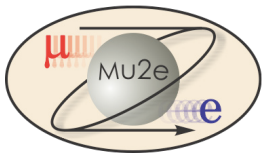
Fermilab

Mu2e Accelerator Systems Overview: Muon Campus Projects, Procedures



Steve Werkema

Mu2e Accelerator Level 2 Manager

10/21/2014

Outline

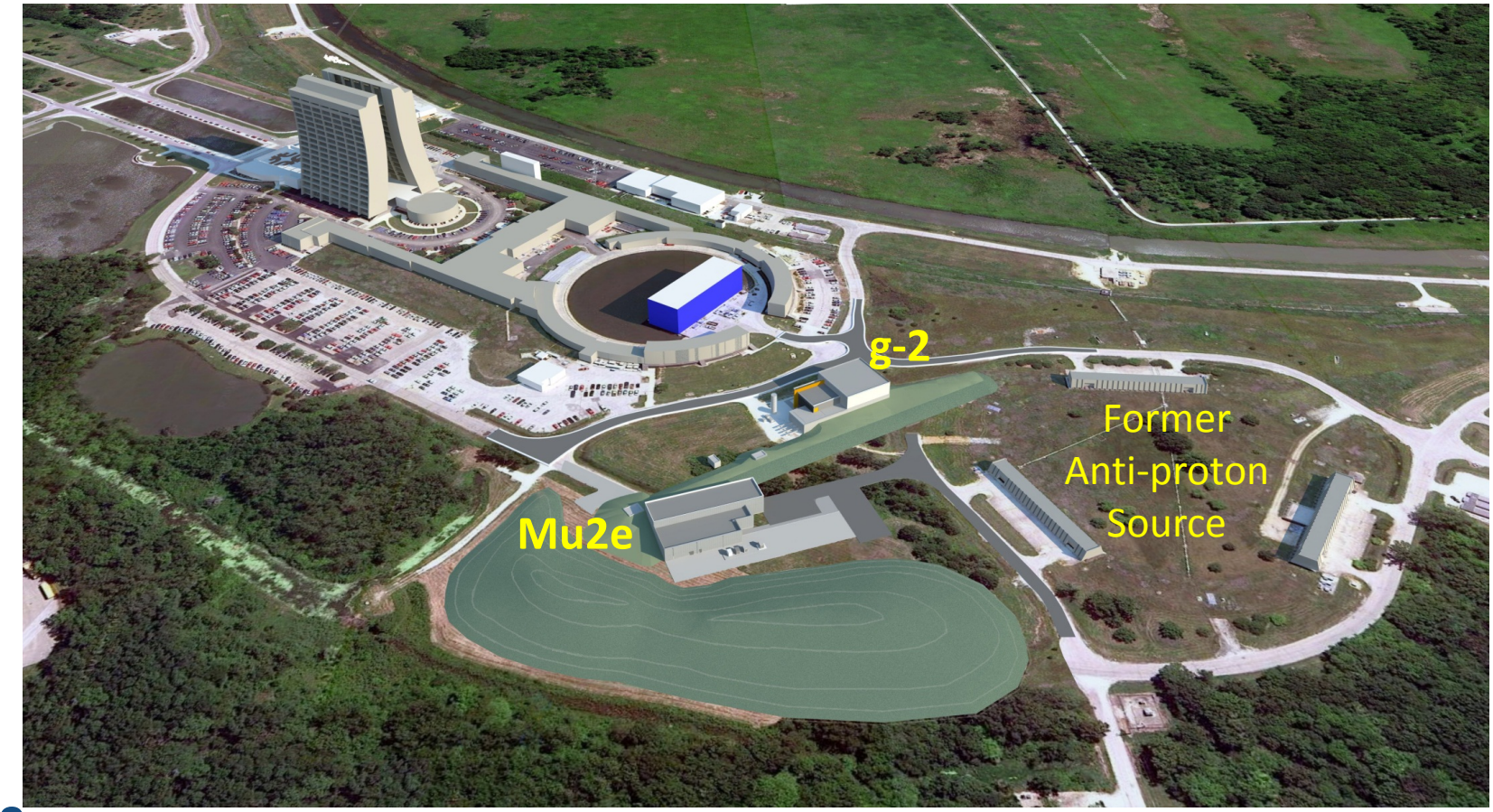
1. Muon Campus Projects
2. Key Performance Parameters
3. Cost Estimating Procedures
4. Risk Management
5. Interface Management
6. Miscellaneous
7. Breakout talks

