Wire-Cell configuration summary

`physics.producers.tpcrawdecoder`

`multi-sim-4.fcl`
`wcls-sim-drift-simchannel-nf-sp.jsonnet`
job types: Simulation, Signal processing

2026-10-27 08:48

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1 Job

This document summarizes the Wire-Cell Toolkit (WCT) configuration produced by compiling a Jsonnet file with the external variables given by a WCLS FHiCL configuration. All quantities are given in WCT system of units (mm, ns, MeV, e^+) followed, where known, by a conversion to more common units.

1.1 FHiCL source

Table 1: WCLS configuration table found in FHiCL.

Parameter	Value	Source
FHiCL file	`/home/bviren/dune/xerosere/multi-sim-4.fcl`	
WCLS table	`physics.producers.tpcrawdecoder`	FHiCL
module_type	`WireCellToolkit`	FHiCL
`wcls_main.tool_type`	`"WCLS"`	FHiCL
`wcls_main.apps`	`["TbbFlow"]`	FHiCL
`wcls_main.plugins`	`["WireCellPgraph", "WireCellGen", "WireCellSio", "WireCellRoot", "WireCellLarsoft", "WireCellTbb"]`	FHiCL
`wcls_main.configs`	`["pgrapher/experiment/dune10kt-vd/wcls-sim-drift-simchannel-nf-sp.jsonnet"]`	FHiCL
`wcls_main.inputers`	`["wclsSimDepoSetSource:"]`	FHiCL
`wcls_main.outputers`	`["wclsDepoFluxWriter:postdrift0", "wclsFrameSaver:simdigits0", "wclsFrameSaver:spsignals0", "wclsDepoFluxWriter:postdrift1", "wclsFrameSaver:simdigits1", "wclsFrameSaver:spsignals1", "wclsDepoFluxWriter:postdrift2", "wclsFrameSaver:simdigits2", "wclsFrameSaver:spsignals2", "wclsDepoFluxWriter:postdrift3", "wclsFrameSaver:simdigits3", "wclsFrameSaver:spsignals3"]`	FHiCL
`wcls_main.logsinks`	`["stdout:debug"]`	FHiCL
`wcls_main.loglevels`	`["debug"]`	FHiCL

FHiCL includes not found (values from these are unresolved unless overridden): `PhotonCalibratorProtoDUNESP.fcl`, `channelstatus_pdsp.fcl`, `dataprep_dune.fcl`, `lifetimecalib_dune.fcl`, `opticaldetectorservices_dune.fcl`, `photpropservices_dune.fcl`, `protodune_dataprep_services.fcl`, `seedservice.fcl`, `xyzcalib_dune.fcl`

1.2 Jsonnet external variables

The WCLS tool passes each `wcls_main.params` entry as a Jsonnet external *string* and each `wcls_main.structs` entry as external *code*. The "origin column gives where the value was defined in FHiCL and the references through which it was obtained.

Table 2: Jsonnet std.extVar() values.

Name	Kind	Value	Origin
`files_wires`	str	`dunevd10kt_3view_30deg_v6_refactored.json.bz2`	wcls-sim-drift-simchannel-nf-sp.fcl:61
`files_fields`	str	`protodunevd_FR_imbalance3p_260501.json.bz2`	wcls-sim-drift-simchannel-nf-sp.fcl:66
`geo_planeid_labels`	str	`default`	wcls-sim-drift-simchannel-nf-sp.fcl:72
`input_depos_tag`	str	`IonAndScint`	wcls-sim-drift-simchannel-nf-sp.fcl:76
`engine`	str	`TbbFlow`	wcls-sim-drift-simchannel-nf-sp.fcl:97
`process_mode`	str	`multi-sim`	multi-sim-4.fcl:8
`frame_tag_pattern`	str	`daq%d`	multi-sim-4.fcl:9
`elecGain`	code	`14`	wcls-sim-drift-simchannel-nf-sp.fcl:102
`nticks`	code	`8500`	detectorproperties_dune.fcl:24 via @local::dunefdvd_detproperties.NumberTimeSamples
`DL`	code	`4.0e-9`	simulationservices_dune.fcl:9 via @local::dunefd_largeantparameters.LongitudinalDiffusion
`DT`	code	`8.8e-9`	simulationservices_dune.fcl:10 via @local::dunefd_largeantparameters.TransverseDiffusion
`lifetime`	code	`10.4e3`	wcls-sim-drift-simchannel-nf-sp.fcl:109
`efield`	code	`0.5`	detectorproperties_dune.fcl:22 via @local::dunefdvd_detproperties.Efield[0]

Table 2: Jsonnet std.extVar() values.

Name	Kind	Value	Origin
temperature	code	87	detectorproperties_dune.fcl:20 via @local::dunefdvd_detproperties.Temperature
G4RefTime	code	0.0	detectorclocks_dune.fcl:9 via @local::dunefd_detectorclocks.G4RefTime
response_plane	code	18.1	wcls-sim-drift-simchannel-nf-sp.fcl:116
process_anode_index	code	0	wcls-sim-drift-simchannel-nf-sp.fcl:118
use_hydra	code	true	wcls-sim-drift-simchannel-nf-sp.fcl:124
use_dnnroi	code	false	wcls-sim-drift-simchannel-nf-sp.fcl:127
adc_resolution	code	14	wcls-sim-drift-simchannel-nf-sp.fcl:128
max_threads	code	0	wcls-sim-drift-simchannel-nf-sp.fcl:131
process_anode_indices	code	[0, 1, 2, 3]	multi-sim-4.fcl:10
save_rawdigits	code	true	multi-sim-4.fcl:11

1.3 Jsonnet compilation

Main Jsonnet file(s): `/home/bviren/dune/xerosere/multi-sim-4/jmap/pgrapher/experiment/dune10kt-vd/wcls-sim-drift-simchannel-nf-sp.jsonnet`

Command:

```
jsonnet -J /home/bviren/dune/xerosere/reference/dunereco/dunereco/DUNEWireCell/protodunevd -J /home/bviren/dune/xerosere/reference/
    ↪ wire-cell-data -J /home/bviren/dune/xerosere/devel/wire-cell-toolkit/cfg -J /home/bviren/dune/xerosere/multi-sim-4/jmap --
    ↪ ext-str files_wires=dunevd10kt_3view_30deg_v6_refactored.json.bz2 --ext-str files_fields=protodunevd_FR_imbalance3p_260501.
    ↪ json.bz2 --ext-str geo_planeid_labels=default --ext-str input_depos_tag=IonAndScint --ext-str engine=TbbFlow --ext-str
    ↪ process_mode=multi-sim --ext-str 'frame_tag_pattern=daq%d' --ext-code elecGain=14 --ext-code nticks=8500 --ext-code DL=4.0e
    ↪ -9 --ext-code DT=8.8e-9 --ext-code lifetime=10.4e3 --ext-code efield=0.5 --ext-code temperature=87 --ext-code G4RefTime=0.0
    ↪ --ext-code response_plane=18.1 --ext-code process_anode_index=0 --ext-code use_hydra=true --ext-code use_dnnroi=false --ext-
    ↪ code adc_resolution=14 --ext-code max_threads=0 --ext-code 'process_anode_indices=[0, 1, 2, 3]' --ext-code save_rawdigits=
    ↪ true /home/bviren/dune/xerosere/multi-sim-4/jmap/pgrapher/experiment/dune10kt-vd/wcls-sim-drift-simchannel-nf-sp.jsonnet
```

1.4 Job types

Table 3: Job types detected from the component types present in the configuration.

Job type	Detected by component types
Simulation	AddNoise, DepoSetDrifter, DepoTransform, Digitizer, Drifter, wclsDepoFluxWriter, wclsSimDepoSetSource
Signal processing	OmnibusSigProc

Table 4: All 98 configured components by type.

Component type	Count
AddNoise	4
AnodePlane	4
ColdElecResponse	1
DepoSetDrifter	1
DepoSetFanout	1
DepoSetFilter	4
DepoTransform	4
DeposOrBust	4
Digitizer	4
Drifter	1
DumpFrames	4
EmpiricalNoiseModel	4
FftwDFT	1
FieldResponse	1
FrameFanin	4
FrameSync	4
HfFilter	10
JsonElecResponse	1
LfFilter	3
MegaAnodePlane	4
OmnibusSigProc	4
PlaneImpactResponse	3

Table 4: All 98 configured components by type.

Component type	Count
RCResponse	1
Random	1
Reframer	4
ResponseSys	1
Retagger	4
TbbDataFlowGraph	1
TbbFlow	1
WireSchemaFile	1
wclsDepoFluxWriter	4
wclsFrameSaver	8
wclsSimDepoSetSource	1

1.5 Data flow graph: TbbFlow

The application TbbFlow has 62 edges between 59 nodes of 16 types. The figure collapses all nodes of one type into one box (with the number of instances); edge labels count the collapsed edges.

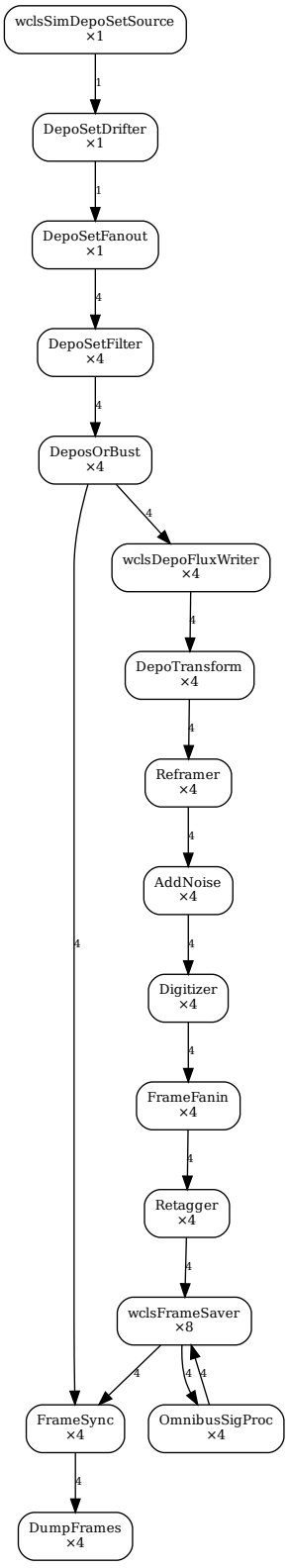


Figure 1: Type-collapsed data flow graph of `TbbFlow`.

2 Detector

The detector is described by 4 `AnodePlane` components. Each anode has up to two faces. For each face the configuration gives the x position of the anode plane (`anode`), of the plane where the field response calculation starts (`response`) and of the cathode (`cathode`). Wire (strip) geometry comes from the wire schema file of the `WireSchemaFile` component.

Coordinate system: WCT uses the global coordinates of the wire schema file. The x axis is the drift axis (field responses are calculated along their `axis`, normally $(1, 0, 0)$) and wires lie in y–z planes. In the DUNE/LArSoft convention y is vertical (up) and z is along the beam. Electrons drift from the cathode toward the anode.

Table 5: Wire schema and common anode parameters.

Parameter	Value	Source
`filename`	`dunevd10kt_3view_30deg_v6_refactored.json.bz2`	`WireSchemaFile`
`(found at)`	`/home/bviren/dune/xerosere/devel/dunereco/dunereco/DUNEWireCell/dune10kt-vd/dunevd10kt_3view_30deg_v6_refactored.json.bz2`	
`nimpacts`	10	`AnodePlane` (all)

2.1 Overall dimensions

Table 6: Overall detector dimensions.

Parameter	Value	Source
number of anodes (TPCs)	4	`AnodePlane`
number of configured faces	8	`AnodePlane.data.faces`
number of wires (all faces)	6912	wire schema
channel range span	491520 (upper bound on channel count)	wire schema
y extent	-672.4 to 672.4 cm (1344.7 cm)	wire schema
z extent	0.5 to 149.4 cm (148.9 cm)	wire schema
x extent (anode/cathode)	-651.9 to -1.8 cm (650.1 cm)	`AnodePlane.data.faces`

2.2 Consistency checks

For each distinct face configuration: x distances relative to the last (collection) wire plane of the face, the drift length (cathode–anode) and, for comparison, the `origin` of the field response(s) used by the anode. The magnitude of the response plane distance should equal the field response origin.

