

Frontier Microfocusing Macromolecular Crystallography (FMX) beamline update

First Light: March 8, 2016

First General User: February 8, 2017

First Paper: TBD

NSLS-II SAC Meeting, September 20th, 2017



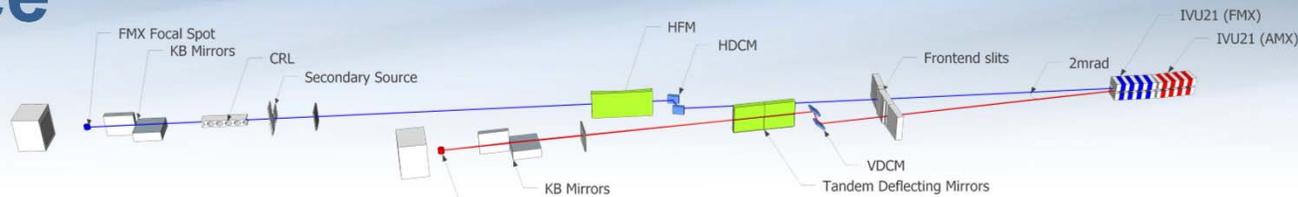
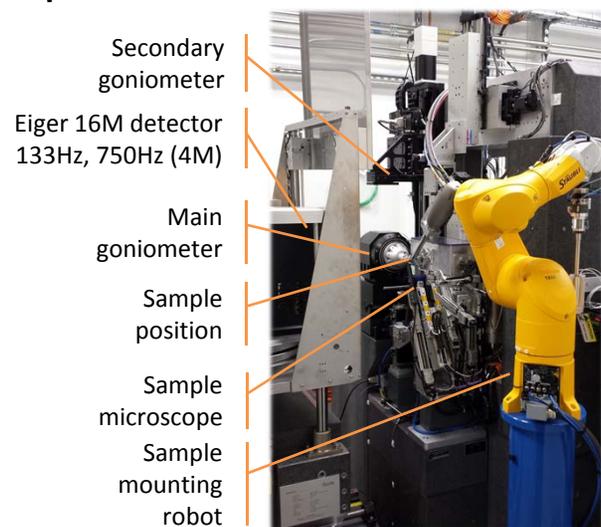
FMX at a glance

Specifications

FMX

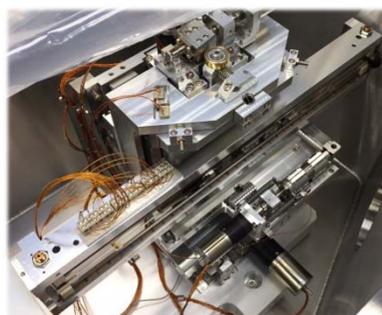
Energy range	5 – 30 keV
Wavelength range	0.4 – 2.5 Å
Flux at 12.7 keV	2×10^{12} ph/s
Focal spot (V×H)	$1 \times 1.5 \mu\text{m}^2$
Focal spot range	1 – 10 μm

