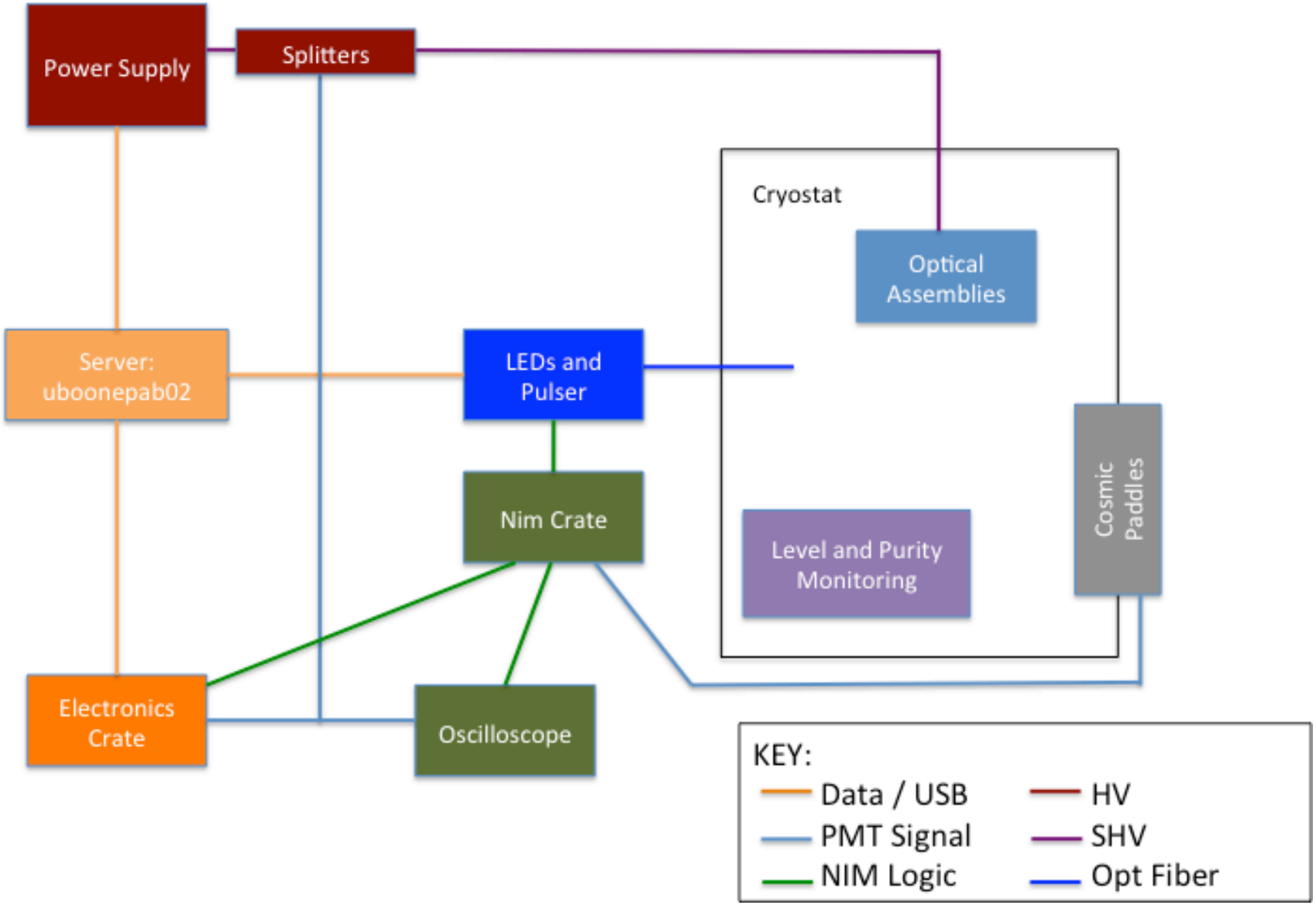
UPDATE FROM PMT VERTICAL SLICE TEST

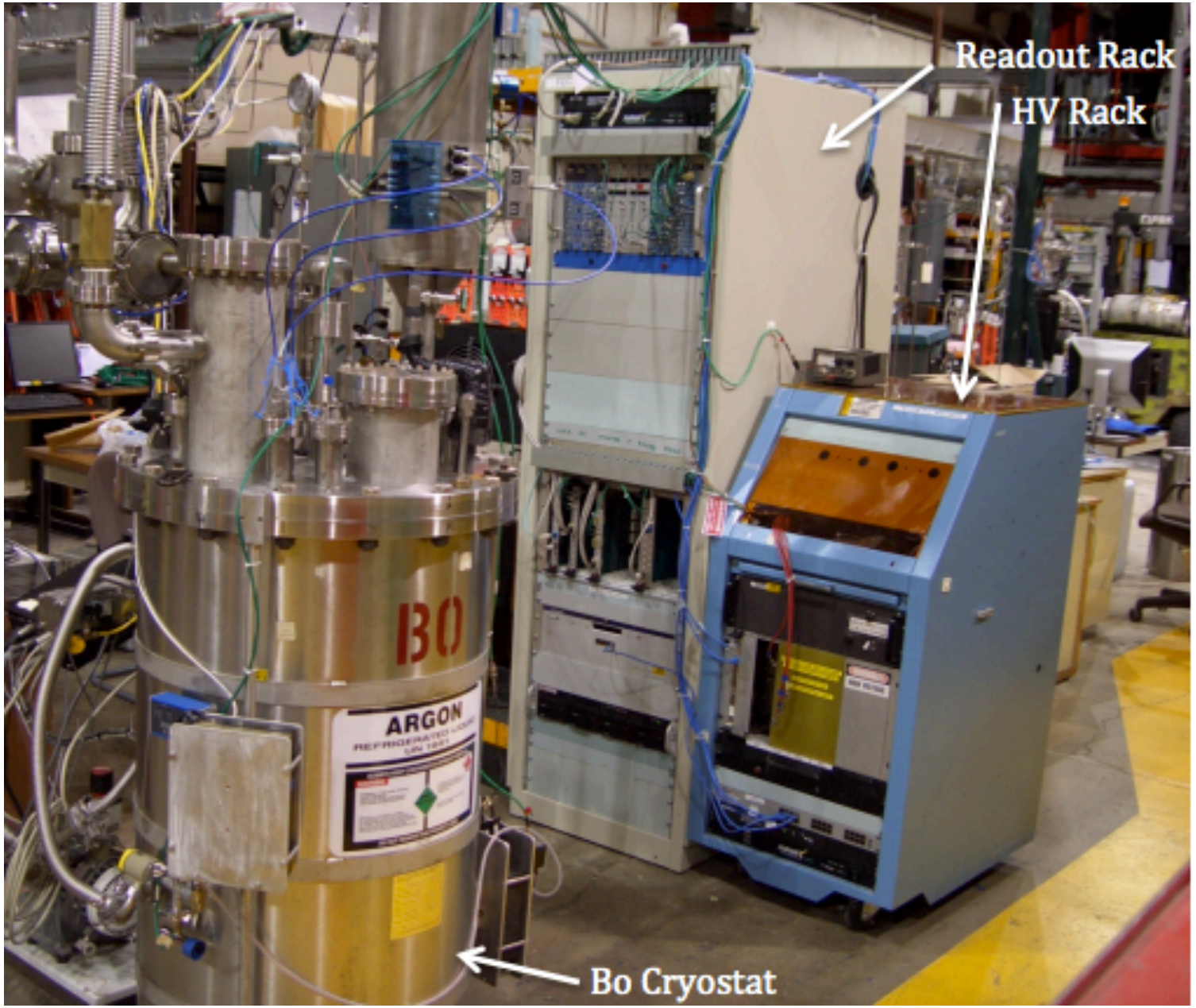
Ben Jones, MIT

Progress Reported Today

- Splitters (Mostly covered by teppei)
- Condenser systems
- Source Deployment
- Preliminary nitrogen injection measurements
- Readout progress and software interfaces

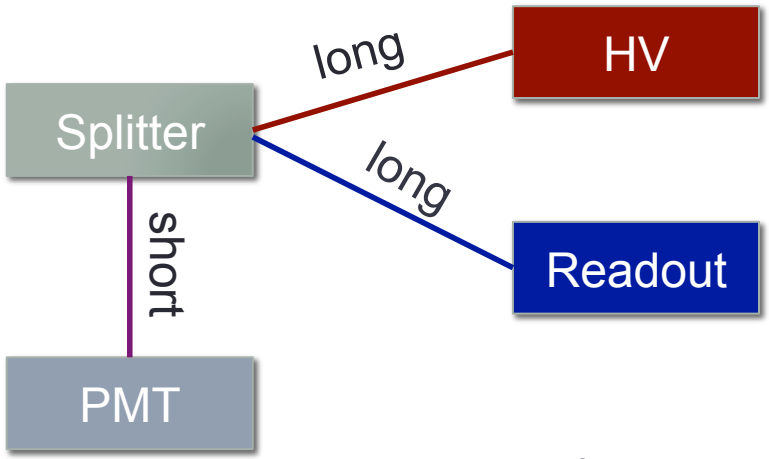
Bo VST Systems:




Readout Rack
HV Rack
BO
ARGON
Bo Cryostat

HV distribution

- Reported by Teppei at this meeting (I think)
