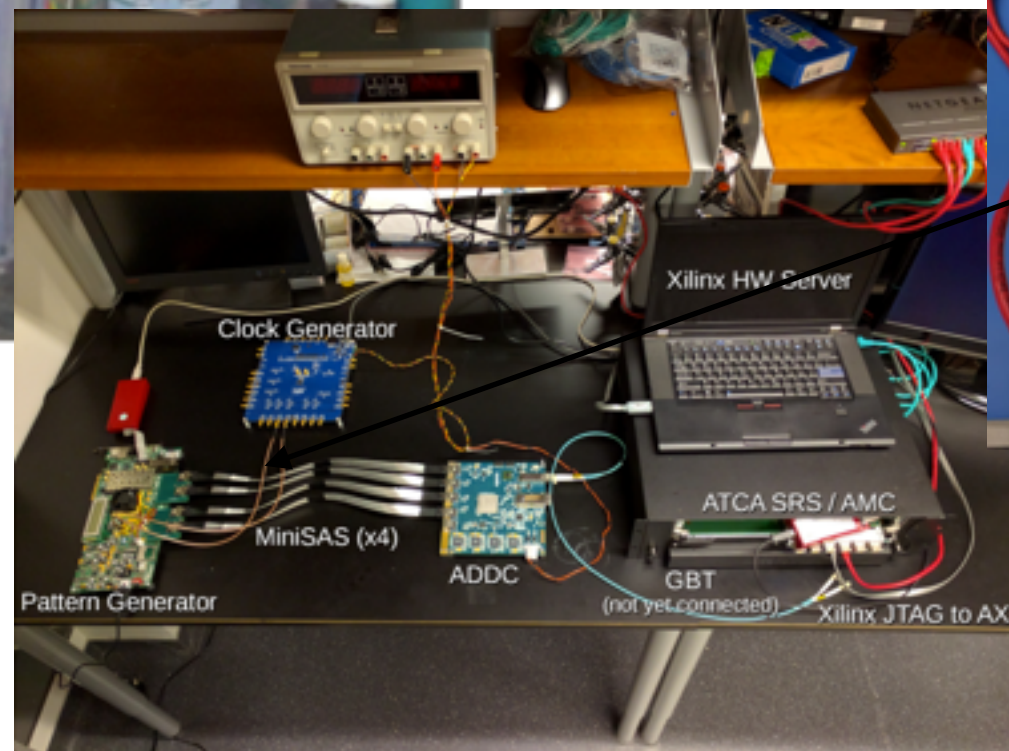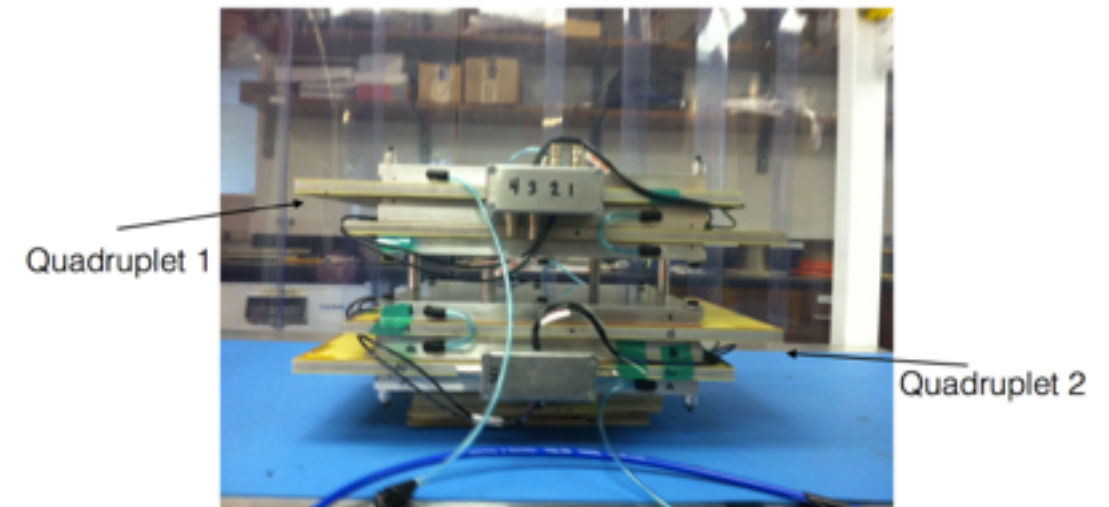# VMM2 with MMFE8: TDO distributions

NSW Electronics Meeting
April 1, 2016

M. Bledsoe, N. Felt, M. Franklin, B. Garber, P. Giromini, J. Grotto, J. Huth, C. Rogan, A. Tuna, A. Wang

Overview

Scintillator/PMT array (top)

Micromegas insertion

z

y

x

Coordinate system

Concrete absorber

W   E

B

Scintillator/PMT array (bottom)

ATL-COM-UPGRADE-2014-038

Quadruplet 1

Quadruplet 2

Clock Generator

Xilinx HW Server

Pattern Generator

MiniSAS (x4)

ADDC

GBT
(not yet connected)

ATCA SRS / AMC

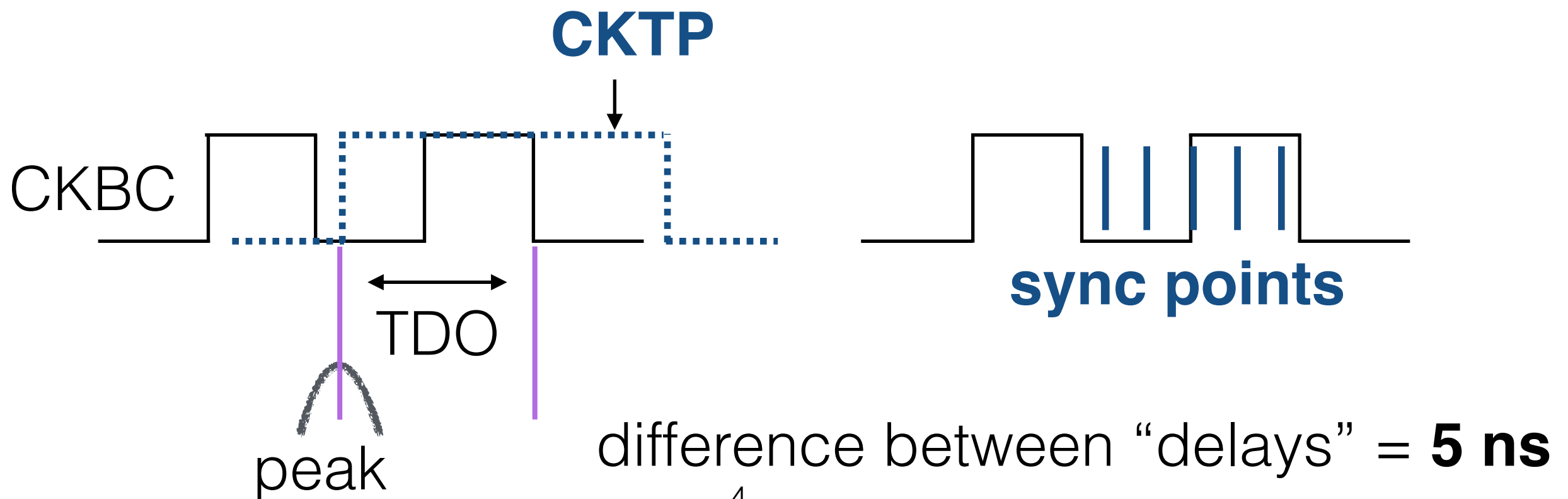Xilinx JTAG to AXI

MMFE8s

Working to put together a functioning system

Timing studies

- Our goal was to examine timing information for data taken with the VMM2 on the MMFE8 board

- Studied TDO distributions with varying peak times and DAC pulse heights
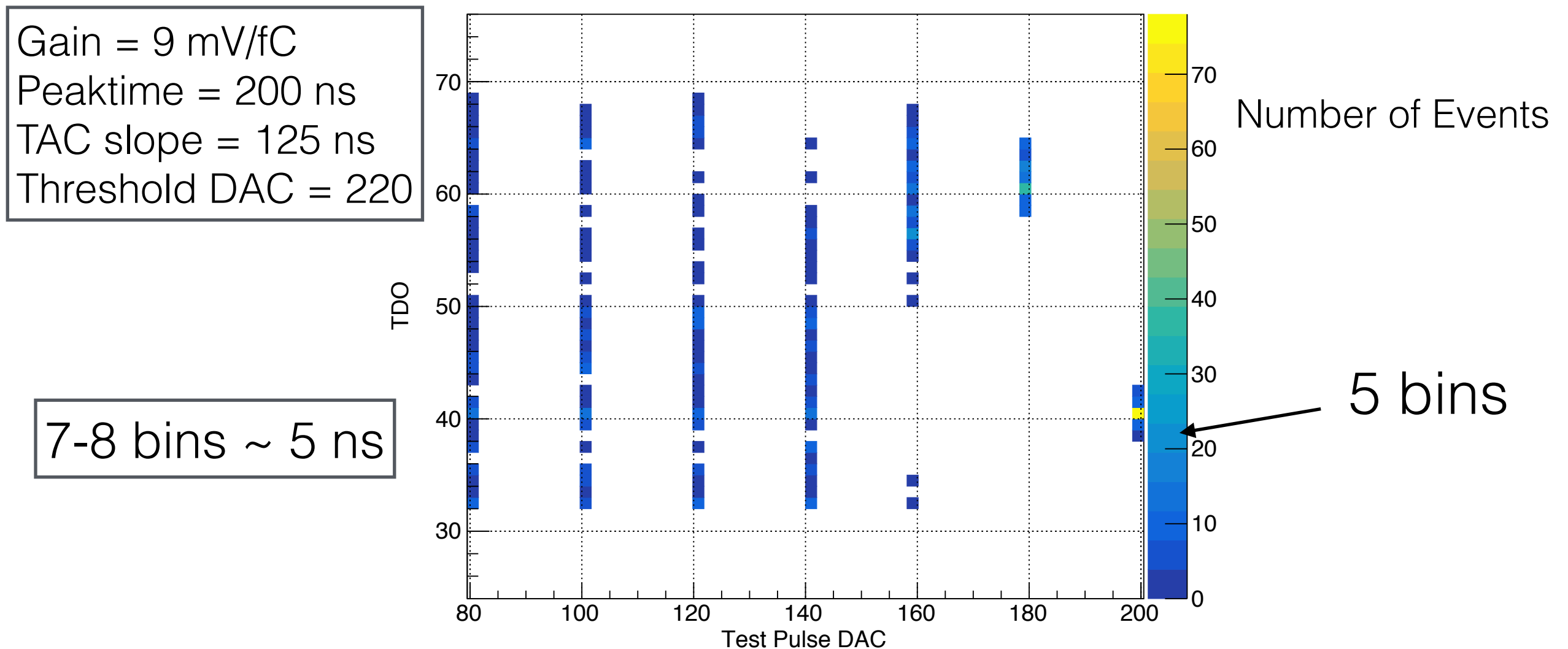
- Compared to data from VMM1 studies

