P 13: Towards femtodiffraction with the hybrid pixel detector XPAD

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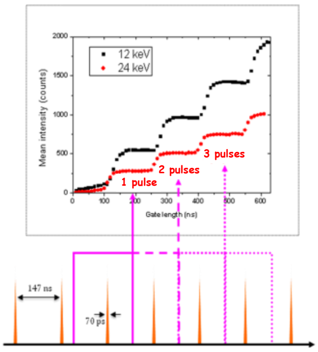
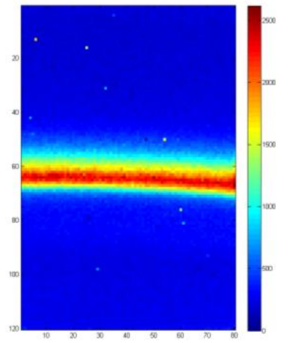
The SOLEIL synchrotron recently launched an ambitious project which aims at producing synchrotron radiation pulses of 100 fs width: the femto-slicing project. It is based on the interaction between a 30 fs infrared laser pulse and one of the 70 ps electron bunches that rotate in the storage ring. When it takes place under suitable conditions, this interaction leads to a change in energy of the electrons in a fs-slice of the bunch, which in turn causes a slight change in their trajectory. The 'sliced' electrons then radiate fs x-ray pulses which can be spatially separated from the regular ps-pulses in a beamline. Obtaining short (ps) or ultra-short (fs) pulses enables to probe the dynamics of solids as they occur after a fs laser excitation, in the so-called 'pump-probe' experiment scheme.



In a diffraction pump-probe experiment, one has to detect the signal that originates from the sliced bunch only. Indeed, the other bunches give rise to signals which correspond to different time-delays after excitation: detecting those would smear the time-resolution. In collaboration with the CCPM (Marseille, France) and the CRG D2AM beamline at ESRF, the Detectors group at SOLEIL currently develops a hybrid pixel 2D detector, whose 3.2 version has been optimised to be able to count during a period specified by the width of a logic gate, at any frequency. A chip from this detector was tested on the CRISTAL beamline in SOLEIL's 8-bunch mode. The figure opposite represents the scattered intensity by a piece of teflon, measured by the XPAD3.2 chip as a function of the length of the gate. The measurement was performed at the frequency of revolution of the electrons in the ring, i.e. 847 kHz, for two energies commonly used in diffraction: 12 keV (black dots) and 24 keV (red dots). The staircase graph shows that it is possible to enable and disable the detector quickly enough to detect in a controlled way the scattering that originates from **only one x-ray pulse**, or from a small number of these pulses. The rise time from one step to the following one is only 80 ns, which shows that the synchronisation of the electronics of each pixel, on the one hand, and the other phenomena causing a fluctuation of the time response of the detector, on the other hand, are controlled on this timescale.



The figure opposite shows a part of the diffraction pattern for Teflon obtained at 12 keV with an 80 ns gate opened at a 10 kHz frequency, for a total exposure time of 85 s. These are the conditions under which pump-probe experiments will be carried out at SOLEIL. The XPAD3.2 detector will therefore allow for detailed studies of photo-induced phase transition mechanisms, in the 8-bunch or hybrid modes of SOLEIL. These results are therefore very encouraging for the pico- and femto-second diffraction experiments at SOLEIL.

Keywords: time-resolved, diffraction, detector

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