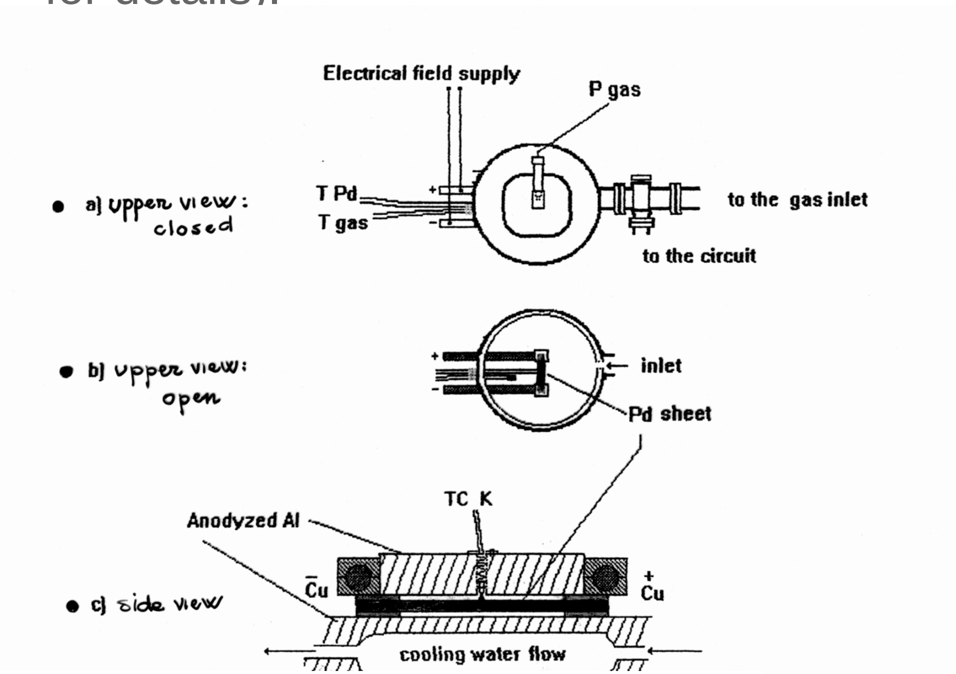
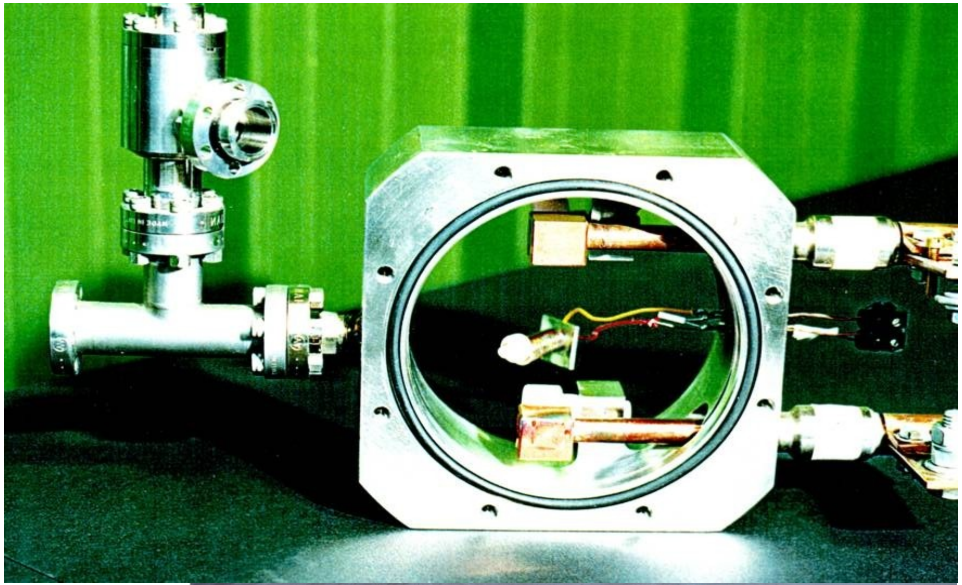
Selected images
from projects I led or worked with in
Physics - Engineering - R&D

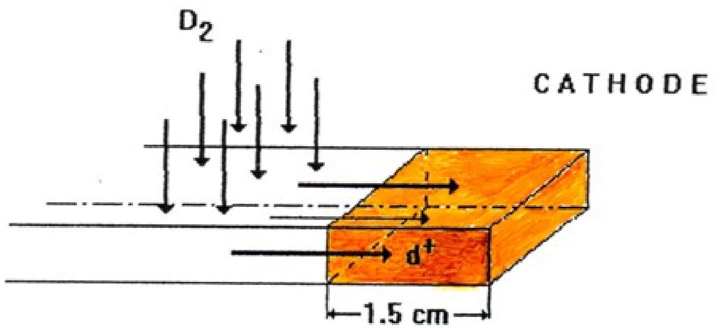
- Nuclear physics in solids (metals)
- Plasma physics
- Industrial plasmas on optics components
- pulsed discharges for EUV
- pulsed discharges for security (n, γ interrogation on luggage, parcels...)

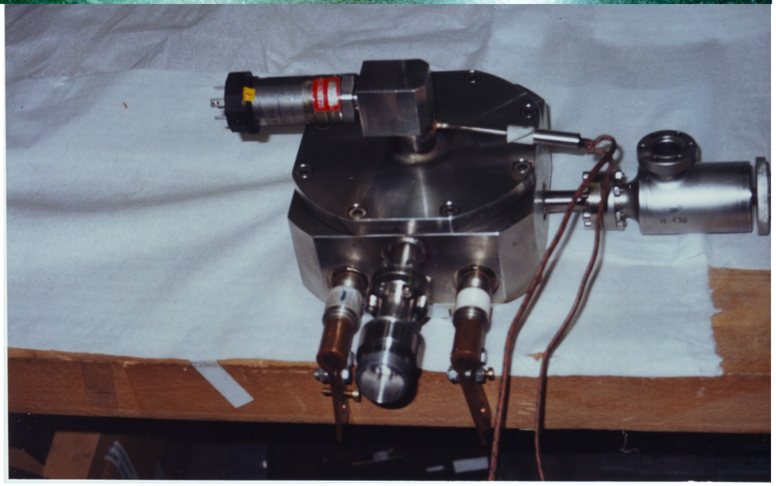
Project : HEPA (1994 – 1997 INFN / FIAT AVIO Turin, italy)

Context : determination of ashes from nuclear reactions potentially occurring in solid state (noble metals / alloys) after deuterium absorption in the gas phase. Deuterium absorption in gas phase is enhanced via electromigration (EM), by applying an electric field between the two extremes of a noble metal lamina, clamped between the electrodes. The lamina is gold plated at the extremes, to prevent desorption whilst subject to the electric field. I constructed the cell and related UHV parts (and designed and ran a diffusion +EM model - contact me for details).





