

Pulseless Precision: Characterizing ElectroOsmotic Pumps for Applications in Sample Delivery

Nevaeh Perez-Bazan^{1, 2}, Raymond G. Sierra¹

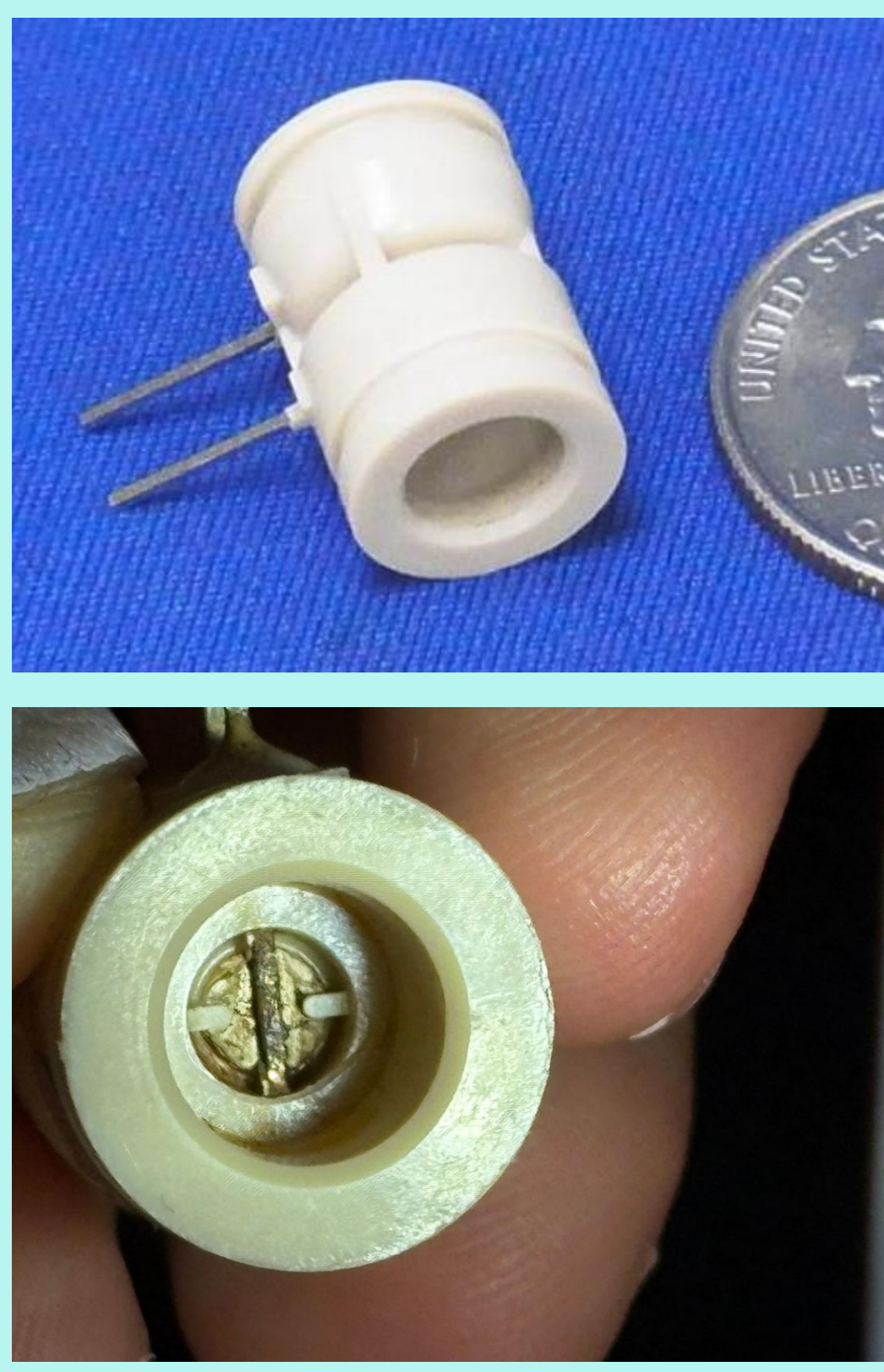
