

CRP #6 + PDS processing with LArSoft

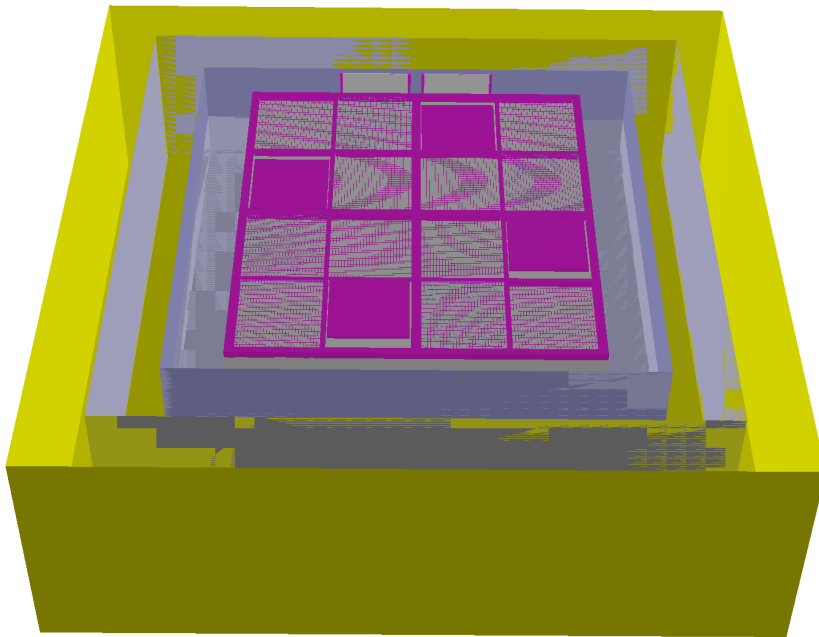
Yoann Kermaïdic*

ProtoDUNE-VD

September 30th, 2024

based on collaboration with Jake C., Ajib P., Wei S. & Laura Z.

The CRP6 + PDS setup



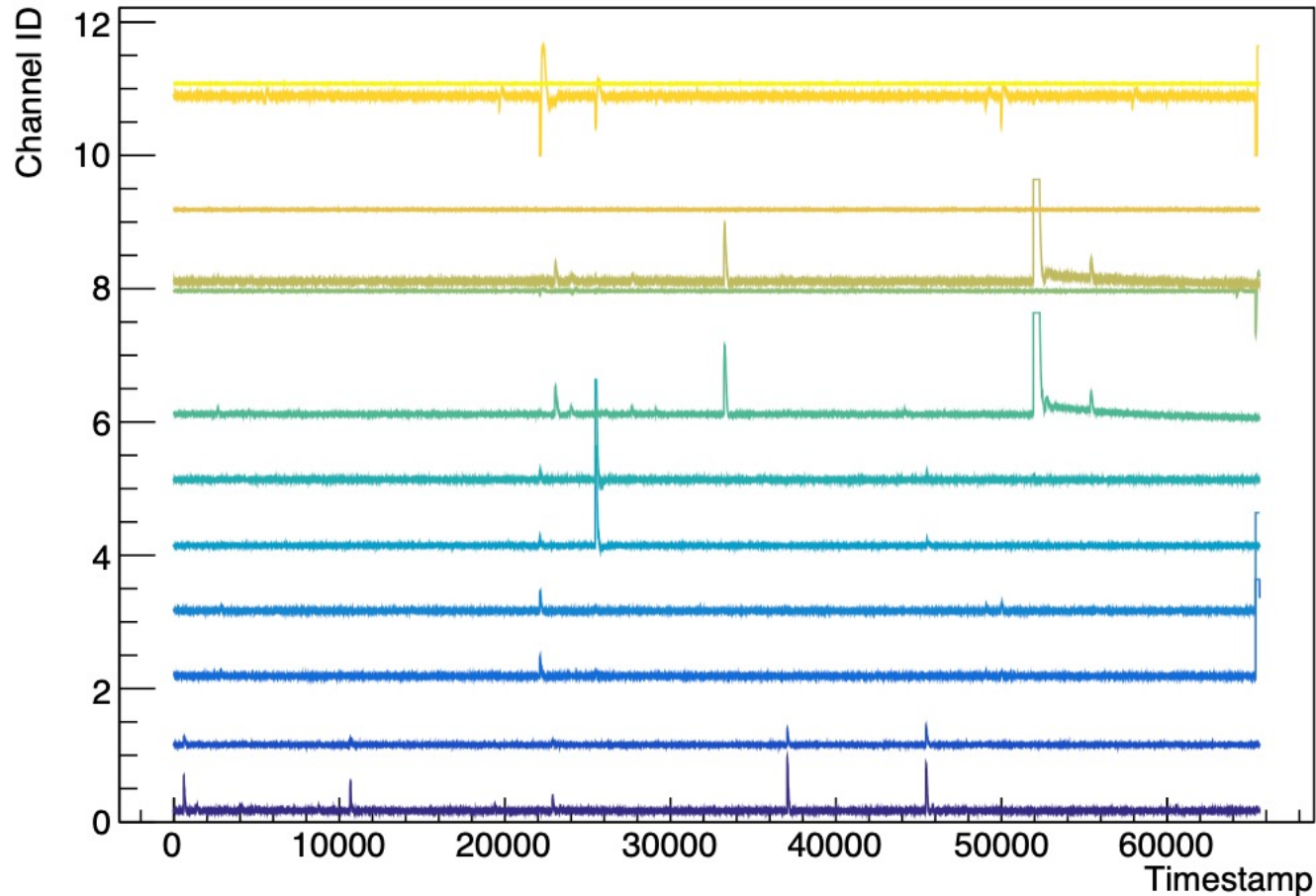
- Interested in reconstructing Pulsed Neutron Source (PNS) dataset - *run 25034 hereafter*
- [April 2024 – runs \[25034, 25086\]](#)
- CRP6 version III
- 6 single sided XAr. PDS
 - 4 on the cathode
 - 2 on the membrane
- 2 readout channels per Op Det.
- Using latest DAPHNE DAQ

See also Laura Z. contributions: https://indico.fnal.gov/event/63459/contributions/285239/attachments/175405/237929/cb_crp6_pds_track_230224.pdf
https://indico.fnal.gov/event/64496/contributions/290064/attachments/177338/241361/cb_crp6_iii_first_look_26424.pdf