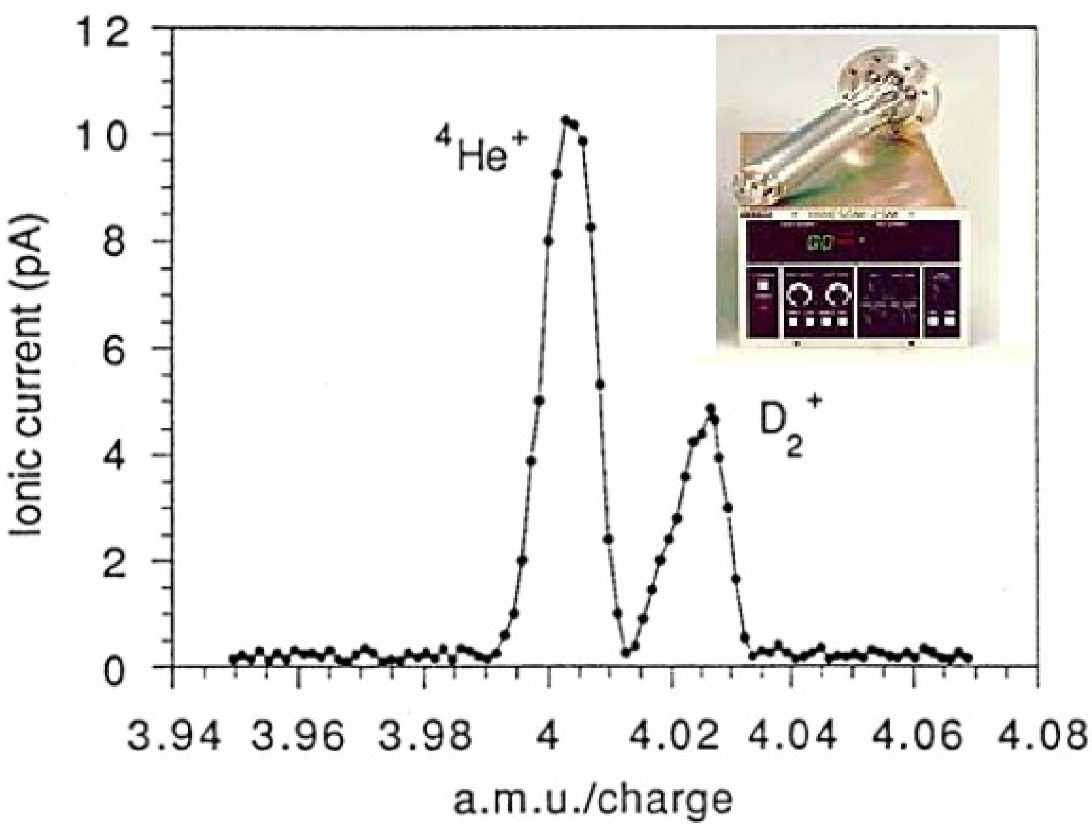




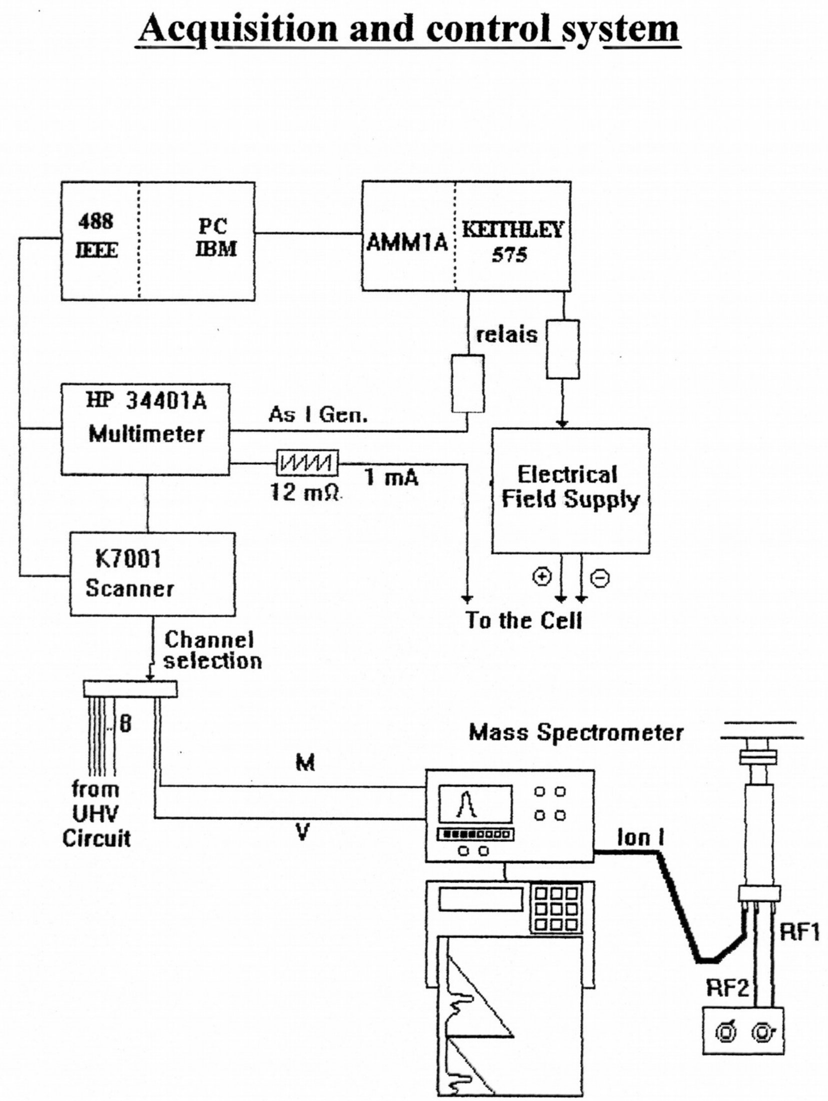
1997, at INFN Turin, Italy.

Project : HEPA (1994 – 1997 INFN / FIAT AVIO Turin, italy)

Context : determination of ashes from nuclear reactions potentially occurring in solid state (noble metals / alloys) after deuterium absorption in the gas phase. Detection techniques : double n-p scattering, gamma (Ge-detector), ultra high resolution (sub-amu) mass spectrometry

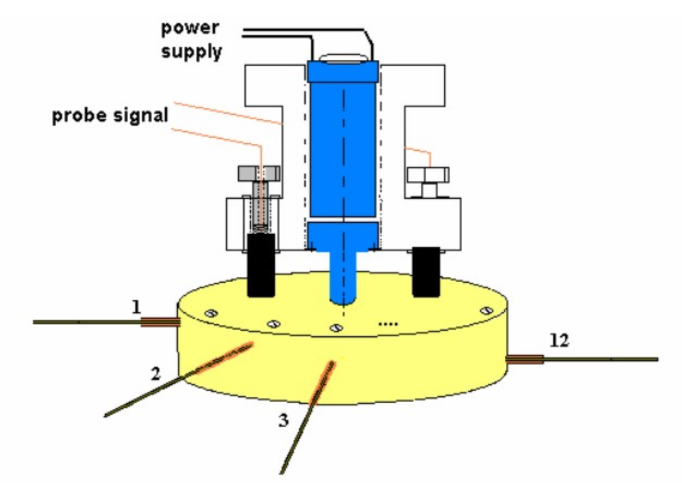


1997, at INFN Turin, italy. Discrimination between D_2 and ^{4}He with ultra-high resolution quadrupole (Hi-RESOM 200, Ulvac Japan, M/ΔM=200)



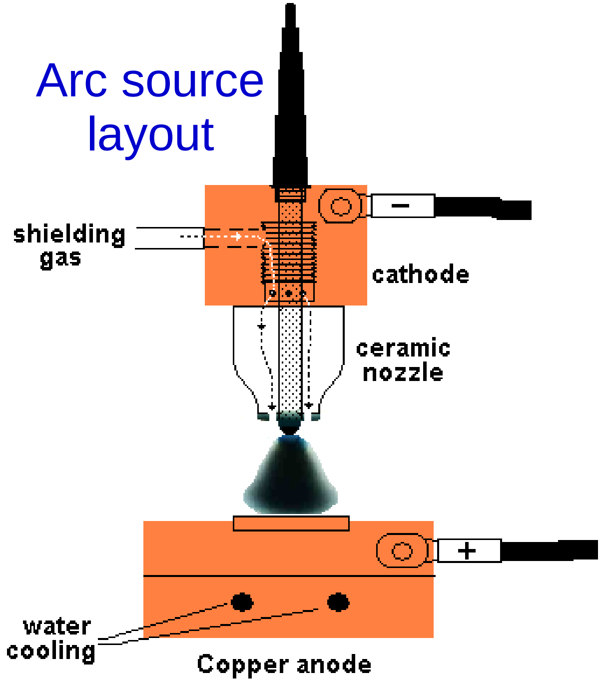
Project : Arc Physics (1999 – 2004 Cranfield University)

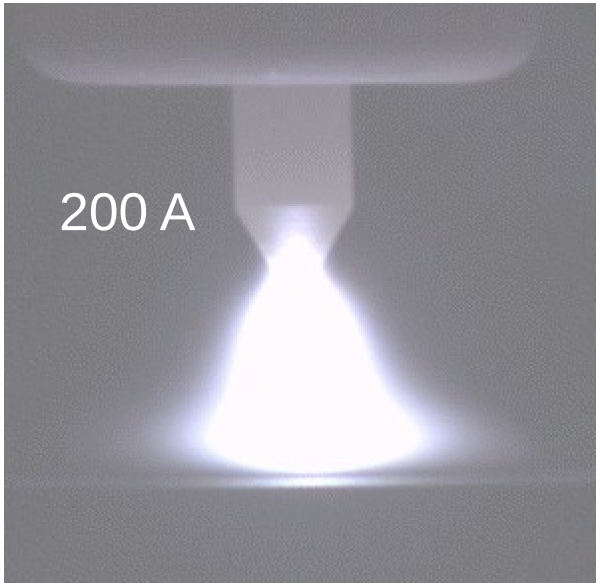
Context : Determination of electrical and thermal structure of amospheric pressure TIG arcs in Ar and mixtures using electrical probes. Study of demixing. Several EPSRC funded projects. School of Industrial and manufacturing sciences, later School of Applied Sciences, Cranfield University.



Multi probe system

Arc source layout



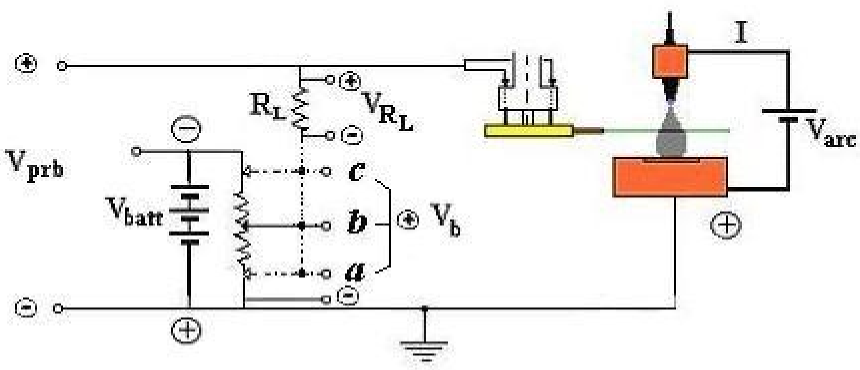


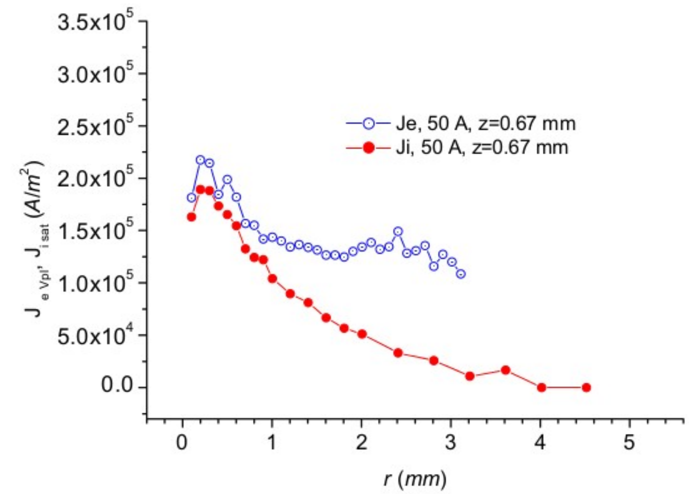
2005, at Cranfield University (WERC), UK – Electric dc Arc and mult-Langmuir probe system, for the characterisation of atmospheric pressure arc plasmas (designed and constructed by me).

