The specification and development progress of a belt conveyor setup at SACLA

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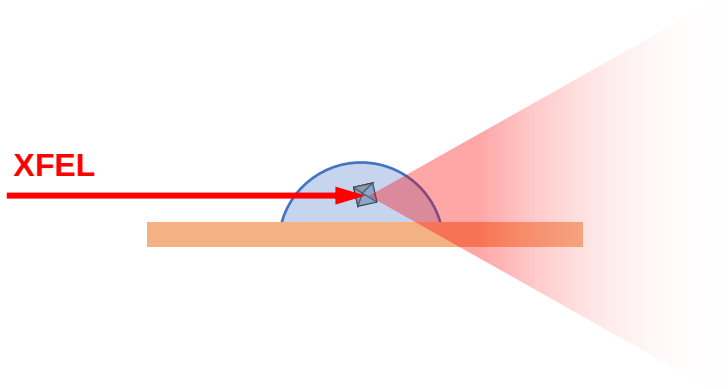
*RSC: RIKEN SPring-8 Center

*JASRI: Japan Synchrotron Radiation Research Institute

Conveyor setup for sample delivery

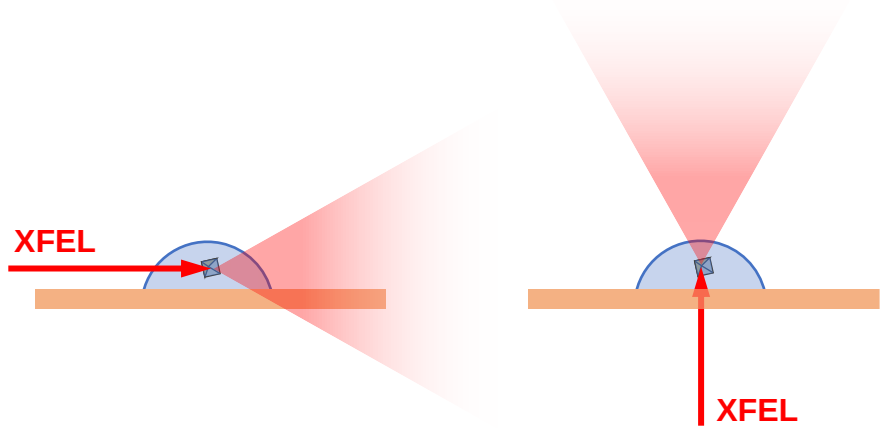
Conveyor belt setup



- Only available for parallel X-ray irradiation to the tape surface
- Need to clean the tape surface for every loop
- Small tape consumption

Fuller et al., *Nat. Methods* **14**, 443 (2017).
Butryn et al., *Nat. Commun.* **12**, 4461 (2021).

