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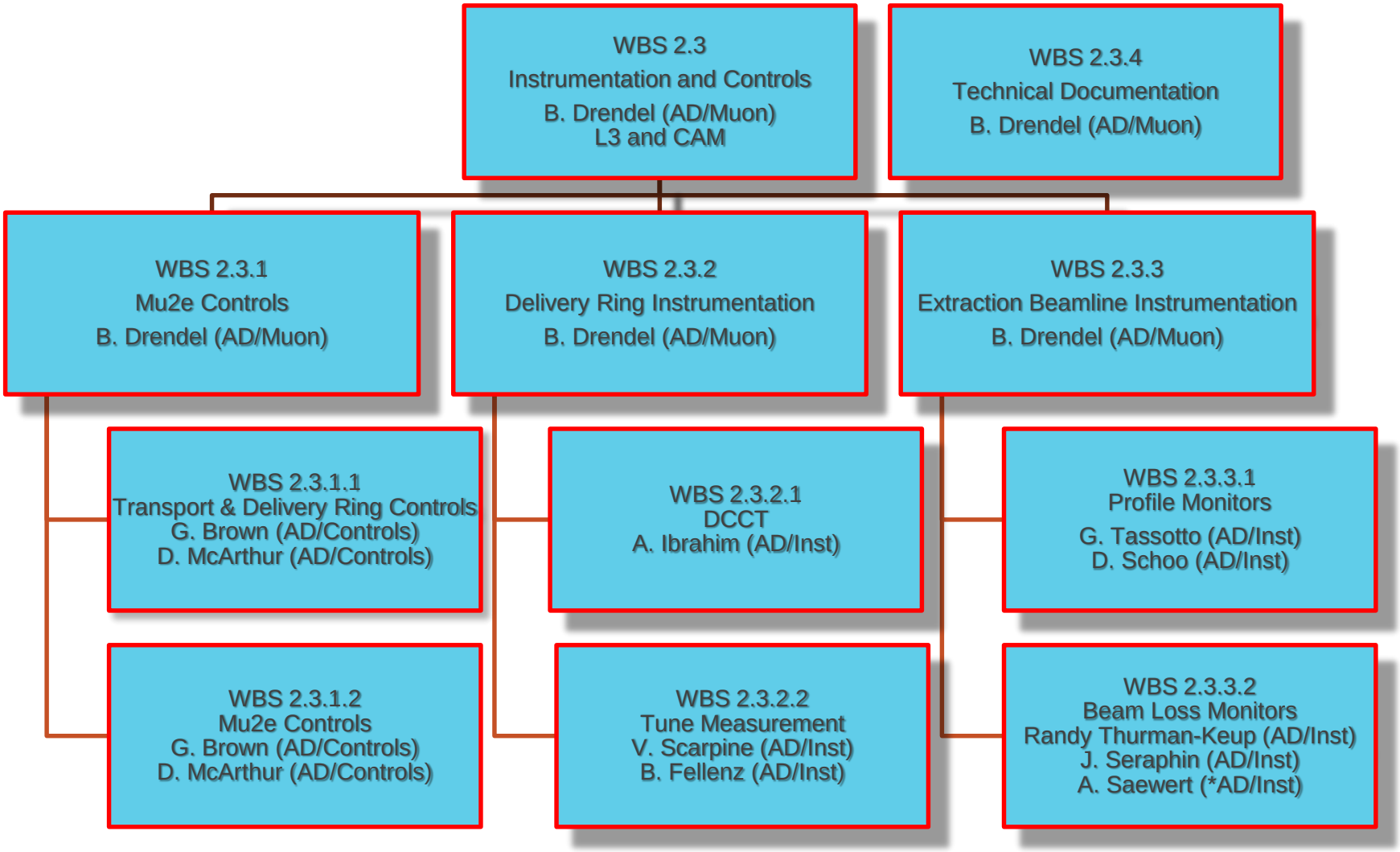
Mu2e Beamline Controls and Instrumentation:

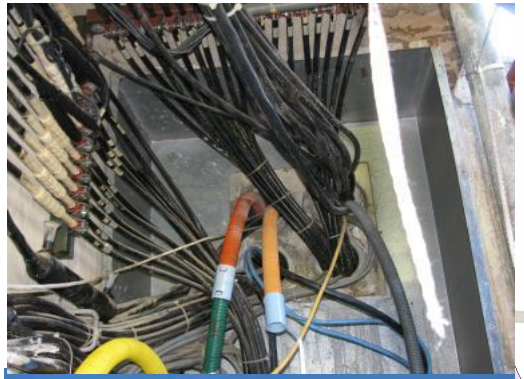
Brian Drendel

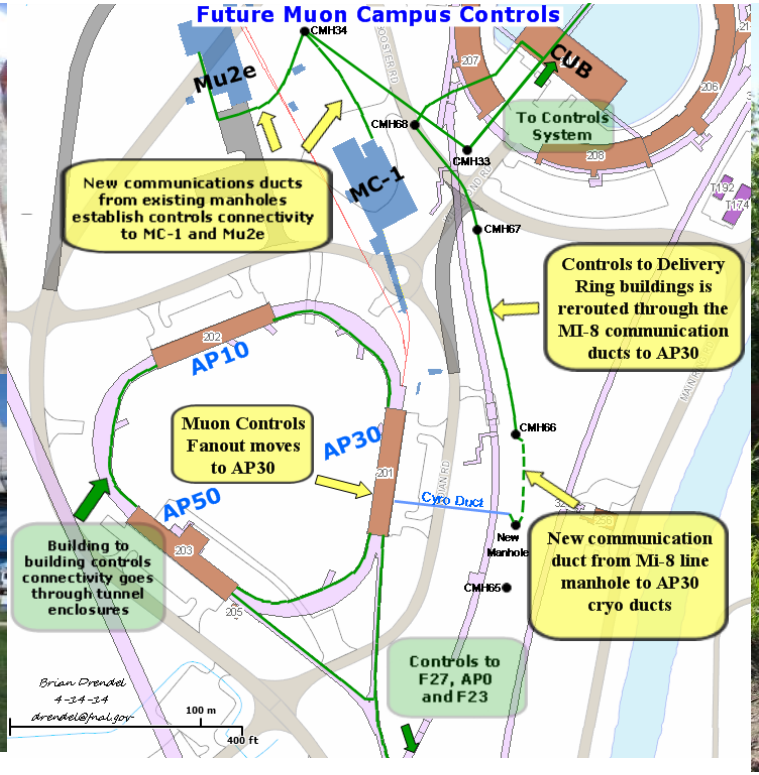
6 October 2015

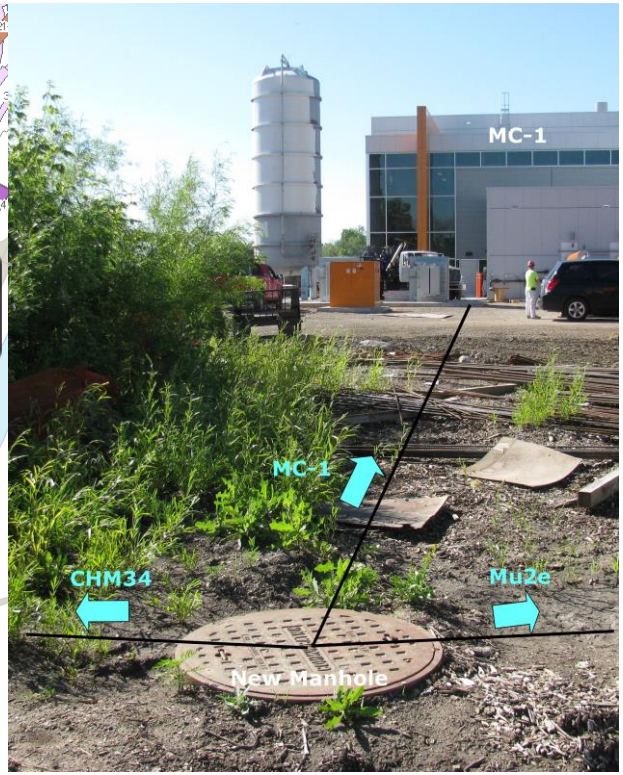
Organizational Breakdown



Controls Scope



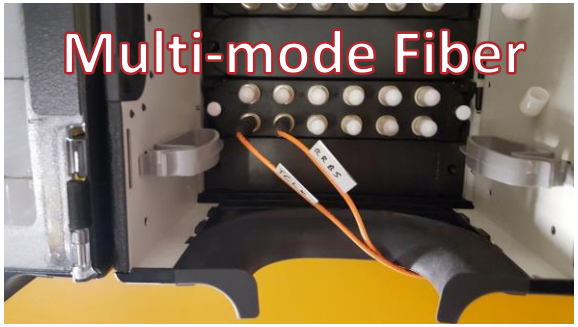




- New controls and communications connectivity will be established from the cross gallery to the Mu2e service building.
  - 96 pair bundle of single mode fiber.
  - 36 pair bundle of multi-mode fiber
  - Various multi-conductor copper cable.

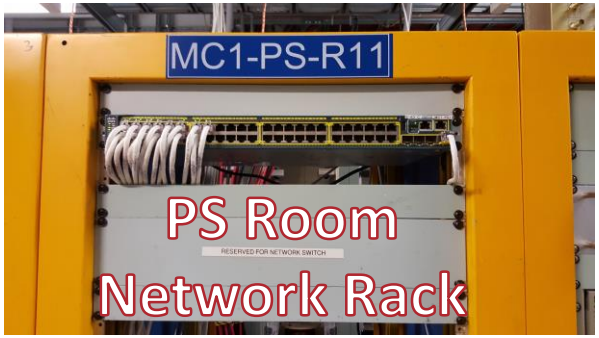
Controls Lessons Learned from g-2

- Network infrastructure moved from Accelerator to Conventional Construction WBS to allow fiber optic communications lines to be run to building as soon as beneficial occupancy allows.
  - Controls Ethernet
  - FIRUS



Controls lessons learned from g-2

- Will implement controls to Mu2e in the same way MC-1 controls were recently established.
- Using standard laboratory network and controls hardware.
- Same experts are implementing the Mu2e system that recently implemented the similar MC-1 system.



Controls Design

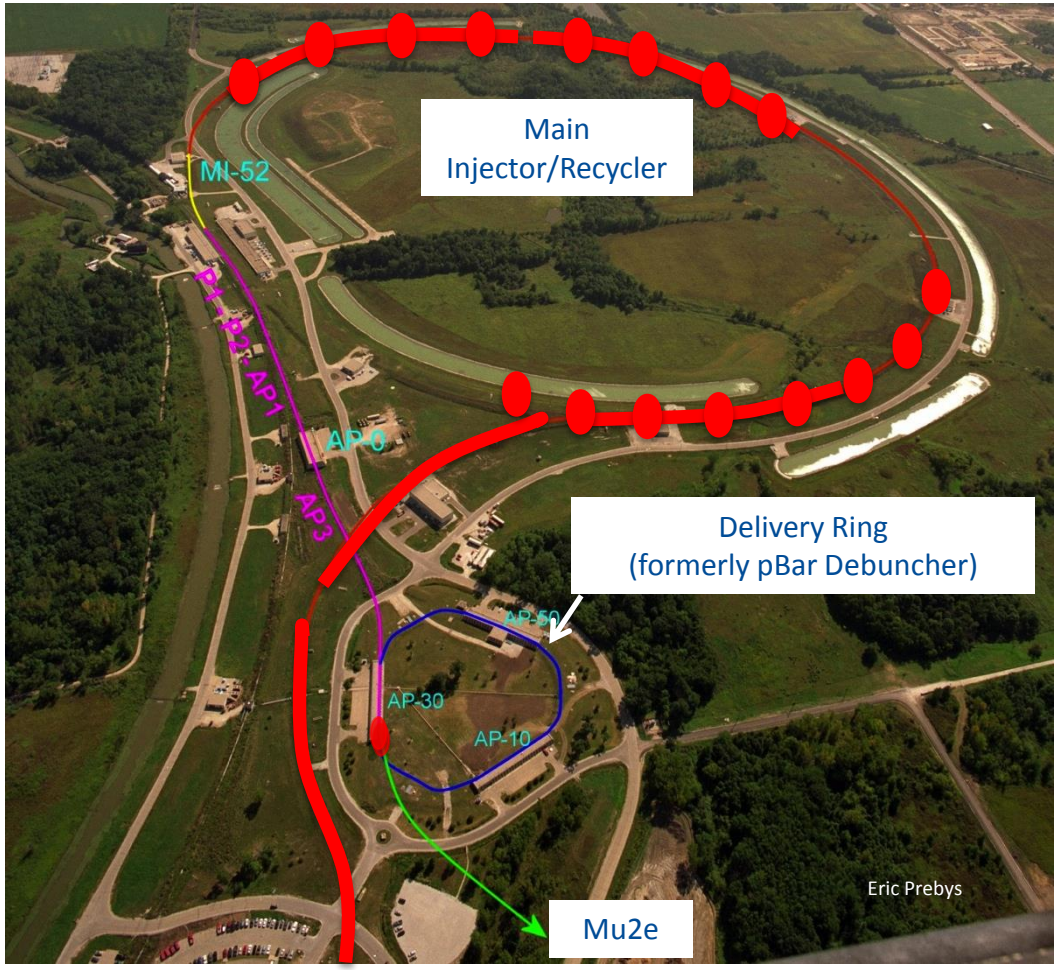
- This WBS covers provides the connectivity of all of the controls signals on the previous slide to Mu2e.
  - This includes everything up to any front end device in the Mu2e service building.
  - Controls needs specific to any given system are included in the costing for that system.
- Software formerly handled in the Operations Preparation WBS for CD-1 have been moved to operations since they will not be required until after project completion.
  - Any special software needs for specific systems that are needed before project closeout are covered in the costing for that system.
- Controls cable pulls and terminations have been moved to conventional construction BoE 475.03.04.05 to coordinate controls infrastructure availability with Mu2e building beneficial occupancy.

Instrumentation Scope

- Instrumentation is funded by five different sources as shown below. The focus of this talk are the items covered under my Mu2e WBS.

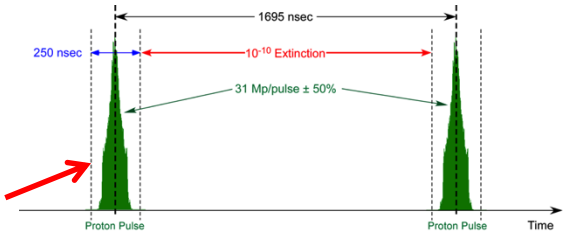
Category	Instrumentation Type	Funding Source
Beam Lines (P1, P2, M1 and M3)	Toroid	Beam Line AIP
	Beam Position Monitor	Beam Line AIP
	Beam Loss Monitors	Beam Line AIP, RR AIP
	Profile Monitors	Beam Line AIP, RR AIP
Delivery Ring	**DCCT**	**Mu2e Project**
	Beam Position Monitor	Delivery Ring AIP
	Beam Loss Monitor	Delivery Ring AIP
	Tune Measurement System	**Mu2e Project**
Abort Line	Toroid/Ion Chamber	g-2 Project
	Profile Monitor	g-2 Project
	Beam Loss Monitors	Delivery Ring AIP
Extraction Line (M4 line)	**Ion Chamber**	**Mu2e Project**
	Profile Monitor	**Mu2e Project**
	Beam Loss Monitor	**Mu2e Project**

Mu2e Proton Delivery



Booster

- Two Booster "batches" are injected into the Recycler (8 GeV storage ring). Each is:
  - 4×10^{12} protons
  - 1.7 μsec long
- These are divided into 8 bunches of 10^{12} each
- The bunches are extracted one at a time to the Delivery Ring
  - Period = 1.7 μsec
- As the bunch circulates, it is resonantly extracted to produce the desired beam structure.
  - Bunches of ~3×10^{7} protons each
  - Separated by 1.7 μsec



