Mexican Nuclear Research Institute

Characterization of Materials Using Accelerators

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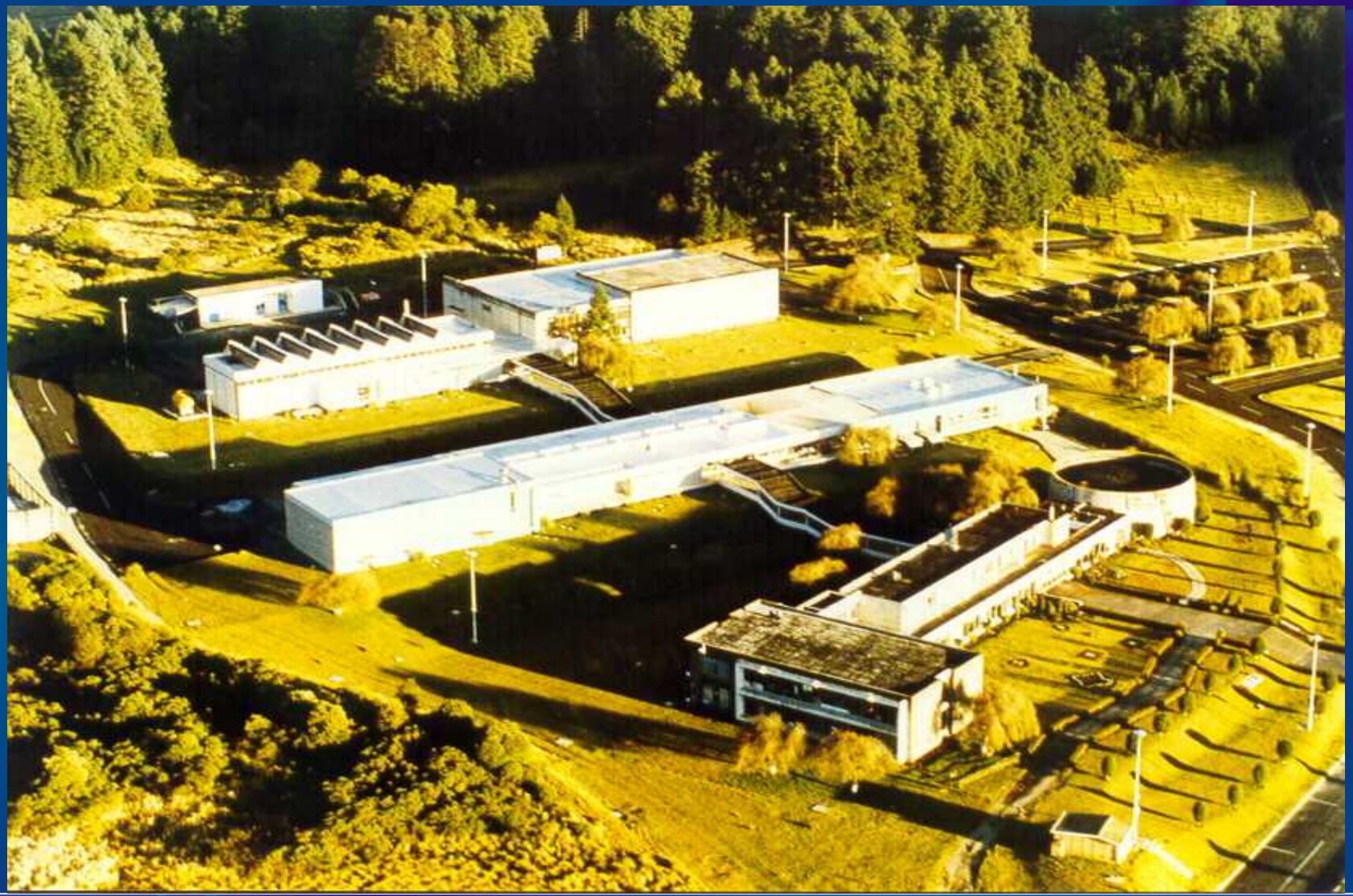
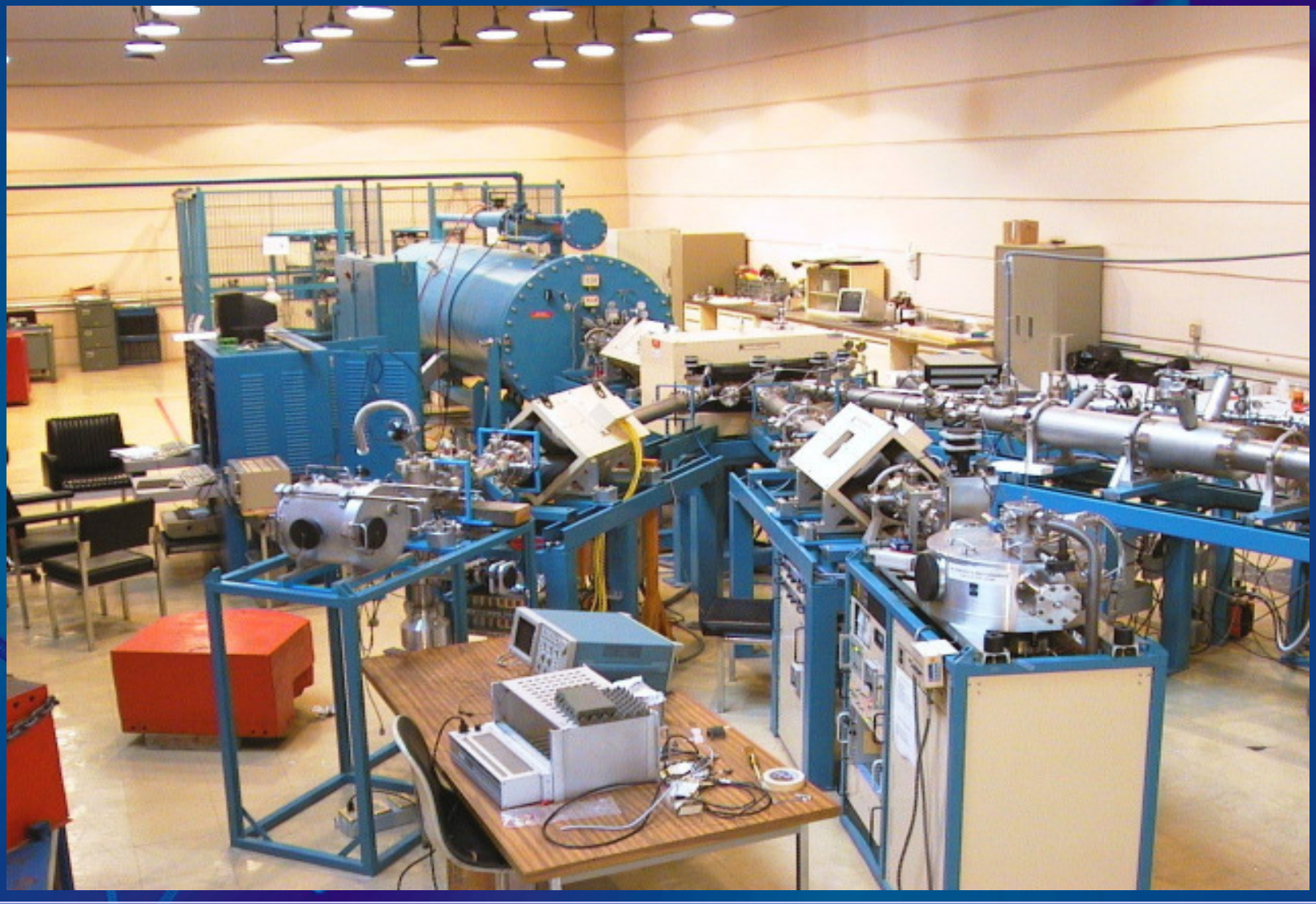
Mexican Nuclear Research Institute



