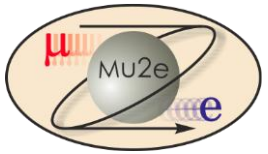
Fermilab

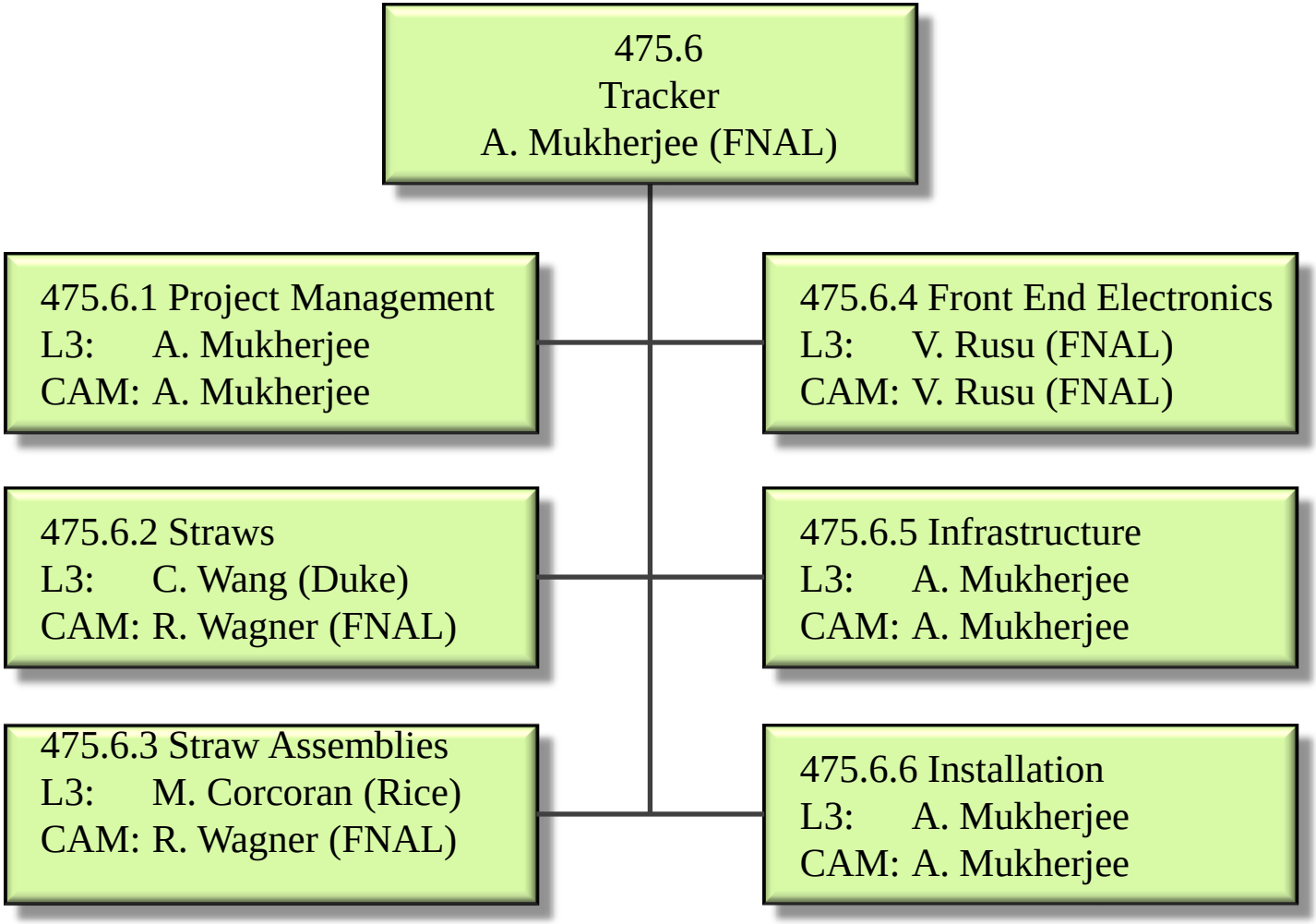
U.S. DEPARTMENT OF ENERGY Office of Science

