

# ProtoDUNE-HD LED calibration results

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ProtoDUNE PDS Sim/Reco meeting - 30 September 2024

# From 2024/09/12 talk on Santa Fe's collaboration meeting

## Introduction

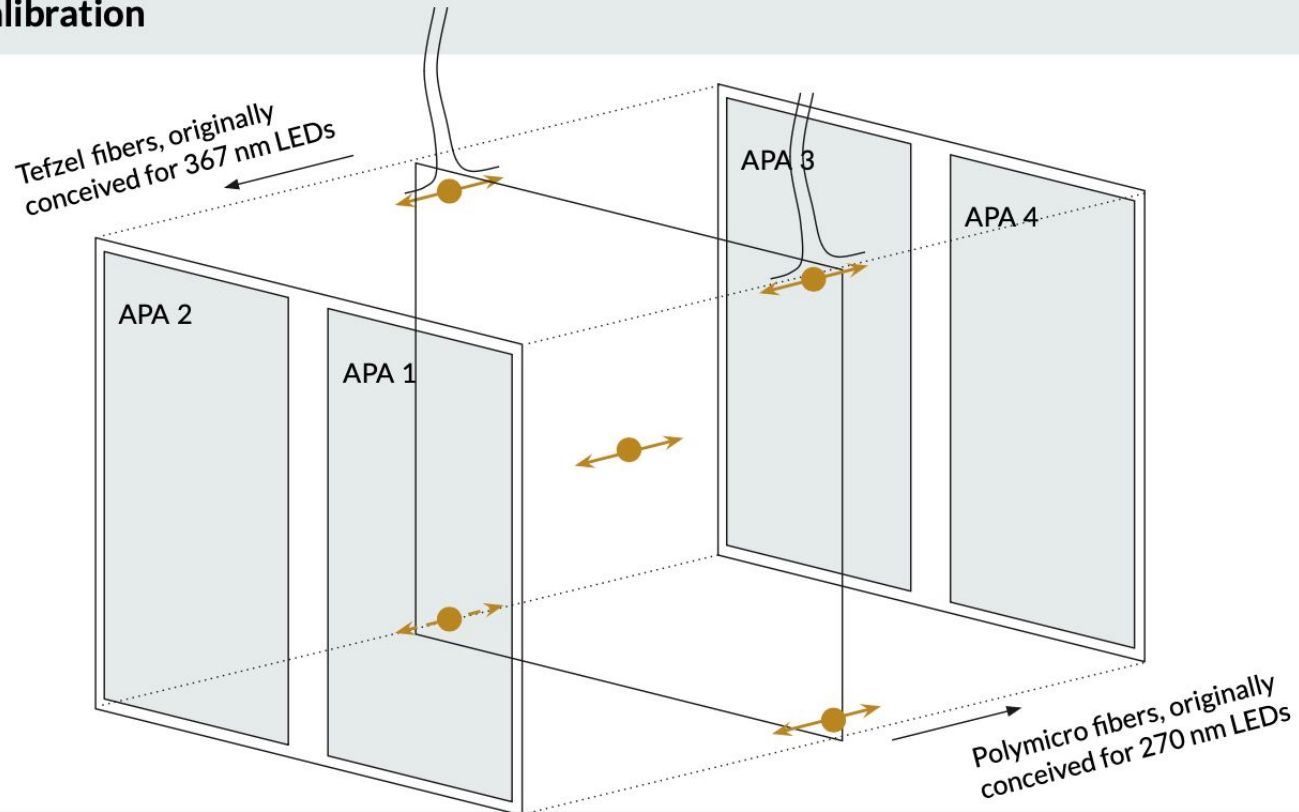
- NP04 started operating on May (with pure LAr), and it is foreseen to end its operation on November
- Since its operation beginning, lots of PDS runs with the LED-ON have been taken to understand which LED configurations should be used in order to acquire data which is suitable to calibrate all of the PDS channels
- On July 9, the first *standard* calibration data-taking was taken for all 4 APAs and 3 different overvoltages (OVs)
- In total, 5 different calibration batches have been taken [1]. Only the first one has been analyzed.

