TELEDYNE CETAC TECHNOLOGIES
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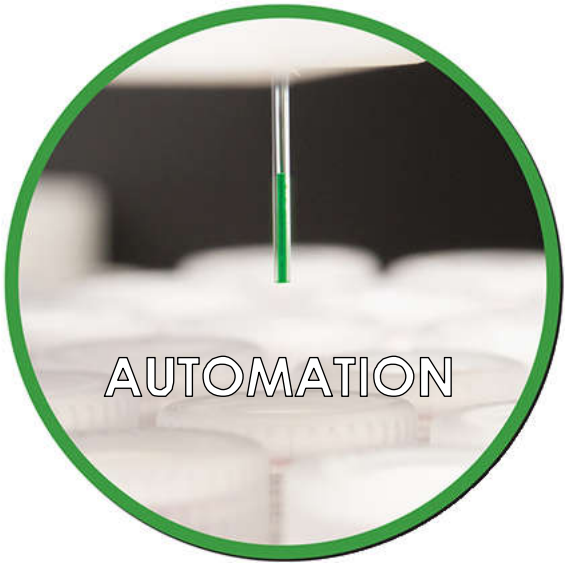
Excimer Laser Ablation Systems



Teledyne CETAC Technologies

Based in Omaha, Nebraska

Part of Teledyne Advanced Chemistry Systems

TELEDYNE CETAC TECHNOLOGIES
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Company Snapshot

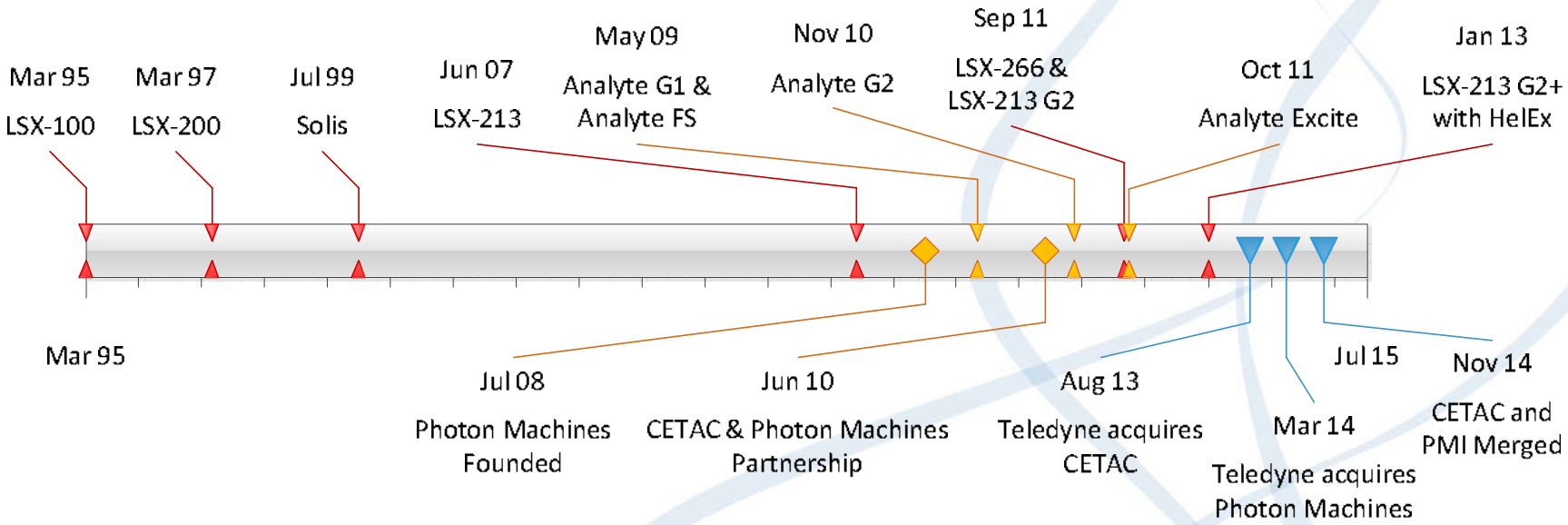
- Part of Teledyne since August 2013
  - Focused investment in R&D
  - Well defined roadmap for product development
- Worldwide leader in sample handling and sample introduction equipment for elemental analysis

- HQ Omaha, Nebraska, USA
- Laser facility in Bozeman, MT, USA
- 130 personnel and growing

- 4 Product Divisions
  - Spectroscopy Automation
  - Laser Ablation
  - Nebulizers
  - OEM Automation

CETAC TECHNOLOGIES

Teledyne, CETAC and Photon Machines



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Our Value Proposition

Outstanding price:performance ratio

Best value LA systems on the market

Systems for all budgets, all applications

4 units spanning 266 nm to fully-featured 193 nm

Responsive, affordable customer service

Parts available at sensible prices, with responsive support

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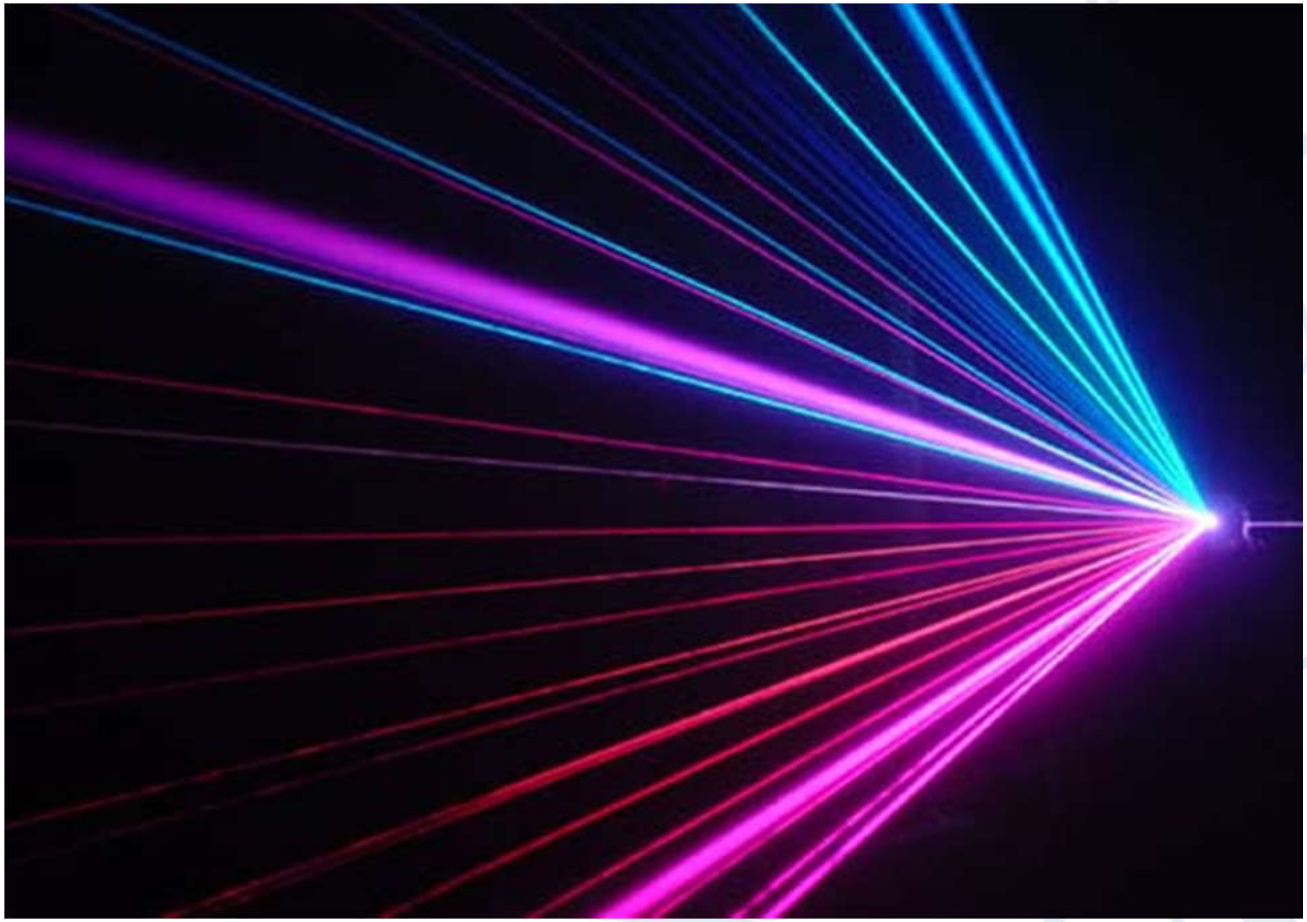
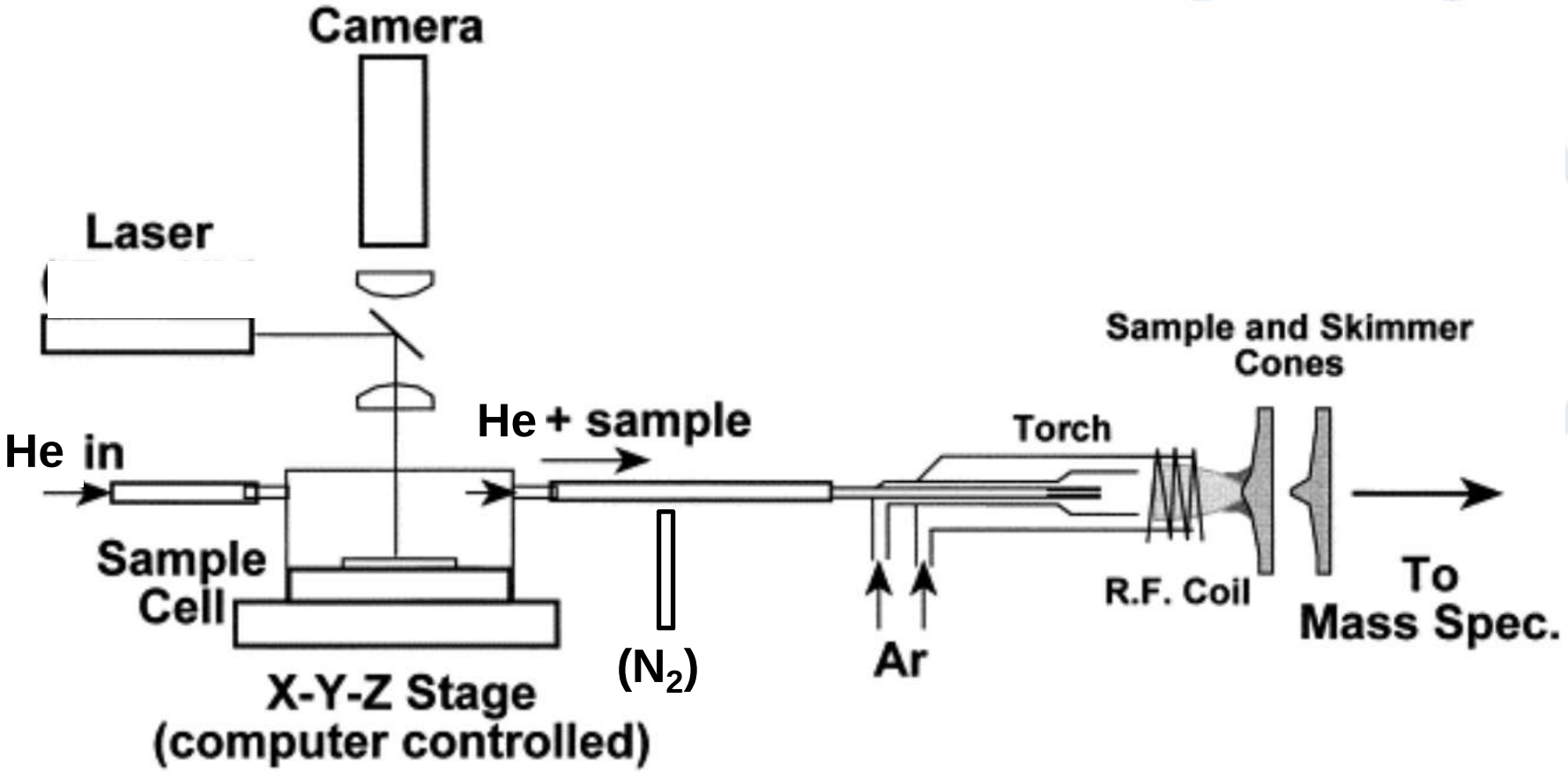
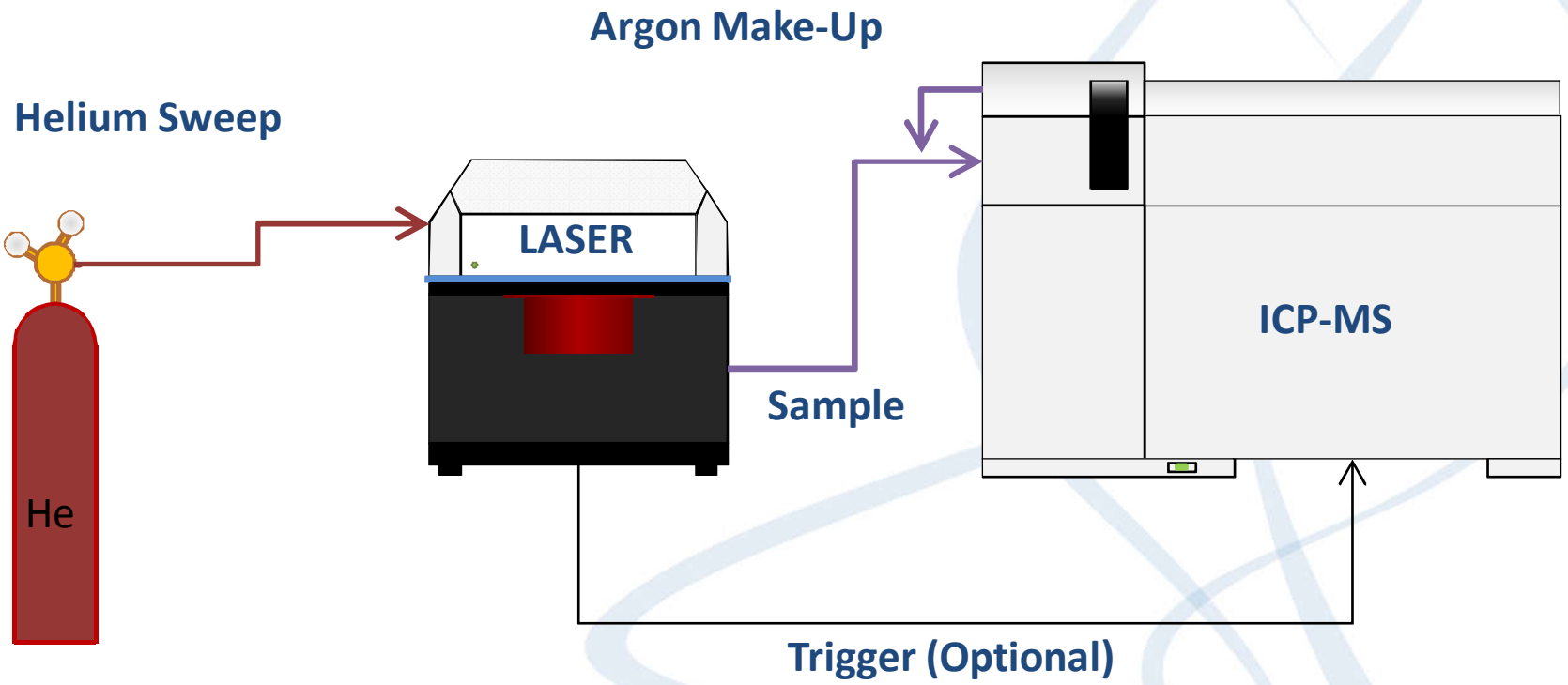
LASER ABLATION FUNDAMENTALS



What is Laser Ablation ICP-MS?

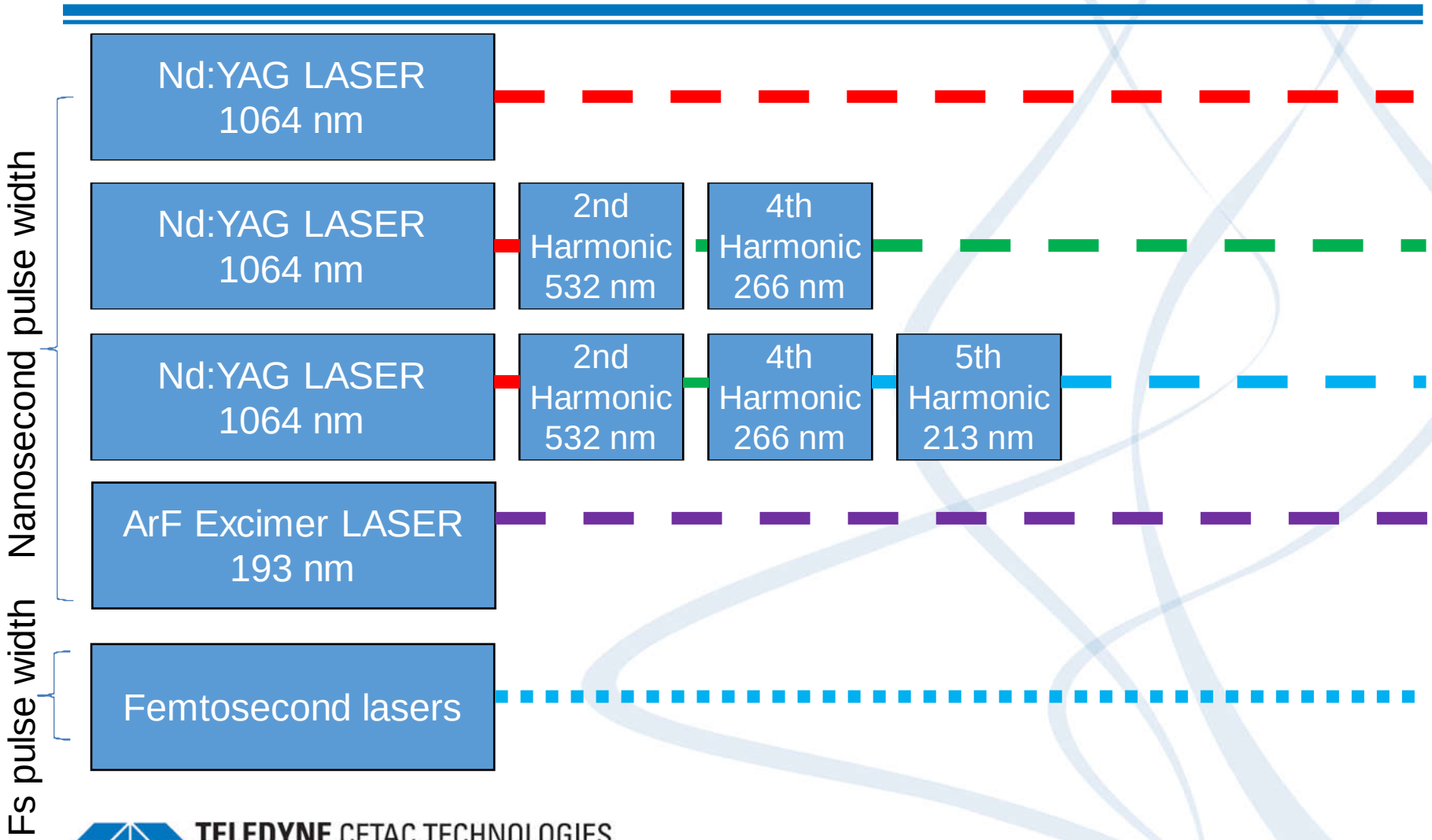


Typical Set-Up



What does laser ablation look like?

Types of Laser Used in LA



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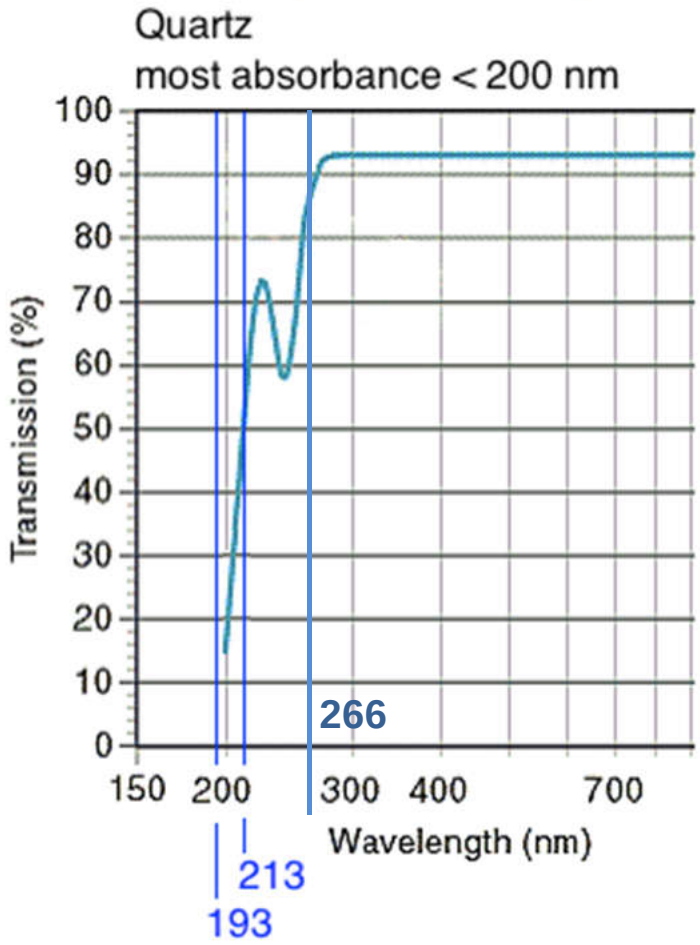
Comparison of wavelengths

Laser Type	Heating Effects	Coupling Efficiency with Translucent Samples	Typical Particle Size Distribution	Overall Fractionation Effects
1064 nm	High	Very Poor	Broad	Poor
266 nm	Moderate	Poor	Moderate	Moderate
213 nm	Low-Moderate	Good	Narrow	Good
193 nm	Low	Excellent	Very narrow	Very Good
Femto	Very Low	Wavelength dependent?	Very narrow	Excellent?

Coupling Efficiency and Wavelength

- Highly light transmitting materials (e.g. quartz) absorb little light under 300nm
- About 20% is absorbed at 266nm
- About 50% is absorbed at 213nm
- > 90% is absorbed at 193nm



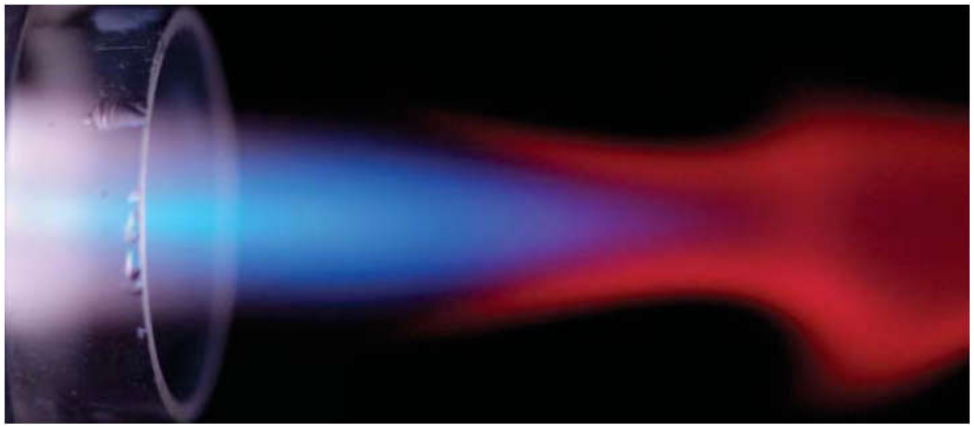
Fractionation

***FRACTIONATION*:**

when the elemental composition of the material measured at the detector is not the same as the true composition of the sample

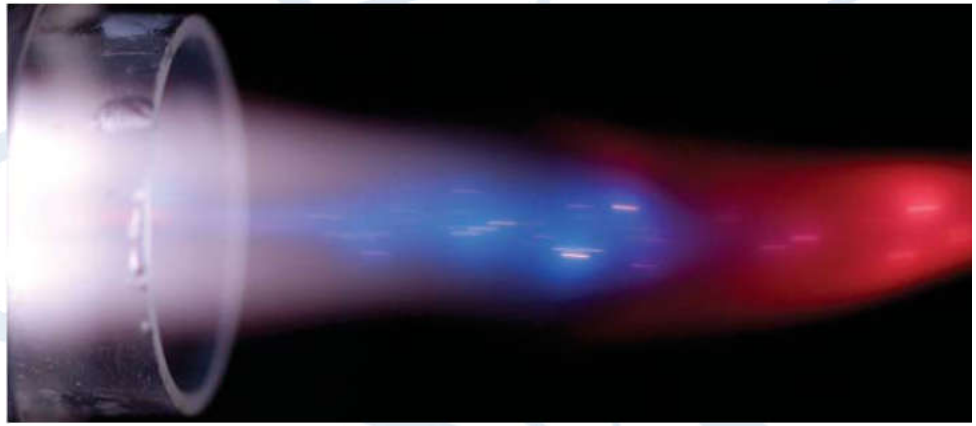
High		**Low**	
Particle Size	High	Particle Size	Low
PS Distribution	High	PS Distribution	Low
Difference in Mass	High	Difference in Mass	Low
Difference in Volatility	High	Difference in Volatility	Low

Fractionation

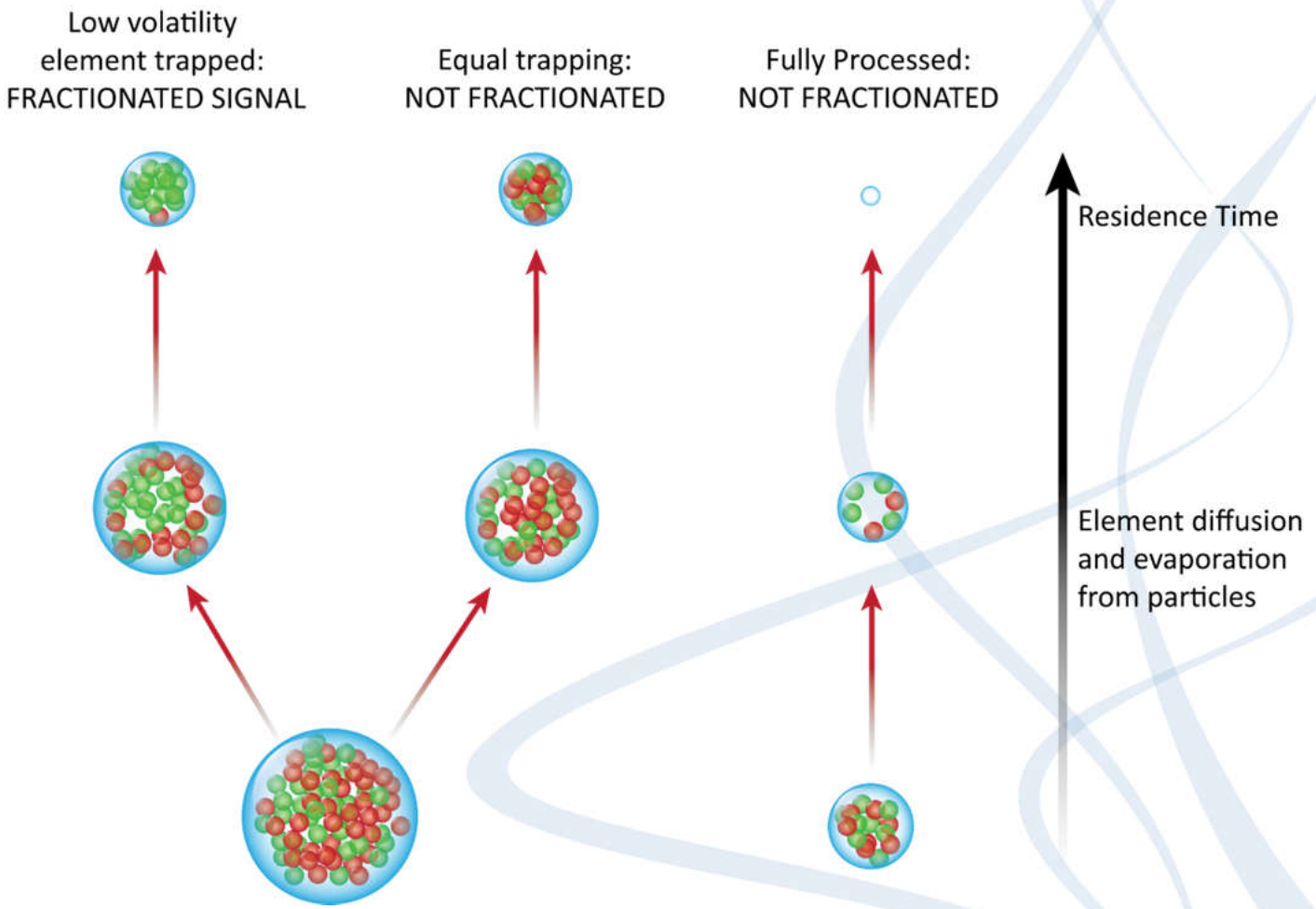


Liquid Nebulization

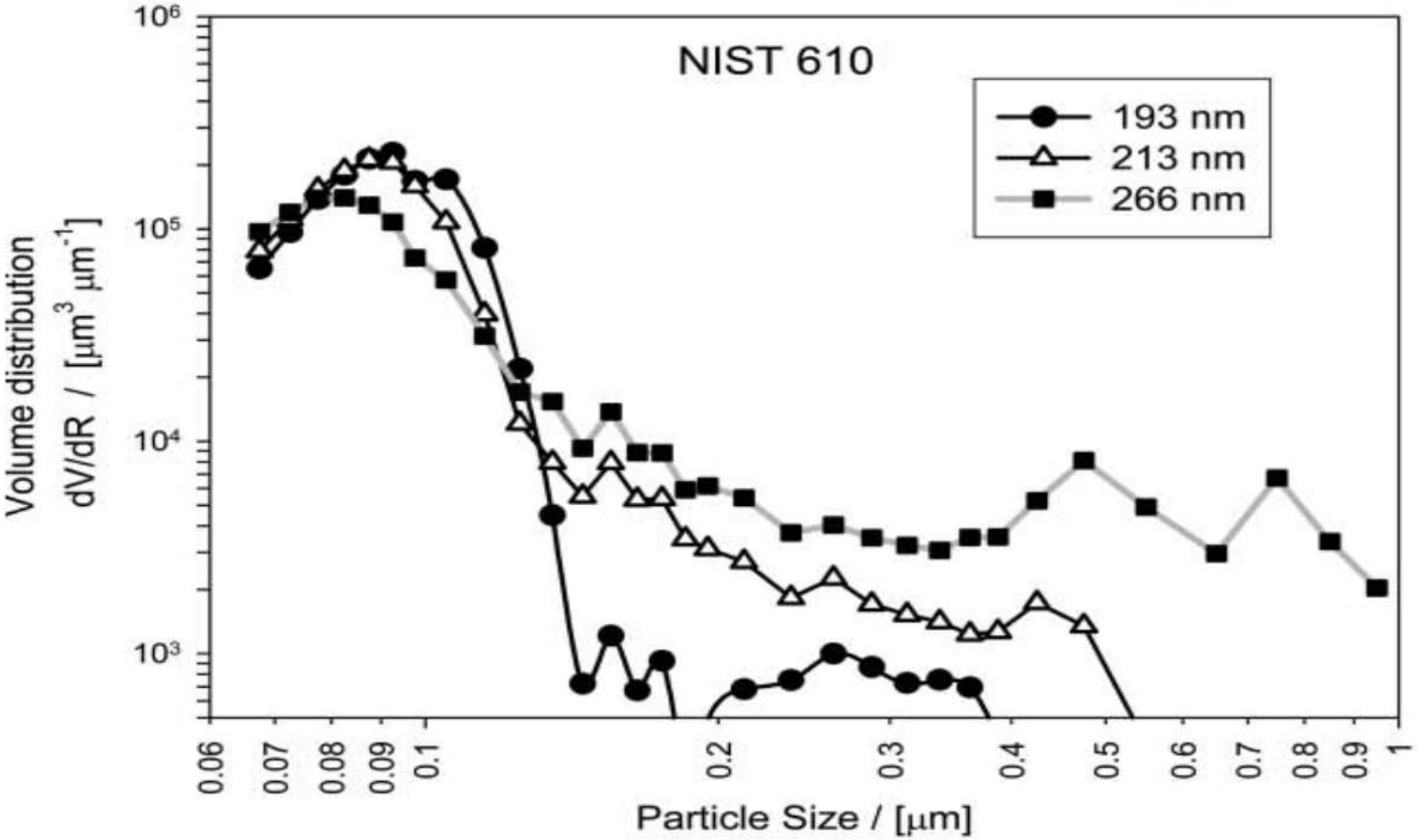
Laser Ablation



Analytical Implications



Impact of particle size on Fractionation



Mean Particle Size for ablation of NIST 610, at three wavelengths

Ideal Laser

- Shorter Wavelength
- Shorter Pulse Width
- Homogenous Energy Density

Teledyne CETAC LA Systems

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Latest Laser Ablation

Pharos Femto

Analyte Excite & Analyte HE

Analyte G2

ArF Excimer

LSX-266

LSX-213 G2+

Solid State Nd:YAG

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2 Products: Excite and G2

Analyte.Excite

- Cost optimised excimer laser ablation system
- 2.5 to 155 micron spot size

- Analyte.G2

- The ultimate excimer laser ablation system
- 1 -250 micron with customised optics

