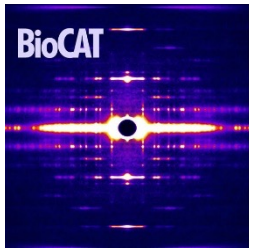

Benefits of APS-U and planned improvements for muscle/fiber diffraction experiments

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BioCAT

ILLINOIS INSTITUTE OF TECHNOLOGY

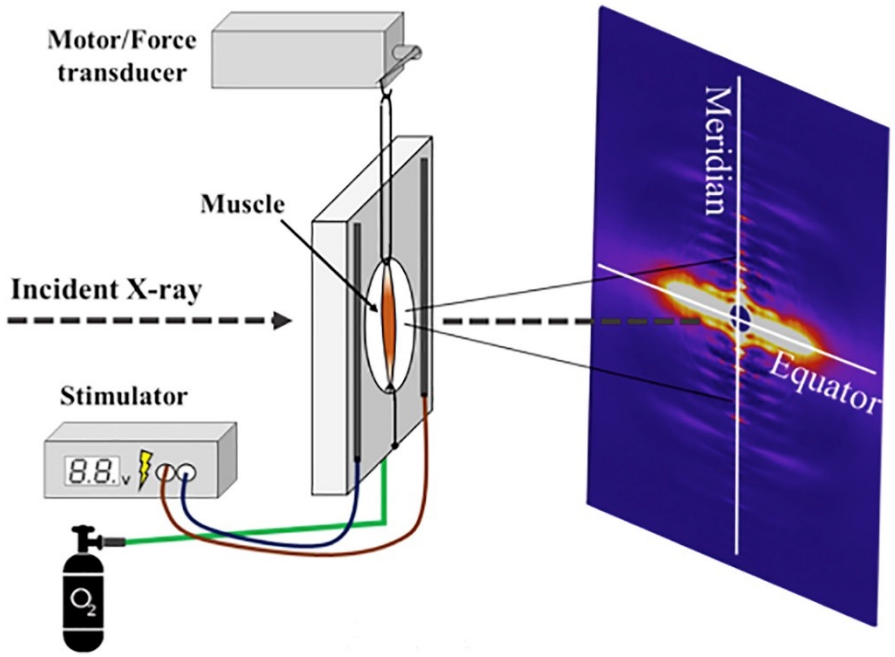
March 15, 2022

CSRRI

APS-U

- Increase in flux to ~5*10^{13} ph/s
- More symmetric beam with reduced horizontal size

Horizontal setup would work as good as vertical



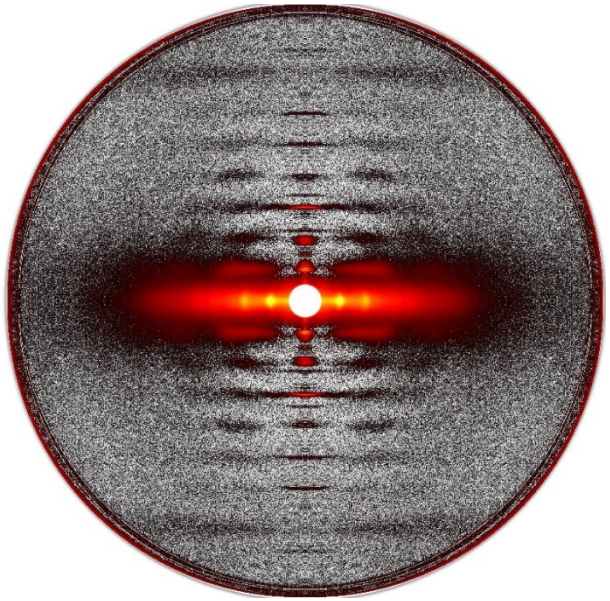
Recent improvements

- EIGER2 XE 9M detector
  - 75 micron pixels
  - 550 Hz max frame rate
  - Dead-time free readout

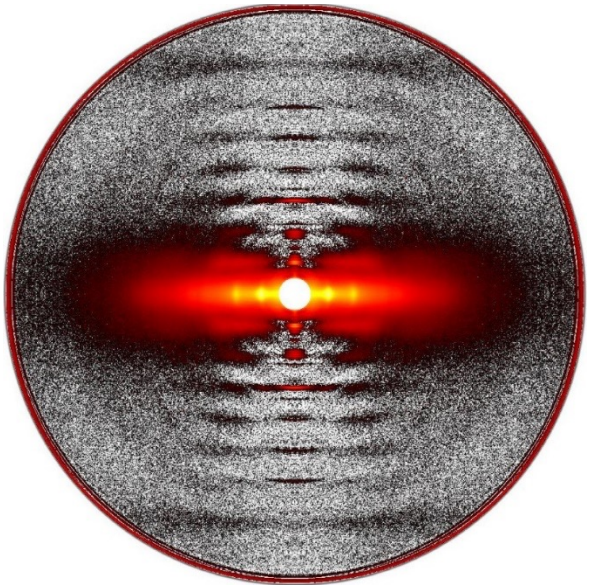
- Will have a significant impact on the muscle diffraction program
- For most experiments will allow collecting all routinely analyzed diffraction data with good order to order resolution with a single camera length

