APPLICATION OF ION BEAM AND RADIOCHEMICAL TECHNIQUES IN MATERIALS SCIENCE AND ENVIRONMENT

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Ion-Beam Analysis (IBA) techniques

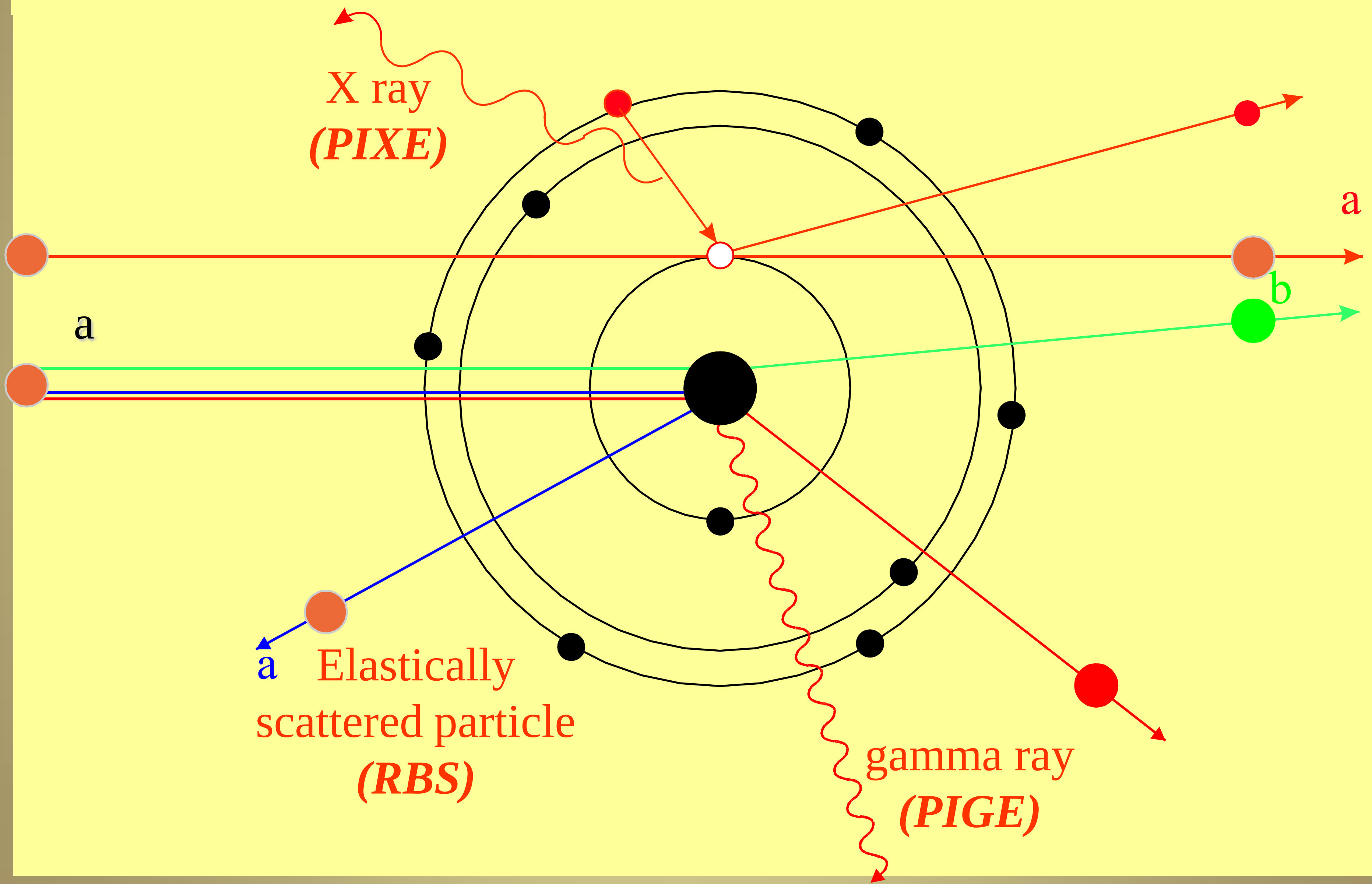
Our aim:

- the characterization of near surface layers of biomaterials in order to investigate their corrosion resistance and biocompatibility
- the characterization and the investigation of the oxidation and corrosion resistance of materials used for industrial applications.

The materials

- Ti-alloys (e.g. Ti-6Al-4V) and Co-based alloys (CoCrMo) used as orthopaedic, dental and cardiac implants
- stainless steels implanted with Al, Zr, Mg, Y for industrial applications
- Cu-alloys in environment and in cultural heritage

