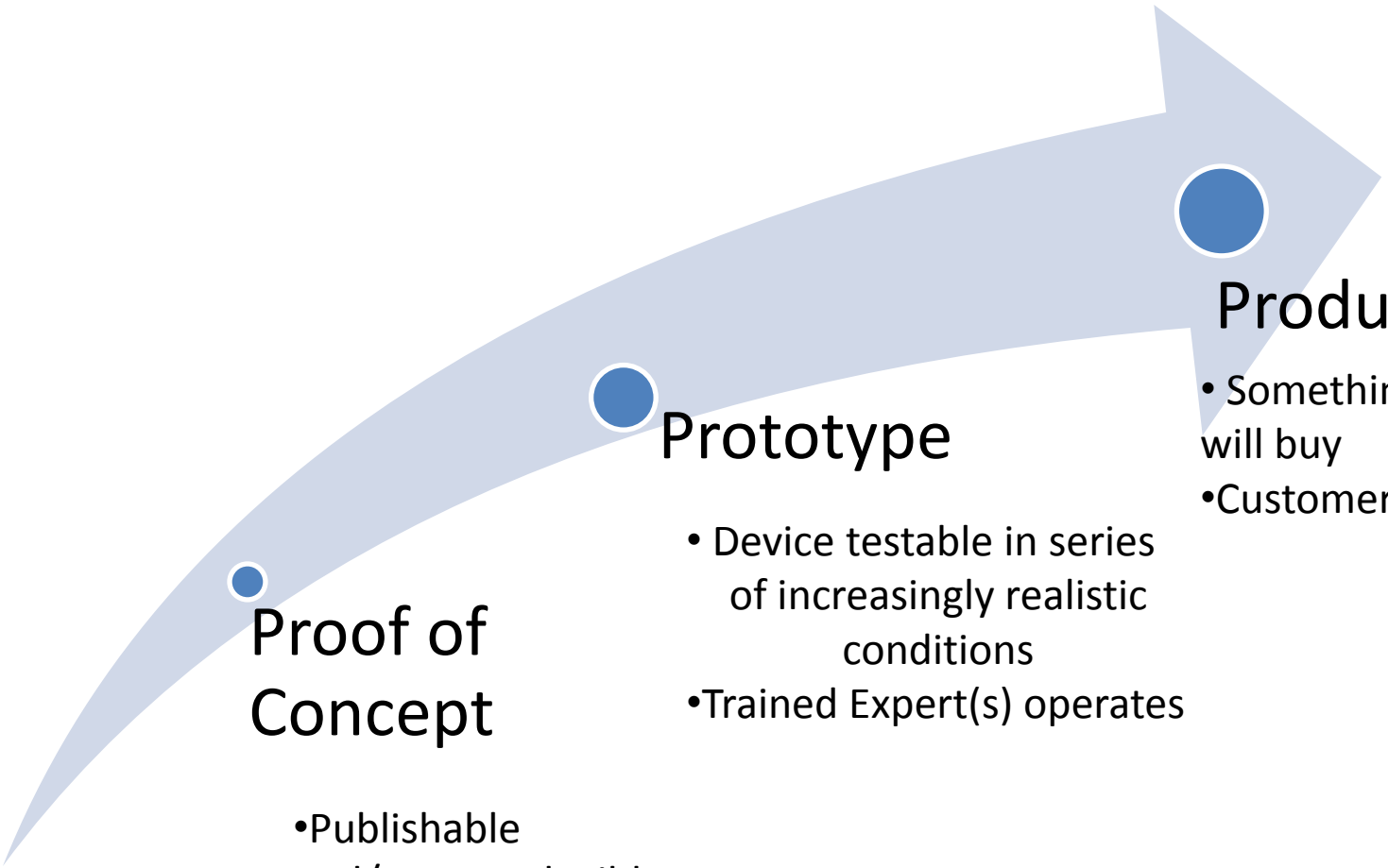
Miniature goes Modular: Principles and Research Applications for Modular Microscale Systems from Sample Preparation to Detection

