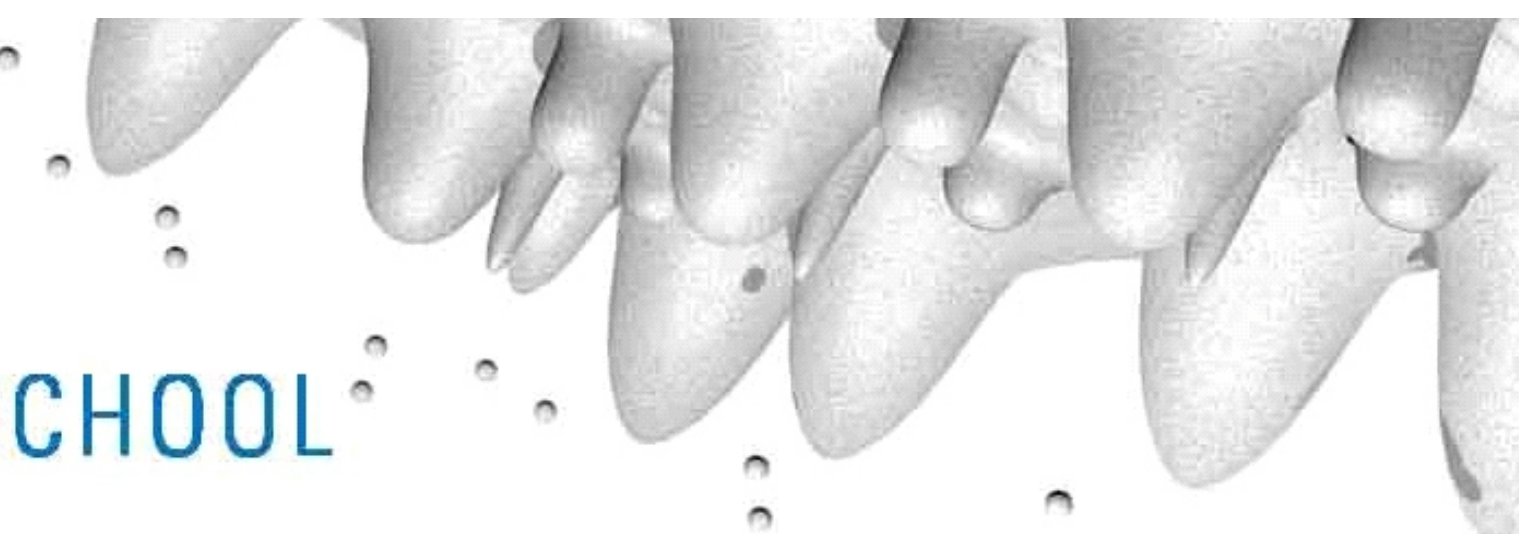




MEDNARODNA  
PODIPLOMSKA ŠOLA  
JOŽEFA STEFANA

JOŽEF STEFAN  
INTERNATIONAL  
POSTGRADUATE SCHOOL



DAVID JEZERŠEK, univ. dipl. met. in mat.  
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Jožef Stefan International Postgraduate School  
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# Ion Beam Analysis Methods

Rutherford  
Backscattering

Some ions are elastically recoiled back in the backward direction. By measuring them we can deconvolute depth elemental profiles of the target which they hit.

