



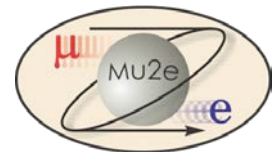
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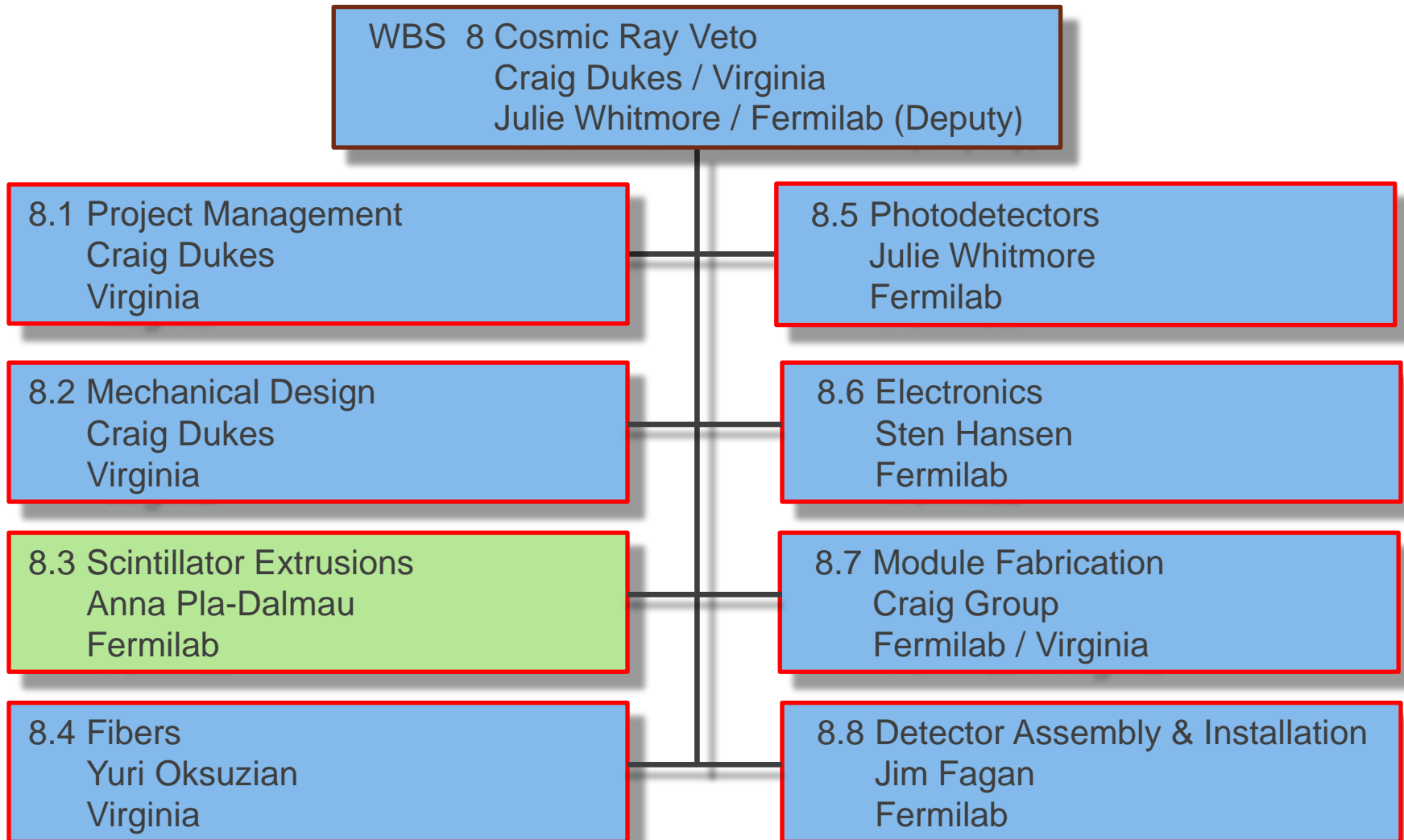
# Mu2e Cosmic Ray Veto

## 8.3 Scintillator Extrusions

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# Organizational Breakdown



# Organizational Breakdown

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## WBS 8.3 Scintillator Extrusions Ann Pla-Dalmau / Fermilab

### 8.3.1 Die Design and Procurement

This task covers the design of the die needed for the production of the scintillation counters, its procurement and testing through the fabrication of prototype extrusions. We assume that two dies will be needed: a prototype and a production die.

