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Abstract

The goal of task was to investigate shielding materials at different beam lines where the neutron spectra are different. We have chosen the beamlines ChipIR at ISIS and BOA beamline at PSI.

1. Experimental Setup

The beamline BOA at PSI is shown in Figure 1.

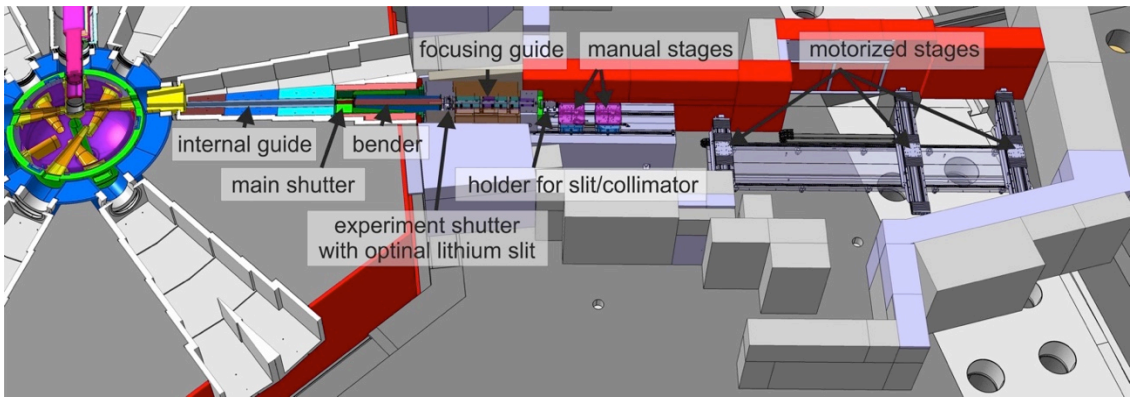

Figure 1: BOA beamline

The advantage of the BOA is that the beamline has a fast neutron beam as well as thermal/cold neutron beam. In addition the beams are separated in space. Figure 2 illustrates the separation. The fast neutron spectra is shown in Figure 3.

