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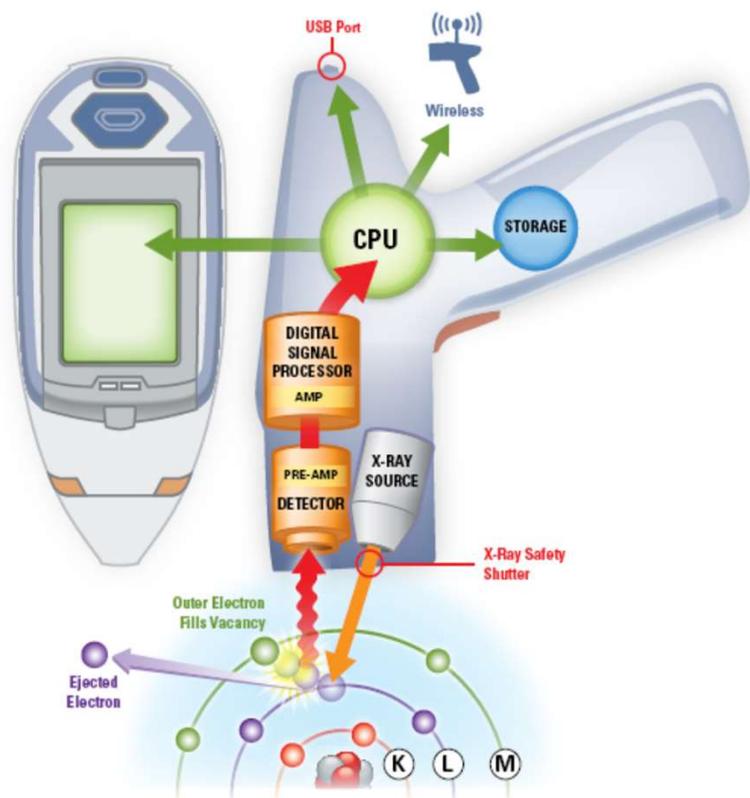
International Atomic Energy Agency
Atoms for Peace and Development

Instrumentation available for portable/transportable X-ray spectrometry techniques

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Hand-held analyzer



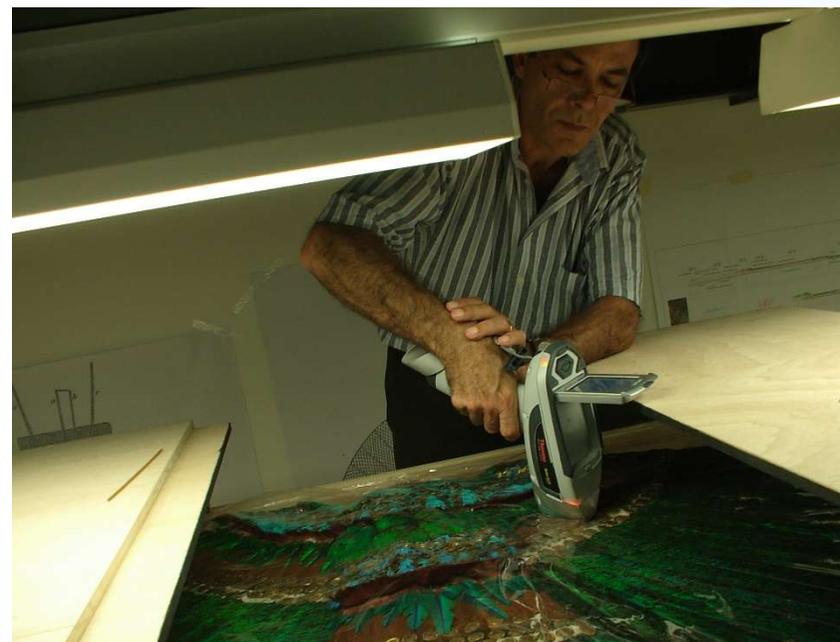
State-of-the-art technology in **miniaturized X-ray sources**, Integrated **Pocket PC technology for digital signal processing**, telecommunications, and solid state reliability.

GPS, wireless transmission, and integrated data analyses are being added rapidly expanding the technology and its applications.