- Complete move to 50ohm impedance scheme to reduce matching problems
  - Cables, splitters, shaper termination
- Splitters re-mounted on Bo lid to reduce length of SHV cable section
- Minor splitter redesign by Teppei implemented
- Significant improvement in signal shape (ringing, etc) from the above



Previous config: swap "long"s with "short"s

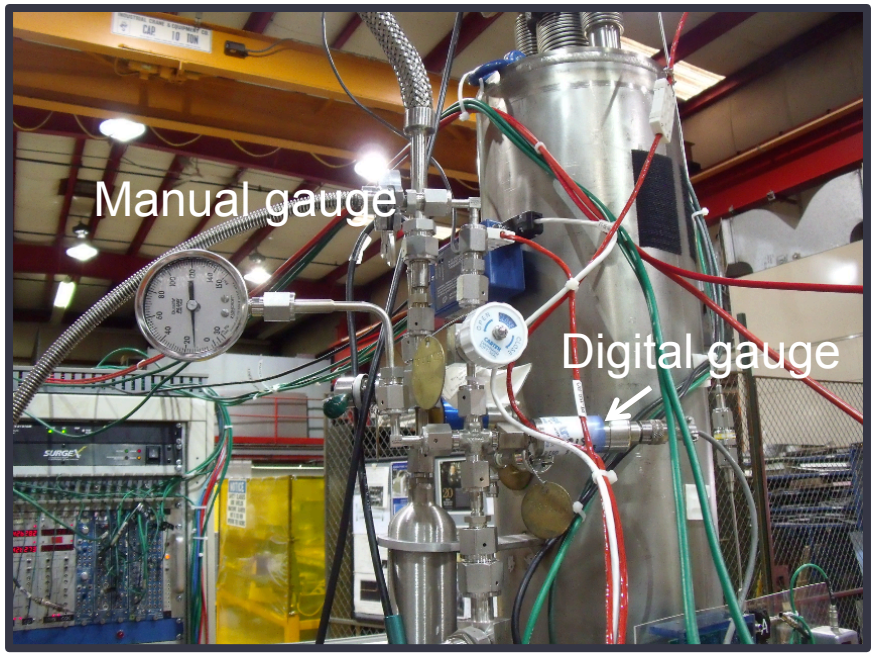
Note: not same horizontal scale – but improvement is still clear.