Recent developments

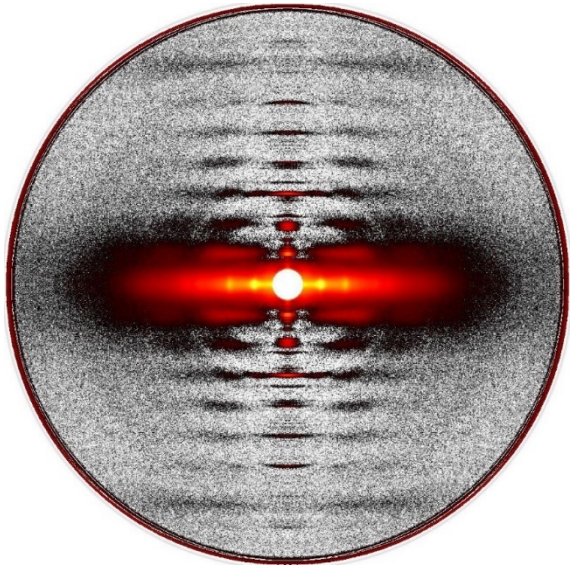
Frozen muscle preparation for X-ray



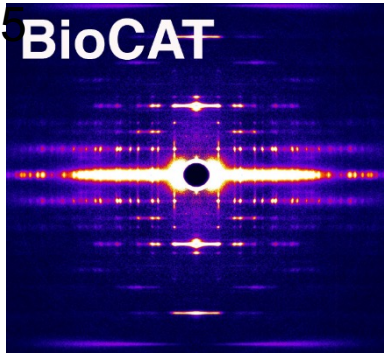
Fresh



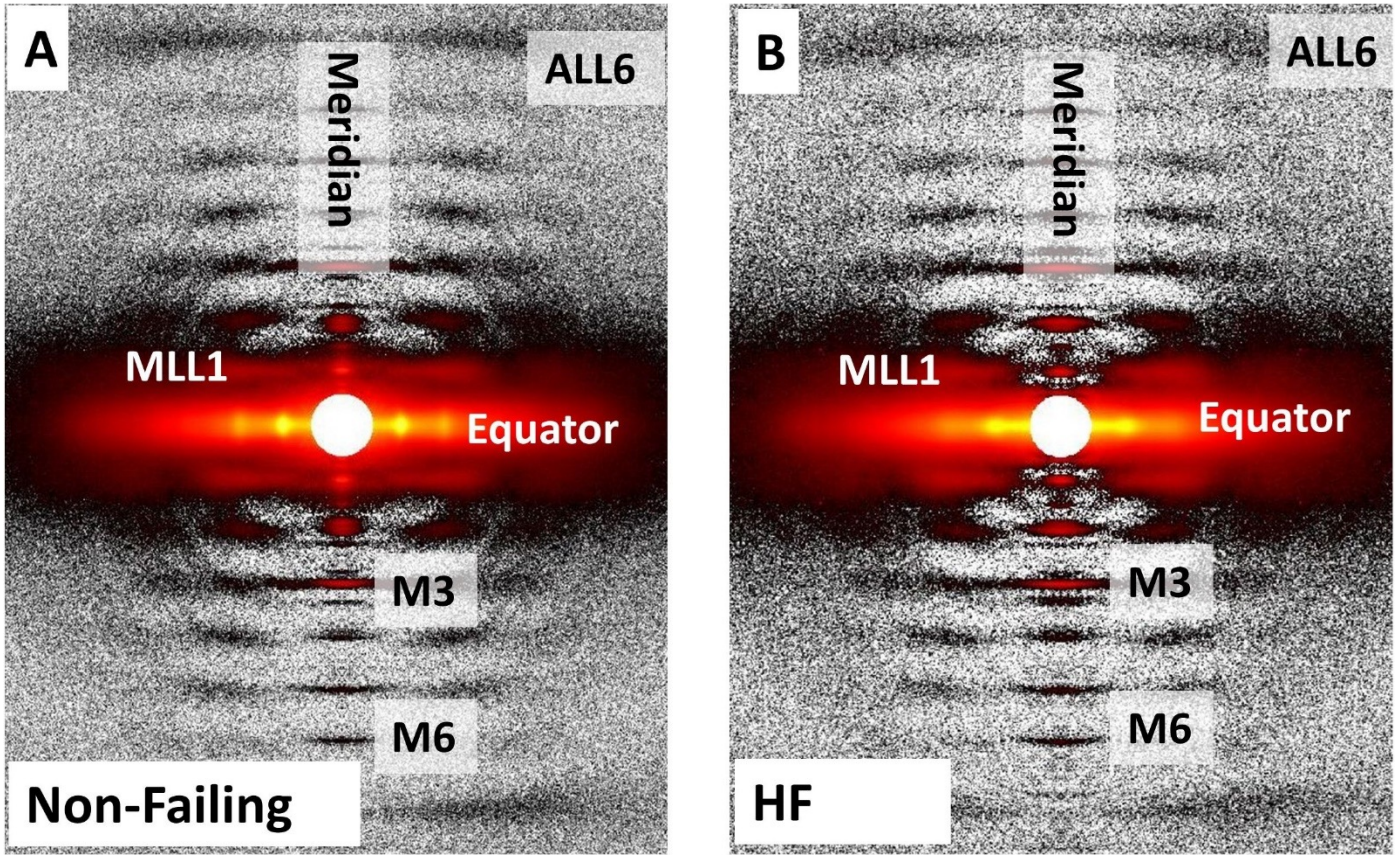
1 month



18 months



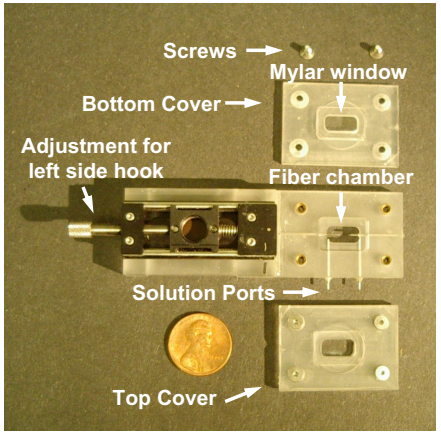
X-ray Diffraction Pattern From Frozen Human Cardiac Tissue



