

THE STUDY OF METAL ARTIFACTS OF SLAVIC POPULATIONS IN THE TERRITORY OF THE MOSCOW REGION BY NEUTRON TOMOGRAPHY AND DIFFRACTION METHODS

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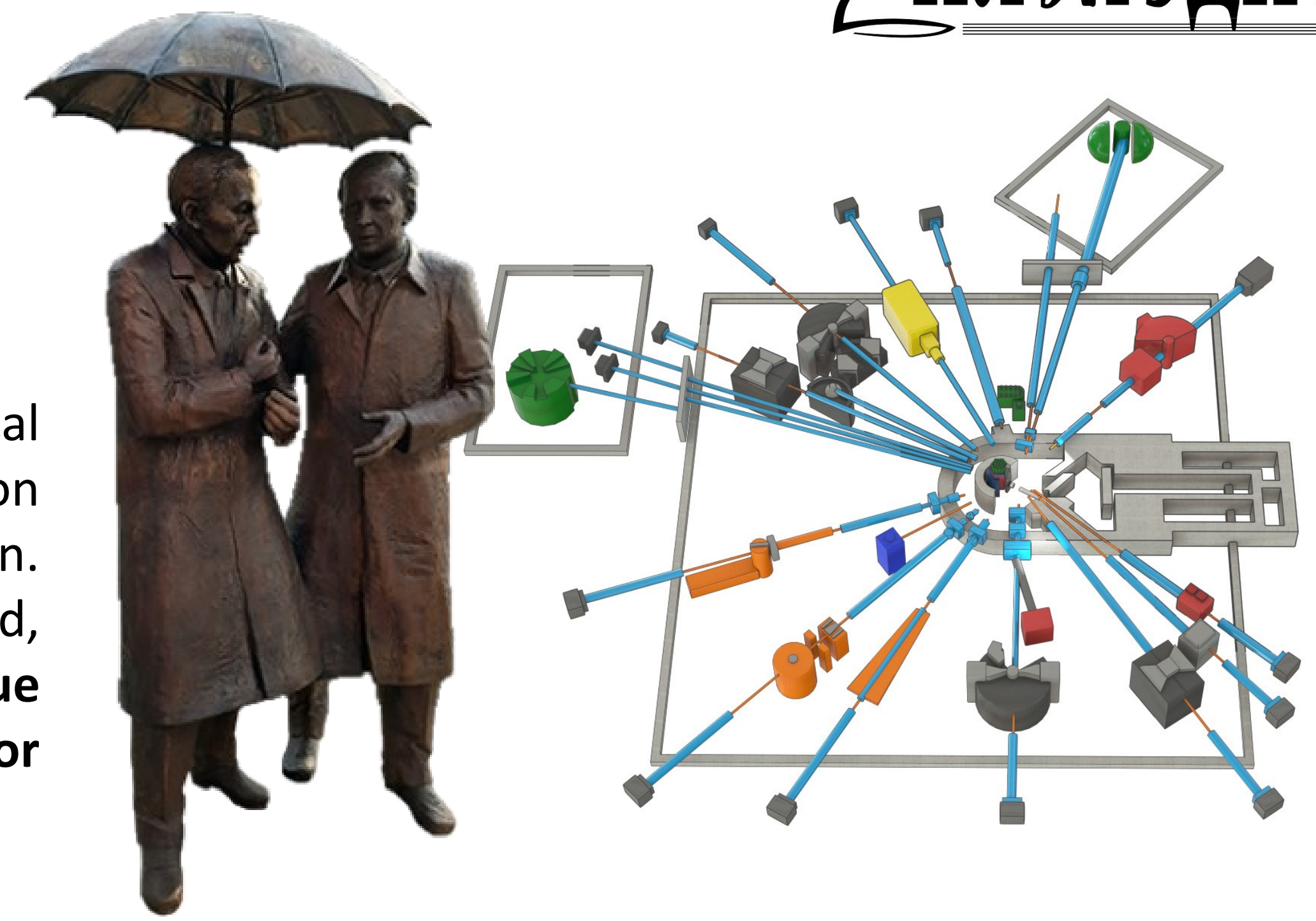
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IBR-2 reactor channel scheme, FLNP, JINR

Introduction

Recently, in archaeological research, there has been a significant increase in interest in the study of archaeological finds by methods of non-destructive structural diagnostics. Among such research methods, the methods of neutron structural diagnostics are distinguished, such as methods of neutron radiography and tomography, neutron diffraction. Non-destructive research ensures an exceptionally careful attitude to the archaeological materials being investigated, which are of high scientific and museum value. And most importantly, neutron methods allow obtaining **new unique information about the phase and elementary composition of archaeological objects, about hidden components or interior decoration of ancient products, about certain features of ancient production technologies.**

Samples

During the study of the territory of **Dubna**, Moscow Region, a number of finds were obtained, some of them were transferred for research using non-destructive methods at **FLNP JINR**.

