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Ռենտգենյան ու գիգա-տերահերցային տոմոգրաֆիա և սպեկտրասկոպիա

«Հեռավար լաբորատորիաների հիմնադրում 2023»
23RL-1C037

Խմբի անդամները

1. (CI) Վարդան Մարգարյան
2. Յուրի Չերեպեննիկով
3. Արուս Շահվերդյան
4. Դավիթ Բաղդասարյան
5. Սոնյա Խոսրովյան
6. Գալսյան Արսեն

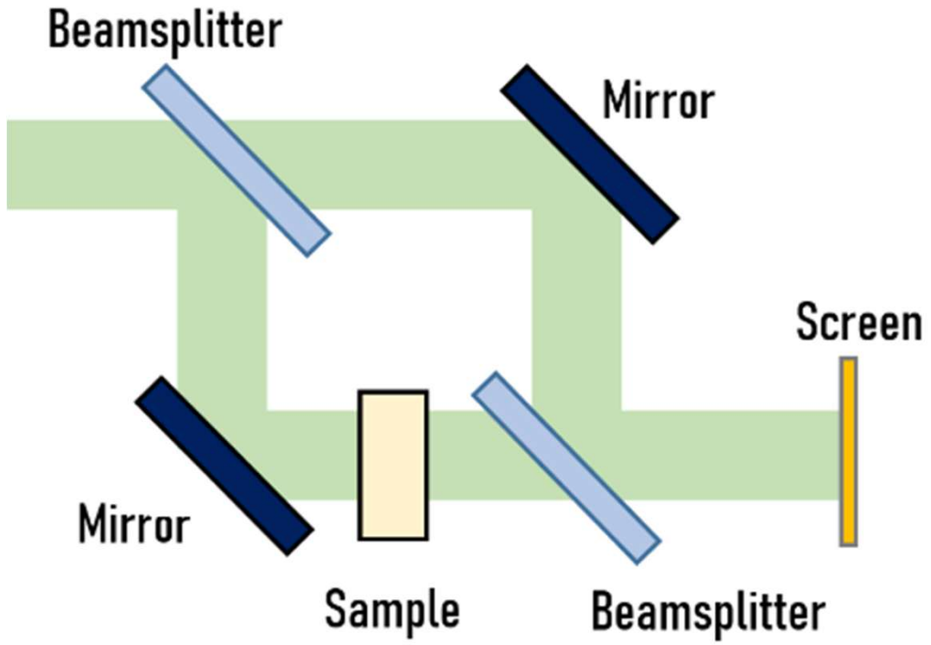
Բյուջե	
Աշխատանքի վարձատրության գումար, ներառյալ հարկերը և այլ պարտադիր վճարները (ՀՀ դրամ)	90 000 000
Սարքեր, նյութեր և ծառայությունների գումար (ՀՀ դրամ)	35 300 000
Գործուղումների գումար (ՀՀ դրամ)	7 200 000
Գիտական խմբի լաբորատորիայի ամրապնդման գումար (ՀՀ դրամ)	15 000 000
Վերադիր ծախսերի գումար (ՀՀ դրամ)	2 500 000
Փաստացի ծախսեր (ՀՀ դրամ)	150 000 000

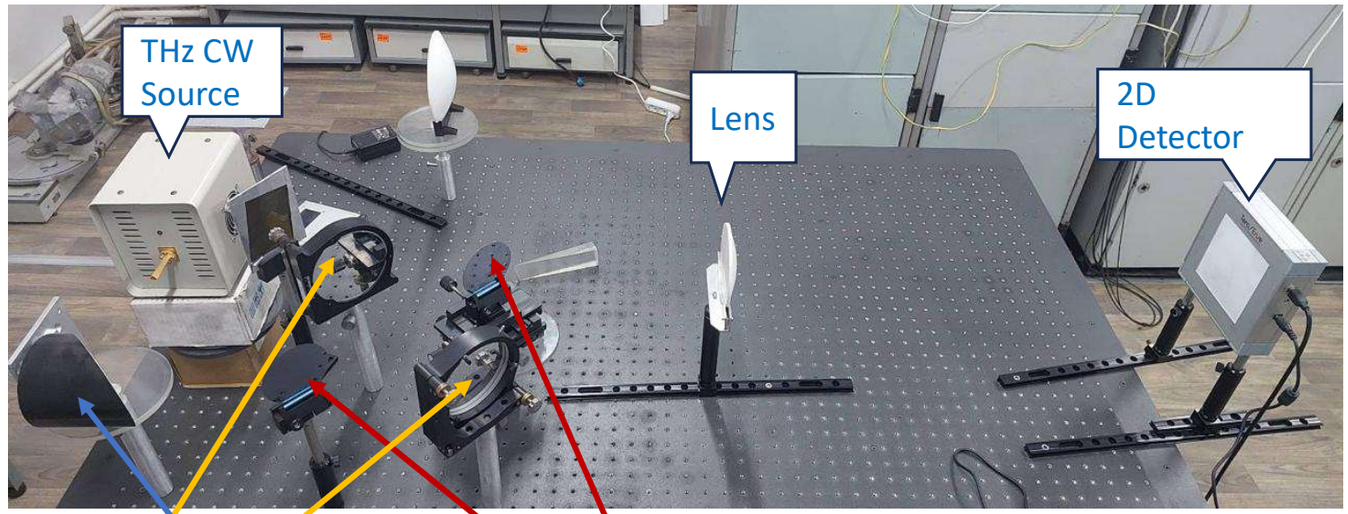
Փաստացի ծախսեր (2024-2025թթ.)	
Աշխատանքի վարձատրության գումար, ներառյալ հարկերը և այլ պարտադիր վճարները (ՀՀ դրամ)	18 000 000
Սարքեր, նյութեր և ծառայությունների գումար (ՀՀ դրամ)	3 851 000
Գործուղումների գումար (ՀՀ դրամ)	1 877 480
Վերադիր ծախսերի գումար (ՀՀ դրամ)	500 000
Ընդհանուր գումար (ՀՀ դրամ)	**24 228 480**

Տպագրված աշխատանքների ցանկ		
1	V. Margaryan, S. Noreyan, M. Mesropyan, K. Trouni, V. Aghabekyan, R. Mirzoyan, V. Kocharyan // Absorption characteristics of diffracted X-ray radiation in a quartz crystal at an external temperature gradient / Journal of Instrumentation, 2024, 19 (05), C05044	Q3
2	S.H. Li, S. Pavlov, Yu Cherepennikov, P. Glumac, M. Zhuravlev, G. Kurapov, A. Bukharkin, G. Remnev // Estimation of the neutron yield generated by neutron source based on pulsed power proton accelerator in 7Li(p, n)7Be reaction / Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, 2025, 1075, 170442	Q2
3	Hakob Simonyan, Vardan Margaryan, Yury Cherepennikov, Arus Shahverdyan, Nikolay Filatov, Vahan Kocharyan // Identification of technological methods of manufacturing bronze jewellery from the Teishebaini burial site (Armenia) by means of X-ray analysis / The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, 2025, XLVIII-2/W9-2025, 257-262	