Project : Arc Physics (1999 – 2004 Cranfield University)

Multi probe system

Probe bias circuit

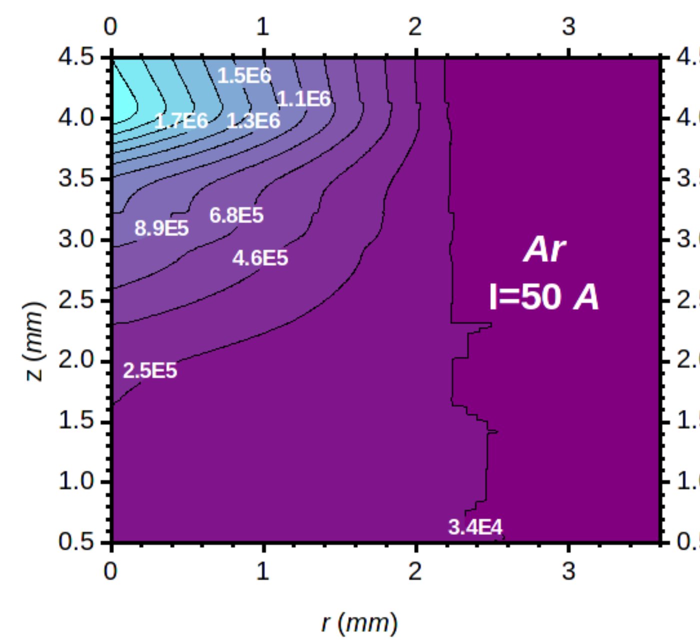




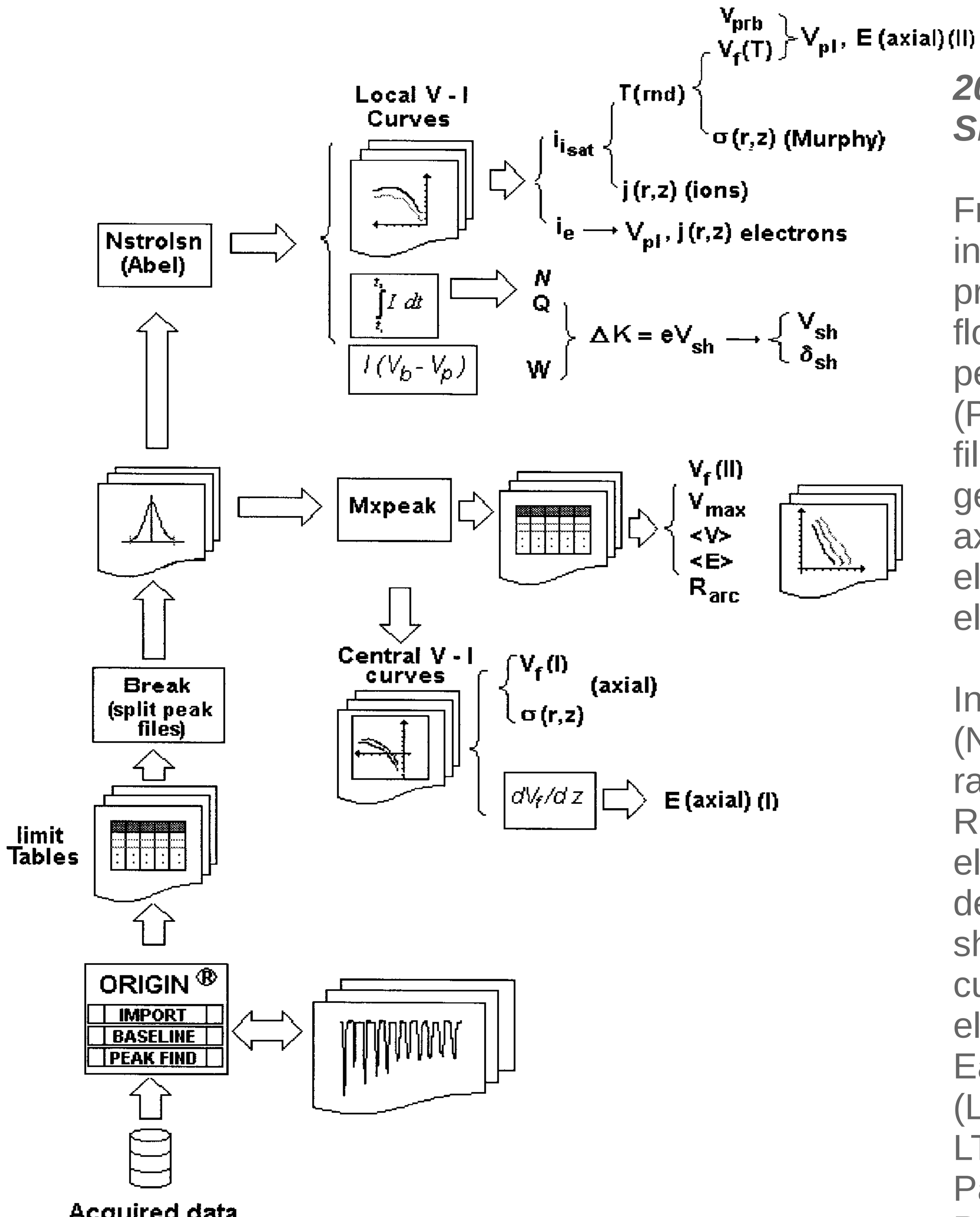
2005, at Cranfield University (WERC), UK – electric dc Arc and Multi-Langmuir probe system, for the characterisation of arc plasmas.

Above, probe and its circuit (designed and constructed by me).

Right, top : the Ion and electron radial current density from a low current (50 A) arc, obtained with the multi-probe at a fixed distance from the Anode (0.67 mm).
Bottom, a 2D distribution (contour plot) for the electron current density from a low current (50 A) arc (geometry: the z axis coincid with the arc axis; vertical distance, z=0 (anode) to 5 mm (cathode) r, radius from the arc central axis)



Project : Arc Physics (1999 – 2004 Cranfield University)



2005, at Cranfield University (WERC), UK.
Sketch of the data Analysis flow

From bottom to top : read out of acquired data into Origin. via dedicated script; production of probes electrical peaks plots in (electrically) floating conditions. Characterisation of the peaks and production of peak feature tables (Per campaign). Splitting into individual peak files and analysis of features (peak statistics, geometry). From those tables: computation of axial characteristic curves, average arc electric potentials and electric field, arc electrical radius.

Individual peaks properties. Use of Abel inversion (Nestor Olsen method) to reconstruct the arc radial characteristics and to determine :
Radial characteristic curves, plasma potential, electric charge, number of particles (particle densities), energy transferred to the probes, sheath potential and thickness, electron and ion current densities, electron and ion temperatures, electrical conductivity.
Each step is realized by an *ad-hoc* script (LabTalk) or program (C language)
LTE (Local Thermodynamical Equilibrium) or Partial LTE is assumed for the transport Parameters.

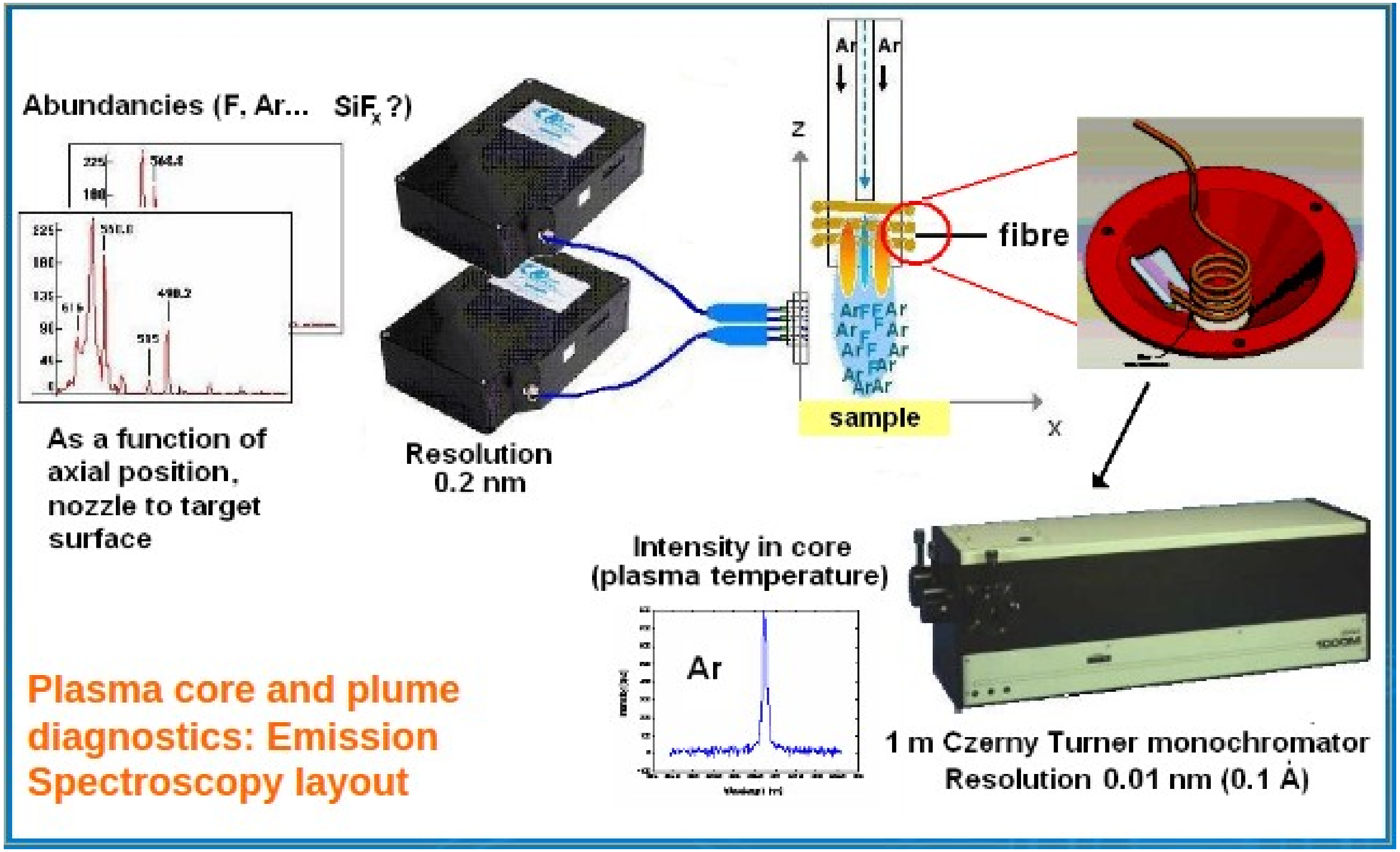
Project : RAPT (2005 – 2008 - Cranfield University)

Context: Ultra high precision finishing of optical surfaces for the next generation of large telescopes by means of atmospheric pressure Inductively Coupled Plasma