Muon Campus Projects

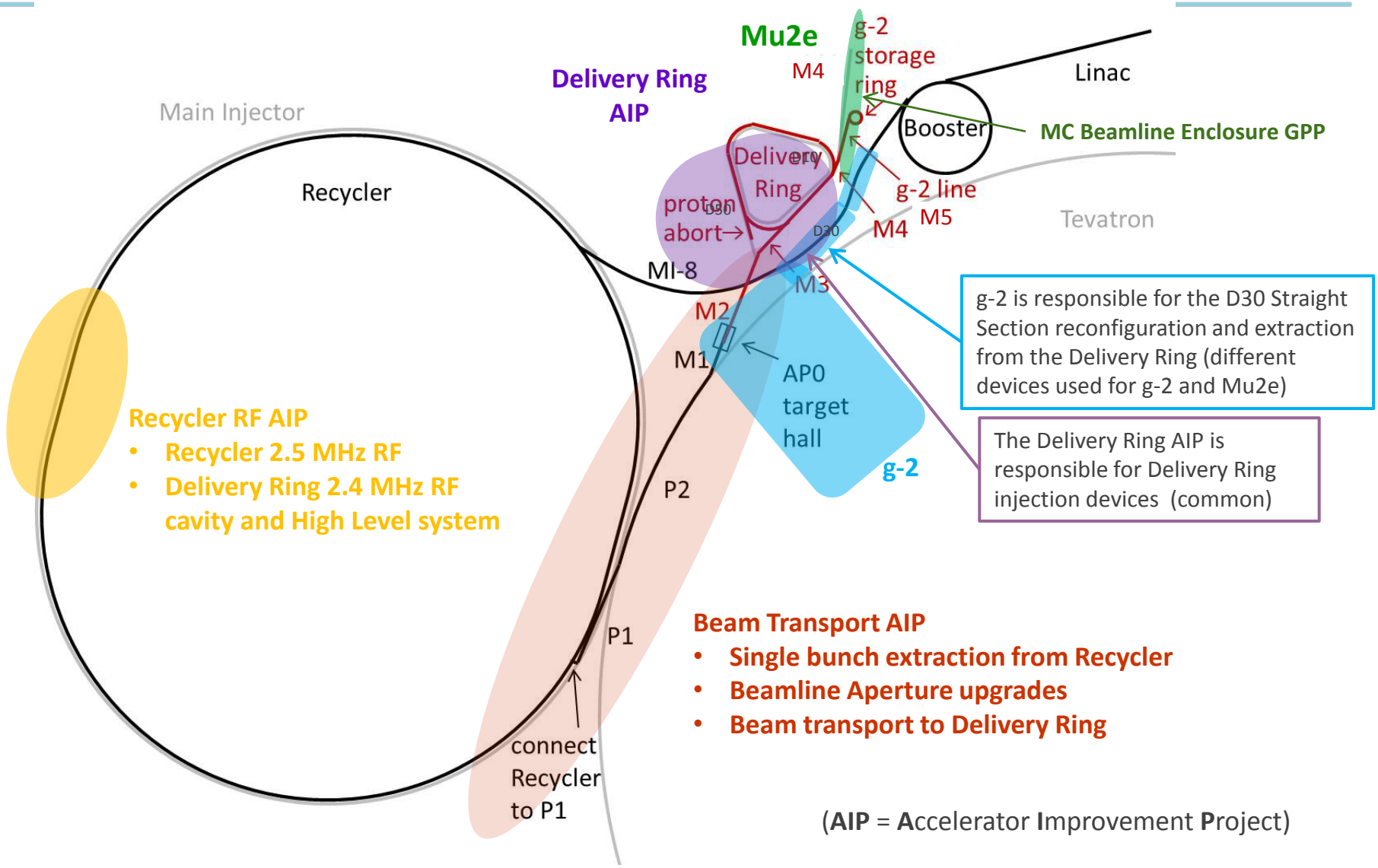
The Fermilab Muon Campus

Three General Components:

1. AIPs and GPPs (AIP = **A**ccelerator **I**mprovement **P**roject, GPP = **G**eneral **P**lant **P**roject)
2. Mu2e project
3. g-2 project



Scope of Muon Campus Projects



Mu2e Scope Overview

475.02.08.03 Extinction Monitor

475.02.09 Target Station

475.02.07 External (M4) Beamline

475.02.08.02 Extinction

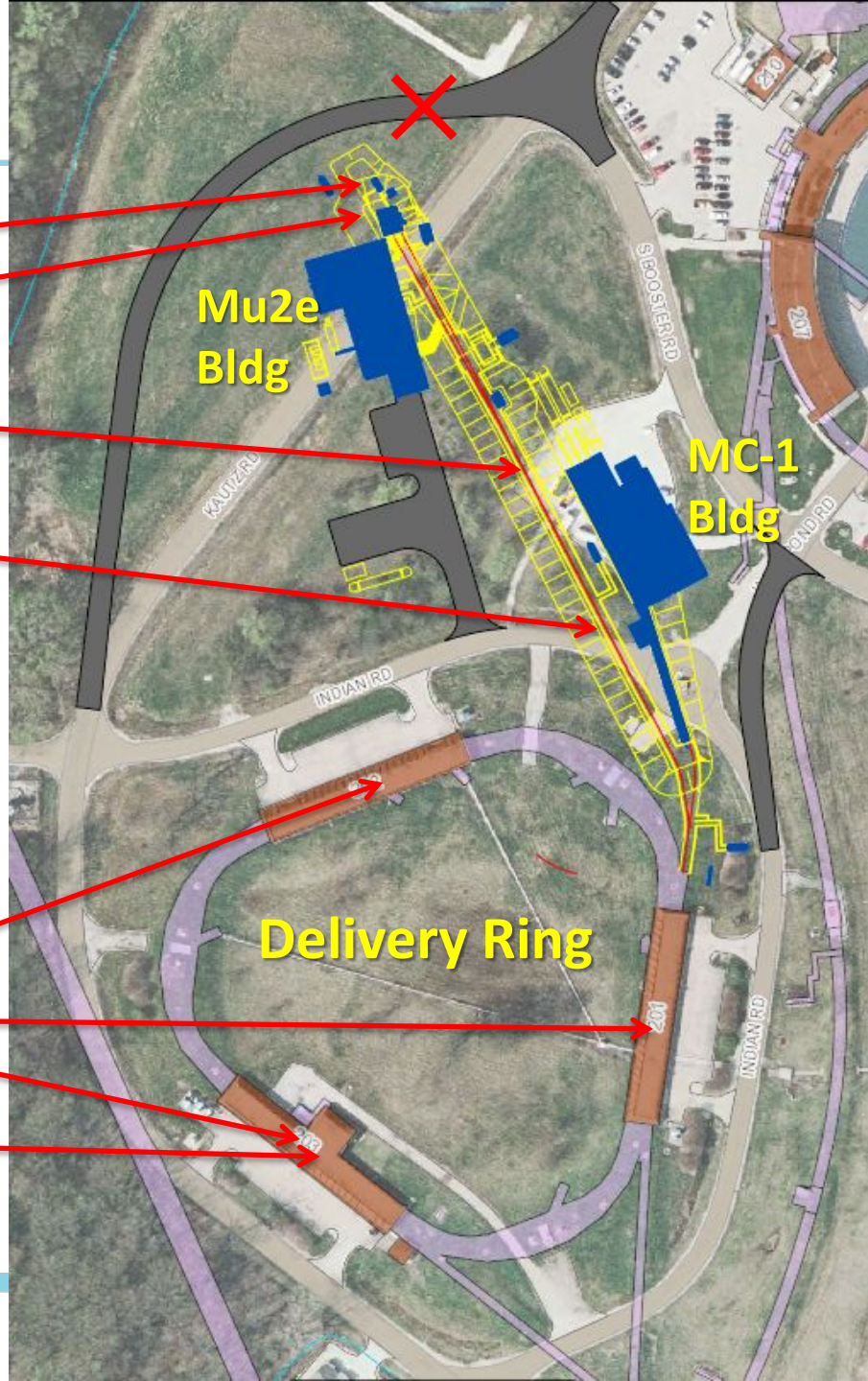
475.02.03 Instrumentation & Controls

475.02.04 Radiation Safety

Everywhere

475.02.05 Resonant Extraction

475.02.06 Delivery Ring RF



Required New Construction Not on the Mu2e Project

Accelerator Upgrade	Project
MI-8 beamline to Recycler Ring Injection	NOvA Project
Recycler Ring 2.5 MHz RF system	Recycler RF AIP
Delivery Ring 2.4 MHz RF Cavities and HL Amps & Cooling	Recycler RF AIP
Single bunch extraction from Recycler Ring	Beam Transport AIP
Beamline aperture upgrades	Beam Transport AIP
AP1, AP2, AP3 to M1, M2, M3 conversion & upgrade	Beam Transport AIP
Beam transport instrumentation & infrastructure	Beam Transport AIP
Beam transport controls	Delivery Ring AIP
Delivery Ring Injection	Delivery Ring AIP
Delivery Ring Abort	Delivery Ring AIP
Delivery Ring infrastructure	Delivery Ring AIP
Delivery Ring Controls and Instrumentation	Delivery Ring AIP
D30 straight section reconfiguration	g-2 Project
Delivery Ring Extraction (except ESS)	g-2 Project
Extraction line (M4) to M5 split	g-2 Project
M4 beamline enclosure	MC Beamline Enclosure GPP

Why Would We Do This to Ourselves?

