Measurement with active pixels in RD50-MPW2

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Bojan Hiti, F9, Jožef Stefan Institute

Content

- **Part 1:** S-curve measurements
- **Part 2:** Timing measurements with Edge-TCT

Measurement setup

- DAQ: ZC706 + Caribou + Sam's GUI software

- Sample mounted in Particulars Edge-TCT setup

- Unirradiated sample W11 (1.9 kOhm cm)

- DAC configuration: default values from documentation

- Comparator baseline (BL) 900 mV

| Channel	Output	Nominal value	Current	Voltage	Description
CH1	VPCOMP	44	10.09 μA	1.23 V	sets current of comparators
CH2	VPTRIM	27	152.7 nA	1.238 V	sets current of trimming DACs
CH3	VNSENSBIAS	13	2.138 nA	1.309 V	bias transistors as the R for DNWELL
CH4	VBLR	25	6.621 nA	1.203 V	bias transistors as the R in HP-filters
CH5	VNSF	18	1.028 μA	418.9 mV	sets current of source followers
CH6	VNFB_CONT	45	401.4 nA	584.4 mV	sets I_{FB} of continuous-reset pixels
CH7	VPFB_SW	25	6.556 nA	1.279 V	sets I_{FB} of switched-reset pixels
CH8	VPBIAS	26	2.98 μA	1.025 V	sets current of the load of CSAs
	VNCASC		995 nA	926.9 mV	bias the cascode transistor of CSAs
CH9	VN	42	6.022 μA	616.3 mV	sets current of CSAs
V_REF	VN_CS_BB	/	34.99 μA	539.9 mV	reference voltage for all DACs
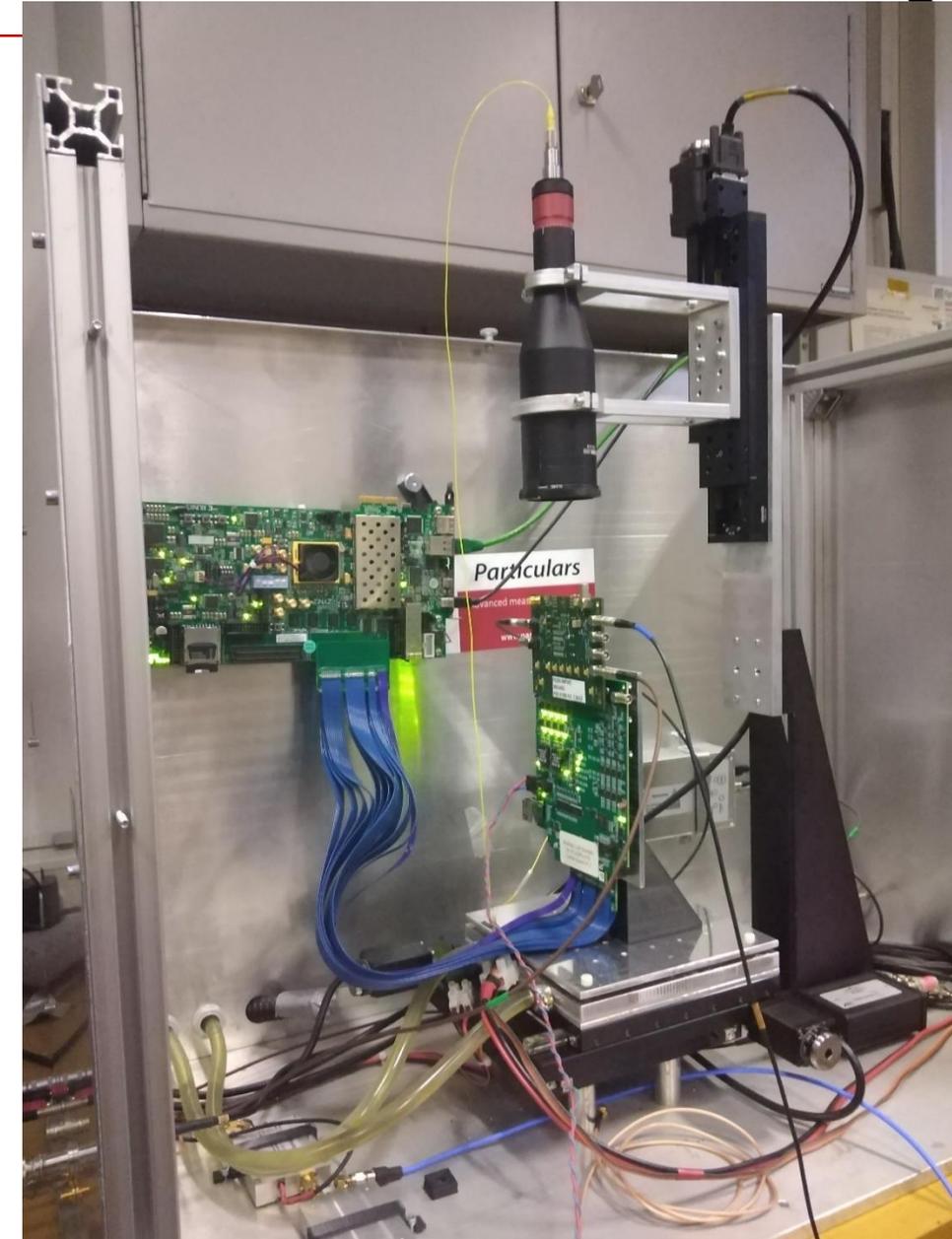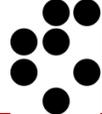
S-curve measurements

- Inject 1000 pulses (internal capacitor injection), count the detected pulses

- BL = 900 mV, different thresholds U_{thr}: 950 – 1100 mV, vary U_{inj} 10 – 300 mV