Hand-held analyser: features

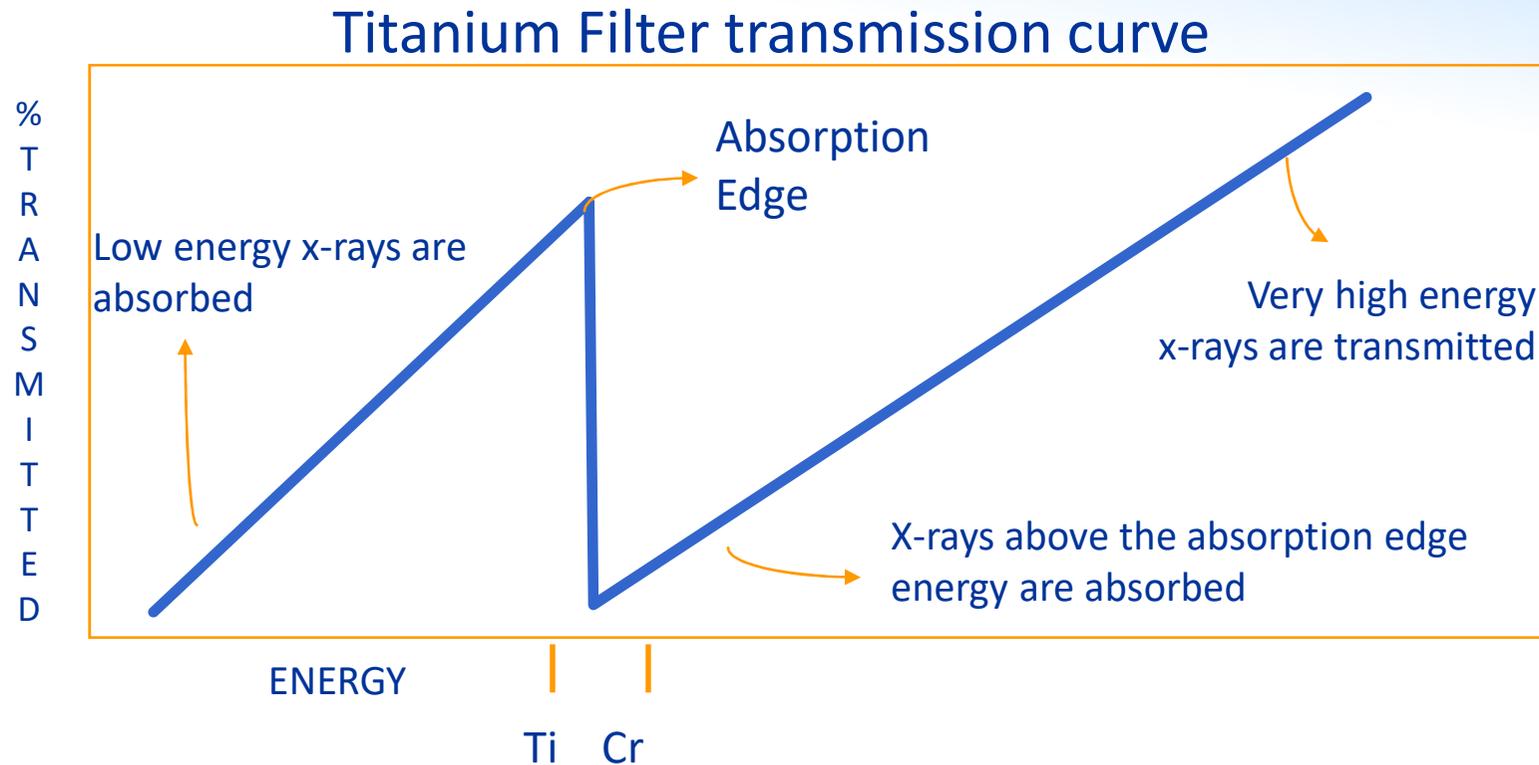
Handheld XRF analyzer (Niton XL3t, GOLDD):

- Miniaturized air-cooled X-ray tube
- **Thin Ag anode** in transmission geometry
- Max. operational values:
50 kV, 200 μ A, 2.5 W
- SDD detector: 30 mm²,
178 eV@MnK α



