ALCOR simulations

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Time-inverted data

T_{coarse} = clk counter (2.5 ns) = coarse ToA

T_{fine} = TDC output = TDC conversion time

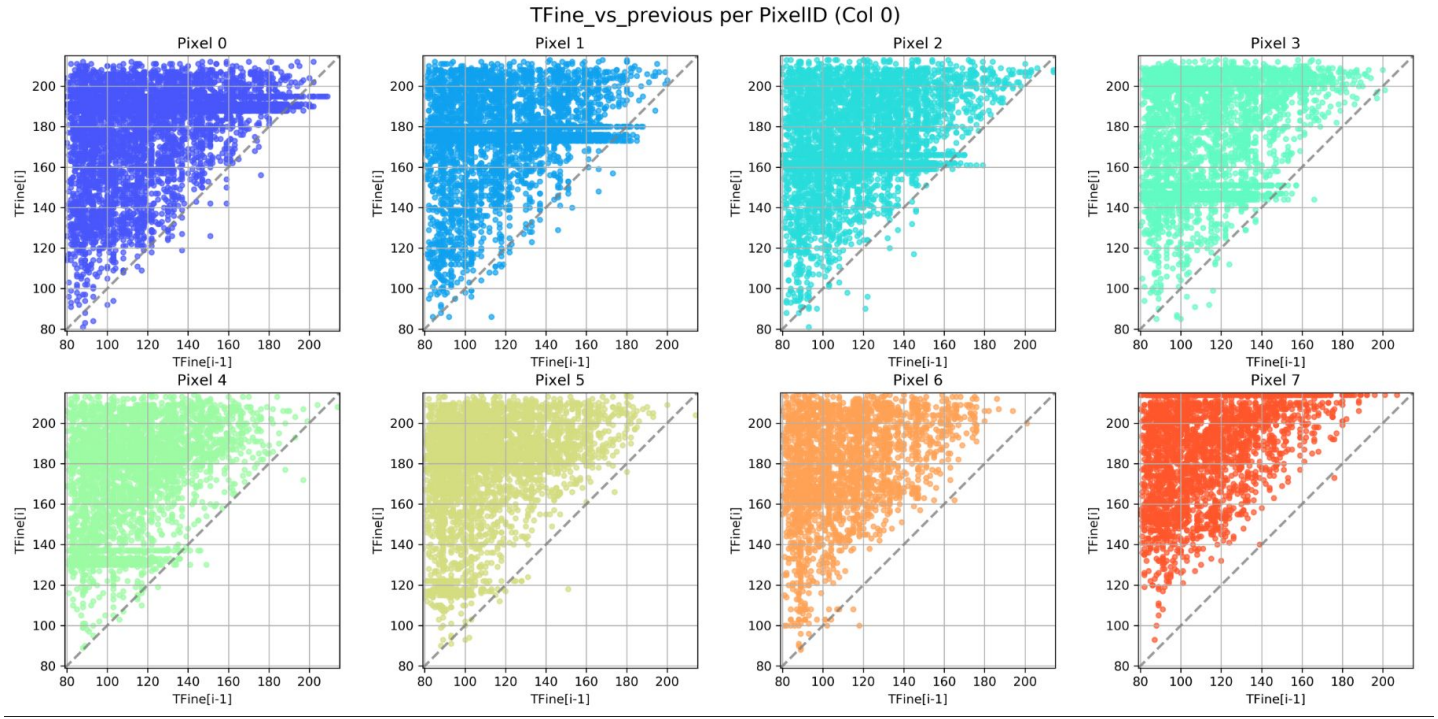
Select time-inverted data outputs → $T_{coarse}[i] < T_{coarse}[i-1]$ (14% events)

Plot $T_{fine}[i]$ vs $T_{fine}[i-1]$

Almost all points have:

$T_{fine}[i] > T_{fine}[i-1]$

➢ Longer conversion time explains time-inverted data outputs



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Time-inverted data

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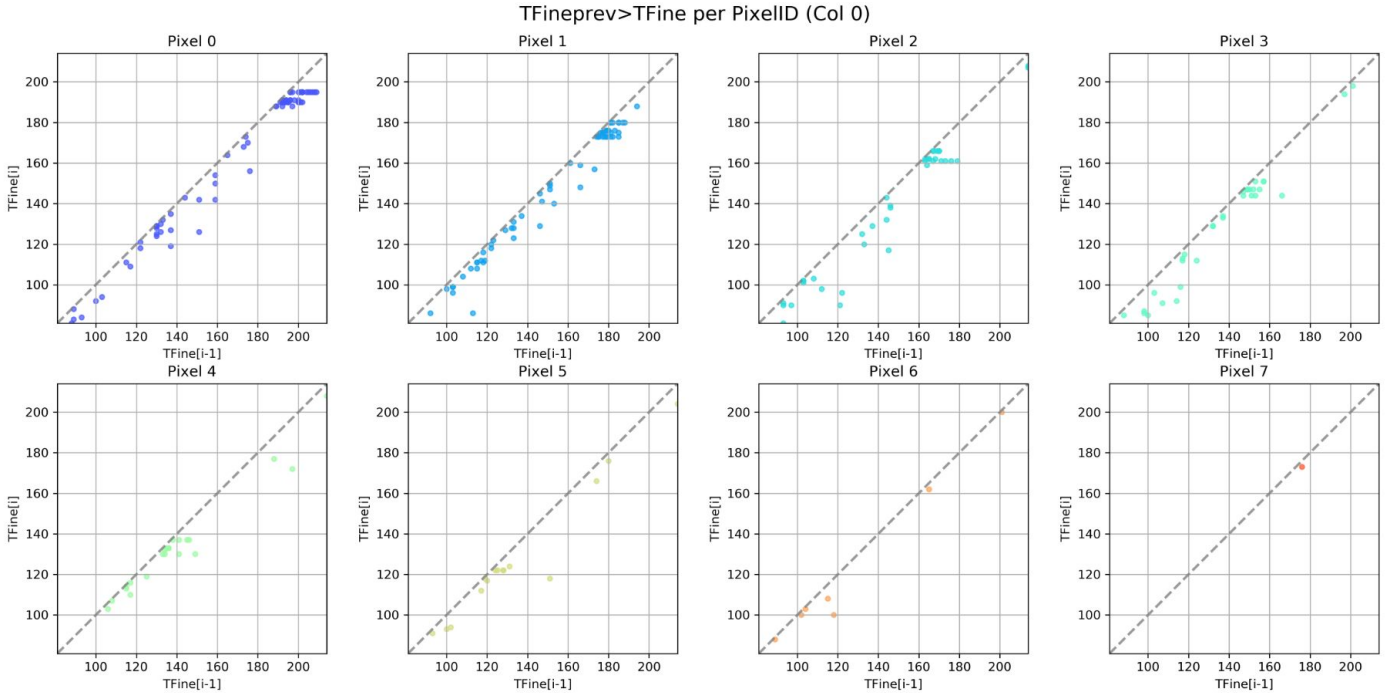
Plot $T_{fine}[i]$ vs $T_{fine}[i-1]$

Check rare cases when:

$T_{fine}[i] < T_{fine}[i-1]$

- ➢ Pixel 0-1-2 have more entries w.r.t. pixel 5-6-7
- ➢ This is due to **pixel readout priority** when more than one pixel has one data ready to be transmitted to the EoC



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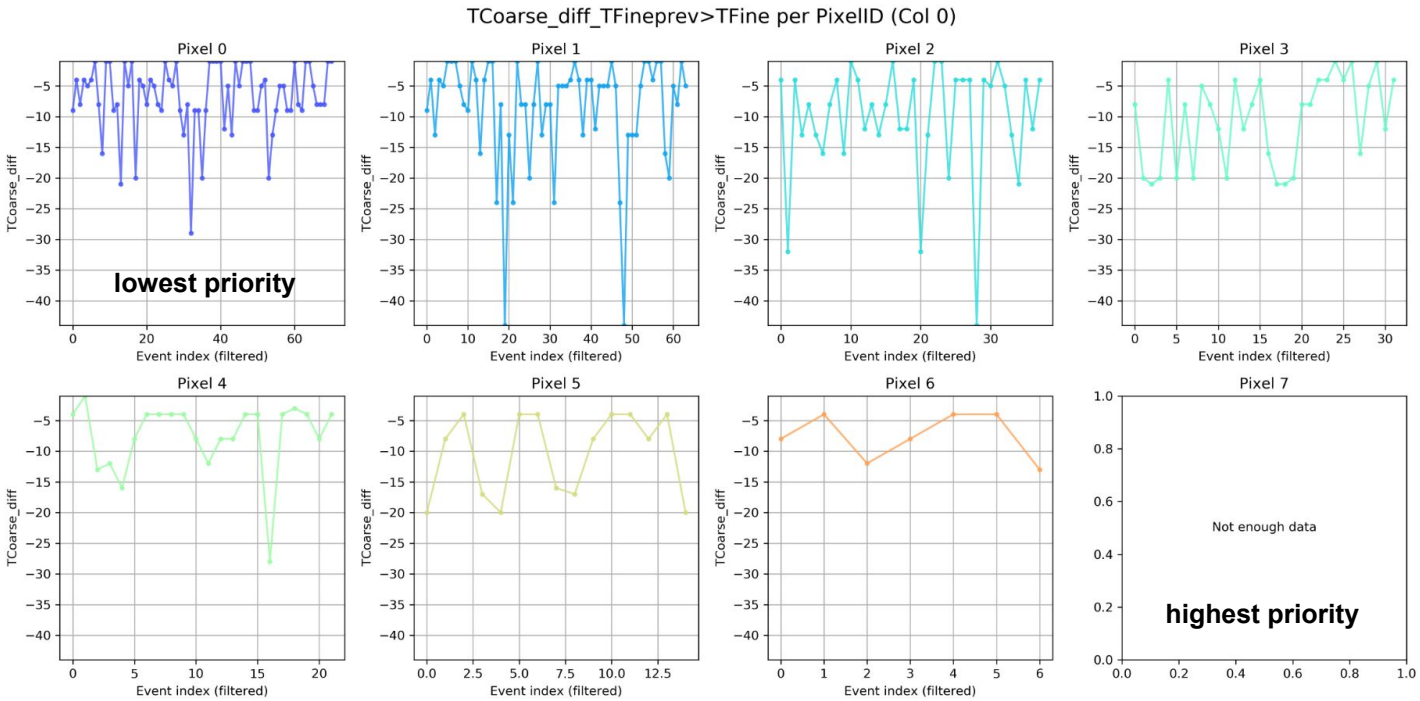
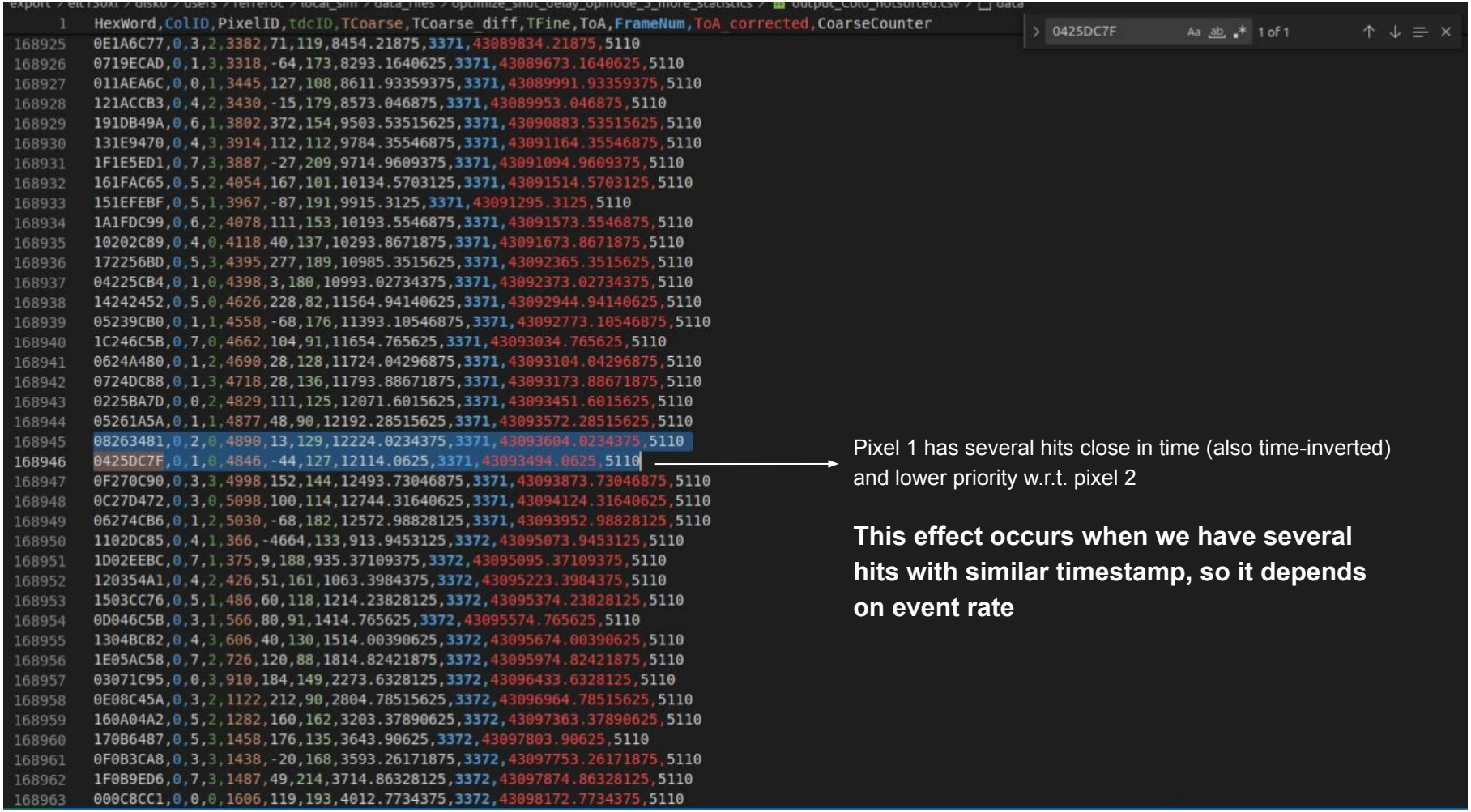