PDS DAPHNE decoder

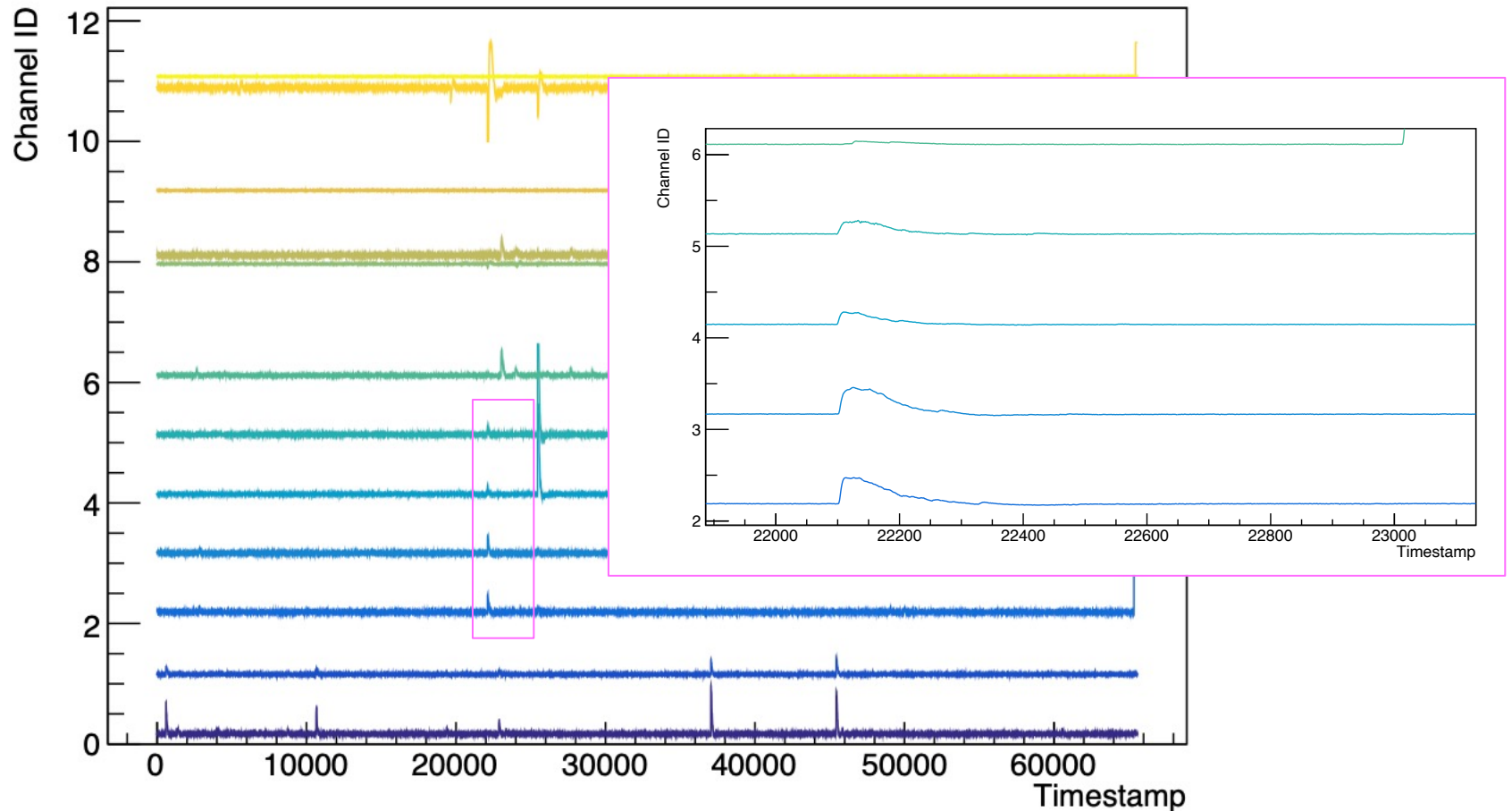
- Worked out the latest DAPHNE version HDF5 data decoder with Jake
- Setup a proper PDS channel mapping with Ajib
- In *v09_92_00d00*, PRs have been merged to include working configs:
 - Jan 2024:
 - CRP+PDS reconstruction: [crp6_data_reco_daphne_bde2.fcl](#)
 - PDS channel mapping: [DAPHNE_vd_coldbox_ChannelMap_bde2.txt](#)
 - April 2024:
 - CRP+PDS reconstruction: [crp6_data_reco_daphne_bde3.fcl](#)
 - PDS channel mapping: [DAPHNE_vd_coldbox_ChannelMap_bde3.txt](#)
 - GDML geometry with PDS onto the cathode + membrane:
 - [dunecrpcb2_v3_refactored.gdml](#)

PDS raw waveforms



- Two channels not showing signals (from membrane dets.)
- Saturation observed in this run (25034) but not much undershoot

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PDS deconvolution

- LArSoft PDS pipeline relies on conversion from `raw::OpDetWaveforms` to `recob::OpWaveforms`
- Done by the deconvolution step by default

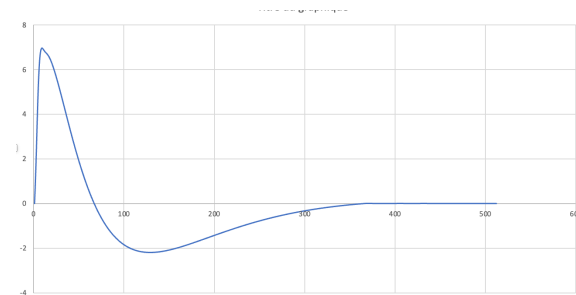
```
physics: {  
  producers: {  
    rns: { module_type: "RandomNumberSaver" }  
    #Decoders  
    tpcrawdecoder: @local::PDHDTPCReaderDefaults  
    pdhddaphne: @local::DAPHNereaderPDHD  
    #PDS reco  
    opdec: @local::dune_deconvolution  
    ophitspe: @local::dune_ophit_finder_deco  
    opflash: @local::protodune_opflash  
    opslicer: @local::protodune_opslicer
```

