Facility/Hardware

Jason St. John

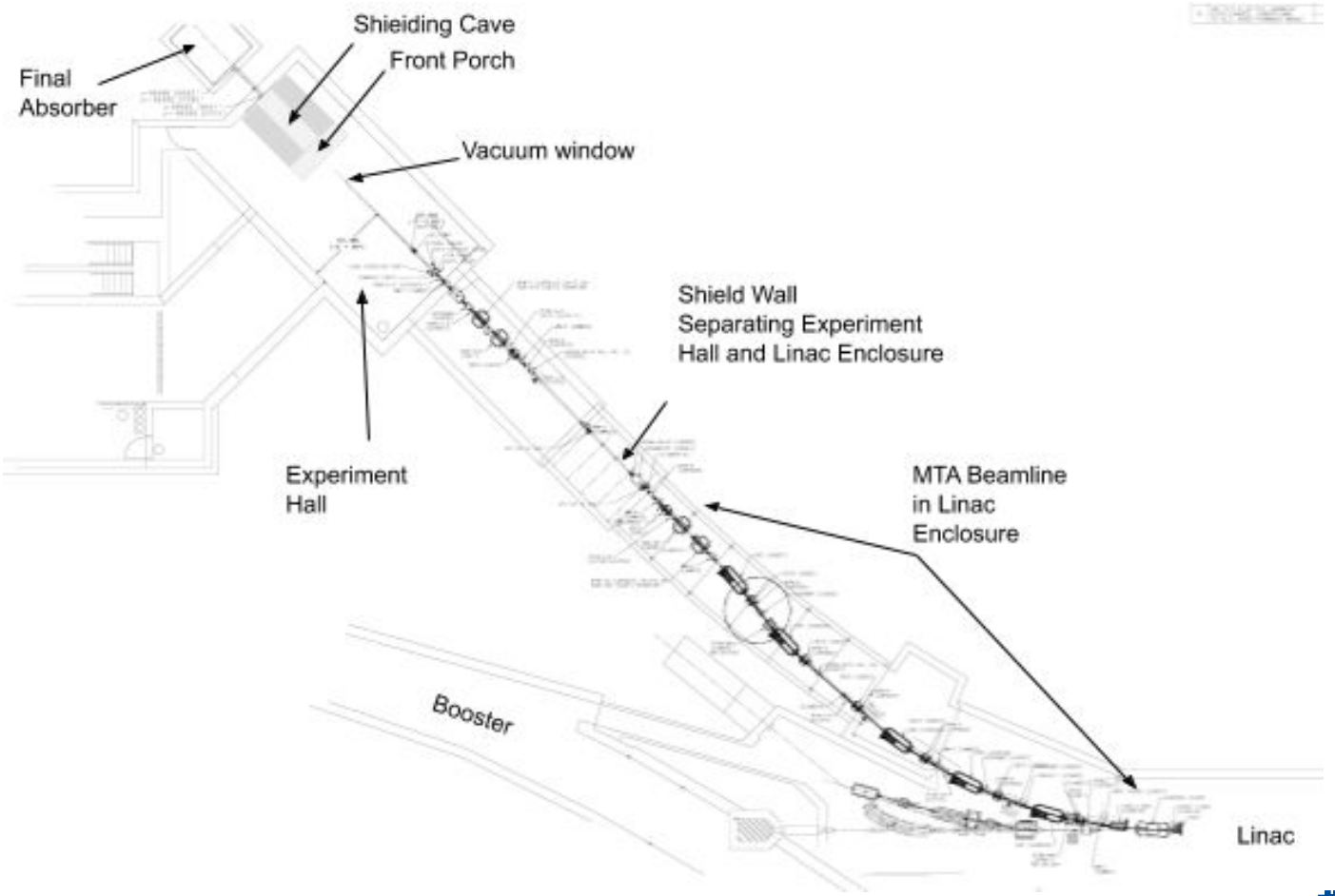
MTA Accelerator Readiness Review

2020 September 9

This presentation

Reconfiguration & Installation Status

- **Facility:**
  - Site preparation
  - Shielding Improvements
    - Filling unused shielding penetrations
    - Shielding Cave and simulations
- **Hardware:**
  - Stripping foil
  - Repositioned final quadrupole focusing magnet triplet
  - Extension of evacuated beam pipe
  - Refurbished multi-wire detectors
  - Reconnected UHB03 power supply
  - Check UHB01 (pulsed C-magnet) performance


Shieiding Cave
Front Porch
Final
Absorber
Vacuum window
Shield Wall
Separating Experiment
Hall and Linac Enclosure
Experiment
Hall
MTA Beamline
in Linac
Enclosure
Booster
Linac

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Facility

Access

These exterior doors are all on AC-4 key, available from the MCR for users.

Interlocked enclosure doors are on the MTA enclosure key

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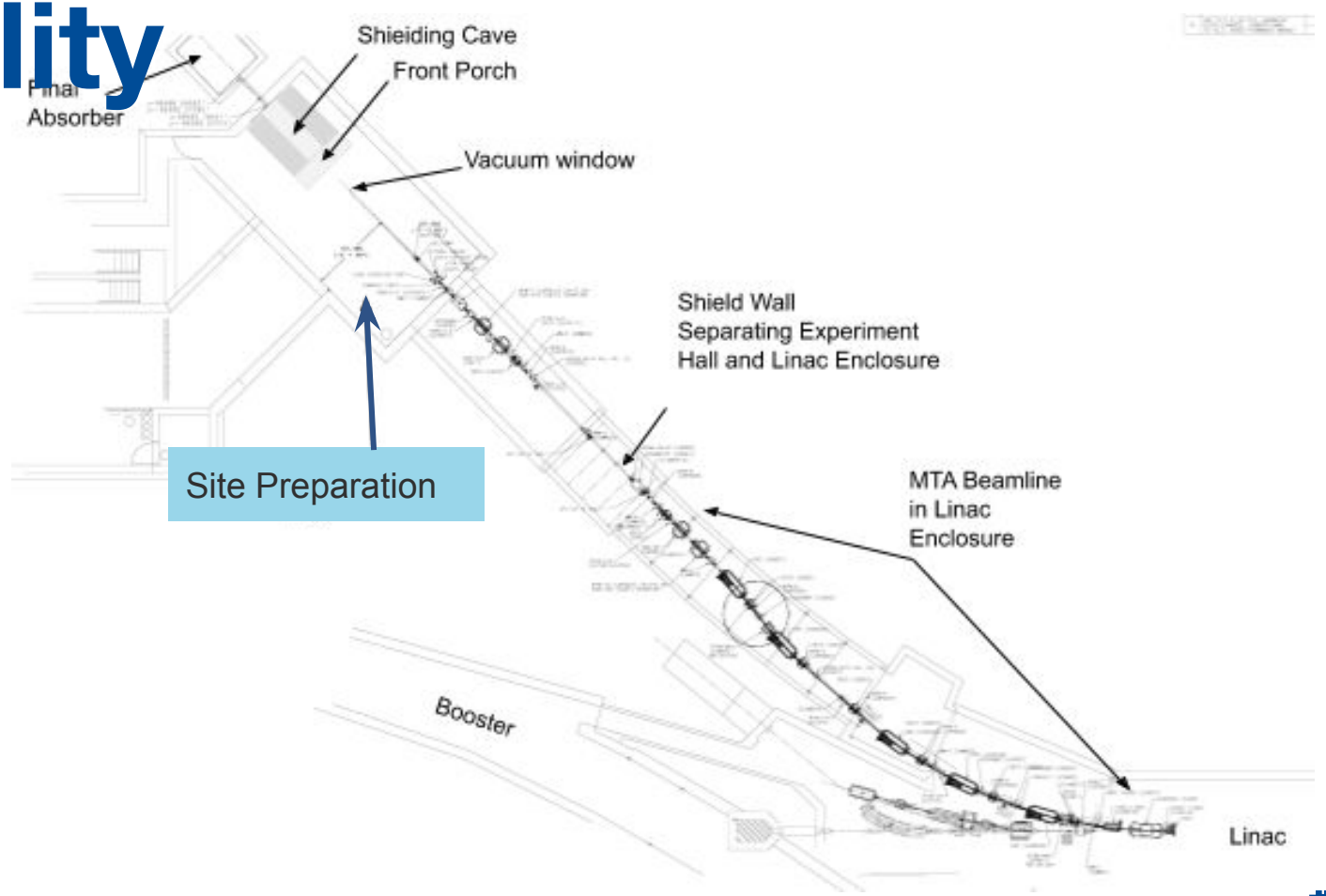
Facility