Excite & G2

Feature	Excite	G2
Chassis construction	Tube steel with metal plate optical bench	Tube steel with Gabbro optical bench – slightly better optical stabilty
Optical arrangement	Factory pre-set	User configurable with rail-mounted components – Greater flexibility for experimental set-ups
Optics	High quality, off-the-shelf components	All custom designed components - Slightly better optical quality
Apertures	30 positions from 2.5 to 155 microns	30 positions from 1 to 250 microns – Smaller spots possible
Demagnification	None	Yes. Extends spot size range to >400 microns. – Larger spots possible (although energy density reduced when demag used)
Dynamic apertures	X-Y rotating aperture and Variable Iris Aperture options available	X-Y rotating aperture and Variable Iris Aperture options available. – Easier to configure.
Second off-axis navigation camera	None	Yes. Enables wide-field of view sample navigation.
Upgrade Path to Femto Second	Yes	Yes
Cell	Single volume Frames cell standard. 100 or 150 mm sq. HelEx II optional.	100 mm HelEx II standard. 150 mm HelEx II optional

ANALYTE PLATFORM

- Analyte G2, based on a gabbro super structure
- Analyte.Excite Isolated Tubular Steel with gabbro stabilizer portions
- Unique isolated laser cabinet and optical bench
- Can easily move in lab or between labs
- Maintains laser alignment - Is always ready to us for best performance,
- no user maintenance required

Vibration Dampening

- High quality vibration dampening coasters

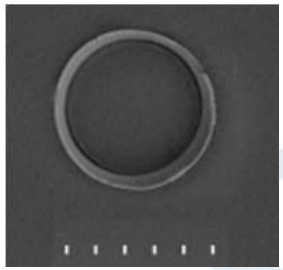
- Beam path and base unit separated
  - Neoprene vibration dampening

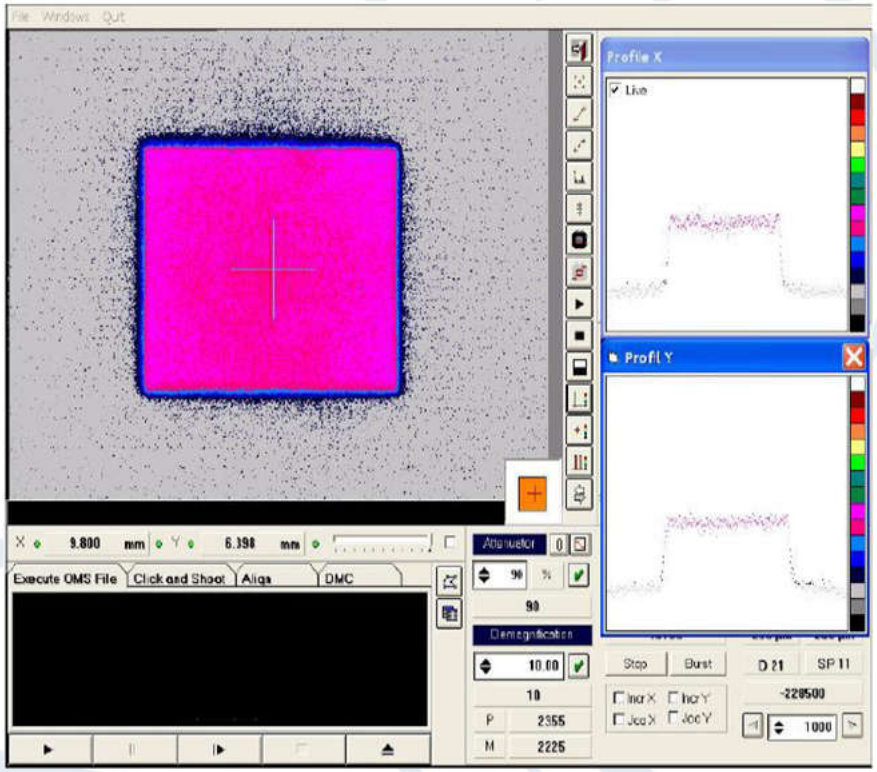
LASER SOURCE

Laser Source	ALTEX-I-LR	ExciStar	Compex Pro	Diode Pumped
Wave Length	193nm	193nm	193nm	266nm
Max Energy	12mJ	8mJ	200mJ	2mJ
Max Energy stabilized	10mJ	5mJ	200mJ	2mJ
Pulse Duration	<4ns	5ns	20ns	<12ns
Energy Stability	1%	<2%	1%	<10%
Repetition range	1-300 Hz	1-200 Hz	1-20Hz	1-100Hz
Warm Up	Turn Key			15m warm up

Laser Beam Homogenisation

- Proprietary flat-field zero order external rotating homogeniser.
  - Best crater Quality
  - No micro fracturing
  - Flat topped beam
  - All laser sources





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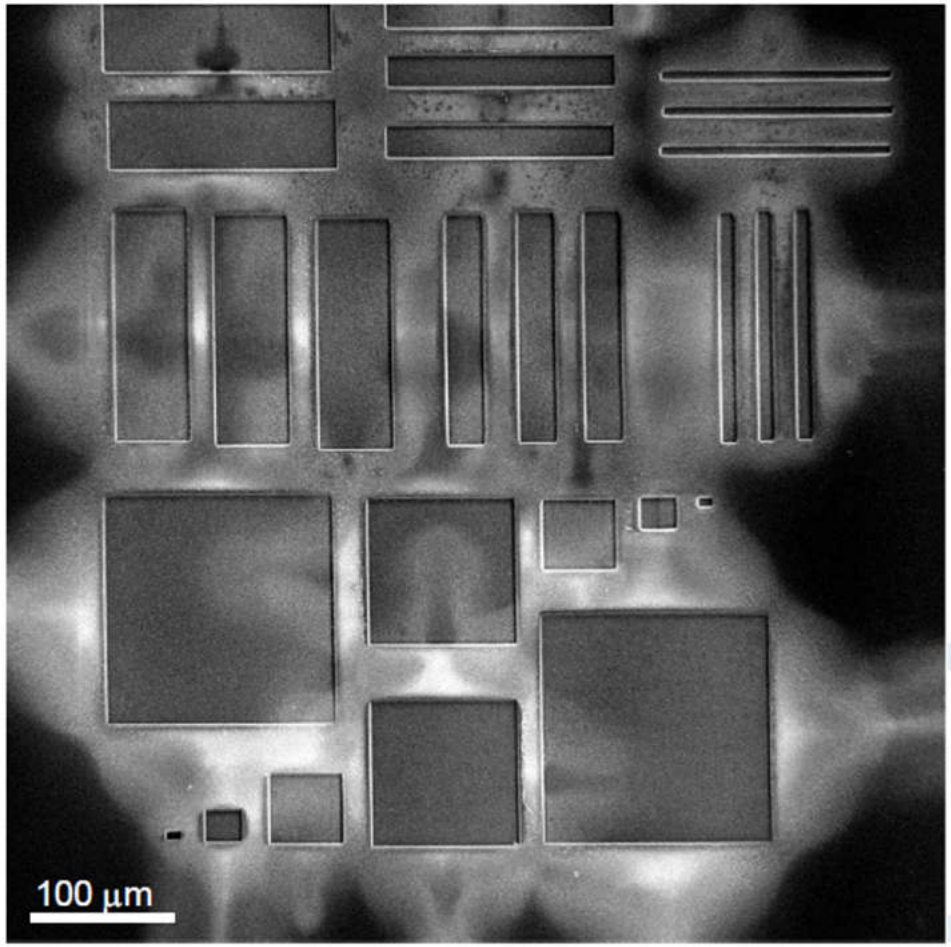
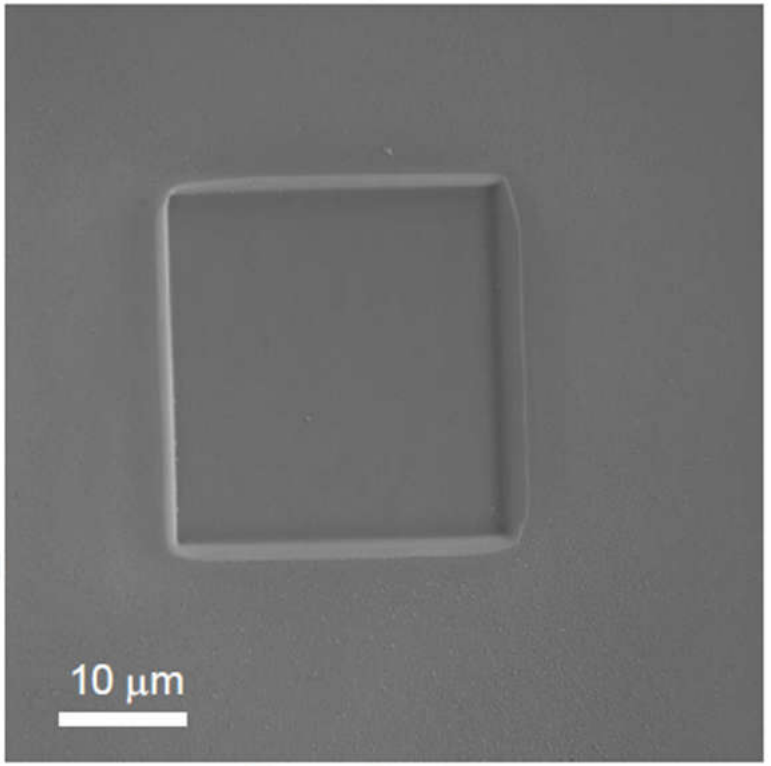
Laser Beam Quality





50 µm square (U. Cambridge)

Ablation of Quartz with ATL

Alan Koenig, USGS
User of Geolas, Analyte and Excite

"The ablation of quartz works very well with the ATL laser. In fact it is my observation that in many cases the energy density required to ablate quartz is lower than expected...of course the expectation is based on published data and experience with the Compex based (20nsec) systems"

Adam Kent, Oregan State University
Compared Resonetics with Analyte G2, both with ATL laser

"comparing the G2 machine against the Resonetics short pulse excimer was to use ablating quartz as a test of ablation control. The short answer is your instrument [Analyte G2] did well - ablated the quartz crystal I had no problem. The reso ATLEX machine did not do well at all - probably because they do not have the same beam homogenizing ."

Simple Open Working Architecture

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Simple Open Working Architecture – Analyte.Excite

Simple Beam Delivery

- Minimum amount of mirrors used
- Reduced cost of ownership
- Efficient laser transportation, so less energy lost before reaching ablation site
- Results in lower energy run on laser head and so less stress on laser head, so longer life time

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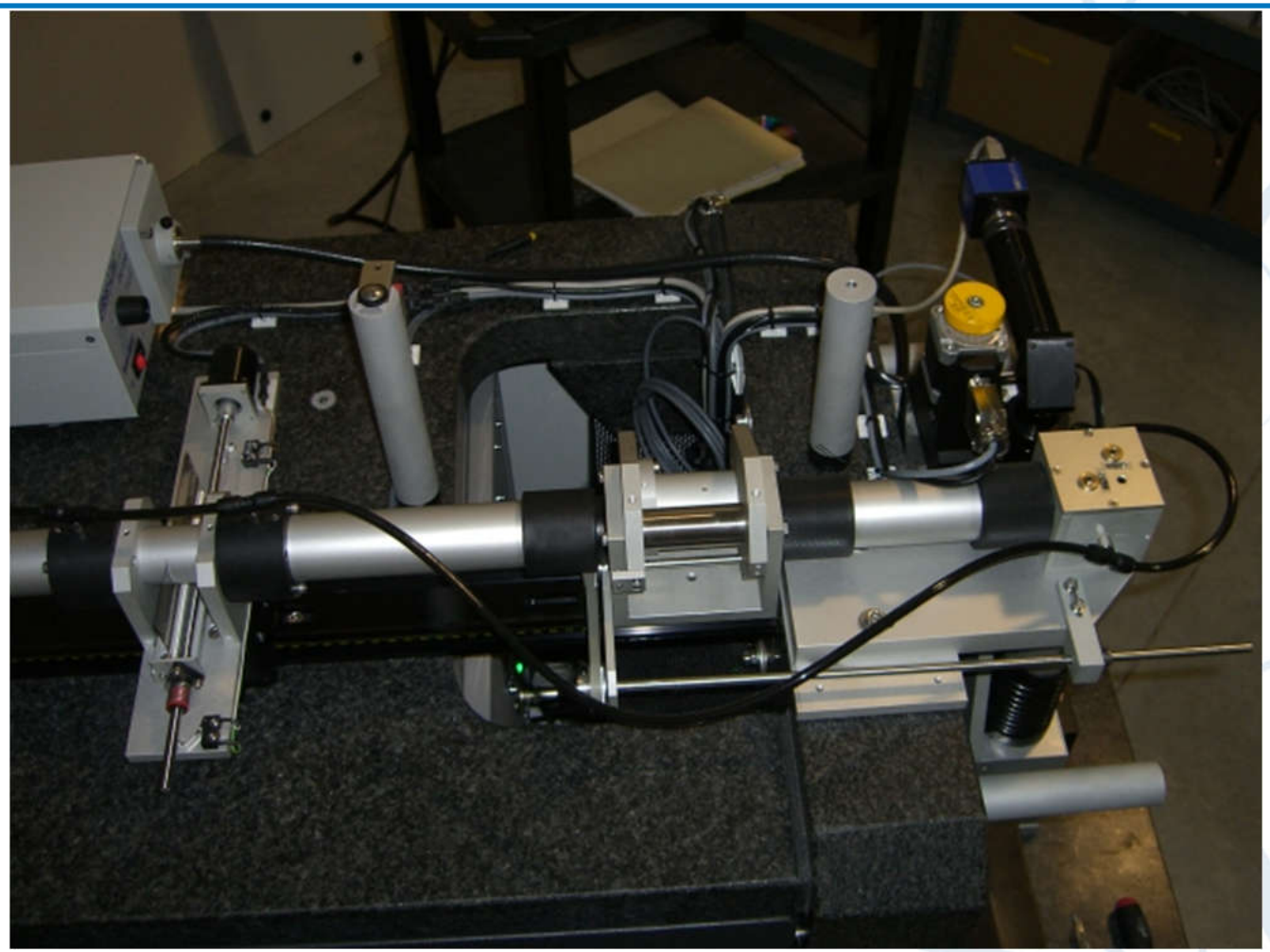
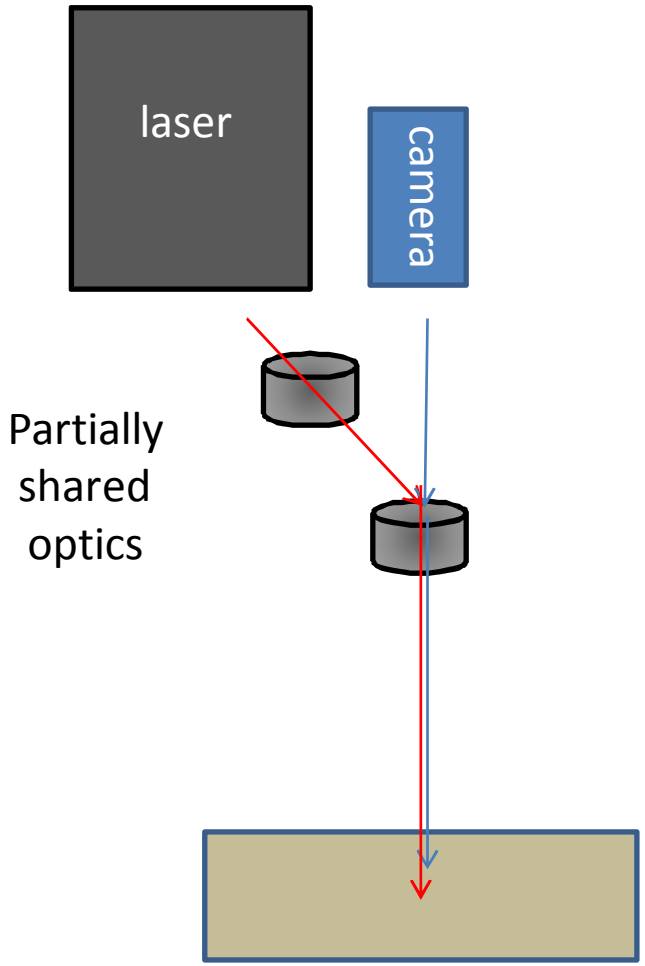
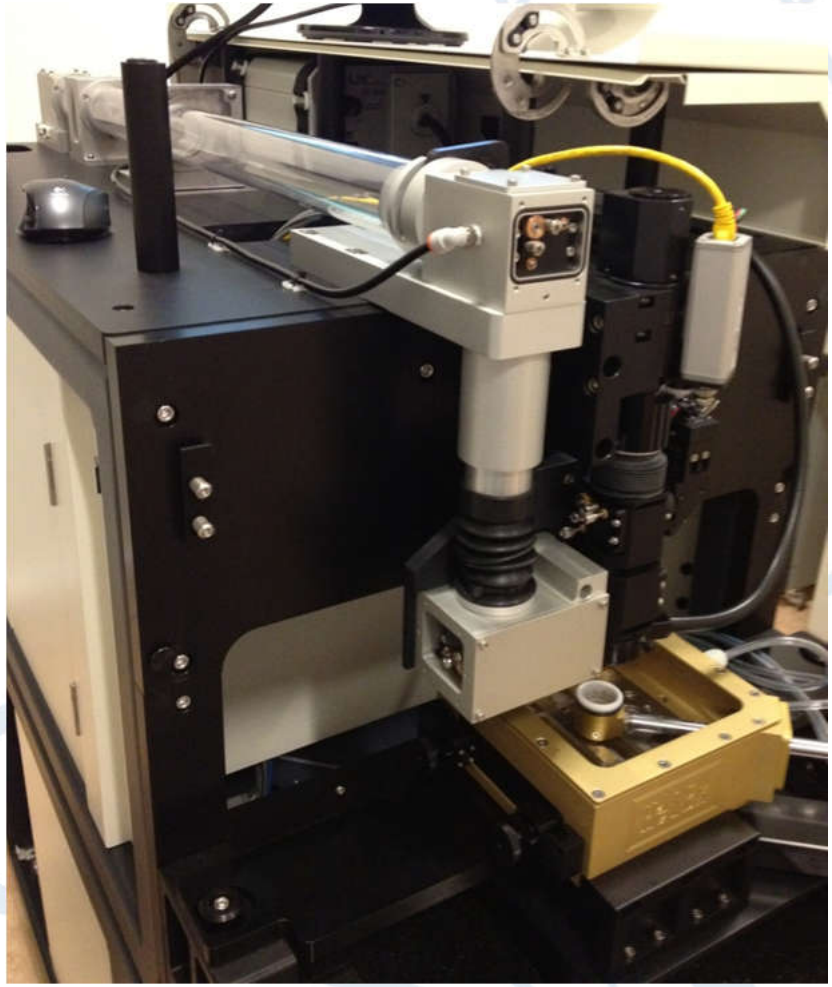
Open Working Architecture – Analyte G2



Objective Lens Layout





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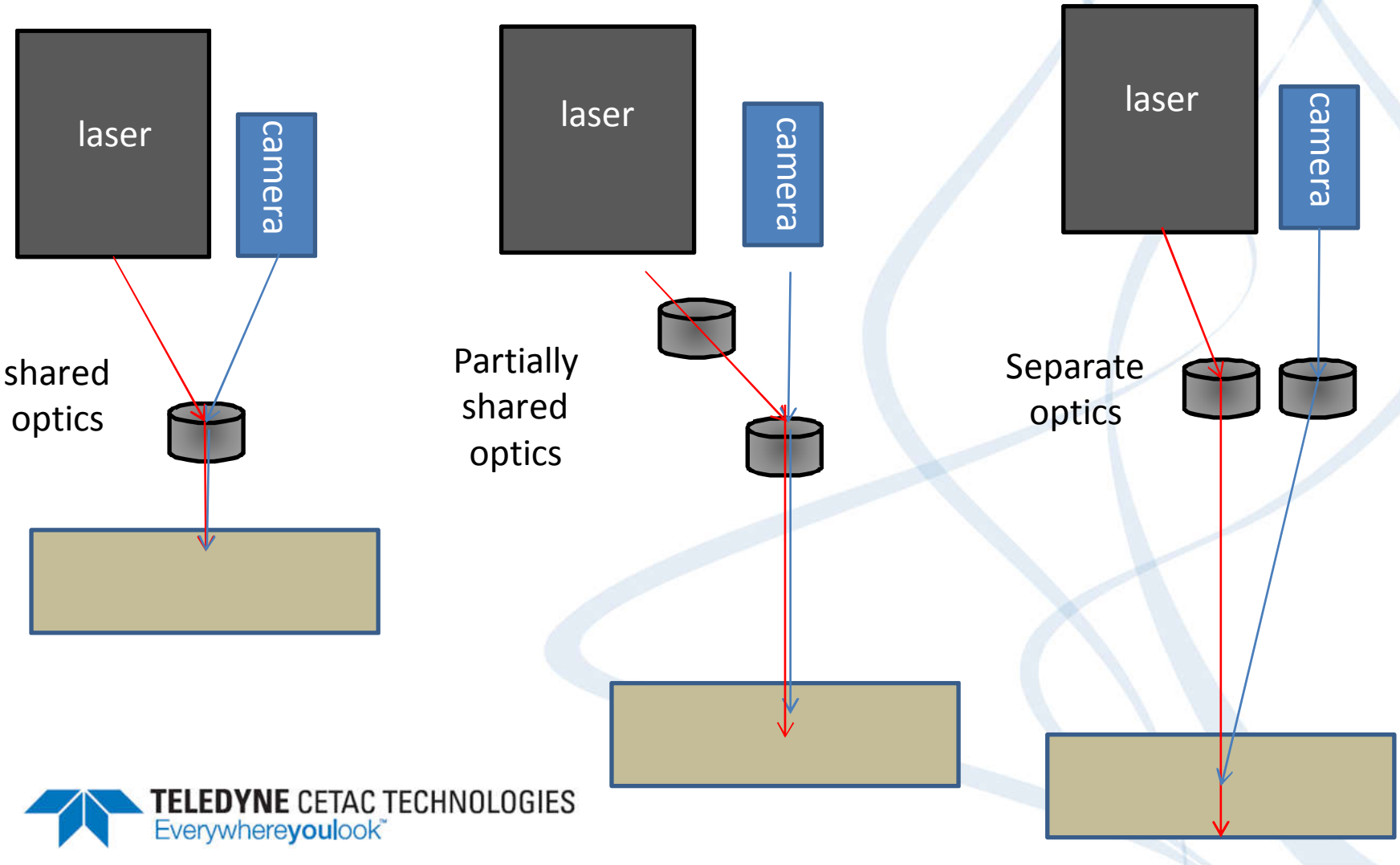
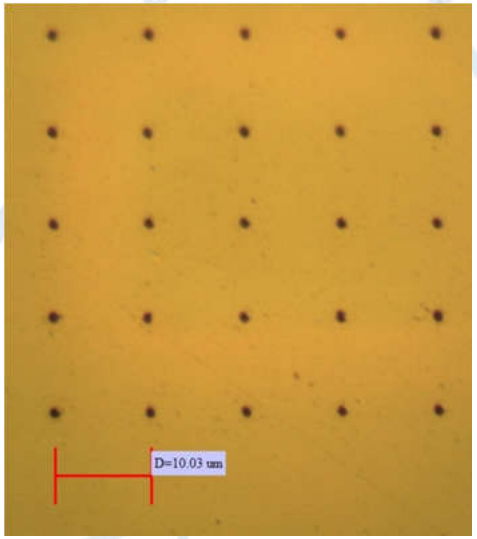
Objective Lens Layout Comparison

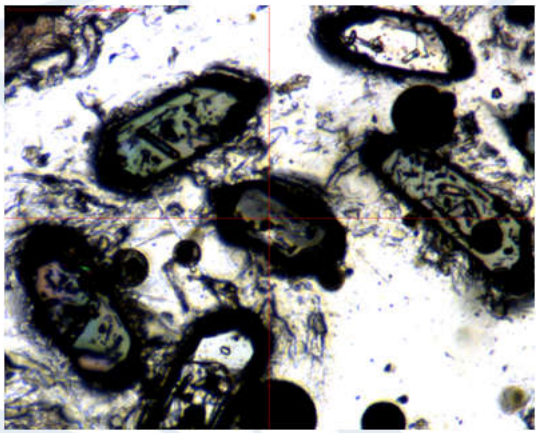


Viewing Quality

- 1 micron feature identification
- Transmitted, Coaxial and ring lighting
- Polarisers
- Fiber optic fed light source
- User Changeable bulb



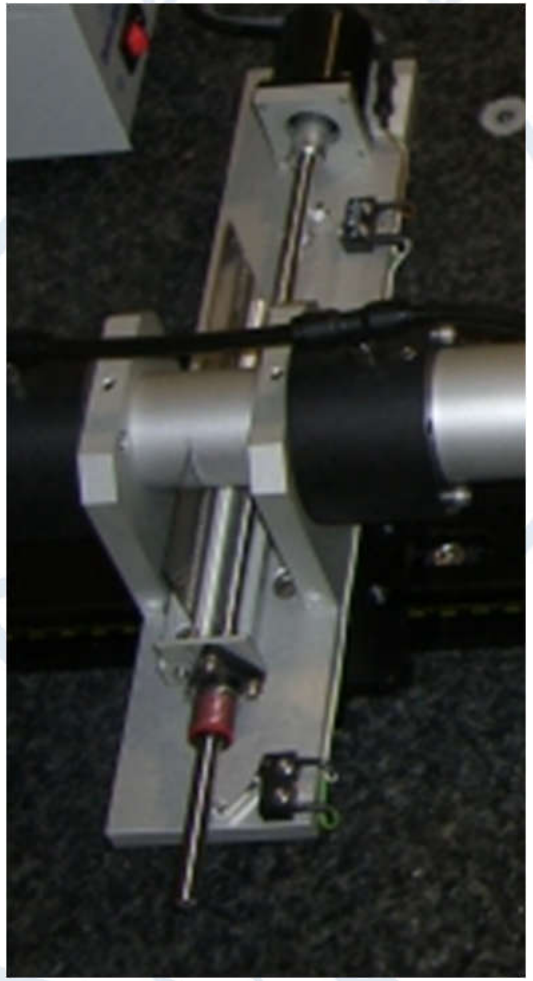
Grid of 1 um spots



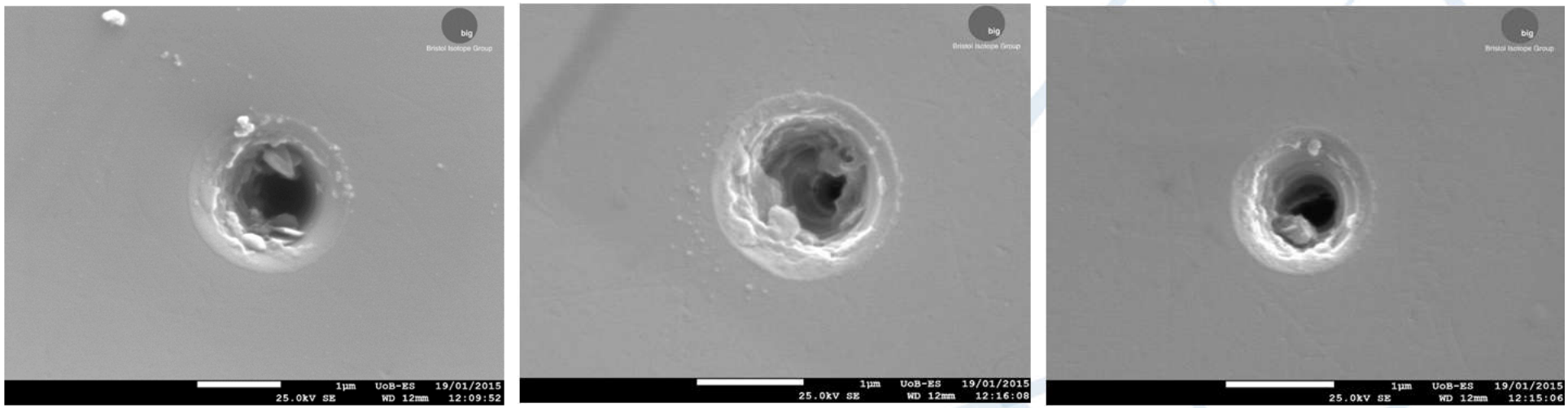
Zircon grains ca 25 um

Apertures, Rapid Position Mask

- Rapid position mask of 30 spots
  - 1 to 155 micron circles
  - 5 to 150 micron squares
  - 65 & 90 micron crosses
  - 155 x 10, 10 x 155, 20 x 155,
  - 155 x 20 micron rectangles
  - Custom masks possible
- 1.6 x demagnification lens on G2
  - Spot sizes up to 250 Micron



Only Excimer system with characterised 1um spots



Courtesy of the University of Bristol Isotope Group

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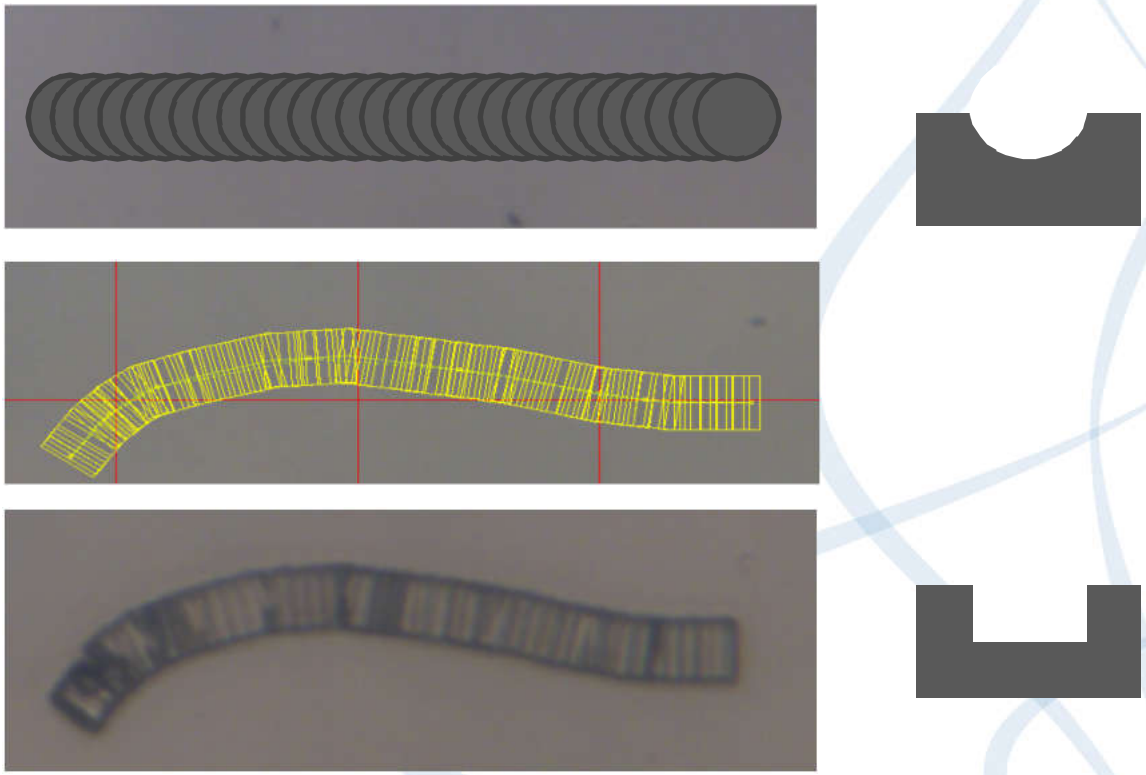
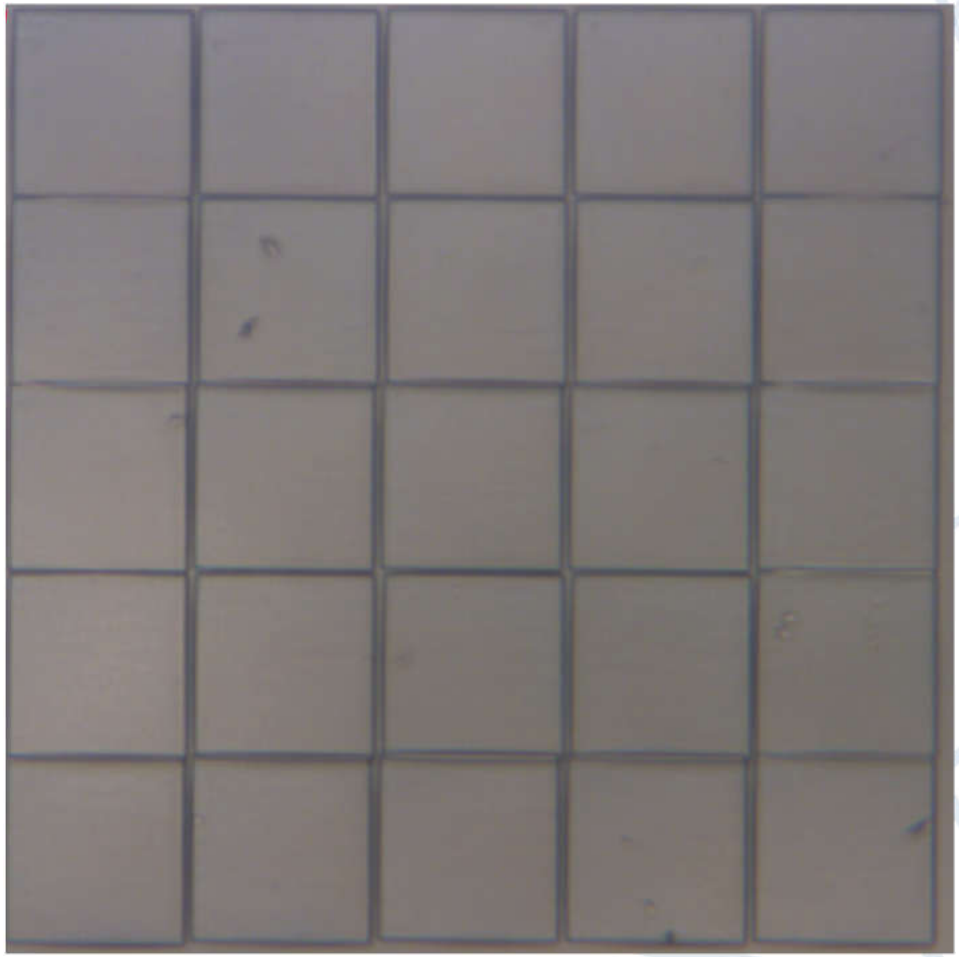
DYNAMIC APERTURES

