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Comparative RGA measurements in the range from 10^{-10} to 10^{-5} mbar

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Overview

- Calibration requirements within the laboratory
- RGA's to be compared
- Experimental set-up and procedure
- Gas injection results
- Conclusions
- Acknowledgements

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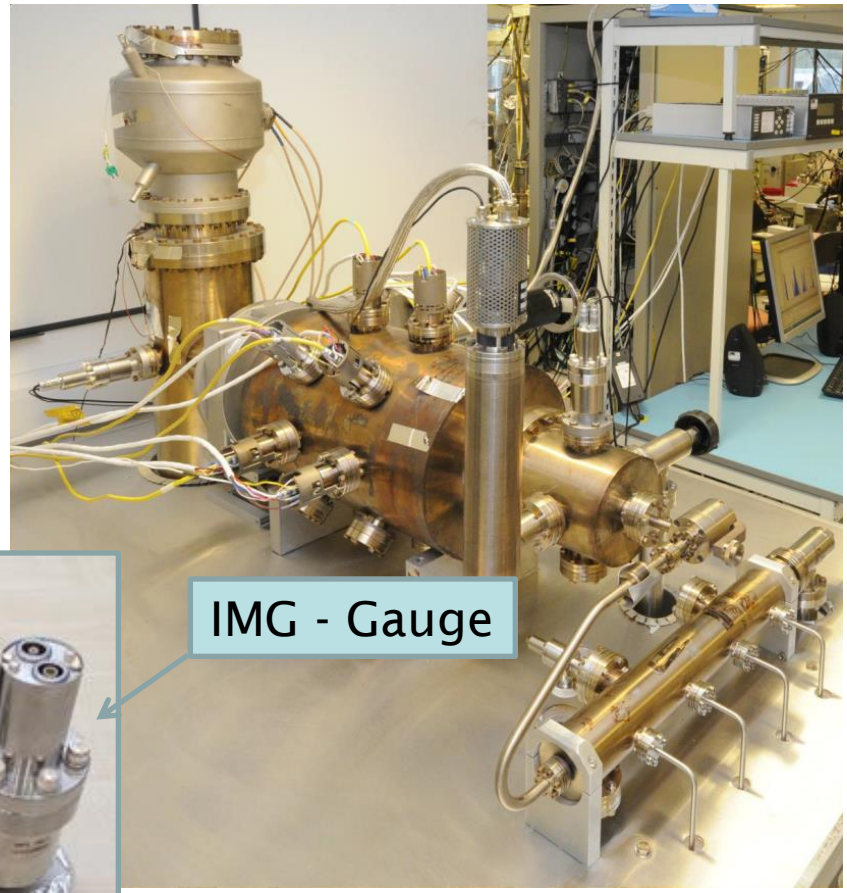
ASTeC Secondary standard calibration facility

- Primary calibrated gauges from PTB & NPL
- Experimental programmes have accuracy and traceability.
- Base pressure 5. 10^{-11} mbar
- Calibration range 10^{-9} to 10^{-5} mbar
- Numerous gas species
- Current work - VELA accelerator measurements
- Future [illegible] calibration



Collars

Requirements for RGA calibration

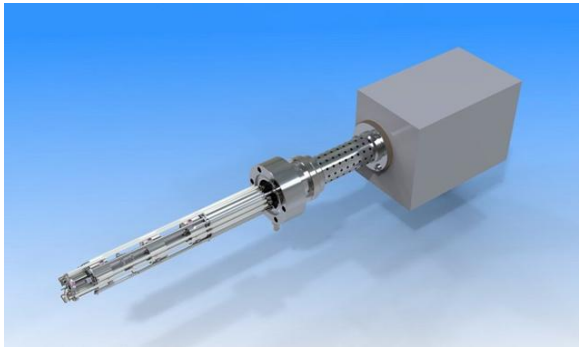
- A need of quantitative partial pressure measurements
  - Lack of space for two instruments: gauge + RGA
  - Outgassing of 'gauge + RGA' is greater than RGA only
- Common findings amongst users:
  - RGAs are not calibrated – they have a number of factory set parameters
    I(m/e=28) usually correspond to $P(N_2)$ measured with a UHV gauge
  - RGAs are adjusted with injection of noble gases – not for residual gases in UHV
  - Generally, '*as-received*' it is a qualitative (not a quantitative) device

