Update on EICROC measurements at IJCLab

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1) Measurements at preamplifier output :
   - Jitter measurements
   - Xtalk measurements

2) Measurements with TDC

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Jitter at preamplifier output

- CMD pulse which generates the calibration input signal has a non negligible jitter
- To measure Front End preamplifier performance, need to deconvolute input signal jitter
- CMD pulse use to trigger scope and read 3 pixels from different columns

  - Compute time with a CFD for preamplifier output with 25 %
  - Compute time for CMD pulse with a fixed threshold in mV

Having 4 times (3 are enough) , can build 9 time differences
For instance :

$$\sigma_{t_1-t_2}^2 = \sigma_{t_1}^2 + \sigma_{t_2}^2$$
$$\sigma_{t_1-t_3}^2 = \sigma_{t_1}^2 + \sigma_{t_3}^2$$
$$\sigma_{t_2-t_3}^2 = \sigma_{t_2}^2 + \sigma_{t_3}^2$$

} solve it and extract $\sigma_{t_1}, \sigma_{t_2}, \sigma_{t_3}$

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  - Compute time with a CFD for preamplifier output with 25 % + linear interpolation between samples
  - Compute time for CMD pulse with a fixed threshold in mV

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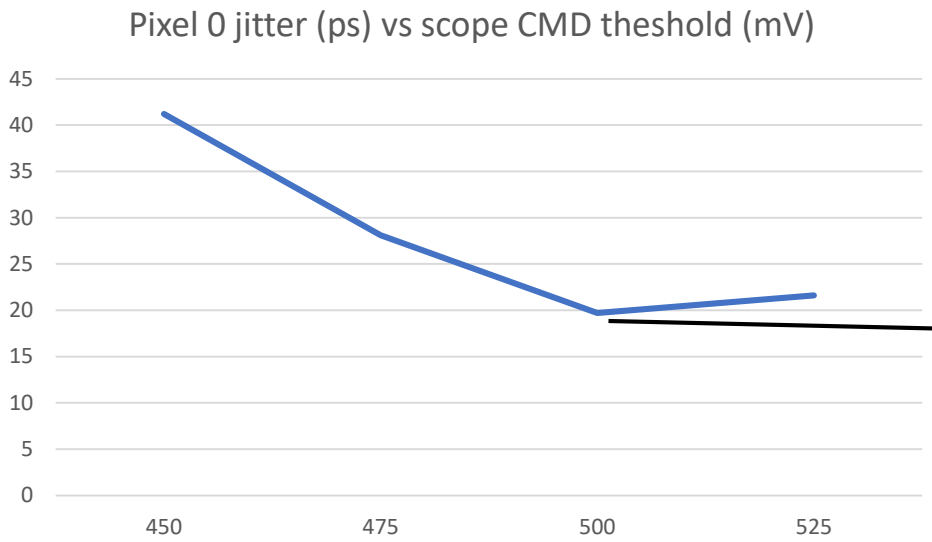
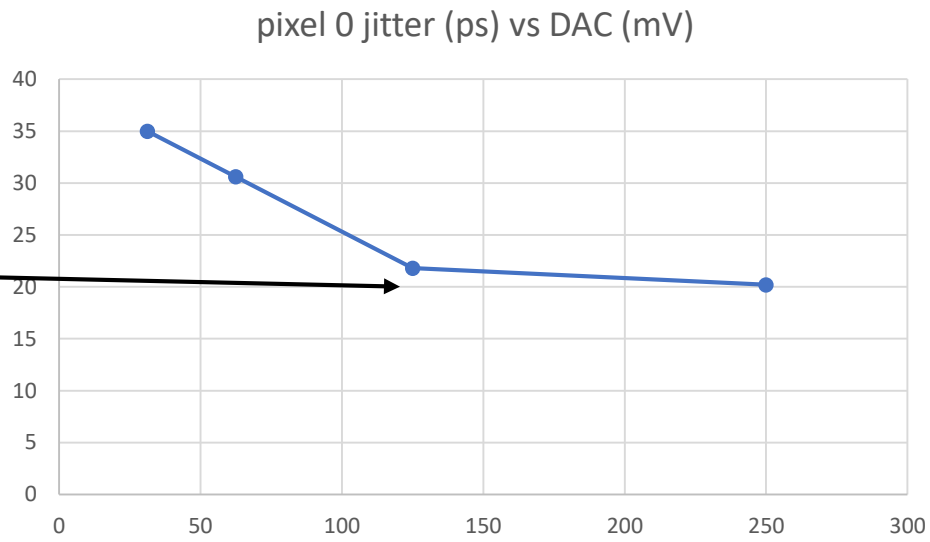
Jitter at preamplifier output