- **No TrimDACs, ambient light**

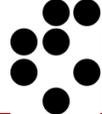- Continuous reset pixels (Col 0 – 3), pulsed reset pixels (Col 4 – 7)

Col 0-7, Threshold 1000 mV
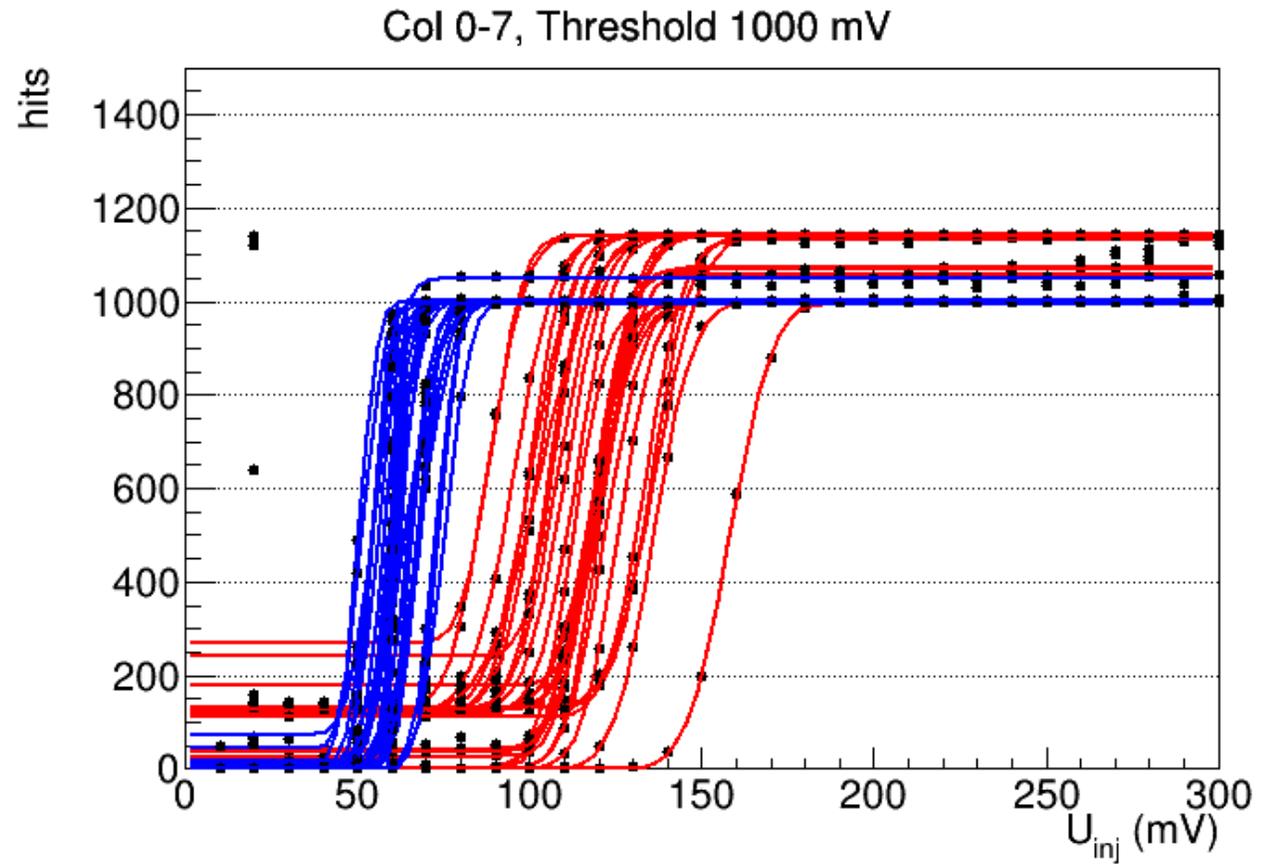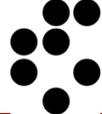
S-curves, threshold 1000 - 1100 mV

$U_{on} \approx 1000 \text{ mV} - 900 \text{ mV}$
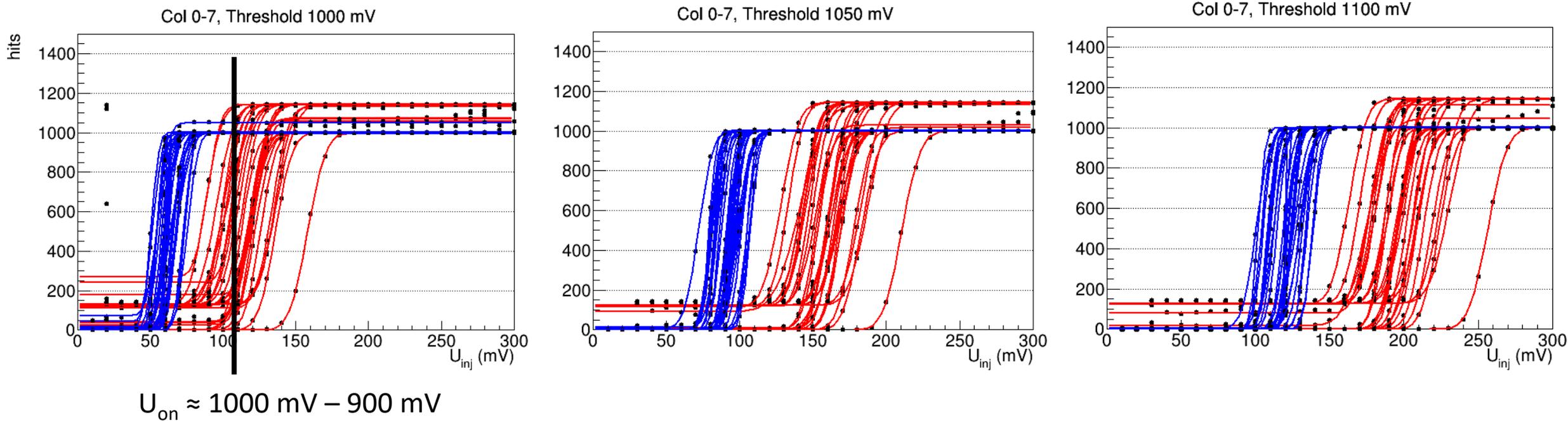
- Inflection point U_{on} (the middle) of S-curves scales with threshold
  - Continuous reset pixels: $U_{on} \approx U_{thr} - BL$ (as expected)
  - Pulsed reset pixels: $U_{on} < U_{thr} - BL$ (consistent with HEPHY, Patrick's RD50 workshop talk)
- Continuous reset pixels have a persistent plateau around 150 hits, which does not change much with U_{thr}
 - Any ideas why?