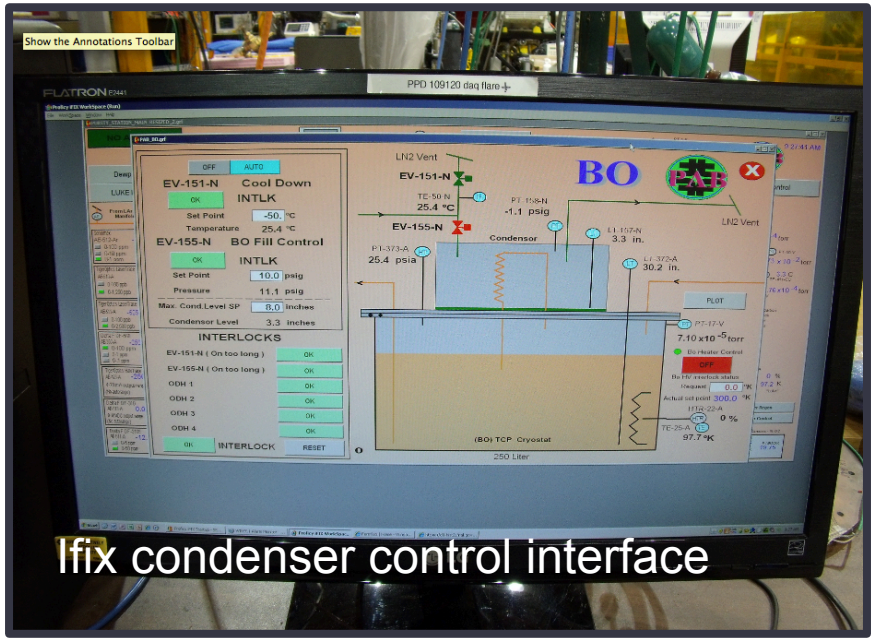
Condenser Tower

- LN2 condenser line improves several things:
  - Maintain argon level without refill for much longer (loss rate was 7” per day, now <1” per day)
  - Allow stable control of Bo pressure between 5 and 11 psig
  - Operate as a truly closed system
- Condenser level controlled automatically in response to internal pressure.
- Control system involves two valves: vent valve for line cooling, and fill valve for nitrogen flow into tower

Condenser controls

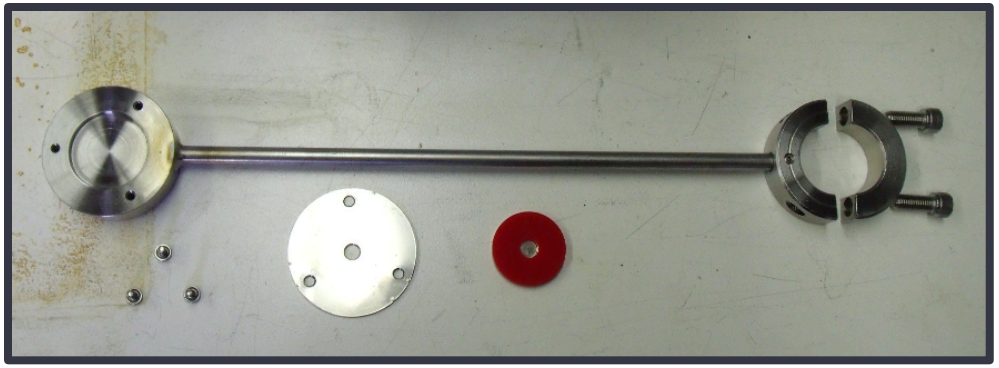
- Condenser level controlled automatically by ifix control system.
- Fill level responds to internal Bo pressure, reported by new pressure gauge
- We had many problems getting this right – not helped by the fact that the vent valve has a tendency to freeze up at low temperatures (~ -150C)
- New valves are being delivered next week, and control logic is now ~stable
- Much help from Dan Markley, Mark Knapp to get this working!

