

BIC test beam analysis

Tanner Mengel

September 29, 2026

Run info

- Looking at run 3062 form overnight run with 4.5 SFILs + Baby BCAL (runs 3060–3064, Aug 13–14)

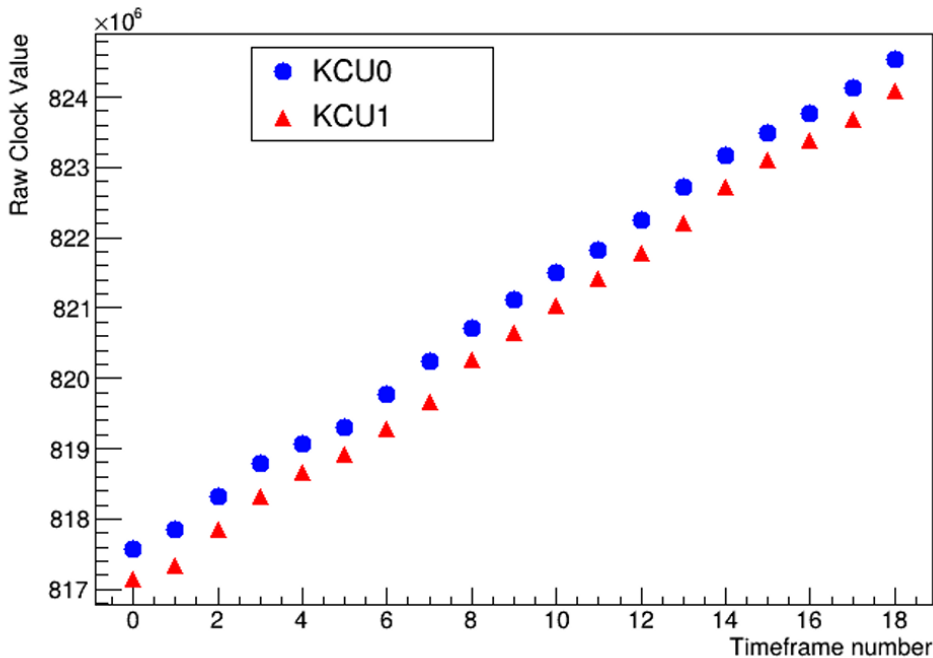
RCDAQ		Date	Start Time	End Time	KCU0	KCU1	AstroPix	CAEN0	CAEN1	Settings	KCU0 N Events	KCU1 N Events	AstroPix N Events	CAEN N Events	Hall D average Beam Current, PS field, Radiator	Notes
Run Number	Run Type															
3062	beam	08-13-2026	23:44	00:09 (8/14)	ON	ON	ON	ON	ON	SiPM HV: 41.70 V SiPM I: 343 μ A T1: NO DATA T2: NO DATA	404,593	162,905	12,148	1,507,461	<I> = 191.11 nA PS field: 1.662 T (~300A setting) Rad: JD80-213 80um 45/135 deg PSrad: HOME (out of beam) @ 0.000 mm TPOL: B (Be ~75 μ m?) @ 70.000 mm	Run with SFIL 1-4 North and South IN, and half of SFIL 5

Run 3062 data streams

Stream	Readout	Detector content	Segments
KCU0 beam_ROC_0	4 H2GCROC ASICs (288 ch) Triggered by paddle OR	A0: SFIL1–4 South, passive boards (16 ch) A1: trigger paddles 3–6 A2: SFIL1–4 North (16 ch) A3: Baby BCAL North (40 ch)	8
KCU1 beam_ROC_1	H2GCROC Triggered by paddle OR	A2: SFIL5 South, single-SiPM boards A0: SFIL5 North, on the old KCU0 board: not working well	3
CAEN beam_CAEN	DT5742 waveform digitizer	Baby BCAL South	3
AstroPix beam_AstroPix	ASTEP FPGA Self-triggered, streaming	One 9-chip PCB layer	1

