TDC Full Crate Tests

William Orejudos
LBNL
DAQ Upgrade meeting
March 3, 1999

Test set-up

- **TESTCLK provides 132 ns clock**

- **TRACER provides calibration pulses**
  - **after each 100 pulses fine delay incremented**
  - **after each 1000 pulses coarse delay incremented**
  - **total of 10000 pulses at 100 points in time**

For each channel of TDC, check:

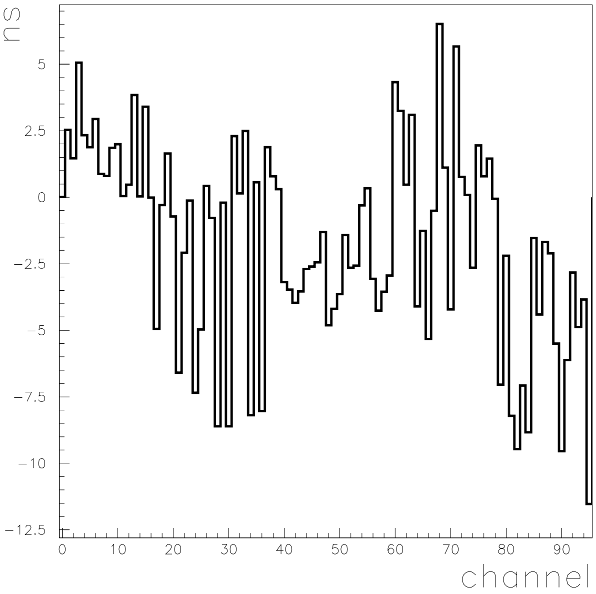
- output width
- output start time
- linearity of response

Checks done with 1 TDC in crate and with 8 TDC's in crate

For now, reference everything to first channel

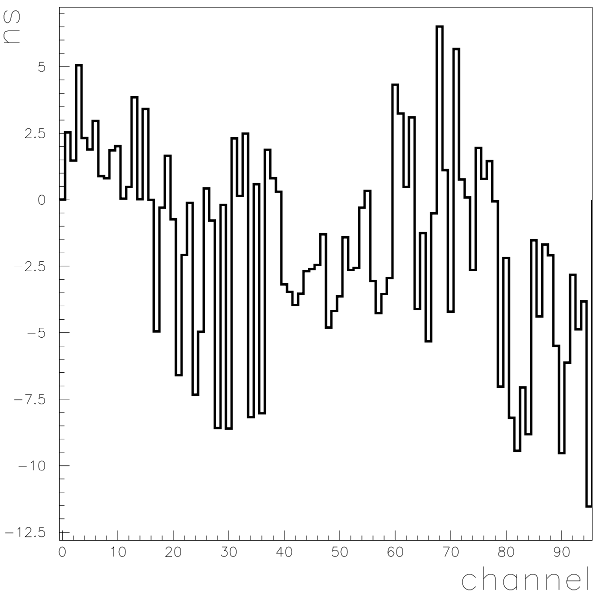
Check of output start time

- Each channel i: 10000 events
- Study $T_{\mathrm{diff_i}}$, the difference in output start time between channel i and channel 1
  - For each channel, calculate the average of $T_{\mathrm{diff_i}}$
  - For each channel, calculate the rms of $T_{\mathrm{diff_i}}$
  - Use both of these quantities to compare 1 TDC case with 8 TDC case



Average $T_{\mathrm{diff}_\mathrm{i}}$
channel-by-channel

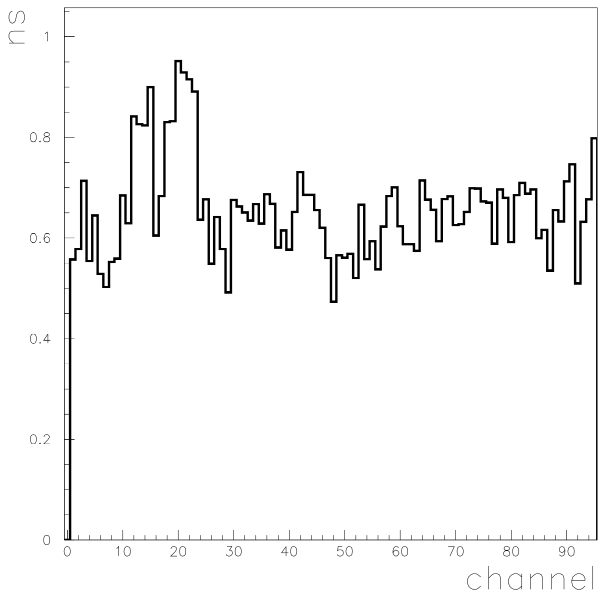
1 TDC case (slot 10)



