Source Calibration System Update:

Recent progress and Future plans

Presented by: S. Middleton (L3 for Source Calibration System)
Organizing effort with: F. Porter, L. Martin (mechanical), T. Mandal & R Davila (controls), H. Jafree & S. Zhou (software), L. Borrel (DT ops)

Calorimeter Meeting
March 2025

Caltech

Hardware Update

Introduction

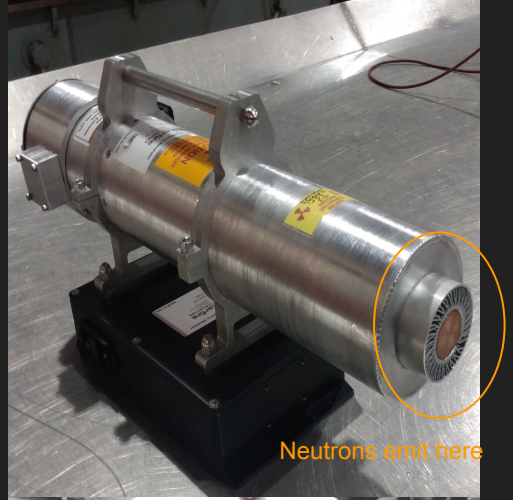
$$^{19}F + n \rightarrow {}^{16}N + \alpha$$
$$^{16}N \rightarrow {}^{16}O^{*} + \beta \quad t_{1/2} = 7\ \mathrm{s}$$
$$^{16}O^{*} \rightarrow {}^{16}O + \gamma(6.13\ \mathrm{MeV})$$

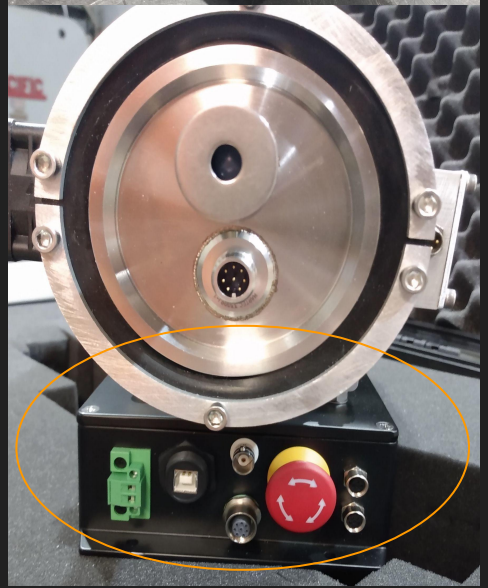
Deuterium-Tritium generator provides absolute calibration at 6.13MeV via above reaction.

Please refer to the following documents for details of the design, operations and test procedure:

- Design - Mu2e-doc-db 12464
- Operations - Mu2e-doc-db 19333
- Test Procedure - Mu2e-doc-db 42003
- Measurement - Mu2e-doc-db 40296
- Acceptance test - Mu2e-doc-db 43753

The neutrons produced by the generator have E_n = 14.2 MeV and we anticipate a rate of 10^9 neutrons per second at 120kV if the device is working as expected.

