

DetSim Status

DUNE FD simulation and reconstruction

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Introduction

The DetSim module was restructured last fall

- Converts SimChannels from GEANT to simulated raw TPC data
- Intent to replace separate 35-ton and FD modules with one module
- New module SimWireDUNE has been in place for many months
 - Most of the code is moved into services (more below)
 - Code copied from the old SimWireDUNE35t module
 - Checks done at that time to verify results from the old and new modules were nearly identical
 - Minor defect in old module was not reproduced
- New code follow the TSI (Tool-Service-Interface) model
 - Algorithmic code resides in art services
 - Services typically inherit a service interface that declares all methods
 - Or at least those that are public and intended for normal use
 - Clients (such as SimWireDUNE) find the service via the interface name
 - So that alternate service implementations can be plugged in at run time
 - Tool is an art extension that will enable use of multiple named instances of a service or service interface

Production status

Like to start using the new DetSim module for MC production

- Has features not present in old simulation
 - 35-ton zero suppression
 - Dual-phase detector simulation
 - Many more to come, e.g. noise models
- Need to update and validate production FCL
 - Recently done for 35-ton and FD single-particle. See following.
 - <https://cdcvs.fnal.gov/redmine/issues/11777>
 - Need same for multi-particle (?) and for protoDUNE
 - I will work on these next unless there are other volunteers
- Also need update of LArSoft random number seed service
 - So services can be access seeds. At present, only modules can do this.
 - Long promised and almost delivered by Gianluca:
 - <https://cdcvs.fnal.gov/redmine/issues/11125>
 - We (I) will need to update DUNE services to use these seeds
 - <https://cdcvs.fnal.gov/redmine/issues/11695>

New DetSim Flow

The table summarizes the flow for the new DetSim module:

Action	Service interface	Module flag
Fetch SimChannel		
Convert SimChannel to signal in each channel-tick bin	SimChannelExtractService	
Add noise to each bin	ChannelNoiseService	NoiseOn
Add pedestal to each bin	PedestalAdditionService	PedestalOn
Convert float signals to integer ADC counts		
Distort ADC counts (e.g. add sticky bits)	AdcDistortionService	DistortOn
Identify suppressed channels	AdcSuppressService	SuppressOn
Apply suppression, compress and format raw data	AdcCompressService	
Write out raw data		

Production configuration for 35-ton and FD

The current configuration for 35-ton DetSim:

- Uses the new module: SimWireDUNE
- Signal extraction done with GenericSimChannelExtractService
 - Single-phase, no migration of charge to or from nominal TPC volume
- Noise is chnoiseold: ExponentialChannelNoiseService
 - This is the old noise model 1
- Pedestals added with ProvidedPedestalAdditionService
 - Makes use of DetPedestalService interface which is in turn configured to use `dune_fixedpeds`: 500 for collection and 1800 for induction
- Distortion is turned off (`DistortOn = false`), i.e. no stuck bits
- Suppression is zslegacy: the old ZS algorithm configured to +/-10 ticks around any signal above 10 ADC counts
- Compression is the standard LArSoft block format without Huffman

For alternatives, see

`dunetpc/dune/DetSim/detsimmodules_dune.fcl`

Changes for FD

New Detsim module started from 35t Detsim

- Old Detsim had a separate module for FD production
 - Largely a copy of the 35t module
- New Detsim uses the same module for both
 - Different service implementations or instances can be used where we want differences
 - Geometry of course taken from geometry service
 - » Be careful that FCL is consistent with input file (latter overrides)
 - E.g. handling of charge deposited outside nominal wire volumes
 - » at present ignored for both
 - » But there is a service for 35t that can be enabled in FCL
 - » Does FD have code we want to move from old module to a new service?
 - Merged 35t and 10kt signal shaping services
 - New Detsim seems OK for FD production
 - See following slides
 - More validation encouraged
 - A few issues to resolve