- X-Y-ϑ *Rotating Aperture*
  - 5 to 150 micron rectangles
  - +/- 45 degree rotation
  - <1s moving between shapes

X-Y-Theta Aperture vs. Circular Spots



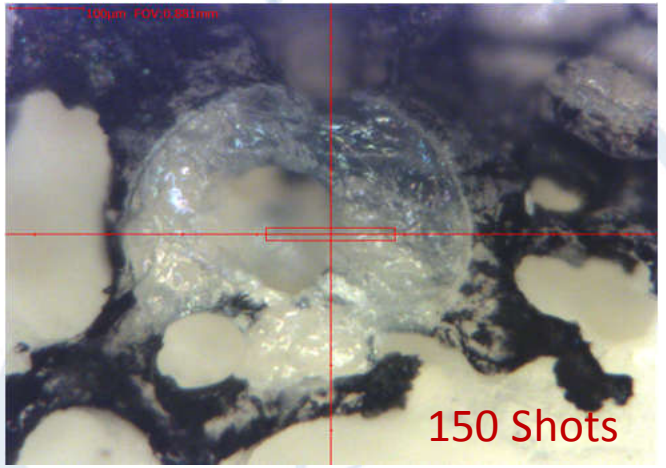
Edge-to-Edge Squares

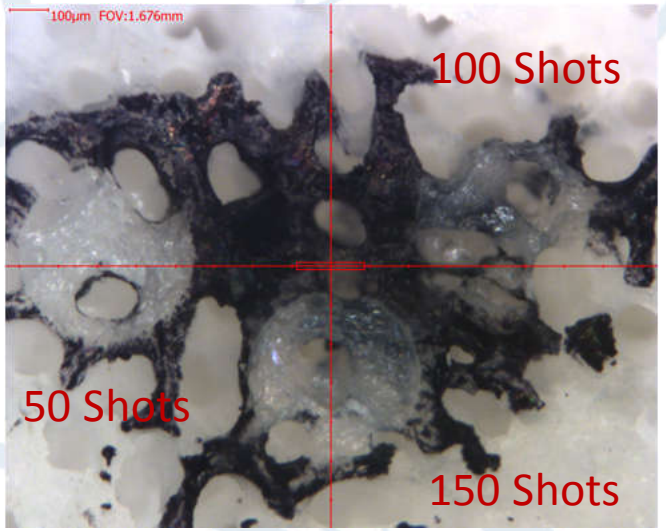


G2 Special Apertures

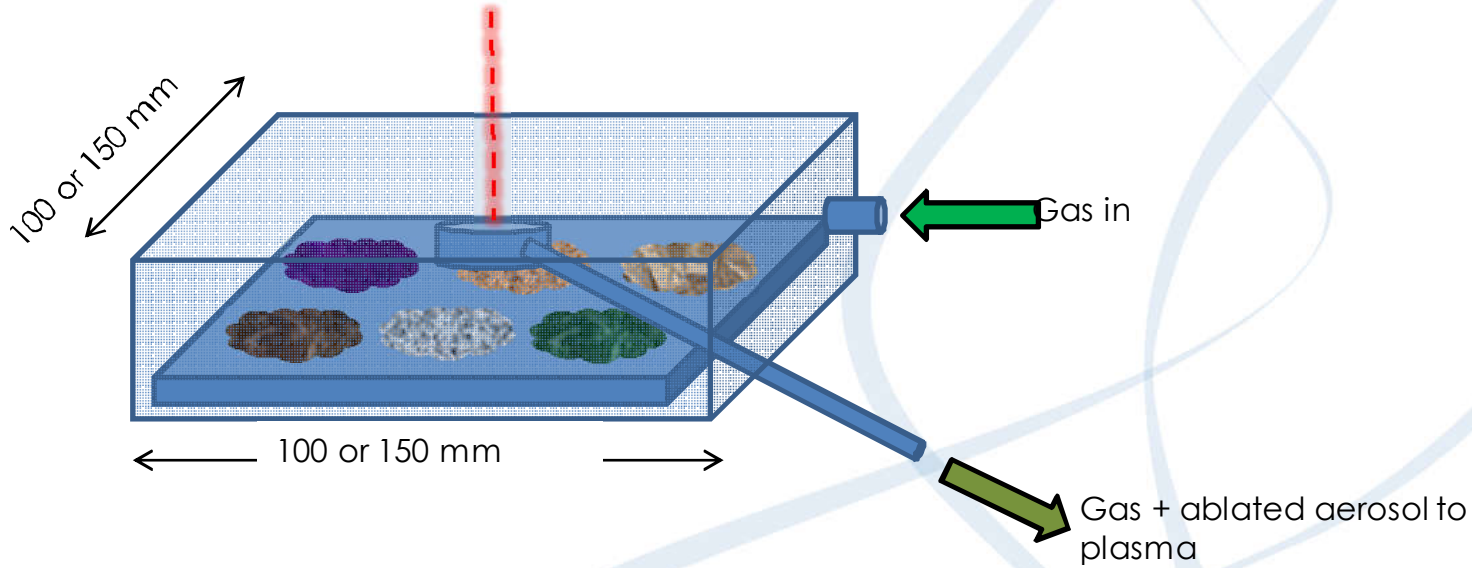
- Spot size up to 440 micron
  - Reduced fluence
  - Specialist applications
  - Custom Aperture mask

- 440 crater on Aragonite at 2.05 J/cm^2





2-Volume Cells



WHAT SHOULD A TWO-VOLUME CELL

1) Efficiently remove as much ablated material as possible and transfer it to the plasma

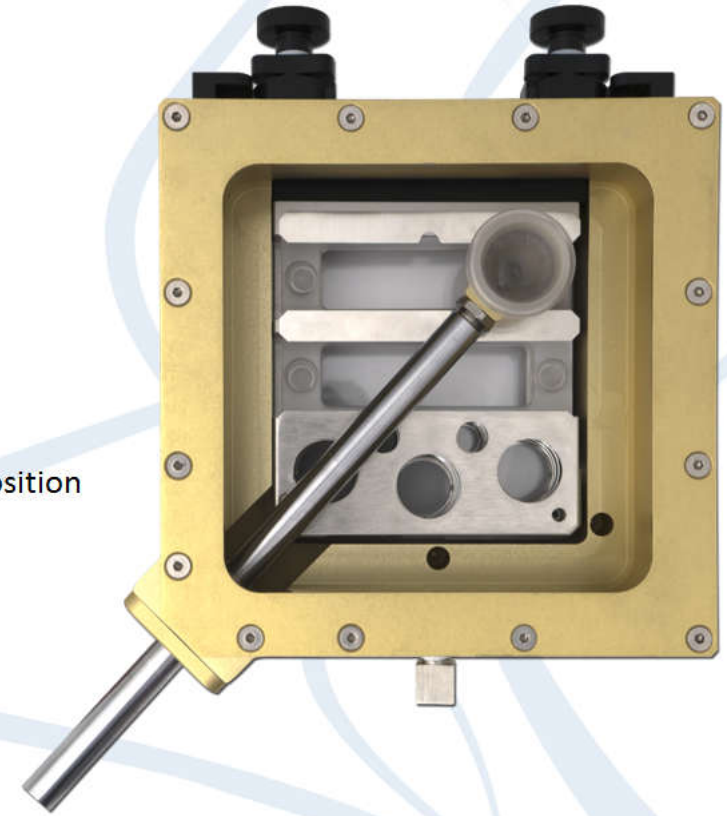
2) Produce the same transfer efficiency and fractionation characteristics regardless of ablation position in the cell

3) Allow large samples or many samples to be placed in the chamber

4) Not leak

HelEx II, The Ultimate Cell

- HelEx II stage mechanical accuracy - 0.7um
  - Further improvement to come free of charge this year through software upgrade
- 1% variation in cell reproducibility
- Only fully active two volume cell available
  - Full active control of the ablation plumb
  - Reproducible ablation environment anywhere in the cell
- Flexible sample holders
  - Sample holder to fit all applications
  - Custom holders available
- Unique Stage Priority lasing
  - Laser will only fire when stages report they are in correct position
    - Prevents mixing and blurring
    - Increased accuracy and resolutions of maps
    - Reduces time of elemental mapping
- Customizable wash out
  - Flexible for all applications
  - Not tied in to one application



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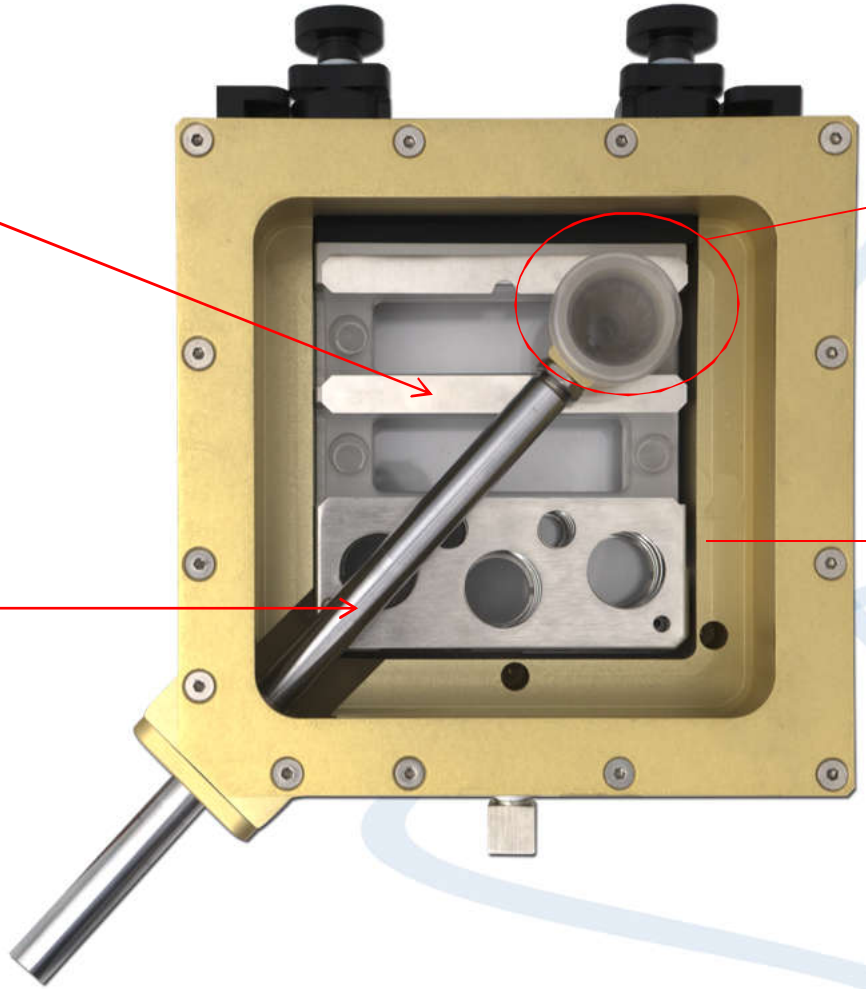
HelEx II, The Ultimate Cell



Sample holder

Internal volume (cup)

External Volume

Articulated gas inlet/outlet arm

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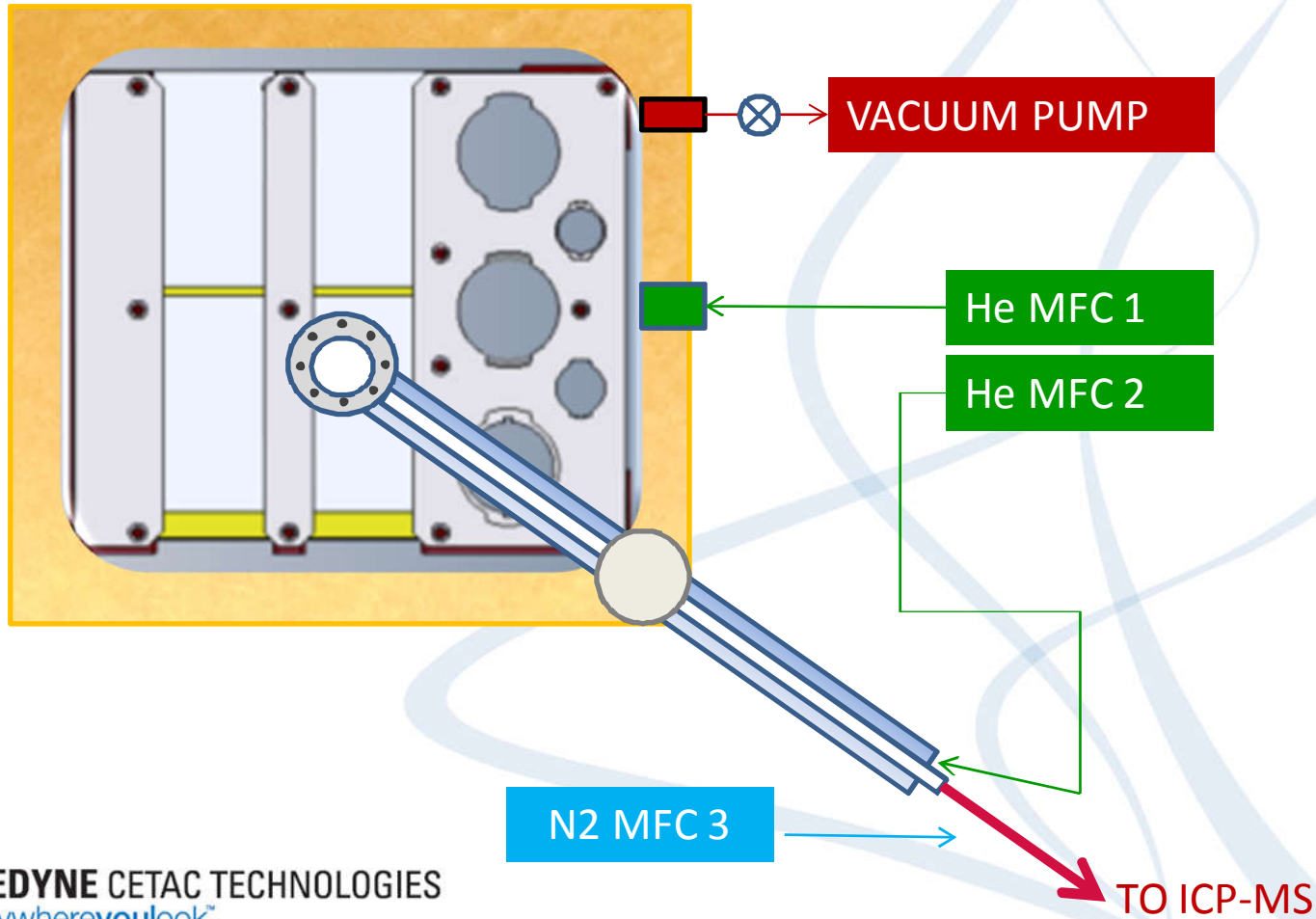
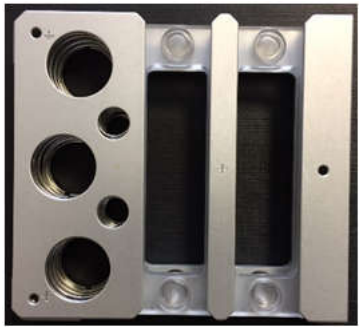
HelEx II Cell Schematic

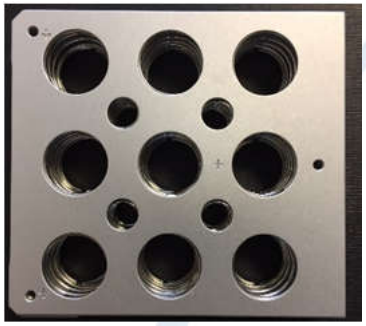


HelEx II, The Ultimate Cell

Standard sample holder:

- 3 x 25 mm pucks
- 2 x 12.5 mm standards
- 4 x petrographic slides / thin sections





Optional sample holder:

- 9 x 25 mm pucks
- 4 x 12.5 mm standards

“Open” sample holder:

- Empty drawer of 100 x 100 x 18 mm
- Removable, height-adjustable shelf

Cryo sample holder:

- -25 to +100 °C
- Includes cryostat

Custom sample holders can also be made in consultation with our design engineers

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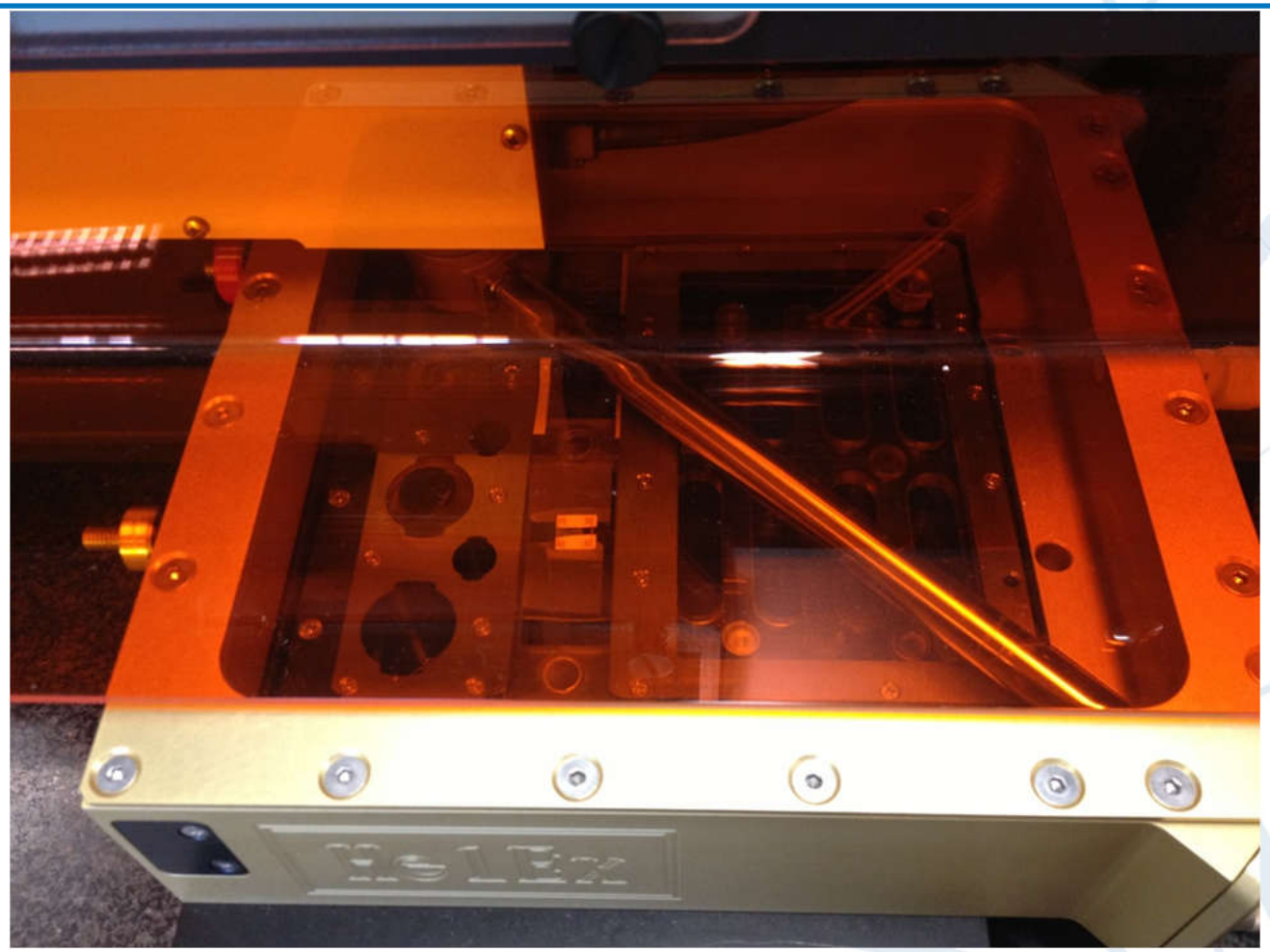
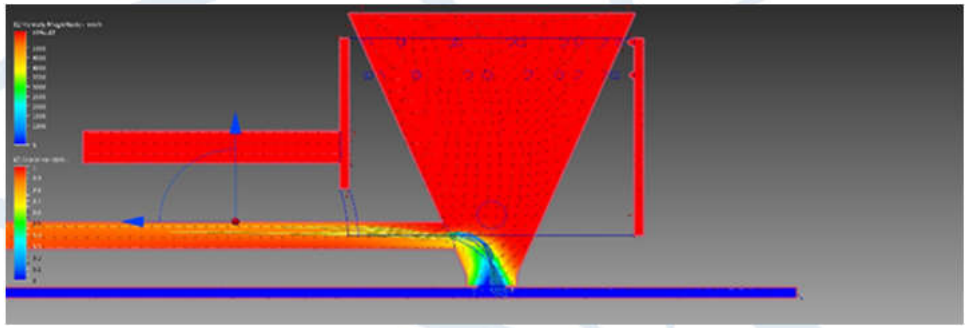
Unique Scalable Design - 150 mm sq HelEx



Interchangeable Inner Cup

- The user interchangeable insert
- Standard insert washout to 0.1% in <700 ms
- Ultra-fast washout configuration: <30ms*



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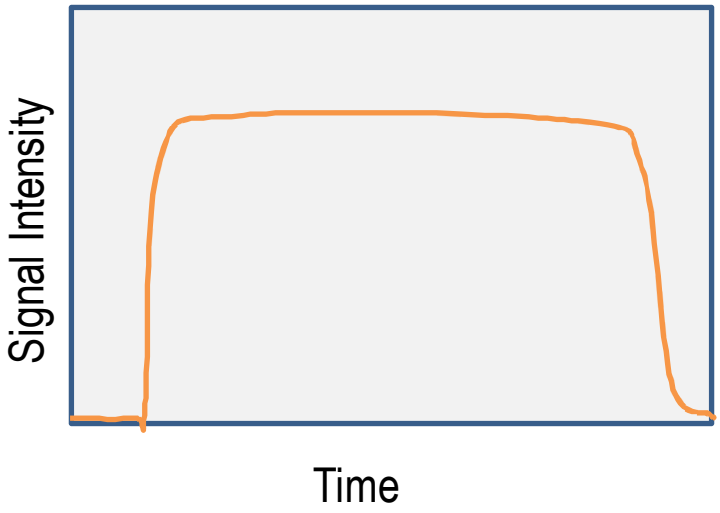
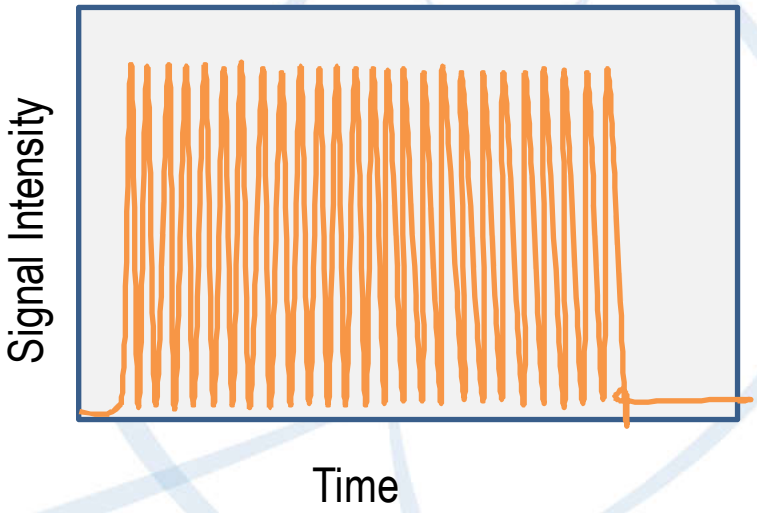
* Sadekov, Goldschmidt 2015

Washout, Why Does It Matter?





Too Slow?

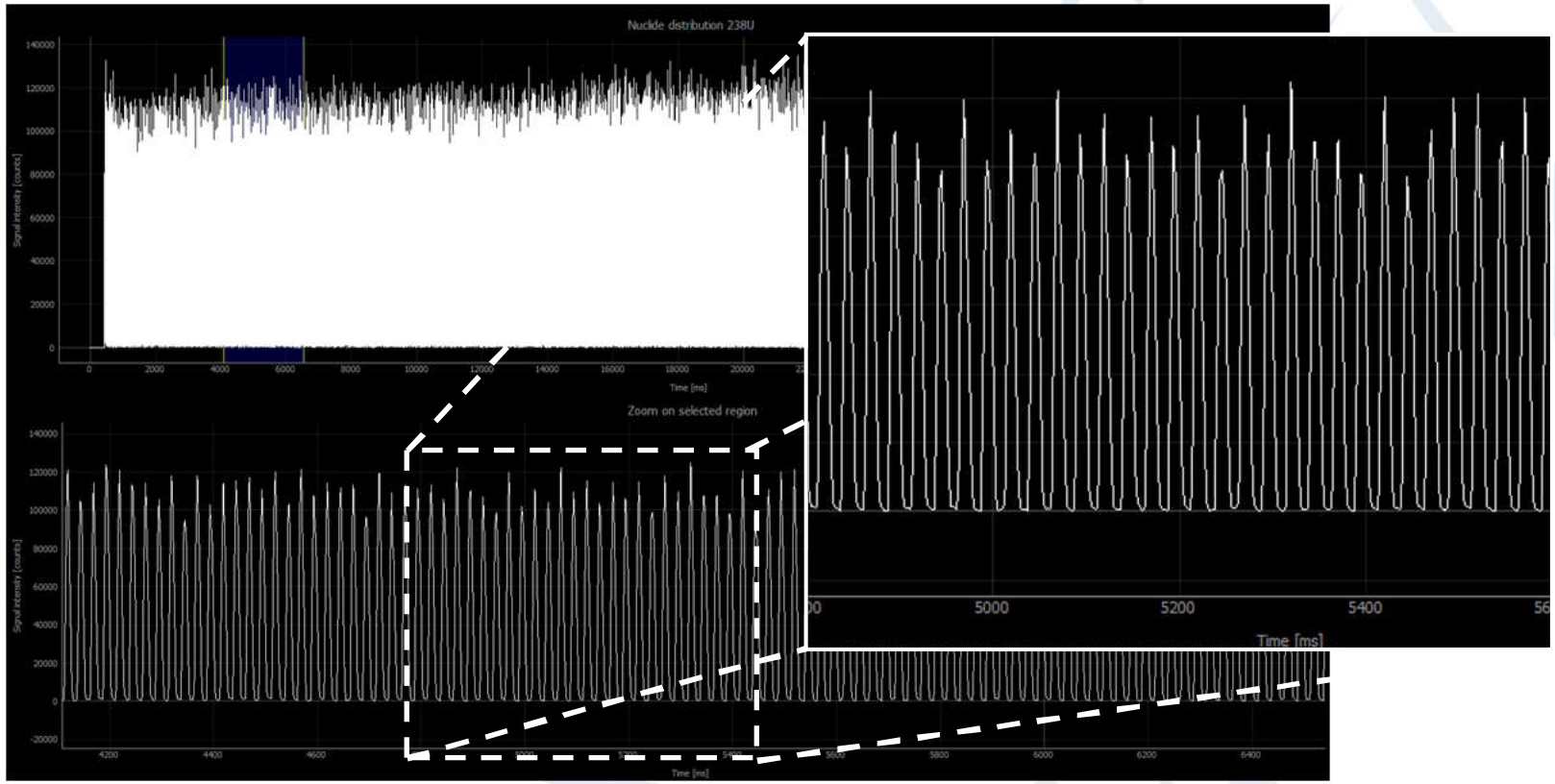
Too Fast?

Washout Speed: Why Does it Matter?

