Performance characteristics of the Nu Astrum

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Nu Instruments

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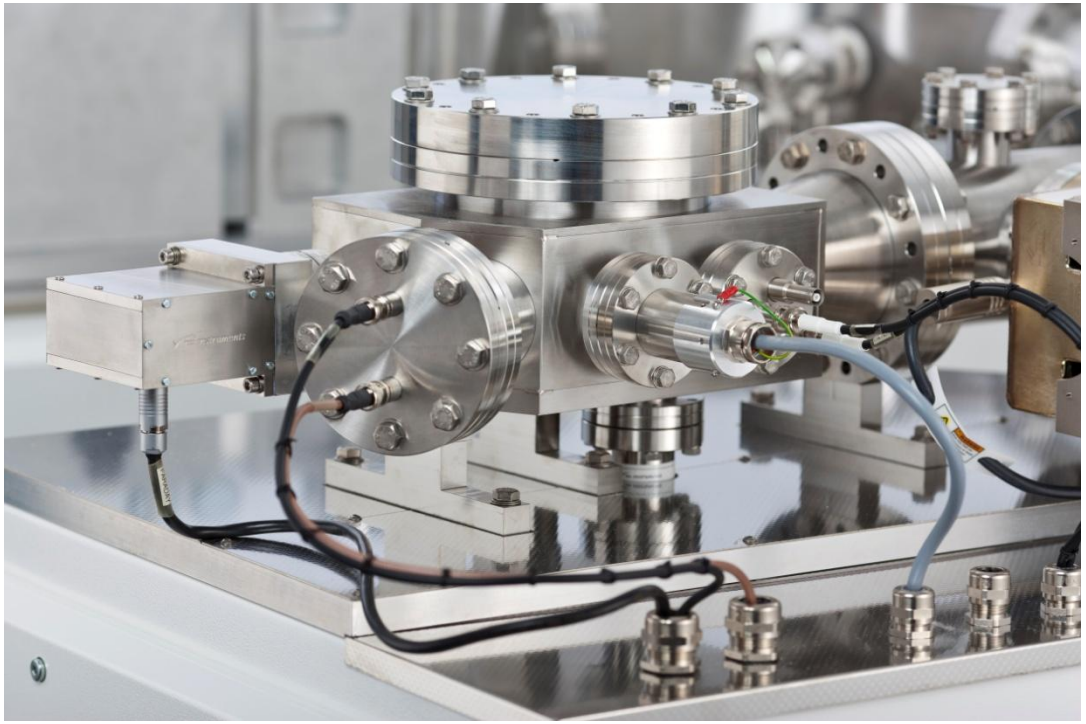
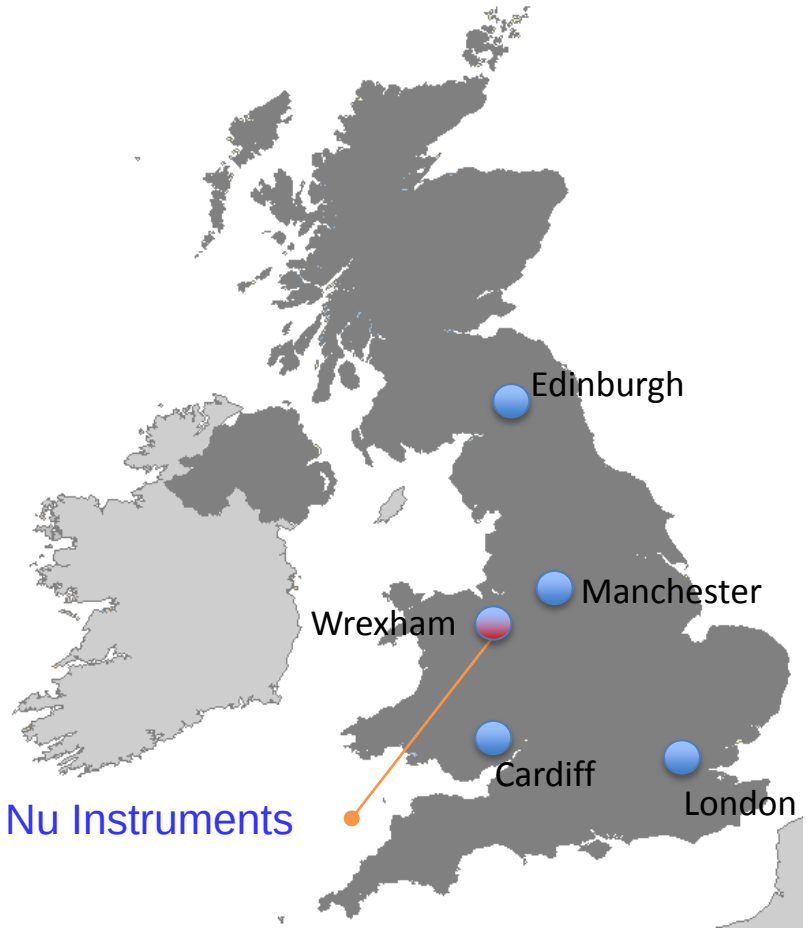
The Astrum

- We've already heard some great talks that mention work done on the Astrum
- I won't be going over the same ground
- This talk is more about how we arrived at the Astrum



Just one slide about the company…



- We're a company of about 100 people
- Based in rural North Wales (sheep >> people)
- The company was started in 1996 (ish)
- For the first five years we were ICP-MS only
- Then came Noble gas, IRMS……..