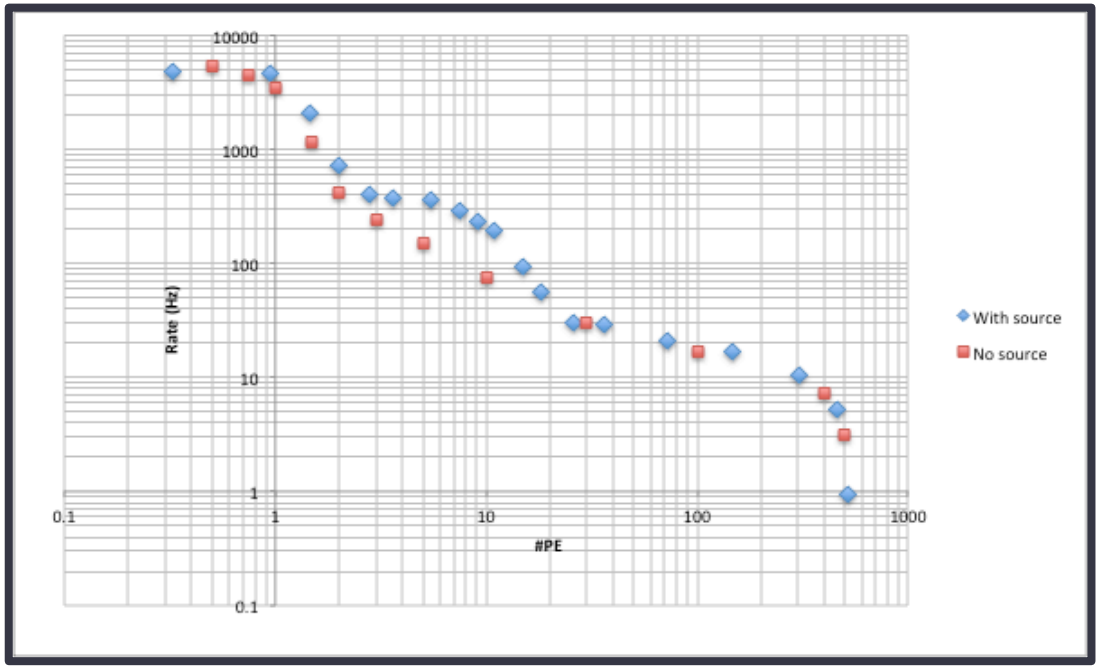


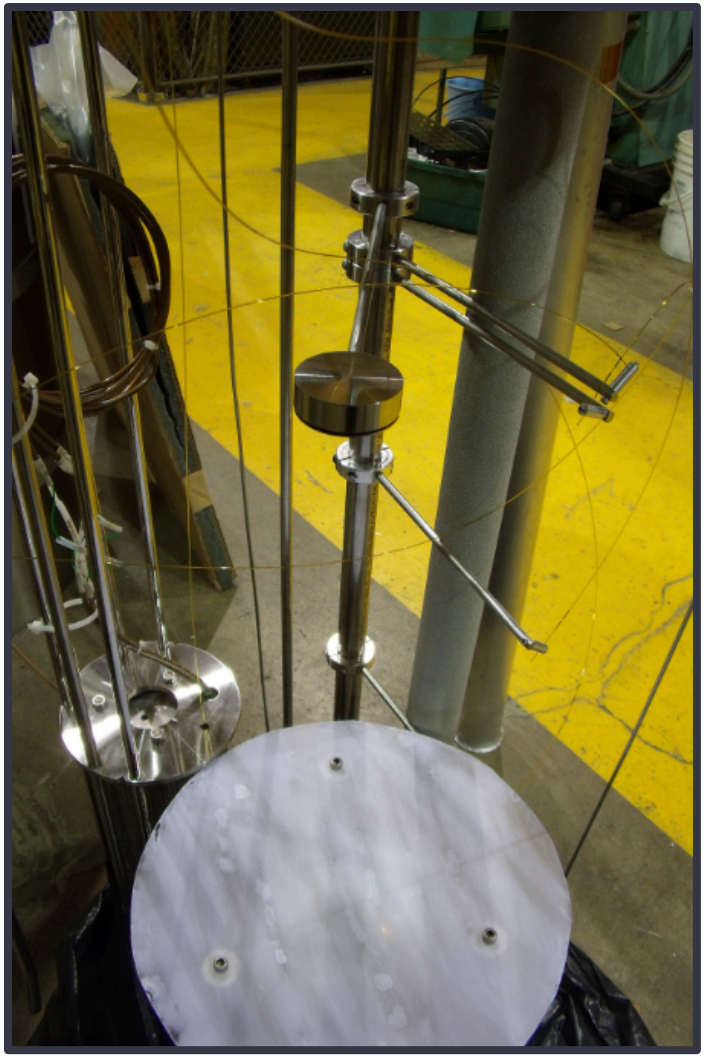


Ifix condenser control interface

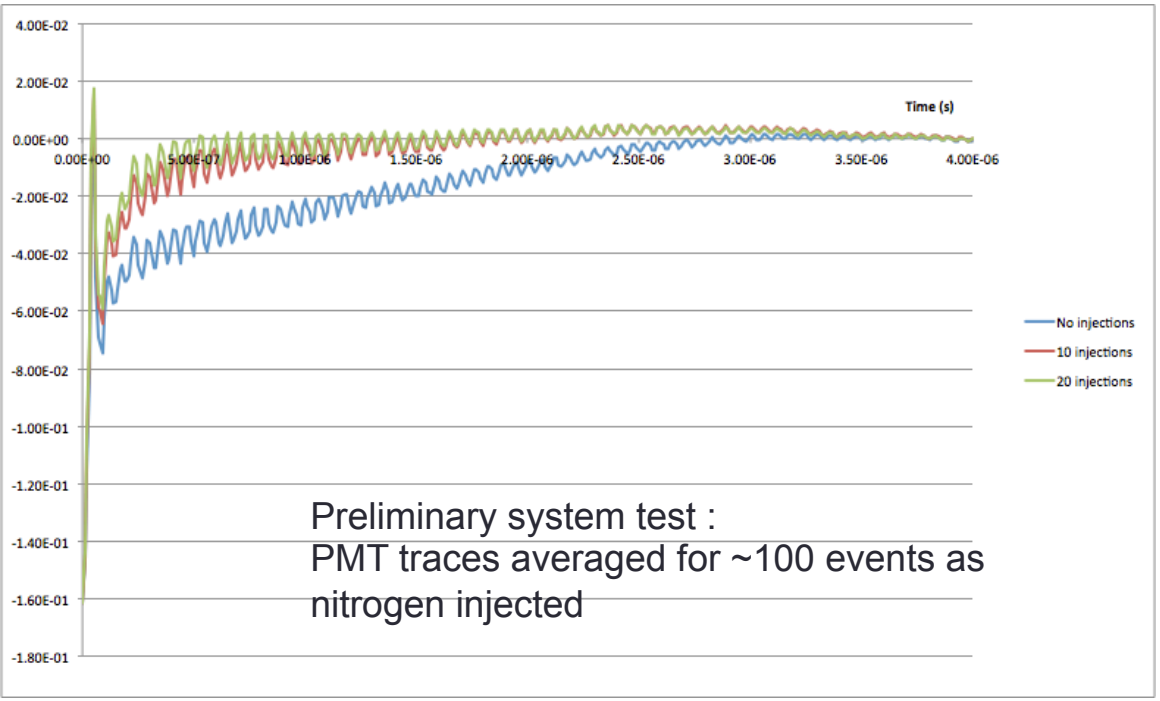
Source Deployment



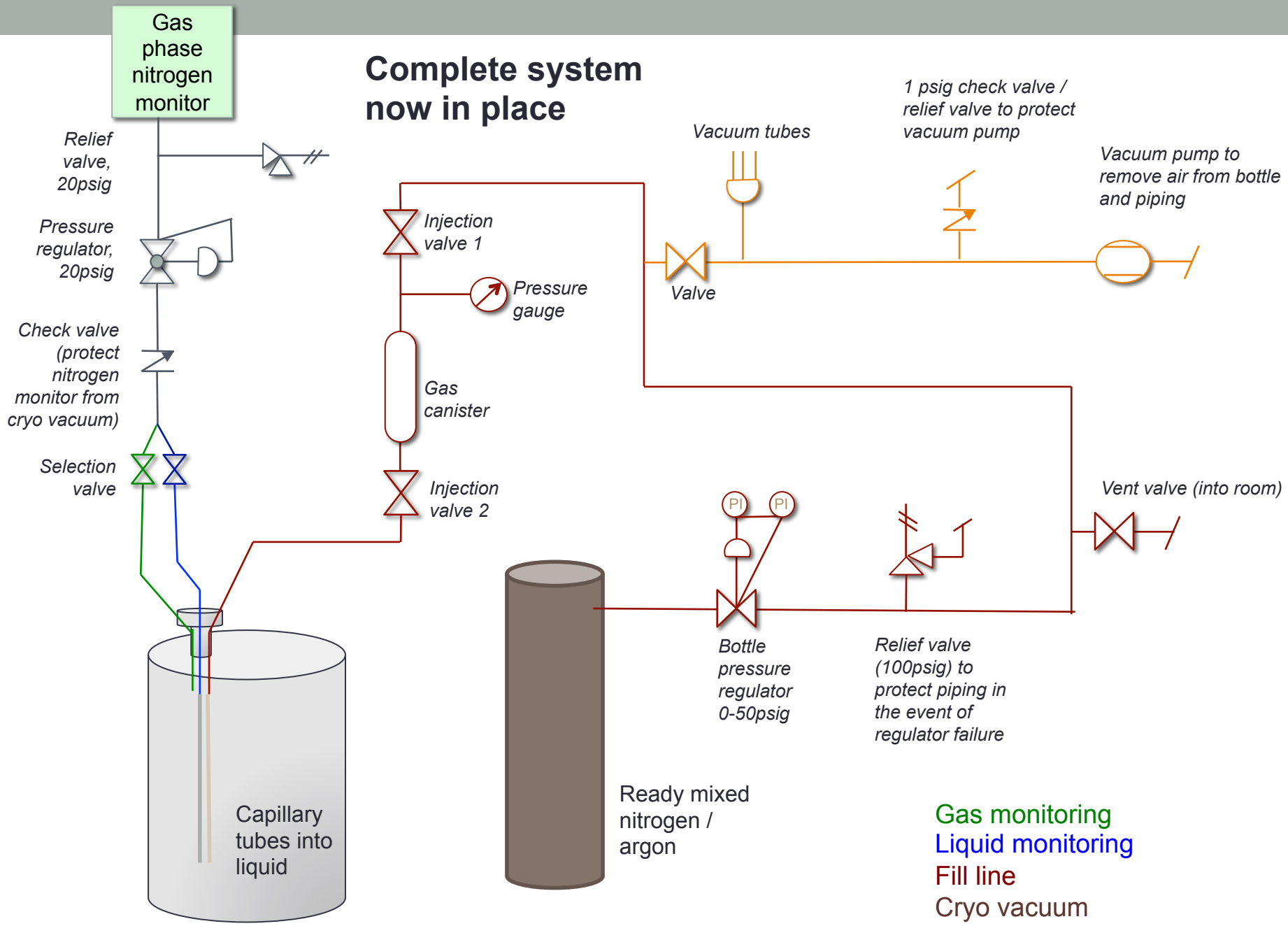




Nitrogen Injection System

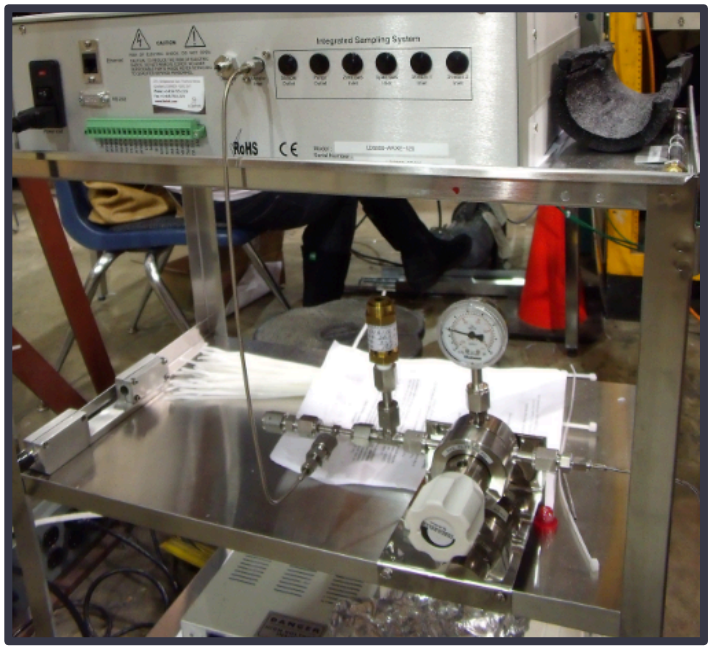


ppm levels of nitrogen lead to excimer collisional de-excitation. This quenches late component of scintillation light.

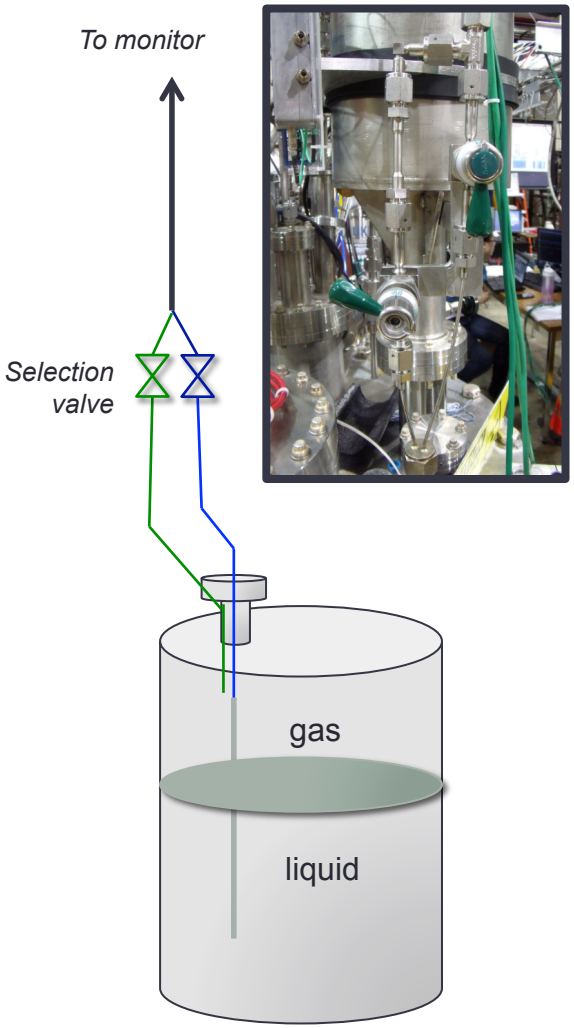

Gas phase nitrogen monitor
Complete system now in place
Relief valve, 20psig
Pressure regulator, 20psig
Check valve (protect nitrogen monitor from cryo vacuum)
Selection valve
Injection valve 1
Pressure gauge
Gas canister
Injection valve 2
Vacuum tubes
1 psig check valve / relief valve to protect vacuum pump
Vacuum pump to remove air from bottle and piping
Valve
Vent valve (into room)
PI
PI
Bottle pressure regulator 0-50psig
Relief valve (100psig) to protect piping in the event of regulator failure
Capillary tubes into liquid
Ready mixed nitrogen / argon
Gas monitoring
Liquid monitoring
Fill line
Cryo vacuum

