Results from LA-ICP-MS analysis of initial magnesium marking trials of sockeye salmon otoliths

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Overview

- Motivation
- Procedure
- Principles of LA-ICP-MS
- LA-ICP-MS Analysis
- Results
- Future Consideration
- Summary

Motivation

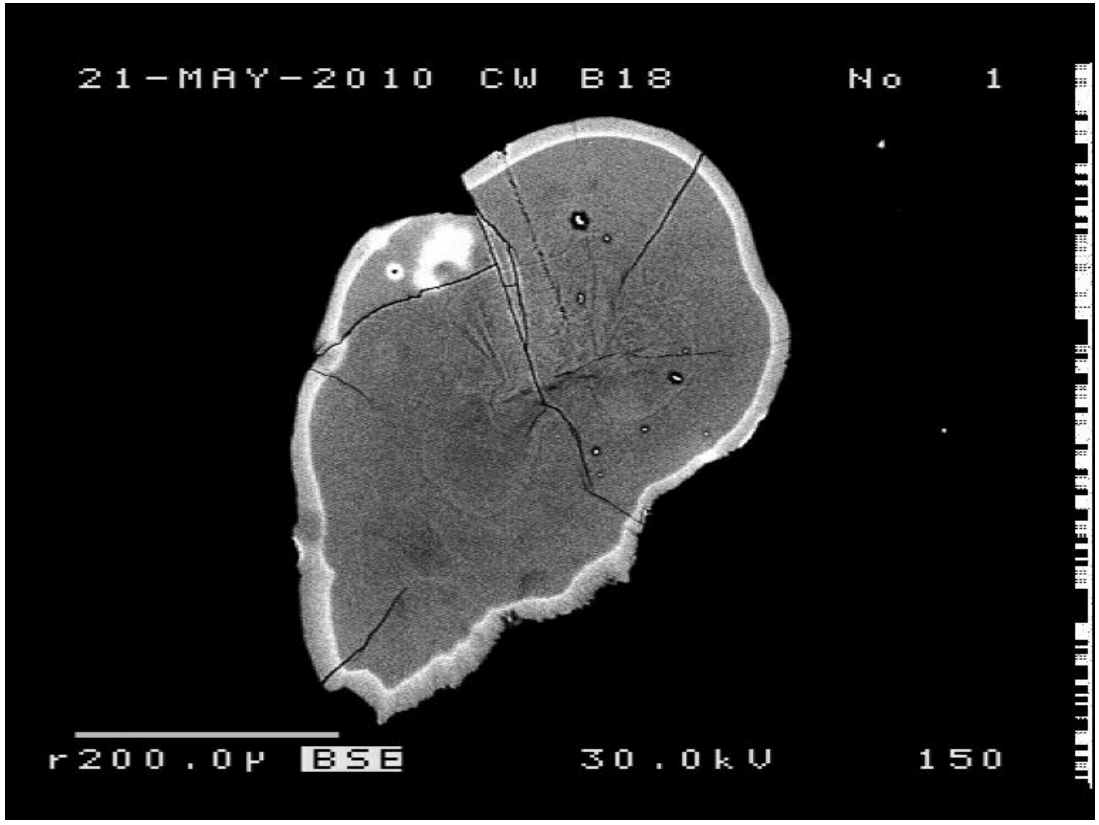
- Gulkana sockeye hatchery have been successfully marking with Sr since 1999
  - Sr marking goals: Mark all fish & in season management tool
  - Current management based on pre-1999 coded wire tag data
- 3 fry release sites—ideally 3 marks
- Any additional marking method would need to easily integrate into existing marking and reading procedures
- Is this feasible? Let's try Mg

18.93 Liter Bucket Tests

- 3 buckets: 3000 ppm $SrCl_2*6H_2O$ + 1500 or 3000 or 6000 ppm $MgCl_2*6H_2O$
- Soaked for 24 hours, no mortality, fry looked normal
- Subsequently treated the same as Sr voucher samples

Standard Voucher Sample Analysis

- Reared for 4 weeks, sacrificed, stored in ethanol
- Otoliths extracted, mounted & polished for electron microscope analysis
- Sr mark confirmed