Phase imaging in the sub-terahertz range

Experimental scheme





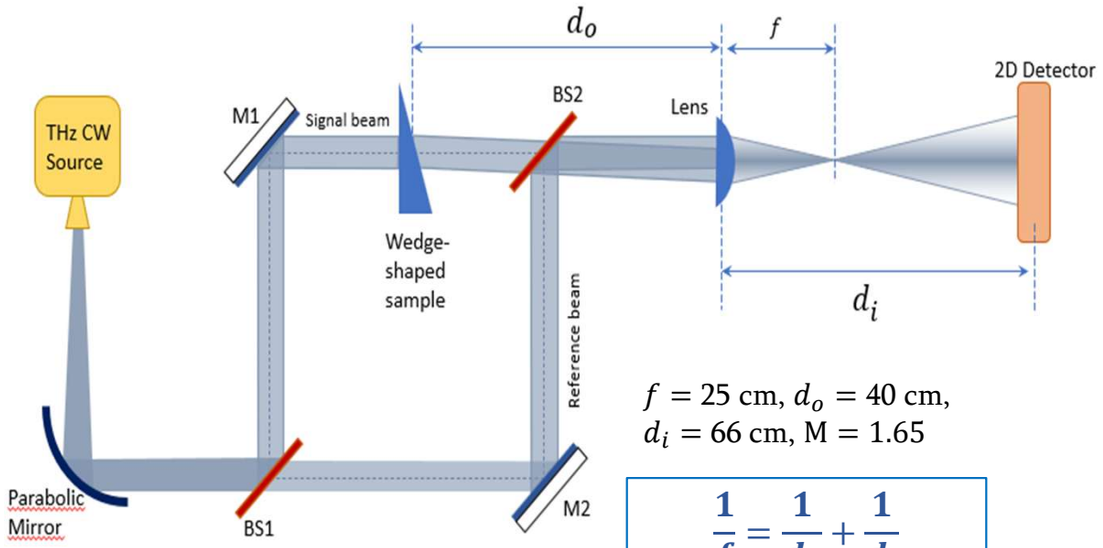
Mirrors

Parabolic Mirror

Beamsplitters (Silicon crystal 80um)

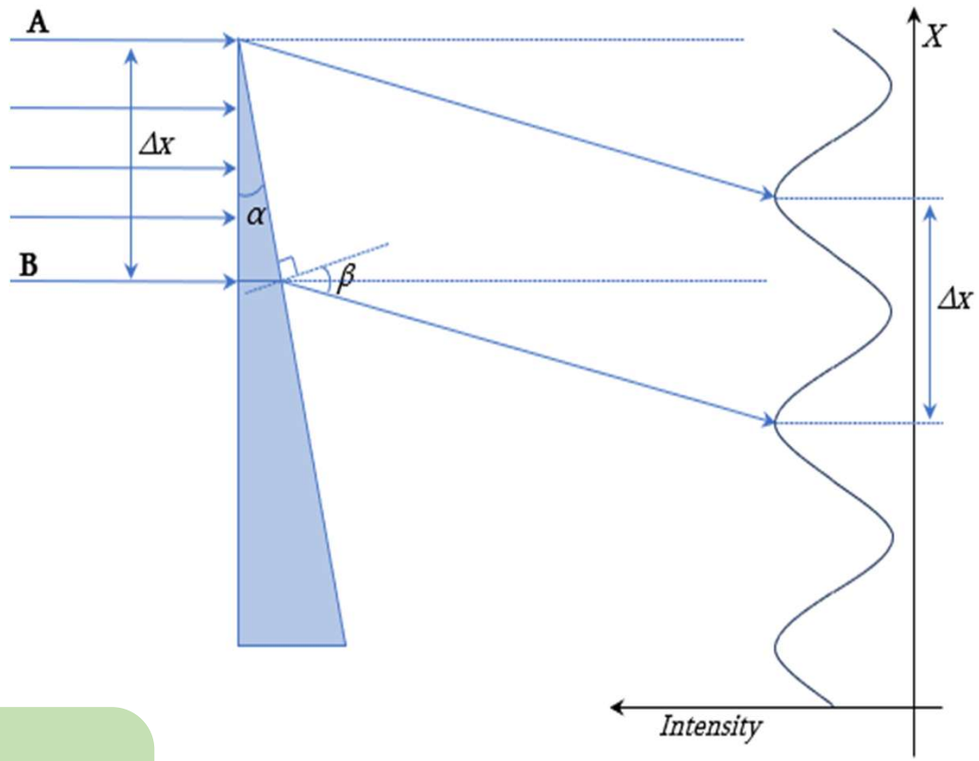
Phase imaging in the sub-terahertz range

Determination of the refractive index for wedge-shaped phase samples



$f = 25$ cm, $d_o = 40$ cm,
$d_i = 66$ cm, M = 1.65

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$



$$\Delta\varphi = k\,\Delta x \frac{\cos\beta}{\cos\alpha}\tan(\beta - \alpha)$$

$$\Delta\boldsymbol{\varphi} = \mathbf{2}\pi$$

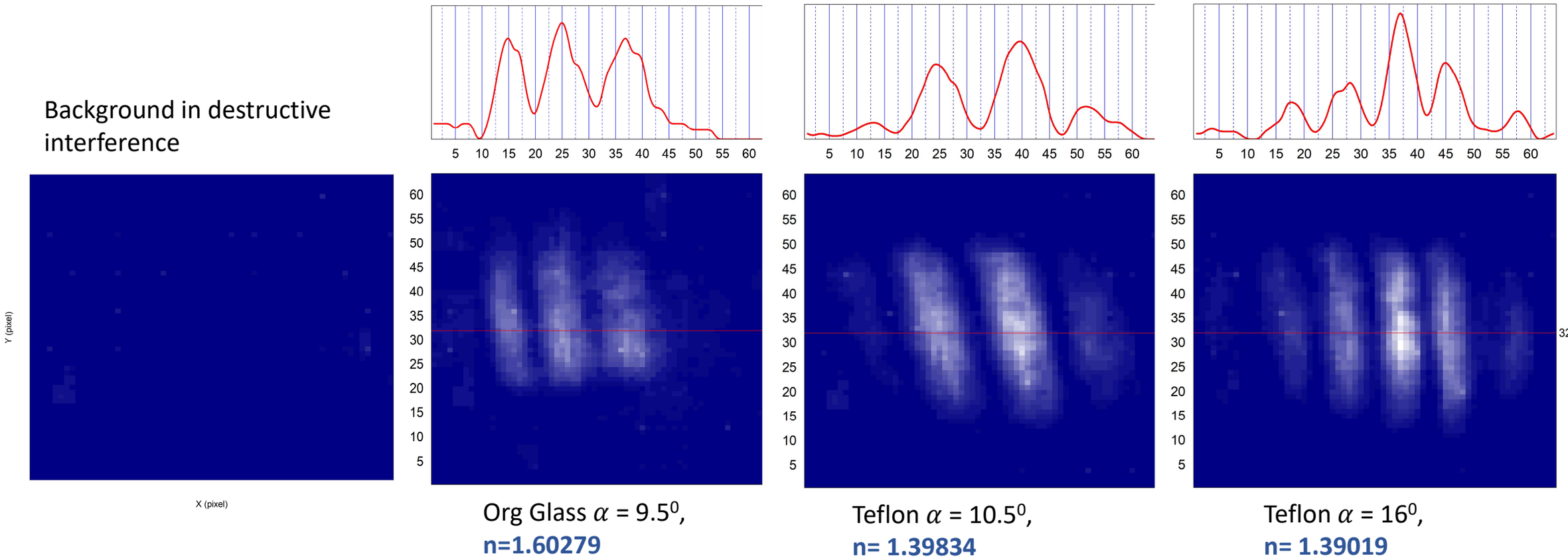
$$\frac{1}{\lambda}\,\Delta x \frac{\cos\beta}{\cos\alpha}\tan(\beta - \alpha) = 1$$

