SAND2022-12097C

Sandia National Laboratories

Electrochemical aptamer-based sensors for measurements in vivo and in undiluted blood

LDRD LABORATORY DIRECTED RESEARCH & DEVELOPMENT WHERE INNOVATION BEGINS

Alex Downs

September 10th, 2022

U.S. DEPARTMENT OF ENERGY | NNSA

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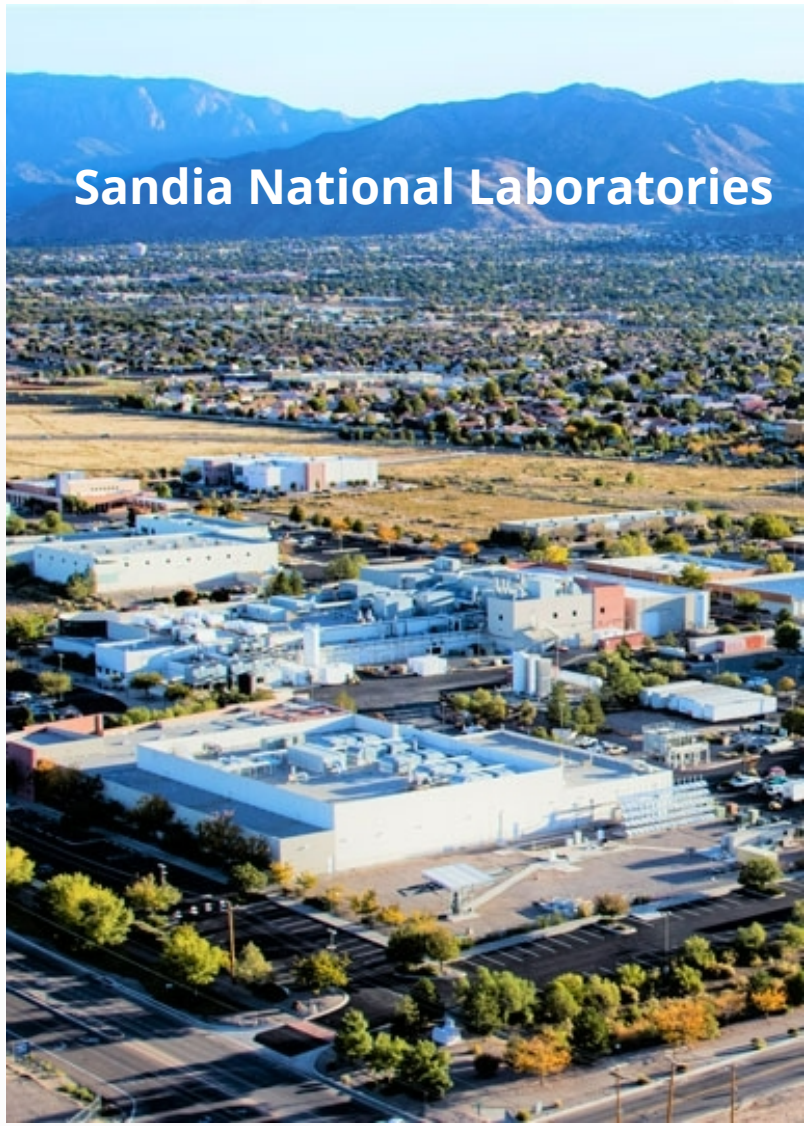
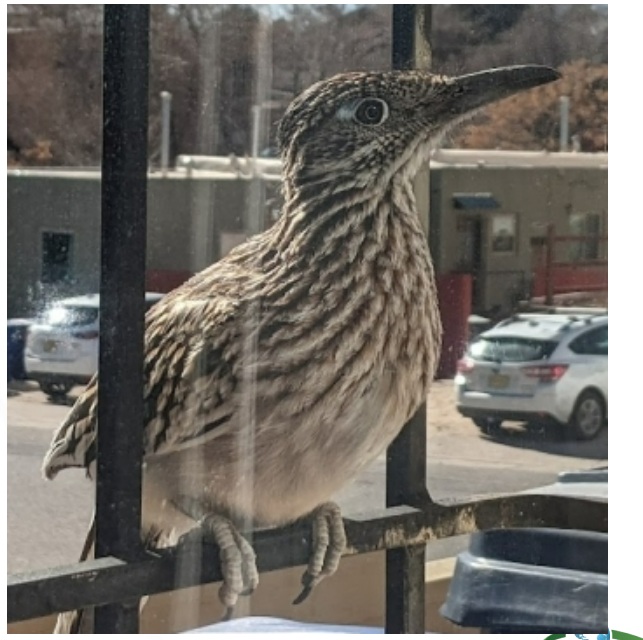
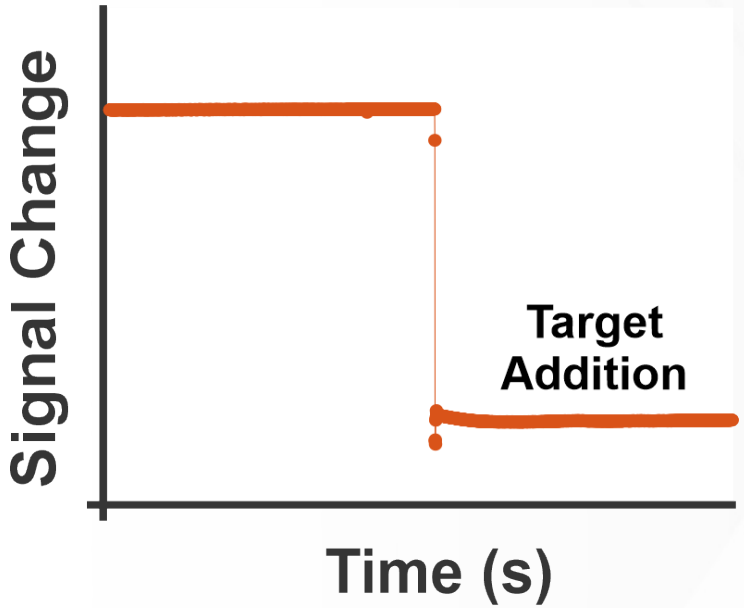
My academic path