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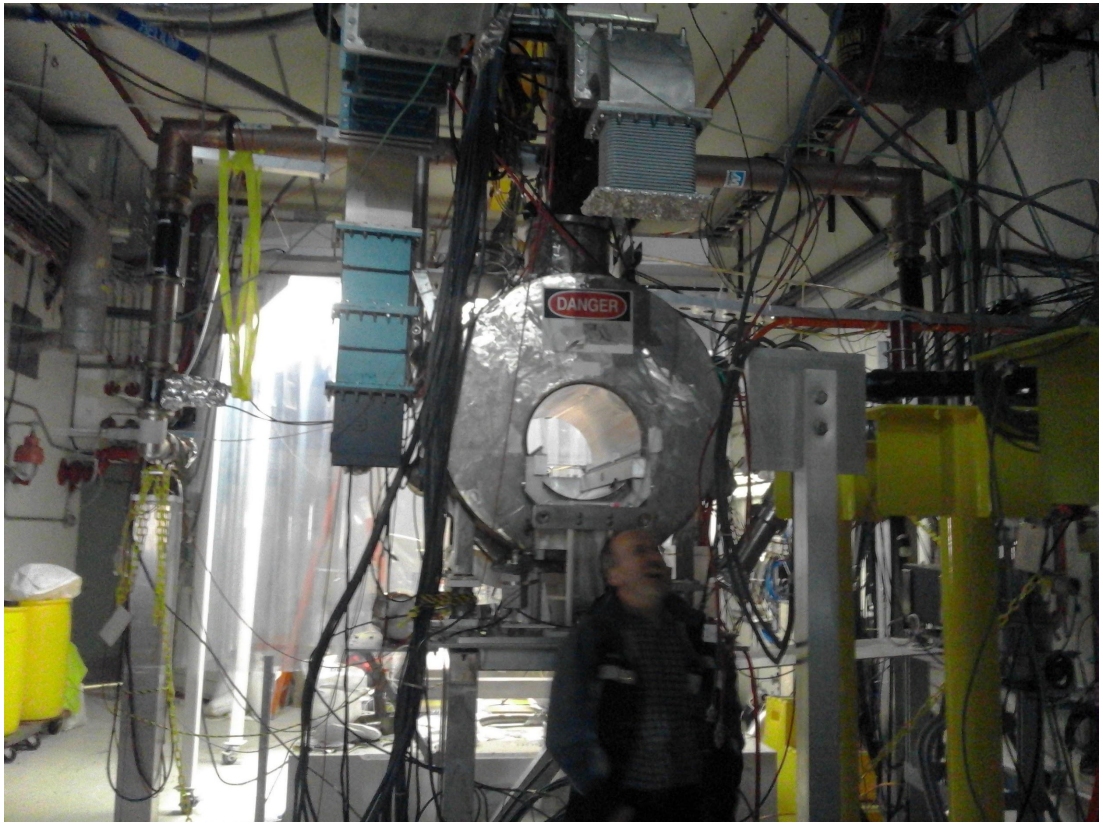
Site Preparation: Cleanout



A big puzzle disassembled with care

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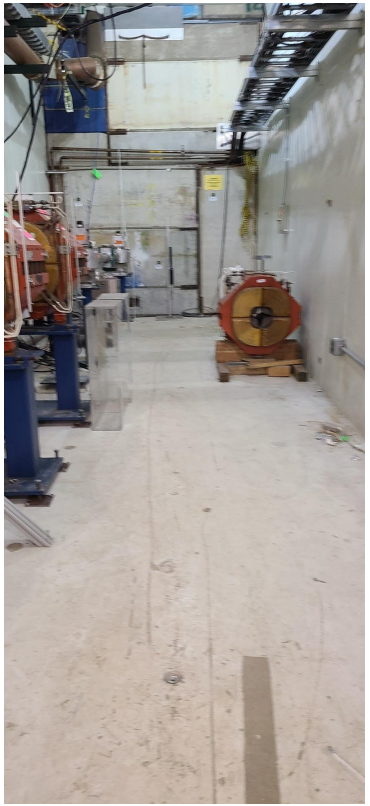
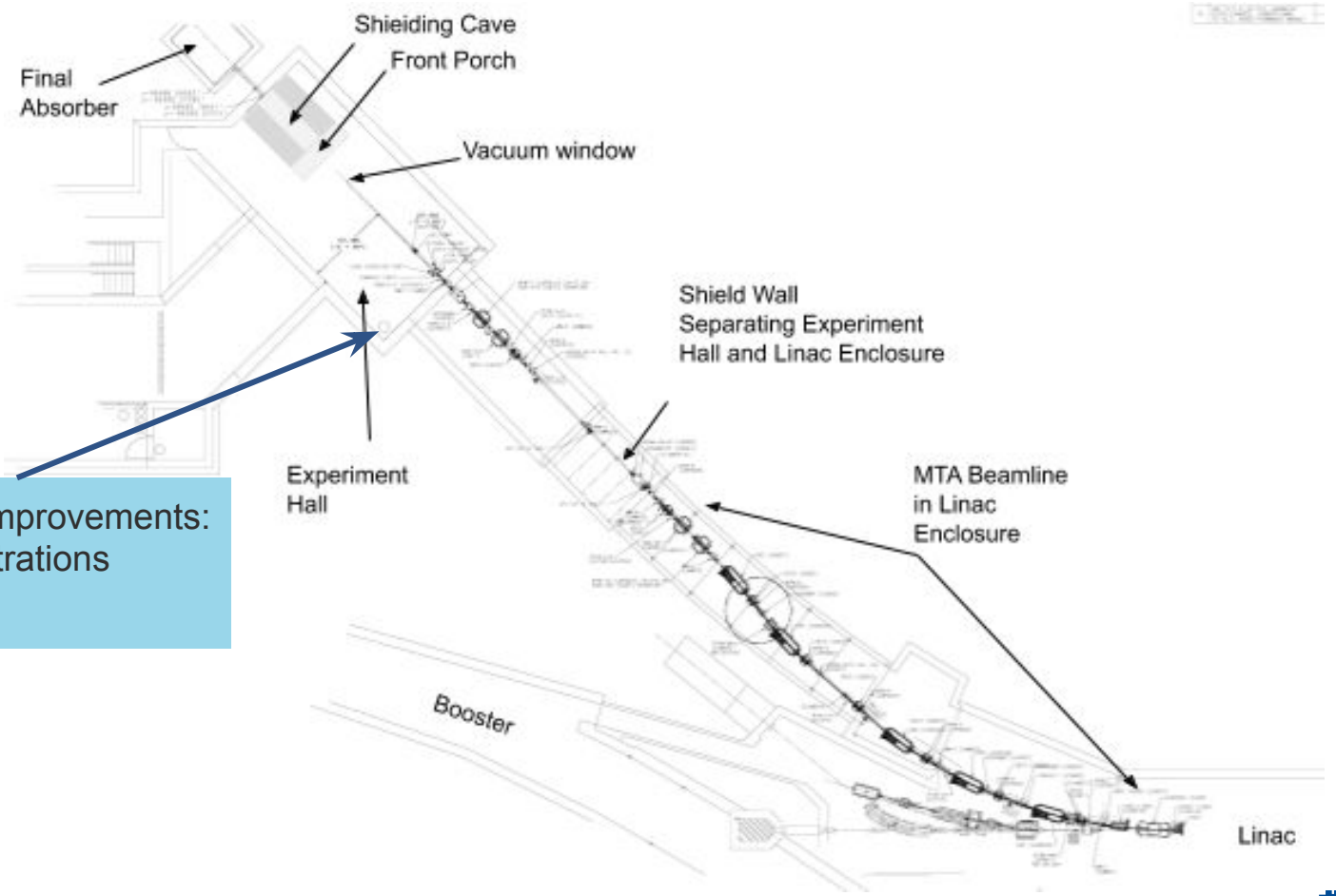
Site Preparation: Cleaned Out





Shielding Improvements: Filled penetrations (vertical)

