

# Hidden QIC MultiStream

Multi-component and multi-stream  
gas analysis

# Introduction

- This presentation provides an overview of gas analysis systems for multi-component, multi-stream off-gas analysis.
- Multi-component, multi-stream off-gas analysis by mass spectrometry provides real-time trend analysis of the gases and vapour species that are important to product yield, O<sub>2</sub>, CO<sub>2</sub>, H<sub>2</sub>, CH<sub>4</sub> for example, and provides vital data for real time process monitoring.
- The mass spectrometer is user programmable to analyse a broad range of gas and vapour species and covers most species of interest in a variety of different environments.

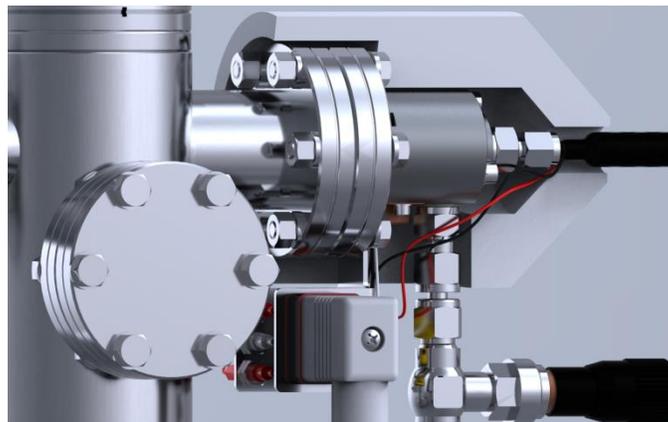
# Hidden QIC Series Gas Analysis Systems

- The QIC series gas analysers are mass spectrometers configured for real-time gas analysis, catalytic reactor exhaust gases for example.
- The QIC systems provide for multiple species real-time trend analysis providing quantitative gas analysis.
- The QIC systems include an inert silica capillary with fast response to both gases and vapours.



*QGA: A single stream real-time gas analyser*

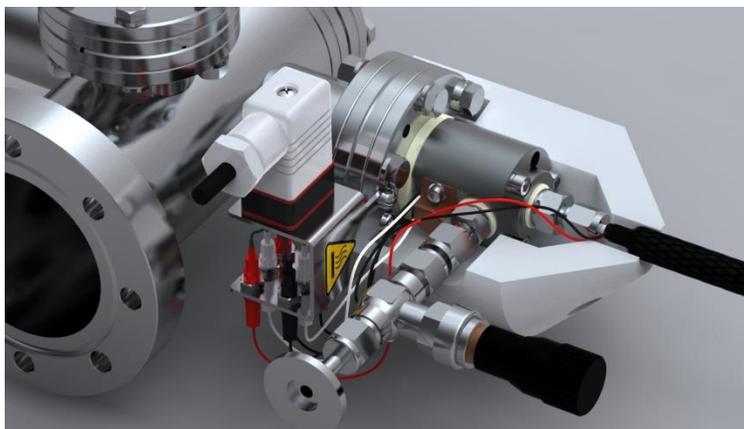
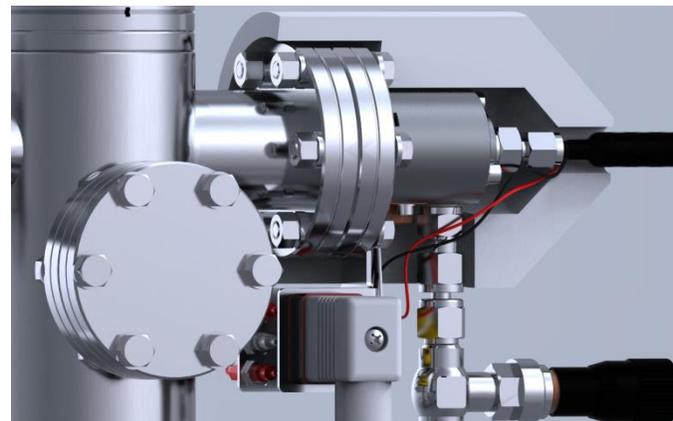
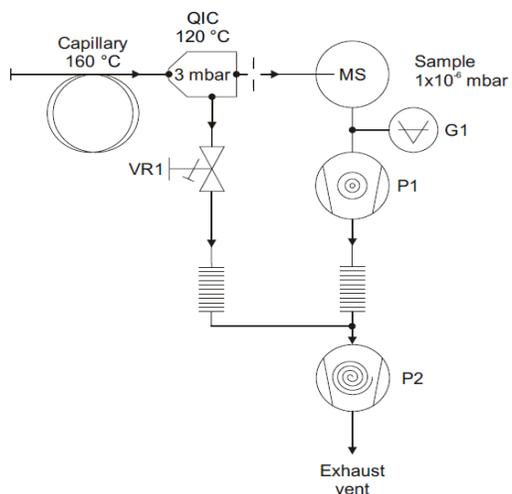
# QIC Inlet Technology



- Quartz and Platinum Wetted Surfaces → No memory effects
- Heated Capillary → No condensation effects
- Flow Matched → Optimum response / recovery
- Minimal Internal Volume → PPB detection

