



Inorganic Mass Spectrometry at LNGS

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Laboratory of Isotopic Mass Spectrometry (LIMS)

MC Thermal Ionization Mass Spectrometry Finnigam MAT261/261

- Discrimination between isotopic ratio values: $<0.01\%$
- Internal precision of the measurement $>0.005\%$



Applications (Cultural Heritage Network)

- **Archaeometry (Pb, Sr)**
- **Food traceability (Sr)**
- **Mobility ancient population**
Through the natural Sr isotope ratio determination in human rest



Soil

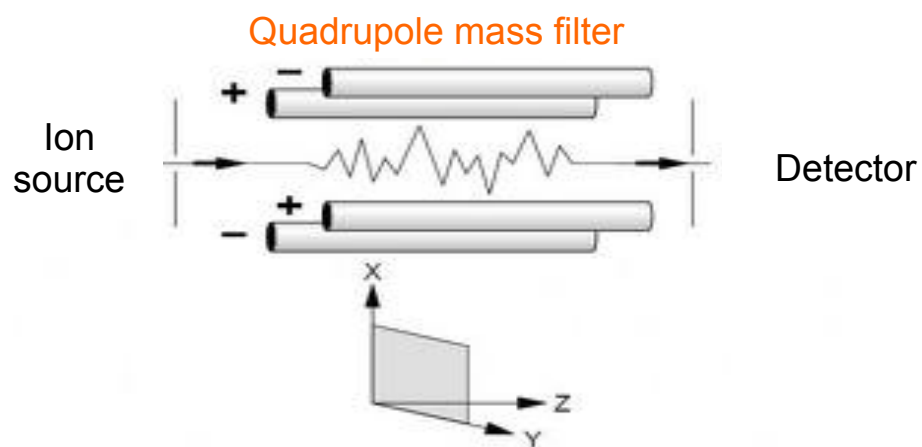
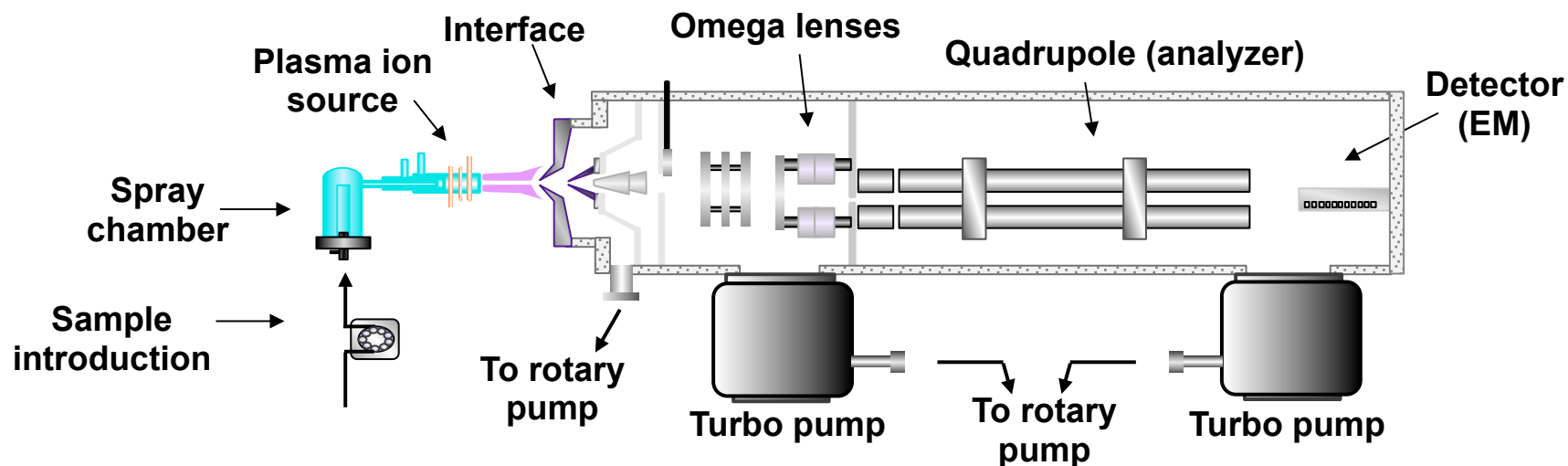
Food chain

