Introducing precisION

The most flexible, and powerful IRMS ever created

Sept 2016 GSA

precisION

ionOS

isoFLOW

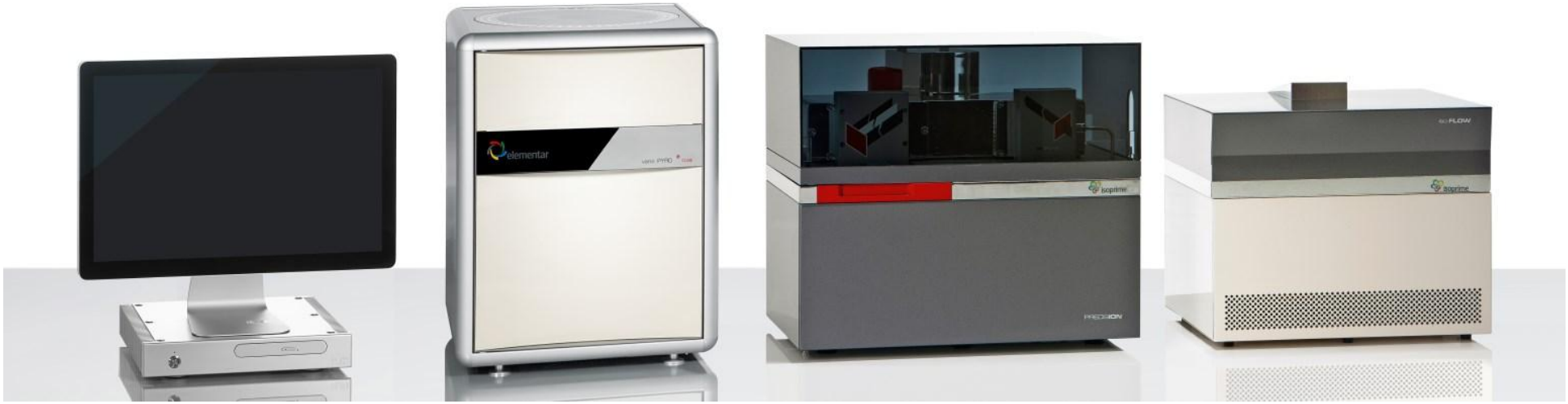
Sam Barker
Elementar Booth 256

elementargroup.
elementar | isoprime

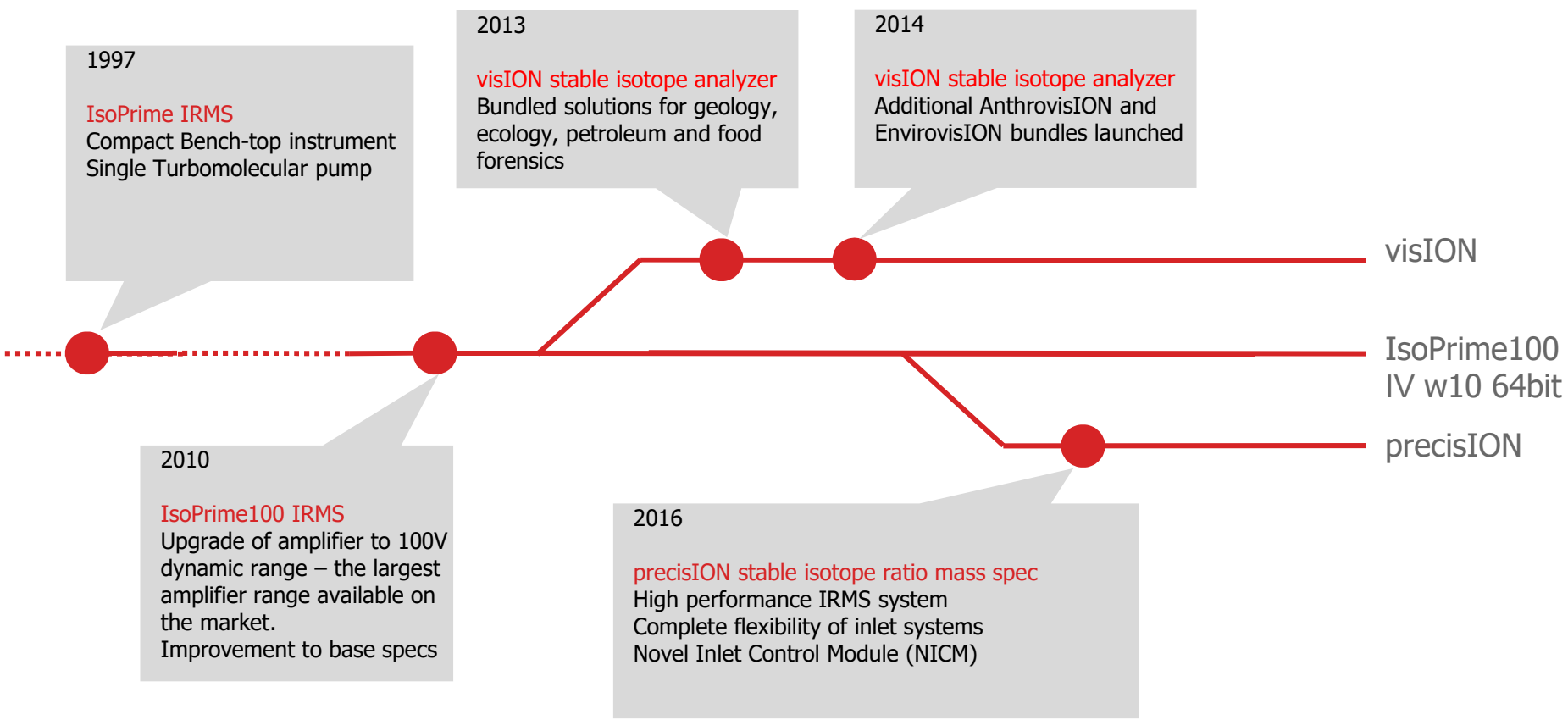
precisION overview

precisION is a high-performance stable isotope ratio mass spectrometer providing an innovative platform for scientists to take their research in any direction they need.

Delivered in the most compact footprint possible and powered by IonOS, precisION provides exceptional configurability, powerful customization and endless possibilities.



