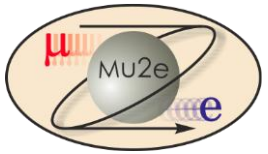
Fermilab

U.S. DEPARTMENT OF ENERGY Office of Science

Mu2e Tracker Infrastructure



A. Mukherjee

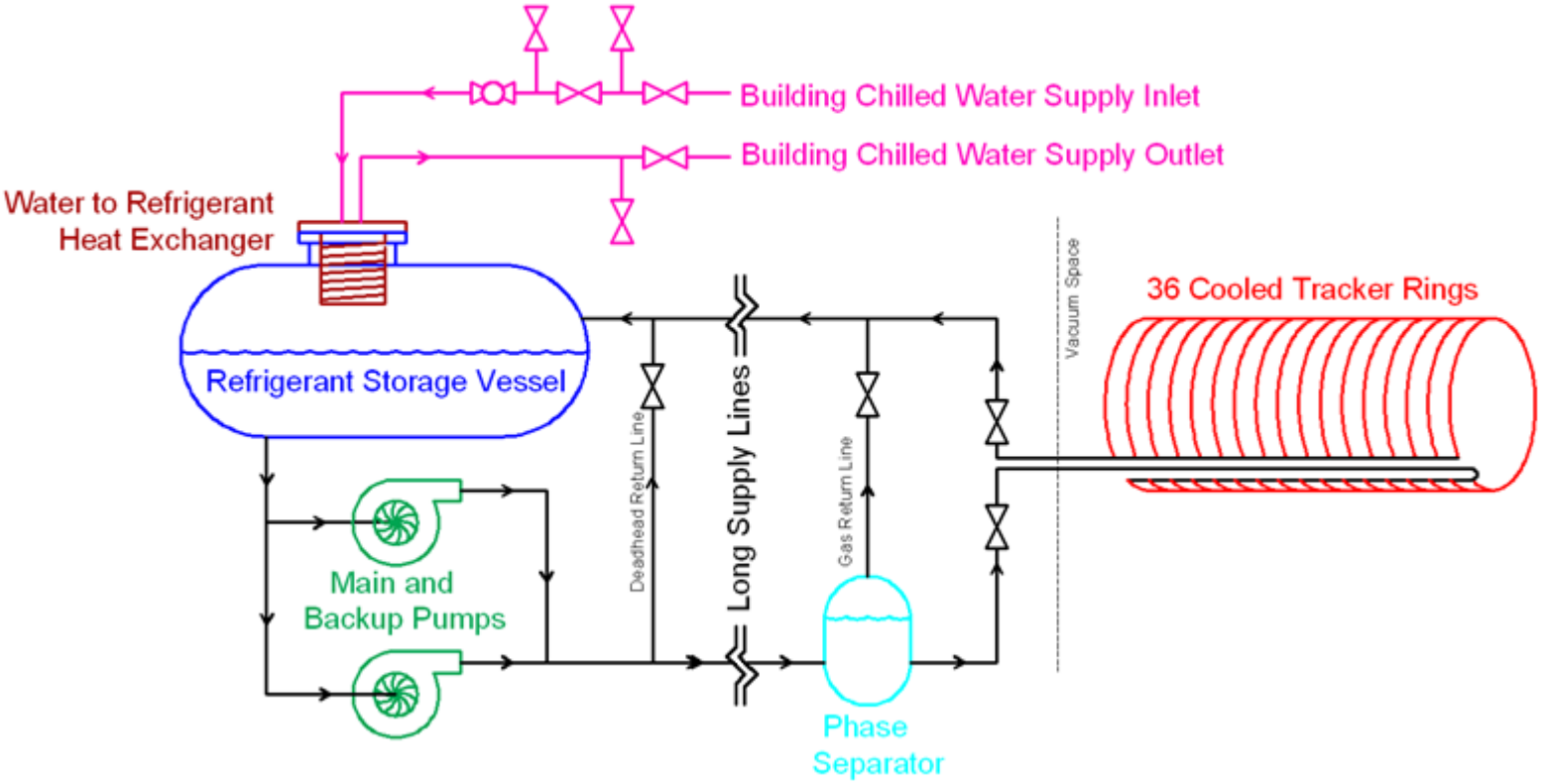
Tracker L2 Manger

Acting Infrastructure L3 manager