Figure 26: Model 300 RAPT machine

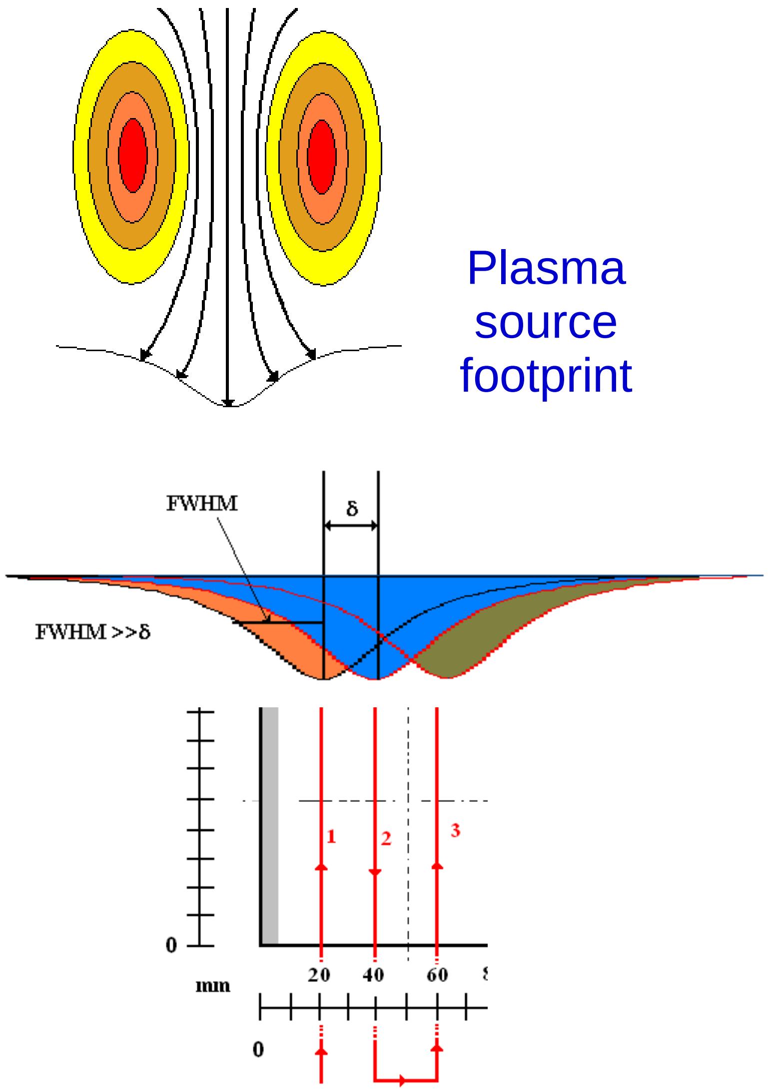
2006-2007, Cranfield University (Hoxam Ultra High Precision Lab). I commissioned the RAPT 300, an ICP (Inductively Coupled Plasma) machine for optical component manufacturing from RAPT Inc in the US . I also installed the scrubbing system (not shown).

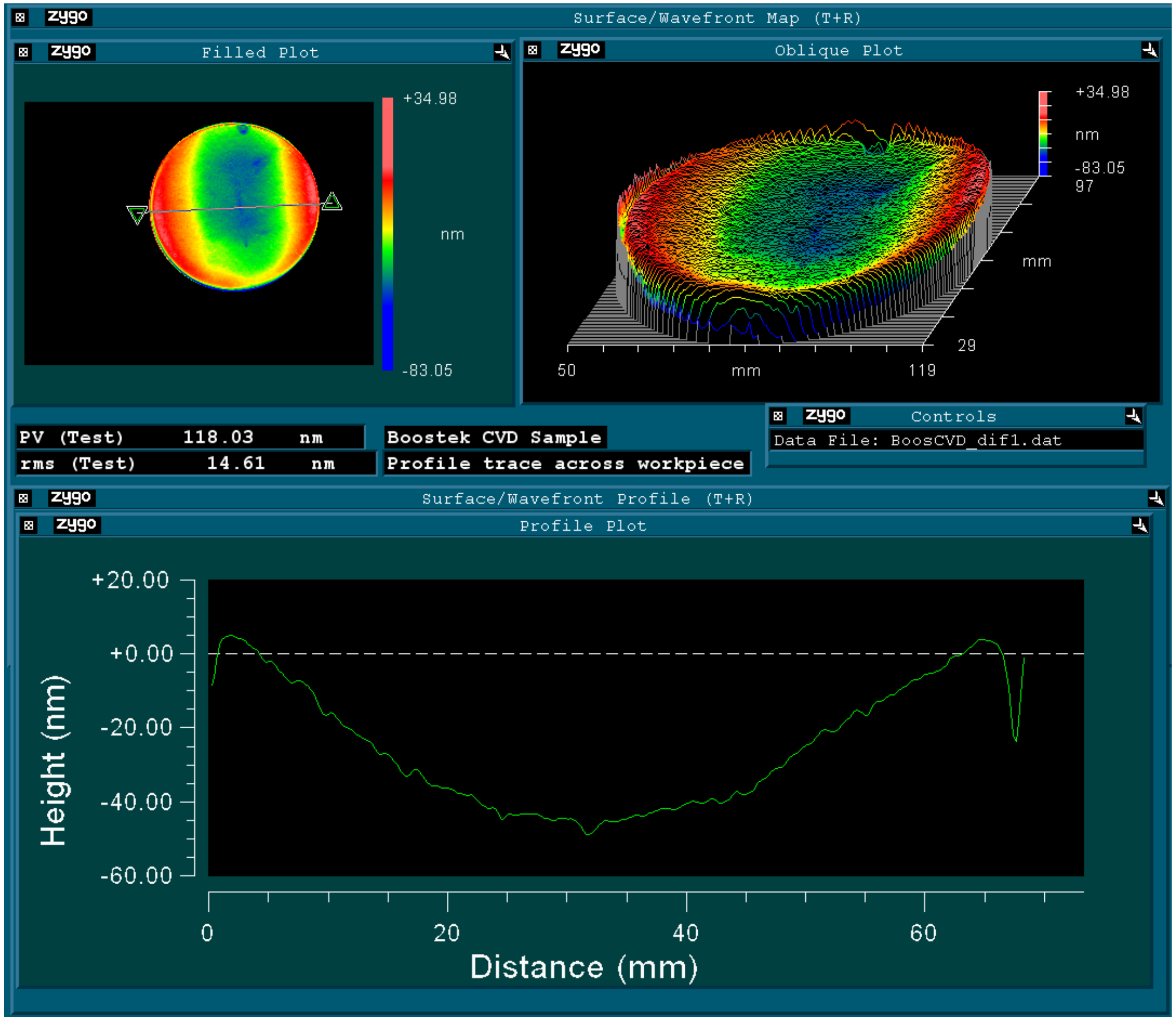
Project : RAPT (2005 – 2008 - Cranfield University)



2007, Cranfield University (Ultra-precision / Hexagon Loxham Lab). I set up the diagnostics for the characterisation of the RAPT 300 ICP machine fof the previous slide, with a dual OES system : high resolution Czerny-Turner monochromator (0.01 nm) for the plasma core ; and a lower resolution System (0.2 nm) for the plume.

Project : RAPT (2005 – 2008 - Cranfield University)



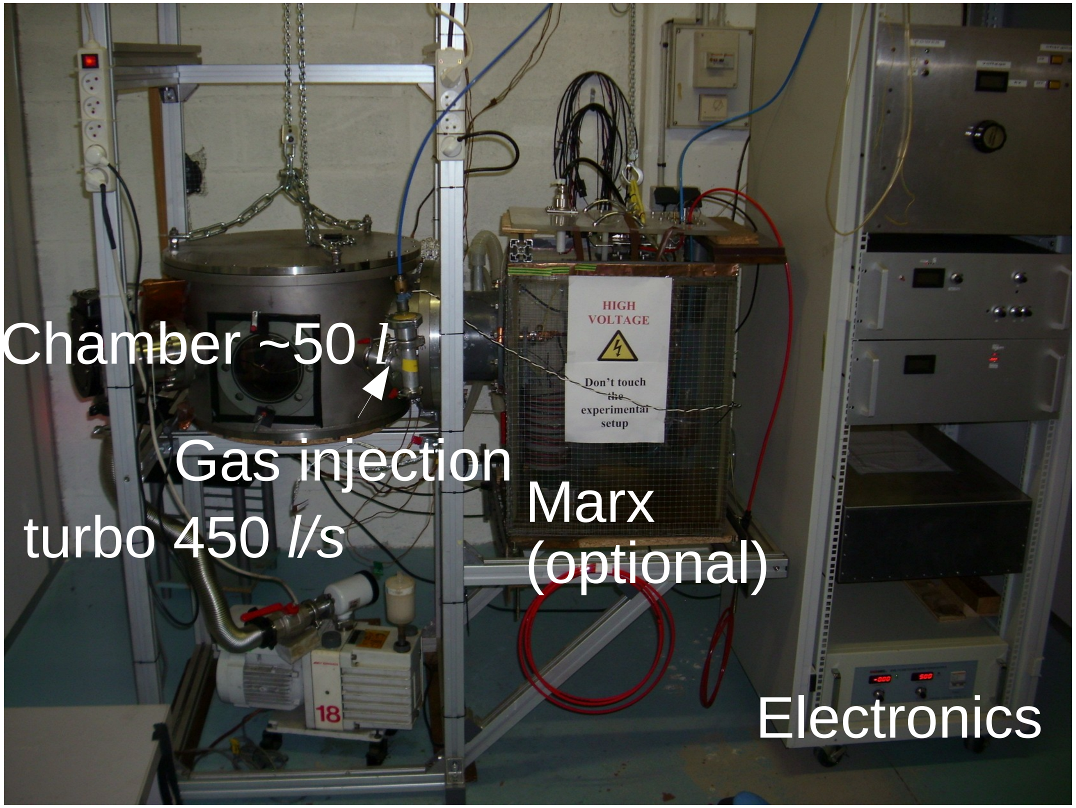


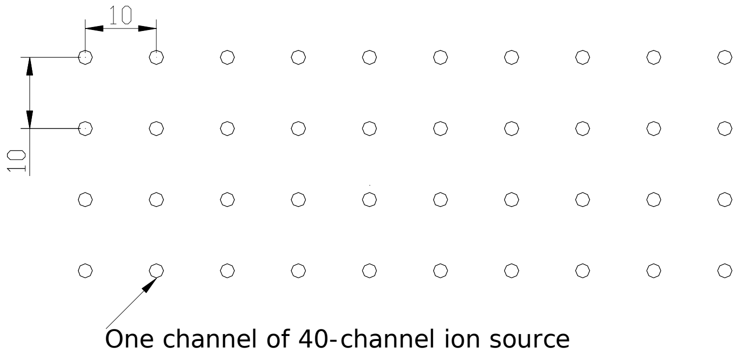
2007, Cranfield University (Hoxam Ultra High Precision Lab). Metrology characterisation of the plasma processed optical surfaces (ULE, Zerodur, SiC) for large telescopes.