Mu2e Tracker



Aseet Mukherjee
Tracker L2 Manager
7/8/2014

Organization

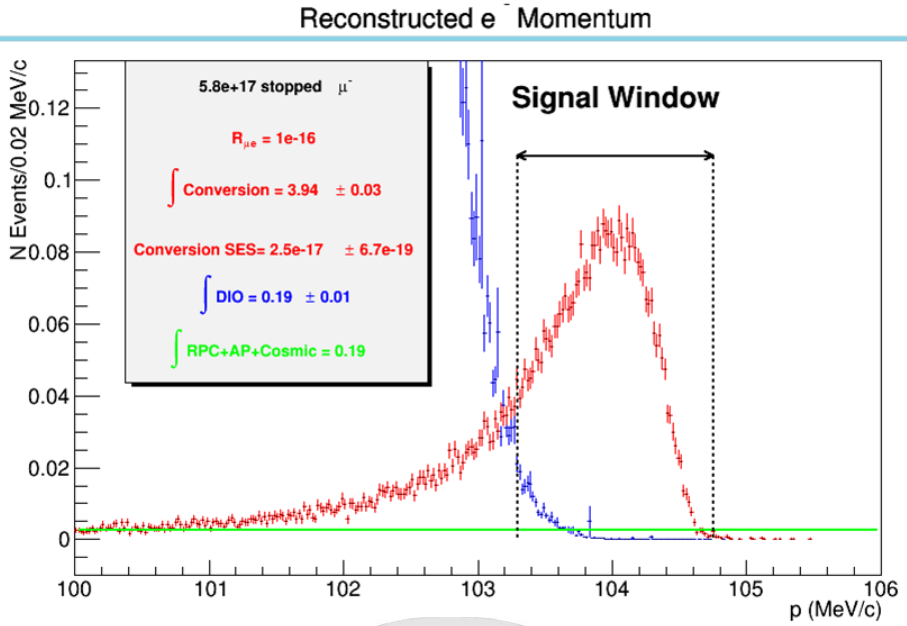


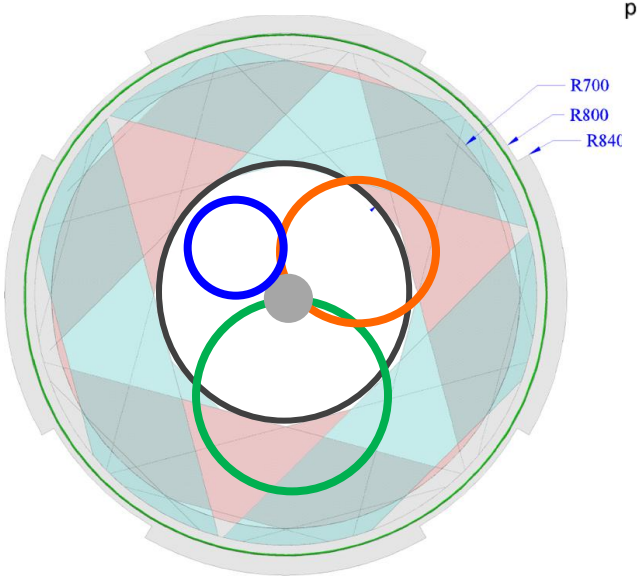
Requirements

	Mu2e Document
Science Driven Requirements	4381
Requirements for the mu2e Tracker Front End Electronics	3879
Tracker Requirements Document	732

Requirements

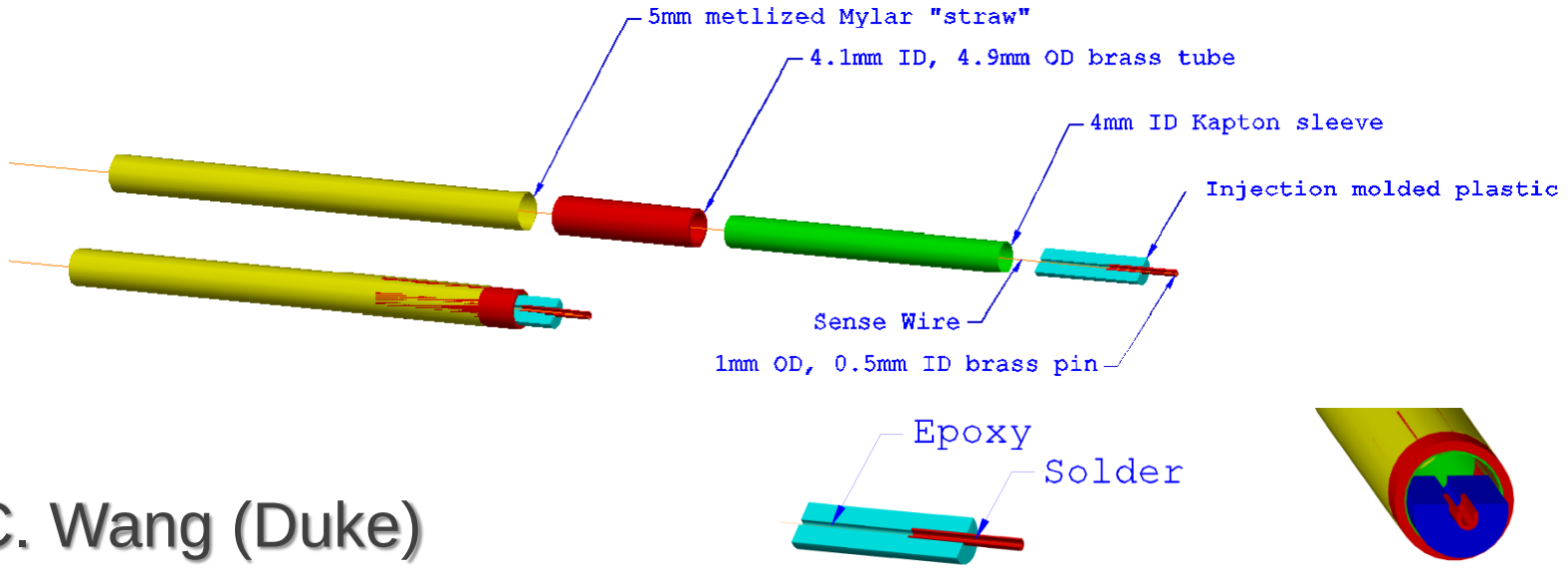
- Blind to low energy background electrons
- Adequate resolution
- Efficient for signal
- **r<380mm**
  "No" mass (vacuum)
- **380<r<700mm**
  Low mass detector
- **r>700mm**
  Support structure





