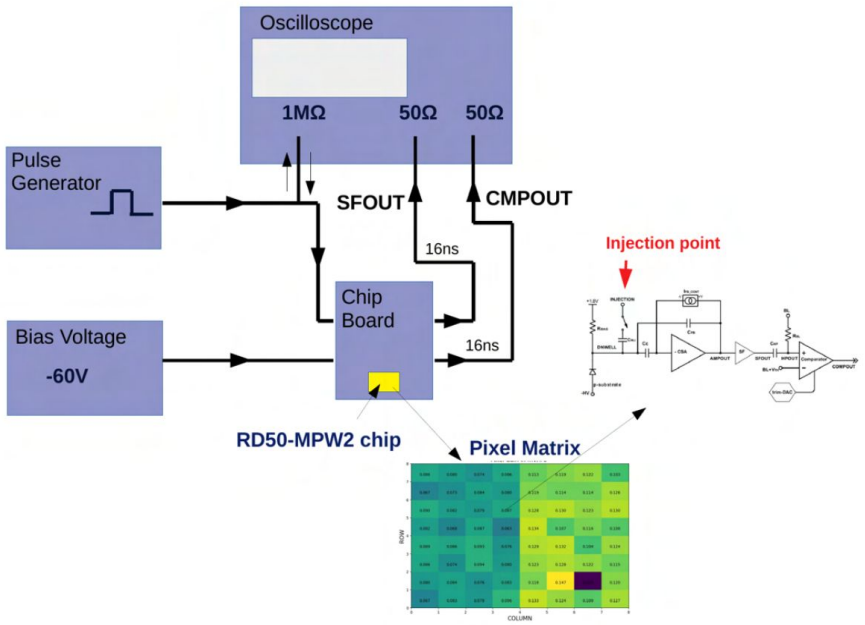
Timing Results MPW2

Douwe Nobels

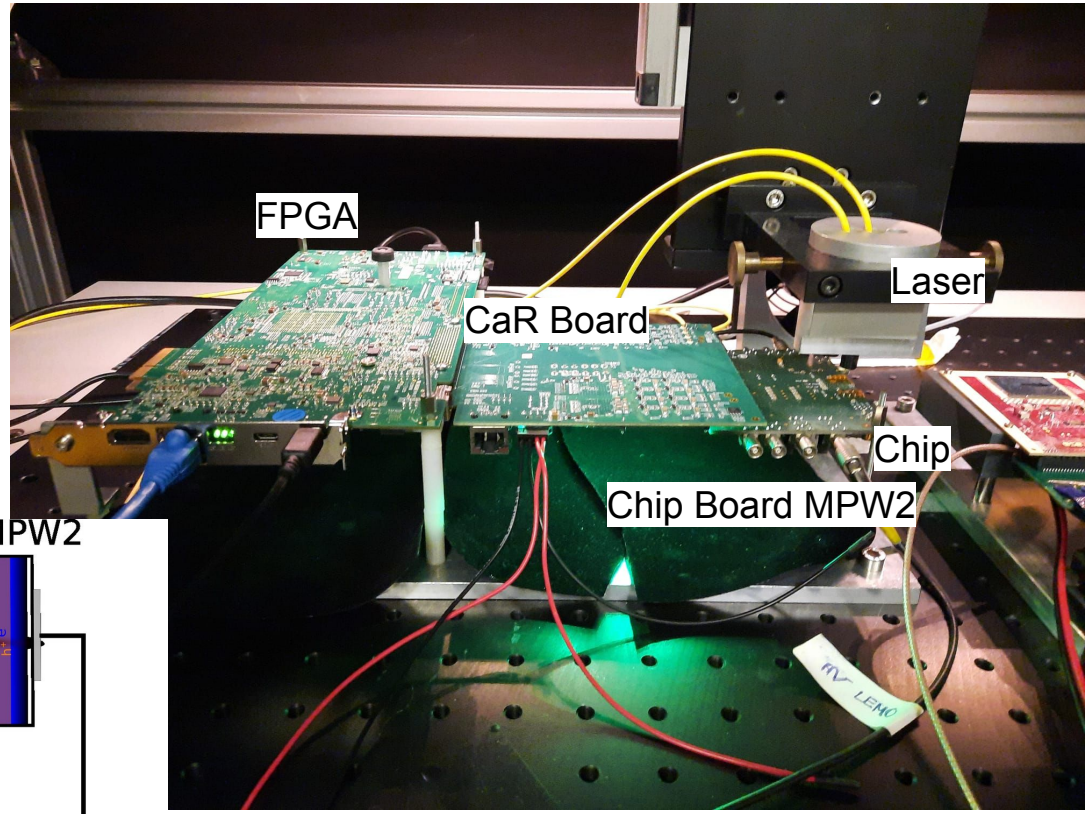
The Setup

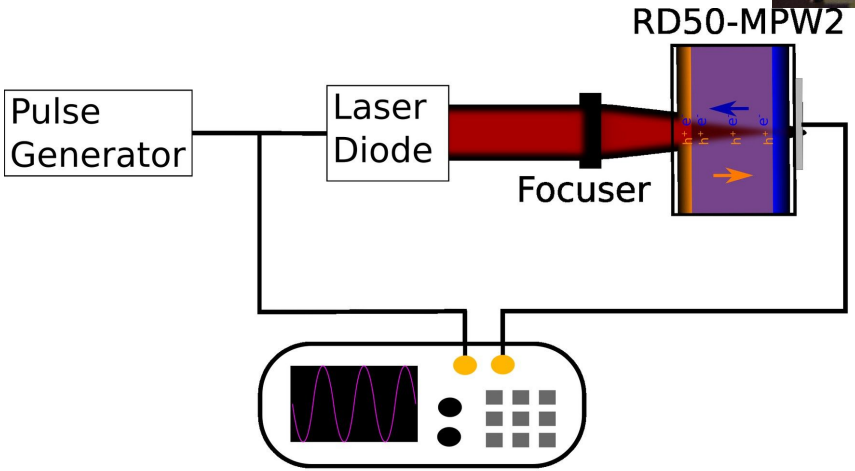
- Keysight 81110A Pulse Pattern Generator
- Pulse frequency 60 Hz
- Pulse width 50 μs
- HV bias 100 V
- Threshold 970 mV(at this level the trimDACs show no signal but still some noise hits without being the highest trimDAC)
- Baseline 900 mV
- Infrared laser 980 nm
- Attenuator
- 1.9 kΩcm



The Setup

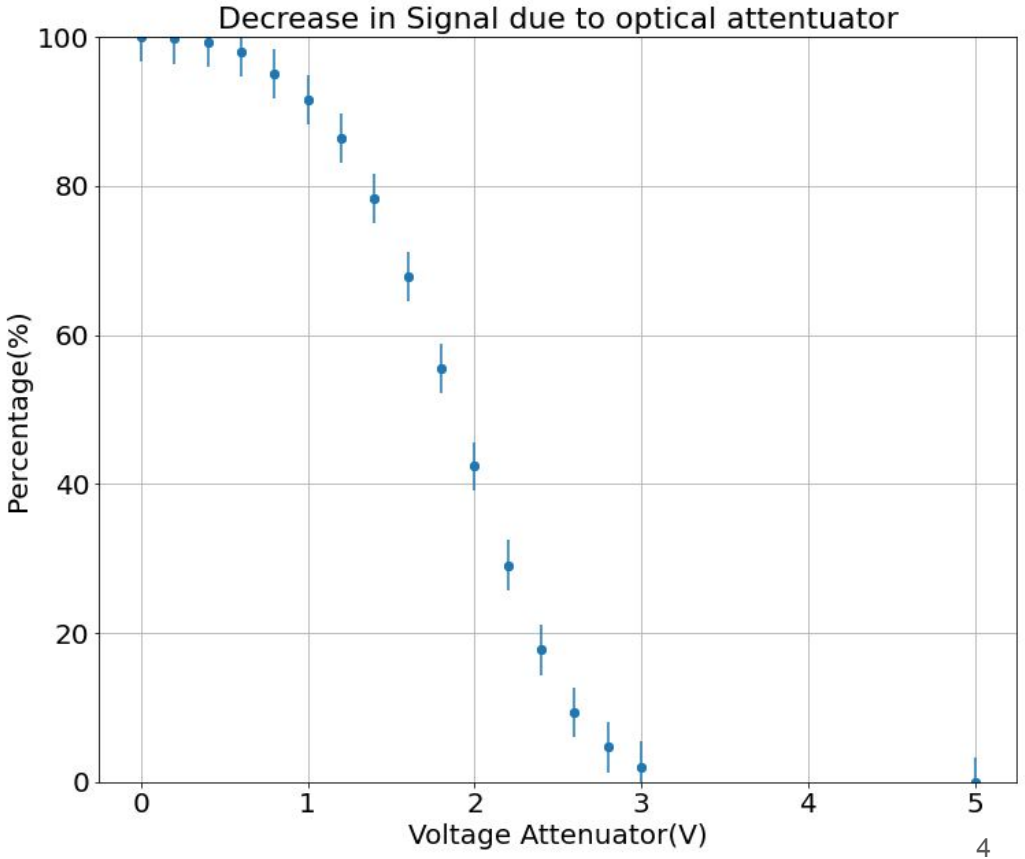
- Laser is shot in from the backside





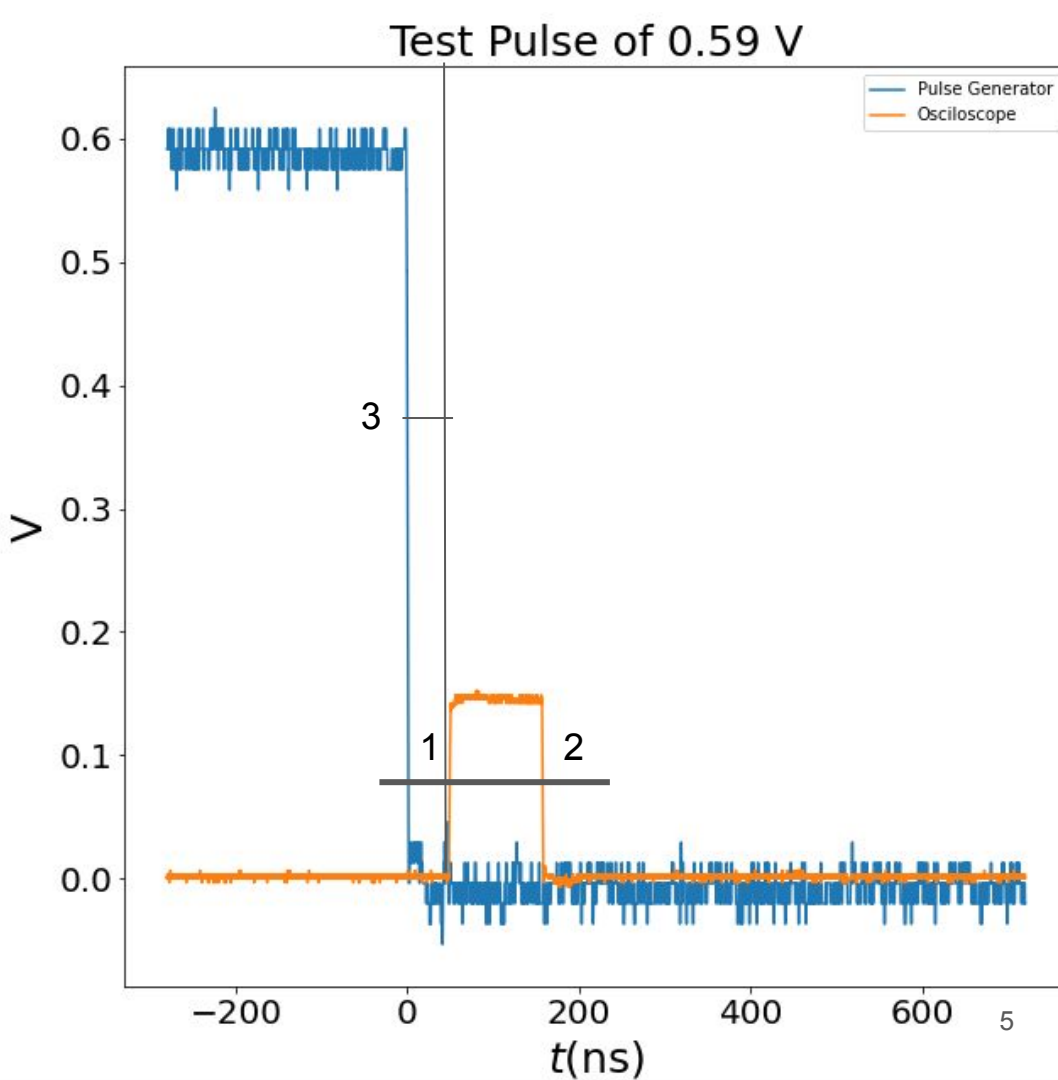
Attenuator

- An Attenuator was added to the setup to lower the laser amplitude and retain a stable signal.
- Higher voltage attenuator →Lower signal amplitude



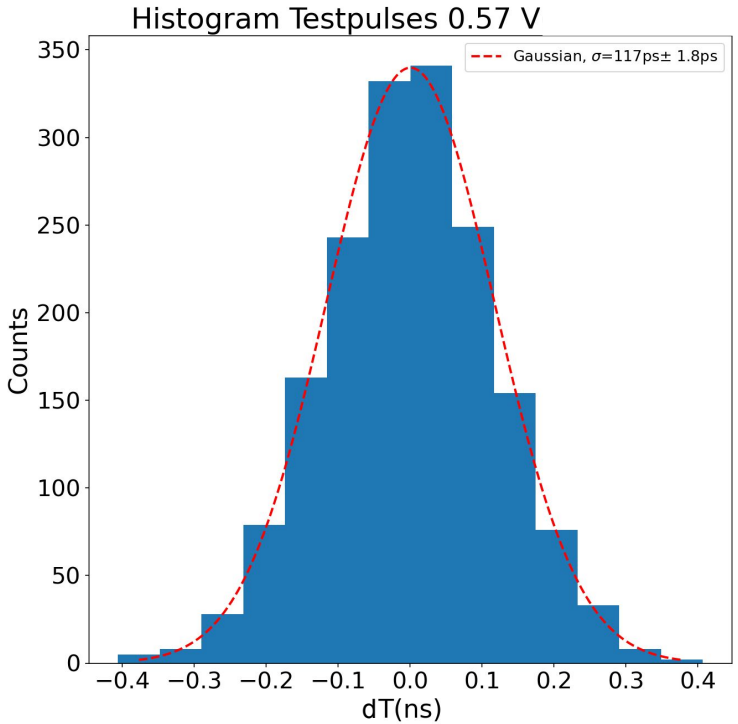
What we Measure

- Time over Threshold:
  - ToT= Δt= t2-t1
  - Where 1 is the time of 50% of the rising edge
  - 2 is the time of 50% of the falling edge
- Time resolution:
  - Is the spread in the time difference where the the time difference is: Δt = t1-t3
  - Where 3 is the time of 50% falling edge if the pulse generator



Determining the Time Resolution

- Plot a Histogram of the spread of the time difference
- Fit a normal distribution and determine the spread of the distribution.
- The time resolution is equal to the spread

