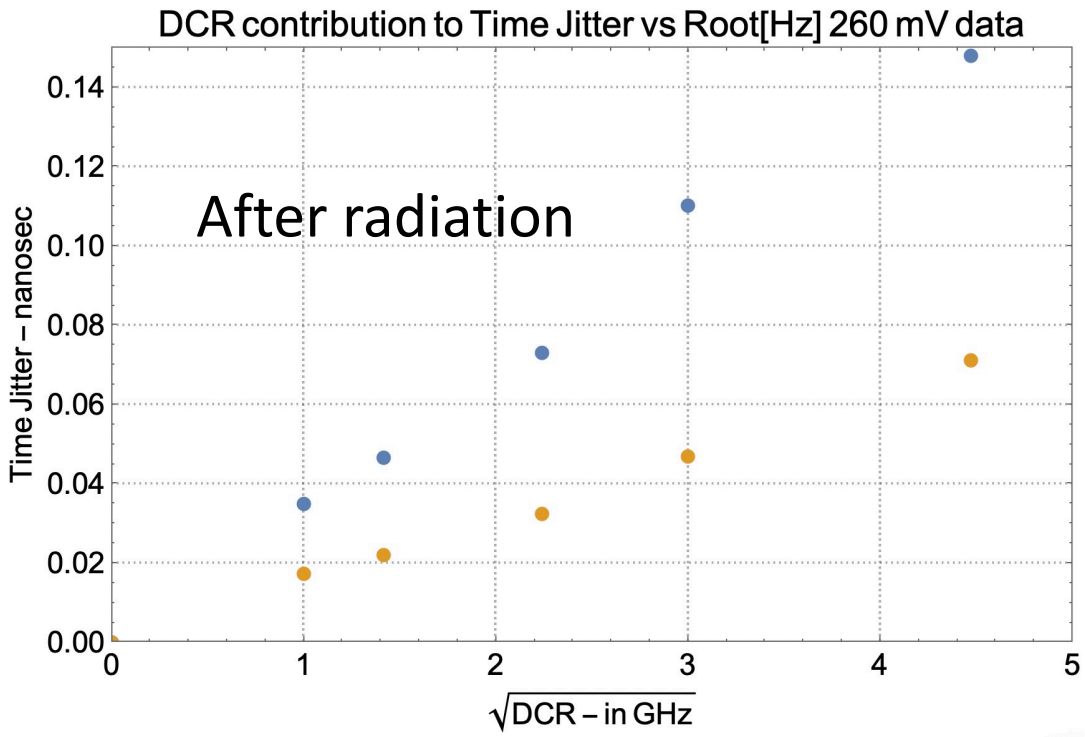
CPAD2022 WG1 Summary

Ulrich Heintz, Brown University
Gabriella Carini, Brookhaven National Laboratory
Xuan Li, Los Alamos National Laboratory

Noise suppression and debugging

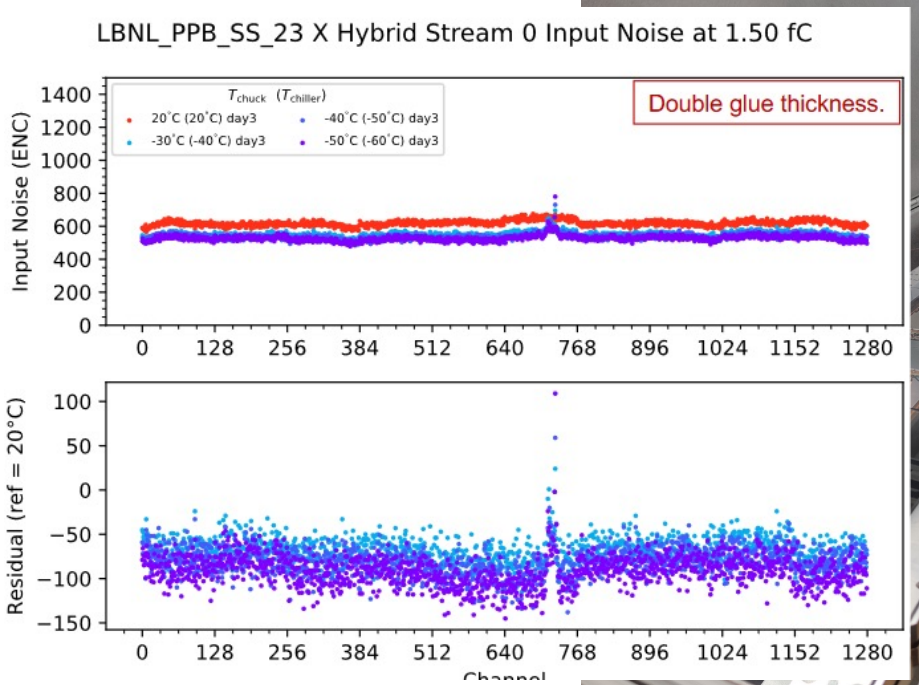
- Signal Processing for SiPM timing applications in the presence of High Dark Count Rate.

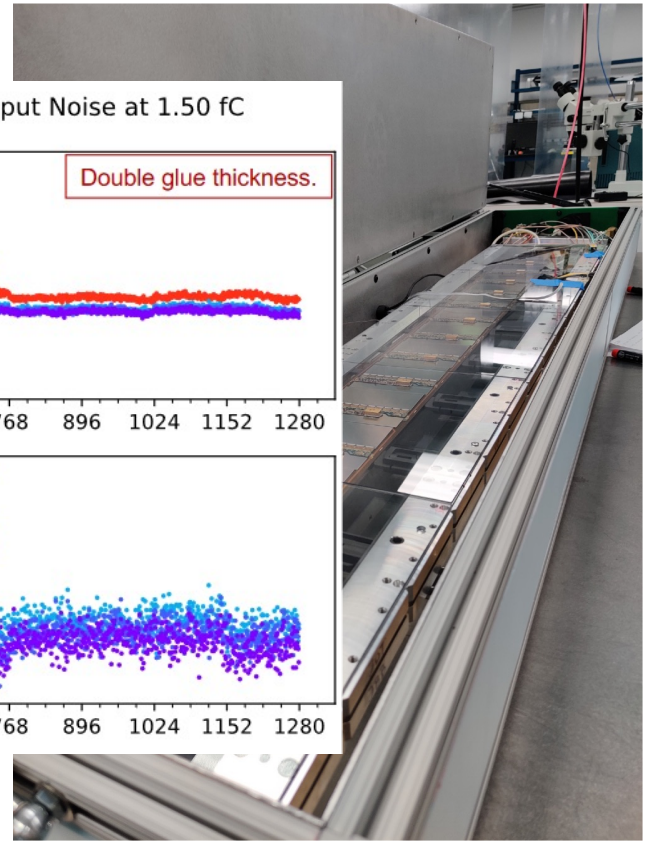
Sebastian While



- ATLAS ITK upgrade for HL-LHC debugged and fixed the cold noise issue.

