

COFFEE3 test beam at SPS

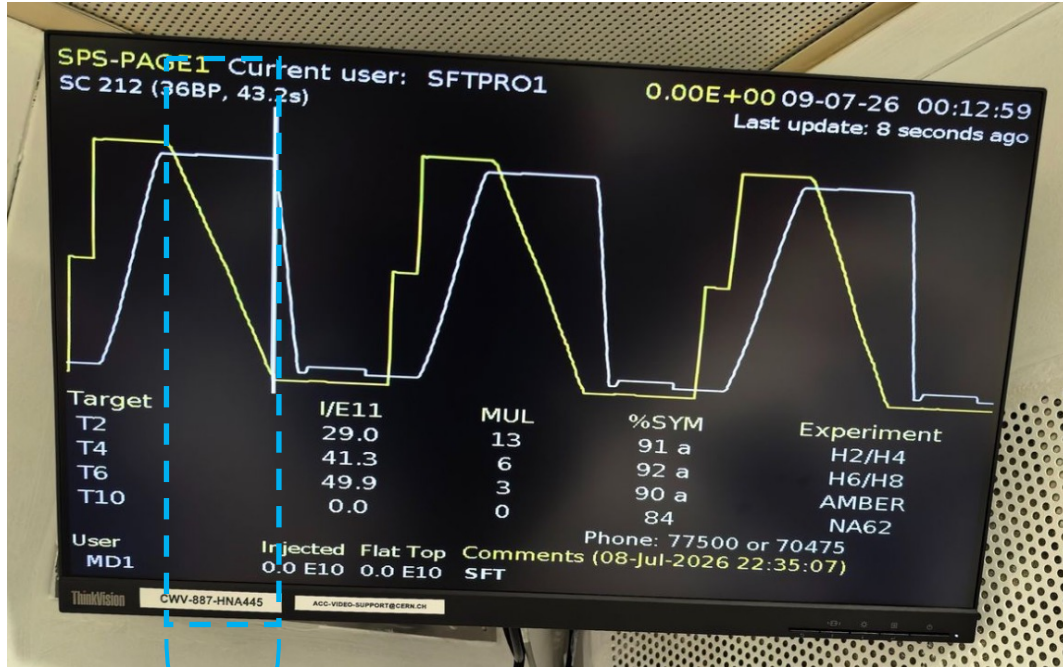
Yuman Cai, Yisheng Fu, Kang Liu, Qinze Li, Yiming Li,
Boxin Wang, Zijun Xu, Yuan Yuan, Hui Zhang

2026 07 21

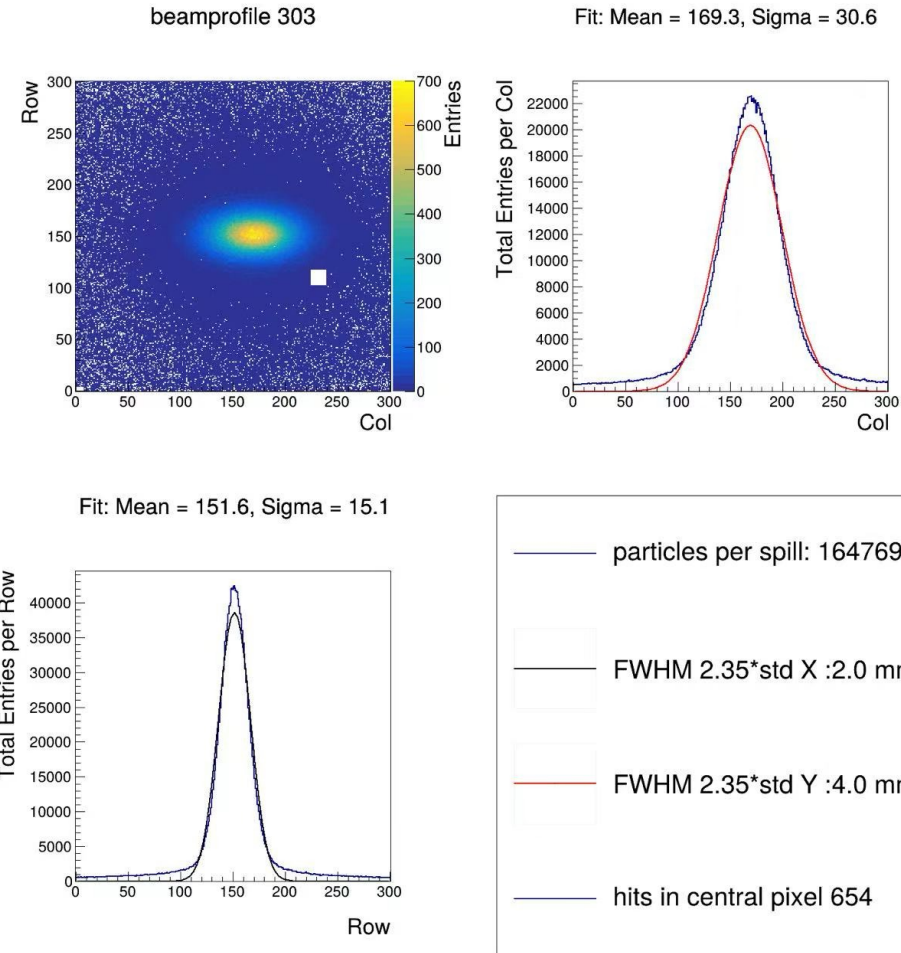
Beam information:

SPS H8 PPE138, Mixed hadron beam, 180 GeV/c, approximately 2×10^6 particles/spill

