P S Analytical Review

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www.psanalytical.com

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P S Analytical Snapshot

- Founded in 1983
- AFS – Our Core Competency
- We analyse for Hg, As, Se, etc
- Environmental, Food, Petrochemical markets
- Laboratory, at line or on line instruments
- Family Owned Business
- Head Office in London, Regional Office in USA and AP

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Purpose built facility near London

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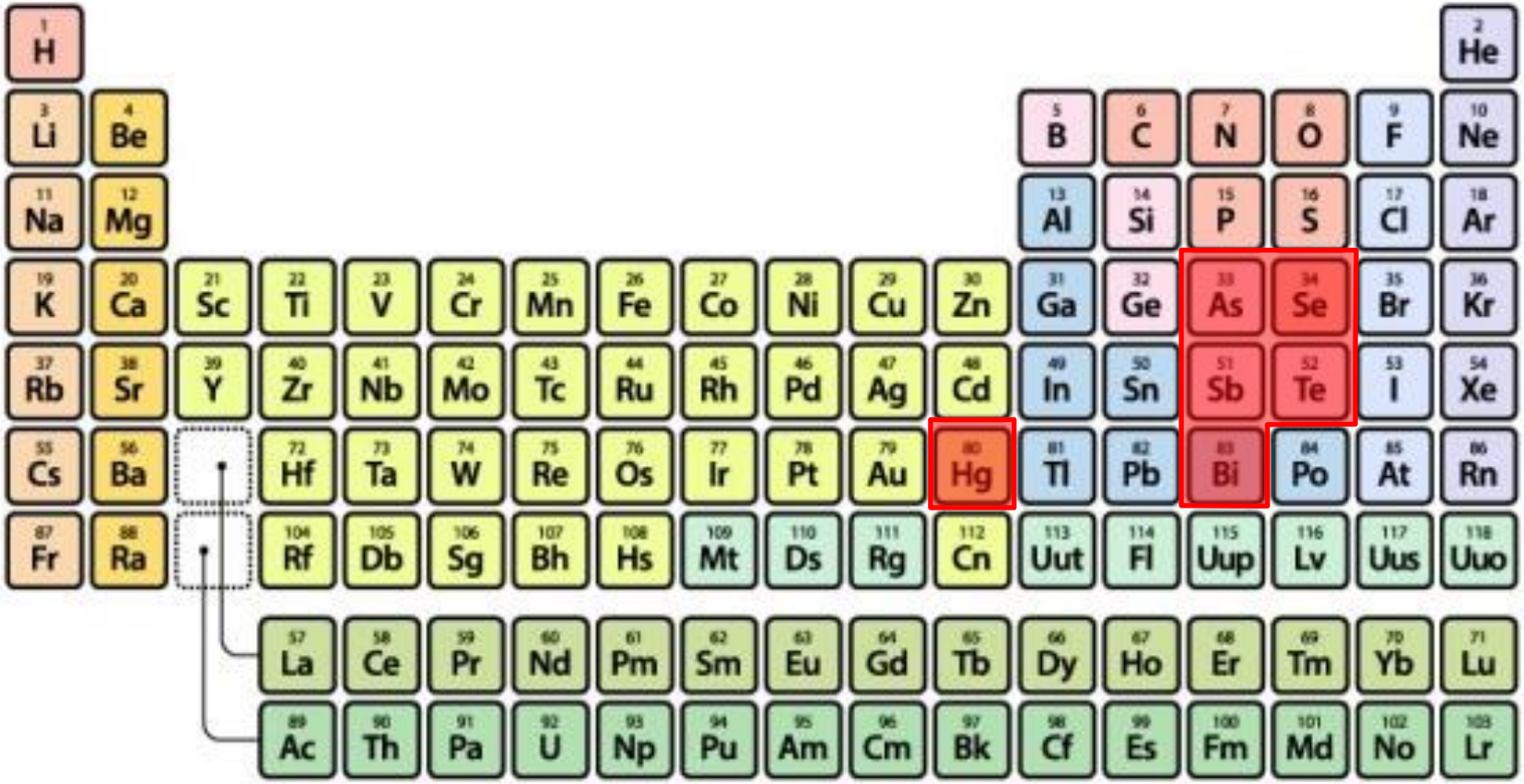
What do we do best?
Mercury and the metalloids



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We can exploit a) Hg has a significant vapour phase b) the volatile metal- hydride formation

Why PSA Utilises Atomic Fluorescence

- Hydride forming elements and mercury all absorb and fluoresce in the UV region below 260nm where AES and AAS are relatively insensitive.
- High intensity excitation sources available.
- Low spectral interference-analyte separated from matrix by the hydride/vapour generation process.
- High selectivity-only the analyte corresponding to the excitation source will fluoresce.
- Excellent sensitivity and linearity.

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Advantages of Atomic Fluorescence Spectrometry (AFS)

- Sensitivity attainable is controlled by the intensity of the light source
- Equipment can be less complex than that needed for AAS or AES
- High sensitivity attainable into the far UV where AAS and AES are insensitive
- Good linearity
- Low spectral interference
- High selectivity
- Analytical line summation

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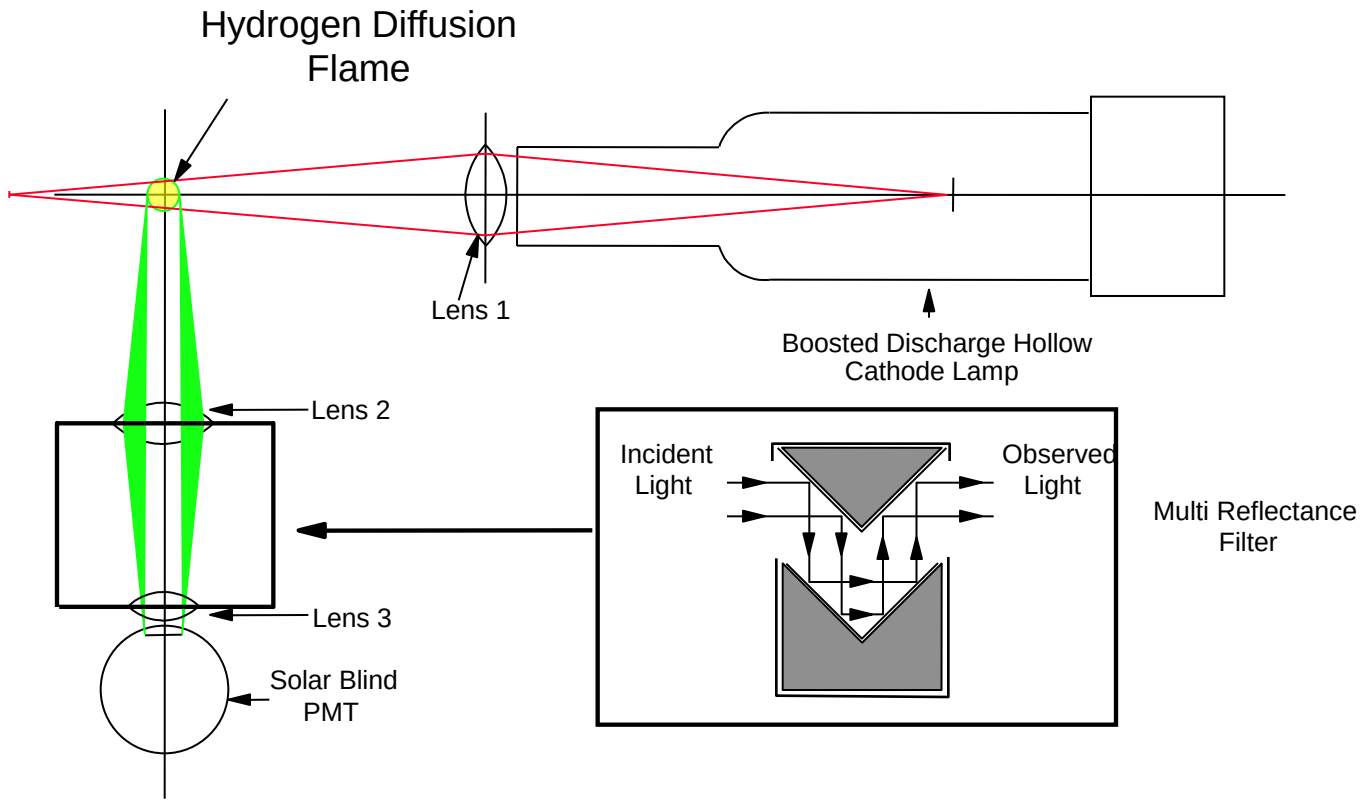
Excalibur Fluorescence Detector for As, Se, Sb, Te and Bi



Schematic Representation of Excalibur Hydride Fluorescence Detector

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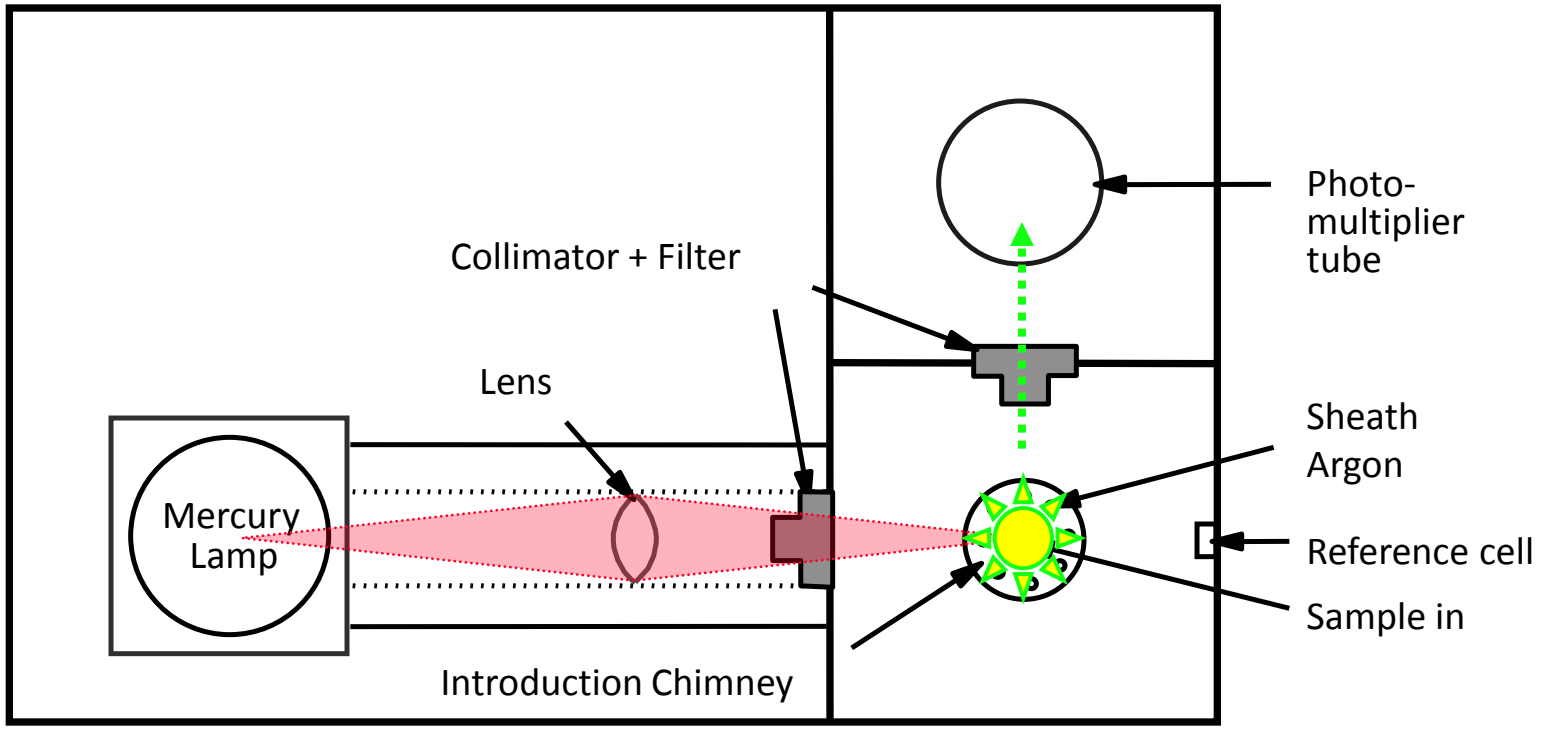
Merlin AFS Optical Configuration Plan View



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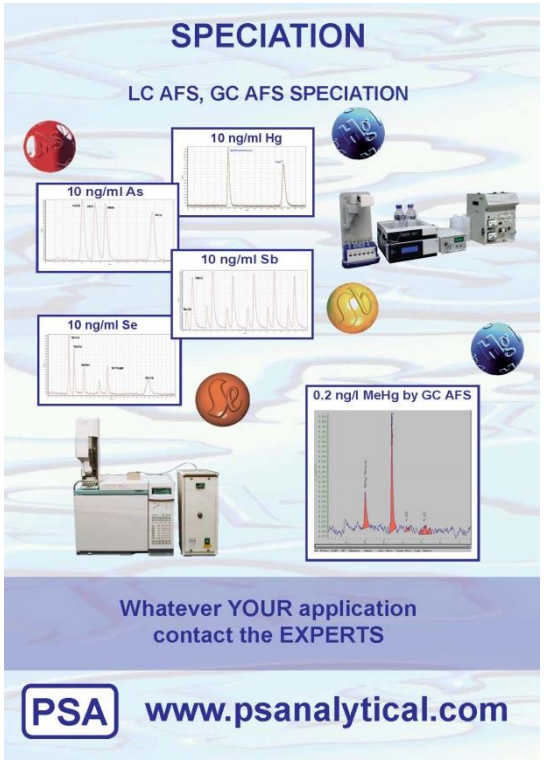
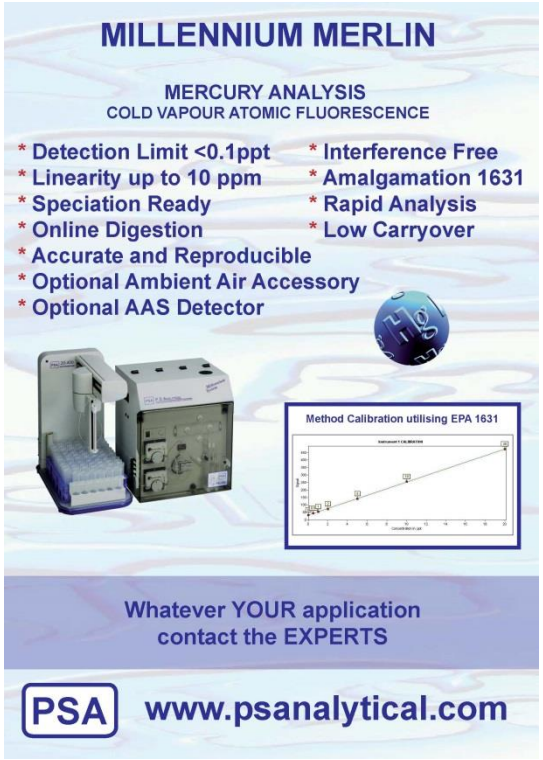
Core Products
Environmental





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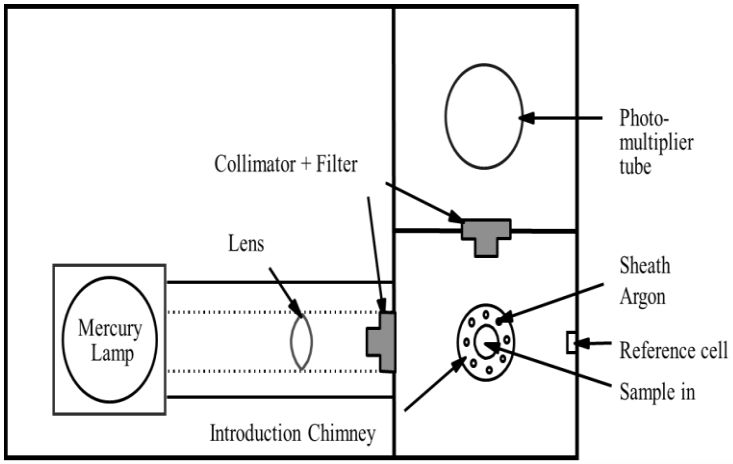
Millennium Merlin – CVAFS and 1631-Hg

- Lab analyser based on Cold Vapour – AFS
- EPA 1631 Method uses gold amalgamation
- Chemical digestion with acidic oxidants
- Stannous chloride reduction of Hg^{2+} to Hg^{o}

$Hg(II) + Sn(II) \rightarrow Hg^{o} + Sn(IV)$

- Automated with 2 min cycle times and optional UV automated digestion
- Detection Limits less than 1 part per trillion. Linearity 5 orders of magnitude.
- No quartz atom cell to avoid carryover between samples
- Suitable for all types of wastewater and plant samples (coal, coke, ash, leachates, gypsum, sorbent traps, impinger solutions etc)



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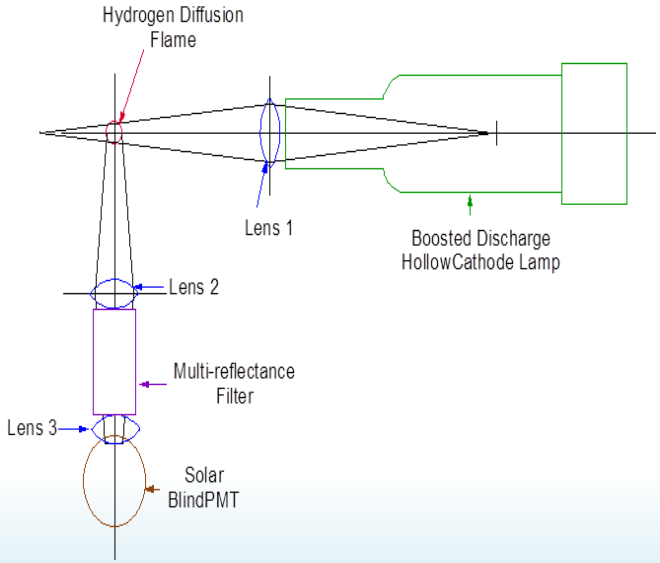
Millennium Excalibur
Hydride Generation AFS – As, Se, Sb

- Laboratory Analyser for As, Se, Sb, Te and Bi Single Element detector defined by lamp.
- Samples require preparation prior to measurement, digestion and conversion to optimal oxidation state
- Automated NaBH4/Acid chemistry to produce gaseous hydrides and hydrogen diffusion flame.

