

A Multimode Hybrid Memristor-CMOS Prototyping Platform Supporting Digital and Analog Projects

Presenter: Kamel-Eddine HARABI ¹

K.-E. HARABI ¹, C. Turck ¹, M. Drouhin ¹, A. Renaudineau ¹, T. Bersani-Veroni ¹, T. Hirtzlin ², E. Vianello ², M Bocquet ³, J.-M. Portal ³, D. Querlioz ¹

¹ Univ. Paris-Saclay, CNRS, C2N, Palaiseau, France

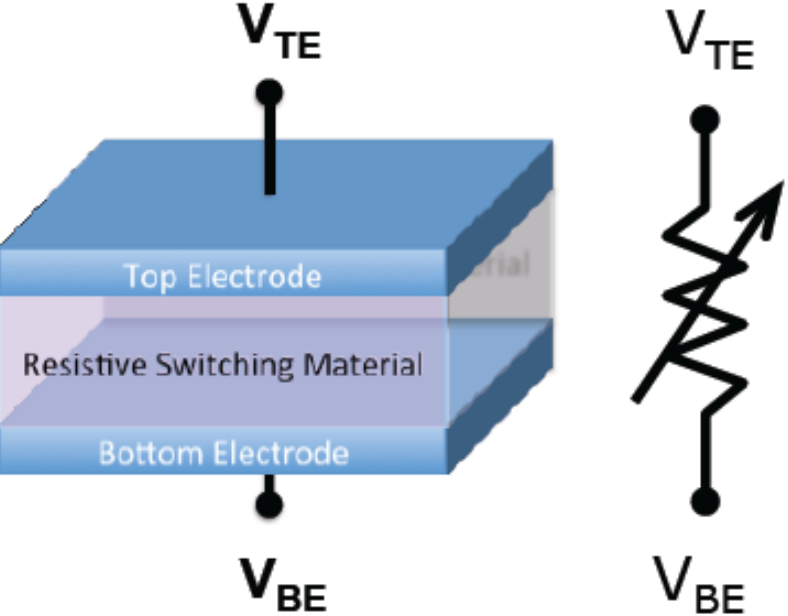
² Univ. Grenoble-Alpes, CEA-LETI, Grenoble, France

³ Univ. Aix-Marseille, Marseille, France

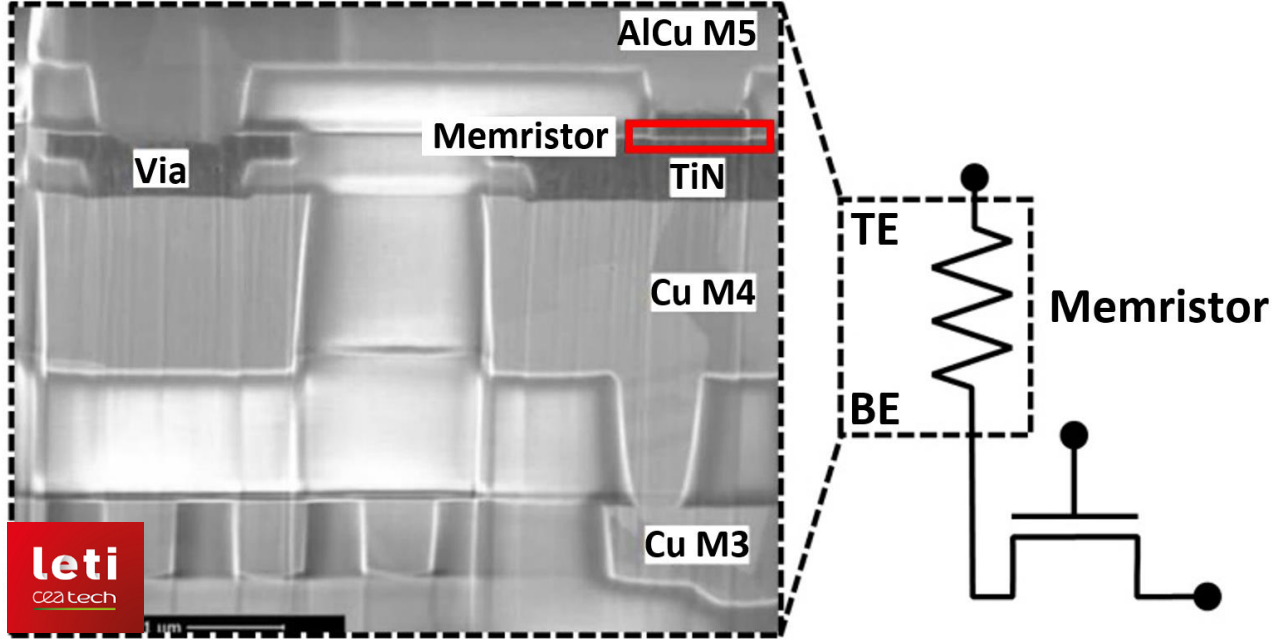
Energy Efficient Hybrid Memristor-CMOS ICs

What's a Memristor?