Physics Institute UNAM



Tandem Van de Graaff 6 MV Laboratory (LAT)

Nuclear techniques at ININ

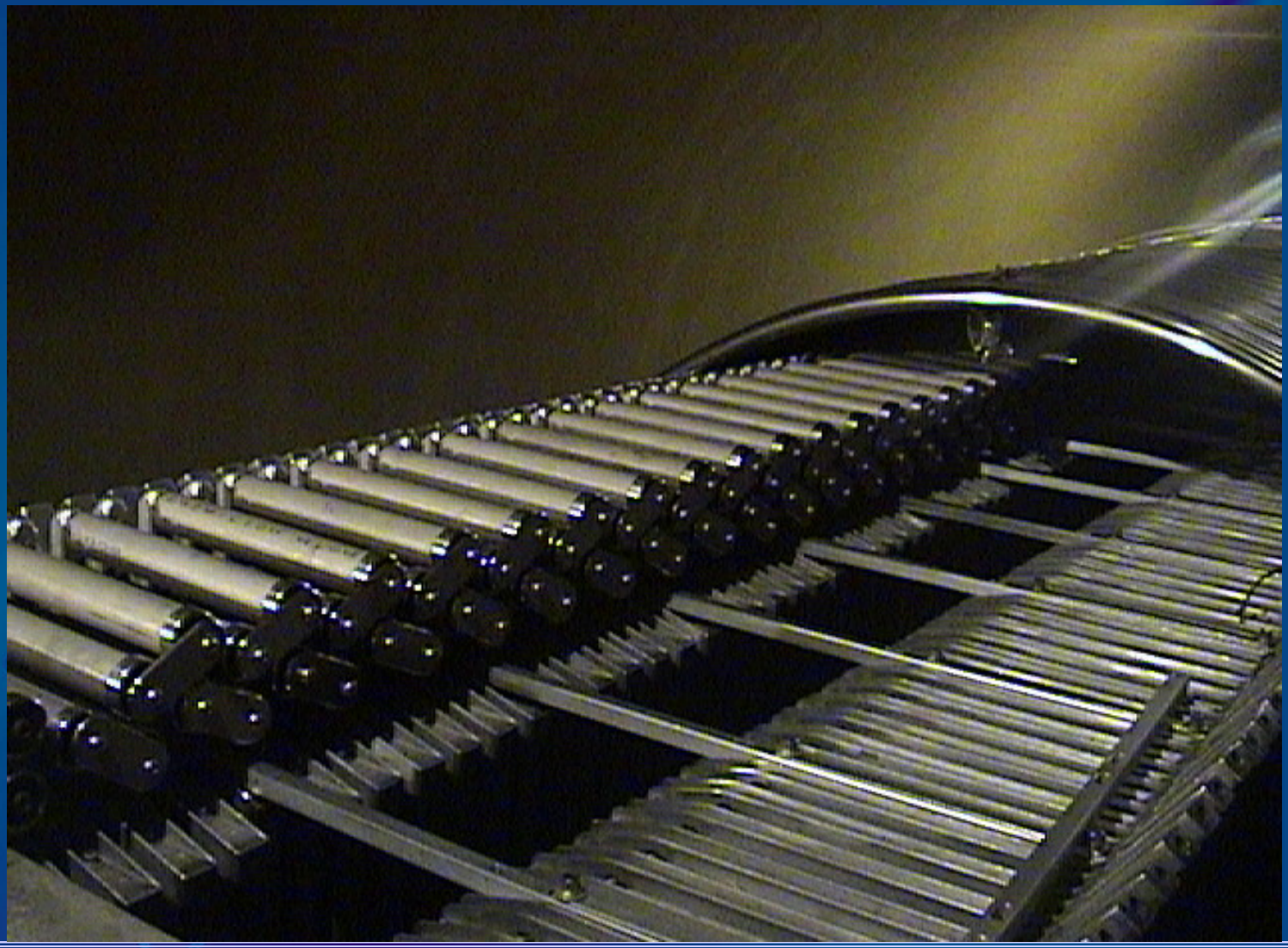
- PIXE : **Proton Induced X-ray Emission**
- DIXE: **Deuteron Induced X-ray Emission**
- PIGE: **Proton Induced γ-ray Emission**
- RBS: **Rutherford Backscattering**
- NRA: **Nuclear Reaction Analysis**
- NFS: **Neutron Fast Spectroscopy**
- ERDA: **Elastic Recoil Detection Analysis**
- EFA: **Elastic Forward Analysis**

Ion sources and Tandem Van de Graaff 6 MV (EN)