7/8/2014

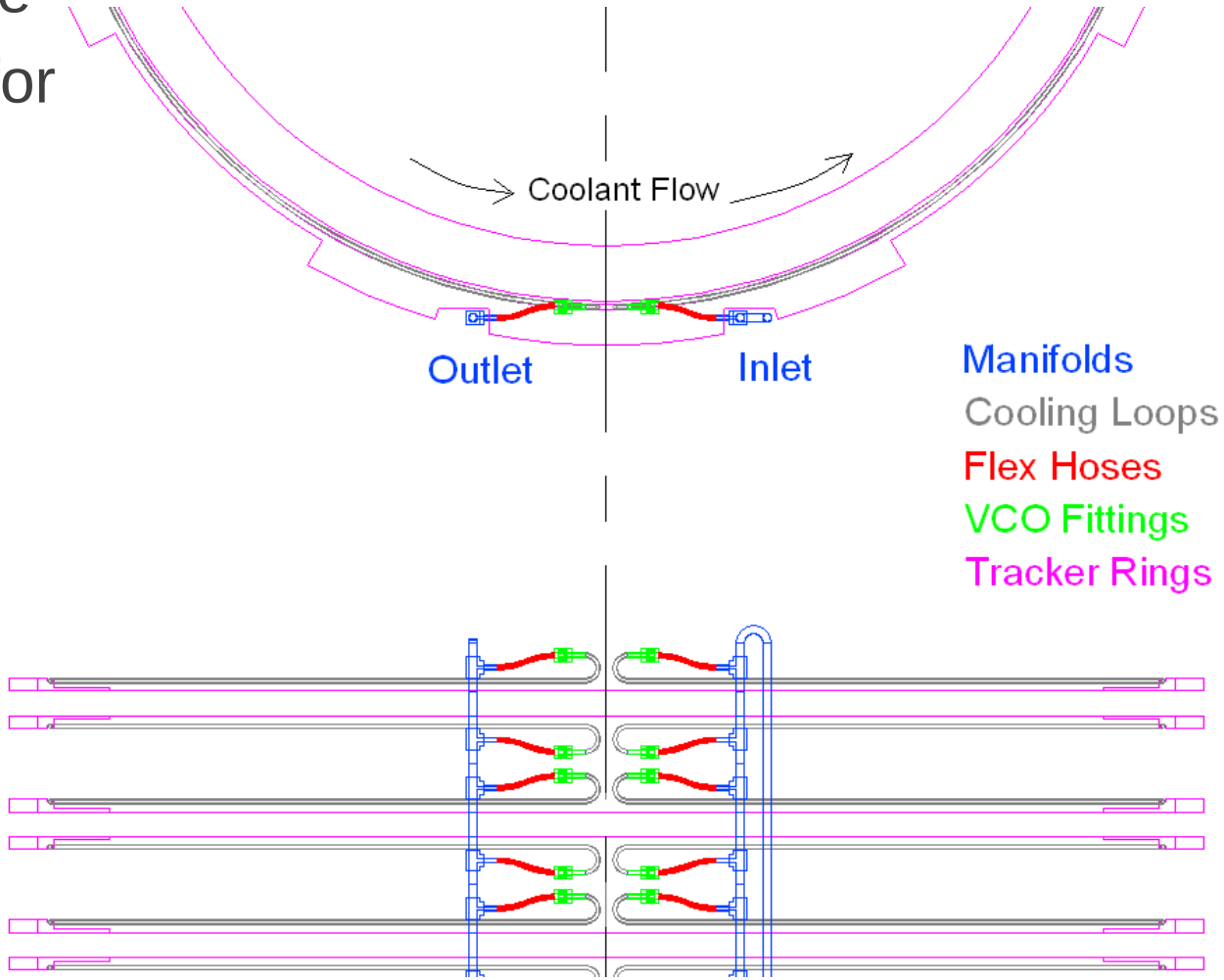
Cooling

- 10kW tracker + 5kW calorimeter → 15kW SUVA system
  - Passive distribution by equalizing line lengths
  - Tap points for calorimeter cooling not shown