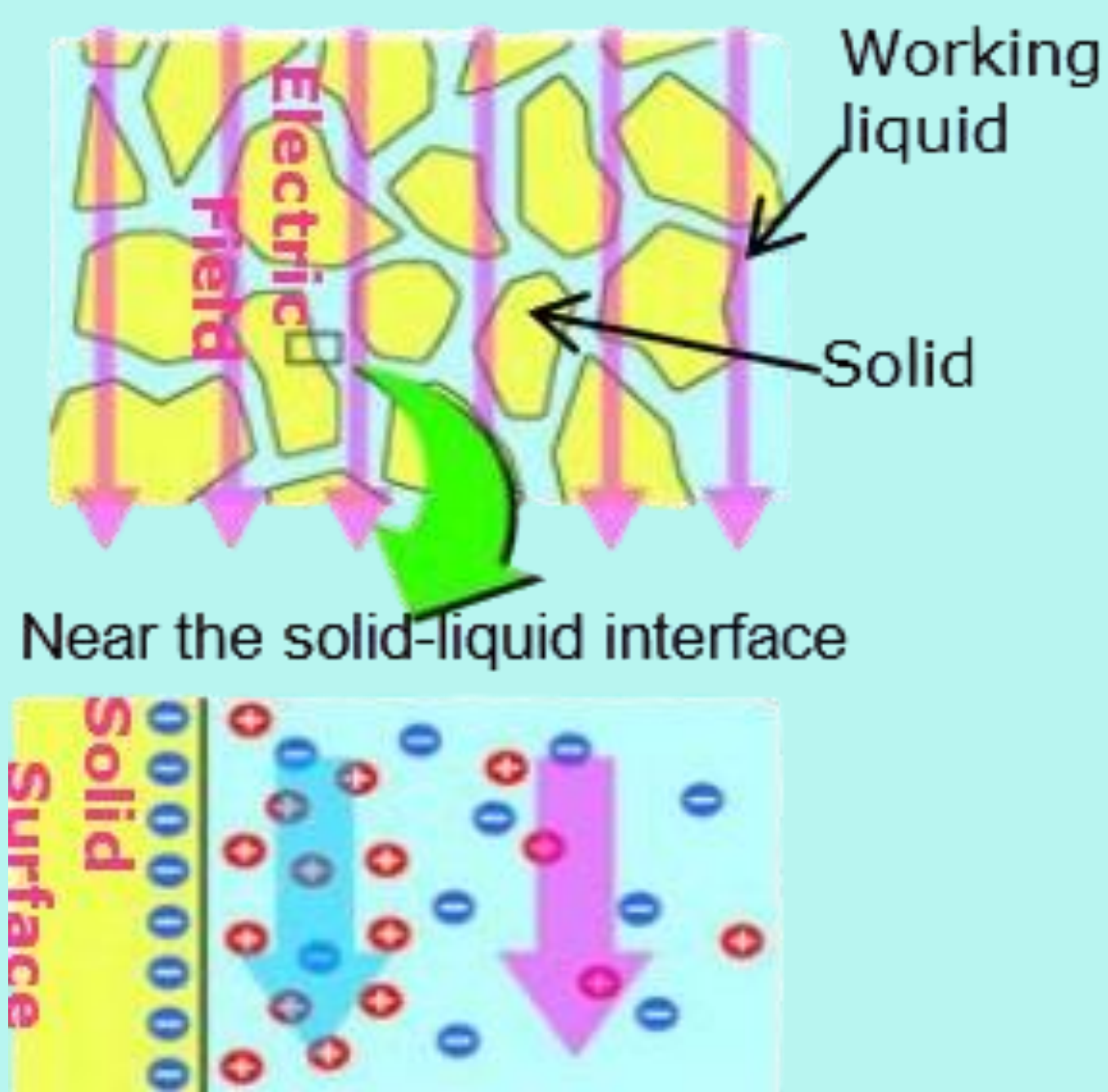
1) Linac Coherent Light Source, SLAC National Accelerator Laboratory, USA.
2) University of Florida, USA.