Experimental station

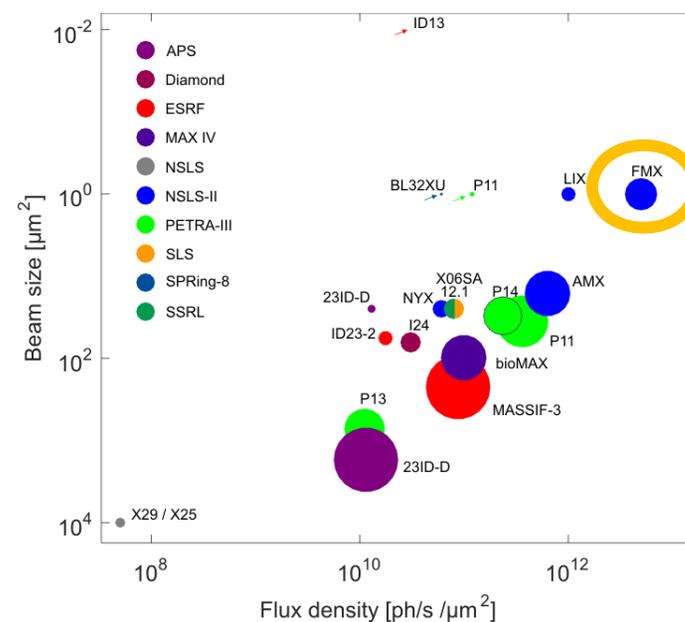


Photon delivery system

- Section 17 shared with AMX
- Horizontal-bounce DCM
- Horizontal 2 stage focusing
- Compound refractive lens defocusing
- 16 piezo-actuator bimorph mirrors



Horizontal KB mirror



- Low synchrotron emittance \rightarrow bright beamlines
- FMX: At full beam, time to Garman limit $\sim 5 - 10$ ms

Scientific capabilities

Micro-crystallography

Tunable energy beam focused to one micron
Variable divergence controlled by slits
Ultra high speed / high precision goniometry

Serial crystallography

From FEL-like few still images per (sub) μm crystals, to merging of sub datasets from few crystals, or from different areas of one crystal. Dedicated processing software is in development.

Large unit cells

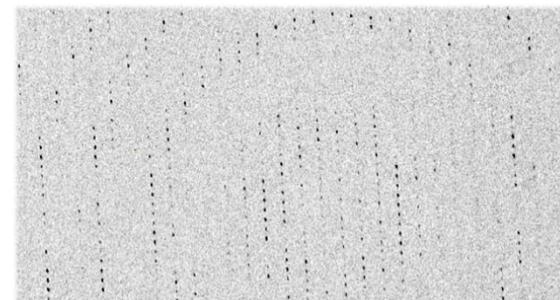
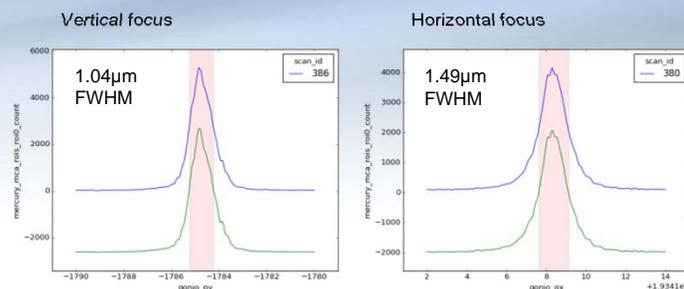
Structure determination of very large molecules and multi-component assemblies