RGA's compared

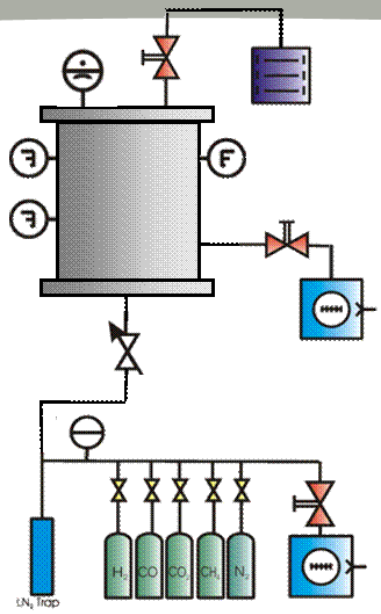
- Make/Model:
- Granville-Phillips Ion trap 835 VQM
- MKS Microvision 2 (1-200amu)
- Hiden HAL 7 RC (1-100amu)

- Modes used:
- FAR and SEM
- Profile, trend and MID
- Leak detection

- Main requirements total pressure range: From 10^{-5} down to below 10^{-12} mbar



Experimental set-up



Hiden RGA

Cal Ext. Gauge

Ion Trap

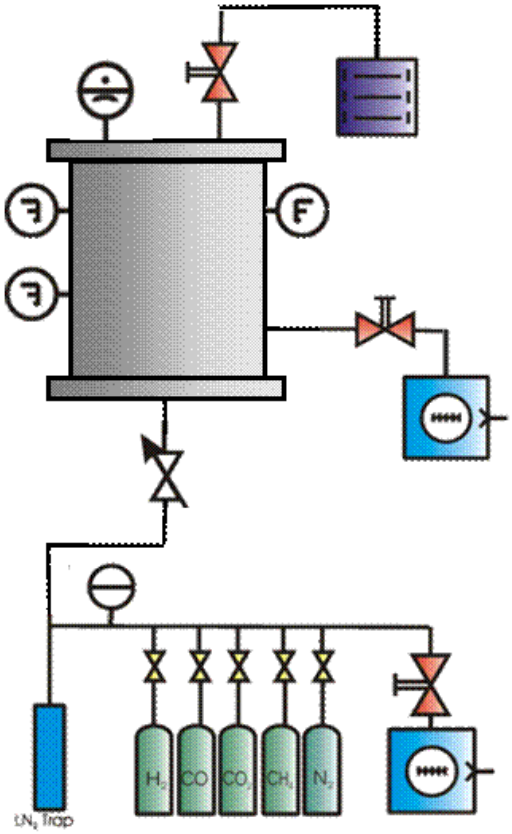
MKS RGA

VAT leak valve

Gas Injection

Selection of injected gases

- The main gases of interest are H_2, CH_4, CO, CO_2, same as in the residual gas spectrum.
- N_2, Ar, O_2 and a noble gas mixture have also been utilised for injections during the comparisons.
- LN_2 trap for cleaning of injected gases
  - Very useful to reduce an impurity of injected gases (even for class 9999 gases)
- H_2O is present for calibration before performing the bakeout or by heating a small part of vacuum chamber, or switching on a filament



Comparing RGA's Vs. Extractor Gauge

- Background pressure recorded for the gauge and RGA's
- Gas manifold ~ 1 mbar easier flux regulation
- Pressure in the test chamber varied between ~10^{-10} mbar to 10^{-6} mbar (2 points per decade)
- Pressure recorded for the gauge and significant RGA peaks
- At 10^{-10} to 10^{-8} mbar SEM mode
- 10^{-8} to 10^{-6} mbar FAR mode
- System left to recover overnight

Measurement analysis

- RGA spectrum: range utilised always a mixture of gases
- Measuring Ion currents therefore relationship between current and pressure for each gas is defined by this formula
- Assuming that the calibration coefficients ***ai*** for the gauge and ***bi*** for the RGA, the measured currents are:

$$I_g(i) = a_i P_i; \quad I_{RGA}(i) = b_i P_i$$

- Then $$I_g = \sum_i a_i P_i = \sum_i \left(\frac{a_i}{b_i} I_{RGA}(i) \right)$$

