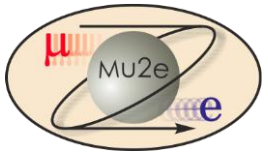
Fermilab

U.S. DEPARTMENT OF ENERGY Office of Science

Mu2e WBS 5.7 DS Internal Shielding Director's CD-2 Review



Henry Glass

Muon Beamline Level 3 Manager

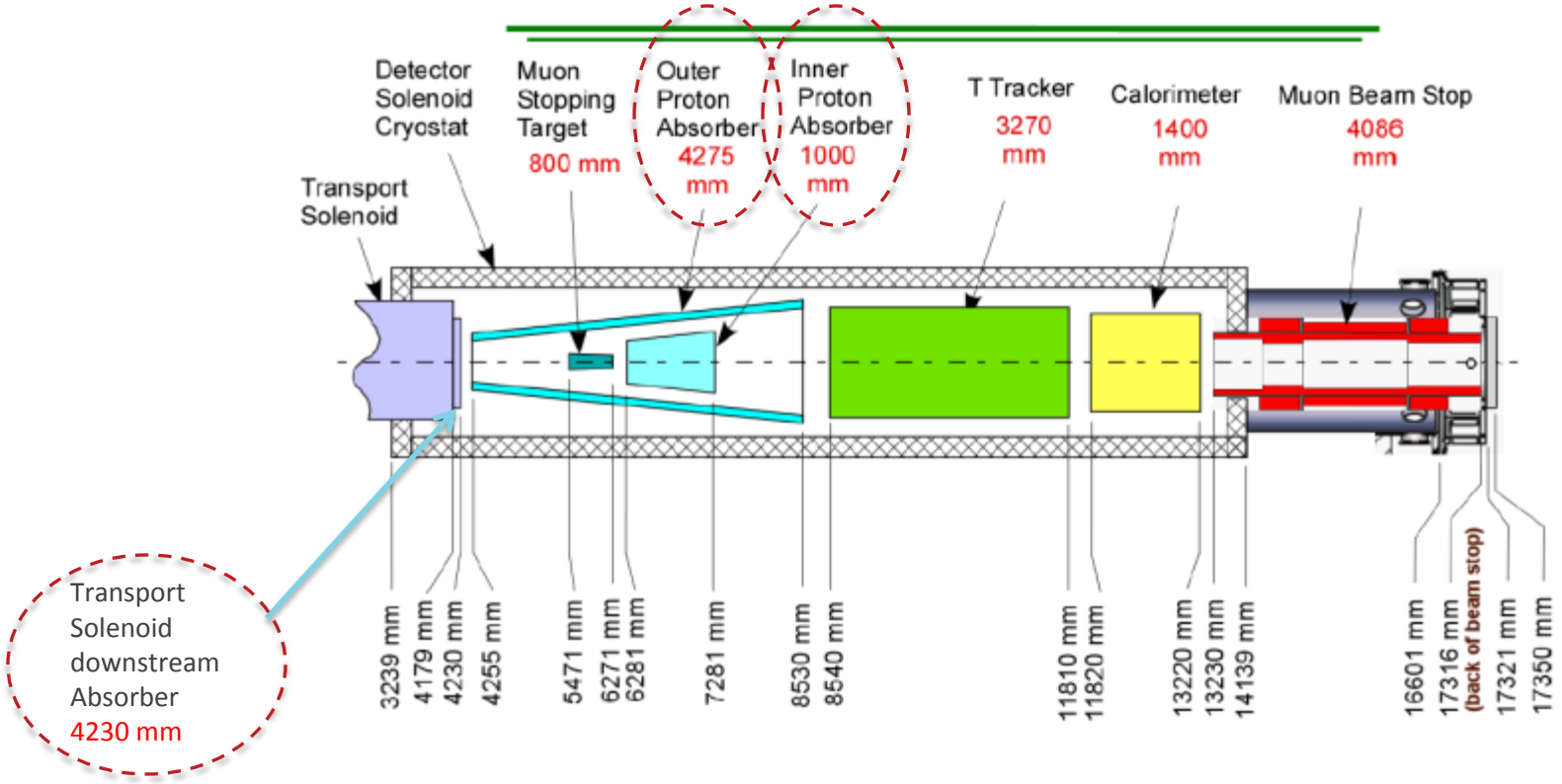
7/8/2014

Requirements

- Physics requirements:
  1. Reduce the background rates at the tracker sufficiently for reliable reconstruction of electron tracks.
  2. Minimize the energy loss and multiple scattering of electrons within the acceptance of the tracker including those that pass through the inner proton absorber and its supports.
  3. Minimize muons stopping on the proton absorber.
  4. Minimize contributions to the background rates in the calorimeter.