$NaBH_4 + HCl + 3H_20 \quad 8H + H_3BO_3 + NaCl \quad MH_x + H_2$

- Part per trillion detection limits. Linearity to 10ppm. 1 min cycle time. Optional UV auto-digestion and species conversion.
- Lower MDL than ICPMS as less dilution required
- Suitable for all types of wastewater and plant samples (coal, coke, ash, leachates, gypsum, sorbent traps, impinger solutions etc)



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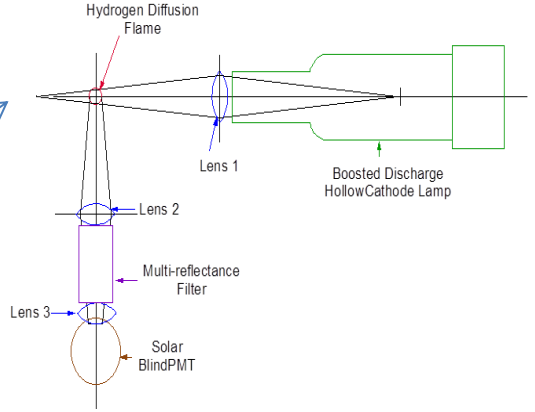
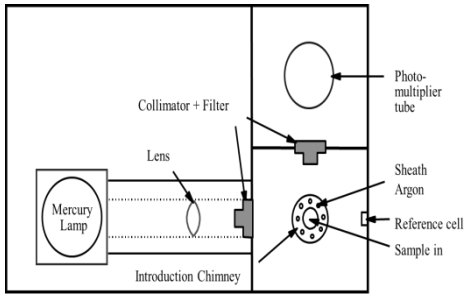
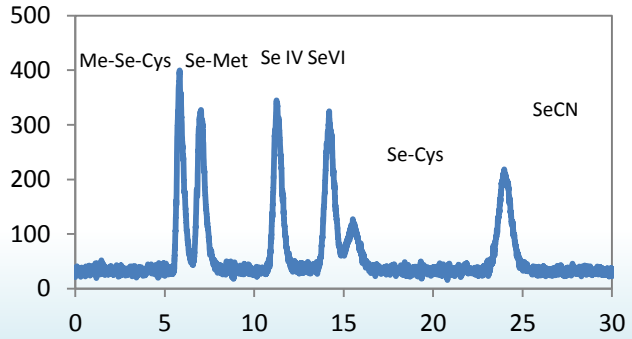
Lab Analysers – CVAFS/HGAFS



Hydride Generation AFS - Se/As/Sb



Cold Vapour AFS Hg



Speciation Se/As/Hg

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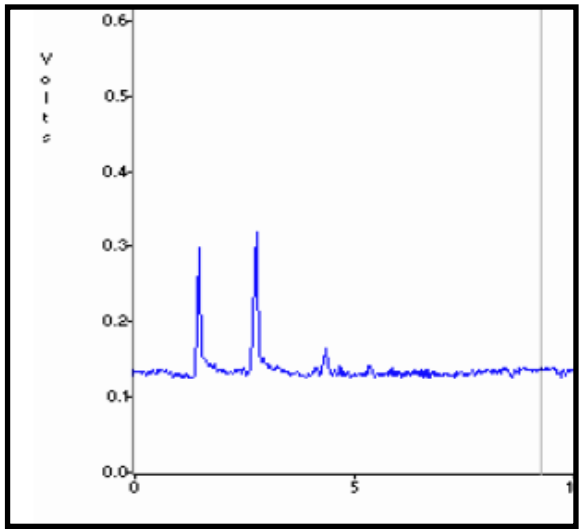
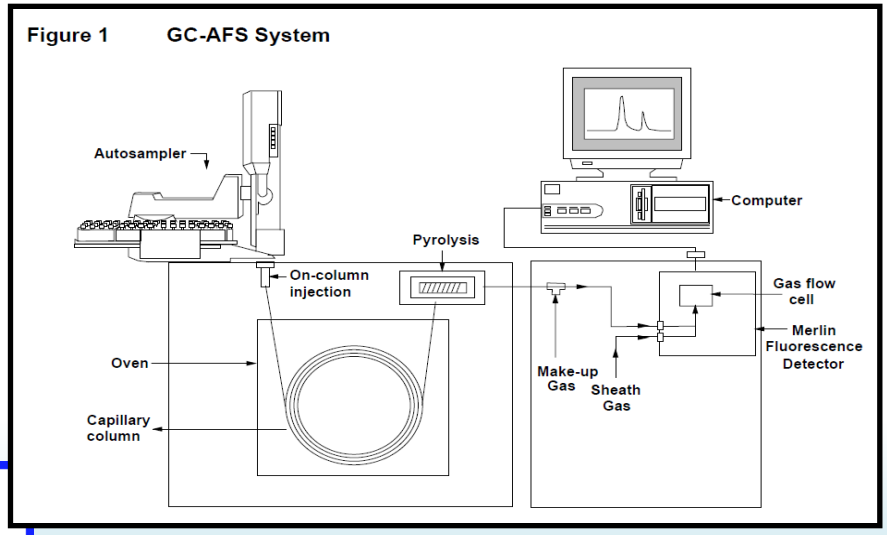
Speciation/Fractionation Studies



Organo- Hg species at 0.1ng/ml



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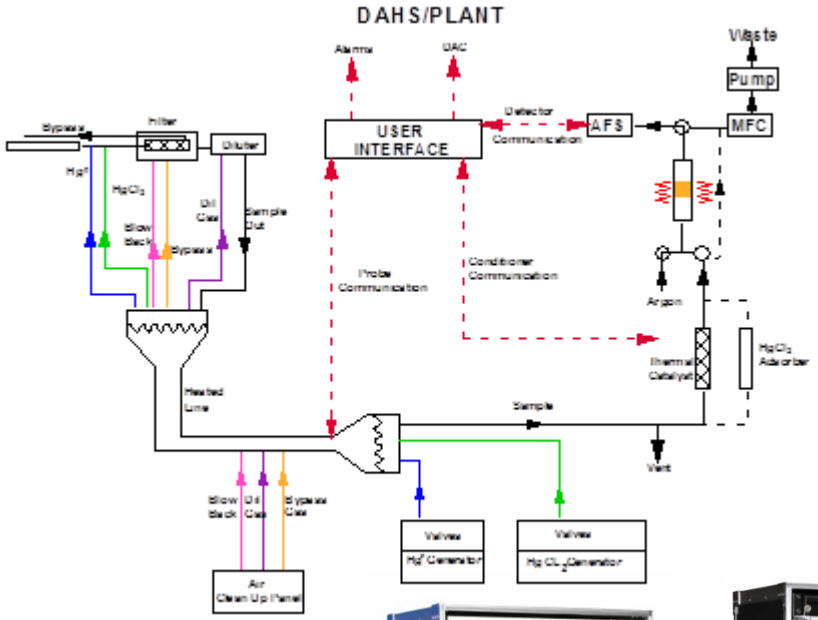
Hg CEM Stack Gas
Typical Configurations



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10.225/10.255 Liquid Online Hg, As & Se

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Core Products
Petrochemicals

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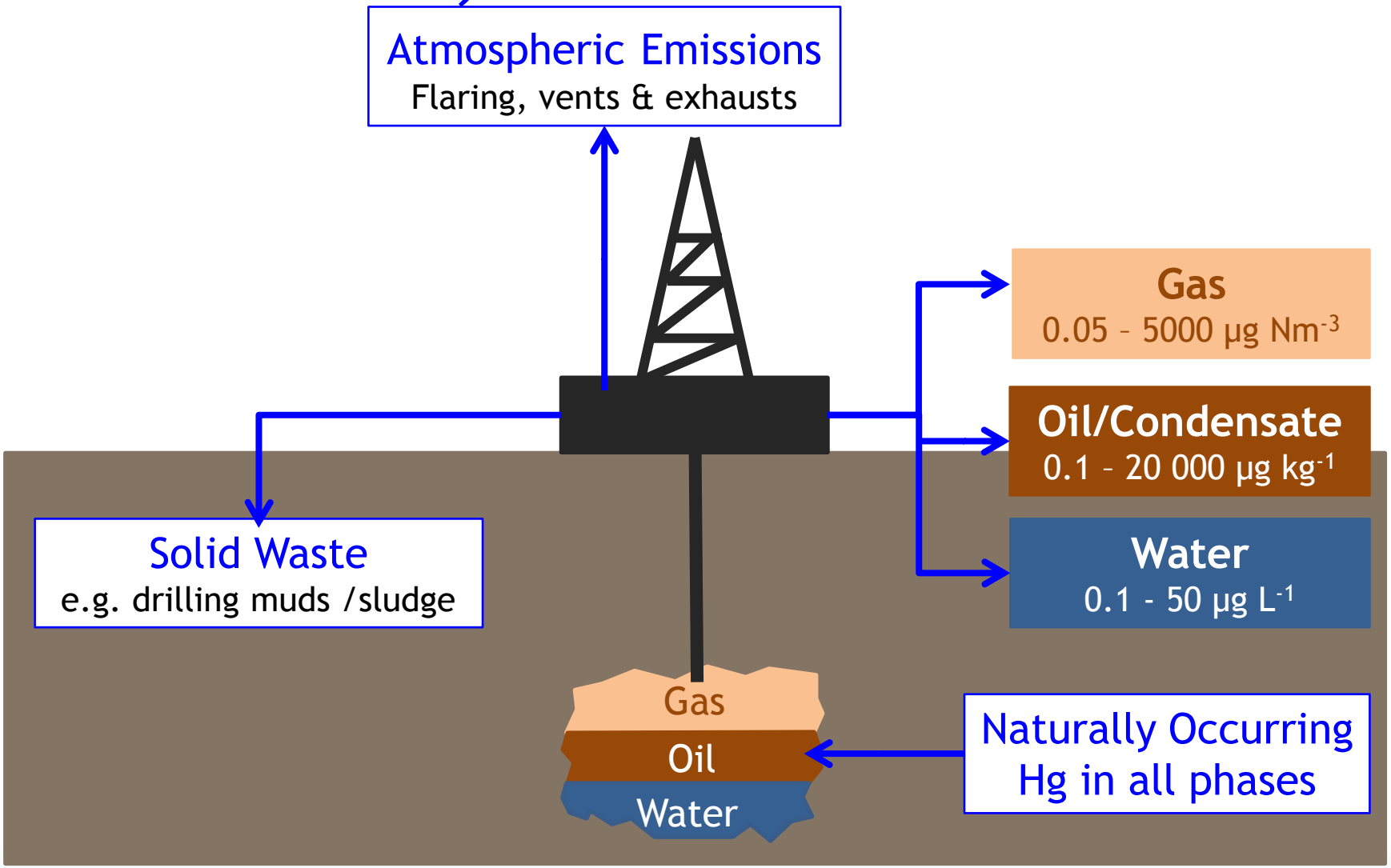
Oil, Gas & Water



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Sir Galahad II (10.525)

For the determination of mercury in a wide range of gaseous media, including;

- ambient air,
- natural gas
- stack gases.

The Sir Galahad is based on amalgamation with atomic fluorescence spectrometry which is inherently more sensitivity than atomic absorption and offers advantages in terms of linearity, accuracy and precision.

ASTM D6350-98(2003) Standard Test Method for Mercury Sampling and Analysis in Natural Gas by Atomic Fluorescence Spectroscopy

This test method covers the determination of total mercury in natural gas streams down to 0.001 µg/m^3. It includes procedures to both obtaining a representative sample and the atomic fluorescence detection of the analyte. This procedure can be applied for both organic and inorganic mercury compounds.

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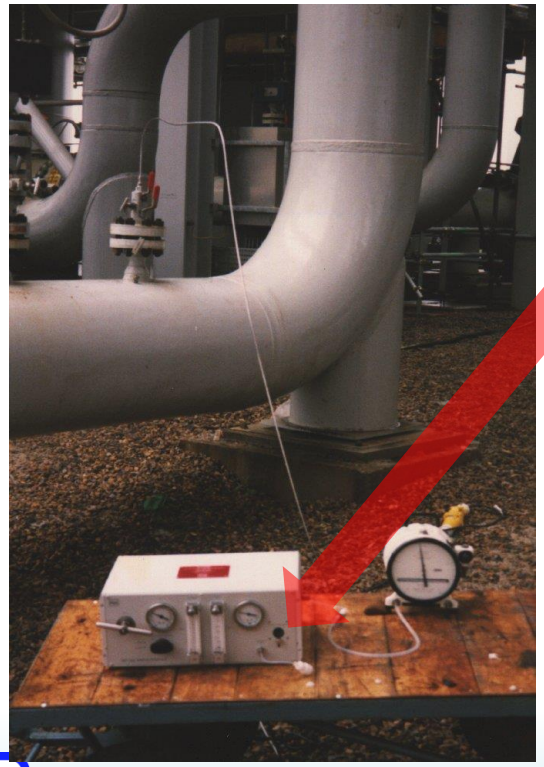
Hg in Process Gases - Sampling and Analysis

At line gas sampling – up to 3000 psi



- Sample is swept over this trap in gaseous form
- Traps all forms of Hg
- Can trap in excess of 82mg of Hg
- Can be used at elevated temps
- Low cost and Reusable

Analysis on the bench
Sir Galahad II

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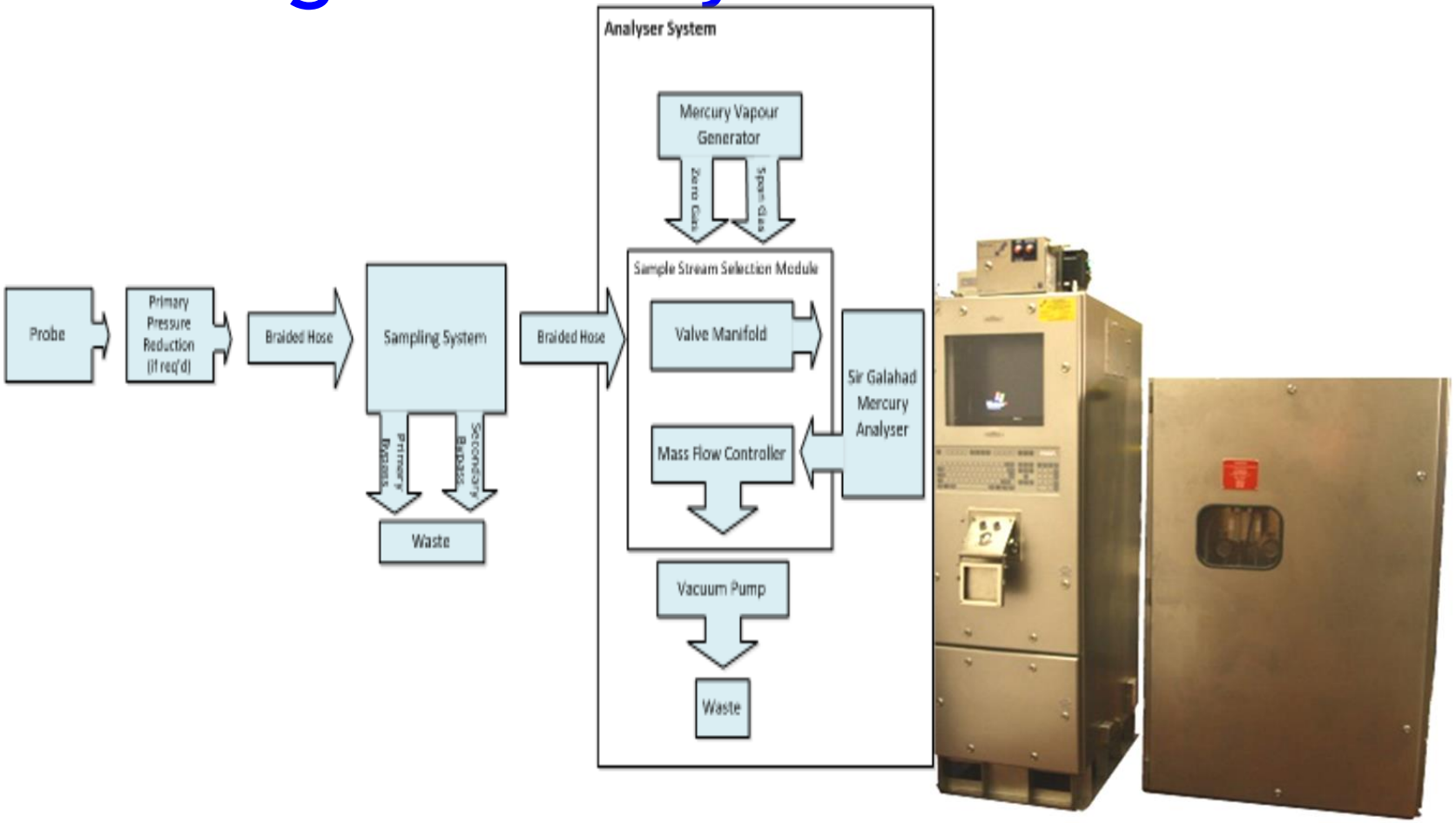
Online Mercury Analyser for gaseous Hydrocarbons