Ion Beam Analysis



A common biomaterial

Ti-6Al-4V

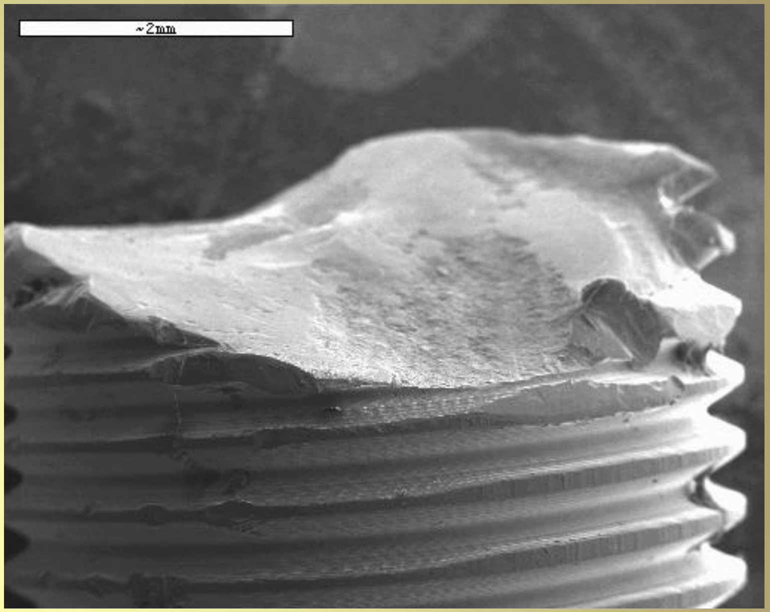
Advantages
biocompatibility, elasticity, corrosion resistance, low density