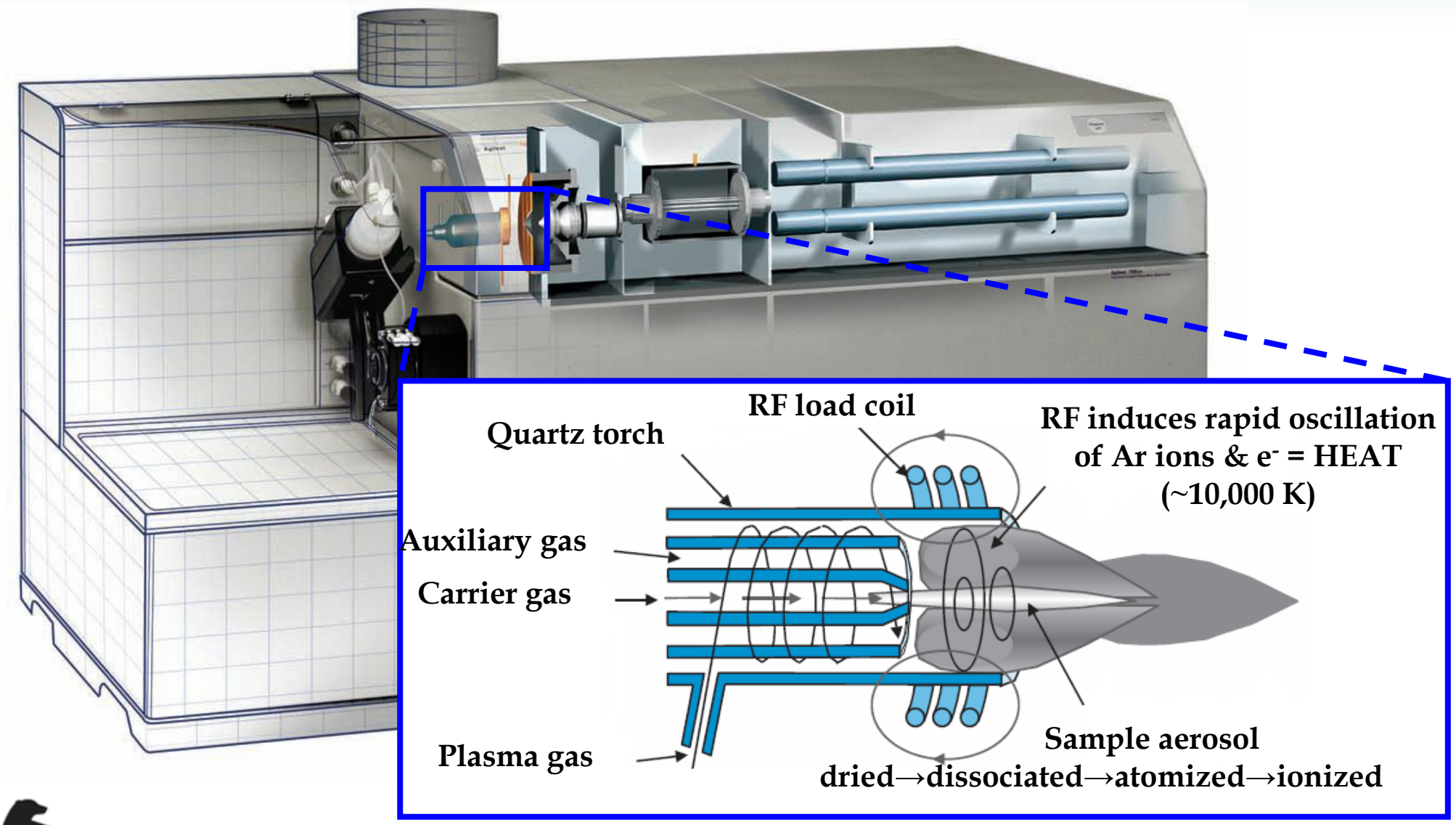


Laser Ablation Inductively Coupled Plasma Mass Spectrometer

New Wave UP213 Laser Ablation unit coupled to Agilent 7500ce ICP-MS

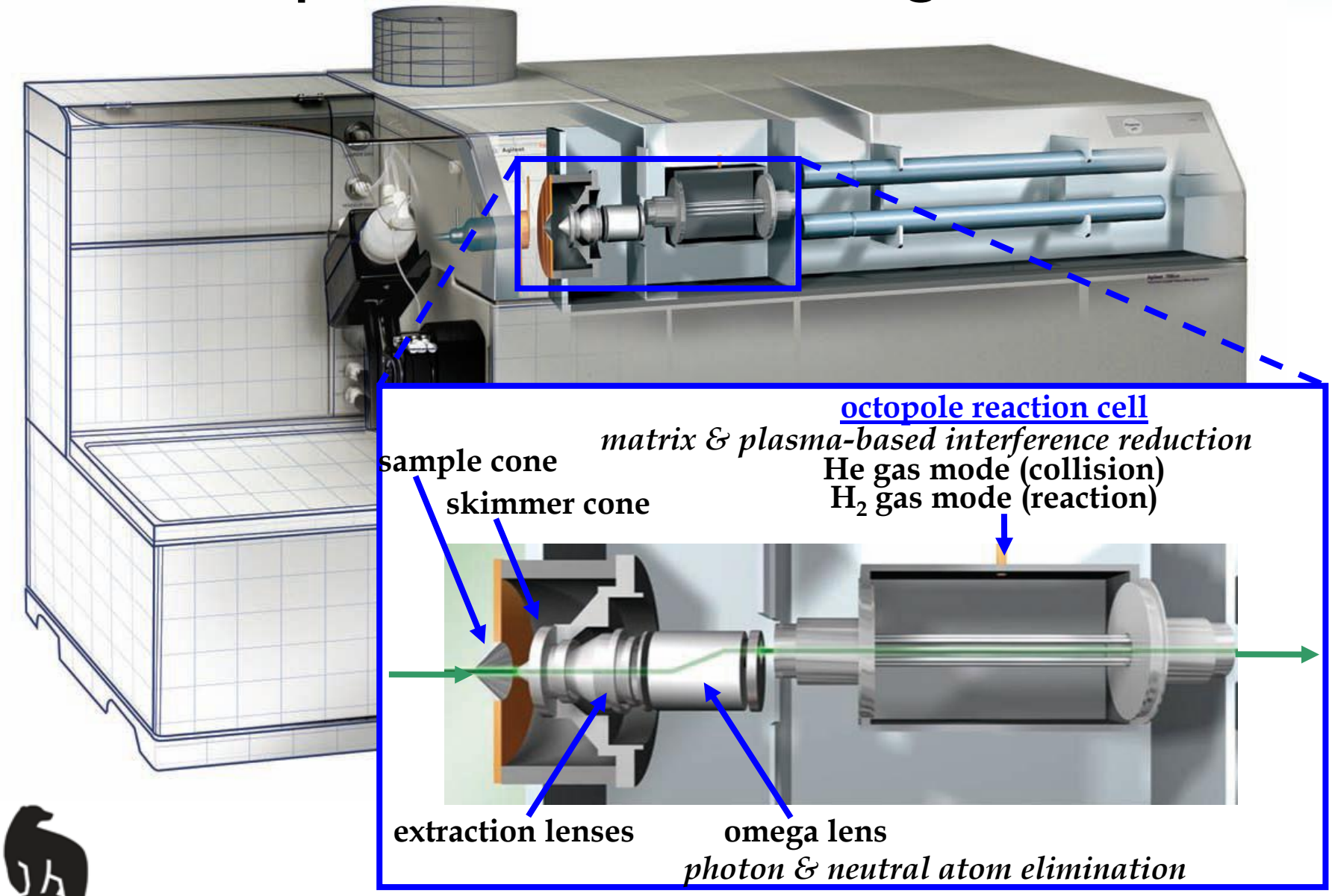
Advanced Instrumentation Laboratory

ICP-MS Fundamentals: The Plasma Torch