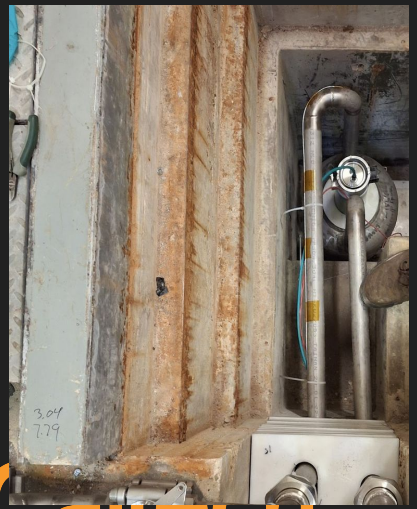


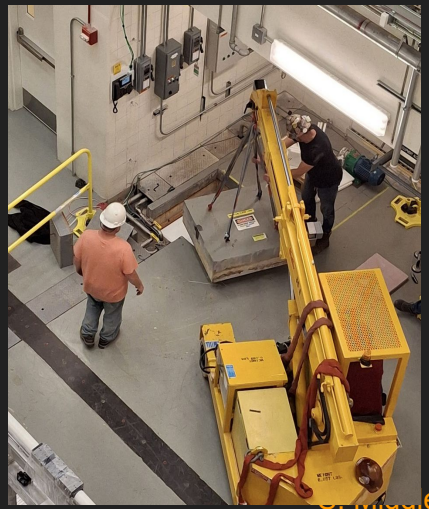


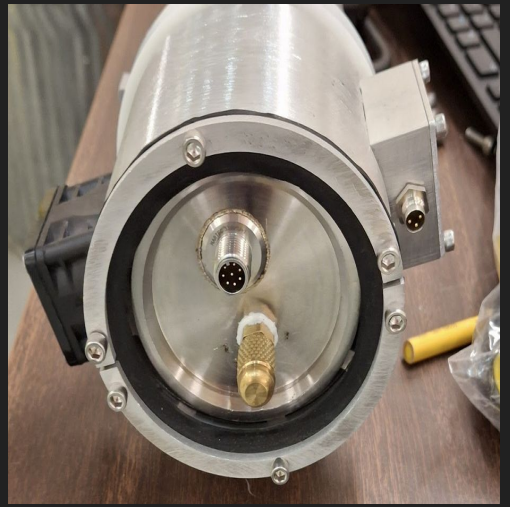
Control box separated from generator and attached via M8 and M12 long cables

December 2024: Reinstallation in Alcove 3

- In December we reinstalled the DT in the pit (same process but with additional fall protection).
- Install the turtle extension (with no electronics) while the pit is open. The incorrect one was placed in the pit last time.
- **Initial acceptance test performed and resurvey → radiation levels << 5 mrem/hr → we are approved to operate whenever we can!**

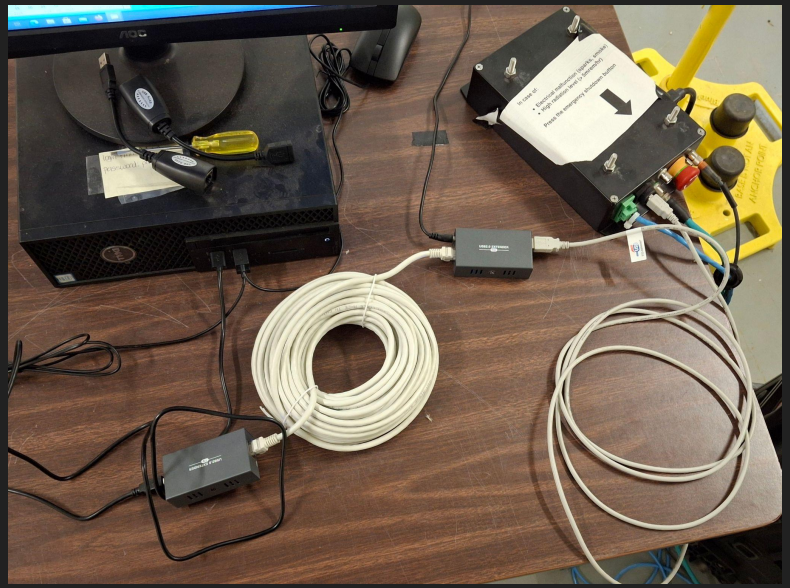






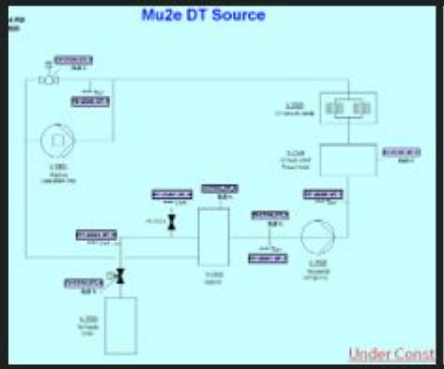
April 2025: Final Remote Operations Preparations

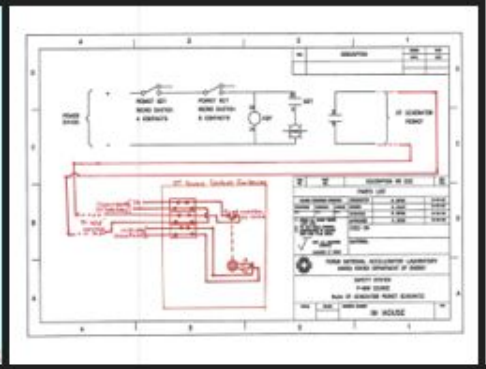
- See https://mu2e-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=48975
- Conclusion was to move the controls PC to the alcove above alcove-3, extending our USB cable straight up through the existing hole.
- 20m limit on the ethernet (so far). Figuring out location of PC and control box/extenders.
- Next steps:
  - Purchase spare cables.
  - Figure final locations.
  - Cable pulling.