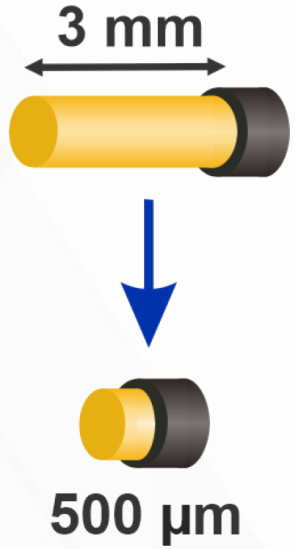


Research Background: Electrochemical Biosensing

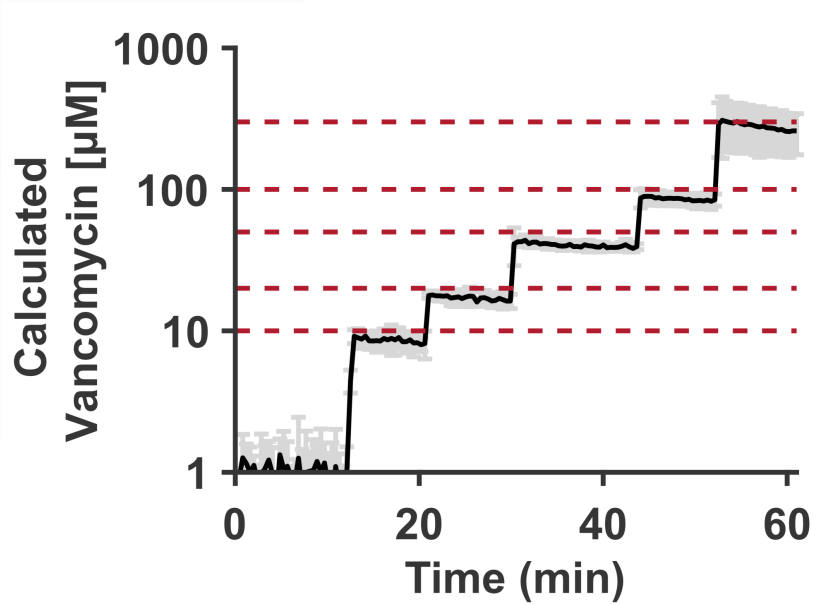
Faster Measurements



Smaller Sensors

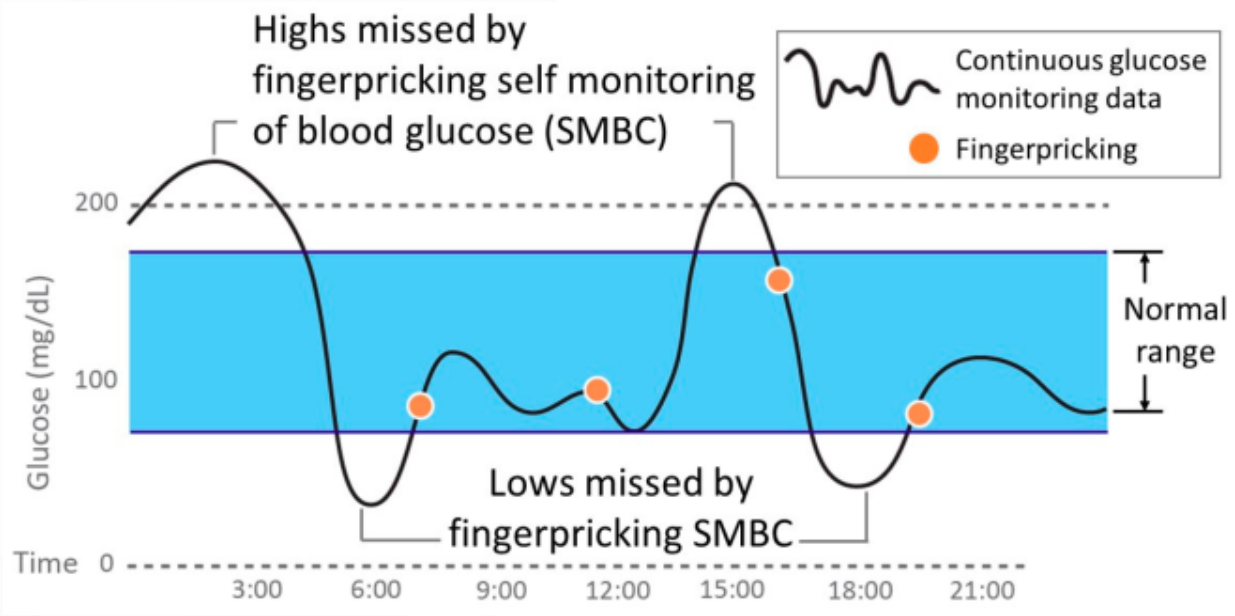


More Accurate Quantification



Wearable sensors can revolutionize medical care, but we have them for very few biomarkers

Continuous glucose meter

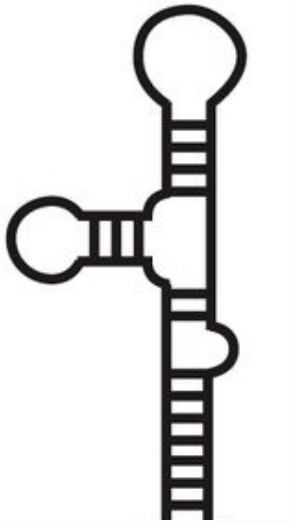


Heo, Y., Kim, S. Applied Sciences. 2019.

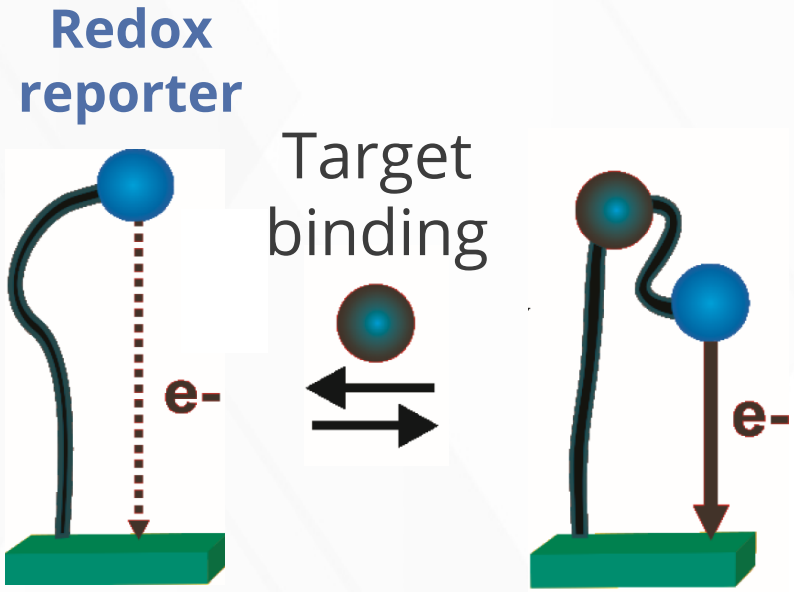
Relies on enzymatic detection, which has not proven widely generalizable to other target

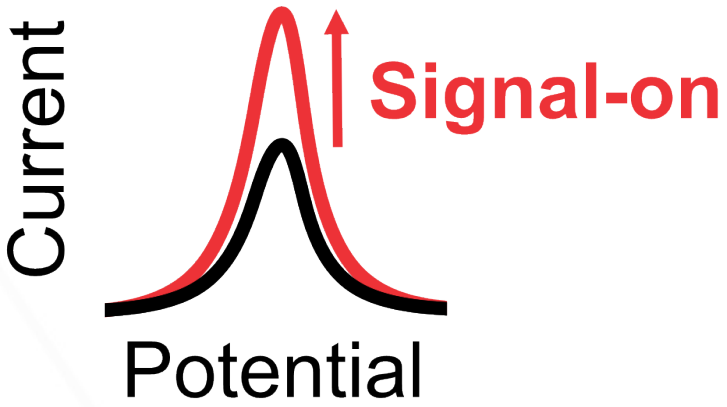
Electrochemical aptamer-based sensors ("EAB Sensors") offer a promising route for wearable sensing of **many biomarkers**

Aptamers: DNA, RNA, or peptide sequence artificially selected to bind specifically to a **small molecule, protein, or cell**

