

Radiation damage effects on the intra-pixel timing performance in planar silicon sensors.



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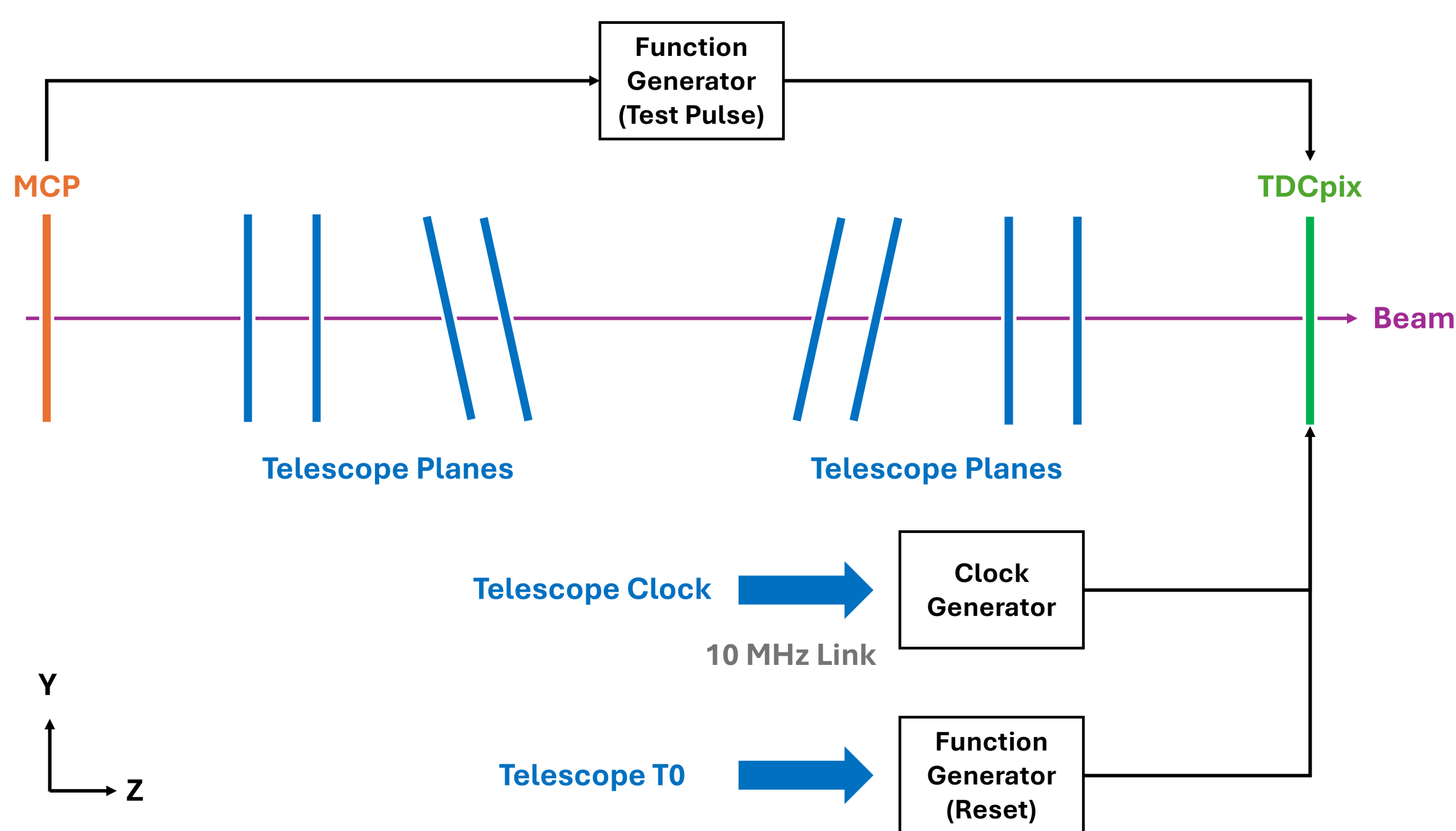
Ceyhan Sam (ceyhan.sam@cern.ch)
University of Birmingham, School of Physics and Astronomy

Introduction

- Fast and radiation hard silicon detectors are requirements for many future experiments.
- I previously studied the impact of the weighting field on the intra-pixel timing performance in non-irradiated planar silicon sensors [1].
- This study focuses on the impact of radiation damage on the intra-pixel timing performance.

