

## Thermo Scientific FLASH HT *Plus* Elemental Analyzer for IRMS

*Fully Automated Multi-Element Isotope Analysis  
for C, N, S, O, H*



Food Testing



Forensics



Environmental Analysis



Earth Sciences

# Thermo Scientific FLASH HT *Plus*

Elemental Analyzer for Isotope Ratio MS

The Thermo Scientific Flash HT *Plus* is a fully automated elemental analyzer optimized for isotope analysis of C, N, S, O and H. It meets the increasing demand for multi-element isotope analysis for applications such as quality control; detection of adulteration of food, beverage, flavors, and pharmaceuticals; environmental analysis; and forensics.

The Flash HT *Plus* combines two furnace systems in a single elemental analyzer and is equipped with an Automatic Switching Valve (ASV) to switch between the two modes of operation: Dynamic Flash Combustion for C, N and S isotope analysis and High Temperature Conversion for O and H isotope analysis.

The FLASH HT *Plus* adds versatility and automation to the proven stability, robustness and reliability of Thermo Scientific Elemental Analyzers for Isotope Ratio MS.

## Fully Automated Multi-Element Isotope Analysis for C, N, S, O and H

- Five elements and five isotope ratios from one fully automated elemental analyzer
- Two furnace systems in one small footprint
- Highest efficiency and versatility resulting from full software control
- Two autosamplers enable full automation
- ASV for automated switching between both modes
- Thermal Conductivity Detector (TCD) in both modes
- Sulfur-ready with sulfur-resistant tubing making extra fittings and modifications obsolete
- He carrier gas consumption as low as for a single line elemental analyzer

The Flash HT *Plus* operates in true continuous flow mode for complete compatibility with principles of CF-IRMS.



The FLASH HT *Plus* includes separate lines which enable the formation and separation of  $N_2$ ,  $CO_2$  and  $SO_2$  in Dynamic Flash Combustion mode and  $H_2$  and  $CO$  in High Temperature Conversion mode. The FLASH HT *Plus* is connected to a Thermo Scientific Isotope Ratio MS via the ConFlo IV universal interface for the isotope analysis of the above gases.

During isotope analysis, the determination of elemental weight percent of N, C, S, O, and H is performed by the Thermo Scientific Isodat software suite using mass traces from the isotope ratio MS and from the TCD (Thermal Conductivity Detector), which is integrated in the FLASH HT *Plus*. Dedicated Thermo Scientific Eager Xperience software also allows operation of the FLASH HT *Plus* as a stand-alone instrument for weight percent determination.

The FLASH HT *Plus* comes with two Thermo Scientific MAS 200R carousel autosamplers for solid samples. It can optionally be equipped with an AS3000 autosampler for liquid samples.



## Dynamic Flash Combustion and High Temperature Conversion in a Single Elemental Analyzer

Dynamic Flash Combustion and High Temperature Conversion in one elemental analyzer, for quantitative yields of all elements

- **Dynamic Flash Combustion**
  - Quantitative Dumas combustion of CNS to  $CO_2$ ,  $N_2$  and  $SO_2$
- **High Temperature Conversion**
  - Quantitative reduction of O and H to  $CO$  and  $H_2$
  - Bottom Feed Connector for increased sample throughput
- **Analysis of Solid and Liquid Samples**
  - Organic and Inorganic Materials
  - Water and other Liquids
  - Can be operated in stand alone mode for elemental analysis

# Dynamic Flash Combustion

## Dynamic Flash Combustion for C, N and S Isotope Analysis

In 1968 we introduced the first fully automated elemental analyzer. This long record of continuous innovation in elemental analysis is the basis for the Dynamic Flash Combustion mode used in the stand-alone and isotope-ready versions of the FLASH HT Plus.

Automated injection of oxygen into the reactor at a predefined time guarantees quantitative sample conversion. The oxygen dosing is variable allowing for optimal reaction of different sample types and the most economic usage of the combustion reactors.

