

Performance of irradiated TI-LGADs at 120 GeV SPS pion beams

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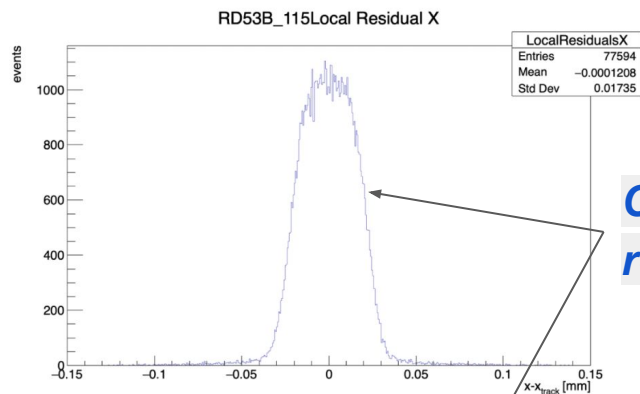
UNIVERSITÉ
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DE BRUXELLES



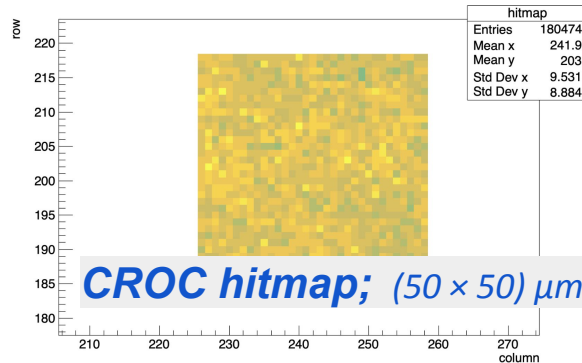
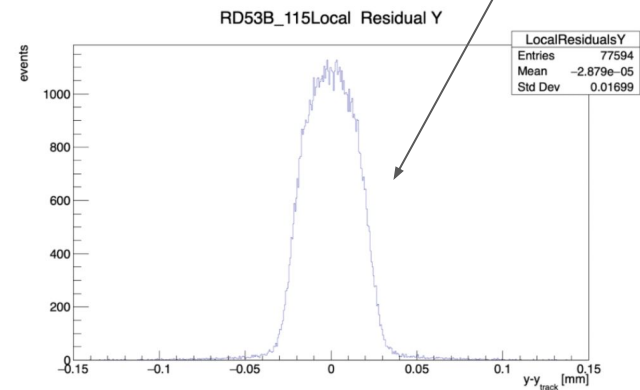
THE UNIVERSITY OF
NEW MEXICO

CMS Readout Chip: $\sigma_x=17.3\text{ }\mu\text{m}$, $\sigma_y=17.0\text{ }\mu\text{m}$

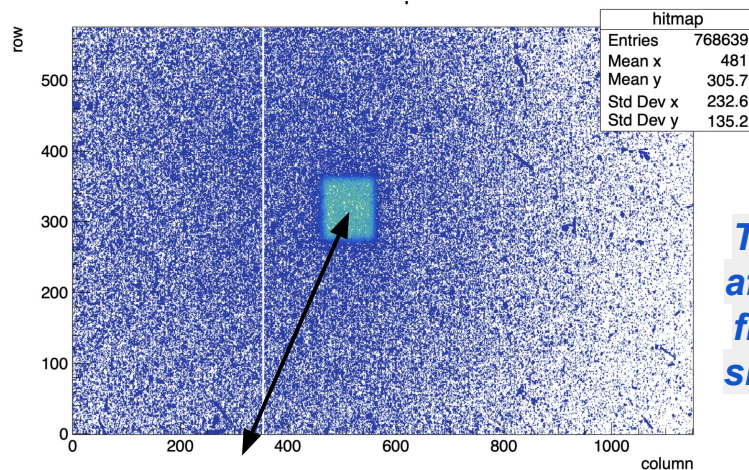
DRD3



CROC
residuals



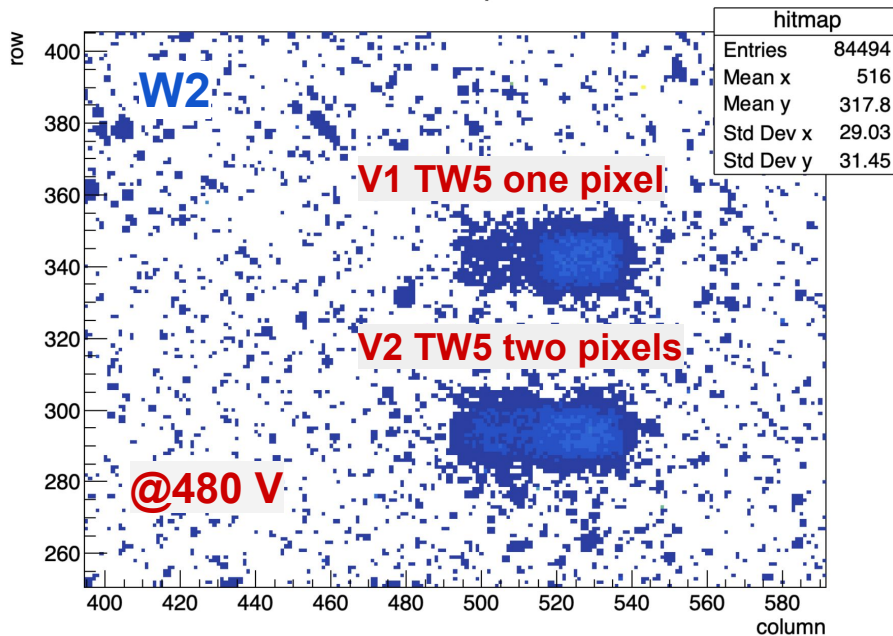
CROC hitmap; (50 × 50) μm pixel size



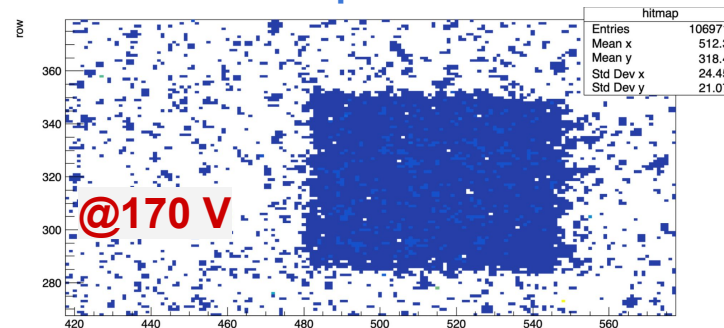
**Triggering on CROC,
after having defined a
fiducial area with the
shadowing procedure**