VMM2 timing study methods

- In order to do the TDO calibration, we have synchronized CKTP to CKBC

- Then we "delay" it using ticks of the faster mother clock (200 MHz) : 5 delays

- Rising edge of CKTP can be held fixed with respect to falling edge of CKBC

CKTP

CKBC

TDO

peak

sync points

difference between "delays" = **5 ns**

VMM7, Ch 14, TDO vs. Test Pulse DAC

For every TP DAC, pulsed 100 times

Gain = 9 mV/fC
Peaktime = 200 ns
TAC slope = 125 ns
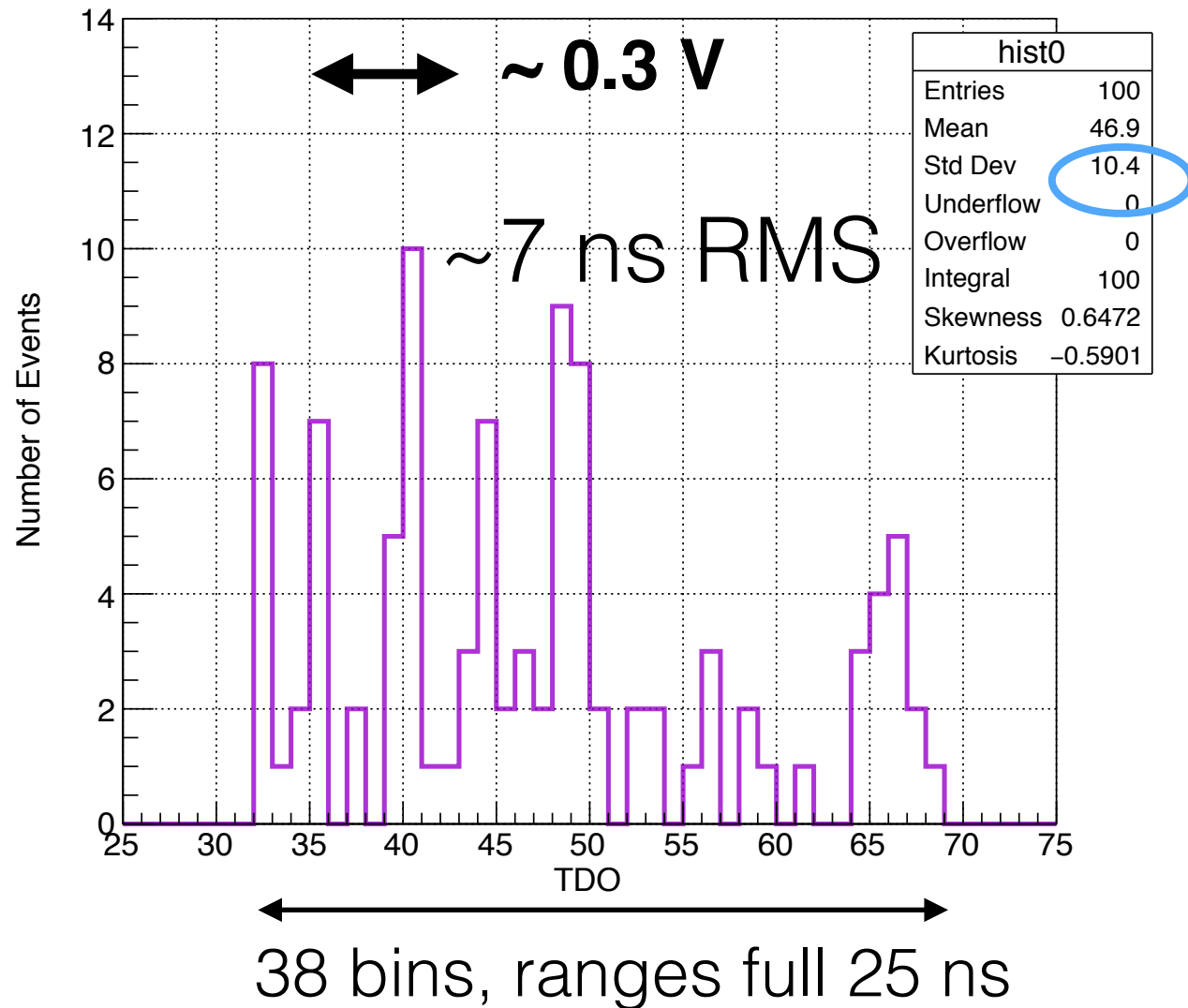Threshold DAC = 220

7-8 bins ~ 5 ns

5 bins

- CKTP pulses with every fixed test pulse DAC TDO distribution are fully synchronized with respect to CKBC

VMM 7, Ch 14
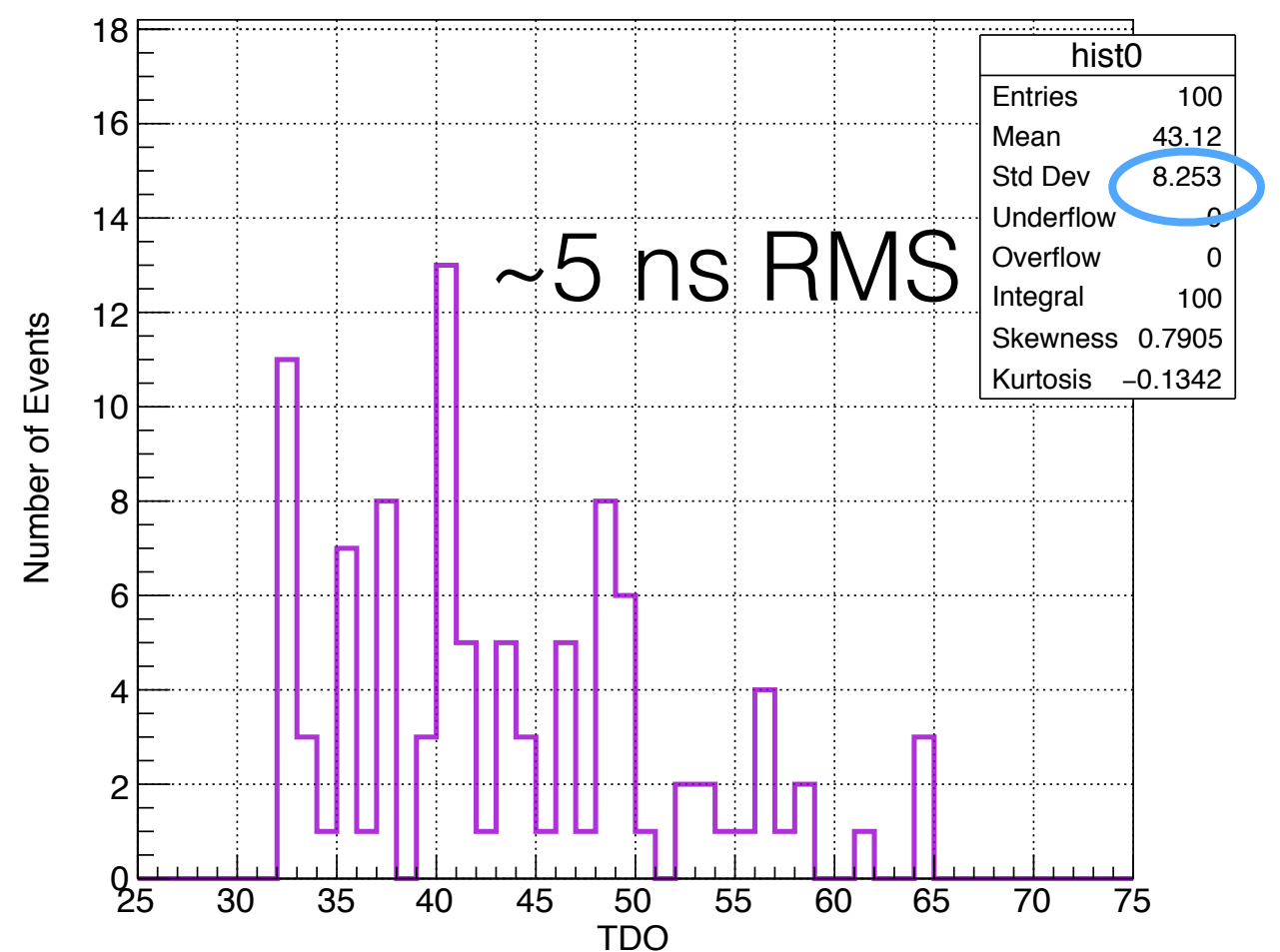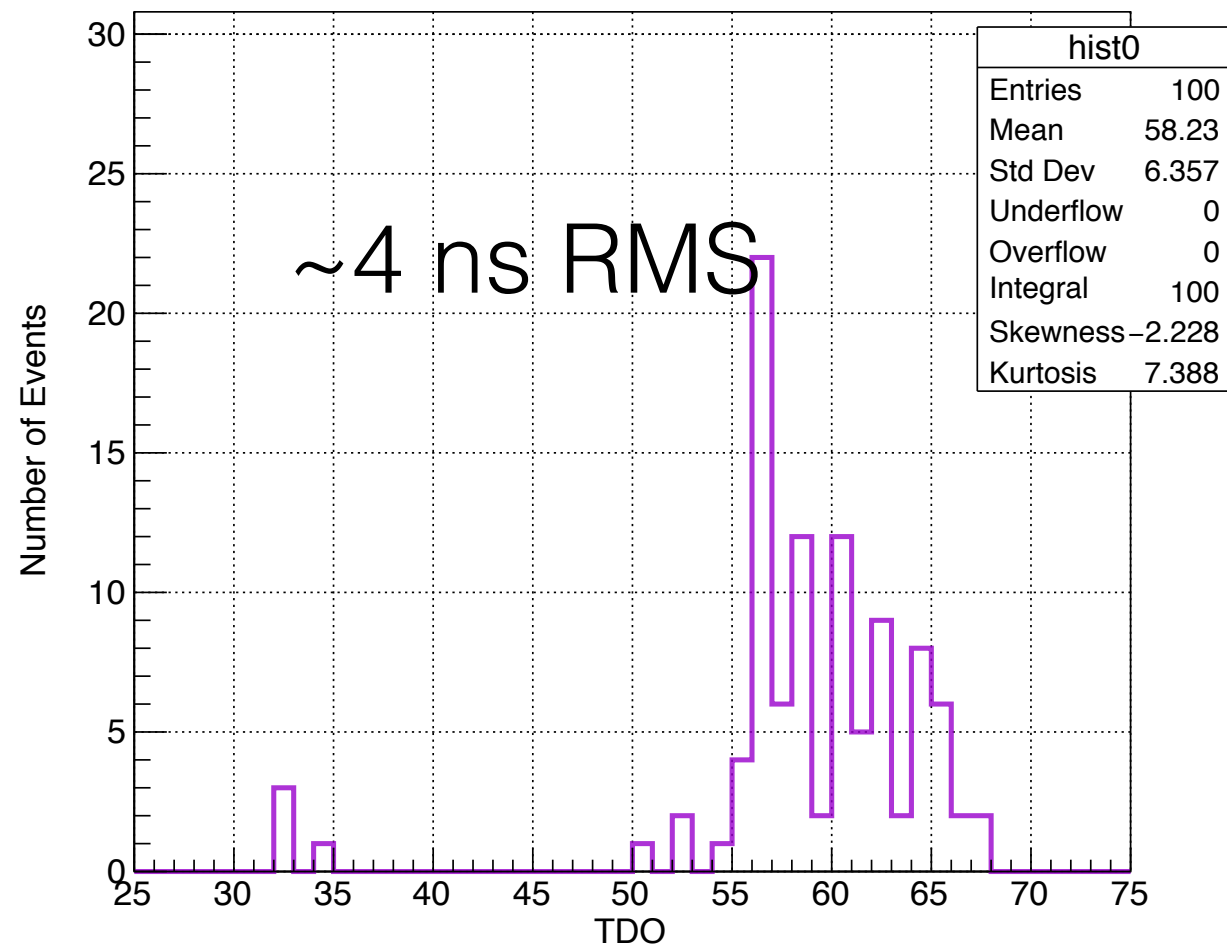# TDO distributions

Test Pulse DAC = 120

~ 0.3 V

~7 ns RMS

hist0	
Entries	100
Mean	46.9
Std Dev	10.4
Underflow	0
Overflow	0
Integral	100
Skewness	0.6472
Kurtosis	−0.5901

38 bins, ranges full 25 ns

Test Pulse DAC = 140

~5 ns RMS

hist0	
Entries	100
Mean	43.12
Std Dev	8.253
Underflow	0
Overflow	0
Integral	100
Skewness	0.7905
Kurtosis	−0.1342