Tin capsules used for sample introduction combust in an exothermic reaction reaching a temperature of up to 1800°C for a few seconds. Nitrous oxides which may be formed during combustion are reduced by Cu to N<sub>2</sub>.

After removal of H<sub>2</sub>O, the N<sub>2</sub>, CO<sub>2</sub> and SO<sub>2</sub> are separated on an isothermal GC column and the <sup>15</sup>N/<sup>14</sup>N, <sup>13</sup>C/<sup>12</sup>C and <sup>34</sup>S/<sup>32</sup>S isotope ratios are measured sequentially. Detailed information on parameters and setup is given in the Thermo Scientific application note AN30194 Simultaneous N, C and S Isotope Ratio Determination on a DELTA V Isotope Ratio MS using a FLASH Elemental Analyzer.

MAS 200R Autosampler for solids

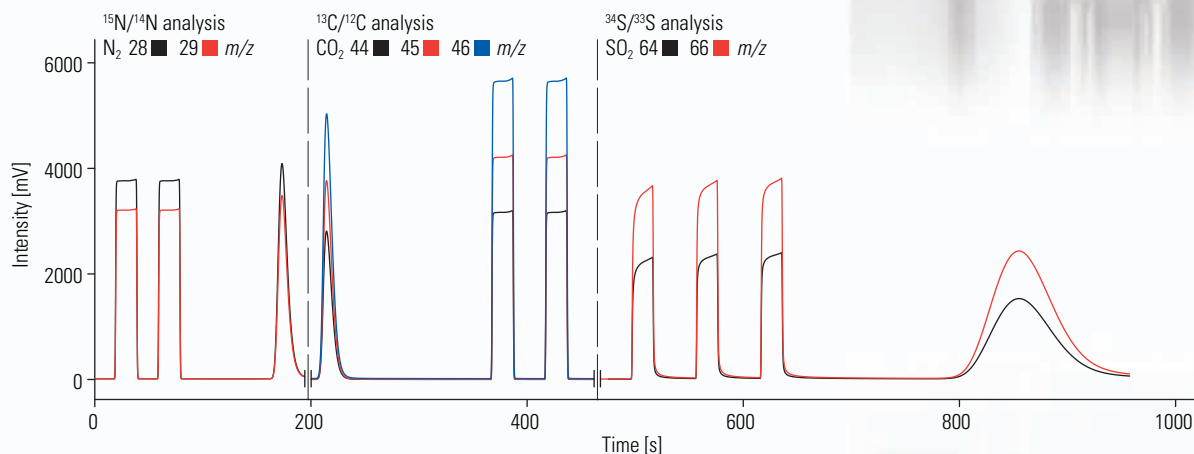
### Applications for Dynamic Flash Combustion

- Authenticity control of beverages, food and drugs
- Forensic science
- Environmental analysis
- Oceanography and limnology
- Tracer analysis

Dynamic Flash Combustion furnace

High Temperature Conversion furnace

FLASH HT Plus fully automated  
Elemental Analyzer for Isotope Ratio MS



# High Temperature Conversion

## High Temperature Conversion for O and H Isotope Analysis

In 1996 we introduced a high temperature conversion elemental analyzer which has revolutionized the measurement of  $^{18}\text{O}/^{16}\text{O}$  and D/H ratios in both organic and inorganic materials. Today, this proven technology has become an integral part of the FLASH HT Plus.

Quantitative high temperature conversion, often referred to as pyrolysis or thermochemolysis, rapidly and quantitatively converts the sample's O and H into  $\text{CO}$  and  $\text{H}_2$  in a reducing environment at high temperatures (typically exceeding  $1400^\circ\text{C}$ ).  $\text{CO}$  and  $\text{H}_2$  are separated in an isothermal GC column prior to transfer into the ion source of the Isotope Ratio MS for sequential determination of hydrogen and oxygen isotopes of the sample.