Triggering on CROC

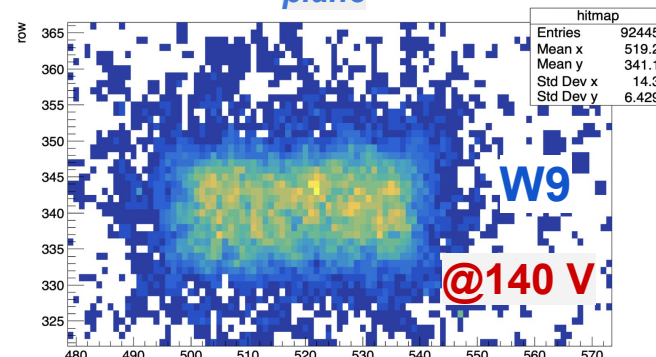
- Triggering on the DUT to get its shadow on the CROC and MIMOSA planes



Shadow of irradiated TI-LGAD $1.5E15 \text{ n}_{eq}/\text{cm}^2$ on CROC plane



Shadow of TREF $1.2 \times 1.2 \text{ mm}^2$ LGAD on MIMOSA plane



Shadow of non-irradiated TI-LGAD V1 TW5 on CROC plane

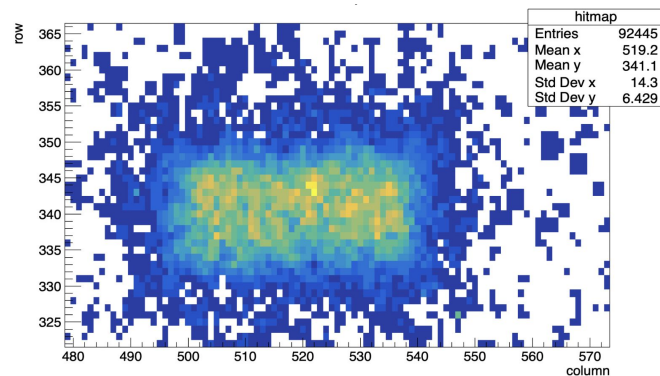
[Waveforms] entries = 164890

[Tracks] entries = 56435

Hits pad1 = 25576

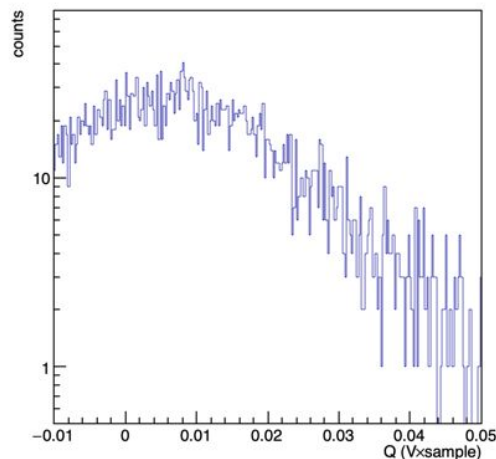