Francesca Capocasa



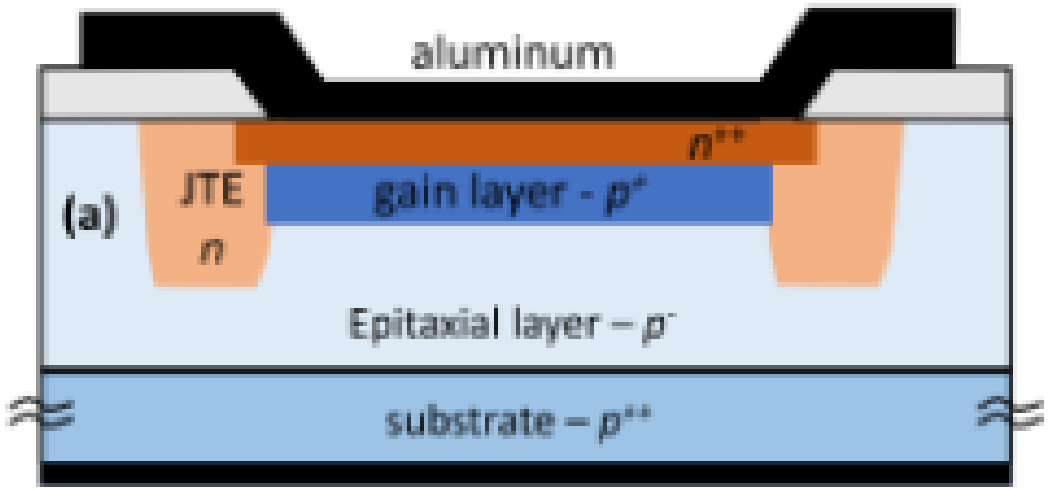


New materials can provide solutions for faster detector

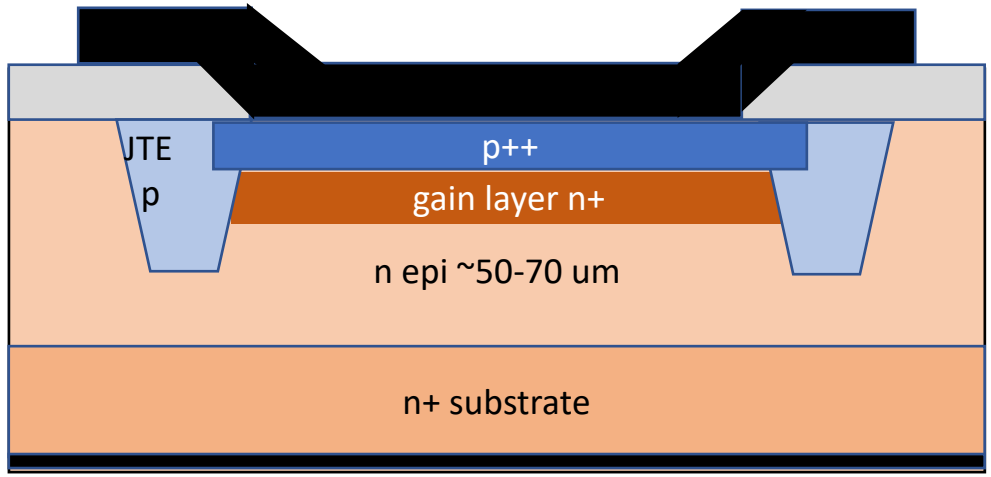
- Fast timing with Silicon Carbide Low Gain Avalanche Detectors

Carl Haber

Silicon LGADs



In SiC/GaN the situation is reversed



Idealized WBG-LGAD structure

α is the ionization coefficient, $N_g = N_p e^{\alpha x}$

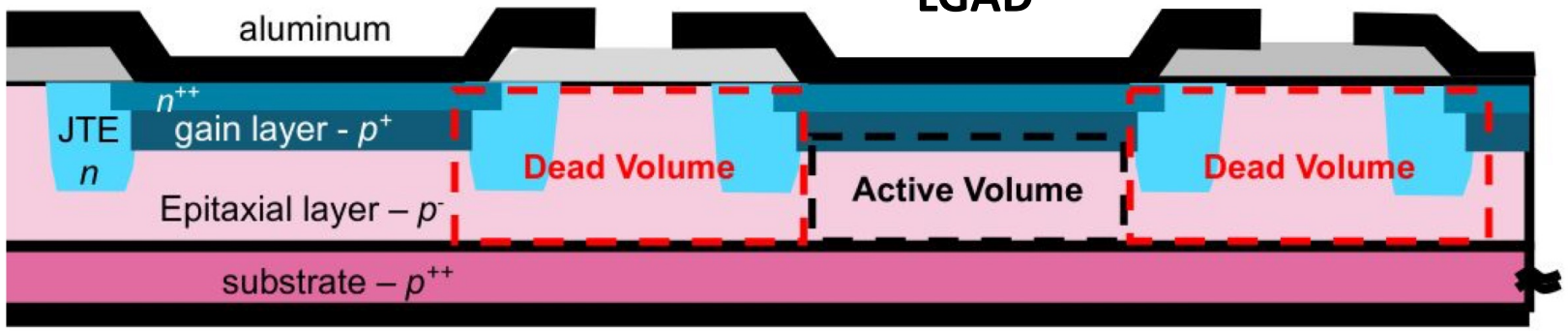
<u>SiC/GaN are faster than Si!</u>

LGAD developments

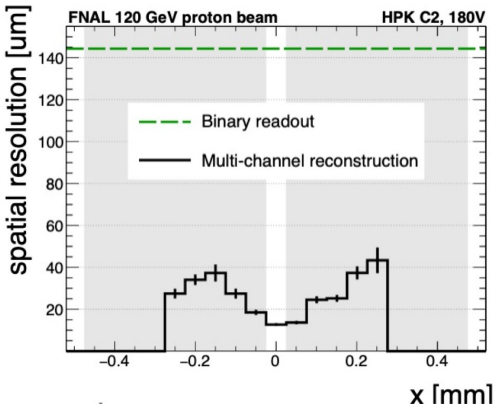
- ATLAS and CMS is building the 4D-tracker based on the LGAD technology.
- AC-LGAD will be applied for the new collider: EIC.