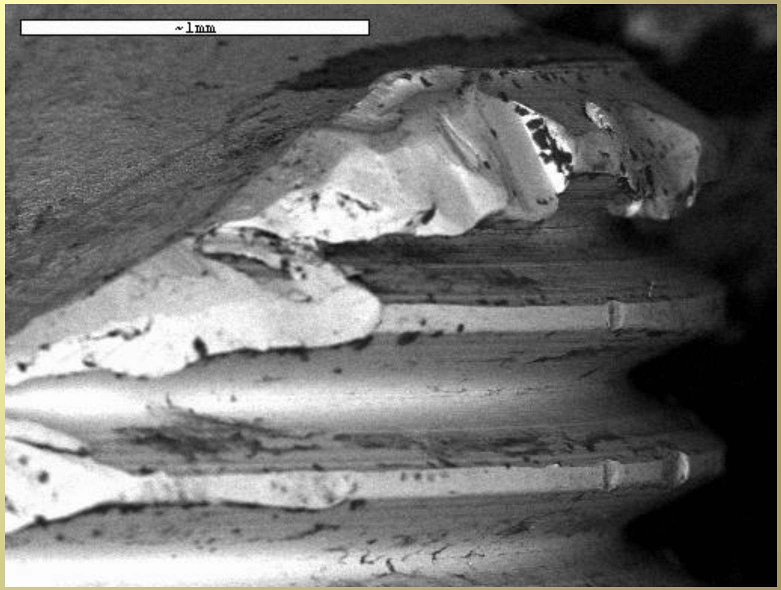
Disadvantages
friction, hardness, wear

Surface modification of the material

Ion implantation , plasma nitridation or oxidation

Coatings
SiC (ion beam sputtering) + Ion Beam Mixing, CVD, PVD



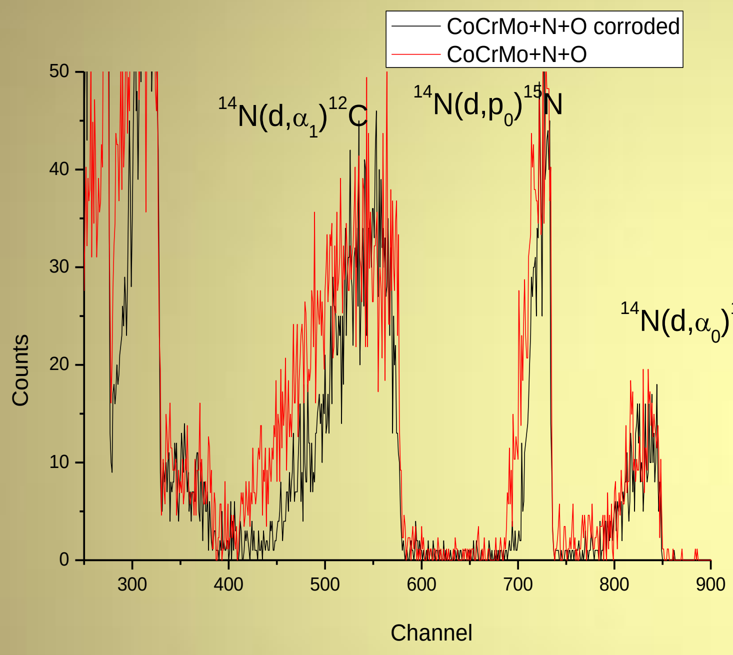


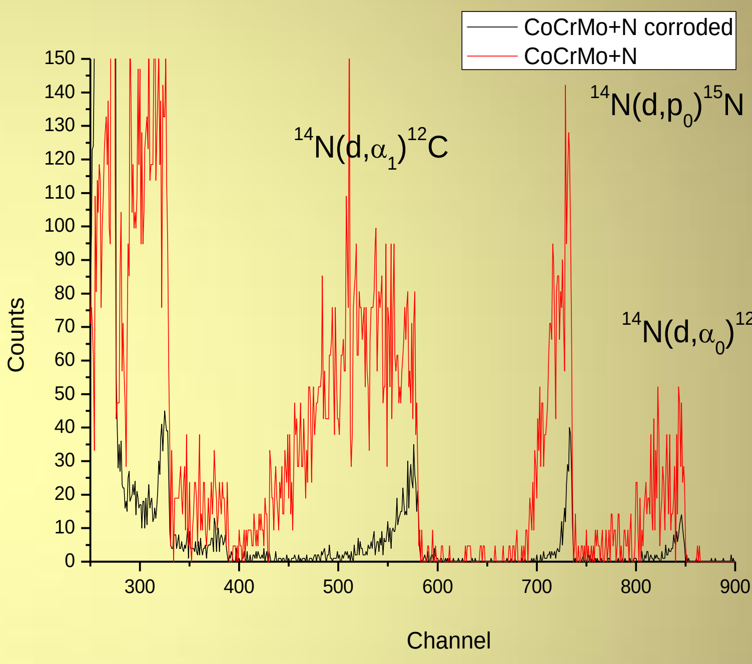
Sample	Treatment	T (^{o}C)	Thickness (μm)	Ti (%)	Ni (%)	N (%)	O (%)	N/Ti
TiNi0*	TiN	300	0.35	48	0	44	8	0.92
TiNi0-N	Nitridation + TiN coating	600-300	0.40	47	0	44	9	0.94
TiNi20	TiN-Ni coating	300	0.43	36	20	36	8	1.00
TiNi20-N	Nitridation + TiN coating	600-300	0.44	36	19	36	9	1.00

***0, 20 correspond to the Ni-content, N corresponds to the nitrided sample.**

Sample	Treatment	T (^{o}C)	Thickness (μm)	Co(%)	Cr (%)	Mo (%)	O (%)	N (%)
CoCrMo	reference	-	-	60	35	5	-	-
CoCrMo+N	Nitridation	395	4.6	40	20	6	-	34
CoCrMo+O	oxidation	400	0.3	54	20	2	34	-
CoCrMo+ N+O	Nitridation+ oxidation	395 and 400	6.0	40	20	2	15	23

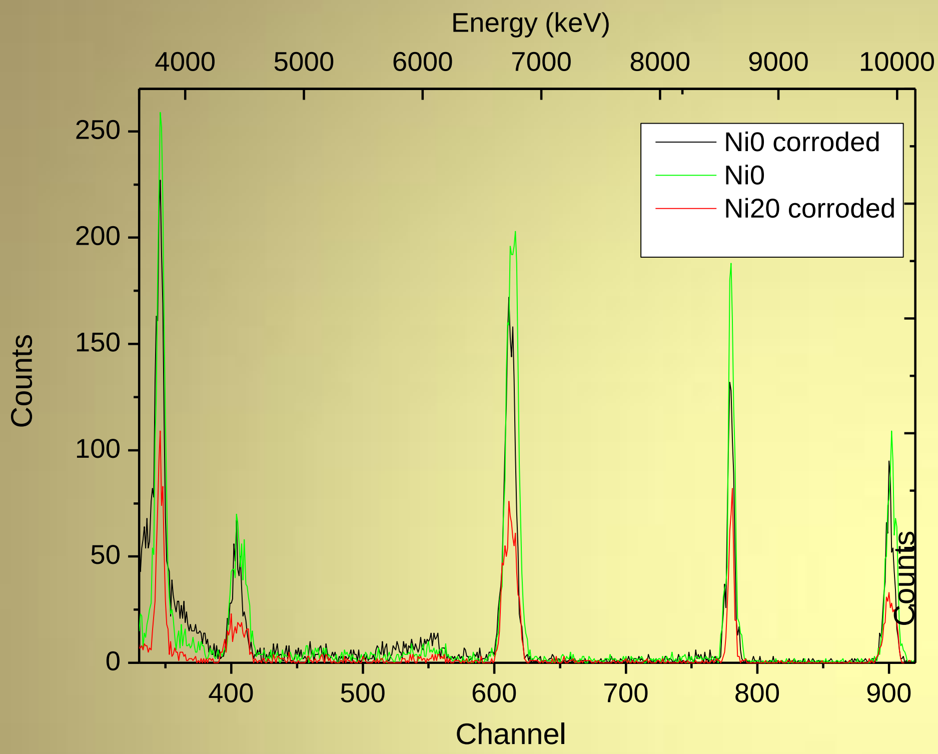
The samples were also investigated prior and after the corrosion tests by d-RBS and NRA (E_d = 1.35 MeV).



