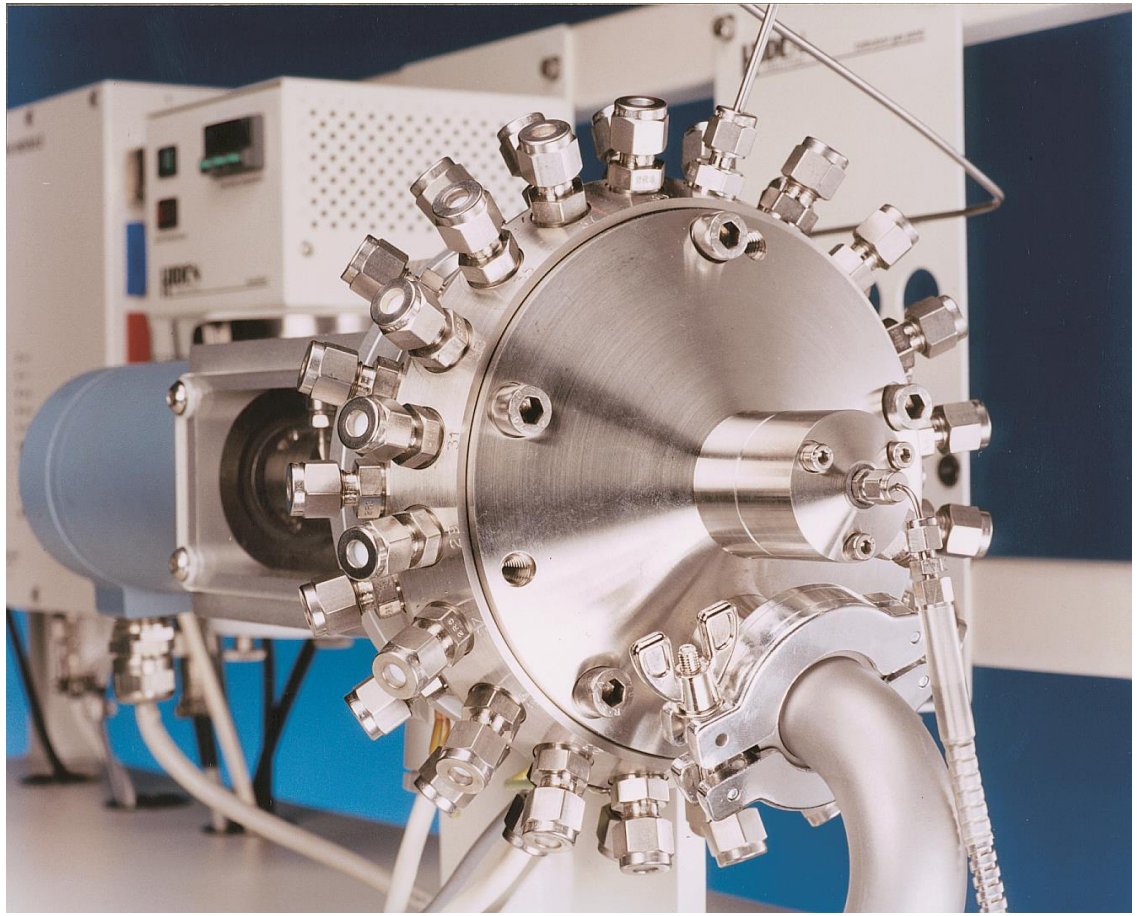
Hiden HPR-20 Gas Analysis System with Proteus Multi-way valve

Mass Spectrometry In Containment Thermal-hydraulic Test Facilities

HPR-20 Gas Analysis System with Proteus 40-way valve



Introduction

The analysis of thermal-hydraulic processes that might occur in a nuclear water reactor containment building under severe accident conditions is very important. Hydrogen behaviour in the reactor containment is studied during a postulated severe accident. Hydrogen is of concern because, at some concentrations, deflagration can occur, resulting in damage to the containment and the release of radioactive material into the environment.

(Helium is used to simulate Hydrogen)