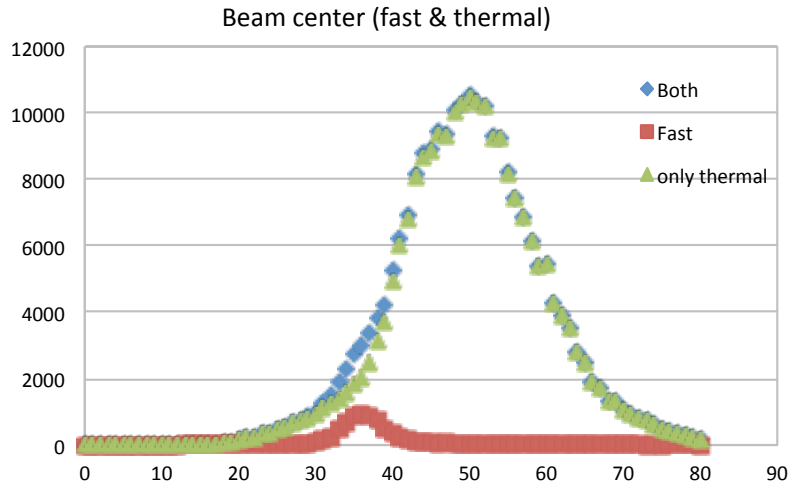

Figure 2: Fast and thermal neutron flux distribution at the BOA beamline

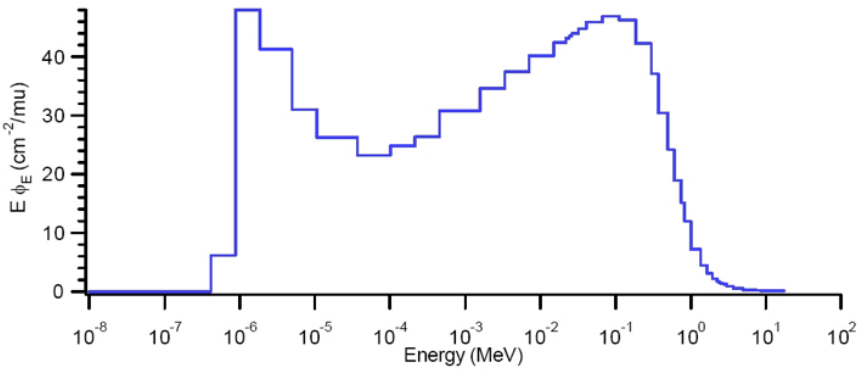

Figure 3: BOA – Fast neutron spectrum

In comparison the ChipIR beamline has direct view to the moderator system (Figure 4). The neutron spectrum looks completely different. It shows a strong fast neutron component in the range above 10 MeV.

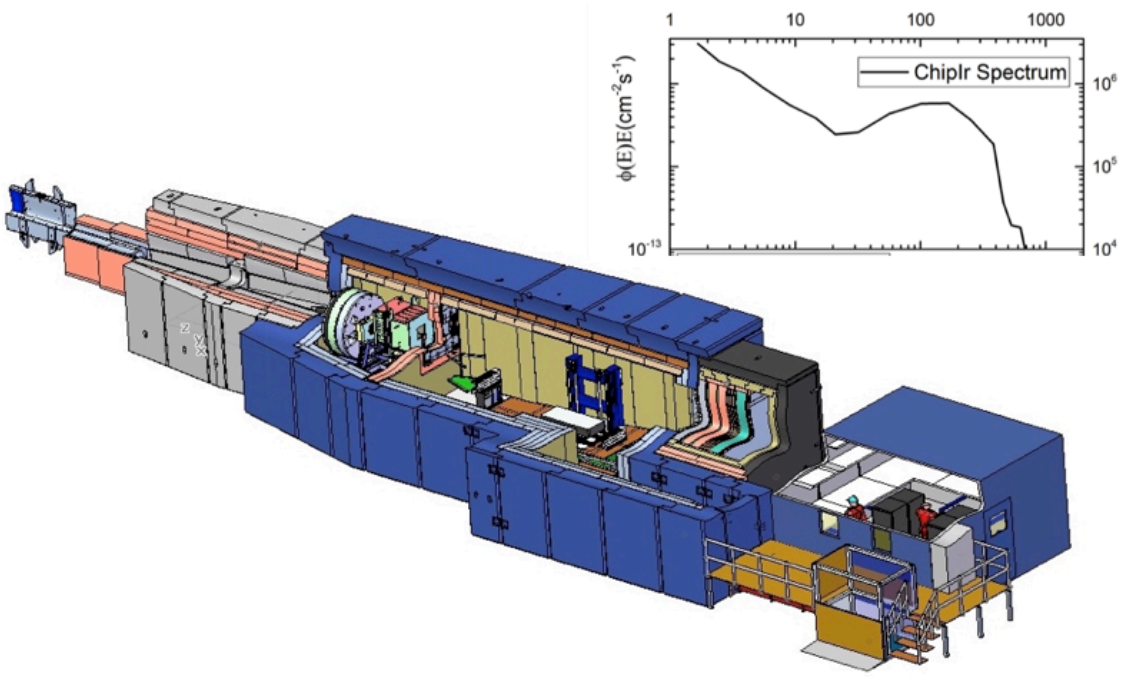

Figure 4: ChipIR beamline at ISIS with high neutron energy spetrum

2. Results

At both beamlines a borated mineral cast was measured. The sample thickness was 80 mm. Following the transmission measurements are shown. Furthermore tungsten (17 mm thick) and silicon (10 mm thick) samples were measured.

The report D8.14 includes additional measurements from the BOA beamline.

