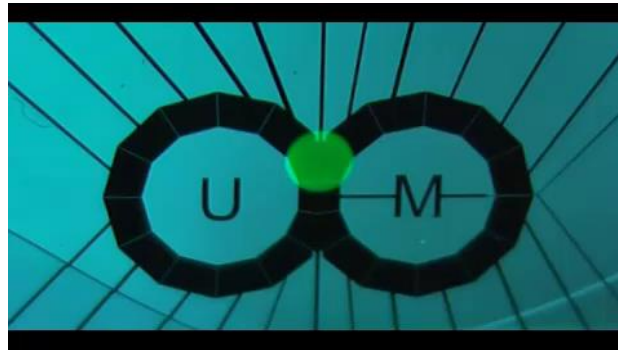


Digital Microfluidic System with Intelligent Control for Ultrafast DNA Analysis



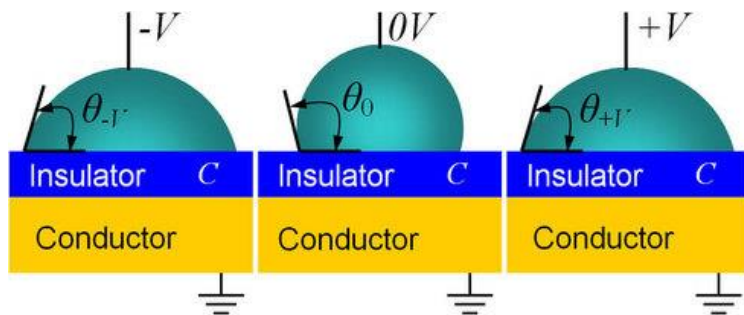
Yanwei Jia, Assistant Professor
State Key Laboratory of Analog and Mixed-Signal VLSI
University of Macau
May 30, 2016

Outline

- Introduction on Digital Microfluidics (DMF)
 - Principles
 - Applications
- Our DMF chip development
 - System Setup
 - Real-time Feedback Control
 - Sub-7-second DNA melting curve analysis
- Our Target

Principles of DMF

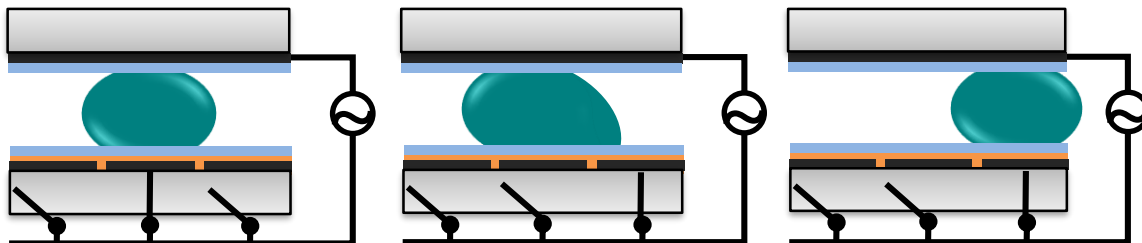
EWOD: Electricwetting-on-Dielectric



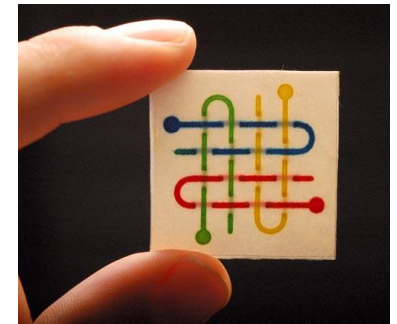
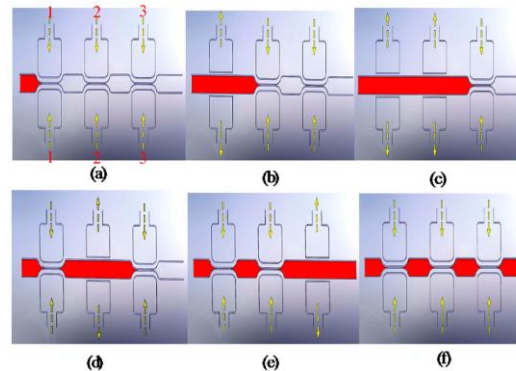
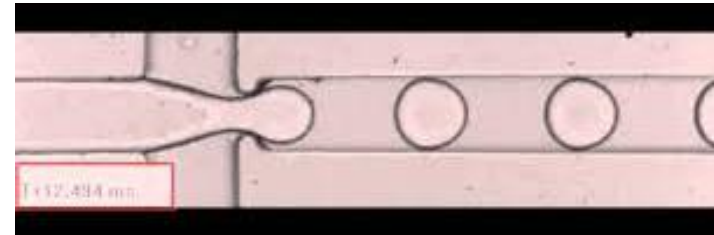
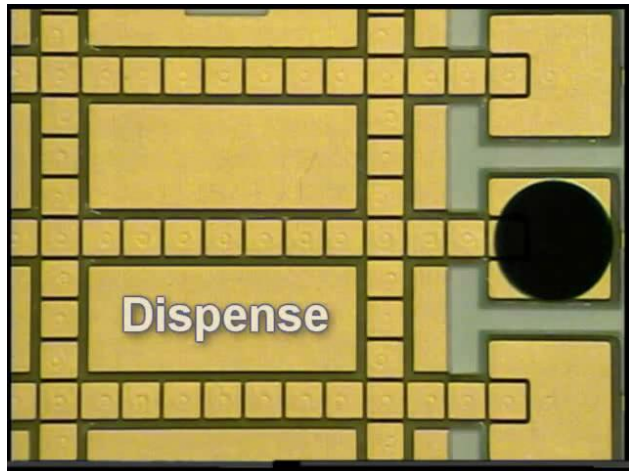
$$\cos \theta_V = \cos \theta_0 + \frac{1}{\gamma_{LG}} \cdot \frac{\epsilon_r \epsilon_0}{2t} V^2$$

