



Mercury Speciation in Flue Gas from Coal-fired Power Stations

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Overview

- Hg in stack gas measurements
 - Why?
 - Offline analysis
- Continuous Emission Monitors
 - Sample collection
 - Sample transport
 - Sample pre-treatment
 - Analysis
 - Calibration
- Typical Data
- Summary

Why Measure Power Station Hg Emissions?

- Public concern about Hg emissions
 - Environmental accumulation of toxic metals
- Major sources of emissions:
 - coal fired power plants
 - waste incinerators
- Transport strongly dependent on speciation
- Regulatory compliance
 - US EPA Clean Air Mercury Rule (March 2005)

Offline Analysis

Reference methods

EPA Methods 29 and 101a (Total Mercury)

Impinger based – $\text{HNO}_3/\text{H}_2\text{O}_2$ or $\text{H}_2\text{SO}_4/\text{KMnO}_4$

Ontario Hydro Method (Speciation)

ASTM Method D6784-02

Impingers with KCl & $\text{H}_2\text{SO}_4/\text{KMnO}_4$

Monitoring methods

QuickSEM™ (Total Mercury)

40 CFR Part 75 Appendix K

Cadmium ion based

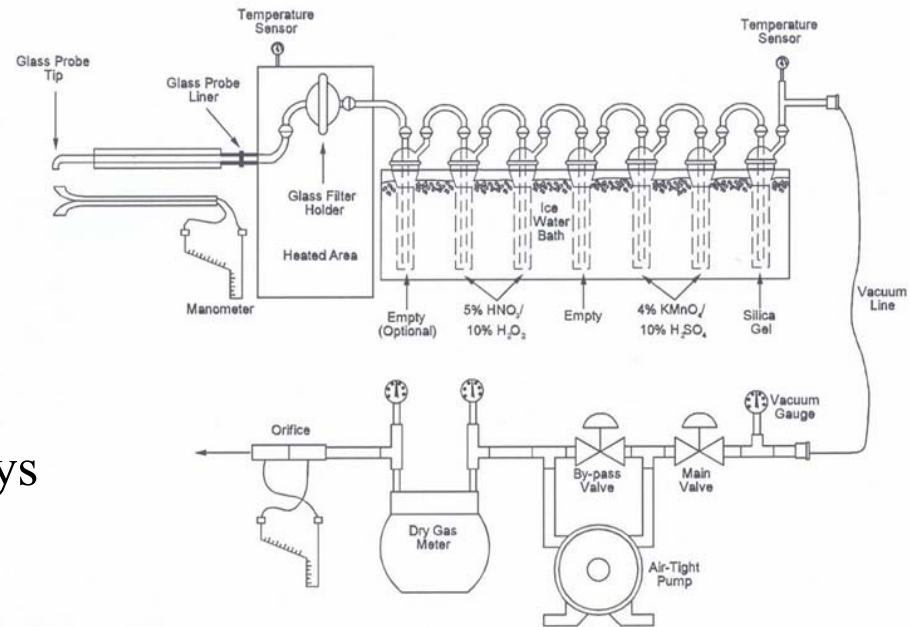
Offline Analysis

Reference methods

- Average data over 1+ hours
- Labour intensive
- Delay for results from lab.

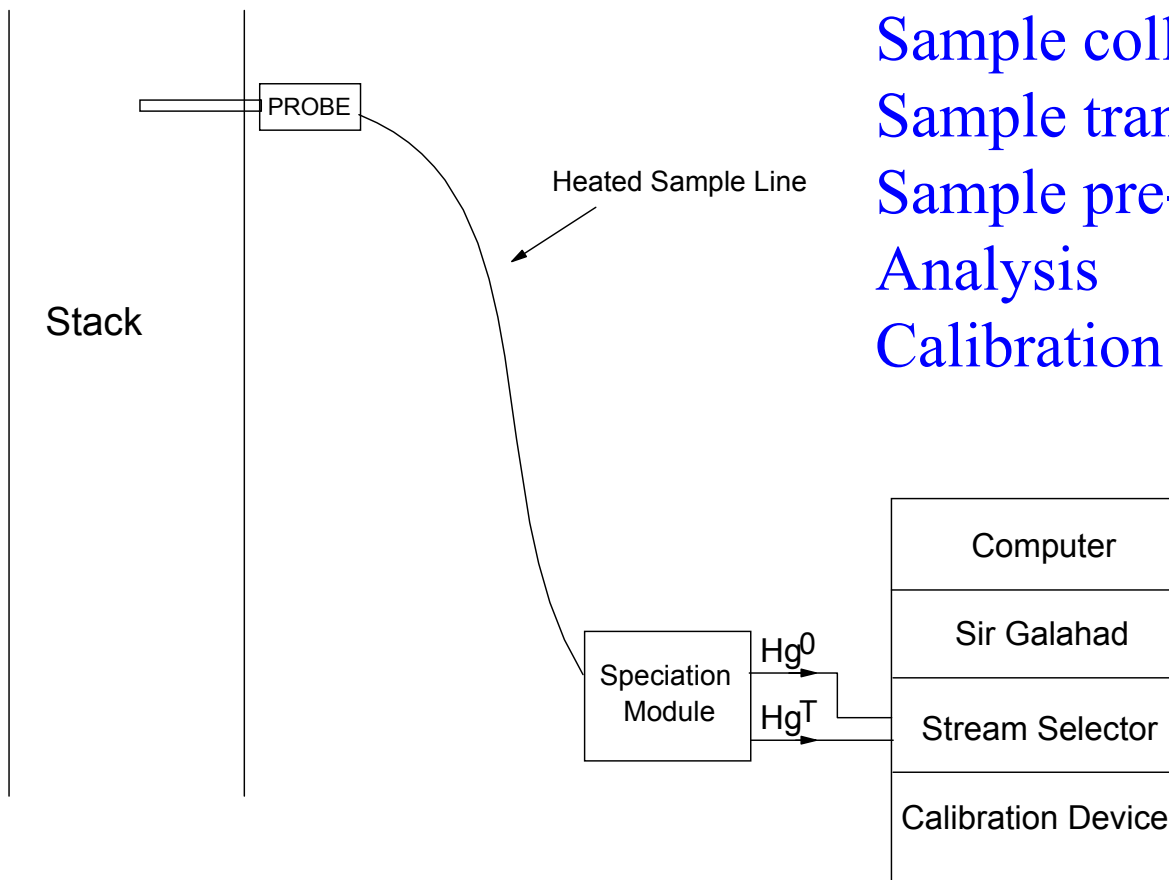
Monitoring methods

- Average data over hours or days
- Delay for results from lab.