PDS deconvolution

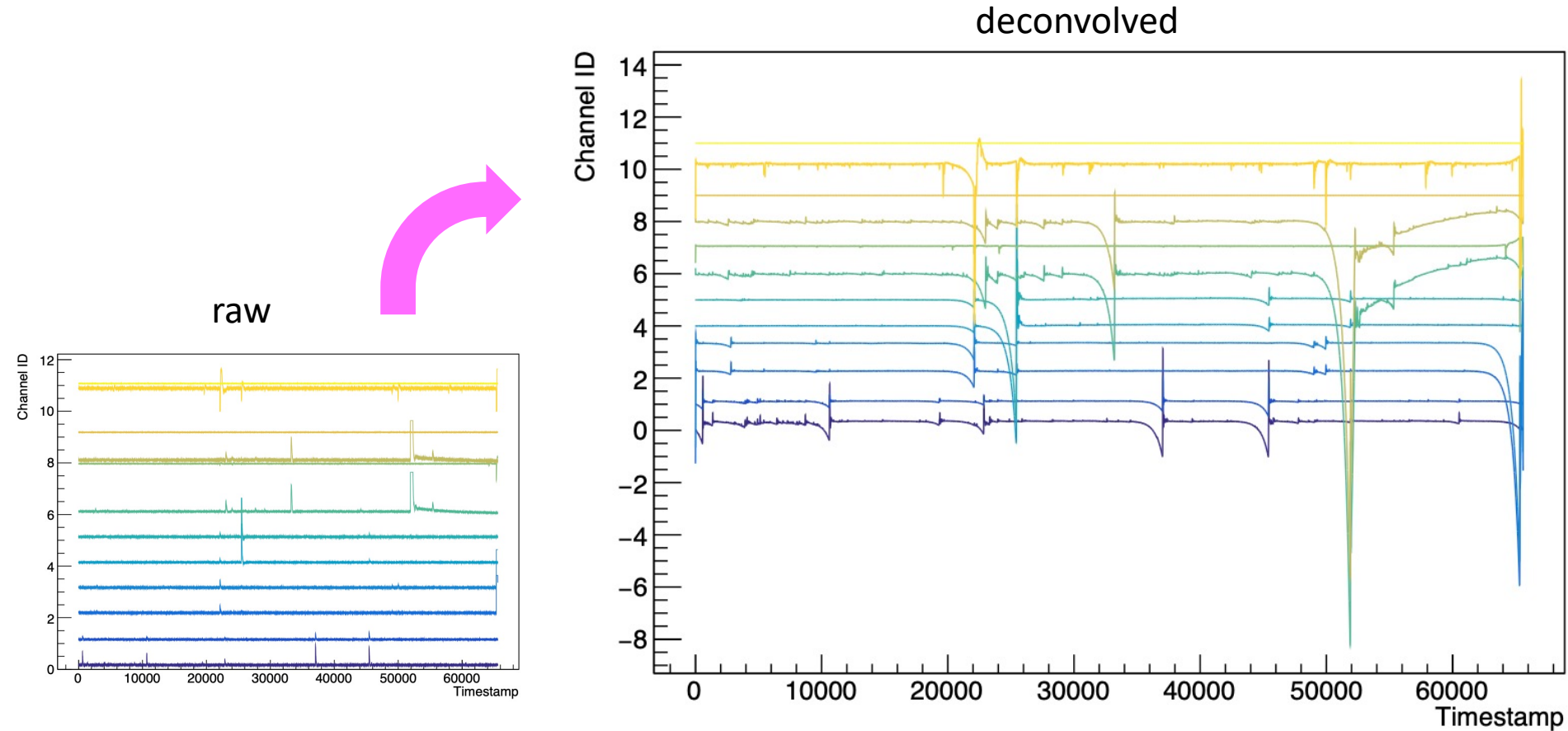
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- Which makes use of a default template waveform
- Obviously not adequate for the PDS R&D runs in CRP6



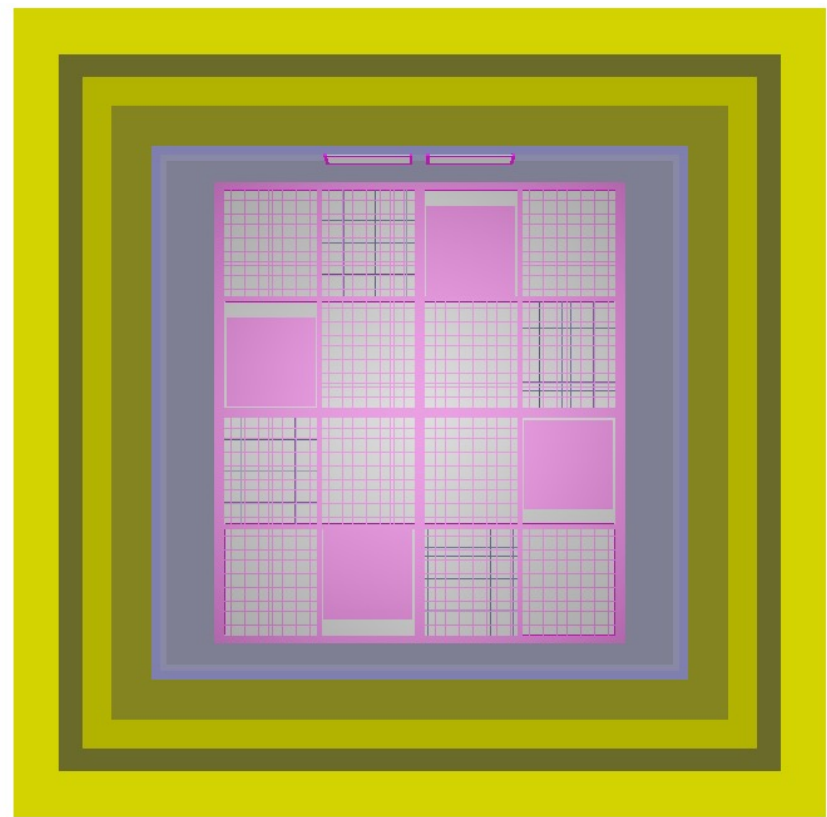
PDS deconvolution



- Need to by-pass this step and run hit/flash finder on raw Wf

PDS hit finder

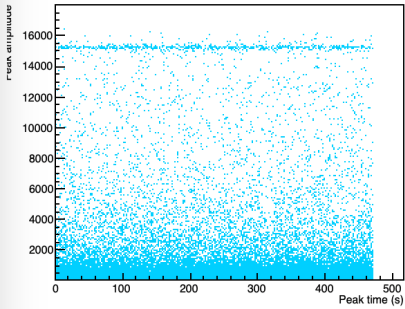
- Removed deconvolution step and look for hit on raw waveforms
- The hit finder relies on the GDML detector implementation to find out the proper amount of optical channels (worked this out with Wei S.)



