Session 1A:
Advances in liquid sample delivery systems and their applications at SACLA

Organizers:
A. Suzuki (Hokkaido University) and Y. Inubushi (SACLA)

Opening

A. Suzuki (Hokkaido Univ.)

Instruments and applications

A compact tape-driven system for liquid sample droplet delivery

J. Kang (SACLA)

Molecular movie of the catalytic reaction of bacterial copper amine oxidase conducted by mix-and-inject serial femtosecond X-ray crystallography

T. Murakawa (Osaka Medical and Pharmaceutical Univ.)

Liquid sample delivery for ultrafast X-ray chemistry

T. Katayama (SACLA)

Micro-liquid enclosure array for XFEL-based coherent diffractive imaging

A. Suzuki (Hokkaido Univ.)

Mn Kα-laser experiment with burnable liquid sample

Y. Michine (Univ. Electro-Communications)

Discussion

Chairs: A. Suzuki & Y. Inubushi

Background & Purpose

- Liquid samples have inherent scientific interests in various fields
- Compatible with high-repetition-rate XFELs, suitable for destructive measurements
- Each research group has been developing their delivery systems independently
- **The purpose of the session: Sharing basic information and challenges of each system, and building new connections beyond research fields**

Discussion

Challenges (now):

Change the delay time during the beamtime (**Mix-and-inject SFX**)
- Stock of various nozzles can realize the request → Improve efficiency of the beam time

Reducing background signals (**CDI**)
- They have been developing a new type of MLEA using a thinner SiN window membrane
- Beam line optics also related background signals and throughput -> already started a discussion between SACLA & users

Toxic materials and other samples that should be handled carefully (**Ultrafast chemistry & Nonlinear X-ray Optics**)
- There are previous instances. Please ask beamline staff in advance.

Challenges (The future):

High speed jet at repetition rate ~1kHz (**Ultrafast chemistry**)
- Use of high pressure gas (> 1MPa), implementation is difficult due to regulation in Japan

New type sample holder suitable for high repetition rate ~1kHz (**CDI**)
- Accumulation of a tremendous number of diffraction patterns enables improvement of spatial resolution (homogeneous sample)

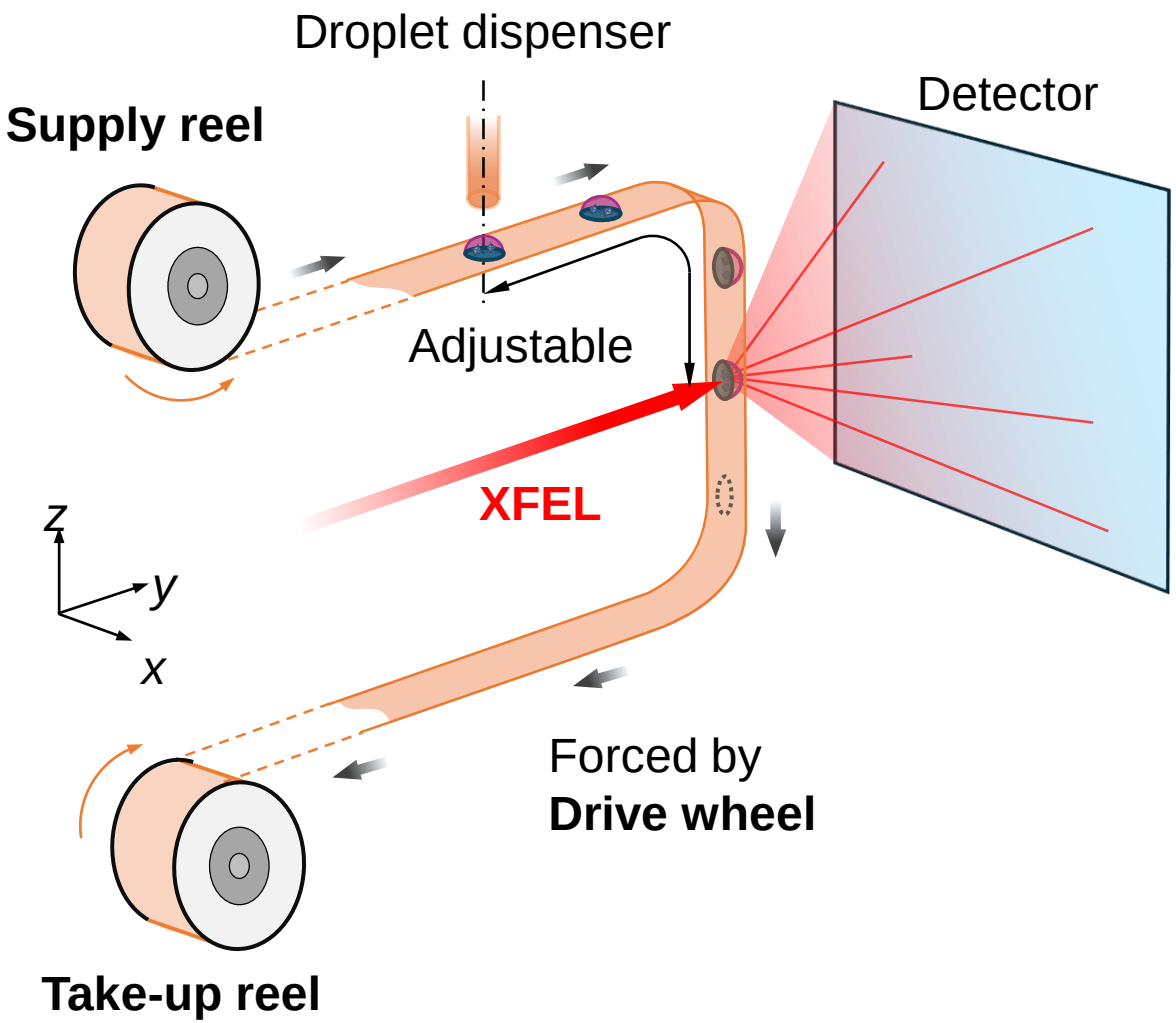
Others:

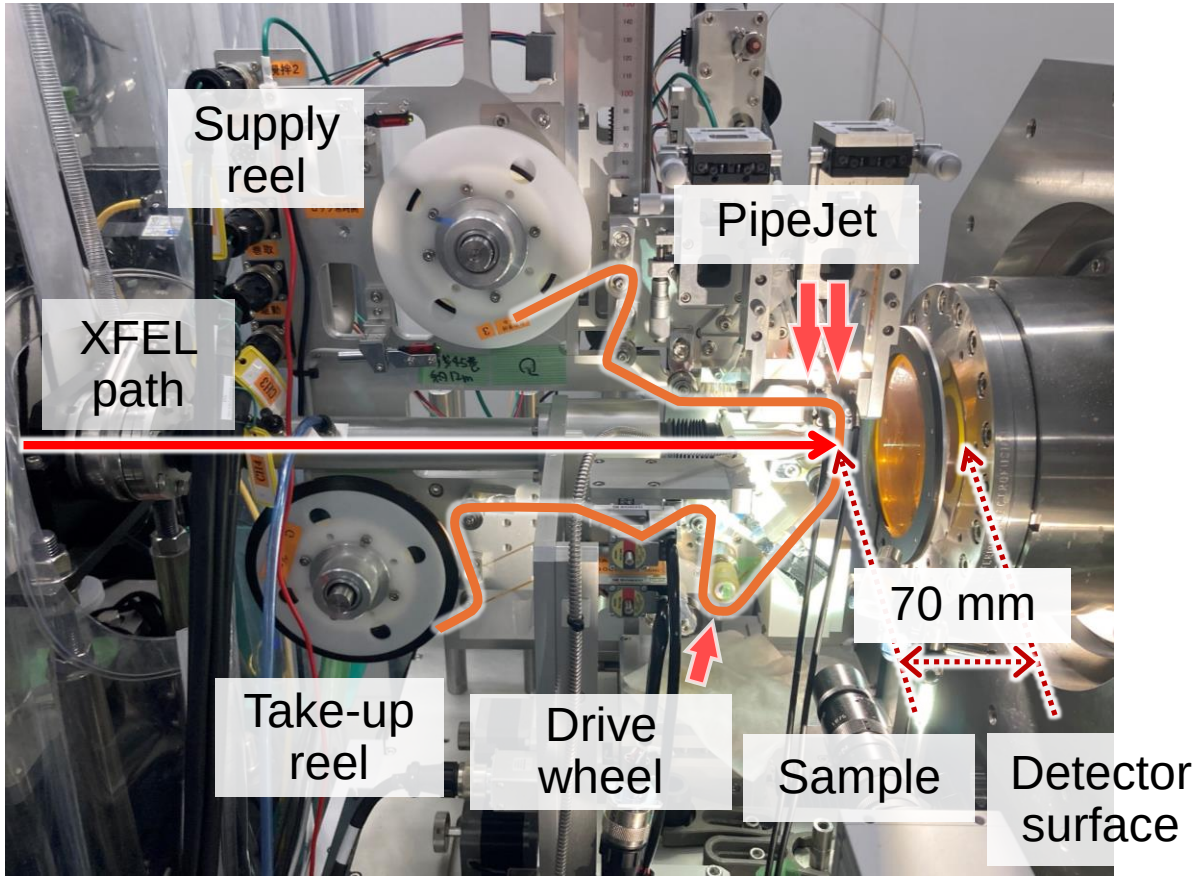
Coordination and support by SACLA staff is essential for new collaborations beyond research fields