### 8.3.2 Scintillator Extrusion Production

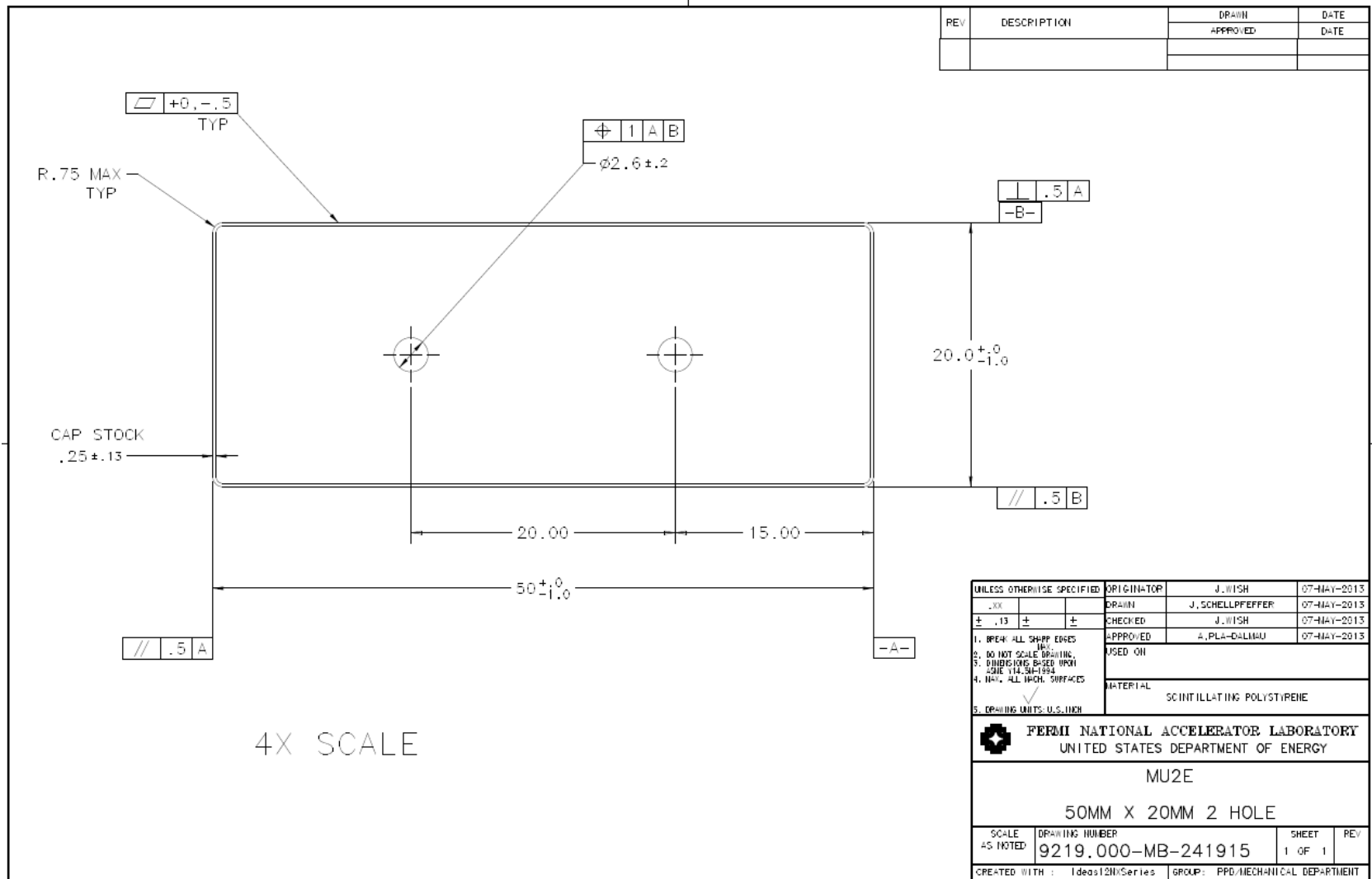
This task covers the procurement of the scintillator extrusions for prototype tests, pre-production tests, and production of the cosmic ray veto. It includes: (1) the procurement of the materials, (2) the fabrication of the extrusions, (3) the quality assurance, and (4) the shipping of the extrusions to the module factory.