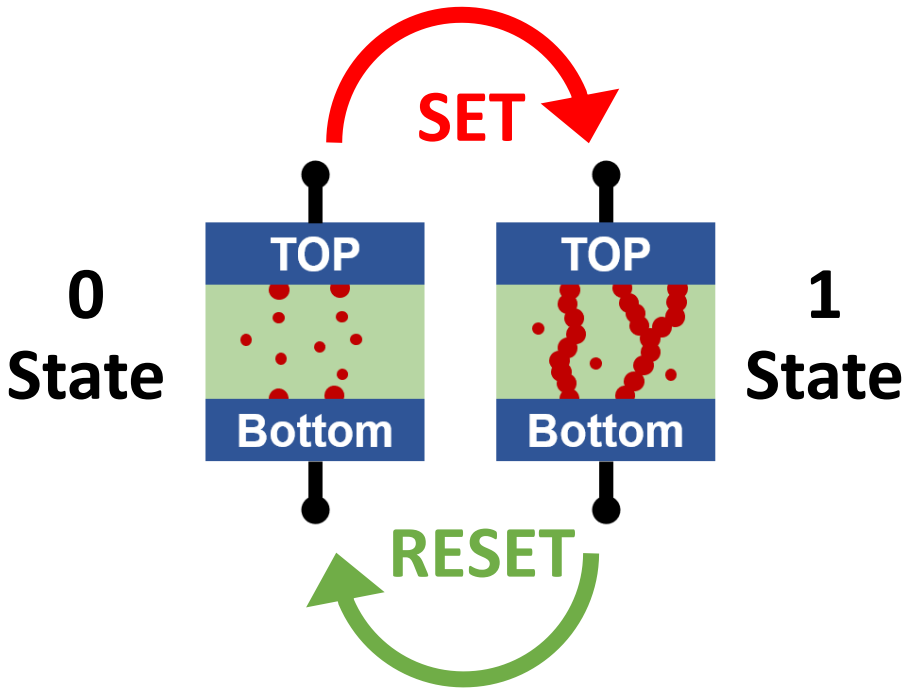
- Non-Volatile Memory
- Programmable Conductance
- CMOS-compatible Nano-device
- Compact, Fast, Cheap



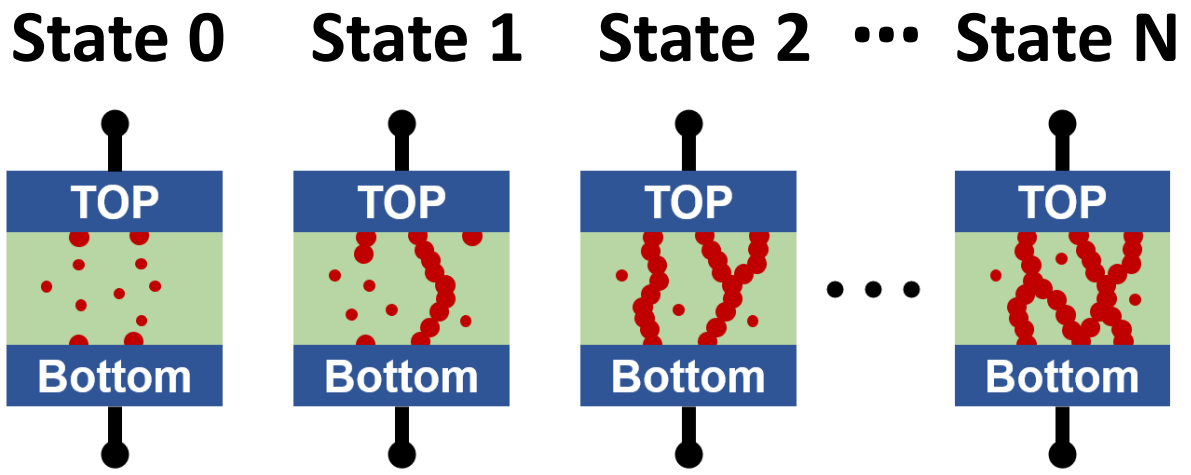
CMOS Back-End-Of-Line Memristor on top of a transistor



Digital Memory



Analog Memory



Memristors are ideal for In/Near Memory Computing!