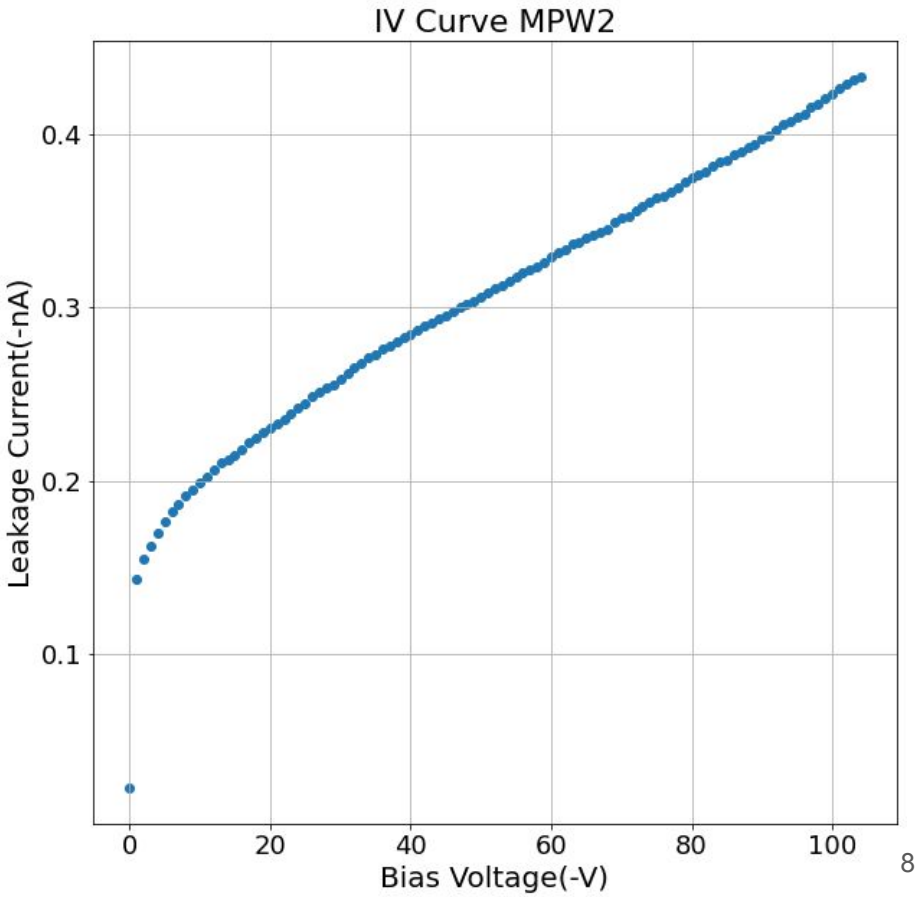


Measurements

- IV-Curve
- Calibration with Test Pulses 0.43 V to 1.79 (with steps of 0.20 V)
- Laser scans 200 waveforms per pixel with Laser amplitude of 2.4 V and a varying attenuator amplitude from 1.6 V to 2.6 V with steps of 0.2 V

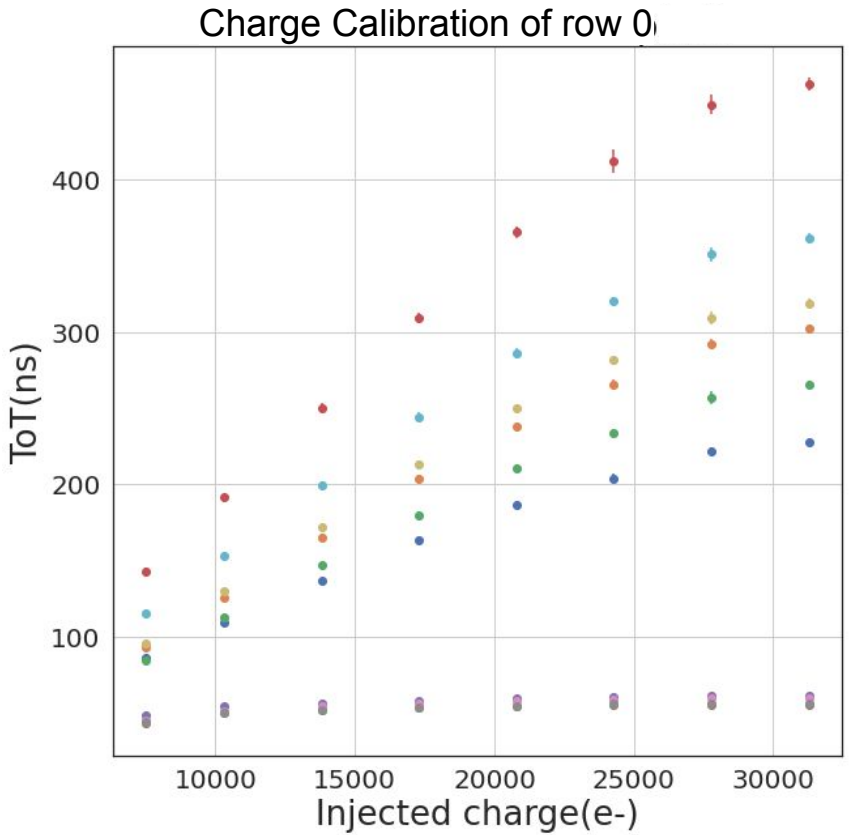
Measurements: IV-Curve

- From -1.0 V to -104 V with steps of -1.0 V



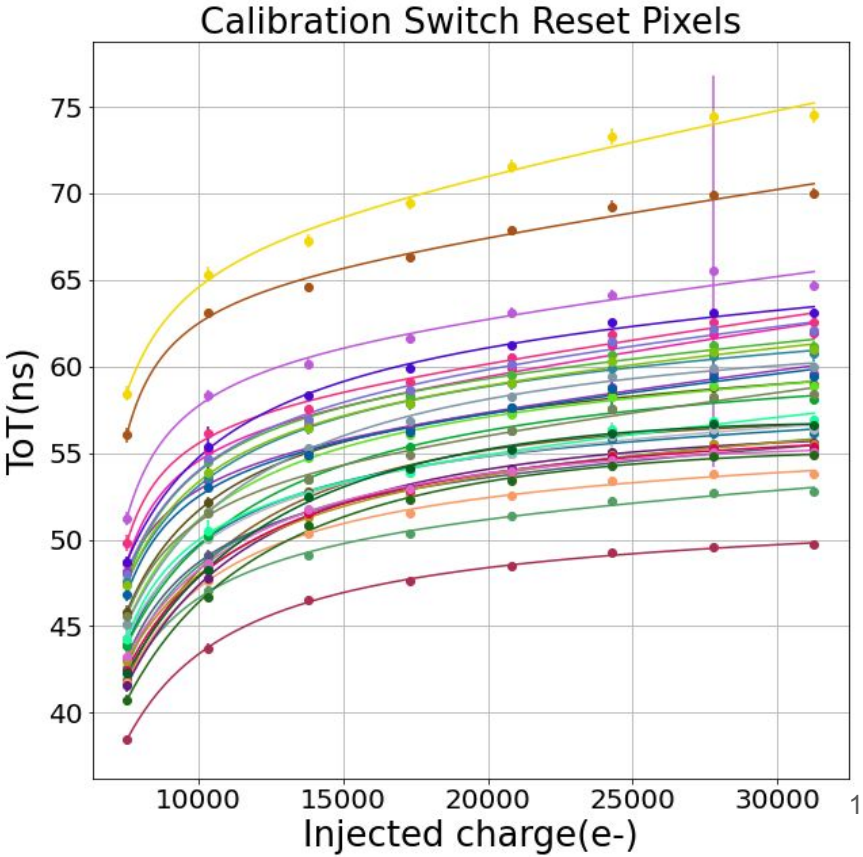
Charge calibration with test pulses

- Test pulses injected by the injection circuit
- Clear difference between Continuous and switch reset pixels



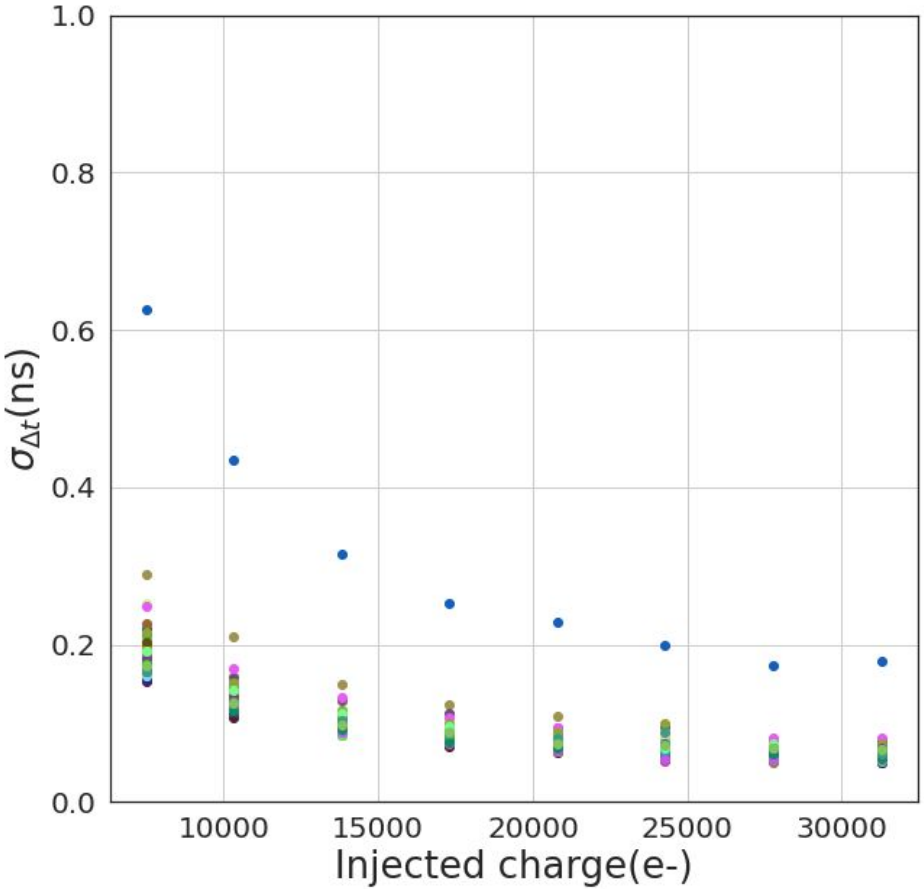
Zoomed in on the Switch reset pixels

- Charge Calibration of all Switch reset pixels
- Fit function:
  - Q= a*ToT+b+ c/(ToT-d)
- The Switch reset pixel's ToT should not be affected by charge but it has a small effect



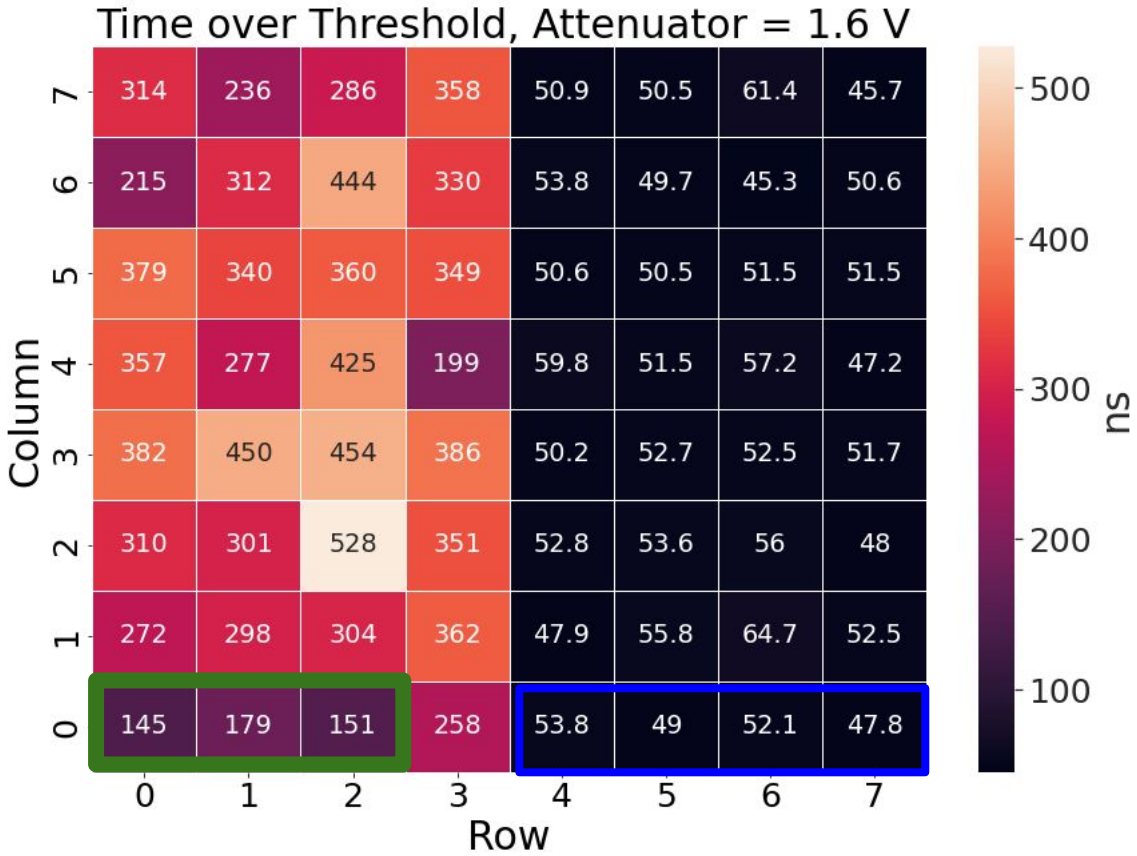
Time Resolution Test Pulses

- Time resolution of all pixels injected with test pulses
- No clear distinction between the 2 types of pixels
- Highest injected charge gives a mean of 64ps for the time resolution



Measurements: ToT scans 1.6-2.8 V

- 200 Waveforms per pixel
- Laser amplitude 2.4 V
- Changing attenuator
- Clear Difference between Continuous and switch reset pixels



