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MEDAPP: Fission neutron beam for science, medicine, and industry

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Abstract: The instrument MEDAPP (**Med**ical **App**lications), operated by the Technische Universität München, and the respective irradiation position are located at the world-wide unique fast neutron beam tube SR10 to which a uranium converter is attached. Thus, the instrument is operated with unmoderated fission neutrons and can be used for a broad variety of applications. For selected tasks, an alternative use with thermal neutrons is possible.

1 Introduction

MEDAPP is an instrument primarily built for the medical treatment of malignant tumours; but the irradiation room (see Figure 1 and 2) can also be used for general purposes, e.g. for biological research and technical irradiations. Due to their energy spectrum, fast reactor neutrons have the highest biological effectiveness of clinical neutron beams used in cancer treatment, comparable only to the effectiveness of heavy ions. This advantage comes at the expense of penetration depth in tissue, which - due to the relatively low energy of 2 MeV - limits the application of fast reactor neutrons to near-surface tumours, typically recurrent breast tumours and melanomas. The particularly large beam cross-section of SR10 allows the irradiation of rather large objects, such as groups of cell culture flasks or complete electronic devices. In addition, the FaNGas (Fast Neutron Gamma Spectrometry) instrument, consisting of a movable shielded HPGe detector system, can be installed within the MEDAPP irradiation chamber to directly measure gamma radiation emitted, e.g., in (n,n'), (n,2n), (n,p), and (n,α) reactions and for non-destructive qualitative elemental analysis.

Figure 1: The irradiation room of MEDAPP (Copyright by W. Schürmann, TUM).

2 Typical Applications

- Neutron medical treatment of malign tumours
- Biological dosimetry, e.g., irradiations of cell cultures
- Irradiations of electronic components (also on-line tests)
- Fundamental physics
- In beam gamma spectrometry

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)

3.2 Neutron spectrum

- Fission spectrum:
  Mean energy: 1.9 MeV
  Flux: up to $7 \cdot 10^8$ n cm^{-2} s^{-1}
  (depending on filter used)
- Thermal spectrum of the D_2O moderator (without converter):
  Mean energy: 28 meV
  Flux: ca. $2 \cdot 10^9$ n cm^{-2} s^{-1}

3.3 Collimation

- Multi-leaf collimator, individually adjustable up to 27 cm x 19 cm.

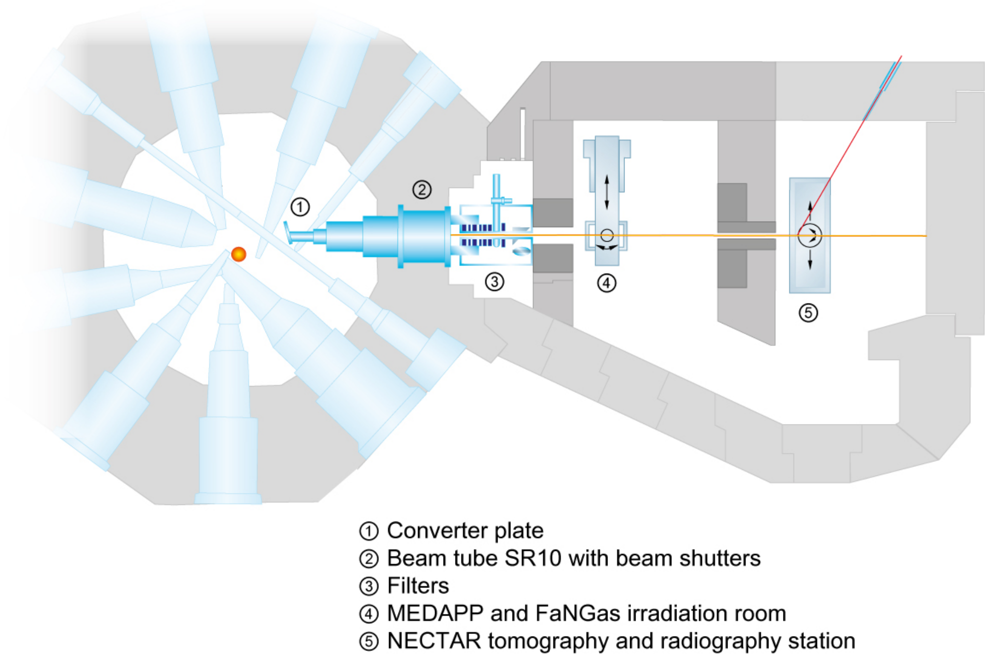

Figure 2: Schematic drawing of the facilities MEDAPP and NECTAR (Heinz Maier-Leibnitz Zentrum, 2015) at beam tube SR10.

3.4 Sample space

- Max. 40 cm x 30 cm

3.5 Detection systems

- Ionisation chambers for dosimetry in custom-made phantoms
- 50 %-HPGe detection system shielded with PE, B_4C, and Pb
- Custom systems can temporarily be installed by users

References

Heinz Maier-Leibnitz Zentrum. (2015). Nectar: radiography and tomography station using fission neutrons. *Journal of large-scale research facilities*, *1*, A19. http://dx.doi.org/10.17815/jlsrf-1-45