www.hidenanalytical.com
info@hiden.co.uk

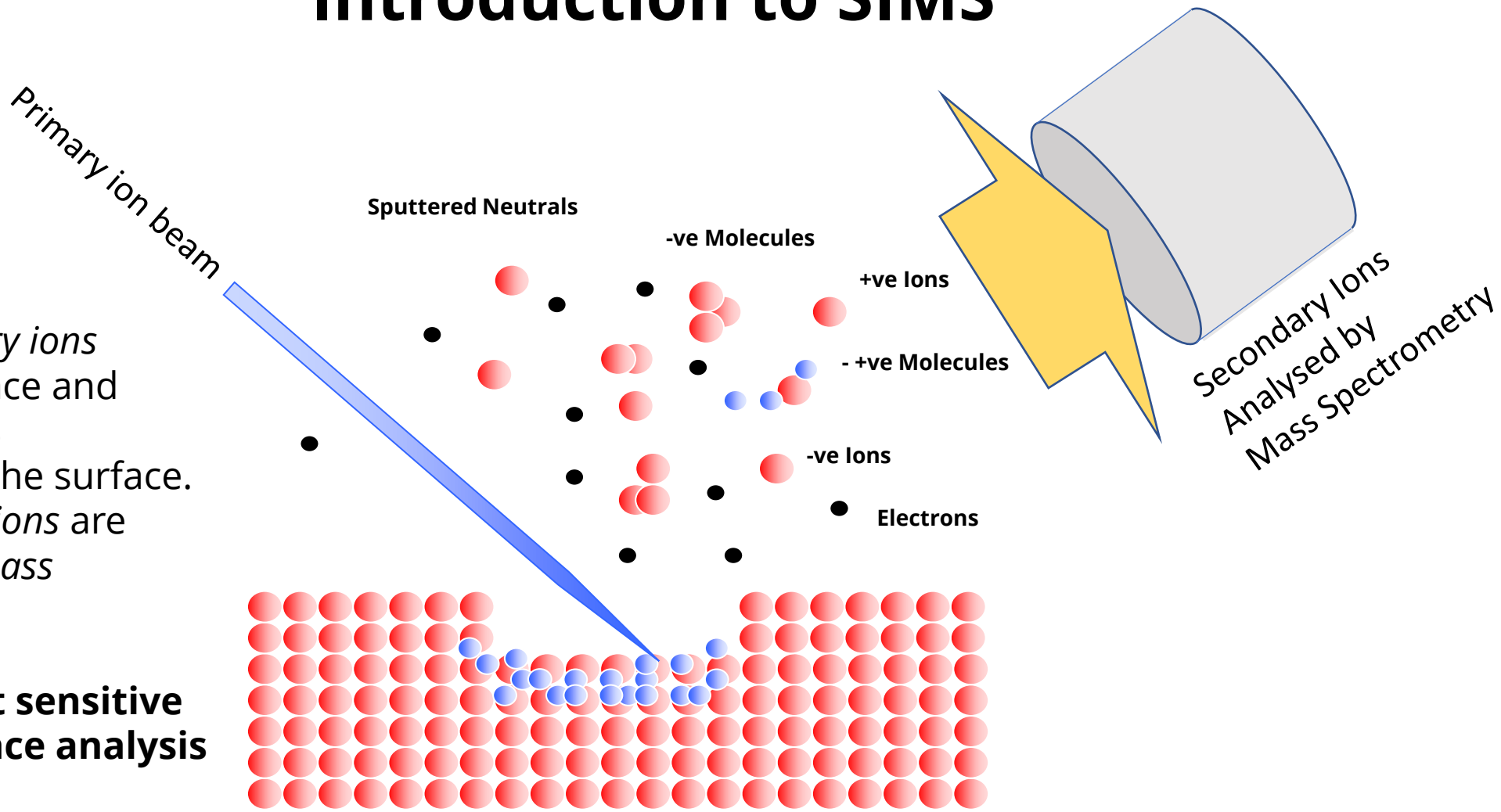
HIDEN ANALYTICAL

Hiden ToF-qSIMS

Innovative combination of Quadrupole and Time of Flight

Mass Spectrometry at the Surface

Introduction to SIMS



A beam of *primary ions* impacts the surface and sputters particles characteristic of the surface. These *secondary ions* are analysed using *mass spectrometry*.

SIMS is the most sensitive laboratory surface analysis technique.

Introduction to SIMS – Static and Dynamic

- There are two main modes, STATIC SIMS where there is minimal material removal and DYNAMIC SIMS where the sputtering removes material so that deeper structures can be analysed.

Static SIMS

- Top monolayer specificity
- Contamination analysis
- Surface preparation monitoring
- Forensic transfer analysis
- Biological and pharmaceutical investigations
- Polymer identification and modification