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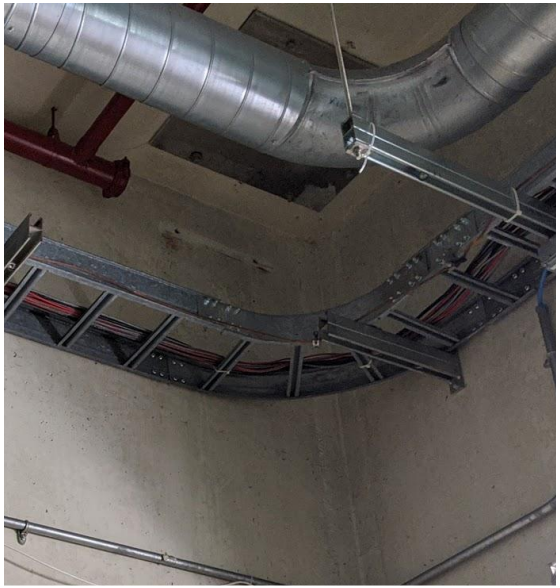
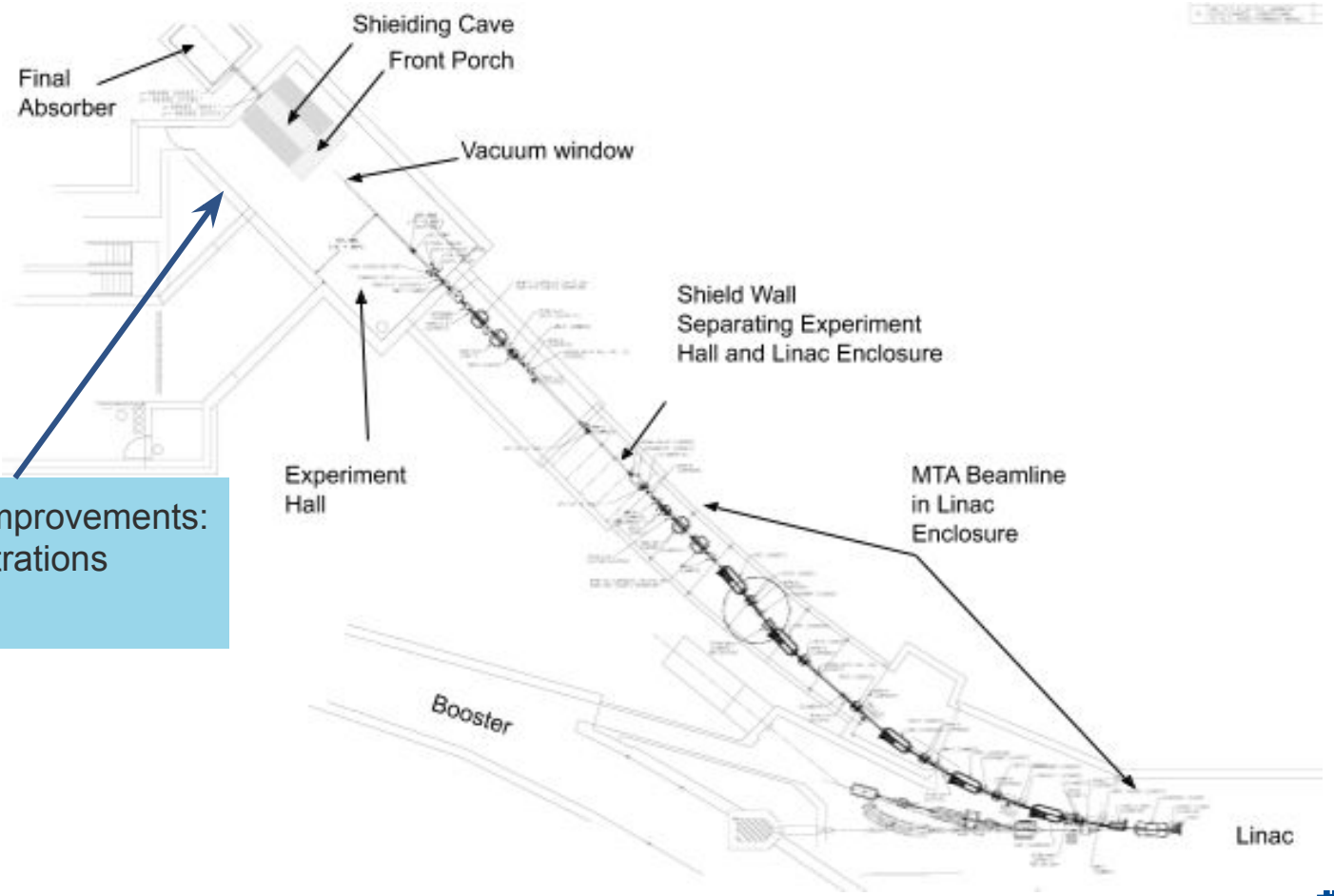
Shielding Improvements: Filled penetrations (vertical)

Vertical penetration through berm for H2 vacuum vent

Shielding Improvements: Filled penetrations (vertical)



Piped cleared away, penetration capped and filled with sand (+ 3' poly beads)



Shielding Improvements: Filled penetrations (horizontal)

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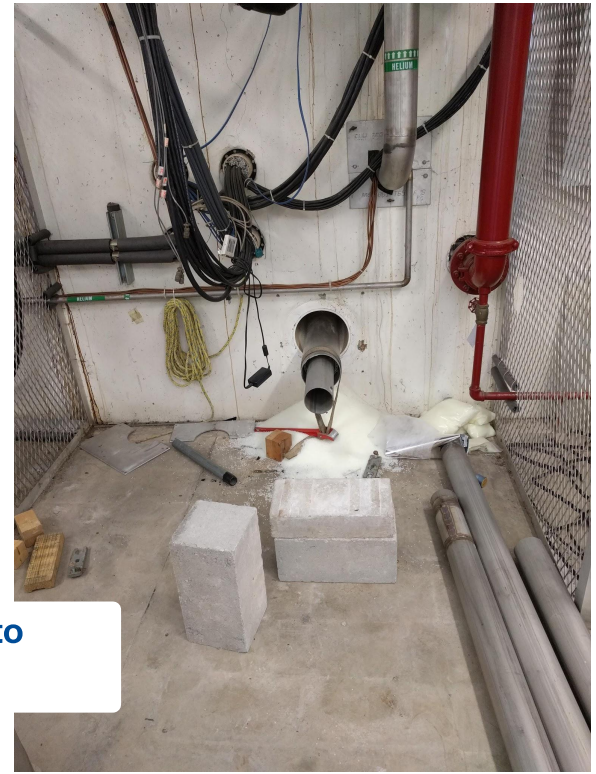
Shielding Improvements: Filled penetrations (horizontal)



Straight, horizontal penetrations to Counting House room for cryo

Shielding Improvements: Filled penetrations (horizontal)

Cleared out, filled with poly beads, sealed and locked.

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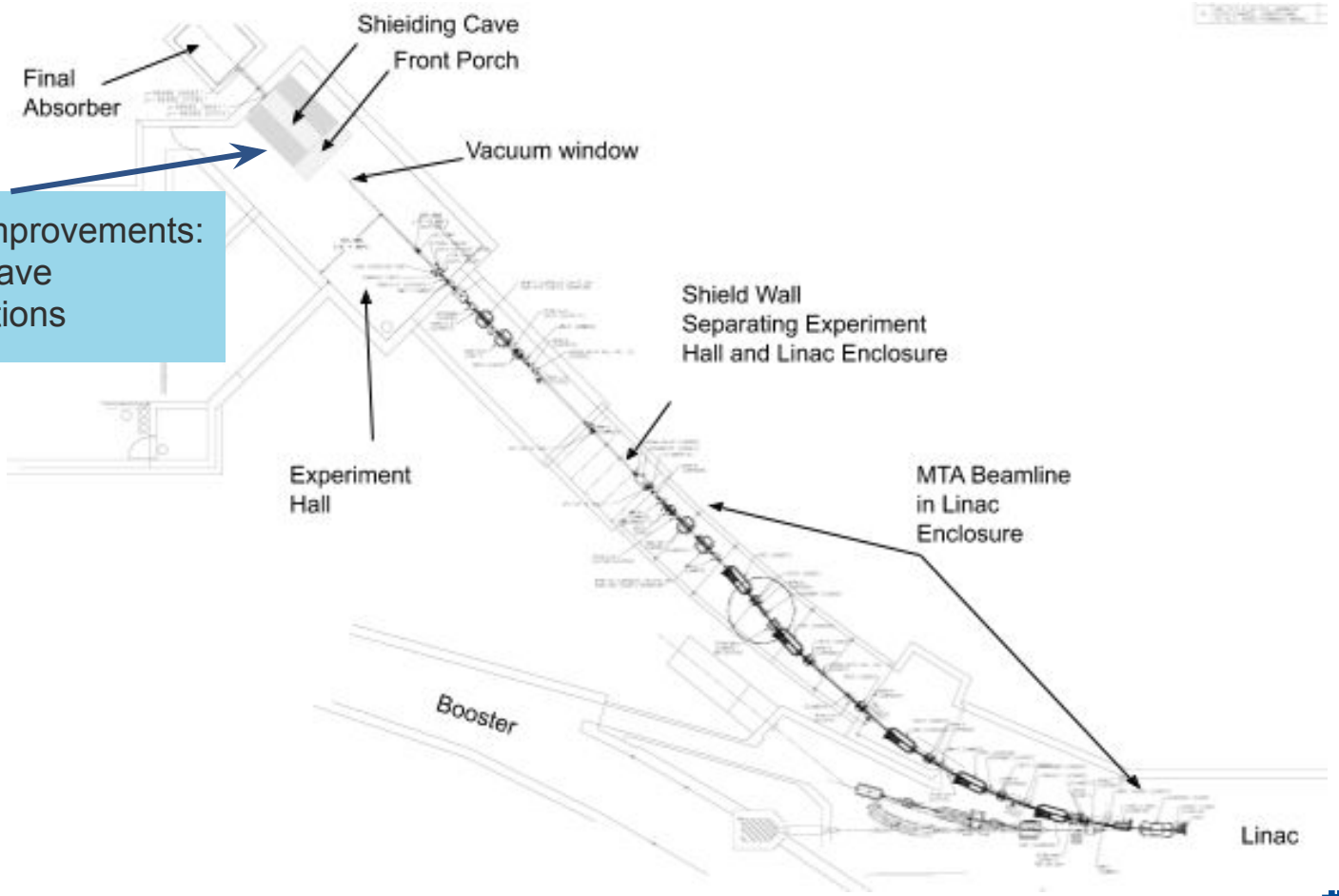
Shielding Improvements:
Shielding Cave
and Simulations



