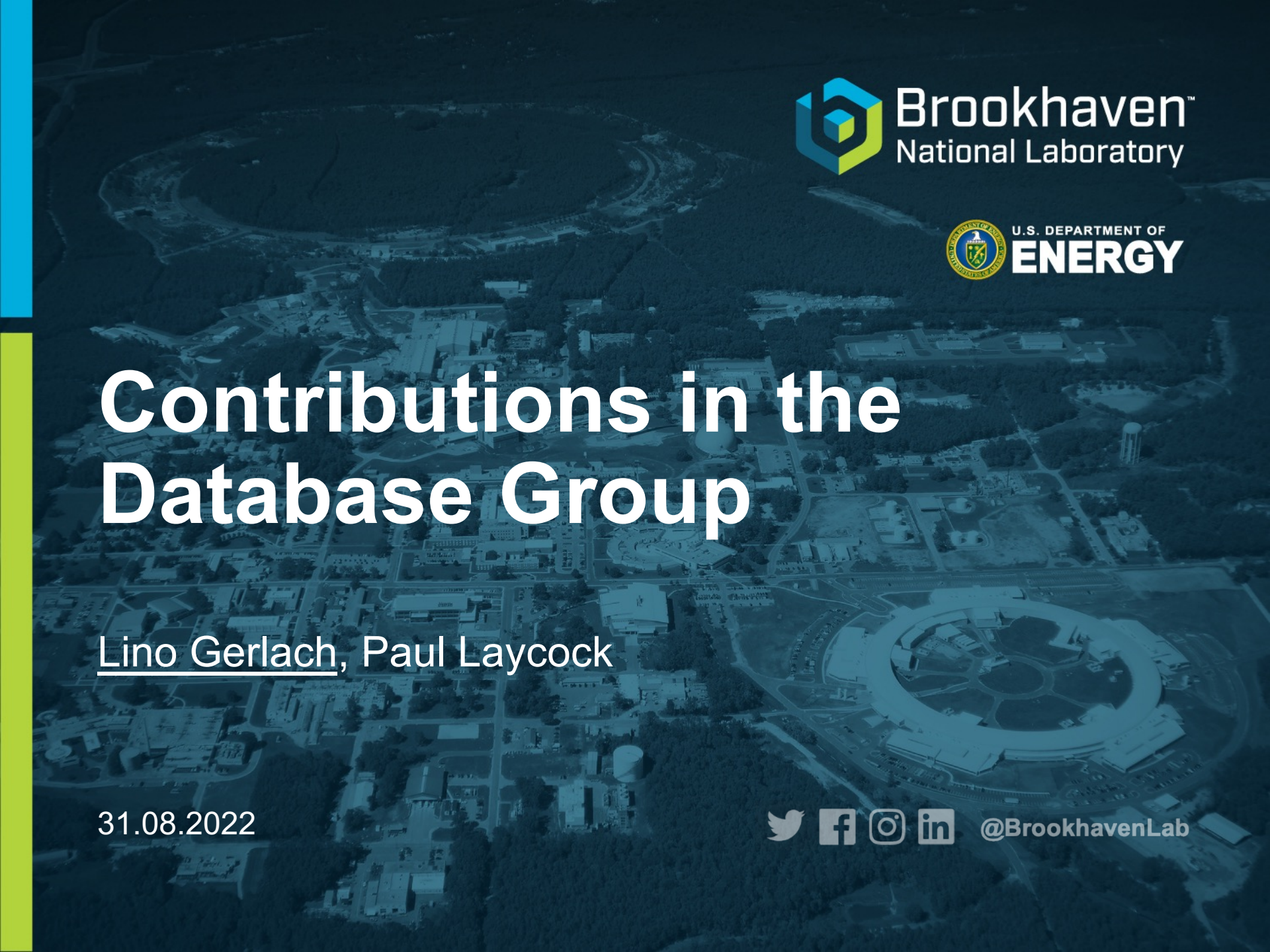

Brookhaven
National Laboratory
U.S. DEPARTMENT OF
ENERGY
Contributions in the Database Group
Lino Gerlach, Paul Laycock
31.08.2022
@BrookhavenLab