Images modified from Agilent publications, slide courtesy Vanessa Ritchie

ICP-MS Fundamentals: Sample Stream Tuning and Filtering



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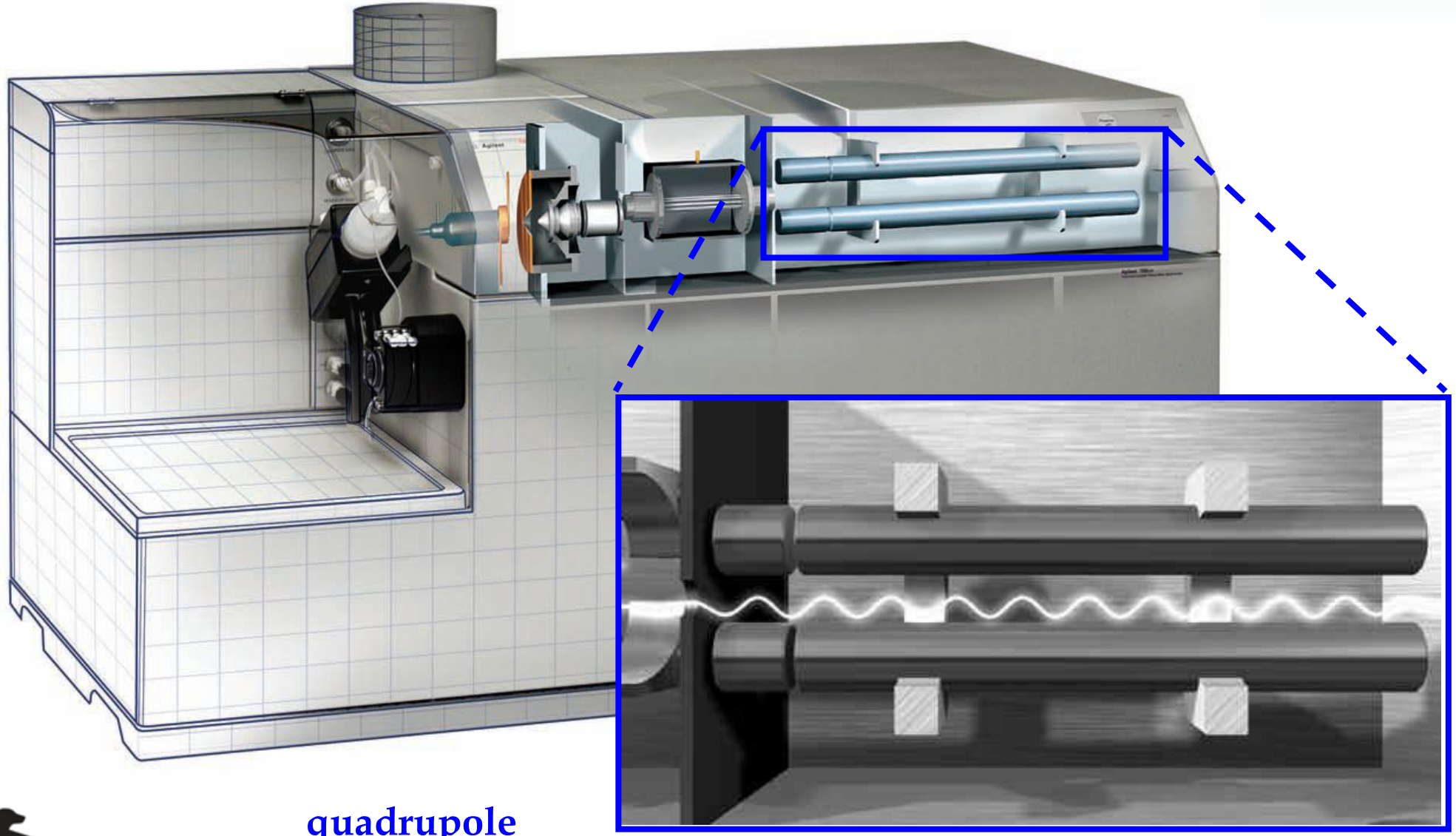
ICP-MS Fundamentals: Sequential Mass Filter



