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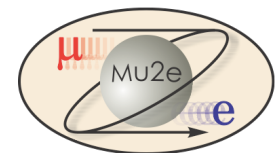
# Mu2e CD-2/3b Review

## 8.8 CRV Assembly & Installation

James Fagan

CRV Detector Assembly & Installation L3 Manager

10/21/2014

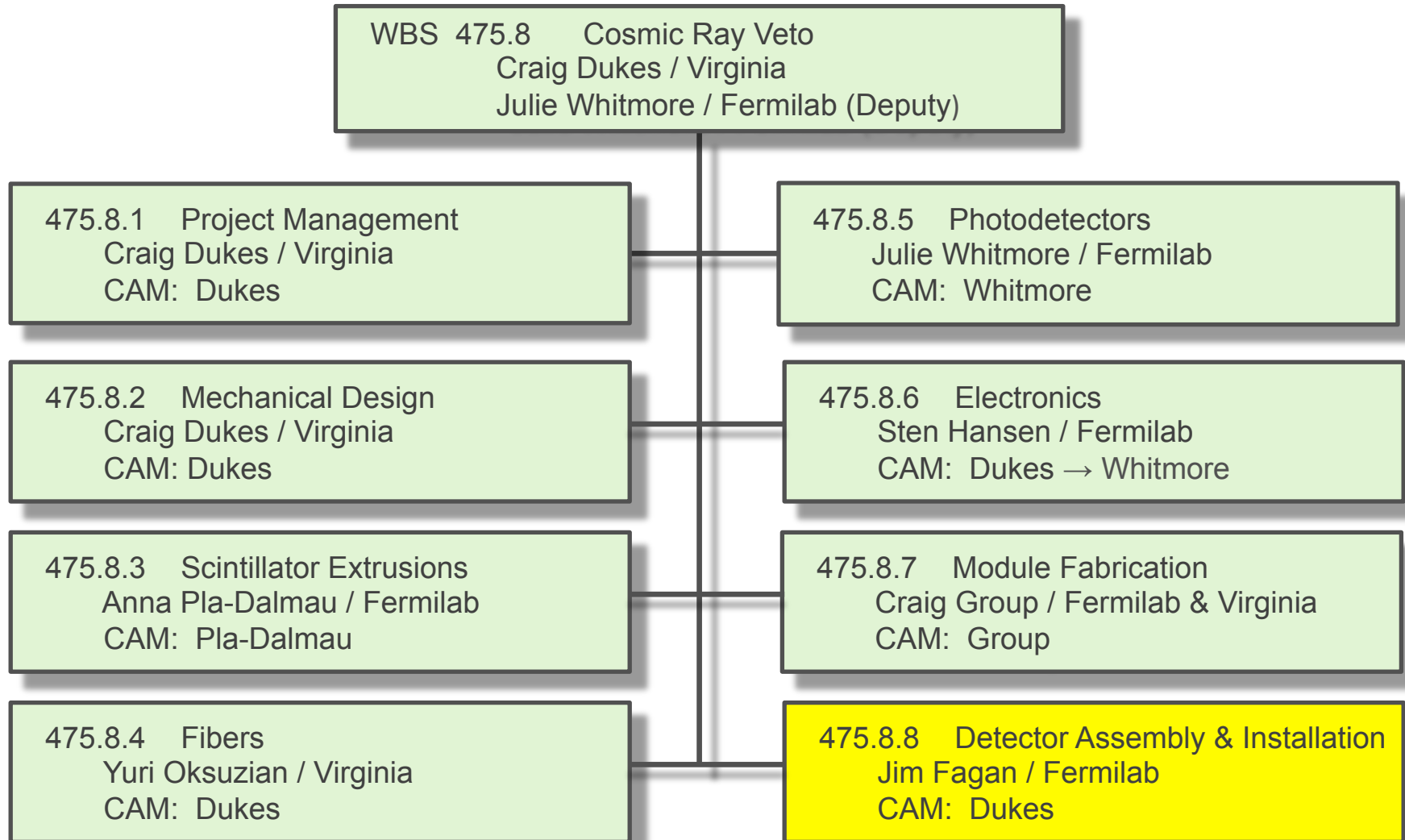


# CRV Detector Assembly & Installation

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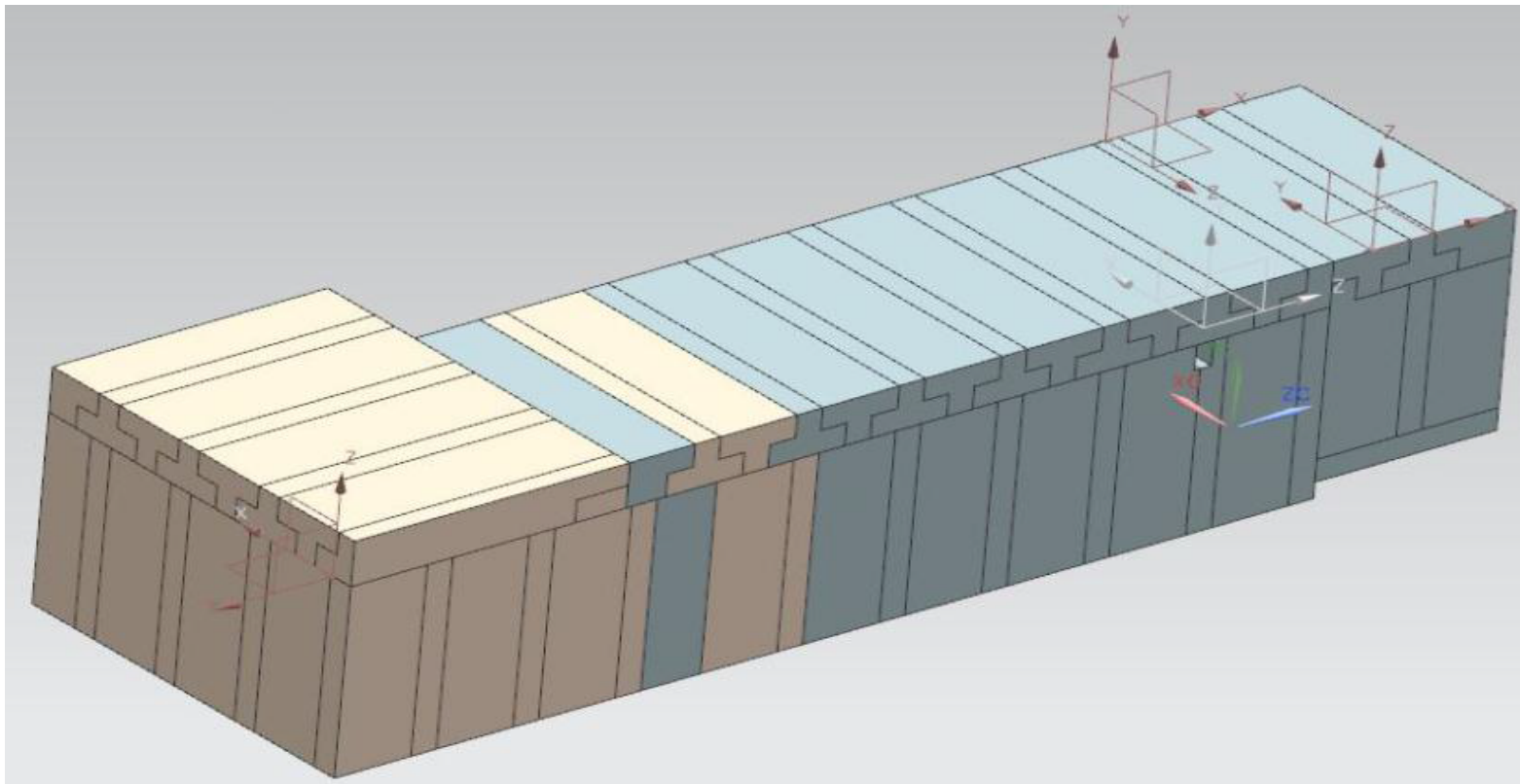
- James Fagan L3 Manager since 10/2013
  - Operations Specialist Sr – Fermilab – 30 yrs.
  - Associate Department Head – DD&OD
  - NOvA L3 manager for PVC Extrusion Production
  - ANL - 10 yrs.
  - B.S. Industrial Technology

# Organization



# Requirements

- Staging area at FNAL - 4k ft<sup>2</sup>– 5k ft<sup>2</sup> with crane access for several years
- Storage area at FNAL – 500 ft<sup>2</sup> for indefinite time – module storage
- Modules & supports should facilitate opening the neutron shielding



Shielding with movable end-cap.