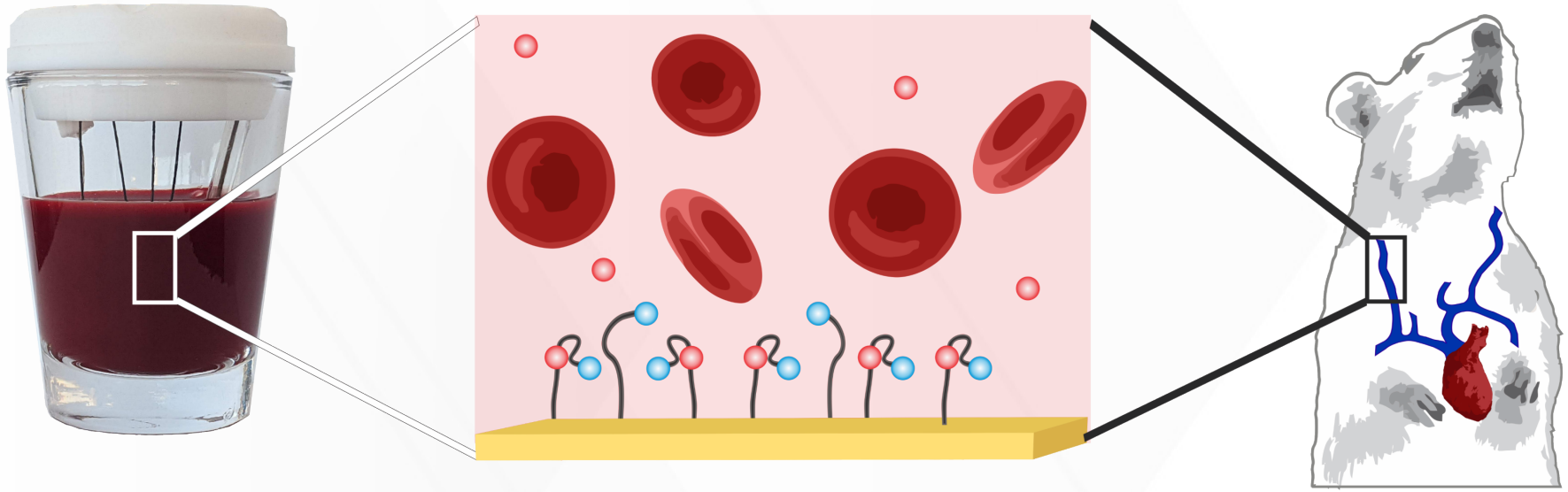


Wolter, Mayer. J. Neurosci.. 2017.



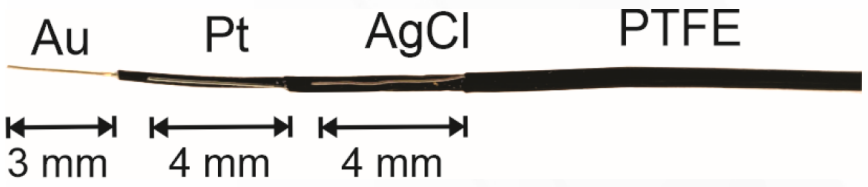


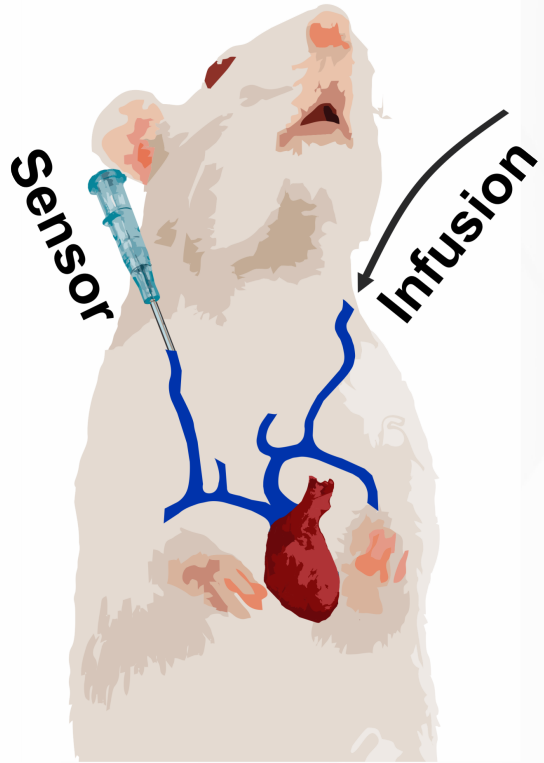
What makes this sensing platform unique?

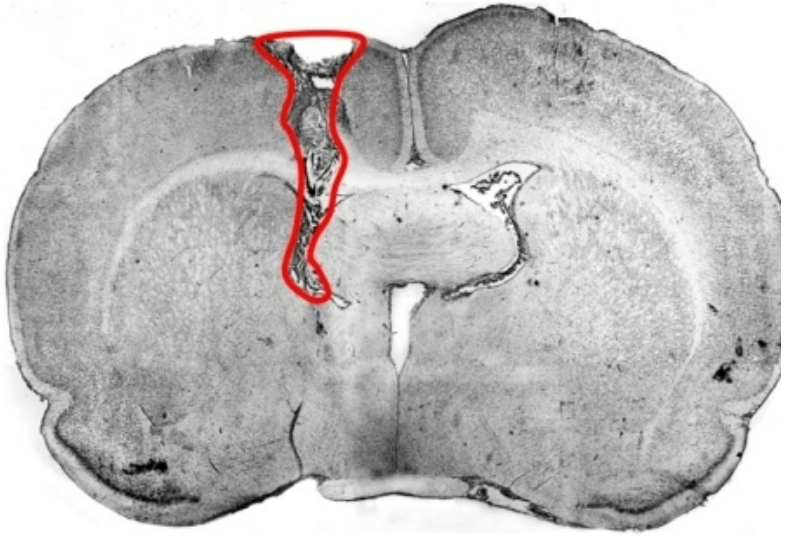


- No washing steps - works directly at the point of detection
- Quantifies increasing and decreasing concentrations
- Works in undiluted bodily fluids, living body