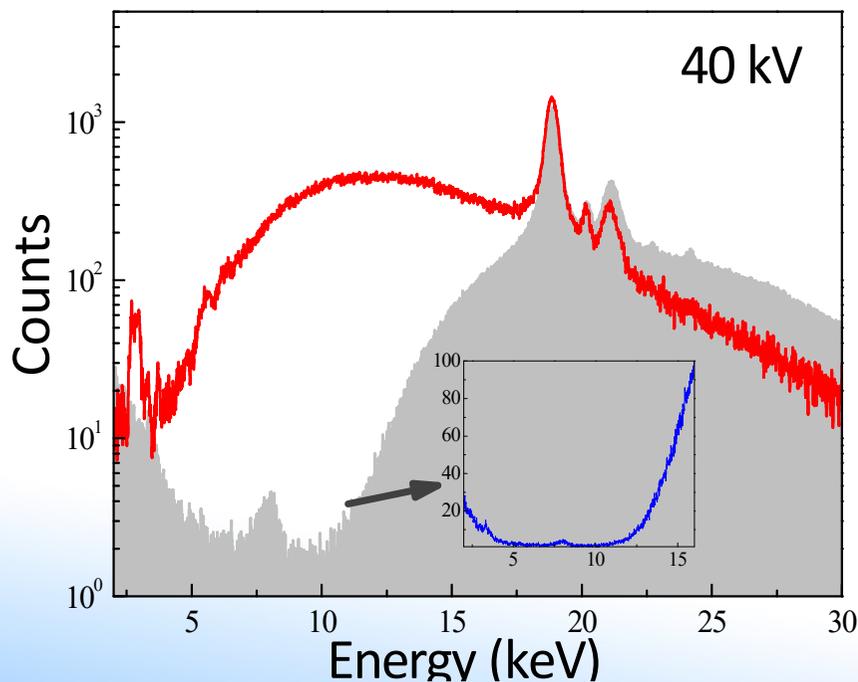
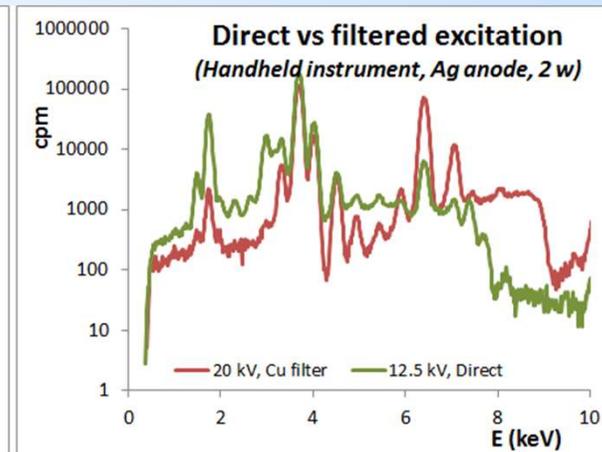
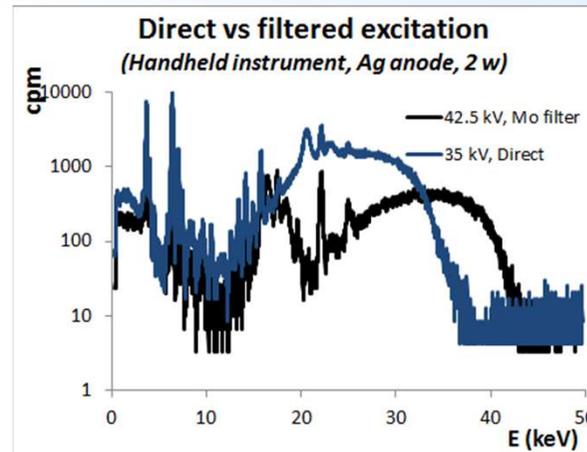
Handheld XRF measurements of a XVI century Mexican feather headdress) at the Ethnology museum of Vienna.

Absorption filters as beam modifier



The transmission curve shows the parts of the source spectrum that are transmitted and those that are absorbed

