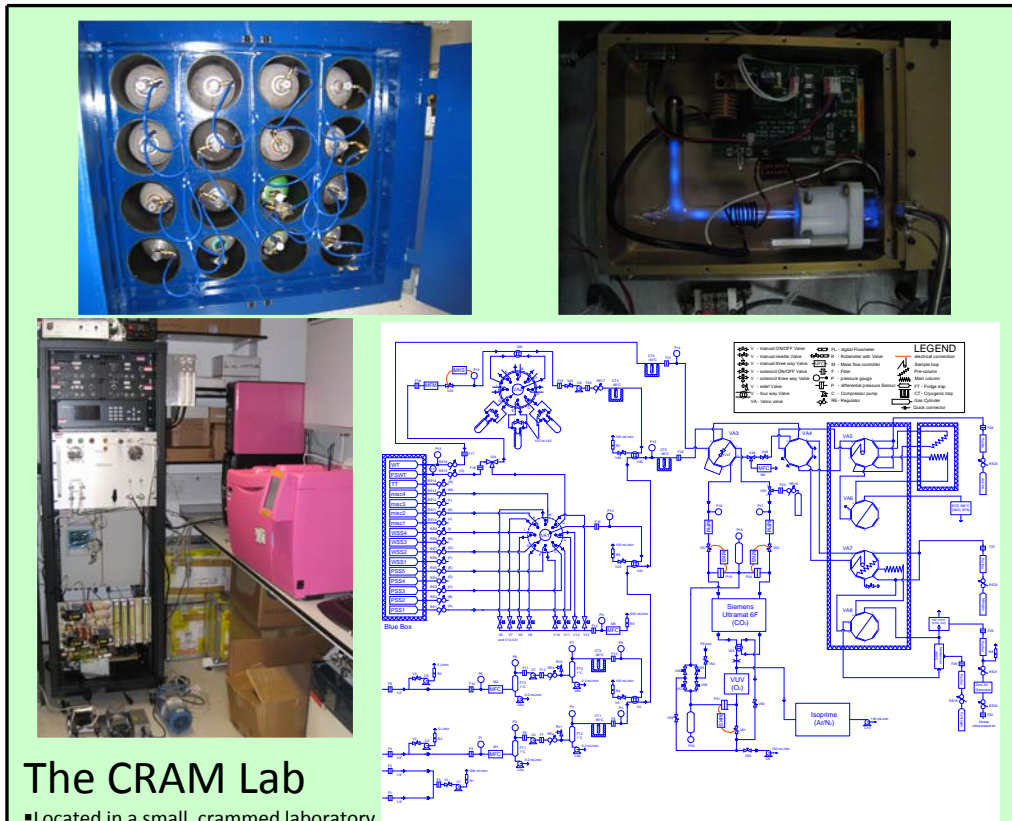


Greenhouse gas measurement capability at the new Carbon Related Atmospheric Measurement (CRAM) Laboratory

Abstract

- Carbon related and greenhouse gas measurements are critical to better understanding the carbon cycle and its continuing role in climate change.
- The CRAM Lab at the UEA/ENV is close to reaching full operational status, together with a working and reference standard cylinder filling facility, the CFF.
- Equipped to provide high precision atmospheric measurements of O₂, CO₂, CH₄, CO, N₂O, SF₆ and Ar/N₂.
- Designed to keep labour operations to a bare minimum; all analyses are automated, and all species are measured together.
- The CRAM Lab and CFF provide support for:
 - Continuous *in situ* measurements from the ENV roof;
 - Continuous measurements at Weybourne Atmospheric Observatory (WAO) on the north Norfolk coast (52.95°N, 1.12°E);
 - Measurements from a flask sampling network in the British owned South Atlantic islands;
 - Continuous ship board measurements along a latitudinal tract in the Atlantic Ocean.



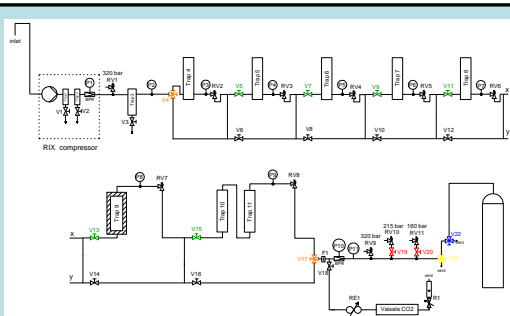
The CRAM Lab

- Located in a small, crammed laboratory in the School of Environmental Sciences at the UEA.
- Measures all species in series from a single air flow via contiguous instruments (significantly reducing labour costs).
- First-ever use of a Perkin Elmer GC for high precision greenhouse gas measurements.
- Isoprime mass spectrometer to be added Jan 2010¹
- Capability to measure:
 - high pressure cylinders;
 - sample flasks.
 - in situ* air monitoring (from roof inlets).
- Routine calibration with a suite of 14 primary calibration gases from NOAA/ESRL and Scripps Institution of Oceanography.
- Calibration scales are maintained and propagated indefinitely via regular analyses of a hierarchical set of secondary and tertiary standards^{2,3}.
- Included in both the 'Cucumber' and 'GOLLUM' worldwide intercomparison programmes⁴.

Species	Analyser
O ₂	Custom built Vacuum Ultraviolet analyser ⁵
CO ₂	Siemens Ultramat 6F
CH ₄ , CO, N ₂ O, SF ₆	Perkin Elmer Clarus 500 GC with flame ionisation and electron capture detectors
Ar/N ₂	Isoprime 10-collector isotope ratio mass spectrometer ¹

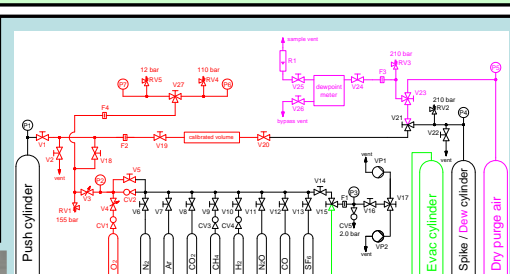
The UEA Flask

- Incorporates many benefits from other flasks, whilst eliminating their weaknesses.
- Two valves at top of flask allow:
 - sample collection and analyses without removing from box;
 - larger sample volume for a given box size (reduced shipping costs);
 - improved strength.
- Valve seals with PCTFE (Kel-F) seat⁶.
- Flask connections via simple hand-screw with Synflex tubing.
- Flasks compatible with the NOAA 'standard' shipping box.



The Cylinder Filling Facility (CFF)

- RIX Industries compressor fills cylinders with dry air at up to 300 bar pressure (150-200 bar typical).
- Drying to <1 ppm H₂O content is achieved with a 3Å molecular sieve trap and two Mg(ClO₄)₂ traps.
- A suite of 5 additional chemical traps allows the scrubbing of the greenhouse and trace gases of interest to provide sub-ambient concentrations.
- One chemical trap can be cooled progressively down to -100°C in a cryogenic bath for improved absorption characteristics.
- CO₂ is monitored in-line on the filling system.



CFF: Spiking System

- Allows the 'spiking' of a filled cylinder to give above ambient concentrations of up to 9 gas species (O₂, N₂, Ar, CO₂, CH₄, H₂, N₂O, CO, SF₆).
- A calibrated volume is filled to a calculated pressure with the spiking species.
- This is then 'pushed' into the cylinder with a short burst of high pressure air from the push cylinder.
- The cylinder should then be reanalysed in the CRAM Lab.
- System also incorporates a moisture meter to analyse cylinder dewpoints, and vacuum pumps to evacuate cylinders prior to filling.

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