Involving researchers at SPring-8/other synchrotron facilities who use liquid samples

A compact tape-driven system for liquid sample droplet delivery

J. Kang (SACLA)

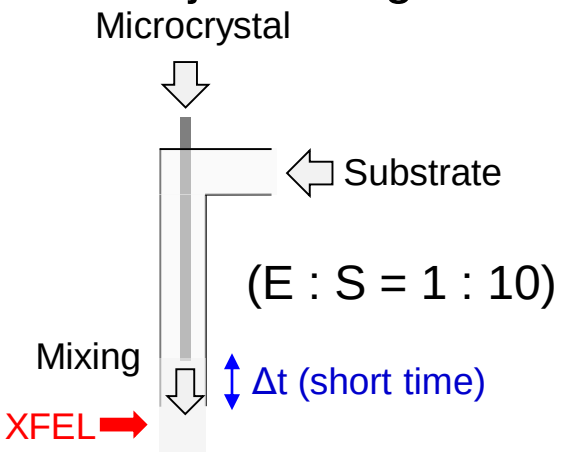




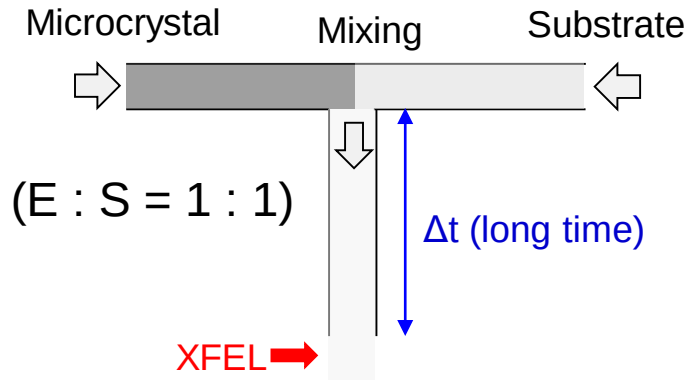
Molecular movie of the catalytic reaction of bacterial copper amine oxidase conducted by mix-and-inject serial femtosecond X-ray crystallography

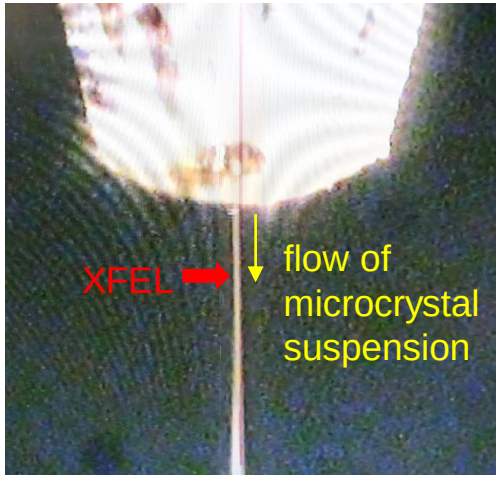
T. Murakawa (Osaka Medical and Pharmaceutical Univ.)