BACKGROUND

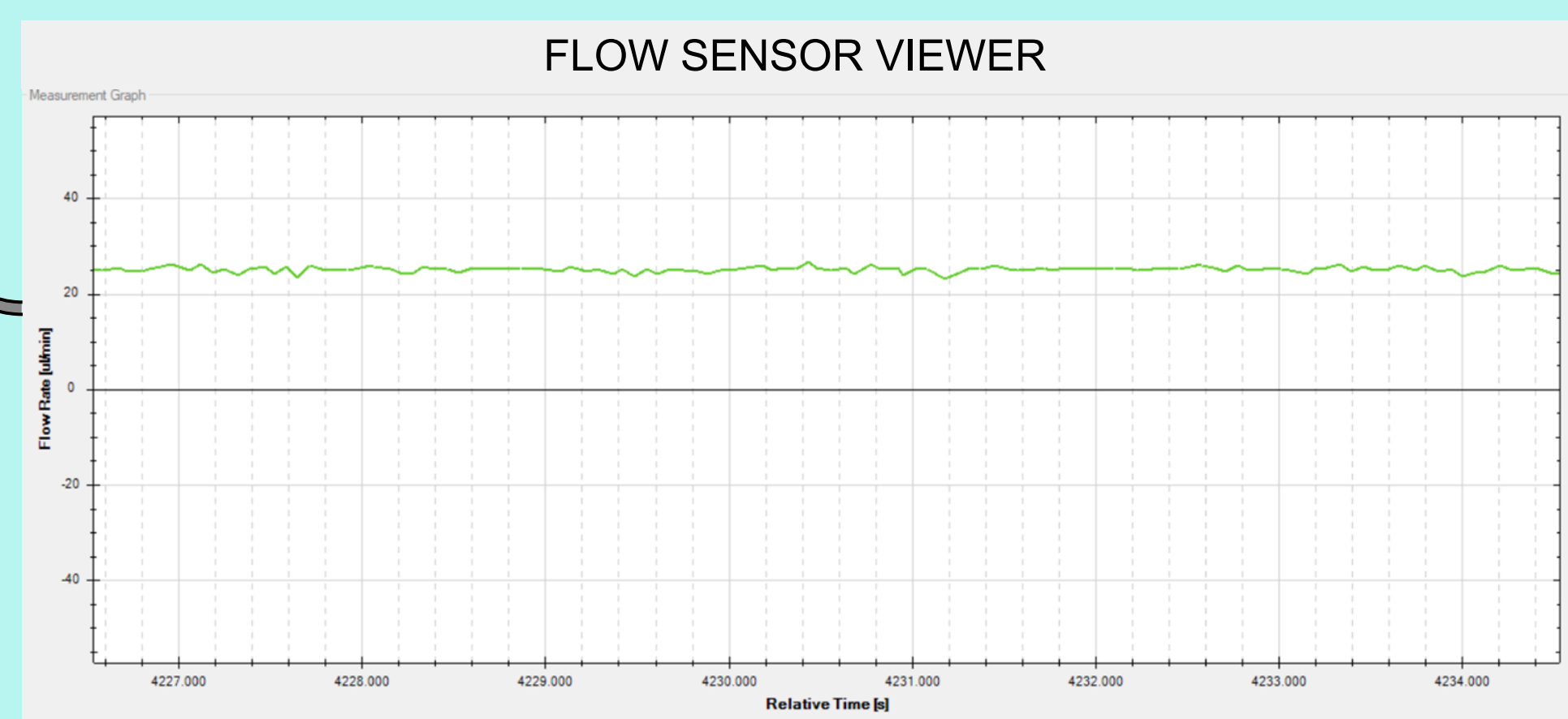
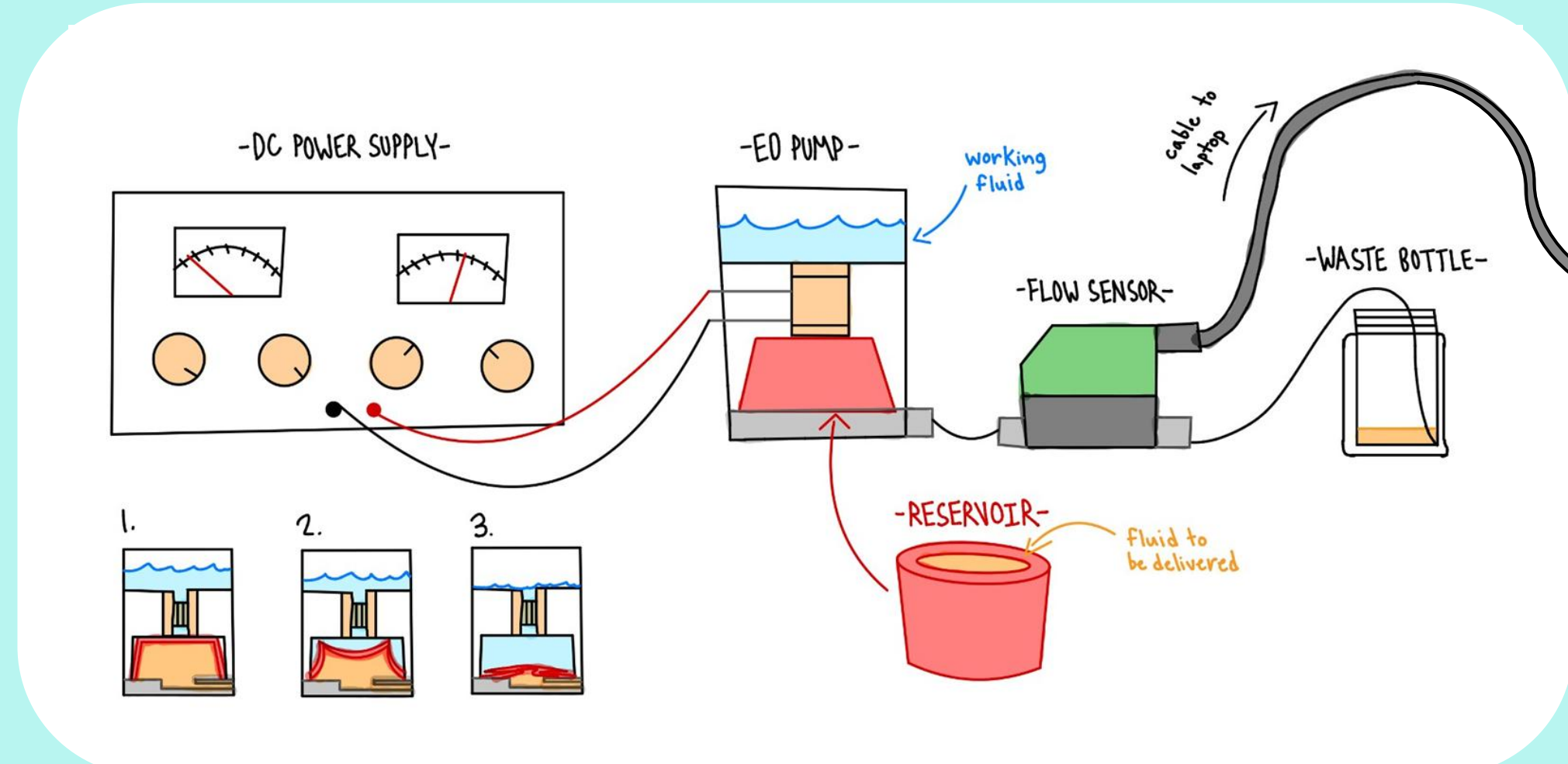
- Syringe, HPLC, and other pumps used in sample delivery can cause instability in flow
- Electroosmotic pumps have no moving parts, potentially providing a constant flow
- The problem: Extreme pH changes corrode electrodes, delaminate platinum coatings, and cause fluctuations in data