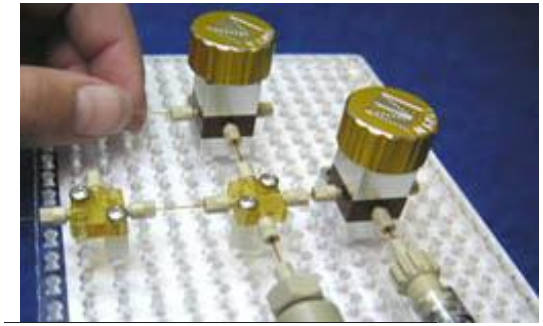
Yolanda Fintschenko, Ph.D.
Director of Business Development
LabSmith
Livermore,CA

μ/nTAS: Development Sequence



Ensuring a Success – Experimental Parameter Control

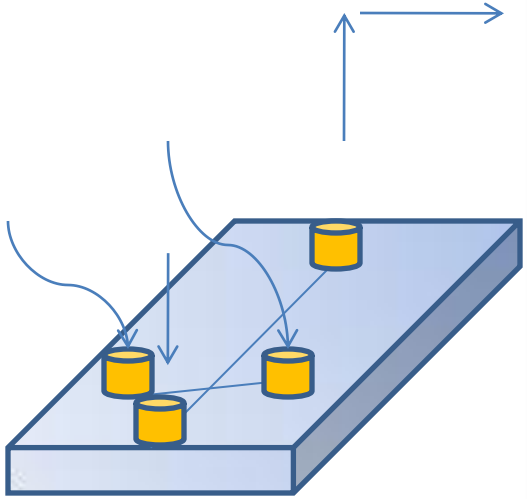
Fluid/Pressure



Electric Fields

LabSmith HVS 448
8-Channel High Voltage Sequencer

Connections



Detection/ Imaging

LabSmith SVM or Other Detector Suitable for the Application

LabSmith
TOOLS FOR SCIENCE

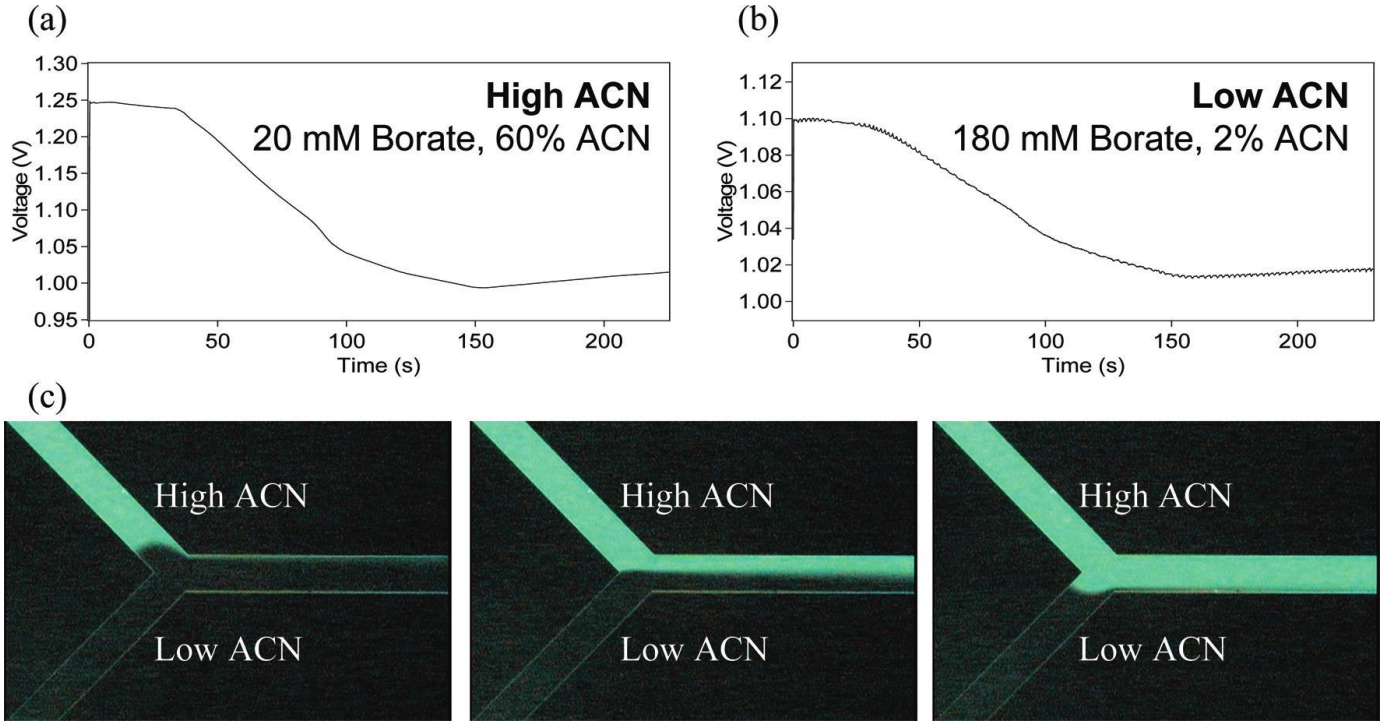
Microfluidic Separations – They're Electric

