

# Biological Science Capabilities at LCLS

Mark Hunter

LCLS Biology and Sample Environment and Delivery Departments

# LCLS Biology Department personnel and associates



## Experimental Structural Biology



**Andy Aquila**



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**Chris Kupitz**



**Frank Moss**



**Mark Hunter**

## Sample Delivery



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DePonte**



**Christina  
Hampton**



**Stella  
Lisova**



**Ray  
Sierra**

## BioChemistry



**Roberto  
Alonso-Mori**



**Brandon  
Hayes**



**Leland Gee**



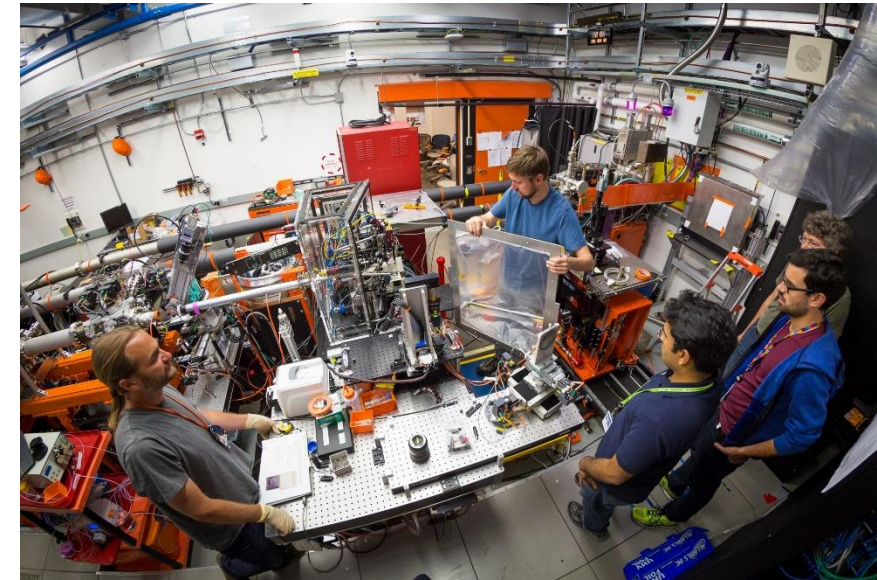
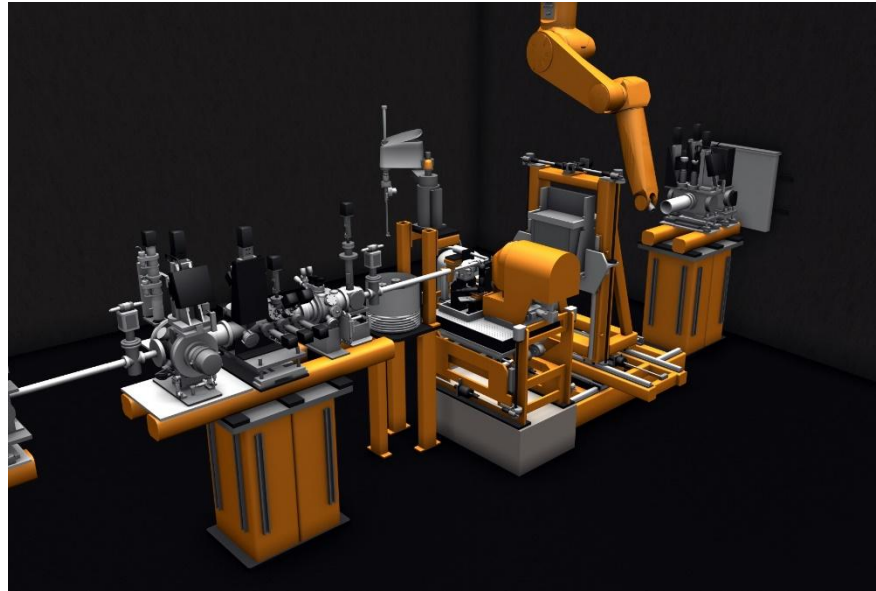
**Jeppe  
Ormstrup**



# MFX: Macromolecular Femtosecond Crystallography



- High power density atmospheric pressure sample environment
- Versatile system, configurable for specific needs