# Requirements

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- Extrude plastic scintillator for Cosmic Ray Veto – FNAL/NICADD Extrusion Line Facility:
  - Blue emitting plastic scintillator:
    - Polystyrene - DOW STYRON 665 W
    - Dopants - 1% PPO + 0.03% POPOP – Curtiss Labs.
    - 15%  $\text{TiO}_2$  in polystyrene coating (0.25 mm)
  - Cross-section – 5 cm x 2 cm with 2 holes for WLS fibers
  - Amount – 20 metric tones

# Design



# Changes since CD-1

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- The cross-section of the scintillator bar has changed:
  - From CD-1: 10 cm x 1 cm with 4 holes
  - To CD-2 : 5 cm x 2 cm with 2 holes

# Value Engineering since CD-1

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- Performed extrusion, mechanical and test-beam tests with existing die of cross-section 4 cm x 2 cm with 3 holes and adapted to produce strips with just 2 holes.
- Worked with coating manufacturer to keep the cost of TiO<sub>2</sub>/PS coating unchanged.

# Performance

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- Extruded a 5 cm x 2 cm profile with 2 fairly round and consistent holes.
- Improved  $\text{TiO}_2/\text{PS}$  coating thickness uniformity
- New  $\text{TiO}_2/\text{PS}$  coating with better extrudability in a wide part



# Remaining work before CD-3

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- Reduce gaps between bars:
  - Address concavity of top and bottom surfaces
  - Minimize round corners

# Quality Assurance

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- Perform QC on extruded scintillator strip
  - Check light yield with radioactive source on test samples
  - Check dimensions on test samples
- Document Quality Control process
- QA: Check purity of raw materials – PS and dopants

## Configuration Management:

- Use labels with barcodes for strips and test samples
- Create a database of dimensions and light yield scanning the labels on the test samples
- Document deliveries and usage of raw materials

# Risks / Opportunities

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## Risks (MINOR!):

- Quality of polystyrene pellets
- Quality of titanium dioxide coating
- Equipment malfunction or breakdown

Experience! FNAL/NICADD Extrusion Line Facility has prepared extruded scintillator for many experiments.

## Opportunities:

- Go to a wider extrusion to increase tolerances on the module layer offset distance
- Reduces numbers of fibers, SiPMs, extrusions, and electronics channels