Overview

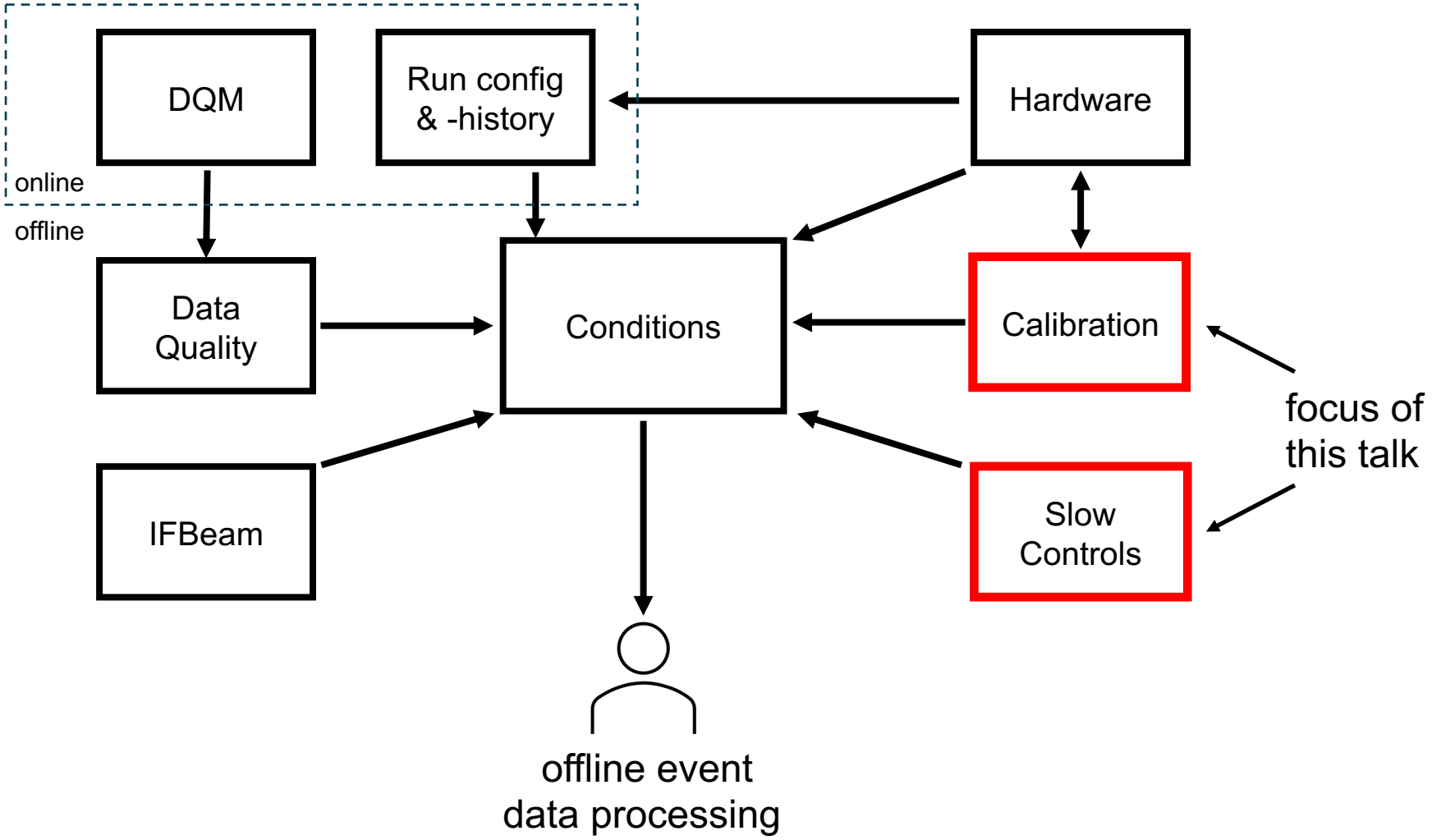
Introduction

- Database group is developing conditions Database
  - Conditions Data: ‘Any additional data needed to process event data’
- Need to understand offline needs for this data

My contributions

- Investigate use cases of conditions data (at ProtoDUNE)
  - From Slow Controls system
  - For calibrations (as ‘Calibration Liaison for Offline Computing’)

