DNA Analysis in a Nanofluidic Device

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SBCC, Chemistry, INSET 2011

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Research Funded By: Pennathur UCSB Startup Fund

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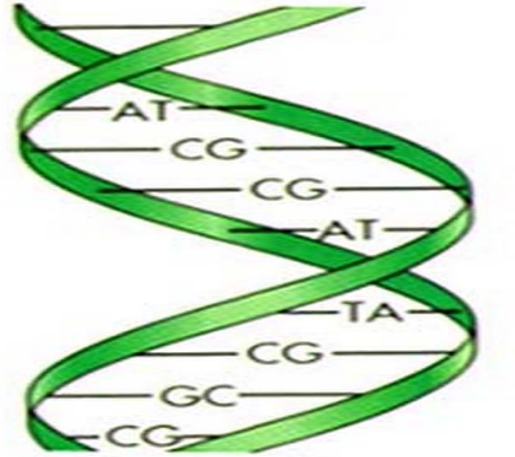
engineering

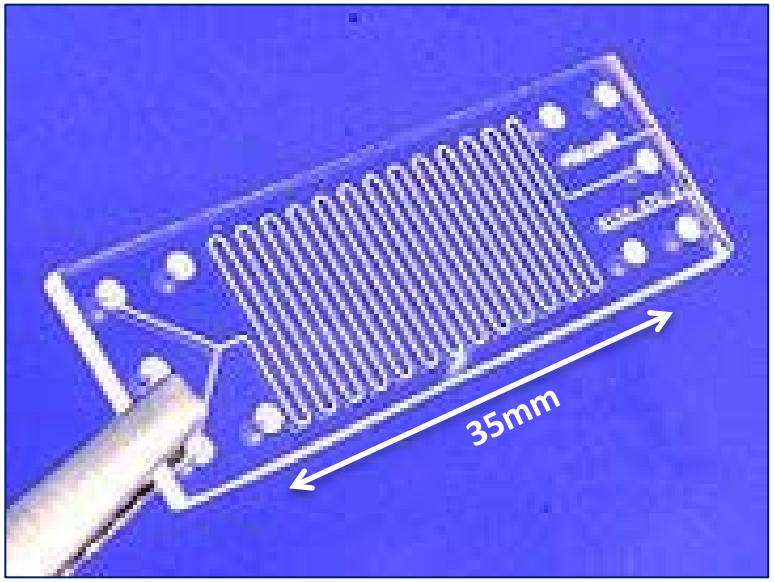
Rapid DNA analysis

Importance of DNA analysis:

- forensic identification
- medicine
- heredity and disease



DNA structure (image from www.calabriadna.com)



Lab-on-a-chip (image from "www.thefullwiki.org")

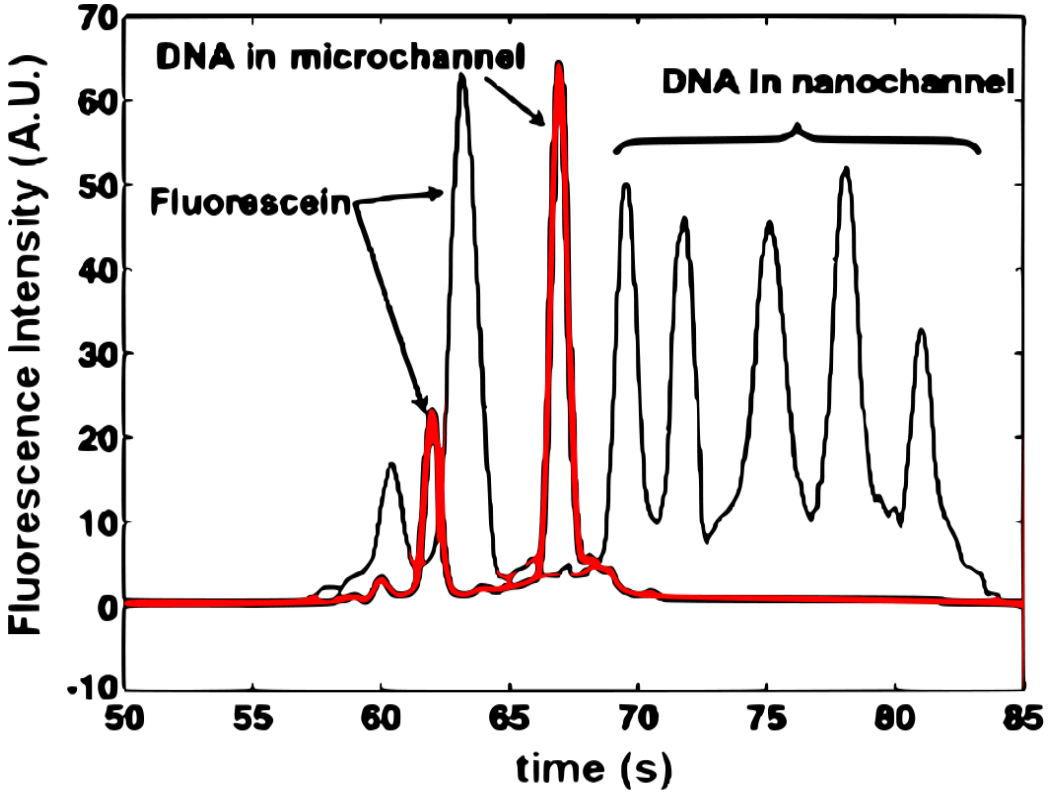
Research aim - smallest, fastest, cheapest and most portable platform for DNA analysis.