- Electrophoresis
  - Analysis of Lithium in Blood
  - Protein size separations
  - DNA/RNA sequencing
- Chromatography
  - Electrokinetic HPLC
  - Capillary Electrochromatography
- Hybridization Assays
  - Immunization assays
  - PCR
- Dielectrophoresis
  - Cells
  - Biopolymers

LabSmith HVS 448
8-Channel High Voltage Sequencer

LabSmith
TOOLS FOR SCIENCE

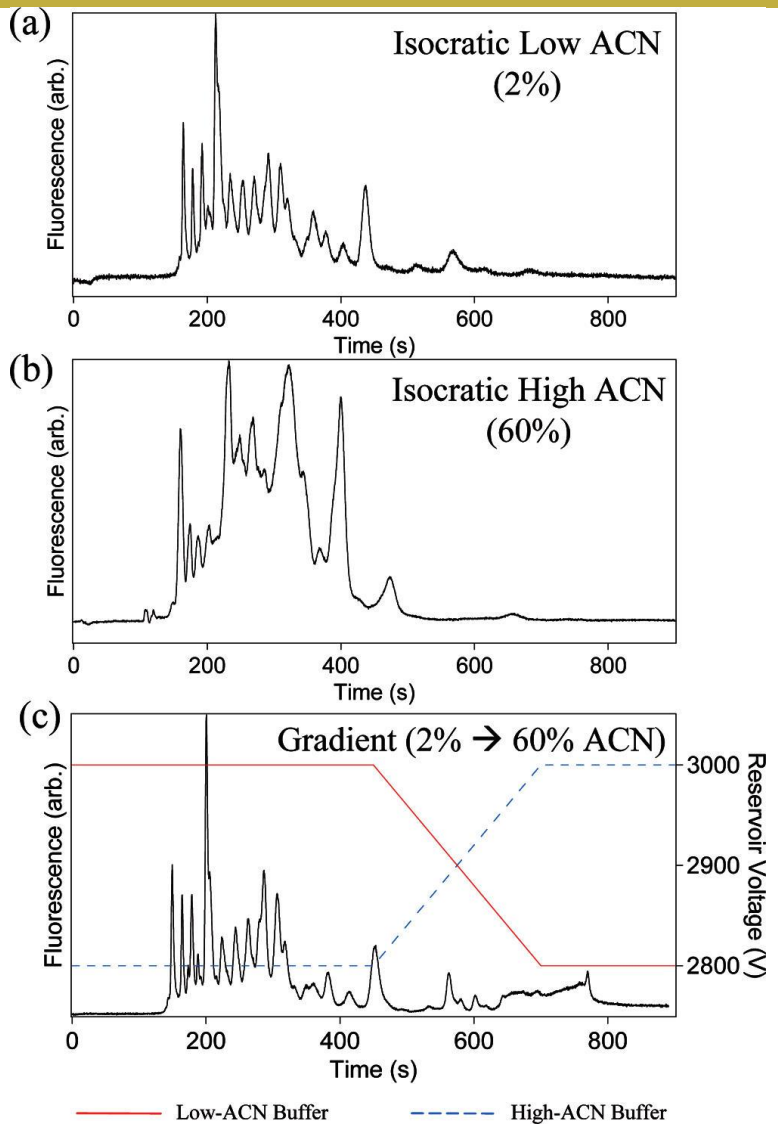
Aqueous/Organic Gradient Control Using the HVS448