Nitrogen Monitoring

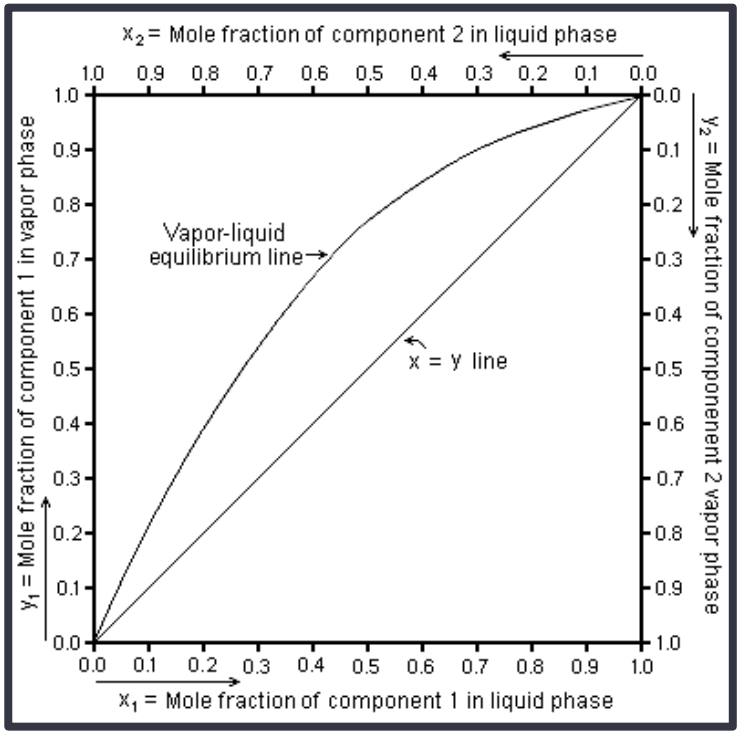
- Gas phase nitrogen monitor plumbed into place and working
- Our delivered argon is very clean – 0.2 - 0.4ppm nitrogen
- For injection studies we calculate amount injected from cylinder volume and pressure. Reading on monitor agrees to within 15%
- This is within the resolution of the injection pressure gauge.
- Monitor is pre-calibrated with 0.1ppm resolution, we base our N2 concentration on this number.



Liquid and Gas Sampling

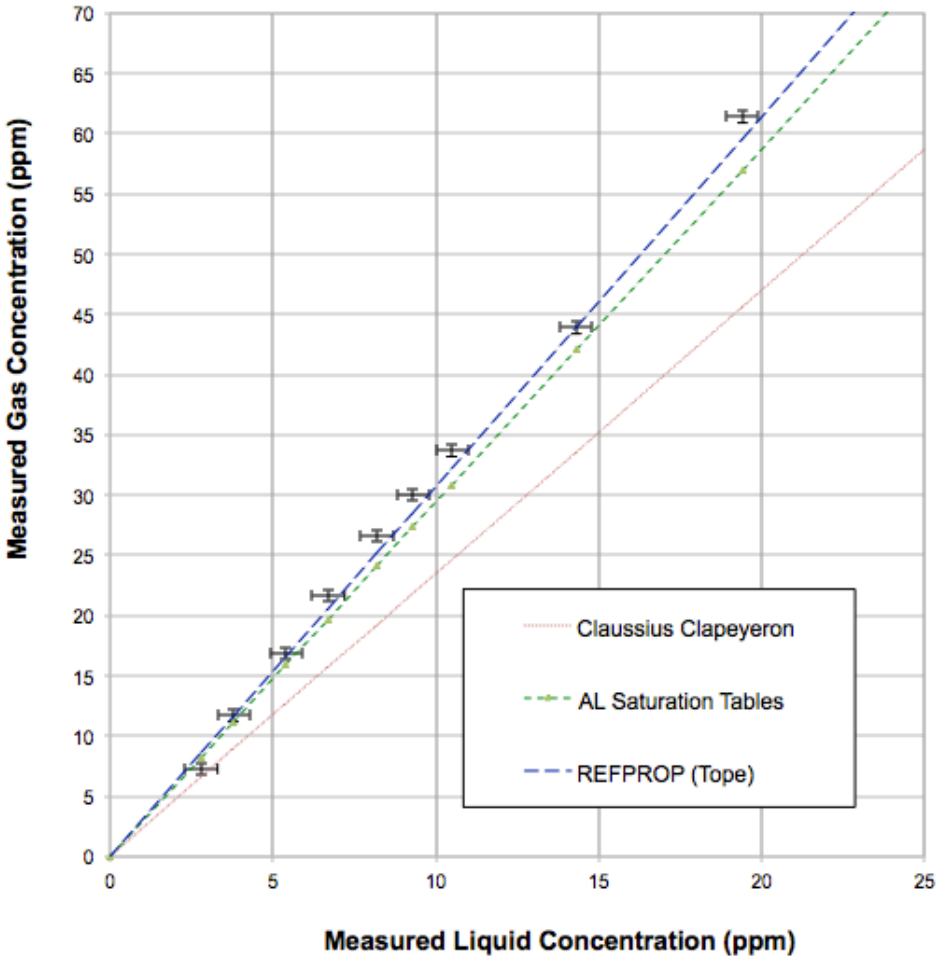


Many subtleties to this measurement :
- Have we reached phase equilibrium?
- Is our gas phase measurement of the liquid line a faithful to the number of ppm in liquid?