EWOD: When an E is applied between a droplet and an insulated electrode, improved wetting is exhibited through a reduction in the surface tension and the droplet's contact angle .

Droplet Manipulation Mechanism



Digital Microfluidics



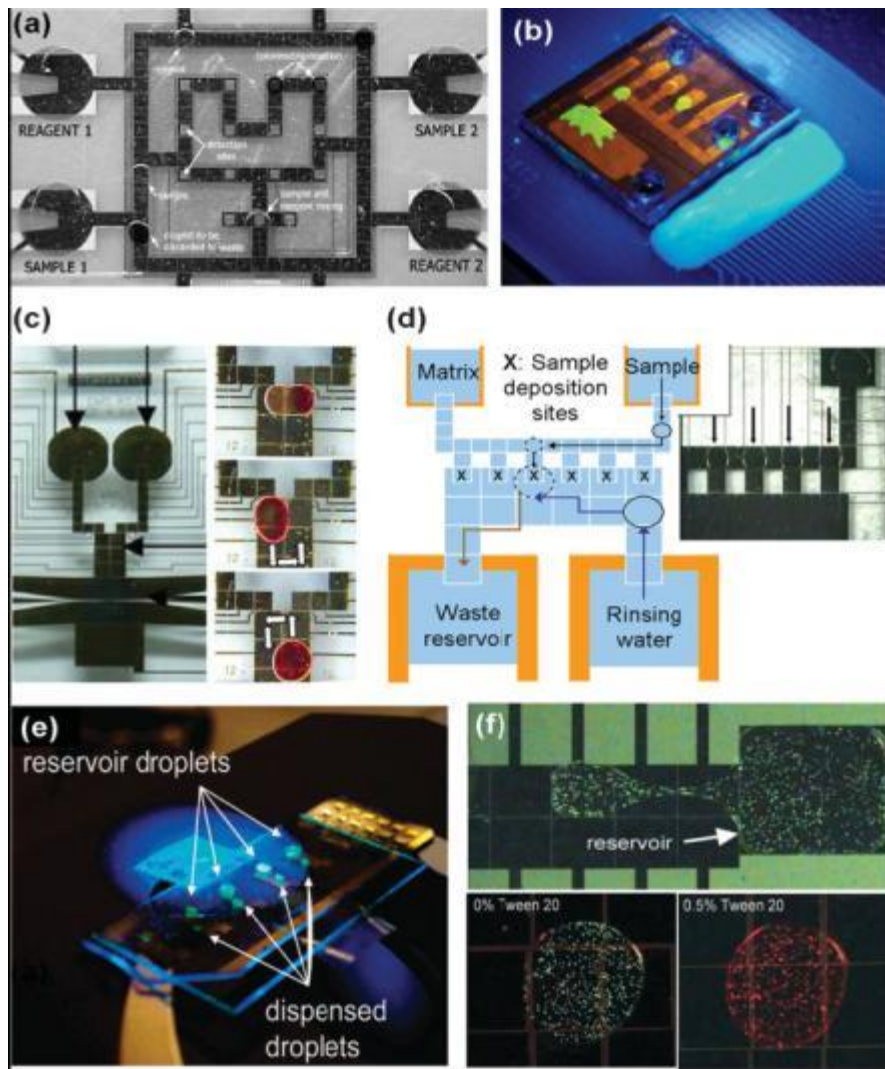
What can be done

- Dispense
- Transport
- Merge
- Mix
- Split

Digital Microfluidics (DMF)

- Electronic based
- Samples addressed individually
- Relatively generic platform