Double jet mixing nozzle



T-junction jet mixing nozzle



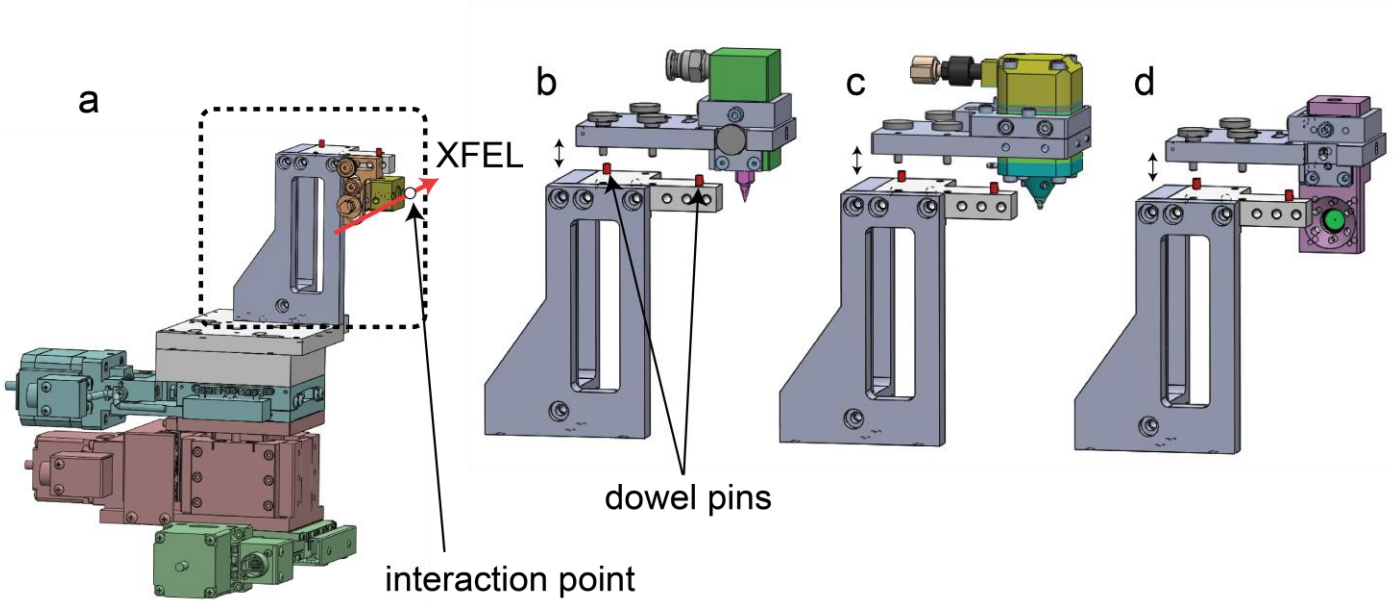


- Flow rate: 0.25 mL / min
- Injector nozzle

  Double jet: 50, 100, 200, 300, and 400 ms time delay after mixing.
  T-junction: 500 and 1000 ms time delay after mixing.

Liquid sample delivery for ultrafast X-ray chemistry

T. Katayama (SACLA)



- High positional reproducibility (~50 μm)