$$\frac{\sin\alpha}{\sin\beta} = \frac{1}{n}$$

Phase imaging in the sub-terahertz range

Determination of the refractive index for wedge-shaped phase samples

Background in destructive interference



Org Glass α = 9.5^0,
n=1.60279

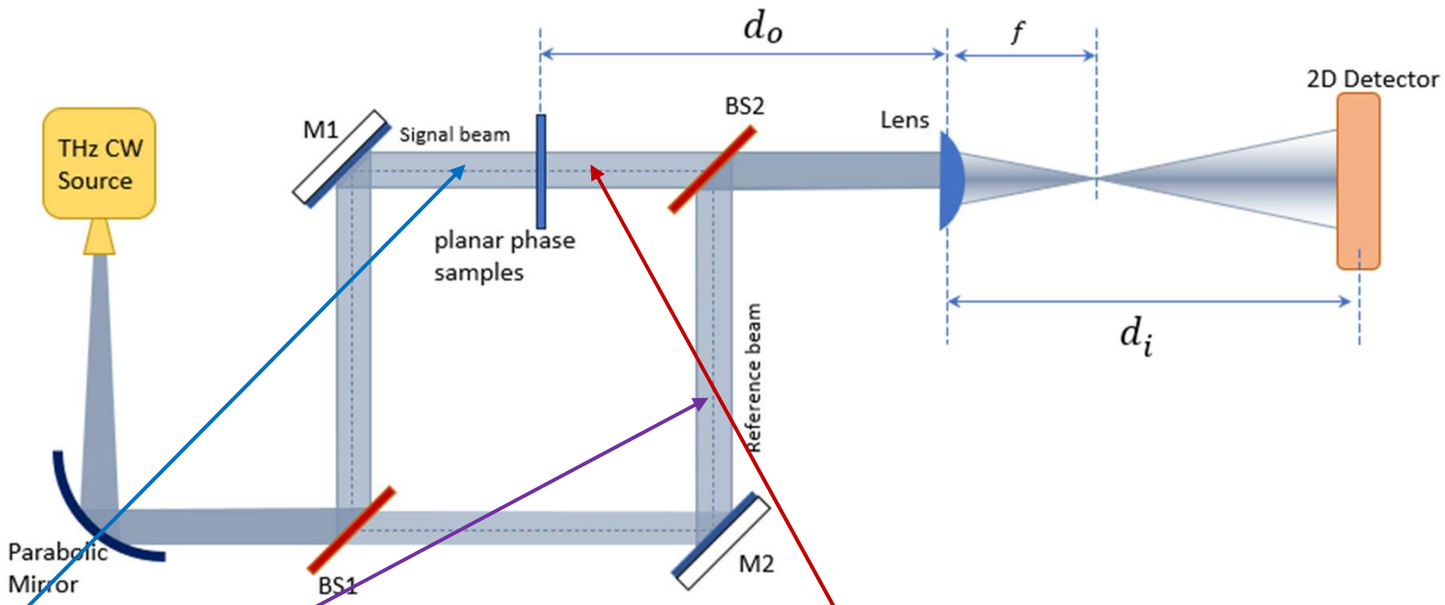
Teflon α = 10.5^0,
n= 1.39834

Teflon α = 16^0,
n= 1.39019

Phase imaging in the sub-terahertz range

Determination of the refractive index for planar phase samples

Teflon film



$$I_0 = I_{sb} + I_{rb} + 2\sqrt{I_{sb} I_{rb}}\,(\cos\varphi_0)$$

Without sample

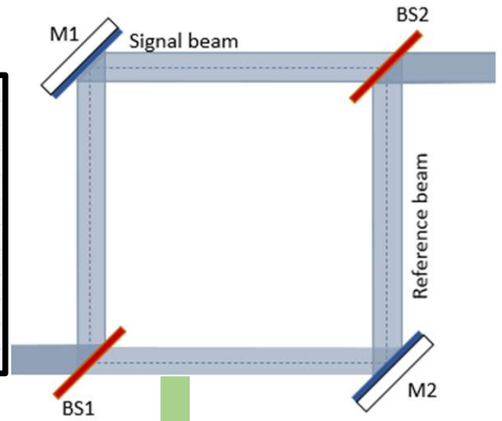
$$I = I'_{sb} + I_{rb} + 2\sqrt{I'_{sb} I_{rb}}\,(cos\,\varphi_0 + \Delta\varphi)$$

With sample

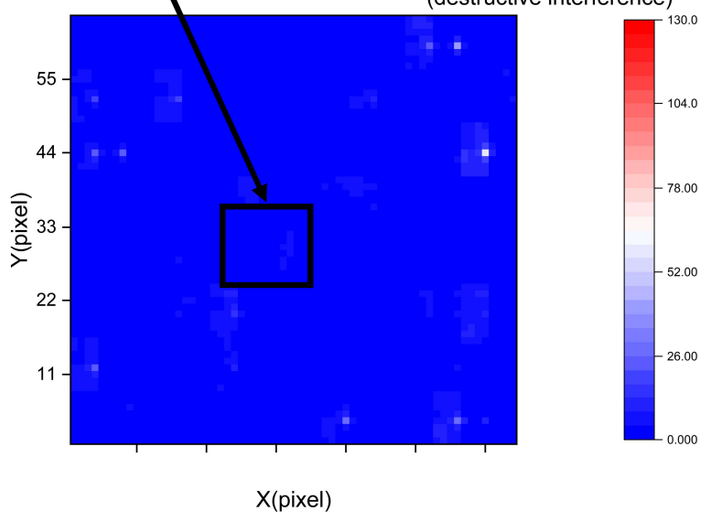
Phase imaging in the sub-terahertz range

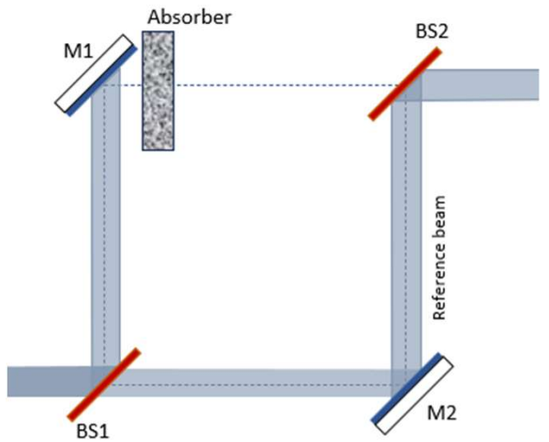
Determination of the refractive index for planar phase samples

2.69	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14
2.5	2.69	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14
2.69	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14
2.69	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14
2.69	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14
2.69	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14
3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14
3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14
3.14	3.14	3.14	3.14	3.14	3.14	3.14	2.69	3.14	3.14
3.14	3.14	3.14	3.14	3.14	3.14	3.14	2.69	3.14	3.14
3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14	2.69	3.14
2.69	3.14	3.14	3.14	3.14	3.14	3.14	2.69	2.69	3.14

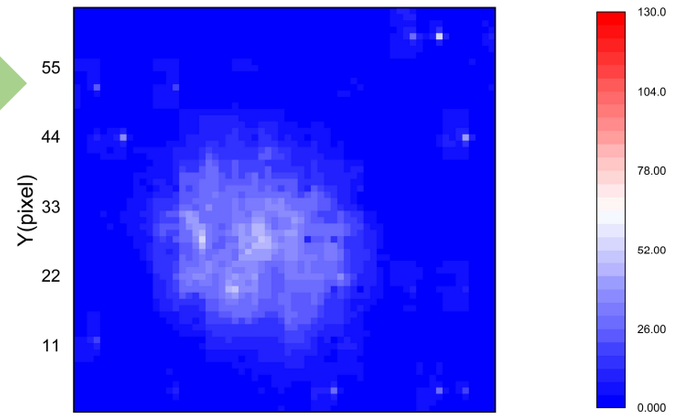


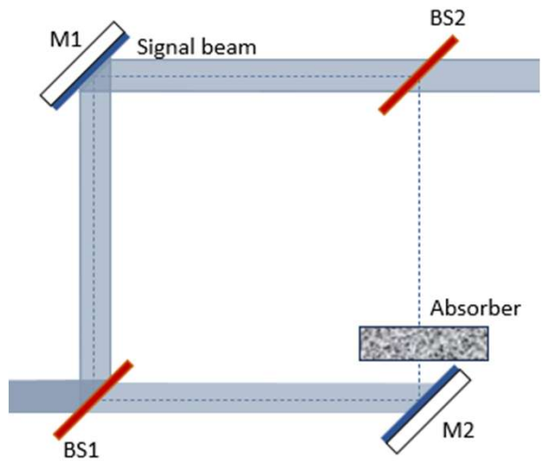
Intensity distribution without sample
(destructive interference)