- Application dependent
  - Too slow – long transients (blurring)
  - Too fast – can observe individual pulses (noisy)
  - BUT – may want to observe individual pulses for rapid elemental imaging!
- Cells developed that offer slow, moderate or rapid washout speeds – application specific cells
- HelEx II is tunable to suit many applications

A glimpse into the future…

- Baseline separation at 40 Hz



Stijn Van Malderen, University of Ghent

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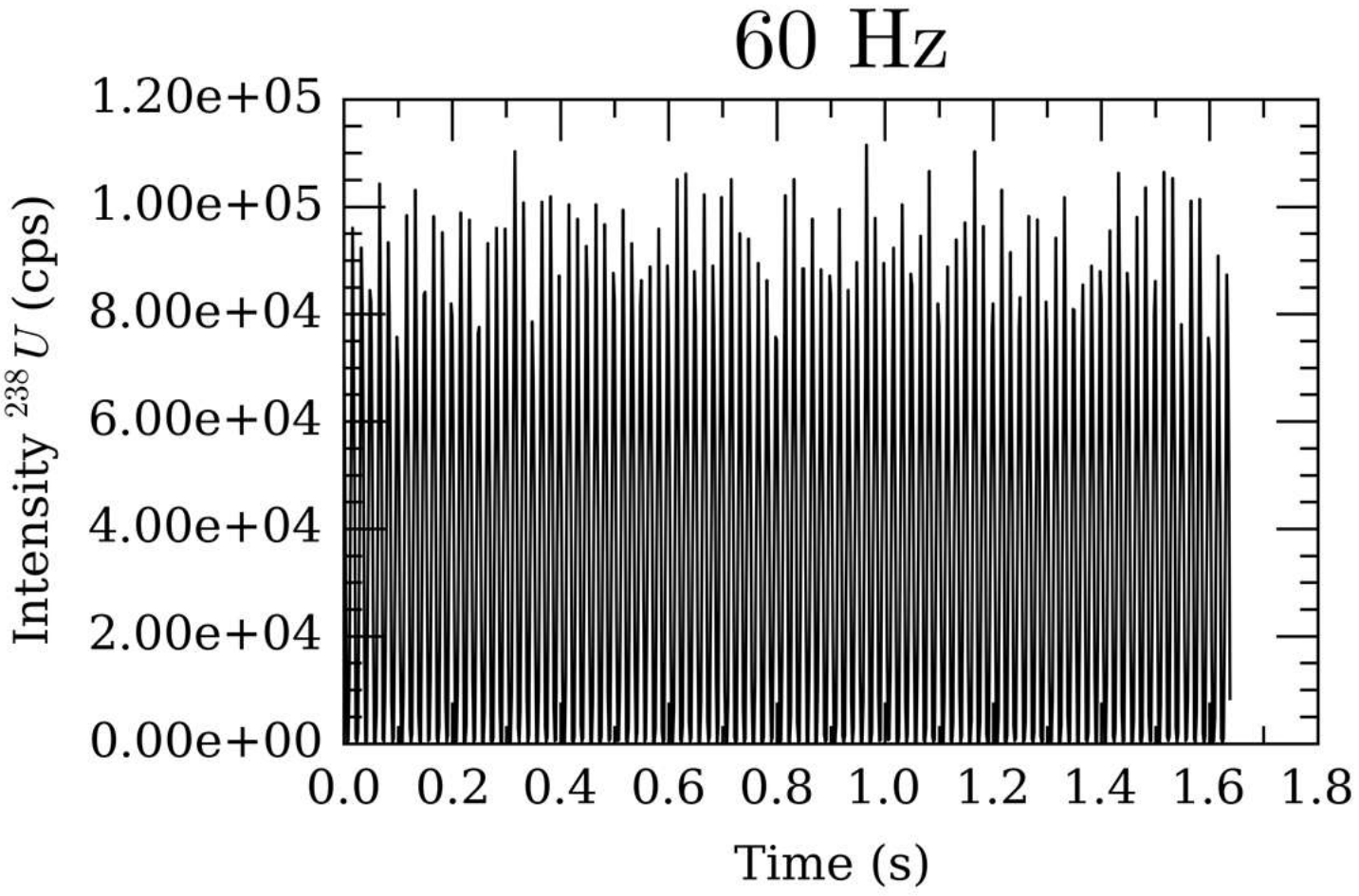
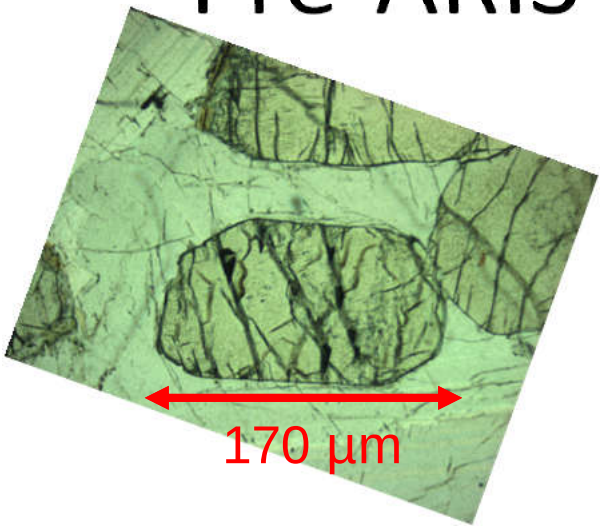
HelEx II, The Ultimate Cell

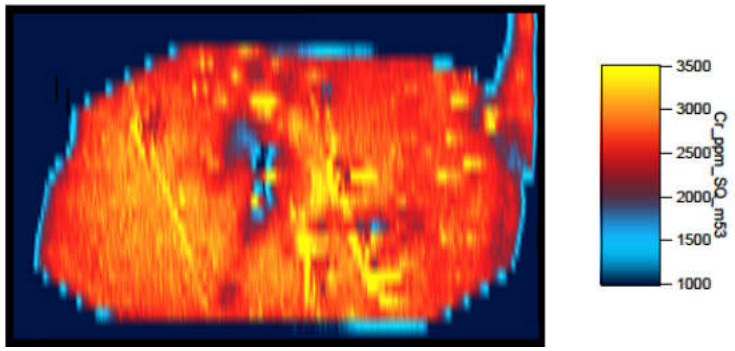
The HelEx cell's flexibility allows for sample single to range from a smoothed a flat top peak at 3Hz to fully resolved peaks at <60Hz with <30ms wash out.



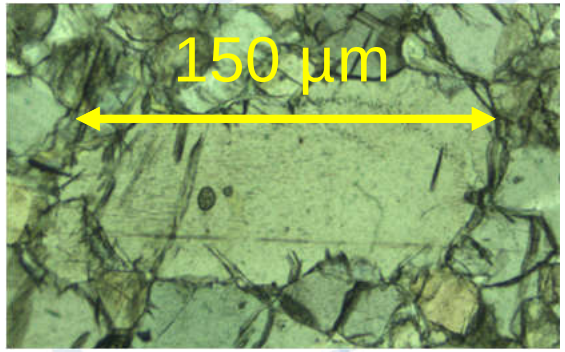
ARIS Comparisons:
What Does Fast Washout Allow You To Do

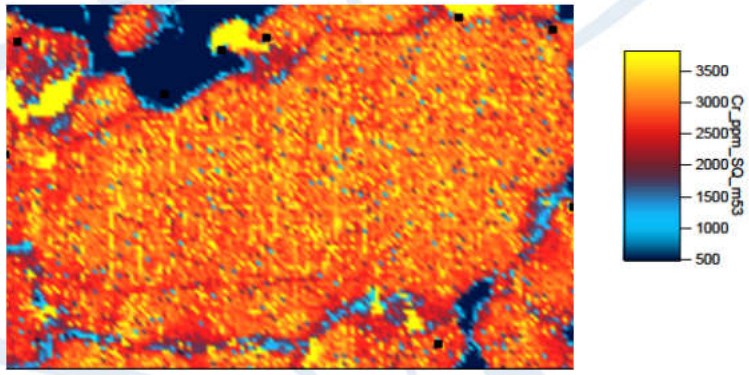
Pre-ARIS





ARIS





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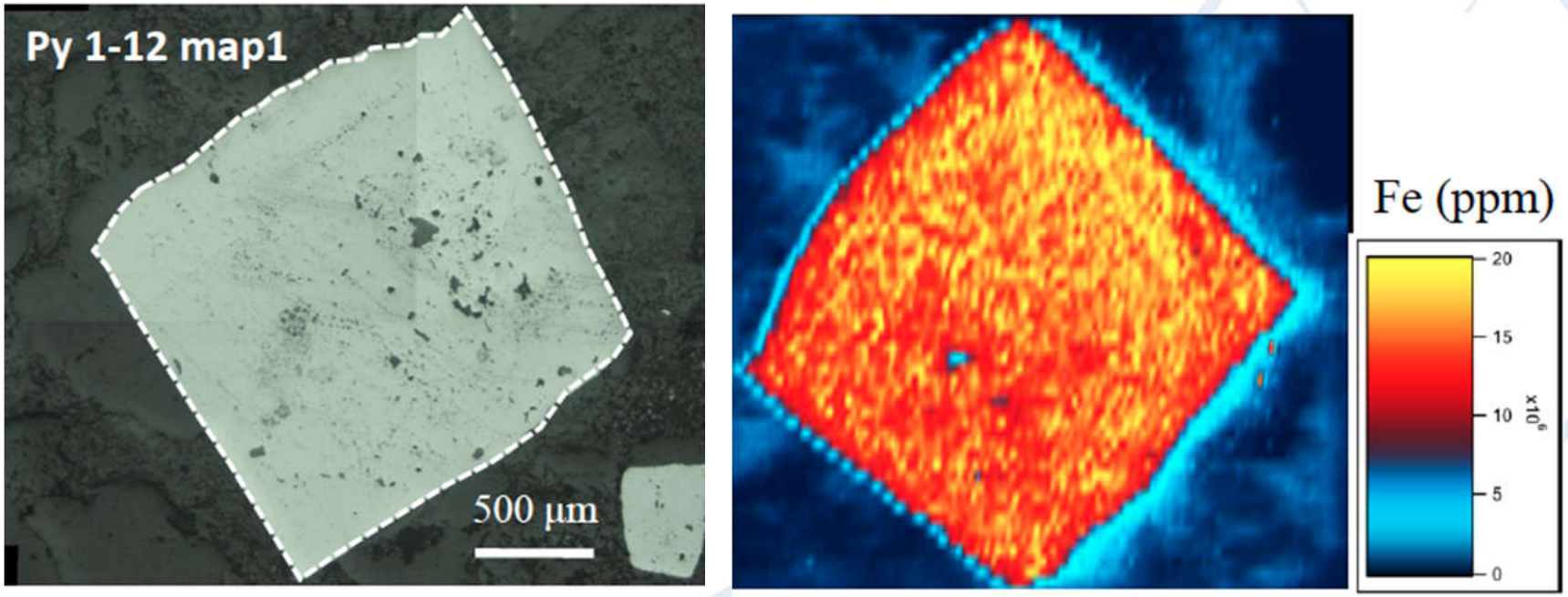
Euhedral pyrite but....



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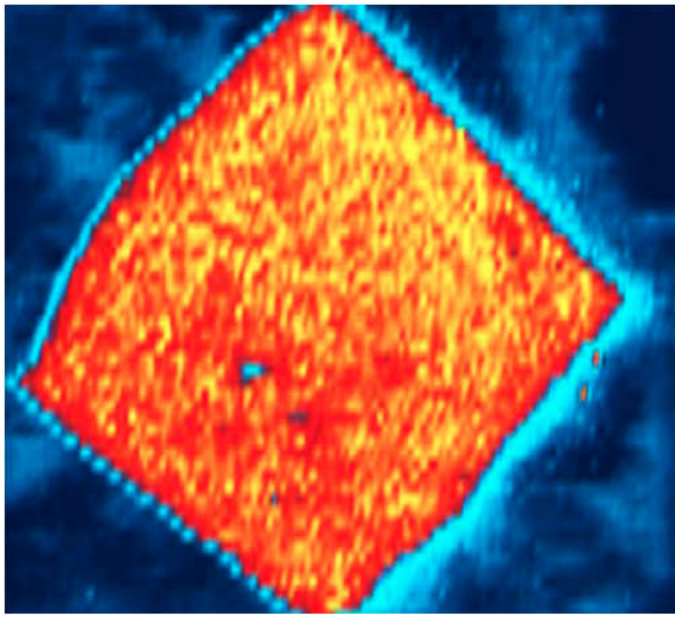
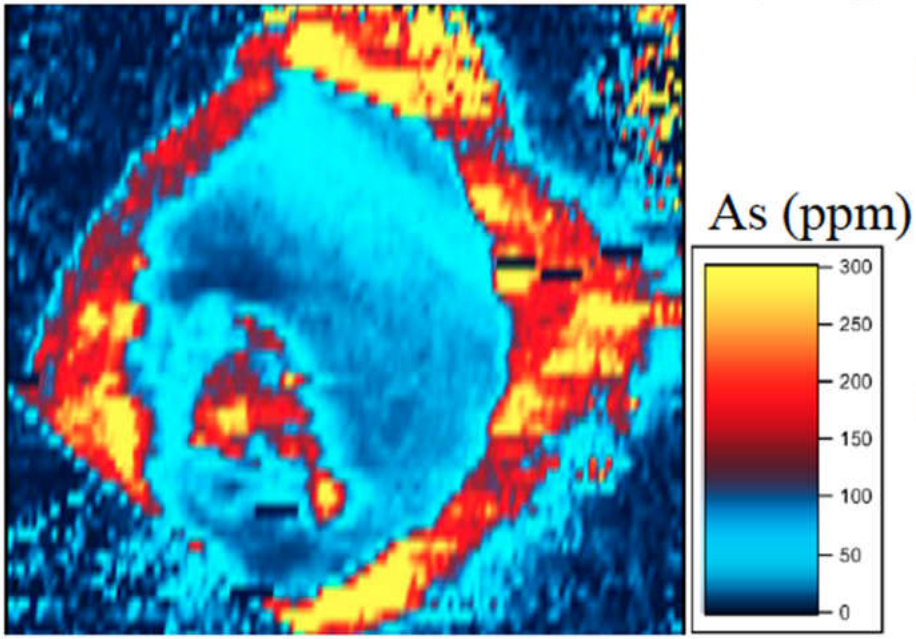
..As reveales the detrital core





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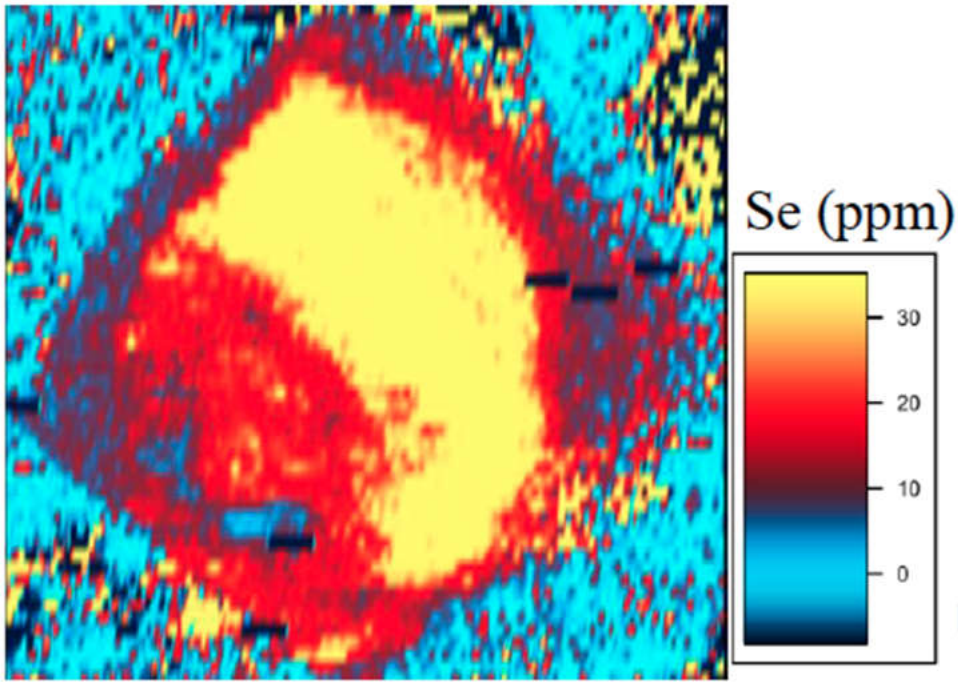
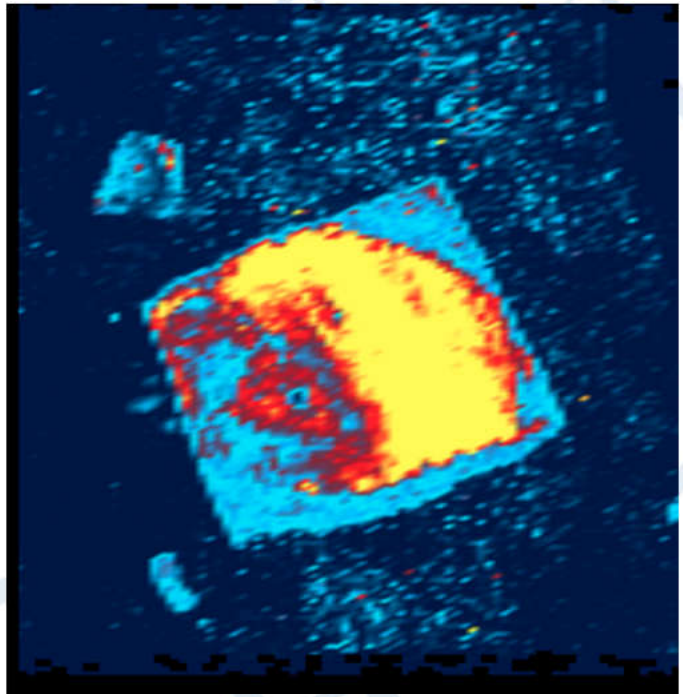
High Resolution Imaging Reveals Truncated Zoning In Detrital Core





Half the ablation time, 75% larger area - ¼ of He consumption – ½ Ar consumption
Firing at 100Hz, reported full baseline resolution at 45Hz
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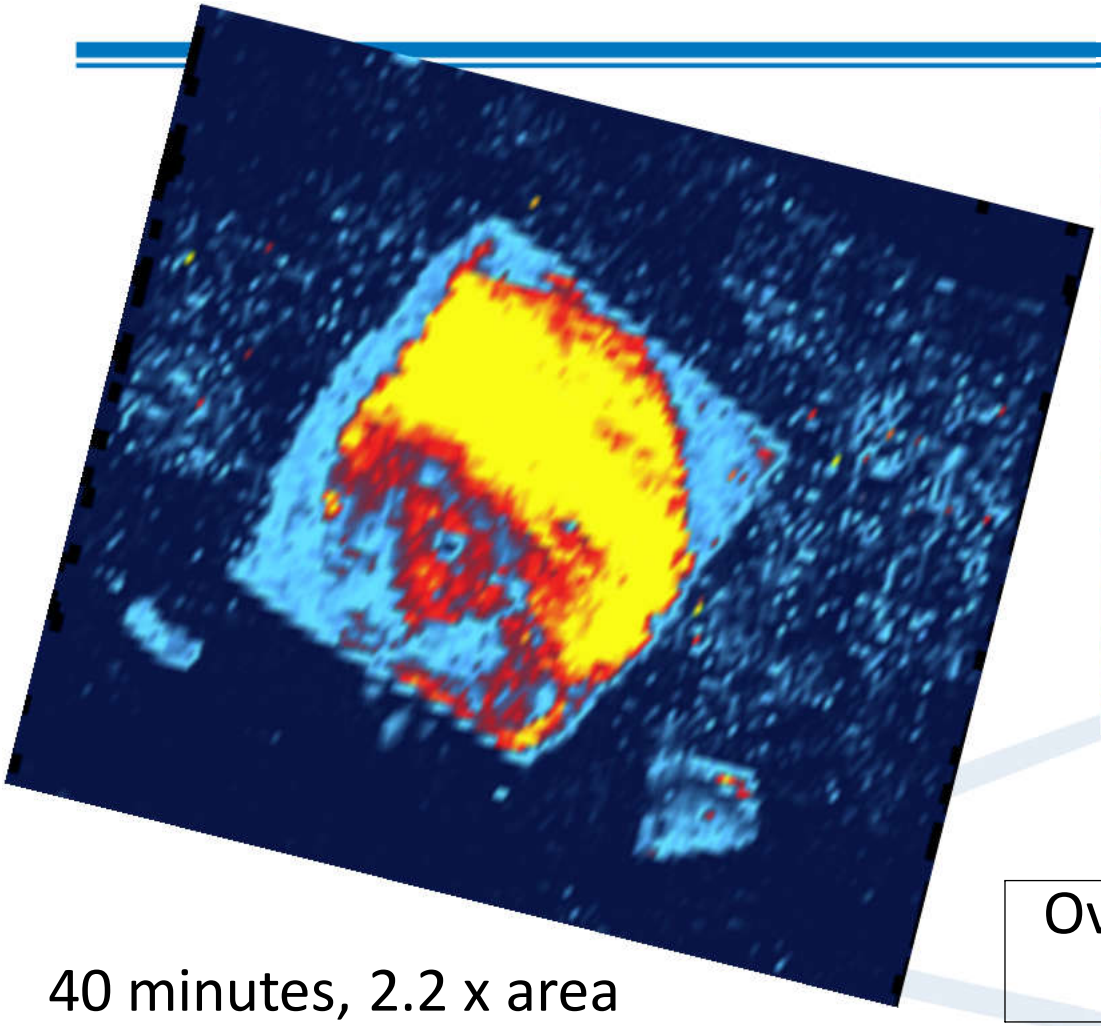
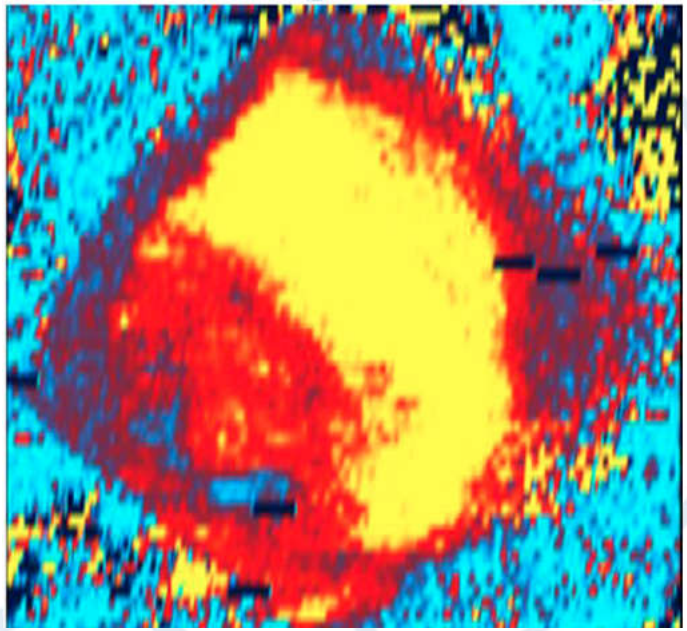
With ARIS



40 minutes, 2.2 x area

Pre-ARIS



1.5 hours

Over half the time = less gas = **less cost**

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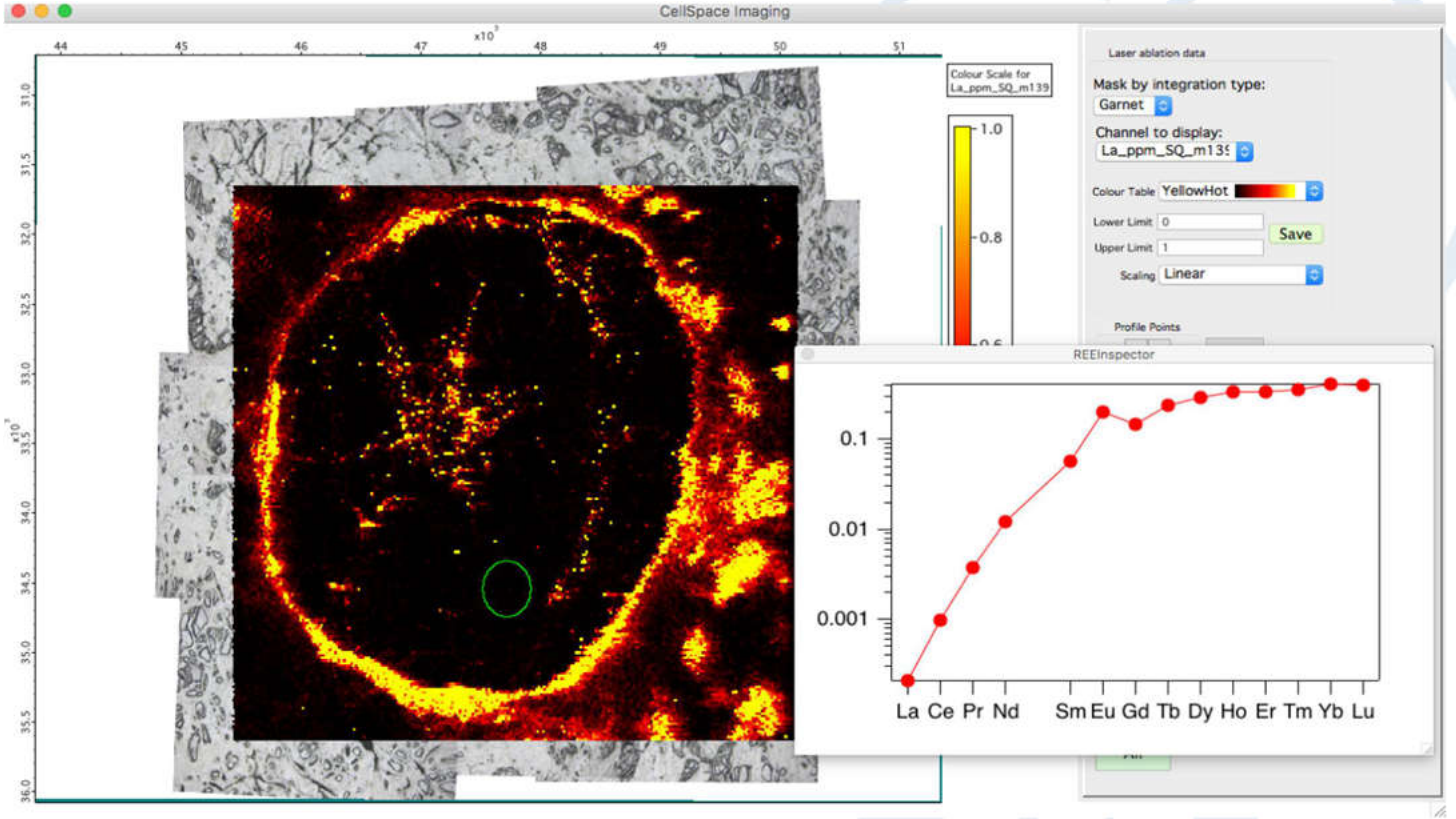
La Distribution in Garnet

- 20µm spot at 50Hz shows 10ppb concentrations
- Map took 3 hours (5mm x 5mm)
- All the REE, Ni and Si, collected



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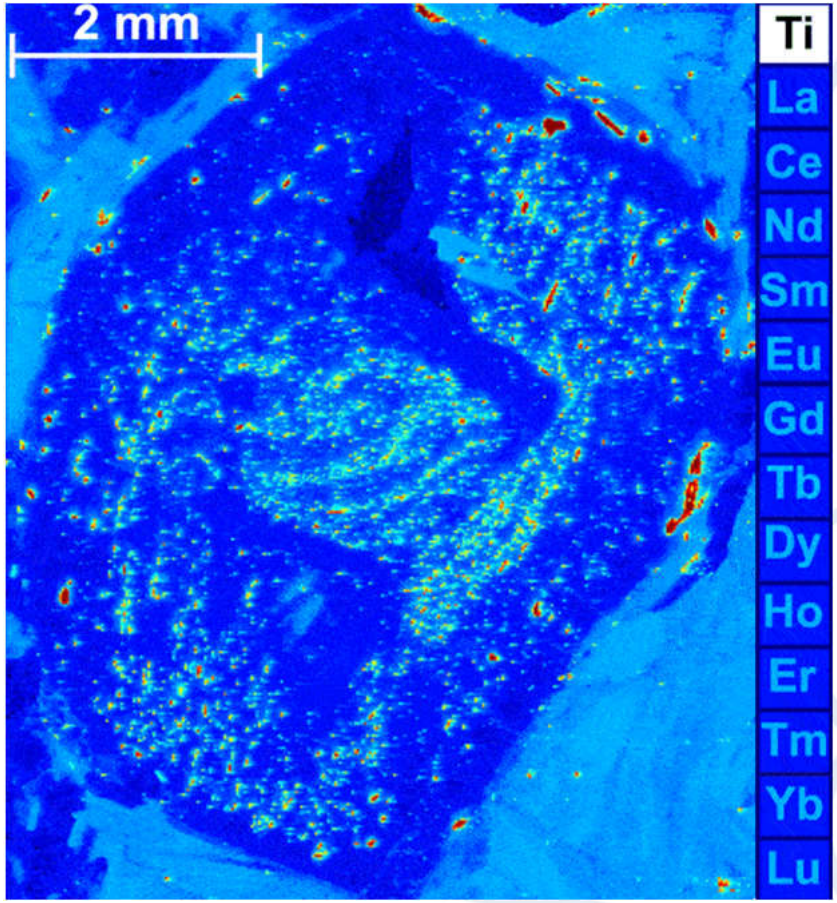
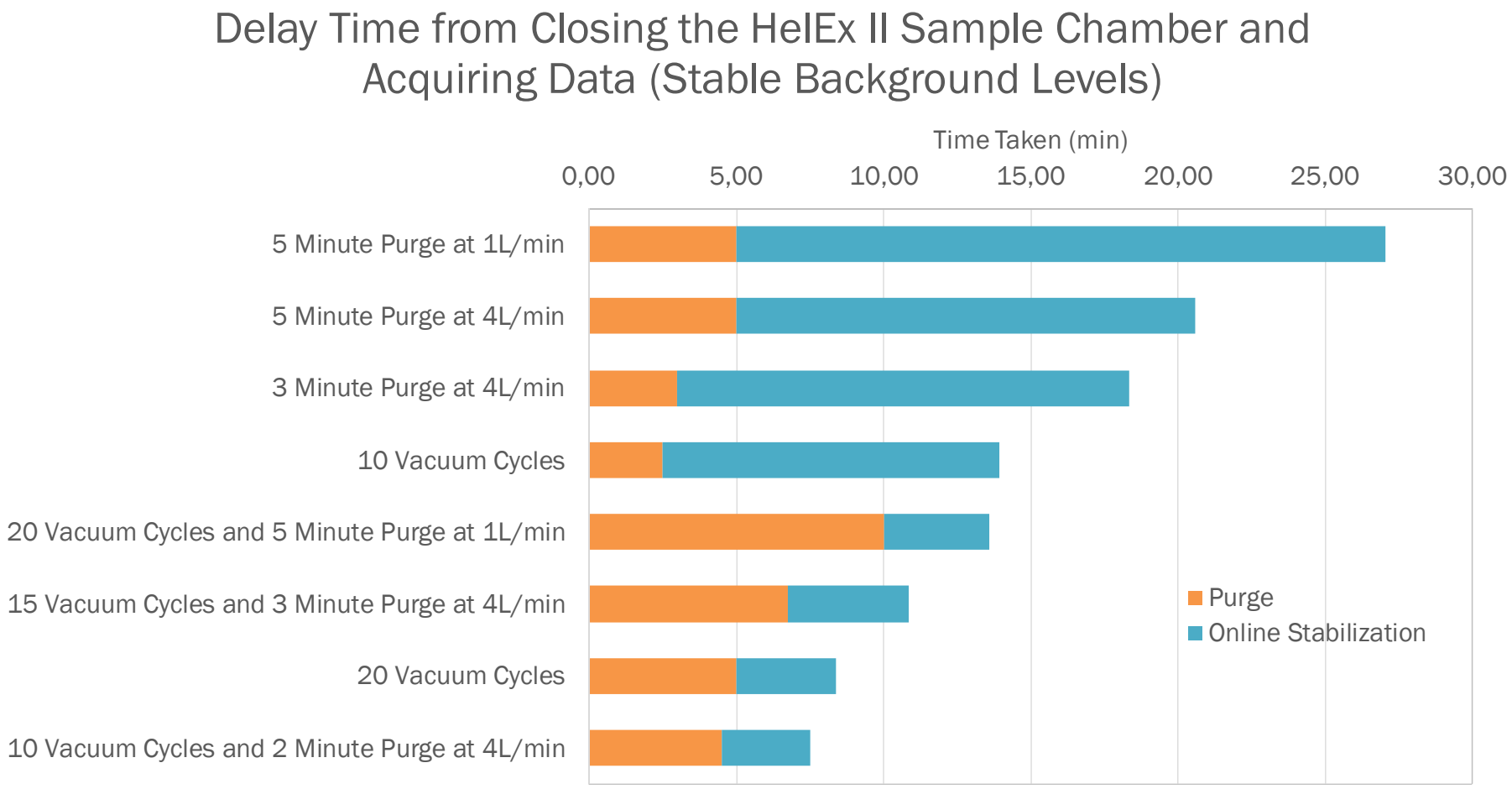
LA Distribution in Garnet



The HelEx® II 2-volume cell



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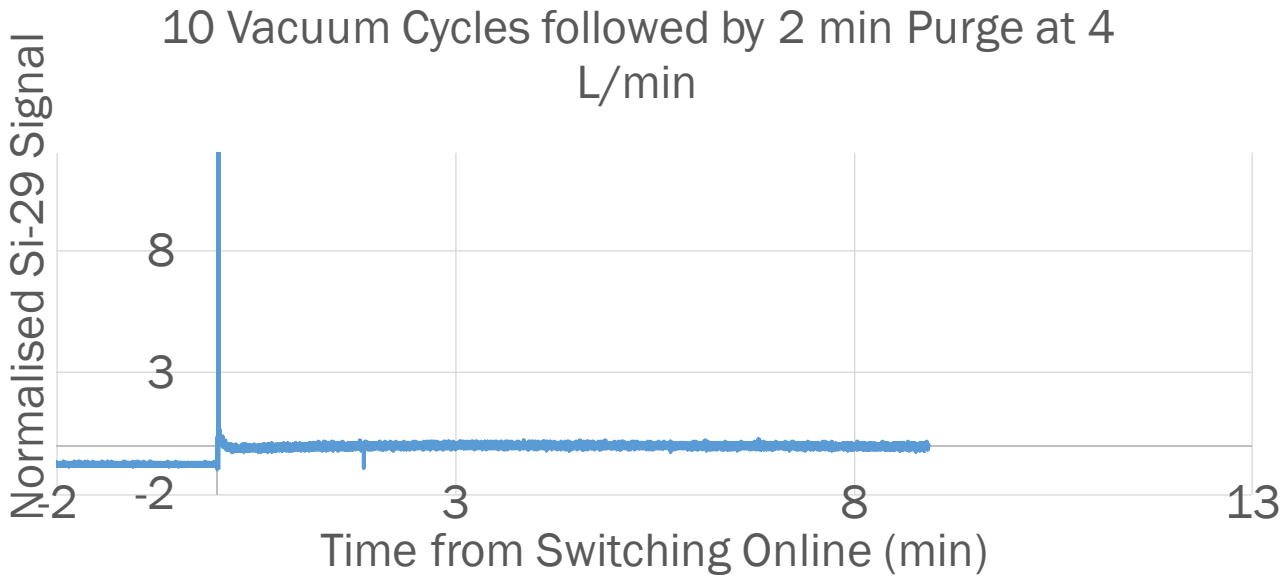
HelEx II The Ultimate Cell
Analytical back ground <6 minutes