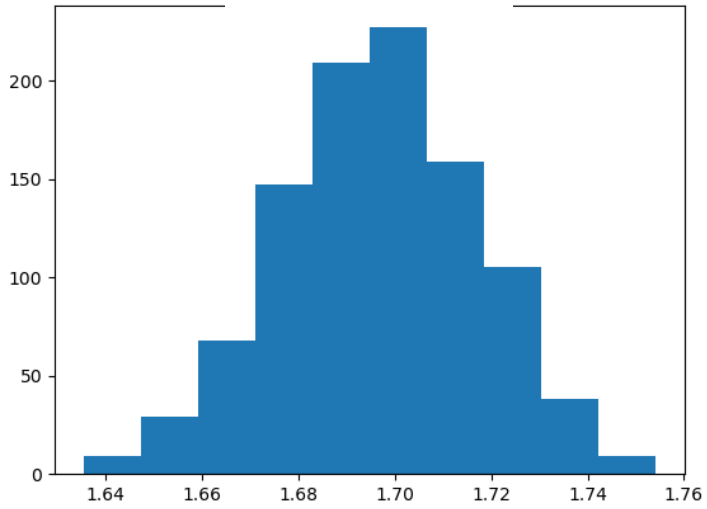




DAC=250 mV

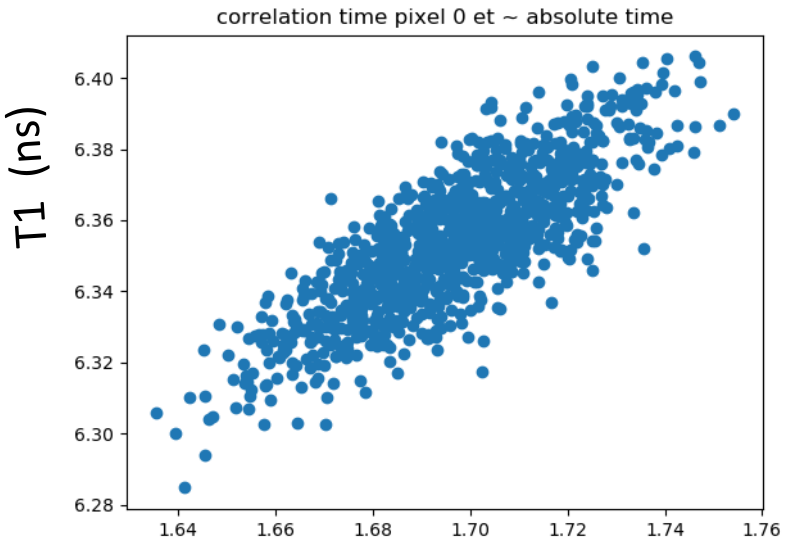
Jitter at preamplifier output

Pixel 0



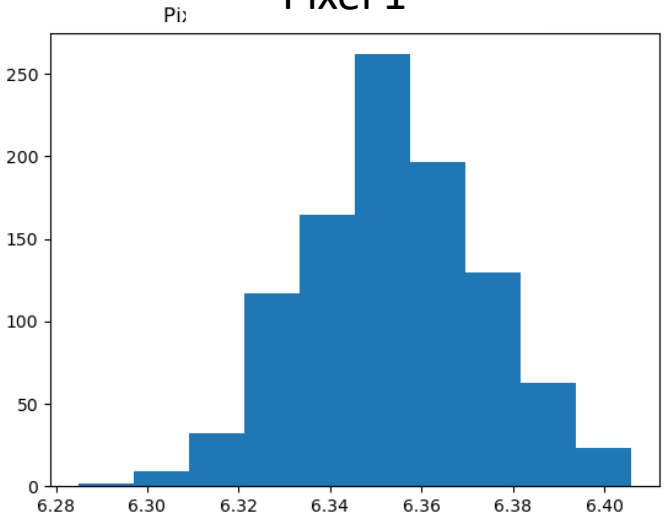