## Standard Configurations

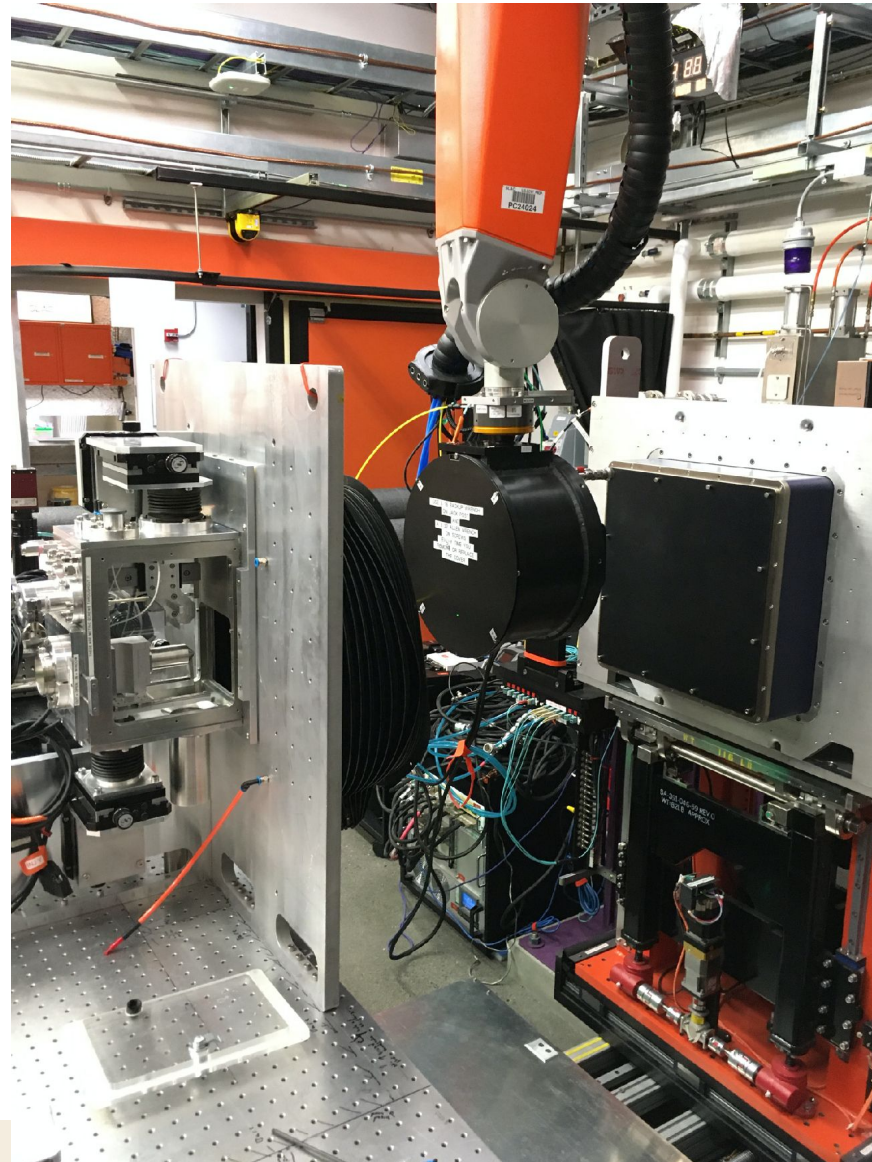
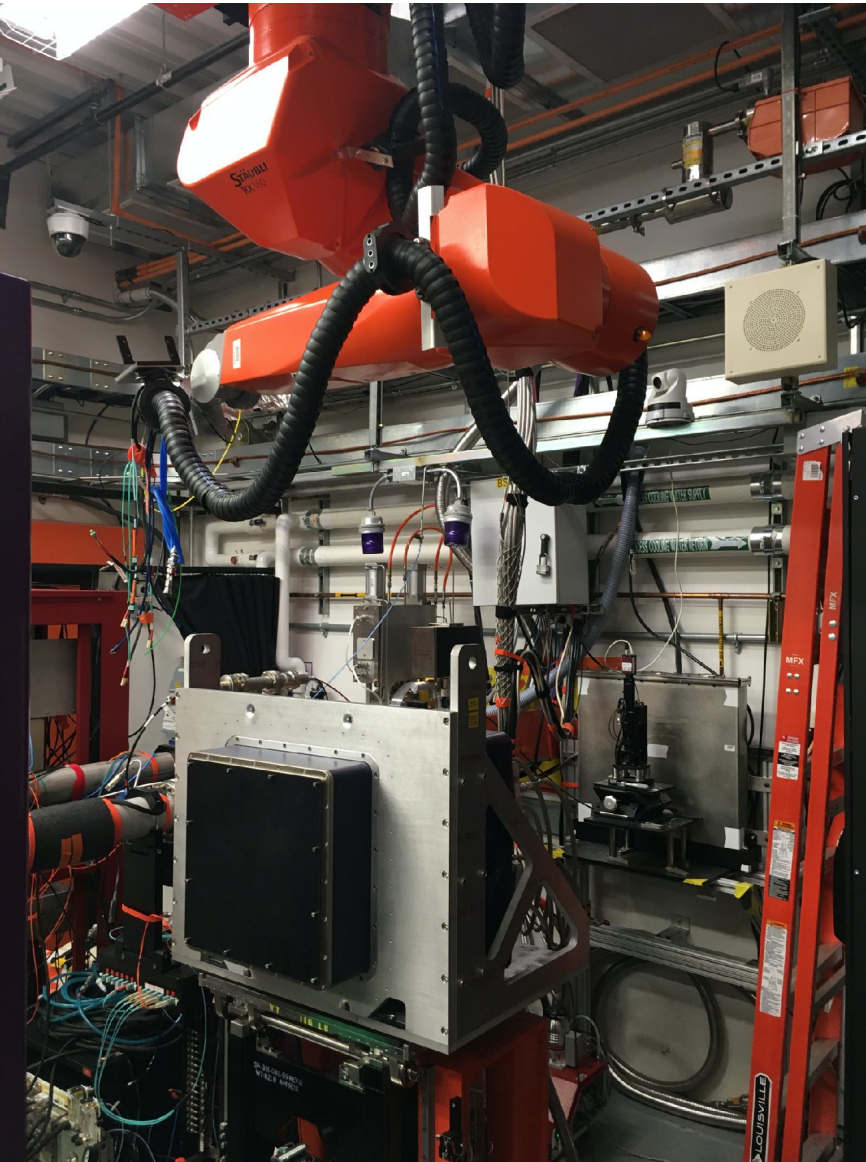
- Goniometer system with sample mounting robot
- Helium-Rich Ambient (HERA) instrument for time-resolved liquid jet crystallography

<https://lcls.slac.stanford.edu/standard-configurations#mfx>



# MFX Detectors

- Rayonix on the mover
- ePix10k-2M and other smaller detectors on the robot arm
- ePix100
- Jungfrau 0.5M and 1M



## fs Ti:Sapphire optical pump laser

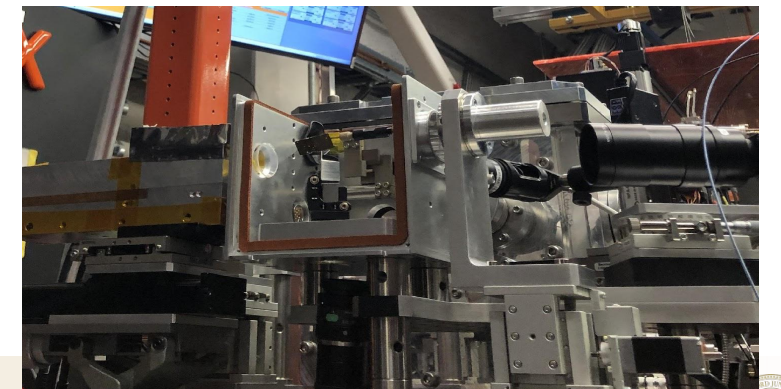
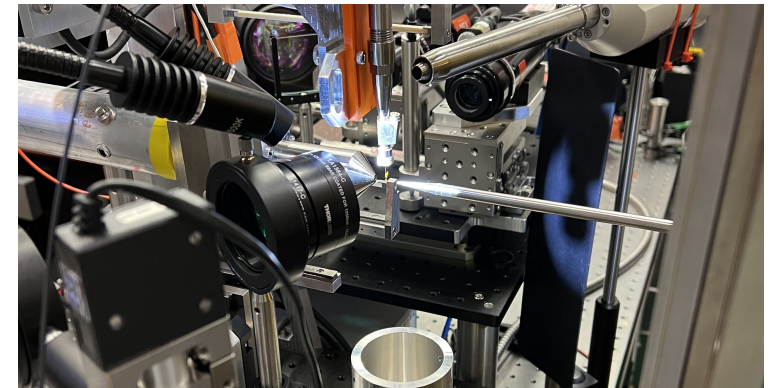
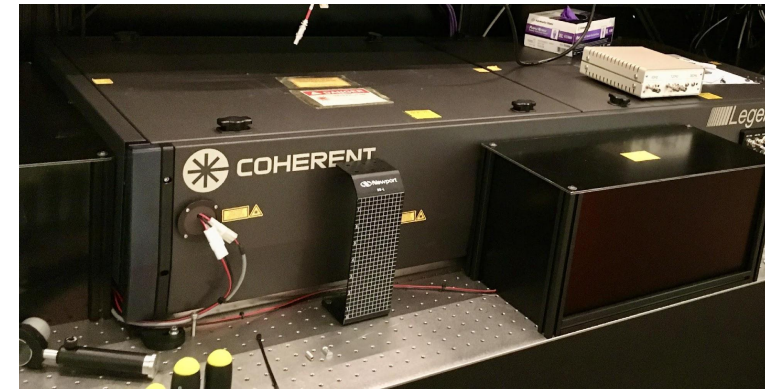
- Fundamental (800 nm) or 2nd harmonic, ~ 50 fs pulse
- Beam delivered to the sample collinearly with X-rays
- TOPAS-Prime OPA capable of 480-2400 nm