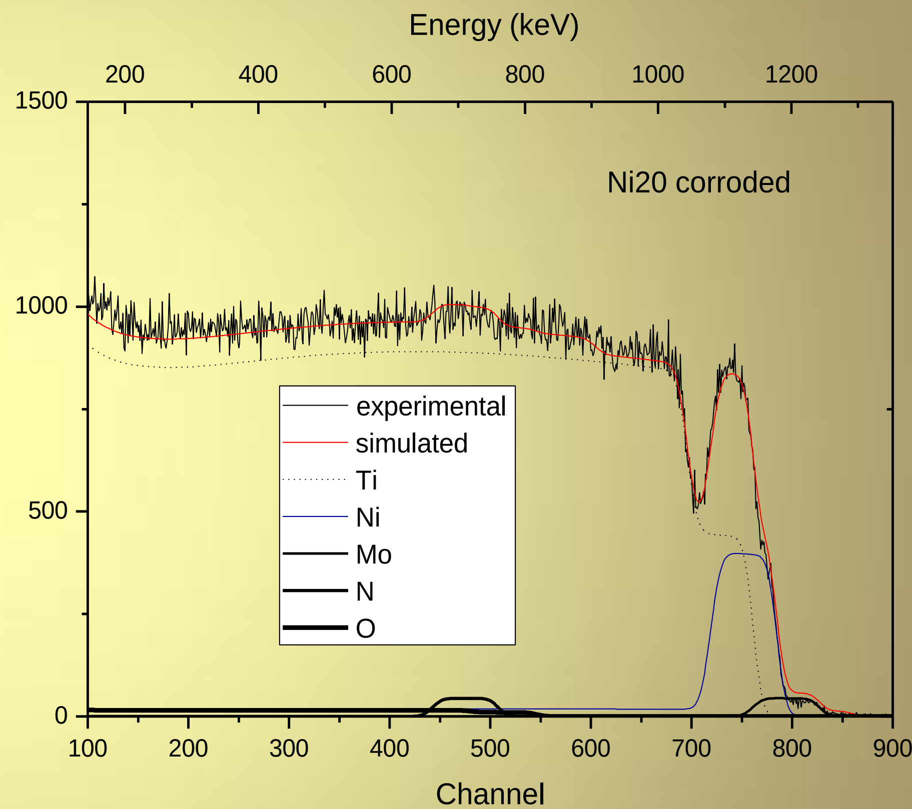


The NRA data also proved that the CoCrMo+N+O showed the lowest deterioration and the best corrosion resistance.

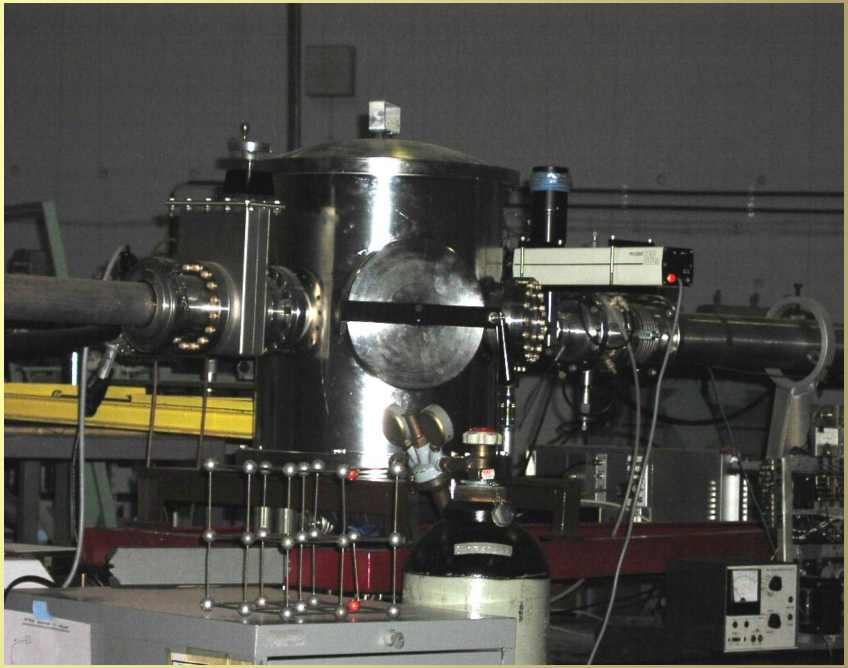
TiN-Ni nano-coating on TAV



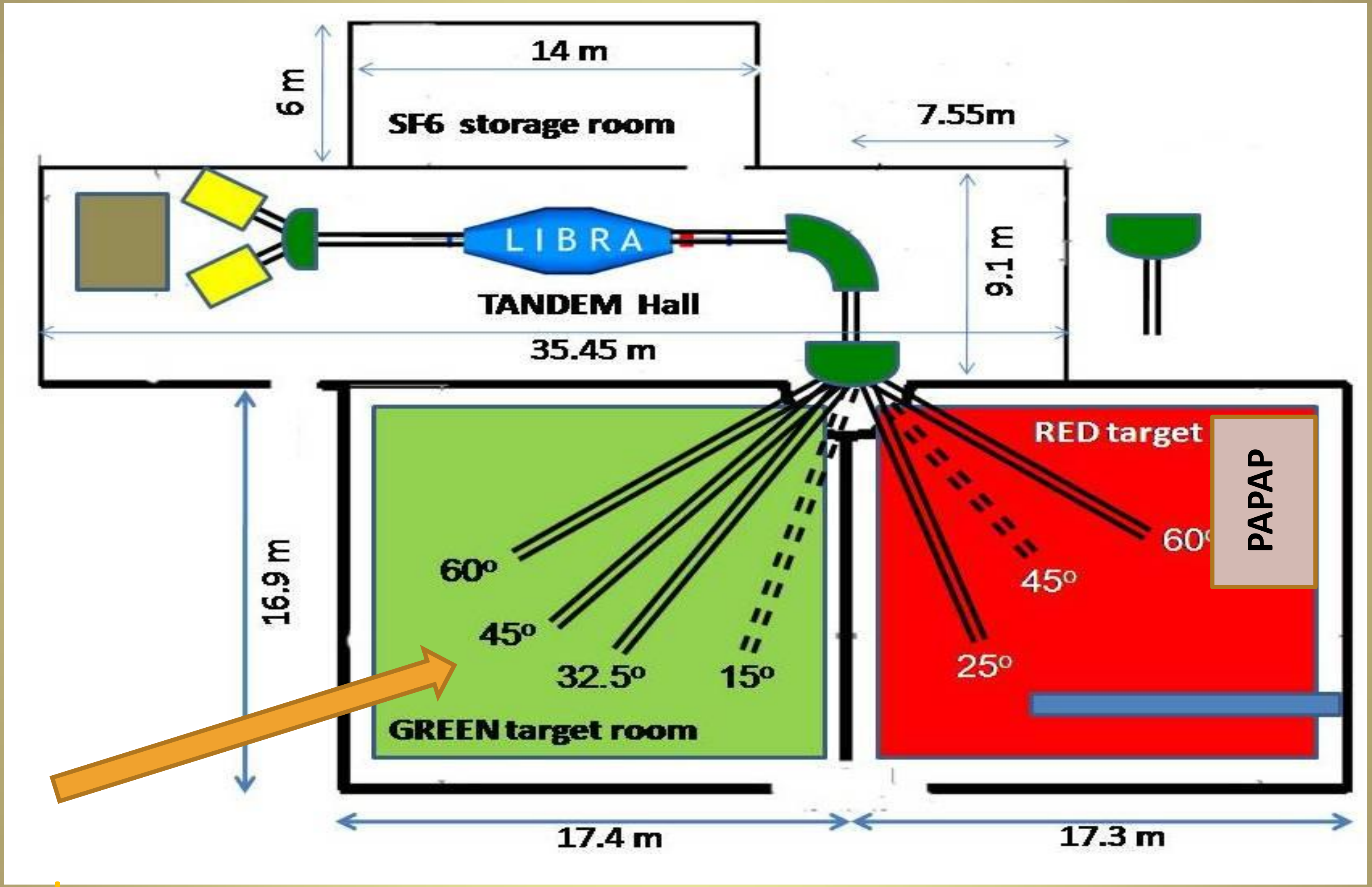
Nitrogen determination by NRA ($^{14}N(d,\alpha)$ and $^{14}N(d,p)$ nuclear reactions)