Table 7: Face geometry consistency.

Faces	anode-coll. [cm]	response-coll. [cm]	drift length [cm]	Field response check
`AnodePlane:crm{0-3}/face{0-1}`	0.09	18.19	650.06	FieldResponse:field0 origin=18.10 cm: differs by +0.90 mm

2.3 Detector drawings

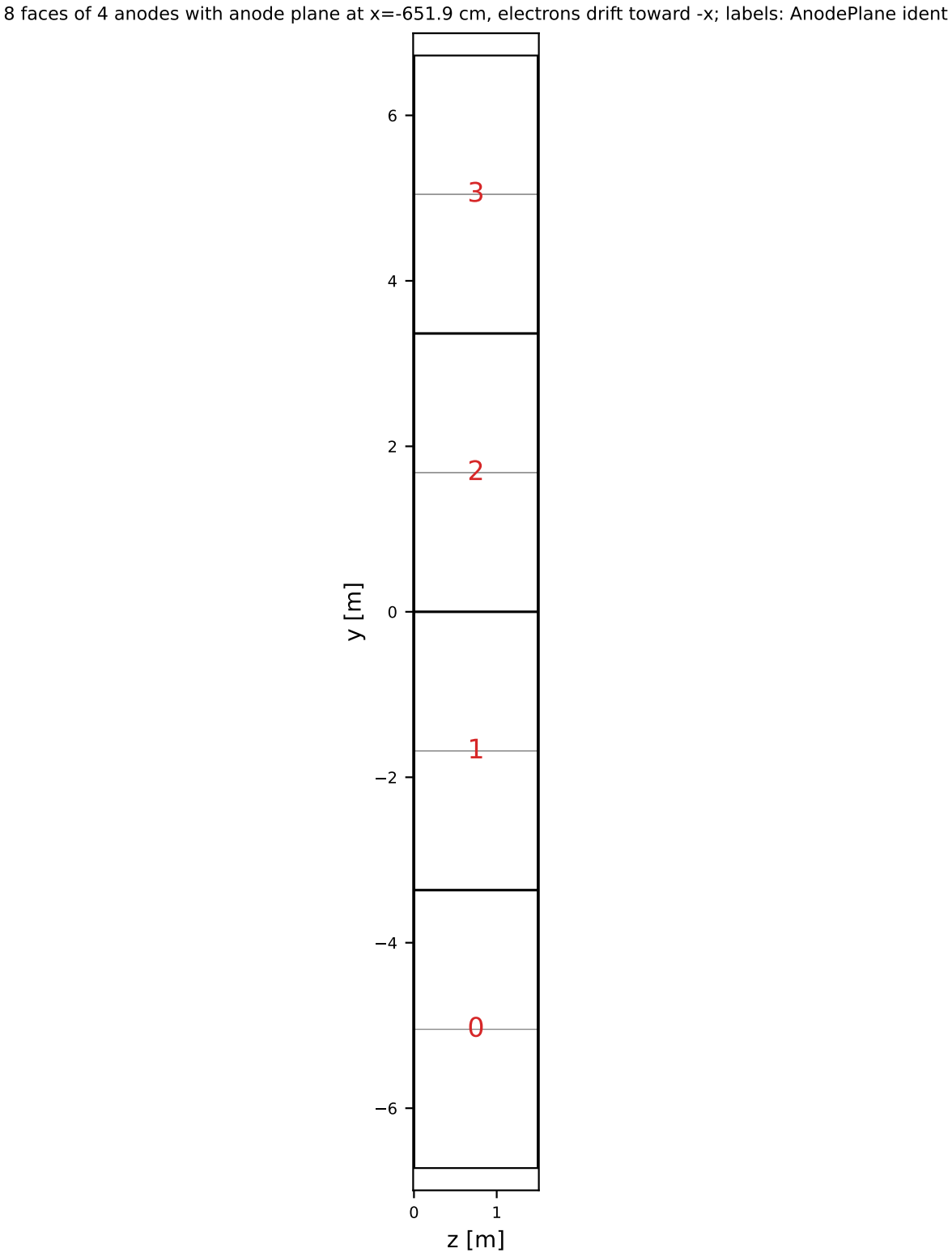


Figure 2: Anodes seen along the drift (x) axis with anode plane at $x = -651.9\,\mathrm{cm}$. Black: y–z extent of all wires of each anode (labeled with the `AnodePlane ident`, the per-TPC number); gray: individual faces. Overall extent $1.49 \times 13.45\,\mathrm{m}^2$ ($z \times y$). Source: `AnodePlane` components and wire schema.

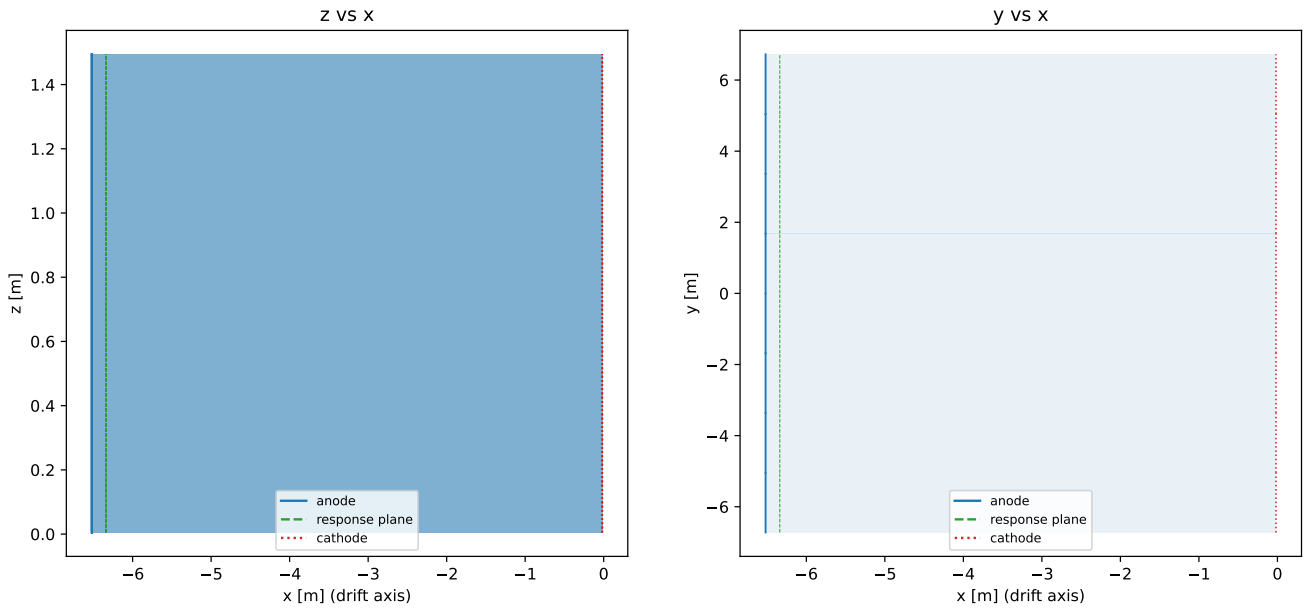


Figure 3: Drift volumes seen from above (z vs x) and from the side (y vs x). Shaded: volume between anode and cathode of each face. Source: `AnodePlane.data.faces`.

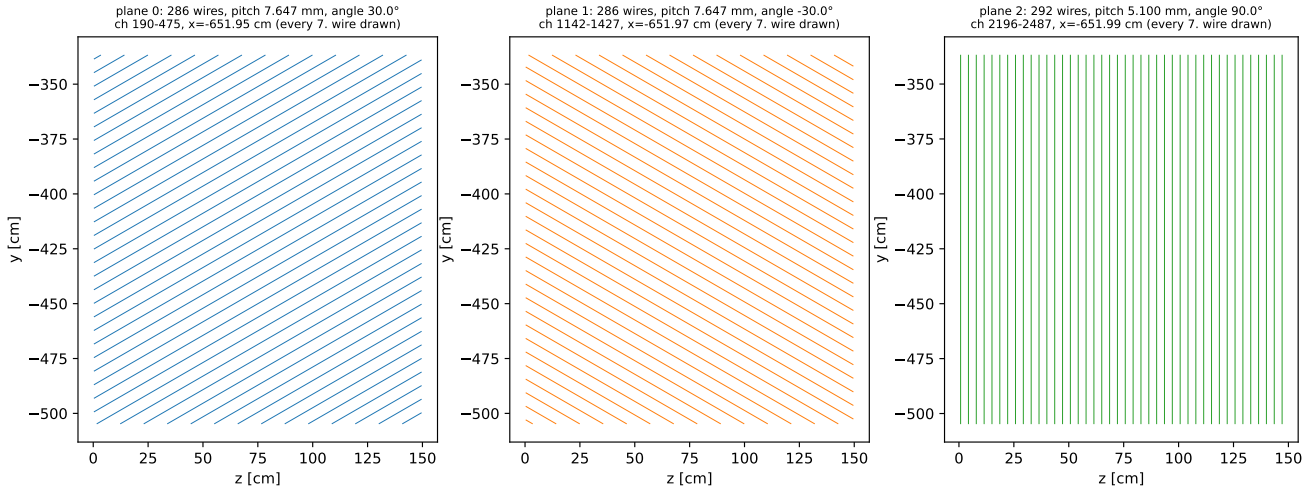


Figure 4: Wires of each plane of face 0 of `AnodePlane:crm0` (angle measured from the z axis toward y). Source: wire schema, `AnodePlane` ident 0.

Table 8: Distinct wire plane layouts (from the wire schema).

Faces	Plane	Wires	Pitch [mm]	Angle [deg]
`AnodePlane:crm{0-3}/face{0-1}`	0	286	7.650	30.0
	1	286	7.650	-30.0
	2	292	5.100	90.0

2.4 Per-anode response and noise assignment

Anodes grouped by the responses, noise spectra and digitizer settings that the configuration attaches to them (via the `anode` parameter of the simulation, noise, digitizer and signal processing components).

Table 9: Per-anode assignment of responses, noise and digitization.

Anodes	Aspect	Value
`AnodePlane:crm{0-3}`	SP elec response	`ColdElecResponse:elecresp0`

Table 9: Per-anode assignment of responses, noise and digitization.

Anodes	Aspect	Value
	SP field response	`FieldResponse:field0`
	digitizer	`14 bit, baselines ['1003.4', '1003.4', '507.7'] mV, fullscale ['200', '1600'] mV`
	noise spectra	`pdvd-bottom-noise-spectra-14mVfC-v1.json.bz2`
	sim RC responses	`0`
	sim field response	`FieldResponse:field0`
	sim short responses	`ColdElecResponse:elecresp0`

2.5 Anodes

Table 10: Per anode geometry: x positions of anode plane, response plane and cathode from AnodePlane faces (one value per distinct face), y/z ranges and channel range from the wire schema.

ident	name	faces	x anode [cm]	x resp. [cm]	x cath. [cm]	y min/max [cm]	z min/max [cm]	channels
0	`crm0`	0,1	-651.90	-633.80	-1.84	-672.4 / -336.8	0.5 / 149.4	0-2487
1	`crm1`	0,1	-651.90	-633.80	-1.84	-336.0 / -0.4	0.5 / 149.4	3072-5559
2	`crm2`	0,1	-651.90	-633.80	-1.84	0.4 / 336.0	0.5 / 149.4	6144-8631
3	`crm3`	0,1	-651.90	-633.80	-1.84	336.8 / 672.4	0.5 / 149.4	9216-11703

3 Physics constants

Liquid argon transport parameters as used by the simulation. The `Drifter` applies diffusion (DL, DT), attachment (lifetime) and fluctuations while drifting depositions to the response plane. The drift speed is also used by the components that convert drifted depositions into signals.

Table 11: Physics constants.

Parameter	Value	Source
`DL`	`4e-07` = 4 cm^2/s	`Drifter`
`DT`	`8.8e-07` = 8.8 cm^2/s	`Drifter`
`lifetime`	`10400000` = 10.4 ms	`Drifter`
`drift_speed`	`0.00160563` = 1.6056 mm/μs	`Drifter`
`drift_speed`	`0.00160563` = 1.6056 mm/μs	`DepoTransform:ductor{0-3}`
`fluctuate`	`true`	`Drifter`
`fluctuate`	`true`	`DepoTransform:ductor{0-3}`
`time_offset`	`0` = 0 μs	`Drifter`

Table 12: Drift speed assumed by field response calculations (for comparison).