09/07	26/07	29-30/07	13/08	28/08
4 APAs, 3 OVs	4 APAs, 3 OVs	APAs 2-4, 3 OVs	nominal OV, V_gain scan: 0.9, 1.0, 1.1	4 APAs, nominal OV

- This analysis has been performed using Waffles: Waveform Analysis Framework For Light Emission Studies [2, 3]
- Waffles is the "official" analysis framework for PDS performance studies (NP04 and NP02). The aim is to migrate all these studies to Waffles in order to speed up development and enhance collaboration between analysers.

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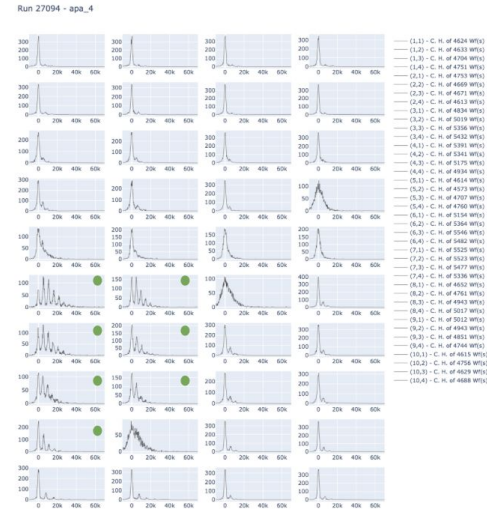
## LED calibration



# From 2024/06/20 talk on NP04 PDS operation meeting

## LED tuning proposal for APAs 3 & 4

pulse\_bias\_percent\_270nm = 1400



These are the pulse\_bias\_percent\_270nm which yield roughly the same amount of 0-PE and 1-PE events, but we could cope with worse (but viable) situations for the sake of reducing the amount of minimal LED configuration, p.e. :

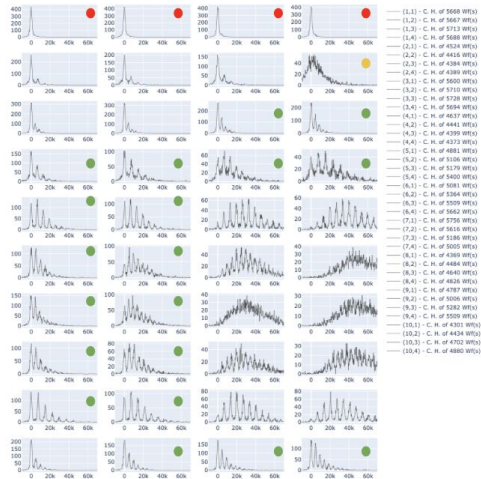
Julio Ureña, on behalf of the PDS team @ CERN - 2024/06/20

# From 2024/06/20 talk on NP04 PDS operation meeting

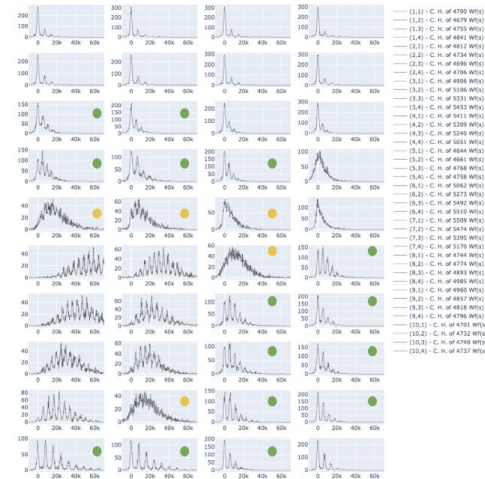
## LED tuning proposal for APAs 3 & 4

pulse\_bias\_percent\_270nm = 1600

Run 27095 - apa\_3



Run 27095 - apa\_4



These are the pulse\_bias\_percent\_270nm which yield roughly the same amount of 0-PE and 1-PE events, but we could cope with worse (but viable) situations for the sake of reducing the amount of minimal LED configuration, p.e. :