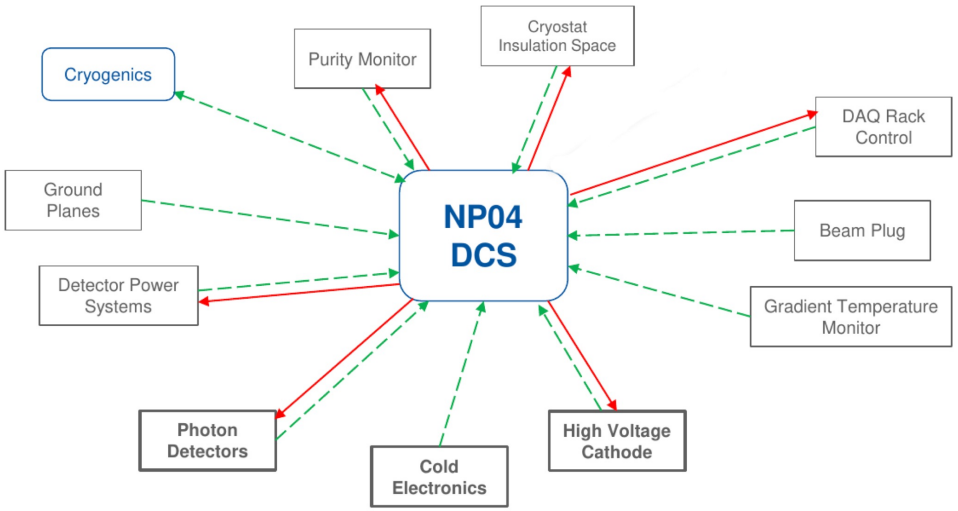
Conditions Data - Sources



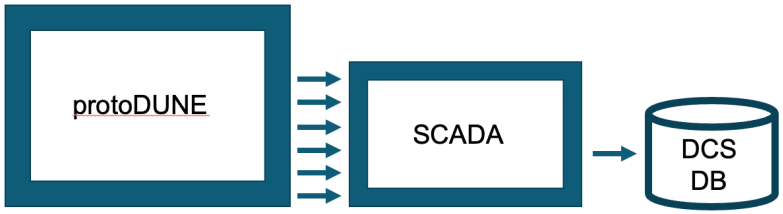
Calibration & Slow Controls data only a subset of all conditions data!

Slow Controls Data - Introduction

- Data from Slow Controls (or Detector Control System, 'DCS')
  - E.g., LAr temp. & purity, high-voltage, ground impedance
  - Indexed by time stamp & stored in archive ('DCS-DB')
  - Accessed predominantly by detector experts
- Challenge: raw data written w/ very high granularity
  - Higher granularity than needed for offline processing

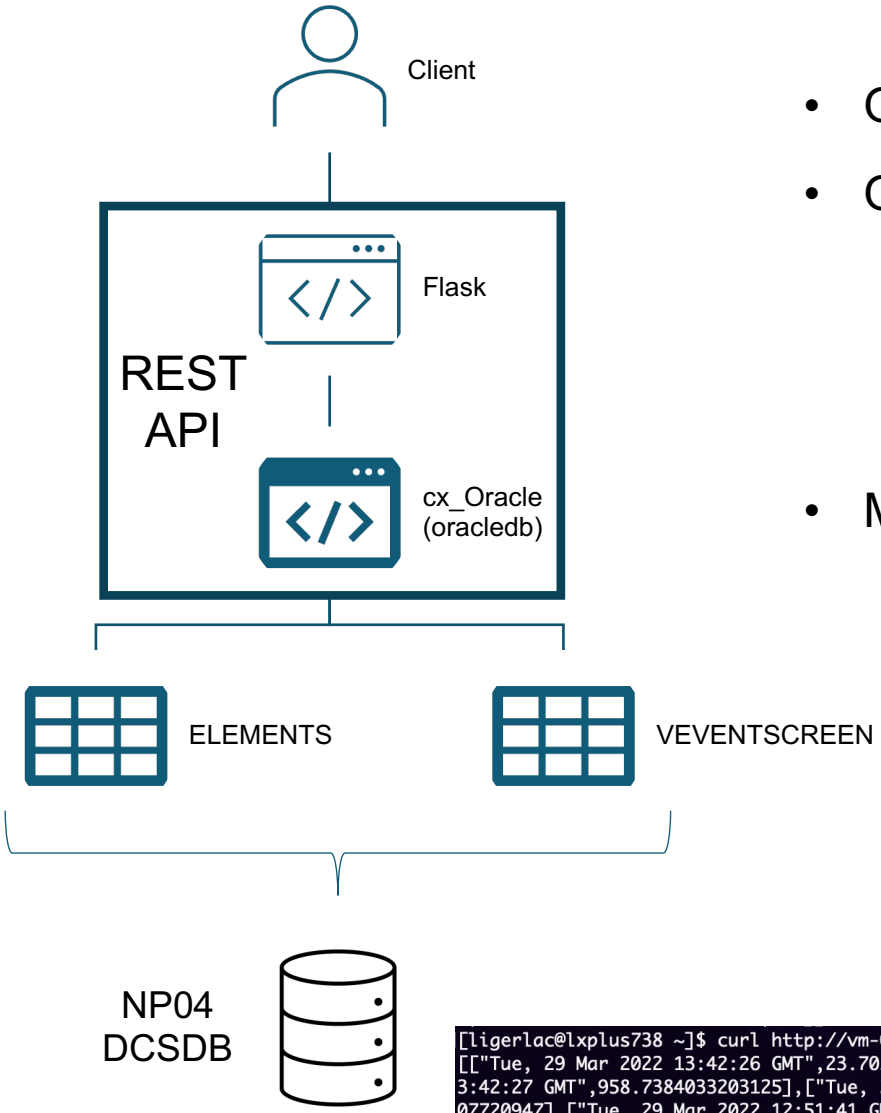


From Manuel J. Rodriguez



Central question:
What subset of this data should be incorporated into the common data base?

