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For time- and wavelength-resolved neutron scattering experiments with up to 10^8 n/s per detector module and two-dimensional position resolution of up to 50-100 µm FWHM in the current (2004-2008) EU Joint Research Activity DETNI of NMI3 (http://jra1.neutron-eu.net/jra1) three neutron detector types and a dedicated event-triggered ASIC family are being developed. These high-contrast single-event counting detectors shall replace integrating detectors e.g. in diffraction or radiography and tomography experiments. The ASIC type delivers single micro-strip, pulse-height (energy) and time readout with 2 ns time resolution. The latter is sufficient to suppress chance coincidences between the X- and Y-planes, whilst the energy resolution is used for background suppression and for improving the position resolution by center-of-gravity determination. Except for neutron scattering, e.g. at next generation pulsed spallation neutron sources like ESS, modified versions of two of these detector types and the ASIC family will also be suitable for X-ray detection. These detectors are (i) double-sided silicon micro-strip detectors (Si-MSD) with 51x51 mm^2 size and 80 µm pitch, of which four are combined in one detector module and (ii) hybrid low-pressure micro-strip gas chamber (MSGC) detectors of 254x254 mm^2 sensitive size with columnar CsI converter layers. For thermal neutron detection in both cases ≈3 µm thick ^{157}Gd converters are used, in the MSGC case in composite ^{157}Gd/CsI converters with columnar CsI of <1 µm thickness. For X-ray detection in the MSGC a CsI converter thickness of a few tenths of µm can be used. In this invited talk the detector principles and the present state of development will be reported.

Keywords: neutrons, detectors, very-high rates

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A Direct-conversion Se-based 2D-detector for Protein Crystallography

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A solid-state detector based on the direct conversion of the absorbed X-rays into charges is described. The conversion takes place in a layer of Selenium as the photoconductor. This concept does not use phosphors and optical elements (e.g. fibre optic tapers), thus avoiding the broadening of reflection spots.

The excellent spatial resolution has two advantages: an excellent spot separation and a significant improvement in signal-to-noise ratio. In addition, the new detector has a low read-out noise level and a high dynamic range.

Although it is intended for synchrotron radiation applications (not only protein crystallography!), it has also been tested successfully on a rotating anode source at 8keV.

Keywords: protein crystallography, X-ray detector, flat panel detector

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Protein Crystallography with the PILATUS 1M Detector

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The PILATUS 1M detector (Pixel Apparatus for the SLS, 1 Million pixels) is a large area X-ray detector, constructed in 2003. X-rays are detected in single photon counting mode leading to excellent and noise free data. The main properties of the device are an energy range of 6 to 30 keV, no leakage current, no readout-noise, a fast read-out time of 6.7 ms and a PSF of one pixel.

Several proteins were measured at the protein crystallography beamline X06SA of the SLS (Swiss Light Source). The properties of the detector enable fine Φ-sliced experiments with continuous sample rotation using the electronic shutter of the camera. This leads to datasets as large as 9000 images. The data are first corrected for flatfield inhomogeneity. The main spatial distortion comes from the tiled assembly of the detector. We have developed a dedicated correction algorithm, which leads to a precision of fraction of a pixel. The corrected data could be processed using a standard crystallographic software package (XDS), leading to reasonable R_{tot}-factors of around 10%. This enabled us to calculate the first refined electron density map ever measured with a pixel detector.

Keywords: data processing, protein crystallography, area detector

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A New High-speed, Photon-counting X-ray Area Detector

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We describe, for the first time, a powerful new type of imaging detector for X-ray crystallography: the Resistive Microgap Detector (RMD). This detector is based on new micropattern detector technologies which have been developed for high-energy particle physics experiments [1]. The detector exhibits a number of compelling advantages over the conventional, analog detectors typically used in crystallography experiments (viz., CCDs and image plates). The RMD is a pure digital photon-counter and thus exhibits true single-photon sensitivity with essentially zero intrinsic noise and zero frame readout dead time. This allows it to acquire both very long exposures on weakly diffracting samples without data degradation and also extremely fast exposures for time resolved experiments. It also demonstrates a very high counting rate capability of up to 10^6 X-rays/mm^2-sec with a linear dynamic range of over 9 orders of magnitude (over a thousand times higher than CCD or image plate detectors). With an active area of 20 cm and a spatial resolution better than 100 microns the RMD can resolve over 400 diffraction orders. Also, the RMD is extremely robust, does not require cooling and has no internal dead areas.

[1] Bachman S., Bressan A., Ropelski L., Sauli F., *Nuclear Physics A*, 2000, **663**, 1069C-1072C.

Keywords: X-ray detector technology, area detectors, X-ray imaging

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Dead-time in X-ray Photon Counting Detectors

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With modern high flux synchrotron X-ray sources, photon counting detectors must operate at high counting rates where there can be significant non linearity in the detector response caused by the dead-time from overlap of pulses in the counting chain. We have shown that the dead-time not only affects the measured number of counts but also degrades the statistical accuracy obtained from a measurement [1], [2]. This effect can actually cause the statistical accuracy to drop if the source flux is increased beyond a certain value, even though the dead-time correction may still be relatively small.

In addition, we have derived an expression for the dead-time correction that must be used when the source of radiation is time dependent. The use of this correction for pulsed radiation from synchrotron sources operating in single bunch or gapped filling mode is demonstrated.

[1] Laundy D., Collins S. P., *J. Synchrotron Rad.*, 2003, **10**, 214. [2] Laundy D., Tang C .C., Collins S. P., *AIP Conference proceedings*, 2004, **705**, 977.

Keywords: detector properties, synchrotron X-ray instrumentation, X-ray detectors

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