NINO Board Crosstalk Studies

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SBS Weekly Meeting, 29/06/16

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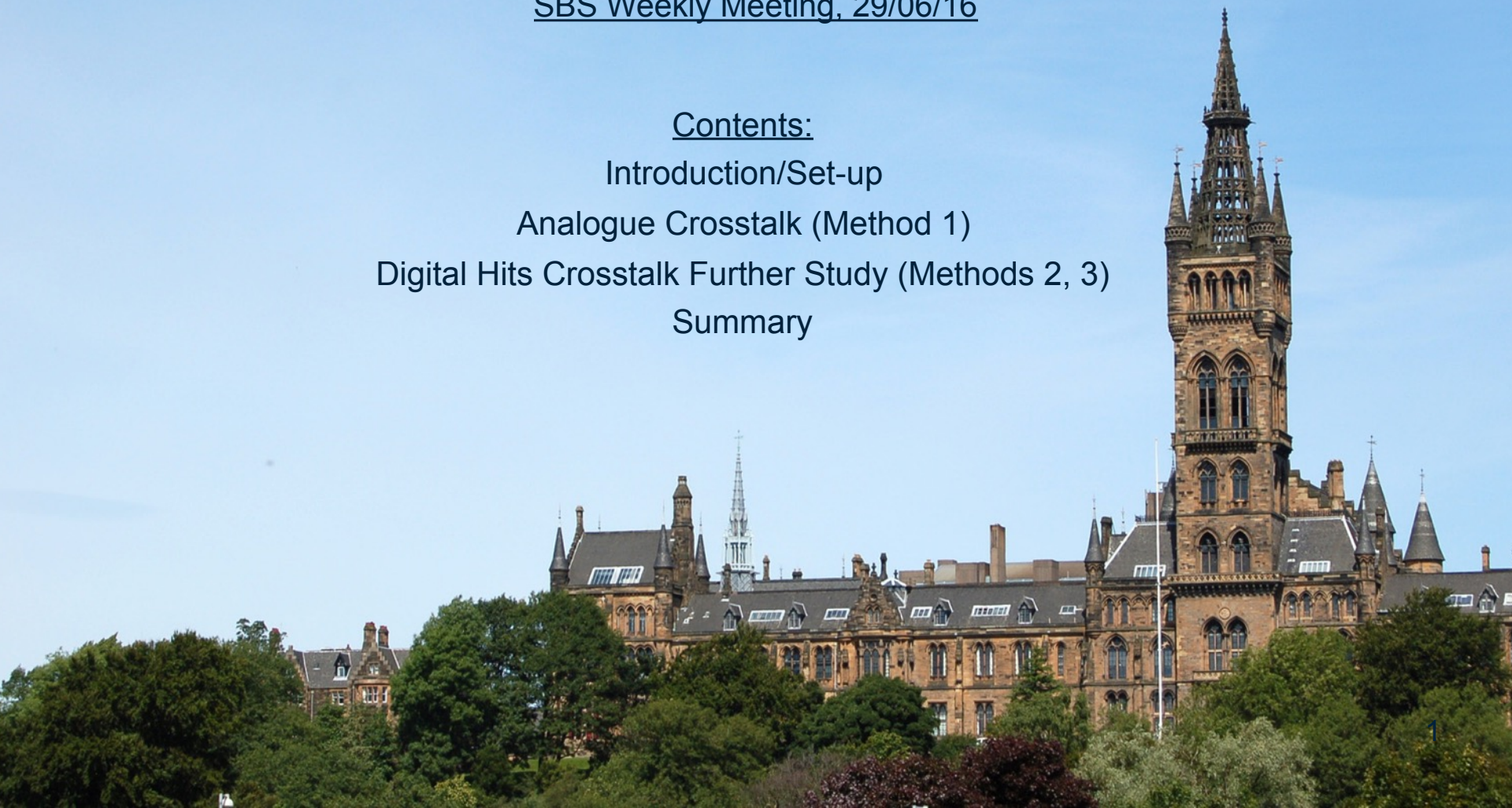
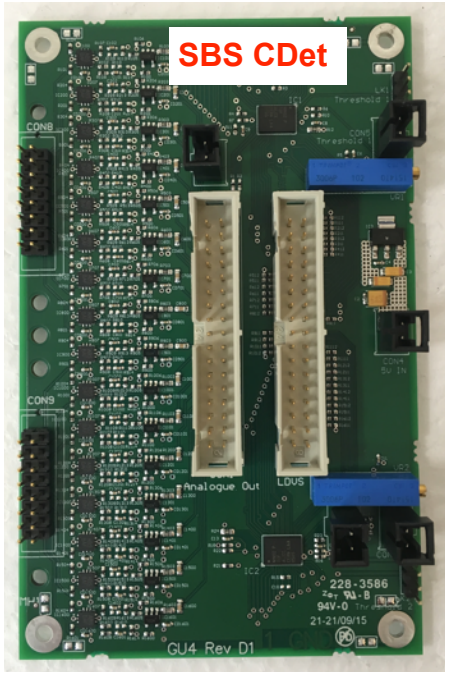
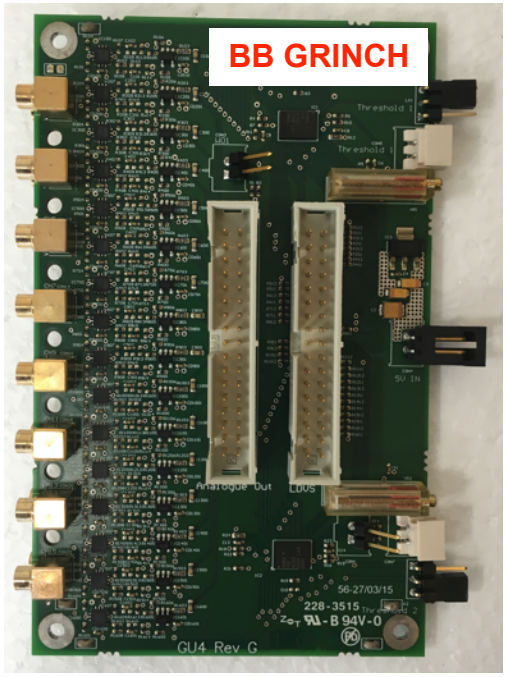






Method 1:

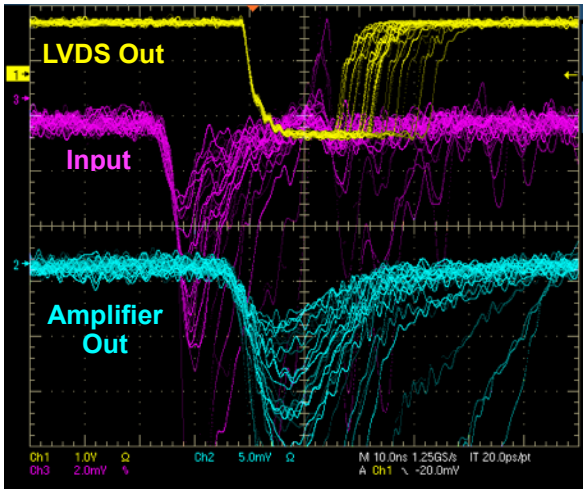
- Both boards' amplifier and LVDS outputs studied for "analogue" crosstalk/spurious hits (method using larger than expected input signals for higher chance of crosstalk)