Product History



The right instrument for your situatION

Our two completely new stable isotope platforms cater for the broad span of customer needs and requirements.

visION

A simple, easy to use stable isotope analyzer targeted for more focused applications

precisION

A high performance, premium stable isotope ratio mass spectrometer. Full peripheral support with NICM lets the scientist pursue any isotopic research.

precisION Key Features

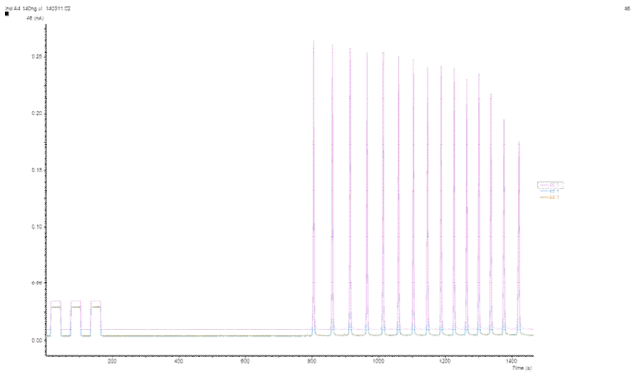
- **100 V amplification** for large dynamic range samples with auto resistor switching
- Simultaneous measurement of up to **10 ion beams** across a ± 25 % mass range for multi-collector experiments
- Improved gas ionization performance of **800 molecules / ion**
- Improved mass resolution of **110 m / Δm** (@ 10 % valley separation)
- Handle up to **6 monitoring gases and 5 inlets** with centrION Continuous Flow Interface System
- Vacuum grade **stainless steel analyzer** for the highest vacuum performance with optional bakeout.
- **Bespoke DAC dual resistor configurations** for non-standard isotopomer distributions
- Instant instrument status recognition with **color LED status lights**
- **Powered by IonOS** with exceptional functionality and automation
- **IonOS Method Designer** gives complete control of the system
- **Novel Instrument Control Module (NICM)** for developing bespoke control of your instruments

Key Feature: dynamic range

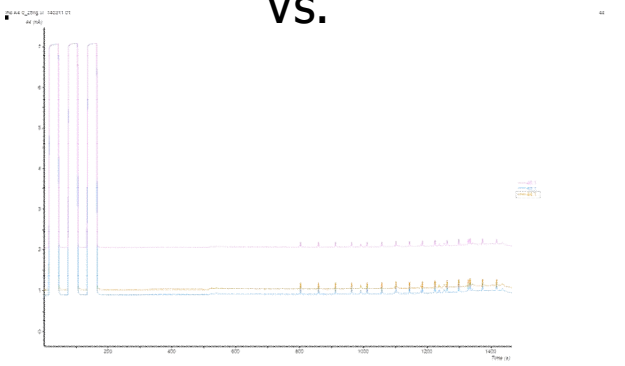
11th March		C16		C17		C18		C19		C20		C21	
		nA	13C	nA	13C	nA	13C	nA	13C	nA	13C	nA	13C
	140ng	50.86	-30.05	50.34	-30.58	50.24	-30.59	52.94	-32.59	59.83	-31.66	67.01	-28.35
	70ng	35.10	-30.20	34.31	-30.84	34.19	-30.89	36.23	-32.98	41.05	-32.15	47.09	-28.78
	35ng	16.19	-30.47	15.91	-31.01	16.07	-31.08	17.11	-32.99	19.94	-32.28	23.73	-29.02
	17ng	8.47	-30.47	8.32	-31.10	8.32	-31.06	8.98	-33.06	10.68	-32.15	12.81	-29.04
	8ng	3.46	-30.38	3.26	-30.97	3.18	-30.98	3.44	-32.94	4.21	-32.12	5.21	-28.78
	4ng	2.08	-30.48	1.89	-31.08	1.76	-31.02	1.74	-33.00	1.95	-32.24	2.33	-28.84
	2ng	1.34	-30.32	1.27	-30.95	1.23	-30.89	1.26	-32.85	1.41	-32.08	1.62	-28.82
	1ng	0.42	-30.17	0.41	-30.47	0.41	-31.26	0.45	-32.61	0.51	-31.84	0.58	-28.59
	0.5 ng	0.20	-30.02	0.20	-31.26	0.20	-31.53	0.22	-33.13	0.26	-32.47	0.31	-29.18
	0.25 ng	0.10	-30.73	0.11	-33.43	0.10	-32.49	0.12	-31.98	0.14	-32.19	0.17	-27.89
	Ave		-30.33		-31.17		-31.18		-32.81		-32.12		-28.73
	std dev (all concs)		0.22		0.83		0.52		0.34		0.23		0.38
	std dev (140 - 1ng)		0.16		0.23		0.19		0.18		0.21		0.22
	per mil /nA	0.014		0.059		0.038		0.022		0.014		0.019	

14th March		C16		C17		C18		C19		C20		C21	
		nA	13C	nA	13C	nA	13C	nA	13C	nA	13C	nA	13C
	140ng	60.83	-29.95	60.19	-30.39	59.18	-30.42	58.59	-32.60	58.03	-31.81	56.79	-28.56
	70ng	35.38	-30.19	35.30	-30.64	34.58	-30.78	34.33	-32.90	34.04	-32.16	33.32	-29.02
	35ng	18.14	-30.56	17.96	-31.09	17.65	-31.03	17.36	-33.15	17.17	-32.30	16.72	-29.07
	17ng	8.10	-30.37	8.04	-30.96	8.00	-30.90	7.85	-32.98	7.72	-32.11	7.49	-28.89
	8ng	4.02	-30.27	3.93	-30.87	3.88	-30.73	3.83	-32.82	3.79	-31.95	3.70	-28.92
	4ng	2.23	-30.37	2.10	-31.10	2.04	-31.04	2.01	-33.11	1.97	-32.22	1.92	-29.05
	2ng	1.26	-30.33	1.19	-31.03	1.11	-30.90	1.05	-32.83	1.00	-32.05	0.95	-28.93
	1ng	0.69	-30.40	0.68	-31.03	0.67	-31.22	0.64	-32.75	0.60	-32.02	0.57	-29.02
	0.5 ng	0.35	-30.48	0.35	-30.84	0.35	-31.03	0.35	-32.88	0.35	-32.21	0.34	-28.88
	0.25 ng	0.15	-30.82	0.15	-30.75	0.15	-31.84	0.15	-32.15	0.15	-31.24	0.15	-28.73
	Ave		-30.37		-30.87		-30.99		-32.82		-32.01		-28.91
	std dev		0.23		0.23		0.37		0.29		0.30		0.16
	per mil /nA	0.014		0.012		0.024		0.017		0.018		0.009	

Total Average		**-30.35**		**-31.02**		**-31.08**		**-32.81**		**-32.06**		**-28.82**	
st dev (all concs)		**0.22**		**0.61**		**0.45**		**0.31**		**0.27**		**0.30**	
stdev (1 - 140ng)		**0.17**		**0.23**		**0.22**		**0.18**		**0.18**		**0.21**	



Vs.