**These features provide excellent analyser performance for multi-component, multi-stream off-gas analysis.**

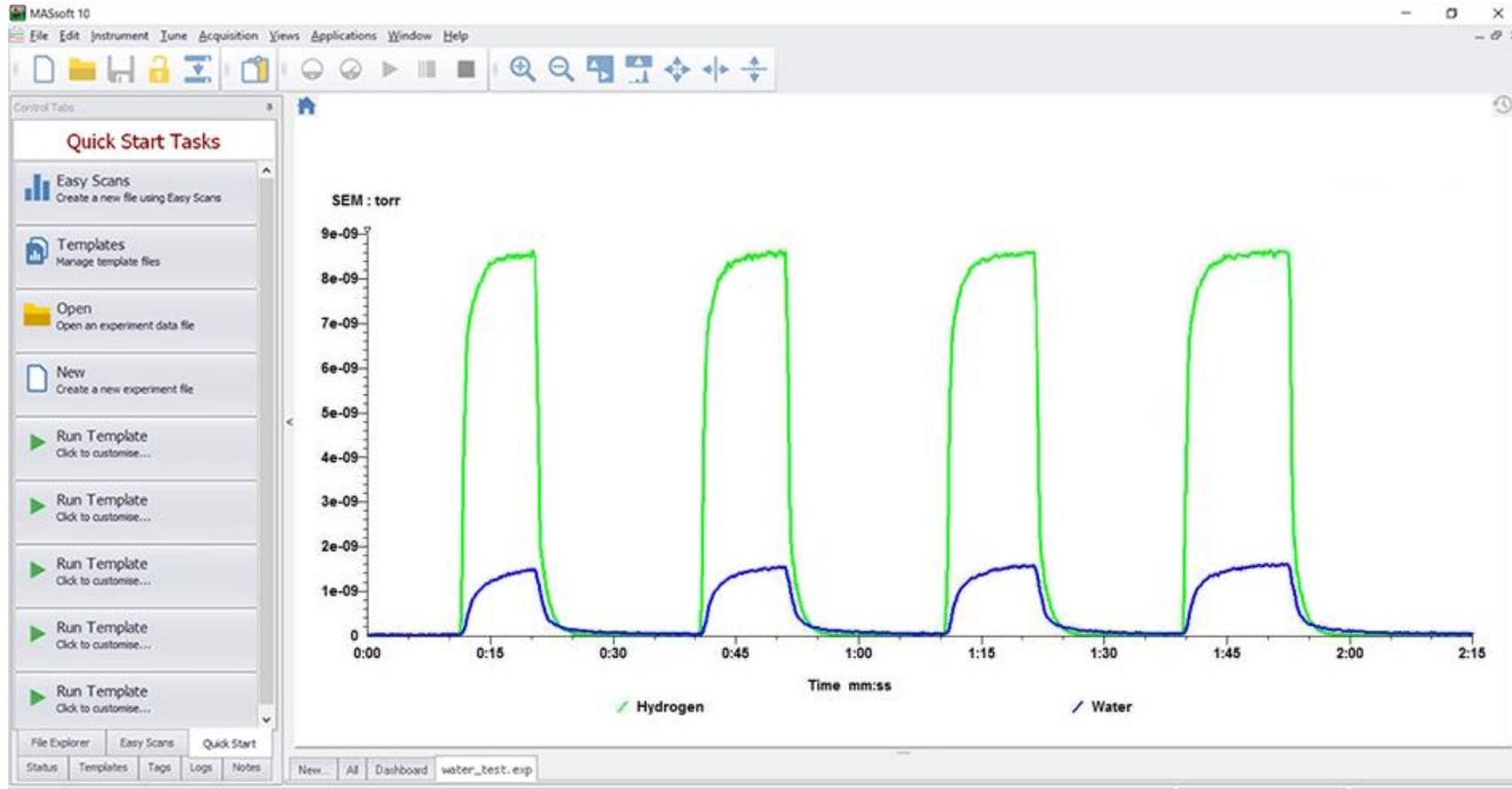
# QIC Inlet- MS Interface Overview



**Key**

- G1 Penning gauge
- VR1 QIC Inlet bypass control valve
- P1 60 l/s turbo drag pump
- P2 Backing and bypass Scroll pump
- MS UHV Housing (Mass spectrometer chamber)

# Fast Response to Permanent Gases / Vapours



Data shows the response of the QIC inlet to gas and vapour during switching between a dry He stream and a wet H<sub>2</sub> and Ar flow. For clarity, only the H<sub>2</sub> and H<sub>2</sub>O data is shown in the graph.

# QIC MultiStream

Modular multi-stream off-gas analyser, bench-top or cart configured for analysis of:

- 8, 20, 40 or 80 sample streams  
for high flow ~ up to 12 l/min sample flow

**Or**

- 20, 40 or 80 sample streams  
for low flow small volume reactors  
~ 4 ml/min sample flow



For flow rates up to 12 l/min, the QIC MultiStream can measure selected stream flow rate.

For higher flow rates, sample flow is connected to the QIC MultiStream via a T piece.

# QIC MultiStream-C bench-top system

Modular configuration:

Small footprint instrument:  
535mm deep X 530mm wide

20 stream version shown  
with dual mass flow meters for  
accurate selected flow  
measurement in the  
flow range to 12 l/min.