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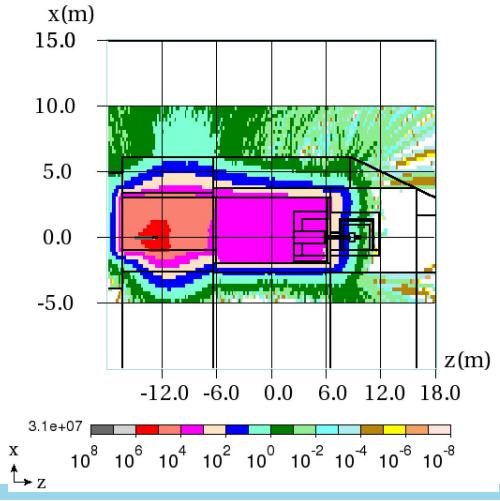
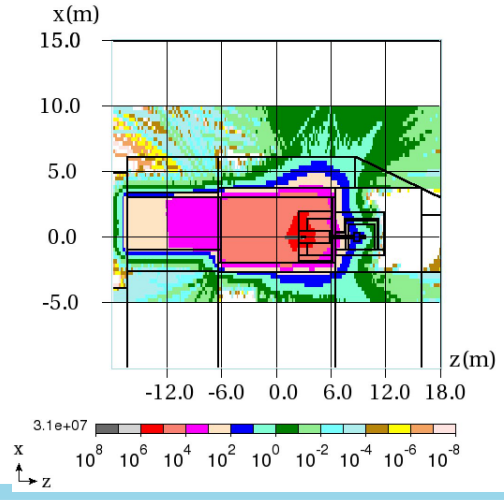
Shielding Improvements: Shielding Cave and Simulation

Added shielding cave and analyzed MARS simulations for targets of different composition and in both Front Porch and Shielding Cave positions.

Outcome: Accident scenarios as in Shielding Assessment

- Worst-case trajectory accident scenario → Upper limit on beam intensity
- Worst-case intensity accident scenario → Interlocked chipmunk on berm





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Facility notes

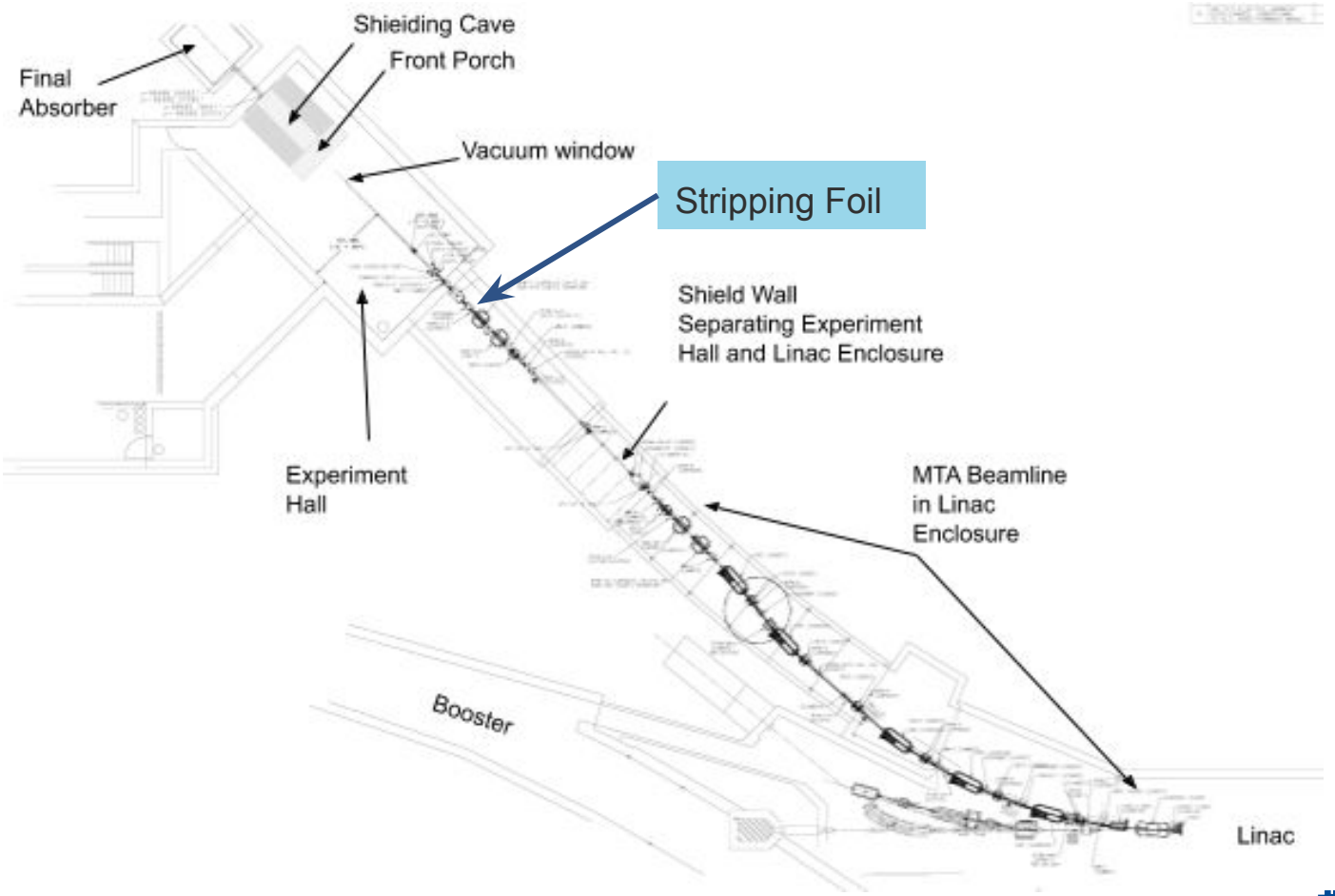
Completed Clearances:

- Movable shielding completed and documented
- Shielding Assessment

Pre-Start Recommendations:

- Housekeeping

Hardware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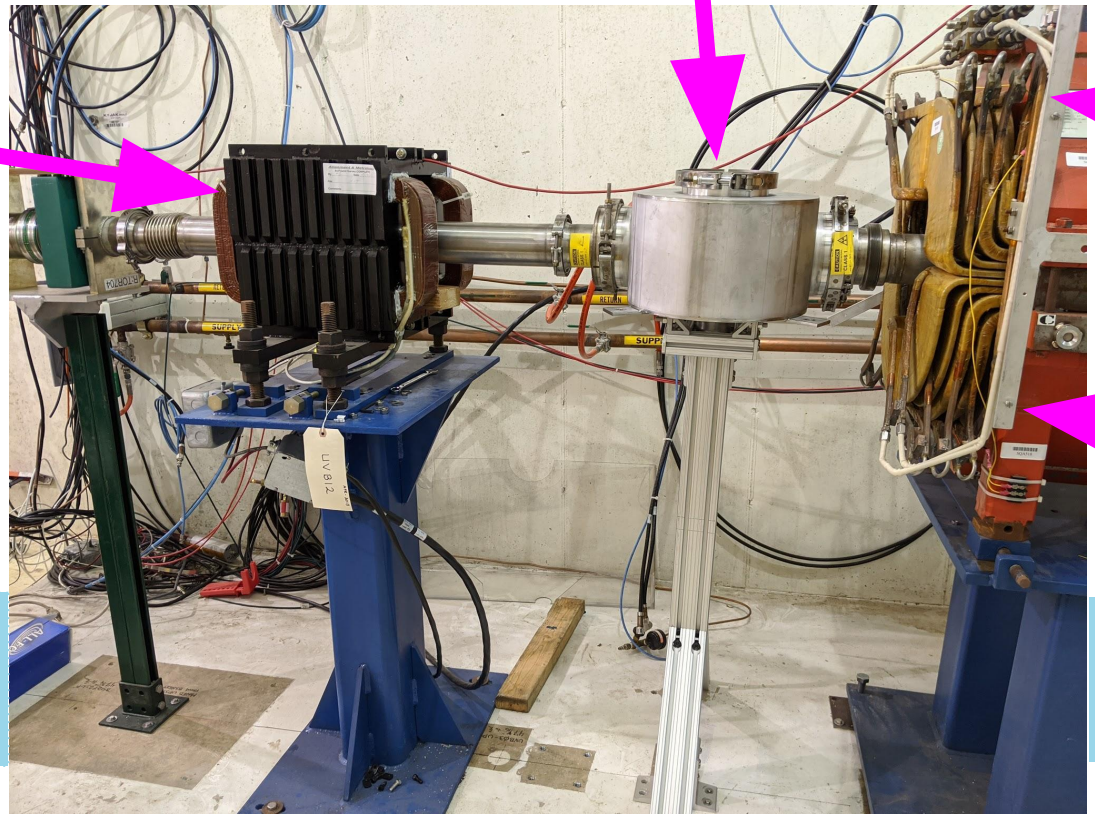
Stripping Foil

New Stripping Foil

Final vertical bend (sets final height of level, horizontal beam)



