ESRF	**Experiment title:** Transparent X-ray beam imaging and position monitoring	**Experiment number:** MI-931
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Introduction

We report on tests at ID 32 with a novel *in situ* (transparent) beam position monitor and imaging camera (BPM/XBI), which was developed at The University of Manchester. The device collects the scattered radiation from a thin amorphous foil placed in the X-ray beam using a dedicated active pixel camera.

During the tests, we have investigated many setup parameters and tested their influence on the attainable precision. Here, we show some highlights of our research conducted at ID 32. For example, measurements were taken to determine beam stability (in terms of position, intensity and size) throughout complete machine runs including periods of refills in which the shutter stayed open. In some of these measurements, we have deliberately closed the front-end for about 15 minutes in order to study the beam behaviour when starting from 'cold' X-ray optics. We also investigated the difference between runs taken with and without monochromator (MOCO) feedback.

The experiments were performed with a focussed beam at an energy of 12.7, 16 and 19.2 keV. The device was installed at the sample position on the HUBER diffractometer.

Results

The BPM measures both beam profile (in the horizontal and vertical directions) and its cross sectional beam intensity distribution (a beam image). From this data, three parameters were used to determine beam centre position, beam FWHM and intensity. Figure 1(a) shows the amplitude of the horizontal beam profile during a refill. Figures 1(b) and 1(c) show the position of the centre of the beam in the horizontal and vertical direction, respectively. It is clear from the data that perturbations and beam drift occur during the refill in particular. Beam swings of 10-20 μm in the horizontal beam position are measured shortly after the refill and correspond to a drop in intensity. Violent swings of up to 70 μm are measured in the vertical beam position during the same period. We speculate that in this brief period some machine adjustments/re-steering take place.

The resolution of the BPM based on the measured RMS noise level is equivalent to

approximately 500 nm and 150 nm in the horizontal and vertical directions, respectively.

Measurements taken with the MOCO feedback system turned off, showed that the device main function is to stabilise the monochromatic beam intensity by feedback on the second crystal. Without continuous corrective feedback, maximum beam swings were measured to be 10 µm and 2 µm in the horizontal and vertical directions, respectively. We were also able to test the beam imaging capability of our device (see figure 2). The FWHM beamsize was 300 µm by 50 µm which matched measurements taken using the ESRF sensicam camera placed directly in the heavily attenuated beam.

Conclusion and follow up

We were pleasantly surprised by the high precision and reliability that could be atchieved with our relatively simple setup. The beam position monitor could measure beam position changes of about 150 nm. During our analysis, we have spotted an opportunity to improve on this in both horizontal and vertical direction by a factor of approximately 3. At ID 32 slow beam drifts of 10 µm and 20 in the horizontal and vertical beam position, respectively are seen typically between synchrotron refills. On a faster timescale, beam excursions of 1-3 µm mainly in the vertical direction are evident.

The thin kapton scatter foil will survive several weeks of exposure but will degrade after extended periods. In our tests, we found that a 150 µm thick beryllium foil proved to be an excellent alternative which gave good signal to noise figures even at the higher X-ray energy of 19.2 keV. The device should, therefore, be able to operate in the direct undulator beam. Availability of such a sensor is vital for proper diagnostics a the performance of the beamline on the whole and remove any doubt on the origin of unexpected beam displacements.

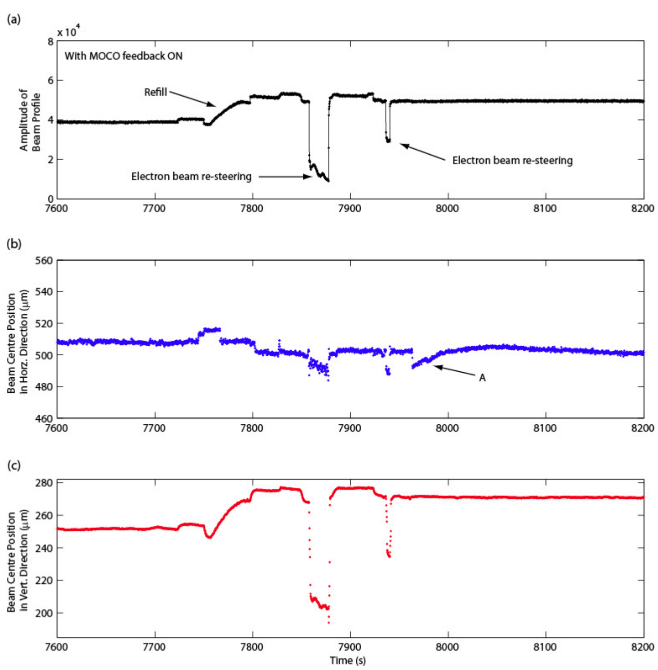

Fig. 1 A 10 min window of a time scan showing (a) amplitude of the beam profile and the beam centre position in the (b) horizontal and (c) vertical direction, respectively, during a refill. Beam drifts of 10 µm and 20 µm are measured in the horizontal and vertical directions, respectively, during the refill. Violent swings of up to 70 µm in the vertical direction are observed during the perturbations that follow the refill.

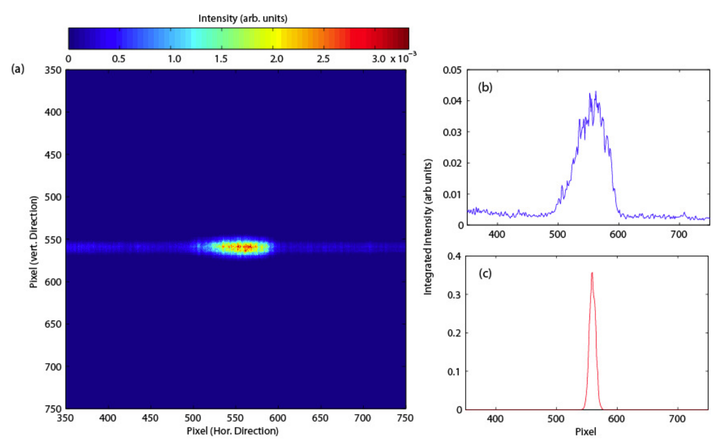

Fig. 2 An image of the beam as measured by the transparent beam imager. On the right the calculated profiles from the image are shown.