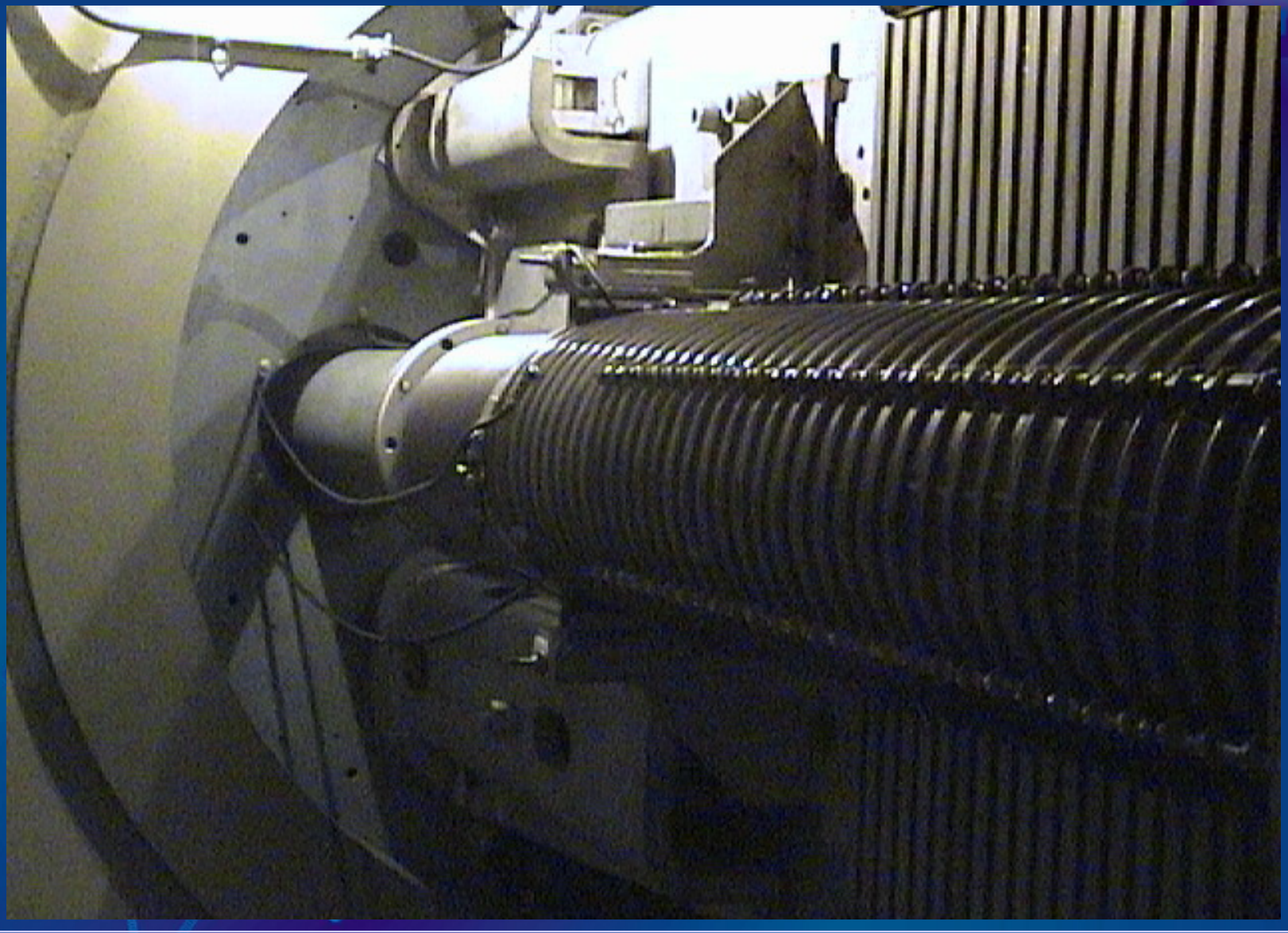
Inside view of accelerator's tank

Equipment for the accelerator

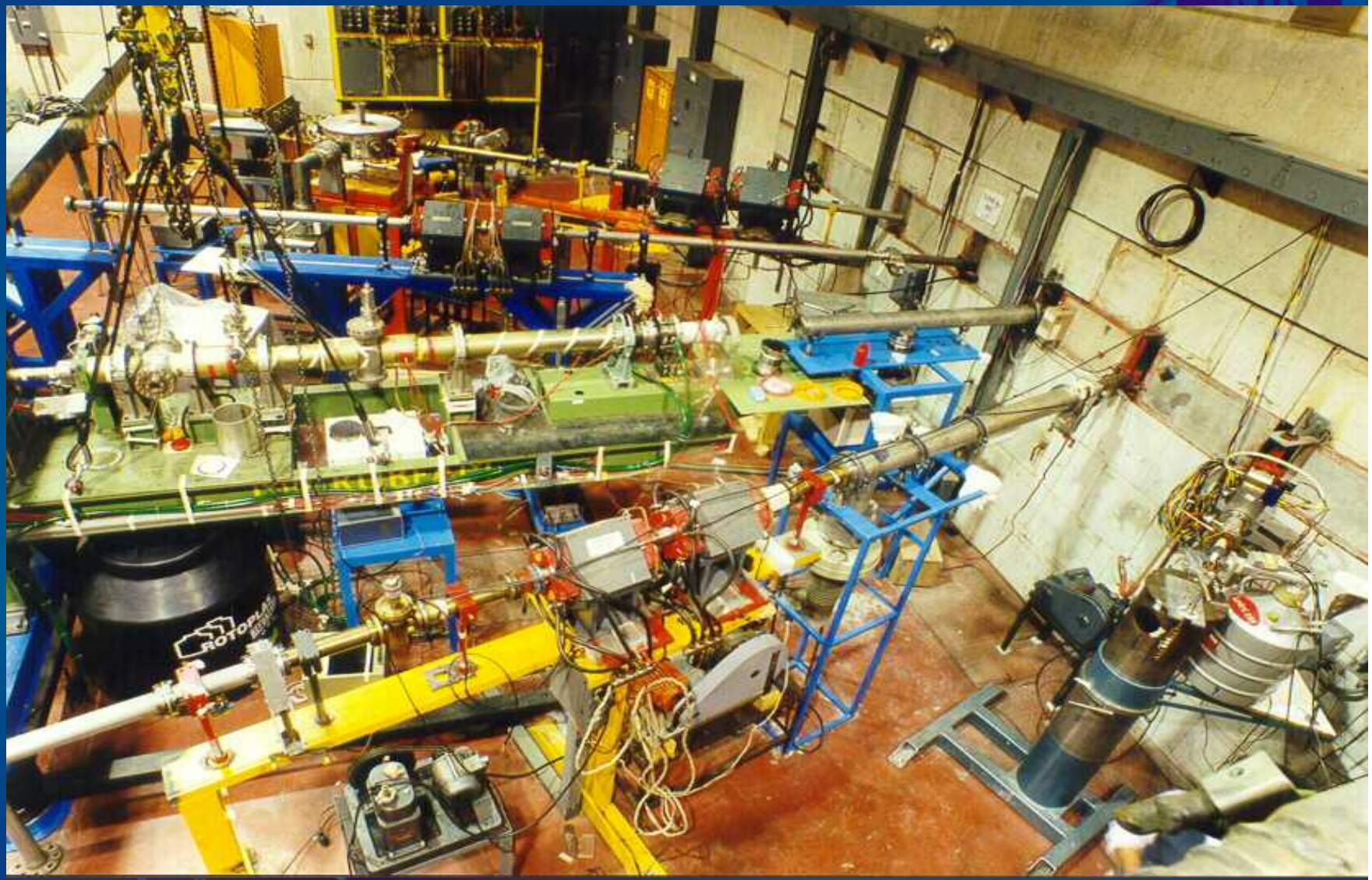