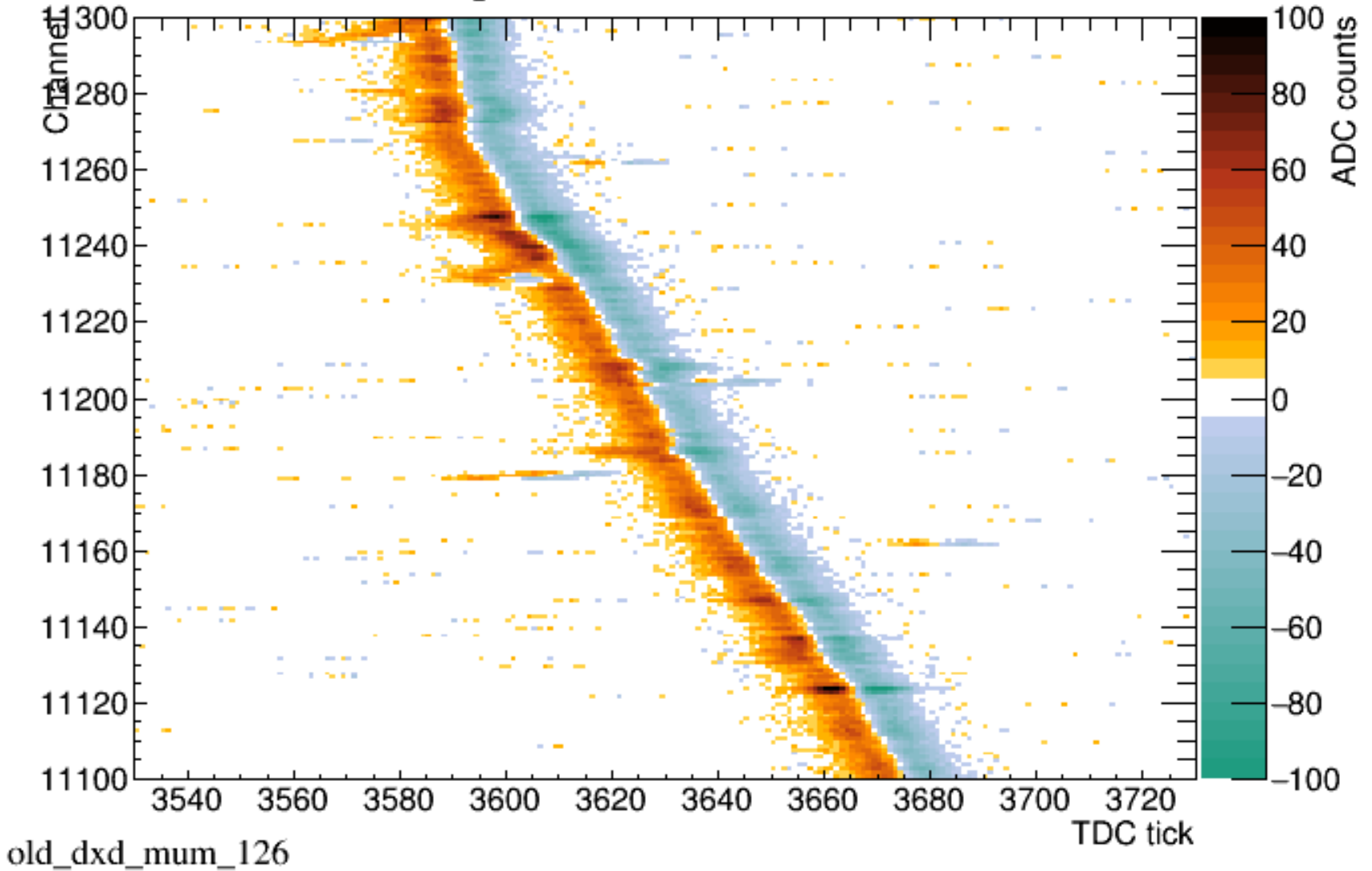
New results

Following slides compare old and new modules

- Show the same tiny channel-tick window for one event
- Old module has higher noise
 - See plots with ZS turned off
 - Presumably due to max-tick-dependence in noise algorithm
 - RMS is 3.5 ADC counts for old, 2.5 for new
- Otherwise the new and old are very similar
 - Expect changes from different random number seeds
- Result also shown for the 35-ton ZS algorithm
 - Keeps more noise on either side of the signal