Rutherford Backscattering Spectrometry

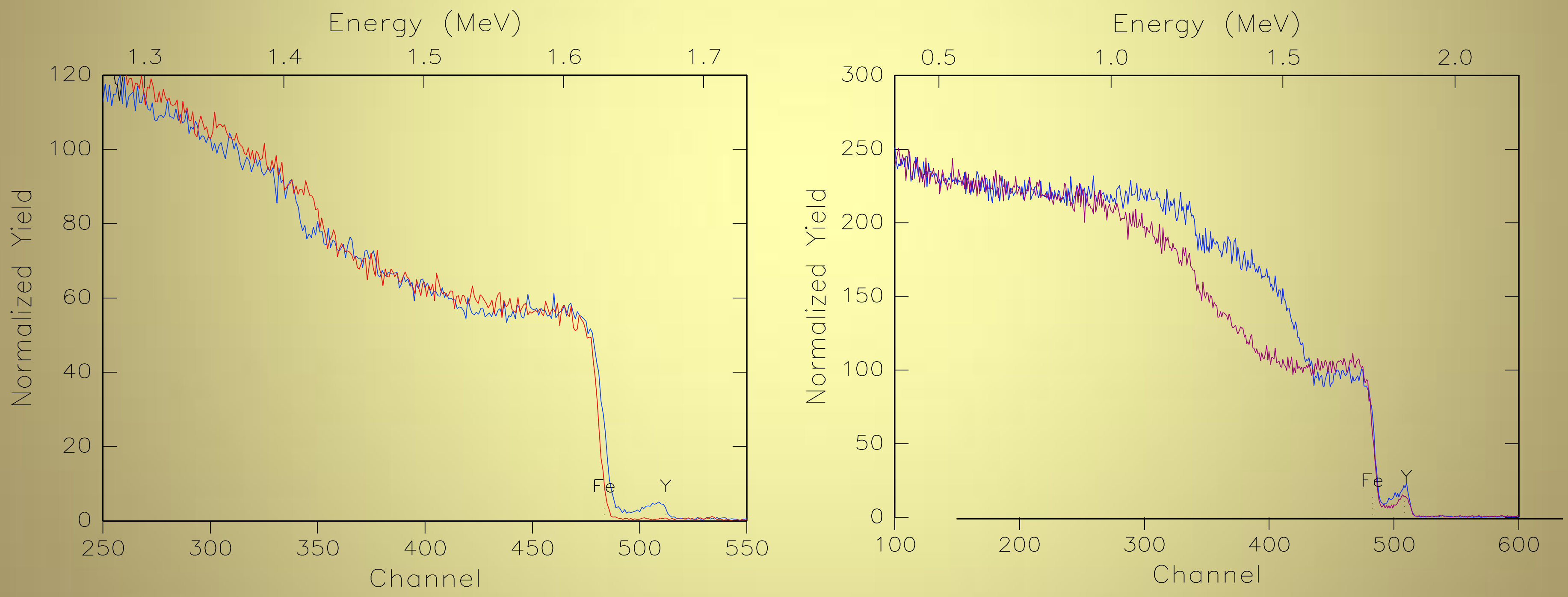


The H.V.E. 5.5 MV Tandem vdG accelerator of the NCSR *Demokritos* (Athens) and the utilized Charles Evans & Assoc. scattering chamber