8 TDC case (slot 10)

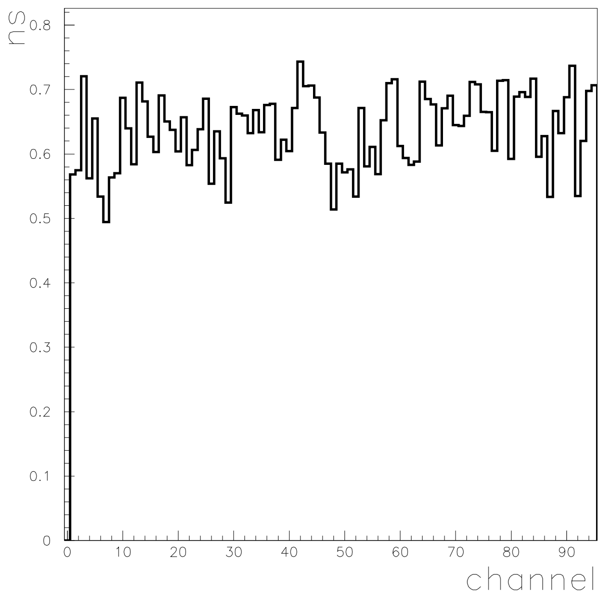
Plots are similiar.

Max. channel-to-channel difference is $\sim$15 ns.



rms of $T_{\mathrm{diff_i}}$ channel-by-channel

1 TDC case (slot 10)

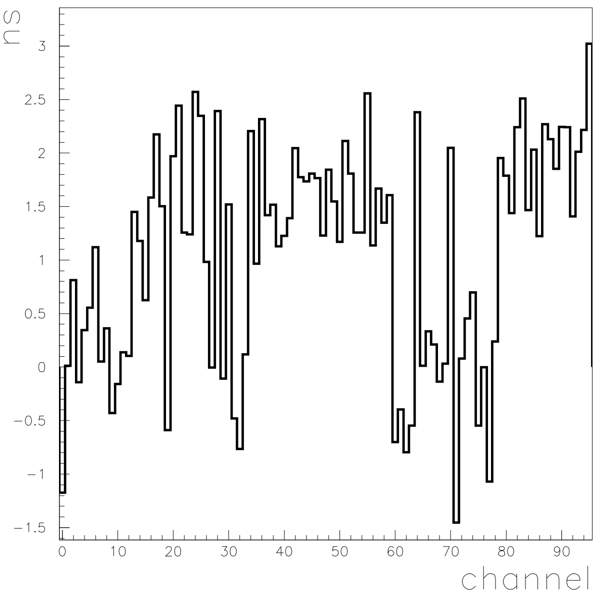


8 TDC case (slot 10)

For all channels rms of $T_{\mathrm{diff_i}}$ is $<$ 1 ns.

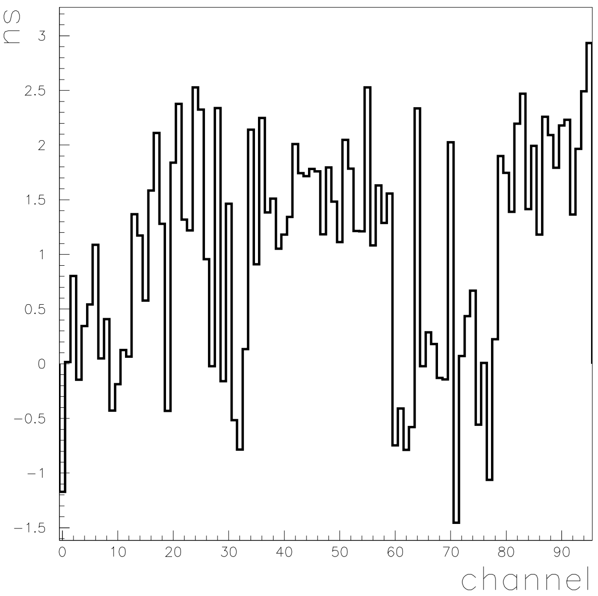
Check of output width

- **Each channel i: 10000 events**
- **Study $W_{\mathrm{diff_i}}$, the difference in width between channel i and channel 1**
  - **For each channel, calculate the average of $W_{\mathrm{diff_i}}$**
  - **For each channel, calculate the rms of $W_{\mathrm{diff_i}}$**
  - **Use both of these quantities to compare 1 TDC case with 8 TDC case**