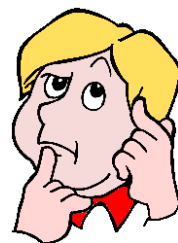
Applications of DMF



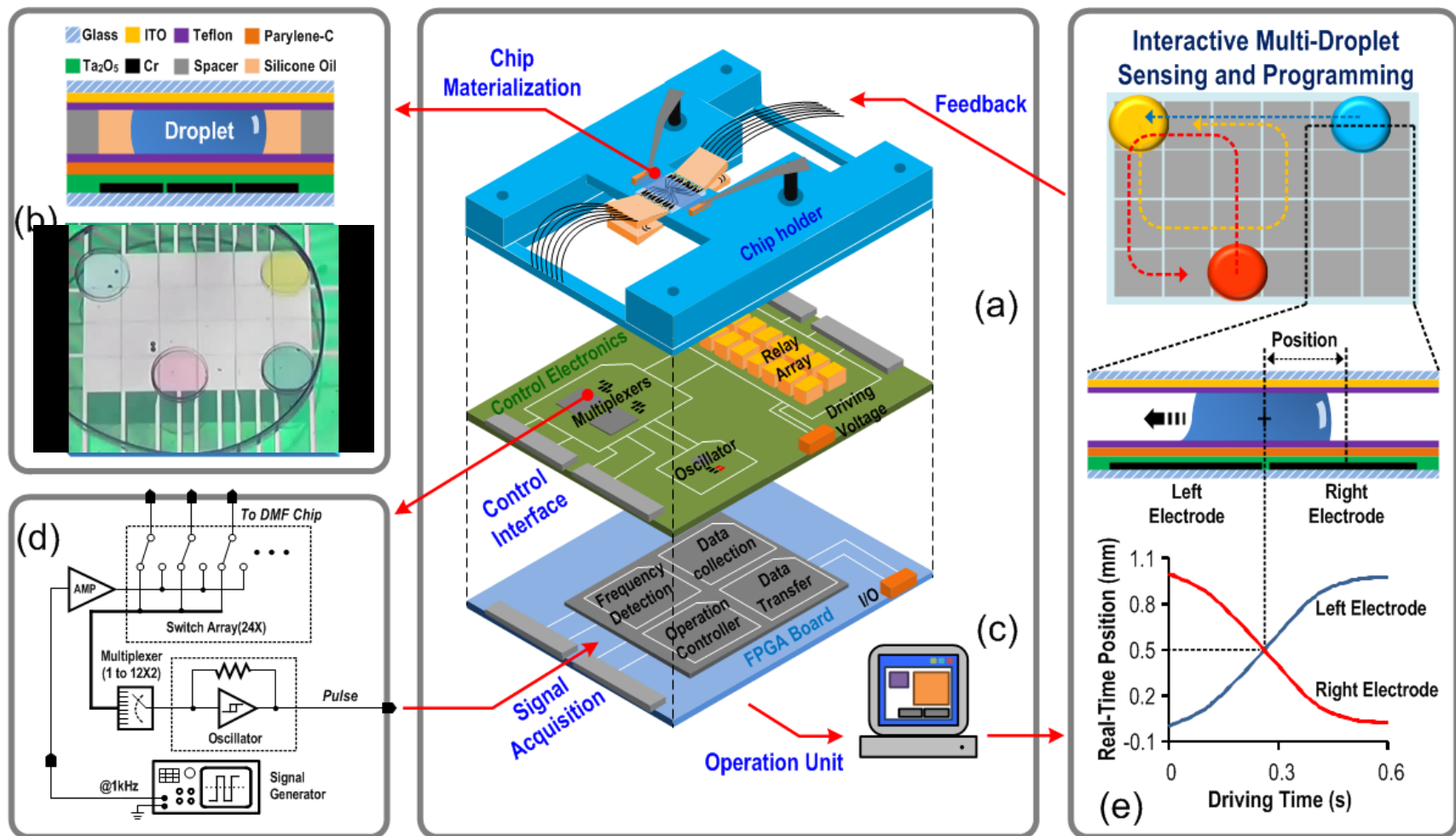
Applications

- DNA Extraction, Amplification
- Enzyme Assays
- Cell Assays
- Immunoassays
- Chemical synthesis
-

