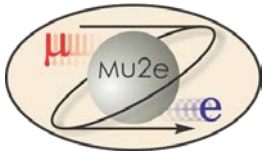
Fermilab

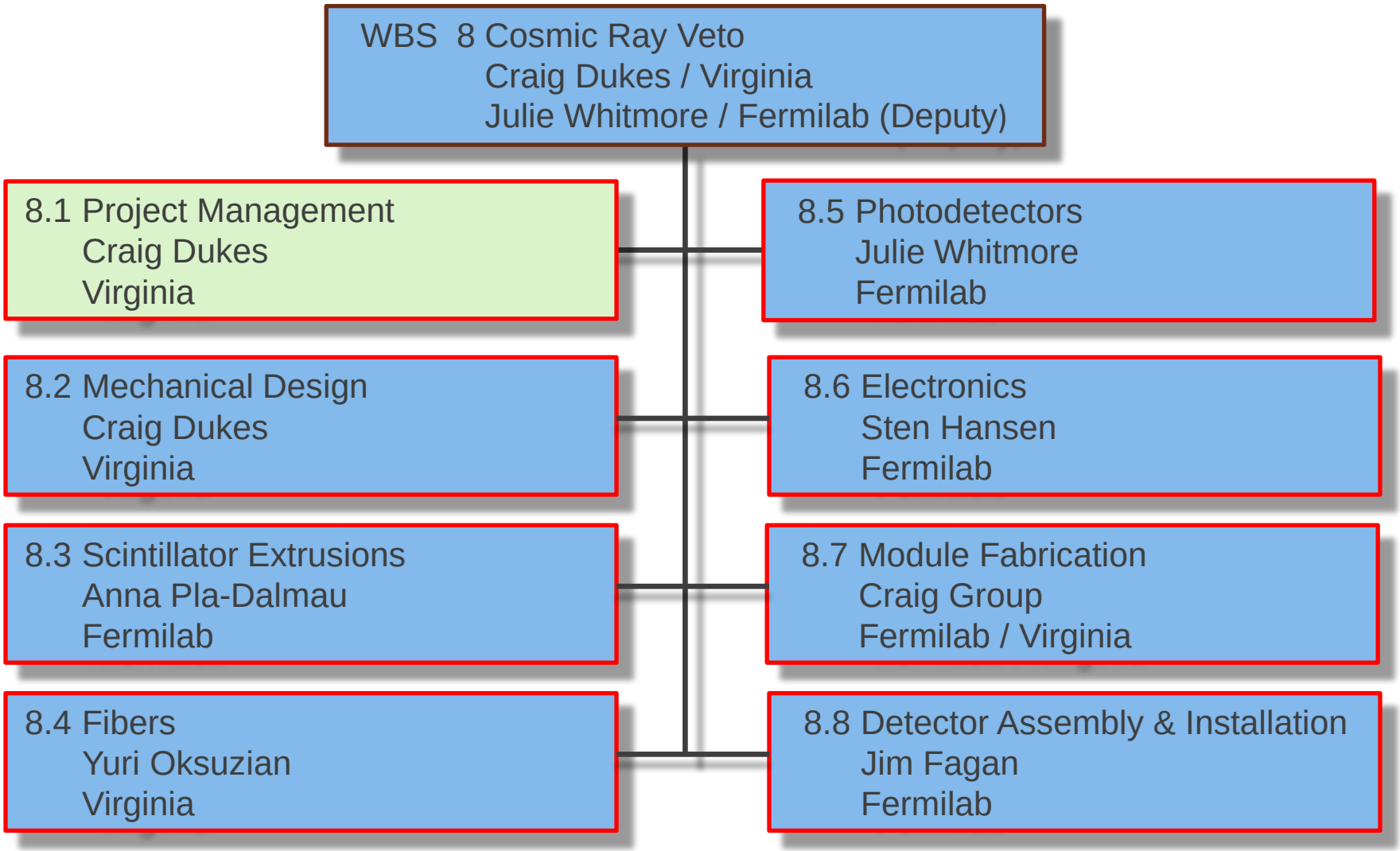
U.S. DEPARTMENT OF ENERGY Office of Science

Mu2e Cosmic Ray Veto
8.1 Project Management



E. Craig Dukes
Level 3 Manager
July 8, 2014

Organizational Breakdown

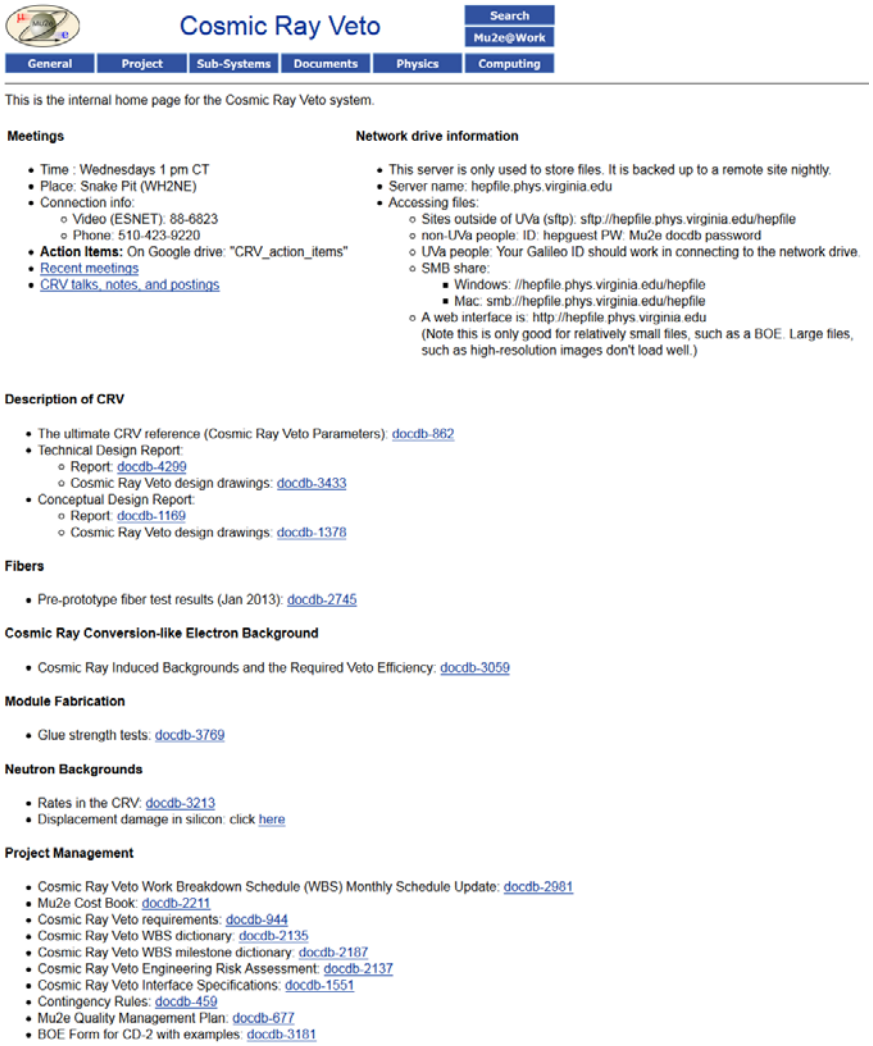


Organizational Breakdown

Cosmic Ray Veto WBS Structure				
L3	L4	Title	CAM	BOE #
8.1		**Project Management (Dukes)**	**Dukes**	
	8.1.1	Conceptual Design (Post CD-0; OPC)		
1	8.1.2	Preliminary & Final Design		3902
2	8.1.3	Implementatoin & Close-out		3903
8.2		**Mechanical Design (Dukes)**	**Dukes**	
3	8.2.1	Detector Design		3904
4	8.2.2	Fabricate and Test Counter Prototypes		3905
5	8.2.3	Cosmic Ray Veto Simulations		3906
8.3		**Scintillator Extrusions (Pla-Dalmau)**	**Pla-Dalmau**	
6	8.3.1	Die Design and Procurement		3907
7	8.3.2	Scintillator Extrusion Production		3908
8.4		**Fibers (Oksuzian)**	**Dukes**	
8	8.4.1	Waveshifting Fiber Procurement		3909
9	8.4.2	Waveshifting Fiber Quality Assurance Design and Fabrication		3910
8.5		**Photodetectors (Whitmore)**	**Whitmore**	
10	8.5.1	Photodetector Procurement		3911
11	8.5.2	Photodetector Quality Assurance Design and Fabrication		3912
8.6		**Electronics (Hansen)**	**Dukes**	
12	8.6.1	Counter Mother Boards		3913
13	8.6.2	Front End Boards		3914
14	8.6.3	Readout Controllers		3915
15	8.6.4	Integration with DAQ		3928
8.7		**Module Fabrication (Group)**	**Group**	
16	8.7.1	Design and Fabricate Assembly Station		3916
17	8.7.2	Assembly Station Quality Assurance Design and Fabrication		3917
18	8.7.3	Fabrication of Module Parts		3918
19	8.7.4	Module Production, Testing, and Shipping		3919
20	8.7.5	Breakdown of Module Factory		3920
8.8		**Detector Assembly and Installation (Fagan)**	**Dukes**	
21	8.8.1	Test Installation		3921
22	8.8.2	Receive Production Modules at Fermilab		3922
23	8.8.3	Cosmic Ray Test Stand		3923
24	8.8.4	Module Support Structure		3924
25	8.8.5	Detector Installation and Testing		3925

How Do We Share Information?

- Weekly CRV meetings
- Permanent repository: Mu2e docdb
- Temporary repository: Network drive hosted at UVa with web interface
- CRV webpage has important links
- Google doc on Google Drive for action items



Cosmic Ray Veto

Search | Mu2e@Work

General | Project | Sub-Systems | Documents | Physics | Computing

This is the internal home page for the Cosmic Ray Veto system.

Meetings

- Time : Wednesdays 1 pm CT
- Place: Snake Pit (WH2NE)
- Connection info:
  - Video (ESNET): 88-6823
  - Phone: 510-423-9220
- **Action Items:** On Google drive: "CRV_action_items"
- Recent meetings
- CRV talks, notes, and postings

Network drive information

- This server is only used to store files. It is backed up to a remote site nightly.
- Server name: hepfile.phys.virginia.edu
- Accessing files:
  - Sites outside of UVa (sftp): sftp://hepfile.phys.virginia.edu/hepfile
  - non-UVa people: ID: hepguest PW: Mu2e docdb password
  - UVa people: Your Galileo ID should work in connecting to the network drive.
  - SMB share:
    - Windows: //hepfile.phys.virginia.edu/hepfile
    - Mac: smb://hepfile.phys.virginia.edu/hepfile
  - A web interface is: http://hepfile.phys.virginia.edu
    (Note this is only good for relatively small files, such as a BOE. Large files, such as high-resolution images don't load well.)

Description of CRV

- The ultimate CRV reference (Cosmic Ray Veto Parameters): docdb-862
- Technical Design Report:
  - Report: docdb-4299
  - Cosmic Ray Veto design drawings: docdb-3433
- Conceptual Design Report:
  - Report: docdb-1169
  - Cosmic Ray Veto design drawings: docdb-1378

Fibers

- Pre-prototype fiber test results (Jan 2013): docdb-2745

Cosmic Ray Conversion-like Electron Background

- Cosmic Ray Induced Backgrounds and the Required Veto Efficiency: docdb-3059

Module Fabrication

- Glue strength tests: docdb-3769

Neutron Backgrounds

- Rates in the CRV: docdb-3213
- Displacement damage in silicon: click here

Project Management

- Cosmic Ray Veto Work Breakdown Schedule (WBS) Monthly Schedule Update: docdb-2981
- Mu2e Cost Book: docdb-2211
- Cosmic Ray Veto requirements: docdb-944
- Cosmic Ray Veto WBS dictionary: docdb-2135
- Cosmic Ray Veto WBS milestone dictionary: docdb-2187
- Cosmic Ray Veto Engineering Risk Assessment: docdb-2137
- Cosmic Ray Veto Interface Specifications: docdb-1551
- Contingency Rules: docdb-459
- Mu2e Quality Management Plan: docdb-677
- BOE Form for CD-2 with examples: docdb-3181

A Few Notes

- Spares are off-project.
  - Put into 475.10
  - They are identified as such in our BOEs
  - This sometimes leads to curious gaps between activities that should be contiguous in the Gantt chart
- Installation off project (WBS 8.8.5)
- 475.8.9 is where OPC costs have been rolled up
- Baseline start date is May 1, 2014
- Known problems with P6 / BOEs are itemized in docdb-4321
  - Most minor: L4 should be M4, title in P6 should be changed, etc.
  - 8.5 sometimes called “Photodetectors”, sometimes “Silicon Photomultipliers (SiPMs)”
  - Only major problem 8.3.2.1235: *Fabrication of production extrusions (Spares) - Labor* 80 hrs → 320 hrs. Note: this is off project.
- Two major resources:
  - TDR (docdb-4299)
  - crv_parameters.xlsx (docdb-862): has every important number

Design: External Review

- We had a day-long external review of: (1) design, (2) photodetectors, (3) electronics, and (4) module fabrication.
- Reviewers: Jim Freeman (Fermilab), Karen Kephart (Fermilab), Iouri Musienko (Notre Dame), Dave Pushka (Fermilab), and Sergey Los (Fermilab).
- Findings are written up in docdb-4250.
- No major issues with either design and plan.

Plan for CD2

- Simulations
  1. Refine the cosmic-ray background simulation to: (1) model changes in the detector hall design, (2) incorporate improvements in the tracking algorithm, and (3) speed it up to allow determine the required position dependence of the CRV efficiency.
  2. Refine and complete the neutron background rate estimates — Done
- Complete preliminary counter and module design — Done
- Fabricate prototype extrusions
  1. Measure their flatness and curvature ("banana") to determine gap size — Done
- Fabricate prototype counters:
  1. Measure their photoelectron yield — Done
  2. Measure their neutron efficiency — Postponed: not critical
- Evaluate SiPMs — First round done: new models ordered
- Fabricate prototype front-end electronics boards — Underway: awaited new rate estimate
- Module fabrication
  1. Fabricate a mockup module to test and optimize fabrication procedures — Done
  2. Fabricate and test working module with electronics: "vertical slice test" — Postponed
- QA/QC: determine procedures, procure free equipment, and design fabrication and testing equipment — Underway
- Value management — Always

8.1 Project Management Activities

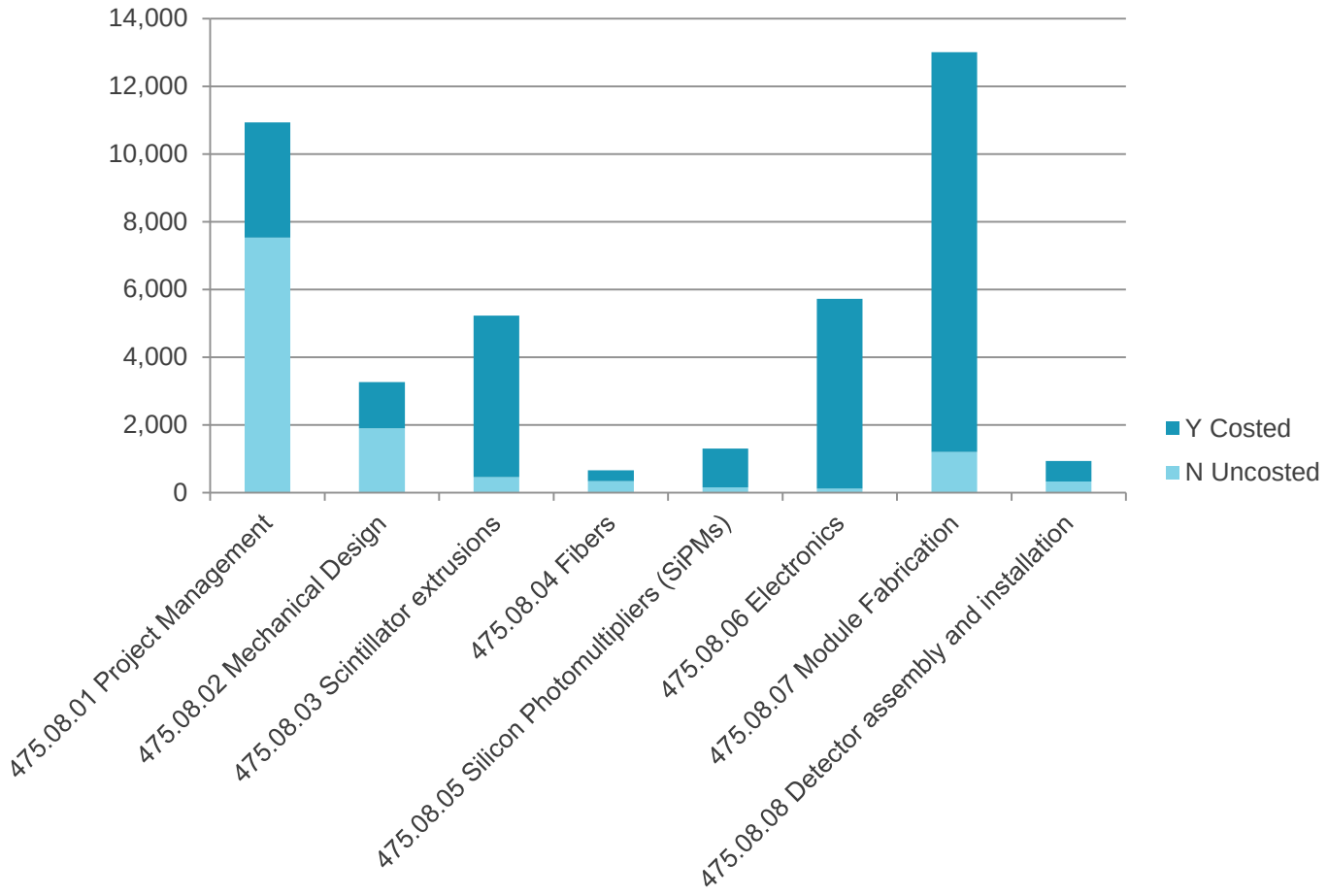
- Project planning.
- Scheduling.
- Costing.
- Integration and maintenance of the fabrication databases
- Miscellaneous management activities.
- Travel to Fermilab for the L2 head of the cosmic ray veto group.
- Partial support for L3 managers.
- Resources are generally assigned as level of effort.

Cost Table: CRV

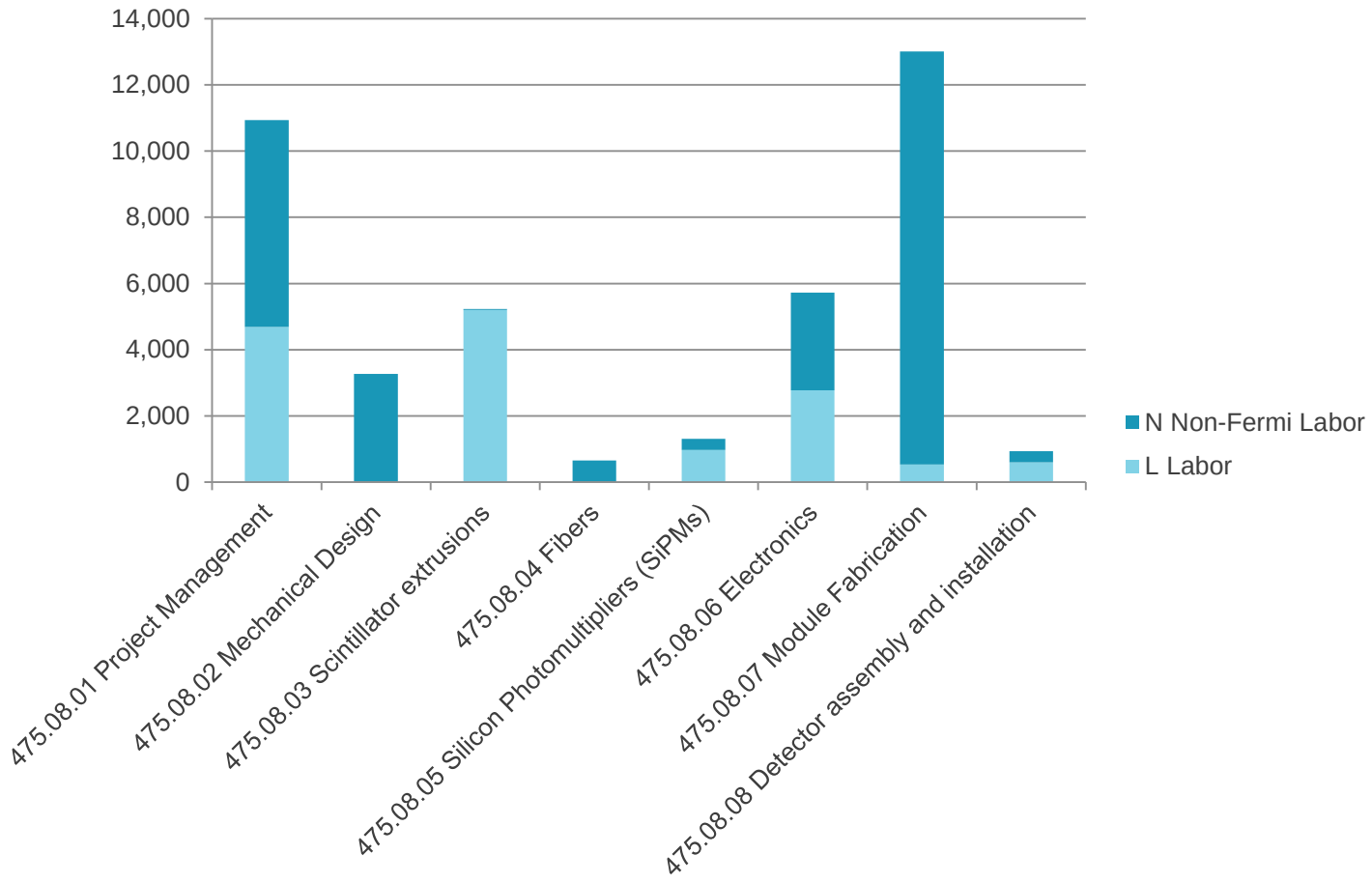
	M&S	Labor	Base Cost	Estimate Uncertainty	% Contingency on ETC	Total
475.08.01 Project Management	273	178	452	75	20%	526
475.08.02 Mechanical Design	136	3	139	24	29%	163
475.08.03 Scintillator extrusions	559	457	1,015	206	22%	1,221
475.08.04 Fibers	455		455	105	24%	559
475.08.05 Silicon Photomultipliers (SiPMs)	460	306	766	188	36%	954
475.08.06 Electronics	1,312	406	1,718	509	32%	2,227
475.08.07 Module Fabrication	1,460	16	1,476	462	34%	1,938
475.08.08 Detector assembly and installation	124	80	204	63	35%	267
475.08.09 Cosmic Ray Veto Conceptual Design/R&D	258	252	511	0	0%	511
Risk Based Contingency				323		323
Total	5,036	1,698	6,735	1,955	36%	8,690

Note: Labor FNAL only.

