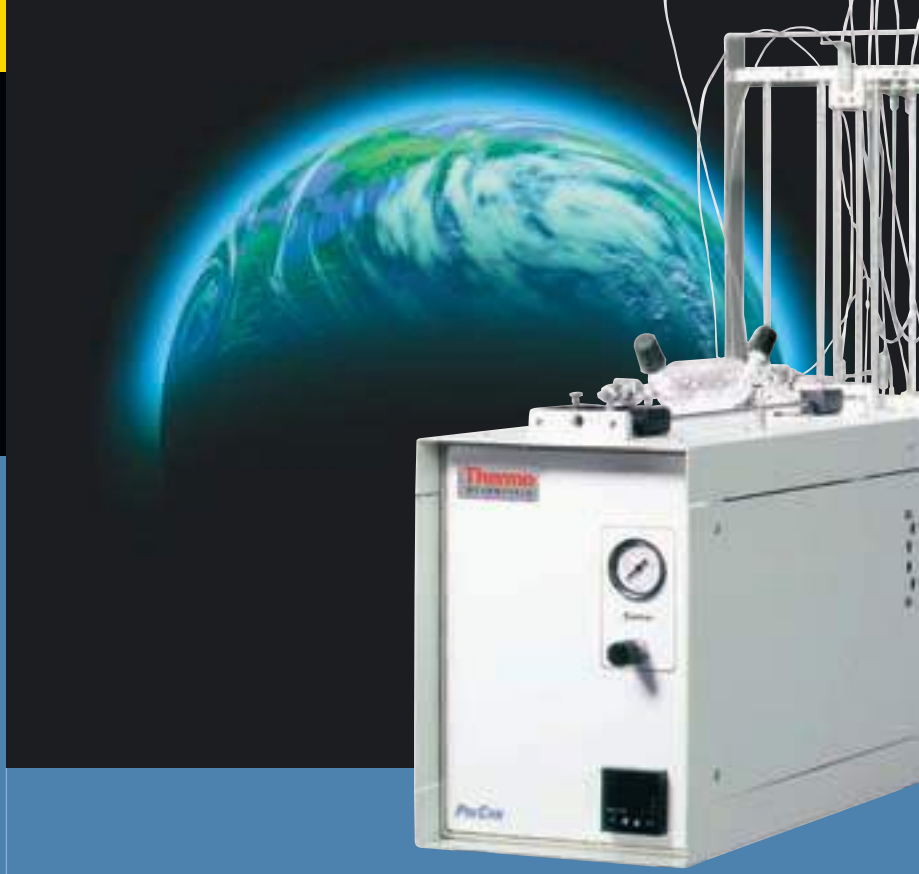
MASS SPECTROMETRY

# Thermo Scientific PreCon



*Automated Trace Gas Pre-Concentrator*

# Thermo Scientific PreCon – Automat

$N_2O$ and $CH_4$ are trace gases that are increasing in the atmosphere, contributing to the greenhouse effect. $N_2O$ also affects the global ozone distribution. Monitoring the concentrations of these gases in the atmosphere has given insight into the overall global budget, but monitoring the isotope ratios of these trace gases is required for a detailed understanding of their sources.

Isotope ratio analysis of these gases has been hampered by the necessity of collecting and manually processing very large sample volumes (e.g. 70 L of air for a $^{13}C/^{12}C$ measurement of $CH_4$).