1 HexWord,ColID,PixelID,tdcID,TCoarse,TCoarse_diff,TFine,ToA,FrameNum,ToA_corrected,CoarseCounter
168925 0E1A6C77,0,3,2,3382,71,119,8454.21875,3371,43089834.21875,5110
168926 0719ECAD,0,1,3,3318,-64,173,8293.1640625,3371,43089673.1640625,5110
168927 011AEA6C,0,0,1,3445,127,108,8611.93359375,3371,43089991.93359375,5110
168928 121ACCB3,0,4,2,3430,-15,179,8573.046875,3371,43089953.046875,5110
168929 191DB49A,0,6,1,3802,372,154,9503.53515625,3371,43090883.53515625,5110
168930 131E9470,0,4,3,3914,112,112,9784.35546875,3371,43091164.35546875,5110
168931 1F1E5ED1,0,7,3,3887,-27,209,9714.9609375,3371,43091094.9609375,5110
168932 161FAC65,0,5,2,4054,167,101,10134.5703125,3371,43091514.5703125,5110
168933 151EFEBF,0,5,1,3967,-87,191,9915.3125,3371,43091295.3125,5110
168934 1A1FDC99,0,6,2,4078,111,153,10193.5546875,3371,43091573.5546875,5110
168935 10202C89,0,4,0,4118,40,137,10293.8671875,3371,43091673.8671875,5110
168936 172256BD,0,5,3,4395,277,189,10985.3515625,3371,43092365.3515625,5110
168937 04225CB4,0,1,0,4398,3,180,10993.02734375,3371,43092373.02734375,5110
168938 14242452,0,5,0,4626,228,82,11564.94140625,3371,43092944.94140625,5110
168939 05239CB0,0,1,1,4558,-68,176,11393.10546875,3371,43092773.10546875,5110
168940 1C246C5B,0,7,0,4662,104,91,11654.765625,3371,43093034.765625,5110
168941 0624A480,0,1,2,4690,28,128,11724.04296875,3371,43093104.04296875,5110
168942 0724DC88,0,1,3,4718,28,136,11793.88671875,3371,43093173.88671875,5110
168943 0225BA7D,0,0,2,4829,111,125,12071.6015625,3371,43093451.6015625,5110
168944 05261A5A,0,1,1,4877,48,90,12192.28515625,3371,43093572.28515625,5110
168945 08263481,0,2,0,4890,13,129,12224.0234375,3371,43093604.0234375,5110
168946 0425DC7F,0,1,0,4846,-44,127,12114.0625,3371,43093494.0625,5110
168947 0F270C90,0,3,3,4998,152,144,12493.73046875,3371,43093873.73046875,5110
168948 0C27D472,0,3,0,5098,100,114,12744.31640625,3371,43094124.31640625,5110
168949 06274CB6,0,1,2,5030,-68,182,12572.98828125,3371,43093952.98828125,5110
168950 1102DC85,0,4,1,366,-4664,133,913.9453125,3372,43095073.9453125,5110
168951 1D02EEBC,0,7,1,375,9,188,935.37109375,3372,43095095.37109375,5110
168952 120354A1,0,4,2,426,51,161,1063.3984375,3372,43095223.3984375,5110
168953 1503CC76,0,5,1,486,60,118,1214.23828125,3372,43095374.23828125,5110
168954 0D046C5B,0,3,1,566,80,91,1414.765625,3372,43095574.765625,5110
168955 1304BC82,0,4,3,606,40,130,1514.00390625,3372,43095674.00390625,5110
168956 1E05AC58,0,7,2,726,120,88,1814.82421875,3372,43095974.82421875,5110
168957 03071C95,0,0,3,910,184,149,2273.6328125,3372,43096433.6328125,5110
168958 0E08C45A,0,3,2,1122,212,90,2804.78515625,3372,43096964.78515625,5110
168959 160A04A2,0,5,2,1282,160,162,3203.37890625,3372,43097363.37890625,5110
168960 170B6487,0,5,3,1458,176,135,3643.90625,3372,43097803.90625,5110
168961 0F0B3CA8,0,3,3,1438,-20,168,3593.26171875,3372,43097753.26171875,5110
168962 1F0B9ED6,0,7,3,1487,49,214,3714.86328125,3372,43097874.86328125,5110
168963 000C8CC1,0,0,0,1606,119,193,4012.7734375,3372,43098172.7734375,5110
0425DC7F Aa ab 1 of 1
Pixel 1 has several hits close in time (also time-inverted) and lower priority w.r.t. pixel 2
This effect occurs when we have several hits with similar timestamp, so it depends on event rate

