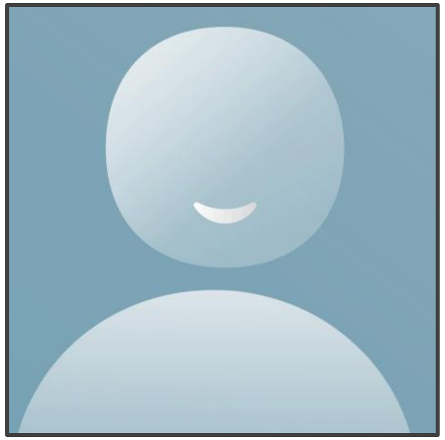
Event-Driven Based CMOS Interface for Magnetic Sensing



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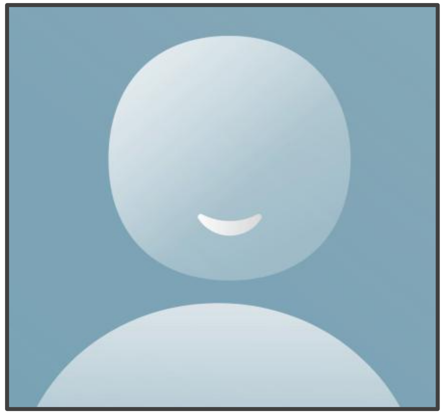
Arman Shahryari



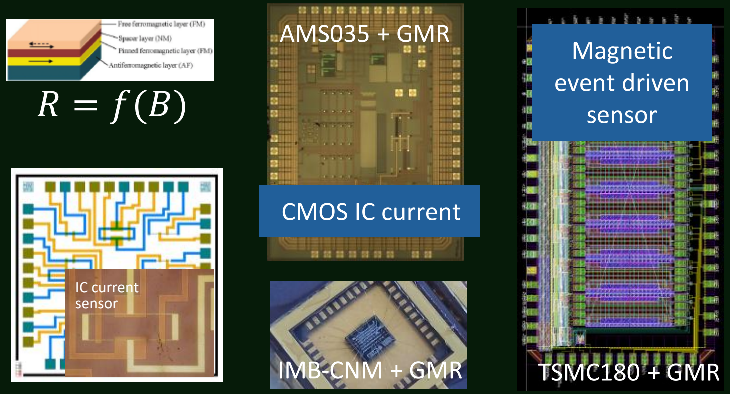
Arman Shahryari received the master’s degree in Electronic Engineering in the University of Valencia, Spain in 2024. He is currently a doctoral student majoring in Microelectronics Engineering at the University of Valencia, ETSE-UV.

His current research interests include magnetic sensing systems based on resistive technologies, event-driven and neuromorphic sensor architectures and analog and mixed-signal integrated circuit design.

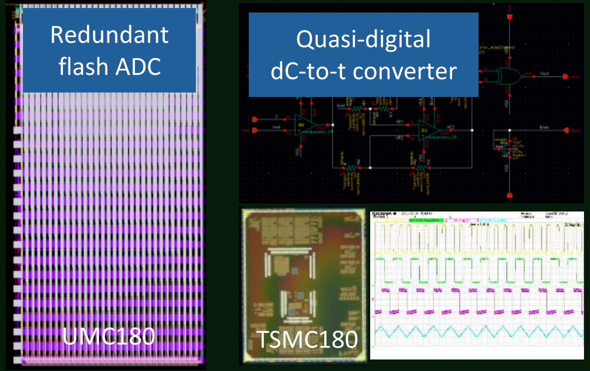
Research Group

GMR Sensors + CMOS integration

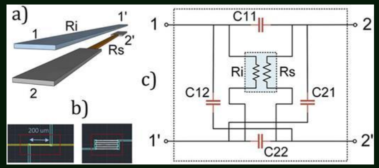
INESC MN
Microsistemas e Nanotecnologias