8 July ~ 15 July

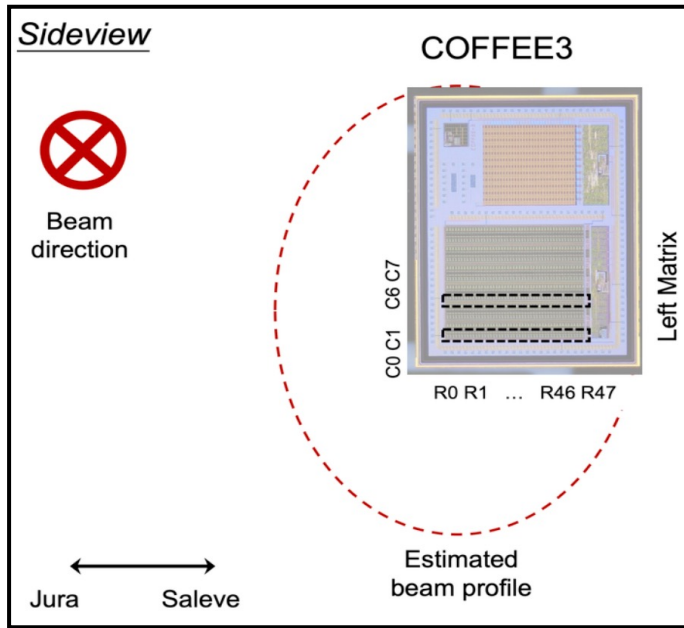
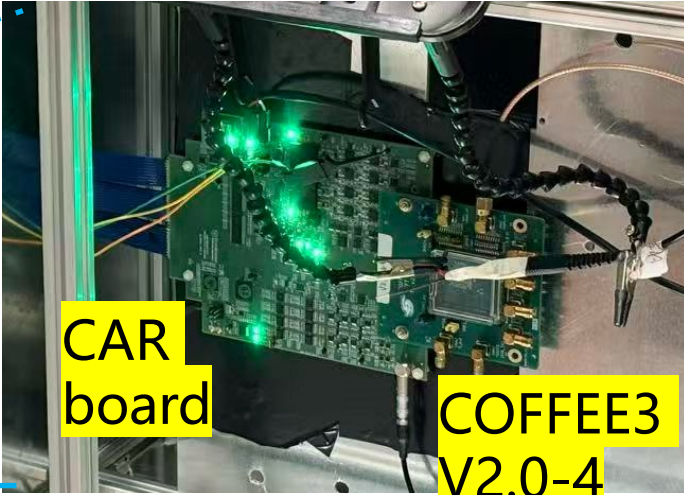
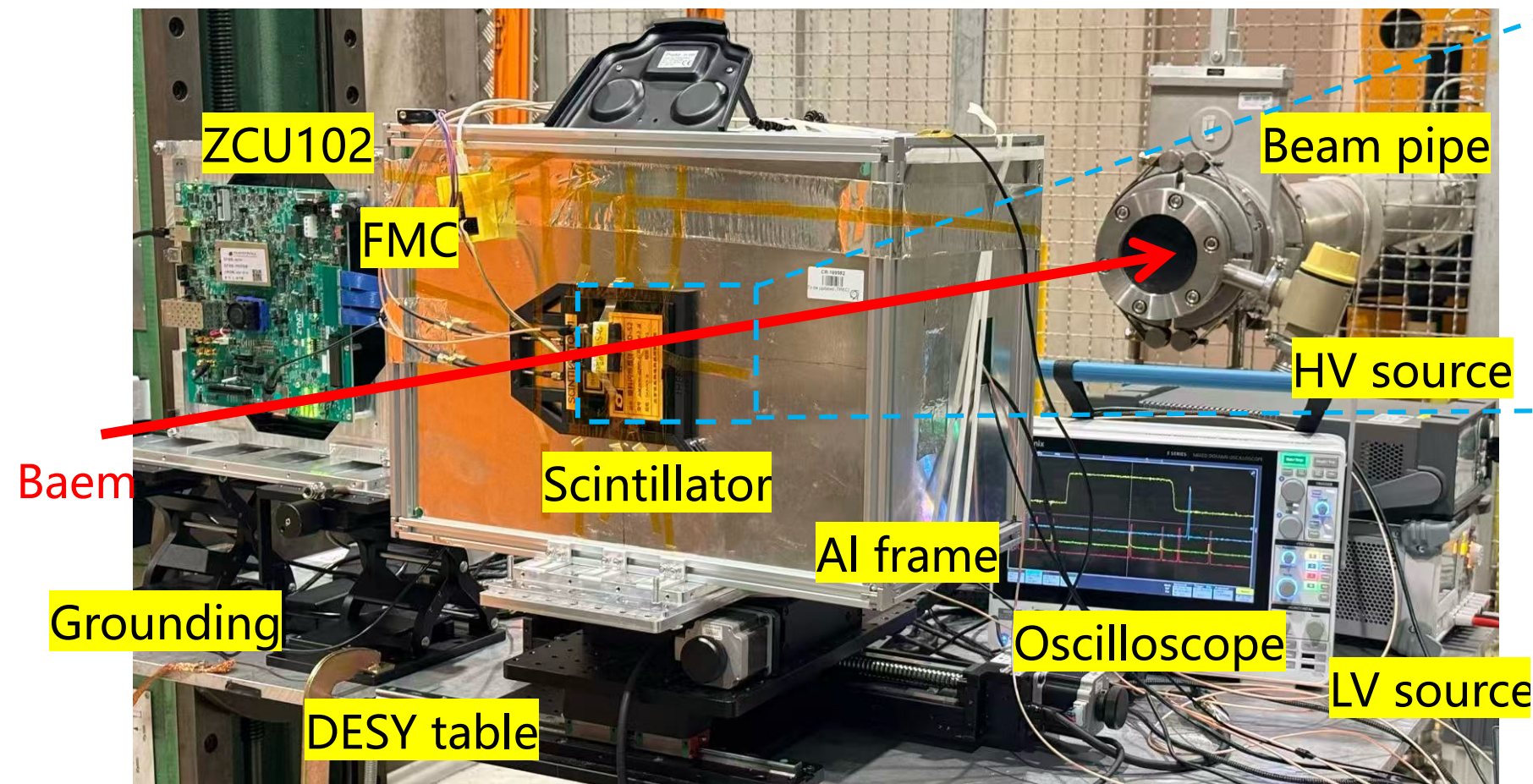


Spill



Beam profile measured by Timepix telescope
(kindly provided by Morag Williams)

Test Beam setup



DUT: COFFEE3 V2.0-4, without telescope

Configuration and Threshold

- Tagged as "v2p0_4"

B1	B2	B3	B4	clamp	com_bias	IB1	IB2
0.9	0.9	0.8	0.34	0.8	0.85	0.5	0.2

- Threshold definition:

- Threshold when no noise hits within 1min (decrease Th 0.001V will observe noise hit)
- **Turn off** (on) the movable platform: **0.837** (0.846)

Sensitive to noise!

