



Data acquisition

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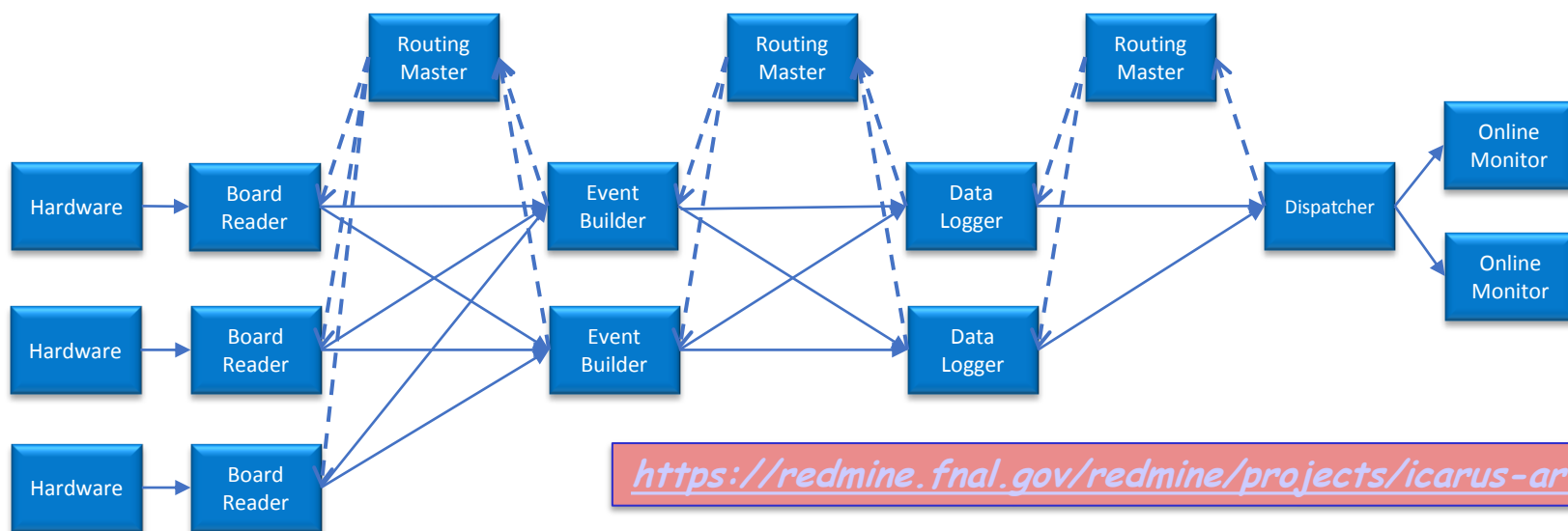
... more people welcome!

Scope of the data acquisition (DAQ) & online

- Readout of TPC, PMT and CRT data fragments.
- Reference timing & integration with trigger.  See A. Guglielmi's talk!
- Event building _ merge of data fragments into one event and formatting.
- Run control & process management _ interface to end users.
- Operational monitoring & logging _ interfaces to slow control.  See A. Fava's talk!
- Online databases _ interface to offline.
- Data management _ temporary and permanent storage.
- Online and nearline data quality monitor _ quick check of data integrity and quality, with feedback to detector operations and input to analysis.

