DATA ACQUISITION SYSTEM TO LOCATE ALPHA DECAYS

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SUMMARY

- Intro to Ba-tagging group
- Goals for the team and summer
- Progress
- Status
- Next steps

BA-TAGGING GROUP

- Demonstrate identification and extraction of individual ions from liquid xenon
- Radon-222 → Polonium-218 alpha decay

- Detection volume: time projection chamber (TPC)
  - Charge collecting system
  - Light collecting system
- Wobble Stick: probe with capillary tube

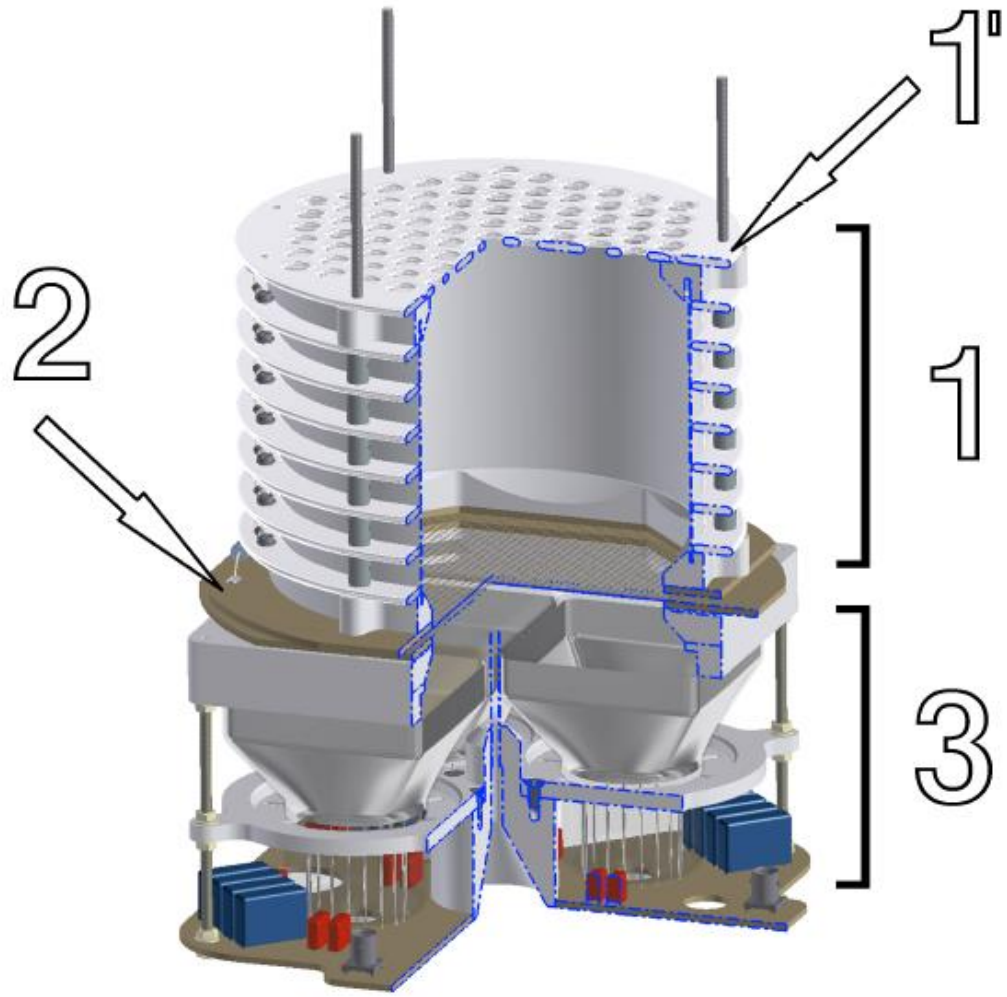


Figure 1: The EXO-100 TPC, shown as a model (left) and assembled. On the left, the parts of the TPC are identified: 1 – detection volume, 1'– cathode, 2 – charge collection system, 3 – light collection system. (Image: S. C. Delaquis [1])