Field response	Drift speed in FR calculation	File
`FieldResponse:field0`	1.53 mm/μs	`protodunevd_FR_imbalance3p_260501.json.bz2`

Table 13: Drift regions (`xregions`) of `Drifter`. Depositions outside are dropped; those inside are drifted to the response plane.

Region	anode x [cm]	response x [cm]	cathode x [cm]
0	-651.90	-633.80	-1.84
1	652.15	634.05	2.09

4 Field responses

Each `FieldResponse` component loads a file of induced currents on the wires of each plane for electrons drifting from the response plane (at distance `origin` from the last plane) along paths at a set of transverse impact positions (`pitchpos`).

4.1 Field response `protodunevd_FR_imbalance3p_260501.json.bz2`

Table 14: Field response `protodunevd_FR_imbalance3p_260501.json.bz2`.

Parameter	Value	Source
filename	`protodunevd_FR_imbalance3p_260501.json.bz2`	`FieldResponse:field0`
path	`/home/bviren/dune/xerosere/devel/dunereco/dunereco/DUNEWireCell/protodunevd/protodunevd_FR_imbalance3p_260501.json.bz2`	
axis	`[1, 0, 0]`	file
origin	`181` = 181 mm	file
tstart	`0` = 0 μs	file
period	`100` = 0.1 μs	file
speed	`0.00153` = 1.53 mm/μs	file
samples per path	1325	file
plane 0	planeid=0, location=`13.2` = 13.2 mm, pitch=`7.65` = 7.65 mm, 126 paths, pitchpos -80.33 to 76.50 mm, wire-0 integrated charge 0.020 e	file
plane 1	planeid=1, location=`3.2` = 3.2 mm, pitch=`7.65` = 7.65 mm, 126 paths, pitchpos -80.33 to 76.50 mm, wire-0 integrated charge 0.017 e	file
plane 2	planeid=2, location=`0` = 0 mm, pitch=`5.1` = 5.1 mm, 126 paths, pitchpos -53.55 to 51.00 mm, wire-0 integrated charge -0.879 e	file

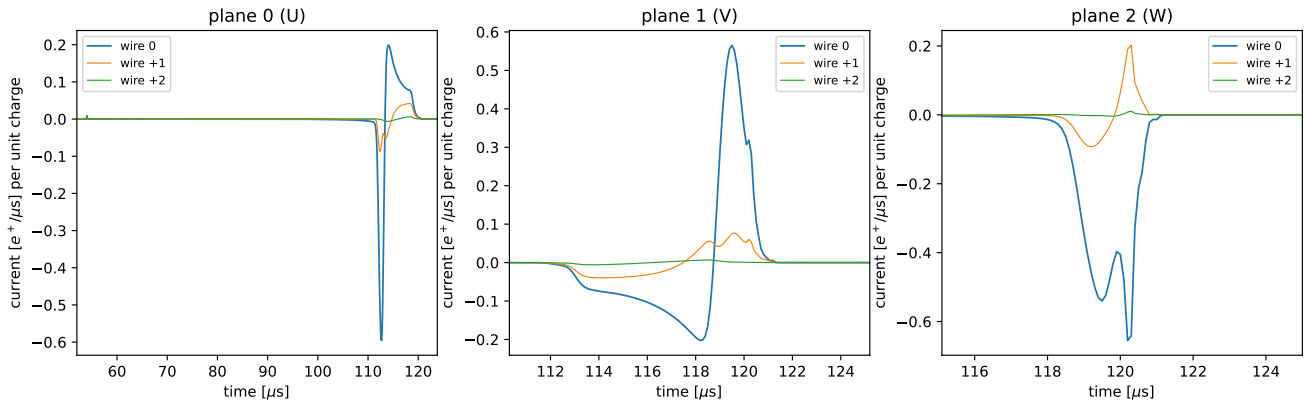


Figure 5: Field response `protodunevd_FR_imbalance3p_260501.json.bz2`: induced current, as stored, averaged over impact positions within the region of the central wire (wire 0) and its neighbors. WCT multiplies this by the charge of each deposition (negative for ionization electrons). Source: `FieldResponse:field0`.

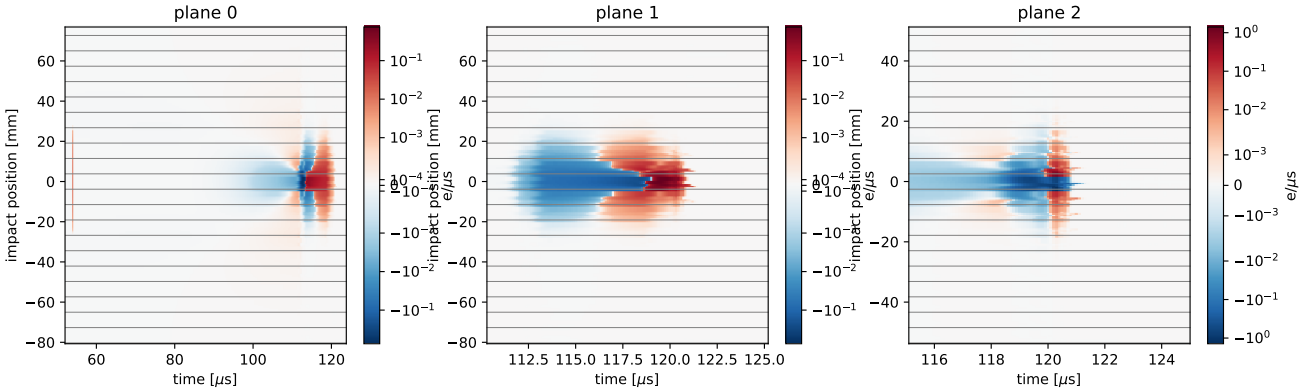


Figure 6: Field response `protodunevd_FR_imbalance3p_260501.json.bz2`: current vs time and impact position for all paths (symmetric log color scale; gray lines are wire region boundaries).

5 Electronics and total responses

Electronics response components give the response of the front end electronics to a unit charge. The simulation combines a field response with "short (electronics) and "long (RC) responses in `PlaneImpactResponse` components; signal processing uses the field and electronics responses named in its configuration.

Table 15: Parameters of 1 `ColdElecResponse` component(s): `ColdElecResponse:elecresp0`

Parameter	Value	Source
`filename`	`''`	`ColdElecResponse:elecresp0`
`gain`	`2.24305e-12` = 14 mV/fC	`ColdElecResponse:elecresp0`
`nticks`	8725	`ColdElecResponse:elecresp0`
`postgain`	1	`ColdElecResponse:elecresp0`
`shaping`	2200 = 2.2 μs	`ColdElecResponse:elecresp0`
`tick`	500 = 0.5 μs	`ColdElecResponse:elecresp0`

Table 16: Parameters of 1 `JsonElecResponse` component(s): `JsonElecResponse:elecresp1`

Parameter	Value	Source
`filename`	`dunevd-coldbox-elecresp-top-psnorm_400.json.bz2`	`JsonElecResponse:elecresp1`
`gain`	`2.24305e-12` = 14 mV/fC	`JsonElecResponse:elecresp1`
`nticks`	8725	`JsonElecResponse:elecresp1`
`postgain`	1.36	`JsonElecResponse:elecresp1`
`shaping`	2000 = 2 μs	`JsonElecResponse:elecresp1`
`tick`	500 = 0.5 μs	`JsonElecResponse:elecresp1`

Table 17: Parameters of 1 `RCResponse` component(s): `RCResponse`

Parameter	Value	Source
`nticks`	8725	`RCResponse`
`tick`	500 = 0.5 μs	`RCResponse`
`width`	1100000 = 1.1 ms	`RCResponse`

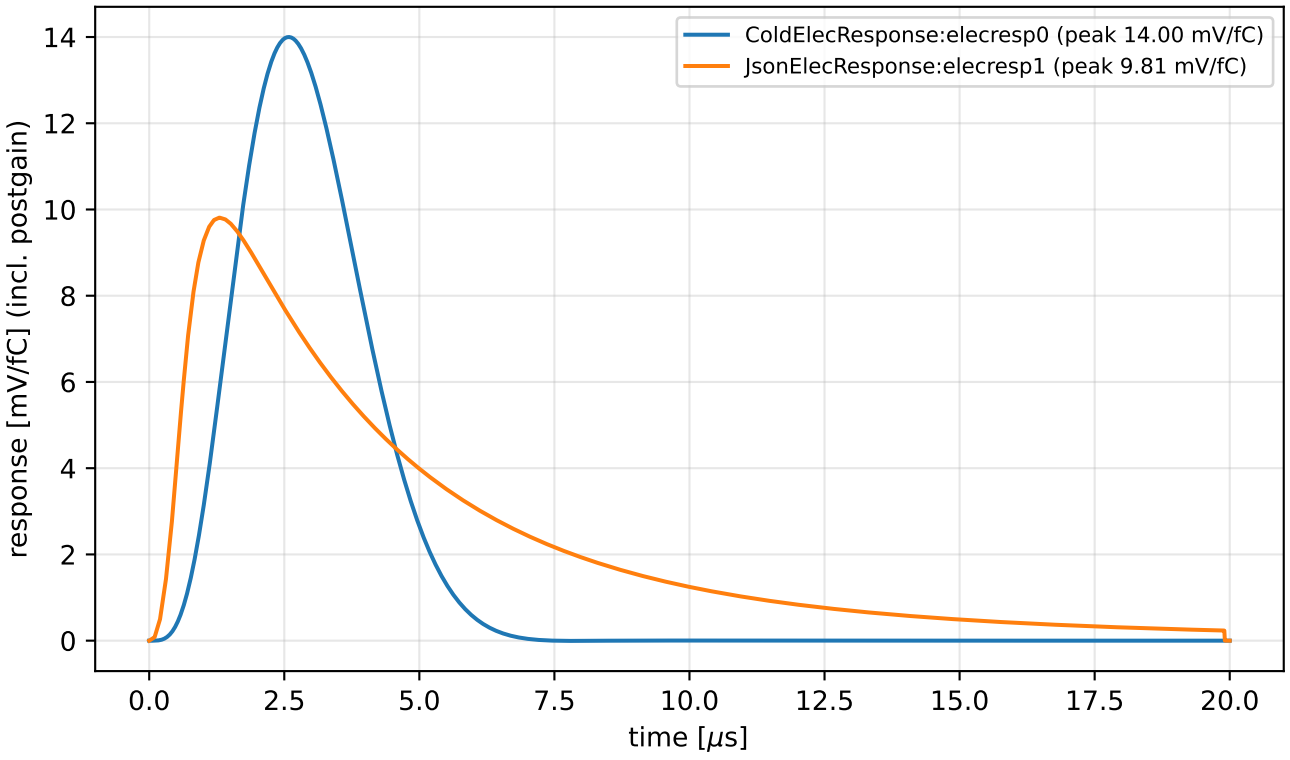


Figure 7: Electronics responses (including postgain). Source: `ColdElecResponse:elecresp0`, `JsonElecResponse:elecresp1`.