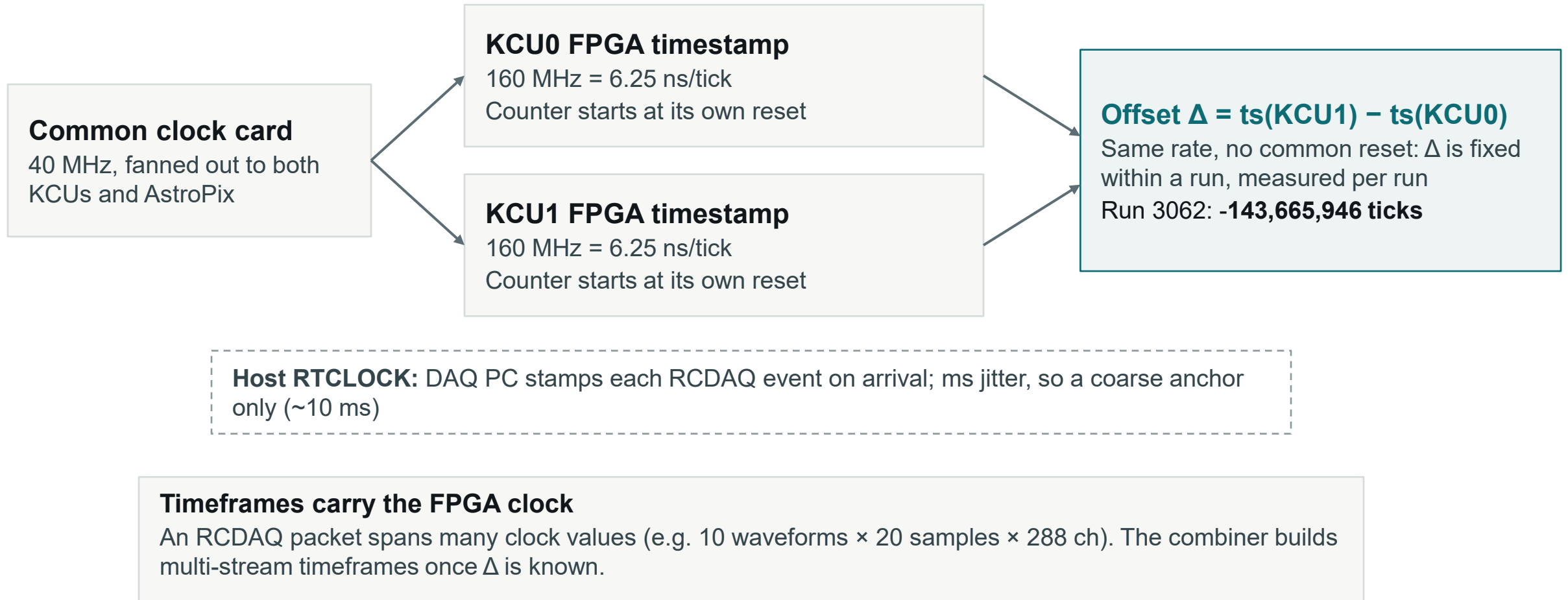
Current objective: KCU alignment

- DAQ deadtime means event numbers do not line up across streams
- KCU clocks share a source but have no common reset
 - Offset is constant within a run, unknown between runs



Quantity	Value	How it was established
KCU FPGA tick	6.25 ns	160 MHz; timestamp vs RTCLOCK slope, -31 ppm from nominal
Trigger latch grid	4 ticks = 25 ns	Every Δt_s is a multiple of 4; fixed phase per board
Sample spacing in ts	164 ticks	1.025 μ s readout cadence, one 25 ns window apart