Goal 1: Miniaturization of in vivo probes

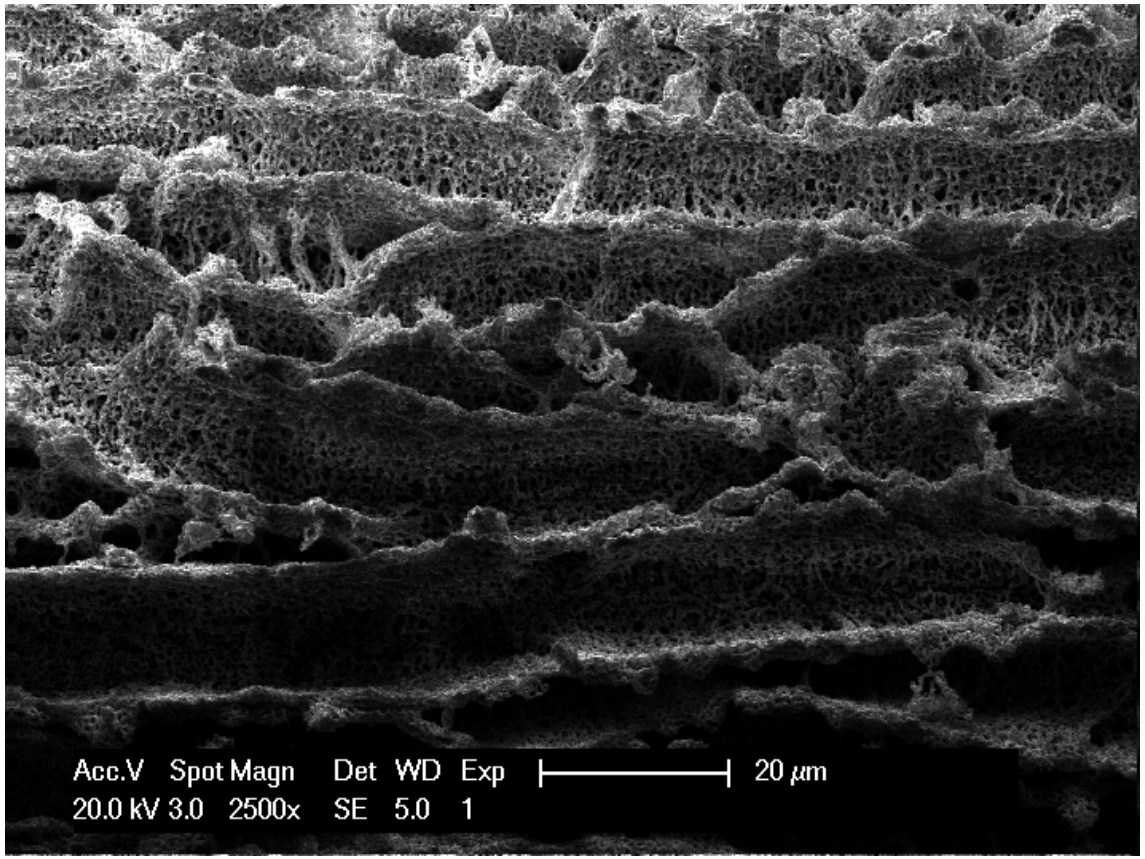




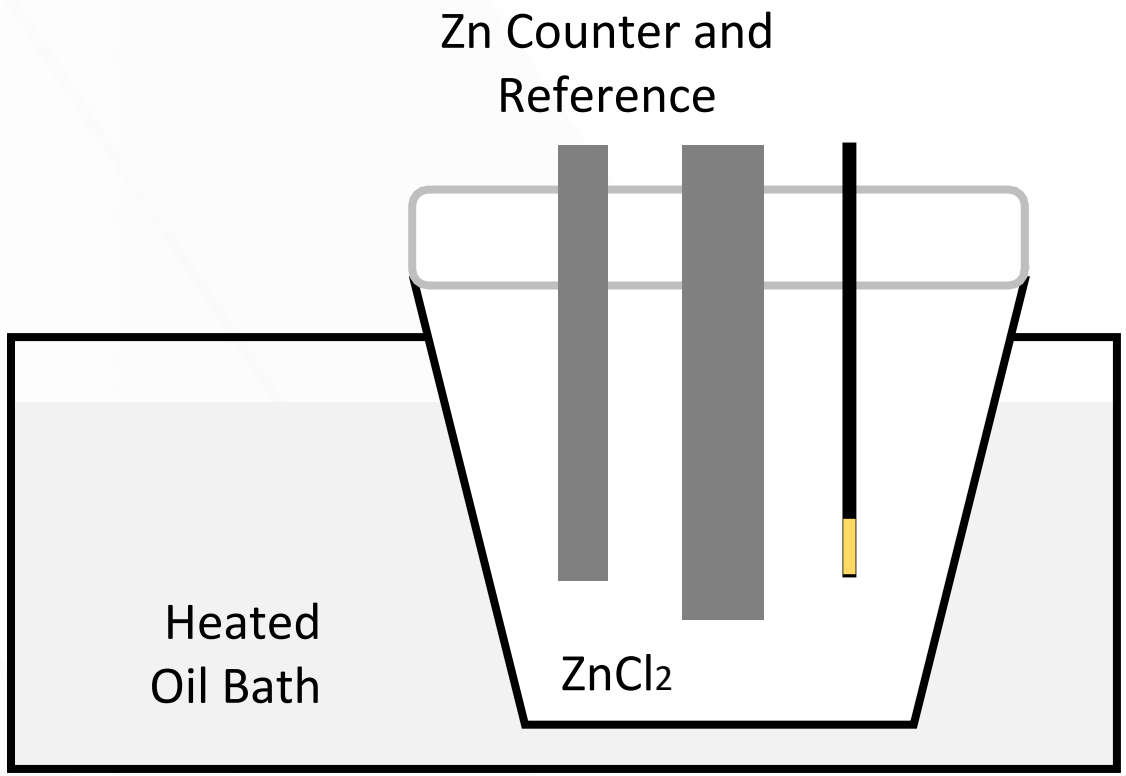


Courtesy of
Kyle Ploense, Ph.D.