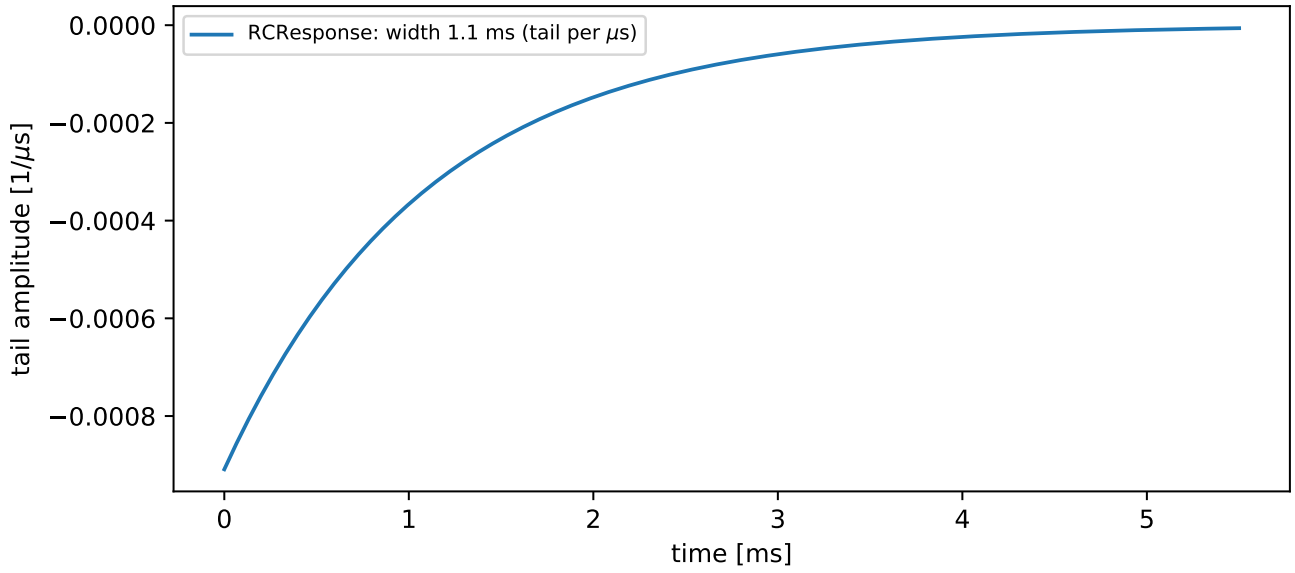


Figure 8: RC responses: a delta function followed by a negative exponential tail. The number of RC responses applied by each `PlaneImpactResponse` is given by its `long_responses`: 3 PIRs apply 0 RC.

5.1 Plane impact responses (simulation)

Table 18: Parameters of 3 `PlaneImpactResponse` component(s): `PlaneImpactResponse: PIRfield0plane{0-2}`

Parameter	Value	Source
`dft`	`FftwDFT`	all 3
`field_response`	`FieldResponse:field0`	all 3
`long_padding`	1500000 = 1.5 ms	all 3
`long_responses`	`[]`	all 3
`nticks`	8725	all 3
`overall_short_padding`	200000 = 0.2 ms	all 3
`plane`	0	`PlaneImpactResponse: PIRfield0plane0`
	1	`PlaneImpactResponse: PIRfield0plane1`
	2	`PlaneImpactResponse: PIRfield0plane2`
`short_responses`	`["ColdElecResponse:elecresp0"]`	all 3
`tick`	500 = 0.5 μs	all 3

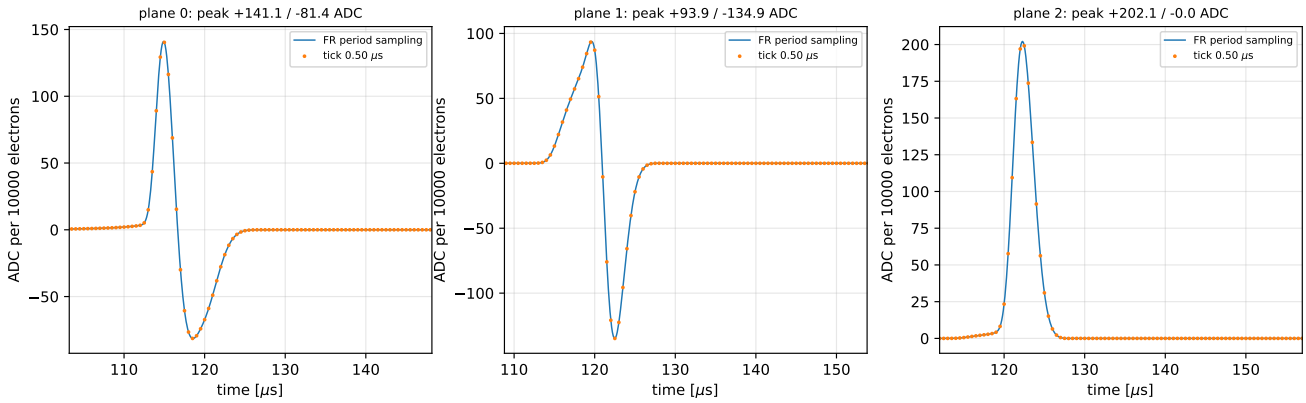


Figure 9: Total response (field response wire-0 average ⊗ `ColdElecResponse:elecresp0`) for 10000 ionization electrons (charge $-10000\,e$) at the response plane, without diffusion. PIRs: `PlaneImpactResponse: PIRfield0plane{0-2}`. Field: `FieldResponse:field0`. Converted to ADC with `Digitizer:digitizer0`. Used by anodes: `AnodePlane:crm{0-3}`.

6 Simulation

Components of the simulation chain. Parameters are grouped over all instances of each component type; where values differ between instances each distinct value is listed with the instances that use it.

6.1 wclsSimDepoSetSource

Table 19: Parameters of 1 wclsSimDepoSetSource component(s): wclsSimDepoSetSource

Parameter	Value	Source
art_tag	IonAndScint	wclsSimDepoSetSource
assn_art_tag	"	wclsSimDepoSetSource
id_is_track	false	wclsSimDepoSetSource
model	"	wclsSimDepoSetSource
scale	-1	wclsSimDepoSetSource

6.2 DepoSetDrifter

Table 20: Parameters of 1 DepoSetDrifter component(s): DepoSetDrifter

Parameter	Value	Source
drifter	Drifter	DepoSetDrifter

6.3 Drifter

Table 21: Parameters of 1 Drifter component(s): Drifter

Parameter	Value	Source
DL	4e-07 = 4 cm^2/s	Drifter
DT	8.8e-07 = 8.8 cm^2/s	Drifter
ar39activity	1.60218e-34 = 1 Bq/kg	Drifter
density	8669456899850258432 = 1.389 g/cm^3	Drifter
drift_speed	0.00160563 = 1.6056 mm/μs	Drifter
fluctuate	true	Drifter
lifetime	10400000 = 10.4 ms	Drifter
rng	Random	Drifter
time_offset	0 = 0 μs	Drifter
xregions[0].anode	-6519 = -651.9 cm	Drifter
xregions[0].cathode	-18.4 = -1.84 cm	Drifter
xregions[0].response	-6338 = -633.8 cm	Drifter
xregions[1].anode	6521.5 = 652.15 cm	Drifter
xregions[1].cathode	20.9 = 2.09 cm	Drifter
xregions[1].response	6340.5 = 634.05 cm	Drifter

6.4 DepoSetFilter

Table 22: Parameters of 4 DepoSetFilter component(s): DepoSetFilter:ds-filter-multi-{0-3}

Parameter	Value	Source
anode	AnodePlane:crm0	DepoSetFilter:ds-filter-multi-0
	AnodePlane:crm1	DepoSetFilter:ds-filter-multi-1
	AnodePlane:crm2	DepoSetFilter:ds-filter-multi-2
	AnodePlane:crm3	DepoSetFilter:ds-filter-multi-3

6.5 DepoTransform

Table 23: Parameters of 4 DepoTransform component(s): DepoTransform:ductor{0-3}

Parameter	Value	Source
anode	AnodePlane:crm0	DepoTransform:ductor0
	AnodePlane:crm1	DepoTransform:ductor1
	AnodePlane:crm2	DepoTransform:ductor2
	AnodePlane:crm3	DepoTransform:ductor3
dft	FftwDFT	all 4
drift_speed	0.00160563 = 1.6056 mm/μs	all 4
first_frame_number	100	all 4
fluctuate	true	all 4
nsigma	3	all 4
pirs	["PlaneImpactResponse:PIRfield0plane0", "PlaneImpactResponse:PIRfield0plane1", "PlaneImpactResponse:PIRfield0plane2"]	all 4
readout_time	4362500 = 4.3625 ms	all 4
rng	Random	all 4
start_time	-112728 = -0.112728 ms	all 4
tick	500 = 0.5 μs	all 4

6.6 Reframer

Table 24: Parameters of 4 Reframer component(s): Reframer:reframer{0-3}

Parameter	Value	Source
anode	AnodePlane:crm0	Reframer:reframer0
	AnodePlane:crm1	Reframer:reframer1
	AnodePlane:crm2	Reframer:reframer2
	AnodePlane:crm3	Reframer:reframer3
fill	0	all 4
nticks	8500	all 4
tags	[]	all 4
tbin	225	all 4
toffset	0 = 0 μs	all 4

6.7 AddNoise

Table 25: Parameters of 4 AddNoise component(s): AddNoise:addnoiseempericalnoisecrm{0-3}

Parameter	Value	Source
dft	FftwDFT	all 4
model	EmpiricalNoiseModel:empericalnoisecrm0	AddNoise: addnoiseempericalnoisecrm0
	EmpiricalNoiseModel:empericalnoisecrm1	AddNoise: addnoiseempericalnoisecrm1
	EmpiricalNoiseModel:empericalnoisecrm2	AddNoise: addnoiseempericalnoisecrm2
	EmpiricalNoiseModel:empericalnoisecrm3	AddNoise: addnoiseempericalnoisecrm3
nsamples	8500	all 4
replacement_percentage	0.02	all 4
rng	Random	all 4

6.8 EmpiricalNoiseModel

Table 26: Parameters of 4 `EmpiricalNoiseModel` component(s): `EmpiricalNoiseModel:empericalnoisecrm{0-3}`

Parameter	Value	Source
anode	AnodePlane:crm0	EmpiricalNoiseModel:empericalnoisecrm0
	AnodePlane:crm1	EmpiricalNoiseModel:empericalnoisecrm1
	AnodePlane:crm2	EmpiricalNoiseModel:empericalnoisecrm2
	AnodePlane:crm3	EmpiricalNoiseModel:empericalnoisecrm3
chanstat	"	all 4
dft	FftwDFT	all 4
nsamples	8500	all 4
period	500 = 0.5 μs	all 4
spectra_file	pdvd-bottom-noise-spectra-14mVfC-v1.json.bz2	all 4
wire_length_scale	10 = 1 cm	all 4

6.9 Digitizer

Table 27: Parameters of 4 `Digitizer` component(s): `Digitizer:digitizer{0-3}`

Parameter	Value	Source
anode	AnodePlane:crm0	Digitizer:digitizer0
	AnodePlane:crm1	Digitizer:digitizer1
	AnodePlane:crm2	Digitizer:digitizer2
	AnodePlane:crm3	Digitizer:digitizer3
baselines	[1.0034e-06, 1.0034e-06, 5.077e-07] → [1003.4 mV, 1003.4 mV, 507.7 mV]	all 4
frame_tag	orig0	Digitizer:digitizer0
	orig1	Digitizer:digitizer1
	orig2	Digitizer:digitizer2
	orig3	Digitizer:digitizer3
fullscale	[2e-07, 1.6e-06] → [200 mV, 1600 mV]	all 4
gain	1	all 4
resolution	14	all 4

6.10 wclsDepoFluxWriter

Table 28: Parameters of 4 `wclsDepoFluxWriter` component(s): `wclsDepoFluxWriter:postdrift{0-3}`

Parameter	Value	Source
anodes	["AnodePlane:crm0"]	wclsDepoFluxWriter:postdrift0
	["AnodePlane:crm1"]	wclsDepoFluxWriter:postdrift1
	["AnodePlane:crm2"]	wclsDepoFluxWriter:postdrift2
	["AnodePlane:crm3"]	wclsDepoFluxWriter:postdrift3
field_response	FieldResponse:field0	all 4
nsigma	3	all 4
reference_time	0 = 0 μs	all 4
sed_label	IonAndScint	all 4
simchan_label	simpleSC0	wclsDepoFluxWriter:postdrift0
	simpleSC1	wclsDepoFluxWriter:postdrift1
	simpleSC2	wclsDepoFluxWriter:postdrift2
	simpleSC3	wclsDepoFluxWriter:postdrift3
sparse	true	all 4
tick	500 = 0.5 μs	all 4

Table 28: Parameters of 4 `wclsDepoFluxWriter` component(s): `wclsDepoFluxWriter:postdrift{0-3}`

Parameter	Value	Source
window_duration	4250000 = 4.25 ms	all 4
window_start	0 = 0 μs	all 4