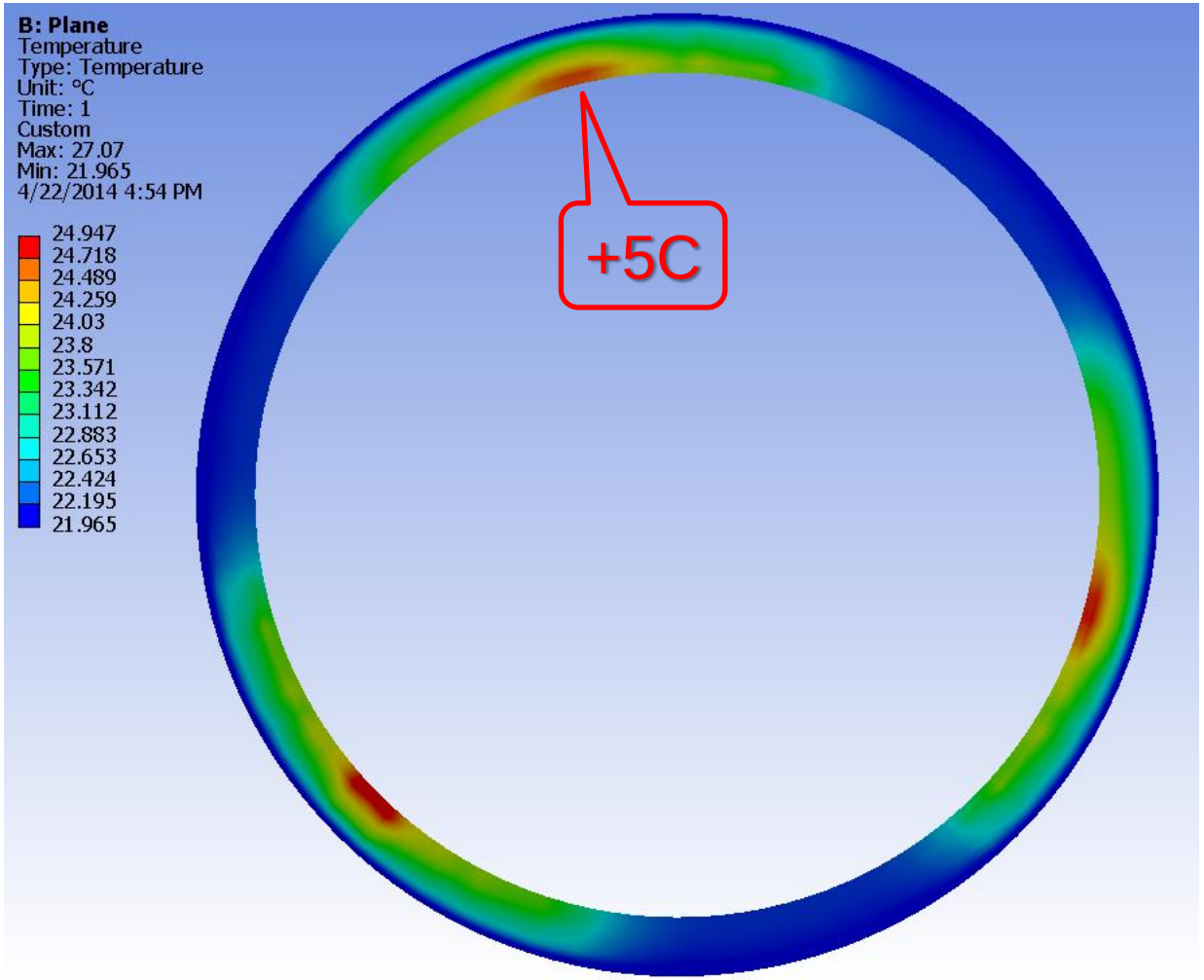
Cooling

- One ring per plane
- VCO disconnect for removing planes
- ±2ºC at OD



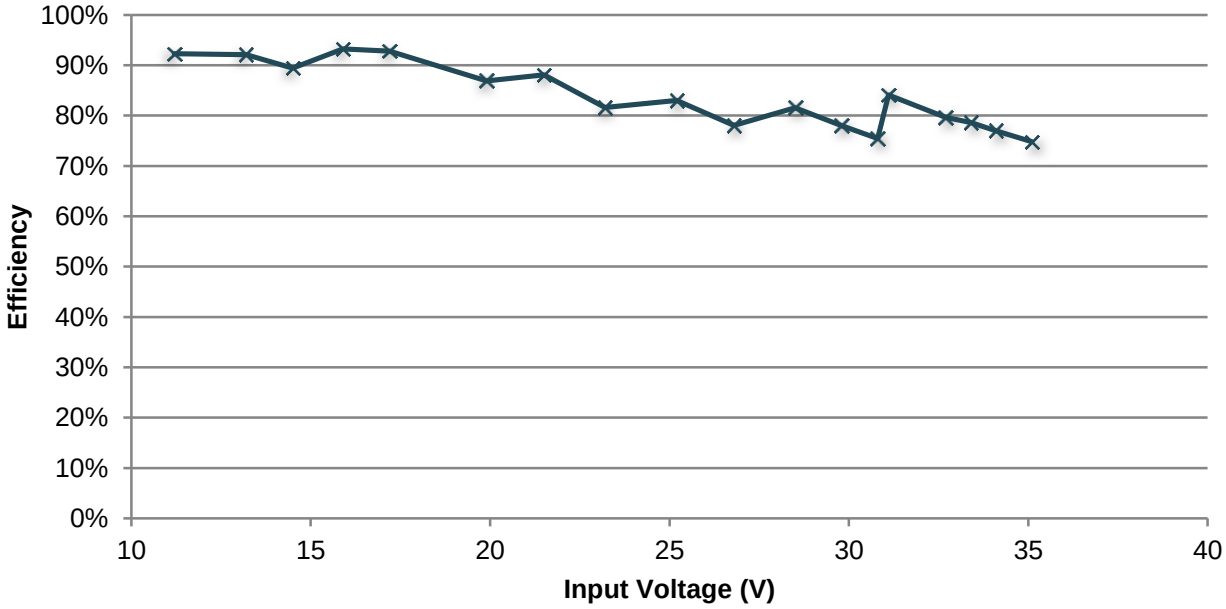
Cooling

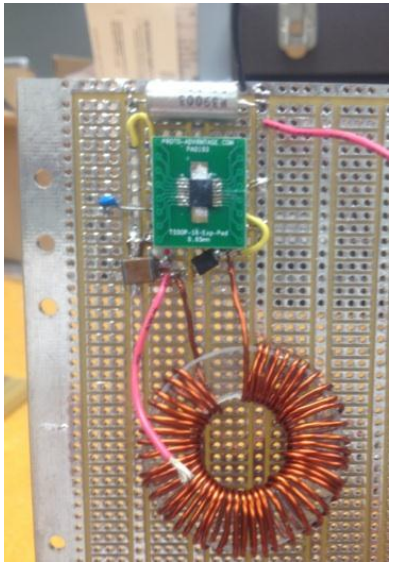
- Temperature gradient with full electronics load