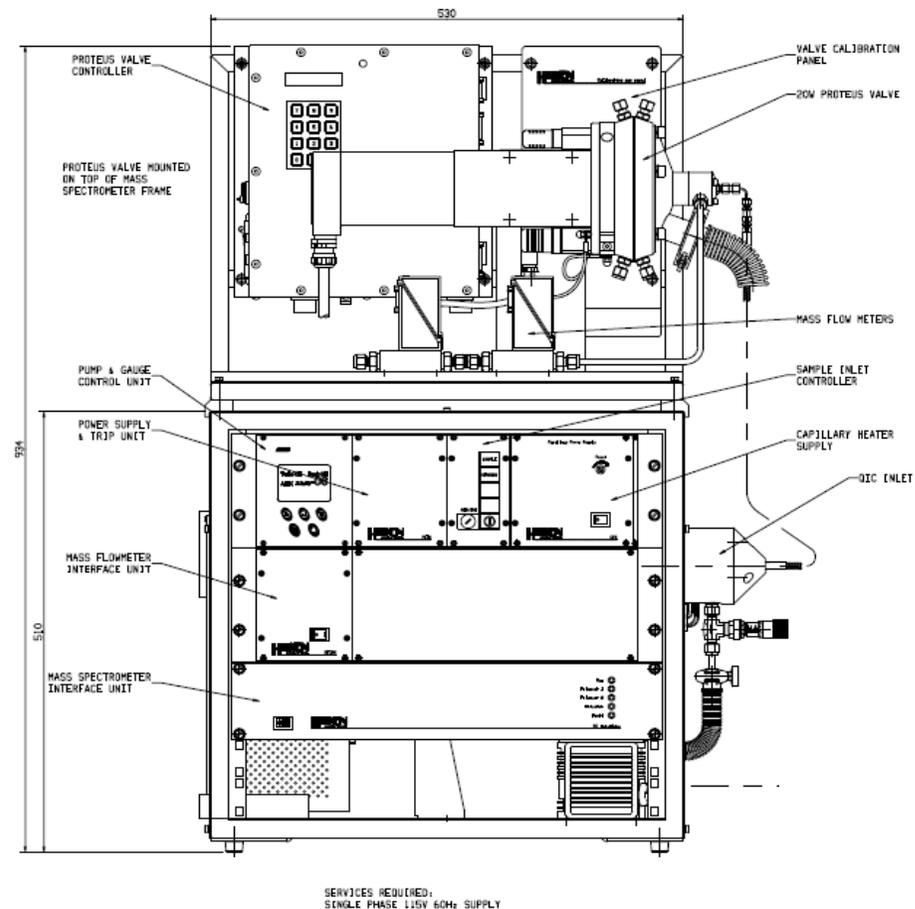


# QIC MultiStream-C bench-top system

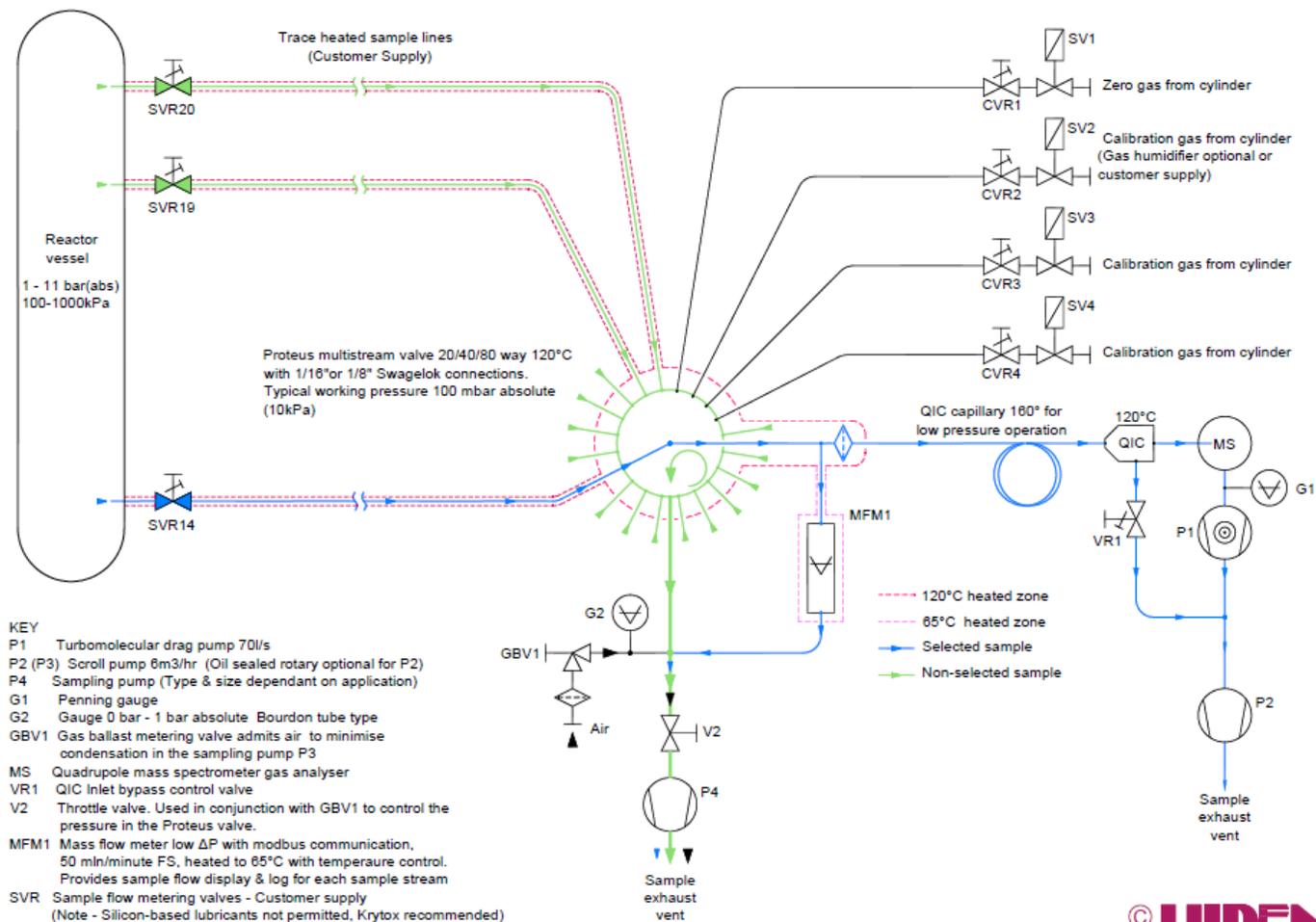
Small footprint instrument:  
535mm deep X 530mm wide

Top mounted Proteus Valve  
20 or 40 stream versions.

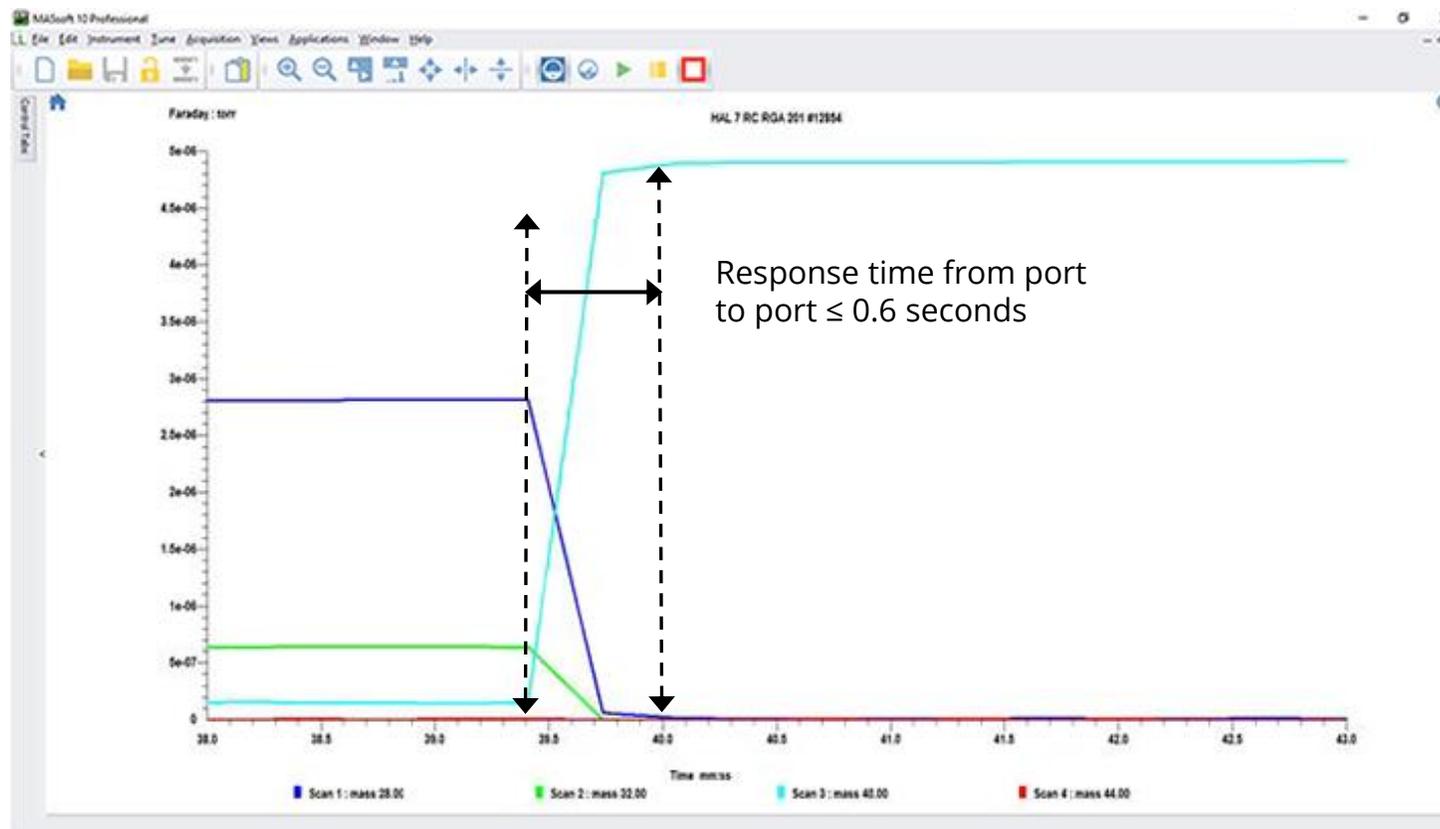
20 stream version shown  
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12 l/min.