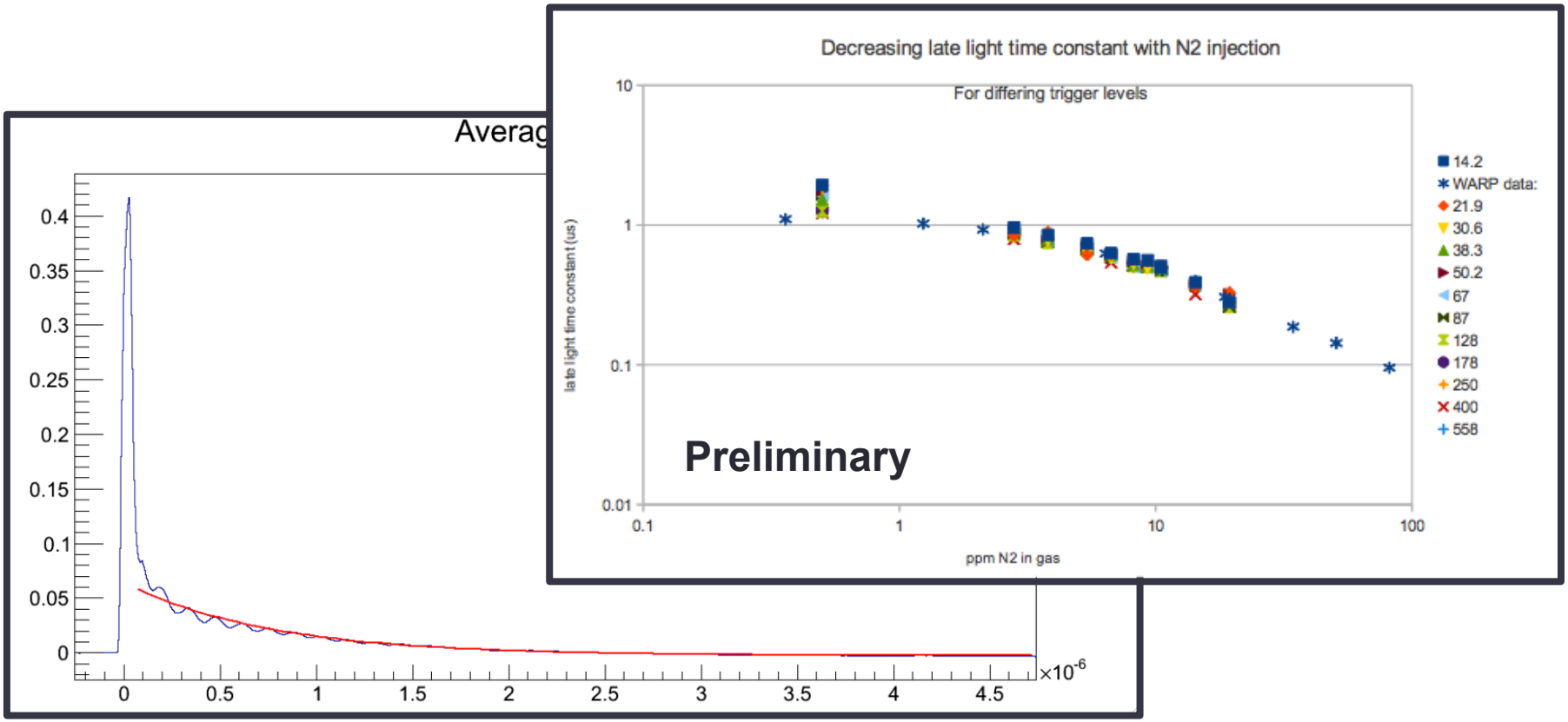
Thermodynamics Calculations

- Empirically, liquid and gas concentrations appear to stabilize after around 1 hour.
- Making the VLE calculations, we find that :
  - We have indeed reached thermal equilibrium
  - Liquid line measurement is a faithful representation of liquid impurity concentration
- We now have three independent measures of the LN2 concentration in liquid:
  - Liquid line measurement (assumed faithful)
  - Gas line measurement (agrees within 5% after thermo correction)
  - Injection volume (agrees within 15% - feasible volume of valve piping, etc)