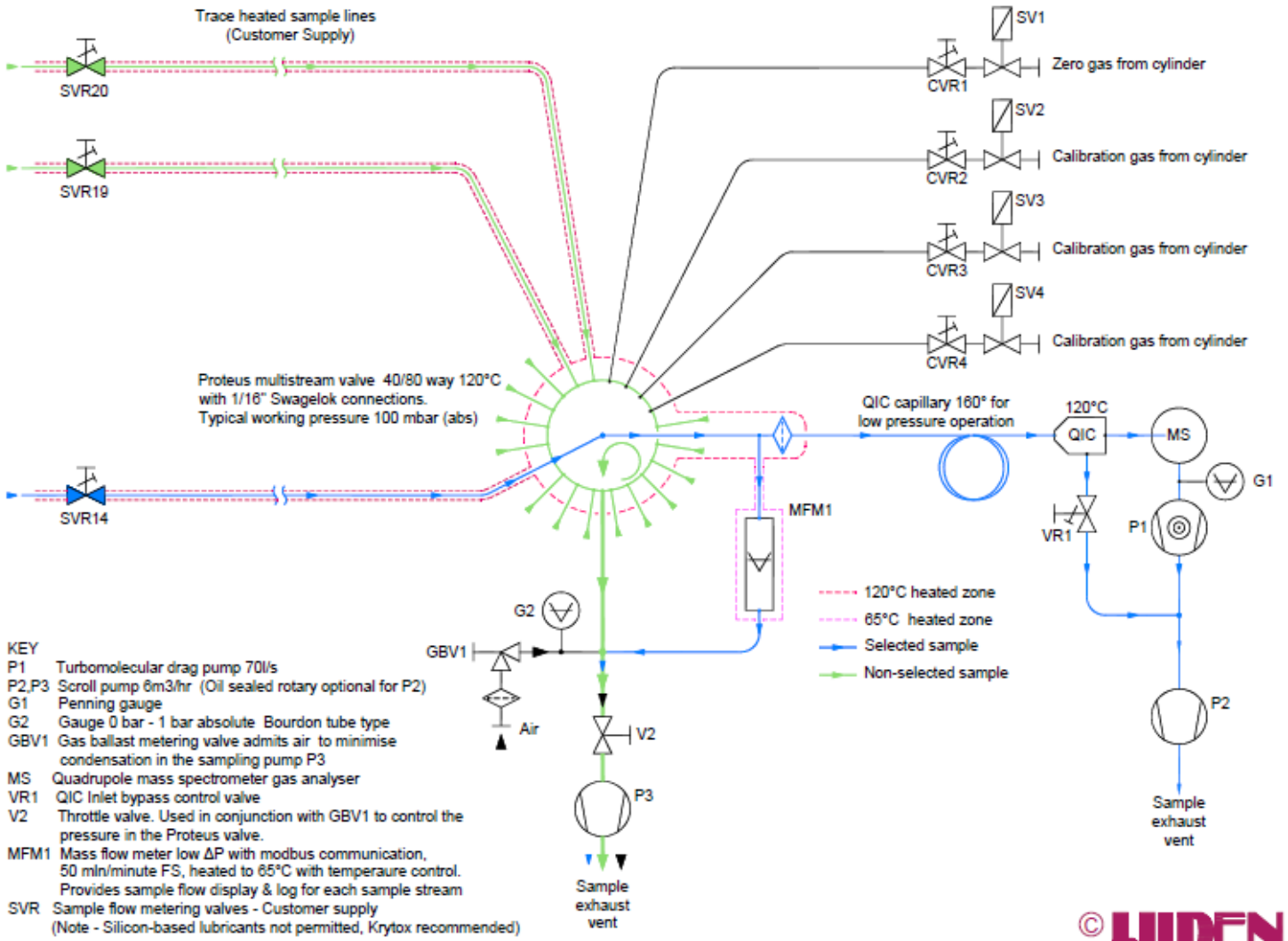


Fig.1 Multipoint system for central analysis of gases from thermal-hydraulic test facilities