New resistors



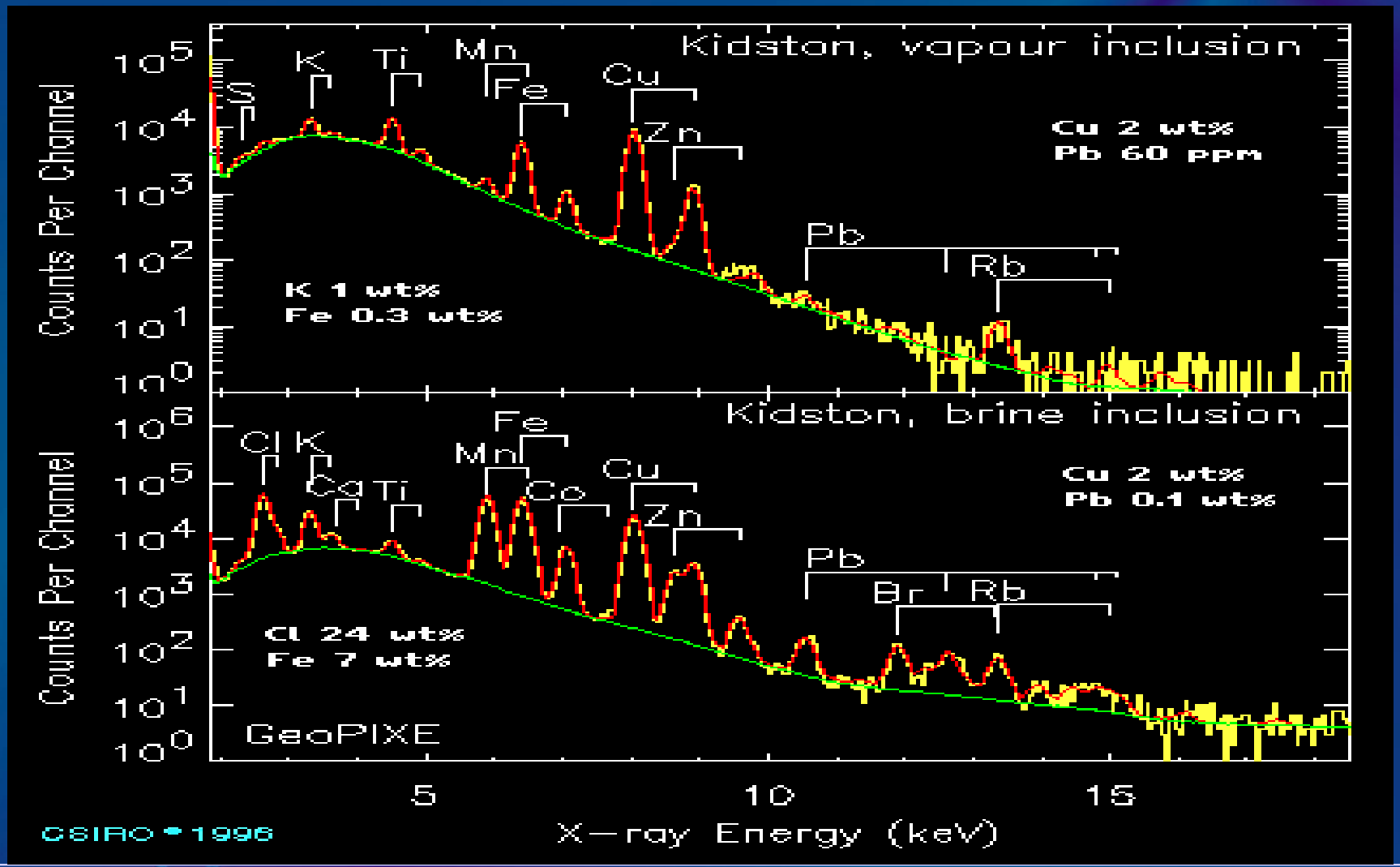
New accelerator's tubes



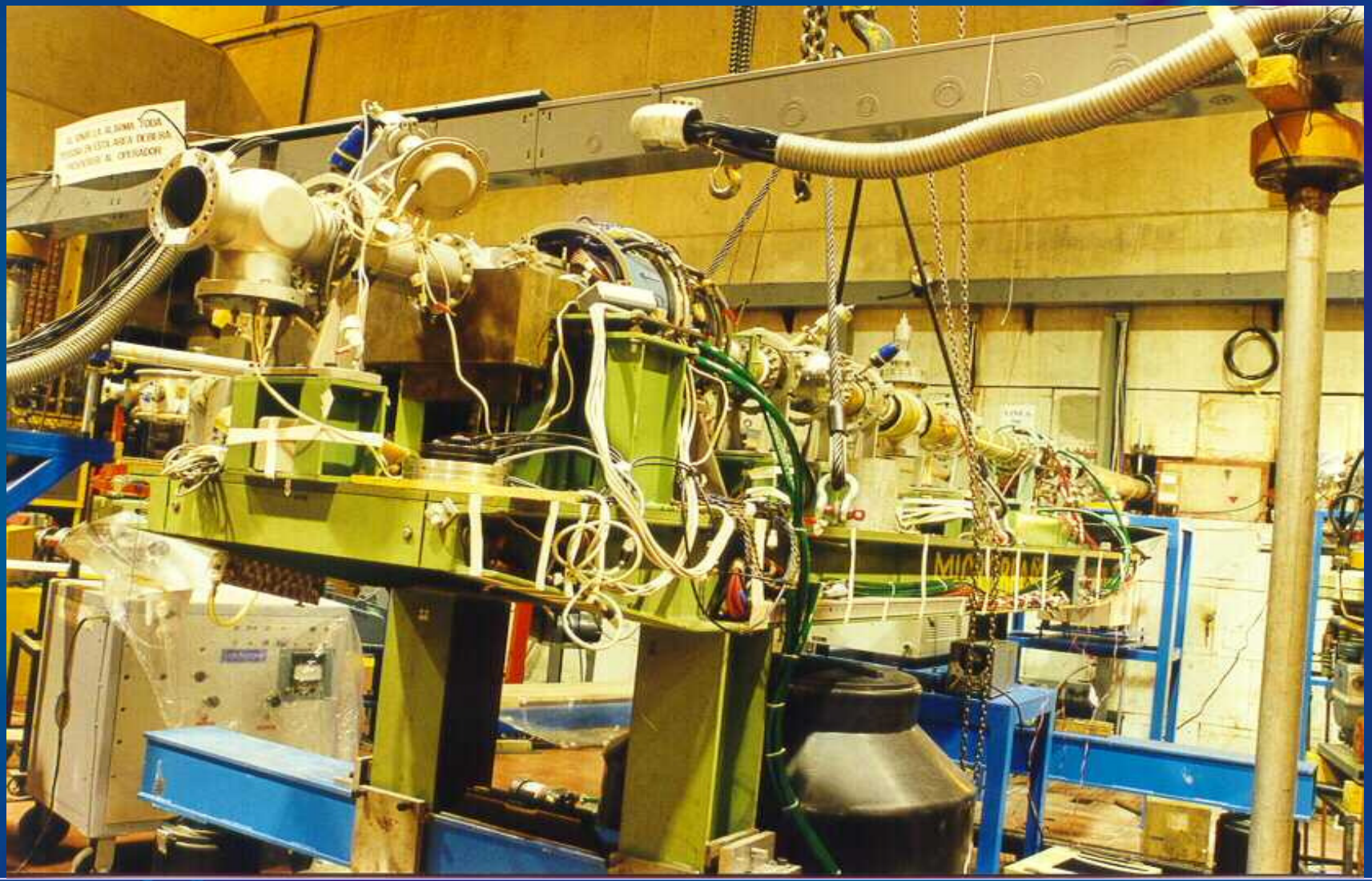
Experimental room (5 lines)