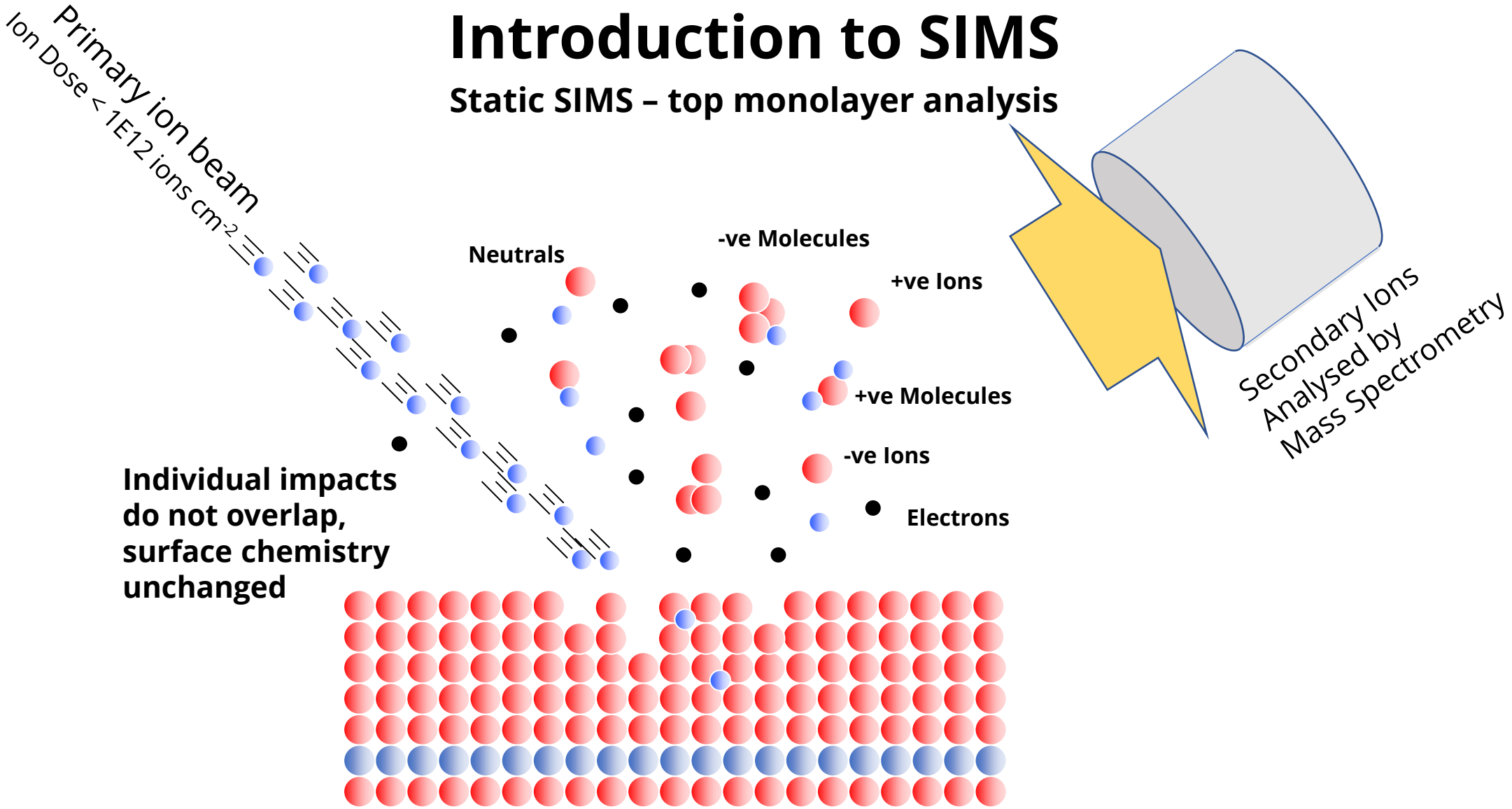
Dynamic SIMS

- High depth resolution (nanometres)
- Parts per million sensitivity
- Thin film and coating analysis
- Interface analysis
- Dopant profiling
- Diffusion measurement

Both modes can create mass spectra and images. The in-depth analysis of Dynamic SIMS can produce 3D reconstructions