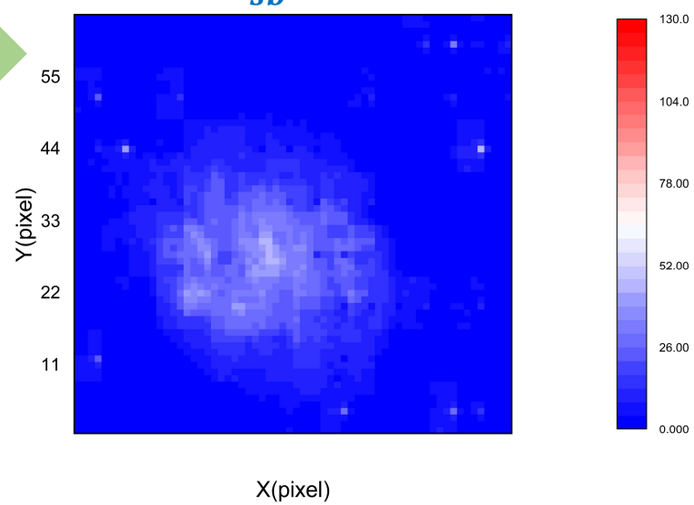


I_{rb} Reference beam intensity distribution





I_{sb} Signal beam intensity distribution

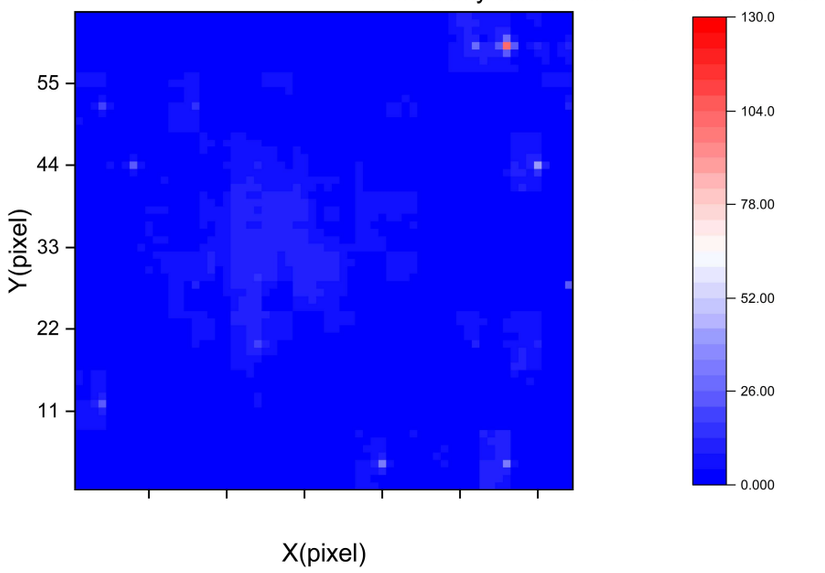


Phase imaging in the sub-terahertz range

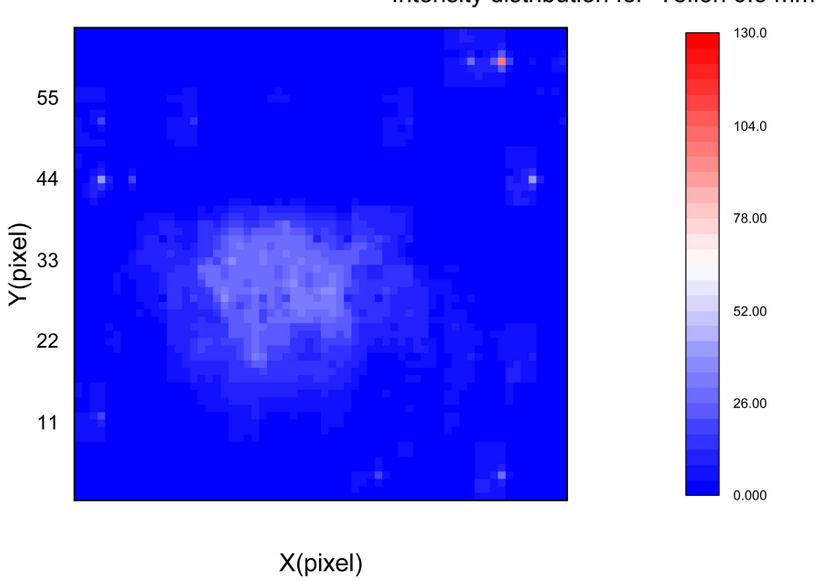
Determination of the refractive index for planar phase samples

$$\Delta\varphi = \frac{2\pi}{\lambda} t(n-1) \quad \lambda - \text{wavelength; } t - \text{thickness of sample}$$