T_{coarse} = clk counter (2.5 ns) = coarse ToA

T_{fine} = TDC output = TDC conversion time

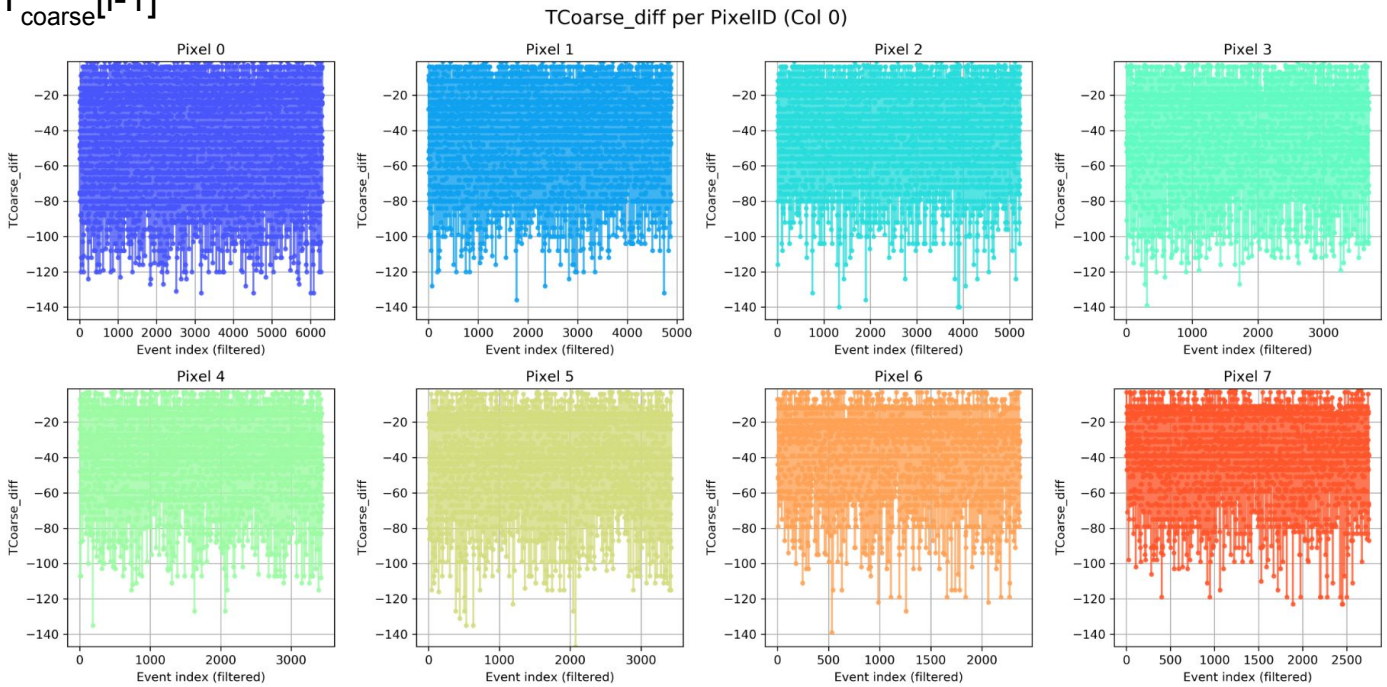
Time-inverted data

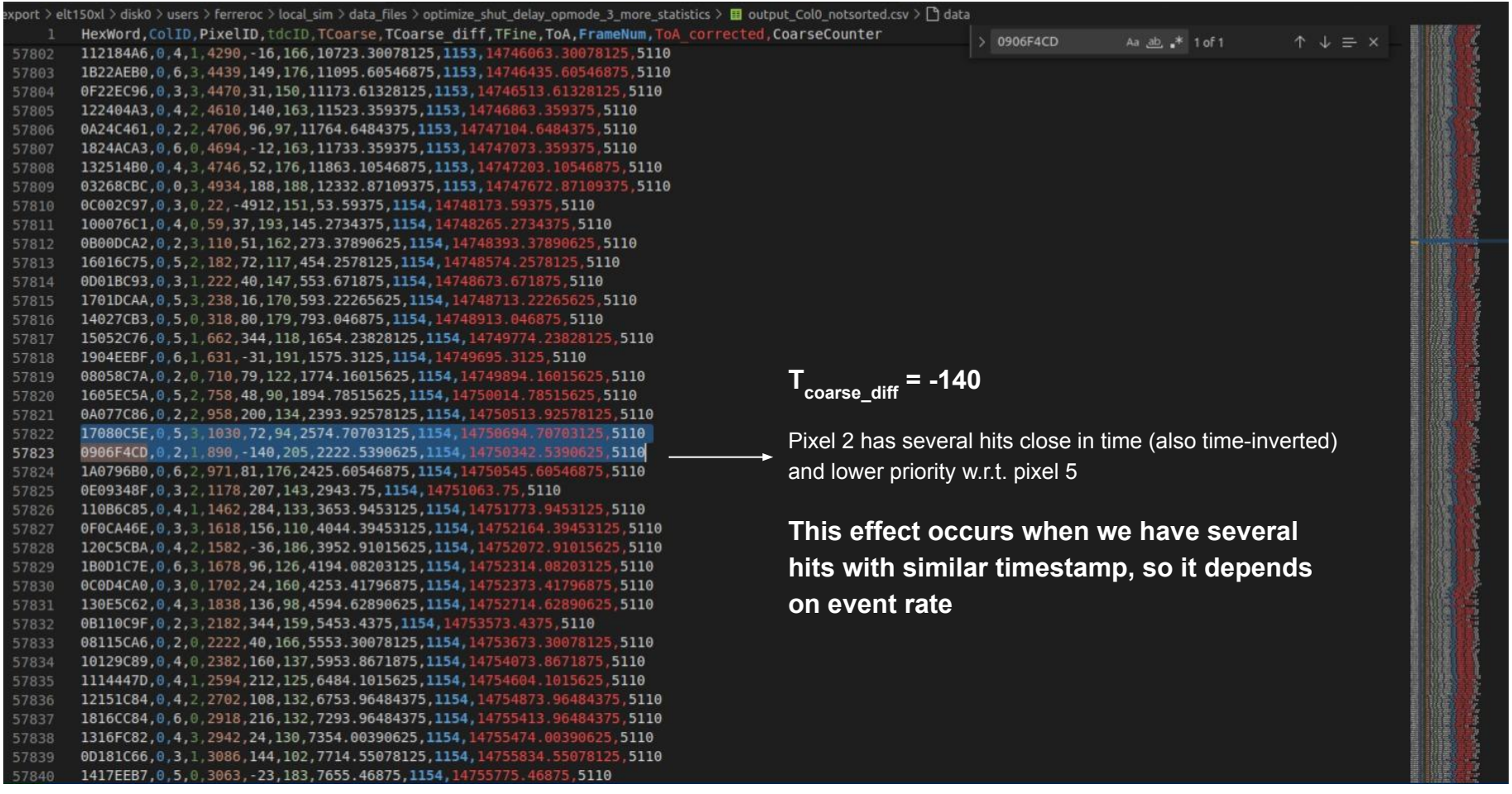
Select time-inverted data outputs → $T_{coarse}[i] < T_{coarse}[i-1]$ (14% events)

Plot $T_{coarse\_diff} = T_{coarse}[i] - T_{coarse}[i-1]$

MAX negative difference is about 128 (= MAX TDC conversion time)

Still some points have: $abs(T_{coarse\_diff}) > 128$





$T_{coarse\_diff} = -140$

Pixel 2 has several hits close in time (also time-inverted) and lower priority w.r.t. pixel 5

This effect occurs when we have several hits with similar timestamp, so it depends on event rate