Old 1x2x6 Detsim

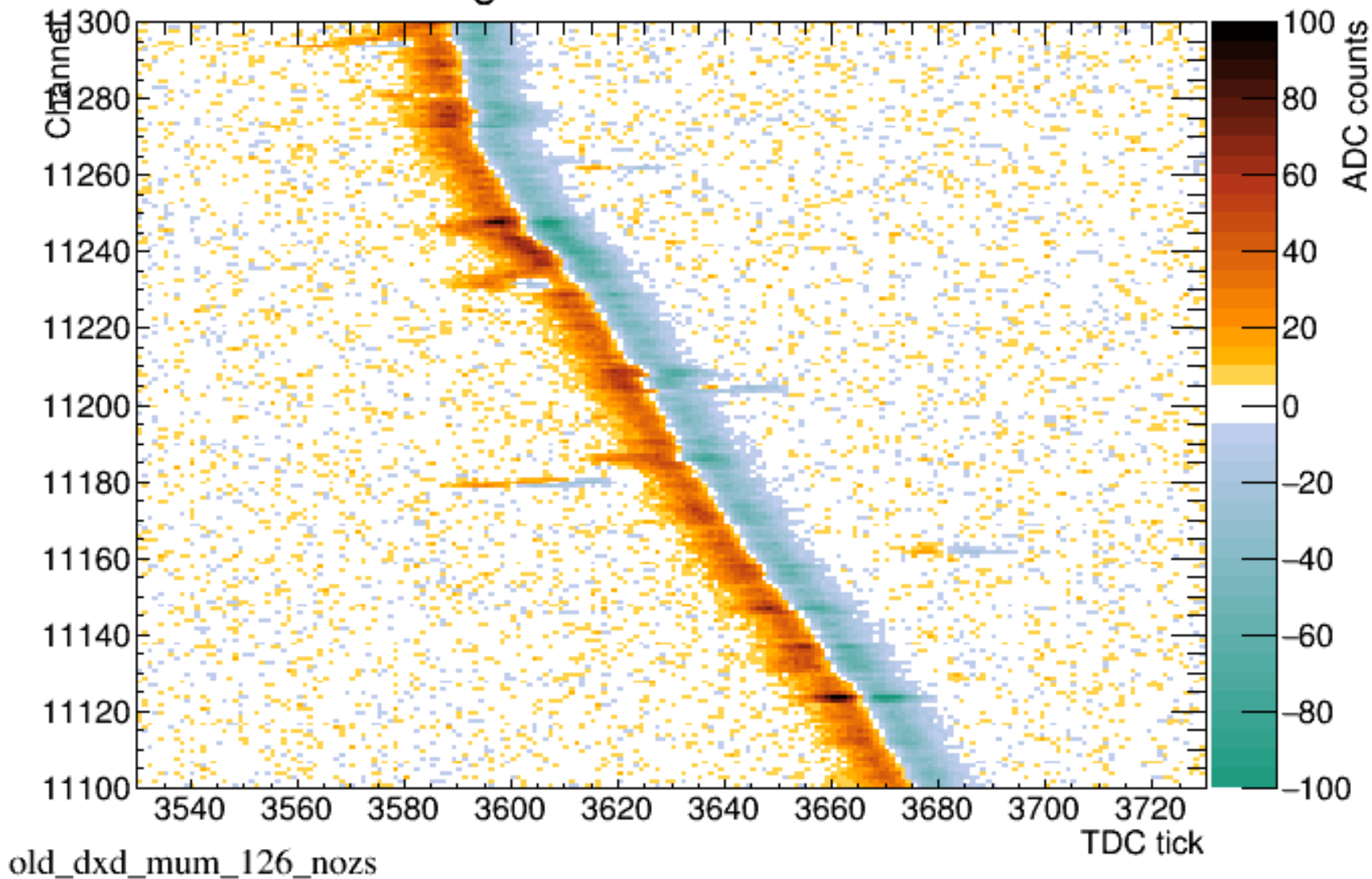
Raw signals for full detector event 4



old_dxd_mum_126

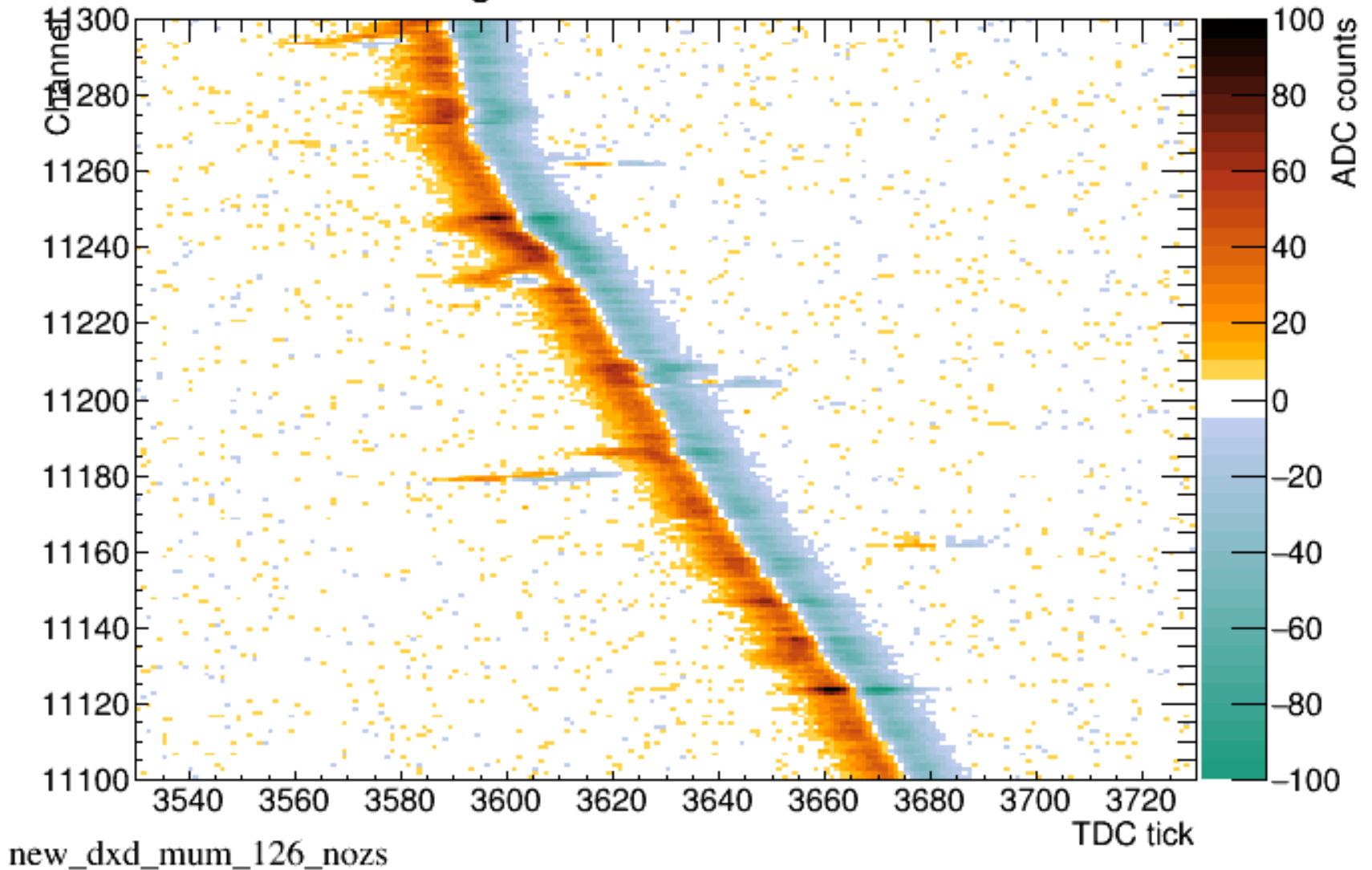
Old 1x2x6 Detsim w/o ZS

Raw signals for full detector event 4



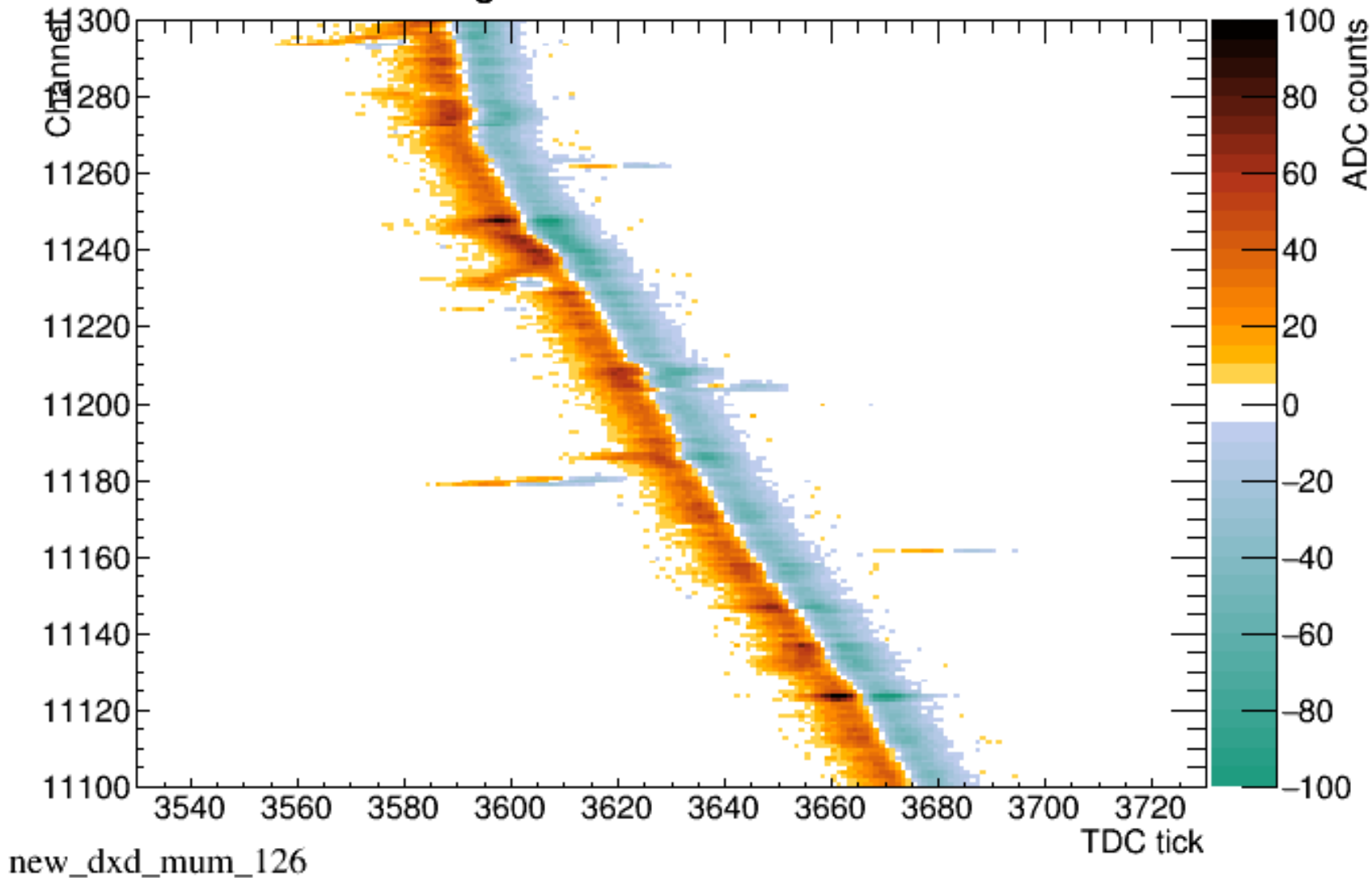
New 1x2x6 Detsim w/o ZS

Raw signals for full detector event 4



New 1x2x6 Detsim w/ legacy ZS (default)