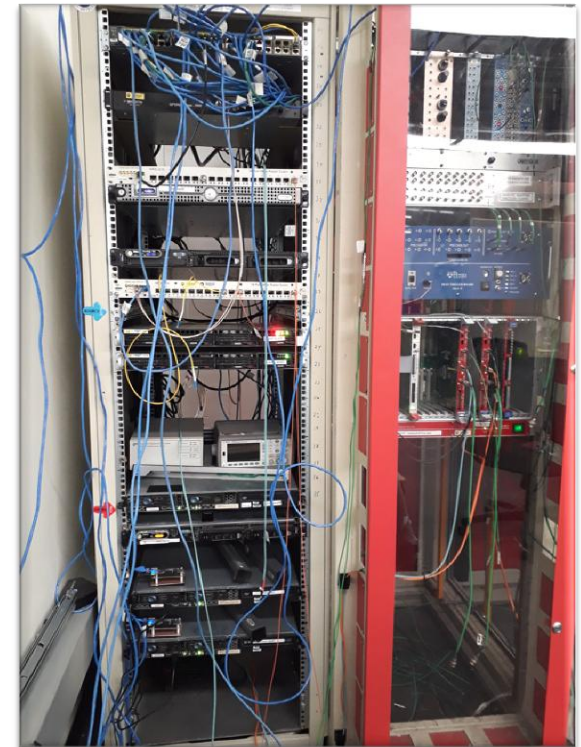
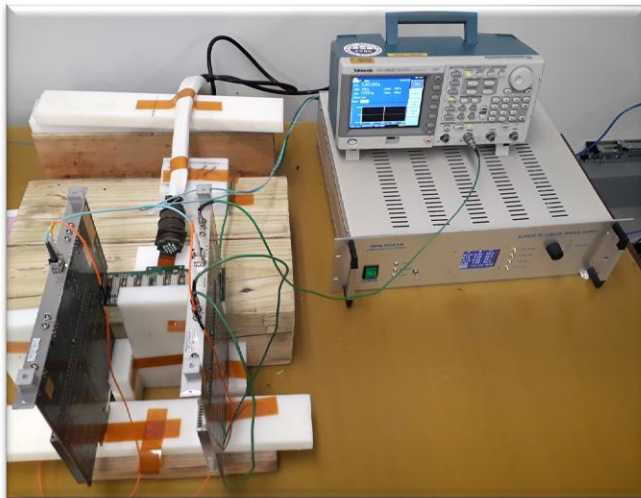
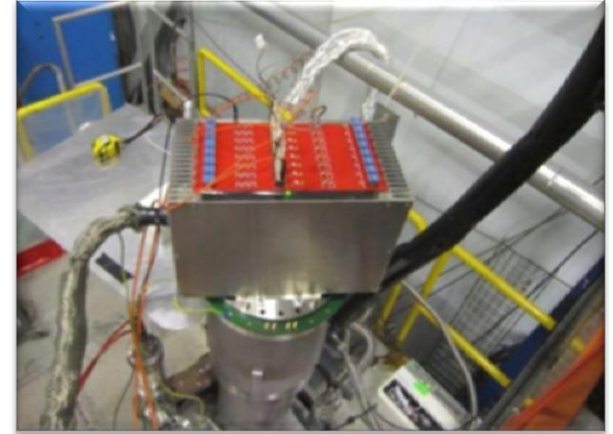
Development framework

- Much of DAQ work in "SBN DAQ and Data pre-processing Working Group".
Bi-weekly meetings on Monday at 10:30 am CDT, sbn-online@fnal.gov.
- Still, some ICARUS peculiarities:
 - ✓ TPC readout;
 - ✓ Double-Chooz CRT readout electronics (bottom panel);
 - ✓ Trigger board/readout;
 - ✓ Many more channels/larger events;
 - ✓ Only triggered readout (no continuous readout mode)...
- ArtDAQ software framework: data flow tools customized at hardware interface