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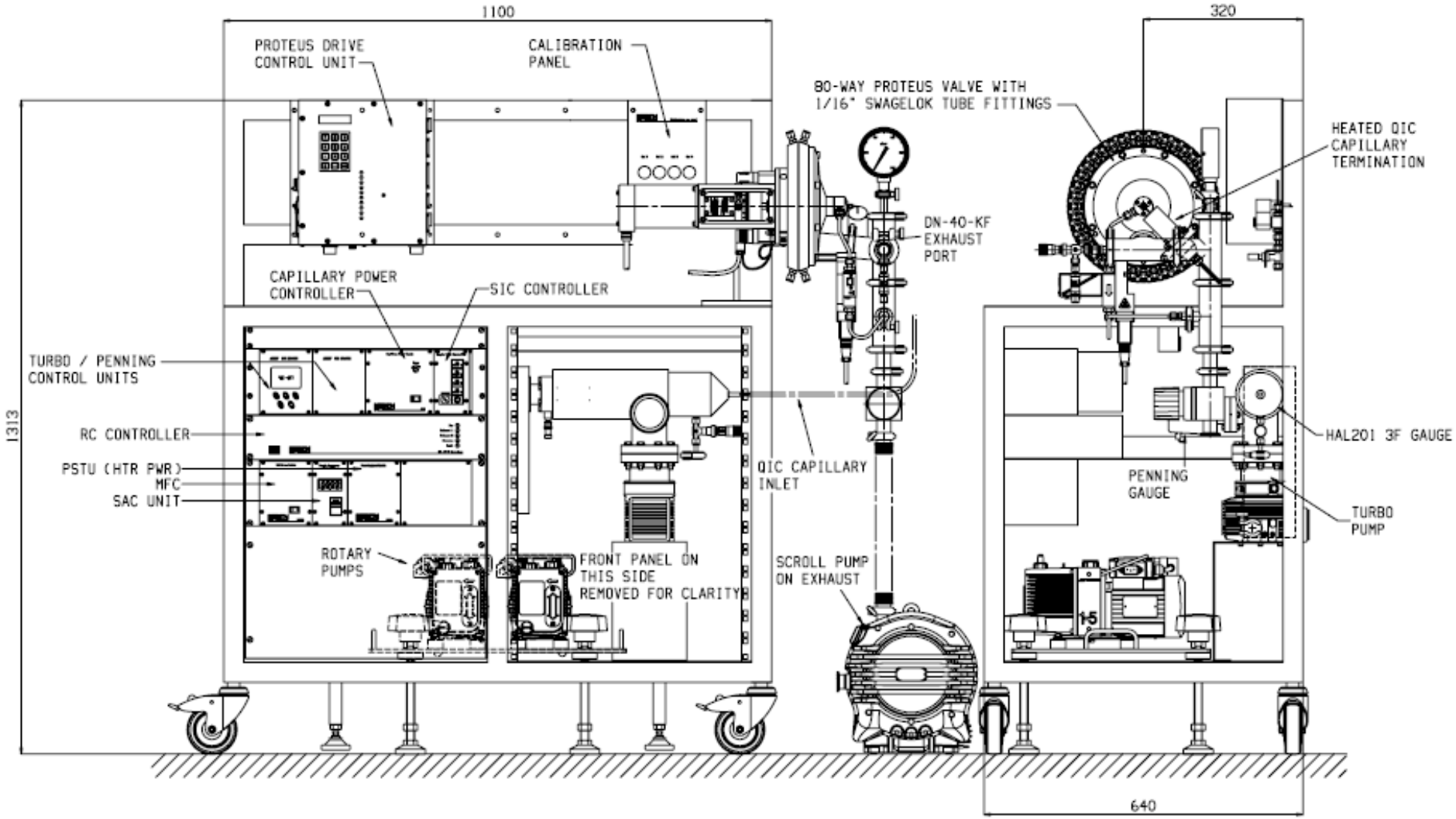
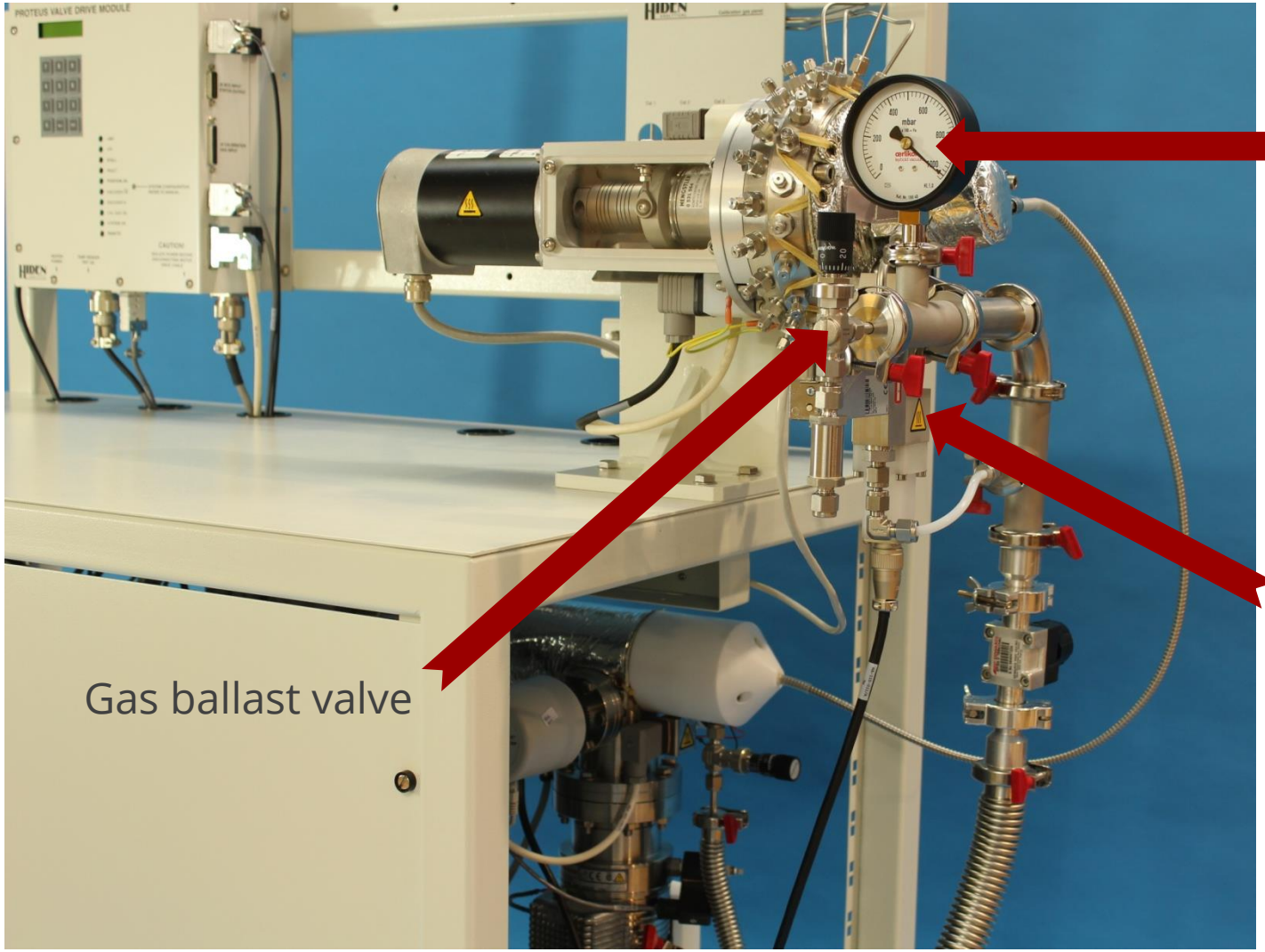
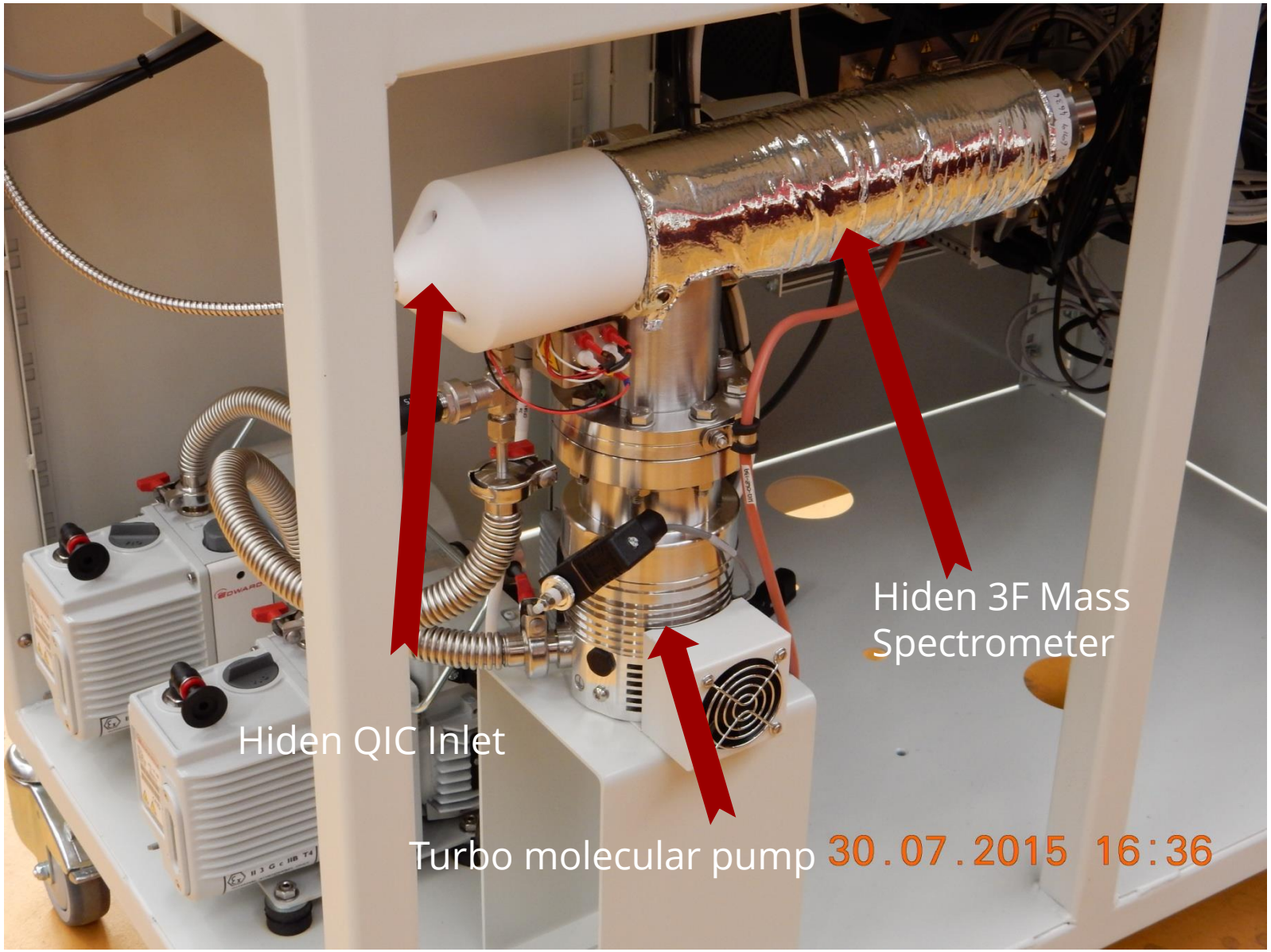