Exactly what we need

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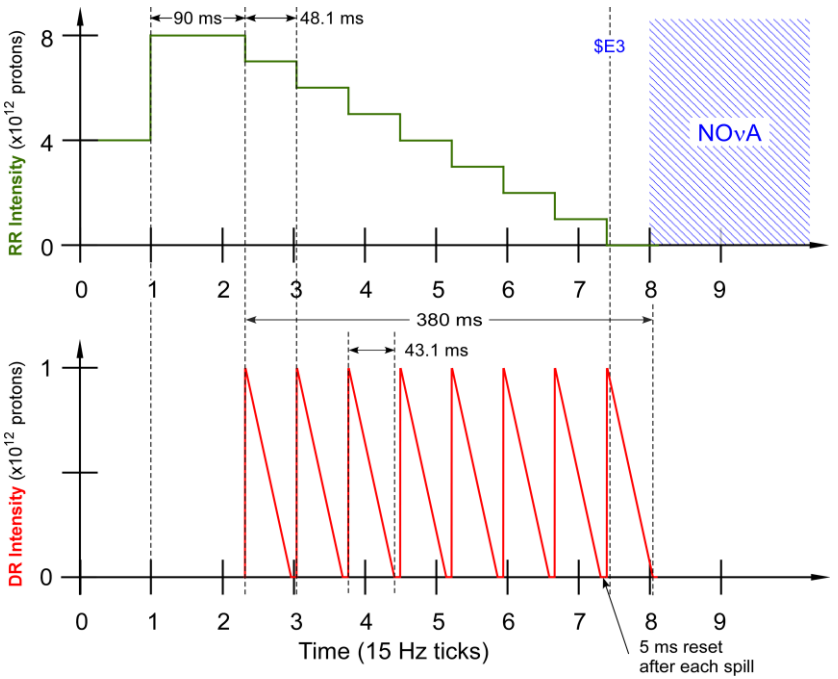
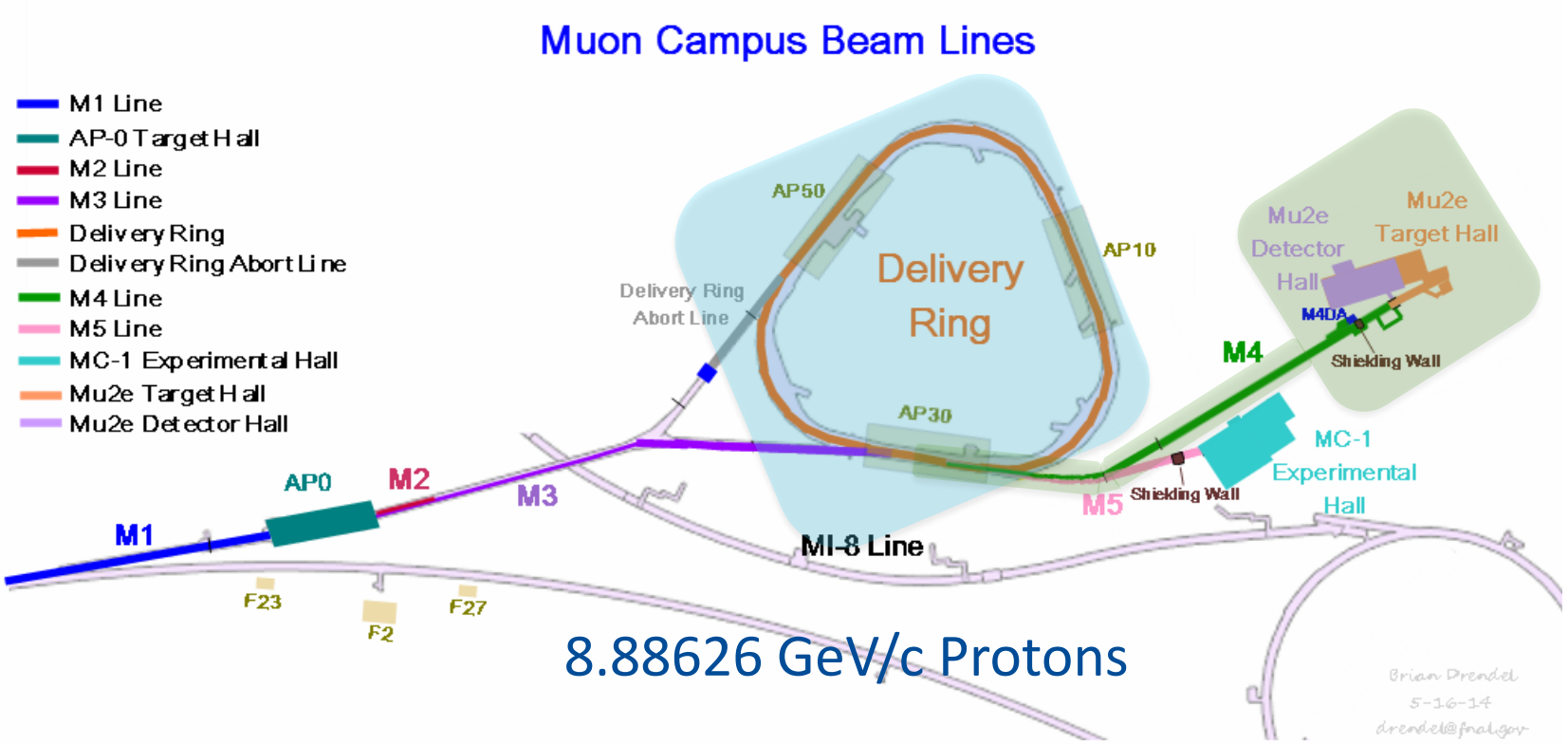
Mu2e Accelerator Timeline

Parameter	Value	Units
MI Cycle time	1.333	sec
Number of spills per MI cycle	8	
Duration of each spill	34-54	msec
Number of protons per micro-pulse	$(3.0\text{-}5.0)\times10^{7}$	protons
Maximum DR Beam Intensity	1.0×10^{12}	protons
Reset Time Gap between spills	5	msec
Operation point (Qx/Qy)	9.650/9.735	
Extraction efficiency	>98	%
Spill uniformity	<50	%



Mu2e Instrumentation Scope



- Delivery Ring Protons (1E12 -> 2E10)
  - Intensity: DCCT
  - Tune: Schottky

- Extraction Line (2E7 slice every 1.69usec)
  - Intensity: Ion Chambers
  - Position/Profile: Multiwires
  - Losses: BLMs

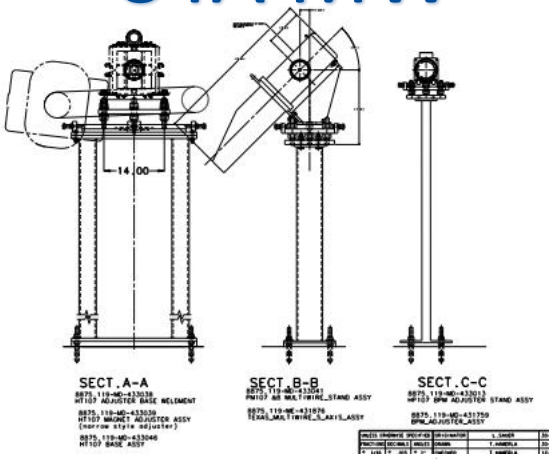
Instrumentation for various operational modes

Mode		Intensity	Measurements	
			Delivery Ring	M4 Line
Commissioning	Single turn protons to M4DA for M4 line commissioning	170W 5E10 protons every 10 sec 2 turns/5-10 Booster bunches	BPMs (2.5 MHz TBT, CO) (53 MHz TBT) IC DCCT	MWs ICs BLMs
	Resonant Extraction to M4DA	4 × 1.0E12 protons to Delivery Ring every 30 sec M4 Intensity: 3E6 to 40E6	BPMs (2.5 MHz TBT, CO) DCCT BLMs Schottkys	MWs ICs BLMs
Normal Running	Normal 8 kW proton beam to Mu2e target	8 × 1.0E12 protons to Delivery Ring every 1.33 sec	BPMs (2.5 MHz TBT, CO) DCCT BLMs Schottkys	MWs (normal scanner cap) ICs BLMs

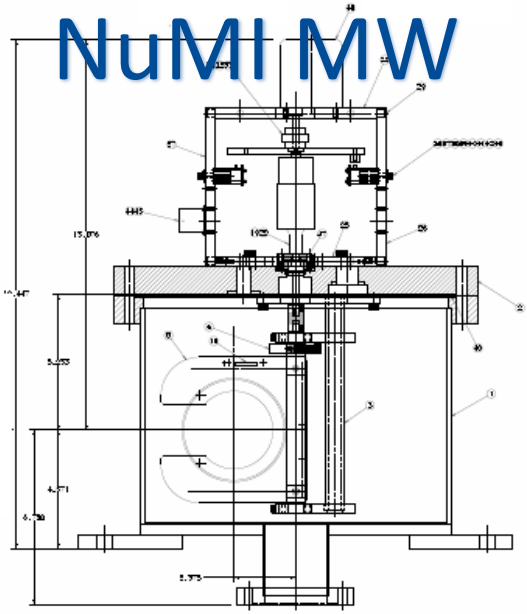
Extraction Instrumentation: Multiwires

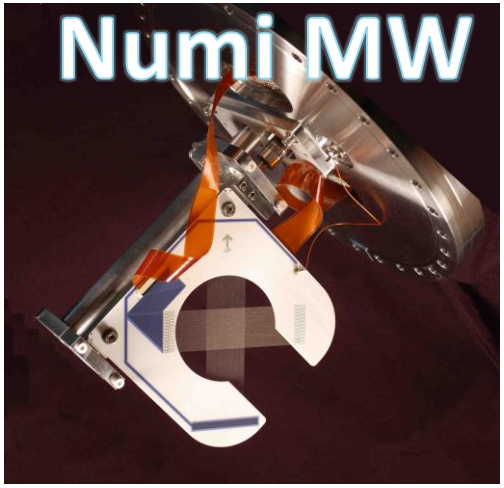
- Primary beam position measurement device in the M4 beam line.
- NuMI multiwire design used with a gap in the ceramic that allows the wires to be moved into and out of the beam while beam is running.
- There will be two varieties of multiwires.
  - New vacuum cans will be constructed based on the NuMI design.
  - 11 available University of Texas (UTA) Multiwire cans will be repurposed.
- The beam positions will be used in the M4 beam line autotune system.

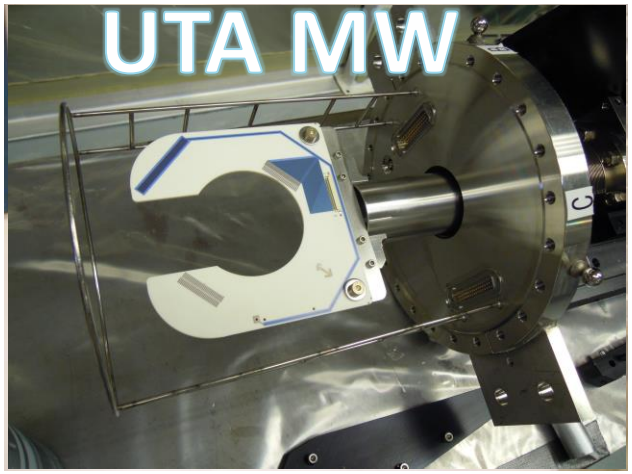
UTA MW



NuMI MW

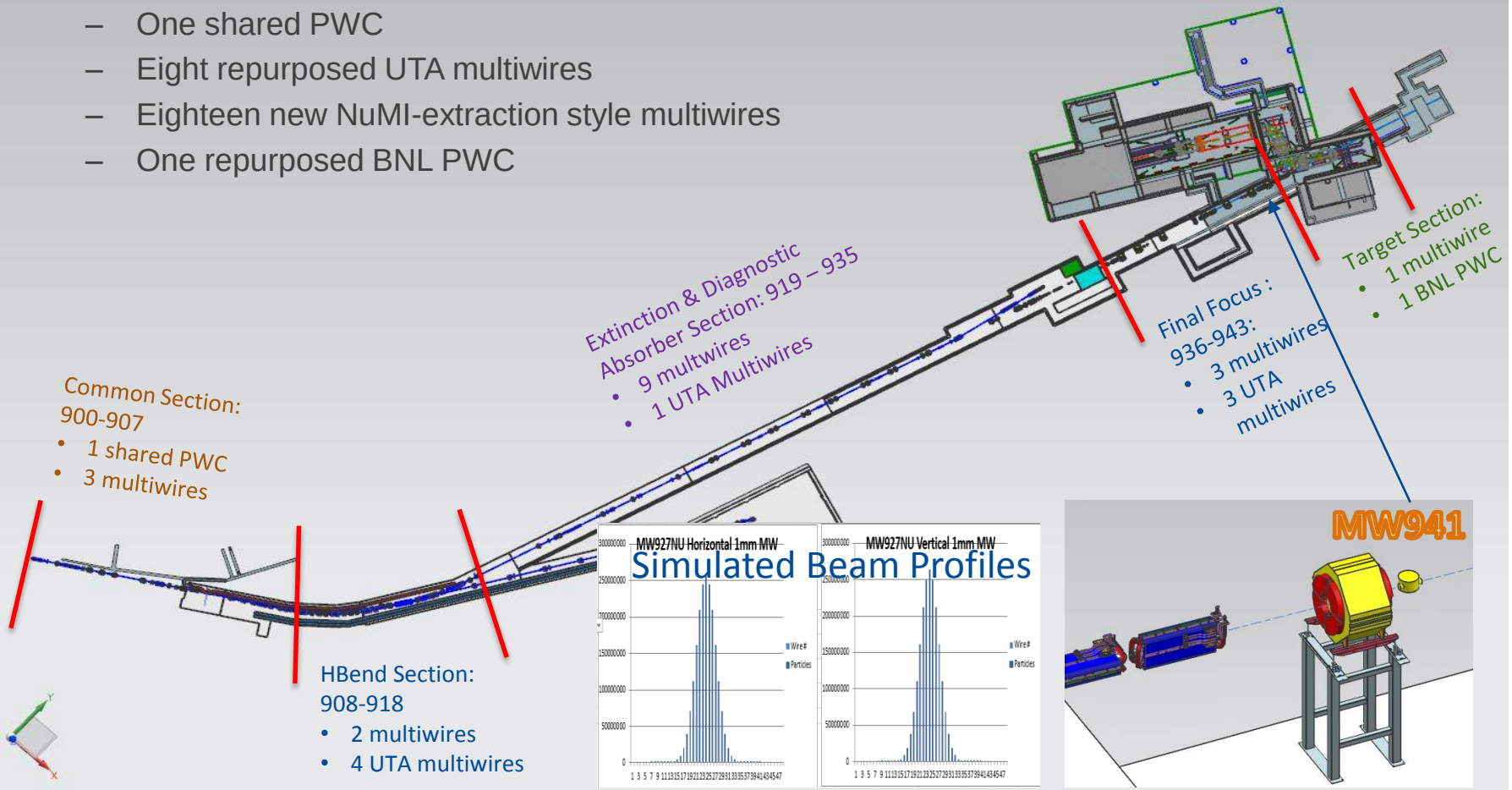






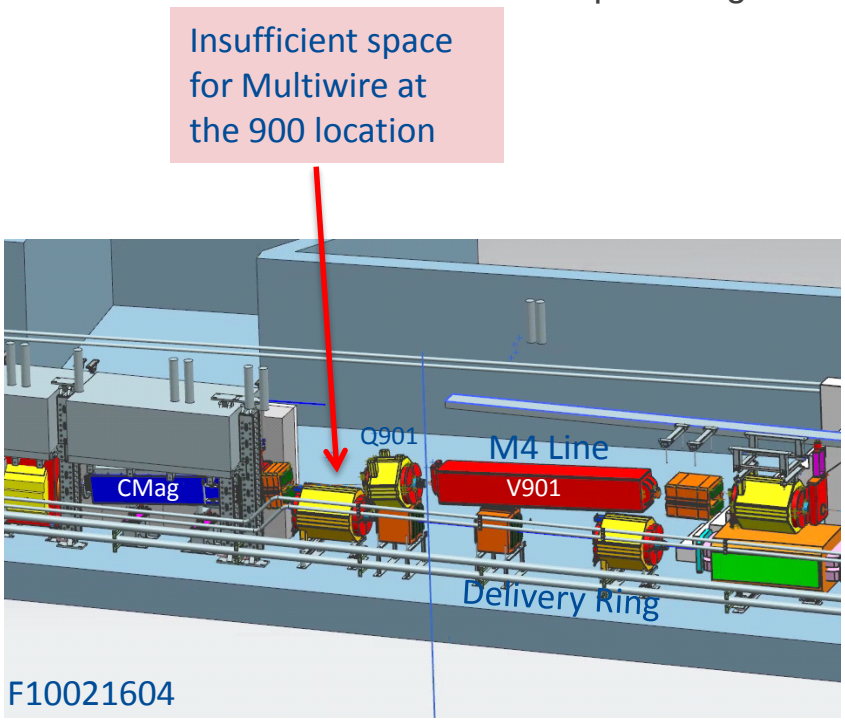
Profile Monitors in the M4 Line

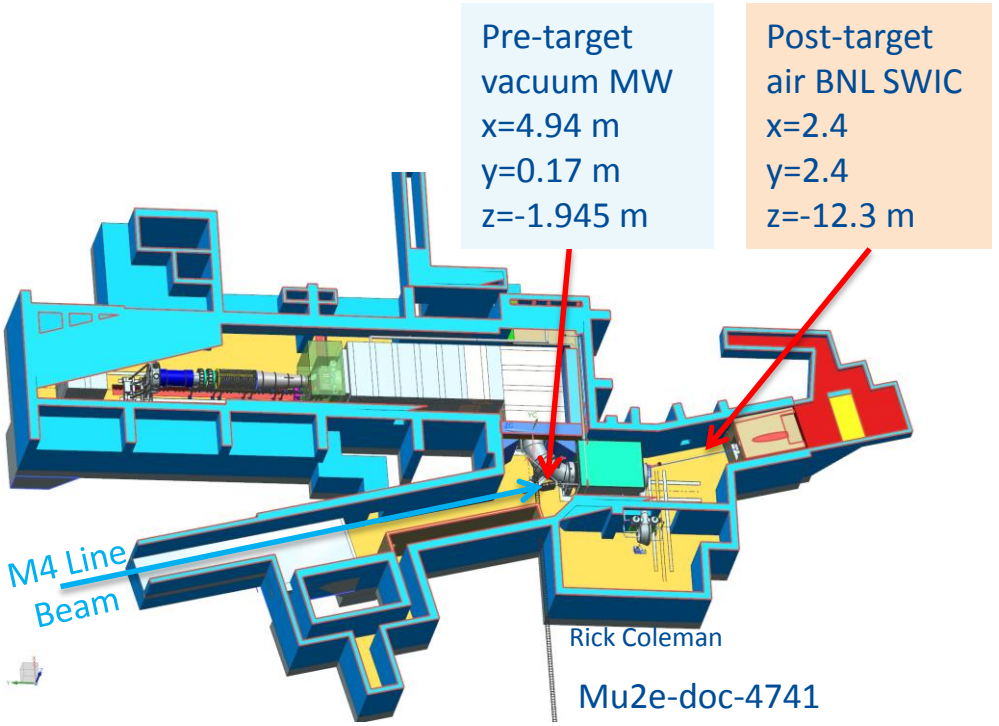
- Based on the lattice design, the M4 line will contain 28 profile monitors that will be used to measure the profile and position of the beam.
  - One shared PWC
  - Eight repurposed UTA multiwires
  - Eighteen new NuMI-extraction style multiwires
  - One repurposed BNL PWC



Scope Changes.