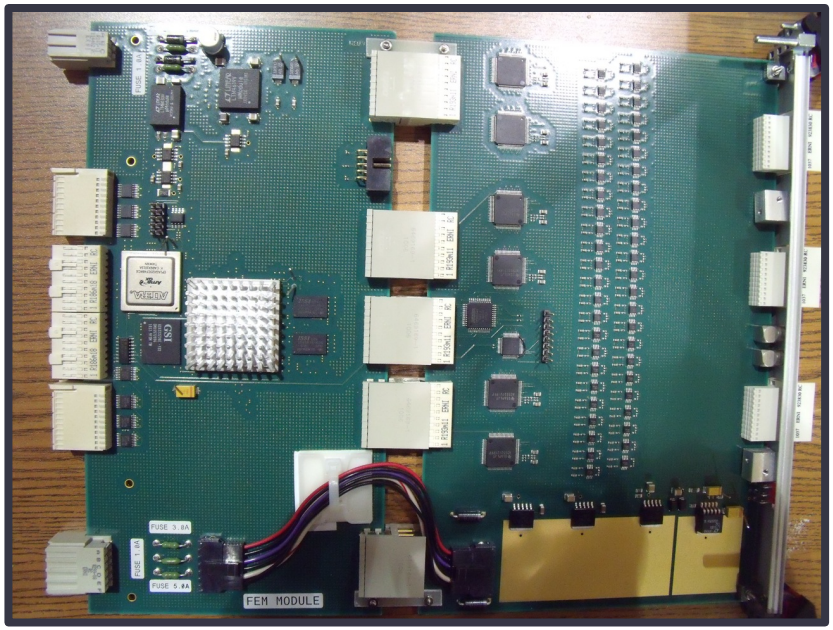
Careful Systematic Study

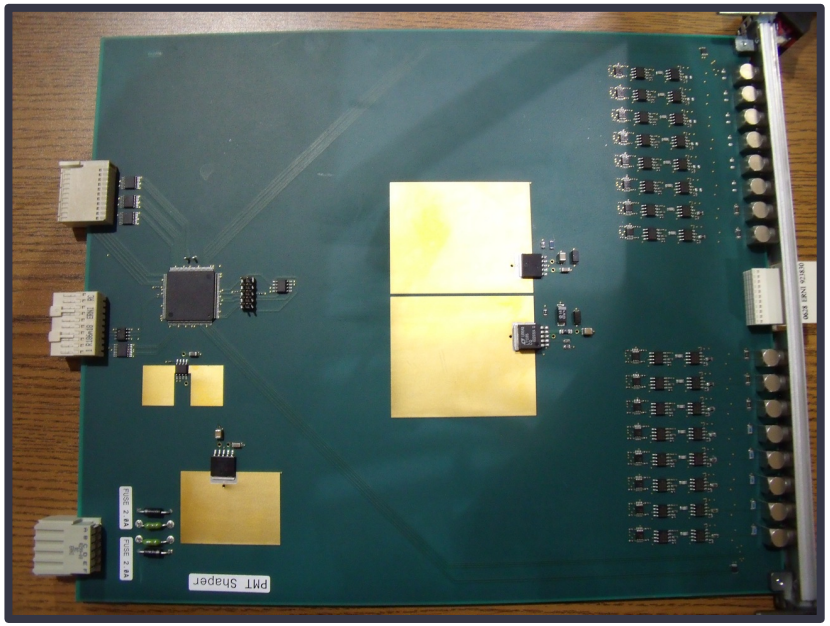
- Christie Chiu is now making a systematic study of the effects of LN2 on lifetime and prompt / slow ratio
- Various trigger thresholds, both alpha and cosmic samples



Readout Systems

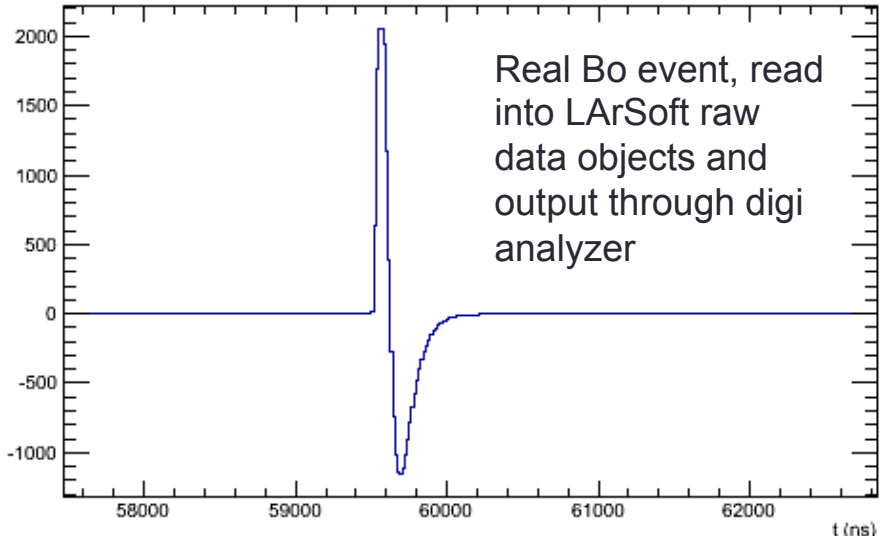
- Moved to real fusing scheme, and implemented all changes required by EDR.
- This was the final hurdle before we were allowed to go for ORC – finally ready to go for it.
- Also successfully operated readout through 50ohm terminated channels.
- Self-triggered (rather than externally triggered) readout made with pulser up to 400Hz
- Self-triggered readout using PMT has not been achievable yet.

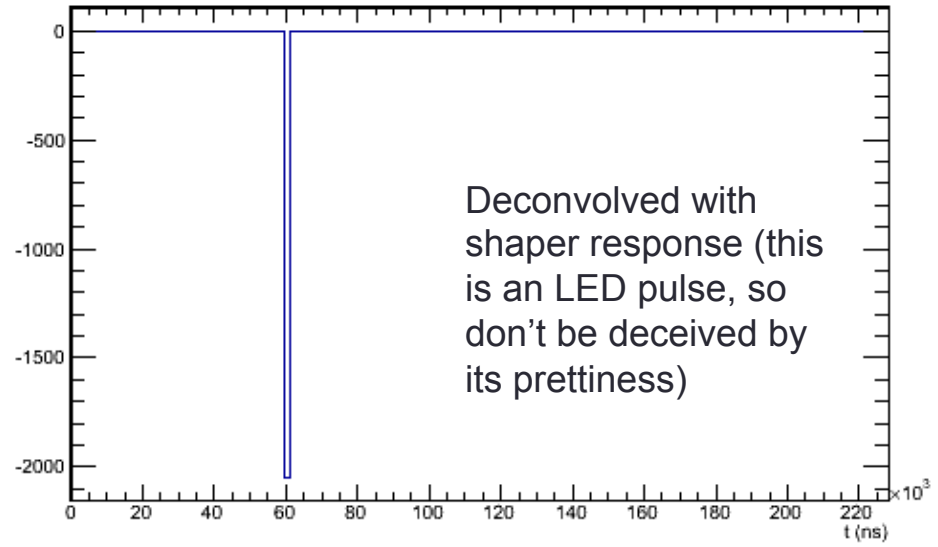




Software Interfaces

- Code now written to input real data from Bo VST into LArSoft raw data objects
- From here, modules can stitch together multiple pulses per channel to one long trace per channel using their timestamps
- We have also written a shaper deconvolution module. Input PMT data and deconvolve shaper response function to get resolution of 1 ADC tick (16ns)
- All LArSoft code directly carries over to MicroBooNE. Interface to read in Bo data will of course be different with real DAQ.





That's All Folks

- Lots of progress on all fronts:
  - Splitters (Mostly covered by teppei)
  - Condenser systems
  - Source Deployment
  - Preliminary nitrogen injection measurements
  - Readout progress and software interfaces

- Next meeting, perhaps full results of nitrogen injection study