Hits pad2 = 23884

Non-irradiated TI-LGAD V1 TW5

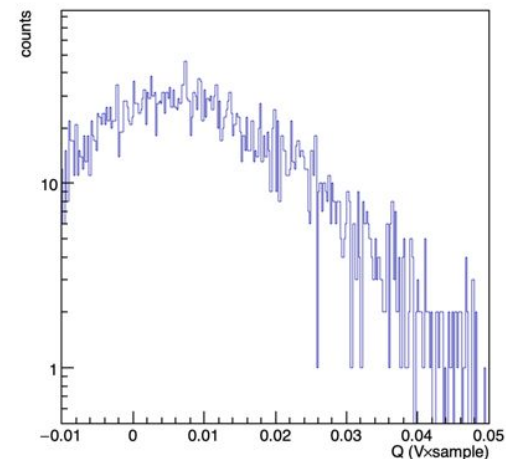


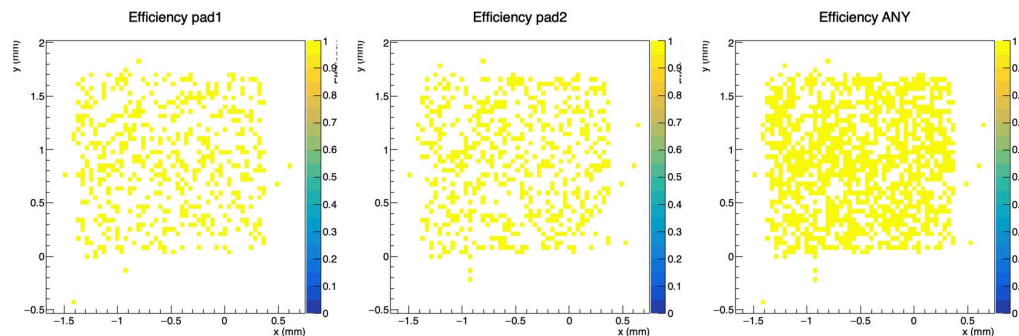
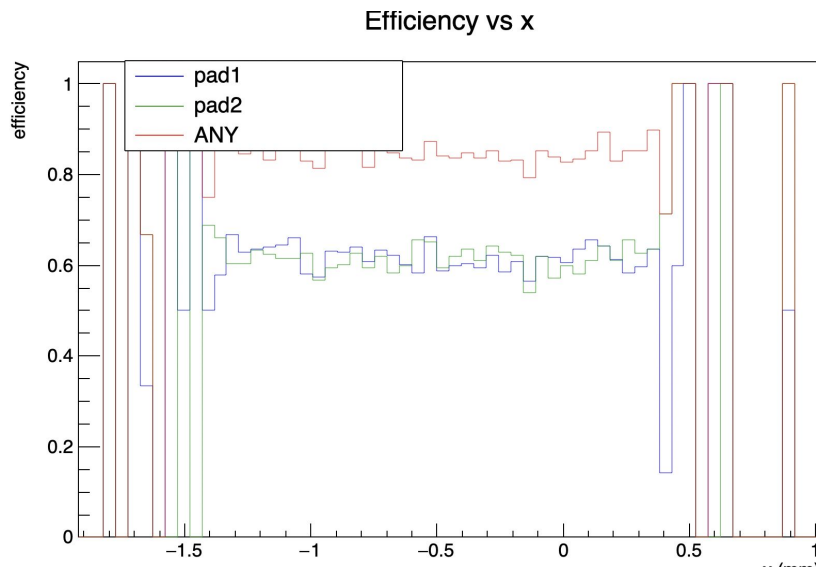
- No visible pad separation
- Charge spectra similar
- DUT rotated

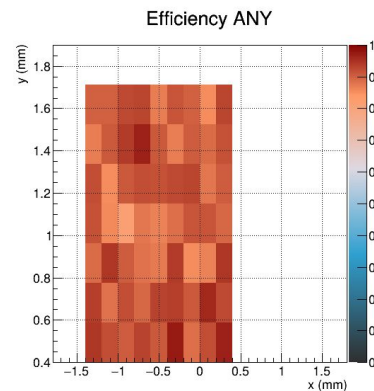
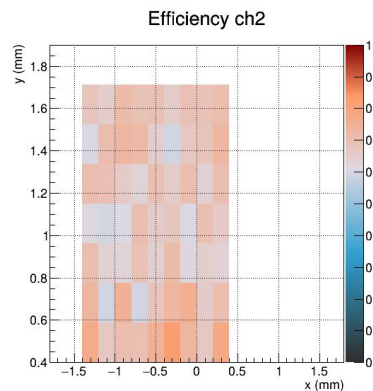
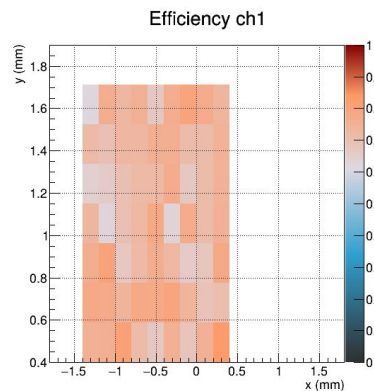
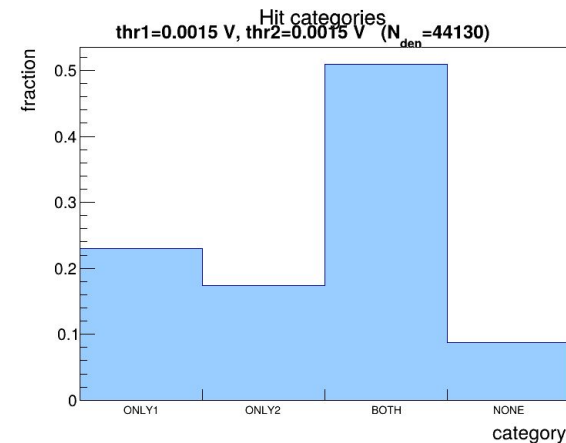
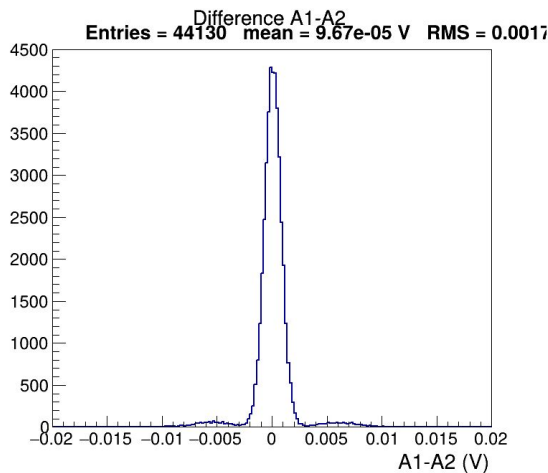
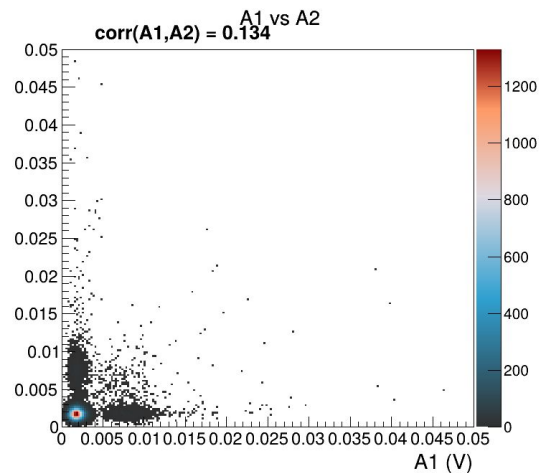
Charge pad1

