Chapter 13
Neutron Radiography at CNA

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Abstract Neutron radiography is a non-invasive imaging technique that uses the attenuation of a neutron beam as a probe to characterize an object [1]. At Centro Nacional de Aceleradores (CNA) in Seville, we want to make the best use of our facilities, particularly in terms of the beams characteristics and neutron production, to obtain the best contrast and spatial resolution possible with a neutron camera. For this purpose, we have tested a comercial camera with a fast-neutrons converter on different configurations of the beam and the neutron production target. This has resulted in a first assessment of the limitations, future requirements and viability of introducing neutron radiography as one of the available analysis tools at CNA.

13.1 Trials and Results

At CNA, we have a 3 MV tandem accelerator type pelletron that allows us accelerating protons until the 3 MeV chosen for this experiment [2]. A solid lithium target is installed at the end of the beam line and a water cooling system allows us to reach a proton current over the target up to 10 μA [3]. The fast neutrons are then produced by means of a lithium-berilium nuclear (p, n) reaction.

The neutron camera (mini-iCam 36 mm of NeutronOptics Grenoble) is located at a determinated distance from the source with the sample placed as close as possible from the camera's aperture. The neutron camera has just in the entrance a filter composed by a combination of a rich hydrogen plastic converter for the neutrons and a scintillator material (ZnS). The incident neutrons interact with the converter, exciting the scintillator. The scintillation photons (in the visible range) are reflected

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J.-E. García-Ramos et al. (eds.), *Basic Concepts in Nuclear Physics: Theory, Experiments and Applications*, Springer Proceedings in Physics 225,
https://doi.org/10.1007/978-3-030-22204-8_13

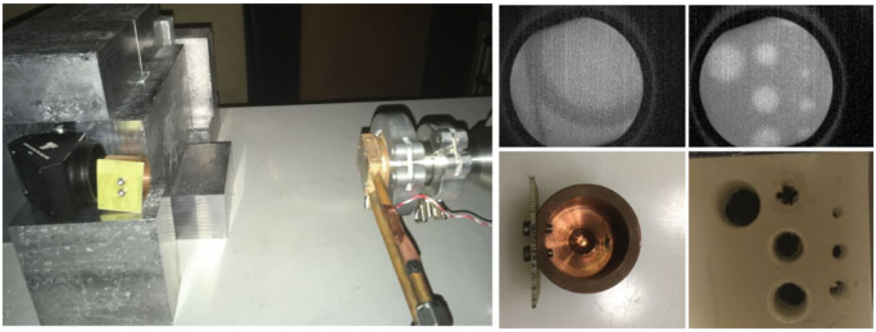

Fig. 13.1 Big panel: Picture of the experimental setup. Small panels: Object and image of some of the tests realized in the campaign. Left: Copper and plastic Faraday Cup. Right: Milimetric holes in a polyethylene piece

at a mirror and illuminate a CCD to produce the image. The CCD is shielded with lead blocks to protect it from the gamma radiation emitted by the target (Fig. 13.1, big panel).

We did a series of tests in order to quantify the viability of the mentioned setup (Fig. 13.1, small panels). These tests supposed the first neutron radiography in a Spanish research center. The conclusions are that we can obtain acceptable images in exposures of tens of minutes, identifying different materials and detecting different thicknesses of the materials, see under metallic shielding and resolve milimetric structures. Despite this promising results, we have to deal with different limitations as the low neutron fluence or the upper limit in the proton current that we can use over the target because of the high activation that we produce on it. In addition, despite the thick shield (5 cm of lead blocks), the long exposure of the camera to the gamma radiation that comes from the source ended up damaging the CCD, increasing the number of dead pixels from a 3 to a 55%.

The future work, in order to reduce this limitations, should be focused on preventing the CCD damage by means of new shieldings and cooling systems, optimizing the image treatment and improving the neutron fluence investigating other production reactions, and studying the viability of collimating the neutron source.

References

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