Reel-to-reel setup

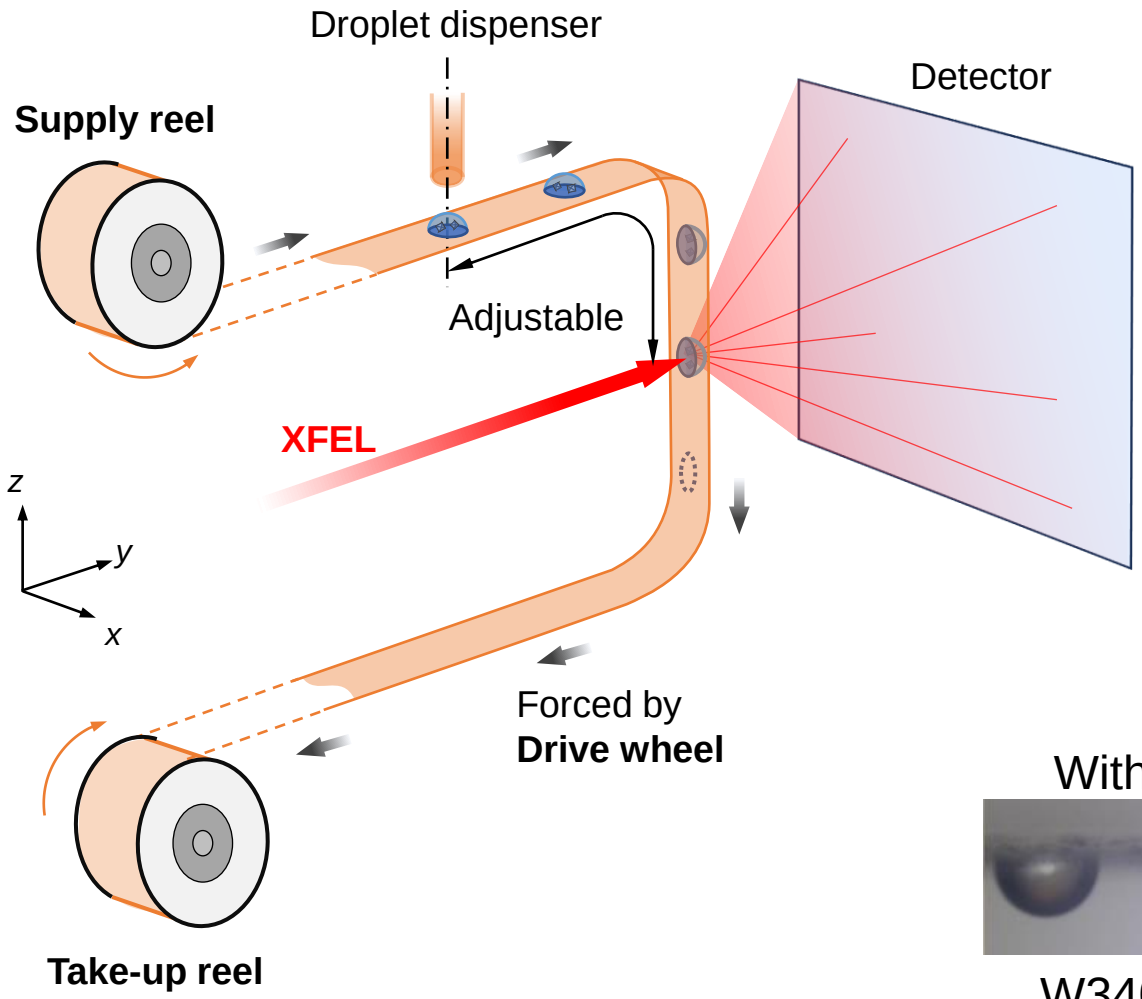


- Available for both parallel and perpendicular X-ray irradiations to the tape surface
- No need to clean the tape surface since for single-use (not recycled)
- Large tape consumption

Beyerlein et al., *IUCrJ* **4**, 769-777 (2017).
Zielinski et al., *IUCrJ* **9**, 778-791 (2022). Henkel et al., *IUCrJ* **10**, 253-260 (2023).

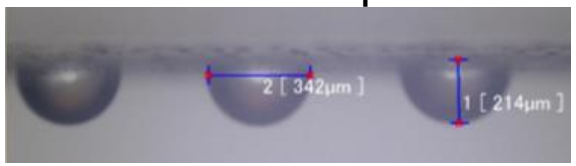
Concept

A reel-to-reel setup with perpendicular XFEL irradiation to the tape surface



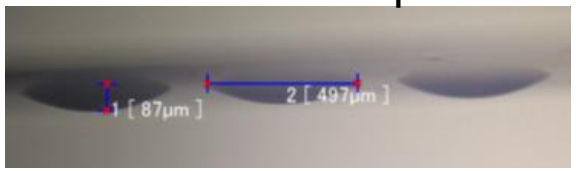
- Supplement of clean tapes
- Alignment of the droplet position to the XFEL irradiation position
  - XFEL irradiation in front of the droplet through the tape
  - No need to increase the droplet height
  - No need for water-repellent tape
- Available to install to the DAPHINS platform with few changings