Yuzhan Zhao
Oskar Hartbrich
Artur Apresyan
Ted Liu

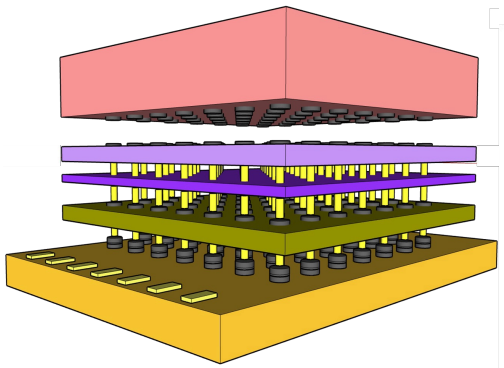
LGAD



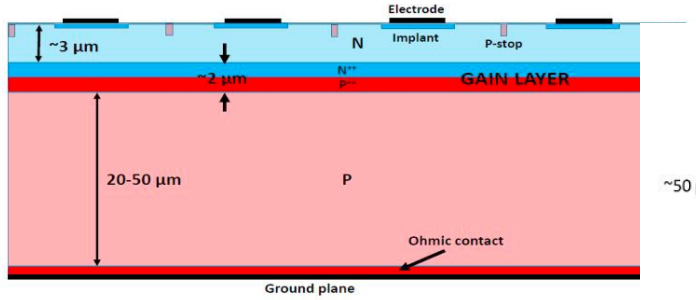
LGAD

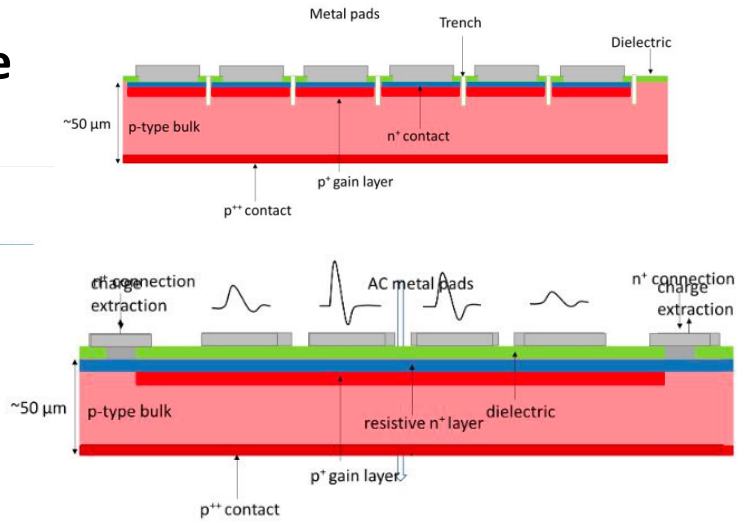


3D readout

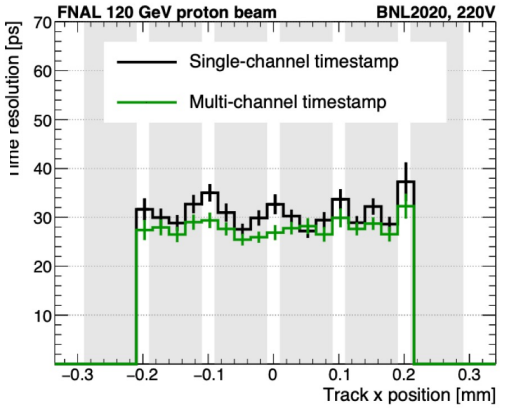


Different solutions to reduce the dead areas:





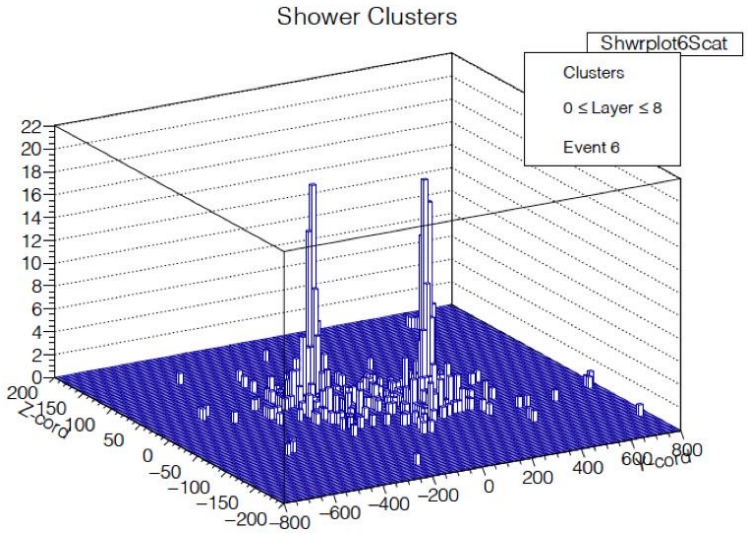
AC-LGAD

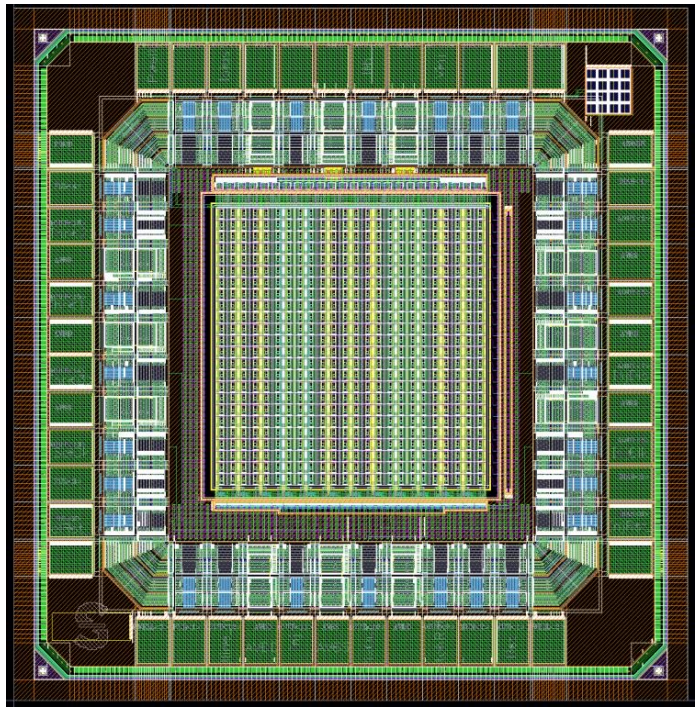


Fast MAPS and readout

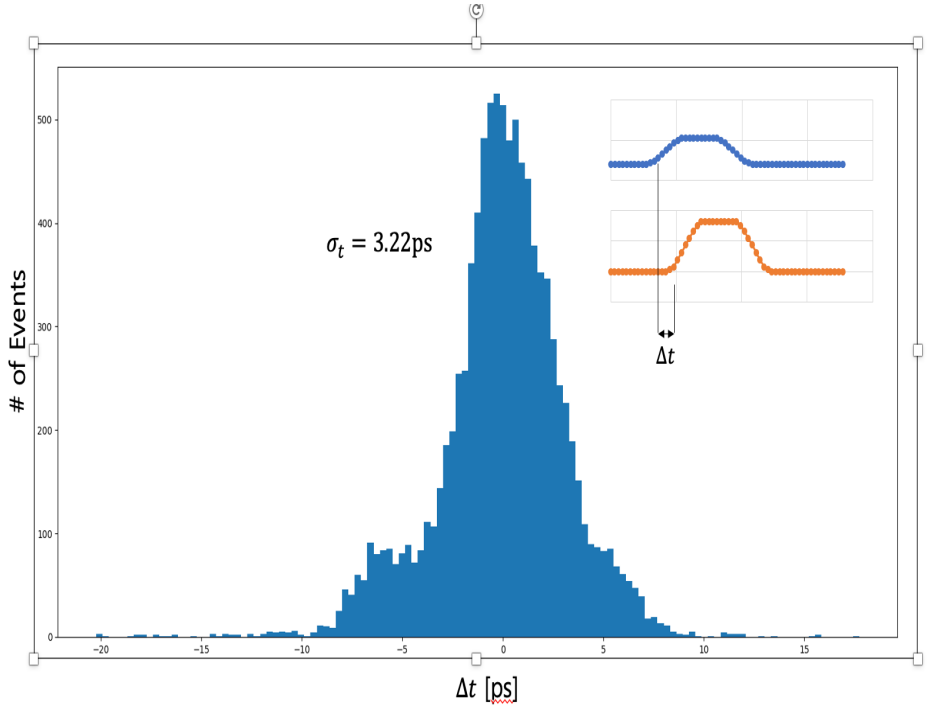
- Fast MAPS: new design has been submitted to use 65 nm CMOS for new MAPS production to achieve ~ns timing resolution and fine spatial separation.
- Fast readout

