Bubble Chamber Upgrades and Preparations for Next Run

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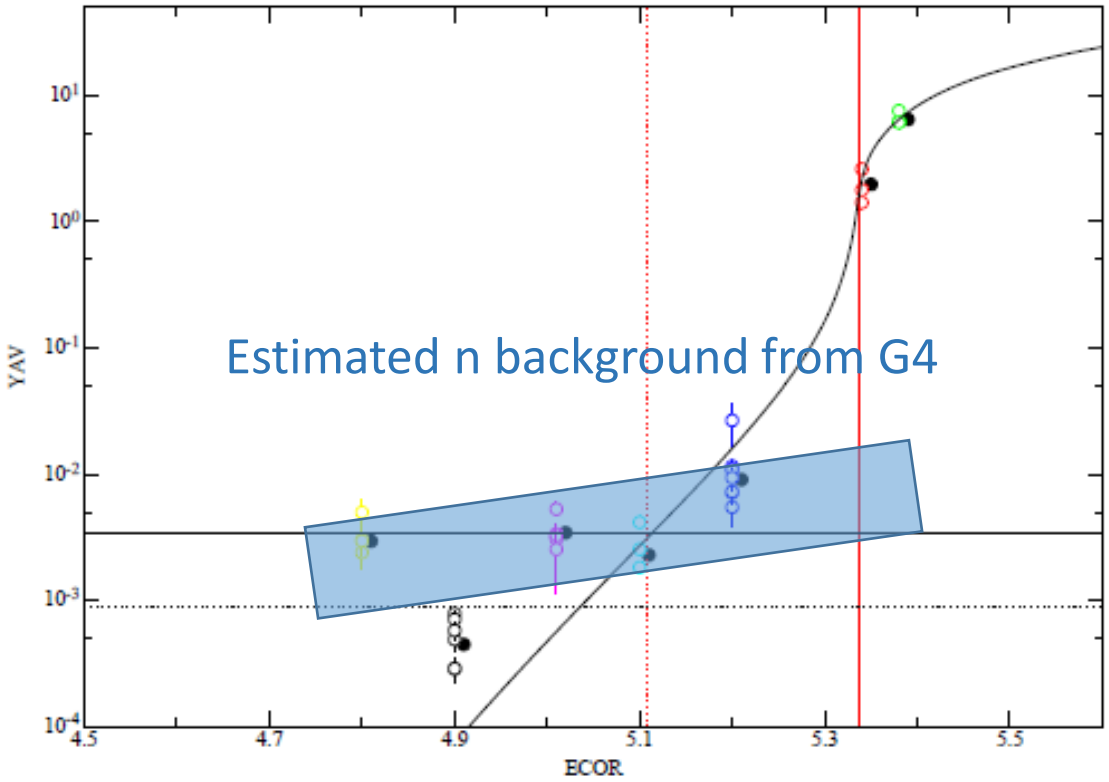
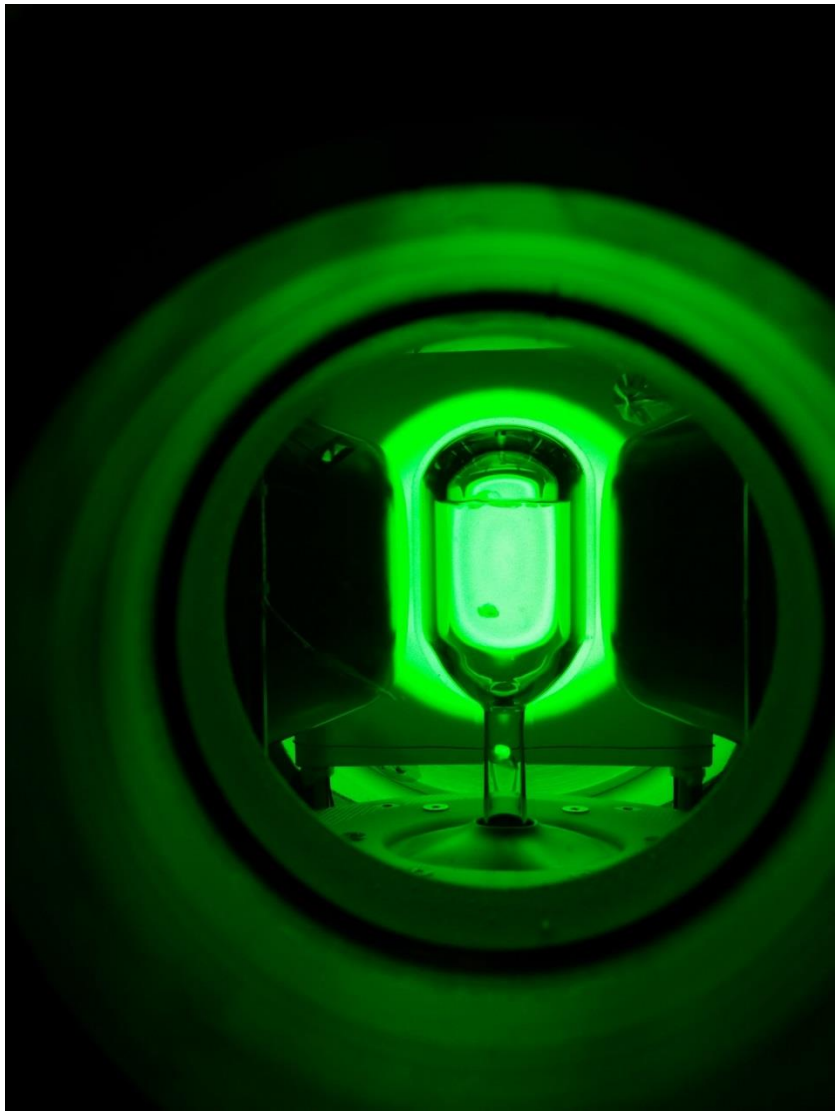
Deuterium Background