- Scope changes. Two additional multiwires were added to the scope from another WBS.
  - One will be just upstream of the solenoid
  - One is downstream of the target (temporary). We will use BNL PWCs so as to not add cost to the project.
  - Seven additional multiwires added with the new lattice.
    - We are refurbishing Texas multiwires to offset the cost.
  - There is not physical space for the Multiwire in the 900 location.
    - Will the proportional wire chamber from g-2, but can't leave in the beam for auto-tune.
- Will write a CR to cover the scope changes.



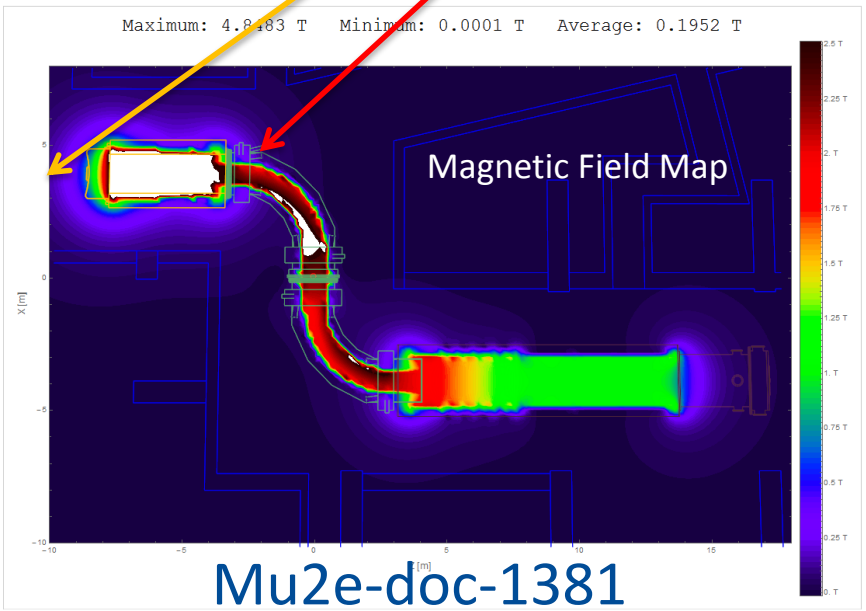


Design considerations

- Need to examine the effects of magnetic field on the multiwire just upstream of the target solenoid.
  - Does the magnetic field impact the motion control (PreTarget MW only)?
  - Does the magnetic field impact the signal?

PostTarget MW: 0.2Kg magnetic field

PreTarget MW: 1.2Kg magnetic field



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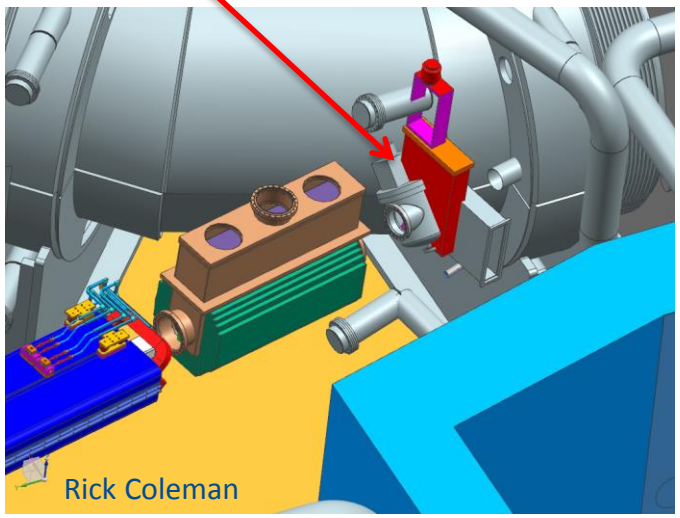

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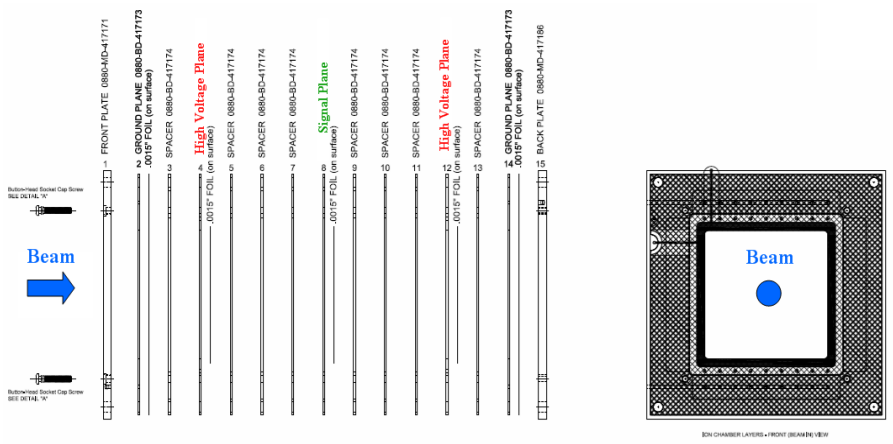
Retractable Ion Chambers



- Primary intensity measurement device in the M4 line.
- Use new PWC stack design to save on Engineering costs.
- Modified IC to fit in existing anti-vacuum box.
- Use recycled Bayonet vacuum cans from Switchyard.
- Ion chambers were tested with beam in the Switchard beam lines.
- Prototype readout digitizer is 10x more sensitive than previous digitizers.
- The bayonet type drive slides the ion chamber linearly into and out of the beam with a screw drive system.

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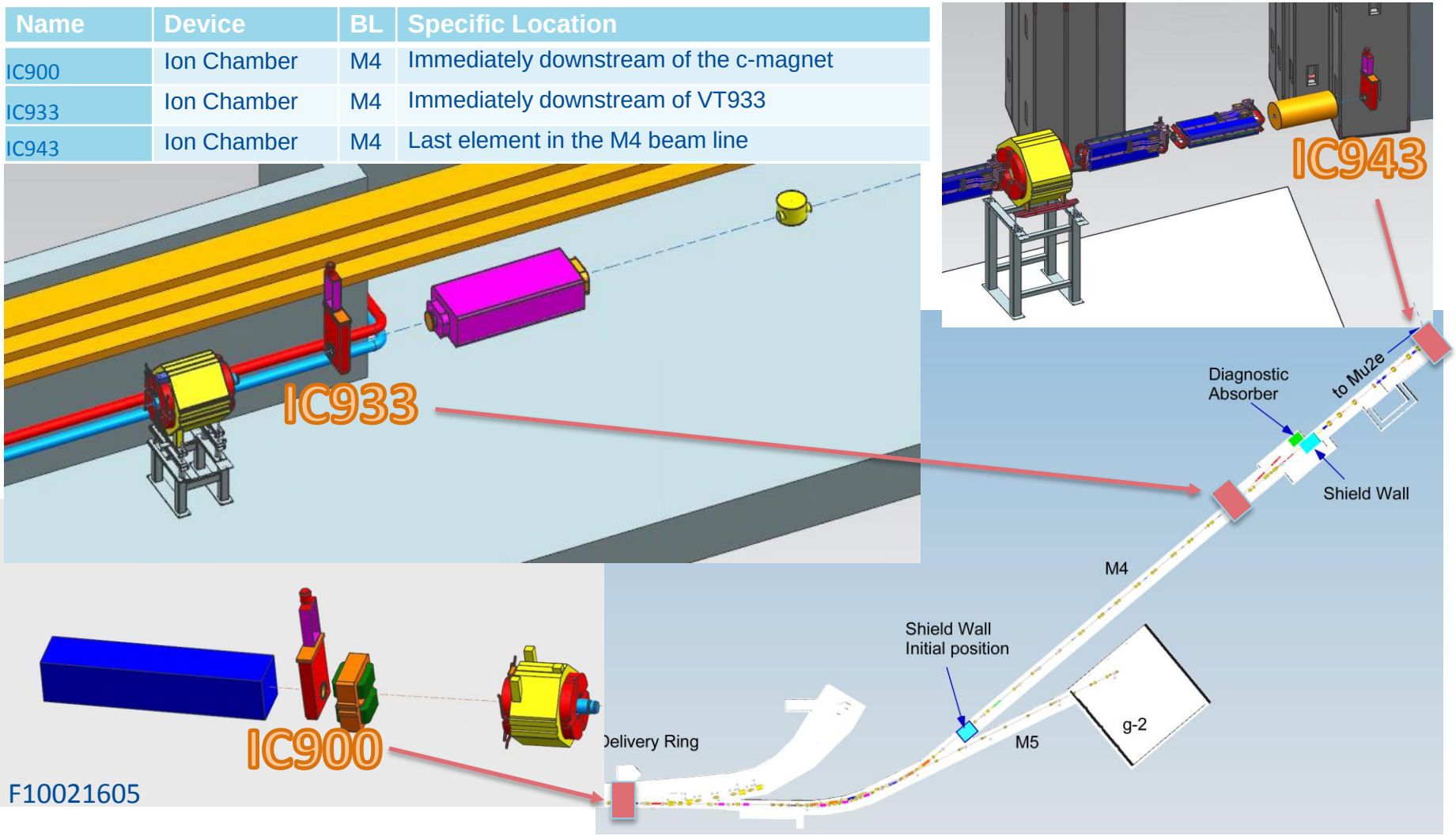
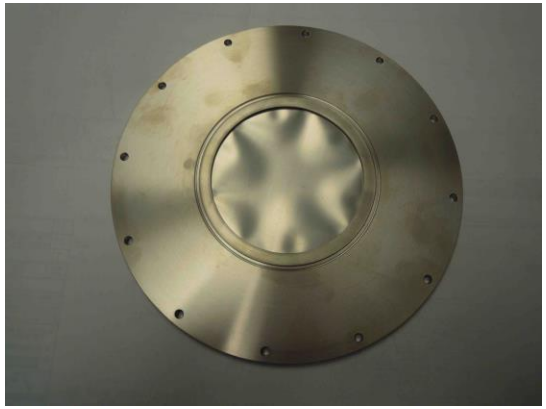
Extraction Beamline Ion Chamber Locations

Name	Device	BL	Specific Location
IC900	Ion Chamber	M4	Immediately downstream of the c-magnet
IC933	Ion Chamber	M4	Immediately downstream of VT933
IC943	Ion Chamber	M4	Last element in the M4 beam line

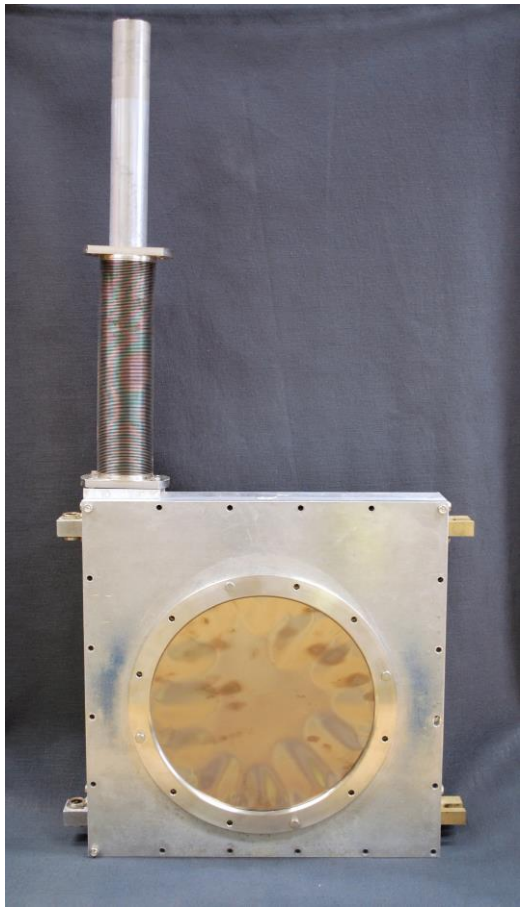


Design considerations

- New vacuum design of antivacuum can needs to be tested.



Replacement 4 inch E-Beam Welded Window



Bayonet drive anti-vacuum box With 9 inch O-ring sealed window

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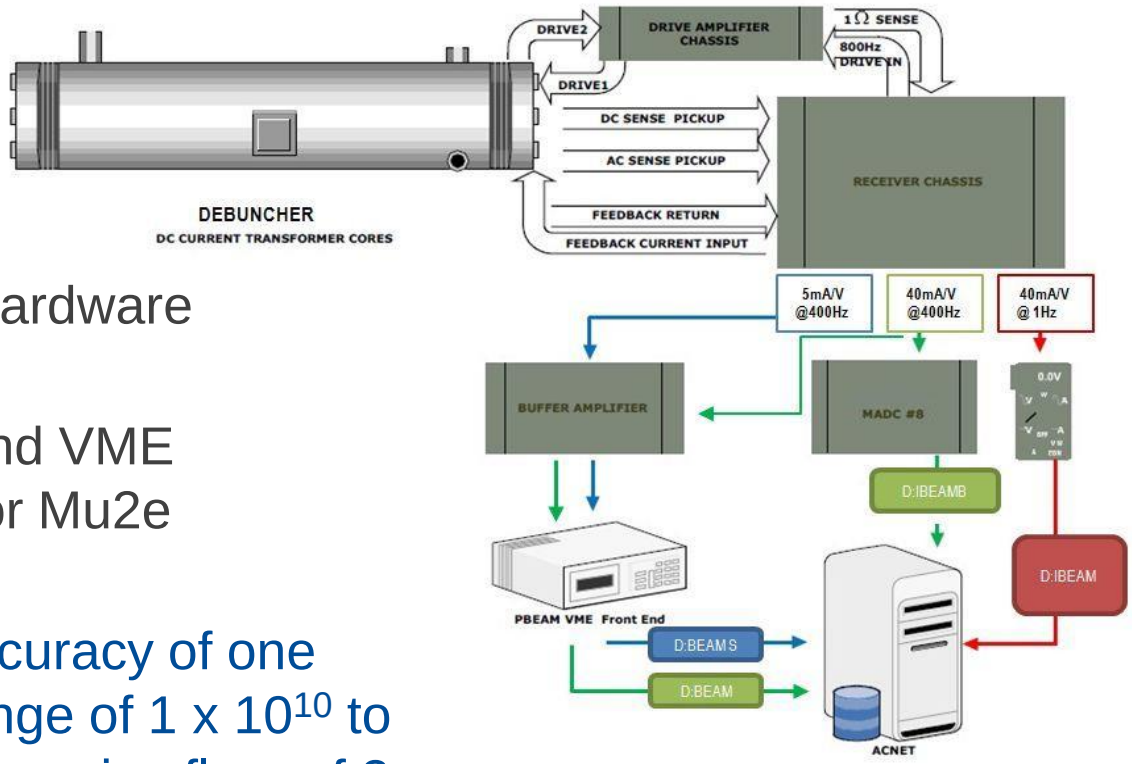
Delivery Ring Instrumentation Design