Approach: Increase surface area

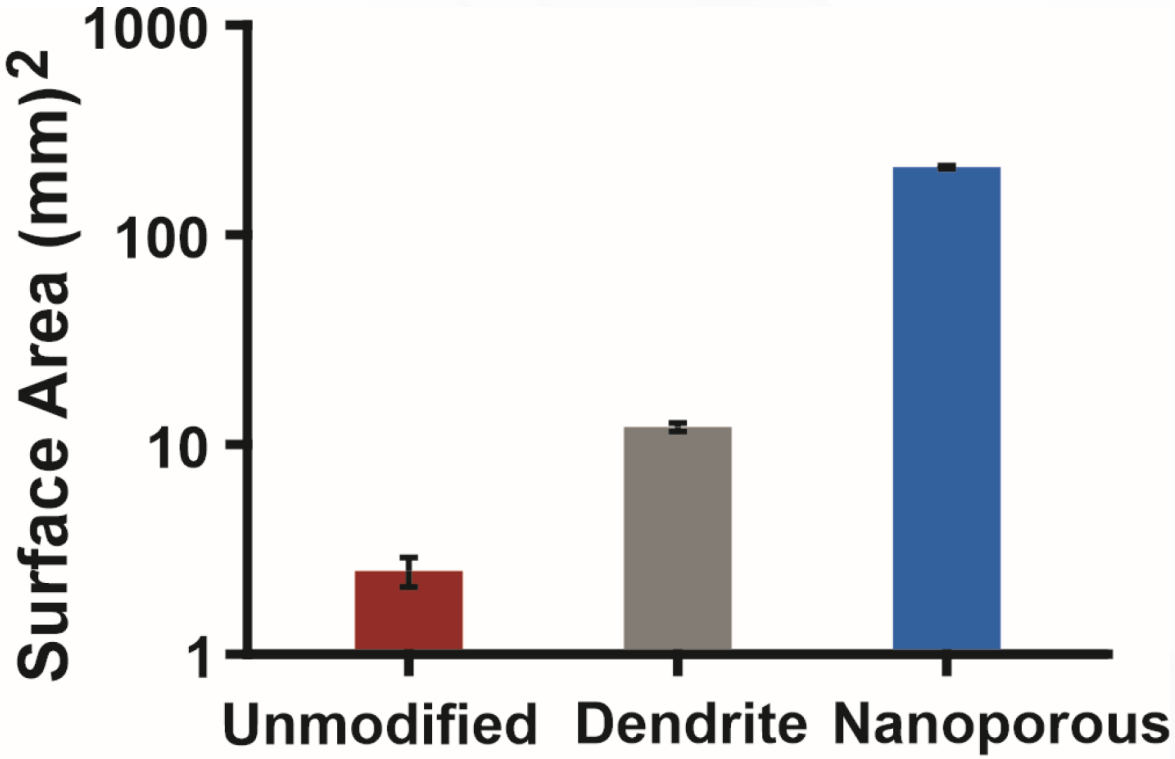


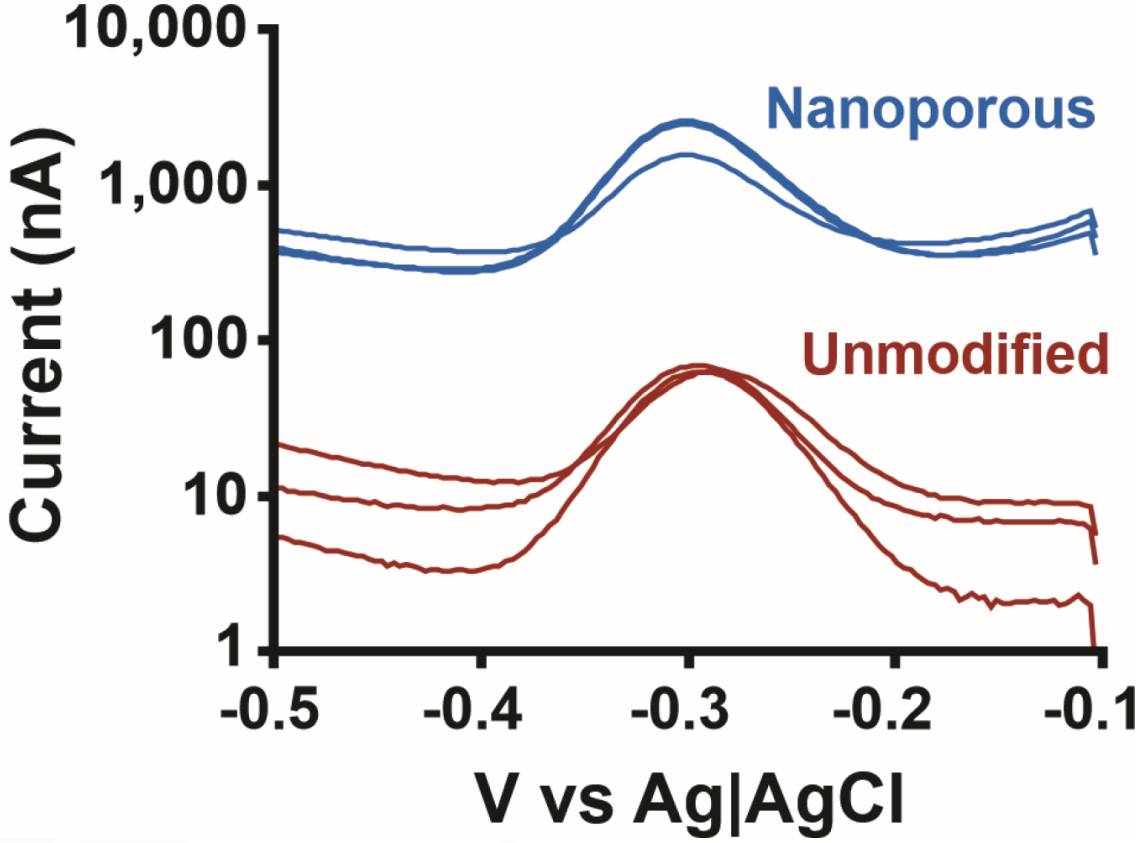
Electrochemical alloying/dealloying



Downs, A., *Gerson, J., Hossain, M., Ploense, K., Pham, M., Kraatz, H.B., Kippin, T., Plaxco, K., "Nanoporous Gold for the Miniaturization of In-Vivo Electrochemical Aptamer-Based Sensors." ACS Sensors. 2021, 6, 6, 2299–2306.*

Nanoporous gold increases surface area and electrochemical signal





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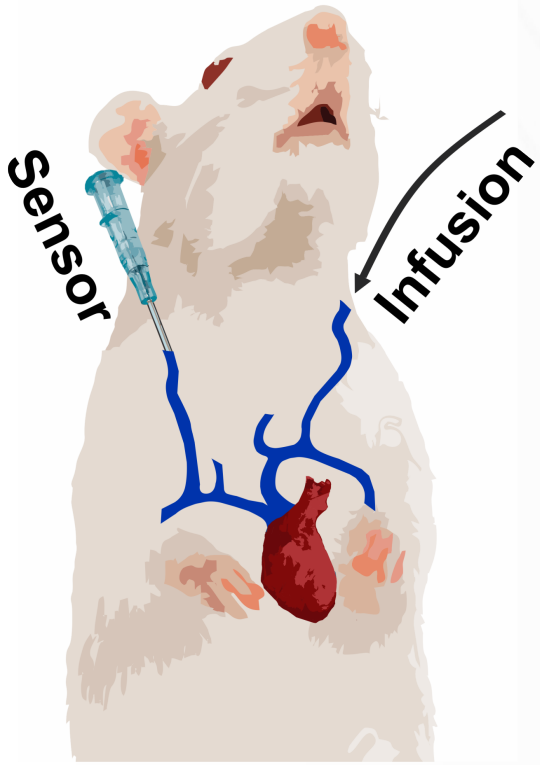
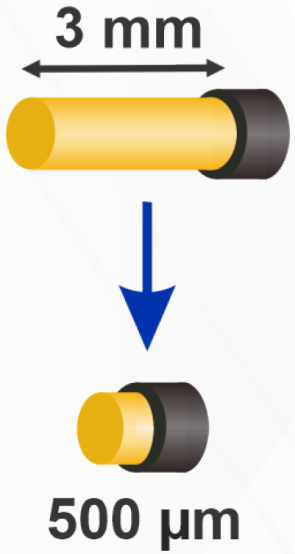
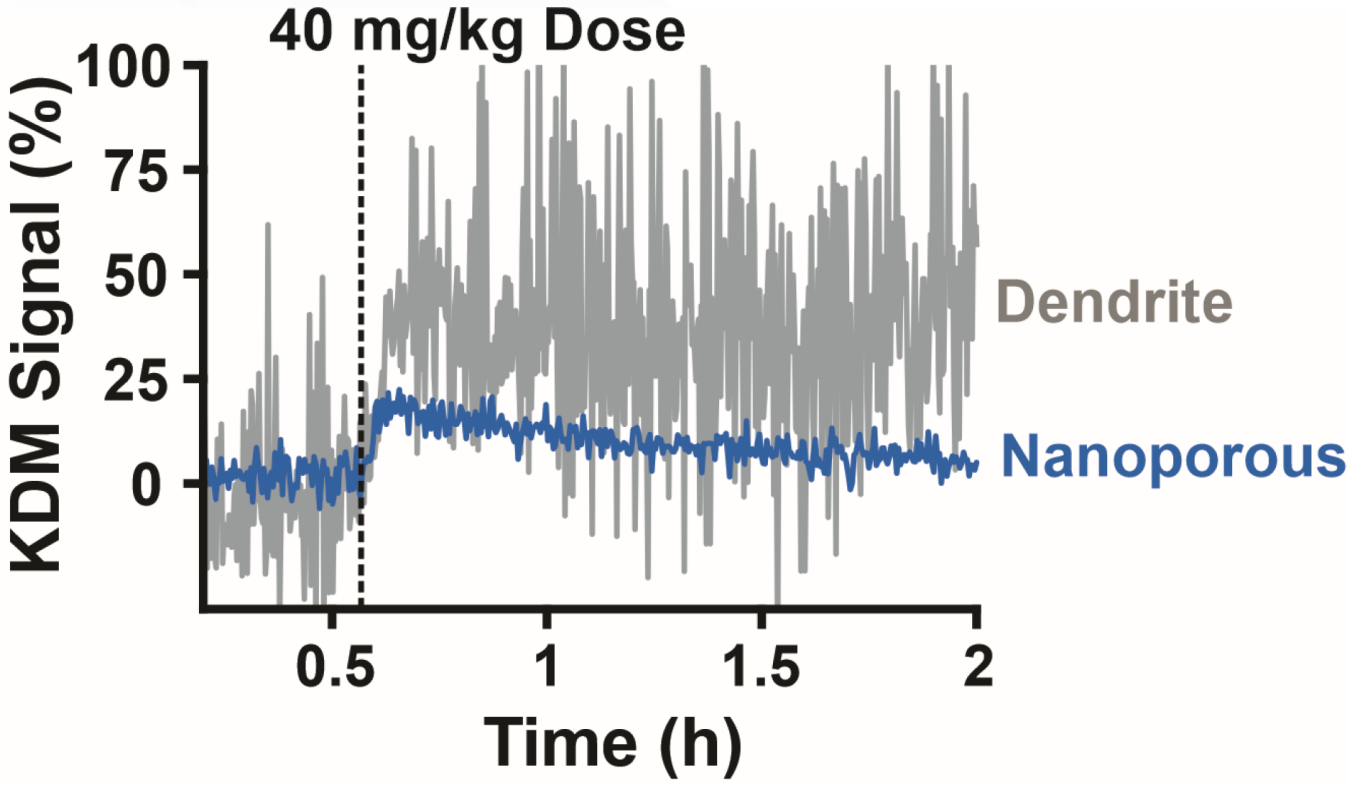
Nanoporous gold enables 6X miniaturization