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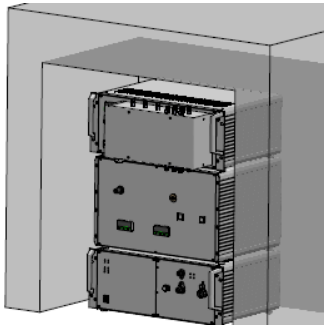
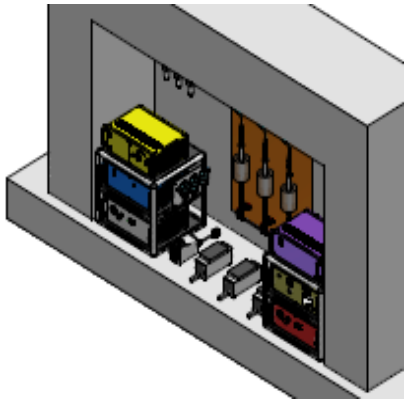
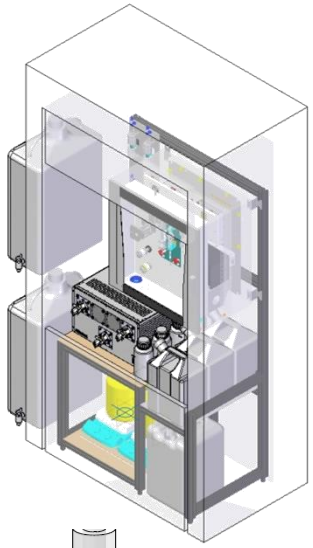
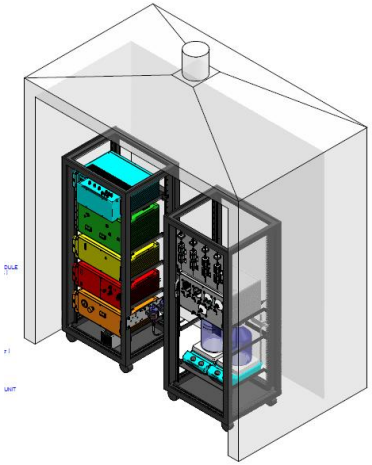
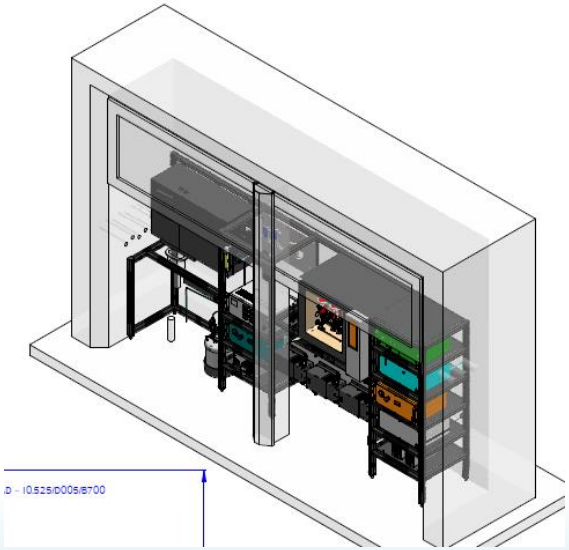
Core Area – Bespoke systems

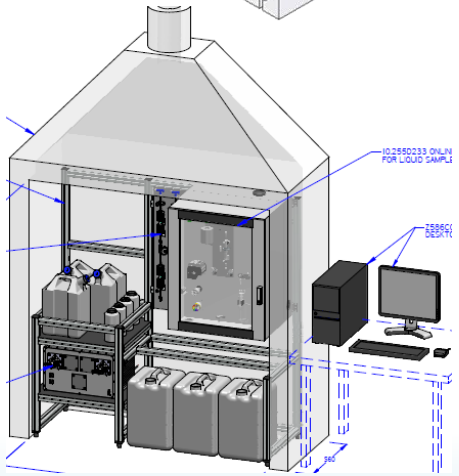












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Introduction

- PSA's experience providing bespoke analyser/test systems
- Examples of some laboratory test systems we have done.
- Discussion of what is possible.

Designing and providing an analyser system that meets the client's expectations and requirements

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Gas Test Bed System

- Designed to fit in client's walk in fumehood
- High concentration mercury feed
- 14 sample points (4 with dilution)
- Two bed trains with flow control/pumps etc

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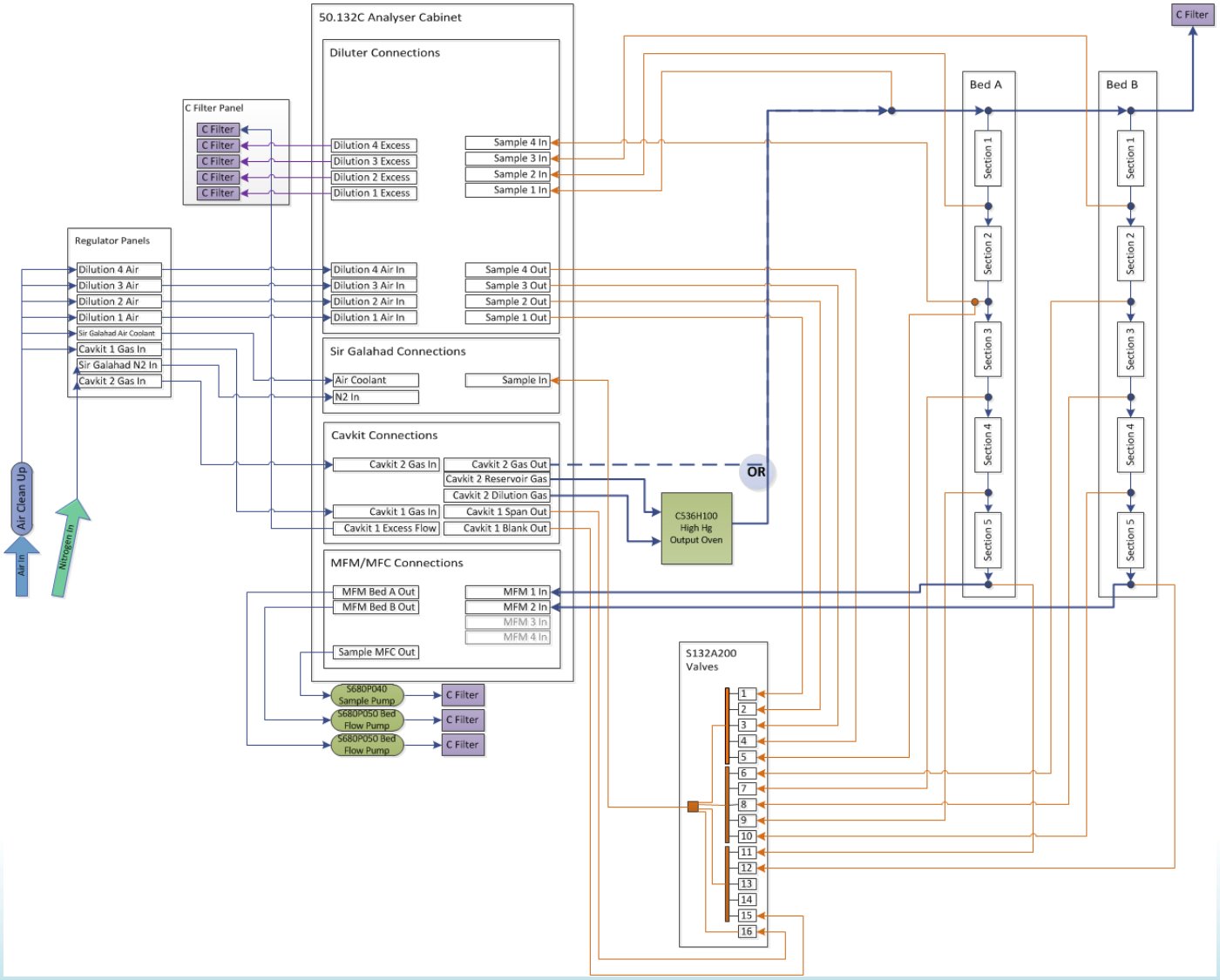
Gas Test Bed System Schematic



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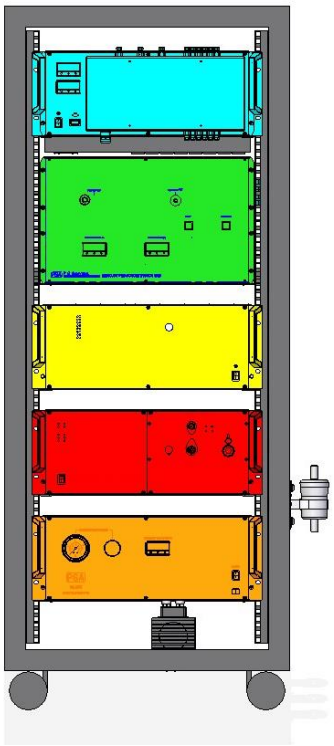
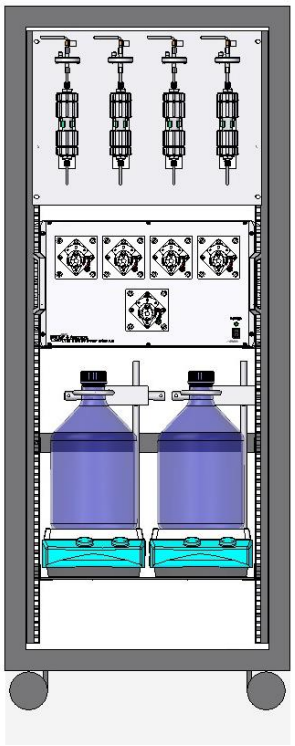
Hg in Liquid Hydrocarbons





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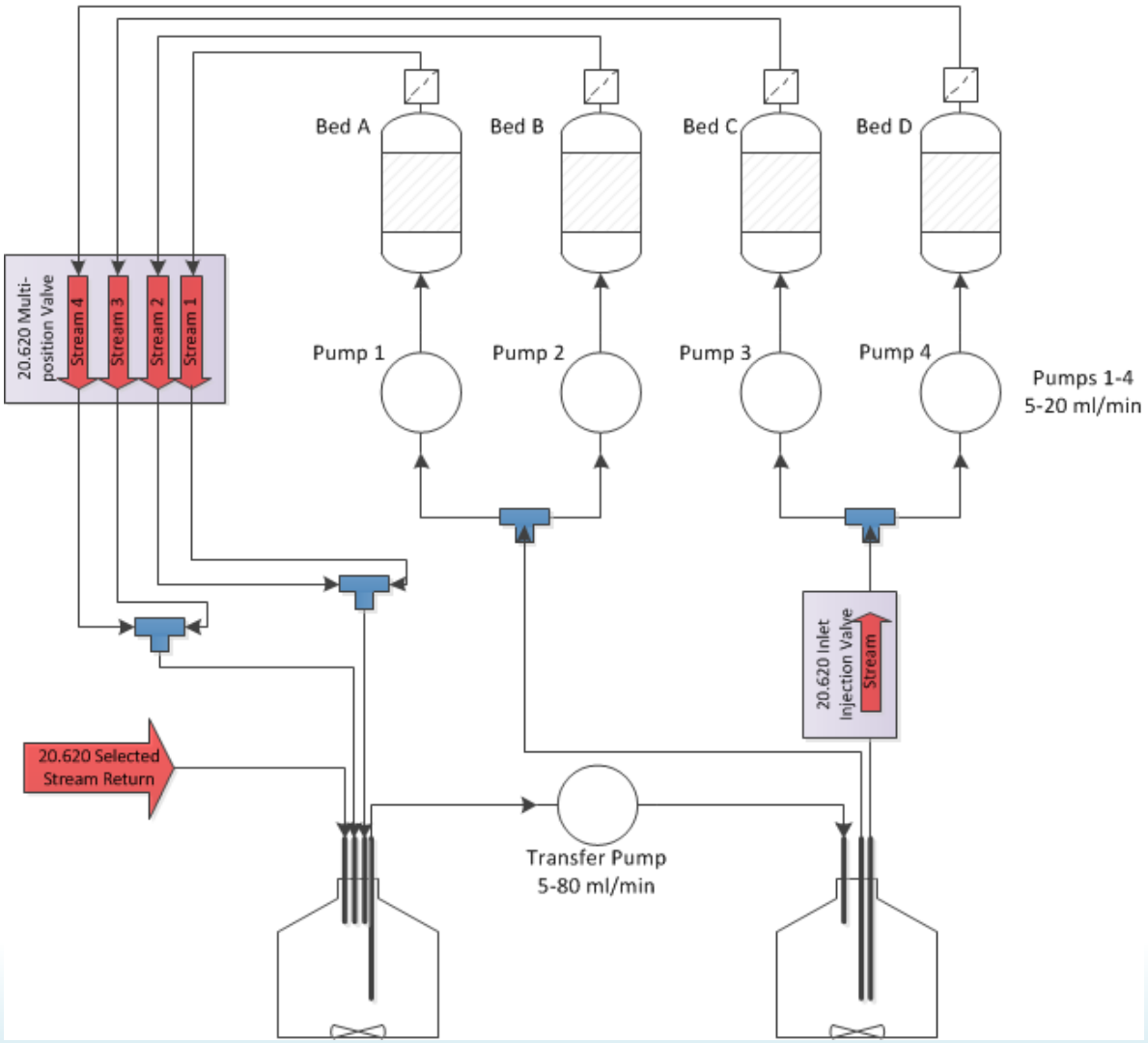
Hg in Liquid Hydrocarbons



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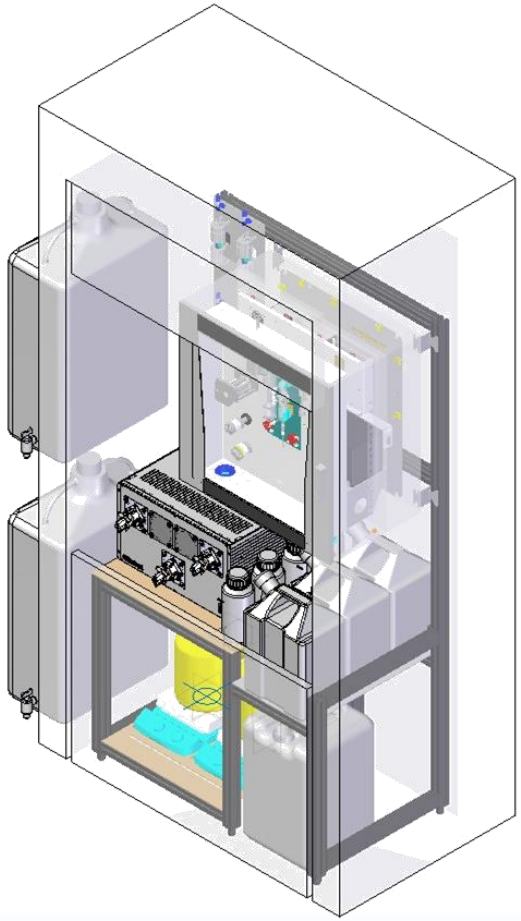
Hg in Aqueous Systems