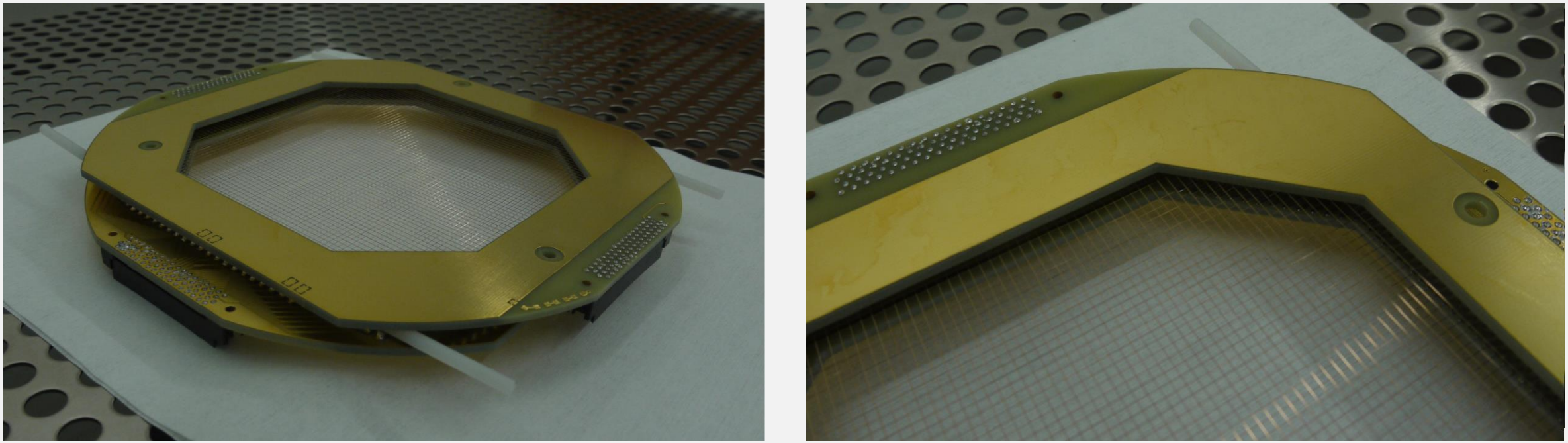


Figure 2: The charge collection system. Left shows both the induction plane and collection plane stacked on top of each other. On the right, a close-up emphasizes how the 63 wires from each plane are perpendicular to one another, creating a grid to aid in positioning. (Images: S. C. Delaquis [1])

LOCATING ALPHA DECAY

Event trigger

- PMT signal arrives first
- Charge arrives at induction then collection layers

Analyzer program:

- Check if valid event
  - Energy, charge
- Get height position of event
  - Use drift velocity
- Get x and y position of event
  - Use induction and collection channel data
  - Wire spacing for location in TPC
- Send location to probe

