Fast native-SAD phasing at 3.75 keV with the JUNGFRAU detector

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Common to all macromolecular crystallographic (MX) structure determination is the phase problem which is primarily addressed by multi- and single-wavelength anomalous diffraction (MAD and SAD) for novel structures. While those experiments typically involved heavy atom derivatization or selenomethionine labeling, more structures are nowadays solved directly from native crystals using the intrinsic anomalous scattering from light scatterers (S essentially). Such signal increases as the X-ray energy is lowered but low energy presents technical challenges caused by the increased absorption and scattering from both the air and the sample, as well as larger diffraction angles. Native-SAD is therefore often practiced at a compromise energy of ~6 keV at conventional synchrotron beamlines with high-multiplicity measurements, obtained from either multiple crystals or from a single crystal collected in multiple orientations at a low X-ray dose [1-3].
Dedicated low-energy beamlines, namely I23 at Diamond, UK, and BL-1A at the Photon Factory, Japan offer specific sample environments (vacuum or helium) and special detector configurations (a curved detector or a V-shaped arrangement). In addition, the use of laser ablation technology to control sample shape and thickness [4], as well as the detector performance are of crucial importance when collecting at energies below 6 keV. Here, I will present our recent native-SAD experiments on laser-shaped crystals at 3.75 keV at BL-1A using a JUNGFRAU 4M detector. The JUNGFRAU, a hybrid pixel charge integrating detector currently being developed at the Paul Scherrer Institut, is particularly well suited for long-wavelength native-SAD application [5]. I will show that JUNGFRAU provided very accurate measurement of reflections intensity from both test and real-life crystals at 3.75 keV in total experiment time below a minute. The potential and challenges of using even lower energy will be discussed.

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