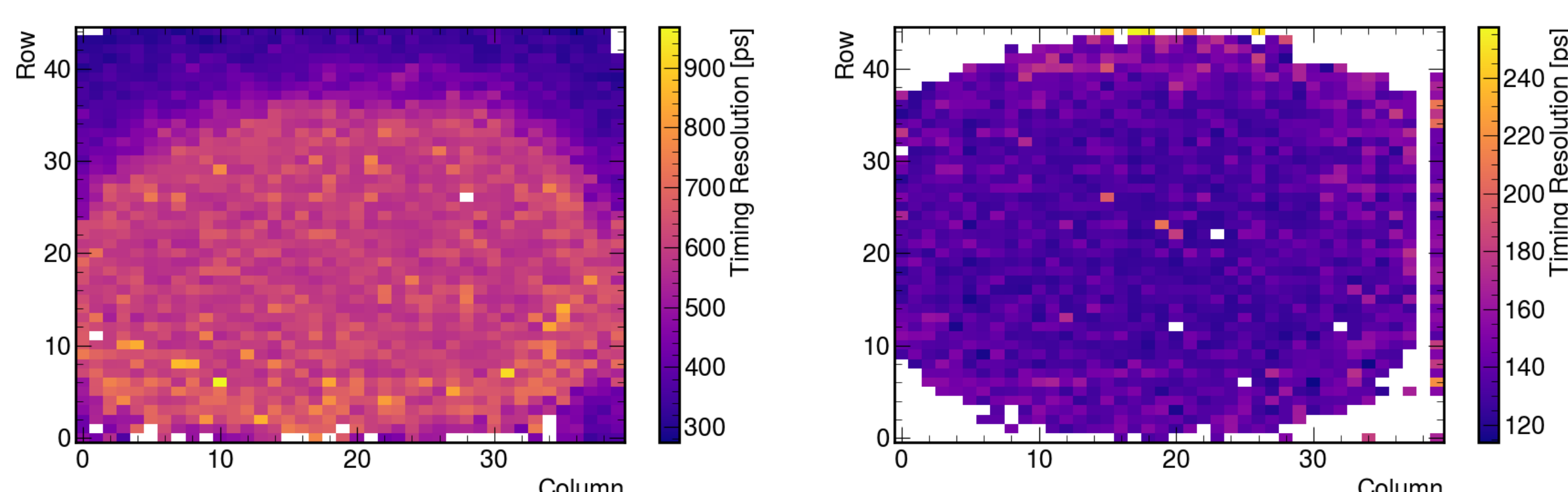
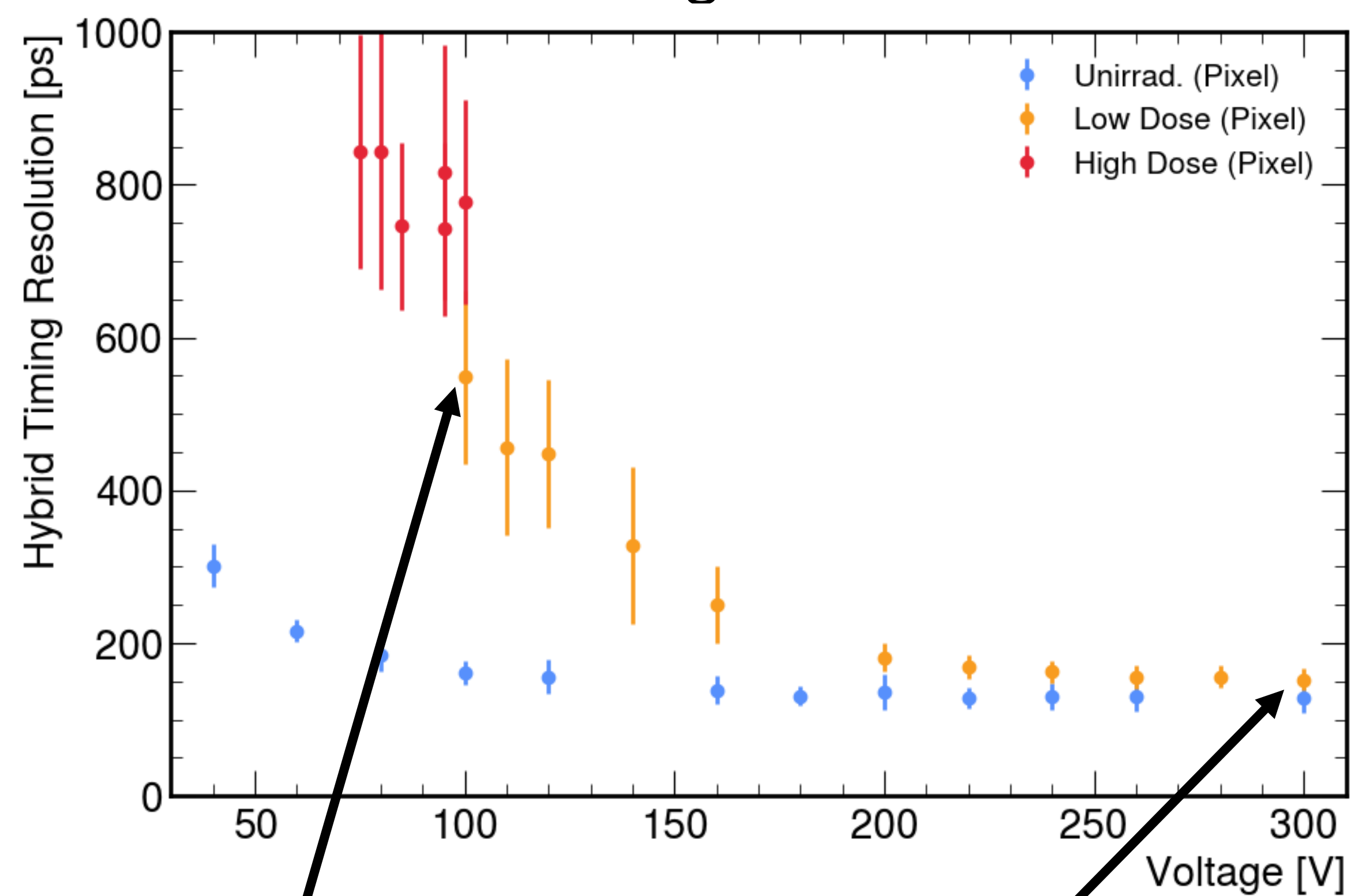
Device Under Test (DUT)