  Easy spatial and timing alignment between XFEL and optical

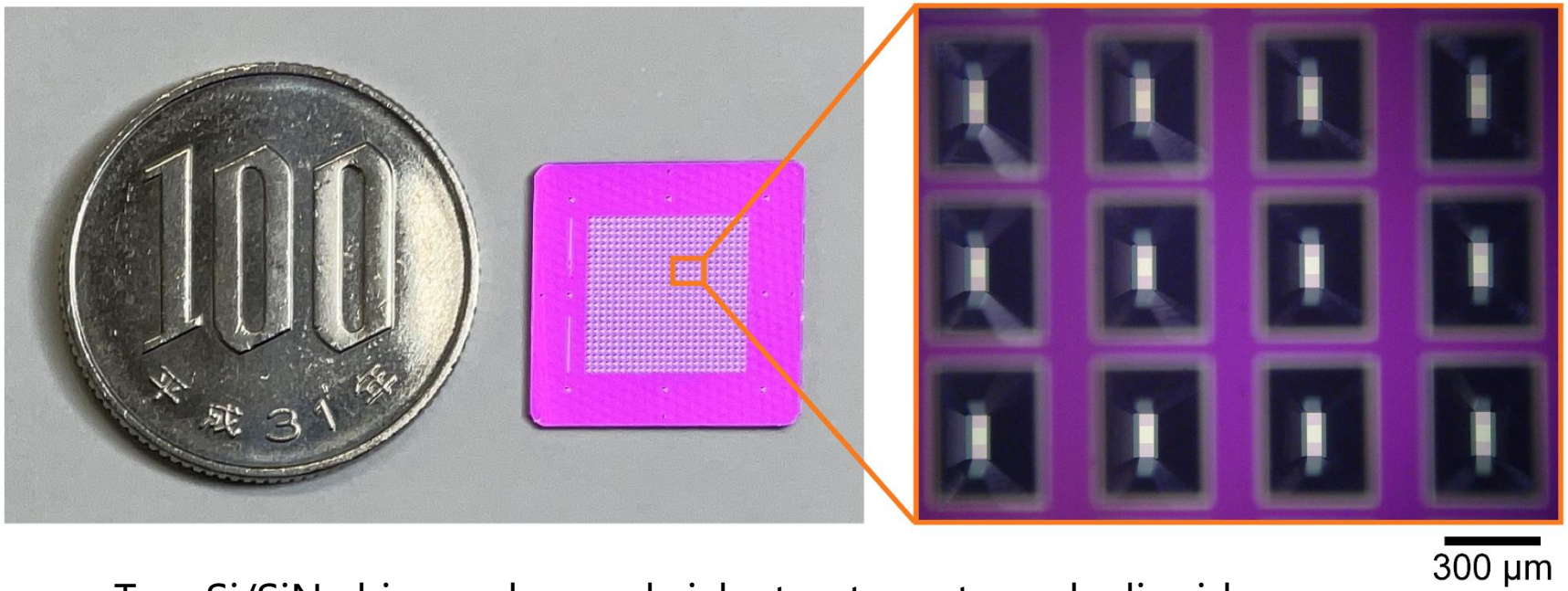
- Cover various viscosity sample and jet thickness (50–500 μm)

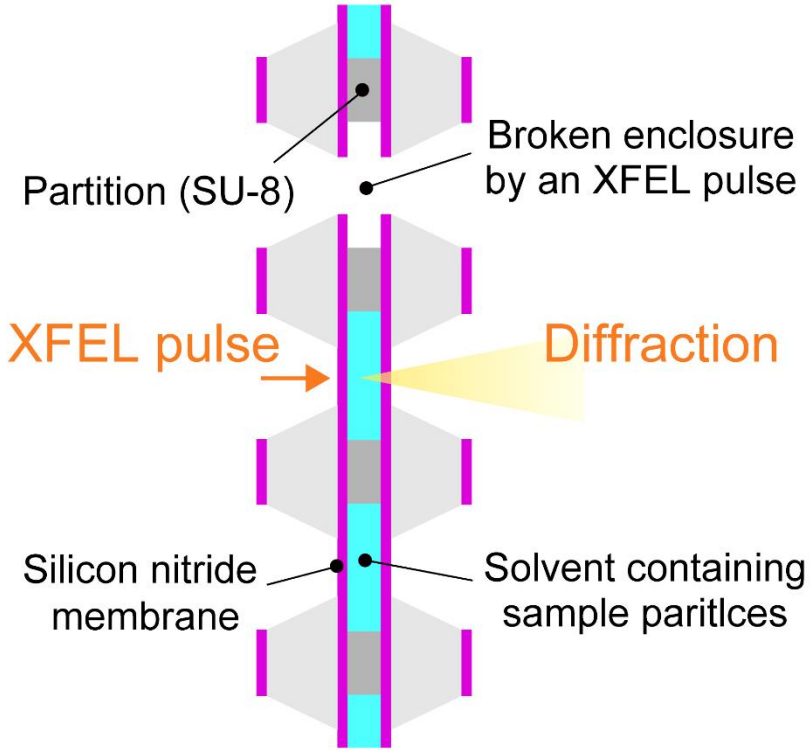
  Water, alcohol, high viscous grease (c), etc