Design

- Three components of DS Internal Shielding

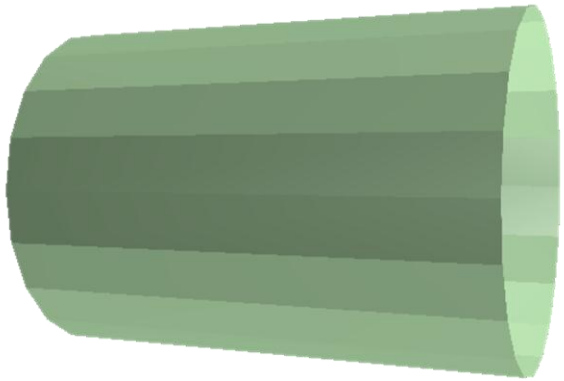


TSdA Design

- Transport Solenoid downstream absorber (TSdA):
  - Disk shaped, center hole allows muon beam to pass through
  - Nominal material: borated polyethylene
  - Reduces hit rate in tracker by ~30% (simulation)
  - No significant technical issues

IPA Design

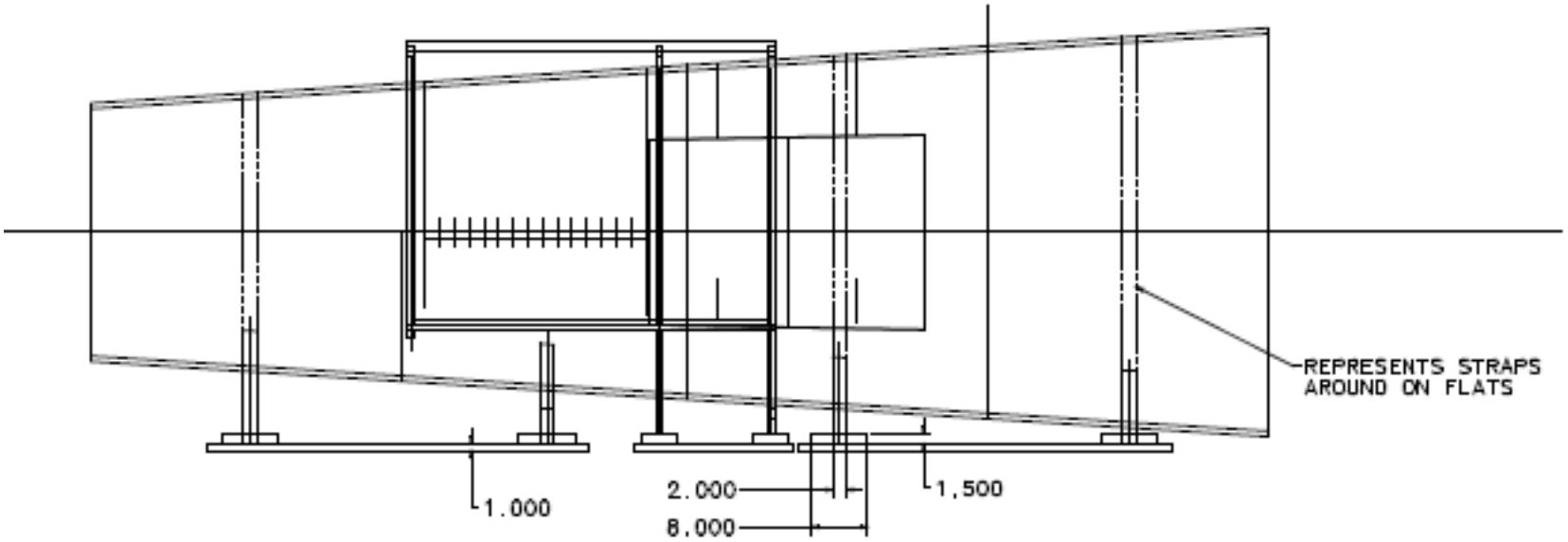
- Inner Proton Absorber (IPA):
  - Conical frustum, 0.5 mm thickness, 1.0 m length
  - Low-Z materials required
  - Mechanical stability requirements best met using carbon fiber
  - Support and align using tungsten wires; support from OPA wall
  - Plan to build and monitor a prototype to refine design