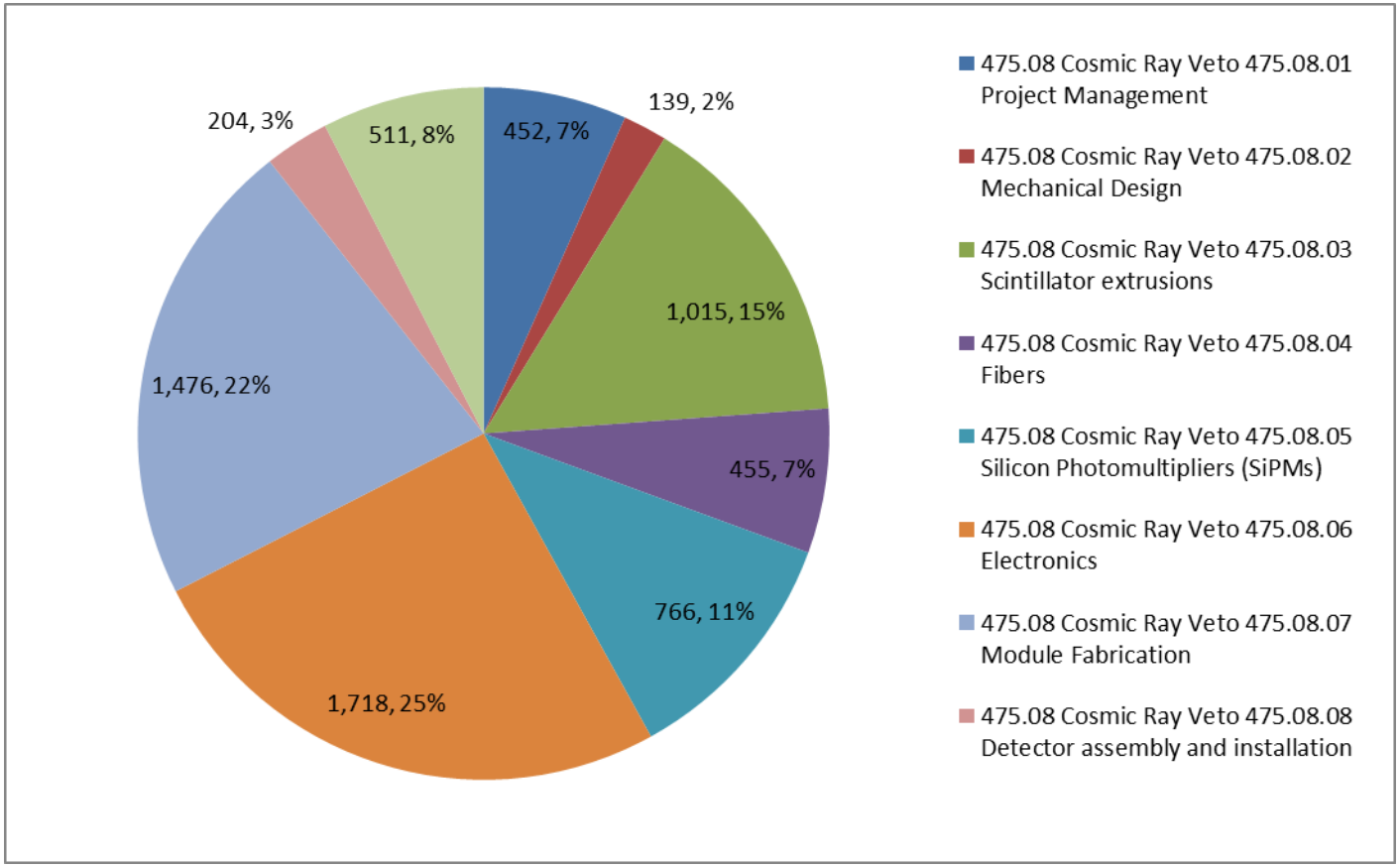
Costed / Uncosted Labor by Hours



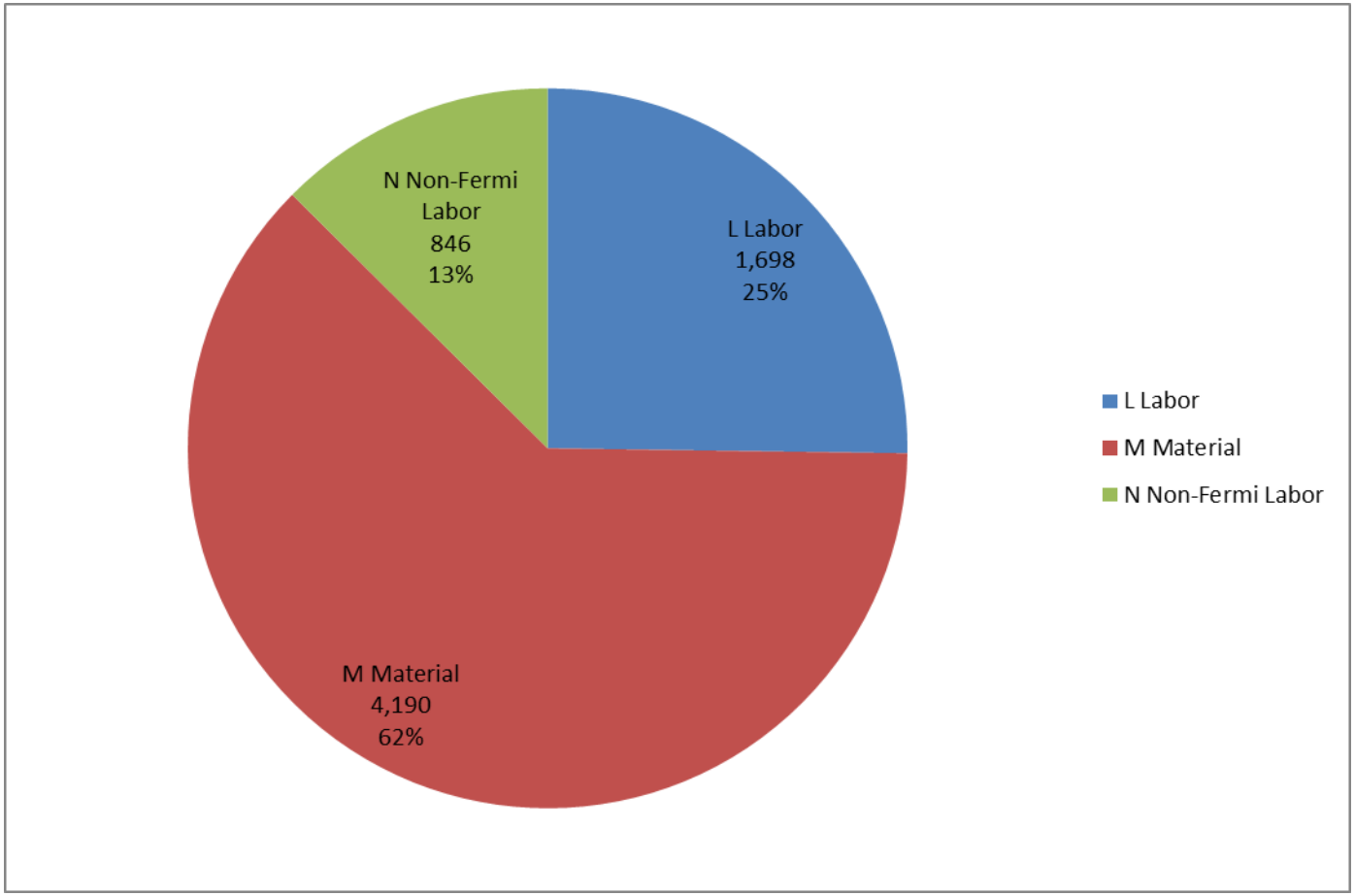
Fermilab / non-Fermilab Labor by Hours



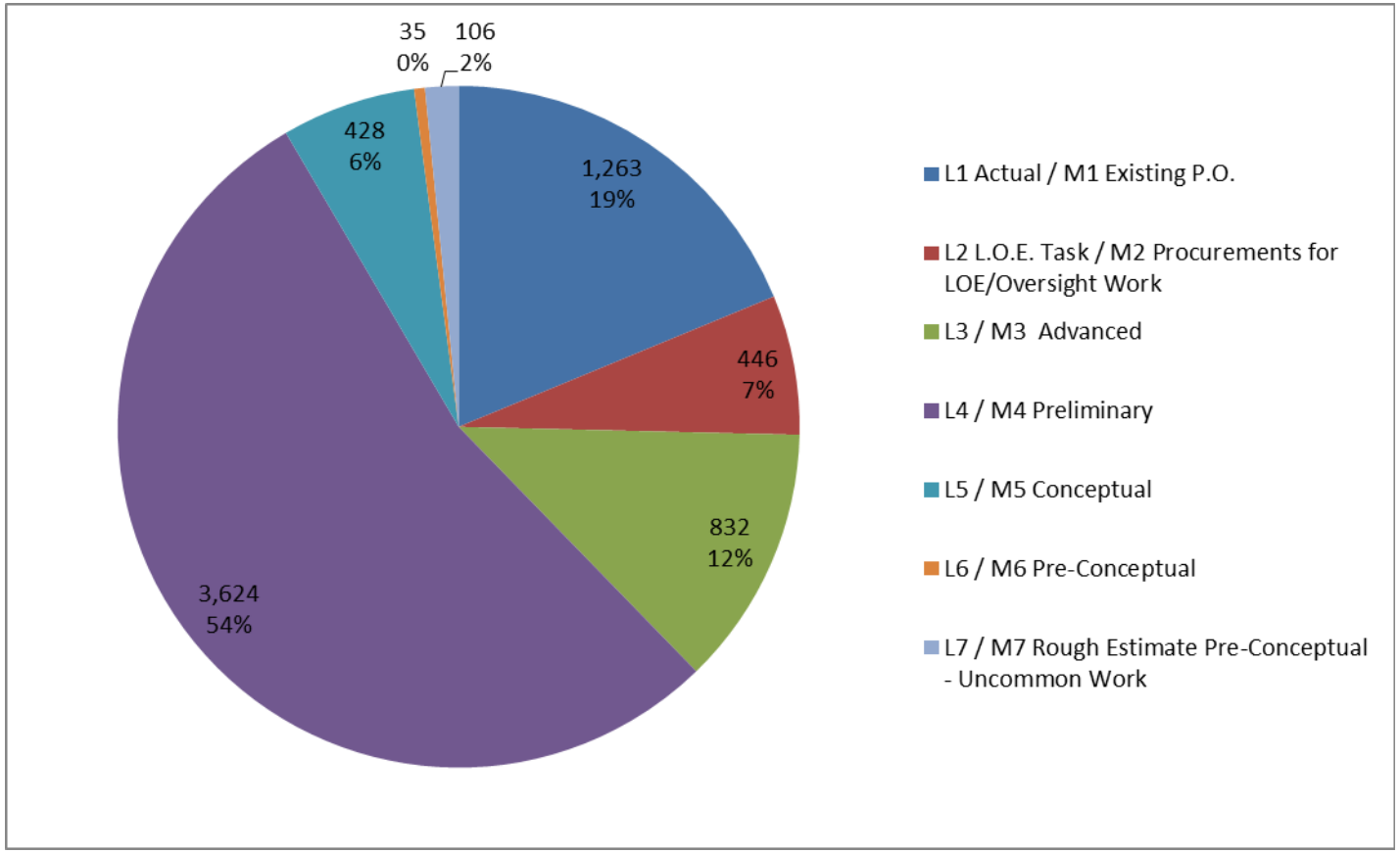
Cost Breakdown: Sub-Project



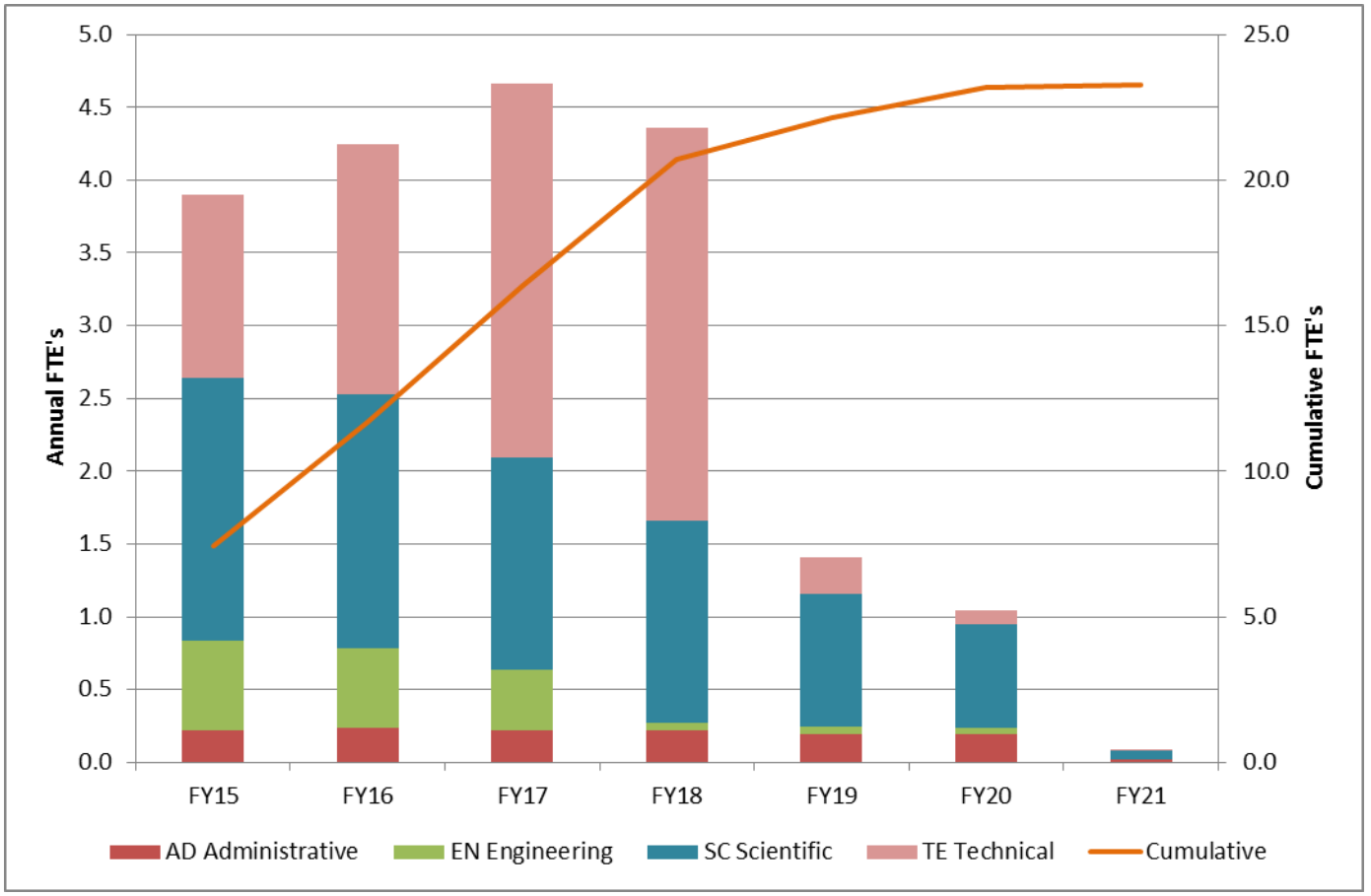
Cost Breakdown: Resource Type



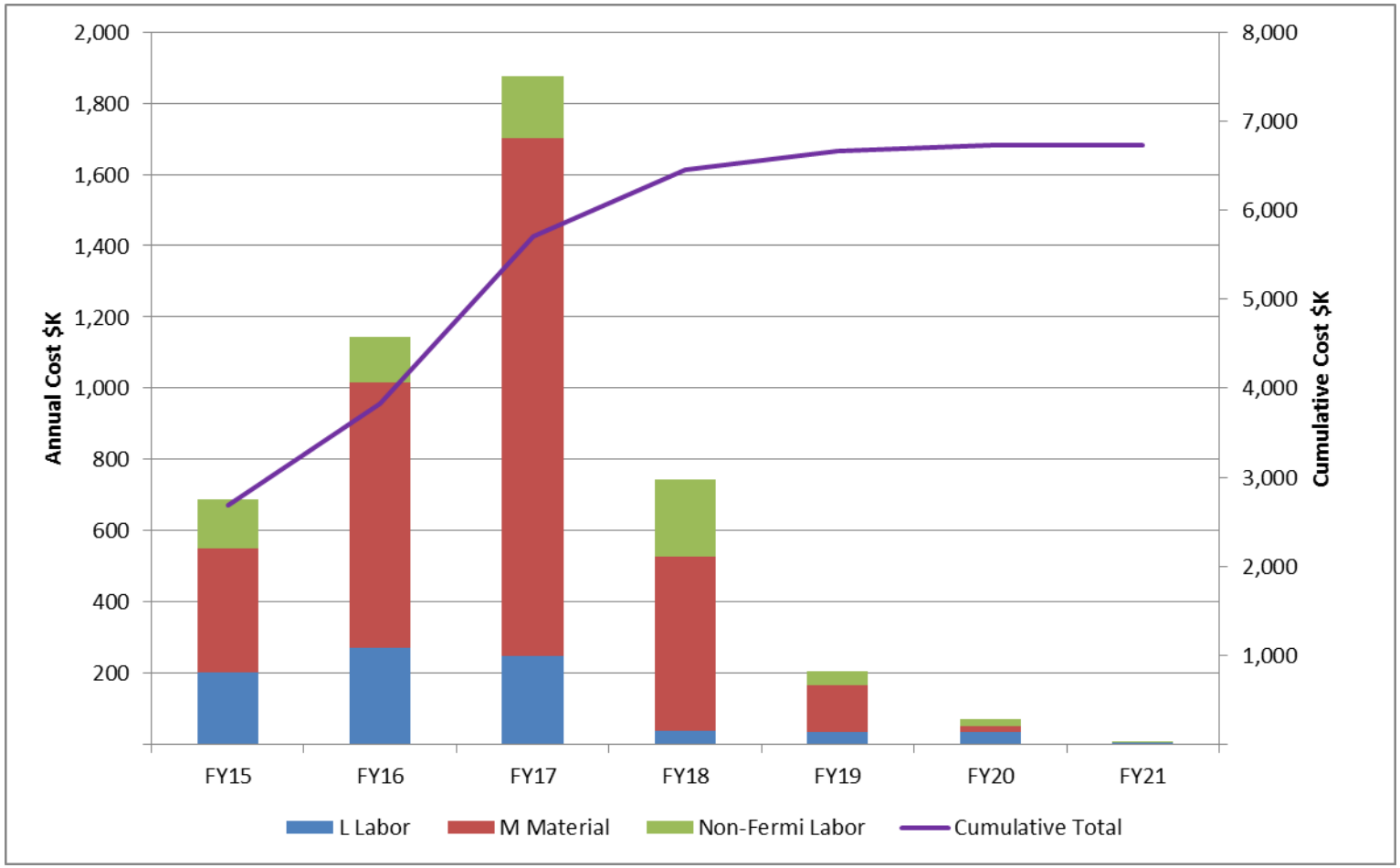
Quality of Estimate



Labor Resources by FY

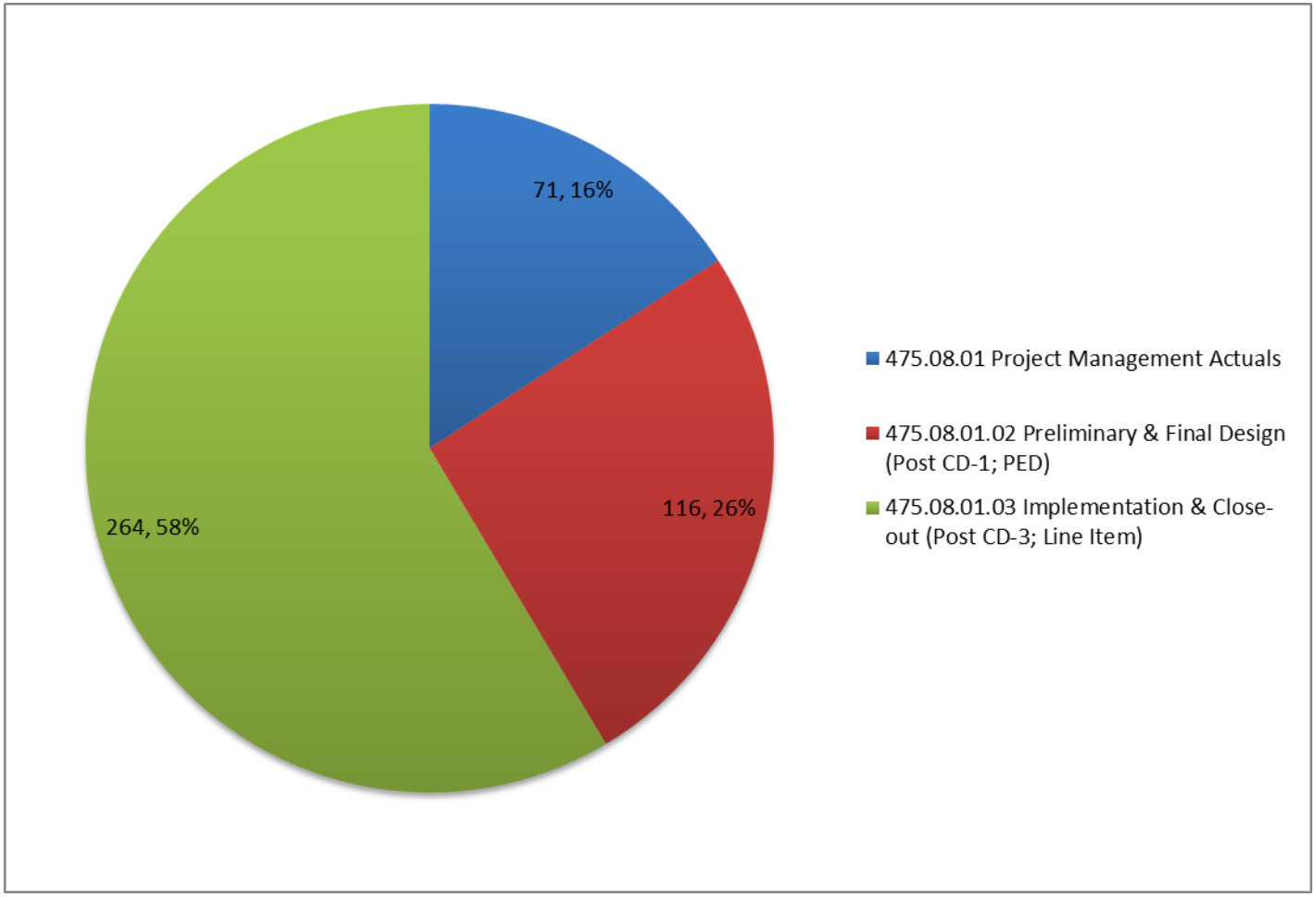


Labor / Material Breakdown by FY

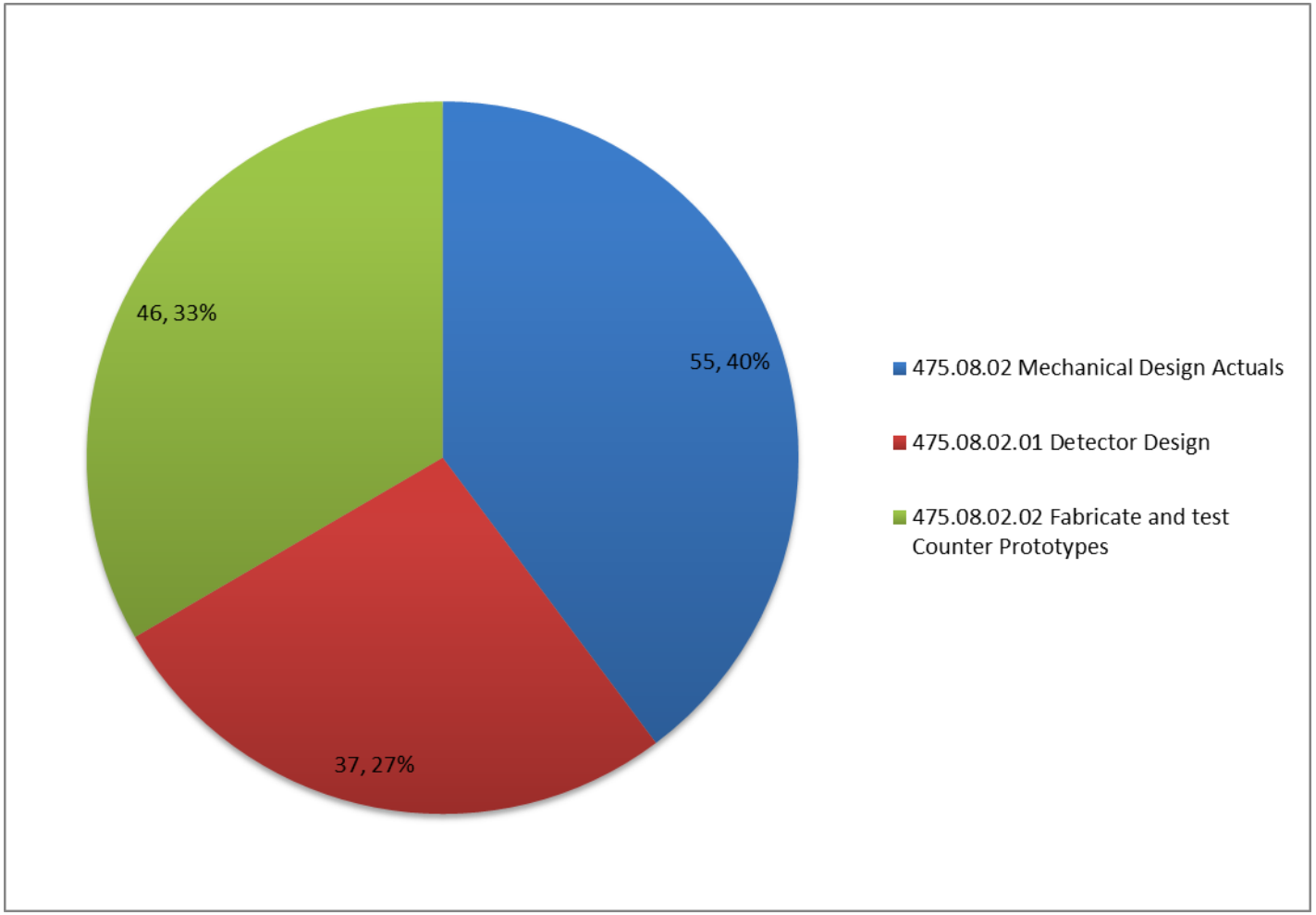