- HelEx II purge cycle consists of 10 x 20s Purging & back filling with He and then 2 minutes of He purge at 4 L/min
- Cell moves online and allows plasma to settle
- Analytical background achieved in under 6 minutes using Si29 as proxy



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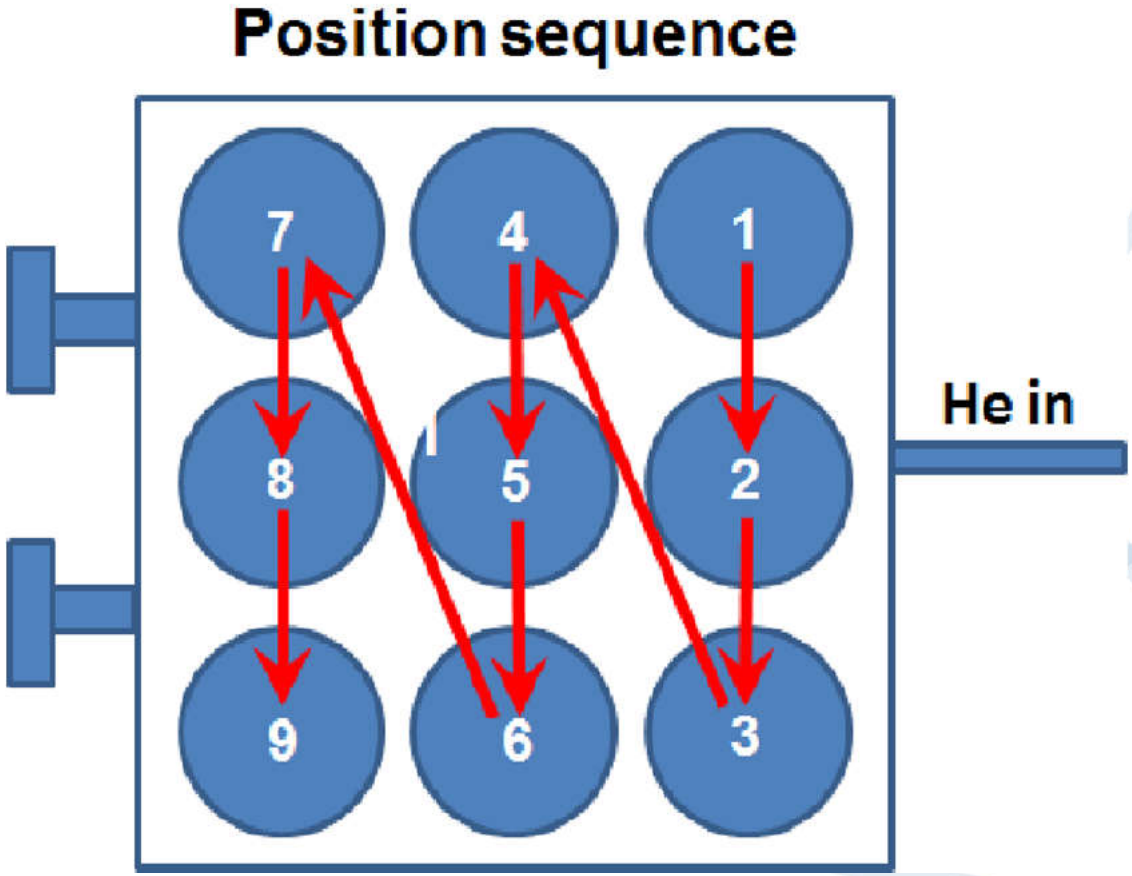
HelEx II The Ultimate Cell
Analytical back ground <6 minutes

- HelEx II rapid drop to analytical background is possible through:
  - Mechanically stronger cell than competitors, with thicker glass and walls
  - Outstanding laser depth of field to efficiently transmit laser through glass
  - Evacuation cycle pulls -5.7 PSI, significantly more than the competition

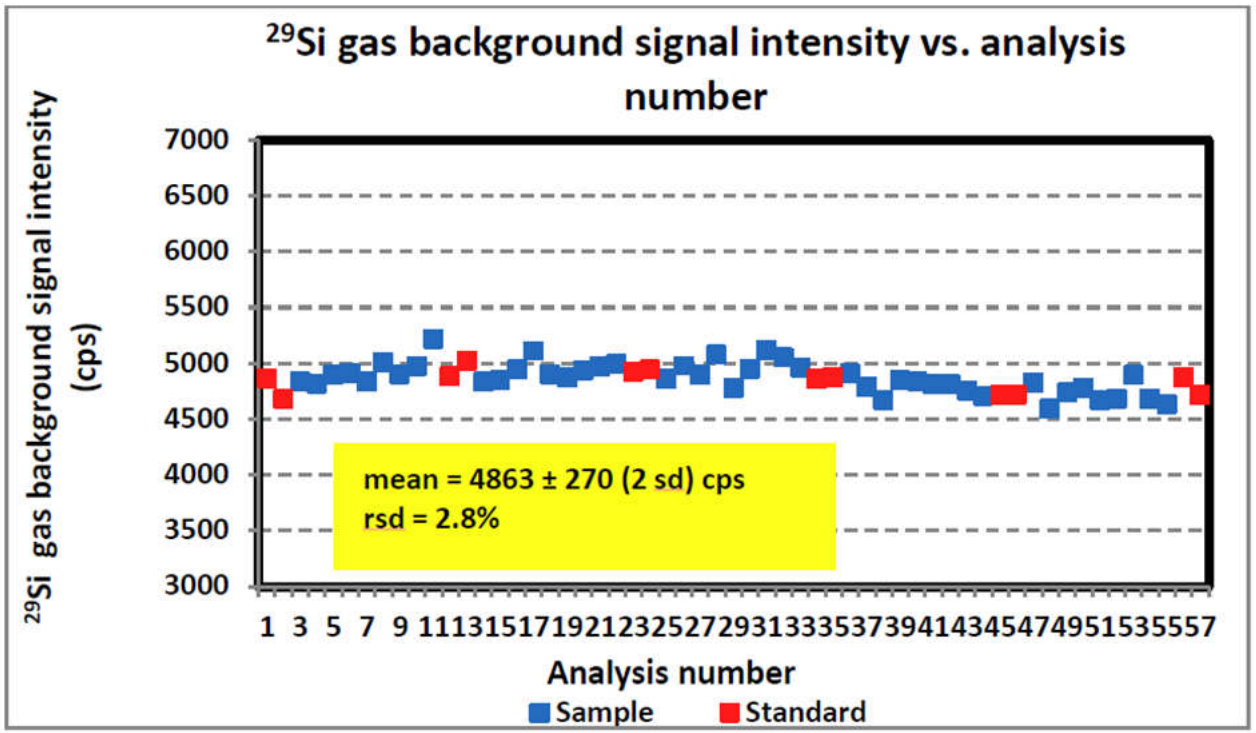
- HelEx purge cycle has the following advantages
  - Only uses vacuum and He back fill and no use of Argon
    - Reduced cost of gas consumption
  - On switching to online, HelEx atmosphere is pure He
    - Competitors cells have to wait for the HEAVEY Argon to be pushed out the cell by LIGHT Helium, before there is a uniform Helium environment
  - Consistent ablation environment
    - No Argon diffusion gradient or pockets of gas
  - HelEx has over pressure warning during backfill
    - Competitors back fill with Argon does not, danger of over pressure

HelEx II Performance Tests



Signal response and variance over 9 positions using NIST 612,
40um spot,
2.5Jcm-2,
Ablation time 50 s,
blank acquisition 30 s

HelEx II: Performance Tests



Back ground stability, after 20 evacuation cycles and 15 minutes He purge (counts versus time)

Moving across the 9 puck sample range

The 29Si gas background signal is a product of C, N2 and O2 polyatomic ions, for the 57 analyses shows no specific patterns and shows and good uniformity with 2.8% RSD

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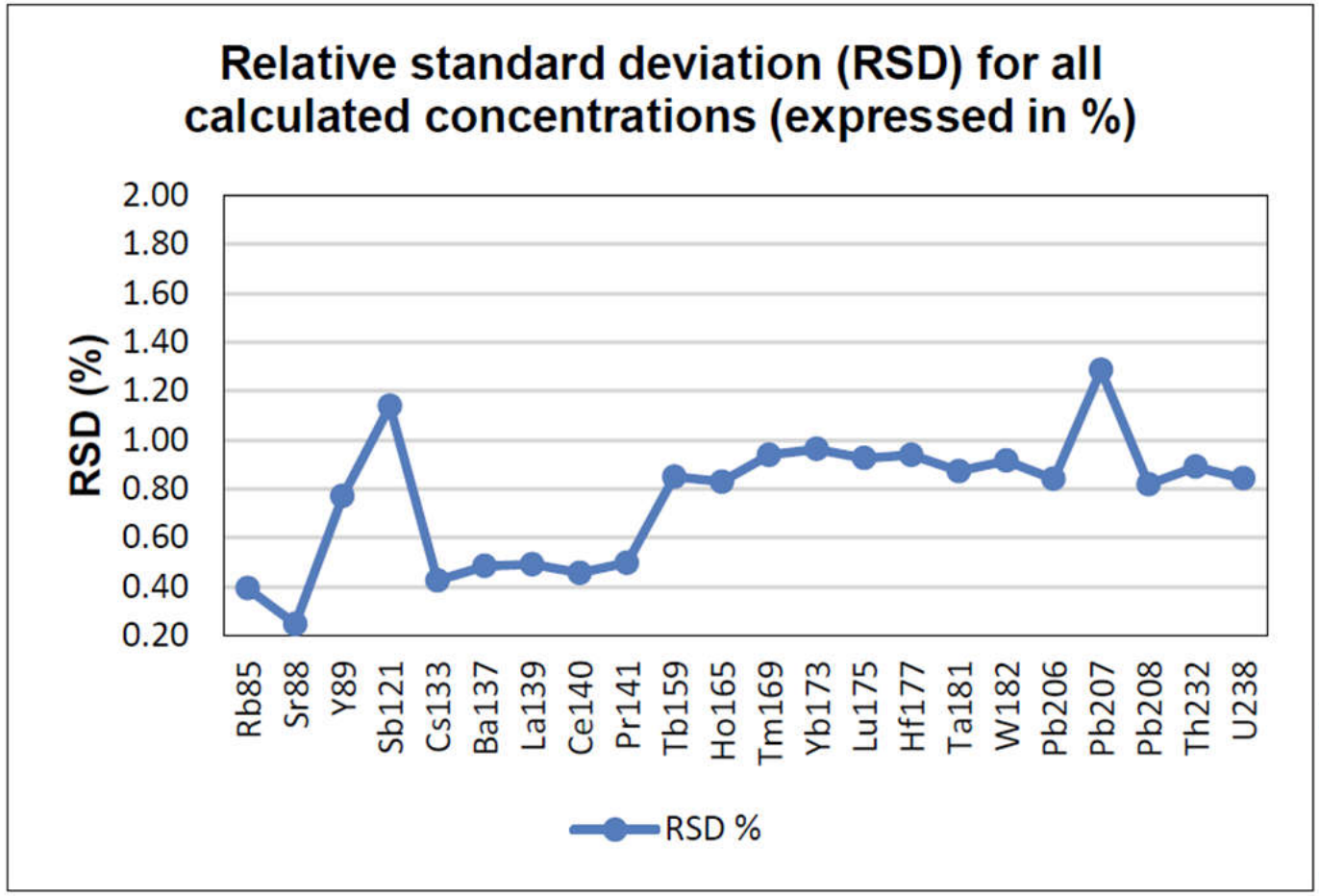
HelEx II: Performance Tests



RSD expressed as percentage of the concentrations and variation from 9 different positions.

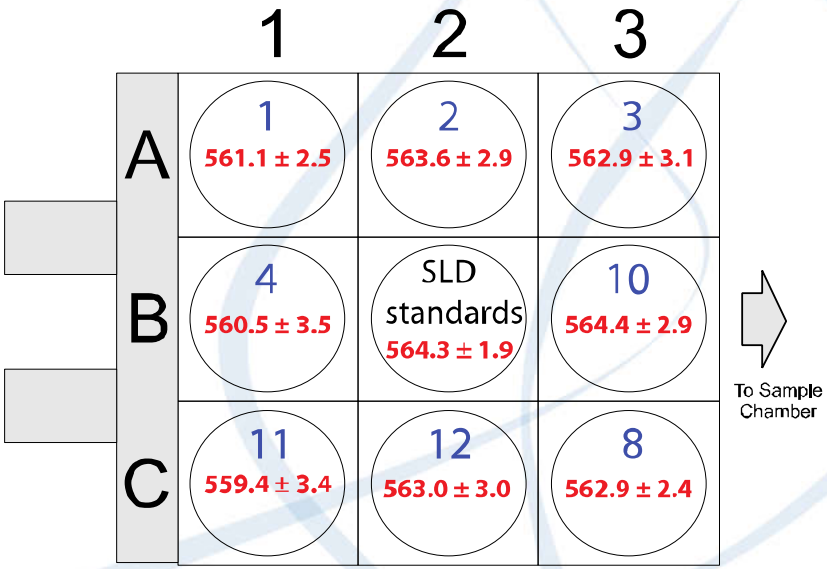
Signal biased reduced For most elements Below 1% RSD, showing no position dependent Bias.

HelEx II *Active* 2-Volume Cell

- Data from George Gehrels randomized U/Pb Zircons dating in different cell positions on HelEx II Cell

- University of Arizona, LaserChron

6/8 age should be ~563.5 Ma



Arizona LaserChron
Photon Sample Chamber

Note: these ages **do not** have all of the systematic errors added in yet.

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Cell Compatibility




Cell	LSX-266	LSX-213 G2+	Analyte.Excite	Analyte.G2
2'' Cylindrical	Standard	Standard	X	X
Large Format	Option	Option	X	X
Cryo	Option	Option	X	X
Document	Option	Option	X	X
Frames	Option*	Option*	Standard	Option
HelEx	X	Option*	Option	Standard
HelEx Cryo	X	Option*	Option	Option
HelEx 150 mm^2	X	X	Option	Option

Smoothing Devices

Squid for pulse smoothing at low rep rates

Effectively smoothes down to ~3 Hz

Other smoothing devices coming soon!

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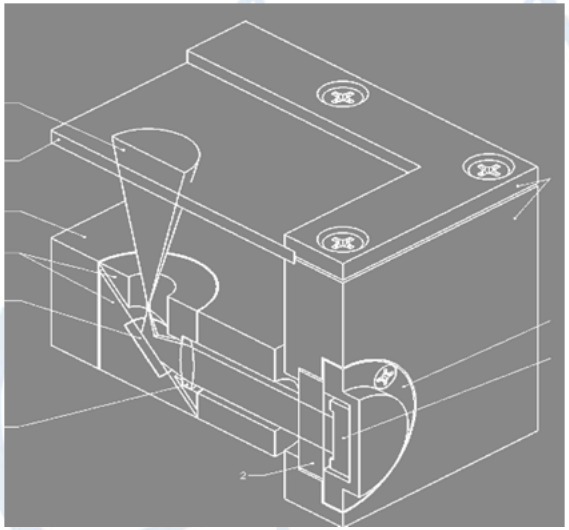
EQC – Patent Pending

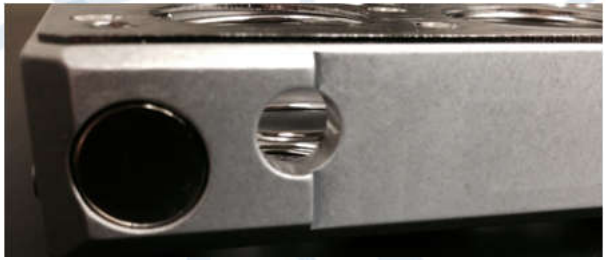
Integrated energy detector (patent pending) within the HELEX II.

A high accuracy detector mounted to the wall of the cell, isolated to prevent possible contamination.

A mirror in the sample holder redirects the energy to the detector for in-situ measurements

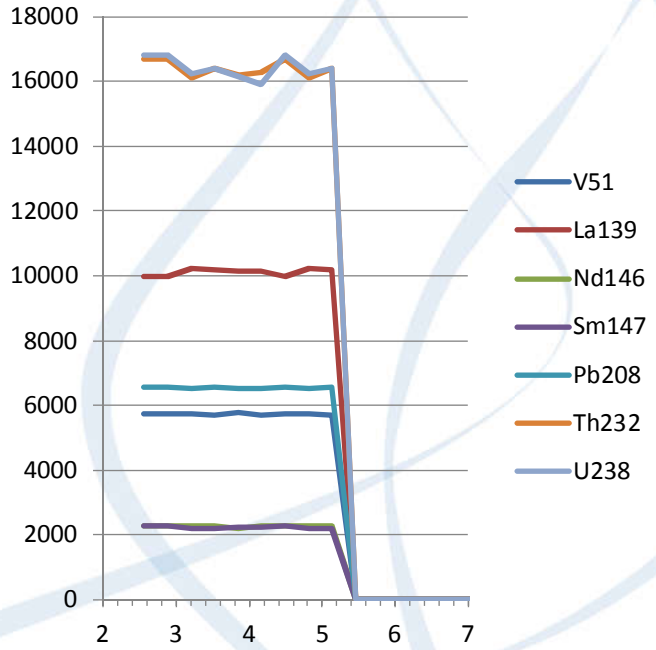
Can be queued automatically during a series of analyses or “on-demand” by the operator.





Real time measurement of energy at the sample holder

CLEANSHOT - Remote Gas Switch



The **CLEANSHOT** switches from Purge to By-Pass to On-Line mode at point blank range next to the torch adapter.

CLEANSHOT permits washout to be cut off instantaneously, allowing for faster repositioning of the sample after each analysis.

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Exicheck – Performance & Convenience

ExiCheck (patent pending)- An automated gas exchange device integrated into the laser system. Laser head always at peak performance and producing the best data with no user interaction required.

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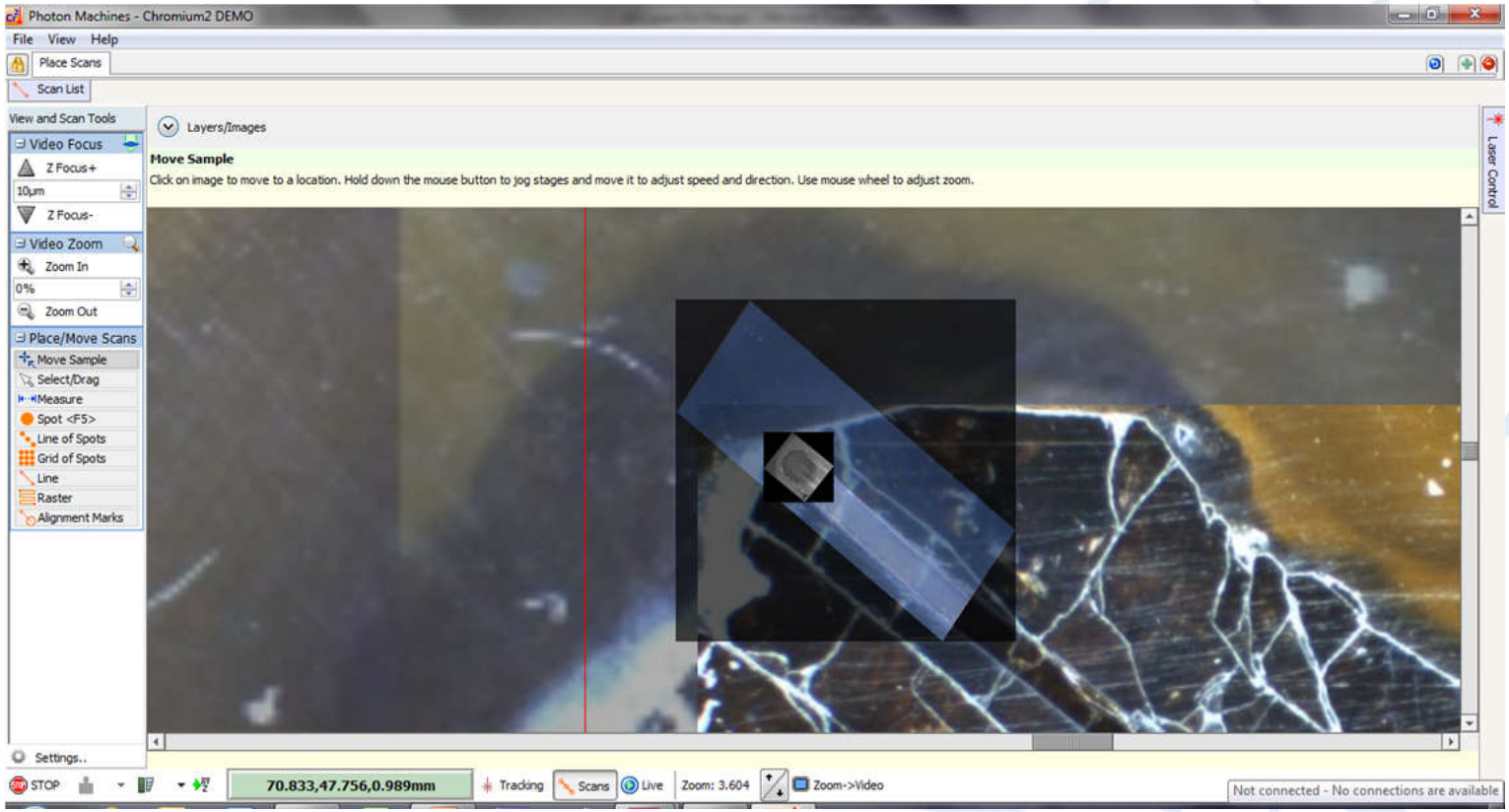
Chromium 2 Software

- Ethos has always been to produce powerful, feature-rich SW
- Major new version: Cr 2: more powerful
  - Sample visualisation, navigation and layering
  - Superior Autofocus technology
  - Bug report/feature request built-in
- 3 full-time software engineers working on improving and developing it
- See quick demo at: https://docs.google.com/file/d/0B_ARAlQYcBhqT1pvQTU5emEwQ1U/edit?usp=sharing

Chromium 2 Software

SEM Image re-coordination for easy navigation in unique dynamic viewport
Exportable position log files for easy data processing.



Software Highlights

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Software triggering

Various levels of sophistication are available, depending on the ICP-MS software used, whereby a plugin allows a higher degree of control, inter-instrument status query, x/y/z position awareness and inter-instrument control and set-up through a single software package.

Full software bi-directional communication with Thermo Qtegra and Agilent Masshunter software via serial coms cable.

EMEA Support

UK Based:

- Adam Douglas – EMEA Laser Ablation Technical Specialist
- Neil Williams – EMEA Technical Specialist
- Nick Westaway – EMEA Business Development Manager
- New Hire – UK and Ireland Technical Sales Specialist
- Bill Spence – VP of Sales and Service
- Damon Green – VP of Marketing and Technology
- Pete Winship – Products Market Manager

German Based

- Ciprian Stremtan – EMEA Laser Ablation Technical Specialist

USA Based

- Teledyne Photon Machines support specialists (6)
- Software Engineers (3)

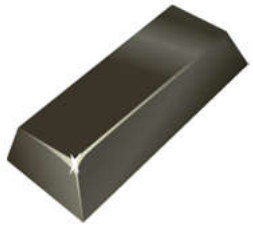
Additional Support:

2 Contracted support personnel

Notable CETAC Bio imaging users

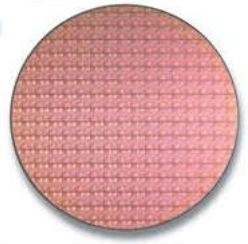
- Phil Doble – U. Technology Sydney – Application leader * don't use yet
- U. Musnter – Germany
- U. Ghent – Belgium
- Boston Medical School - USA

APPLICATION AREAS



- Earth Sciences
  Minerals, toxic elements, zoning, U-Pb dating, coral, environmental record, etc.
- Forensics
  Glass, paint, plastic, metals, inks, etc.
- Archeology
  Ceramics, shards, bone, teeth
- Pharmaceutical
  Tablet powders and coatings
- Metals
  - Alloys, precious metals, QC and defects, etc.
- General Industrial Materials
  Glass, quartz, silicon, etc
- Biological/Medical
  Tissue (frozen or dried), bone, teeth, etc.

…..