Wheeler, *et al. Anal. Chem.,* Gradient Elution in Microchannel Electrochromatography, 2009, 81, 3851–3857.

LabSmith
TOOLS FOR SCIENCE

Gradient Elution of Tryptic Digest of FITC-Casein using HVS



Wheeler, A.R. *et al.* , *Anal. Chem.*, Gradient Elution in Microchannel Electrochromatography, 2009, 81, 3851–3857.

LabSmith
TOOLS FOR SCIENCE

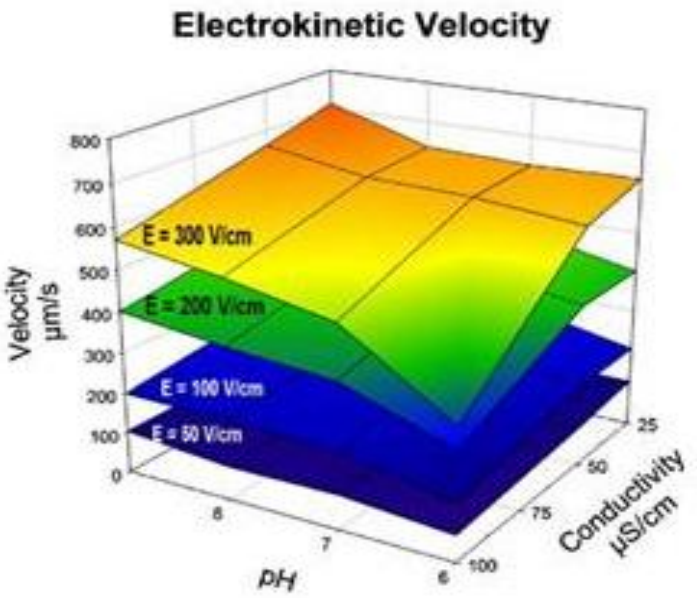
Monitoring More Than Electric Fields

Synchronized Video Microscope

- **PIV measurements**
- **Bottom-up viewing and illumination**
- **Motionless stage for unperturbed microsystems**

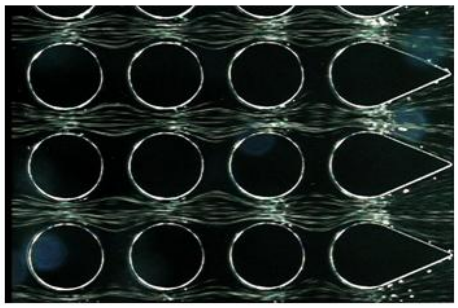
LabSmith
TOOLS FOR SCIENCE

Going with the Flow – micro Particle Image Velocimetry



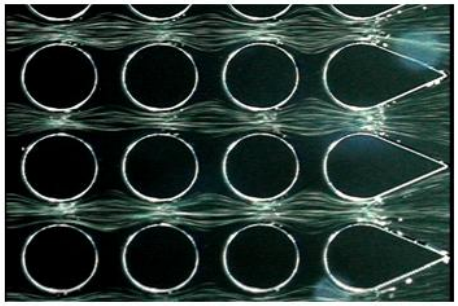
µPIV results showing the measured electrokinetic velocities as a function of pH and conductivity.