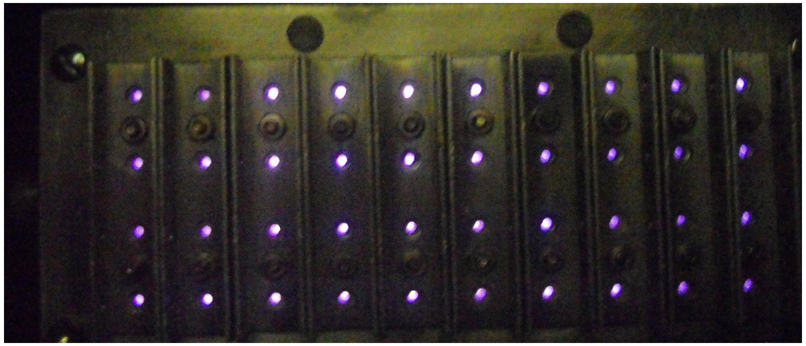
Left, from top to bottom, plasma footprint on a surface and multiple pseudo-gaussian trenches by adjacent passes of the moving source. *Right*, surface footprint of single plasma pass on CVD SiC disk (Zygo interferometer) .

Project : FIMED – EPPRA Sas, France - 2010-2012

Context : ion implantation on Ti-alloys and plastics for the production of medical implant materials (hip prostheses)

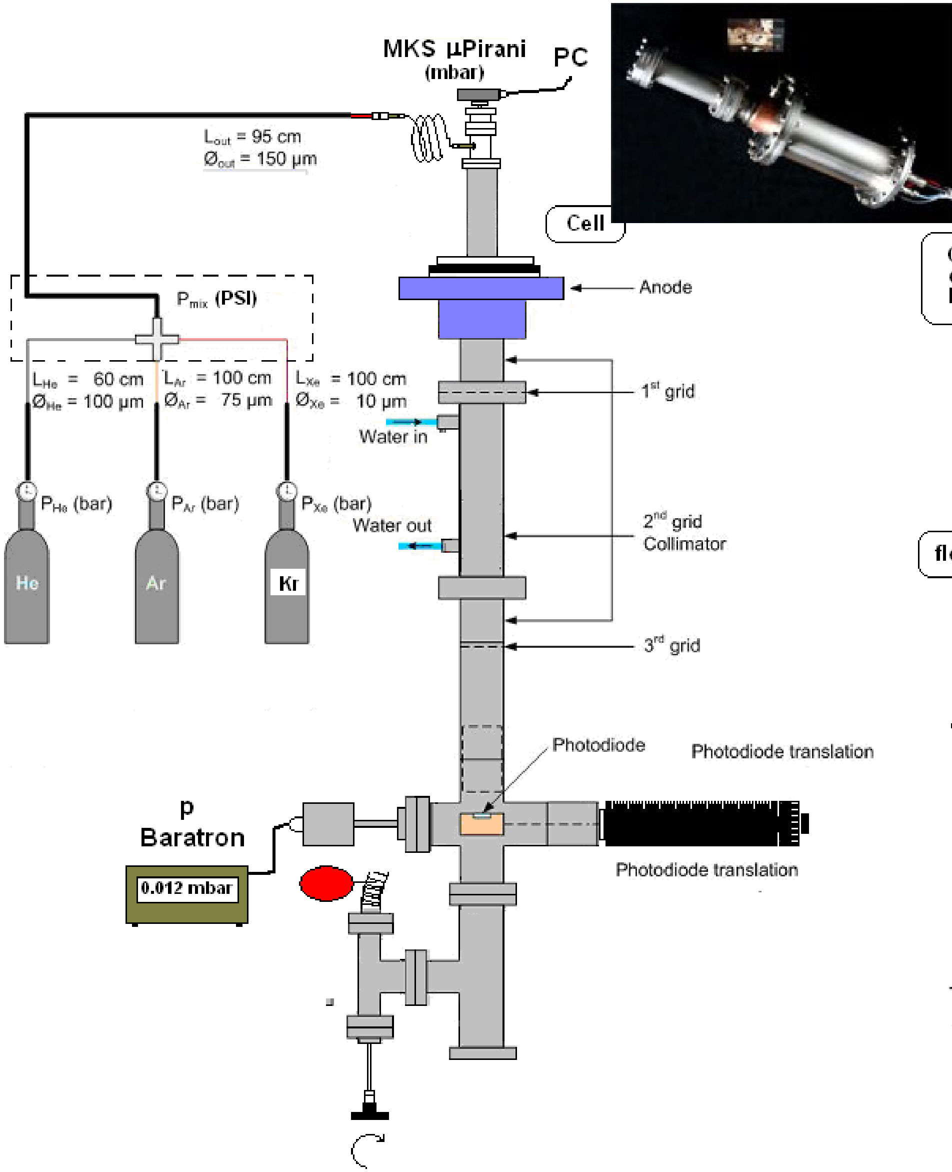


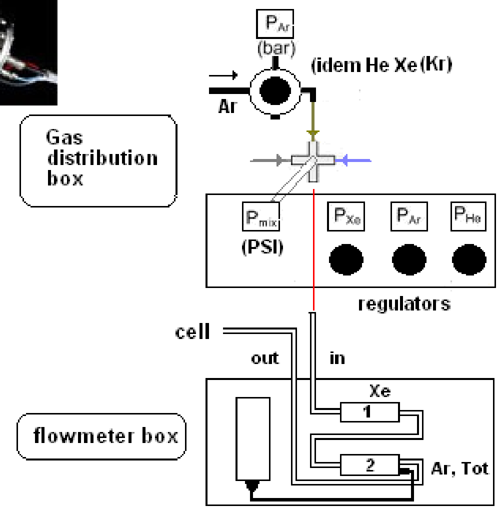


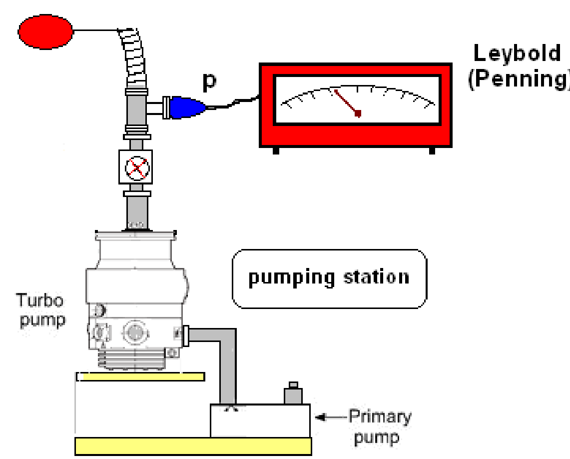


2010, at EPPRASaS, Villebon sur Yvette, Courtaboeuf, France. Left, the HEDI (High Energy Density Ion) Machine. Right, planar Ion beam multi-source for the ion implantation on biomedcal alloys. Top, geometry; bottom, the 40 sources lighted on (EU-MNT-ERANET FIMED project)

Project : HYDRA – EPPRA Sas, France - 2009-2012



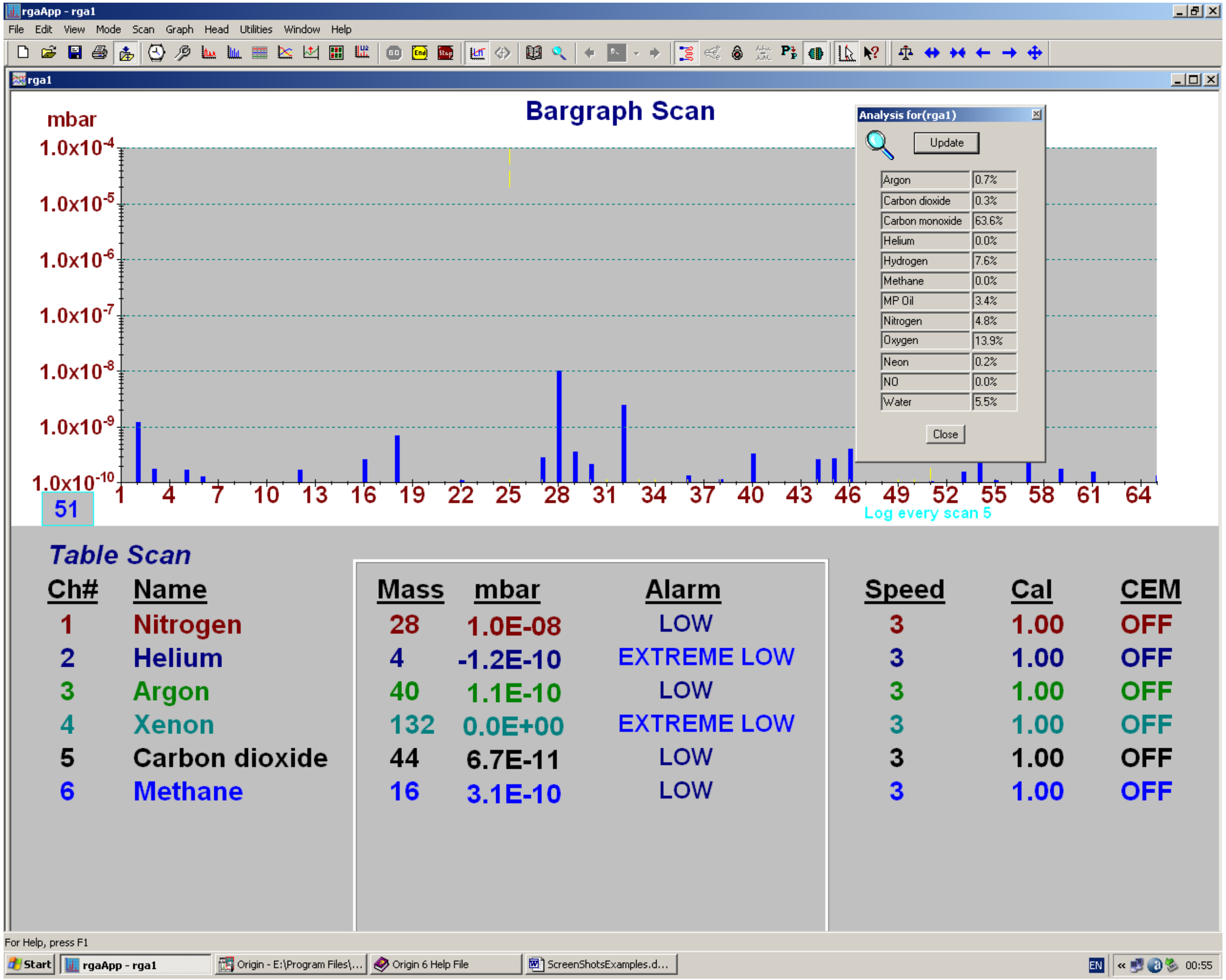




Context: characterization and monitoring of pulsed hollow cathode discharges for the production of EUV light (lithography)

2009, at EPPRA SaS, Villebon sur Yvette, Courtaboeuf, France. Layout of gas calibration system to pulsed hollow cathode discharge (designed and tested by me. Not shown: connections for light detection system)

