Development of Jamin-Type Cold Neutron Interferometer with Complete Path Separation

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We have succeeded in developing a new large-dimensional multilayer interferometer for cold neutrons, in which the two paths are completely separate for the first time.

Our Jamin-type interferometer (Fig. 1 (Top)) consists of two "beam splitting etalons" (BSEs) [1], which contains two multilayer mirrors parallel to each other with a set of spacers. The BSEs enable us to align the four independent mirrors with required accuracy. The thickness of the spacers of previous BSEs were, however, only 9.75 μm, a distance much narrower than the incident beam width, so that the two paths of the interferometer almost overlapped. This disadvantage limited range of the application of multilayer interferometer.

To solve this problem, we have fabricated new BSEs with 189 μm spacers. A demonstration of the interferometer with these BSEs was performed at the monochromatic cold neutron beamline MINE2 on the JRR-3 reactor in JAEA. The mean wavelength of the beam was 0.88 nm with a bandwidth of 2.7% in FWHM. As shown in Fig. 1 (Middle), the beam profile confirms that the two paths of the interferometer are completely separate. We have also observed clear interference fringes with a contrast of 67 $\pm$ 4% at maximum (Fig. 1 (Bottom)). The interferograms were obtained by scanning the phase of the oscillating magnetic field in π flipper.

With complete path separation, we can perform various experiment in some configurations: the insertion of phase objects into the one-side path, the enclosure of devices between the two paths, and phase differences depending on the area enclosed by the two paths. One of such experiments is the precision measurement of the Aharonov-Casher (AC) effect, in which electrodes to induce the phase difference are inserted between the two path. Our interferometer with long paths is more sensitive to the AC phase than silicon neutron interferometers. We are also trying to apply BSEs to white neutron beam with supermirrors fot high intensity measurements of the AC effect at J-PARC.

References [1] M. Kitaguchi *et al.*: Phys. Rev. **A 67** (2003) 033609.

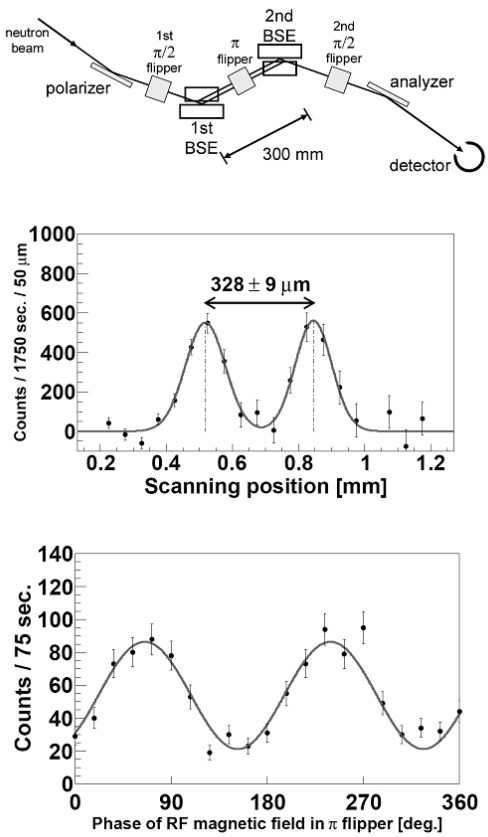

Fig. 1. (Top) Jamin-type interferometer with two BSEs, (Middle) Beam profile of the two separated paths between the two BSEs, (Bottom) Intererence fringes with a contrast of 67%.