Slow Controls DB API

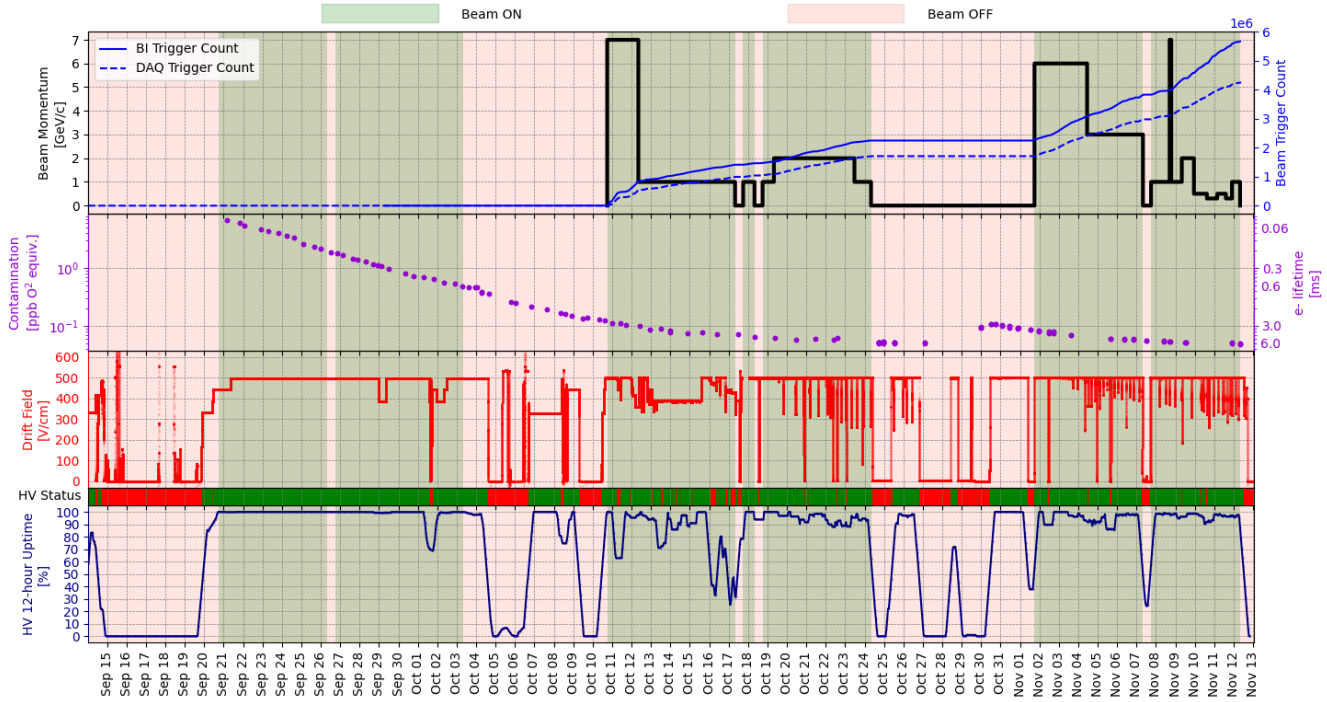


- Originally written by Roland Sipos
- Oracle DB accessed by REST API
  - Read-only
  - Deploying cx_Oracle & Flask
- My contribution:
  - Debugging: All original functionalities work now
  - Implemented basic plotting
  - Deployed on CERN VM
    - Now online & accessible!

```
[ligerlac@lxplus738 ~]$ curl http://vm-01.cern.ch:5000/current/beamplug
[["Tue, 29 Mar 2022 13:42:26 GMT",23.705150604248047],["Tue, 29 Mar 2022 13:42:45 GMT",22.39800453186035],["Tue, 29 Mar 2022 1
3:42:27 GMT",958.7384033203125],["Tue, 29 Mar 2022 13:41:41 GMT",7.999131679534912],["Tue, 29 Mar 2022 13:41:41 GMT",4.5572915
07720947],["Tue, 29 Mar 2022 12:51:41 GMT",22.0],["Tue, 29 Mar 2022 13:11:41 GMT",21.10000610351562 5],["Tue, 29 Mar 2022 12:43
:17 GMT",998.0026245117188],["Tue, 29 Mar 2022 12:43:17 GMT",0.4530164897441864],["Tue, 29 Mar 2022 13:42:47 GMT",0.0084257144
48094368]]
```