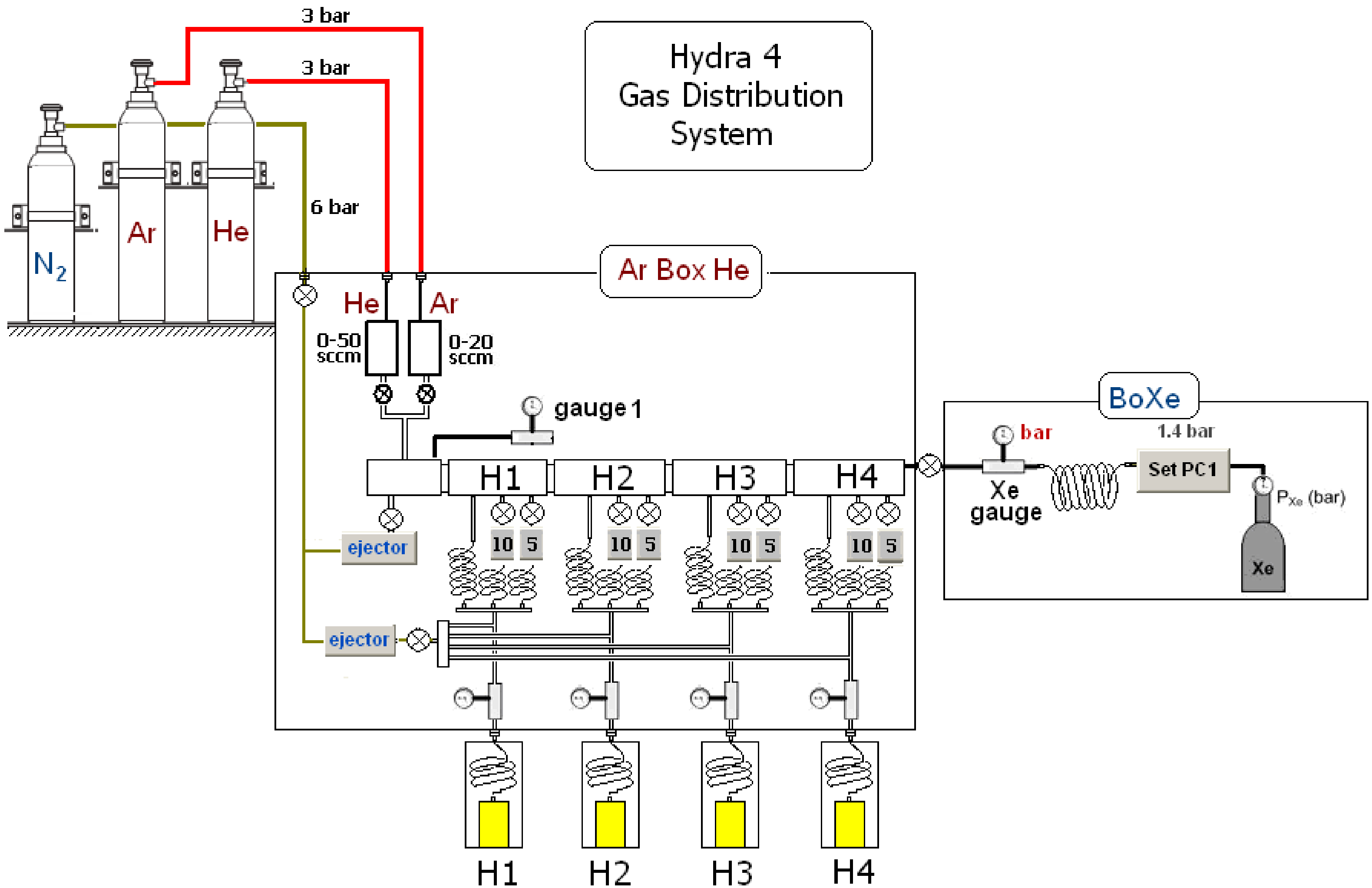
Project : HYDRA – EPPRA Sas, France - 2009-2012



2009, at EPPRASaS, Villebon sur Yvette, Courtaboeuf, France. Control of plasma plasma capillary source chamber contamination with SRS RGA

Project : HYDRA – EPPRA Sas, France - 2009-2012

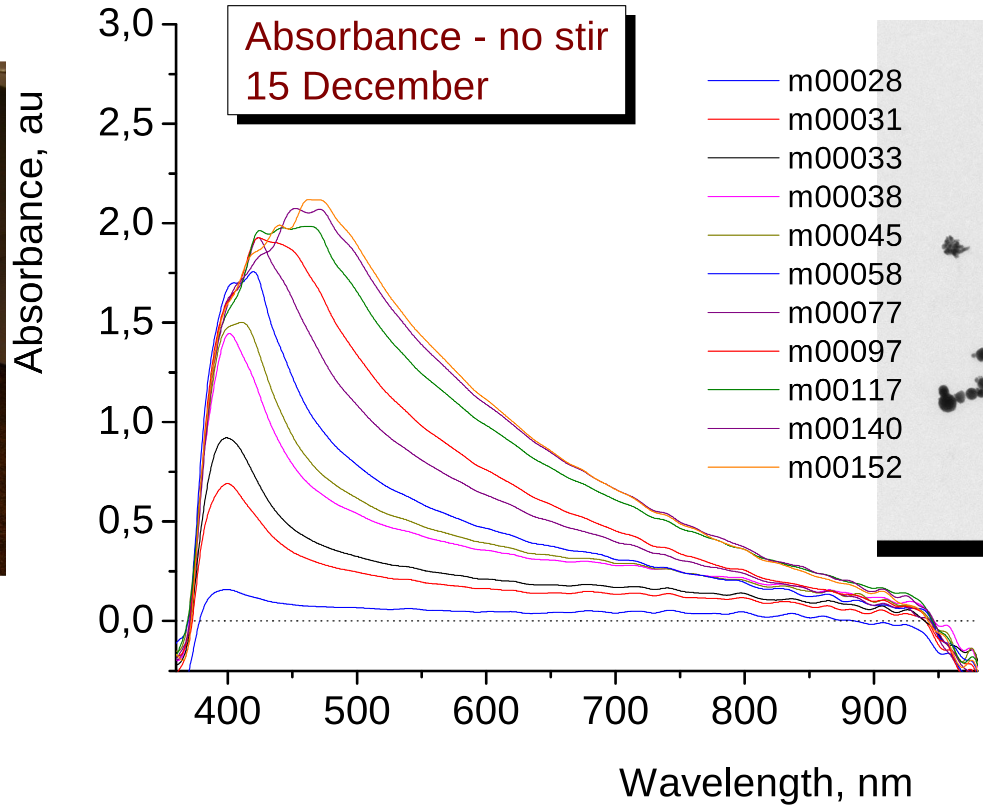
Context: Gas Distribution System. Capillary gas feeding system and its monitoring for multiple pulsed hollow cathode discharges with mixed noble gases (Ar, He, Xe)

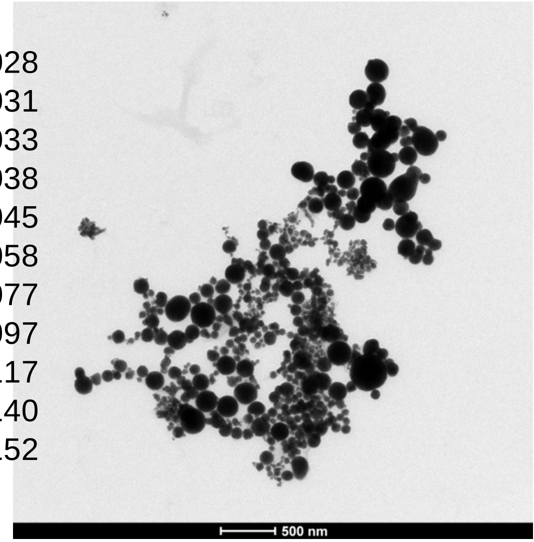


2010, at EPPRASaS, Villebon sur Yvette, Courtaboeuf, France. Layout of Gas Distribution Box – Capillary gas feeding system to Multisource pulsed hollow cathode discharge (designed and tested by me). [Pumping station for sources not shown]

Project : FIRE – EPPRA Sas, France – 2010-2013 and UCD – Rep. of Ireland

Context (of sub-part of project) : production of nanoparticles by means of (I) pulsed laser ablation of metals.