Measurement	Device	Beam Line	Specific Location
Intensity	DCCT	Delivery Ring	Between D1Q2 and D1Q3
Horizontal Tune	Schottky	Delivery Ring	Between D5Q3 and D5Q4
Vertical Tune	Schottky	Delivery Ring	Between D5Q2 and D5Q3

Resonant extraction instrumentation

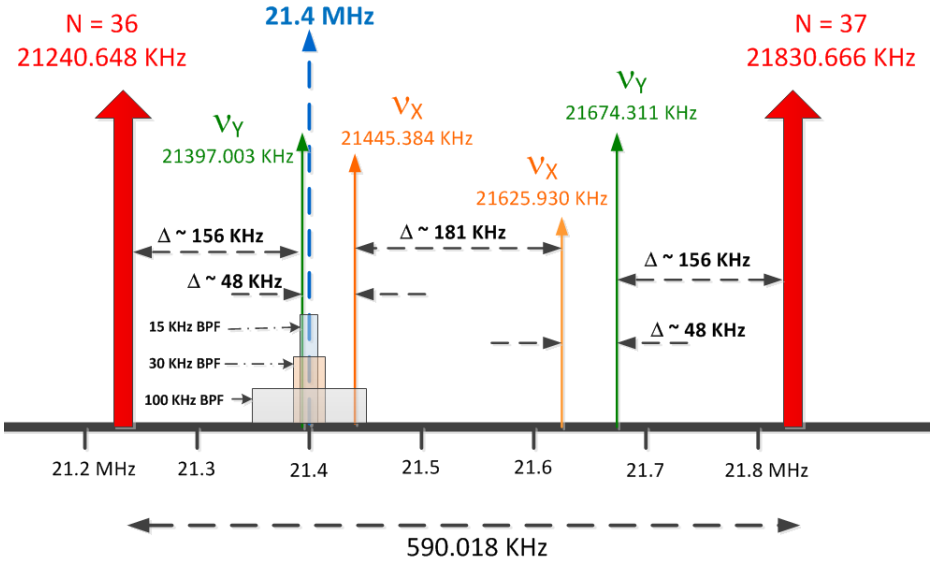
Delivery Ring Instrumentation: DCCT

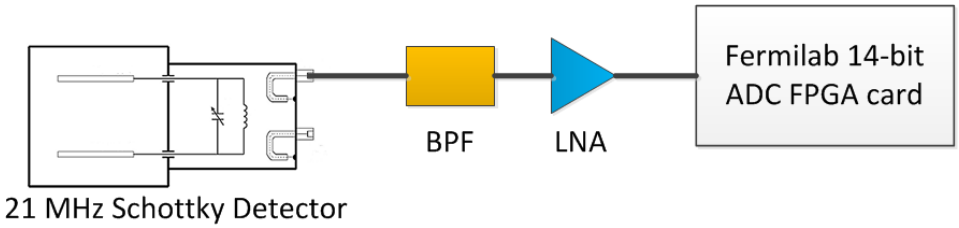


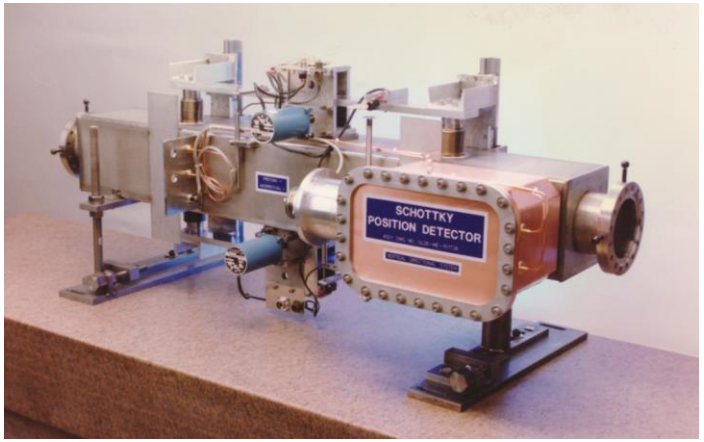
- Delivery Ring DCCT hardware repurposed.
- Analog conditioning and VME electronics modified for Mu2e operation.
- The system has an accuracy of one part in 10^5 over the range of 1×10^{10} to 2×10^{12} particles with a noise floor of 2×10^9.
- The Accumulator unit will become a working spare.

Delivery Ring Instrumentation: Tune Measurement

- Repurpose Tevatron 21.4MHz Schottky which has an acceptable aperture.
- Down convert from 36th/37th harmonics to 1st harmonic (0 to 590 KHz)
- Use Fermilab FPGA Digitizers
  - 14-bit ADC, 250 MHz sampling
  - Real-time FFTs in FPGA
- Use digital signal processing to produce tunes
  - Tunes to ±0.001 at 590 Hz
  - Tunes to ± 0.0001 with averaging over many spills







Extraction Instrumentation: BLMs

- The M4 Line Beam Loss Monitor (BLM) system has been designed to measure a 0.2% localized loss with microsecond integration.
- This will allow seeing losses develop inside of an individual slow spill.
- 30 BLMs will be placed at key locations along the 245m beam line.
- This system design is identical to the existing Main Injector, P1, P2, M1 and M3 line BLM systems.
- We will repurpose spare hardware and electronics from the Tevatron to reduce project costs.

Value Engineering

- Instrumentation
  - Tune Measurement
    - Repurpose Tevatron Schottky detectors for our tune measurement system.
  - M4 Line Profile Monitors
    - Changed type of profile monitor in the M4 line to save on labor and refurbishment costs
    - Use ANU multiwire design for M4 line multiwires.
    - Repurpose Texas Multiwire vacuum cans for our M4 line multiwires
    - Reduce the number of multwires needed by repurposing BNL SWIC for target profile monitor and share upstream proportional wire chamber with g-2.
  - Retractable Ion Chambers
    - Repurpose Switchyard Bayonet vacuum cans for ion chambers.
    - Modify PWC design to fit ion chamber.
  - M4 Line beam loss monitors.
    - Use standard Fermilab BLM electronics. No engineering time required.

Quality Assurance:

- **Use of Government Lab and Project QA Standards**
  - Fermilab Engineering Manual http://www.fnal.gov/directorate/documents/FNAL_Engineering_Manual.pdf
  - Fermilab's Integrated Quality Assurance Program https://esh-docdb.fnal.gov:440/cgi-bin/RetrieveFile?docid=2469
  - Mu2e Quality Management Plan http://mu2e-docdb.fnal.gov:8080/cgi-bin/ShowDocument?docid=677.
  - Mechanical Engineering QA practices, policy and procedures http://mu2e-docdb.fnal.gov:8080/cgi-bin/ShowDocument?docid=4646.
  - Configuration Management Plan: http://mu2e-docdb.fnal.gov:8080/cgi-bin/ShowDocument?docid=508
  - Fermilab Software QA Plan: http://goo.gl/wf1HtA
- **Quality Assurance for Controls**
  - All innerduct and cable pulls will be completed by contract electricians under the direction of Accelerator Division management.
  - Fiber optic terminations will be completed by contract electricians, safety system cable terminations will be managed by FNAL ES&H personnel, and phone cable termination will be managed by Computing Division, telecommunications department.
  - All controls links, FIRUS configuration and network connections work will be managed by Accelerator Division Controls Department personnel.
  - All parts are expected to be procured by FNAL personnel and inspected before being installed. Final testing and calibration of controls devices will be performed by FNAL technical staff before locating equipment in the service buildings.
- **Quality Assurance for Instrumentation**
  - Repurposing, design, upgrading, building and commissioning of M4 line instrumentation will be completed by qualified Accelerator Division Instrumentation and Controls Department Engineers and Technicians under the direction of Instrumentation and Muon Department management.
  - All necessary parts will be procured by FNAL personnel and inspected by qualified Instrumentation engineers or technicians prior to installation.
  - Final testing of instrumentation devices will be performed by FNAL technical staff before devices are installed.
  - Controls checkout and beam commissioning of each device will be completed by qualified Instrumentation, Controls and Muon Department technical staff.

Risks

- ACCEL-015 Injection Damper Required for Delivery Ring
  - ◊ Orbit control in the beam lines may not adequately control trajectory and may lead to excessive emittance dilution.
  - ◊ Note: Delivery Ring injection will be made to work for g-2 before the need for Mu2e.
  - ◊ Threat: $240K
  - ◊ Mitigation: If beam studies indicate instabilities of injected beam into the Delivery Ring, an injection damper system will be developed.
- Insufficient Network Controls
  - ◊ Legacy 10MBps network systems F23, F27 and AP0 are not fast or stable enough for Mu2e operations.
  - ◊ **Threat Retired**: Scope was added to the Delivery Ring AIP to run high speed fiber to F23, F27 and AP0c.

ES&H

Tunnel Enclosures and Service Buildings

- Electrical hazards from exposed bus work and high voltage connectors.
- Mechanical hazards (sharp edges, protruding fixtures)
- Radiation hazards
  - Potentially lethal doses during beam operation
  - Residual radioactivity after beam operations
  - Radioactive surface and air contamination

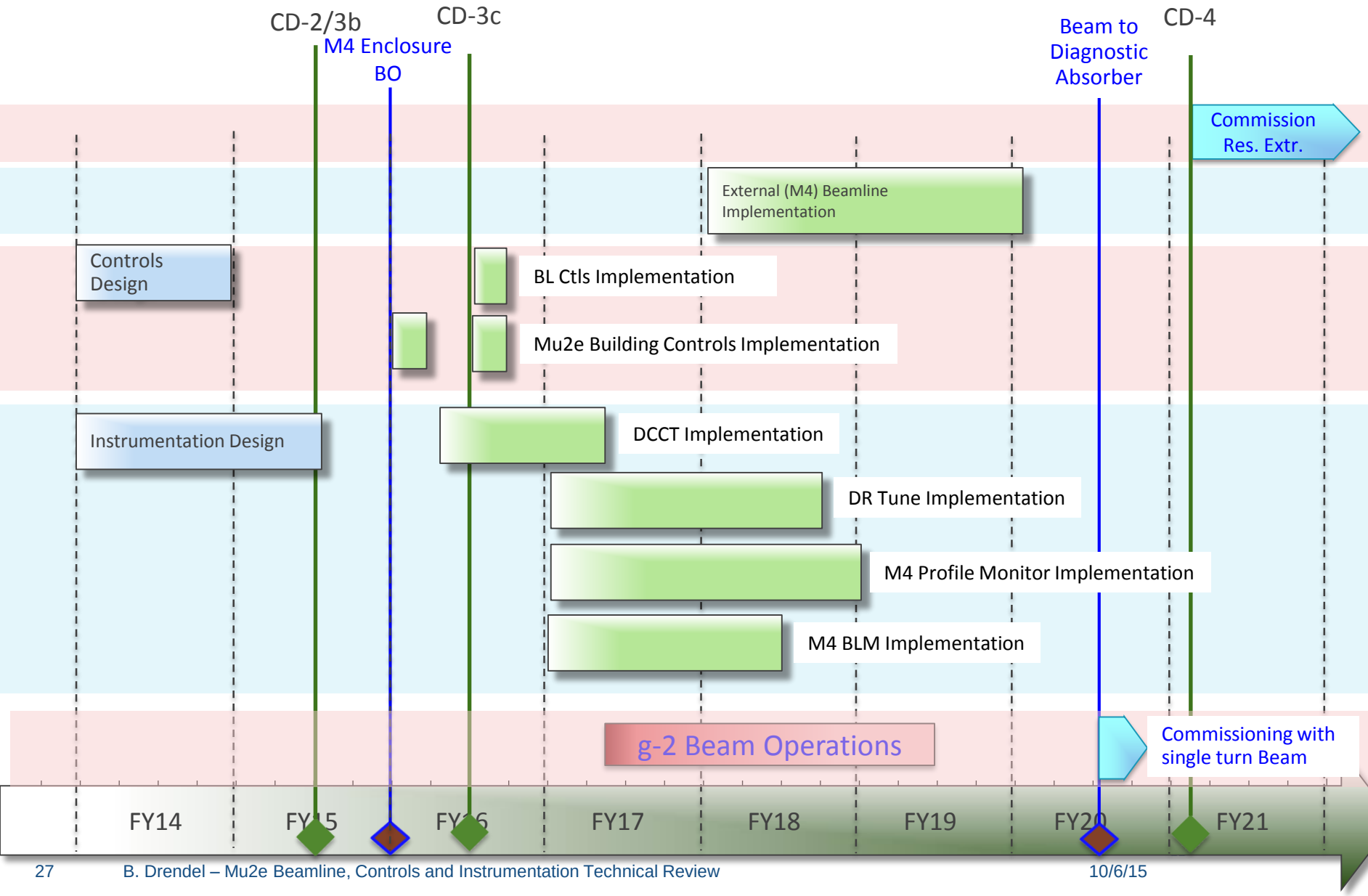
Laboratory ES&H

- Instrumentation and controls systems will all be implemented within the guidelines documented in the Fermilab Environment, Safety and Health Manual (FESHM) which can be found online at http://esh.fnal.gov/xms/FESHM.
  - Laboratory safety practices will be observed for all work.
  - Job hazard analyses will be performed for installation and other appropriate work.

Mu2e ES&H

- All hazards in this WBS are covered in the Mu2e Hazard Analysis Report document Mu2e-doc-675 (http://mu2e-docdb.fnal.gov:8080/cgi-bin/ShowDocument?docid=675).

Schedule


CD-2/3b
M4 Enclosure
BO
CD-3c
Beam to
Diagnostic
Absorber
CD-4
Commission
Res. Extr.
External (M4) Beamline
Implementation
Controls
Design
BL Ctls Implementation
Mu2e Building Controls Implementation
Instrumentation Design
DCCT Implementation
DR Tune Implementation
M4 Profile Monitor Implementation
M4 BLM Implementation
g-2 Beam Operations
Commissioning with
single turn Beam
FY14
FY15
FY16
FY17
FY18
FY19
FY20
FY21

Summary

- Final Design is near completion and we are ready to proceed to the DOE CD3 review.
  - Controls Final Design is complete.
  - M4 Profile Monitors Design is nearly complete.
    - Address MW functionality in magnetic field of production solenoid.
  - M4 Ion Chamber Final Design is nearly complete.
    - Electronics Final Design Complete.
    - Ion Chamber stack Final Design Complete.
    - Repurposed vacuum can design modifications ready to test.
  - M4 BLM Final Design is complete.
  - M4 DCCT and Tune Measurement Systems Final Designs are complete.

Delivery Ring Spill Parameters

Parameter	Value	Units
MI Cycle time	1.333	sec
Number of spills per MI cycle	8	
Number of protons per micro-pulse	3.1×10^{7}	protons
Time between micro-pulses	1.695	μsec
Maximum Delivery Ring Beam Intensity	1.0×10^{12}	protons
Instantaneous spill rate	18.5×10^{12}	protons/sec
Average spill rate	6.0×10^{12}	protons/sec
Duty Factor (Total Spill Time ÷ MI Cycle Length)	32	%
Duration of each spill	54	msec
Spill On Time per MI cycle	497	msec
Spill Off Time per MI cycle	836	msec
Time Gap between 1st set of 4 and 2nd set of 4 spills	36	msec
Time Gap between spills	5	msec
Pulse-to-pulse intensity variation	±50	%

[1] The pulse intensity is expected to be approximately uniform on short time scales (< 1 msec). The time scale of the variation in pulse intensity is expected to be of order a few msec.

Mu2e Proton Beam Requirements

Parameter	Design Value	Requirement	Unit
Total protons on target	3.6×10^{20}	3.6×10^{20}	protons
Time between beam pulses	1695	>864	nsec
Maximum variation in pulse separation	< 1	10	nsec
Spill duration	**54**	>20	msec
Beamline Transmission Window	230	250	nsec
Transmission Window Jitter (rms)	5	<10	nsec
Out-of-time extinction factor	10^{-10}	$\leq 10^{-10}$	
Average proton intensity per pulse	**3.1×10^{7}**	$< 5.0\times10^{7}$	protons/pulse
Maximum Pulse to Pulse intensity variation	50	50	%
Minimum Target rms spot size	1	0.5	mm
Maximum Target rms spot size[6]	1	1.5	mm
Target rms beam divergence	0.5	< 4.0	mrad

Requirements: Instrumentation

- Instrumentation designed to measure proton beam based on the Proton Beam Requirements Mu2e-doc-1105.