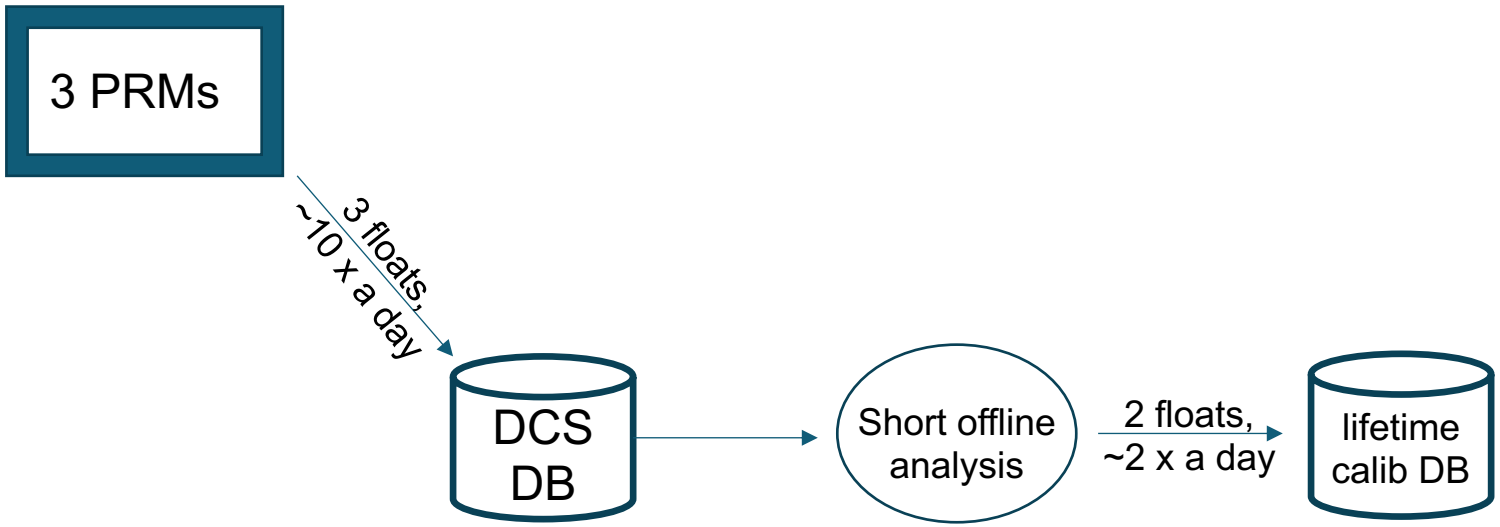
Example use case 1: Search for unstable HV periods

- protoDUNE-SP Run-1 Analysis conducted by Kevin Wood
- Analyze current and voltage to identify periods of unstable HV
  - Originally cut-based -> looking at ML improvements (IRIS HEP Fellowship)
- Resulting in event filter (ProtoDUNEUnstableHVFilter.fcl)
  - LArSoft Module checks if event falls into such period



Example Use Case 2: Electron Lifetime

- Electron lifetime constantly measured by 3 monitors (PrM) across detector
  - Store ~10 values each per day in DCS-DB
- PrM values are transformed into TPC values (simple scaling)
  - Results are written into dedicated ‘lifetime calib DB’
  - Granularity: Roughly twice a day (central value + unc.)



protoDUNE-SP Calibrations

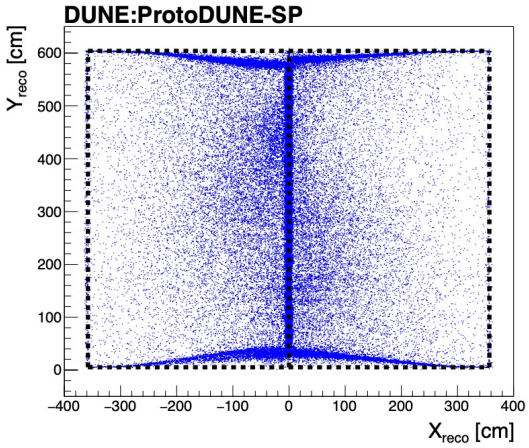
- Space Charge Effects (SCE) using E-field map
- Electron life-time (from PurMon)
- dQ/dx non-uniformity correction (from crossing μ)
  - In X-direction
  - In YZ-plane
  - Normalization
- dE/dx calibration (from stopping μ)

From .root file on /cvmfs/ (TH3)