Elements detected: from He up  
analyzed depth: up to 10  $\mu\text{m}$

Secondary Electron Analysis

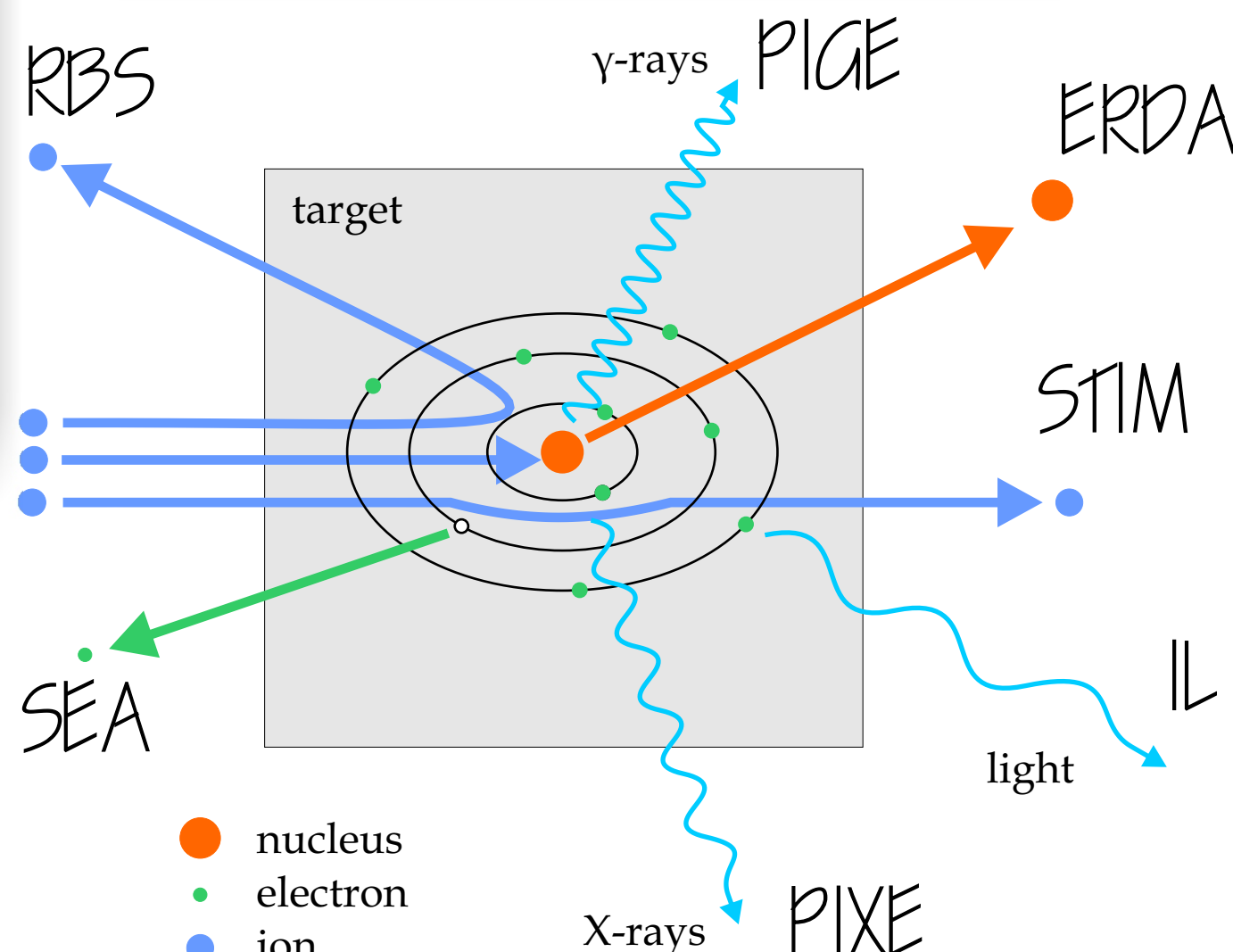
PIGE - Particle Induced Gamma-rays Emission  
When incoming high-energy ion hits the core of an atom it scatters inelastically. This event results in emission of characteristic high-energy photon in the gamma-ray region.

Elastic Recoil Detection Analysis

The incoming ion with a higher mass knocks out the lighter ion in the target. By a selective filter before the particle detector we measure just the light knocked-out ions. Measuring concentrations of hydrogen and deuterium is possible.

Scanning Transmission Ion Microscopy  
We measure depths of a sample by the loss of energy of incoming ions.

Ionoluminescence  
The color and intensity of visible light is measured. The light is induced by incoming ion beam.



