



Developing the Off-line Data Quality Monitoring framework for DUNE

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The Second Wire-Cell Reconstruction Summit

Hosted by Brookhaven National Laboratory
The workshop will held as a hybrid event on April 10-12, 2024

April 10, 2024

Introduction to off-line Data Quality Monitoring (DQM)

Online Monitoring*

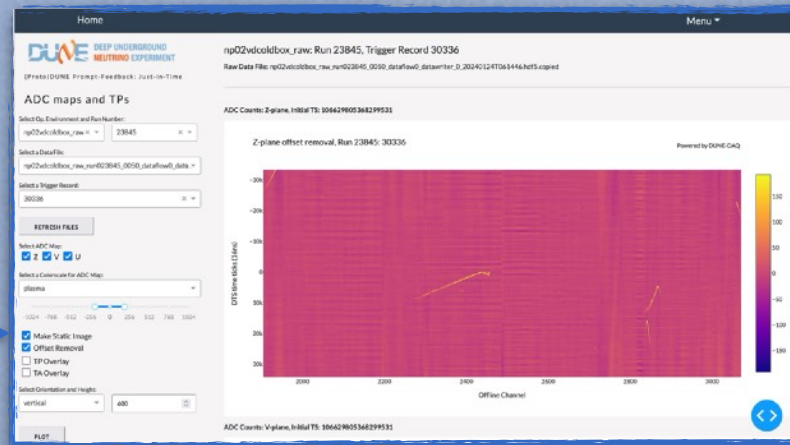
- Monitors the status of the detector electronics and ensures the Data Acquisition System is properly working;
- Computes and display quality metrics of the raw data fragments:

- Number and size of the fragment;
- TPC and PDS waveforms: pedestal values, noise, timestamp alignment;
- Event display;
- ...

*From Wesley Ketchum's [talk](#) at DUNE Collaboration Meeting (Sep/2023)



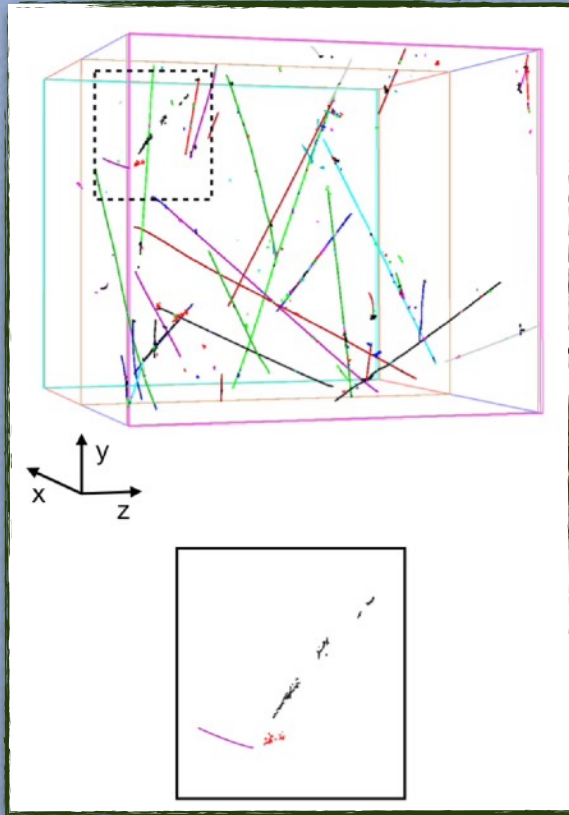
GRAFANA (up) and JustinTime (bottom) display tools for monitoring protoDUNE DAQ**



**From Wesley Ketchum's [talk](#) at DUNE Collaboration Meeting (Jan/2024)

Introduction to off-line Data Quality Monitoring (DQM)

Reconstructed particles by Pandora. Bottom: charged pion (magenta), neutral pion (red) and photon (black) candidates. Figure taken from: [arxiv/2206.14521.pdf](https://arxiv.org/abs/2206.14521)



Full Reconstruction*

- Signal processing: do noise filtering, apply calibration, do 1D/2D waveform deconvolution -> Charge arriving on each TPC channel per time;
- Find signal regions of interest to discard low-frequency noise from TPC induction planes. Do 3D imaging (WireCell technique);
- Hit finder algorithm: find peaks of the deconvolved waveforms;
- Pattern recognition techniques (Pandora).

*See [arxiv/2007.06722](https://arxiv.org/abs/2007.06722), [arxiv/1803.04850](https://arxiv.org/abs/1803.04850) and [arxiv/2206.14521.pdf](https://arxiv.org/abs/2206.14521) for example

Introduction to off-line Data Quality Monitoring (DQM)

What about the off-line
DQM / Prompt
Processing?

Online Monitoring*

- Monitors the status of the detector electronics and ensures the Data Acquisition System is properly working;
- Computes and display quality metrics of the raw data fragments:

Number and size of the fragment;

TPC and PDS waveforms: pedestal values, noise, timestamp alignment;***

Event display;

...

*From Wesley Ketchum's [talk](#) at DUNE Collaboration Meeting (Sep/2023)

The idea is to apply a more sophisticated data processing algorithm, but still fast enough to ensure quality of the data!

What about the off-line DQM / Prompt Processing?

stays in between!

***examples of what we can include in the prompt-processing algorithm!

Full Reconstruction**

- Signal processing: do noise filtering, apply calibration, do 1D/2D waveform deconvolution -> Charge arriving on each TPC channel per time;***
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***See [arxiv/2007.06722](#), [arxiv/1803.04850](#) and [arxiv/2206.14521.pdf](#) for example

What is the plan we have for protoDUNE?