- Used in beam test at May

B1	B2	B3	B4	clamp	com_bias	IB1	IB2
0.9	0.9	0.8	0.34	0.75	0.75	0.5	0.2

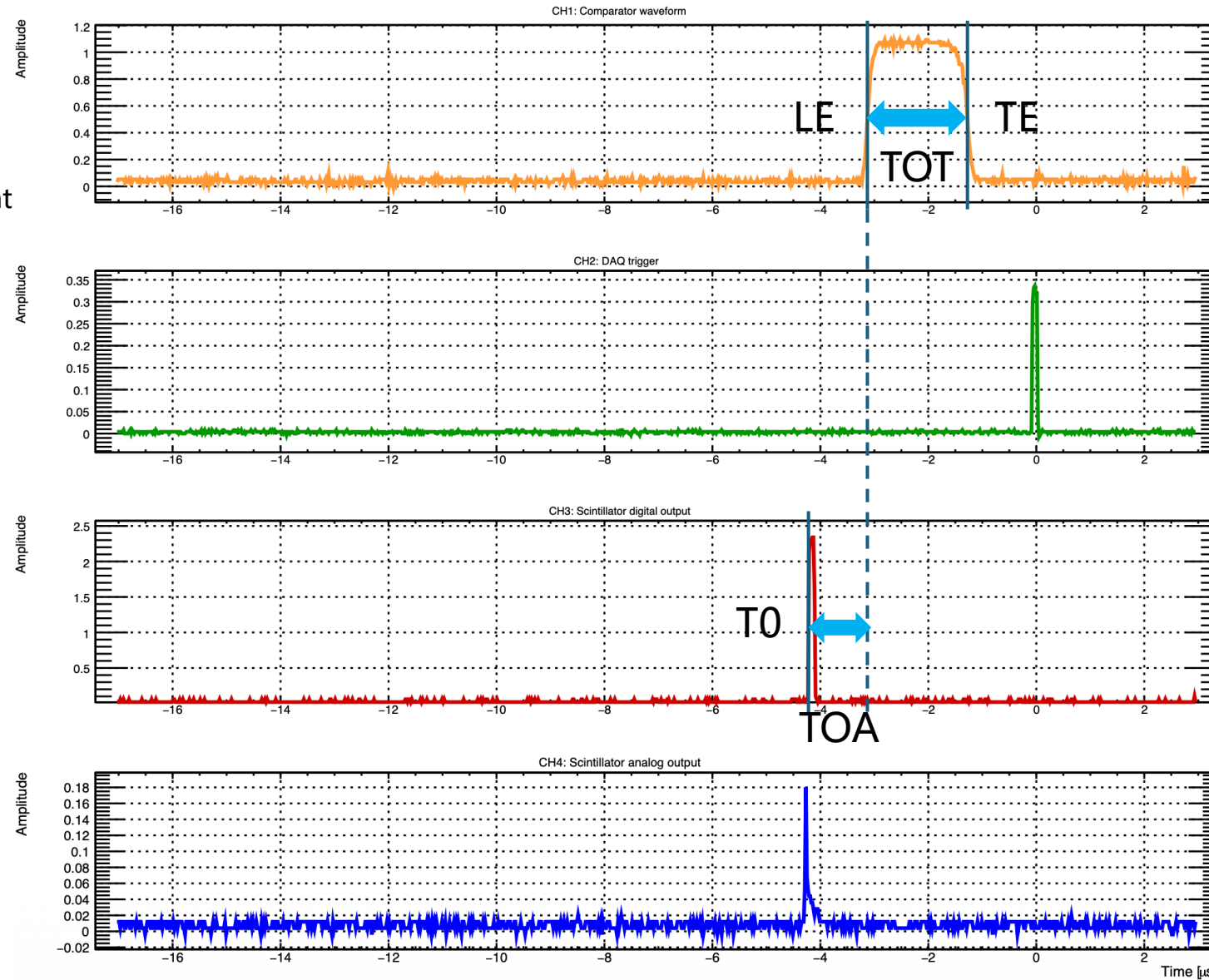
C1R0 Single-Pixel analysis

LE: $\text{Time}_{\text{half_max}}(A)_{\text{left}}$

TE: $\text{Time}_{\text{half_max}}(A)_{\text{right}}$

Use DAQ as trigger

T0: $\text{Time}_{\text{half_max}}(A)$
before LE



Comparator

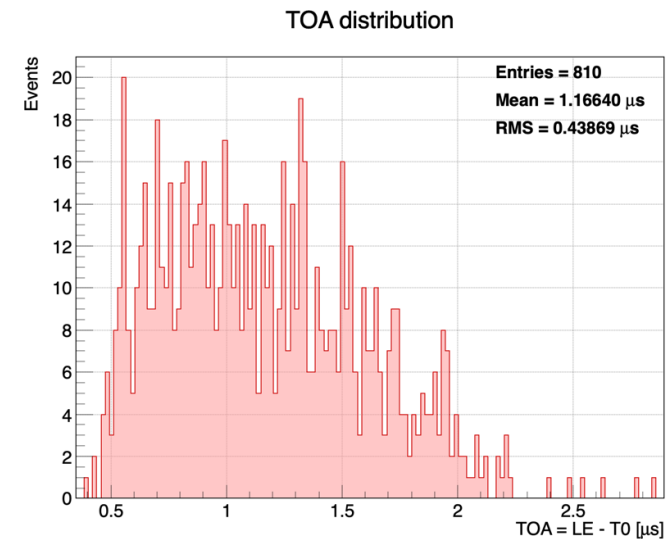
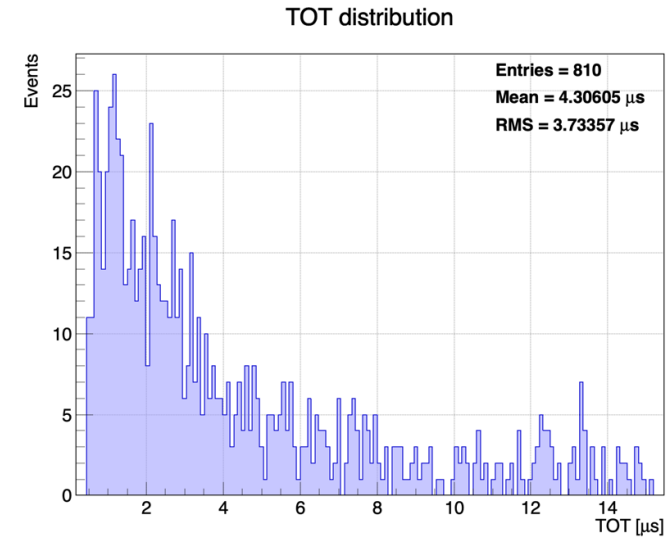
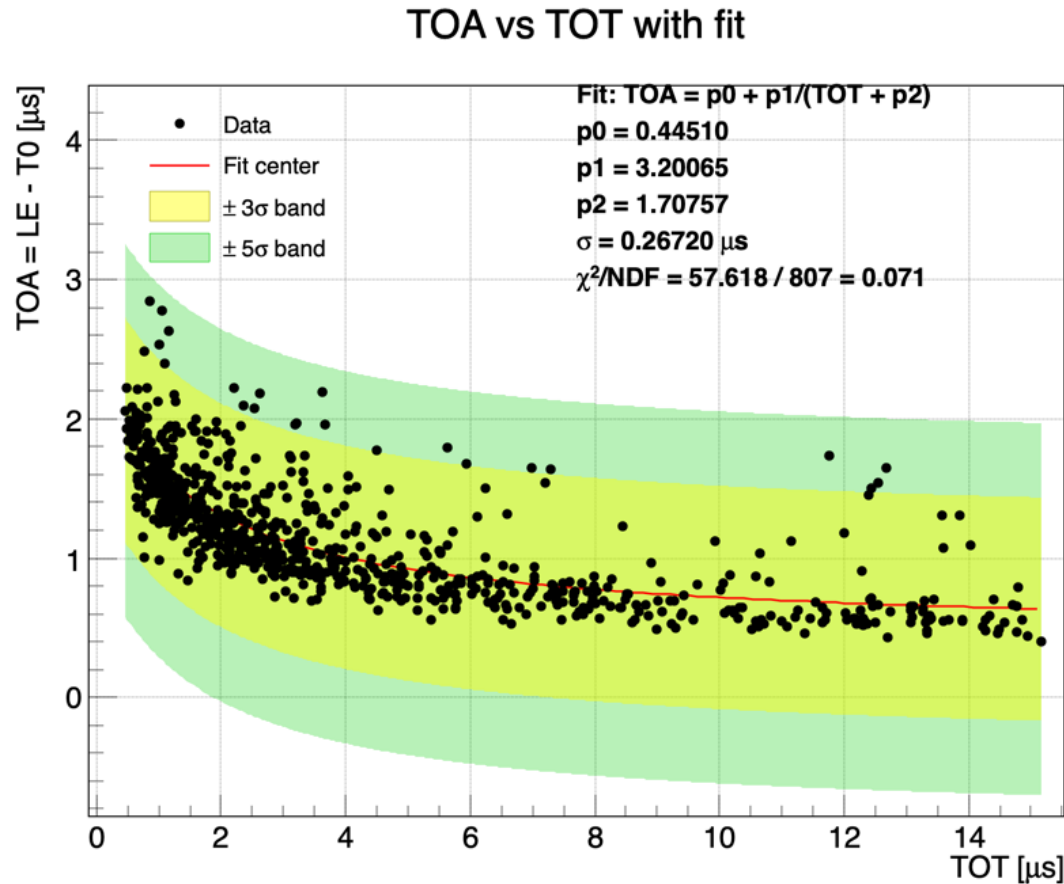
DAQ trigger