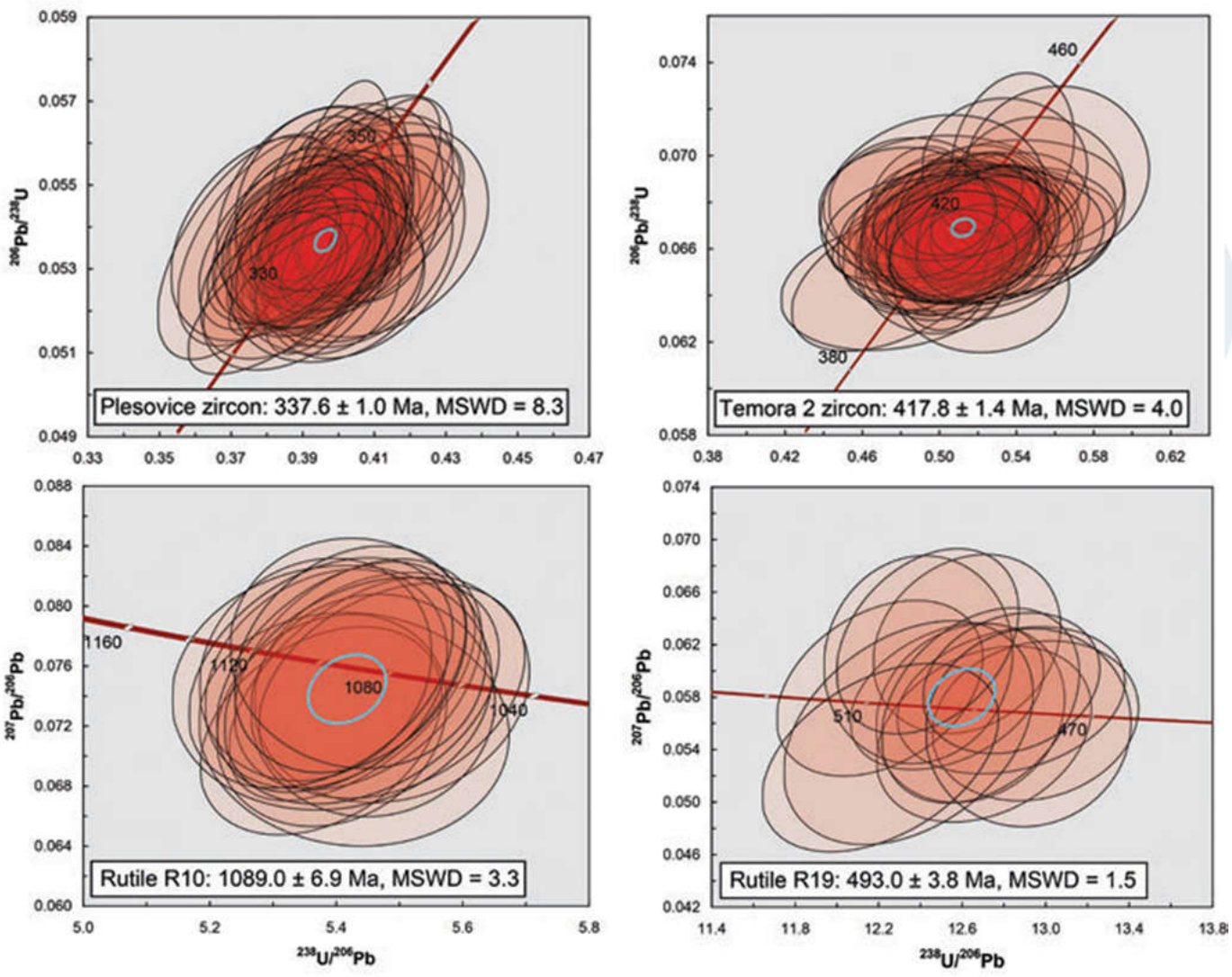
ISOTOPIC ANALYSIS: GEOCHRONOLOGY

Analyte Excite

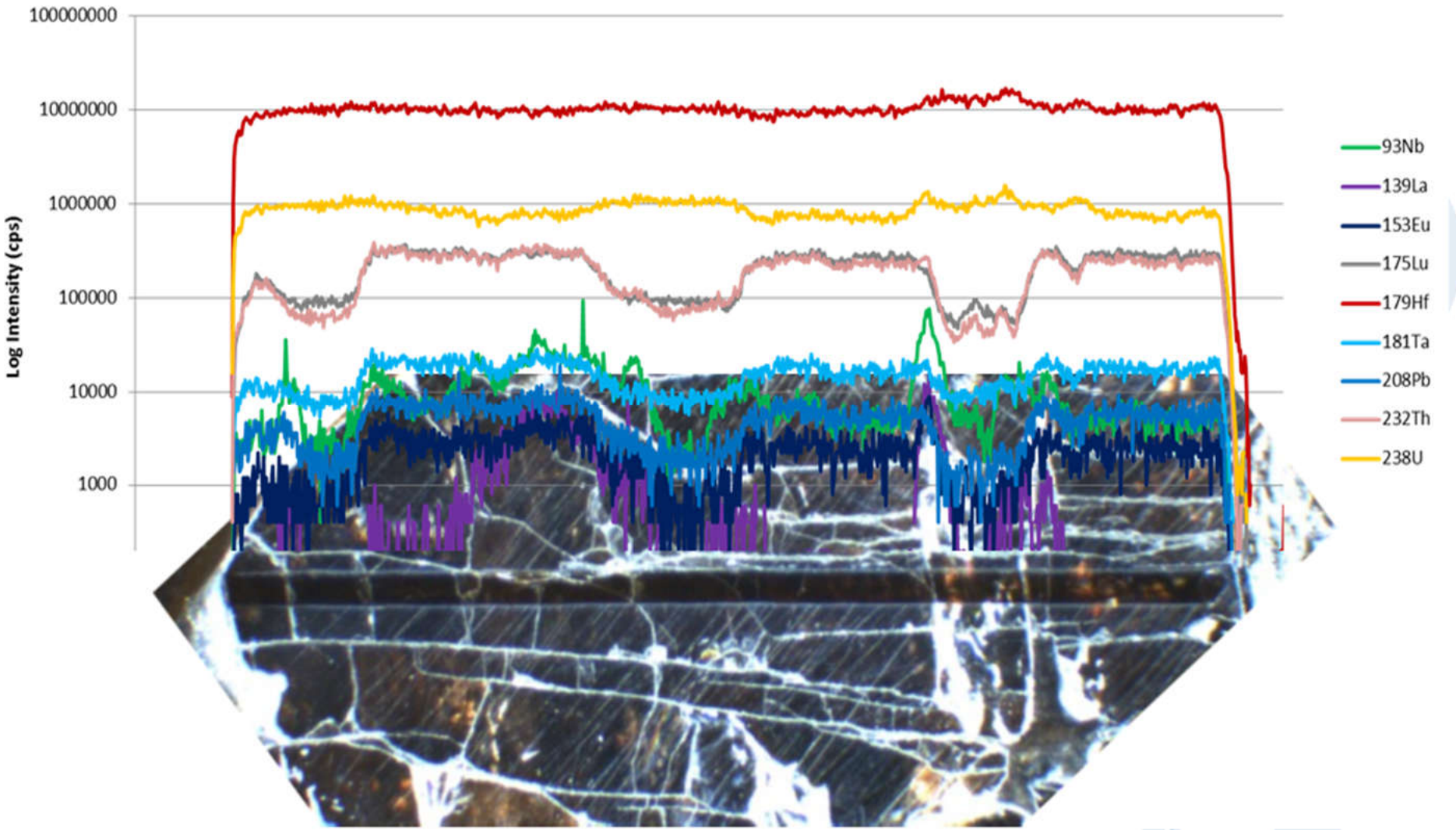
Thermo iCAP Q

Trinity College Dublin

Prof. Balz Kamber

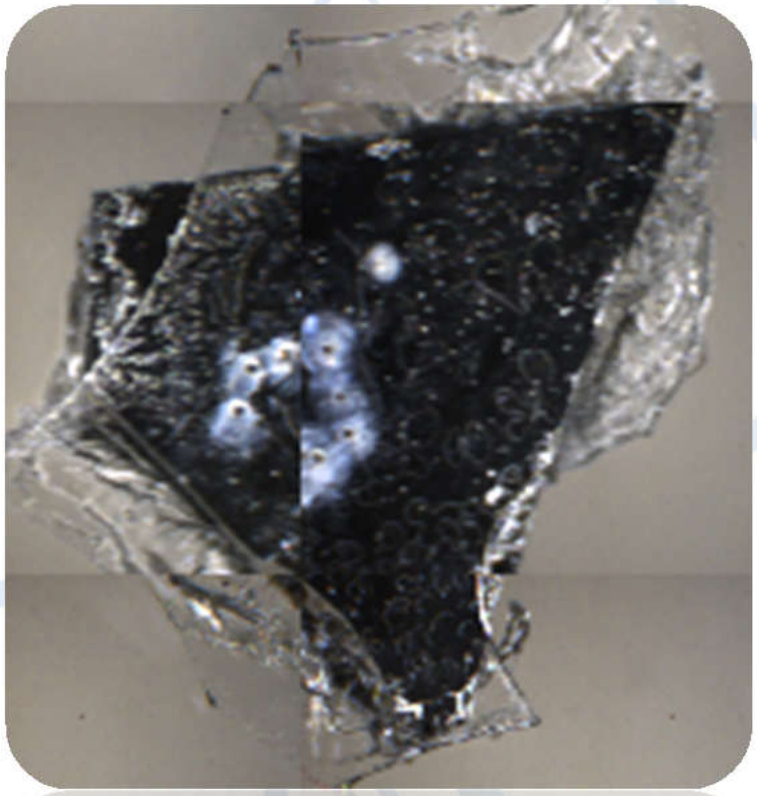


Spatial: Line Scan on a Zircon

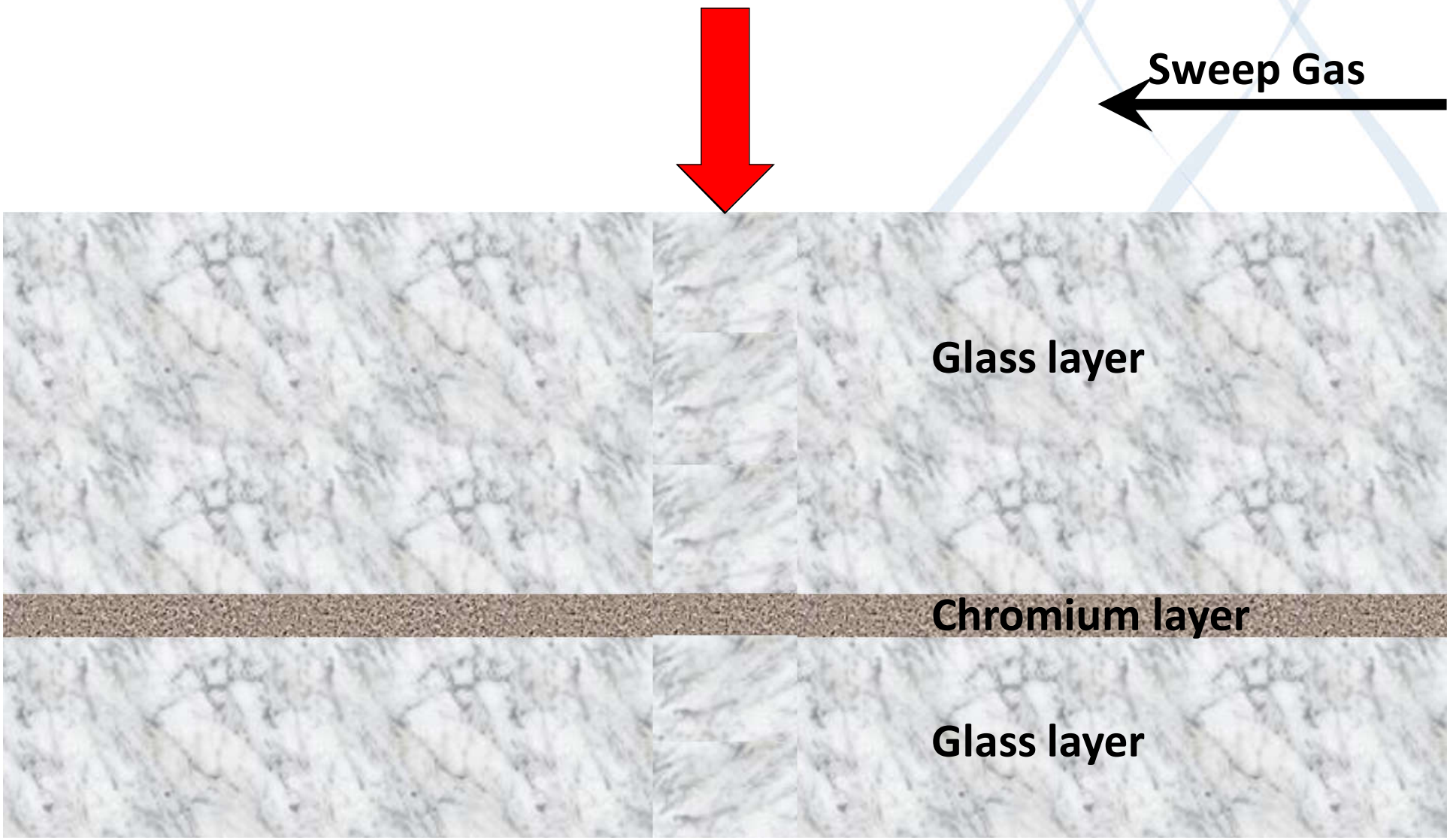


Spatial: Depth Profiling

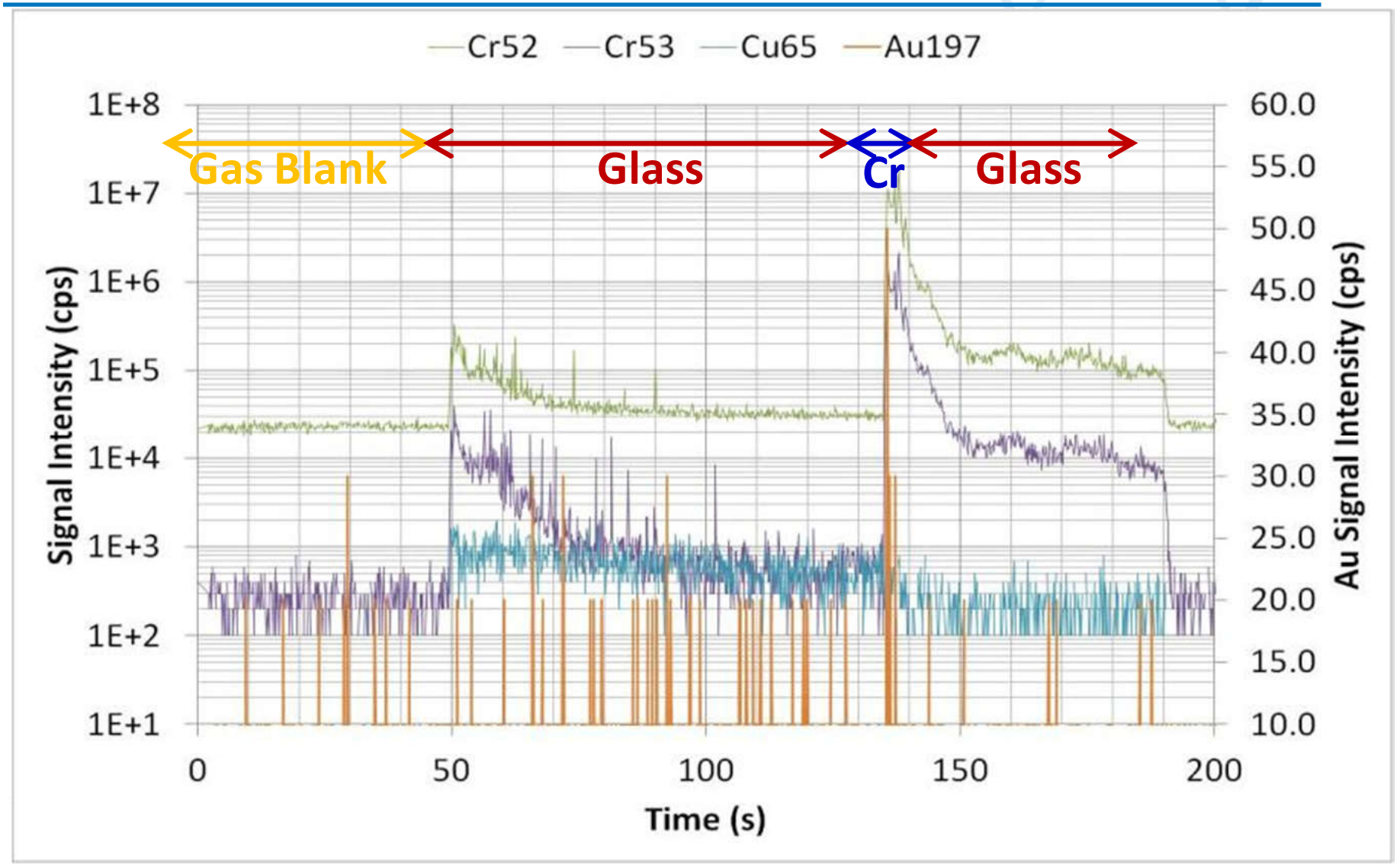
- Glass with 50 µm chromium layer
- Chromium layer contains approx. 200 ppm gold contamination
- Drill down with laser and monitor element profile



DEPTH PROFILING APPLICATION

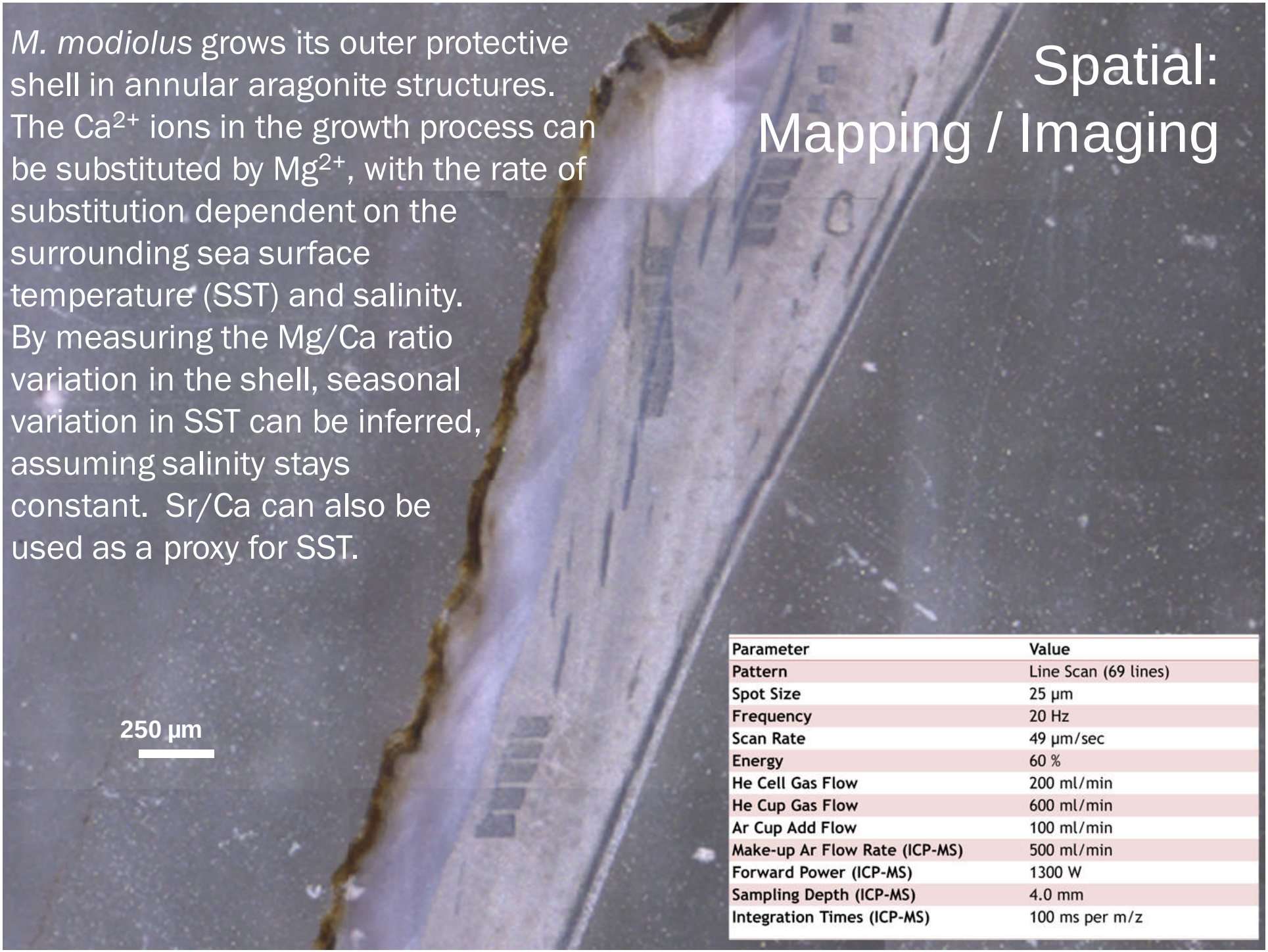


Able to Distinguish 200 ppm Au Contamination in 50 µm Cr Layer!

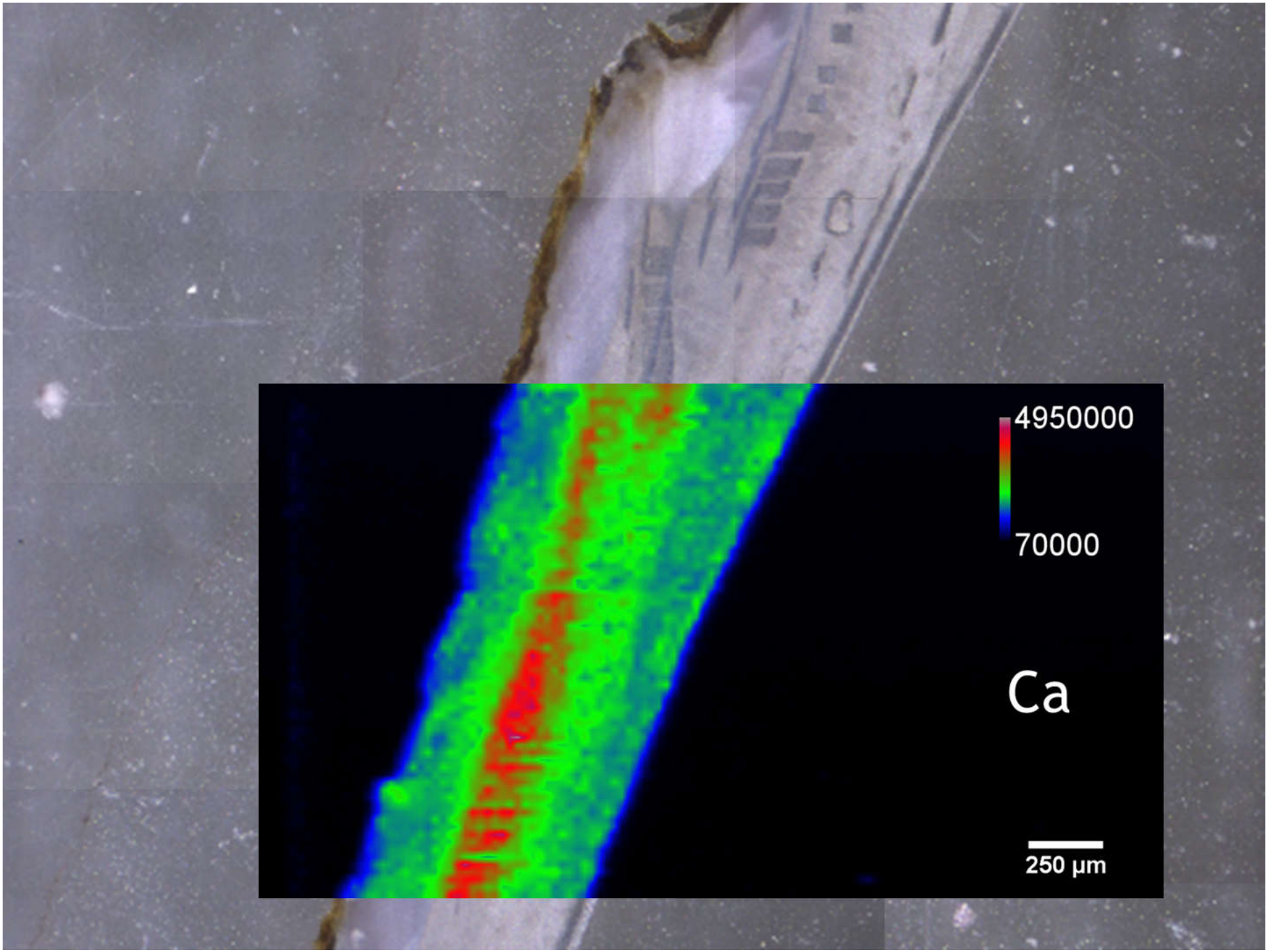


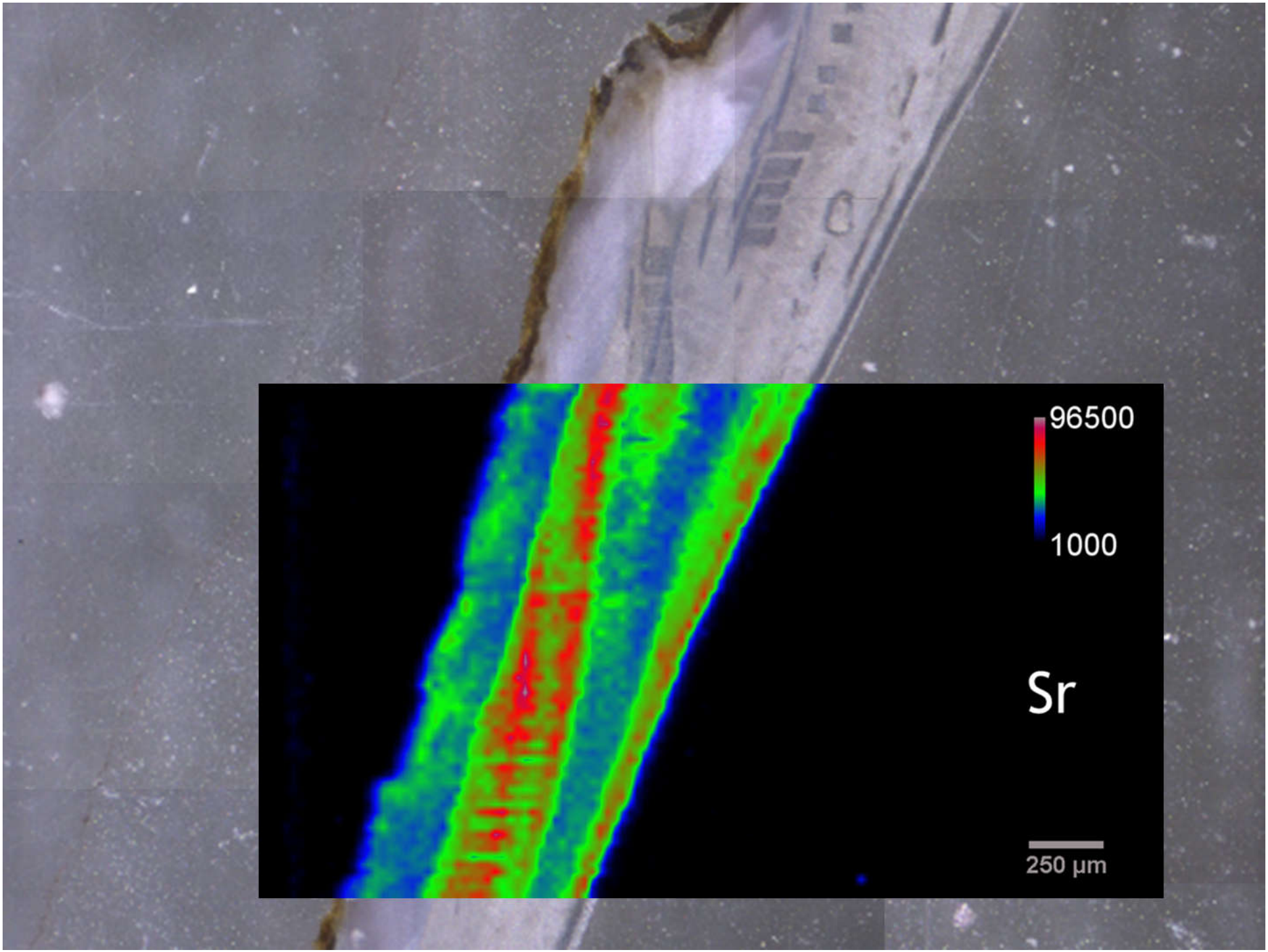
Spatial: Mapping / Imaging

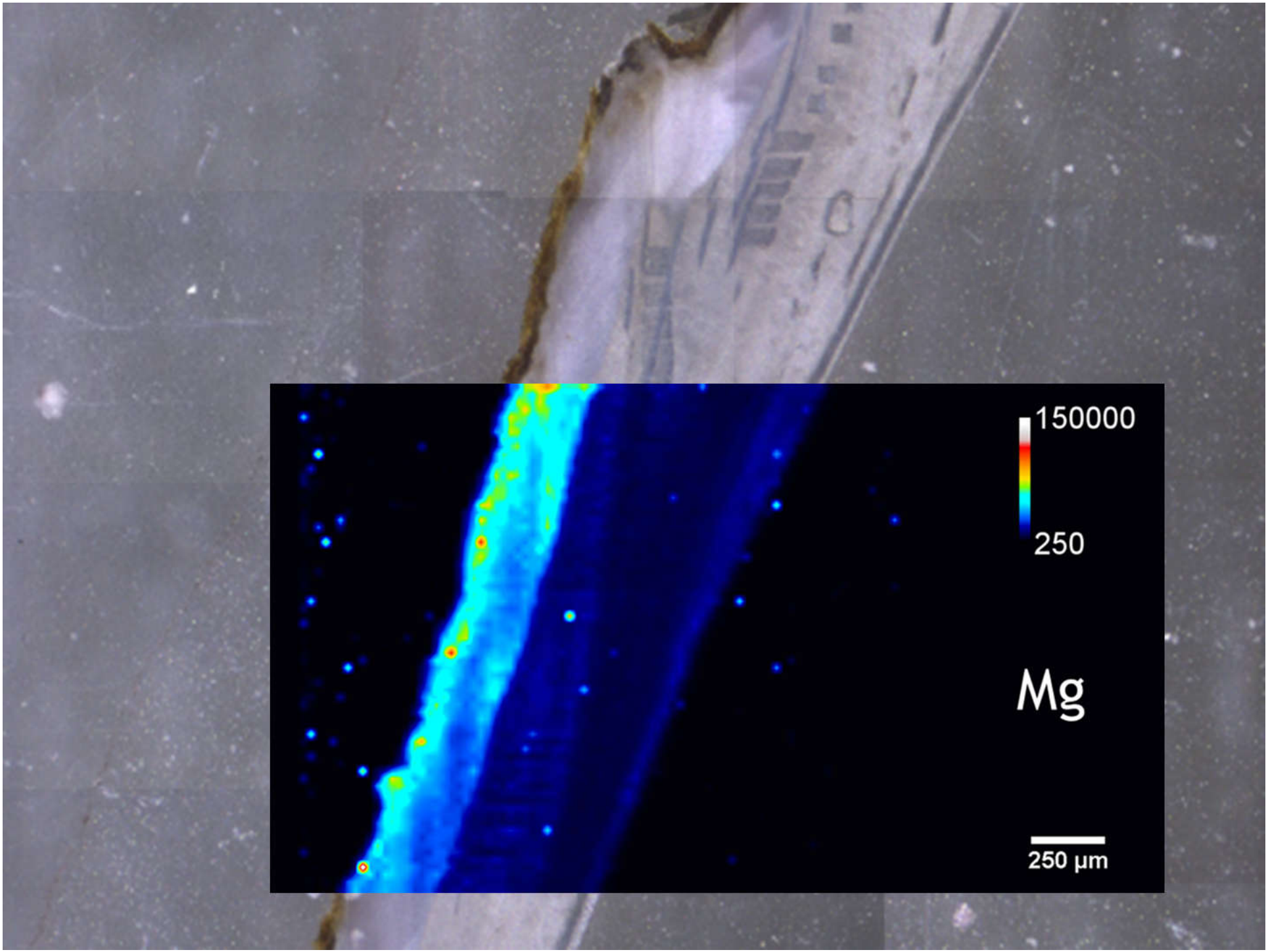
M. modiolus grows its outer protective shell in annular aragonite structures. The Ca^{2+} ions in the growth process can be substituted by Mg^{2+}, with the rate of substitution dependent on the surrounding sea surface temperature (SST) and salinity. By measuring the Mg/Ca ratio variation in the shell, seasonal variation in SST can be inferred, assuming salinity stays constant. Sr/Ca can also be used as a proxy for SST.



Parameter	Value
Pattern	Line Scan (69 lines)
Spot Size	25 µm
Frequency	20 Hz
Scan Rate	49 µm/sec
Energy	60 %
He Cell Gas Flow	200 ml/min
He Cup Gas Flow	600 ml/min
Ar Cup Add Flow	100 ml/min
Make-up Ar Flow Rate (ICP-MS)	500 ml/min
Forward Power (ICP-MS)	1300 W
Sampling Depth (ICP-MS)	4.0 mm
Integration Times (ICP-MS)	100 ms per m/z

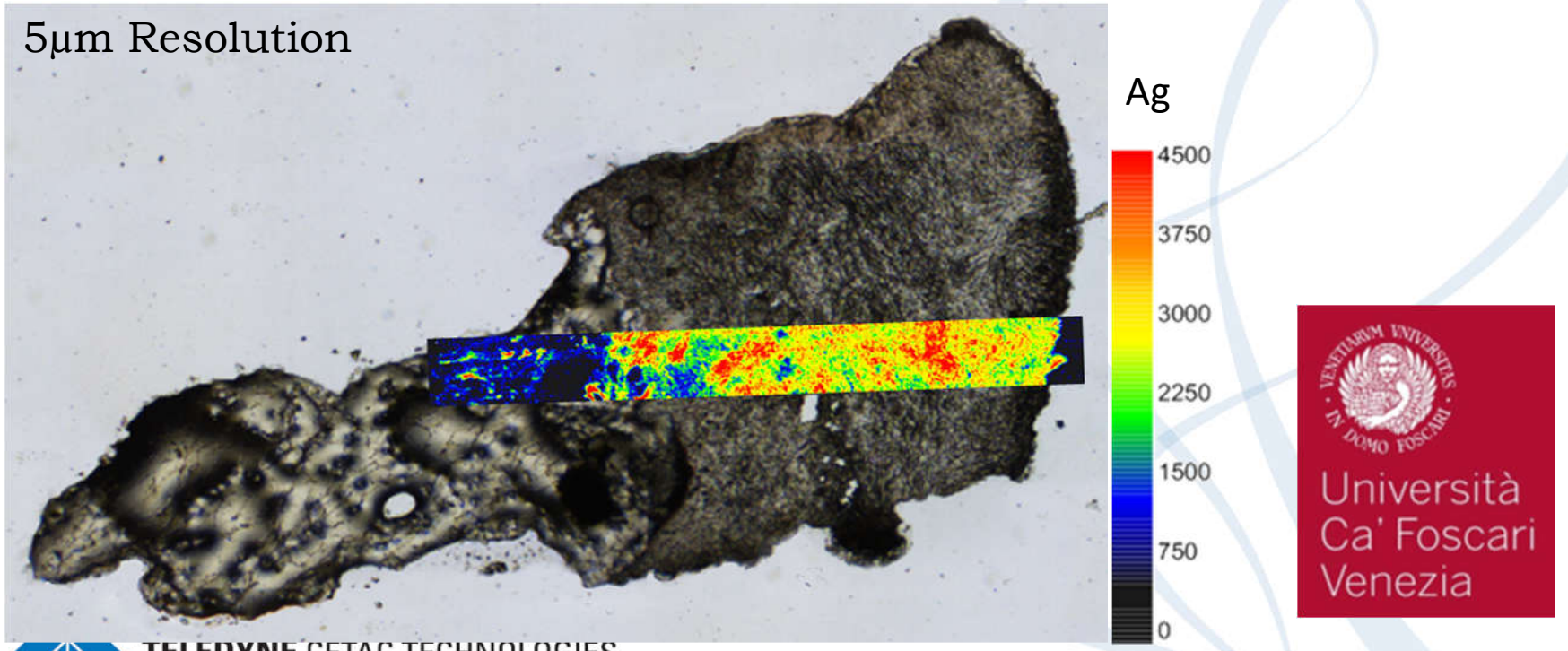

4950000
70000
Ca
250 µm


96500
1000
Sr
250 µm


150000
250
Mg
250 µm

Silver distribution in human skin samples

- Burn dressings contain silver nanoparticles Since medieval times, silver nitrate has been used to treat and heal skin ulcers, wounds, and burns
- The silver nanocrystals (<10µm) coating the dressing are released in solution as agglomerates of Ag NPs



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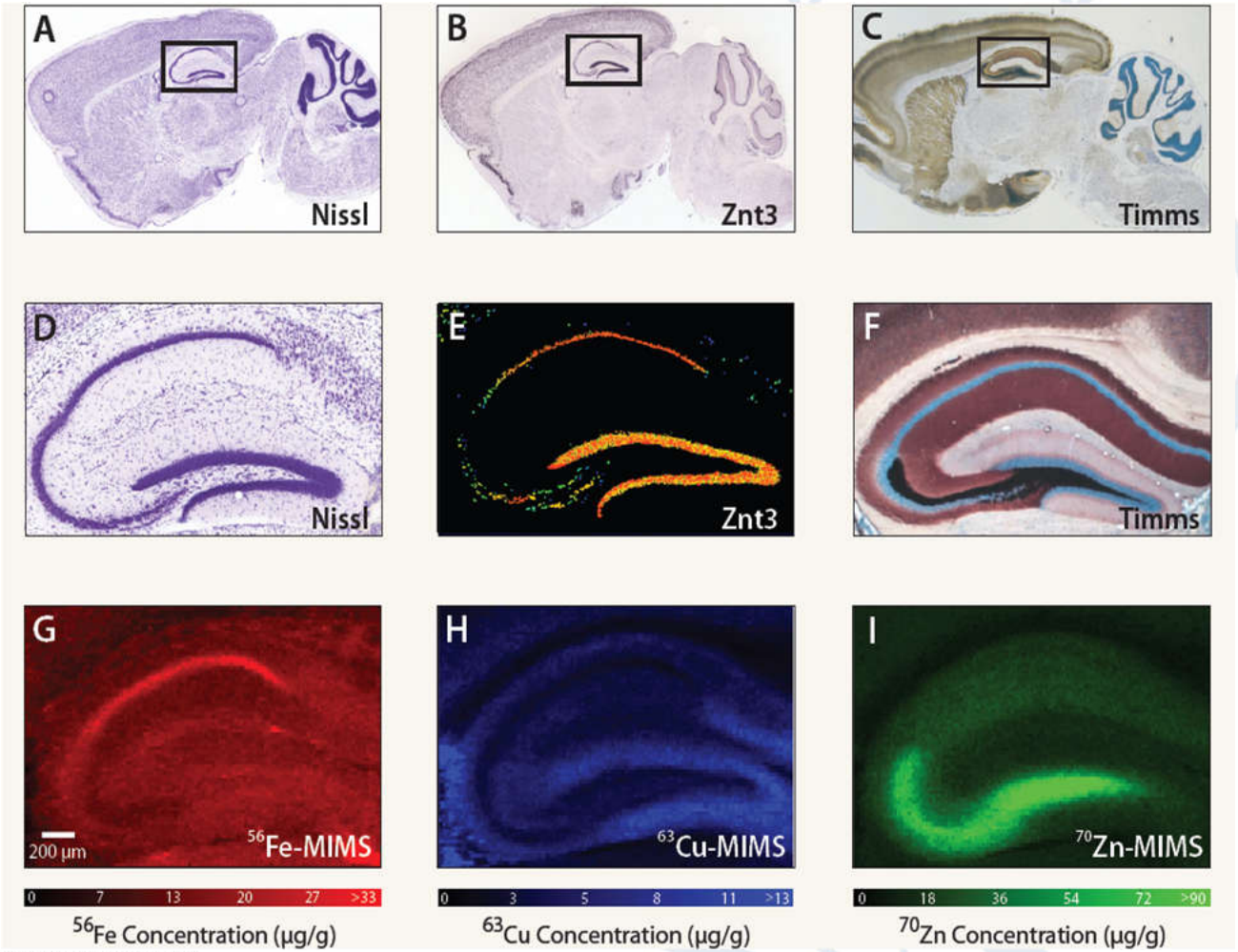
Università Ca' Foscari Venezia