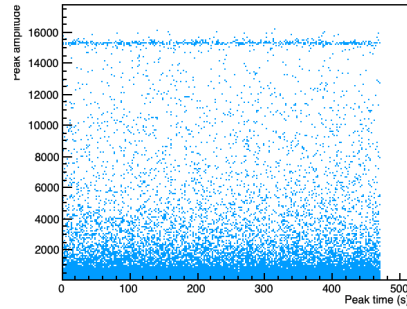
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    opflash: @local::protodune_opflash_data_internal
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PDS hit finder

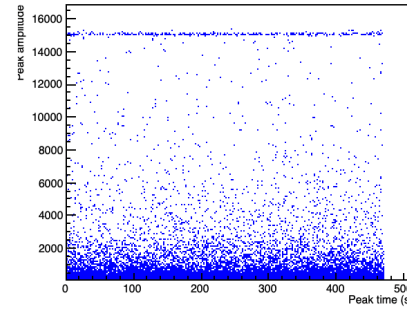
Optical channel 0



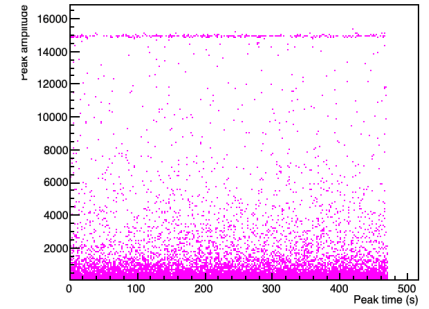
Optical channel 1



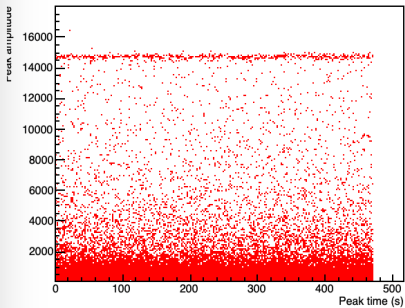
Optical channel 2



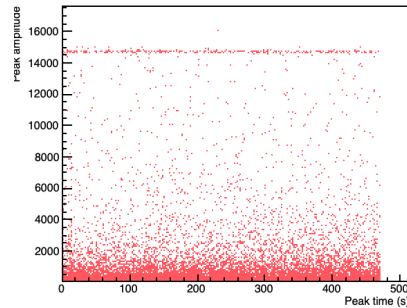
Optical channel 3



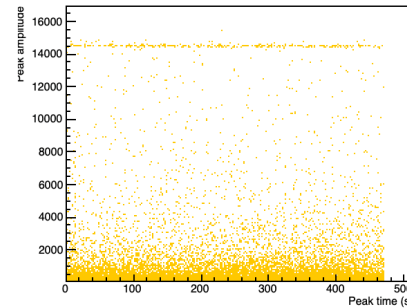
Optical channel 4