Ma et al. 2022 *Biophys J.* 121(4):565-574.

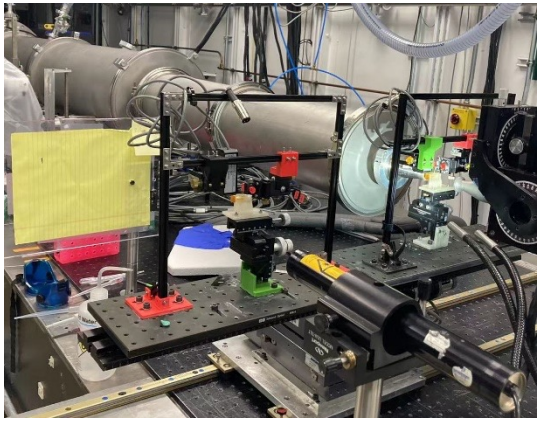
Future Plans

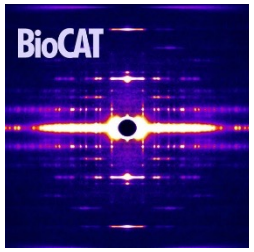
- Further optimize cryopreserve methods on skeletal muscle



- Redesign BSL 2 muscle mechanic setup

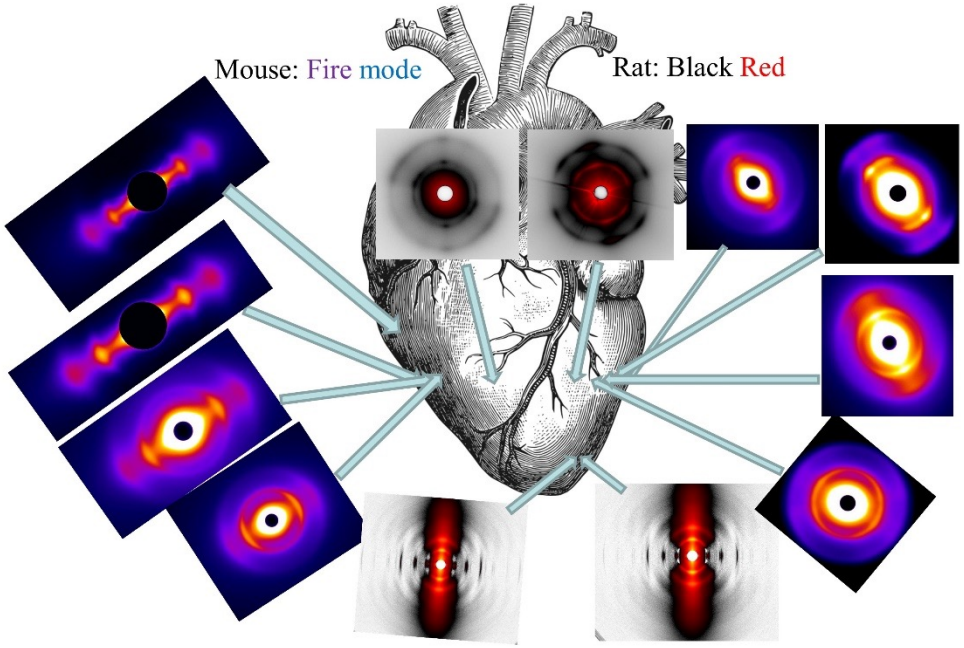
- Redesign high throughput multi-rigs system





