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Abstract

Simulating complex spallation source setups related to background is time-consuming and it is connected with uncertainties. That's why neutron spectra measurements are very important for the optimisation of neutron scattering instruments. The goal of the task was to perform a series of background measurements at facilities in Europe.

1. Neutron detector system

The developed BSS-System (within this project) was used to measure at first the neutronic background at SINQ@PSI (Switzerland) and secondly at AKR-2@TU Dresden (Germany). Figure 1 shows the used detector and moderator spheres.

Figure 1: New BSS-system with PE moderators and Cu shells

2. Selected Neutron Facilities

2.1. SINQ neutron guide bunker

The neutron guide bunker at SINQ/PSI was chosen to perform most of the background measurements because the guide bunker offers ideal conditions for measurement. The bunker can be accessed during beam development time of SINQ (every three weeks) and it was known that a significant fast neutron spectrum can be measured. Figure 2 shows the neutron guide bunker layout including the measurement positions.

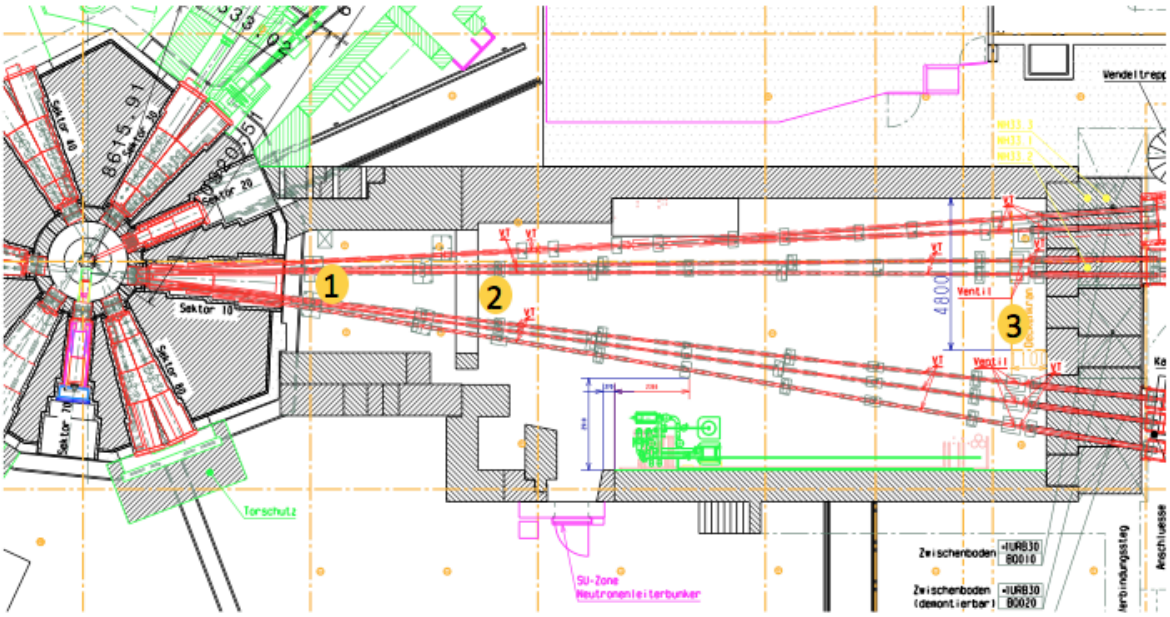

Figure 2: SINQ neutron guide bunker with the three measurement position

In total 3 different position were chosen to measure the background. The first position is very closed to the target. The distance is approximately 6m. The second position (see figure 3) was chosen because the neutron guide bunker is divided into two sections. The sections are also physically separated by a 70 cm thick concrete wall. The distance to the target is 12 m.

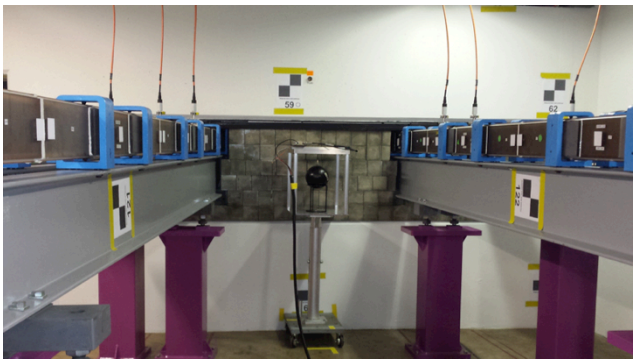

Figure 3: Setup in the middle position 2

The third position is at the end of neutron guide bunker. The neutron scattering instruments are located behind the last shielding wall.