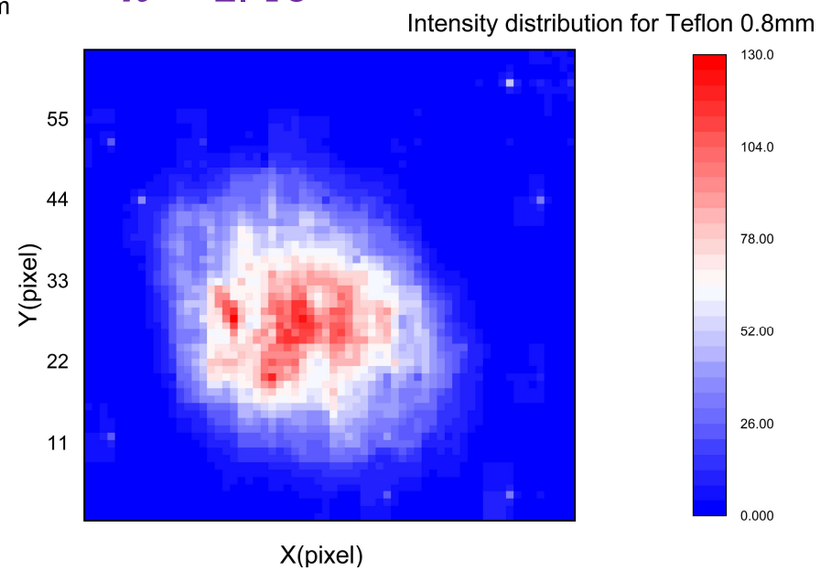
$n = 1.55$



$n = 1.42$



$n = 1.40$

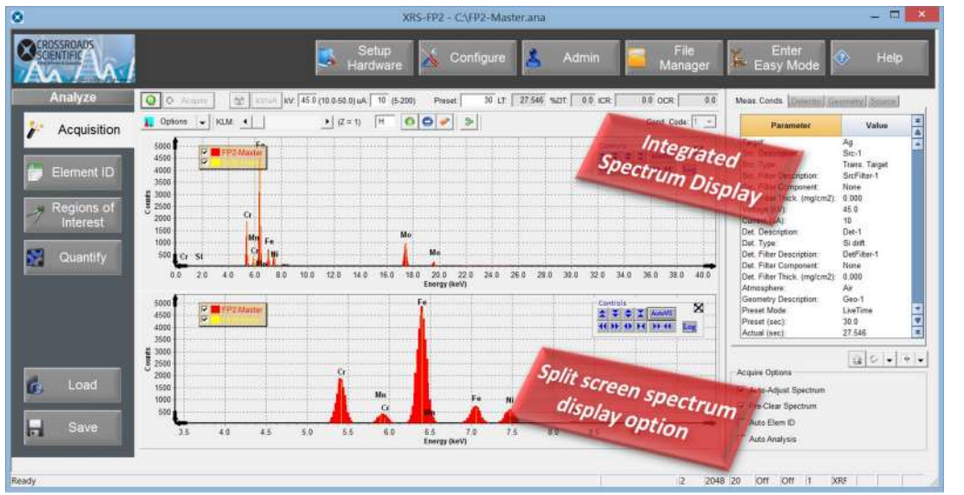


X-ray μ-tomography and spectroscopy

μ-tomograph

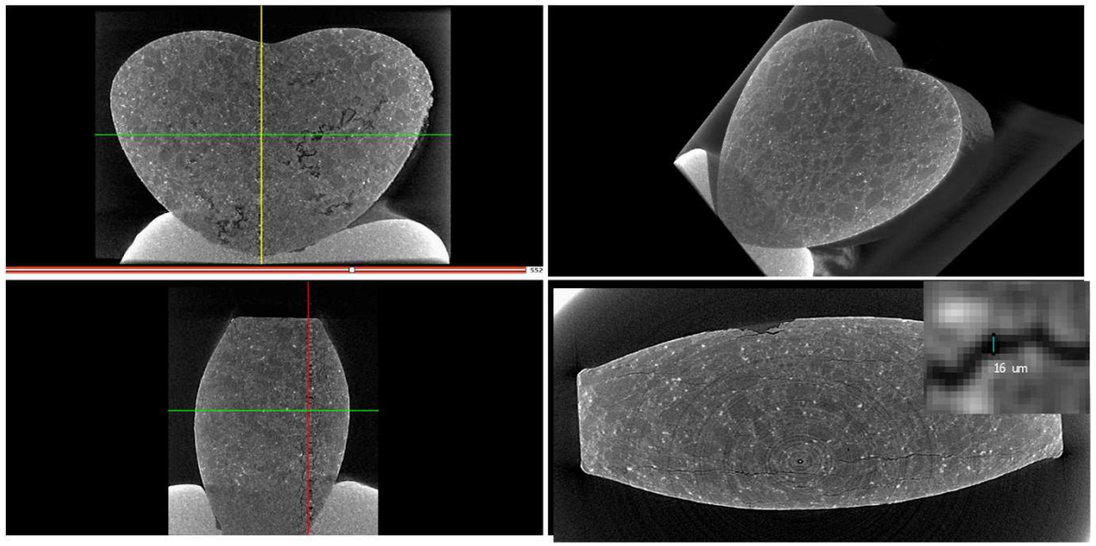
X-123 Complete X-Ray Spectrometer with Si-PIN Detector (AMPTEK) Energy range up to 40 keV Thickness: 500 μm

XRS-FP2 XRF Analysis Software Allows qualitative and quantitative XRF analysis



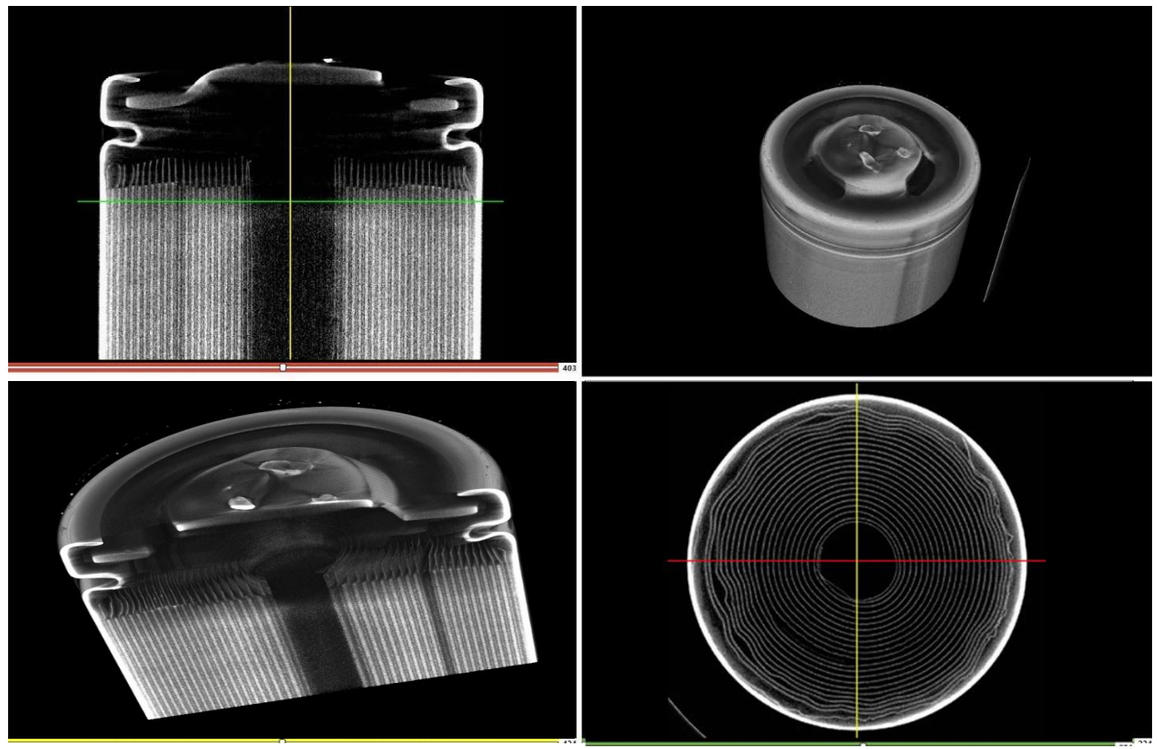
X-ray µ-tomography and spectroscopy

Collaborations



FIVEBRANE™

Designed to help medical AI companies build robust and cost-effective medical imaging AI solutions



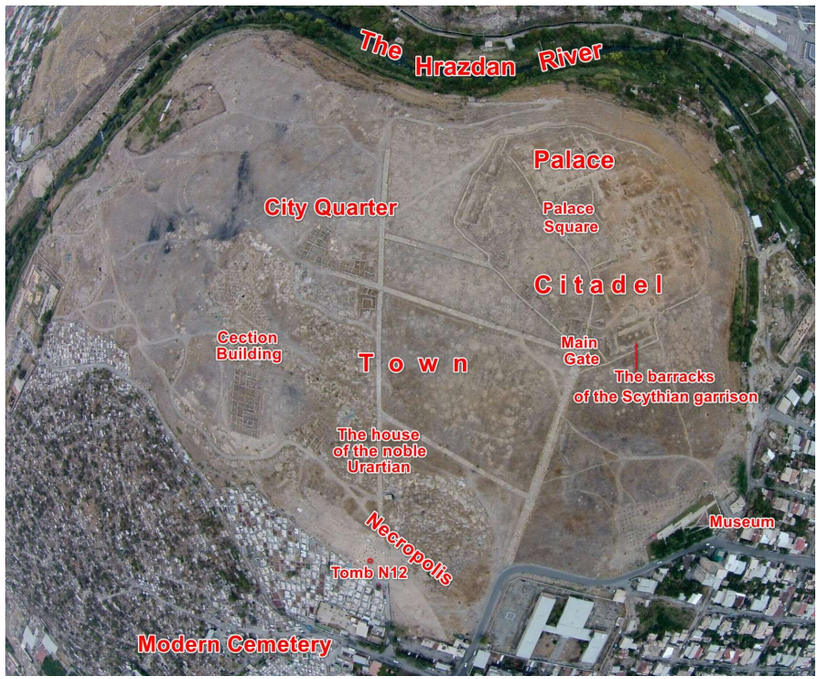
ARPIMED

Care for health...

X-ray μ-tomography and spectroscopy

Collaborations

Teishebaini necropolis (700 BCE)



The Teishebaini necropolis, located in the southwestern part of modern Yerevan, Armenia, represents a key archaeological component of the ancient Urartian city of Teishebaini (Karmir Blur). Excavations conducted between 2013 and 2016 by the Scientific Research Center of Historical and Cultural Heritage uncovered over 280 burials, largely contemporaneous with the city's occupation in the 7th century BCE. The site had been preserved beneath 2–3 meters of later construction debris.