quadrupole

Ion filter based on m/z ratio

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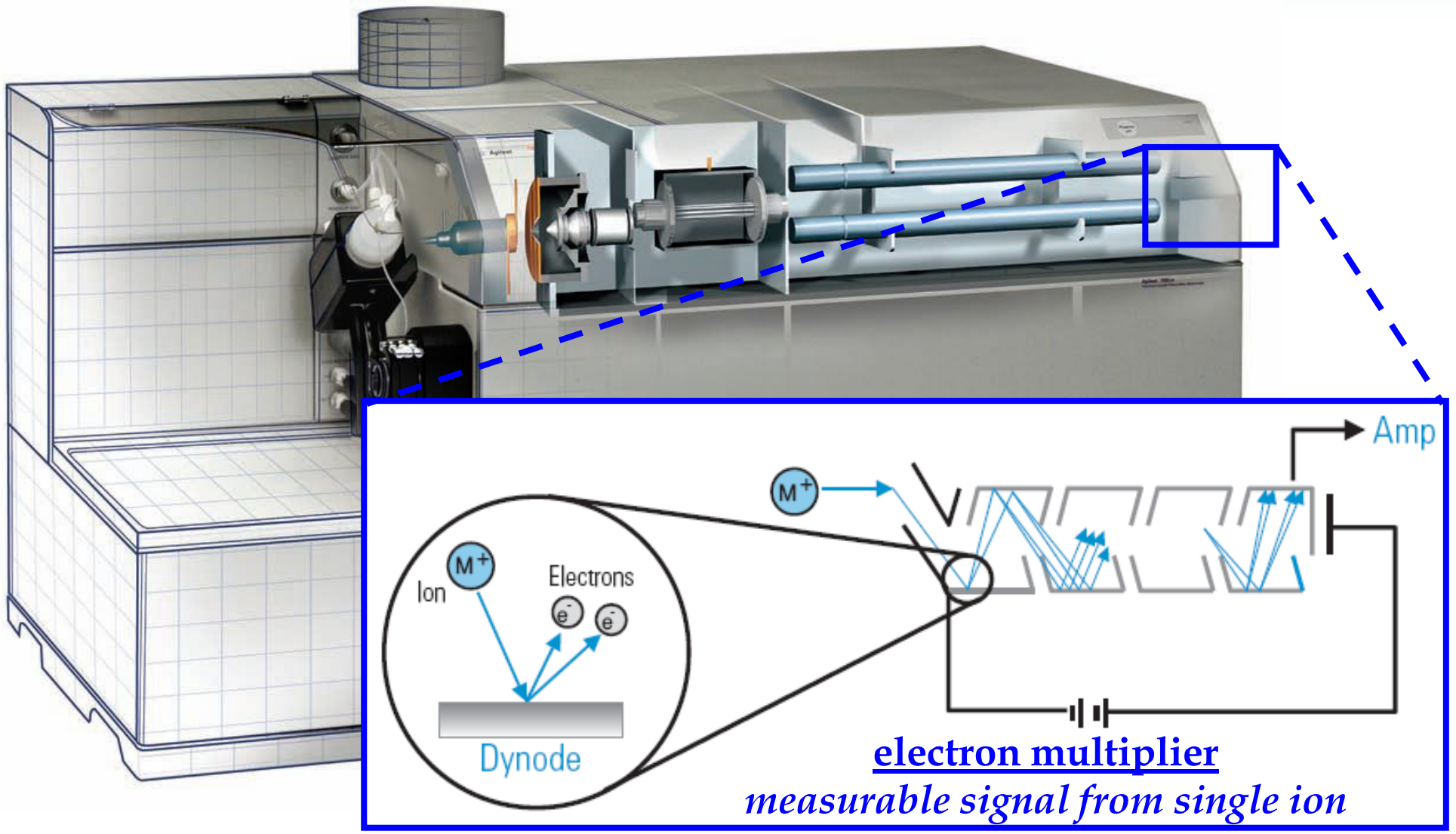
ICP-MS Fundamentals: The Detector



