses monolithic all-metal valve blocks with gold-sealed and gold-seated valves. The changeover valve is mounted directly to the ion source housing. This design gives minimal dead volume, shortest transit distance and minimum gas path length.

The variable bellows can be adjusted between 3 and 40 mL volume. ***Adjustment of the bellows has been made faster for better sample utilization.*** The waste line is pumped by a dedi-cated turbo molecular pump. The Dual Inlet System can be heated in order to achieve high purity sample introduction. The Dual Inlet System can be expanded by one or two multiports (10 ports each). A cryogenic dual micro volume inlet system can be added. The built-in pressure transducers and intelligent software allow extreme flexibility using the multiport for sample inlet.

Isodat Software Suite

Isodat is the software suite for system control, data acquisition, and data evaluation. It is an integral part of the system architecture and enables the analytical power and flexibility of the Thermo Scientific MAT 253 to be routinely brought to bear on solving the toughest applications.

System Control

All aspects of the mass spectrometer are controlled by software, including ion generation, mass separation, and ion detection. *Control of the ion source* allows manual tuning, auto tuning, as well as storage and retrieval of ion source parameters. System configurations can be easily defined. Different configurations representing different analytical setups can be stored and retrieved. Up to eight simultaneous data acquisition streams are supported.

Automation

The system is designed to fully automatically execute pre-defined procedures and run sequences of analyses, including customized reporting.

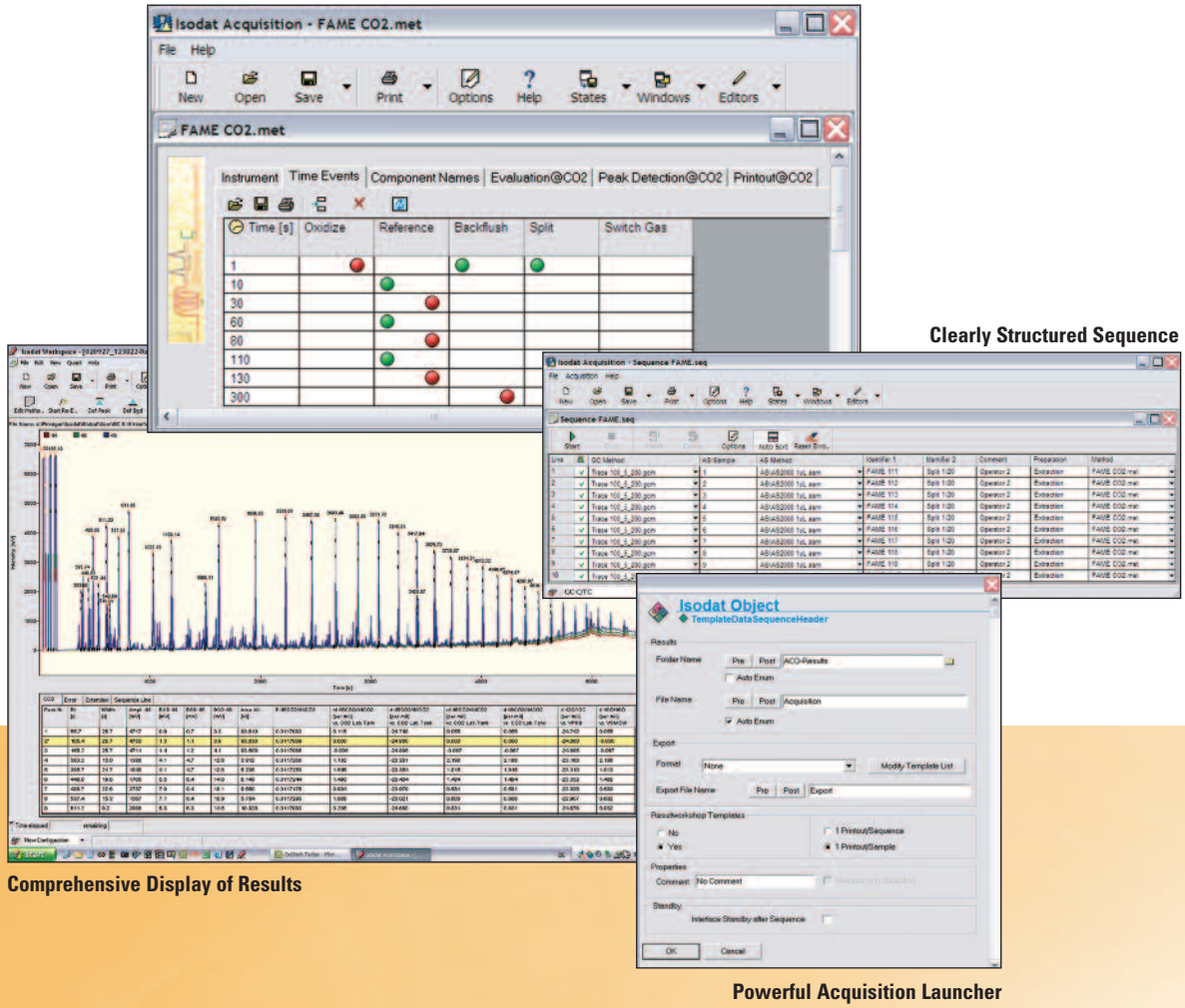
Open Architecture

Isodat Script Language (ISL) is the tool giving the expert user full access to the mass spectrometer, the inlet systems, and additional user-supplied devices. An input-output module allows connection and control of up to five interfaces. Scripts can be developed for customized applications. The export of all data is extremely flexible and can be easily customized.