Methods 2/3

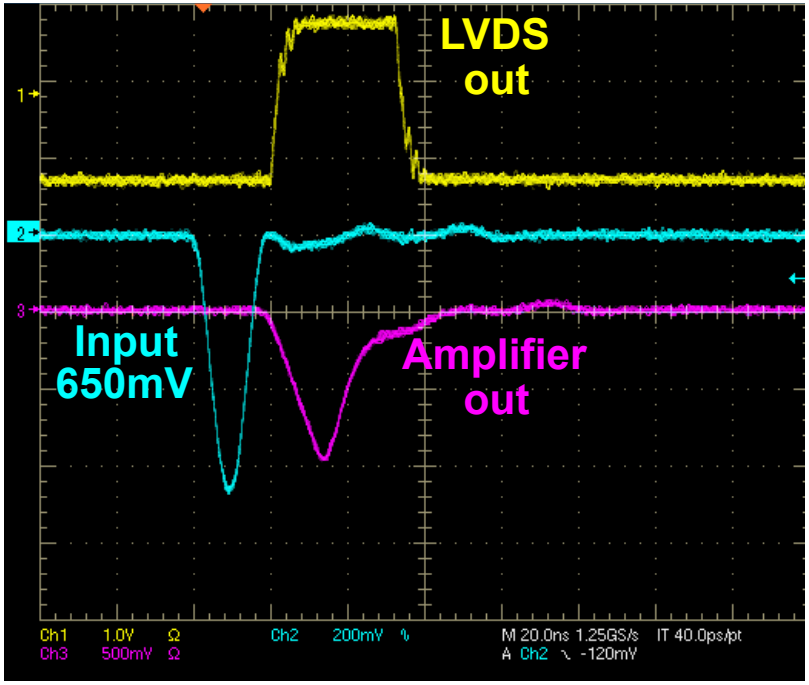
- Threshold and timing of LVDS output/ digital hits further studied with GU4 Rev G type/GRINCH (method using signals closer to threshold/more realistic)

Set-Up:

- Tektronix AFG3102 waveform generator as input to NINO
- NIM units (gate generator/coincidence unit etc) as alternative input to NINO
- NINO Boards: GU4 Rev G (co-ax inputs) and D1 (pair input connectors) types
- CAEN v1190A 128ch 100ps multi-hit TDC for LVDS outputs
- CAEN v792 32ch QDC for amplifier outputs
- LVDS and amplifier output connected to TDC and QDC by several metres (~6-10m) flat ribbon cables (16 ch)



Example: Board GU4 Rev G

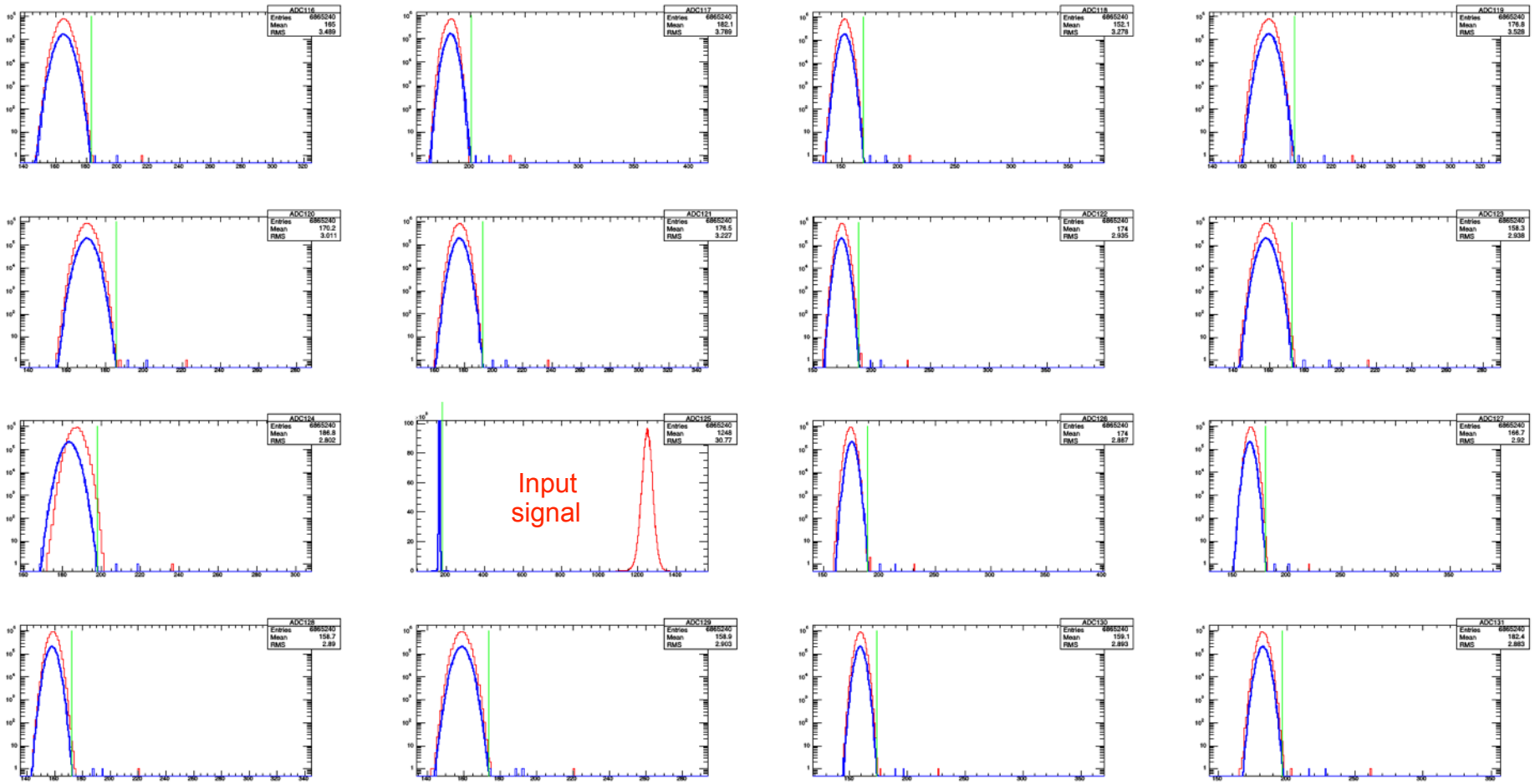


- Input signal from generator on one channel only and varied from 150mV to 1V (unreasonably high)
- External threshold used (both 1.5V (lower) and 1.9V (higher) settings)
- ADC spectra of amplifier outputs checked for charge sharing/spurious hits induced in neighbouring channels
- TDC spectra checked for any digital hits above threshold
- Data sets were on order of a few x 10^6 events