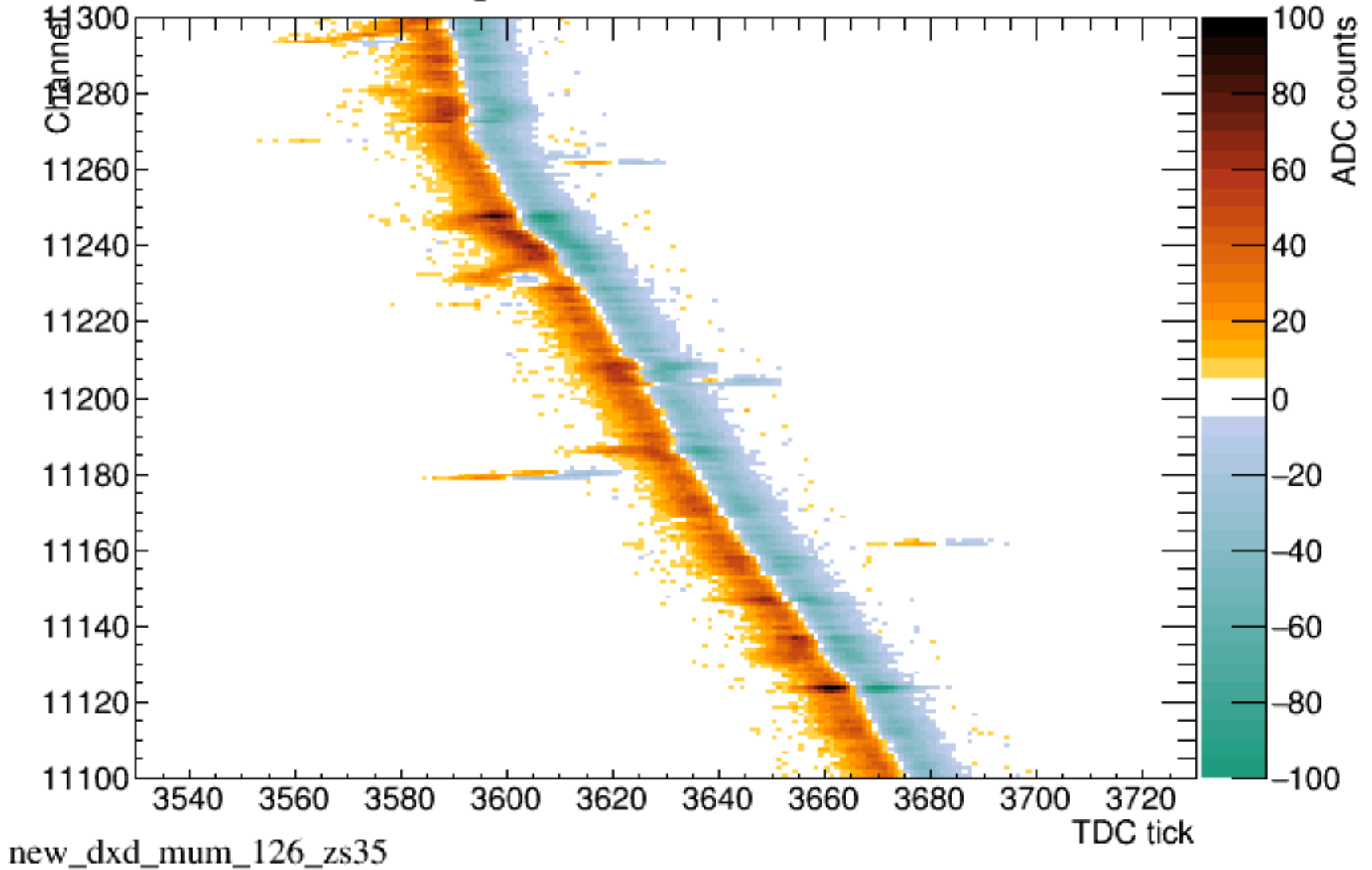
Raw signals for full detector event 4



new_dxd_mum_126

New 1x2x6 Detsim w/ online ZS

Raw signals for full detector event 4



new_dxd_mum_126_zs35

Event sizes

Table gives the event sizes

- Averaging over 10 events (input is 0.7 MB/event, Root comp=1)
- ZS = zero suppression
- HC = Huffman compression

Detsim	ZS	HC	Event size [MB]
Old	none	off	110.2
	legacy	off	10.1
New	none	off	88.7
		on	96.8
	legacy	off	1.2
		on	1.2
	online	off	1.1

Production configuration

Some issues for production configuration

- Which ZS (zero suppression) do we want?
 - None, legacy or online
- Do we want Huffman compression?
 - Not now—it is making events bigger
- Anything else?