# S-curve of pixel for Edge-TCT measurements (Col2 Row4)
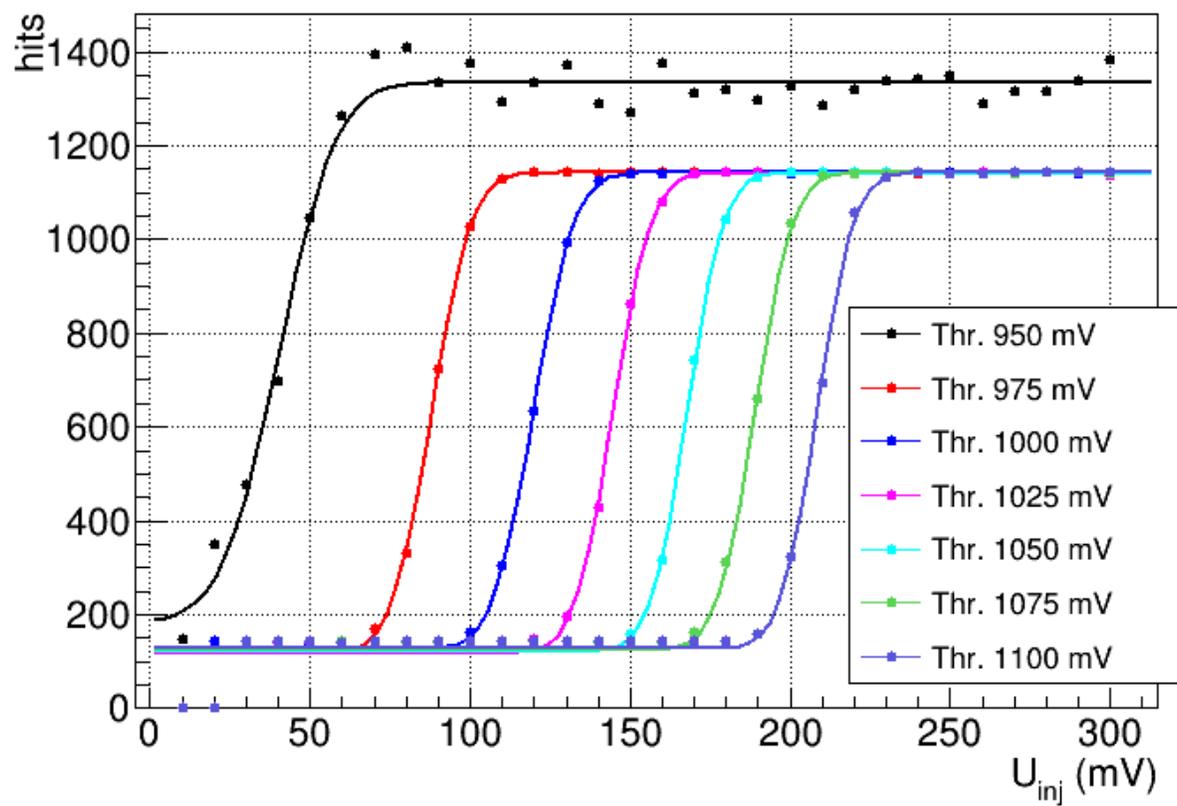
- Continuous reset pixel used in Edge-TCT measurements
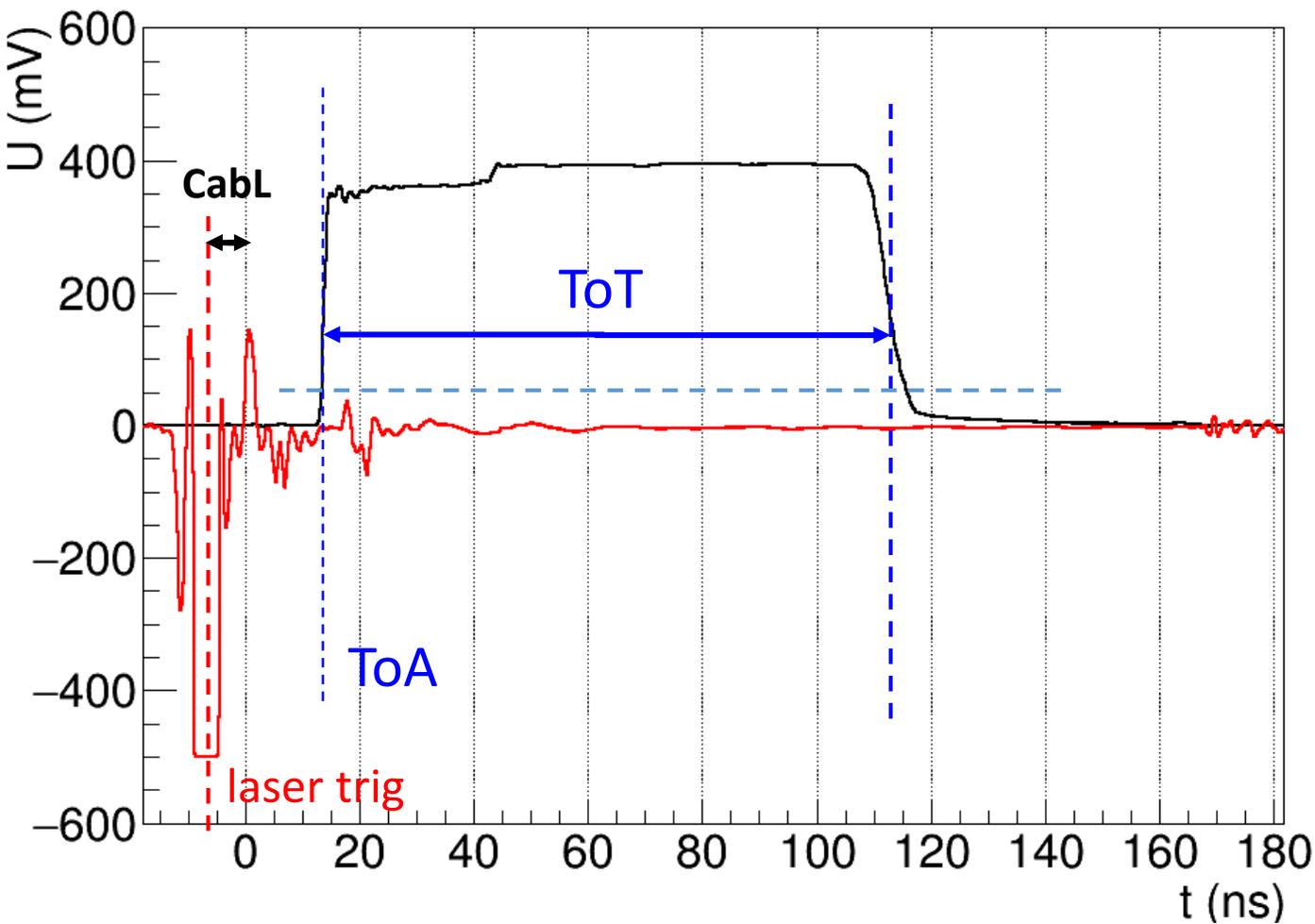- Noise plateau around 150 hits visible, not changing with threshold