Goals of DNA Analysis in Nanochannels

- Separate DNA in a nanochannel

  (small increments of DNA can be detected)
- Improve DNA analysis

  (portability and accuracy)
- Develop fast, cheap, portable, and accurate methods of DNA analysis

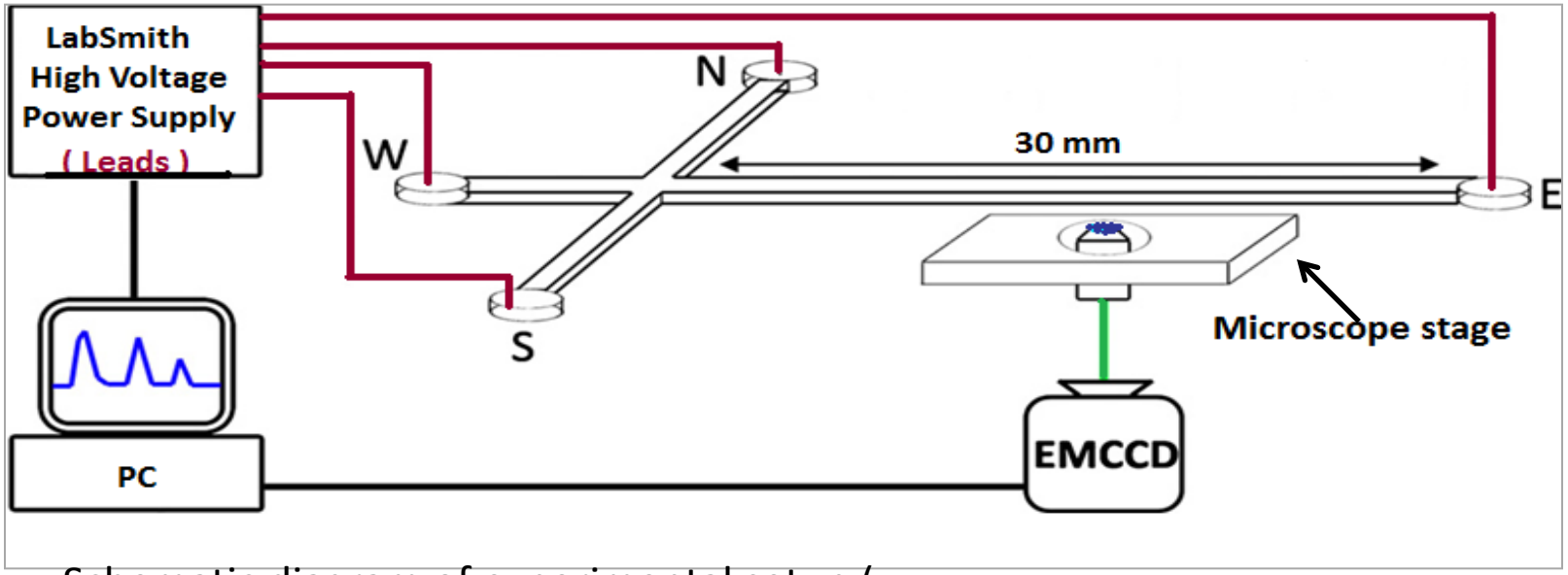


Electropherogram of DNA separation in a nano- and microchannel (Michael G. Kattah, Jonathan B. Steinman, and Paul J. Utz, *Anal. Chem.*, 2007, *79* (21), pp 8316–8322)

Approach

- **Apply voltages to nanochannels**
- **Drive and separate DNA in a solution**

Experimental Setup



Schematic diagram of experimental setup (modified from Jess M. Sustarich, Brian D. Storey, and Sumita Pennathur, **Phys. Fluids**, 2010, **22**/11, p.2003-2024)

