A High-Throughput Serial Crystallography Beamline at CHESS

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Serial crystallography (SX) is a data collection technique in which a few frames of diffraction data from several crystalline entities, typically of micron size, are collected and merged together. This approach is necessary when examining room-temperature crystals, when only extremely small crystals are available, or when using an XFEL source (which destroys crystals with one exposure). Because of the small size of the crystals and their typically weak diffraction, X-rays of high intensity and small beam size are necessary; they can be provided by XFELs or by synchrotron sources. The latter have a lower flux but much greater availability. The lower flux produces relatively weak data, but permits use of the oscillation method, meaning that each dataset will have more reflections and better reflection profiling than a single XFEL exposure, and fewer samples will be needed for structure solution. Maximizing data quality to make the most of the inherently weak data collected is paramount.

Our goal is to make SX available at synchrotron facilities around the world. To that end, we have worked on optimizing both sample delivery and data collection at our facility. We have developed a high-throughput serial crystallography beamline, with programmable oscillation, at beamline G3, an undulator-based source and currently the brightest beamline at CHESS. A microchip delivery method, in which microcrystals are deposited into micron-sized wells on a chip, ensures high hit rates for crystal data collection. Beam sizes of 10 µm or less were achieved with a compound refracting lens (CRL) setup. An EIGER 1M detector was used for fast framing. Data collected using this system at beamline G3 has led to structure solution of challenging microcrystalline targets.