High energy photons

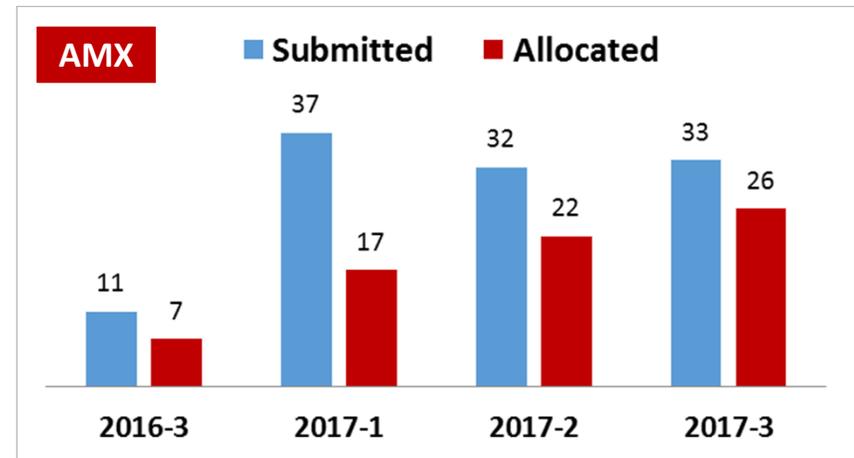
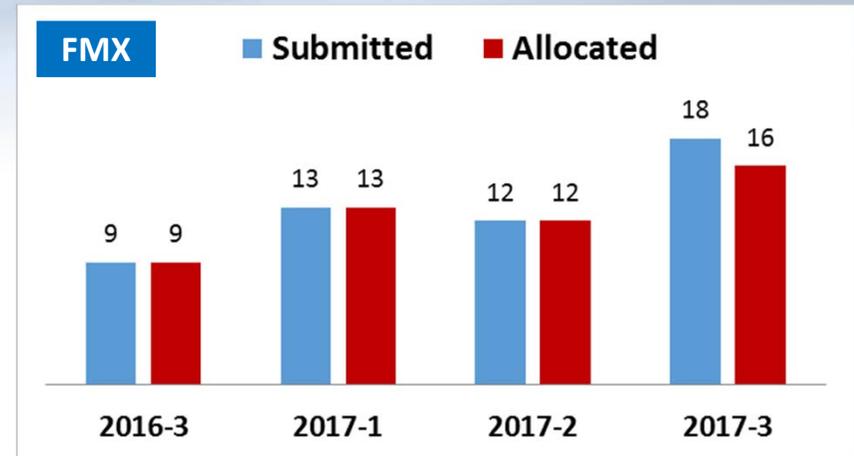
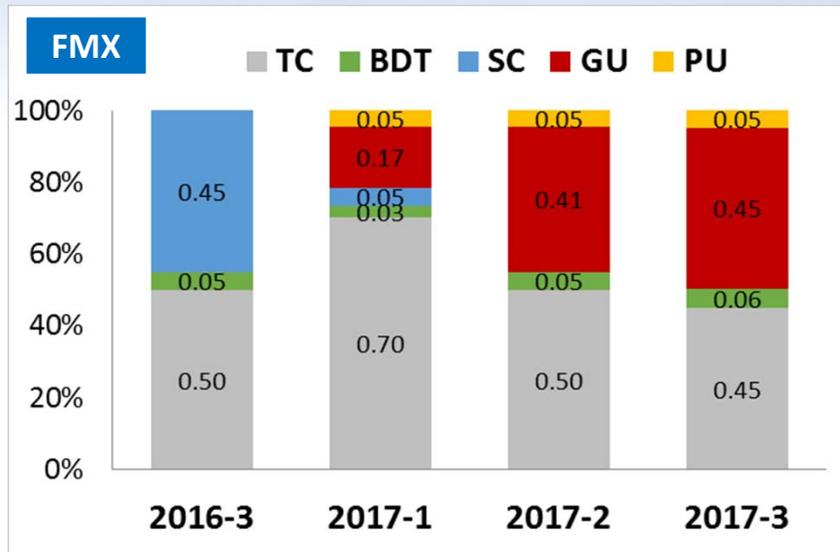
Energy range up to 30 keV to mitigate, in conjunction with the micro beams, radiation damage in especially sensitive crystals

Sample exchange automation

Rapid cryogenic sample exchange automation at the state of the art as well as room temperature data collection



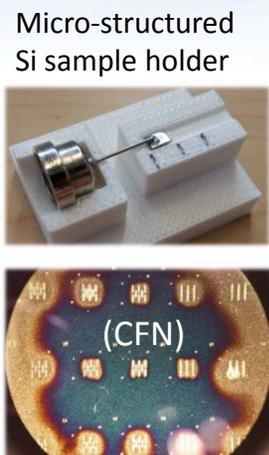
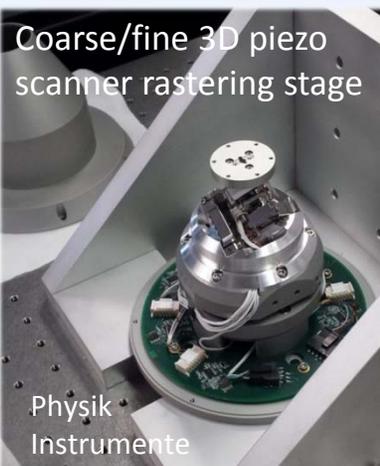
User stats