- GD-MS is quite a recent thing, from 2010 onwards

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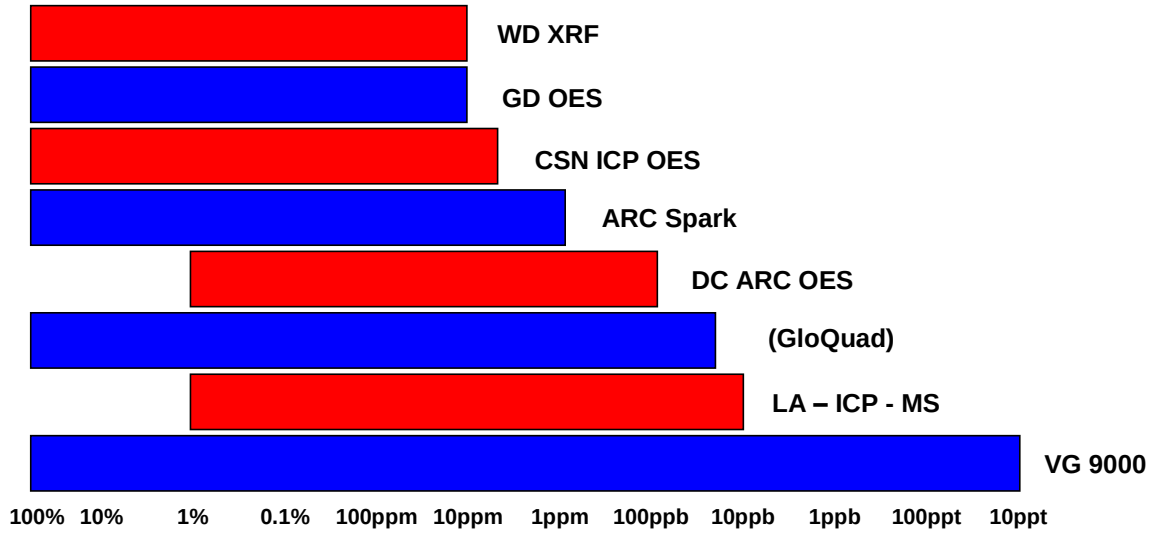
Why GDMS?

- Direct solids analysis
- Full elemental coverage at all concentrations
- Unrivalled sensitivity
- Linear calibration plots
- Minimal matrix effects

- …but you knew all this already



Dynamic range chart courtesy of VG circa 1990

The ‘tried and trusted’ VG 9000 GDMS

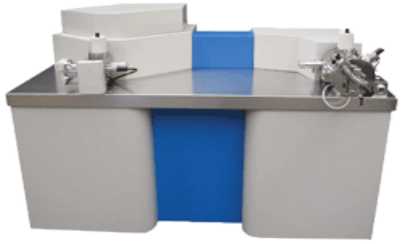
- **Manufactured by VG in UK 1985 – 2002**
  - Total of around 80 made
  - All were double focussing except the first system
  - >50% of these in Japan
  - The “Gold Standard” in direct solid bulk analysis
  - The mainstay of GD-MS for many years
  - Many are still in use

Why did Nu Instruments develop a GD-MS?

- VG9000 production stopped in about 2002
- Other instruments have nicely filled the gap

- However, double focusing inorganic MS is what we do best
- We did some market research
- We wanted to find out what Nu Instruments could offer

