



*INTERDISCIPLINARY USE OF  
INDUCTIVELY COUPLED PLASMA  
MASS SPECTROMETRY (ICP MS) AT  
THE GRAN SASSO NATIONAL LAB*

*Maria Laura di Vacri, MD*

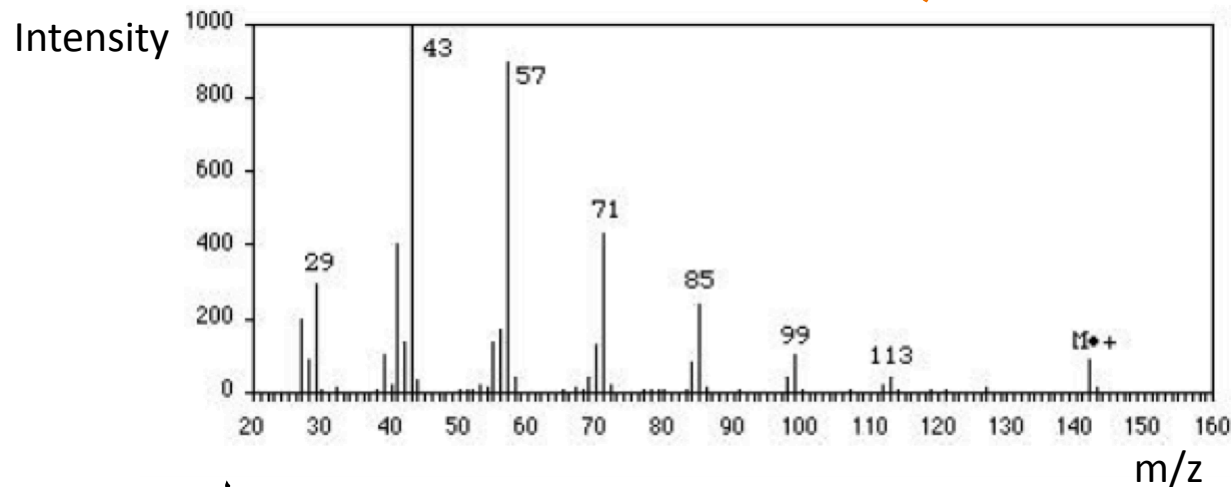
*Gran Sasso National Laboratory - Chemistry Division*

# What is mass spectrometry?

- Identification and quantification of molecules and elements



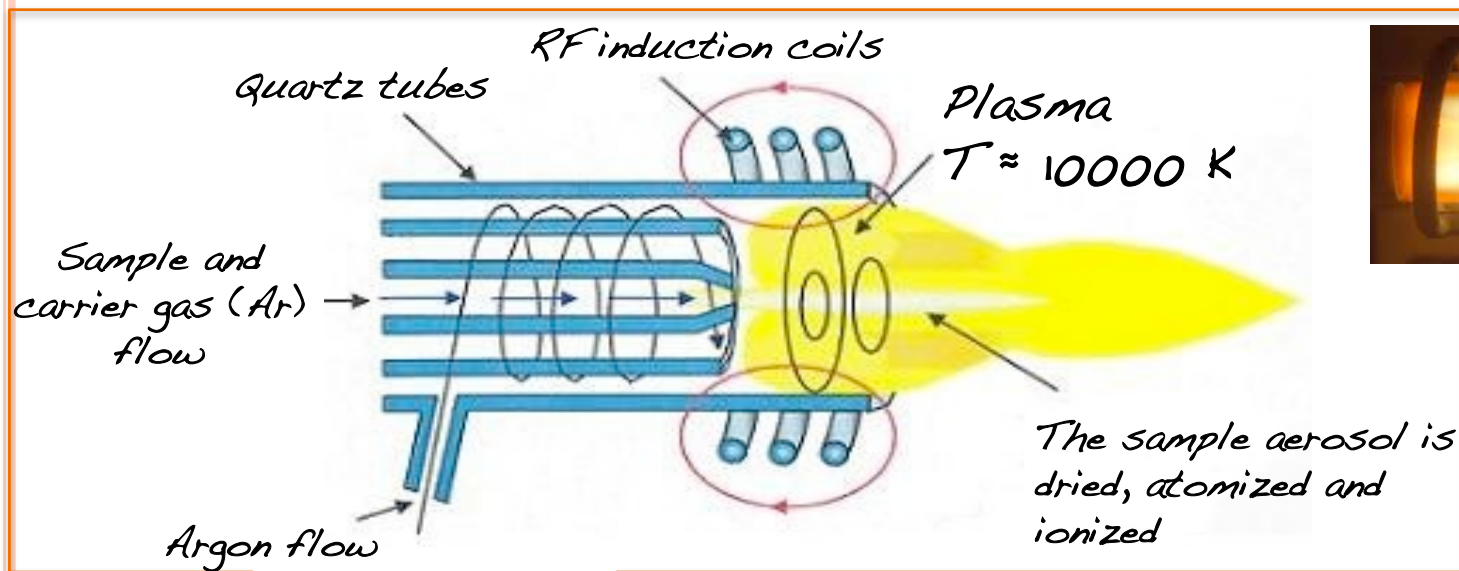
mass spectrum (intensity vs  $m/z$ )