Measurements: ToT scans 1.6-2.8 V

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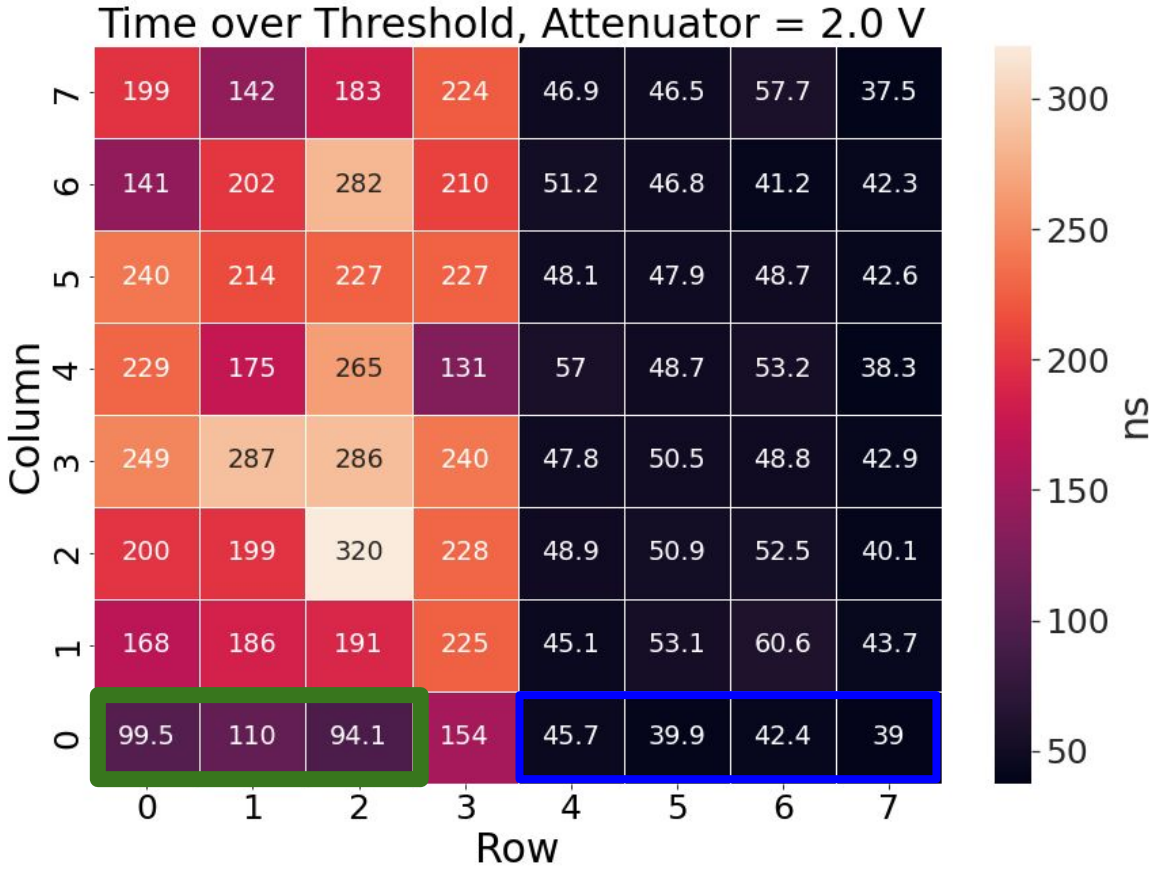
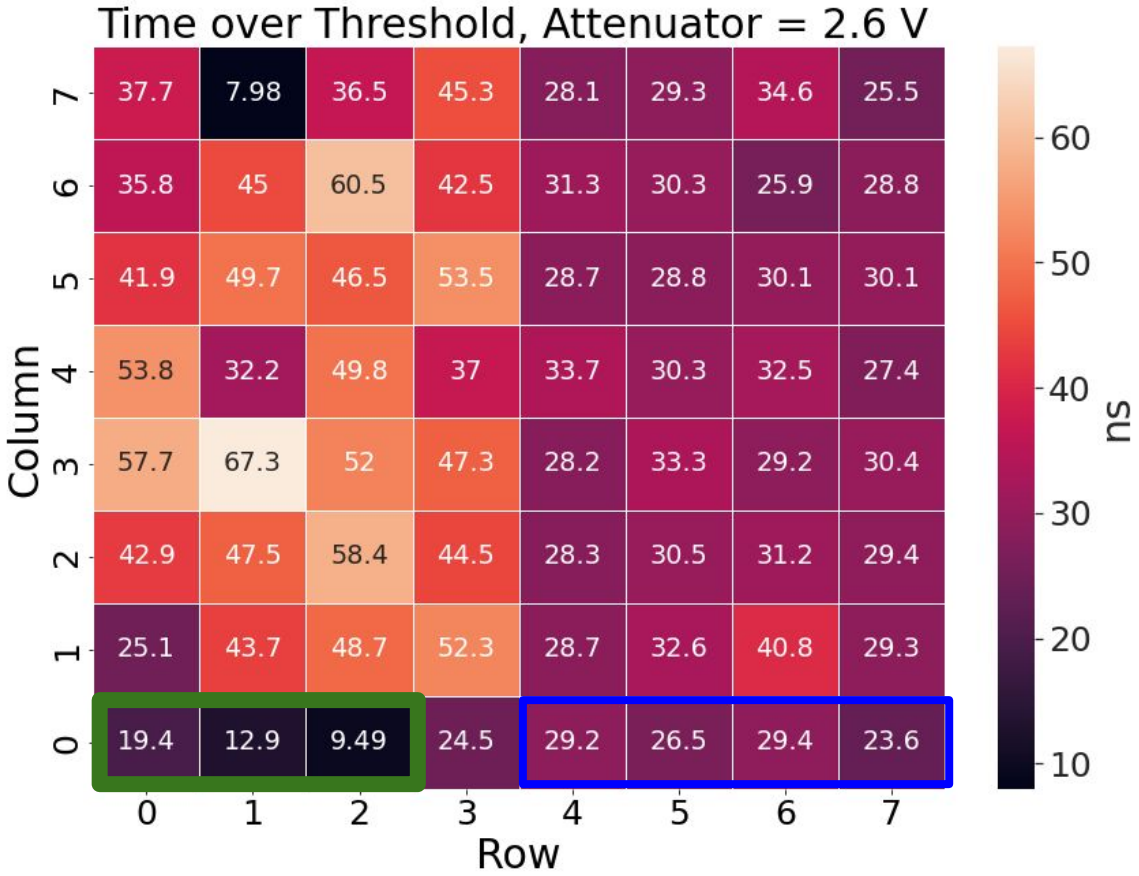


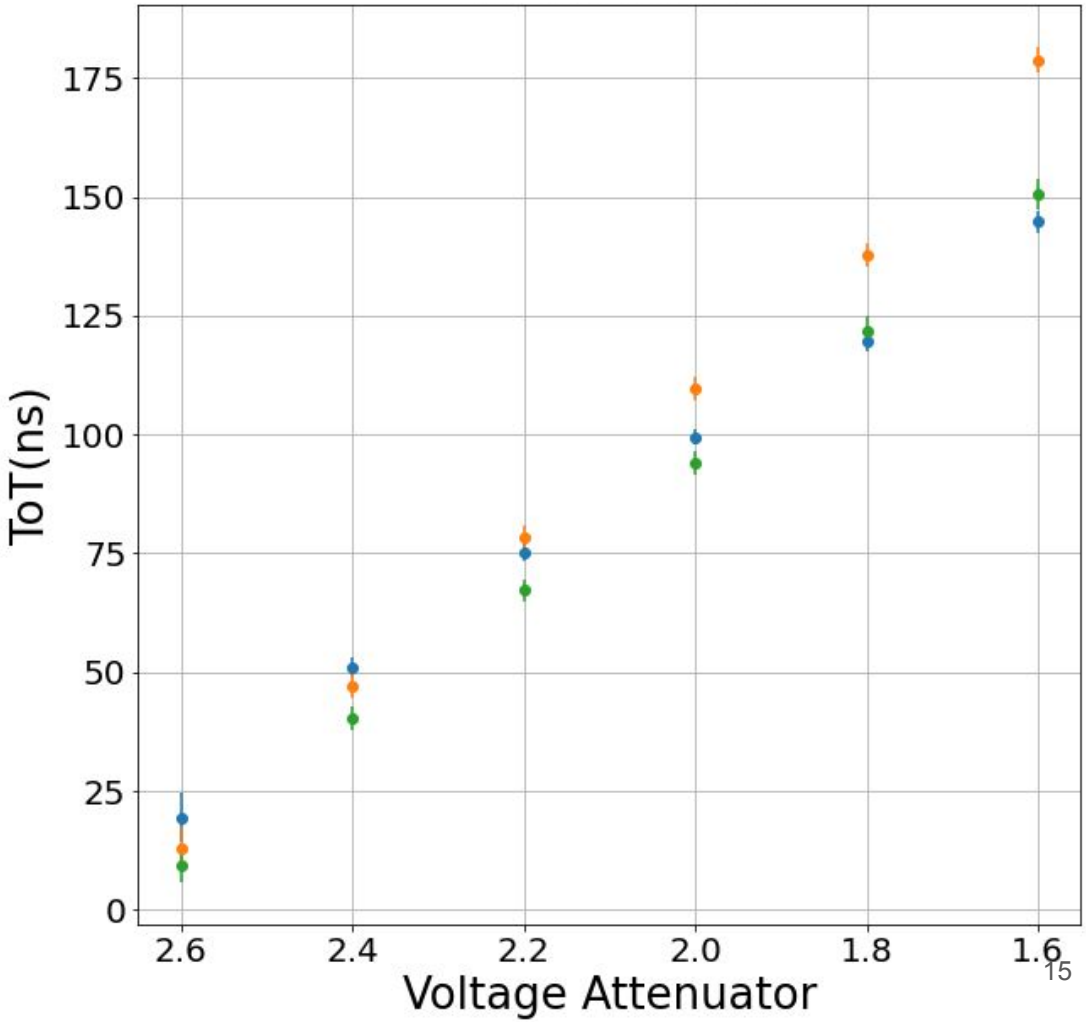
Measurements: ToT scans 1.6-2.8 V

- 200 Waveforms per pixel
- Laser amplitude 2.4 V
- Changing attenuator
- Clear Difference between Continuous and switch reset pixels



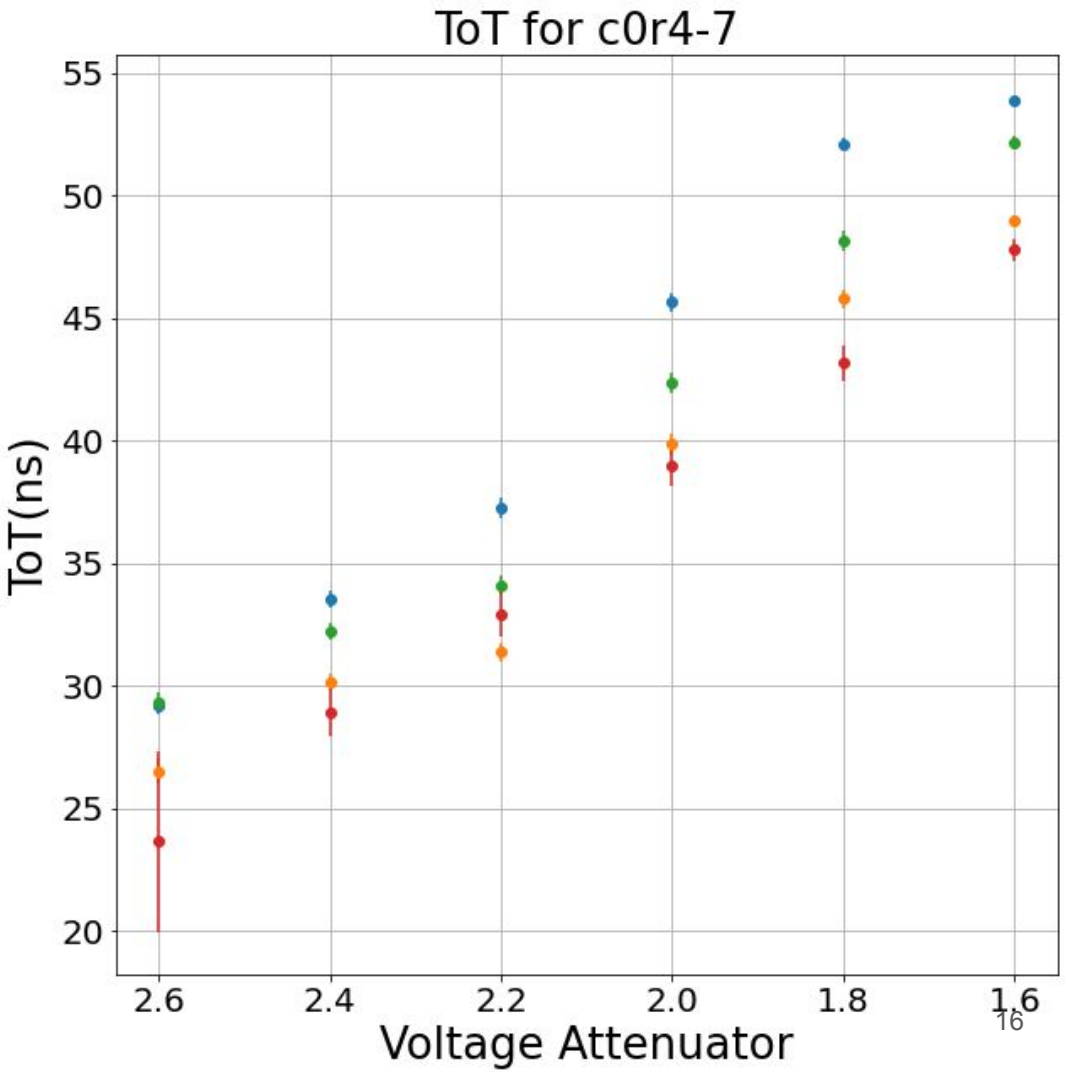
Change in ToT(green)

- Continuous reset pixels behave linear



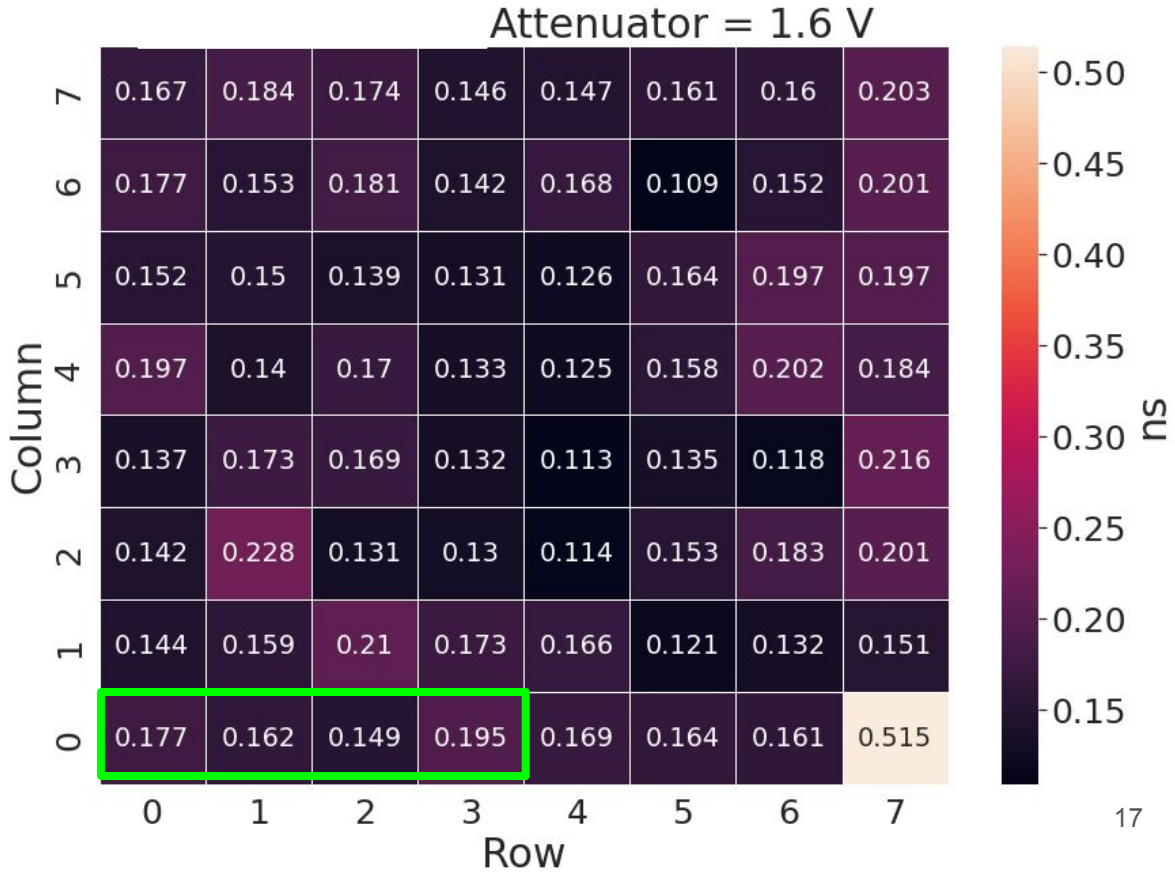
Change ToT(Blue)