Alexandre Habib



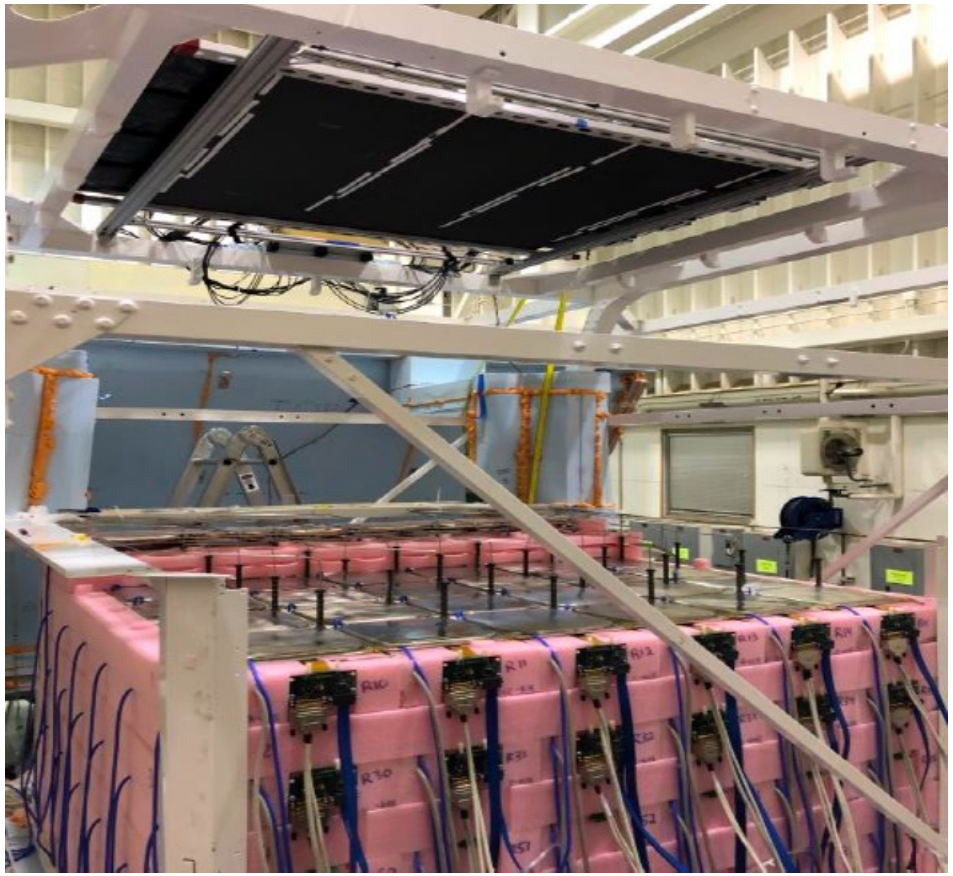


Jinseo Park

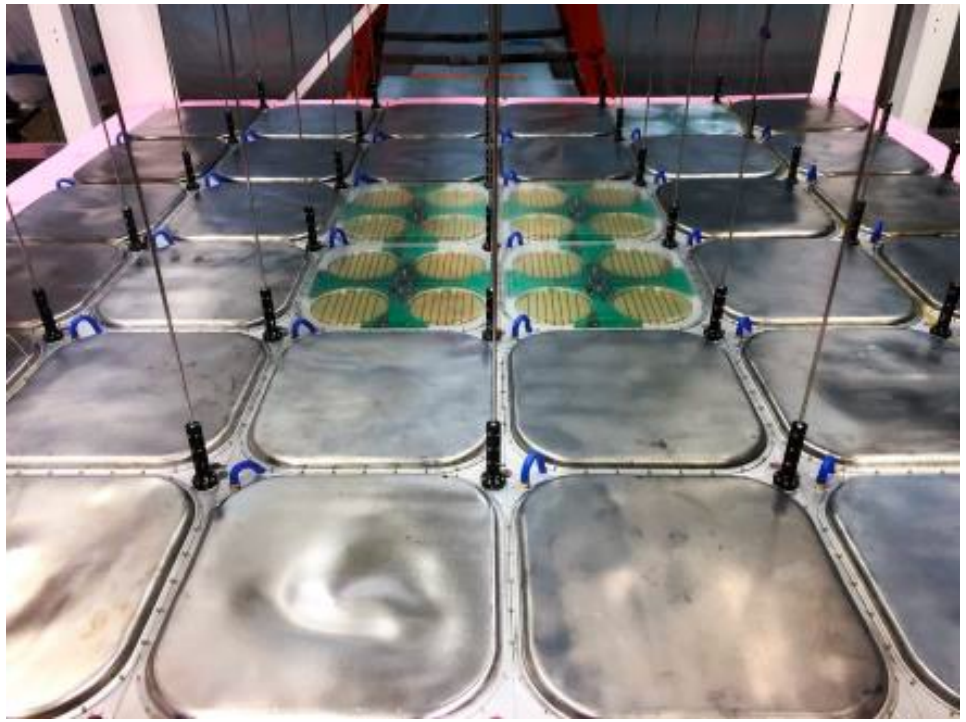


Silicon tracker for the GAPS Instrument

- Lithium-drifted silicon (Si(Li)) detector of the GAPS experiment.

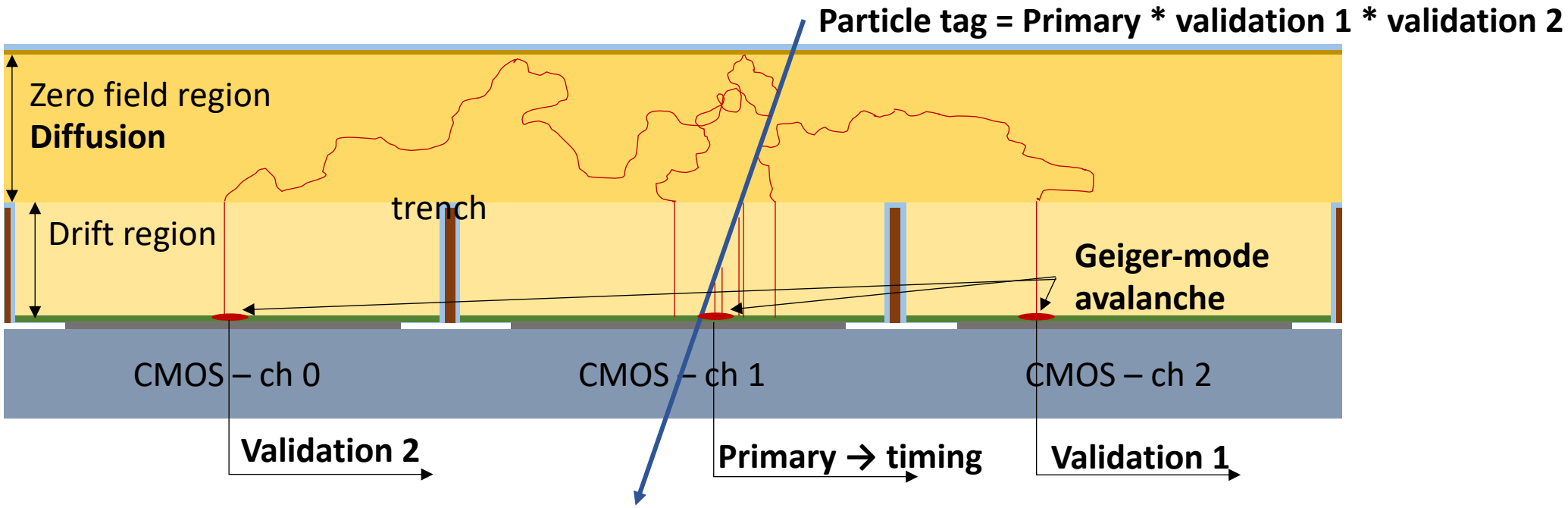


Mengjiao Xiao



The Array of Saturated Gain Avalanche Diode for charged particle tracking

Fabrice Retiere

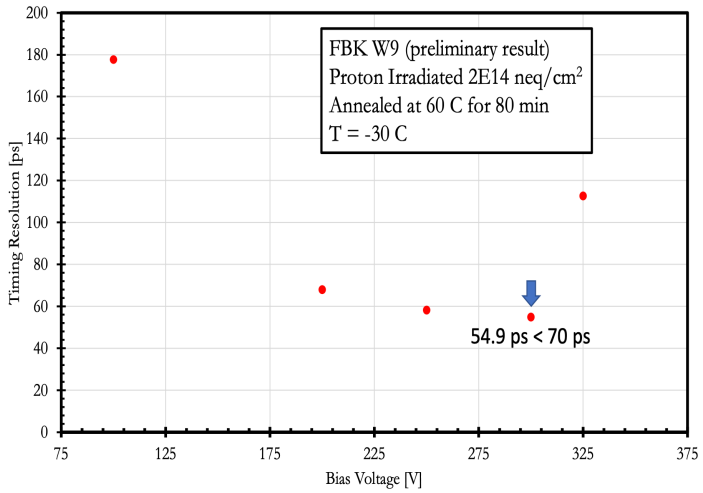


- Pros
  - Outstanding (<10ps) timing resolution
  - Fully integrated (sensor+readout) thin (<50um) detector
  - << pitch position resolution likely possible
- Cons
  - Validation logic needed
  - Validation delay ~40ns
  - No charge information
  - Radiation hardness?