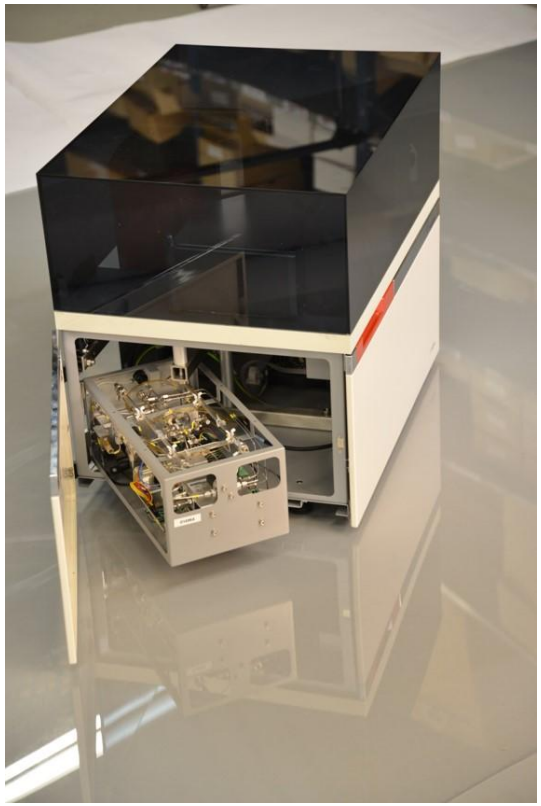


Key Feature: centrION MAX

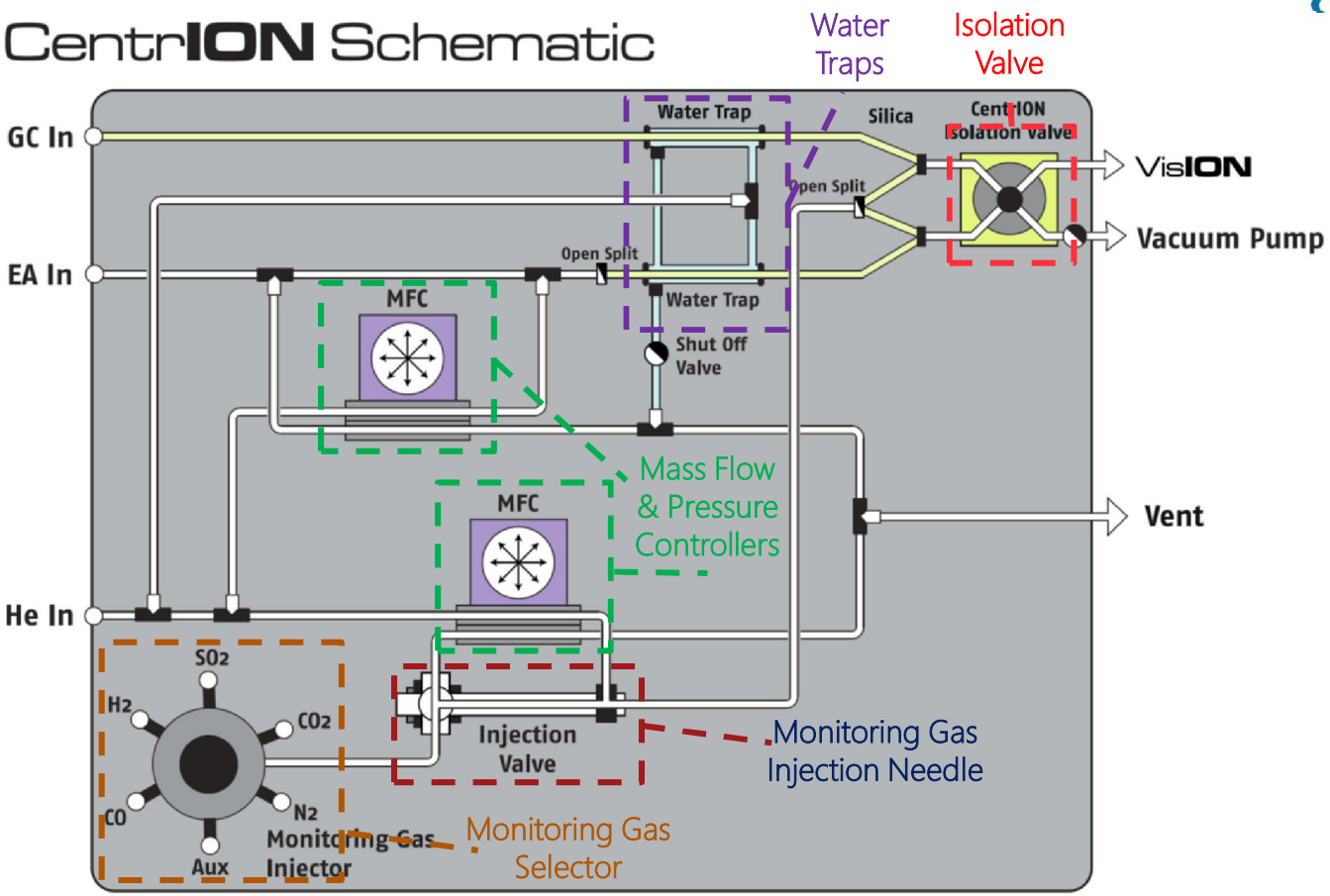
- The flexibility of precisION is delivered by centrION MAX
- centrION MAX offers up to 6 monitoring gases permanently available and connection for up to 5 peripheral inlet systems
  - 1 inlet system can be "low flow" (GC)
  - 4 other inlets can be "high flow" (EA, iso FLOW, iso TOC…)
- precisION can be automatically switched between all inlet systems.
- Automatic sample dilution for all inlets connected to the high flow port.
- Automatic source isolation valve.
- System stand-by.

Key Feature: centrION MAX

- centrION is completely enclosed inside the precisION instrument chassis
- All connecting fused silica is routed internally so there is no exposed vulnerable silica lines
- centrION includes automatic isolation valve which allows the ion source and vacuum chamber to be isolated from the gas inlet for maintenance and sleep/standby functionality
- centrION has two water removal membranes – one for low flow and the other for high flow inlets – which perform "selective drying" i.e., they dry only the gas entering the ion source, not all gas leaving the inlet