- 200 μm sensors bonded to the TDCpix ASIC [2].
- DUTs irradiated at the MC40 cyclotron to fluences of 5×10^{13} (low) and 1×10^{14} (high) $1 \text{ MeV n. eq cm}^{-2}$.
- DUTs installed into the TimePix4 telescope [3] on the CERN SPS, exposed to a 180 GeV mixed hadron beam.



Timing Resolution

- Timing resolution was studied across the pixel matrix and as a function of voltage.



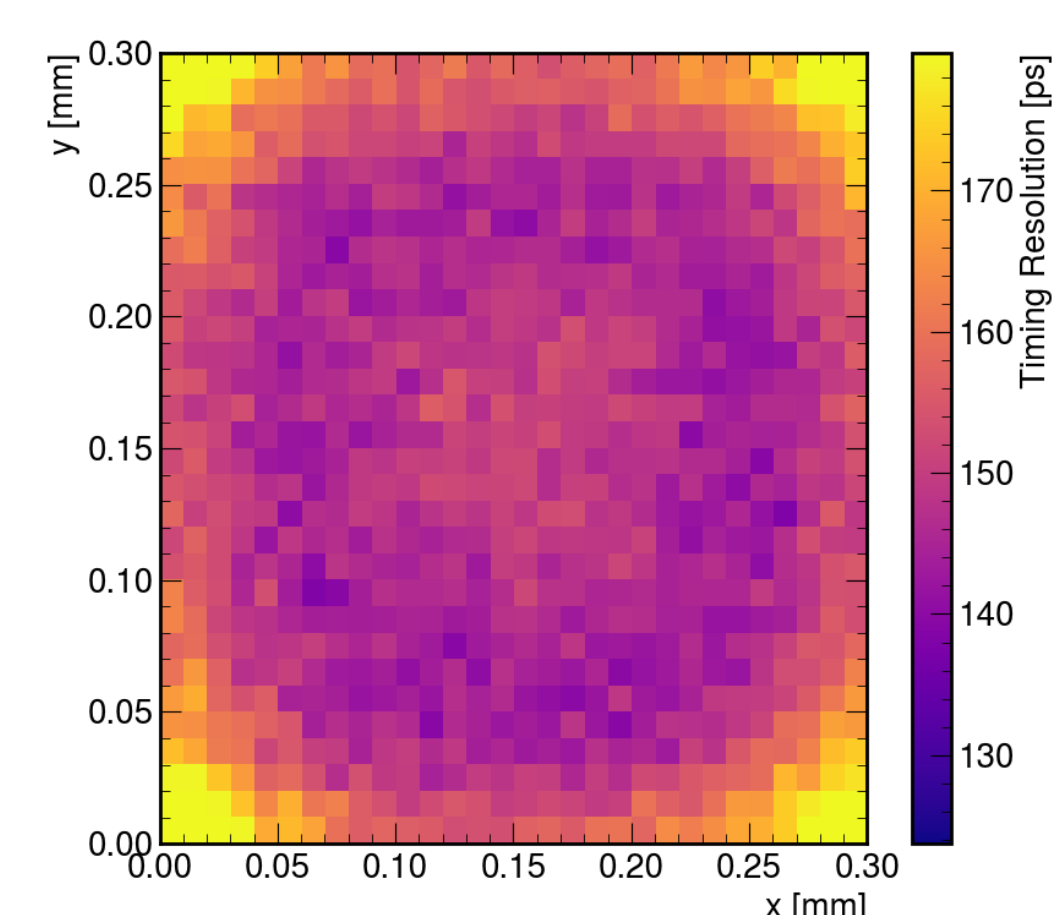
- Increase in the bias voltage required for full depletion of the sensor is apparent in the low dose DUT.