## AirA standard configuration

- In Air environment and not He enclosure (HERA)
- Multiple sample delivery modes permitted
- Compatible with optical pumping

## Liquid Jet Endstation (LJE)

- He environment compatible with spectroscopy and forward scattering
- Horizontal sample delivery



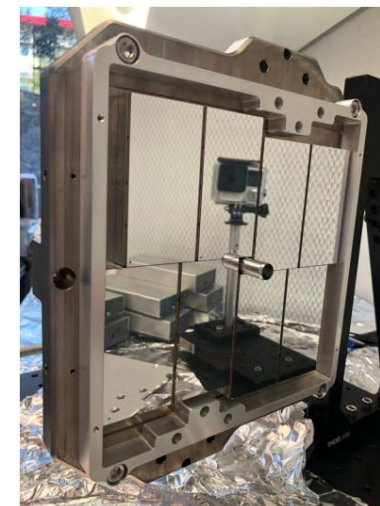
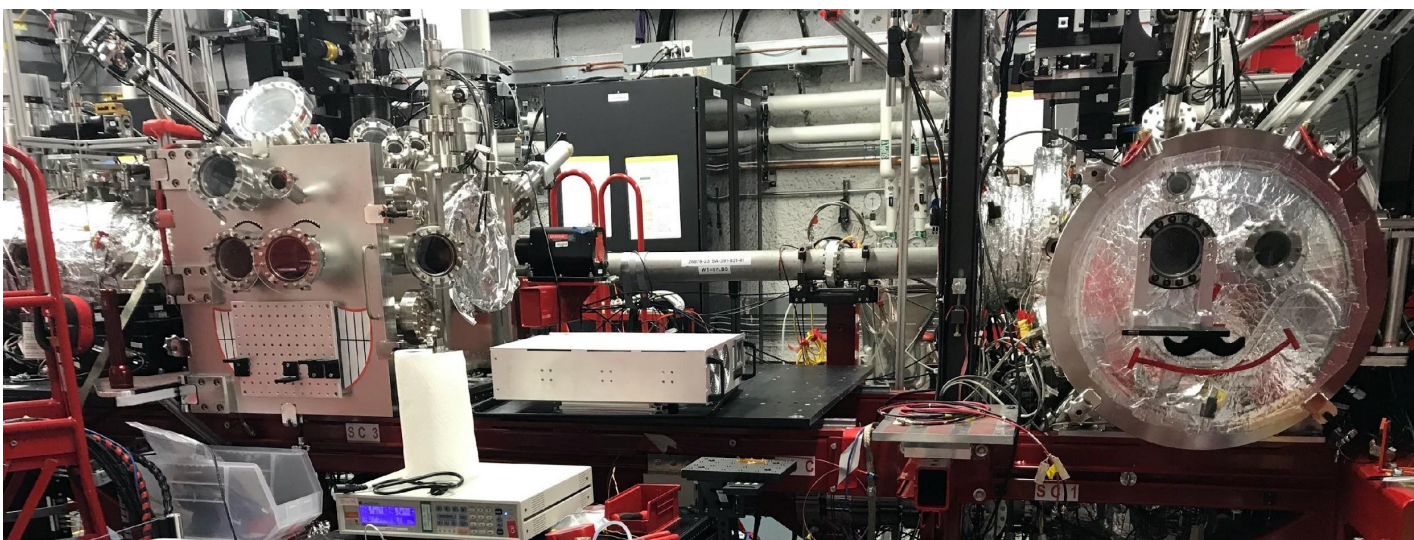
Forward scattering – high power density, optimal signal to noise (vacuum)

two interaction regions:

- 1 micron focus
- “parasitic” Chamber uses a refocused beam from microfocus
- Unfocused or CRL focused beam – photon energies  $>10\text{keV}$