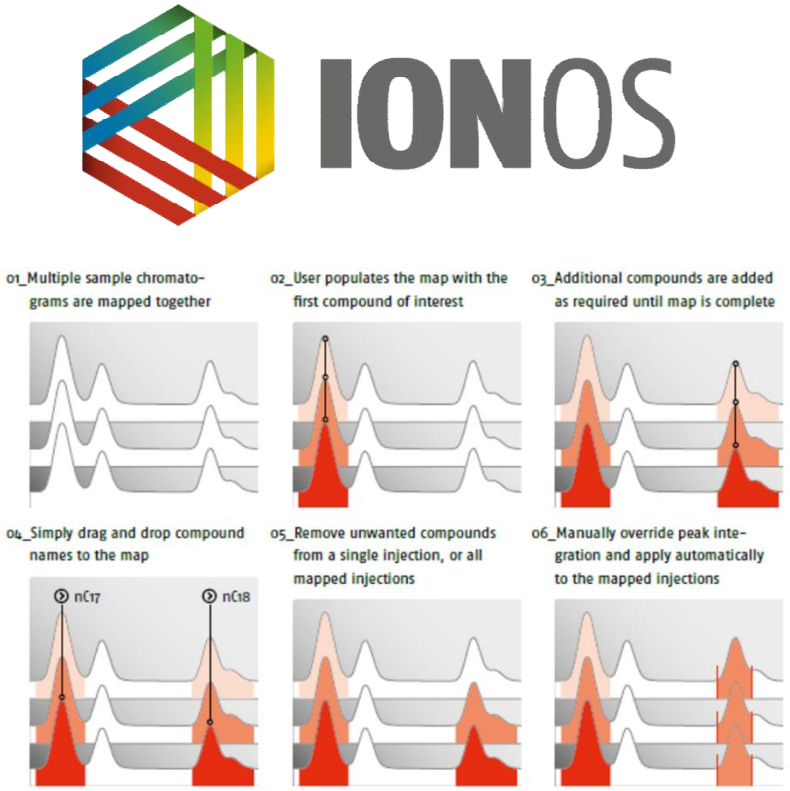
CentrION Schematic



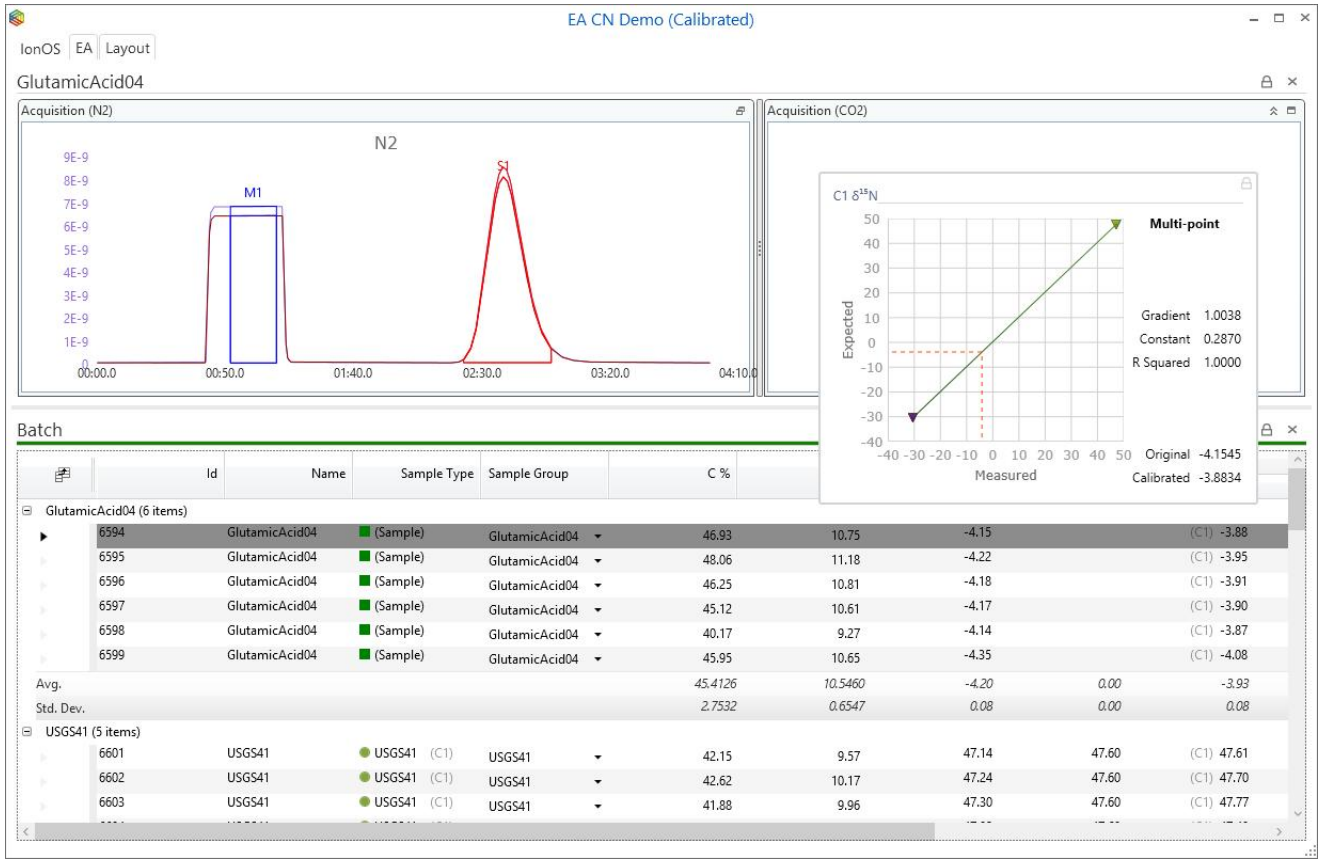
Key Feature: Powered by IonOS

precisION offers the same exceptional functionality and automation as visION

- Quick Tasks
- Automatic Task Scheduling (eg Early morning!)
- GC Peak Mapping
- Multi-Point Isotopic Calibrations
- Data Processing for all continuous flow inlet systems
- Rapid local and network drive search functionality
- iArc data archiving
- **Demo at users group meeting**



