AIDAInnova/DRD3 TI-LGAD Testbeam Results

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Run 607: April test beam overview CERN SPS

Operating point

- Data collector: **276,813 waveform events**
- Used after track matching and TREF anchor: **61,311 events**
- Temperature: -23.72°**C**
- TREF bias: **180 V**

Sensors in this run

- DUT1_0: non-irradiated TI-LGAD at **165 V**
- DUT3: irradiated TI-LGAD, $1.5 \times 10^{15}\ n_{eq}/\mathrm{cm}^2$, at **495 V**

Statistics after 3σ clipping

2.7–3.1k events per channel, DUT1_0

2.75–2.95k events per channel, DUT3

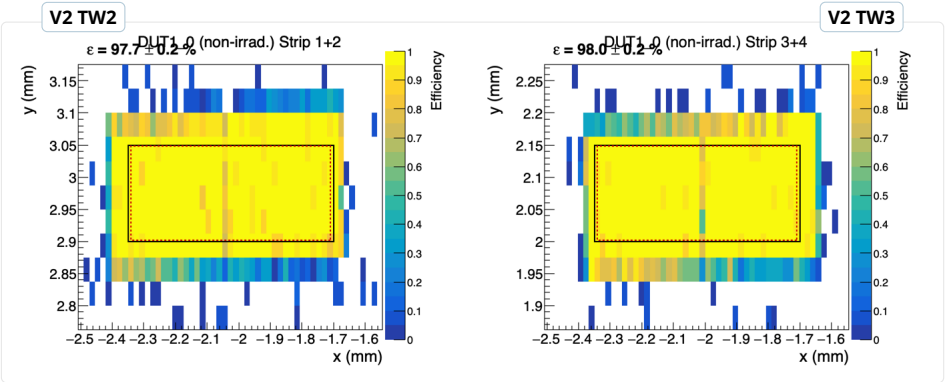
$\sim$18 ps DUT3 jitter indication

5 GS/s 0.2 ns/sample

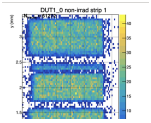
TREF anchored **track matched** **baseline corrected**

Efficiency: non-irradiated TI-LGAD

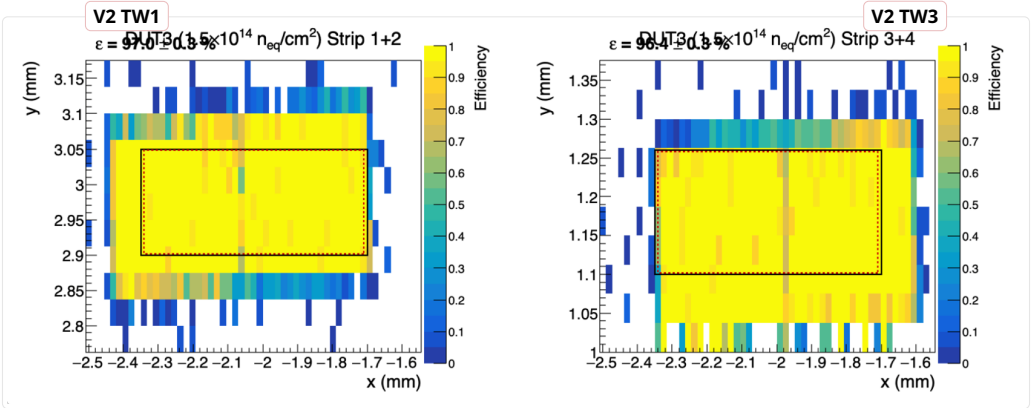
DUT1_0 at 165 V;



Non-irradiated structure shows high efficiency in the active region. The comparison of time windows is used as a robustness check for the strict TREF-anchored selection.