•Coefficients found = calculated = true pressure measurement

- Ref: paper **J. Vac. Sci. Technol. A 26 (2008), p. 1474**

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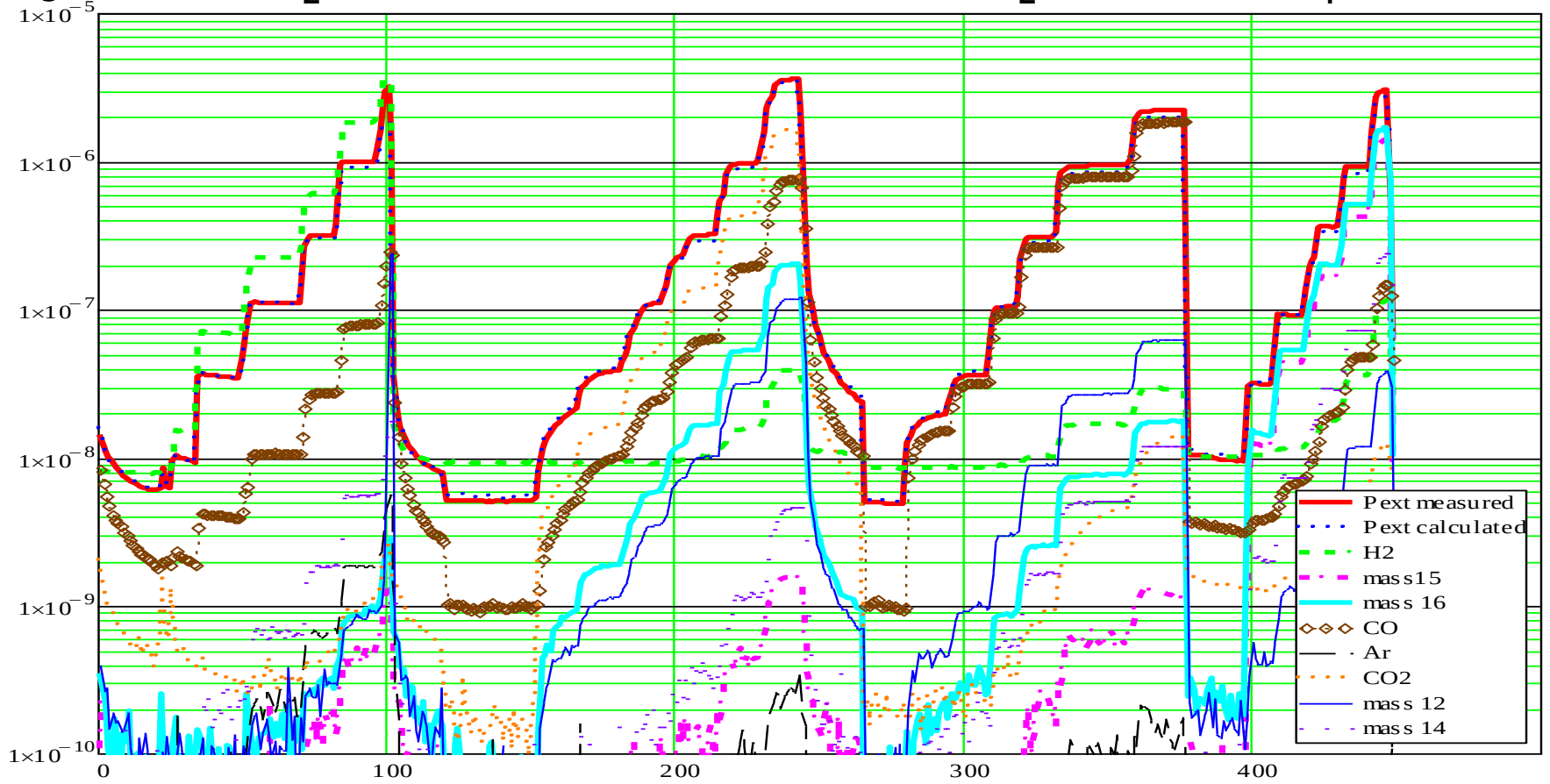
RGA calibration check vs. extractor gauge

Injection: H_2 CO CO_2 CH_4



The Calibration coefficients are normalised to a Nitrogen coefficient and compared with referenced coefficients for an ionisation gauge

Gas Type	H_2	CH_4	CO	N_2	O_2	Ar	CO_2
Extractor Gauge	0.44	1.5	1.04	1	0.85	1.3	1.6
MKS –FAR	2.5	1.5	1.3	1	0.25	1.3	1.4
MKS –SEM	4	1.7	1.05	1	0.3	1.3	1.4
HIDEN-FAR	1.95	1.85	1.7	1	0.9	2.5	2
HIDEN-SEM	2.28	1.14	0.98	1	0.52	0.73	0.78
I/T-SEM	0.5	1.3	1.1	1	1.024	1.25	1.5

- Table of results - coefficients are calculated at 10^{-8} mbar
- Coefficients utilised give the best fit except N_2

