ESRF	**Experiment title: Full performance test of the Large Pixel Detector for single-shot scattering at high repetition rate XFELs**	**Experiment number**: MI-1230
Beamline: ID09B	**Date of experiment**: from: 15.09.2015 to: 19.09.2015	**Date of report**: 13.04.2018
Shifts: 12	**Local contact(s)**: Norman Kretzschmar	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

Dmitry Khakhulin*, Laboratory European XFEL Scientific Instrument FXE Albert-Einstein-Ring 19 DE - 22761 HAMBURG

Philipp-Michael Lang*, Laboratory European XFEL GmbH Albert-Einstein-Ring 19 DE - 22761 HAMBURG

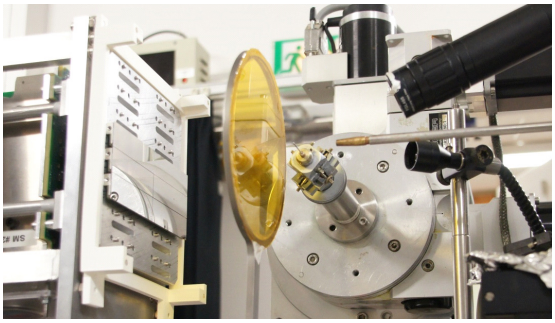
Matthew Hart, STFC Rutherford Appleton Laboratory, Didcot, Oxfordshire OX11 0QX, United Kingdom

Christian Bressler, Laboratory European XFEL GmbH Albert-Einstein-Ring 19 DE - 22761 HAMBURG

Report:

This report describes measurements performed during an ID09B beamtime on a prototype LPD detector module to be used at the European XFEL. The LPD is a 4.5 MHz framerate detector suitable for single-shot detection in the burst mode operation of the European XFL. The goal of this beamtime was to conduct full performance tests of partially populated supermodule (1/16th of the full 1 megapixel detector) together with gain calibration and flatfield measurements. The detector was installed on translation stages behind the sample position at ID09B (Fig. 1A). We took advantage of the 4-bunch mode at the ESRF as it has almost exactly 3 times lower reprate compared to the future 4.5 MHz operation of the European XFEL, so when synchronized (Fig. 1B) sets of filled and empty images were acquired back-to-back to study crosstalk between the successive frames. We use

A)



B)

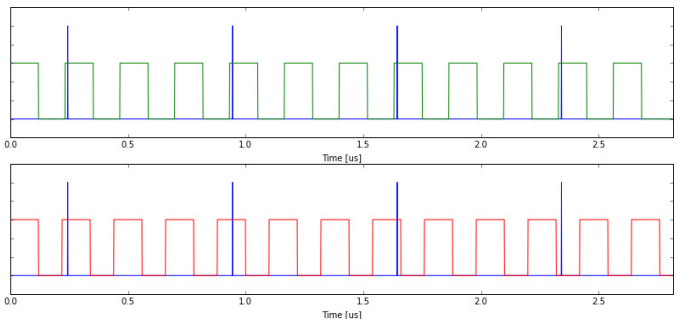


Fig.1 **A):** A photograph of the experimental setup at ID09 with Si powder filled capillary at the sample position. The partially populated LPD module is on the left, X-ray beam comes from the right side. **B)**: Timing pattern of the single-pulse measurements: blue bars indicate X-ray pulses in the 4-bunch mode of ESRF and the green and red boxes show the LPD integration windows in the synchronized and free-running detector modes, respectively.

a heatload chopper to produce the burst-like pulse patters at ID09, which also allowed reducing the heatload on the optics while keeping relatively high flux in a single pulse. A stand-alone data acquisition and timing systems for the LPD was brought and implemented by our group one day before the beamtime. Ove the following shifts various diffraction and diffuse scattering patters were collected in single-shot mode from powers in capillaries, Sr-doped glass and water jet samples. Fig. 2 represents two selected results from the single shot measurements on Si powder and water jet.

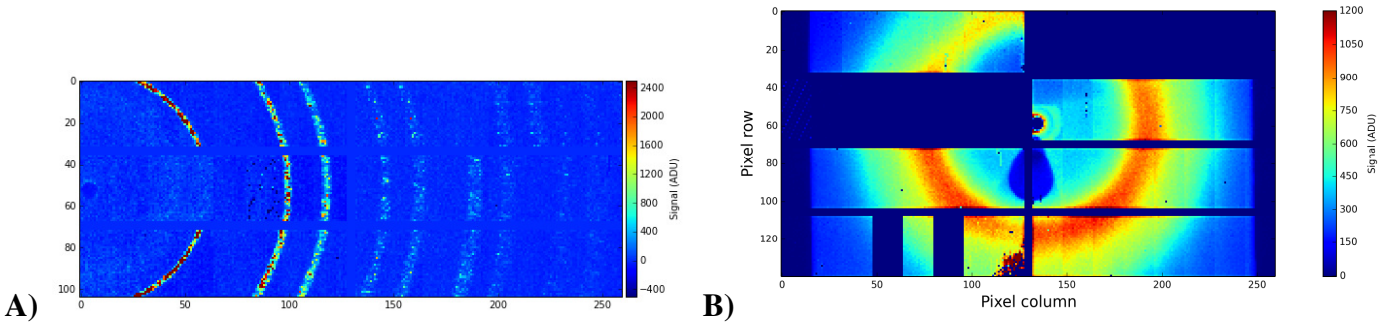


Fig. 2 **A):** Single-shot diffraction pattern from Si powder in 0.7 mm-thick glass capillary. B): Average of 500 single-shot scattering images from 0.3 mm-thick flat water jet, red colour indicates around 35 photons per pixel.

Full set of gain calibration was performed on these selected detector tiles for all 3 gain stages (1x, 10x , 100x) and both settings of the preamplifier capacitance (5 pF and 50 pF). These test were done also for a flat X-ray field illumination using Sr-doped glass and tuning the incoming energy to just above the absorption K-edge of Sr (16.1 keV) to ensure maximum fluorescence. In this mode we could investigate the possibility of capacitive depletion of the sensor bias voltage due to high amount of charge collected from the sensor. The Si powder diffraction patterns allowed spanning over multiple automatically switchable gain stages within one image and verifying continuity of the gain curve. Additionally, illumination of a statistical set of individual pixels (0.5x0.5 mm^2 size) with an attenuated direct beam focused to 0.1x0.1 mm^2 was performed to study the spatial crosstalk across the pixels and the ASIC borders.

Overall, the beamtime was very successful and the results were essential for understanding the detector and especially for future successful implementation of the 1 megapixel LPD at the European XFEL. The results were used in various reports and presented at several conferences giving a proper credit to the ESRF and the beamline.