Scintillator digital

Scintillator analog

C1R0 Single-Pixel analysis

Configuration: v2p0_4, Unmask: C1R0, Th: 0.835, HV: -65V

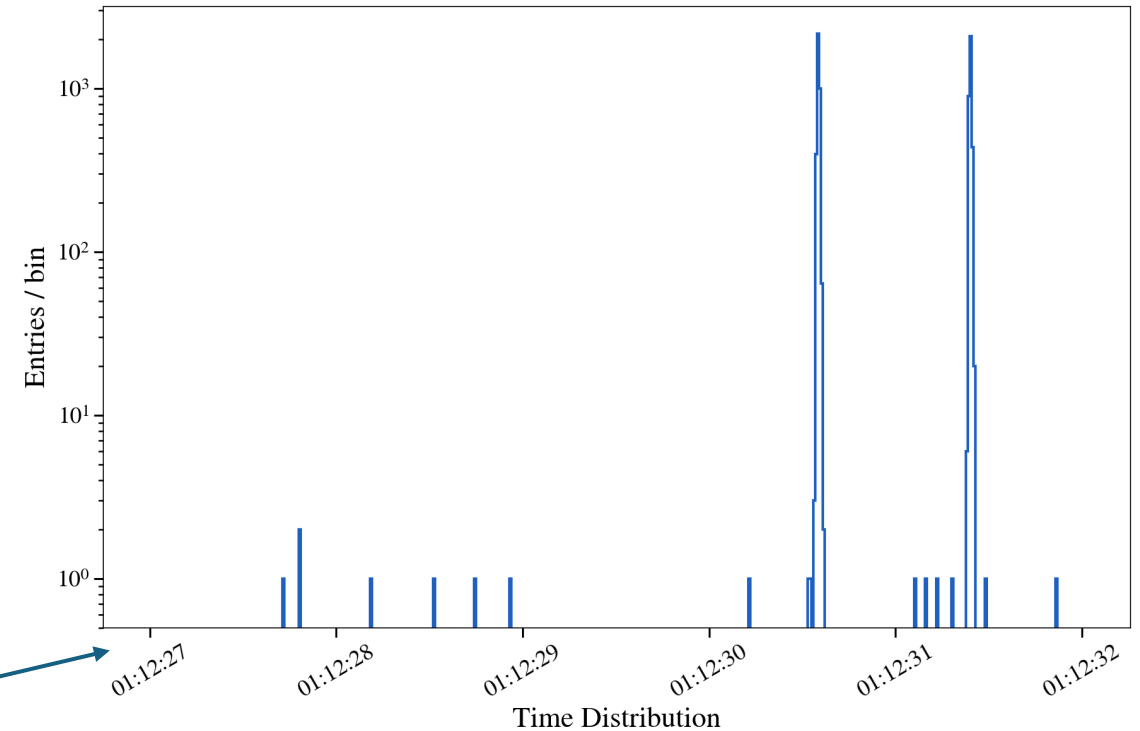
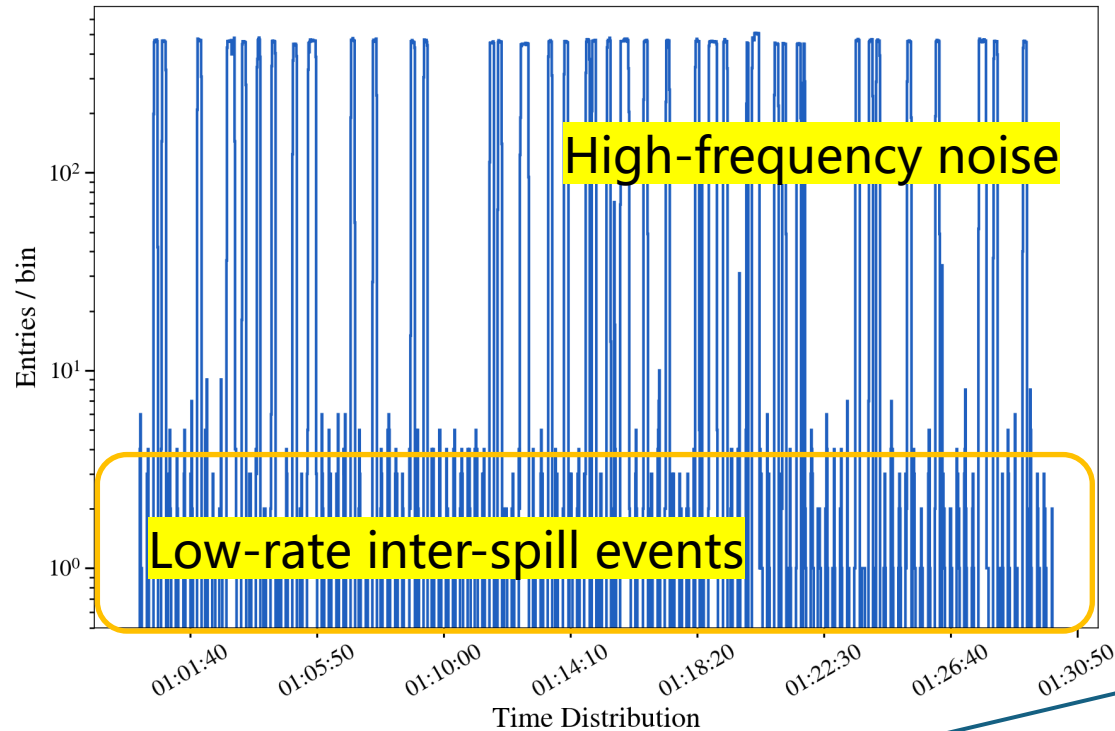