# Requirements

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- Access to CRV electronics
- Shield blocks
  - Surfaces must be flat and allow anchor attachments
  - Dead spots no larger than 8 X 15 in<sup>2</sup>
  - No penetrations on the top
  - Positioning tolerance should be no greater than  $\pm 1$  inch
- The gap between counters of the same layer must be  $\leq 5$  mm
- Module position tolerance must be  $\pm 5$  mm
- Side clearance on CRV-R and CRV-L must be at least 36 inches

# Requirements

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- Overhead crane
  - Must have fine positioning in 3 dimensions
  - The block must be sized to allow side module positioning
  - The vertical reach must accommodate rotating side modules
  - Must have the capacity to lift 7,500 lbs.
- Interior space to off-load modules & rotate vertical
- End-cap moving should allow reposition of modules to  $\pm 4$  mm
- Module mounting must allow modules on or near the end-cap to be moved to prevent possible damage.

# CRV Detector Assembly & Installation

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- Test Installation - 475.8.8.1 – Pre CD-3 Task
  - Receive two prototype side modules from module factory
  - Construct neutron shield mockup
  - Install module supports
  - Use lifting jig to install prototypes testing hardware and procedures
- Receive Production Modules at Fermilab – 475.8.8.2
  - Receive modules
  - Inspect and test
  - Return to crate for storage
- Cosmic Ray Test Stand – 475.8.8.3
  - Transport a few modules to Mu2e facility
  - Setup and operate to test the tracker and calorimeter integration to DAQ – (Threshold Key Performance Parameter(KPP))
  - Disassemble cosmic ray test stand

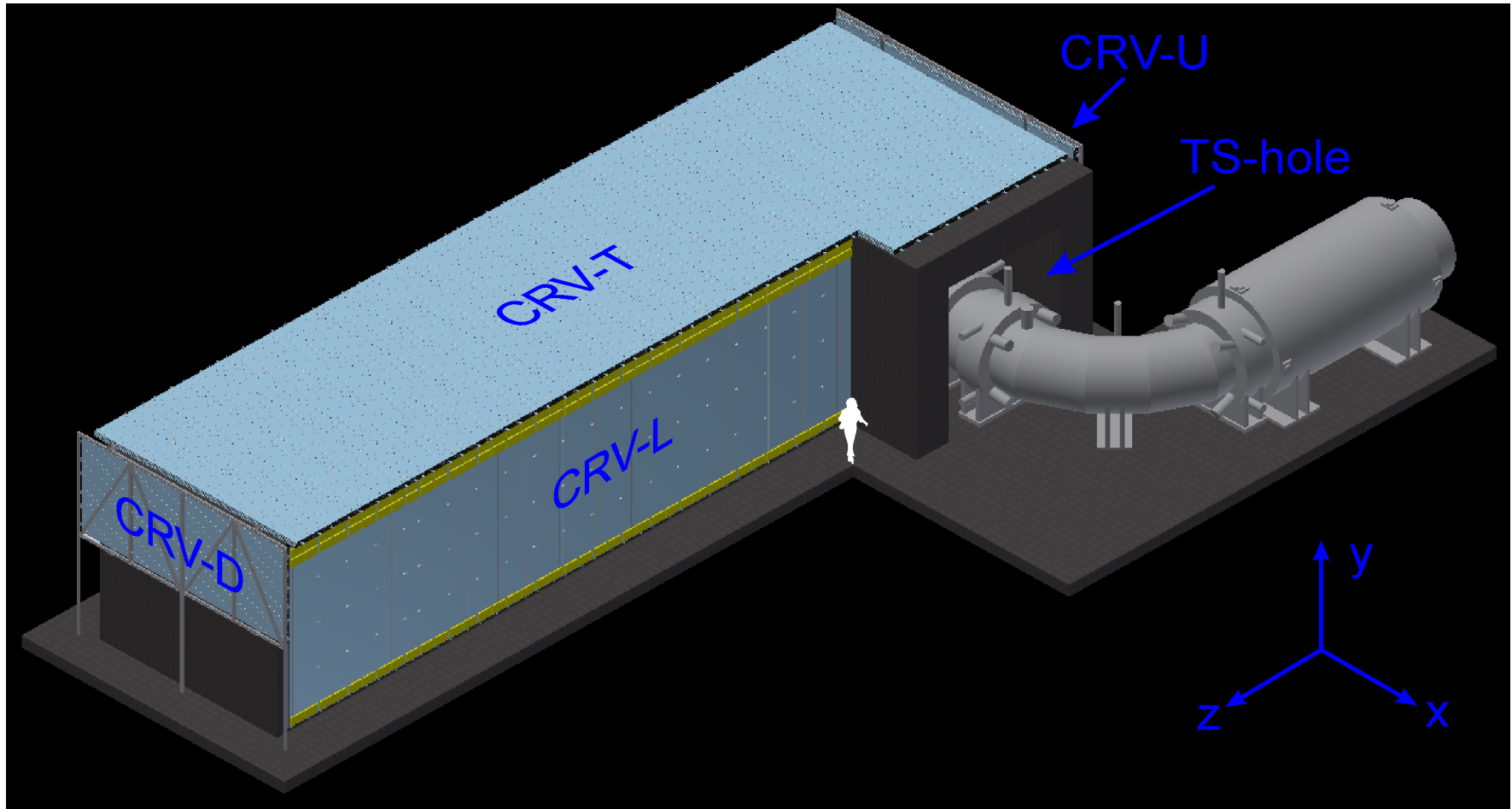
# CRV Detector Assembly & Installation

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- Module Support Structure – 475.8.8.4
  - Design of components is found in 475.08.02
  - Engineering Review
  - Fabricate module supports
- Detector Installation and Testing – 475.8.8.5 (Off project)
  - Install module supports
  - Install modules
  - Obtain operational readiness certificate
  - Commission Cosmic Ray Veto

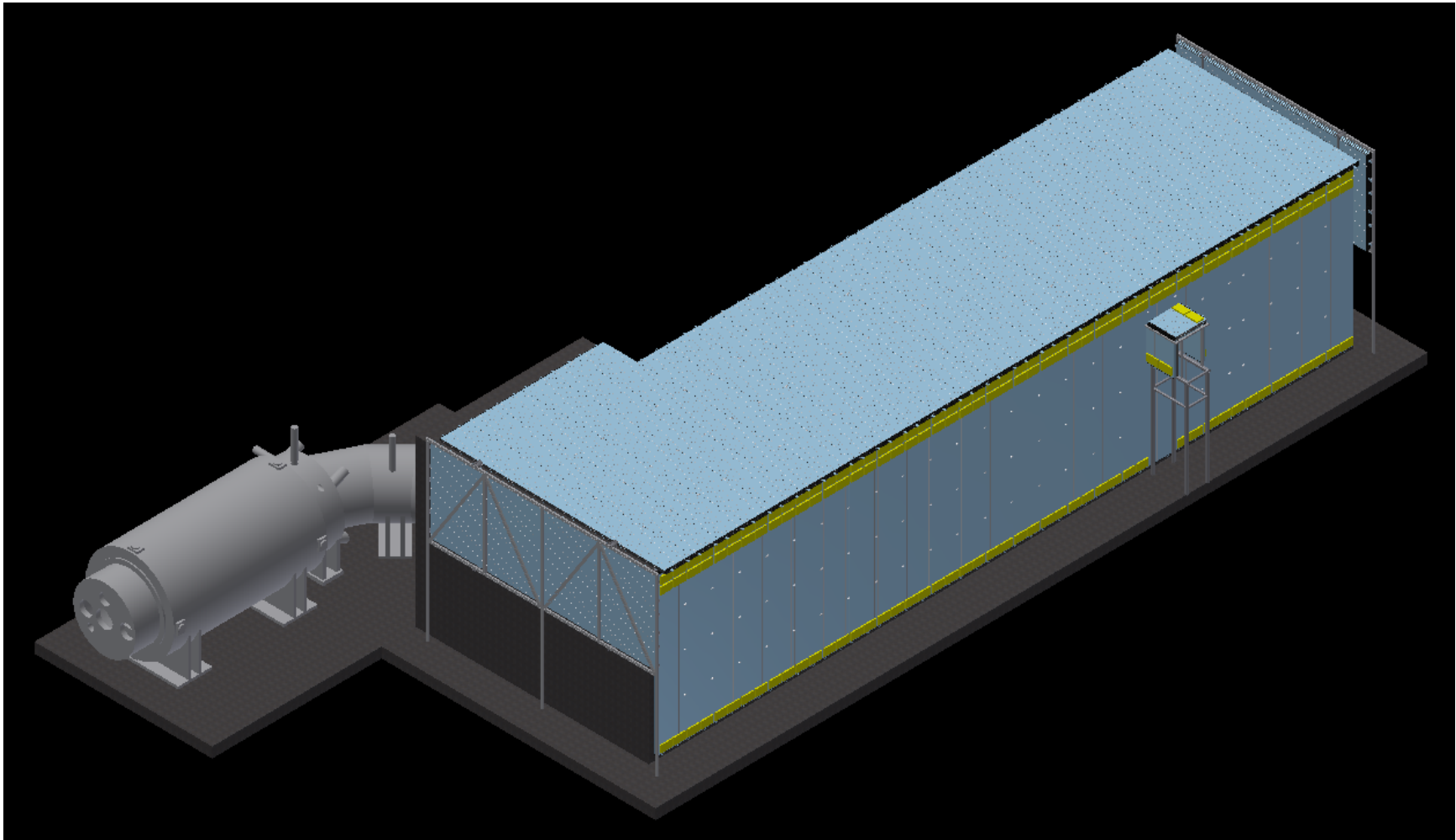


# Design



The cosmic ray veto covering the detector solenoid looking upstream, showing the downstream (CRV-D), left (CRV-L), top (CRV-T) sectors, as well as the hole where the transport solenoid enters the enclosure.