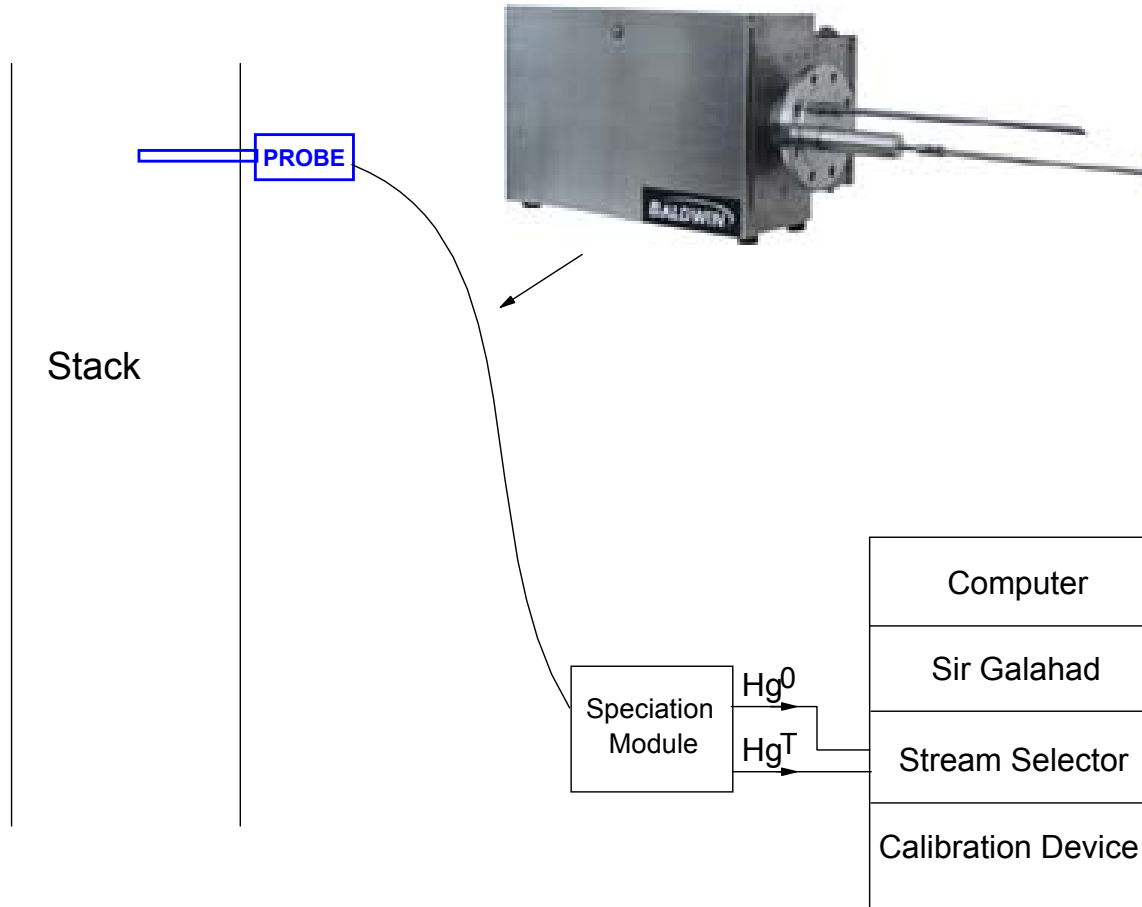


Online Analysis

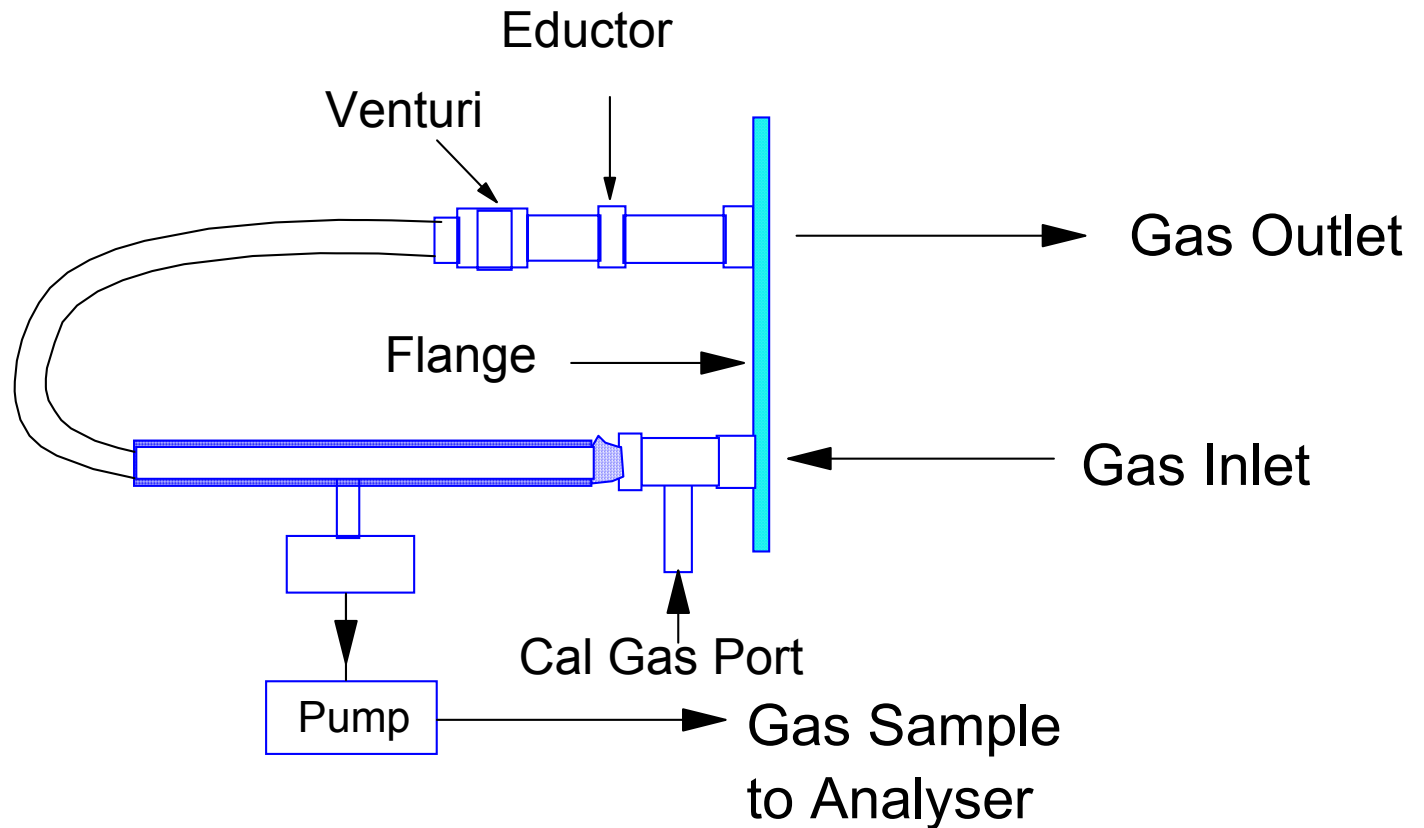
Continuous Emissions Monitor (CEM)