Edge-TCT setup

- Measuring one active pixel (col. 2, row 4) – **continuous reset**
  - IR light injected through sensor edge
  - Analog readout of COMPOUTBUFF with DRS4
 - Cont. reset in order to measure charge from ToT

Laser light

Laser light
1064 nm

Pixel
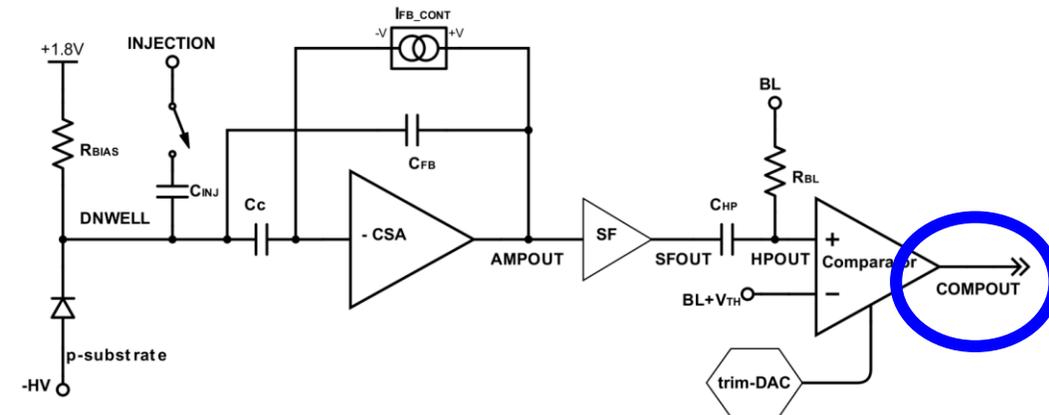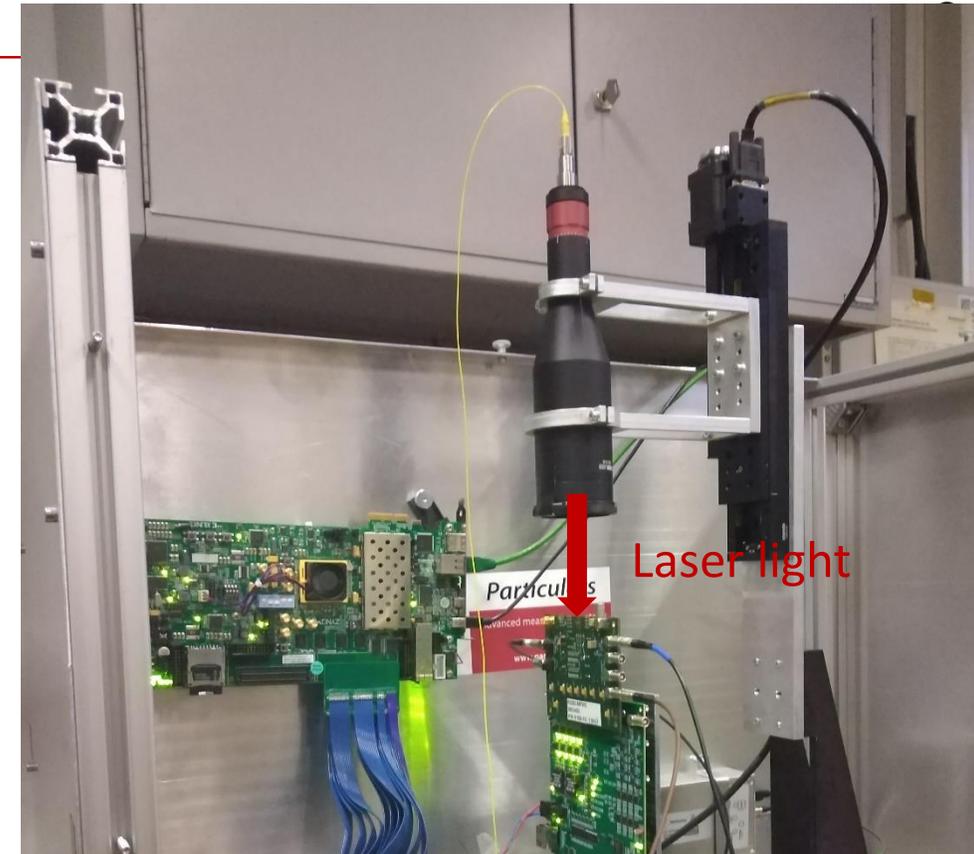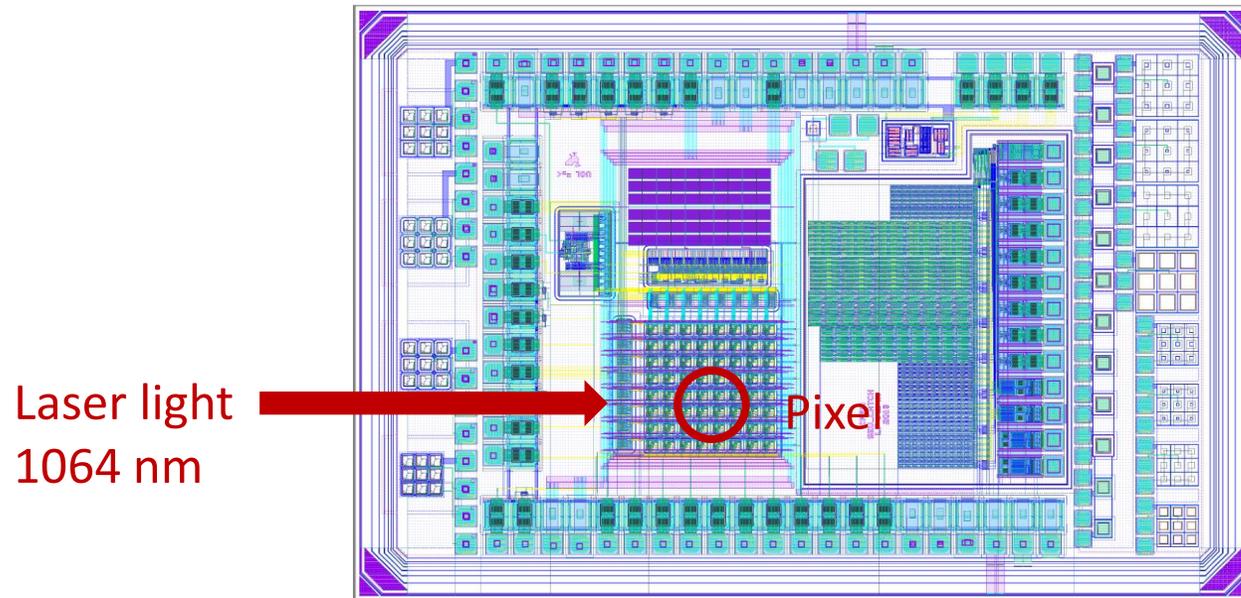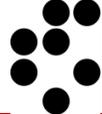
Edge-TCT pulse


- Acquisition triggered by laser driver output
- Time scale adjusted for **cable and fibre length**, light hits the sample at t=0
- Signal is the comparator output **COMPOUTBUF**
  - Should be 1.8 V logic level, but current driver not powerful enough for 50 Ohm termination
- Measure **Time of Arrival** and **Time over Threshold** (→ charge from simulation in doc)