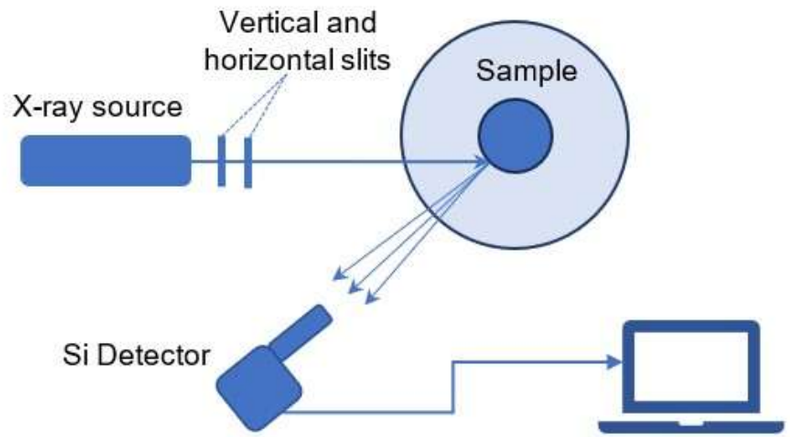
23 × 19 cm

D ~ 6 cm

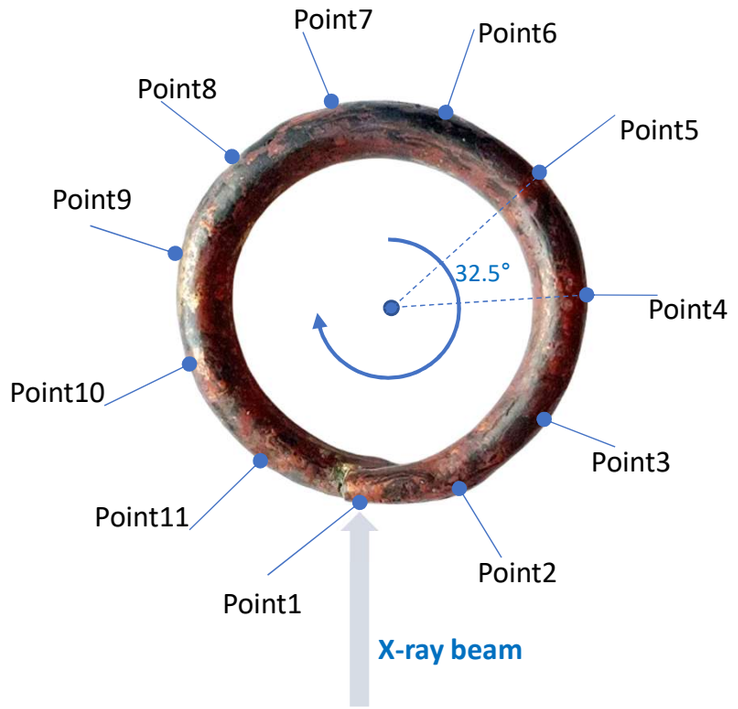
D ~ 4 cm

X-ray μ-tomography and spectroscopy

XRF analysis



Mo X-ray tube (33 kV and 10 mA) was used as a source

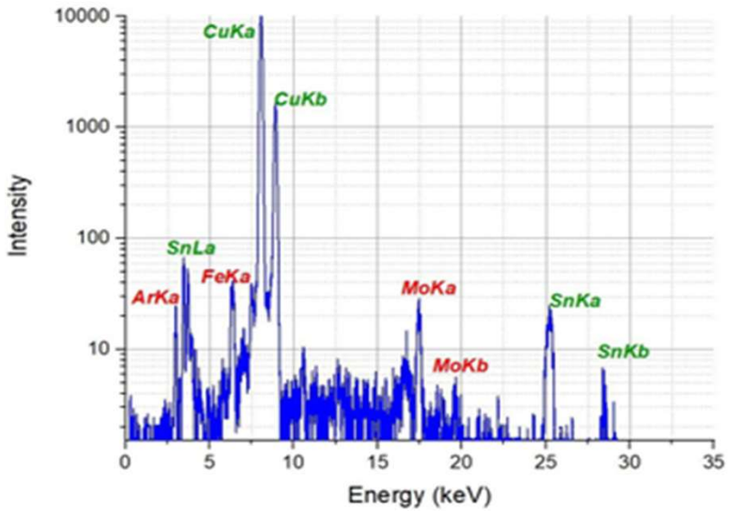


	Point no.1	Point no.2	Point no.3	Point no.4	Point no.5	Point no.6	Point no.7	Point no.8	Point no.9	Point no.10	Point no.11
Cu	70.2%	73.1%	99.5%	62.4%	85.0%	95.4%	80.6%	99.9%	100%	86.9%	64.8%
Sn	28.3%	25.7%	0%	35.8%	14.3%	3.8%	19.0%	0%	0%	12.9%	33.7%

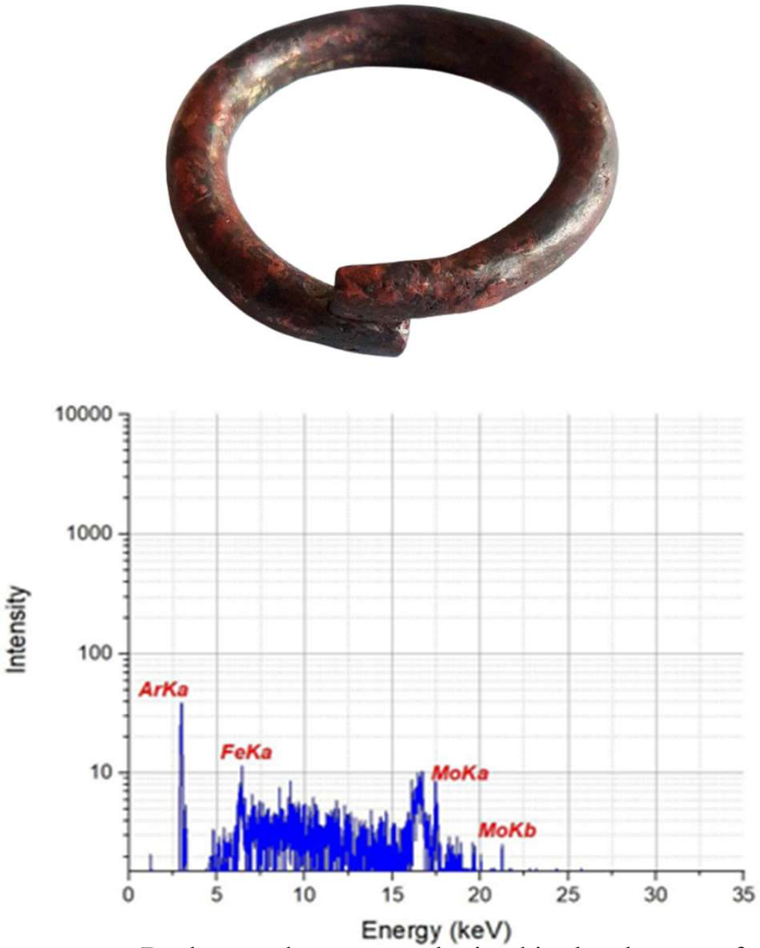
Results of XRF analysis from different areas of the bronze bracelet.

X-ray μ-tomography and spectroscopy

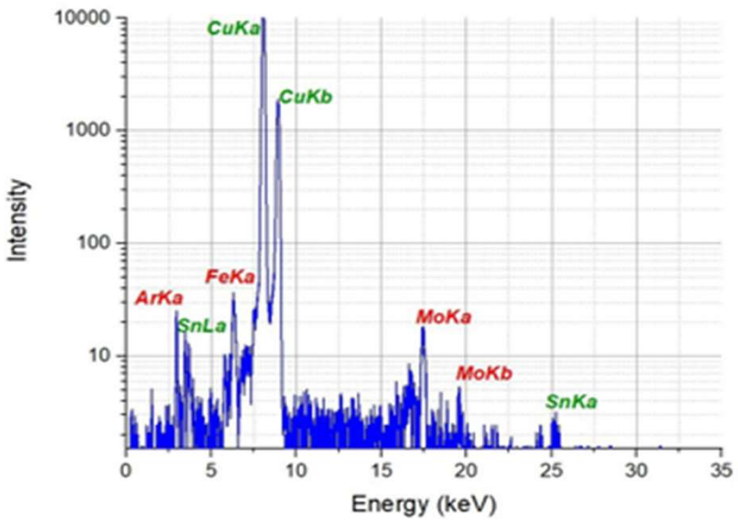
XRF spectra



XRF spectrum acquired from the point of the sample with high concentration of tin.