(a)



pH 6, 25µS, 800 V

(b)



pH 9,100µS, 800 V

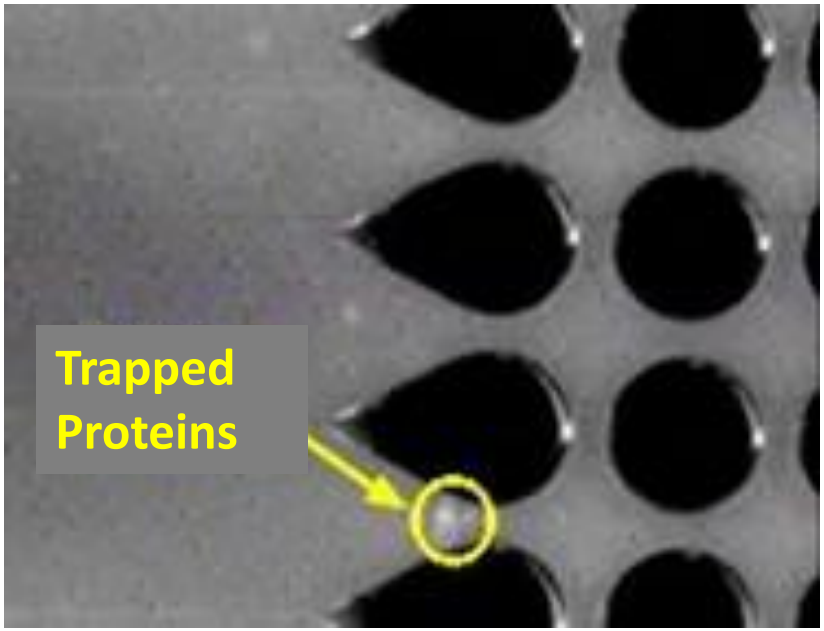
(c)

pH6, 100µS, 800 V

Lapizco, *et al. Anal Bioanal Chem* (2009) 394:293-302.

LabSmith
TOOLS FOR SCIENCE

Imaging On-Chip Protein Concentration with the HVS 448 and SVM 340



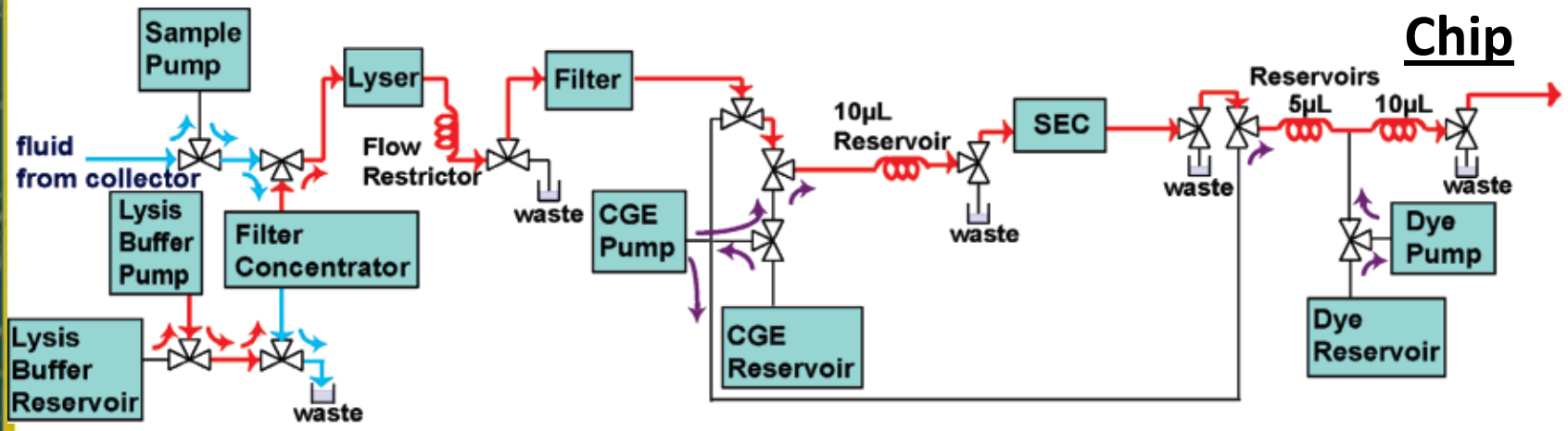
Lapizco-Encinas, B.H., *et al.*, "Protein manipulation with insulator-based dielectrophoresis and direct current electric fields , *Journal of Chromatography A,* Volume 1206, Issue 1, 3 October 2008, Pages 45-51.