Power

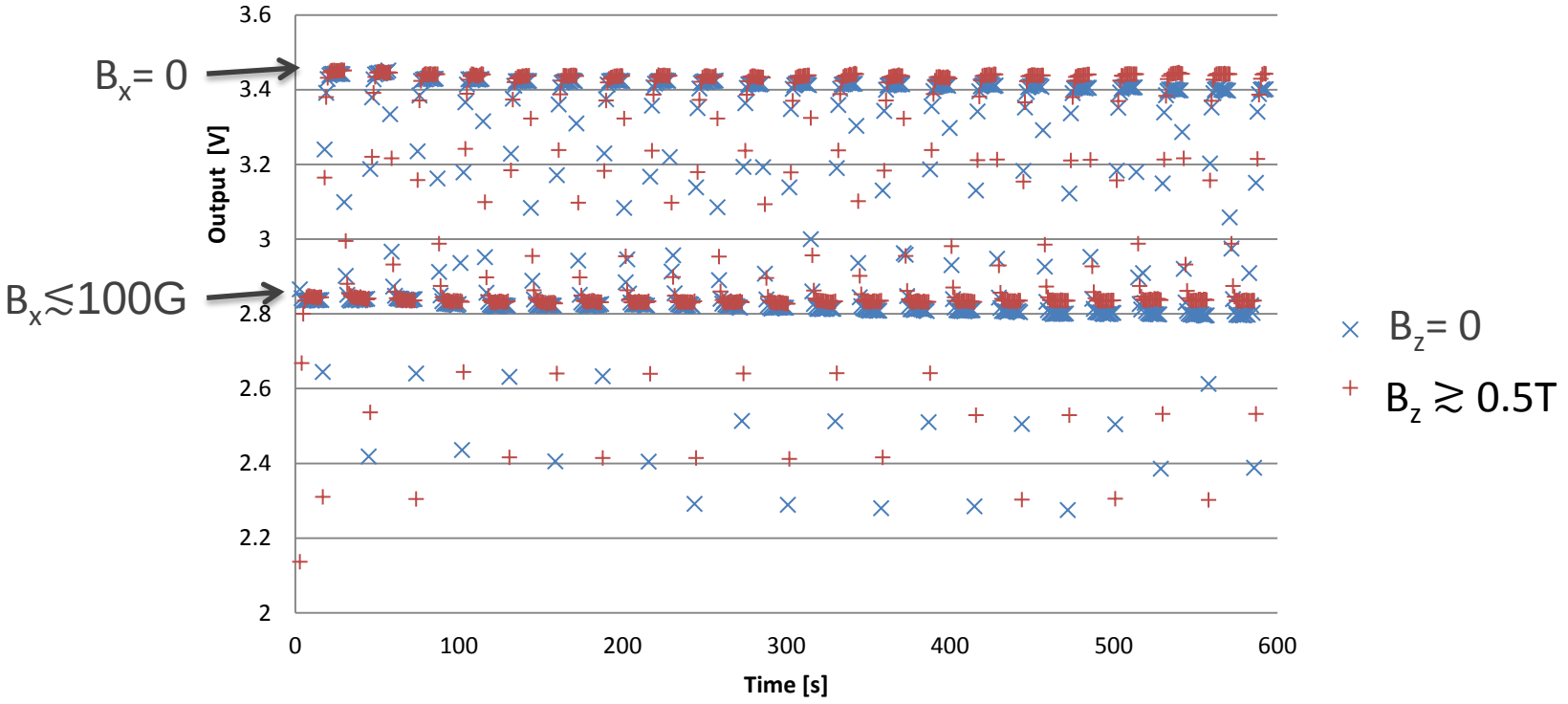
- Reduce magnetic field perturbations and power loss in lines by sending power at 48V
- Buck DC-DC convertor with air-core toroid
  - Tested to 36V with hand-wound toroid
  - Working on 48V version with toroid manufactured on PCB