Silicon radiation damage studies

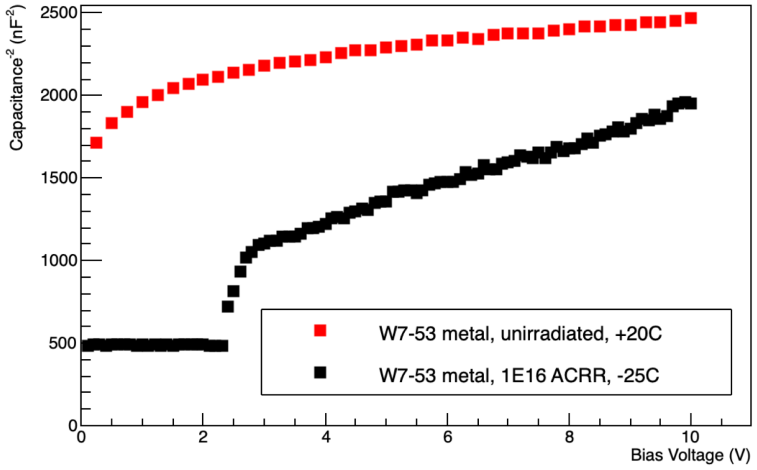
- A series of radiation tests have been performed for silicon detectors.

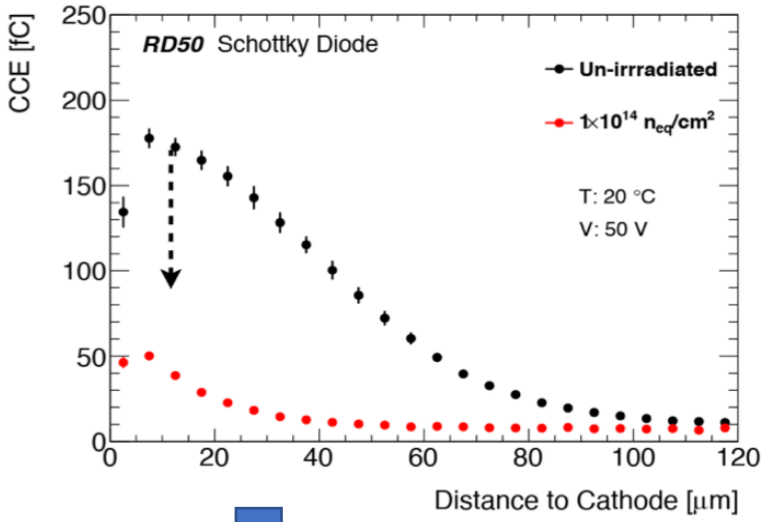
AC-LGAD timing resolution with radiation

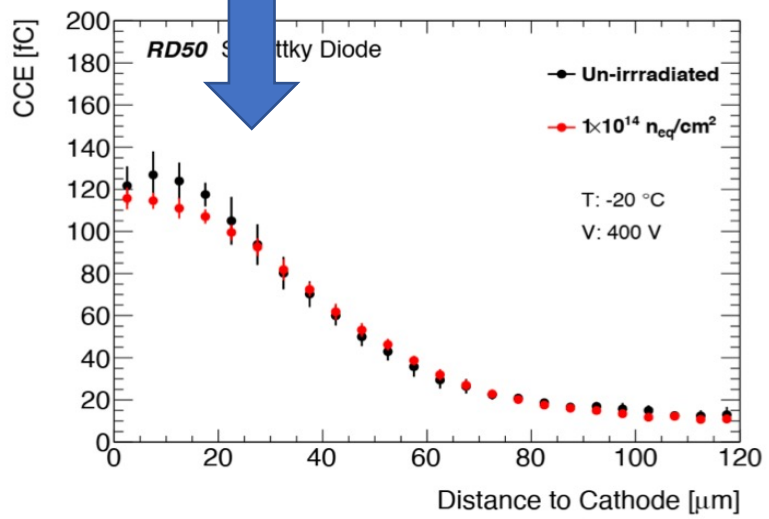


Jiahe Si
Christoph Klein
Andrew Gentry

C-V curve for small pitched 3D sensors





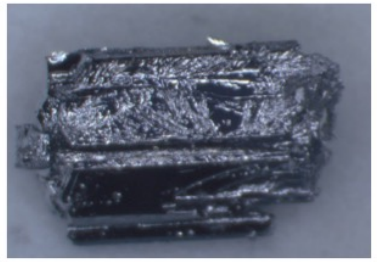


Develop novel semiconductors with new materials and geometry

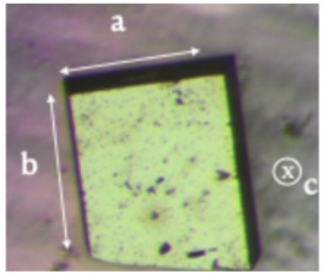
- Develop novel semiconductors with point contact charge collection geometries for light dark matter search by the SPLENDOR project.