OPA Design

- Outer Proton Absorber (OPA)
  - Also conical frustum, 20 mm thickness, ~4.3 m length, ~300 kg
  - Nominal material is 5% borated polyethylene
  - Made in two longitudinal sections to allow access to stopping target
  - Slots cut into OPA will allow for tungsten support wires to be strung between stopping target and support frame
  - OPA supported by stainless steel cradles

Proton Absorber / Stopping Target Assembly



Changes since CD-1

- IPA length reduced by 50%
- OPA is new item
- TSdA is also new

Downselects

- IPA geometry: conical frustum selected over blade design

Performance

- Geometries of OPA and IPA are being optimized by simulation (M.J. Lee, LBNL)

Remaining work before CD-3

- Complete simulations and studies to optimize proton absorber design
- Build IPA prototype
- Optimize fabrication technique for OPA

Quality Assurance

- Components of the DS internal shielding which are received from vendors will be inspected at Fermilab by quality control technicians.

Risks

- IPA: material does not maintain its desired shape.
  - Solution: investigate use of support ribs

- OPA: Vendor may not be able to form borated polyethylene into required shape.
  - Fallback: construct OPA from flat segments into barrel configuration

ES&H

- No significant ES&H issues

Cost Table

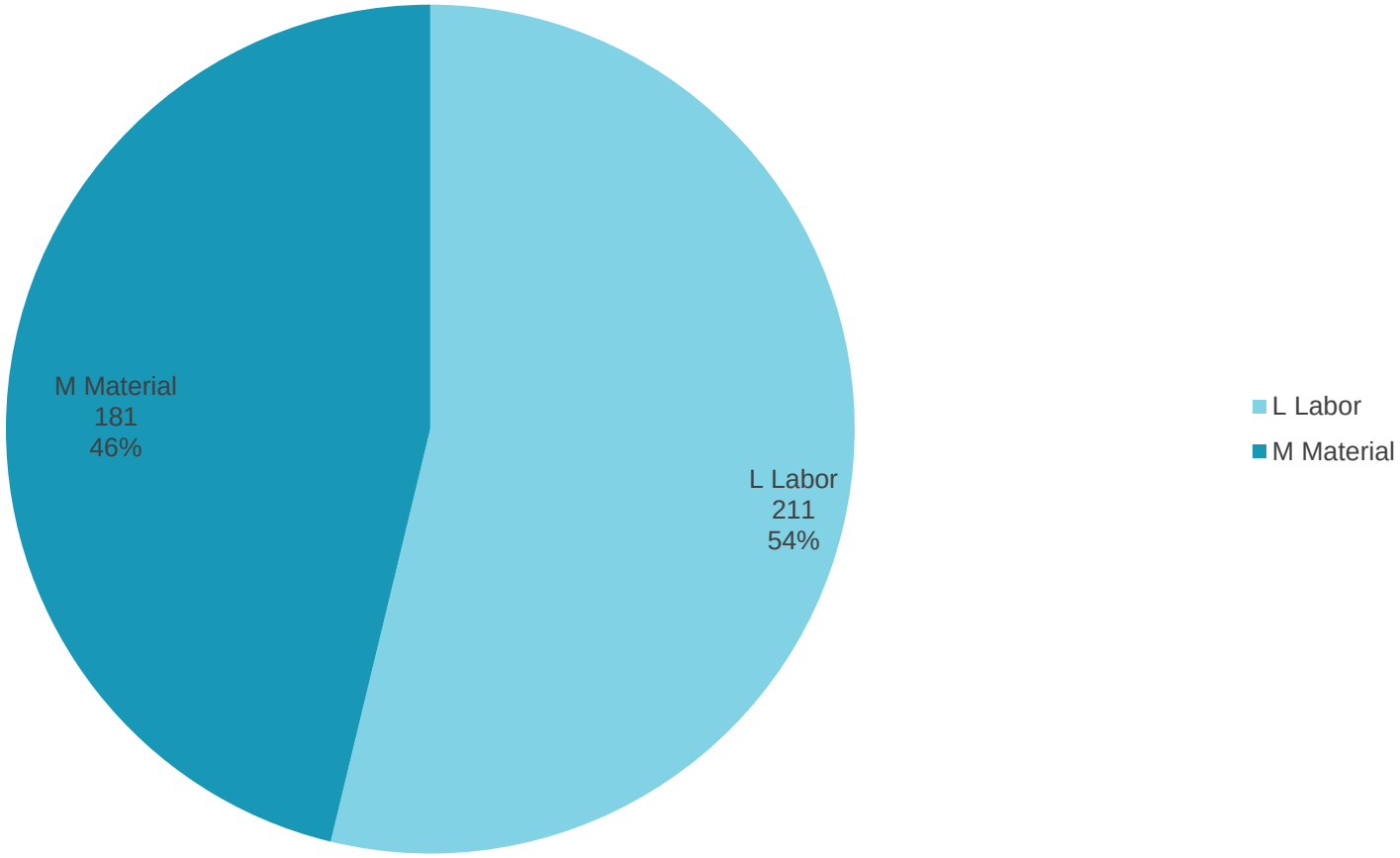
	Base Cost (AY k$)					
	M&S	Labor	Total	Estimate Uncertainty (on remaining costs)	% Contingency on ETC	Total Cost
475.05 Muon Beamline						
475.05.07 Detector Solenoid Internal Shielding						
475.05.07 Detector Solenoid Internal Shielding	181	211	392	119	34%	511
Grand Total	181	211	392	119	34%	511