Average $W_{\mathrm{diff}_{\mathrm{i}}}$
channel-by-channel

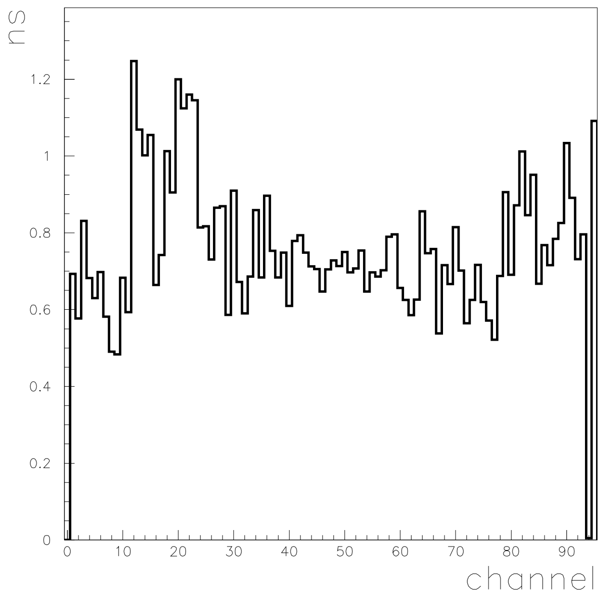
1 TDC case (slot 10)



8 TDC case (slot 10)

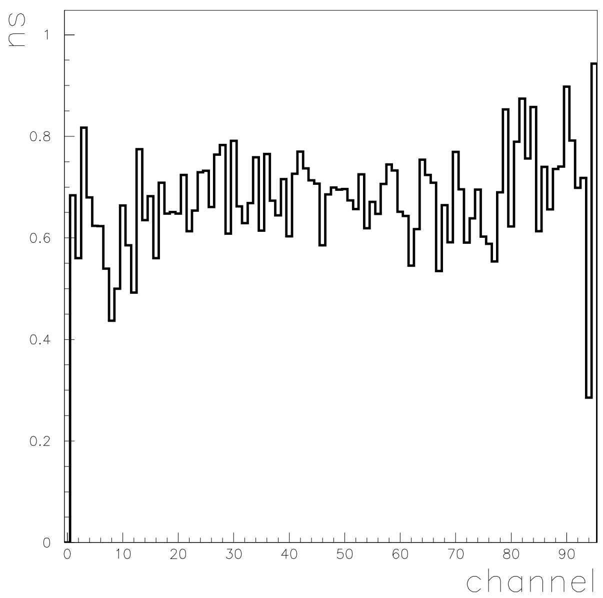
Plots are similiar

Max. channel-to-channel difference is ∼2.5 ns



**rms of $W_{\mathrm{diff_i}}$
channel-by-channel**

1 TDC case (slot 10)



8 TDC case (slot 10)

For all channels rms of $W_{\mathrm{diff_i}}$ is $< \sim$1 ns.