- Deuterium can photodisintigrate with subsequent neutron elastic scattering on ^{19}F and ^{12}C
- Estimated rates using Geant4 with D natural abundance
- Obtained threshold-dependent rate consistent with observation of rate floor in data



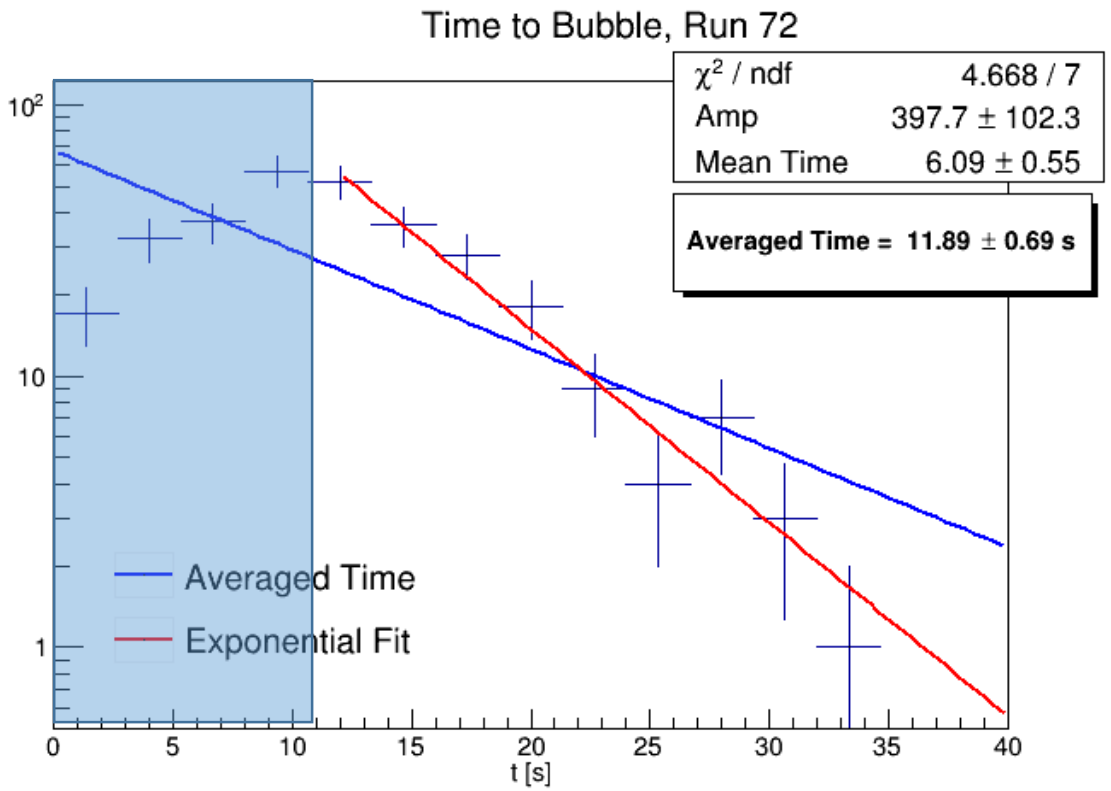
Replace Hydraulic Fluid

- Natural abundance of deuterium in hydrocarbons precludes use in photon beam path
- Simulations show borating fluid not effective
- Options
  - Replace with fluorocarbon “oil” such as $C_{11}F_{20}$ (perfluoromethyldecalin)
  - Displace by shimming with material



