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'Scintillation Materials and detector systems' at I13 Diamond-Manchester Imaging Branchline

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The I13 imaging and coherence beamline at Diamond Light Source consists of two independently operating branchlines, one focussing on imaging techniques in reciprocal space such as ptychography, the other mainly operating with micro-tomography (μCT) techniques (absorption and in-line phase contrast (PC), grating interferometry) and also a transmission X-ray microscope (TXM).
We will focus in the presentation on detector instrumentation –and especially on scintillation screens - for μCT. The detectors cover a large range of spatial and temporal resolutions.
For μCT we developed a detector system based on scintillation screens coupled via microscope optics to a CCD or sCMOS detector. This optical setup is designed for achieving highest spatial resolution.
We are currently using a large range of scintillation screen materials* procured mostly from commercial suppliers. We will provide a brief review about our experience with these materials and suppliers in terms of surface quality, internal defects, efficiency and resolution. The surface quality of the screens depends on scratches, digs and dust; these –together with deeper defects such as microfractures –limit image quality significantly. Negotiating with suppliers to obtain scintillators of sufficient quality is non-trivial due to the aim of exceeding the best scratch-dig specifications.
For dust protection we have trialled various approaches based on earthing and physical shielding, such as using conductive covering slides, ensuring good conductive contacts with housing, and sputtering protective earthing layers or bonding a protective kapton cover directly onto the scintillator.
The other factors that we are looking at are scintillators with anti-reflection coating vs. the spray-coated scintillators. We have also tried using intermediate optical components to reduce browning of the 4x and 10x objectives, which so far has not significantly reduced browning significantly. Recently we are also investigating using GAGG scintillators (high yield).
For medium resolution optical systems we have been carrying out some initial tests with camera objectives; this project has not been followed up any further so far. For the TXM we procured a Hamamatsu detector system, which provides a high photon yield at moderate spatial resolution.
We would like to highlight our experience with different suppliers of scintillation screens and challenges met with quality and performance. If time allows within this workshop we would like to address also some more general issues relating to our detector systems.
* CdWO4; ZnWO4; LuAG:Ce; GGG:Eu

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