	Beam Line	Delivery Ring	Abort Line	Extraction
Beam Line Names	P1 Stub, P1, P2, M1, and M3	Delivery Ring	Abort Line	M4
Particles	Protons	Protons	Protons	Protons
Momentum (GeV/c)	8.88626	8.88626	8.88626	8.88626
# of Particles	1E12	1E12 -> 2E10 slow spill over 54msec	2E10 at the end of every cycle or up to 1E12 when beam permit is pulled.	Slices of 2E7 every 1.695usec totaling 1E12 over the 56msec slow spill cycle.
Bunch Length	120nsec	120 nsec	120 nsec	120 nsec
Transverse Emittance (mm-mrad)	15pi	19pi	40pi	40pi
Beam Line Length	~975m	505m	72m	244m

Accelerator Parameters

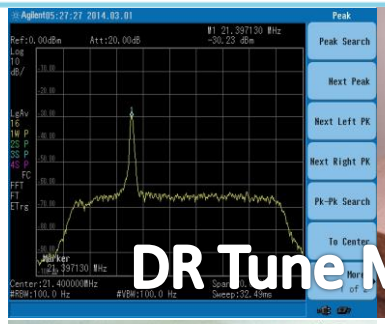
Parameter	Value	Units
Booster		
Beam Energy	8.9	GeV
Intensity per batch	4×10^{12}	protons
53 MHz Bunches per batch	81	
Repetition rate	15	Hz
Average Repetition rate for Mu2e Beam	1.5	Hz
Transverse emittance	15π	mm-mrad
Longitudinal emittance per 53 MHz bunch	0.12	eV-sec
Recycler Ring		
Maximum Beam Intensity (for Mu2e)	4×10^{12}	protons
Revolution Frequency	89.824	kHz
η	-0.00876	
2.5 MHz Re-bunch time	90	msec
2.5 MHz bunches/batch	4	
Average Mu2e beam power	7.69	kW
Transverse emittance	16π	mm-mrad
Delivery Ring		
Maximum Intensity	1×10^{12}	protons
Revolution Frequency (central orbit)	590018	Hz
η	0.00607	
Orbit Length (central orbit)	505.294	m
Average Injection Frequency	6.0	Hz
Peak Injection Frequency	17.0	Hz
ν_x	9.650	
ν_y	9.735	
Average β_x	9.5	m
Average β_y	9.5	m
Horizontal Admittance	35π	mm-mrad
Vertical Admittance	35π	mm-mrad
Peak Laslett space charge tune shift	0.0097	
Peak Space charge tune shift from tracking simulations	0.0070	
Bunch Length (rms)	35	nsec
Synchrotron tune	5.9×10^{-5}	
Transverse emittance	16π	mm-mrad
Maximum Extracted Beam Power	7.69	kW

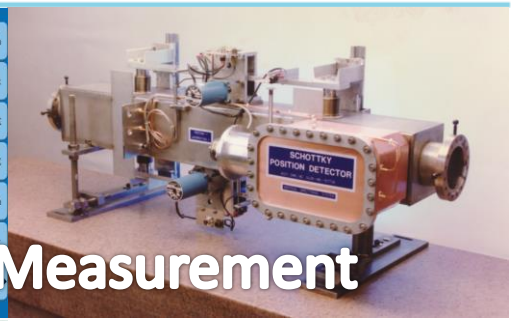
Standard Specifications: Accelerator Controls

- Ethernet (Controls & General): Communicating with controls system and the outside world.
- Experiment data: > 1GB/s pipeline between Mu2e and FCC.
- Camac/HRM: Communication with ACNET controls.
- Timing Links: TCLK timing for devices.
- Beam Synch: RF synched timing for devices.
- Permit Loop: Permit for Delivery Ring beam abort.
- FIRUS: Fire and Utility system for building monitoring.
- Safety System: Interlocks and safety system for Mu2e and M4 enclosure.
- SEWs: Site Emergency Warning system.
- Radmux: Collects data from connected radiation monitors throughout the accelerator areas, beam line areas, and test areas at the Laboratory
- Phone: Hard-lined phone connection to building.

WBS 475.02.03 Instrumentation and Controls

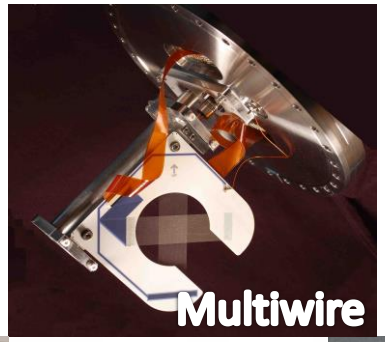
- **Controls**
  - New fiber optic and copper pulls from cross gallery to Mu2e will provide all necessary network and controls signals.
  - Mirror that work that was just completed at MC-1.
- **Instrumentation**
  - **DR Tune** – Measurements made with repurposed Tevatron Schottky in the Delivery Ring.
  - **Intensity** – New ion chamber design complete and prototype has been built.
  - **Multiwire**
    - Refurbish Texas Multiwires with new drive assembly. Prototype is being tested now.
    - Use existing NuMI extraction Multiwire design for remaining profile monitors.
  - **Losses** – Use existing Tevatron BLM design.

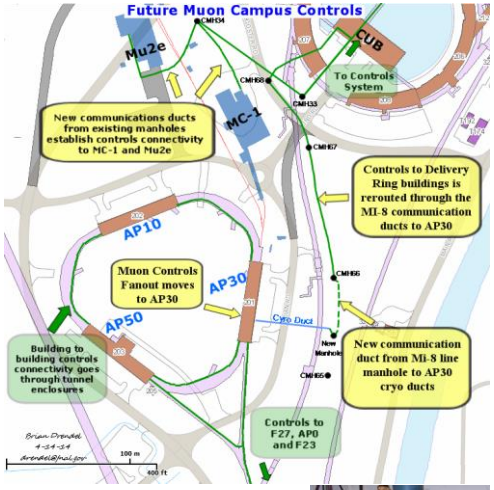


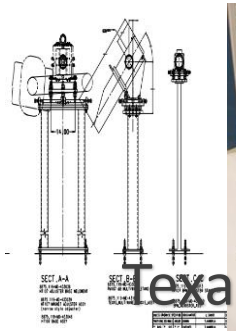


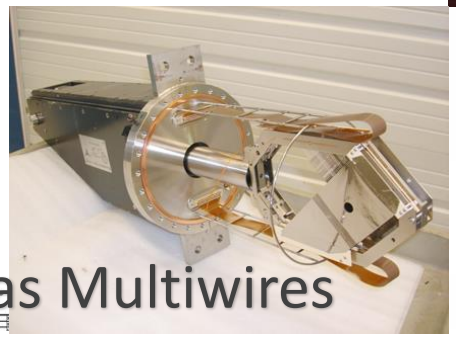
DR Tune Measurement

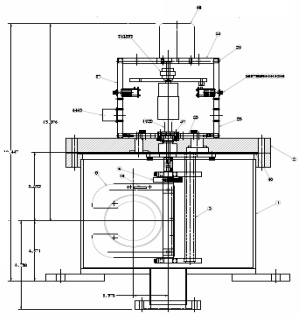
BLMs


Multiwire






Texas Multiwires



Retractable Ion Chamber

Low Intensity Secondary Beam Instrumentation

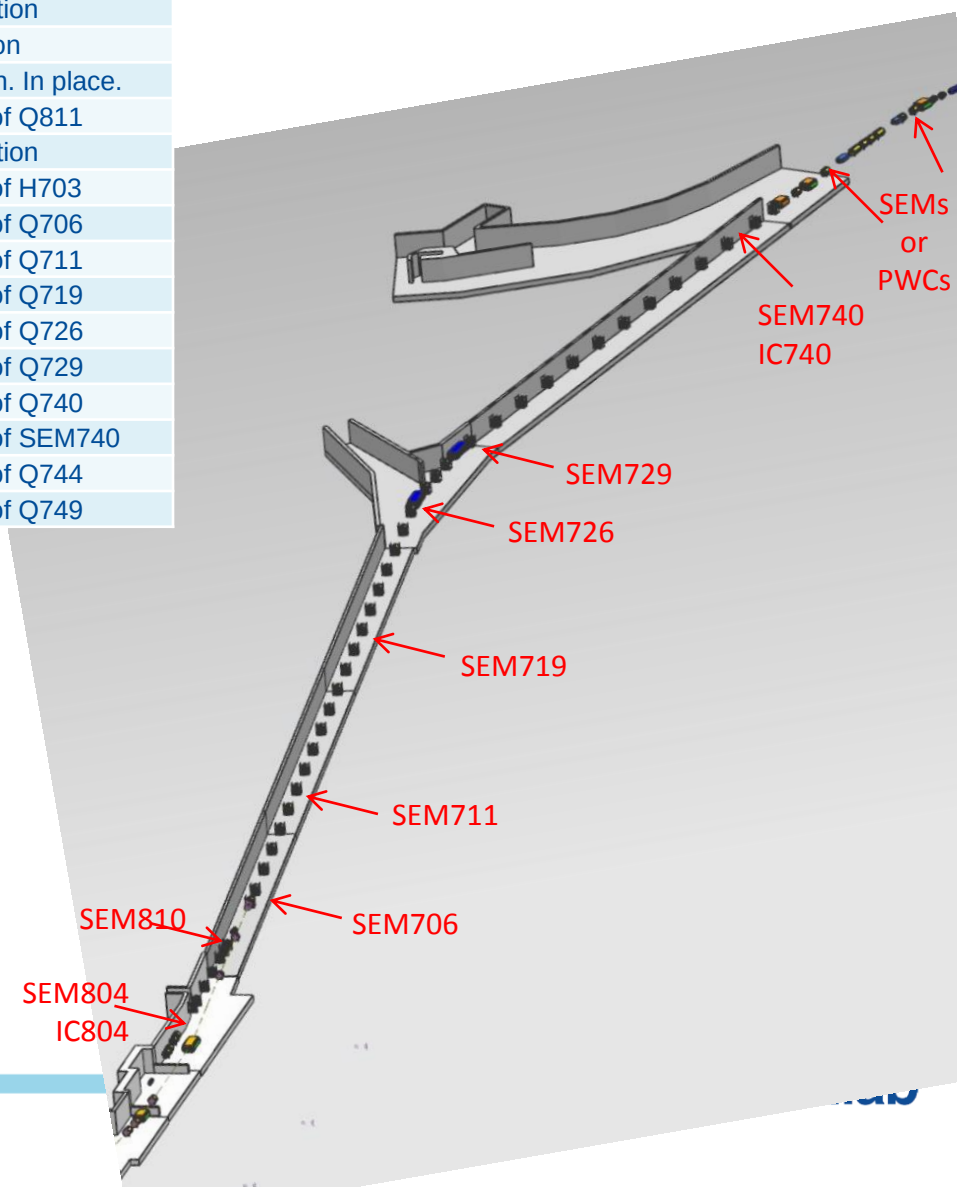
Name	Device	Beam Line	Specific Location
SEM804	SEM	M2	Use existing SEM704 location
Tor804	Toroid	M2	Use existing Tor704 location
IC804	Fixed Ion Chamber	M2	Use existing IC704 location. In place.
SEM810	SEM	M2	Immediately downstream of Q811
SEM702	SEM	M3	Use existing SEM926 location
SEM703	SEM	M3	Immediately downstream of H703
SEM706	SEM	M3	Immediately downstream of Q706
SEM711	SEM	M3	Immediately downstream of Q711
SEM719	SEM	M3	Immediately downstream of Q719
SEM726	SEM	M3	Immediately downstream of Q726
SEM729	SEM	M3	Immediately downstream of Q729
SEM740	SEM	M3	Immediately downstream of Q740
IC740	Ion Chamber	M3	Immediately downstream of SEM740
SEM744	SEM or PWC	M3	Immediately downstream of Q744
SEM749	SEM or PWC	M3	Immediately downstream of Q749

SEMS

- Repurpose 21 Pbar SEMS
- Should have hardware for two spares
- Build 21 super high gain preamps
- Build 21 generation 3 scanners

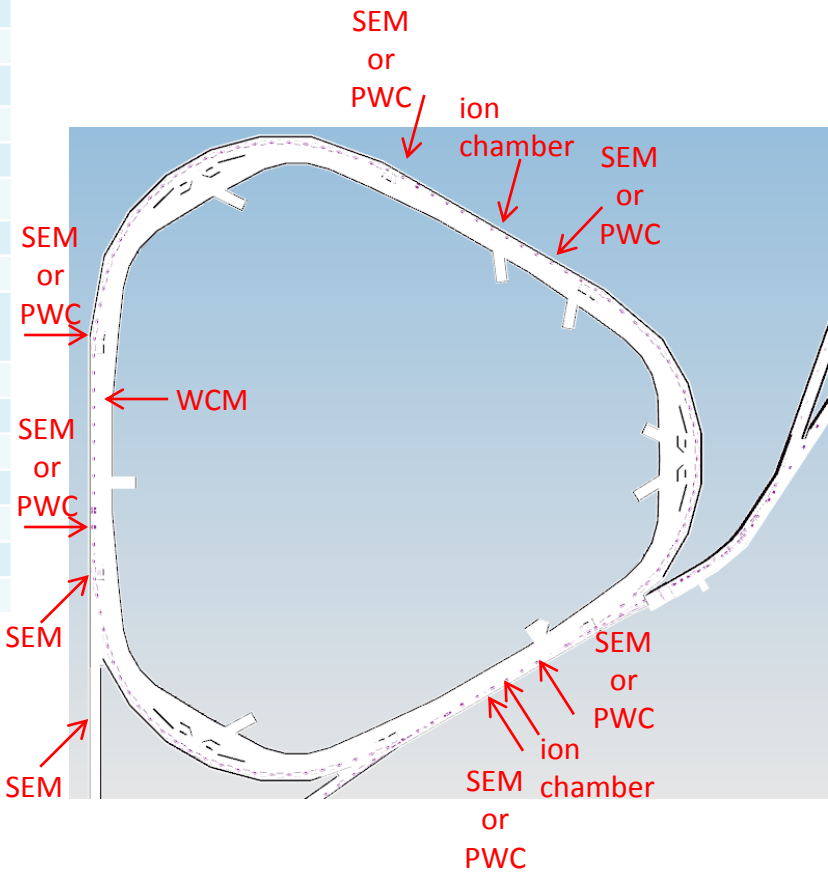
Ion Chambers

- Two Fixed (in air) ion chambers. Need to be mindful of scattering.
- Four retractable ion chambers using bayonet cans.



Low Intensity Secondary Beam Instrumentation

Name	Device	Beam Line	Specific Location
SEM204	SEM or PWC	DR	Immediately upstream of ELAM
SEM302	SEM or PWC	DR	Immediately downstream of ISEP
IC300	Ion Chamber	DR	D30 straight (Retractable)
SEM607	SEM or PWC	DR	Use existing SEM607 location
SEM105	SEM or PWC	DR	Near D1Q5
IC100	Ion Chamber	DR	D10 straight (Retractable)
SEM403	SEM or PWC	DR	Use existing SEM403 location
SEM506	SEM or PWC	DR	Near D5Q6
WCM503	WCM	DR	Between D5Q3 and D5Q4. Mu2e Device
IC500	Ion Chamber	DR	D10 straight (Retractable) – Not costed
ICABT	Fixed Ion Chamber	Abort Line	Immediately upstream of abort block
Tor000	Toroid	Abort Line	Existing Tor733 as is
TorABT	Toroid	Abort Line	Existing Tor724 near abort block.
MWA00	SEM	Abort Line	Existing SEM733 at current location
MWA05	SEM	Abort Line	Existing SEM728 at current location
MWABT	SEM	Abort Line	Immediately upstream of ICABT



SEMS

- Repurpose 21 Pbar SEMS
- Should have hardware for two spares
- Build 21 super high gain preamps
- Build 21 generation 3 scanners
- May use PWCs in DR and some of M3.

Ion Chambers

- Two Fixed (in air) ion chambers
- Four retractable ion chambers using bayonet cans.