Memristor Imperfection and Modeling Challenges

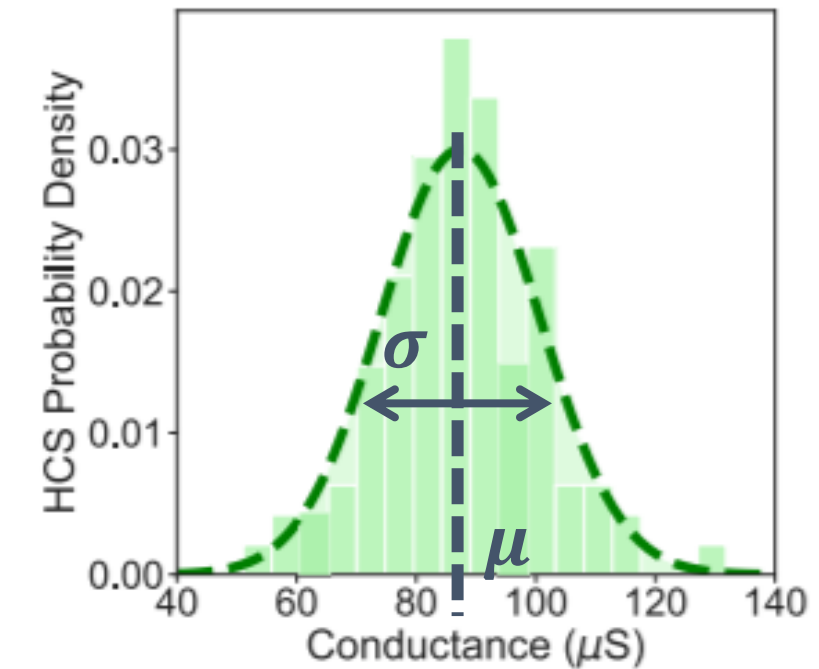
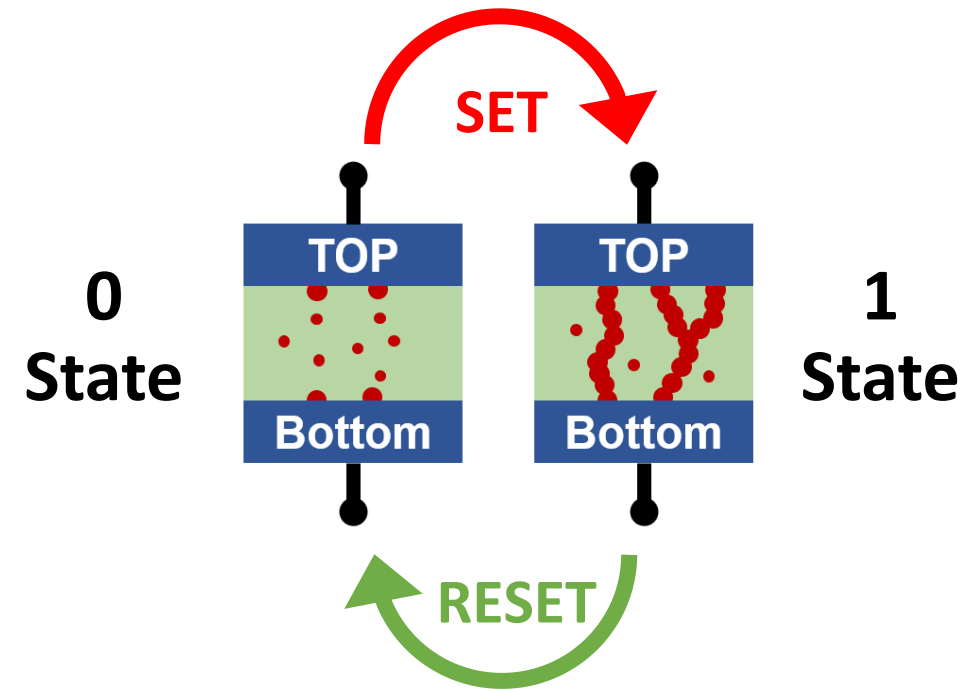
Memristor Modelling Challenges