Introduction to SIMS

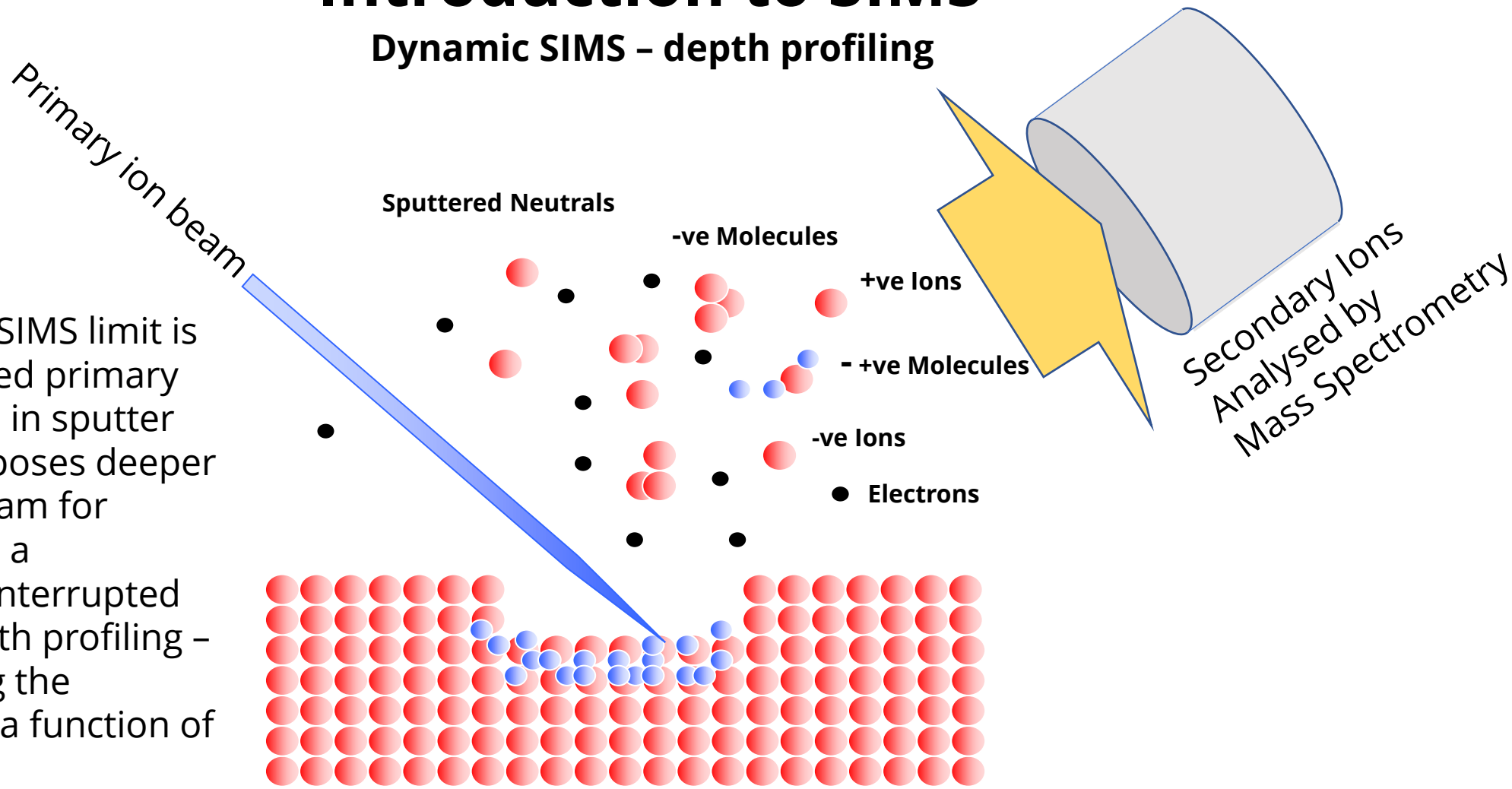
Static SIMS – top monolayer analysis



Individual impacts do not overlap, surface chemistry unchanged

Introduction to SIMS

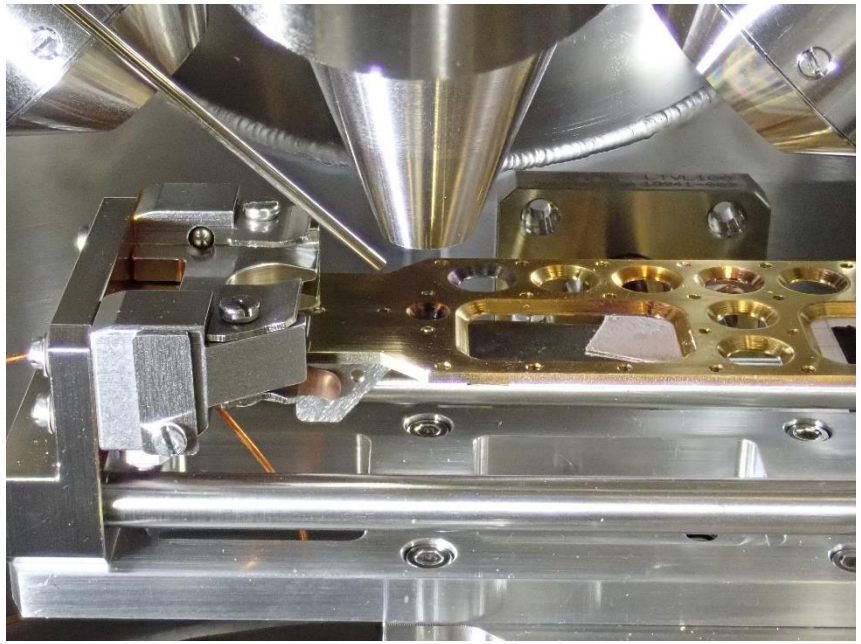
Dynamic SIMS – depth profiling



Once the static SIMS limit is passed, increased primary ion dose results in sputter erosion that exposes deeper layers to the beam for analysis. This is a continuous, uninterrupted process for depth profiling – that is analysing the composition as a function of depth.