Project Slides: WBS Breakdown

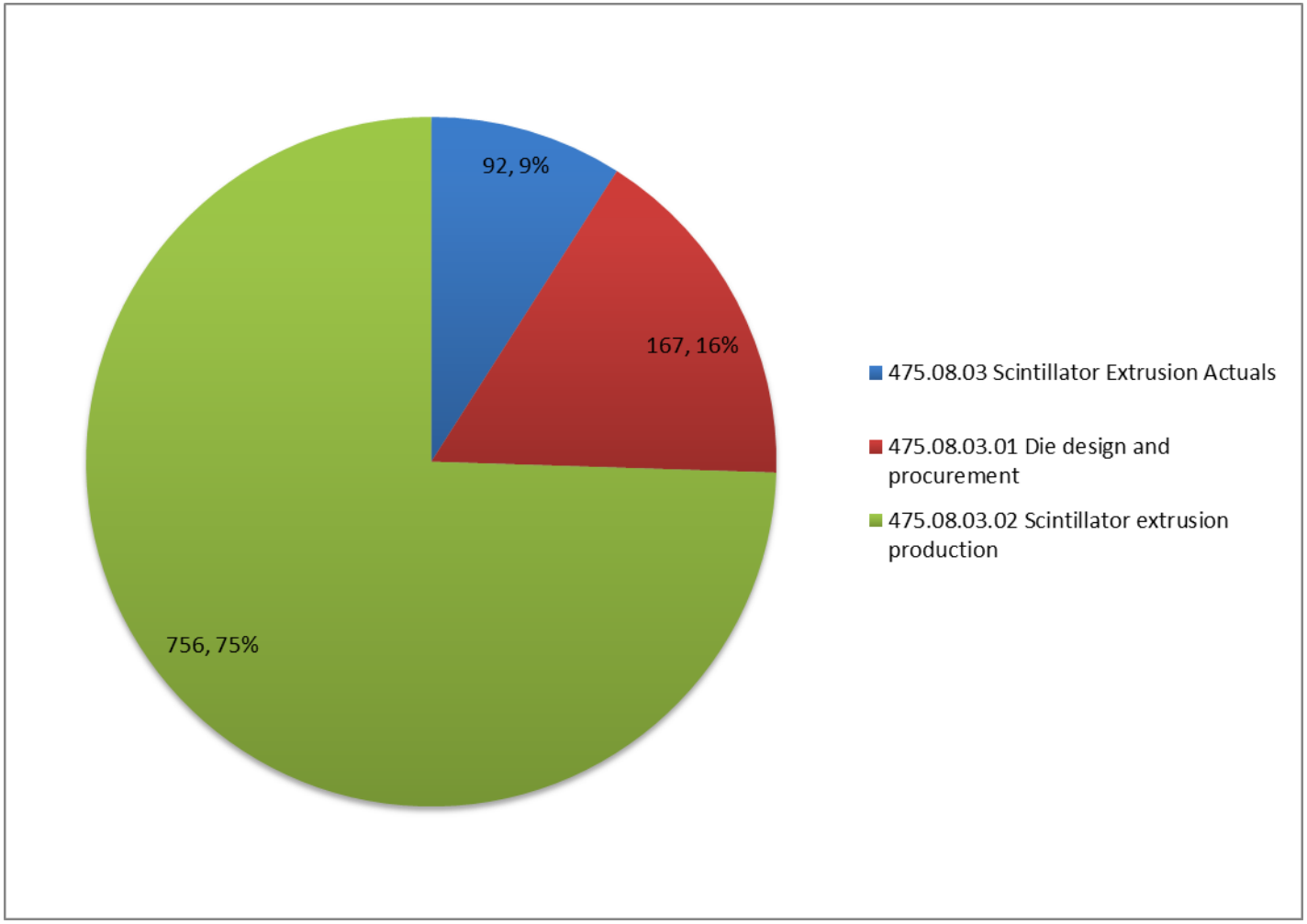
8.1 Project Management



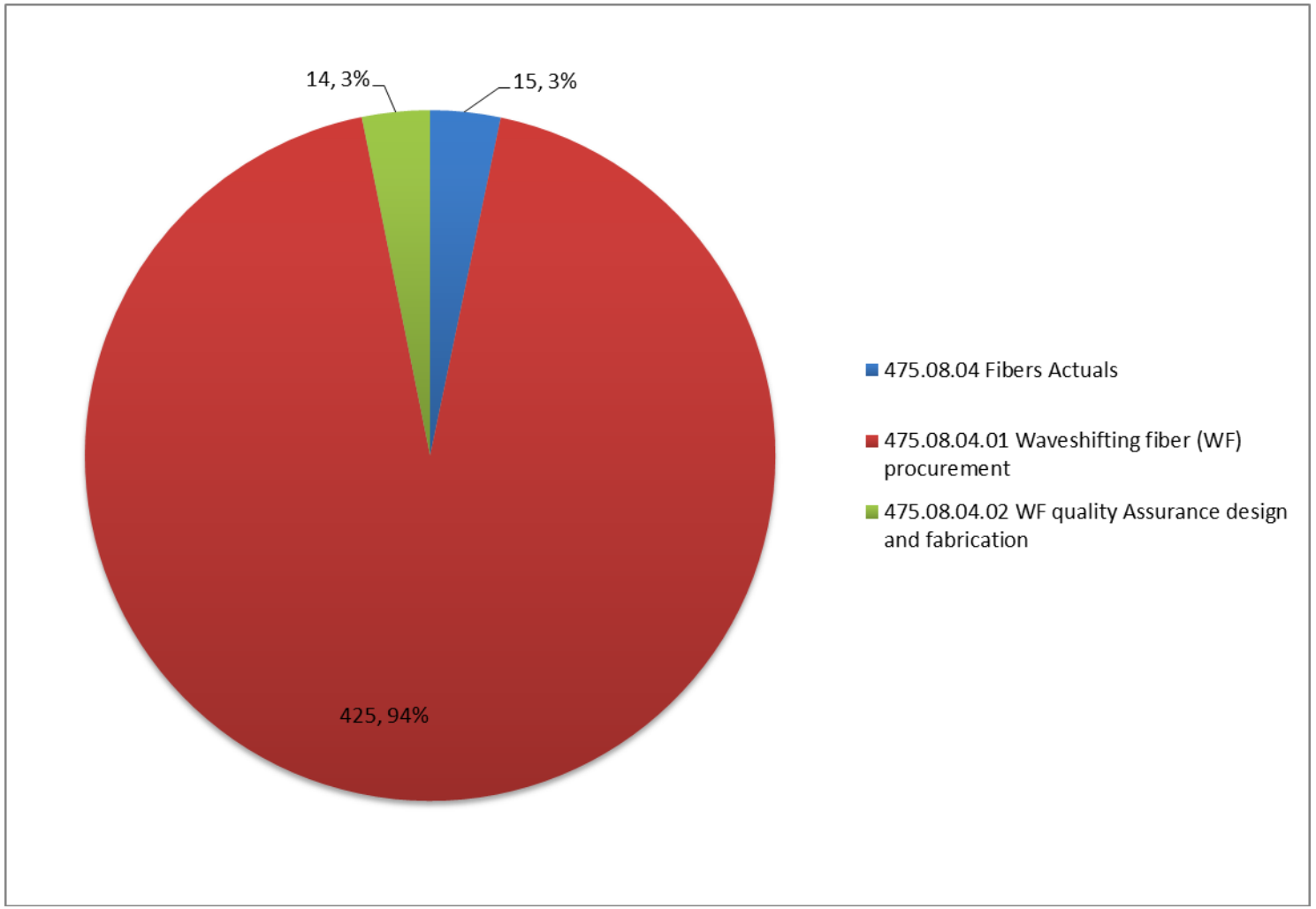
8.2 Mechanical Design



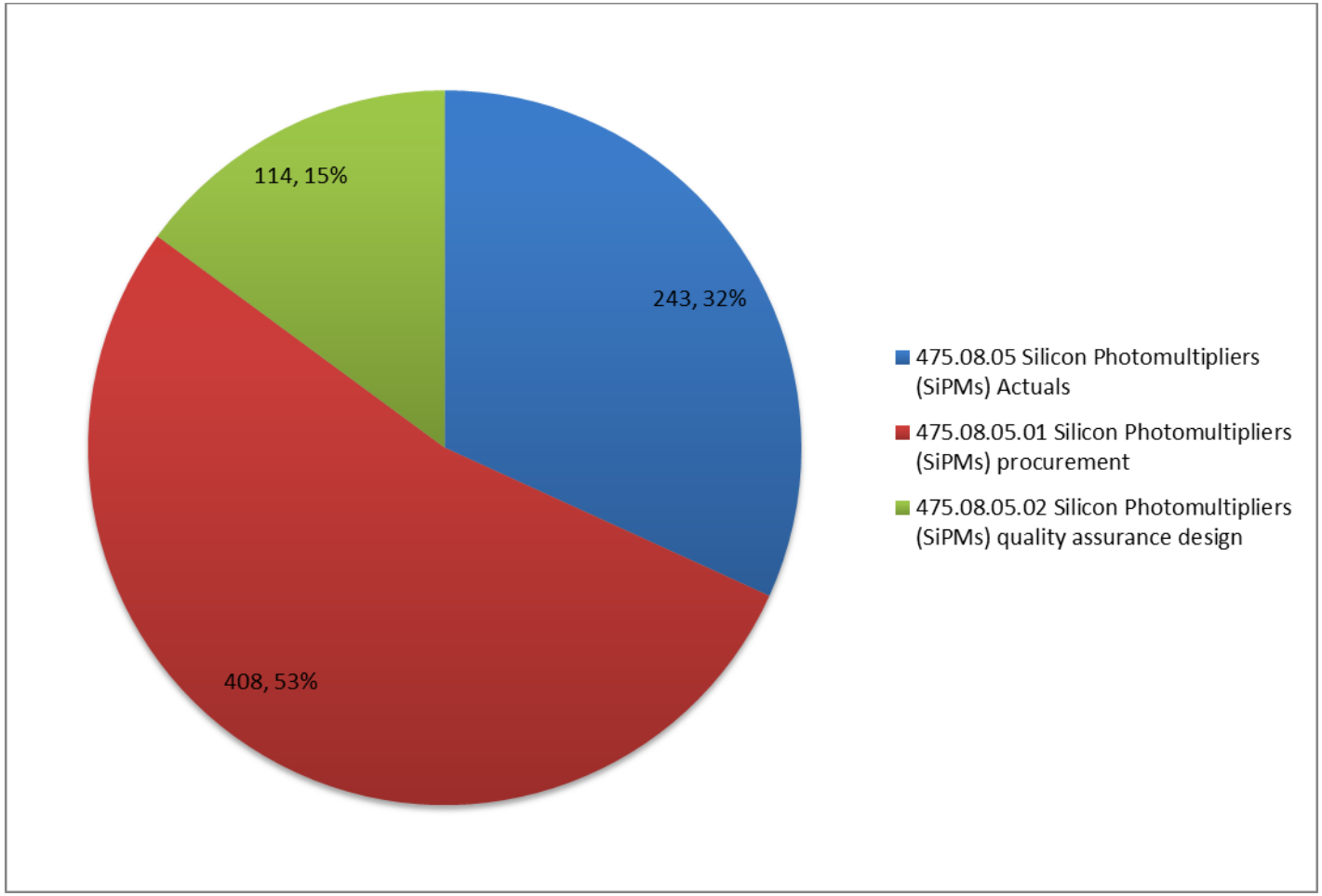
8.3 Scintillator Extrusions



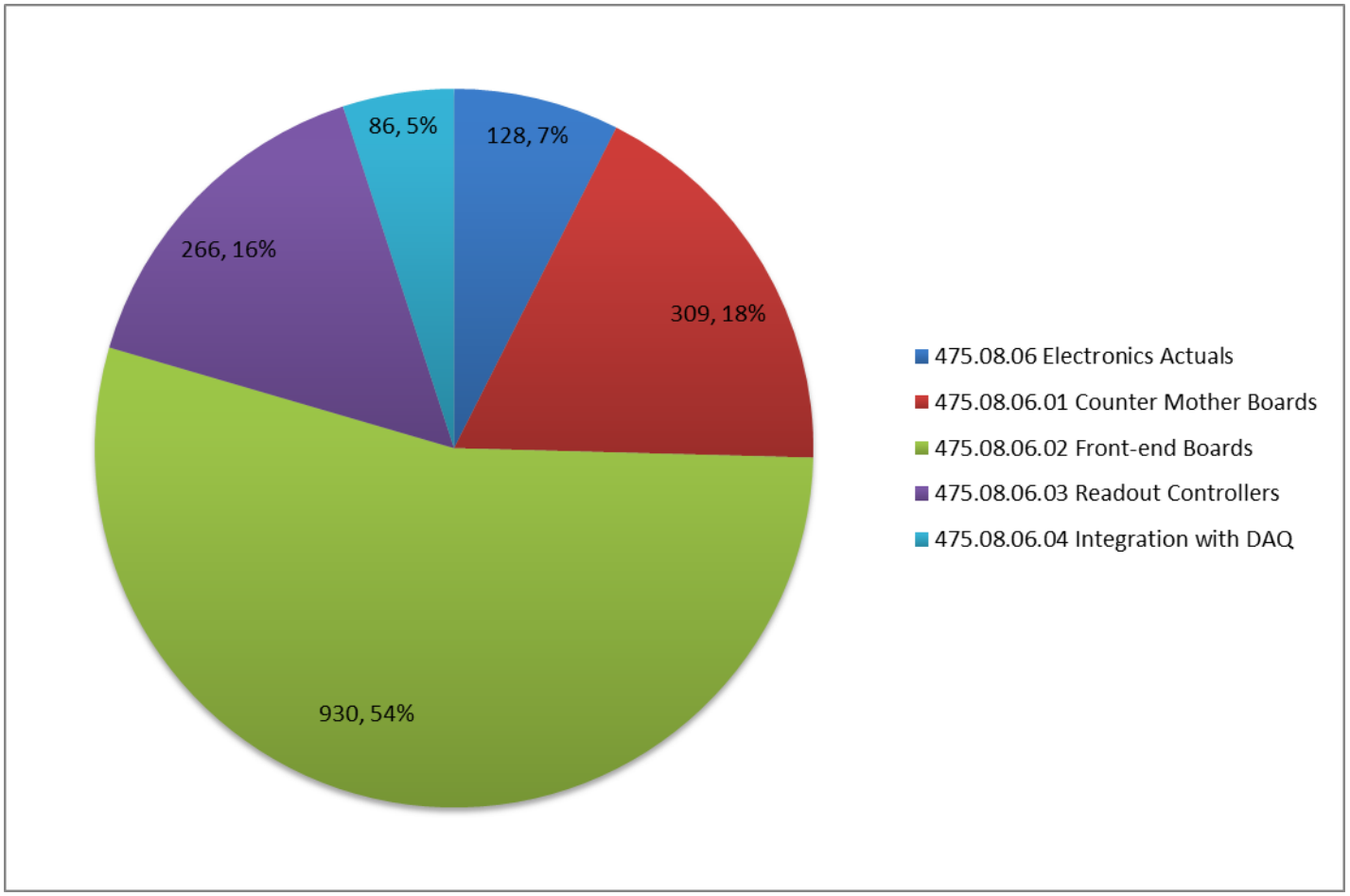
8.4 Fibers


14, 3%
15, 3%
425, 94%
475.08.04 Fibers Actuals
475.08.04.01 Waveshifting fiber (WF) procurement
475.08.04.02 WF quality Assurance design and fabrication

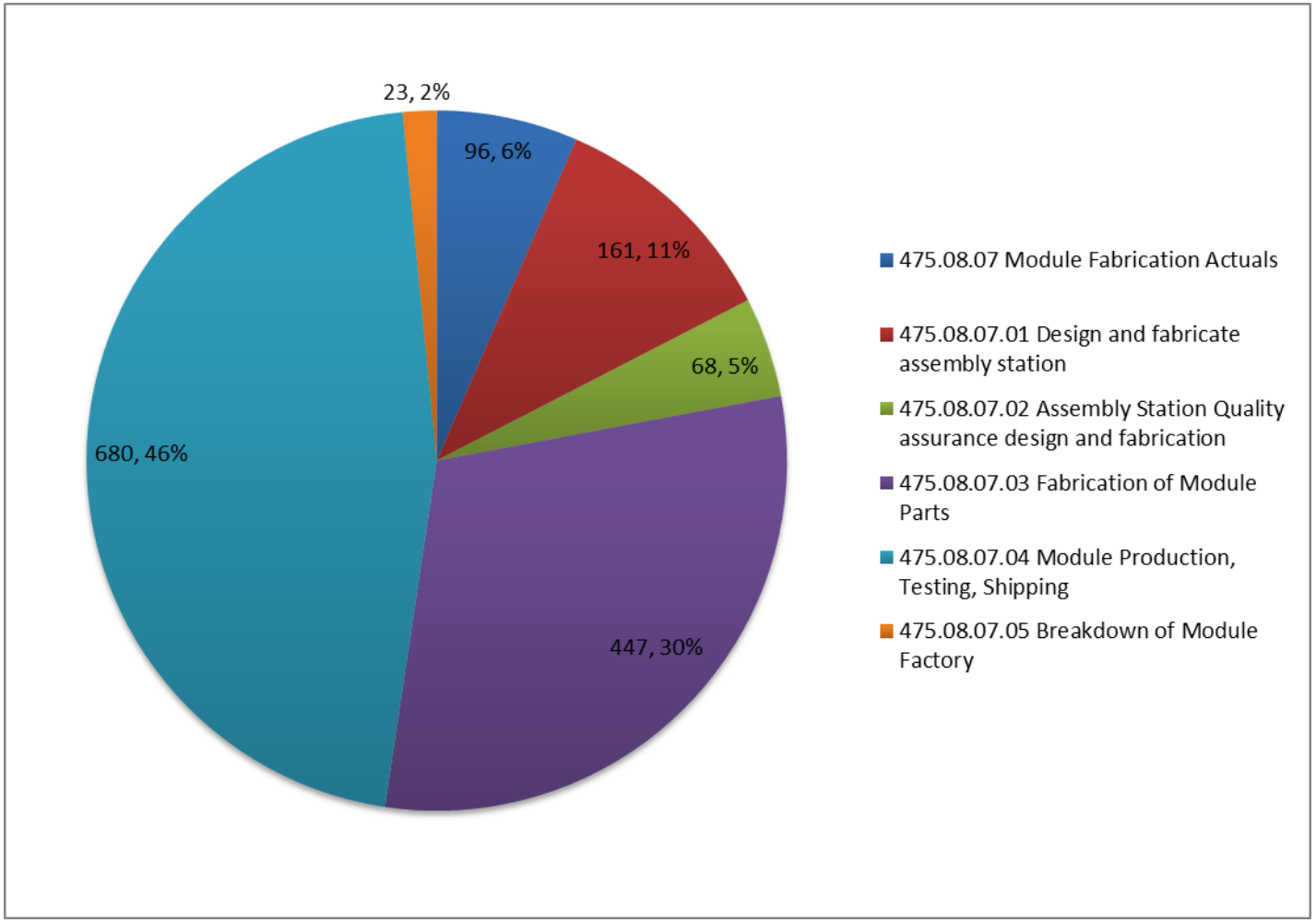
8.5 Silicon Photomultipliers (SiPMs)