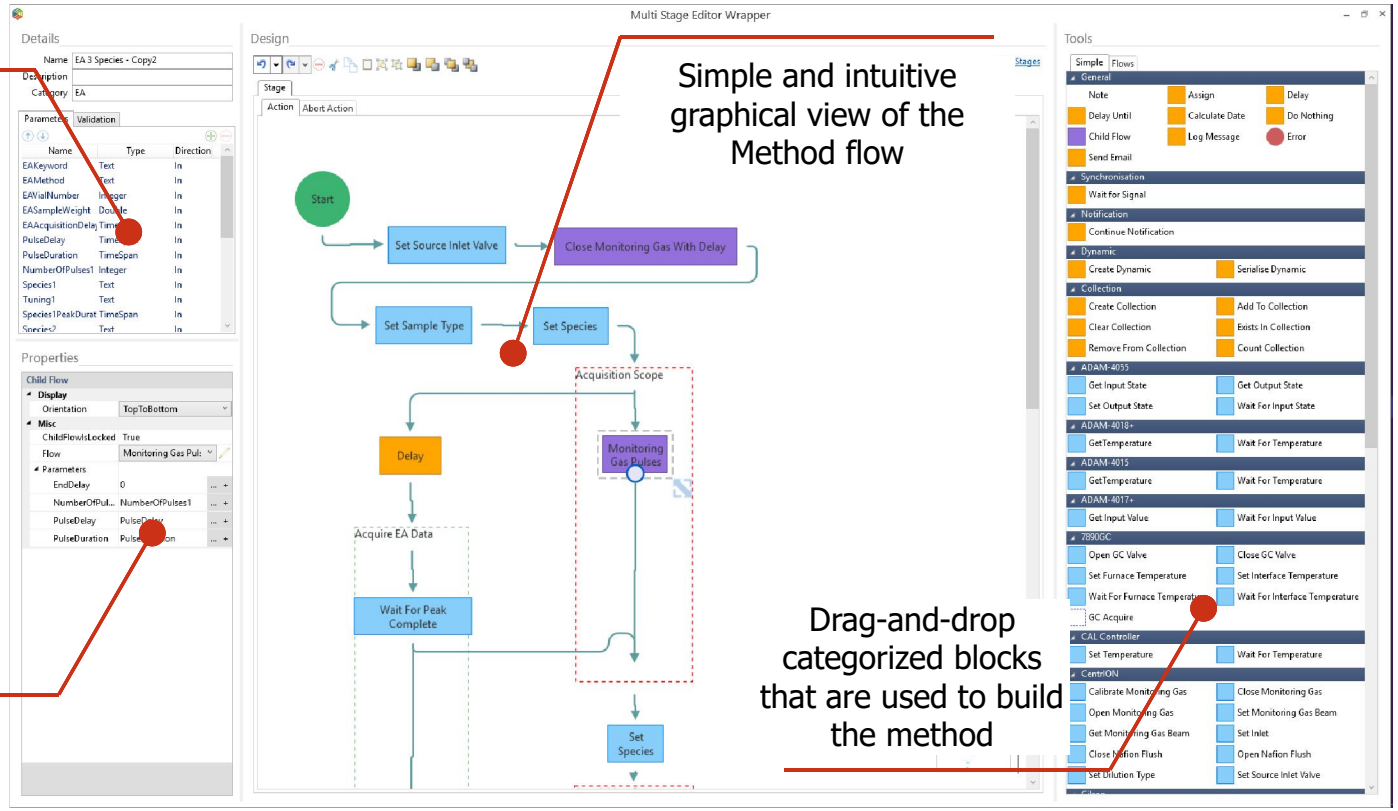
Key Feature: Powered by IonOS



Key Feature: IonOS Method Designer

Parameters which are available for editing and referenced by the used method blocks

Properties of the selected method block



Simple and intuitive graphical view of the Method flow

Drag-and-drop categorized blocks that are used to build the method

precisION Inlet Flexibility

Elemental Analysis

- vario ISOTOPE select
- vario ISOTOPE cube
- vario PYRO cube
- iso TOC cube

Chromatography

- Liquid Chromatography
- Gas Chromatography

Gas & Headspace

- iso FLOW

Other Inlets

- Other non-standard equipment
- Third party inlet system
- Customer designed novel inlet (NICM)

Key Feature: Novel Inlet Control Module (NICM)

We regularly receive requests from customers to support inlet systems which we do not supply. Some are simple, others are not.

Custom-built preparation system for analysing ^2H from CH_4 trapped in ice cores controlled by IonVantage *(Bock et al. RCMS 2010)*

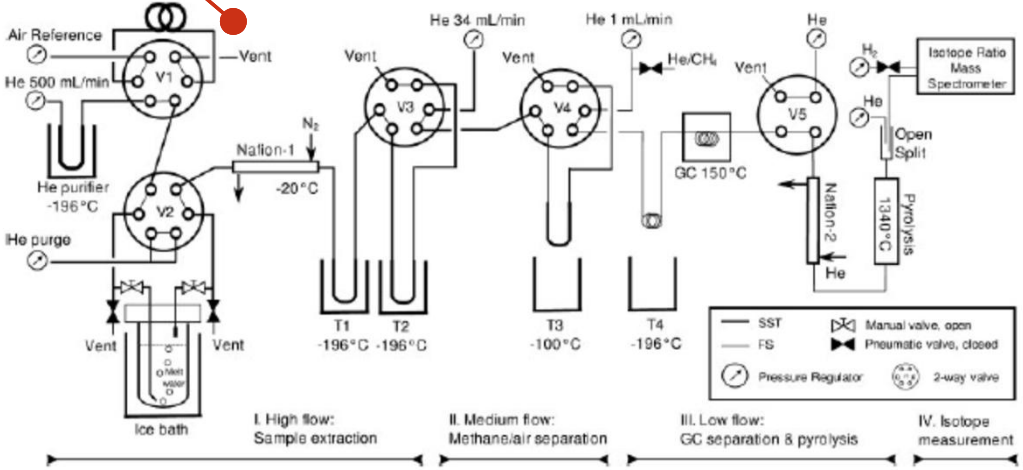
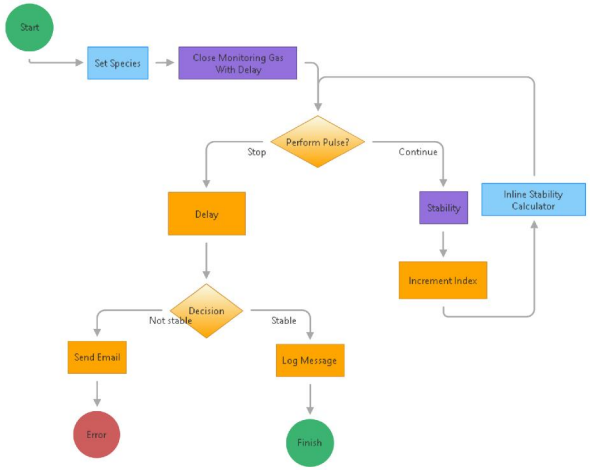
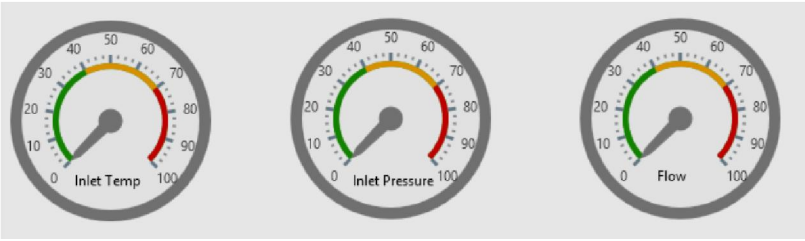


Figure 1. Flow scheme of the presented $\delta D(CH_4)$ system.