SIMS Workstation Plus ToF – no compromise analysis

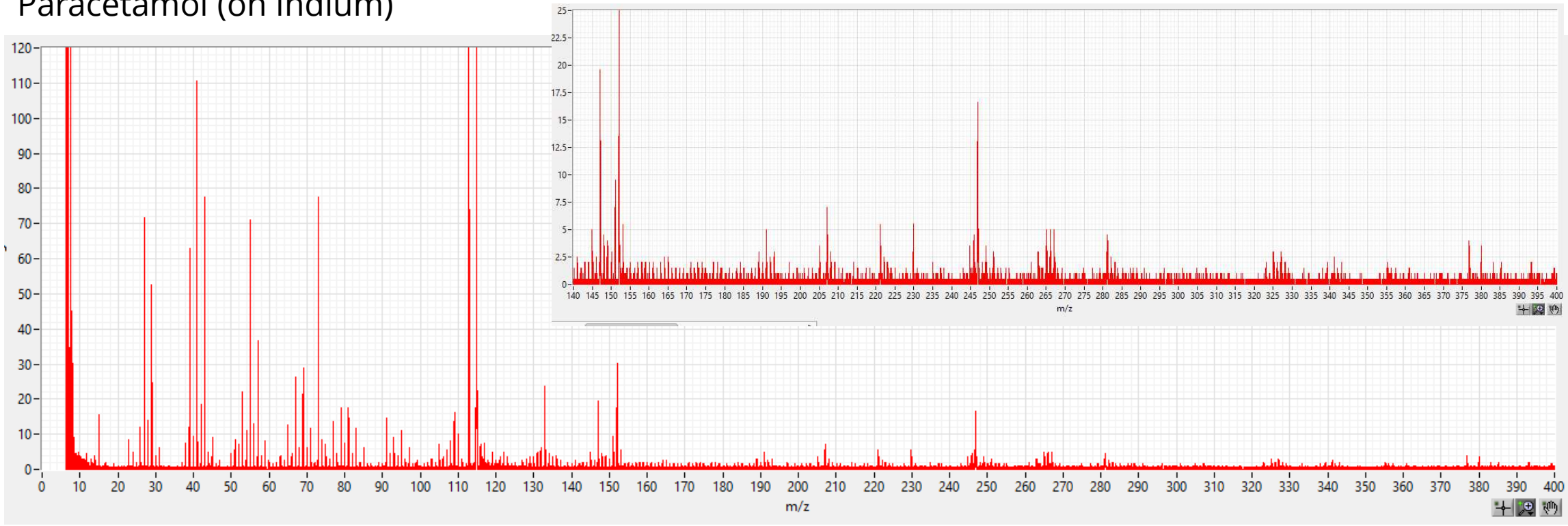
Orthogonal Time of Flight analyser brings high sensitivity, top- monolayer analysis while still maintaining the low concentration depth profiling and high speed imaging capability of the quadrupole spectrometer.



Pharmaceuticals

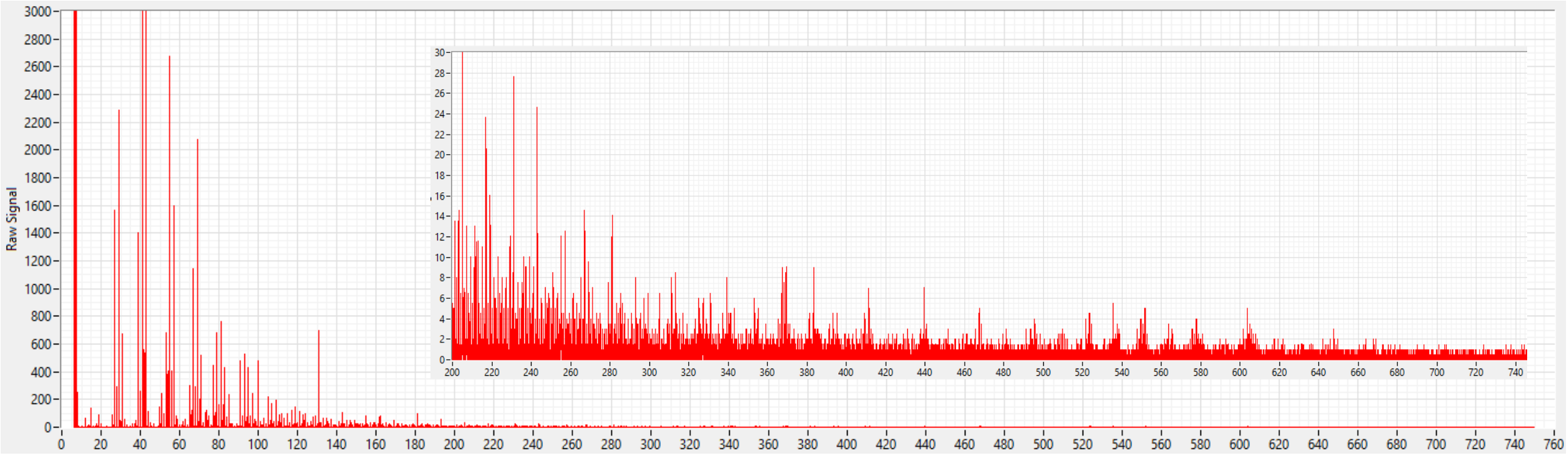
The high mass resolution, and ability to sensitively collect high mass fragments makes the Time of Flight analyser the choice for this work.

Paracetamol (on Indium)



Polymers

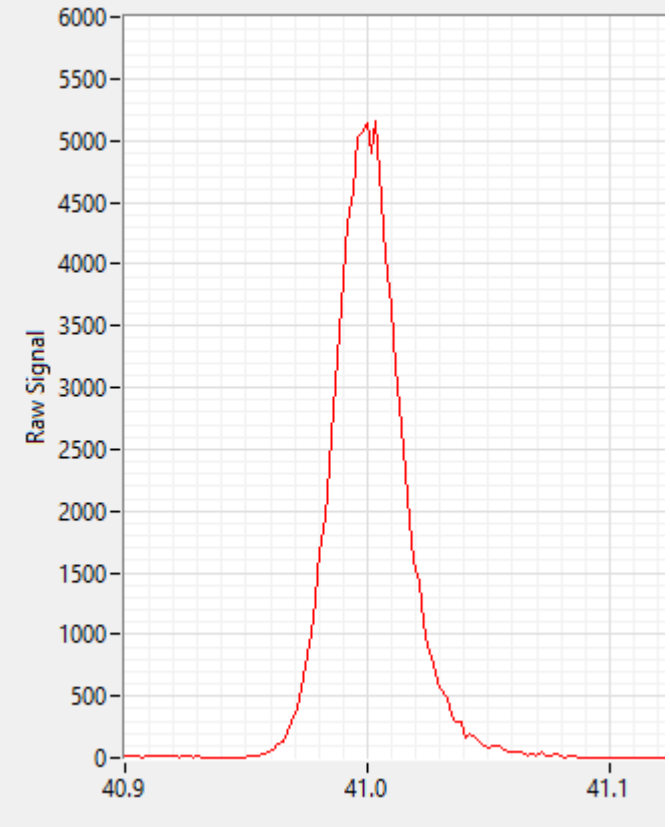
ToF mass spectrometer is more sensitive at higher mass and provides astatic SIMS spectrum that is rich in heavy polymer fragments, enabling identification.



