Pore Characterization and Event Detection in Solid-State Nanopores

The nanopores we create are much less precise than nature’s own. Can we still get useful information from ours?

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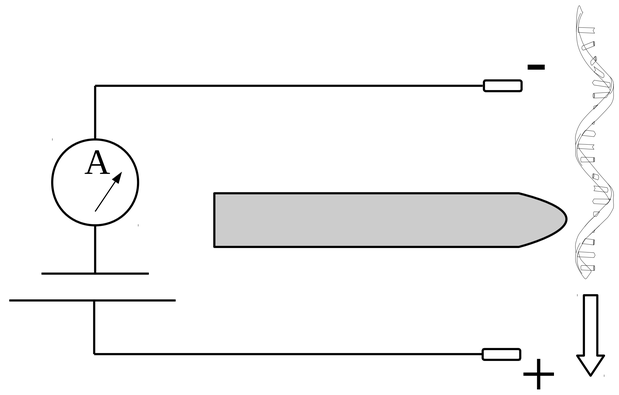
Nanopores are used for DNA sensing.

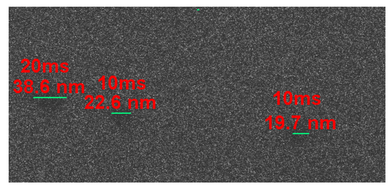


In a saline solution, a voltage run across the membrane causes ions to flow through the pore. Voltage force pulls negatively charged DNA through the pore.

We measure the current through the pore. When DNA is pulled through the pore, this current is attenuated.

Solid-state nanopores offer greater flexibility at the cost of a noisier signal.

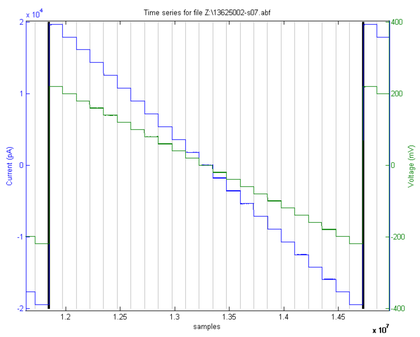
Solid state nanopores, milled through a silicon-based substrate, lack the atomic-level geometric precision of biological, protein-mediated pores, but are promising due to their greater stability and potential for modification.

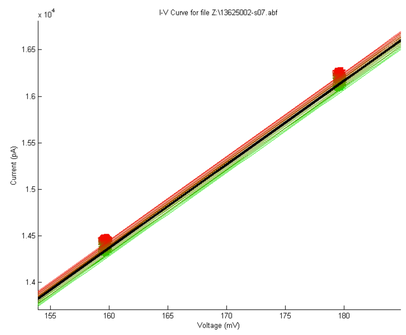


These two pores were milled to the same specifications, but differ substantially in diameter.

Pore fabrication is inexact. We measure a pore's resistance to infer its diameter.

We created a flexible program which gives pore diameter estimates for a variety of experimental conditions.

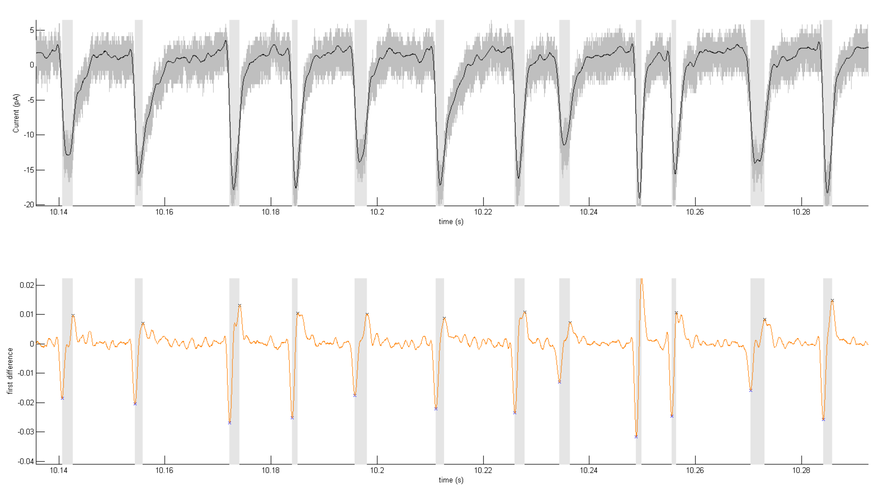




The program takes data on the current through the pore at a variety of voltages, fits an I-V curve to the steady-state data to find the resistance of the pore, and uses data about the amount and type of ions present to estimate the pore diameter.

When identifying events amidst the noise, robustness is key. We found that simpler is better.

Ideally, each DNA translocation event results in a square wave in the current signal. Experimental setup, filtering, and imperfections in the pore corrupt this waveform and introduce significant noise. We wish to reconstruct the original signal in order to find the duration and magnitude of each event. We wrote a program to expedite this process.



After trying many methods, we ended up settling on one of the simplest. We use Savitsky-Golay filtering and differentiation, then identify the beginning and end of events as inflection points.

With high noise, this method was more accurate than other well-defined techniques due to its robustness to pathological signal deformation.