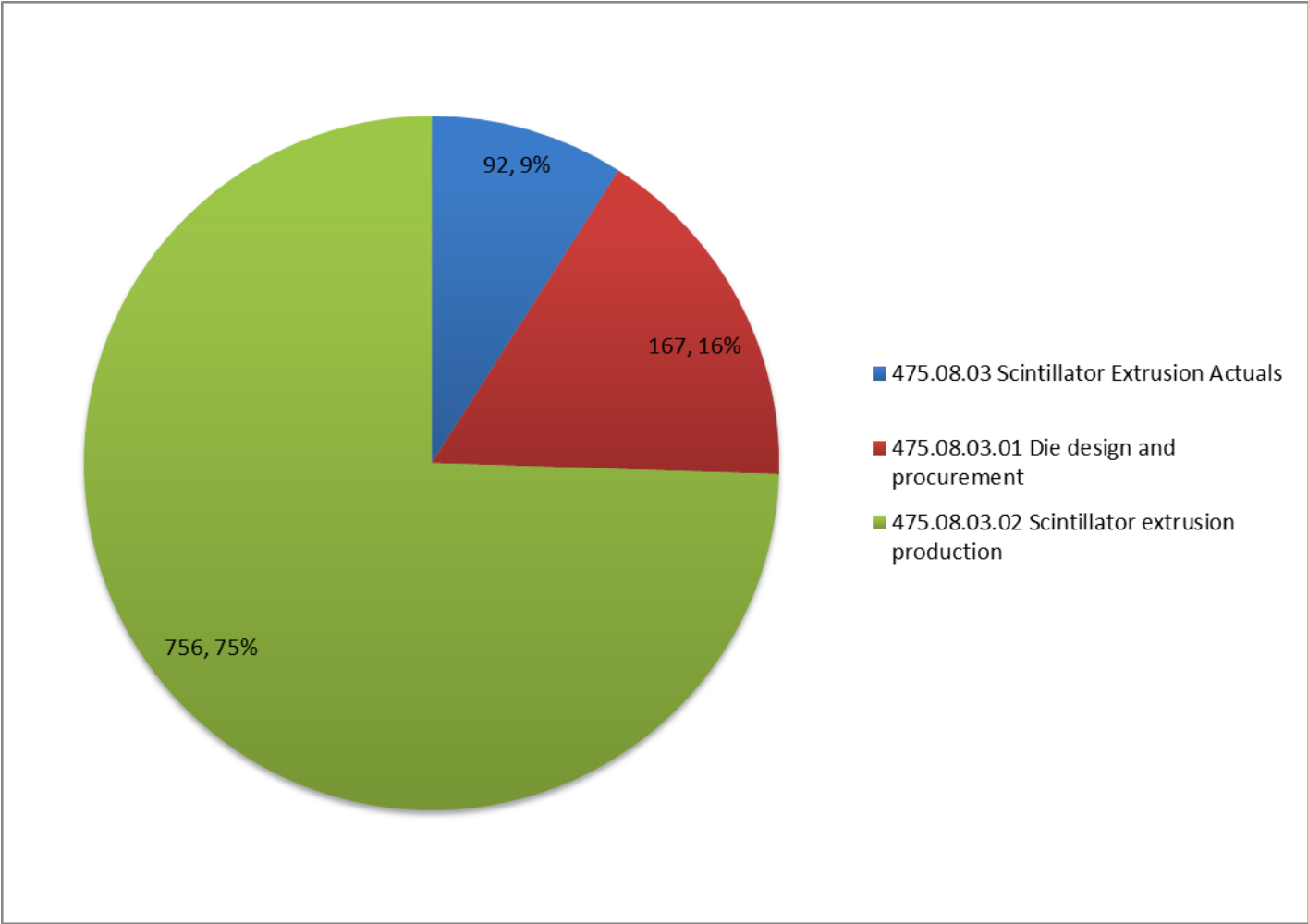
- Follow established safety procedures at Fermilab
- Follow established extrusion procedures at Fermilab