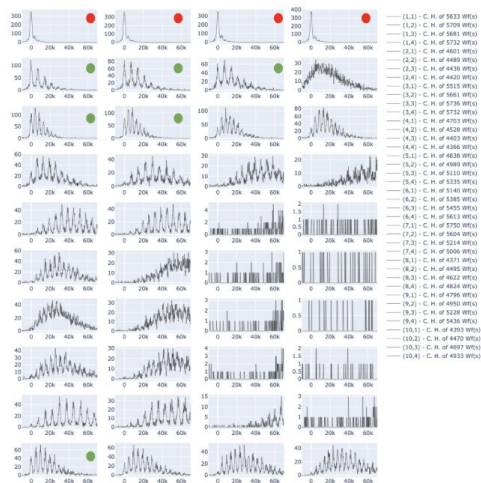
Julio Ureña, on behalf of the PDS team @ CERN - 2024/06/20

# From 2024/06/20 talk on NP04 PDS operation meeting

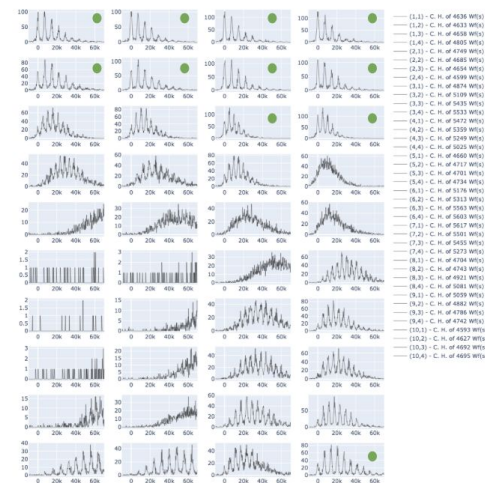
## LED tuning proposal for APAs 3 & 4

pulse\_bias\_percent\_270nm = 2200

Run 27098 - apa\_3



Run 27098 - apa\_4



These are the pulse\_bias\_percent\_270nm which yield roughly the same amount of 0-PE and 1-PE events, but we could cope with worse (but viable) situations for the sake of reducing the amount of minimal LED configuration, p.e. :

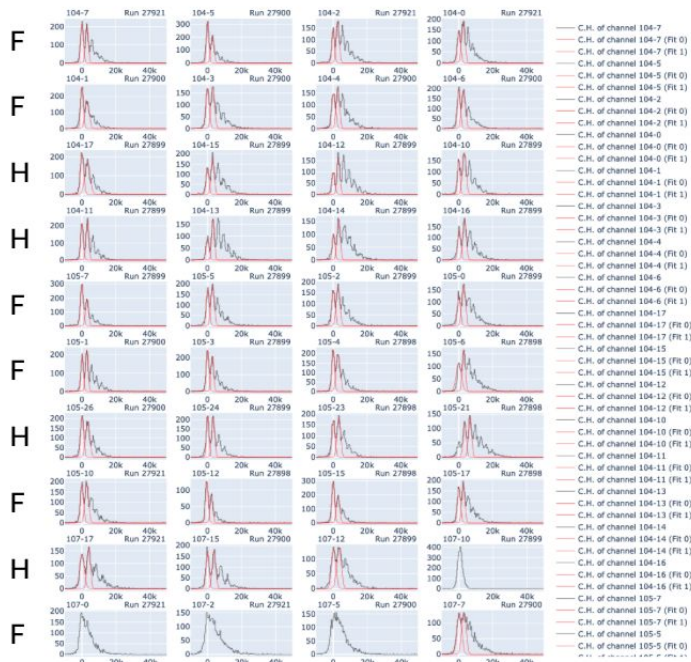
Julio Ureña, on behalf of the PDS team @ CERN - 2024/06/20