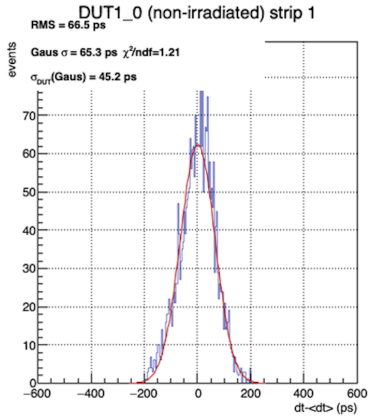


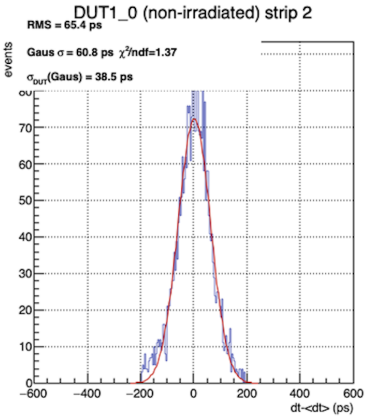
Efficiency: irradiated at $1.5 \times 10^{15}\ n_{eq}/\mathrm{cm}^2$ biased at 495 V;



Irradiated sensor performance is evaluated with the same TREF-anchored logic as the non-irradiated reference.

Timing results: pixels 1 and 2

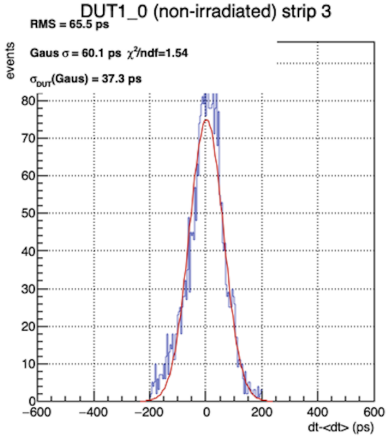


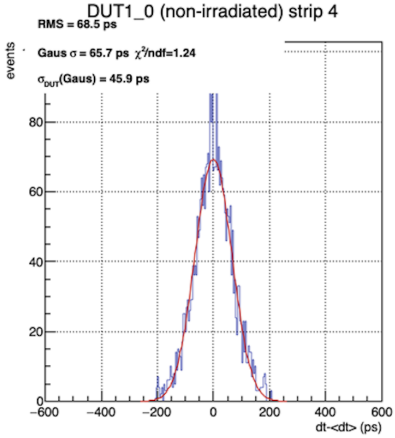


Pixel 2

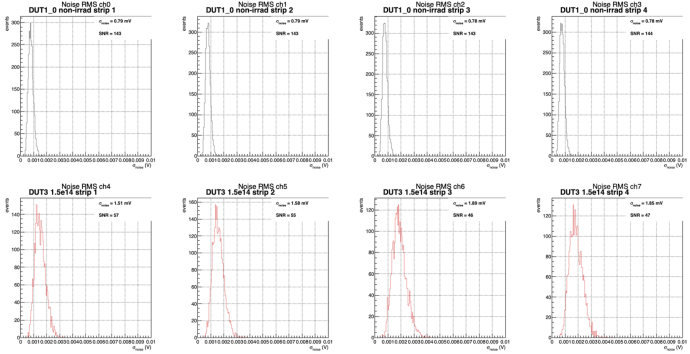
Pixel 1 Timing distributions are extracted after baseline correction, waveform quality cuts, and reference-time anchoring.

Timing results: pixels 3 and 4





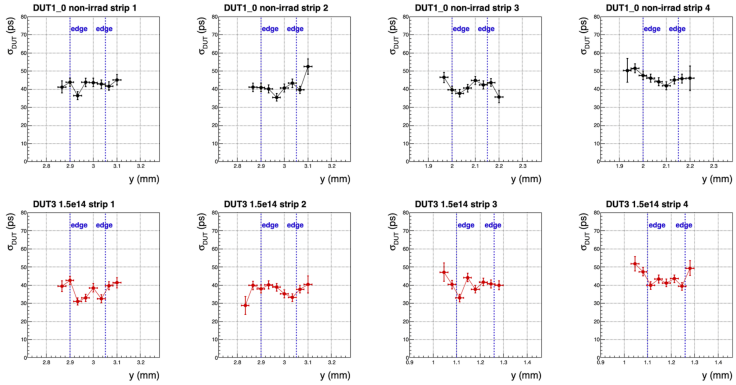
Baseline noise and signal-to-noise ratio



