CRP #4 and #5 processing with LArSoft

Yoann Kermaïdic & Wenqiang Gu

ProtoDUNE-VD

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IJCLab Irène Joliot-Curie Laboratoire de Physique des 2 Infinis
université PARIS-SACLAY
cnrs

Wirecell configuration fix

- For a long time, the VD BDE configuration was not adequately set
- Wenqiang implemented some changes:
  - `clock_speed: 2.5` should be `clock_speed: 1.953125`
  - `ClockSpeedTPC: 2.5` should be `ClockSpeedTPC: 1.953125`
  - `Efield: [4.11e-1,1,1]` should be `Efield: [4.38e-1,1,1]`
  - new WireCell config.: `pgrapher/experiment/dunevd-crp4`
- Electric field to be adjusted on case by case basis
- Three related PRs:
  - https://github.com/DUNE/dunesw/pull/116
  - https://github.com/DUNE/dunereco/pull/100
  - https://github.com/DUNE/duneprototypes/pull/41

New production protocol

- SL7 -> ALMA 9 now need to run LArSoft, justin, … within a container

```
/cvmfs/oasis.opensciencegrid.org/mis/apptainer/current/bin/apptainer shell --shell=/bin/bash -B
/cvmfs,/exp,/nashome,/pnfs/dune,/opt,/run/user,/etc/hostname,/etc/hosts,/etc/krb5.conf --ipc --pid
/cvmfs/singularity.opensciencegrid.org/fermilab/fnal-dev-sl7:latest
```

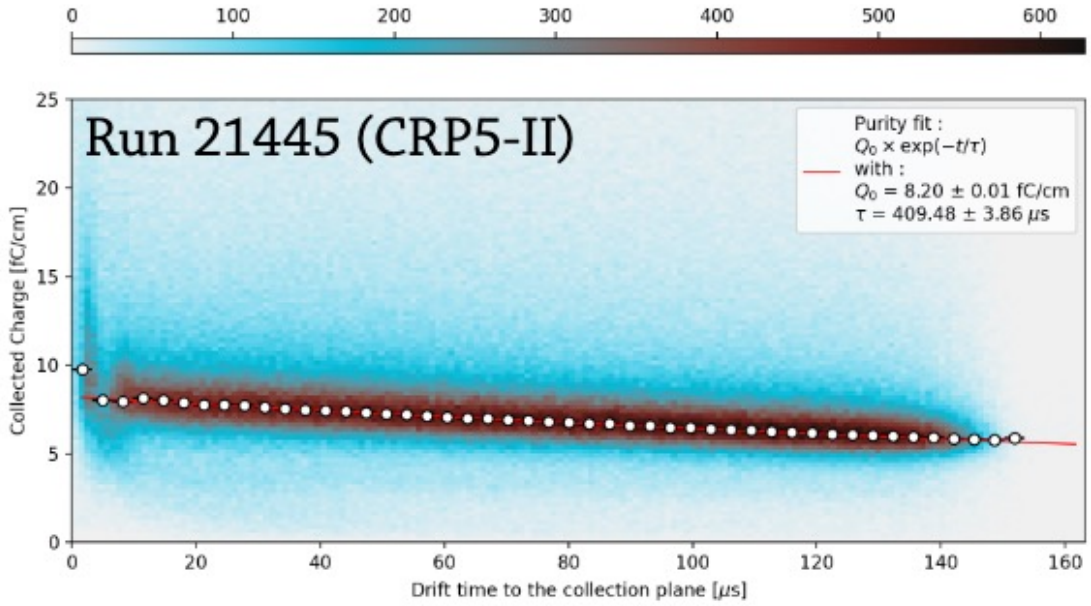
- **Submit jobs:**
  - Create a jobscript to load your software https://justin.dune.hep.ac.uk/docs/tutorials.dune.md
  - Test it '`justin-test-jobscript`' and run it '`justin simple-workflow`'
- Query for this study (110 files from run 21445):
  - **`MQL_QUERY`**`="files where 21445 in core.runs and core.data_tier=raw limit 110"`