Chiara Rigo, University of Venice

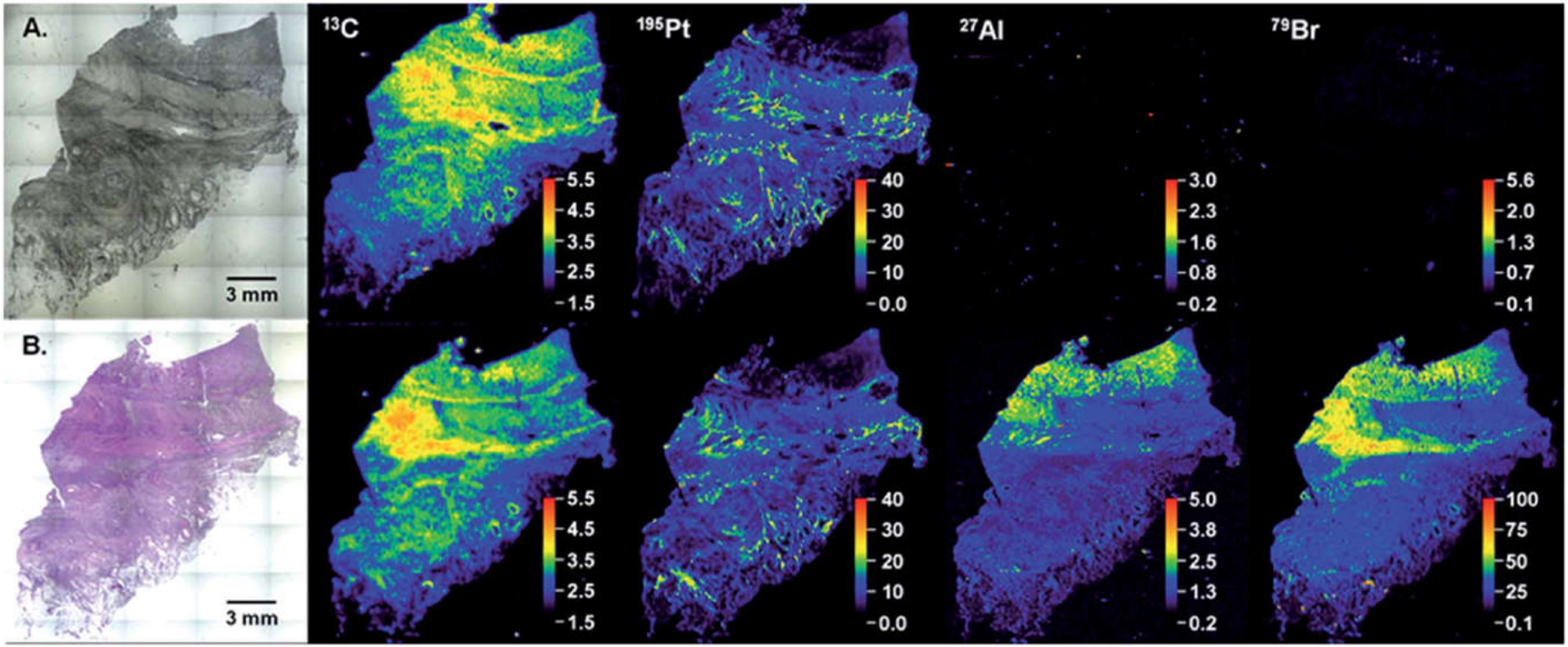
Murine Hippocampus mapping

Mettallome mapping of mouse brain

A. Nissil Stain
B. ZnT3 Zinc Transporter
C. Timms Stain
D. Nissil Stain
E. ZnT3 Zinc Transporter
F. Timms Stain
G. 56Fe map, 20um resolution
H.63 Cu map, 20um resolution
I. 70 Zn map, 20 um resolution



Human Esophageal Tumor Tissue



Christoph Wehe – U. Muenster

100 um spot elemental analyses compared to a H&E stain and unstained photo micrograph

Platinum distribution in Mouse Cochlea

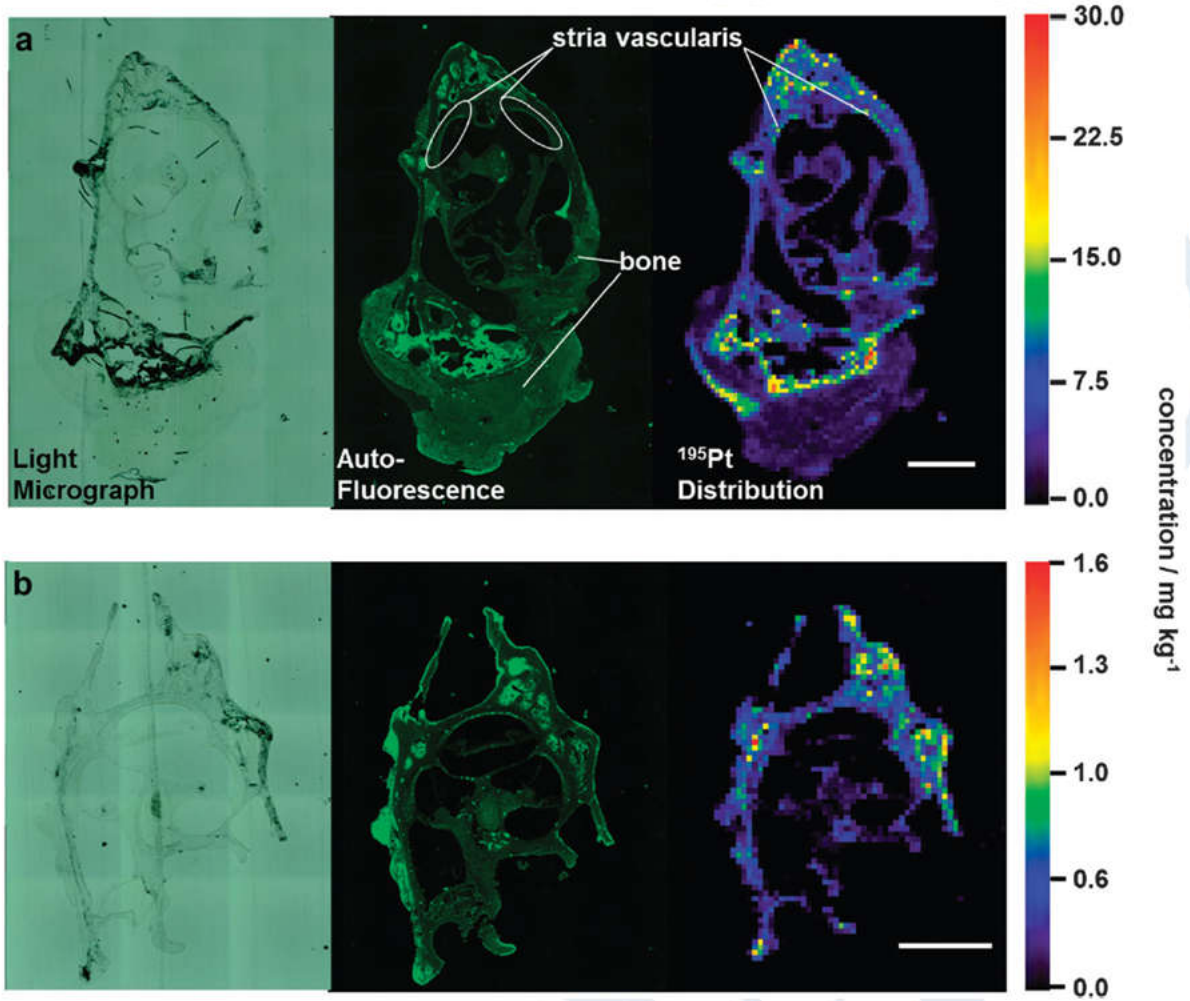
Measuring of Cisplatin concentrations

Comparison of bright field and fluorescence micrographs with elemental map.

Top images hour after Pt dose

Bottom image 4 days after Pt dose

Scale is 1 mm



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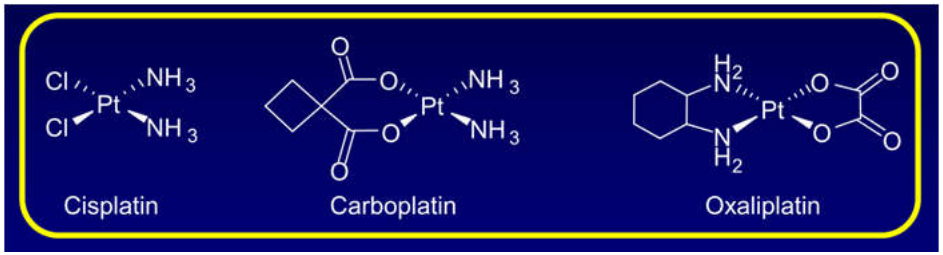
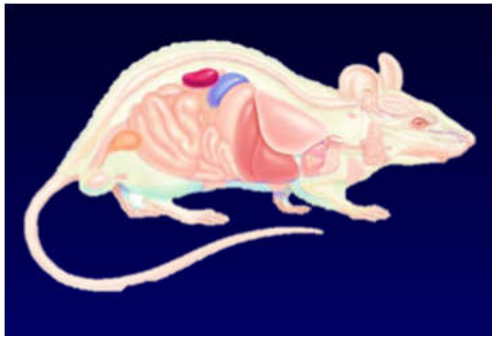
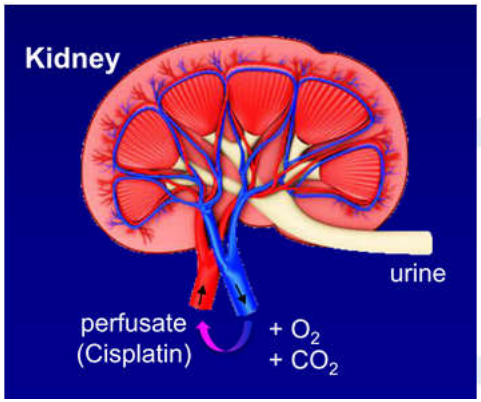
LA-ICP-TOF Cisplatin nephrotoxicity study







Sample

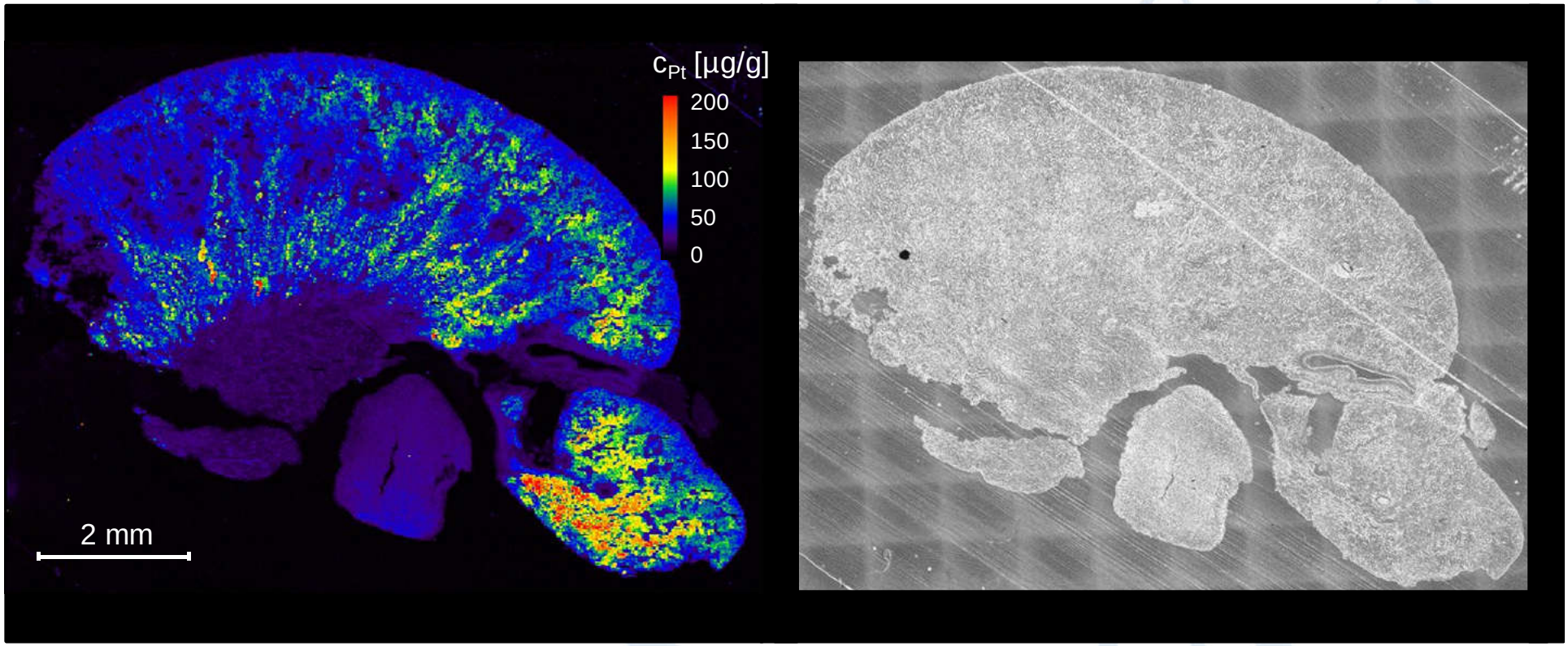
- Male rats were anesthetized and kidneys isolates
- Perfusion with Cisplatin and electrolyte on functioning kidney
- Fixed, dehydrated
- embedded in Technovit and sliced

Experimental

- Analyte G2 193 excimer laser + ARIS
- 100 Hz scan with 20 µm ablation spot
- 200 µm/s scan speed → 10 pixels/s
- Quantification with element standards embedded in Technovit

Collaboration work with O. B. Bauer, U. Karst, Uni Münster and CETAC Teledyne Technology

PT Quantitative Image



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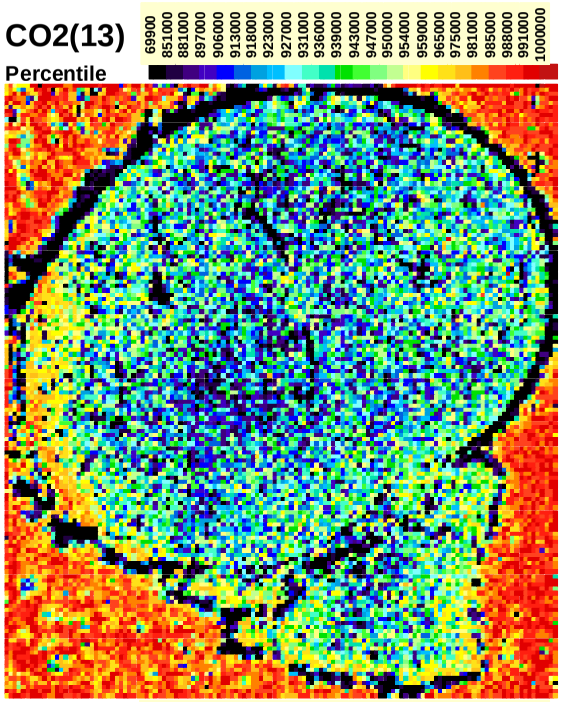
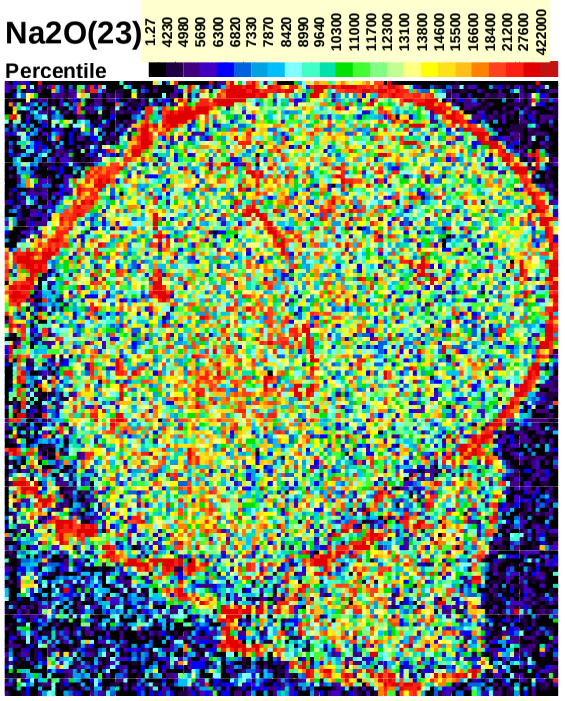
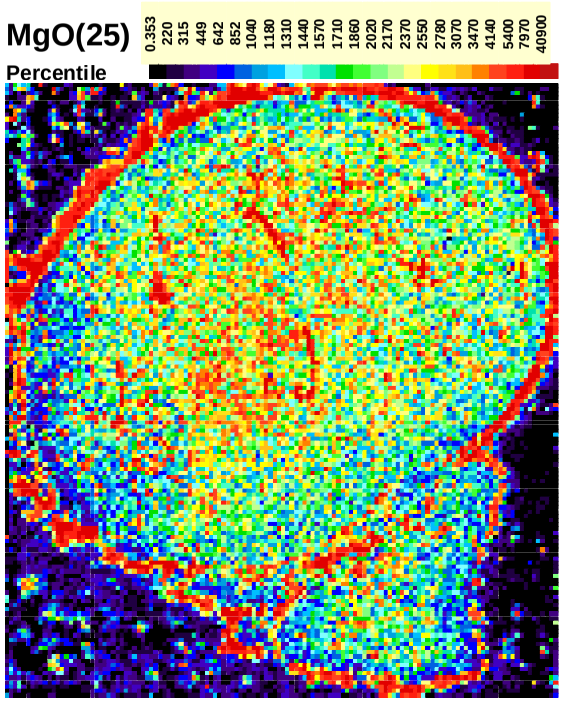
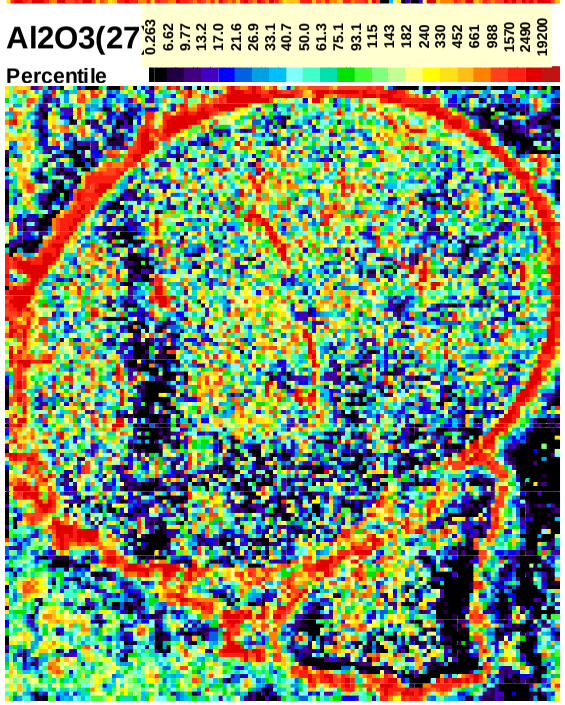
Collaboration work with O. B. Bauer, U. Karst, Uni Münster and CETAC Teledyne Technology

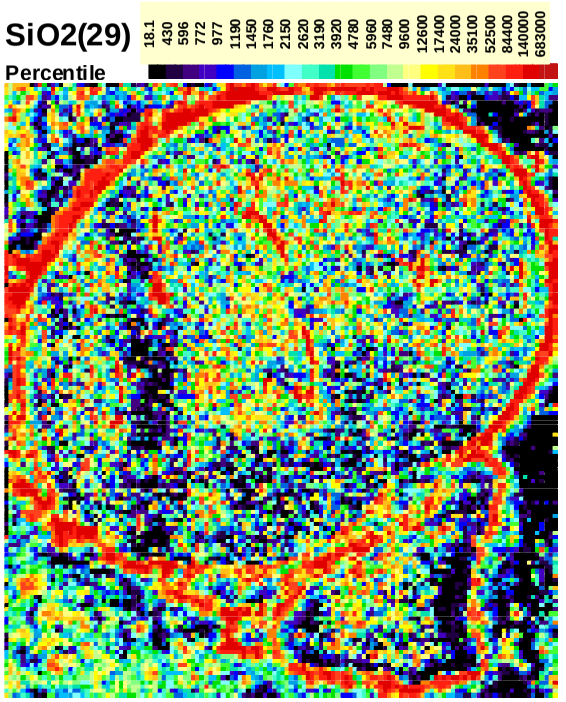
Section through Mouse Brain



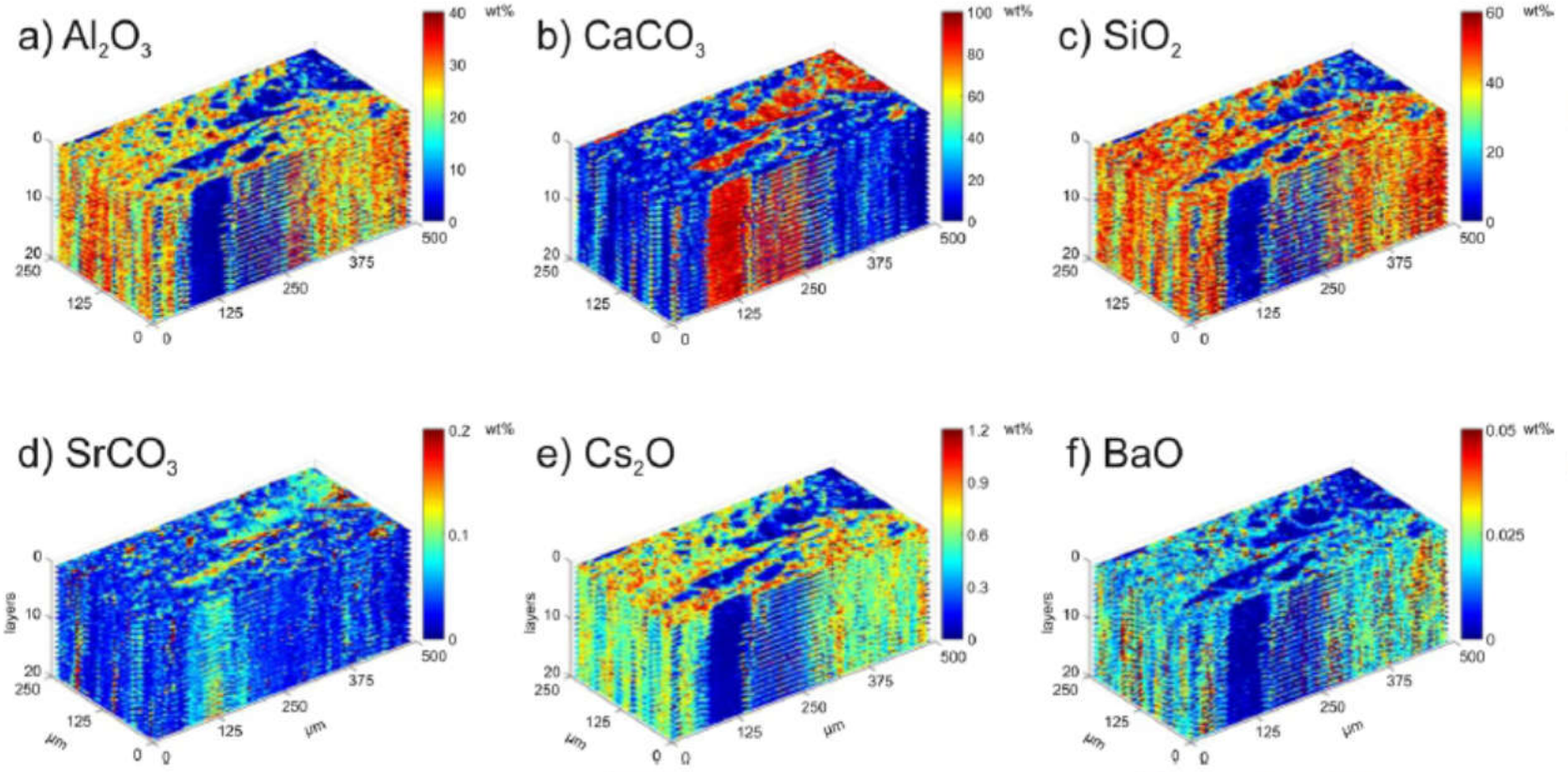








3D Mapping (Stacked Maps)



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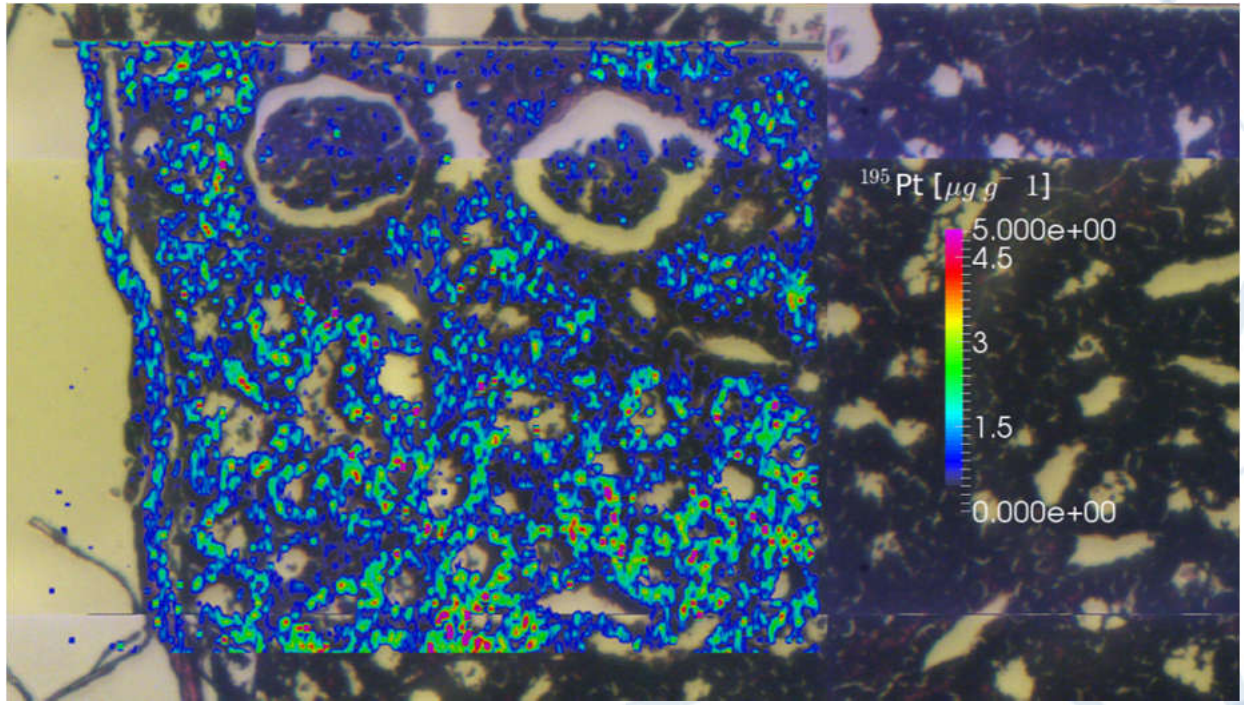
From Burger et al, Anal Chem, DOI 10.1021/acs.analchem.5b01977

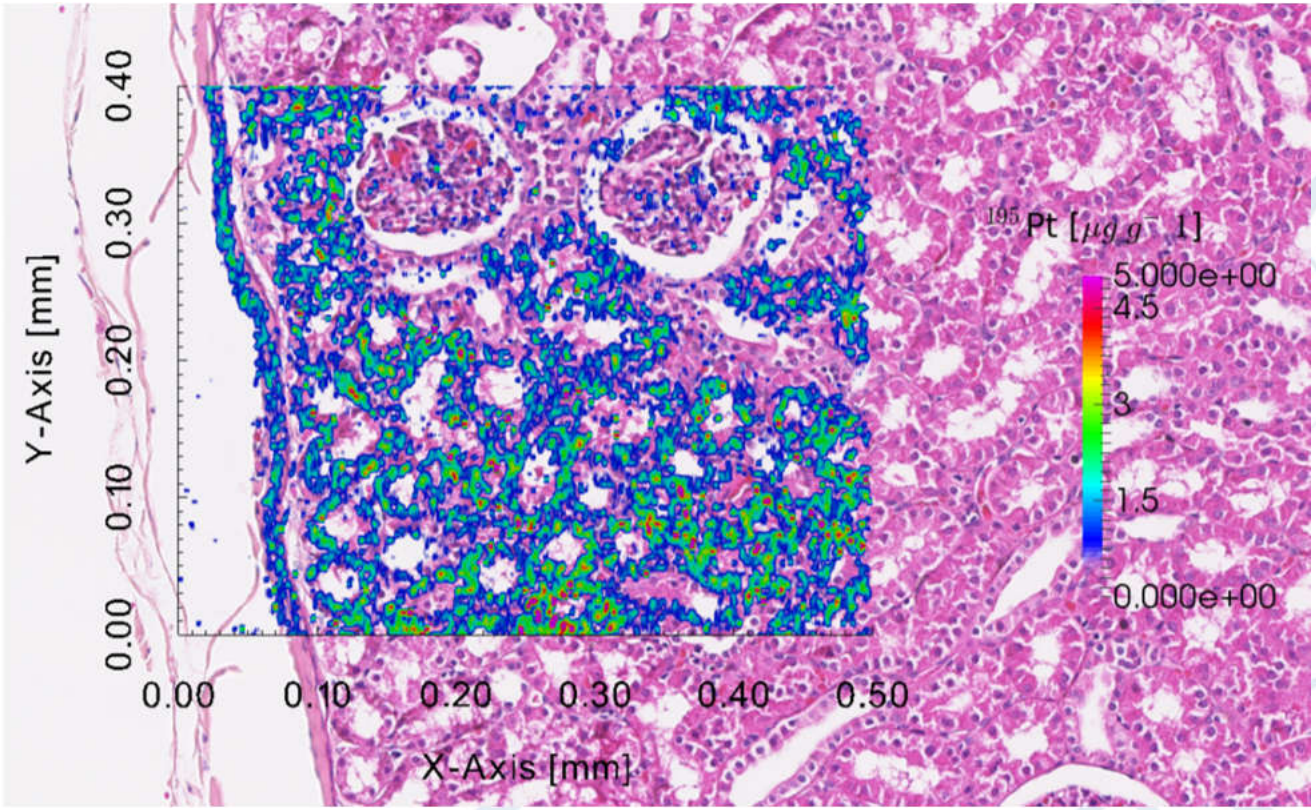
Step One: Imaging with ARIS
LA-ICP-MS Imaging With Cellular Resolution



- LA-ICP-MS result perfectly traces morphology at the cellular level
- No distortion from washout
- Excellent ablation characteristics at the 193 nm wavelength, no melting/ evaporation/ splashing effects observed

Frank Vanhaecke, University of Ghent

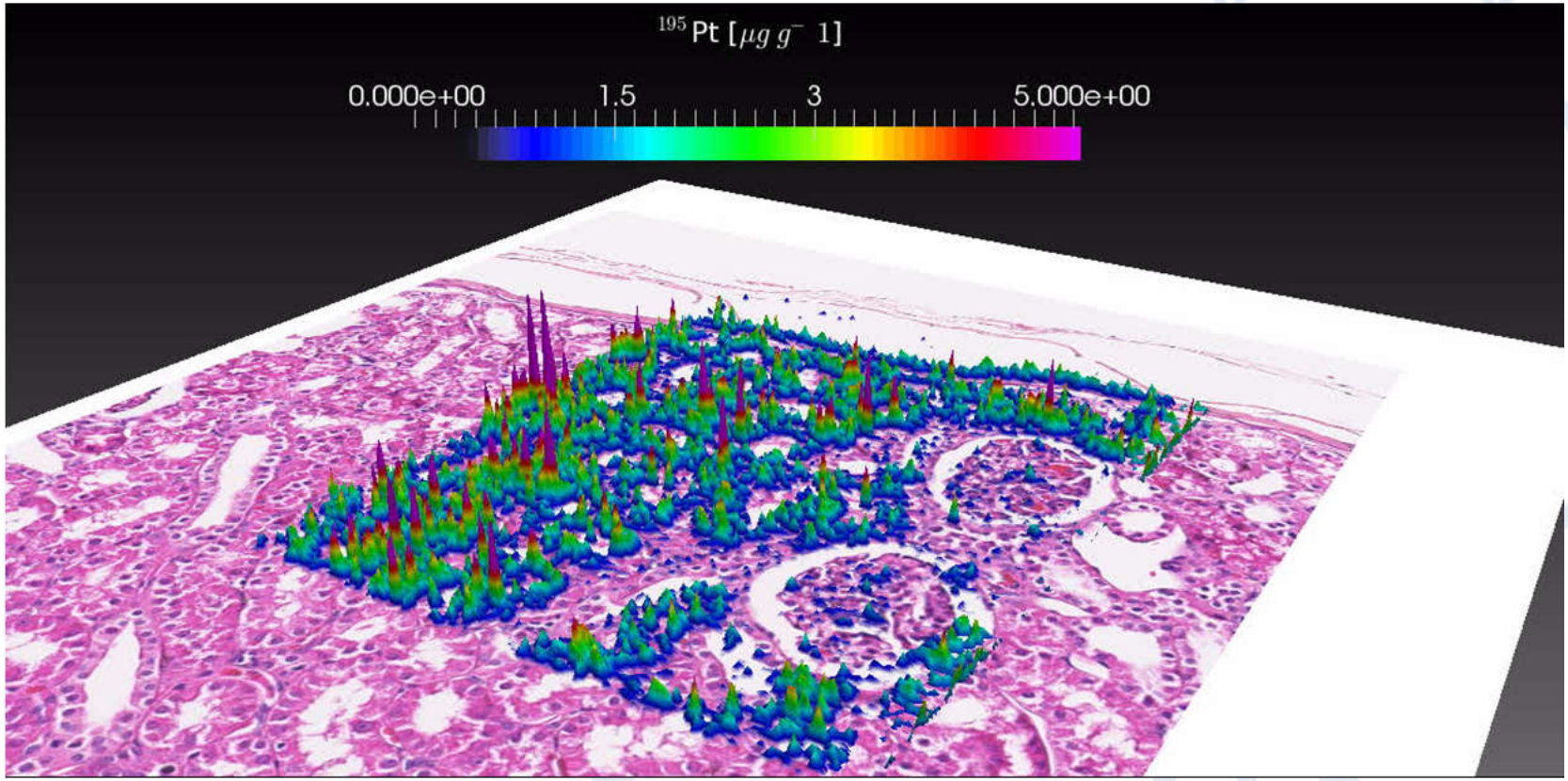
Step 2: Data interpretation: comparison to histology by overlaying a sequential HE-stained microtome slice