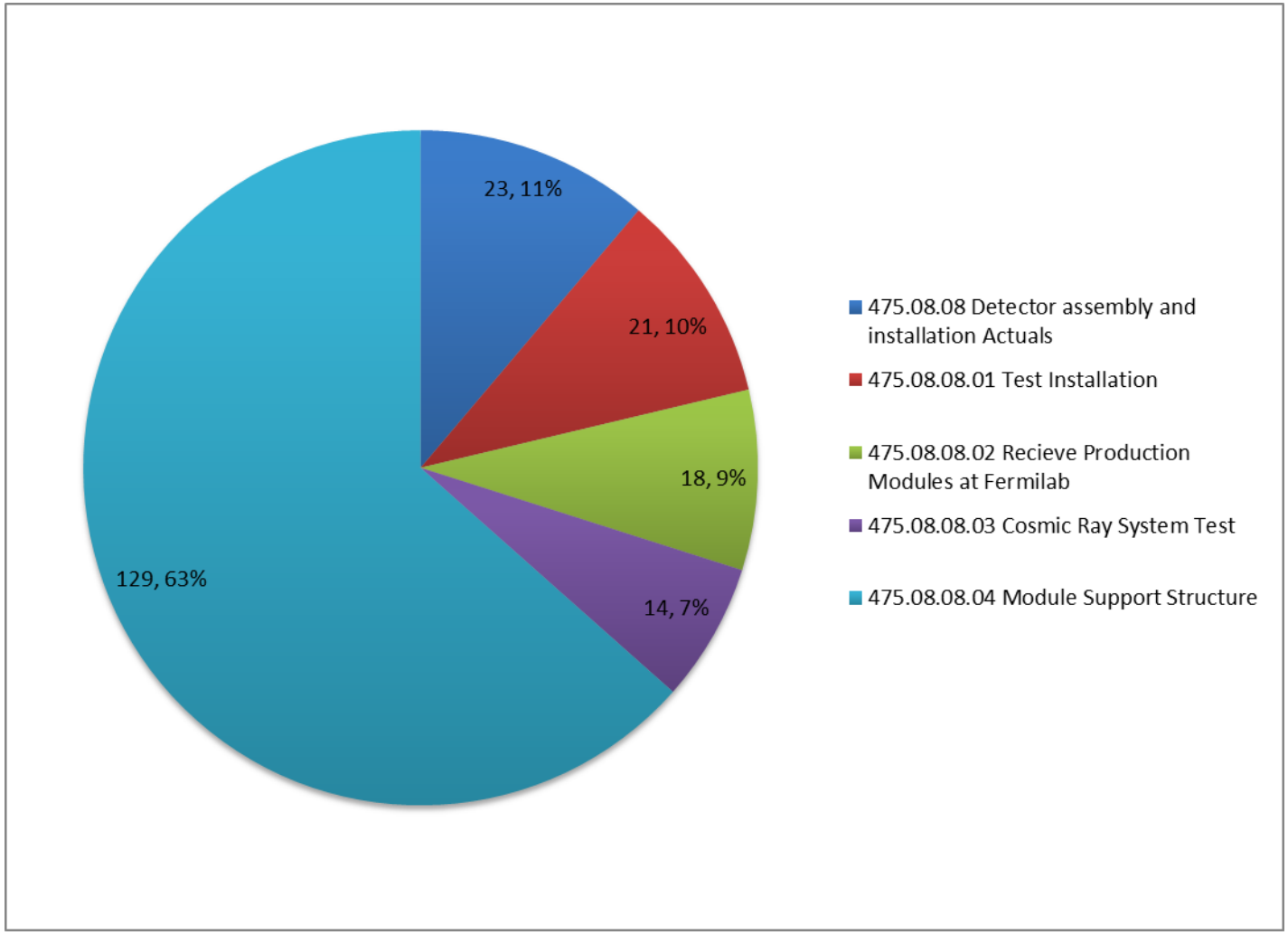
8.6 Electronics



8.7 Module Fabrication



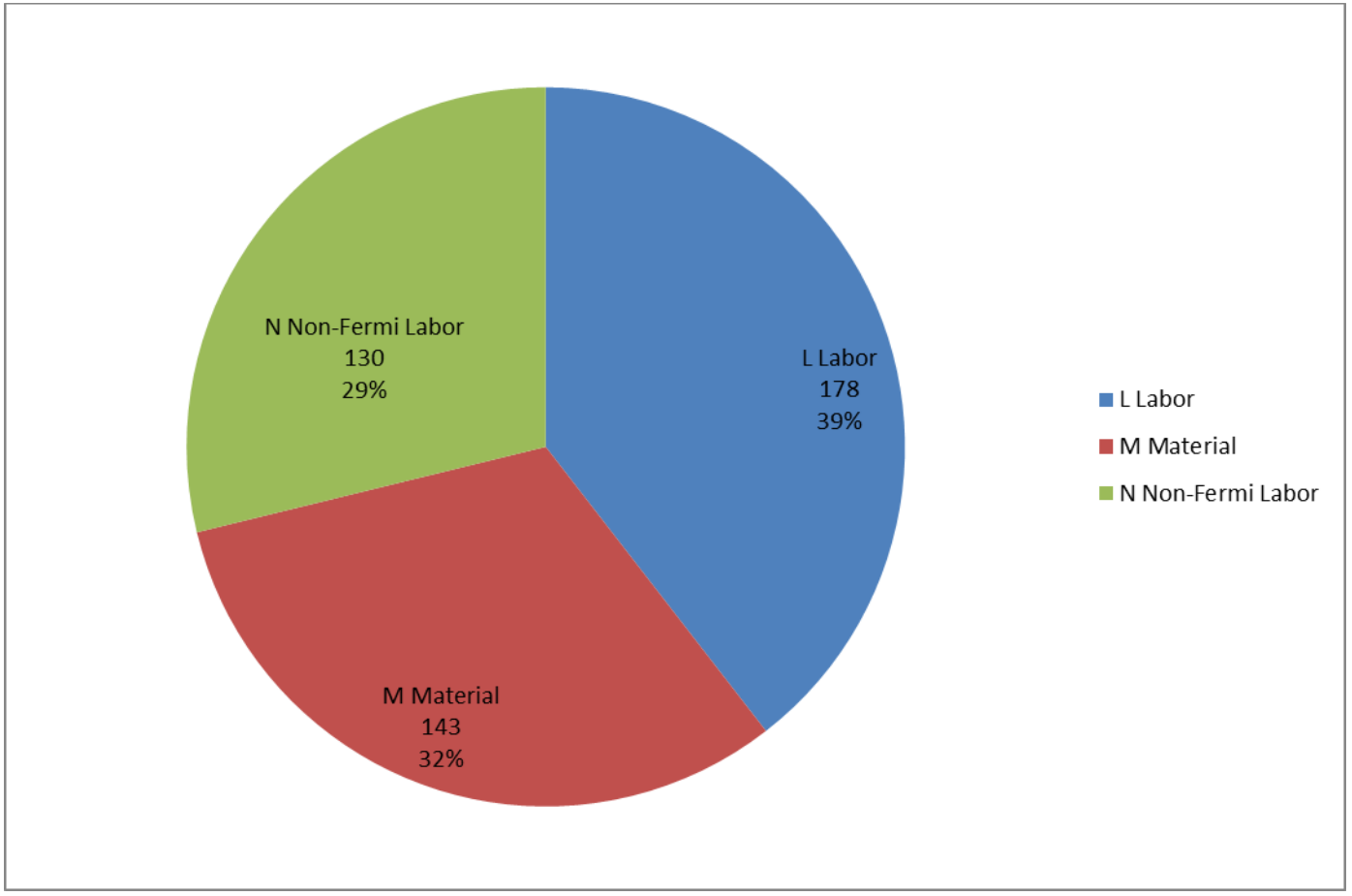
8.8 Detector Installation & Assembly



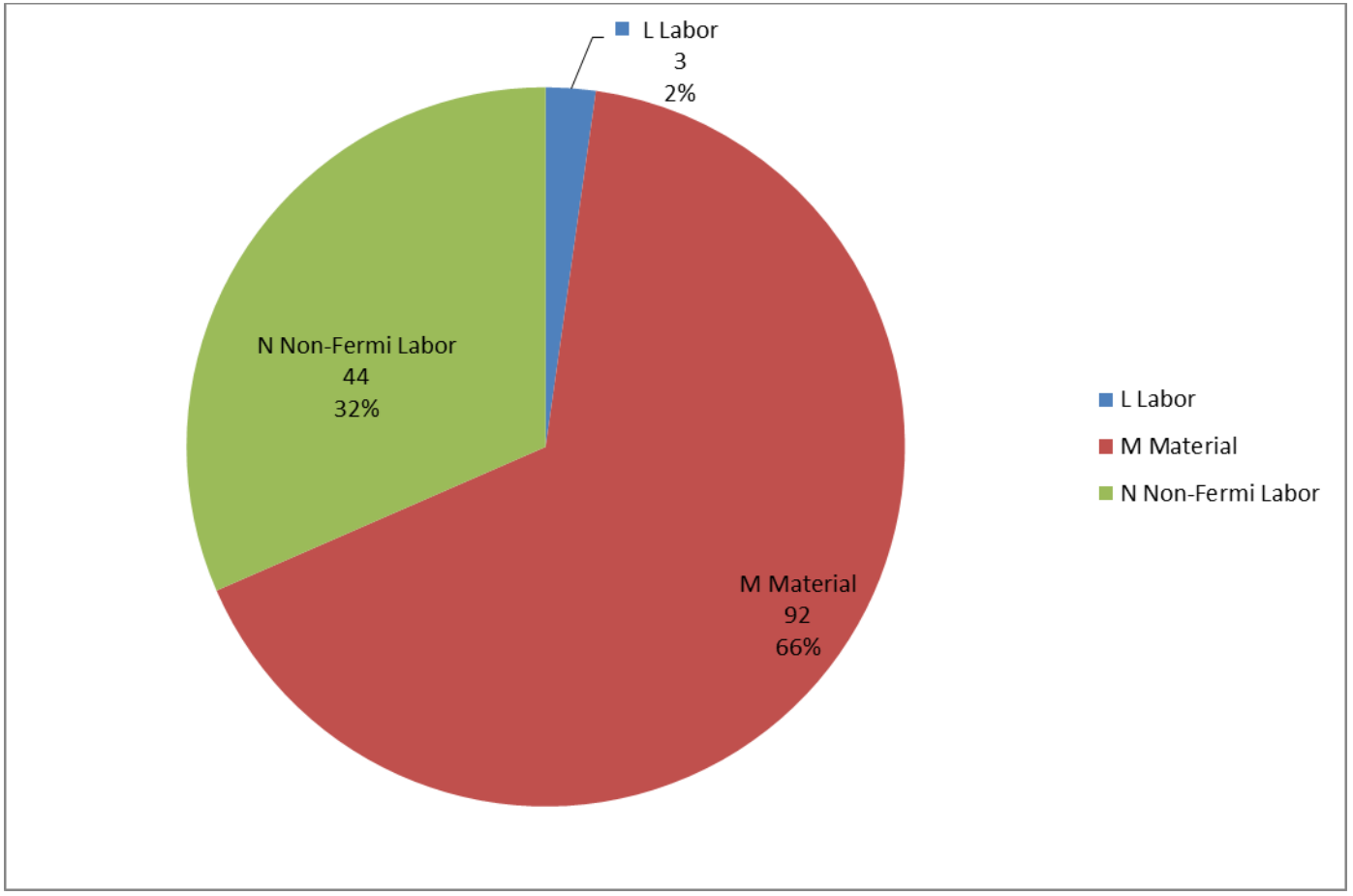
Cosmic Ray Veto

Project Slides: Resource Type

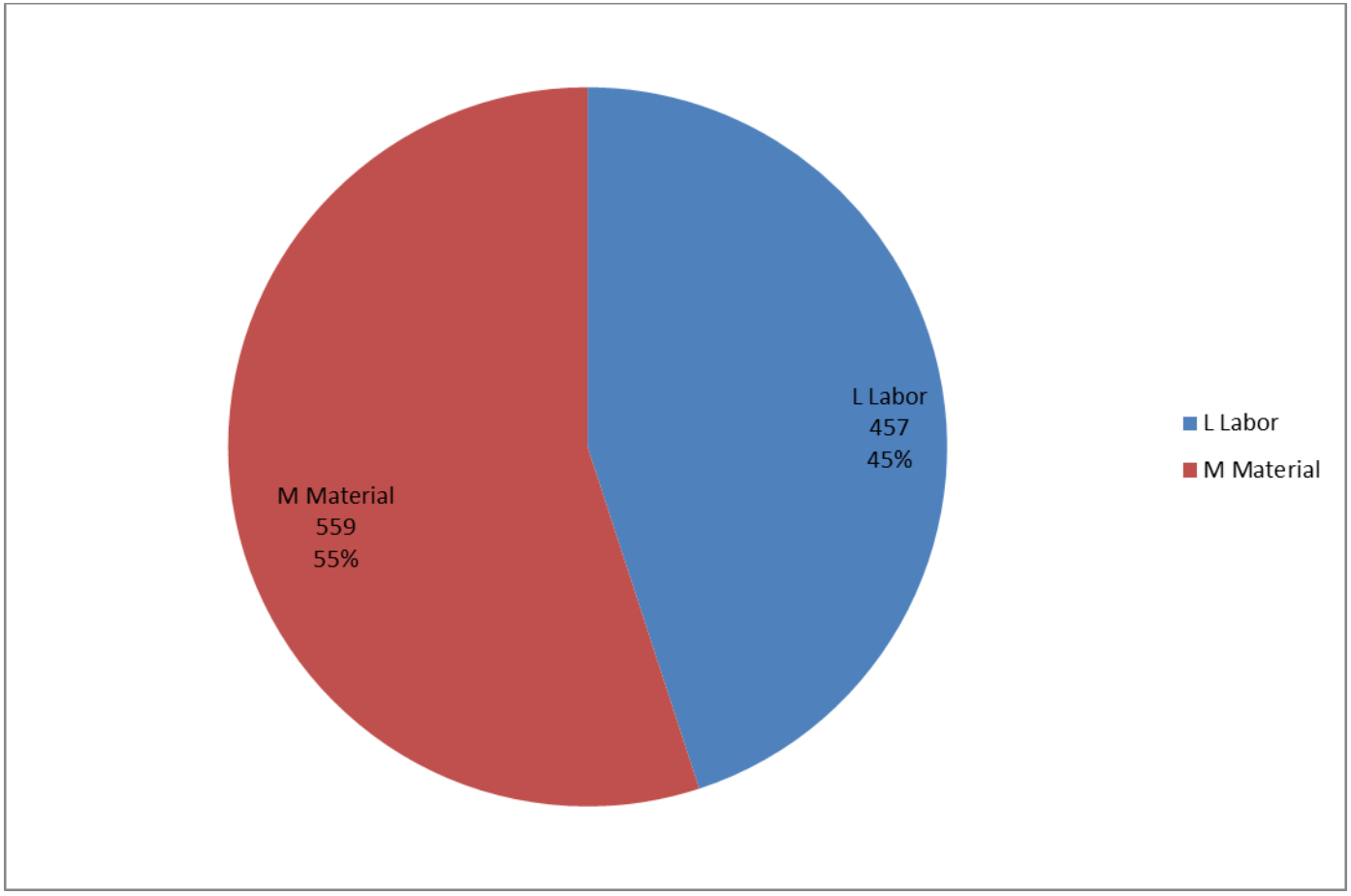
8.1 Project Management



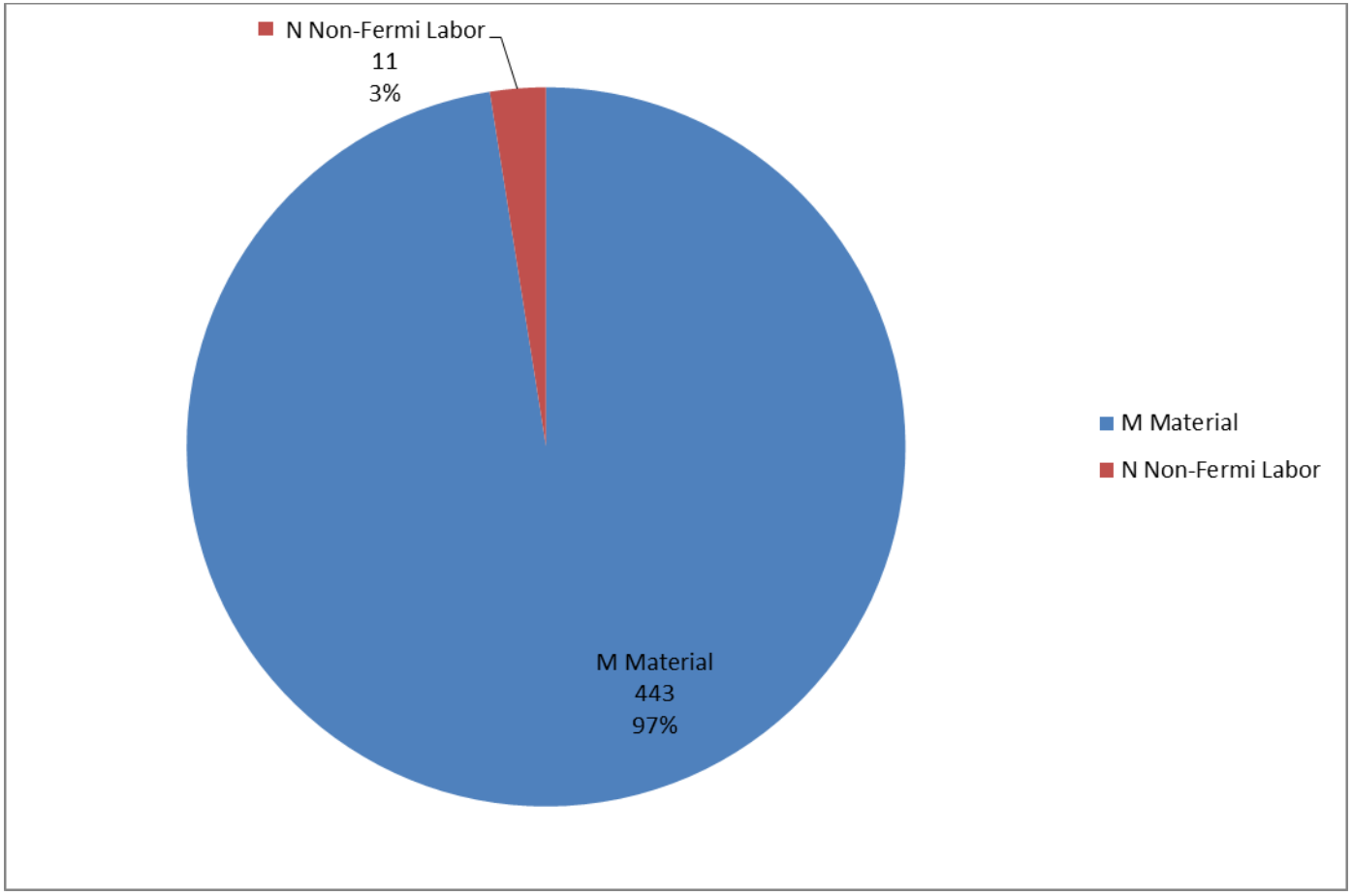
8.2 Mechanical Design



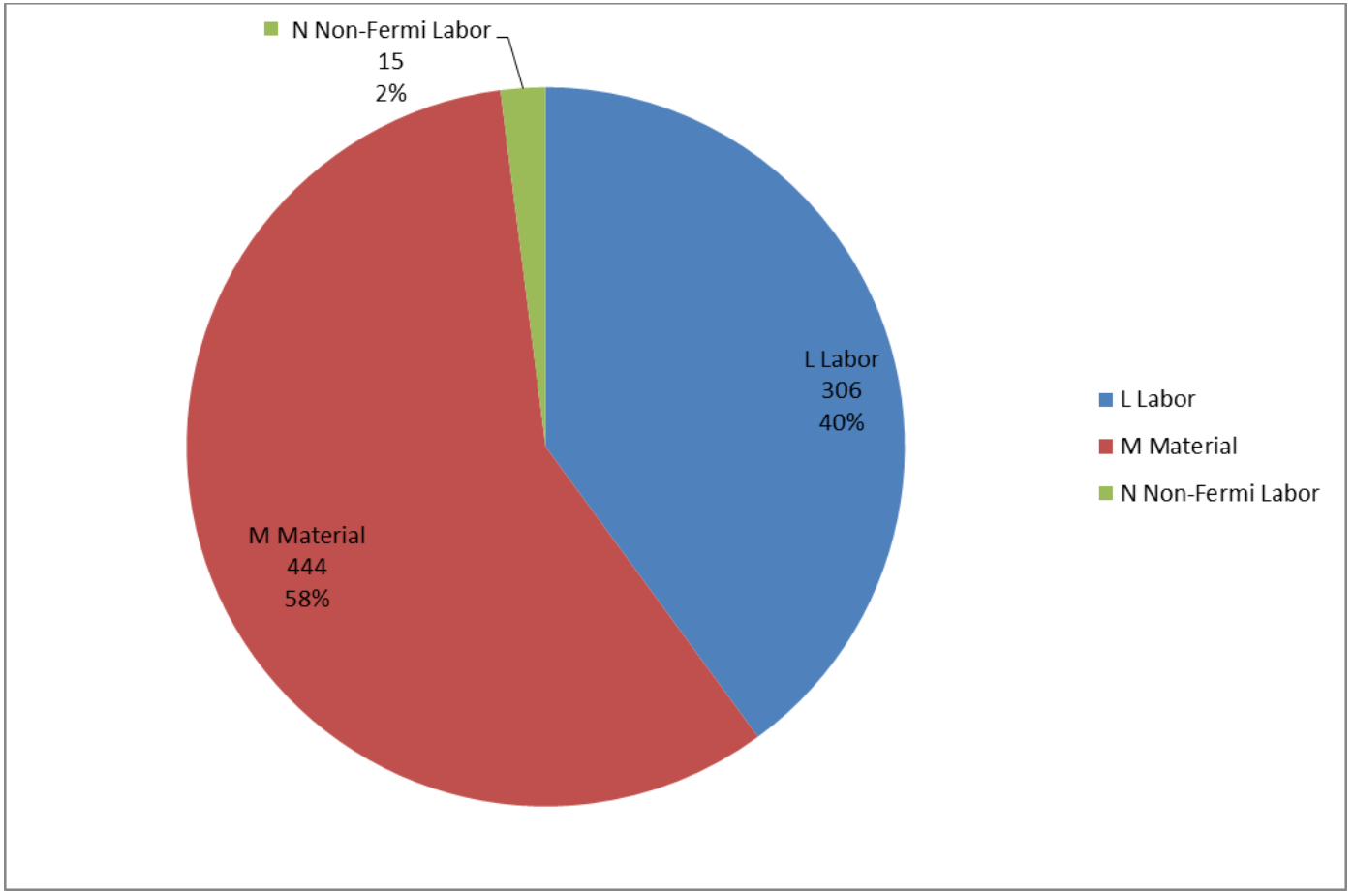
8.3 Scintillator Extrusions



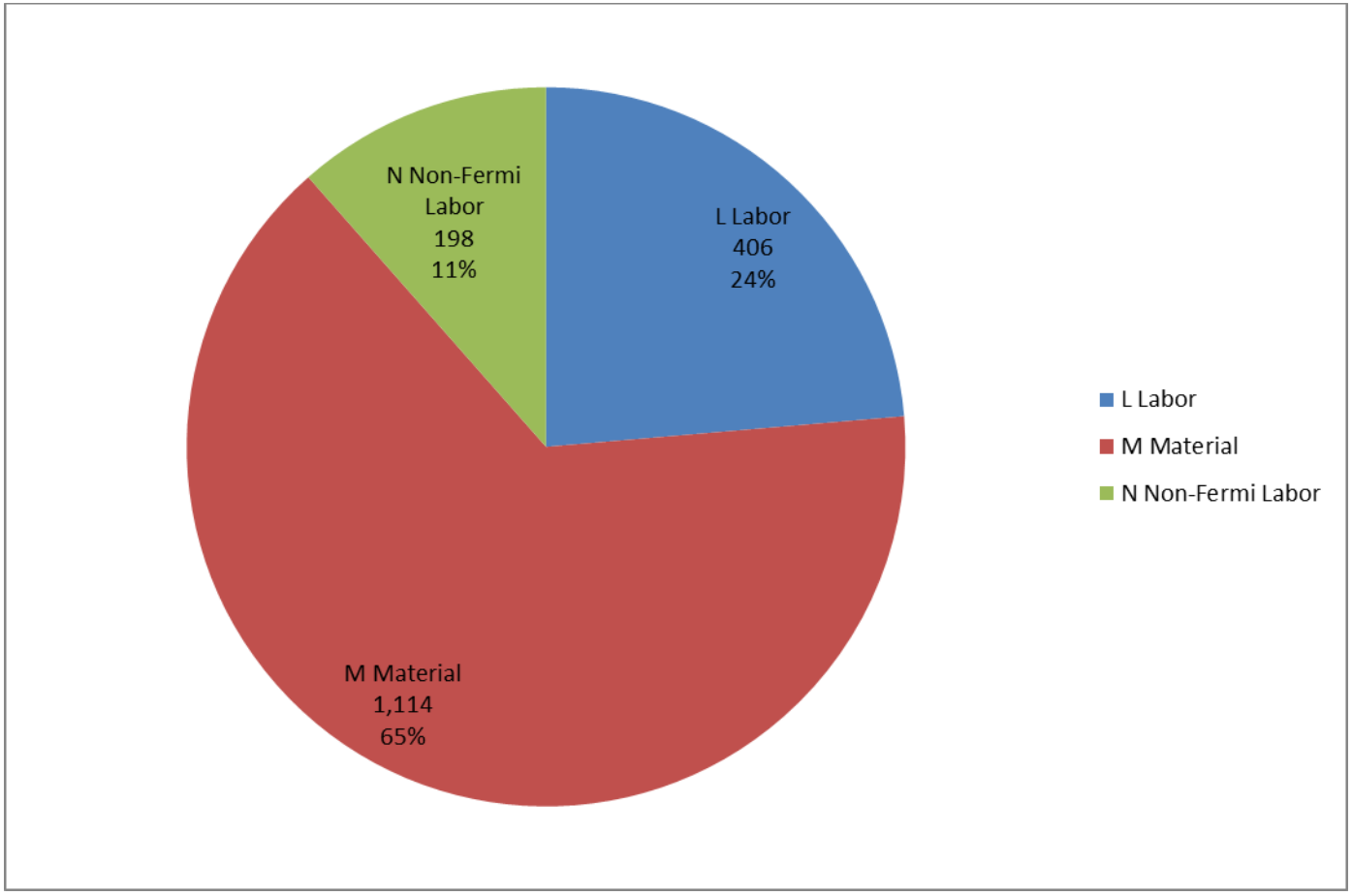
8.4 Fibers


N Non-Fermi Labor
11
3%
M Material
443
97%
M Material
N Non-Fermi Labor

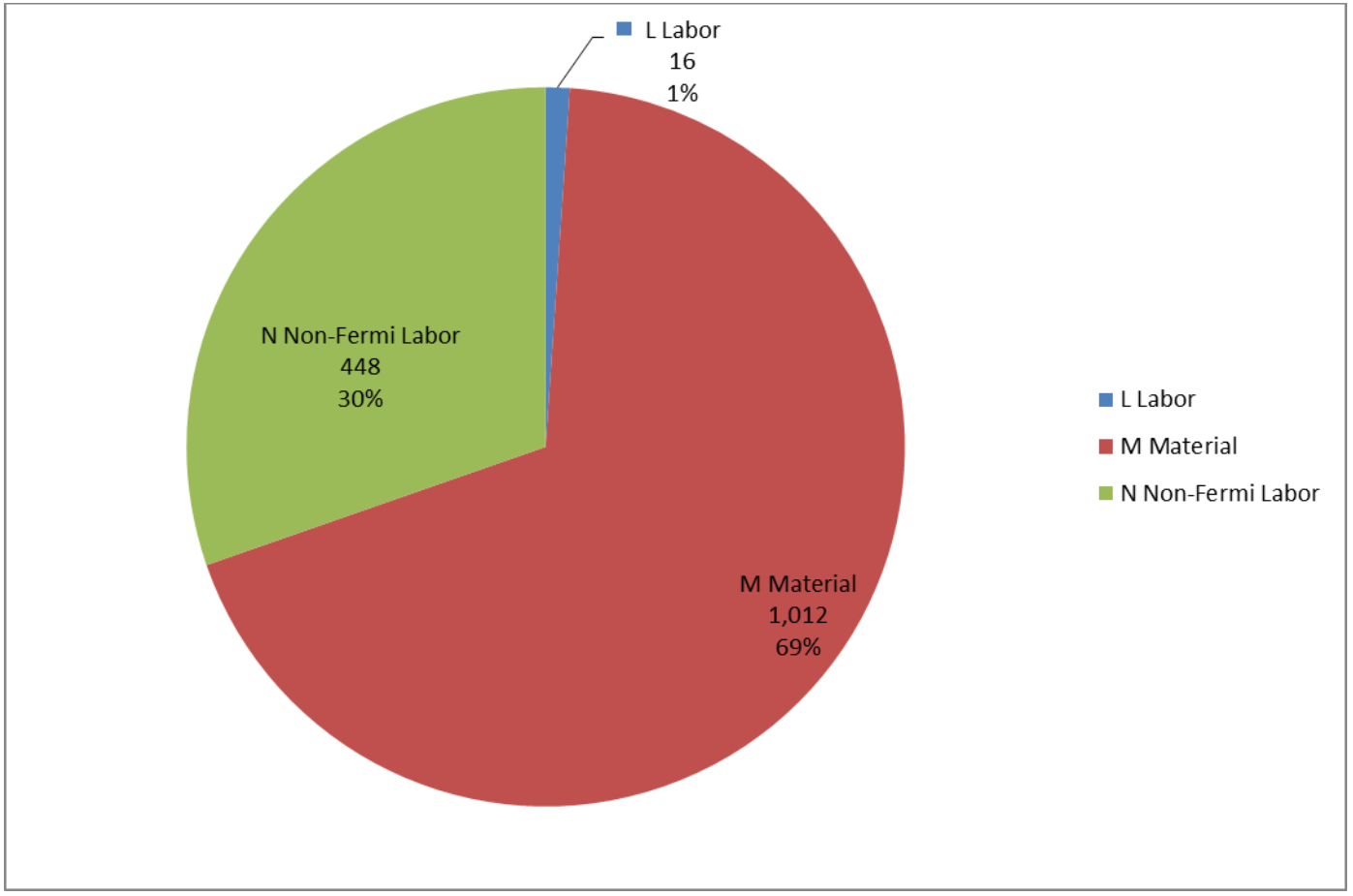
8.5 Silicon Photomultipliers (SiPMs)