- CKTP in each plot is fully synchronized with respect to CKBC

VMM 7, Ch 14
TDO distributions

Test Pulse DAC = 160

~4 ns RMS

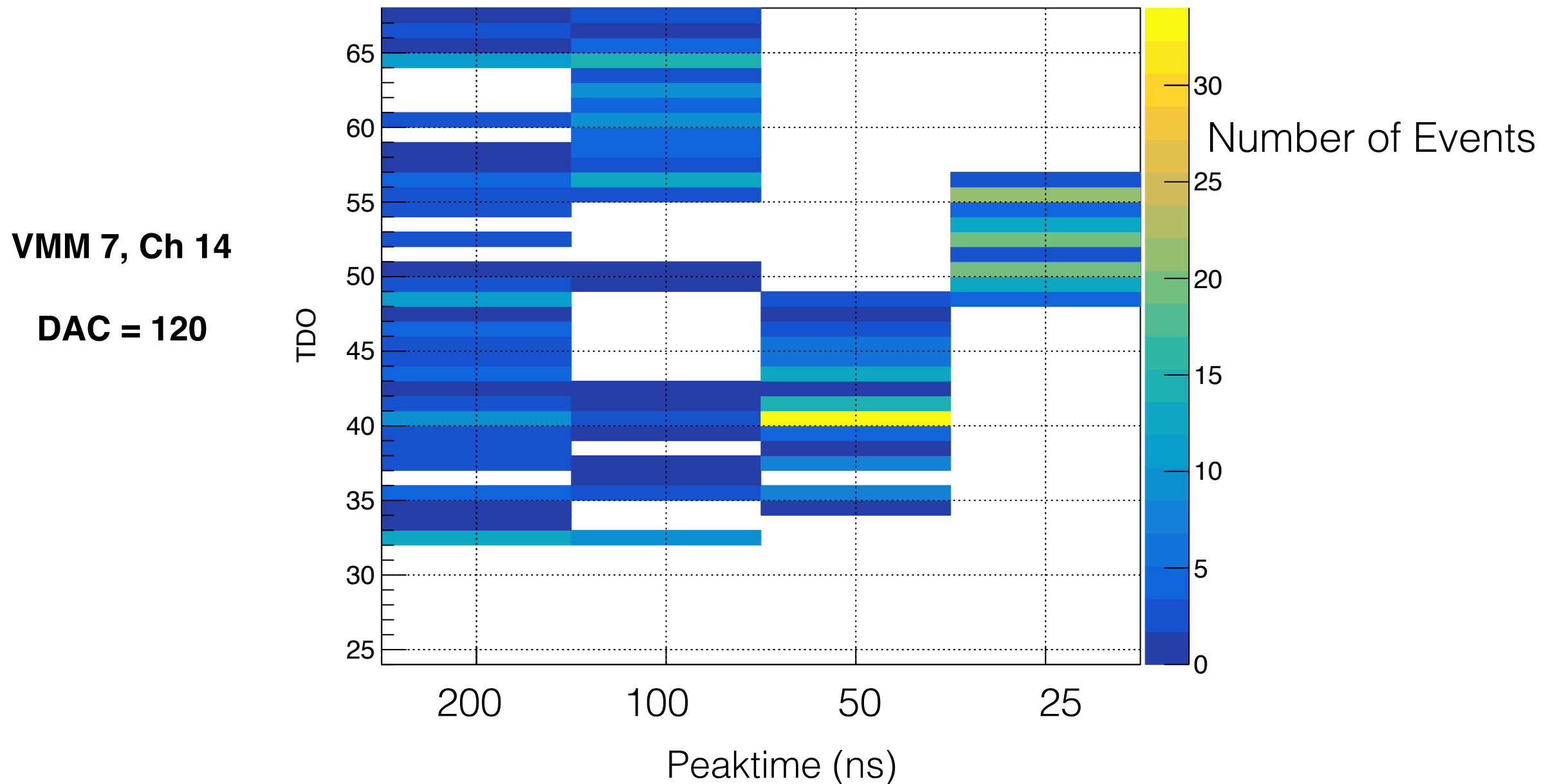| hist0	
Entries	100
Mean	58.23
Std Dev	6.357
Underflow	0
Overflow	0
Integral	100
Skewness	−2.228
Kurtosis	7.388

Test Pulse DAC = 180

~1 ns RMS

hist0	
Entries	100
Mean	60.75
Std Dev	1.577
Underflow	0
Overflow	0
Integral	100
Skewness	1.338
Kurtosis	0.6816
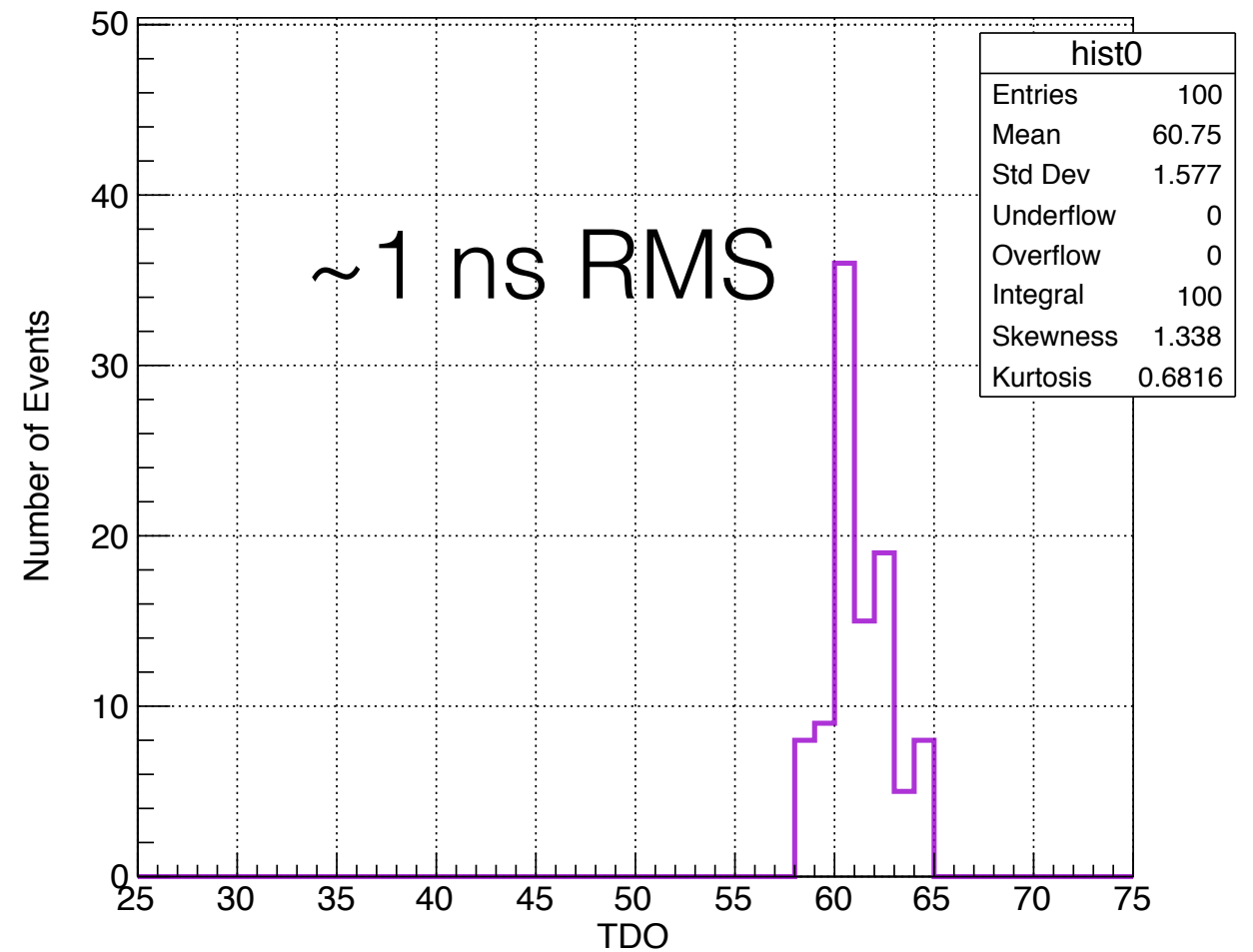
- Large decrease in RMS

Studying the TDO as a function of the peak time

VMM 7, Ch 14

DAC = 120

Smaller the peak time -> smaller TDO RMS

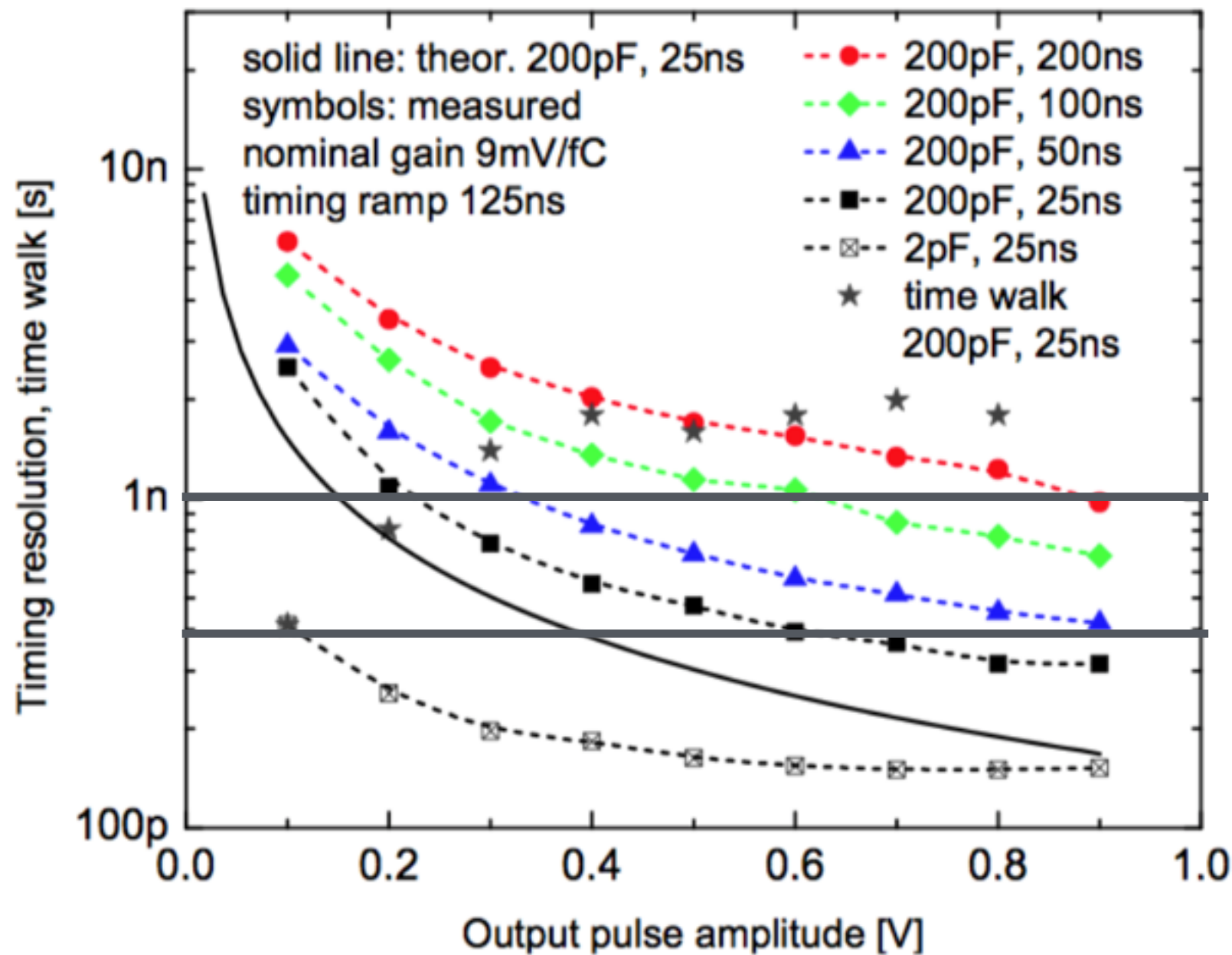# Investigating origin of the dependence

- Since TDO is the difference between the next falling edge of CKBC and the peak time, we don't know if the large RMS is because of the bunch crossing or the peak detection

- In order to see if the large dependence of TDO on PDO / peaktime was caused by some phenomenon unique to each channel, we pulsed two channels simultaneously and examined the differences in TDO for each data point