6.11 wclsFrameSaver

Table 29: Parameters of 8 `wclsFrameSaver` component(s): `wclsFrameSaver:simdigits{0-3}`, `wclsFrameSaver:spsignals{0-3}`

Parameter	Value	Source
anode	MegaAnodePlane:meganodes_0	wclsFrameSaver:simdigits0, wclsFrameSaver:spsignals0
	MegaAnodePlane:meganodes_1	wclsFrameSaver:simdigits1, wclsFrameSaver:spsignals1
	MegaAnodePlane:meganodes_2	wclsFrameSaver:simdigits2, wclsFrameSaver:spsignals2
	MegaAnodePlane:meganodes_3	wclsFrameSaver:simdigits3, wclsFrameSaver:spsignals3
digitize	true	wclsFrameSaver:simdigits{0-3}
	false	wclsFrameSaver:spsignals{0-3}
frame_tags	["daq0"]	wclsFrameSaver:simdigits0
	["gauss0","wiener0"]	wclsFrameSaver:spsignals0
	["daq1"]	wclsFrameSaver:simdigits1
	["gauss1","wiener1"]	wclsFrameSaver:spsignals1
	["daq2"]	wclsFrameSaver:simdigits2
	["gauss2","wiener2"]	wclsFrameSaver:spsignals2
	... 2 more distinct values	
pedestal_mean	native	wclsFrameSaver:simdigits{0-3}
chanmaskmaps	[]	wclsFrameSaver:spsignals{0-3}
frame_scale	[0.005, 0.005]	wclsFrameSaver:spsignals{0-3}
nticks	8500	wclsFrameSaver:spsignals{0-3}
plane_map.1	0	wclsFrameSaver:spsignals{0-3}
plane_map.2	1	wclsFrameSaver:spsignals{0-3}
plane_map.4	2	wclsFrameSaver:spsignals{0-3}
sparse	true	wclsFrameSaver:spsignals{0-3}

6.12 Noise spectra

`EmpiricalNoiseModel` components provide, per plane, noise amplitude spectra measured or modeled for several wire lengths; the model interpolates in wire length and `AddNoise` adds random noise with this spectrum to the (voltage) waveforms before digitization. Amplitudes are shown as stored (WCT voltage units converted to mV).

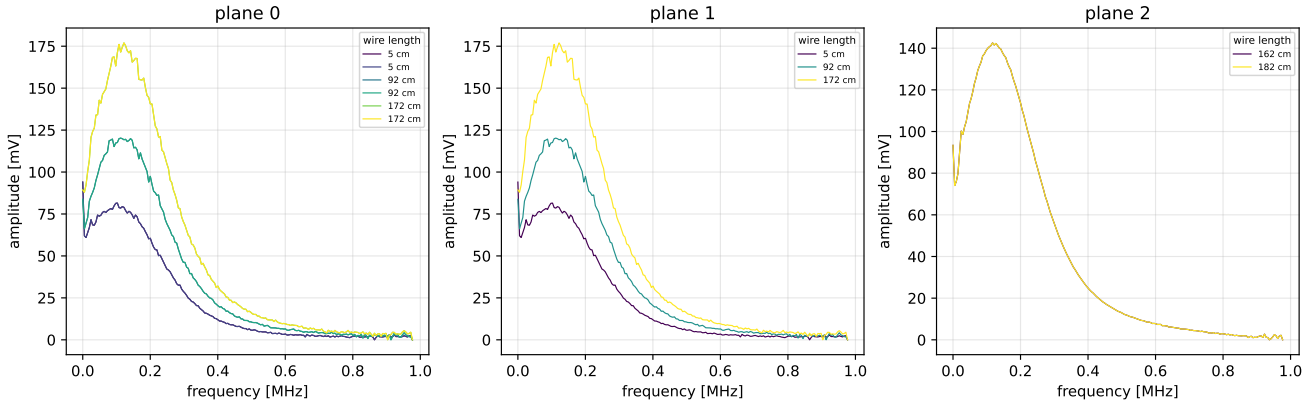


Figure 10: Noise spectra in `pdvd-bottom-noise-spectra-14mVfC-v1.json.bz2`, used by `EmpiricalNoiseModel:empericalnoisecrm{0-3}` (anodes `AnodePlane:crm{0-3}`).

Table 30: Entries of noise spectra file `pdvd-bottom-noise-spectra-14mVfC-v1.json.bz2`.

Plane	**Wire length [cm]**	**Gain [mV/fC]**	**Shaping [μs]**	**nsamples**	**Period [μs]**	**Const [mV]**	**nfreqs**
0	5.2	14	2.2	6000	0.5	6.765	201
0	5.2	14	2.2	6000	0.5	6.765	201
0	91.8	14	2.2	6000	0.5	8.863	201
0	91.8	14	2.2	6000	0.5	8.863	201
0	172.1	14	2.2	6000	0.5	10.9	201
0	172.1	14	2.2	6000	0.5	10.9	201
1	5.2	14	2.2	6000	0.5	6.765	201
1	91.8	14	2.2	6000	0.5	8.863	201
1	172.1	14	2.2	6000	0.5	10.9	201
2	162.1	14	2.2	6000	0.5	11.72	201
2	182.1	14	2.2	6000	0.5	11.72	201

7 Signal processing

`OmnibusSigProc` deconvolves the field and electronics responses from the waveforms (2D in time and wire), applying time-domain (Wiener, Gaussian), low-frequency (ROI) and wire-domain filters, and finds regions of interest.

7.1 `OmnibusSigProc`

Table 31: Parameters of 4 `OmnibusSigProc` component(s): `OmnibusSigProc:crm#sigproc# #= {0-3}`

Parameter	Value	Source
ADC_mV	1.17021e+10 = 11.702 ADC/mV	all 4
anode	AnodePlane:crm0	OmnibusSigProc:crm0sigproc0
	AnodePlane:crm1	OmnibusSigProc:crm1sigproc1
	AnodePlane:crm2	OmnibusSigProc:crm2sigproc2
	AnodePlane:crm3	OmnibusSigProc:crm3sigproc3
break_roi_loop1_tag	break_roi_1st0	OmnibusSigProc:crm0sigproc0
	break_roi_1st1	OmnibusSigProc:crm1sigproc1
	break_roi_1st2	OmnibusSigProc:crm2sigproc2
	break_roi_1st3	OmnibusSigProc:crm3sigproc3
break_roi_loop2_tag	break_roi_2nd0	OmnibusSigProc:crm0sigproc0
	break_roi_2nd1	OmnibusSigProc:crm1sigproc1
	break_roi_2nd2	OmnibusSigProc:crm2sigproc2
	break_roi_2nd3	OmnibusSigProc:crm3sigproc3
cleanup_roi_tag	cleanup_roi0	OmnibusSigProc:crm0sigproc0
	cleanup_roi1	OmnibusSigProc:crm1sigproc1
	cleanup_roi2	OmnibusSigProc:crm2sigproc2
	cleanup_roi3	OmnibusSigProc:crm3sigproc3
ctoffset	4000 = 4 μs	all 4
decon_charge_tag	decon_charge0	OmnibusSigProc:crm0sigproc0
	decon_charge1	OmnibusSigProc:crm1sigproc1
	decon_charge2	OmnibusSigProc:crm2sigproc2
	decon_charge3	OmnibusSigProc:crm3sigproc3
dft	FftwDFT	all 4
elecresponse	ColdElecResponse:elecresp0	all 4
extend_roi_tag	extend_roi0	OmnibusSigProc:crm0sigproc0
	extend_roi1	OmnibusSigProc:crm1sigproc1
	extend_roi2	OmnibusSigProc:crm2sigproc2
	extend_roi3	OmnibusSigProc:crm3sigproc3
fft_flag	0	all 4
field_response	FieldResponse:field0	all 4
ftoffset	0 = 0 μs	all 4
gauss_tag	gauss0	OmnibusSigProc:crm0sigproc0
	gauss1	OmnibusSigProc:crm1sigproc1
	gauss2	OmnibusSigProc:crm2sigproc2
	gauss3	OmnibusSigProc:crm3sigproc3
loose_lf_tag	loose_lf0	OmnibusSigProc:crm0sigproc0
	loose_lf1	OmnibusSigProc:crm1sigproc1
	loose_lf2	OmnibusSigProc:crm2sigproc2
	loose_lf3	OmnibusSigProc:crm3sigproc3
lroi_jump_one_bin	1	all 4
lroi_rebin	6	all 4
lroi_th_factor	3.5	all 4
lroi_th_factor1	0.7	all 4
mp2_roi_tag	mp2_roi0	OmnibusSigProc:crm0sigproc0
	mp2_roi1	OmnibusSigProc:crm1sigproc1
	mp2_roi2	OmnibusSigProc:crm2sigproc2
	mp2_roi3	OmnibusSigProc:crm3sigproc3
mp3_roi_tag	mp3_roi0	OmnibusSigProc:crm0sigproc0
	mp3_roi1	OmnibusSigProc:crm1sigproc1
	mp3_roi2	OmnibusSigProc:crm2sigproc2
	mp3_roi3	OmnibusSigProc:crm3sigproc3
per_chan_resp	"	all 4
postgain	1	all 4
r_fake_signal_high_th	750	all 4
r_fake_signal_high_th_ind_factor	1	all 4
r_fake_signal_low_th	375	all 4

Table 31: Parameters of 4 OmnibusSigProc component(s): OmnibusSigProc:crm#sigproc# #={0-3}

Parameter	Value	Source
r_fake_signal_low_th_ind_factor	1	all 4
r_low_peak_sep_threshold_pre	1200	all 4
r_sep_peak	6	all 4
r_th_factor	3	all 4
r_th_peak	3	all 4
shrink_roi_tag	shrink_roi0	OmnibusSigProc:crm0sigproc0
	shrink_roi1	OmnibusSigProc:crm1sigproc1
	shrink_roi2	OmnibusSigProc:crm2sigproc2
	shrink_roi3	OmnibusSigProc:crm3sigproc3
sparse	true	all 4
tight_lf_tag	tight_lf0	OmnibusSigProc:crm0sigproc0
	tight_lf1	OmnibusSigProc:crm1sigproc1
	tight_lf2	OmnibusSigProc:crm2sigproc2
	tight_lf3	OmnibusSigProc:crm3sigproc3
troi_col_th_factor	5	all 4
troi_ind_th_factor	3	all 4
use_multi_plane_protection	false	all 4
use_roi_debug_mode	false	all 4
wiener_tag	wiener0	OmnibusSigProc:crm0sigproc0
	wiener1	OmnibusSigProc:crm1sigproc1
	wiener2	OmnibusSigProc:crm2sigproc2
	wiener3	OmnibusSigProc:crm3sigproc3

7.2 Filters

Table 32: Filter components. HfFilter: $\exp(-\frac{1}{2}(f/\sigma)^p)$ (zero at $f = 0$ if flag); LfFilter: $1 - \exp(-(f/\tau)^2)$.