University of Glasgow

Method 1 - ADC Spectra

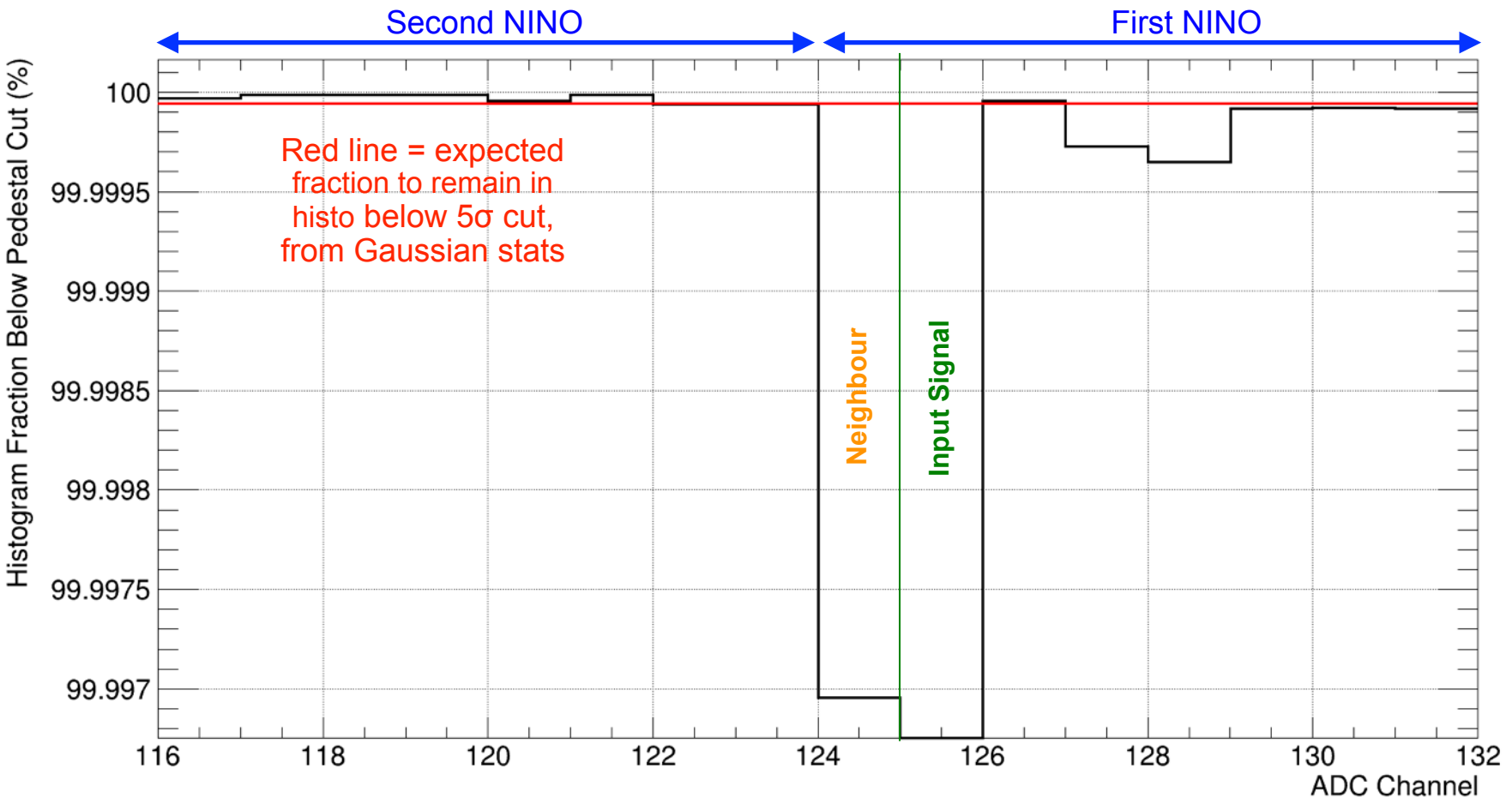
Example: Board GU4 Rev G with 650mV input, external threshold 1.5V



- Blue = pedestal run
- Red = run with 650mV input on one channel
- Green line = 5σ pedestal cut

Method 1 - ADC Spectra

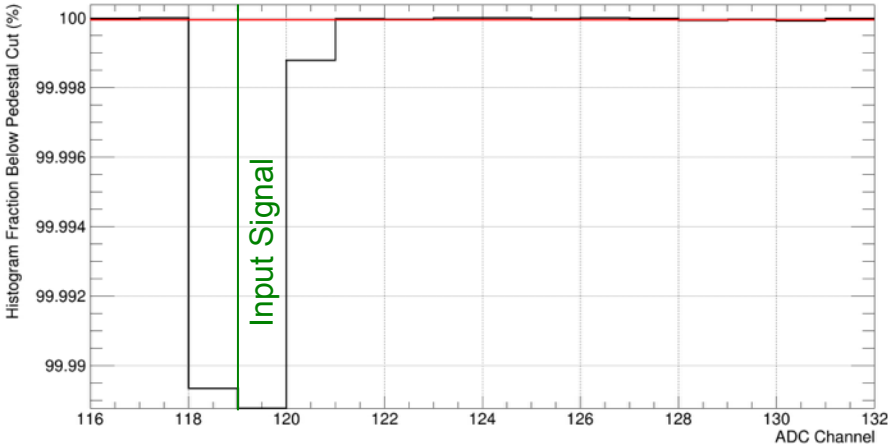
Example: Board GU4 Rev G with 650mV input, external threshold 1.5V

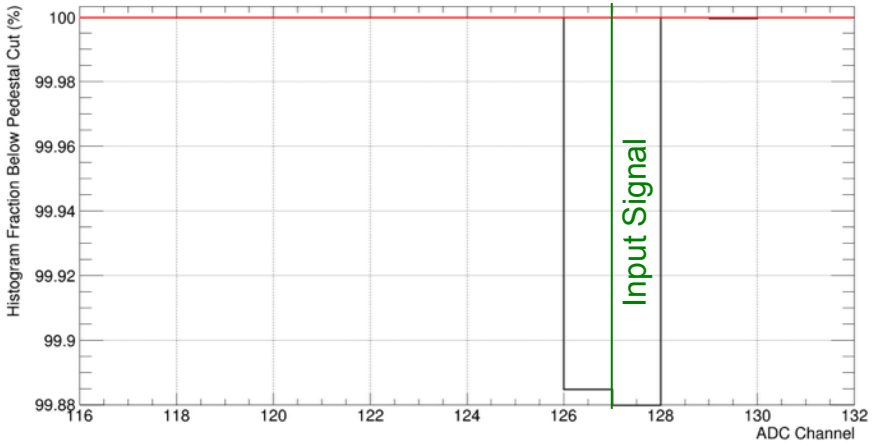


- Smaller fraction below pedestal cut implies higher number of counts above i.e. possible crosstalk signals (any effects are of tiny magnitude)
- Next neighbour always affected the strongest, even with input on different channels/ different NINO chip