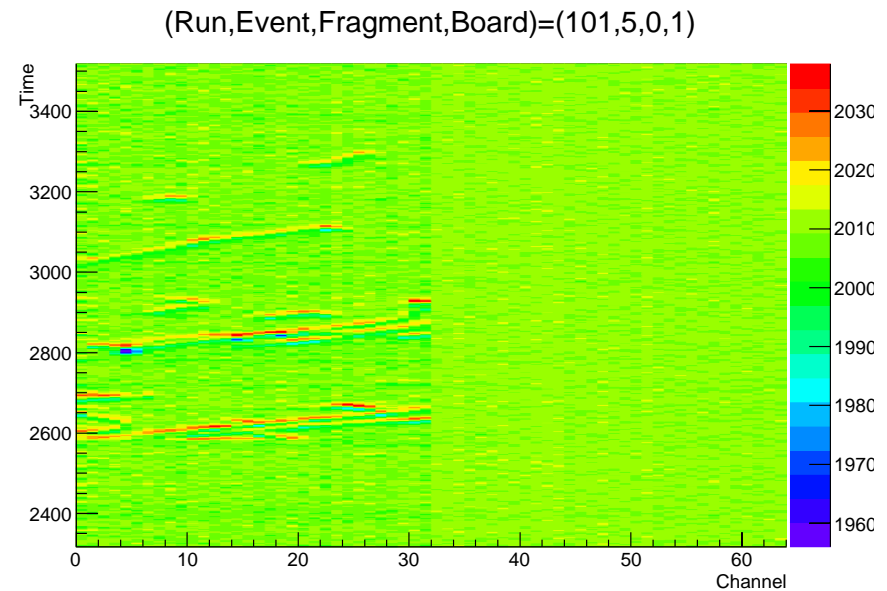
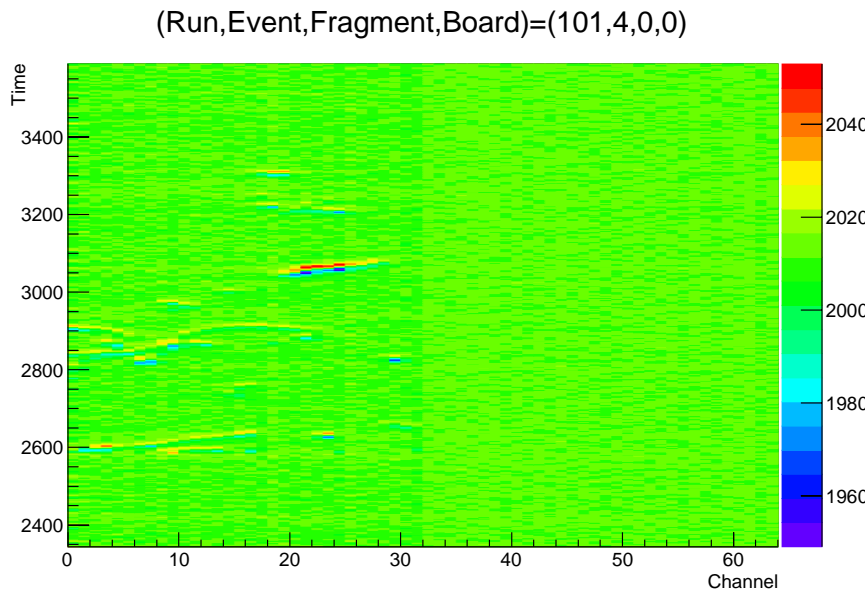
Test-stands

- Dedicated ICARUS test-stand at CERN
 - ✓ 50l LAr-TPC with 256 channels readout with production TPC electronics;
 - ✓ ~ 1600 liters LAr cryostat with 10 PMTs readout with production PMT electronics.
- Common SBN DAQ teststand at DAB
 - ✓ PMT and CRT readout electronics;
 - ✓ Some TPC readout to be improved!



TPC readout

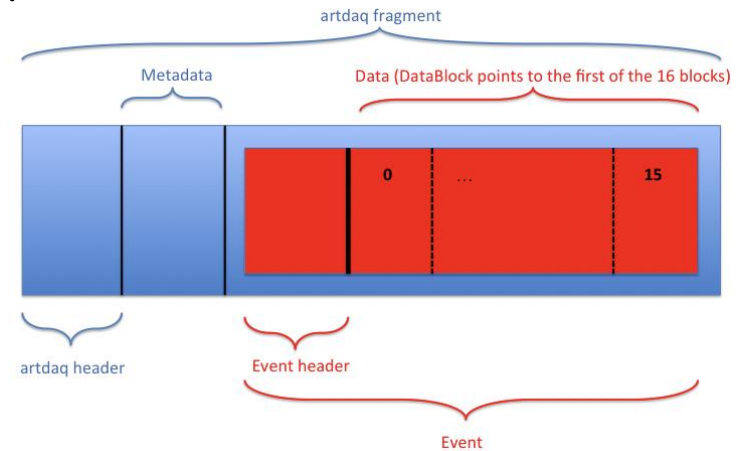
- ICARUS-specific CAEN readout electronics. ← See S. Centro's talk!
- Prototype BoardReader software, built off of DAQ software from LNGS, run on test-stand at CERN.
- Further testing and development needed:
 - ✓ improve latency;
 - ✓ investigate data throughput;
 - ✓ integrate compression techniques, etc.