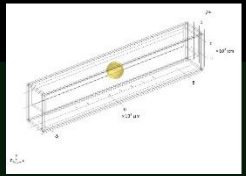


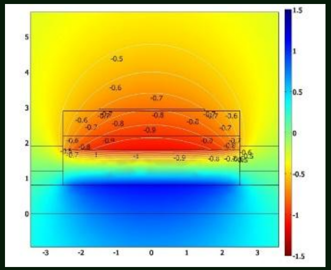
Mixed signal CMOS design



Device modeling







- **Compact Electrical**
- **FEM (multiphysics)**
- Thermal
- Magnetic
- Microfluidics

Test + characterization

- I/V, f (also RF)
- Noise
- Thermal
- Magnetic
- Microfluidics

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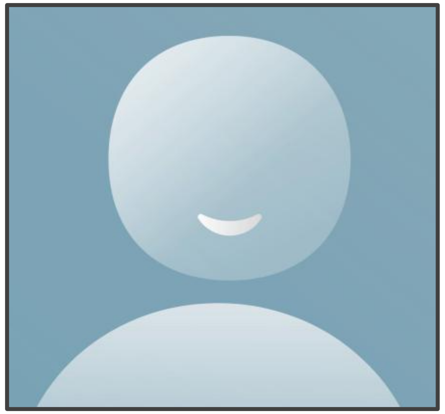
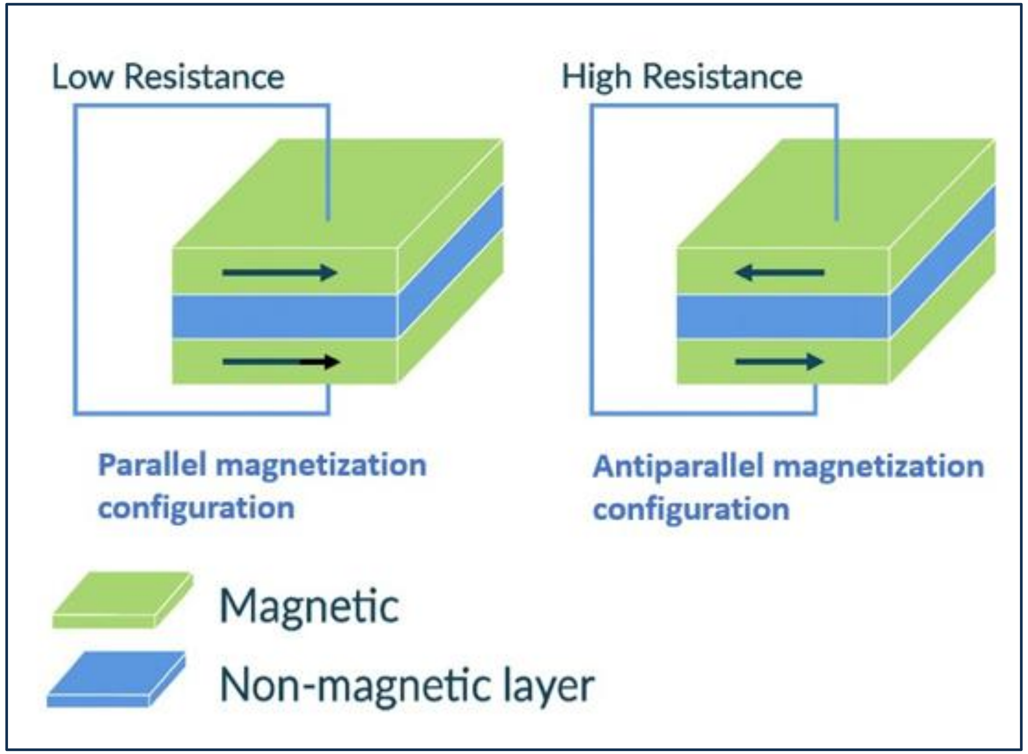
Giant Magnetorresistive Sensors