# Schematic of QIC MultiStream for thermal-hydraulic testing

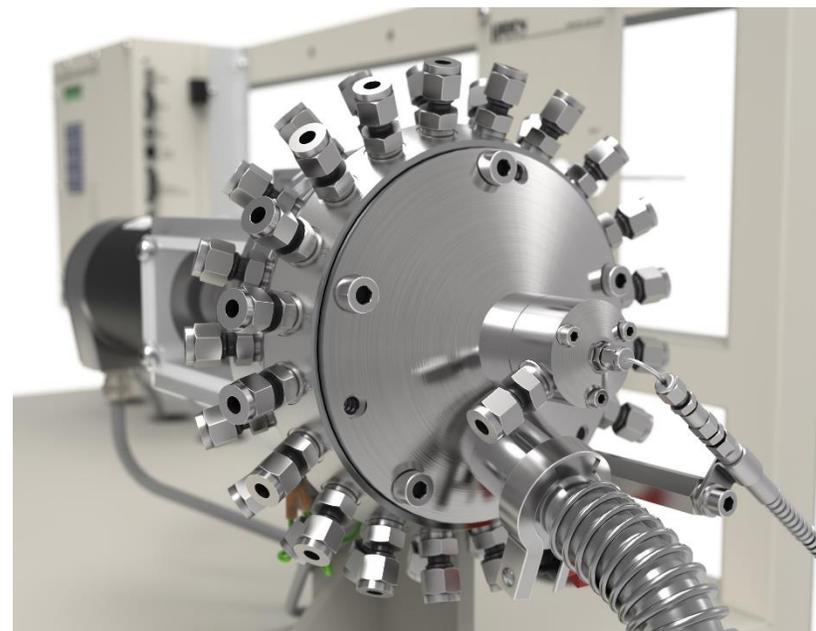


# QIC MultiStream switching time between sample streams in $\leq 0.6$ seconds



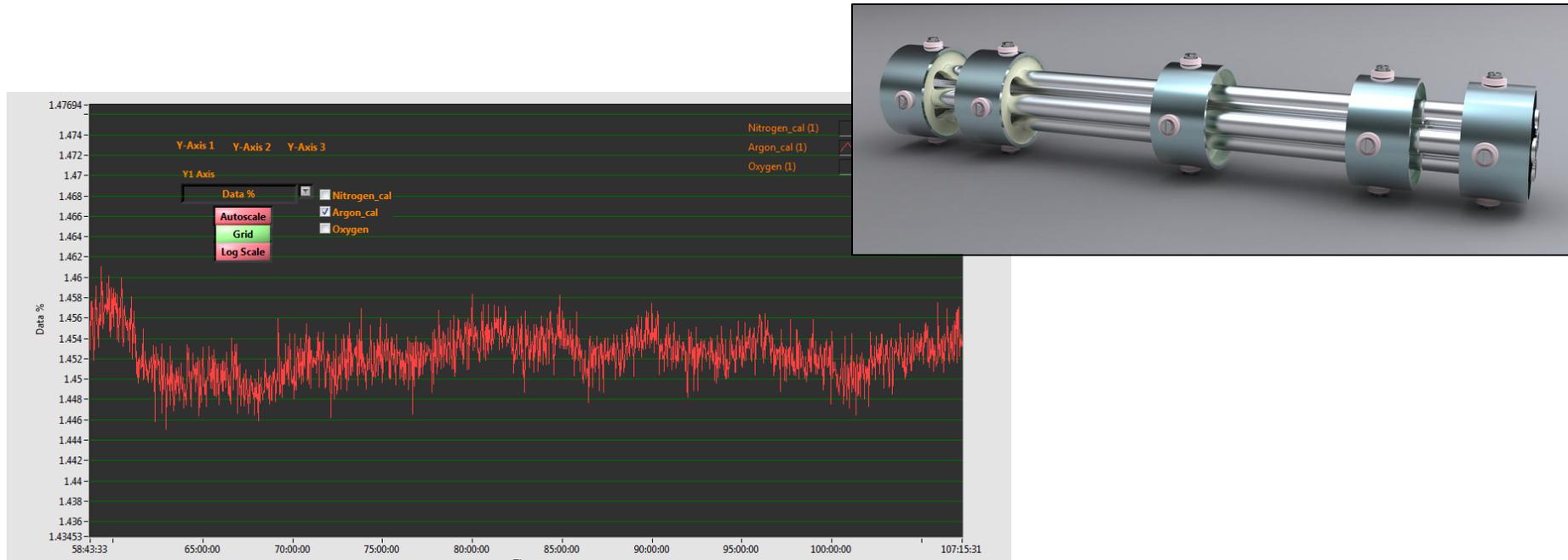
Hiden Proteus MultiStream Valve	
Type	Gas Selector valve - relies on novel face sealing technology to provide effective sealing with long life.
Max Operating Temperature	120°C
Minimum Sample Flow	Not applicable - Determined by analyser (no sample lost)
'Crosstalk' from other samples	Zero
Number of operations before maintenance	>6 x 10 <sup>6</sup>
Memory (carry over) From previous sample	Class leading low memory due to minimised internal switching volume and low sample wetted surface area. The face seal is isolated from the sample by a secondary internal seal.
Number of ports	20, 40, 80
Actuation	Direct drive, high torque micro-stepping motor with IP65 protected incremental rotary encoder providing home z-position and closed loop motion control. Full motion management including intelligent acceleration/deceleration, position maintenance, bi-directional drive and position error annunciation.