Test dataset

- Pick-up good cosmics run 21445 (source L. Zambelli database)

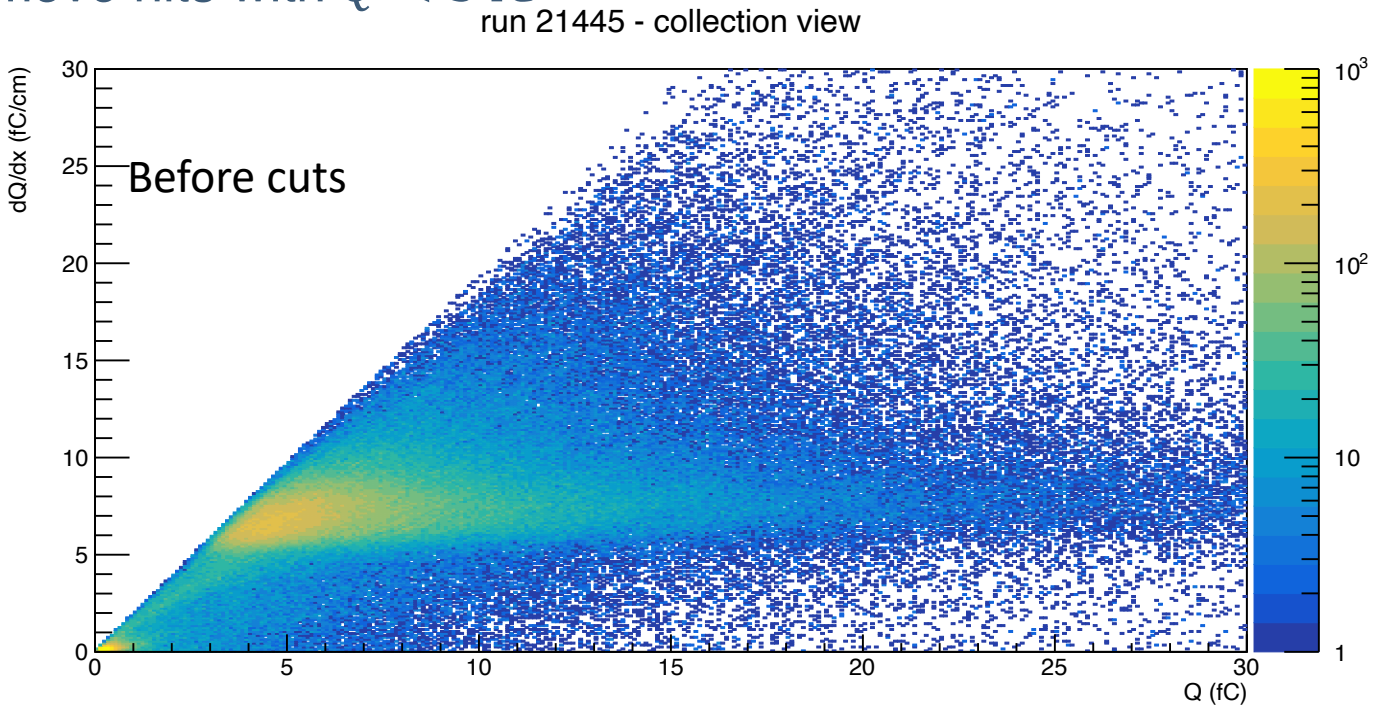
21445	**304**	**-1**	**2023-05-01-17:35:59**	**1682955359.000**	**1682961725.000**	**6366.000**	**COSMICS**

- Exhaustive analysis presented at the last FNAL CM (05/2023):
  https://indico.fnal.gov/event/57487/contributions/267283/attachments/167421/223403/coldbox_crp4and5_cm_lz.pdf