Caleb Fink

$Eu_5In_2Sb_6$

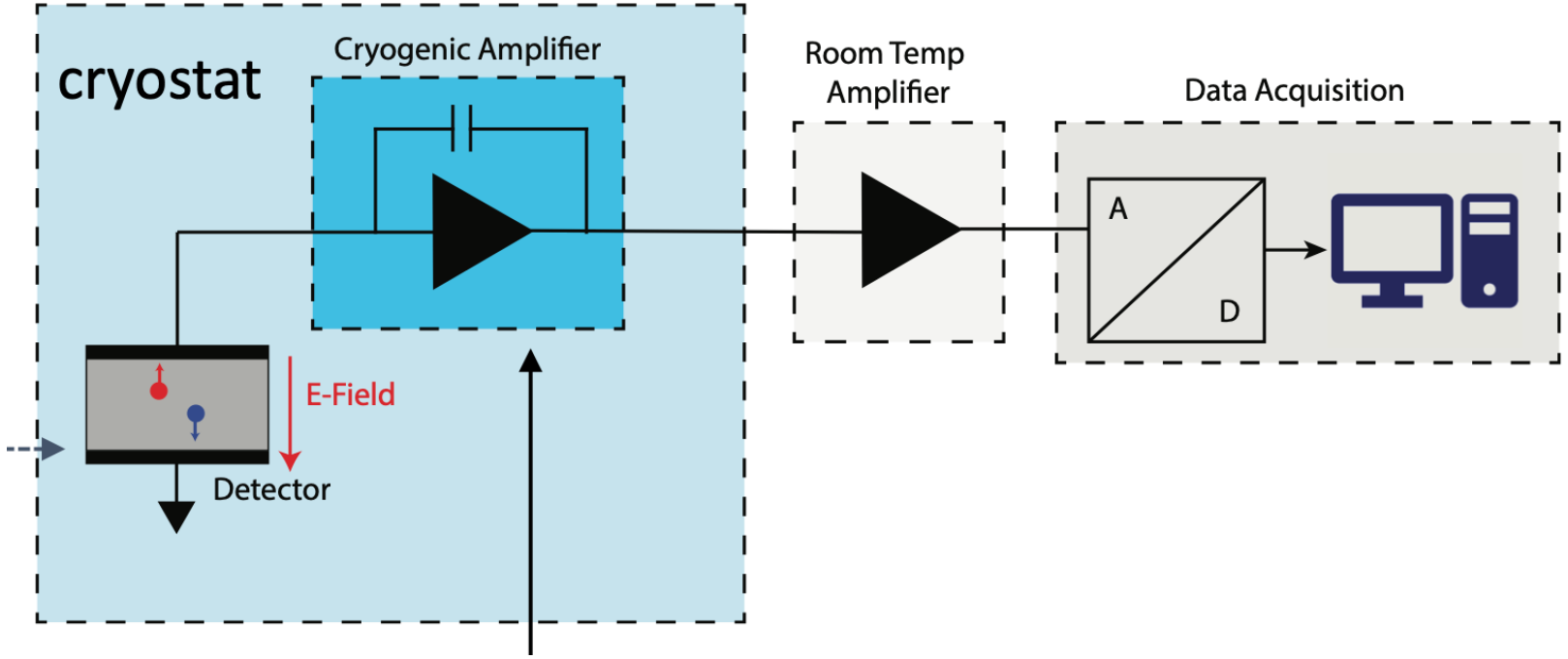


$La_3Cd_2As_6$



$Ba_3Cd_2As_4$

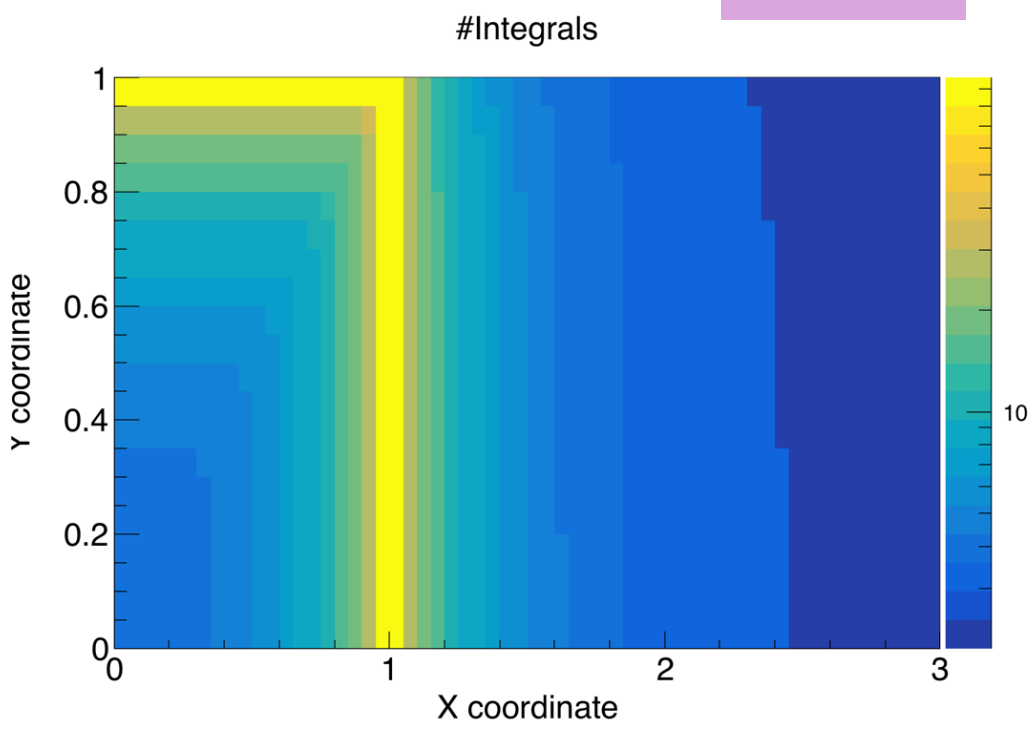
?



Pixel developments

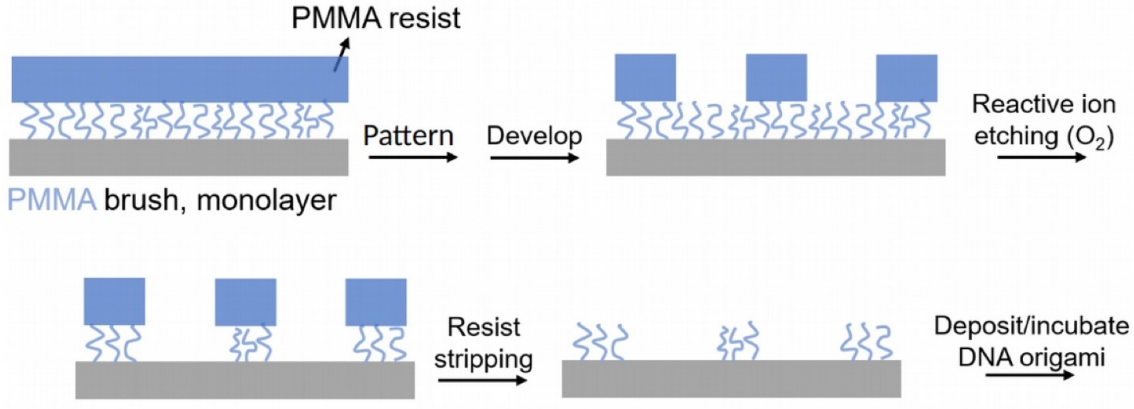
- Charge sharing in pixelated semiconductor detector: EM-CCD. 1.5 hour of direct numerical computation to ~4 sec for look up table.

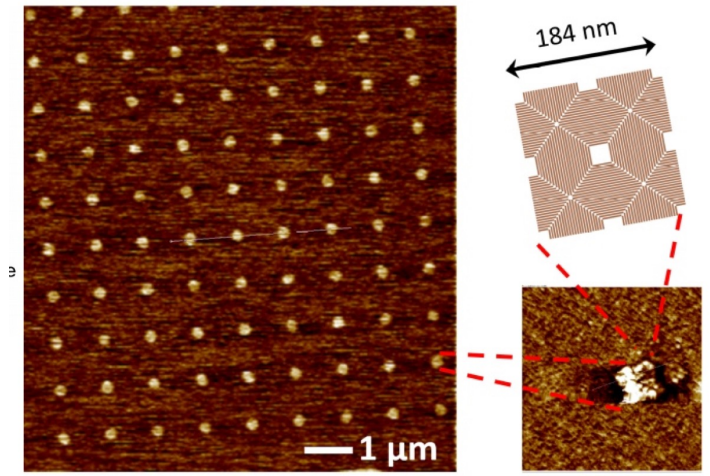
Ivan Kotov



- Smaller pixels enabled by new technologies.