Micro-liquid enclosure array for XFEL-based coherent diffractive imaging

A. Suzuki (Hokkaido Univ.)

Structure of MLEA



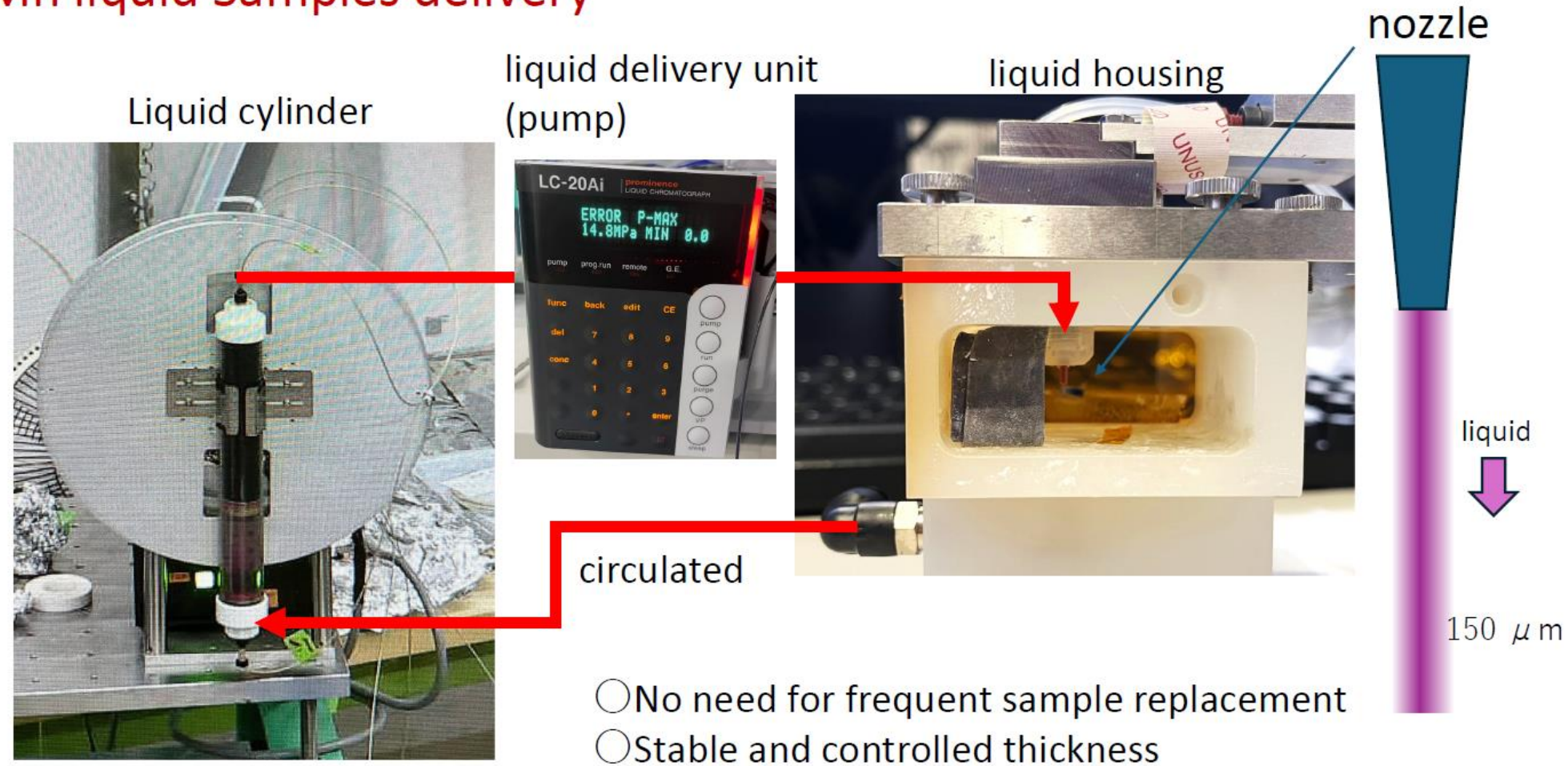


- Two Si/SiN chips make sandwich structures to make liquid arrays
- A MLEA has 576 liquid arrays (24 (H) x 24 (V))
- XFEL pulses and sample stages are synchronized with ~6Hz measurement
- Hit rate on interested sample particle is ~20-30% (Easily tunable be changing particle concentration)

Mn Kα-laser experiment with burnable liquid sample

Y. Michine (Univ. Electro-Communications)

Mn liquid Samples delivery



○No need for frequent sample replacement
○Stable and controlled thickness