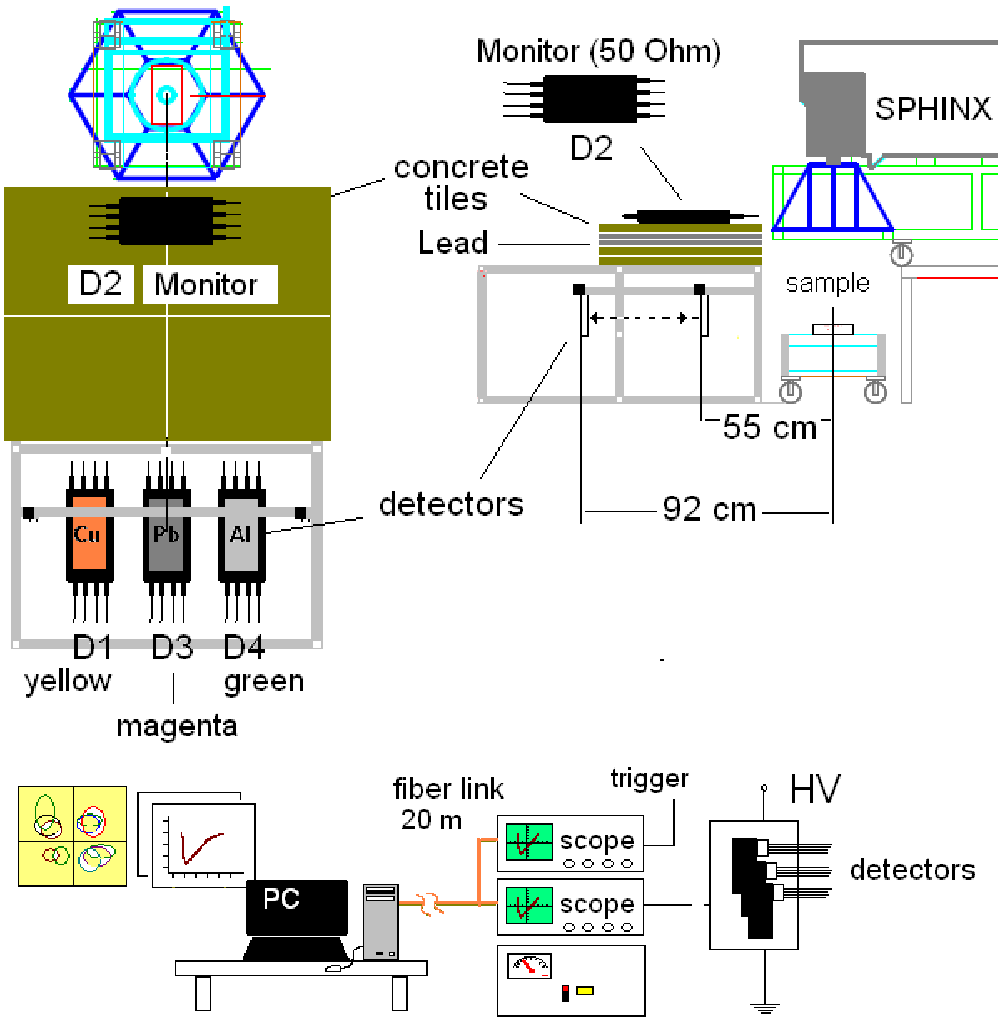




Winter 2011-12, at UCD – Dep. Physics and Astronomy – detached from EPPRA SaS. Nanoparticles production from high power pulsed laser ablation of Ag foils. Top left, Laser Source, Spectra, λ=1064 nm, Repetition Rate 10 Hz, pulse energy 300 mJ. D2 (deuterium) and W (tungsten) lamps (not shown) used to monitor the transmittanceat the different wavelength (in time, as condition to end each ablation run). Centre, the absorbance evolution during a monitored ablation. Time increases from lowest blue curve up to abot 20 min (upper orange curve).
Right, TEM image of nanoparticles (9600 x), scale indicated at 500 nm.

Project : SPHINX (IMSK, Protectrail) – EPPRA Sas, France – 2008-2013

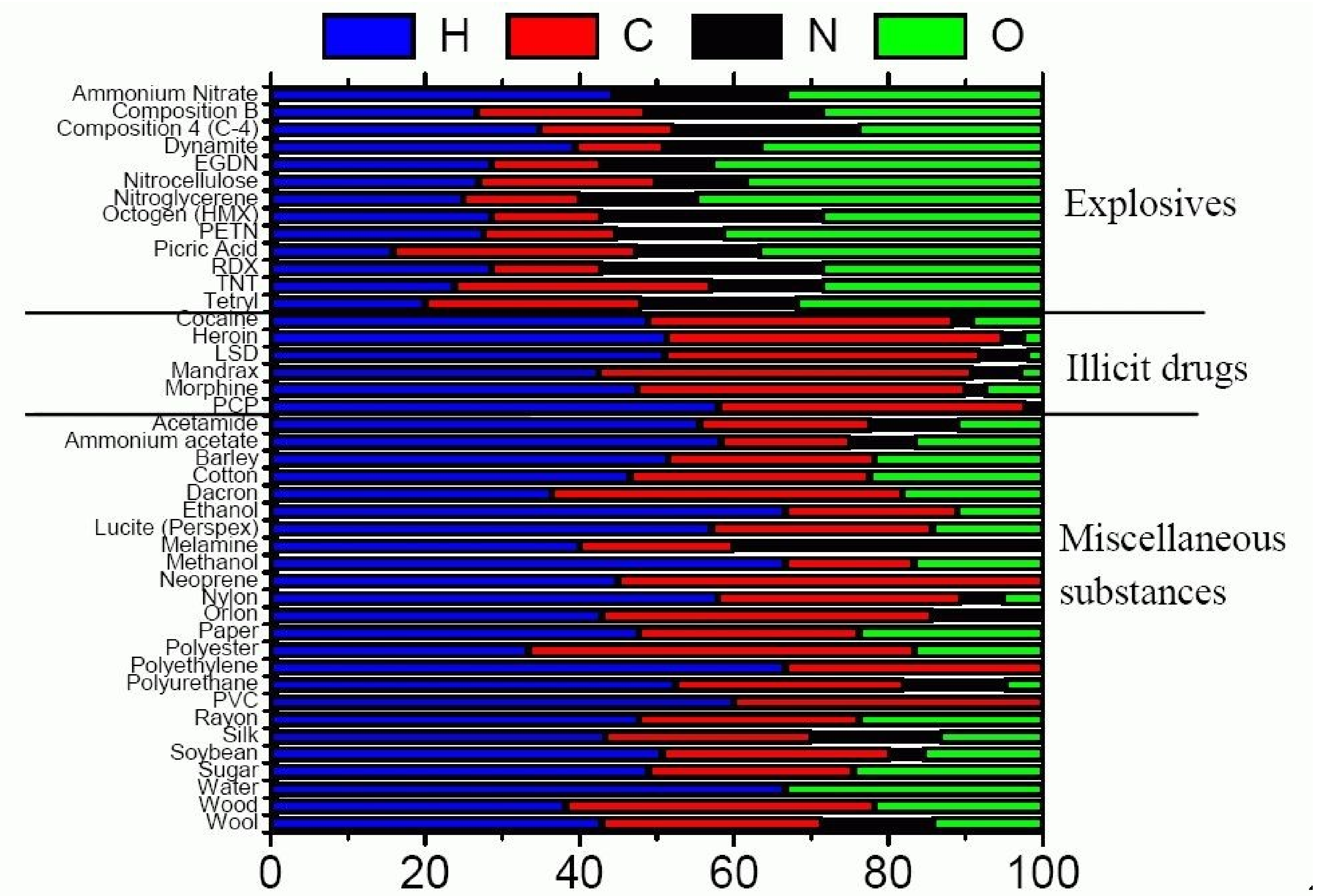
Context : detection and identification of forbidden substances (explosives, drugs) from parcels, luggage and containers, by means of neutron and gamma interrogation technique, implemented in the Sphinx machine. I have been responsible for the data taking campaigns, the detectors, and the data analysis.



The samples to be examined are put into a container and placed beneath the source on a trolley.
Upon activation with a short neutron pulse (~10 ns, 10^7/s), the sample emitted radiation is
detected by different detectors placed at various distances and and stored for offline analysis.

The ratio of four key chemical elements (H,C,N,O, see next slide) permits the identification of the examined sample (provided it has been previously seen and stored as « known » substance !)

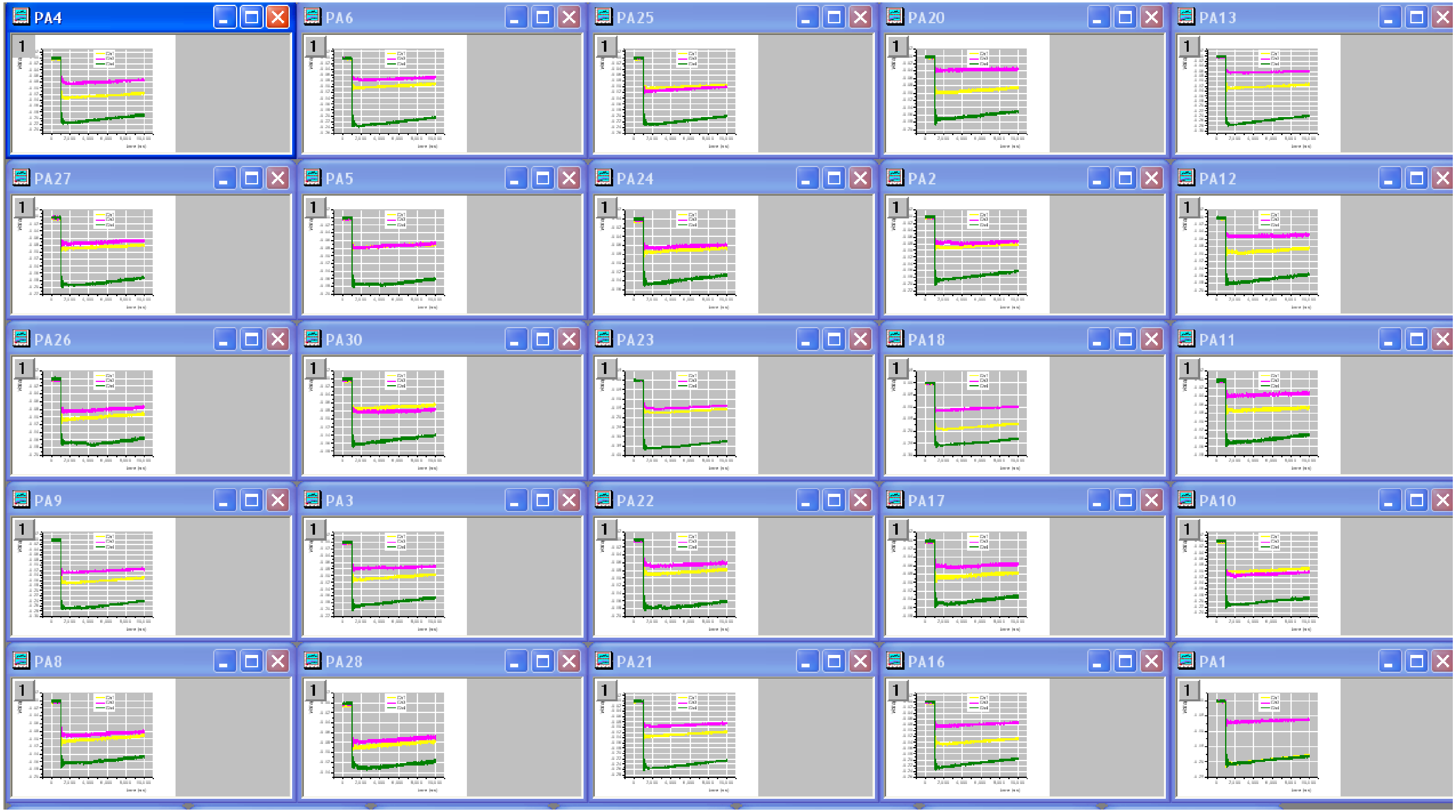
Project : SPHINX (IMSK, Protectrail) – EPPRA Sas, France – 2008-2013



Proportions of H, C, N, O in typical materials of interest in the security sector (illicit drugs and explosives)

2008-13, at EPPRASaS, Villebon sur Yvette, Courtaboeuf, France.

Project : SPHINX (IMSK, Protectrail) – EPPRA Sas, France – 2008-2013



Raw signals (as gathered from the detectors) are plotted for the case of three detectors (three curves per plot). Each plot, made of 10,000 points over a time of up to 10 µs, represents a 'shot' (between 20 and 30 shots are stored per each material sample for further analysis). Several hundreds of these plots are produced for each data campaign.