Time (ns)

σ(jitter) = 20,2 ps



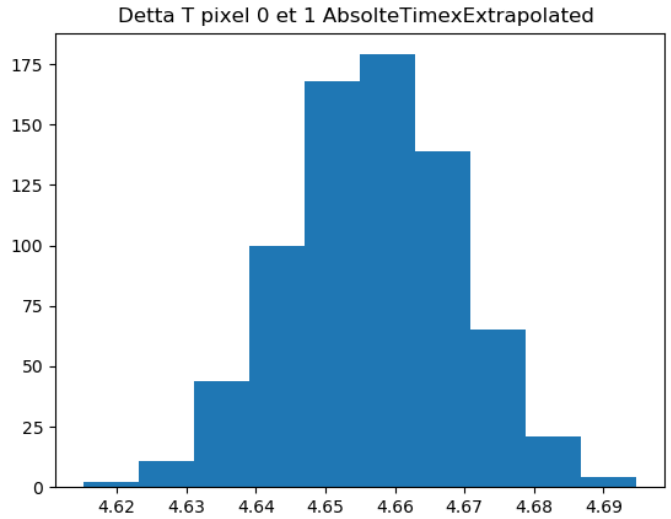
T0 (ns)

Pixel 1



Time (ns)

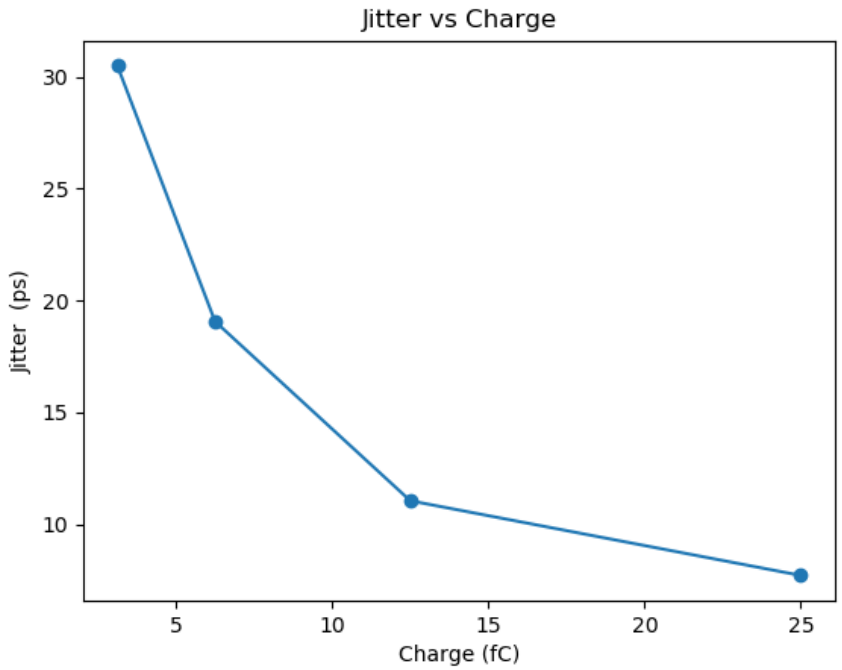
σ(jitter) =19,8 ps



T1-T0 (ns)