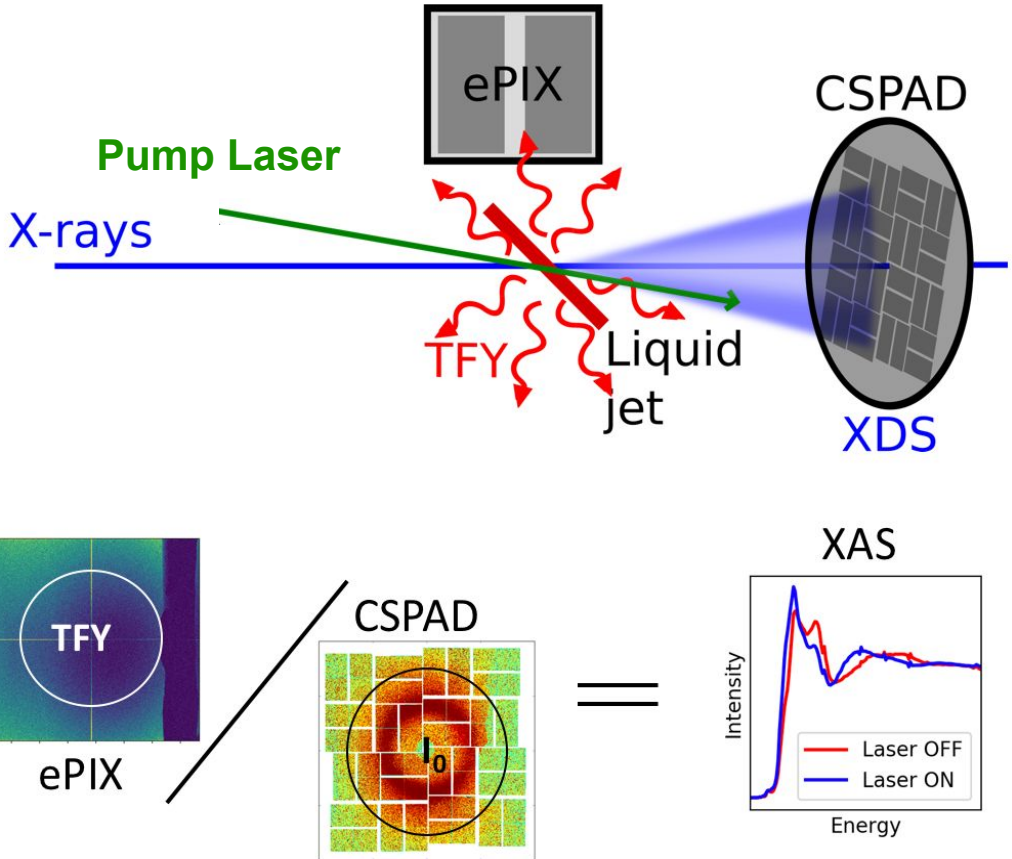
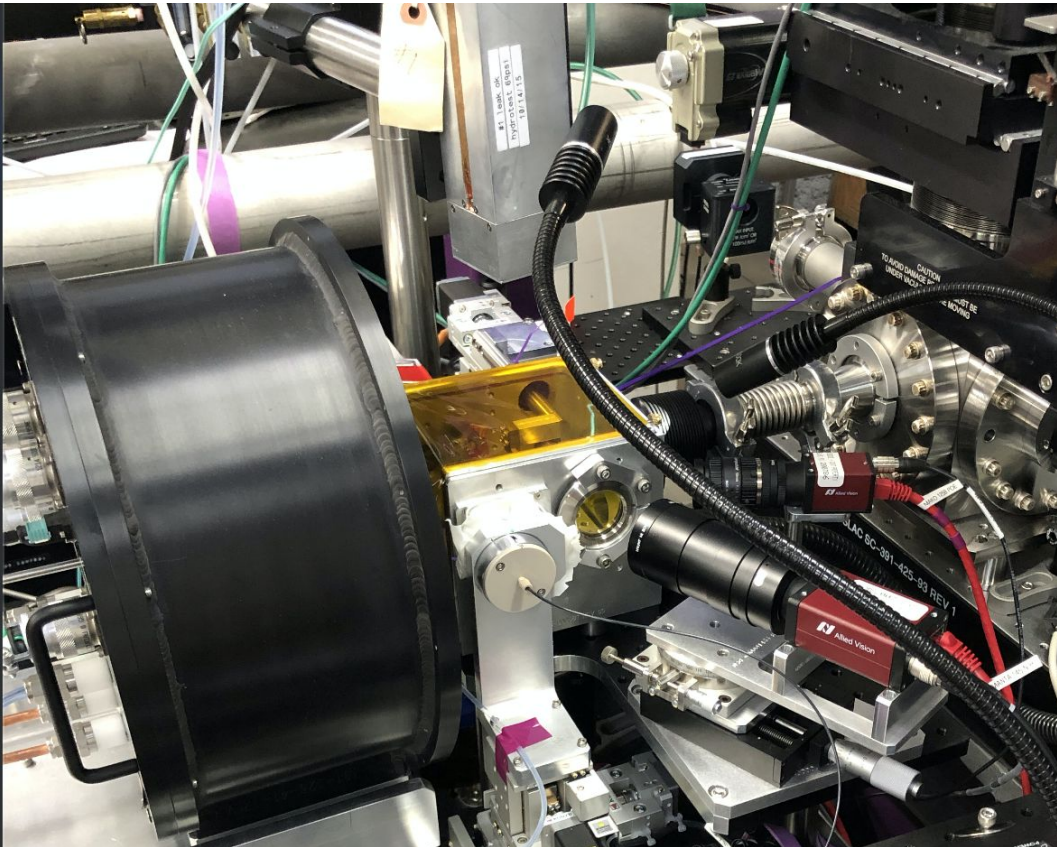
Jungfrau 4M

- Microfocus
- Adaptive gain
- Higher dynamic range
- Up to 1kHz repetition rate
- CSPAD for Parasitic Experiments