Time resolution: $\mathcal{O}(100)$ ns (**~ 90 ns if cut $\text{TOT} > 8$ us**)

efficiency $\sim 1\%$: July 11th, 00:45-10:30, total events: 5505

Multi-pixel data acquisition

Hit explosion observed



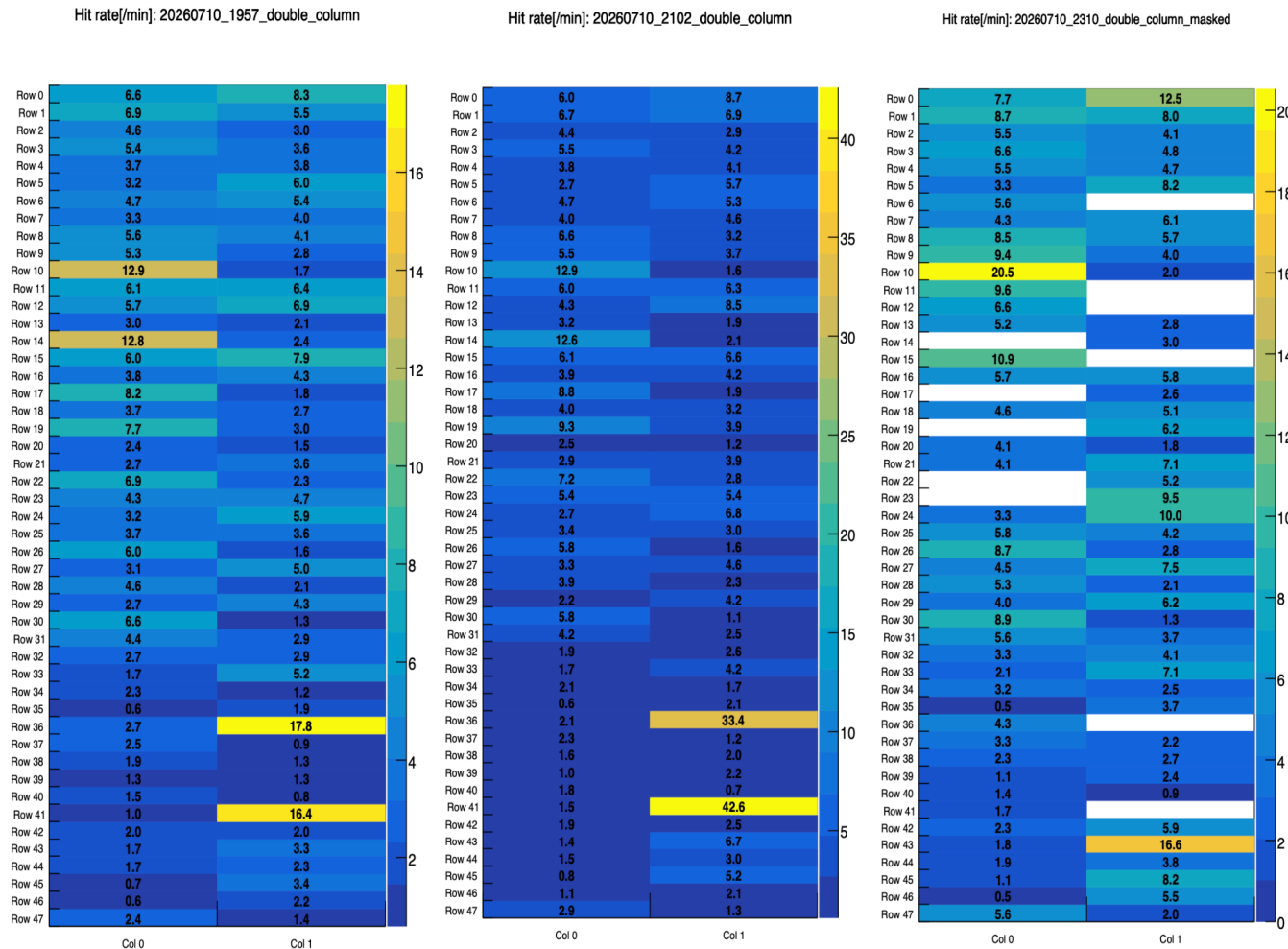
Zooming in on a single spill (10 ms/bin) reveals sudden bursts of over 1,000 hits in some bins.

Signal: fewer than 10 events within 50 ms.

Multi-pixel data acquisition

The **first** double column

TH=0.836 / TH=0.83 / TH=0.808, 11px masked



Single-pixel tests of C1R36, C1R41

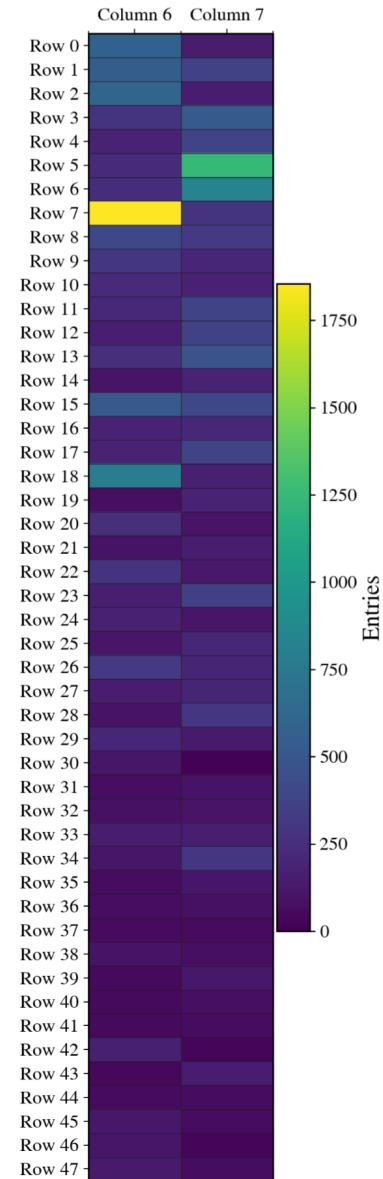
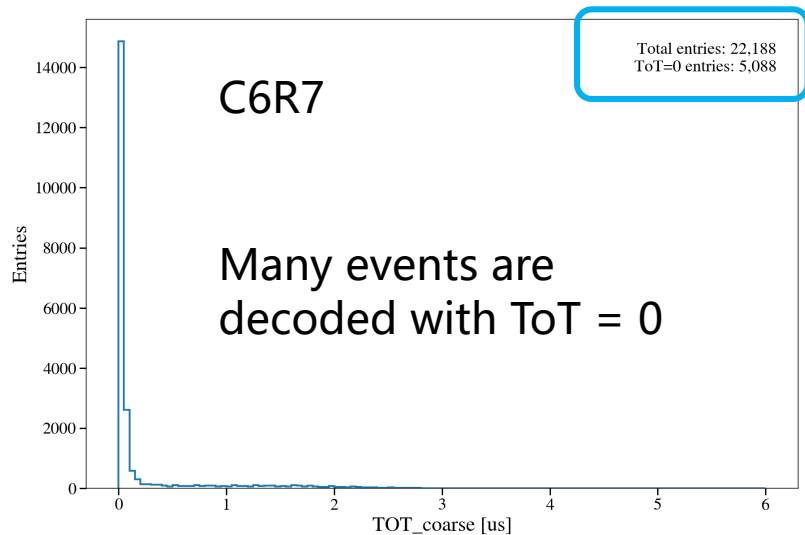
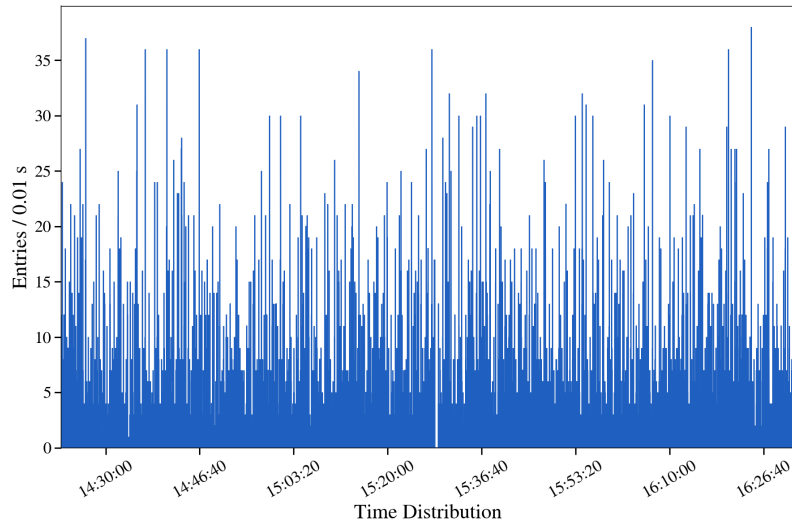
TH(noise-free) = 0.891