σ(jitter) = 12,1 ps

Jitter at preamplifier output



Cross talk measurements

When you pulse a channel, there is a coupling of the CMD pulse with other channels
→ Should remove it when estimating the cross talk

In addition DAC=111111 (no signal) can contain a offset

Try subtraction of DAC000000 - DAC111111
DAC000000 - DAC100000
DAC100000- DAC111111

Cross talk measurements

Channel 1 (signal / 20)

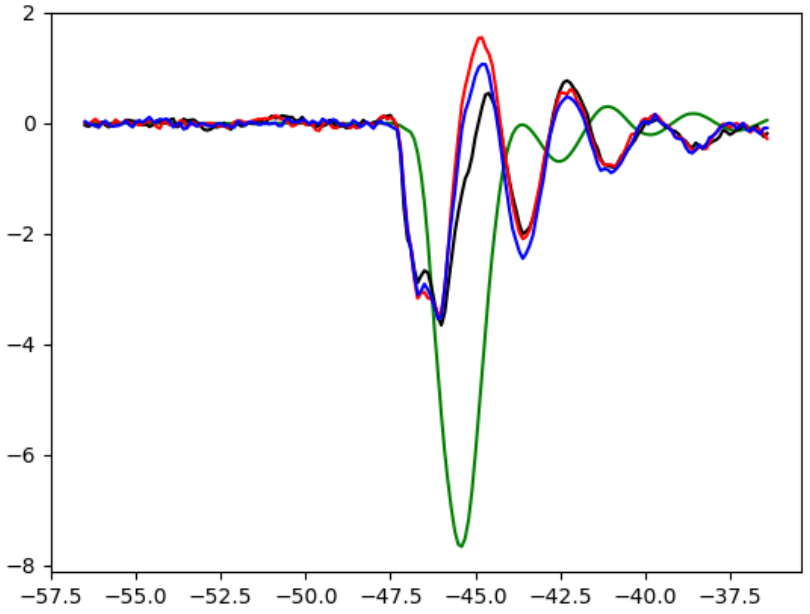
Green signal in chan 0 for DAC=0000000 (dashed green is channel 5)

Black (left) chan 0 DAC=111111 right (000000 - 100000)

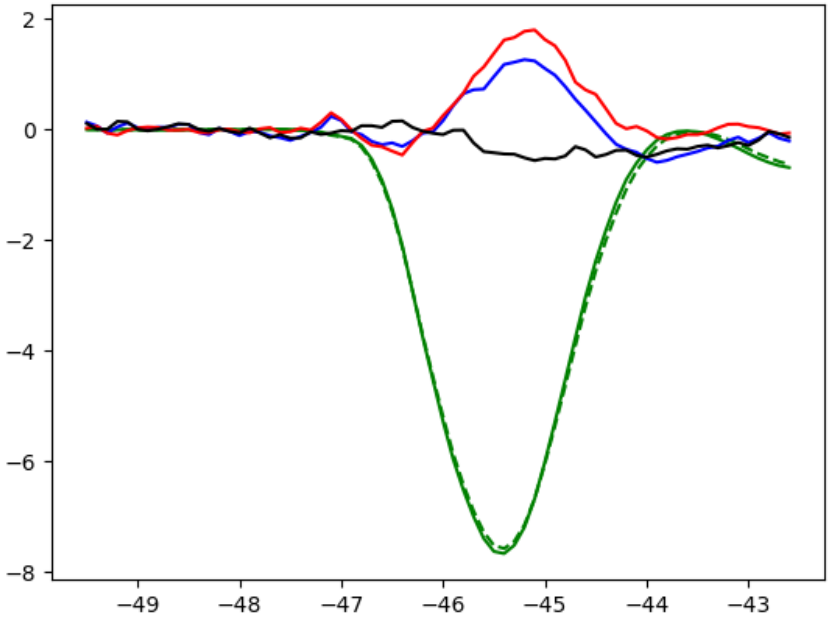
Red (left) chan 0 DAC=100000 (100000 - 111111)