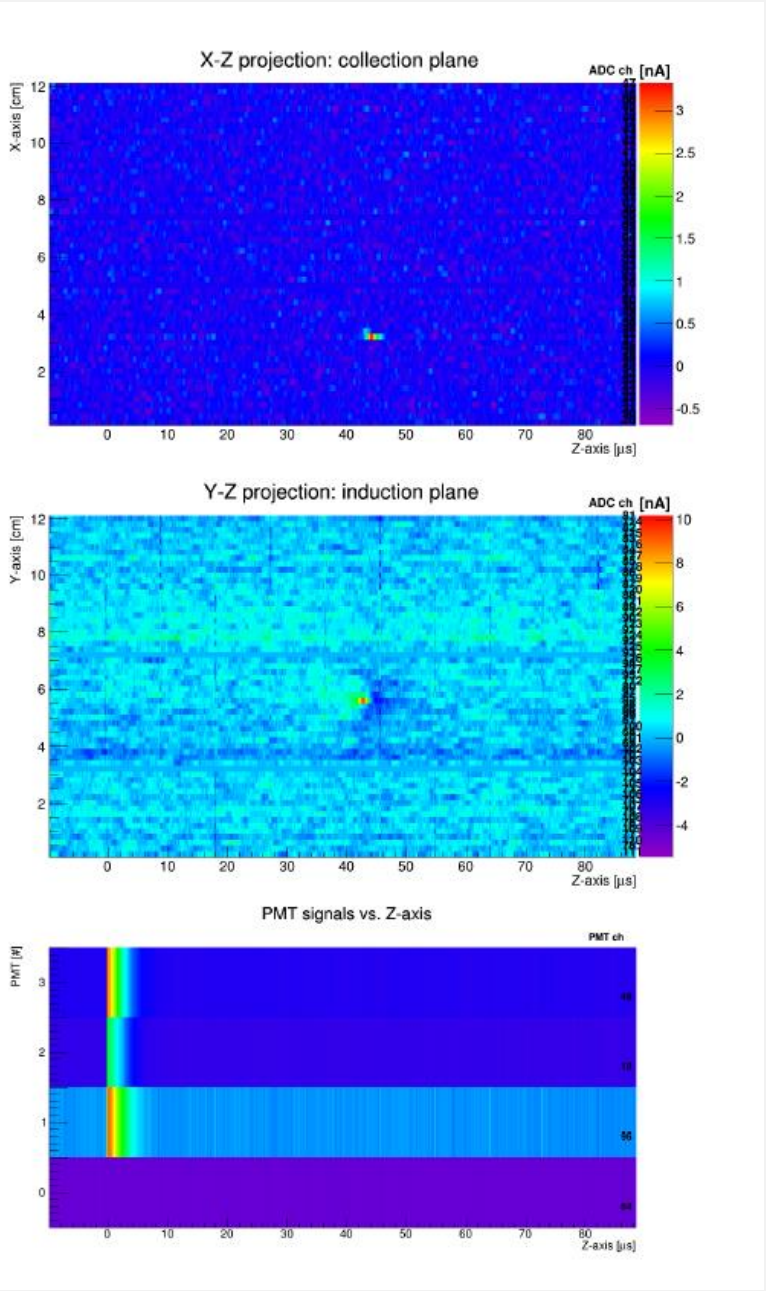


Figure 4: Heatmap plots of the charge collection and light collection system on an alpha decay event. The XZ and YZ projections correspond to the collection and induction plane respectively. The PMT signal becomes the reference starting time, from which the vertical distance Z can be obtained. (Images: S. C. Delaquis [1])

WHAT IS NEEDED?