- Equal beam time distributions at FMX and AMX up to cycle 2017-03
- Assignment of proposals to beamline based on measurement and scheduling requirements
- Starting 2017-03 AMX increasing number of available rapid access shifts

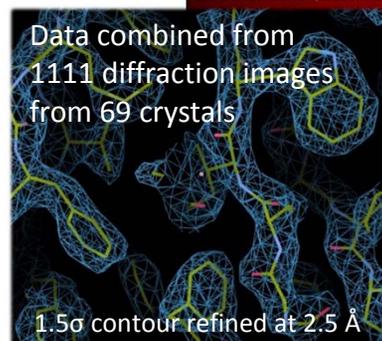
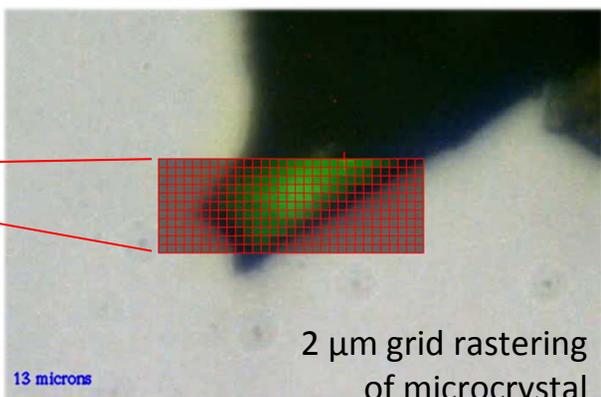
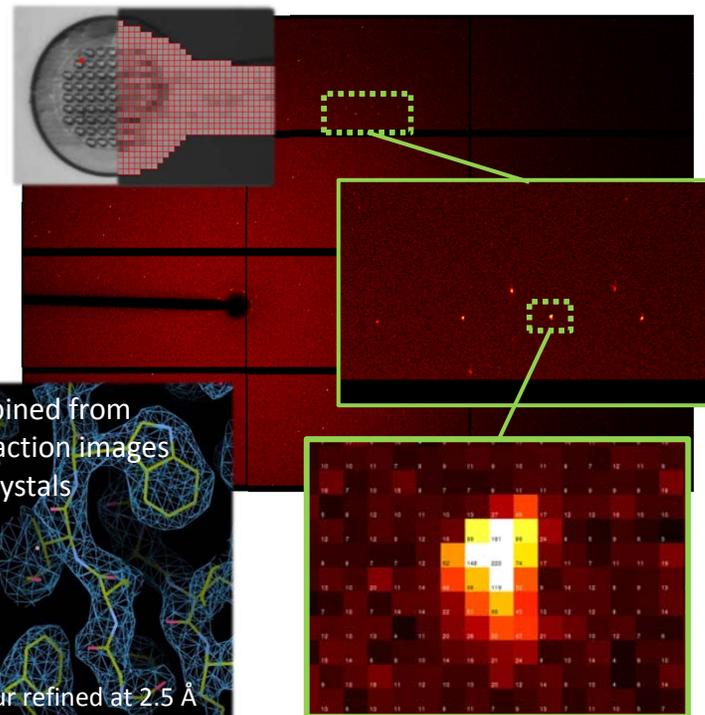
Science highlight 1: Internal research

LDRD FY16 "Serial Micro-crystallography at Full Flux"



Developing raster data processing Q. Liu (Biology Dept)