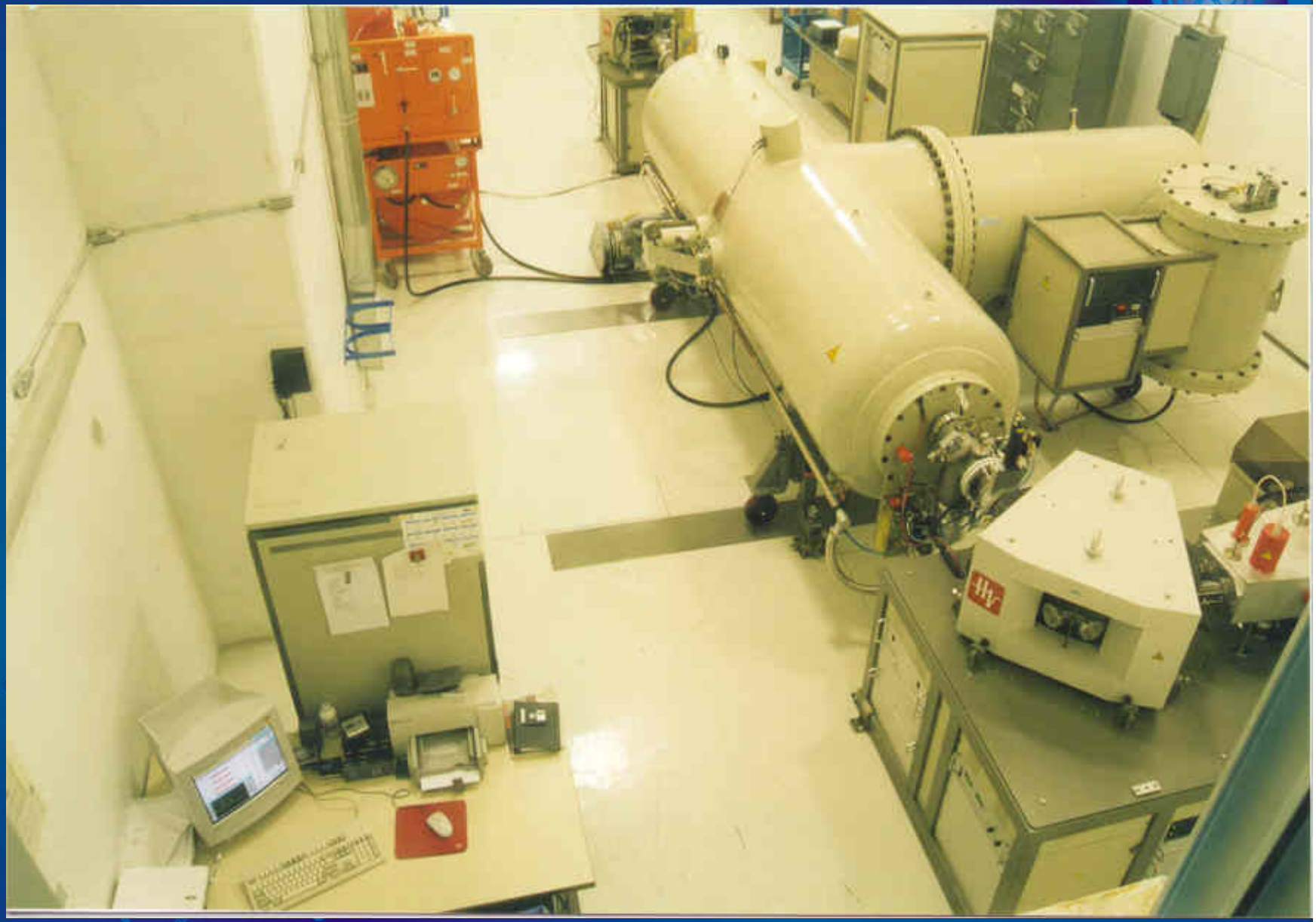
Typical PIXE spectrum



Microbeam System



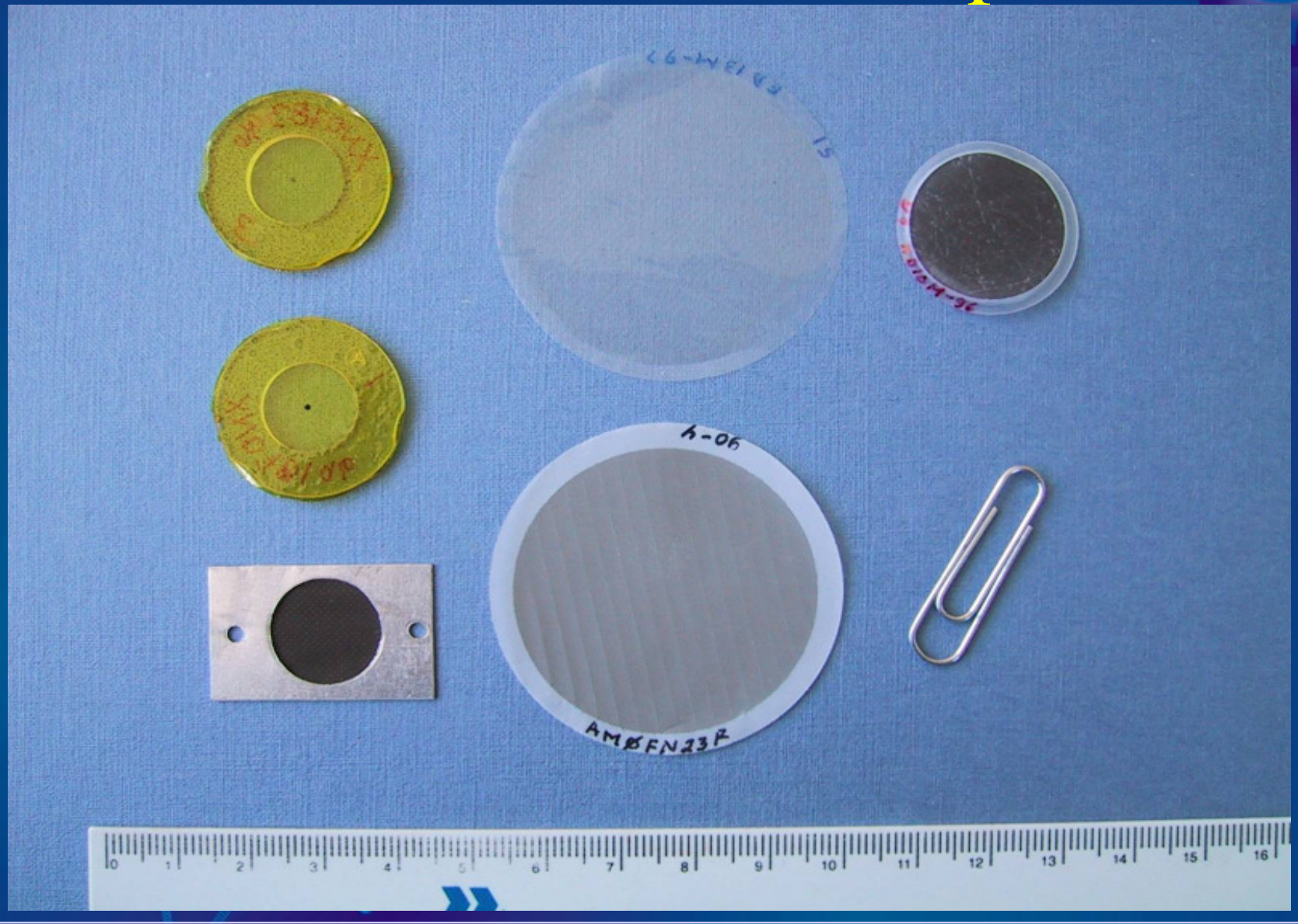
ININ Tandetron Accelerator



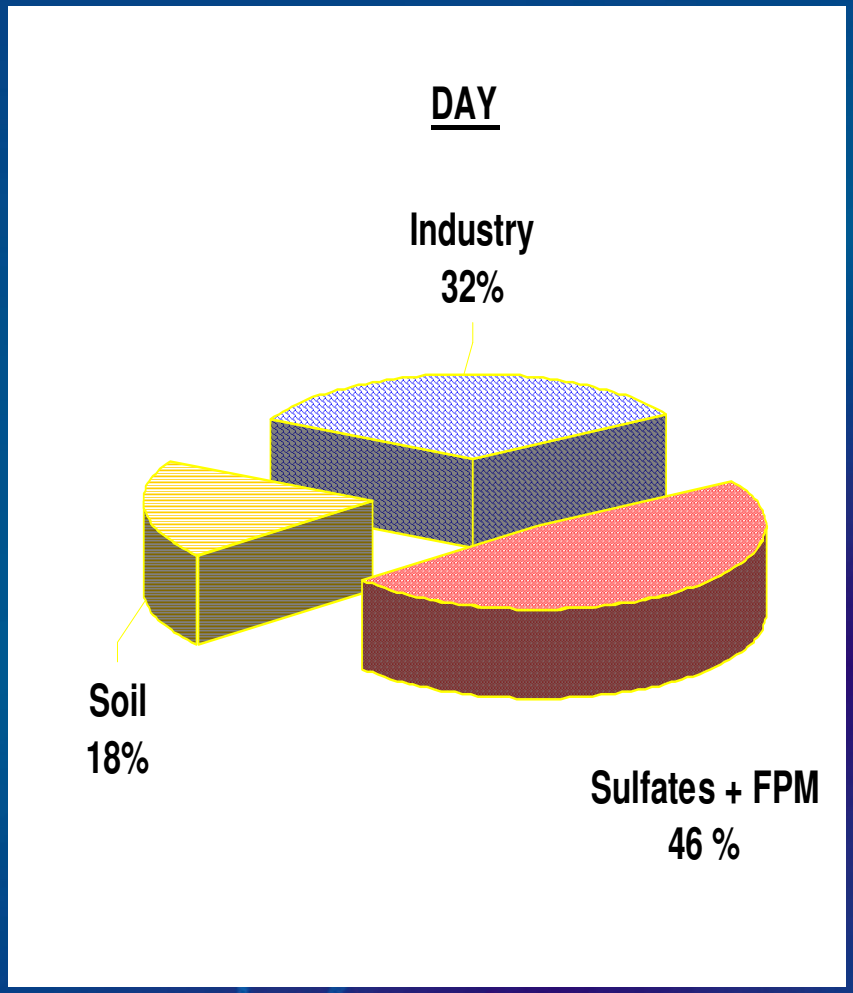
X- Ray Detection System

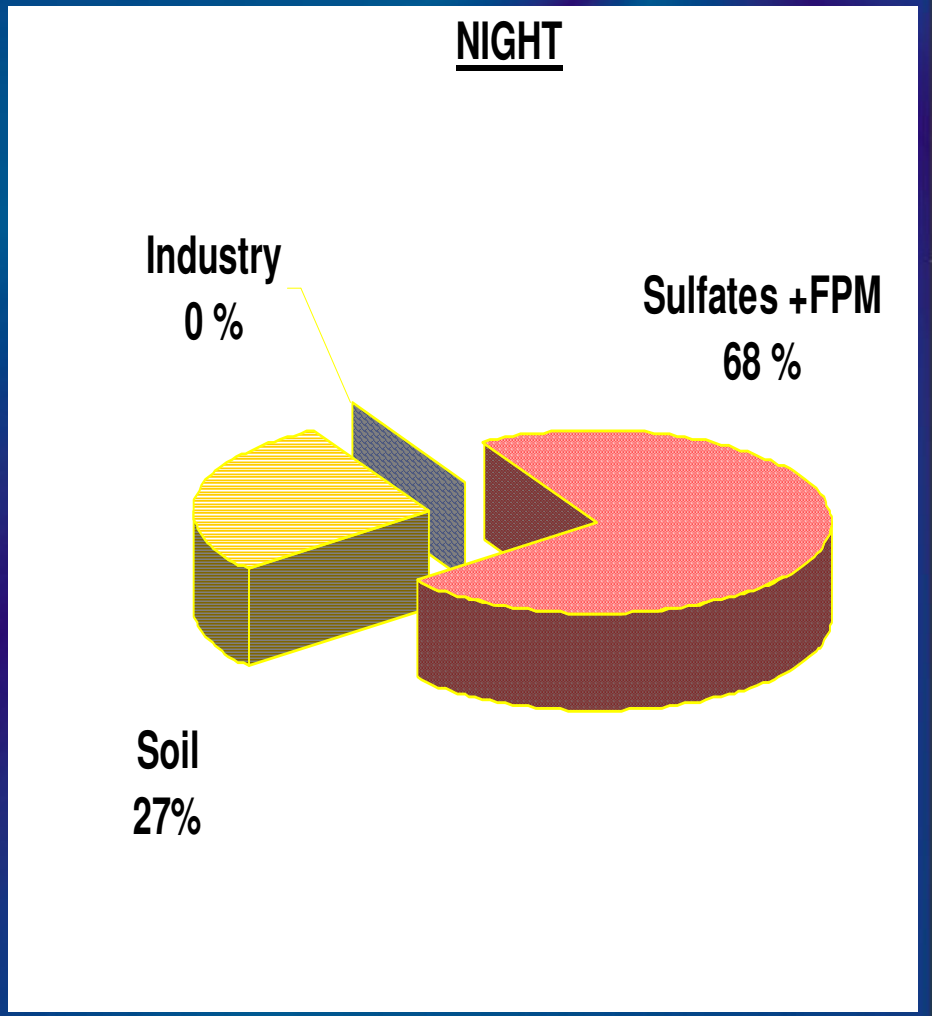
Airbone particles Collectors

Airborne Particles Sample17



Sources of Pollutants to the Atmosphere





PIXE Analysis

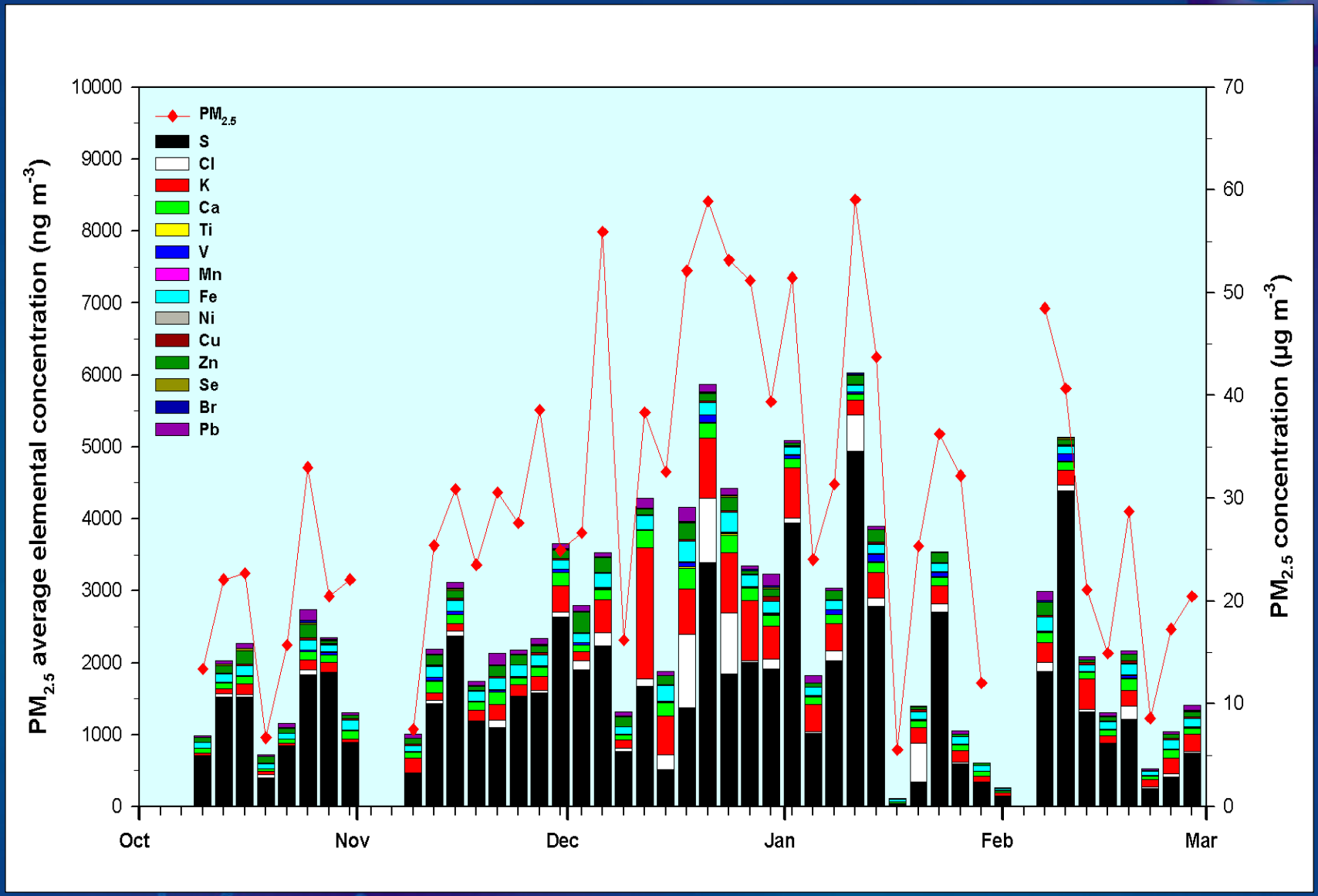
	DRY-COLD SEASON				RAINY SEASON			
	N	**Min**	**Max**	**Mean**	**N**	**Min**	**Max**	**Mean**
SO_2	49	0.0016	0.0584	1.56E-02	48	0	0.02	8.90E-03