- Device-to-Device Variability
- Cycle-to-Cycle Variability
- State-dependent distribution

The need for an Experimental Prototyping Platform

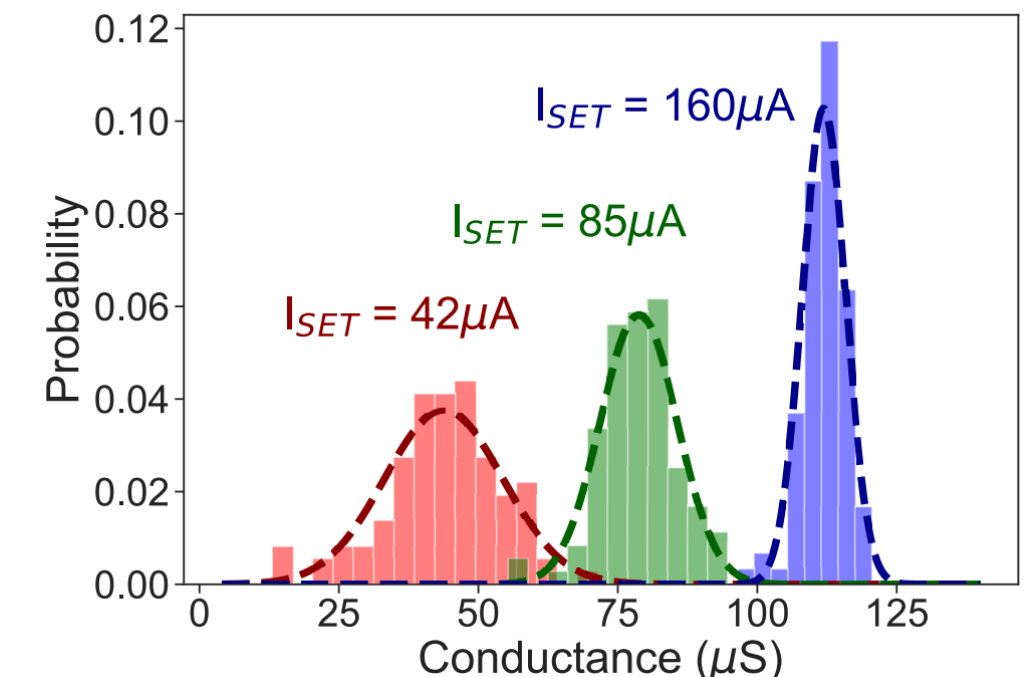
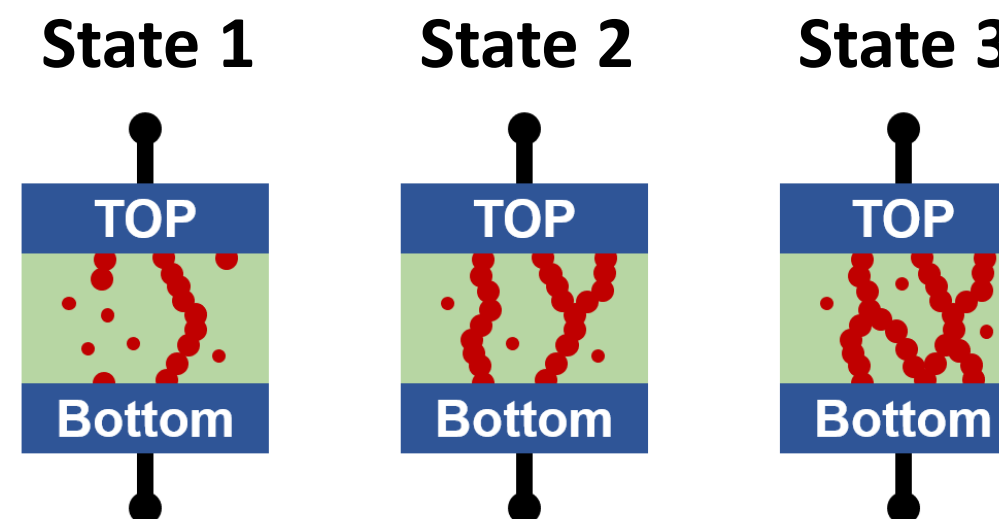
- Explore program conditions space
- Real implementation of concepts
- Exploit or Tolerate Imperfections?