# XPP Standard Configuration #2: Liquid Phase XAS

## Time Resolved Hard X-ray XAS

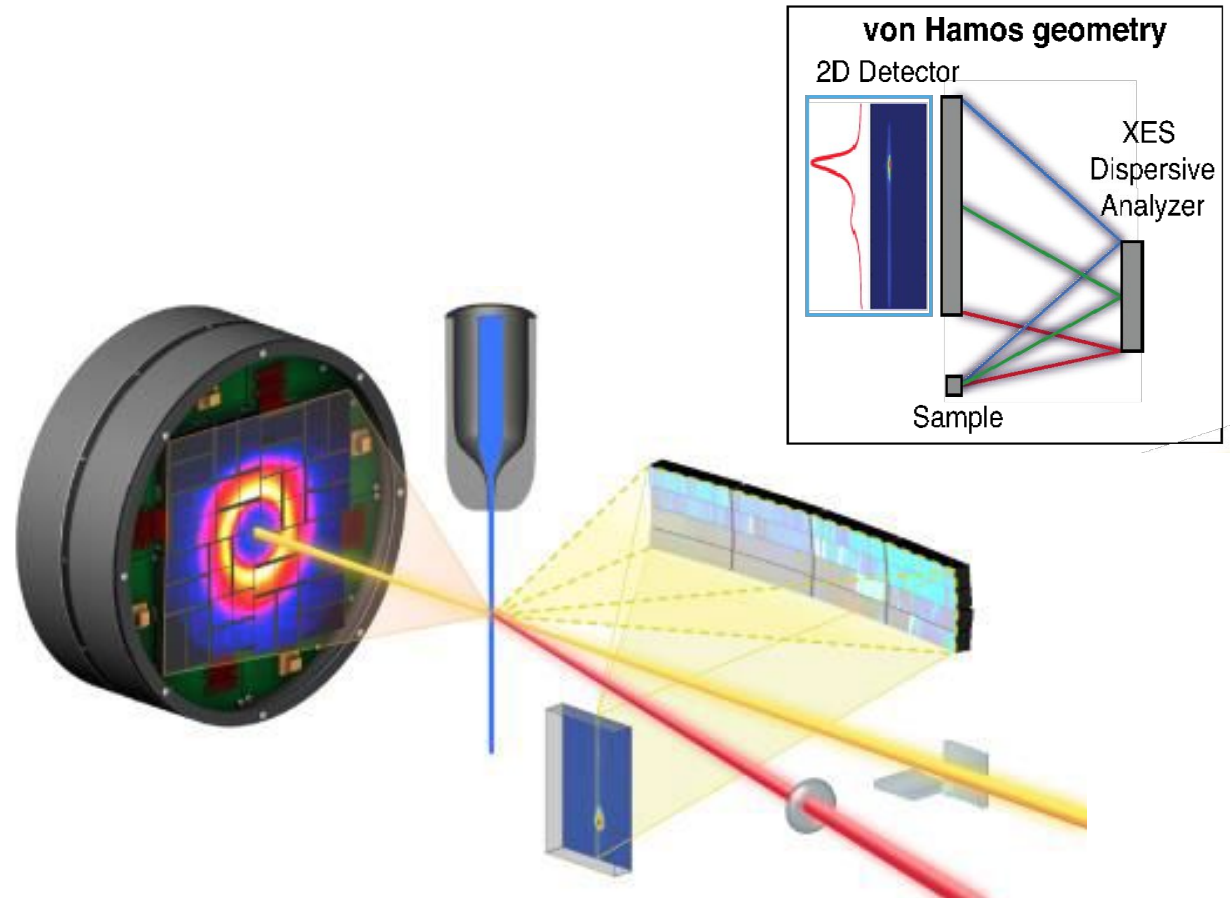
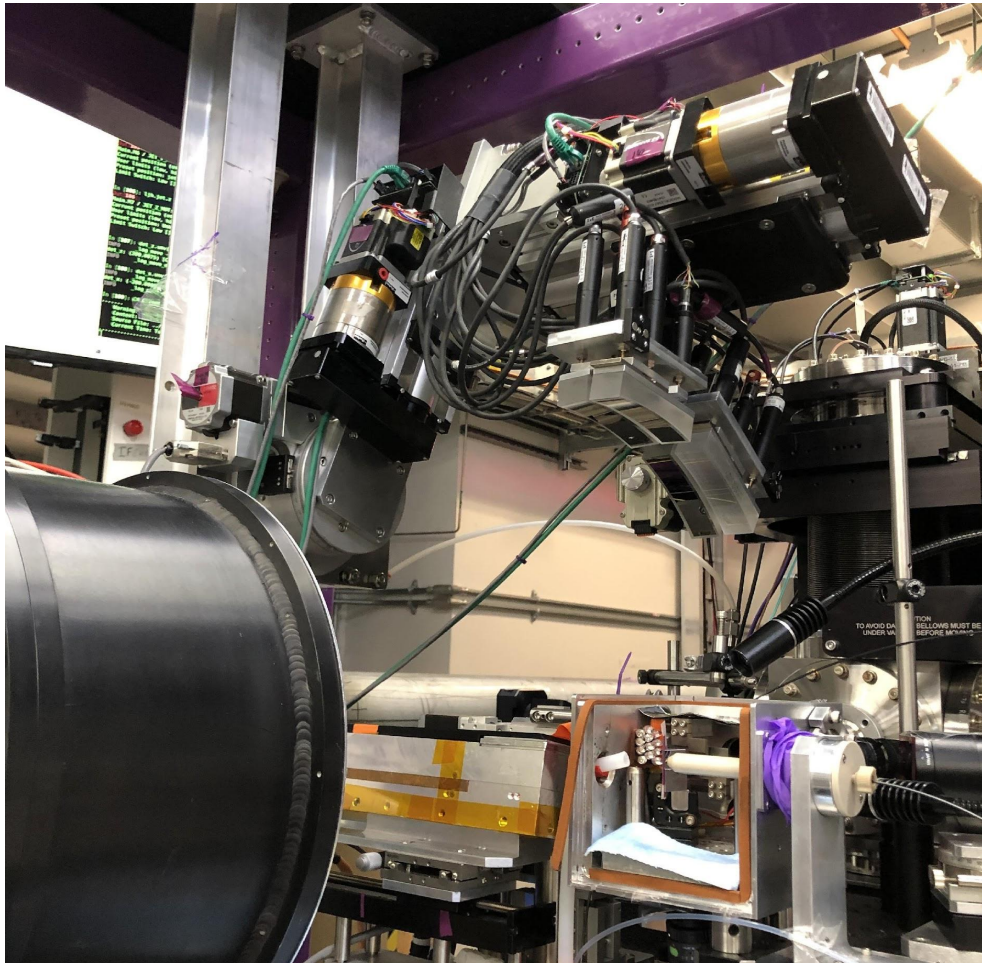