Interpretation

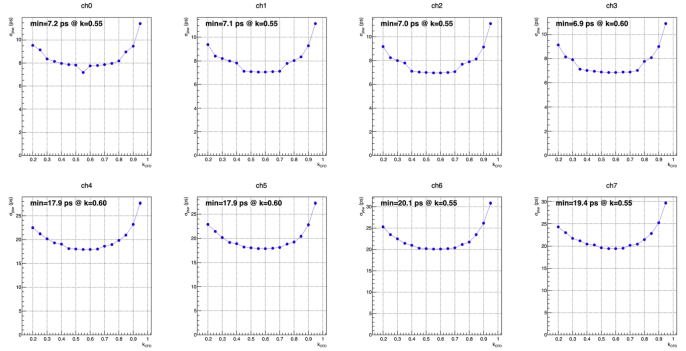
Baseline RMS from bins 10–55. DUT1_0: $\sigma_{\text{noise}} \approx 0.79$ mV, SNR ≈ 143. DUT3: $\sigma_{\text{noise}} \approx 1.5$–$1.9$ mV, SNR ≈ 46–57, consistent with higher leakage current after irradiation.

Time resolution across the pixel width



Resolution is uniform within the active area, with no clear degradation at the LGAD edges - supporting TI-LGAD full-fill-factor behaviour.

Jitter comparison after irradiation



Main message

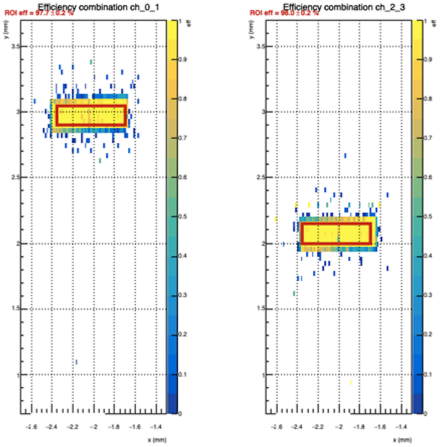
DUT3 shows higher jitter (∼18 ps) because irradiation reduces LGAD gain, producing smaller/slower signals. Even at $1.5 \times 10^{15}\ n_{eq}/\mathrm{cm}^2$, the detector keeps good timing performance at 495 V.

Strict TREF-anchored efficiency analysis

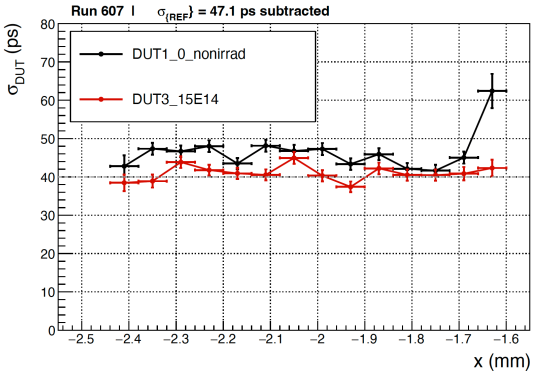
Run 607 analysis settings

Selection logic

- Baseline subtraction on all channels
- Per-group TREF reference: channel0 for group 0, channel8 for group 1
- CFD at 50% of peak amplitude
- NPeaks = 1, RiseTime > 0.3 ns
- Track pointing at pixel ROI (from telescope)
- Pulse integral above threshold



Timing results: Batch 3 run 607

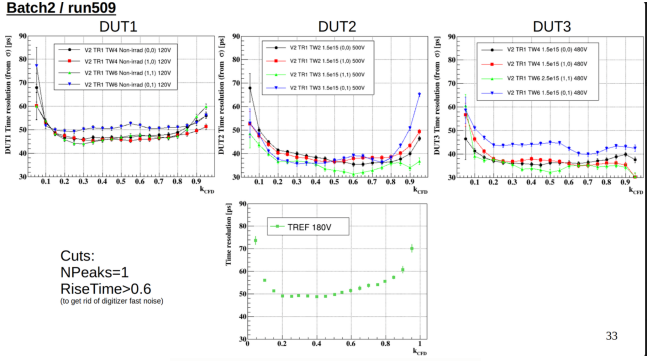


Summary

	B2	**B3**
DUT1 non-irrad	∼47 ps	**43 ps**
DUT3 1.5×10^{15}	∼38 ps	**38 ps**
TREF 180V	∼49 ps	47 ps ✓

$\sigma_{\mathrm{REF}} = 47.1$ ps from triplet. Batch 3 consistent with Batch 2.