Positioning accuracy	+/- 0.09°
Full brown-out sensing and protection	Yes
Communication (valve port position select)	Binary, BCD RS232C
Available as separate product	Yes



# Triple Filter Quadrupole Mass Spectrometer

- Precision machined ceramic supports
- Independently driven RF pre and post filters
- Long term stable operation



- Oxygen, Nitrogen and Argon measured over 110 hours
- Data shows stability of the Argon signal for an extended period

# QGA Software

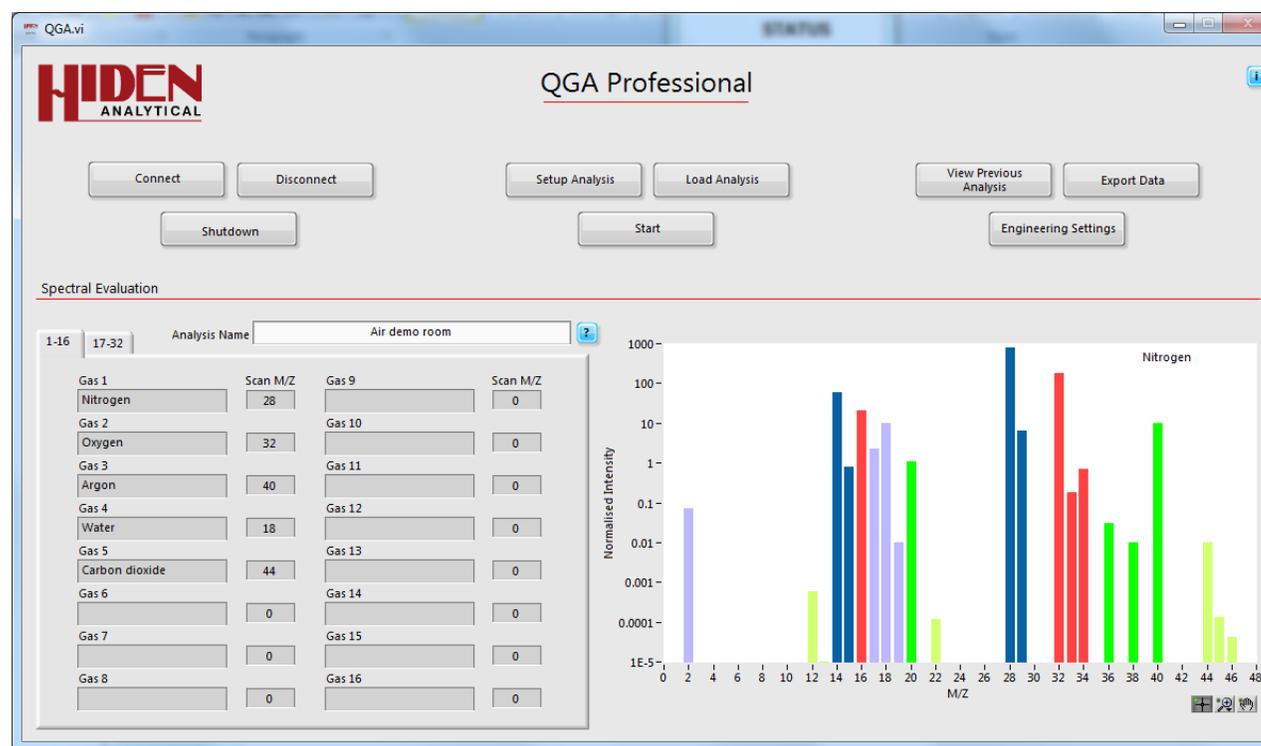
## Quantitative gas analysis software

Template operation from pre defined analysis set up for up to 32 gases and vapours.

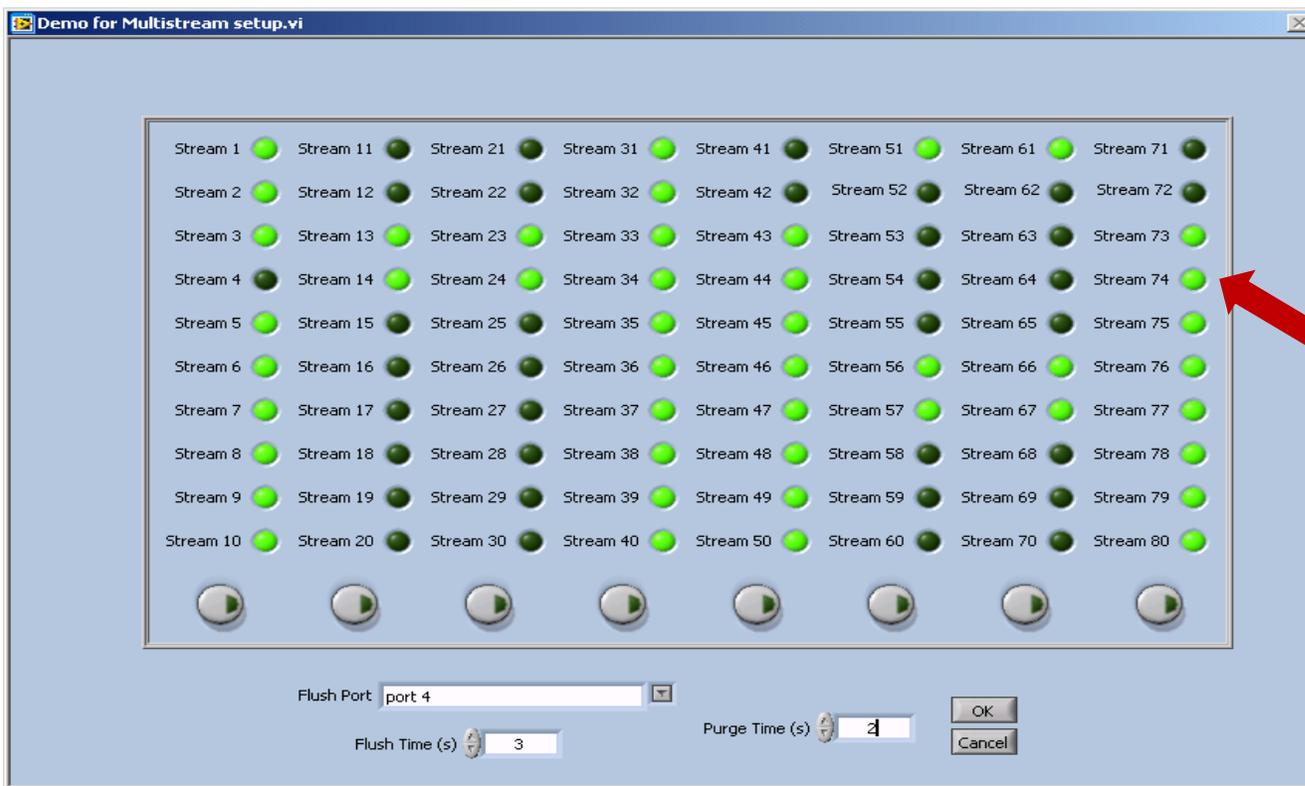
Automatic data acquisition.