LabSmith
TOOLS FOR SCIENCE

Automated Pathogen Detection

Bread boarded System – Sample Prep

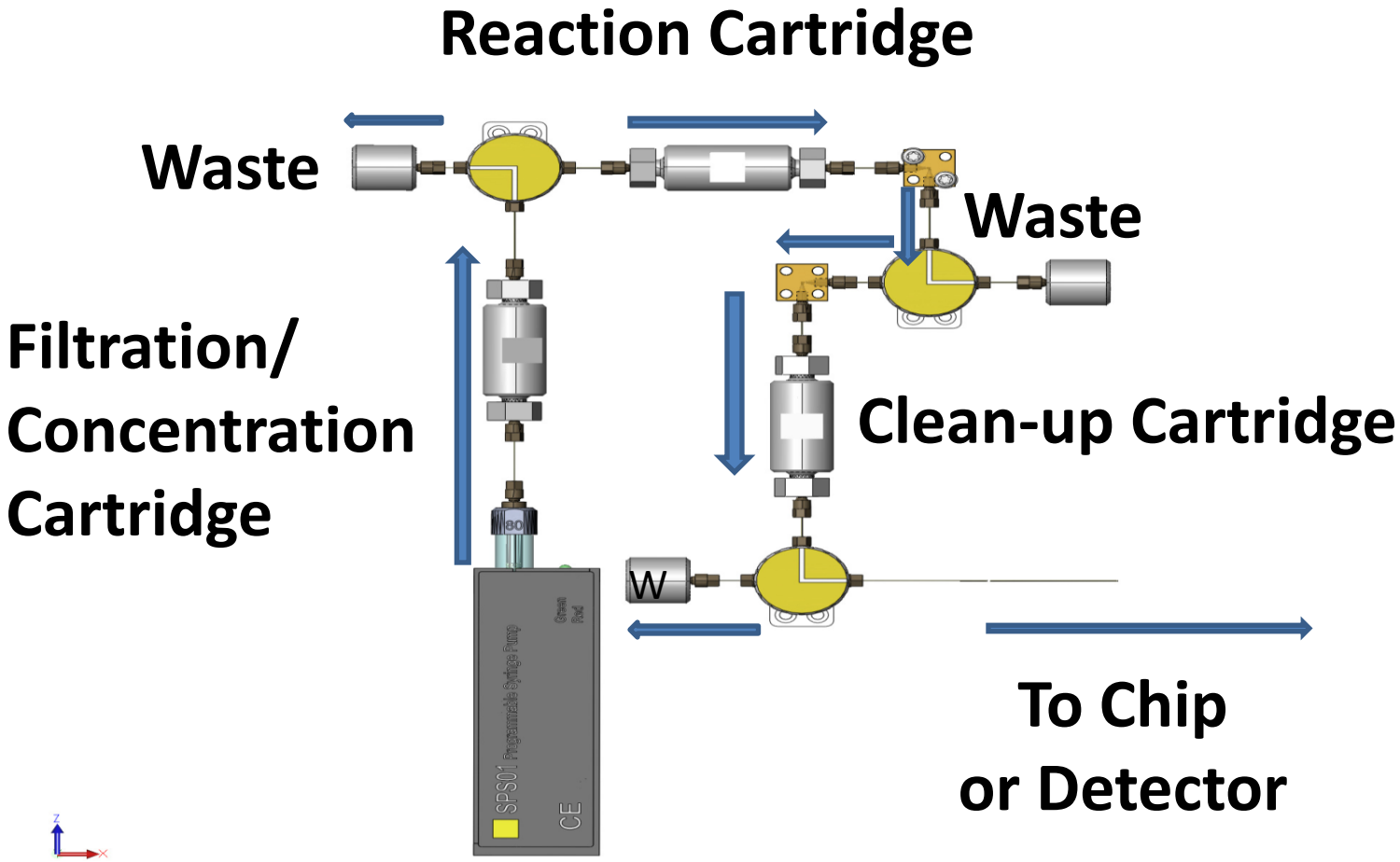
To CGE Chip



The Sandia automated sample preparation (ASP) system had a total cycle time (included sample prep and on-chip analysis) of 15 minutes for *Bacillus subtilis*.