Input Data from CERN EOS (disk storage)

We assume here we will run the prompt-processing algorithm using the grid scheme. We can use JustIn tool to take care of data orchestration (identifying new data recorded, add them to job queue and not reprocessing the same data set.)

Here we are considering the raw data that comes out from protoDUNE DAQ, but we can go further and consider the Monte Carlo samples from production.

LarSoft Analyzer

Computes Prompt-Processing metrics:

- Signal deconvolution to retrieve charge deposited per wire channel;
- Can we use WireCell algorithm here?

Export the metrics to a database hosted by a server in University of Edinburgh.

Database

- Store the quality metrics;
- Security protocols to control its access!

User Interface (website)

- Select run number and event;
- Plot the calculated metrics from the database;
- Access a table that contains Data Quality information: is data good or not for reconstruction?

Resulting ROOT file.
root://.../output/...

Proceed with full reconstruction!



What is the plan we have for protoDUNE?

1. Which features from the WireCell toolkit can we use in the way we still can process the data “promptly”?
2. What are the WireCell criteria to evaluate the data is good for reconstruction?

LET'S DISCUSS!

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Exercising computation, storage and display of generic metrics

Input Data from protoDUNE single phase, run 5758

LarSoft Toy Analyzer

Gets ADC signals recorded by the wires from collection plane.

SQLite Database

Sent metrics:

- EVENT;
- WIRE CHANNEL;
- TIME TICK;
- ADC.

FLASK SESSION ON
DUNEGPVM (Fermilab)

- Reads back from database every 1 minute and plots the raw ADC for each channel per time tick;
- Can read database simultaneously with LarSoft writing on it.

Team:

- Robert Currie;
- Wenlong Yuan;
- Gabriela Vitti Stenico

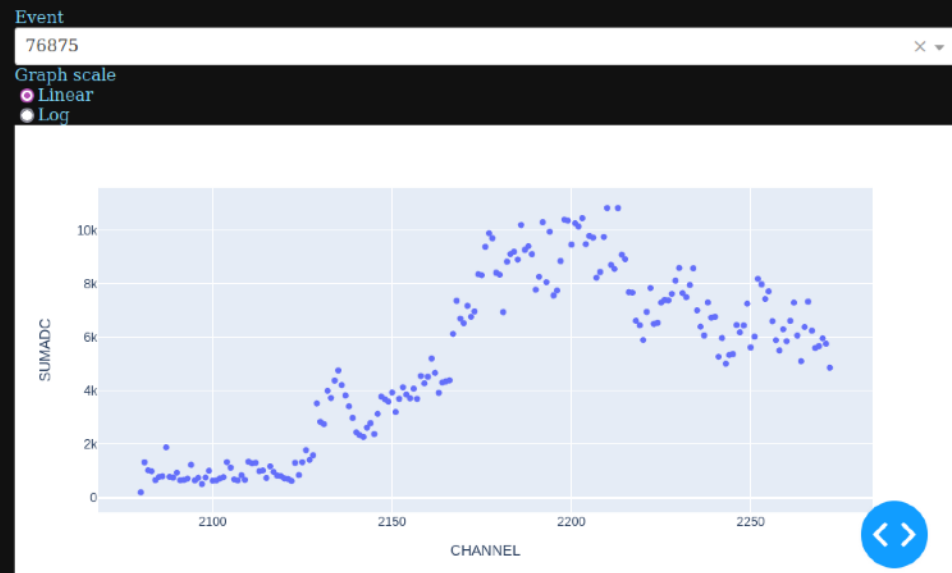
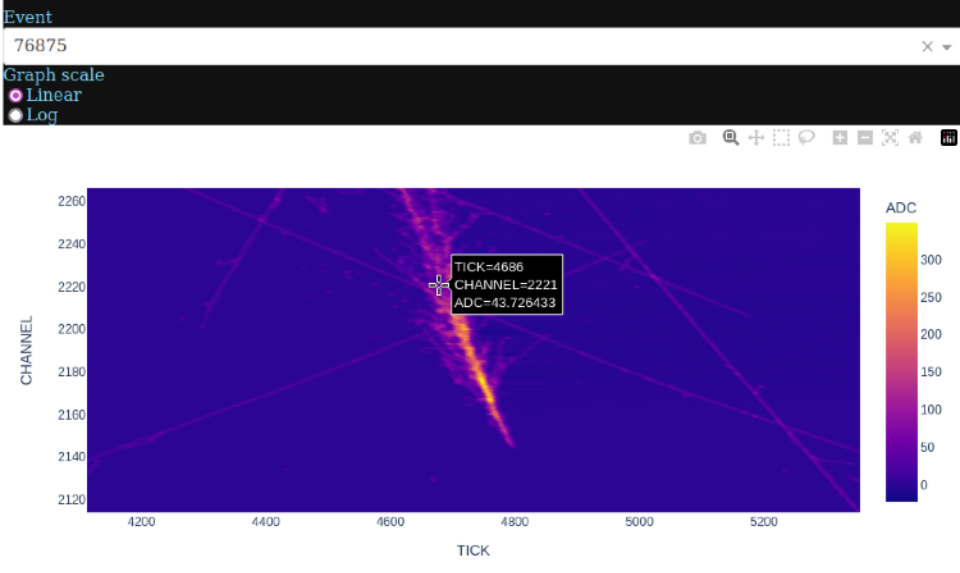




DEEP UNDERGROUND NEUTRINO EXPERIMENT

This is a DQM mock display!

Raw ADC per Event





Thank you!

Feedback is very welcome!

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