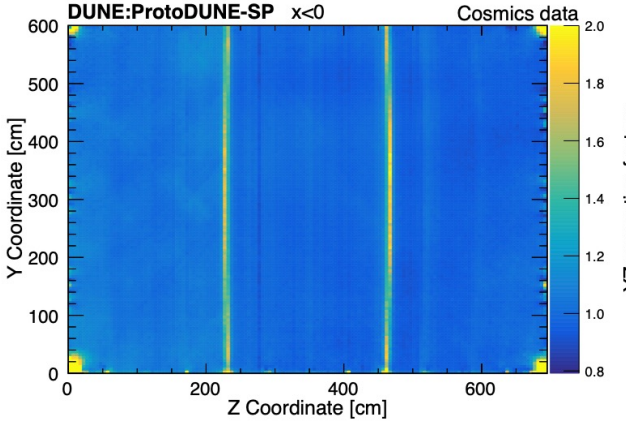
From Fermilab condDB

From .fcl file (dunesw/fcl/common/calorimetry_pdune.fcl)

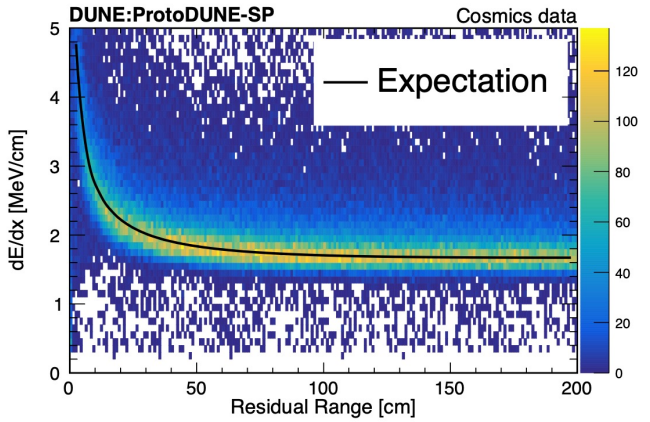
SCE



dQ/dx YZ



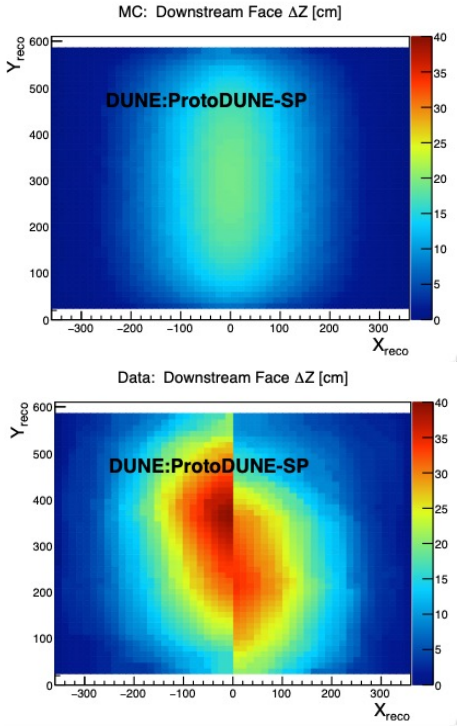
dE/dx



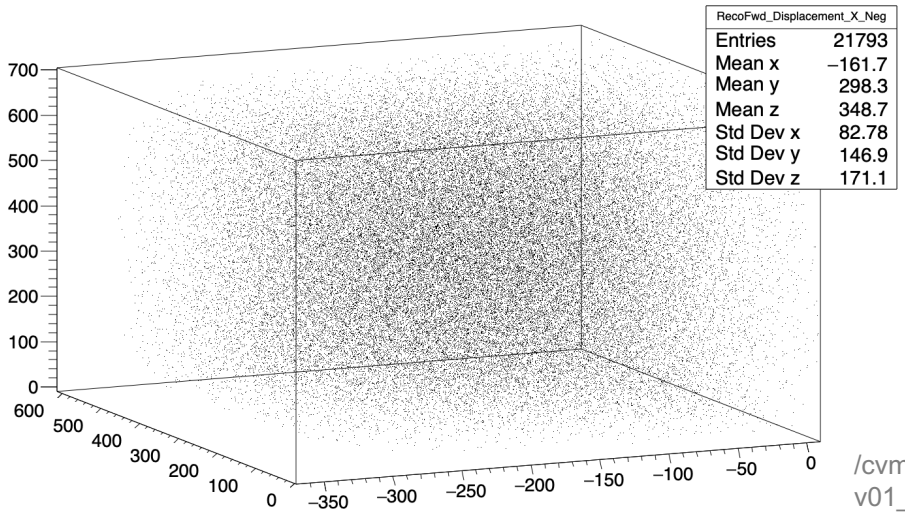
B. Abi *et al* 2020 *JINST* **15** P12004

SCE Calibration

- Positive ions build up in detector and distort E-field
  - Displaced spatial reconstruction
  - Altered absolute charge response (recomb.)
- Simulate E-field distortions in 3D
  - Augment with data from cosmics
- Assumed as constant over time!
  - Might become time-dependent for HD



B. Abi *et al* 2020 *JINST* **15** P12004



Fwd & bkw displacement, E-field
- X,Y,Z coordinate
- Split into pos and neg x-values