Absorption filters



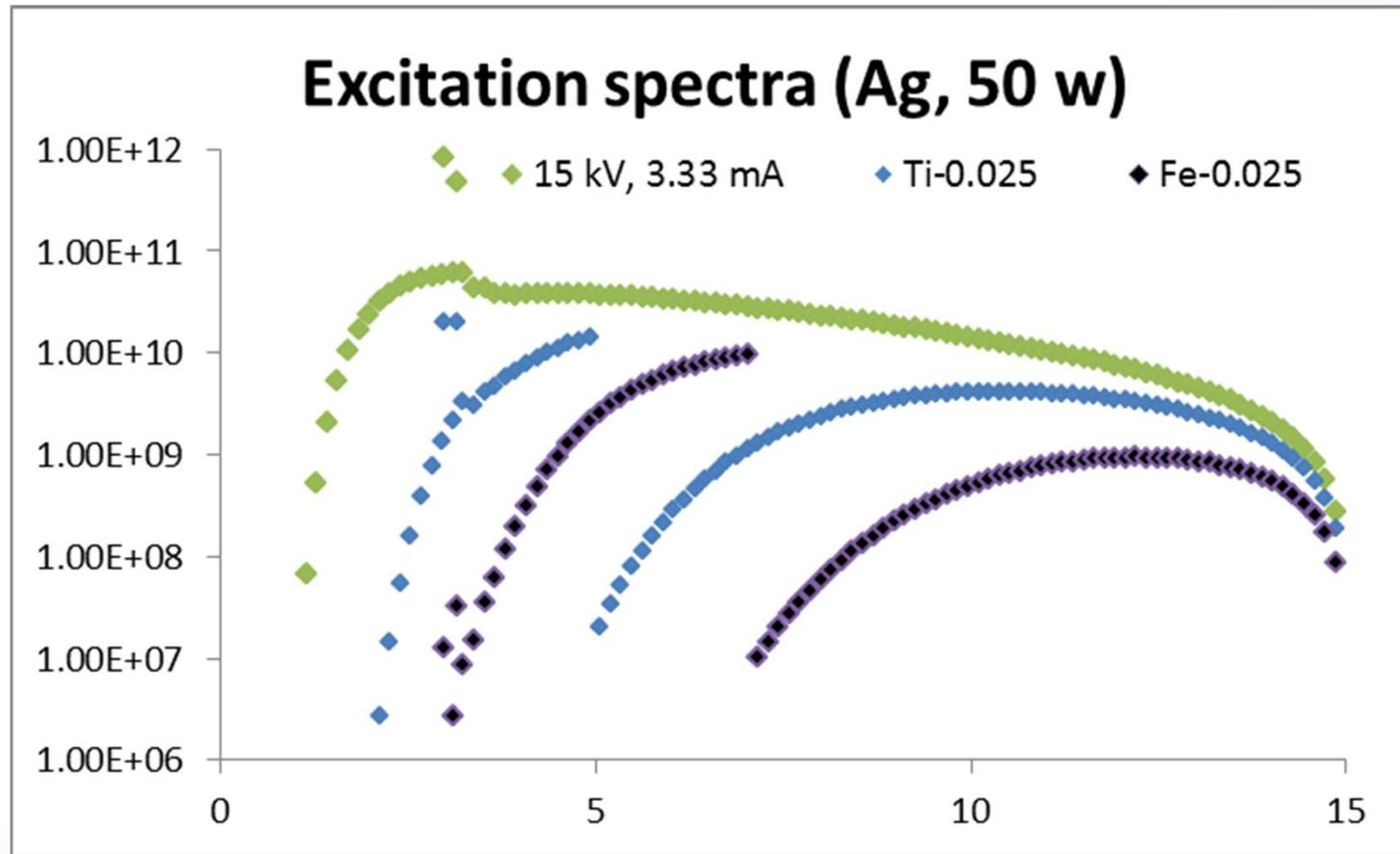
Filter: Ni\V\Kapton

Background decrease:

@19 keV: 3 – 4 times

@5-15 keV: 10 – 100 times

Absorption filters (Ag anode)



HH XRF - Conditions

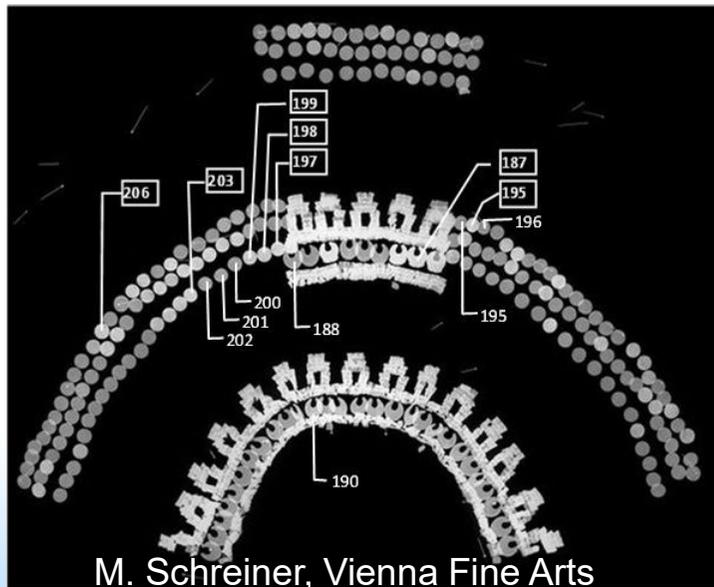


Material	Condition							
Condition	Light		Low		Main		High	
	Voltage (kV)	Filter (mil)	Voltage (kV)	Filter (mil)	Voltage (kV)	Filter (mil)	Voltage (kV)	Filter (mil)
Mining	8	-	20	1 Cu	38	4 Al + 1 Ti + 4 Fe	50	3 Mo + 4 Fe
Soil	8	-	20	1 Cu	38	4 Al + 1 Ti + 4 Fe		
Alloy	8	-	15	1 Fe	38	4 Al + 1 Ti + 4 Fe		
Plastic	8	-	20	1 Cu	40	3 Mo + 4 Fe		

HH XRF Analysis of a feather headdress



- **16th century feather headdress** in the Museum of Ethnology Vienna is the most renowned of the few remaining pre-Columbian “Arte Plumaria” artefacts
- The recorded history of the headdress begins in 1596, when it is first mentioned in the estate inventory of the art collection of Archduke Ferdinand II of Tyrol at Ambras Castle



Analytical Questions:

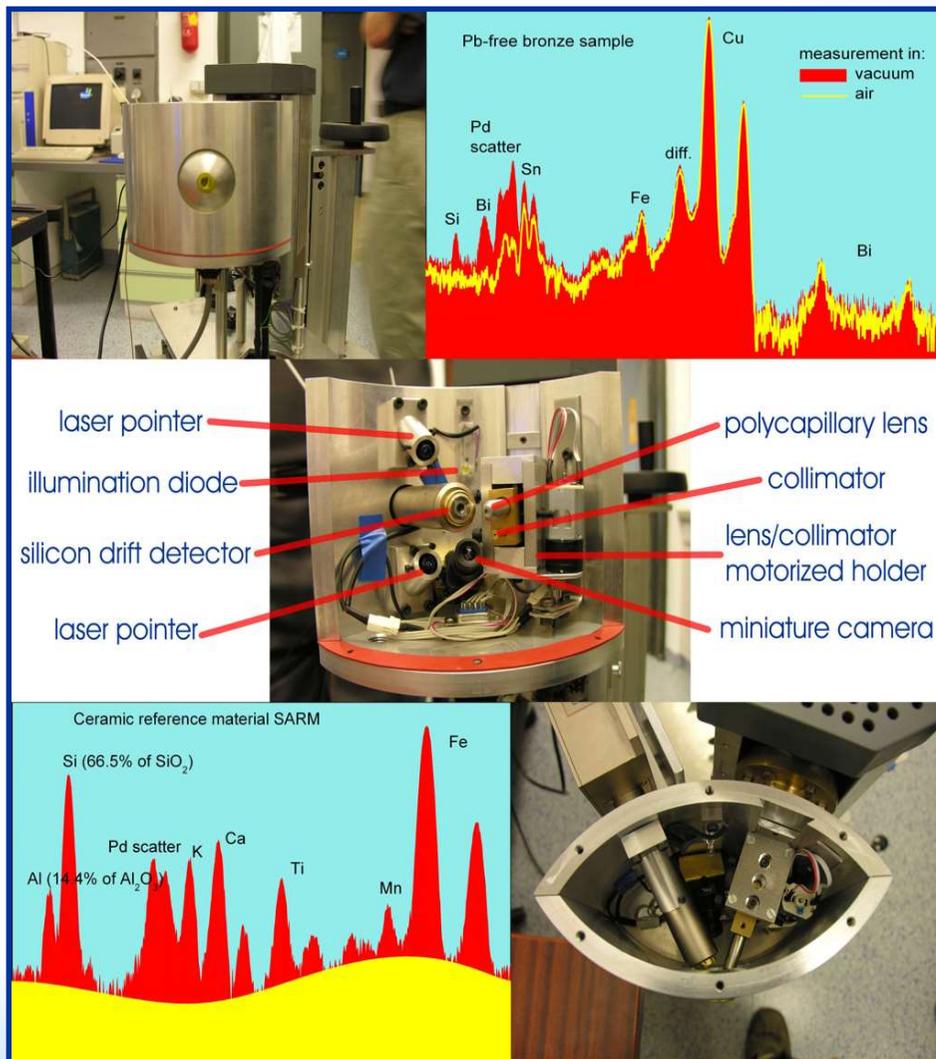
- Metal ornaments: Composition?
- Two types
 - Coated brass ornaments
 - Gold ornaments
- Inorganic Pigments?
- Presence of pesticides?

Portable XRF spectrometer PART1



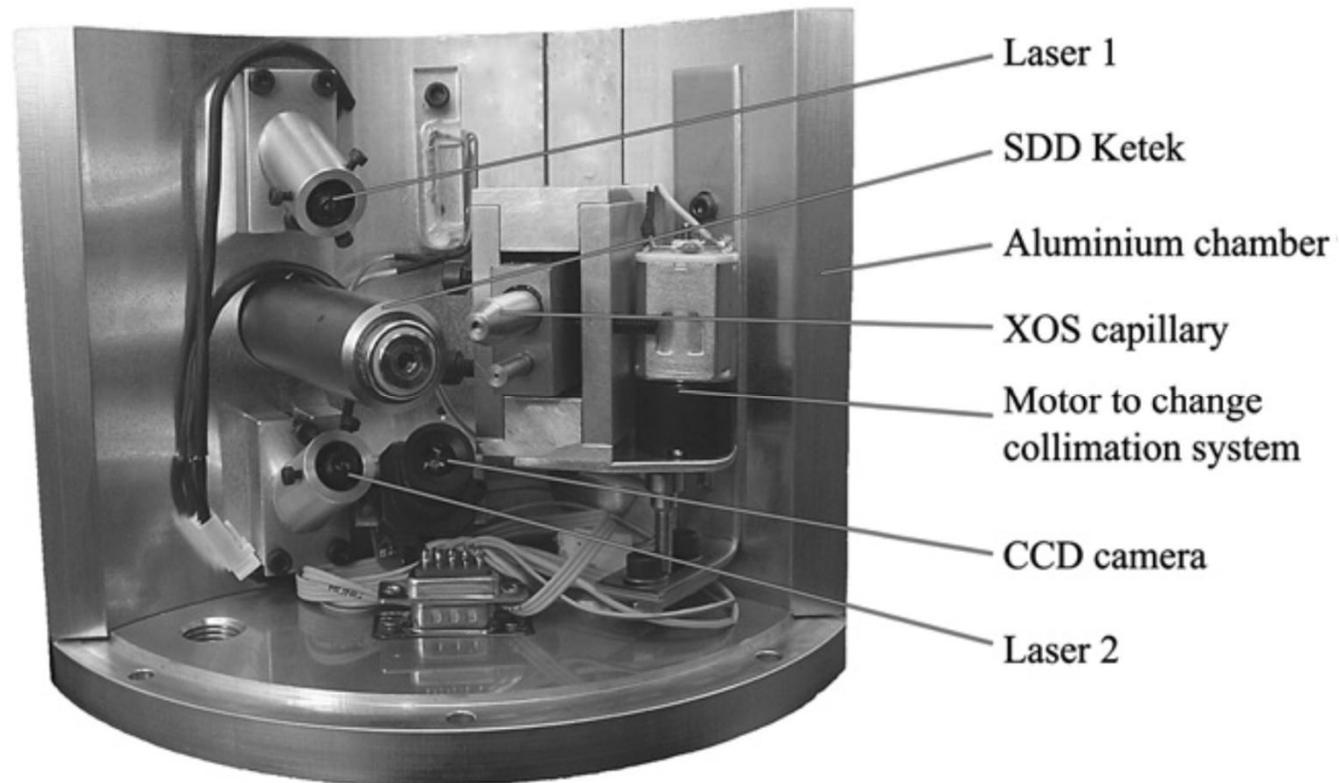
Direct excitation
Vacuum/air
SD detector
polycapillary optics/collimator