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LA-ICP-MS Analysis Conditions

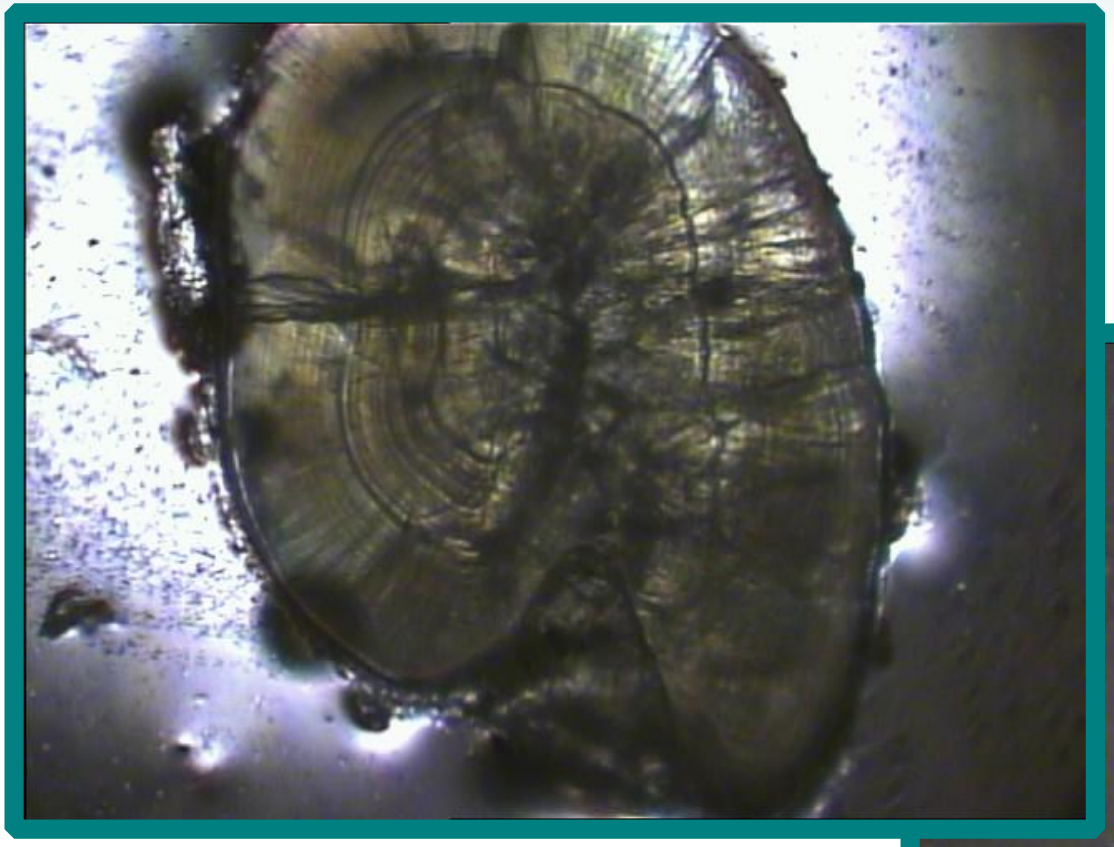
ICP-MS – cs lens stack installed

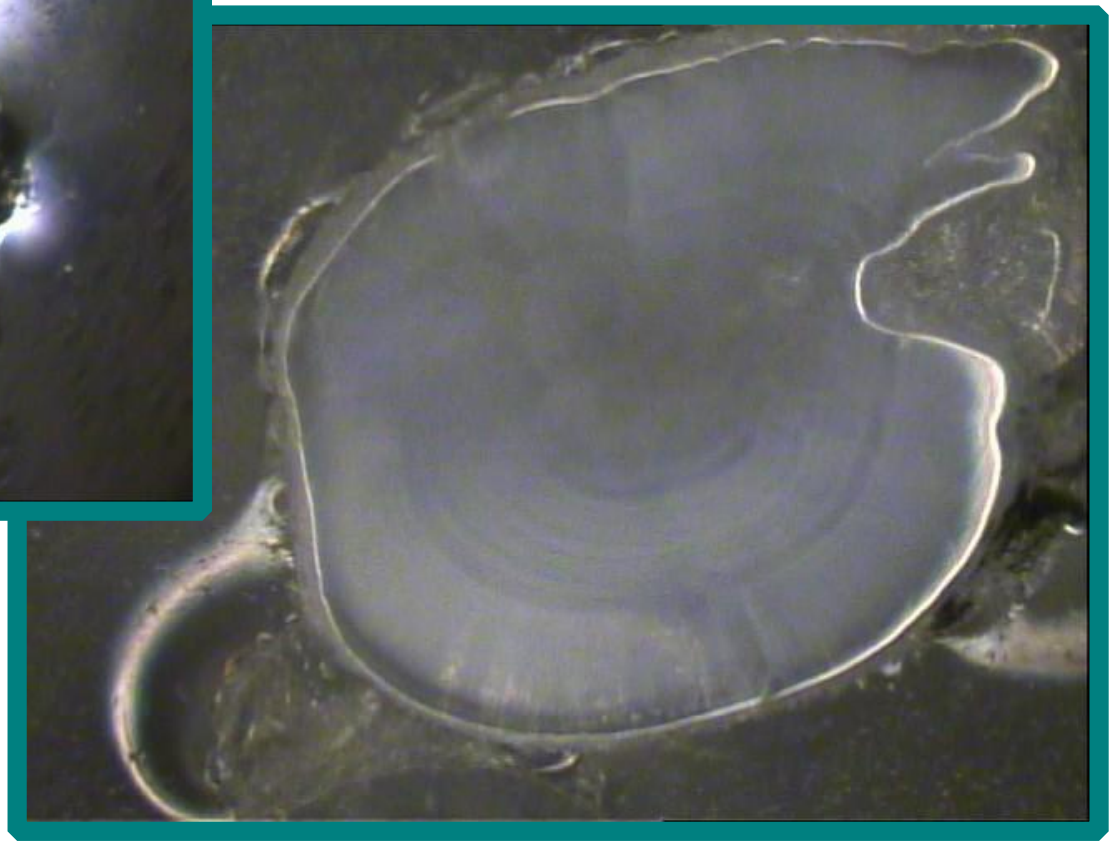
- Isotopes collected: Mg24, Ca42, Ca43, Mn55, Sr86, Sr88, Ba138
- RF power: 1200 W
- Argon carrier gas: 1.2 L/min
- Sample depth: 5 mm
- 0.1 second dwell time

Laser

- 5 µm/sec scan speed
- 80% Power
- 10 Hz Pulse rate
- 25 µm spot size
- 30 second laser warm up (gas blank) prior to each transect