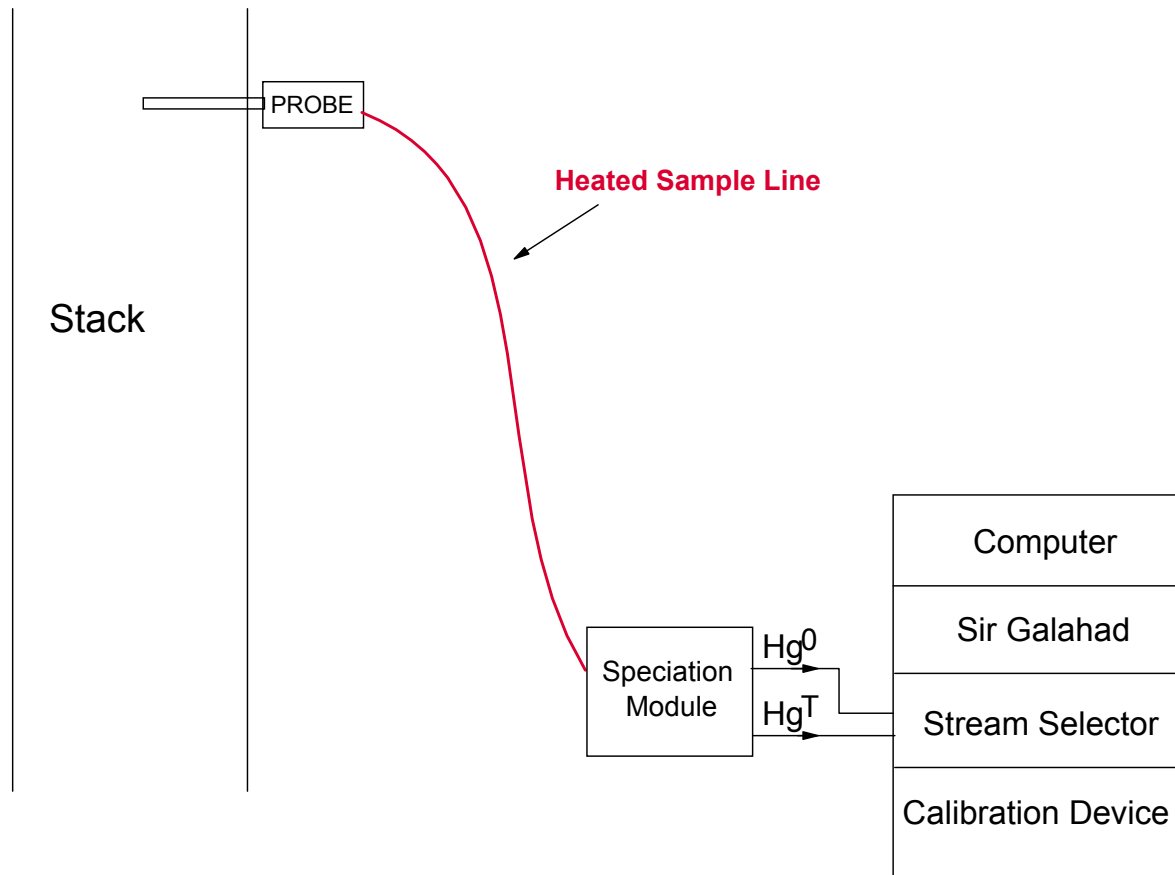
Sample Collection - The Probe



Inertial Probe Schematic



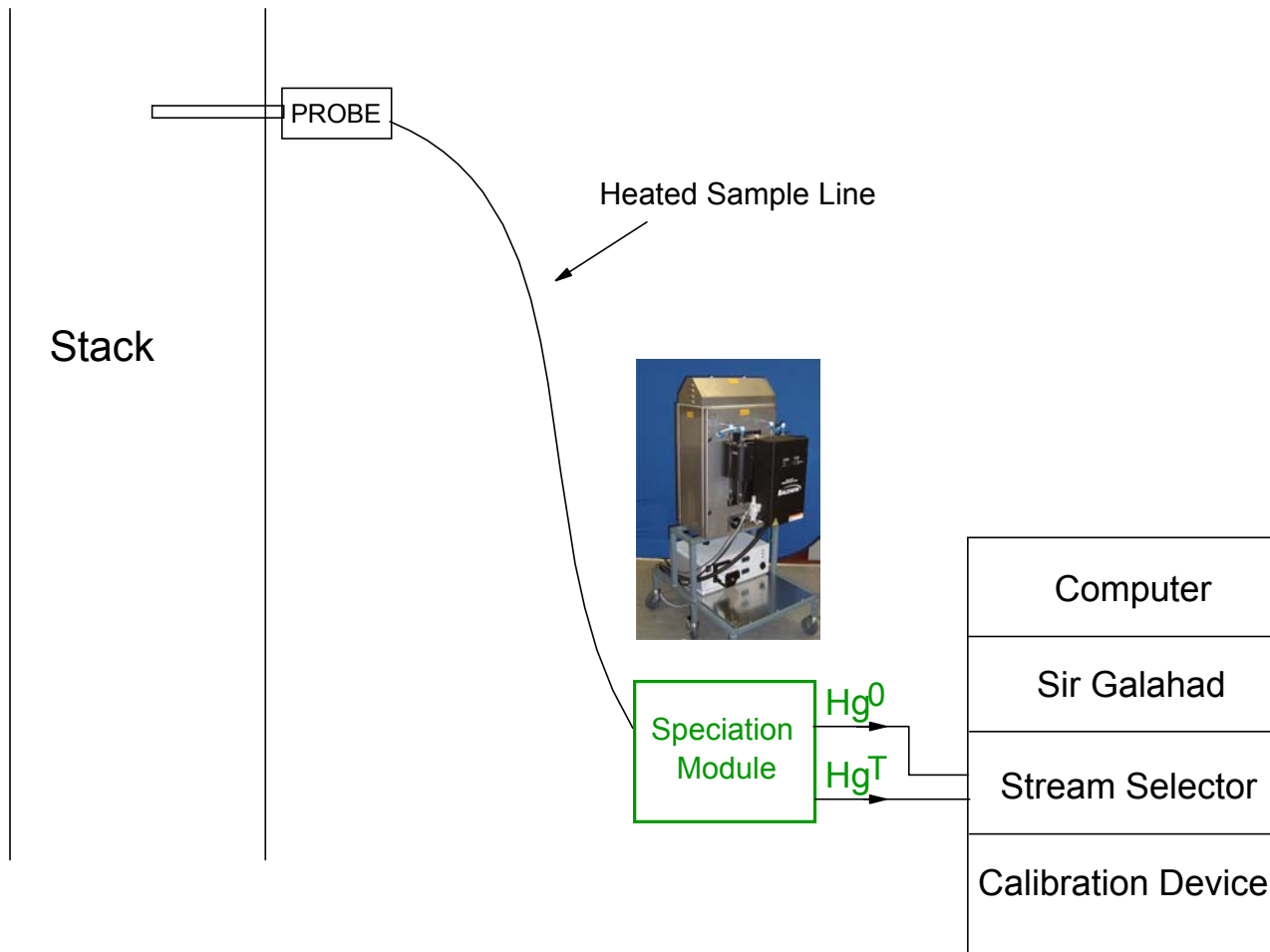
Sample Transport – Heated Lines



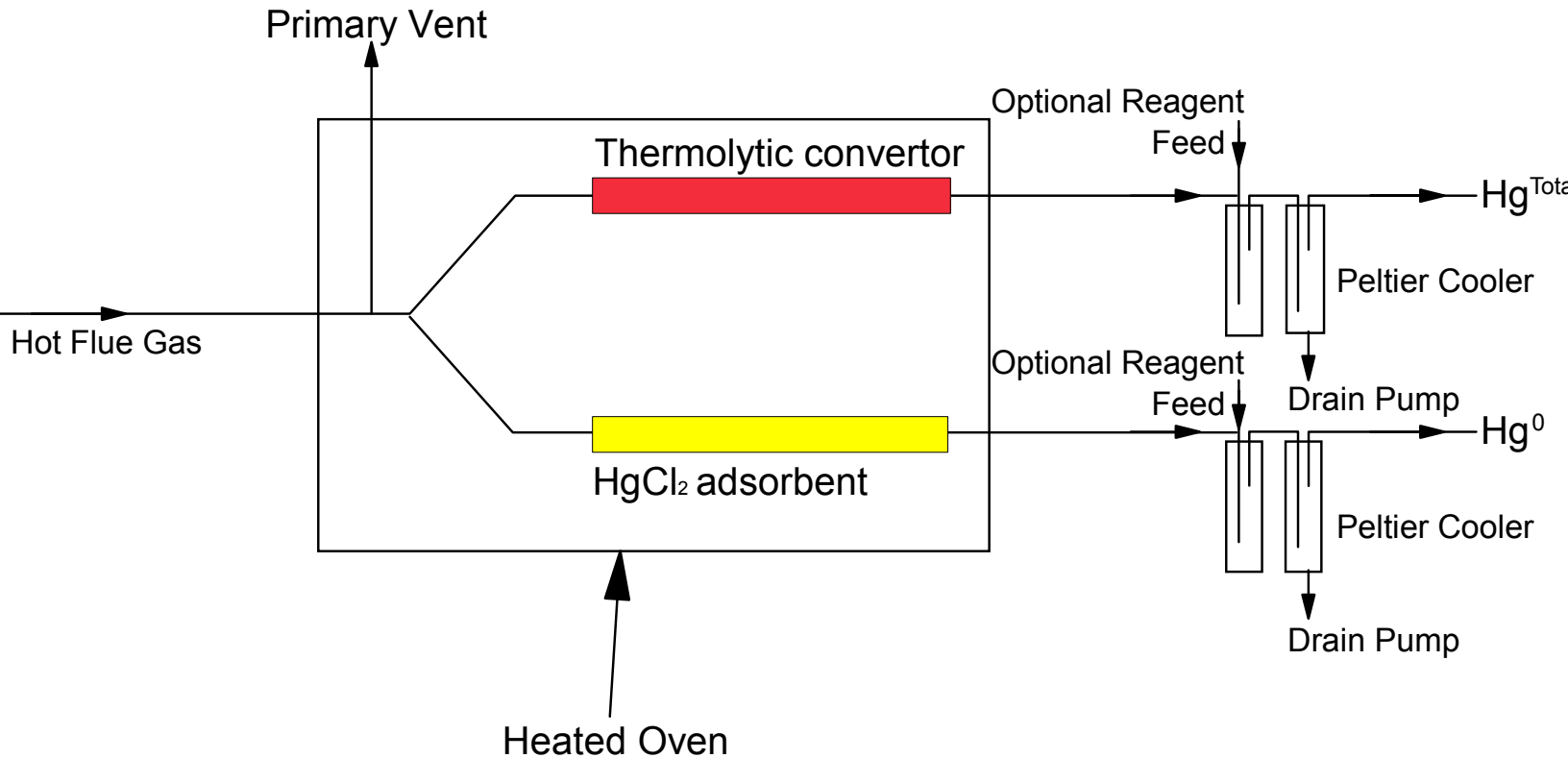