Blue (left) chan 0 DAC=000000 (000000 - 111111)

Raw from scope



After subtraction of CMD couplings



Blue and red should be similar but in fact are different because injection not linear and DAC=1111111 different from 2 * DAC=100000 → apply a correction of non linearity when extracting xtalk in %

Channel 8 (signal / 20)

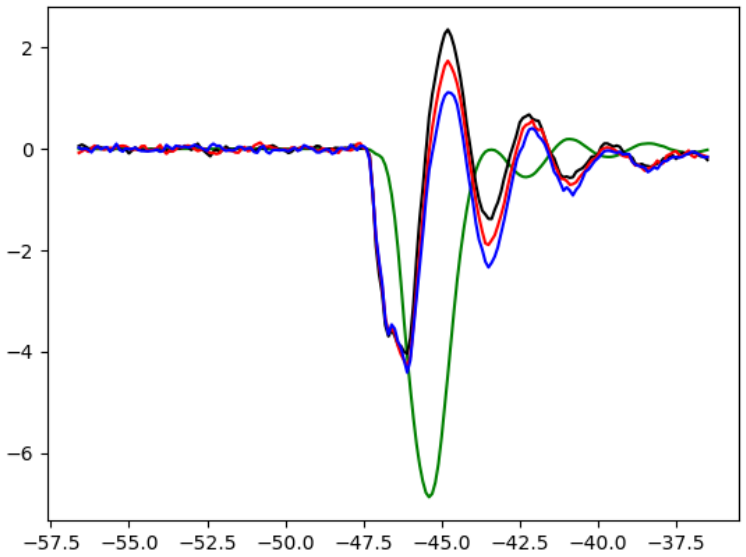
Green signal in chan 0 for DAC=0000000 (dashed green in channel 5)

Black (left) chan 0 DAC=111111 right (000000 - 100000)

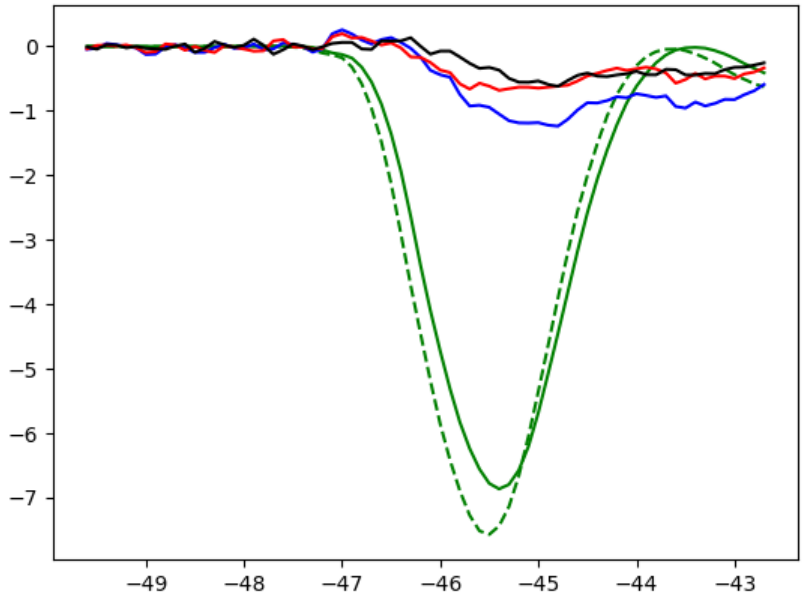
Red (left) chan 0 DAC=100000 (100000 - 111111)