- Switched reset pixels smaller ToT



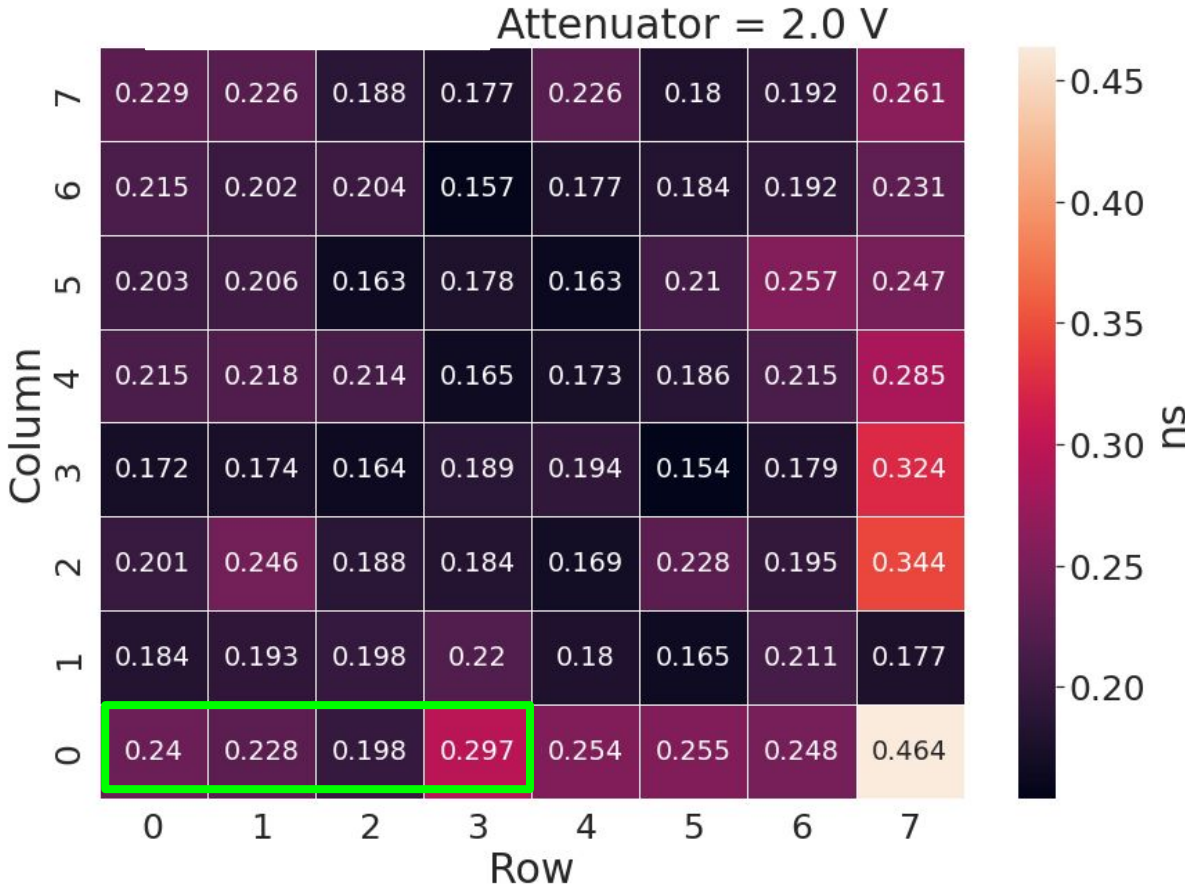
Measurements: Time resolution scans 1.6-2.8 V

- 200 Waveforms per pixel
- Laser amplitude 2.4 V
- Changing attenuator
- No clear difference between the two types of pixels



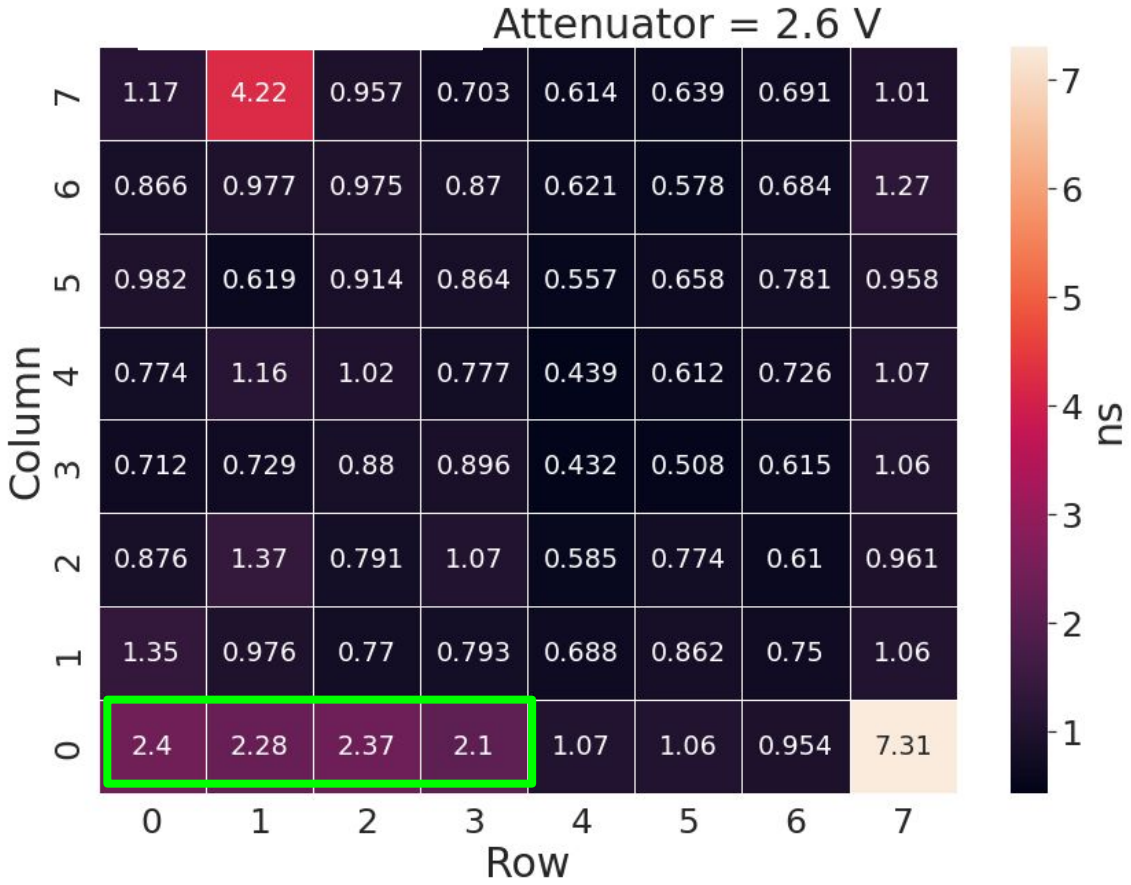
Measurements: Time resolution scans 1.6-2.8 V

- 200 Waveforms per pixel
- Laser amplitude 2.4 V
- Changing attenuator
- No clear difference between the two types of pixels



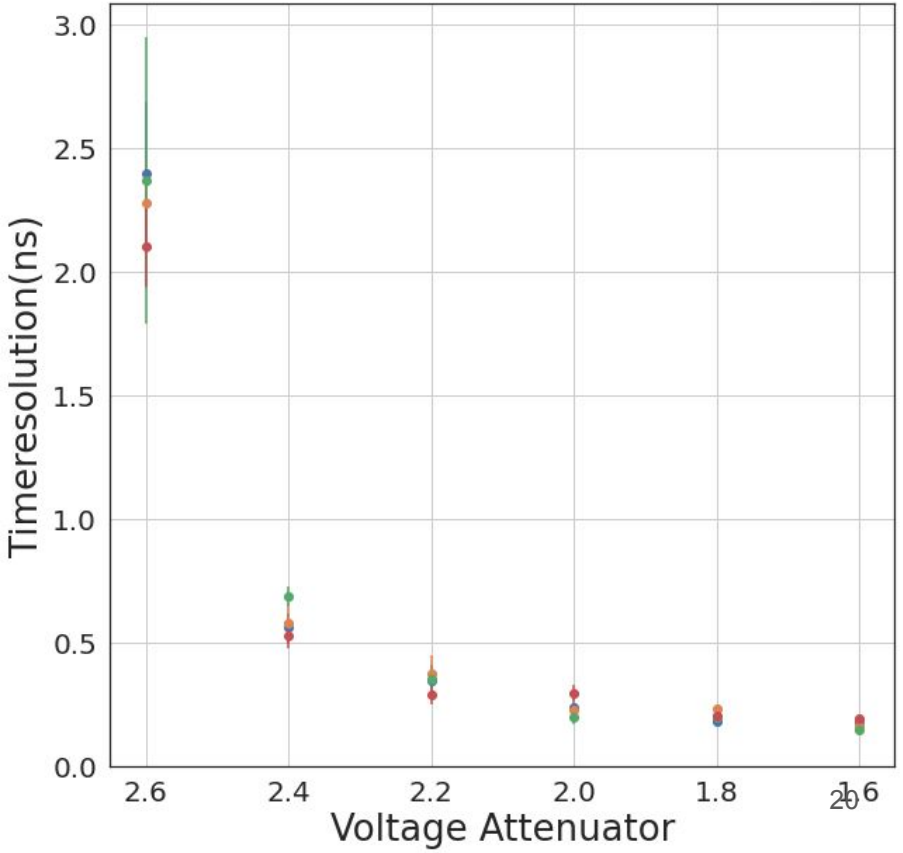
Measurements: Time resolution scans 1.6-2.8 V

- 200 Waveforms per pixel
- Laser amplitude 2.4 V
- Changing attenuator
- No clear difference between the two types of pixels



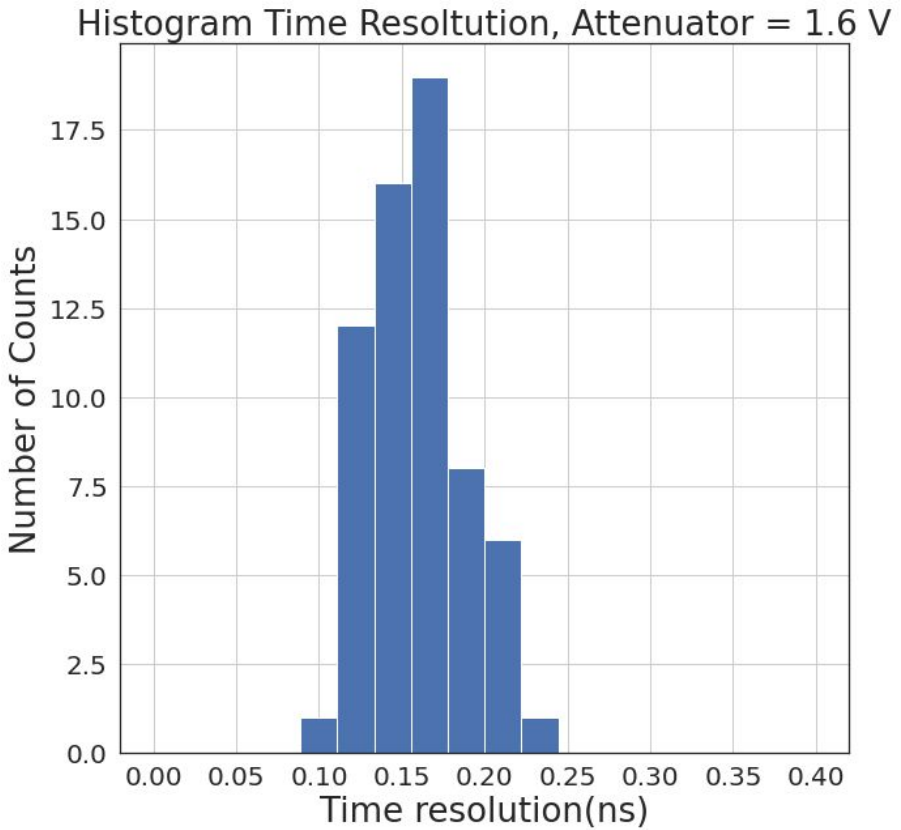
Time Resolution

- Time resolution improves when the laser intensity goes up
- Bigger error for low intensity



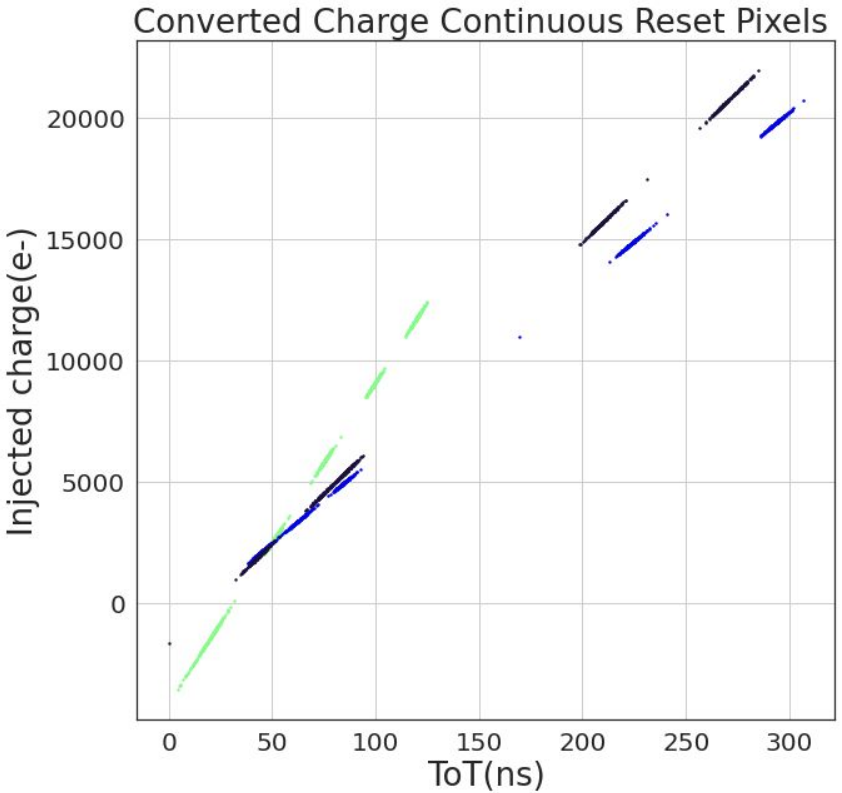
Histogram of the Time Resolution

- Mean of 165ps
- Standard deviation 52ps



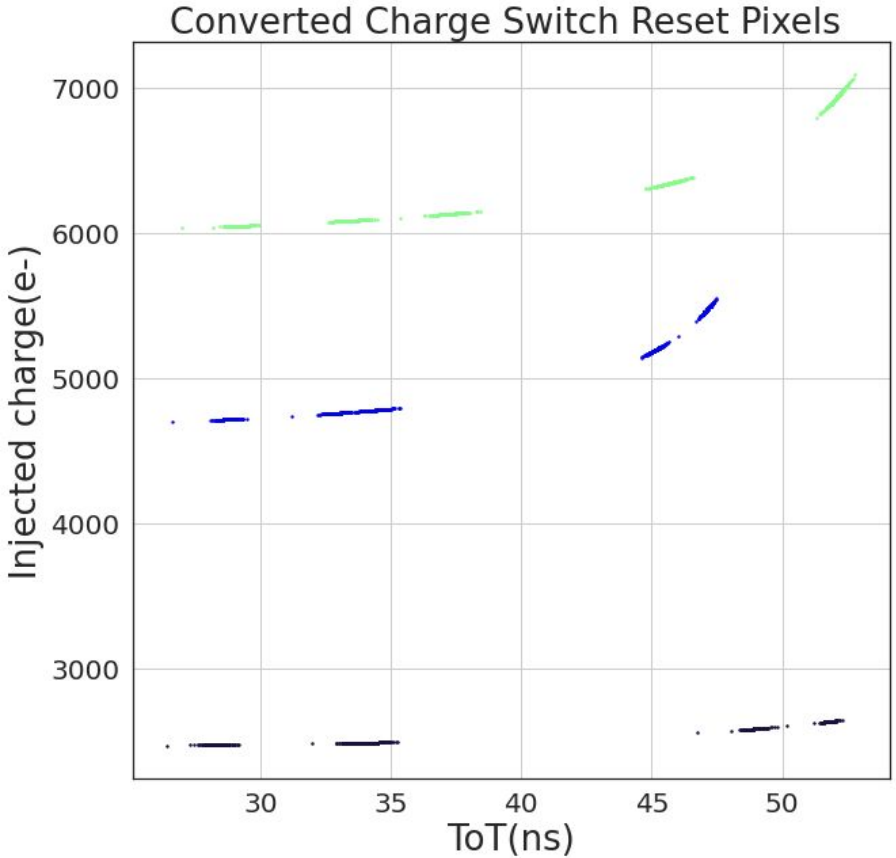
Laser ToT to charge conversion

- Pixels r0c0-2
- Not enough low test pulses
- Discontinuos laser amplitude
- Lower end not well defined
  → Results in negative charges
- Unable to bin the data since the binsize differ too much



Laser ToT to charge conversion Switch Reset Pixels

- Similarly as the previous slide we need more low test pulses to make a good calibration.
- However, we should not that the reset pixels behave like binary pixels and thus the ToT does not get influenced a lot by a change in charge