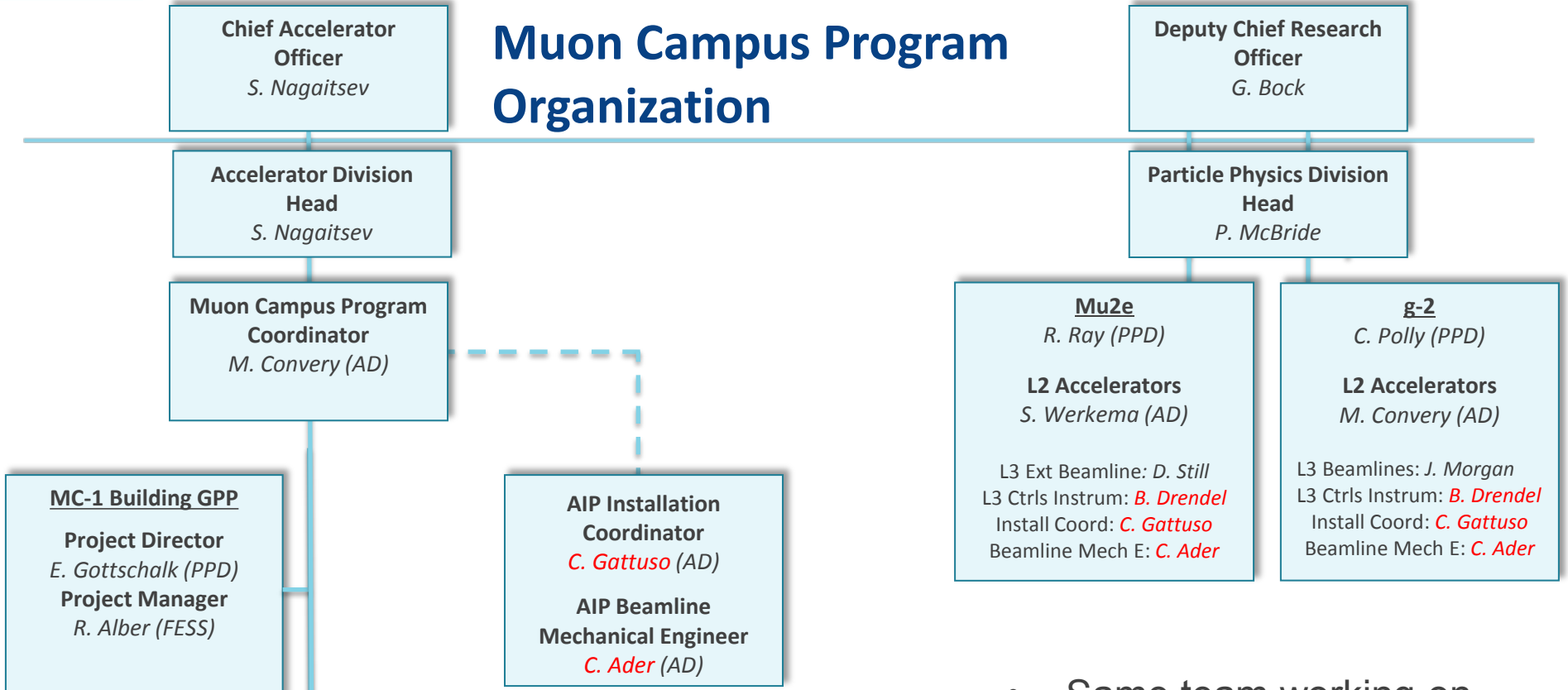
Advantages

- Exploits the common requirements of Mu2e and g-2. Integrated planning to meet these requirements reduces the combined cost of these two projects
- Scheduling: moving scope that must be accomplished early to AIPs allows implementation to begin before CD-3 for either project –
  - Muon Campus construction is underway now and neither Mu2e or g-2 have CD-3.
  - Without this scheduling flexibility the g-2 run would start later (1 – 2 years) which would delay the start of the Mu2e run
- Why many AIPs?
  - Collect common scope
  - Keep AIP TPCs below $10M maximum

Risk

- Complicated interdependence … a setback in one project may affect the others
- Mitigation: This risk is mitigated by continuous management attention
  - Monthly PMGs (Mu2e, g-2, Muon Campus) and POGs
  - Key management straddles Muon Campus project boundaries (next slide)
  - Interface Milestones maintained by the Muon Campus Program Coordinator

Muon Campus Program Organization



- Same team working on Mu2e accelerators, g-2 Accelerators, and AIP beamlines (Muon Dept.)
- Common installation coordinator and beamline mechanical engineer

Interface Milestones

Muon Campus Interface Milestones

Milestone Name	Responsibility	Impacts	Forecast	Target	Needed by	Actual
MC-1 Bldg Beneficial Occupancy for Cryo	MC-1 Building GPP	Cryo AIP	1/8/14	1/8/14	as soon as possible	1/8/2014
MC-1 Bldg Beneficial Occupancy for g-2 Ring	MC-1 Building GPP	g-2	4/10/14	2/18/14	as soon as possible	4/10/2014
End of Circulating Beam Studies	g-2, Mu2e	g-2, Mu2e, Delivery Ring AIP	4/25/14	4/1/14	6/30/14	4/25/2014
MC-1 Cryo Room Controls Available	MC-1 Building GPP	Cryo AIP	9/22/14	9/22/14	as soon as possible	6/6/2014
Cryo Compressor Cooling Established	MC Infrastructure GPP	Cryo AIP	9/30/14	9/30/14	10/31/14	8/15/2014
Cryo g-2 acceptance tests complete	Cryo AIP	lower-level milestone for g-2	10/24/14	10/24/14	as soon as possible	
Cryo Ready to Cool g-2	Cryo AIP	g-2	3/15/15	3/15/15	as soon as possible	
Beamline Enclosure Beneficial Occupancy	Beamline Enclosure GPP	g-2	6/9/15	9/30/15	1/21/16	
MI-52 Bldg Extension Beneficial Occupancy	MC Infrastructure GPP	Beam Transport AIP	9/30/15	9/30/15	9/30/15	
Beam Transport Complete	Beam Transport AIP	g-2, Mu2e	2/1/16	2/1/16	3/31/17	
D30 Straight Section Ready for New Installation	g-2	Delivery Ring AIP	2/5/15	2/5/15	5/17/16	
Recycler RF Complete	Recycler RF AIP	g-2, Mu2e	9/30/16	9/30/16	3/31/17	
Delivery Ring Complete	Delivery Ring AIP	g-2, Mu2e	9/30/16	9/30/16	3/31/17	
Shield Wall Installation	g-2	Mu2e	1/5/17	1/5/17	before g-2 running	
Cryo: Mu2e Distribution Box Cold	Cryo AIP	Mu2e	7/15/17	7/15/17	9/15/17	

Mu2e _____ date 8/25/14

g-2 _____ 8/25/14

- Interface milestone document under configuration control in the Beams Document Database
- Maintained by the Muon Campus Program Coordinator (Mary Convery)