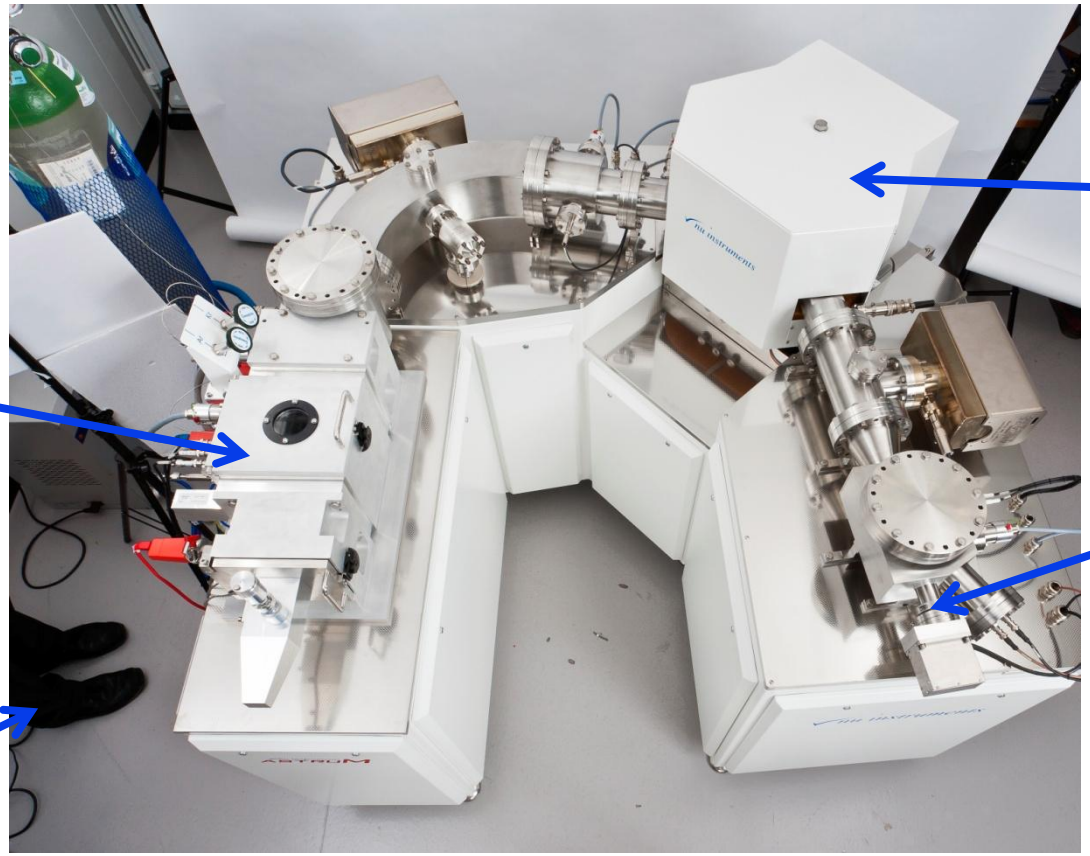
- To our big surprise, in several cases, the answer was:
- “Build us a VG9000!”
- That’s why we took design pointers from the VG9000



Nu Astrum: The New GD-MS

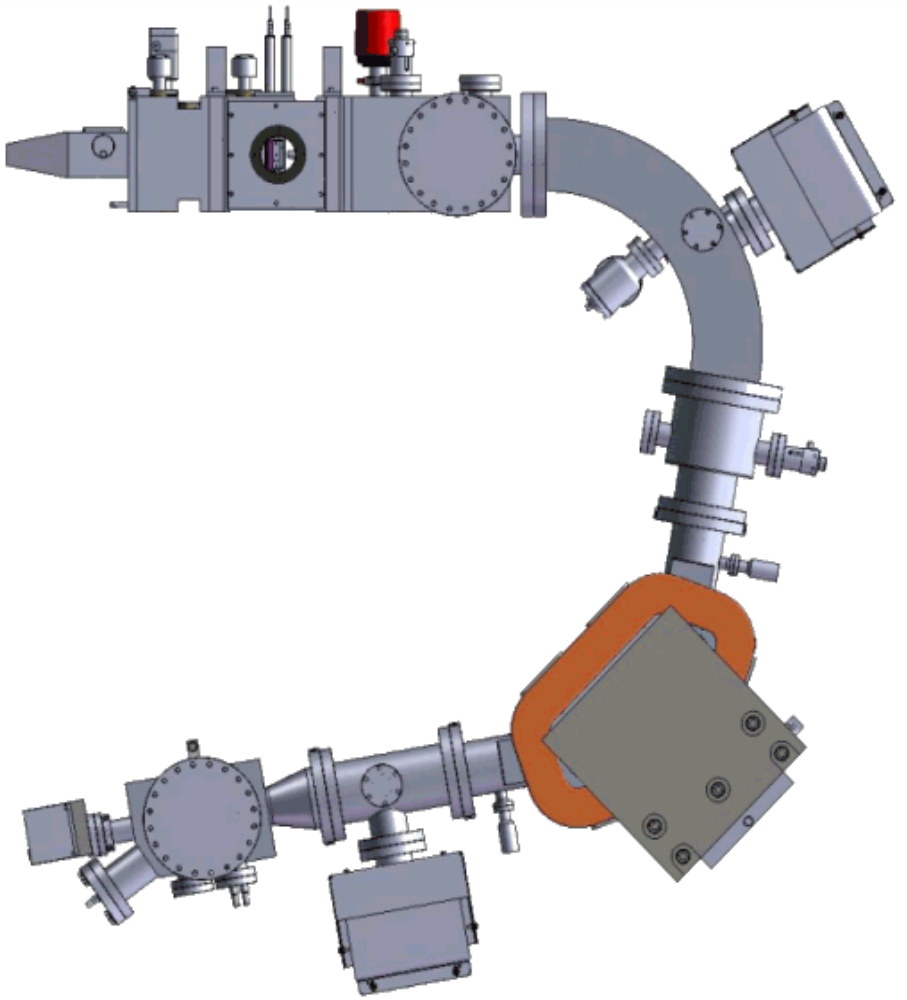
To give you some size perspective, the bench is 0.881 VG9000's in height