# Design

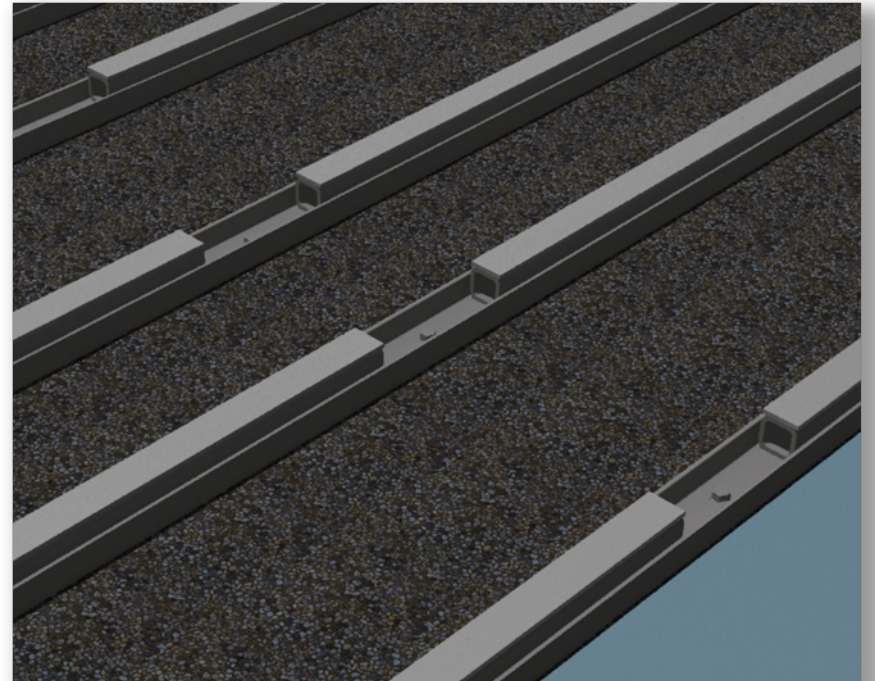
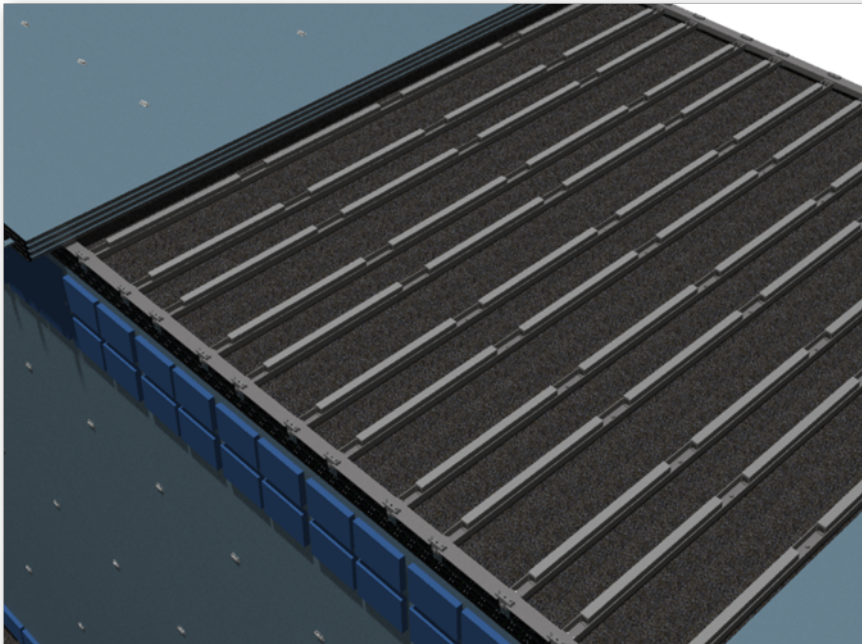


The cosmic ray veto covering the detector solenoid looking downstream, showing the upstream (CRV-U), right (CRV-R), and top (CRV-T) sectors.

# Design: Top Support Structure

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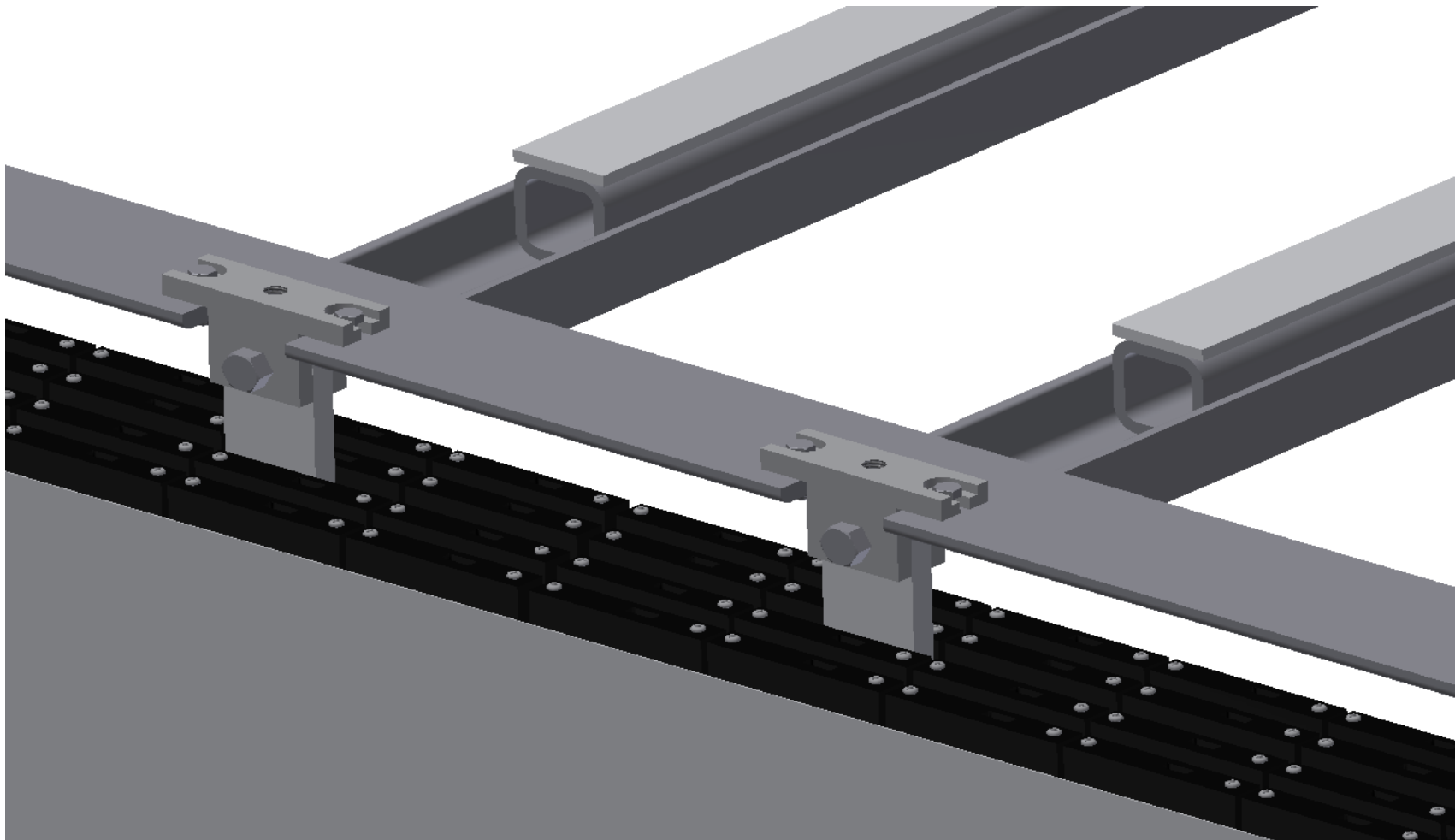
- Strips of Teflon will be attached to the tops of the 2 inch square tubing using counter-sunk bolts. This will allow the top modules to slide into position without risking damage to the scintillator.