The Periodic Table of the Elements

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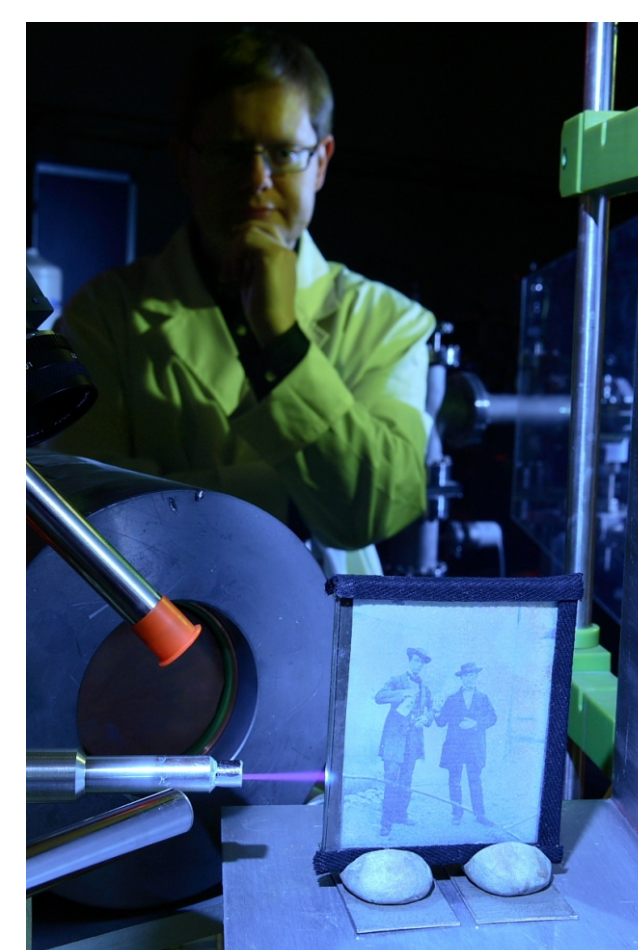
PIXE - Particle Induced X-rays Emission  
When inner-shell electron is kicked out of the orbital by an incoming high-energy ion, the outer-shell electron drops to the inner shell while emitting characteristic X-ray photon.

Elements detected: from Na (Z=11) up  
analyzed depth: ~20  $\mu\text{m}$   
detection threshold: ~10 ppm

NRA - Nuclear Reaction Analysis  
If the incoming ions have enough energy, they can induce the nuclear reaction which results in gamma ray (PIGE) or/and a released particle which we can measure.  
This technique excels with high sensitivity for light elements and features isotope resolution.