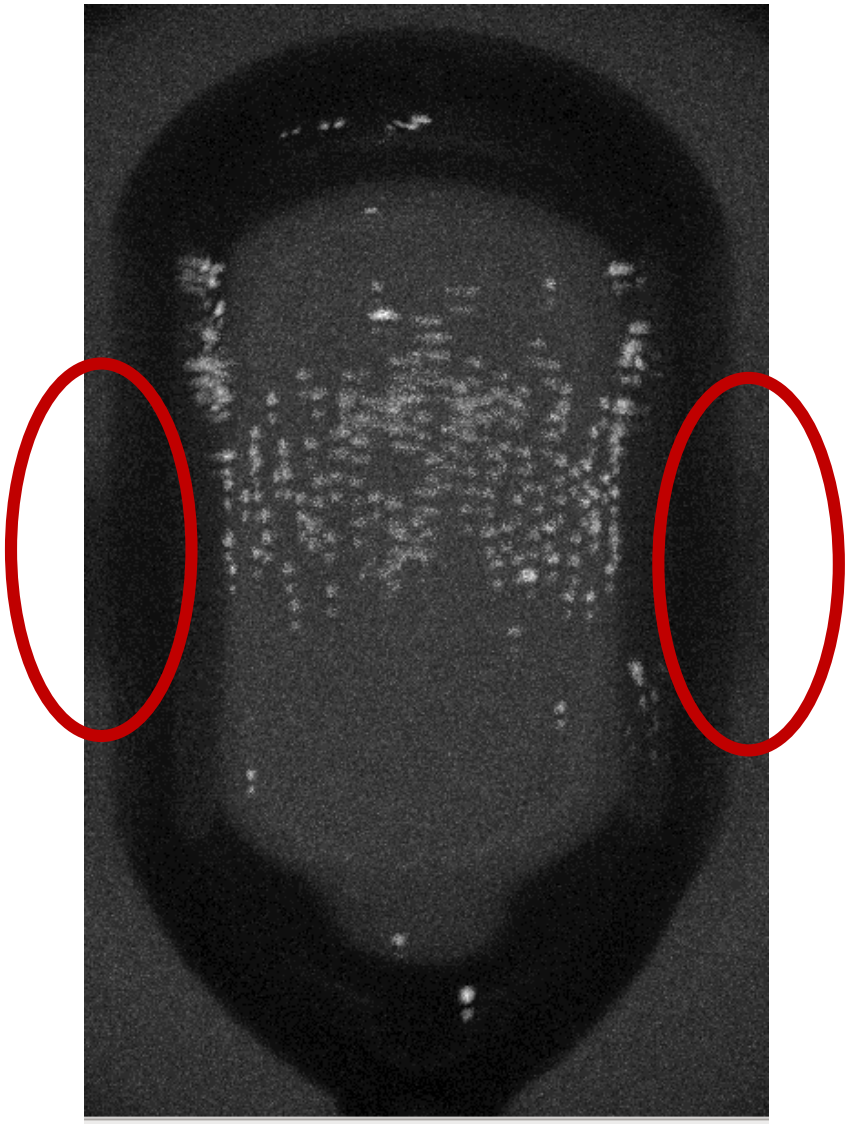
Shutter and Deadtime

- Detector shows inefficiencies in early times which affect rate extraction
- Likely fluid dependent – will be monitored closely and adjusted for given runs
- Shutter opening delayed to after superheat by 10+ seconds will help overall statistics



