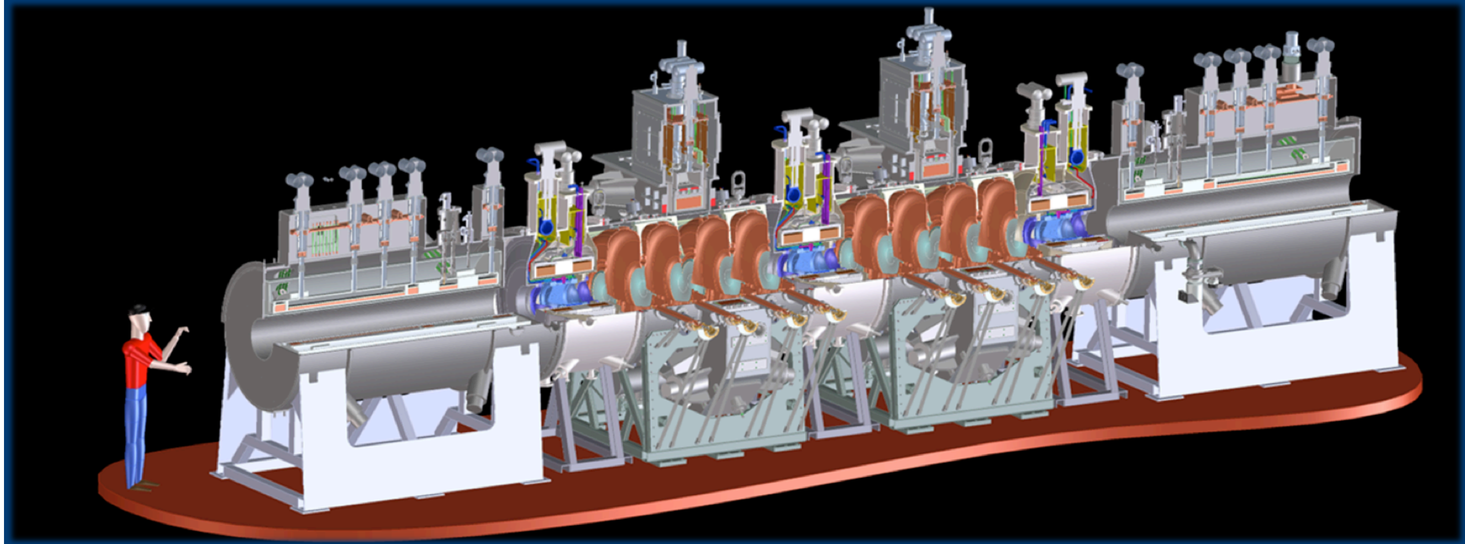
Muon Ionization Cooling Experiment: U.S. Muon Accelerator Program Perspective and Approach