ToT < 55 ns:
$y = 0.091$ ke$^-$/ns × ToT

ToT > 55 ns:
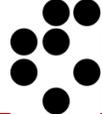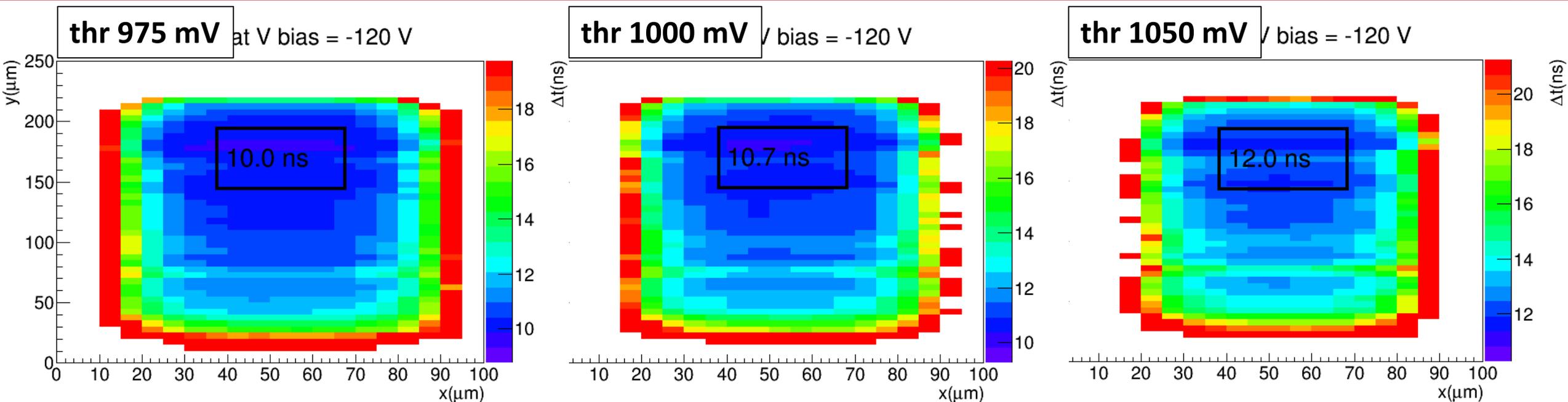$y = -2.9$ ke$^-$ + 0.144 ke$^-$/ns × ToT
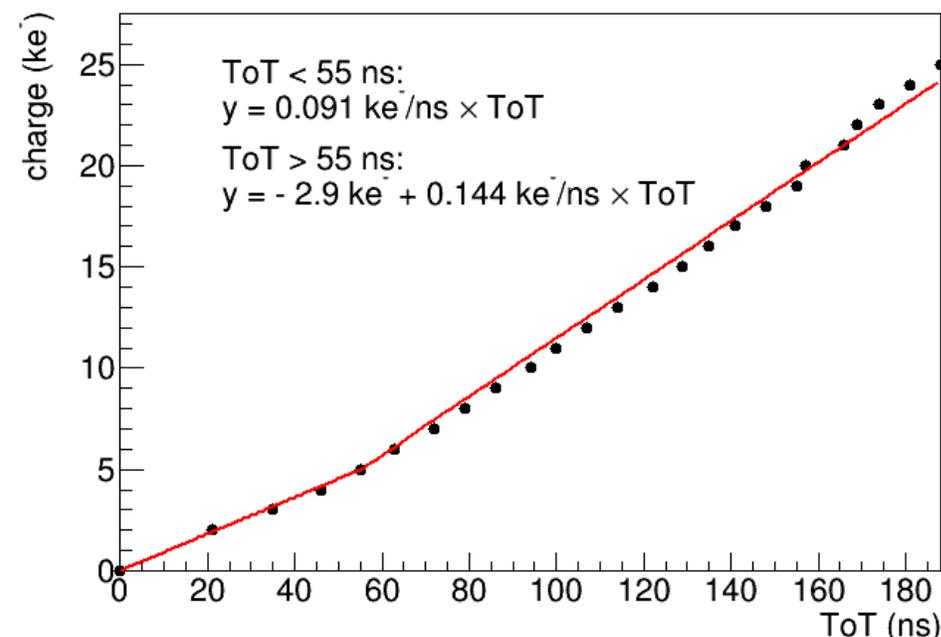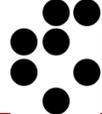
Charge collection at different thresholds
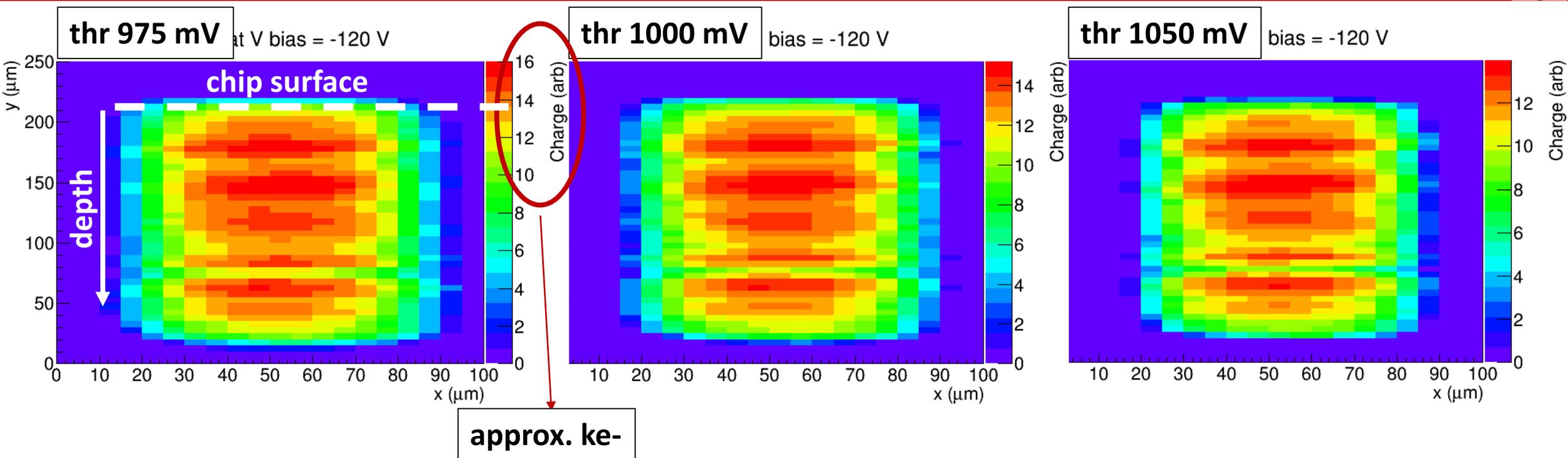
- Charge map within a pixel at different comparator thresholds (BL = 900 mV)
  - Laser intensity selected so that max signals are approx 15 ke
- Shape does not change with threshold
- Less charge at higher thresholds (as expected due to lower ToT)

Time of arrival at different thresholds

thr 975 mV at V bias = -120 V   **thr 1000 mV** V bias = -120 V   **thr 1050 mV** V bias = -120 V