1100
320
PROTEUS DRIVE CONTROL UNIT
CALIBRATION PANEL
80-WAY PROTEUS VALVE WITH 1/16" SWAGELOK TUBE FITTINGS
HEATED QIC CAPILLARY TERMINATION
DN-40-KF EXHAUST PORT
CAPILLARY POWER CONTROLLER
SIC CONTROLLER
TURBO / PENNING CONTROL UNITS
1313
RC CONTROLLER
PSTU (HTR PWR)
MFC
SAC UNIT
QIC CAPILLARY INLET
HAL201 3F GAUGE
PENNING GAUGE
TURBO PUMP
ROTARY PUMPS
FRONT PANEL ON THIS SIDE REMOVED FOR CLARITY
SCROLL PUMP ON EXHAUST
640

Quadrupole Mass Spectrometers for Advanced Science

- Multi-stream measurement system
- Specialised for helium/air/steam mixtures.


0 to 1bar Bourdon tube gauge
Mass flow meter with Modbus communication and 65°C heating
Gas ballast valve


Hiden 3F Mass Spectrometer
Hiden QIC Inlet
Turbo molecular pump
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QIC Connection to Hiden Mass Spectrometer

Dual rotary backing pumps

Proteus Valve Features and Benefits

- Gas Selector Valve – novel face sealing technology – to give effective sealing and long life
- Maximum operating temperature 120°C
- No minimum sample flow
- Zero crosstalk from other samples
- > 6 x10^6 operations before maintenance
- 20, 40 or 80 ports
- Direct drive, high torque micro-stepping motor with IP65 protected incremental rotary encoder providing z-home position and closed loop motor control.
- Full motion management including intelligent acceleration/ deceleration, position maintenance, bi-directional drive and position error annunciation
- Positional Accuracy +/- 0.09°
- Full brown-out sensing and operation
- Communication (valve port position select) via Binary, BCB and RS232C
- Also available as a separate product

Worked Example – Multi-stream Analysis

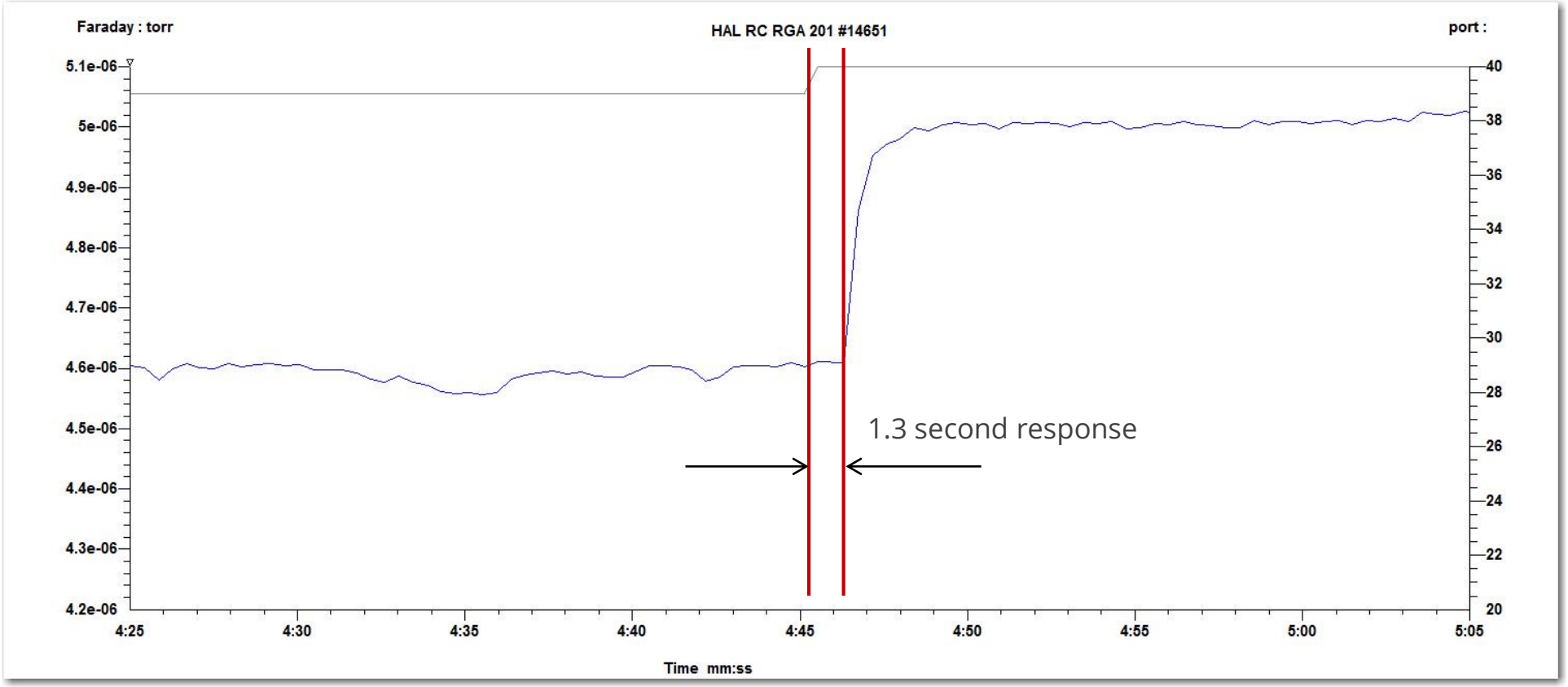
Test Setup:

- 2 x 5 m lines (1/16”OD x 0.05”ID) heated to 170°C.
- Line 1: Port 40 – 100% steam
- Line 2: Port 39 – 96% steam, 4% He