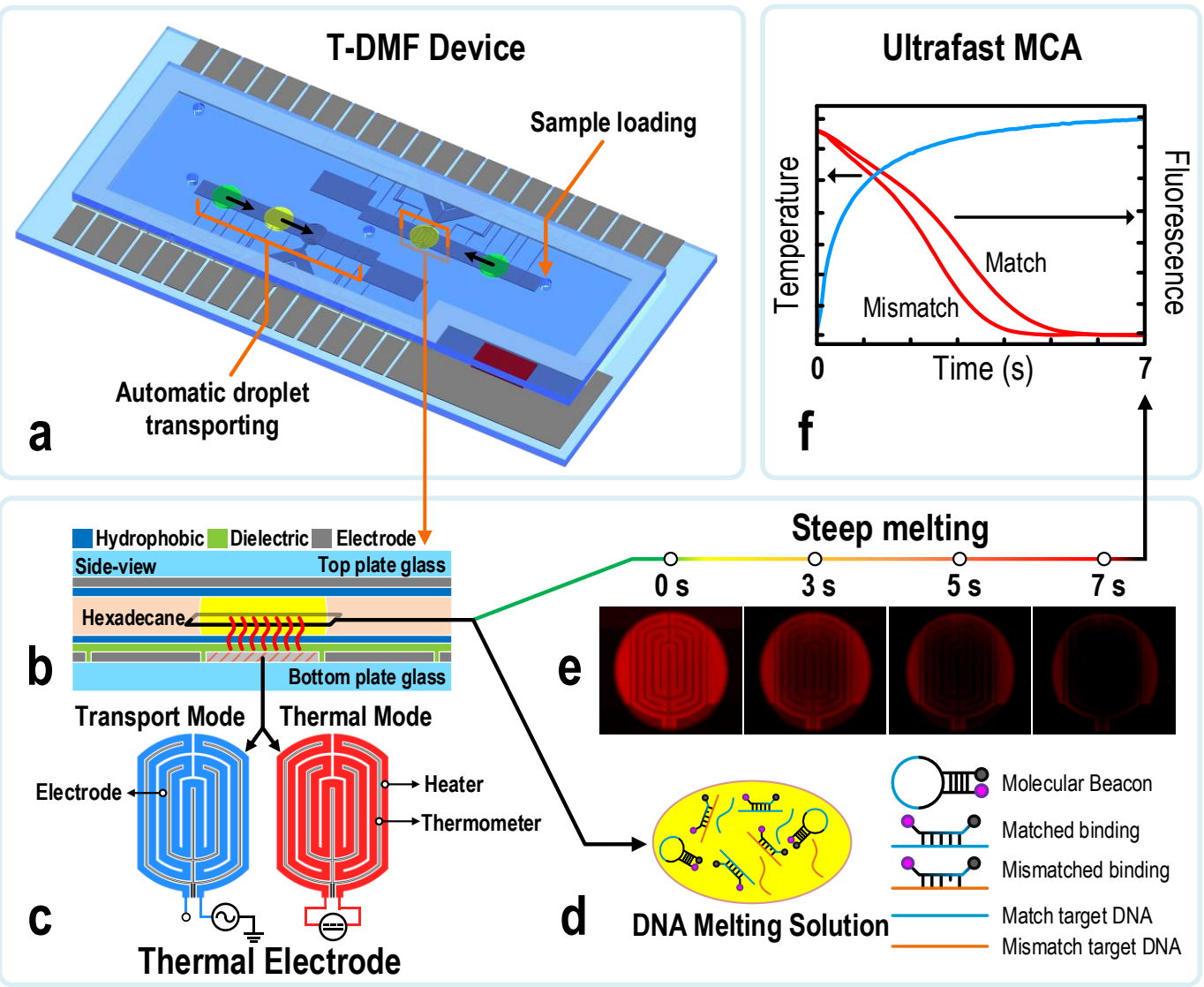
How can I have a real-time control?