$m$  = ion mass  
 $z$  = ion charge

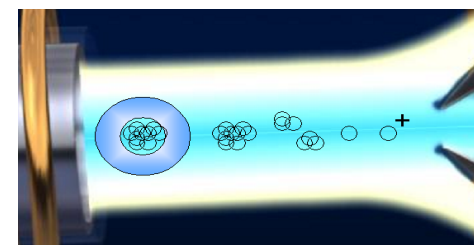


# Inductively Coupled Plasma Mass Spectrometry (ICP MS)



High energy!

Plasma torch ion source



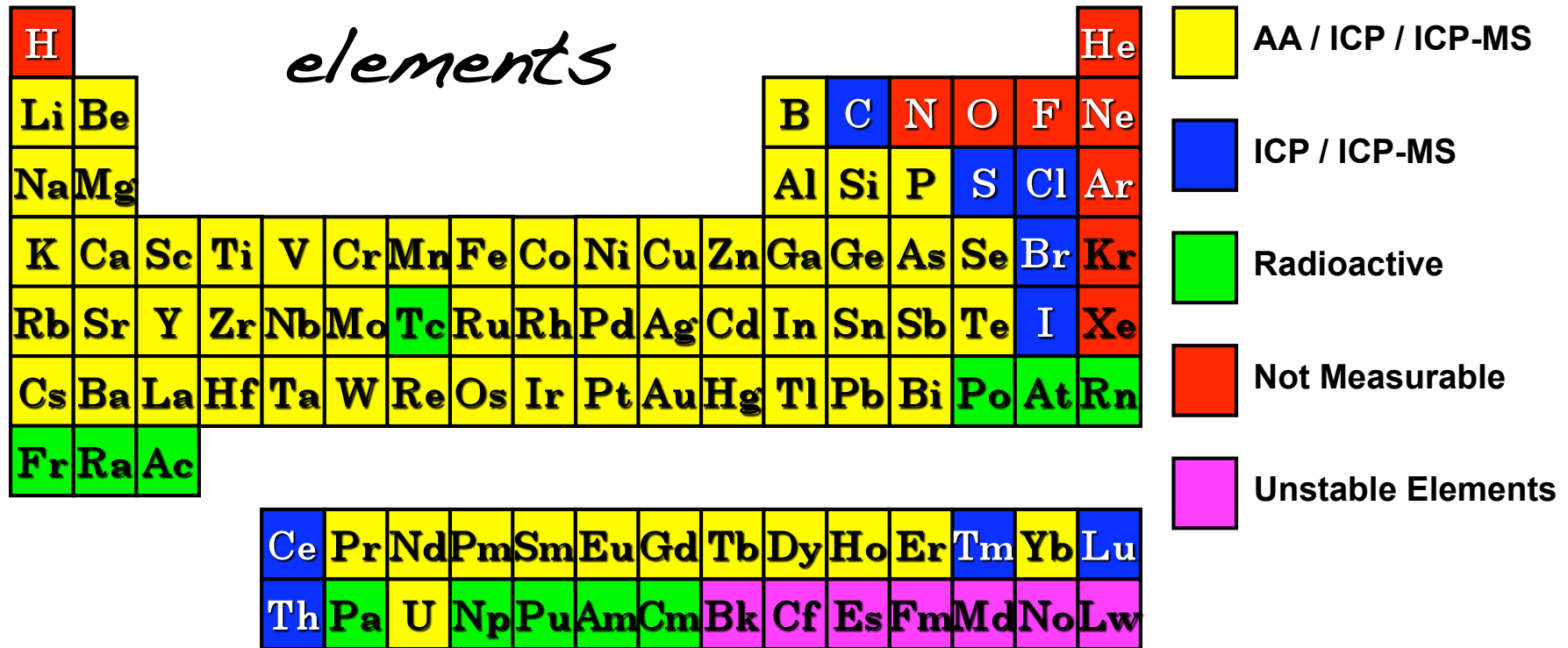
Elemental analysis

Complete (almost):

