Lesson learned Diagnostic and monitoring tools - MicroBooNE

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Argon Purity monitoring

- Purity monitor has a lifetime. When the purity monitor stopped working, implemented analysis based on cosmics to understand the lifetime of the detector.
- Lesson-learned:
  - better have two methods from the beginning to cross-check the purity and it's stability.
  - purity monitor underestimate the lifetime, gives different result from the lifetime analysis using cosmic data.
  - Be aware purity recovery time may be longer than desired. Plan ahead for shut down or unexpected incidents, e.g. pump off for 10 hours->one week for recovery

Software Trigger

- Data volume in LArTPC is very large if we record every beam spill, and most events without neutrino interactions. MicroBooNE implemented software trigger @ DAQ using PMT signals, cut down the data rate by ~25.
- Lesson learned:
  - Implement an efficient Trigger system that allows to obtain all the data to reach physics goals within computing resources constraints.
  - Rate from various trigger streams should be closely monitored: first level of defense for high quality data.

Slow control monitoring:

- Very important system for operation, MicroBooNE monitors ~5000 variables through slow control. False alarms are counter productive.
- Assure good communication between subsystem experts and Slow control team: subsystem experts must ensure alarm variables, ranges and instructions are clear and up to date.

Nearline monitoring:

- Sampling the data with fast analysis: monitoring the data quality in time. Lifetime analysis to monitor purity is the first implementation of nearline monitoring pipe line, MicroBooNE uses POMS to manage these jobs.
- Suggested trend plots of physics objects: Single PE rate, # of neutrino interactions, pulse height, cosmic activity/calibration sources, etc.

Make plans for periodical special runs for detector calibration.

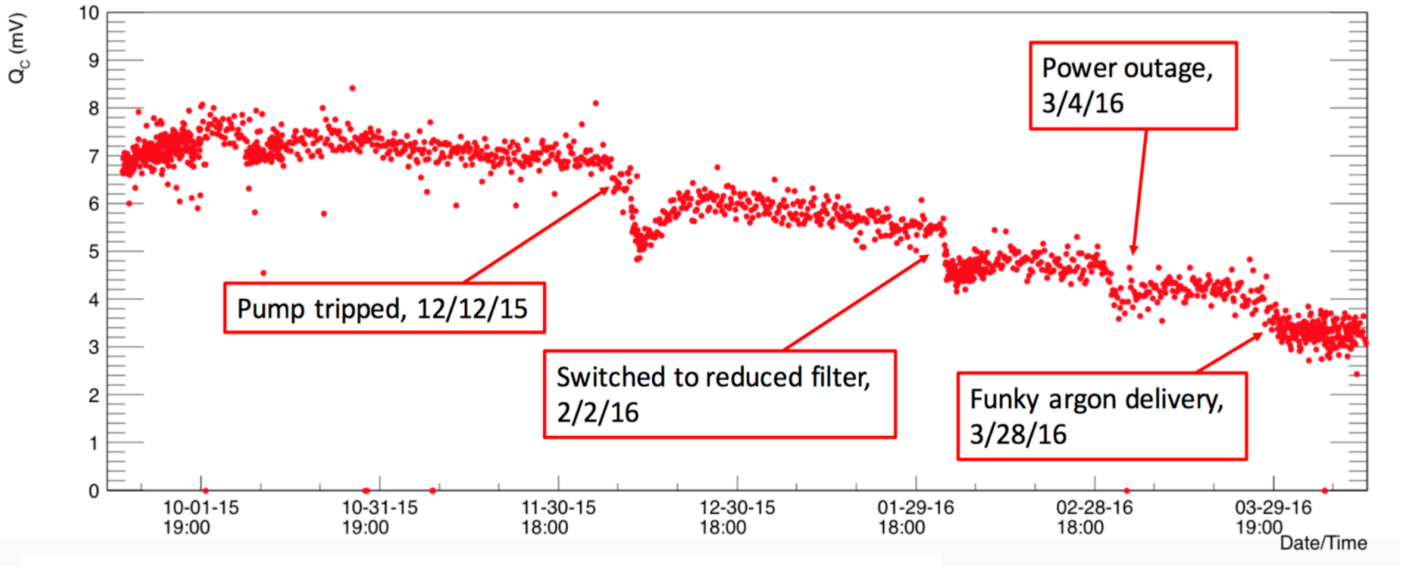
- Pulser runs with different configuration, for signal response and gain calibration
- Different HV, for various detector physics topics
- Radioactive Source: used to calibration CRT in MicroBooNE.
- Systematically turn off the detectors for noise investigation.

TPC diagnostic and monitoring:

- take time to develop a reliable channel database mapping. This will save a lot of time during trouble shooting.
- Stress test of the electronics.
- Channel health monitoring in longer time frame: unresponsive channels, misconfigured channels, noisy channels.

