A Thermal Neutron Beam Option for NECTAR at FRM II

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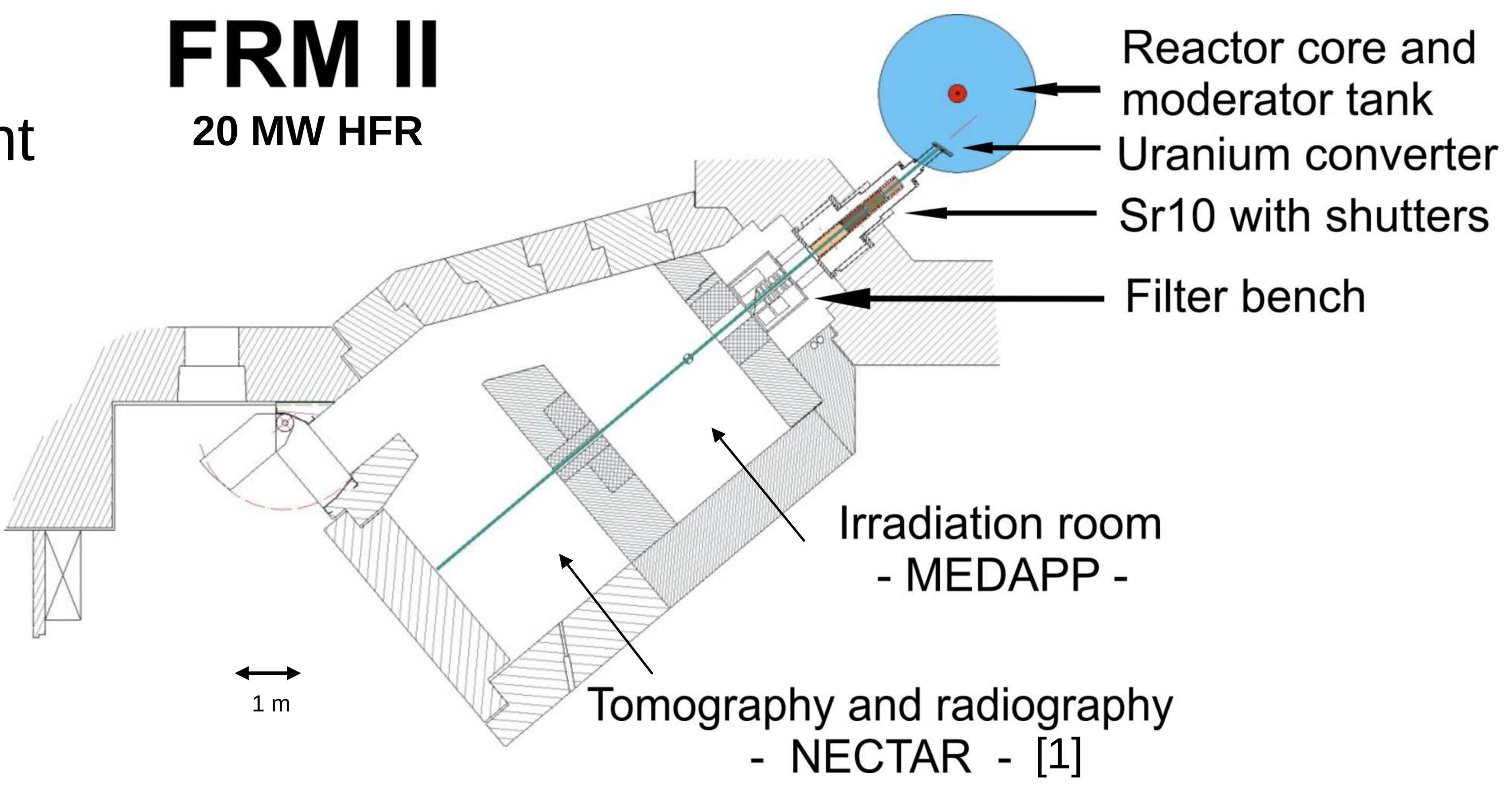
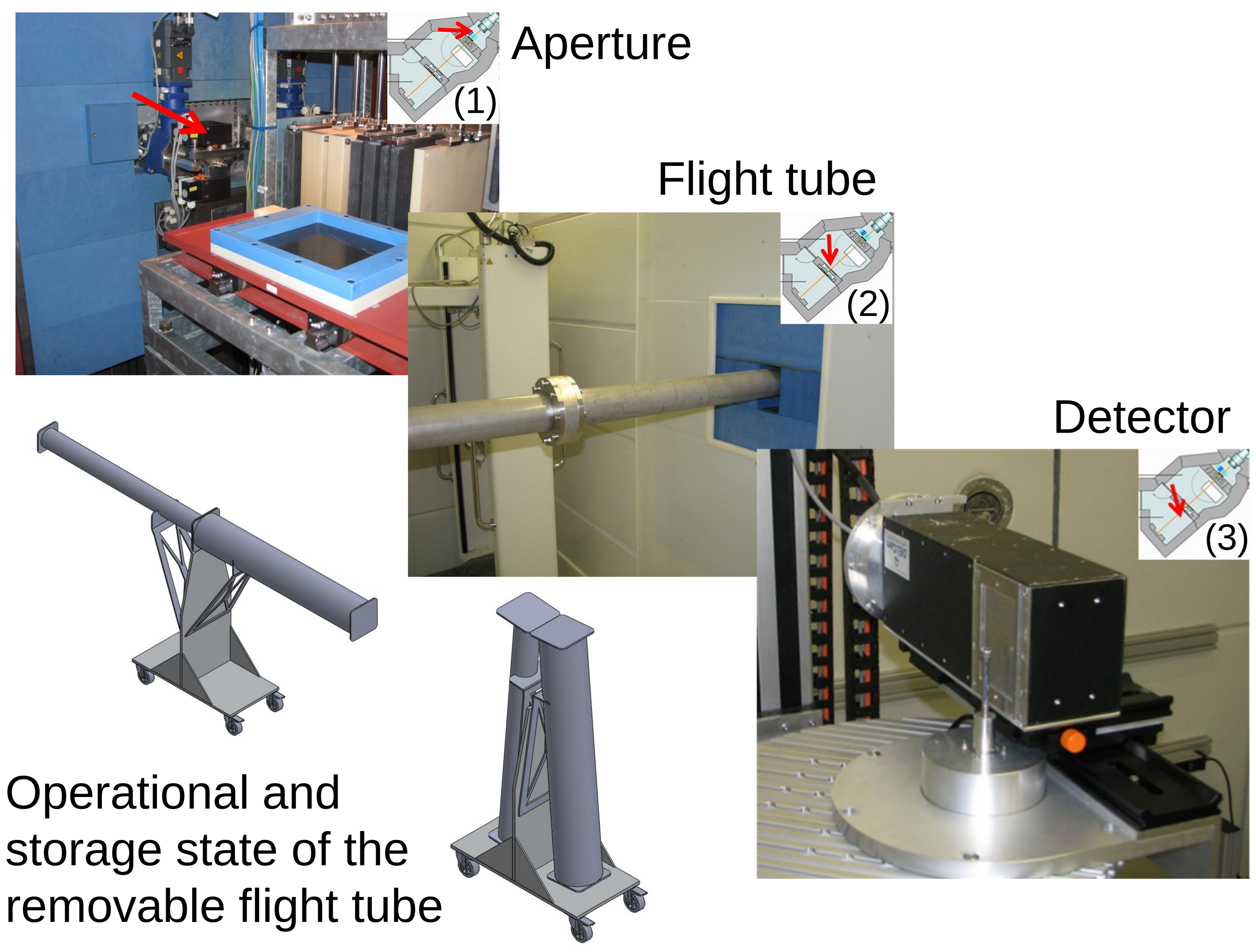
Motivation