KCU FPGA alignment

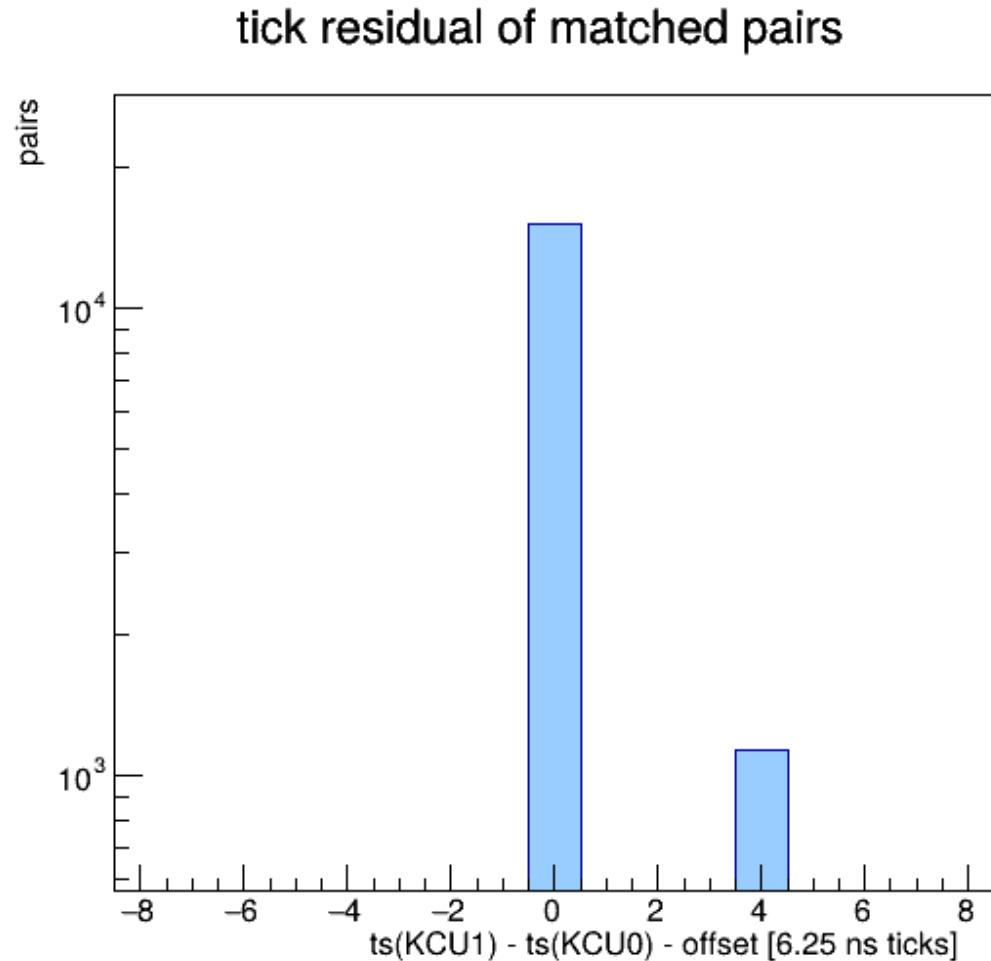


Source: M. Purschke, RCDAQ, DAQ meeting Aug 27 2026 (slides 3, 5–11); ePIC TIC, Sep 15 2026 (slides 6, 33, 36). Run 3062 offset from this analysis.

KCU0 & KCU1 FPGA offset

1. **Coarse (RTCLOCK):** $\text{RTCLOCK} - 6.25 \text{ ns} \times t_s$ gives each board's reset time on the host clock. The difference between the two boards gives the offset to about 10 ms
2. **Peak in 4-tick bins** take every KCU0 trigger and subtract its reading from every KCU1 reading close to the guess (within $\pm 20 \text{ ms}$). Most of those differences are random, because the triggers belong to different particles. But when the two readings come from the same event, the difference is always the true offset.
3. **Exact mode inside the bin:** true differences are congruent mod 4, so the bin center alone leaves a 2-tick error