18 TH3's, 27027 bins (21*33*39) containing doubles
File size: ~1 MB

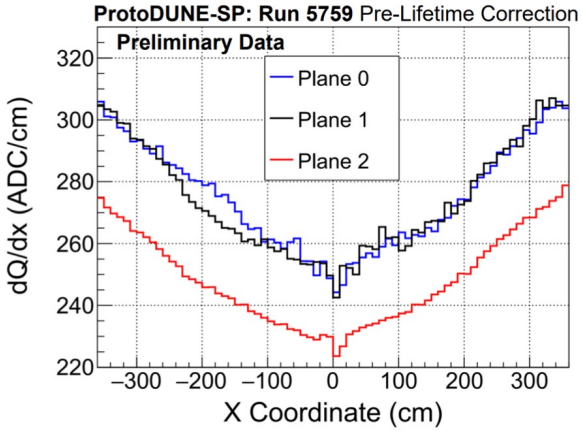
/cvmfs/dune.opensciencegrid.org/products/dune/dune_pardata/v01_80_00/SpaceChargeProtoDUNE/SCE_DataDriven_180kV_v4.root

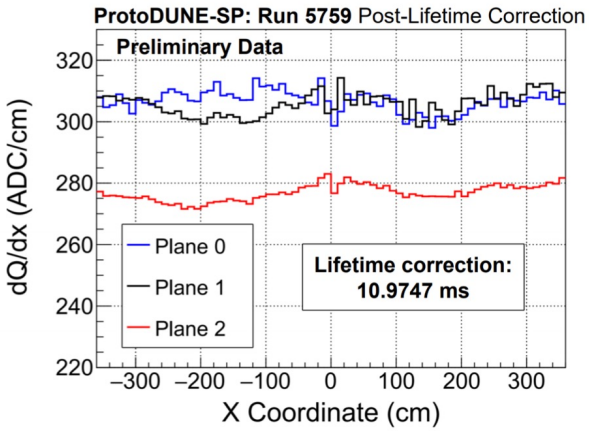
Electron Lifetime & dQ/dx Calibrations

Lifetime calibration

$$Q(t) = Q_0 \exp(-(t_{hit} - t_0/\tau))$$

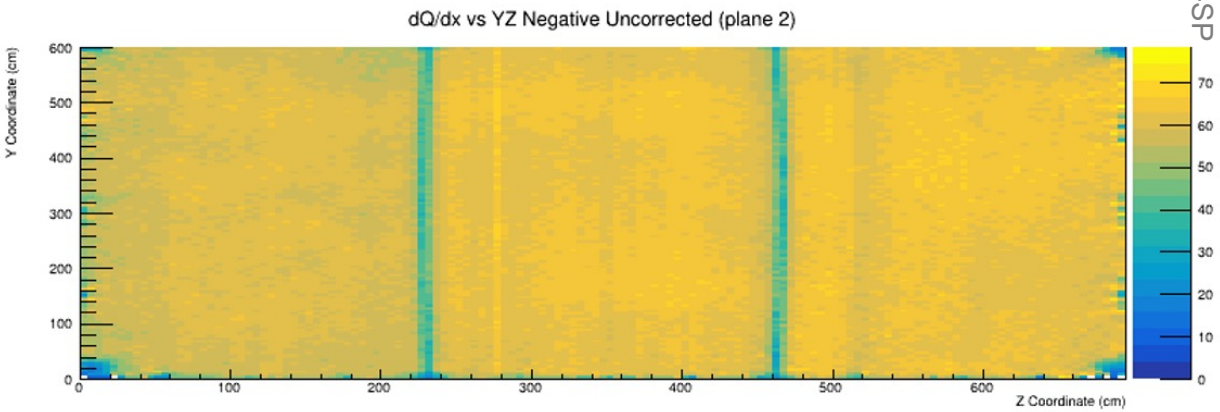
- Only pass param τ
  - time-indexed
  - Run1: 107 values





dQ/dx calibration

- 5x5 cm^2 grid in YZ
- 5cm grid in X
- for each wire plane (x6)
  - ~10^5 floats
- Run-index (one per run)



from Mitchell mote (DRA meeting, 19.05.21)

Summary

- Investigated use cases of conditions data to understand requirements
  - Slow Controls: Unstable HV & Electron lifetime
  - Calibrations: SCE, dQ/dx, Electron lifetime, dE/dx
- Debugged & deployed REST-API to read Slow Controls data