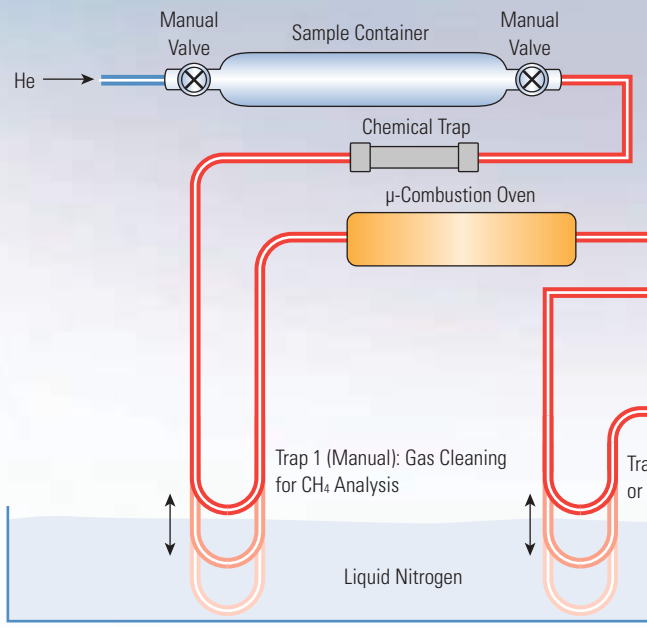
The Thermo Scientific PreCon allows sample sizes to be reduced by three orders of magnitude and improves sample throughput by at least one order of magnitude.

## Principle of the PreCon Process

The PreCon is a fully automated trace gas pre-concentrator for the isotope characterization of $N_2O$ and $CH_4$ at natural concentrations and natural isotope abundances. It attaches to any Thermo Scientific isotope ratio monitoring device like the GC IsoLink or the GasBench II interfaced to a Thermo Scientific isotope ratio MS. Both $CH_4$ ($^{13}C/^{12}C$) and $N_2O$ ($^{15}N/^{14}N$ and $^{18}O/^{16}O$) can be measured at natural concentrations ($CH_4$: 1700 ppb; $N_2O$: 330 ppb) in air sample volumes <100 mL. Samples can be provided either manually using containers with valves or fully automated by using containers with septa and a Thermo Scientific GC-PAL autosampler.

For both $N_2O$ and $CH_4$ the PreCon carries out sample concentration and purification (removal of $H_2O$, $CO_2$ and condensable (for $CH_4$) and non-condensable (for $N_2O$) gases), cryofocusing, and injection onto a gas chromatograph. For $CH_4$, combustion in a special combustion oven with 100% combustion efficiency and a $CO_2$ pre-concentration step are added prior to cryofocusing. After GC separation the samples are transferred in a stream of He carrier gas into the ion source of the isotope ratio MS, and integration is carried out over the entire GC peak. Samples are bracketed by reference pulses from the automated reference gas injection system, allowing highly precise isotope ratio determination.

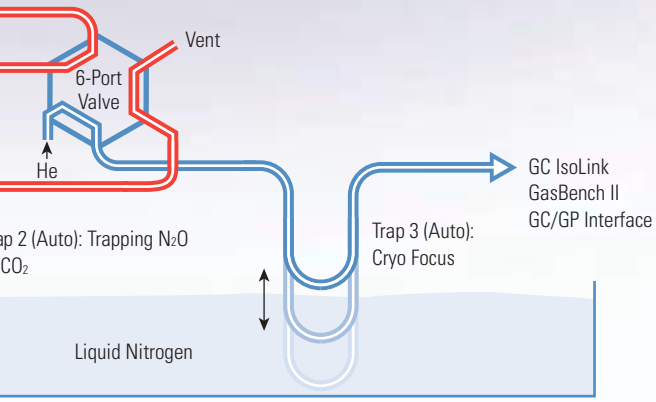
## PreCon Schematic




## $\delta^{15}N$ and $\delta^{18}O$ from $N_2O$

$N_2O$ is formed as a by-product of nitrification and as an intermediate in denitrification. These processes, which operate on different N pools and have different isotopic fractionation, make distinctive contributions to the $^{15}N$ and $^{18}O$ composition of $N_2O$. It is thus critically important when characterizing $N_2O$ to measure both $^{15}N/^{14}N$ and $^{18}O/^{16}O$. The PreCon analyzes $N_2O$ as the intact molecule, so that the important $^{18}O/^{16}O$ information is preserved.