High level results #1

- Selection:
  - Track length: [23 - 430] cm
  - Remove 25 cm from CRP edges
  - Remove hits with $Q < 3$ fC



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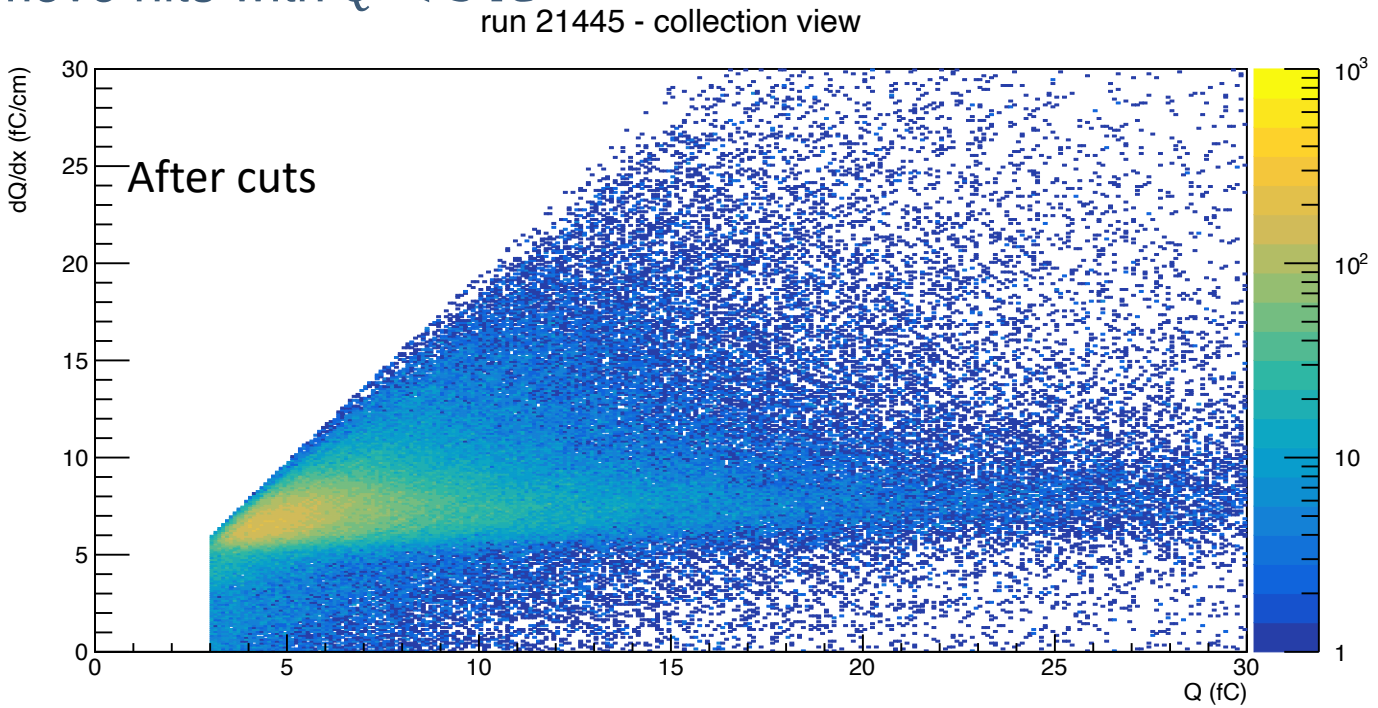
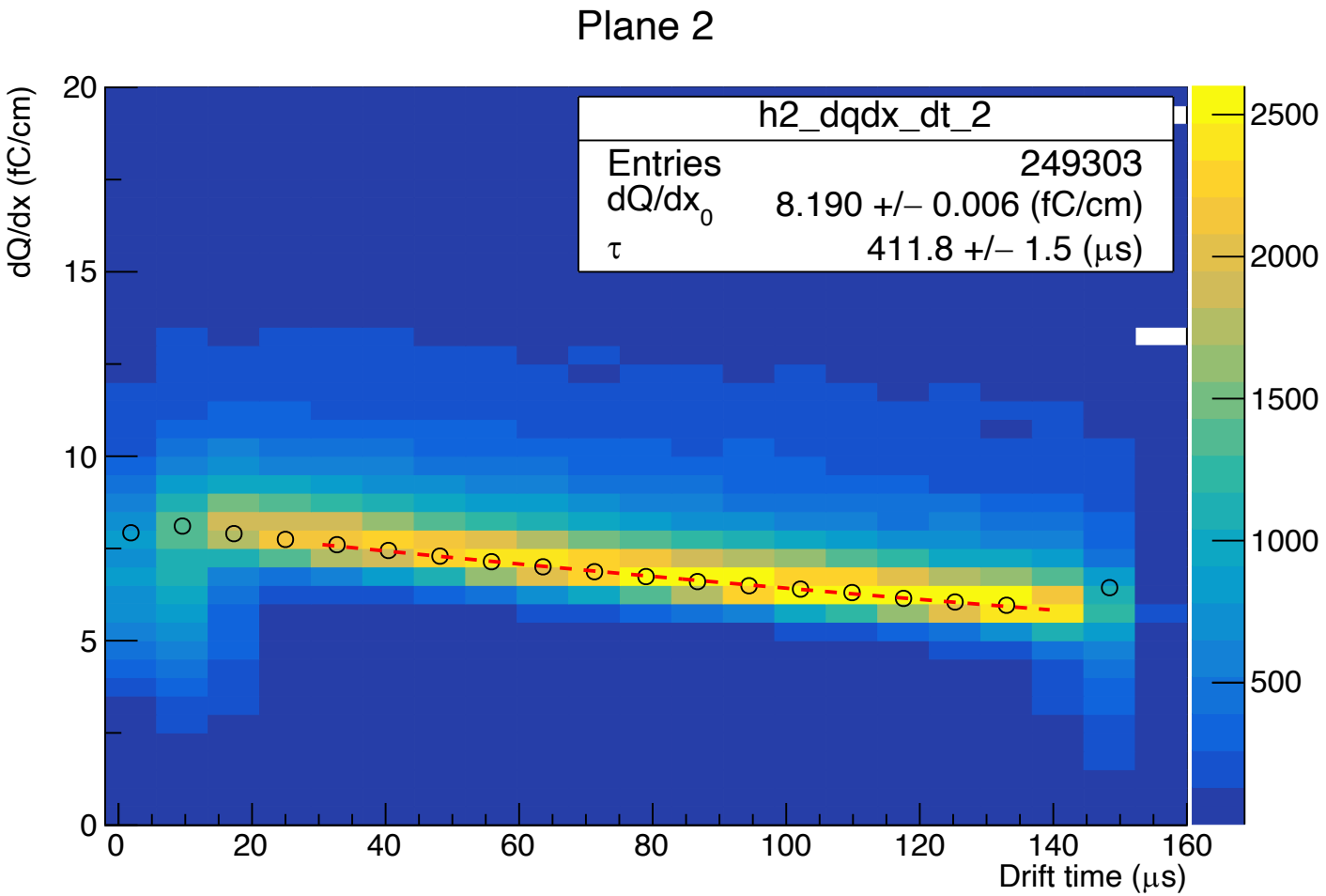


