Status of DPTS bench setup at LBL

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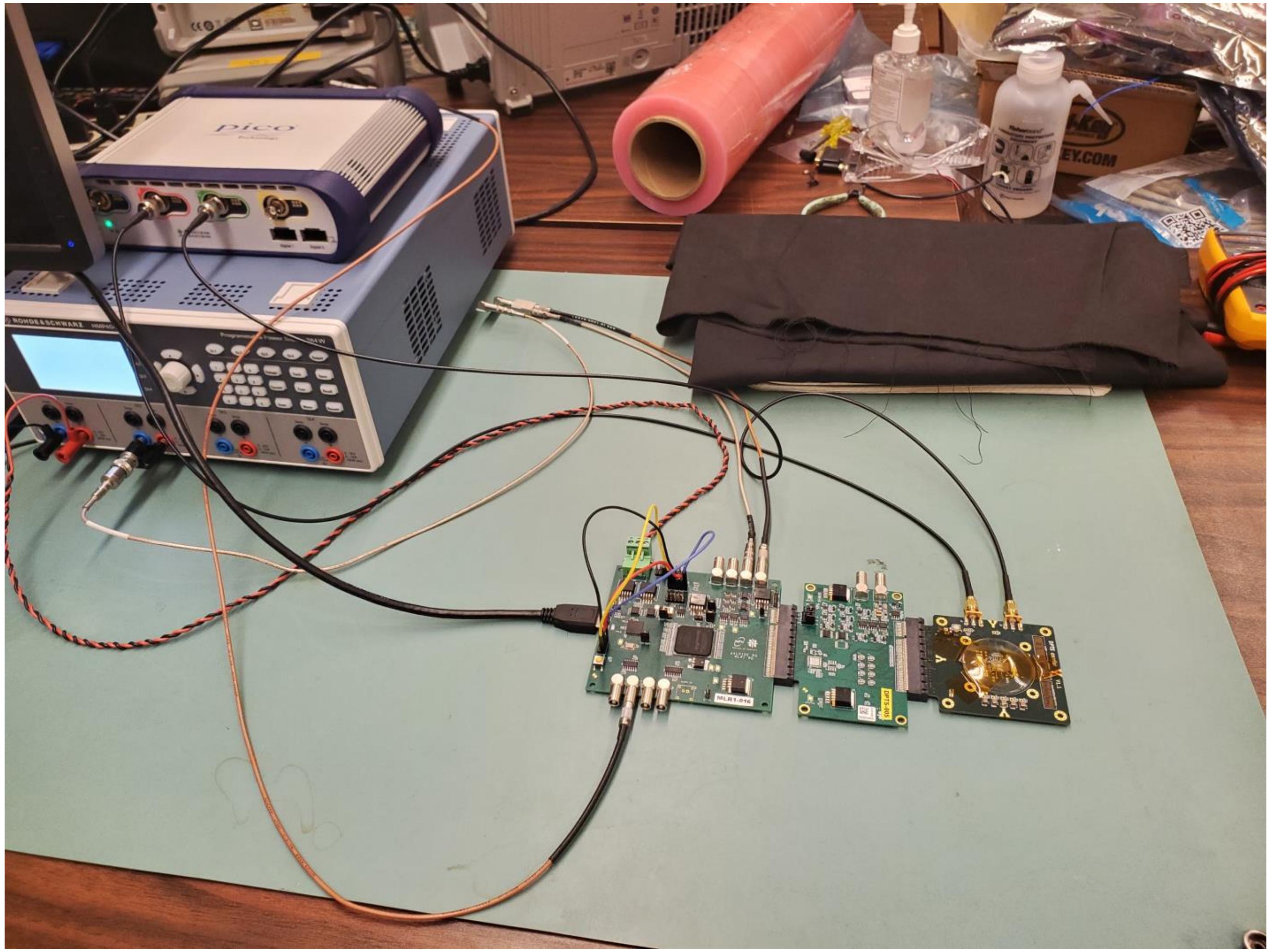
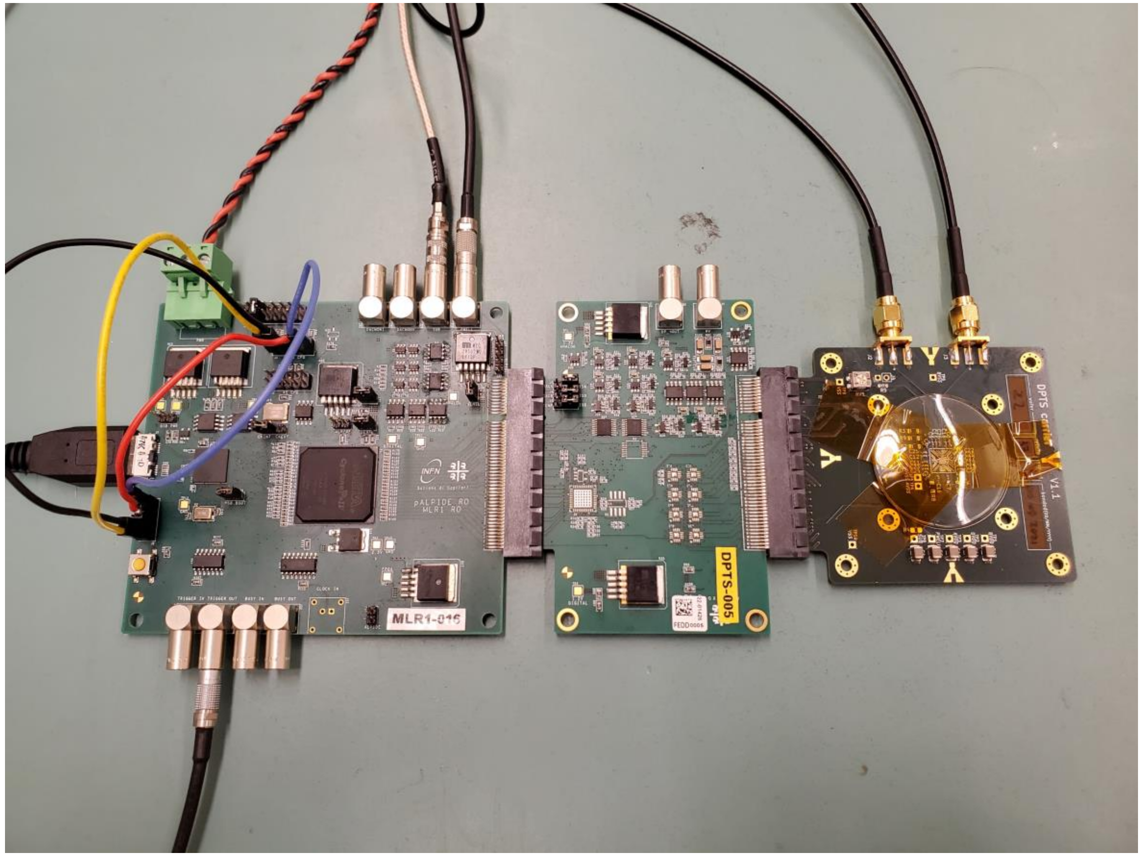
with lots of help from
Nicole Apadula, Peng Miao, Yuan Mei