Porous Structure

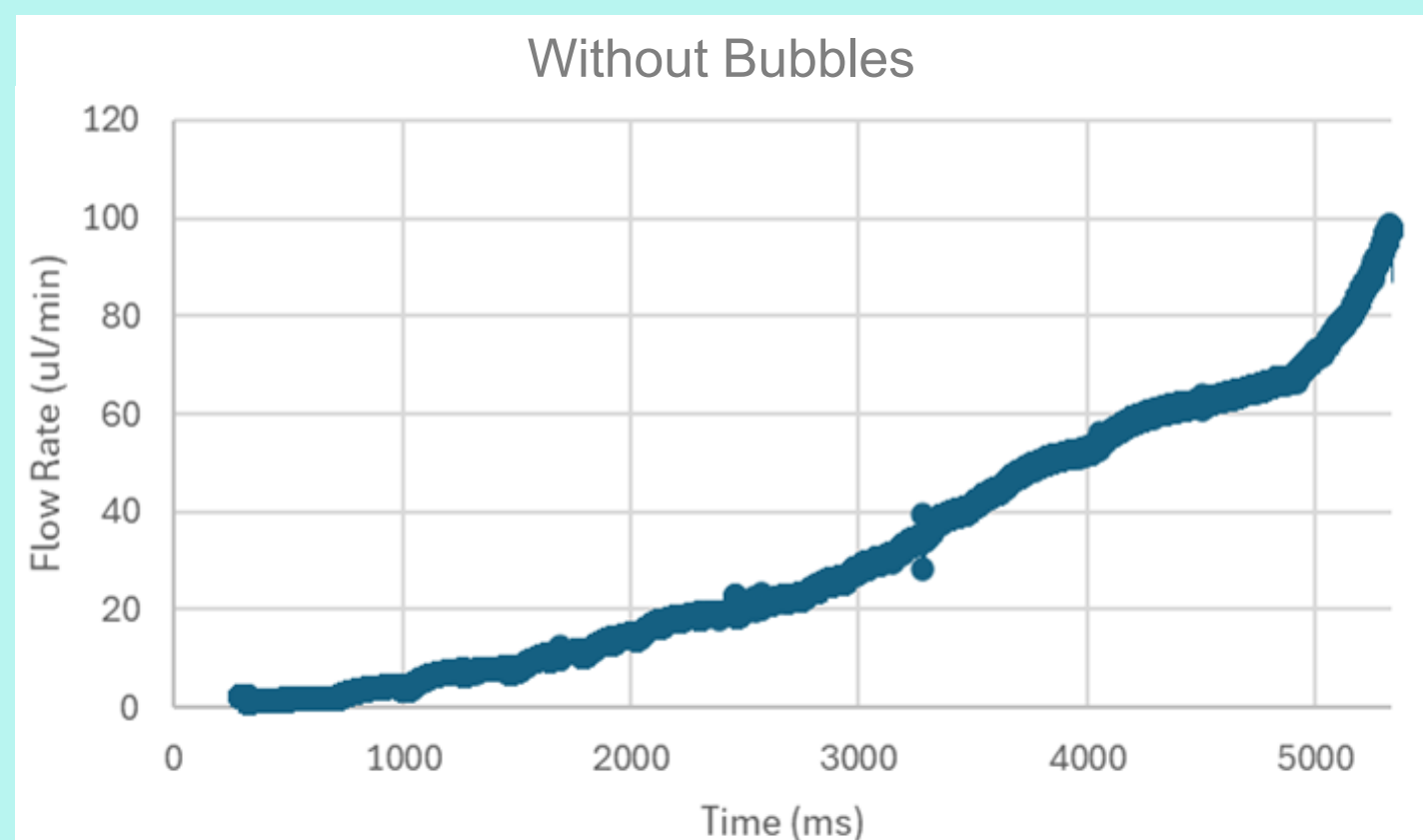
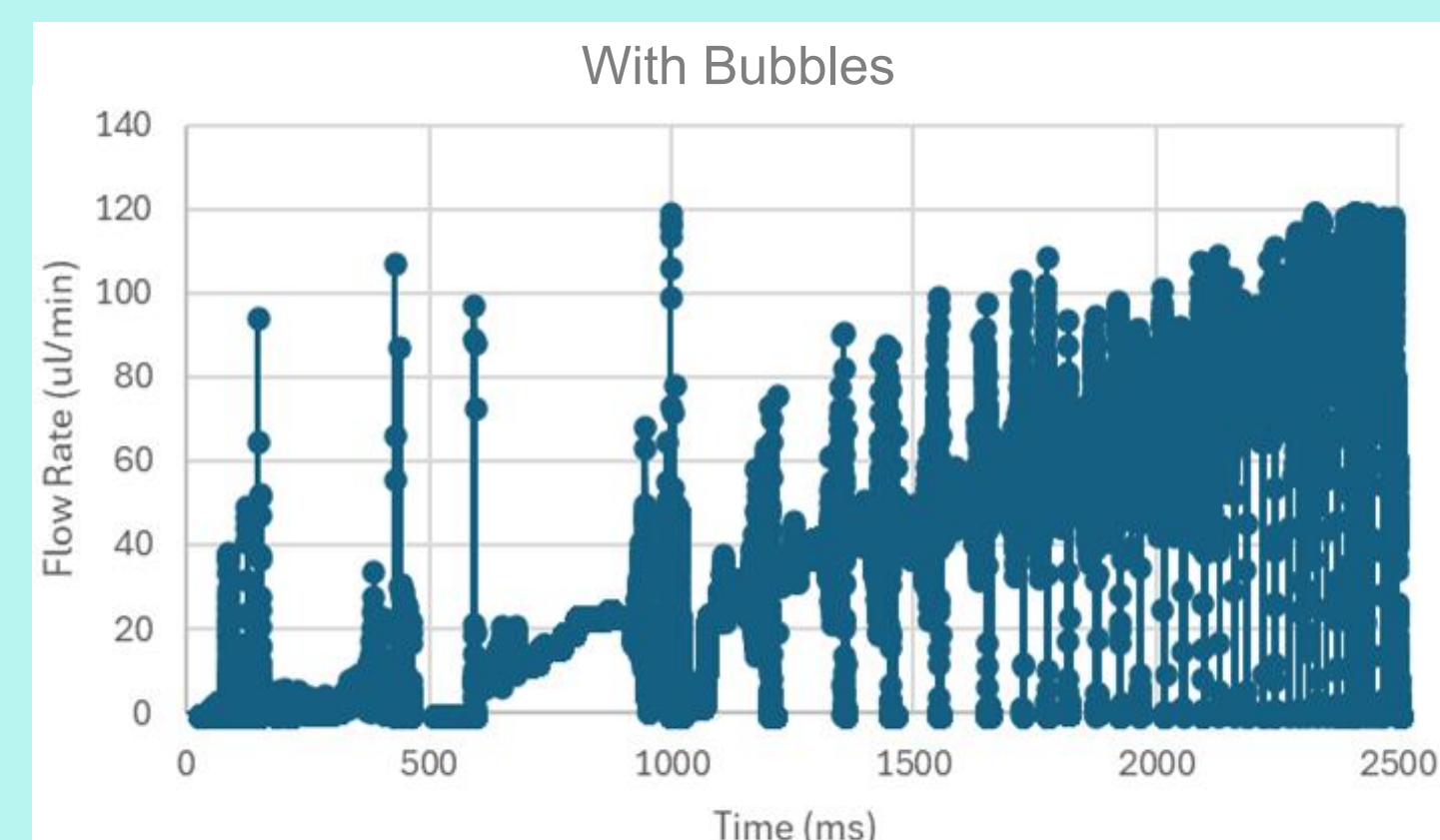