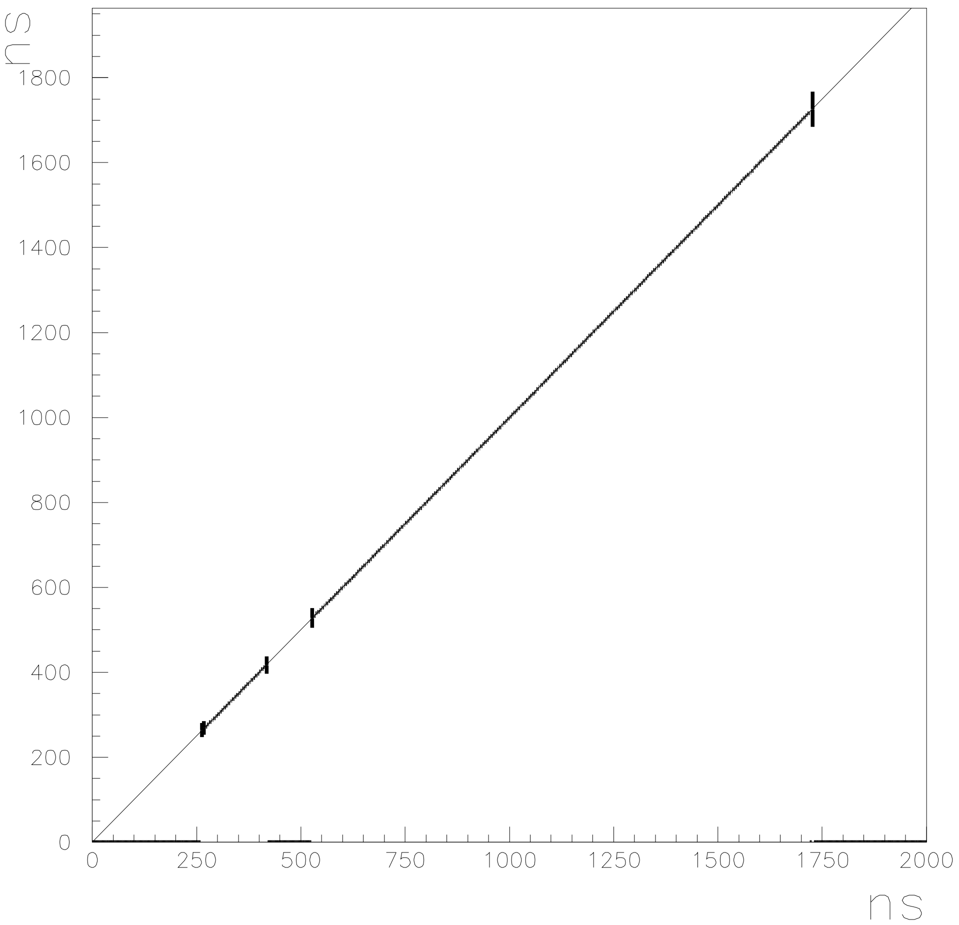
Linearity of output start time

- For each channel i, plot $T_{\mathrm{start}_\mathrm{i}}$ vs. T_{start_1} for all 10000 points

- Fit a straight line. For each channel we then have a slope and an offset

- Offset is essentially $T_{\mathrm{diff}_\mathrm{i}}$

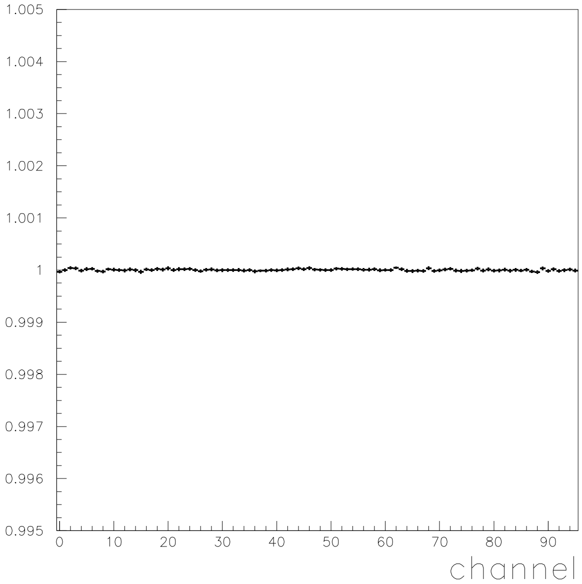
- Want to have slope = 1, i.e. $T_{\mathrm{diff}_\mathrm{i}}$ should not change as function of time



1 TDC case, channel 11

$T_{\mathrm{start}_{11}}$ **vs.** T_{start_1}

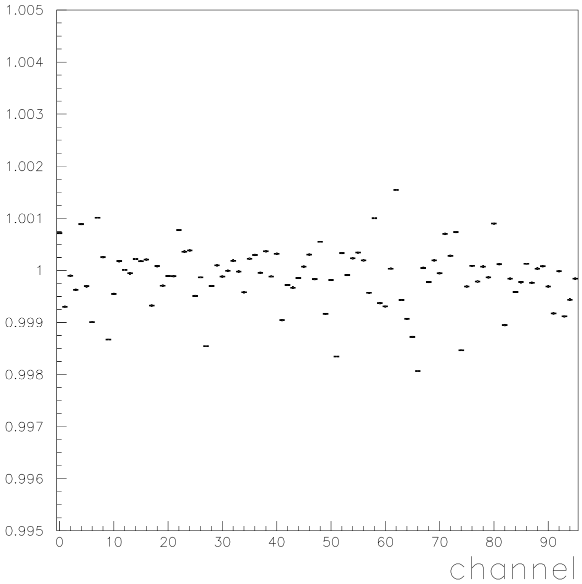
Plot done as a profile histogram
Bins of T_{start_1} **are 5 ns wide**