- Desolvation
- Atomization
- Ionization

3

# Measurable elements

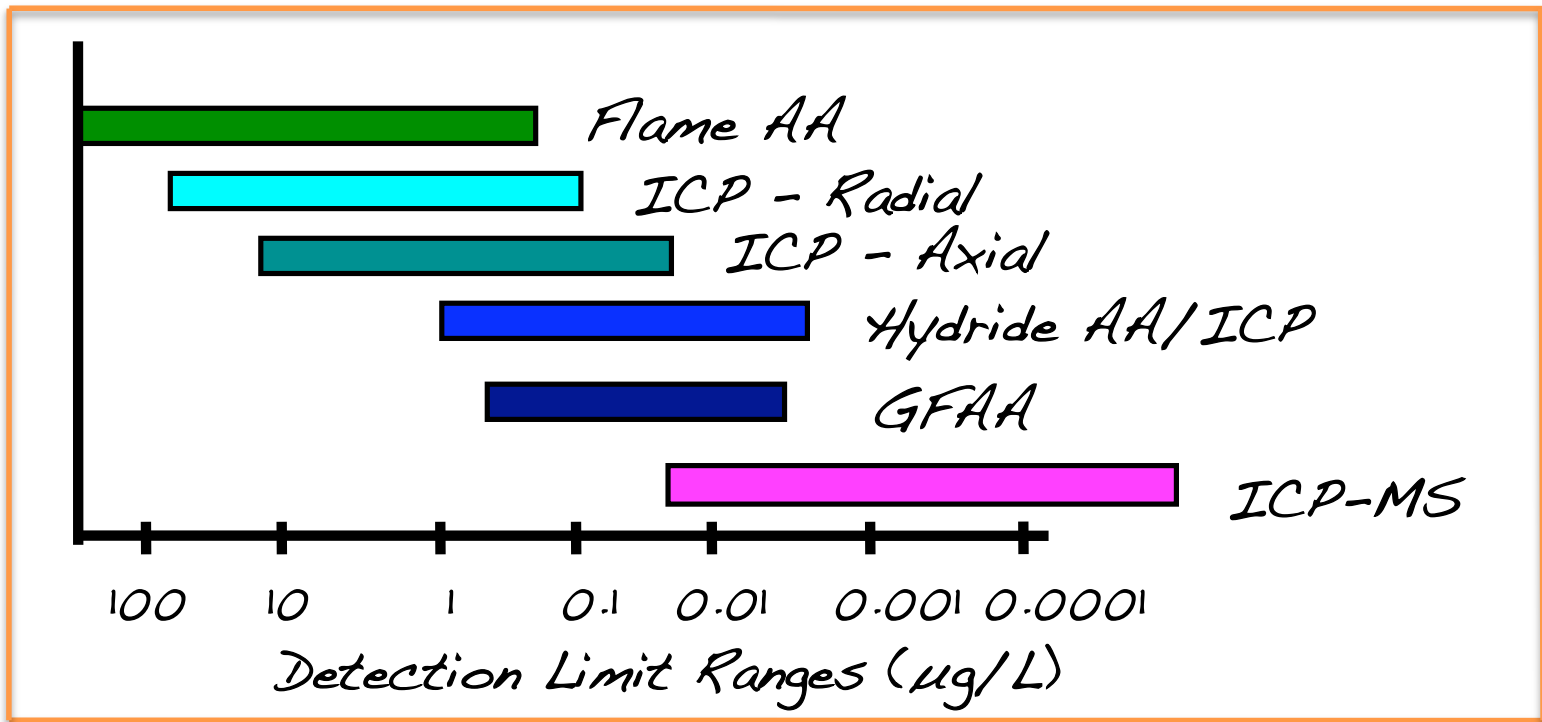
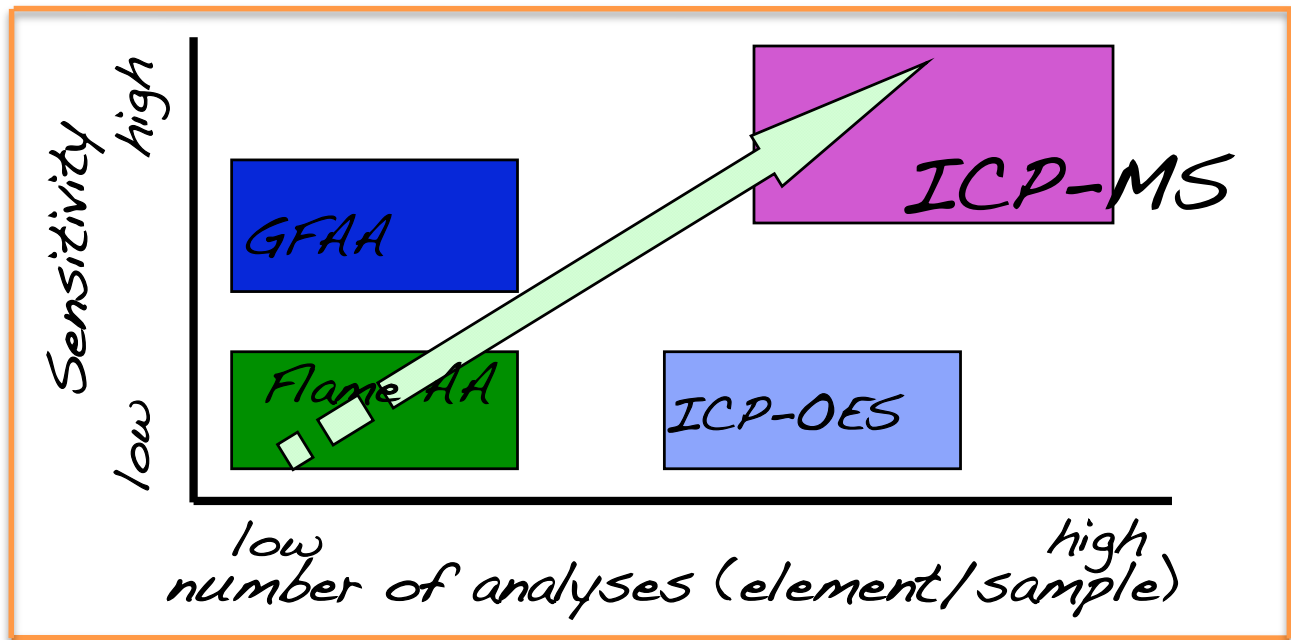