Conclusions

New DetSim is almost ready for FD single-particle production

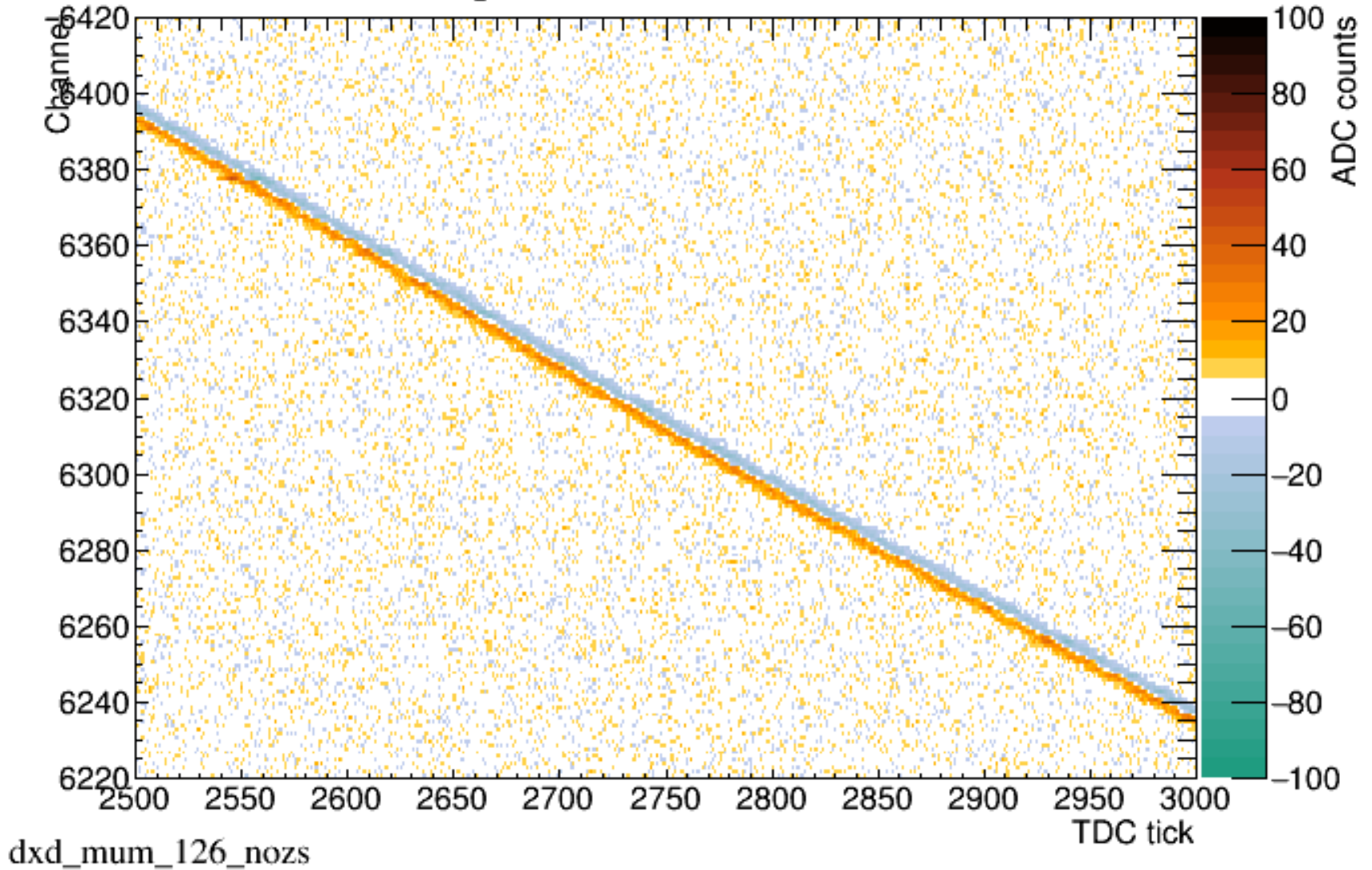
- Need update for random number seed service
 - We have been waiting many months for this
- Then we need to update DUNE code to use this service
- Decision on the configuration we want to use for production
- Validate protoDUNE
- Nice to do some additional checks
 - 3-mm and 45-deg geometries
 - Reconstruction following the new Detsim
 - And more?