<https://lcls.slac.stanford.edu/instruments/xpp/standard-configurations>

# XCS Standard Configuration #1: Liquid Phase XES/XDS



## Time Resolved Hard X-ray XES + XDS



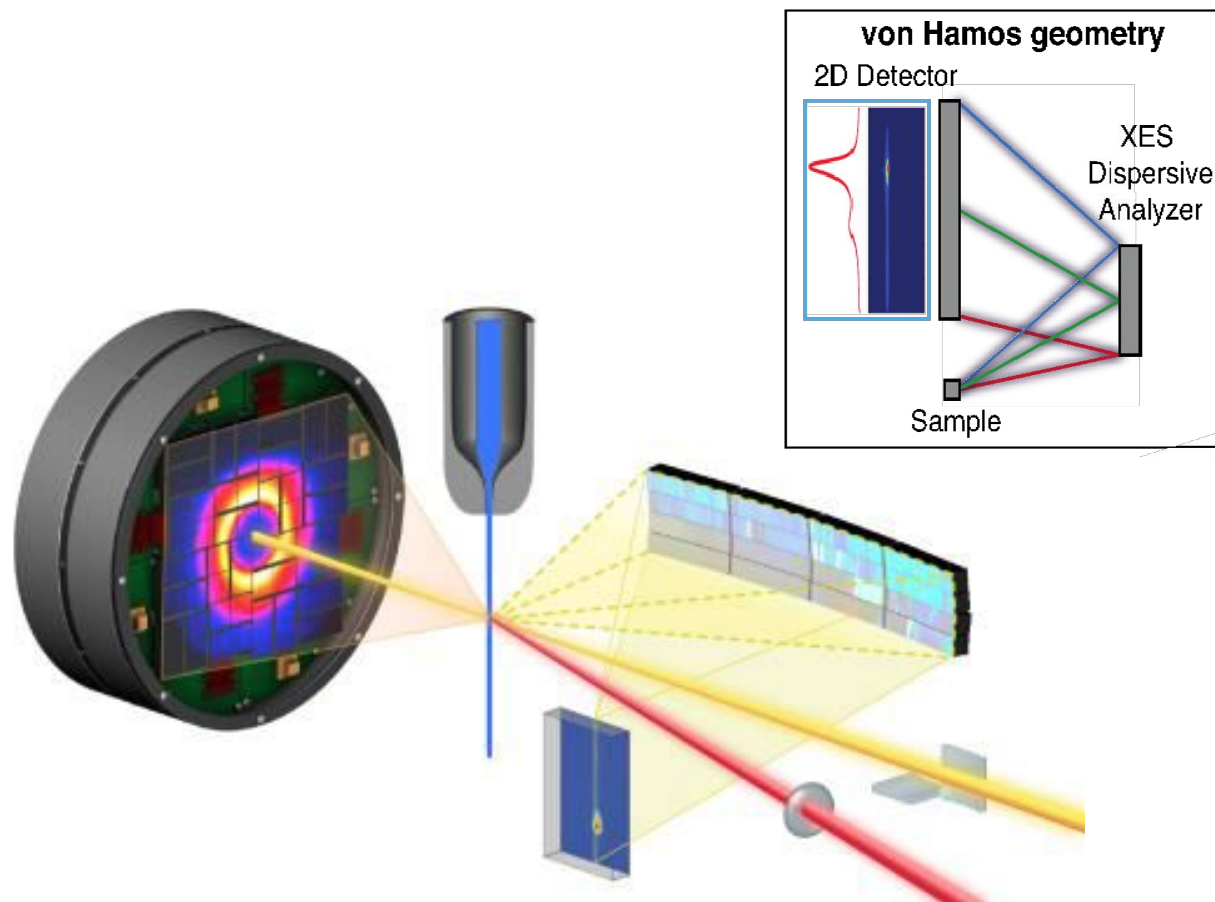
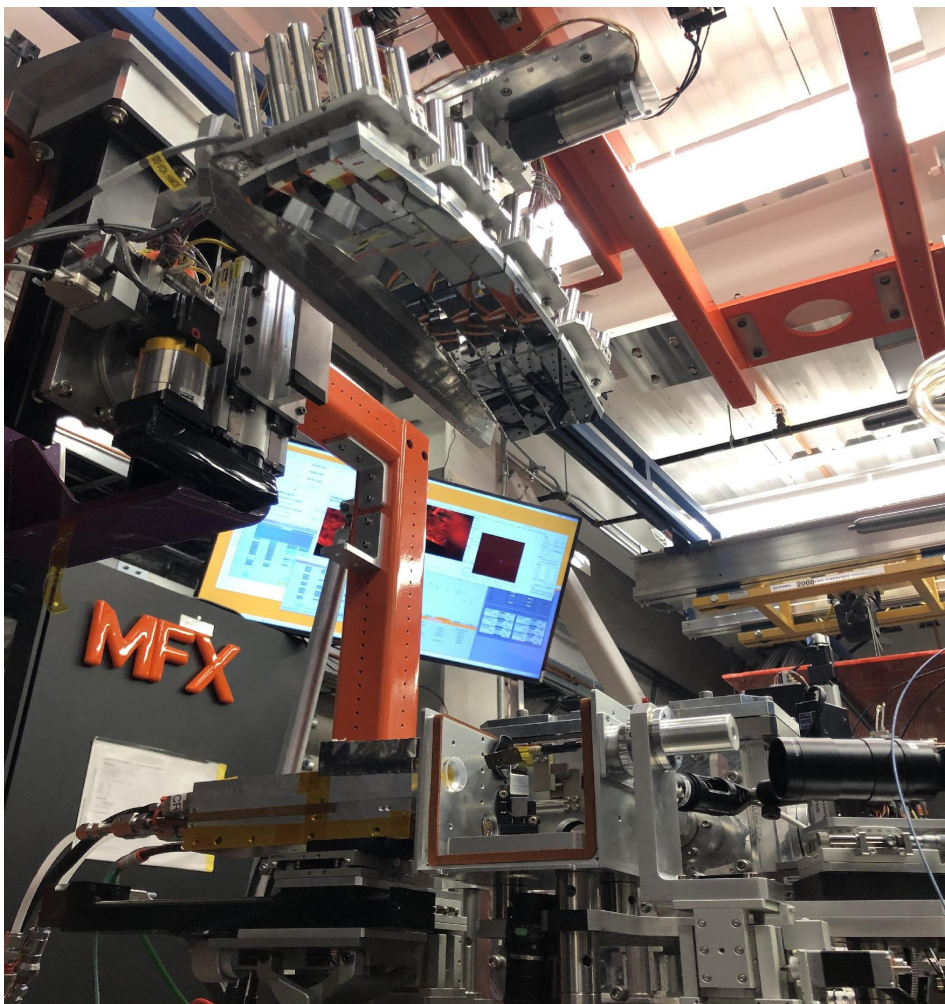
<https://lcls.slac.stanford.edu/instruments/xcs/standard-configurations>





# MFX Standard Configuration #3: XRD/XES

Hard X-ray XES+XRD: Damage-free atomic and electronic structure of metalloproteins at RT



<https://lcls.slac.stanford.edu/instruments/mfx/standard-configurations>

# Standard sample delivery hardware



**Proportioners**



**Shimadzu LC-20 and LC-40 series HPLCs**

**Sample selector boxes**

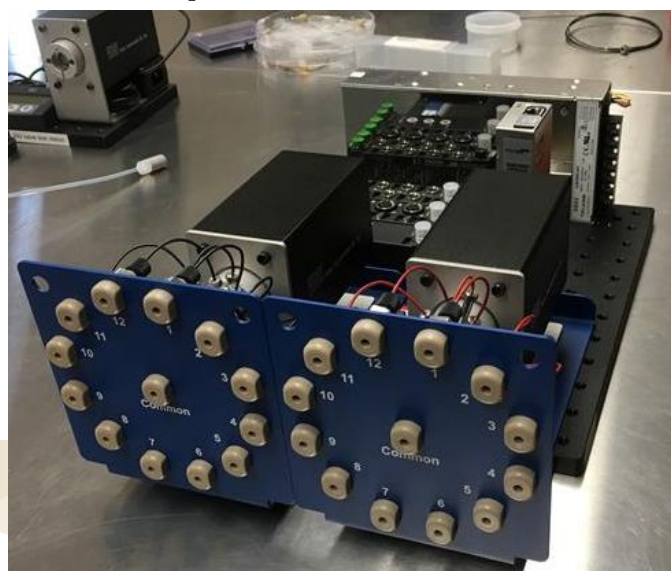


**Sensirion liquid flow meters**

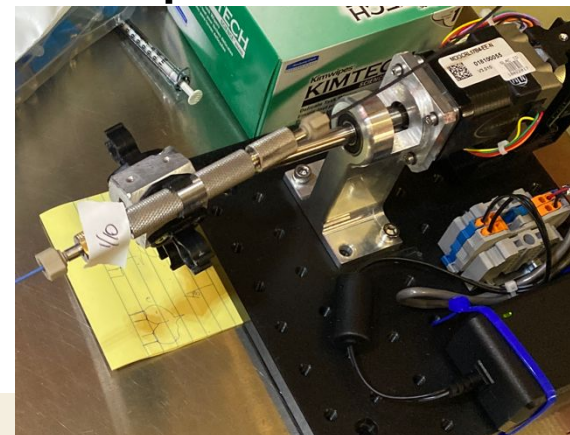
**High pressure reservoirs**



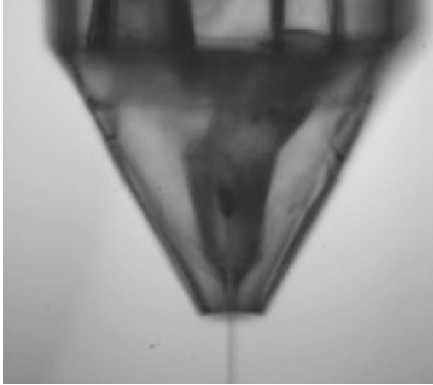
**Bronkhorst gas mass flow controllers**



