Mitigation of Radiation Damage to Protein Crystals using a Helium Cryostream

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Experiments at APS Beamline 14BM-C (BioCARS) with D-xylose isomerase crystals tested the effect of cryogen temperature in minimizing radiation damage at synchrotron beamlines. Data were collected using cryogenic helium (Pinkerton Device) and nitrogen (Oxford Industries CryoJet). Helium data were collected at 15 K, 50 K and 100 K on similar quality crystals. Nitrogen data were collected at 100 K. Multiple crystals were used at each temperature. Initial data were collected on each crystal followed by a 10 minute exposure. Data collection and exposure cycles were completed for at least 6 cycles. Crystal statistics showed significant reduction in radiation damage at the lowest data collection temperatures (15 K helium stream). In particular, the signal-to-noise estimate, $I/\sigma(I)$, of the highest resolution shell showed progressively less deterioration as temperature of the cold stream decreased. The average decay in $I/\sigma(I)$ for the highest resolution shell was 52 % for 15 K crystals, 63 % for 50 K crystals and 75 % for 100 K crystals. The results indicate that manifestations of radiation damage appear less rapidly at lower temperatures and the effects of radiation damage can be partially mitigated at very low temperatures particularly for high resolution data.

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