Intra-pixel Timing Performance

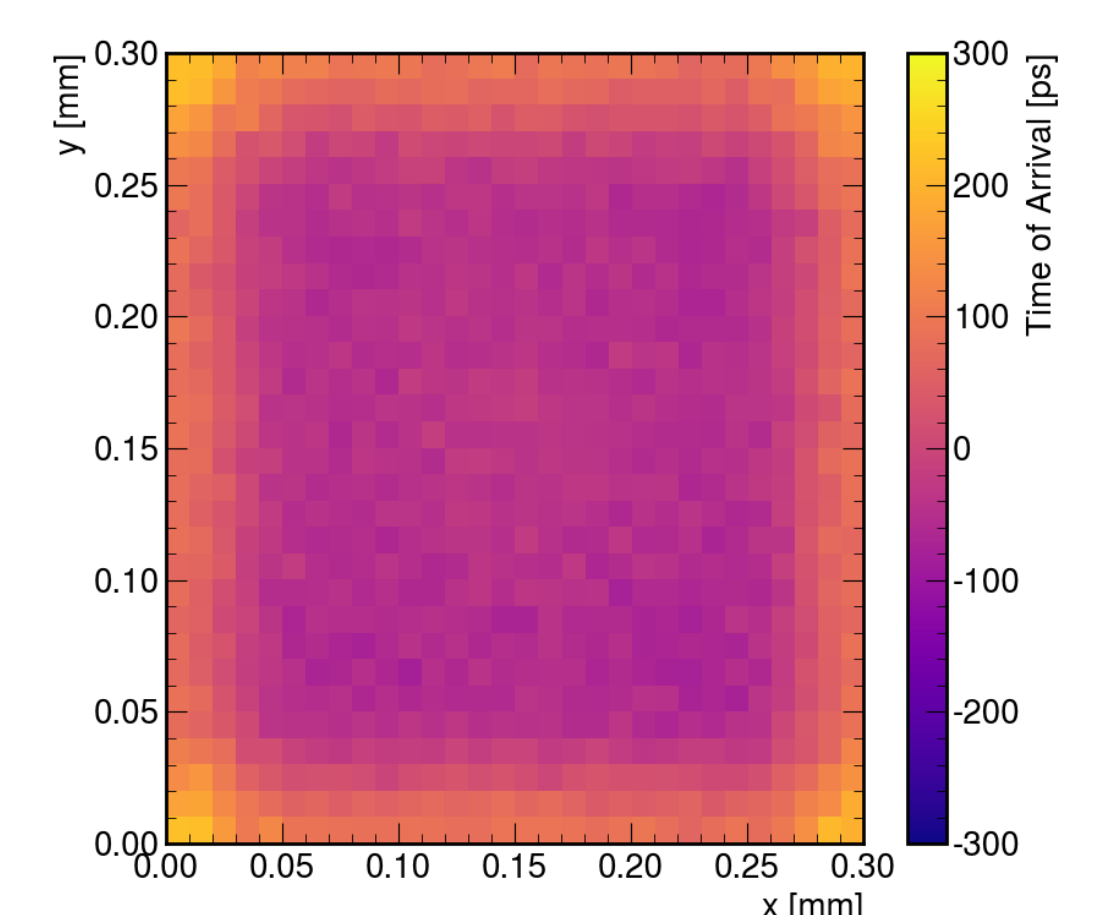
- Intra-pixel timing performance studied using reconstructed TimePix4 tracks.
- Tracks analysed using a custom Python framework.