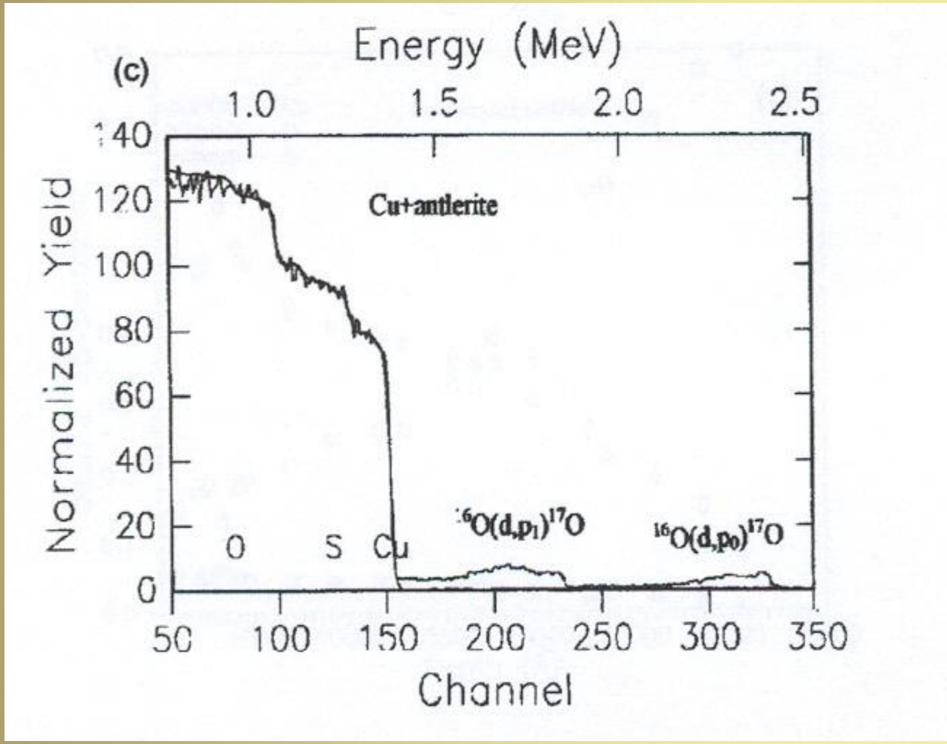


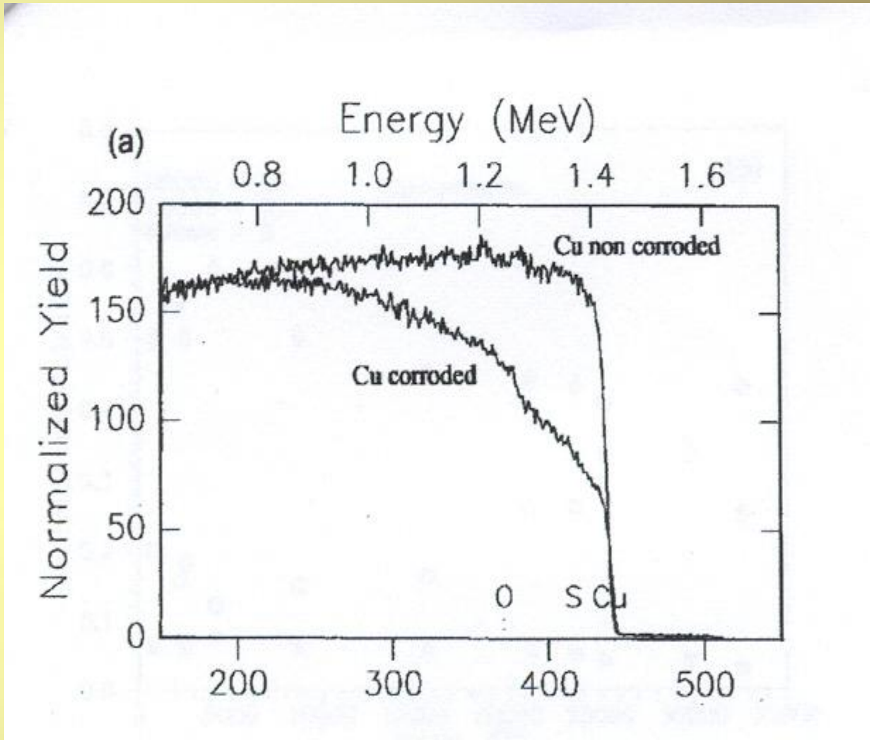
Microbeam
Line

RBS-spectra; a) Y-implanted steel (40keV) and non implanted steel oxidised at 900 ºC, b) Y-implanted steel (55 and 80 keV respectively) oxidised at 900 ºC