# Design: Side Support Structure

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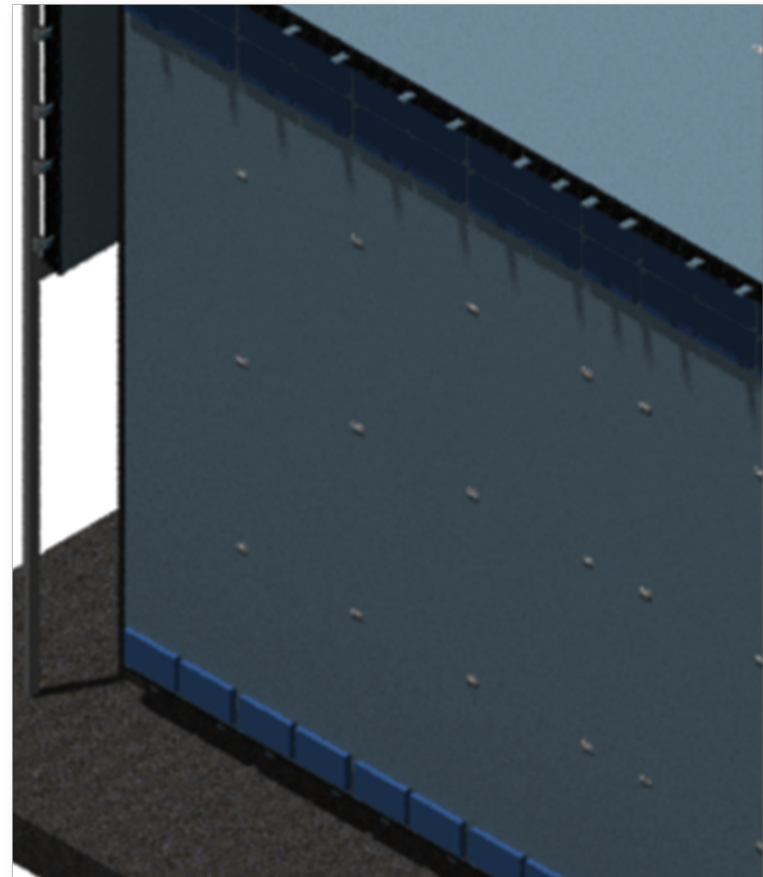
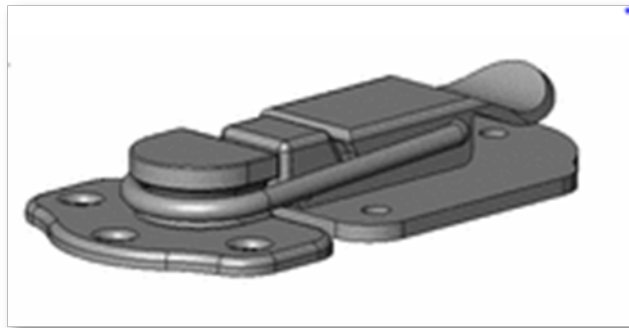
Module support structure – top and side



# Design: Side Support Structure

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We plan to ensure that the modules are flush and in the correct position by using latches attached to their sides using epoxy.