Final Focusing Quads

Stripped protons bent down 1.678º to flat & level

Upward H^- ion beam pitch: 1.678º

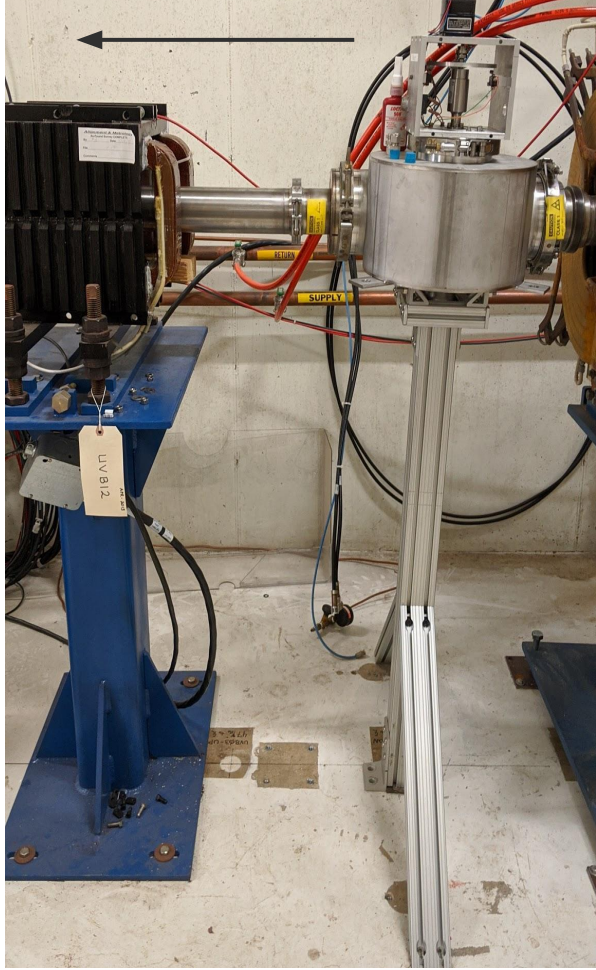
Stripping Foil

0.004” grade-4 Ti alloy beam window mounted on an empty multiwire frame, with lab-standard vacuum vessel, drive arrangement, and position controls

Two effects on beam:

- Expected ~100.0% electron **stripping** efficiency based on areal density (45.0 mg/cm^2, cf Booster’s 0.30 mg/cm^2 carbon foils).
- Expected additional **scattering** ~0.290 milliradians (98% containment).

$$\theta_0 = \frac{13.6}{\beta cp} z\sqrt{x/X_0}\,[1 + 0.038\ln(x/X_0)]$$



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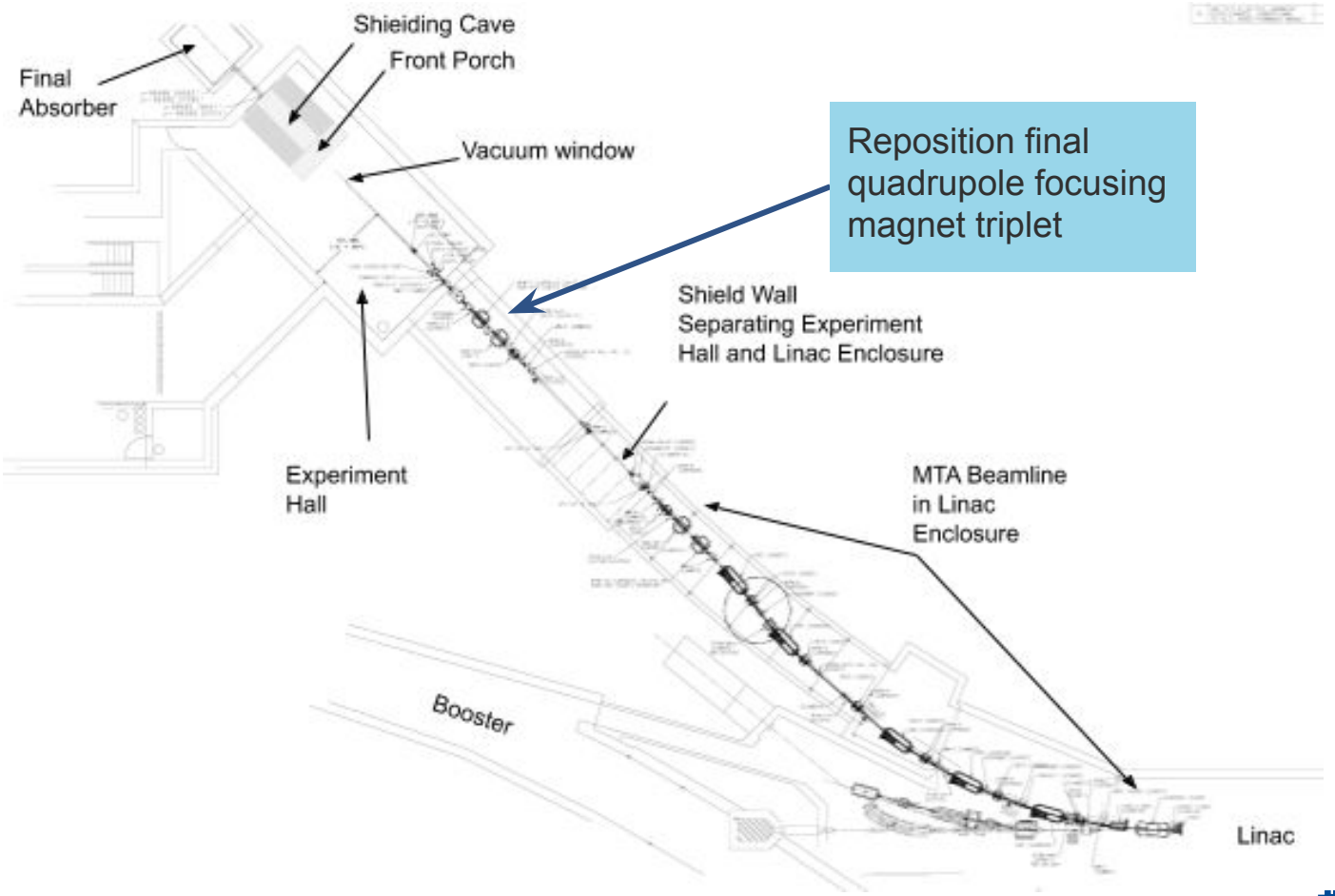
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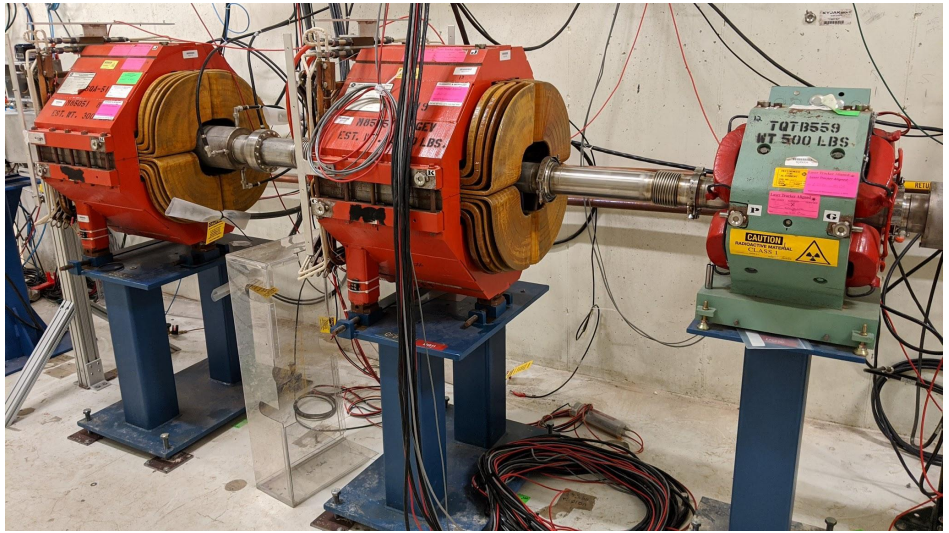
Repositioned final quadrupole focusing magnet triplet

Final focus quadrupole triplet UQ10,11,12 relocated Dec. 2019 upstream 18” to open space for stripping foil. Recalculated magnet currents. (Smaller by a few percent for a given choice of focus, as expected with longer lever arm).

```
Q1: 26.199
Q2: -16.805
Q3: 28.189
Q4: -23.470
Q5: 36.460
Q6: -5.366
Q7: -74.993
Q8: 139.7`44
Q9: -31.0911
Q10: -31.870
Q11: 107.757
Q12: -34.223
```