Filter	Parameter	Value	Type
ROI_tight_lf	max_freq	0.001 = 1 MHz	LfFilter
ROI_tight_lf	tau	1.4e-05 = 0.014 MHz	LfFilter
ROI_tighter_lf	max_freq	0.001 = 1 MHz	LfFilter
ROI_tighter_lf	tau	6e-05 = 0.06 MHz	LfFilter
ROI_loose_lf	max_freq	0.001 = 1 MHz	LfFilter
ROI_loose_lf	tau	2e-06 = 0.002 MHz	LfFilter
Gaus_tight	flag	true	HfFilter
Gaus_tight	max_freq	0.001 = 1 MHz	HfFilter
Gaus_tight	power	2	HfFilter
Gaus_tight	sigma	0 = 0 MHz	HfFilter
Gaus_wide	flag	true	HfFilter
Gaus_wide	max_freq	0.001 = 1 MHz	HfFilter
Gaus_wide	power	2	HfFilter
Gaus_wide	sigma	0.00012 = 0.12 MHz	HfFilter
Wiener_tight_U	flag	true	HfFilter
Wiener_tight_U	max_freq	0.001 = 1 MHz	HfFilter
Wiener_tight_U	power	3.76194	HfFilter
Wiener_tight_U	sigma	0.000148788 = 0.1488 MHz	HfFilter
Wiener_tight_V	flag	true	HfFilter
Wiener_tight_V	max_freq	0.001 = 1 MHz	HfFilter
Wiener_tight_V	power	4.36125	HfFilter
Wiener_tight_V	sigma	0.000159657 = 0.1597 MHz	HfFilter
Wiener_tight_W	flag	true	HfFilter
Wiener_tight_W	max_freq	0.001 = 1 MHz	HfFilter
Wiener_tight_W	power	3.35324	HfFilter
Wiener_tight_W	sigma	0.00013623 = 0.1362 MHz	HfFilter
Wiener_wide_U	flag	true	HfFilter
Wiener_wide_U	max_freq	0.001 = 1 MHz	HfFilter
Wiener_wide_U	power	5.05429	HfFilter
Wiener_wide_U	sigma	0.000186765 = 0.1868 MHz	HfFilter
Wiener_wide_V	flag	true	HfFilter
Wiener_wide_V	max_freq	0.001 = 1 MHz	HfFilter
Wiener_wide_V	power	5.77422	HfFilter
Wiener_wide_V	sigma	0.0001936 = 0.1936 MHz	HfFilter
Wiener_wide_W	flag	true	HfFilter
Wiener_wide_W	max_freq	0.001 = 1 MHz	HfFilter
Wiener_wide_W	power	4.37928	HfFilter
Wiener_wide_W	sigma	0.000175722 = 0.1757 MHz	HfFilter
Wire_ind	flag	false	HfFilter
Wire_ind	max_freq	1	HfFilter

Table 32: Filter components. HfFilter: $\exp(-\frac{1}{2}(f/\sigma)^p)$ (zero at $f = 0$ if flag); LfFilter: $1 - \exp(-(f/\tau)^2)$.

Filter	Parameter	Value	Type
Wire_ind	power	2	HfFilter
Wire_ind	sigma	0.423142	HfFilter
Wire_col	flag	false	HfFilter
Wire_col	max_freq	1	HfFilter
Wire_col	power	2	HfFilter
Wire_col	sigma	1.69257	HfFilter

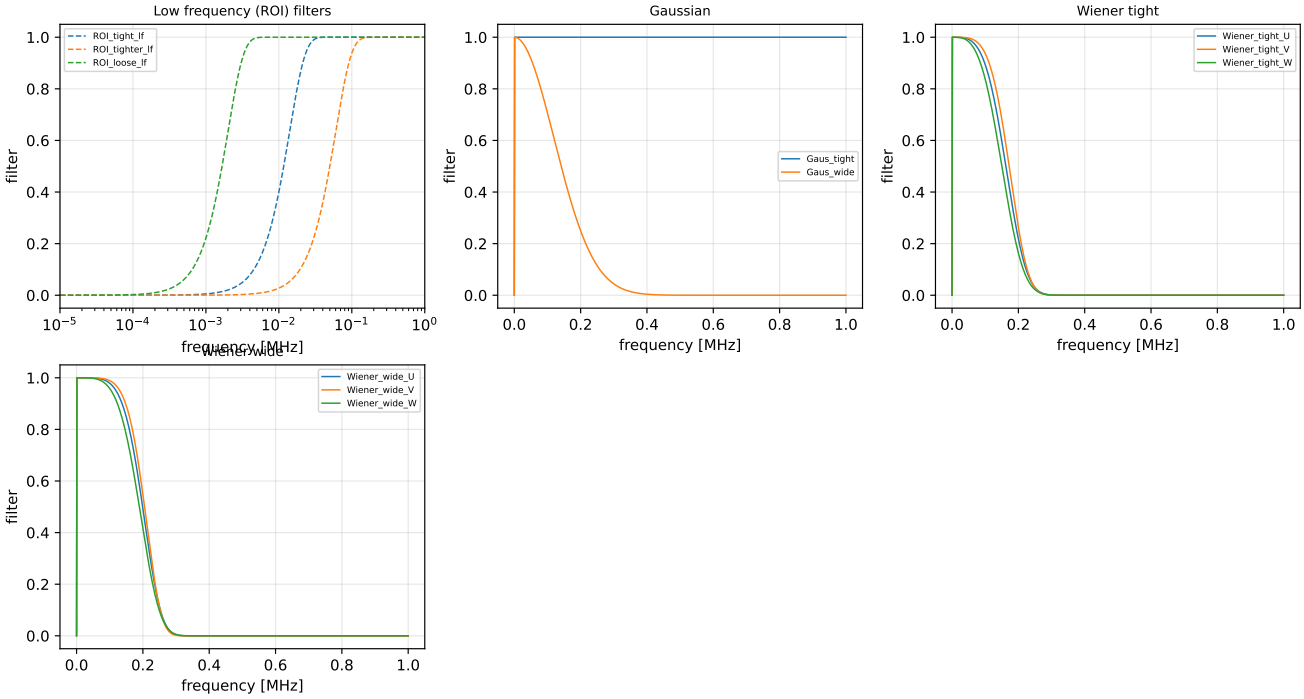


Figure 11: Time-domain filters vs frequency. Source: HfFilter/LfFilter components named in legends.

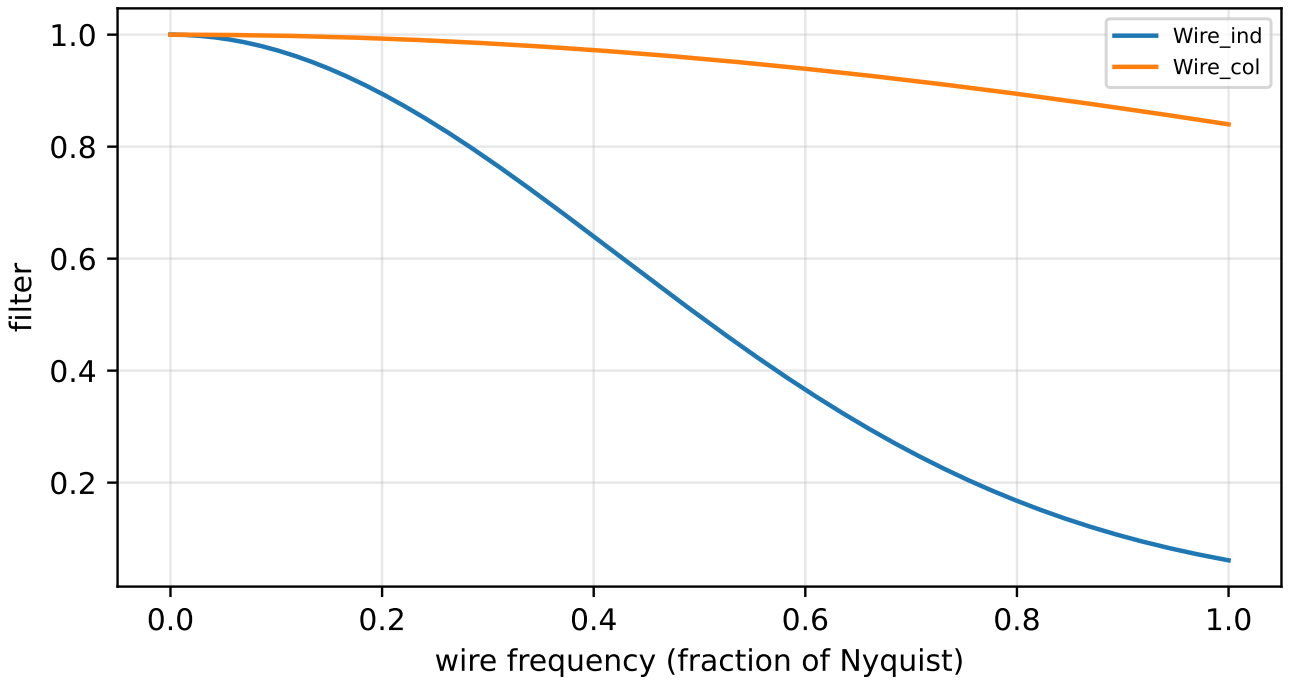


Figure 12: Wire-domain filters. Source: HfFilter components named in legend.

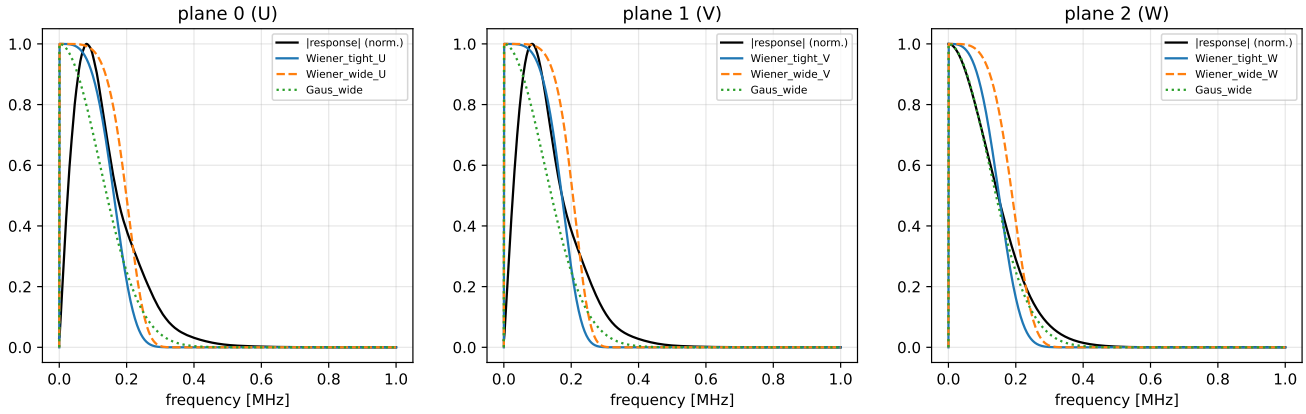


Figure 13: Magnitude of the response spectrum used in deconvolution (field response `FieldResponse:field0` wire-0 average ⊗ `ColdElecResponse:elecresp0`, sampled at 0.50 μs) with the filters applied by `OmnibusSigProc:crm#sigproc# #={0-3}`.

8 Other components

Components not covered above which may affect results.

8.1 ResponseSys

Table 33: Parameters of 1 ResponseSys component(s): ResponseSys

Parameter	Value	Source
magnitude	1	ResponseSys
nticks	8725	ResponseSys
start	$0 = 0$ μs	ResponseSys
tick	$500 = 0.5$ μs	ResponseSys
time_smear	$1000 = 1$ μs	ResponseSys

8.2 TbbDataFlowGraph

Table 34: Parameters of 1 TbbDataFlowGraph component(s): TbbDataFlowGraph

Parameter	Value	Source
max_threads	0	TbbDataFlowGraph

9 Appendix: all components

9.1 AddNoise

Table 35: Parameters of 4 AddNoise component(s): AddNoise:addnoiseempericalnoisecrm{0-3}

Parameter	Value	Source
dft	FftwDFT	all 4
model	EmpiricalNoiseModel:empericalnoisecrm0	AddNoise: addnoiseempericalnoisecrm0
	EmpiricalNoiseModel:empericalnoisecrm1	AddNoise: addnoiseempericalnoisecrm1
	EmpiricalNoiseModel:empericalnoisecrm2	AddNoise: addnoiseempericalnoisecrm2
	EmpiricalNoiseModel:empericalnoisecrm3	AddNoise: addnoiseempericalnoisecrm3
nsamples	8500	all 4
replacement_percentage	0.02	all 4
rng	Random	all 4

9.2 AnodePlane

Table 36: Parameters of 4 AnodePlane component(s): AnodePlane:crm{0-3}

Parameter	Value	Source
faces[0].anode	-6519 = -651.9 cm	all 4
faces[0].cathode	-18.4 = -1.84 cm	all 4
faces[0].response	-6338 = -633.8 cm	all 4
faces[1].anode	-6519 = -651.9 cm	all 4
faces[1].cathode	-18.4 = -1.84 cm	all 4
faces[1].response	-6338 = -633.8 cm	all 4
ident	0	AnodePlane:crm0
	1	AnodePlane:crm1
	2	AnodePlane:crm2
	3	AnodePlane:crm3
nimpacts	10	all 4
wire_schema	WireSchemaFile	all 4

9.3 ColdElecResponse

Table 37: Parameters of 1 ColdElecResponse component(s): ColdElecResponse:elecresp0