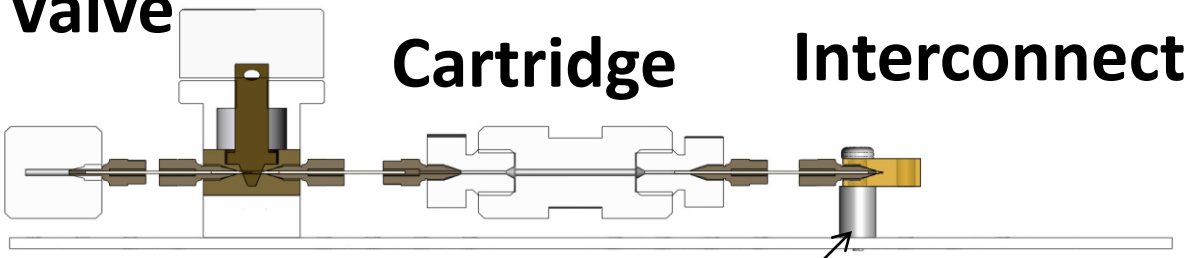
Vandernoot *et al*, Anal. Chem. **2007, 79, 5763-5770**

CapTite™ Fluid Connections and Sample Preparation System



LabSmith
TOOLS FOR SCIENCE

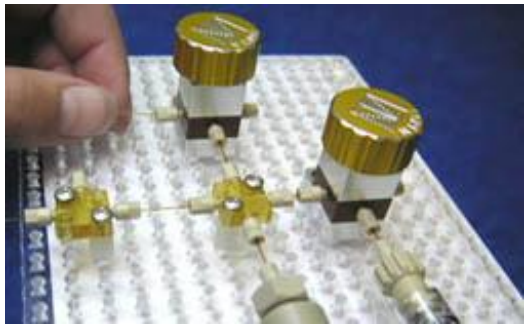
Assay Breadboard – Cross Sectional View



LabSmith TOOLS FOR SCIENCE

Controlling Flow with Pressure

Programmable Syringe Pump



- **Breadboard mounted**
- **Inter-compatible with LabSmith's complete line of CapTite™ Microfluidic Components.**
- **Low dead volumes**
- **500 PSI max**
- **Connects directly to 360 µm capillary tubing,**
- **Volume resolution of 10 nanoliters**
- **Volume and flow rate accuracy of ~1%.**

LabSmith
TOOLS FOR SCIENCE

Conclusion

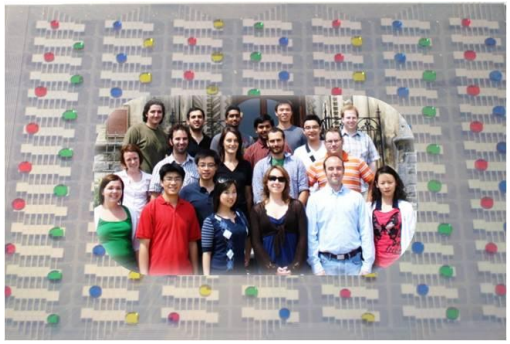
- LabSmith provides practical solutions to control lab-on-a-chip experiments for ideas on the path to products
  - Voltage control
  - Pressure-driven flow control
  - Fluid interconnects
  - Modular sample prep
  - Imaging and detection

LabSmith
TOOLS FOR SCIENCE

Acknowledgements

LabSmith Customers

- Aaron Wheeler, Michael Watson, and the Wheeler Lab



- Blanca Lapizco-Encinas and Lapizco-Encinas Lab

Sandia National Laboratories

- Gabriela Chirica, Ron Renzi, and many more

Sandia National Laboratories

LabSmith TOOLS FOR SCIENCE

LabSmith
TOOLS FOR SCIENCE