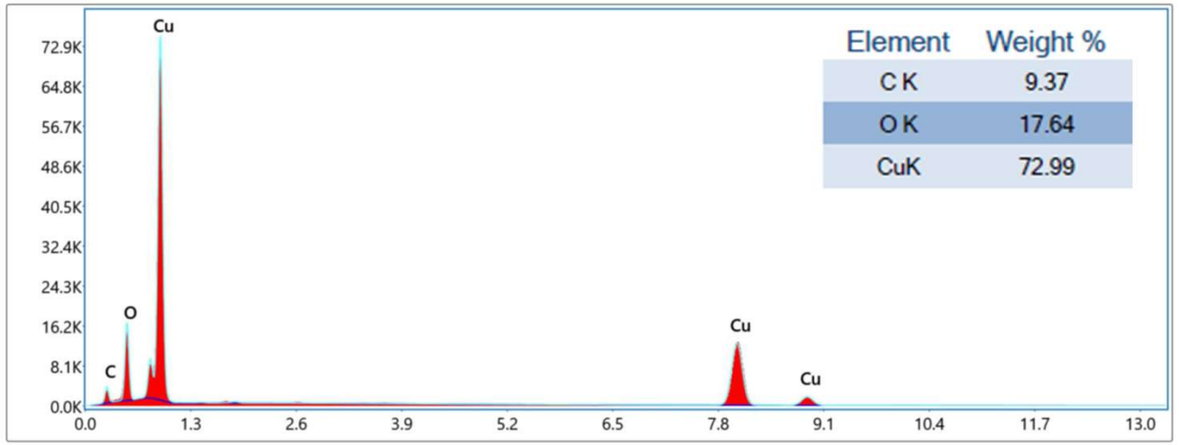
Background spectrum obtained in the absence of the investigated object.



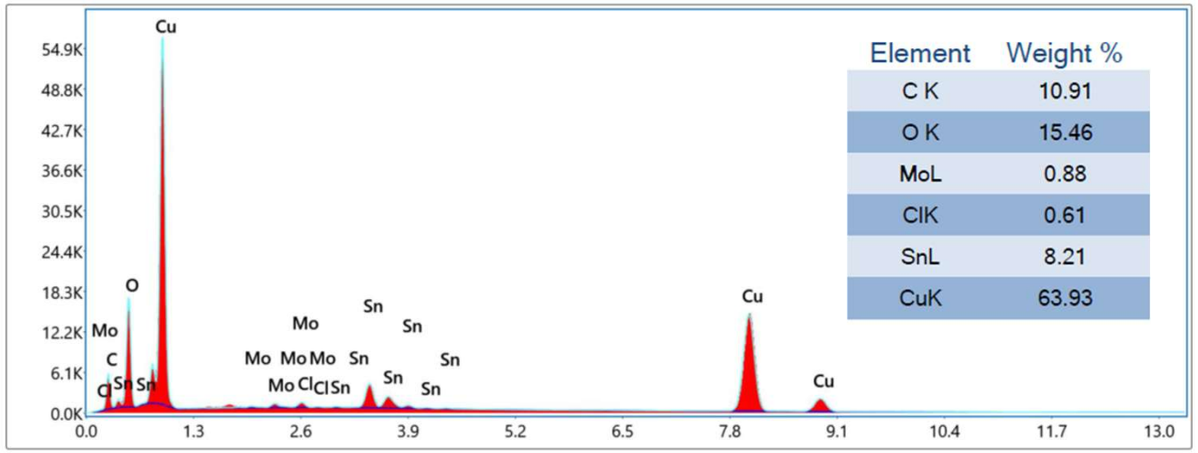
XRF spectrum acquired from the point of the sample with low concentration of tin.

X-ray μ-tomography and spectroscopy

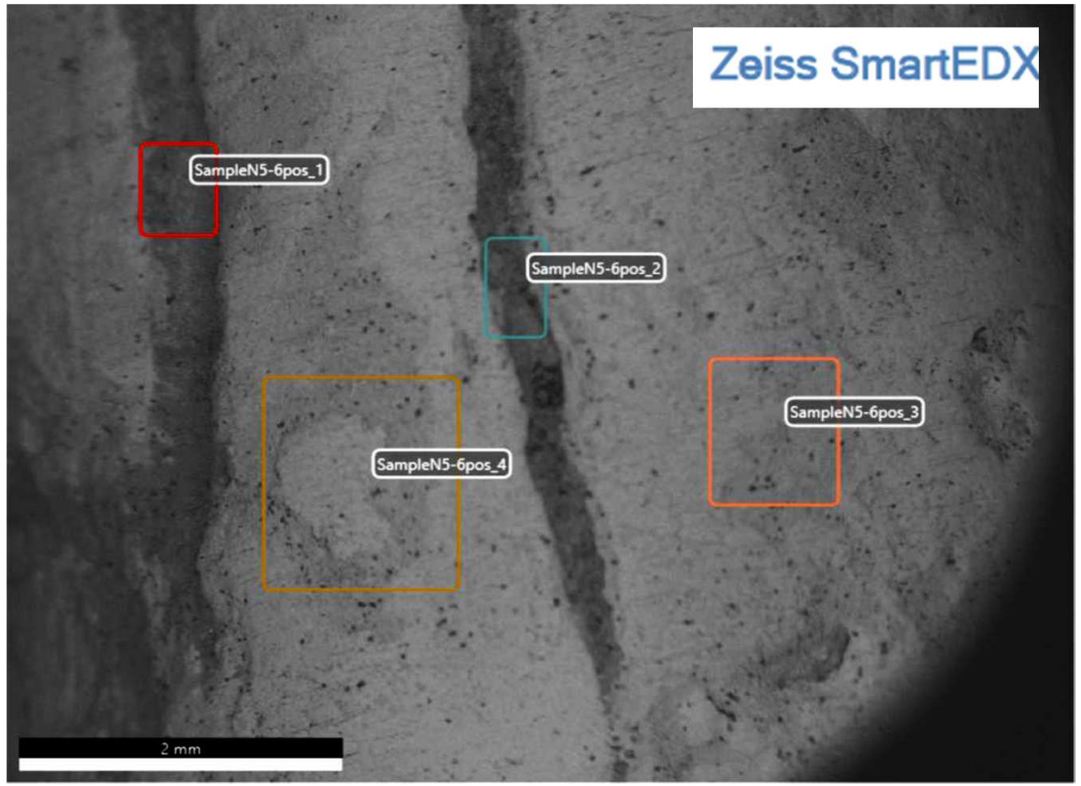
SEM analysis by the CANDLE Synchrotron Research Institute