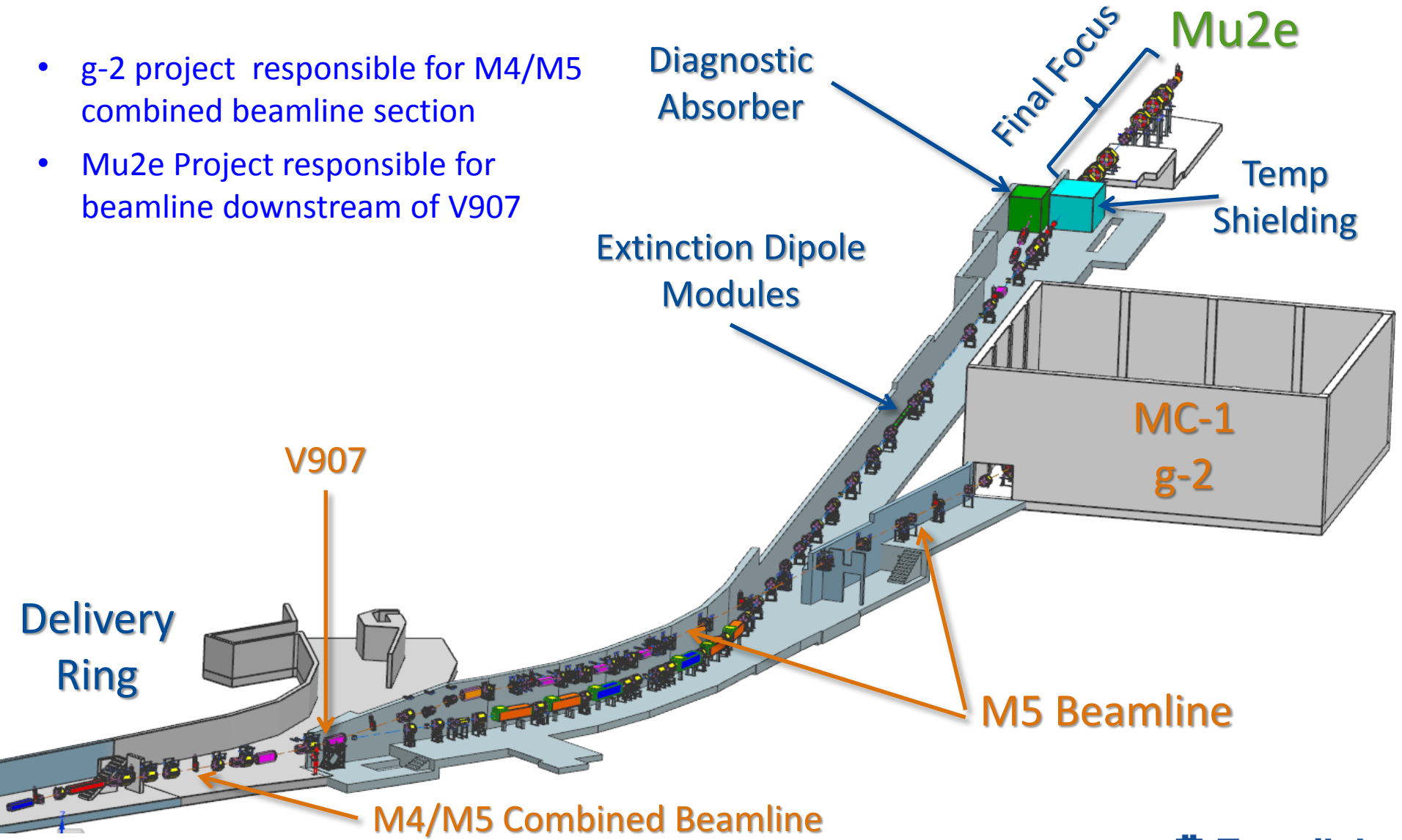
WCM

- Mu2e device, but can be used to measure g-2 beam intensity.

Fermilab

External Beamline

- g-2 project responsible for M4/M5 combined beamline section
- Mu2e Project responsible for beamline downstream of V907



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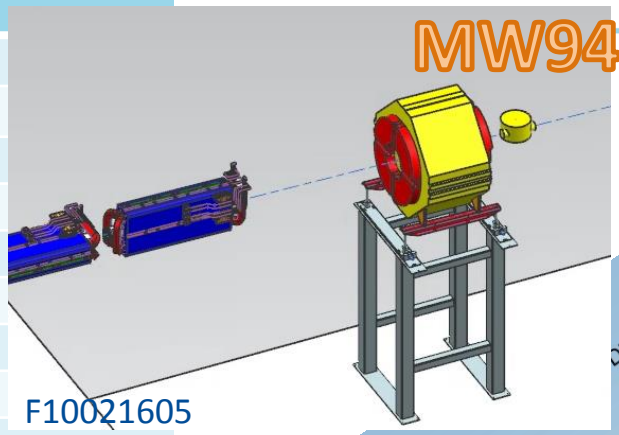
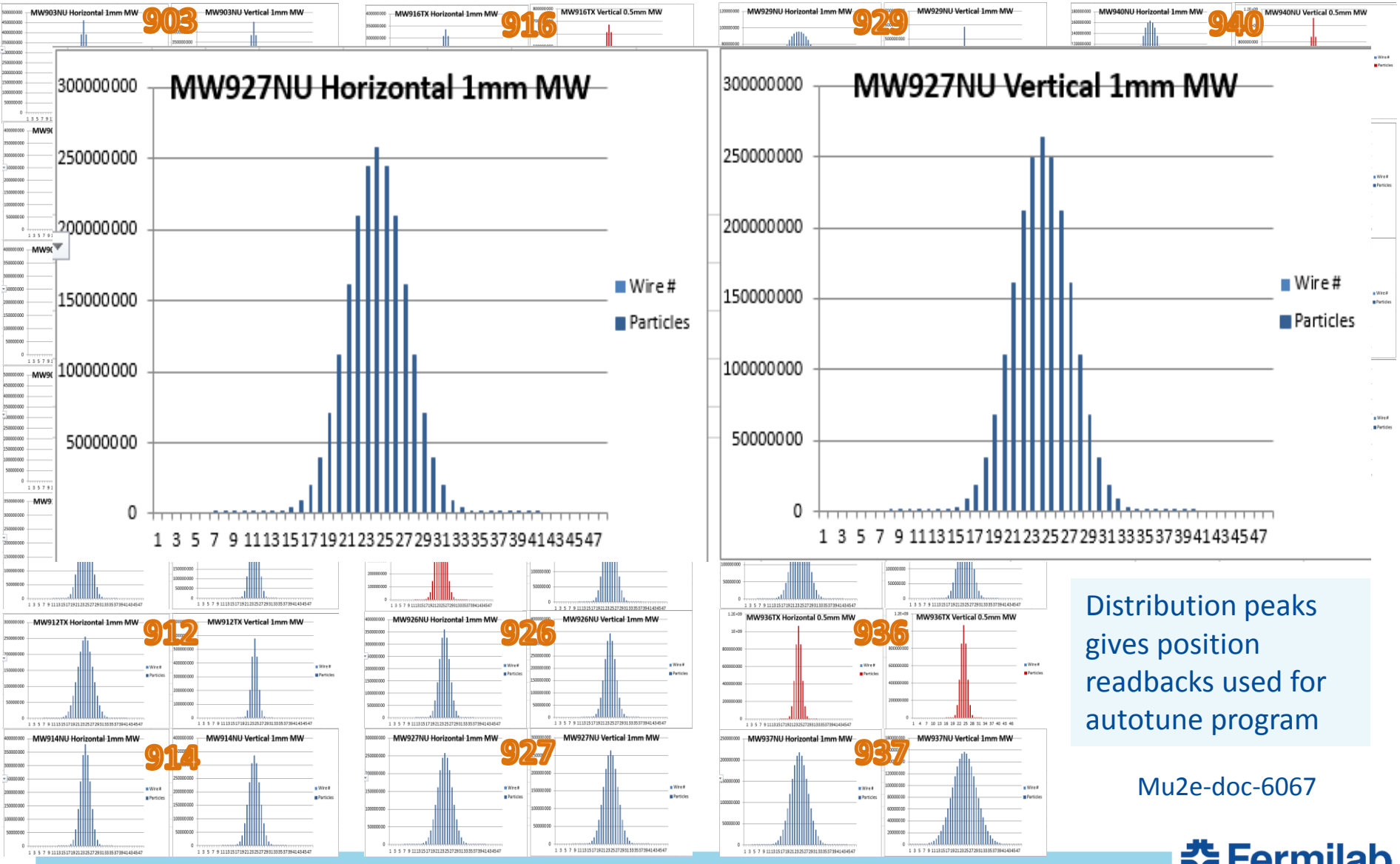
Extraction Beamline Multiwire Locations

Name	Device	BL	Specific Location
MW903NU	Multiwire	M4	Immediately downstream of Q903
MW906NU	Multiwire	M4	Immediately downstream of V906
MW907NU	Multiwire	M4	Immediately downstream of V907
MW908NU	Multiwire	M4	Immediately downstream of Q908
MW910TX	Texas MW	M4	Immediately downstream of Q910
MW912TX	Texas MW	M4	Immediately downstream of H912
MW914NU	Multiwire	M4	Immediately downstream of HT914
MW916TX	Texas MW	M4	Immediately downstream of H916
MW917TX	Texas MW	M4	Immediately downstream of H917
MW919NU	Multiwire	M4	Immediately downstream of VT919
MW922NU	Multiwire	M4	Immediately downstream of Q922
MW924NU	Multiwire	M4	Immediately downstream of collimator at 924
MW926NU	Multiwire	M4	Downstream of Q926
MW927NU	Multiwire	M4	Immediately downstream of HT927
MW929NU	Texas MW	M4	Immediately downstream of Q929
MW930NU	Multiwire	M4	Immediately downstream of VT930
MW932NU	Multiwire	M4	Immediately downstream of Q932
MW933NU	Multiwire	M4	Immediately upstreamc of Q934
MW935NU	Multiwire	M4	Immediately downstream of Q935
MW936TX	Texas MW	M4	Immediately downstream of beam stop at 936
MW937NU	Multiwire	M4	Immediately downstream of Q937
MW940NU	Multiwire	M4	Immediately downstream of Q940
MW941NU	Multiwire	M4	Immediately downstream of Q941
MW943ATX	Texas MW	M4	Immediately downstream of Q943
MW943BTX	Texas MW	M4	Immediately downstream of HT943
SWTGT	BNL SWIC	M4	Downstream of production target.



Simulated Profile Sizes for 0.5mm and 1.0mm wire spacing



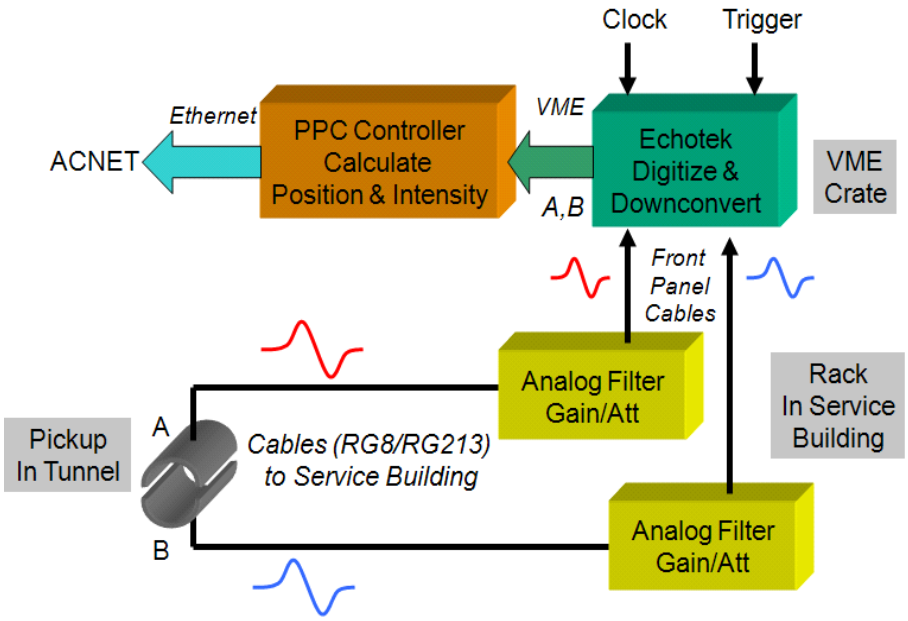
Distribution peaks gives position readbacks used for autotune program

Mu2e-doc-6067

Fermilab

Beam Position Monitors

- Debuncher BPMs can only see 53MHz and will be upgraded to Echotech standard with 2.5MHz electronics.
  - –Repurpose Tevatron BPM crates
  - –Repurpose Recycler BPM electronics
- Tunnel hardware will be repurposed.
- BPMs will have sub-millimeter resolution.
  - –Closed orbit and TBT available.
- Delivery Ring BPM system is off-project on the Delivery Ring AIP.



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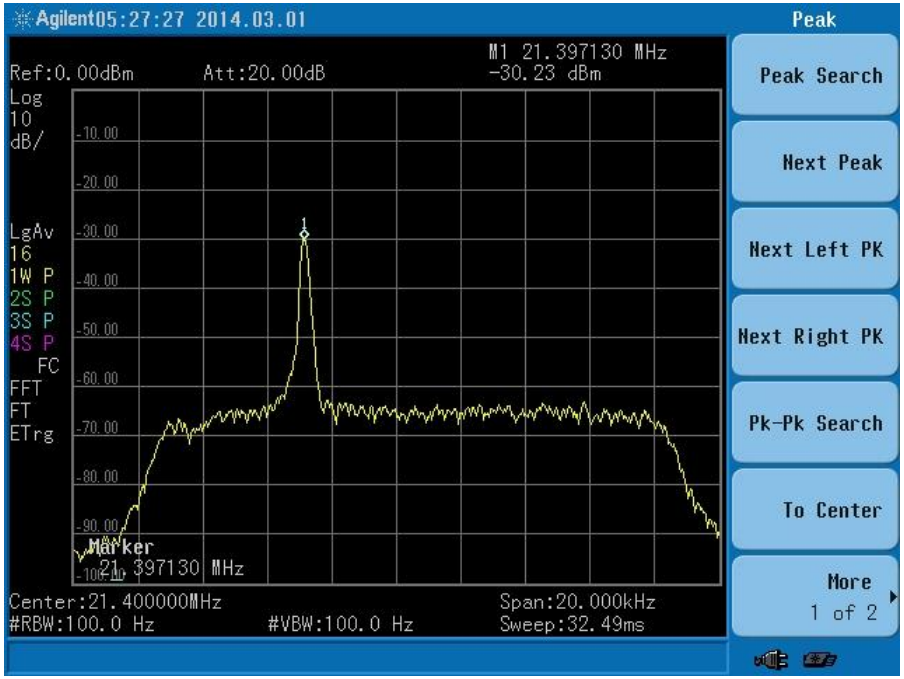
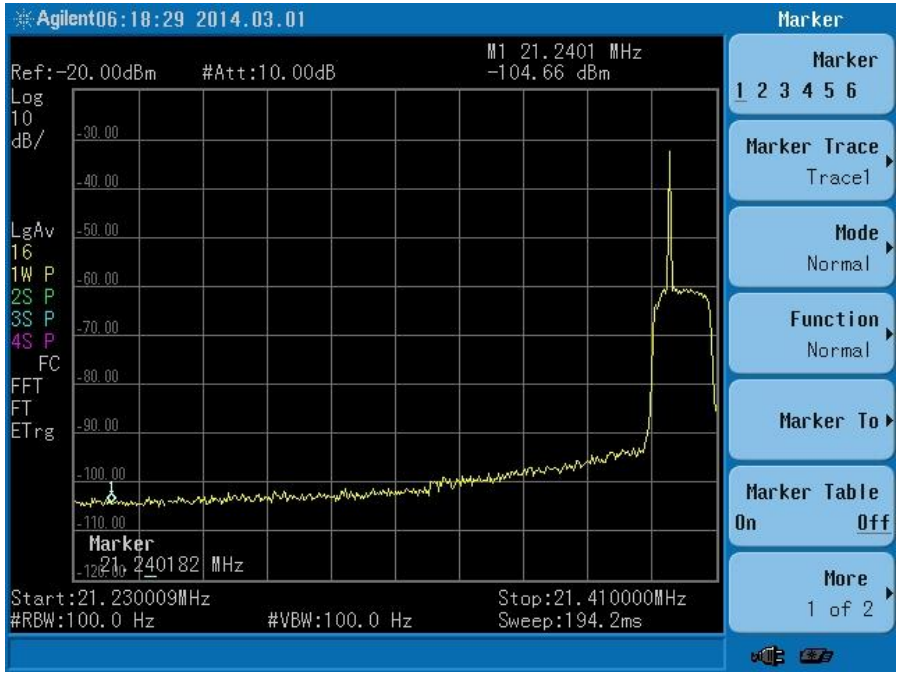
Performance: Schottky Tune Measurement

- 5.3e10 protons in Debuncher
- 21.397130 MHz is equal to a vertical tune of 0.7348
- Pbar Schottky tune was 0.7348





- Performance was sufficient to continue with Schottky tune measurement system.