The reactor is a glassy carbon tube filled with glassy carbon granules surrounded by a ceramic tube. The glassy carbon tube ensures that neither sample nor reaction gases make contact with the ceramic tube to preclude oxygen isotope exchange at high temperature. This is the only analytical technology which allows high precision isotope ratio monitoring of D/H and  $^{18}\text{O}/^{16}\text{O}$  during a single analysis (see chromatogram below).

High Temperature Conversion has been increasingly used for isotope ratio analysis of  $\text{H}_2\text{O}$ . Precisions close to those of classical analytical techniques can be attained on sub-microliter amounts of water with analytical time of 5-6 minutes for both isotopes.

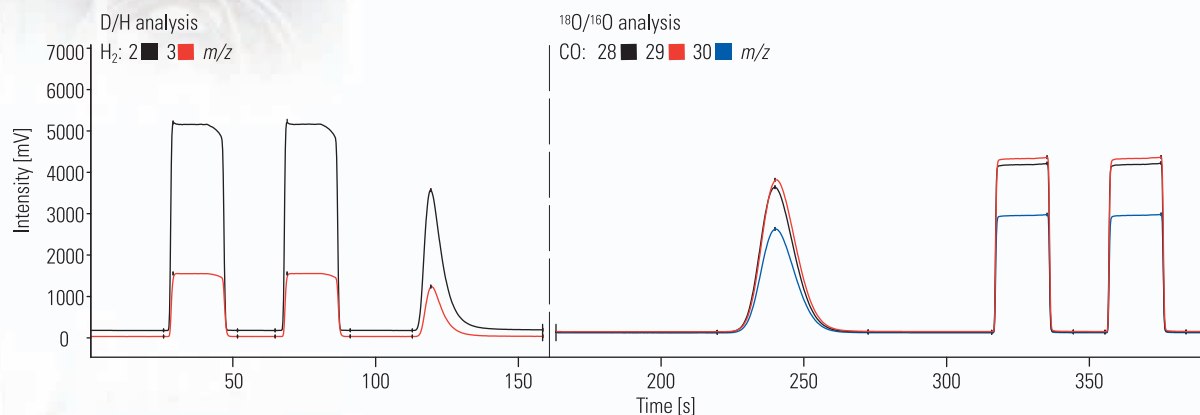


Status panel

Water trap and GC cabinet with one column for  $\text{N}_2$  and  $\text{CO}_2$  separation and another column for  $\text{H}_2$  and  $\text{CO}$  separation, TCD Thermal Conductivity Detector.

### Applications for High Temperature Conversion

- Oxygen and hydrogen analysis of organic matter
- Isotope ratio analysis of  $\text{H}_2\text{O}$
- Medical tracer studies (doubly labeled water)
- Oxygen isotopes of sulfates, phosphates, nitrates
- Nitrogen and oxygen isotopes from nitrates
- Hydrogen isotopes of phyllosilicates and amphiboles