Muon Beamline

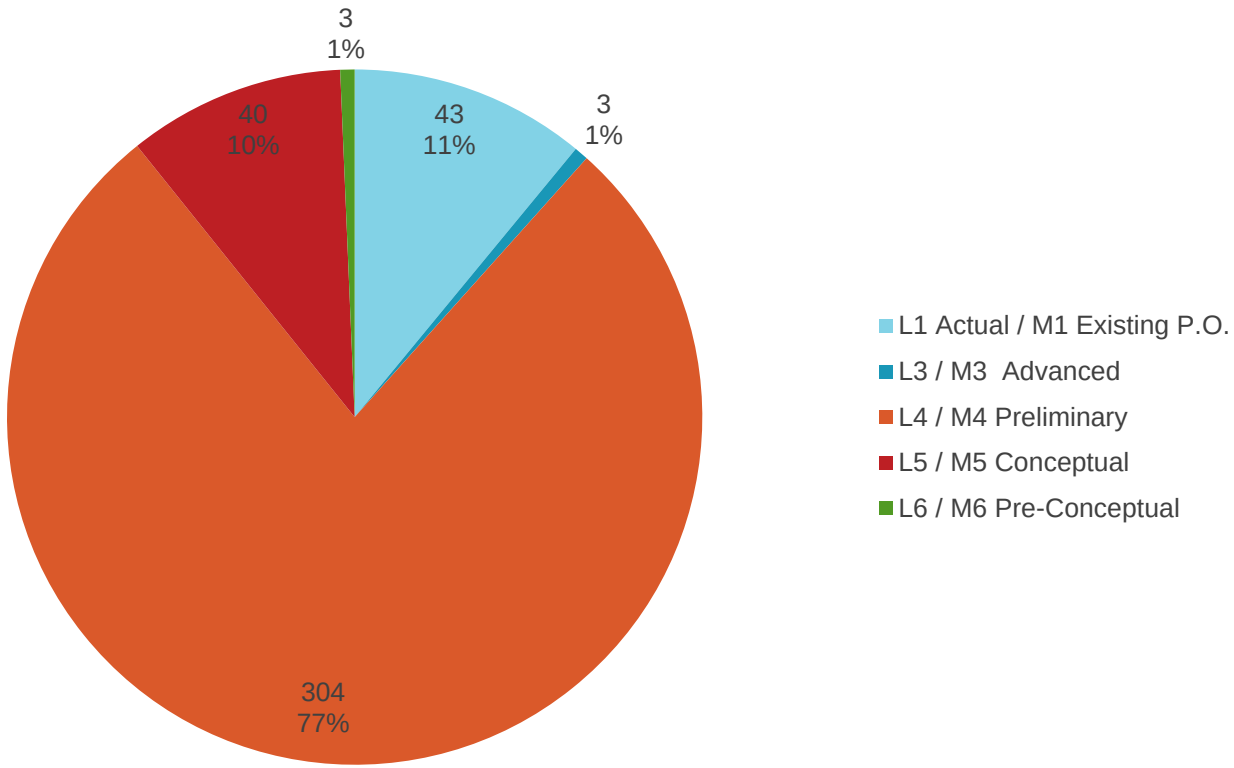
	M&S	Labor	Base Cost	Estimate Uncertainty	% Contingency on ETC	Total
475.05.01 Muon Beamline Project Management	71	3,289	3,360	194	7%	3,554
475.05.02 Vacuum System	2,041	1,264	3,305	1,174	37%	4,480
475.05.03 Collimators	725	830	1,555	515	42%	2,070
475.05.04 Upstream External Shielding	1,452	421	1,873	889	47%	2,762
475.05.05 Stopping Target	54	121	175	63	38%	238
475.05.06 Stopping Target Monitor	192	127	319	182	57%	501
475.05.07 Detector Solenoid Internal Shielding	181	211	392	119	34%	511
475.05.08 Muon Beam Stop	433	300	734	206	36%	940
475.05.09 Downstream External Shielding	2,478	826	3,304	1,339	45%	4,642
475.05.10 Detector Support Structure	1,304	1,041	2,344	620	31%	2,965
475.05.11 Systems Integration, Test & Analysis	27	348	375	193	54%	568
475.05.13 Muon Beamline Conceptual Design/R&D	107	1,873	1,980	0	0%	1,980
Risk Based Contingency				499		499
Total	9,065	10,650	19,715	5,993	38%	25,708