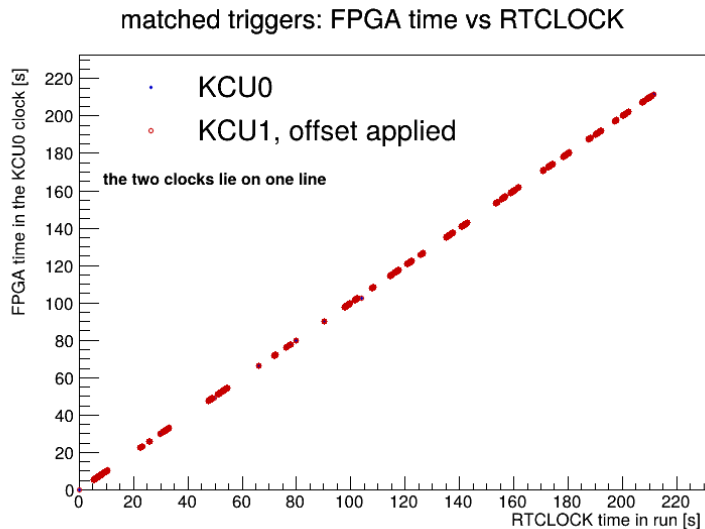
Offset : $-143,665,946$ ticks. Residual is 0 for 93% of pairs and +4 ticks (*only in KCU1*) for 7%, flat across the run



KCU0 & KCU1 alignment validation

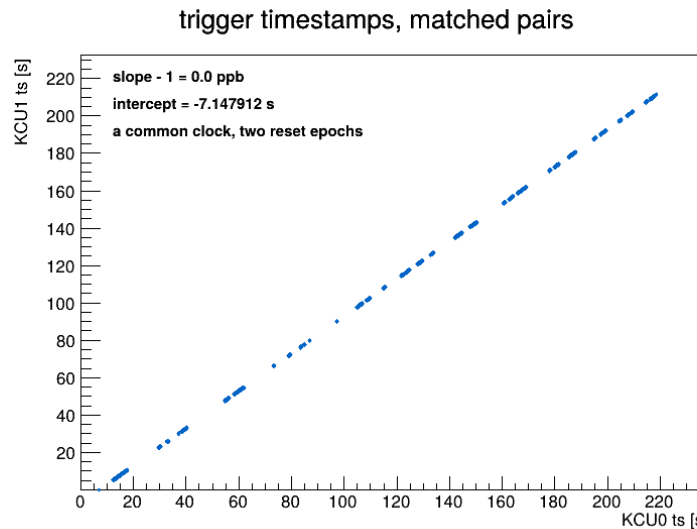
One timeline

With the offset applied, KCU1 trigger times sit on the KCU0 line against RTCLOCK for the full 220 s



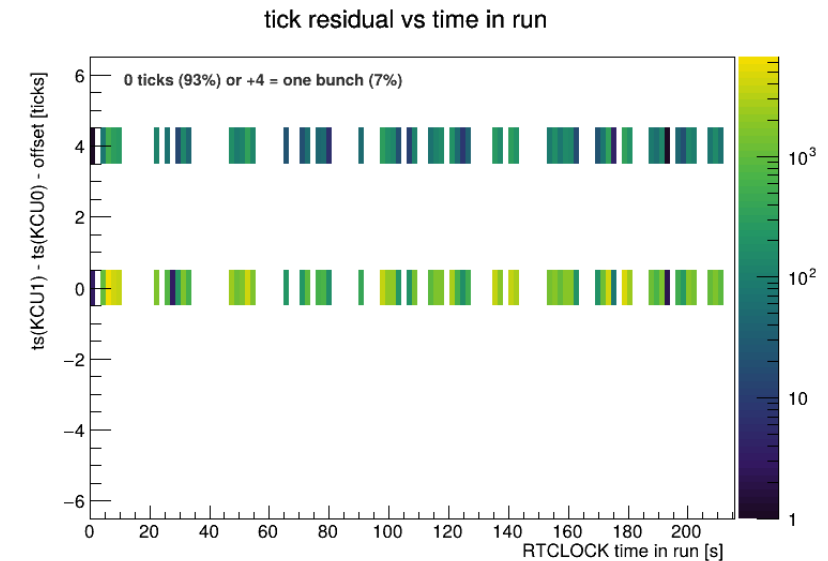
Same clock speed

KCU1 vs KCU0 fits slope $-1 = 0.0$ ppb over 101,800 matched pairs; the y-intercept is the reset-epoch gap