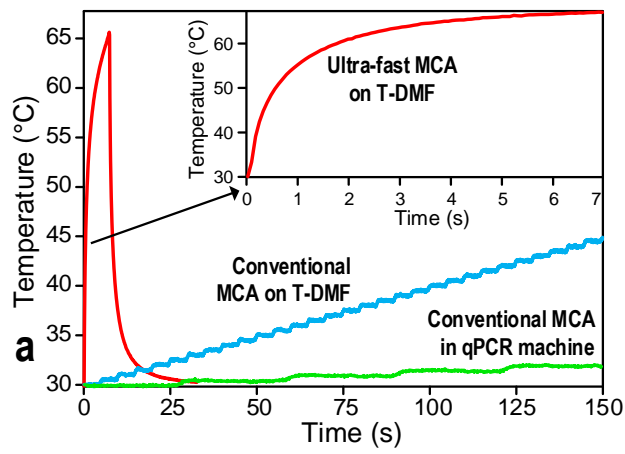
Real-time Feedback Control



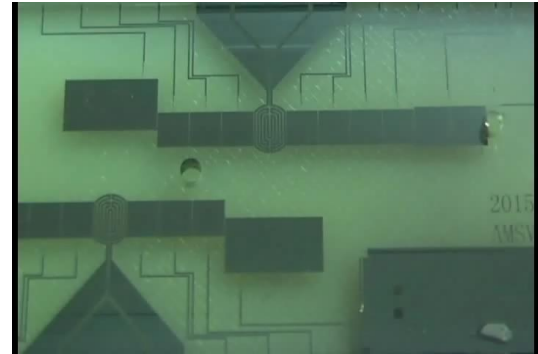
Ultrafast DNA Melting Curve Analysis



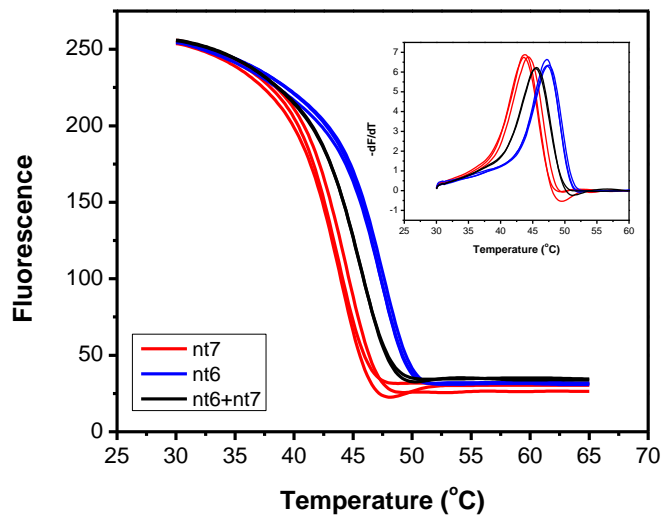
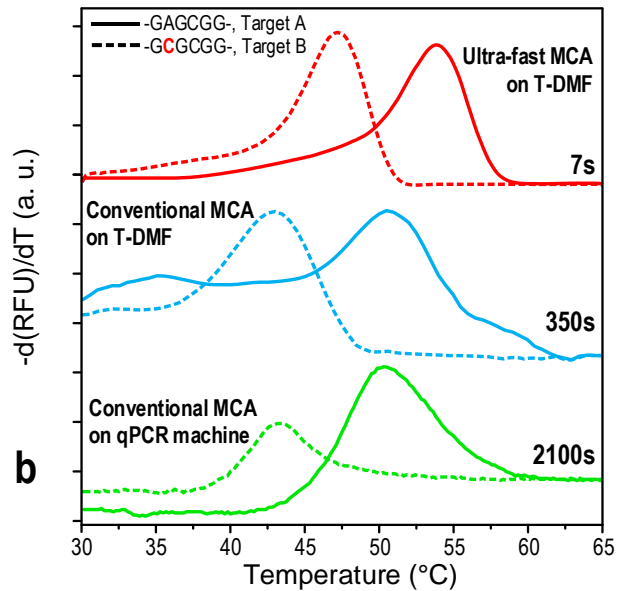
Ultrafast DNA Melting Curve Analysis



