Reconstruction of an Old Watch with Neutron Tomography

W. Treimer, S.-O. Seidel, O. Ebrahimi (January 2010)

Application Note

Introduction

The Beuth Hochschule für Technik Berlin operates two instruments at the BER II reactor of the Helmholtz-Centre for Materials and Energy Berlin (HZB), an ultra small angle neutron scattering instrument USANS (V12) and a neutron tomography instrument for polarized neutrons PONTO (V19). The tomography instrument uses a camera box with a back illuminated CCD detector (DV434-BV by Andor Technology).

Experiment

The camera was used at two different set ups, first at test set up using parts of the USANS instrument, a "short – version" of a neutron tomography instrument, having a length 208 cm. Then the camera was used at the PONTO instrument which has a 5 times higher flux.

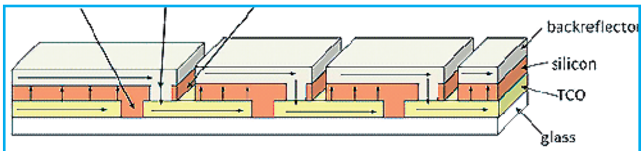

Fig.1 - Sketch of instrument V12c
Details in Fig.1

1 – Object on rotation axis
2 - Scintillator
3 - Mirror
4 - Objective
5 – CCD detector (Andor DV434-BV)
6 – Data processing equipment

The tomography of an old watch was carried out at the short-version-CT instrument, realising a spatial resolution of 170 µm, depending on the best combination of lenses and scintillators. A graphite crystal [002] directs a monochromatic neutron flux with λ= 0,524 nm and with an approximate neutron flux density of $5x10^5$ $cm^{-2}s^{-1}$ towards the position of the sample which was app. 120 cm apart from beam limiting slits.

The sample could be rotated with an accuracy of 0.01°. The detector consisted of a LiZnS scintillator (400 µm), a mirror, an objective and a CCD camera with a pixel field of 1024 x 1024 pixels, each pixel size of 13 µm.

The luminescent screen converts the neutron into photons that are collected on a CCD chip via mirror and lens. The mirror is used to minimize the high energy background radiation (gammas) that would otherwise destroy the chip. As an objective we used the new AF-S Nik 105, 2.8. The camera used has a dynamic range of 16 bit.

The reconstruction was done from 301 projections over an angular range of 180° with an exposure time of 17 min/projection. Moreover, 10 dark fields' and 10 flat fields with identical exposure time were registered. The dimensions of the object were (w x h x d) 35 x 40 x 12 mm^3. The resolution of the system was 220 µm in horizontal direction and 300 µm in vertical direction for a maximum sample-detector position of nearly 35 mm. The reconstruction of the slices was carried out with the programme Octopus® and the one of the three-dimensional object was carried out with the software VG Studio Max®.

Results

The2D reconstruction shows details that are clearly visible, which are attributed on one hand to the set-up and on the other hand to the progressive software (Fig.2).

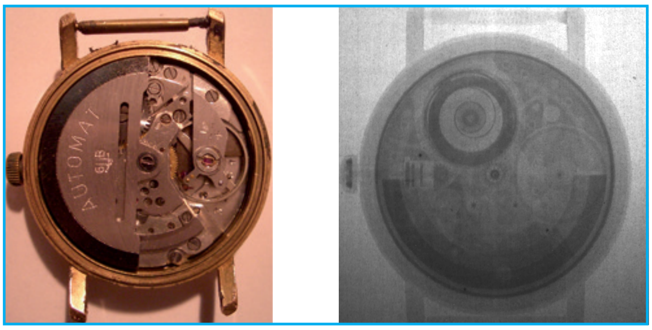

Fig.2 - Left: picture of old watch, right: radiogram at 180°

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With the same experimental parameter except the 50 μm thick scintillator screen we carried out the tomography at PONTO using the higher neutron flux. Fig.3 shows the result. With the Andor camera we reached at spatial resolution <100 μm.

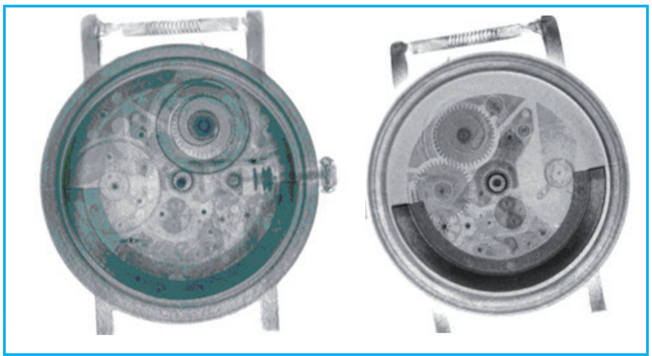

Fig. 3 - Neutron tomography reconstruction of an old watch, different layers

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