Mu2e Accelerator Systems Key Performance Parameters

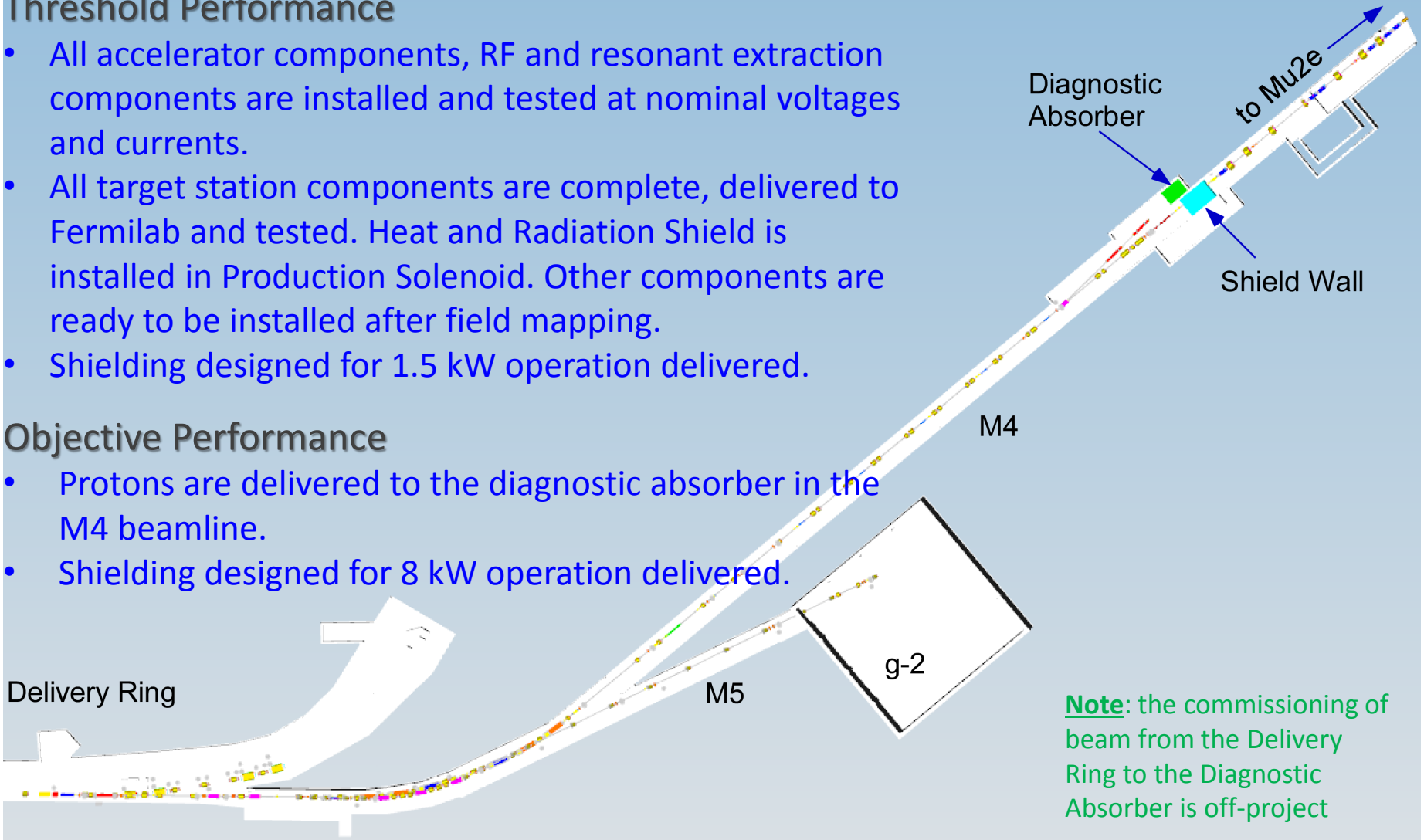
Mu2e Accelerator KPPs

Threshold Performance

- All accelerator components, RF and resonant extraction components are installed and tested at nominal voltages and currents.
- All target station components are complete, delivered to Fermilab and tested. Heat and Radiation Shield is installed in Production Solenoid. Other components are ready to be installed after field mapping.
- Shielding designed for 1.5 kW operation delivered.

Objective Performance

- Protons are delivered to the diagnostic absorber in the M4 beamline.
- Shielding designed for 8 kW operation delivered.



Note: the commissioning of beam from the Delivery Ring to the Diagnostic Absorber is off-project

Cost Estimating Procedures

- Mu2e BOEs
- BOE Review

Cost Estimate Procedure

1. Project Controls (Mike Gardner) generates a BOE Report that contains an entry for every activity in the schedule (example on next slide).
   - Sent to every L3 manager and selected L4 managers. Posted to Mu2e-doc-3001
   - Updated at least Monthly
2. L3 and L4 managers in consultation with technical experts enter the resources, estimate uncertainties, and estimate types into the BOE report and return it to project controls.
3. Project Controls meets face-to-face with each L3/L4 manager to transfer the resource data into the schedule along with any associated schedule logic. This is an iterative process – adjustments are made as the schedule and cost estimates evolve.
4. L3 and L4 managers generate BOE Forms (details later) that contain the justification for the resources loaded for each activity.
5. Review: BOEs are reviewed at all levels: preparers, CAMs, L2 management