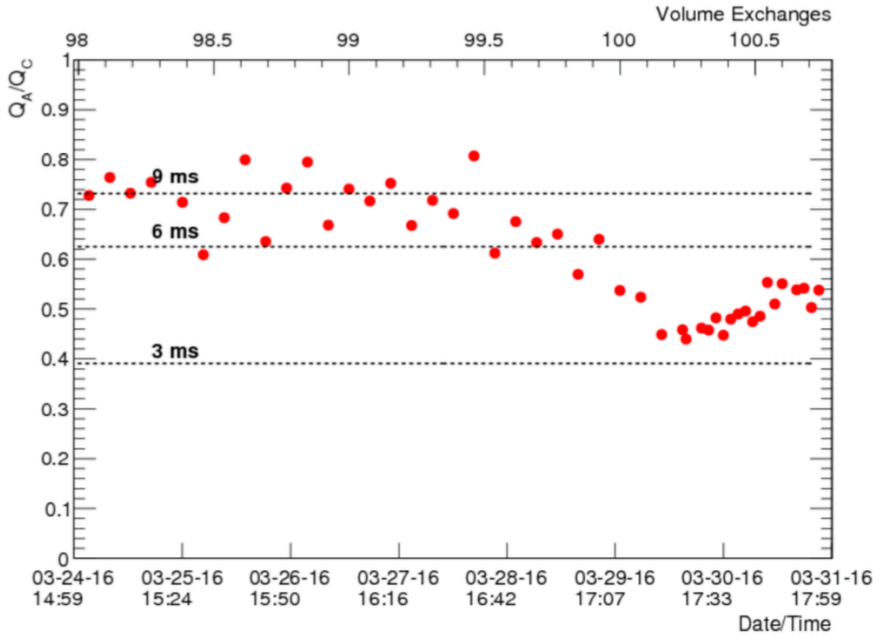
Backup

Purity monitor Vs lifetime analysis using crossing cosmic muons

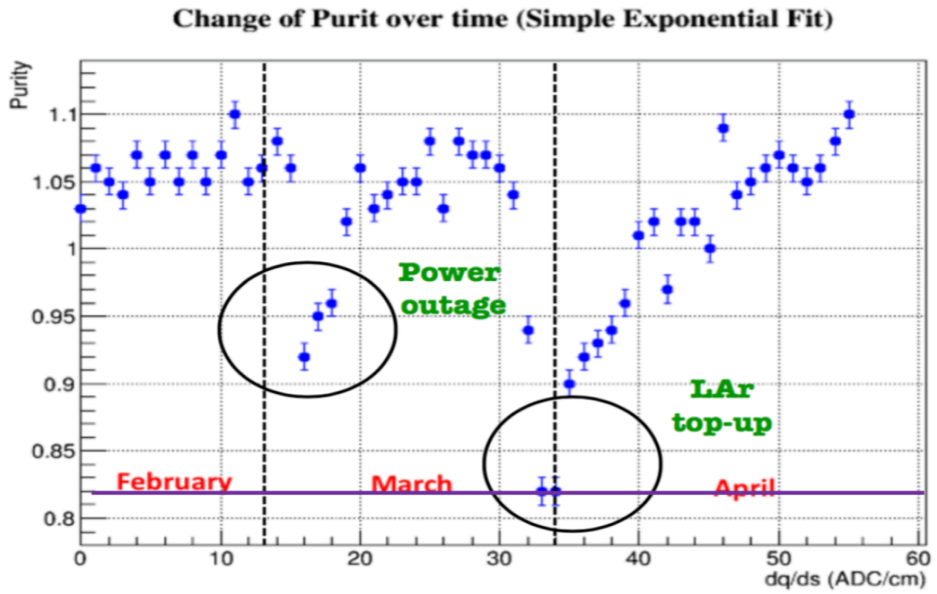


Potentail Problems:

- Slowly dying flash lamp
- Fiber aging
- Photo cathode degrading
- Contaminants plating out the photo cathode
- Create lot of lights observed by PMTs while PrM are running.



Purity Monitor (left)
Vs
lifetime analysis (right)



Trigger cocktail

Stream	Threshold	prescale	Rate After SWtrigger
BNB (5Hz)+ SWTrigger	>6.5 PE	1.0	0.2 Hz
BNB (5Hz)+ unbiased		0.0026	0.013 Hz
EXT (10Hz) + BNB SWTrig	**>6.5 PE**	**1.0**	**0.26 Hz**
EXT (10Hz) + unbiased		**0.02**	**0.13 Hz**
MuCS		0.01	0.03 Hz
Total			<0.63Hz

- Raw BNB: raw EXT = 1:2
- BNB takes priority, vetos 35% of the EXT trigger
- Total rate at readout: 12Hz
- Total rate after software trigger: 0.63Hz
- DAQ uptime higher than 97%

Trend plot examples