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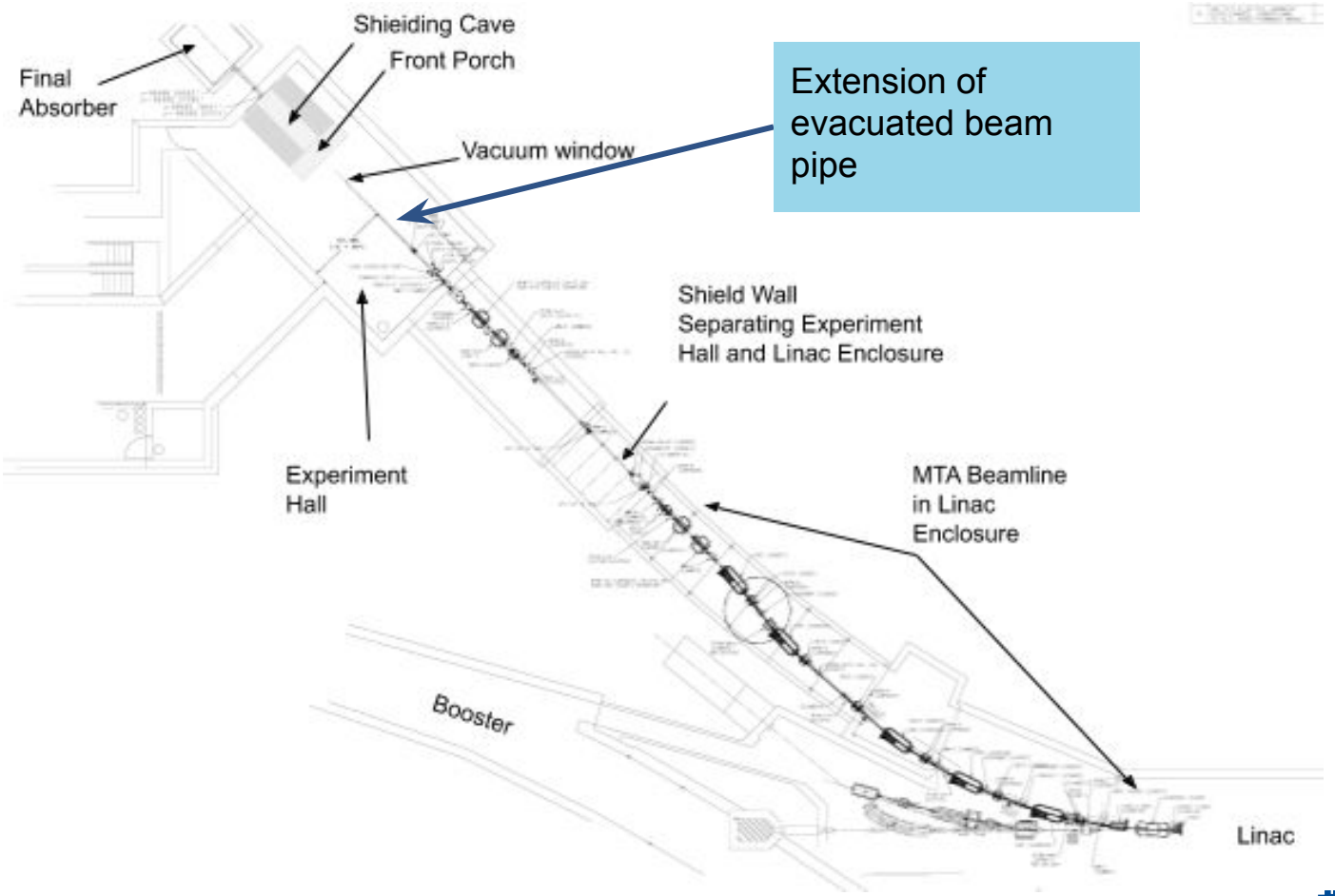
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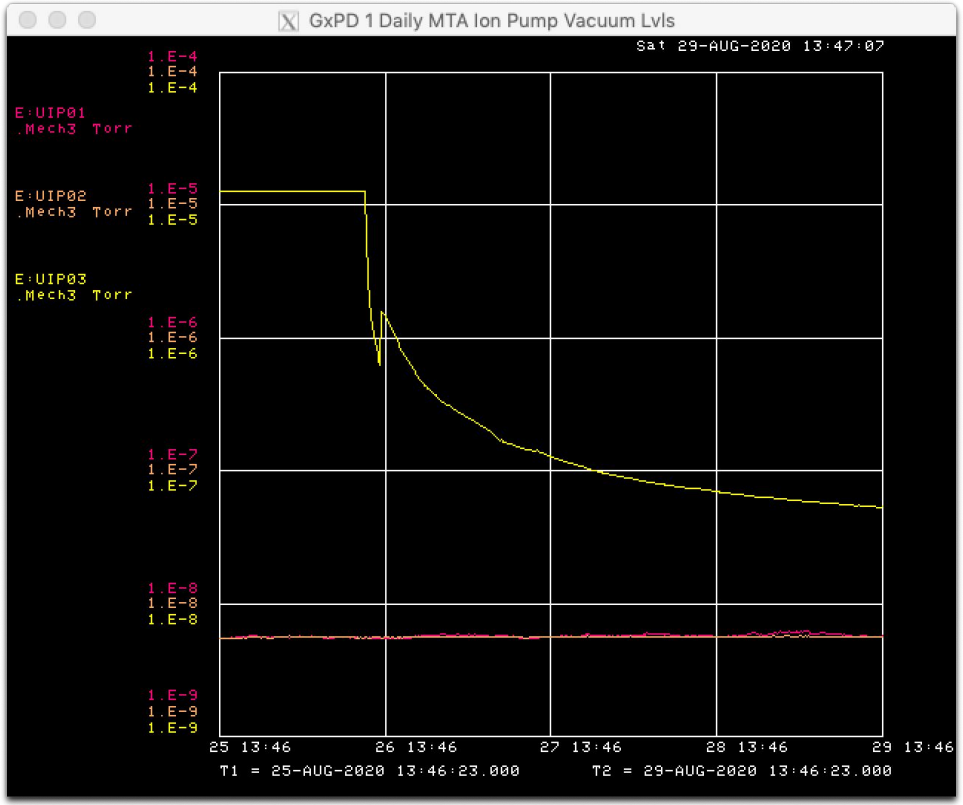
Extension of evacuated beam pipe

Replaced Ion Pump IP03:

Gamma Titan 600 L Conventional Diode

1.6E-6 → 5.0E-8 Torr (First 72 hours)



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Extension of evacuated beam pipe

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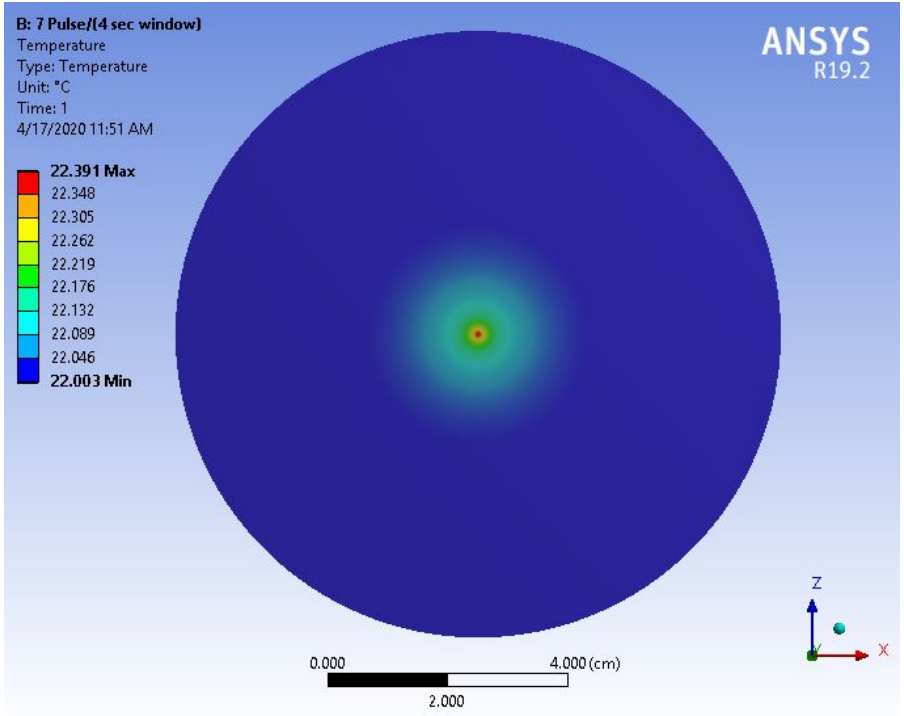
Extension of evacuated beam pipe



EN04138
"Thermal Analysis of Grade 5 Ti-6Al-4V 3.625" Aperture Vacuum Window"
by Rob Ridgway

Includes App. A, calculation of beam heating and effect on window strength.

