

## Macromolecular Crystallography APS 5-year Plan

- 1) Automation – Four of the 8 CATs have operational robots , 2 are in commissioning mode and one is awaiting the delivery of their robots. In the next couple of years all Macromolecular Crystallography (MX) beamlines will have operational robots. The most obvious reason for these automounters are convenience and efficiency. They will become indispensable in screening large numbers of crystals of variable quality to identify a few well diffracting ones. The molecules themselves are becoming larger and more complex and the crystallization more difficult.
- 2) Remote operations - Three of the CATs use remote operations. Of the three, two of the beamlines are for pharmaceutical companies. SER CAT is the only academic beamline that offers remote operations to its member institutions. This is not to be confused with mail-in service. It is for the use of the beamline by experimenters while at their home institutions. SSRL claims about 80% remote operations. The prerequisites are an operational robot and remote access. A fast, accessible network infra-structure would benefit all beamlines. Computational and experimental methods for quickly and reliably detecting and centering crystals are still being developed and tested.
- 3) Mini/micro beams and micro crystals – crystals are getting smaller and the sample molecules are getting larger. Mini/micro beams will allow users to reduce background, obtain data from several parts of a crystal or the best parts of large crystals, and to provide a workaround radiation damage. In most crystallographic beamlines, with this mini/micro-beam capabilities, the beam is produced by aperture restricting a focused but larger beam. Further investigation of the use of focused microbeams will determine future directions. This area is growing rapidly in the US and the APS is the best source to take advantage of this. Technical problems that will need to be solved are increased beam stability in the ring, in the beamline optics, and stable experimental equipment.
- 4) Detectors – During the next five years most of the detectors on the beamlines will be at least 10 years old. The switch over will be to improved CCD detectors or tiled pixel array detectors. The advantages are improved accuracy, lower background, increased sensitivity, and the possibility for shutterless, continuous data collection. The higher dynamic range will allow collecting data to search for smaller (sulfur) anomalous signals. The speed of the detectors is a bonus that will tax both network and storage capabilities. Network infrastructure will need to be upgraded and file handling capabilities will need to keep up with the speed of the detectors.
- 5) Combined techniques – Development/Implementation of compact in situ spectrophotometers. The spectrophotometer would depend on the system being studied. Possibilities range from absorption, Raman, FT-IR, or fluorescence.

- 6) Sample environment – This category covers screening crystals in their growth environment, helium chambers and cryostats for low energy, commercial devices that adjust the relative humidity around the sample, and high pressure cells.
- 7) Laue/time-resolved crystallography – remains a unique branch of protein crystallography that would benefit from the development of fast-readout large-area detectors for pump/probe experiments in the sub-ms time domain.
- 8) Access to beamlines – Further improvements to streamline general user application to beamlines and to provide easily accessible general information. Cost normalization for bend magnet beamlines versus undulator beamlines may stimulate interest in these beamlines.
- 9) Crystallographic software support – Automated crystal alignment, scoring of diffraction images, pipelining of images to structure solution, and data bases to handle the increased efficiency of screening and data collection, are areas that will continue to grow in the next five years.