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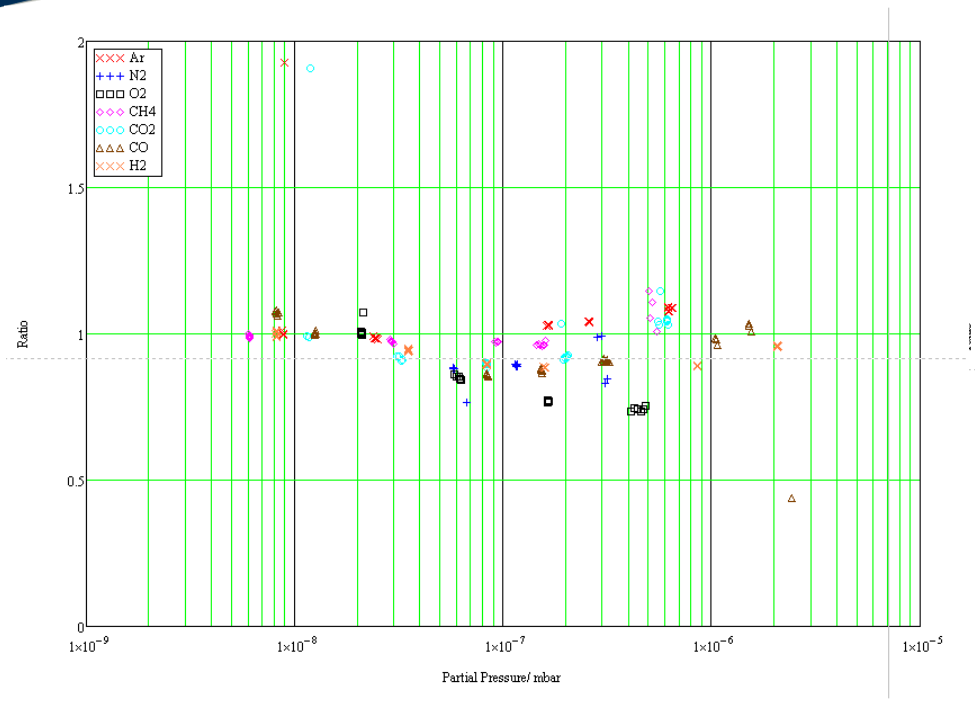
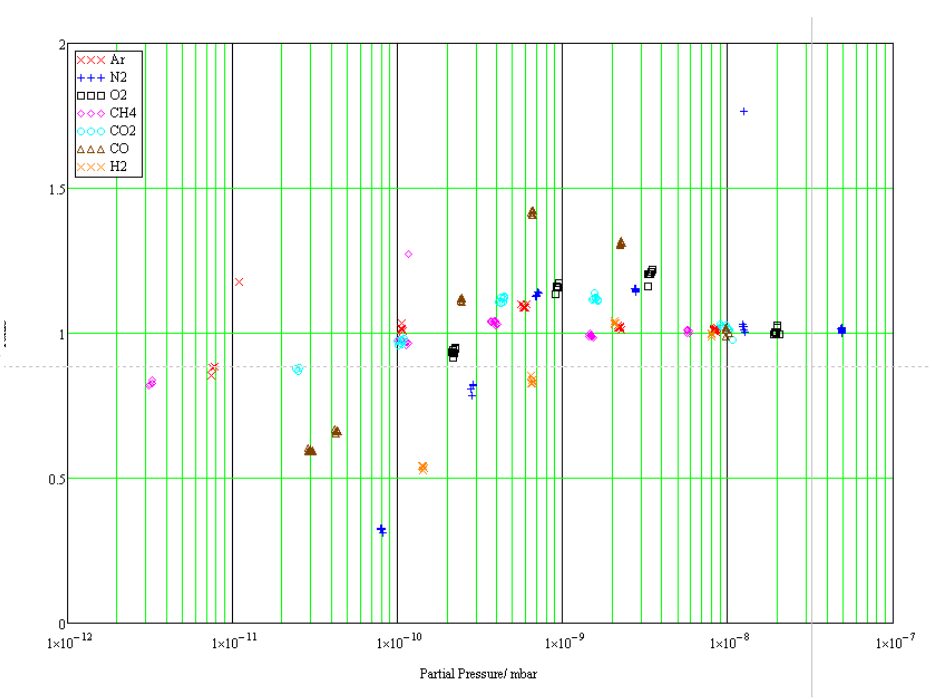
HIDEN FARADAY