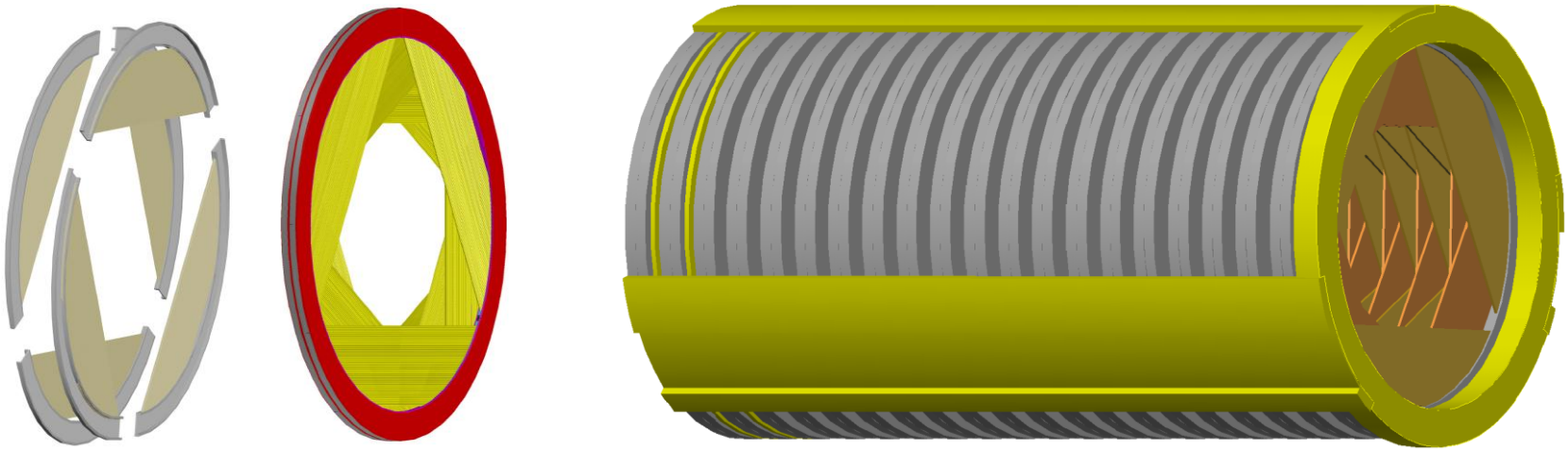
Straw Tubes: 475.06.02

$1,753k



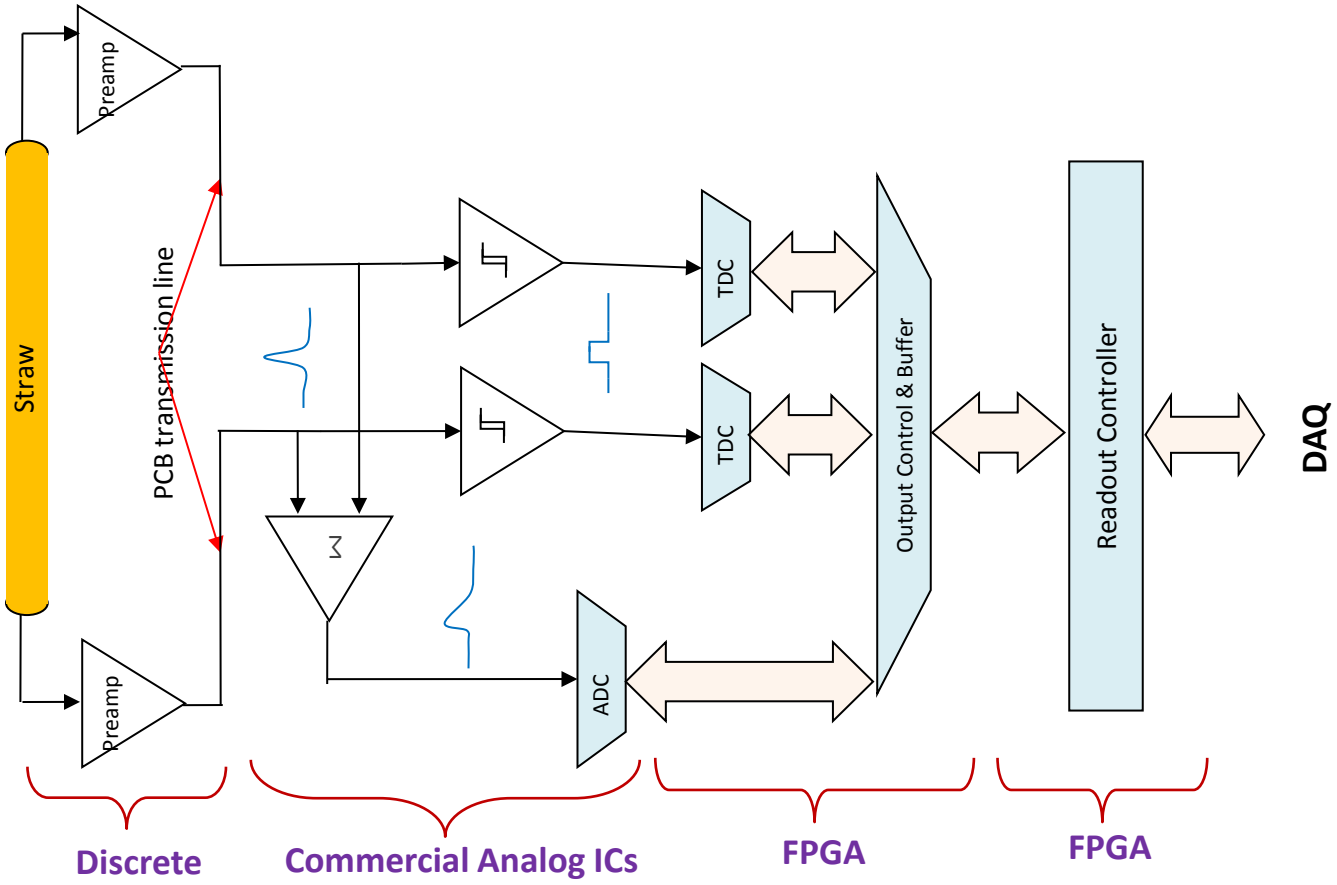
- L3: C. Wang (Duke)
  CAM: R. Wagner (FNAL)
- 5 mm OD metalized Mylar® straws, 15µm wall
  - Mylar for higher yield and modulus (compared to Kapton)
  - Aluminum on inner and outer surface
  - Gold on inner surface
- 25 µm gold plated tungsten sense wire