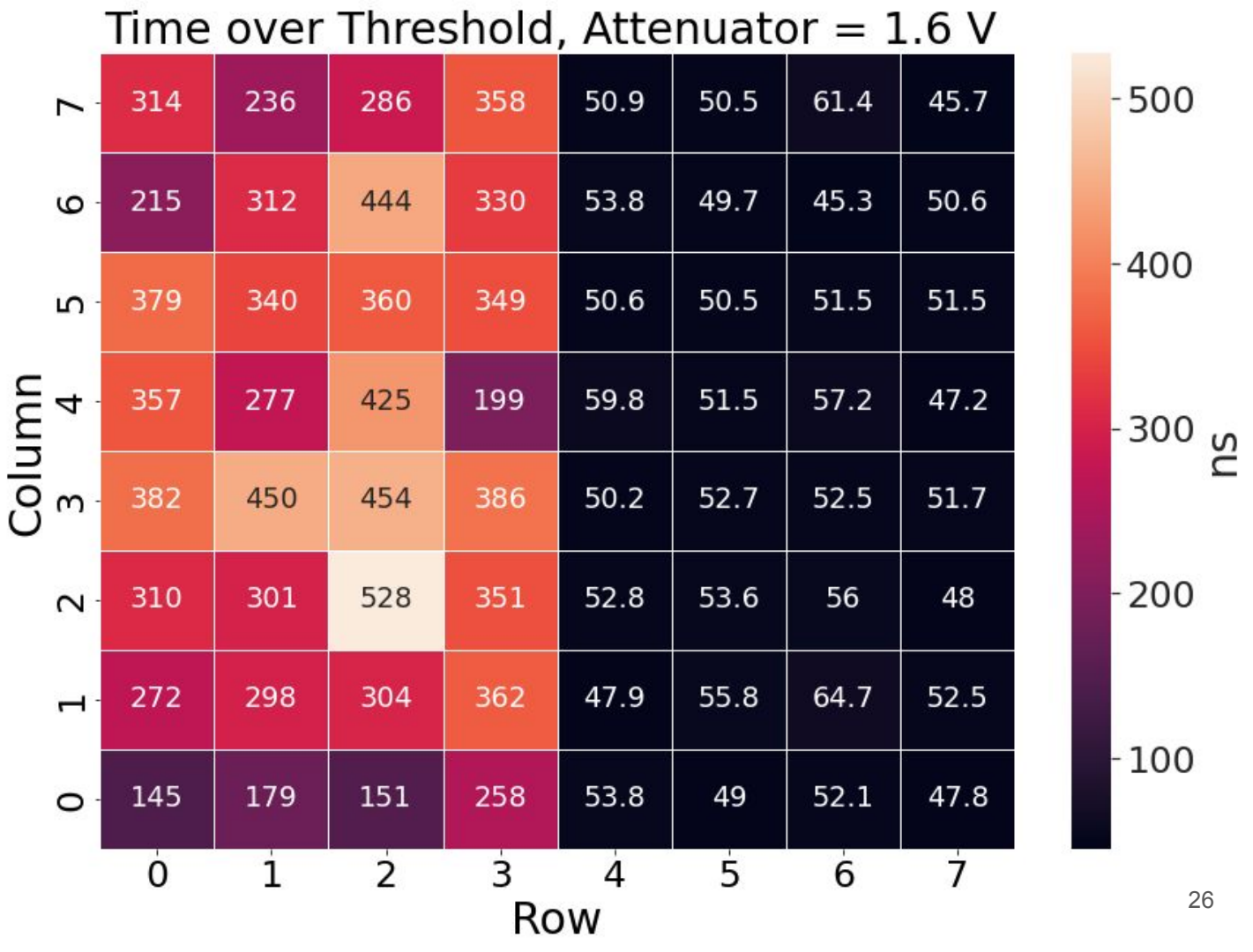
Outlook

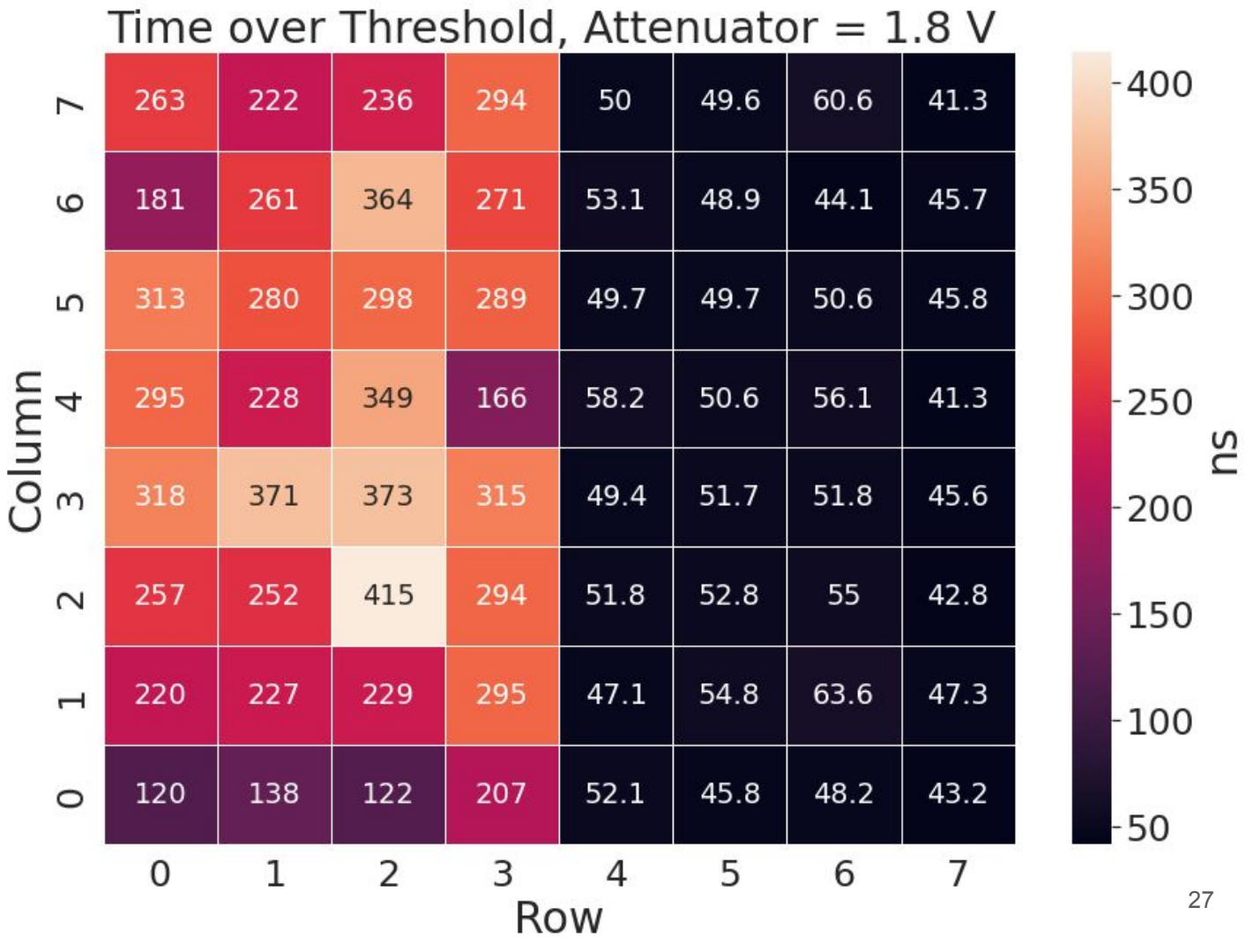
- More Test pulses for better calibration
- Calibration with radioactive sources
- Back to back laser scans(when our lab is reopened)

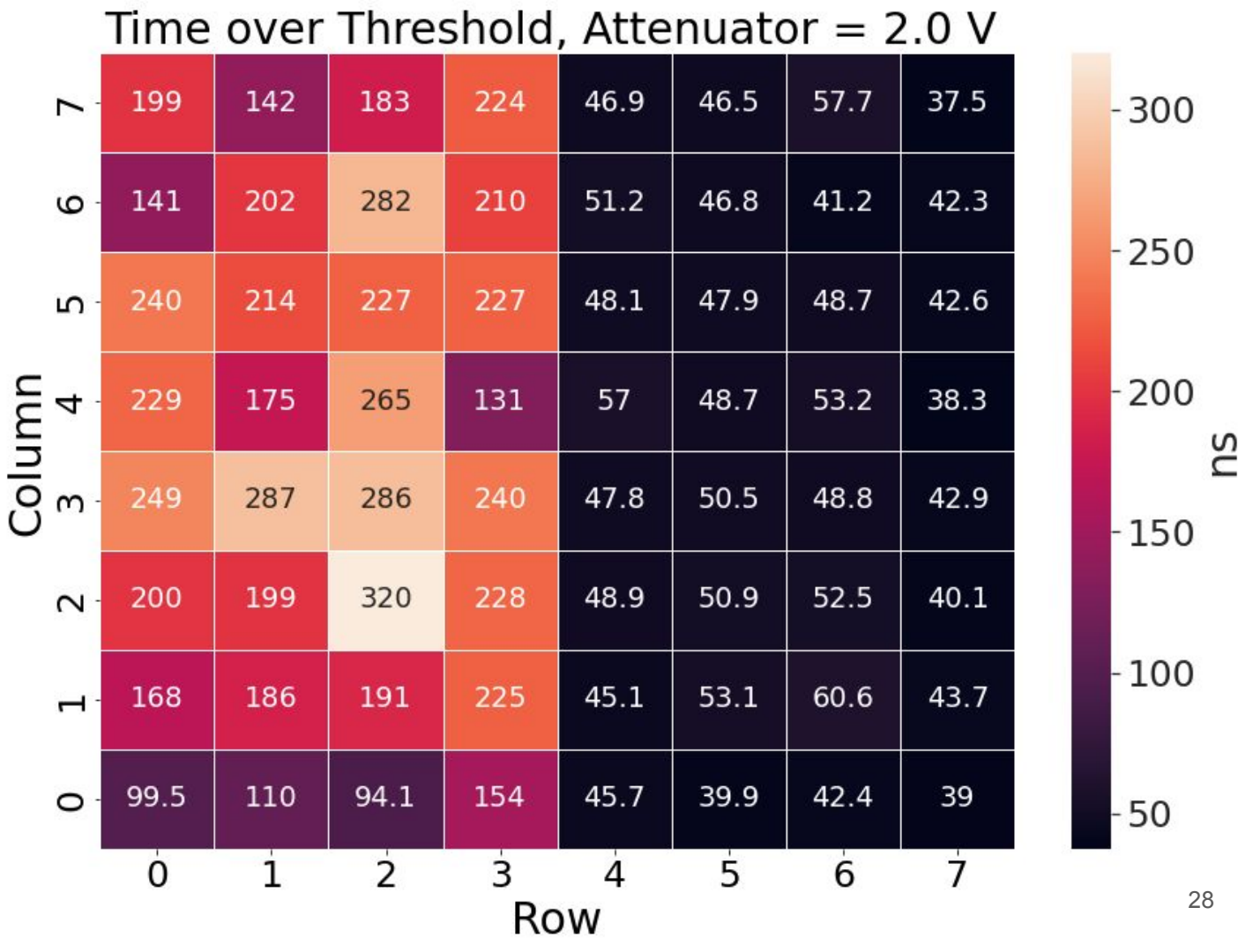
Backup slides

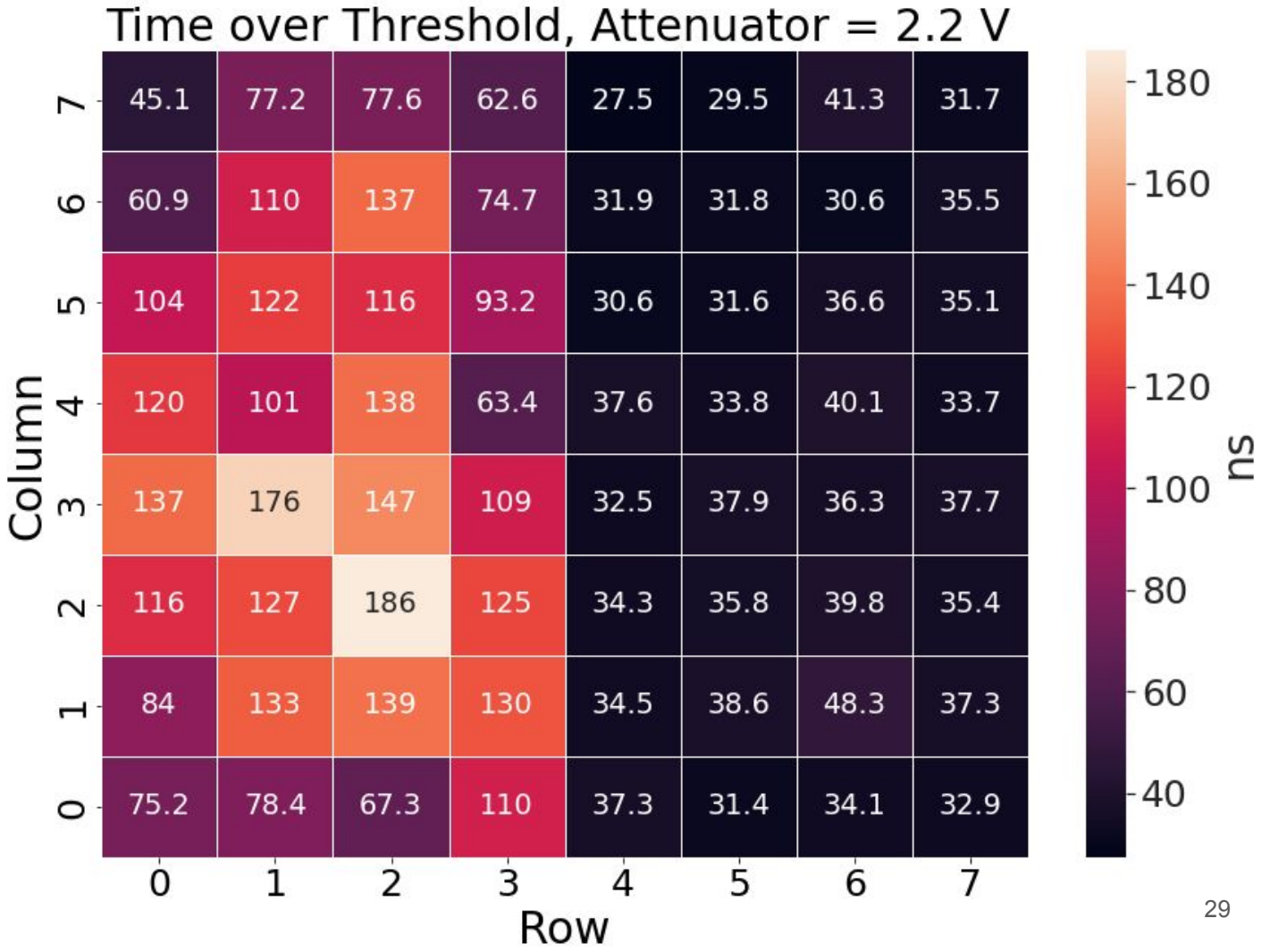
- ToT maps
- Time resolution Maps
- Histograms of ToT of some pixels