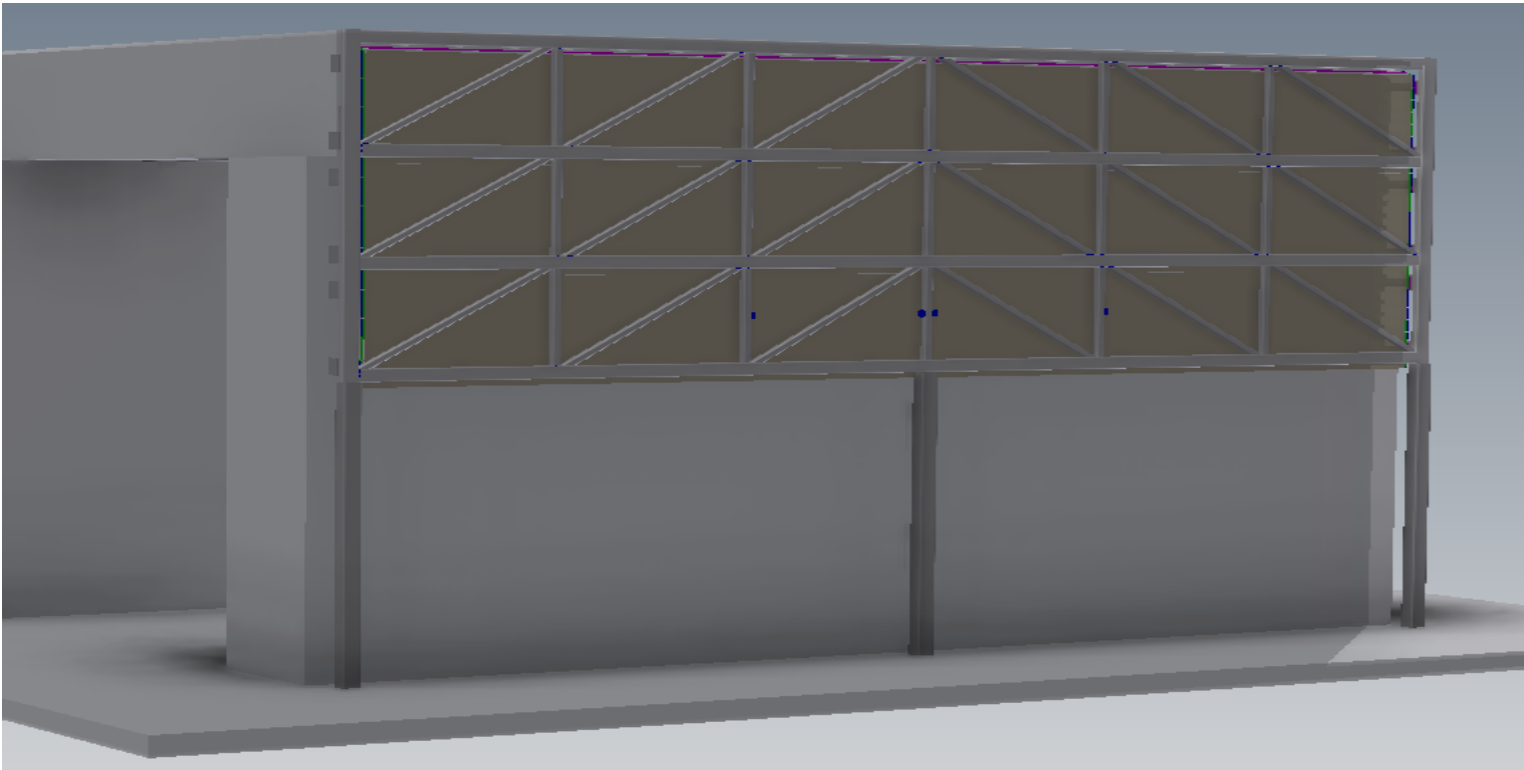




# Design: CRV-U and CRV-D

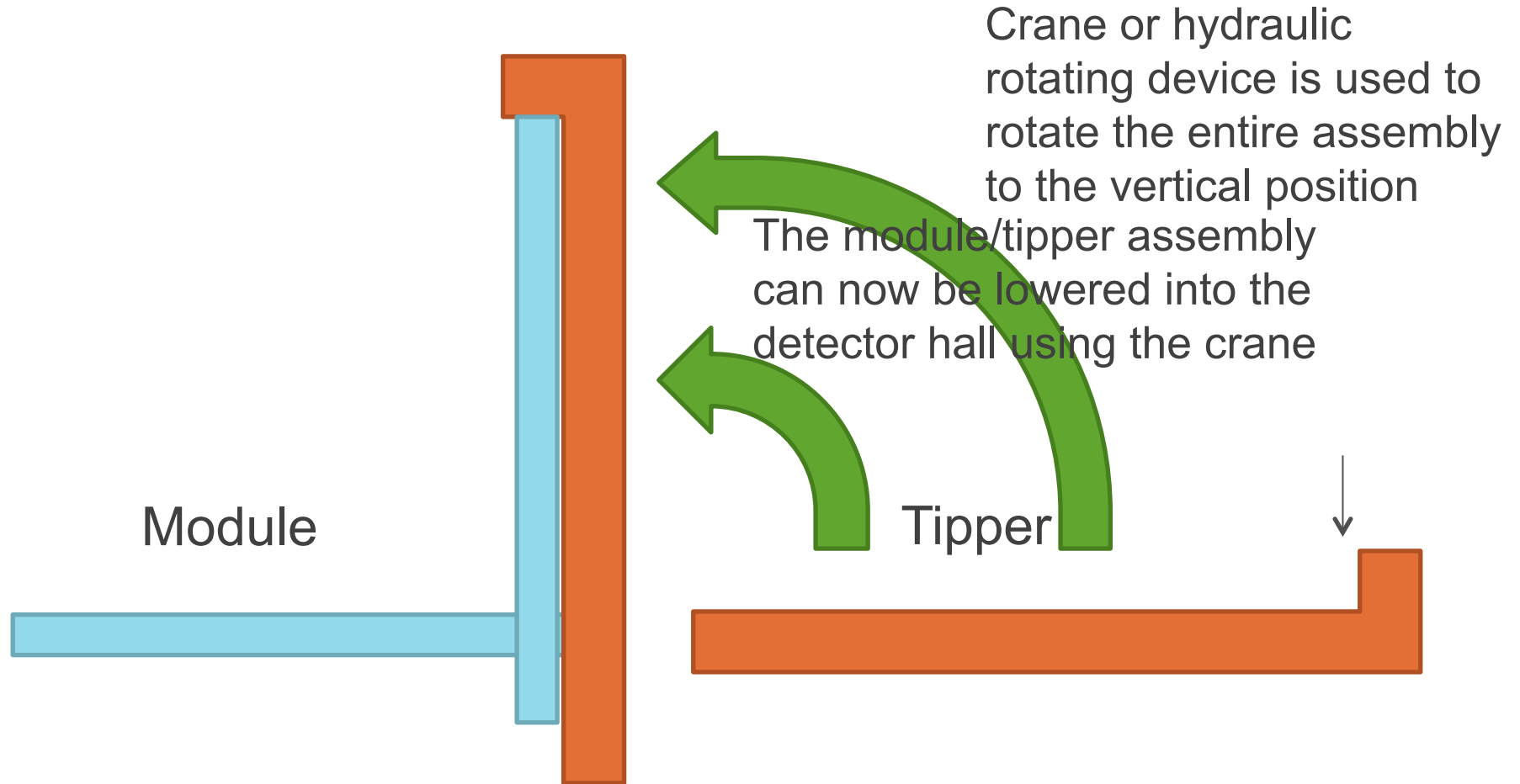
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- Strong-back supports the modules in the CRV-U and -D sectors
- Modules loaded onto the strong-back upstairs and lowered by crane into positions



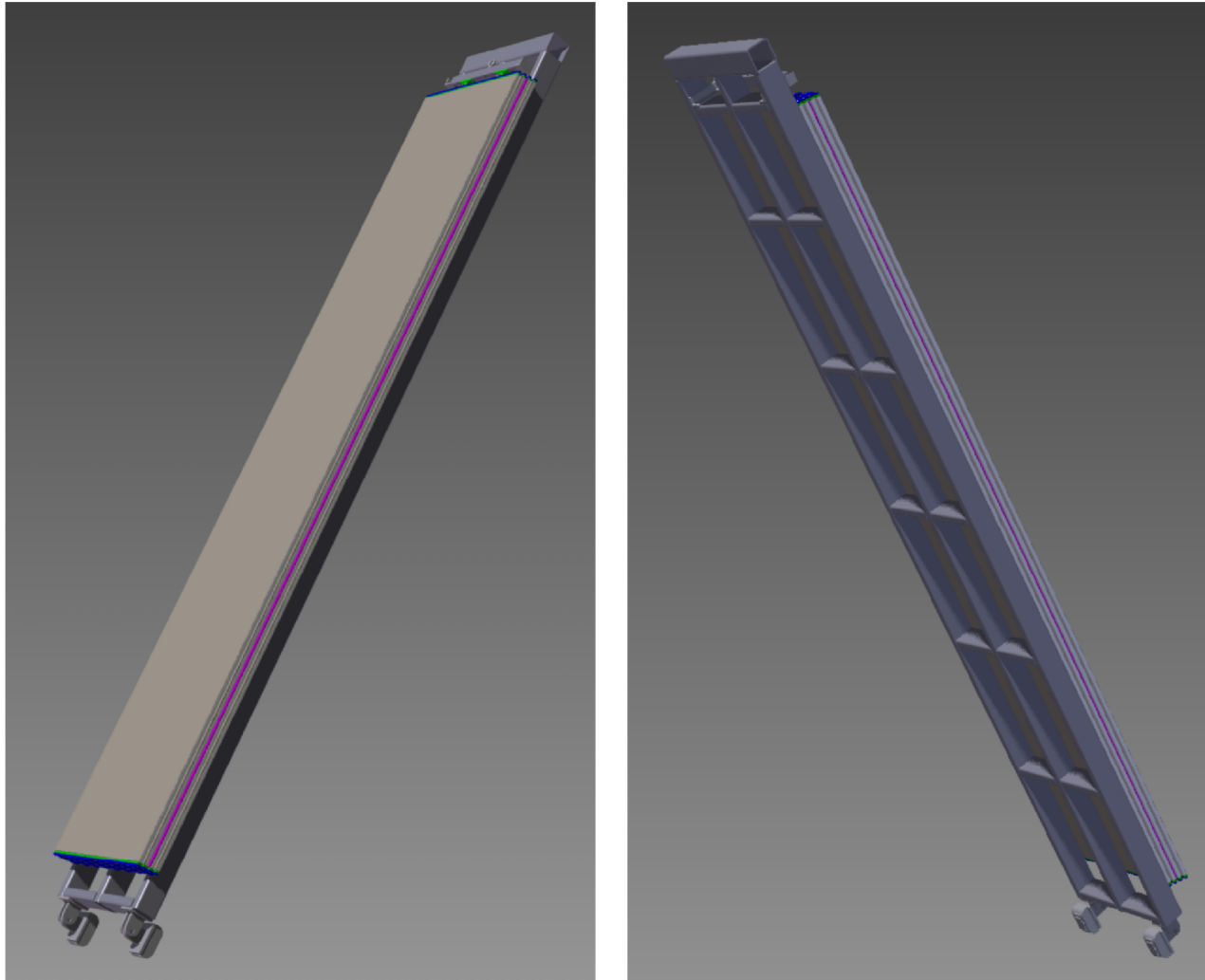
# Installation: Tipping Procedure

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# Installation: Lifting Jig

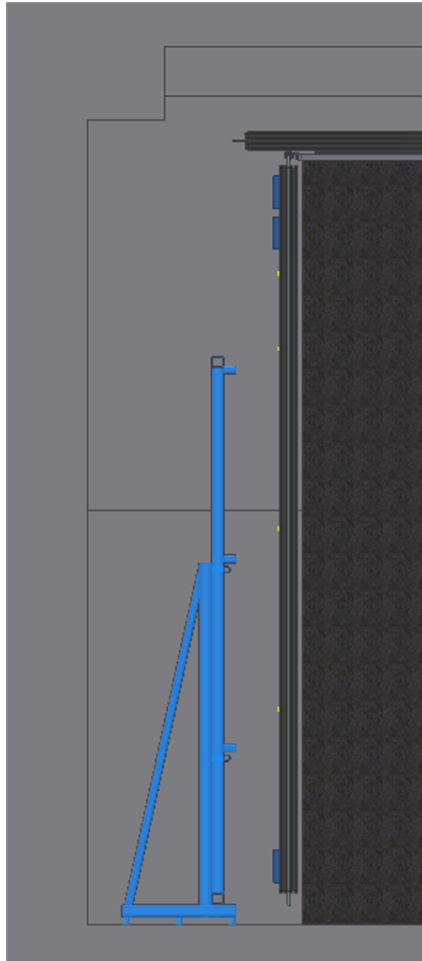
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Front and back views of module lifting jig



# Installation: Lifting Jig



The installer will be made from standard lengths of different sized square tubing, welded together to form a kind of forklift whose size would be small enough to maneuver within the confined spaces of the building. It would need to fit between the wall and the neutron shielding as well as under the cryo tube assembly.



