Percival: a soft x-ray Imager for Synchrotron Rings and Free Electron Lasers

Alessandro Marras*[1], C.B. Wunderer[1], J. Correa[1], B. Boitrelle[6], P. Göttlicher[1], M. Kuhn[1], F. Krivan[1], S. Lange[1], I. Shevyakov[1], M. Zimmer[1], N. Guerrini[2], B. Marsh[2], I. Sedgwick[2], G. Cautero[3], D. Giuressi[3], A. Khromova[3], R. Menk[3], G. Pinaroli[3], L. Stebel[3], A. Greer[4], T. Nicholls[2], U. Pedersen[4], N. Tartoni[4], H.J. Hyun[5], K.S. Kim[5], S.Y. Rah[5], and H. Graafsma[1]

[1]*Deutsches Elektronen-Synchrotron (DESY), Hamburg, Germany*

[2]*Science & Technology Faculties (STFC), Didcot, U.K.*

[3]*ELETTRA Sincrotrone Trieste, Trieste, Italy*

[4]*Diamond Light Source (DLS), Didcot, U.K.*

[5]*Pohang Accelerator Lab (PAL), Pohang, South Korea*

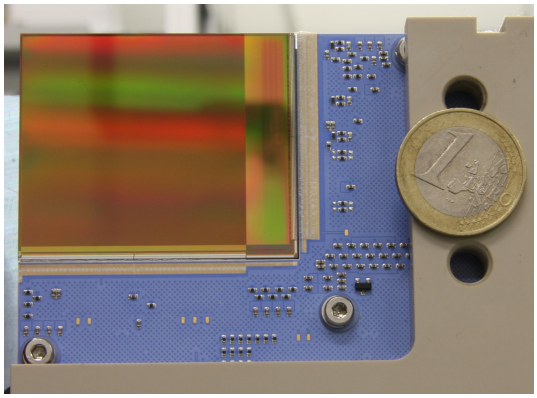
[6]*Synchrotron SOLEIL, Saint Aubin, France*

**alessandro.marras@desy.de*

Percival is a soft-X-ray detector for Photon Science applications at Synchrotron Rings and Free-Electron Lasers, developed as a collaboration between DESY, STFC, ELETTRA, DLS and PAL. It is aimed at direct x-ray detection in the 250-1000eV energy range (extended range from $<$100eV to $>$2 keV). The "P2M" system features a large imaging area ($\sim$4$\times$4 cm^2, $\sim$2 Mpixels of 27 μm) without dead zones. Its core is a Monolithic Active Pixel Sensor (MAPS) array, manufactured in a commercial 180 nm CMOS technology on a high-resisitivity epitaxial layer. In its soft-x-ray version, the MAPS is back-thinned and Back-Side-Illuminated (BSI); back-side entrance window is minimized.

In-pixel circuitry is used to extend dynamic range, modulating the pixel gain according to the impinging photon flux (lateral overflow). The signal collected is digitized on-chip to 12(+3) bits and streamed out up to 300 frame/s. The MAPS is wire-bonded to a ceramic (LTCC) board; bias, monitoring and (reconfigurable) addressing are provided by ad-hoc developed boards. To cope with the considerable data rate ($\sim$20 Gbit/sec), its outputs are passed to a data-concentrator board and streamed out through parallel 10Gb ethernet links to multiple nodes, through a buffer switch. A HDF5 Virtual Dataset architecture has been decided for the data storage, to access images as a single data archive.

The Full 2M-pixel system in its Front-Side-Illuminated version (Figure) has been produced: preliminary tests show the expected functionality, and the first images (using visible light) have been taken. The lateral-overflow dynamic range extension ($\sim$50000 photons of 250 eV), low-flux noise ($\sim$15e), thin entrance window (response to low-energy photons down to 92 eV), and single-shot operation capability were demonstrated on reduced-sized prototypes. The full 2M-pixel system in its BSI variant is being post-processed, and is estimated to be back-thinned $\sim$ April 2018.



the P2M imager