BOE Report

WBS	WBS Name	Activity ID	Activity Name	Most Likely Duration	Estimate Type Activity Level	Division / Section	Resource Name	Most Likely Units	Estimate Uncertainty Factor	Resource Note	Predecessors	BOE DocDB
475.02W.03.01.1	Transport Controls and Delivery Ring Controls	47502.03.01.1.001195	Coordinate Implementation Plan with Delivery Ring AIP	30	L3	AD	Control System Engineer	8	0.25	G Brown	47502.03.01.1.001190	3703
		47502.03.01.1.001200	Purchase Network & Communication Hardware Implementation and Closeout	30	M4		M&S Standard with Base Year FY14	5000	0.25	Repurposed / Pro Card	47502.01.02.001050, 47502.03.01.1.001195	3703
		47502.03.01.1.001220	Abort Link Implementation	60	L4	AD	Engineering Physicist	10	0.3	A Franck	47502.03.01.1.001200	3703
							Electronics Design Engineer	100	0.3	D McArthur	47502.03.01.1.001200	3703
							Control System Engineer	47	0.3	G Vogel	47502.03.01.1.001200	3703
		47502.03.01.1.001230	Camac and Timing Links Implementation and Closeout	60	L4	AD	Electronics Technician	40	0.3	TBD	47502.01.02.001050, 47502.03.01.1.001200	3703
							Control System Engineer	10	0.3	G Vogel	47502.01.02.001050, 47502.03.01.1.001200	3703
		47502.03.01.1.001240	Network Installation Implementation and Closeout	60	L4	AD	Electronics Technician	16	0.3	S Conlon	47502.03.01.1.001200	3703
							Control System Engineer	8	0.3	G Brown	47502.03.01.1.001200	3703
475.02W.03.01.2	Mu2e Experimental Hall Controls	47502.03.01.2.001090	Purchase Controls Hardware	30	M3		M&S Standard with Base Year FY14	31000	0.15		47502.01.02.001050, FY18B02	3553
		47502.03.01.2.001110	Purchase Network and Communication Hardware	30	M3		M&S Standard with Base Year FY14	45800	0.15		47502.01.02.001050, FY18B02	3553
		47502.03.01.2.001130	Pull Innerduct	4	M4		Electrician	128	0.3	Assumes 4 day pull for 4 workers	47502.03.01.2.001110, 47502.03.01.2.001120	3553
		47502.03.01.2.001140	Pull Cable CrossGallery(Xgal) to Mu2e	5	M4		Electrician	160	0.3	5 day pull for 4 workers	47502.03.01.2.001130, 47502.03.01.2.001100, 47502.03.01.2.001090	3553
		47502.03.01.2.001150	Pull Cable AP30 to Mu2e	3	M4		Electrician	96	0.3	3 day pull for 4 workers	47502.03.01.2.001140, 47502.03.01.2.001100, 47502.03.01.2.001090	3553
		47502.03.01.2.001160	Terminate Connectors	20	M4		Electrician	64	0.3	Fiber Terminations	47502.03.01.2.001150, 47502.03.01.2.001140, 47502.03.01.2.001130	3553
		47502.03.01.2.001170	Controls Infrastructure	60	L3	AD	Electrical Technician	47	0.2	M Colburn (FIRIS)	47502.03.01.2.001160	3553
								94	0.2	TBD	47502.03.01.2.001160	3553
							Control System Engineer	14	0.2	G Vogel	47502.03.01.2.001160	3553
										A Franck	47502.03.01.2.001160	3553
		47502.03.01.2.001180	Network Infrastructure	60	L3	AD	Electrical Technician	9	0.2	S Conlon	47502.03.01.2.001160	3553
							Control System Engineer	5	0.2	G Brown	47502.03.01.2.001160	3553
		47502.03.01.2.001190	HRM Installation	60	L3	AD	Electrical Technician	188	0.2	TBD	47502.03.01.2.001160	3553
							Control System Engineer	4	0.2	G Vogel	47502.03.01.2.001160	3553
							Computing Services Specialist	64	0.2	TBD	47502.03.01.2.001160	3553

This is a small portion of the Instrumentation and Controls part of the BOE report

- The BOE Report is a working document
- The BOE Report is the vehicle by which the L3, L4 managers and project controls communicate with one another about schedule and resource information

Access to Mu2e BOEs

Accelerator BOE Documents

Existing supporting documentation is either bundled with its associated BOE documents or referenced within them.

WBS Number	Task Name	Mu2e doc #
475.02.01	**Project Management**	1888
475.02.03	**Instrumentation & Controls**	
475.02.03.01	*Mu2e Accelerator Controls*	
475.02.03.01.1	Transport Controls & Delivery Ring Controls	3703
475.02.03.01.2	Mu2e Experimental Hall Controls	3553
475.02.03.02	*Delivery Ring Instrumentation*	
475.02.03.02.1	Delivery Ring DC Beam Meausurement	3690
475.02.03.02.2	Delivery Ring Tune Measurement	3689
475.02.03.03	*Extraction Beamline Instrumentation*	
475.02.03.03.1	M4 Line Profile and Intensity Monitors	3675
475.02.03.03.2	M4 Line Beam Loss Monitors	4480
475.02.03.04	*Accelerator Controls and Instrumentation Project Management*	3843
475.02.04	**Radiation Safety Improvements**	
475.02.04.01	*AP1 Line to Delivery Ring Total Loss Monitoring System*	1890
475.02.04.02	*Delivery Ring Raditation Safety Upgrades*	
475.02.04.02.1	In Tunnel Shielding Over Loss Points	1872
475.02.04.02.2	Ring Safety System Total Loss Monitoring	1891
475.02.04.03	*External Beam Line Safety System*	

Mu2e Accelerator BOEs are accessible from the Accelerator page on the review web site: http://mu2e.fnal.gov/public/project/reviews/cd2-review/accel.shtml

The Mu2e doc # links take you to the Mu2e doc DB item containing the BOE and its supporting documents.

BOE Doc DB contents

Document #:
Mu2e-doc-1665-v14
Document type:
BoE
Submitted by:
R Coleman
Updated by:
Andy Stefanik
Document Created:
06 Jul 2011, 16:38
Contents Revised:
26 Jun 2014, 13:24
DB Info Revised:
26 Jun 2014, 13:24

Update Document

Update DB Info

Add Files

Username:

Password:

Mu2e Document 1665-v14

CD2 BOE 475.02.9.05 Target Station Proton Absorber

Abstract:
Cost estimate for the proton beam absorber and associated steel shielding.

Files in Document:

- BOE Proton Beam Absorber (BOE Proton Beam Absorber.docx, 53.2 kB)

Other Files:

- (1) Mu2e proton beam absorber - Cost estimate for materials and fabrication (Mu2e proton
- (2) Mu2e proton beam absorber steel shielding - Cost estimate for materials and fabrication (
- (3) P6 schedule spreadsheet corresponding to this BOE (Excel) (2014 01 13 4750209 05 A
- (4) Mu2e Proton Beam Absorber Layout Drawing 494372. (MU2E_PROTON_BEAM_AI
- (5) Review of this BOE (BOE_Review_475.02.09.05_20140621.docx, 34.3 kB)
- (6) CAM responses to the BOE Review (BOE_Review_475.02.09.05_20140621 CAM RESPONSES.docx, 38.0 kB)

Get all files as tar.gz, zip.

Topics:

- Accelerator:Shielding
- Accelerator:Production Target
- Basis of Estimates for CD-2:BOE WBS 2 Accelerator

Authors:

- R Coleman
- Andy Stefanik

Keywords:
BoE

BOE Form (Often there are more than one)

Supporting Documents

BOE Report spreadsheet

BOE Review and Response

Mu2e BOE – Page 1

Mu2e
BASIS of ESTIMATE (BoE)

Date of Estimate: March 31, 2011
Revision Date: June 26, 2014

Prepared by: Andy Stefanik
Contributing:

Docdb #: 1665

WBS number: 475.02.09.05 | **Control Account:** 475.02.09 | **WBS Title:** Target Station Proton Beam Absorber

WBS Dictionary Definition: Design, fabrication, and installation of the elements required for the absorption of non-interacting proton beam and secondary particle flux downstream of the proton target.

Supporting Documents (including but not limited to):
See Electronic docdb file referenced above for supporting documentation:
(1) P6 schedule spreadsheet corresponding to this BOE (Excel).
(2) Mu2e Proton Beam Absorber Layout Drawing 494372.
(3) Mu2e proton beam absorber - Cost estimate for materials and fabrication.
(4) Mu2e proton beam absorber steel shielding - Cost estimate for materials and fabrication.