# From 2024/09/12 talk on Santa Fe's collaboration meeting

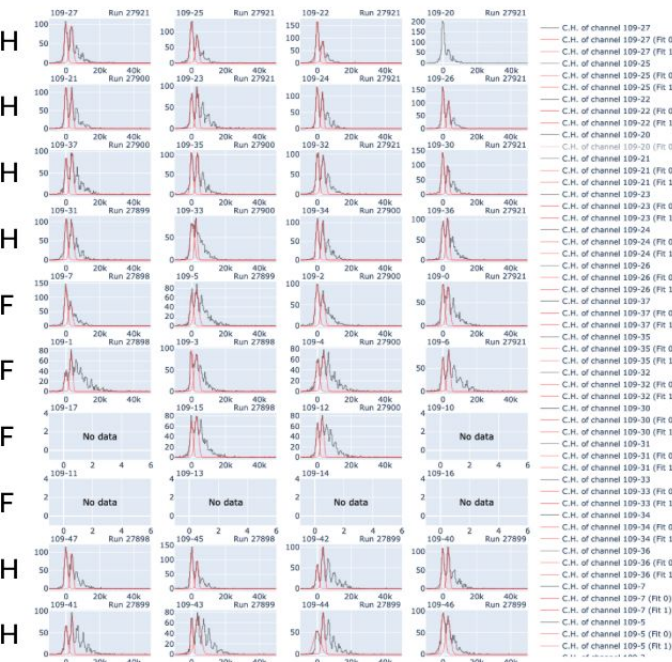
**Results (APAs 1 & 2, PDE = 40%)**  $HPK_{OV} = 2V, FBK_{OV} = 3.5V$

This analysis can be found and reproduced at [2] >  
[src/waffles/np04\\_analysis/LED\\_calibration](http://src/waffles/np04_analysis/LED_calibration)

APA 1 - Runs [27921, 27898, 27899, 27900]



APA 2 - Runs [27921, 27898, 27899, 27900]