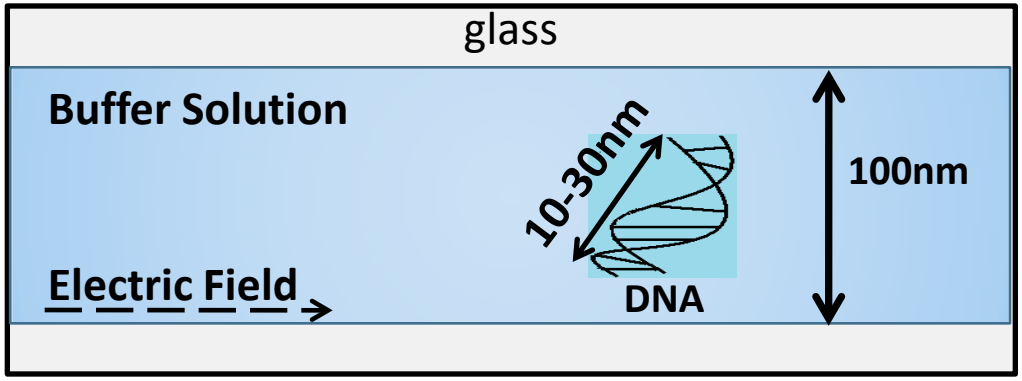
Equipment Used

- Cross-channel nano-chips
- High Voltage Power Supply
- EMCCD Camera
- Automated Microscope Stage
- Light Source Mercury Bulb

DNA in a Nanochannel

Materials Used

- DNA ladder (25-300bp)
- Fluorescent labeling with YOYO-1 dye
- Tris/EDTA Buffers