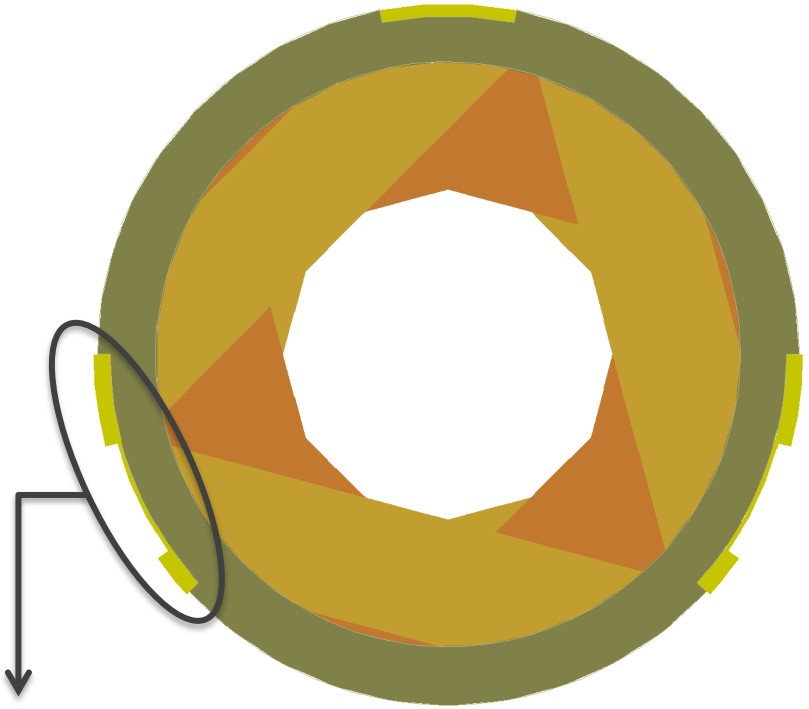
Alignment Monitoring: Hall Probe

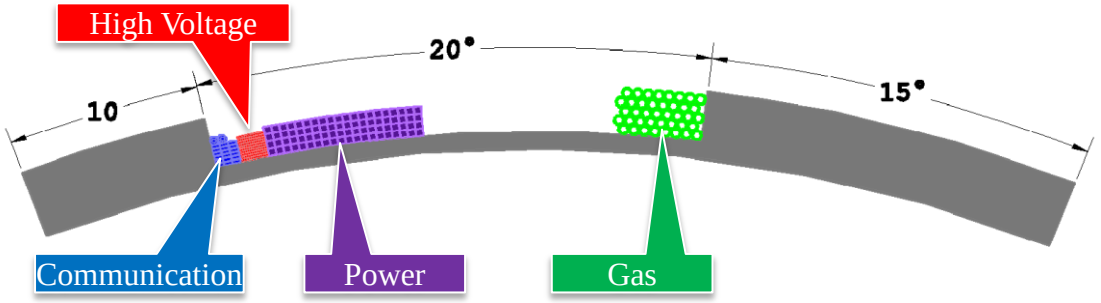
- Not for absolute alignment: monitors variation over time
- 2-axis Hall probe aligned perpendicular to magnetic field
- 20μradian resolution with 1T field



Cabling

- Horizontal beams support cabling, gas lines on tracker
- Cables must run past calorimeter to IFB
- Azimuthal position set to minimize interference with calorimeter electronics
- Leave room for late additions and to sight panel survey monuments





Cabling

- Gas
  - One pair per plane
  - IFB penetration: Standard welded feedthroughs
  - Panel penetration: stainless steel compression fitting with epoxy
- Low voltage
  - One pair per plane
  - In vacuum: Nomex covered ~2.5mm square magnet wire
    Similar to that used by CDF
  - Outside vacuum: THHN (flexible) wire
  - IFB penetrations: standard electric vacuum feedthroughs
  - Panel penetrations: Copper with Kapton sleeve