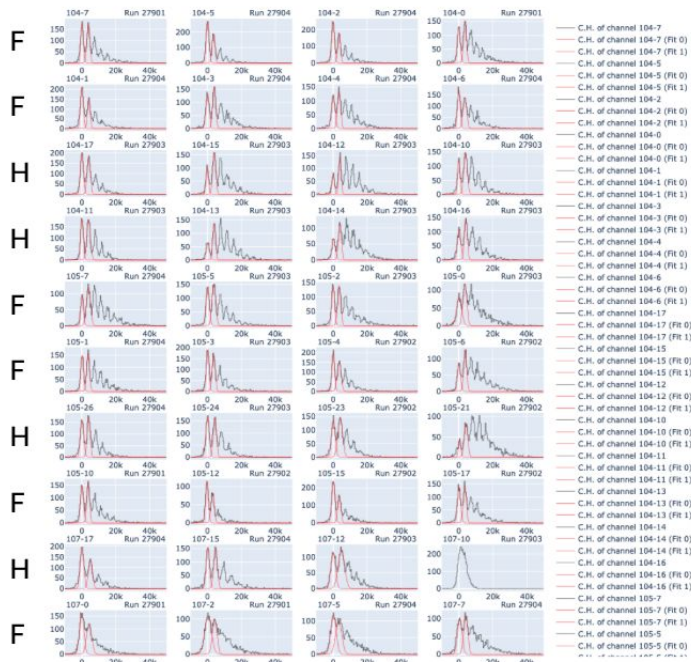


# From 2024/09/12 talk on Santa Fe's collaboration meeting

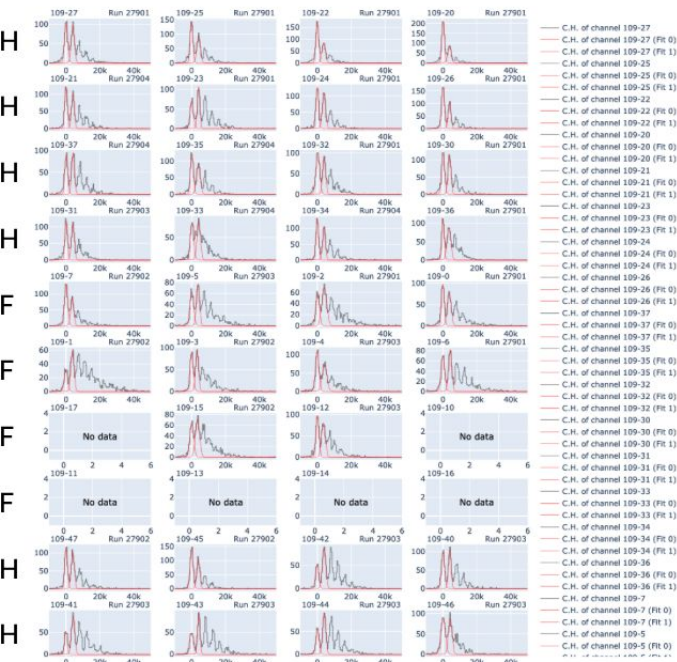
**Results (APAs 1 & 2, PDE = 45%)**  $HPK\_OV = 2.5V$ ,  $VBK\_OV = 4.5V$

This analysis can be found and reproduced at [2] > [src/waffles/np04\\_analysis/LED\\_calibration](https://src.waffles.np04_analysis/LED_calibration)

APA 1 - Runs [27904, 27901, 27902, 27903]



APA 2 - Runs [27904, 27901, 27902, 27903]