Completed setup





First checks

- Checked resistances between VSS, BVDD, DVDD, AVDD, PWELL, SUB on DPTS chip before powering ON. Instructions said resistances should be >10 kOhm; but a few were ~4 kOhm. We confirmed this was okay with Trieste and CERN experts before powering the chip.
- With the chip powered ON, we adjusted the bias voltage from 0 to (negative) 3 V in steps of 0.3 V and confirmed that the readback current remained <1 mA (it stayed around 0.1 mA for all bias voltages). We then returned the bias voltage to the ‘nominal’ value of 1.2 V.
- We then confirmed that the voltage across the R5 (Jumper J4) on the DPTS card was set correctly to 400 mV. It was set correctly. (Otherwise, we would have adjusted it by turning the RV1 dial with a small screwdriver.)
- Lastly, we tested the shift register using the DAQ software.

First tests – firmware and DPTS Power ON

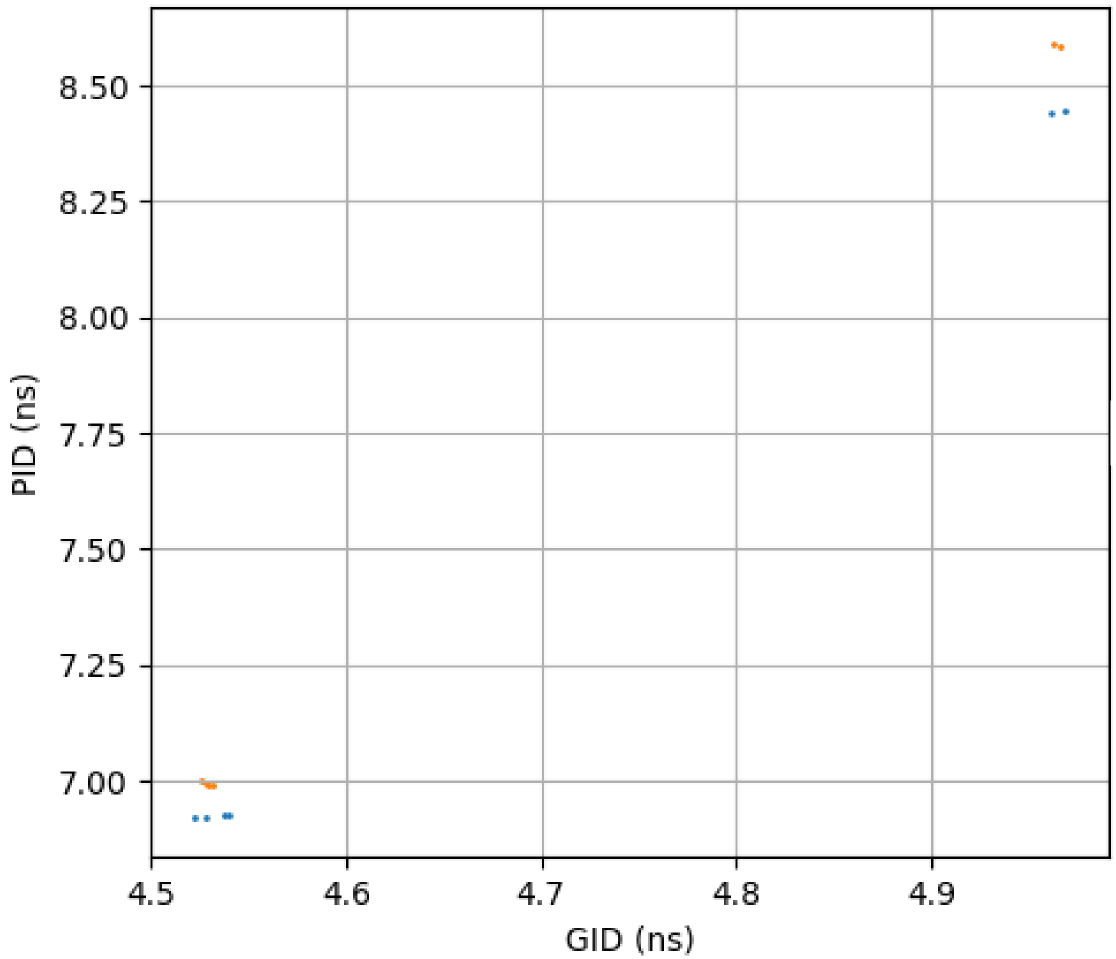
MLR1 DAQ board connection and firmware programming

```
lbl268a@lbl268a-K30AD-M31AD-M51AD:~$ mlr1-daq-program --list
1 device(s) with unprogrammed FX3 firmware found:
- DAQ-000901010542272A (bus: 3, address 13)
lbl268a@lbl268a-K30AD-M31AD-M51AD:~$ mlr1-daq-program --fx3=/home/lbl268a/Documents/mlr1/firmware/fx3.img --fpga=/home/lbl268a/Documents/mlr1/firmware/0x107E6513.bit
Programming FX3(s): ['DAQ-000901010542272A'] ...DONE
Waiting for re-enumeration...
  DAQ-000901010542272A: DONEALL DONE
Programming FPGA(s)...
DAQ-000901010542272A: 100%|██████████████████████████████| 1191814/1191814 [00:12<00:00, 92517.13it/s]
FPGA programming DONE
lbl268a@lbl268a-K30AD-M31AD-M51AD:~$ python3
Python 3.10.6 (main, Mar 10 2023, 10:55:28) [GCC 11.3.0] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>> import mlr1daqboard
>>> daq = mlr1daqboard.MLR1DAQBoard()
>>> print(daq.read_fw_version())
0x107E6513
>>> exit()
lbl268a@lbl268a-K30AD-M31AD-M51AD:~$ mlr1-daq-program --list
1 device(s) with programmed FX3 firmware found:
- DAQ-000901010542272A (bus: 3, address 14)
```

```
lbl268a@lbl268a-K30AD-M31AD-M51AD:~/Documents/mlr1/apts-dpts-ce65-daq-software/dpts$ ./dpts_power.py DPTS-005 ON
2023-04-06 13:02:01,154 - WARNING - Non specific chip ID 'DPTS' kept
2023-04-06 13:02:01,154 - INFO - Initialising MLR1 DAQ Board
2023-04-06 13:02:01,479 - INFO - Powering ON the chip with default DAC settings.
2023-04-06 13:02:01,480 - INFO - Currents before Proximity ON: Ia = 0.08 mA, Id = 0.06 mA, Ib = 0.00 mA
2023-04-06 13:02:01,484 - INFO - Currents after Proximity ON: Ia = 0.08 mA, Id = 0.09 mA, Ib = 0.00 mA
2023-04-06 13:02:01,486 - INFO - Chip powered ON.
2023-04-06 13:02:01,787 - INFO - Currents after setting DACs: Ia = 3.93 mA, Id = 6.66 mA, Ib = 7.15 mA
2023-04-06 13:02:02,089 - INFO - VCASB  = 300 mV
2023-04-06 13:02:02,089 - INFO - VCASN  = 300 mV
2023-04-06 13:02:02,090 - INFO - IRESET = 10 pA
2023-04-06 13:02:02,090 - INFO - IDB    = 100 nA
2023-04-06 13:02:02,090 - INFO - IBIAS  = 100 nA
2023-04-06 13:02:02,090 - INFO - IBIASN = 10 nA
2023-04-06 13:02:02,090 - INFO - IBIASF = 0 mA
2023-04-06 13:02:02,090 - INFO - VH     = 600 mV
2023-04-06 13:02:02,090 - INFO - Powered ON
```