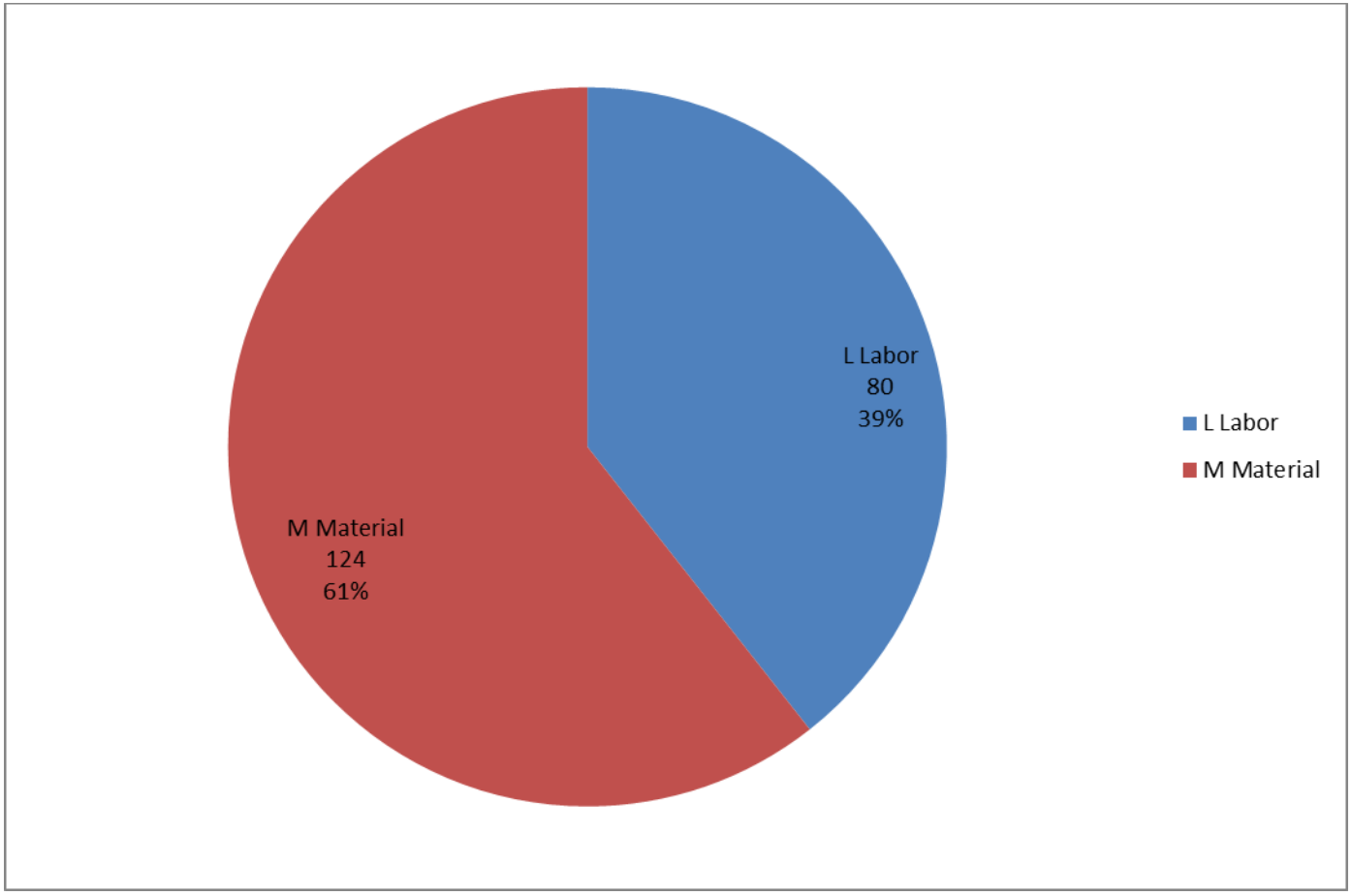
8.6 Electronics



8.7 Module Fabrication

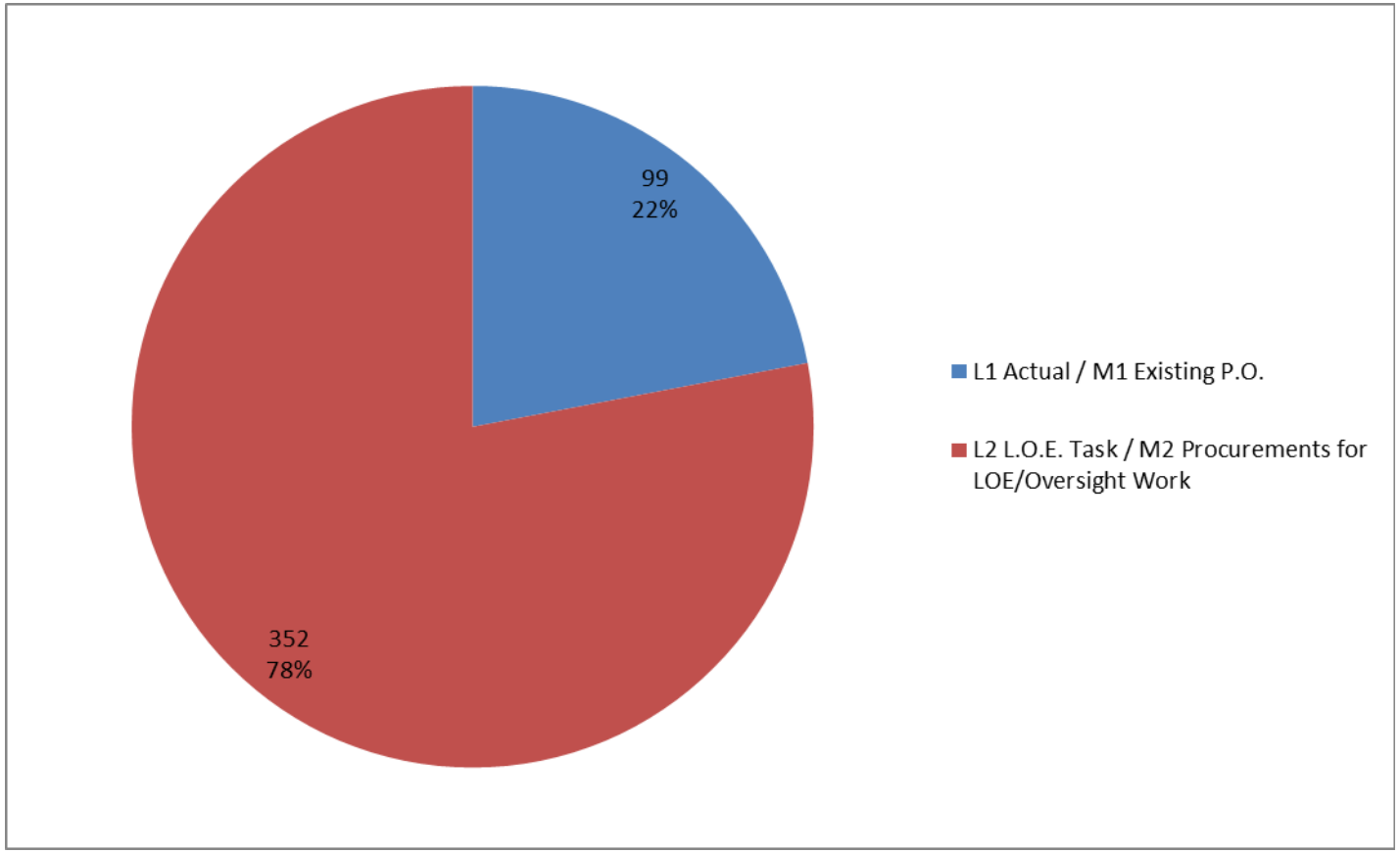


8.8 Detector Installation & Assembly

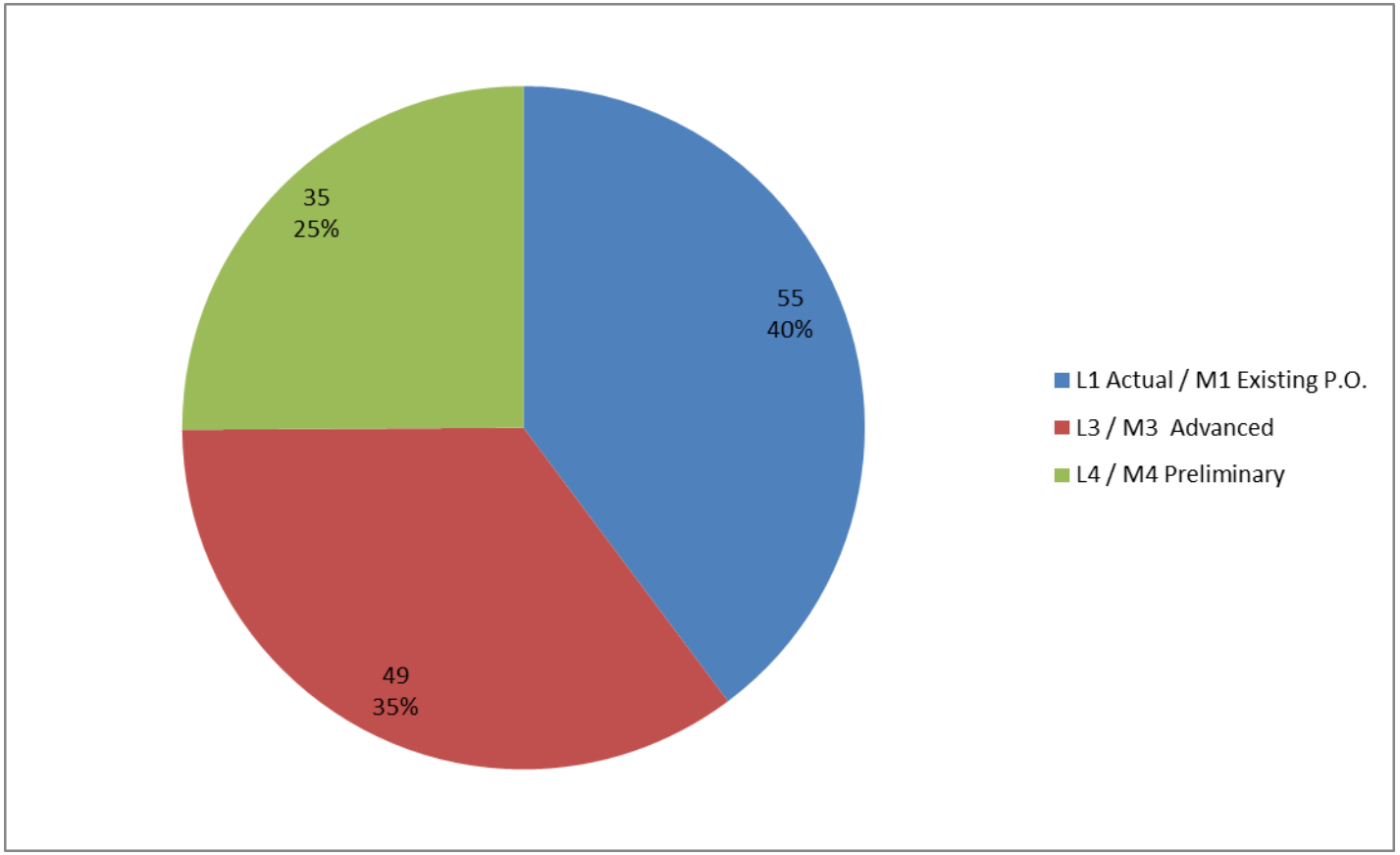


Project Slides: Quality of Estimate

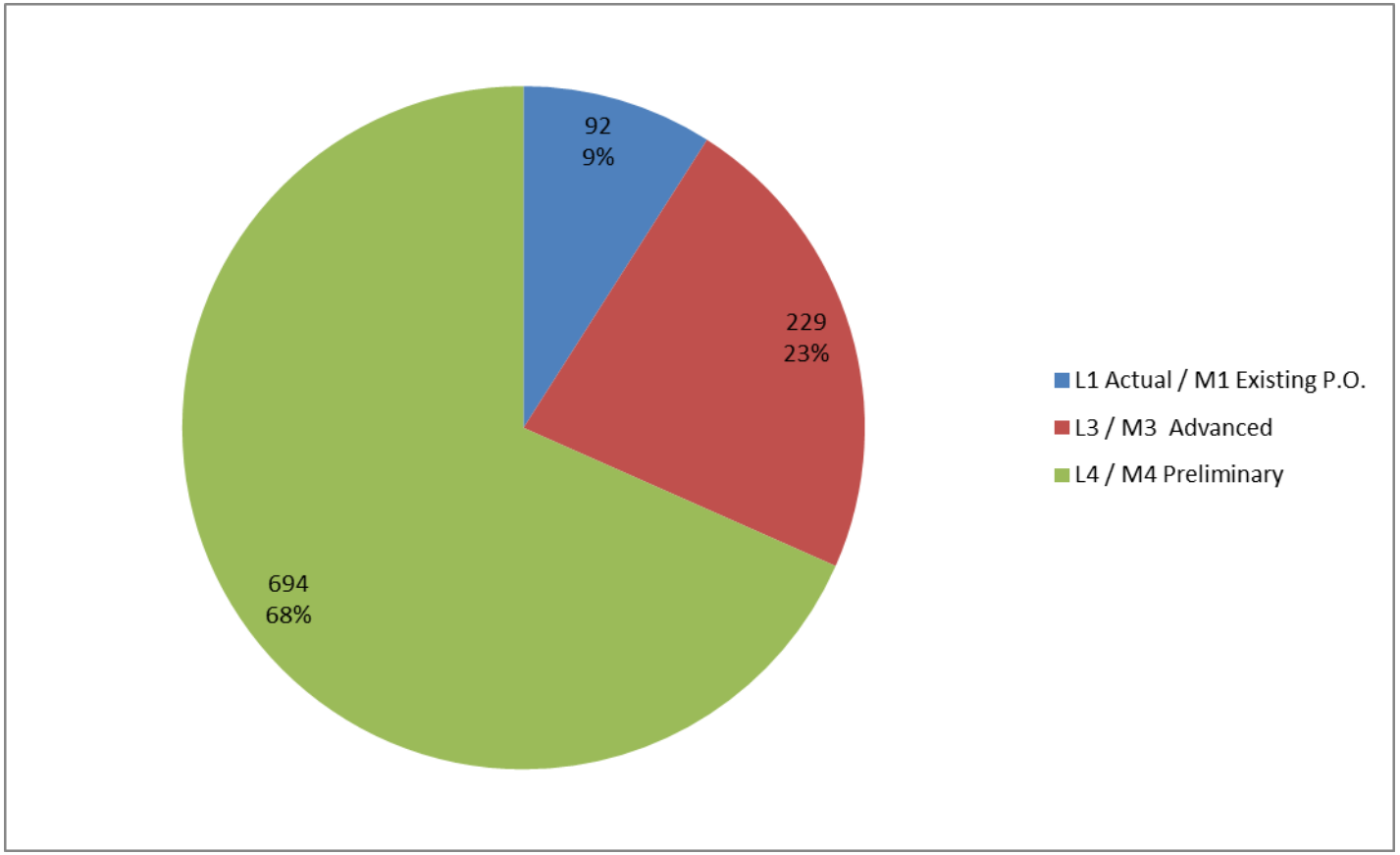
8.1 Project Management



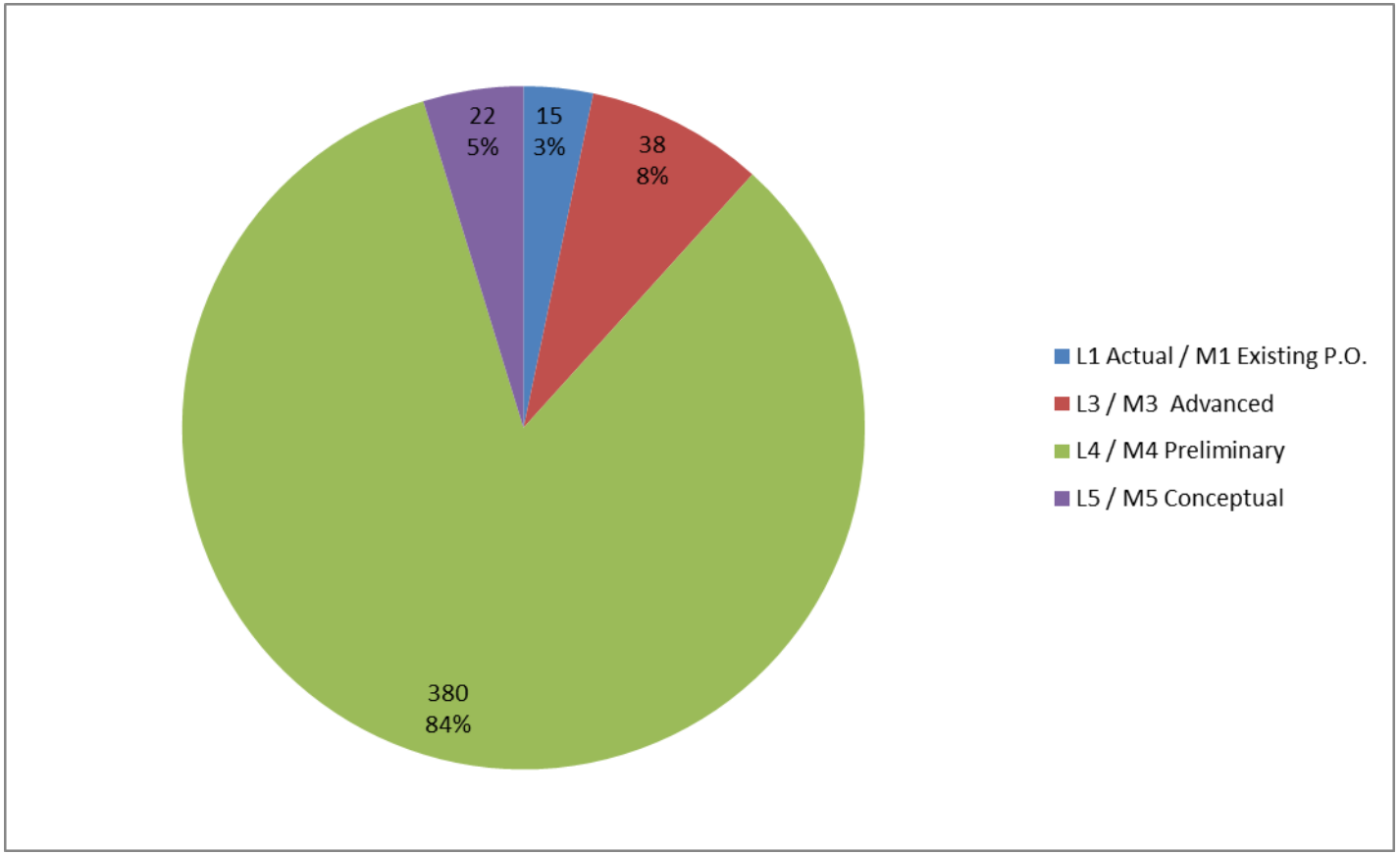
8.2 Mechanical Design



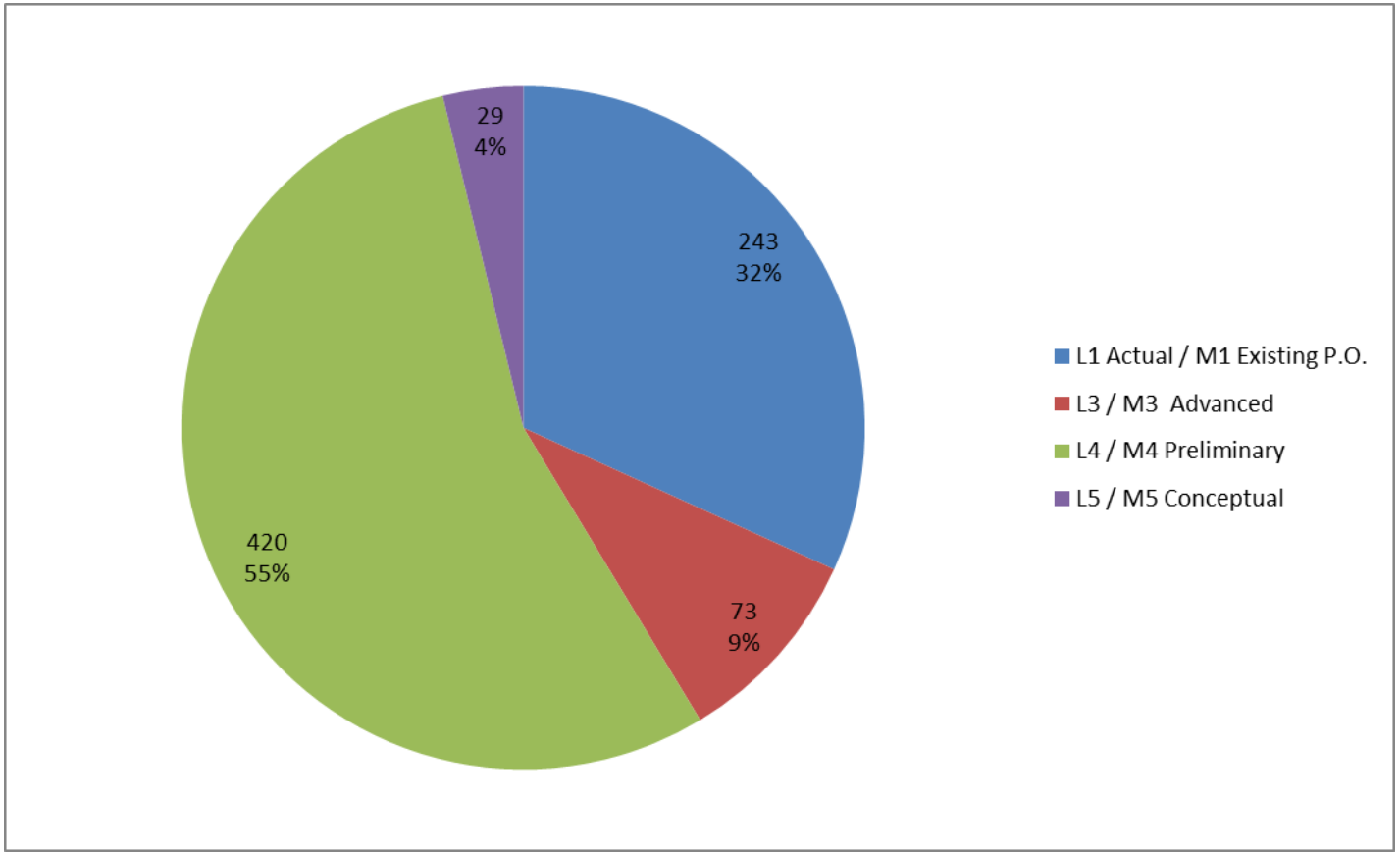
8.3 Scintillator Extrusions



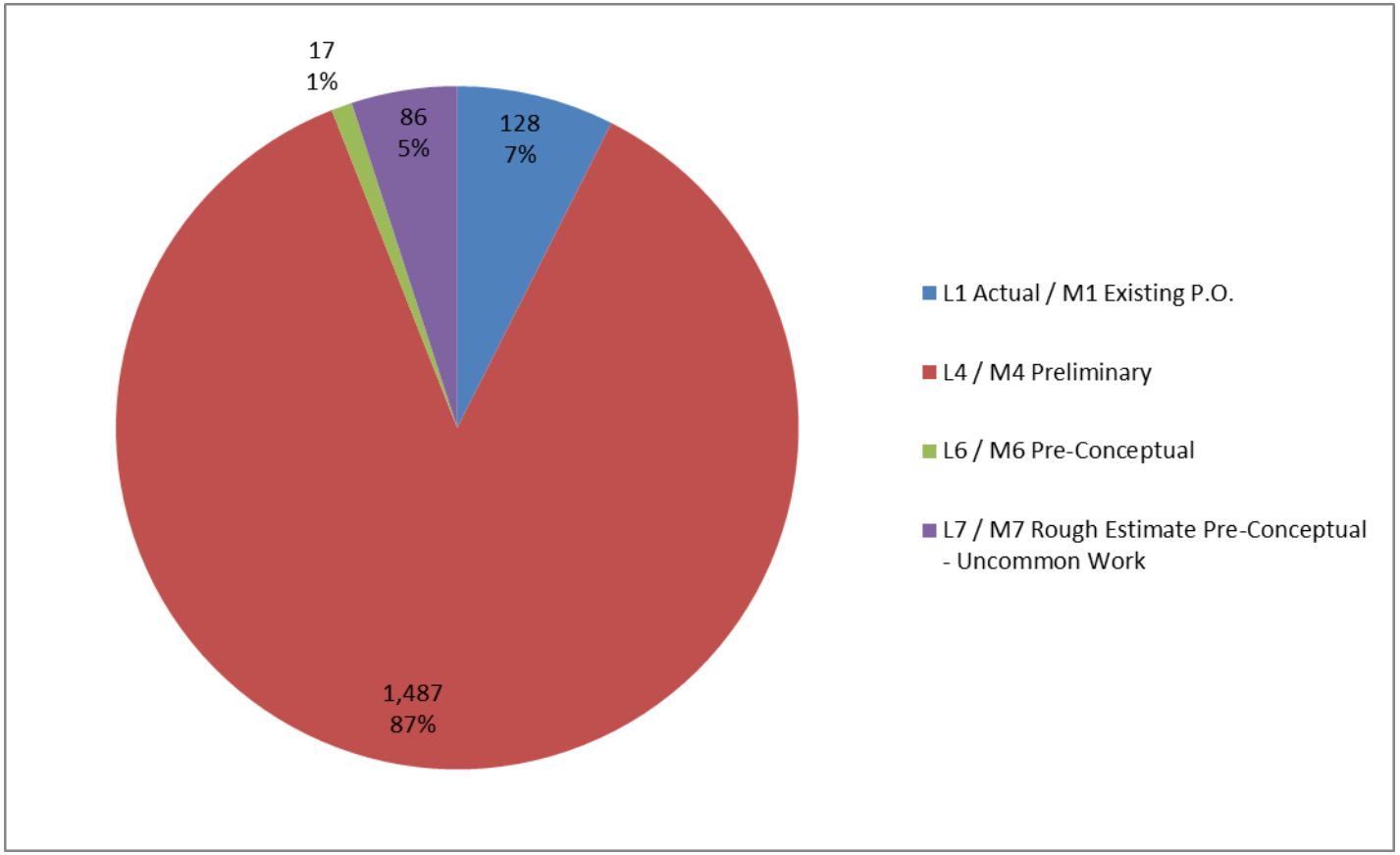
8.4 Fibers


22
5%
15
3%
38
8%
380
84%
L1 Actual / M1 Existing P.O.
L3 / M3 Advanced
L4 / M4 Preliminary
L5 / M5 Conceptual