With water-repellent

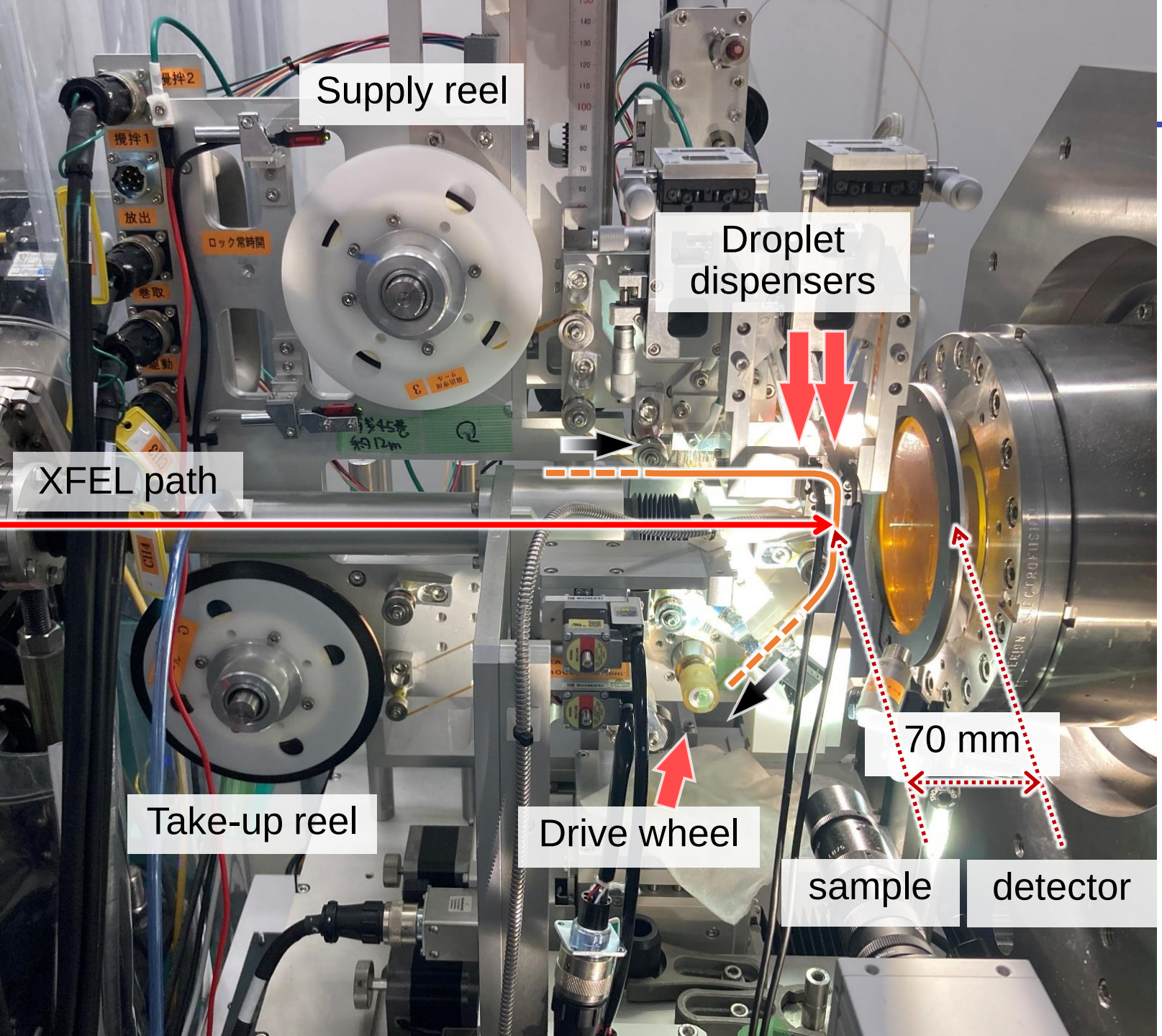


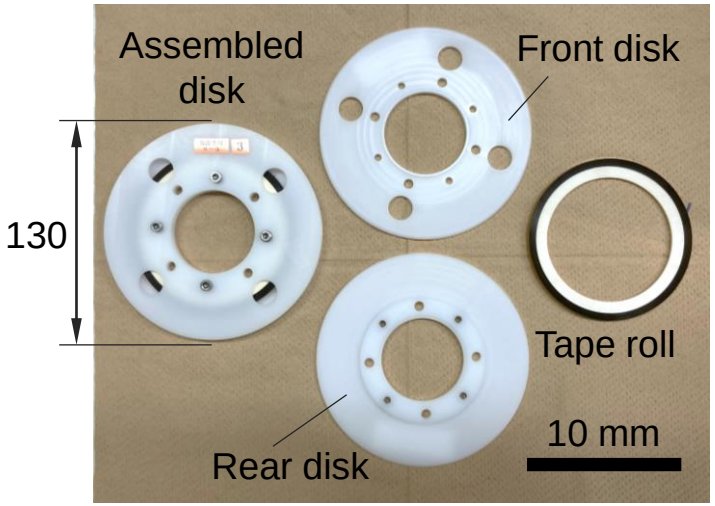
W340 µm x H210 µm

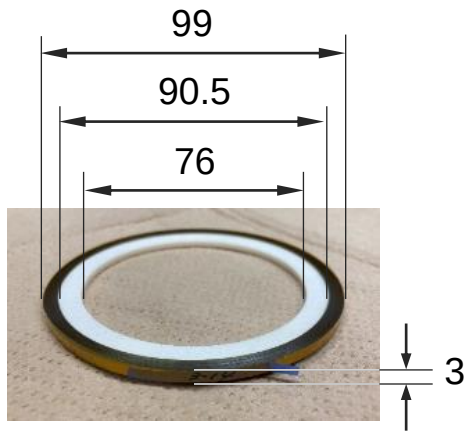