New Wave Laser Optical Image

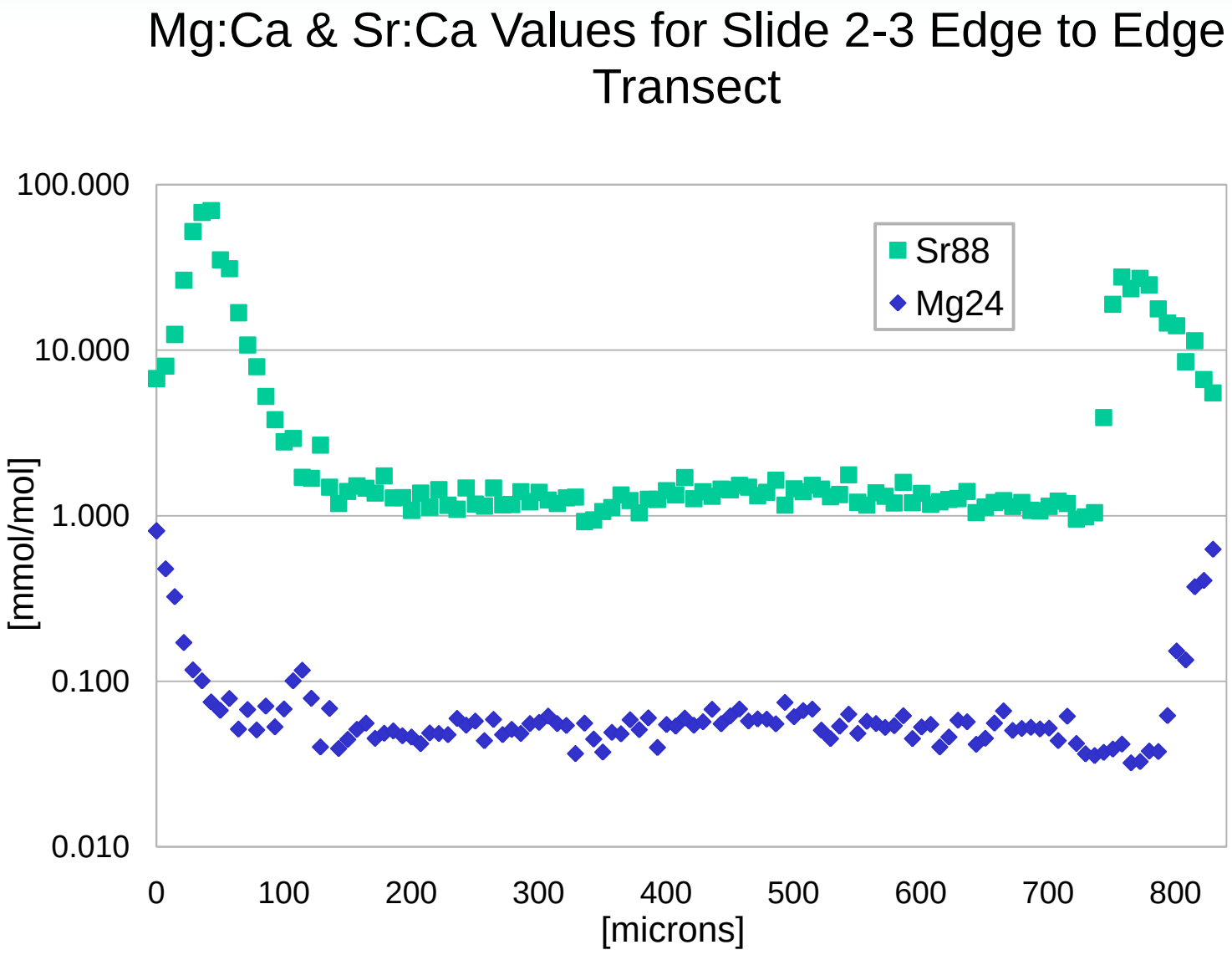




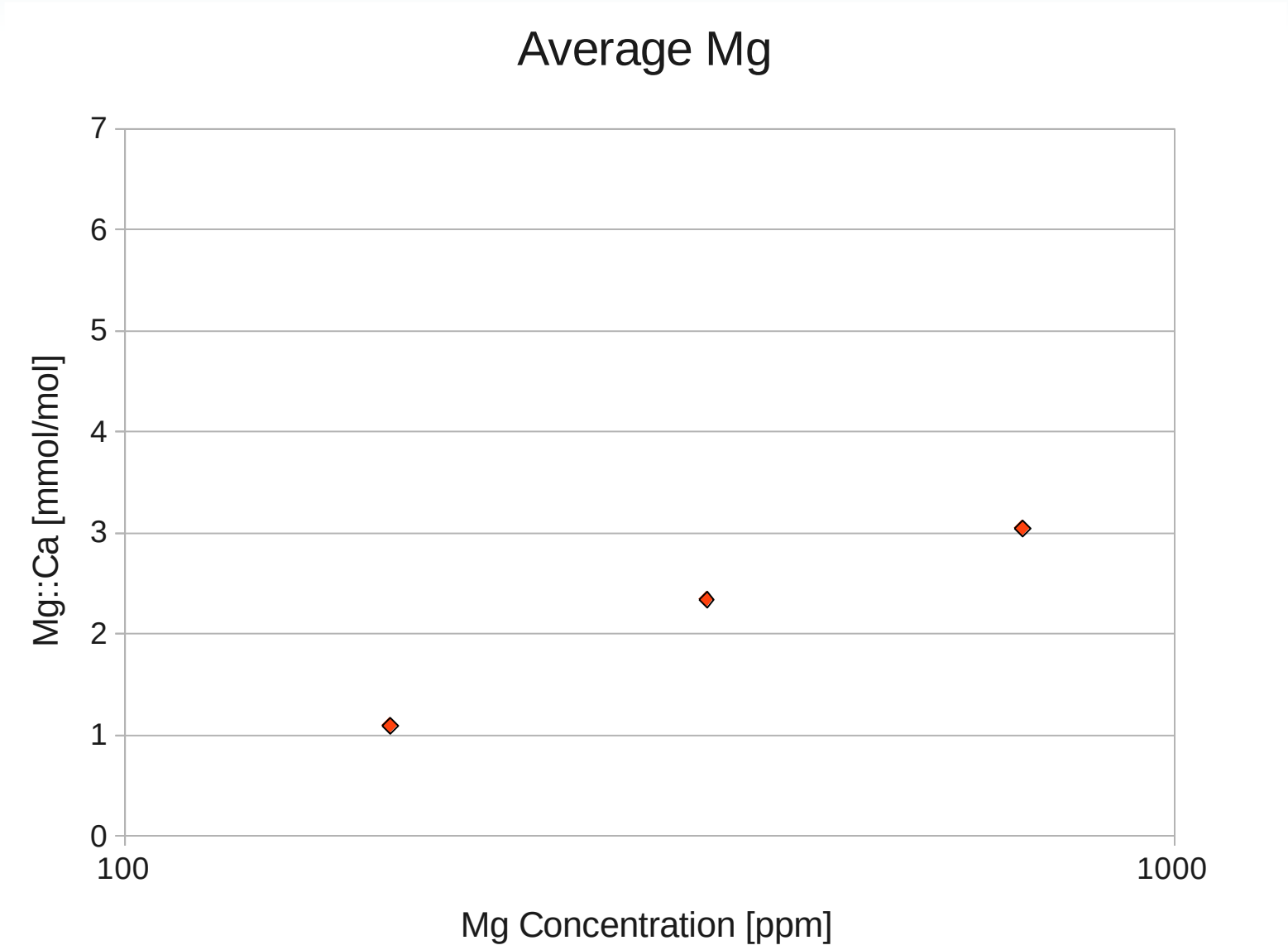
Laser Analysis

- NIST610 primary calibration standard
- FEBS-1 NRC Otolith secondary standard
- Ca43 Internal Standard
- 30 second gas blank prior to each edge to edge transect
- Determine interval of interest in data by examining Ca42 signal
- Data reduction via Longerich 1996
- Select peak Mg24 value within interval of interest near transect end