DPTS Power ON

Fake Hit Rate Scan Results



Triggers: 1.0e+04
Hits: 6
Noise occ.: 1.46e-02

train #0
train #1

Measures number of hits seen in absence of external stimuli. That is, no charge injected into pixel circuitry by the trigger pulse.

LBL Setup

DPTS

$I_{reset} = 10$ pA

$I_{bias} = 100$ nA

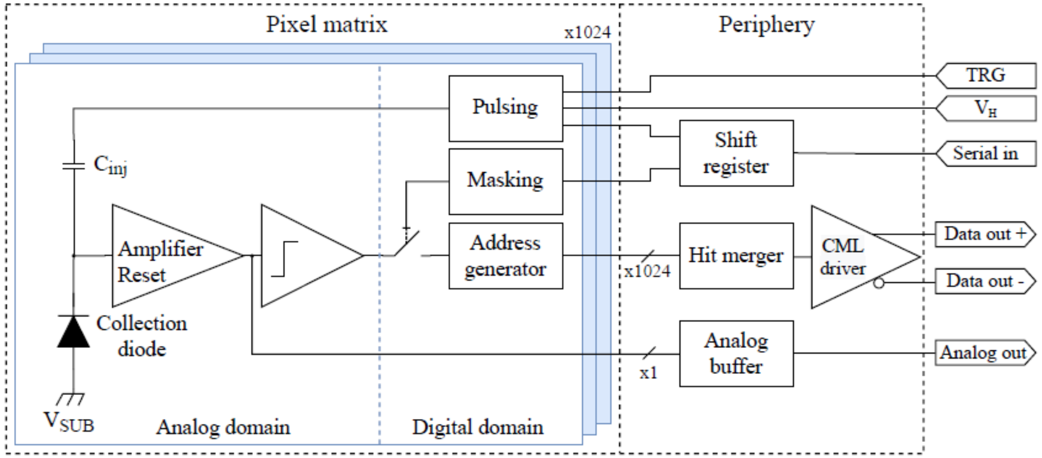
$I_{biasn} = 10$ nA

$I_{db} = 100$ nA

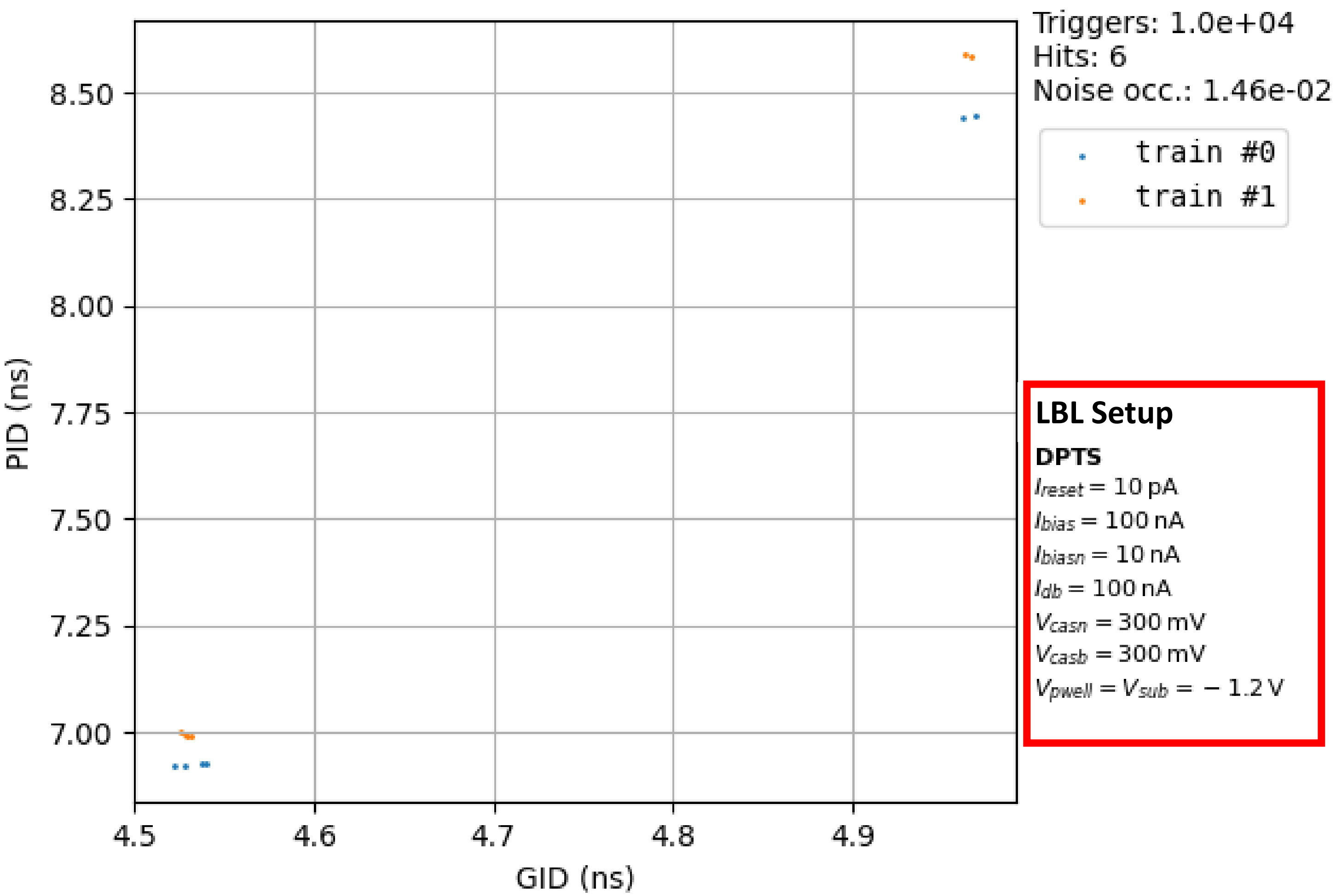
$V_{casn} = 300$ mV

$V_{casb} = 300$ mV

$V_{pwell} = V_{sub} = -1.2$ V



Fake Hit Rate Scan Results



LBL Setup