Difference in TDO values for two simultaneously pulsed channels
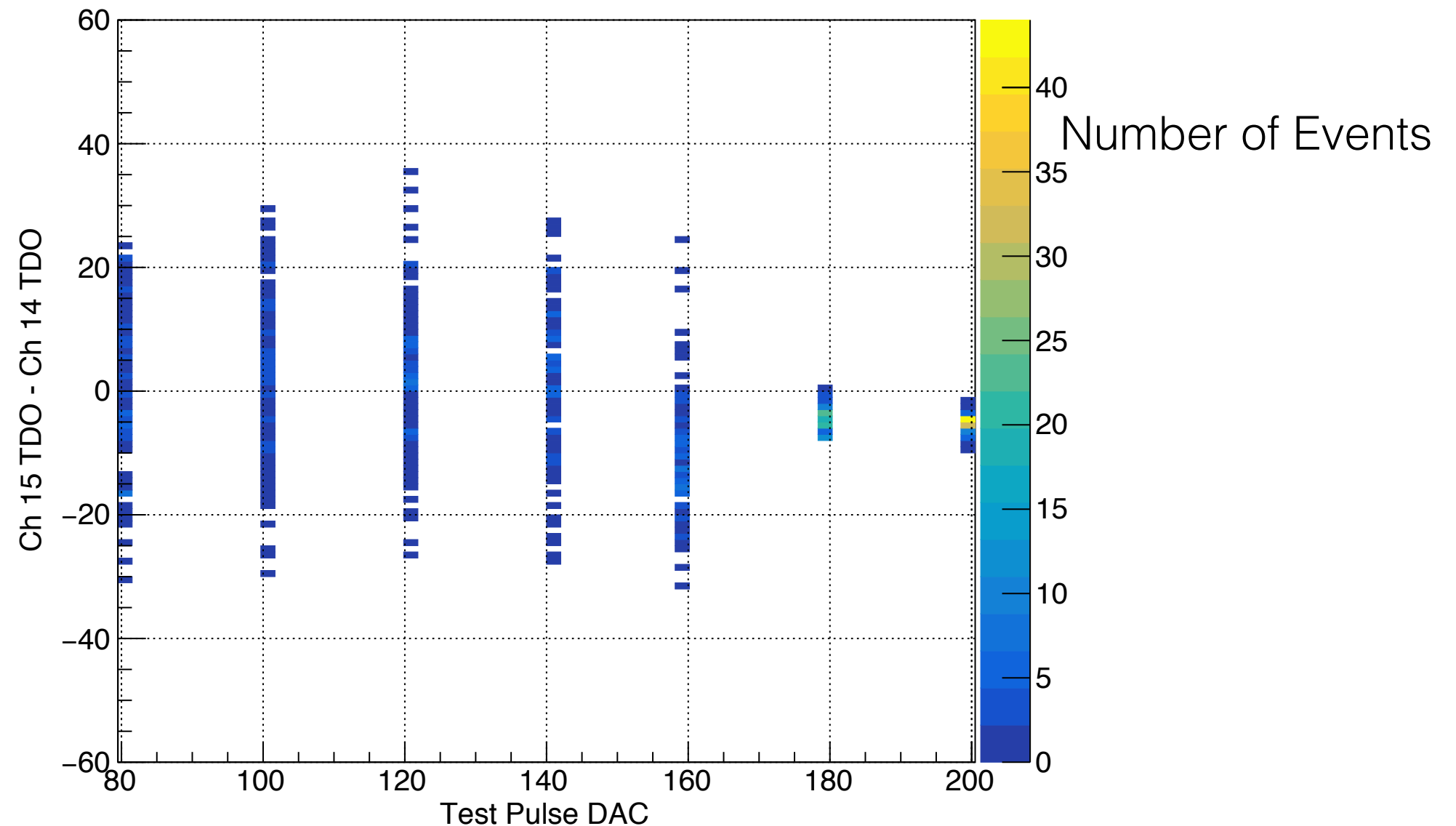
- The RMS of the difference is larger than the RMS of just one channel -> problem is with peak detection
- We are surprised that the RMS is so large

Going back in time to VMM1

solid line: theor. 200pF, 25ns
symbols: measured
nominal gain 9mV/fC
timing ramp 125ns

200pF, 200ns
200pF, 100ns
200pF, 50ns
200pF, 25ns
2pF, 25ns
time walk 200pF, 25ns

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Between 0.3 to 0.9 V, timing resolution < 3 ns for a 200 ns peak time

11

Going back in time to VMM1: logbook edition

June 2013

1 count ~ 1 ns
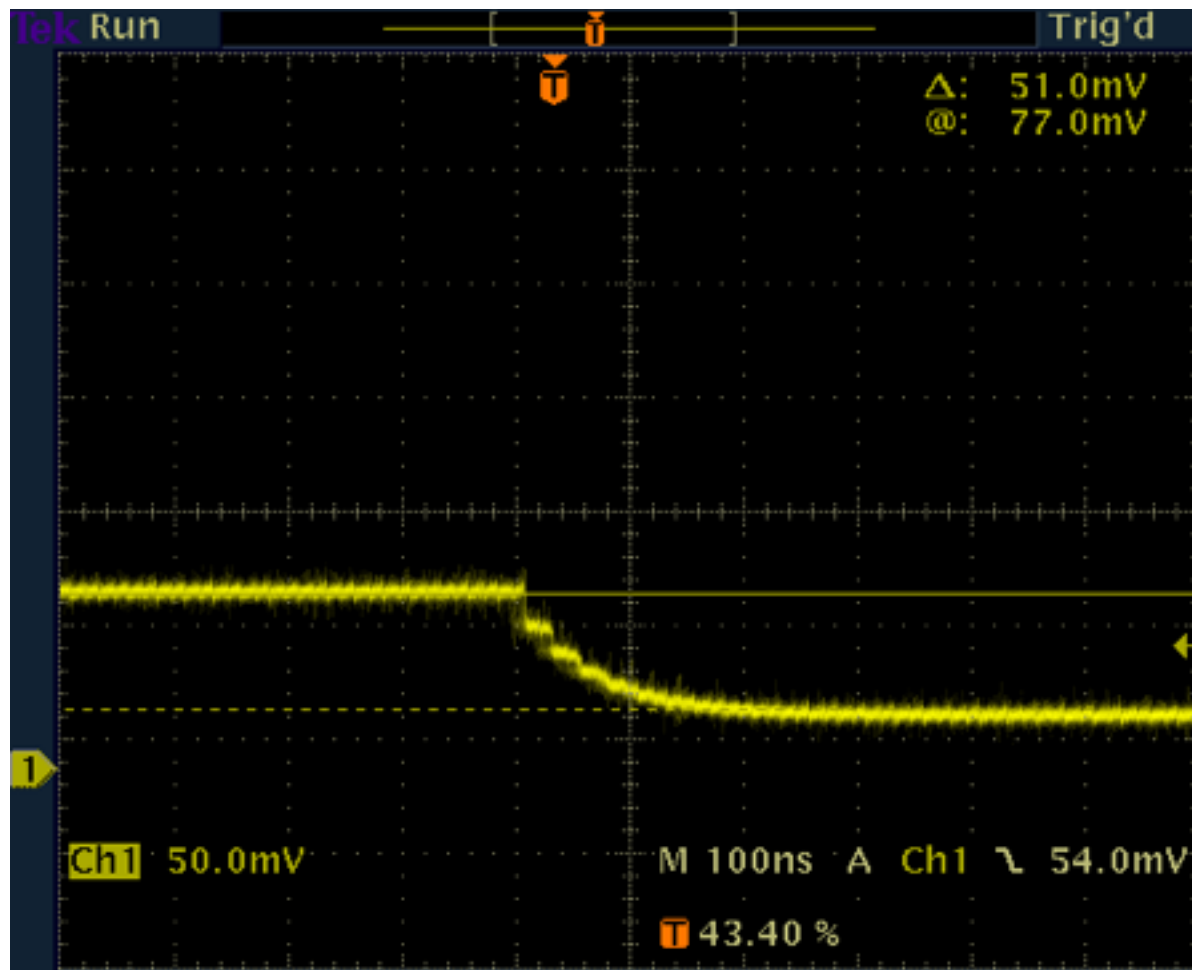
Dependence of test pulse amplitude on peak time

- After we noticed that the RMS was improved with shorter peak time and larger test pulse DAC, we wanted to see if a change in peak time would change the voltage of the test pulse amplitude

- Also collected approximate values for test pulse amplitudes on VMM7, Ch 14

Changing peak time changes shaped pulse amplitude

TP DAC	200 ns Peak Time	25 ns Peak Time
200	~920 mV	~650 mV
120	~330 mV	~230 mV
80	~290 mV	~220 mV

- Pulse height is affected by the peak time
- Shorter peak time ~ shorter pulse amplitude

Fall time of DAC step pulse

- The fall/rise time of the DAC step pulse is long, > 100 ns
- Accounts for the dependence of test pulse pulse amplitude on peak time

- For TP DAC = 0, we still have a pulse amplitude of ~100-200 mV
- Not probing low enough voltages

Summary

- TDO distributions at lower test pulse DACs / long peak time are very wide and span the full bunch cross

- At even lower voltages, using just the BCID may be better than using the time of flight (with just the BCID, 25 ns / sqrt(12) ~ 7.2 ns RMS)

- May signal a problem in the peak detection of the signal

- Test pulse amplitude dependent on peak time of test pulse, most likely because DAC step pulse has a long rise time