PTFE film – primary ions argon @ 5keV and electron beam charge compensation

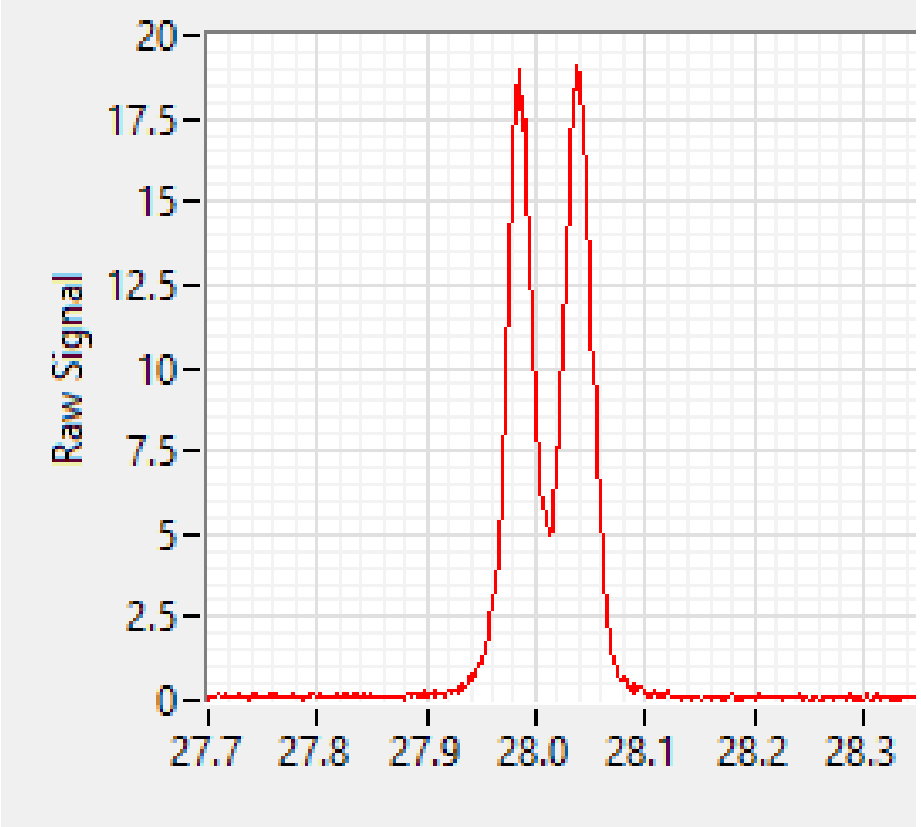
High mass resolution for separating molecular interferences

Mass resolution ~1500



m/z ~28

Si (27.977) C_2H_4 (28.031)