Mu2e Controls

Activity ID	Activity Name	Original Duration	Budgeted Material Cost	Budgeted Nonlabor Cost	Start	Finish	Budgeted Labor Units
475.03BL.04.05 Building Controls		62d	$91,600	$448	01-Oct-15	04-Jan-16	0h
47503.04.05.001130	Pull Innerduct	4d	$0	$128	12-Nov-15	17-Nov-15	0h
47503.04.05.001150	Pull Cable AP30 to Mu2e	3d	$0	$96	25-Nov-15	01-Dec-15	0h
47503.04.05.001140	Pull Cable Cross Gallery(Xgal) to Mu2e	5d	$0	$160	18-Nov-15	24-Nov-15	0h
47503.04.05.001160	Terminate Connectors	20d	$0	$64	02-Dec-15	04-Jan-16	0h
47503.04.05.001109	Purchase Network and Communication Hardware M&S Fabricate	28d	$0	$0	02-Oct-15	10-Nov-15	0h
47503.04.05.001195	T5 - Mu2e Building Essential Services Installed	0d	$0	$0		04-Jan-16	0h
47503.04.05.001110	Purchase Network and Communication Hardware M&S Deliver	1d	$45,800	$0	11-Nov-15	11-Nov-15	0h
47503.04.05.001120	Purchase Network and Communication Hardware (Obligation)	1d	$45,800	$0	01-Oct-15	01-Oct-15	0h

- Cable purchases are in progress

Activity ID	Activity Name	Original Duration	Budgeted Material Cost	Budgeted Nonlabor Cost	Start	Finish	Budgeted Labor Units
475.02BL.03.01.2 Mu2e Experimental Hall Controls		361d	$62,000	$0	02-Mar-15	03-Aug-16	440h
47502.03.01.2.001170	Controls Infrastructure	60d	$0	$0	05-Jan-16	29-Mar-16	169h
47502.03.01.2.001180	Network Infrastructure	60d	$0	$0	05-Jan-16	29-Mar-16	14h
47502.03.01.2.001190	HRM Installation	60d	$0	$0	10-May-16	03-Aug-16	256h
47502.03.01.2.001089	Purchase Controls Hardware M&S Fabricate	28d	$0	$0	16-Jun-16	26-Jul-16	0h
47502.03.01.2.001200	T5 - Mu2e Experimental Hall Controls Complete	0d	$0	$0		03-Aug-16	0h
475.014 CD2	475.014 CD-2 Baseline Single Point Adjustment	1d	$0	$0	02-Mar-15	02-Mar-15	1h
47502.03.01.2.001090	Purchase Controls Hardware M&S Deliver	1d	$31,000	$0	27-Jul-16	27-Jul-16	0h
47502.03.01.2.001100	Purchase Controls Hardware (Obligation)	1d	$31,000	$0	15-Jun-16	15-Jun-16	0h

Multiwire and Ion Chamber Schedule

Activity ID	Activity Name	BOE Docdb #	Estimate Type	Planned Duration	Cobra PMT Code	Cost Class 1	Planned Labor Units	Planned Material Cost	Planned Joplabor	Control Account	Control Account Manager	Chargeable Task Code	Start	Finish
475.02S.03.03.1	M4 Line Profile and Intensity Monitors			1070.0d			487d	$651,840	$480				02-Jun-14 08:00 AM A	04-Sep-18 05:00 PM
47502.03.03.1.001080	Mechanical Design/Drawings Ion Chamber in square can	3675	L3	40.0d	C	CB	8d	$0	$0	475.02.03	09990N	475.647	01-Oct-15 08:00 AM	25-Nov-15 05:00 PM
47502.03.03.1.001140	Procurement of controls electronics (Obligation)	Obligation	M4	1.0d	C	OB	0d	$73,000	$0	475.02.03	09990N	475.153	04-Oct-17 08:00 AM	04-Oct-17 05:00 PM
47502.03.03.1.001090	Electrical Design/Drawings of Multiwires in NuMI style Multiwire vacuum can	3675	L3	20.0d	C	CB	9d	$0	$0	475.02.03	09990N	475.647	02-Jun-14 08:00 AM A	30-Jun-14 05:00 PM A
47502.03.03.1.001100	Mechanical Design/Drawings of Multiwires in NuMI style Multiwire vacuum can	3675	L3	20.0d	C	CB	8d	$0	$0	475.02.03	09990N	475.647	30-Nov-15 08:00 AM	29-Dec-15 05:00 PM
47502.03.03.1.001129	Procurement of controls electronics M&S Fabricate	3675	M4	18.0d	C	MC	0d	$0	$0		09990N		05-Oct-17 08:00 AM	30-Oct-17 05:00 PM
47502.03.03.1.001150	Build Multiwire scanners	3675	L4	90.0d	K	CB	182d	$0	$0	475.02.03	09990N	475.153	01-Nov-17 08:00 AM	15-Mar-18 05:00 PM
47502.03.03.1.001160	Install Multiwire scanners	3675	L4	10.0d	C	CB	9d	$0	$0	475.02.03	09990N	475.153	16-Mar-18 08:00 AM	29-Mar-18 05:00 PM
47502.03.03.1.001170	Build Ion Chamber Electronics	3675	L4	20.0d	C	CB	25d	$0	$0	475.02.03	09990N	475.153	01-Nov-17 08:00 AM	30-Nov-17 05:00 PM
47502.03.03.1.001180	Install Ion Chamber Electronics	3675	L4	20.0d	C	CB	6d	$0	$0	475.02.03	09990N	475.153	01-Dec-17 08:00 AM	03-Jan-18 05:00 PM
47502.03.03.1.001189	Procurement of parts for Multiwires and Ion Chambers M&S Fabricate	3675	M4	18.0d	C	CB	1d	$0	$0	475.02.03	09990N	475.153	03-Oct-17 08:00 AM	26-Oct-17 05:00 PM
47502.03.03.1.001209	Procure Cables M&S Fabricate	3675	M4	22.0d	C	MC	0d	$0	$0		09990N		03-Oct-17 08:00 AM	01-Nov-17 05:00 PM
47502.03.03.1.001280	Modification of Vacuum Cans for Ion Chambers	3675	L4	13.0d	C	CB	12d	$0	$0	475.02.03	09990N	475.153	30-Oct-17 08:00 AM	15-Nov-17 05:00 PM
47502.03.03.1.001290	Assembly of wire planes	3675	L3	51.0d	K	CB	51d	$0	$0	475.02.03	09990N	475.153	08-Feb-18 08:00 AM	19-Apr-18 05:00 PM
47502.03.03.1.001300	Assemble and Test Ion Chambers	3675	L3	21.0d	C	CB	21d	$0	$0	475.02.03	09990N	475.153	26-Feb-18 08:00 AM	26-Mar-18 05:00 PM
47502.03.03.1.001310	Assemble stands	3675	L4	11.0d	C	CB	12d	$0	$0	475.02.03	09990N	475.153	30-Oct-17 08:00 AM	13-Nov-17 05:00 PM
47502.03.03.1.001294	Assemble and test Multiwires: Final Testing	3675	L3	17.0d	K	CB	19d	$0	$0	475.02.03	09990N	475.153	22-May-18 08:00 AM	14-Jun-18 05:00 PM
47502.03.03.1.001292	Install motor controller	3675	L3	5.0d	K	CB	6d	$0	$0	475.02.03	09990N	475.153	15-May-18 08:00 AM	21-May-18 05:00 PM
47502.03.03.1.001291	Installation SEM into vacuum can	3675	L3	17.0d	K	CB	17d	$0	$0	475.02.03	09990N	475.153	20-Apr-18 08:00 AM	14-May-18 05:00 PM
47502.03.03.1.001130	Procurement of controls electronics M&S Delivery	3675	M4	1.0d	C	MC	0d	$73,000	$0	475.02.03	09990N	475.153	31-Oct-17 08:00 AM	31-Oct-17 05:00 PM
47502.03.03.1.001190	Procurement of parts for Multiwires and Ion Chambers M&S Deliver	3675	M4	1.0d	C	MC	0d	$196,240	$0	475.02.03	09990N	475.153	27-Oct-17 08:00 AM	27-Oct-17 05:00 PM
47502.03.03.1.001210	Procure Cables M&S Deliver	3675	M4	1.0d	C	MC	0d	$52,780	$0	475.02.03	09990N	475.153	02-Nov-17 08:00 AM	02-Nov-17 05:00 PM
47502.03.03.1.001230	Vendor builds Multiwire electronic circuits M&S Deliver	3675	M4	1.0d	C	MC	0d	$3,900	$0	475.02.03	09990N	475.153	11-Jan-18 08:00 AM	11-Jan-18 05:00 PM
47502.03.03.1.001330	Mechanical and Electrical Installation	3675	L4	33.0d	C	CB	35d	$0	$0	475.02.03	09990N	475.153	19-Jul-18 08:00 AM	04-Sep-18 05:00 PM
47502.03.03.1.001120	Create purchase order for controls electronics	3675	L4	2.0d	C	CB	1d	$0	$0	475.02.03	09990N	475.153	02-Oct-17 08:00 AM	03-Oct-17 05:00 PM
47502.03.03.1.001229	Vendor builds Multiwire electronic circuits M&S Fabricate	3675	M4	46.0d	C	MC	0d	$0	$0		09990N		31-Oct-17 08:00 AM	10-Jan-18 05:00 PM
47502.03.03.1.001320	Reference SWIC/SEM (Internal Align)	3675	L4	9.0d	C	CB	11d	$0	$0	475.02.03	09990N	475.153	19-Jan-18 08:00 AM	31-Jan-18 05:00 PM
47502.03.03.1.001200	Procurement of parts for Multiwires and Ion Chambers (Obligation)	Obligation	M4	1.0d	C	OB	0d	$196,240	$0	475.02.03	09990N	475.153	02-Oct-17 08:00 AM	02-Oct-17 05:00 PM
47502.03.03.1.001240	Vendor builds Multiwire electronic circuits (Obligation)	Obligation	M4	1.0d	C	OB	0d	$3,900	$0	475.02.03	09990N	475.153	30-Oct-17 08:00 AM	30-Oct-17 05:00 PM
47502.03.03.1.001220	Procure Cables (Obligation)	Obligation	M4	1.0d	C	OB	0d	$52,780	$0	475.02.03	09990N	475.153	02-Oct-17 08:00 AM	02-Oct-17 05:00 PM

Multiwire/Ion Chamber Schedule (continued)

Activity ID	Activity Name	BOE Docdb #	Estimate Type	Planned Duration	Cobra PMT Code	Cost Class 1	Planned Labor Units	Planned Material Cost	Planned Joblabor	Control Account	Control Account Manager	Chargeable Task Code	Start	Finish
47502.03.03.1.001220	Procure Cables (Obligation)	Obligation	M4	1.0d	C	OB	0d	$52,780	$0	475.02.03	09990N	475.153	02-Oct-17 08:00 AM	02-Oct-17 05:00 PM
47502.03.03.1.001270	Machining cans for multi wires	3675	L4	68.0d	K	CB	67d	$0	$0	475.02.03	09990N	475.153	30-Oct-17 08:00 AM	09-Feb-18 05:00 PM
47502.03.03.1.001110	T5 - Final Design of Profile and Intensity Monitors Complete	Mile		0.0d	B		0d	$0	$0		09990N			29-Dec-15 05:00 PM
47502.03.03.1.001295	T5 - Multiwire Assembly Complete			0.0d	B		0d	$0	$0		09990N			14-Jun-18 05:00 PM
47502.03.03.1.001305	T5 - Ion Chamber Assembly Complete			0.0d	B		0d	$0	$0		09990N			26-Mar-18 05:00 PM
47502.03.03.1.001340	T5 - Multiwire and Ion Chamber Installation Complete			0.0d	B		0d	$0	$0		09990N			04-Sep-18 05:00 PM
47502.03.03.1.001115	T5 - Start M4 beamline Profile and Intensity Monitor Procurements			0.0d	B		0d	$0	$0		09990N		02-Oct-17 08:00 AM	
47502.03.03.1.001275	T5 - Start of M4 Beamline Ion Chamber and Multiwire Assembly			0.0d	B		0d	$0	$0		09990N		11-Jan-18 08:00 AM	
475.647 CD2	475.647 CD-2 Baseline Single Point Adjustment	ACWP	L1	1.0d	A	CB	-13d	$0	$0	475.02.03	09990N	475.647	02-Mar-15 08:00 AM A	02-Mar-15 05:00 PM A
475.102 CD2	475.102 CD-2 Baseline Single Point Adjustment	ACWP	L1	1.0d	A	CB	0d	$0	$0	475.02.03	09990N	475.102	02-Mar-15 08:00 AM A	02-Mar-15 05:00 PM A
47502.03.03.1.001091	(1) Electrical (1) Design/Drawings of Multiwires in NuMI style Multiwire vacuum can	3675	L3	1.0d	C	CB	9d	$0	$0	475.02.03	09990N	475.647	02-Mar-15 08:00 AM A	02-Mar-15 05:00 PM A
47502.03.03.1.001092	(2) Electrical (1) Design/Drawings of Multiwires in NuMI style Multiwire vacuum can	3675	L3	20.0d	C	CB	-9d	$0	$0	475.02.03	09990N	475.647	01-Jun-15 08:00 AM A	29-Jun-15 12:00 AM A
47502.03.03.1.001260	M4 Line Profile and Intensity Monitors - Terminate Cables	3675	M4	20.0d	C	CB	0d	$0	$160	475.02.03	09990N	475.153	05-Dec-17 08:00 AM	05-Jan-18 05:00 PM
47502.03.03.1.001250	M4 Line Profile and Intensity Monitors - Pull Cables	3675	M4	20.0d	C	CB	0d	$0	$320	475.02.03	09990N	475.153	03-Nov-17 08:00 AM	04-Dec-17 05:00 PM

DCCT Schedule

Layout: BOE Review | Filter All: Completion after 4/30/2014

Activity ID	Activity Name	BOE Docdb #	Estimate Type	Planned Duration	Cobra PMT Code	Cost Class 1	Planned Labor Units	Planned Material Cost	Planned Joplabor	Control Account	Control Account Manager	Chargeable Task Code	Start	Finish
475.02S.03.02.1	Delivery Ring DC Beam Measurement			577.0d			41d	$1,245	$0				02-Mar-15 08:00 AM A	14-Jun-17 05:00 PM
47502.03.02.1.001210	T5 - Delivery Ring DCCT Complete			0.0d	B		0d	$0	$0		09990N			14-Jun-17 05:00 PM
47502.03.02.1.001115	Complete purchase DCCT Electronics components	3690	M3	44.0d	C	CB	0d	$375	$0	475.02.03	09990N	475.018	06-Sep-16 08:00 AM	04-Nov-16 05:00 PM
47502.03.02.1.001135	Complete purchase DCCT conditioning components	3690	M3	44.0d	C	CB	0d	$125	$0	475.02.03	09990N	475.018	06-Sep-16 08:00 AM	04-Nov-16 05:00 PM
47502.03.02.1.001120	Assemble DCCT Electronics	3690	L3	30.0d	C	CB	10d	$0	$0	475.02.03	09990N	475.018	07-Nov-16 08:00 AM	20-Dec-16 05:00 PM
47502.03.02.1.001130	Initial purchase DCCT conditioning components	3690	M3	44.0d	C	CB	0d	$125	$0	475.02.03	09990N	475.018	05-Jul-16 08:00 AM	02-Sep-16 05:00 PM
47502.03.02.1.001140	Assemble & test DCCT conditioning circuit	3690	L3	30.0d	C	CB	10d	$0	$0	475.02.03	09990N	475.018	07-Nov-16 08:00 AM	20-Dec-16 05:00 PM
47502.03.02.1.001110	Initial purchase DCCT Electronics components	3690	M3	44.0d	C	CB	0d	$375	$0	475.02.03	09990N	475.018	05-Jul-16 08:00 AM	02-Sep-16 05:00 PM
47502.03.02.1.001170	Purchase parts for DCCT Hardware Updates	3690	M3	30.0d	C	CB	0d	$250	$0	475.02.03	09990N	475.018	05-Jul-16 08:00 AM	15-Aug-16 05:00 PM
47502.03.02.1.001180	Perform DCCT Hardware Updates	3690	L3	60.0d	K	CB	5d	$0	$0	475.02.03	09990N	475.018	08-Feb-17 08:00 AM	02-May-17 05:00 PM
47502.03.02.1.001150	Test DCCT Signal Processing	3690	L3	30.0d	C	CB	8d	$0	$0	475.02.03	09990N	475.018	21-Dec-16 08:00 AM	07-Feb-17 05:00 PM
47502.03.02.1.001200	Complete DCCT Documentation	3690	L3	14.0d	C	CB	3d	$0	$0	475.02.03	09990N	475.018	05-Jul-16 08:00 AM	22-Jul-16 05:00 PM
47502.03.02.1.001190	Calibrate DCCT	3690	L3	30.0d	C	CB	4d	$0	$0	475.02.03	09990N	475.018	03-May-17 08:00 AM	14-Jun-17 05:00 PM
475.016 CD2	475.016 CD-2 Baseline Single Point Adjustment	ACWP	L1	1.0d	A	CB	2d	($5)	$0	475.02.03	09990N	475.016	02-Mar-15 08:00 AM A	02-Mar-15 05:00 PM A