Data export  
OPC and/or direct to Excel.

Multi-stream capability for up to 80 gas sample streams.



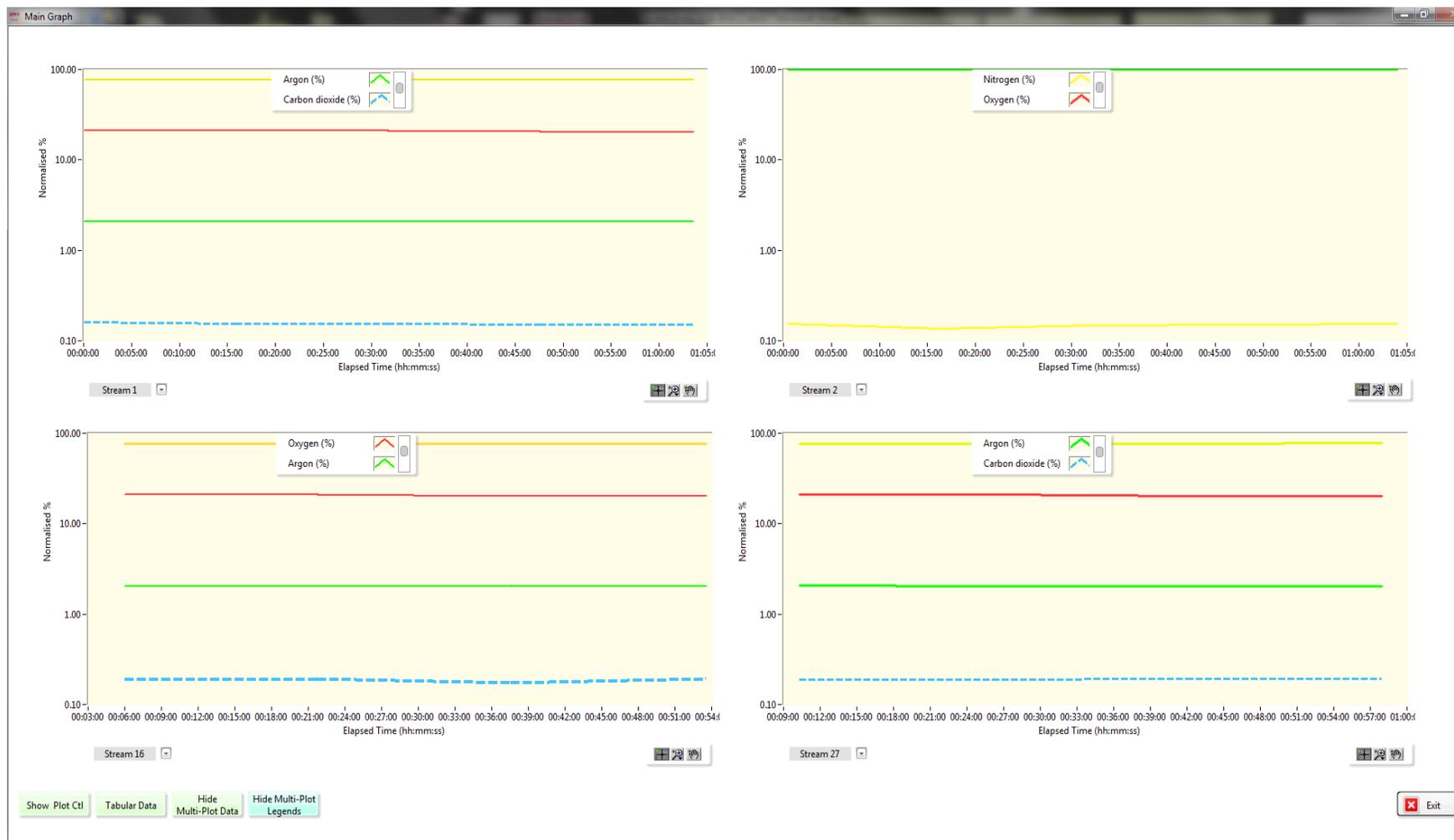
# Multiple stream sequence set up - 80 stream example



Click to add  
or subtract  
a stream  
from the  
analysis sequence

Different sampling points can be added or subtracted from the stream sequence at any time during the analysis with a simple click on the stream LED.

# Multi-stream gas analysis - The real-time trend analysis of up to 4 selected streams can be viewed in real-time and in review



## Data Export

- Data export to MS Excel.
- New workbook for each data file.
- Quantitative data, raw data values and corrected data values are exported.
- Calibration factors and background correction values are recorded.
- The workbook contains a worksheet for each gas stream.