Nu Astrum: viewed from above



Outline of Key Features

- GD source based on proven technology
- Pin/flat samples, easy sample changeover
- Cryo-cooling of source region
- Low gas backgrounds
- Variable high resolution capabilities
- Large dynamic range
- New software suite



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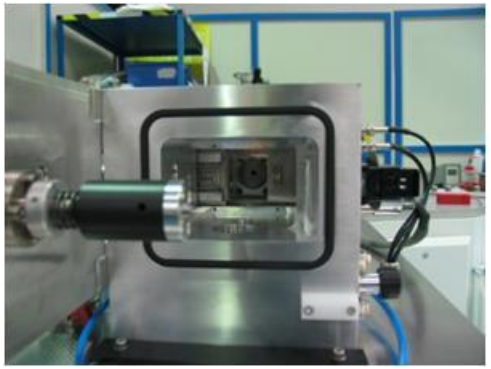
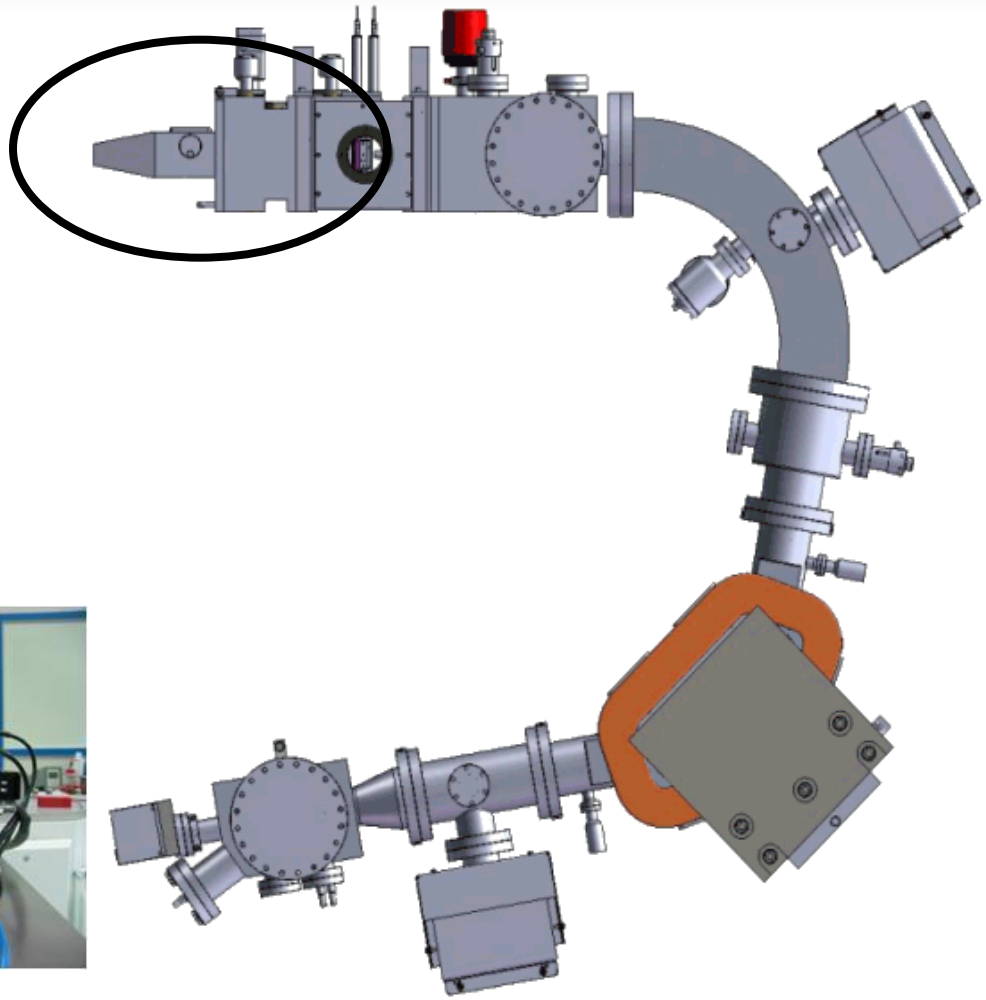
The Source