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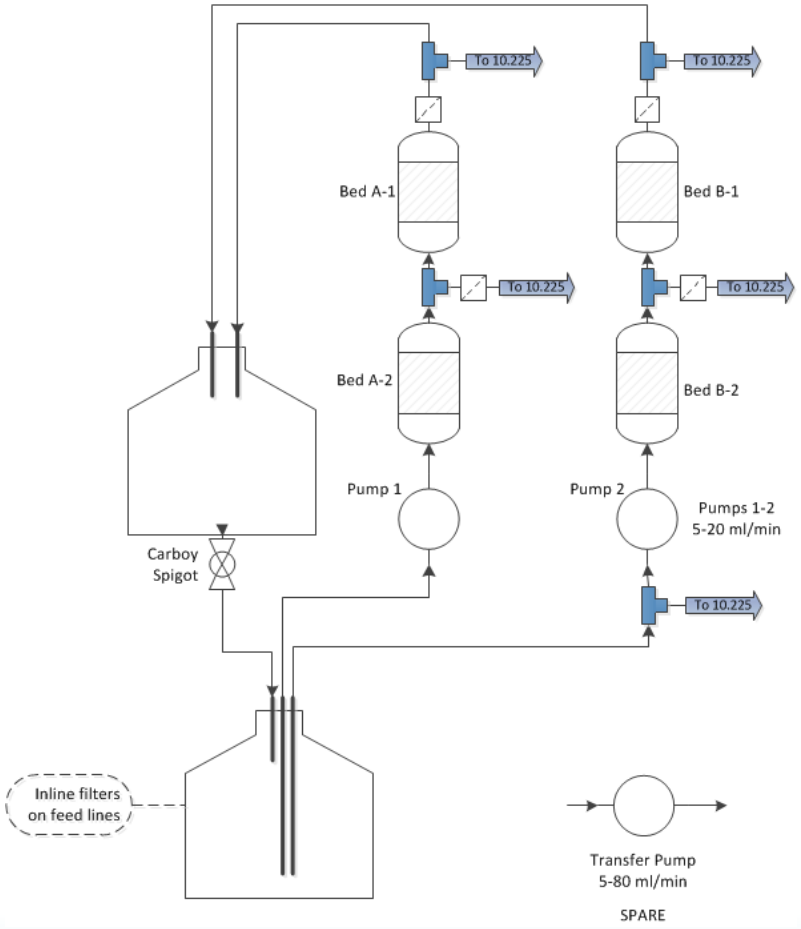
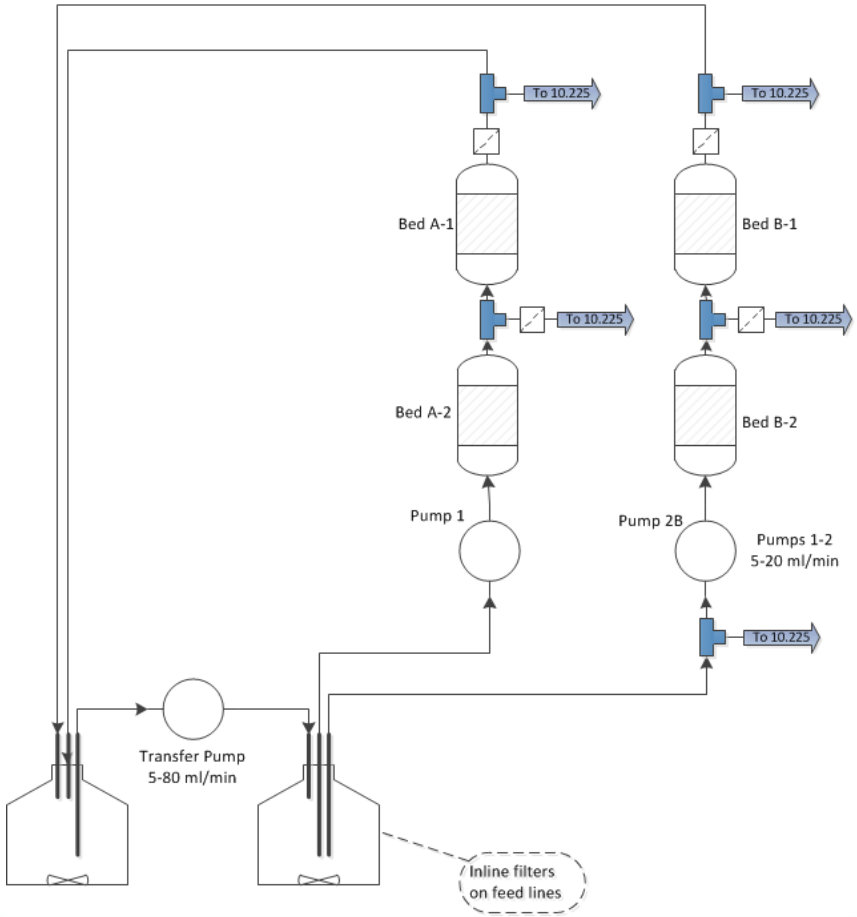
Hg in Aqueous Systems





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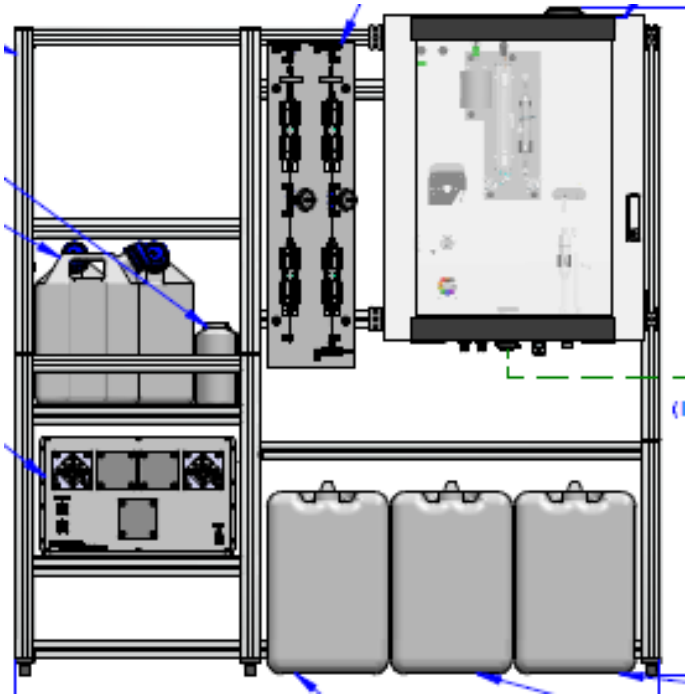
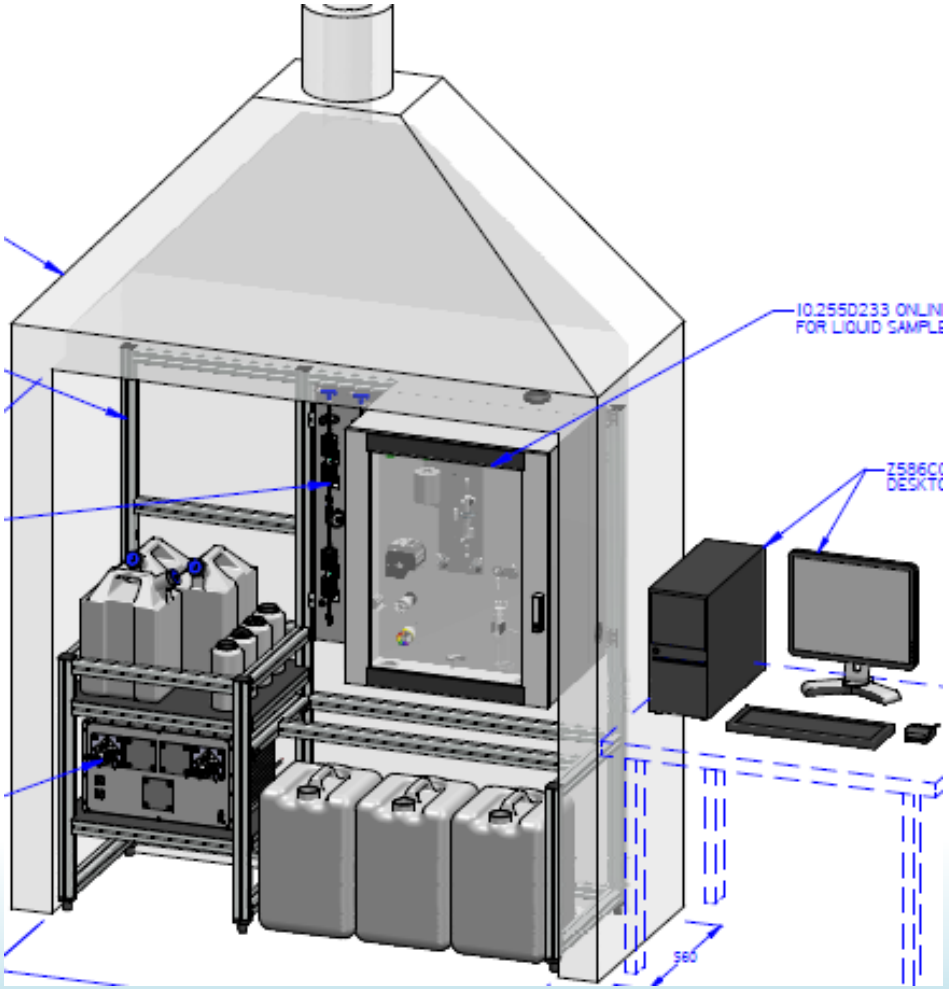
As, Se and Sb in Waste Water Streams





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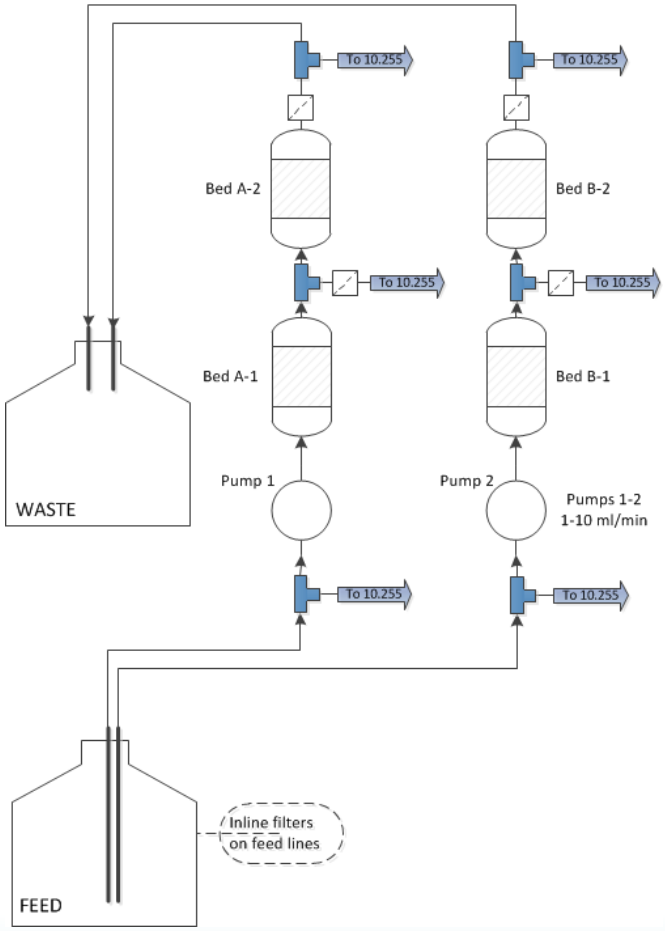

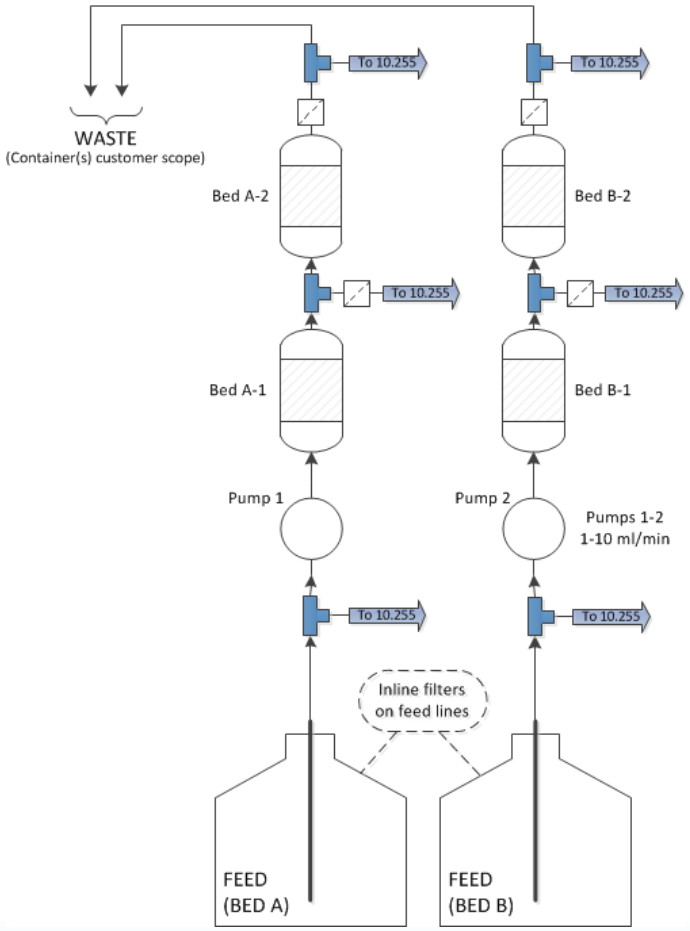

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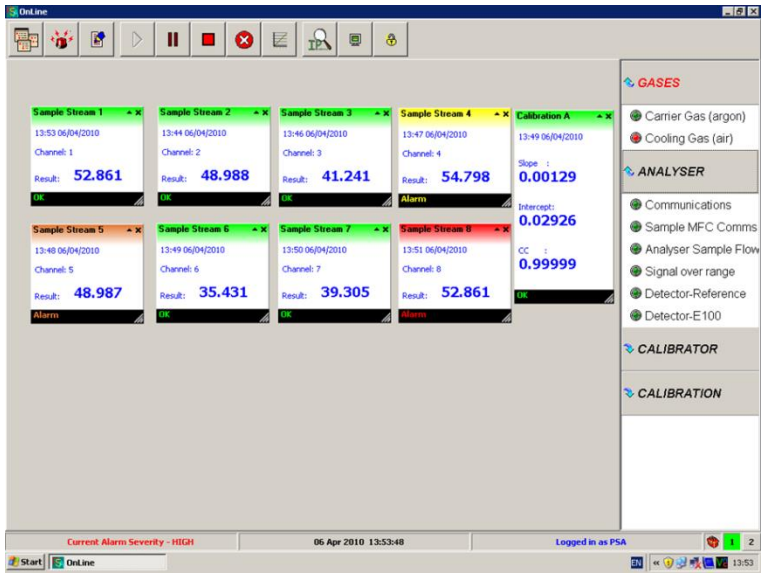
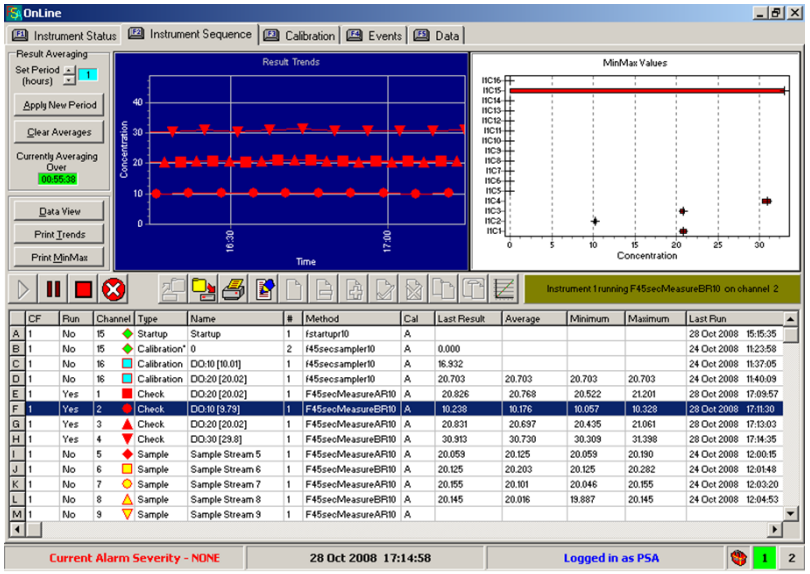
PSA Online Software

- Proven platform for online automation
- Configurable to provide what the customer needs
- Capable of upgrade as and when required

PSA OnLine Process Control Software





- Full instrument control
- Highly configurable
- Simple user interface
- Alarm and result outputs by digital and analogue methods