1ppq  
( $10^{-15}$  g/g)

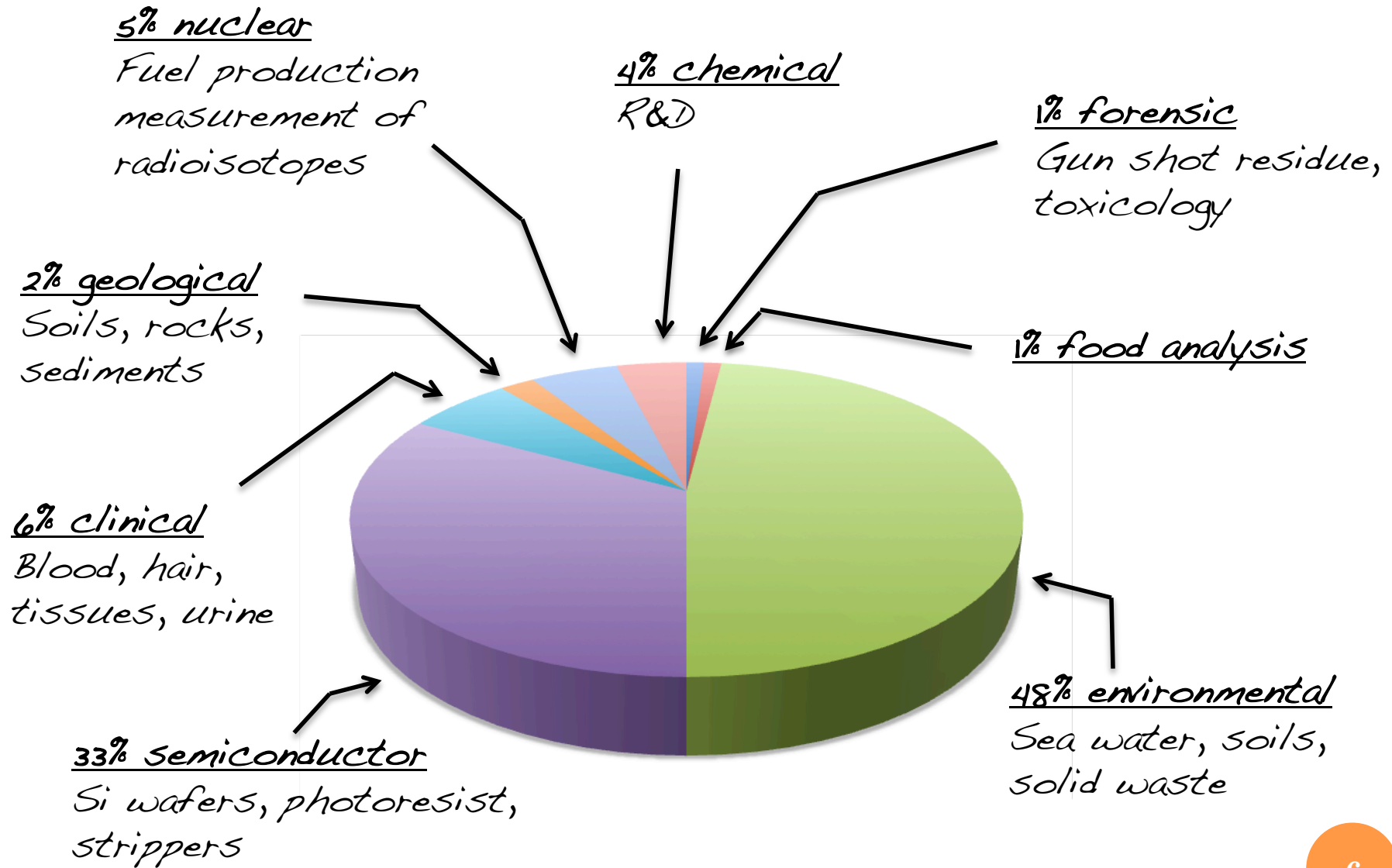
1ppt  
( $10^{-12}$  g/g)