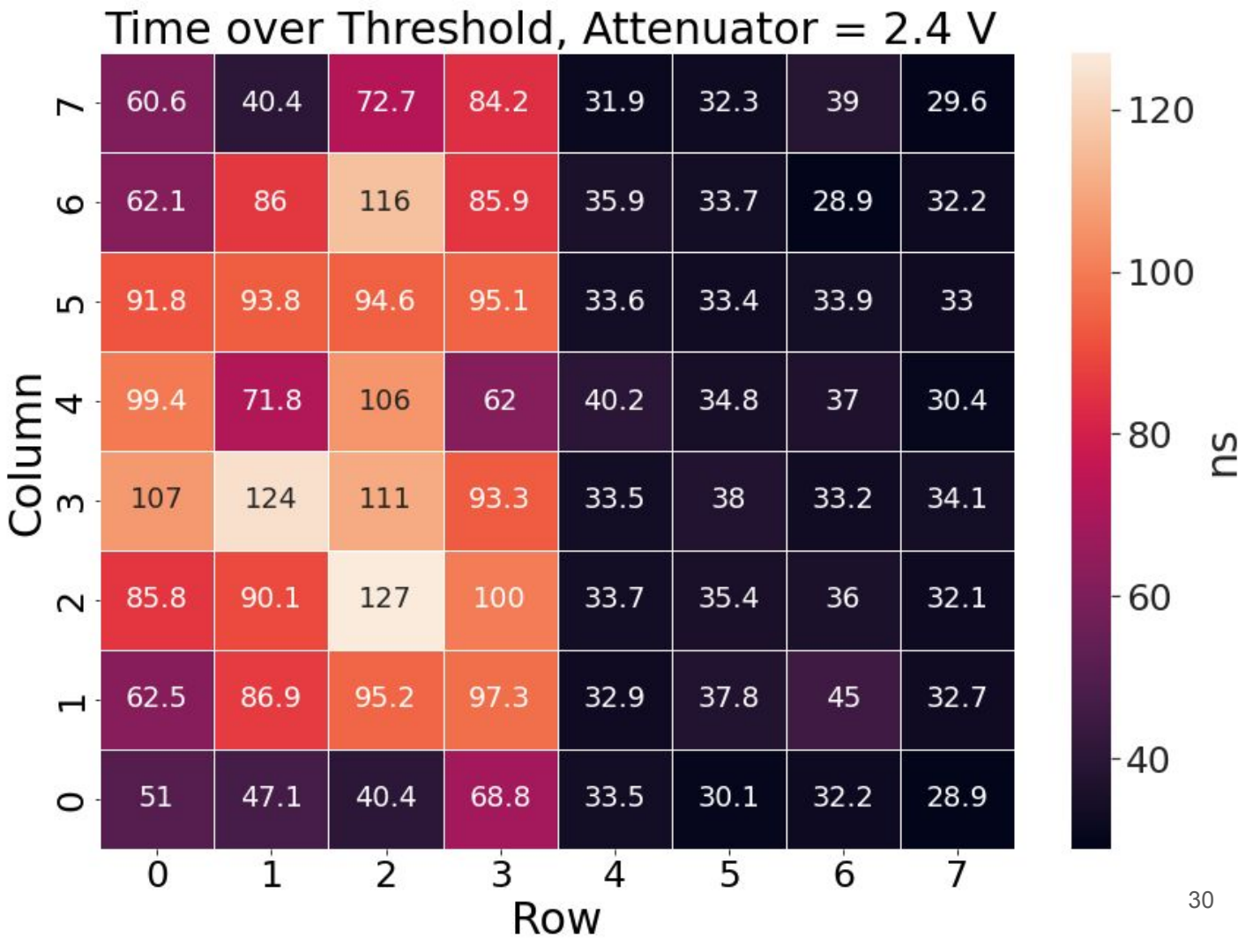
Measurement

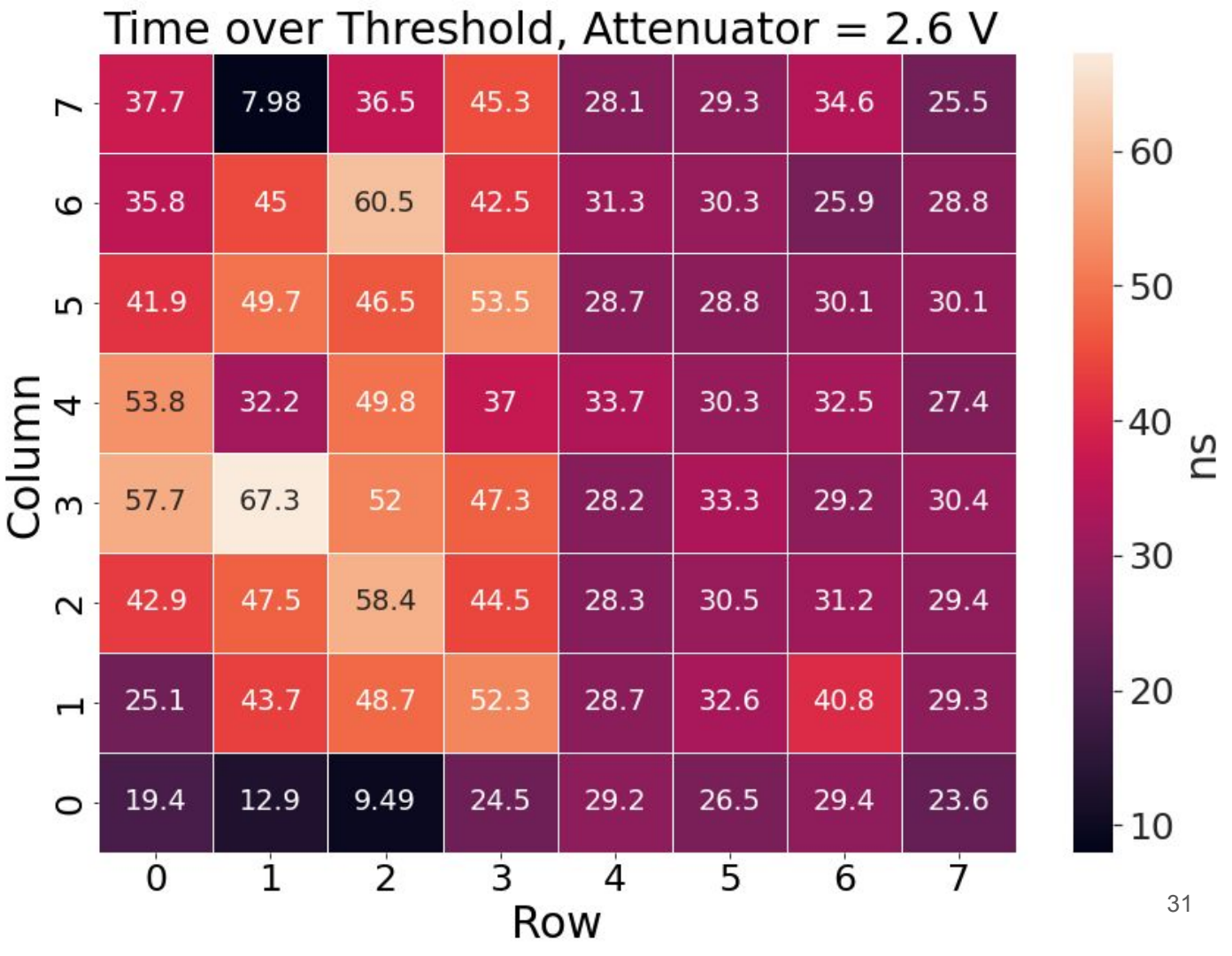



Time over Threshold, Attenuator = 1.8 V
Column
Row
ns
7 263 222 236 294 50 49.6 60.6 41.3
6 181 261 364 271 53.1 48.9 44.1 45.7
5 313 280 298 289 49.7 49.7 50.6 45.8
4 295 228 349 166 58.2 50.6 56.1 41.3
3 318 371 373 315 49.4 51.7 51.8 45.6
2 257 252 415 294 51.8 52.8 55 42.8
1 220 227 229 295 47.1 54.8 63.6 47.3
0 120 138 122 207 52.1 45.8 48.2 43.2
0 1 2 3 4 5 6 7
400
350
300
250
200
150
100
50


Time over Threshold, Attenuator = 2.0 V
Column
Row
ns
0 1 2 3 4 5 6 7
7: 199 142 183 224 46.9 46.5 57.7 37.5
6: 141 202 282 210 51.2 46.8 41.2 42.3
5: 240 214 227 227 48.1 47.9 48.7 42.6
4: 229 175 265 131 57 48.7 53.2 38.3
3: 249 287 286 240 47.8 50.5 48.8 42.9
2: 200 199 320 228 48.9 50.9 52.5 40.1
1: 168 186 191 225 45.1 53.1 60.6 43.7
0: 99.5 110 94.1 154 45.7 39.9 42.4 39
300
250
200
150
100
50

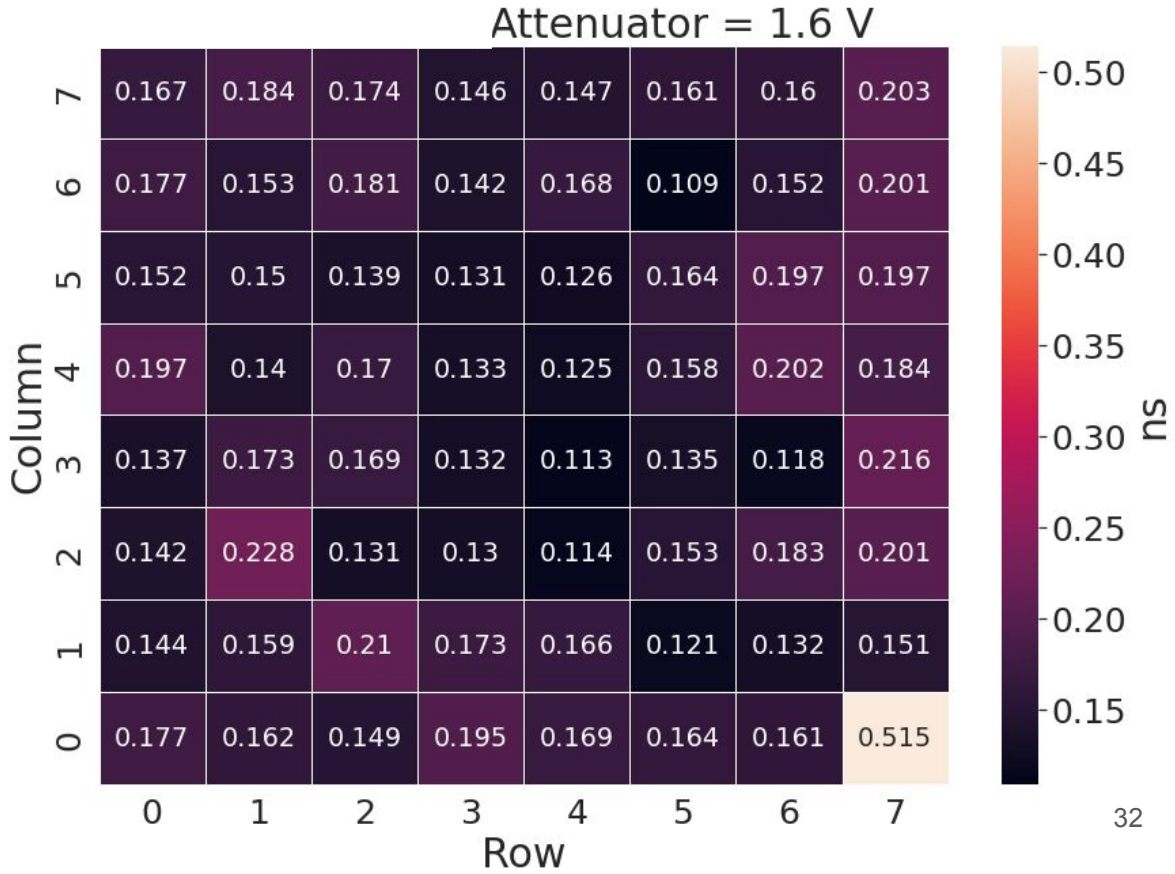

Time over Threshold, Attenuator = 2.2 V
Column
Row
ns
7 45.1 77.2 77.6 62.6 27.5 29.5 41.3 31.7
6 60.9 110 137 74.7 31.9 31.8 30.6 35.5
5 104 122 116 93.2 30.6 31.6 36.6 35.1
4 120 101 138 63.4 37.6 33.8 40.1 33.7
3 137 176 147 109 32.5 37.9 36.3 37.7
2 116 127 186 125 34.3 35.8 39.8 35.4
1 84 133 139 130 34.5 38.6 48.3 37.3
0 75.2 78.4 67.3 110 37.3 31.4 34.1 32.9
0 1 2 3 4 5 6 7
180
160
140
120
100
80
60
40

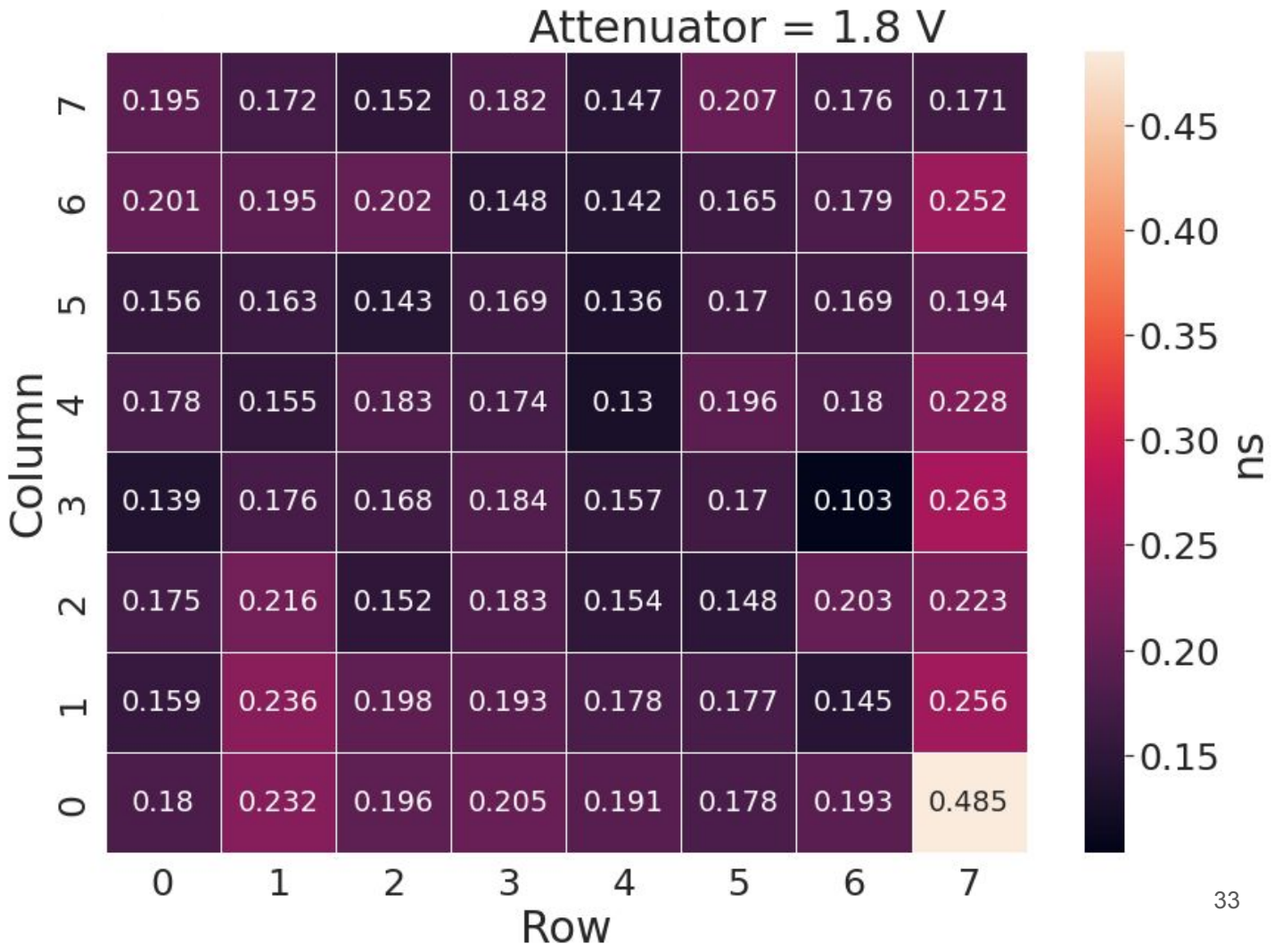

Time over Threshold, Attenuator = 2.4 V
Column
Row
ns
7
6
5
4
3
2
1
0
0
1
2
3
4
5
6
7
60.6 40.4 72.7 84.2 31.9 32.3 39 29.6
62.1 86 116 85.9 35.9 33.7 28.9 32.2
91.8 93.8 94.6 95.1 33.6 33.4 33.9 33
99.4 71.8 106 62 40.2 34.8 37 30.4
107 124 111 93.3 33.5 38 33.2 34.1
85.8 90.1 127 100 33.7 35.4 36 32.1
62.5 86.9 95.2 97.3 32.9 37.8 45 32.7
51 47.1 40.4 68.8 33.5 30.1 32.2 28.9
120
100
80
60
40