DAQ system

- Connect equipment to computer
- Experiment control

Online analyzer program

LEARNING MIDAS

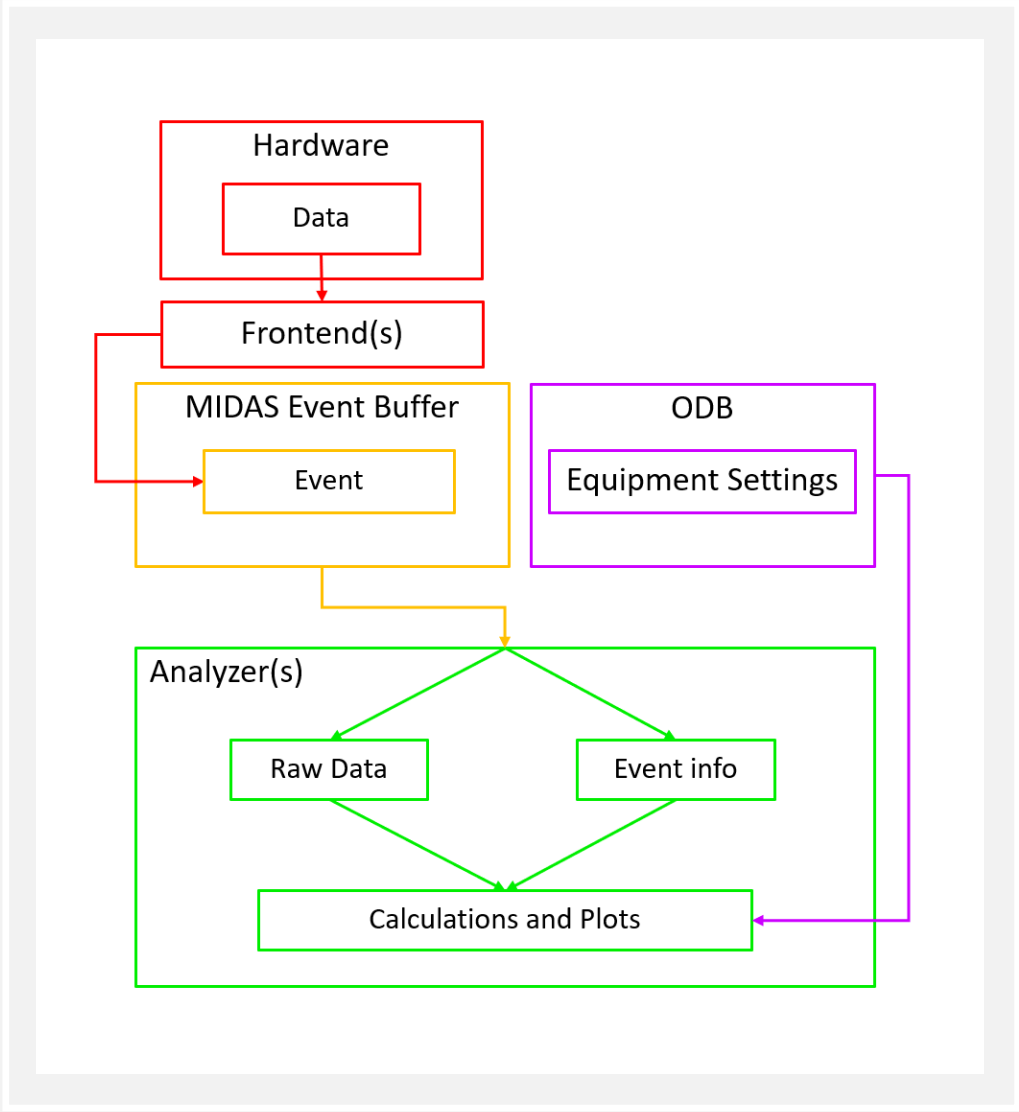
Code framework for data acquisition

Compatible with equipment (CAEN)

Allows remote control of experiment

Offers:

- Main information hub – ODB
- Register programs as clients
  - Frontends
  - Analyzers



RECOVERY OF PROGRAMS AND TOOLS

Multiple-board Frontend

- Links CAEN equipment reading data with DAQ computer
- Control equipment settings through ODB

RECOVERY OF PROGRAMS AND TOOLS

Analysis Tools - *ReadMidas*

- Used for offline analysis
- Recovery of a working system better than starting from scratch
- Would facilitate event location and data handling with Analyzer
  - *Datalib* → custom library with data storing and analysis classes
  - *mid2root* → event data decoding and organization
  - *EventDisplay* → makes ample use of library features

UPDATING *DATALIB*

Datalib classes depend on file access to load data

Incompatible with online analysis

- Files generated at the end of run

Update requirements:

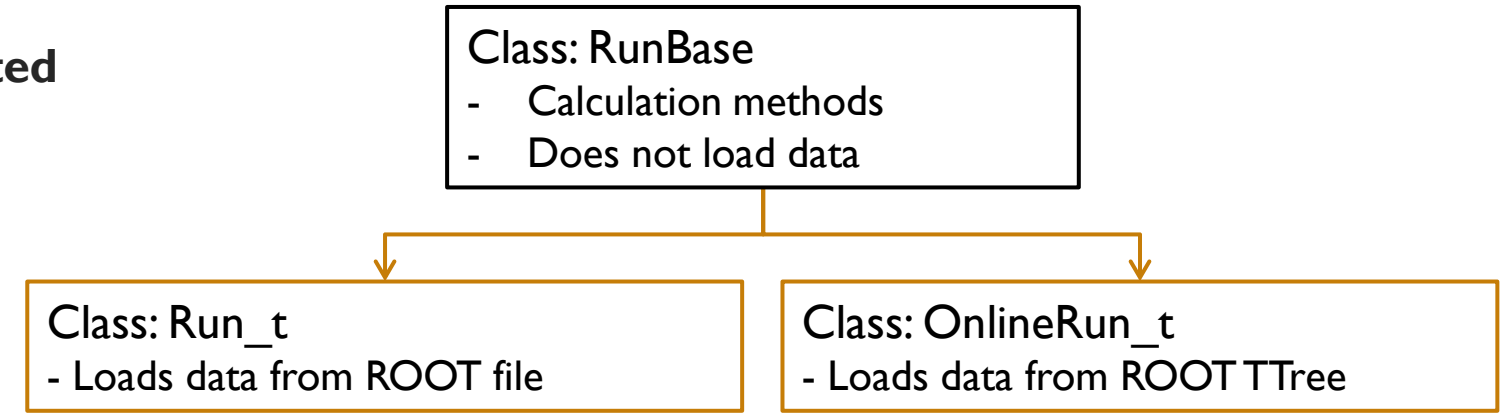
- Maintain old functionality
- Bypass file dependency