2.1 Transmission measurements of mineral cast

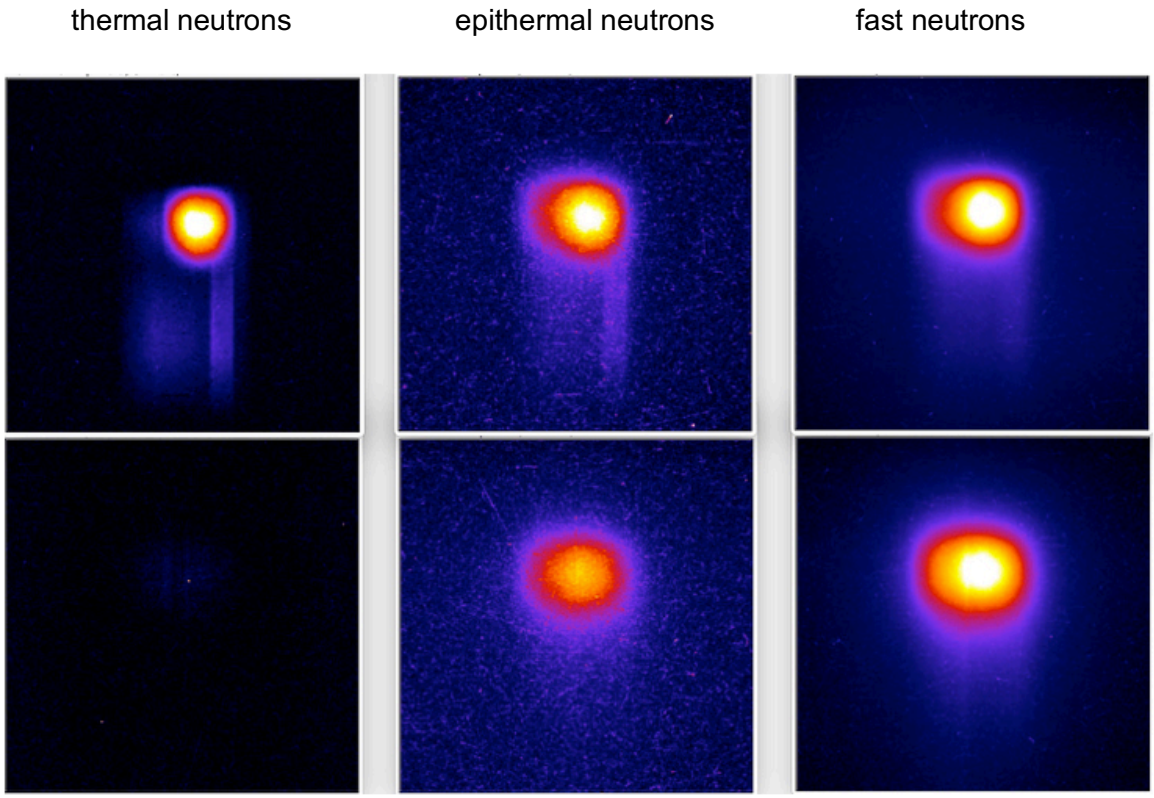

Figure 5: Transmission measurement for fast, epithermal and fast neutrons; first row – without sample; second raw – with sample

The thermal transmissions were measured at both beamlines BOA and ChipIR (first column of Figure 5). The transmission values are very closed. At ChipIR the measured thermal transmission was 2 percent. At the BOA beamline the value is a little bit lower (1 percent). That can be explained by the cold neutron spectrum at the BOA beam port. At ChipIR the thermal neutrons are more pronounced.

The epithermal transmission of the mineral cast was only measured at ChipIR (second column of Figure 5). The transmission was determined by 63 %.

Finally the fast neutron transmission was measured (third column of Figure 5). Here we can observe the expected difference. At BOA, where the fast neutron spectrum is related to around 1 MeV neutrons, the transmission was measured with 58%. In comparison at the ChipIR beamline the transmission is lower. The measured value was 93 %.