- Combination of thermal and fast neutrons at a single instrument
- Thermal beam accessible by simply removing the uranium converter via remote control
- Only slight modifications of the existing instrumentation; main components like shielding, shutter system, access control and sample positioning do not need to be changed or adapted
- Pure thermal beam extends the neutron energy spectra available for neutron imaging at FRM II





Operational and storage state of the removable flight tube

Prove of concept

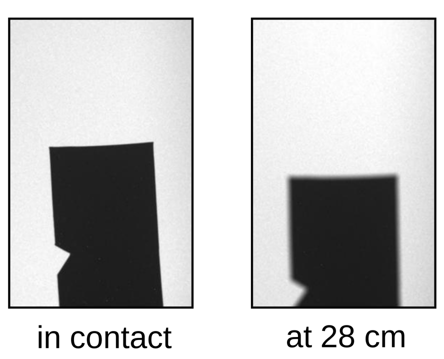
- Installation of an aperture, 25 mm in diameter, at the neutron beam window in front of the filter bench (Fig.1)
- Evacuated flight tube mounted temporarily inside the irradiation room (Fig. 2)
- DELCam [2] used as a preliminary detector for thermal neutrons, small rotation stage for tomography (Fig. 3)
- estimated parameters:
  - neutron flux 10^7 n s^{-1} cm^{-2}
  - L/D ratio 240
  - beam size 85 mm

The thermal neutron beam option does fulfill the requirements of a state of the art neutron imaging facility [3]. A removable flight tube has to be constructed for the irradiation room.

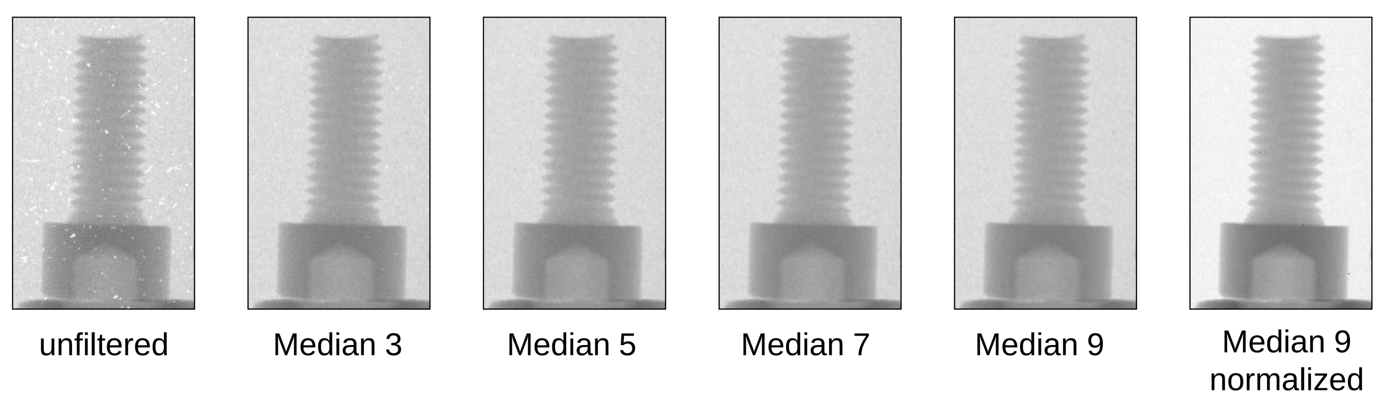
Preliminary results

- The spatial resolution could be determined by a Cd edge to be 88.2 µm (5.66 lp/mm); at a distance of 28 cm still 569 µm (0.88 lp/mm) were reached.
- Gamma spots are efficiently removed by filtering a series of 3 to 5 images (here for a M5 screw).
- For samples with higher neutron absorption a pure thermal beam helps to reduce beam hardening effects and cell activation compared to a cold neutron beam, e.g. for lithium-ion batteries.
- Tomography data sets acquired at ANTARES (cold/thermal), NECTAR (thermal) and SPODI (monochromatic, λ=1.548 Å) have been compared, where a thermal spectrum seems to be a good compromise between neutron statistics and beam hardening effects.