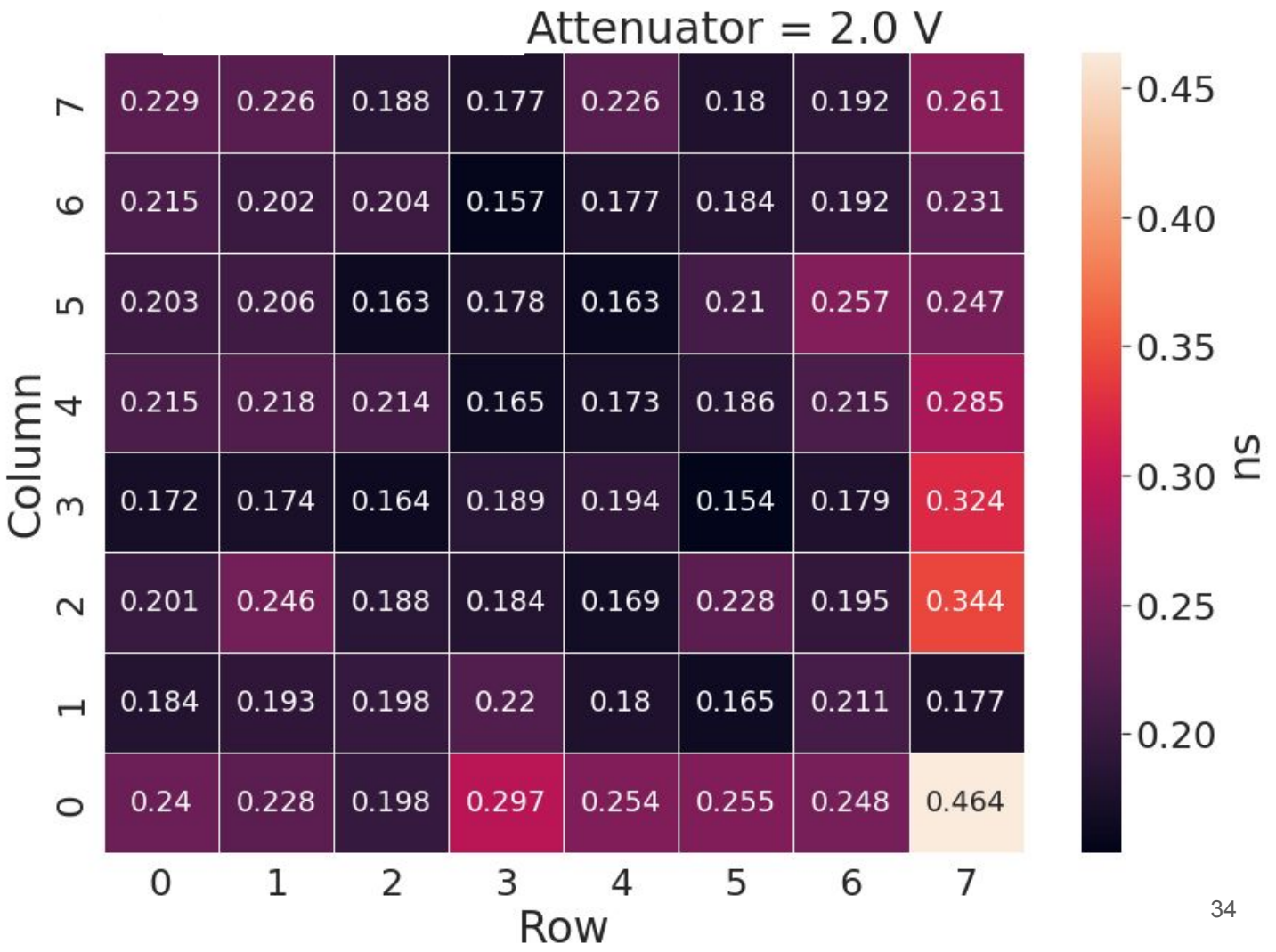

Time over Threshold, Attenuator = 2.6 V
Column
Row
ns
0 1 2 3 4 5 6 7
37.7 7.98 36.5 45.3 28.1 29.3 34.6 25.5
35.8 45 60.5 42.5 31.3 30.3 25.9 28.8
41.9 49.7 46.5 53.5 28.7 28.8 30.1 30.1
53.8 32.2 49.8 37 33.7 30.3 32.5 27.4
57.7 67.3 52 47.3 28.2 33.3 29.2 30.4
42.9 47.5 58.4 44.5 28.3 30.5 31.2 29.4
25.1 43.7 48.7 52.3 28.7 32.6 40.8 29.3
19.4 12.9 9.49 24.5 29.2 26.5 29.4 23.6
10 20 30 40 50 60

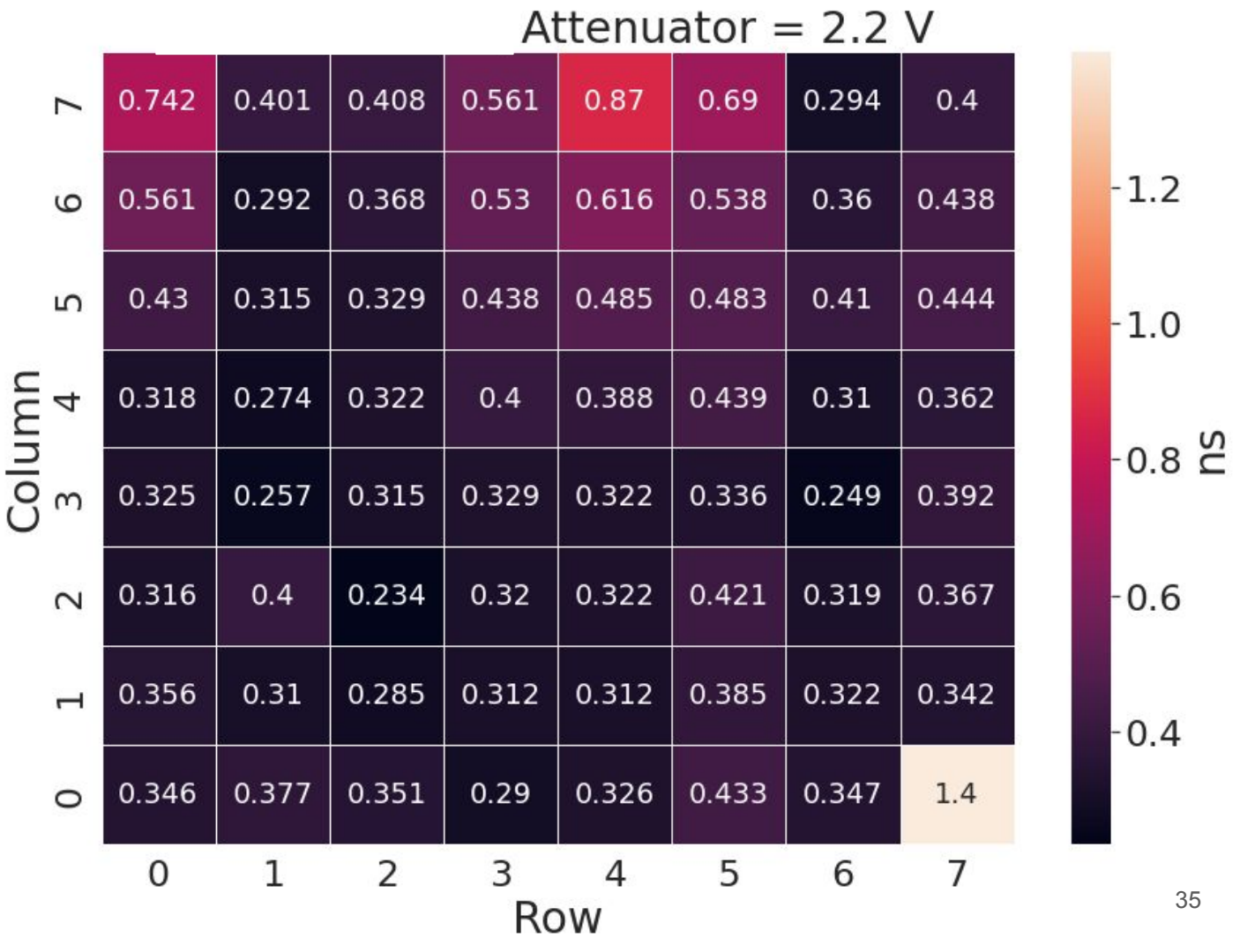
Measurements: Time resolution scans 1.6-2.8 V

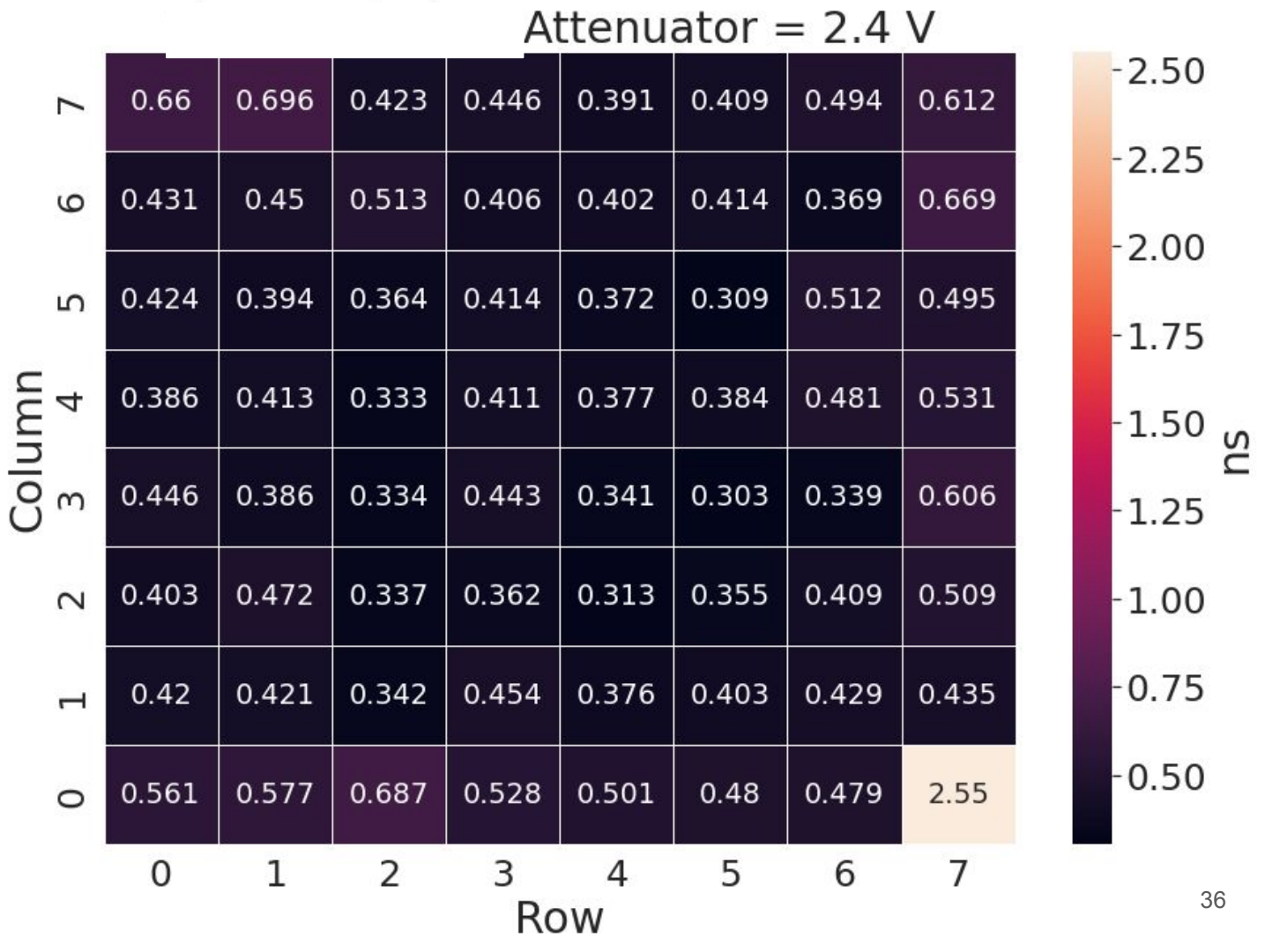
- 200 Waveforms per pixel
- Laser amplitude 2.4 V
- Changing attenuator
- No clear difference between the two types of pixels

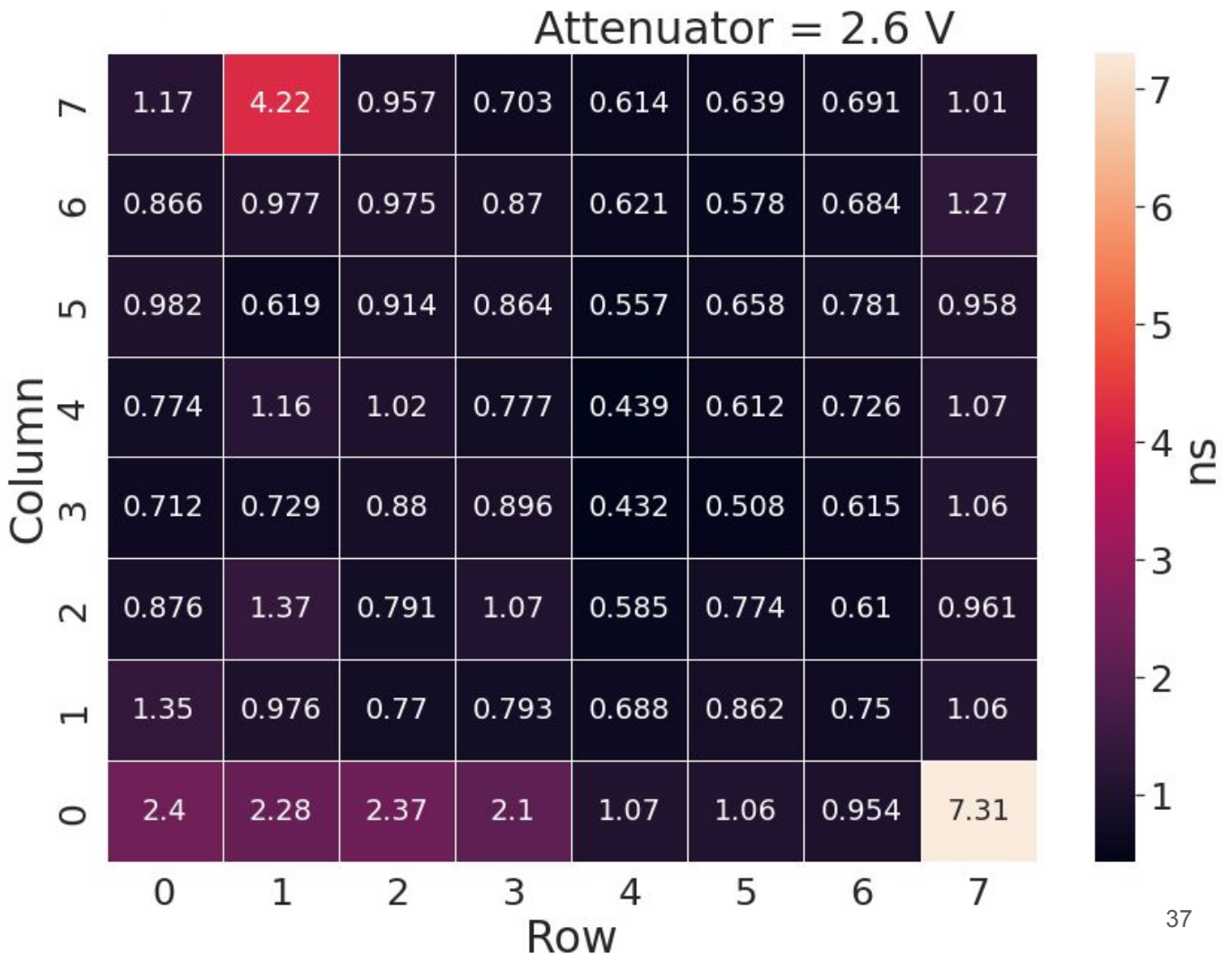



Attenuator = 1.8 V
Column
Row
ns
0.195 0.172 0.152 0.182 0.147 0.207 0.176 0.171
0.201 0.195 0.202 0.148 0.142 0.165 0.179 0.252
0.156 0.163 0.143 0.169 0.136 0.17 0.169 0.194
0.178 0.155 0.183 0.174 0.13 0.196 0.18 0.228
0.139 0.176 0.168 0.184 0.157 0.17 0.103 0.263
0.175 0.216 0.152 0.183 0.154 0.148 0.203 0.223
0.159 0.236 0.198 0.193 0.178 0.177 0.145 0.256
0.18 0.232 0.196 0.205 0.191 0.178 0.193 0.485
0 1 2 3 4 5 6 7
0.45 0.40 0.35 0.30 0.25 0.20 0.15