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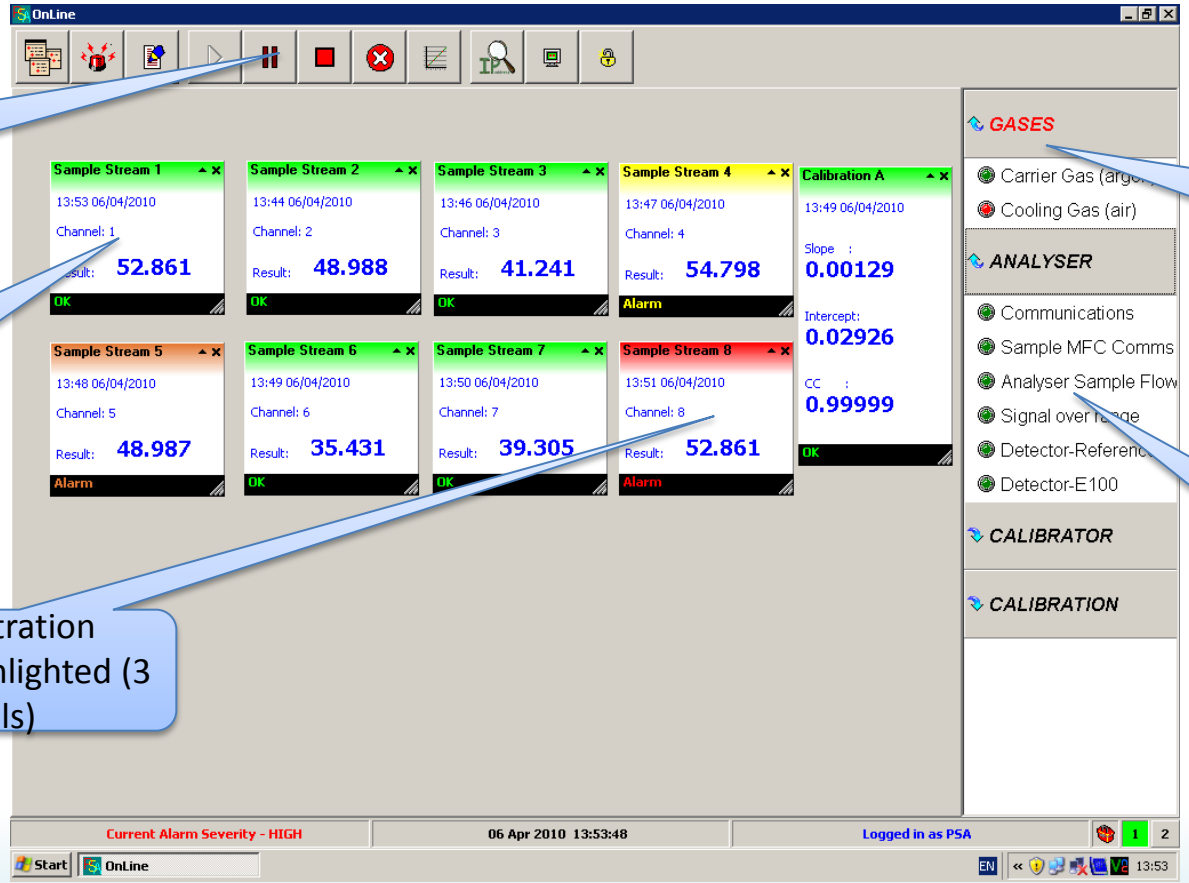
PSA OnLine
Primary User Interface



Basic Analyser Controls

Panels showing Results

Concentration Alarms Highlighted (3 levels)

Active Alarms Highlighted

Grouped Alarms Display

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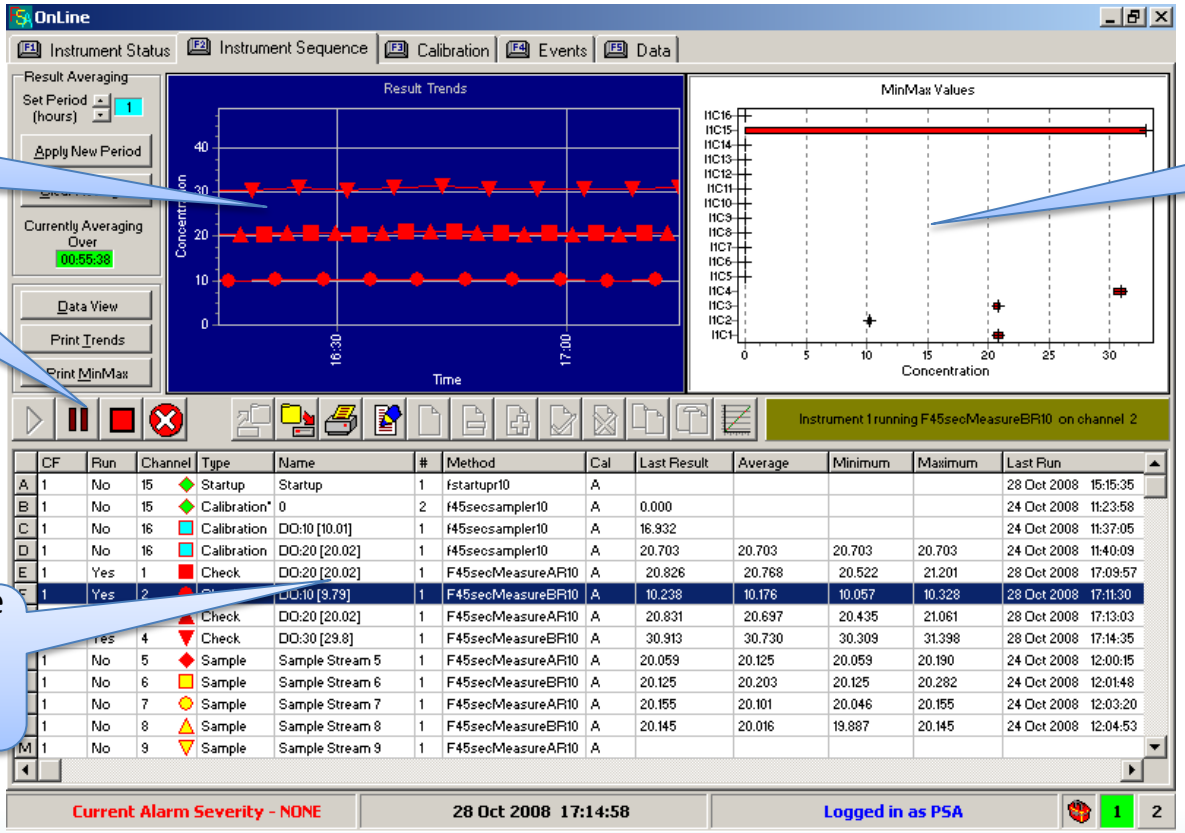
PSA OnLine
Instrument Sequence Tab



Results Trend Graph

Basic Analyser Controls

Configurable Instrument Operating Sequence

Result Min/Max Display

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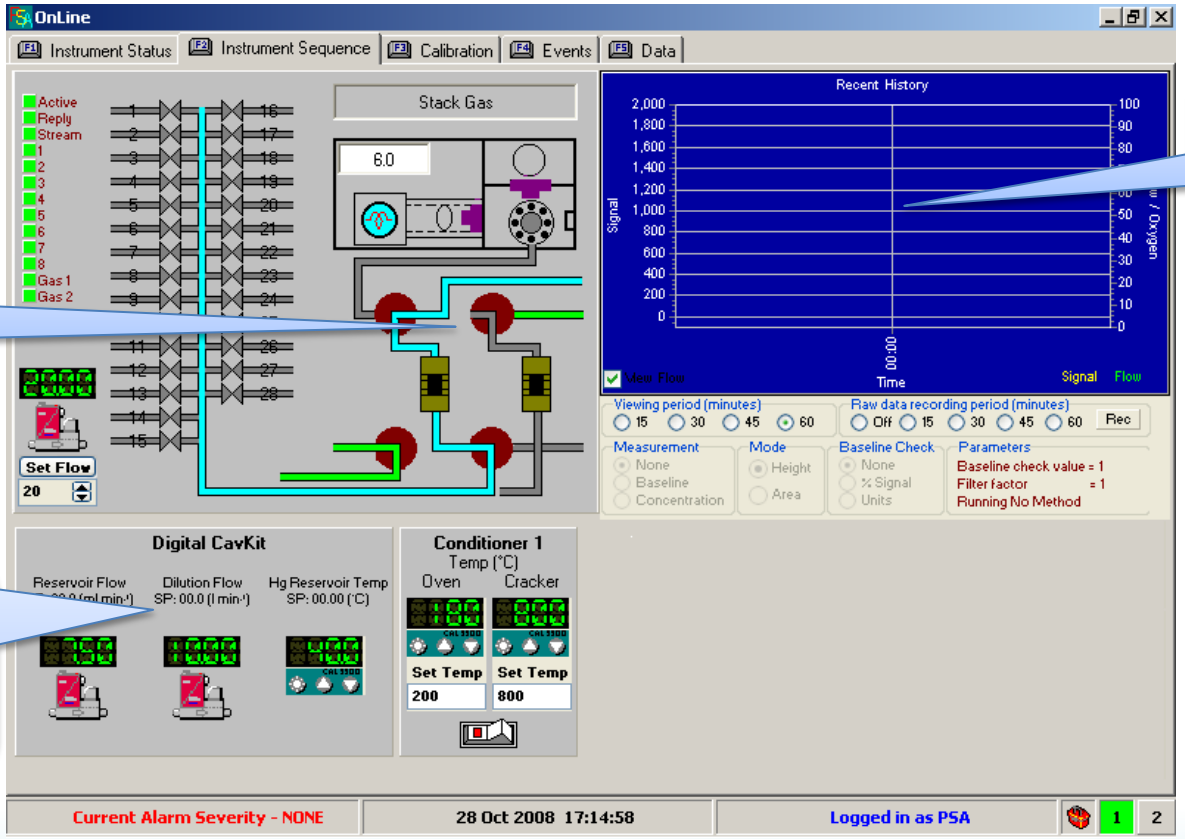
PSA OnLine
Instrument Status Tab



Analyser Mimic

Raw Detector Output Graph

Sampling System & Calibrator temperature s & flows

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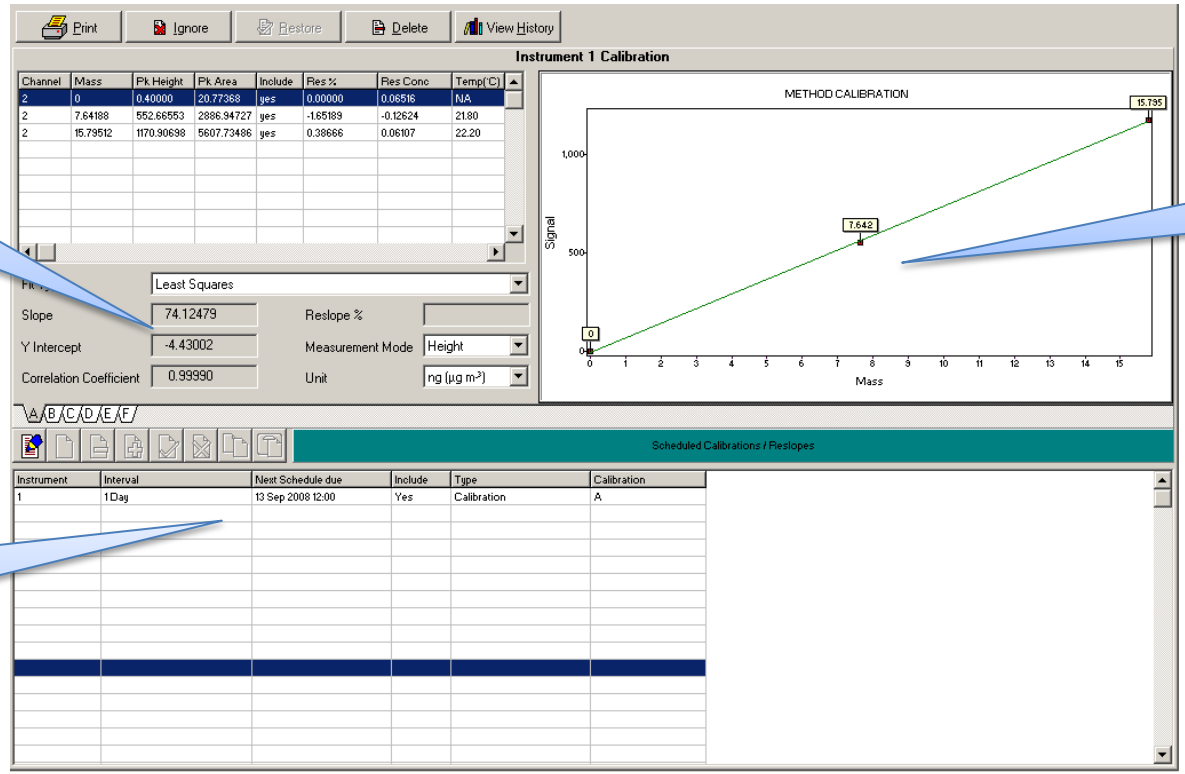
PSA OnLine
Calibration Tab



Calibration Curve Parameters

Calibration Graph

Calibration Schedule

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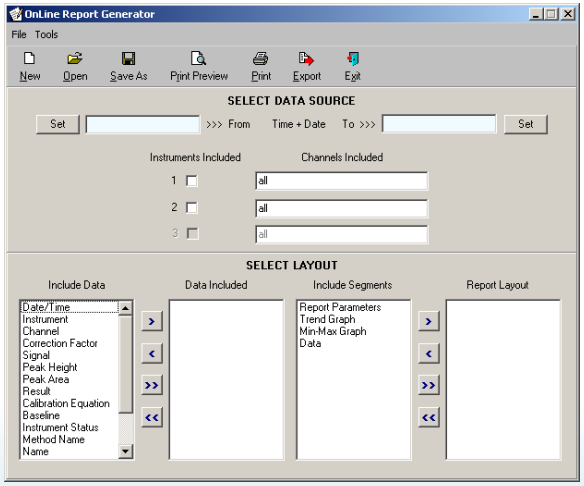
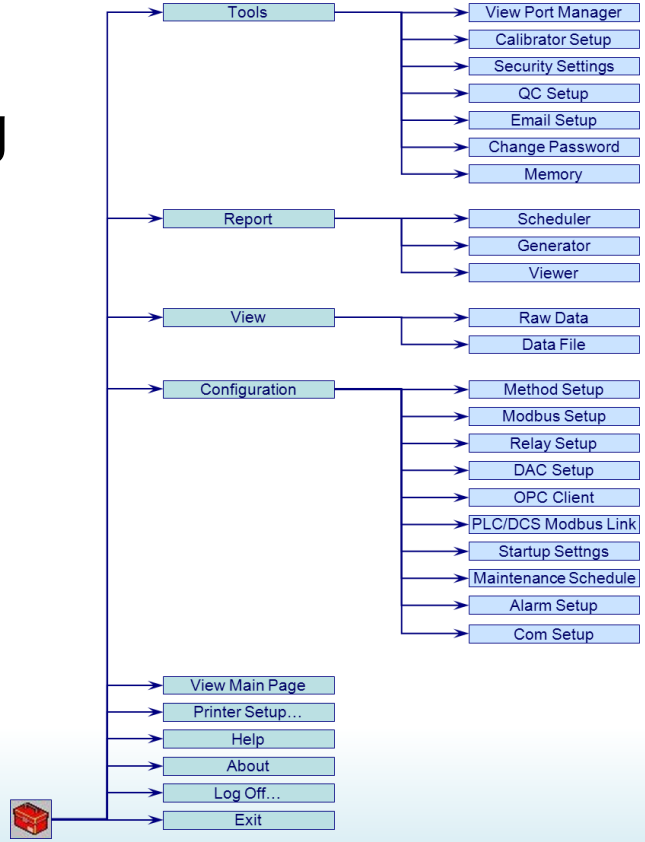
PSA OnLine
Other

- Results Tables/logs
- Events display/log
- Maintenance Scheduling
- Report Generation:



Menu Structure:



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PSA Online Systems

- Review of some typical configurations
- Some Typical data

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Online Mercury Analyser for Hydrocarbon Gases