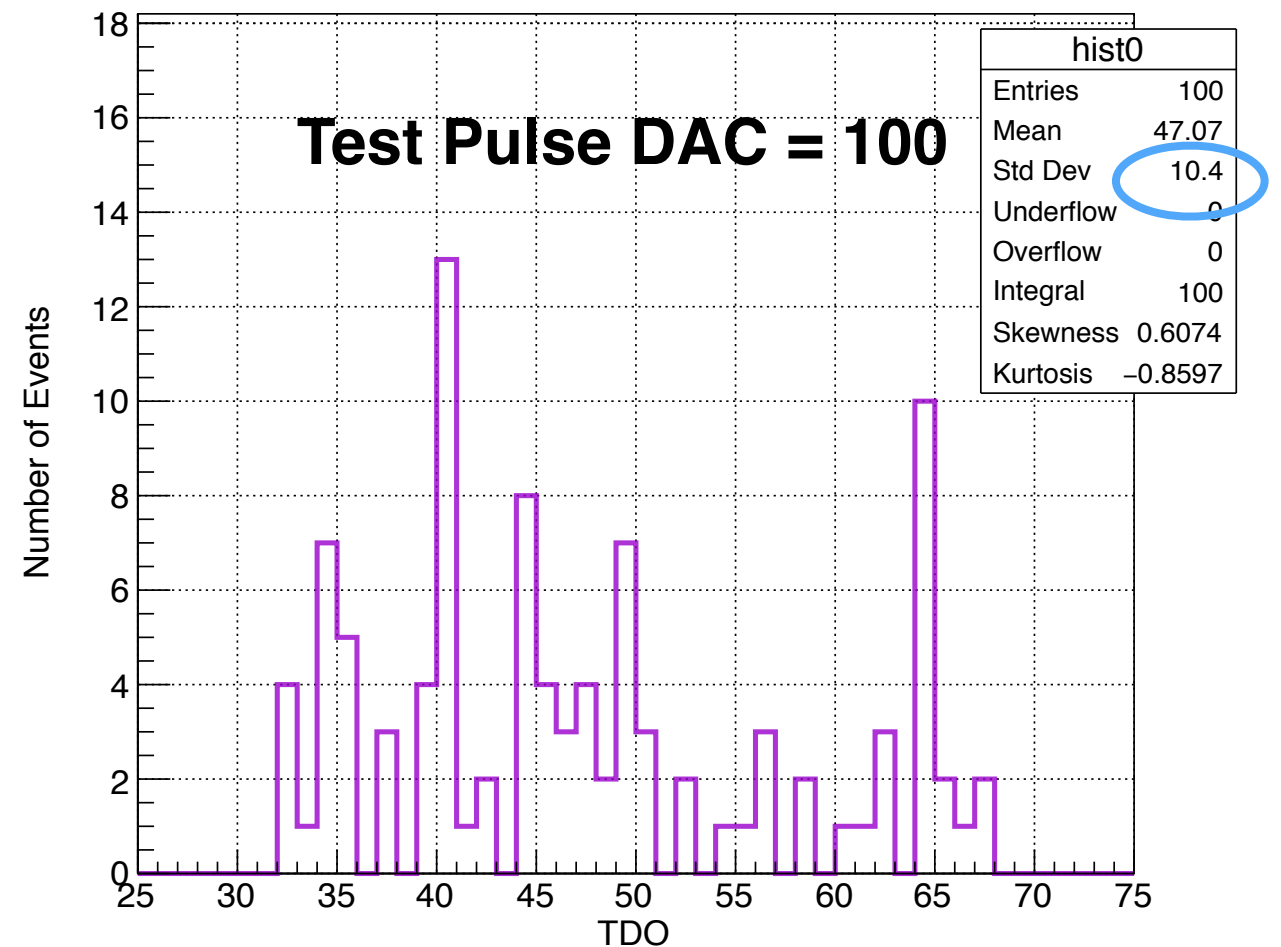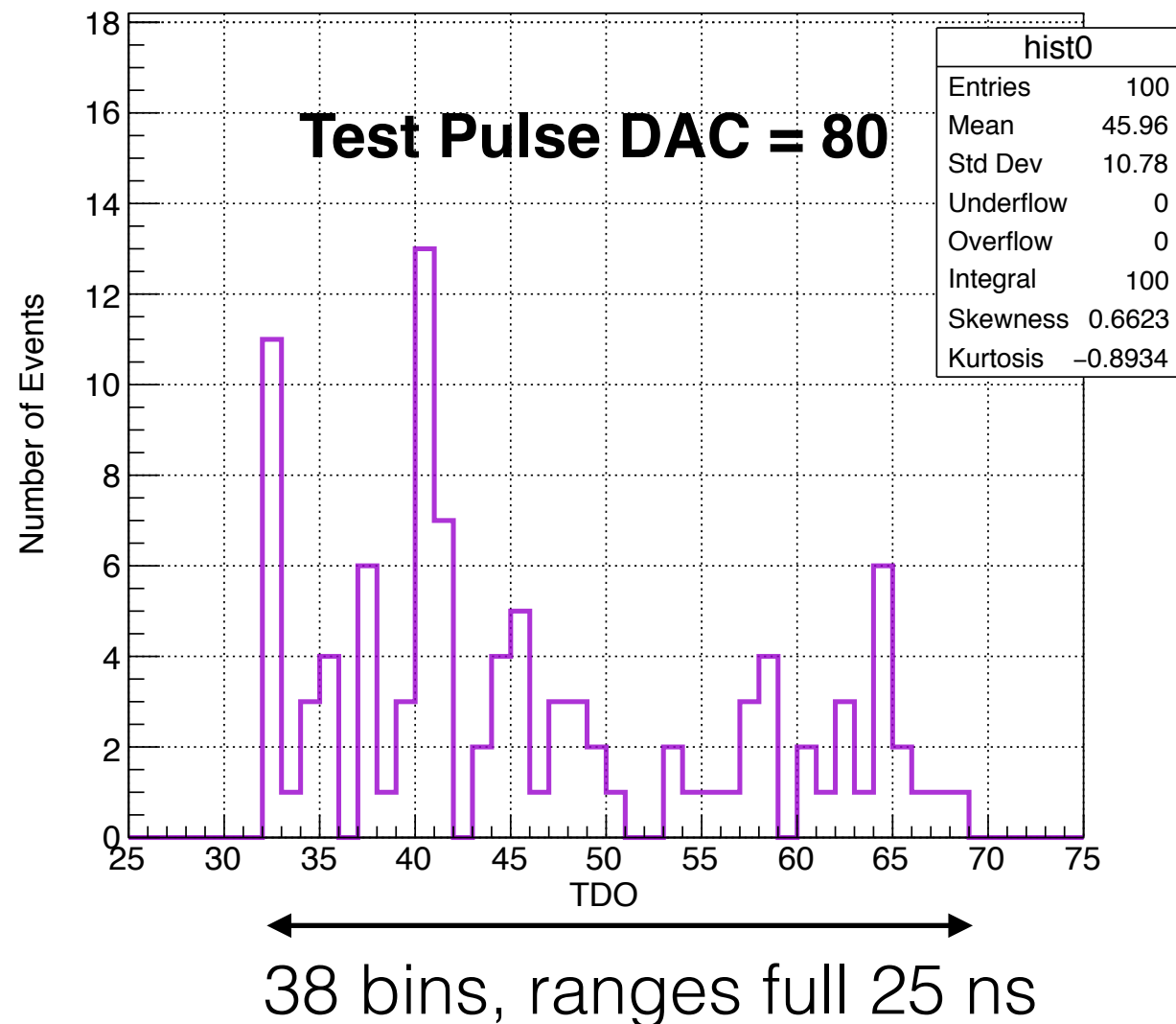# Backup

VMM 7, Ch 14, overlaid distributions

VMM 7, Ch 14, overlaid distributions

~ 0.9 V
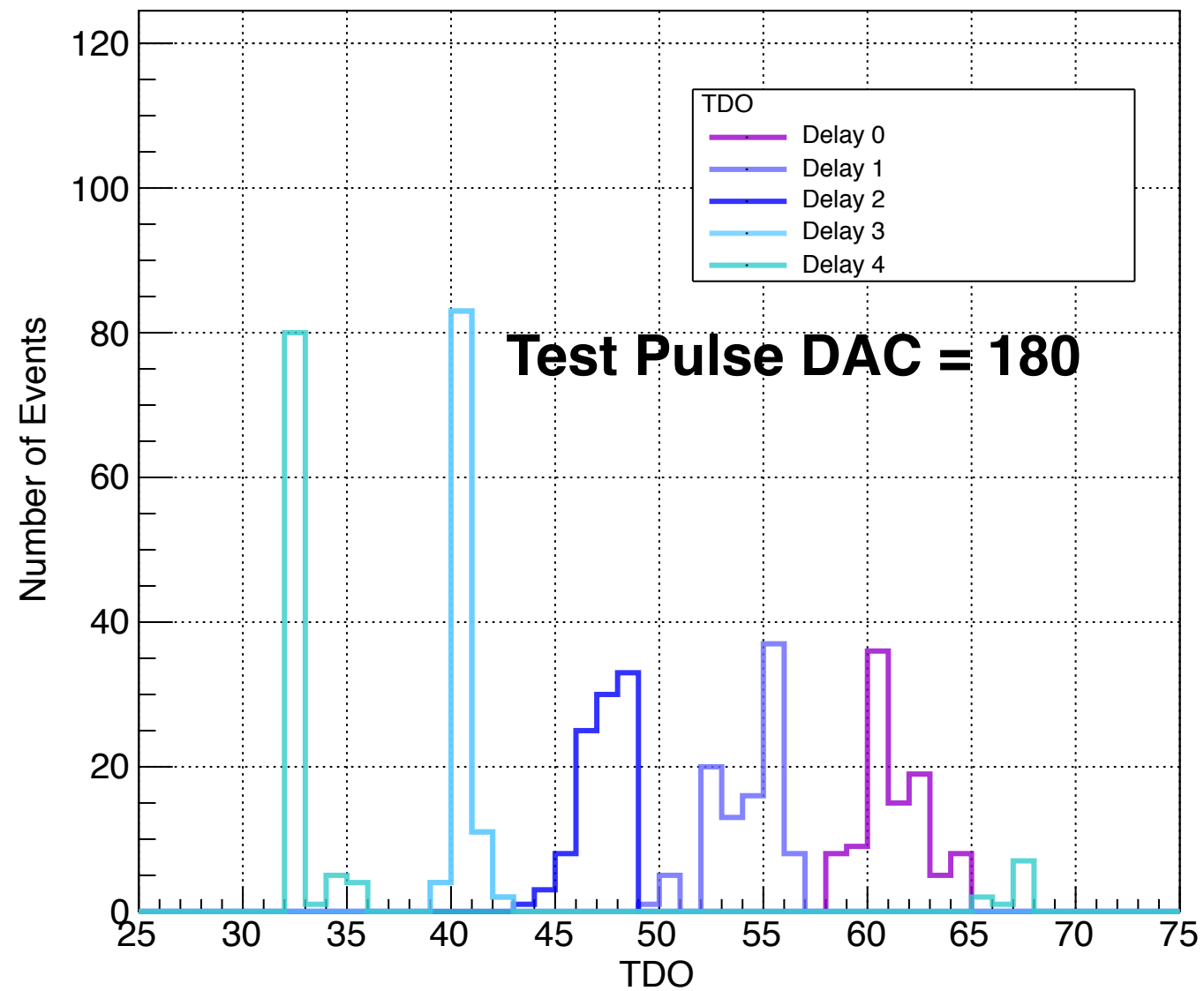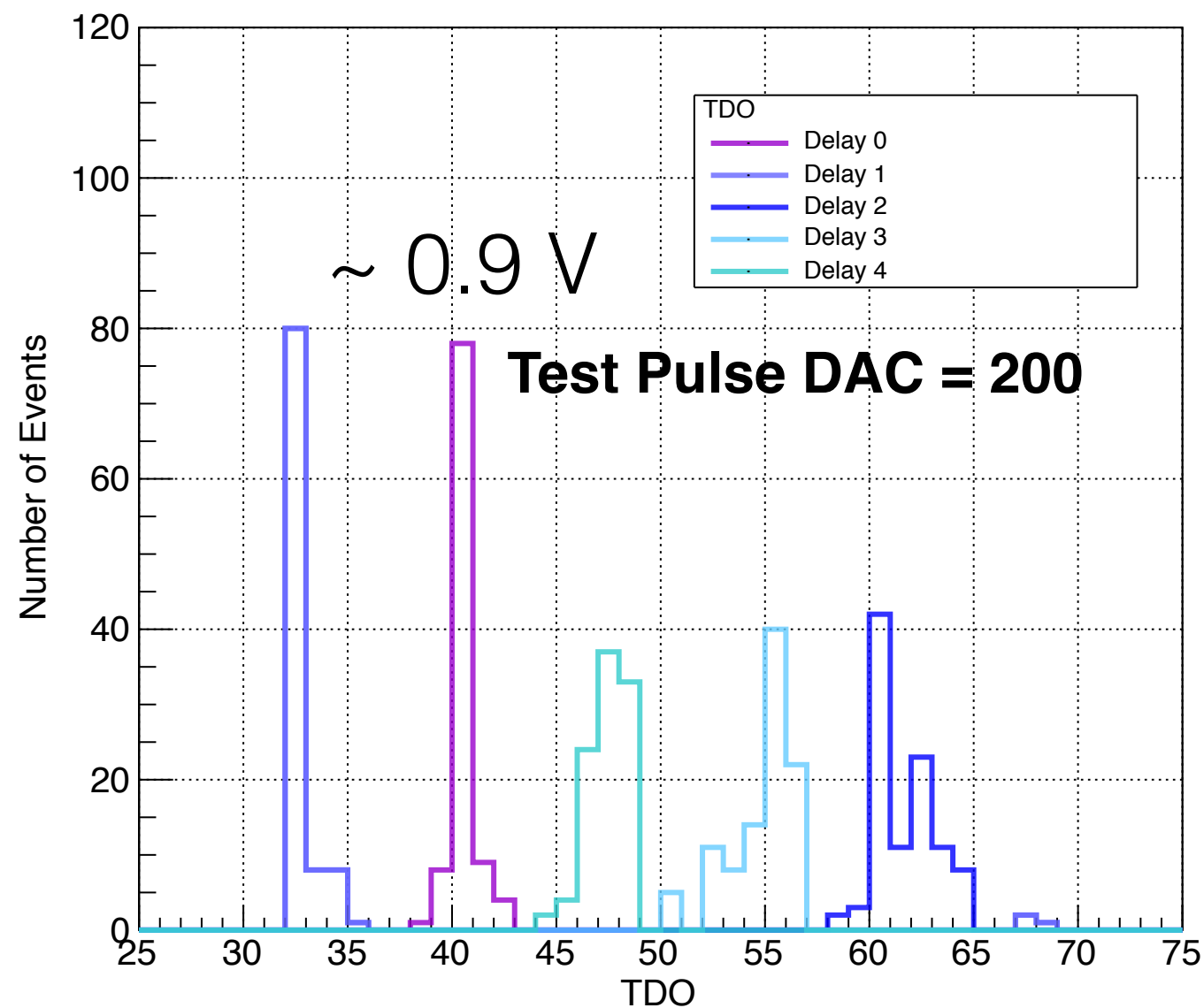
7-8 bins ~ 5 ns