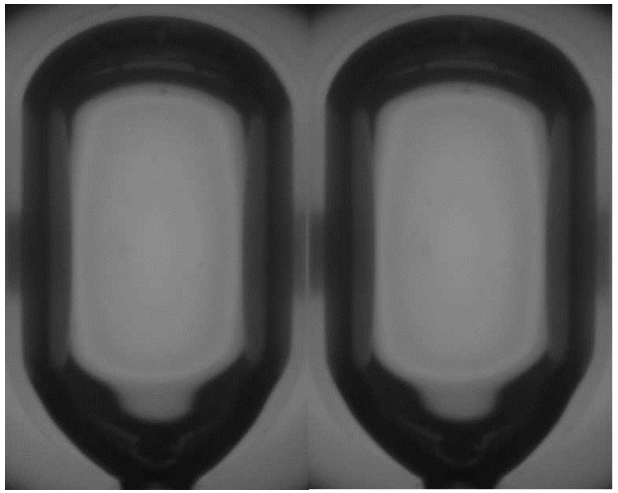
Glass Cell Replacement

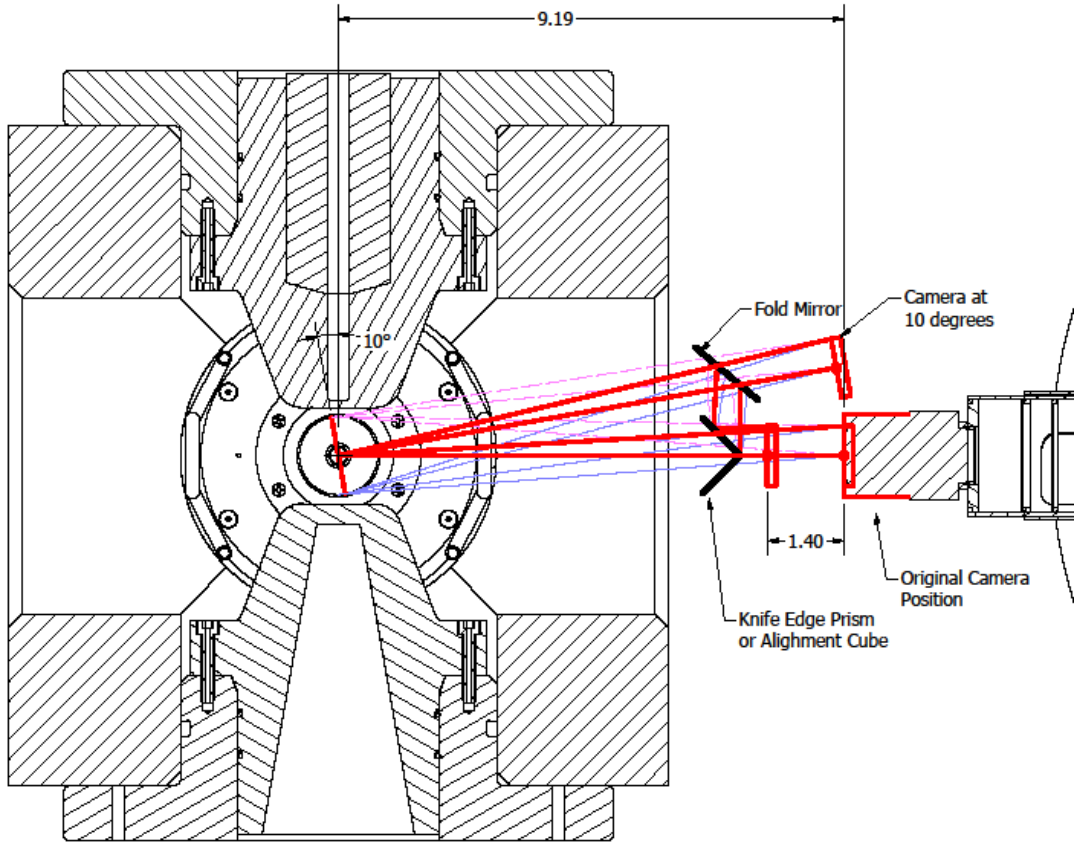
- Saw some darkening of cell during running
- U and Th in cell can cause α event near wall
  - PICO/COUPP collaborators at FNAL raised similar issue
- Boron in borosilicate can also cause wall reaction $^{10}B(n,\alpha)^{7}Li$
- Geant4 shows small contribution, but reasonable to implement
- Fused silica mitigates these issues



3D Bubble Reconstruction and Optics

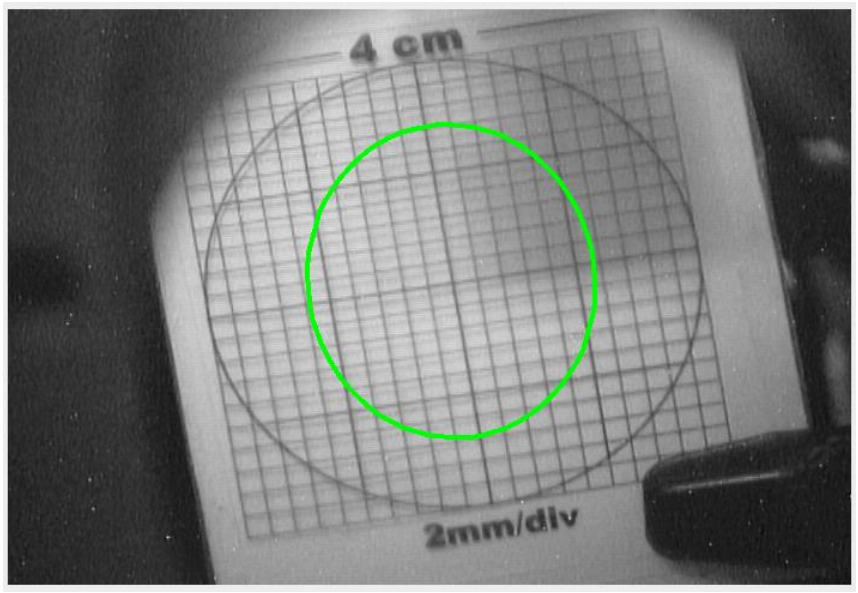
- Prism and mirrors can provide depth imaging of bubbles for events outside fiducial region
- Optics components on hand
- Chamber has returned to ANL and will be made operational

