ESRF

Experiment title: Commission of a X-ray ns Delay line	**Experiment number:** MI-888

Beamline: ID10C Troika	**Date of experiment:** from: 16.05.2007 to: 28.05.2007	**Date of report:** 23.08.2007
Shifts: 32	**Local contact(s):** Dr. Federico Zontone	*Received at ESRF:*

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Report:

The aim of the experiment MI-888 was to characterize the performance of a X-ray Delay Line, a device manufactured with the aim to conduct fast time domain XRD and pump&probe experiments at future X-ray Free Electron Laser (XFEL) sources. The device is based based on splitting synchrotron X-ray pulse into two pulses and recombining them back on the primary path with a time delay between them. The purpose of the measurement was to obtain delay times between the two X-ray pulses from 2.6 ns down to 0 ns.

The experiment was carried out at the beamline TROIKA ID10C during the 16 and 4 bunch mode operation of the storage ring. Figure 1 shows a sketch of the experimental setup. An X-ray radiation of 8.39 keV coming from the undulator source was monochromatized in the horizontal scattering geometry by a Si(111) channel cut monochromator. The energy resolution of 1.4x10^{-4} was further improved to 8.8x10^{-6} by mounting downstream an additional monochromator i.e Si(333) channel cut. The achieved energy bandwidth of ΔE=74meV matched the bandwidth of the first crystal(SP1) and ensured proper beam splitting.

The X-ray Delay Line consist of 8 perfect Si crystals arranged in 90 degree scattering geometry. Figure 1 shows the side view of the experimental setup. The monochromatized beam was split by the symmetric Si(511) crystal in Laue geometry (SP1) and traveled around two unequal path lengths defined by Bragg crystals (R1, R2, R3 and R4). On the last stage (SP2) two beams were recombined and brought back on the direct beam path.

In the first part of the beamtime we carried out the performance tests of the X-ray beam splitter and reflector stages of the Delay Line. The procedure of guiding the X-ray beam through the experimental setup consists aligning of all 8 crystals. Figure 2 (left) shows the reflection curve measured by rocking the Si(511) crystal mounted on R1 stage. Due to the very narrow Darwin width (i.e. $\Delta\omega \approx 2$ arcsec at E=8.39KeV) the alignment procedure was the most time demanding process during the beamtime and consumed more than the expected 12 shifts.
The delay time (i.e. the time interval between the arrival of two pulses at the detector position) is given by the difference of the distances between the two path, $2*(L_1 - L_1)$. It is adjusted by the movement of 4 reflecting crystals (R1, R2, R3, R4) in the direction perpendicular to the beam. The measurements of delay time between X-ray pulses were carried out with an avalanche photodiode(APD) detector. Figure 2(right) shows one time pattern corresponding to maximum time delay. The time interval of 2.62 ns was obtained by the fit procedure. During the experiment we were able to obtain series of delay times ranging from 2.6 ns up 0 ns (i.e. the case when both branches paths are equal). The success of this experiment opens the possibility to perform split-pulse measurements at future XFEL. We would like to thank Dr. Federico Zontone for his help during experiment.

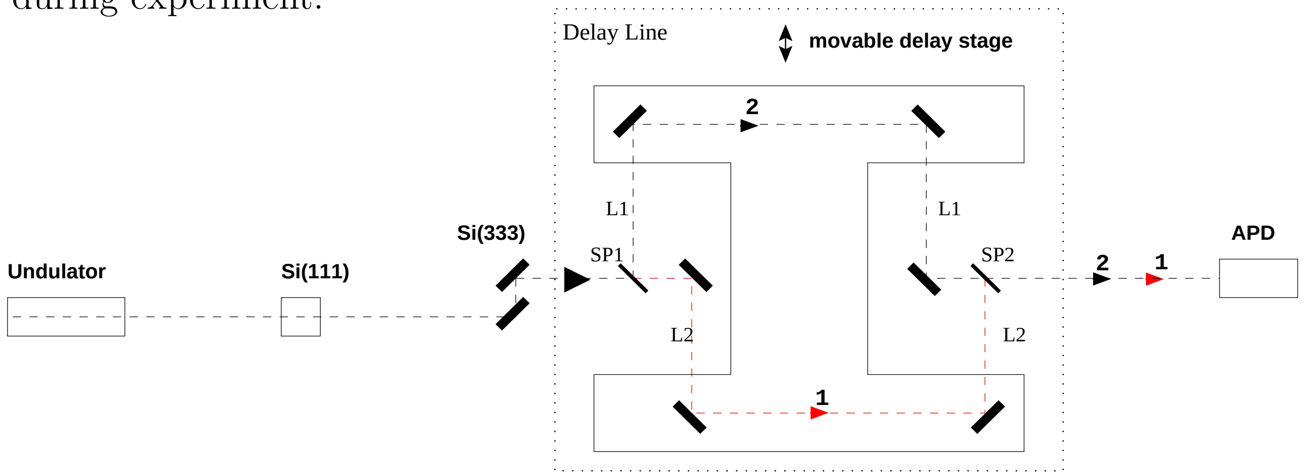
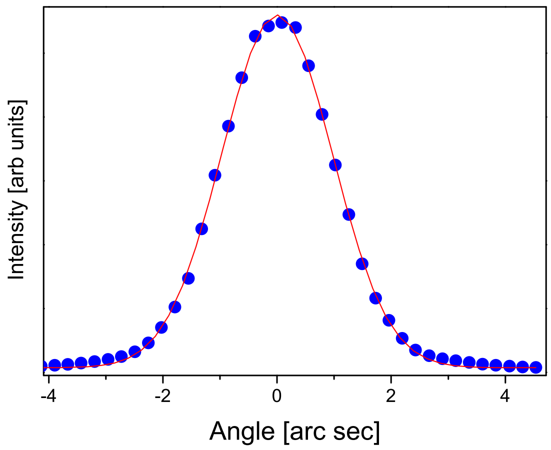


Fig. 1: Experimental scheme of the beamline ID10C and the Delay Line. R and SP denotes the reflector and splitter stages, respectively.



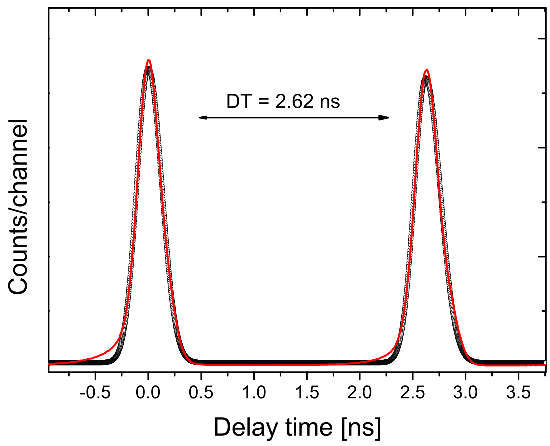


Fig. 2(left): Rocking curve of Si(511) measued at E=8.399 keV(dots). The FWHM=2.28 arcsec was obtained from the fit (solid line). (right): The time pattern of two X-ray pulses measured by the APD detector. The solid line correspond to the fit of measured data.