Comparison with Batch 2 run 509



	Batch 2 run509	Batch 3 run607
DUT1 non-Irrad	~47 ps @ 120V	**43 ps @ 165V**
DUT3 1.5×10¹⁵	~38 ps @ 500V	**38 ps @ 495V**
TREF 180V	~49 ps	47 ps ✓

Batch 2 cuts

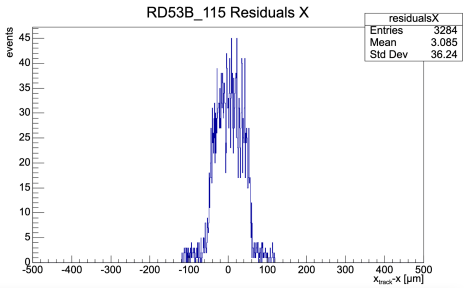
- NPeaks $= 1$
- RiseTime > 0.6 ns
- Reports σ_{meas}(DUT$-$TREF) including TREF contribution

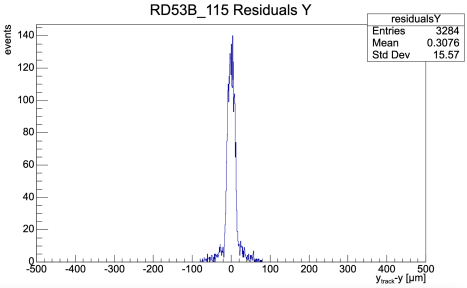
Key comparison

- TREF: 49 ps (B2) vs 47 ps (B3) ✓
- DUT3: 38 ps in both batches ✓
- B3 explicitly subtracts $\sigma_{\text{REF}} = 47.1$ ps via triplet

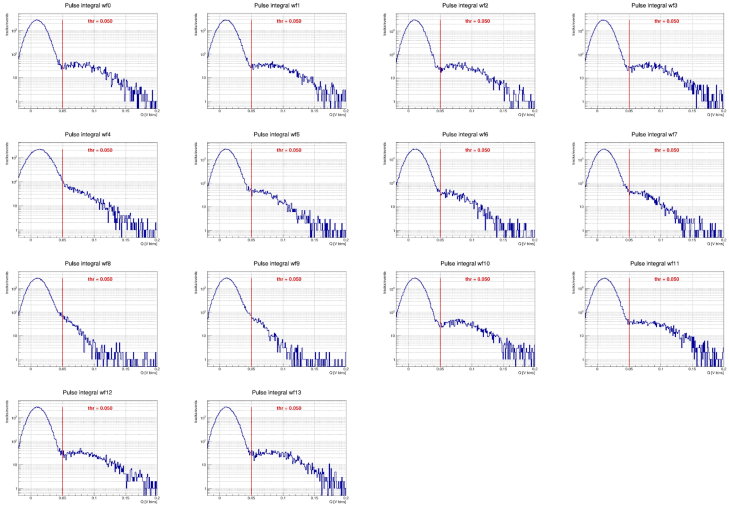
Batch 1: March TB 2026 with CROC $100\,\mu\mathrm{m} \times 25\,\mu\mathrm{m}$ CROC

Batch 1							
Wafer	Version	Trench parameter	Fluence	# daughterboard	Chubut CH1,2	Chubut CH3,4	
W5	V2	TW1-2			V2TW1	V2TW2	
W5	V2	TW1-2			V2TW1	V2TW2	Angled
W5	V1-V2	TW5			V1TW5	V2TW5	
W5	V1-V2	TW5			V1TW5	V2TW5	Angled