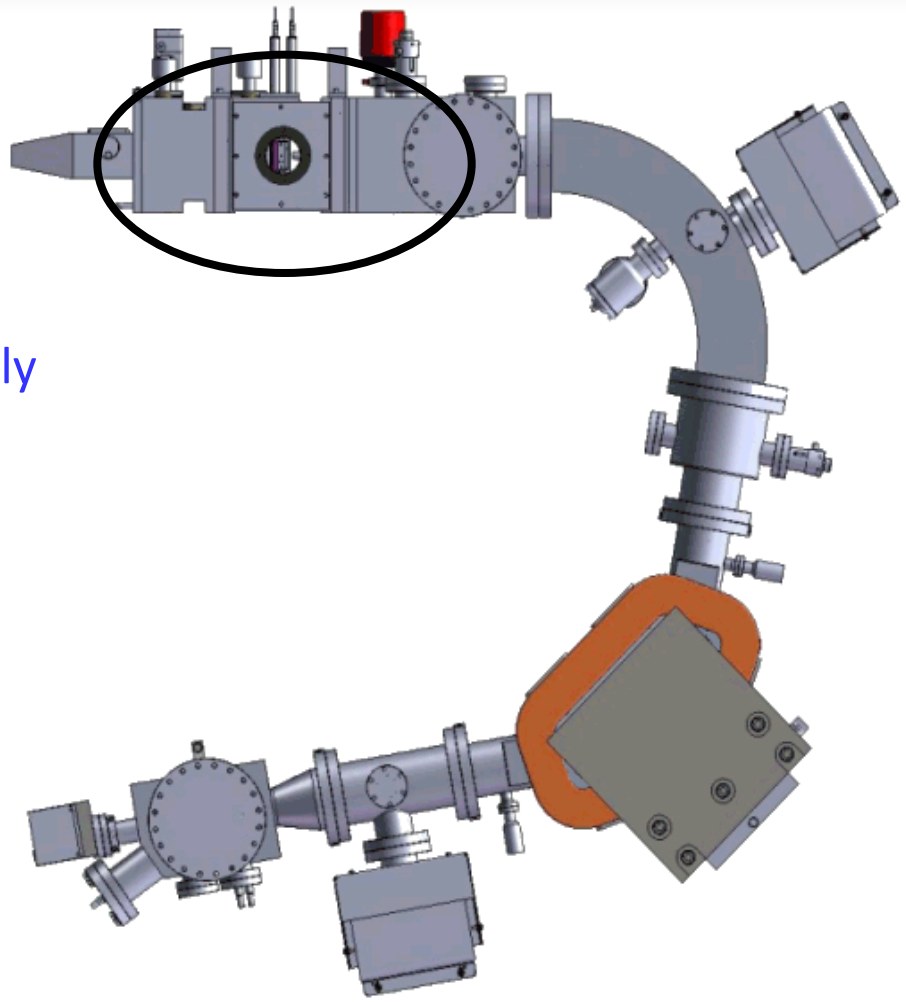
- Low pressure static discharge
- Similar benefits to VG9000 source
- Argon flow rate typically 0.2 sccm
- Positioning of the sample loading chamber is much lower than VG9000
- Long sample loading arm is not required