CO	47	0.7	3.2792	1.997434	49	0.6	2.6	1.4653
NO_X	51	0.0415	0.1799	0.100754	47	0.01	0.13	5.53E-02
NO_2	51	0.0205	0.082	4.81E-02	48	0.02	0.07	3.74E-02
FPM	51	7	59	30	49	11	40	21
S	51	252	4937	1598	49	418	2376	1132
C1	46	12	1022	152				
K	51	37	1824	287	49	46	750	135
Ca	51	38	289	122	49	40	927	113
Ti	48	3.7	26	9				
Mn	47	1.6	14	5	47	0	16	6
Fe	51	64	284	133	49	41	577	132
Cu	50	2.2	74	20	49	2	135	27
Zn	51	10	285	108	49	28	484	140
Pb	48	22	196	68	47	18	126	54

Number of appearances (N), minimum and maximum values detectd (min/max) in ng/m3 and mean value.

Mean Source Contribution to each Variable for the Dry-Cold Season

Variable	Automotive	Road Dust	Sulphates	Small Industry
SO_2	35.04	0.00	64.96	0.00
CO	89.89	0.00	0.00	10.11
NO_x	73.68	8.62	4.93	12.77
NO_2	67.65	12.13	10.44	9.78
FPM	44.88	24.45	30.68	0.00
S	15.81	15.90	68.29	0.00
Cl	0.00	109.85	55.00	-64.86
K	127.16	30.79	0.00	-57.95
Ca	59.84	30.63	9.54	0.00
Ti	60.67	39.33	0.00	0.00
Mn	22.21	62.17	0.00	15.62
Fe	53.15	35.94	3.49	7.41
Cu	0.00	0.00	0.00	100.0
Zn	0.00	47.78	12.38	39.84
Pb	7.31	31.72	19.78	41.19