# Installation: Side Module Mount. Procedure

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1. Attach hangers to a module and then bolt the module to the module tipper
2. Rotate the entire assembly 90 degrees using the crane and maneuver it into the correct position to be lowered onto the installer.
3. Lower the module tipper assembly onto the installer, and ensure that they have interfaced correctly before detaching the crane.
4. Using the installer, maneuver the module so that it can be lowered onto the support structure. The installer will be equipped with a jack, allowing it to raise and lower the module, and will move laterally using either tracks or rollers.
5. Lower the module onto the support structure and detach it from the module tipper.
6. Using the installer jack, lift the module tipper up and away from the module.
7. Using bolts, secure the module to the support structure.
8. Using the crane, lift the module tipper up and away from the installer, returning it to the correct position to have another module attached to it.

# Quality Assurance

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- Quality Assurance Program for the Mu2e Project Doc 677
  - Design reviews
  - Written & approved procedures
  - Worker qualifications & training
  - Inspection & testing
  - Test installation

# ES&H Issues

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- Worker Training
  - Standard FNAL rigging procedures
  - Crane & fork truck
  - Working at heights – fall protection
- JHA & Written Procedures
  - Rigging modules
  - Vacuum lifter
- ES&H Reviews

# Integration and Interfaces

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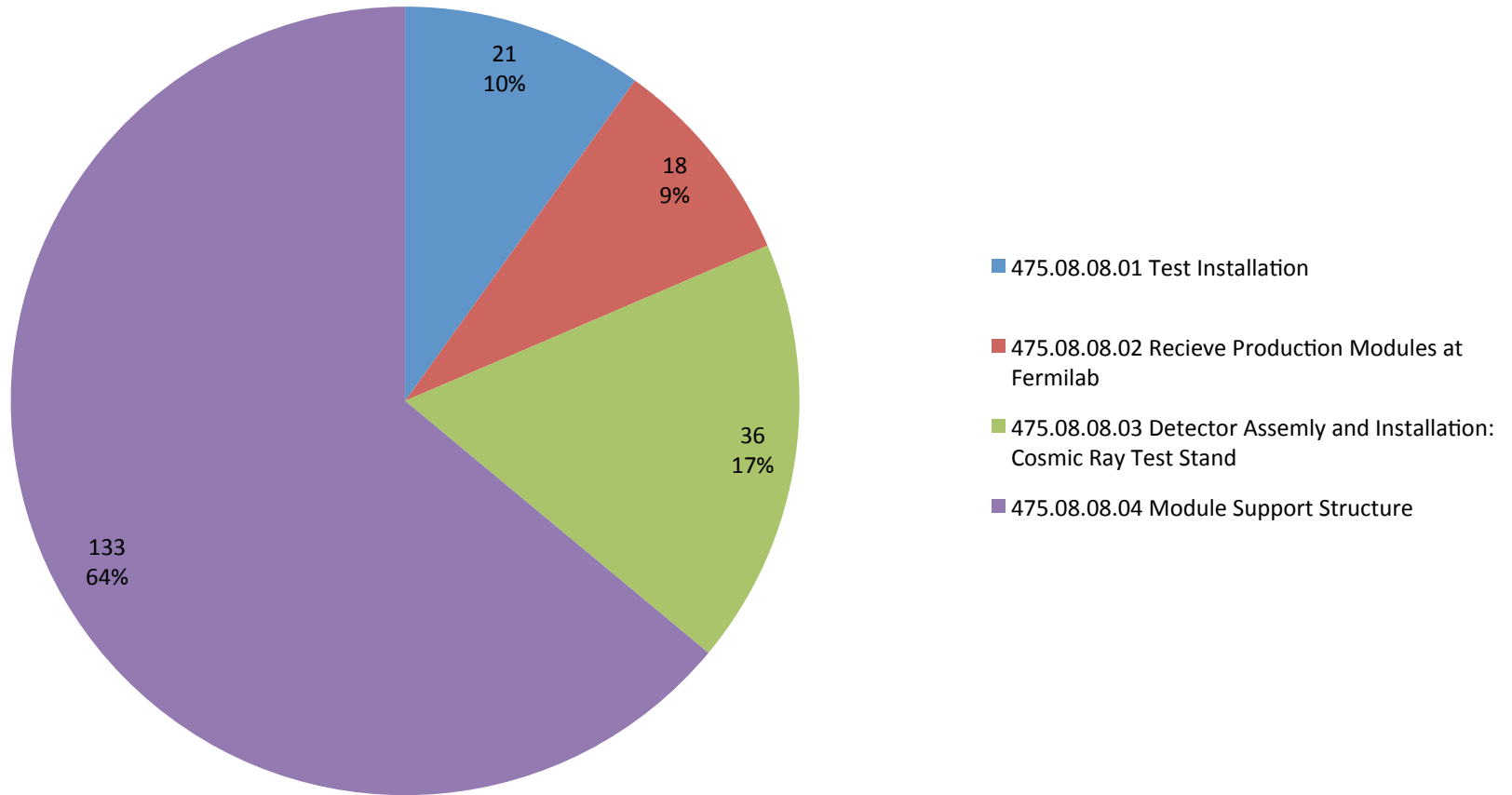
- CRV interfaces to the neutron shielding and movable end-cap
- Participation in bi-weekly integration meetings
- Formal sign-off between owners of all external interfaces as part of final design requirements
- Interfaces understood and under control
  - Reference DocDB 1551

# 8.8 Detector Assembly & Installation

	Base Cost (AY K\$)			Uncertainty (on remaining budget)	% Contingency (on remaining budget)	Total Cost
	M&S	Labor	Total			
475.08.08.01 Test installation		21	21	7	35%	28
475.08.08.02 Receive Production Modules at FNAL		18	18	6	35%	24
475.08.08.03 Cosmic Ray Test Stand	4	32	36	11	80%	47
475.08.08.04 Module Support Structure	123	10	133	40	30%	173
Grand Total Detector Assembly & Installation	127	81	208	64	35%	273

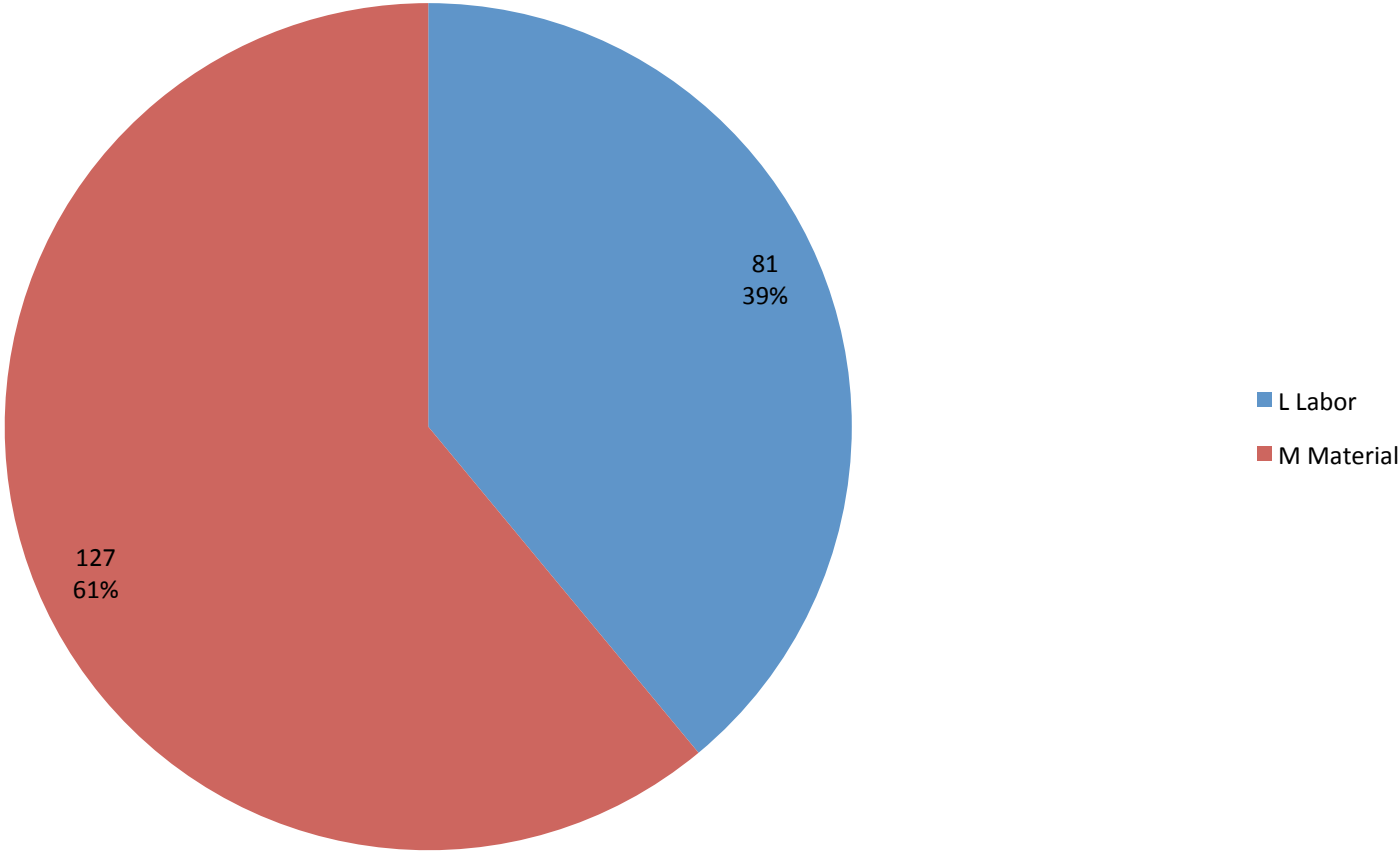
# WBS Breakdown Base cost in AY K\$

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# Resource Type Base cost in AY K\$