Straw Assemblies: 475.06.03 *$5,079k*



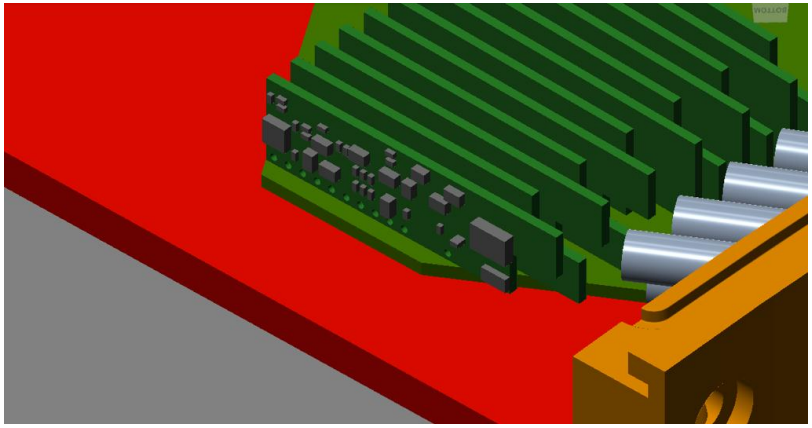
- L3: M. Corcoran (Rice)
  CAM: R. Wagner (FNAL)
- 96 straws form a panel (120˚ arc)
- 6 panels form a self supporting ring called a plane
- Two planes, with a small gap, form a station
- 18 stations form the tracker

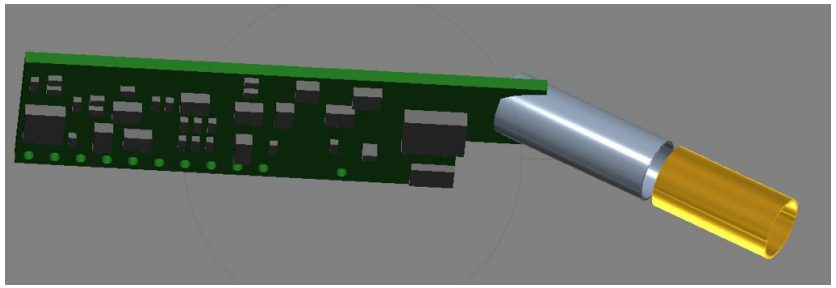
Front End Electronics: 475.06.04 *$2,893k*