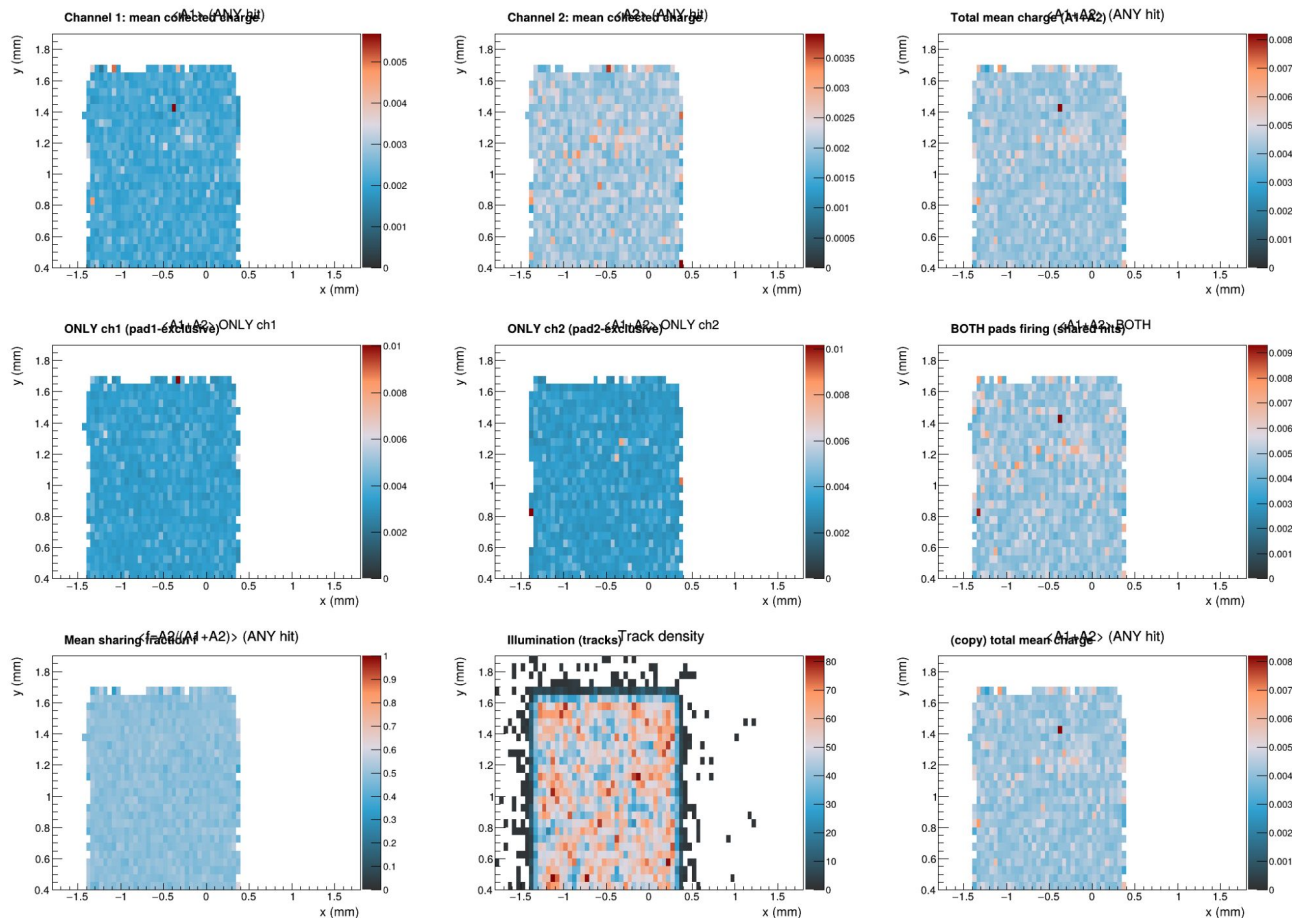


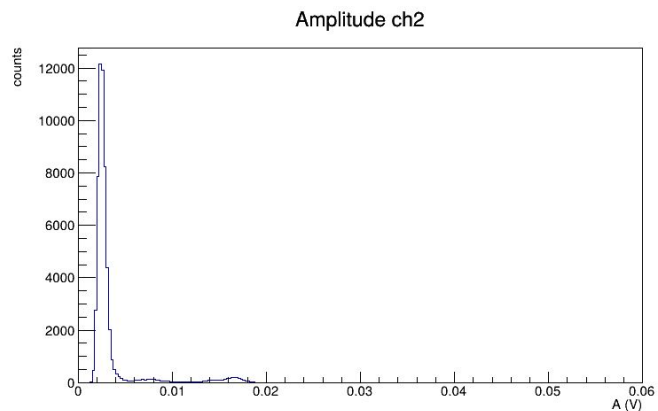
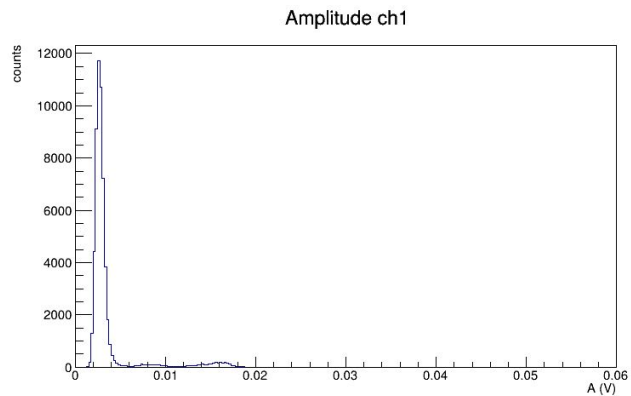
Charge pad2