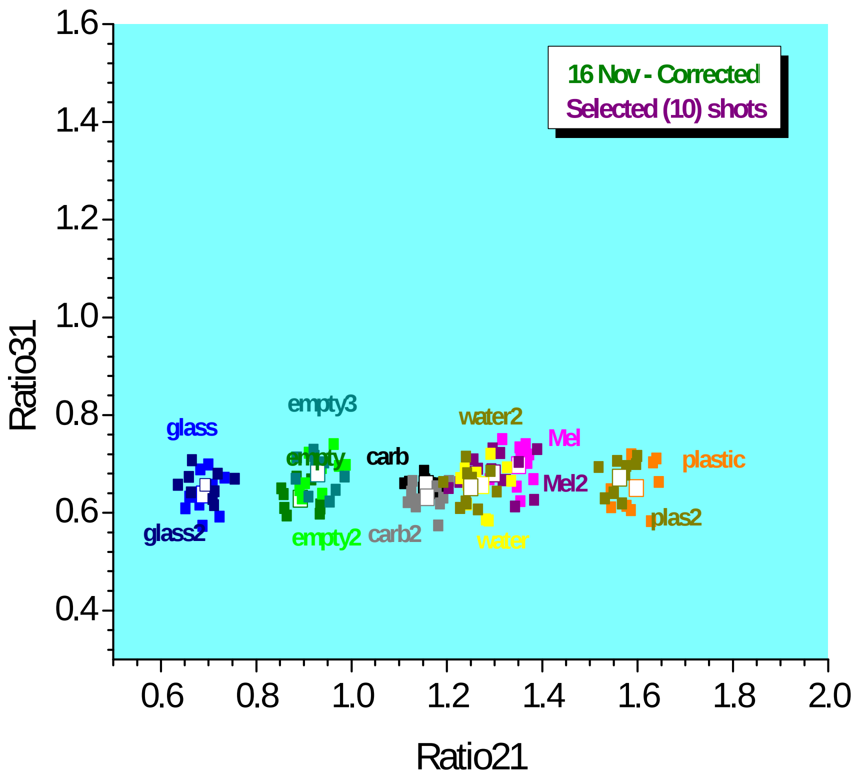
2008-13, at EPPRASaS, Villebon sur Yvette, Courtaboeuf, France.

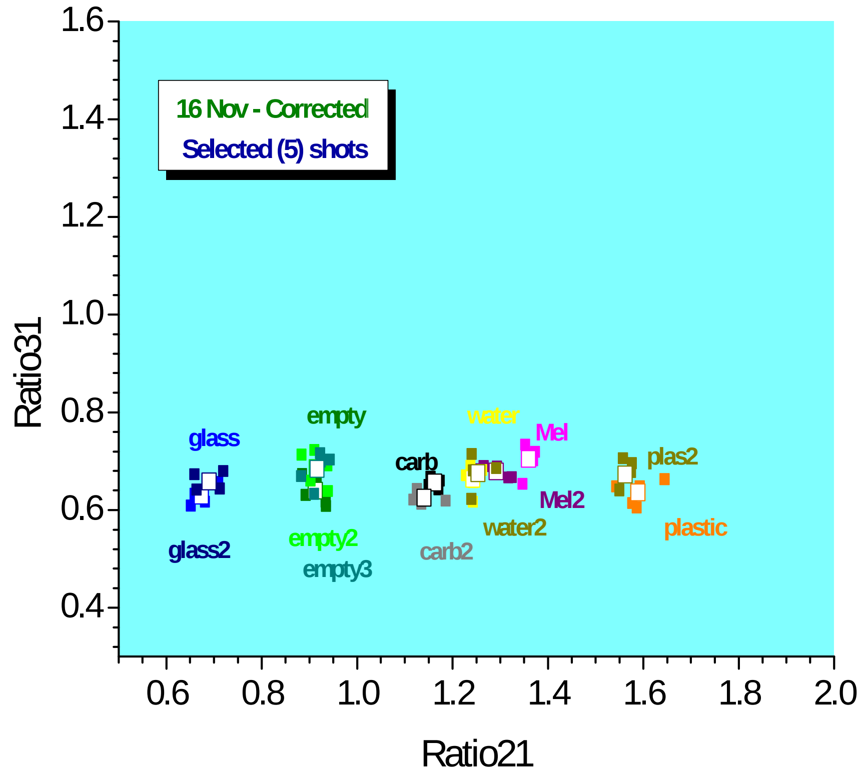
Project : SPHINX (IMSK, Protectrail) – EPPRA Sas, France – 2008-2013

The analysis algorithm/s (smoothing, cleaning, coordinates transform, outliers management, not discussed here) allow to plot points pertaining to the different materials samples on a (X, Y) diagram, each in its own zone.

Different test materials are shown (glass, also repeated, empty container, carbon, water, melamine and plastics). Some of these 'inert' materials are used because very similar to the ones shown two slides above).

One can see that a number of limited shots can be employed with success (left, 10 out of the initial 25-30 shots; right, only 5 shots)



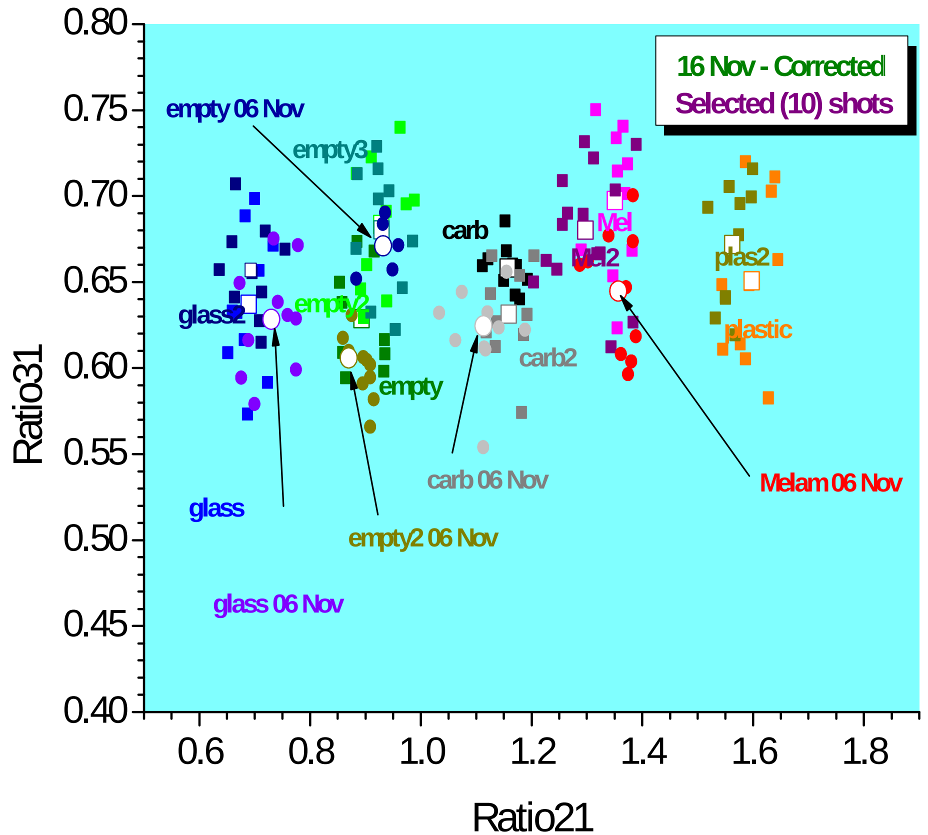


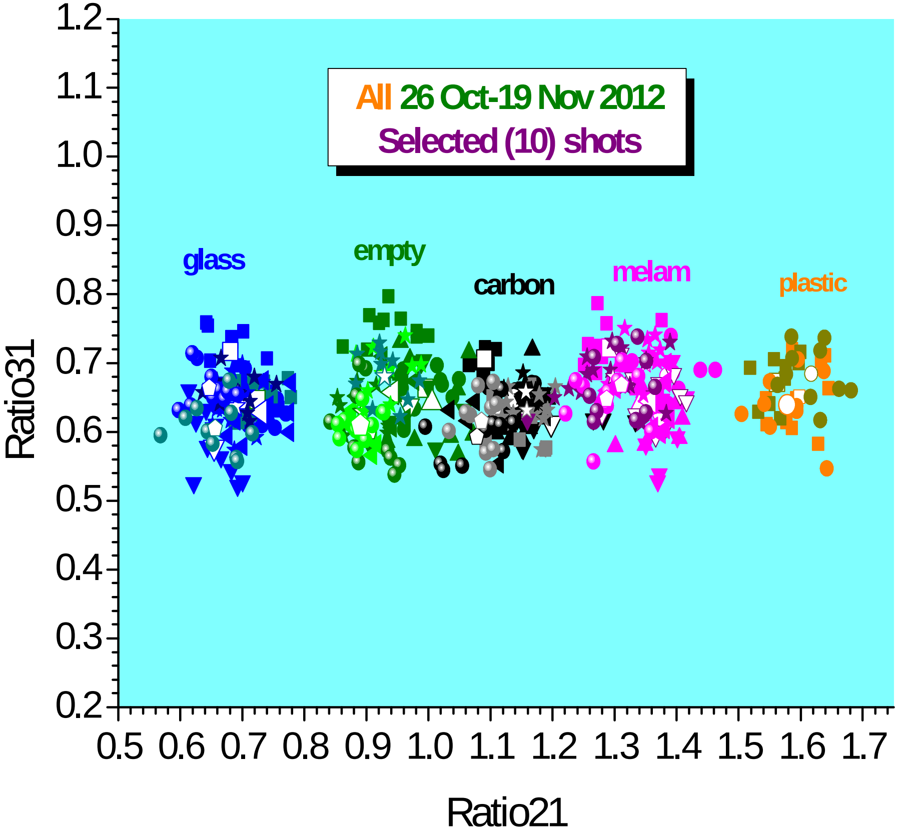
2008-13, at EPPRASaS, Villebon sur Yvette, Courtaboeuf, France.

Project : SPHINX (IMSK, Protectrail) – EPPRA Sas, France – 2008-2013

Repeatability

Left, shots repetitions from two different campaigns. Right, shots from a prolongued time period (several campaigns). Materials are always located in the same zone, which ensures repeatability of the analysis.
So, yes, the machine identifies different materials in a repeatable way.





2008-13, at EPPRASaS, Villebon sur Yvette, Courtaboeuf, France.