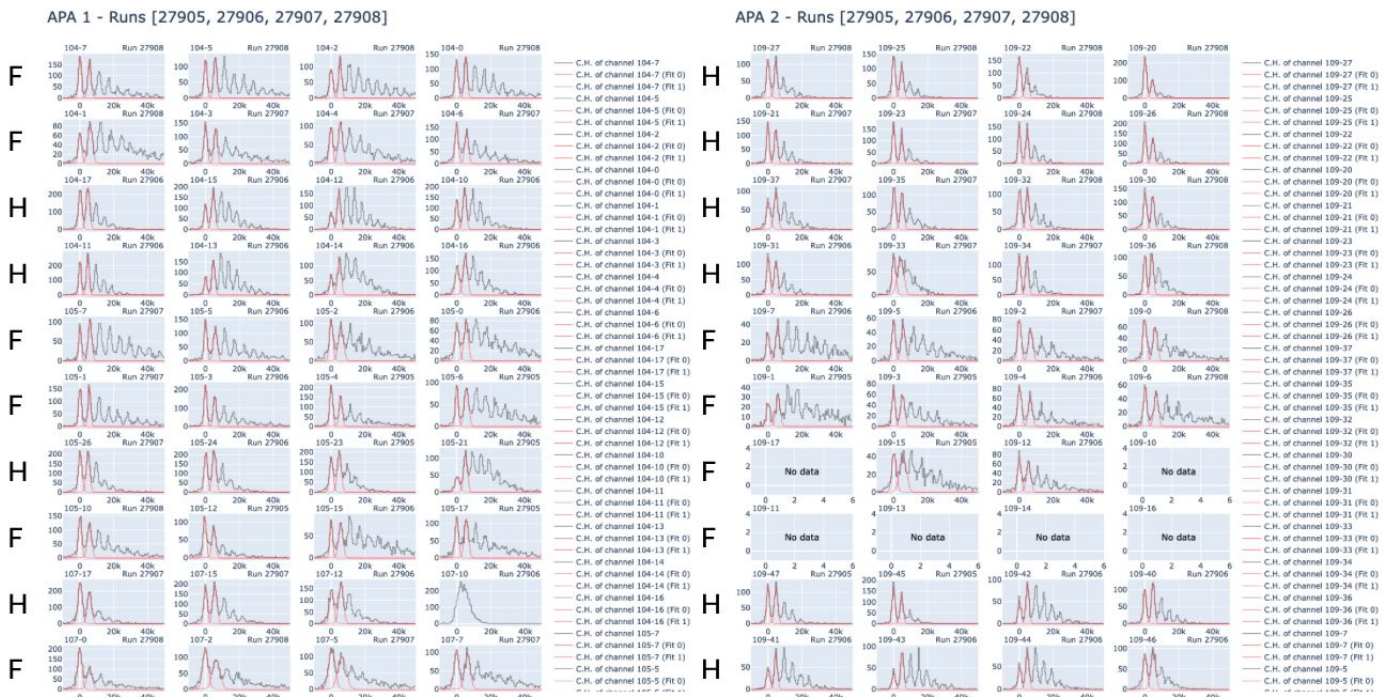




# From 2024/09/12 talk on Santa Fe's collaboration meeting

**Results (APAs 1 & 2, PDE = 50%)**  $HPK\_OV = 3V$ ,  $FBK\_OV = 7V$

This analysis can be found and reproduced at [2] > [src/waffles/np04\\_analysis/LED\\_calibration](https://src.waffles.np04_analysis/LED_calibration)