Quality Control Process Applied by: Steve Werkema **date:** 7/5/2014

Assumptions:
- BOE only covers activities from the baseline date of **May 1, 2014** onward. Activities prior to the baseline date are entered into the schedule as actuals with 0% contingency.
- Costs are in 2014 dollars and do not include in-directs.
- Durations are in working days.
- 1 FTE = 1768 hours for an average year. P6 uses the actual calendar for each year with the exact number of workdays.

Supporting Documents – all available in the same doc DB item

BOE Review

BOE Baseline date = May 1, 2014

M&S in 2014 dollars

Details of the Base Estimate (explanation of the Work, Contingency and Duration)
This set of activities includes the labor and M&S necessary to (1) engineer and design the components, (2) fabricate the components, and (3) provide engineering support to Civil Construction and the Alignment Group during installation.

Currently Assigned Personnel

L2 Manager: Steve Werkema
L2 Deputy: Vladimir Nagaslaev
L3 Manager: Rick Coleman
L4 Manager: Andy Stefanik

Mu2e BOE – Page 3ff

Task 47502.09.05.001222 **Absorber material: Prep purchase requisitions and award PO M&S.**
Purchase materials.

M&S	$16,000	Source: Mu2e proton beam absorber - Cost estimate for materials and fabrication ($16,000) and Mu2e proton beam absorber steel shielding - Cost estimate for materials and fabrication ($0). Refer to the summary at the end of each estimate document.
Duration	30 days	
Estimate type	Preliminary	Contingency of 25% based on contingency rule M4.

Task 47502.09.05.001230 **Absorber: Fabricate.**
Fabricate the absorber at Fermilab.

Mechanical Design Engineer	40 hours	Fabrication support.
Mechanical Designer	40 hours	Fabrication support.
Fermi mech tech supervisor	216 hours	Sources: Mu2e proton beam absorber - Cost estimate for materials and fabrication (120 hours) and Mu2e proton beam absorber steel shielding - Cost estimate for materials and fabrication (96 hours). Refer to the summary at the end of each estimate document.
Fermilab mech tech	1164 hours	Sources: Mu2e proton beam absorber - Cost estimate for materials and fabrication (588 hours) and Mu2e proton beam absorber steel shielding - Cost estimate for materials and fabrication (576 hours). Refer to the summary at the end of the estimate document. Refer to the summary at the end of each estimate document.
Welder – M&S	406 hours	Sources: Mu2e proton beam absorber - Cost estimate for materials and fabrication (214 hours) and Mu2e proton beam absorber steel shielding - Cost estimate for materials and fabrication (192). Refer to the summary at the end of each estimate document.
M&S	$9,000	Sources: Mu2e proton beam absorber - Cost estimate for materials and fabrication ($5,000) and Mu2e proton beam absorber steel shielding - Cost estimate for materials and fabrication ($4,000). Refer to the summary at the end of each estimate document.

Page 4 of 6

There is an entry for each Activity in the schedule

Contingency and contingency rule used are cited (Called "Estimate Uncertainty" in schedule)

Each Resource this activity is listed with quantities and justification

BOE Review

This is an excerpt from a BOE review form (Mu2e-doc-4265) for the BOE shown in the preceding slides.

The BOE review checks the following:

- that all the required information is present and correct
- the information given actually supports the cost estimate given
- contingency rules are properly applied
- resources given match the Mu2e schedule in P6
- that all costs have been accounted for

Mu2e Accelerator BOE Review Check List

Reviewer: Steve Werkema

Date of Review: 20 August 2014

BOE examined in this review: CD2 BOE 475.02.9.05 Target Station Proton Absorber

Mu2e doc DB number and version number: Mu2e-doc-1665-v21

Individual BOE Checks

1. Is the title of the doc DB item correct (i.e. does the title contain the correct WBS number, have a format similar to other BOEs)? Yes: ☒ No: ☐
2. Checks that basic information is present and correct.

Yes: ☒	No: ☐	Date of Estimate
Yes: ☒	No: ☐	Revision Date (if applicable)
Yes: ☒	No: ☐	Doc db #
Yes: ☒	No: ☐	WBS number
Yes: ☒	No: ☐	Control Account
Yes: ☒	No: ☐	WBS Title (Does it match the WBS name in the schedule?)
Yes: ☒	No: ☐	WBS Dictionary Definition (Does it match the WBS Dictionary (Mu2e-doc-2185?). If not, what should the definition be?
Yes: ☒	No: ☐	Are the items listed in the Supporting Documents box available in the Doc db item?
Yes: ☒	No: ☐	Is the P6 schedule spreadsheet for this BOE available in the Doc db item?

Do the assumptions listed contain the following?

Yes: ☒	No: ☐	BOE only covers activities from the baseline date of **May 1, 2014** onward. Activities prior to the baseline date are entered into the schedule as actuals with 0% contingency.
Yes: ☒	No: ☐	Costs are in 2014 dollars and do not include indirects
Yes: ☒	No: ☐	Durations are in working days.
Yes: ☒	No: ☐	1 FTE = 1768 hours for an average year.

Risk Management

Risks

- **22** Accelerator Risks in Risk Register
  - All risks mitigated to the extent possible
  - **8** Threats
    - 4 High
    - 3 Medium
    - 1 Low
  - **2** Opportunities
  - **12** Retired Risks
- Detailed mitigation plans for all risks are documented in risk forms in the Mu2e doc DB and are linked from the Risk Register (docdb column)
- All risks are understood and under control
- Details on specific risks will be provided in the breakout session