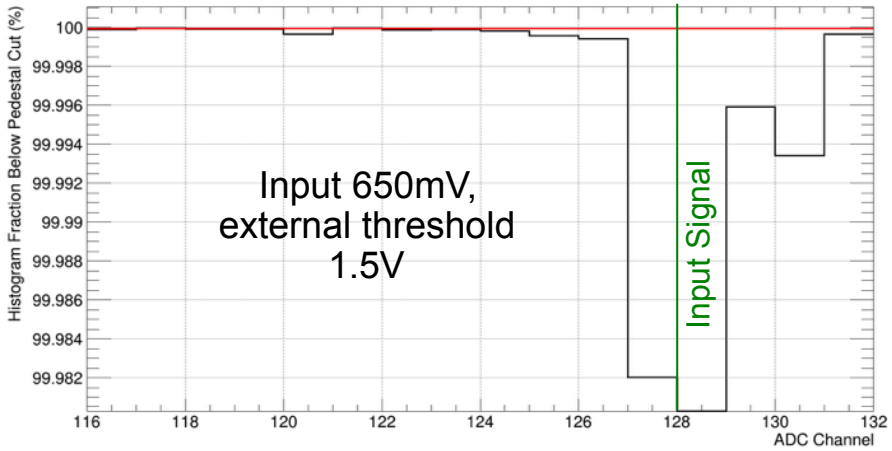
Method 1 - ADC Spectra

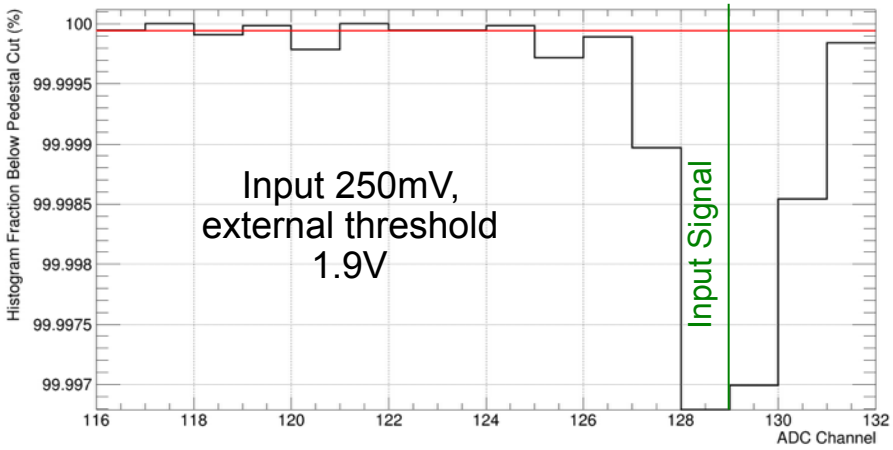
Further Examples: GU4 Rev G with 650mV input, external threshold 1.9V





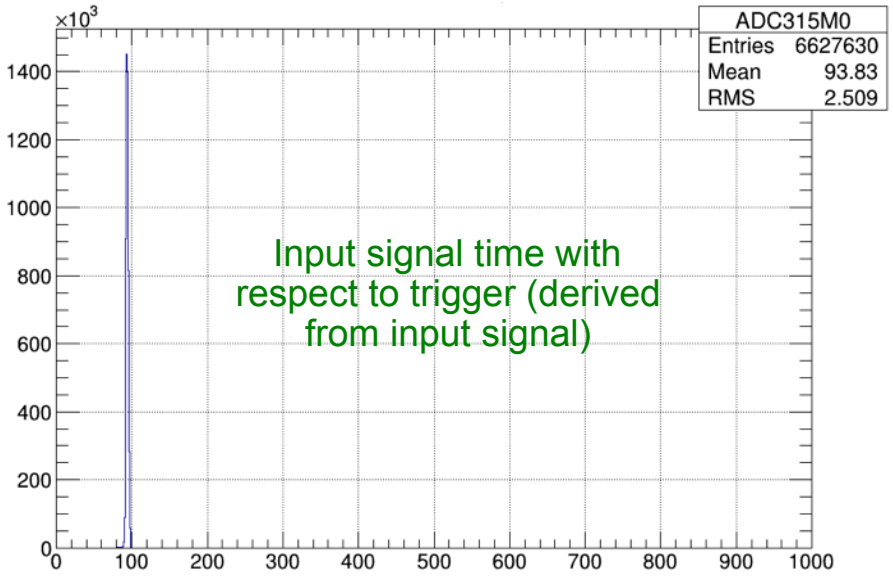
Further Examples: GU4 Rev D1

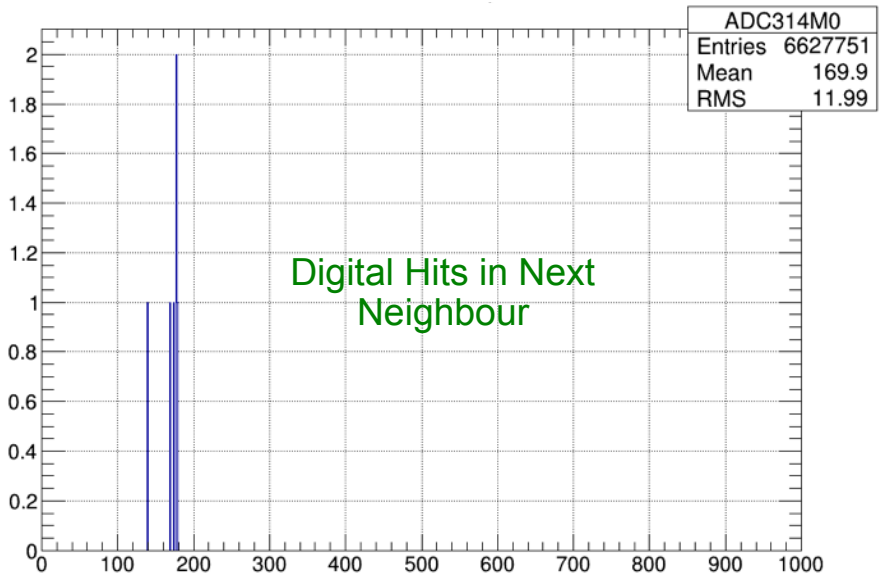




Method 1 - TDC Spectra

Search for Digital Hits Caused by Crosstalk (i.e. hits in neighbours above threshold causing LVDS out)