DPTS

$I_{reset} = 10$ pA
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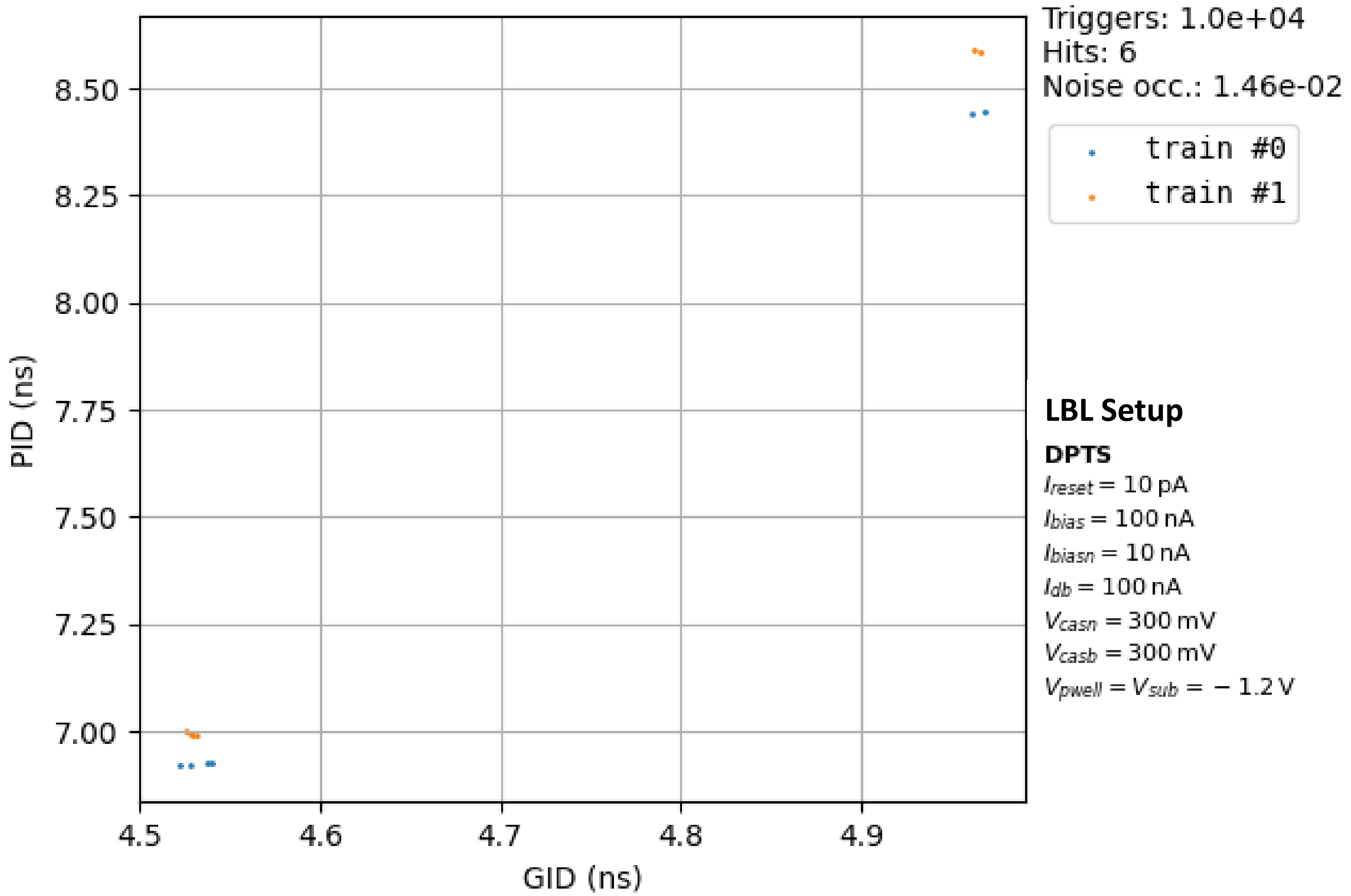
$I_{db} = 100$ nA
$V_{casn} = 300$ mV
$V_{casb} = 300$ mV
$V_{pwell} = V_{sub} = -1.2$ V

Measures number of hits seen in absence of external stimuli. That is, no charge injected into pixel circuitry by the trigger pulse.

We use ‘nominal’ bias settings here.

Fake Hit Rate Scan Results



Measures number of hits seen in absence of external stimuli. That is, no charge injected into pixel circuitry by the trigger pulse.