Extras

Plots for old workspace detector

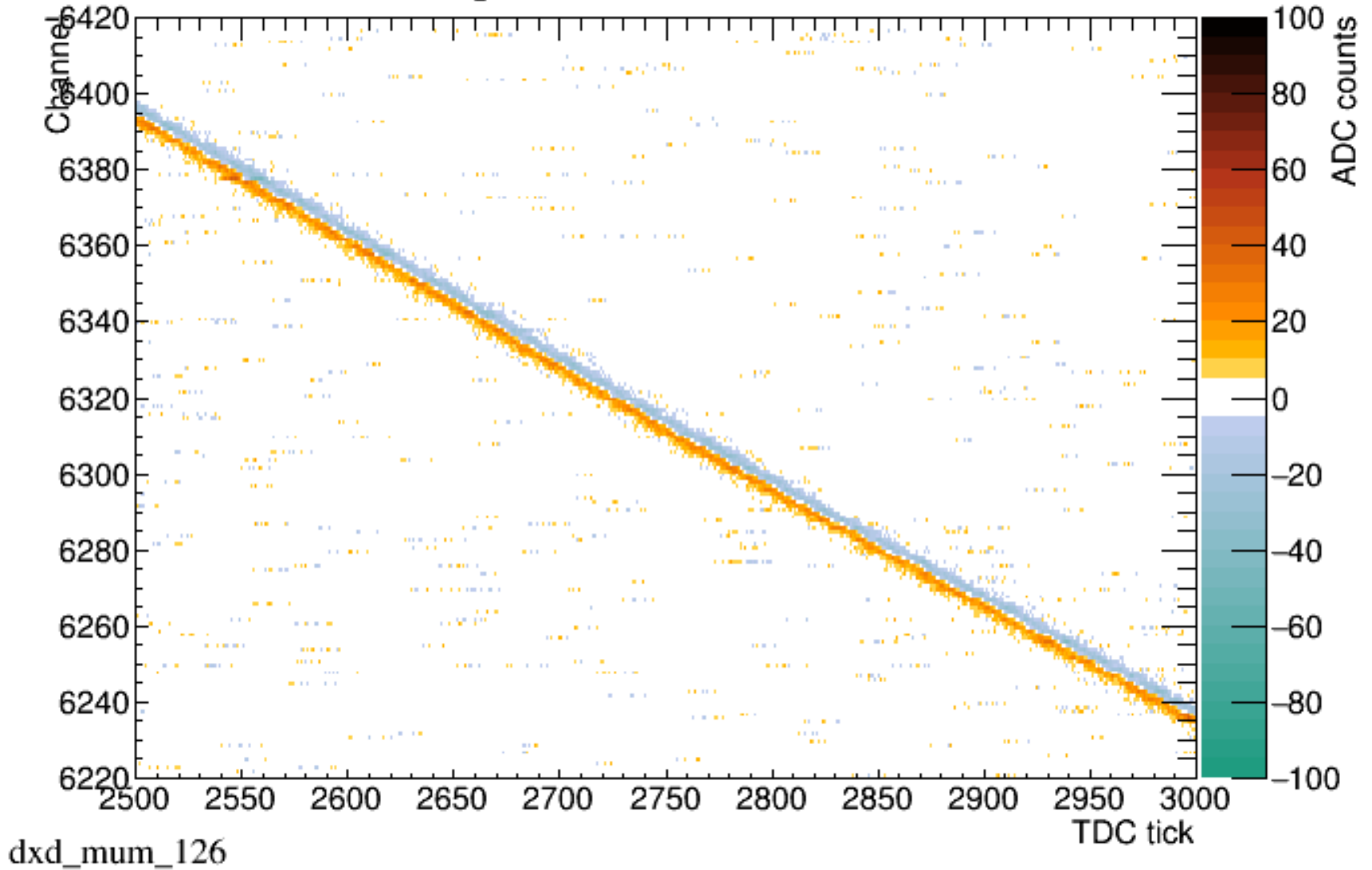
Old FD Detsim w/o ZS

Raw signals for full detector event 4



Old FD Detsim

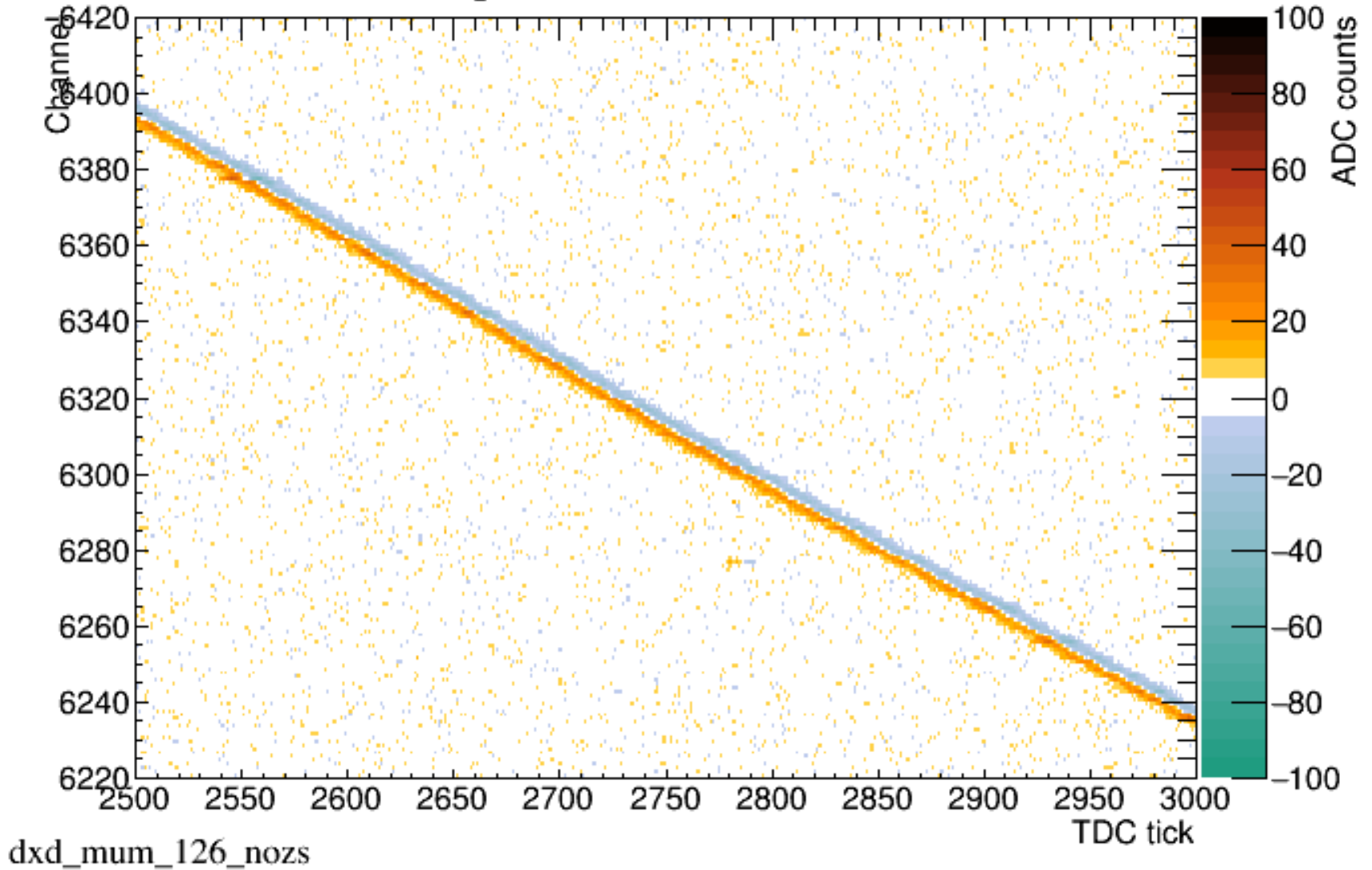