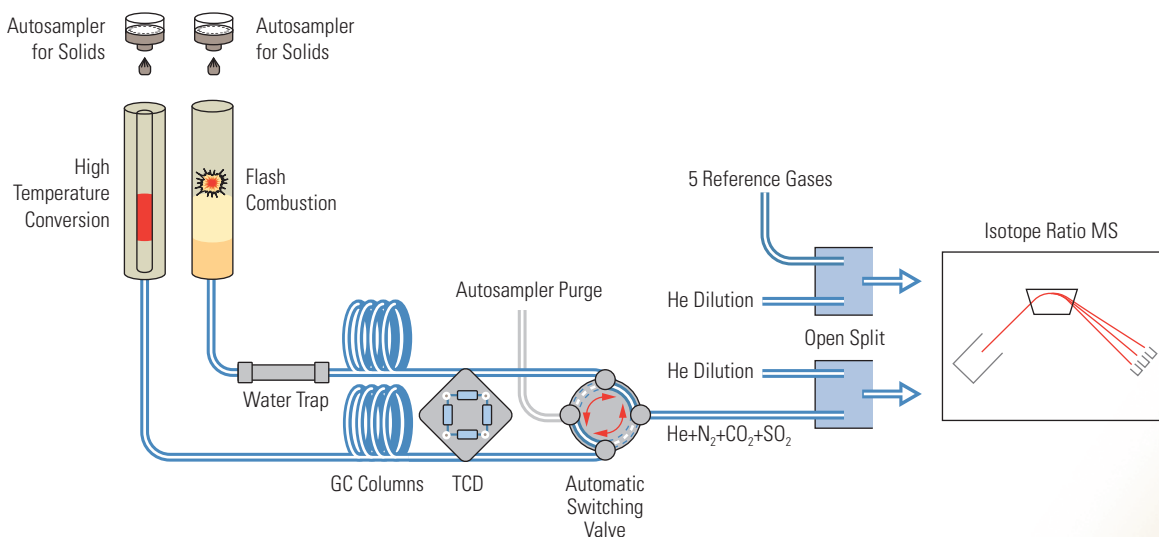
# Principle of the FLASH HT *Plus*

The FLASH HT *Plus* elemental analyzer facilitates multiple isotope ratio analysis by enabling conversion reactions in either of the two reaction lines – Dynamic Flash Combustion or High Temperature Conversion – with subsequent separation of the gases in two dedicated isothermal GC columns. Two autosamplers and optimized chromatography allow the analysis of up to five isotopes with two sample drops in reduced time giving maximum benefit for multi-element isotope ratio analysis.

The ConFlo IV universal open split interface between the FLASH HT *Plus* and the Isotope Ratio MS is the essential partner. Five permanently-connected reference gases and the patented incremental helium dilution allow automated dilution of the sample gas for highest sample size range of CNS and OH content together with the control of reference gas introduction and intensities. Automation benefits are even higher with the Thermo Scientific smartEA option. The smartEA™ uses the TCD output to monitor signal intensities from the EA, which enables automatic adjustment of any dilution that might be required to match signal intensity with the dynamic range of the IRMS.

The Flash HT *Plus* is configured with a dedicated sulphur reactor and separation column for optimal sulphur analysis. The separation column allows triple analysis of C, N and S isotopes, any combination of the three isotopes or single analyses. The CNS separation column is operated at a temperature sufficient to allow for fast switching time between combustion and high temperature conversion mode. The packing of the reactor and an optional chemical trap define if SO<sub>2</sub> and/or CO<sub>2</sub> from the combustion process are to be adsorbed, which reduces the analytical time from 18 minutes in CNS mode to 4 minutes for single <sup>15</sup>N isotope analysis. A dedicated chromatographic separation column for NC dual analysis is optional. It is operated at the same temperature as the molecular sieve.

## Principle of the Thermo Scientific FLASH HT *Plus*



- The Flash HT *Plus* is equipped with Sulfinert® tubing in the combustion line. This guarantees reduced nitrogen background and avoids the formation of acidic compounds by SO<sub>2</sub> with adsorbed water.
- Two software-controlled Thermo Scientific MAS 200R autosamplers for solid samples, leverage the full potential of automation. When switching between the Dynamic Flash Combustion and High Temperature Conversion modes, the Isodat software automatically activates the required autosampler.
- The Bottom Feed Connector in the High Temperature Conversion line ensures a sample throughput of up to 400 solid samples without any maintenance. Channeling of the carrier gas through the outer mantle of the glassy carbon reactor increases the flow velocity through the reaction zone. This delivers sharper peaks and maintains performance independent from ash build-up.



# Analytical Setups

The FLASH HT *Plus* supports many different analytical setups

## **C, N and S simultaneous isotope analysis (triple analysis)**

Using a dedicated reactor for sulfur analysis and an optimized separation column. The analytical time can be less than 18 minutes. The analysis is limited to samples with C/S ratios < 70.