1ppb  
( $10^{-9}$  g/g)

1ppm  
( $10^{-6}$  g/g)

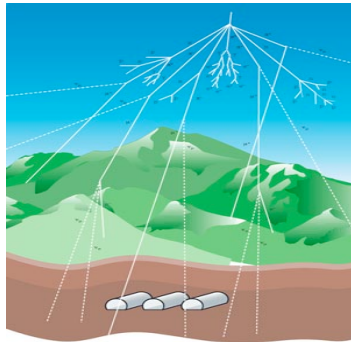


# ICP MS applications



# Why ICP MS @ LNGS?

Detection of extremely weak events



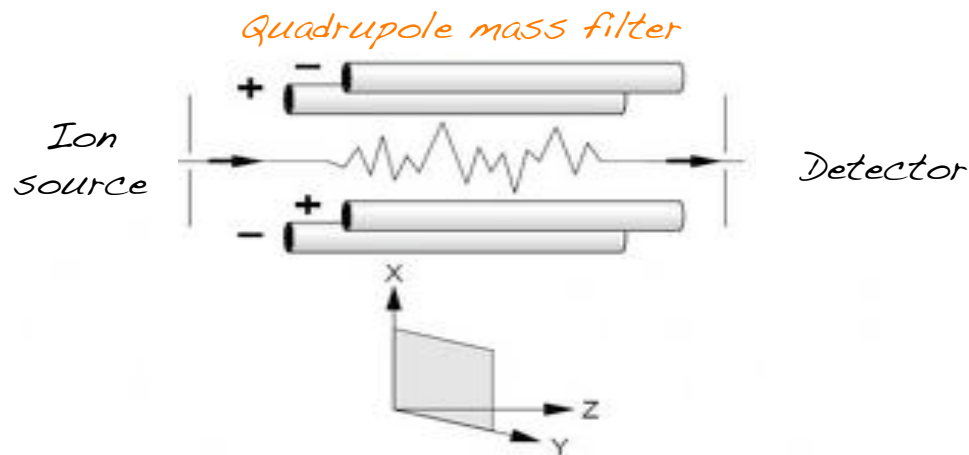
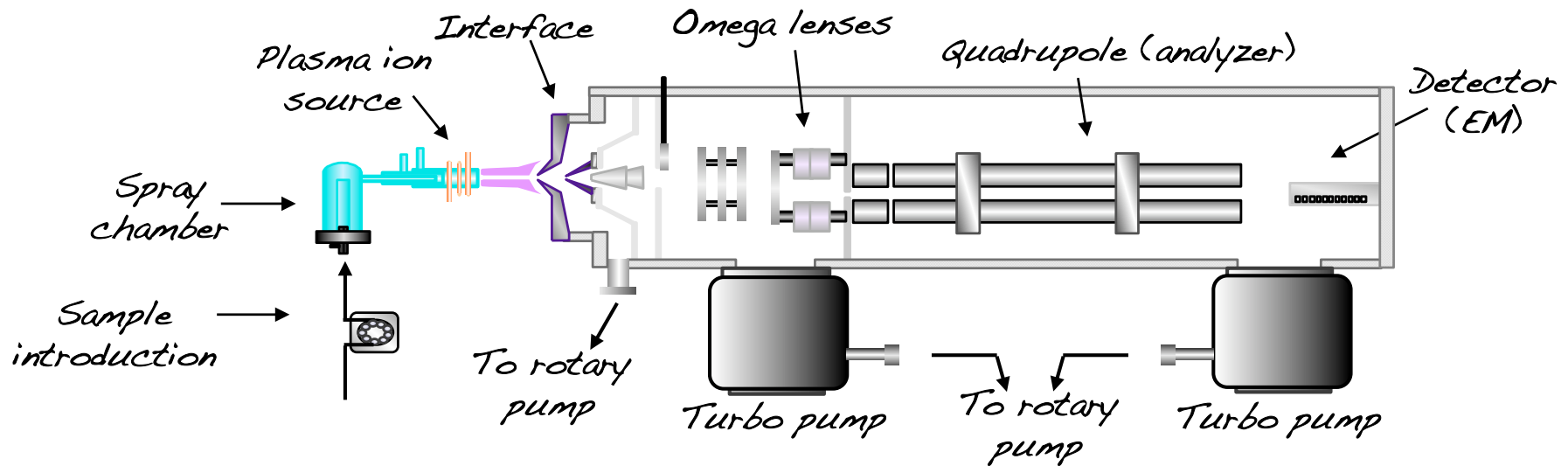
1400 m of rock (3600 mwe)  
Cosmic ray flux reduction:  $10^6$   
Neutron flux reduction:  $10^4$