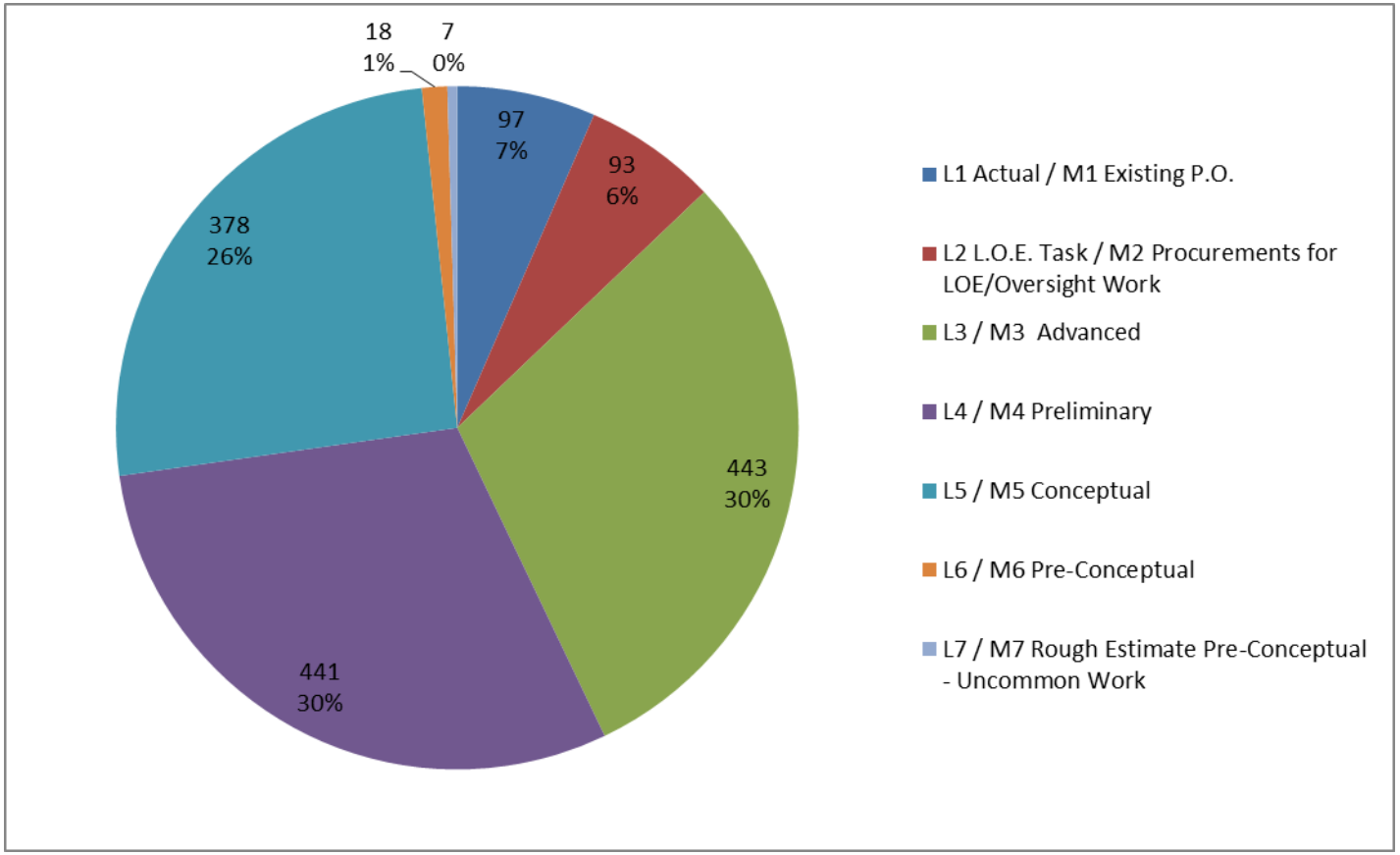
8.5 Silicon Photomultipliers (SiPMs)