Hyperspectral Imaging

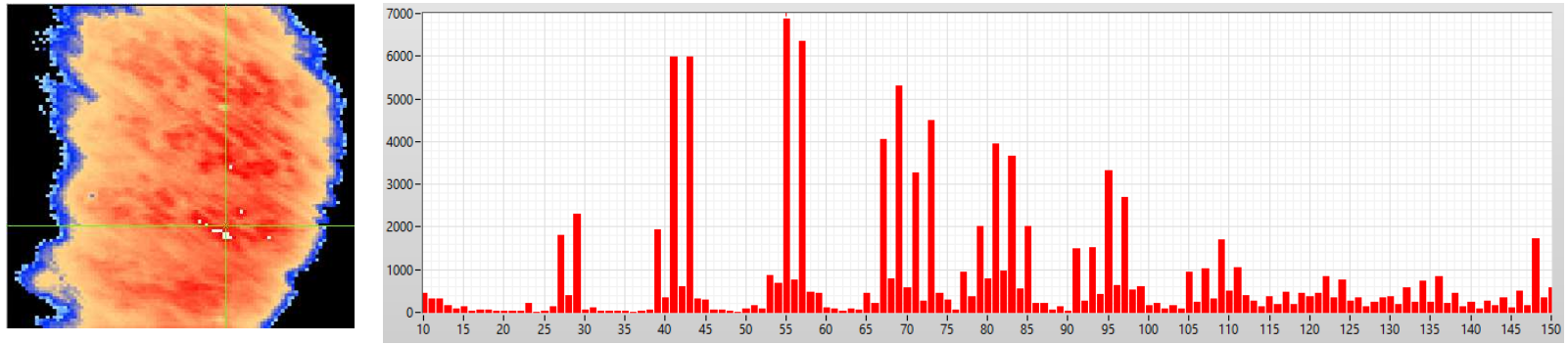


Image at m/z=55
C_4H_7

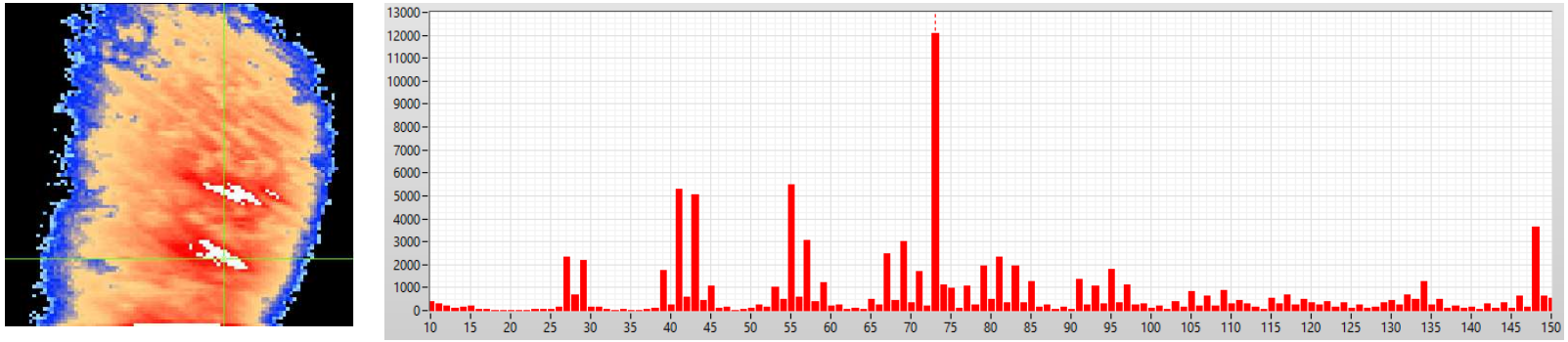


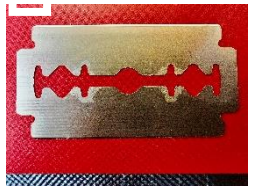
Image at m/z=73
$(CH_3)_3Si$
From Polydimethyl Siloxane (PDMS)

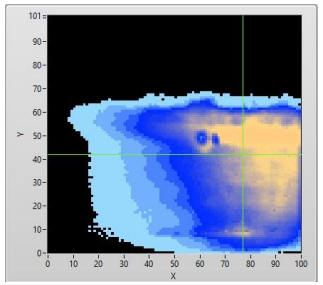
The parallel detection of the time of flight spectrometer means that an entire high resolution mass spectrum is recorded for every pixel in the image. The image can be displayed for any mass and the spectrum can be displayed at any pixel.

The data above shows part of a finger mark on aluminium with hydrocarbon and silicone being the predominant species transferred to the surface (note low resolution spectra are shown for clarity).

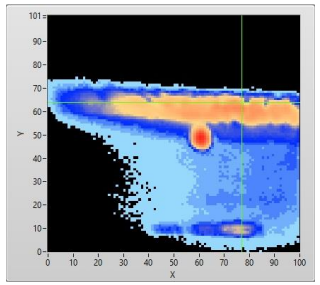
Razor blade analysis

Fe/Cr blades are heat treated in molten NaCl before being ground, chemically etched to enhance the surface Cr concentration, before a protective Pt (atomic layer) coating and final fluorocarbon lubrication layer are applied