Raw signals for full detector event 4



dxd_mum_126

New FD Detsim w/o ZS

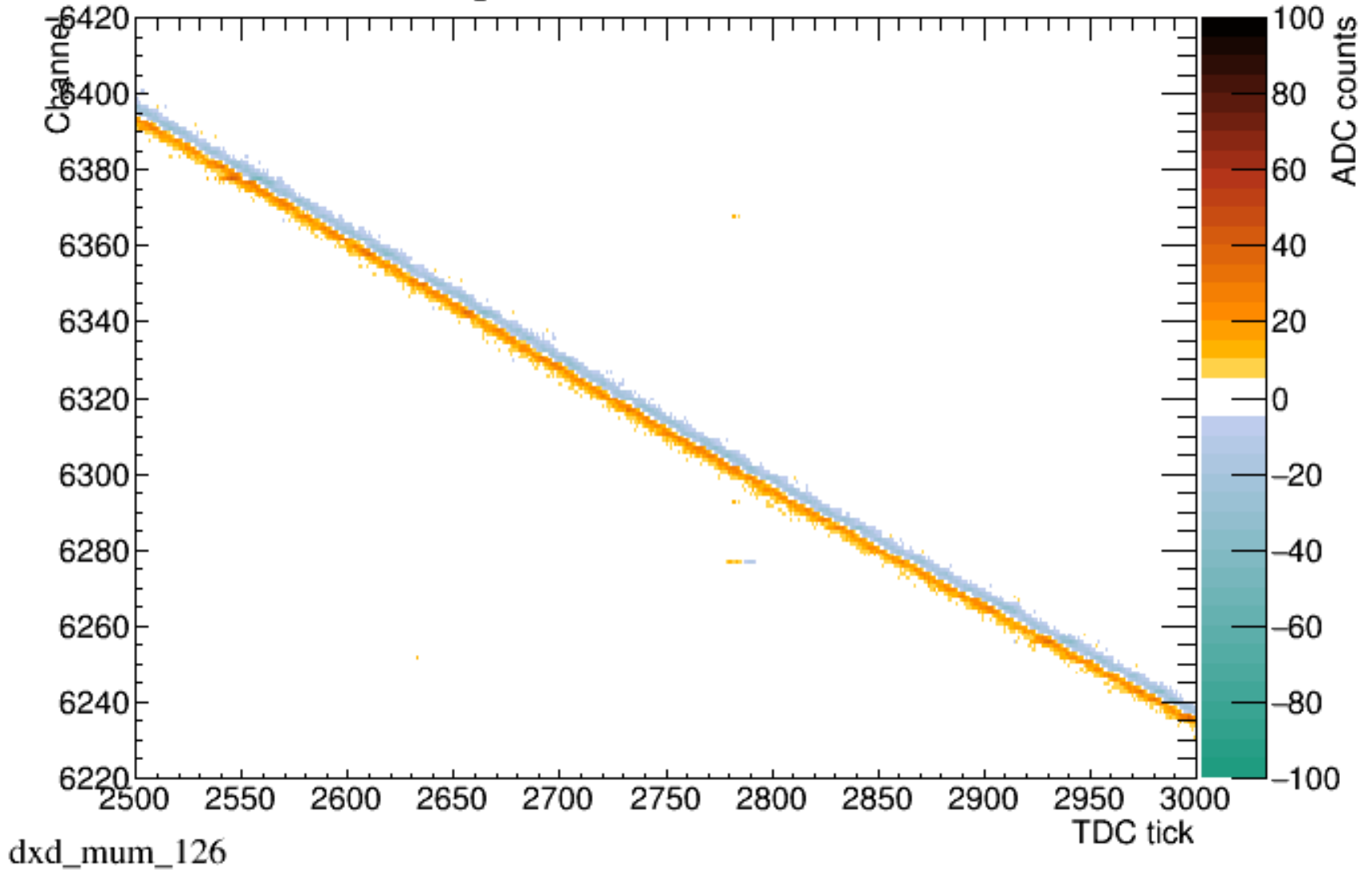
Raw signals for full detector event 4



dxd_mum_126_nozs

New FD Detsim w/ legacy ZS (default)