Multilayered materials, alternating thin films of ferromagnetic and non-magnetic metals
Resistance value is **inversely** proportional to magnetic field



Advantages

- Compatible with CMOS process
- Precisely designable resistive sensors

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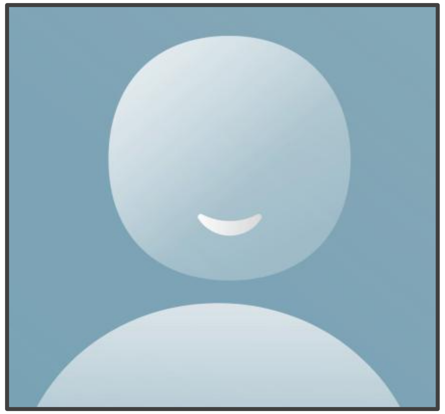
Aims and Contributions of our Paper



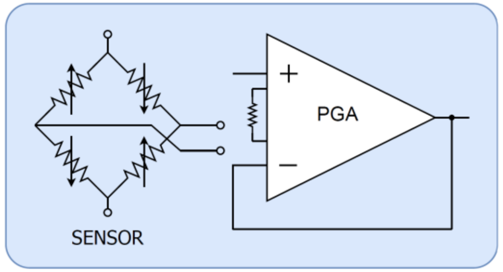
In our paper we aimed at:

1. developing a Selective Change-Driven interface for magnetic sensing and,
2. evaluating its capability for efficient detection and tracking magnetic particles.

Contributions:

1. we designed and implemented a 1x8 GMR-based interface in CMOS technology,
2. validated the system through Cadence Virtuoso simulations using both electrical stimuli and synthetic magnetic signals generated via particle modeling,
3. we demonstrated the utility of event-driven magnetic sensing for reducing data redundancy and enabled efficient particle tracking applications.

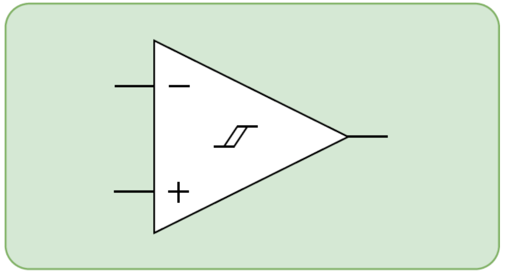
Analog Building Blocks



Sensing and Conditioning

Adjustable transconductance

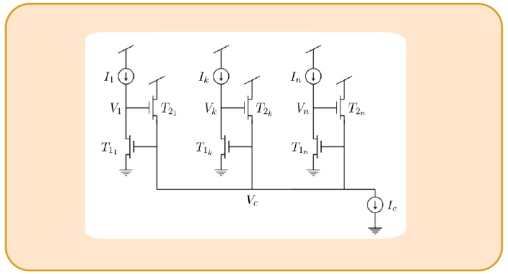
Dynamic baseline



Capacitive Comparator

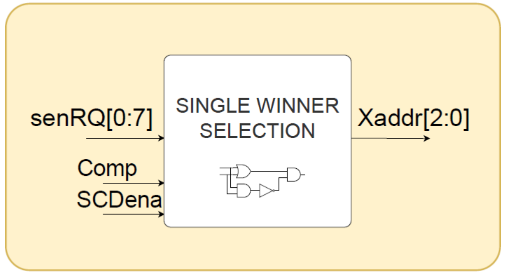
DC Isolation

Dynamic Sensitivity



WTA ON / OFF

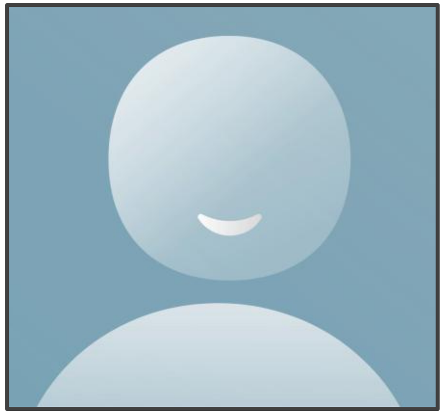
Detects strongest positive or negative variation