Element	Weight %
C K	9.37
O K	17.64
CuK	72.99

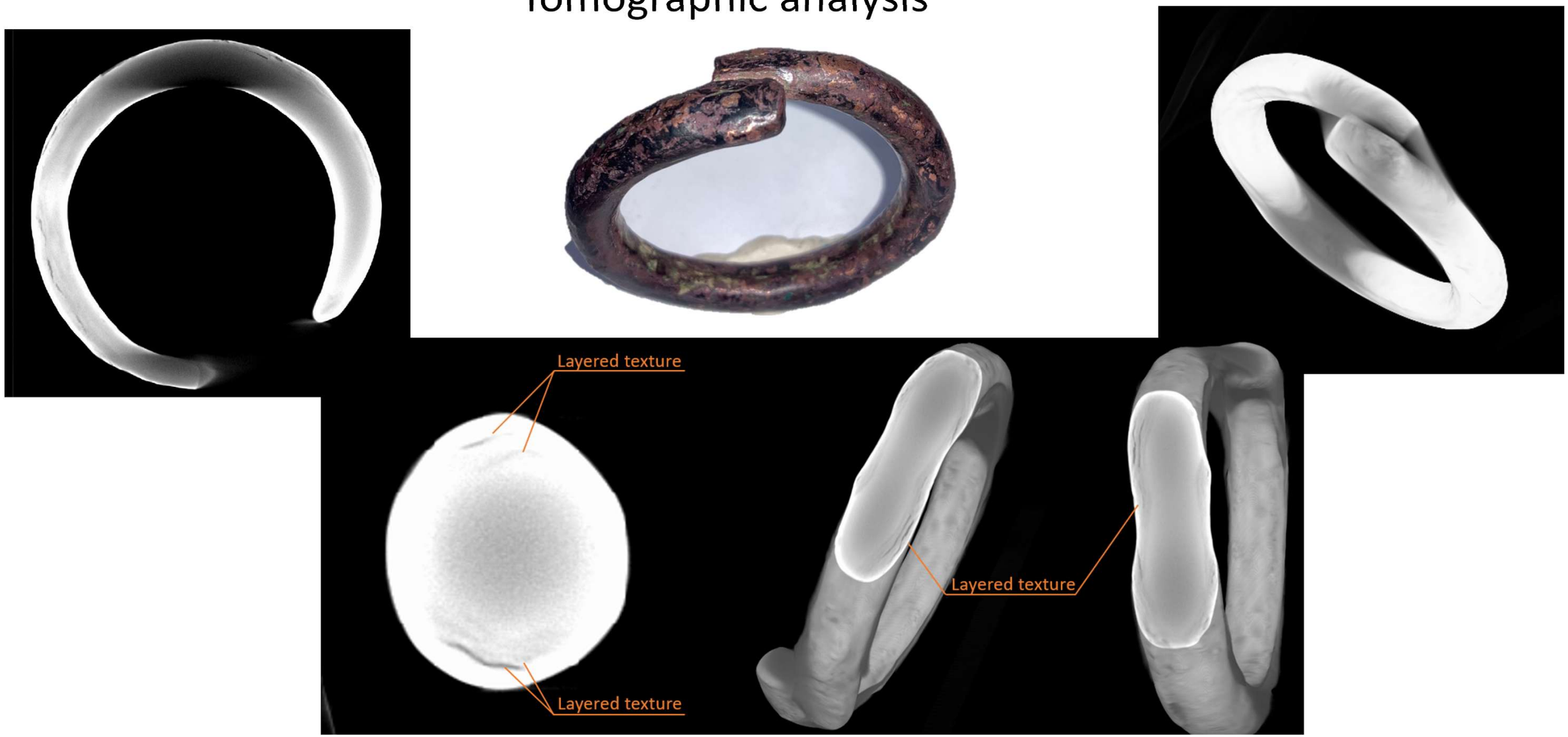


Element	Weight %
C K	10.91
O K	15.46
MoL	0.88
ClK	0.61
SnL	8.21
CuK	63.93



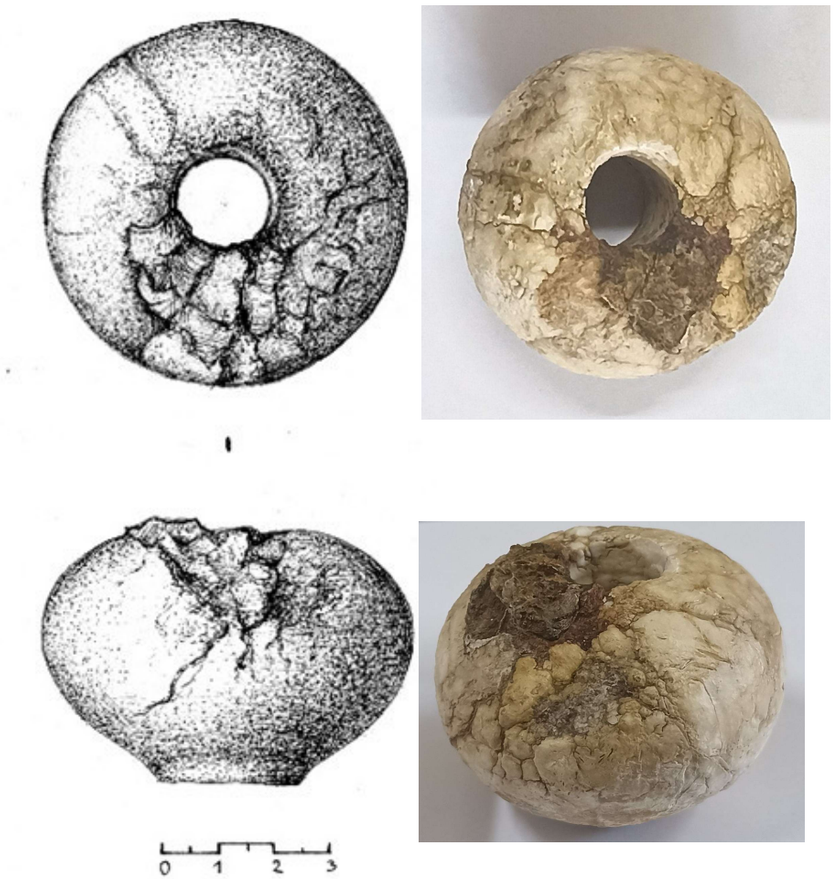
X-ray µ-tomography and spectroscopy

Tomographic analysis

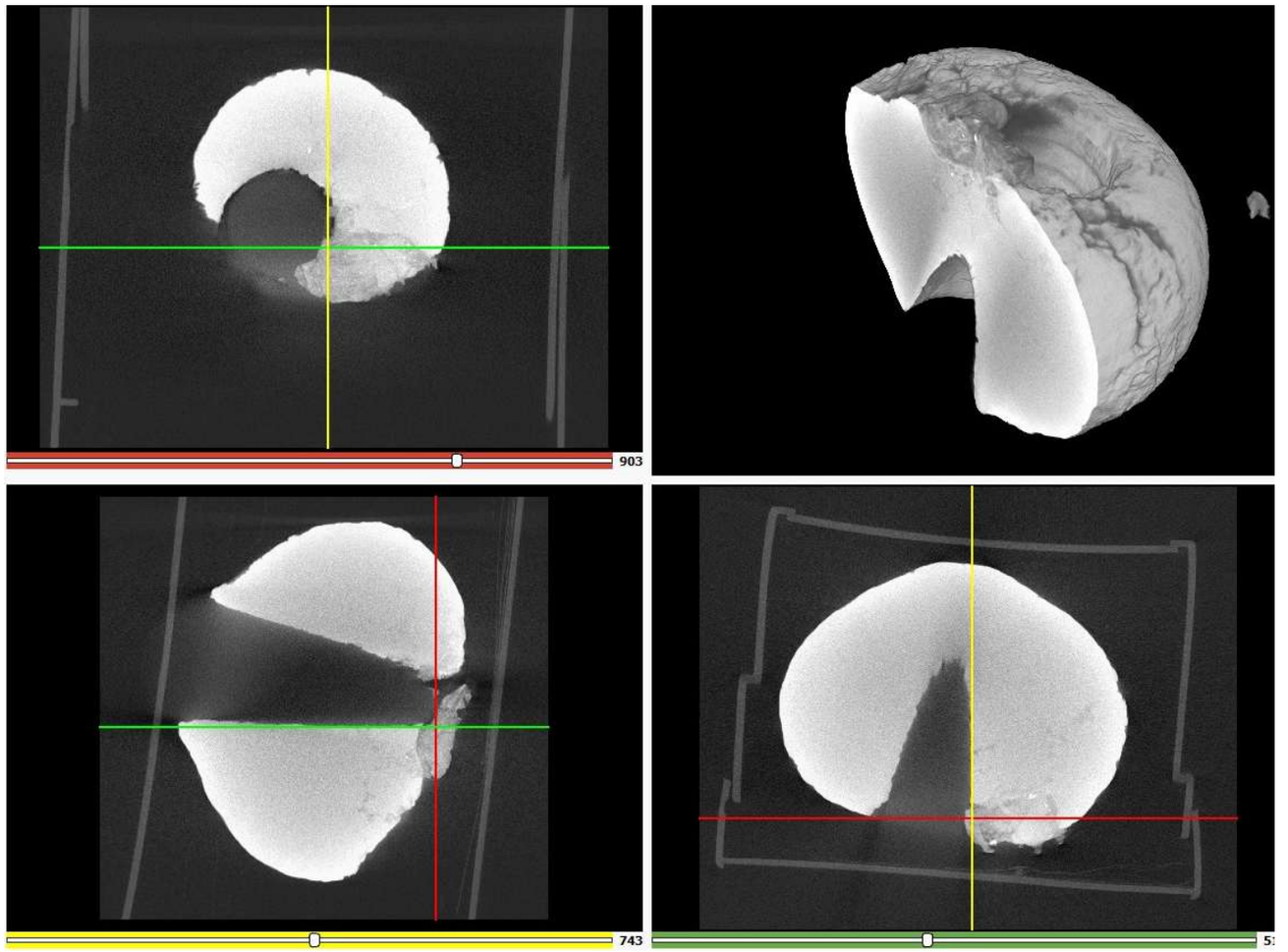


X-ray μ-tomography and spectroscopy

Tomographic analysis



Late Chalcolithic period
(4500–3500 BCE)



Շնորհակալություն