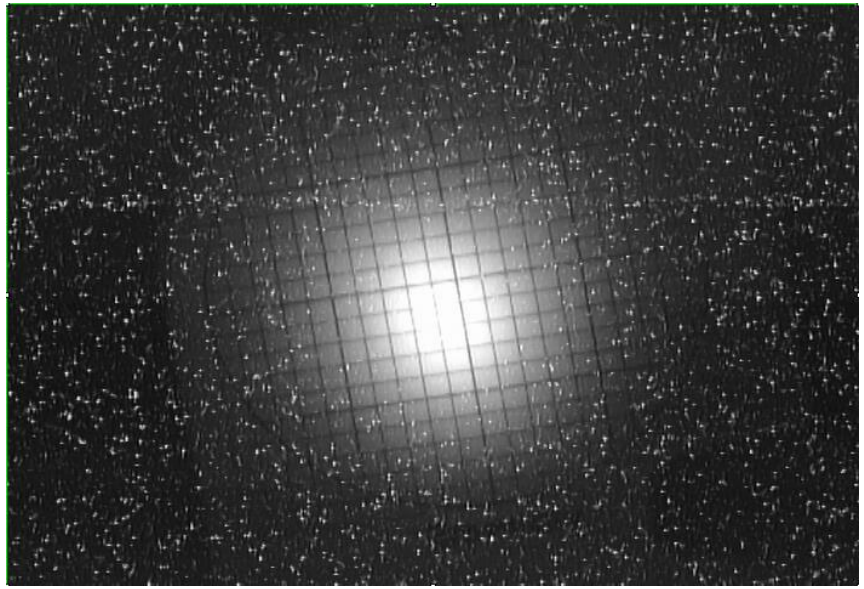




Beamline Modifications

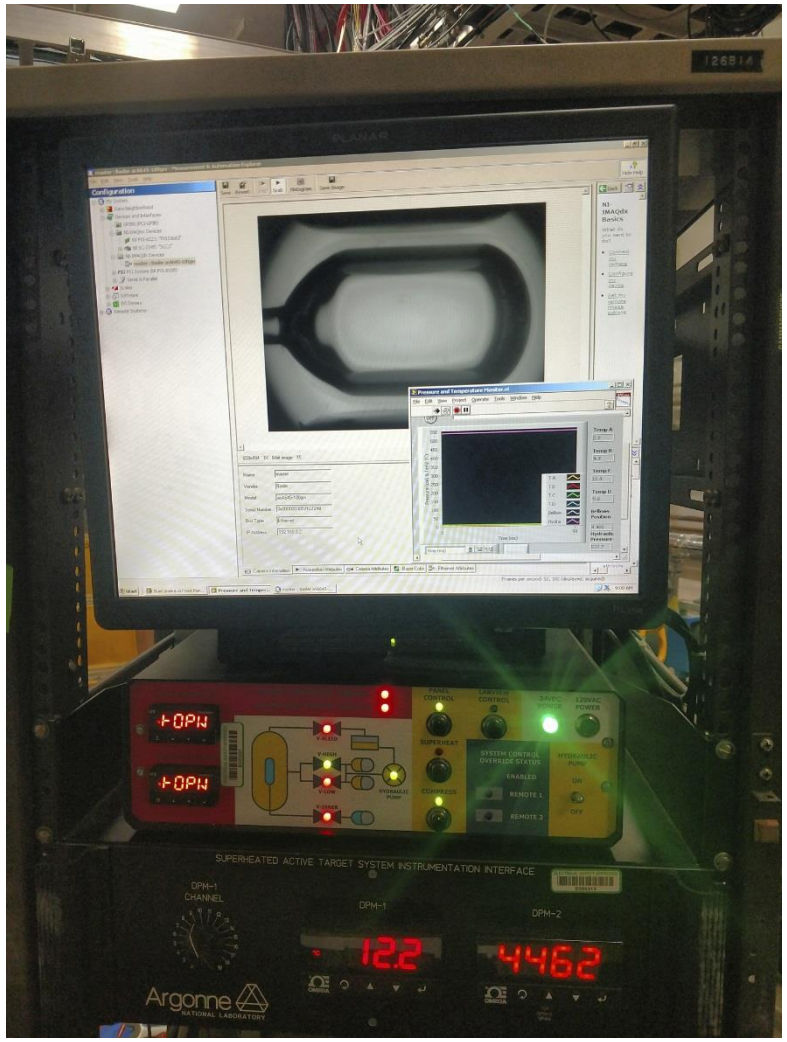
- Installation of xray viewer for centering
  - Provide instant check of centering beam on target relative to collimator
- Proposed energy resolution 0.1% (8 keV)
- Possible modifications at injector:
  - Fiducialize harps
  - Additional quads