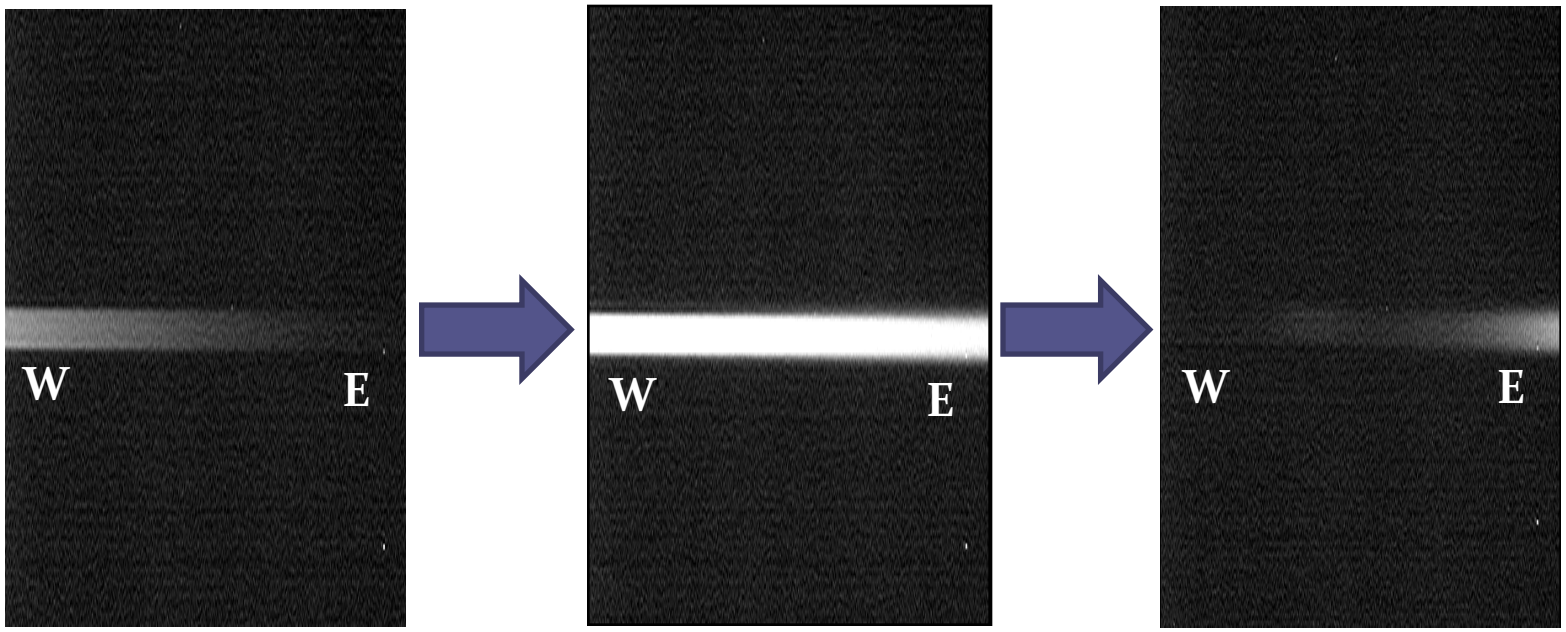
Schematic side view of a nanochannel

We observe

- Electrophoretic movement of DNA with fluorescence microscopy

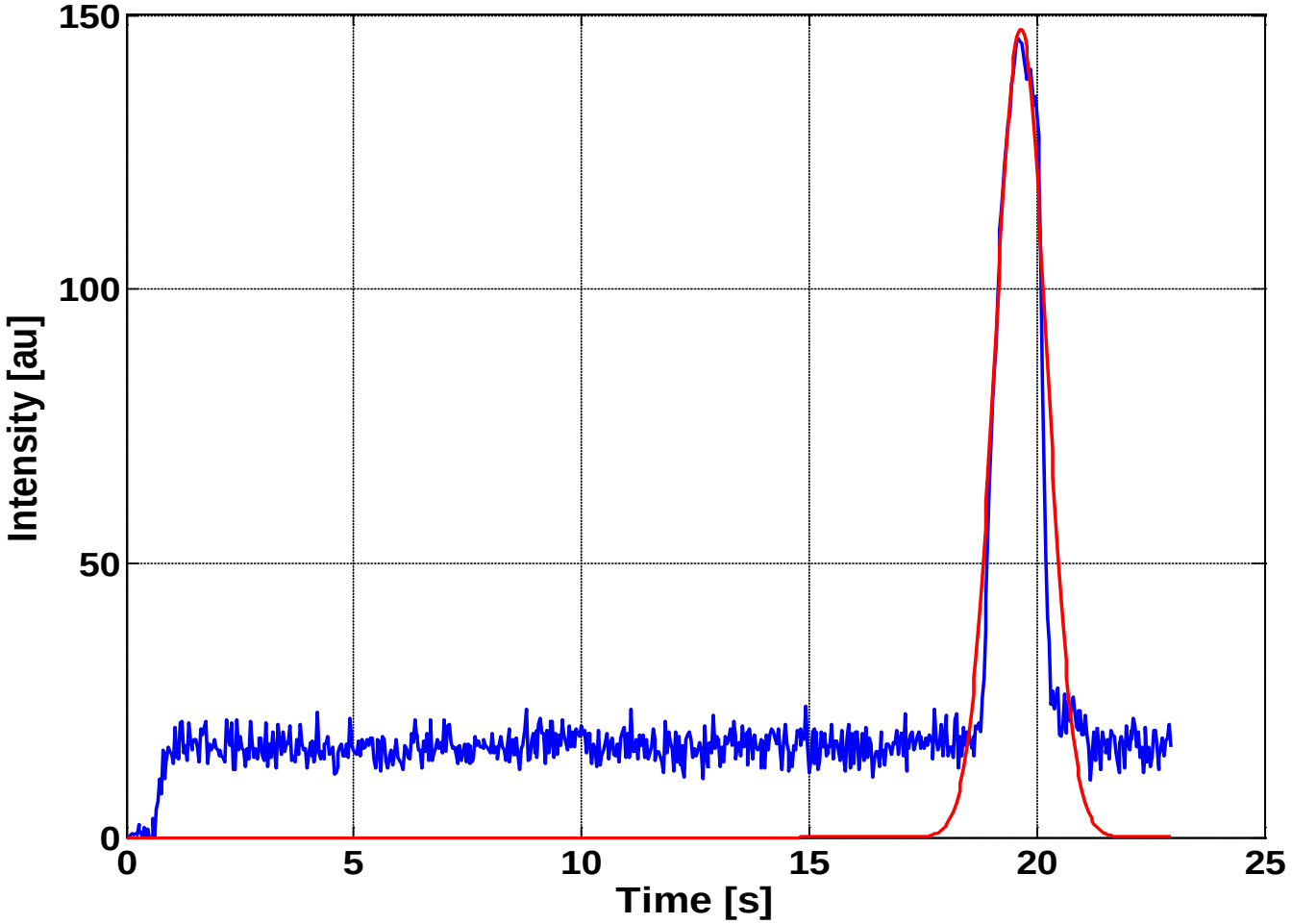
Run Control Experiments

- Ran FASS nanochannel injections (control to make sure our setup works)



Movement of a plug (fluorescently labeled sample)