2.2. Transmission measurements - Tungsten and Silicon sample

Tungsten is known as one of the best shielding materials for fast neutrons. For comparison reason tungsten test samples were measured at the ChipIR beamline. A steel sample (20 mm thick) was positioned above the tungsten to illustrate the strong shielding behaviour of tungsten. Figure 6 shows the fast neutron transmission of tungsten. The tungsten sample was 17 mm thick. The measured transmission was 78 %. The steel sample has 95 % transmission.

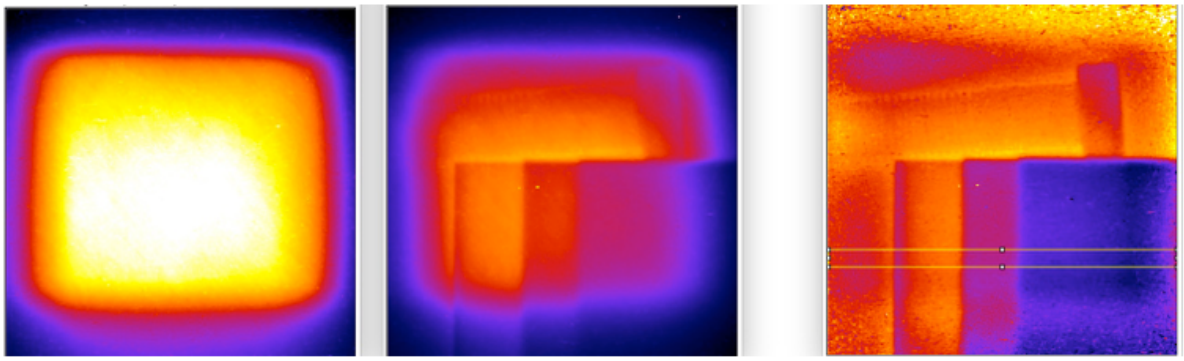

Figure 6: Tungsten transmission by 3 plates – each 17 mm thick; on the top the steel sample is positioned. Left: without sample; middle: transmission measurement; right: corrected/ substracted data

The mineral cast shows strong shielding characteristics in the thermal neutron range. A Silicon sample was chosen to demonstrate the difference in shielding power. Figure 7 shows the thermal transmission of Silicon at the ChipIR beamline. The transmission is more than 85 %.

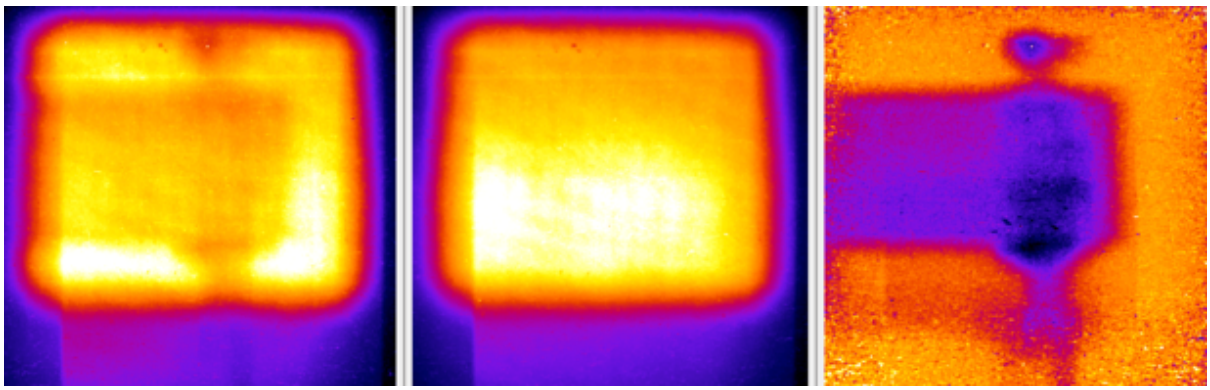

Figure 7: Silicon transmission - 10 mm thick; Left: measurement with sample; middle: measurement without sample; right: corrected/substracted data