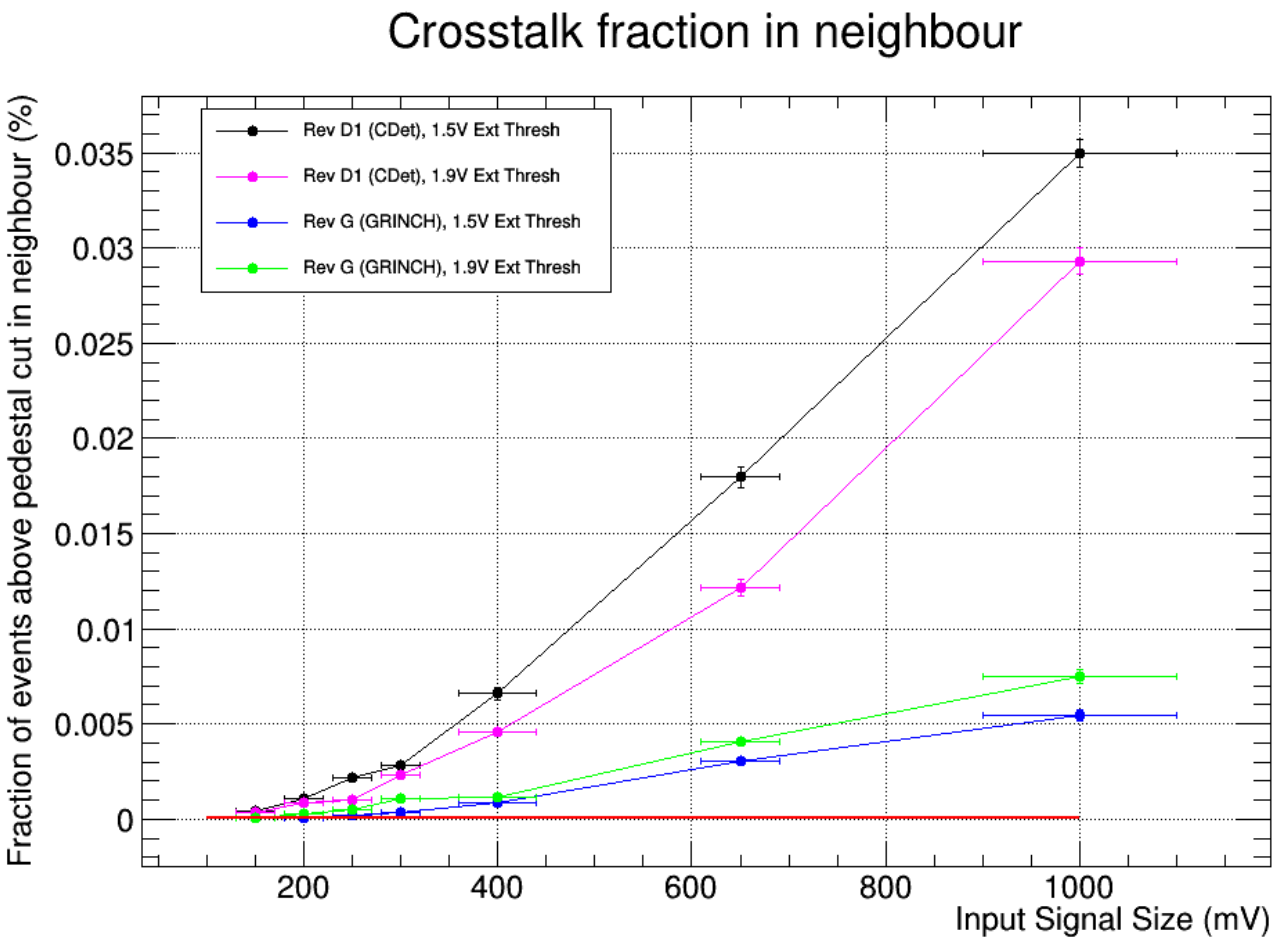




The **only** set-up in which this was observed was:

- GU4 Rev D1 (CDet) board; external threshold 1.5V (low); input signal size 1V
- **Effect negligible** - only 6 digital hits out of a run size of >6M events

Method 1 - Results



(from ADC spectra)

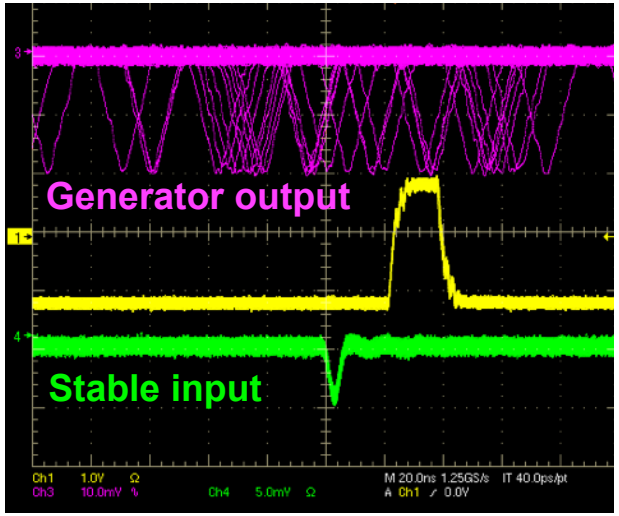
- Red line = expected remnant from 5σ Gaussian pedestal cut in ADC spectrum

- **Larger values in Rev D1 next-neighbour compared to Rev G**
- **Overall - values tiny/negligible and almost exclusively do not cause digital hits**

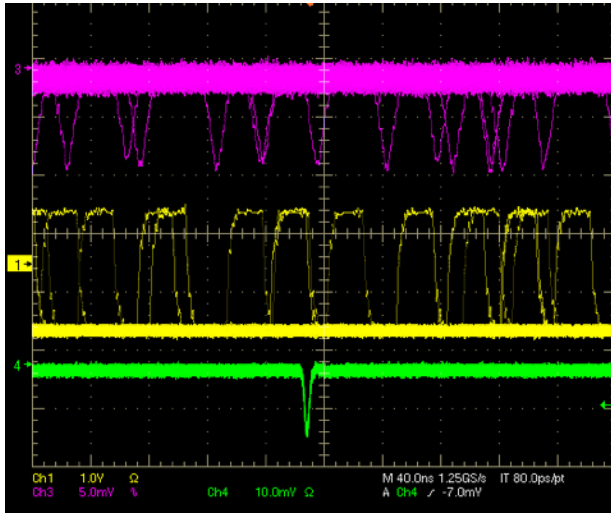
Method 2

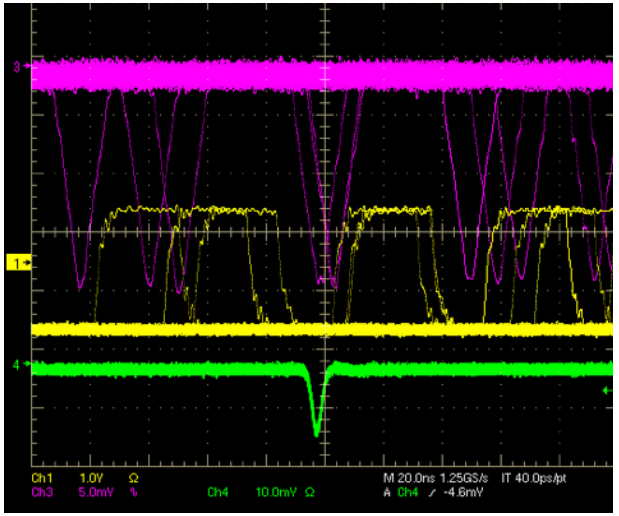
- Stable signal fed to one input of NINO using NIM electronics
- Frequency ~160kHz, signal varied from just below threshold up to ~10mV in couple steps
- External threshold 1.5V
- Stable signal used to derive DAQ trigger