Summary

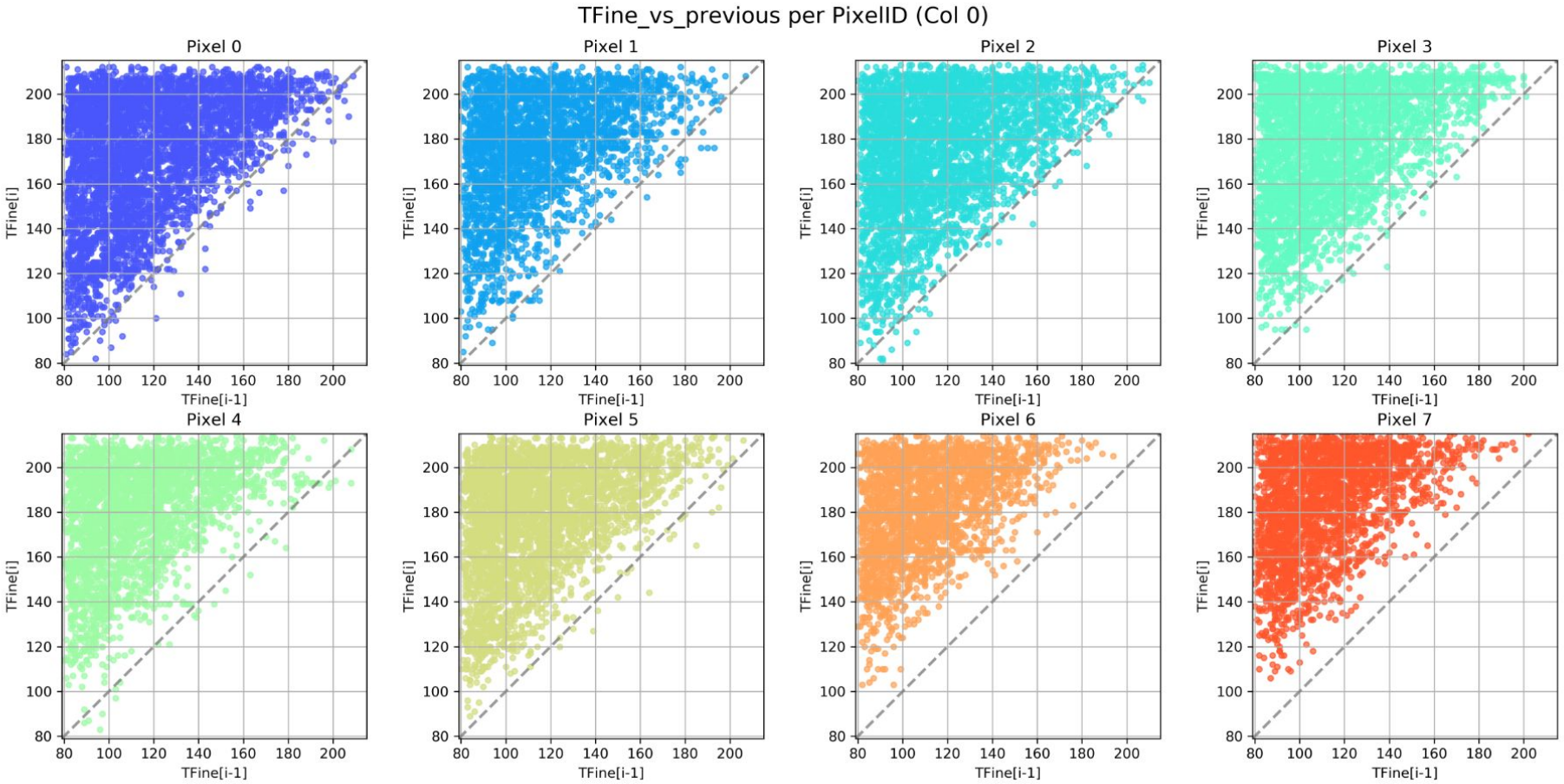
Simulation settings:

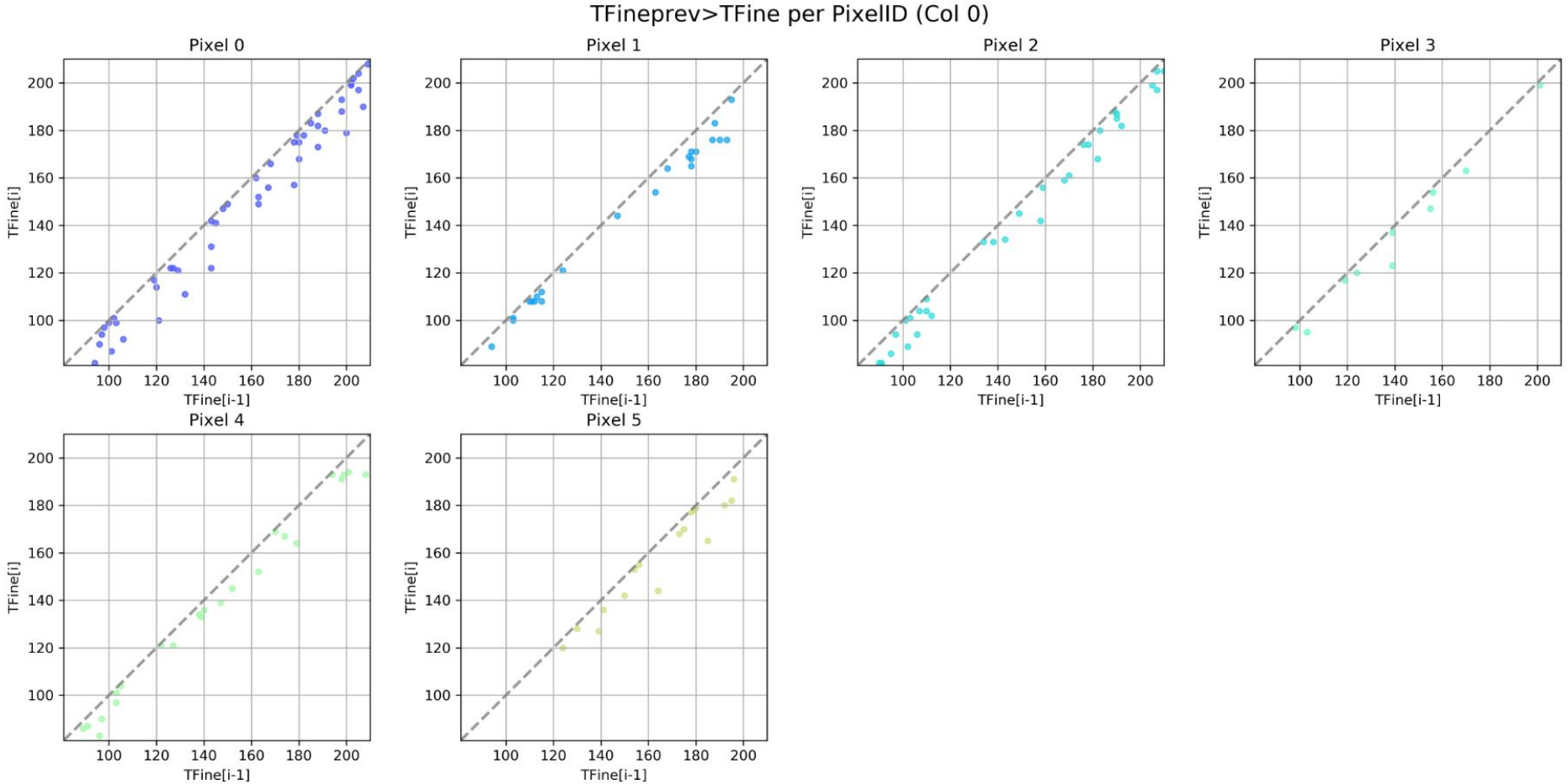
- LE mode
- DCR = 16 MHz/column = 2 MHz/ch → real DCR = 1.25 MHz/ch
- PHY rate = 1 MHz/column
- Shutter width = 2.5 ns