Data Evaluation and Display

Isodat provides a comprehensive set of customizable data evaluation routines. Standard report forms are provided according to the application. In addition, reports can be easily customized using Isodat's unique Result Workshop.

Intuitive Method Creation



Clearly Structured Sequence

Comprehensive Display of Results

Powerful Acquisition Launcher

Flexible & Powerful
Straightforward & Easy

System Performance

Mass Range

1 – 150 Dalton at 10 kV

Resolution

CNOS: m/Δm = 200 (10% valley)
H/D: m/Δm = 25 (10% valley)

Peak Top Flatness

Better than 2 x 10^{-4}

Sensitivity

600 molecules CO_2 per mass 44 ion at the collector (600 molecules/ion) in the Dual Inlet mode

Ion Source Linearity

0.02 ‰/nA ion current (mass 44) at a sensitivity corresponding to **900 molecules/ion** in the Continuous Flow mode

Abundance Sensitivity

The contribution of the mass 44 intensity to the intensity of mass 45 is less than 2 x 10^{-6}

Sample Consumption

0.031 nmol/s for 1.5 V signal (5 nA) at mass 44 in the Dual Inlet mode 0.047 nmol/s for 1.5 V signal (5 nA) at mass 44 in the Continuous Flow mode

H_3^+ Factor

Smaller than 10 ppm/nA

Dual Inlet Performance

Standard performance data of the Thermo Scientific MAT 253 by viscous flow gas introduction using the Dual Inlet system and changeover valve:

GAS	MINOR ISOTOPES	PRECISION (‰) INTERNAL (2σ mean)	PRECISION (‰) EXTERNAL* (1σ)	SAMPLE SIZE STANDARD Inlet (bar µl)	SAMPLE SIZE COLD FINGER Inlet (bar µl)
CO_2 [C]	^{13}C	0.005	0.01	> 70	> 3
		0.03	0.1	-	> 1
CO_2 [O]	^{18}O	0.01	0.03	> 70	> 10
		0.02	0.05	-	> 4
N_2	^{15}N	0.008	0.01	> 70	-
		0.05	0.1	-	> 20
SO_2	^{34}S	0.006	0.01	> 70	> 10
SF_6	^{34}S	0.006	0.01	> 70	> 10
H_2	^{2}H	0.09	0.4	> 130	-

* measured using internal multiport -10

Continuous Flow Performance

Standard performance data of the Thermo Scientific MAT 253 by continuous flow gas introduction. 10 pulses of reference gas at an amplitude of 5 nA (1.5 V, for H_2 5 V):

GAS	MINOR ISOTOPE	PRECISION (1σ)	LINEARITY
CO_2	^{13}C	0.06 ‰	0.02 ‰ / nA
	^{18}O	0.08 ‰	0.02 ‰ / nA
N_2	^{15}N	0.06 ‰	0.02 ‰ / nA
O_2	^{18}O	0.08 ‰	0.03 ‰ / nA
	^{17}O	0.20 ‰	0.04 ‰ / nA
CO	^{18}O	0.15 ‰	0.04 ‰ / nA
H_2	^{2}H	0.40 ‰	0.20 ‰ / nA
SO_2	^{34}S	0.10 ‰	0.03 ‰ / nA

Installation Requirements

Environment

Heat output 2.5 kW during normal operation, 4.5 kW during bakeout. Ambient temperature must be 18 - 28 °C with a relative humidity of 20 – 70%

Power

230 V – 10% + 6%, 16 A, three-phase, 50/60 Hz, dedicated lines. Voltage must be free of spikes. Maximum permissible voltage between ground and neutral lines < 400 mV

Compressed air

350 to 500 Kpa (50 to 75 psi)

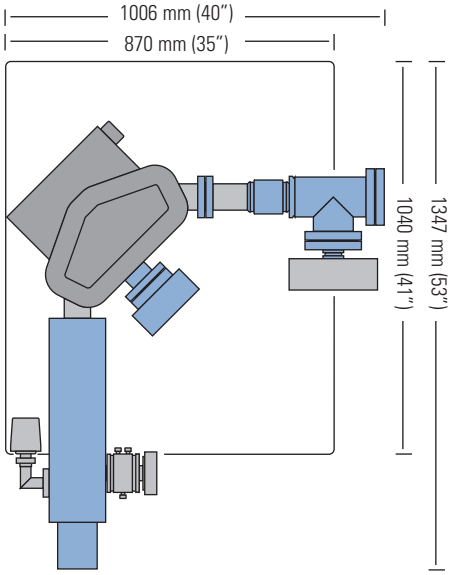
Dimensions

Mass spectrometer system:
101 cm (width) x 135 cm (depth) x 136 cm (height); 40 inch x 53 inch x 53 inch. Width for transport 87 cm (35 inch).

Weight

680 kg (1500 lb), basic system.

Thermo Scientific MAT 253 Footprint and Dimensions



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