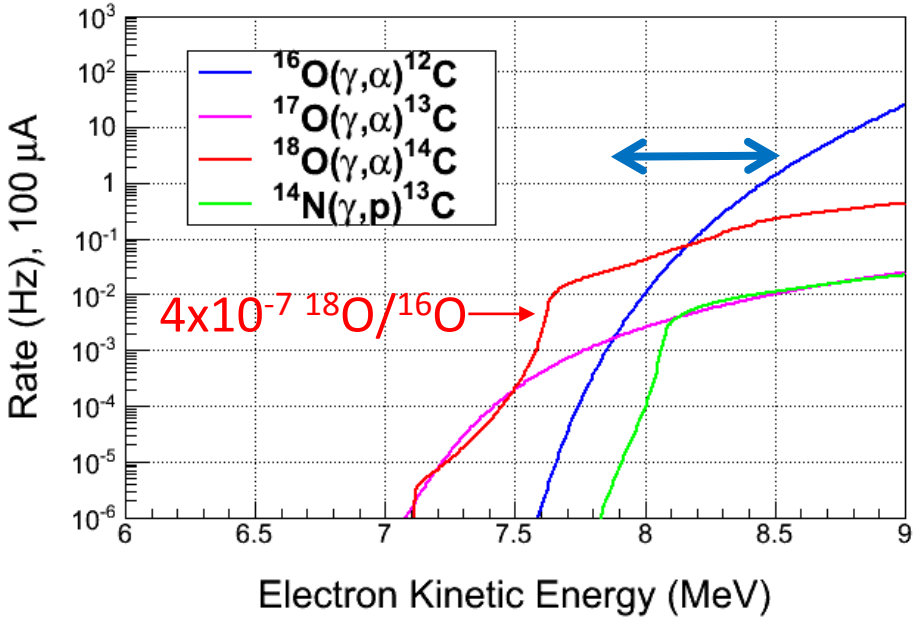
Data Acquisition and Controls Computer

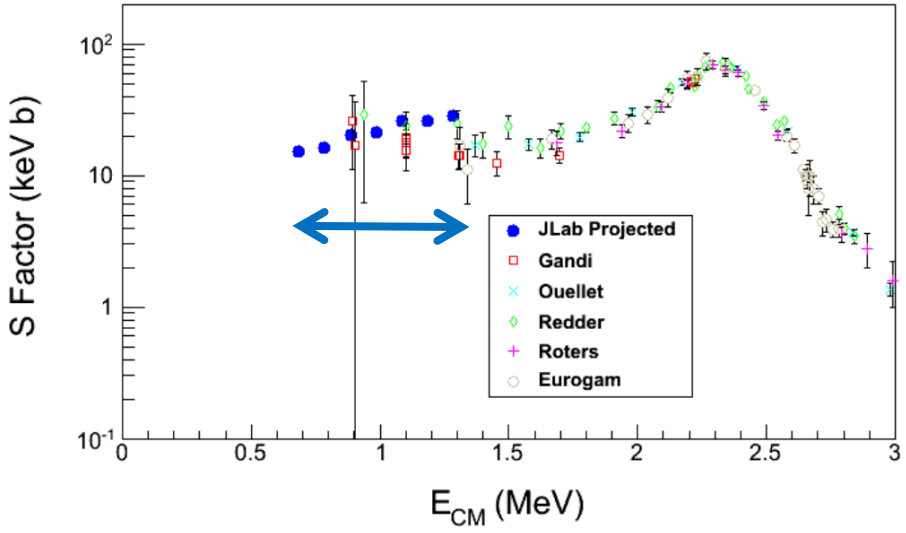
- DAQ and controls running on Labview computer which is several years old
- Reviewing options for upgrading to modern system
- UIC is funded for this