Mark Palmer

May 7, 2013

Fermilab

Outline

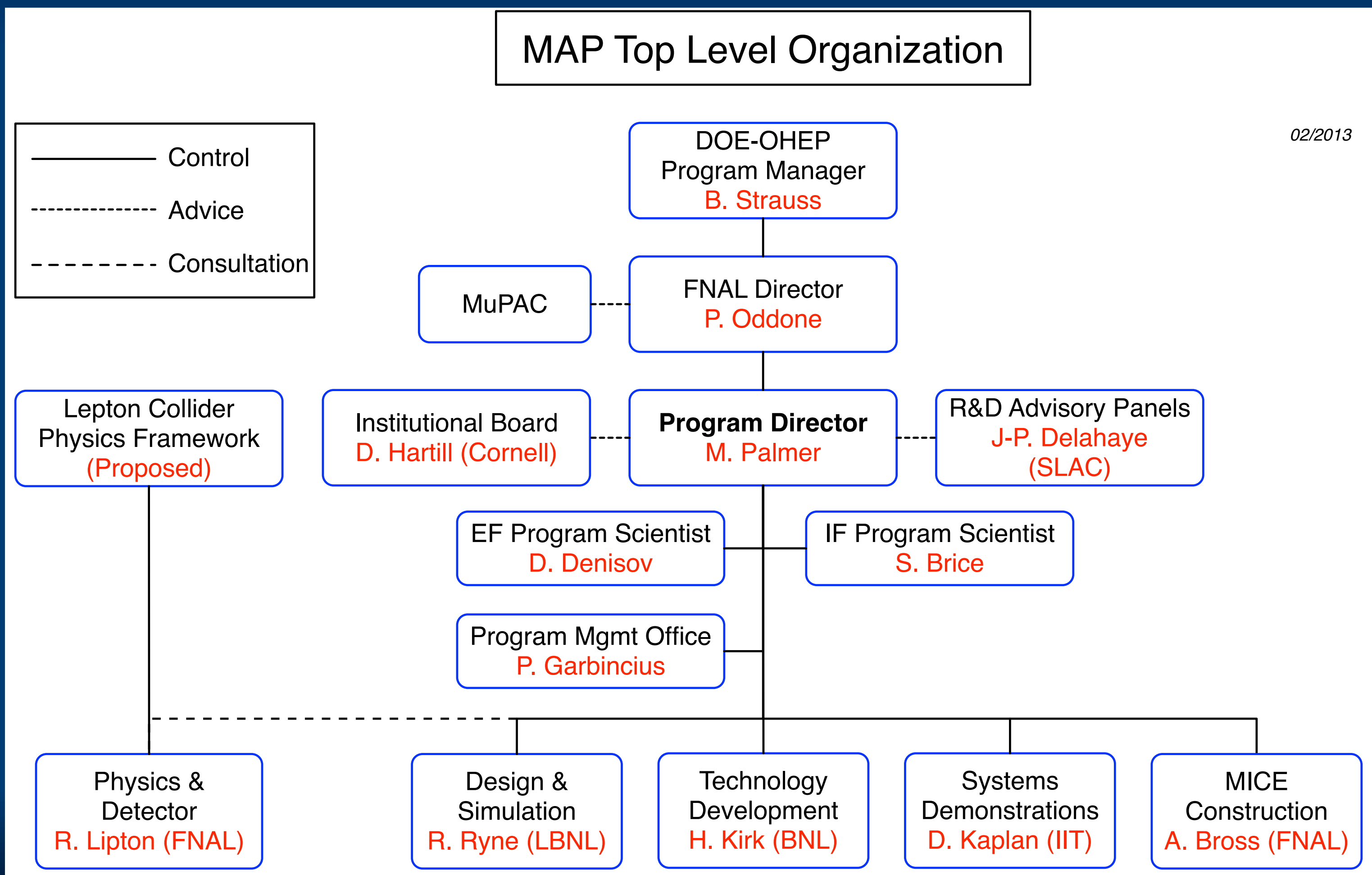
- The U.S. Muon Accelerator Program
  - Introduction
  - U.S. Perspective on MICE
- U.S. Schedule
  - Status
  - Assumptions
  - Ongoing Effort
- U.S. Budget
  - Status
  - Assumptions
  - Ongoing Effort
- Achieving Success with MICE

MAP: Introduction (I)

- MAP Scope
  - R&D effort to demonstrate the technologies required for high energy muon accelerator capabilities
  - This includes Muon Collider and Neutrino Factory designs and technology
  - MAP is charged to produce an assessment of the feasibility of these facilities on the several year timescale – practically speaking, this means by the end of the decade
- Thus MAP Effort Spans
  - A Broad Design Effort
  - Support and Development of Multiple Test Facilities (including MICE)
  - Multiple Technology Development Thrusts

MAP: Introduction (II)

- MAP is in the process of re-organizing the US Muon Accelerator R&D structure along Project lines



MAP: Introduction (III)