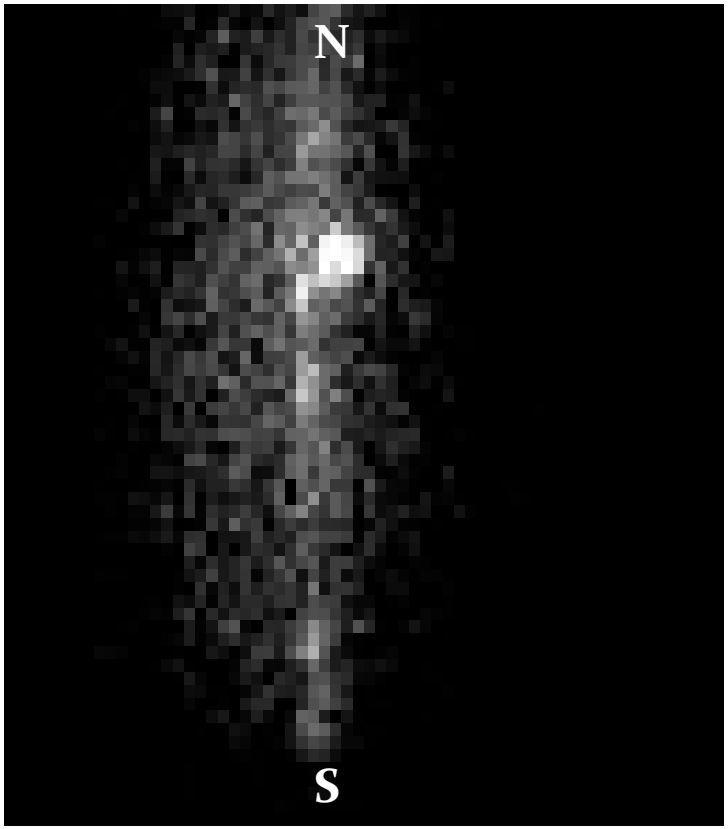
Analysis of Fluorescein Phosphate Plug



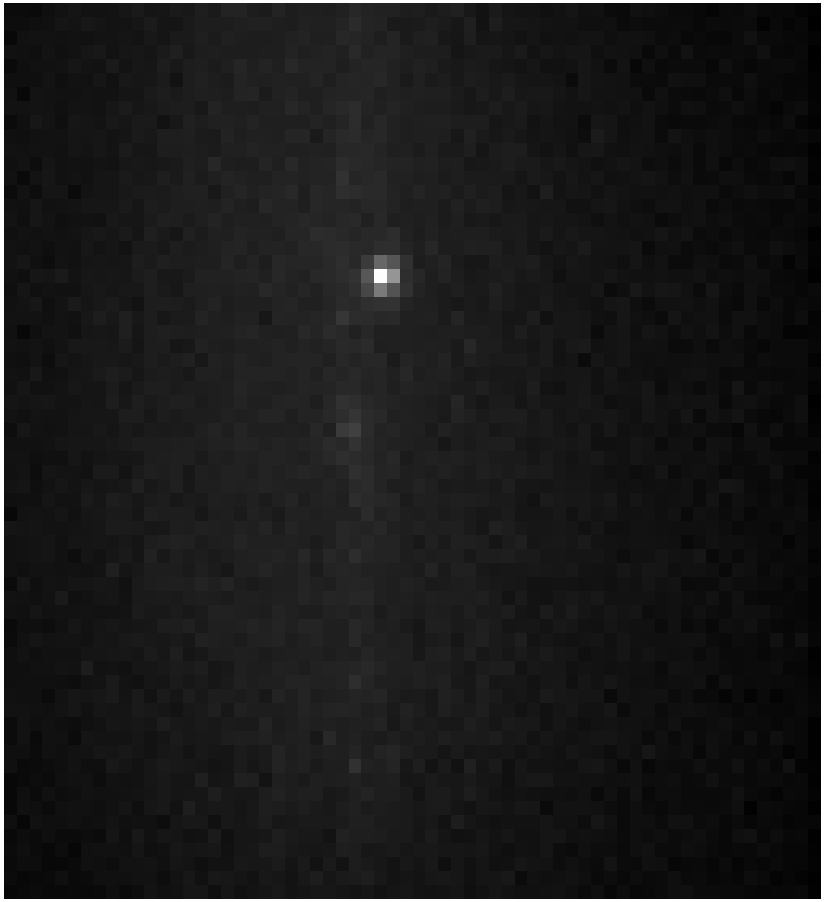
MatLab generated electropherogram of fluorescently labeled phosphate buffer sample. Tall and narrow peak proves the sample to be well concentrated.