Sample transport

- Inert materials
 - Durinert (glass) coatings
 - PFA/PTFE components
- Temperature
 - Raw sample
 - Ash-free sample

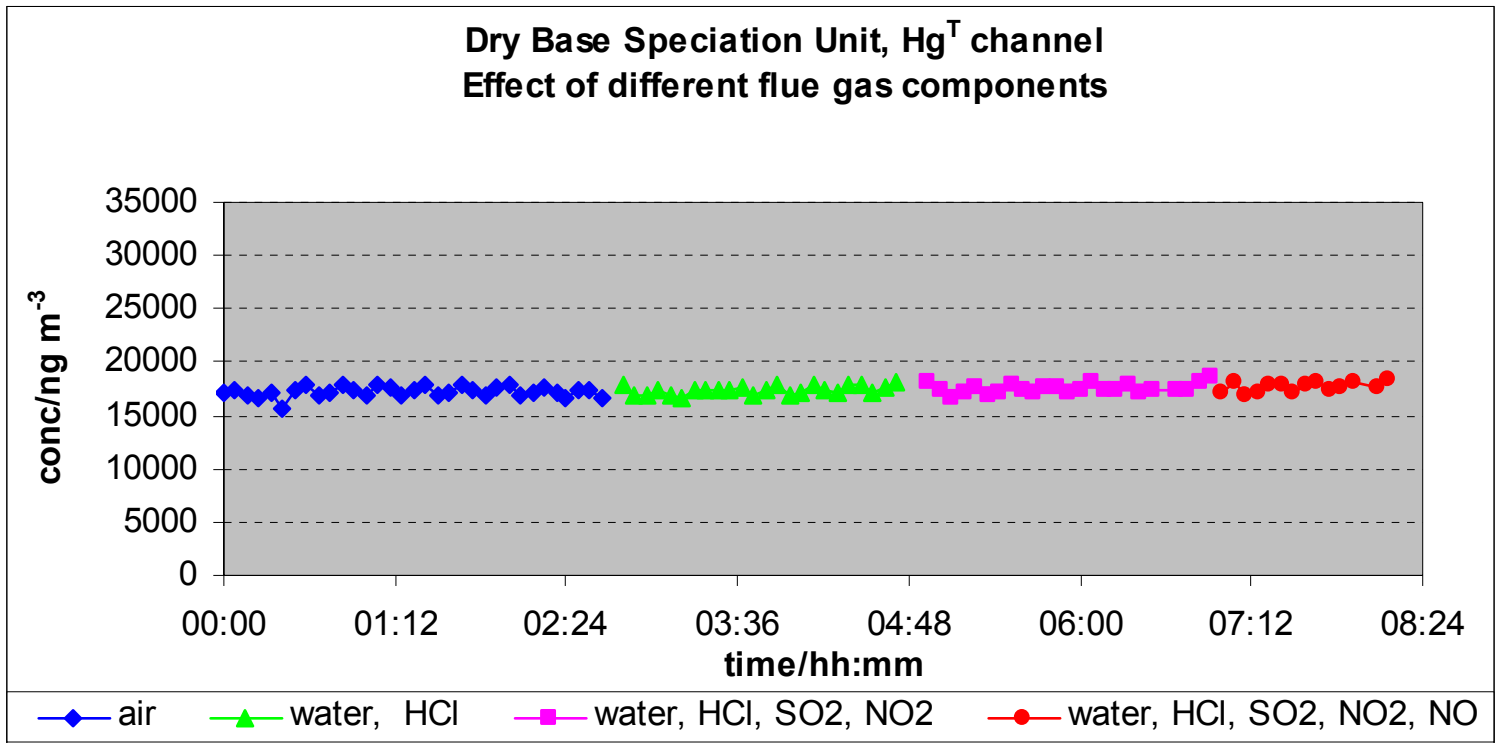
Sample Pre-treatment – The Speciation Module