PART1: features

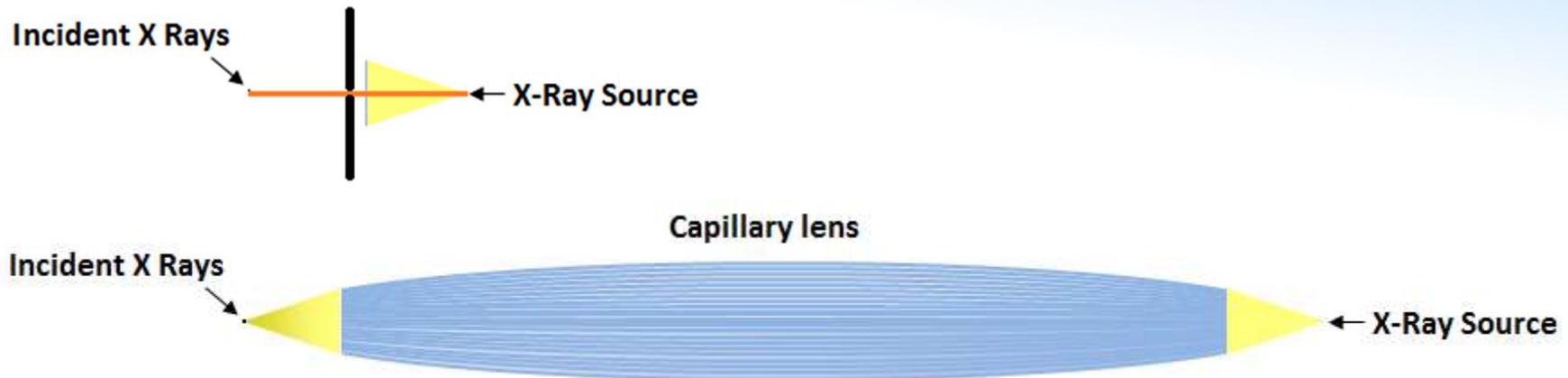


- Pd-anode X-ray tube (50 kV, 1 mA, 50 W), direct excitation
- vacuum or air set-up (Kapton window 7.5 μm thick)
- polycapillary lens (160 μm beam size), brass collimator (1 mm beam size)
- silicon drift detector, 10 mm^2 , 300 μm thickness, 140 eV@MnKa
- 2 laser pointers
- CMOS camera
- mechanical positioning system