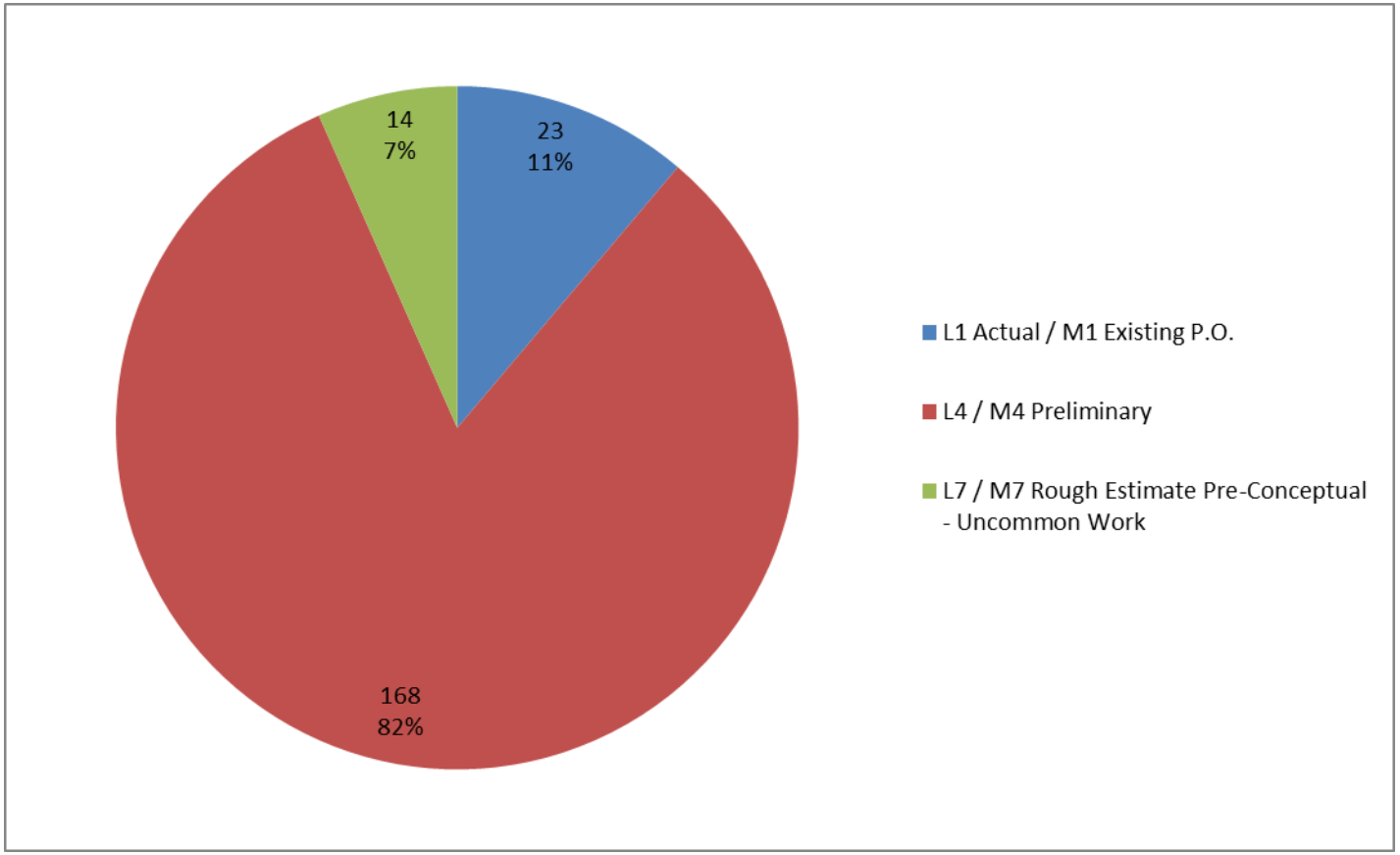
8.6 Electronics



8.7 Module Fabrication



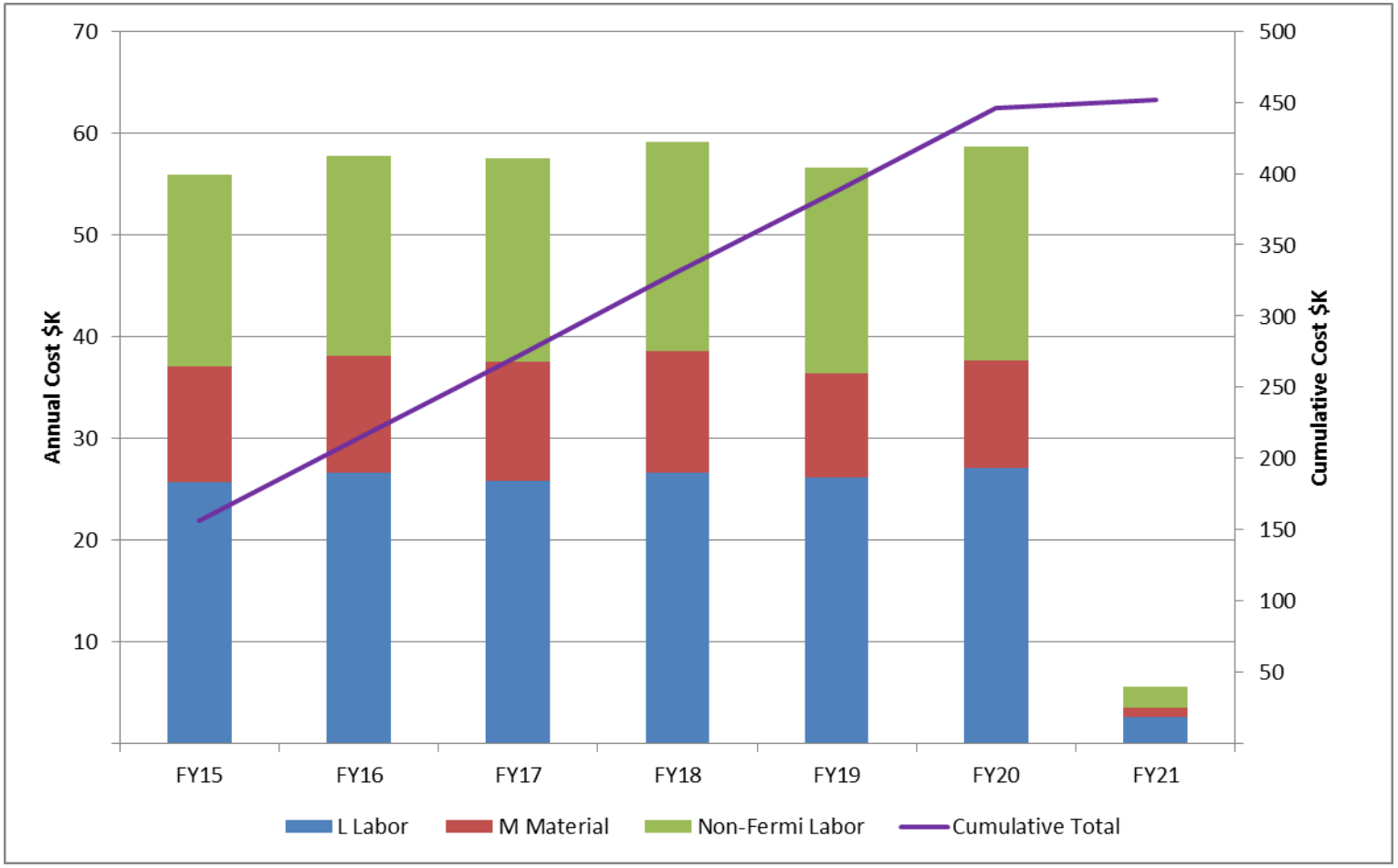
8.8 Detector Installation & Assembly



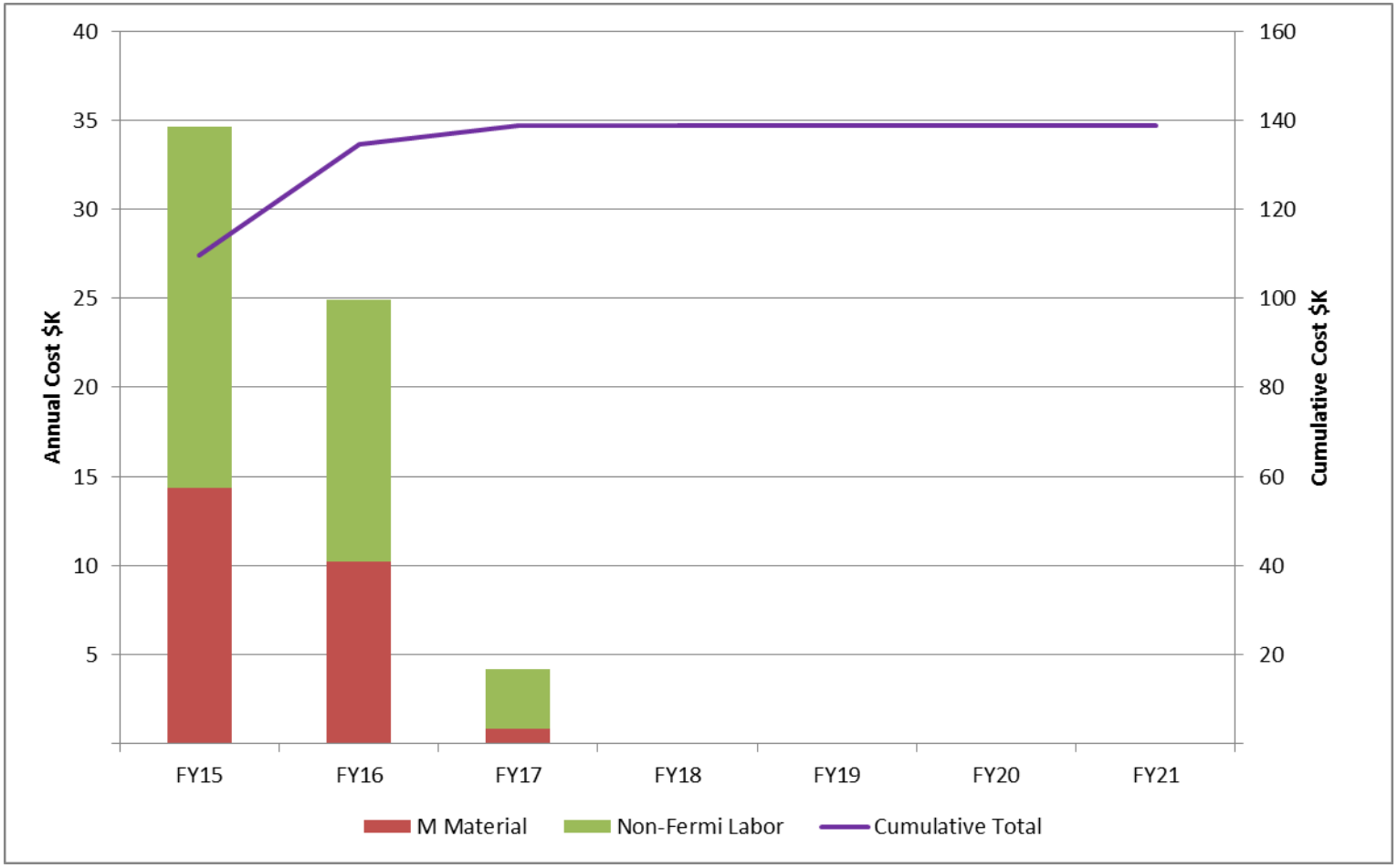
Cosmic Ray Veto

Project Slides: Labor / Material Breakdown

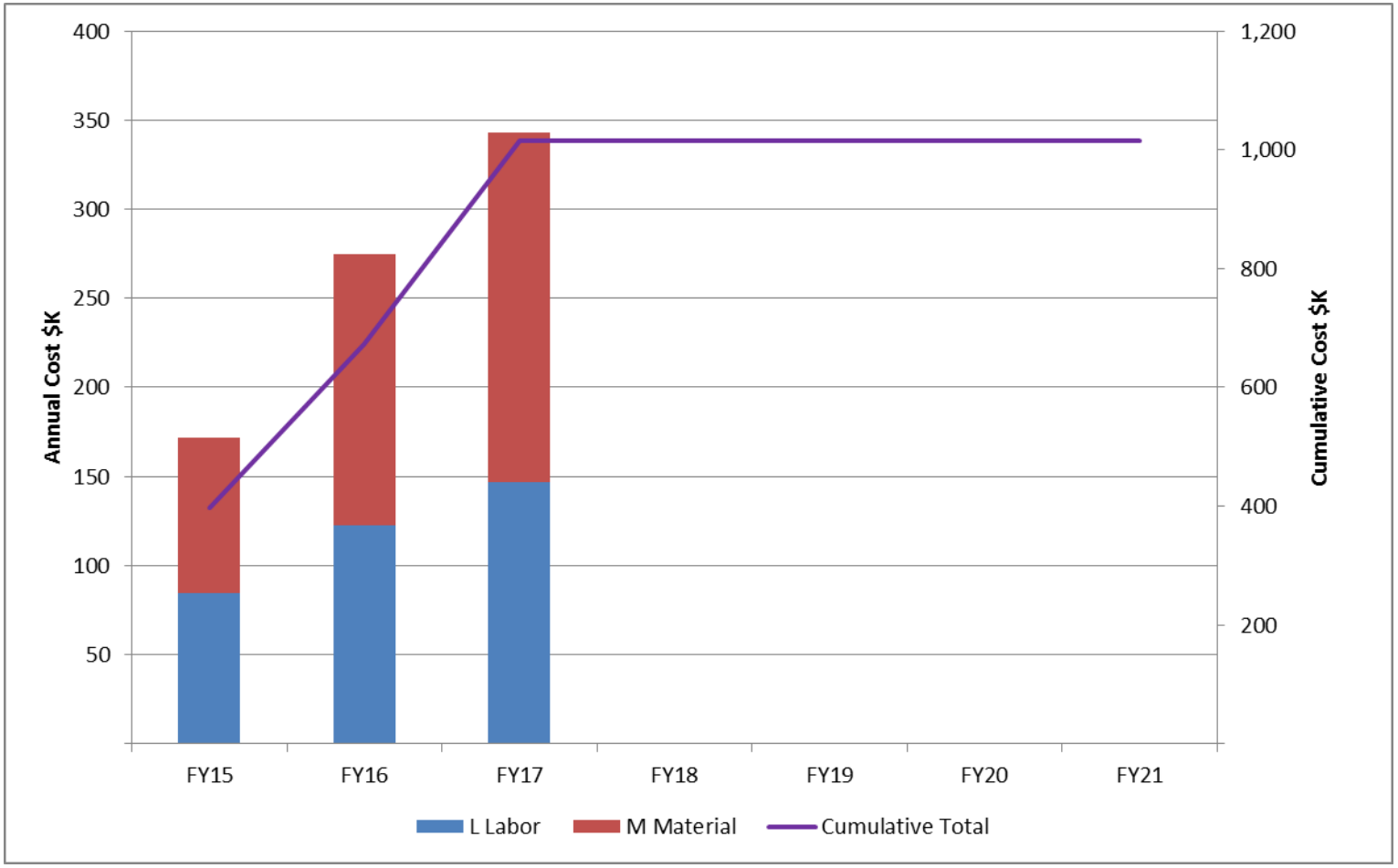
8.1 Project Management



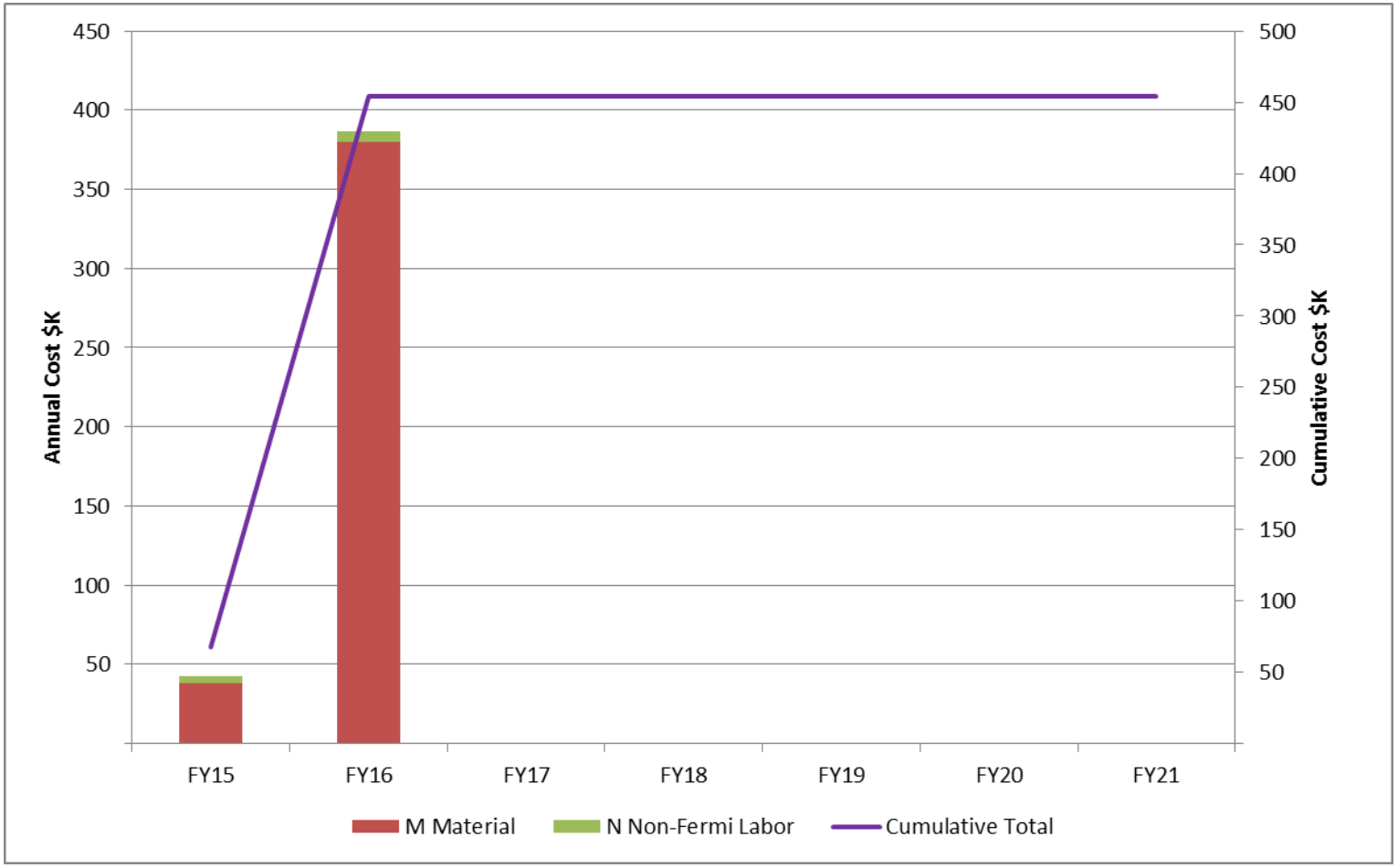
8.2 Mechanical Design



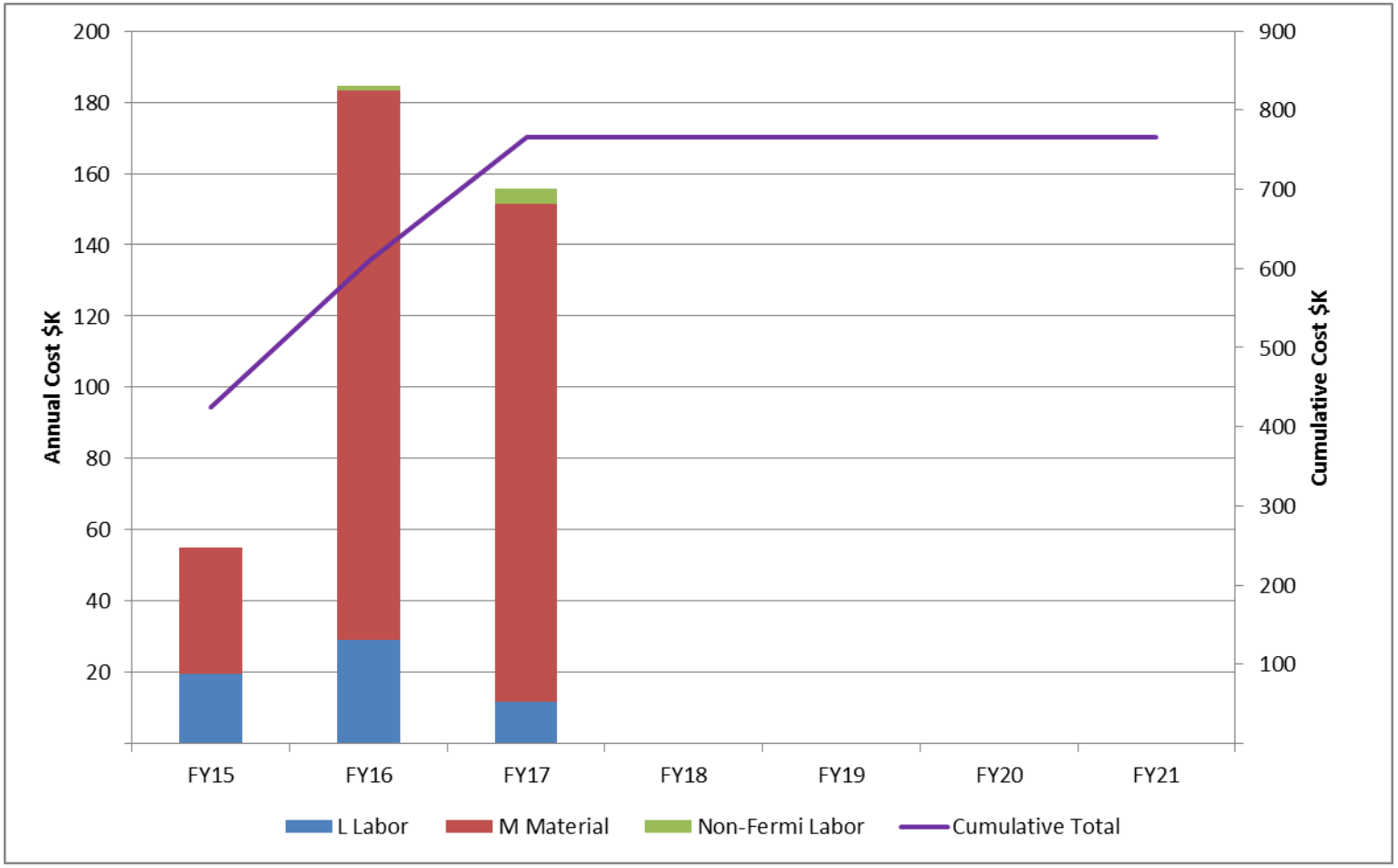
8.3 Scintillator Extrusions



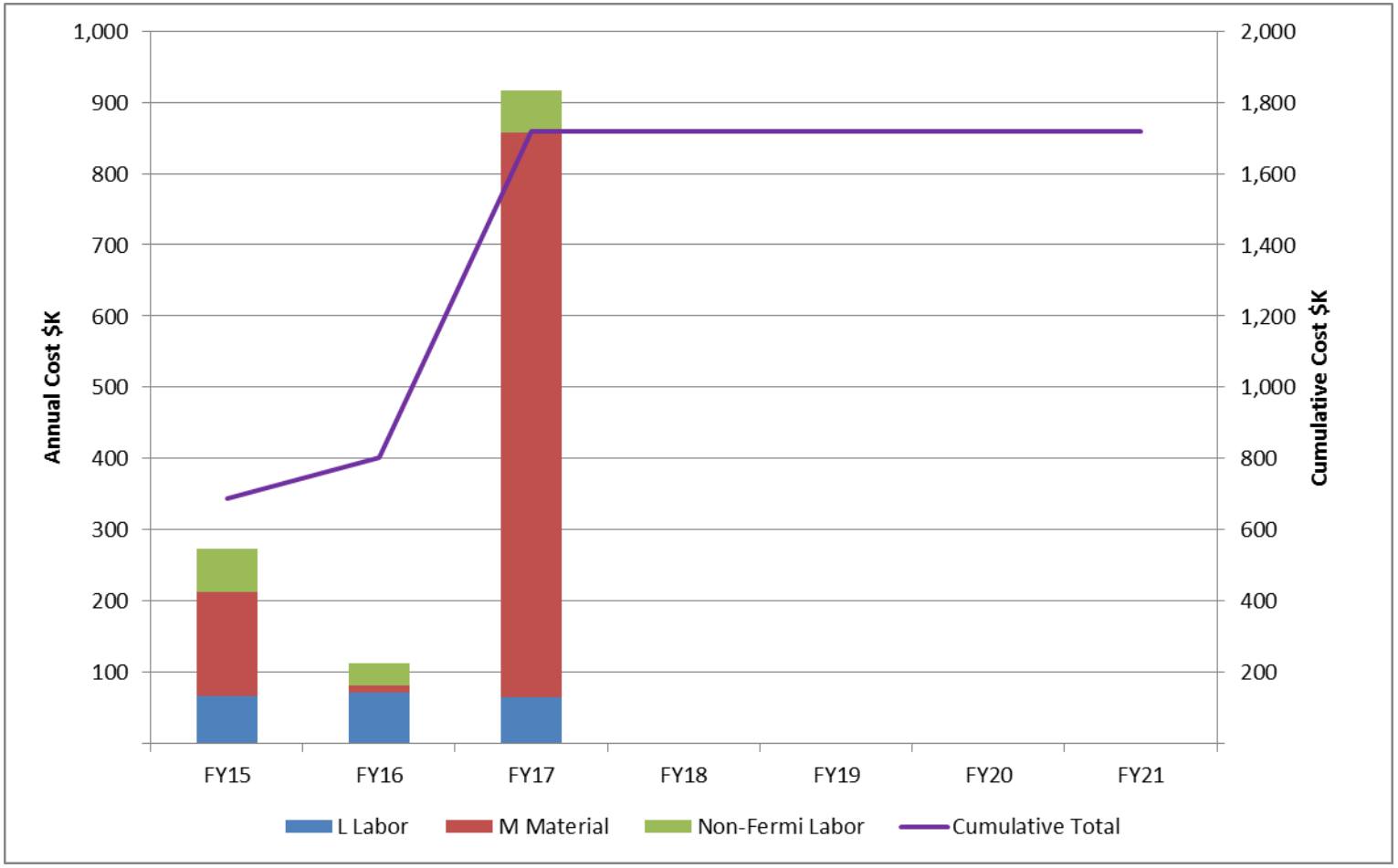
8.4 Fibers


450
400
350
300
250
200
150
100
50
Annual Cost $K
500
450
400
350
300
250
200
150
100
50
Cumulative Cost $K
FY15
FY16
FY17
FY18
FY19
FY20
FY21
M Material
N Non-Fermi Labor
Cumulative Total

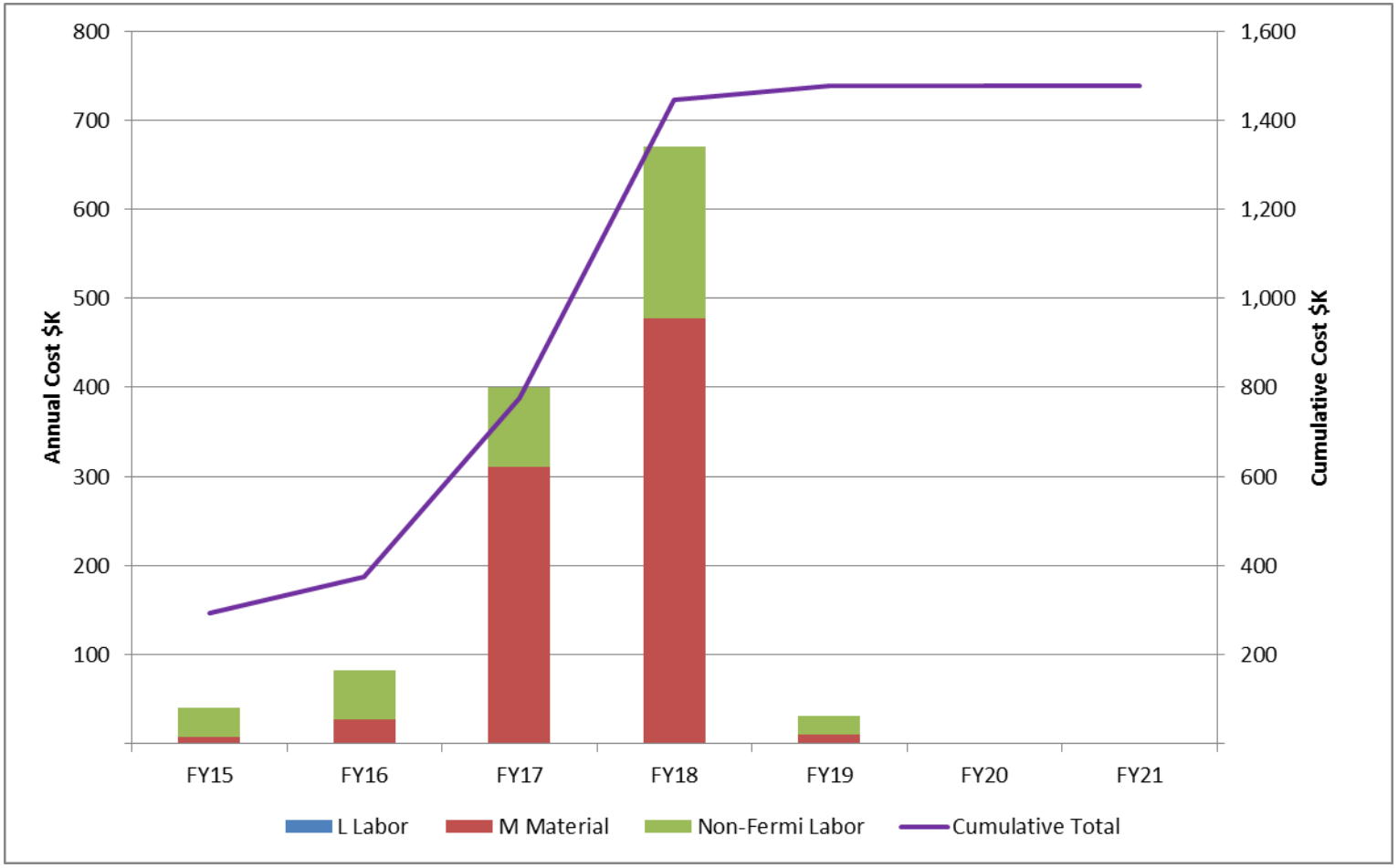
8.5 Silicon Photomultipliers (SiPMs)