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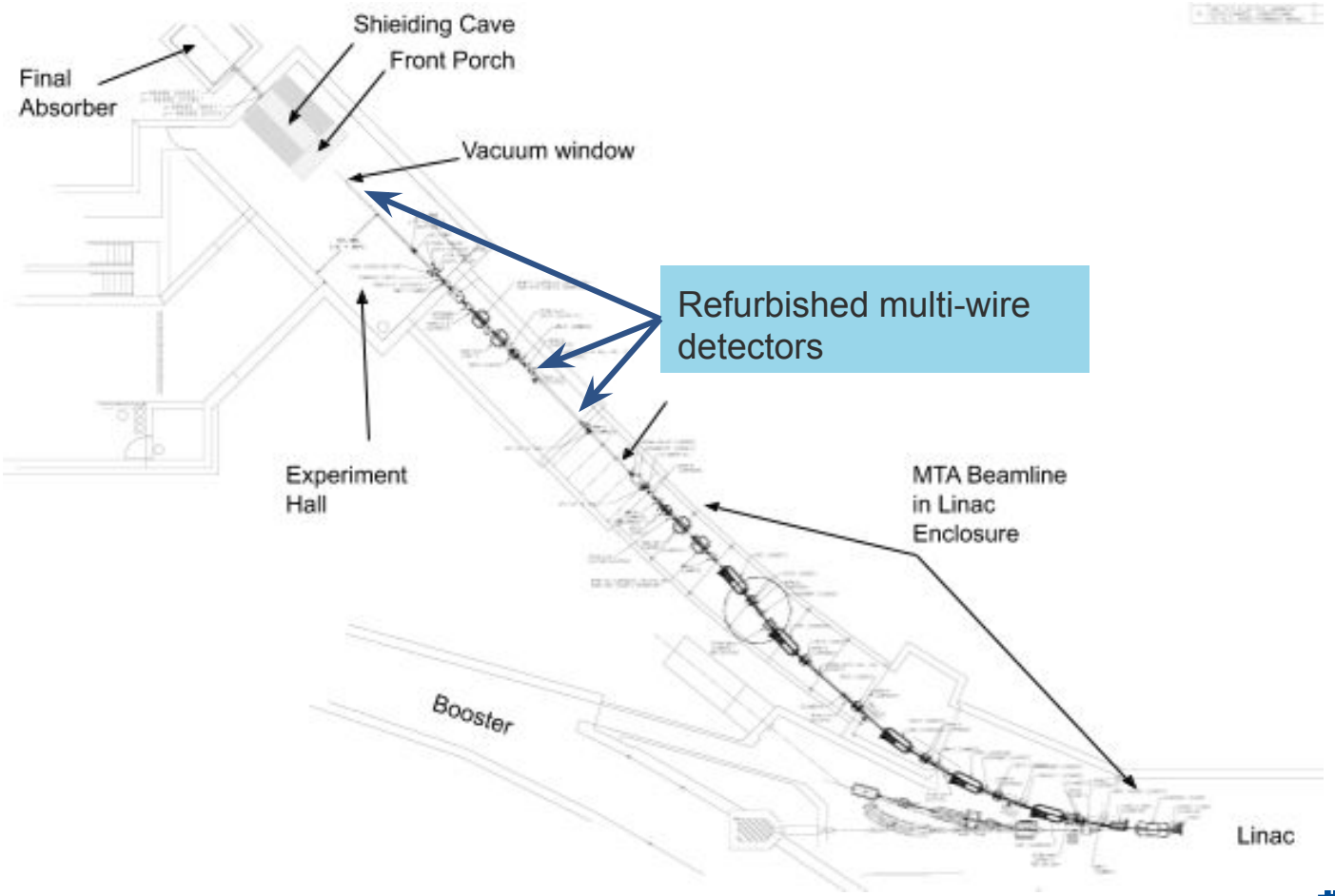
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Refurbished multi-wire detectors

Ti-wire stacked-style planes improve beam tuning speed

Re-using former FRIGMU node for SWIC controllers

Above:
One assembled vacuum can

Left: Readout and positioning electronics
Center: Close-up of wire planes in ceramic frame

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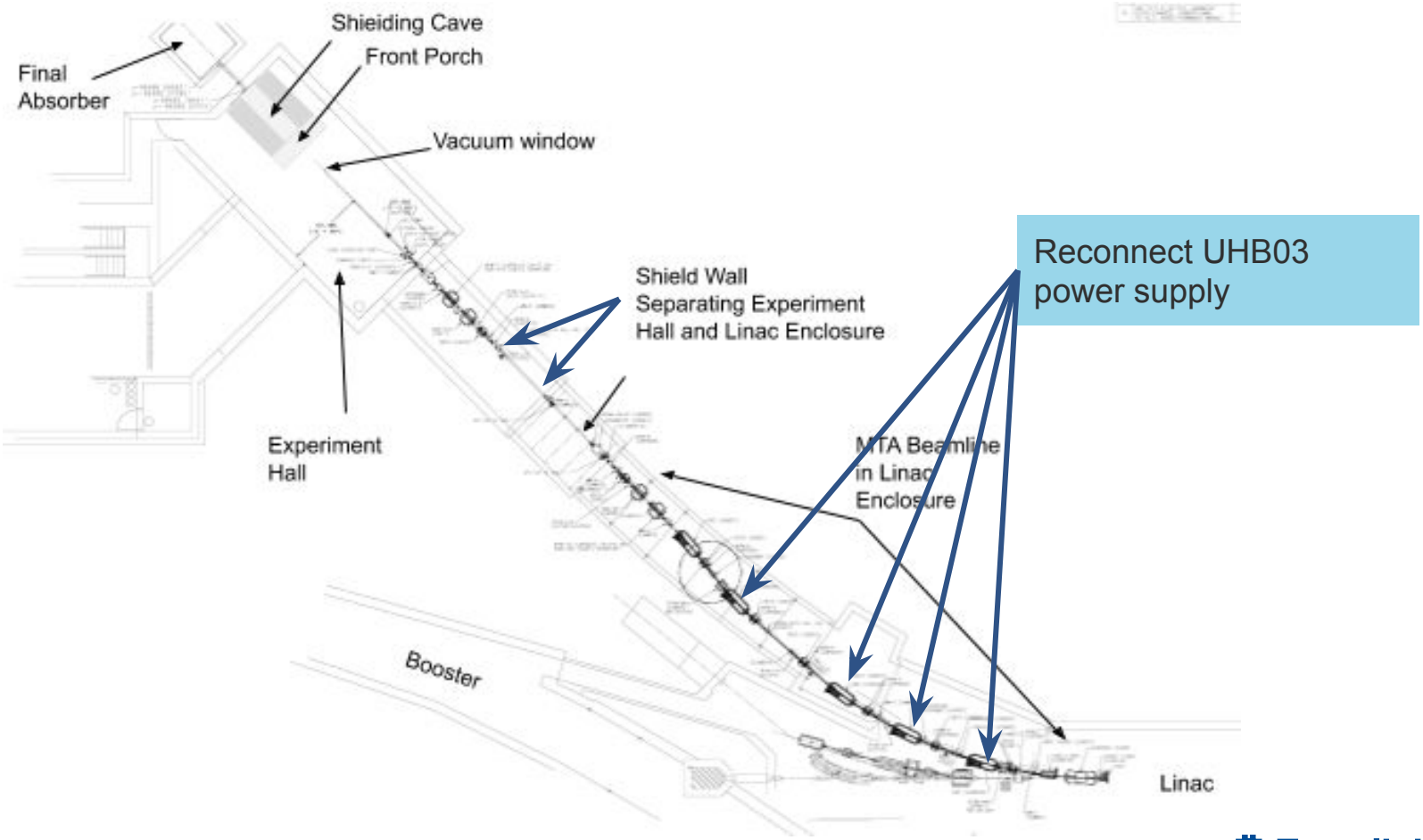
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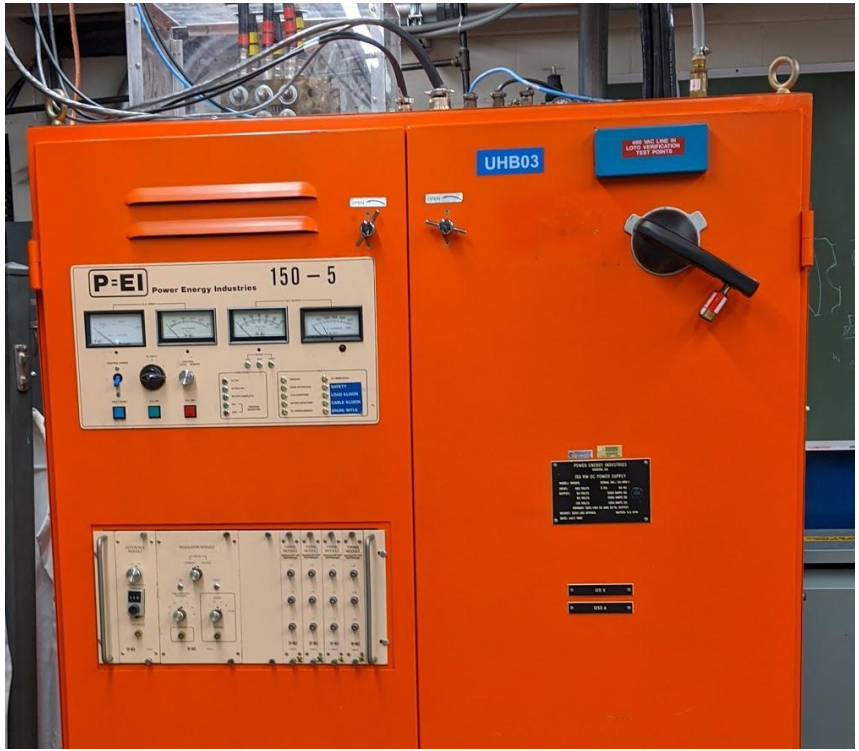
Reconnected UHB03 power supply