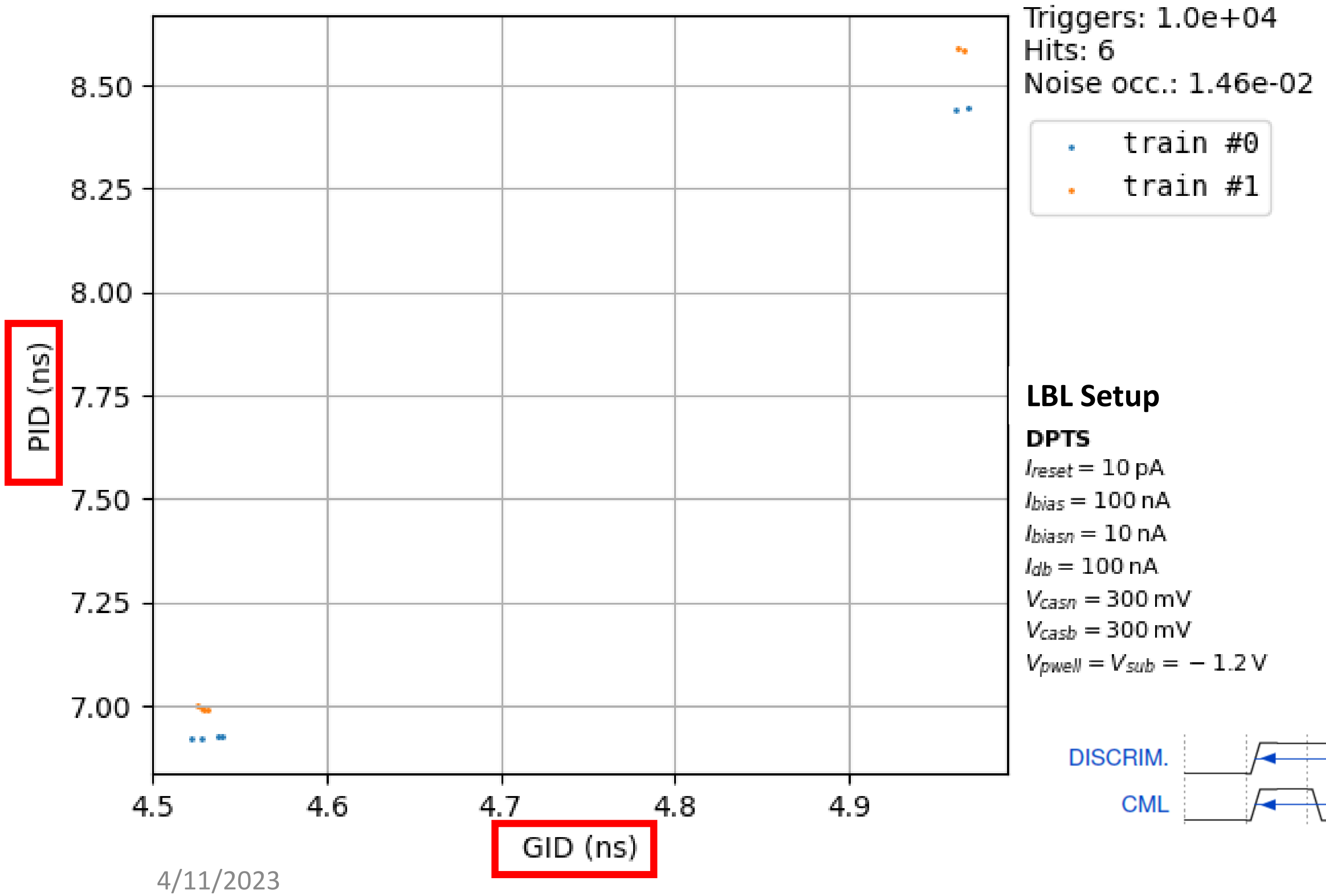
$$Noise\ Occ. =$$

$$\frac{Hits}{(Triggers \times Pixels \times scope\ capture\ time)} =$$

$$\frac{6}{(10{,}000 \times 1024 \times 40\ us)} =$$

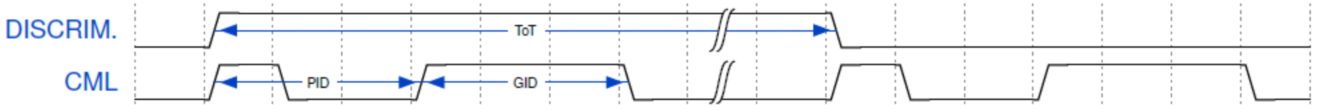
$$0.0146\ per\ pixel\ per\ s$$

Fake Hit Rate Scan Results

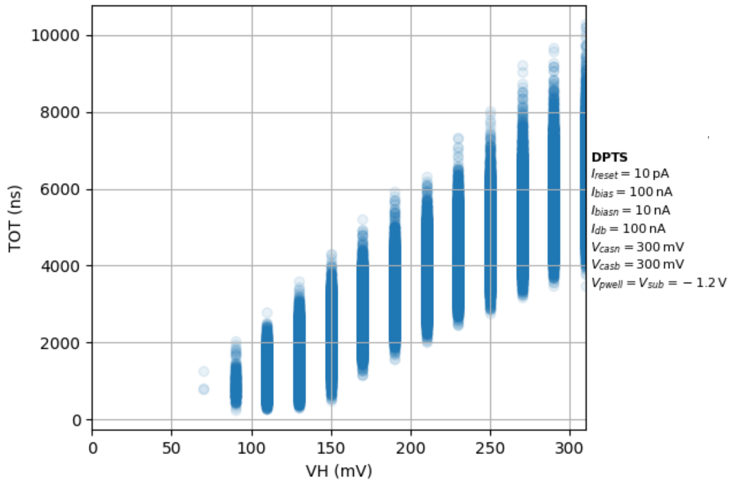


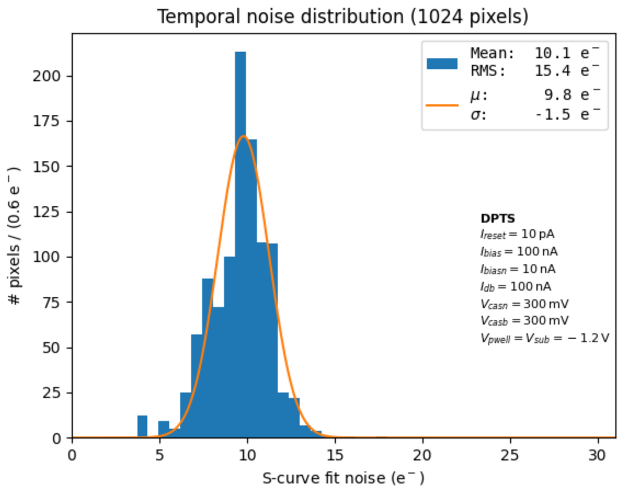
Measures number of hits seen in absence of external stimuli. That is, no charge injected into pixel circuitry by the trigger pulse.