- Pulse generator used to create “random” signal in neighbouring channel
- “random” pulse not correlated by any trigger from stable pulse
- Frequency > frequency of stable pulse
- Couple of different frequencies (200kHz, 250kHz) and input sizes (20mV, 100mV, 600mV) tested, but no noticeable difference in effect



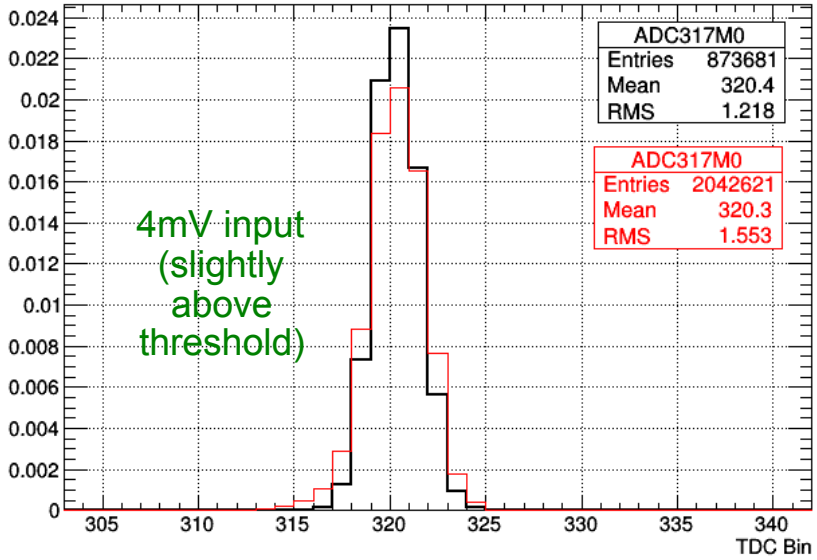
LVDS pulse from stable input (yellow)

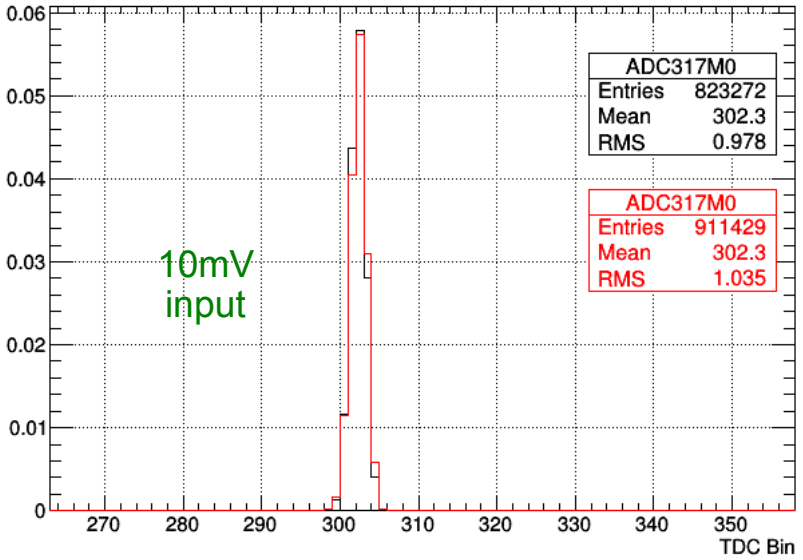


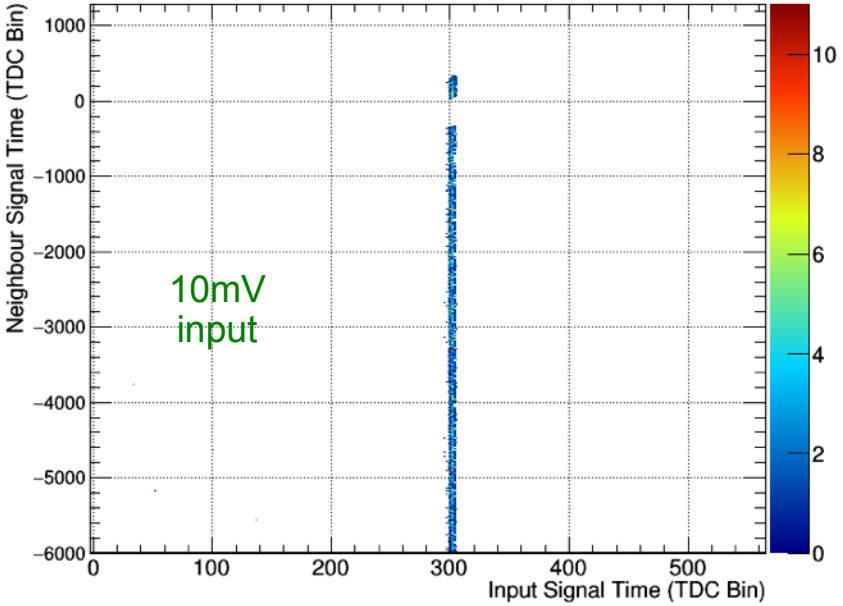


LVDS pulses from “random” signal in neighbour (yellow)

Method 2 - Results







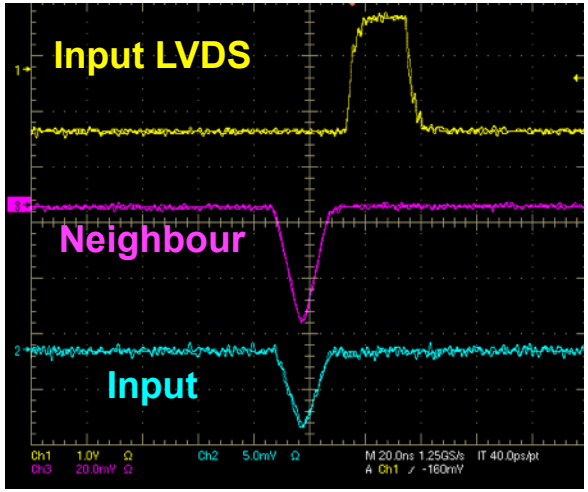
- Top graphs: TDC spectra of input signal time wrt trigger derived from itself:
  - Black = no neighbour pulse
  - Red = 20mV neighbour pulse at 200kHz
- Left: neighbour time (20mV at 200kHz) against input signal (10mV) time