Data for up to 80 gas sample streams

Gas composition				RAW data				Corrected data							
OGA %	Time (ms)	Nitrogen 28	Argon 40	Oxygen 32	Water 18	Time (ms)	Nitrogen 28	Argon 40	Oxygen 32	Water 18	Time (ms)	Nitrogen 28	Argon 40	Oxygen 32	Water 18
95.30	80.148	1.074	18.124	0.714	0.204	5.64E-03	1.27E-07	1.46E-09	2.67E-08	1.06E-09	5.64E-03	1.25E-07	1.59E-09	2.82E-08	1.11E-09
95.60	80.198	1.004	18.094	0.704	0.204	3.95E-04	1.26E-07	1.43E-09	2.66E-08	1.04E-09	3.95E-04	1.25E-07	1.59E-09	2.81E-08	1.09E-09
94.955	80.137	1.002	18.142	0.719	0.205	6.46E-04	1.26E-07	1.42E-09	2.66E-08	1.06E-09	6.46E-04	1.24E-07	1.55E-09	2.81E-08	1.11E-09
93.416	80.173	1.001	18.121	0.705	0.205	9.34E-04	1.26E-07	1.42E-09	2.66E-08	1.04E-09	9.34E-04	1.24E-07	1.55E-09	2.80E-08	1.09E-09
122952	80.225	1.005	18.045	0.725	0.205	1.23E-06	1.26E-07	1.43E-09	2.64E-08	1.07E-09	1.23E-06	1.24E-07	1.55E-09	2.79E-08	1.12E-09

09.Feb.09 Calibration factor					
gen 28	Argon 40	Oxygen 32	Water 18	Background	Calibration Factor
25E-07	1.58E-09	2.82E-08	1.11E-09	8.19E-11	1.01349
25E-07	1.56E-09	2.81E-08	1.09E-09	1.53E-10	0.91654
24E-07	1.55E-09	2.81E-08	1.11E-09	1.54E-10	0.9474
24E-07	1.55E-09	2.80E-08	1.09E-09	1.14E-09	0.95104
24E-07	1.55E-09	2.79E-08	1.12E-09	0	1
24E-07	1.54E-09	2.82E-08	1.11E-09	0	1
24E-07	1.54E-09	2.81E-08	1.11E-09	0	1

38	903940	80.193	1.009	18.102	0.695
39	932948	80.203	1.016	18.076	0.705
40	961778	80.065	1.018	18.221	0.696
41	990701	80.181	1.015	18.091	0.714
42	1019570	80.185	1.031	18.077	0.707
43	1048680	80.149	1.023	18.125	0.704
44	1077430	80.12	1.023	18.155	0.702
45	1106301	80.076	1.013	18.218	0.693
46	1135051	80.207	0.996	18.099	0.698
47	1163923	80.185	1.018	18.089	0.708
48	1192796	80.148	0.997	18.172	0.684
49	1221607	80.195	1.011	18.1	0.694

# OPC – Data Output

The screen shot is from an OPC data viewer showing data tags for each stream and for each gas channel.

OPC data can be selected as raw, corrected or %, PPM values

Tags are automatically updated for the active streams:  
[\\QGAPro\2\\_2](#) is the current value for stream 2 gas 2.  
[\\QGAPro\2\\_RQ](#) is the current RQ value for stream 2.

Item ID	Access Path	Value	Quality	Timestamp	Status
\\QGAPro\2_1		79.1131058460503	Good, non-specific	11/29/2011 9:10:42.444 AM	Active
\\QGAPro\2_10		0	Good, non-specific	11/29/2011 9:10:42.444 AM	Active
\\QGAPro\2_11		0	Good, non-specific	11/29/2011 9:10:42.444 AM	Active
\\QGAPro\2_12		0	Good, non-specific	11/29/2011 9:10:42.444 AM	Active
\\QGAPro\2_13		0	Good, non-specific	11/29/2011 9:10:42.444 AM	Active
\\QGAPro\2_14		0	Good, non-specific	11/29/2011 9:10:42.444 AM	Active
\\QGAPro\2_15		0	Good, non-specific	11/29/2011 9:10:42.444 AM	Active
\\QGAPro\2_16		0	Good, non-specific	11/29/2011 9:10:42.444 AM	Active
\\QGAPro\2_2		18.7962157343888	Good, non-specific	11/29/2011 9:10:42.444 AM	Active
\\QGAPro\2_3		0.8728409069347	Good, non-specific	11/29/2011 9:10:42.444 AM	Active
\\QGAPro\2_4		4557.52377693532	Good, non-specific	11/29/2011 9:10:42.444 AM	Active
\\QGAPro\2_5		1.21783751262622	Good, non-specific	11/29/2011 9:10:42.444 AM	Active
\\QGAPro\2_6		0	Good, non-specific	11/29/2011 9:10:42.444 AM	Active
\\QGAPro\2_7		0	Good, non-specific	11/29/2011 9:10:42.444 AM	Active
\\QGAPro\2_8		0	Good, non-specific	11/29/2011 9:10:42.444 AM	Active
\\QGAPro\2_9		0	Good, non-specific	11/29/2011 9:10:42.444 AM	Active
\\QGAPro\2_CER		0.00121341998855826	Good, non-specific	11/29/2011 9:10:42.444 AM	Active
\\QGAPro\2_OUR		0.00184848166579476	Good, non-specific	11/29/2011 9:10:42.444 AM	Active
\\QGAPro\2_RQ		0.656441451928897	Good, non-specific	11/29/2011 9:10:42.444 AM	Active
\\QGAPro\3_1		79.3545815798548	Bad, non-specific	11/28/2011 2:00:14.542 PM	Active
\\QGAPro\3_10		0	Bad, non-specific	11/28/2011 2:00:14.543 PM	Active
\\QGAPro\3_11		0	Bad, non-specific	11/28/2011 2:00:14.544 PM	Active
\\QGAPro\3_12		0	Bad, non-specific	11/28/2011 2:00:14.544 PM	Active
\\QGAPro\3_13		0	Bad, non-specific	11/28/2011 2:00:14.544 PM	Active
\\QGAPro\3_14		0	Bad, non-specific	11/28/2011 2:00:14.544 PM	Active
\\QGAPro\3_15		0	Bad, non-specific	11/28/2011 2:00:14.544 PM	Active
\\QGAPro\3_16		0	Bad, non-specific	11/28/2011 2:00:14.545 PM	Active
\\QGAPro\3_2		1.51106640662871	Bad, non-specific	11/28/2011 2:00:14.542 PM	Active
\\QGAPro\3_3		18.437938745529	Bad, non-specific	11/28/2011 2:00:14.542 PM	Active
\\QGAPro\3_4		0.696413267987495	Bad, non-specific	11/28/2011 2:00:14.542 PM	Active
\\QGAPro\3_5		0	Bad, non-specific	11/28/2011 2:00:14.543 PM	Active

# Real time data export, system control and I/O for process control

## Three options for output of real time data

- OPC for process control providing real time data tags from QGA Pro software.
- RS232 streamed data in ASCII format from the mass spectrometer interface unit.
- Socket interface for windows client compatible applications with MASsoft Pro software.