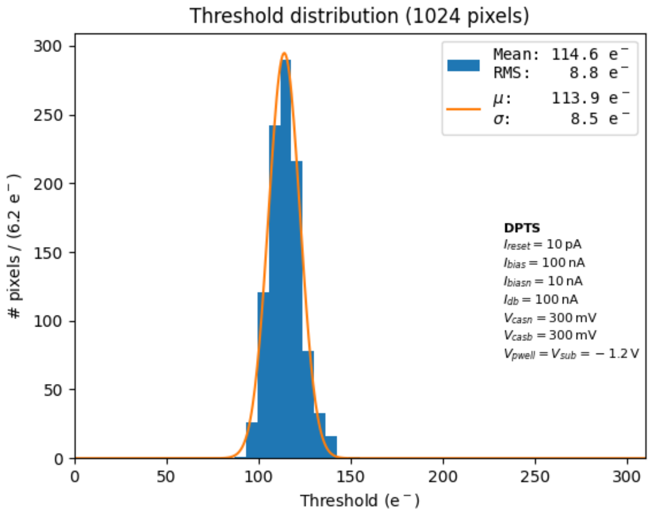
These PID and GID times identify the pixel.

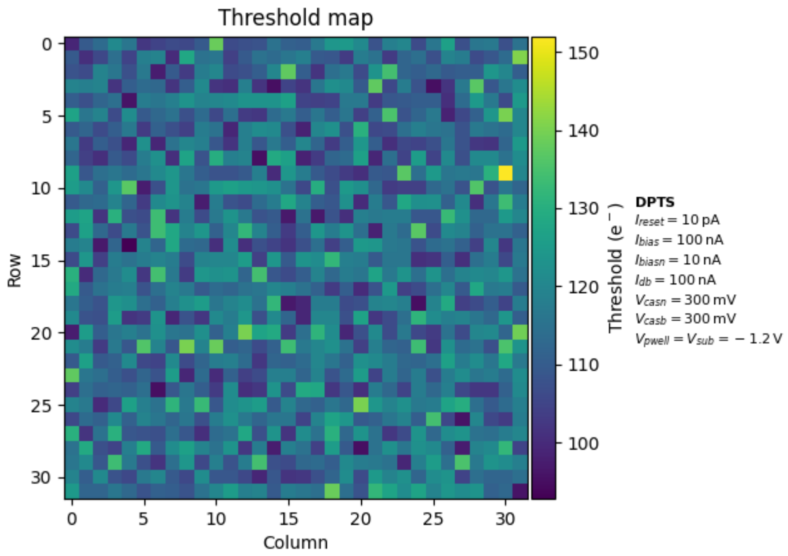


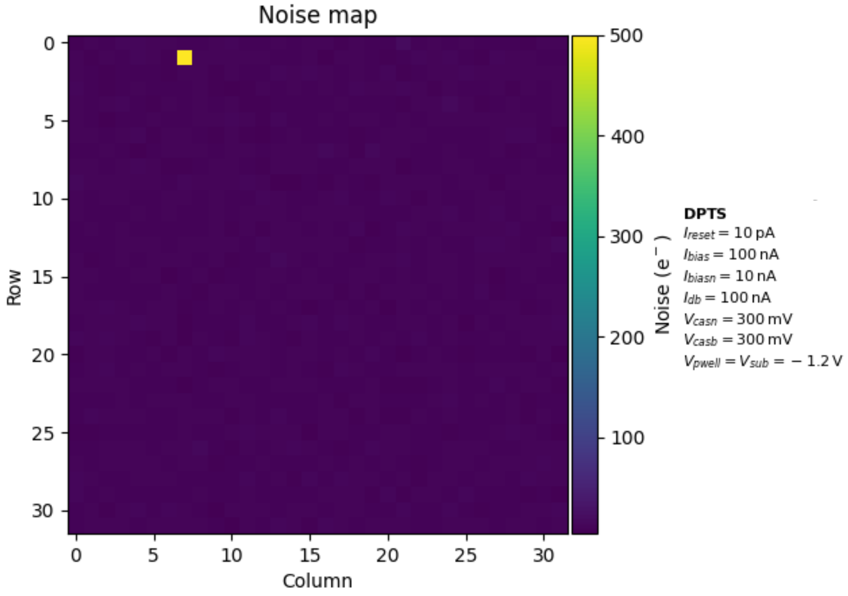
Threshold Scan Results

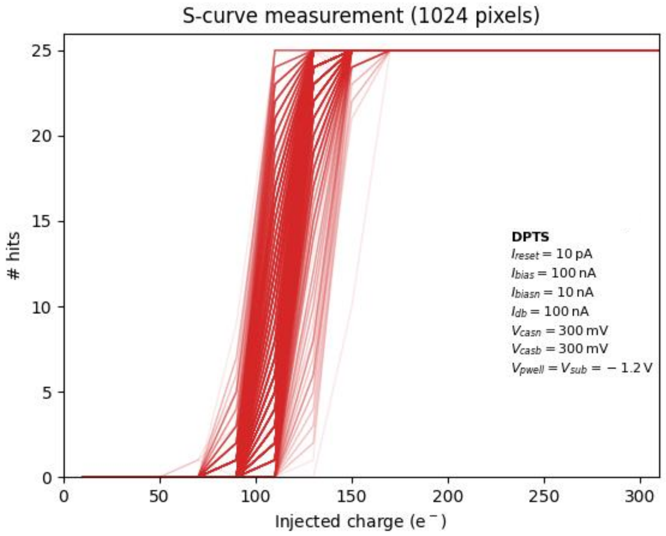




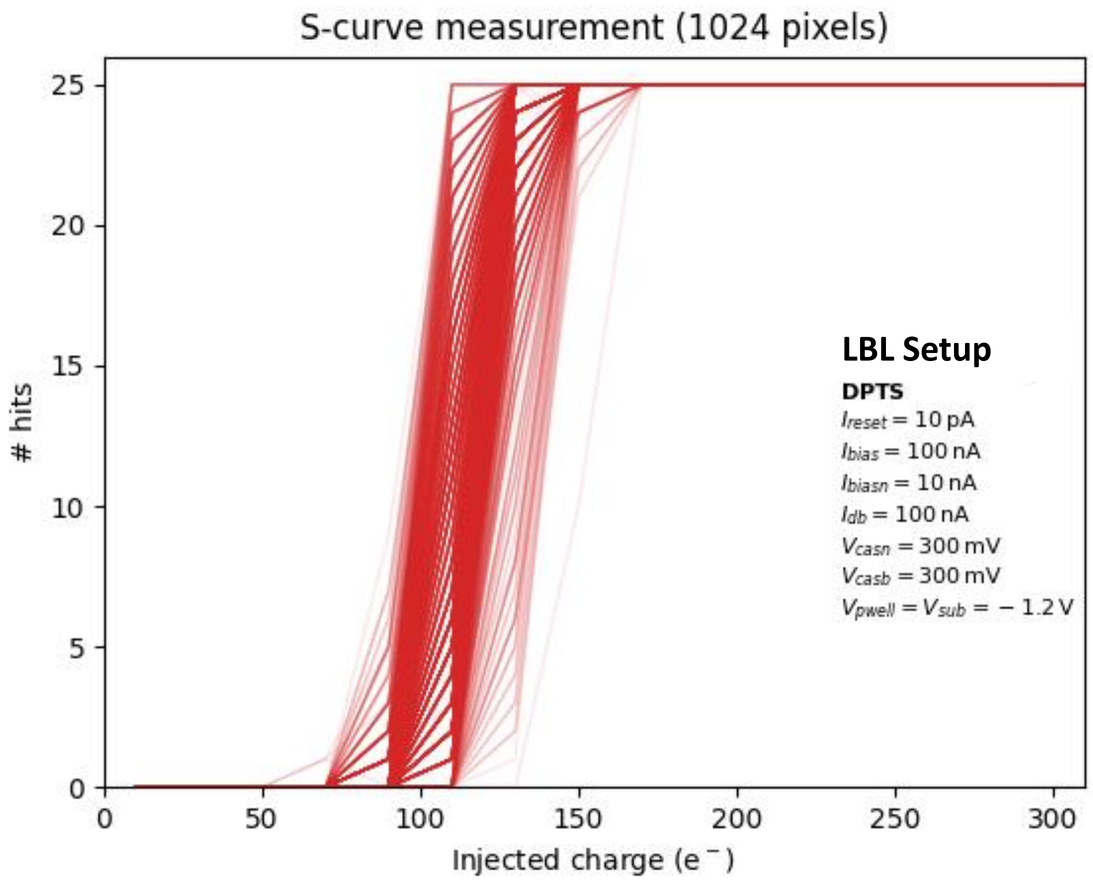




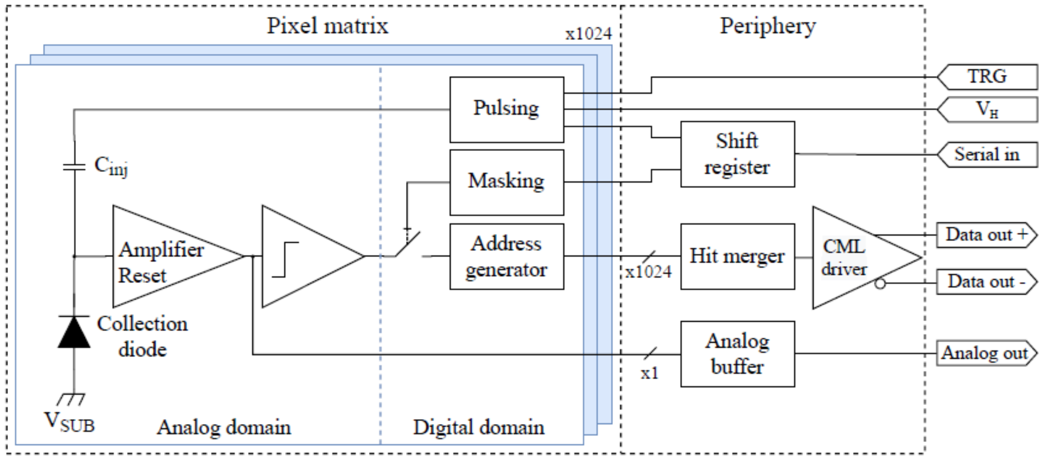