Hits were noise-induced

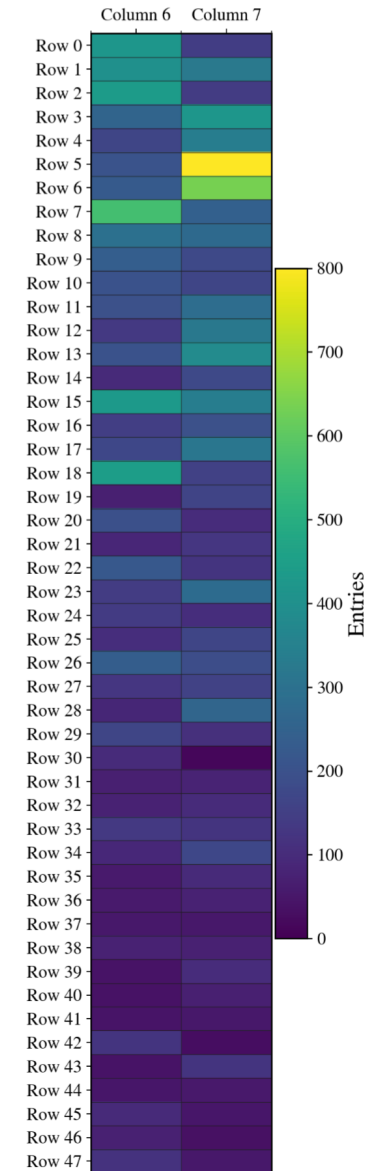
Large pixel-to-pixel variations in hit rate

Multi-pixel data acquisition

The **fourth** double column, **TH=1.09**



Raw hit map



Exclude events with ToT = 0

TDAC tuning

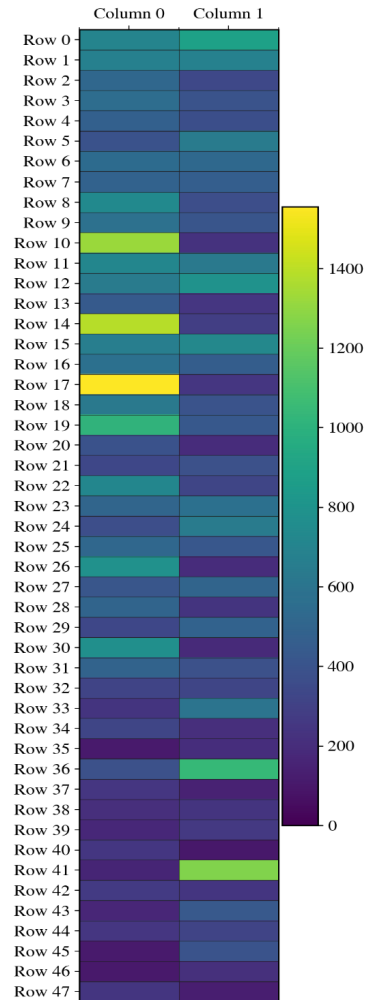
To increase the reception of certain low event rate pixels.

For each 4-bit TDAC setting, scan TH to find the noise free threshold.

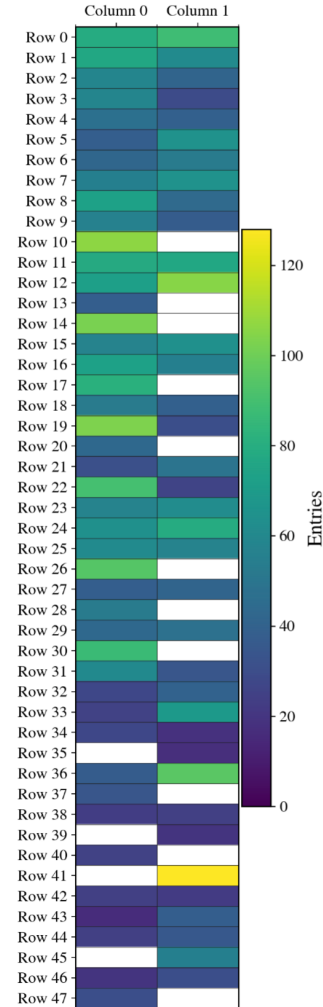
像素	0000	1000	0100	0010	0001	1010	global_TH 0.893
C1R0	0.835	0.002	0.011	0.022	0.042	0.025	0101 =0.053 (0.058)
C1R1	0.809	0.007	0.015	0.020	0.042	0.024	0111 =0.077 (0.084)
C1R38	0.836	0.008	0.013	0.026	0.067	0.036	1110 =0.047 (0.057)
C0R25	0.831	0.006	0.014	0.029	0.057	0.036	0001 =0.057 (0.062)

TDAC tuning

Testing on C1R10 C1R13 C1R17 C1R26 C1R20 C1R28 C1R30 C1R37 C1R40 C1R47 C0R35 C0R39 C0R41 C1R14 C0R45



TDAC 0000

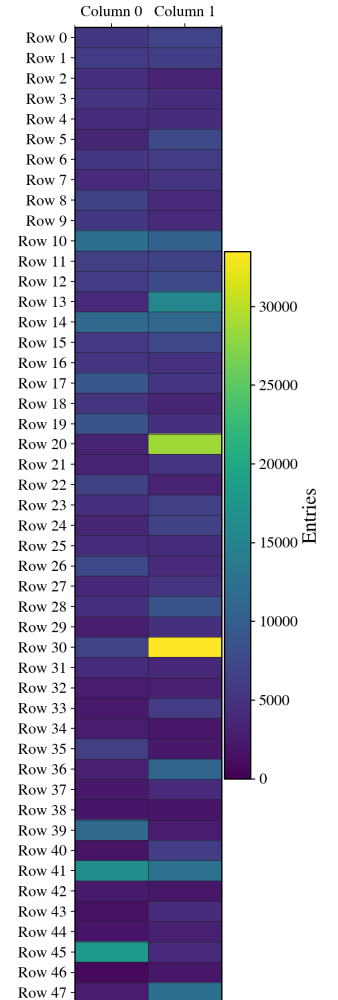


TDAC 1111

A high TDAC -> lower the threshold
too much -> comparator remain high
-> no digital pulses