Risk Register

Risk							Post-mitigation											Risk Contingency $K					
Risk ID	Risk Form DocDb #	Type	Title	Date of Risk	Mitigation Cost (Included in baseline)	Category	Probability	Schedule Delays Level 3 Milestone or Project Critical	Cost	Technical	ES&H	Score	Owner	Point estimate (cost k$)	Point Estimate (sched-days)	Point estimate (prob)	EXPECTATION VALUE IN k$	EXPECTATION VALUE IN Days	Prob Range		Prob RMS	80%CL	85% CL	90% CL
ACCEL-011	3328	Threat	Inadequate AD Engineering Resources	FY15-FY19		Current Risk	M	L	N	N	N	L	Ron Ray	$ 75	60	25%	$ 19	15	25.0%	75.0%	14.4%	$37	$38	$39
ACCEL-015	3331	Threat	Injection damper required for Delivery Ring	FY16-FY19		Current Risk	L	N	N	VH	N	H	J. Morgan	$ 185	0	10%	$ 19	0	10.0%	25.0%	4.3%	$32	$33	$34
ACCEL-020	3333	Threat	Cannot use TLMs to control beam losses.	FY15-FY19		Current Risk	L	N	VH	N	N	H	T. Leveling	$ 2,000		2%	$ 40	0	10.0%	25.0%	4.3%	$289	$298	$311
ACCEL-038	3344	Threat	Radiated target will not survive in the Beam.	FY16-FY20	$ 100,000	Current Risk	L	N	M	N	N	M	R. Coleman	$ 175		10%	$ 18	0	10.0%	25.0%	4.3%	$30	$31	$32
ACCEL-151	3833	Threat	Redesign the Remote Handling System for Water cooled target	FY16-FY18	$ 100,000	Current Risk	VL	N	VH	M	N	M	M.Campbell, R.Coleman	$ 3,300		5%	$ 165	0	0.0%	10.0%	2.9%	$211	$222	$235
ACCEL-200	4589	Threat	Need to add new power supplies to the beam line.	FY15-FY16	$ 20,000	Current Risk	M	VL	H	VL	N	H	D. Still	$ 400	20	60%	$ 240	12	25.0%	75.0%	14.4%	$241	$248	$256
ACCEL-201	4590	Threat	Need to fabricate additional magnets to the beam line.	FY15-FY16	$ 20,000	Current Risk	L	VL	M	VL	N	M	D. Still	$ 200	20	20%	$ 40	4	10.0%	25.0%	4.3%	$41	$42	$43
ACCEL-202	4591	Opportunity	Replace the Diagnostic Absorber dipole with an existing magnet	FY15-FY16	$ 5,000	Current Risk	M	VL	M	VL	N	M	D. Still	$ (110)	20	50%	$ (55)	10	25.0%	75.0%	14.4%	($63)	($64)	($67)
ACCEL-203	4592	Opportunity	sextupole magnets for use in Mu2e	FY15-FY16		Current Risk	L	N	M	N	N	M	V.Nagaslaev	$ (166)		15%	$ (25)	0	10.0%	25.0%	4.3%	($31)	($32)	($33)
ACCEL-204	4593	Threat	Need to add 2 more collimators to the Extinction section	FY15-FY16		Current Risk	L	N	M	N	N	M	E.Prebys	$ 160		10%	$ 16	0	10.0%	25.0%	4.3%	$27	$28	$29
CAL-108	3347	Threat	INFN cannot deliver full in-kind scope.	FY16-FY20		Current Risk	L	N	VH	H	N	H	R. Ray	$ -		10%	$ -	0	10.0%	25.0%	4.3%	$0	$0	$0
CAL-148	3834	Threat	Cannot develop UV-extended solid state photodetector that is blind to longer wavelengths	FY15	$ 100,000	Current Risk	M	M	N	H	N	H	D. Hitlin	$ -	40	50%		20	25.0%	75.0%		$0	$0	$0
CAL-170	4468	Threat	Inability to purchase DT generator from Russia	FY18-FY19		Current Risk	M	N	L	N	N	L	Frank Porter	$ 90	0	50%	$ 45	0	25.0%	75.0%	14.4%	$51	$53	$55
CONST-049	3351	Opportunity	Conventional construction bids are lower than estimated cost.	FY15		Current Risk	M	N	VH	N	N	H	T. Lackowski	$ (1,200)		50%	$ (600)	0	25.0%	75.0%	14.4%	($684)	($704)	($728)
CONST-165	4425	Threat	Cost growth of conventional construction facilities because of changing stakeholder requirements.	FY15		Retired	L	M	M	M	VL	M	T. Lackowski	$ 276	140	10%	$ 28	14	10.0%	25.0%	4.3%	$47	$49	$50
MUON-138	3360	Threat	Detector installation takes longer than expected.	FY19		Current Risk	M	M	H	N	N	H	G. Ginther	$ 400	0	50%	$ 200	0	25.0%	75.0%	14.4%	$228	$235	$243
MUON-146	3835	Threat	Rates exceed Muon Stopping Target Monitor capabilities	FY17-18		Current Risk	M	N	M	M	N	M	J. Miller	$ 200		25%	$ 50	0	25.0%	75.0%	14.4%	$97	$101	$105
MUON-147	3836	Threat	Degrader needed for calibration	FY16-FY19		Current Risk	M	N	M	M	VL	M	G. Ginther	$ 250		50%	$ 125	0	25.0%	75.0%	14.4%	$143	$147	$152
PM-007	3363	Threat	CD-4 float inadequate.	FY20		Current Risk	L	M	L	N	N	M	Ron Ray	$ 2,546	500	10%	$ -	50	10.0%	25.0%	4.3%	$435	$448	$463
			Additional resources																					

RISK REGISTER | Risk Dollars per year | Retired risks | Transfer Risk Events | Realized Risk events | Risk Mapping | Deleted Items | Sheet1

Links to risk forms

Interface Management

Project Interface Matrix

Available on Project Management page of the review web site under "Requirements and Interface Documents"

Mu2e Interface Matrix

WBS #	L2 Sub Project Interface Doc	Project Management	Accelerator	Conventional Construction	Solenoids	Muon Beamline	Tracker	Calorimeter	Cosmic Ray Veto	DAQ	GPP	AIP	g-2
475.01	Project Management												
475.02	Accelerator			1529	1529	1529				1529	1529	1529	1529
475.03	Conventional Construction		1537		1537	1537	1537	1537	1537	1537			
475.04	Solenoids		1470	1470		1470	1470		1470			1470	
475.05	Muon Beamline		1168	1168	1168		1168	1168	1168	1168			
475.06	Tracker			1562	1562	1562		1562		1562			
475.07	Calorimeter			2195	2195	2195	2195			2195			
475.08	Cosmic Ray Veto			1551		1551				1551			
475.09	DAQ			1520		1520	1520	1520	1520				
(none)	GPP		4427	4427									
(none)	AIP		4427		4427								
(none)	g-2		4427										

Accelerator Interface Document

Accelerator Interface Document

Table of Contents

Accelerator Interface Document is divided into two sections:

1. Internal interfaces – interfaces of each Accelerator L3 with other Accelerator L3s
2. External Interfaces – interfaces of each Accelerator L3 with other Mu2e L2s and other Muon Campus projects

The Accelerator Interface document is available from the review web site

Accelerator Interface Document (continued)

3.5 WBS 475.02.07 EXTERNAL BEAM LINE (EXTERNAL)

Table 102.07.2 lists all of the interfaces from the External Beam line to outside of the Accelerator subproject.