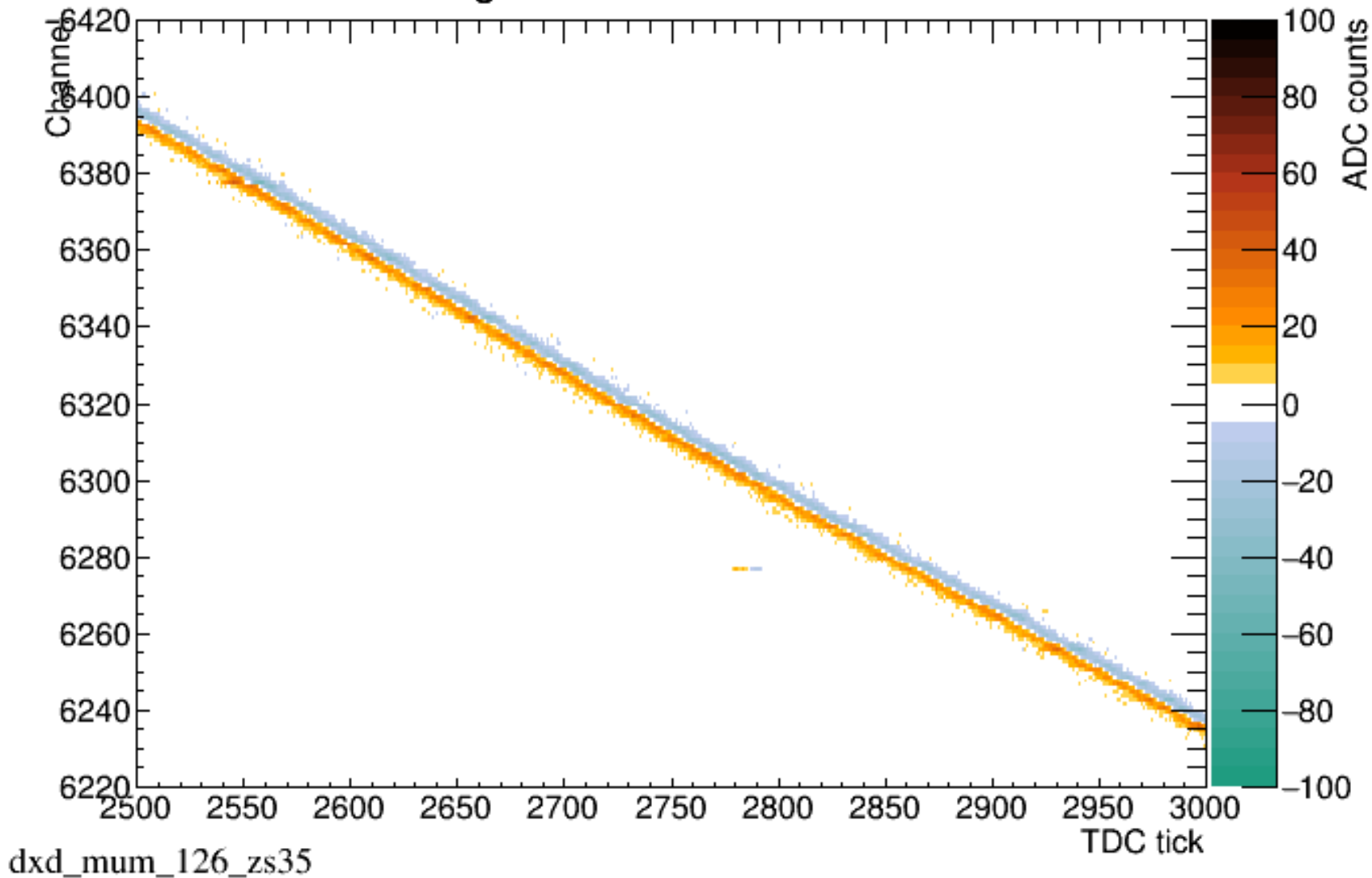
Raw signals for full detector event 4



dxd_mum_126

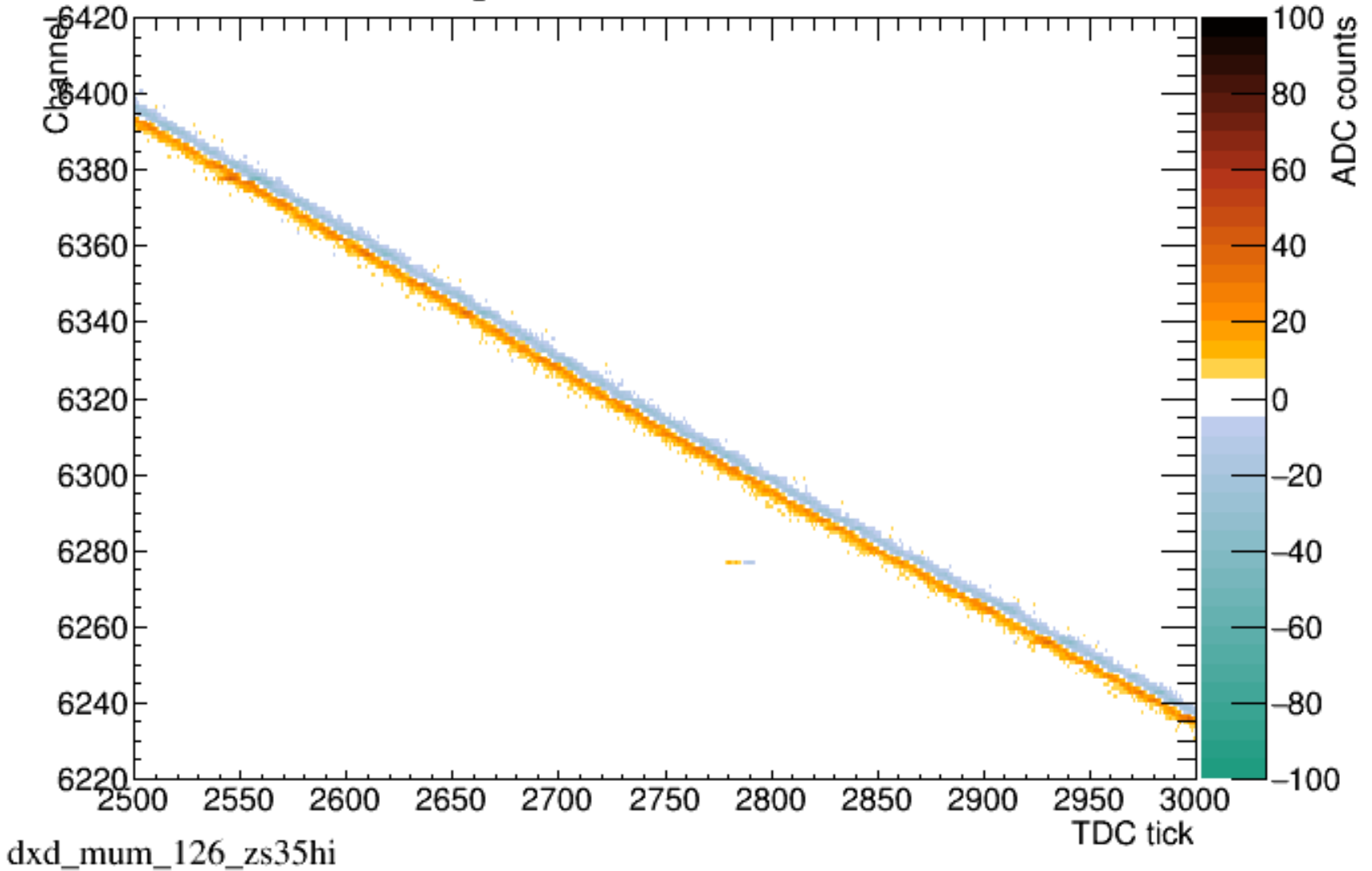
New FD Detsim w/ online ZS

Raw signals for full detector event 4



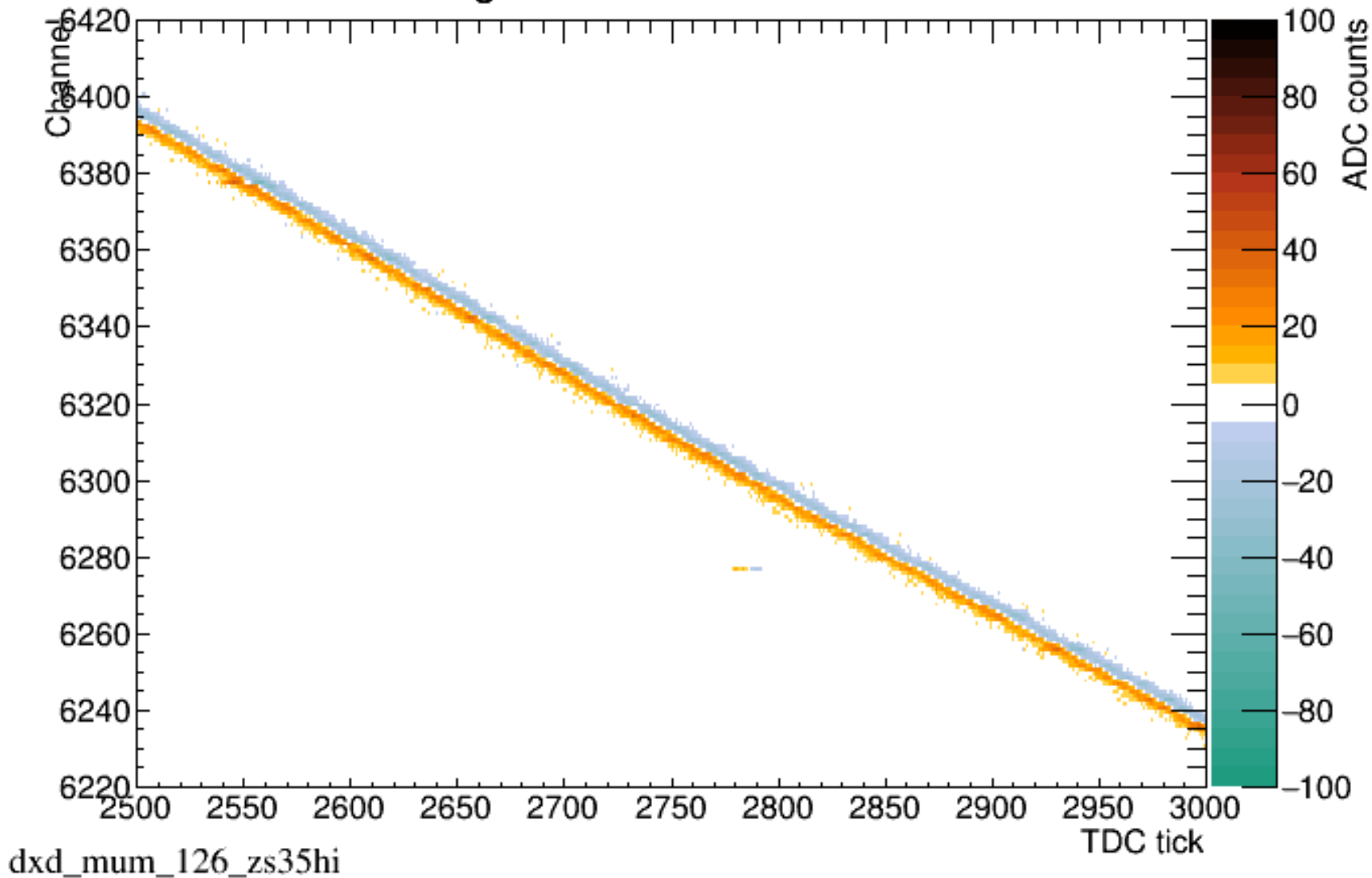
New FD Detsim w/ high-threshold online ZS

Raw signals for full detector event 4



New FD Detsim w/ high-threshold online ZS

Raw signals for full detector event 4



dxd_mum_126_zs35hi