# From Tapes to CDs: Advances in Sample Delivery and Microfabrication

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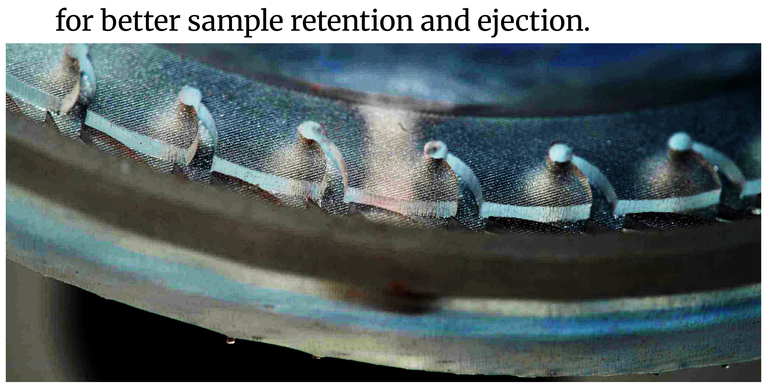
## BACKGROUND

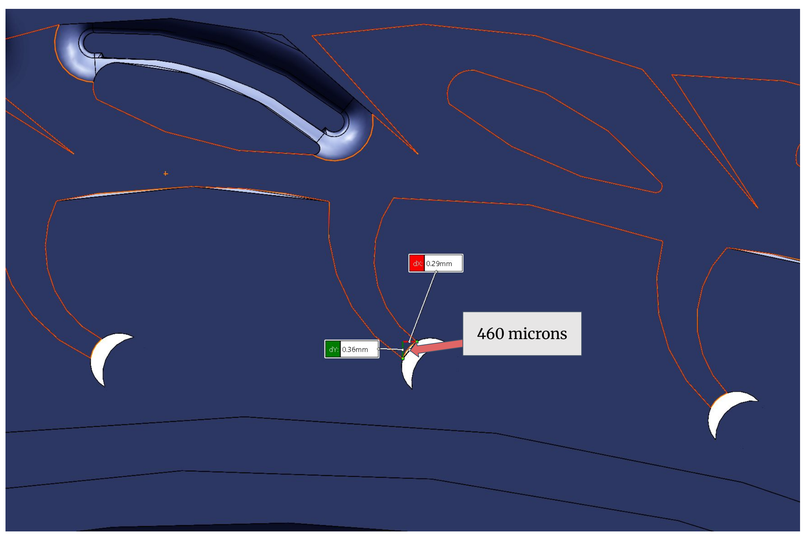
- Current Drop on Tape systems are successful for SFX delivery but struggle at the higher speeds necessary for future XFEL upgrades (LCLS-HE-II)
- Inspired by Lab-on-a-Disk (LoaD) systems, we leverage centripetal forces for fluid manipulation in microfluidic platforms.
- By adjusting spin frequency (Hz), we leverage centripetal and inertial forces to control sample movement and replenishment **without complex external hardware.**

## METHODS

- Designed and tested 17 iterative versions, gradually improving well shape, wall thickness, and symmetry for better sample retention and ejection.