Restored power to 1250 A, 120 V PEI power supply via critical device contactor

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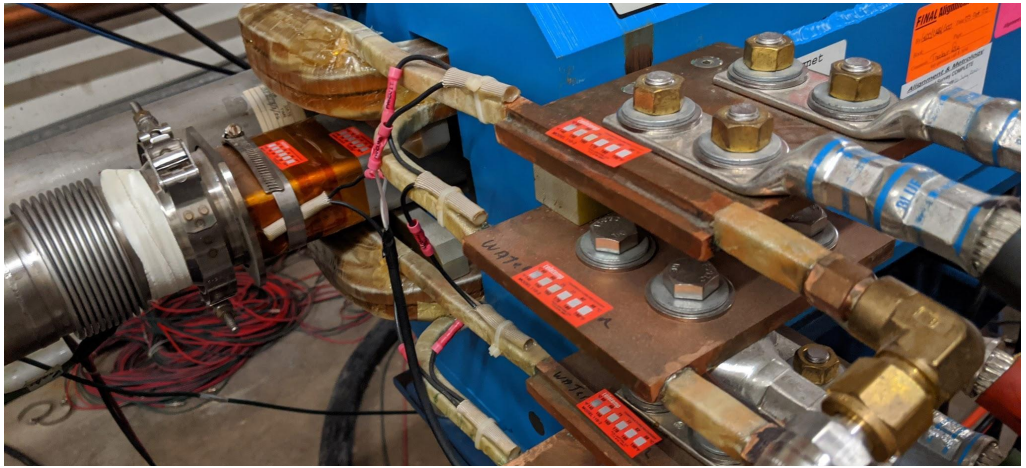
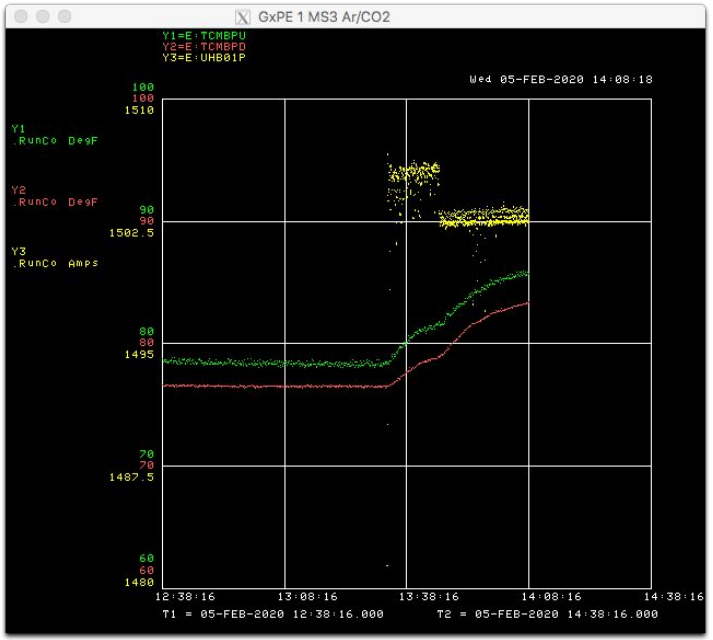
Check UHB01 (pulsed C-magnet) performance

Made use of down time Wed 2020-02-05 to test pulsed magnet with internal and external ($02) triggers.

- Beampipe heating effect: <90º F equilibrium, (safety limit: 150º F)





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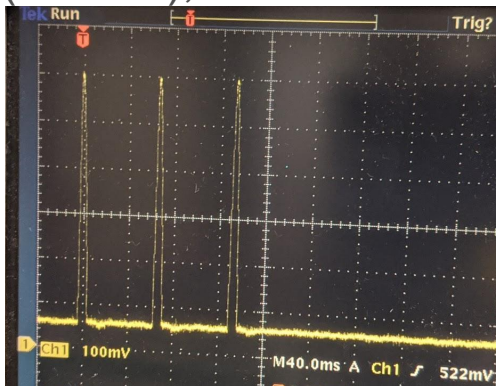
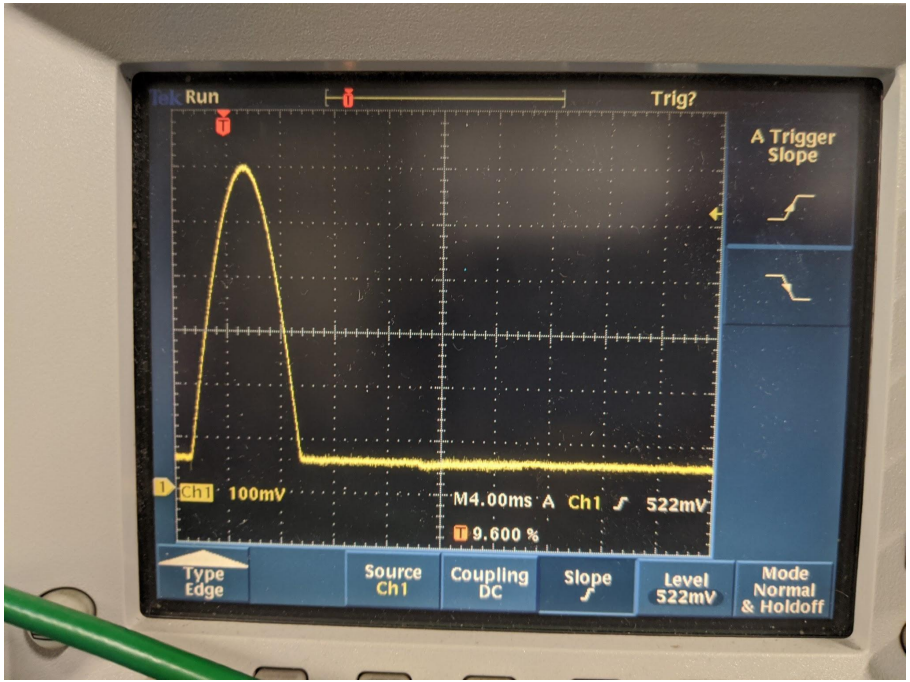
Check UHB01 (pulsed C-magnet) performance

Made use of down time Wed 2020-02-05 to test pulsed magnet with internal and external ($02) triggers.

- Waveform is a healthy sine arc
- Amplitude (current) correct correspondence to reference voltage at 960 V (1567 A), variation ~20 A (0.2%)





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System Start-Up Sign Off

- Controls
- Electrical Engineering Support
- Radiation Safety
- External Beamlines
- Instrumentation
- Interlocks
- Mechanical Support
- Operations
- Proton Source
- ENG Support
- Shutdown Coordinator

From the header of the System Start-Up Sign Off sheet:

“The signatures... indicate that the relevant systems are ready for the restart of beam operations.”

Operation does not begin until all signatures have been affixed.

Hardware Notes

Completed Clearances:

- Vacuum window Engineering Note complete

Pre-Start Recommendations:

- Complete checkout of magnet & power supplies before commissioning

Summary

Facility completed changes:

- Site preparation
- Shielding improvements

Hardware completed changes:

- Inserted stripping foil and adjusted quad positions, refurbished instruments, added beam pipe, replaced vacuum window
- Thorough checkout of all systems will be complete before commissioning begins

Pre-start: Finish housekeeping and magnet / power supply checkout

Questions?

Backup Slides

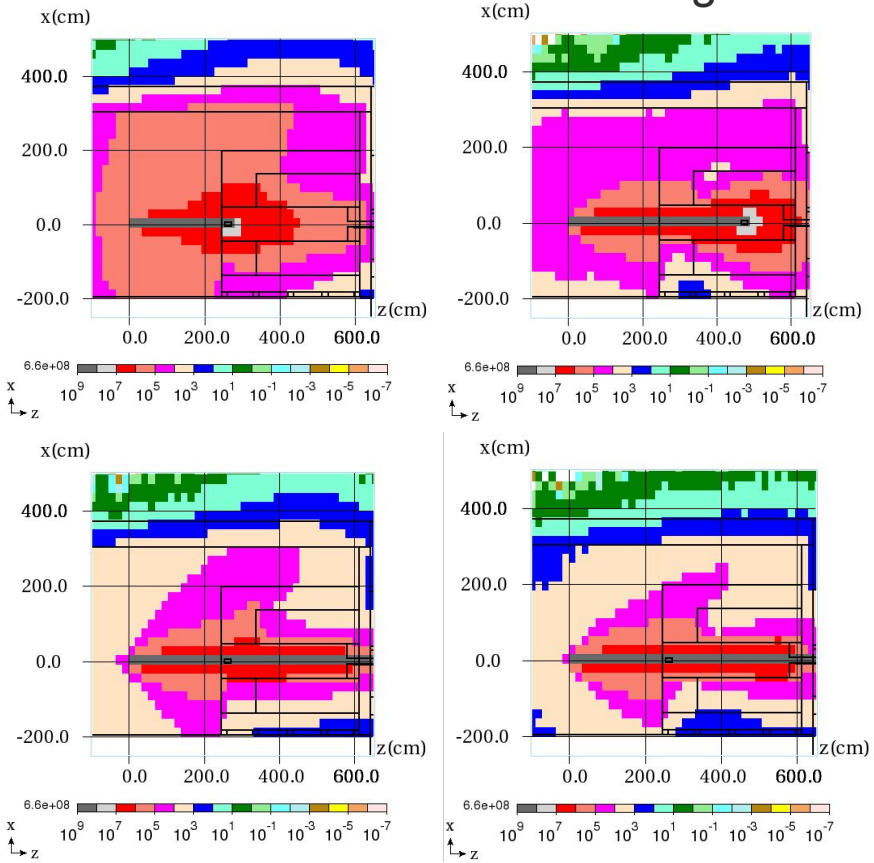
Target Material and Placement Studies

Front Porch

Shielding Cave

Iron Slug →

10 Si slabs →



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