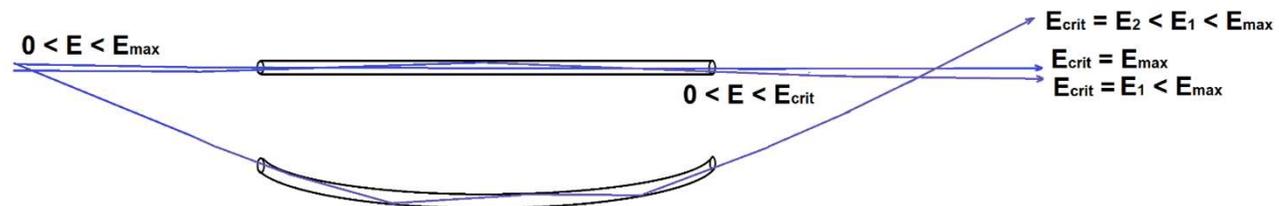
PART1: measuring head



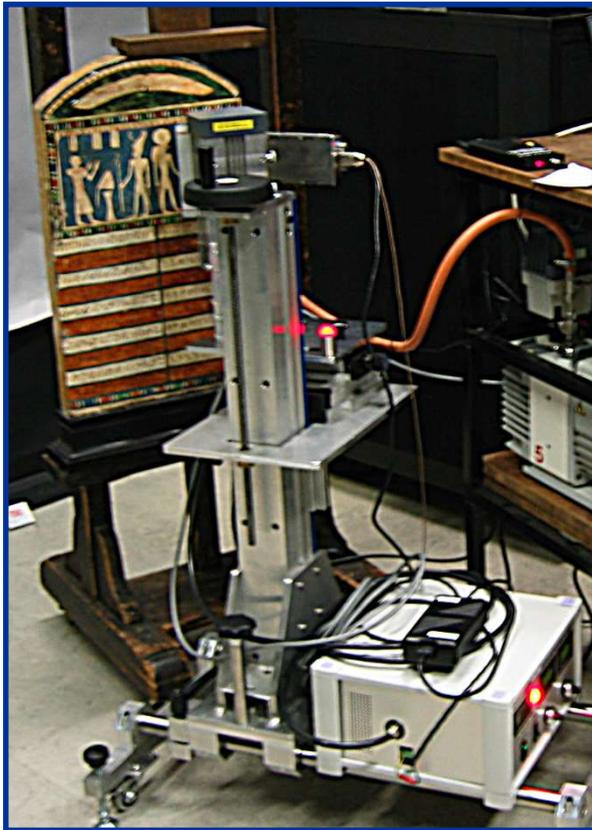
Policapillary lens



Spot size down to 15 - 20 μm
Gain in intensity x 300



PART1: applications



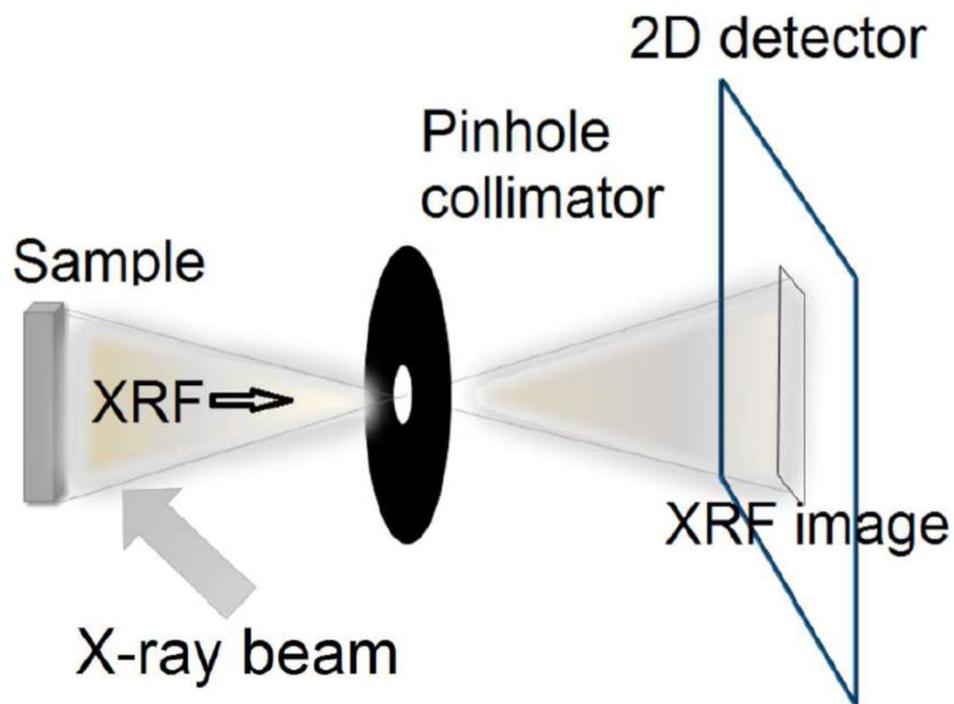
Identification of Polychromy in a wooden stele from XXVI Dynasty, Thebes (640 B.C.).



Gold salt cellar, so called *Saliera*, by Benvenuto Cellini (1500-1571). The only work of gold which can be attributed to Cellini with certainty.

Full-Field XRF

A broad X-ray beam illuminates a large area of the sample



The induced X-rays are detected by a position- and energy-sensitive detector, through a pin-hole collimator

FF-XRF: CCD



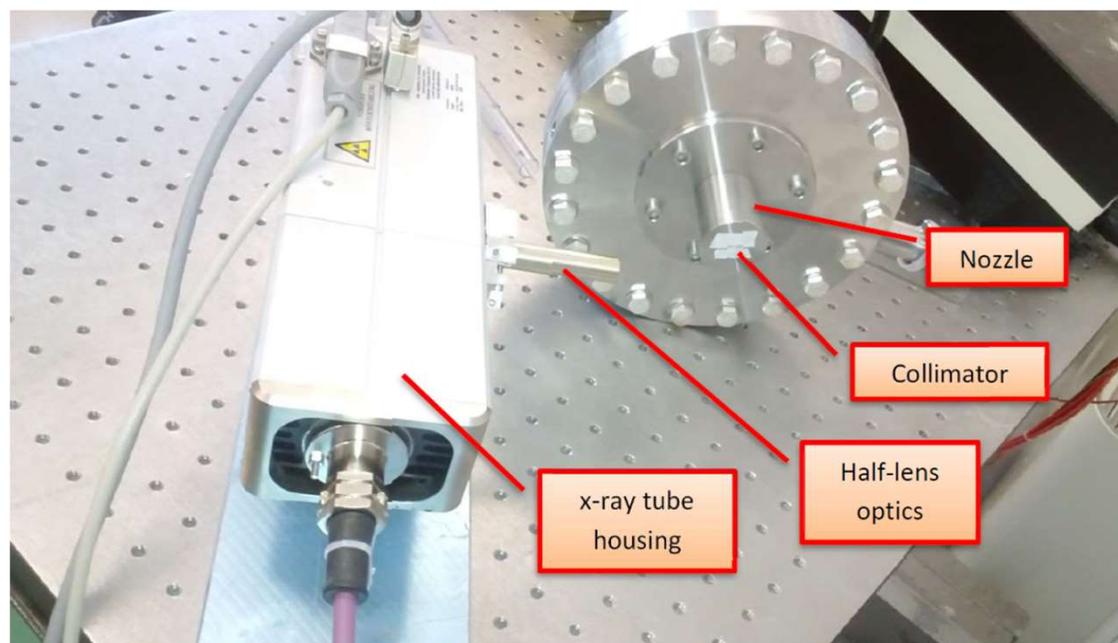
- 1024x1024 pixels (full bin), 13.3x13.3 mm² (13x13 μm² pixel size)
- Operated at -85°C to reduce electronic noise
- Operated in vacuum
- Be window 25.4 μm (light)
- Kapton window 25 μm (vacuum)