UPDATING DATALIB

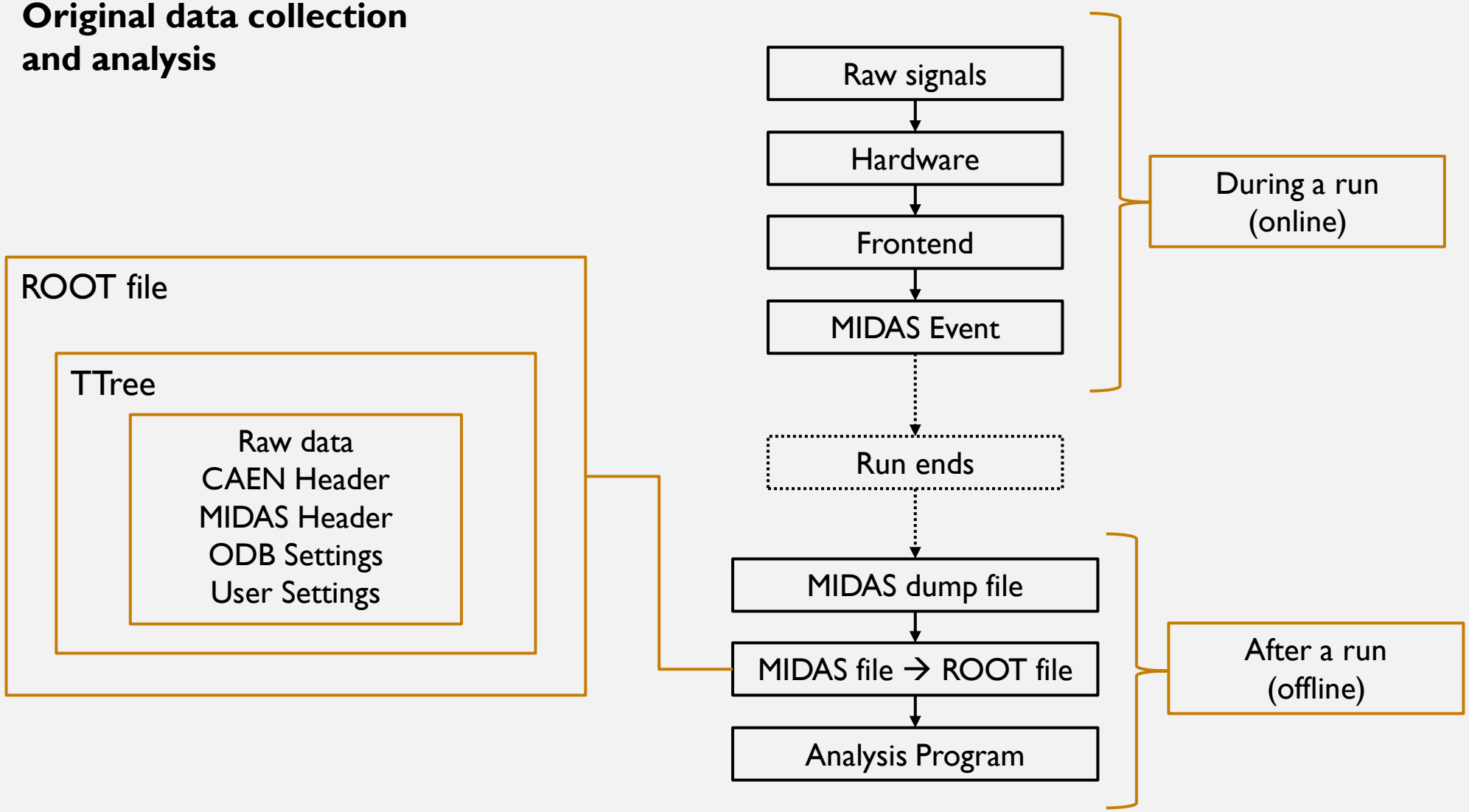
Original

Class: Run_t
- Loads data from ROOT file
- Calculation methods

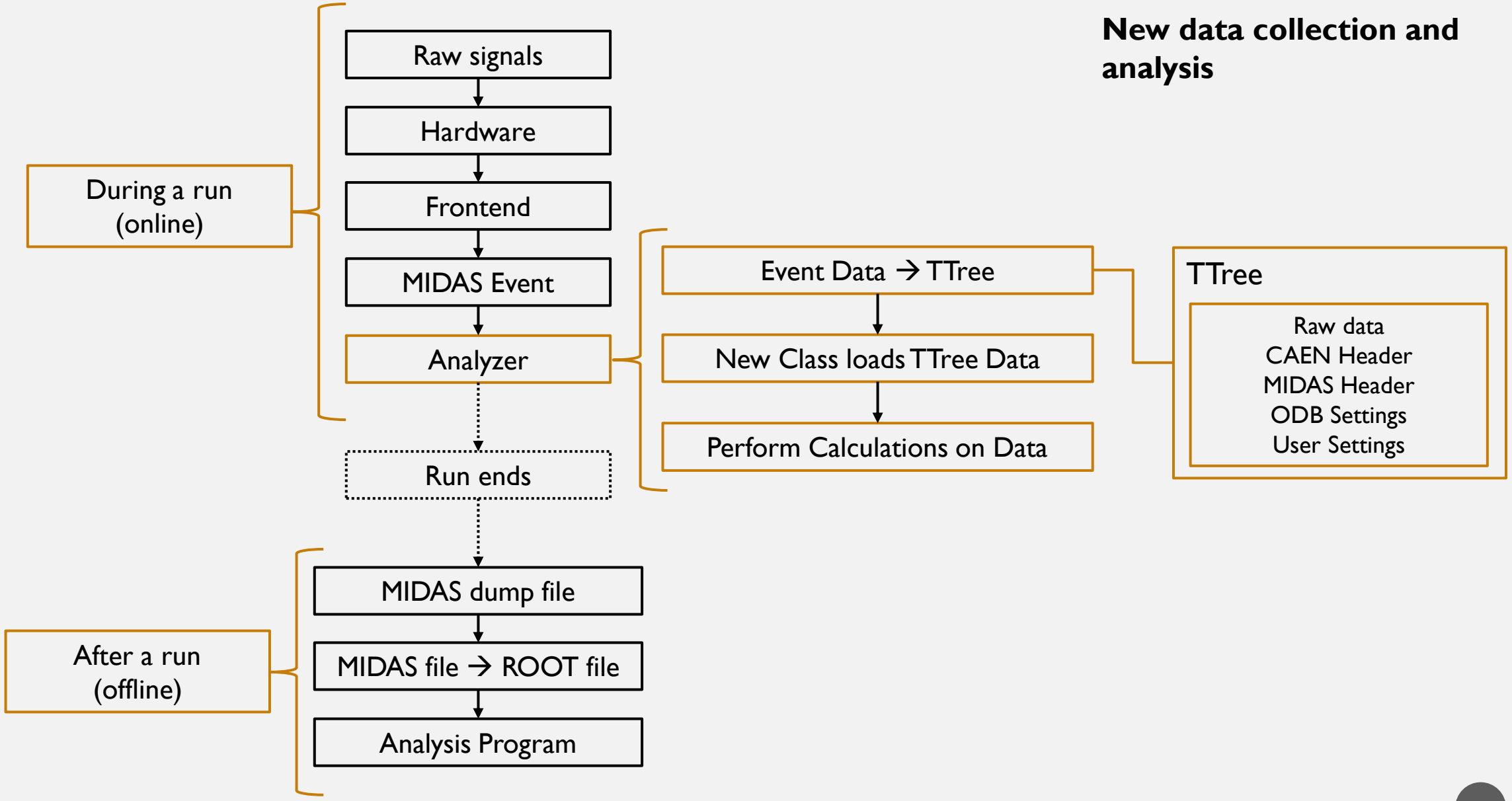
Updated



Original data collection and analysis



New data collection and analysis



CURRENT STATUS

Analyzer in progress

- Main structure and flow is done
- Most of event decoding done
- Test function to output plots

Setup DAQ computer in clean room

Frontend was able to detect hardware and prime for run

Problems sending and receiving signals

- Think it is optical link related

NEXT STEPS

Analyzer needs more work:

- Currently decodes 64 channel events
  - We have 128 channels
- Add procedure to identify the type of event
  - Charge, energy calculation
  - Prevents locating noise/other non-alpha events