- Evaluation of links between cell-types and the nuclide, compound, or anti-body distribution made possible

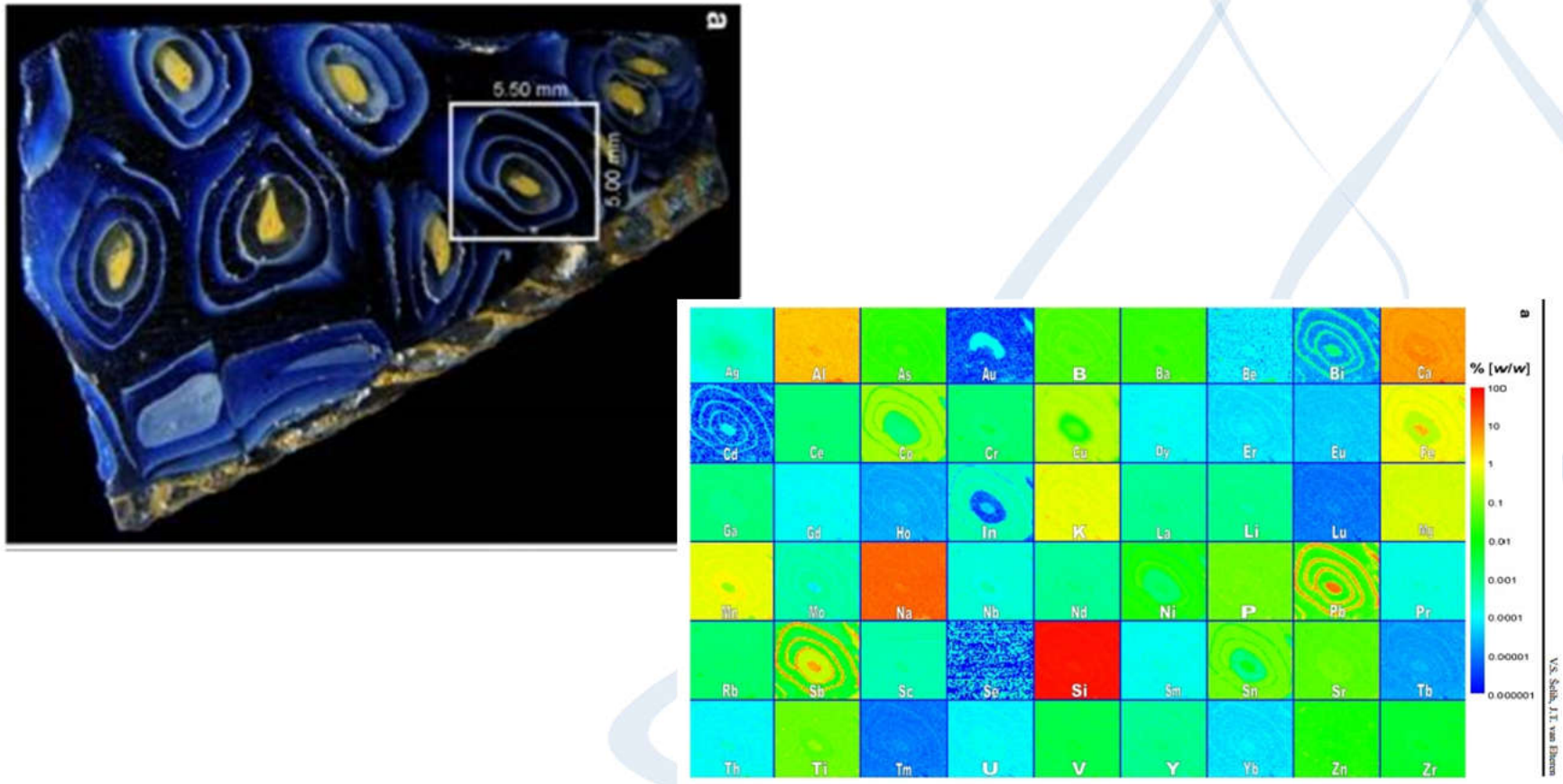
Frank Vanhaecke, University of Ghent

3D Fly-Over of Concentration Image



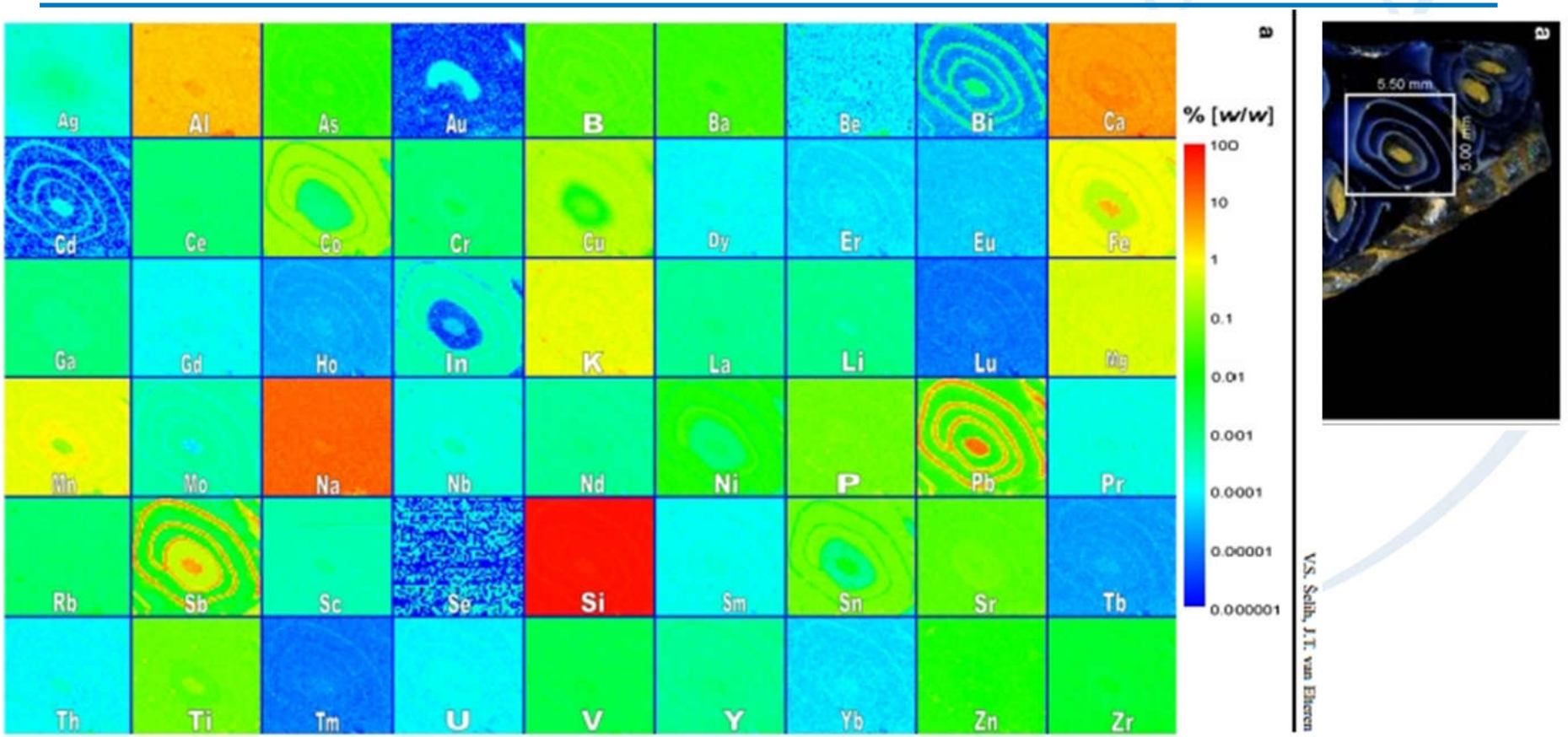
T Van Acker, University of Ghent

2D Quantitative elemental imaging of historic glass – 54 elements



From Dr Vid Selih, National Institute of Chemistry, Slovenia

2D Quantitative elemental imaging of historic glass – 54 elements



From Dr Vid Selih, National Institute of Chemistry, Slovenia

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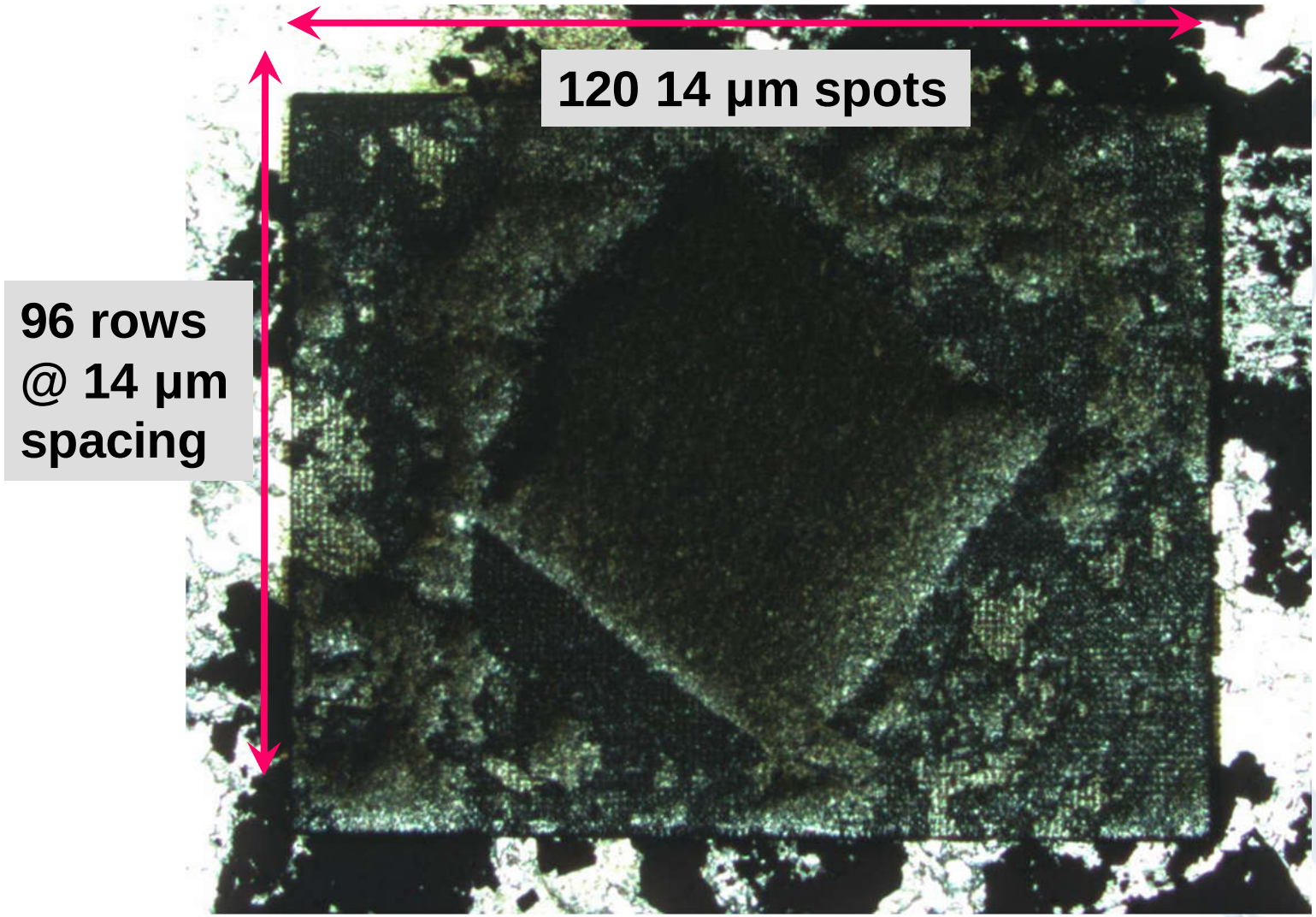
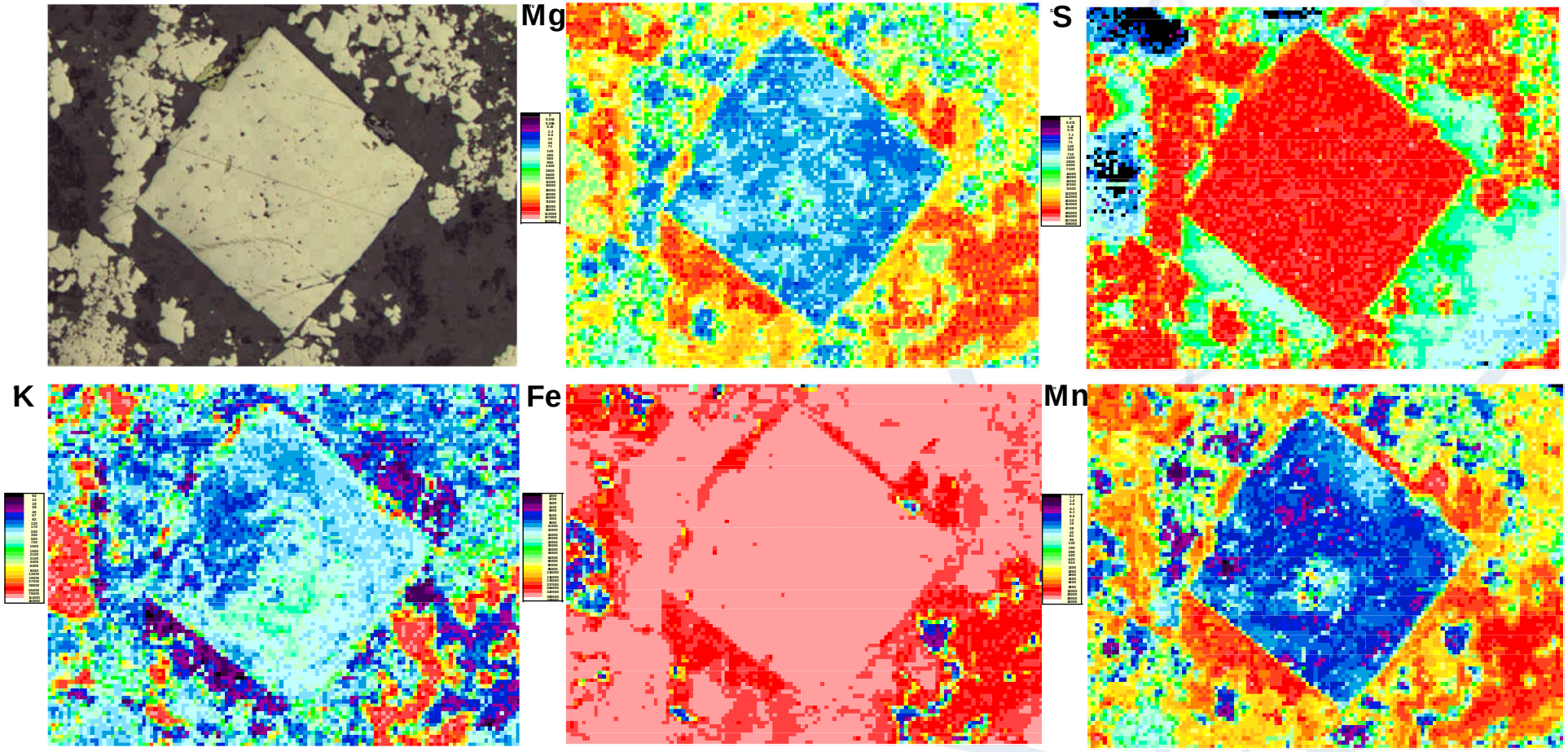
193nm Hi Resolution Mapping
The Sample and the 'Damage Done'



High Resolution Geological Mapping



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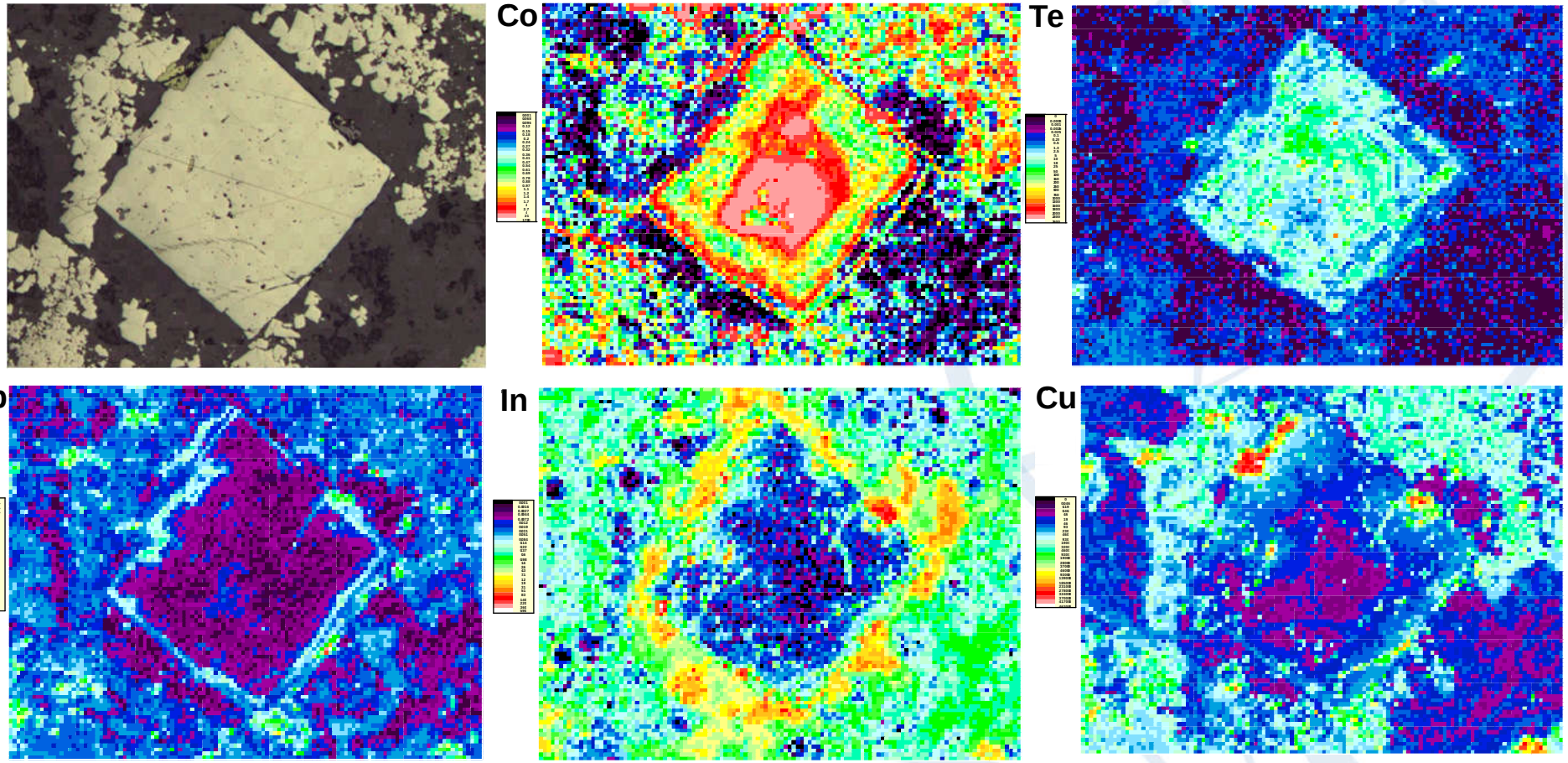
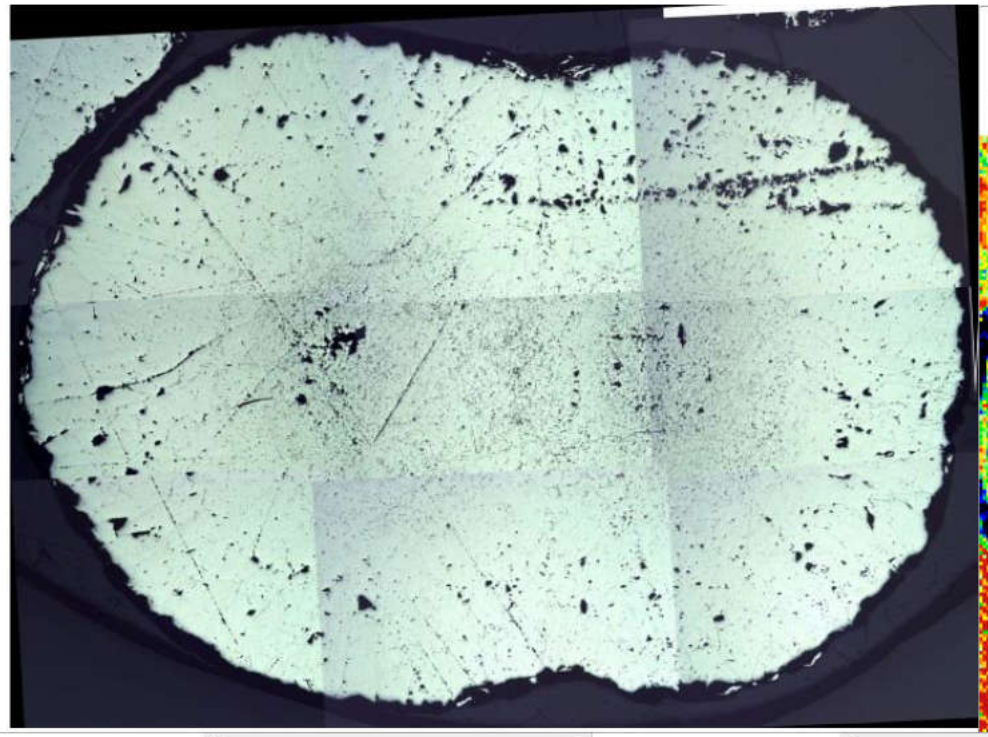
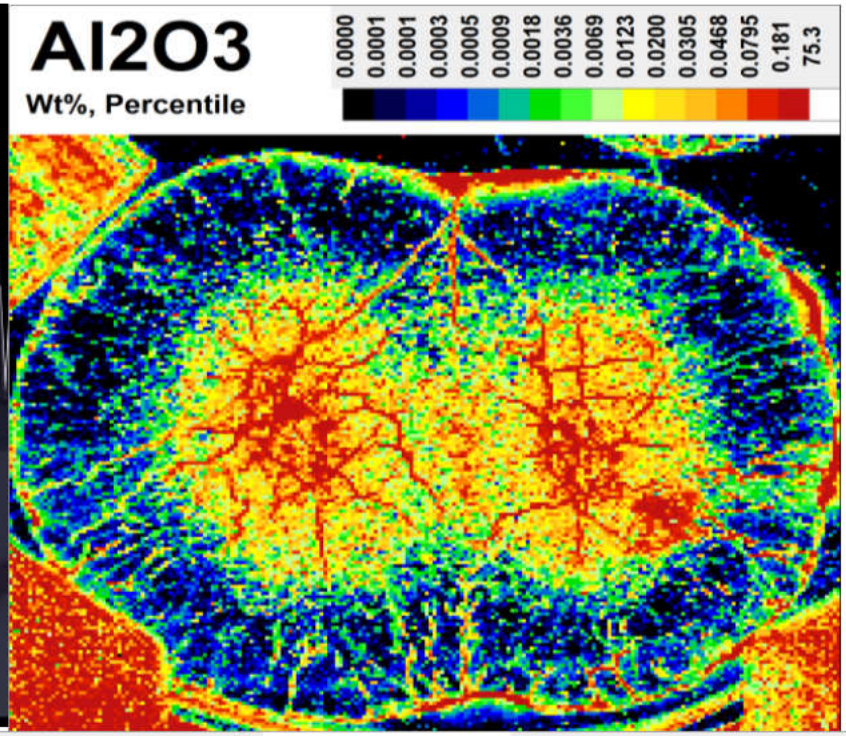
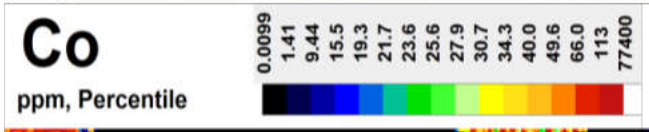
High Resolution Mapping






Al2O3
Wt%, Percentile
0.0000
0.0001
0.0001
0.0003
0.0005
0.0009
0.0018
0.0036
0.0069
0.0123
0.0200
0.0305
0.0468
0.0795
0.181
75.3


Co
ppm, Percentile
0.0099
1.41
9.44
15.5
19.3
21.7
23.6
25.6
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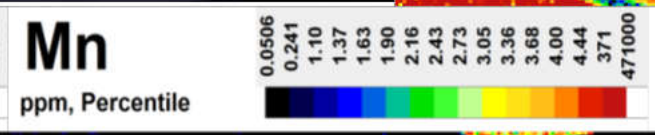
30.7
34.3
40.0
49.6
66.0
113
77400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2.16
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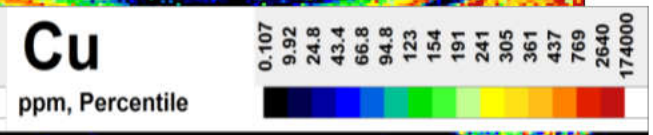
3.05
3.36
3.68
4.00
4.44
371
471000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ppm, Percentile
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43.4
66.8
94.8
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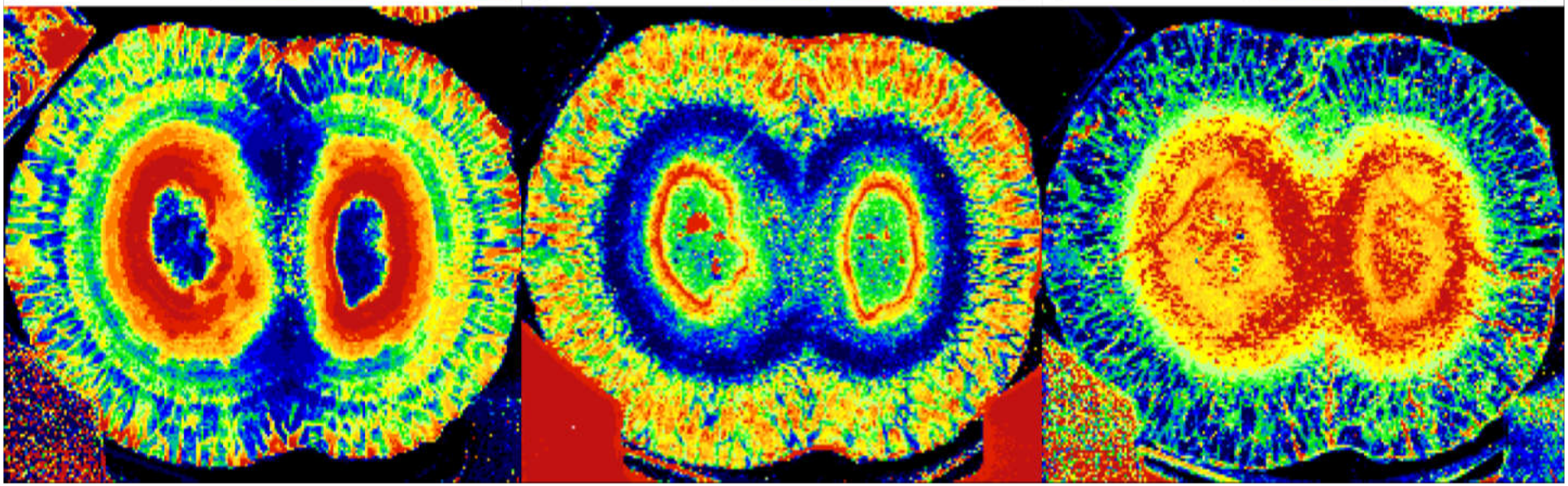
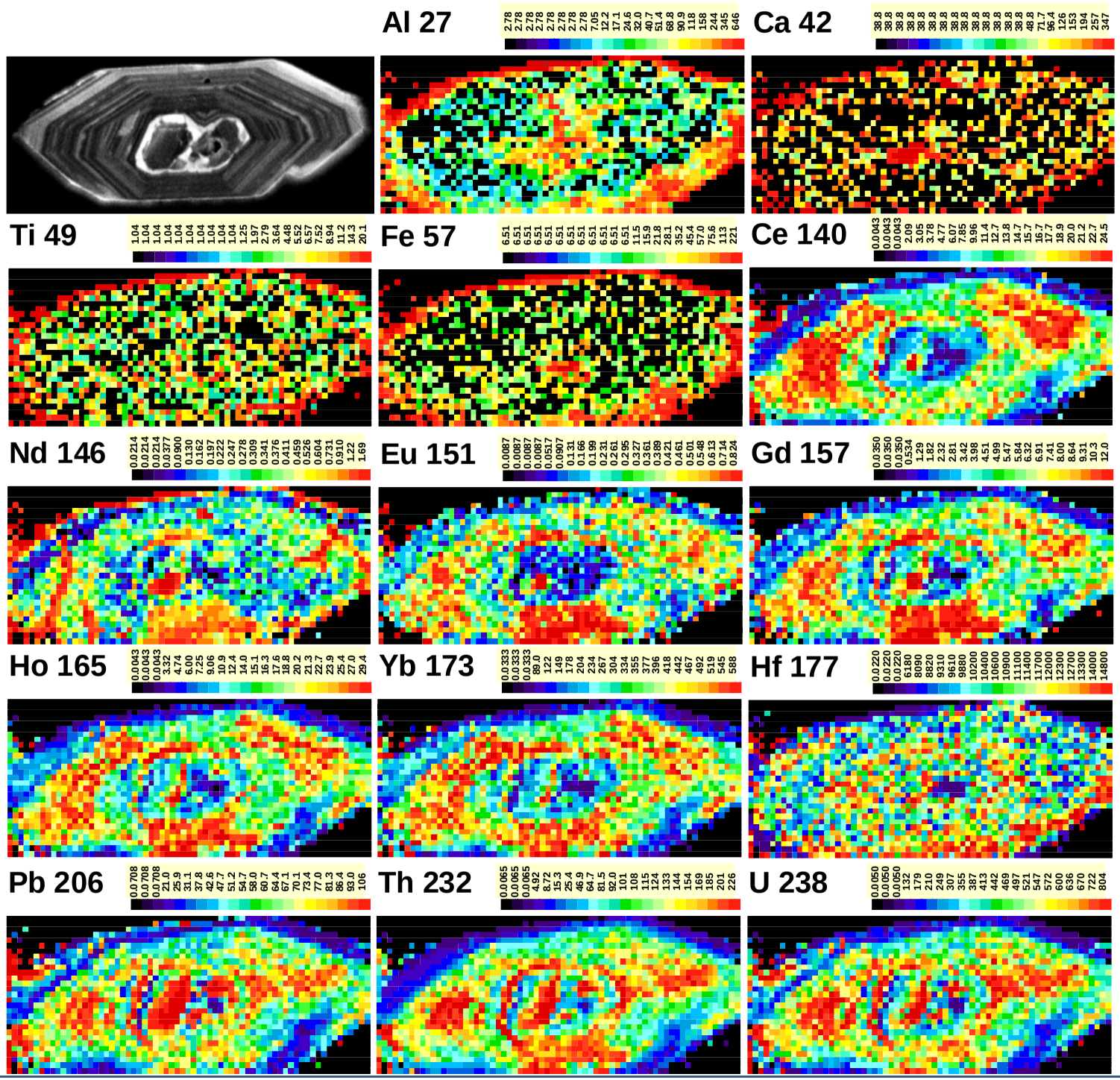
191
241
305
361
437
769
2640
174000



Semiquant maps of a zircon grain

- Analyte Excimer LA with HelEx cell
- ICP-QMS
- 8 µm squares ablated edge-to-edge



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