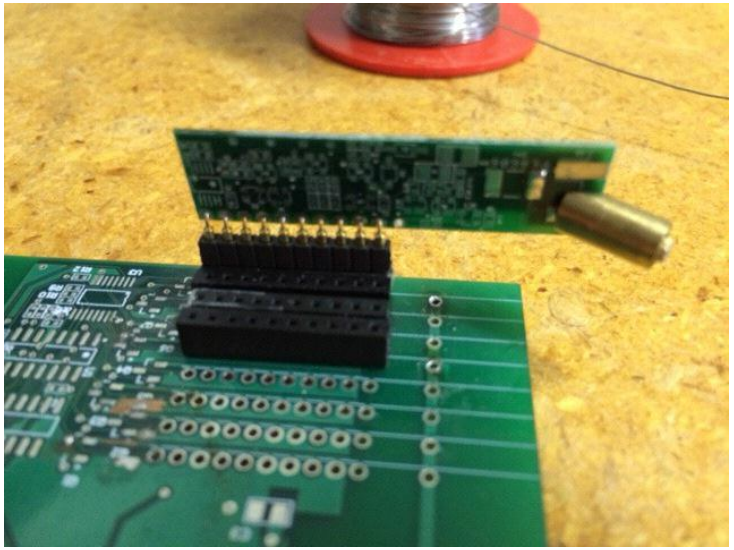


- L3 & CAM: V. Rusu (FNAL)
- All commercial, off the shelf parts

Preamps: 475.06.04.01

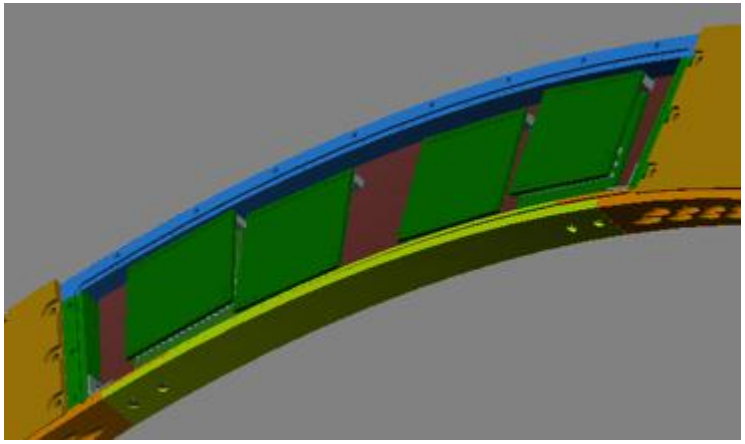


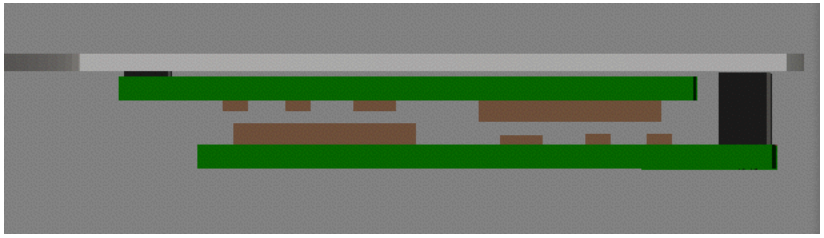




- Electronics is straightfoward
- Mechanically challenging to make connections to straws

Digitizers: 475.06.04.02

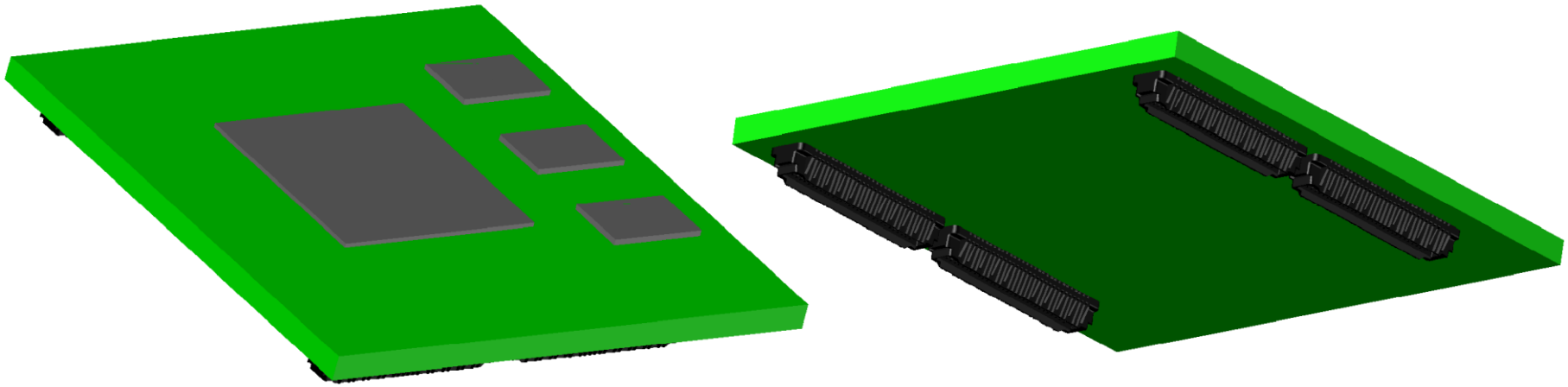




- Tight fit, but it does fit
- Design complete
  (subject to value engineering as new parts become available)
- Quotes for parts, boards, assembly