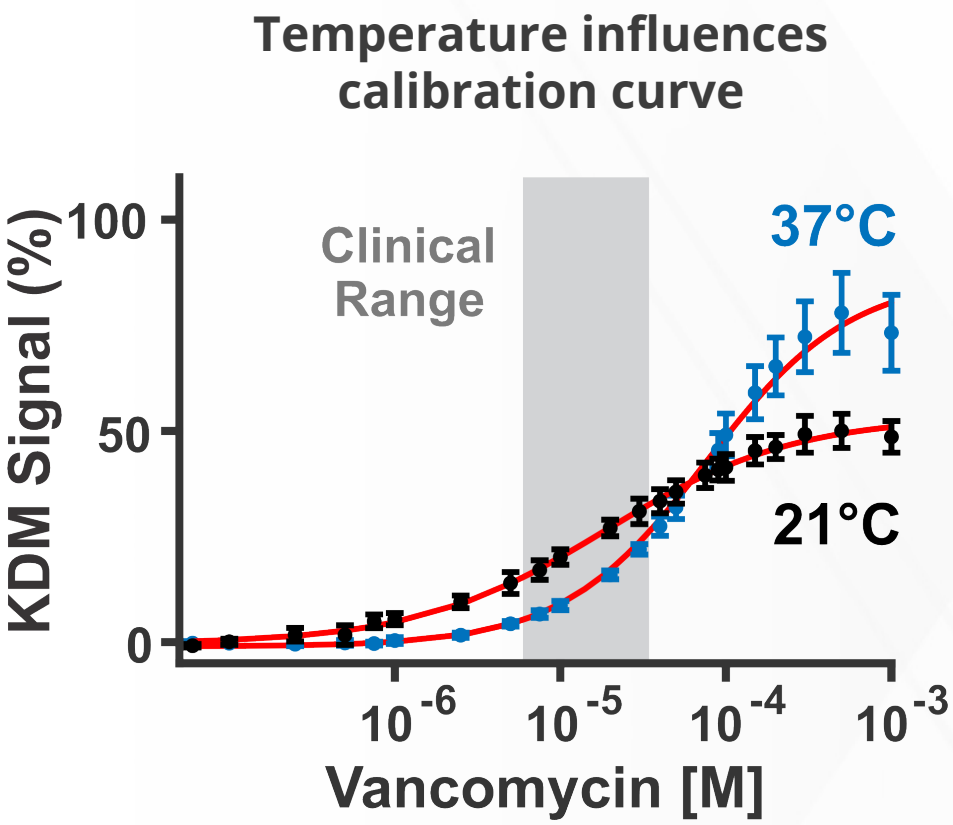






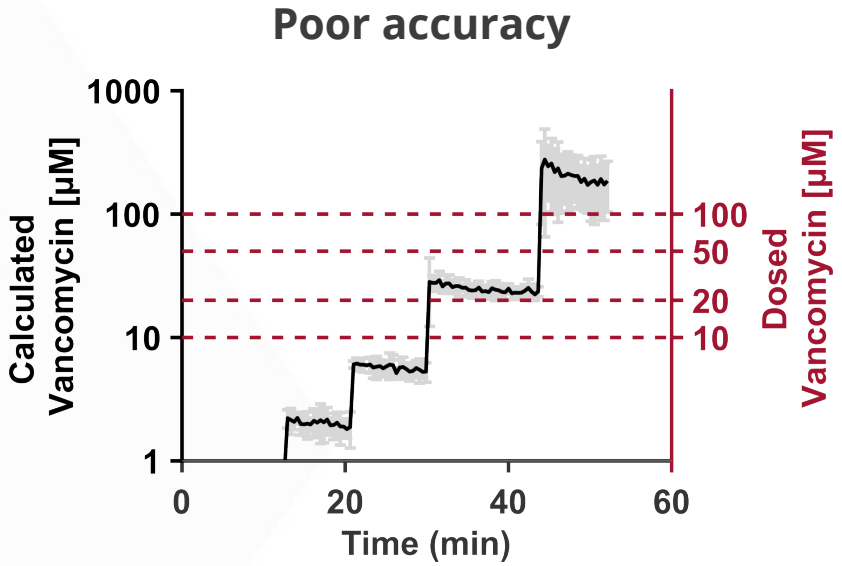
Downs, A., *Gerson, J., Hossain, M., Ploense, K., Pham, M., Kraatz, H.B., Kippin, T., Plaxco, K., "Nanoporous Gold for the Miniaturization of In-Vivo Electrochemical Aptamer-Based Sensors." ACS Sensors. 2021, 6, 6, 2299–2306.*