Programming Imperfections



Dalgaty et al, Nature Electronics 4, p. 151, 2021

Regional distributions



Dalgaty et al, Nature Electronics 4, p. 151, 2021

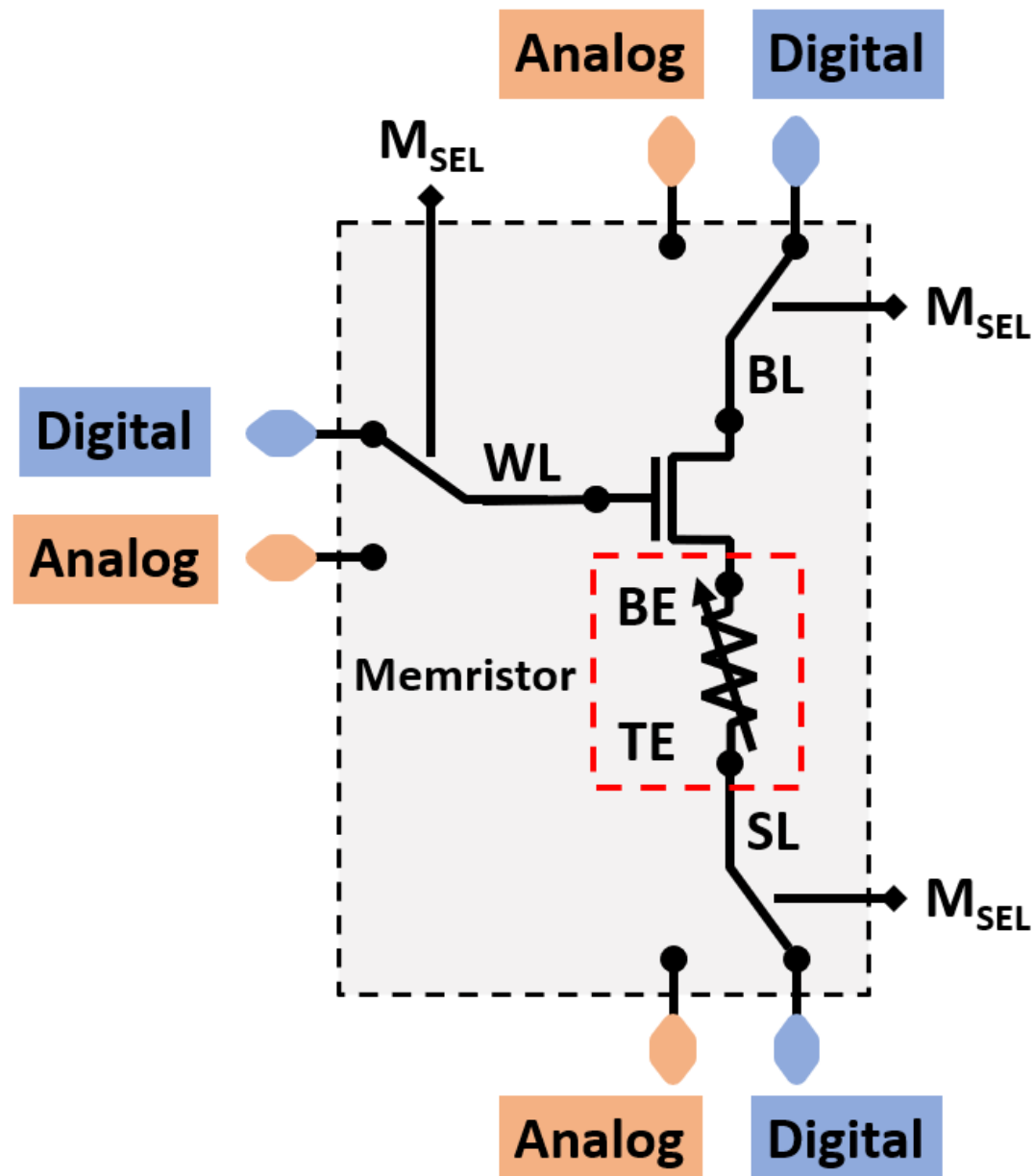
Design of Memristor Array with Multi-Mode Access

Analog Mode

- ✓ Analog 8k devices
- ✓ Read devices' conductance

Digital Mode

- ✓ Digital 4kbits memory
- ✓ Read digital words



Schematics of the prototyping design