2.2. AKR-2 Reactor

The AKR-2 reactor was chosen as the second neutron facility where background measurements can be done. Also the facility in Dresden offers good conditions to measure the fast neutron spectra. The detector system can be positioned around 1.5m away from the reactor core. In both cases, position A as well as position B, direct view to the reactor core is given (see figure 4).

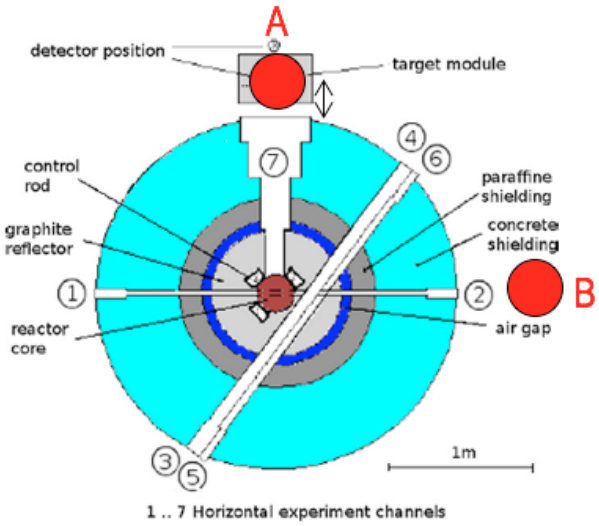

Figure 4: Cross section of the reactor setup and the two measurement positions

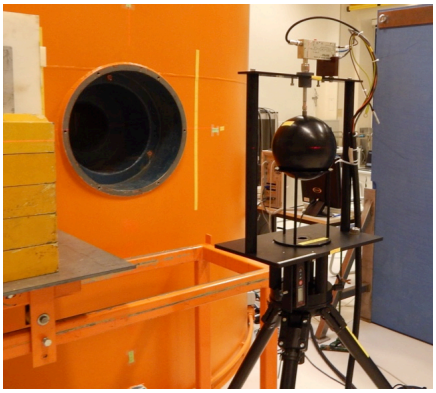

Figure 5: Measurement setup at position A

Especially position A can be used for the BSS measurements because the opening (see figure 5) has a dimension of around 48 cm in diameter. The biggest BSS sphere is 30 cm in diameter. The detector setup was positioned to the centre coordinates of the beam port.

3. Results

3.1. SINQ neutron guide bunker measurements

Figure 6 shows the results of the measurements in the SINQ neutron guide bunker. In addition MCNPX simulations for position 1 were done to cross check the results.