Item	*Interface*	*Description*	*Owners*	*Reference Documents/ Drawing*
102.07.2.1	Target Station, Production Solenoid (PS)	The experimental detector specifies the location of the target and its orientation. The Production Solenoid (PS) also defines the beam trajectory through the magnetic field to the solenoid entrance. The Extraction Line subproject is responsible for delivering the proton beam at the specified entry coordinates and angles. The subproject also provides beam trajectory variability for target scans without a significant deterioration in beam quality.	WBS475.04	TBD
102.07.2.2	G-2	After vertical extraction from the Delivery ring, the next 25 meters of external beamline is shared by the Mu2e and g-2 experiments, although with different operating tunes. The M5 g-2 line then separates vertically from the M4 Mu2e line by reverse-powering a single MDC dipole facilitating simple and efficient switching between the two modes of operation. The shared part of the beamline and the line connecting to the g-2 storage ring will be designed, procured and installed as part of g-2 project. The M4 line that connects to the Mu2e experiment will be part of the Mu2e WBS. G-2 building (MC-1) provides the space for some beam line and extinction power supplies.	M.Convery	TBD
102.07.2.3	GPP	The components that make up the M4 beamline will be installed as part of the Mu2e WBS. The tunnel enclosure and basic infrastructure will be managed as a GPP. The L3 manager for the Extraction Line will need to interface with the Project Manager for the GPP so that the tunnel dimensions and geometry match what is	T.Lakowski	TBD

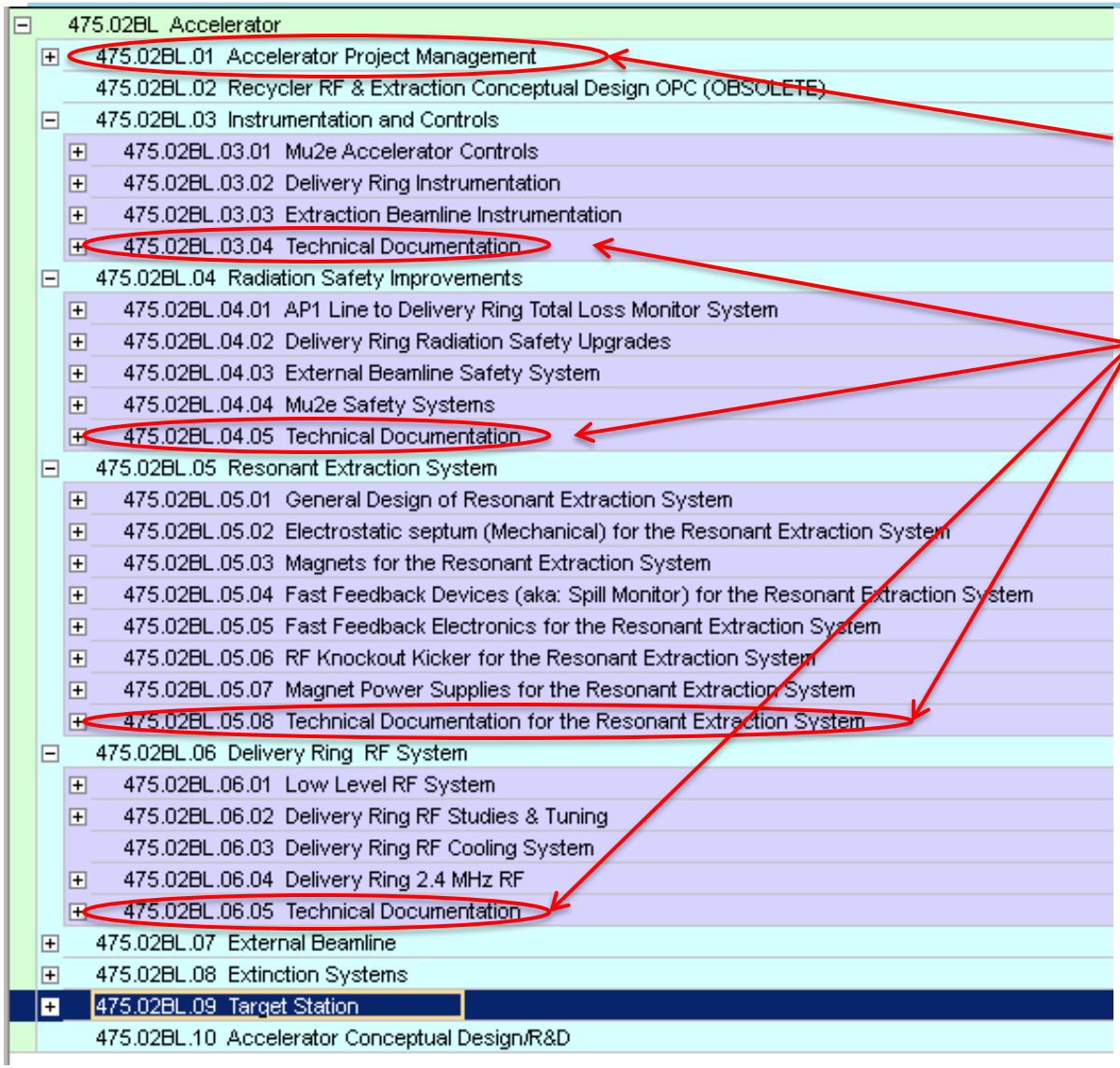
Extract from the Accelerator Interface Document for External Beamline external interfaces

- Owners are the L3 manager for the External Beamline *and* one of the following:
  - The L2 manager for the indicated Mu2e L2, or
  - The AIP/GPP/g-2 manager indicated by name
- Reference Documents/Drawing will be created and signed by the owners prior to CD-3c

Miscellaneous

- Technical Documentation

Project Management Costs



- Project management costs for L2 management is in the Accelerator Project management L3.
- Project management activities and costs for each L3 are contained in a L4 category called “Technical Documentation”

Mu2e Accelerator Breakout Session Talks

Mu2e Accelerator Breakout talks

Title	File	Speaker	Time (min)
Mu2e Accelerator Overview	B02-1 Accelerator Overview	S. Werkema	30
Radiation Safety	B02-2 Radiation Safety	A. Leveling	30
Delivery Ring RF	B02-3 Delivery Ring RF	J. Dey	20
Target Station	B02-4 Target Station	R. Coleman	50
Resonant Extraction	B02-5 Resonant Extraction	V. Nagaslaev	30
External Beamline Design	B02-6 External Beamline Design	E. Prebys	20
External Beamline Cost & Schedule	B02-7 External Beamline Cost-Sched	D. Still	20
Instrumentation & Controls	B02-8 Instrumentation-Controls	B. Drendel	30
Extinction	B02-9 Extinction	E. Prebys	30
Extinction Monitoring	B02-10 Extinction Monitoring	P. Kasper	30
Installation & Commissioning	B02-11 Installation-Commissioning	S. Werkema	20

>>> Not shown in chronological order

Proposed Schedule

Tuesday Afternoon (3:10 – 5:00 pm) *Combined Session*

• Accelerator Overview	S. Werkema	40 min
• Muon Beamline Overview	G. Ginther	40 min
• Muon Beamline Vacuum	D. Pushka	30 min

Wednesday Morning (8:00 – 11:30 am)

• Target Station	R. Coleman	60 min
• Radiation Safety	A. Leveling	40 min
• *Break*		*10 min*
• Delivery Ring RF	J. Dey	30 min
• Resonant Extraction	V. Nagaslaev	40 min
• Instrumentation & Controls	B. Drendel	40 min

Proposed Schedule (continued)

Wednesday Afternoon (12:30 – 2:00 pm)

• External Beamline Design	E. Prebys	30 min
• External Beamline Cost & Schedule	D. Still	30 min

Thursday Morning (8:00 – 11:30 am)

• Extinction	E. Prebys	40 min
• Extinction Monitoring	P. Kasper	40 min
• Installation and Commissioning	S. Werkema	20 min