bones and teeth

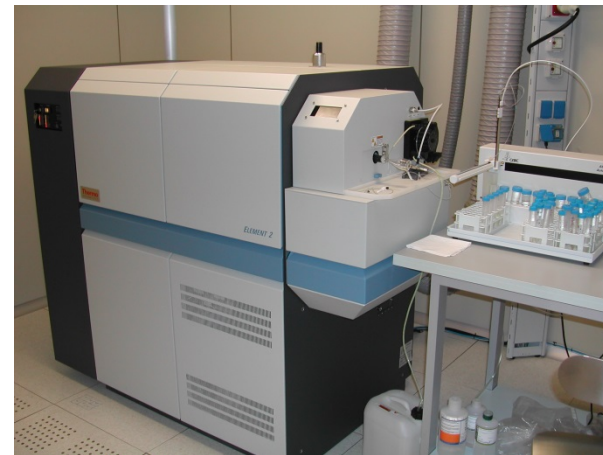
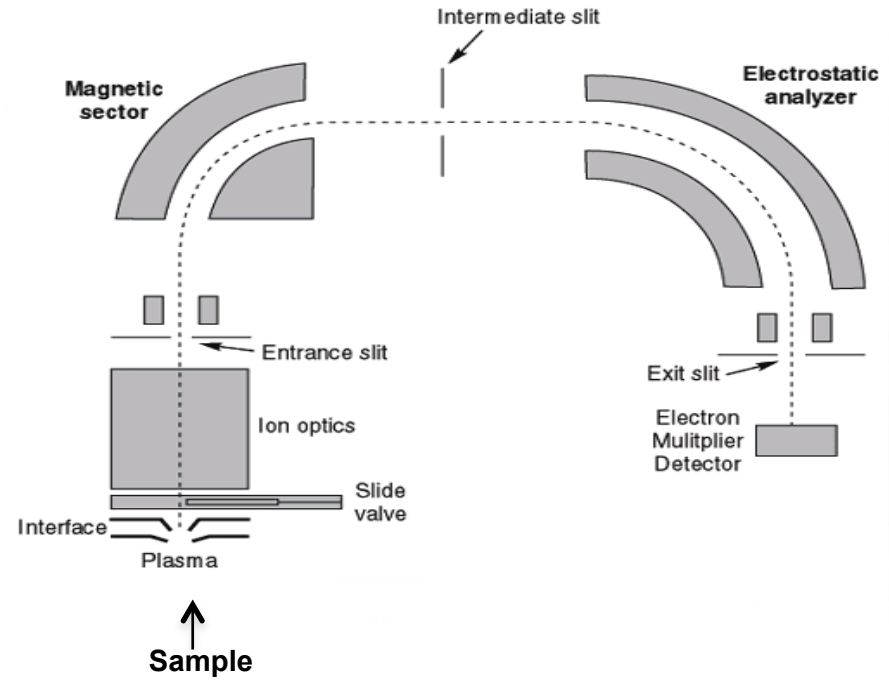
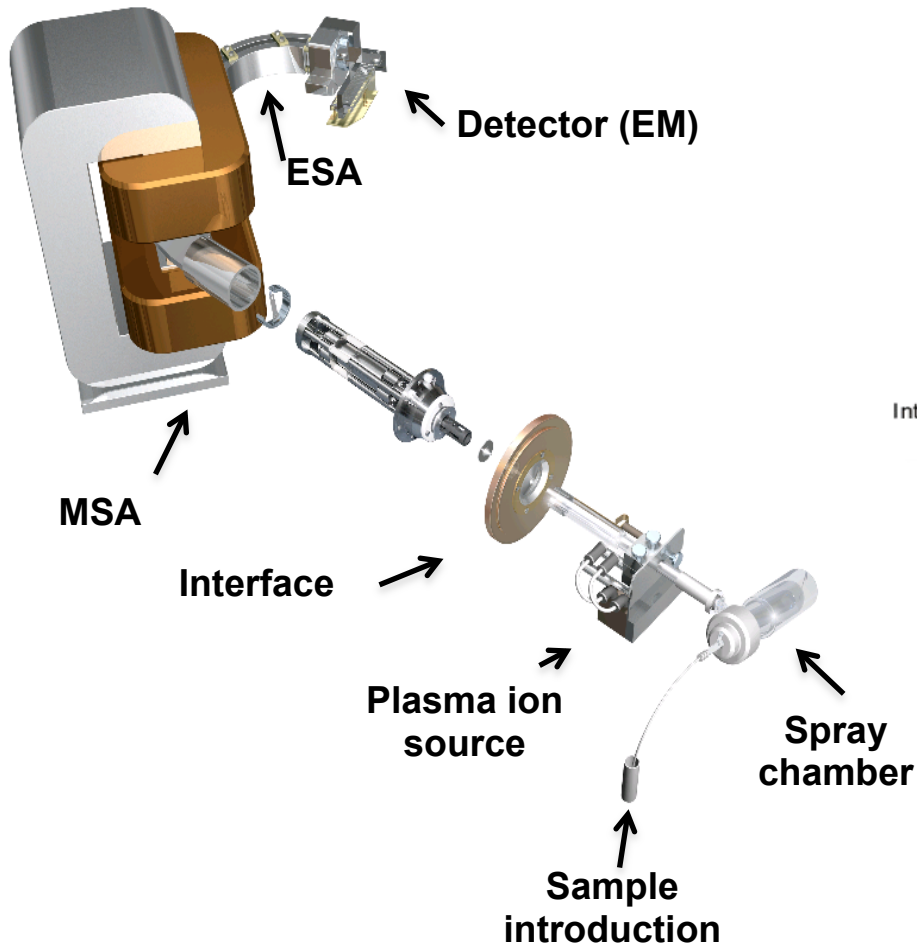