## **C and N isotope analysis in dual or single mode**

Using a single-reactor setup with chemical trapping of SO<sub>2</sub>. This reduces the analytical time to less than 8 minutes. Installing an additional CO<sub>2</sub> trap for single N isotope analysis reduces the analytical time to 4-5 minutes.

## **S isotope analysis in single mode**

If no separation of N<sub>2</sub> and CO<sub>2</sub> is required, the GC temperature can be increased to reduce the analytical time of <sup>34</sup>S determination to 7 minutes.

## **H and O isotope analysis in dual or single mode**

Using the well established and superior High Temperature Conversion technique (also referred to as pyrolysis) with glassy carbon reactor. The Bottom Feed Connector results in sharper peaks and higher throughput. An additional trap protects the molecular sieve from introduction of CO<sub>2</sub> and H<sub>2</sub>O keeping maintenance times low.

**Thermo Scientific DELTA V isotope ratio mass spectrometer with ConFlo IV universal interface, FLASH HT *Plus* elemental analyzer, AS 3000 autosampler for liquids and MAS 200R autosampler for solids.**



The Thermo Scientific FLASH HT *Plus* elemental analyzer can be connected to any current Thermo Scientific Isotope Ratio MS equipped for continuous flow application with ConFlo IV universal interface. If hydrogen isotope ratios are to be analyzed, the IRMS must be equipped with an energy filter to suppress  $4\text{He}^+$  ions on the DH collector (MAT 253, DELTA V Plus, DELTA V Advantage and DELTA Plus XP).

### Instrument Description

- Base unit FLASH HT *Plus* (two furnaces)
- Eager Xperience software
- 2 MAS 200R autosamplers for solids with 32 sample tray
- Standard outfit for CNS and OH determination

### Gases

Helium: 99.999% purity  
Oxygen: 99.995% purity

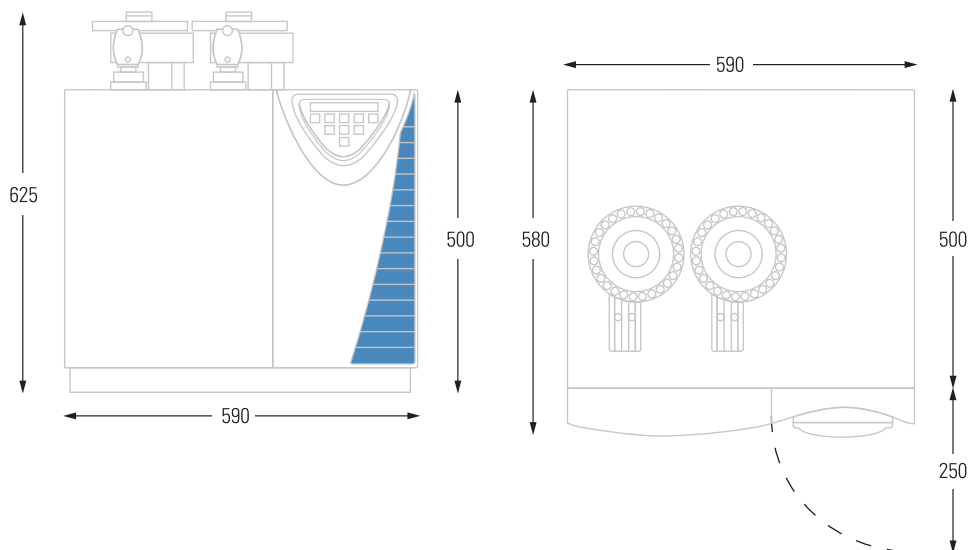
### Power supply

230 V, 50/60 Hz, 1400 VA

### Dimensions and Weight

590 x 580 x 500 mm (w x d x h)  
67 kg (net value)

### Thermo Scientific FLASH HT *Plus* Dimensions (in mm)



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