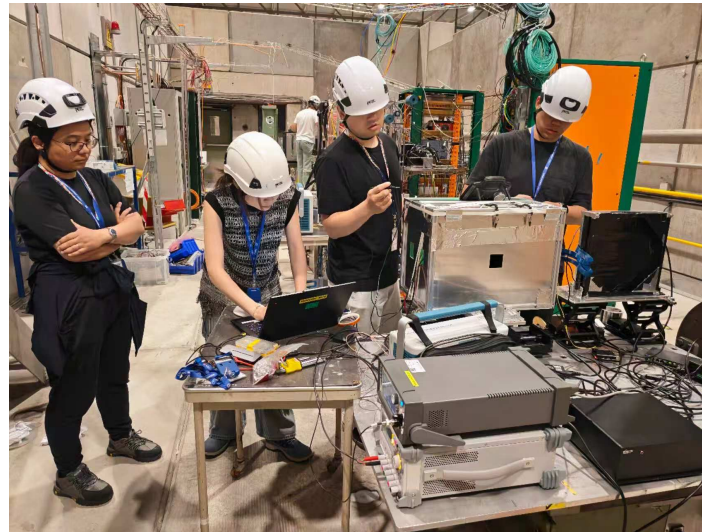
```
>>> cl.set_all_pixel_data(mask="1",tdac="0000")
>>> cl.set_double_column_data(0,mask="0",tdac="0000")
>>> cl.set_single_pixel_data(1,10,tdac="0010")
>>> cl.set_single_pixel_data(1,13,tdac="0010")
>>> cl.set_single_pixel_data(1,20,tdac="0010")
>>> cl.set_single_pixel_data(1,30,tdac="0010")
>>> cl.set_single_pixel_data(0,39,tdac="0010")
>>> cl.set_single_pixel_data(0,41,tdac="0010")
>>> cl.set_single_pixel_data(1,14,tdac="0100")
>>> cl.set_single_pixel_data(1,17,tdac="0100")
>>> cl.set_single_pixel_data(1,26,tdac="0100")
>>> cl.set_single_pixel_data(1,37,tdac="0100")
>>> cl.set_single_pixel_data(1,47,tdac="0100")
>>> cl.set_single_pixel_data(1,28,tdac="1100")
>>> cl.set_single_pixel_data(1,40,tdac="1100")
>>> cl.set_single_pixel_data(0,35,tdac="1110")
>>> cl.set_single_pixel_data(0,45,tdac="1010")
>>> cl.config_all("011","000","100","101","110","111")
```

The TDAC works as expected.



Summary

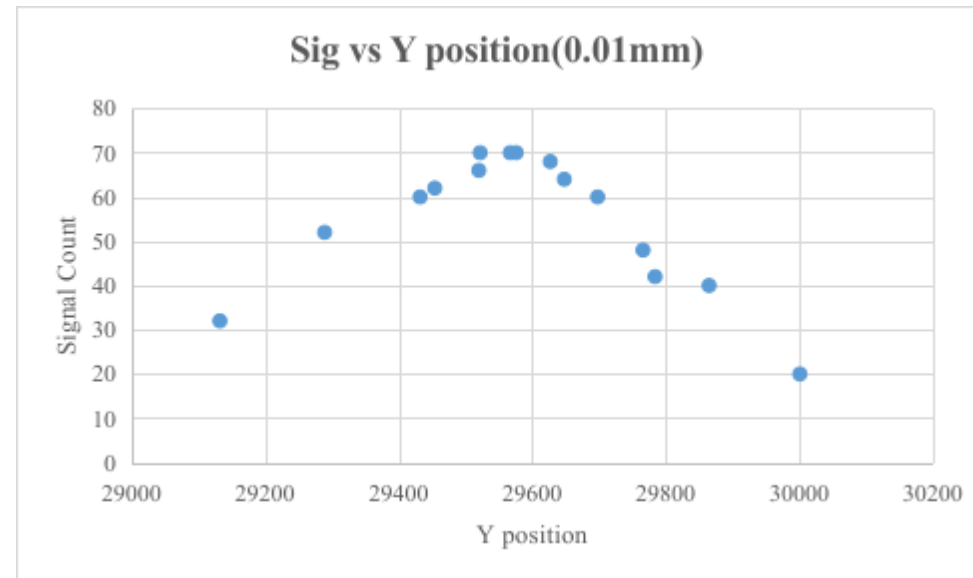
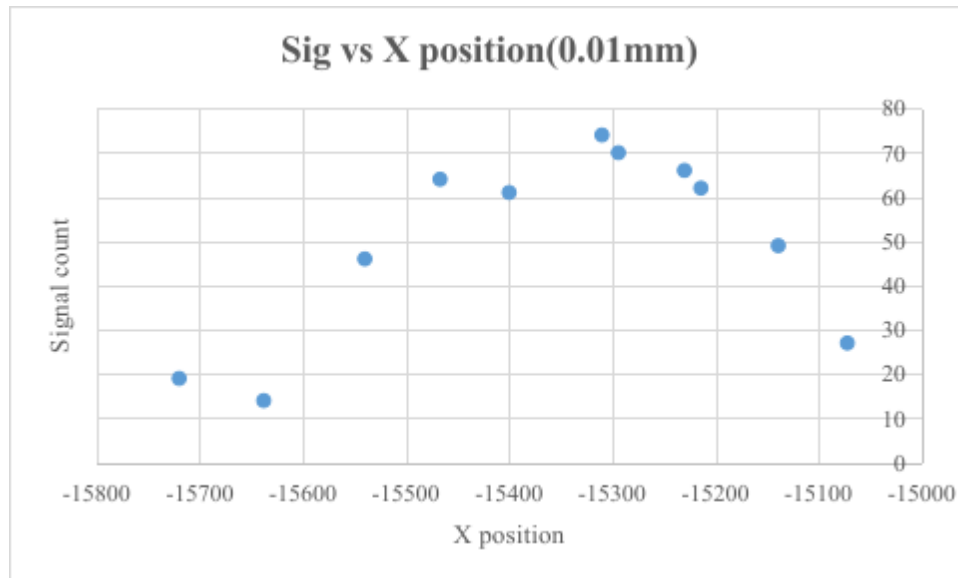
- A standalone beam test of the COFFEE3 chip was completed.
- The time resolution is $\mathcal{O}(100)$ ns, reaching ~ 90 ns for large signals ($\text{ToT} > 8 \mu\text{s}$).
- Both double columns 1 and 4 responded when all pixels were unmasked.
- Large pixel-to-pixel variations in hit rate were observed at the same global TH.
- Per-pixel local-threshold tuning with TDAC was validated.
- S-curve scans and TDAC tuning for all pixels were also performed and will be presented by Yuman.