CH_4 +/- 3%

H_2 +/- 12%

HIDEN SEM



Ar +/-10%

Co +/- 40%

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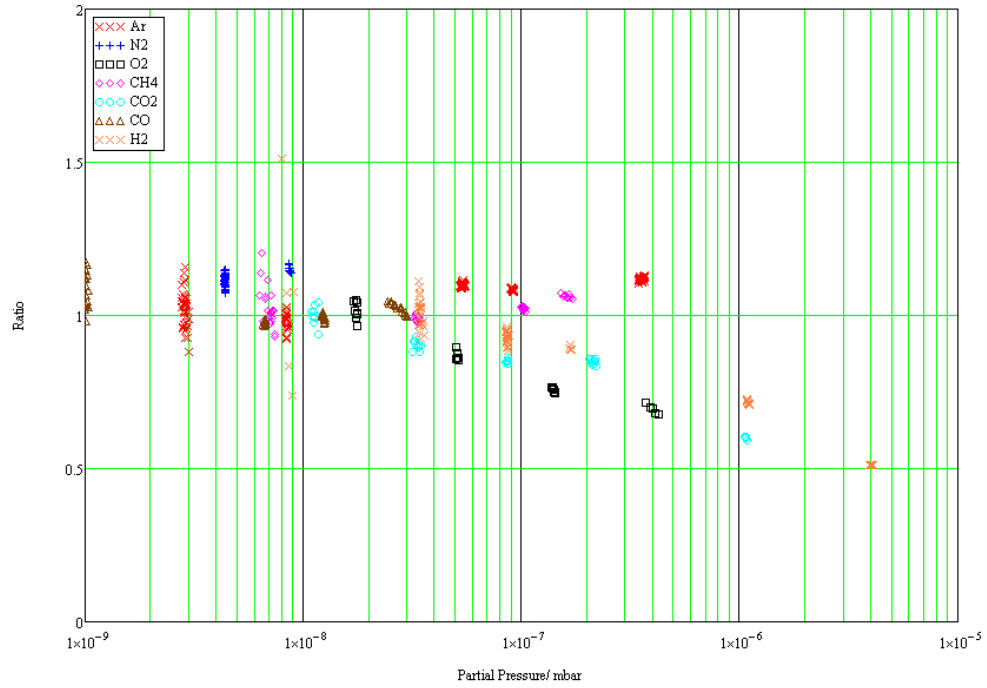
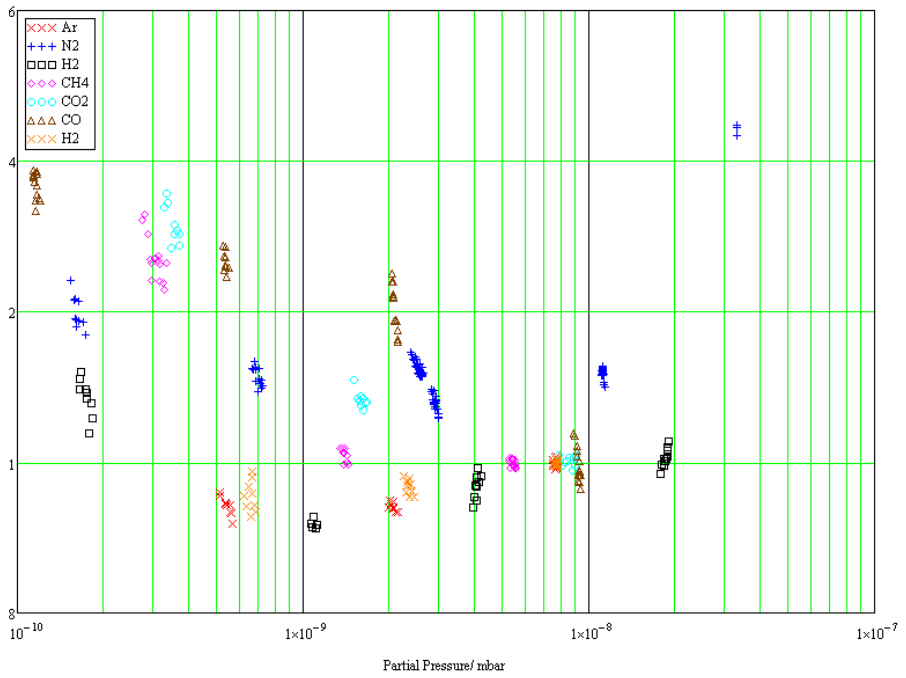
MKS FAR