- Locating decay
  - Establish coordinate system
  - Send coordinates to probe program
- Testing
  - Interfacing with frontend
  - Fine-tuning settings

CONCLUSION

Worked on advancing the DAQ setup for Ba-tagging group

- Recovered frontend program, analysis tools and custom library
- Updated library to be online analyzer compatible
- Began analyzer to locate alpha decay events

Experience:

- Very software oriented; something completely new
- Got to see what DAQ system looks like and needs

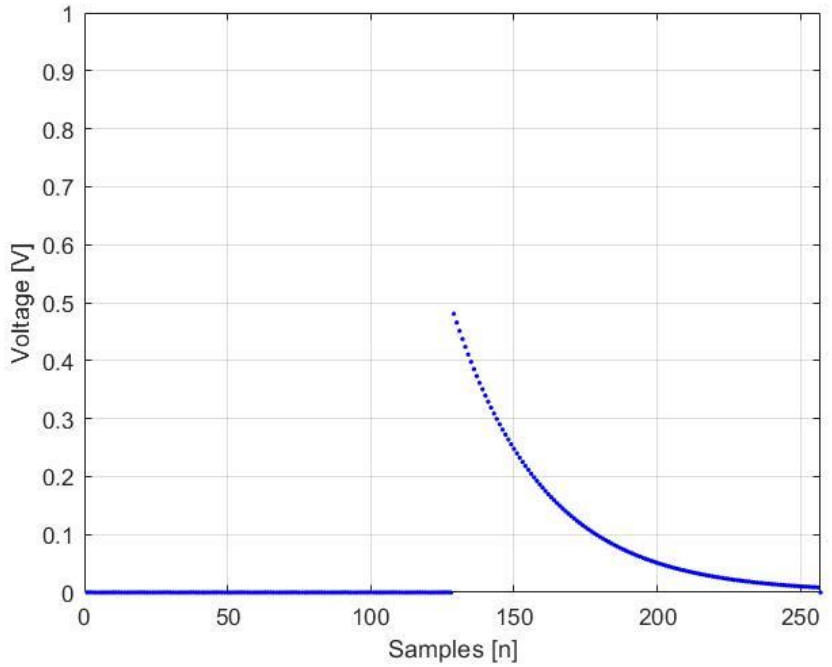
QUESTIONS?

REFERENCES

[1] S. C. Delaquis, "Construction and operation of the EXO-100 cryogenic facility for R&D in liquid xenon: advances in barium ion tagging," May 2016, doi: http://dx.doi.org/10.7892/boris.82606.