Experimental Use of DNA Sample

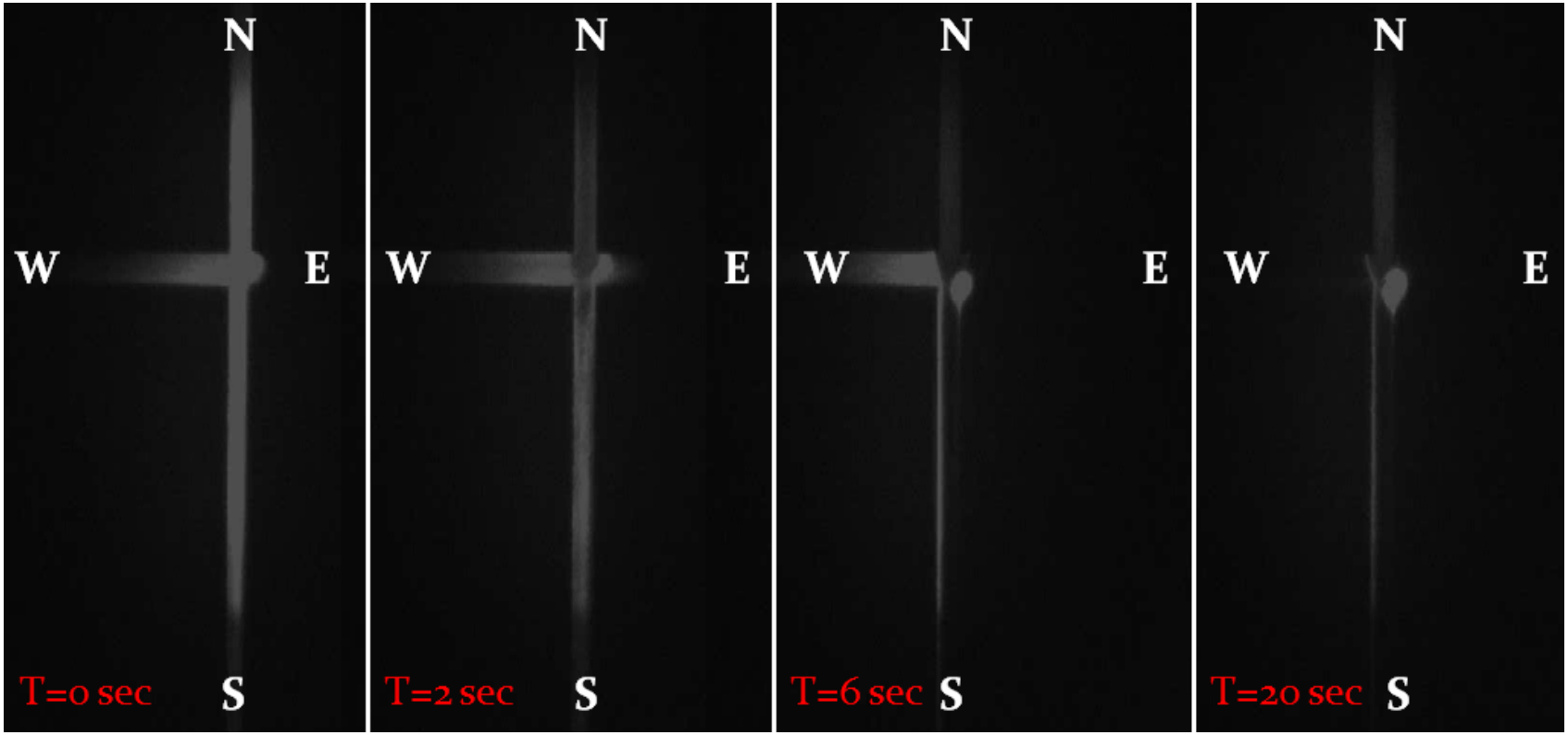
- Run DNA Loading Step
- DNA Injection



Fluorescently labeled DNA molecules accumulate at the injection site.