Without water-repellent



W500 µm x H90 µm



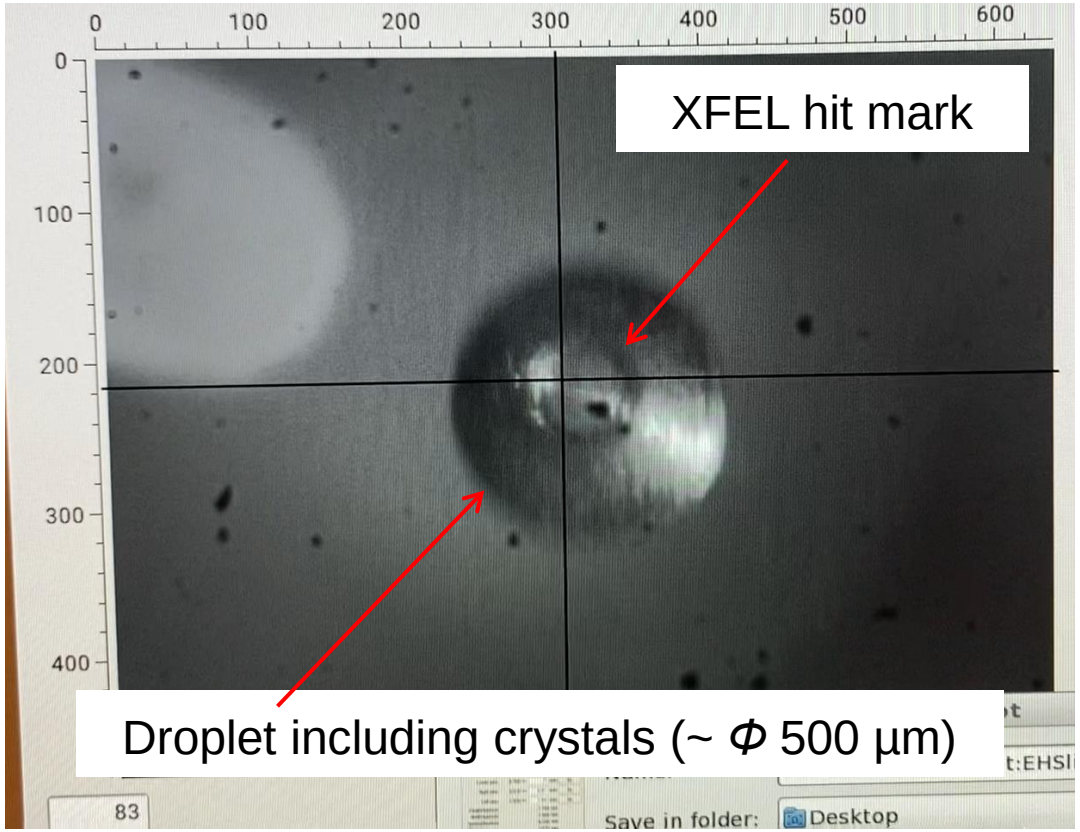




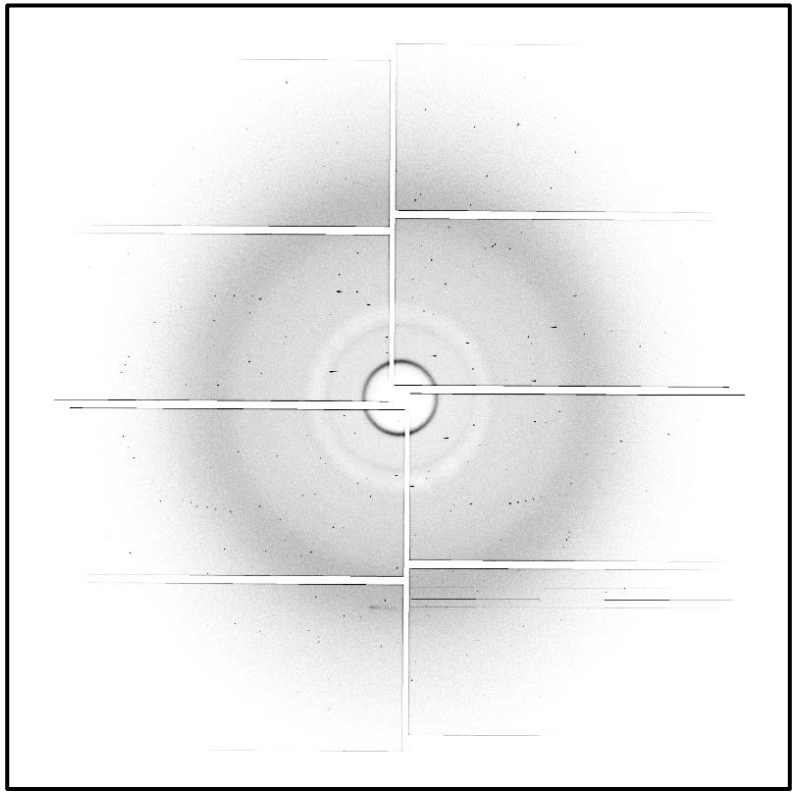
100 m-long roll
e.g., Runtime ~55 min. @30 mm/s