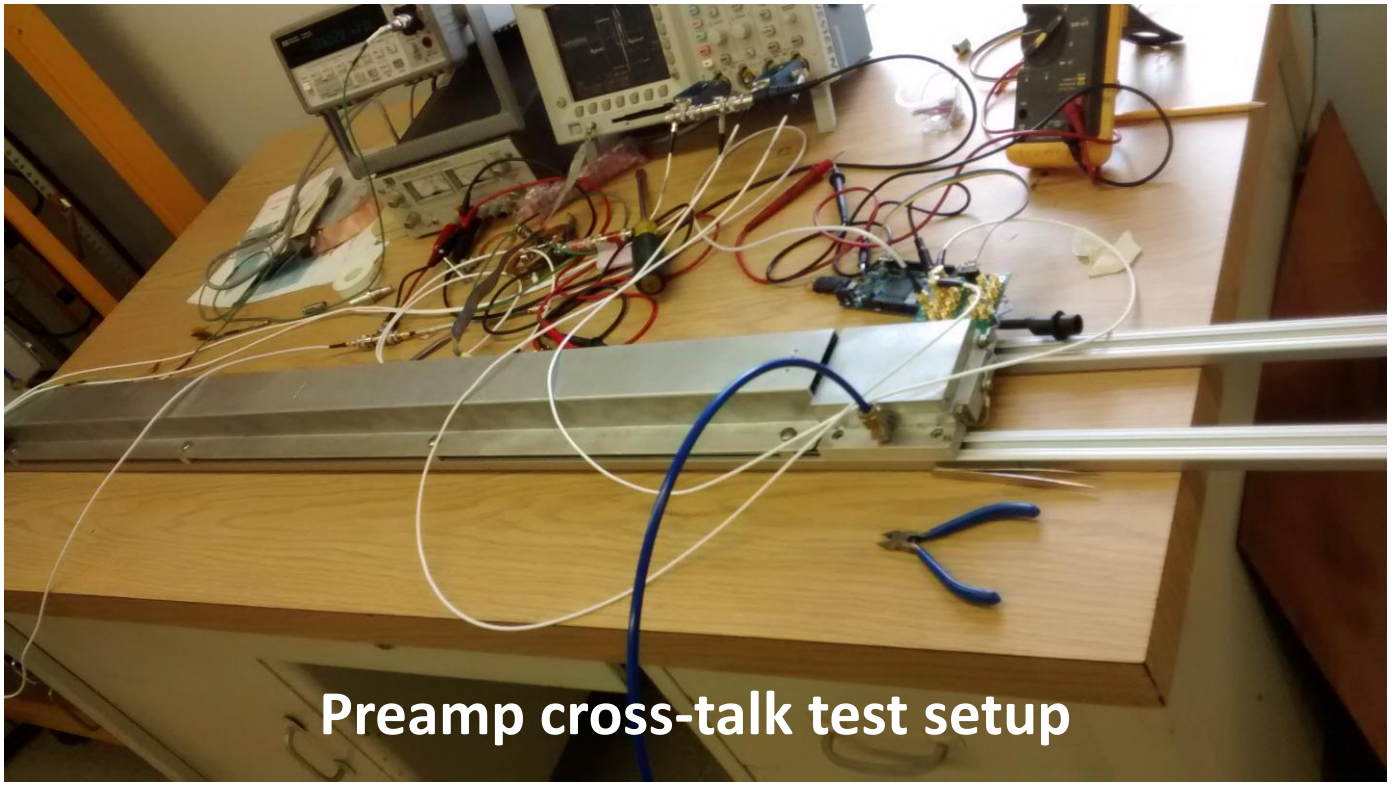
Readout Controller: 475.06.04.03

- Work is being done by Fermilab and U. of Houston
- Preliminary designs exist.
  - 1st iteration: Over-size boards with many test features
  - Next iteration: Reduce size. Conceptual layout exists