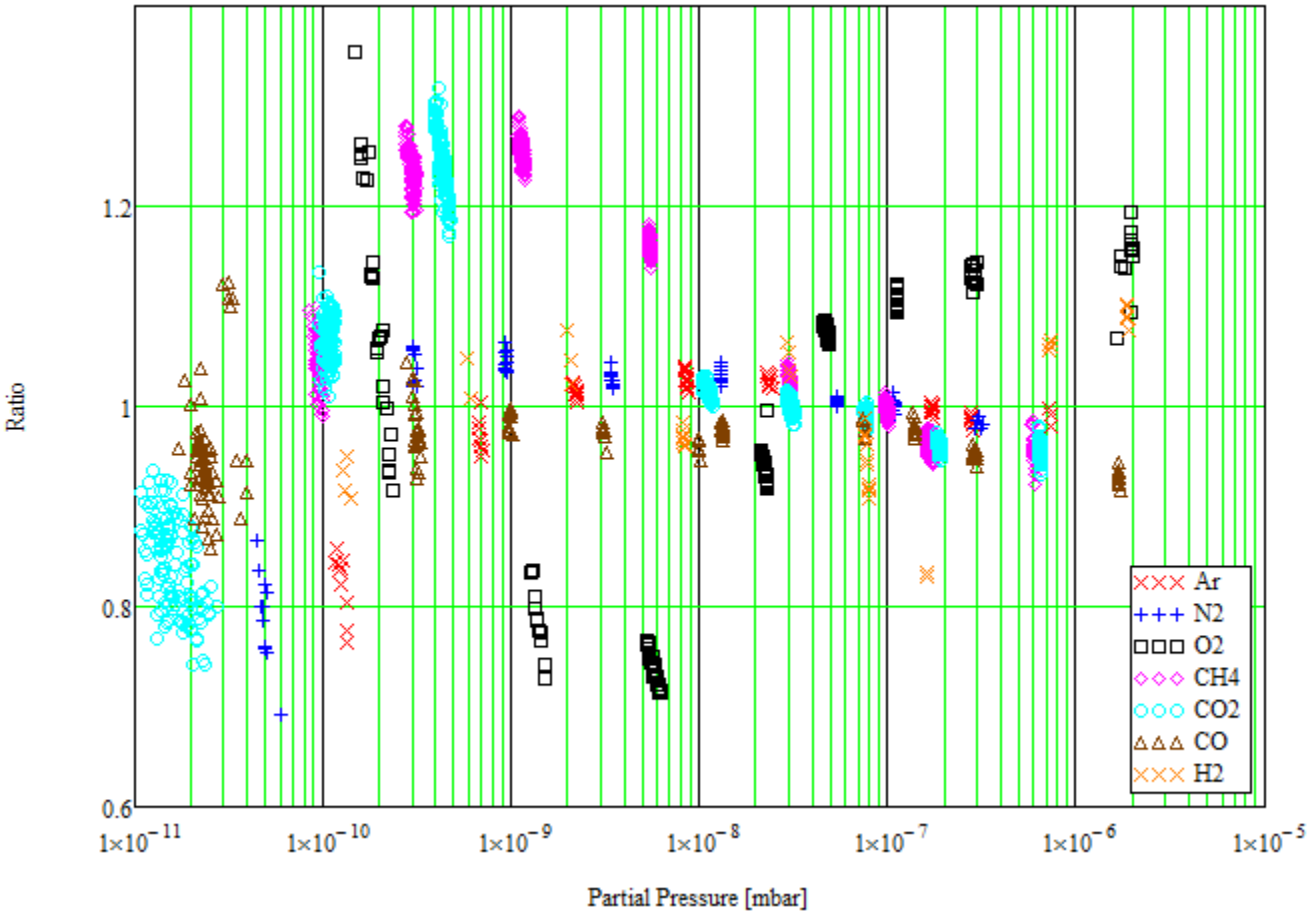
MKS SEM



CH_4 +/- 5% H_2 +/- 25%

Ar +/- 25 % Co + 40%

ION TRAP RGA



- Measuring the ratio between currents

Conclusions

- Work recently performed - preliminary results highlighted.
- 1st effort utilising the secondary gauge calibration facility to Compare the 3 RGAs
- Faraday mode producing similar results for Hiden and MKS
- Ion trap RGA looks linear at pressure greater 1e-9mbar +/- 20 %
- At best results 10 – 20% requirement for user community to get this number lower
- Work to continue comparing the 3 instruments.

Acknowledgments

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Thank you..