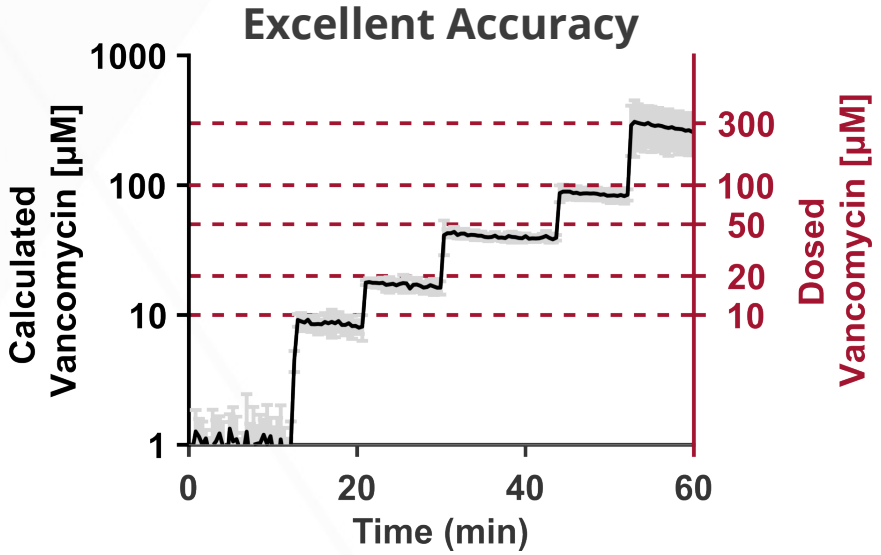
Goal 2: Improve calibration accuracy



37C data quantified with **25C** calibration curve

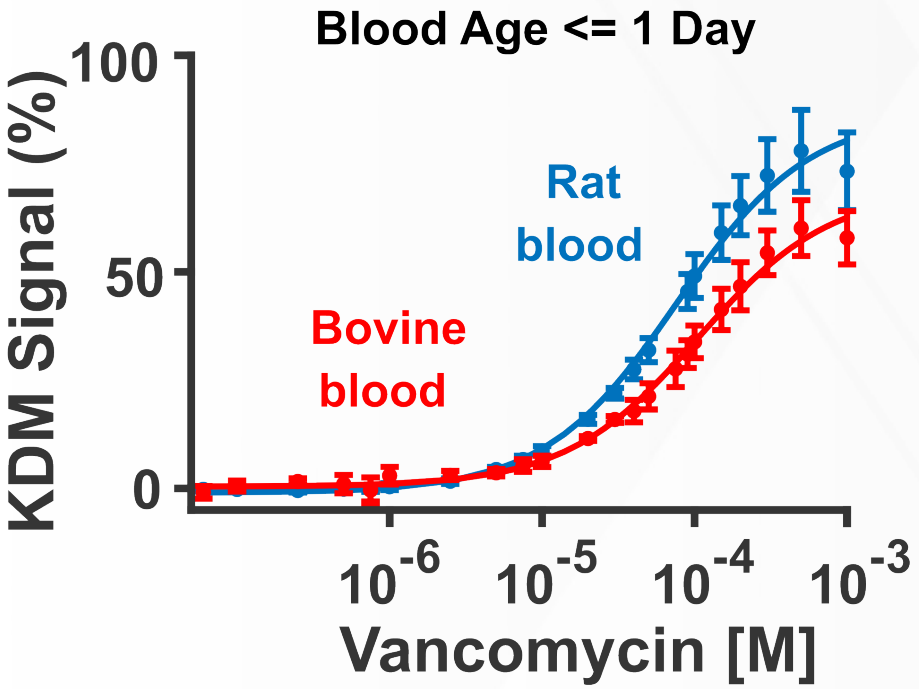
37C data quantified with **37C** calibration curve

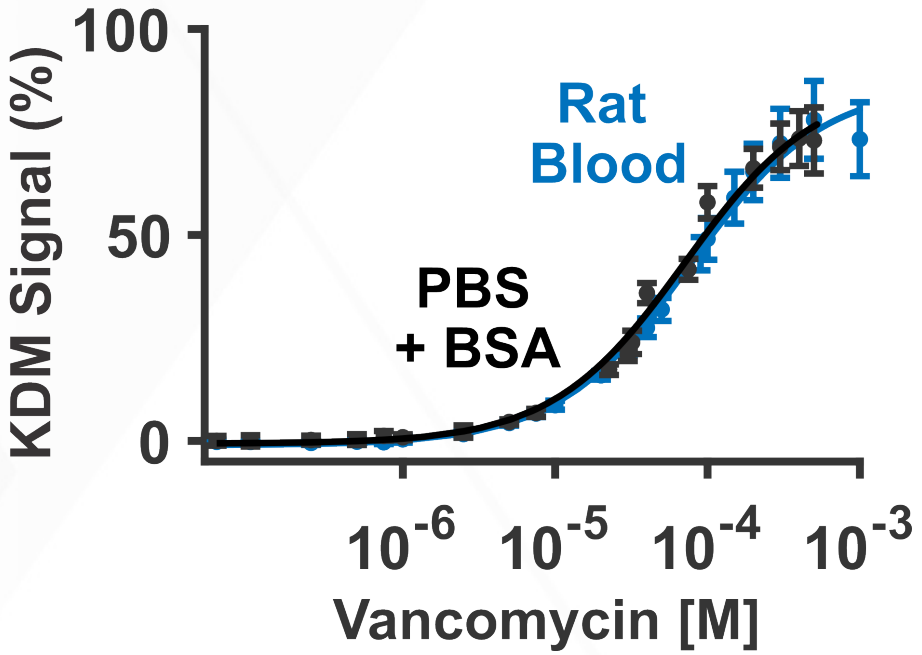




Downs, A., *Gerson, J., Honeywell, K., Kippin, T., Plaxco, K., "Improved Calibration of Electrochemical Aptamer-Based Sensors ." Under submission to Scientific Reports.*

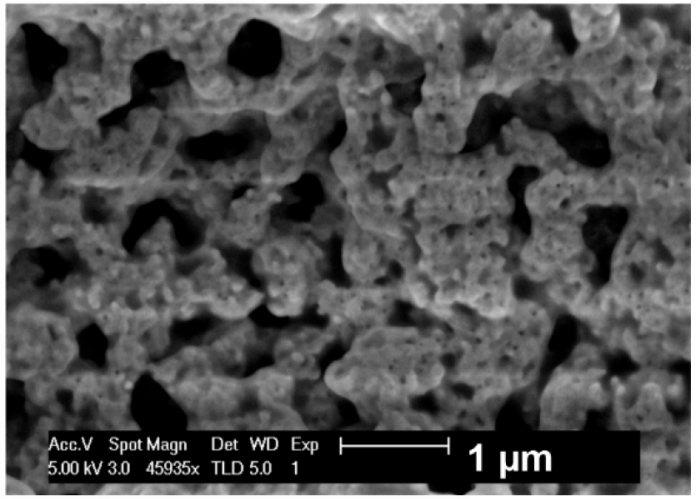
Developing a calibration curve: media matters

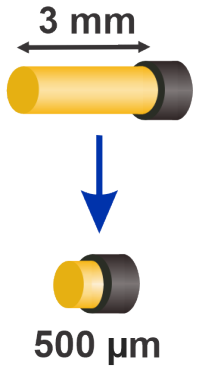




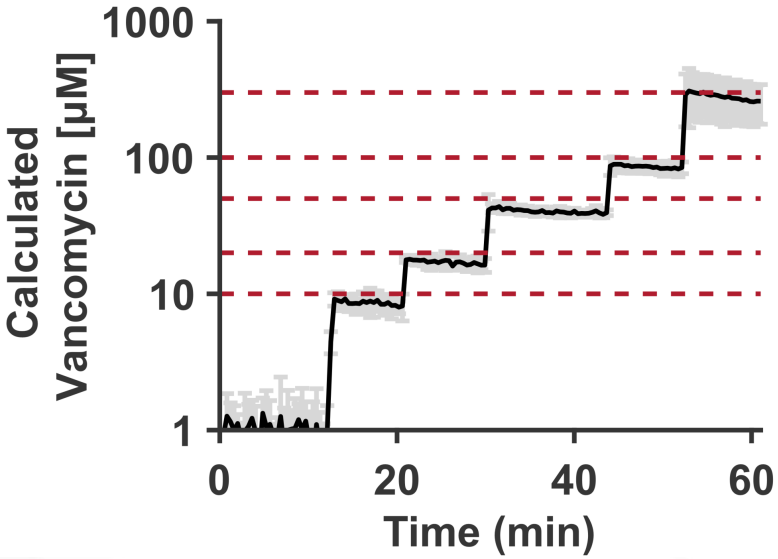
Takeaways

- Nanoporous gold can enable miniaturization of EAB sensors for in vivo applications