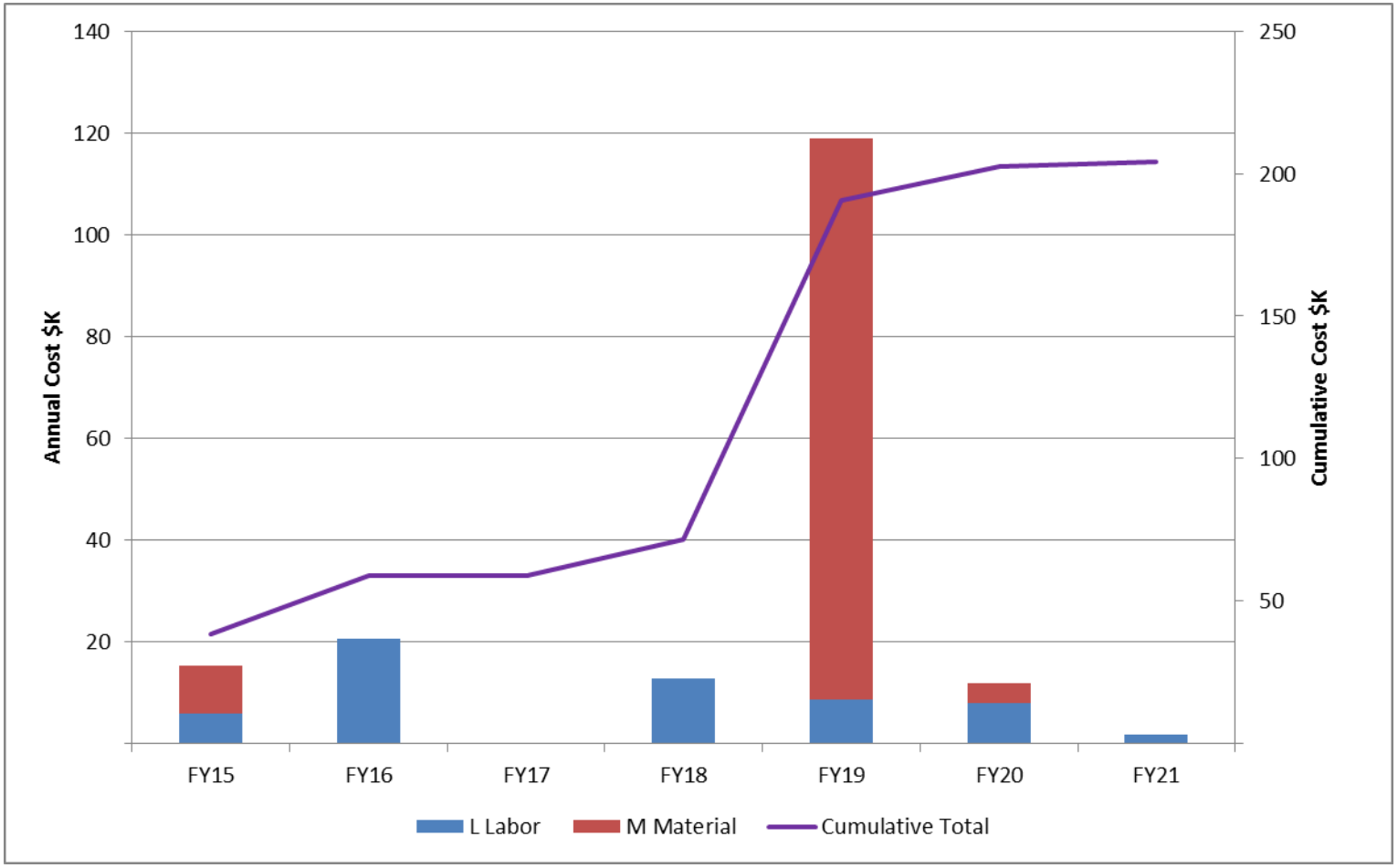
8.6 Electronics



8.7 Module Fabrication

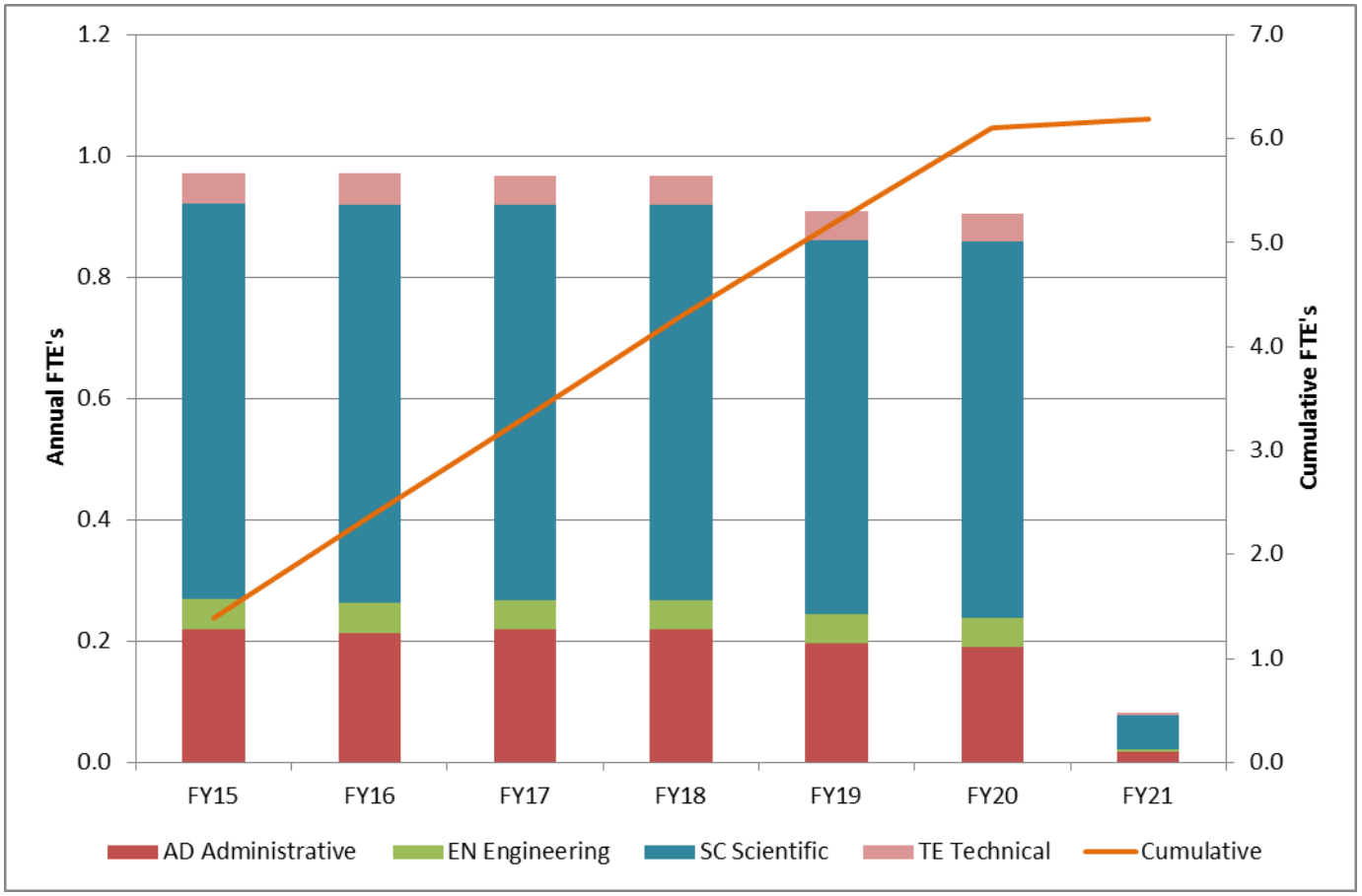


8.8 Detector Installation & Assembly

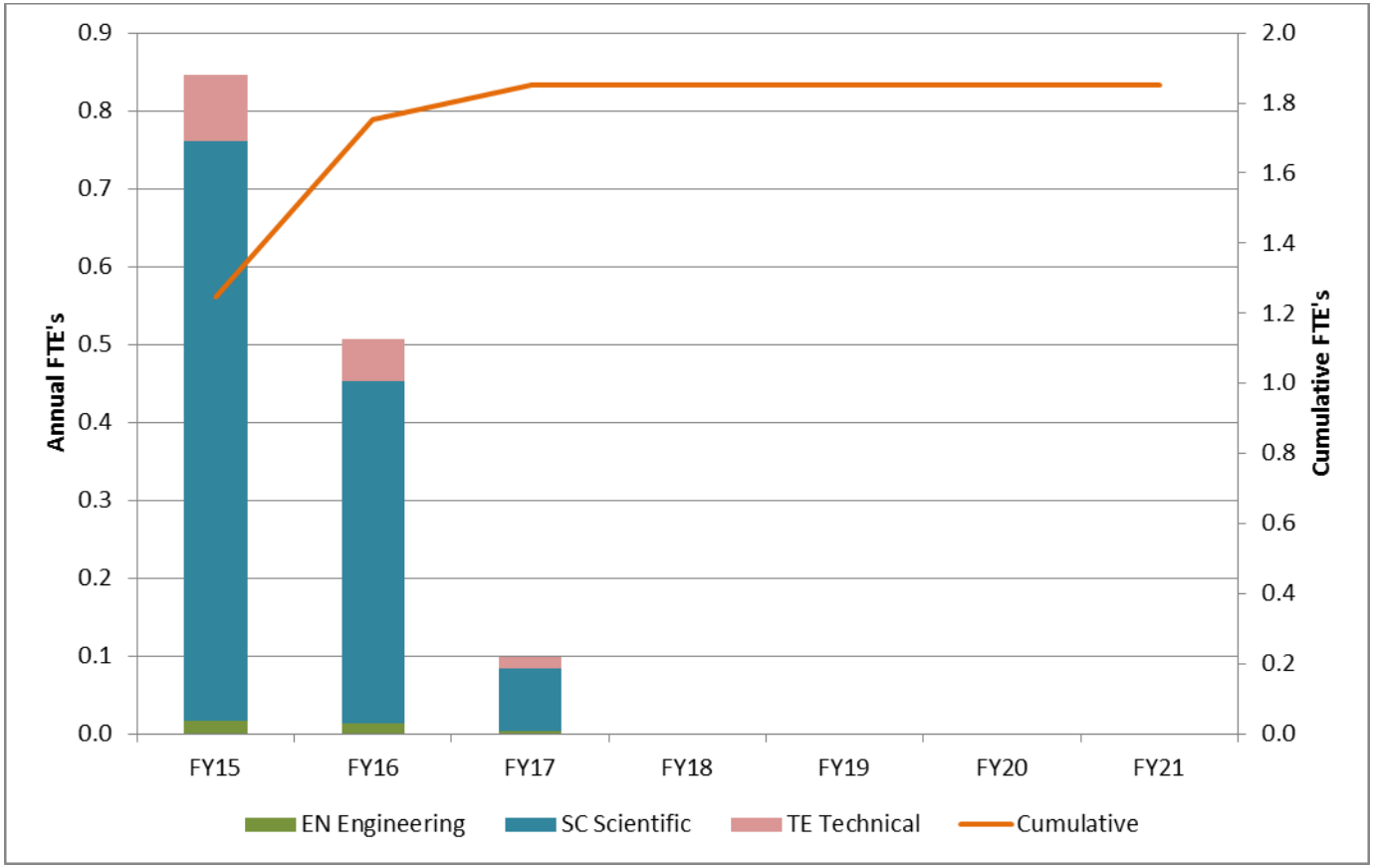


Project Slides: FTE's by Discipline

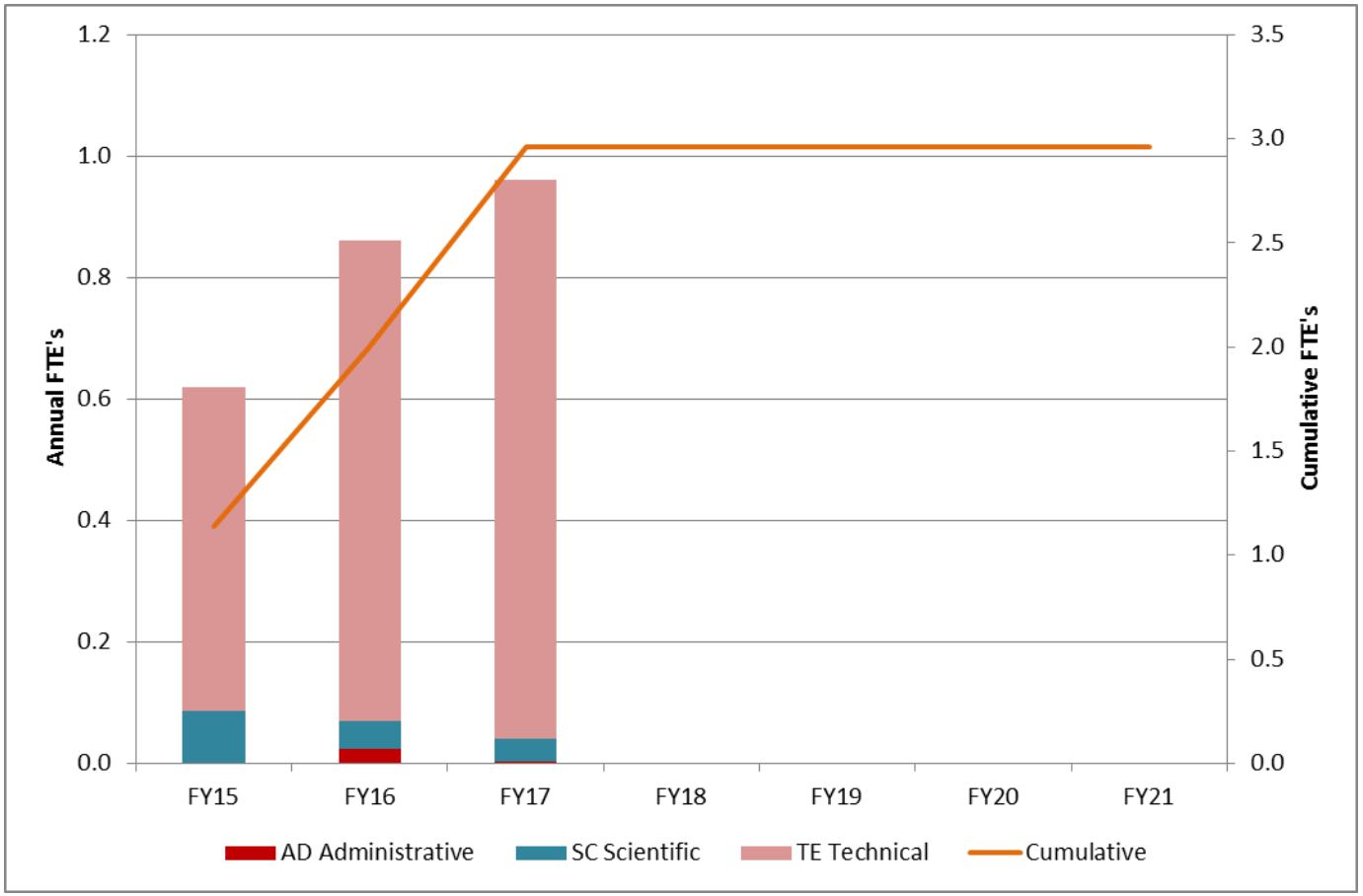
8.1 Project Management



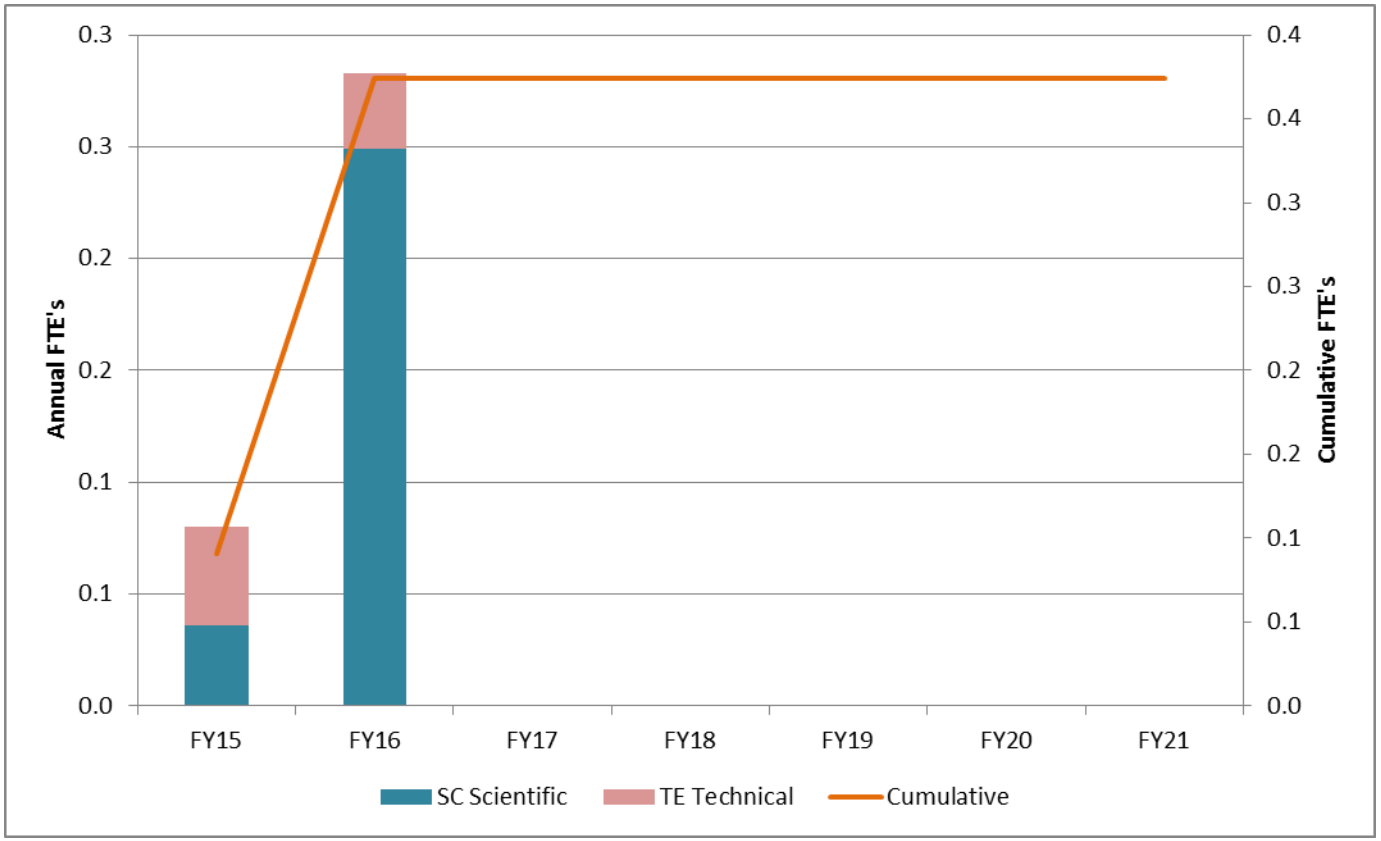
8.2 Mechanical Design



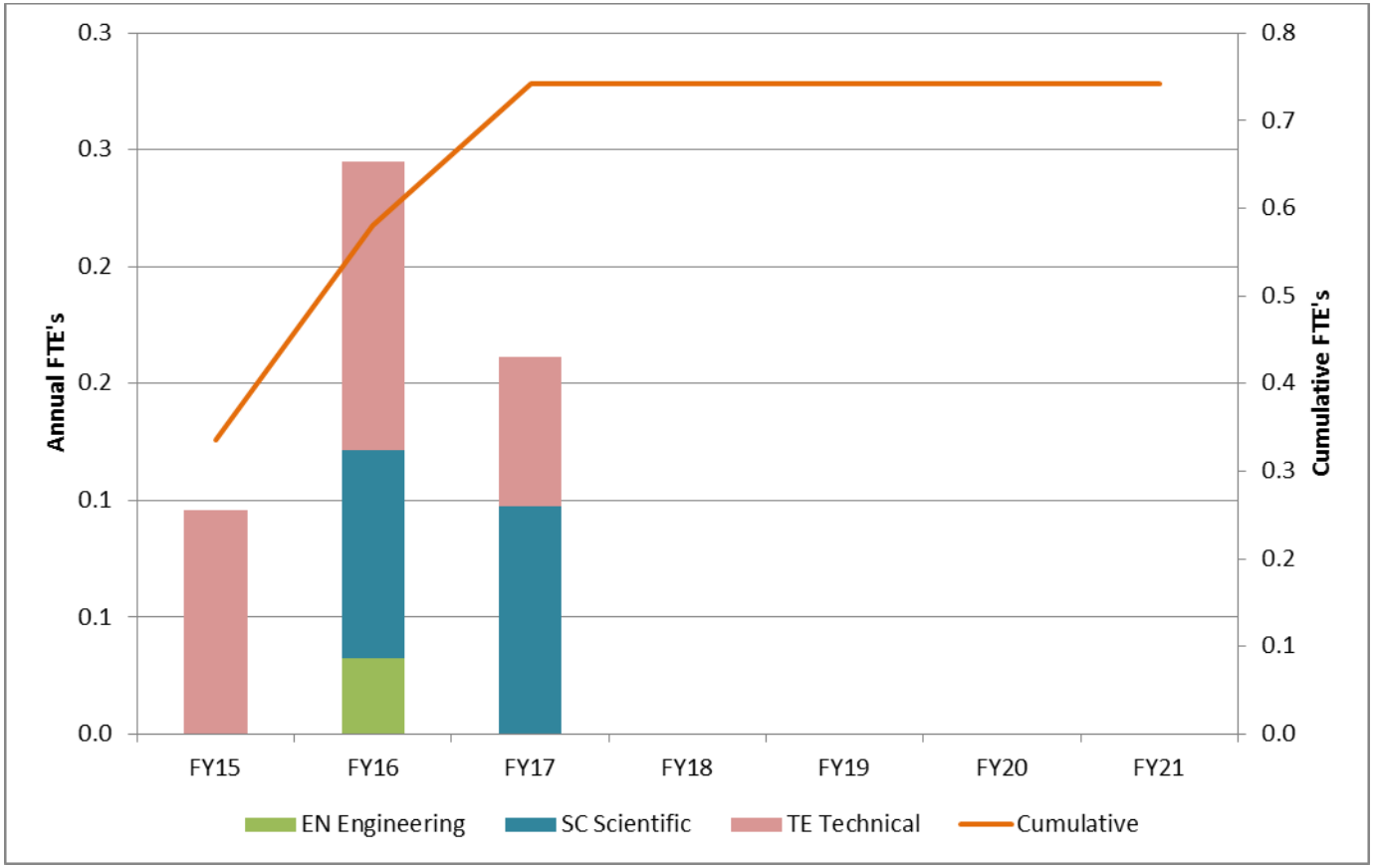
8.3 Scintillator Extrusions



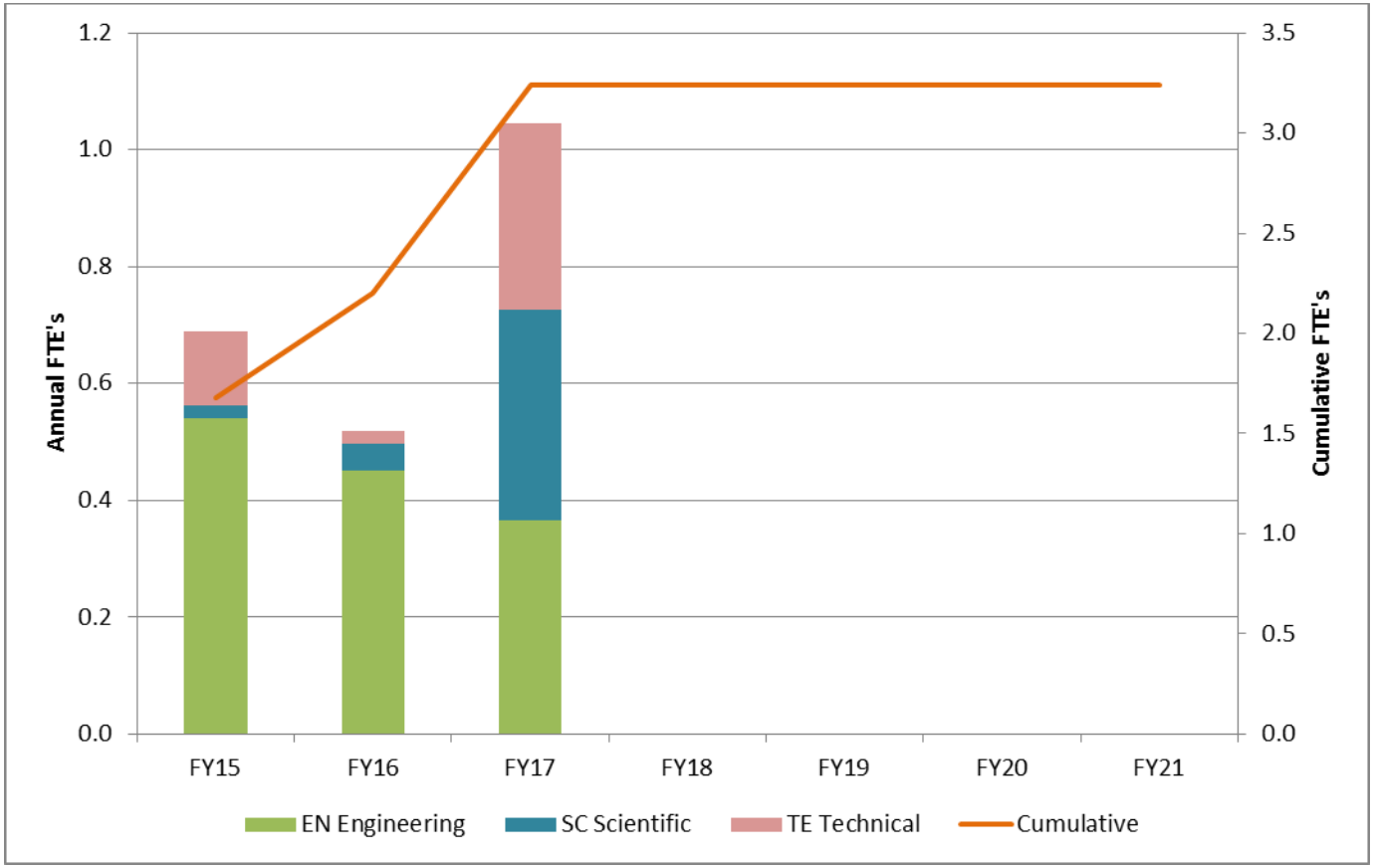
8.4 Fibers


0.3
0.3
0.2
0.2
0.1
0.1
0.0
Annual FTE's
0.4
0.4
0.3
0.3
0.2
0.2
0.1
0.1
0.0
Cumulative FTE's
FY15
FY16
FY17
FY18
FY19
FY20
FY21
SC Scientific
TE Technical
Cumulative

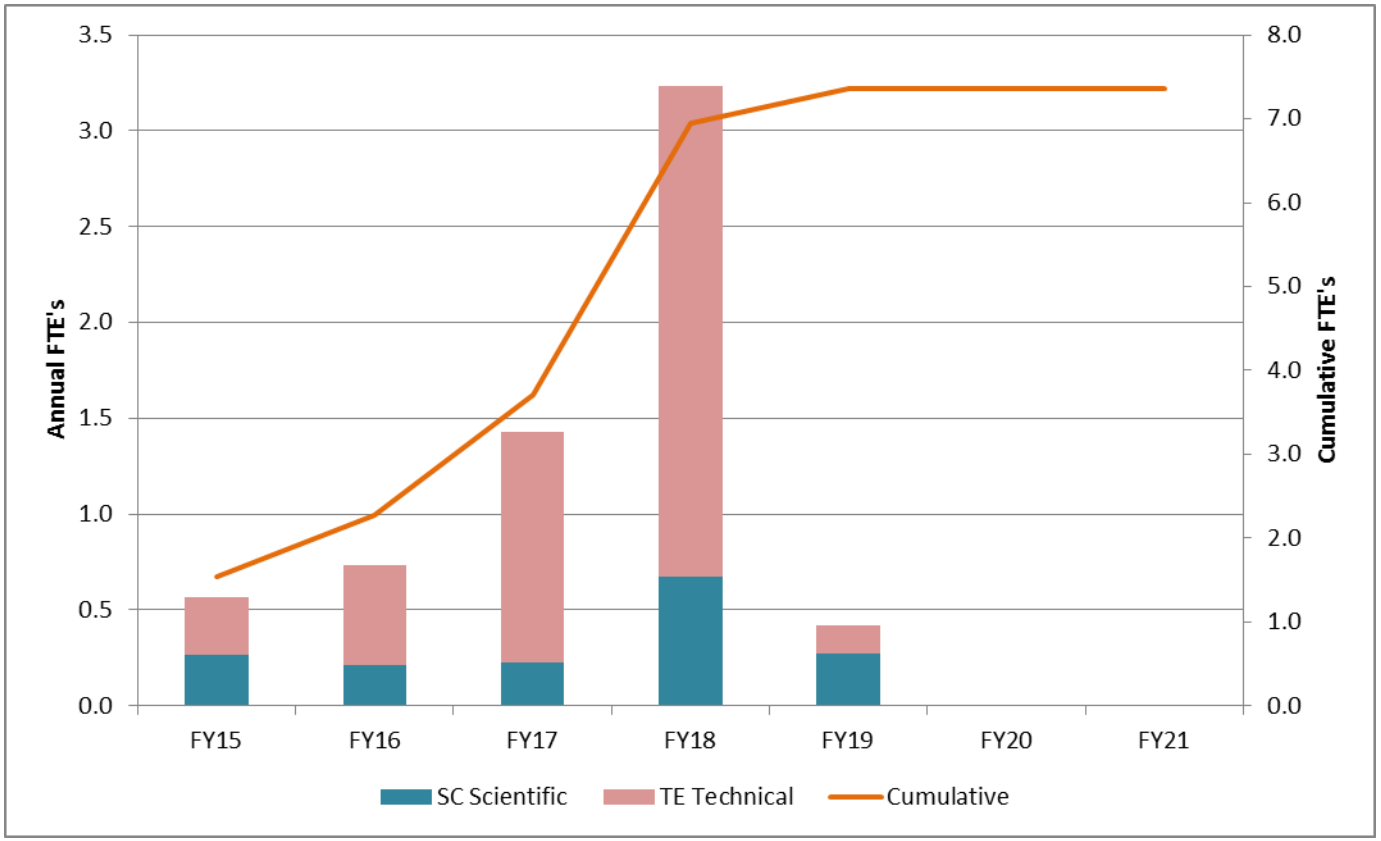
8.5 Silicon Photomultipliers (SiPMs)



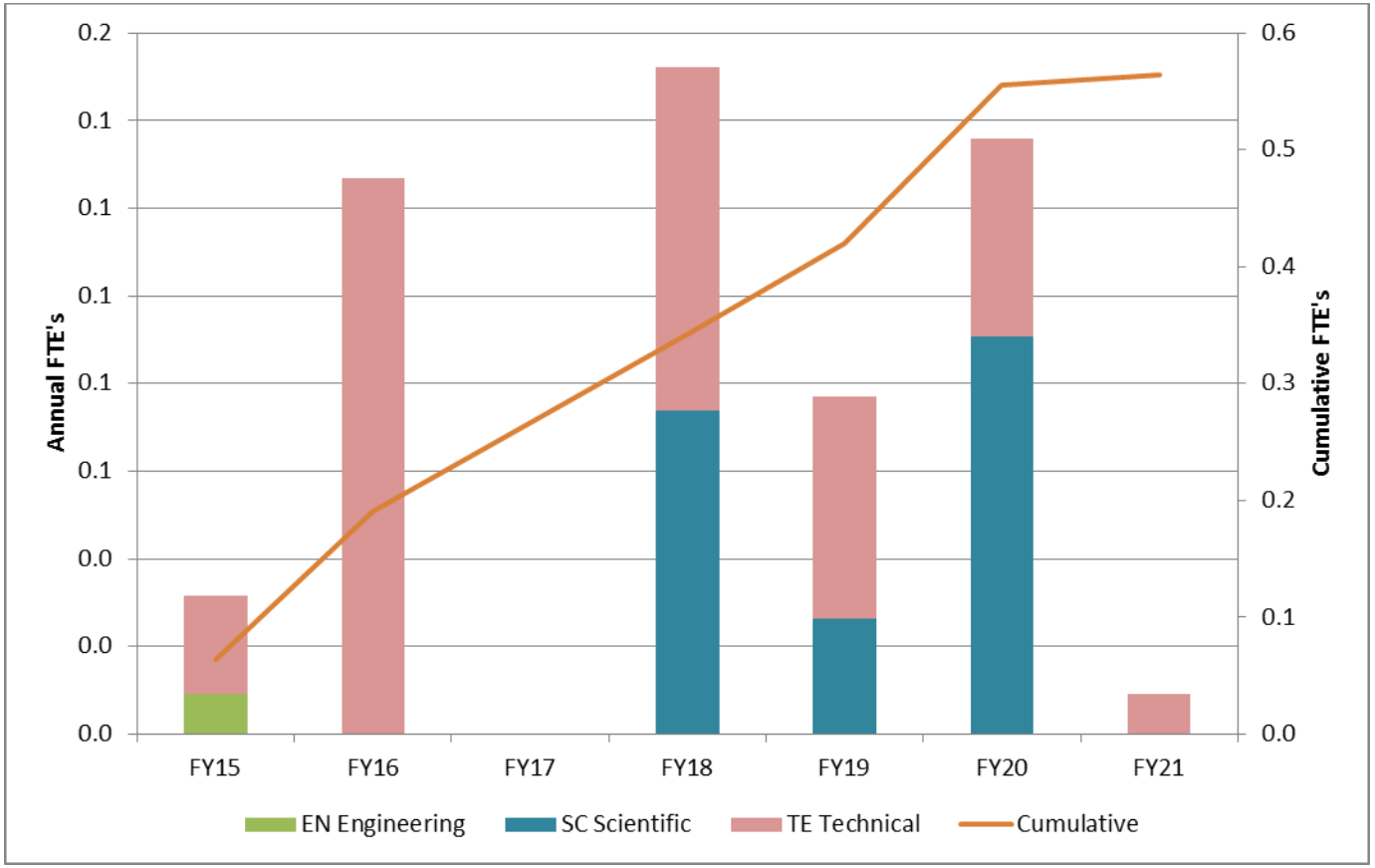
8.6 Electronics



8.7 Module Fabrication



8.8 Detector Installation & Assembly



Project Slides: Cost Book

475.8 Cost Book

	Base Cost (AY k$)					
	M&S	Labor	Total	Estimate Uncertainty (on remaining costs)	% Contingency on ETC	Total Cost
475.08 Cosmic Ray Veto						
475.08.01 Project Management	273	178	452	75	20%	526
475.08.02 Mechanical Design	136	3	139	24	29%	163
475.08.03 Scintillator extrusions	559	457	1,015	206	22%	1,221
475.08.04 Fibers	455		455	105	24%	559
475.08.05 Silicon Photomultipliers (SiPMs)	460	306	766	188	36%	954
475.08.06 Electronics	1,312	406	1,718	509	32%	2,227
475.08.07 Module Fabrication	1,460	16	1,476	462	34%	1,938
475.08.08 Detector assembly and installation	124	80	204	63	35%	267
475.08.09 Cosmic Ray Veto Conceptual Design/R&D	258	252	511		0%	511
475.08.99 Risk Based Contingency				323		323
Grand Total	5,036	1,698	6,735	1,955	36%	8,690

8.1 Project Managment

	Base Cost (AY k$)					
	M&S	Labor	Total	Estimate Uncertainty (on remaining costs)	% Contingency on ETC	Total Cost
475.08 Cosmic Ray Veto						
475.08.01 Project Management						
475.08.01 Project Management Actuals	64	7	71			71
475.08.01.02 Preliminary & Final Design (Post CD-1; PED)	66	50	116	22	20%	138
475.08.01.03 Implementation & Close-out (Post CD-3; Line Item)	144	121	264	53	20%	317
Grand Total	273	178	452	75	20%	526

8.2 Mechanical Design

	Base Cost (AY k$)					
	M&S	Labor	Total	Estimate Uncertainty (on remaining costs)	% Contingency on ETC	Total Cost
475.08 Cosmic Ray Veto						
475.08.02 Mechanical Design						
475.08.02 Mechanical Design Actuals	52	3	55			
475.08.02.01 Detector Design	37		37	9	25%	47
475.08.02.02 Fabricate and test Counter Prototypes	46		46	15	32%	61
Grand Total	136	3	139	24	29%	163

8.3 Scintillator

	Base Cost (AY k$)					
	M&S	Labor	Total	Estimate Uncertainty (on remaining costs)	% Contingency on ETC	Total Cost
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

8.4 Fibers

	Base Cost (AY k$)					
	M&S	Labor	Total	Estimate Uncertainty (on remaining costs)	% Contingency on ETC	Total Cost
475.08 Cosmic Ray Veto						
475.08.04 Fibers						
475.08.04 Fibers Actuals	15		15			15
475.08.04.01 Waveshifting fiber (WF) procurement	425		425	103	24%	528
475.08.04.02 WF quality Assurance design and fabrication	14		14	1	10%	16
Grand Total	455		455	105	24%	559

8.5 Silicon Photomultipliers (SiPMs)

	Base Cost (AY k$)					
	M&S	Labor	Total	Estimate Uncertainty (on remaining costs)	% Contingency on ETC	Total Cost
475.08 Cosmic Ray Veto						
475.08.05 Silicon Photomultipliers (SiPMs)						
475.08.05 Silicon Photomultipliers (SiPMs) Actuals	31	213	243			243
475.08.05.01 Silicon Photomultipliers (SiPMs) procurement	375	33	408	147	36%	555
475.08.05.02 Silicon Photomultipliers (SiPMs) quality assurance design	54	60	114	42	37%	156
Grand Total	460	306	766	188	36%	954

8.6 Electronics

	Base Cost (AY k$)					
	M&S	Labor	Total	Estimate Uncertainty (on remaining costs)	% Contingency on ETC	Total Cost
475.08 Cosmic Ray Veto						
475.08.06 Electronics						
475.08.06 Electronics Actuals	92	36	128			128
475.08.06.01 Counter Mother Boards	309		309	85	30%	394
475.08.06.02 Front-end Boards	636	294	930	269	29%	1,199
475.08.06.03 Readout Controllers	260	6	266	85	32%	351
475.08.06.04 Integration with DAQ	15	71	86	69	80%	155
Grand Total	1,312	406	1,718	509	32%	2,227

8.7 Module Fabrication

	Base Cost (AY k$)					
	M&S	Labor	Total	Estimate Uncertainty (on remaining costs)	% Contingency on ETC	Total Cost
475.08 Cosmic Ray Veto						
475.08.07 Module Fabrication						
475.08.07 Module Fabrication Actuals	95	1	96			96
475.08.07.01 Design and fabricate assembly station	161		161	61	38%	222
475.08.07.02 Assembly Station Quality assurance design and fabrication	53	15	68	27	40%	96
475.08.07.03 Fabrication of Module Parts	447		447	92	21%	539
475.08.07.04 Module Production, Testing, Shipping	680		680	272	40%	952
475.08.07.05 Breakdown of Module Factory	23		23	10	43%	33
Grand Total	1,460	16	1,476	462	34%	1,938

8.8 Detector Assembly & Installation

	Base Cost (AY k$)					
	M&S	Labor	Total	Estimate Uncertainty (on remaining costs)	% Contingency on ETC	Total Cost
475.08 Cosmic Ray Veto						
475.08.08 Detector assembly and installation						
475.08.08 Detector assembly and installation Actuals		23	23			23
475.08.08.01 Test Installation	21	21	21	7	35%	21
475.08.08.02 Recieve Production Modules at Fermilab	18	18	18	6	35%	18
475.08.08.03 Cosmic Ray System Test	18	10	14	11	80%	14
475.08.08.04 Module Support Structure	120	10	129	39	30%	168
Grand Total	124	80	204	63	35%	267