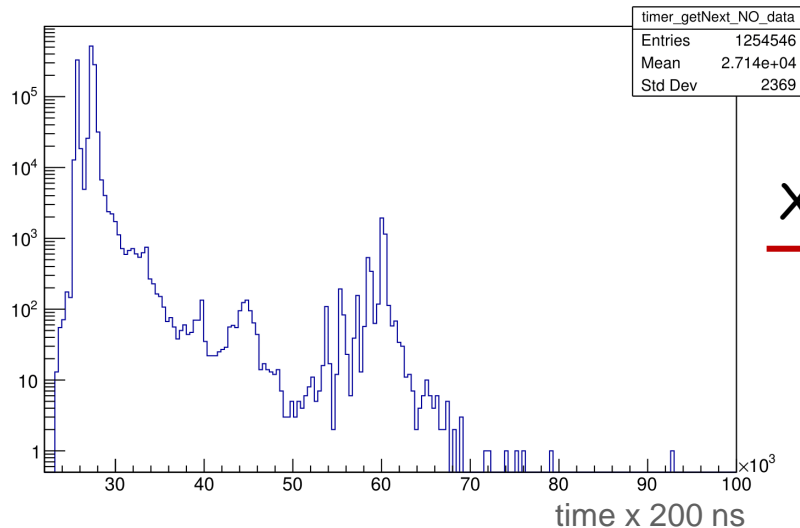
PMT readout

- Common hardware with SBND (CAENV1730), triggered by logical processing of LVDS primitives.
- BoardReader software existing, with more testing/development to come.
- Move soon to operational tests of throughput, timing, trigger output...
- Preparing for test run at CERN.

See GL. Raselli's talk!



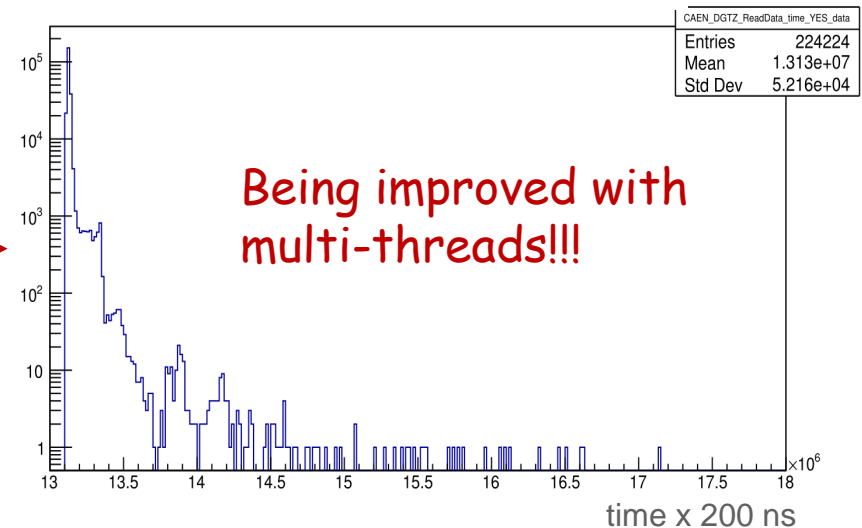
Readout time without data



X 1000



Readout time with data



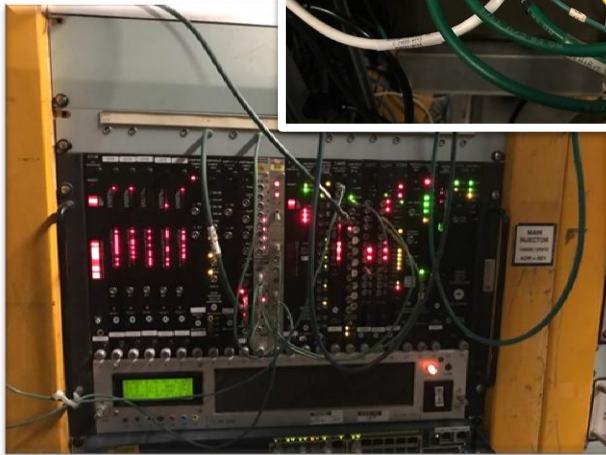
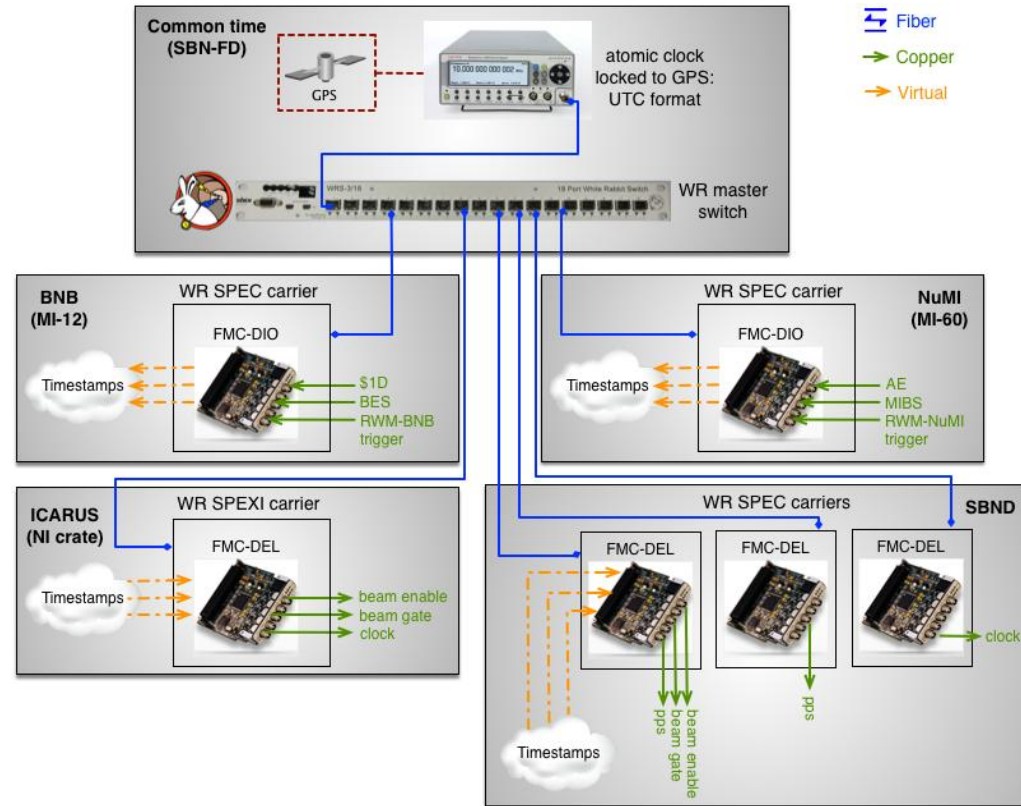
CRT readout