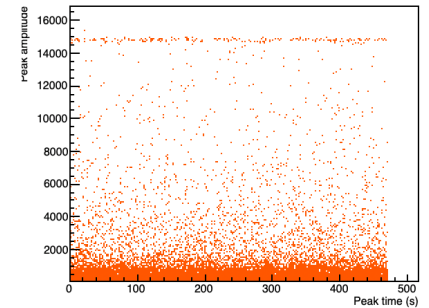
Optical channel 5



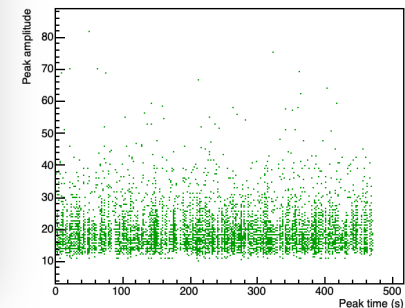
Optical channel 6



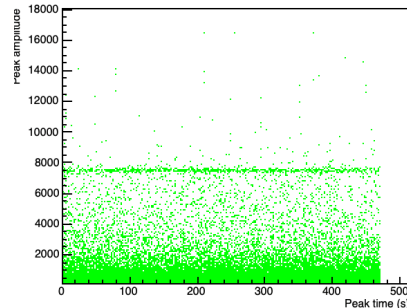
Optical channel 7



Optical channel 8

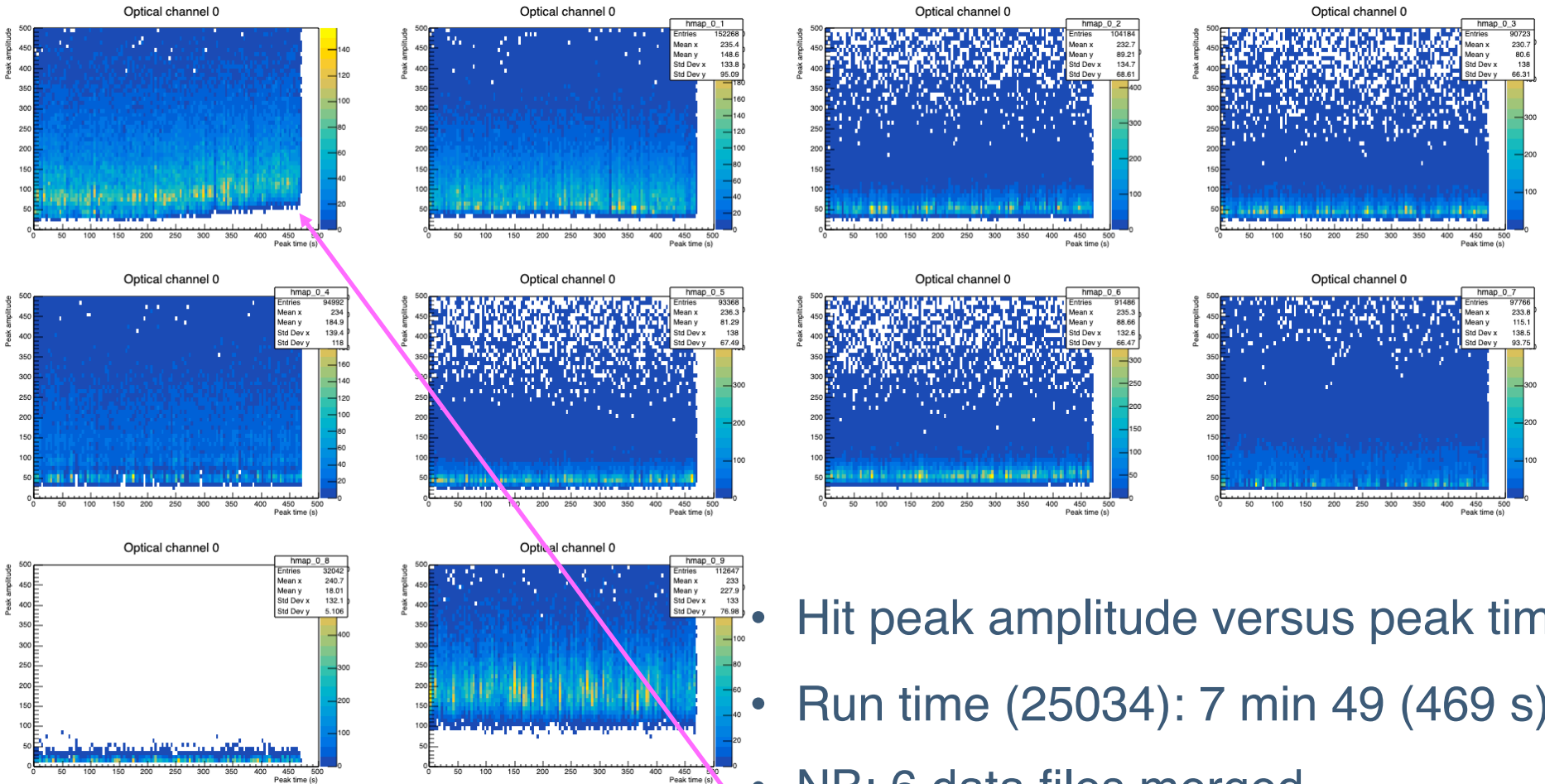


Optical channel 9



- Hit peak amplitude versus peak time
- Run time (25034): 7 min 49 (469 s)
- NB: 6 data files merged

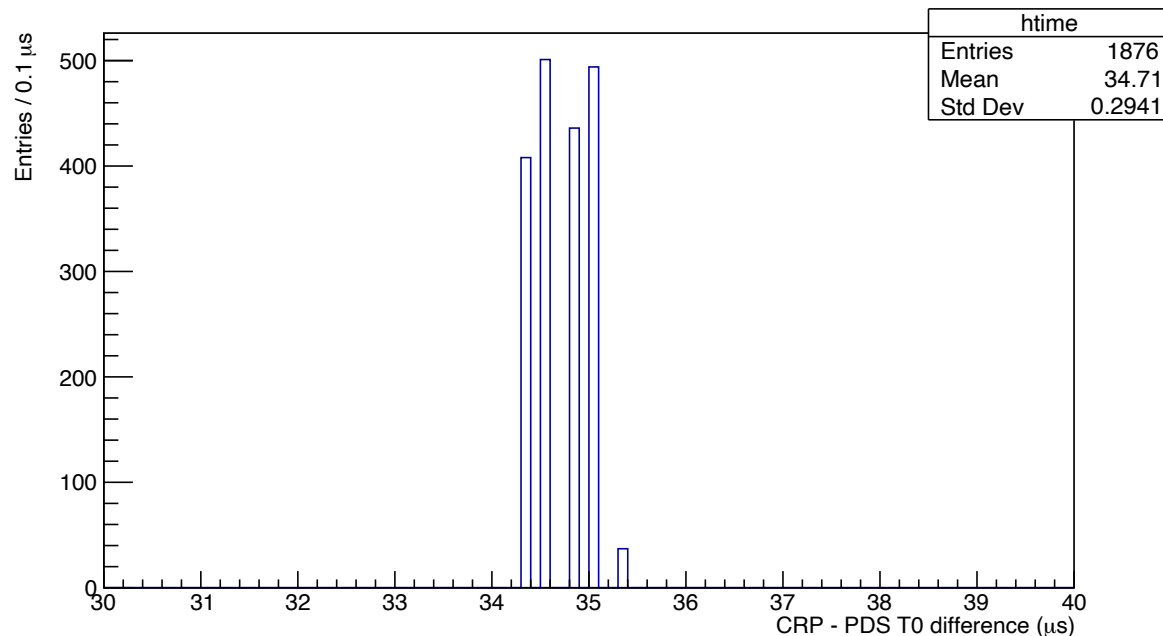
PDS hit finder



- Hit peak amplitude versus peak time
- Run time (25034): 7 min 49 (469 s)
- NB: 6 data files merged
- Some time variation found