# Cost Table

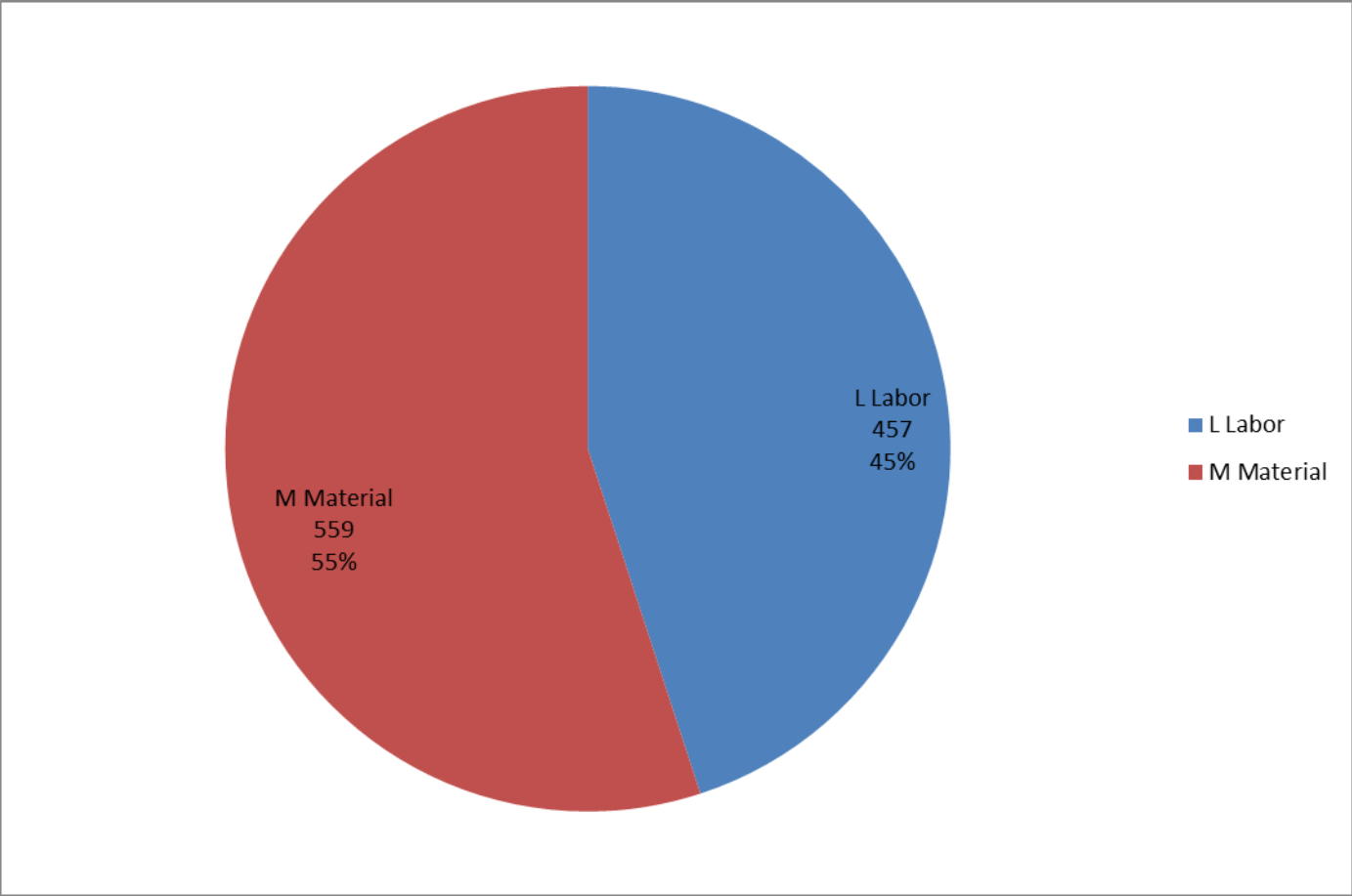
	Base Cost (AY k\$)			Estimate Uncertainty (on remaining costs)	% Contingency on ETC	Total Cost
	M&S	Labor	Total			
475.08 Cosmic Ray Veto						
475.08.03 Scintillator extrusions						
475.08.03 Scintillator extrusions Actuals	58	33	92			92
475.08.03.01 Die design and procurement	99	68	167	37	22%	204
475.08.03.02 Scintillator extrusion production	401	356	756	169	22%	926
Grand Total	559	457	1,015	206	22%	1,221

Note: Labor FNAL only.