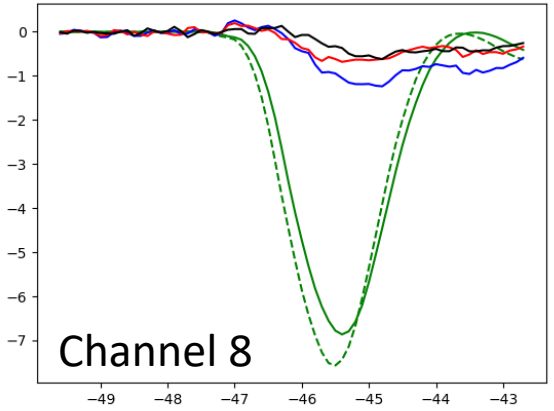
Blue (left) chan 0 DAC=000000 (000000 - 111111)

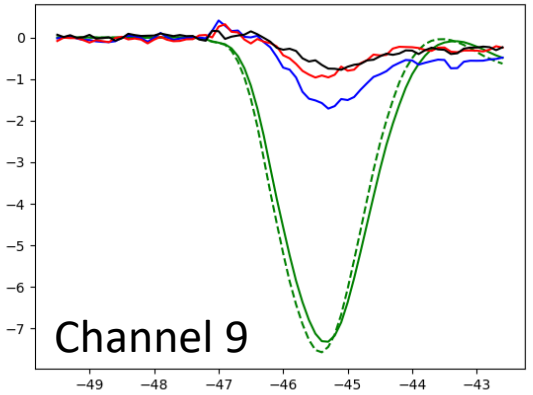
Raw from scope

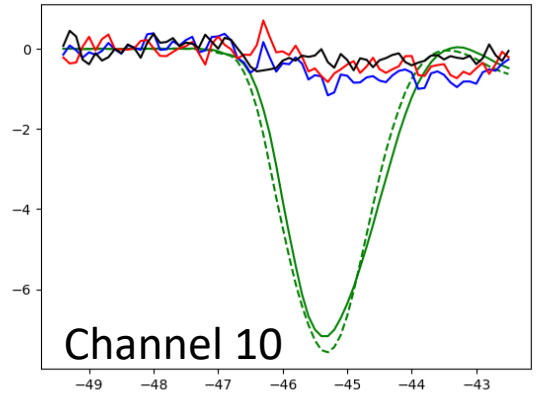


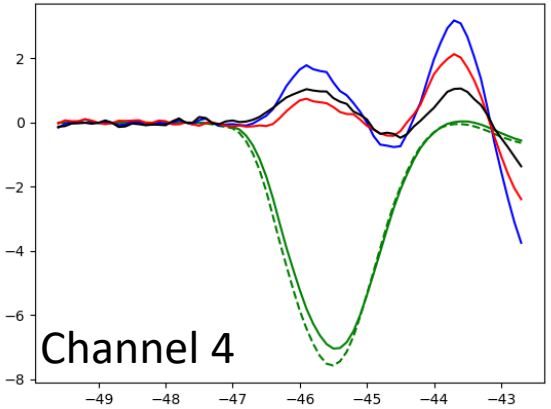
After subtraction of CMD couplings



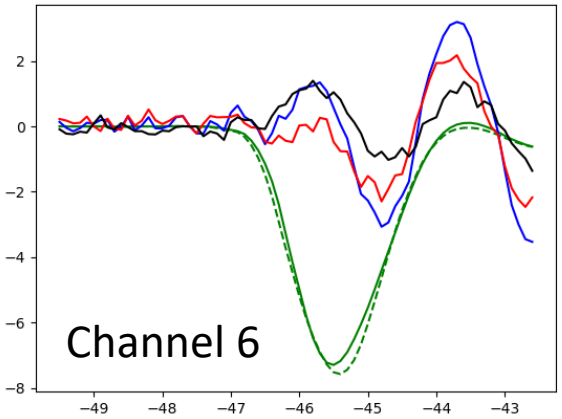


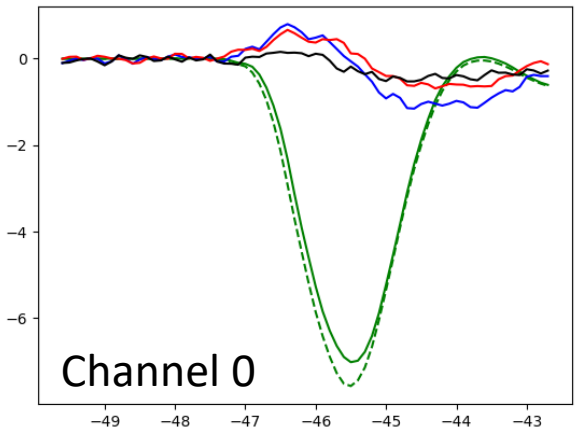


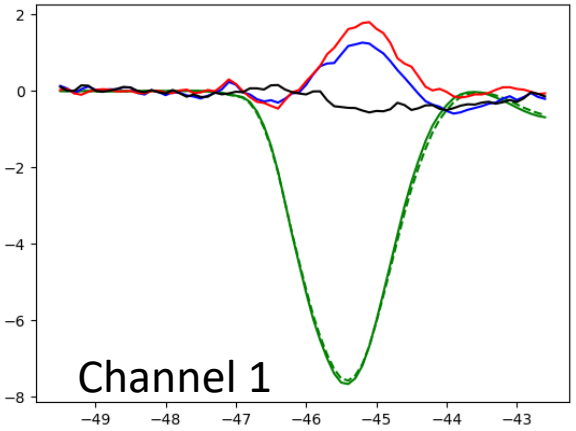


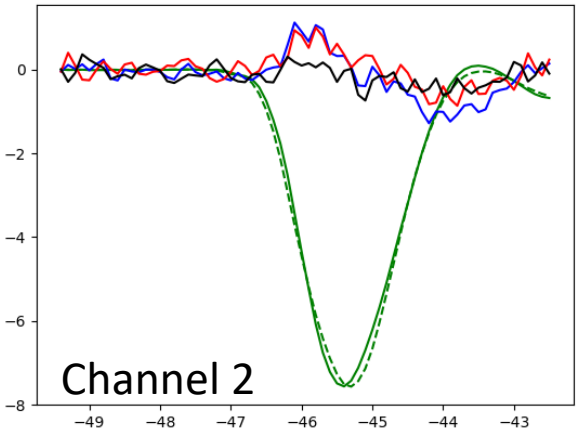