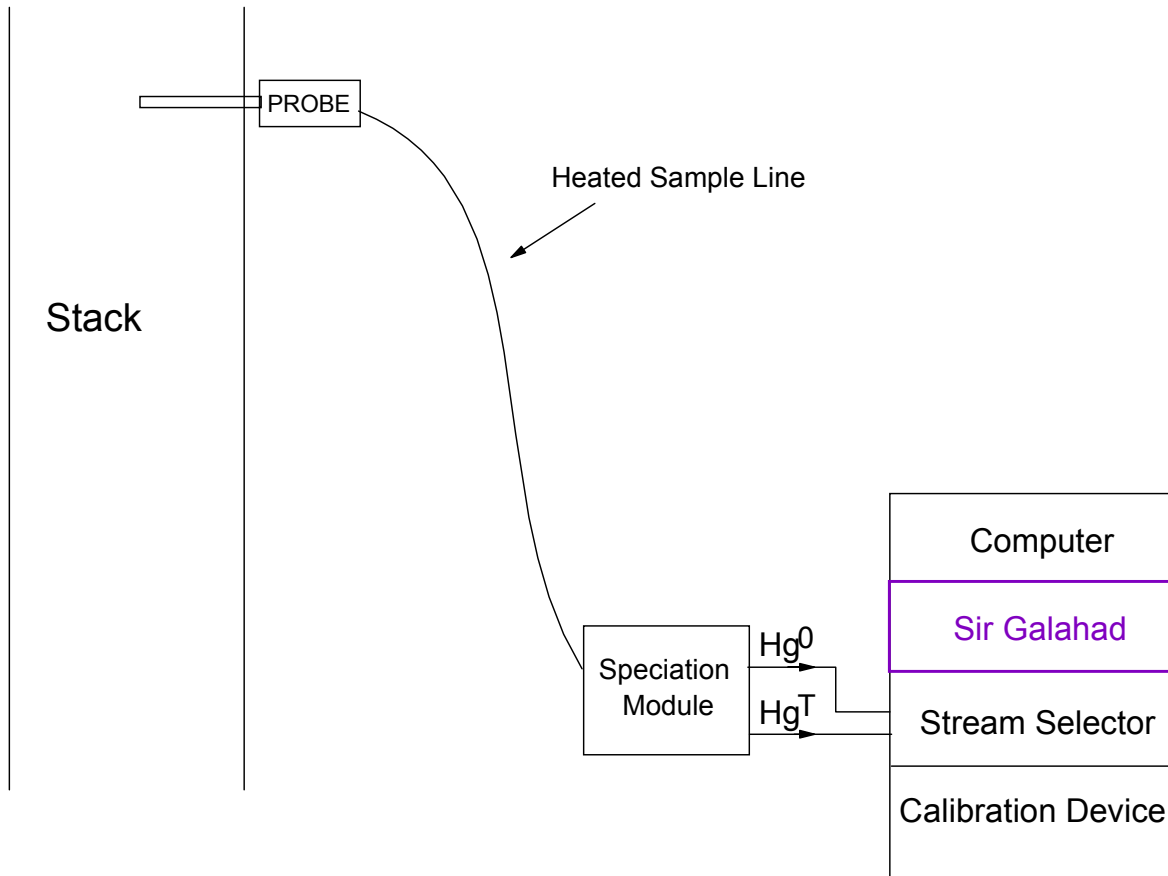
The Speciation Module



Typical Data Using Bench Scale Apparatus



Analysis – The Sir Galahad



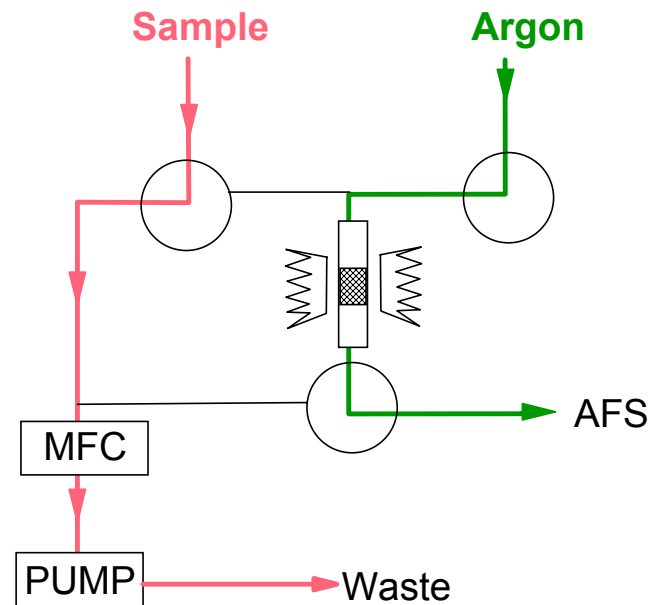
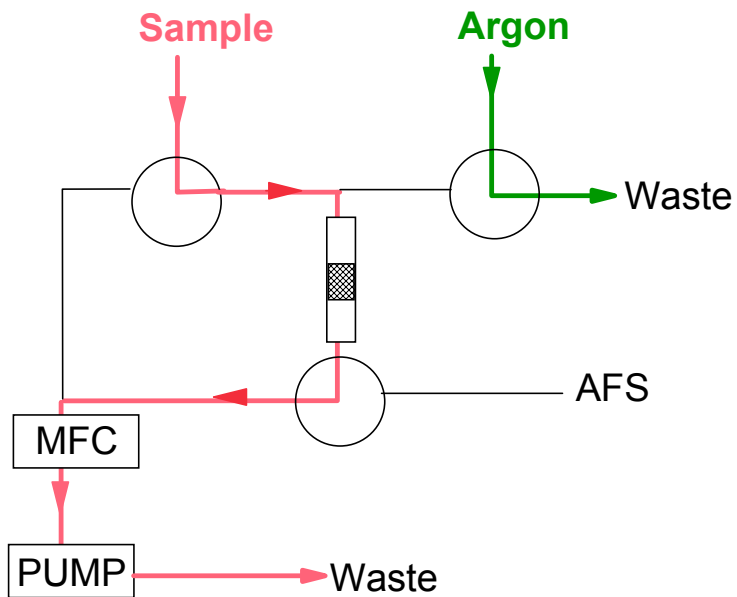
Sir Galahad