Key Feature: Novel Inlet Control Module (NICM)

- Generally, requests for interfacing "home-grown" inlet systems come from advanced academic customers
- New inlet systems allow labs to do new research, or expand their capabilities cheaply.
- Customers are happy to build these systems themselves, but face a challenge when it comes to integration and control.
- Before NICM, customers would have to have strong software programming skills to achieve custom inlet control.
- precisION presents a completely new Method Designer and novel Dashboard Designer where the operator does not need any programming experience





Hardware for measuring simple gases

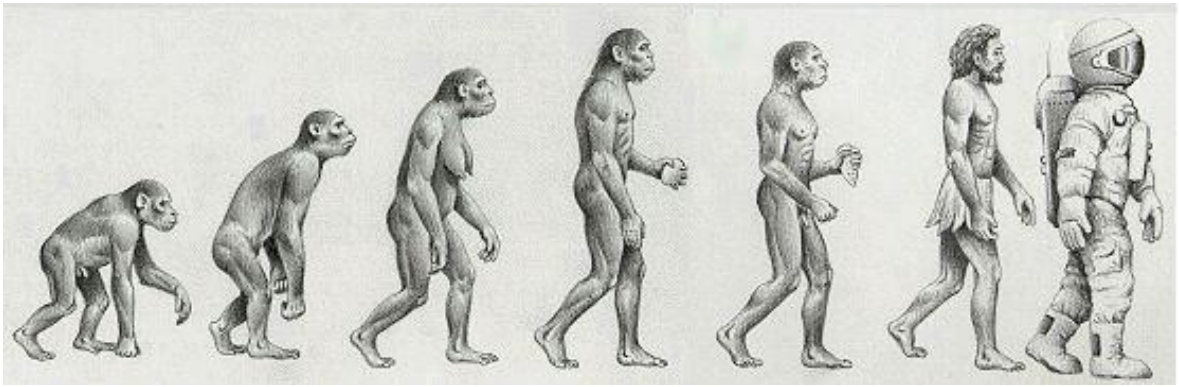
- Typically, there is one set of hardware for direct measurements, and one set of hardware for indirect measurements

- IsoPrime TraceGas – Direct measurements
  LN2 Traps
  Pre-trap combustion for CH_4
  DVB-PLOT Column for purification

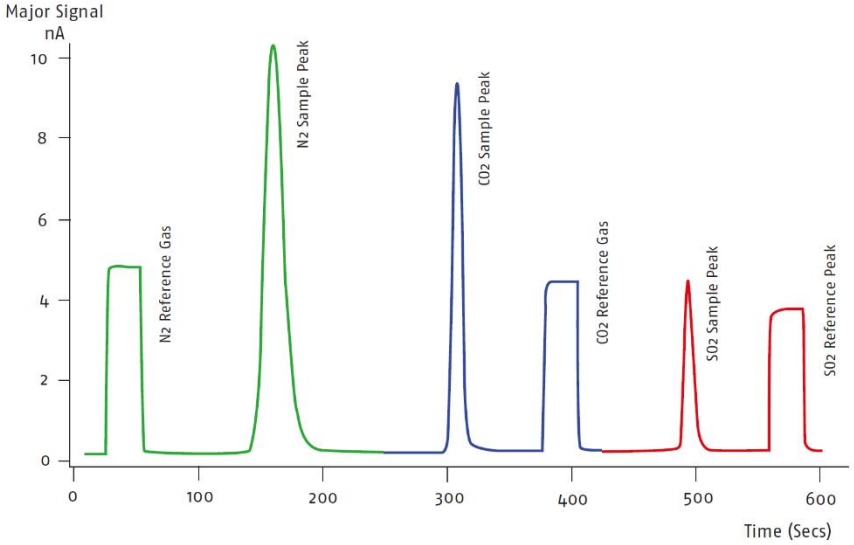
- IsoPrime MultiFlow– Direct/Indirect measurements
  Sample processing built-in
  Integrated DVB isothermal GC

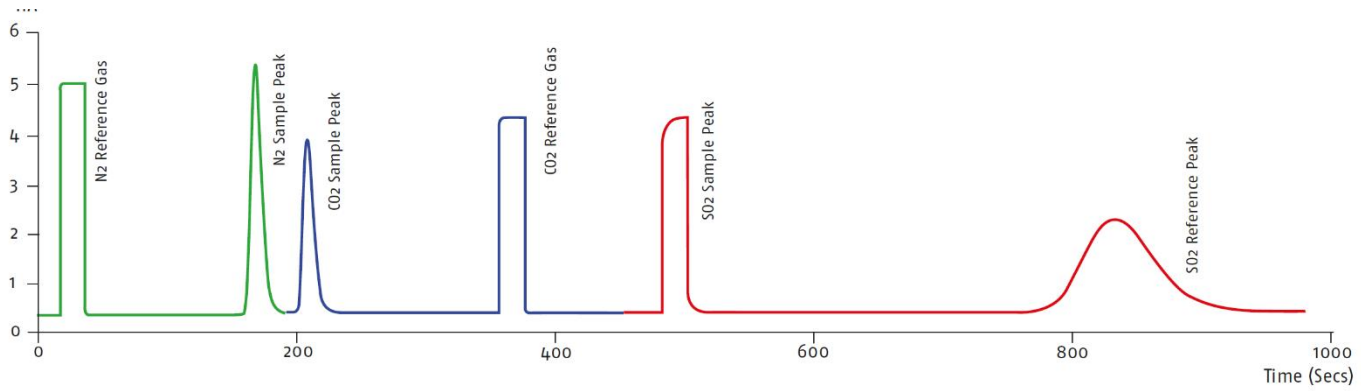
Time for the iso FLOW!

- Can we eliminate liquid nitrogen, external recirculation chillers, and slurries?
- Can we leverage Elementar's technology to enhance and expand the measurement possibilities?
- Can we combine the MultiFlow and TraceGas into one?



Typical NCS TPD-Column Separation





e:

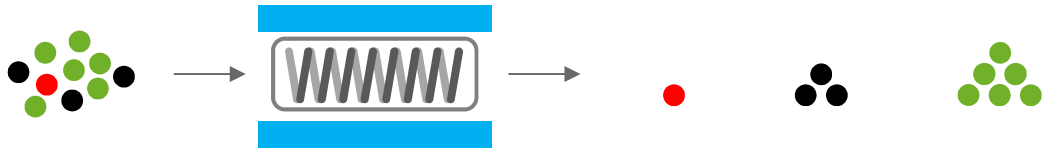
olumns, which are in

aration obsolete.

ues is like night and day

UltiTrap™ – APT™ for minute amounts

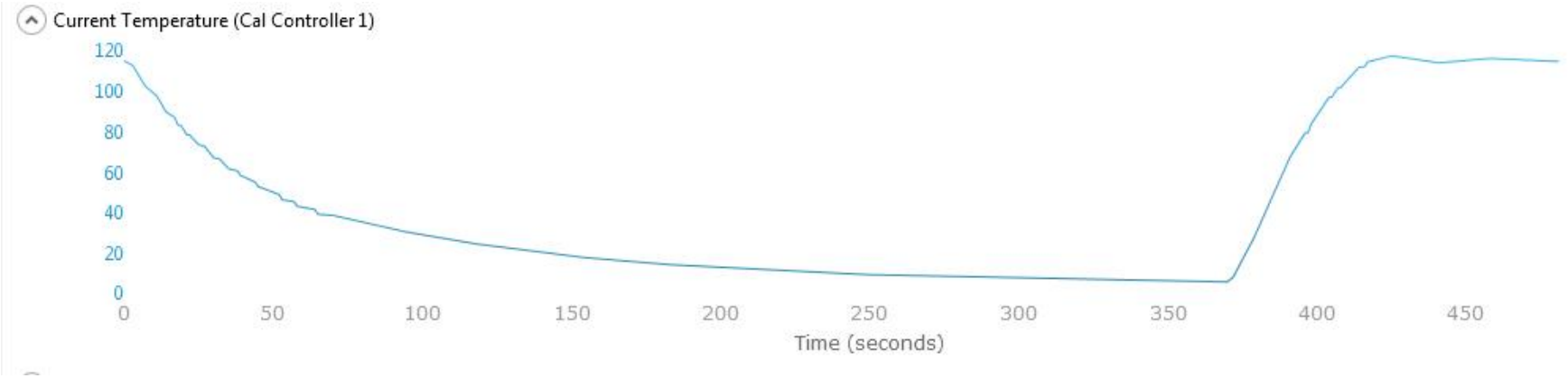
- Patented (pending), proprietary design
- Leveraged from Elementar's Benchmark Advanced Purge and Trap (APT)™ Technology
- Extremely compact – 100 cm (L) x 1.6 mm (d) analytical micropacked column with a 6 x 3 x 3 cm footprint.
- Same packing material as used in Elementar's CUBE series of Elemental Analyzers
- Preconcentration device and separation column in one.
- Dynamic temperature mode for peak focussing – Heats at rates up to 250 °C/min
- Isothermal mode for higher throughput with no degradation in peak shape or quality