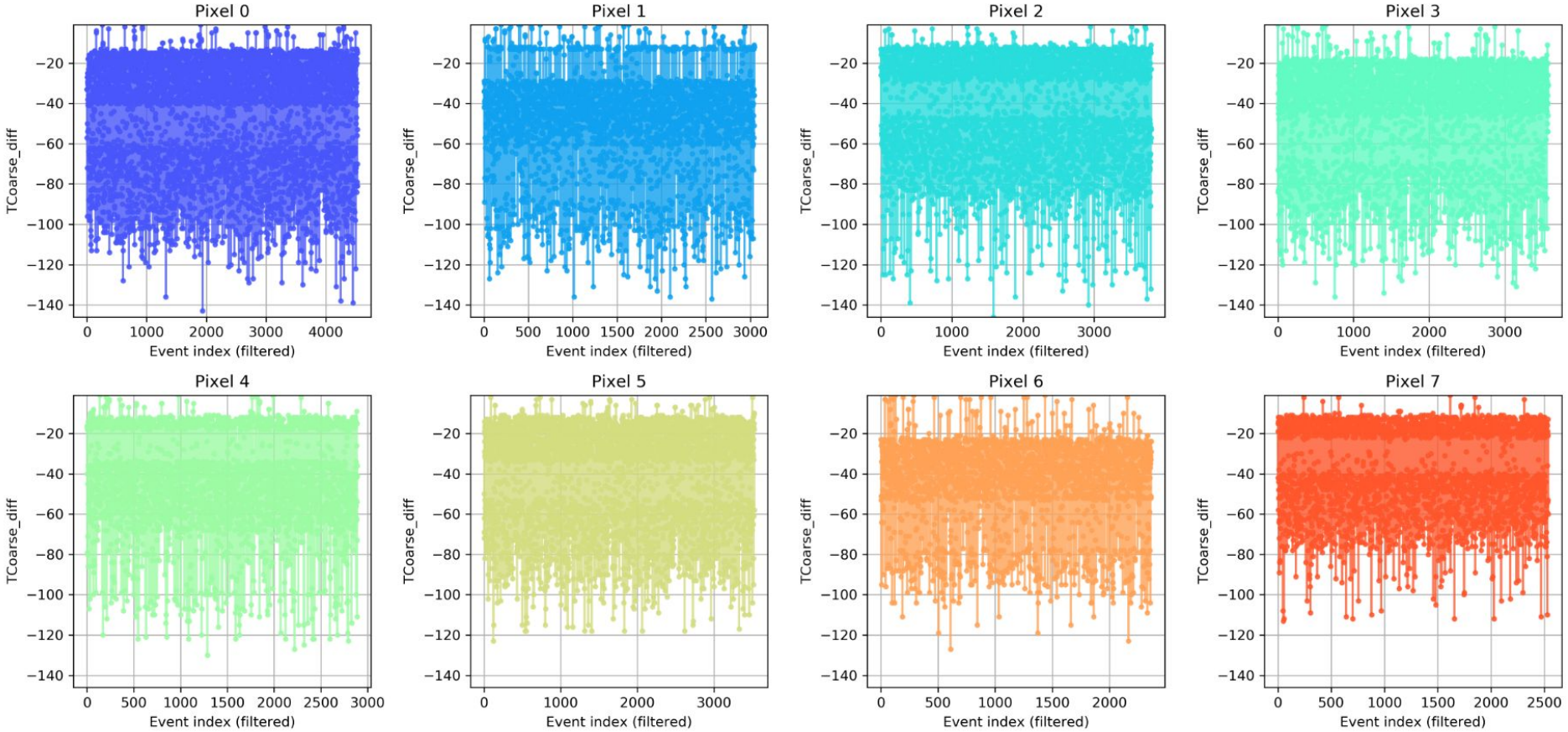
➢ In this simulation we have 14% events with time-inverted data output
➢ Same simulation in SR mode gives 21% events