10.0 ns   10.7 ns   12.0 ns

- Estimate timing response by averaging ToA in a volume close to the pixel surface at ≈ 15 ke:
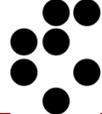
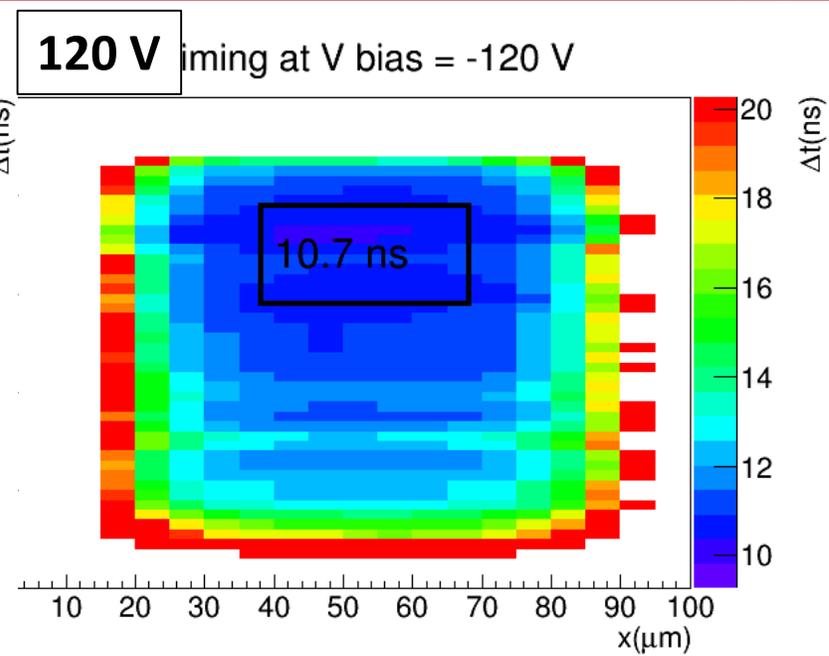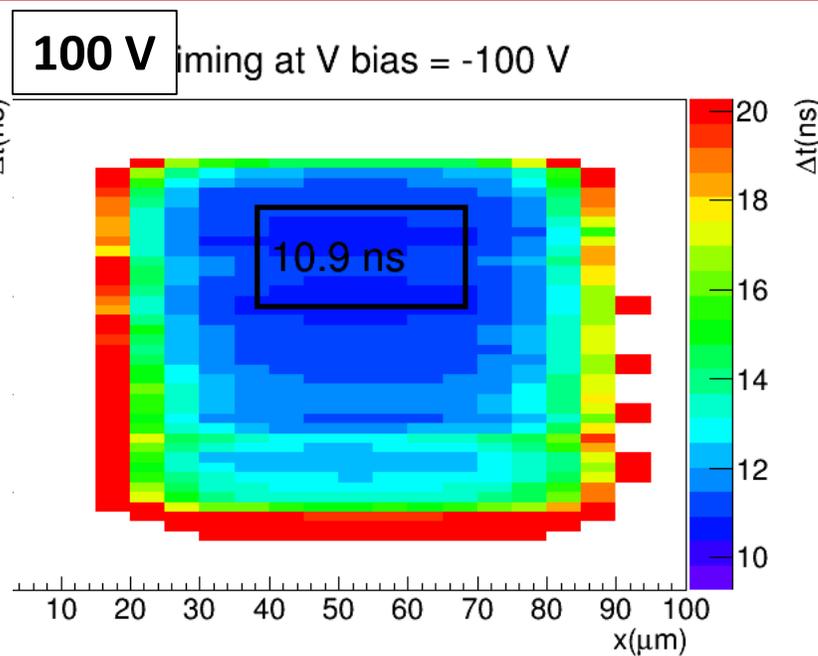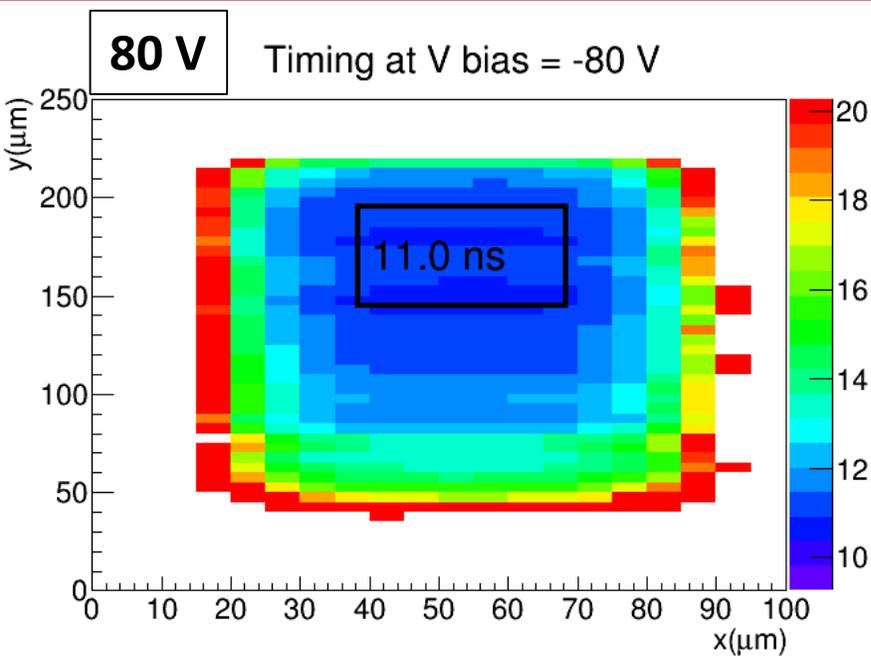| Thr (mV)	ToA (ns)
975	10.0
1000	10.7
1050	12.0

What is a meaningful threshold range?