XFEL pulse irradiation

View of XFEL pulse direction (tape-through)



Typical diffraction image
showing the tape background on the CCD

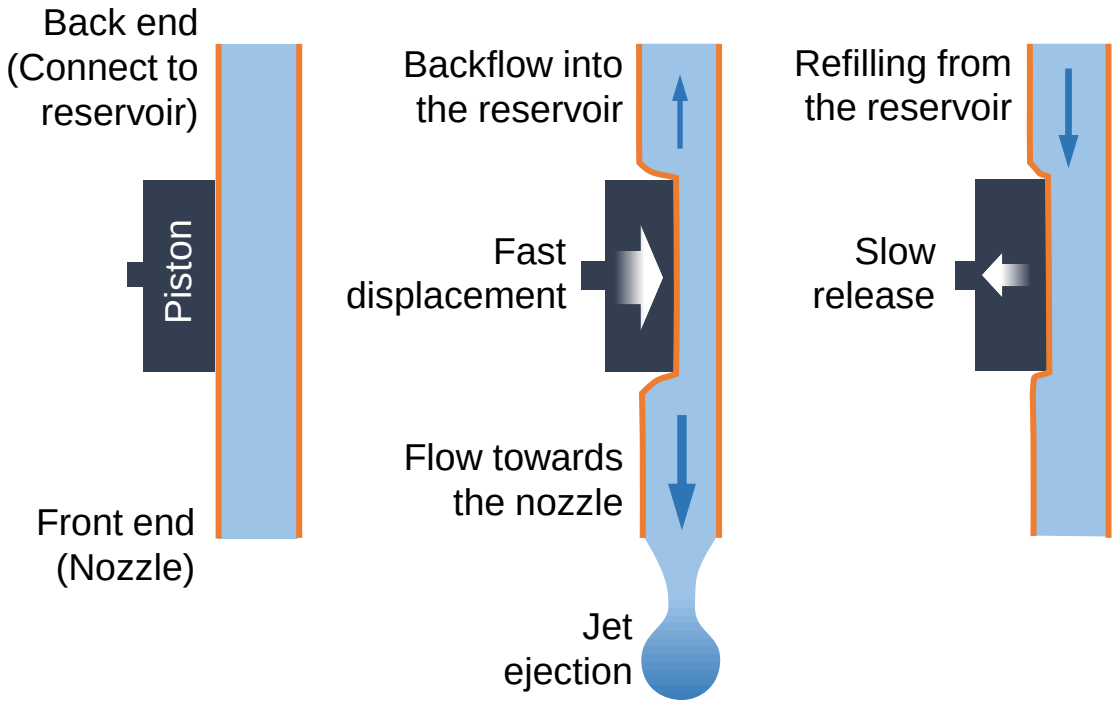


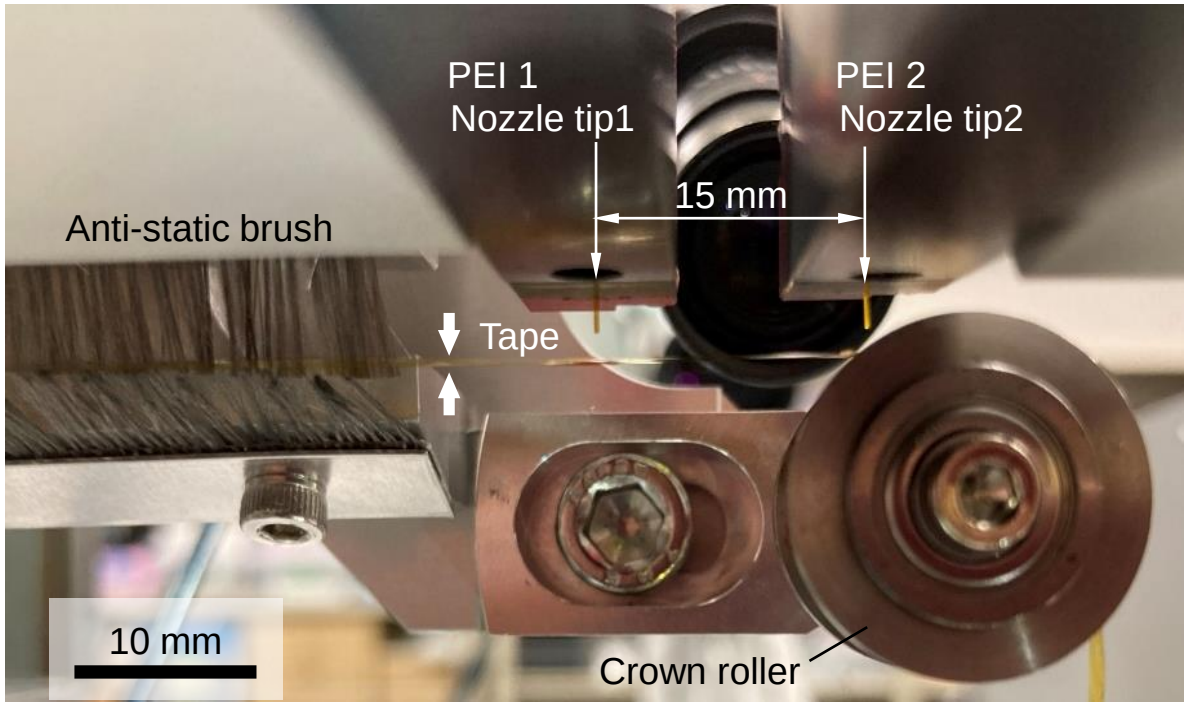
- The tape background remaining at the diffraction: Little to no affection on data collection.
- Easy for irradiating XFEL; Much consumption for the tape.