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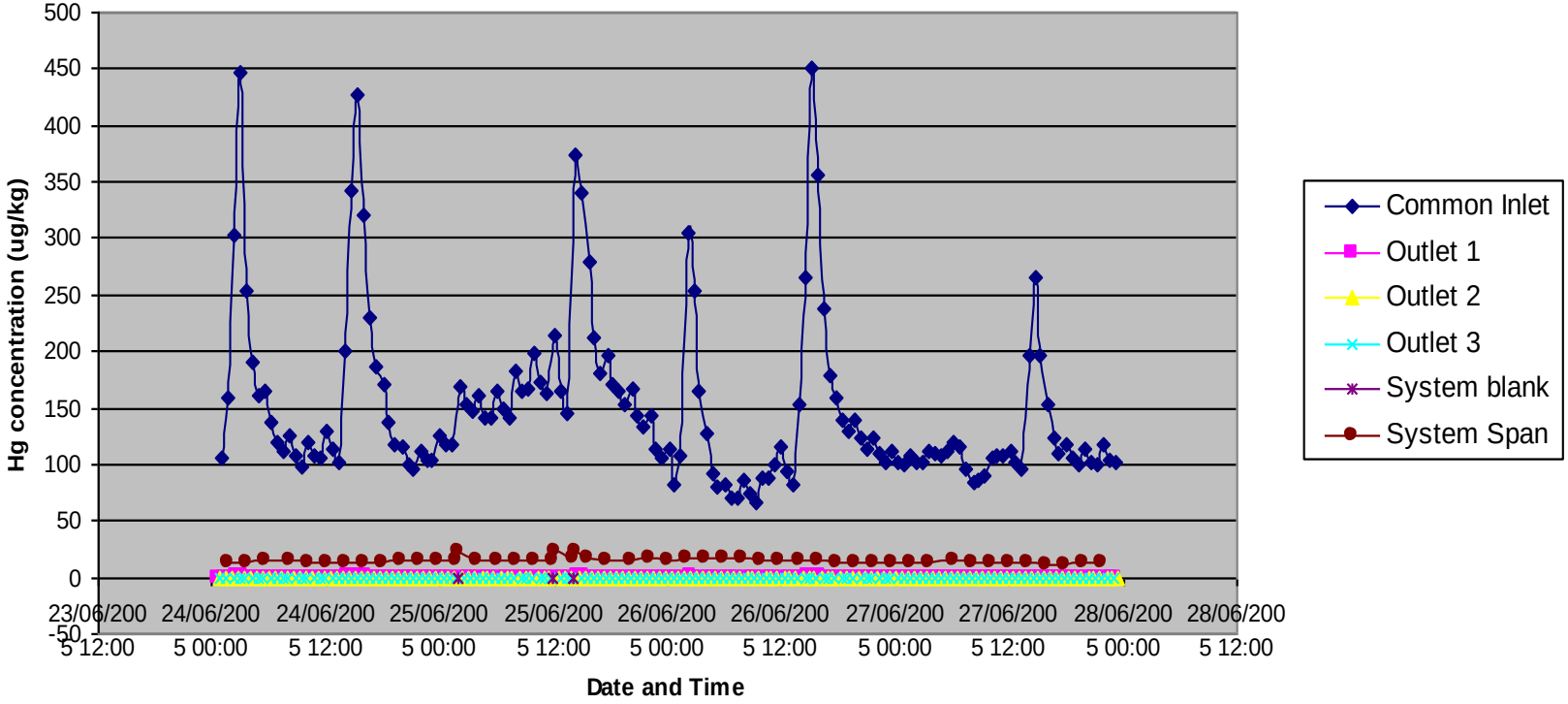
Online Determination of Mercury in LNG



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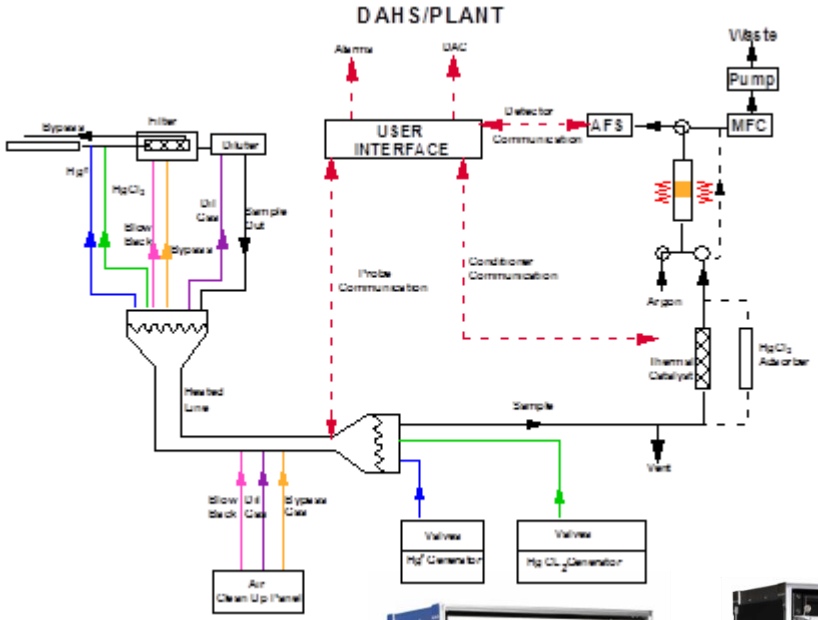
Hg CEM Stack Gas
Typical Configurations



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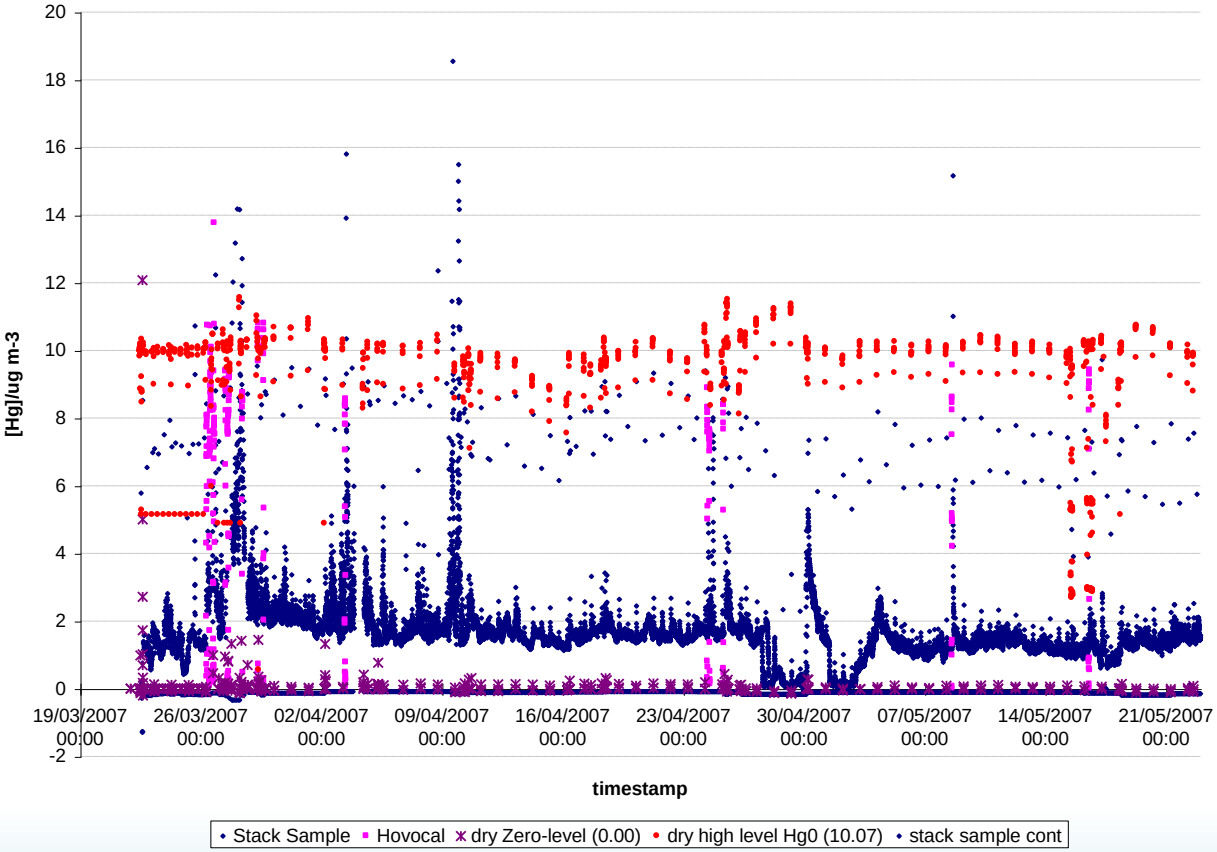
A Power station in Kentucky
Typical long term data – Wet scrubber site



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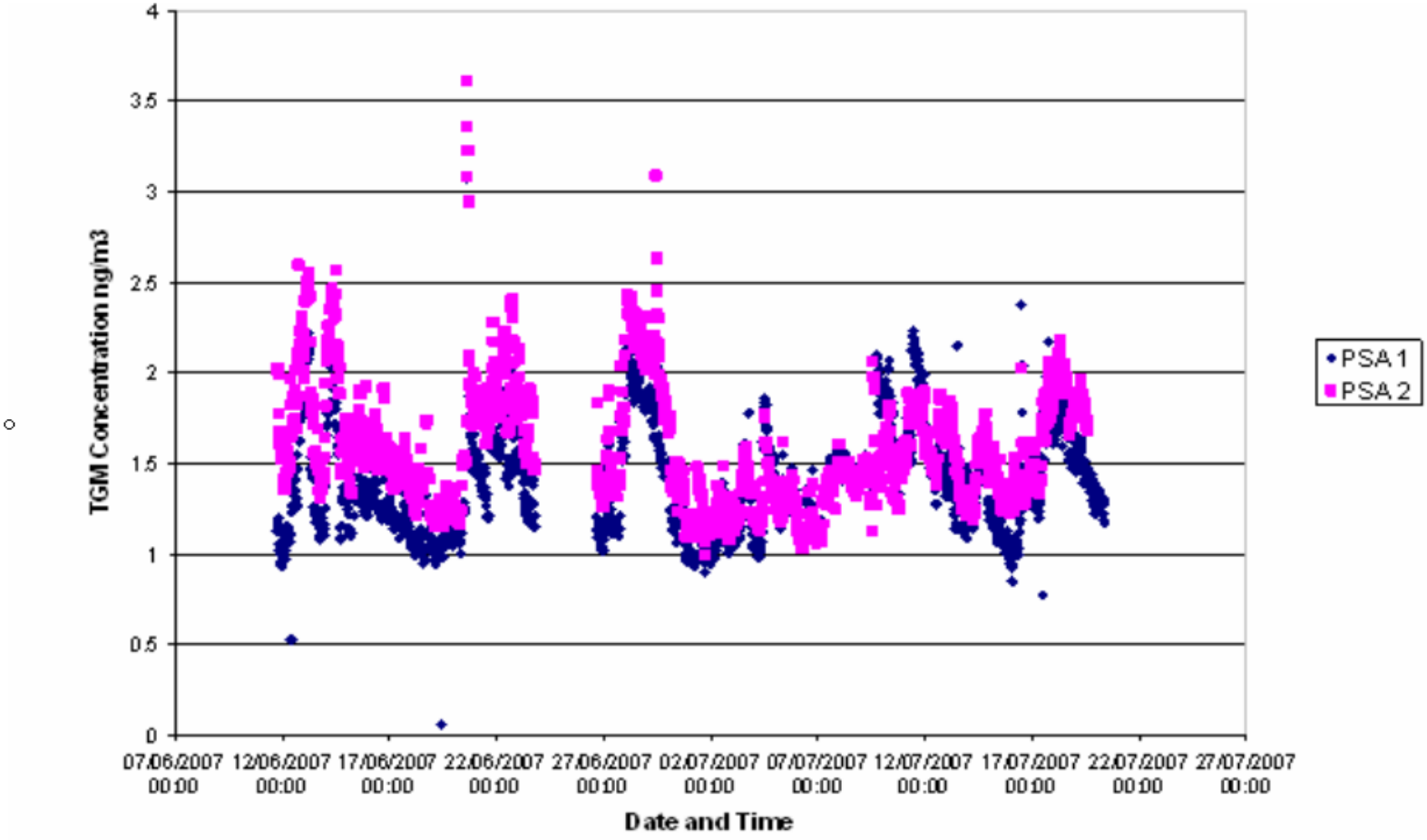
Parallel TGM in air from Sir Galahads Online 2 month period – Sweden Coastal Site



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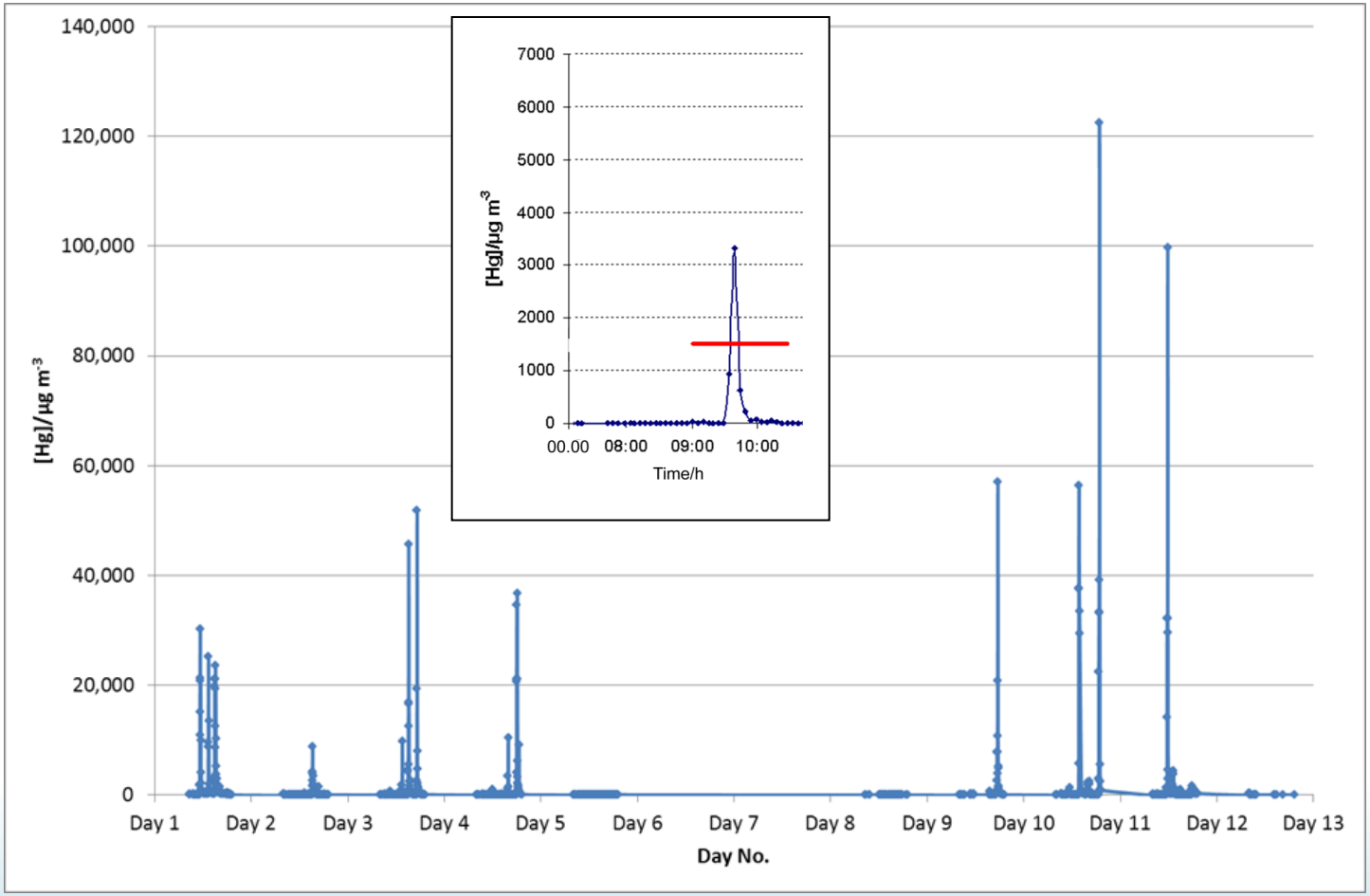
Data from Crematorium in UK