- The underground facility provides the necessary low radioactive background
- Selection of highly radio-pure materials

K Pb Th U

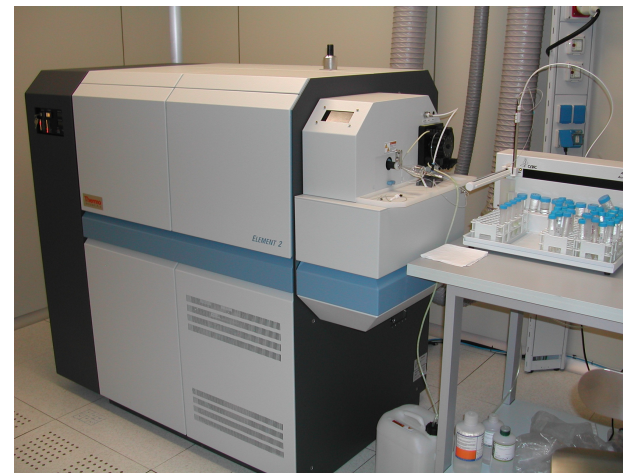
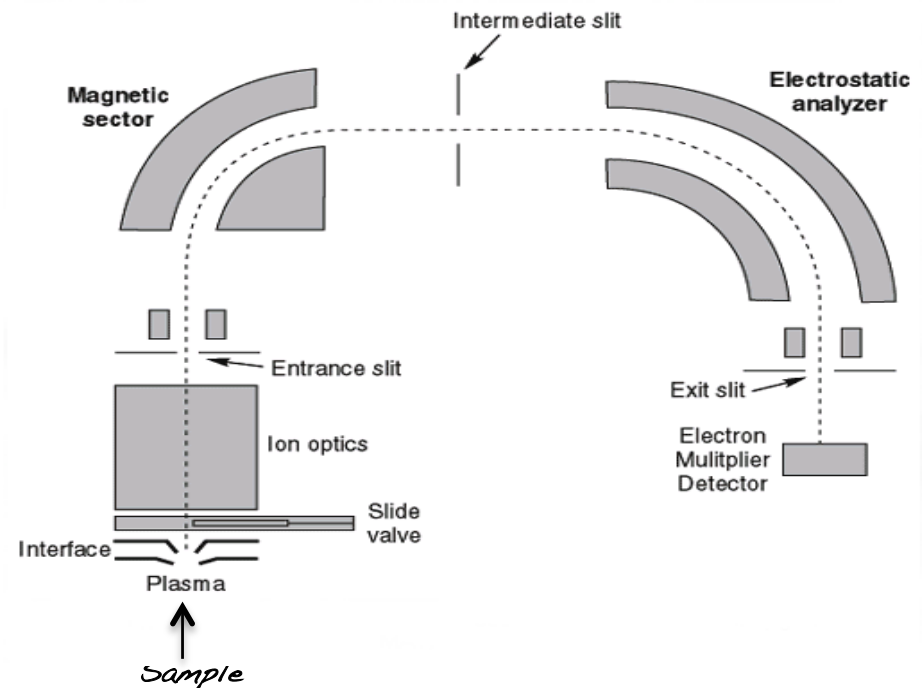
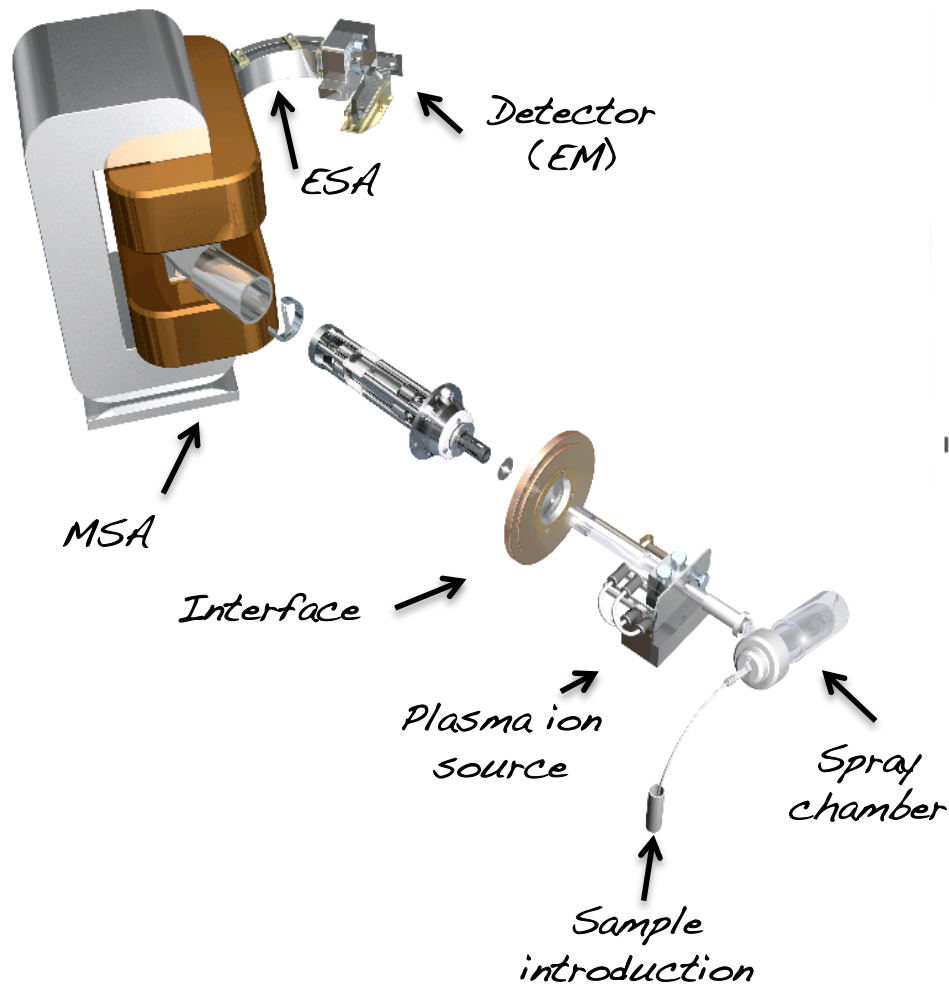
# Two ICP mass spectrometers @ LNGS