  ⇒ Multi-use of tapes is currently under development.

Sample droplet dispenser

Conventional Piezoelectric Injector

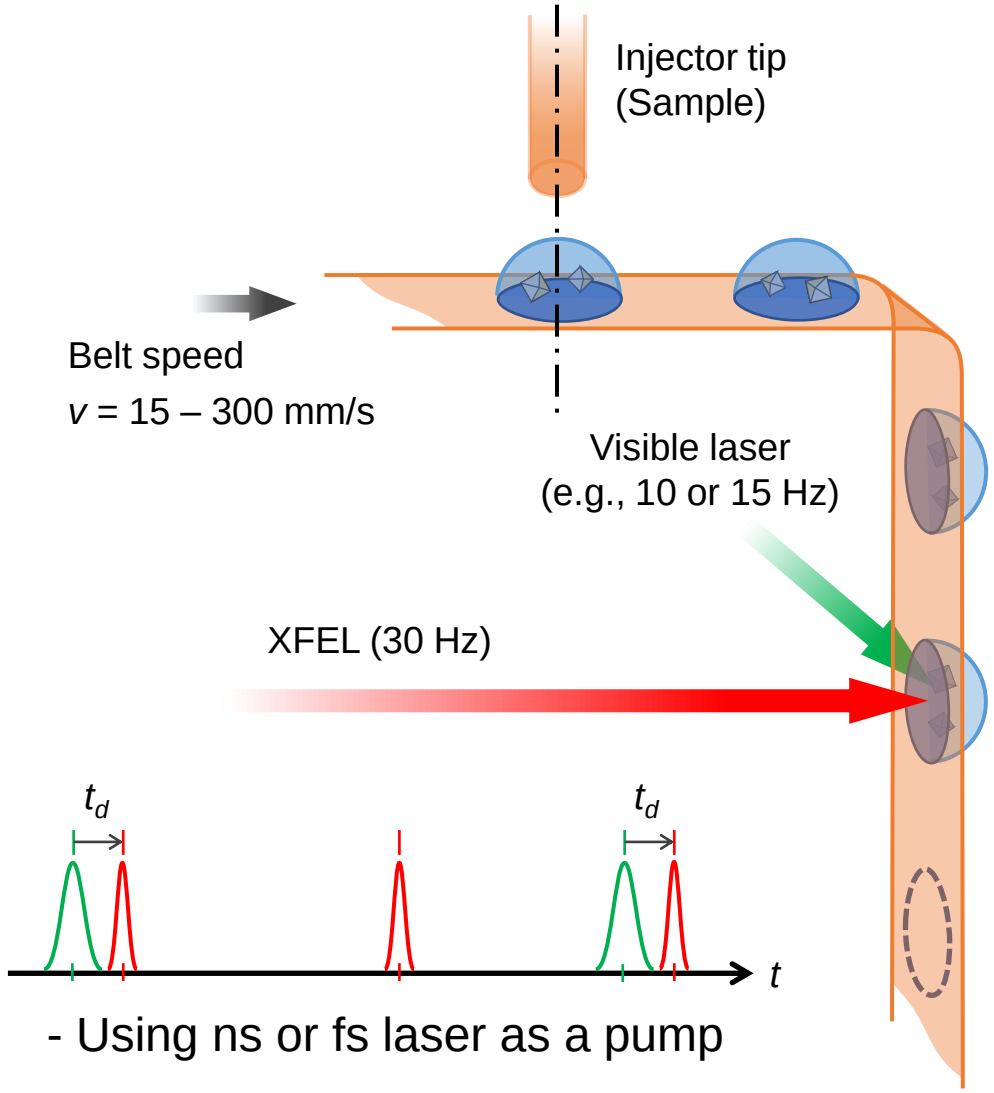




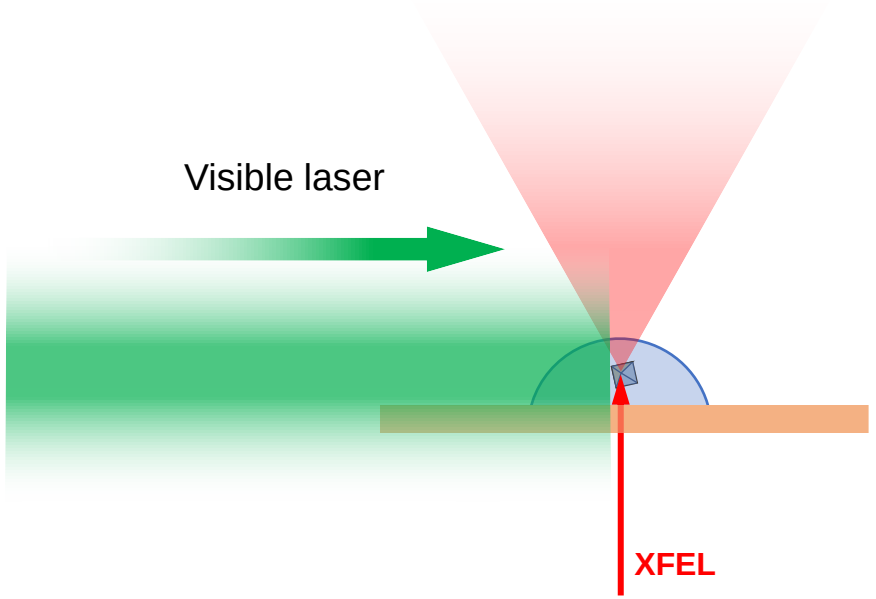
- Easy control for nano-liter droplet dispensing on the tape surface
- Synchronized with XFEL pulse frequency (30 Hz)
- Nozzle tip ID: 125 µm (1 to 8 nl)*, 200 µm (8 to 20 nl)*, 500 µm (20 to 70 nl)*