- Some common hardware ("Bern") electronics with MicroBooNE and SBND, and similar readout scheme:
 - ✓ continuous stream of data that needs to get chopped up and time-stamped properly;
 - ✓ building off of prototype BoardReader from MicroBooNE.
- Additional readout of "Double-Chooz" electronics:
 - ✓ prototype readout software installed and tested.
- Additional tasks:
 - ✓ maintaining/updating readout libraries, data format (overlay) code, readout (fragment generator) code;
 - ✓ operational tests of throughput, timing, trigger output, etc.

Architecture of the White Rabbit network at Fermilab

White Rabbit network for distribution of:

- GPS timing (1 Hz & 10 MHz) with sub-ns accuracy;
- BNB & NuMI beam extraction signals with 8 ns resolution.



Backup of the entire network available.

- Preliminary network deployment complete.
- Latency tests ongoing to guarantee arrival of beam signals on time for gate opening.
- To be developed for performance improving.

DAQ dataflow software & control

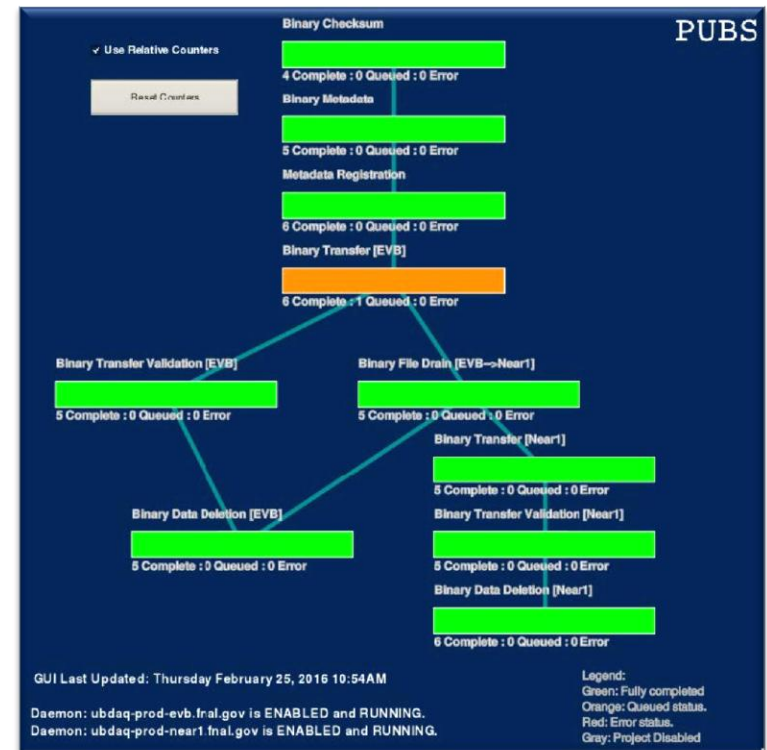
- General data flow structure and tools provided by artdaq.
Additional tasks:
 - ✓ setup/testing of data transport, event-building, and disk-writing performance;
 - ✓ development and integration of additional auxiliary elements, e.g. trigger inhibit mechanisms can build off of preliminary implementation at CERN test-stand.
- Run control: processes to startup/shutdown and communicate with artdaq, to pass through DAQ state machine, completed with high-level "shifter" interface and documentation
Needed development:
 - ✓ evaluate/build-out artdaq's existing "DAQInterface" scripting collection;
 - ✓ choose/develop process management routine;
 - ✓ run automation and monitoring;
 - ✓ Graphical User Interface (GUI) and shifter interactions.
- Status monitoring:
 - ✓ existing artdaq debugging (TRACE) to be complemented by database schemes;
 - ✓ interface to slow control (Epics plugin) to be tested and possibly extended.

