



Characterization of a neutron imaging setup at the INES facility



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ABSTRACT

The Italian Neutron Experimental Station (INES) located at the ISIS pulsed neutron source (Didcot, United Kingdom) provides a thermal neutron beam mainly used for diffraction analysis. A neutron transmission imaging system was also developed for beam monitoring and for aligning the sample under investigation. Although the time-of-flight neutron diffraction is a consolidated technique, the neutron imaging setup is not yet completely characterized and optimized. In this paper the performance for neutron radiography and tomography at INES of two scintillator screens read out by two different commercial CCD cameras is compared in terms of linearity, signal-to-noise ratio, effective dynamic range and spatial resolution. In addition, the results of neutron radiographies and a tomography of metal alloy test structures are presented to better characterize the INES imaging capabilities of metal artifacts in the cultural heritage field.

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1. Introduction

Analysis techniques based on thermal and epithermal neutrons represent a powerful tool to characterize metal alloy artifacts in the cultural heritage field. Neutrons are a non-invasive diagnostic tool and can penetrate thick layers of samples. Neutron transmission imaging, obtained with radiographic or tomographic techniques, allows to investigate the inner structure of artworks, determining, as an example, the materials thickness and the conservation condition [1,2]. All this information can be helpful to assist restoration activities, to increase the knowledge of the work of art and to help dating or attributing an artifact through the understanding of the manufacturing techniques used.

The Italian Neutron Experimental Station (INES) is a neutron diffractometer located at the ISIS pulsed neutron source [3]. A low-cost imaging device is currently installed and used for beam monitoring and samples positioning. Preliminary measurements were performed by Bartoli et al. [4] to test the imaging setup.

Salvato et al. realized an upgrade of the system providing the first neutron tomography investigation at INES [5].

The aim of this paper is to fully characterize the present imaging setup in terms of linearity, signal-to-noise ratio, effective dynamic range and spatial resolution. A comparison with a different converter screen and a different CCD camera will be shown. Moreover, the analysis of neutron radiography and tomography of metal alloy test structures will be presented in order to assess the diagnostic potential of the INES imaging apparatus on metal artifacts in the cultural heritage field.

2. Experimental set up

The Italian Neutron Experimental Station, INES, provides a stable pulsed neutron beam with an approximately uniform intensity distribution over a cross section, at the sample position, of $35 \times 35 \text{ mm}^2$ ($40 \times 40 \text{ mm}^2$ including also non-uniform borders). The divergence of the beam, in terms of L/D ratio, is about 90.

The neutron imaging setup currently installed consists of a scintillator converter screen, a mirror and a commercial CCD camera [6]. The scintillator is made of $\text{ZnS}/^6\text{LiF}$, 225 μm thick, layered on an aluminum substrate; in the following we will refer

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