No drift

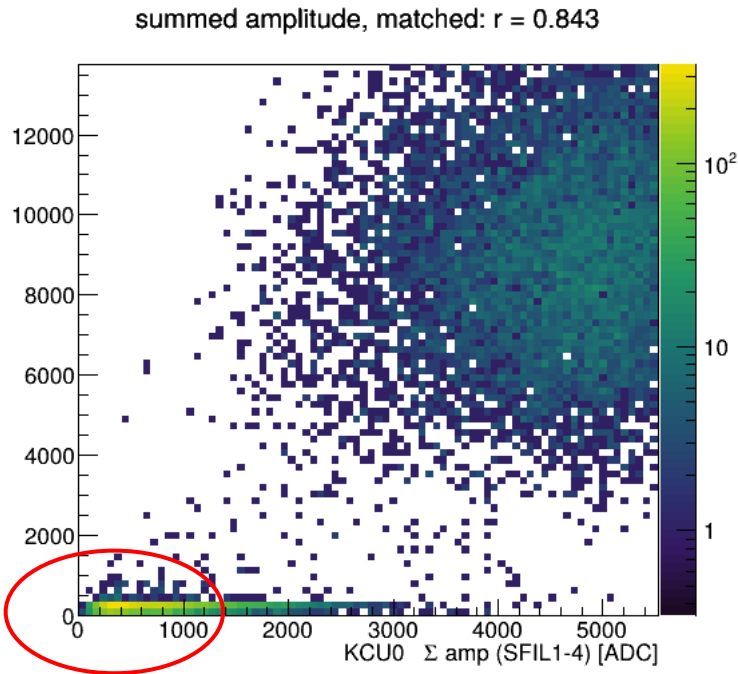
Residual stays at 0 ticks (93%) or +4 ticks (7%), across the whole 0000 segment



ADC sum check

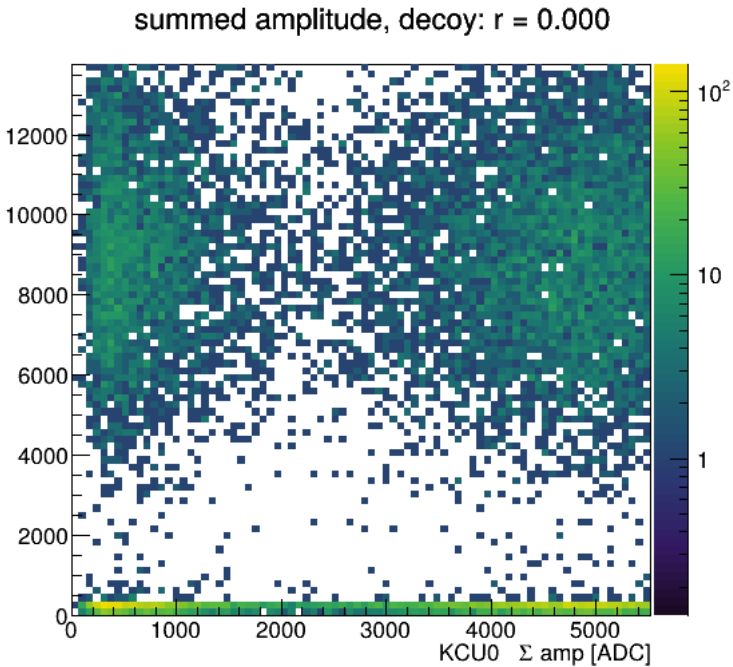
Showers pair with showers

Matched triggers split into empty/empty and shower/shower ($r = 0.84$); no energy trend, since SFIL5 samples one thin slice of the shower