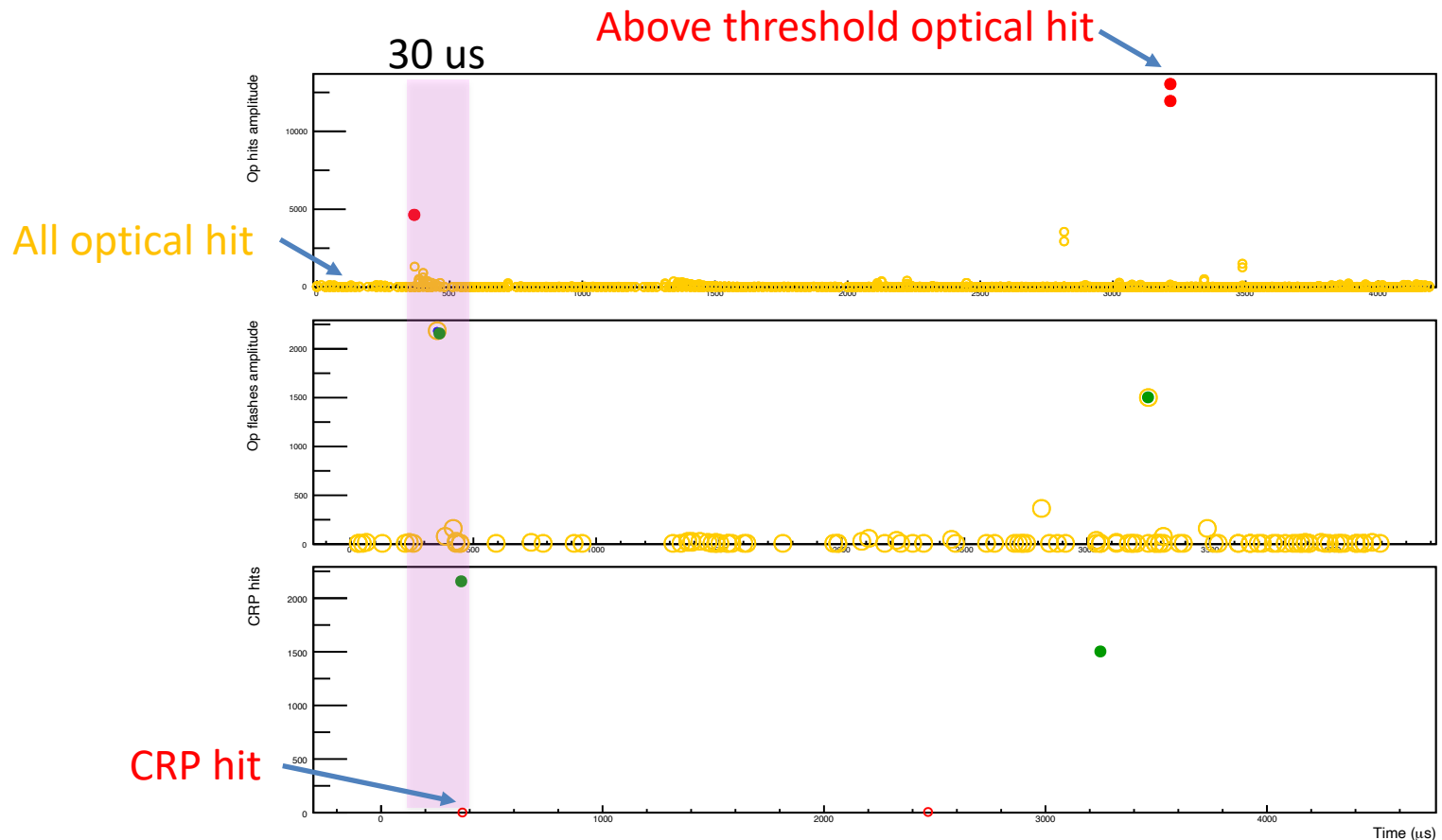
PDS vs CRP timing

- T0 of CRP RawDigits (RDTimeStamp) is compared to PDS waveform T0 TimeStamp
- Using custom LArSoft v09_91_04d00
- 34.7 μs offset observed (lower jitter achieved in other version)



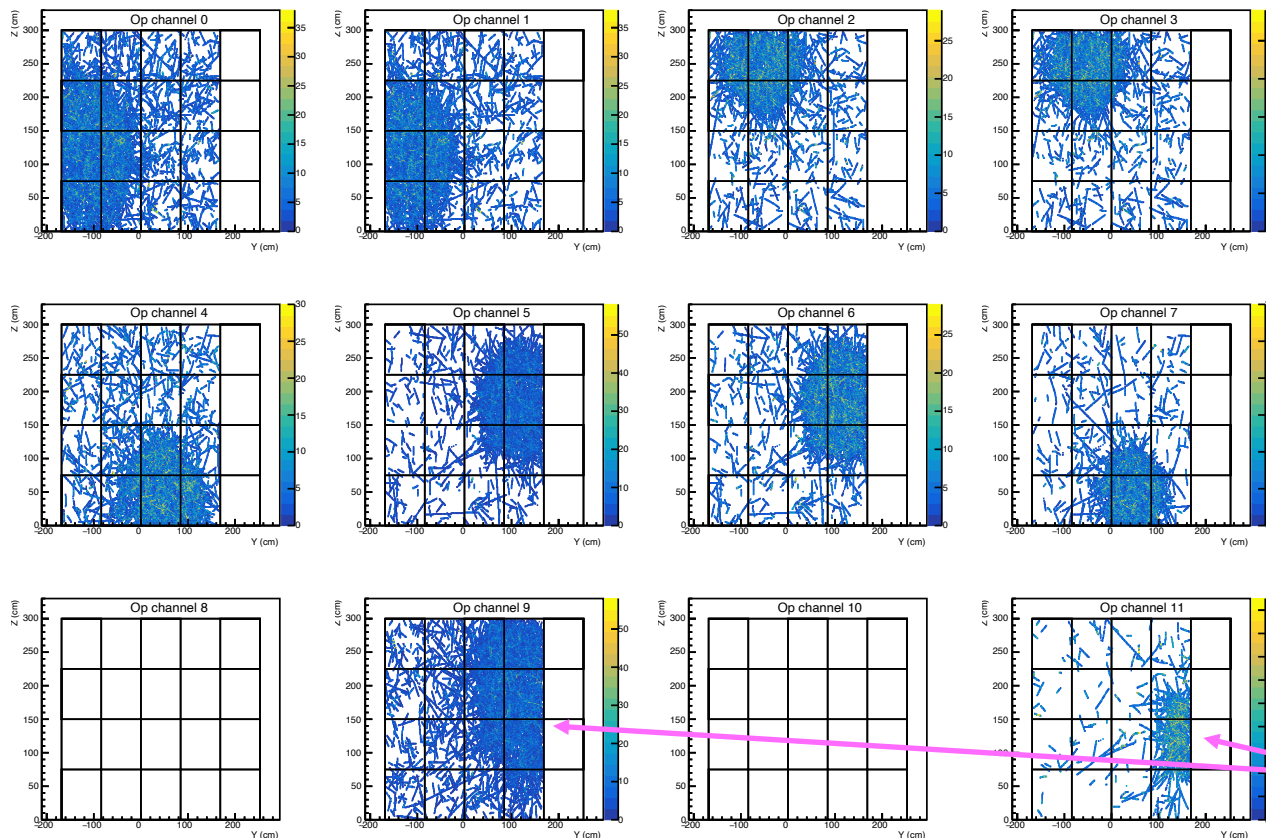
CRP vs Optical hits matching

- Set a threshold on OpHit amplitude and match it with CRP hit



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- Set a threshold on OpHit amplitude and match it with CRP hit
- Plot all CRP tracks that have a match with one OpChannel