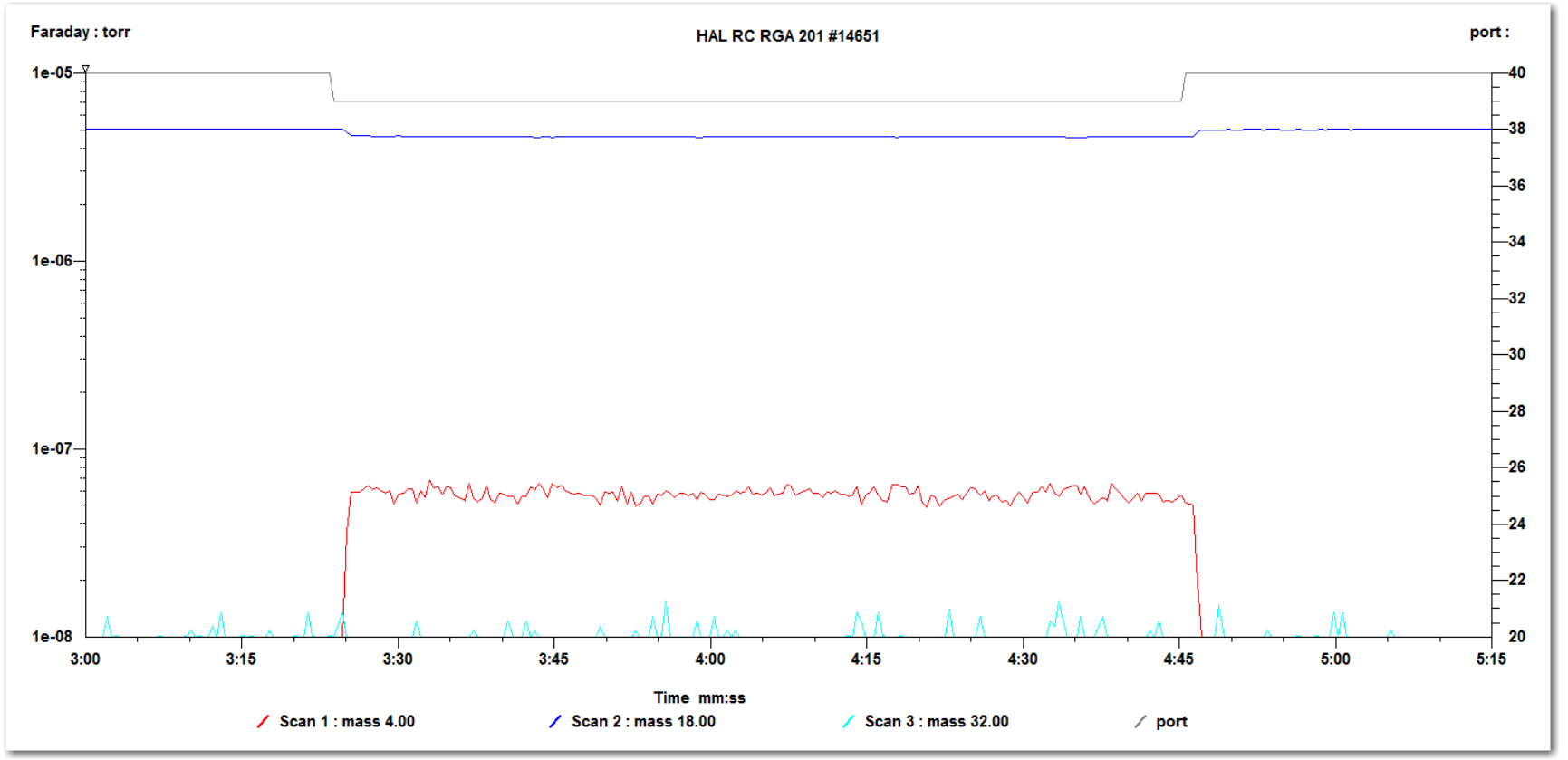
Test design:

- Measure response (s) switching between steam and steam/helium at 10 mln/min, (this is about 8.5 mln/min as read on the MFM and 1.5 mln/min through the capillary taken from the pressure vs flow table).
- Pressure 100 mbar, flow rate ~10 mln/min, sample time 400 ms (this is the time for a data cycle).