METHODS/MATERIALS

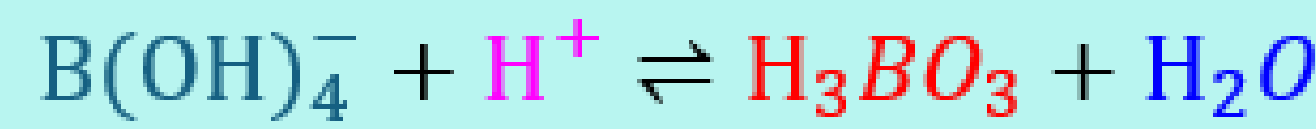
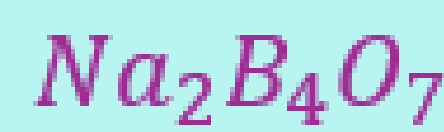
Setup:



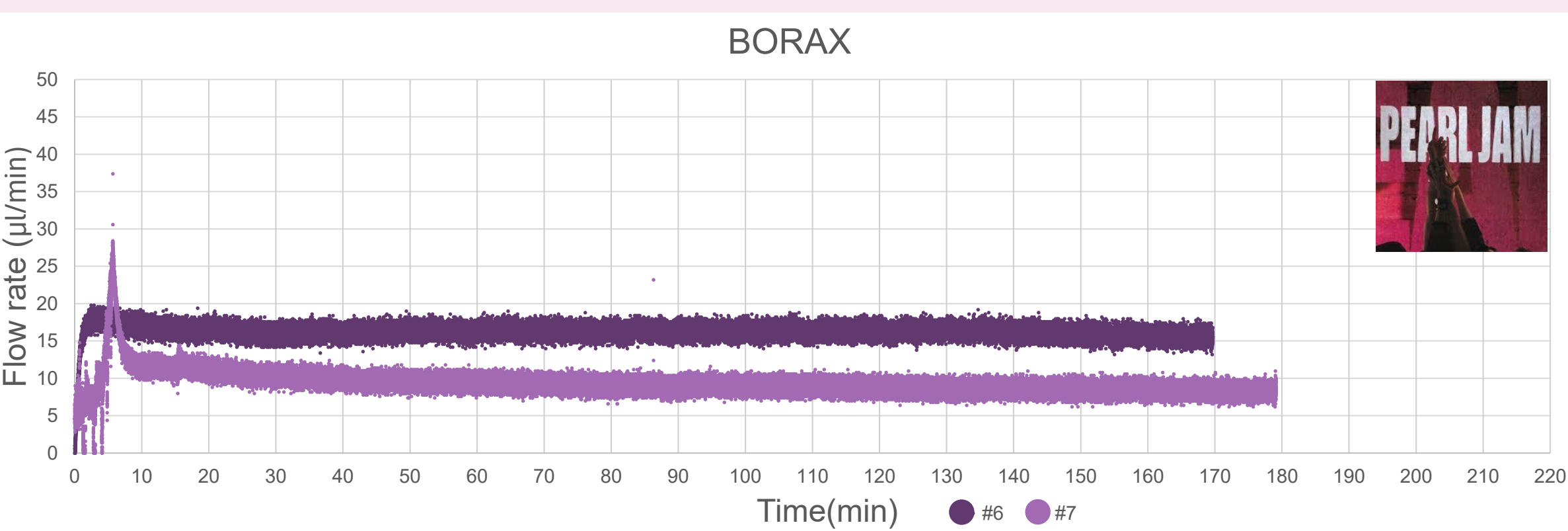