## System control and outputs

- 5 I/O for TTL signal control for automatic operation- start /stop for example.
- Up to 16 channel signal output options as 0 – 10V analogue outputs.

## System data logging

- Three RS485 inputs provide for up to three device type protocols for reading data from external devices, temperature for example. Synchronously logged and displayed with the mass spectrometer data.

# QIC MultiStream gas analyser for sampling flow rates for high to low flow conditions

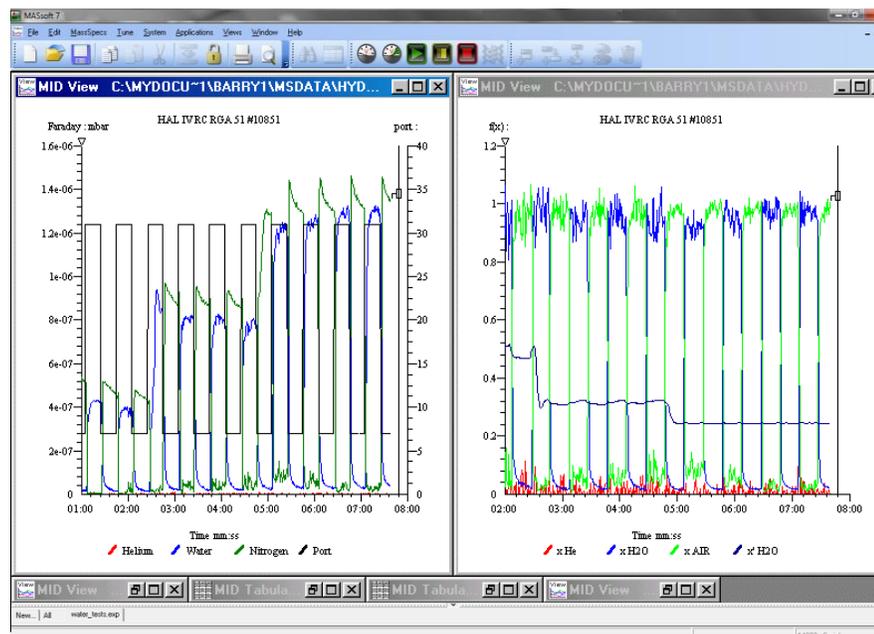
- Small diameter sample tubing is used to connect the QIC MultiStream to the sampling point.
- Sample gas flow through the sample tubing is induced by creating a pressure gradient along the tube.
- The sample flow may be achieved by a positive pressure at the sampling point & venting the sample flow to ambient pressure after analysis.
- Alternatively, a sampling pump may be connected to the analyser exhaust.
- This type of system will typically accept individual sample flow rates from several litres/minute to 0.1 litres/minute. Sample transit times become unacceptably long (several minutes) below 0.02 litres/minute.
- Applications using lower sampling flow rates use the low flow configuration of the QIC MultiStream optimized for flow rate < 4ml/minute.

# QIC MultiStream gas analyser for very low flow conditions

- The QIC MultiStream low flow system utilizes the unique capability of the Proteus multi-stream selector valve to operate under very low pressure (vacuum) conditions.
- This system is optimized for fast response with very low sample flow rates. This is achieved with small-bore capillary tubing. The sampling lines then become the 1st stage of the inlet pressure reduction system. The exhaust of the Proteus valve is connected to the dry scroll pump to provide a vacuum of a few mbars absolute within the valve.
- Atmospheric pressure sample gas enters the capillary sample tubing at the sampling point at 1.8 metres/s (typical for 0.2mm ID x 2.0 metre sampling capillary) then accelerates rapidly along the tubing due to the progressive expansion of the sample.
- For example, 4 ml/minute atmospheric flow expands to  $4 \times >200 = 800$  ml/min (0.8 litres/minute).
- This increase in sample volume flow rate provides rapid sample transit along the sampling capillary & the fast switching response, switching time between sample streams is  $< 0.6$  seconds.

# Application Example - Nuclear Reactor Safety Research

- The QIC MultiStream was commissioned to investigate the function and reliability of passive condensers in the presence of “non-condensable” gases e.g. N<sub>2</sub>, which can affect the efficiency of the Passive Protection Systems.
- The QIC MultiStream showed a good response to the gradual introduction of steam. Switching from ‘100’% → 0% steam in 20 / 20s cycle showed reproducible response.
- The system was also required to display insensitivity to pressure fluctuations. This was confirmed by (i) increasing source pressure which showed a partial pressures increase but an unchanged composition ratio and (ii) switches between mixed gas/ vapour / gas only streams which showed a response in seconds with no memory effects.



# Summary – QIC MultiStream for Off-gas analysis

QIC MultiStream – cart or compact bench top configuration

Off-gas analysis for 8, 20, 40, or 80 streams

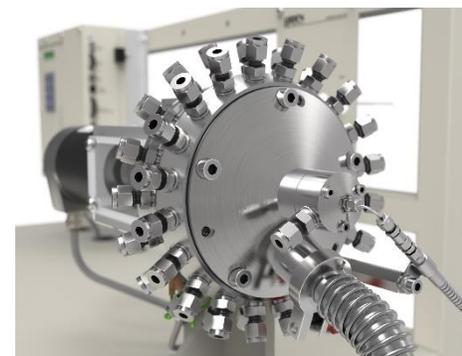
Analysis of gases and vapours

Triple filter quadrupole mass spectrometer

Optional data displays of MS and derived functions  
e.g. Vapour Pressure from Dew Point temperature  $T_{dp}$

Data output through OPC shared variable engine

**Lifetime application and service support**



QIC MultiStream mobile cart



QIC MultiStream-C bench-top

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- [www.HidenAnalytical.com](http://www.HidenAnalytical.com)
  - The Hiden website is an excellent resource with product pages, brochures, catalogues, product pages with some application notes, presentation and other information.
  - Contact +44 1925 445225 for direct support.