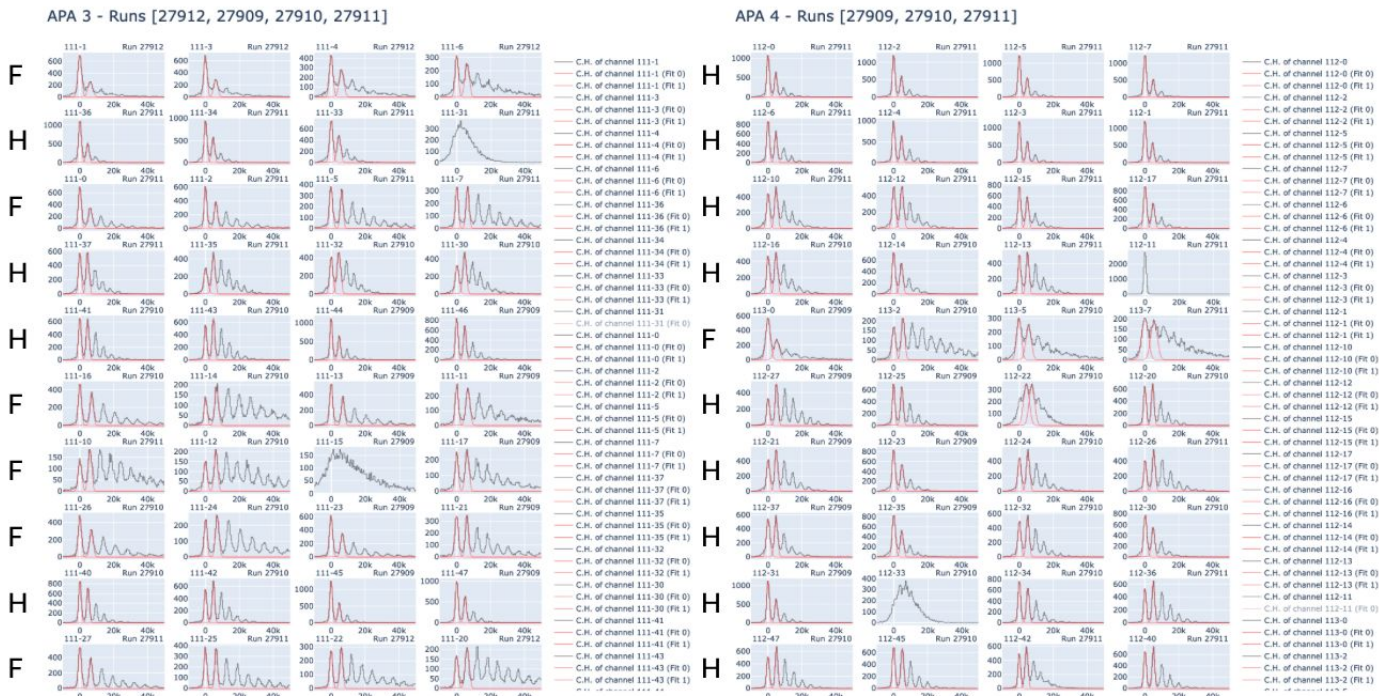




# From 2024/09/12 talk on Santa Fe's collaboration meeting

**Results (APAs 3 & 4, PDE = 50%)**  $HPK\_OV = 3V$ ,  $FBK\_OV = 7V$

This analysis can be found and reproduced at [2] > [src/waffles/np04\\_analysis/LED\\_calibration](https://github.com/led-waffles/src/waffles/np04_analysis/LED_calibration)

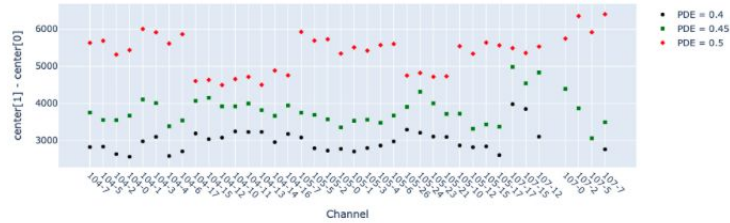


# From 2024/09/12 talk on Santa Fe's collaboration meeting

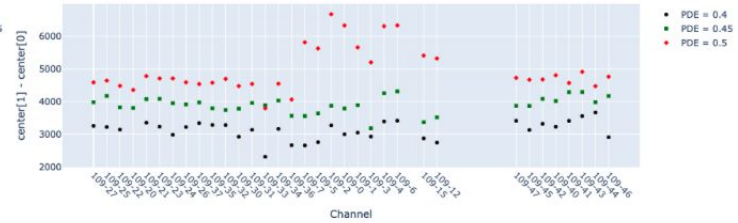
## Results summary

This analysis can be found and reproduced at [2] >  
[src/waffles/np04\\_analysis/LED\\_calibration](src/waffles/np04_analysis/LED_calibration)