The finds included two encolpion crosses, two underwear pectoral crosses and one zoomorphic pommel in the form of a bear's head and skin.

Encolpion crosses date back to the XII - XIII centuries, consist of two valves and a head, on the obverse there is a relief image of a cross and blackening, the parts are not detached, covered with patina.

Underwear pectoral crosses with indentations for enamel.

A **pommel**, which depicted a skin removed from a **bear with a head and paws**, in which a person could put on during ritual actions. Most likely, this pommel was shaped like a wooden or bone handle of a knife or, less likely, some kind of wand. In the Dyakian tribes, the bear was the subject of special worship as the owner of the forest. A small fragment in the lower part is broken off, the surface is corroded.



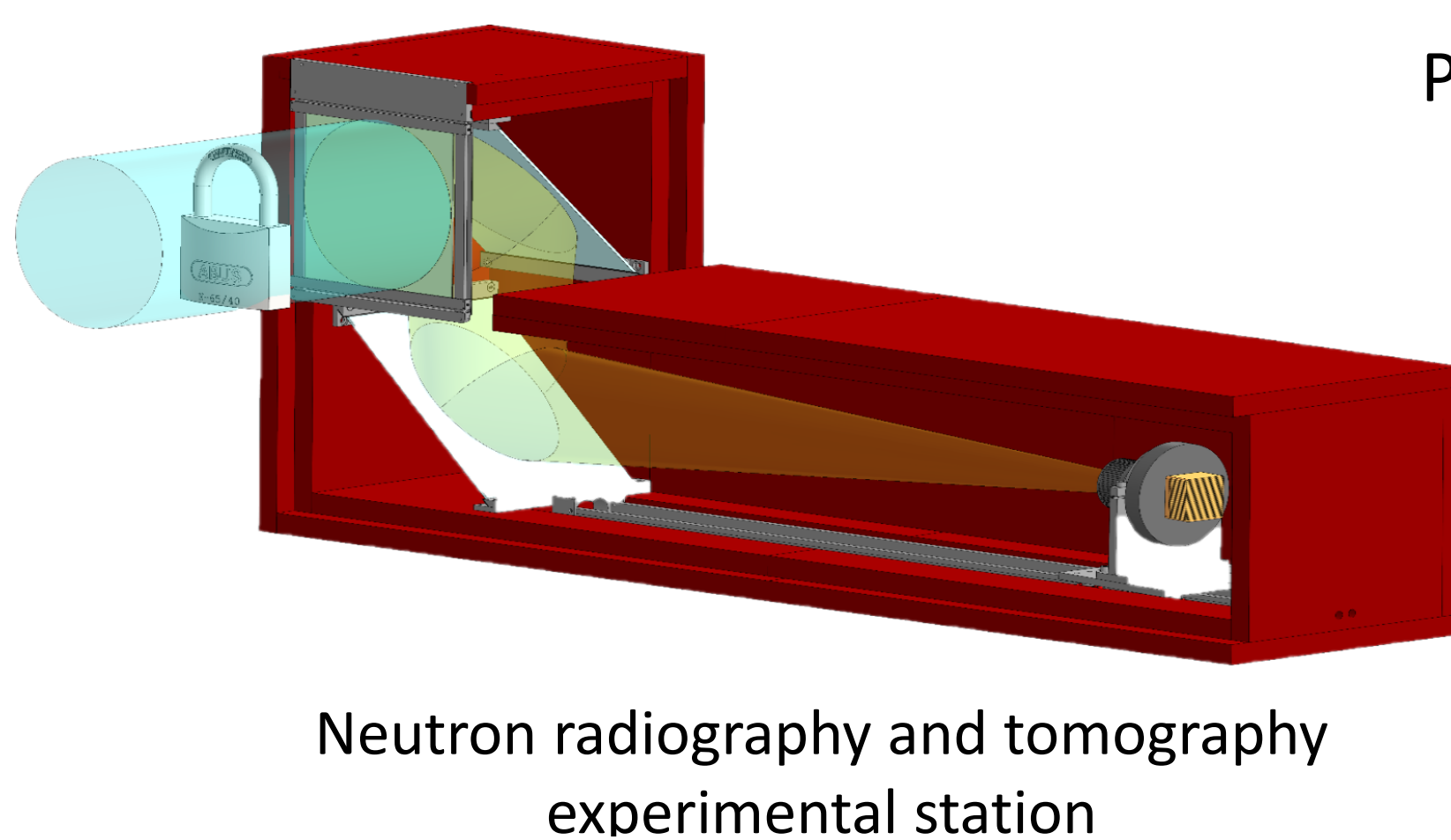
Dubna, Moscow region, Russia



IBR-2 reactor, FLNP, JINR

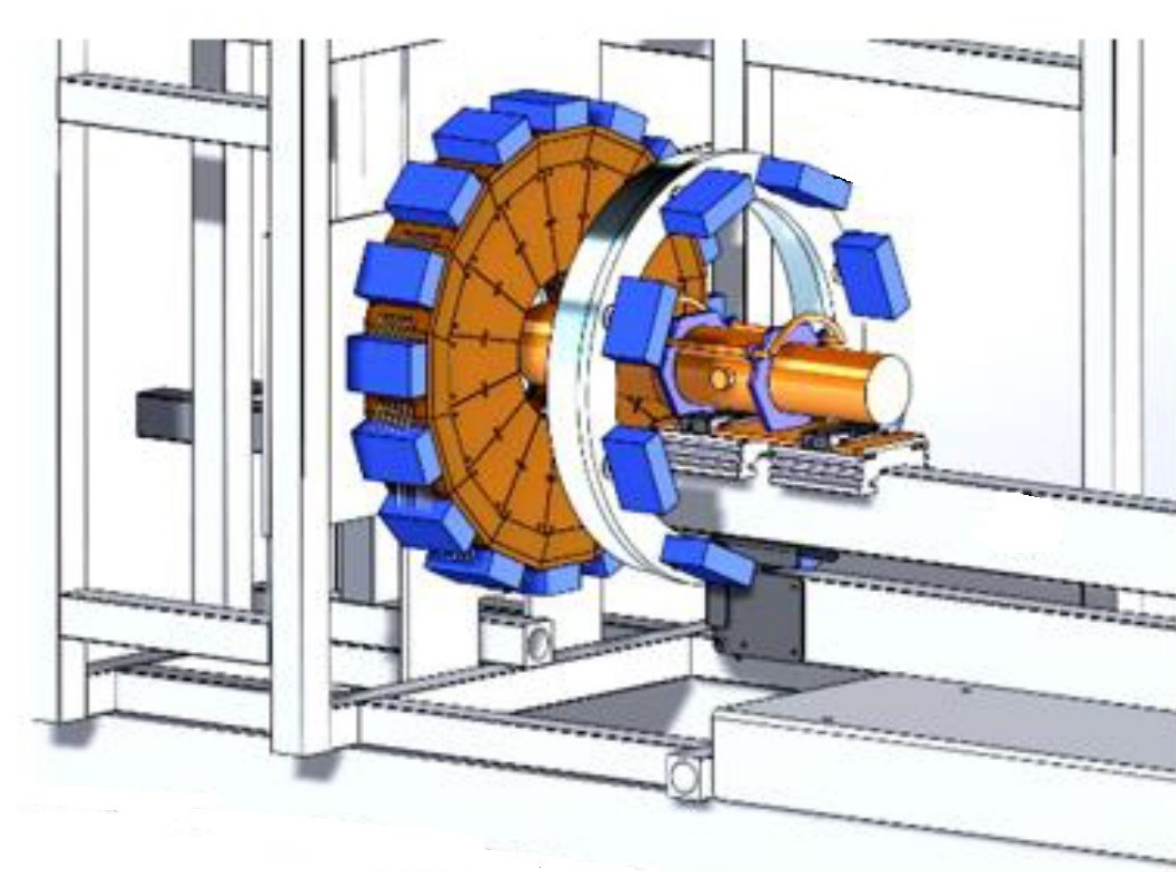
Methods

The spatial distribution of phases and components within the volume of the product was restored using the method of **neutron radiography and tomography** at a specialized experimental station on the 14th channel of the **IBR-2** pulsed reactor.