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BLM Schedule

Activity ID	Activity Name	BOE Docdb #	Estimate Type	Planned Duration	Cobra PMT Code	Cost Class 1	Planned Labor Units	Planned Material Cost	Planned Joplabor	Control Account	Control Account Manager	Chargeable Task Code	Start	Finish
475.02S.03.03.2 M4 Line Beam Loss Monitors				128.0d			129d	$93,150	$256				02-Oct-17 08:00 AM	06-Apr-18 05:00 PM
47502.03.03.2.001060	Req. prep BLM Log Integrator Cards	4480	L3	6.0d	C	CB	5d	$0	$0	475.02.03	09990N	475.631	02-Oct-17 08:00 AM	09-Oct-17 05:00 PM
47502.03.03.2.001069	Purchase BLM Log Integrator Cards M&S Fabricate	4480	M3	28.0d	C	MC	0d	$0	$0		09990N		11-Oct-17 08:00 AM	17-Nov-17 05:00 PM
47502.03.03.2.001090	Assemble Log Integrator Cards	4480	L3	9.0d	C	CB	8d	$0	$0	475.02.03	09990N	475.103	21-Nov-17 08:00 AM	05-Dec-17 05:00 PM
47502.03.03.2.001100	Test Log Integrator Cards	4480	L3	9.0d	C	CB	8d	$0	$0	475.02.03	09990N	475.103	06-Dec-17 08:00 AM	18-Dec-17 05:00 PM
47502.03.03.2.001110	Req prep BLM Ion chambers	4480	L3	6.0d	C	CB	5d	$0	$0	475.02.03	09990N	475.631	02-Oct-17 08:00 AM	09-Oct-17 05:00 PM
47502.03.03.2.001119	Purchase BLM Ion Chambers M&S Fabricate	4480	M3	28.0d	C	MC	0d	$0	$0		09990N		11-Oct-17 08:00 AM	17-Nov-17 05:00 PM
47502.03.03.2.001140	Assemble BLM Ion Chambers	4480	L3	38.0d	C	CB	38d	$0	$0	475.02.03	09990N	475.103	21-Nov-17 08:00 AM	22-Jan-18 05:00 PM
47502.03.03.2.001150	Leakage Test BLM Ion Chambers	4480	L3	9.0d	C	CB	4d	$0	$0	475.02.03	09990N	475.103	23-Jan-18 08:00 AM	02-Feb-18 05:00 PM
47502.03.03.2.001160	Radiation Test BLM Ion Chambers	4480	L3	9.0d	C	CB	8d	$0	$0	475.02.03	09990N	475.103	05-Feb-18 08:00 AM	15-Feb-18 05:00 PM
47502.03.03.2.001170	Install Service Building Hardware	4480	L3	9.0d	C	CB	4d	$0	$0	475.02.03	09990N	475.103	19-Dec-17 08:00 AM	04-Jan-18 05:00 PM
47502.03.03.2.001180	Install Tunnel Hardware	4480	L3	18.0d	C	CB	4d	$0	$0	475.02.03	09990N	475.103	16-Feb-18 08:00 AM	13-Mar-18 05:00 PM
47502.03.03.2.001190	Req prep parts for Cabling	4480	L3	1.0d	C	CB	1d	$0	$0	475.02.03	09990N	475.631	02-Oct-17 08:00 AM	02-Oct-17 05:00 PM
47502.03.03.2.001200	Purchase Cable Hardware	4480	M3	30.0d	C	CB	0d	$4,950	$0	475.02.03	09990N	475.103	03-Oct-17 08:00 AM	13-Nov-17 05:00 PM
47502.03.03.2.001220	M4 Line Beam Loss Monitors- Terminate Cables	4480	L3	2.0d	C	CB	2d	$0	$0	475.02.03	09990N	475.103	28-Nov-17 08:00 AM	29-Nov-17 05:00 PM
47502.03.03.2.001230	Test Cables	4480	L3	2.0d	C	CB	2d	$0	$0	475.02.03	09990N	475.103	30-Nov-17 08:00 AM	01-Dec-17 05:00 PM
47502.03.03.2.001005	T5 - Start M4 Beamline BLM Procurements			0.0d	B		0d	$0	$0		09990N		02-Oct-17 08:00 AM	
47502.03.03.2.001025	T5 - M4 Beamline BLM Procurements Complete			0.0d	B		0d	$0	$0		09990N			30-Nov-17 05:00 PM
47502.03.03.2.001280	T5 - External Beamline BLM Installation Complete			0.0d	B		0d	$0	$0		09990N			06-Apr-18 05:00 PM
47502.03.03.2.001205	T5 - Start M4 Beamline BLM Assembly and Installation			0.0d	B		0d	$0	$0		09990N		21-Nov-17 08:00 AM	
47502.03.03.2.001020	Purchase BLM Chassis parts M&S Deliver	4480	M3	1.0d	C	MC	0d	$12,000	$0	475.02.03	09990N	475.103	30-Nov-17 08:00 AM	30-Nov-17 05:00 PM
47502.03.03.2.001070	Purchase BLM Log Integrator Cards M&S Deliver	4480	M3	1.0d	C	MC	0d	$19,500	$0	475.02.03	09990N	475.103	20-Nov-17 08:00 AM	20-Nov-17 05:00 PM
47502.03.03.2.001120	Purchase BLM Ion Chambers M&S Deliver	4480	M3	1.0d	C	MC	0d	$12,600	$0	475.02.03	09990N	475.103	20-Nov-17 08:00 AM	20-Nov-17 05:00 PM
47502.03.03.2.001240	Finalize readback software	4480	L3	20.0d	C	CB	10d	$0	$0	475.02.03	09990N	475.631	02-Oct-17 08:00 AM	27-Oct-17 05:00 PM
47502.03.03.2.001250	Test Finished System	4480	L3	9.0d	C	CB	8d	$0	$0	475.02.03	09990N	475.103	14-Mar-18 08:00 AM	26-Mar-18 05:00 PM
47502.03.03.2.001260	Commission BLM System	4480	L3	9.0d	C	CB	8d	$0	$0	475.02.03	09990N	475.103	27-Mar-18 08:00 AM	06-Apr-18 05:00 PM
47502.03.03.2.001270	Document BLM System	4480	L3	90.0d	K	CB	5d	$0	$0	475.02.03	09990N	475.103	02-Oct-17 08:00 AM	13-Feb-18 05:00 PM
47502.03.03.2.001130	Purchase BLM Ion Chambers (Obligation)	Obligation	M3	1.0d	C	OB	0d	$12,600	$0	475.02.03	09990N	475.103	10-Oct-17 08:00 AM	10-Oct-17 05:00 PM
47502.03.03.2.001080	Purchase BLM Log Integrator Cards (Obligation)	Obligation	M3	1.0d	C	OB	0d	$19,500	$0	475.02.03	09990N	475.103	10-Oct-17 08:00 AM	10-Oct-17 05:00 PM
47502.03.03.2.001030	Purchase BLM Chassis parts (Obligation)	Obligation	M3	1.0d	C	OB	0d	$12,000	$0	475.02.03	09990N	475.103	18-Oct-17 08:00 AM	18-Oct-17 05:00 PM
47502.03.03.2.001010	Req. prep for BLM Chassis	4480	L3	12.0d	C	CB	5d	$0	$0	475.02.03	09990N	475.103	02-Oct-17 08:00 AM	17-Oct-17 05:00 PM
47502.03.03.2.001019	Purchase BLM Chassis parts M&S Fabricate	4480	M3	28.0d	C	MC	0d	$0	$0		09990N		19-Oct-17 08:00 AM	29-Nov-17 05:00 PM
47502.03.03.2.001040	Assemble BLM Chassis	4480	L3	9.0d	C	CB	8d	$0	$0	475.02.03	09990N	475.103	01-Dec-17 08:00 AM	13-Dec-17 05:00 PM
47502.03.03.2.001050	Test BLM Chassis	4480	L3	2.0d	C	CB	2d	$0	$0	475.02.03	09990N	475.103	14-Dec-17 08:00 AM	15-Dec-17 05:00 PM
47502.03.03.2.001210	M4 Line Beam Loss Monitors- Pull Cables	4480	M3	8.0d	C	CB	0d	$0	$256	475.02.03	09990N	475.103	14-Nov-17 08:00 AM	27-Nov-17 05:00 PM

Tune Measurement Schedule

Layout: BOE Review | Filter All: Completion after 4/30/2014

Activity ID	Activity Name	BOE Docdb #	Estimate Type	Planned Duration	Cobra PMT Code	Cost Class 1	Planned Labor Units	Planned Material Cost	Planned Nonlabor	Control Account	Control Account Manager	Chargeable Task Code	Start	Finish
475.02S.03.02.2	Delivery Ring Tune Measurement			988.0d			88d	$53,981	$32				02-Jun-14 08:00 AM A	08-May-18 05:00 PM
47502.03.02.2.001270	T5 - Schottky Tune Measurement System Complete			0.0d	B		0d	$0	$0		09990N			08-May-18 05:00 PM
47502.03.02.2.001290	T5 - Delivery Ring Tune Measurement Systems Complete			0.0d	B		0d	$0	$0		09990N			08-May-18 05:00 PM
47502.03.02.2.001280	T5 - BBQ Tune Measurement System Complete			0.0d	B		0d	$0	$0		09990N			10-Apr-18 05:00 PM
47502.03.02.2.001120	T5 - Final Design Tune Measurement System Complete	Mile		0.0d	B		0d	$0	$0		09990N			30-Jun-14 05:00 PM A
47502.03.02.2.001150	Finalize Schottkey Software	3689	L4	40.0d	C	CB	10d	$0	$0	475.02.03	09990N	475.021	02-Oct-17 08:00 AM	28-Nov-17 05:00 PM
47502.03.02.2.001160	Modify Schottkey Electronics	3689	L4	30.0d	C	CB	8d	$0	$0	475.02.03	09990N	475.021	13-Nov-17 08:00 AM	28-Dec-17 05:00 PM
47502.03.02.2.001229	Procure BBQ Cables M&S Fabricate	3689	M4	28.0d		MC	0d	$0	$0		09990N		03-Oct-17 08:00 AM	09-Nov-17 05:00 PM
47502.03.02.2.001190	Finalize testing of Schottkey system	3689	L4	60.0d	K	CB	13d	$0	$0	475.02.03	09990N	475.021	14-Feb-18 08:00 AM	08-May-18 05:00 PM
47502.03.02.2.001260	Finalize testing of BBQ system	3689	L4	30.0d	C	CB	13d	$0	$0	475.02.03	09990N	475.021	28-Feb-18 08:00 AM	10-Apr-18 05:00 PM
47502.03.02.2.001140	Procure Parts (Obligation)	Obligation	M4	1.0d	C	OB	0d	$20,000	$0	475.02.03	09990N	475.021	02-Oct-17 08:00 AM	02-Oct-17 05:00 PM
47502.03.02.2.001240	Procure BBQ Cables (Obligation)	Obligation	M4	1.0d	C	OB	0d	$7,000	$0	475.02.03	09990N	475.021	02-Oct-17 08:00 AM	02-Oct-17 05:00 PM
47502.03.02.2.001130	Procure Parts M&S Deliver	3689	M4	1.0d	C	MC	0d	$20,000	$0	475.02.03	09990N	475.021	10-Nov-17 08:00 AM	10-Nov-17 05:00 PM
47502.03.02.2.001230	Procure BBQ Cables M&S Deliver	3689	M4	1.0d	C	MC	0d	$7,000	$0	475.02.03	09990N	475.021	10-Nov-17 08:00 AM	10-Nov-17 05:00 PM
47502.03.02.2.001210	Build BBQ Electronics	3689	L4	40.0d	C	CB	20d	$0	$0	475.02.03	09990N	475.021	13-Nov-17 08:00 AM	16-Jan-18 05:00 PM
47502.03.02.2.001200	Finalize BBQ Software	3689	L4	40.0d	C	CB	10d	$0	$0	475.02.03	09990N	475.021	05-Jul-16 08:00 AM	29-Aug-16 05:00 PM
47502.03.02.2.001220	Install BBQ System	3689	L4	30.0d	C	CB	5d	$0	$0	475.02.03	09990N	475.021	17-Jan-18 08:00 AM	27-Feb-18 05:00 PM
47502.03.02.2.001129	Procure Parts M&S Fabricate	3689	M4	28.0d		MC	0d	$0	$0		09990N		03-Oct-17 08:00 AM	09-Nov-17 05:00 PM
47502.03.02.2.001110	Finalize BBQ system design	3689	L4	10.0d	C	CB	3d	$0	$0	475.02.03	09990N	475.019	02-Jun-14 08:00 AM A	13-Jun-14 05:00 PM A
47502.03.02.2.001170	Install Schottkey Electronics	3689	L4	30.0d	C	CB	8d	$0	$0	475.02.03	09990N	475.021	02-Jan-18 08:00 AM	13-Feb-18 05:00 PM
475.019 CD2	475.019 CD-2 Baseline Single Point Adjustment	ACWP	L1	1.0d	A	CB	0d	($19)	$0	475.02.03	09990N	475.019	02-Mar-15 08:00 AM A	02-Mar-15 05:00 PM A
47502.03.02.2.001250	Install BBQ Cables	3689	M4	1.0d	C	CB	0d	$0	$32	475.02.03	09990N	475.021	13-Nov-17 08:00 AM	13-Nov-17 05:00 PM

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Delivery Ring AIP BPM Schedule

UID	WBS	Name	Start	Finish	M&S	Resource	Hours
69	**DR1.05**	**Delivery Ring Instrumentation**	**10/1/15**	**3/11/16**	**$17,920**		**1,320 hrs**
89	**DR1.05.01**	**Instrumentation Design**	**10/1/15**	**1/8/16**	**$0**		**979 hrs**
274	DR1.05.01.01	Delivery Ring BPM Design Oversight	10/1/15	12/3/15	$0	FNAD_ENGNRING_PHYST[11%]	40 hrs
273	DR1.05.01.02	Delivery Ring BPM System Design	10/1/15	10/30/15	$0	FNAD_ELTN_DESIGN_EN[12%]	21 hrs
272	DR1.05.01.03	Delivery Ring BPM 2.5MHz Transition Board Design	11/2/15	12/3/15	$0	FNAD_ELTN_DESIGN_EN[6%]	10 hrs
271	DR1.05.01.04	Delivery Ring BPM 2.5MHz Transition Board Layout	11/2/15	12/3/15	$0	FNAD_ELEC_DRAFTER[68%]	120 hrs
270	DR1.05.01.05	Delivery Ring BPM Software Design	11/2/15	12/3/15	$0	FNAD_CT_SRVCS_SPCLST[284%]	500 hrs
269	DR1.05.01.06	Delivery Ring BPM Digital Downconverter design	11/2/15	12/3/15	$0	FNAD_ELEC_DESIGN_EN[17%]	30 hrs
268	DR1.05.01.07	Delivery Ring BPM System Integration & manufacture	12/4/15	1/8/16	$0	FNAD_ELEC_DESIGN_EN[5%],FNAD_ELEC_TECH[91%]	168 hrs
90	**DR1.05.02**	**Instrumentation Implementation**	**10/1/15**	**3/11/16**	**$17,920**		**341 hrs**
283	DR1.05.02.01	Delivery Ring BPM Implementation Oversight	10/1/15	12/3/15	$0	FNAD_ENGNRING_PHYST[7%]	25 hrs
282	DR1.05.02.02	Delivery Ring BPM Installation	2/11/16	3/11/16	$0	FNAD_ELTN_DESIGN_EN[34%]	60 hrs
281	DR1.05.02.03	Delivery Ring BPM Refurbish	1/11/16	2/10/16	$0	FNAD_ELEC_TECH[24%]	42 hrs
280	DR1.05.02.04	Delivery Ring BPM Documentation	1/11/16	2/10/16	$0	FNAD_ELEC_TECH[45%]	80 hrs
279	DR1.05.02.05	Delivery Ring BPM Electronics purchases	12/4/15	1/8/16	$16,920	FNAD_ELEC_TECH[5%],FN_MS_STND_FY13[16,920]	8 hrs
390	DR1.05.02.10	Delivery Ring Instrumentation Complete	3/11/16	3/11/16	$0		0 hrs

Delivery Ring and Abort Line BPMs

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