Cabling

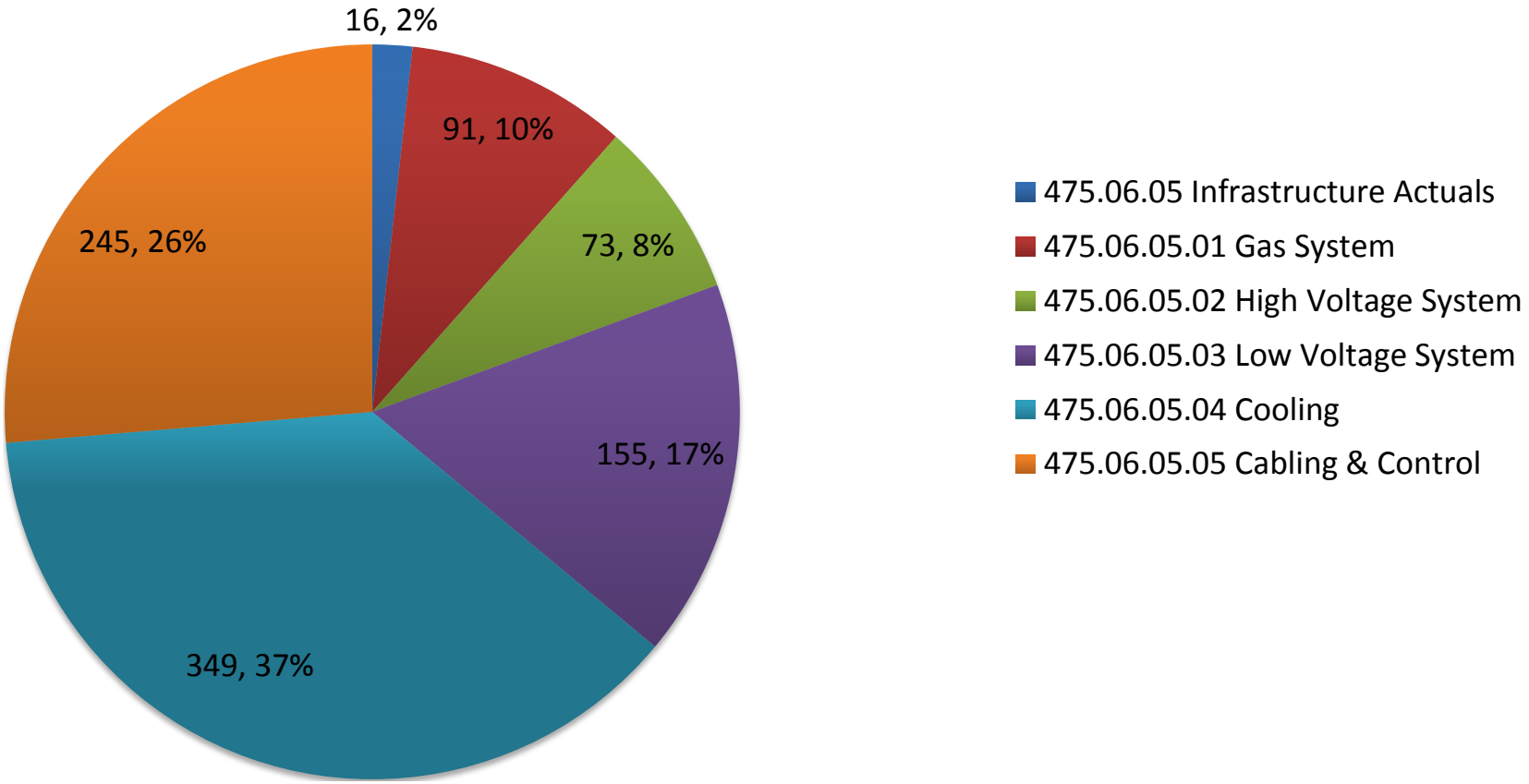
- High Voltage
  - One line per panel
  - Silicone insulated, 0.05” pitch ribbon cable
  - IFB penetration: Vacuum rated DB25
    - Note all lines are at the same voltage
    - Tested in air
    - Breakdown tests in vacuum underway
  - Panel penetrations: Copper with ceramic sleeve
- Copper communication
  - Two coax per panel
  - IFB and Panel Penetration: Standard vacuum rated SMA

Cabling

- Optical Communication
  - One pair per panel
  - Jacket but no fiber reinforcement
    - Reinforcement traps air and forms a virtual leak
  - IFB penetration: standard vacuum rated fiber feedthrough
  - Panel penetration: individual fibers with epoxy seal