TEST FRONTEND AND ANALYZER

- Frontend generated mock signals periodically
  - No hardware needed
  - Simplified signals emulate real pulses
    - Noise, spike, decay
  - Settings to change behaviour
    - Fraction of samples as noise
    - Total number of samples
- Analyzer received signals
  - Checked if peak passed a threshold
  - Saved peak value and event ID if so



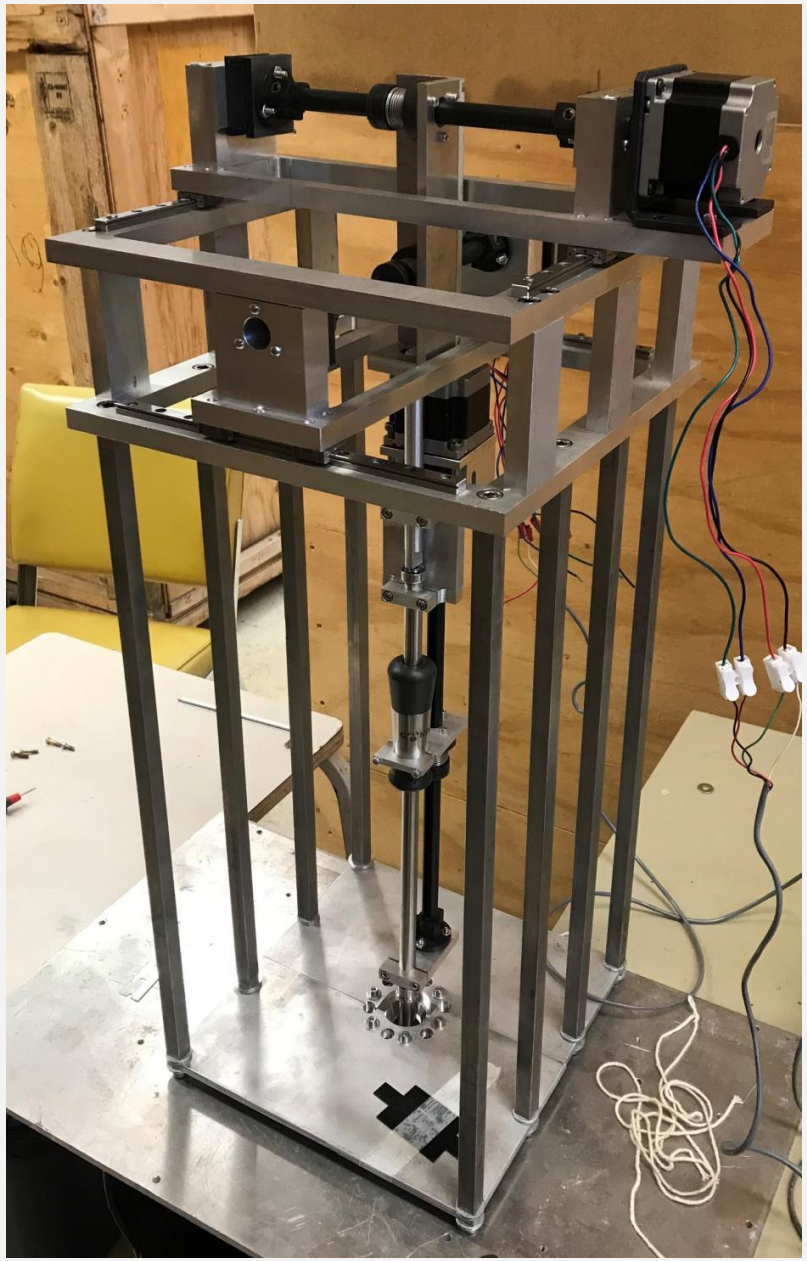


Figure 3: Picture of the Wobble Stick and computer-controlled displacement device. Through stepper motors, the displacement device allows the Wobble Stick probe to pivot about the hole in the base, and then extend to insert the capillary inside the TPC.