ESRF	**Experiment title:** Polarization, depolarization, and birefringence of x-rays in LiF mosaic crystals	**Experiment number**: HE-3785
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Report:

Scientific background

Modern X-ray optics allows complete determination of the polarization state of an X-ray, e.g. by measuring all four Poincaré-Stokes parameters, but this task is very tedious and time consuming. To find a more efficient procedure to this problem is, therefore, worthy to make the efforts. In this proposal we were intended to perform quantitative studies of depolarization and extinction effects in mosaic crystals using circularly polarized X-rays. LiF single crystals were chosen as perfect model systems because of a) strong extinction effect, b) availability of large size crystals of good quality, c) small absorption in the hard X-ray range.

Experimental configuration

The experimental set-up is schematically shown on the figure 1. The experiments were performed at the beamline ID12 using the first harmonic of the emission of an APPLE- II helical undulator with circular polarization rate in excess of 98 %. The double crystal fixed-exit monochromator was equipped with a pair of Si <111> crystals. At the photon energy of 6.4575 keV where all experiments were performed the transfer of circular polarization through the monochromator is not perfect, it was reduced to 90 %. To characterize the polarization state of the monochromatic beam we have used a quarter wave plate (QWP) set-up based on a 0.9mm thick diamond <111> crystal exploiting the asymmetric (11-1) reflection [1]. A Si(400) crystal diffracting at a Bragg angle of 44.997° was used as a perfect X-ray linear polarimeter. In the experiments, the diamond QWP was replaced by the sample of a LiF mosaic crystal. As a detector of X-rays we used standard detection system at the beamline based on Si photodiodes and digital lock-in detection modules.

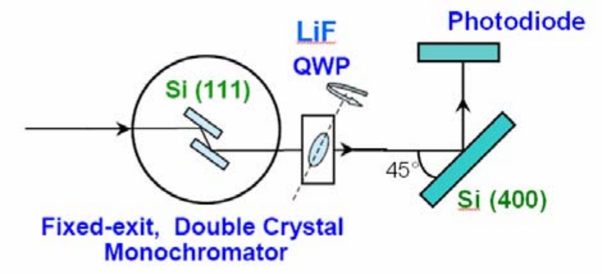

Figure 1. Schematic presentation of the experimental set-up for X-ray polarimetry.

Results and Discussions

A polarization transfer by Si <111> monochromator at photon energy of 6.4575 keV (Bragg angle of 17.829°) was determined by the QWP set-up. A typical QWP profile through the linear polarimeter is shown on fig.2.

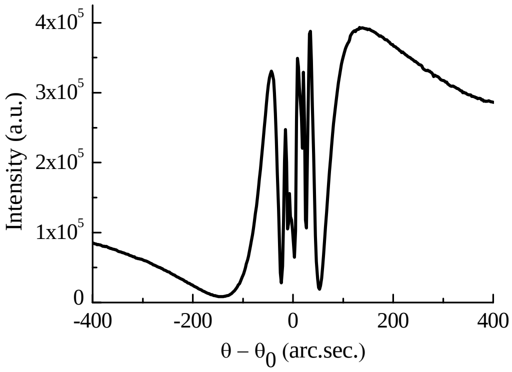

Figure 2. A typical diamond (111) quarter wave plate profile measured at 6.4575 keV with linear polarimeter based on Si(400) crystal.

With the same set-up we have tried to investigate the depolarization of circularly X-ray beam diffracted by different LiF crystals set in Laue geometry using the reflection (400). According to the theory of X-ray diffraction in mosaic crystals [2], the depolarization occurs only if the polarization of the incident beam differs from pure sigma and pure pi. That’s why we have used circularly polarized beam.

Four different mosaic crystals of good structural quality (mosaicity below 0.25 degree) were selected using a laboratory Bragg diffraction set-up.

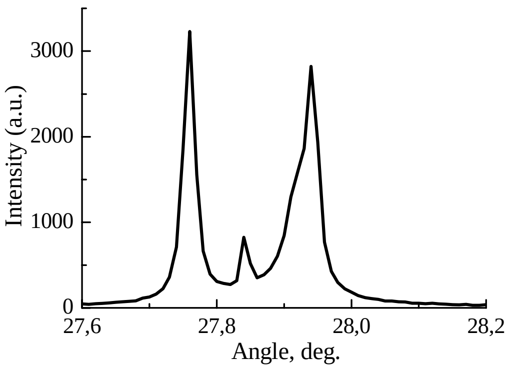

Figure 3. Laue diffraction profile through a 2 mm thick LiF <400> crystal

Unfortunately, extremely high collimated X-ray beam from the helical undulator at the ID12 beamline revealed that all our “mosaic” crystals were consisting of rather large blocks. Typical diffraction profile is shown on fig.3 and this does not allow us from observation of the expected depolarization effect. As an experiment of last chance we also tried to do measurements with an HOPG crystal loaned by the beamline staff, but the results were even worse that those with our LiF crystals.

1. J.Goulon, C.Malgrange, C.Giles, C.Neumann, A.Rogalev, E.Moguiline, F.De Bergevin and C.Vettier. *J. Synchrotron Rad.* **3**, 272-281 (1996).
2. V.E.Dmitrienko and V.A.Belyakov. *Acta Cryst.* **A36**, 1044-1050 (1980).