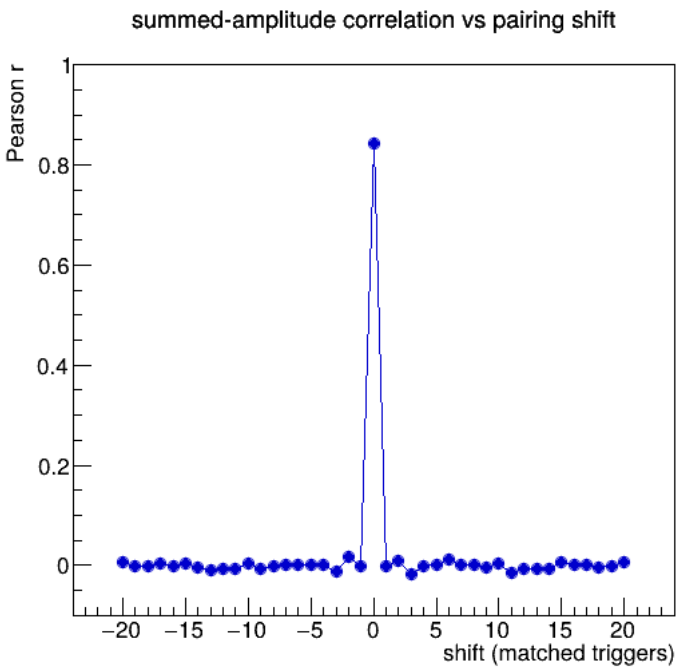
Decoys do not

Pairing each KCU0 trigger with a non-matching KCU1 trigger gives $r = 0.00$



Peak only at $k = 0$

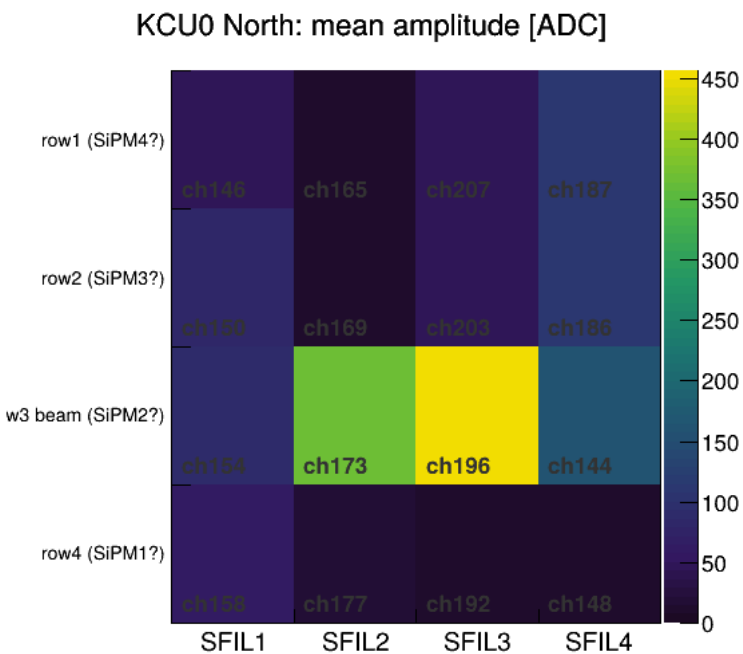
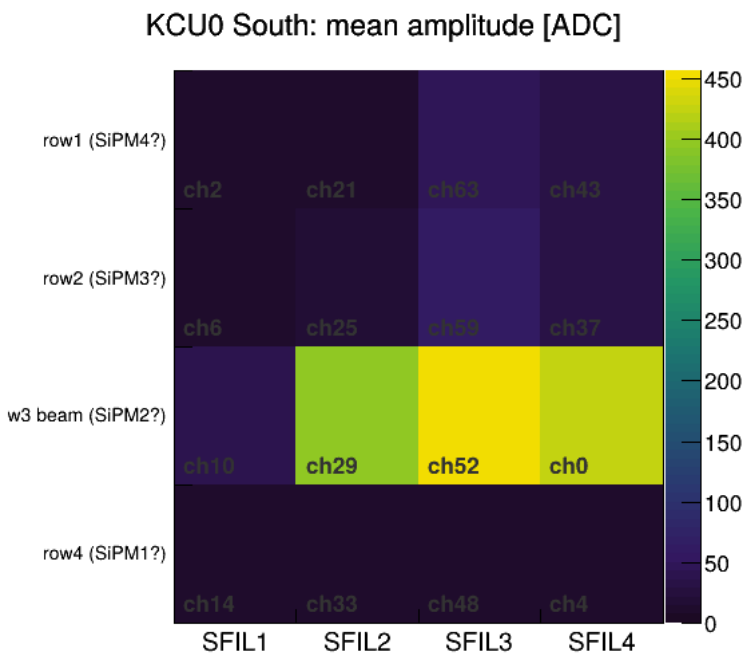
Shifting the pairing by k triggers: $|r| < 0.02$ at every other shift



