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Calculation of high energy neutron spectra for 23 neutron beam lines at JSNS

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1 Outline

Neutron component with energies higher than 20 MeV has been calculated for 23 neutron beam-lines planned at JSNS on the basis of the target-moderator-reflector assembly design on August, 2003. Since the point detector is not available in our calculation code system, surface detector has been employed. The detector position has chosen as 50 cm from the moderator surface. This position was determined to obtain good statistics in detection of the neutrons which advances along the neutron beam line, *i.e.* almost free from the spread of angle with respect to the direction from moderator to the instrument.

It is noted that the neutron beam line is modeled that just a rectangular port of 10 $\times$ 10 cm^2 is located in a shielding without complicated beam line components such as neutron beam windows, collimators, guide tubes. Moreover, the area of viewed surface for the neutron beam line No.16 of a horizontal reflectometer is 5 $\times$ 10 cm^2 of the upper half of the moderator from which two channels begins with different tangential angles with respect to the horizontal plane. Once a particle has gone out of the neutron beam line at the outer region of target monolith with a radius of 4 m, its trajectory is not traced in the calculation by setting the importance as zero.

2 Results

The calculated result of the time-integrated neutron spectrum is given by the units of "(n/cm^2/s/sr/lethargy)" under the condition that the input proton beam power in 1-MW. This is the number of neutrons emitted from the area of 1 cm^2 at the surface of the moderator in one second in a solid angle toward a neutron instrument. The neutron spectrum per second with an energy bin of E_j, $\phi(t, E_j)$, is expressed as follows:

$$\phi(t, E_j) = N(t, E_j) \cdot \frac{S_d}{L^2} \cdot \frac{1}{S_m} \cdot \frac{1}{\ln(E_{j,high}) - \ln(E_{j,low})} \tag{1}$$

where, $N(t, E_j)$ is the number of neutrons emitted from a viewed surface of a moderator per second with an energy bin of E_j, S_d the area of the point detector, L the distance from center of the viewed surface to the point detector, S_m the area of the viewed surface of the moderator, $E_{j,high}$ and $E_{j,low}$ the upper and the lower values of the energy bin E_j. In this calculation the lethargy width is 0.23025 in the energy bins less than 1.122 MeV, whereas 0.46052 for those above 1.122 MeV. The calculated neutron spectra at beam ports No.3, 8, 11, 15, 19 and 22 are shown in **Fig. 1.** It is noted that the beam ports of 3 and 22 are located in the forward direction with respect to the proton beam axis. Figure 1 shows that

the number of high energy neutrons higher than 1 MeV is significantly larger at the beam ports of No.3 and 22 than those of No.11 and 15. For example, the number of neutrons with 20 MeV at No.3 and 22 is about twice as much as at No.11 and 15. The difference is about four times for 100 MeV and about one figure for 200 MeV, respectively.

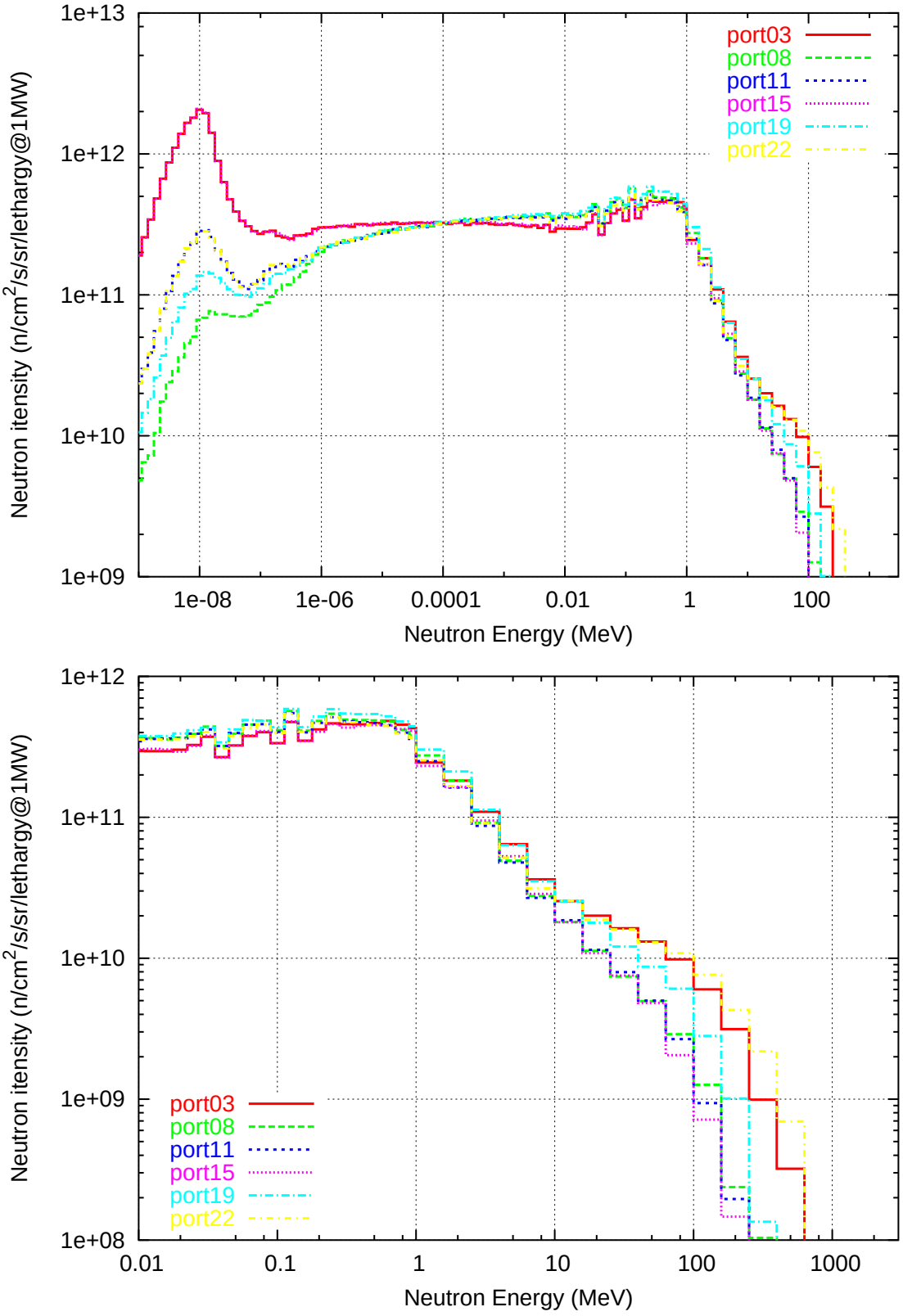

Figure 1: Calculated neutron spectra at beam ports of No.3, 8, 11, 15, 19 and 22.