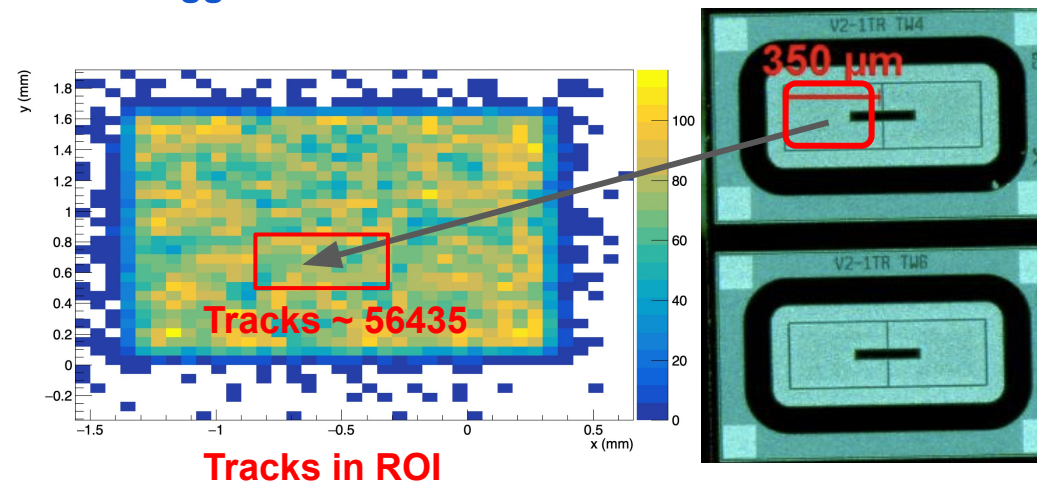




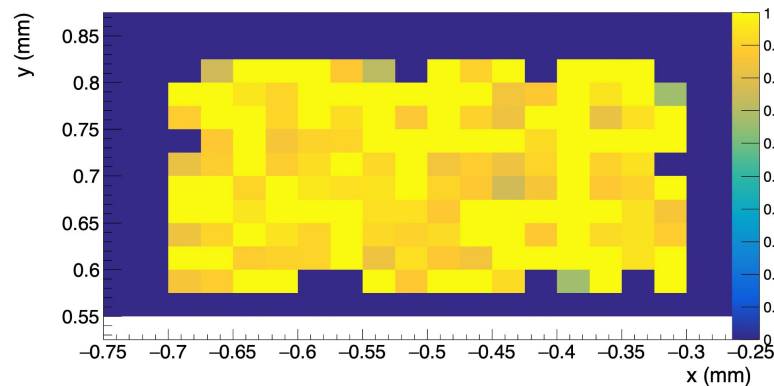




- Triggering configuration: coincidence of CROC HitOR signal and external scintillator triggers for track selection

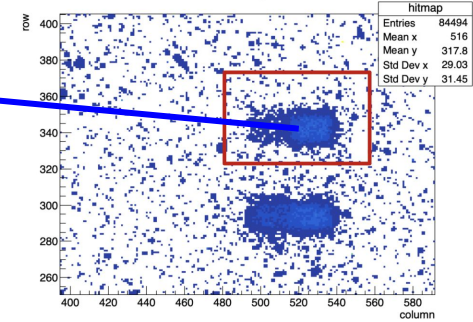
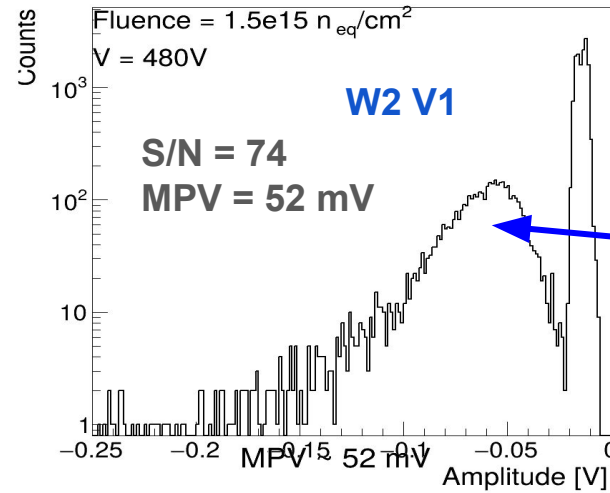
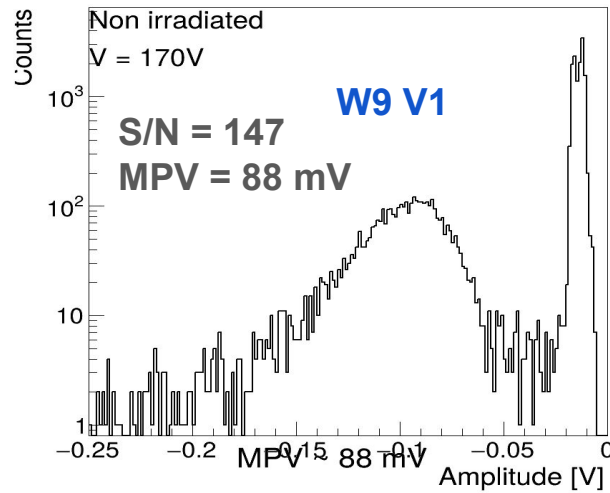