SFIL geometry check

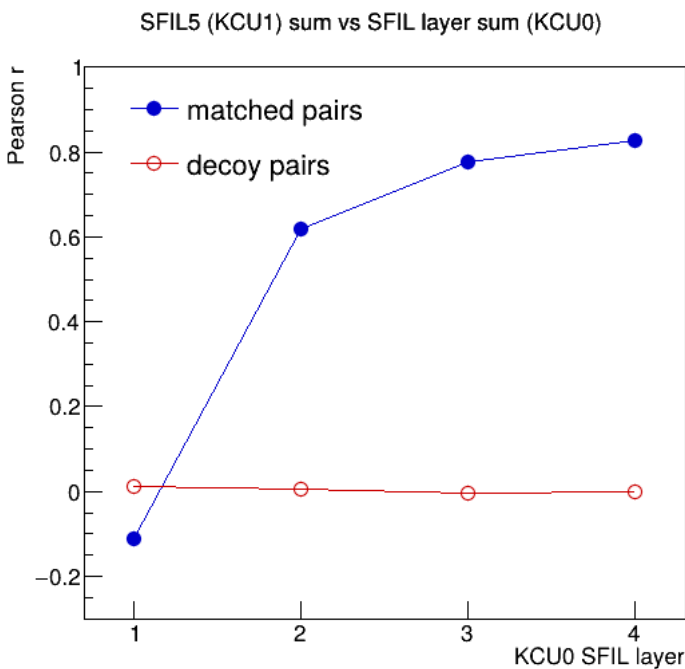
Beam row lights up on both ends (KCU0)

South and North maps agree: the same layer at both ends gives $r = 0.96$ (SFIL2) and 0.98 (SFIL3)