UltiTrap™
With Solid State Cooling

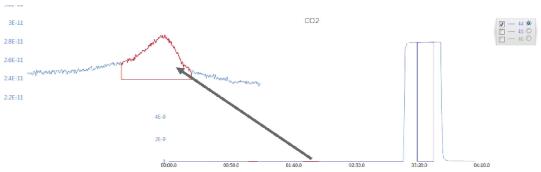
Thermal Electric Cooling

- Temperature profile
  - Cooling rates of 30 °C/min (4 minutes from 120 to 0 °C)
  - Heating rates of 250 °C/min (30 seconds from 0 to 120 °C)

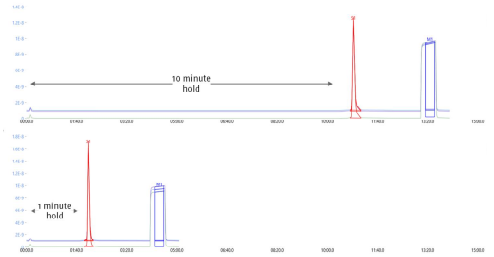


UltiTrap™ Performance

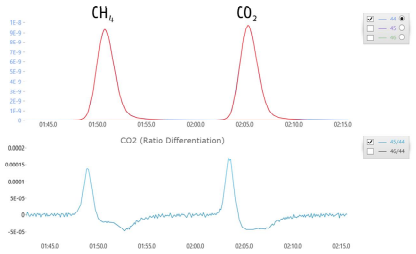
- Zero column blank/bleed. Trap held at 10 °C for 5 minutes, then heated to 120 °C.



- Real Trapping. 500 ppm N_2O in a balance of air. 100 µL sample loop injection at 10 °C (1 min vs. 10 min hold). Release at 120 °C

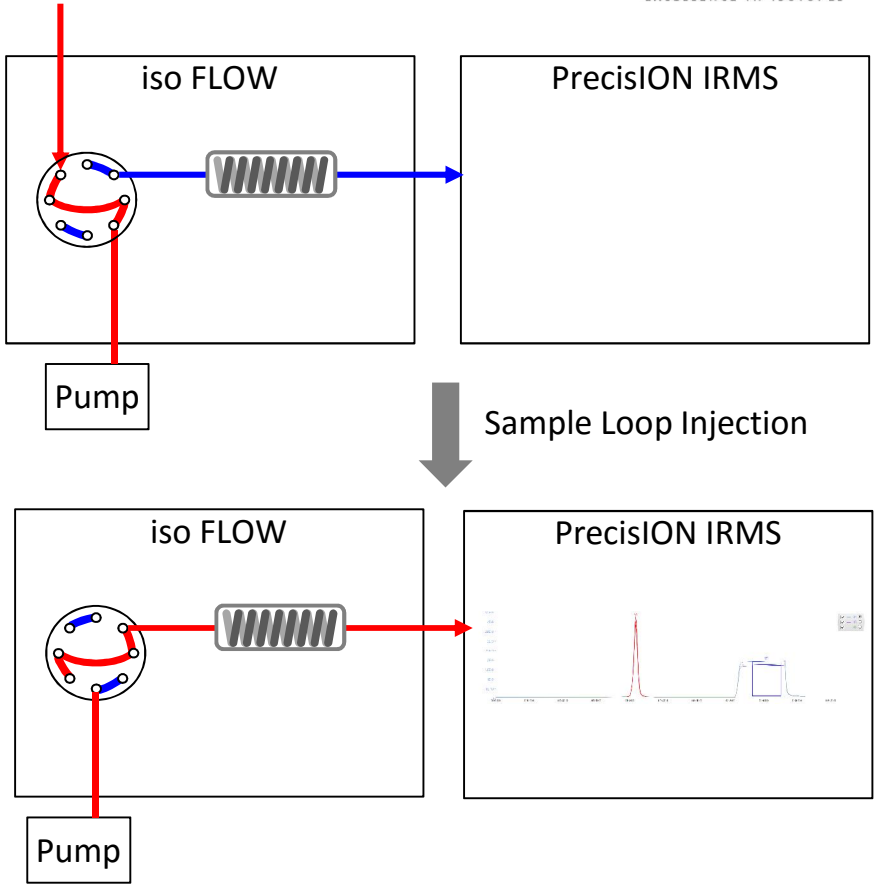


- Baseline separation. 1% CH_4 and 1% CO_2 in a balance of air. 100 µL sample loop injection at -5 °C. Release at 120 °C into CuO/Pt/Ni reactor at 1020 °C