Timing Resolution

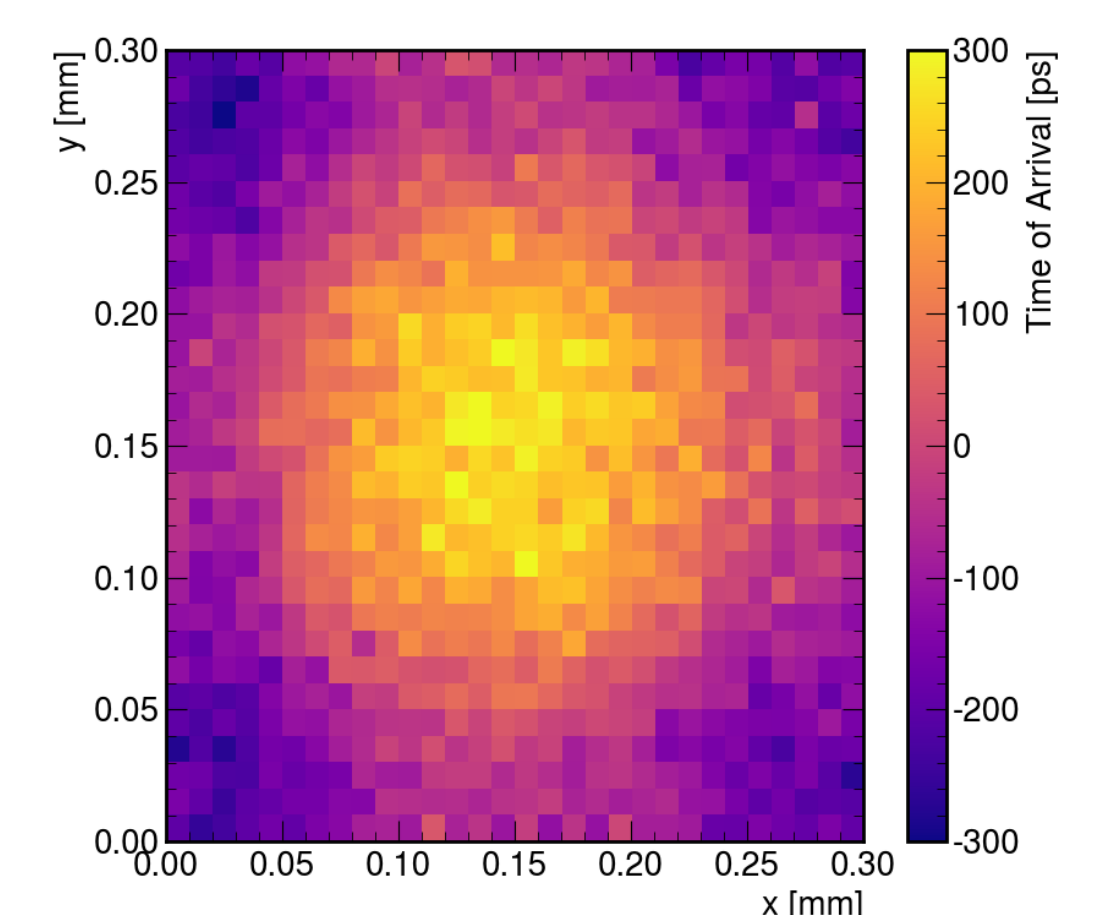
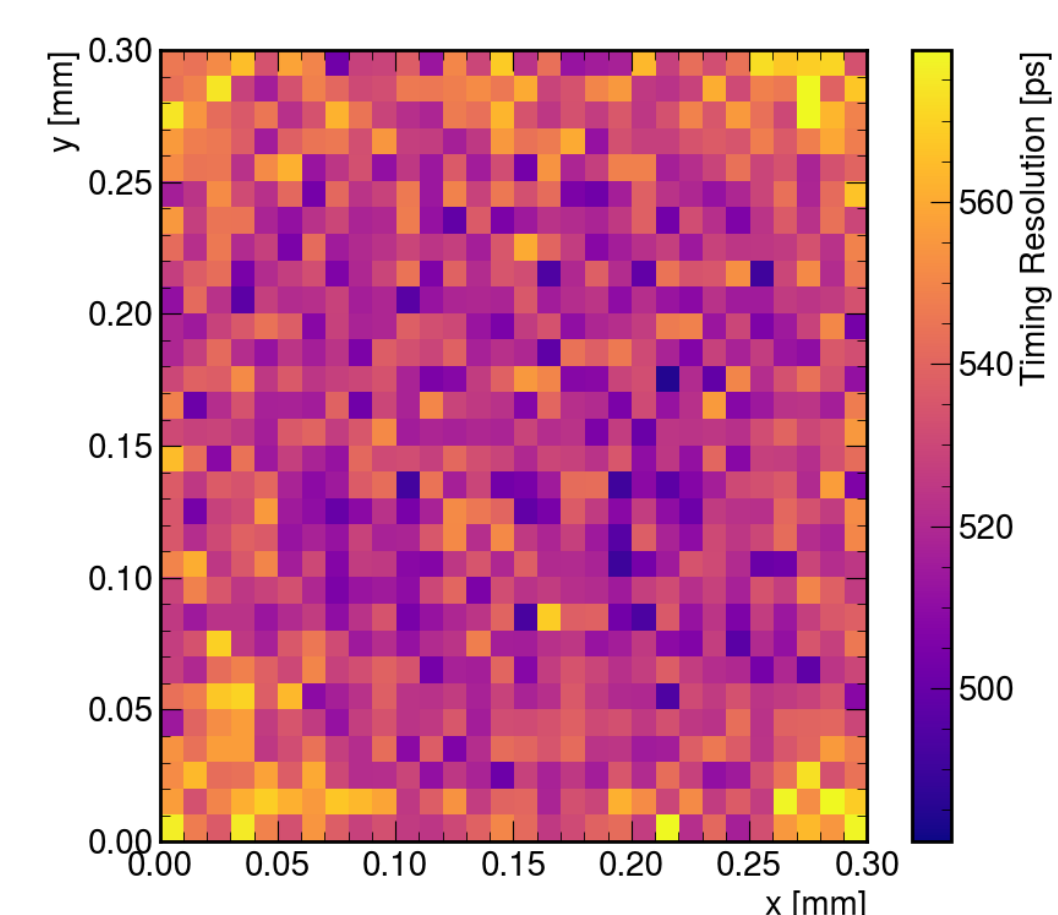
Unirradiated (100V)