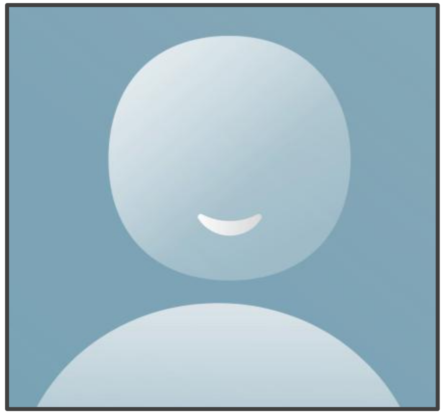
Logic & Addressing

Single Winner selection

Asynchronous event handling



Validation I - Pulse excitation



Objective

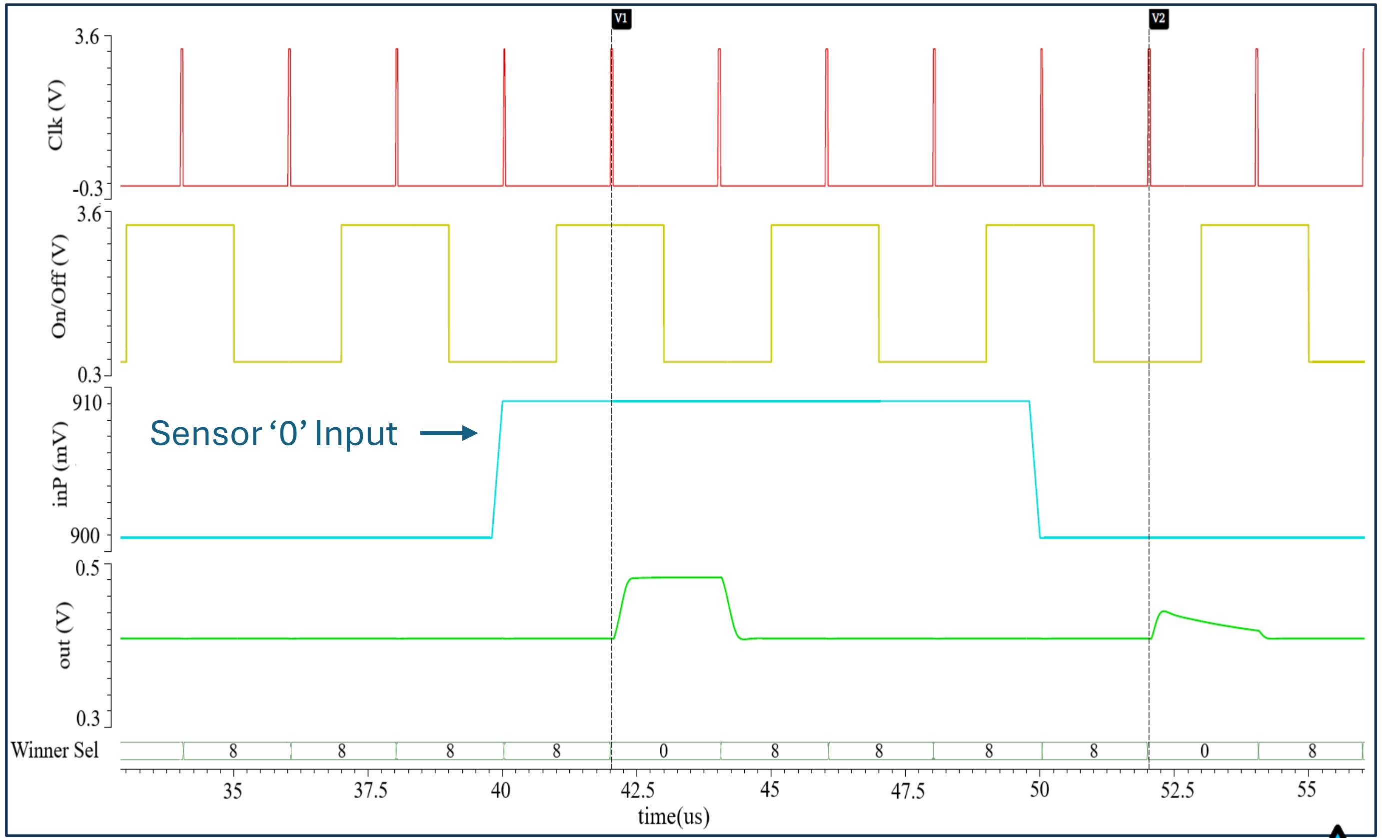
Validate the winner-selection logic and
timing behavior of the SCD architecture.