*Typical information from the vendor with pure water

For time-resolved SFX: Pump-probe setup



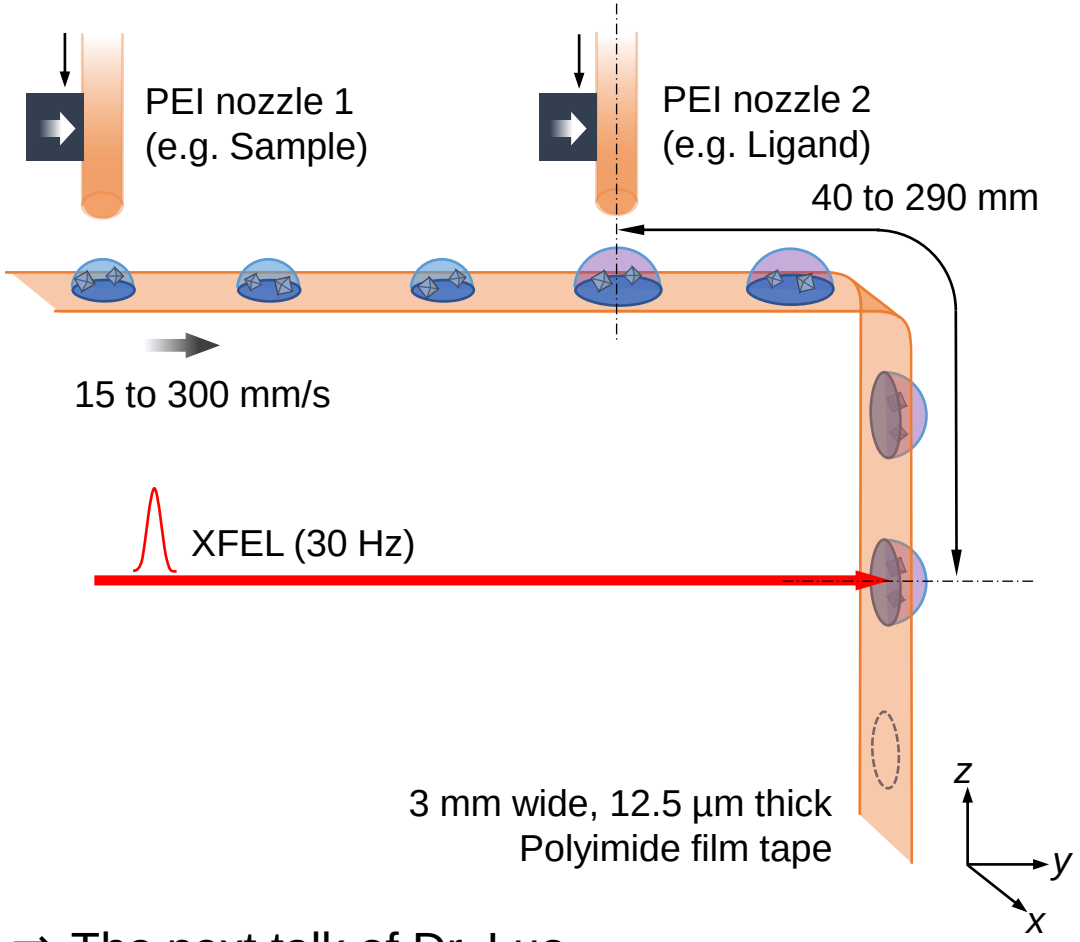
- Using ns or fs laser as a pump

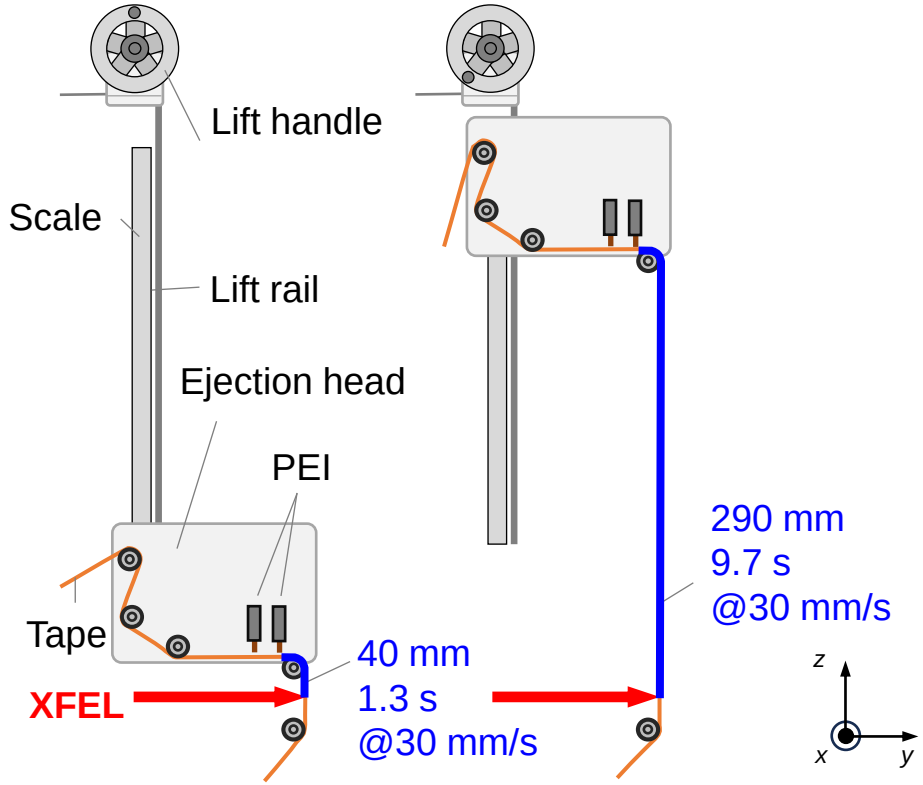


⇒ The next talk of Dr. Fujiwara

"*Pump-probe time-resolved experiments of microbial rhodopsin*"

For time-resolved SFX: Mix-and-inject setup





⇒ The next talk of Dr. Luo

"*Visualization of substrate binding to an enzyme by mixing two droplets on a tape*"

⇒ The next talk of Prof. Nagano

"*Anaerobic sample handling with a belt conveyor system at SACLA*"

Summary

Developed a tape conveyor sample delivery system for serial femtosecond crystallography at SACLA

- A reel-to-reel setup with perpendicular XFEL irradiation through to the tape surface
- Easy to supply clean tapes, easy to align the droplet position to the XFEL position

Under development for time-resolved serial femtosecond crystallography with demonstrations:

- Pump-probe experiment for the microbial rhodopsin
- Enzymatic binding experiment as mix-and-inject for the lysozyme and *N*-acetyl-glucosamine
- Trials for anaerobic sample handling

Thank you for your attention