Application of RBS to Corrosion Studies

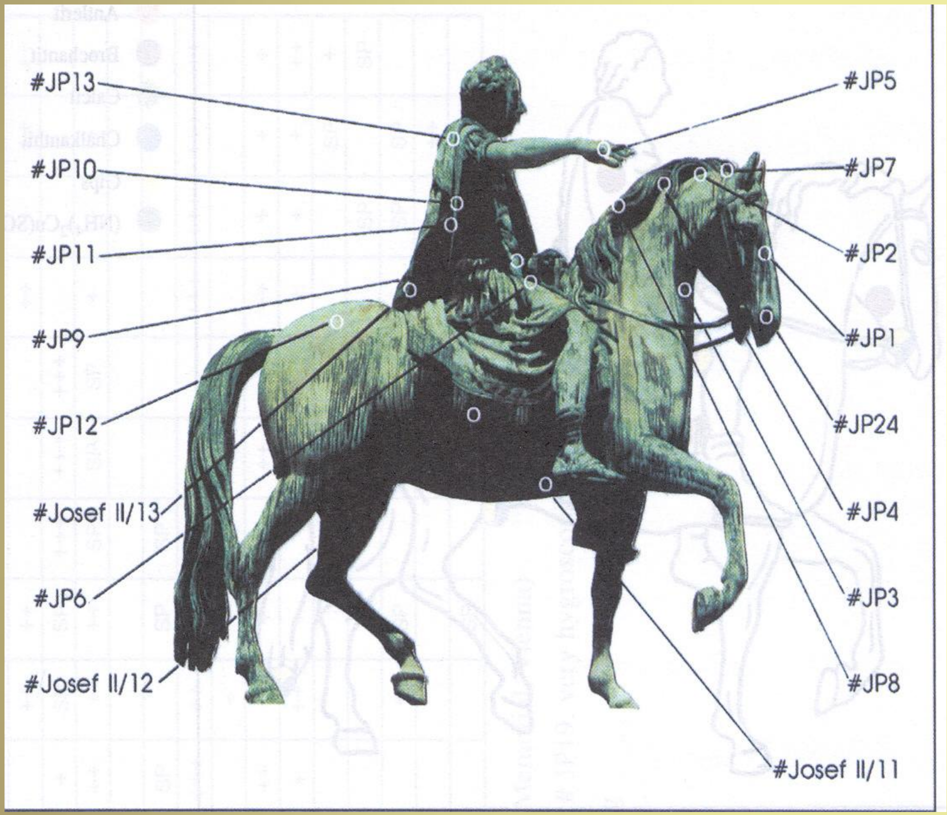




From:

F. Noli, P. Misaelides, A. Hatzidimitriou, E. Pavlidou and M. Kokkoris, Investigation of artificially produced and natural copper patina layers, J. Mat. Chem. 13(2003)114

Investigation of Cu-Patinas (natural and synthetic)

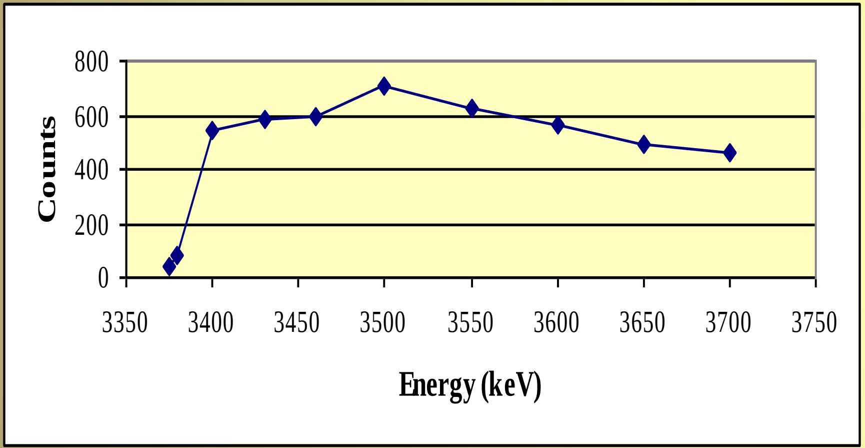


Work performed within the frame of the ENV4-CT95-0098 Project

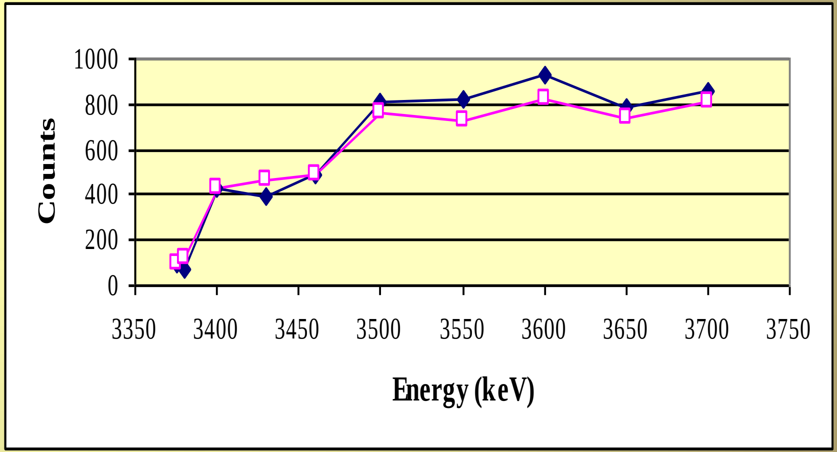
Sulfur distribution in patina layer determined by means of $^{32}S(p,p'\gamma)^{32}S$ nuclear reaction

(E_{res} = 3716 keV, E_{γ} = 2230 keV, $d\sigma(E, 90^o)\Gamma/d\Omega$) = 48.10 mb/sr from C. Tsartsarakos, P. Misaelides and A. Katsanos, Nucl. Instr. and Meth. B45(1990)33)

Natural patina (Vienna Hofburg)



Corroded (♦) and non-corroded (□) mixed patina consisting of antlerite ($CuSO_4.2Cu(OH)_2$) + brochantite ($CuSO_4.3Cu(OH)_2$) + chalcanthite ($CuSO_4.5H_2O$)