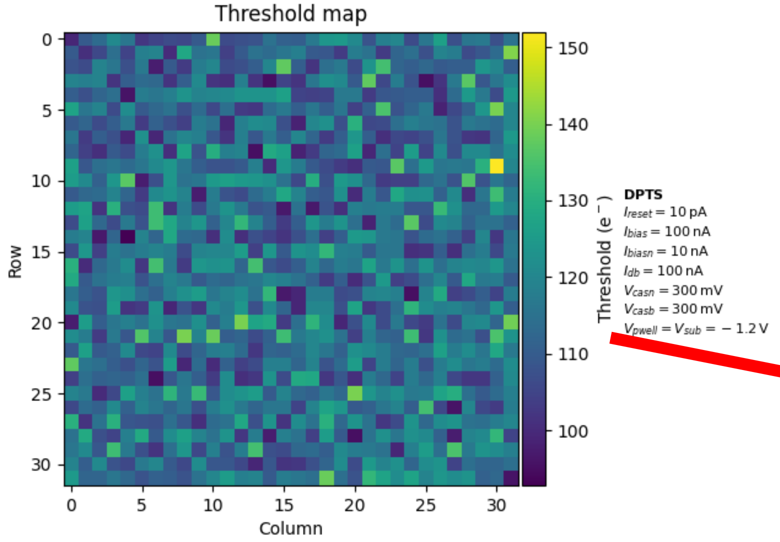
Threshold Scan Results

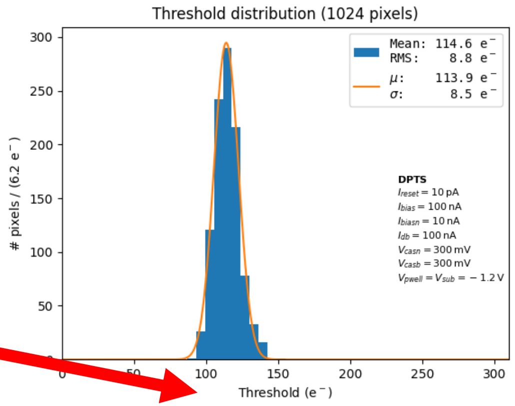


At a given V_H (i.e. input charge), each pixel is pulsed 25 times and the number of hits is recorded. A hit requires two pulses to be captured by the scope – indicating the assertion and de-assertion of the discriminator pulse.