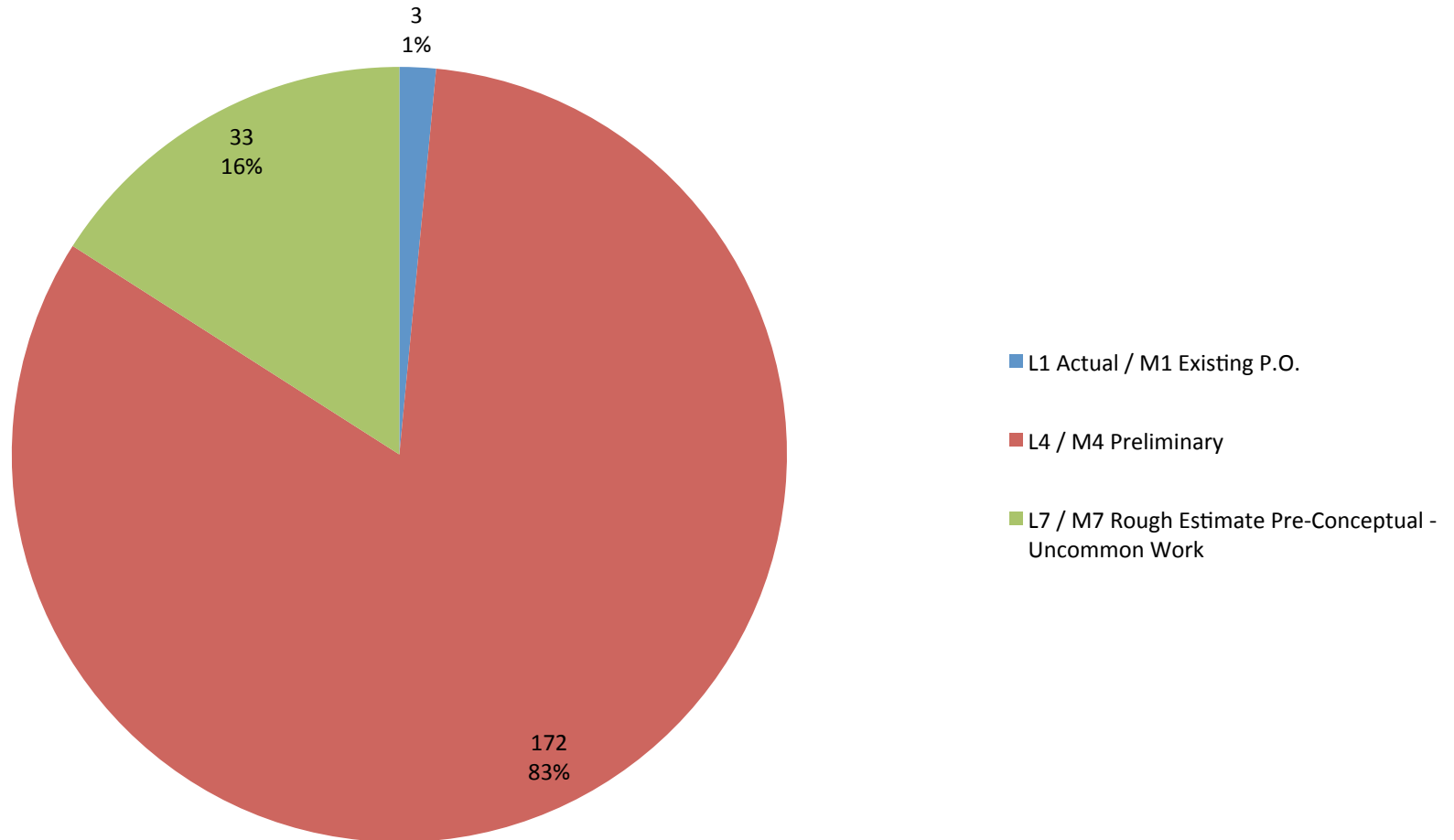
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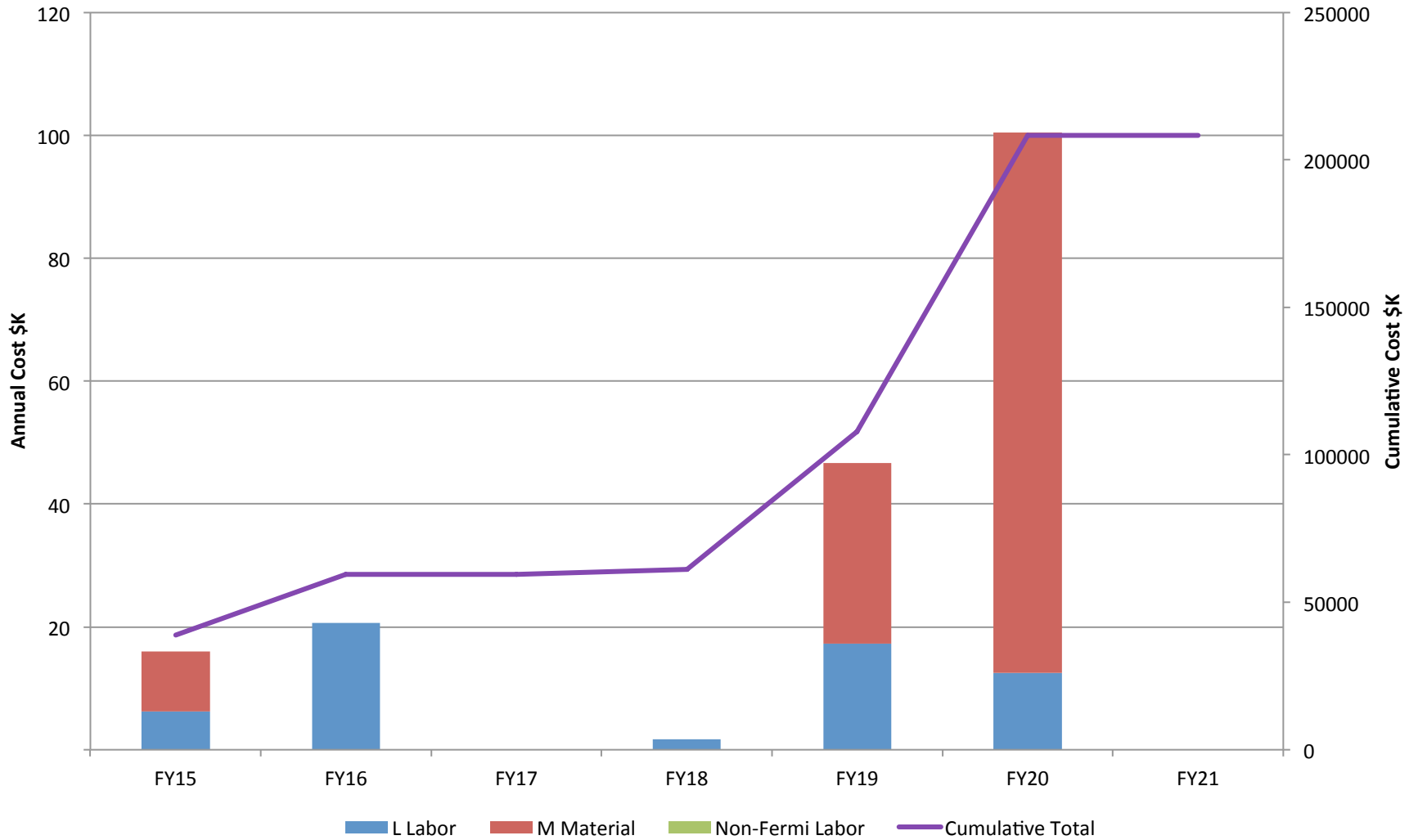