Parameter	Value	Source
filename	"	ColdElecResponse:elecresp0
gain	2.24305e-12 = 14 mV/fC	ColdElecResponse:elecresp0
nticks	8725	ColdElecResponse:elecresp0
postgain	1	ColdElecResponse:elecresp0
shaping	2200 = 2.2 μs	ColdElecResponse:elecresp0
tick	500 = 0.5 μs	ColdElecResponse:elecresp0

9.4 DepoSetDrifter

Table 38: Parameters of 1 DepoSetDrifter component(s): DepoSetDrifter

Parameter	Value	Source
drifter	Drifter	DepoSetDrifter

9.5 DepoSetFanout

Table 39: Parameters of 1 DepoSetFanout component(s): DepoSetFanout:multi_sim_fanout

Parameter	Value	Source
multiplicity	4	DepoSetFanout:multi_sim_fanout

9.6 DepoSetFilter

Table 40: Parameters of 4 DepoSetFilter component(s): DepoSetFilter:ds-filter-multi-{0-3}

Parameter	Value	Source
anode	AnodePlane:crm0	DepoSetFilter:ds-filter-multi-0
	AnodePlane:crm1	DepoSetFilter:ds-filter-multi-1
	AnodePlane:crm2	DepoSetFilter:ds-filter-multi-2
	AnodePlane:crm3	DepoSetFilter:ds-filter-multi-3

9.7 DepoTransform

Table 41: Parameters of 4 DepoTransform component(s): DepoTransform:ductor{0-3}

Parameter	Value	Source
anode	AnodePlane:crm0	DepoTransform:ductor0
	AnodePlane:crm1	DepoTransform:ductor1
	AnodePlane:crm2	DepoTransform:ductor2
	AnodePlane:crm3	DepoTransform:ductor3
dft	FftwDFT	all 4
drift_speed	0.00160563 = 1.6056 mm/μs	all 4
first_frame_number	100	all 4
fluctuate	true	all 4
nsigma	3	all 4
pirs	["PlaneImpactResponse:PIRfield0plane0", "PlaneImpactResponse:PIRfield0plane1", "PlaneImpactResponse:PIRfield0plane2"]	all 4
readout_time	4362500 = 4.3625 ms	all 4
rng	Random	all 4
start_time	-112728 = -0.112728 ms	all 4
tick	500 = 0.5 μs	all 4

9.8 DeposOrBust

DeposOrBust:dorb-multi-{0-3}: *no configuration parameters.*

9.9 Digitizer

Table 42: Parameters of 4 Digitizer component(s): Digitizer:digitizer{0-3}

Parameter	Value	Source
anode	AnodePlane:crm0	Digitizer:digitizer0
	AnodePlane:crm1	Digitizer:digitizer1
	AnodePlane:crm2	Digitizer:digitizer2
	AnodePlane:crm3	Digitizer:digitizer3
baselines	[1.0034e-06, 1.0034e-06, 5.077e-07] → [1003.4 mV, 1003.4 mV, 507.7 mV]	all 4
frame_tag	orig0	Digitizer:digitizer0

Table 42: Parameters of 4 `Digitizer` component(s): `Digitizer:digitizer{0-3}`

Parameter	Value	Source
	`orig1`	`Digitizer:digitizer1`
	`orig2`	`Digitizer:digitizer2`
	`orig3`	`Digitizer:digitizer3`
`fullscale`	`[2e-07, 1.6e-06]` → [200 mV, 1600 mV]	all 4
`gain`	`1`	all 4
`resolution`	`14`	all 4

9.10 `Drifter`

Table 43: Parameters of 1 `Drifter` component(s): `Drifter`

Parameter	Value	Source
`DL`	`4e-07` = 4 cm^2/s	`Drifter`
`DT`	`8.8e-07` = 8.8 cm^2/s	`Drifter`
`ar39activity`	`1.60218e-34` = 1 Bq/kg	`Drifter`
`density`	`8669456899850258432` = 1.389 g/cm^3	`Drifter`
`drift_speed`	`0.00160563` = 1.6056 mm/μs	`Drifter`
`fluctuate`	`true`	`Drifter`
`lifetime`	`10400000` = 10.4 ms	`Drifter`
`rng`	`Random`	`Drifter`
`time_offset`	`0` = 0 μs	`Drifter`
`xregions[0].anode`	`-6519` = -651.9 cm	`Drifter`
`xregions[0].cathode`	`-18.4` = -1.84 cm	`Drifter`
`xregions[0].response`	`-6338` = -633.8 cm	`Drifter`
`xregions[1].anode`	`6521.5` = 652.15 cm	`Drifter`
`xregions[1].cathode`	`20.9` = 2.09 cm	`Drifter`
`xregions[1].response`	`6340.5` = 634.05 cm	`Drifter`

9.11 `DumpFrames`

`DumpFrames:multi-dump-{0-3}`: *no configuration parameters.*

9.12 `EmpiricalNoiseModel`

Table 44: Parameters of 4 `EmpiricalNoiseModel` component(s): `EmpiricalNoiseModel:empericalnoisecrm{0-3}`

Parameter	Value	Source
`anode`	`AnodePlane:crm0`	`EmpiricalNoiseModel:empericalnoisecrm0`
	`AnodePlane:crm1`	`EmpiricalNoiseModel:empericalnoisecrm1`
	`AnodePlane:crm2`	`EmpiricalNoiseModel:empericalnoisecrm2`
	`AnodePlane:crm3`	`EmpiricalNoiseModel:empericalnoisecrm3`
`chanstat`	`"`	all 4
`dft`	`FftwDFT`	all 4
`nsamples`	`8500`	all 4
`period`	`500` = 0.5 μs	all 4
`spectra_file`	`pdvd-bottom-noise-spectra-14mVfC-v1.json.bz2`	all 4
`wire_length_scale`	`10` = 1 cm	all 4

9.13 `FftwDFT`

`FftwDFT`: *no configuration parameters.*

9.14 `FieldResponse`

Table 45: Parameters of 1 FieldResponse component(s): FieldResponse:field0

Parameter	Value	Source
filename	protodunevd_FR_imbalance3p_260501.json.bz2	FieldResponse:field0

9.15 FrameFanin

Table 46: Parameters of 4 FrameFanin component(s): FrameFanin:multi-raw-fanin-{0-3}

Parameter	Value	Source
multiplicity	1	all 4
tag_rules[0].frame..*	daq0	FrameFanin:multi-raw-fanin-0
	daq1	FrameFanin:multi-raw-fanin-1
	daq2	FrameFanin:multi-raw-fanin-2
	daq3	FrameFanin:multi-raw-fanin-3
tag_rules[0].trace..*	daq0	FrameFanin:multi-raw-fanin-0
	daq1	FrameFanin:multi-raw-fanin-1
	daq2	FrameFanin:multi-raw-fanin-2
	daq3	FrameFanin:multi-raw-fanin-3
tags	["daq0"]	FrameFanin:multi-raw-fanin-0
	["daq1"]	FrameFanin:multi-raw-fanin-1
	["daq2"]	FrameFanin:multi-raw-fanin-2
	["daq3"]	FrameFanin:multi-raw-fanin-3

9.16 FrameSync

FrameSync:frame-sync-multi-{0-3}: *no configuration parameters.*

9.17 HfFilter

Table 47: Parameters of 10 HfFilter component(s): HfFilter:Gaus_tight, HfFilter:Gaus_wide, HfFilter:Wiener_tight_U, HfFilter:Wiener_tight_V, ... (6 more)

Parameter	Value	Source
flag	true	HfFilter:Gaus_tight, HfFilter:Gaus_wide, HfFilter:Wiener_tight_U, HfFilter:Wiener_tight_V, ... (4 more)
	false	HfFilter:Wire_ind, HfFilter:Wire_col
max_freq	0.001 = 1 MHz	HfFilter:Gaus_tight, HfFilter:Gaus_wide, HfFilter:Wiener_tight_U, HfFilter:Wiener_tight_V, ... (4 more)
	1 = 1000 MHz	HfFilter:Wire_ind, HfFilter:Wire_col
power	2	HfFilter:Gaus_tight, HfFilter:Gaus_wide, HfFilter:Wire_ind, HfFilter:Wire_col
	3.76194	HfFilter:Wiener_tight_U
	4.36125	HfFilter:Wiener_tight_V
	3.35324	HfFilter:Wiener_tight_W

Table 47: Parameters of 10 `HfFilter` component(s): `HfFilter:Gaus_tight, HfFilter:Gaus_wide, HfFilter:Wiener_tight_U, HfFilter:Wiener_tight_V, ...  (6 more)`

Parameter	Value	Source
	5.05429	HfFilter:Wiener_wide_U
	5.77422	HfFilter:Wiener_wide_V
	... 1 more distinct values	
sigma	0 = 0 MHz	HfFilter:Gaus_tight
	0.00012 = 0.12 MHz	HfFilter:Gaus_wide
	0.000148788 = 0.1488 MHz	HfFilter:Wiener_tight_U
	0.000159657 = 0.1597 MHz	HfFilter:Wiener_tight_V
	0.00013623 = 0.1362 MHz	HfFilter:Wiener_tight_W
	0.000186765 = 0.1868 MHz	HfFilter:Wiener_wide_U
	... 4 more distinct values	

9.18 JsonElecResponse

Table 48: Parameters of 1 `JsonElecResponse` component(s): `JsonElecResponse:elecresp1`

Parameter	Value	Source
filename	dunevd-coldbox-elecresp-top-psnorm_400.json.bz2	JsonElecResponse:elecresp1
gain	2.24305e-12 = 14 mV/fC	JsonElecResponse:elecresp1
nticks	8725	JsonElecResponse:elecresp1
postgain	1.36	JsonElecResponse:elecresp1
shaping	2000 = 2 μs	JsonElecResponse:elecresp1
tick	500 = 0.5 μs	JsonElecResponse:elecresp1

9.19 LfFilter

Table 49: Parameters of 3 `LfFilter` component(s): `LfFilter:ROI_tight_lf, LfFilter:ROI_tighter_lf, LfFilter:ROI_loose_lf`

Parameter	Value	Source
max_freq	0.001 = 1 MHz	all 3
tau	1.4e-05 = 0.014 MHz	LfFilter:ROI_tight_lf
	6e-05 = 0.06 MHz	LfFilter:ROI_tighter_lf
	2e-06 = 0.002 MHz	LfFilter:ROI_loose_lf

9.20 MegaAnodePlane

Table 50: Parameters of 4 `MegaAnodePlane` component(s): `MegaAnodePlane:meganodes_{0-3}`

Parameter	Value	Source
anodes_tn	["AnodePlane:crm0"]	MegaAnodePlane:meganodes_0
	["AnodePlane:crm1"]	MegaAnodePlane:meganodes_1
	["AnodePlane:crm2"]	MegaAnodePlane:meganodes_2
	["AnodePlane:crm3"]	MegaAnodePlane:meganodes_3

9.21 OmnibusSigProc

Table 51: Parameters of 4 `OmnibusSigProc` component(s): `OmnibusSigProc:crm#sigproc# #={0-3}`

Parameter	Value	Source
ADC_mV	1.17021e+10 = 11.702 ADC/mV	all 4
anode	AnodePlane:crm0	OmnibusSigProc:crm0sigproc0
	AnodePlane:crm1	OmnibusSigProc:crm1sigproc1
	AnodePlane:crm2	OmnibusSigProc:crm2sigproc2
	AnodePlane:crm3	OmnibusSigProc:crm3sigproc3

Table 51: Parameters of 4 OmnibusSigProc component(s): OmnibusSigProc:crm#sigproc# #={0-3}

