Structure and Dynamics of Biological Systems: Part 2

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Pacific Northwest NATIONAL LABORATORY
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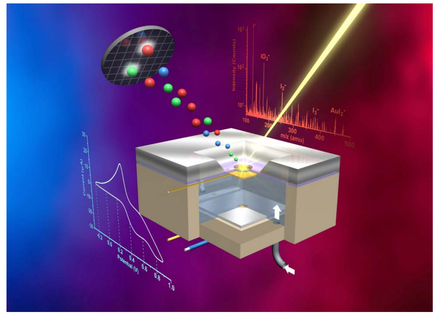
ST2, Project 1.8; October 2012-September 2015

FY14 Key Successes

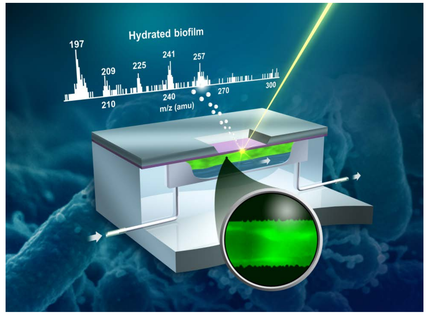
- BER Mesoscale Pilot Project funded
- 6 published or In Press papers
- 2 submitted manuscripts
- 2 journal covers
- 8 invited presentations
- 3 contributed talks/posters
- 48 hours of LCLS beamtime
  - 2 LCLS access proposals still in review

Research Accomplishments

Optimization of In-situ Time-of-Flight-Secondary Ion Mass Spectrometry (ToF-SIMS) imaging

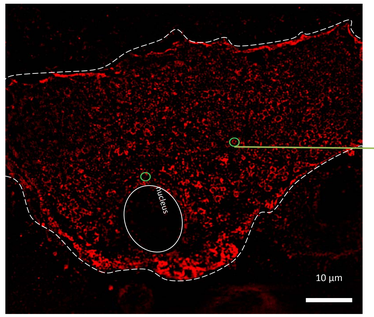


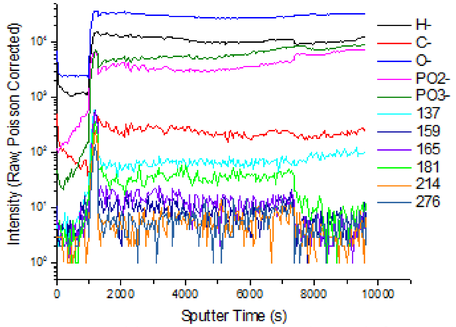
First direct in-situ observation of the electrode-electrolyte solution interface by ToF-SIMS. Liu B et al. 2014. *Lab Chip* 14(5):855-859 (Back Cover)



First direct in situ bioimaging of hydrated biofilm in its native state by ToF-SIMS. Hua X et al. 2014. *Analyst* 139:1609-161 (Front Cover)

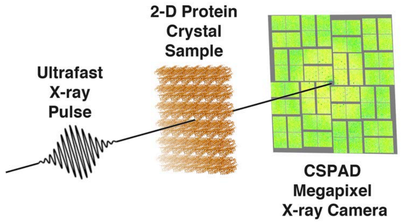
First correlative in-situ ToF-SIMS and structured illumination (SIM) fluorescence imaging

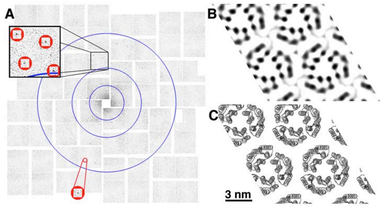




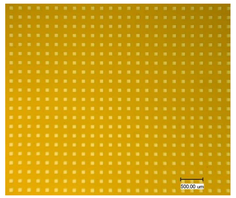
In-situ ToF-SIMS depth profile (right) of the same 2-µm area imaged by SIM (green circles in left panel) illustrating characteristic lipid fragments indicative of first observations of the C10 cells exposed to carboxylate functionalized fluorescent quantum dots (red) in the designed microchannel.

Extending Ultrafast X-ray Diffraction to Protein Monolayers

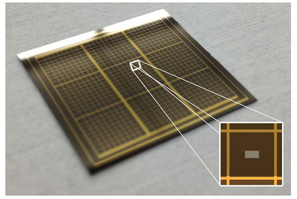


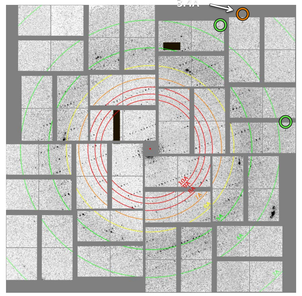


First-ever forward diffraction (transmitted) of 2-D protein crystals using X-rays made possible with ultrafast pulses at LCLS. Frank M et al. 2014. *IUCrJ* 1:95-100. Work posted on PNNL website, reported by Time Magazine Online, highlighted on DOE website, and featured as an example technique on the LCLS CXI overview webpage.



New microfabrication designs allow up to 10,000 windows per 1-in² chip increasing data collection >5-fold, while metal patterned chips allow in-situ liquid imaging to >4 Å, enabling pump-probe dynamic imaging. Similar cells will allow synergistic in-situ imaging using short electron pulses with Dynamic TEM.





Next Steps

- Pursue external funding opportunities:
  - DOE Early Career/NIH R01 Grant
- Acquire real-time movies of protein dynamics
- Adapt Nano-SIMS for robust serial section biosystem analysis
- Implement transfer hub for correlative ion, optical, and electron microscopy of same sample
- Move from method and technique optimization to applying the imaging platform towards imaging biofilms and nanoparticle uptake.

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