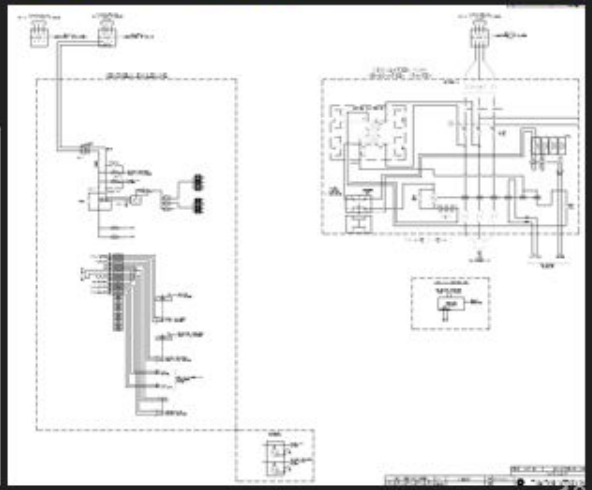


Update on Electrical/Controls

- Lots of progress:
  - Disconnect replaced with combination starter and wired to circulation pump.
  - Controls enclosure mounted and key switch moved.
  - Outlets for drain pump and neutron generator installed.
  - Planning for cable pull, cables prepared by Roberto.
  - Electrical drawing updated and iFix picture created.







Remaining Work: Design

Associated activities for tasks 47507.6.001040:

- Reservoir:
  - Complete reservoir design, Luke
  - Gain approval through review of the design
  - Order parts needed to complete design
  - Order reservoir, Caltech
  - SOW expires: March 31, 2026
- Flow meter
- Level gauge
  - Agree on or alter quote, Luke
  - Order, Caltech
- Control valves:
  - Order, Caltech
- Drain pump
  - Agree on or alter quote, Luke
  - Order, Caltech
- Head gas system
  - Complete specifications for orders, Luke
  - Order, Caltech
- Other:
  - Pipes:
    - Complete design of routing, Luke
  - Pressure gauges:
    - Finalize specification, Luke/Tarunima
    - Order, Caltech

Remaining Work: Installation

47507.8.003040: source installation (Luke and others):

What are the associated activities?

- Install reservoir, Luke & techs, welder?
  - Install level gauge
- Install drain pump, Luke&techs
- Install flow meter, Luke&techs
- Install head gas system, Luke&techs
- Drain pump
  - Agree on or alter quote, Luke

47507.8.003100: electrical/controls (Tarunima and others)

What are the associated activities?

- Cable drain pump control, Tarunima&techs
- Cable level gauge, Tarunima&techs
- Cable flow meter, Tarunima&techs
- Cable head gas controls, Tarunima&techs
- Cable valve controls, Tarunima&techs
- Cable DT generator controls/interlocks, Tarunima&techs
- Cable sensors, Tarunima&techs
  - Pressure
  - temperature
- Program controls, Tarunima, controls sw engineer
  - GUI
  - Testing

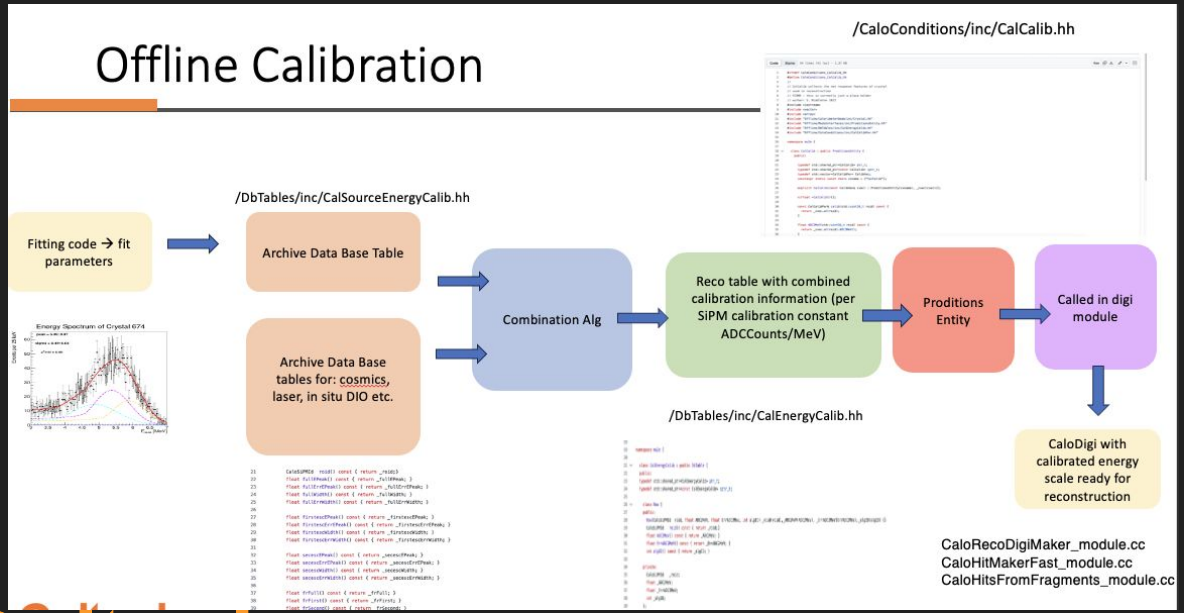
Remaining Work: On disk plumbing

- Conflats possibly going to be used → need to understand studies
- Required experimental test → need to understand possible leaks
- Need to see how things change once in a vacuum
    - Research what other experiments have experienced…