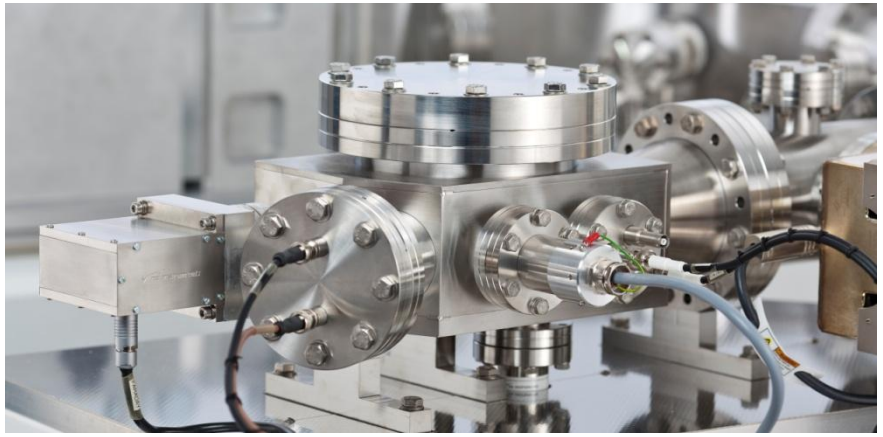
The Sample Cell

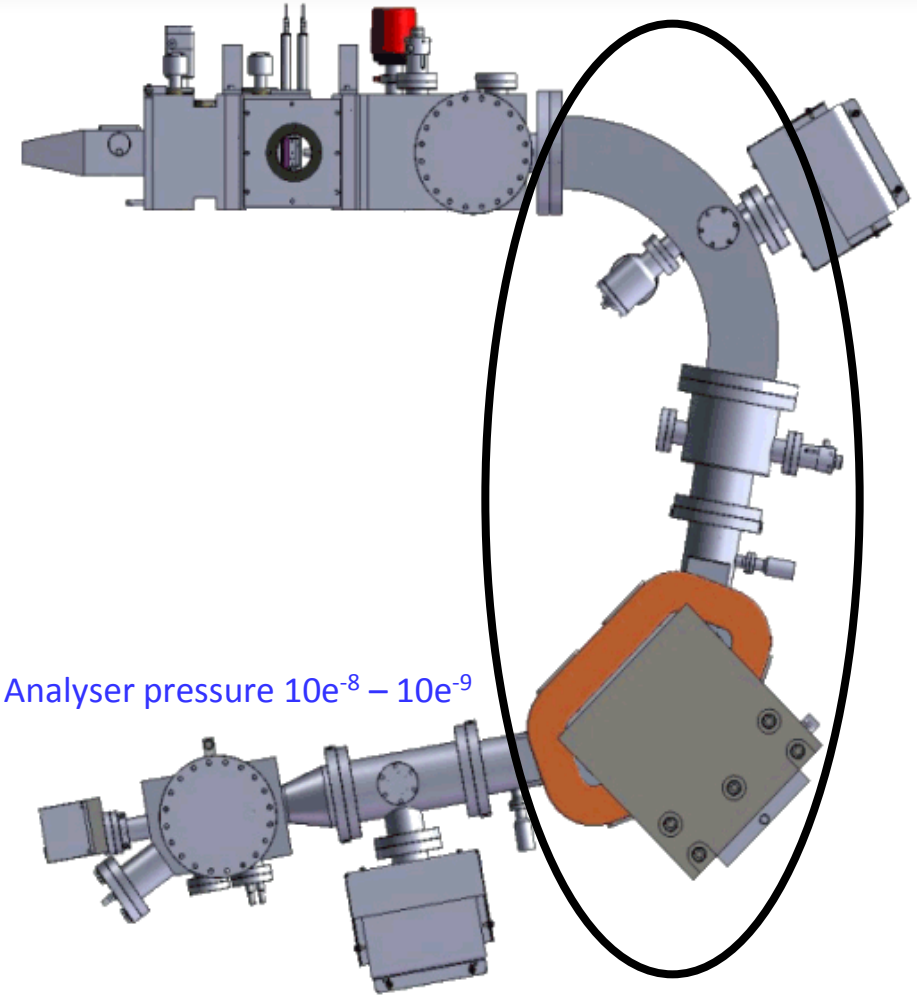
- The sample cell is tantalum
- Pin cell only initially (flat cell now as well)
- The source design minimises cross contamination from samples
- The cell is simple to remove and can be easily cleaned (*more on this later*)
- Short pump-down time after re-insertion of source and/or cell



The Analyser

- Metal seals and stainless steel construction
- Analyser is ion pumped
- Extraction lenses and ion optics designed to minimise contamination
- Abundance sensitivity <<1ppm (at m/z 63)
- Fast, stable electromagnet
- Faraday detector
- Full size discrete dynode electron multiplier





Analyser pressure $10e^{-8}$ – $10e^{-9}$

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Sample Cell Cleaning

Element	Isotopes Measured	ppm
Mg	24	0.0001
Al	27	0.0054
Cr	52	0.0008
Mn	55	0.0003
Fe	56	0.0033
Ni	58, 60	0.0010
Zn	68	0.0228
As	75	0.0052
Ag	107, 109	0.0018
Pb	207	0.0026

Concentrations of ten elements measured in a high purity Cu sample using the Astrum

Element	Isotopes Measured	ppm
Mg	24	0.0006
Al	27	0.0026
Cr	52	0.0008
Mn	55	0.0005
Fe	56	0.0003
Ni	58, 60	0.0008
Zn	68	0.0162
As	75	0.0027
Ag	107, 109	0.0026
Pb	207	0.0028

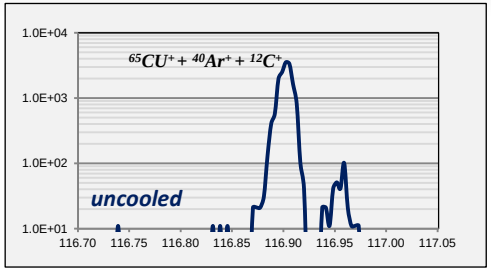
Concentrations measured in the same sample following analysis of a Zn sample and a cell cleaning procedure

- GD-MS instruments can suffer from memory
- Due to contamination of the cell or ion optics
- We have tried to minimise this with the Astrum
- The first data set shows a bulk Cu sample
- The Zn is measured at 23ppb

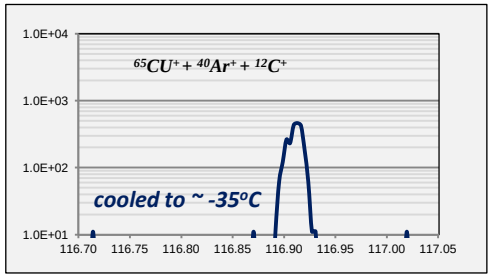
- A bulk Zn sample was then analysed, followed by a simple cell clean
- The same Cu sample was then re-analysed
- The Zn is measured at 16ppb

- Memory effects from one matrix to another can be minimised with a short cleaning procedure.