- In the future estimate time-walk by varying laser power at a fixed threshold?

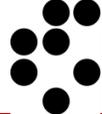# Time of arrival at different bias voltages

- Threshold 1000 mV

| V_{bias} (V)	ToA (ns)
80	11.0
100	10.9
120	10.7

Summary

- Measured S-curves, results roughly consistent with HEPHY
  - Observing noise plateau roughly independent of threshold

- Charge collection measurements with Edge-TCT
  - ToT → charge calibration from simulation

- Measurement of timing response in unirradiated chip (one pixel)
  - **ToA ≈ (11 ± 1) ns   in pixel center** at various thresholds/bias
  - To do: time walk estimation by varying signal size at fixed threshold
  - Open for suggestions regarding chip settings, methods, focus on continuous/pulsed reset
- To do: irradiatied chips (still to be mounted)

BACKUP
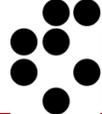
S-curves, threshold 950-1000 mV
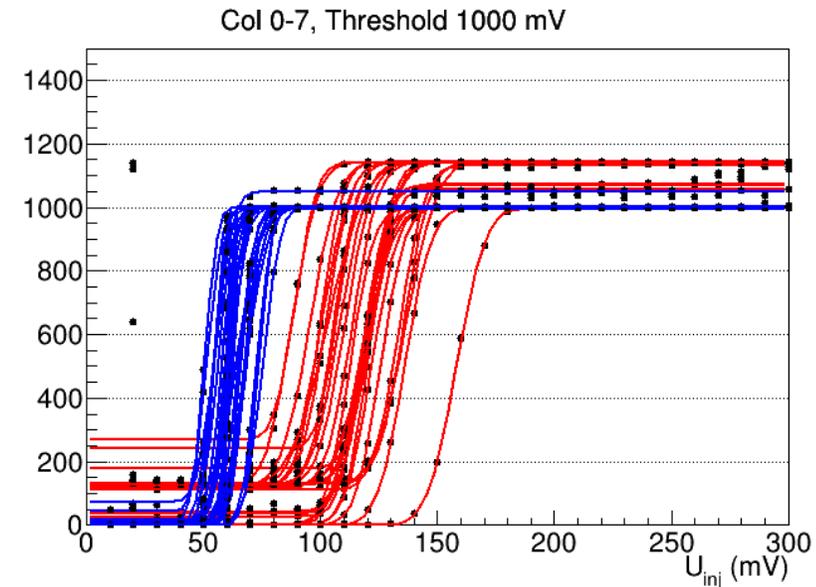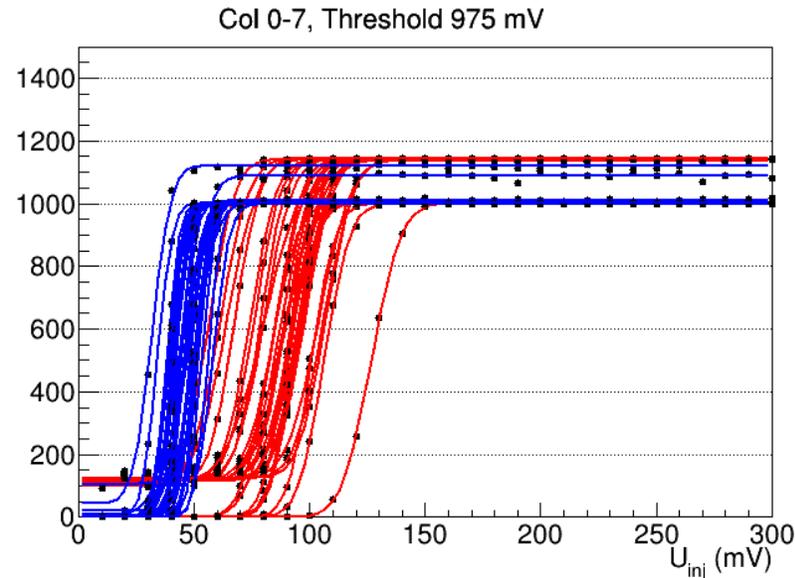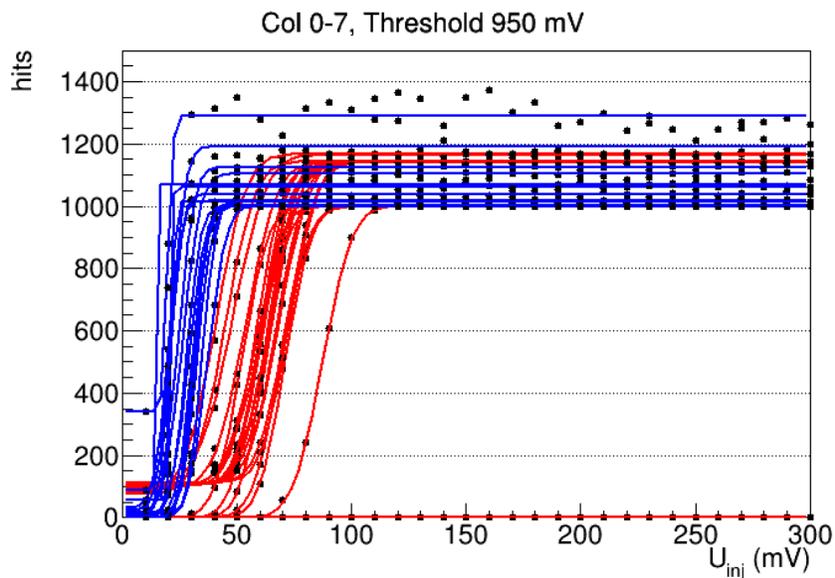
- At low threshold voltages (< 1000 mV) noise hits more common