Test Pulse DAC = 200

Distributions have become much narrower

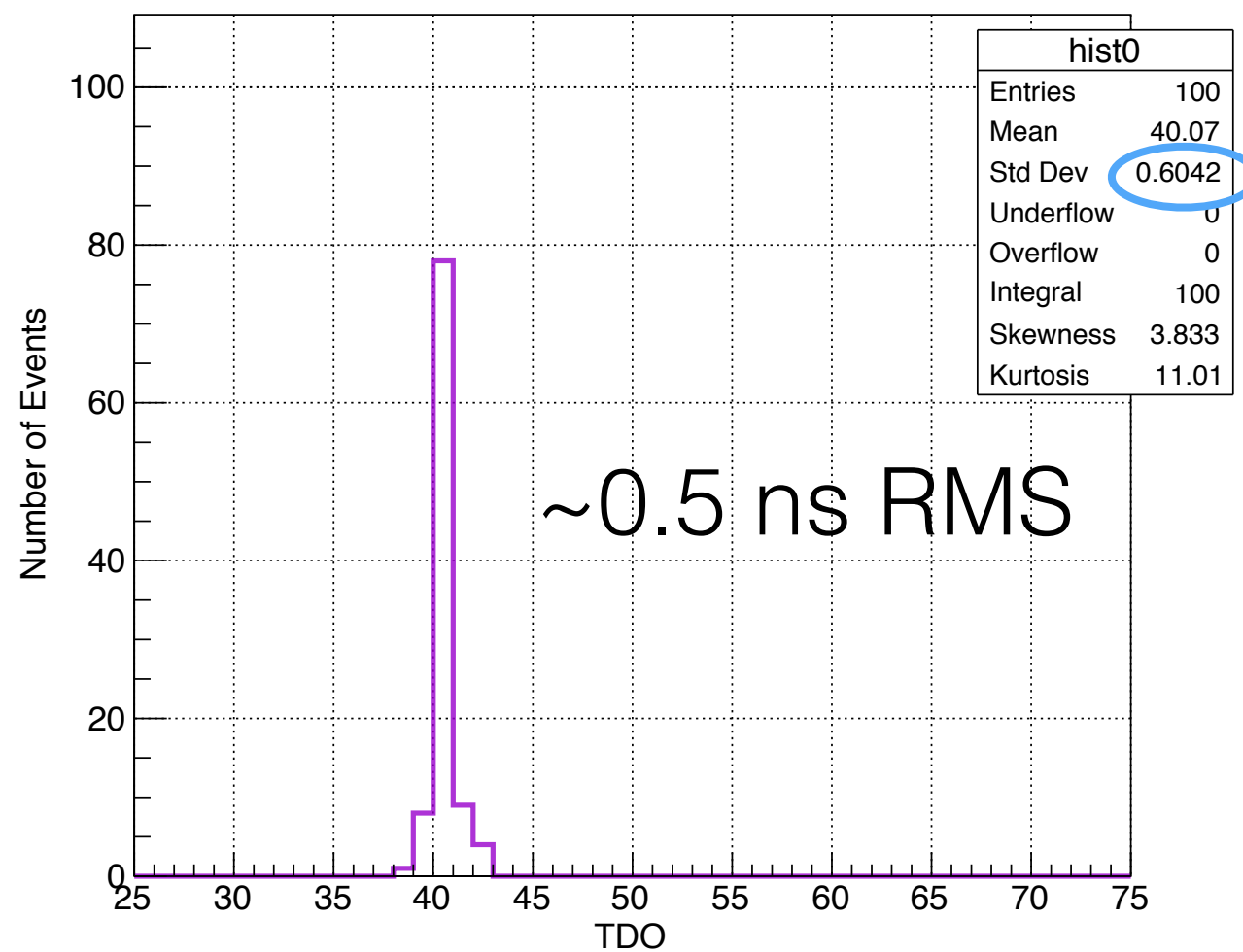# VMM 7, Ch 14, TDO distributions

- All of data is from one synchronization point with respect to CKBC
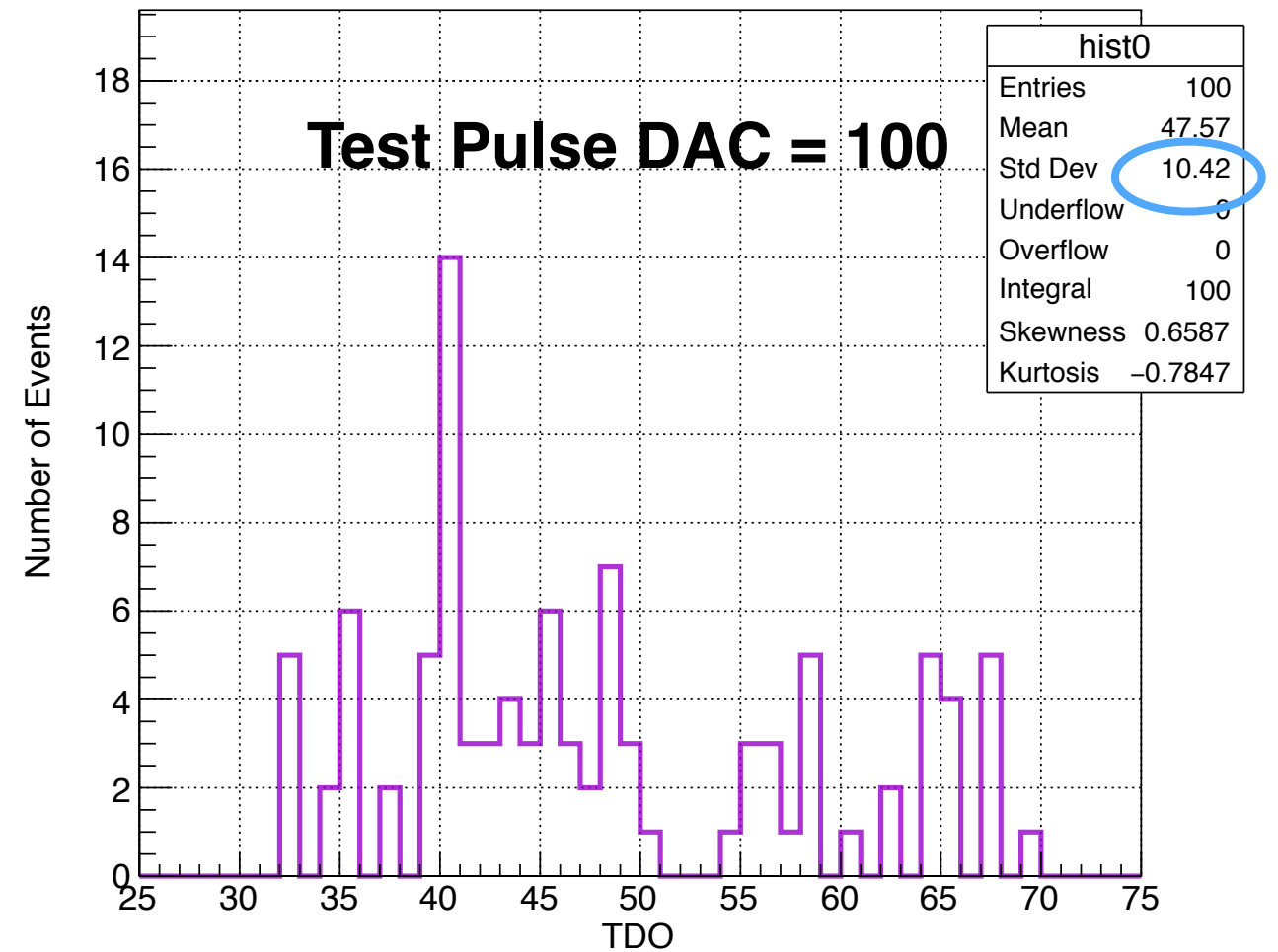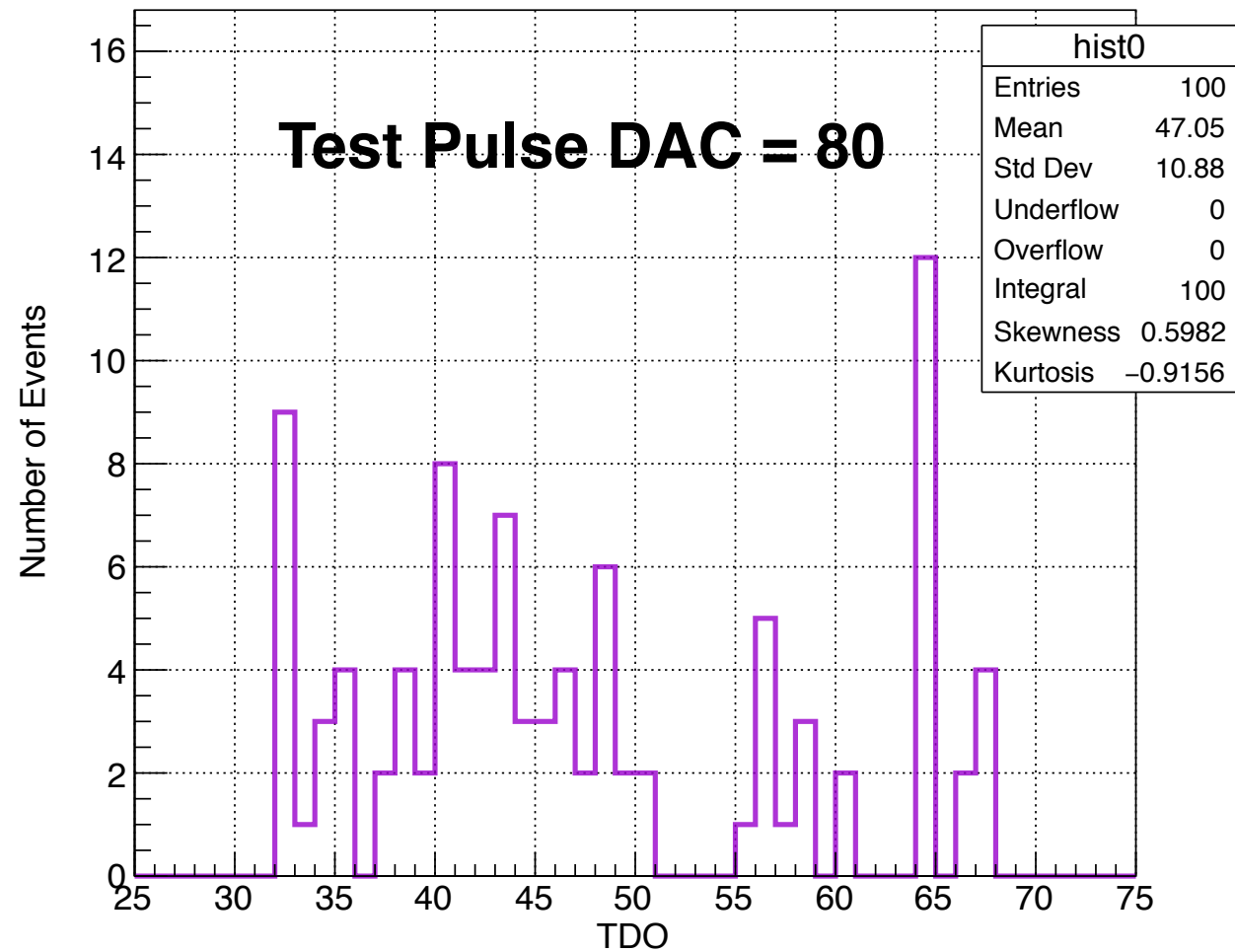
VMM 7, Ch 14
TDO distributions