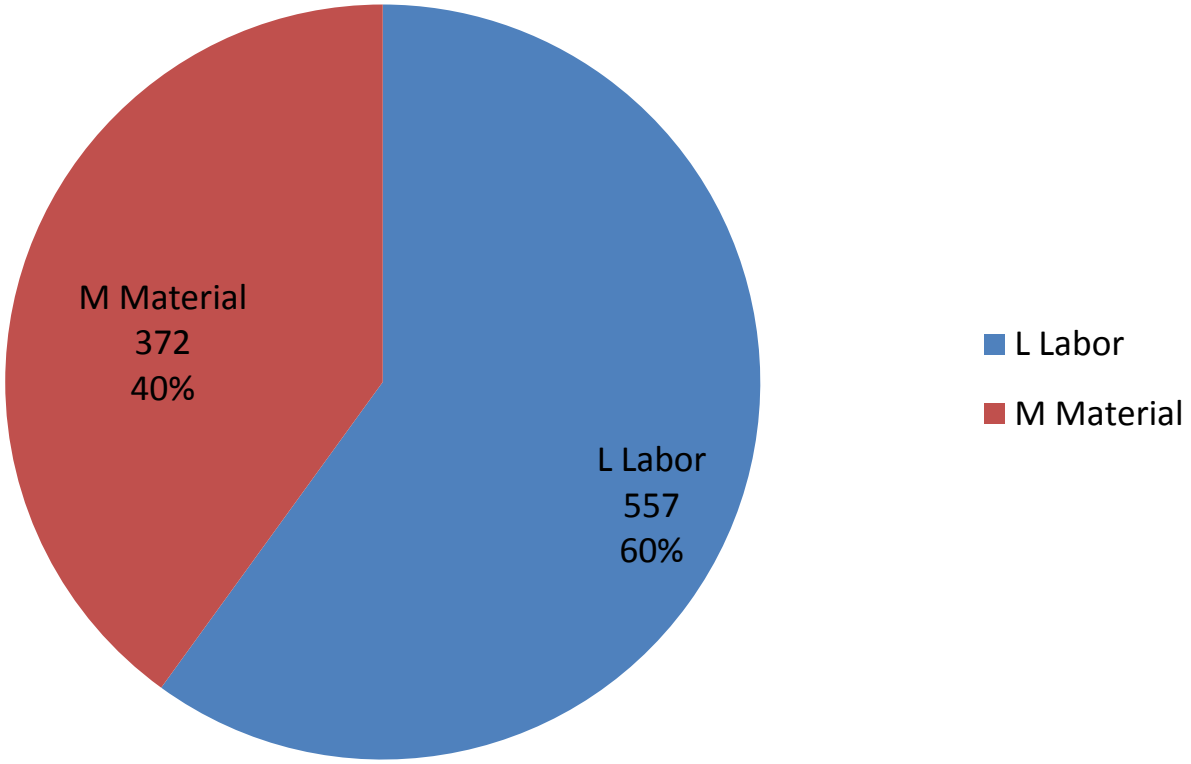
Cost Distribution by L4

Base Cost by L4 (AY $k)



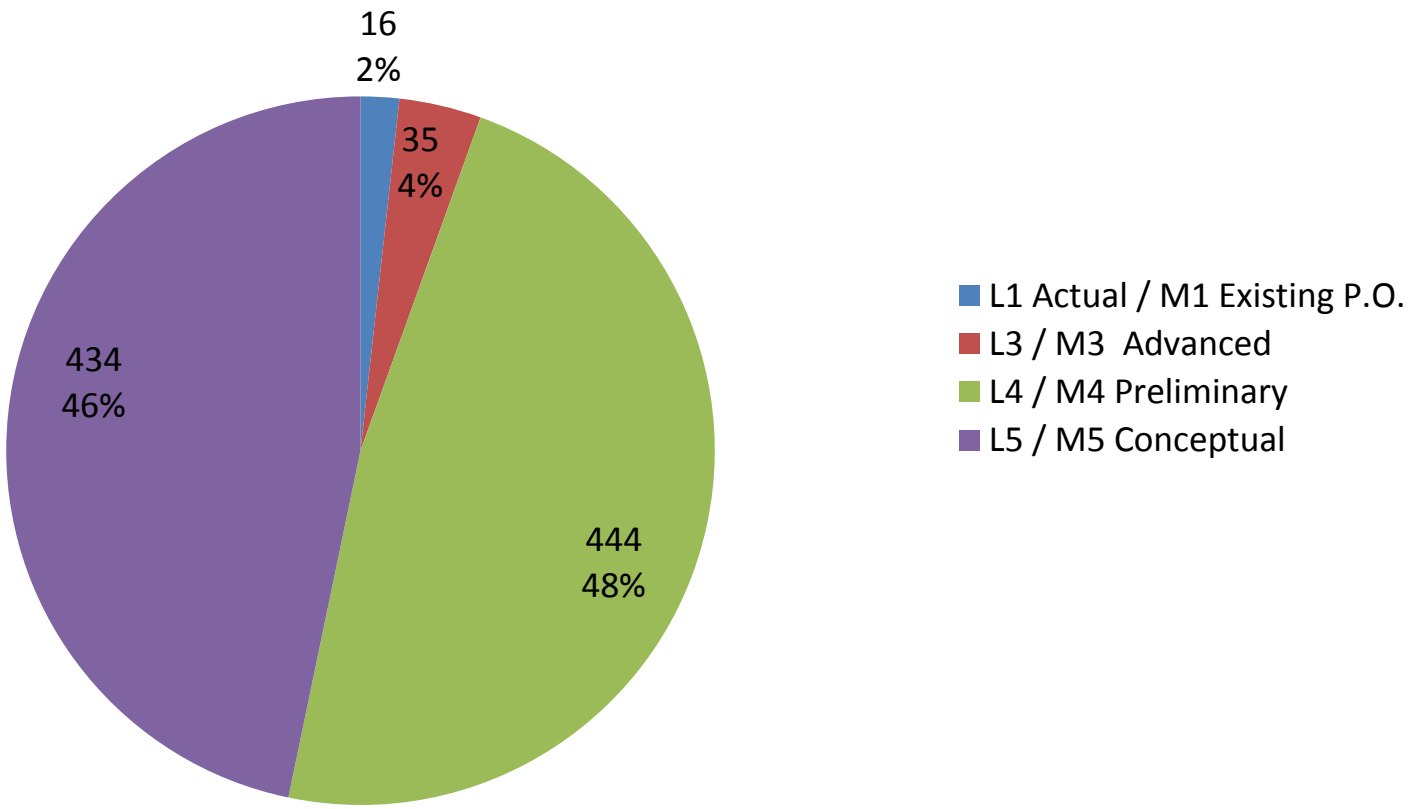
Cost Distribution by Resource Type

Base Cost (AY $k)