Channel 5 is pulsed
(Green dashed line)









Summary crosstalk (in %) normalized to amplitude of channel 5

From 000000-111111
250 mV

0.8	1.0	
0.8	1.1	0,8
-2.1		-2.1
0.8	-0.8	0.7

100000 -111111
125 mV

0.9 (0.7)	1.3 (1.0)	
0.9 (0.7)	1.3 (1.0)	1.1 (0.9)
-2.8 (-2.2)		-2.9 (-2.3)
0.9 (0.7)	**-2.3 (-1.8)**	1.3 (1.0)

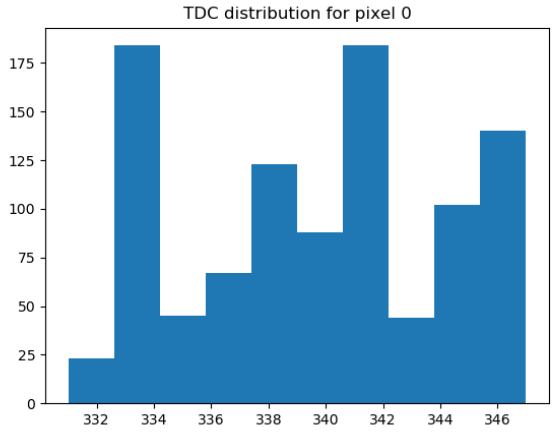
000000-10000
assume linearity of amplitude !