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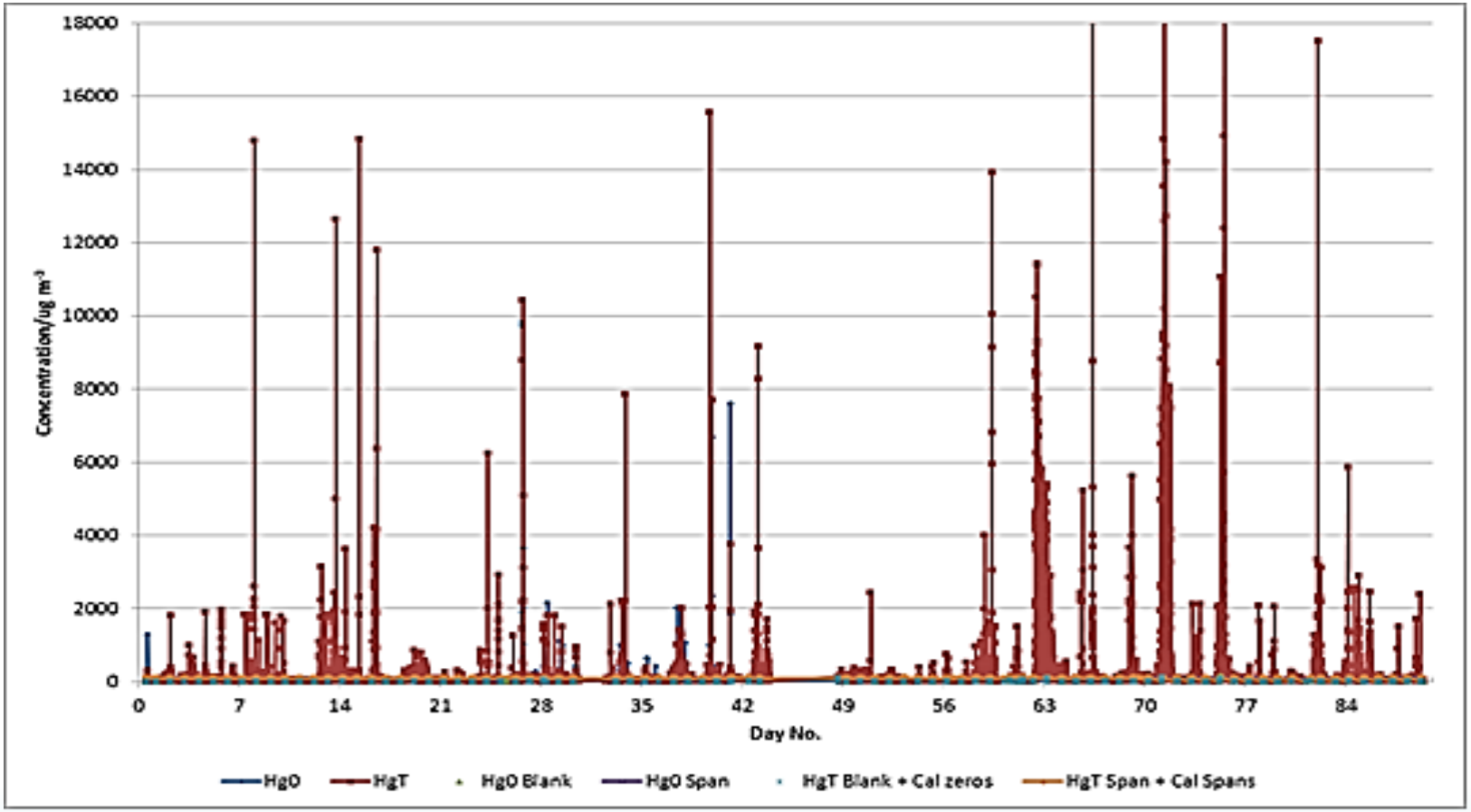
Waste Incinerator



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Online Hg in Liquid Hydrocarbons

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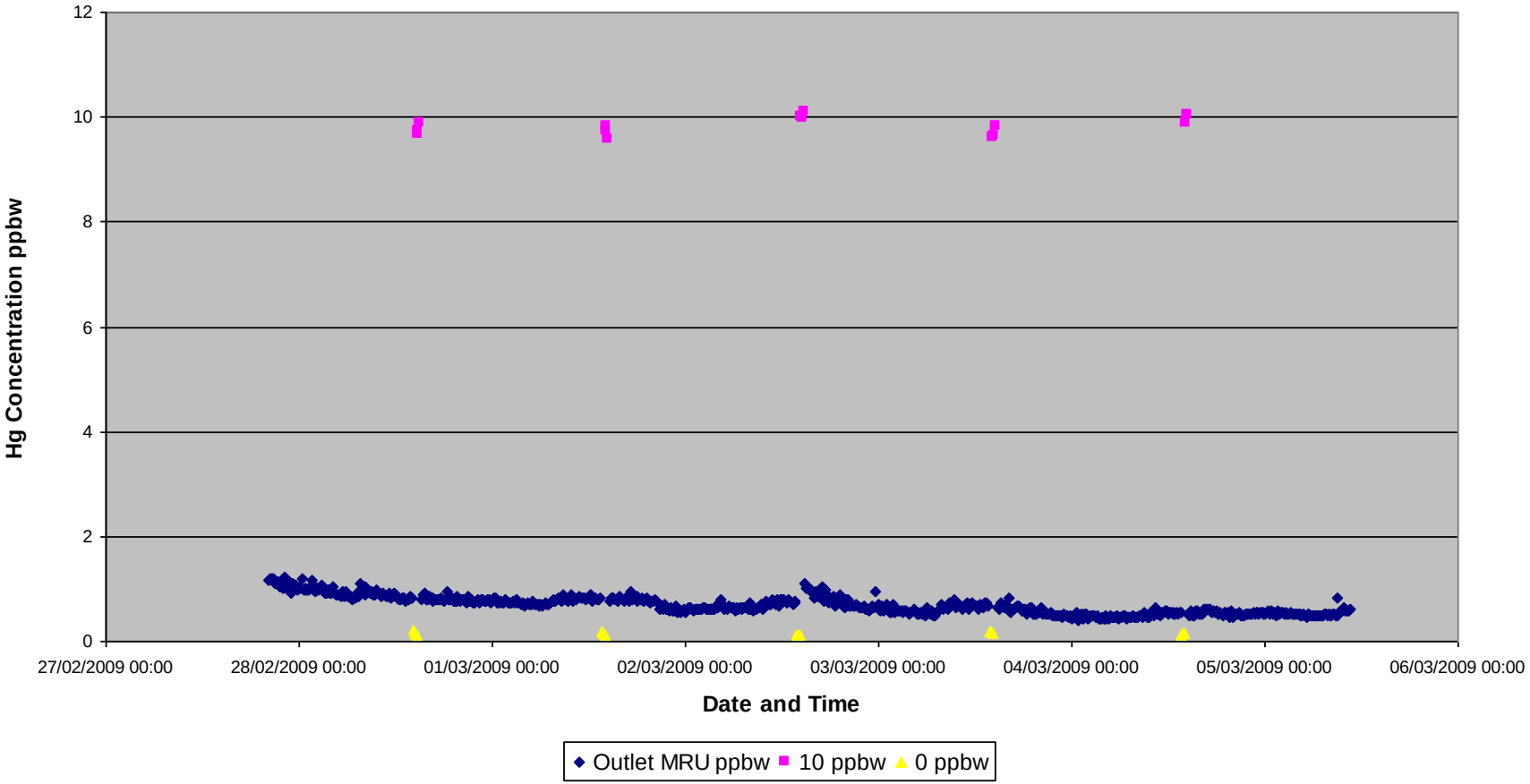
Online Hg in Naphtha Results from MRU with Zero and 10ppbw Conostan Span Checks



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10.225/10.255 Liquid Online Hg, As & Se

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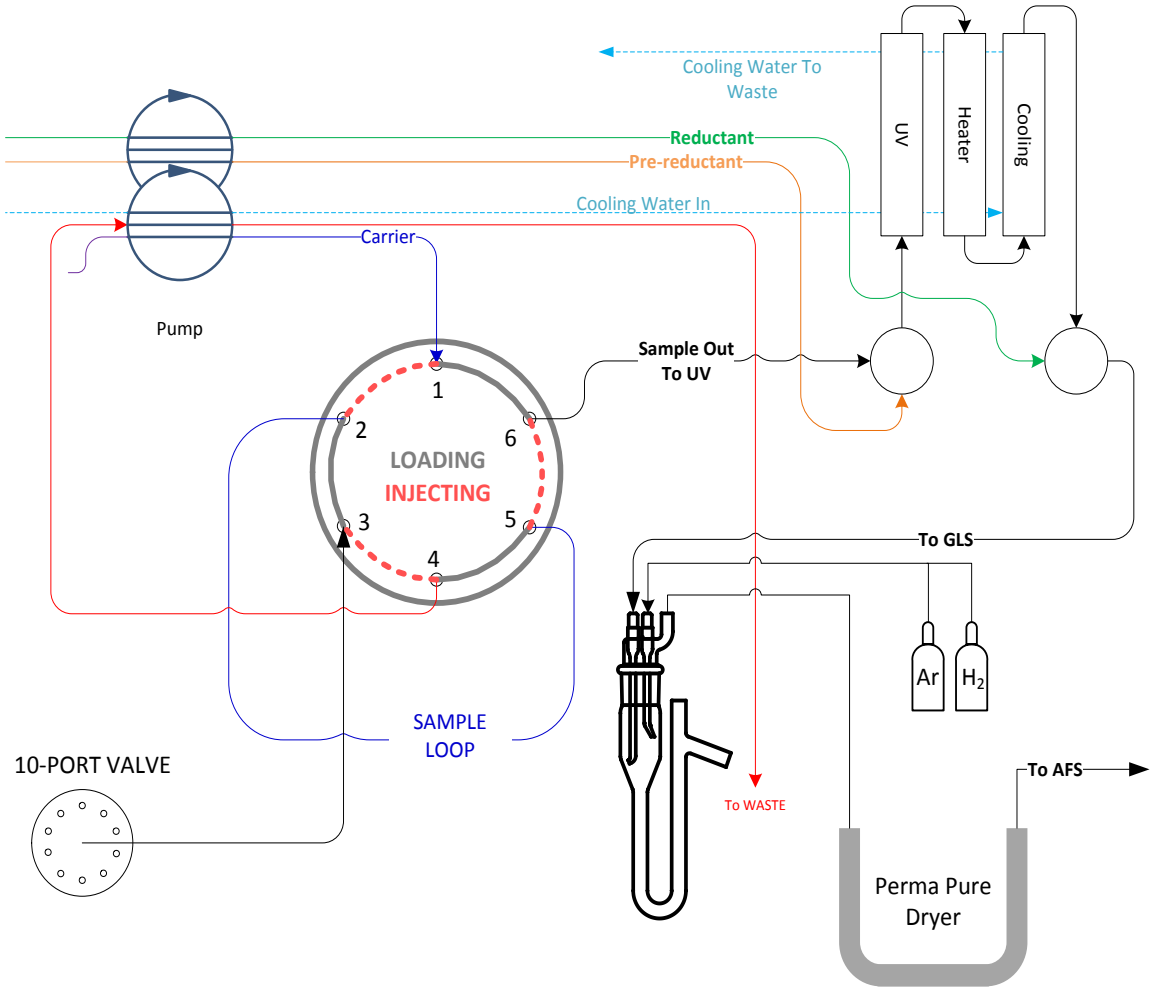
Schematic Diagram of Online Systems



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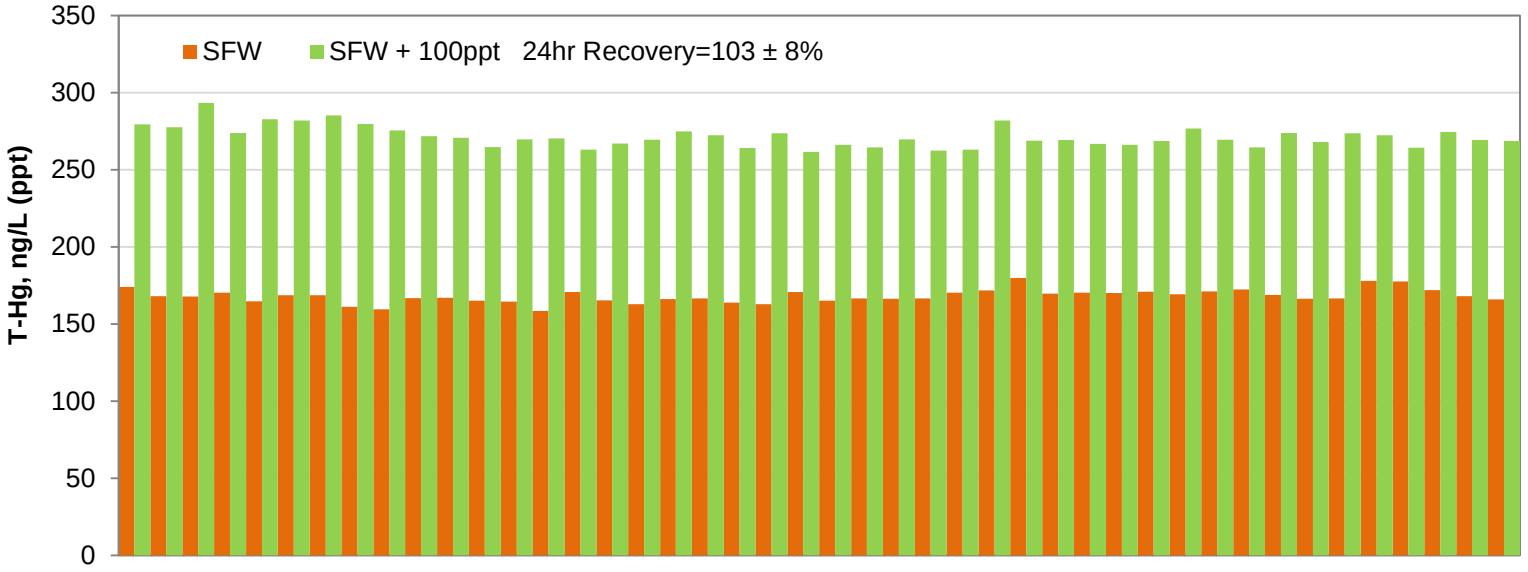
T-Hg in Synthetic FGD Wastewater



LOD based on 10 FIA measurements with 100 microliter injection

LOD (3σ), ppt	6.6

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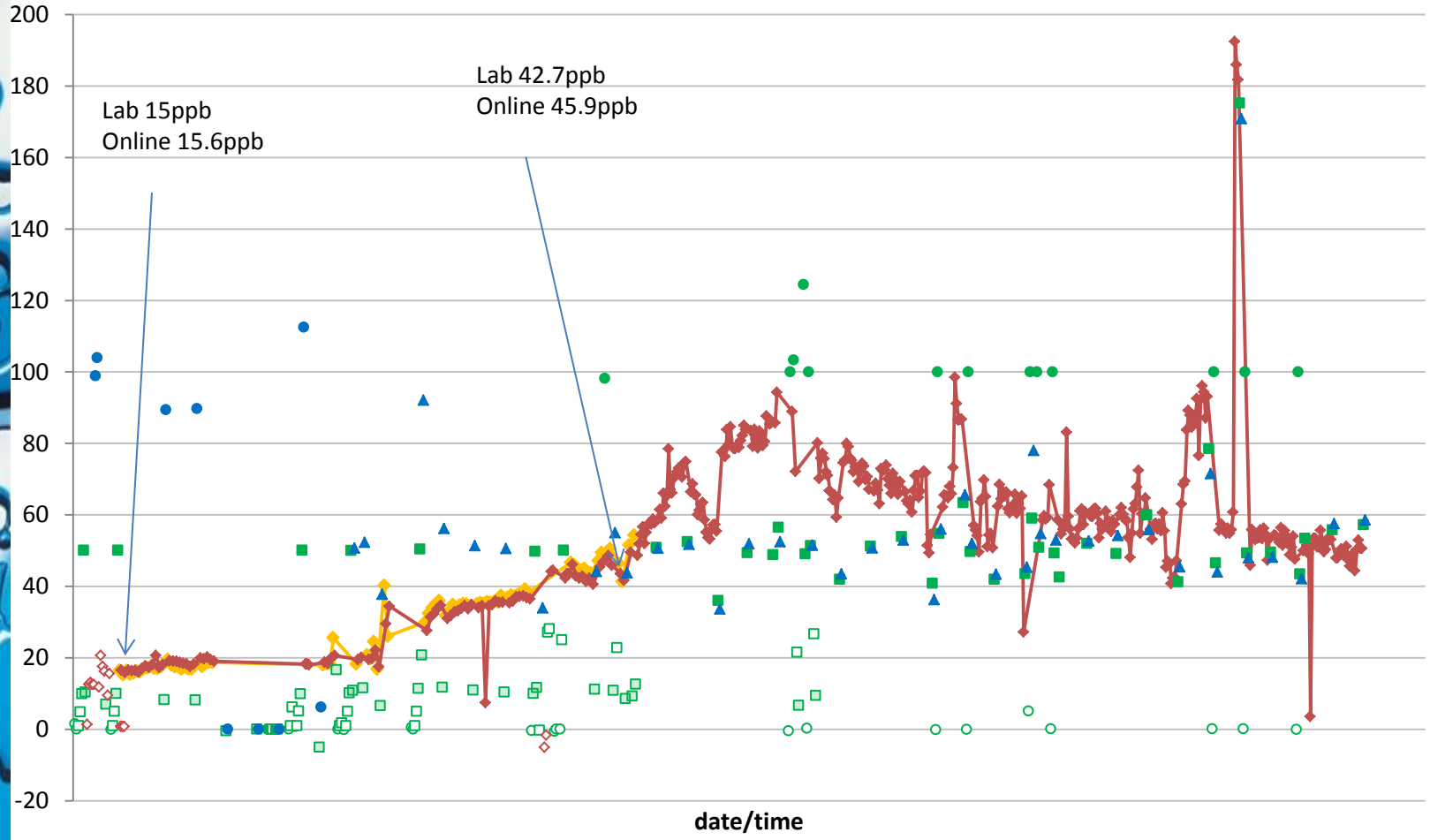
Online Selenium