Software Update

Overview of Effort: Offline

- Source calibration software team: S. Middleton, H. Jafree and S. Zhou
- Weekly source calibration software meetings to finalize the implementation in the Offline world.
- There are multiple parts to the software effort:



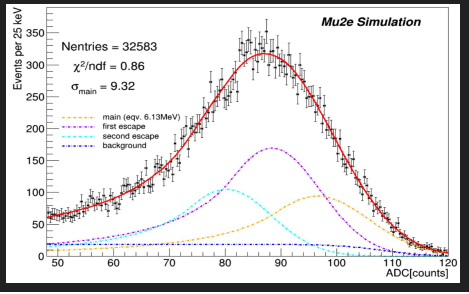
Majority of this effort is written, pieces just need to be connected.

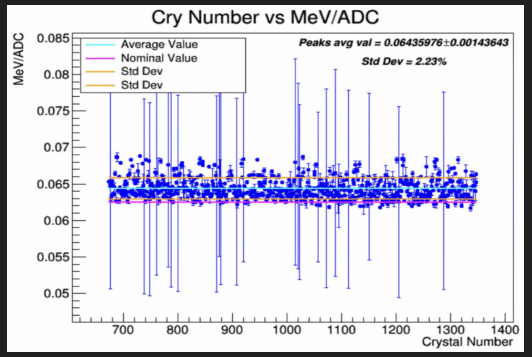
Overview of Effort:

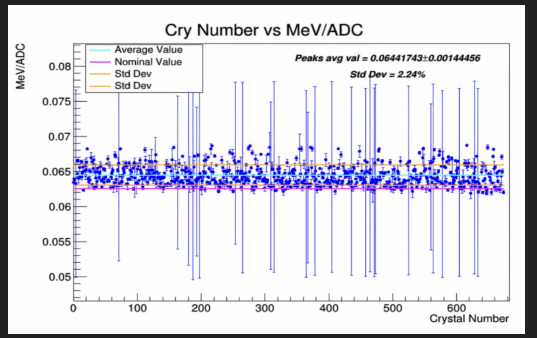
Fitting Algorithm

- Weekly meeting have ensured good progress:
  - Large amount of progress made for Offline fitting (Huma);
  - Simulation workflow has evolved to match data (Sophie);
  - See talk doc-db 52237 from TDAQ meeting, we now have a good understanding of data- and trigger-rates and run plans (Sophie).
  - Effort on going to understand analysis procedures and how to flag issues in data-base (Huma).
- Code available: https://github.com/Mu2e/CaloCalibration/tree/main/SourceCalib

H. Jafree. Fits to SiPMs





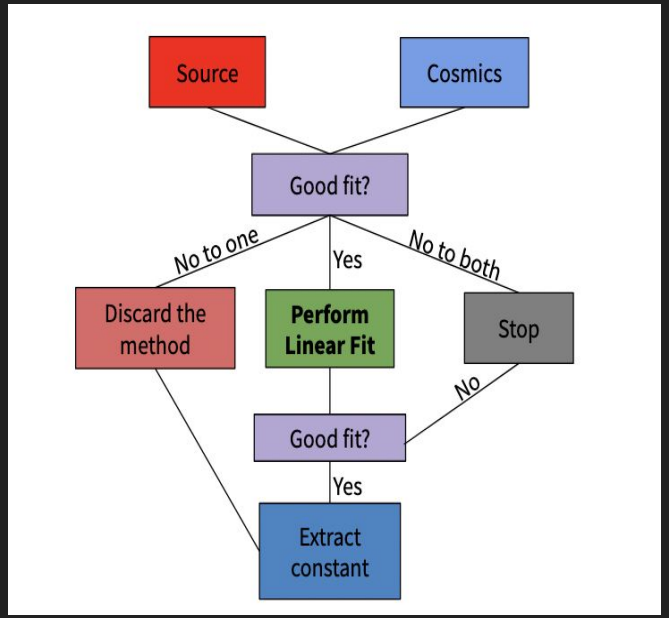


Overview of Effort:

Combination/refinements with Cosmic:

- Sam Zhou working on an algorithm to combine/refine source information and cosmic calibration.
- New directory: https://github.com/Mu2e/CaloCalibration/tree/main/Combinations

S. Zhou, concept of combining calibration modes.



Next Steps

Design and Installation of hardware

- Finish the remaining CAD work for the parts external to the pit and trenches.
- Procure remaining valves, instruments and components.
- Update the P&ID and share that with the controls group.
- Fabricate, test and commission the system.

Software:

- Finalize analysis and flagging of “bad” fits
- Finalize combination algorithm
- Fully integrate tables into workflows