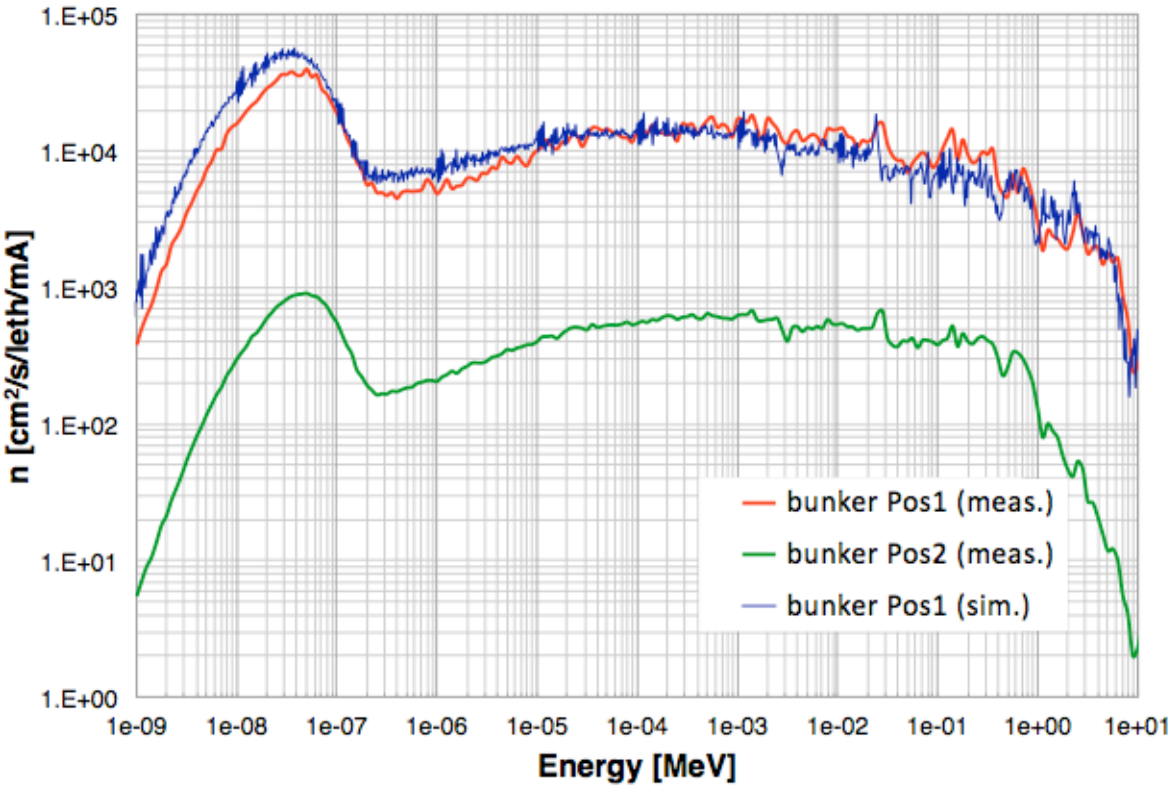

Figure 6: Neutron spectra for Position 1 and 2 in the SINQ neutron guide bunker

The measurements were done outside of the neutron beam but the data are showing a strong contribution in the thermal region. The fast part of the spectra has few resonances which can be explained by the cross section resonances of iron. At SINQ the main shielding is realized by iron.

The agreement between simulations and measurement is very good. The small differences in the thermal region could be scattering effects which are not fully implemented in the MCNPX model.

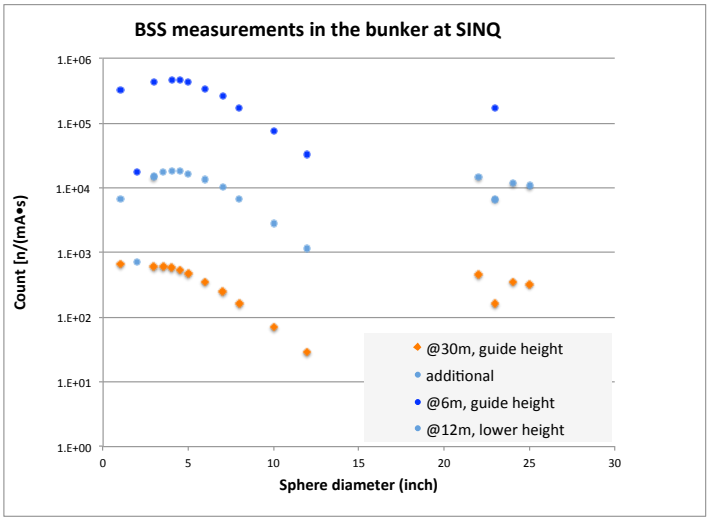

Figure 7: Measured BSS data for all 3 positions

The neutron spectrum at positions 3 has the same shape as position 2 but the intensity is a factor 10 lower (see figure 7).

3.2. AKR-2 measurements

The BSS detector system is mainly developed to measure neutron spectra in homogenous fields. Otherwise it need response function corrections. For that reason neutron imaging was done at the AKR-2 in Dresden. Figure 8 shows the thermal neutron distribution of measurement position A. The image was combined by 9 separate measurements because the field of view of the detector is only 100 mm x 100 mm. The conclusion was that the standard BSS data treatment can be used because the beam is homogenous enough. The centre image was used for normalization.