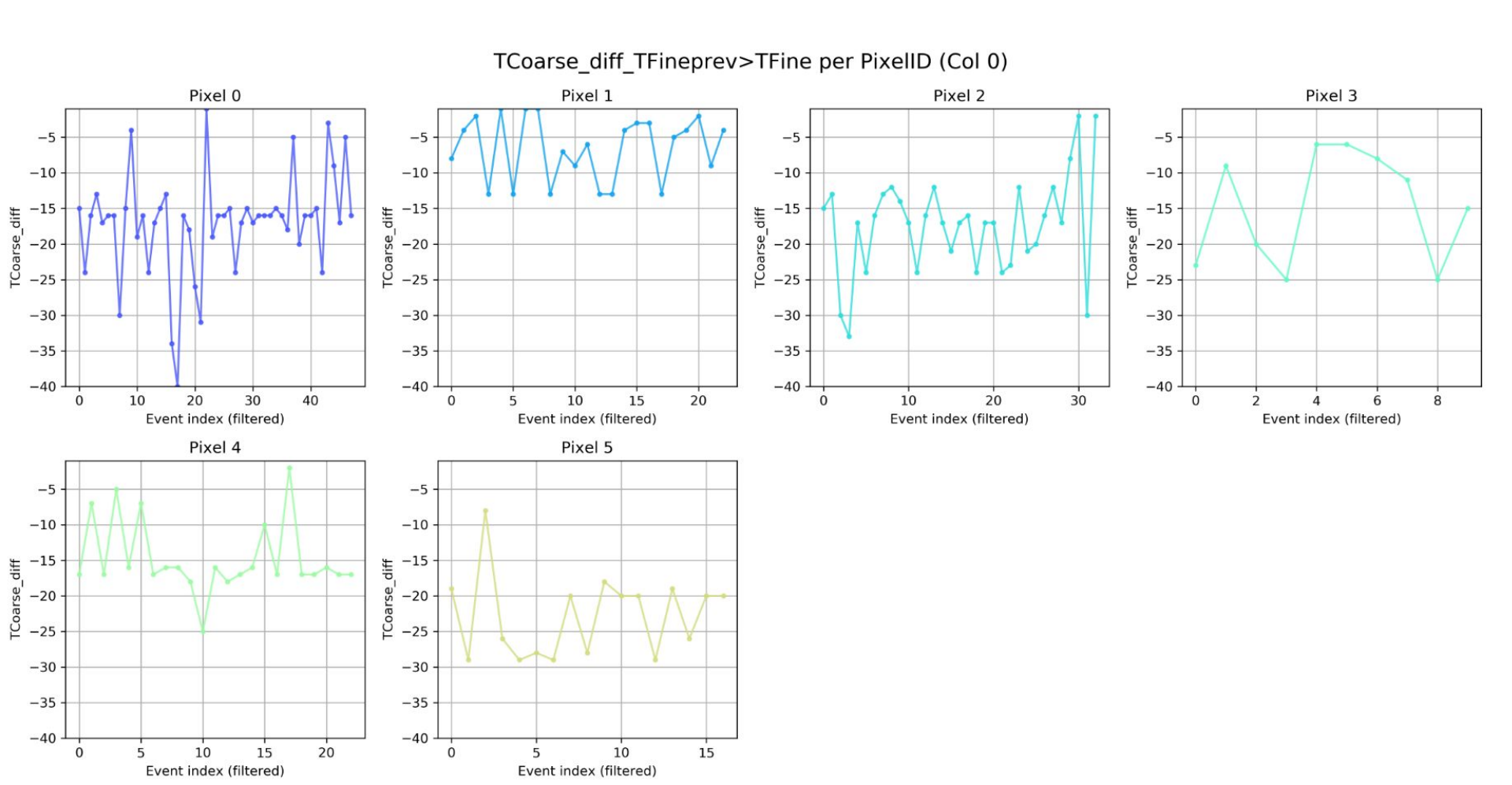
New simulation in SR mode with:

- DCR = 4 MHz/column = 500 kHz/ch → real DCR = 450 kHz/ch
- PHY rate = 100 kHz/column
- Shutter width = 7.5 ns


TFine_vs_previous per PixelID (Col 0)
Pixel 0
Pixel 1
Pixel 2
Pixel 3
Pixel 4
Pixel 5
Pixel 6
Pixel 7
TFine[i]
TFine[i-1]
80
100
120
140
160
180
200


TFineprev>TFine per PixelID (Col 0)
Pixel 0
Pixel 1
Pixel 2
Pixel 3
Pixel 4
Pixel 5
TFine[i]
TFine[i-1]
100
120
140
160
180
200


TCoarse_diff per PixelID (Col 0)
Pixel 0
Pixel 1
Pixel 2
Pixel 3
Pixel 4
Pixel 5
Pixel 6
Pixel 7
TCoarse_diff
Event index (filtered)


TCoarse_diff_TFineprev>TFine per PixelID (Col 0)
Pixel 0
Pixel 1
Pixel 2
Pixel 3
Pixel 4
Pixel 5
TCoarse_diff
Event index (filtered)