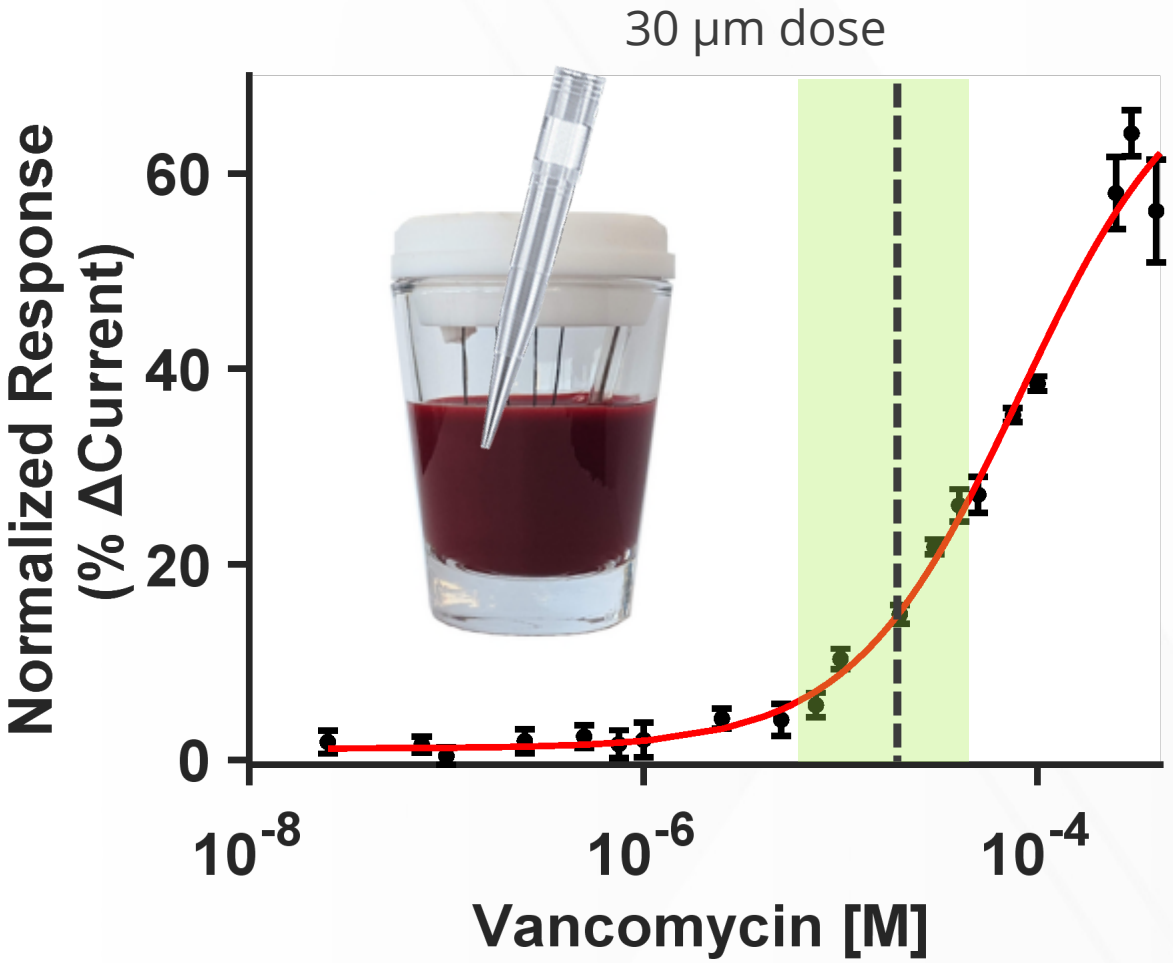


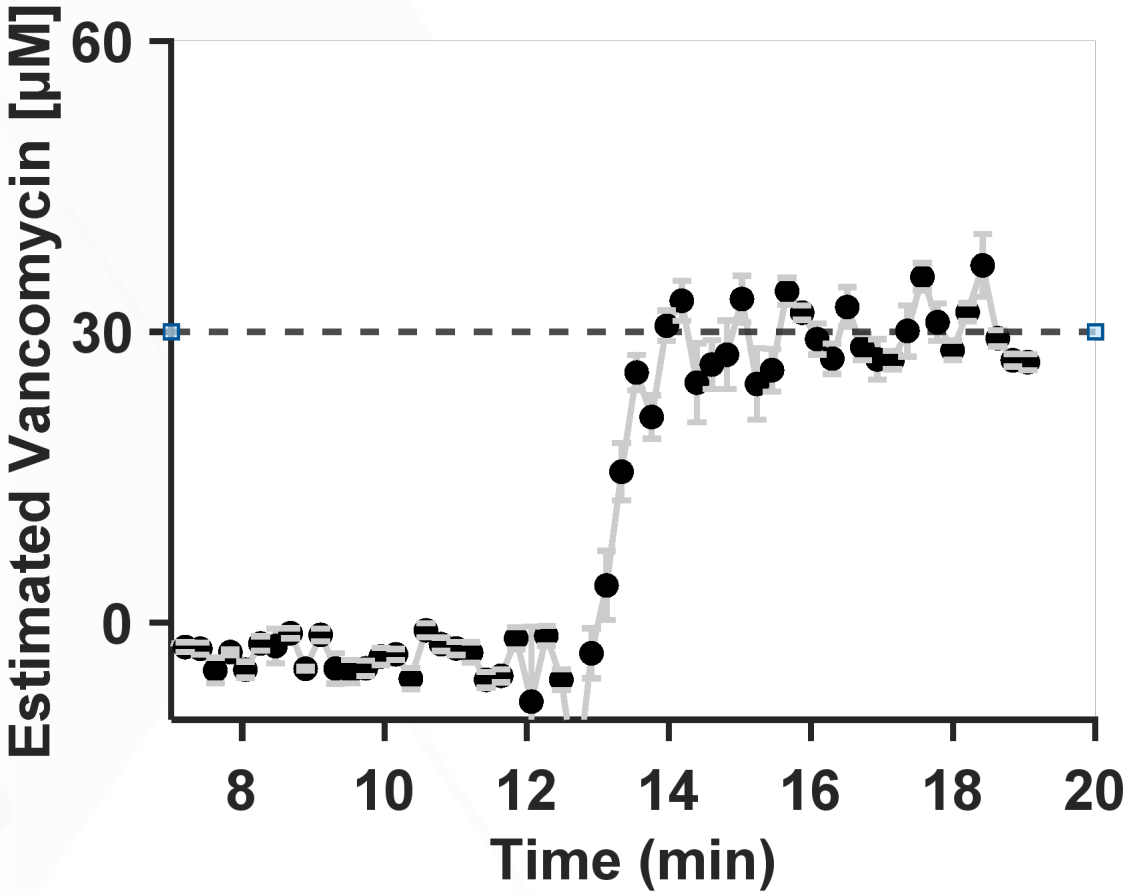


- Calibrating measurements in the body, however, requires careful consideration of temperature and media
  - Matching temperature of calibration achieves most accurate measurements



Current goal at Sandia National Laboratories: Adapt aptamer sensors for microneedle-based measurements





Thank you for your attention

Questions?

Acknowledgements:
- Plaxco, Kippin, and Kraatz group
- Sandia Chemical and Biological Sensors Department

Graduate School Funding: NSF GRFP, UCSB Graduate Division, Institute for Collaborative Biotechnologies

Postdoctoral Funding:
Sandia National Laboratories Hruby Fellowship

If you're interested in working at a national lab or applying to postdoctoral fellowships there, reach out on Linkedin or at amdowns@sandia.gov