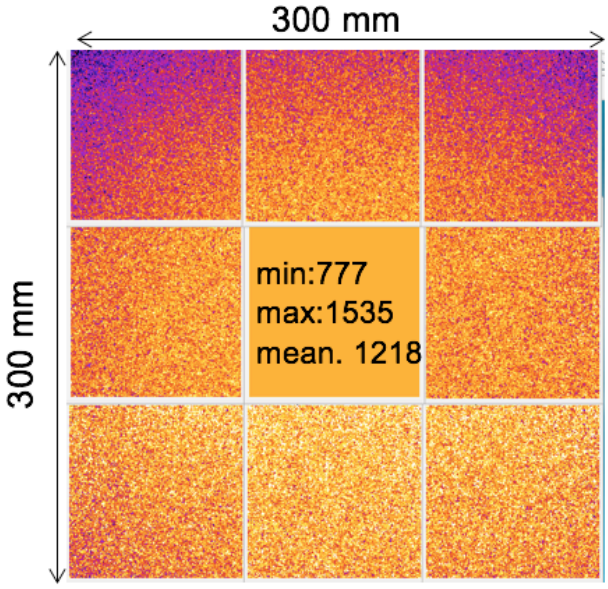

Figure 8: Thermal Neutron flux distribution of position A

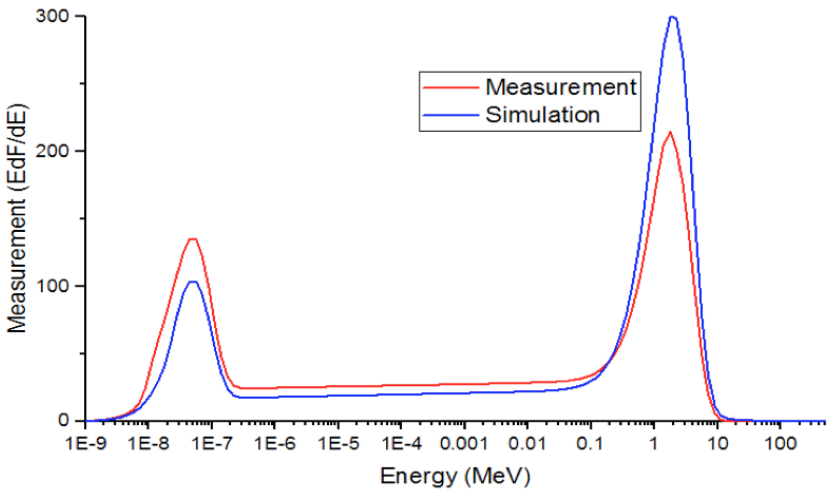

Figure 9: Measurements and Simulations for Position A

The data evaluation is shown in figure 9. A dominant fast neutron spectrum was measured where the fast neutron region is higher as the thermal part of the spectrum. The additional MCNP simulation confirmed the measurement and shows the even higher fast neutron peak at 2 MeV. The spectrum can be explained that most of the released neutrons are not moderated in the core.

The data treatment of the position B is complicated because the beam size is very small and the adaption of the BSS response functions is not finished. Figure 10 shows the measured thermal neutron flux distribution of position B. The size of the beam is only around 50 mm x 50 mm. The neutron image shows in the inner part a circle structure which comes from the geometry inside the beam port (step before exit).

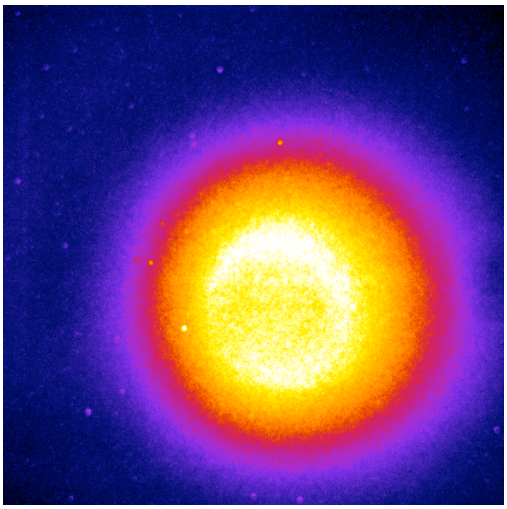

Figure 10: Thermal neutron flux distribution

at position B