Online databases

- Additional online databases to be designed, developed and implemented for determining/recording state of detector and data:
 - ✓ run configuration and history;
 - ✓ event history.
- Integration with offline databases to be realized through identification of needs and coordination of access rights
E.g. data quality monitoring needs communication with channel-mapping
- Replication of online databases to be studied and realised.

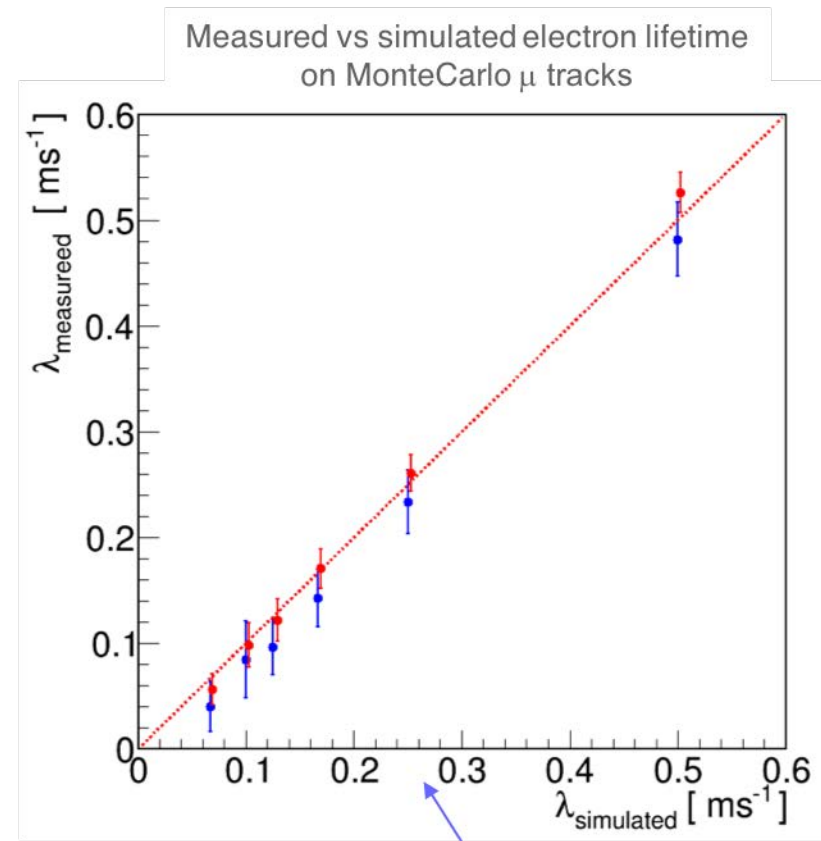
Data management

- Once data is to disk, need to see data through to offline storage at Fermilab and any additional backup sites.
- Common infrastructure envisioned, using Fermilab-based tools (FileTransferService, SAM database, etc.).
- Dataflow plan needs to be designed, developed and tested for transfer out of DAQ cluster.
- Monitoring tools for data management needs to be built, possibly exploiting experience with MicroBooNE (ex. PUBS).



Online & nearline data quality monitor (DQM)

- Higher-level monitoring of data events to ensure good-quality data.
- Use of common basic format (*artdaq/art* events) and common data formats/overlays allows joint development of infrastructure and analysis-level modules.
- Main developments needed:
 - ✓ software infrastructure for data transport to monitoring nodes;
 - ✓ art modules for prompt DQM analysis.
- Build off of existing algorithms & experience from LNGS run.
Co-development with SBND vertical slice test to be operated this summer.



See D. Gibin's talk!