Preliminary results

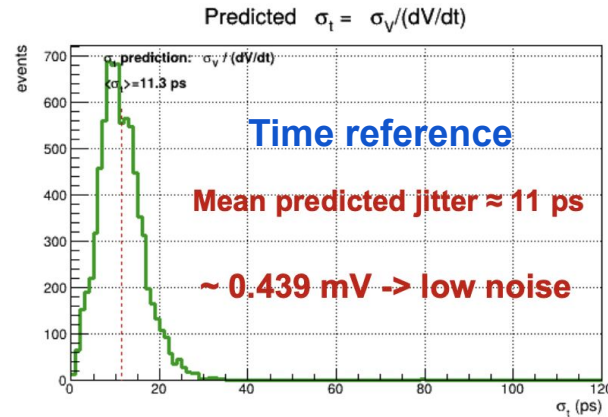
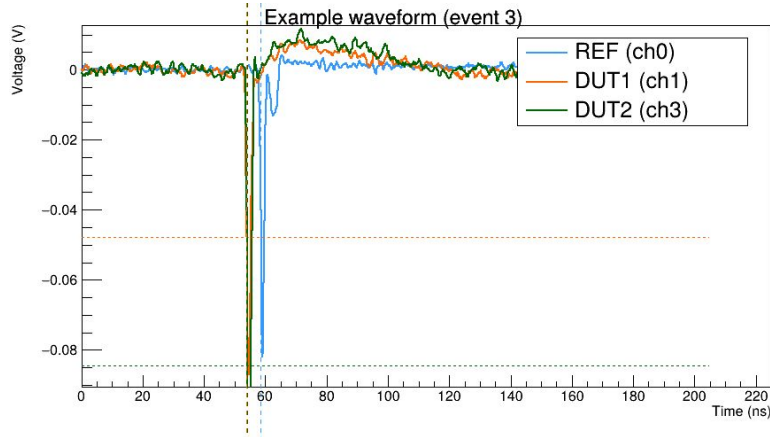


- Only tracks inside the pad
- Single-track events only
- Signal selection: Amplitude + ToA window ($\text{mean} \pm 2\sigma$ per channel).
- Threshold choice: 1.0 mV $\approx 1.2\text{--}1.3 \sigma_{\text{noise}}$
- sideband & pre-trigger fake rate = 0 / 10 k $\rightarrow$ efficiency not noise-driven

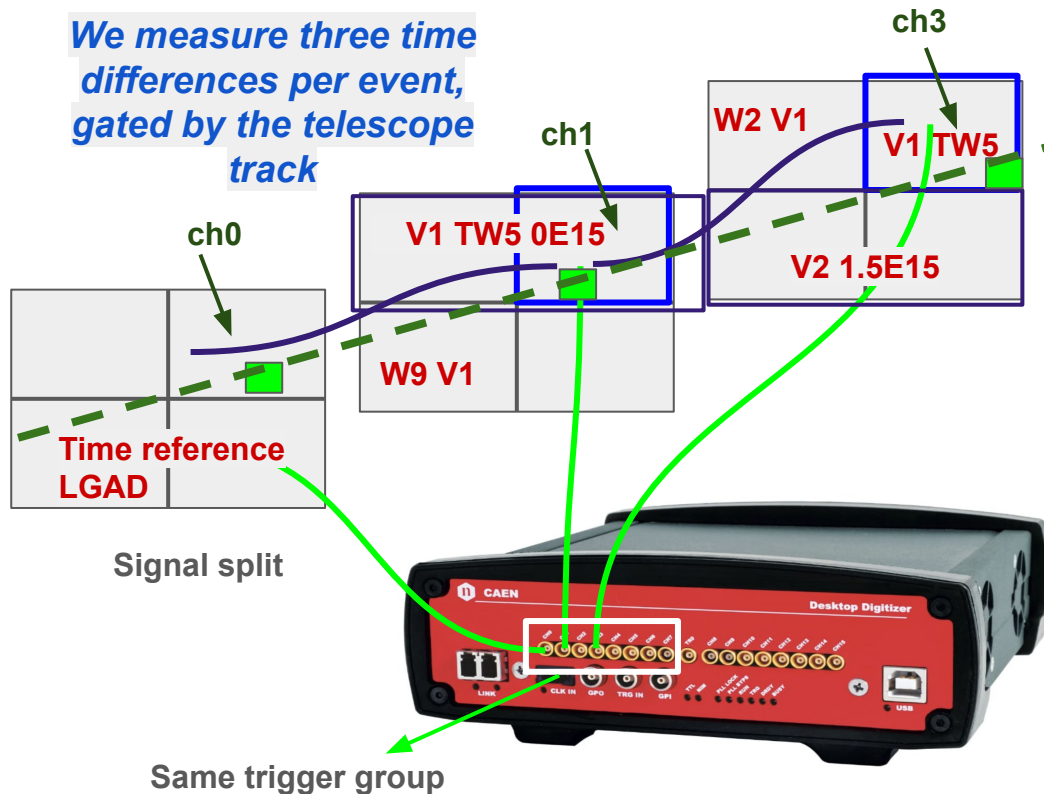
Analysis ongoing for V1 1.5E15



- **Signal-to-noise (S/N)** decreases from 147 $\rightarrow$ 74 after $1.5E15 \text{ n}_{eq}/\text{cm}^2$
- **Most probable amplitude (MPV)** reduces from 88 mV $\rightarrow$ 52 mV
- **Predicted time jitter $\approx 11 \text{ ps}$** (consistent with low electronic noise $\approx 0.44 \text{ mV}$)
- **Stable waveform shape and timing precision**



We measure three time differences per event, gated by the telescope track



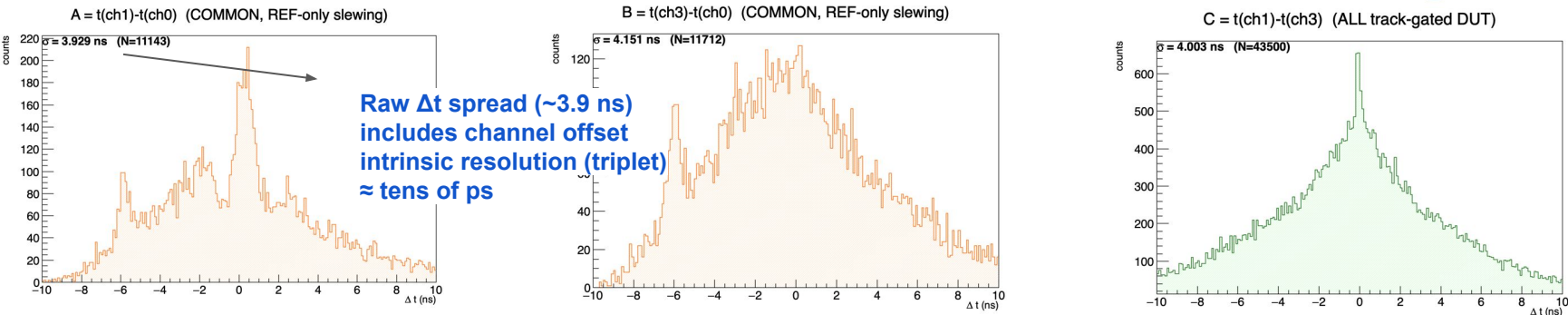
For each event, the track is interpolated across the three sensors, and the time differences between their signals are calculated.

