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What Future in Neutron Imaging?

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The usage of neutron beams for non-destructive material studies has a long tradition since suitable sources were available. Meanwhile, neutron imaging has been developed towards a routine method at many places with basic (radiography, tomography) and more advanced (grating interferometry, polarized and diffractive imaging, data fusion) features. This development was only possible after the introduction of digital detection systems which mostly replaced analogue (film based) detection methods.

A generic neutron imaging facility consists of the following components: primary source, beam tuning devices, sample environment and a neutron imaging detector. There is no real standard how to tune and to compose these different pieces in the best way: each neutron imaging facility is built uniquely, taking into account the specific properties, mainly those of the neutron source.

Most of the powerful neutron sources in use for neutron imaging are based on research reactors. IAEA is providing a useful tool for a survey about the situation of research reactors world-wide [1]. It gives the following status: operational: 223, usage for neutron radiography: 72, under construction: 8, planned: 14. In addition to these sources there are projects planned and realized for neutron imaging stations at spallation sources. Other accelerator driven sources, based on D-D or D-T reactions are available and used partly for some imaging activities.

In general, the number of sources will be more reduced than increased, given by the reactor age and the public acceptance in several countries. Therefore, the way to increase further the capabilities for neutron imaging is to access the underutilized sources and to equip them with best-performing infra-structure. Fortunately, some of the new source projects take neutron imaging options into account from the beginning and a best performing facility can be built. To install neutron imaging stations at an already equipped source needs special considerations and often compromises.

Another important aspect is the introduction of neutron imaging methods into practice either of scientific or practical applications. Since X-ray methods are much more common and increasingly used for research and in industry, a direct competition is not possible although some technical details are similar. We have to focus more on the inherently strength of neutrons and to perform related investigations under highly professional and best performing conditions. Therefore, the access for scientific users and industrial partners to neutron imaging facilities has to be enabled easily. Due to the limited number of high performing beam lines and the different shut-down phases a dialogue between the facility operators will help to increase the utilization on highest level.

There is still much potential for further methodical development and technical improvements. In addition, a focus has to be given to the data treatment and evaluation while the image data volume is increasing dramatically. A link to neutron diffraction and scattering enables a deeper insight to material properties and their modifications. New aspects like additive manufacturing and the study of materials for energy conversion and storing are handled very efficiently using neutron imaging techniques.

[1] https://nucleus.iaea.org/RRDB/RR/ReactorSearch.aspx?rf=1

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