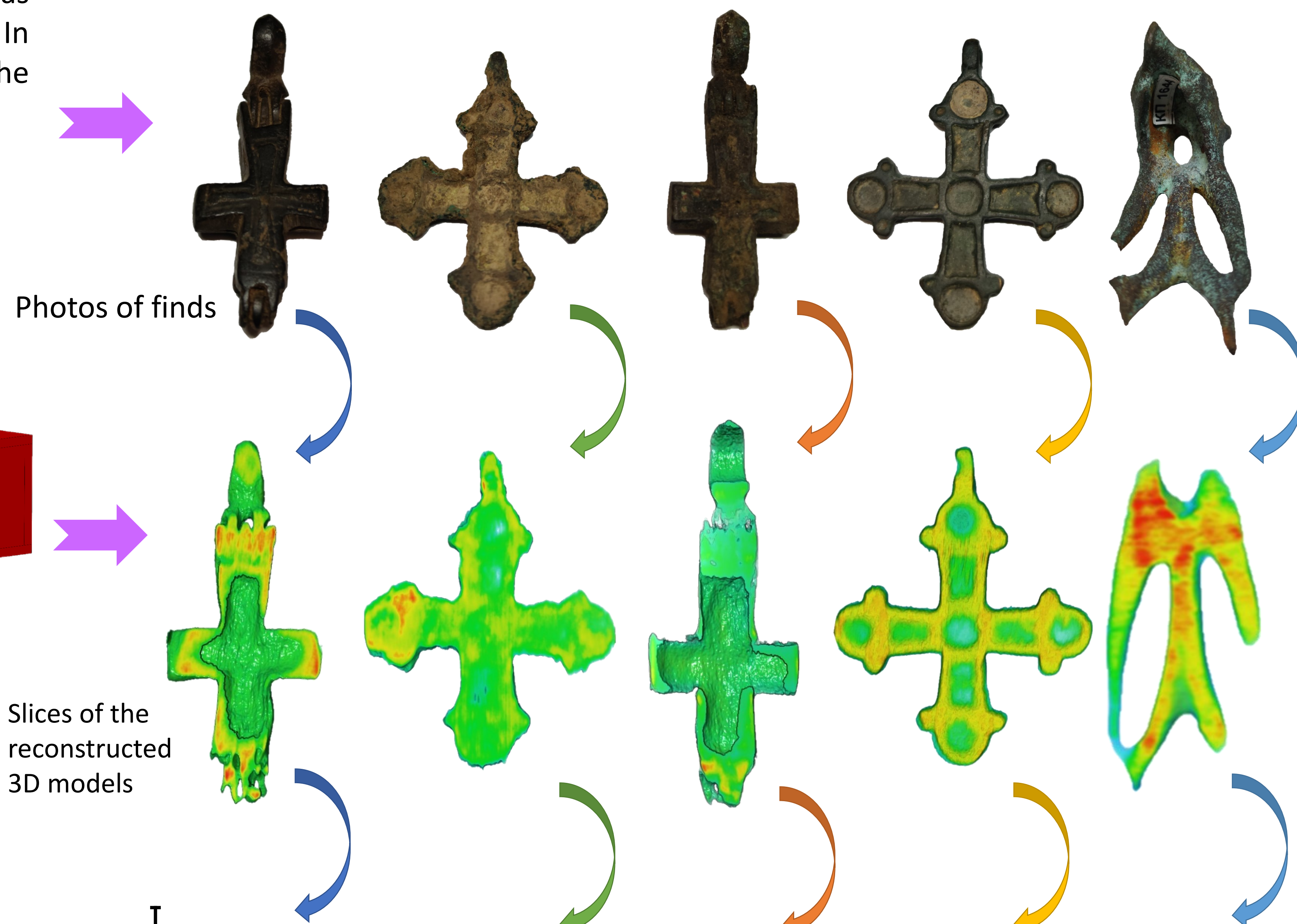


Neutron radiography and tomography experimental station

To study the phase composition, the **neutron diffraction method** was used, which was carried out on a specialized **DN-12** diffractometer at the **IBR-2** reactor.