Use

archaeology and art

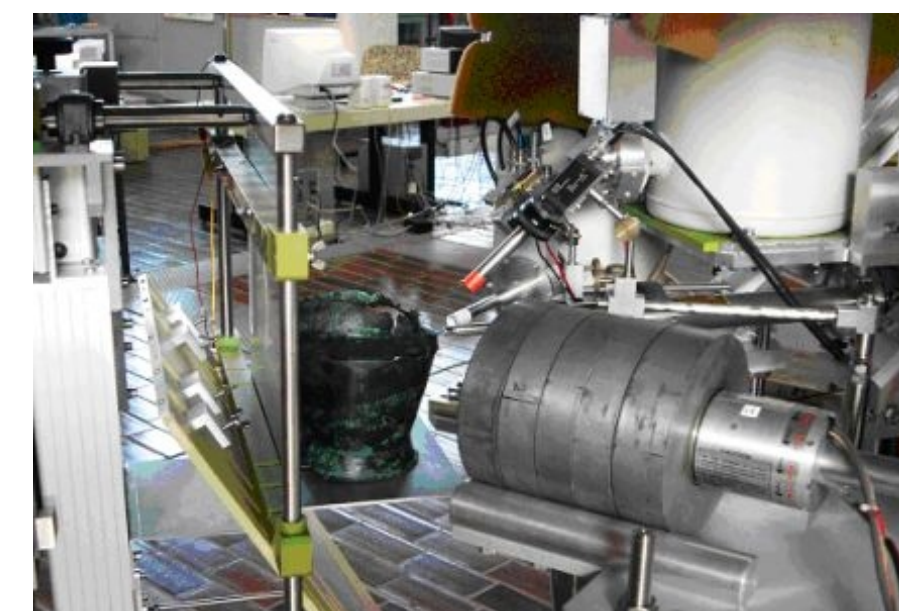


analysis of a photography on glass made by Janez Puhar

and



measuring of a secession glass vase



measuring of a bronze situla

biology and medicine

## Applications

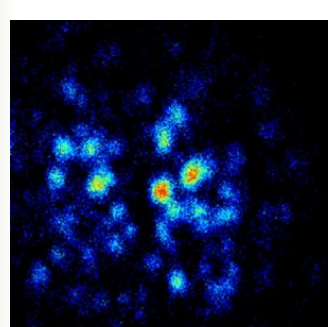
environment: aerosols  
sampling and measuring