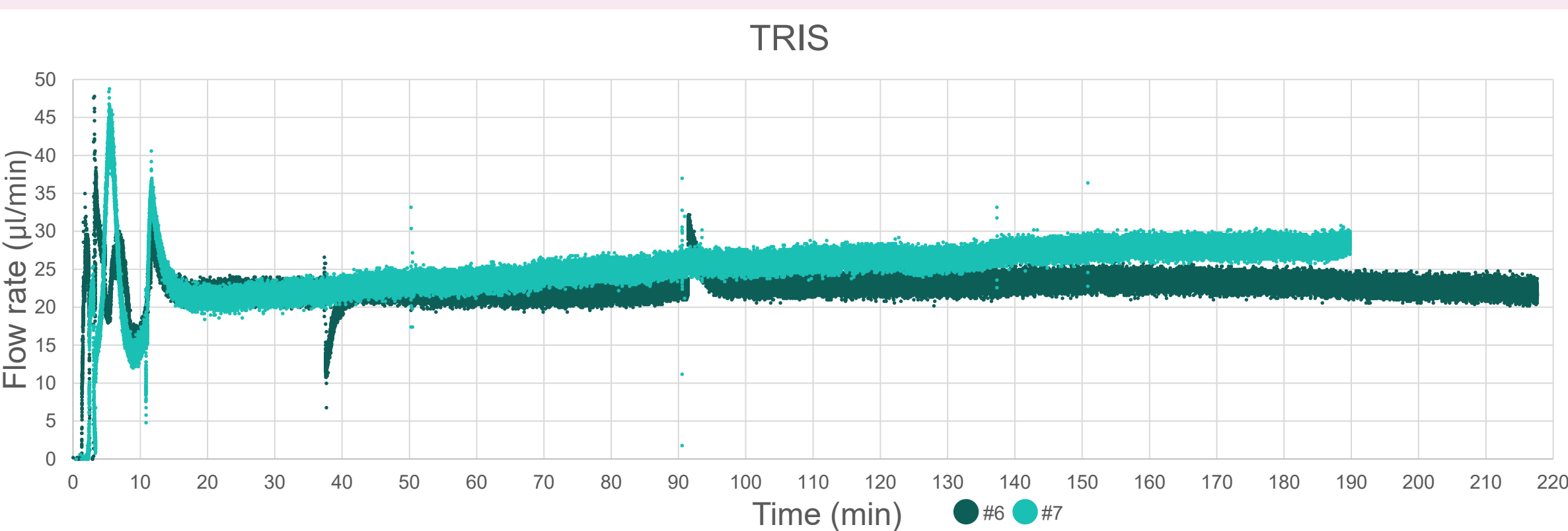
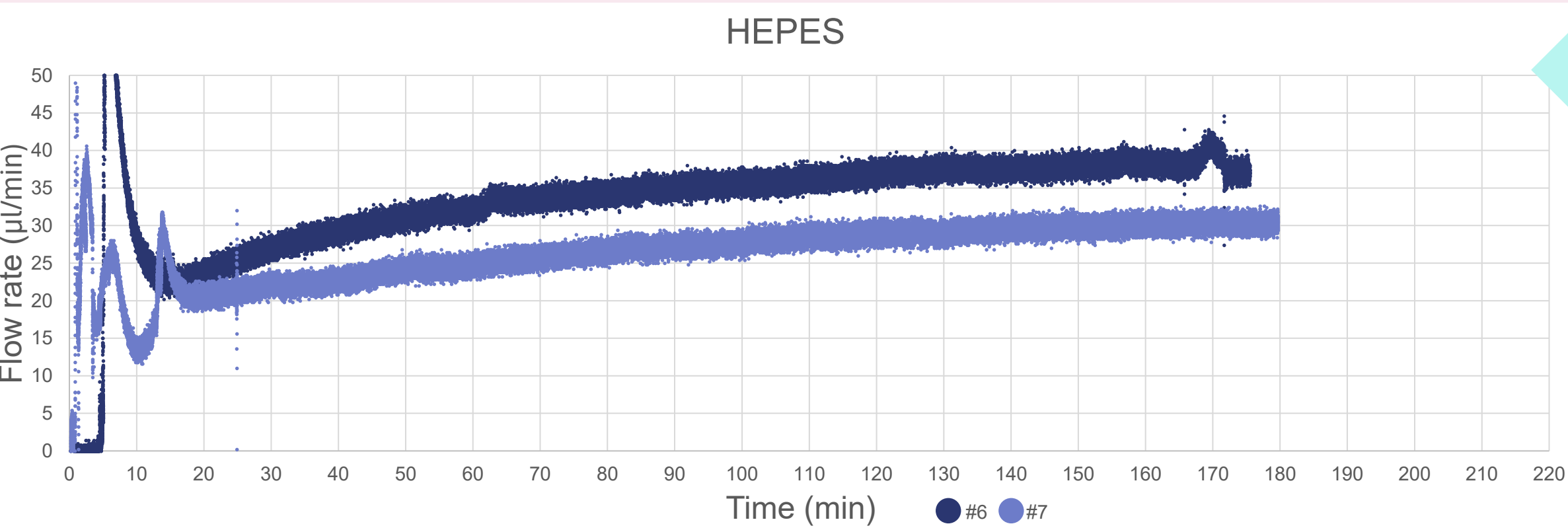
- Two-liquid system prevents air bubbles from meddling with flow rate