Amalgamation – Atomic Fluorescence Spectroscopy

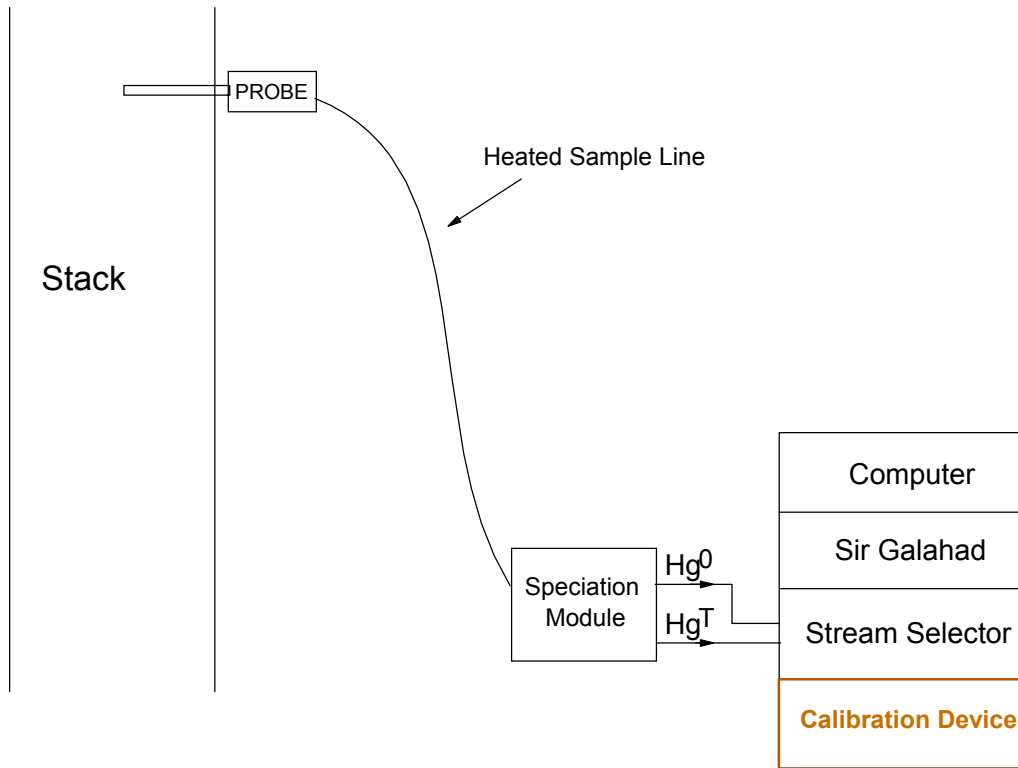
- Why AFS?
 - Sensitivity
 - Selectivity
 - Simplicity
- Why amalgamation?
 - Sample pre-treatment – selectivity
 - Sample preconcentration



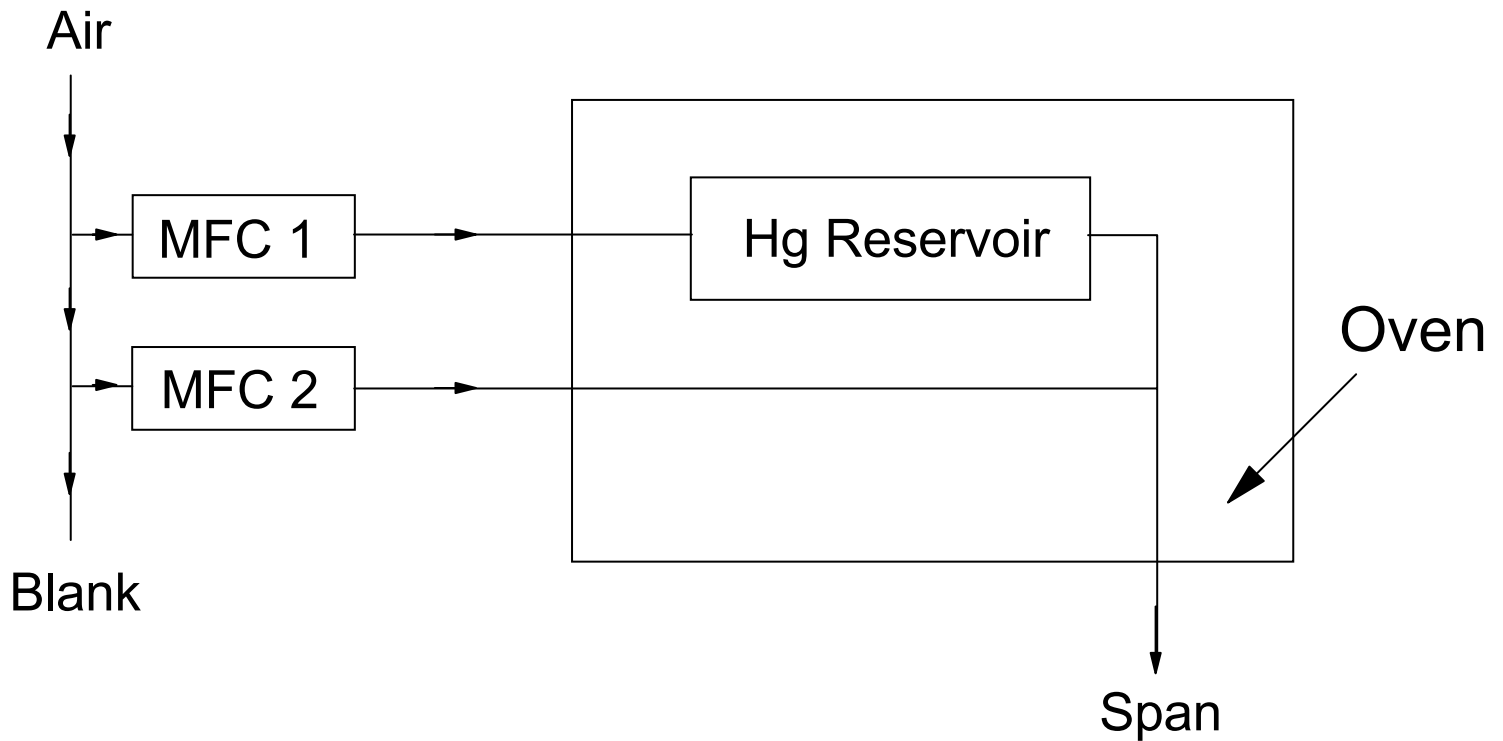
Schematic Flow Diagram of the Sir Galahad