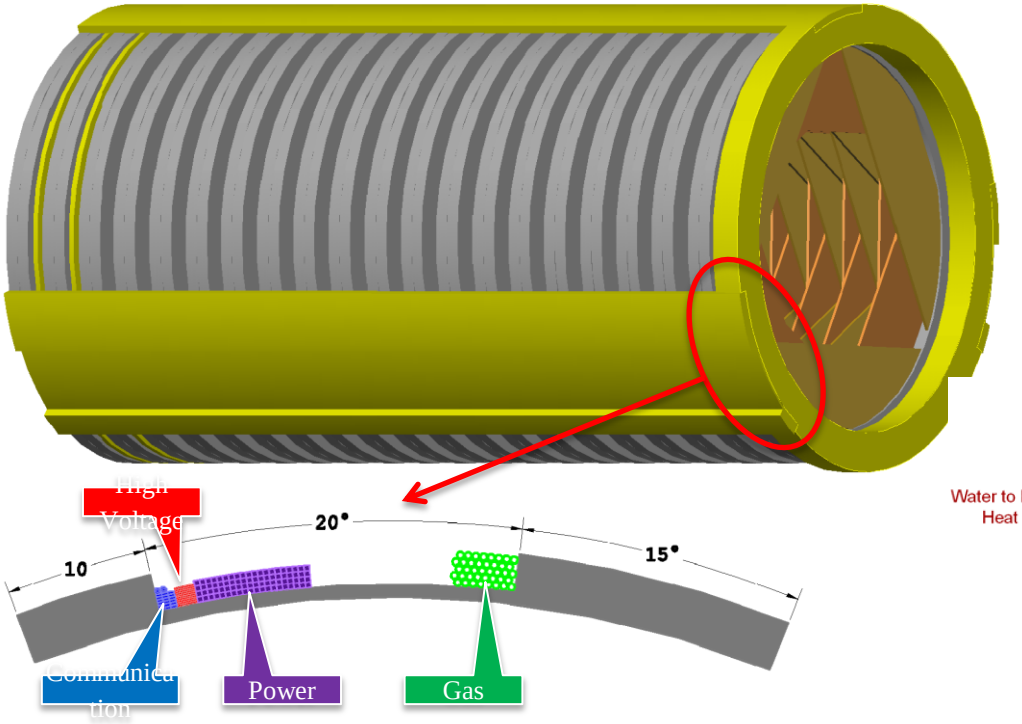
Test Stands: 475.06.04.04

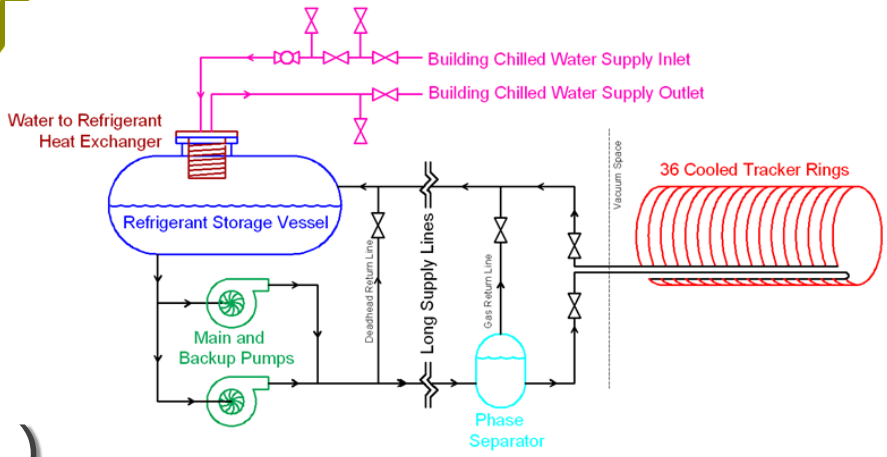
- Exist… Periodic modifications required as testing moves through different stages
- Final version for testing during operations transferred off-project



Infrastructure: 475.06.05

$1,296k



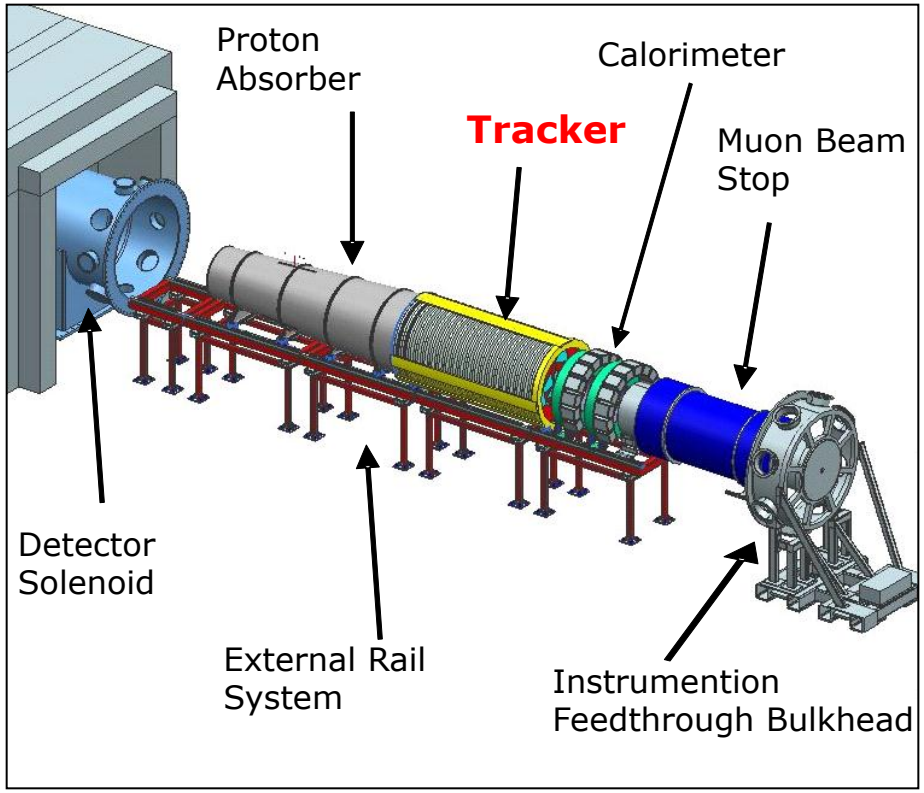


- L3 & CAM: A. Mukherjee (FNAL)
- Utilities run along support beams
- Cooling runs around each plane