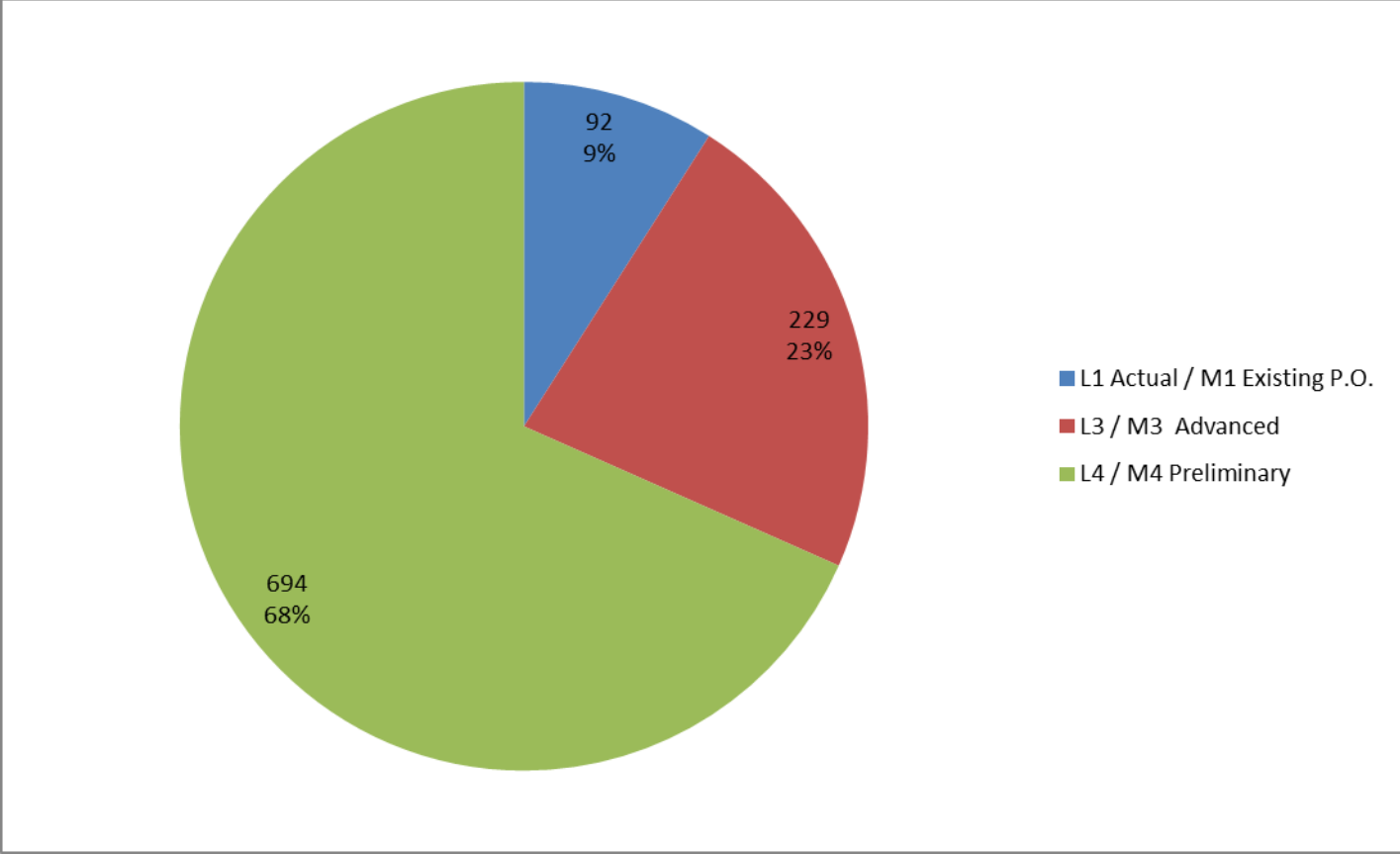
# Cost Breakdown: Sub-Project



# Cost Breakdown: Resource Type

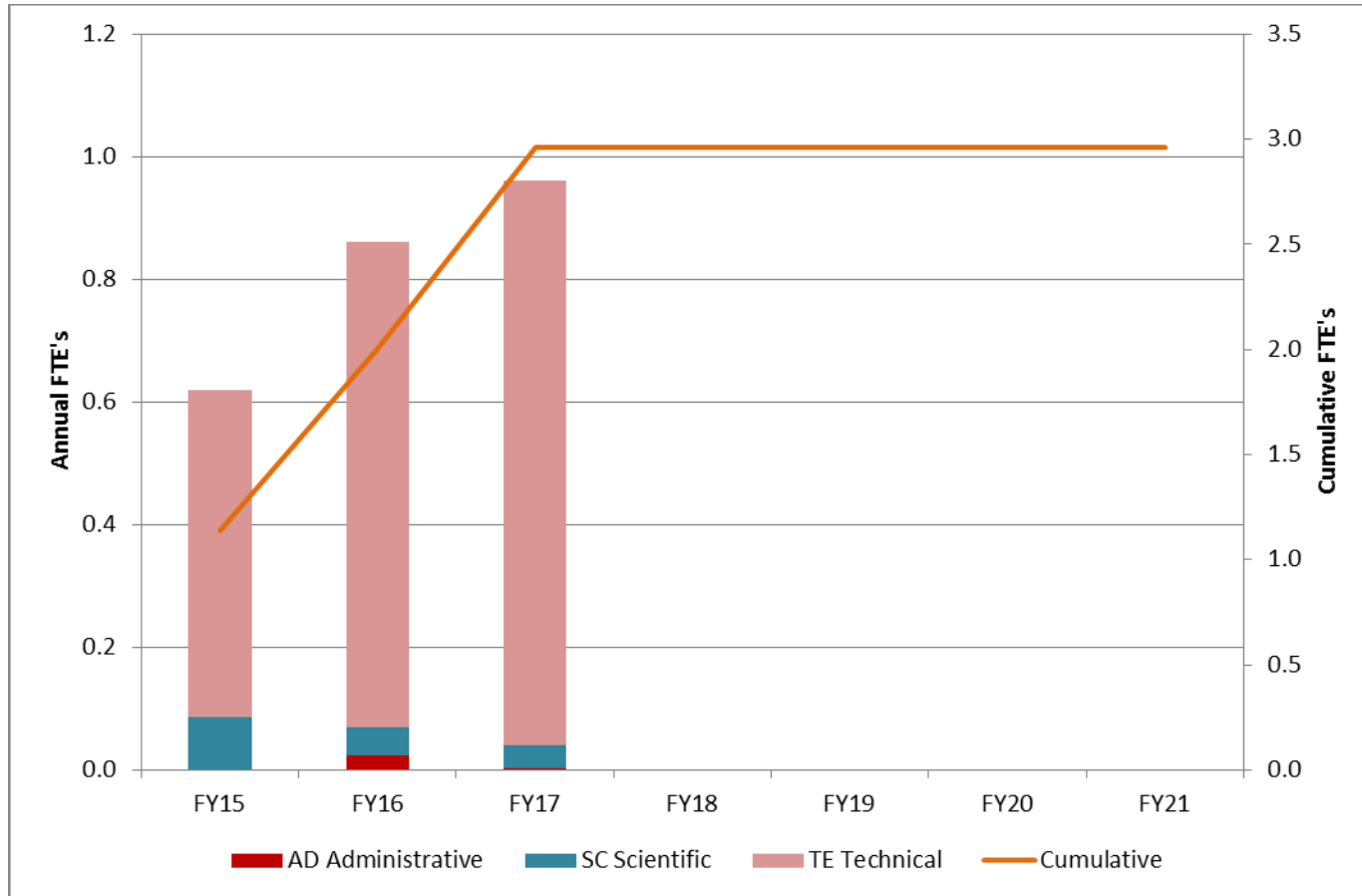


# Quality of Estimate





# Labor Resources by FY

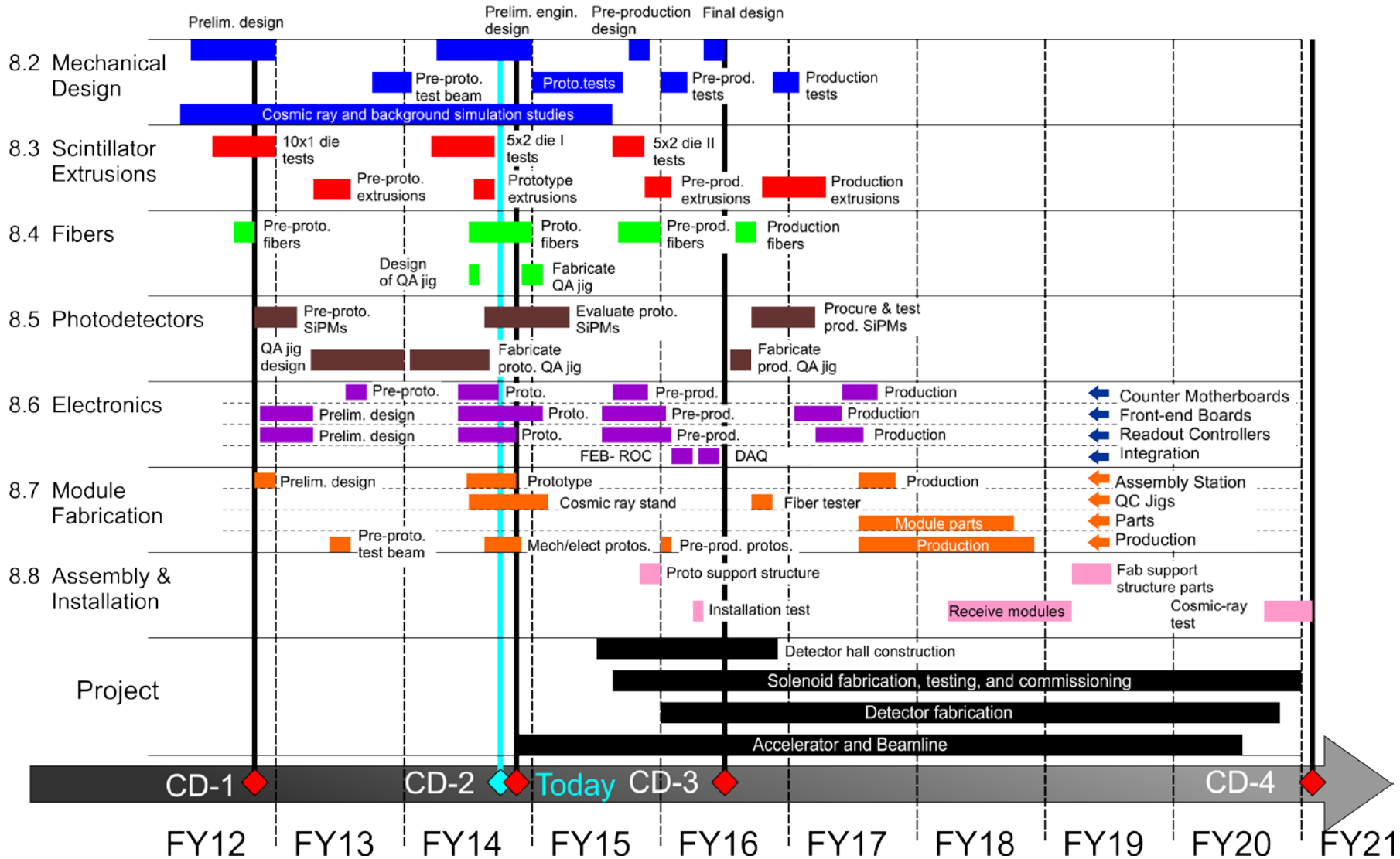


# Major Milestones

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- Aug 2015: Final die design approved
- Jul 2016: PO issued for materials for production extrusions fabrication
- Feb 2017: Production extrusions complete

# Schedule



# Summary

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- FNAL/NICADD Extrusion Line Facility with co-extruder to deliver the white reflective coating has been in operation since 2005.
- Mu2e CRV Die for “5 cm x 2 cm – 2 holes” strip has been tested.
- About 500 m of extruded scintillator bars were just sent to University of Virginia for testing.