Calibration



On-Line Calibration System



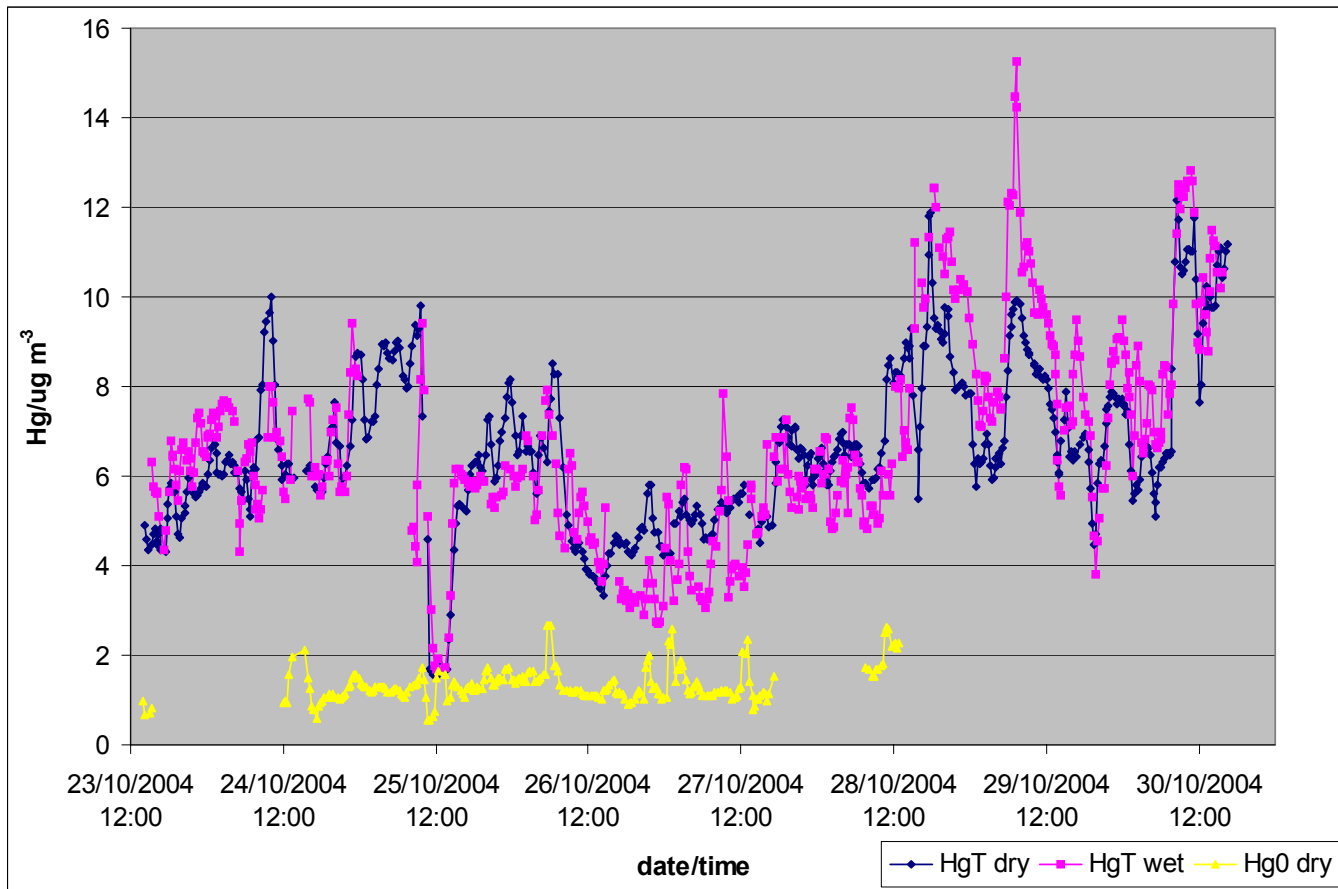
A Power Station in Kentucky

- 120MW unit
- Fuel: bituminous coal
 - Kentuckian
- Environmental controls
 - Electrostatic Precipitator (ESP)
 - *No* Flue Gas Desulfurisation (FGD)
 - *No* DeNO_x
 - (low NO_x burners)