Attenuator = 2.0 V
Column
Row
ns
0.45
0.40
0.35
0.30
0.25
0.20
0 1 2 3 4 5 6 7
0.24 0.228 0.198 0.297 0.254 0.255 0.248 0.464
0.184 0.193 0.198 0.22 0.18 0.165 0.211 0.177
0.201 0.246 0.188 0.184 0.169 0.228 0.195 0.344
0.172 0.174 0.164 0.189 0.194 0.154 0.179 0.324
0.215 0.218 0.214 0.165 0.173 0.186 0.215 0.285
0.203 0.206 0.163 0.178 0.163 0.21 0.257 0.247
0.215 0.202 0.204 0.157 0.177 0.184 0.192 0.231
0.229 0.226 0.188 0.177 0.226 0.18 0.192 0.261


Attenuator = 2.2 V
Column
Row
ns
0.742 0.401 0.408 0.561 0.87 0.69 0.294 0.4
0.561 0.292 0.368 0.53 0.616 0.538 0.36 0.438
0.43 0.315 0.329 0.438 0.485 0.483 0.41 0.444
0.318 0.274 0.322 0.4 0.388 0.439 0.31 0.362
0.325 0.257 0.315 0.329 0.322 0.336 0.249 0.392
0.316 0.4 0.234 0.32 0.322 0.421 0.319 0.367
0.356 0.31 0.285 0.312 0.312 0.385 0.322 0.342
0.346 0.377 0.351 0.29 0.326 0.433 0.347 1.4
0 1 2 3 4 5 6 7
1.2 1.0 0.8 0.6 0.4

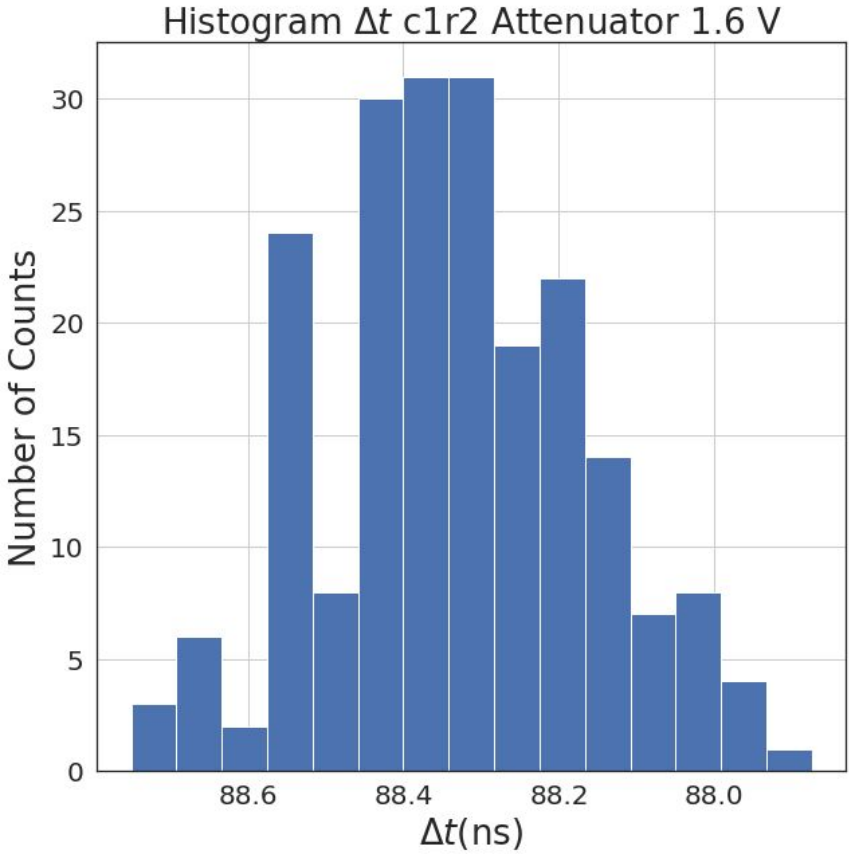

Attenuator = 2.4 V
Column
Row
ns
0.66 0.696 0.423 0.446 0.391 0.409 0.494 0.612
0.431 0.45 0.513 0.406 0.402 0.414 0.369 0.669
0.424 0.394 0.364 0.414 0.372 0.309 0.512 0.495
0.386 0.413 0.333 0.411 0.377 0.384 0.481 0.531
0.446 0.386 0.334 0.443 0.341 0.303 0.339 0.606
0.403 0.472 0.337 0.362 0.313 0.355 0.409 0.509
0.42 0.421 0.342 0.454 0.376 0.403 0.429 0.435
0.561 0.577 0.687 0.528 0.501 0.48 0.479 2.55
0 1 2 3 4 5 6 7
2.50 2.25 2.00 1.75 1.50 1.25 1.00 0.75 0.50

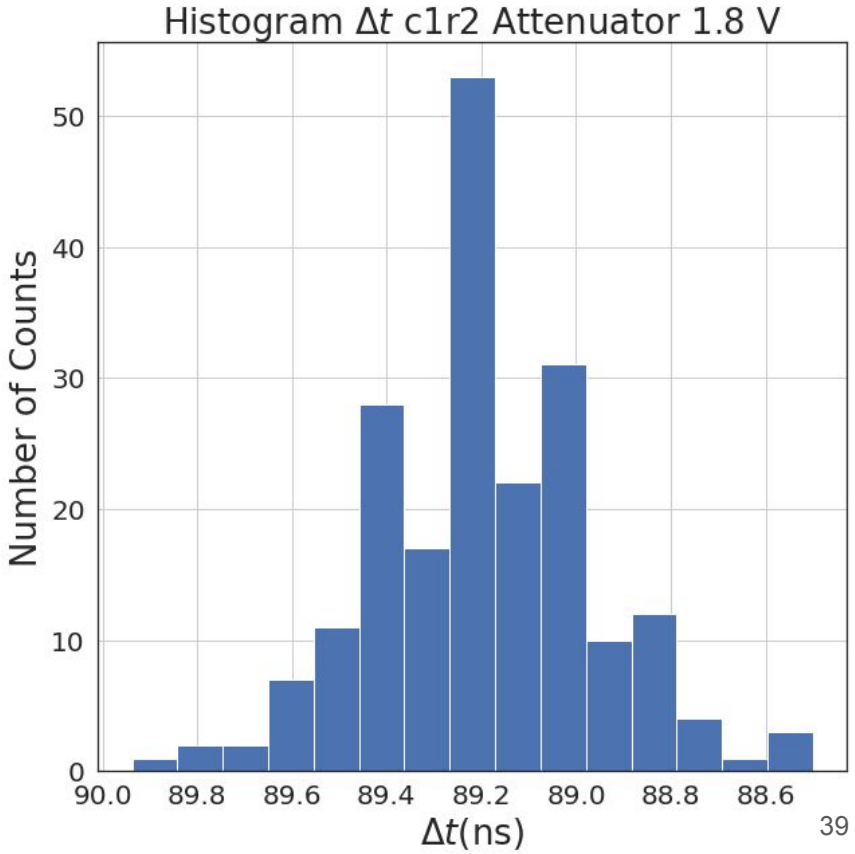

Attenuator = 2.6 V
Column
Row
ns
7 1.17 4.22 0.957 0.703 0.614 0.639 0.691 1.01
6 0.866 0.977 0.975 0.87 0.621 0.578 0.684 1.27
5 0.982 0.619 0.914 0.864 0.557 0.658 0.781 0.958
4 0.774 1.16 1.02 0.777 0.439 0.612 0.726 1.07
3 0.712 0.729 0.88 0.896 0.432 0.508 0.615 1.06
2 0.876 1.37 0.791 1.07 0.585 0.774 0.61 0.961
1 1.35 0.976 0.77 0.793 0.688 0.862 0.75 1.06
0 2.4 2.28 2.37 2.1 1.07 1.06 0.954 7.31
0 1 2 3 4 5 6 7
7 6 5 4 3 2 1

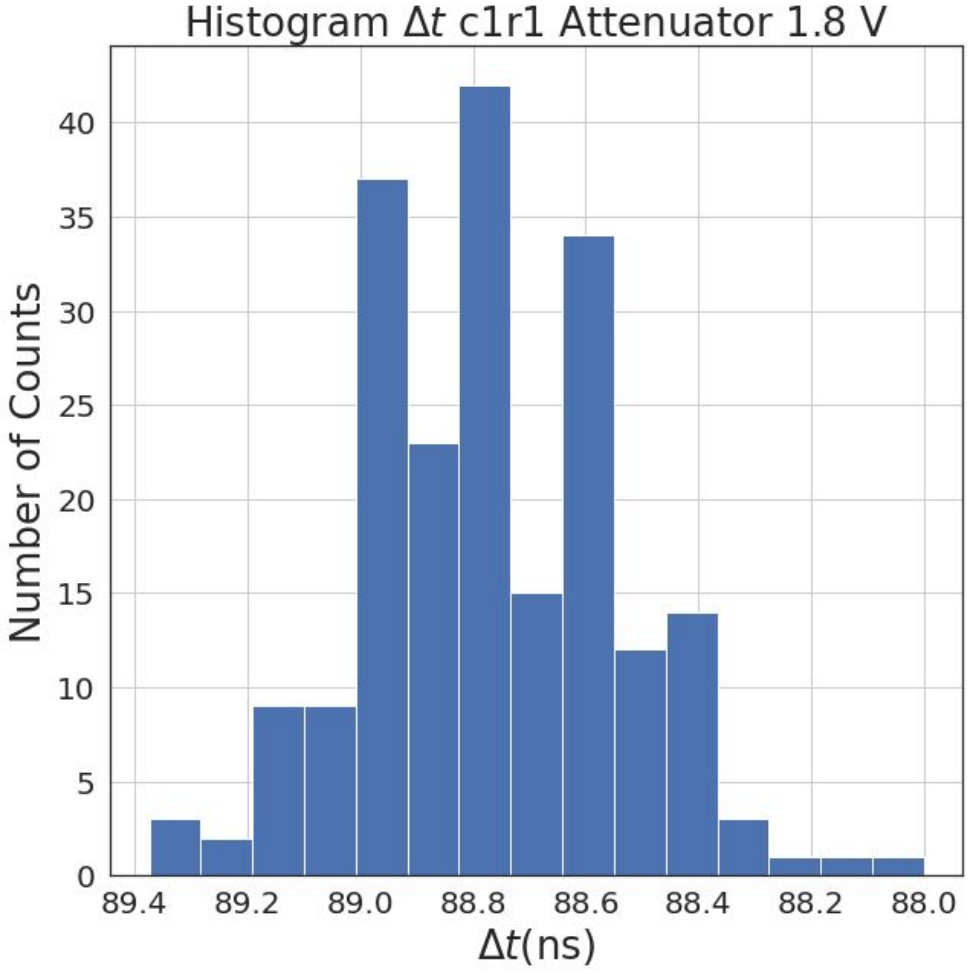
Time resolution

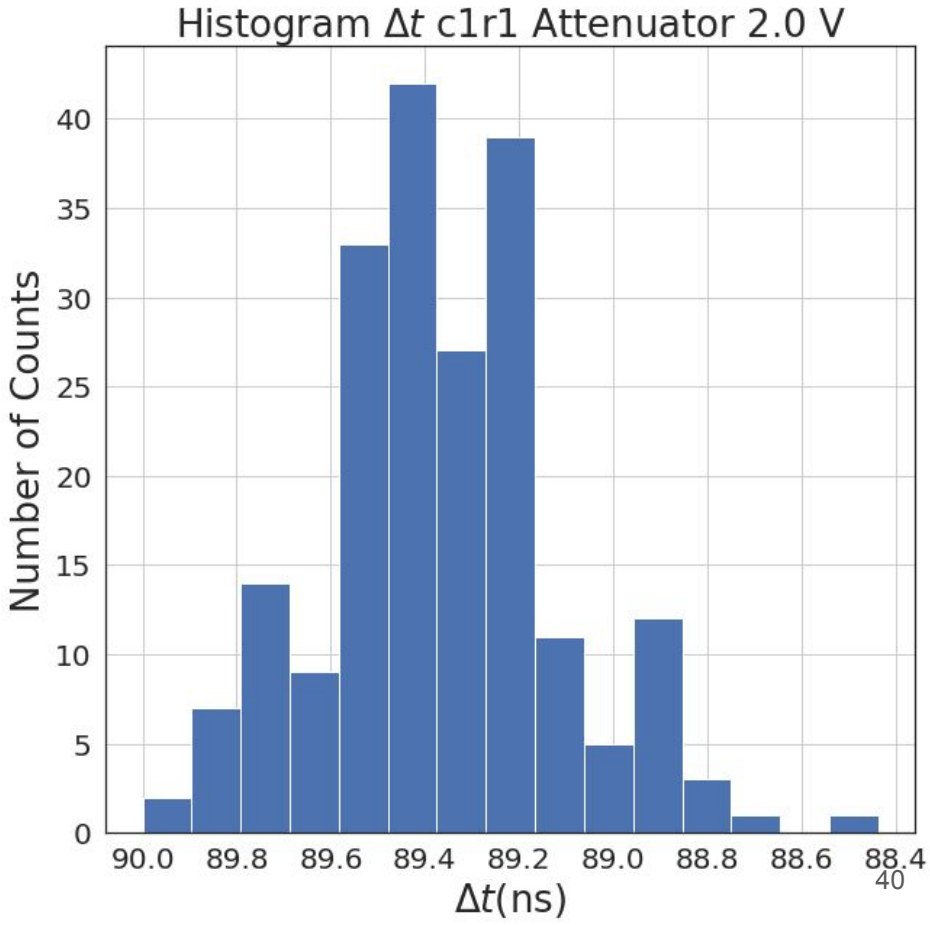
- Due to the fact the laser was used during measurements there are some variations to the maps. Meaning that with a decrease of intensity we saw for some pixels a decrease in time resolution this was the case for the following measurements:
  - 1.6-1.8: c1r2 c2r5 c2r1 c3r6 c4r0 c4r6 c5r5 c5r6 c7r3
  - 1.8-2.0: c0r7 c1r1 c1r5 c1r7 c2r6 c3r1 c3r2 c3r5 c4r3 c4r5 c6r7
  - 2.2-2.4: c2r4 c3r5 c4r4 c4r5 c5r0 c7r0 c7r4
- Some examples of these measurements can been seen at the next 2 slides

Backup Slides: Histograms delta t






Histogram Δt c1r1 Attenuator 1.8 V
Number of Counts
0
5
10
15
20
25
30
35
40
89.4
89.2
89.0
88.8
88.6
88.4
88.2
88.0
Δt(ns)


Histogram Δt c1r1 Attenuator 2.0 V
Number of Counts
0
5
10
15
20
25
30
35
40
90.0
89.8
89.6
89.4
89.2
89.0
88.8
88.6
88.4
Δt(ns)