Test Pulse DAC = 200

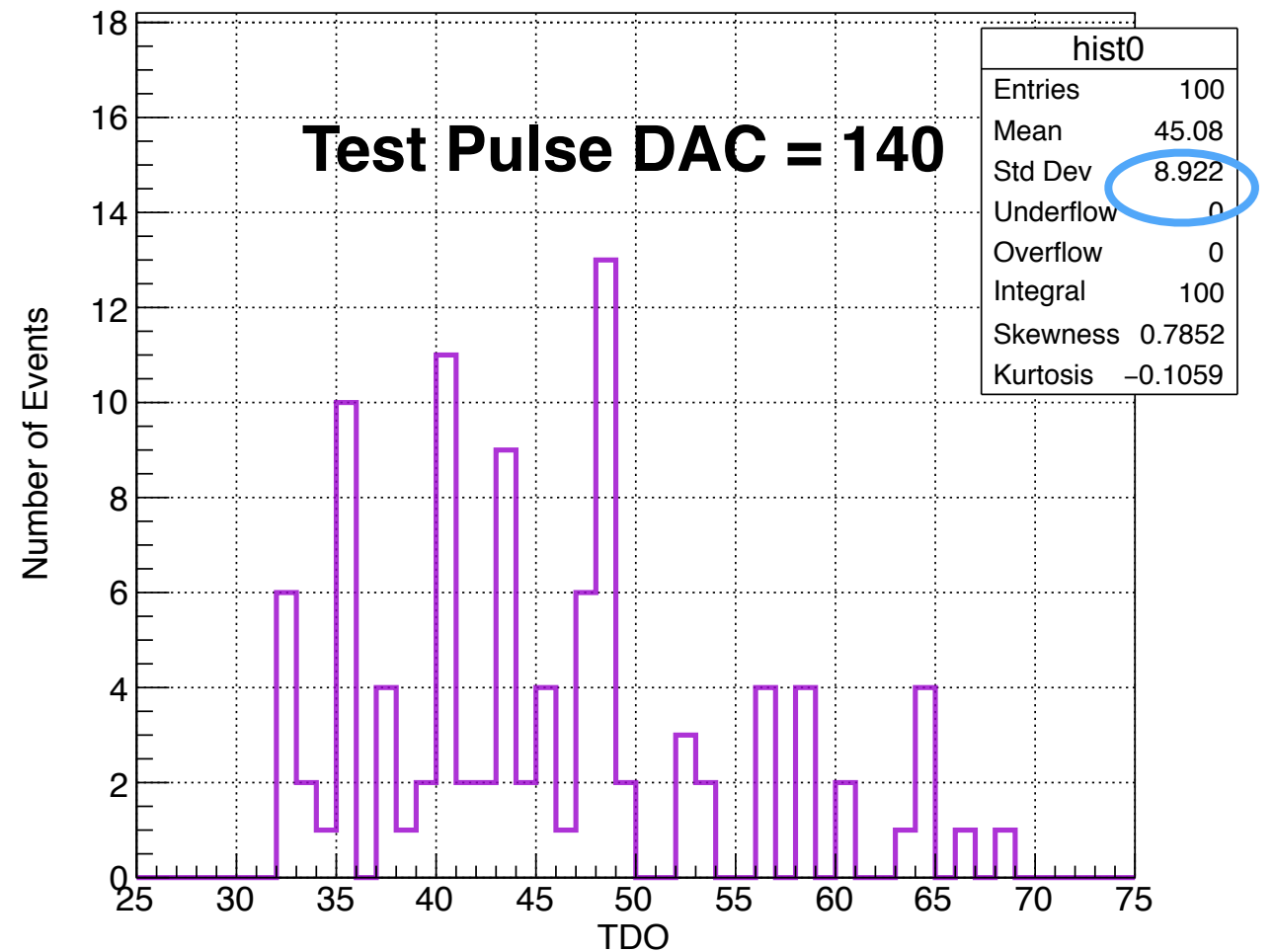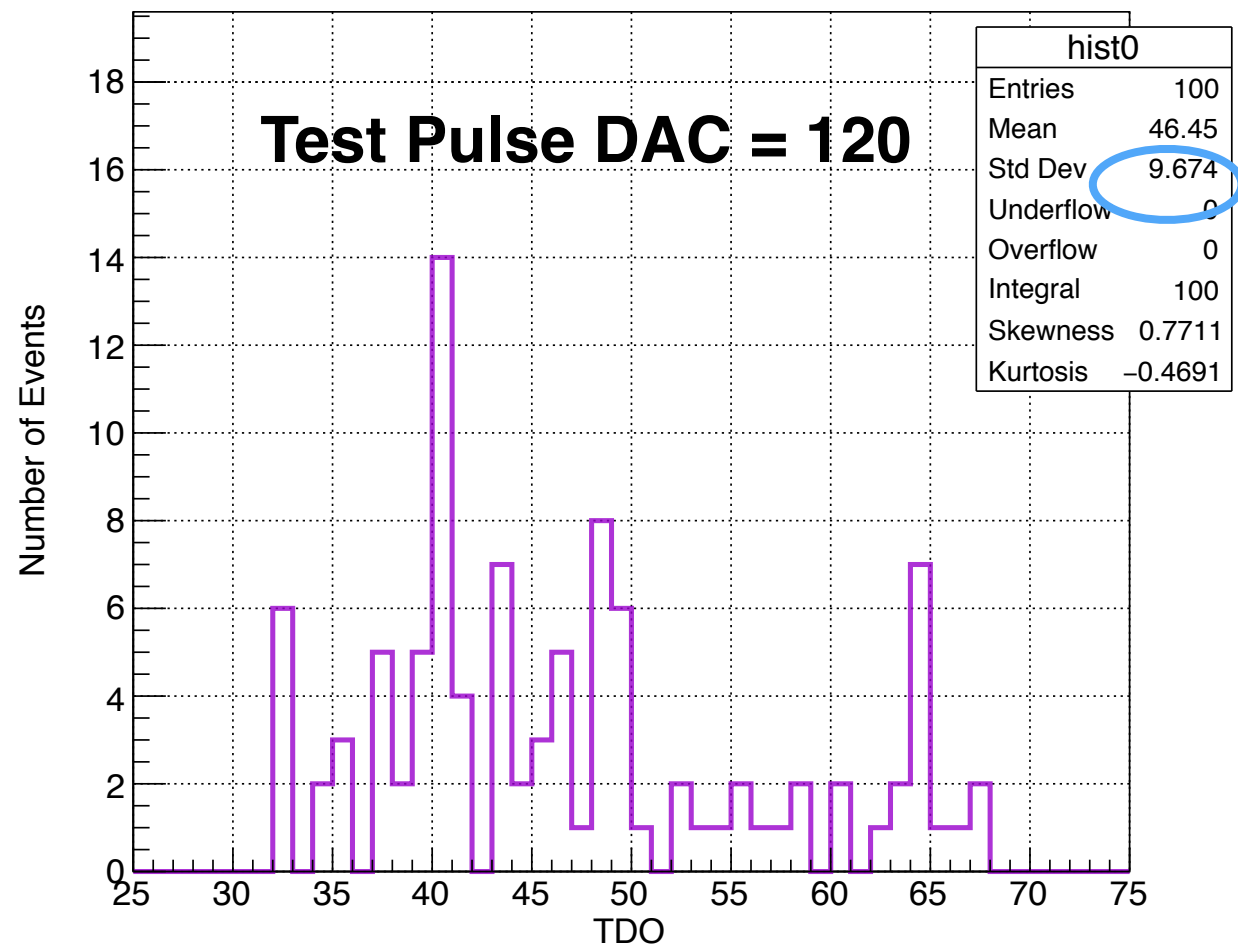| hist0	
Entries	100
Mean	40.07
Std Dev	0.6042
Underflow	0
Overflow	0
Integral	100
Skewness	3.833
Kurtosis	11.01

~0.5 ns RMS

With some reduced noise (disconnected logic probes)

VMM 7, Ch 14, TDO distributions

VMM 7, Ch 14, TDO distributions

Test Pulse DAC = 120

hist0	
Entries	100
Mean	46.45
Std Dev	9.674
Underflow	0
Overflow	0
Integral	100
Skewness	0.7711
Kurtosis	−0.4691