Parameter	Value	Source
break_roi_loop1_tag	break_roi_1st0	OmnibusSigProc:crm0sigproc0
	break_roi_1st1	OmnibusSigProc:crm1sigproc1
	break_roi_1st2	OmnibusSigProc:crm2sigproc2
	break_roi_1st3	OmnibusSigProc:crm3sigproc3
break_roi_loop2_tag	break_roi_2nd0	OmnibusSigProc:crm0sigproc0
	break_roi_2nd1	OmnibusSigProc:crm1sigproc1
	break_roi_2nd2	OmnibusSigProc:crm2sigproc2
	break_roi_2nd3	OmnibusSigProc:crm3sigproc3
cleanup_roi_tag	cleanup_roi0	OmnibusSigProc:crm0sigproc0
	cleanup_roi1	OmnibusSigProc:crm1sigproc1
	cleanup_roi2	OmnibusSigProc:crm2sigproc2
	cleanup_roi3	OmnibusSigProc:crm3sigproc3
ctoffset	$4000 = 4$ μs	all 4
decon_charge_tag	decon_charge0	OmnibusSigProc:crm0sigproc0
	decon_charge1	OmnibusSigProc:crm1sigproc1
	decon_charge2	OmnibusSigProc:crm2sigproc2
	decon_charge3	OmnibusSigProc:crm3sigproc3
dft	FftwDFT	all 4
elecresponse	ColdElecResponse:elecresp0	all 4
extend_roi_tag	extend_roi0	OmnibusSigProc:crm0sigproc0
	extend_roi1	OmnibusSigProc:crm1sigproc1
	extend_roi2	OmnibusSigProc:crm2sigproc2
	extend_roi3	OmnibusSigProc:crm3sigproc3
fft_flag	0	all 4
field_response	FieldResponse:field0	all 4
ftoffset	$0 = 0$ μs	all 4
gauss_tag	gauss0	OmnibusSigProc:crm0sigproc0
	gauss1	OmnibusSigProc:crm1sigproc1
	gauss2	OmnibusSigProc:crm2sigproc2
	gauss3	OmnibusSigProc:crm3sigproc3
loose_lf_tag	loose_lf0	OmnibusSigProc:crm0sigproc0
	loose_lf1	OmnibusSigProc:crm1sigproc1
	loose_lf2	OmnibusSigProc:crm2sigproc2
	loose_lf3	OmnibusSigProc:crm3sigproc3
lroi_jump_one_bin	1	all 4
lroi_rebin	6	all 4
lroi_th_factor	3.5	all 4
lroi_th_factor1	0.7	all 4
mp2_roi_tag	mp2_roi0	OmnibusSigProc:crm0sigproc0
	mp2_roi1	OmnibusSigProc:crm1sigproc1
	mp2_roi2	OmnibusSigProc:crm2sigproc2
	mp2_roi3	OmnibusSigProc:crm3sigproc3
mp3_roi_tag	mp3_roi0	OmnibusSigProc:crm0sigproc0
	mp3_roi1	OmnibusSigProc:crm1sigproc1
	mp3_roi2	OmnibusSigProc:crm2sigproc2
	mp3_roi3	OmnibusSigProc:crm3sigproc3
per_chan_resp	"	all 4
postgain	1	all 4
r_fake_signal_high_th	750	all 4
r_fake_signal_high_th_ind_factor	1	all 4
r_fake_signal_low_th	375	all 4
r_fake_signal_low_th_ind_factor	1	all 4
r_low_peak_sep_threshold_pre	1200	all 4
r_sep_peak	6	all 4
r_th_factor	3	all 4
r_th_peak	3	all 4
shrink_roi_tag	shrink_roi0	OmnibusSigProc:crm0sigproc0
	shrink_roi1	OmnibusSigProc:crm1sigproc1
	shrink_roi2	OmnibusSigProc:crm2sigproc2
	shrink_roi3	OmnibusSigProc:crm3sigproc3
sparse	true	all 4
tight_lf_tag	tight_lf0	OmnibusSigProc:crm0sigproc0
	tight_lf1	OmnibusSigProc:crm1sigproc1

Table 51: Parameters of 4 OmnibusSigProc component(s): OmnibusSigProc:crm#sigproc# #={0-3}

Parameter	Value	Source
	tight_lf2	OmnibusSigProc:crm2sigproc2
	tight_lf3	OmnibusSigProc:crm3sigproc3
troi_col_th_factor	5	all 4
troi_ind_th_factor	3	all 4
use_multi_plane_protection	false	all 4
use_roi_debug_mode	false	all 4
wiener_tag	wiener0	OmnibusSigProc:crm0sigproc0
	wiener1	OmnibusSigProc:crm1sigproc1
	wiener2	OmnibusSigProc:crm2sigproc2
	wiener3	OmnibusSigProc:crm3sigproc3

9.22 PlaneImpactResponse

Table 52: Parameters of 3 PlaneImpactResponse component(s): PlaneImpactResponse:PIRfield0plane{0-2}

Parameter	Value	Source
dft	FftwDFT	all 3
field_response	FieldResponse:field0	all 3
long_padding	1500000 = 1.5 ms	all 3
long_responses	[]	all 3
nticks	8725	all 3
overall_short_padding	200000 = 0.2 ms	all 3
plane	0	PlaneImpactResponse:PIRfield0plane0
	1	PlaneImpactResponse:PIRfield0plane1
	2	PlaneImpactResponse:PIRfield0plane2
short_responses	["ColdElecResponse:elecresp0"]	all 3
tick	500 = 0.5 μs	all 3

9.23 RCResponse

Table 53: Parameters of 1 RCResponse component(s): RCResponse

Parameter	Value	Source
nticks	8725	RCResponse
tick	500 = 0.5 μs	RCResponse
width	1100000 = 1.1 ms	RCResponse

9.24 Random

Table 54: Parameters of 1 Random component(s): Random

Parameter	Value	Source
generator	default	Random
seeds	[0, 1, 2, 3, 4]	Random

9.25 Reframer

Table 55: Parameters of 4 Reframer component(s): Reframer:reframer{0-3}

Parameter	Value	Source
anode	AnodePlane:crm0	Reframer:reframer0
	AnodePlane:crm1	Reframer:reframer1

Table 55: Parameters of 4 Reframer component(s): Reframer:reframer{0-3}

Parameter	Value	Source
	AnodePlane:crm2	Reframer:reframer2
	AnodePlane:crm3	Reframer:reframer3
fill	0	all 4
nticks	8500	all 4
tags	[]	all 4
tbin	225	all 4
toffset	$0 = 0$ μs	all 4

9.26 ResponseSys

Table 56: Parameters of 1 ResponseSys component(s): ResponseSys

Parameter	Value	Source
magnitude	1	ResponseSys
nticks	8725	ResponseSys
start	$0 = 0$ μs	ResponseSys
tick	$500 = 0.5$ μs	ResponseSys
time_smear	$1000 = 1$ μs	ResponseSys

9.27 Retagger

Table 57: Parameters of 4 Retagger component(s): Retagger:multi-raw-retag-{0-3}

Parameter	Value	Source
tag_rules[0].frame..*	daq0	Retagger:multi-raw-retag-0
	daq1	Retagger:multi-raw-retag-1
	daq2	Retagger:multi-raw-retag-2
	daq3	Retagger:multi-raw-retag-3
tag_rules[0].merge..*	daq0	Retagger:multi-raw-retag-0
	daq1	Retagger:multi-raw-retag-1
	daq2	Retagger:multi-raw-retag-2
	daq3	Retagger:multi-raw-retag-3

9.28 TbbDataFlowGraph

Table 58: Parameters of 1 TbbDataFlowGraph component(s): TbbDataFlowGraph

Parameter	Value	Source
max_threads	0	TbbDataFlowGraph

9.29 TbbFlow

Table 59: Parameters of 1 TbbFlow component(s): TbbFlow

Parameter	Value	Source
edges	[{"head":{"node":"DepoSetDrifter","port":0},"tail": {"node":"wclsSimDepoSetSource","port":0}},{"head": {"node":"DepoSetFanout:multi_sim_fanout","port":0}, "tail":{... (62 elements)	TbbFlow

9.30 WireSchemaFile

Table 60: Parameters of 1 WireSchemaFile component(s): WireSchemaFile

Parameter	Value	Source
filename	dunevd10kt_3view_30deg_v6_refactored.json.bz2	WireSchemaFile

9.31 wclsDepoFluxWriter

Table 61: Parameters of 4 wclsDepoFluxWriter component(s): wclsDepoFluxWriter:postdrift{0-3}

Parameter	Value	Source
anodes	["AnodePlane:crm0"]	wclsDepoFluxWriter:postdrift0
	["AnodePlane:crm1"]	wclsDepoFluxWriter:postdrift1
	["AnodePlane:crm2"]	wclsDepoFluxWriter:postdrift2
	["AnodePlane:crm3"]	wclsDepoFluxWriter:postdrift3
field_response	FieldResponse:field0	all 4
nsigma	3	all 4
reference_time	$0 = 0$ μs	all 4
sed_label	IonAndScint	all 4
simchan_label	simpleSC0	wclsDepoFluxWriter:postdrift0
	simpleSC1	wclsDepoFluxWriter:postdrift1
	simpleSC2	wclsDepoFluxWriter:postdrift2
	simpleSC3	wclsDepoFluxWriter:postdrift3
sparse	true	all 4
tick	$500 = 0.5$ μs	all 4
window_duration	$4250000 = 4.25$ ms	all 4
window_start	$0 = 0$ μs	all 4

9.32 wclsFrameSaver

Table 62: Parameters of 8 wclsFrameSaver component(s): wclsFrameSaver:simdigits{0-3}, wclsFrameSaver:spsignals{0-3}

Parameter	Value	Source
anode	MegaAnodePlane:meganodes_0	wclsFrameSaver:simdigits0, wclsFrameSaver:spsignals0
	MegaAnodePlane:meganodes_1	wclsFrameSaver:simdigits1, wclsFrameSaver:spsignals1
	MegaAnodePlane:meganodes_2	wclsFrameSaver:simdigits2, wclsFrameSaver:spsignals2
	MegaAnodePlane:meganodes_3	wclsFrameSaver:simdigits3, wclsFrameSaver:spsignals3
digitize	true	wclsFrameSaver:simdigits{0-3}
	false	wclsFrameSaver:spsignals{0-3}
frame_tags	["daq0"]	wclsFrameSaver:simdigits0
	["gauss0","wiener0"]	wclsFrameSaver:spsignals0
	["daq1"]	wclsFrameSaver:simdigits1
	["gauss1","wiener1"]	wclsFrameSaver:spsignals1
	["daq2"]	wclsFrameSaver:simdigits2
	["gauss2","wiener2"]	wclsFrameSaver:spsignals2
	... 2 more distinct values	
pedestal_mean	native	wclsFrameSaver:simdigits{0-3}
chanmaskmaps	[]	wclsFrameSaver:spsignals{0-3}

Table 62: Parameters of 8 `wclsFrameSaver` component(s): `wclsFrameSaver:simdigits{0-3}`, `wclsFrameSaver:spsignals{0-3}`

Parameter	Value	Source
frame_scale	[0.005, 0.005]	wclsFrameSaver:spsignals{0-3}
nticks	8500	wclsFrameSaver:spsignals{0-3}
plane_map.1	0	wclsFrameSaver:spsignals{0-3}
plane_map.2	1	wclsFrameSaver:spsignals{0-3}
plane_map.4	2	wclsFrameSaver:spsignals{0-3}
sparse	true	wclsFrameSaver:spsignals{0-3}

9.33 wclsSimDepoSetSource

Table 63: Parameters of 1 `wclsSimDepoSetSource` component(s): `wclsSimDepoSetSource`

Parameter	Value	Source
art_tag	IonAndScint	wclsSimDepoSetSource
assn_art_tag	"	wclsSimDepoSetSource
id_is_track	false	wclsSimDepoSetSource
model	"	wclsSimDepoSetSource
scale	-1	wclsSimDepoSetSource

10 Warnings

- FHiCL include "seedservice.fcl" not found (from seedservice_dune.fcl:17)
- FHiCL include "photpropservices_dune.fcl" not found (from services_common_dune.fcl:15)
- FHiCL include "opticaldetectorservices_dune.fcl" not found (from services_common_dune.fcl:17)
- FHiCL include "channelstatus_pdsp.fcl" not found (from services_common_dune.fcl:20)
- FHiCL include "dataprep_dune.fcl" not found (from services_common_dune.fcl:26)
- FHiCL include "protodune_dataprep_services.fcl" not found (from services_common_dune.fcl:27)
- FHiCL include "xyzcalib_dune.fcl" not found (from services_common_dune.fcl:30)
- FHiCL include "lifetimecalib_dune.fcl" not found (from services_common_dune.fcl:31)
- FHiCL include "PhotonCalibratorProtoDUNESP.fcl" not found (from services_common_dune.fcl:32)