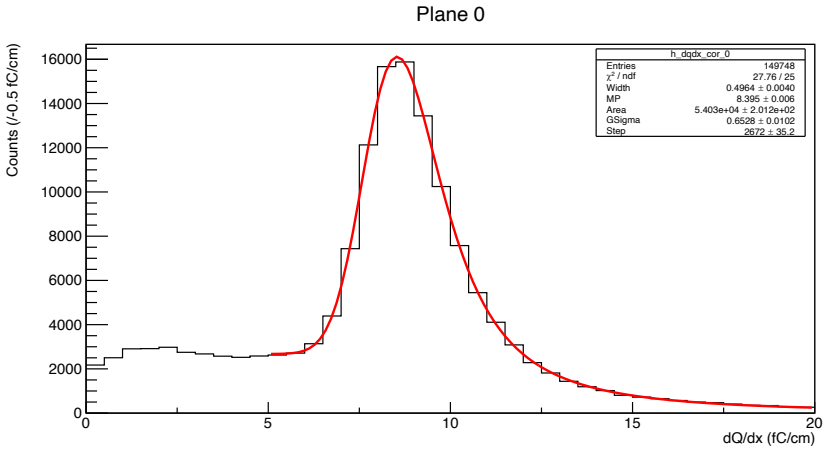
High level results #2

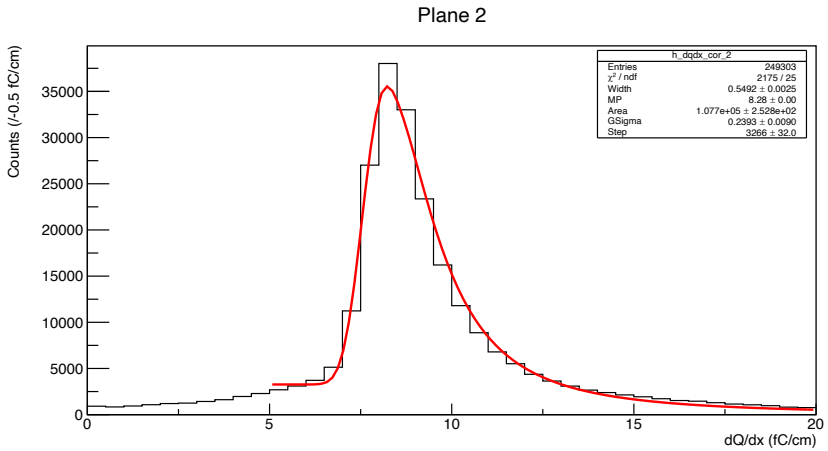
- Electron lifetime found to be compatible with LARDON analysis

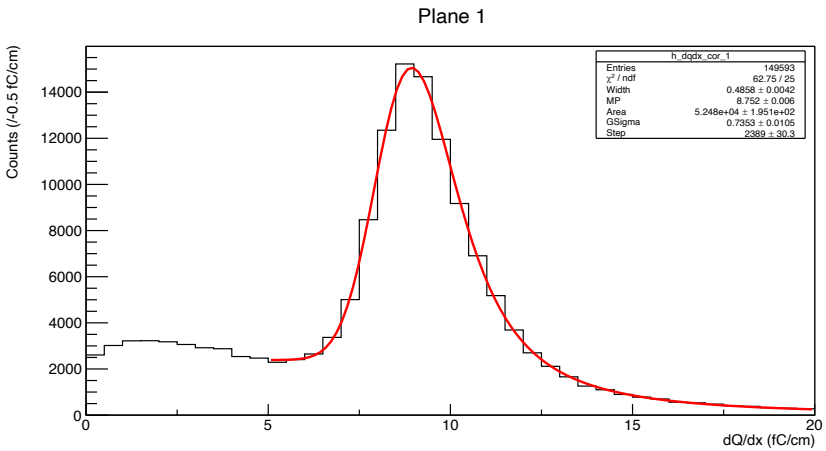


High level results #3

- dQ/dx distributions after lifetime correction
- Collection view dQ/dx(0): 8.28(1) vs 8.20(1) fC/cm (LArSoft / LARDON)