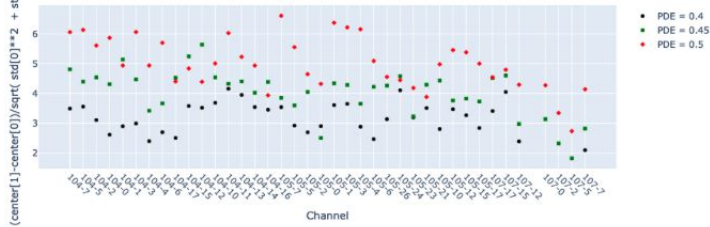
Gain per channel in APA 1



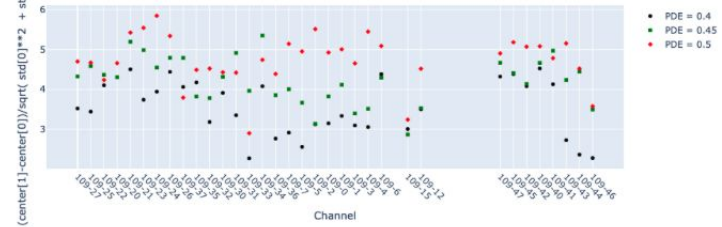
Gain per channel in APA 2



SNR per channel in APA 1



SNR per channel in APA 2

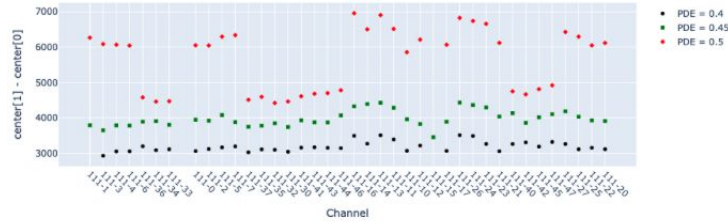


# From 2024/09/12 talk on Santa Fe's collaboration meeting

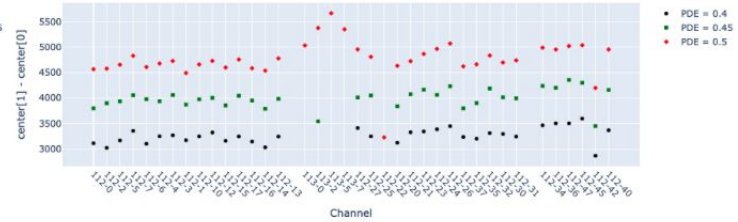
## Results summary

This analysis can be found and reproduced at [2] >  
[src/waffles/np04\\_analysis/LED\\_calibration](src/waffles/np04_analysis/LED_calibration)

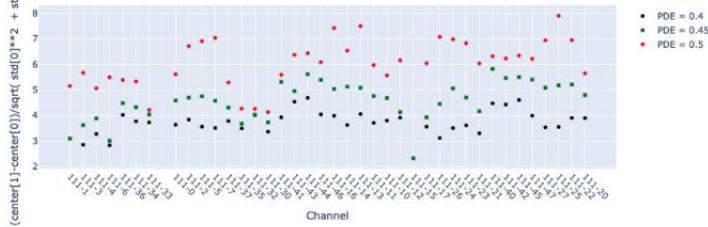
Gain per channel in APA 3



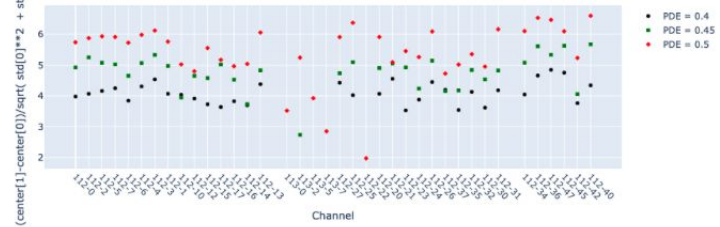
Gain per channel in APA 4



SNR per channel in APA 3



SNR per channel in APA 4



# Comments

- The gain results of this analysis, **for PDE=45%**, have been output to json files, which are available in the indico of this meeting
  - `gain_map_PDE_0.45_NP04.json` contains a 3-levels dictionary where the first (resp. second, third) contains the APA number (resp. endpoint, channel)
  - `gain_map_PDE_0.45_LArSoft.json` contains a 2-levels dictionary where the first (resp. second) contains the APA number (resp. LArSoft PDS channel)
  - `gain_map_PDE_0.45_flattened_LArSoft.json` contains a 1-level dictionary where the keys are the LArSoft PDS channel

in any case, the deepest values of such dictionaries are gain values

- The NP04-channel-to-LArSoft-channel map was taken from [https://github.com/DUNE/duneprototypes/blob/develop/duneprototypes/Protodune/hd/ChannelMap/DAPHNE\\_test5\\_ChannelMap\\_v1.txt](https://github.com/DUNE/duneprototypes/blob/develop/duneprototypes/Protodune/hd/ChannelMap/DAPHNE_test5_ChannelMap_v1.txt)
- Channel 32 of endpoint 109 (i.e. APA 2, 3rd row, 2nd column) is missing in such map
- Is there any preference for an input format other than json?