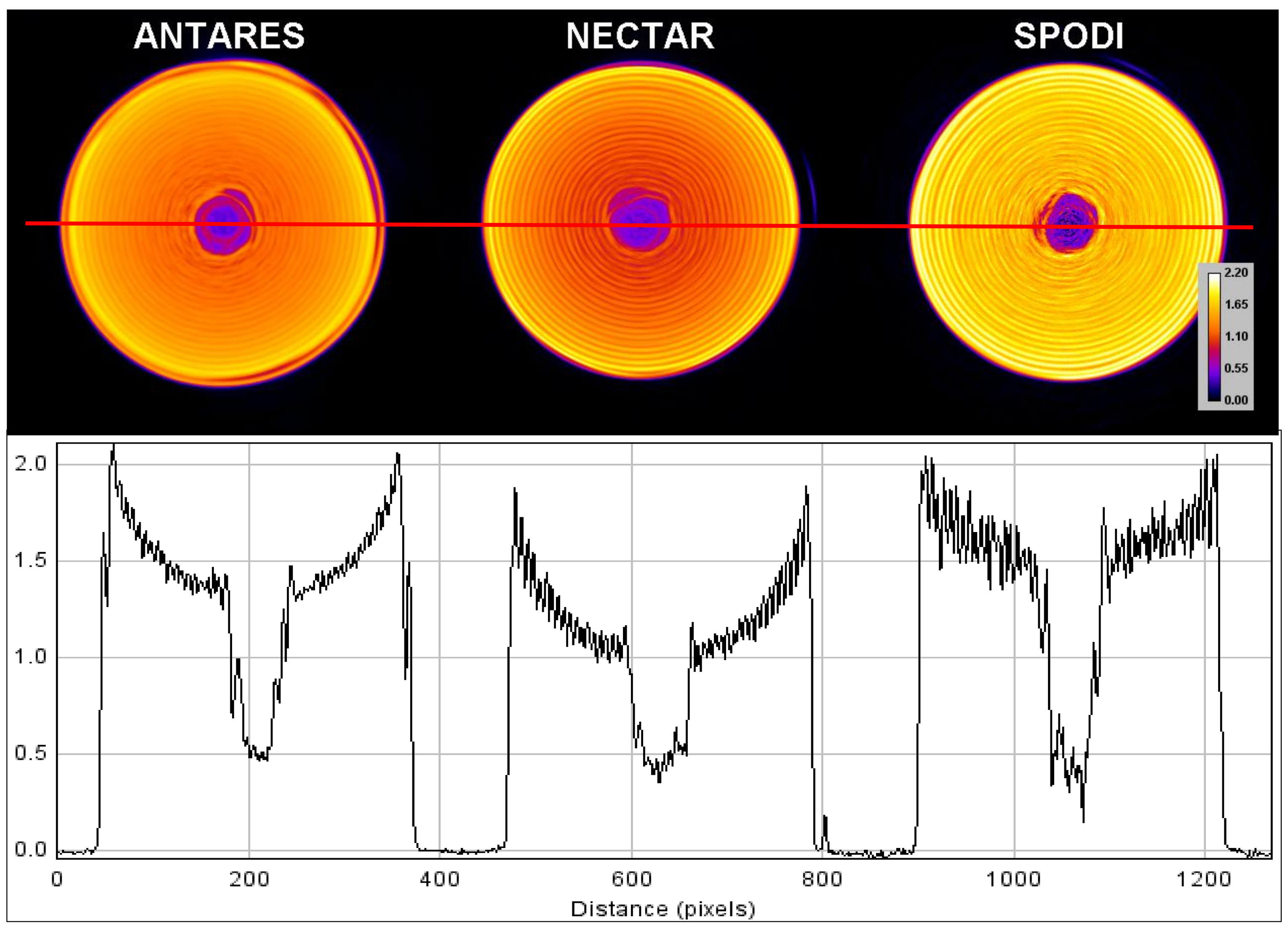
Cd edge



M5 screw




18650-type Li-ion cell



Future applications

- "Dual Energy" experiments combining thermal and fast data, e.g. hydrogen storage materials
- Irradiation and activation of samples
- Neutron imaging using a pure thermal beam, e.g. investigation of lithium-ion batteries
- Detector development making use of the two quite different neutron energy spectra

References:
[1] T. Bücherl et al., NIM A 651 (2011) 86-89.
[2] M.J. Mühlbauer et al., NIM A 542 (2005) 324-328.
[3] E.H. Lehmann et al., NIM A 615 (2011) 1-5.

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