channel-by-channel slopes of $T_{\mathrm{start}_\mathrm{i}}$ vs T_{start_1}

1 TDC case (slot 10)

Slopes are 1 within a few parts of 10^5

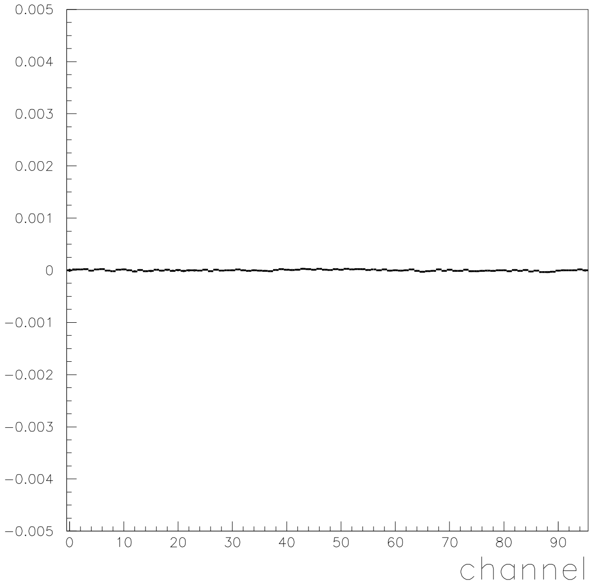


8 TDC case (slot 10)

Large spread in slopes!

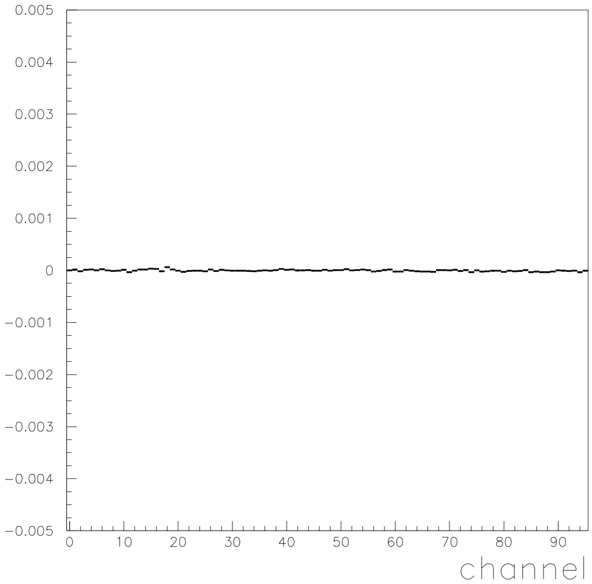
Investigate further:

- **For each channel i, plot $T_{\mathrm{diff}_\mathrm{i}}$ vs. T_{start_1} for all 10000 points**
- **Fit a straight line**
- **Want to have slope $=$ 0**



channel-by-channel slopes of T_{diff_i} vs T_{start_1}

1 TDC case (slot 10)



8 TDC case (slot 10)

Slopes are 0 within a few parts of 10^5

Working hypothesis:

- Something is causing the start time of all channels on a TDC to flucuate throughout the 10000 events when there are multiple TDC's in crate

- Shows up in $T_{\mathrm{start}_\mathrm{i}}$ vs. T_{start_1} because the x-axis (T_{start_1}) is binned, with bin size larger than flucuation

- Doesn't show up in $T_{\mathrm{diff}_\mathrm{i}}$ vs. T_{start_1} because the flucuation is subtracted out

Currently checking calibration pulse from TRACER to see if it changes as more TDC's are added to crate.

Another problem: occasionally, no output will be present. There are several ways in which this problem manifests itself:

- **No output from a given channel for all 10000 events**
- **A given channel has no output for a fraction of the 10000 events. The failures are distributed evenly throughout the 10000 events**
- **Almost all channels have no output for a fraction of the 10000 events. Again, the failures are distributed evenly**

Number of channels and events with no output seems to depend on:

- **Number of TDC's in crate**
- **Number of TDC's that are read out**
- **Day that data was taken! (AC power problem?)**

Work to understand this is still ongoing...

Conclusions

- **Start time, width, and linearity seem ok with 8 TDC's**

- **Still need to understand the flucuation in start time common to all channels**

- **Still need to understand the events with no output**