M. Garcia-Sciveres

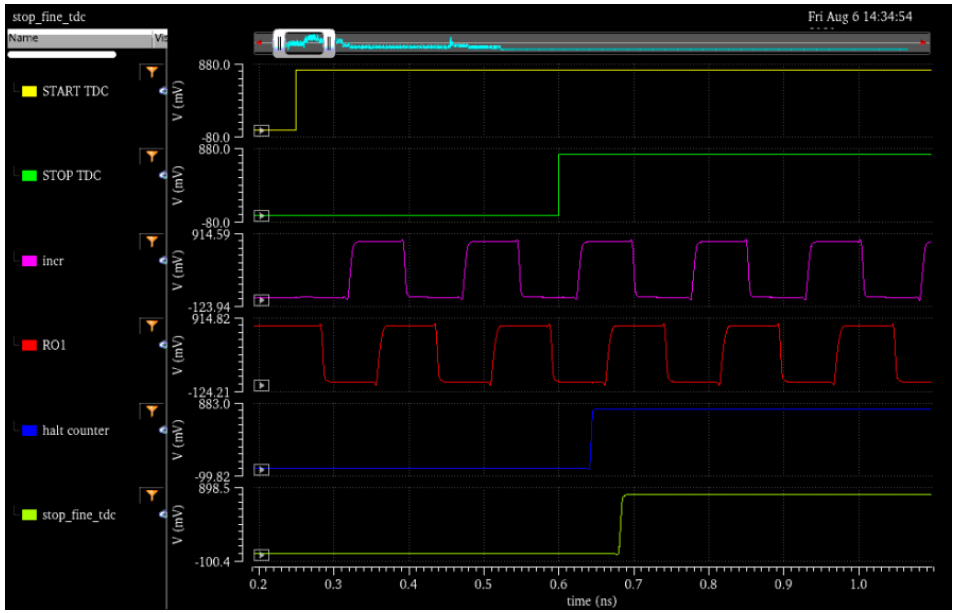




Cryogenic electronics

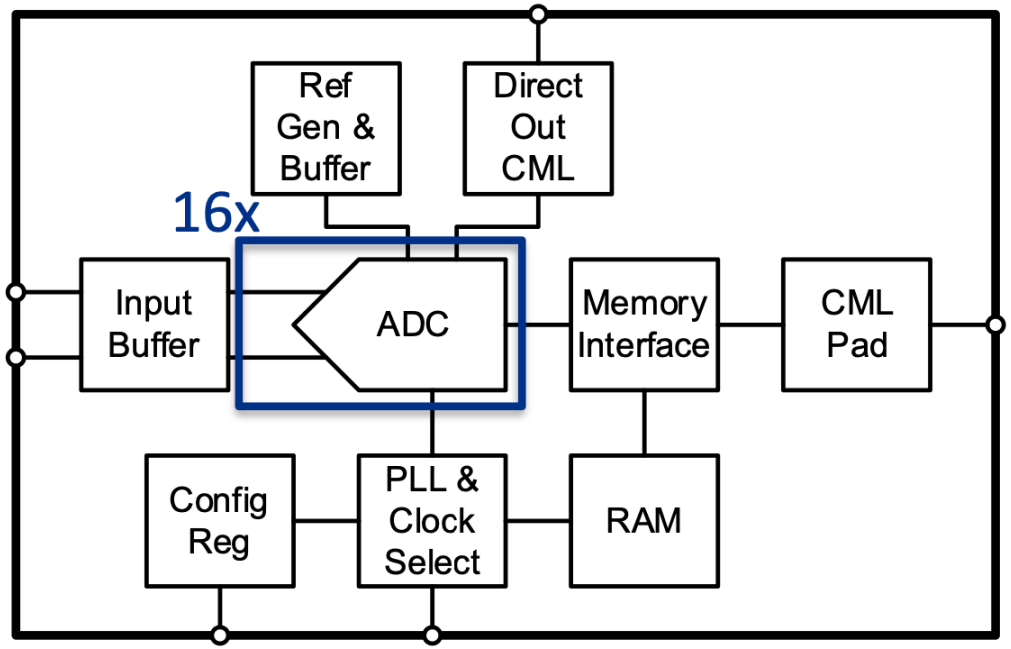
- Front-End Evaluation for Pixelated Liquid-Argon Particle Detectors:
  - Charge Replenishment Front-End
- Very fine TDC resolution
- Chip development toward 12 bit 10 GSPS Cryogenic ADC for Multiplexed Quantum Readout

Kyle Woodworth
Adam Quinn
Troy England



$t_{R(fine)} = -2.6375$ ps
$t_{R(coarse)} = 152.75$ ps
$T_{OS} + T_{gd} = -173.62$ ps