SFIL5 tracks deeper layers

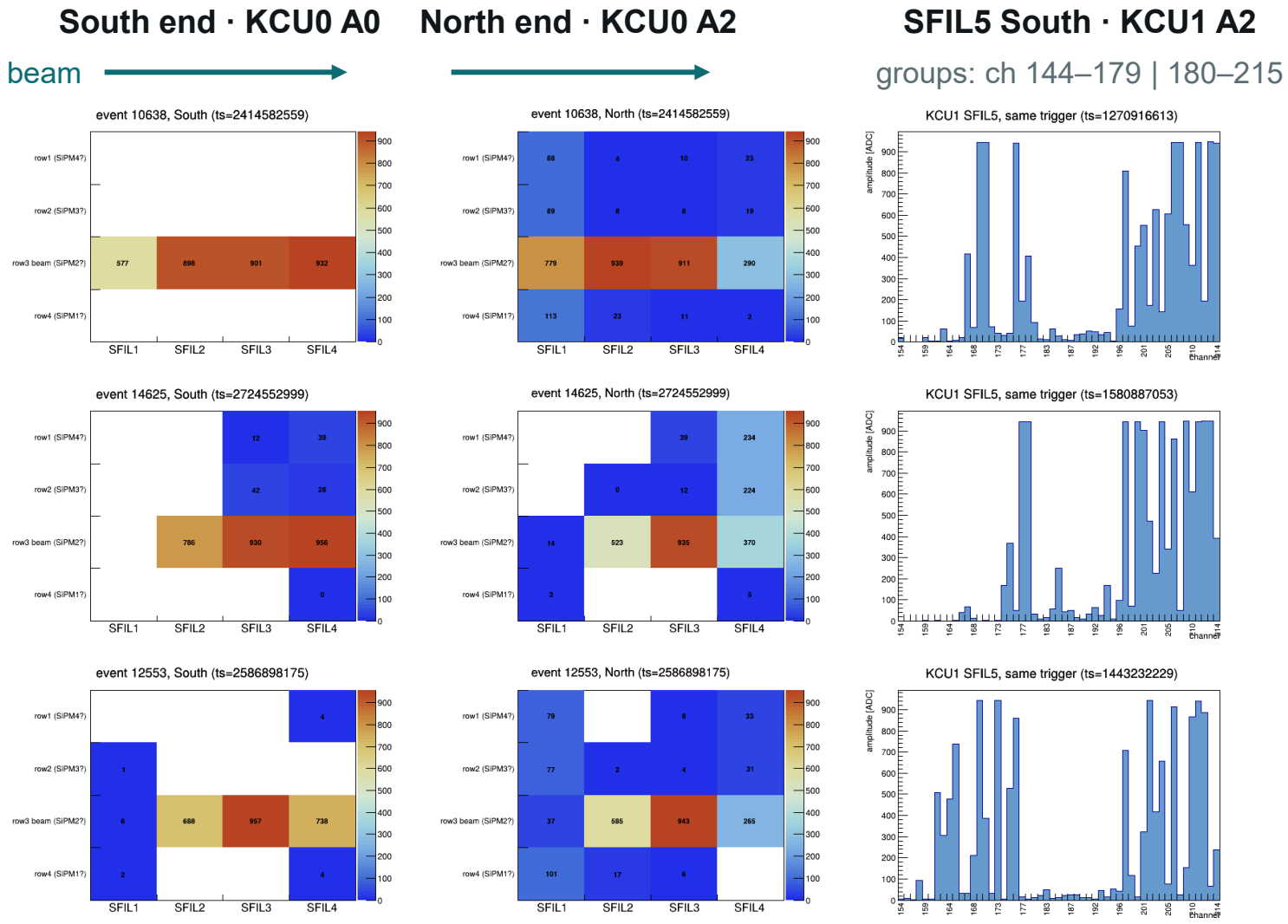
Matched r rises from -0.11 (SFIL1) to 0.83 (SFIL4); decoys stay at 0. Qualitative only: summed amplitudes inflate r



Events w/ matched triggers

- Each row is one trigger, found by timestamp on both KCUs
- Shower sits in the beam row and **peaks at SFIL3–4** on both ends (saturating near 950 ADC)
- North SFIL4 reads lower than South in all three events
- SFIL5 (KCU1) has signal on the same trigger

Beam-row channels (KCU0)
South (A0): ch 10, 29, 52, 0
North (A2): ch 154, 173, 196, 144
for SFIL1 → SFIL4; row order tentative



Next steps

1. Resolve the CAEN trigger source, confirm pulser state, and beam conditions for run 3062
Should we always expect a “geometric correlation” in SFILs, even for unaligned events?
Was the 10 Hz pulser enabled in run 3062?
Is low sum ADC in SFIL5 expected, or is this a misalignment?
2. Add the KCU1 SFIL5 channel map to turn the transverse correlation into a position measurement **TODO**
3. CAEN Trigger time alignment from paddles **TODO**
4. Add AstroPix by time window around each KCU trigger (1 AstroPix tick = 4 KCU ticks) **TODO**