Installation of high-resolution scintillation detector on SANS-U

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The SANS-U spectrometer is one of conventional steady-state pinhole small-angle neutron scattering (PSANS) spectrometers operated in major research-reactor facilities across the world. The total spectrometer length is 32 m. So far, using wavelength of 7 Å and sample-to-detector distance (L_2) of 12 m, the accessible low Q limit (Q_{min}) is realized to be 2.5×10^{-3}Å^{-1}. In this work, In order to extend the Q_{min} to the order of the 10^{-4} Å^{-1}, we upgrade the SANS-U spectrometer from a conventional PSANS spectrometer to a FSANS spectrometer by installing a high-resolution position sensitive detector (HR-PSD).

Figure 1a shows the newly installed HR-PSD (assembled by J-NOP Co. Ltd, Japan). The HR-PSD consists of a cross-wired position sensitive photomultiplier tube combined with a ZnS/^{6}LiF scintillator made by Katagiri (J-PARC). The size of the effective area and its spatial resolution are 74 mm and 0.45 mm FWHM, respectively. The HR-PSD, packed in an aluminum vessel (Fig. 1a) was mounted on an X-Z movable bench in front of the main ^{3}He-PSD, shown in inset of Fig. 1a. In the case of conventional PSANS experiments using the main ^{3}He PSD, the HR-PSD can be moved out from the neutron beam line. The beam stopper (ϕ2mm diameter) was set up in front of the HR-PSD. The position of the beam stopper is offset near the upper-left edge of the active area in order to increase the observable Q-range. In order to confirm the reliability of the FSANS measurement using the HR-PSD, we conducted FSANS measurements on polystyrene latex (an average particle radius: 2980Å) using a stack of 55 MgF_2 biconcave compound refractive lenses. Figure 1b shows the combined SANS profiles observed by the FSANS (L_2 = 11.3m) and the PSANS (L_2 = 8 and 1.03m). The SANS profile obtained by the PSANS at L_2 = 12m was also plotted for its vertical shift, being the best-resolution data obtained before the upgrade. The value of Q_{min} was estimated to be 2.5×10^{-3}Å^{-1} for PSANS at L_2 = 12m and 3.8×10^{-4}Å^{-1} for the FSANS, respectively, indicating that the Q_{min} was successfully extended by about one order of magnitude. This result indicates that by employing FSANS (one condition) and conventional PSANS (two conditions; L_2 = 8 and 1.03m) with a wavelength of 7 Å, the SANS-U can continuously cover the wide Q-range from 3.8×10^{-4} to 0.35Å^{-1}, which corresponds to a range of a few micrometers to several nanometers in real space.

This work was carried out by the support of Atomic Energy Initiative, MEXT, Japan.

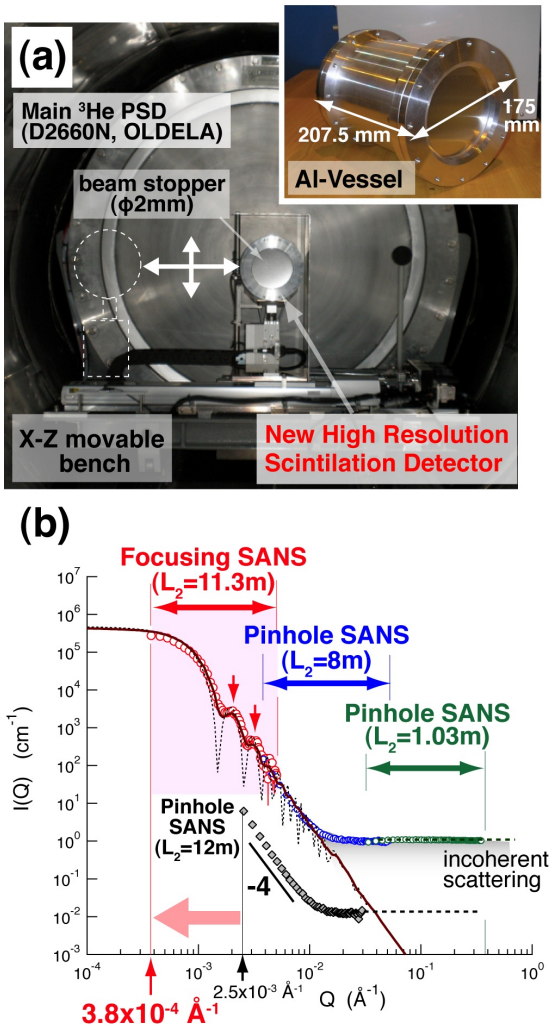

Fig. 1. (a) Newly installed High-resolution detector. (b) FSANS and PSANS profiles of polystyrene latex (an average particle radius: 2980).