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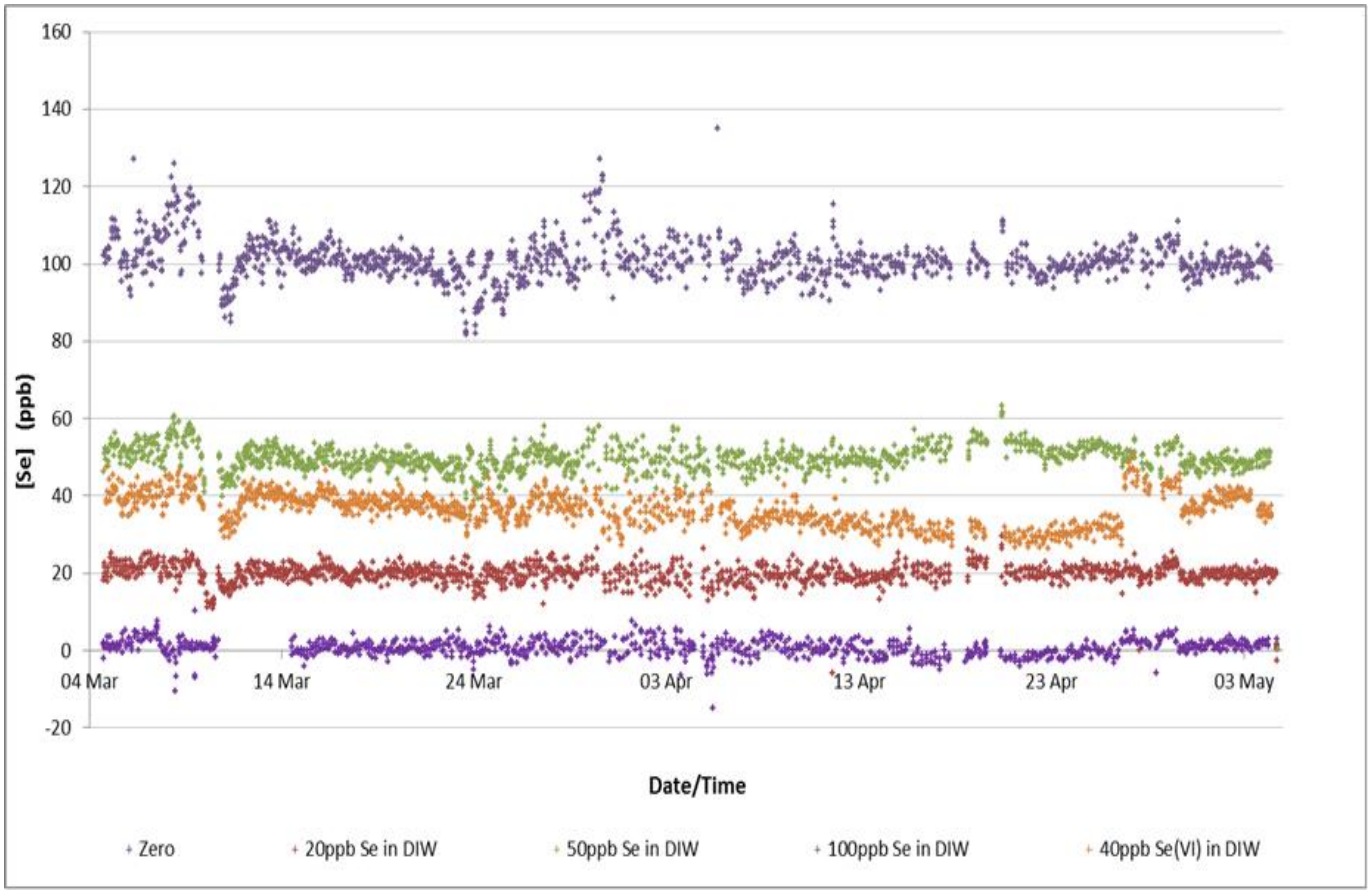
Two months operation with daily calibrations operating with same peristaltic pump tubing, reagent top up every 2 weeks.



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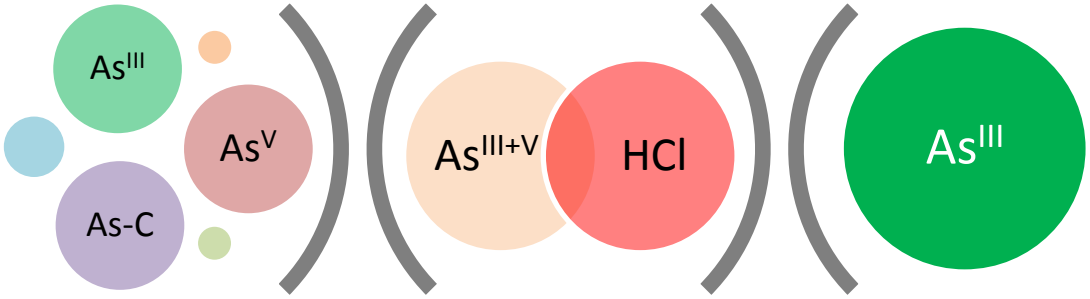
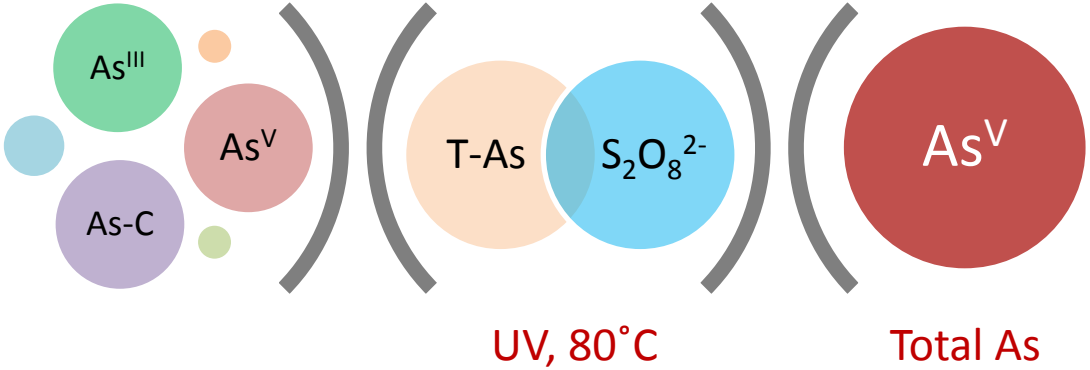
Chemistry – Online As analysis





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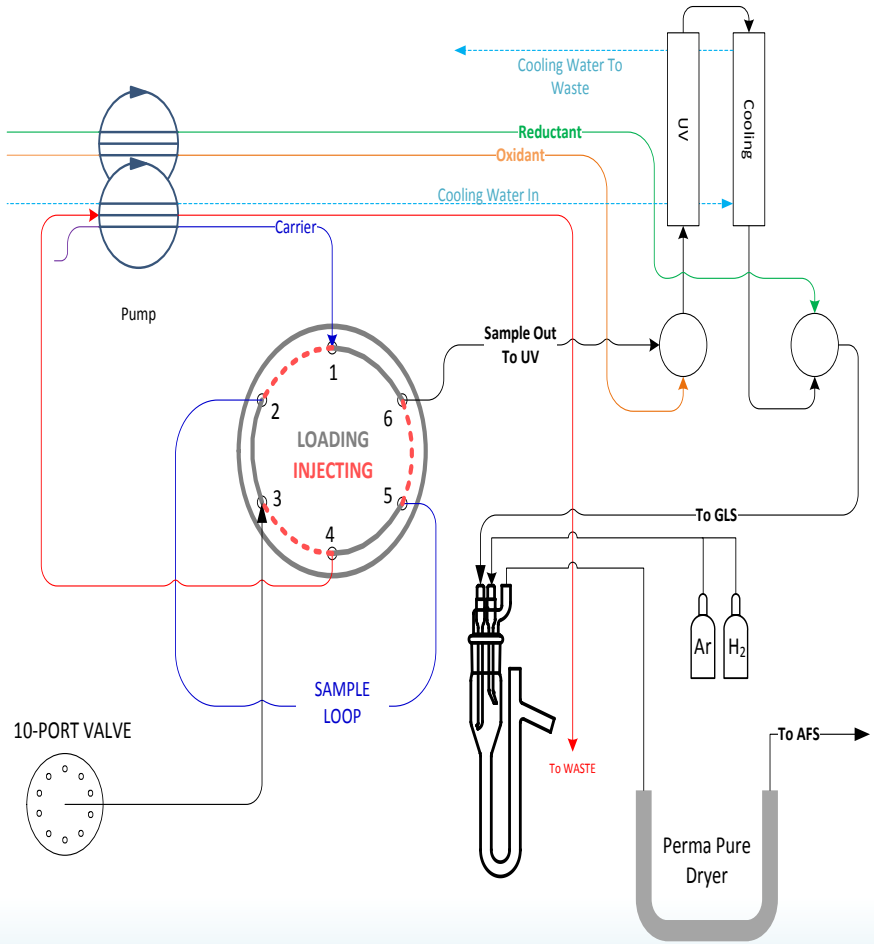
Schematic for Online System



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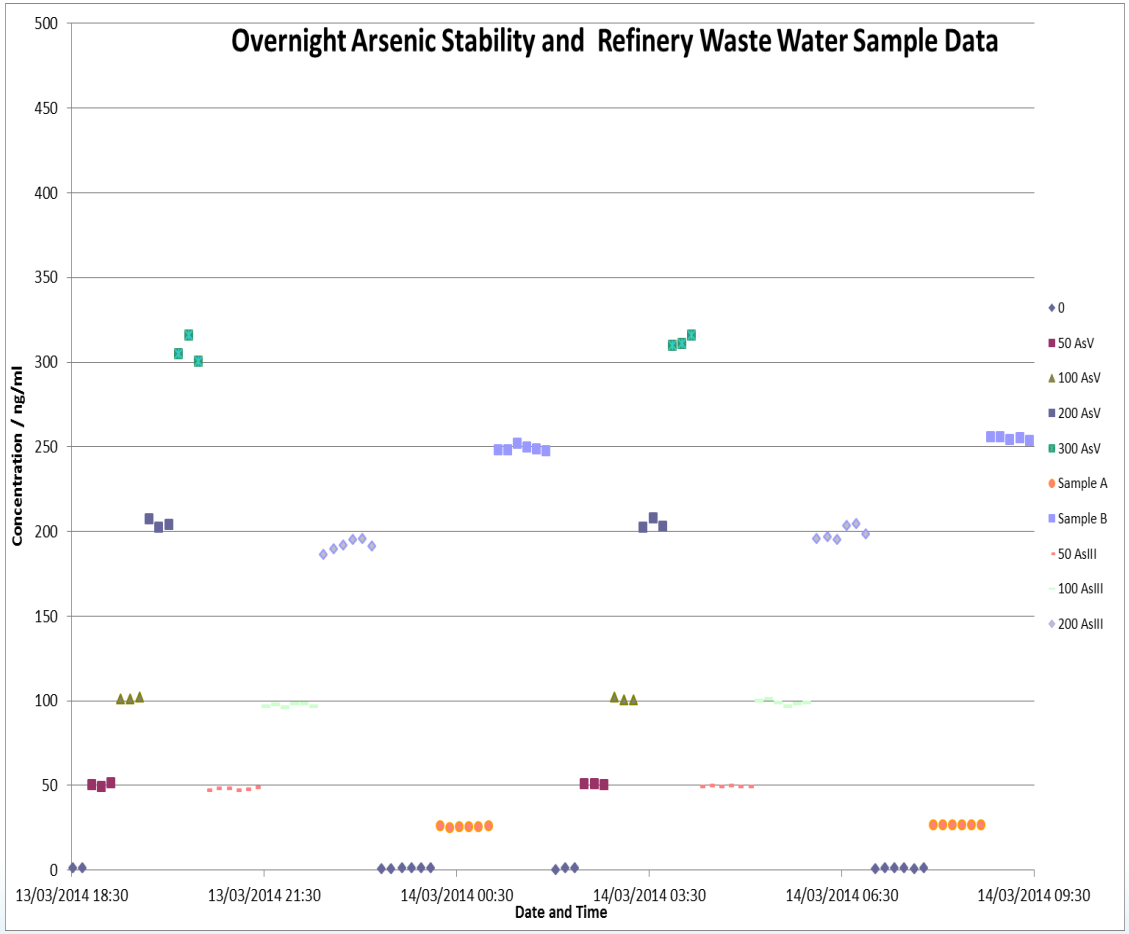
Wastewater Online Arsenic Data



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Precision and Bias Data for standards

Description	Mean ± SD ng/ml	RSD%	%Recovery
0 ppb As (V)	0.66 ± 0.71	107%	n/a
50 ppb As (V)	50.21 ± 1.09	2.2%	100.4%
100 ppb As (V)	101.29 ± 0.40	0.4%	101.3%
200 ppb As (V)	204.34 ± 2.56	1.3%	102.2%
300 ppb As (V)	306.98 ± 8.06	2.6%	102.3%
50 ppb As (III)	47.69 ± 0.62	1.3%	95.3%
100 ppb As (III)	97.12 ± 0.94	1.0%	97.1%
200 ppb As (III)	191.53 ± 3.44	1.8%	95.7%
50 ppb As (V)	50.83 ± 0.31	0.6%	101.6%
100 ppb As (V)	100.92 ± 0.89	0.9%	100.9%
200 ppb As (V)	204.47 ± 3.07	1.5%	102.2%
300 ppb As (V)	311.88 ± 3.27	1.1%	103.9%
50 ppb As (III)	49.25 ± 0.32	0.7%	98.5%
100 ppb As (III)	98.75 ± 1.50	1.5%	98.8%
200 ppb As (III)	198.92 ± 3.88	1.9%	99.5%

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Comparison on Lab versus Online

Sample Description	Online Result ng/ml	Laboratory Result ng/ml
Wastewater Sample A	25.5 ± 0.8 (n=20)	23.6 ± 1.2 (n=4)
Wastewater Sample B	249.1 ± 4.8 (n=20)	242.4 ± 0.7 (n=4)

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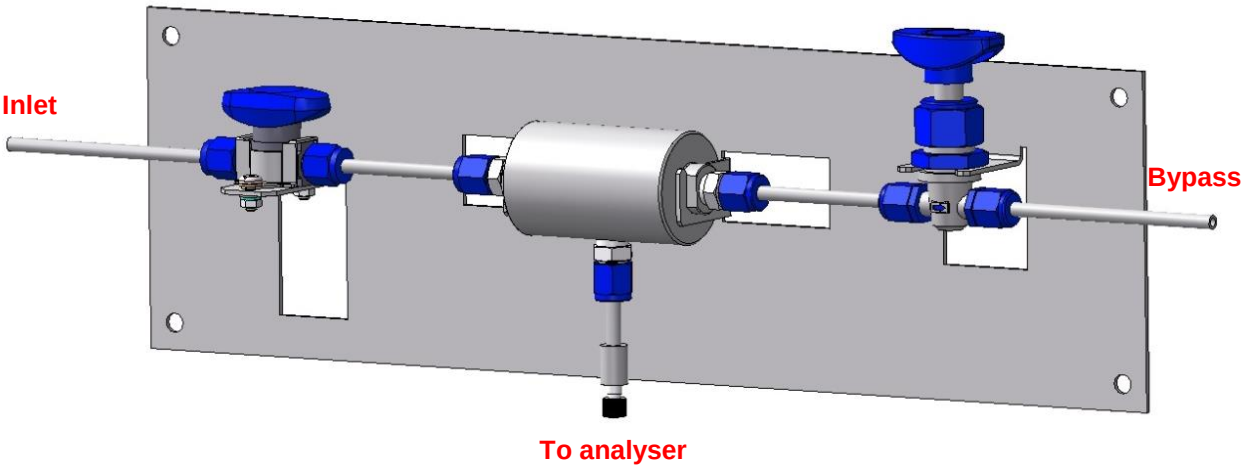
Sampling system with fast loop filter



- All fluoropolymer (PTFE & PFA) wetted path
- Filter sizes 1-25µm in Teflon. Larger sizes in other materials.
- Self cleaning inertial filter, easily replaceable
- Sample flow through filter is 0.8ml/min from a higher flow bypass circa few hundred ml/min or more
- Filtration does not seem to influence results.
- Internal bore of tubing on instrument is 0.6mm (i.e. 600 micron).
- Pre-acidification options and dilution available.

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Thank you for attention. Any Questions?

- Authorized Representative
- For Additional Information, Quotes, Power Points, & Specifications contact:
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