Elemental concentration for particles PM2.5

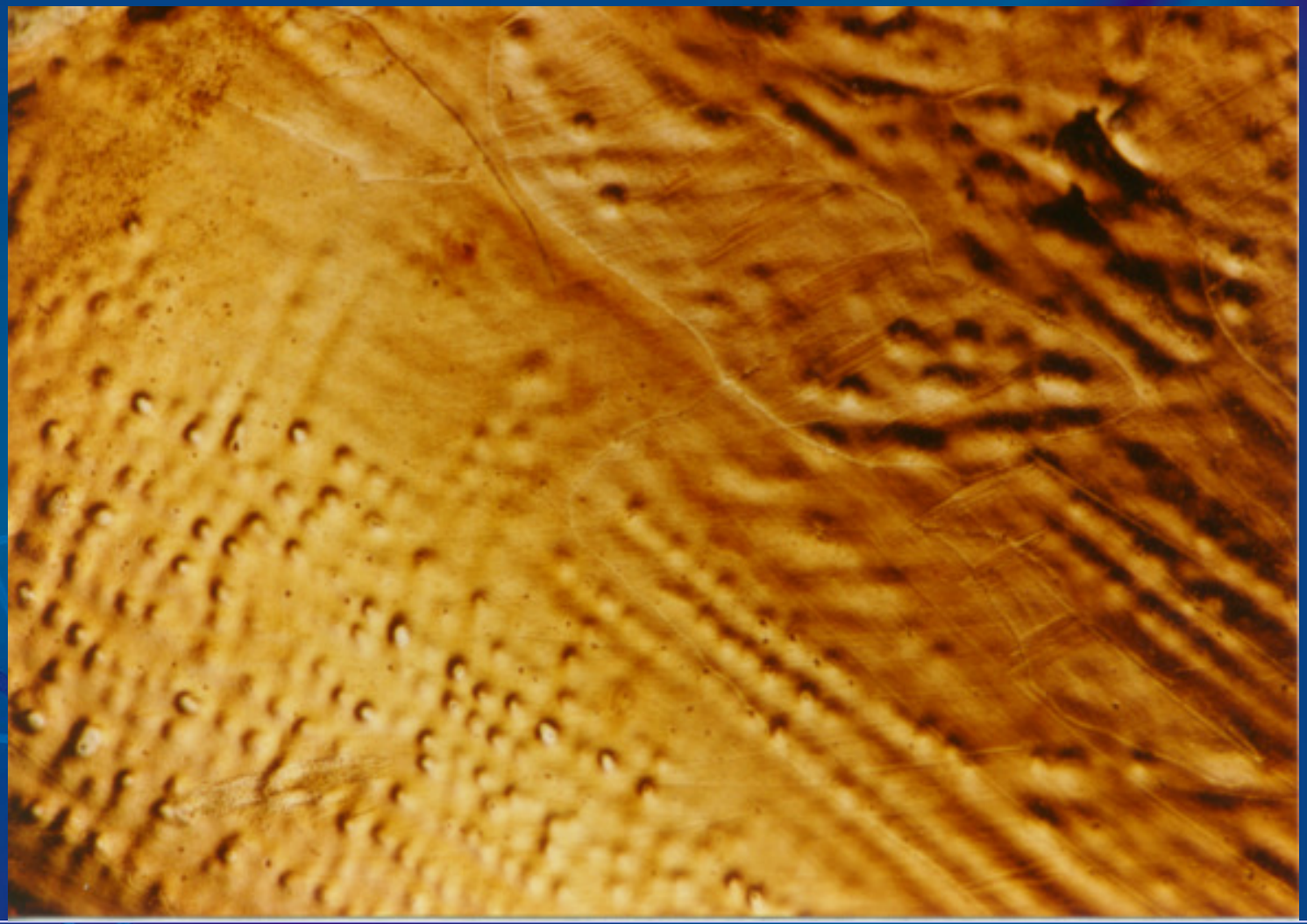


Archaeological Objects Under Study

Sample	Weight(g)	Height, wide, thickness (cm).
Ax	800	18, 8.5, 1.0
Coiled wire	0.3	1.0, 2.5, 0.01
Belt (3 CH)	0.6	6.0, 0.04, 0.09
Belt (3 G)	7.4	4.0, 2.0, 0.05
Belt (4)	1.4	2.5, 1.0, 0.03
Anthropomorphic figure	6.5	3.0, 8.5, 4.0
Metal ring or copper band	11.6	---, ---, 4.0, diameter 4.6
Flat Disk	1.6	---, ---, 0.01, diameter 2.2
Pliers Fragments (5 G)	6.3	---, ----, ---
Pliers Fragments (5 CH)	5.6	---, ----, ---
Punch with 2 extremes(U12)	6.5	7.3, ---, 0.04
Punch with 2 extremes(U13)	7.5	7.0, ---, 0.05
Needle (U14)	4.7	12.0, 0.04,0.02

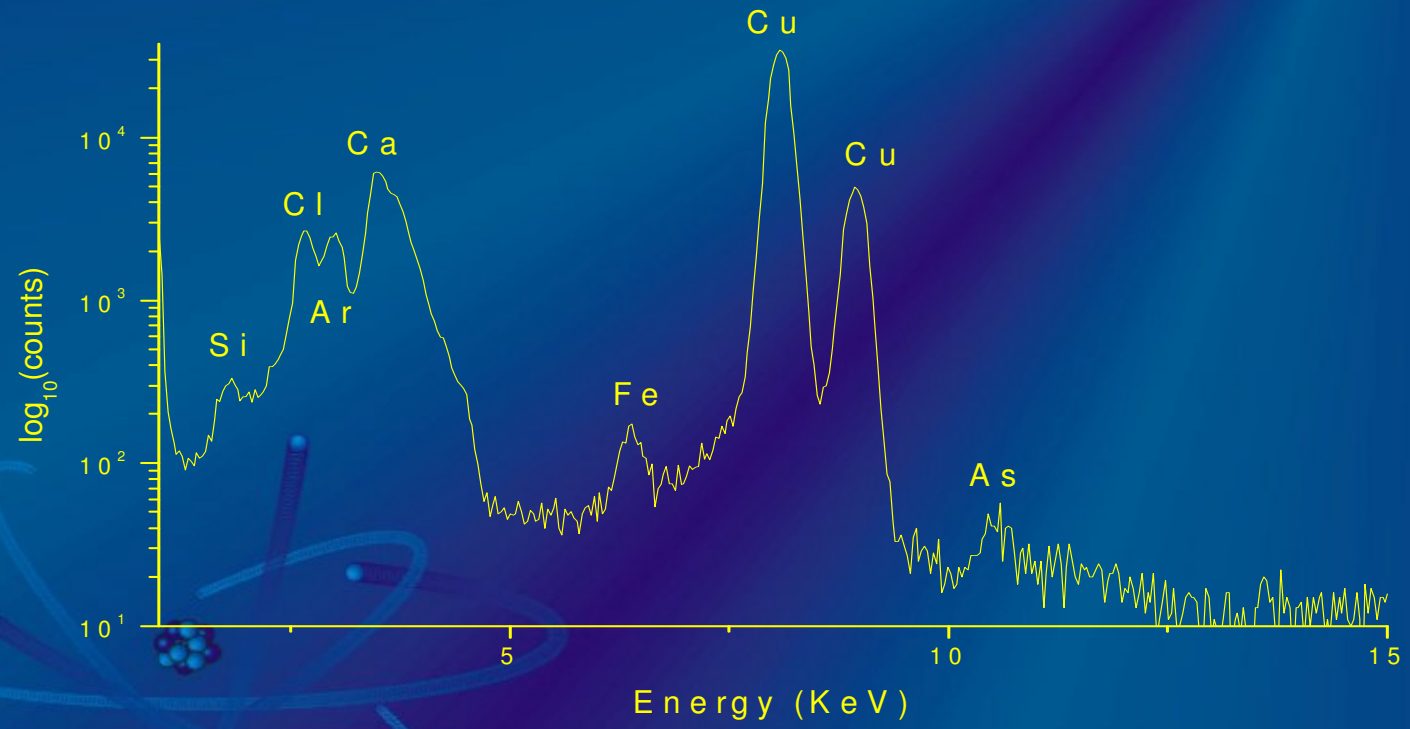
Rattle

Wax



Metallic Surface

Typical X-ray spectrum obtained with a 2.6 proton bombardment of a metallic object.



Conclusions

- The Research Accelerators in Mexico are used mainly for elemental determination of different type of materials.
- PIXE is the most used technique and it is has proved to be a very suitable technique for elemental analysis of archaeological and environmental samples