Oxygen Medium for Full Run

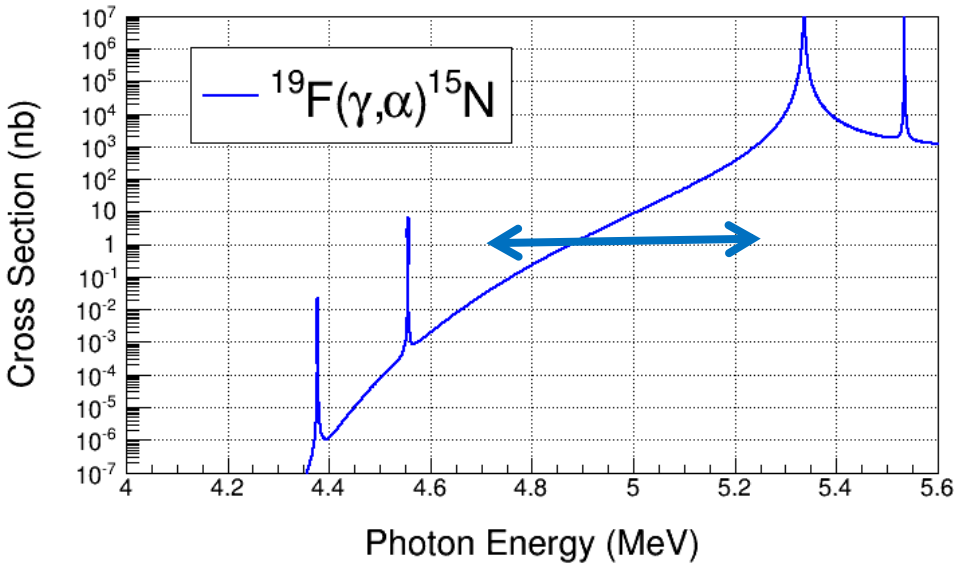
- $^{17,18}O$ have large (γ,α) cross section
- Have several L of isotopically pure H_2O
  - $^{17,18}O/^{16}O < 4x10^{-6}$, will have remeasured
  - Proposal assumed $^{18}O \sim 4x10^{-7}$ level
- Exploring production of N_2O with this
  - $^{14}N(\gamma,p)$ can be suppressed by threshold
  - Superheated running is cooler ~10C

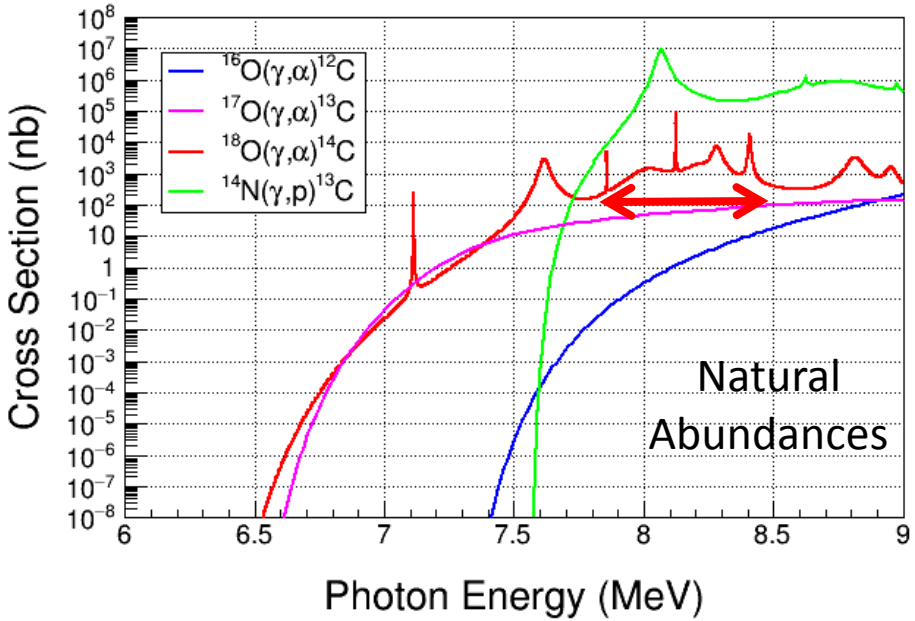




Future Needs and Timeline

- Require another C_3F_8 Engineering Run
  - Show deuterium background is controlled
  - Focus on achieving error bars
  - Aim for 10 pb σ with 10-20% stat uncertainty
  - Ready for March-May 2019
- Natural Oxygen Engineering Run
  - Demonstrate single fluid in beam
  - Demonstrate low temperature running
  - Measure ^{18}O cross section
  - Ready for August-September 2019
- Production Run
  - Summer 2020





