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NECTAR: Radiography and tomography station using fission neutrons

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Abstract: NECTAR, operated by the Technische Universität München, is a versatile facility for the non-destructive inspection of various objects by means of fission neutron radiography and tomography, respectively.

1 Introduction

The images (radiographs, 2- and 3-D-tomographs etc.) obtained from probing objects by means of fission neutrons often show complementary or additional information compared to the investigation with X-rays, γ-radiation or even cold or thermal neutrons. Especially for large objects consisting of dense materials, the deep penetration of fission neutrons is well suited for their non-destructive investigation, still beeing sensitive for the detection of hydrogen containing materials.

The instrument NECTAR is controlled using the NICOS (see also Networked Integrated Control System (2002)). It is a python based control environment, allowing a simple use for non-experienced users and the development of individual scripts for more advanced users.

The acquired radiographs are available in different image formats (e.g. fits and tif) and can be processed by most common image processing tools. On demand, reconstruction and visualization software is available on-site for data analysis.

The NECTAR facility shares the available beam time with the MEDAPP facility (Heinz Maier-Leibnitz Zentrum, 2015) as both are using the same beam tube SR10.

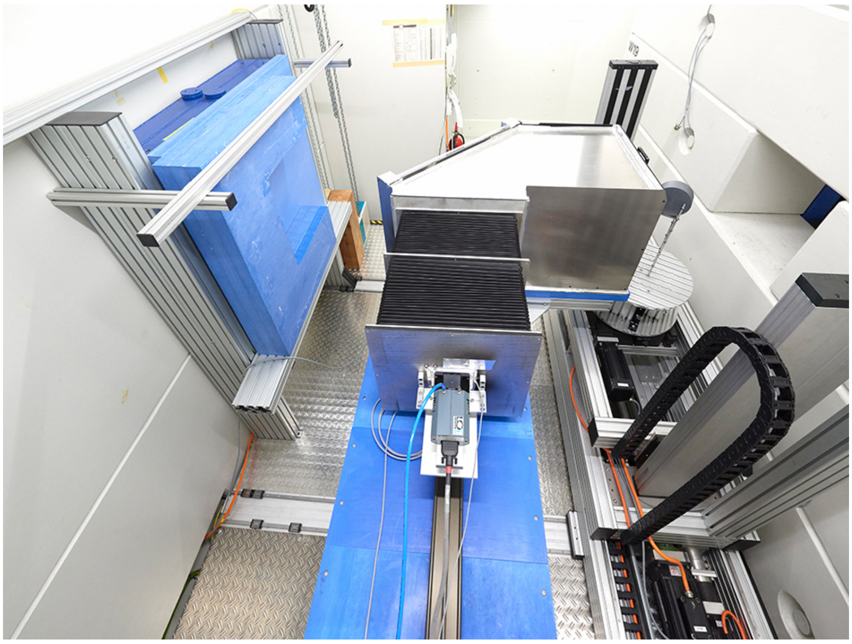

Figure 1: Instrument NECTAR: The fission neutrons are coming from the right, penetrating the sample fixed on the manipulator, and are detected by a CCD-based system (center). A beamstop (left) minimizes scattered radiation. (Copyright by W. Schürmann, TUM).

2 Typical Applications

- Cultural Heritage
  - Restauration and conservation of objects
  - Inner structure of large archaeological objects
- Technology
  - Hydrogen storage
  - Degradation of glue in timber
  - Water or oil in large metallic objects (e.g. gearboxes)
- Biology
  - Water uptake in large wooden samples

3 Technical Data

3.1 Neutron source

- Converter facility at FRM II:
  - Consisting of 2 plates of uranium-silicide (93 % ^{235}U, total 540 g)
  - P = 80 kW

3.2 Neutron spectrum

- Fission spectrum:
  - Mean energy: 1.8 MeV
  - Neutron flux: up to $8.7 \cdot 10^5$ cm^{-2} s^{-1} – $4.7 \cdot 10^7$ cm^{-2} s^{-1} (depending on filter used)
- Thermal spectrum of the D_2O moderator:
  - Mean energy: 28 meV
  - Neutron flux: up to $1 \cdot 10^7$ cm^{-2} s^{-1}

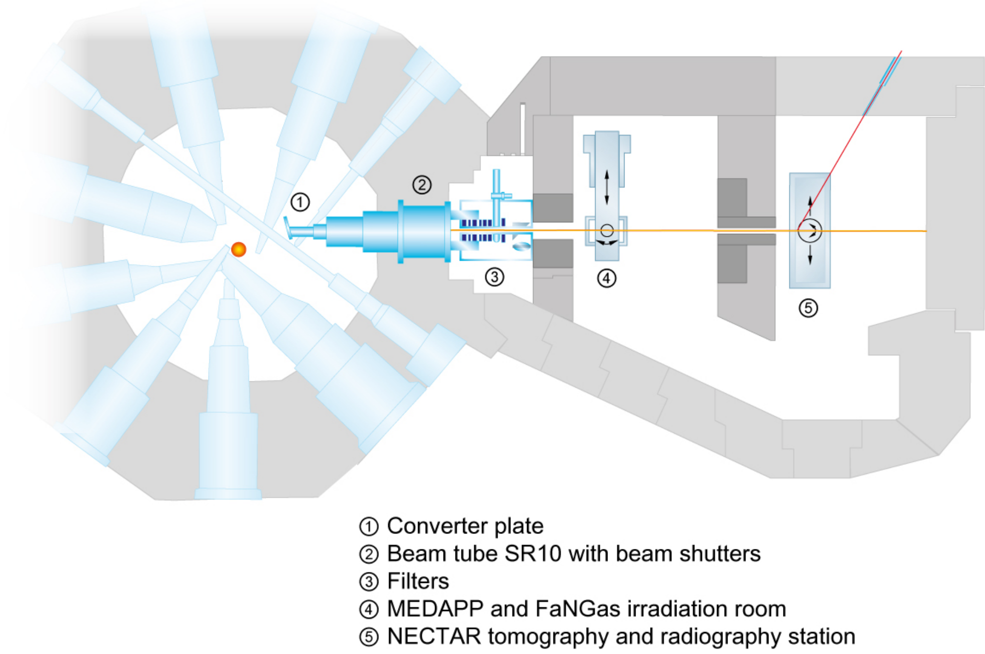

Figure 2: Schematic drawing of NECTAR and MEDAPP (Heinz Maier-Leibnitz Zentrum, 2015).

3.3 Collimation

- L/D: $\leq 233 +/- 16$ (depending on collimator)

3.4 Sample space

- Max. 80 cm x 80 cm x 80 cm (W x H x T), maximum thickness also depends on material
- Max. 500 kg
- Any standard sample environment available MLZ and custom environments required for specific user experiments can be easily attached (e.g. hydrogen supply)

3.5 Detection systems

- CCD-based (ANDOR DV434-BV, Andor iKon-M-BV, pco. 1600) detection systems with different converters, e.g. PP-converter with 30 % ZnS and 30 cm x 30 cm x 0.24 cm (W x H x T) available

References

Heinz Maier-Leibnitz Zentrum. (2015). MEDAPP: fission neutron beam for science, medicine, and industry. *Journal of large-scale research facilities*, *1*, A18. http://dx.doi.org/10.17815/jlsrf-1-43

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