0.8 (1.1)	0,9 (1.2)	
0.8 (1,1)	1 (1.3)	0.8 (1.1)
-1.4 (-1.9)		-1,8 (-2.4)
0,6 (0.8)	0,7 (0.9)	0.9 (1.2)

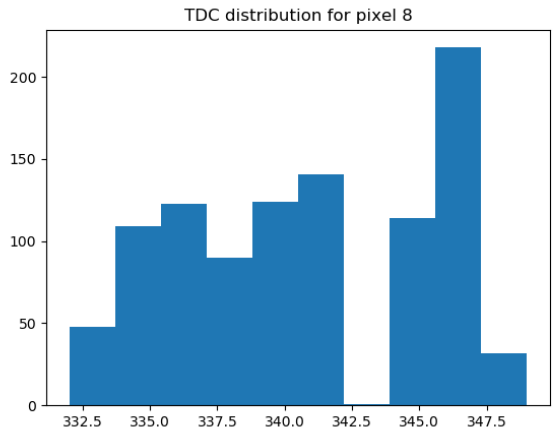
Comments :

- Xtalk extracted from three differences. In fair agreement when taken into probe amplitude non linearity (blue number for second and third method. One strange measurement in yellow.
- Xtalk in 4 corners small, <~1 % looks similar in channel 12 and 13 → **Long range xtalk through ground ?**
- Xtalk in left/right column is the largest (~2 %) and looks inductive (negative derivative / signal)
- Xtalk in same column looks opposite sign between up and down

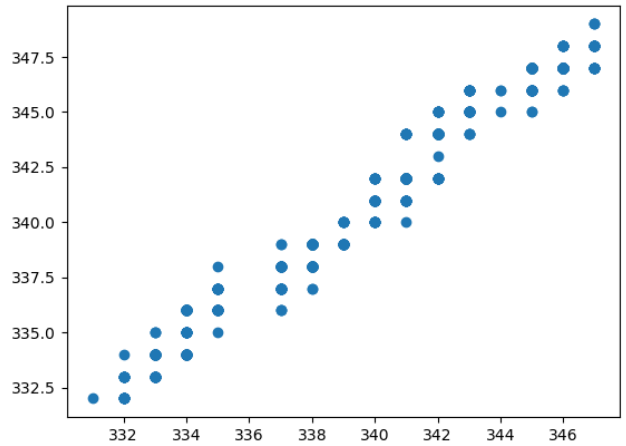
Time resolution on TDC can be extracted with 3 measurements as with probe measurements,
→ not yet done



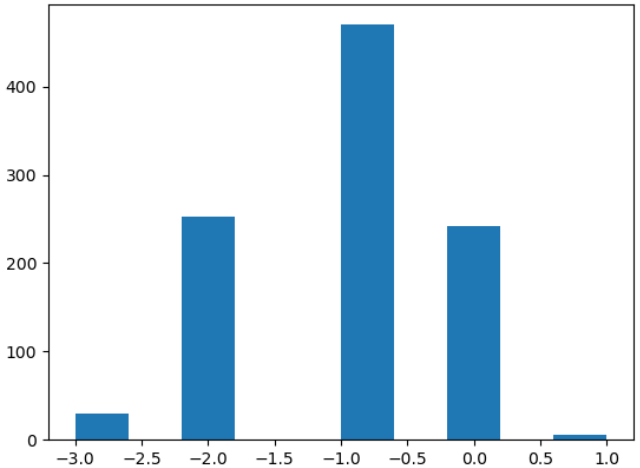
Pixel 0 <> = 339.7 rms = 4.4



Pixel 8 <> = 340.7 rms = 4.8



Delta T <> = -1.0 rms = 0,79



Assuming 25 ps for TDC lsb

Pixel 0 : 110 ps
Pixel 8 : 120 ps

But DeltaT has 19,7 ps resolution showing dominant contribution (clock coupling) is coherent between all pixels

Assuming that the common jitter is removed, time resolution per pixel is 19.7/sqrt(2) = 14 ps