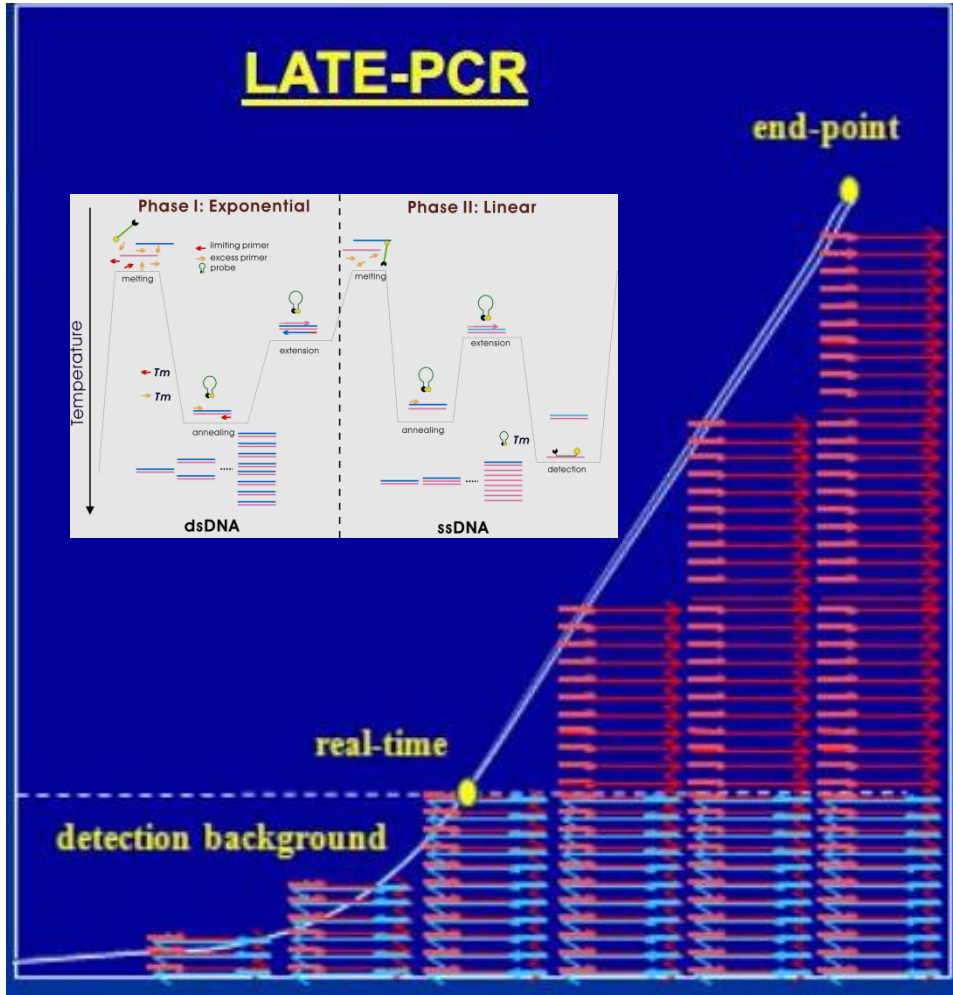
Sample Loading



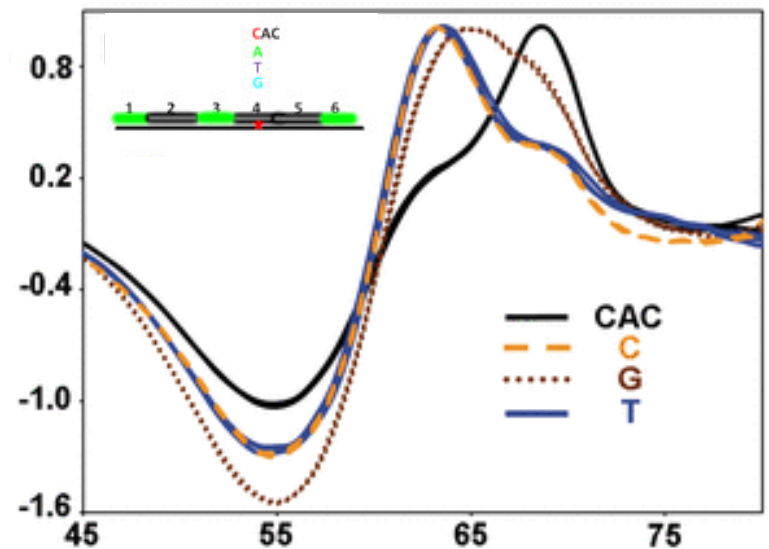
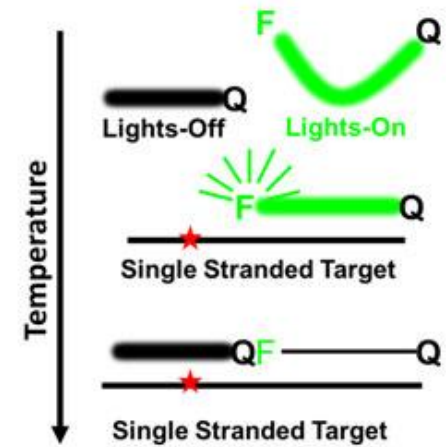
DNA Melting



Molecular Diagnostics



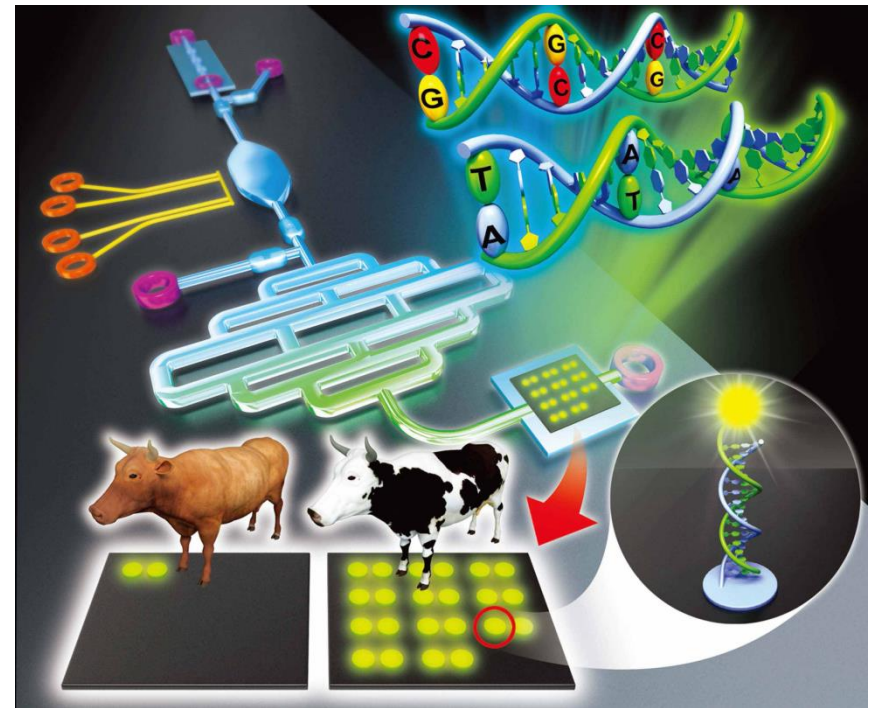
Lights-On/Lights-Off Probes



Our Target

Integrated Automated Point-of-Care Device

- **Fast Sample-in Results-out**
- **Portable**
- **Automated**
- **Inexpensive**
- **Accurate and Quantitative**
- **User-friendly**