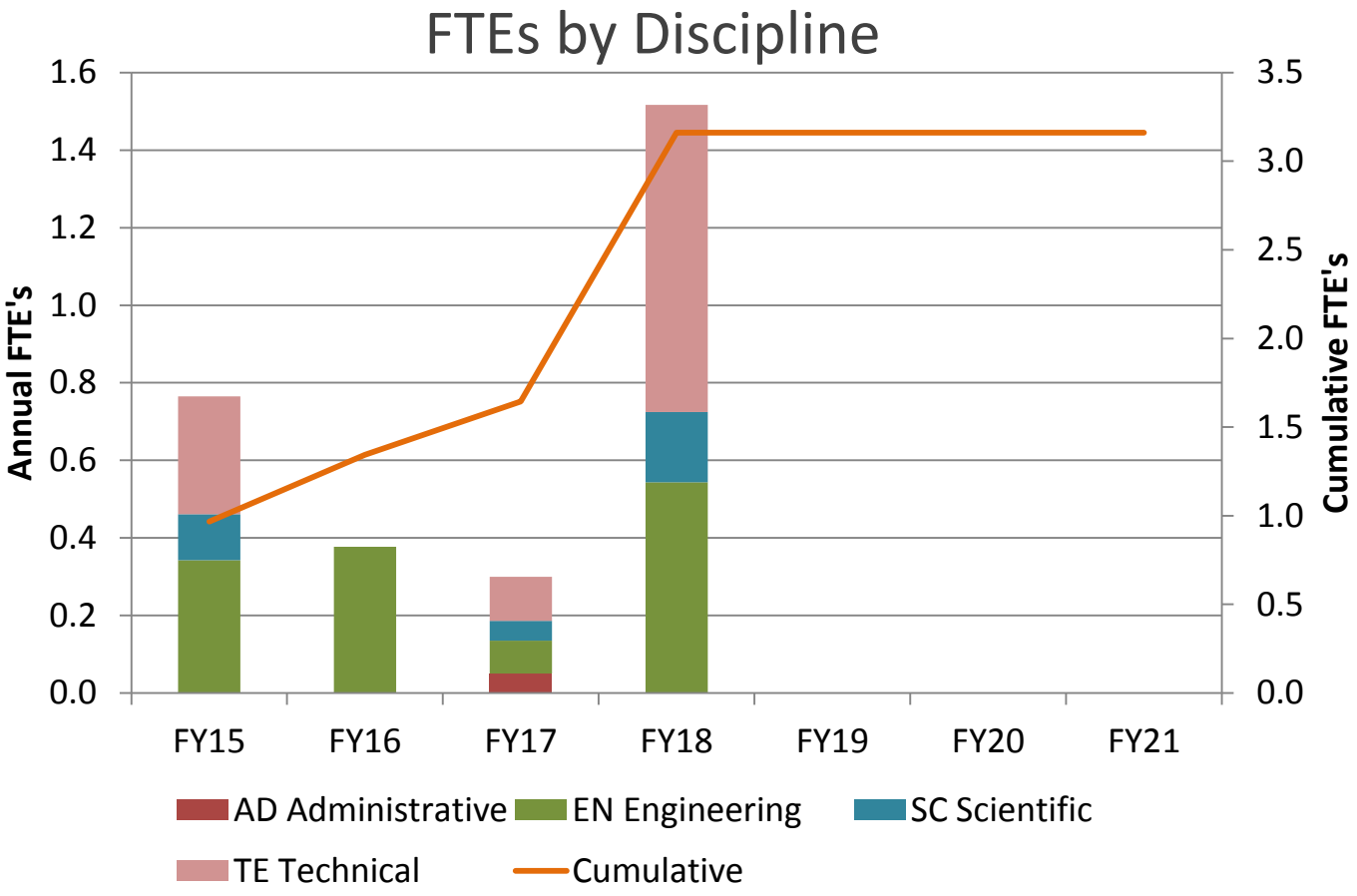


Quality of Estimate

Base Cost by Estimate Type (AY$k)



Labor Resources



Cost Table

Costs are fully burdened in AY $k

	Base Cost (AY k$)					
	M&S	Labor	Total	Estimate Uncertainty (on remaining costs)	% Contingency on ETC	Total Cost
475.06.05 Infrastructure Actuals	2	15	16			16
475.06.05.01 Gas System	8	83	91	44	48%	134
475.06.05.02 High Voltage System	12	61	73	31	43%	104
475.06.05.03 Low Voltage System	64	91	155	69	45%	224
475.06.05.04 Cooling	128	221	349	142	41%	492
475.06.05.05 Cabling & Control	158	87	245	61	25%	306
Grand Total	372	557	929	347	38%	1,276

Summary

- Focus so far has been defining requirements and interfaces
- Many details to work through
  - Continue outgassing studies of cables
  - Complete vacuum penetration designs
  - Placement of DC-DC convertors
  - Routing around each plane
- Engineering will shift here as other L3s move into production