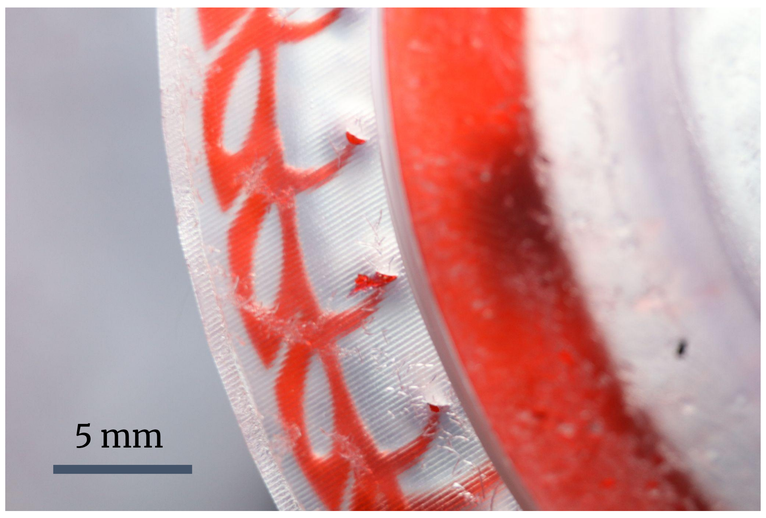


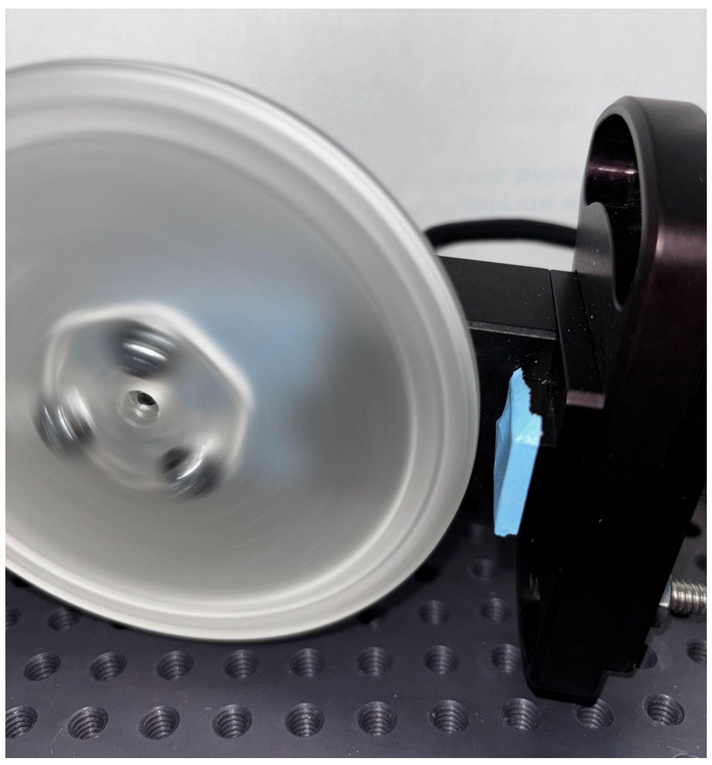
- Each of the 40 crescent-shaped wells retains 67.5 nL of **10% cellulose mixture (common in current HVE experiments)**




## RESULTS

- The sample (4 mL) is pre-loaded in the large inner ring. Upon rotation, the sample migrates to the crescent-shaped wells (30s) awaiting the incident X-rays. Once probed, the sample is replenished by centripetal forces.
- **Delivers 67.5 nL samples at 1200 Hz (4.86 ml/min)**, enabling timed, high-throughput sample injection.

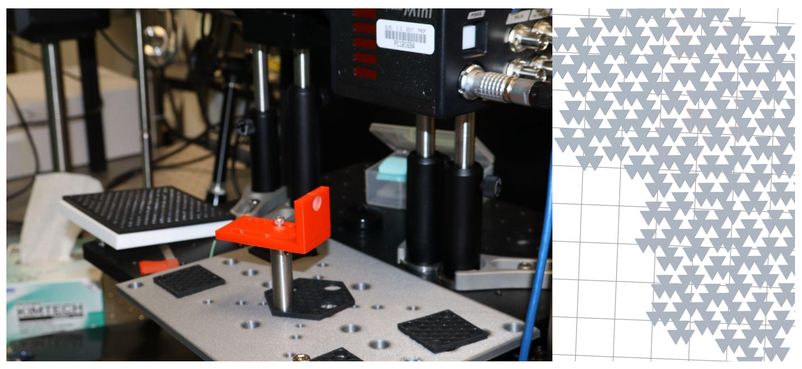


## OTHER PROJECTS

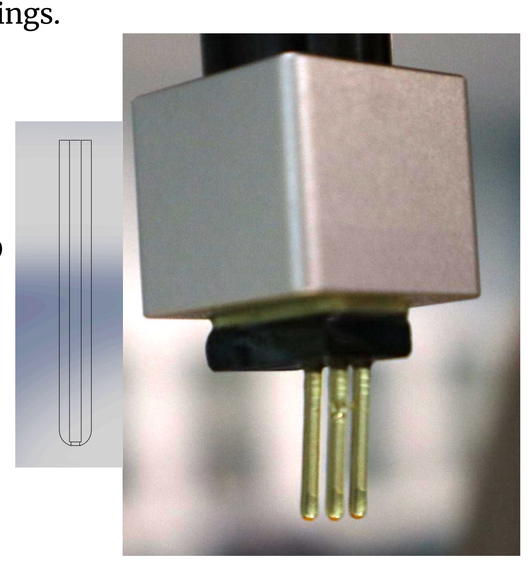
To further improve on the Crystal Disk (CD) design, we needed finer precision in rapid prototyping. I explored the suite of 3D printers at SED and Maker Space–while helping on other projects–to understand the limitations of each printer.

- **Vibration Dampening Design:** Printed geometrically self similar and fractal-based structures using SLA silicone resin (Formlabs) to reduce broadband vibration in high speed jet imaging and characterization studies



- **Micro-SLA Printer Restoration (in progress):** Cleaned, realigned, and reparameterized the system; developed a tailored print configuration for custom nozzles and created a comprehensive user manual based on experimental findings.

The successful printing of these nozzles will save SED from ordering expensive user consumables for current HVE experiments ($400/nozzle)



## NEXT STEPS

- **Disk Fabrication:** Explore more advanced manufacturing methods (e.g. laser powder bed fusion) like those used at EuXFEL, to improve precision and material compatibility beyond SLA resins.
- **Flow Characterization:** Test with crystal slurries and use a high-speed camera to analyze sample ejection and flow behavior. Explore replenishing behavior with photons to determine realistic sample consumption and repetition rates.
- **Future of 3D Printing at SED:** Investing in higher-precision printers would bring component fabrication in-house, enabling custom designs tailored to each experiment's needs.

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## REFERENCES

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