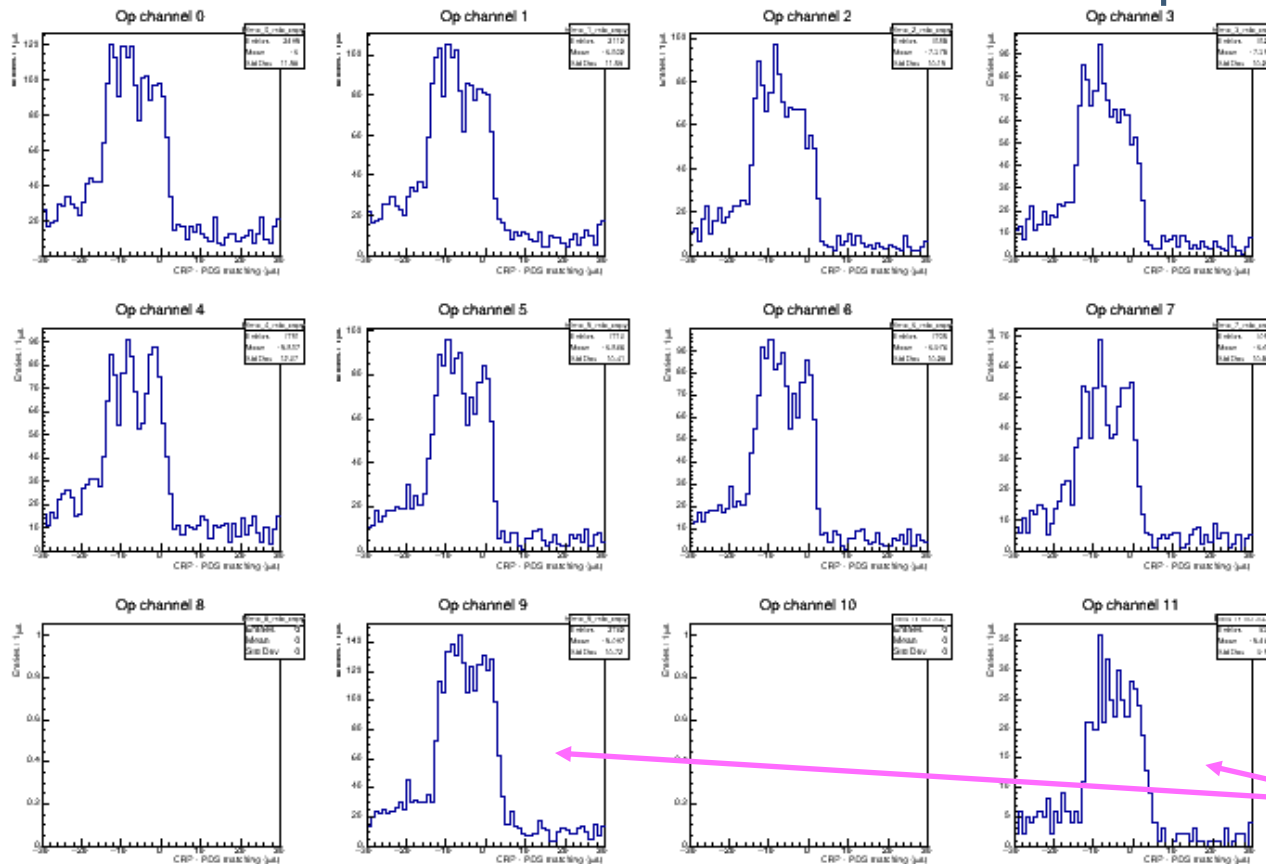


Cathode frame overlaid

Membrane OpChannel

CRP vs Optical hits matching

- Set a threshold on OpHit amplitude and match it with CRP hit
- Plot all CRP tracks that have a match with one OpChannel