Test Pulse DAC = 140

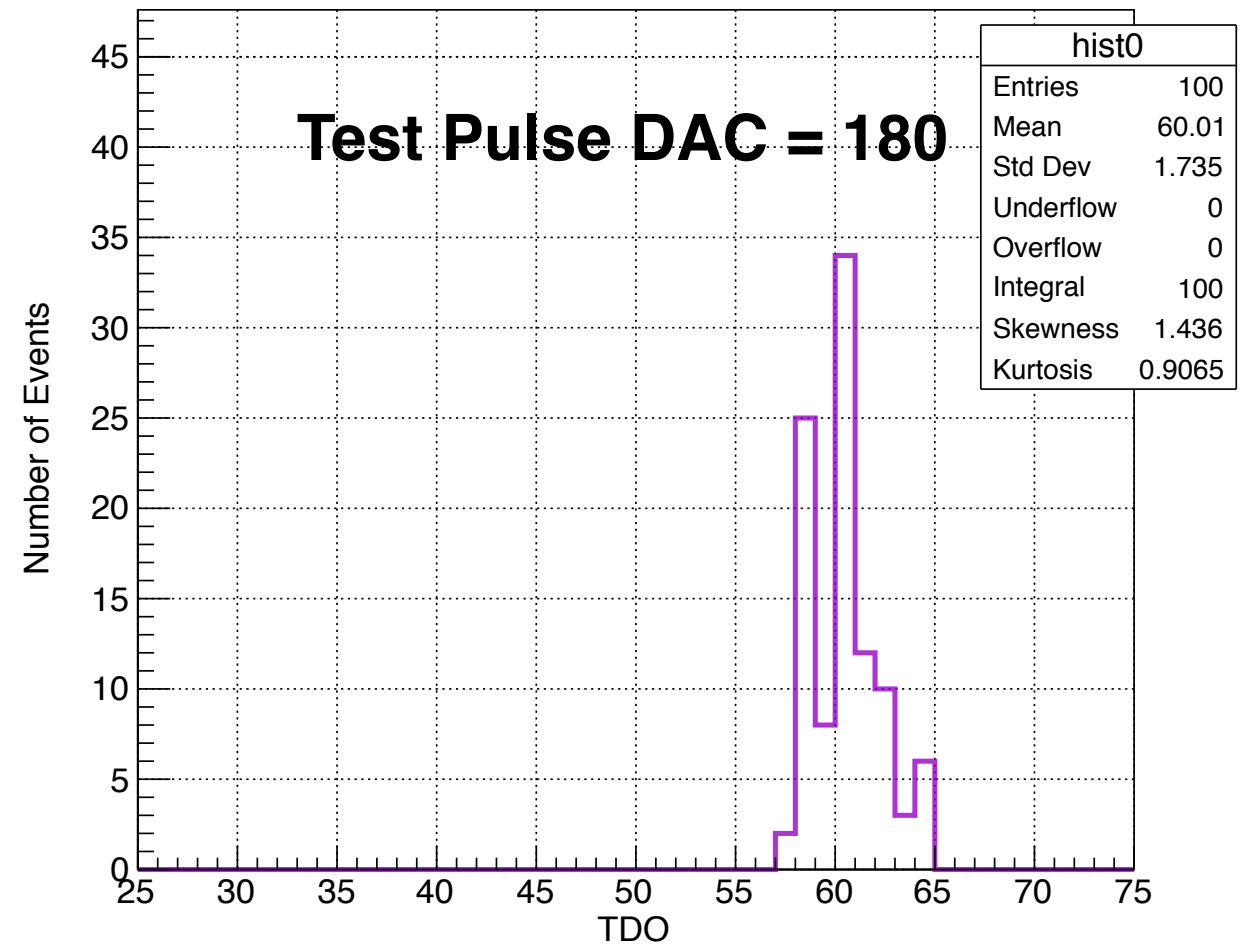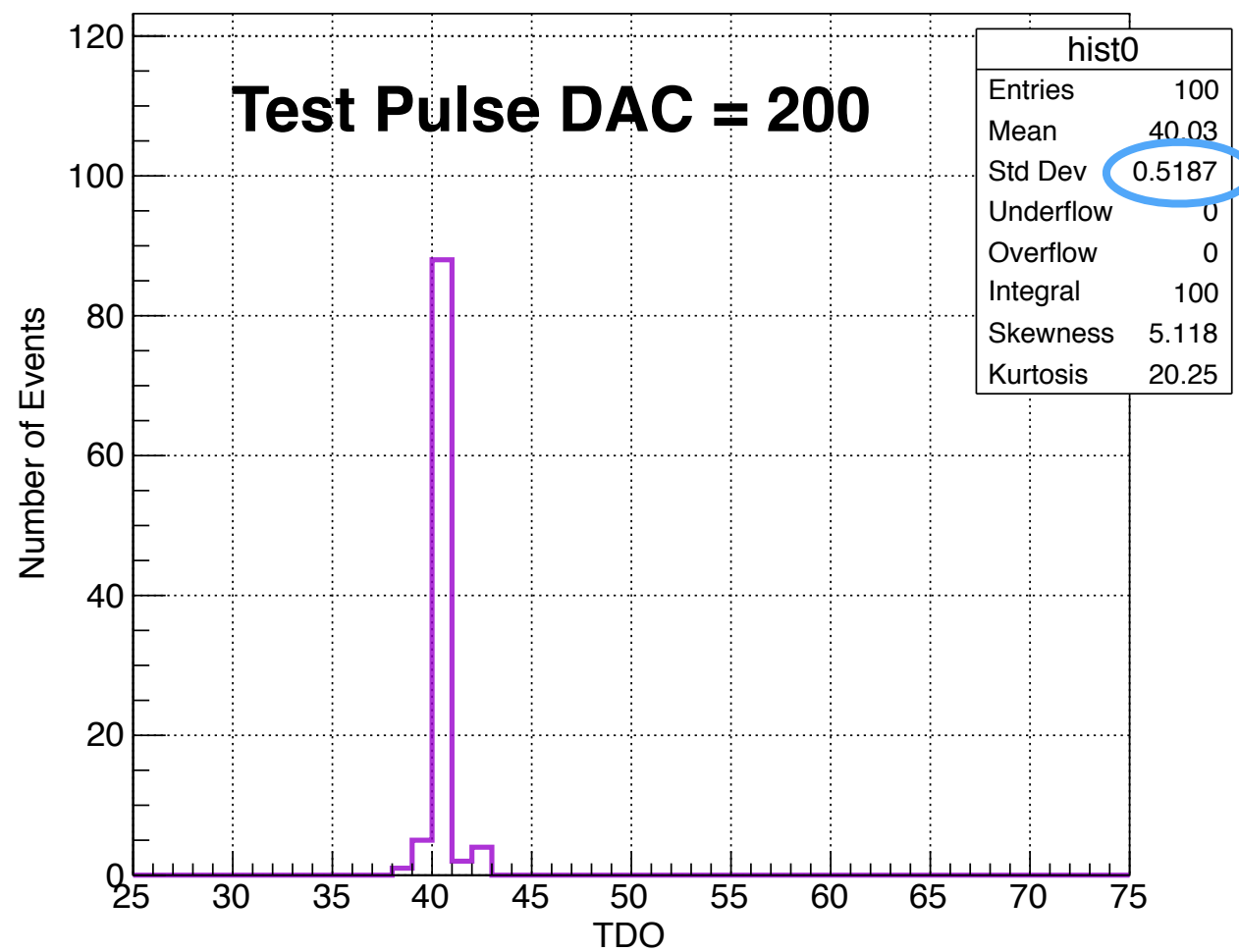| hist0	
Entries	100
Mean	45.08
Std Dev	8.922
Underflow	0
Overflow	0
Integral	100
Skewness	0.7852
Kurtosis	−0.1059

VMM 7, Ch 14,
TDO distributions

VMM 7, Ch 14, TDO distributions

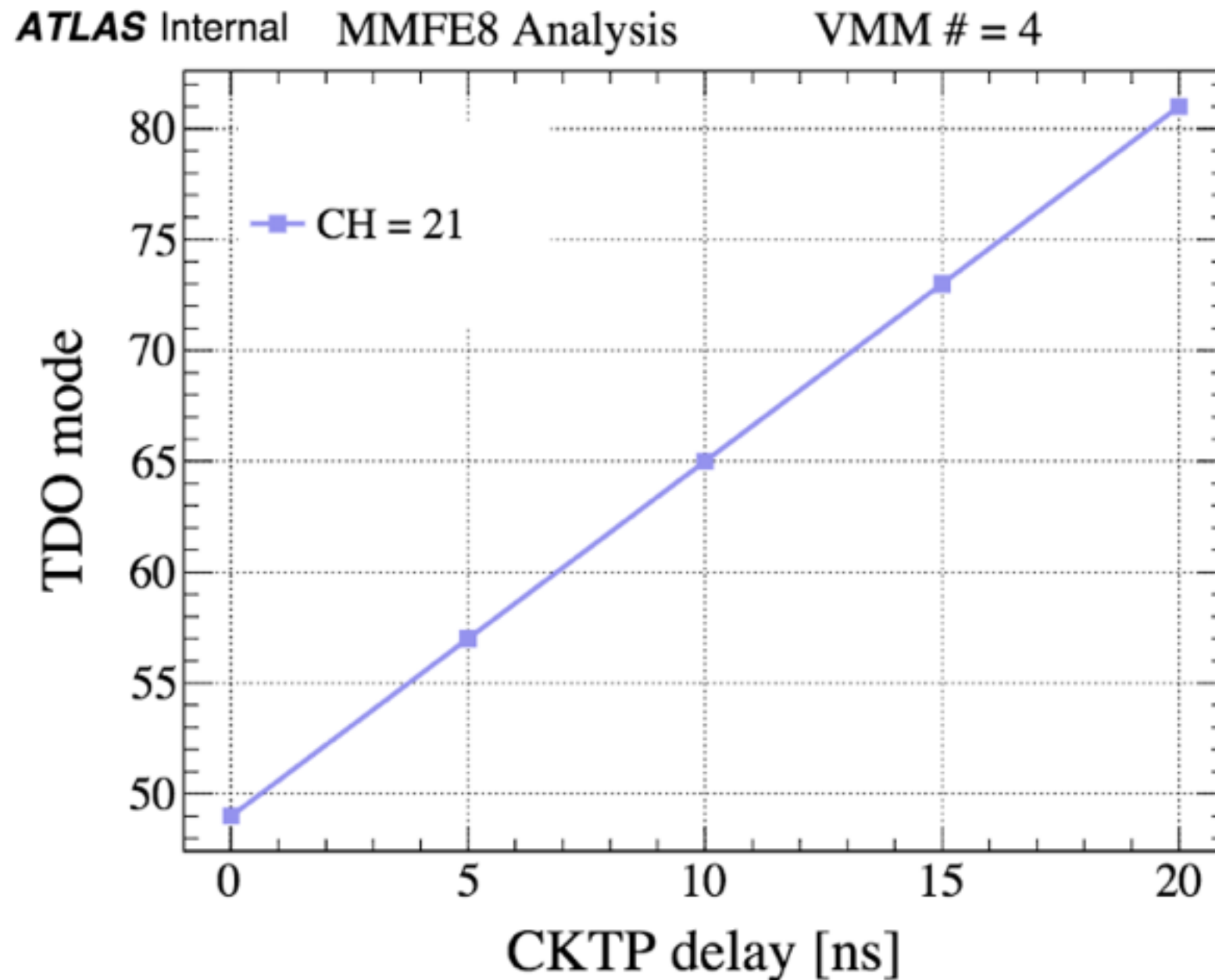**Test Pulse DAC = 200**

hist0	
Entries	100
Mean	40.03
Std Dev	0.5187
Underflow	0
Overflow	0
Integral	100
Skewness	5.118
Kurtosis	20.25
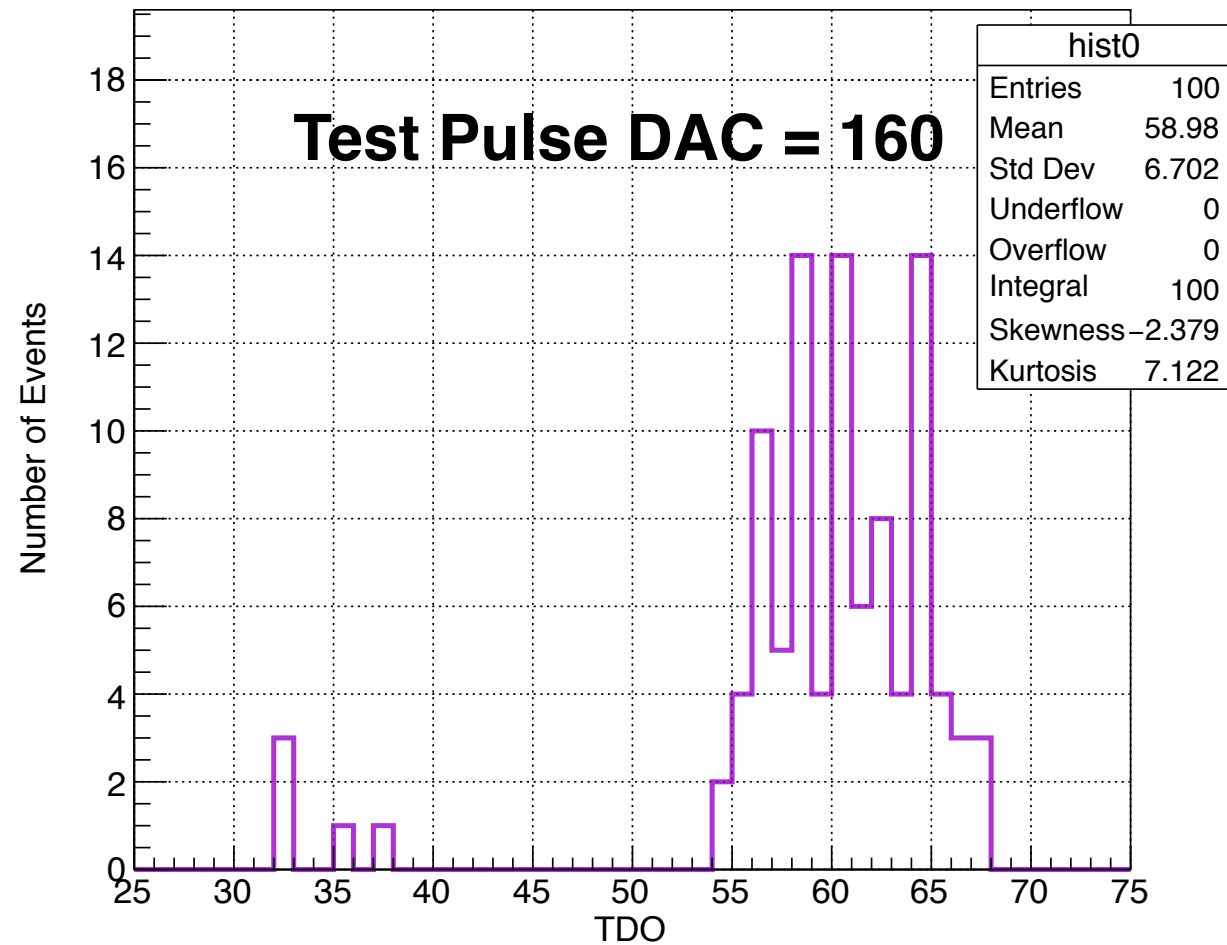
Rough calibration plot

Talk by C. Rogan: https://indico.cern.ch/event/512405/