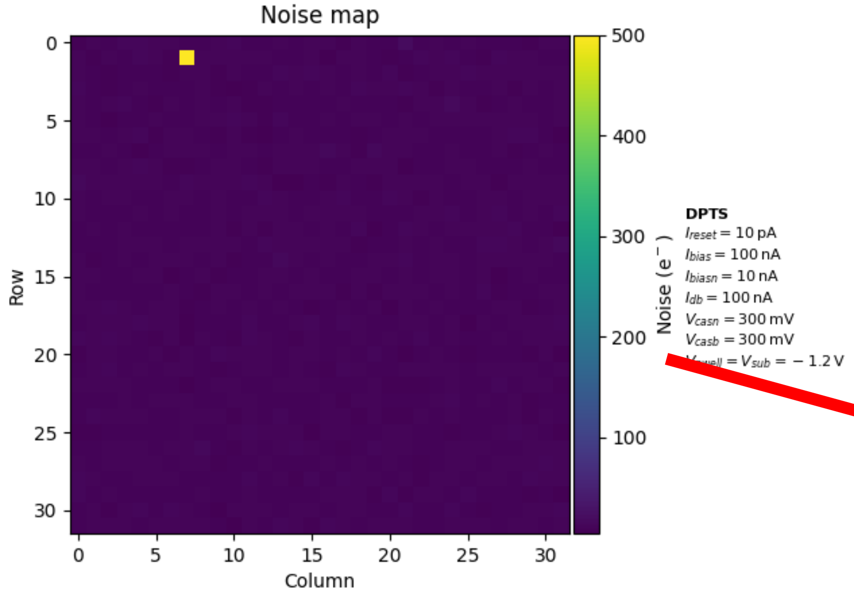


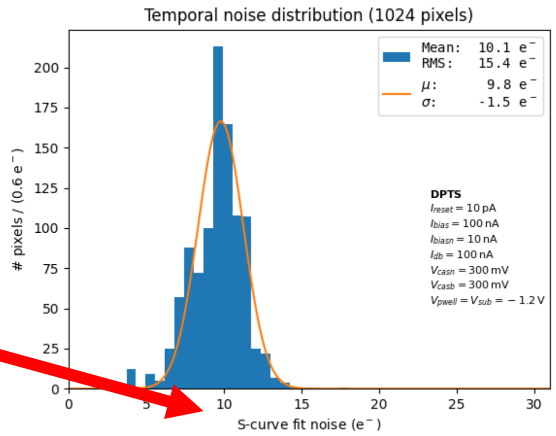
Threshold Scan Results



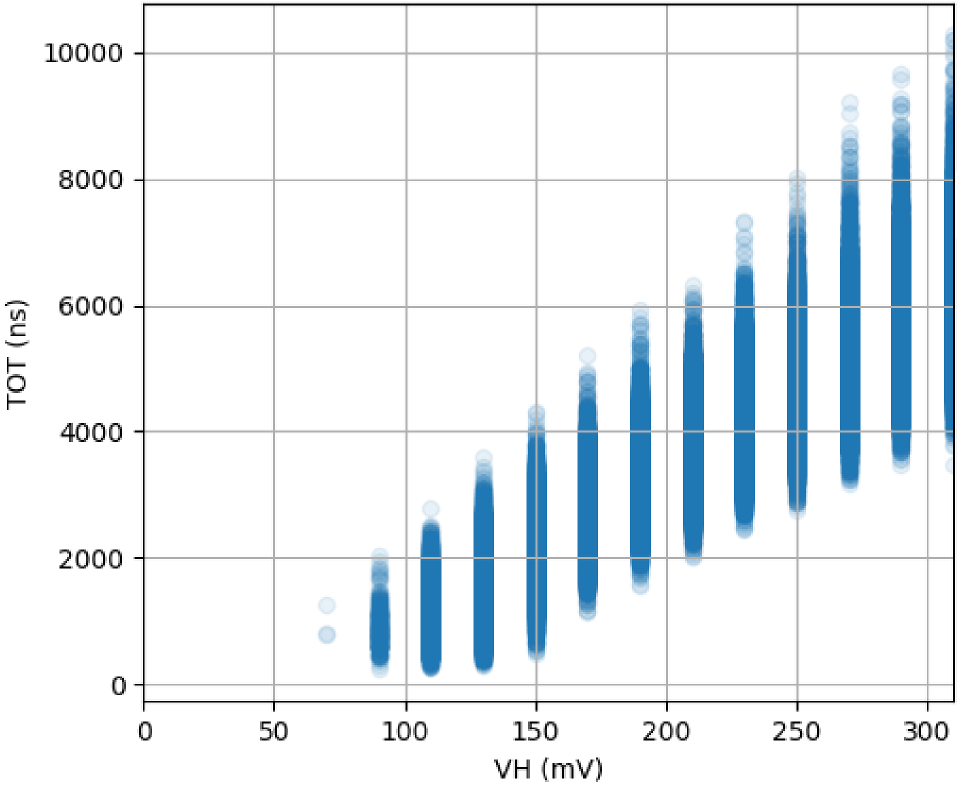


The threshold and noise can be determined from the S-Curve. The threshold. I think this is calculated from the mean and standard deviation of the <u>derivative</u> of the S-Curve?





Threshold Scan Results

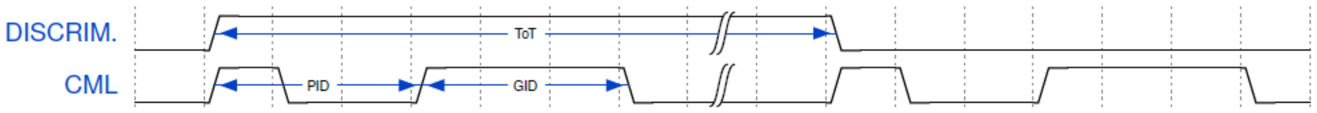


LBL Setup

DPTS
$I_{reset} = 10\,\mathrm{pA}$
$I_{bias} = 100\,\mathrm{nA}$
$I_{biasn} = 10\,\mathrm{nA}$
$I_{db} = 100\,\mathrm{nA}$
$V_{casn} = 300\,\mathrm{mV}$
$V_{casb} = 300\,\mathrm{mV}$
$V_{pwell} = V_{sub} = -1.2\,\mathrm{V}$

The front end is designed such that the pulse length will increase linearly with the input signal. This means that the Time-over-Threshold (ToT) provides information on the collected or injected charge.

Plot on left shows results for all pixels. ToT shows considerable pixel-to-pixel spread.



Summary

- We now have a working DPTS+MLR1 bench setup.
- We can also test the MLR1 DAQ boards that we are making at LBL with this setup. Peng and I tested one LBL board and were able to power the DPTS using it.
- Ezra Lesser spent time working with the DPTS system last year in Trieste. He will help me get a better understanding of the DAQ/analysis software.
- What tests do we want to perform next?