Combined Langendorff preparation with X-ray diffraction

- Langendorff preparation is a classic whole heart physiology technique.



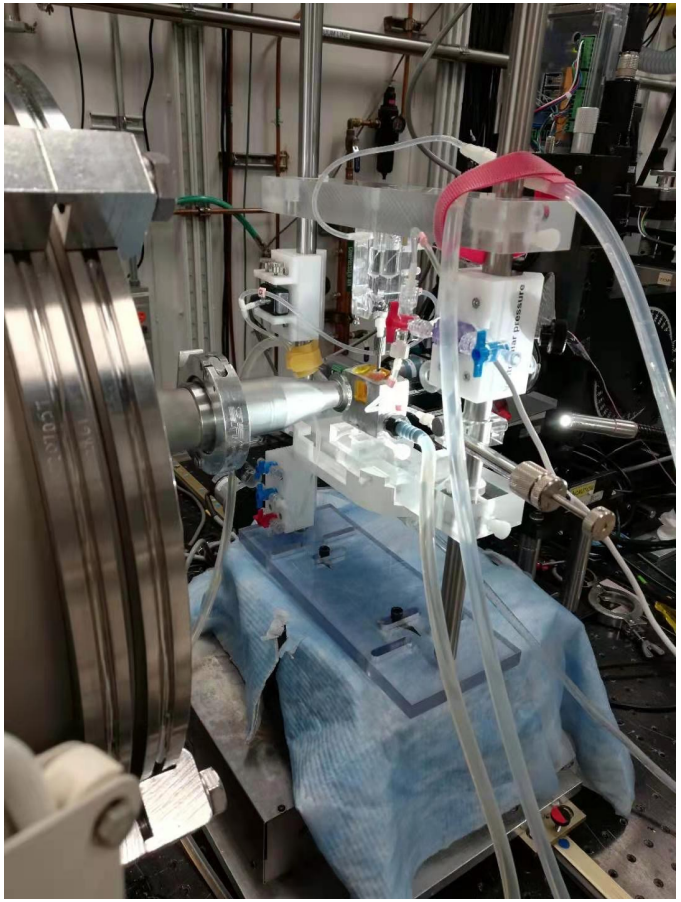
- Allows the examination of heart performance under different conditions

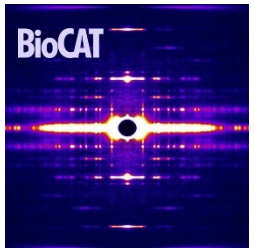
- Multiscale approach to study cardiac muscle structure: skinned fibers, intact fibers, whole heart

Planned improvements

- Langendorff system was acquired and preliminary design was made to work in the beamline

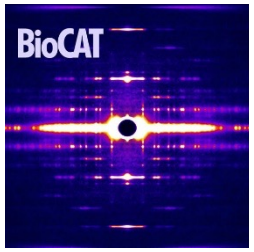
- Will be fully commissioned during APS-U





Recent developments, MuscleX

- Transformative impact on muscle program
  - Even basic data analysis used to require lengthy process by trained personnel (many weeks for a single experiment).
  - Non-expert users now have the ability to analyze their data. Truly general user mode is possible now.
  - Greatly reduces the lag time to publication.



Future Plans, MuscleX

RO1 is funded to develop

- MuscleX 2.0, Continue developments of MuscleX
- MUSICO-X
  - Goal is to develop a “forward problem” approach to simulating/interpreting muscle X-ray diffraction experiments based on the MUSICO (MUscle SImulation COde) package. Collaboration with Srba Mijailovich (IIT)
  - Will be a potent hypothesis generating tool to motivate new experiments.