Method

Cadence Virtuoso Spectre simulation
Sequential square pulses applied to each node

Verification

Correct WTAON / WTAOFF operation
Sequential winner identification



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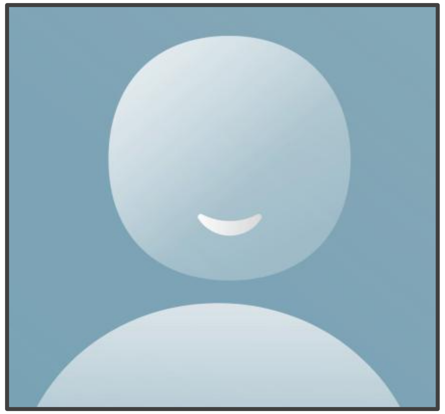
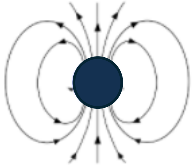
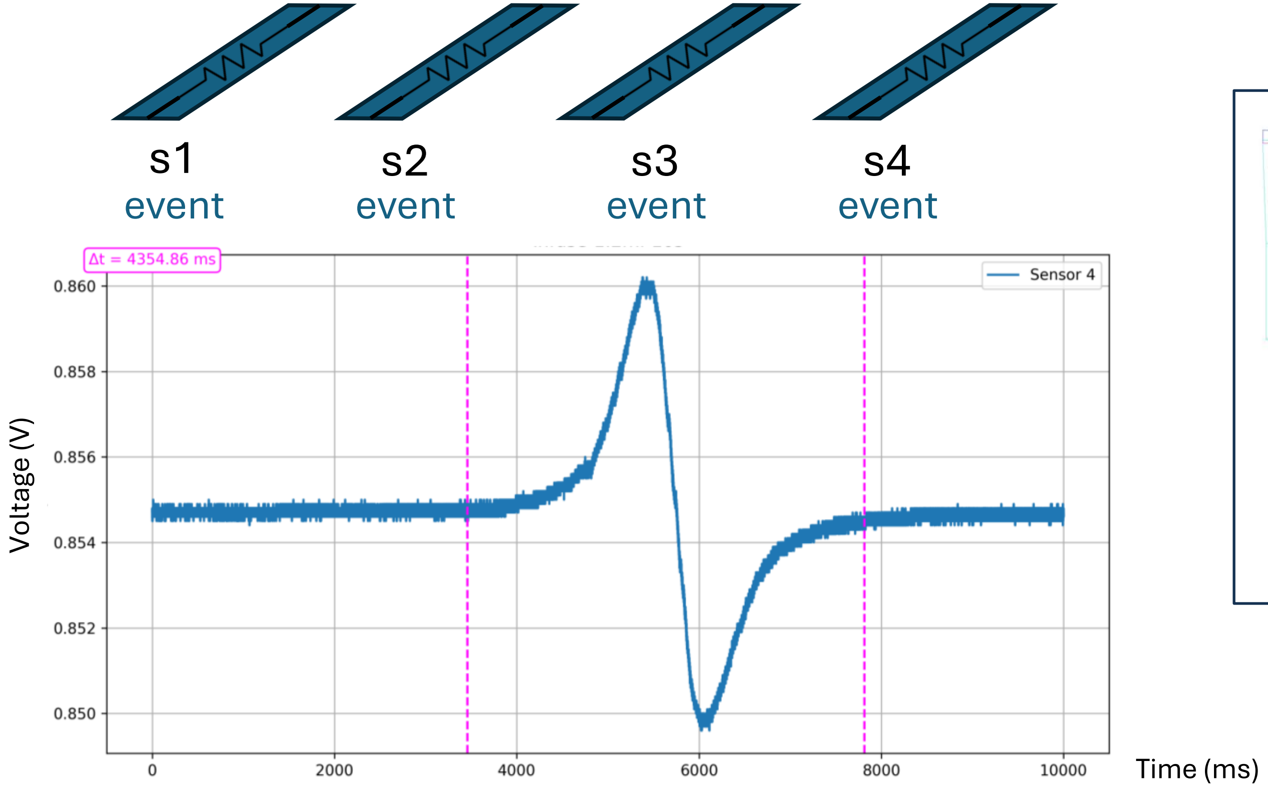
Possible Applications