# Quality of Estimate Base cost in AY K\$

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# Labor/Material Breakdown

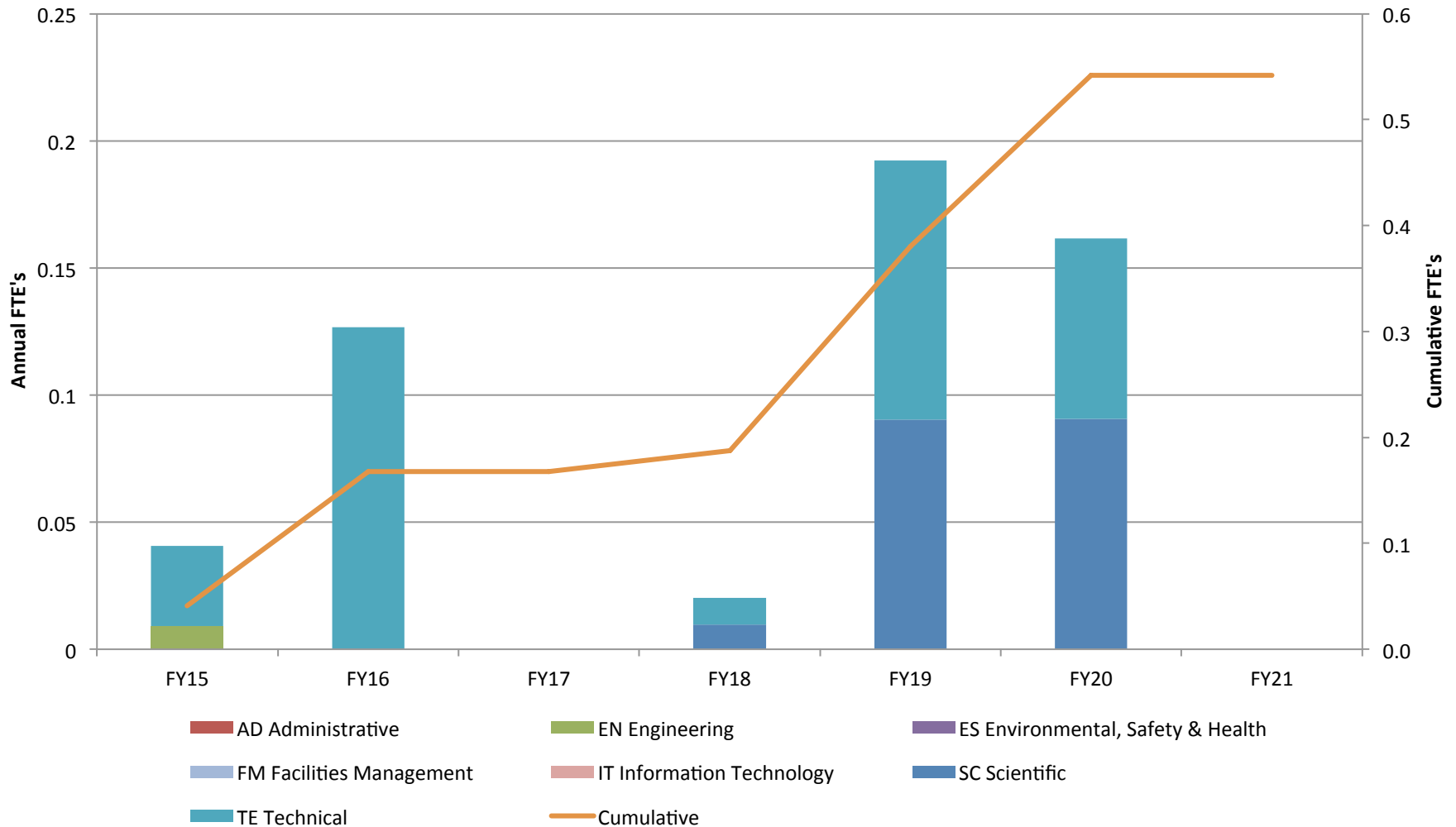


M&S estimates are based on Quotes Labor estimates are based on extensive previous experience

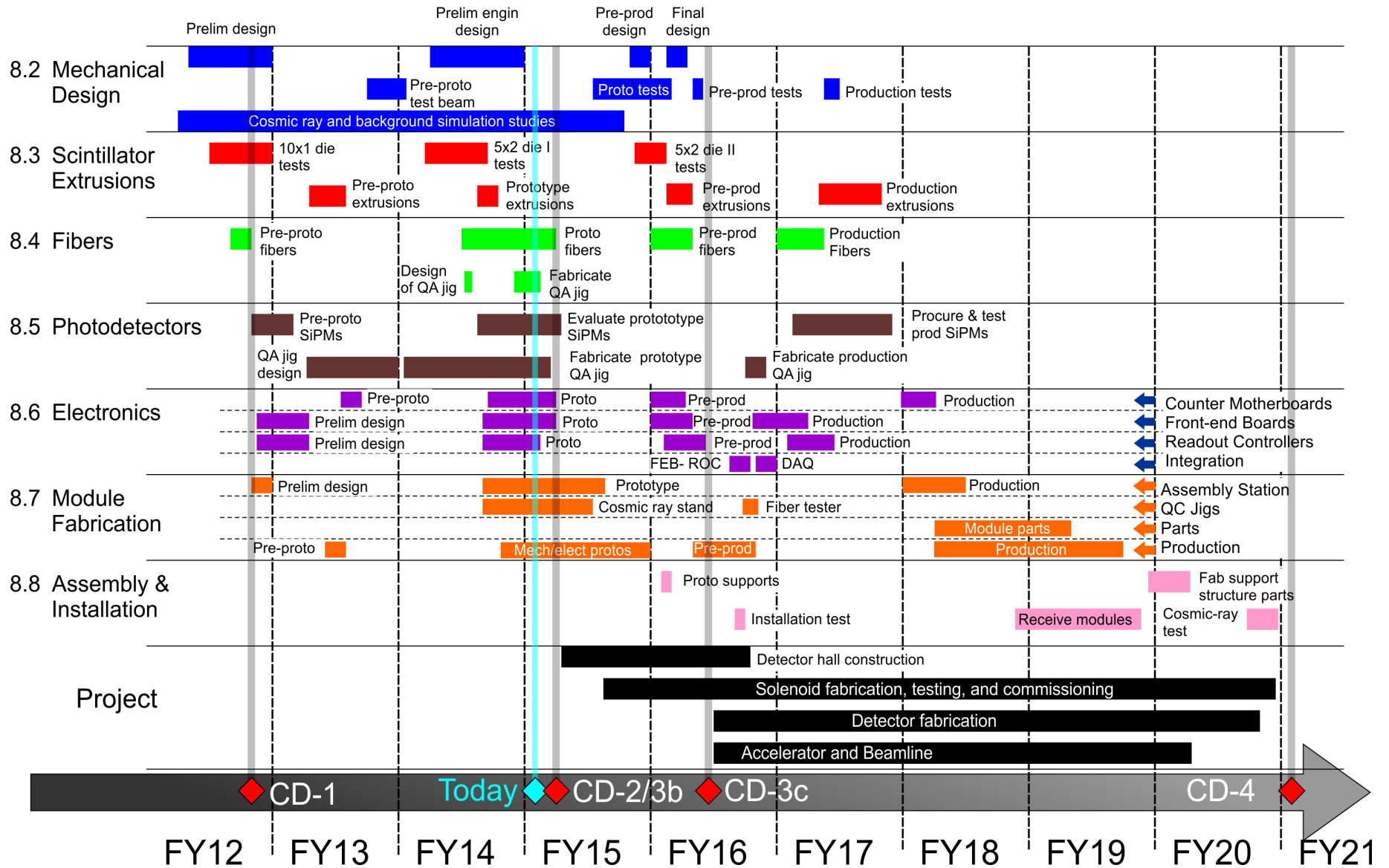
Mu2e



# FTE's by Discipline AY K\$



# Schedule



Mu2e



# Milestones

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- Side module test installation complete - 3/16/16
- 10% Production modules received at Fermilab - 11/5/18
- Production modules received at Fermilab - 8/29/19, 10/29/19, 12/2/19, 3/2/20
- Module support structure components fabricated - 12/26/19

# Remaining work before CD-3

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- What needs to be completed before design is complete?
  - Test Installation - 475.8.8.1
    - Receive two prototype side modules from module factory
    - Construct neutron shield mockup
    - Install module supports
    - Use lifting jig to install prototypes testing hardware and procedures
  - Complete engineering design - 475.08.02

# Summary

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- Installation Plan Factorized
  - Module support (on project)
  - Detector Installation and Testing (off project)
- We have a design that fully satisfies the requirements
- Installation Requirements are well understood and achievable
- Installation plan, cost, and schedule are well understood
- All interfaces are identified and defined