Acknowledgement

Prof. Rui Martins

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Gao Jie

Chen Tianlan

Dong Cheng

Wan Liang

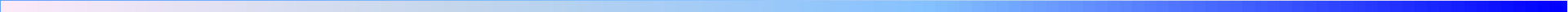
FDCT

AMSV

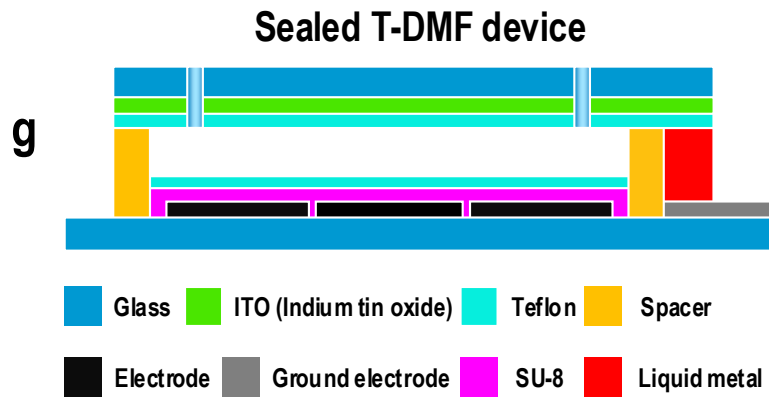
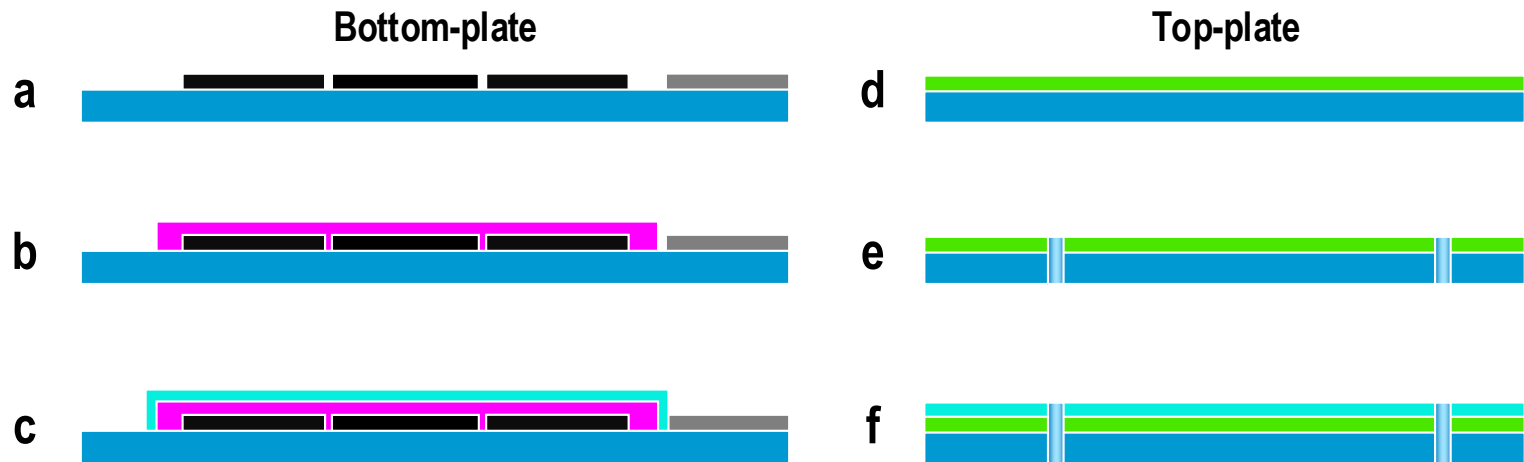
University of Macau