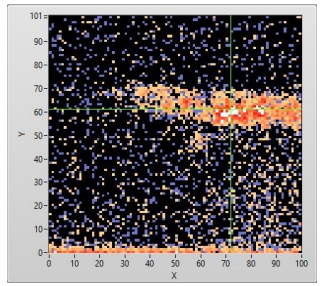




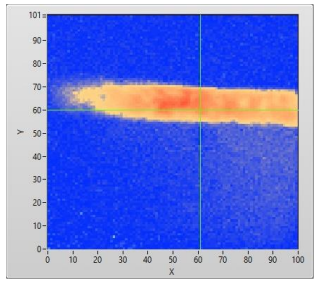
^{23}Na



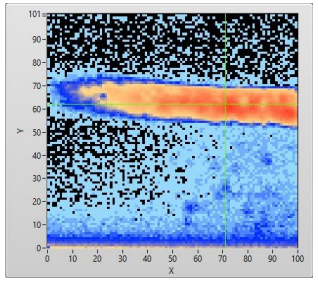
^{52}Cr



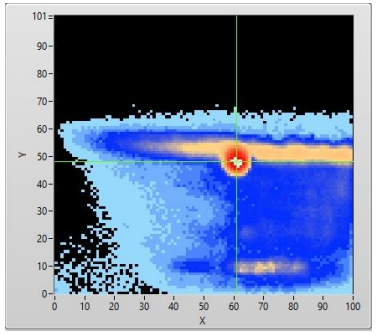
^{194}Pt

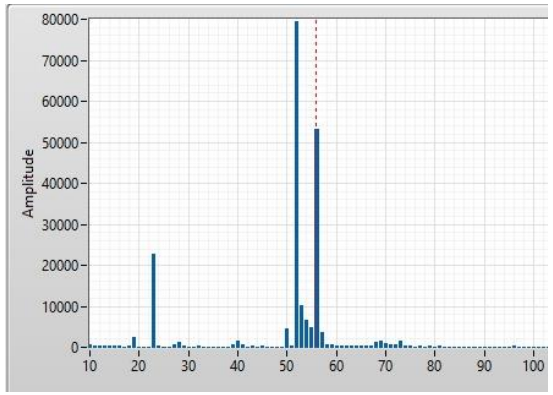


^{12}C

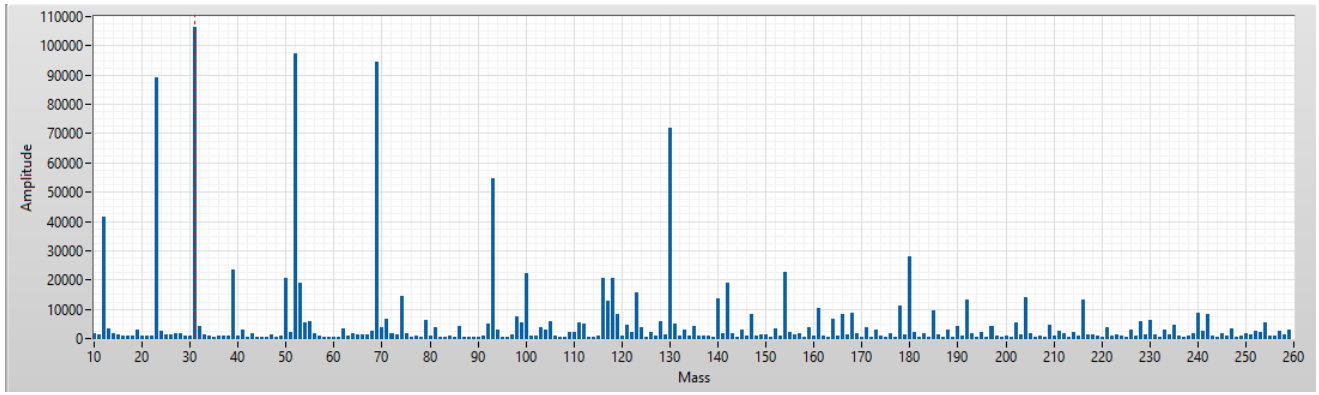


^{31}CF





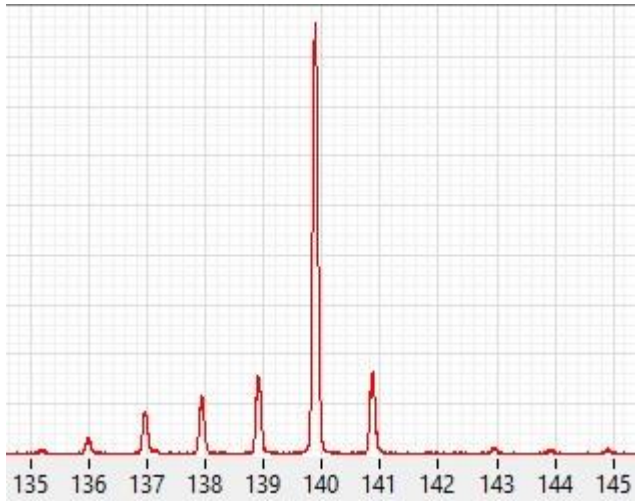
Bulk analysis at point
[^{56}Fe image]



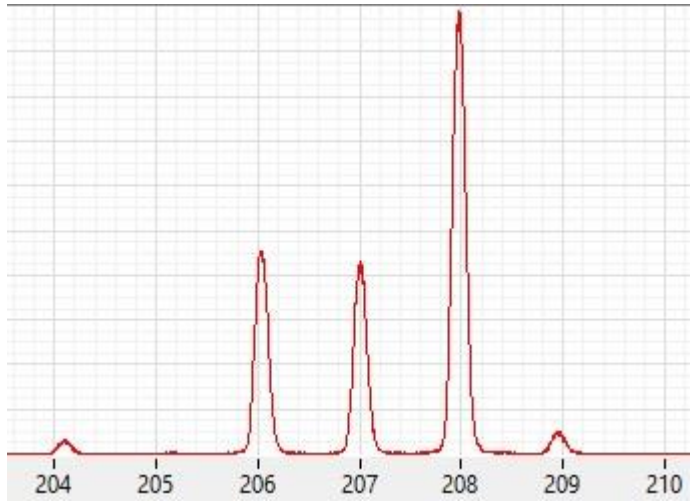
Mass spectrum on cutting edge

Gunshot Residue

Gunshot Residue is the burned propellant ejected from discharging a firearm. It comprises a very fine powder (usually less than 5µm) that can be deposited on the person firing the weapon and on the target. Key to analysis are the mass peaks of lanthanides and lead from the primer charge. These have characteristic compositions which may be used to match the target and shooter.