475.05.07 Detector Solenoid Internal shielding

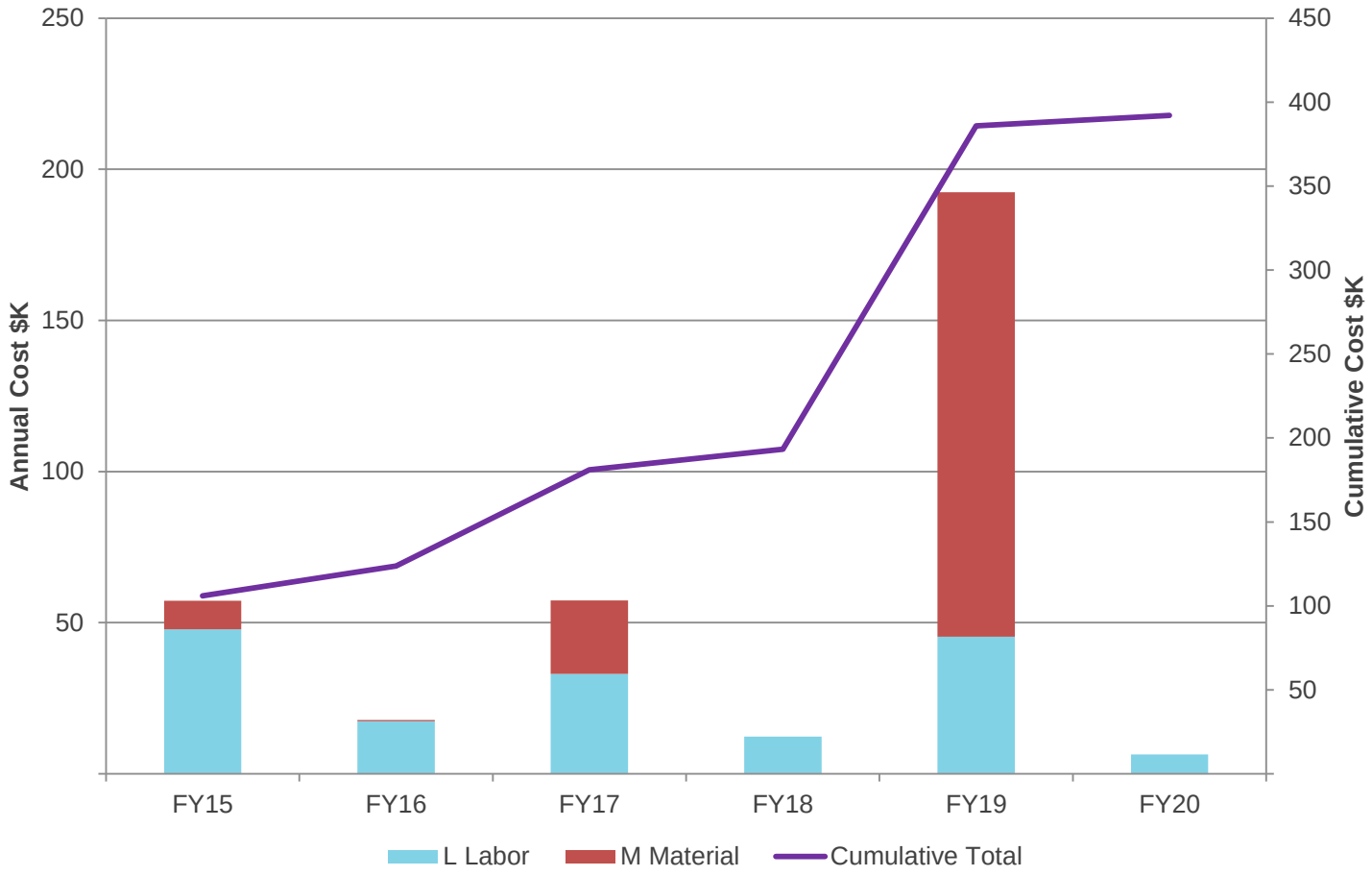
Resource Type		AY K$		Budget



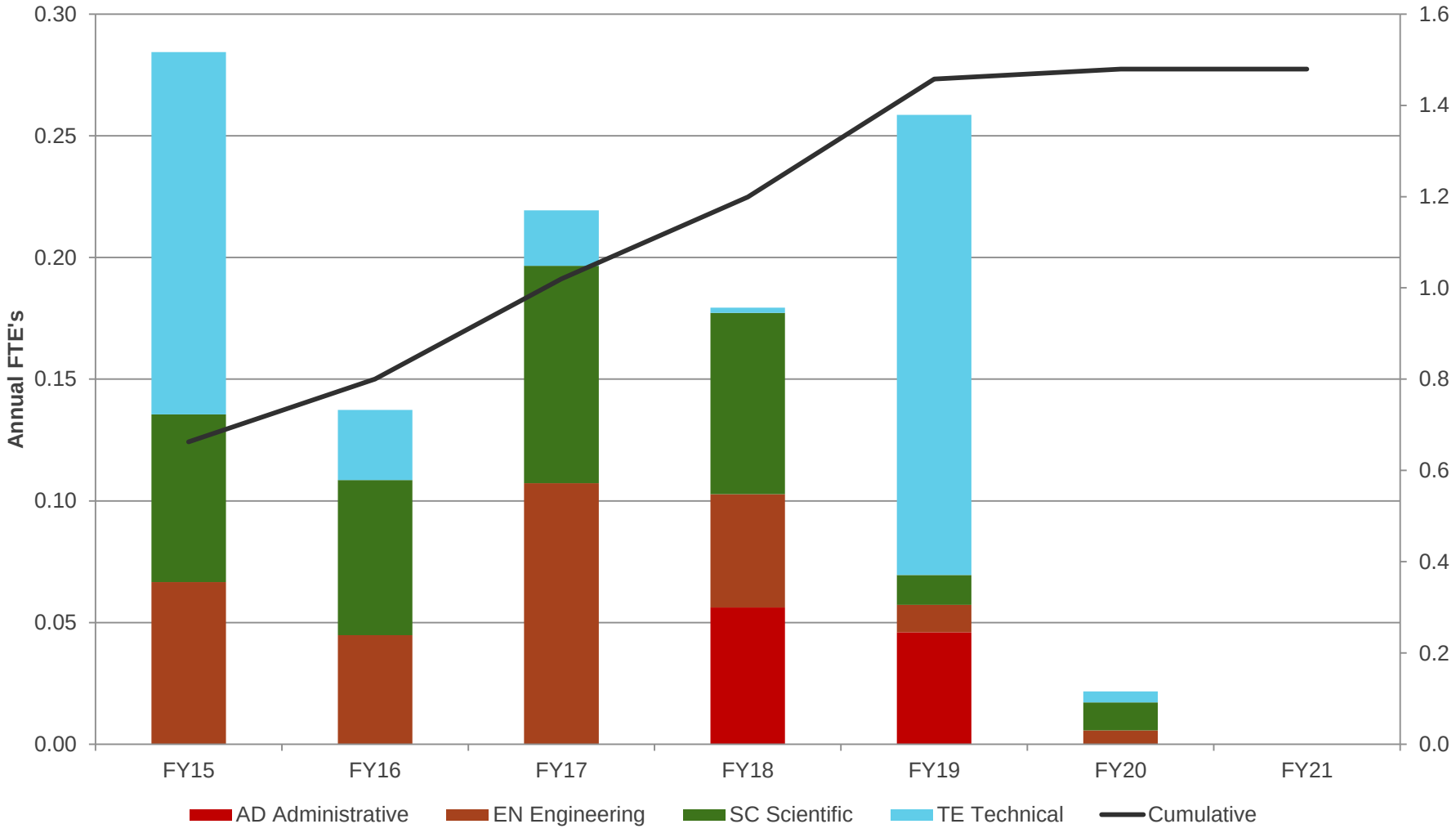
Quality of Estimate



Labor Resources by FY



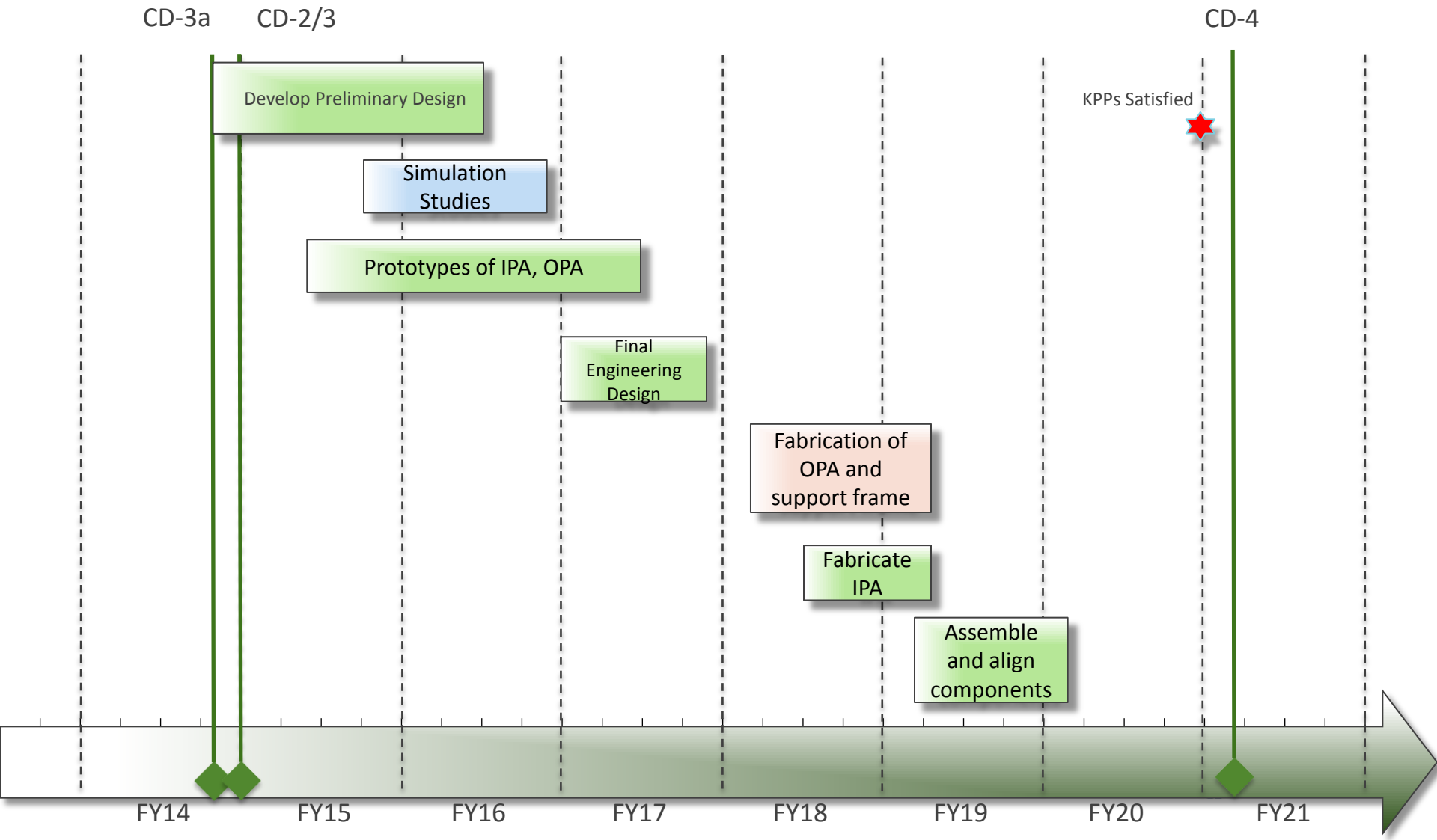
FTEs by Discipline



Major Milestones

- L5: DS Internal Shielding ready for CD-3a Review: 2/14/18
- L5: CD-3a approval: 2/28/18
- L5: Proton Absorber components inspected at FNAL: 6/26/19
- L4: DS Internal Shielding ready for CD-4: 10/17/19

Schedule, DS Internal Shielding



Summary

- Proton absorbers reduce rate of protons reaching tracker
- Solution is three independent passive absorbers (OPA, IPA, TSdA)
- Engineering designs in progress