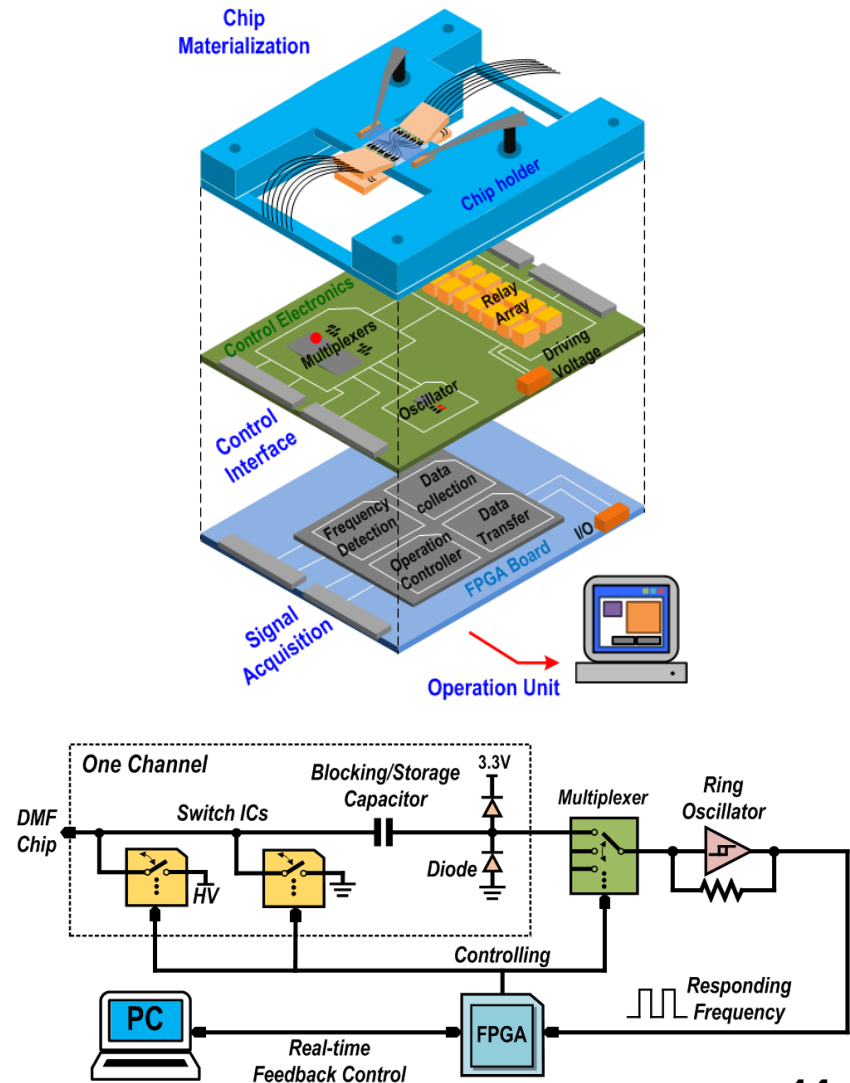
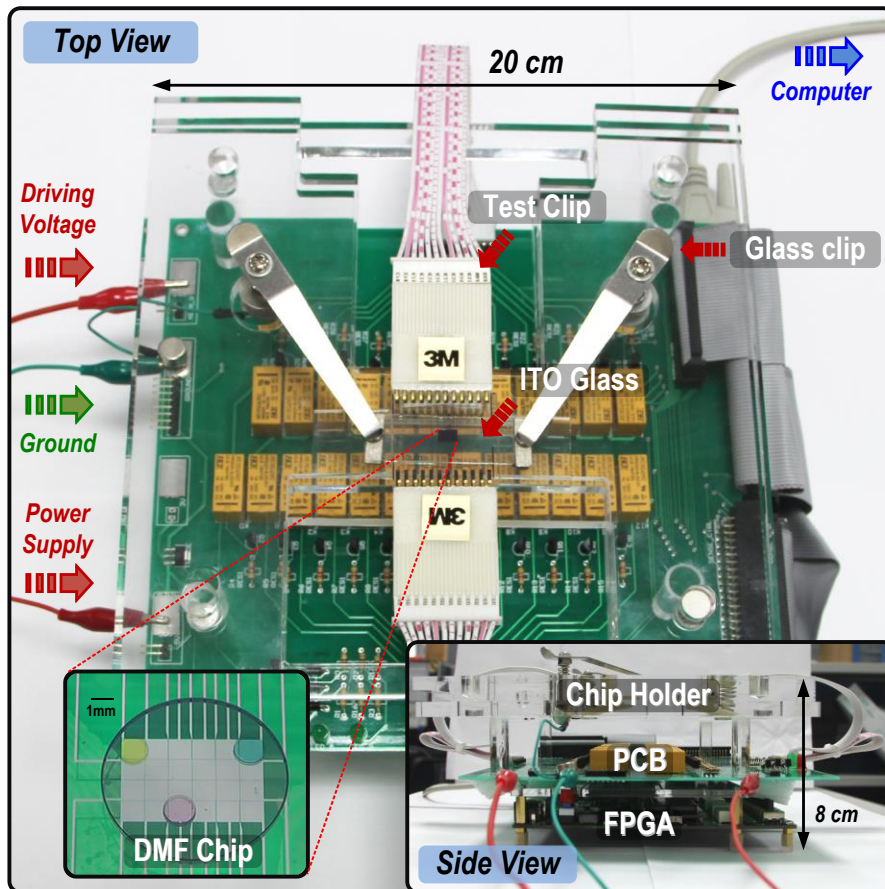
THANK YOU!



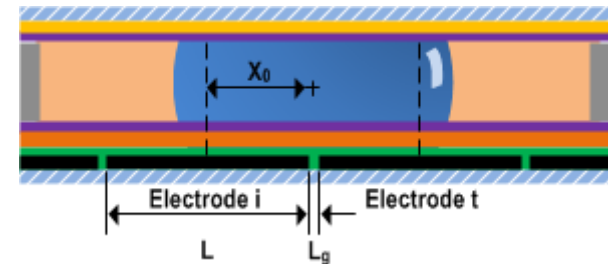
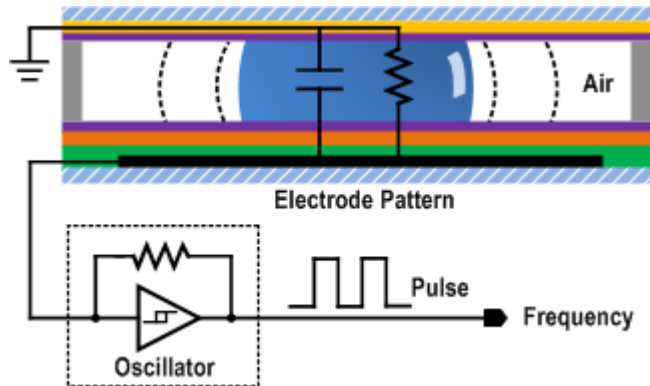
DMF Chip Fabrication



System setup



Real-time Feedback control



$$X_0 \cong \frac{C_t}{(C_i + C_t)} (L + L_g)$$