lanthanides



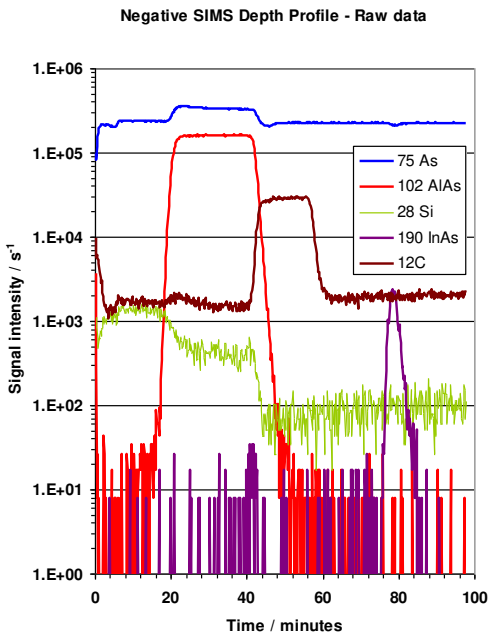
lead and barium isotopes

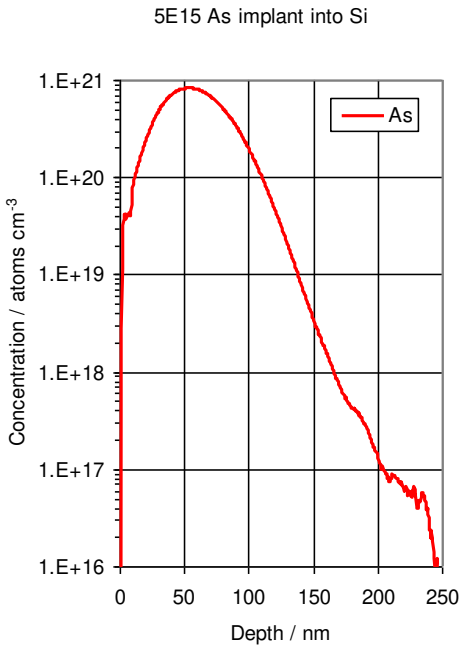
Mass spectra from a nearby paper target

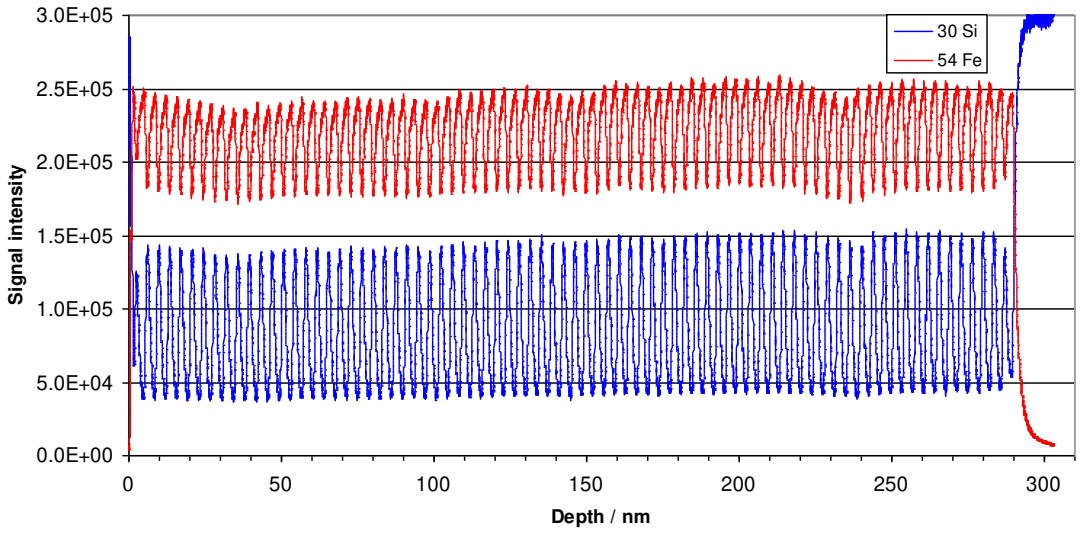
The Quadrupole Spectrometer on the ToF-qSIMS

The integral quadrupole of the ToF-qSIMS instrument is used to provide rapid, high depth resolution profiles, with nanometre depth resolution and high dynamic range, a technique that is not achievable with the Time of Flight Spectrometer.

Having both high performance quadrupole and ToF SIMS analysers gives the new, unique, instrument the best of both detection systems and uncompromised flexibility







Who should use the ToF-qSIMS?

- The ToF spectrometer makes the instrument ideal for monitoring the very top monolayers, where the parallel detection, high mass resolution and high mass range can be employed to characterise contamination and surface condition (cleanliness or functionalisation) in the **semiconductor, glass manufacturing, adhesives, aerospace, thin film coatings and pharmaceutical** industries as well as **general materials analysis and research.**

- It is ideally suited to **failure analysis (debonding and failed interfaces), forensic and reverse engineering** where the species are unknown.

- In a production environment the ToF-qSIMS can give rapid answers to questions about contamination and cleanliness that cannot be obtained using other techniques like EDX.

Combined Spectrometers For Optimal Performance

MAXIM - Quadrupole

- Known material (limited number of species)
- Extremely high elemental sensitivity
- Inorganic elemental analysis
- Low mass elements <20u
- Ultra high depth resolution profiling
- Quantitative composition analysis

- Elemental diffusion measurement
- Engineering coatings, metals and tribology
- Electronic materials

Time-of-flight

- Top monolayer analysis
- Hyperspectral imaging (unknown materials)
- Sensitive to molecular groups and fragments
- Organic analysis
- High mass elements and molecules >20u
- Qualitative surface distribution (imaging)

- Surface contamination and adhesion investigation
- Biological and pharmaceutical
- Forensic analysis

Summary

- The ToF-qSIMS is a unique surface analysis tool that combines the best of quadrupole and time of flight spectrometers to provide an instrument with unparalleled flexibility.
- Using the time of flight spectrometer it is possible to collect hyperspectral images that allow rapid assessment of the surface species and which can be re-analysed any time in the future.
- The ToF-qSIMS also retains the easy to use and low cost of ownership features of the Workstation series of instruments, with simple templates for routine and unattended analysis as well as a large range of additional features for the expert user.

- www.HidenAnalytical.com
- The Hiden website is an excellent resource with product pages, brochures, catalogues, product pages with some application notes, presentation and other information.
- Contact +44 1925 445225 for direct support.