Response of water H_20^+ signal switching port 40 to port 39



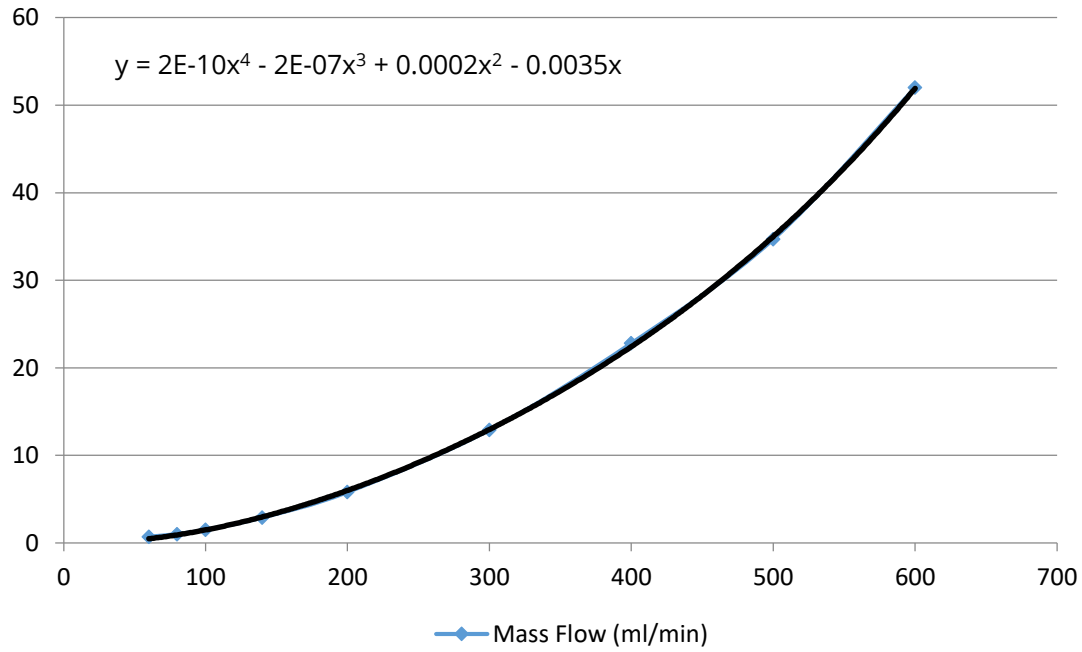
Helium response



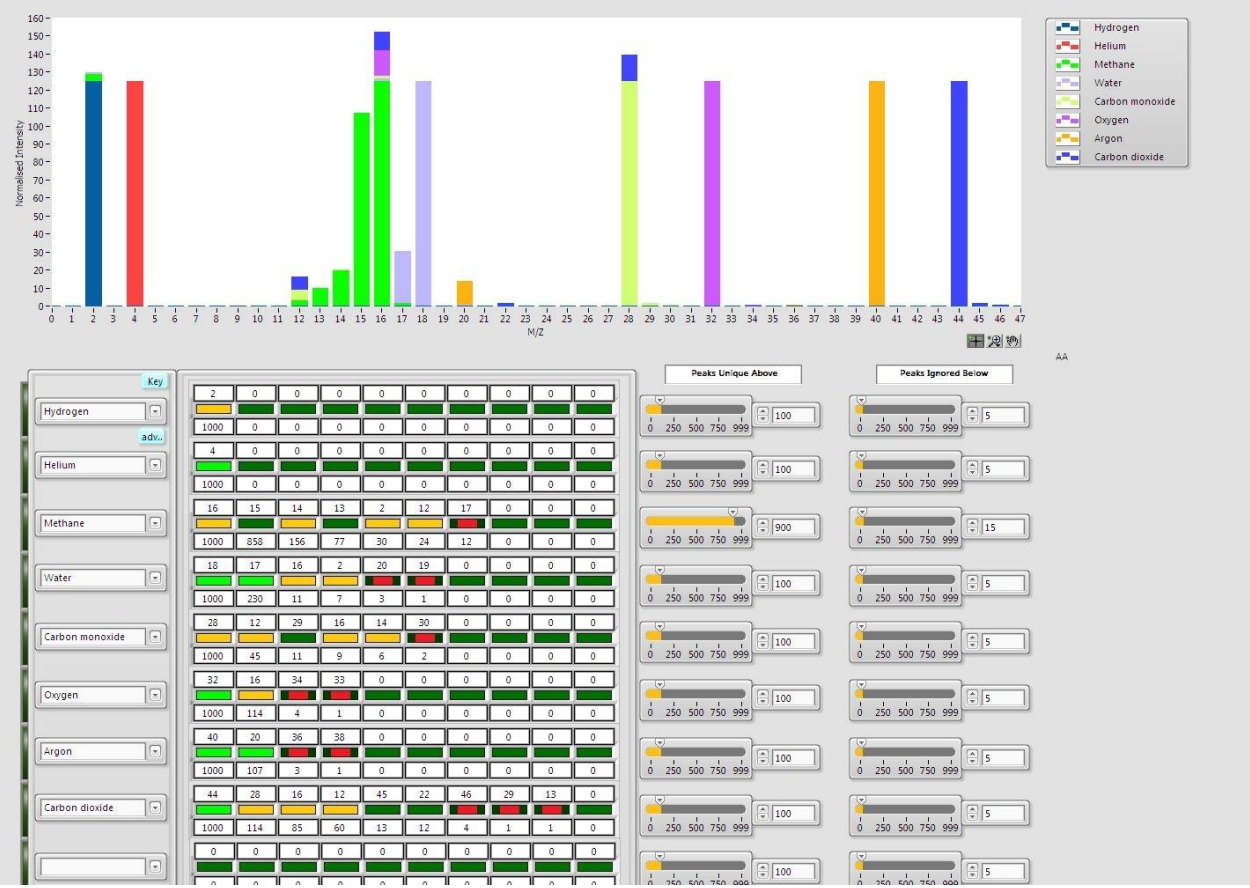
Typical data cycle including stream switching and measurement of helium , oxygen, nitrogen, water is 5 seconds

Bourdon gauge Pressure with respect to Mass Flow

Bourdon gauge pressure mbar



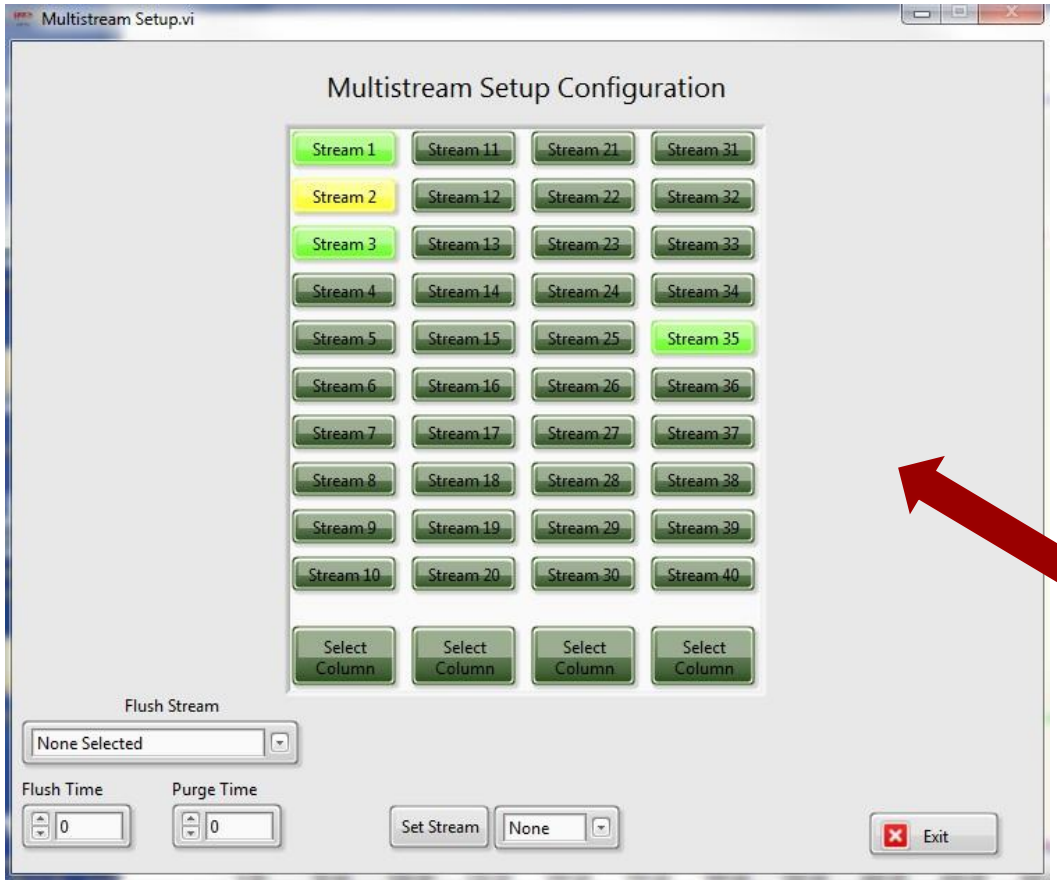
QGA Professional Software for Quantitative Gas Analysis