- TRIS and HEPES, Good's buffers, were both selected for water-like pH range and low conductivity
- Sodium borate (borax) has been used by other researchers to stabilize pH



RESULTS



Left side:

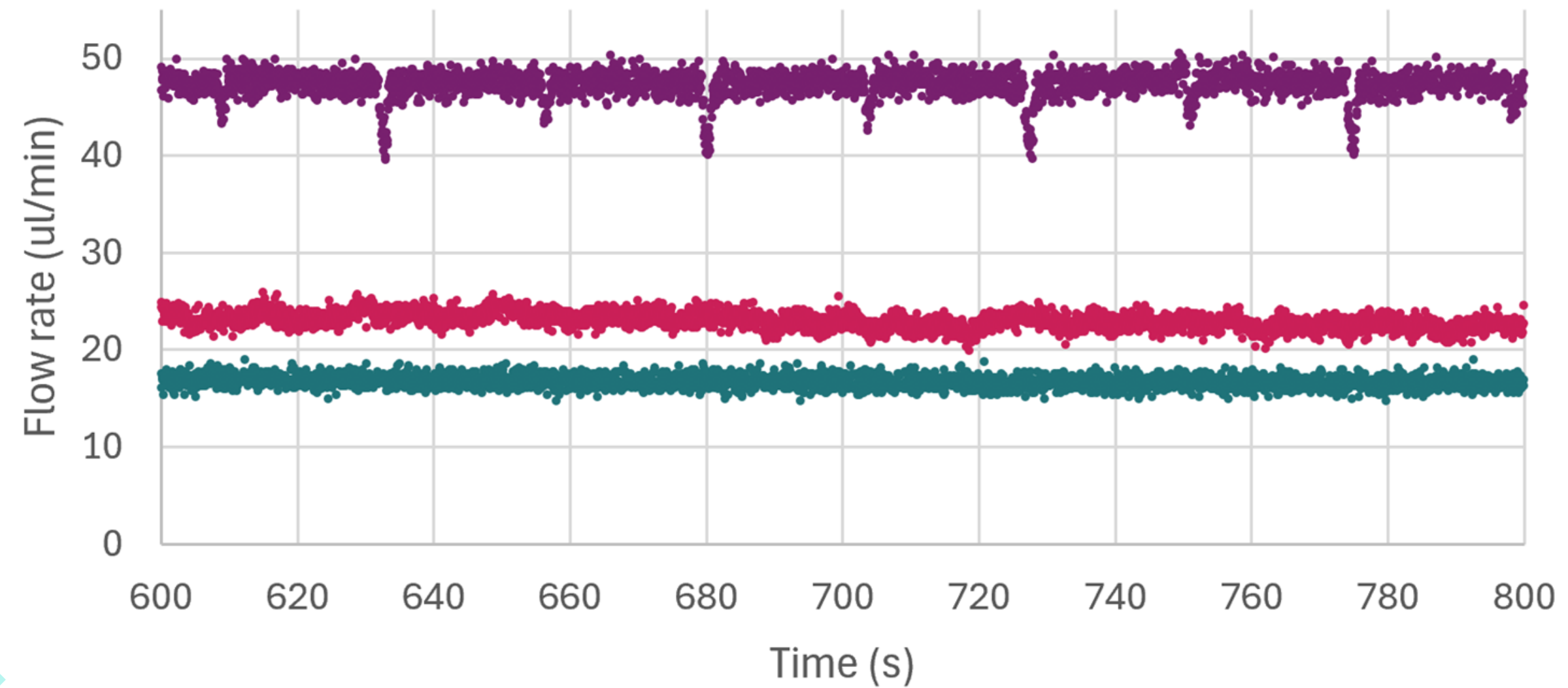
- All tests done at 24V and 5mM
- Borax decreased flow rate but provided the most even flow
- +/-3 flow rate margin of error



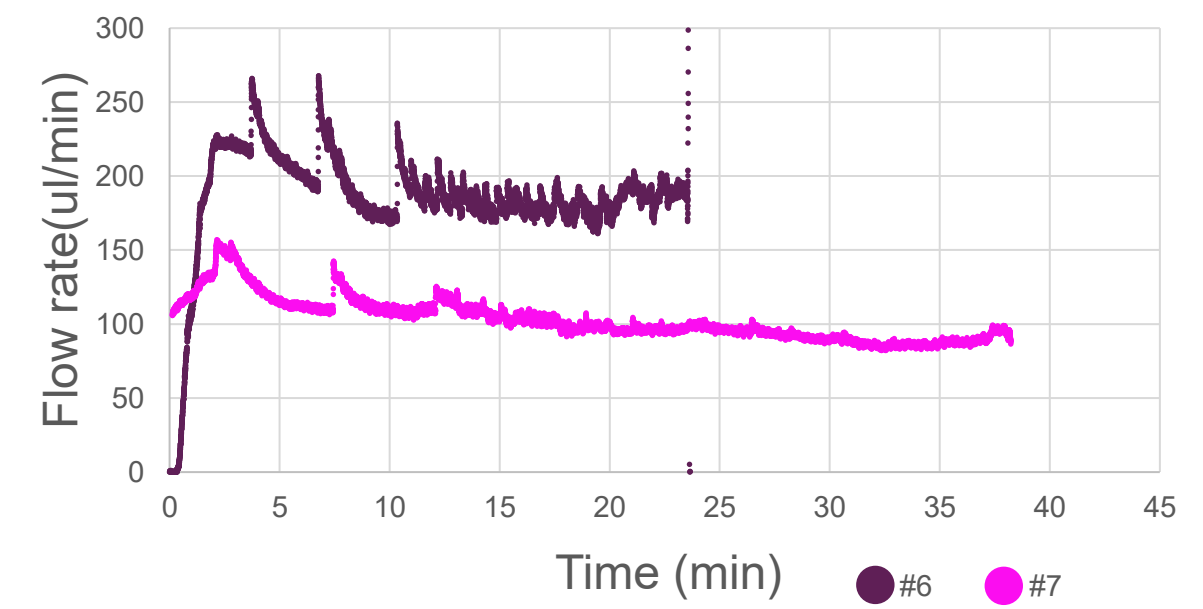
Right side:

- Comparison of EO pump to HPLC and syringe proved even flow rate
- Tested est. max voltage and flow rate
- 150 V caused uneven flow
- Flow rate of 60 ul/min proved to be stable
- Was not able to pump reservoir chamber that is commonly used for delivering sample

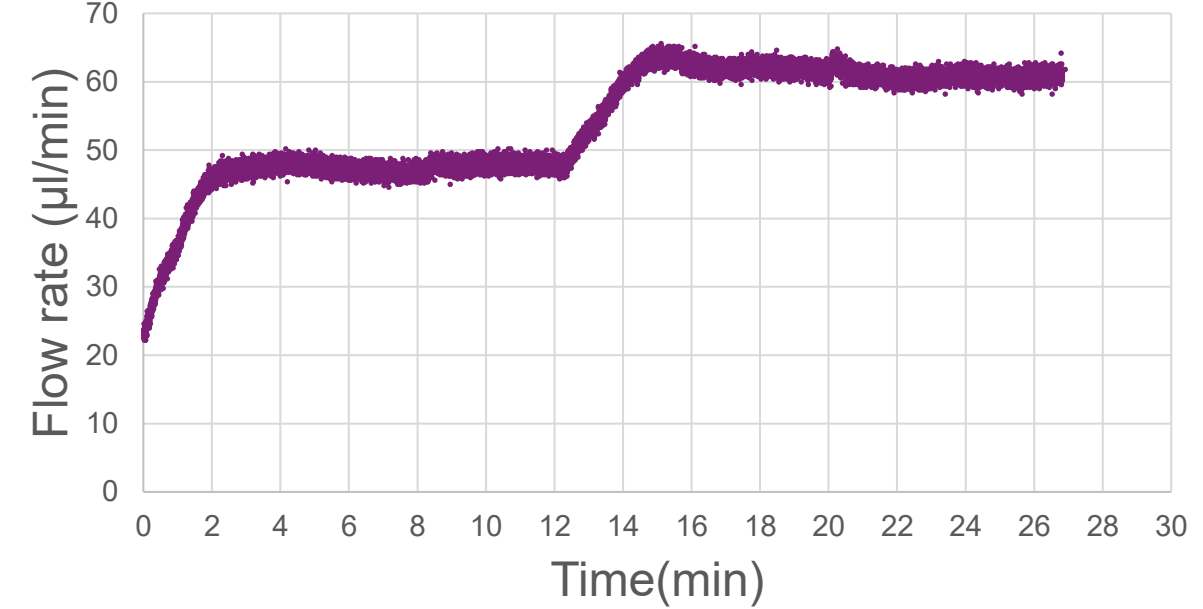
Pump Comparisons



Max Voltage (150V)



Max Flow Rate (60 ul/min)



CONCLUSION/ FUTURE PLANS

- Borax is the winner!
- Upsides:
 - Extremely stable flow rate
 - Cost efficient
 - Easy to set up
- Downsides:
 - Low flow rate
 - Slight drift over time
- Future plans
 - Stack 3 pumps to increase pressure to 300 psi
 - Try different molarities
 - Make plastic chamber larger than 5 mL
 - Find voltage-to-flow rate ratio

ACKNOWLEDGEMENTS

This work is dedicated in memory of Bob Sublett. I would like to thank my mentor Ray for his support throughout this project, as well as Wing, Kathryn, Cynthia, Brigid, and all the interns. Many thanks to the LCLS Summer Internship Program and the Department of Energy for making this opportunity possible.



REFERENCES

- Wang, X., Cheng, C., Wang, S., & Liu, S. (2009). Electroosmotic pumps and their applications in microfluidic systems. *Microfluidics and nanofluidics*, 6(2), 145. <https://doi.org/10.1007/s10404-008-0399-9>
- Purnendu K. Dasgupta, Shaorong. Liu; Electroosmosis: A Reliable Fluid Propulsion System for Flow Injection Analysis. *Anal. Chem.* 1 June 1994; 66 (11): 1792–1798. <https://pubmed.ncbi.nlm.nih.gov/14611783/>
- Yao S;Hertzog DE;Zeng S;Mikkelsen JC;Santiago JG; (2003, July 17). *Porous Glass electroosmotic pumps: Design and experiments*. Journal of colloid and interface science. <https://pubmed.ncbi.nlm.nih.gov/14611783/>
- Yao, S., & Santiago, J. G. (2003, July 17). *Porous Glass electroosmotic pumps: Theory*. Journal of colloid and interface science. <https://pubmed.ncbi.nlm.nih.gov/14611782/>