From

F. Noli, P. Misaelides, M. Kokkoris, Investigation of natural and artificially produced copper patina layers using ion-beam analysis techniques, Proc. of the Nuclear and Related Techniques Conference, La Habana, Cuba, October 2003

• Radiochemical techniques

Our aim:

- **measurement of the natural radioactivity using γ-ray sectroscopy**
- **determination of alpha-emmiters (radionuclides: U-238, U-235, U-234, Ra-226, Ra-224) using α-ray sectroscopy**

The materials

-Environmental samples (waters, soils, sediments, air filters etc.)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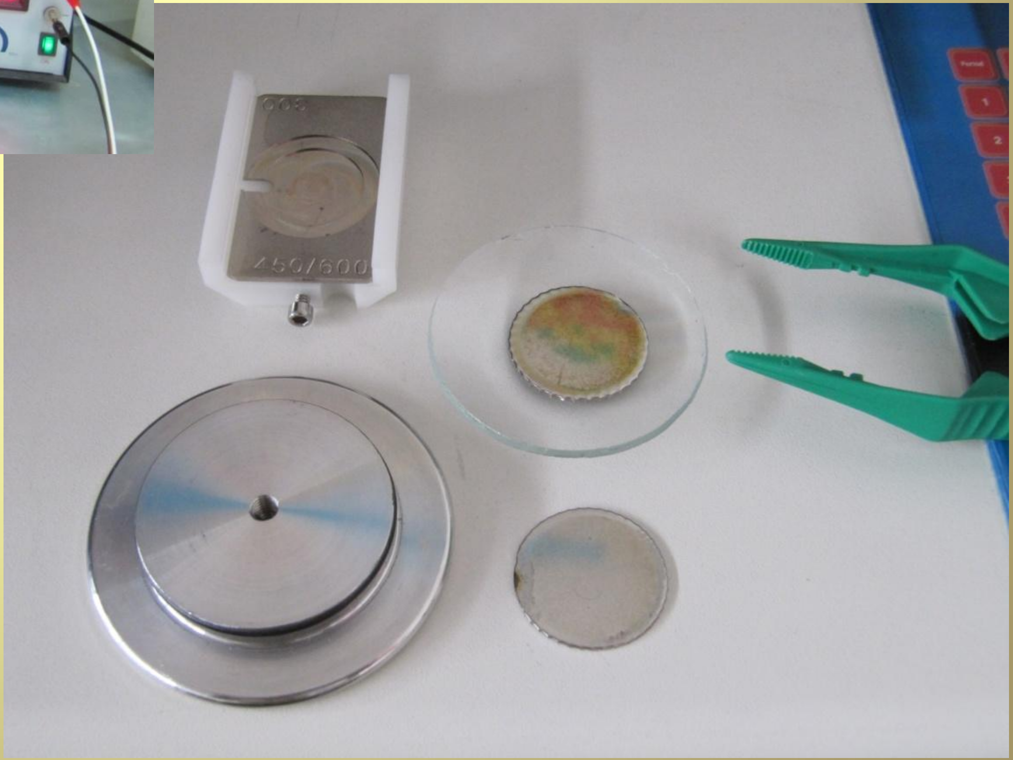
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SPECTROSCOPY AMPLIFIER
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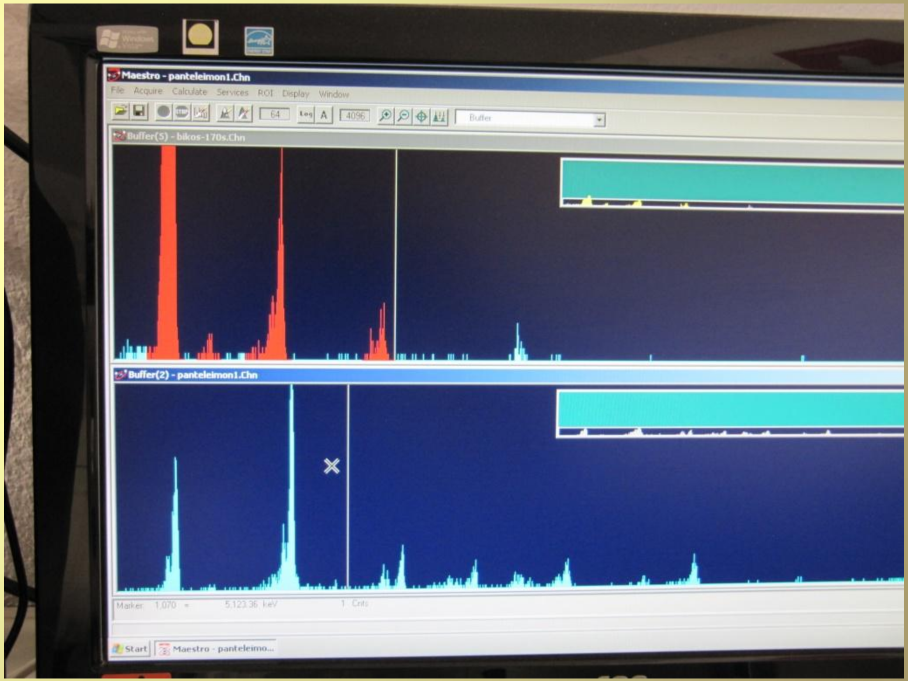
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