Backup

DUT position calibration

- with C1R0, C0R25, C1R38 unmasked, DAQ as trigger
- Movement using DESY table controller. Absolute reading: 1000 ~ 1mm
- Measure hit rate in 5 mins at each position



HV lost

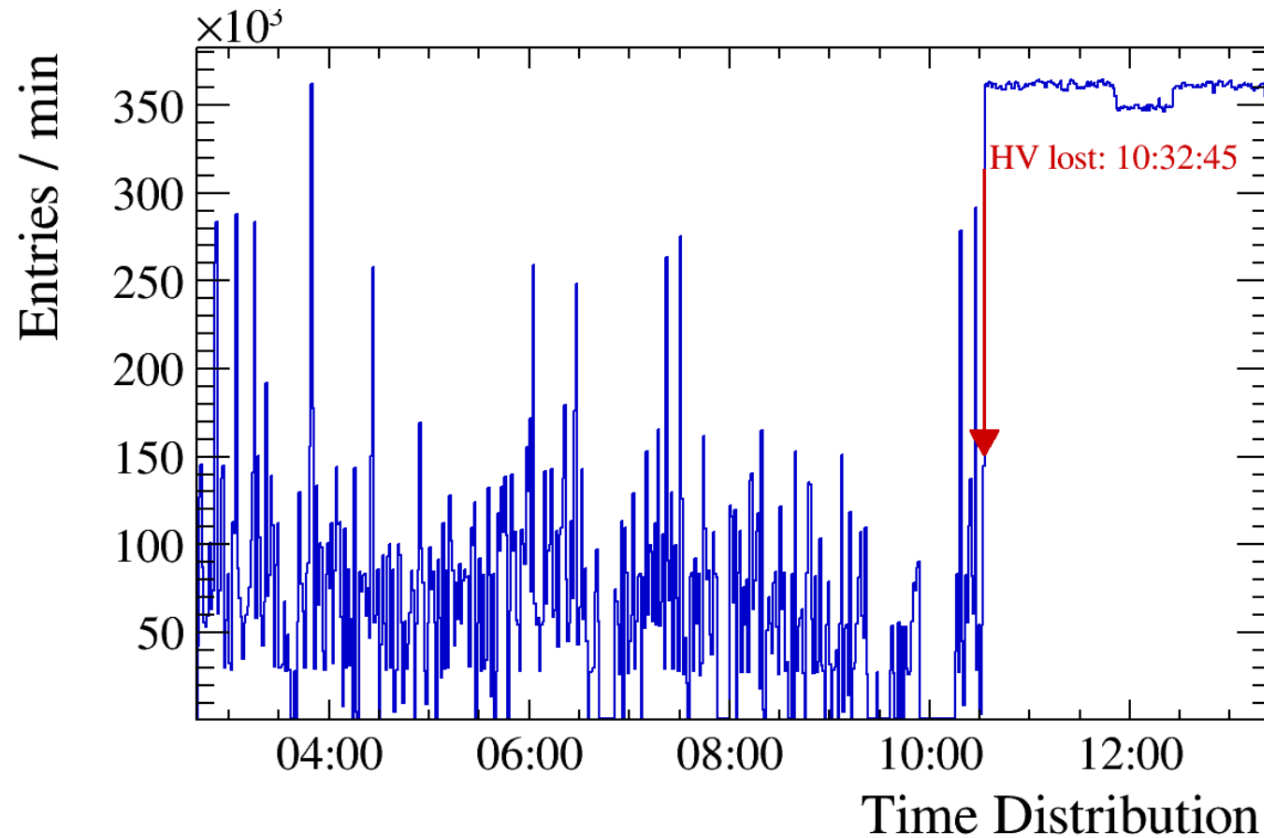
Th = 0.777

C1R0, C0R25, C1R38 tested separately, all pixels have comparable hit rate.

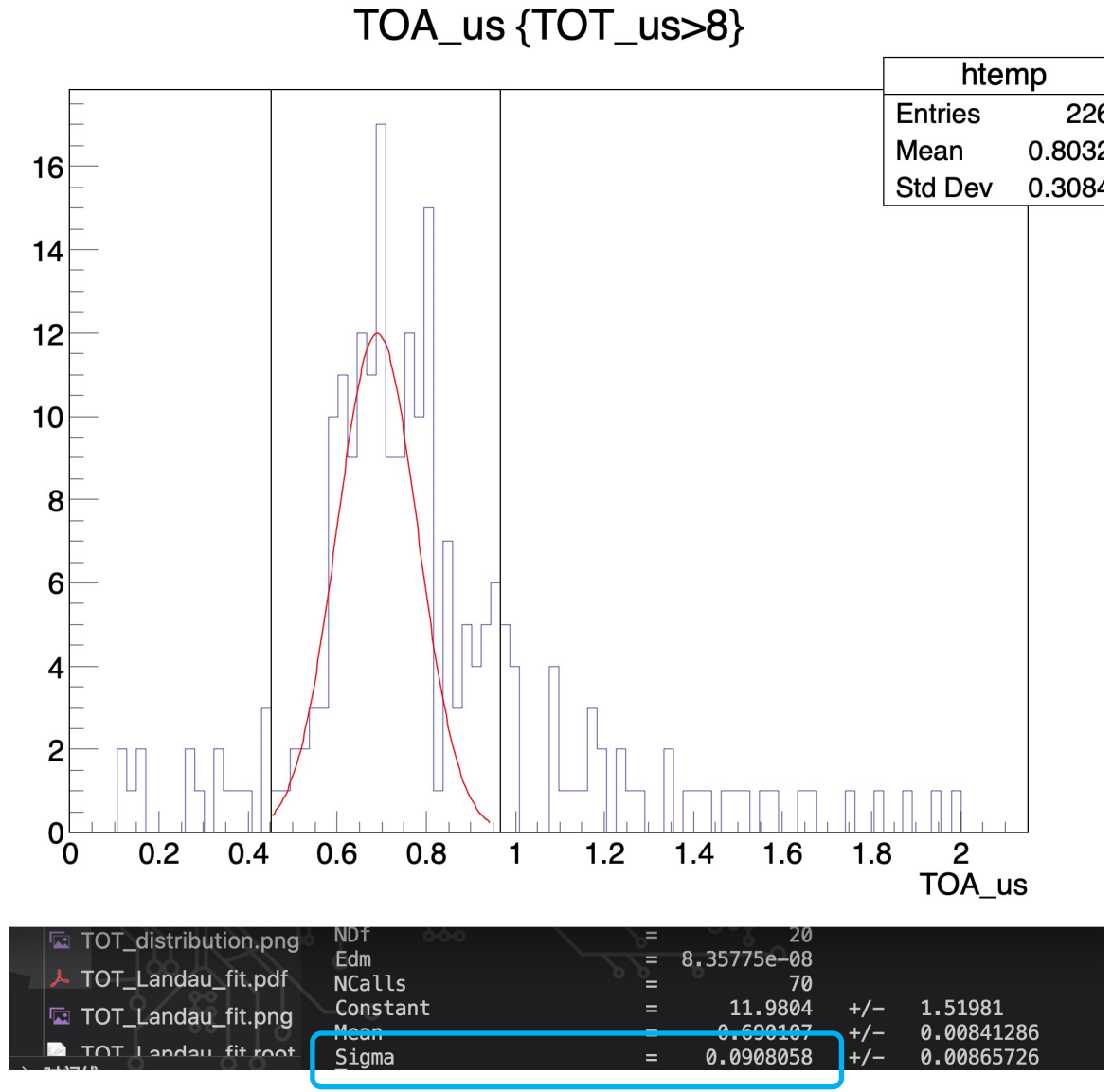
DUT position calibration

0709/2:38~0710/13:22持续取数, 发现10:32高压丢失

fixed by resetting CAR board



TOA fit



2470 fatal system error

12 July 发现2470 fatal error, 但当时从取数结果看没有看到明显的高压lost。说明书提到这种情况会保持最后设定的输出电压, 遂决定继续取数。

14 July 测量2470的输出端只有 - 0.5 V 电压。