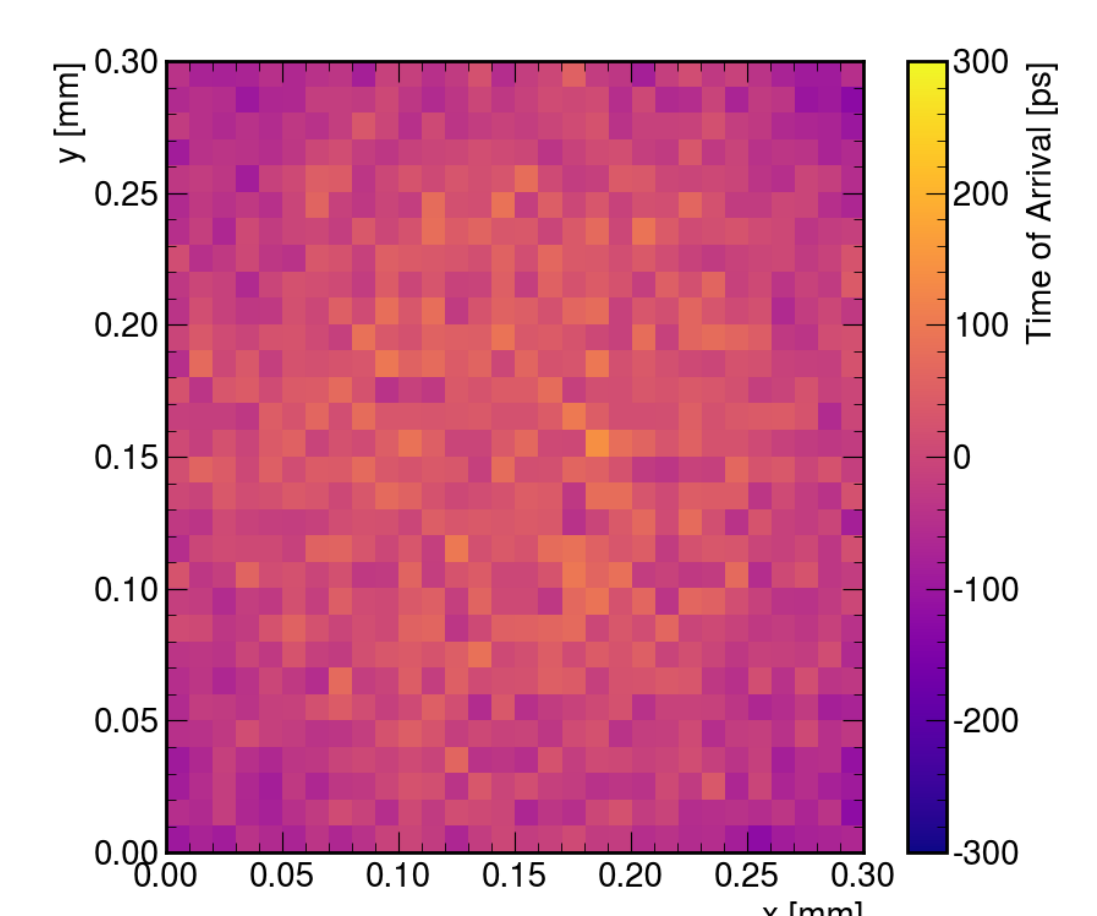
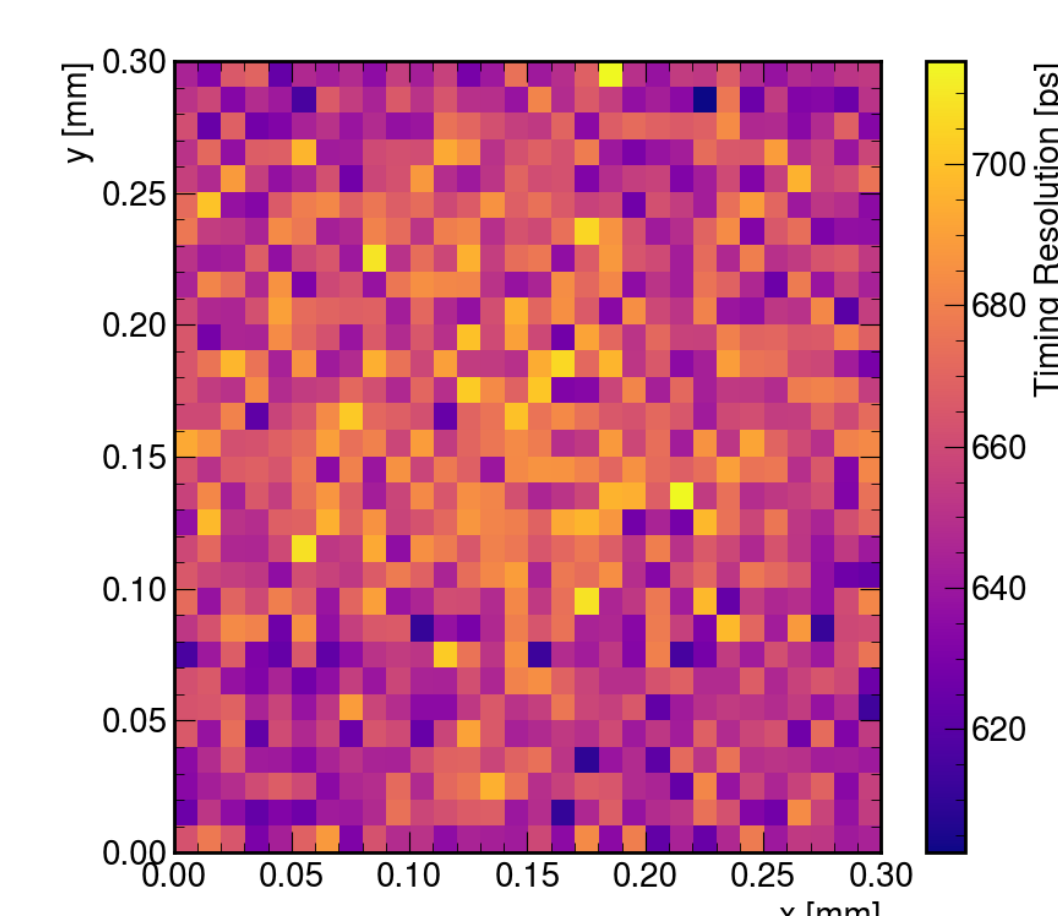
Time of Arrival