Installation: 475.06.06

$107K

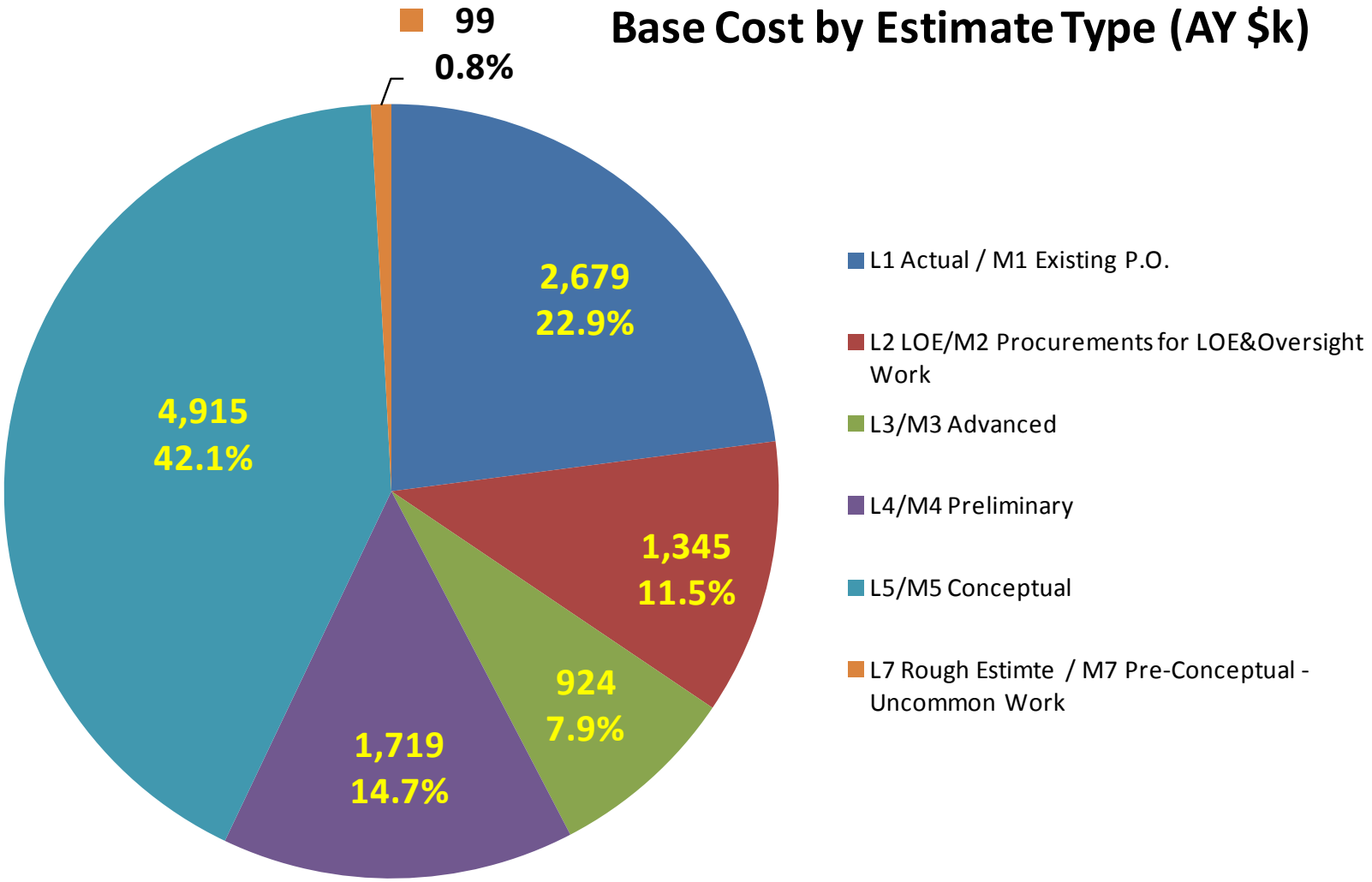
- L3 & CAM: A. Mukherjee (FNAL)
- Work with muon beamline (475.05) to install detector on rails
- Post-installation optical survey
- Route cables through DS
- Test connections



Cost Table

475.06 Tracker				Costs are fully burdened in AY $k		
	M&S	Labor	Base Cost	Estimate Uncertainty	% Contingency on ETC	Total
475.06.01 Project Management	21	1,800	1,821	251	19%	2,072
475.06.02 Straws	1,244	69	1,313	440	37%	1,753
475.06.03 Straw Assemblies	2,798	832	3,629	1,449	43%	5,079
475.06.04 Front End Electronics	1,654	599	2,253	639	31%	2,893
475.06.05 Infrastructure	373	569	943	353	38%	1,296
475.06.06 Detector Assembly & Installation		70	70	37	53%	107
475.06.07 Tracker Conceptual Design/R&D	999	654	1,653		0%	1,653
475.06.99 Risk Based Contingency				651		651
Total	7,088	4,593	11,681	3,821	42%	15,502

Quality of Estimate



Risks

- Drop in price of 3D printing
- Drop in price of electronic components
- Catastrophic mechanical failure of Tracker
- Simulations indicate that tracker occupancy higher than expected
- Gain loss in tracker
  - Tested and ruled out to the expected dose
  - If rate estimates increase, will need to redo tests
- Need to switch straw manufacturer
  - Manufacturing process is propreitary
  - Adhesive and curing process can cause aging
  - Repeating aging tests takes ~1 year

Risks

- High crosstalk between straws
  - Being tested
  - Degrades efficiency if not mitigated
  - If realized, would require redesign of preamp system
- Mylar creep limits tracker lifetime
  - Tests have been in progress for >2 years
  - If realized, would require adding carbon fiber support
- Detector support structure not sufficiently rigid or stable
- 18 Tracker stations is inadequate to satisfy Tracker requirements
  - Extensive studies for TDR assumed 20 station tracker
  - Forced to drop to 18 stations for budgetary reasons
  - Meets requirements… but not robust

Summary

- A lot of progress in the last several months on all aspects of the tracker
- For Front End Electronics
  - Understanding of preamp performance
  - Connection to straws
  - High voltage disconnect (“fuse”)
  - Quotes for parts, boards, assembly of Digitizers
- Probable drop in electronic component costs is not in the baseline, but is put as an opportunity in the risk registry