A Power station in Kentucky

Stack monitoring

Inertial probe & wet/dry speciation



- Wet and Dry Hg^{T} show good agreement

A Power Station in SE England

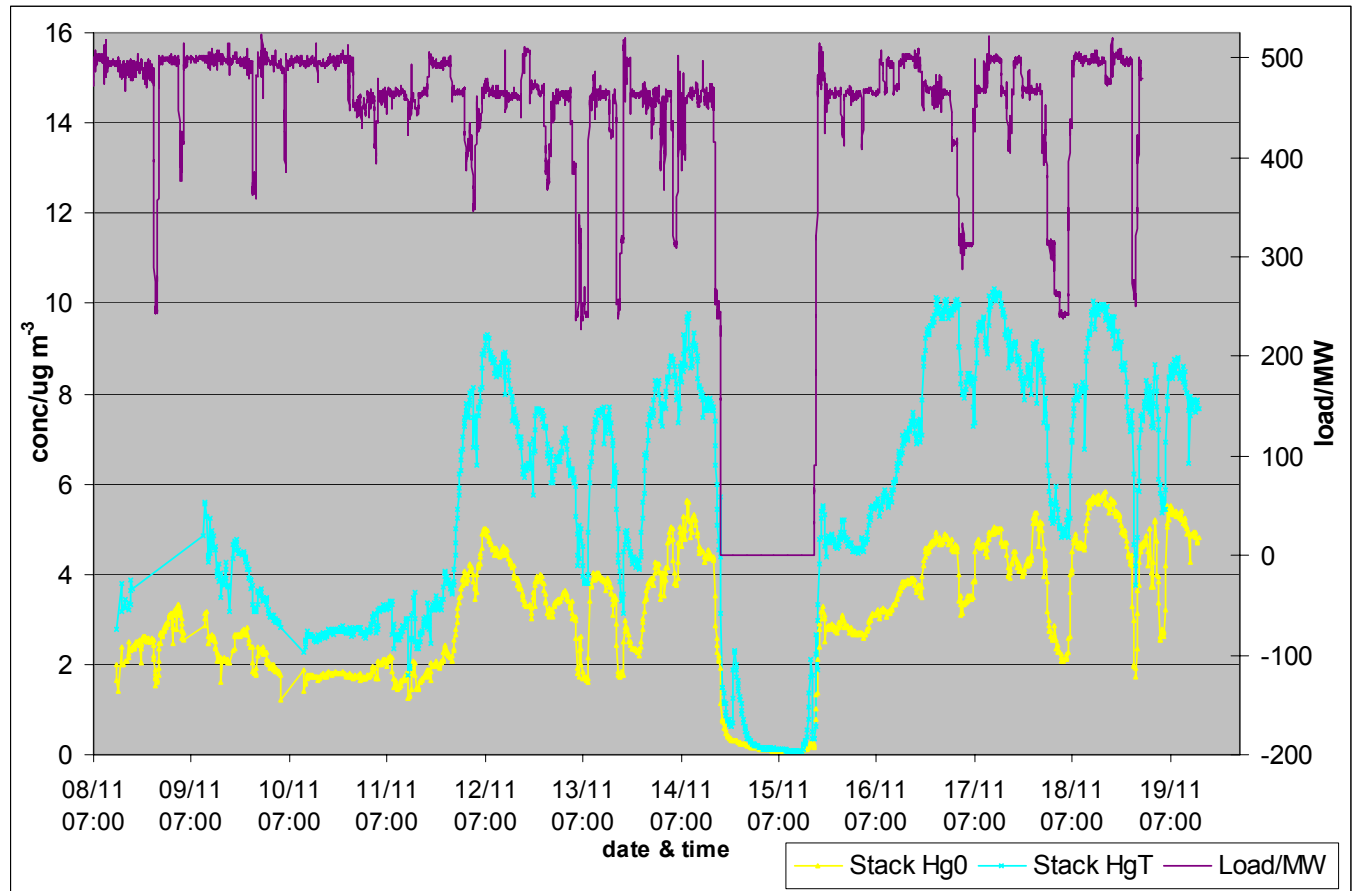
- 500MW unit
- Fuel: bituminous coal
 - Russian
 - Colombian
 - South African
 - $\leq 10\%$ biomass (cereal pellets)
- Environmental controls
 - Electrostatic Precipitator (ESP)
 - *No* Flue Gas Desulfurisation (FGD)
 - *No* DeNO_x

A Power station in SE England

Stack monitoring

Heated filter blowback probe & dry speciation

Unattended operation



PSA

- Hg levels trend with unit load

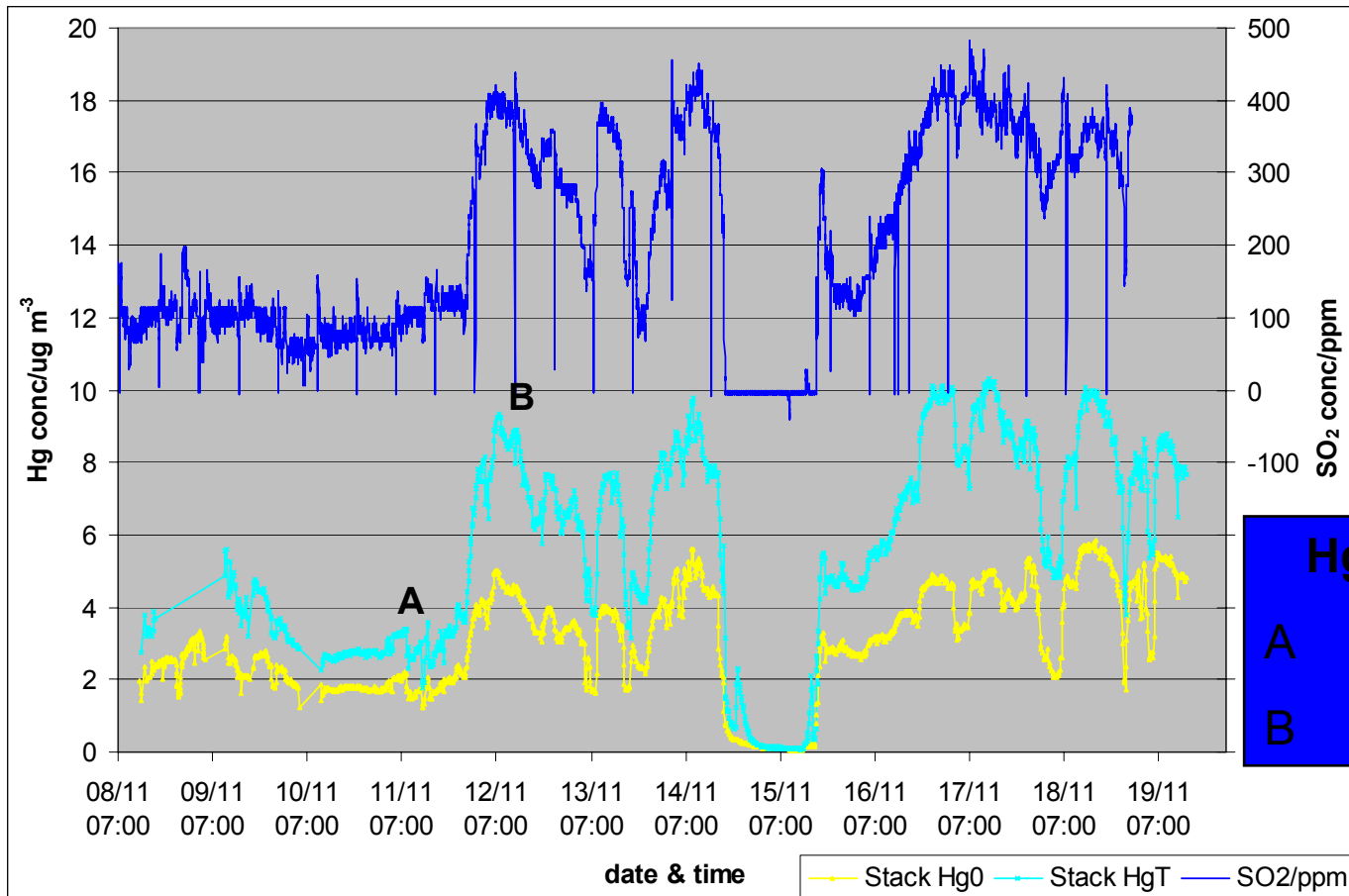
A Power station in SE England

Stack monitoring

Heated filter blowback probe & dry speciation

Unattended operation

- SO₂ trending – shows variation in fuel



Conclusion

CEM developed to measure mercury in power station stack gases

Difficult sampling, transport and pretreatment issues have been addressed

Successfully operated unattended on numerous power station stacks