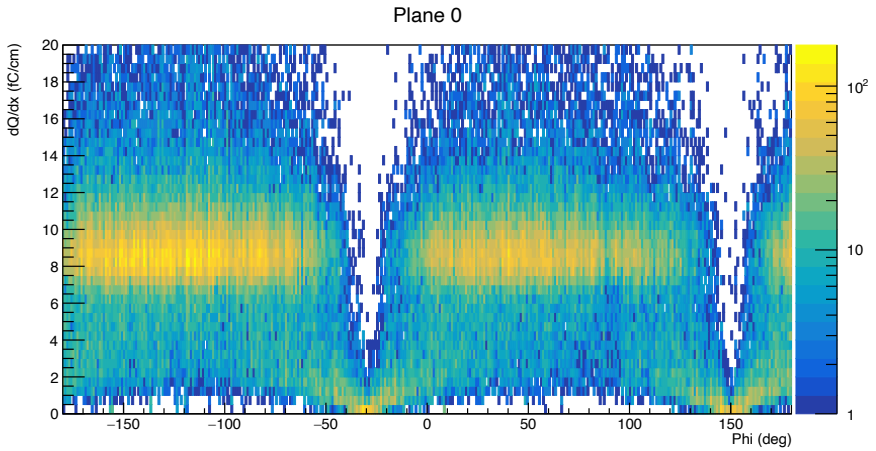


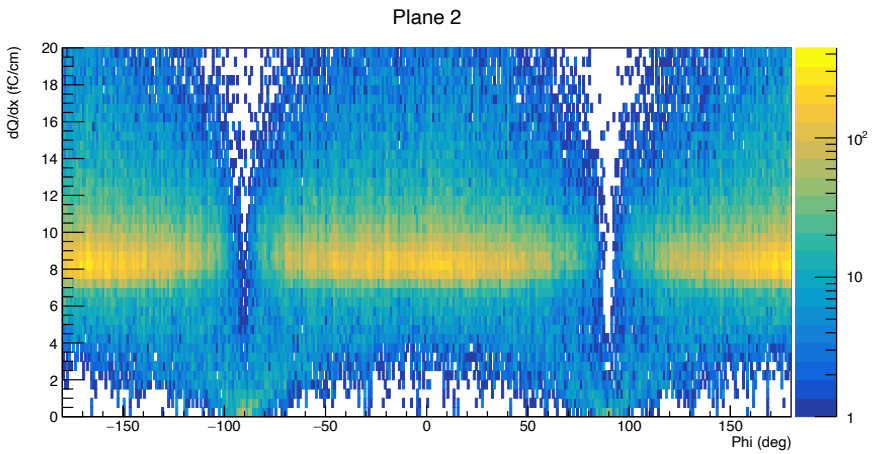


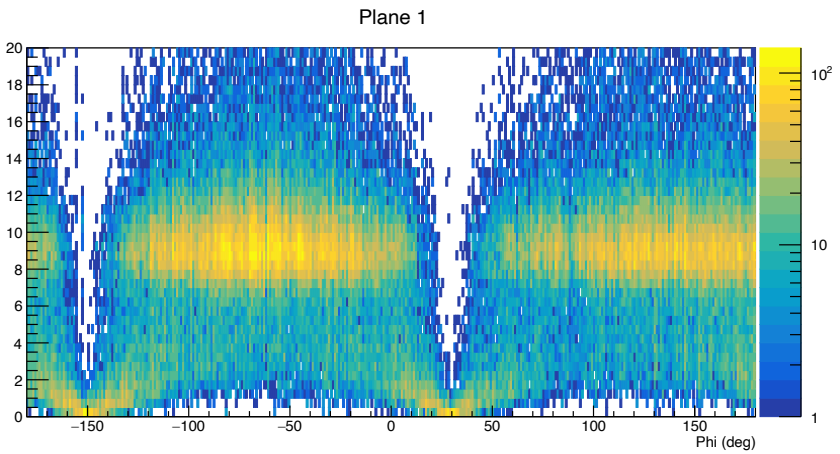


High level results #4

- Angular dependence explaining the low dQ/dx pedestal after cut







Next

- Will approve the current PRs
- Look into recent CRP light files decoding and reconstruction
- Then request production of valid BDE runs