- $A = t(\text{ch1}) - t(\text{ch0})$ (non-irradiated DUT - REF)
- $B = t(\text{ch3}) - t(\text{ch0})$ (irradiated DUT - REF)
- $C = t(\text{ch1}) - t(\text{ch3})$ (DUT - DUT, REF-independent)

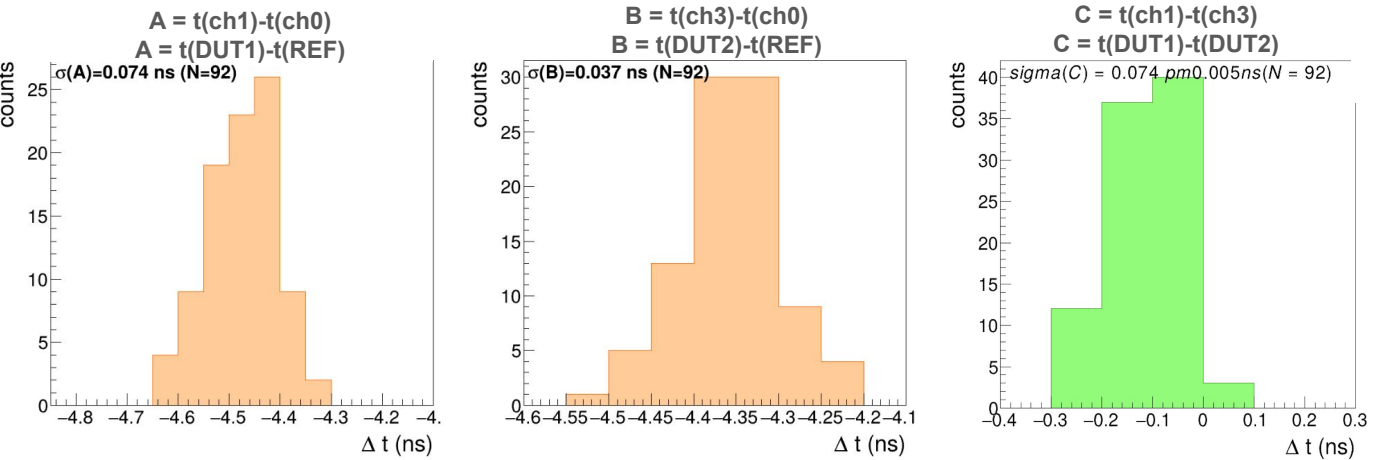
Triplet system equations:

$$A^2 = \sigma_1^2 + \sigma_R^2, \quad B^2 = \sigma_3^2 + \sigma_R^2, \quad C^2 = \sigma_1^2 + \sigma_3^2$$

¹ Track gating is the process of keeping only data associated with valid particle tracks and rejecting unrelated or noisy events



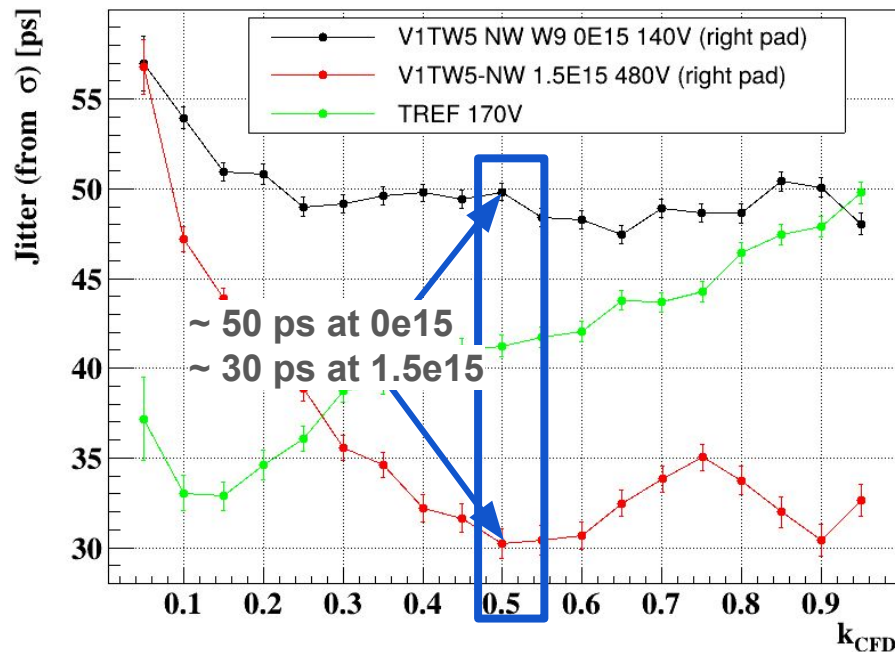
Inclusive results $\Rightarrow$ long tails (time walk + pile-up) $\longrightarrow$ Tight timing selection (narrow timing window, CFD at 50–55%)