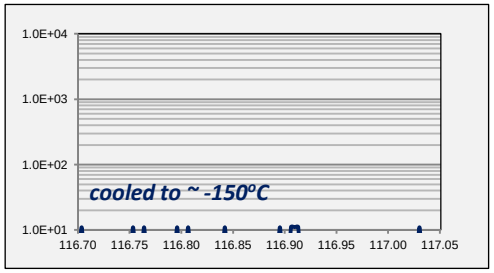
Sample Cell Cooling



(i)



(ii)

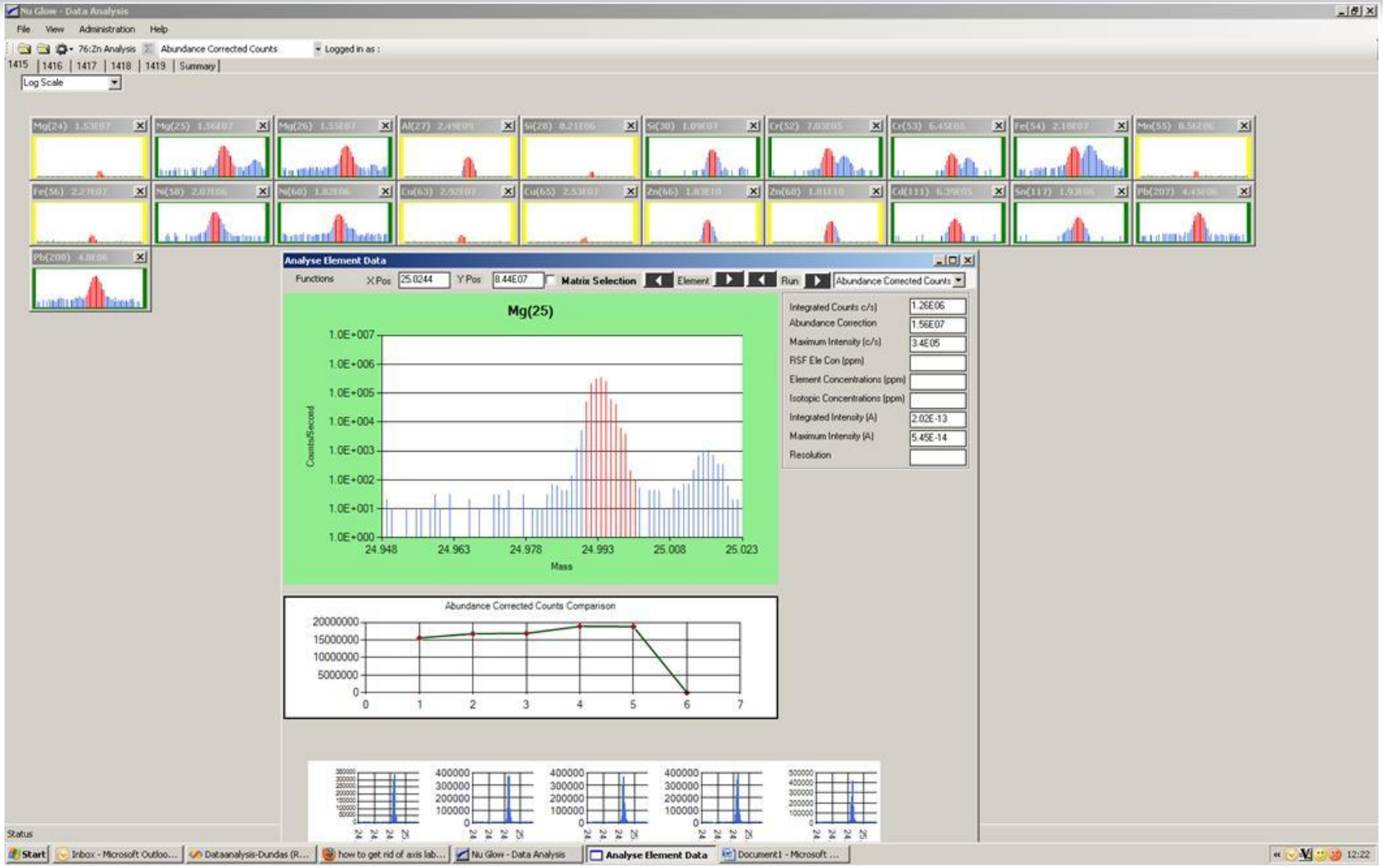


(iii)