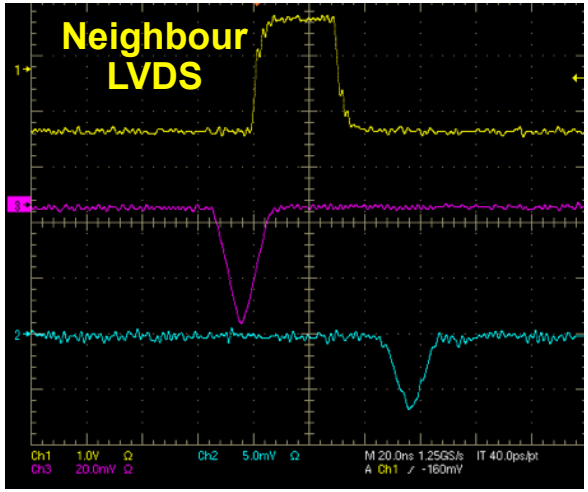
➡ **Neighbouring pulse did not have any significant effect on the input signal timing** (or on charge spectra, not shown here)

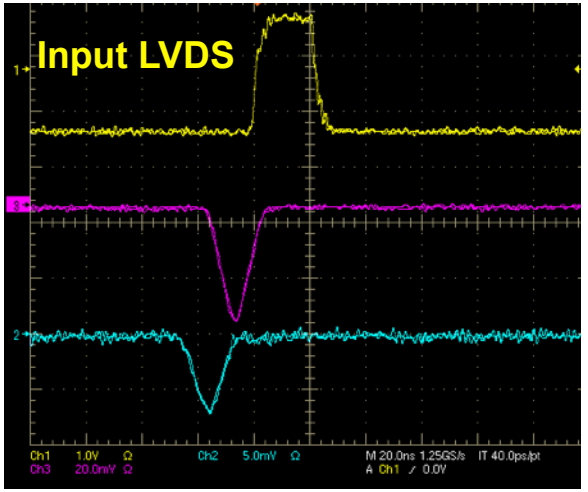
➡ **With input signal just below threshold (3mV), no digital hits were found for any of neighbouring pulses tested**

Method 3

- Pulse generator used as input signal to NINO (4mV, **just on/above** threshold and 7mV slightly above)
- Input signal used to derive DAQ trigger (as always)
- Different pulse generator channel used for neighbour channel signal (~40mV height, ~38ns LVDS width)
- Delay between input signal and neighbouring channel signal varied on generator (neighbour channel scanned form 60ns before to 60ns after true input signal)



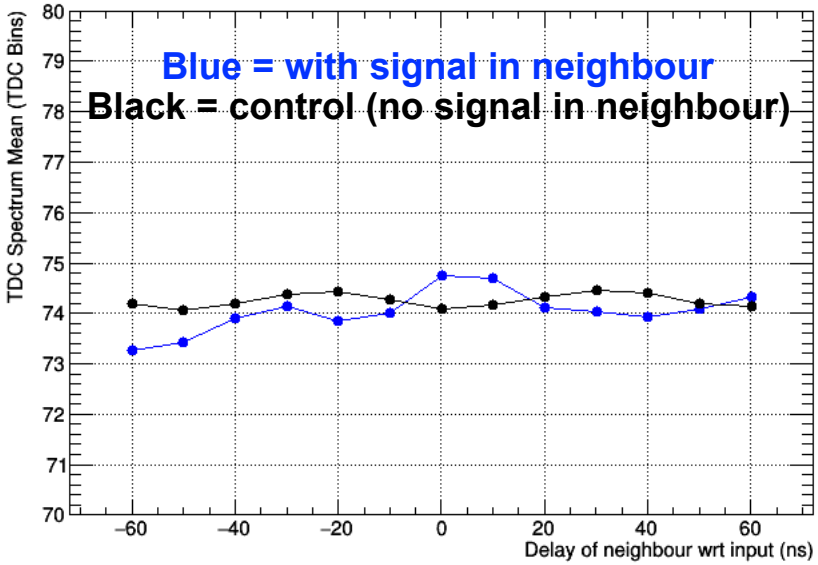


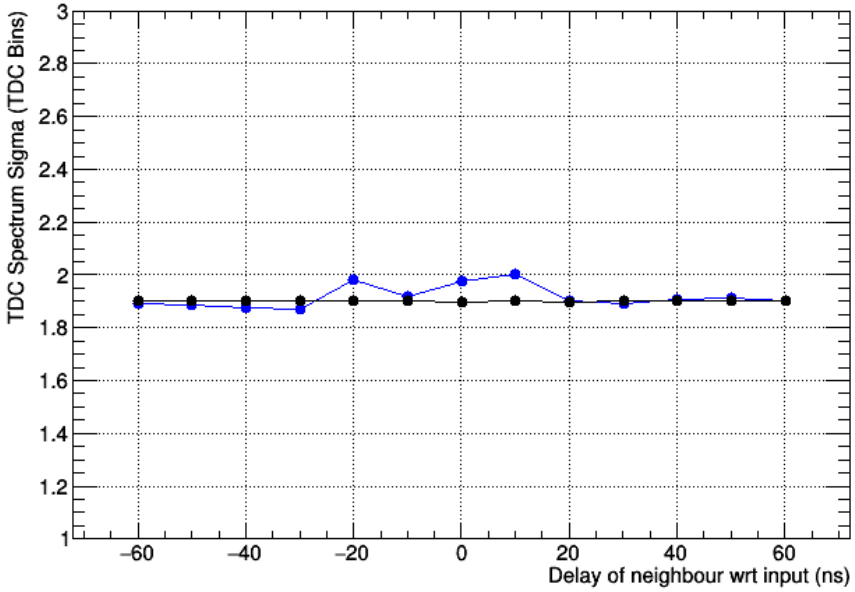


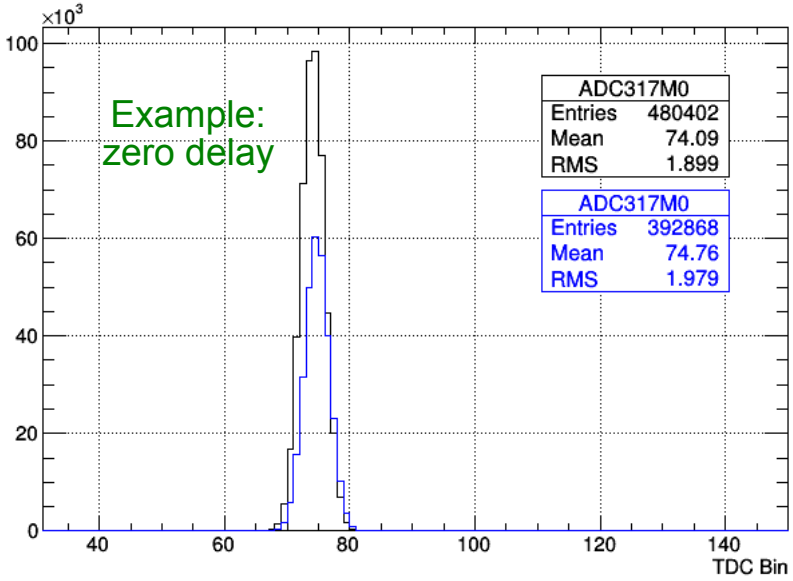
- Also repeated delay scan of 40mV neighbouring channel with true input signal just below threshold at 3mV, but recorded no digital LVDS hits in below threshold channel