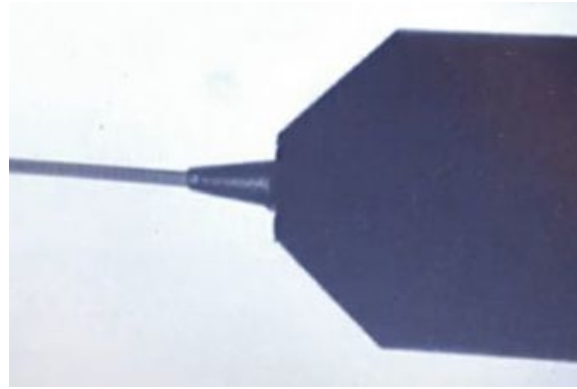
**Compact anti-settlers**



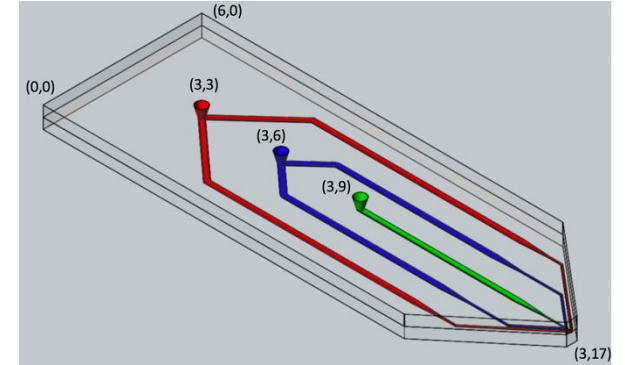
Several injection formats are supported across the hutches



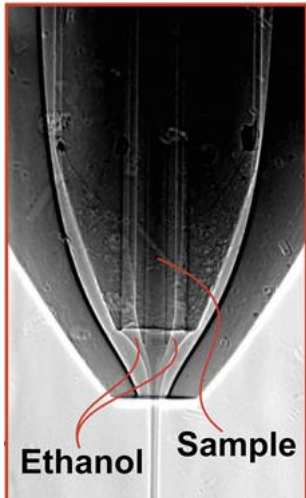
3D printed GDVN (above) and DFFN (below) (Kirian Group ASU)



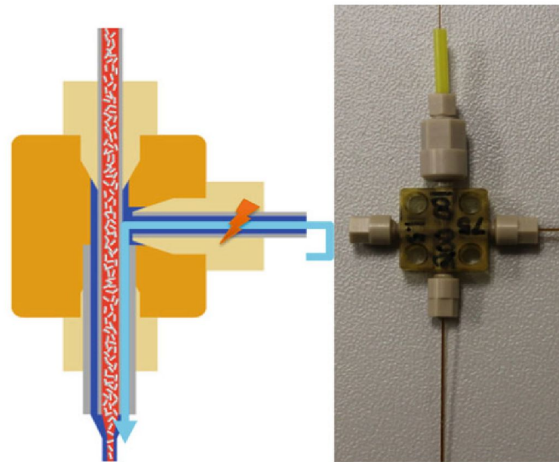
LCP and HVE sample injector (Weierstall group ASU)



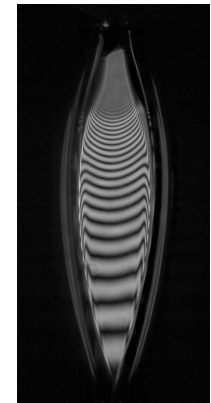
Chip nozzles and chip interfaces



Ethanol Sample



Electrokinetic (MESH/coMESH)



Sheet jets\*

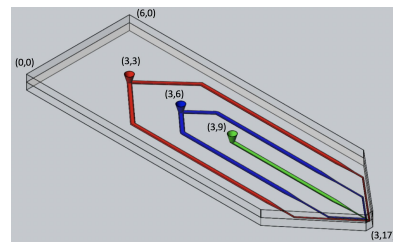
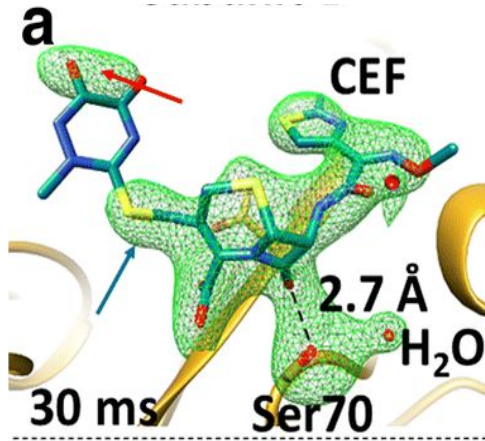
# Biolabs at the Arrilliaga Science Center



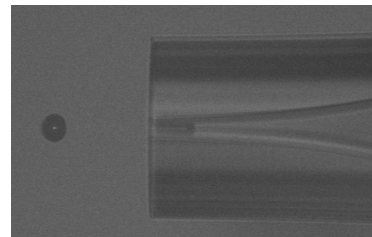
- ~7,000 sqft of usable space
- 300 sqft of coldroom
- Two darklabs
- BSL1 and BSL2 zones
- Equipment to go from cell growth through protein purification and crystallization



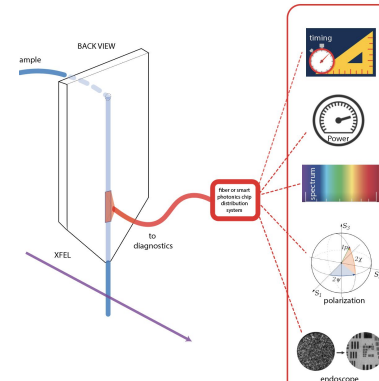
# NIGMS Center for Structural Dynamics in Biology