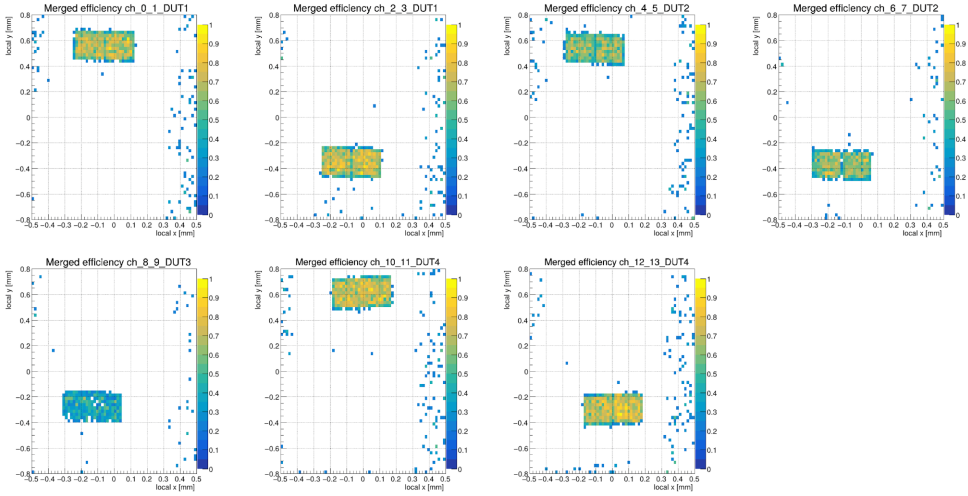




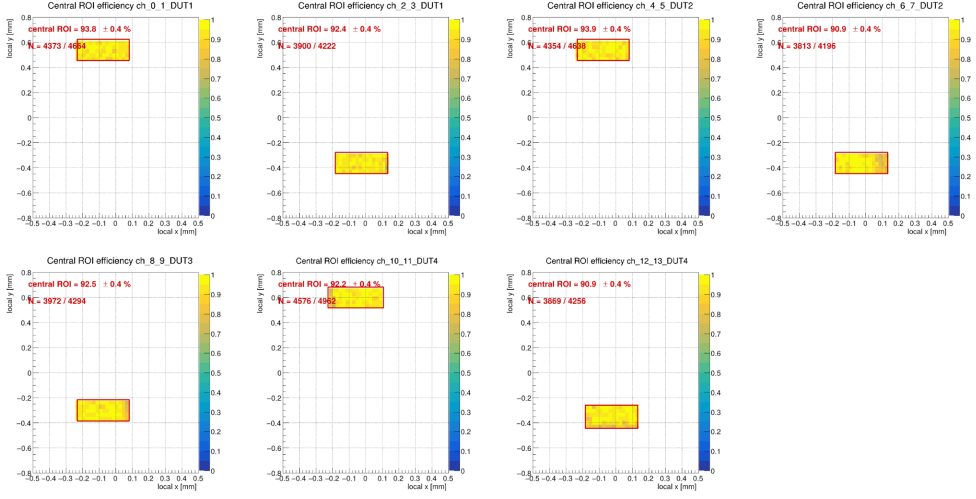
Batch 1 pulse integrals



Preliminary Efficiency maps

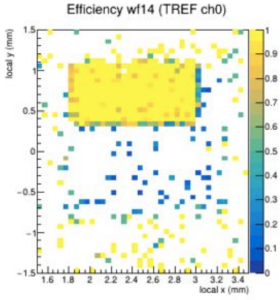


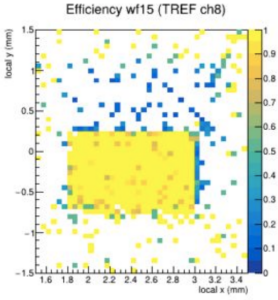
Additional CROC-associated result

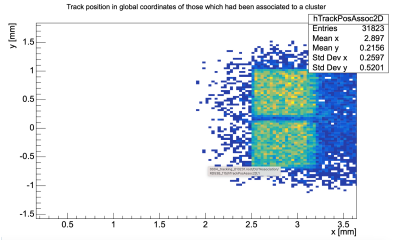


CROC ROI selection -> Batch2

run 13231 cross-check







Selection

Tracks are selected only when they pass through the CROC active region, improving the associated-track population used in the efficiency plots.

Summary

April TB / Run 607

- Strict TREF-anchored analysis implemented
- DUT1_0: high SNR and stable non-irradiated reference
- DUT3 at $1.5 \times 10^{15}\ n_{eq}/\mathrm{cm}^2$: good timing at 495 V

Physics message

- Uniform time resolution across the pixel width
- No strong timing degradation at LGAD edges
- Results support TI-LGAD full-fill-factor behaviour

next: finalize efficiency + timing plots for March TB

cross-check CROC ROI association