Method 3 - Results

7mV input (slightly above threshold)



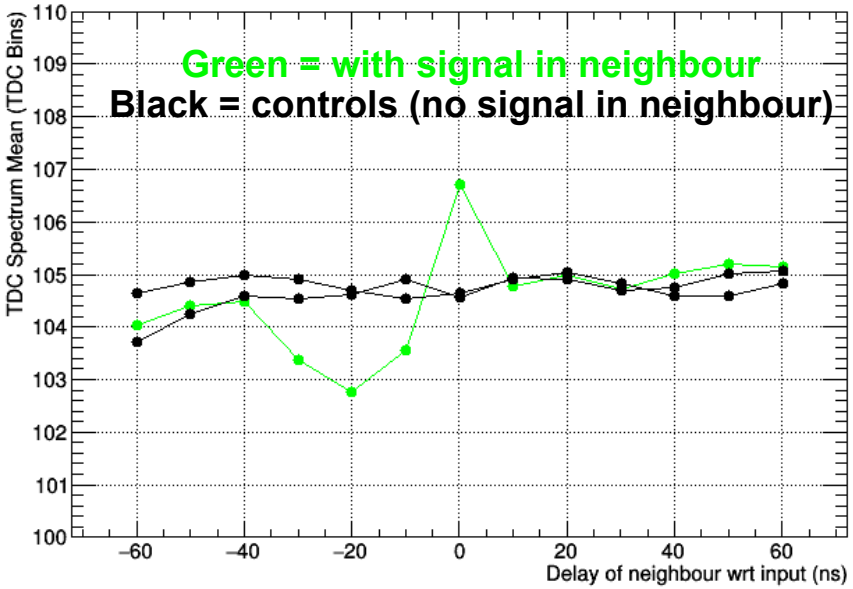


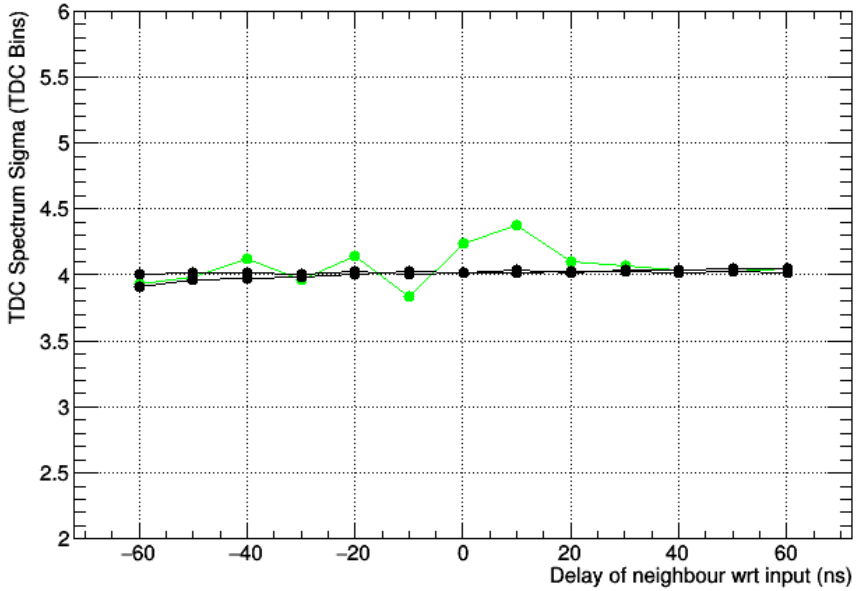


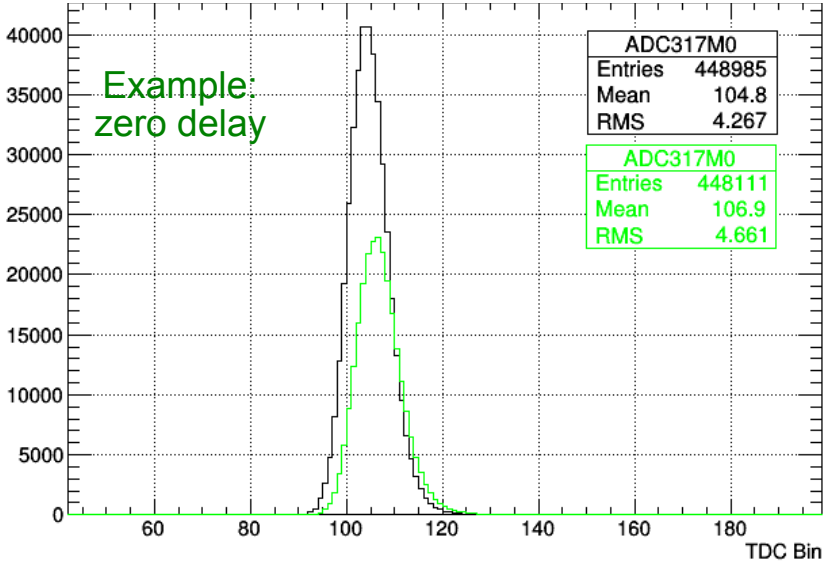
- TDC spectrum fitted with Gaussian
- Top two plots mean and sigma widths variation
- Spectra with neighbouring channel present compared to control sample with no neighbour present
- Errors from fits smaller than markers
- Any fluctuation in mean time with control sample is tiny and mostly within ~1TDC bin
- Fluctuation in sigma negligible
- (TDC resolution is 100ps)

Method 3 - Results

4mV input (just on/very slightly above threshold)







- Fluctuation in mean time with control sample is larger than for 7mV when the neighbour pulse is before and coincident with the input
- Effect is on order of 2TDC bins shift in mean time at most in the worst case and perhaps a smaller fraction of digital hits above threshold
- Fluctuation in sigma negligible

Summary

- Several tests were performed to study possible crosstalk effects in the NINO readout boards
- Overall level of analogue crosstalk is not of a major concern to cabling, although it is most likely to affect the next neighbouring channel
- Crosstalk in the digital line is most likely to affect neighbouring channels and signals which are at/just above threshold on a small-scale, but for signals which are already a few mV above threshold this effect is negligible