Serial microcrystallography of 1-5 μm size Thaumatin crystals



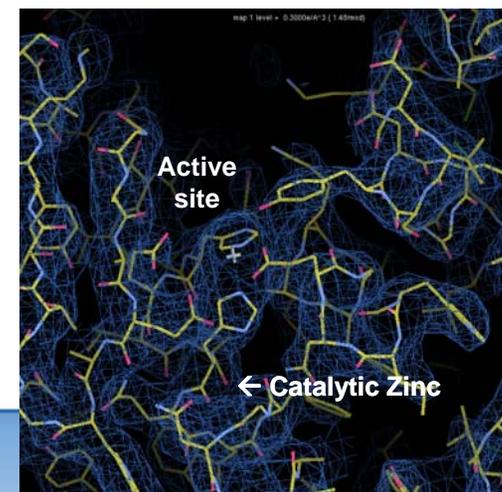
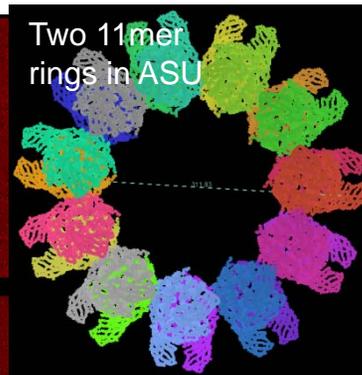
Science highlight 2 : External group

Endoplasmic-reticulum associated aminopeptidase 1 (ERAP1)

Z. Maben, L. Stern (U Massachusetts Medical School)

- Enzyme involved in immune system function
- Very large unit cell $585 \times 545 \times 125 \text{ \AA}^3$
- Full separation of 2 large axes
- Resolution 3.25 \AA

Two 11mer
rings in ASU



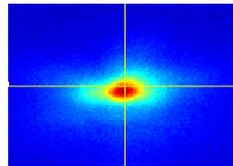
Future plans

Target smallest crystals	Internal projects User projects that compare microfocus MX with micro electron diffraction results	12 months
Fixed target serial MX	High speed, anomalous data collection, optimized sample supports	12 months
Jet serial MX	Partner user proposal	Start in 2018
Remote operation	Roll out with increasing automation	2018-01
Automation	Sample mounting throughput, beam alignment, and energy changes. Support unattended night operation	12 months
Beam size control	Support few discrete sizes up to 10 μm	6 months
Stability improvements	Reduce noise input, active beam feedback	12 months
Additional capabilities	Room temperature plates, crystal washer	Start in 6 months
Collaborations	Increased scientific collaboration with BNL Biology Dept	Now

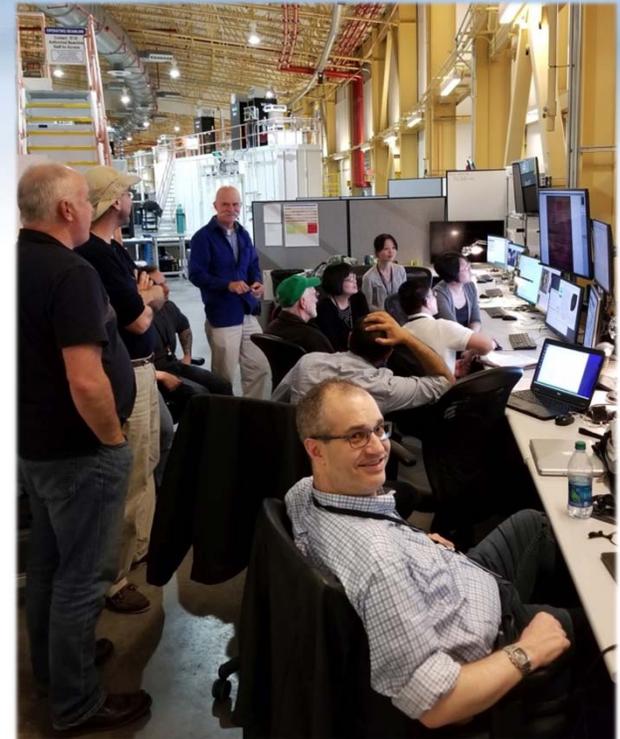
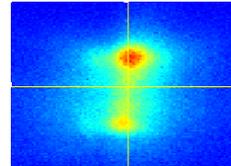
Summary

- The Beamline is up and running with very positive feedback from the users
- The Key performance parameters have been met
- We are focusing on our key capabilities and strengths
- We will increase the user throughput and efficiency
- Communication with the users is critical
- Ongoing efforts on improving the beam stability

Quiet environment



People walking on hutch roof, climbing stairs



- Six PIs from Einstein College of Medicine at FMX
- Current record for users/m²