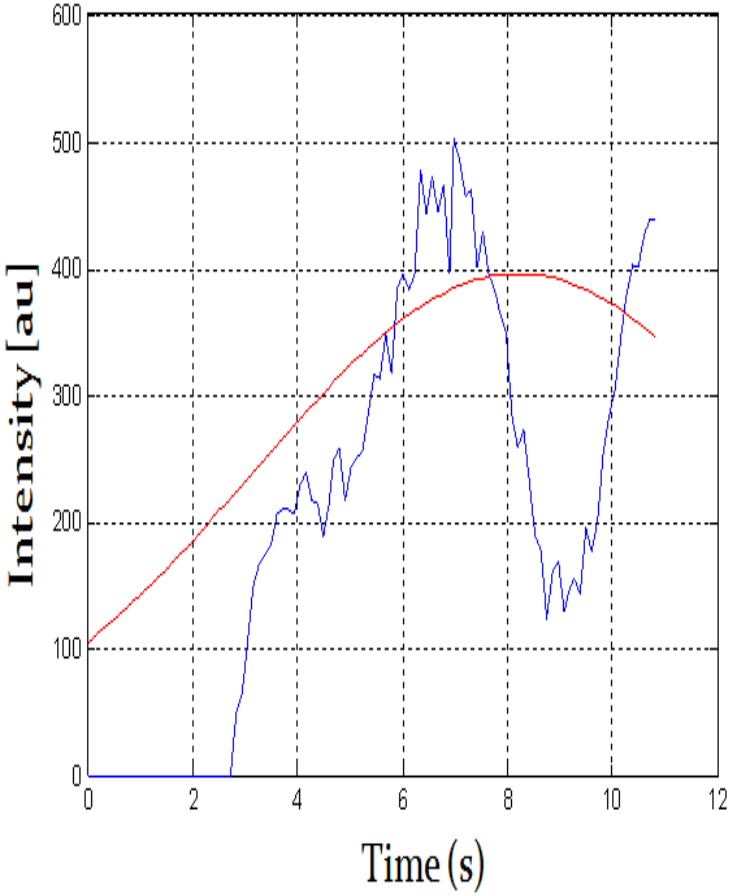


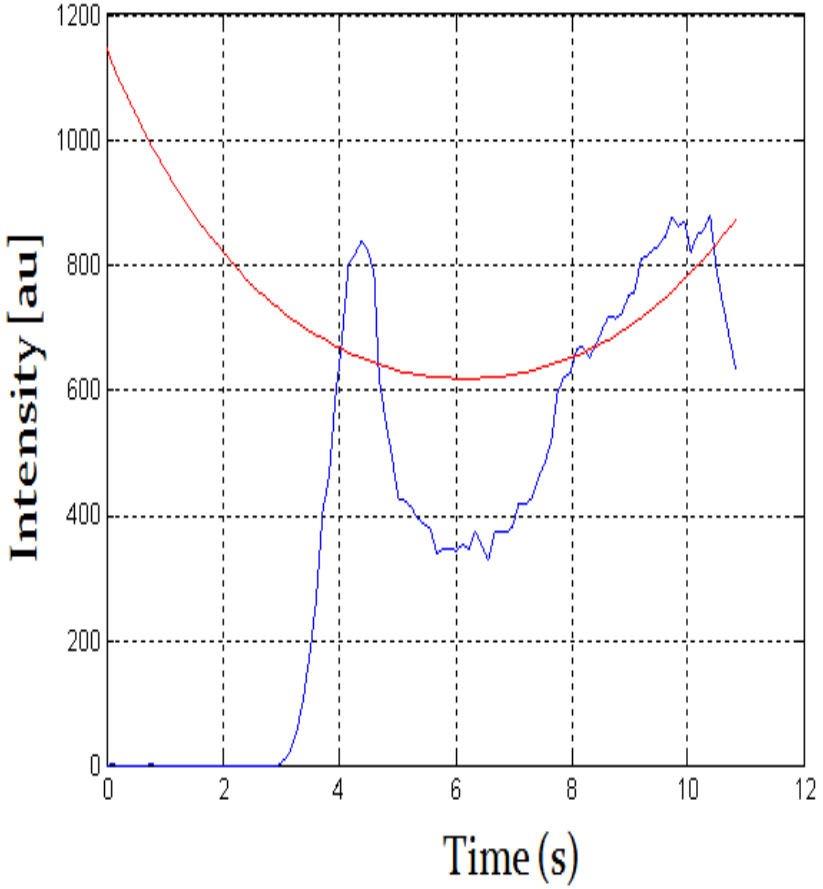
DNA Particle Accumulation



As loading step progresses there appears to be an accumulation of DNA particles at East channel entrance preventing further DNA injection