Michigan chip, Glebe

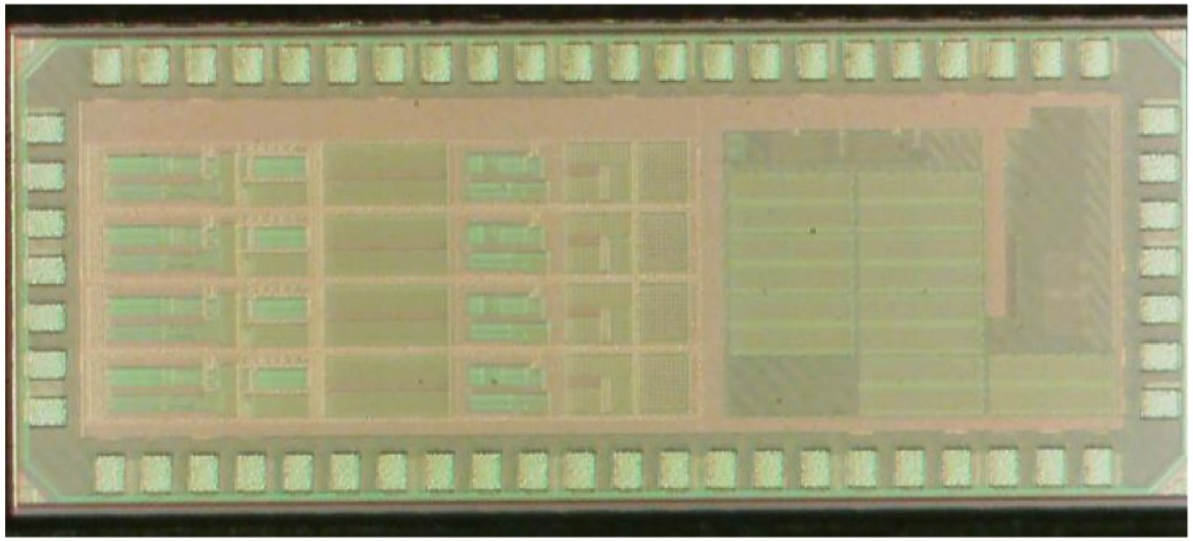


Skipper CCD

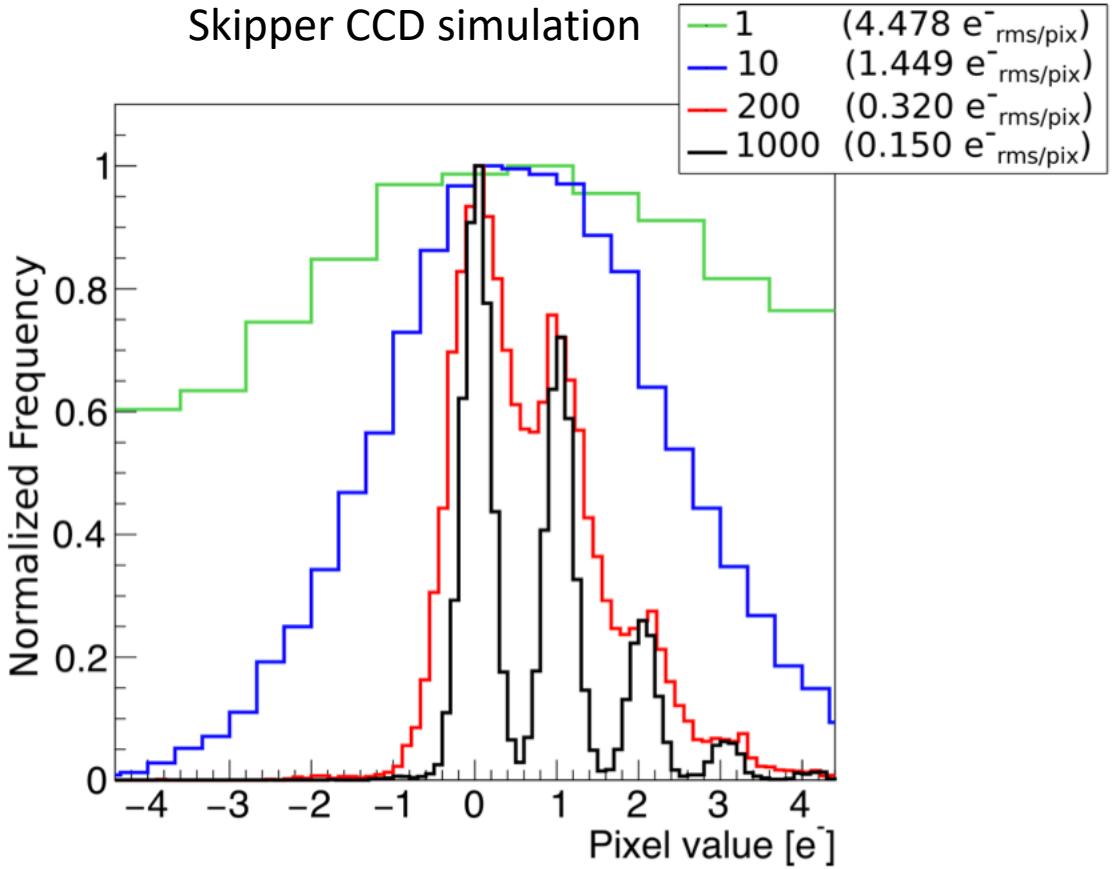
Benjamin Parpillon
Davide Braga

- MIDNA 2 adds support circuitry on chip for OSCURA scaling.
- Integrated noise < 1 e- is possible, which allows to do single photon imaging.

MIDNA 2 chip design



Skipper CCD simulation



AI implementation

- Cryogenic operation + Applicability for quantum control
- In-Pixel AI: From Algorithm to Accelerator

Manuel Blanco Valentin
Priyanka Dilip

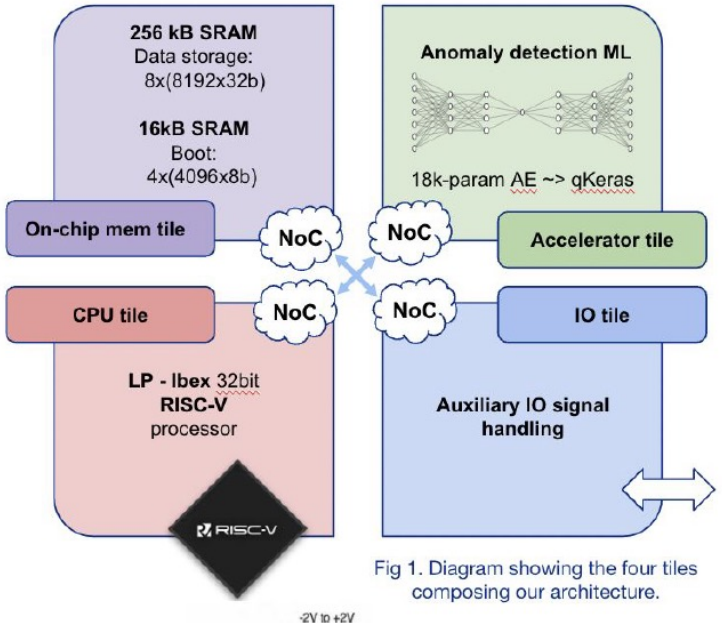
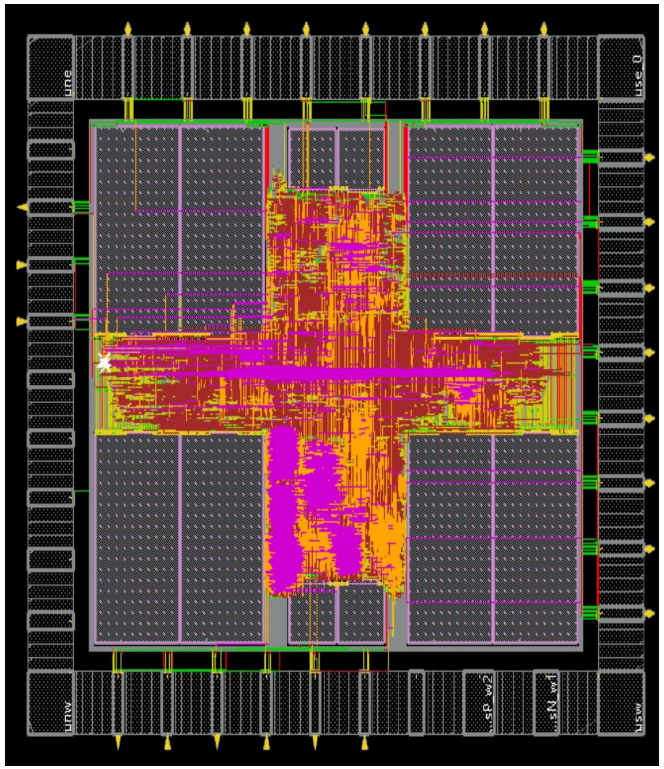
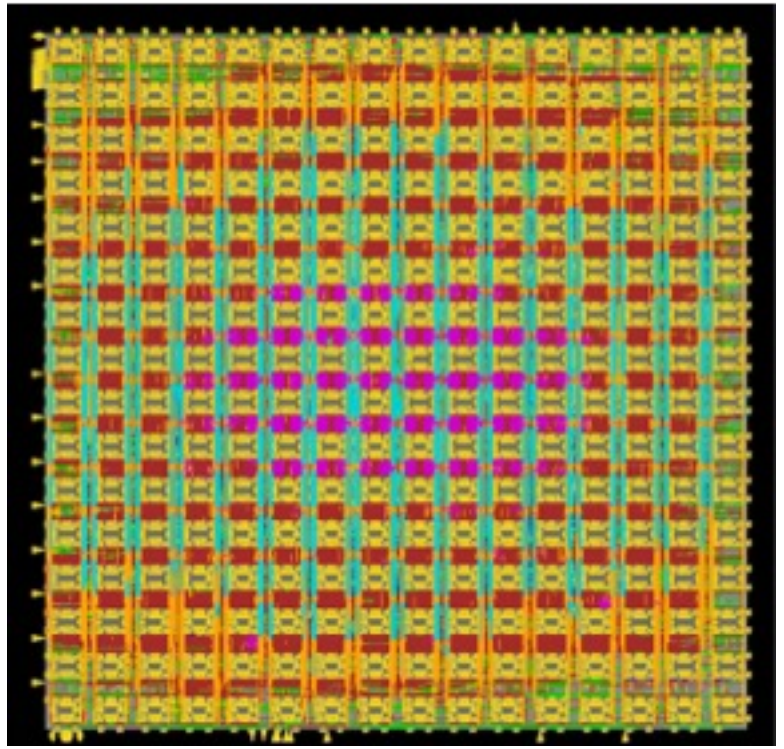


Fig 1. Diagram showing the four tiles composing our architecture.



Physical Design

(digital AI logic “mesh” around analog “islands”



ASIC development

- An On-Chip Low-Power Low-Noise Arbitrary Waveform Generator for Portable Optical Trapped-Ion Atomic Clocks:
  - Preliminary experimental results show good linearity and uniformity of different channels.
- All-Digital Implementation of Configuration-Testability-Readout Functionalities in Front-End ASICs

Hongzhi Sun
Dominik Gorni