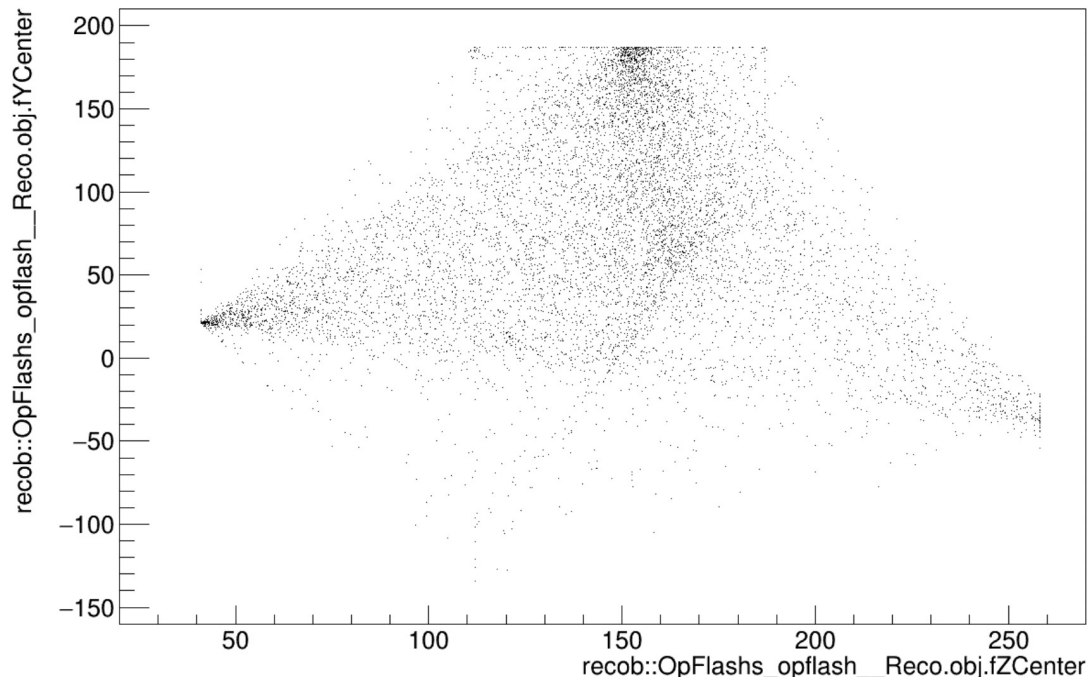


Cathode frame overlaid

Membrane OpChannel

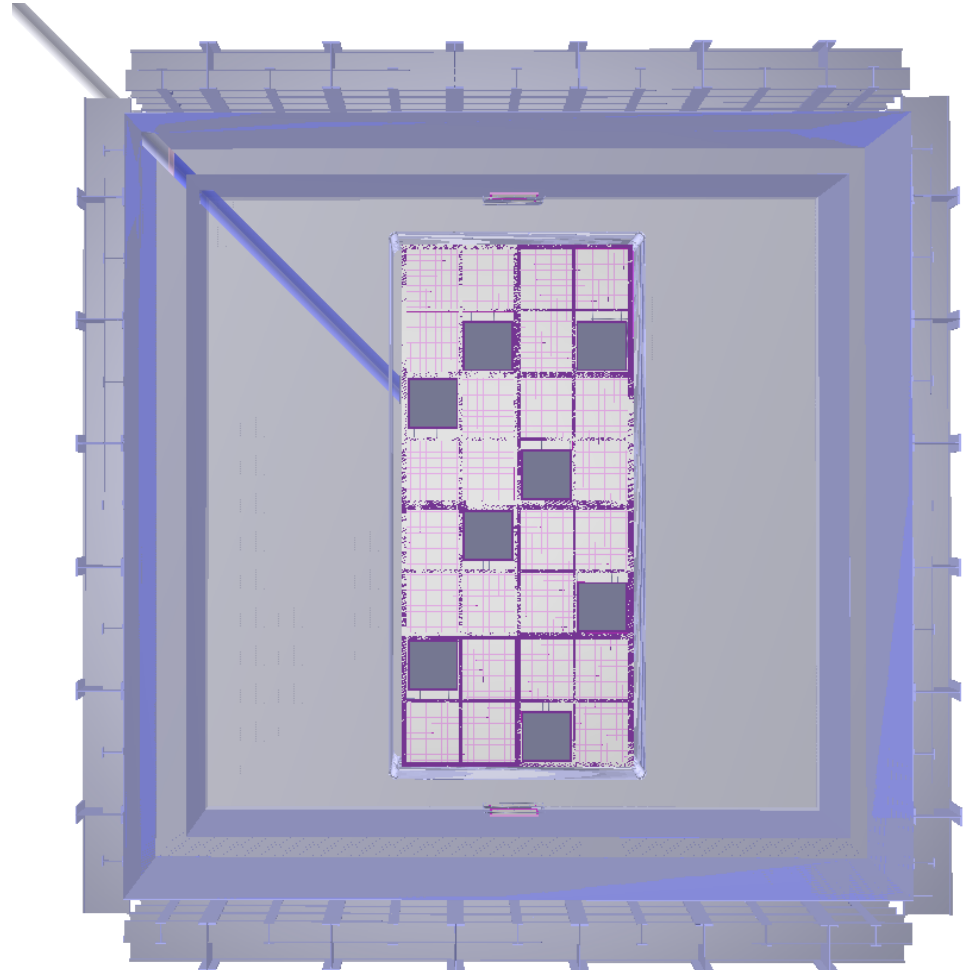
Optical flashes

- The module is running but no diagnostic on the results yet
- **Channel mapping vs position should be cross-checked first**
- Example of OpFlash output in the current reco tests:



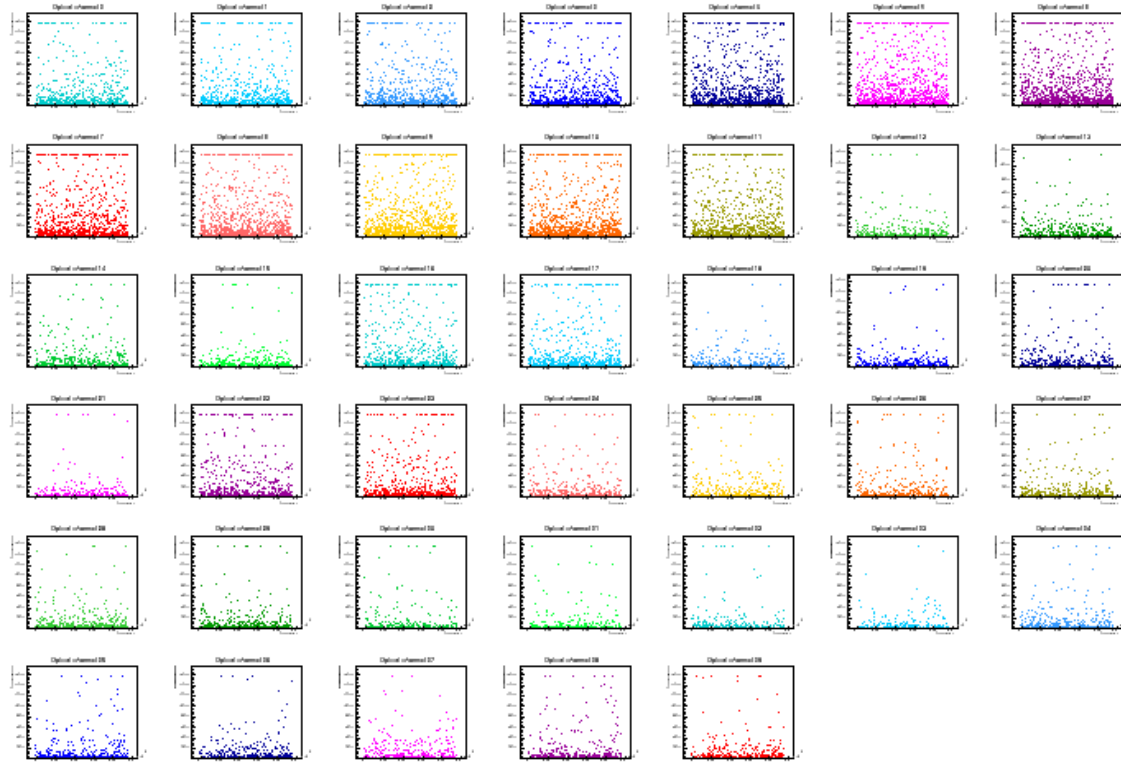
ProtoDUNE-VD sim status

- Two cosmics datasets available:
 - [Pure Ar](#) & [10 ppm Xe doping](#)
- 40 PDS channels found
- Tried to simply copy/paste coldbox reconstruction scheme (no deconvolution)



ProtoDUNE-VD sim status

- Two cosmics datasets available:
 - [Pure Ar](#) & [10 ppm Xe doping](#)
 - OpDetWaveforms already produced. Below output of CBVD-like reco!



**Need to look
at waveforms =)
+
Hits calibration!**

Outlook

- *First CRP+PDS data reconstruction chain implemented in LArSoft for VD prototypes to my knowledge*
- PDS configuration properly implemented up to flash matching
- Analysis of the low energy PNS charge deposits should follow with Emile L. module
- ProtoDUNE-VD simulation need to be processed with PDS reconstruction included

CRP data analysis

- Quick look at ongoing production (run 25086) shows no particular issues in terms of reconstruction pipeline
- More exhaustive studies made by Laura Z. with LARDON