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





- High Resolution ICP MS (double focusing mass analyzer)  
Thermo Element 2

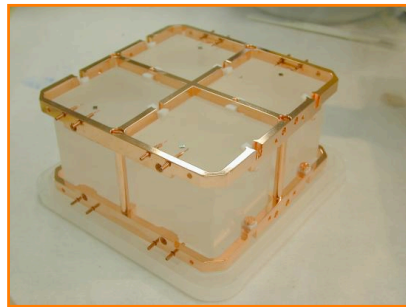


Double focusing mass analyzer  
(MSA + ESA)

# MAINLY: low radioactivity measurements

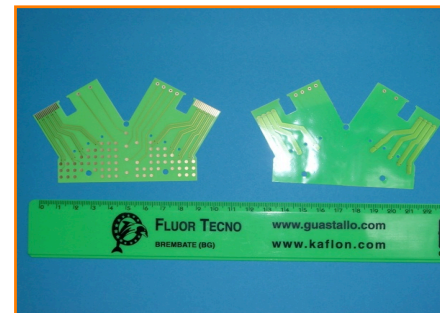
- $\approx 200$  samples/year (complex matrices)
- few hundreds samples/year (reagents and water)

Few examples...



Cu, TeO<sub>2</sub> and reagents  
-CUORE-

Printed Circuit Board (PCB)  
-GERDA-



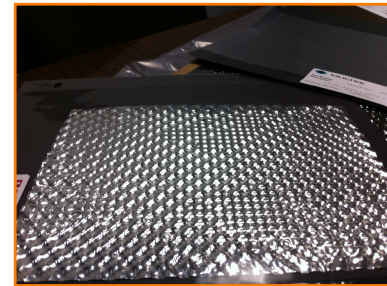


Metals and alloys

-GERDA, XENON, DARK SIDE-

Al-Mylar insulating foils

-XENON, DARK SIDE-



**CHALLENGE:**

*always better detection limits*

$10^{-15}$  g/g (ppq) in water samples

$10^{-11}$  g/g (ppt) in solid samples

## BUT ALSO:



University of  
L'Aquila

Traceability of the geographical origin of Italian saffron based on the mineral composition

27 samples from three different Italian regions:



*Crocus sativus*



Dried stigmas of  
*Crocus sativus*

Medio  
Campidano

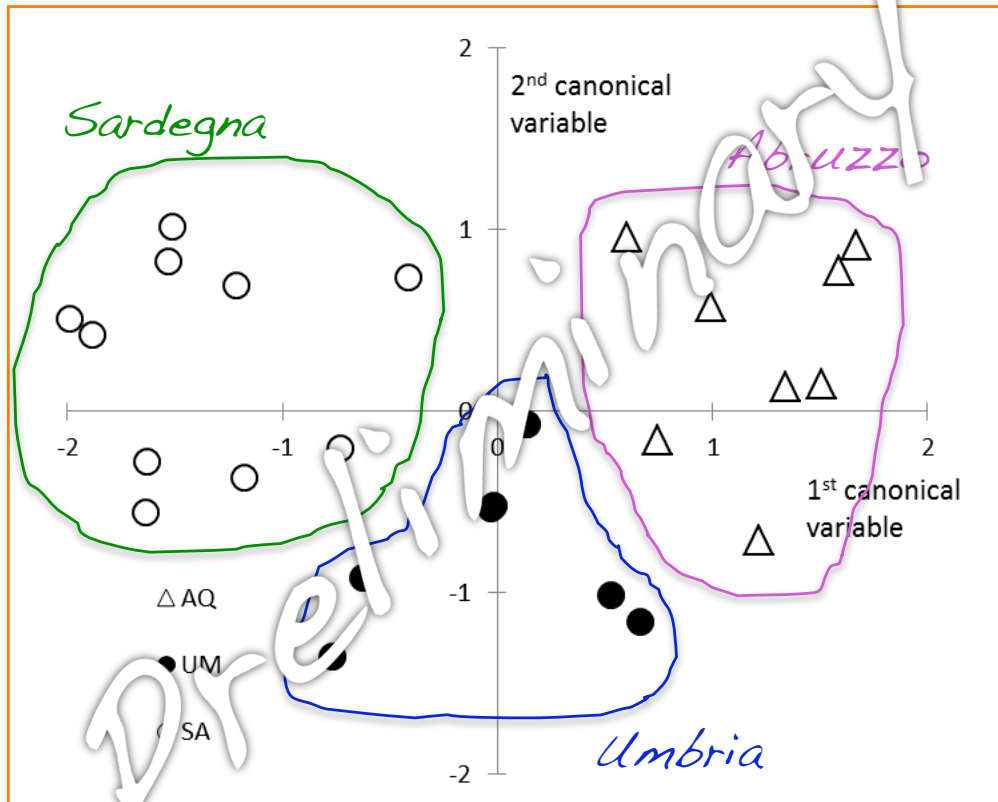


Perugia

L'Aquila

# Multivariate data analysis

Linear Discriminant Analysis (LDA) - program package PARVUS 2010



First rough discrimination



For a publication



Center for Excellence  
on Aging (CeSi)



Fondazione  
Università  
Gabriele d'Annunzio

Validation of a method for the  
quantitative multi-element  
profiling of brain tissues

Neurodegenerative  
diseases



Changes in brain levels of some elements, among them:

Li, Al, Cr, Co

Mouse brain  
and cerebellum



Highly complex  
biological matrices



Isobaric  
interferences and  
matrix effects

Complementary use of ICP QMS and HR ICP MS

Validation of a method for the trace element  
analysis of Li, Al, Cr, Co in brain tissue

Ciavardelli et al, "Characterization of element profile  
changes induced by long-term dietary supplementation  
of zinc in the brain and cerebellum of 3xTg-AD mice by  
alternated cool and normal plasma ICP MS",  
Metallomics, 2012

# Thanks to

*Domenico Ciavardelli*

*Ada Consalvo*

*Angelo D'Archivio*

*Angela Incani*

*Stefano Nisi*

*Chemistry Division @ LNGS*



*And you all for your attention!*