DUT1 (ch1): $69 \pm 5 \text{ ps}$
DUT2 (ch3): $26 \pm 2 \text{ ps}$
Average intrinsic timing resolution of the two DUTs: $52 \pm 1 \text{ ps}$

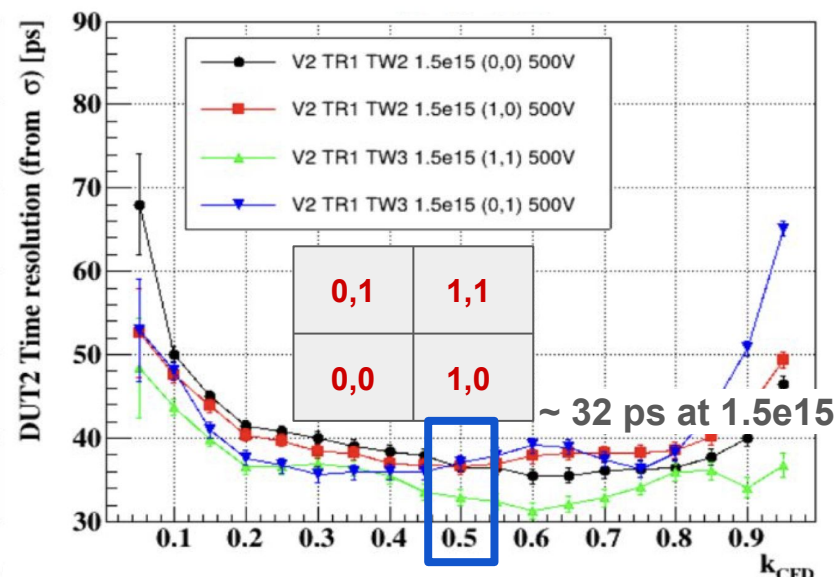
Measured spreads are dominated by symmetric detector jitter!

DUT1 $\rightarrow$ non-irradiated W9 V1 TW5
DUT2 $\rightarrow 1.5\text{E}15 \text{ n}_{\text{eq}}/\text{cm}^2$ W2 V1 TW5



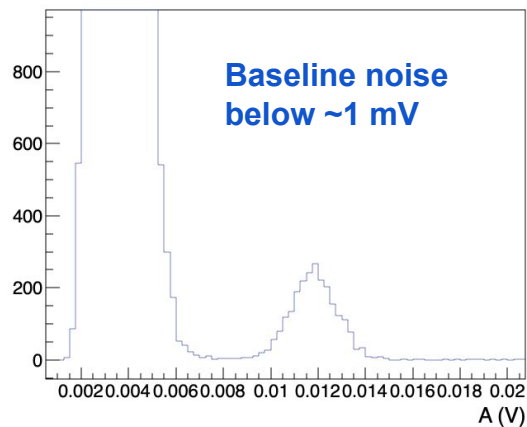
Without tracking, the Δt width depends on the CFD fraction improving up to ~ 0.5 – 0.8 where the signal slope is steepest

3 sensor method employed to extract time resolution of each of the DUT in the triplet (TREF, non irradiated and irradiated DUT)

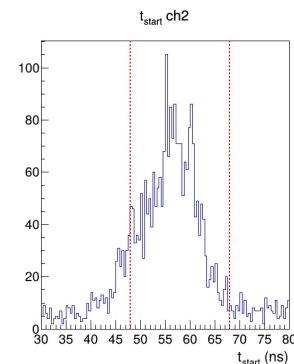
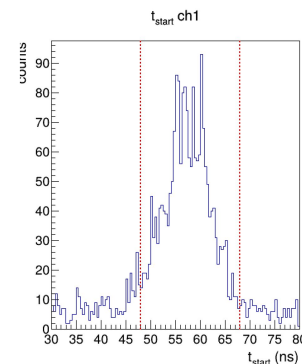
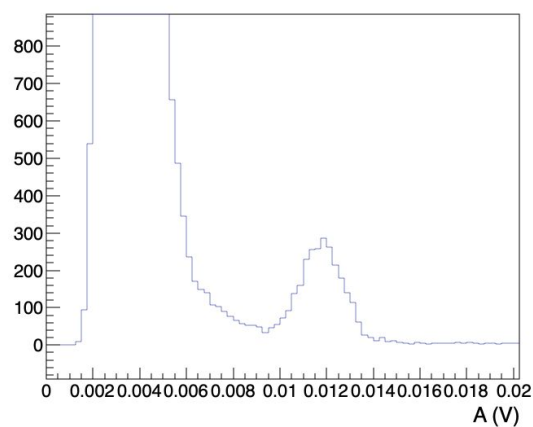


Results from Marcos Fernandez Garcia

Amplitude pad 1

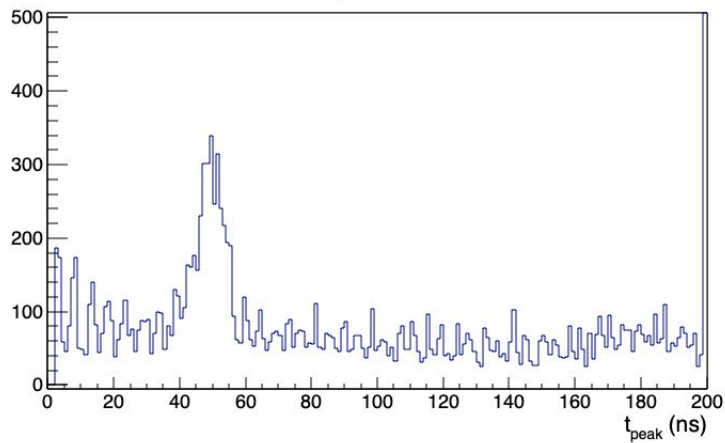


Amplitude pad 2



October '25 Non-irradiated V1 TI-LGAD @140 V

t_{peak} ch1



t_{peak} ch2