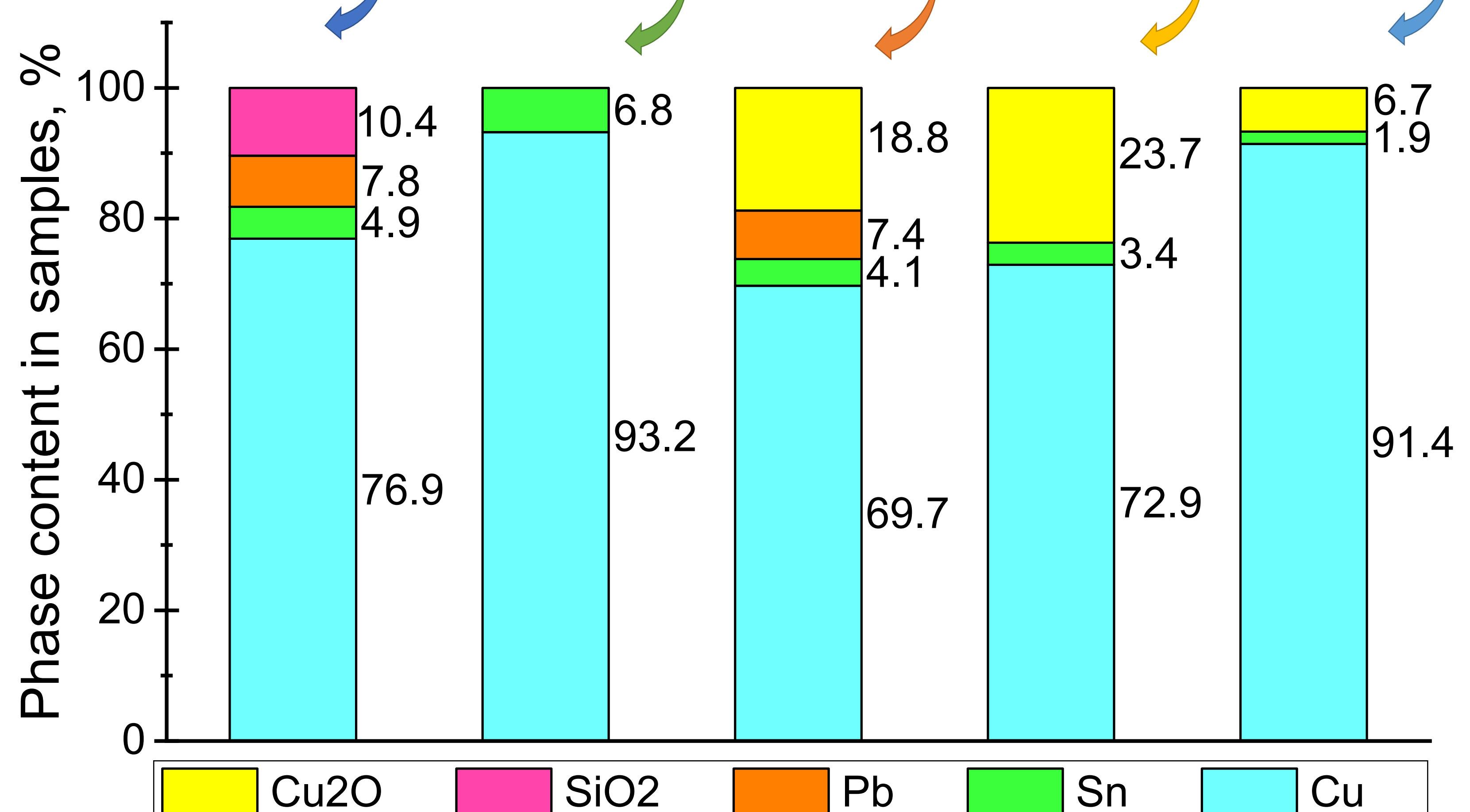
DN-12 diffractometer



Conclusions

Neutron tomography shows **uneven phase distribution** in the samples. In encolpion crosses, such unevenness is associated with the spread of corrosion in the connecting parts of the sample. It can also be seen that corrosion penetrates deep enough into the thickness of the bear-shaped figurine. Unfortunately, the contents of the encolpion crosses have not survived. The technology of making all the samples is **casting**.

All samples are composed of **tin bronze** with a tin content of 1.9% to 6.8%, which indicates **the artificial addition of tin to the alloy**. In pectoral crosses, lead is also present as an additive at a concentration of 7.4 - 7.8%. Corrosion on all samples consists of Cu_2O . One sample contains quartzite.



The phase composition diagram of samples