Gent sampler in action



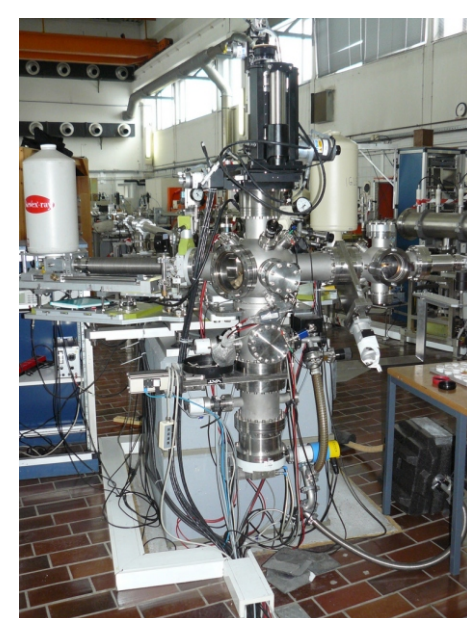
a sampling head



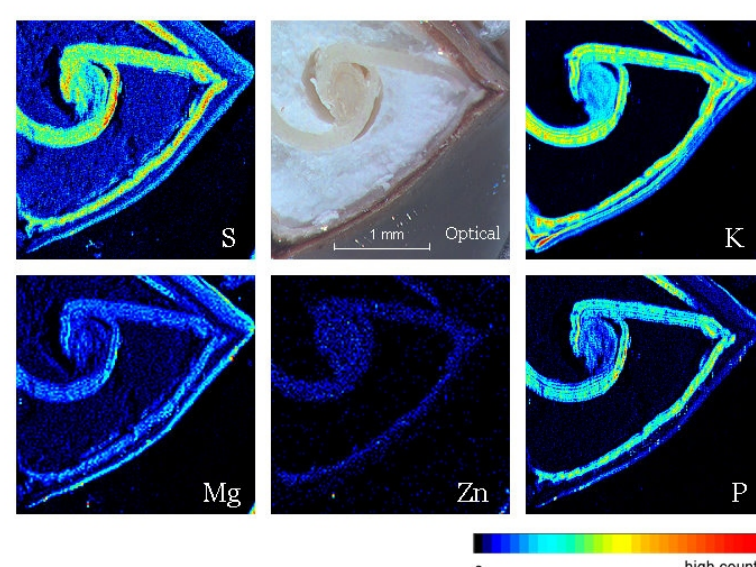
an elemental map  
of aerosol particles



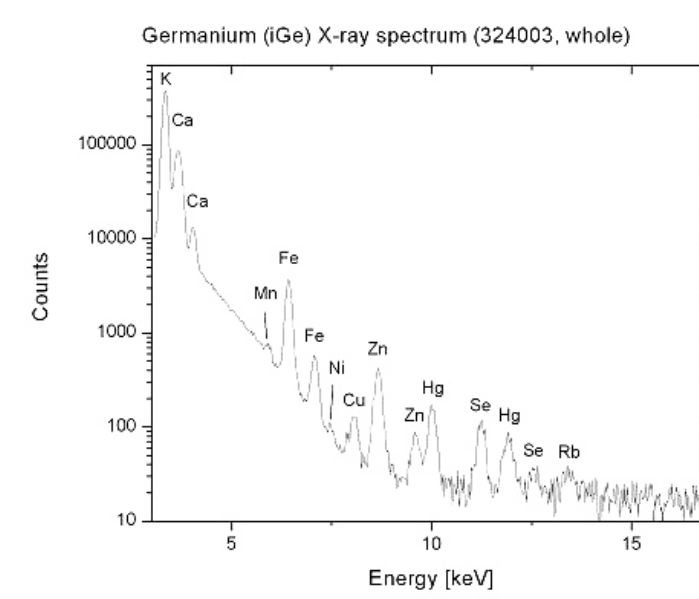
measurements were done  
for Luka Koper d.d.



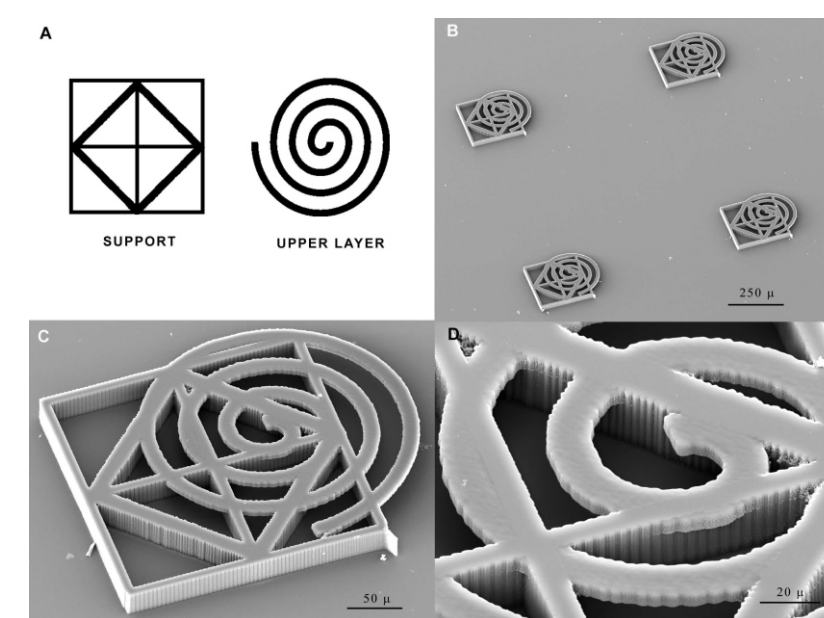
a microbeam  
experimental station



a buckwheat seed's elemental maps

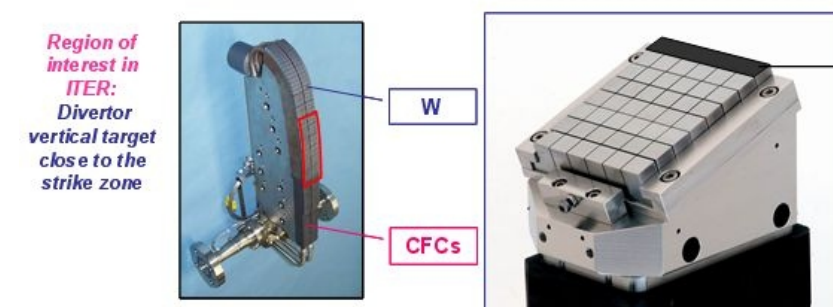


PIXE spectrum of a hypophysis  
tissue of the Hg-exposed person

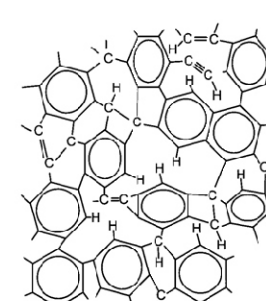


micro structures made with  
an ion beam lithography  
(Proton Beam Writing, PBW)

hydrogen/deuterium distribution in materials



distribution of deuterium penetrating the material  
of a divertor - critical part of a tokamak



Diamond-like carbon (DLC) coatings  
can be analyzed for hydrogen content