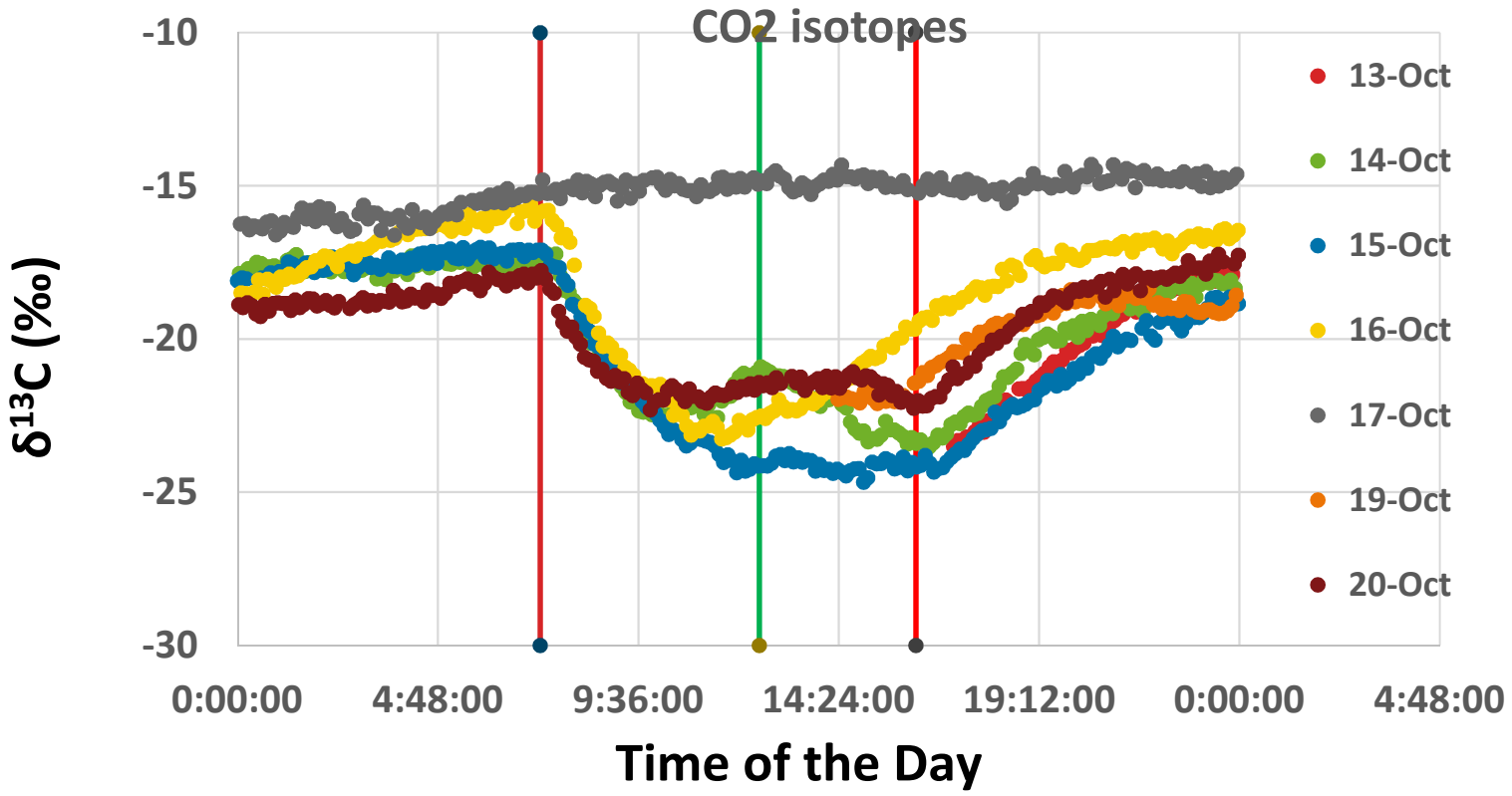


Chamber Experiment: Engineers' CO_2 Emissions

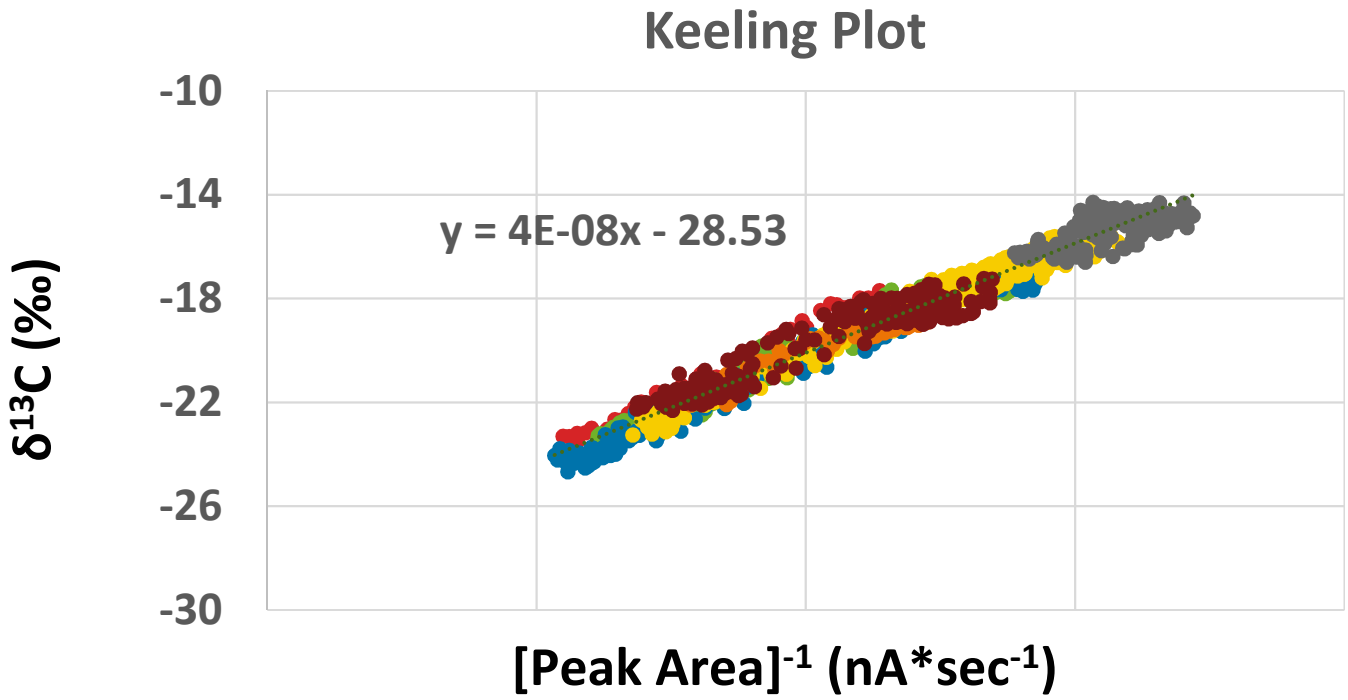
- A prototype iso FLOW was connected to a PrecisION IRMS in "Test Floor B"
- A 4 m x 1/16" stainless steel tube was affixed to the ceiling and connected to the "Sample In" port of the instrument. A diaphragm pump was connected to the "Sample Waste" line to pull in air continuously through the line
- Samples were measured every 5 minutes through a 100 µL Sample Loop in Dynamic Mode (10 °C to 120 °C)
- The PrecisION was re-tuned every 100 injections (once every 8 hours)
- The experiment was carried for one week ***without any intervention***



Chamber Experiment: Engineers' CO_2 Emissions



Chamber Experiment: Engineers' CO_2 Emissions



precisION Key Features

isoprime
EXCELLENCE IN ISOTOPES

Great Flexibility

Complete integration of all inlet systems, including novel inlets

High Sensitivity

Analyze the most challenging samples with exceptionally high ion source sensitivity

Small Footprint

Almost 50% smaller than any other commercial stable isotope ratio mass spectrometer

High Data Quality

Achieve the highest analytical performance with the most precise instrument available