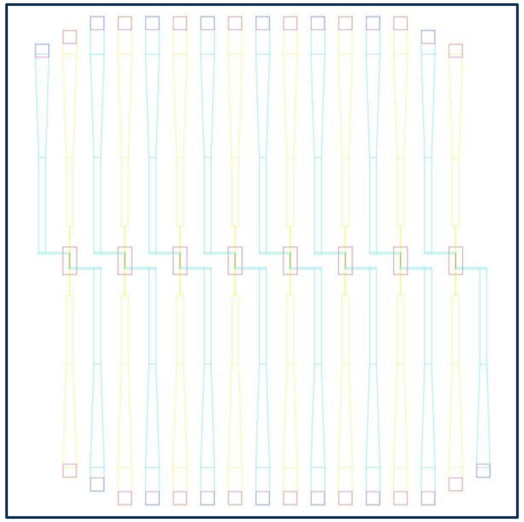
Magnetic particle tracking & Modeling

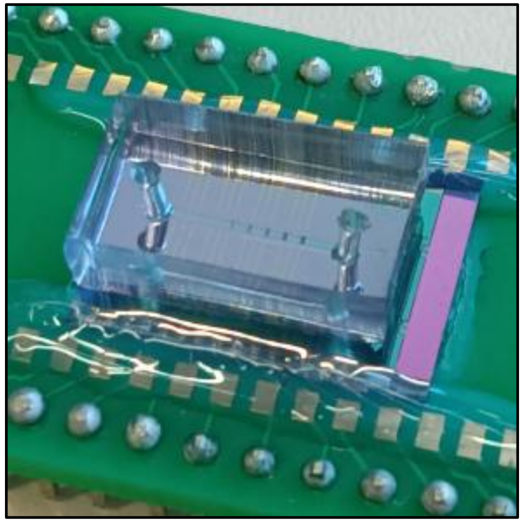




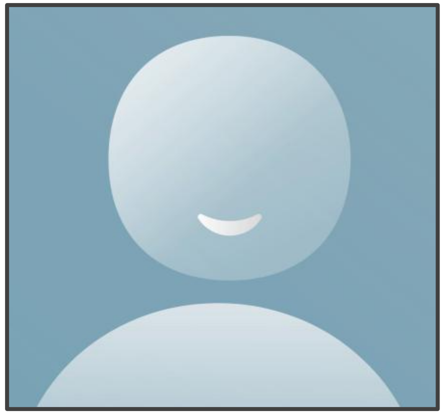
GMR Sensor response to flowing magnetic particle. Electrical signal