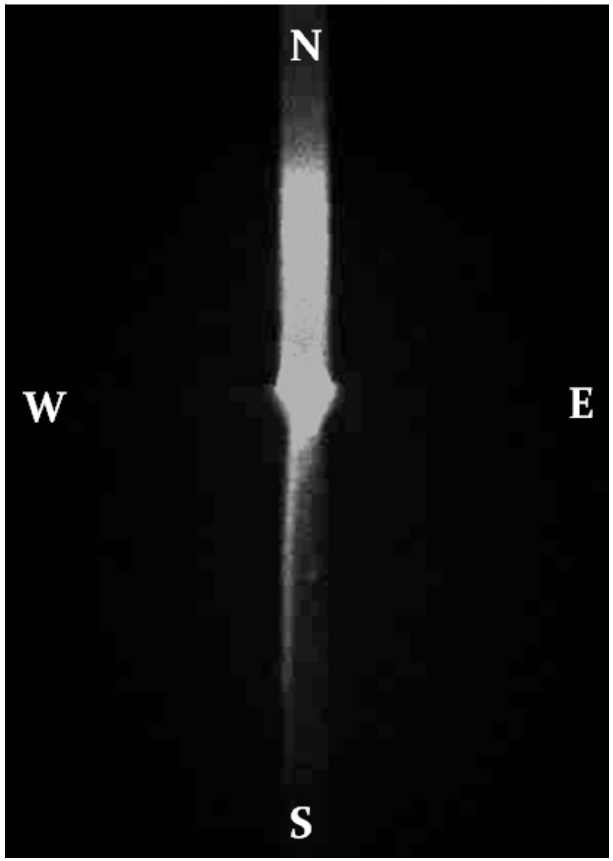
Analysis of Preliminary Data



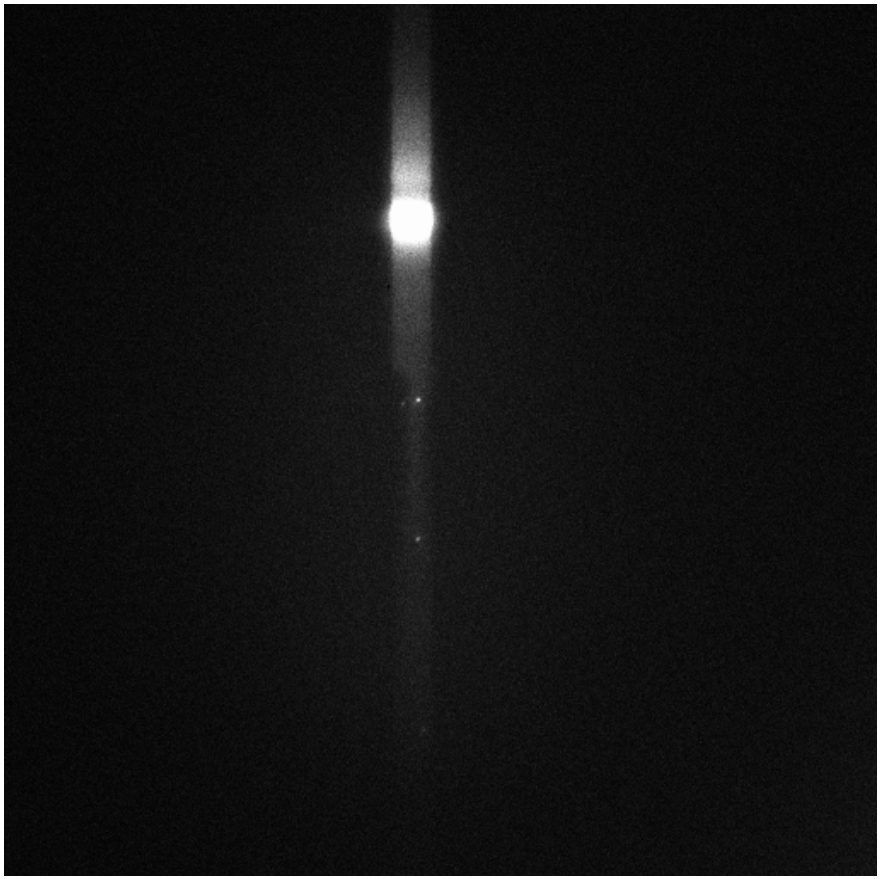


Both graphs represent 25bp DNA injection 5mm down the East channel. There is no defined Gaussian fit.

Using Freshly Stained DNA Dilution



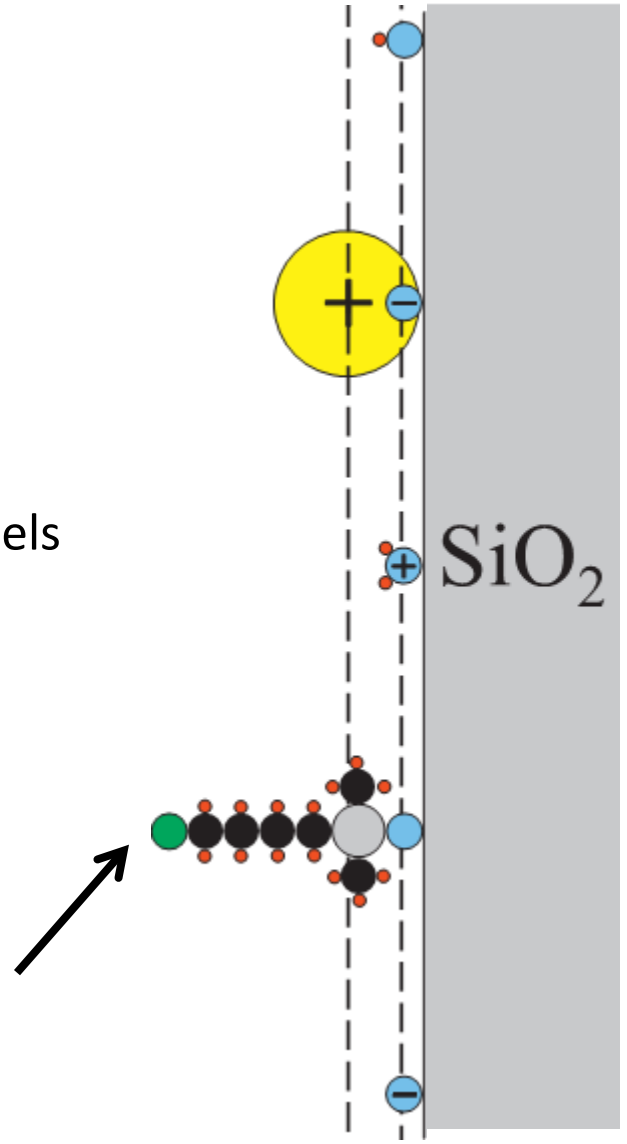
DNA has coated North-South channel after running only one experiment



Future work

We plan to run our experiments using

- Hydrophilic neutral silane coated channels
- 25bp and 10 bp DNA ladders
- Optimized voltage
- Optimized concentration
- Ideal buffering conditions



3-cyanopropyldimethylchlorosilane

Andersen et al, Journal of Colloid and Interface Science Volume 353, Issue 1, 1 January 2011, Pages 301-310

Acknowledgements

- Dr. Sumita Pennathur
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Gaussian function is a probability density function of a normal distribution. Has to do with diffusion.

Mercury bulb emits a broad spectrum of light

Fluorescein dye max absorption 494nm, emission 529nm