An application specific software package for quantitative gas and vapour analysis providing real time continuous analysis of up to 32 species with concentrations measured in the range 0.1PPM to 100%.

- Automatic subtraction of spectral overlaps
- Automated calibration routines
- Mass spectral library with intelligent scan feature
- Multi-stream support
- Data export OPC and/or direct to Excel

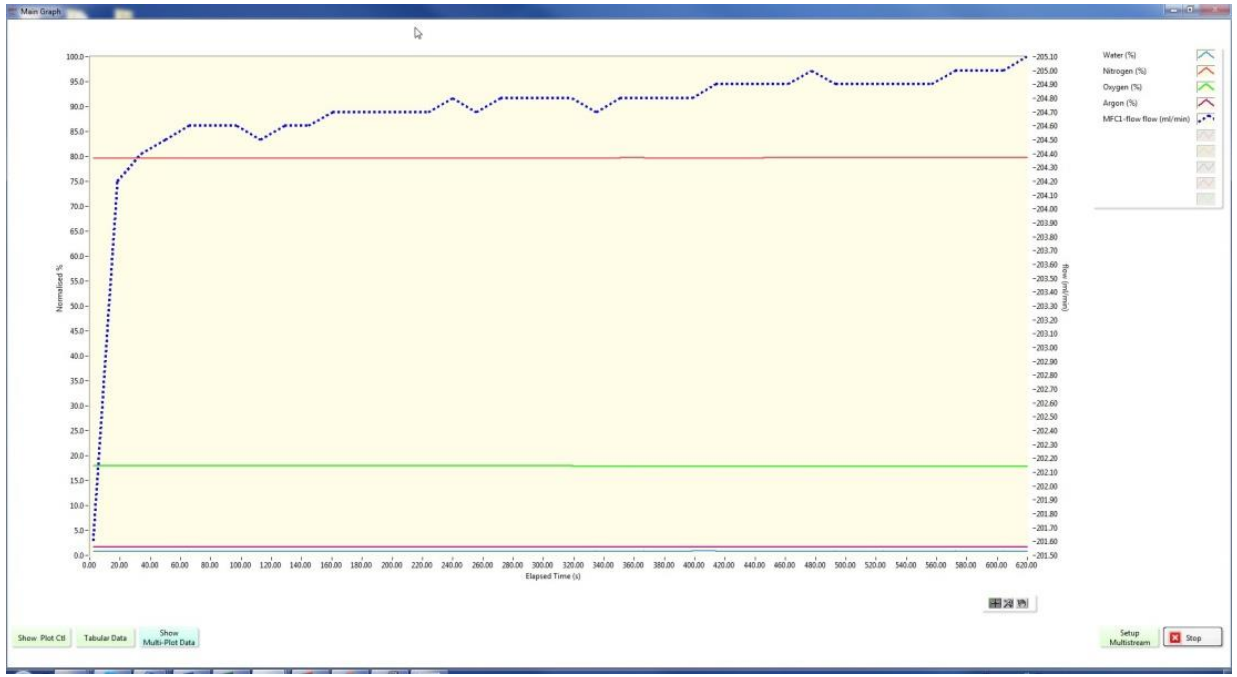
Multiple stream sequence set-up – 40 stream example



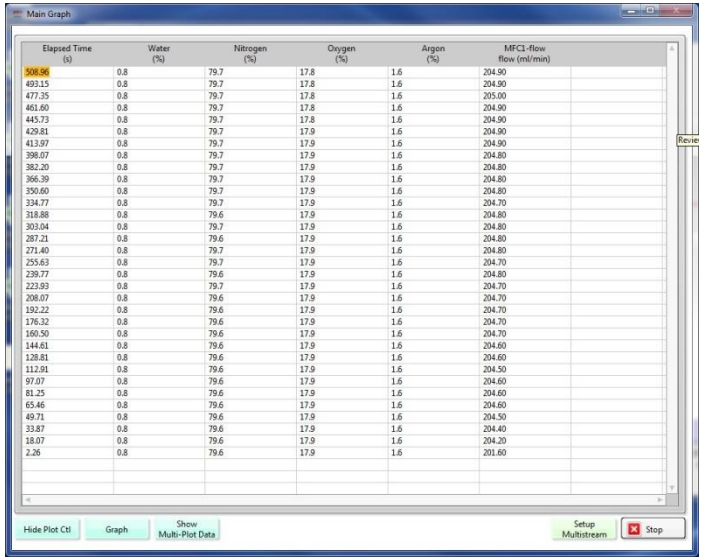
Click to add or subtract a stream from the analysis sequence

Additional streams 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.