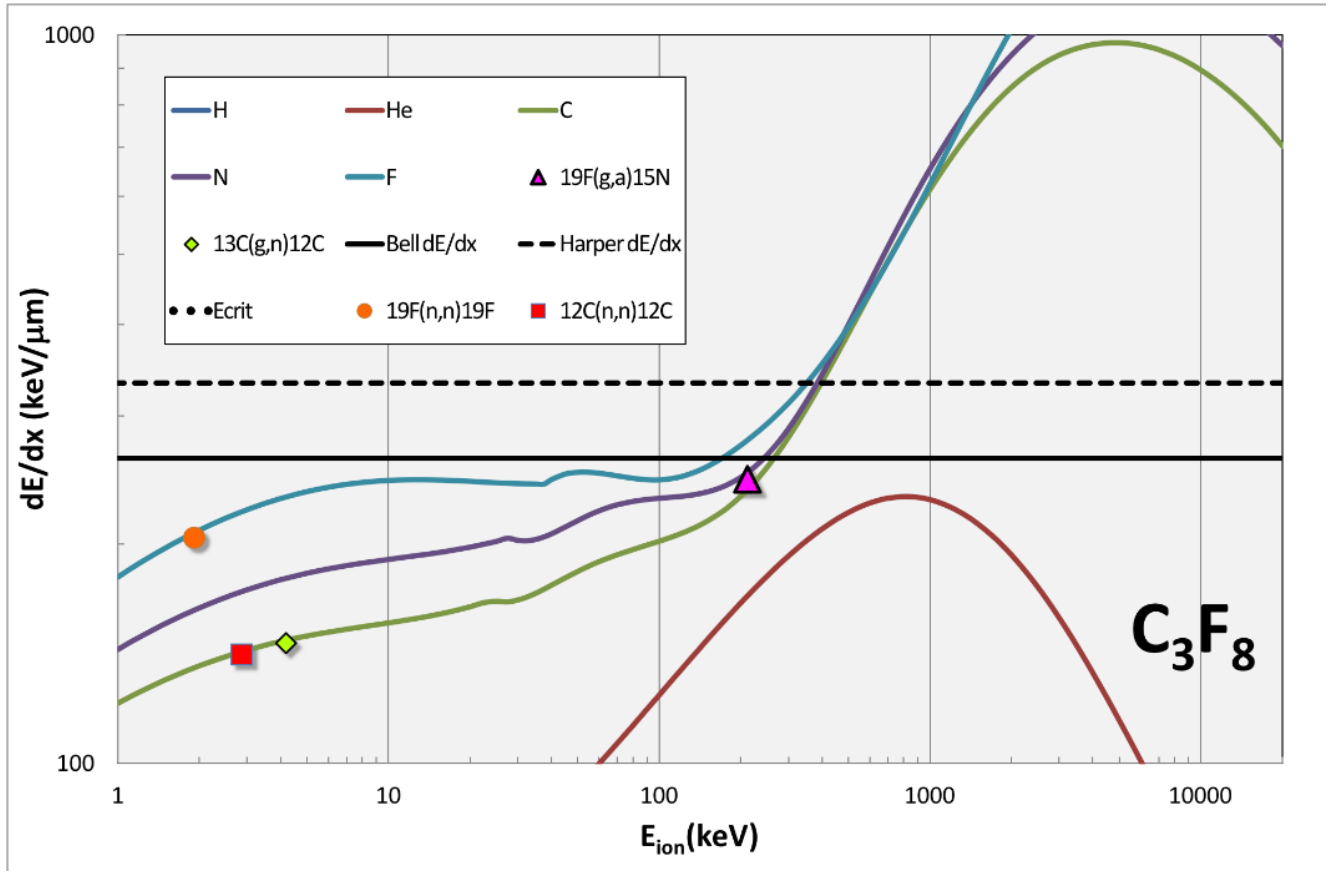
Preparation Timeline

- Sep – Dec 2018
  - Reassemble chamber at ANL
  - Acquire new Labview computer
  - Finalize results of May 2018 run
  - Demonstrate depth perception optics
- Jan – Mar 2019
  - Install quartz cell
  - Test with fluorocarbon fluid
  - Shutter integrated to deadtime
  - Crate and ship to JLab
  - Natural N_2O tests

- Post 2019 ^{19}F Run
  - Analysis showing 10 pb floor
  - Retest depleted H_2O ^{18}O levels
- Late 2019-early 2020
  - Natural N_2O analysis
  - Obtain depleted N_2O

Backup

Thresholds


1000
100
1
10
100
1000
10000
dE/dx (keV/µm)
E_ion(keV)
H
He
C
N
F
19F(g,a)15N
13C(g,n)12C
Bell dE/dx
Harper dE/dx
Ecrit
19F(n,n)19F
12C(n,n)12C
C3F8