The relocation of the neutron spin echo spectrometer, iNSE

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The neutron spin echo (NSE) spectrometer, ISSP-NSE, located at the C2-2 port [1] was relocated to the C2-3-1 port from Dec. 2003 and renamed “iNSE”. In this report, the re-construction of the spectrometer is summarized. In Fig. 1, the dynamic range of ISSP-NSE and iNSE is shown. ISSP-NSE had very narrow dynamic range and measurable scientific theme has been limited. Due to the relocation of the spectrometer, the dynamic range can be enhanced to the range presented in Fig. 1 as a bold line.

1 Spatial dynamic range

The scattering angle, $2\theta$, of ISSP-NSE was limited at $2\theta \sim 15^\circ$ by the next beam line. ISSP-NSE used a supermirror bender as a monochrometer and the available wavelength, $\lambda$, was not easy to change from 7.14 Å with the wavelength resolution, $\Delta\lambda/\lambda$, of 18%. Therefore, the highest momentum transfer, $q$, was about 0.2 Å$^{-1}$.

On the other hand, iNSE has a neutron velocity selector and $\lambda$ is easy to tune in the range from 4 to 15 Å with $10 \leq \Delta\lambda/\lambda \leq 20\%$. In order to achieve the large scattering angle, a dancing floor for a counter arm was newly equipped. A new type of epoxy resin was introduced from the power plant technology. The viscosity of the epoxy resin gradually increased, and finally the surface becomes very hard and flat. In Fig. 2 the measured surface roughness is shown. The flatness is within 100 µm for the whole surface area of 42m$^2$. [2] Thus the counter arm moves smoothly up to 98˚. The maximum $q$ is possible to cover up to 2.8 Å$^{-1}$ with $2\theta = 98^\circ$ and $\lambda = 4Å$.

2 Temporal dynamic range

Because the Fourier time, $t$, is proportional to the field integral, $D(=\int Bdl)$, and the third power of $\lambda$ ($t \propto D\lambda^3$) for the Mezei NSE, the increase of $\lambda$ is the most effective choice to increase the time resolution of NSE. Where $B$ and $l$ are the magnetic field and the length of the precession field, respectively. In this upgrade, the maximum $D$ did not change because the precession coils were the same as before. Therefore, the maximum $t$ can be estimated from the maximum $\lambda$ of the spectrometer. By using $\lambda = 15Å$, the maximum
$t$ is expected to be 130ns.

The maximum $t$ also depends on the incident neutron intensity in order to get reliable data. The incident neutron flux for $\lambda = 7$ Å was estimated from the measurement of the irradiation to the gold leaf. The result indicated that the neutron flux at sample position is about $3 \times 10^5$ n/cm$^2$/s and it is several times higher than that at ISSP-NSE.

3 Reliability of NSE signals

Spin polarizer and analyzer were changed and the overall polarization slightly decreased from 0.9 at ISSP-NSE to 0.88 at iNSE. ISSP-NSE used polarizer and analyzer as a reflection geometry with high magnetic field, and it was necessary to align the supermirrors depending on $\lambda$. On the other hand, iNSE uses a remanent supermirror bender guides for both the polarizer and analyzer. The advantages of these mirrors are weak magnetic field and the realignment free geometry against the change of $\lambda$. In Fig. 3 the precession coil current, $I_{PC}$, dependence of the polarization, $P$, is shown. Almost a constant value of $P$ was obtained at low-$q$, while at high-$q$, it is a decreasing function with $I_{PC}$.

Finally, a comparison of the intermediate scattering functions, $I(q,t)/I(q,0)$, between the data at ISSP-NSE and at iNSE is shown in Fig. 4. The inset figure shows the typical NSE signal at iNSE. The measured sample was a binary C$_{12}$E$_5$ / water system with the surfactant volume fraction of 0.1. Open symbols show the data obtained by ISSP-NSE [3] and full symbols by iNSE [4] with the fit result according to the Zilman and Granek theory. [5] It is clearly indicated that the quality of the data is almost the same between ISSP-NSE and iNSE, while the exposure time at iNSE is much shorter than that at ISSP-NSE. This result indicated the reliability of iNSE and completion of the relocation. Further upgrades are now progressed.

References