Mass scans for tin with the sample cell (i) uncooled, (ii) cooled to ~ -35°C, and (iii) cooled to ~ -150°C. The peak corresponds to $^{65}Cu^{+} + {}^{40}Ar^{+} + {}^{12}C^{+}$

- Liquid N_2 cooling of the sample cell is standard on the Astrum
- It helps to reduce background gas peaks
- The figures show scans of Sn117 in bulk Cu taken under the following conditions:
  - (i) sample cell uncooled
  - (ii) sample cell cooled to typical Peltier temperatures (-35°C)
  - (iii) sample cell cooled with liquid nitrogen
- The peaks are molecular gas peaks (Sn not visible)
- Lower temperatures make a significant difference to the gas backgrounds
- Useful for the analysis of low melting point materials.

Nu Astrum Software



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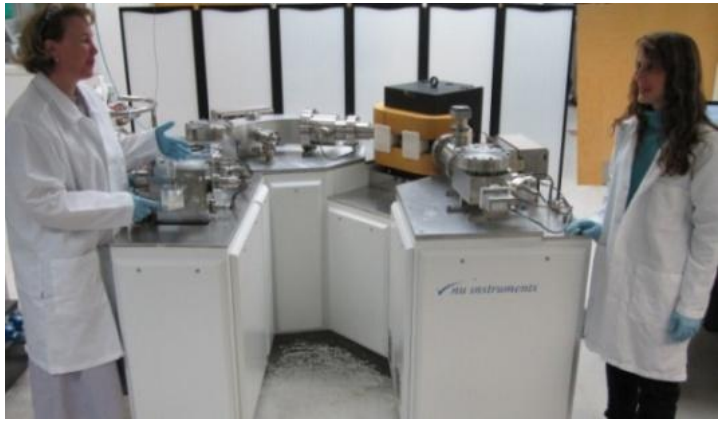
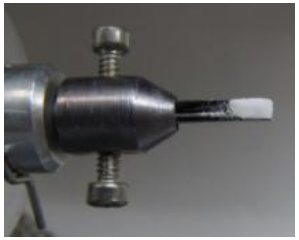
Astrum: First installation

- The photo shows the first instrument during installation in Syracuse, New York

Astrum: First Users

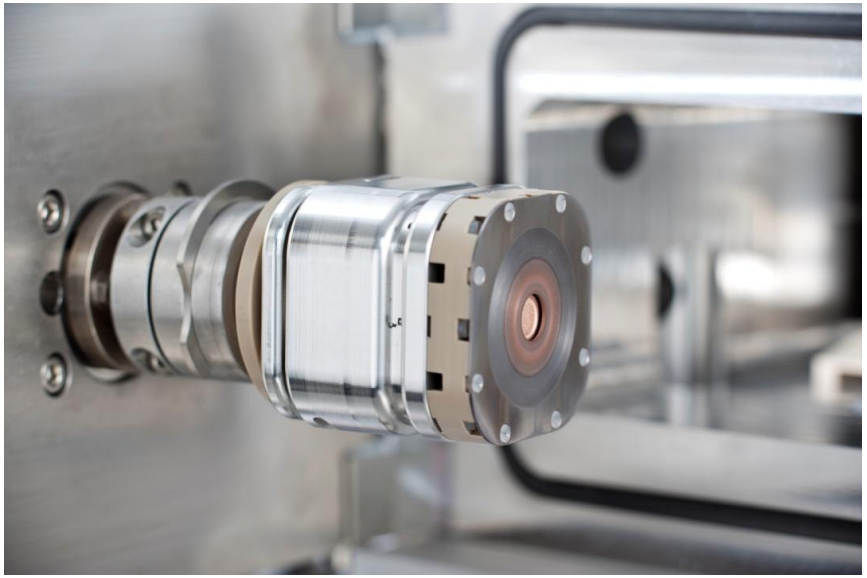
- The first Astrum users are EAG (Evans Analytical Group) in the USA
- They use the instrument routinely for contract sample analysis
- They are also undertaking developmental research of their own





Astrum: Development

- There are a number of development projects that we have planned
- The first development post-launch was the flat sample cell
- More development projects are being planned



Astrum: Summary

- The Astrum is a new high performance GD-MS
- It uses the best design elements of the VG9000
- It has a novel sample cell design with cryo-cooling
- Gas backgrounds and memory effects are low
- So far it has proved quite popular with its users

- However, there is a lot more development ahead.

A big thank you to the organisers for inviting Nu Instruments

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