The vacuum system allows reaching 2-3 10⁻⁵ mbar



FF-XRF: X-ray tube

- 50 kV, 0.6 mA, 30 W
- Rh anode
- Filters Ti, Ni, Rh
- Supplied with half lens optics

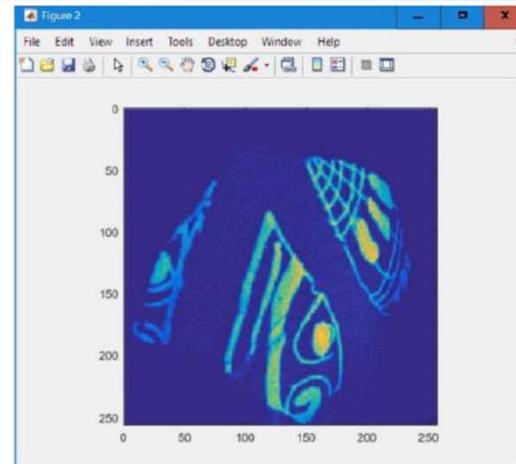
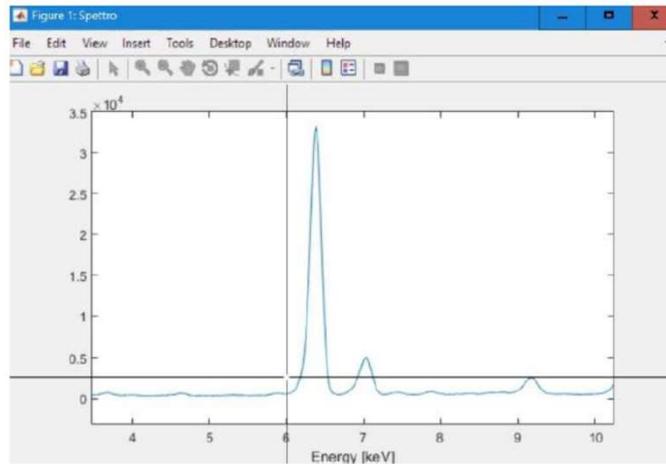


FF-XRF: possible set-ups

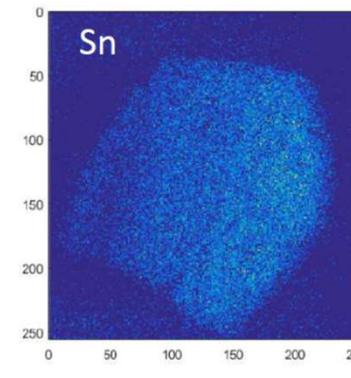
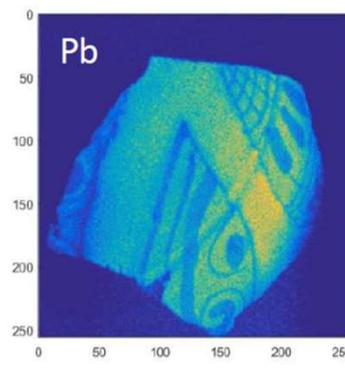
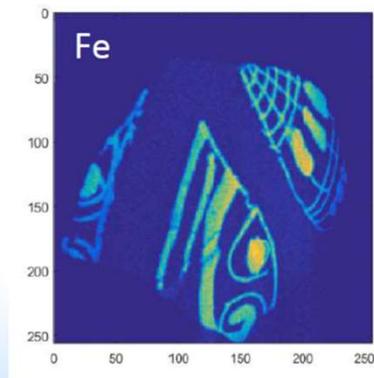


<i>D</i> : Collimator diameter (μm)	<i>S</i> : Collimator thickness (mm)	Nozzle length (mm)	<i>q</i> Det- Coll (mm)	<i>p</i> Samp-Coll (mm)	Magnification (x)	Resolution (μm)	FOV (mm)
5	0.05	80	110	15	7.3	6	3
5	0.1	45	75	15	5.0	6	1.5
15	0.1	45	75	15	5.0	18	4.5
25	0.1	45	75	40	1.9	38	20
25	0.1	15	45	60	0.8	58	30
50	0.1	10	40	75	0.5	145	75
50	0.1	10	40	115	0.3	194	115
100	0.1	10	40	95	0.4	338	190
100	0.1	10	40	120	0.3	400	240

FF-XRF: example of application



D - Collimator diameter (mm)	S Collimator thickness (mm)	Nose Length (mm)	Distance Det-Coll q, (mm)	Distance Sample-Coll. p, (mm)	Magnification	Resolution (um)	FOV (mm)	Total travel	Travel in air	Object
0.1	0.1	5	40	95	0.4	338	190	135	105	Ceramic





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Thank you!