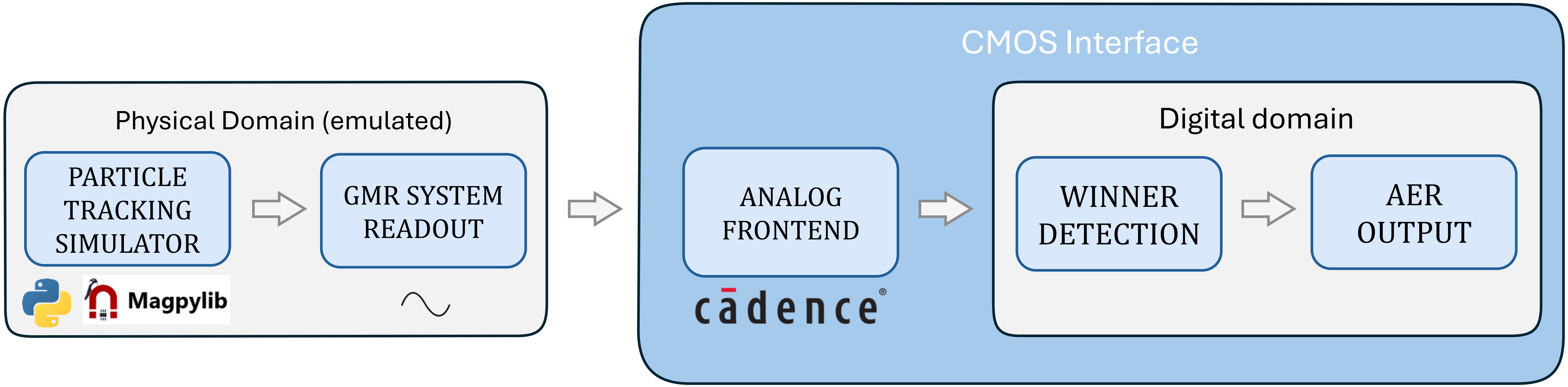
Microfluidics





Emulated Particle Tracking Pipeline





Validated outputs

- Particle localization
- Sequential event generation
- Real-time particle tracking

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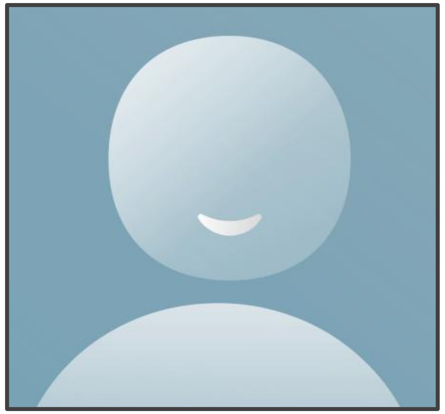
Conclusions and Future Work



Conclusions

We developed and validated a neuromorphic interface for resistive sensors

We demonstrated the proper function of the system and its capabilities by use of Cadence/Virtuoso

We tracked and identified magnetic particles

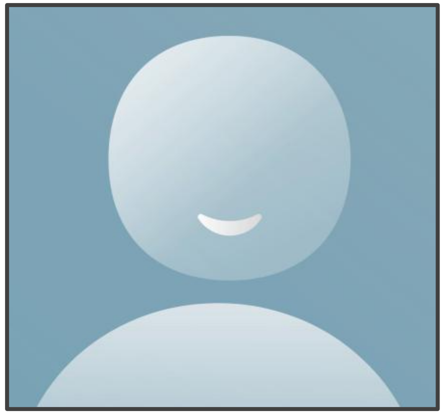
Future work

Transition from simulation to physical prototyping.

Tape-out in 180 nm CMOS chip to characterize the impact of thermal noise and substrate coupling.

The integrated system will be validated within a microfluidic setup.

References



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