# ed Trace Gas Pre-Concentrator




## Trace Studies

The high precision required to carry out work at natural abundance means that the PreCon can easily handle isotopically enriched $N_2O$ or $CH_4$, in which either $^{13}C$ or $^{15}N$ has been enhanced above natural levels by incorporation of tracers.

## Analytical Performance

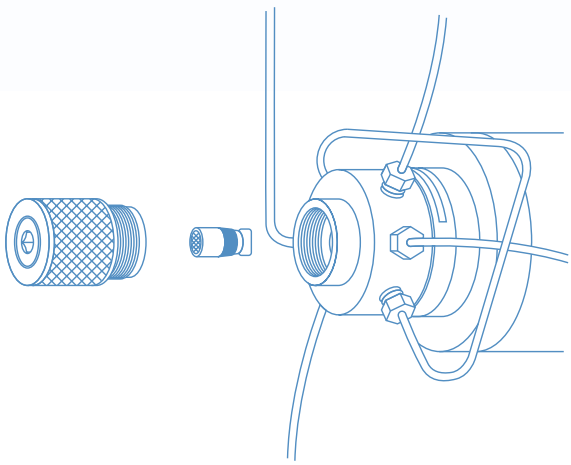
100 mL air with natural trace gas concentrations and natural isotope abundances.

| EXTERNAL PRECISION (N=5) | CONC. (PPM) | δ (‰) |
|---|---|---|
| $^{13}C/^{12}C$ from $CH_4$ | 1.7 | 0.5 |
| $^{15}N/^{14}N$ from $N_2O$ | 0.33 | 0.5 |
| $^{18}O/^{16}O$ from $N_2O$ | 0.33 | 1.0 |

## PreCon Integration and Automation

The PreCon can be loaded manually or operates fully automated using the GC-PAL autosampler with a two line needle for continuous sample transfer. The GC-PAL can be equipped with a 96 x 10 mL sample tray. User-defined sample trays for higher sample volumes and specific container geometries can easily be registered and automated due to the fully object oriented structure of the GC-PAL.

All processes are controlled and can be expanded by user-definable ISL scripts in the Isodat software suite.



# Installation Requirements

## Instrumentation

The Thermo Scientific PreCon attaches to any Thermo Scientific *irm*-GC/MS interface, either

- GC IsoLink
- GC/GP interface
- GasBench II

The interface requires a Thermo Scientific Isotope Ratio Mass Spectrometer e. g. DELTA V series, MAT 253.

## Sample Containers

Analysis of $CH_4$ and $N_2O$ requires separate samples due to different operating conditions in the interface. CO is not removed prior to combustion of $CH_4$ so that a correction for background CO (70 ppb in air) is required for most accurate analysis.

- 100 mL flasks with gas tight manual valves
- Connectors with ¼" Cajon Ultra-Torr fittings
- 250-350 mm distance between connectors (flask length)
- Automation with the GC-PAL system requires sample containers with septa

## Gases

- Ultra-pure He (≥5.0); additional purification is recommended (e.g. zeolite filled, $LN_2$ cooled trap)
- Calibrated $CO_2$ and $N_2O$ reference gases must be provided locally.

## Liquid Nitrogen

About 3 L/day

## Power

230 V Single phase, 1.5 A, 154 W

## Dimensions

230 mm (width) x 765 mm (depth) x 640 mm (height)
9.1 (width) x 30.2 (depth) x 25.2 inch (height)

## Weight

About 23 kg (51 pound)

## References

The PreCon is described and its performance is characterized in:


[1] W. A. Brand, PreCon: A Fully Automated Interface for the Pre-Gc Concentration of Trace Gases on Air for Isotopic Analysis, *Isotopes Environ. Health Stud.* **1995**, *31*, 277-284.

[2] A. L. Rice, et. al., High-Precision Continuous-Flow Measurements of $\delta^{13}C$ and $\delta D$ of Atmospheric $CH_4$ *Anal. Chem.* **2001**, *73*, 4104-4110.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