Outlook

- Deploy HSF-recommended Conditions Database

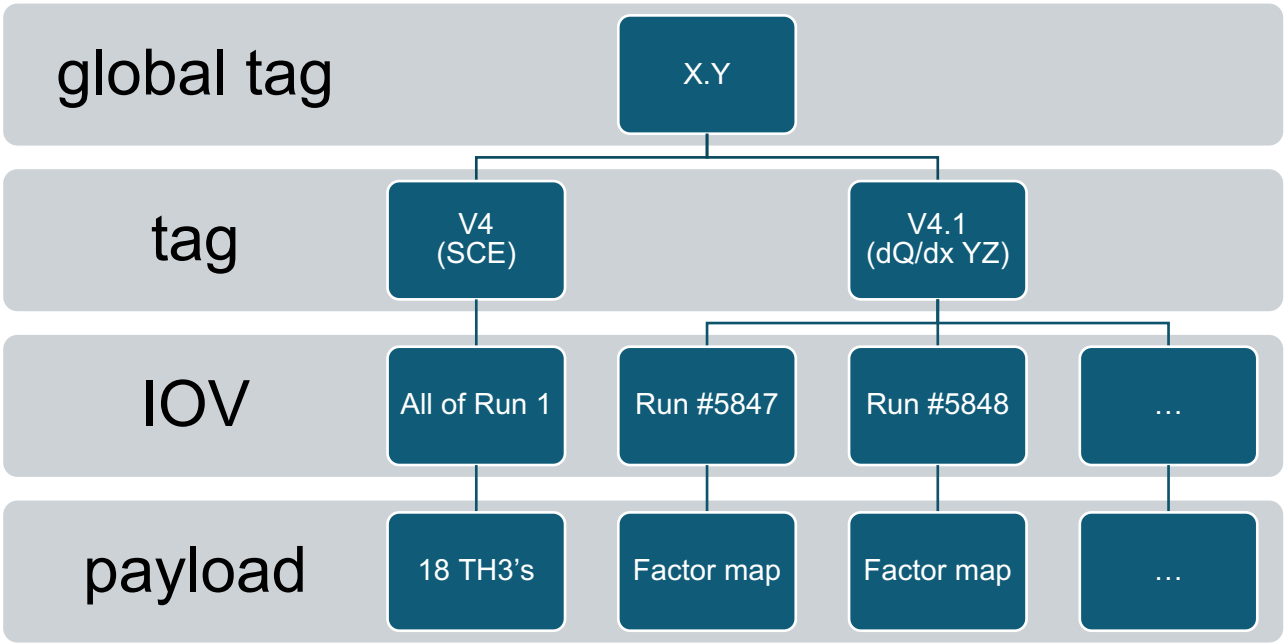
  (See Paul's talk for details)
- Adapt existing conditions data to new run-indexed schema
  - Construct payloads & update user-modules to handle them

Thank you for your attention!

Questions?

Common Interface - Example

Example of a common interface for the two calibrations mentioned previously:



‘Conditions Database’ (Fermilab)

- 2 kinds of calibration, 4 tables in DB (there are more):
  - Electron lifetime
  - dQ/dx YZ
  - dQ/dx X
  - dQ/dx normalization

DB content also stored here:
/dune/data/users/wwu/protodune/database/

DUNE Conditions Database

Tables in namespace: pdunesp

Go to namespace: pdunesp Go

Name	Snapshots	Plot data
pdunesp.adcgain	0	plot
pdunesp.channel_status	0	plot
pdunesp.distcorrnorm	13	plot
pdunesp.distcorrx	36	plot
pdunesp.distcorryz	61	plot
pdunesp.gain	0	plot
pdunesp.lifetime_purmon	3	plot
pdunesp.pedestals	0	plot
pdunesp.wwu_test	2	plot

dunesw accesses data via http service:

DBWeb query: https://dbdata0vm.fnal.gov:9443/dune_con_prod/app/get?table=pdunesp.lifetime_purmon&type=data&tag=v1.1&t0=1539711086&t1=1539883886&columns=center,low,high
Got 3 rows from database
run: 5387 ; subrun: 1 ; event: 3
evttime: 1539797486
fLifetime: 17518.348506 [us]

from logfiles when running reconstruction on raw data

Content of 'Conditions Database' (Run1)

- Lifetime Table: 107 rows (4 float cols: timestamp, low, center, high)
  - Granularity: twice per day, 3 channels each
  - Versions: 2

- dQ/dx X Table: 39,728 rows, 6 cols: channel, tv, x, dx, shape, shape_err
  - Granularity: once per run number, 432 channels per run (5cm)
  - Versions: 4

- dQ/dx YZ Table: 6,197,659 rows, 8 cols: channel, tv, y, dy, z, dz, corr, corr_err
  - Granularity: once per run number, 100080 channels per run (5cmx5cm)
  - Versions: 4

- dQ/dx Norm Table: 276 rows, 4 cols: channel, tv, norm, norm_err
  - Granularity: once per run number, 3 channels per run
  - Versions: 4