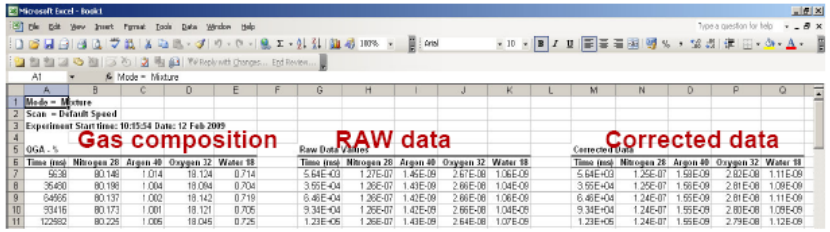
- Graphical view with % on left axis and flow on the right axis

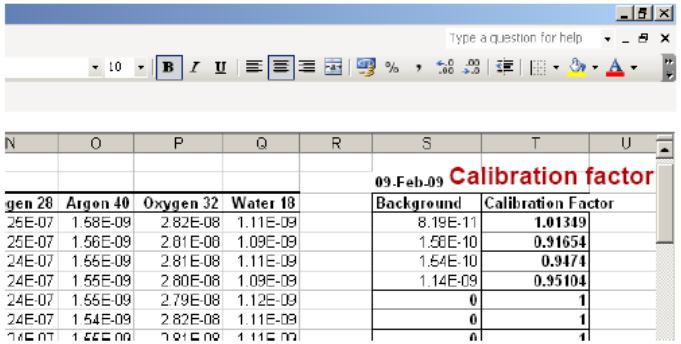


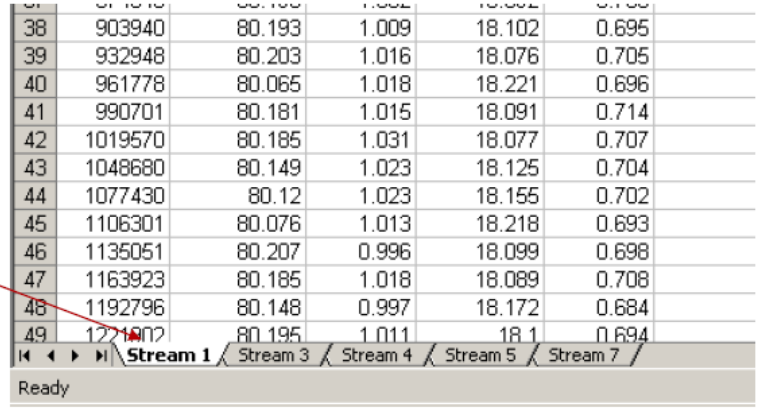
- Tabular data view

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.

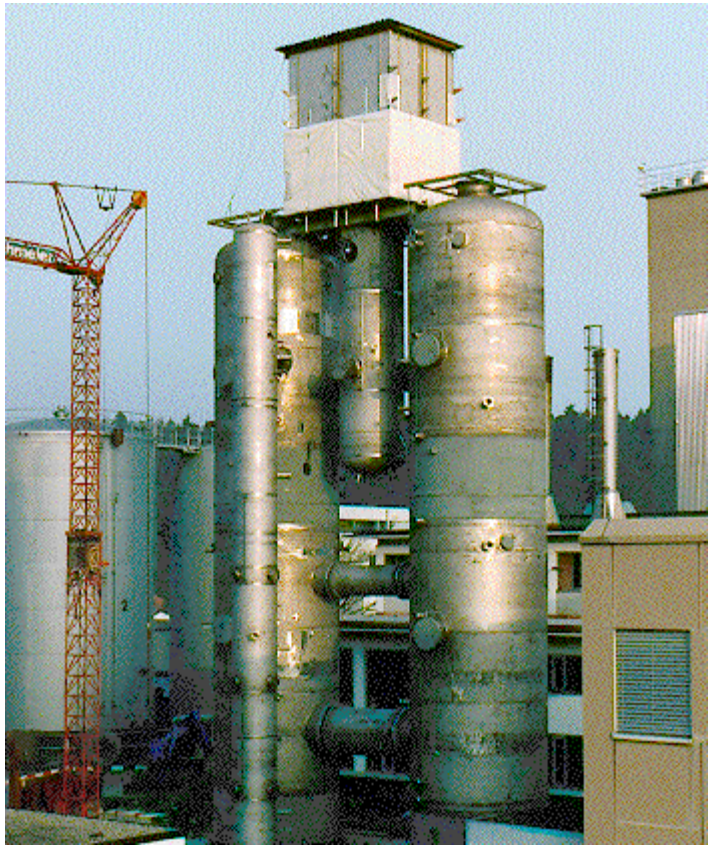






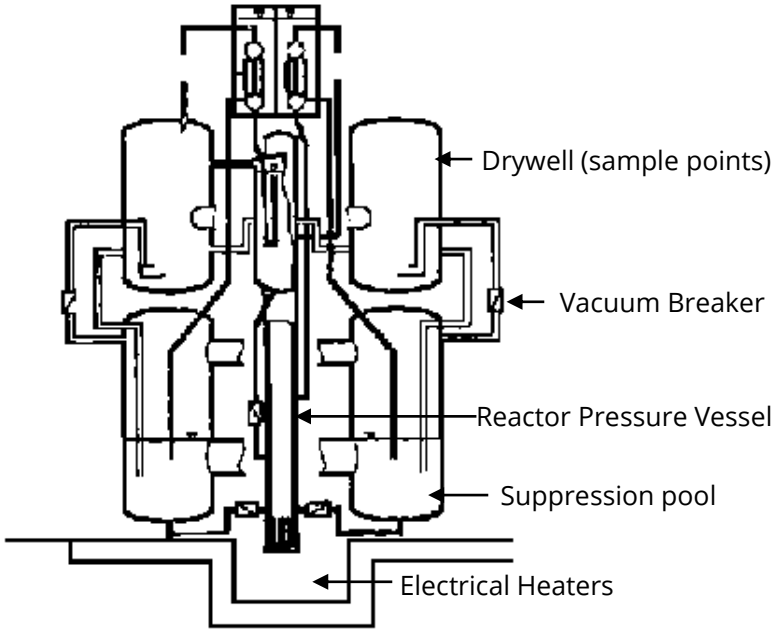
Data for up to 80 gas sample streams

Paul Scherrer Institute – PANDA Test Facility Studies



PANDA during construction

Passive condensers are at the top of the large cylindrical vessels



Paul Scherrer Institute – PANDA Test Facility Studies

- Analysis of the composition and characteristics of vent streams from a Passive Decay Heat Removal safety system for Advanced Light Water Reactor Systems

- The development of Passive Protection Systems eliminates sources of failure present for active systems e.g. Human error or power failure

- The Hiden system was commissioned to investigate the function and reliability of passive condensers under severe accident conditions, in presence of "non-condensable" gases e.g. N_2, which can markedly affect the efficiency of the PPS

Hiden HPR-20 Gas Analysis System with Proteus Multi-way valve – Selected Customers

References

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Investigation of Key Issues for the Simulation of Thermal-Hydraulic Conditions in Water Reactor Containment.
NEA/CSNI/R (2012)5, 06 April 2012.

Alternative Configuration

Bench-top version of the
instrument is also available

- 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.