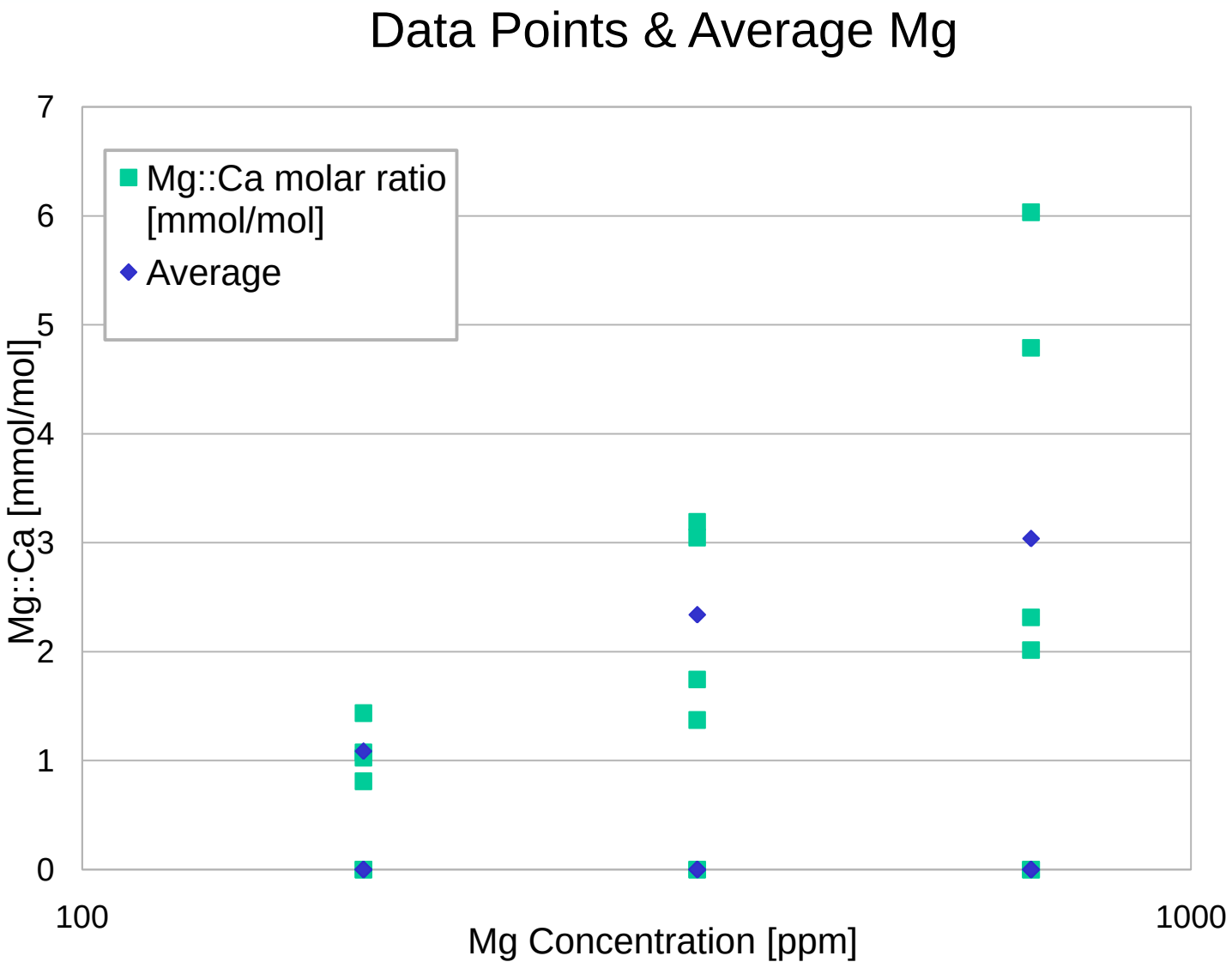
Typical Transect



Results


Average Mg
Mg::Ca [mmol/mol]
0
1
2
3
4
5
6
7
100
1000
Mg Concentration [ppm]

Okay, Maybe not That Beautiful



Considerations about Mg

- What is the uptake mechanism of Mg to the otolith?
- Mg latency in fish tissue for human health consumption?
- At what levels do toxicity and adverse effects appear?
- What levels of Mg are naturally in the sockeye environment?
- Cost & disposal of baths?

What about Barium?

- Documented correlation of water chemistry & otolith chemistry
- Nominal latency in fish tissue post exposure, gets dumped to bone
- Toxicity levels
- Low levels of Ba present in the sockeye environment
- Cost & disposal of baths?

Future Consideration

- Higher levels of Mg
- Ba levels 50-200 ppm ballpark
- Bath water sampling to confirm levels

Summary

- Preliminary attempt at differentiating Mg marks in Gulkana sockeye fry success!
- First time in salmonids?
- Worth pursuing further Mg trials and adding Ba

Questions?