Two ICP mass spectrometers @ LNGS

-ICP QMS (quadrupole mass analyzer) – Agilent 7500a



- High Resolution ICP MS (double focusing mass analyzer)
ThermoFisher Element2



Double focusing mass analyzer
(MSA + ESA)

ICP-MS ULL-GRS comparison

The techniques are absolutely complementary since by the application of both ICP MS and ULL GRS it is possible to have more complete information

ULL-GRS Ultra Low Level Gamma Ray Spectrometry

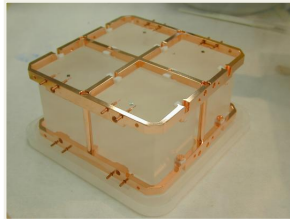
- + Almost sample treatment free
- + Often is possible to measure different radionuclides in decay chain
- + Non destructive
- Sensitivity depends on the sample mass (Kg)
- Long measurement time is requested to achieve high sensitivity (weeks)

ICP-MS

- + Small sample (g)
- + Relatively quick measurement
- + Set of similar samples can be processed in parallel
- + Surface contamination study can be performed (deep profile conc)
- + Single contribute measurement of inhomogeneous material (PCB)
- Sample treatment is mandatory and delicate (time cons. and contam. risk)

ICP-MS activity: low radioactivity measurements

- \approx 200 samples/year (complex matrices)
- few hundreds samples/year (reagents and water)



Cu, TeO₂ and reagents
-CUORE-



Printed Circuit Board (PCB)
-GERDA-



Metals and alloys
-GERDA, XENON, DARK SIDE-



Al-Mylar insulating foils
-XENON, DARK SIDE-

Issues in ICP MS ultra-trace analysis for ultra-low background applications

- **Lack of validated methods and reference materials** (unusual matrices or analytes)
- High **risk of contamination** during sample preparation (we are looking for very very low concentrations!!!)
- **Background**
- **Isobaric interferences**
- **Sensitivity**, especially for solid samples (the instrument does not tolerate high matrix content, dilution is necessary) and **matrix effect**

Limiting factors to the achievement of strict detection limits required by neutrino experiments!!!

Our routine ICP-MS detection limits:

Sample	Liquid	Metals (solid)		Plastic (solid)
		Dissolution and dilution	Analyte separation	
Element	[pg g ⁻¹]	[pg g ⁻¹]	[pg g ⁻¹]	[pg g ⁻¹]
K	50	5×10 ⁴	-	5×10 ⁴
Pb	0.5	500	-	100
Th	0.05	50	1.0	10
U	0.05	50	0.5	10

U in Cu AVG 3Meas SD
ppt 2.36 0.05



30 ± 0,6 μBq/Kg

Detection limit = 0.2*10⁻¹² g/g



2,4 μBq/Kg

Perspective and future development?

-Detection Limit improvement in ICPMS radiopurity. Develop analytical procedures

Matrix separation

Analyte pre-concentration

Background and contamination reduction

Increase of sensitivity

New generation quadrupole based ICPMS (Triple quadrupole) equipped with Laser Ablation System for direct solid measurement ?