Low Dose (100V)

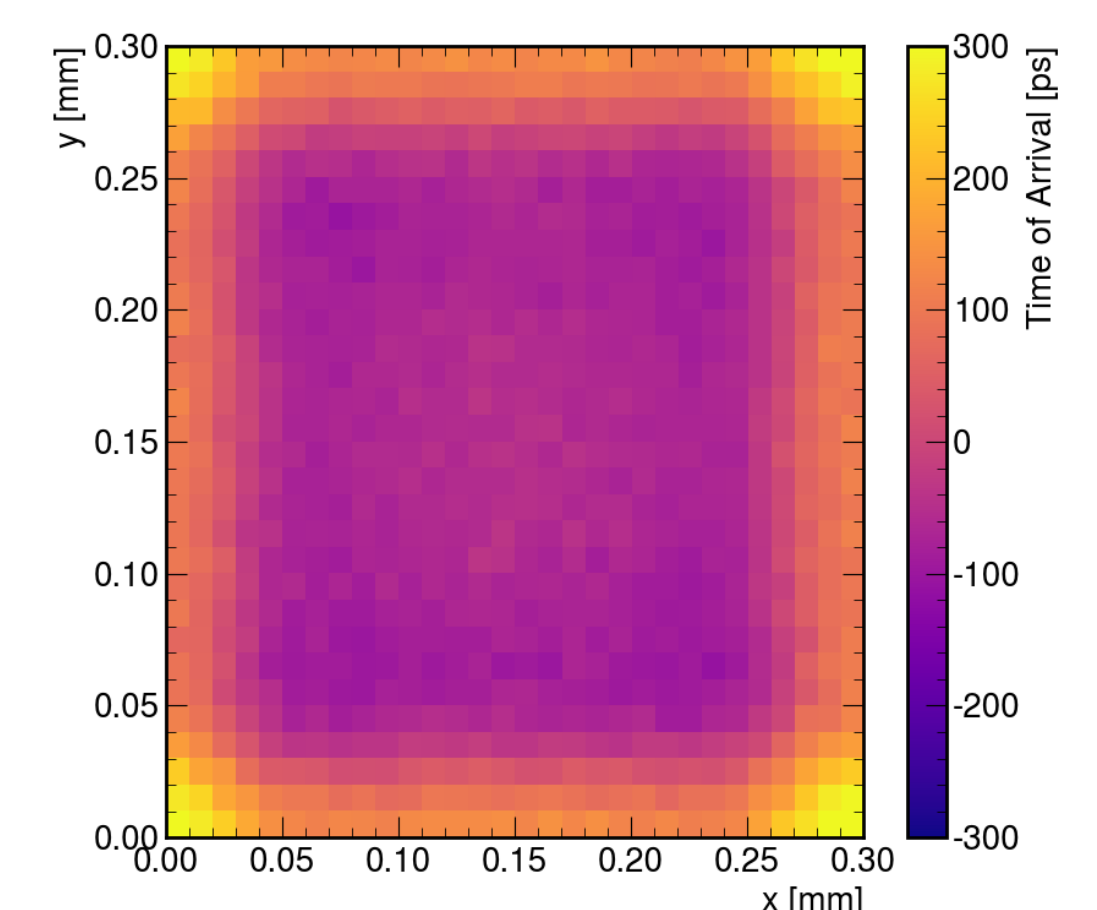
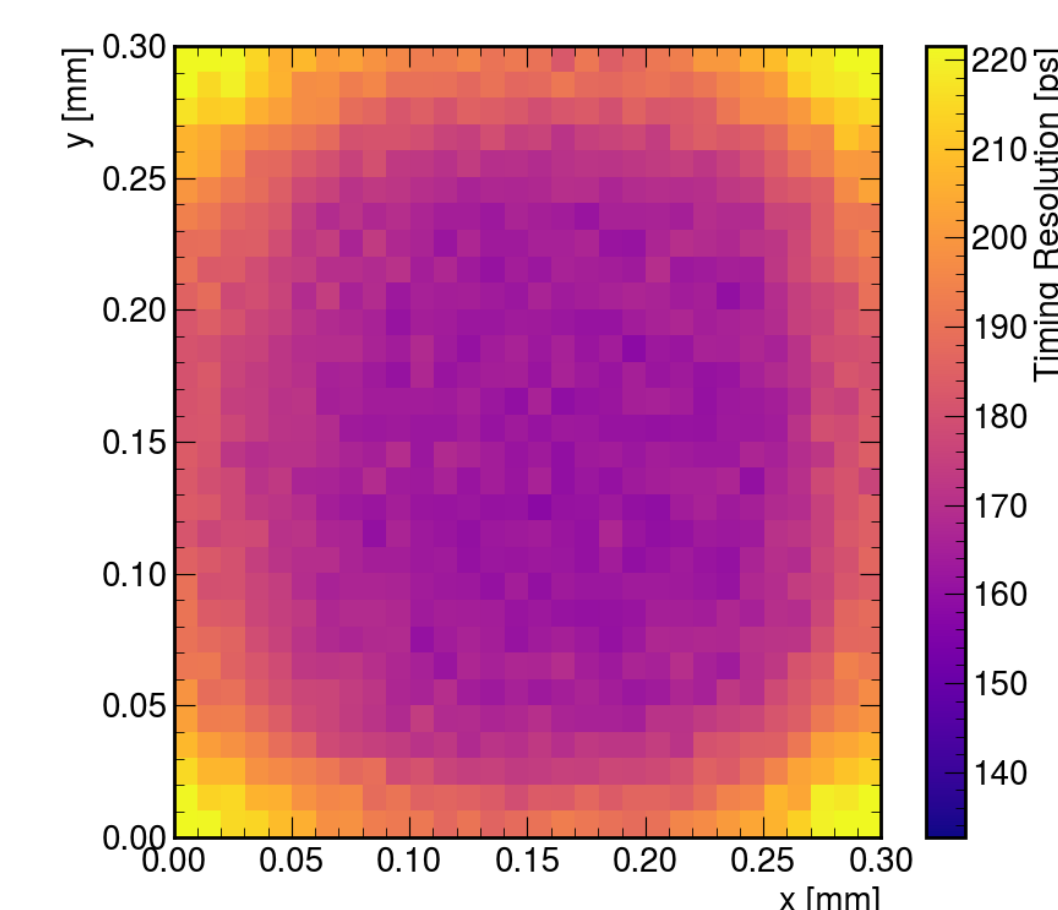


High Dose (100V)



- For the low dose DUT, performance could be largely recovered with a higher bias voltage.
- Charge collection efficiency minimally impacted.

Low Dose (200V)



- High dose DUT performance could not be recovered due to large leakage current, limiting the maximum bias voltage.

References

- [1] – The impact of weighting field on timing response of planar pixel sensors, TREDI 2026.
- [2] – Nucl. Instrum. Methods Phys. Res., Sect. A 1053 (2023) 168331.
- [3] – Nucl. Instrum. Methods Phys. Res., Sect. A 1084 (2026) 171234.