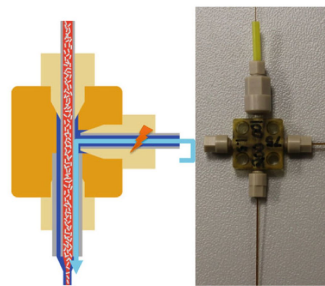
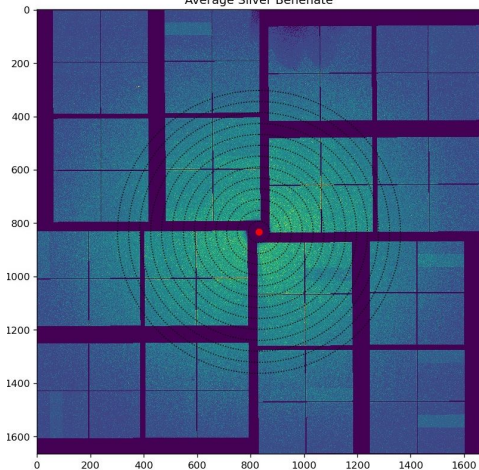
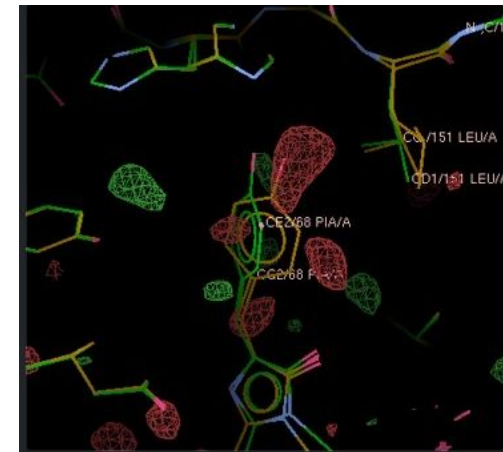
**Standardized (chip) nozzles\***



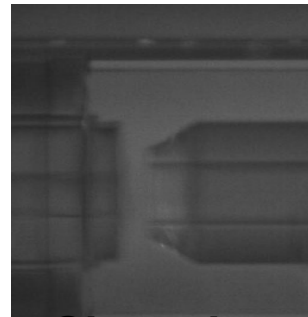
**Droplet on Demand\***



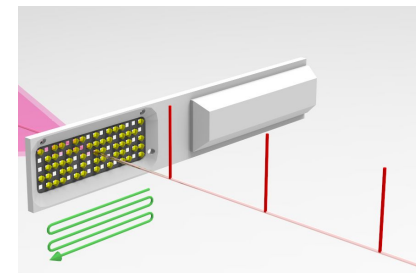
**Integrated diagnostics\***



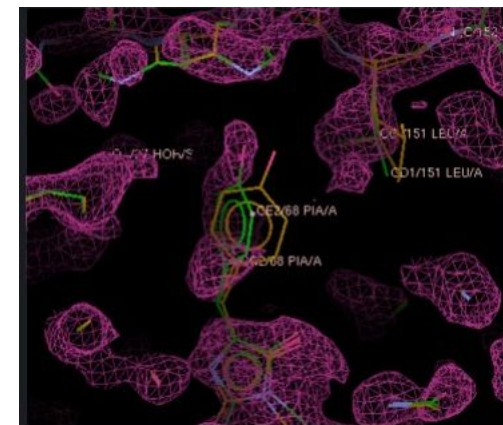
**Electrokinetic (MESH/coMESH)**



**Short time point mixers**



**Fast fixed target**

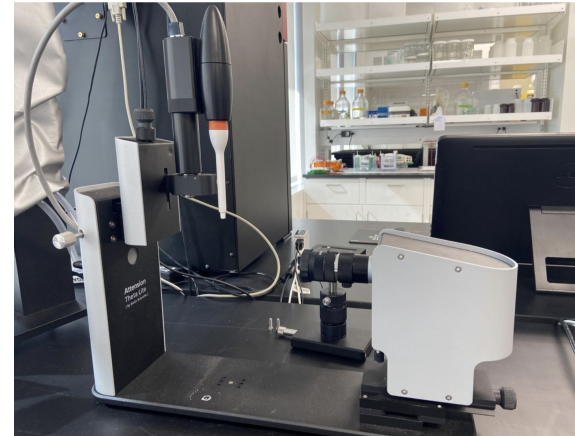


# New equipment at the Biolabs at the Arrillaga Science Center

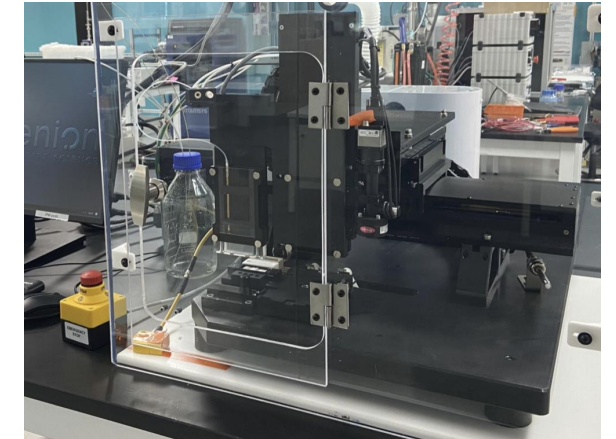


## Anaerobic Glove Box

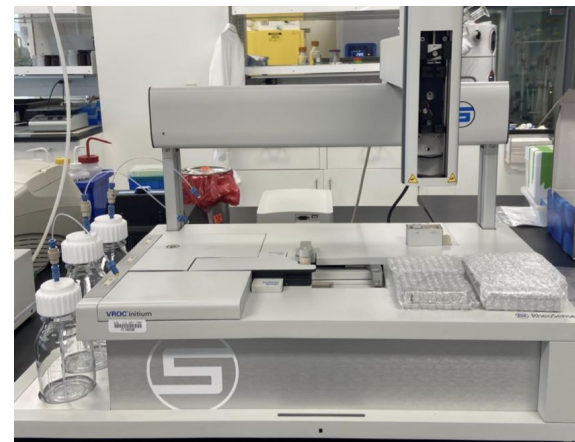
- ppm O<sub>2</sub> levels
- Nanosight, microscope in box
- Schlenk line available



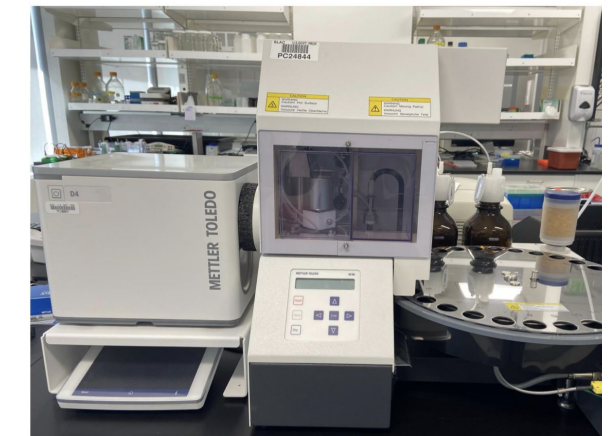
## Surface Tensiometer



## Automated Droplet on Demand



## Automated Viscometer



## Automated Densimeter



# Thank you!



Rapid Access and Biology at LCLS Website

- <https://biology-lcls.slac.stanford.edu/>

Biolabs at ASC Website

- <https://lcls.slac.stanford.edu/biolabs-asc>

LCLS Sample Prep Labs Website

- <https://lcls.slac.stanford.edu/spl>

Injector Characterization Labs Website

- <https://lcls.slac.stanford.edu/sed/lab>

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Bio@LCLS



Bio-Bloopers



XFELs for Bio Book