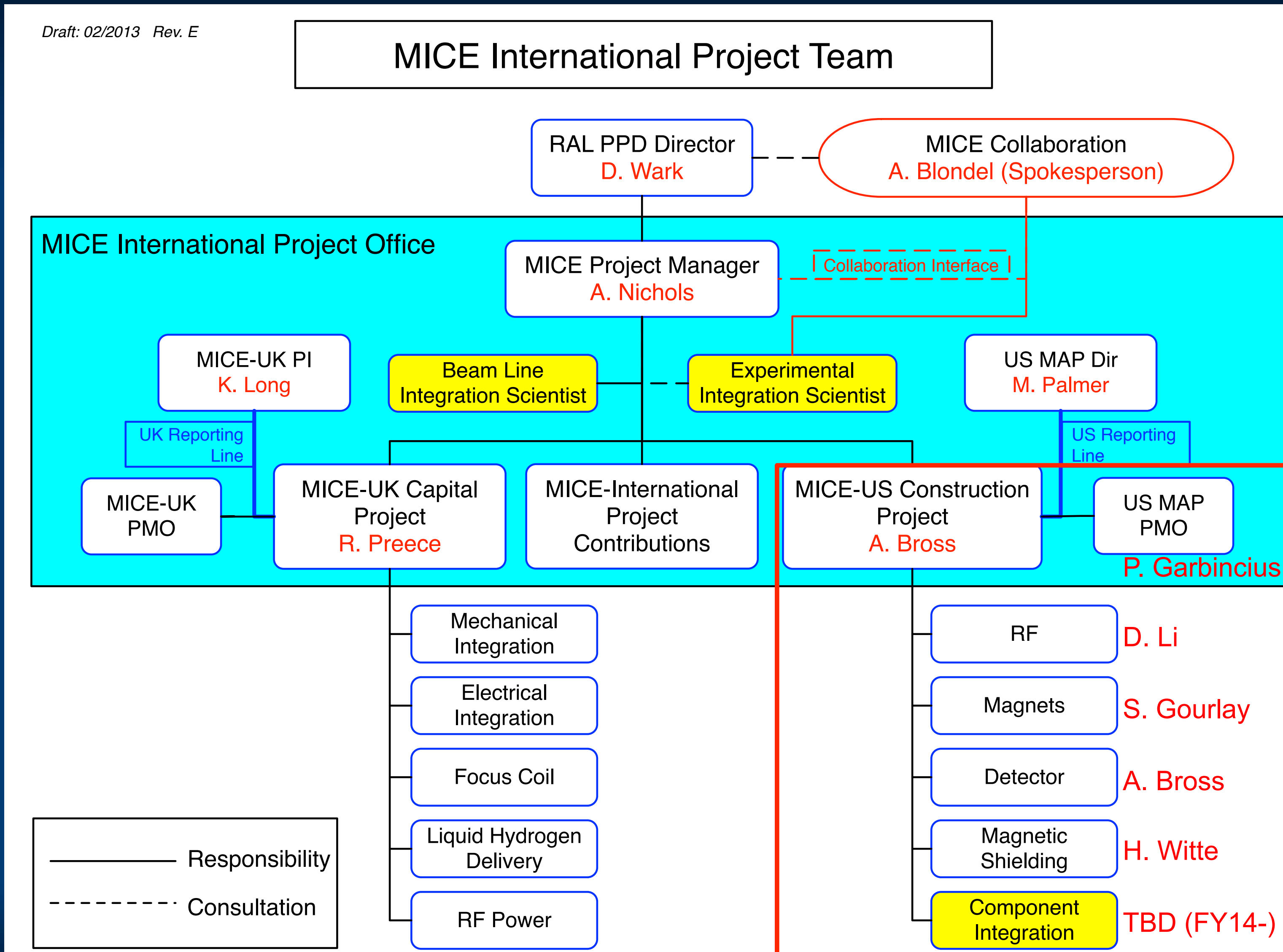
- MAP Re-organization
  - Complete the U.S. MAP project implementation by the conclusion of US FY13
    - Provide a management structure populated with capable managers and which provides a clear chain of responsibilities
    - Provide a Program Management Office to plan, oversee and track the Program Effort
  - Provide a ~6 year execution plan to complete the feasibility assessment for an HEP facility based on Muon Accelerators
    - Address basic design and technology uncertainties with a multi-faceted R&D program
    - Identify critical R&D to be addressed during a subsequent Technical Design Effort towards Muon Accelerator facilities (if approved)
    - Ensure that ongoing activities are executed *successfully*

U.S. Perspective on MICE

- MICE serves as a demonstration of the principal of *Ionization Cooling*
  – *This is a necessary and critical, but not sufficient, demonstration of the technologies required for developing an accelerator facility to support operation of a Neutrino Factory or Muon Collider*
  – *It is imperative that this experiment reach a successful conclusion*

- With respect to MICE, the U.S. program goals are:
  – Creation of a U.S. *MICE Construction Project* within MAP which has clearly defined reporting lines
  – Preparation of a multi-year resource-loaded plan – that fits within a budget profile developed in consultation with the U.S. DOE
  – Integration of the U.S. construction effort into the international construction effort, *with clearly defined interfaces to an international project office*
  – Ensuring sufficient support for the *MICE Experimental Collaboration* to accomplish its research goals

MICE Construction Project



U.S. Schedule: Status (I)

- All major activities now have cost and schedule estimates associated with them
  - Detailed refinement needed in many cases
  - It would be reasonable to assume a nominal 30% budget uncertainty with the present level of estimation
  - Each construction activity has been loaded with a nominal contingency (labor and M&S)
  - More detailed contingency assessments have been completed for some activities

U.S. Schedule: Status (II)

- The construction schedule identifies critical interface points
  - Domestic & International
  - Interface definitions (and required resources) remain a source of likely schedule slippage until more planning effort can be applied
- Potential for delays (being actively addressed)
  - Too many partial FTEs in multi-institutional critical path efforts
  - Component R&D being carried out during the construction effort
    - Ideally the most significant R&D risks would have been retired in advance of a construction start

U.S. Schedule: Assumptions (I)

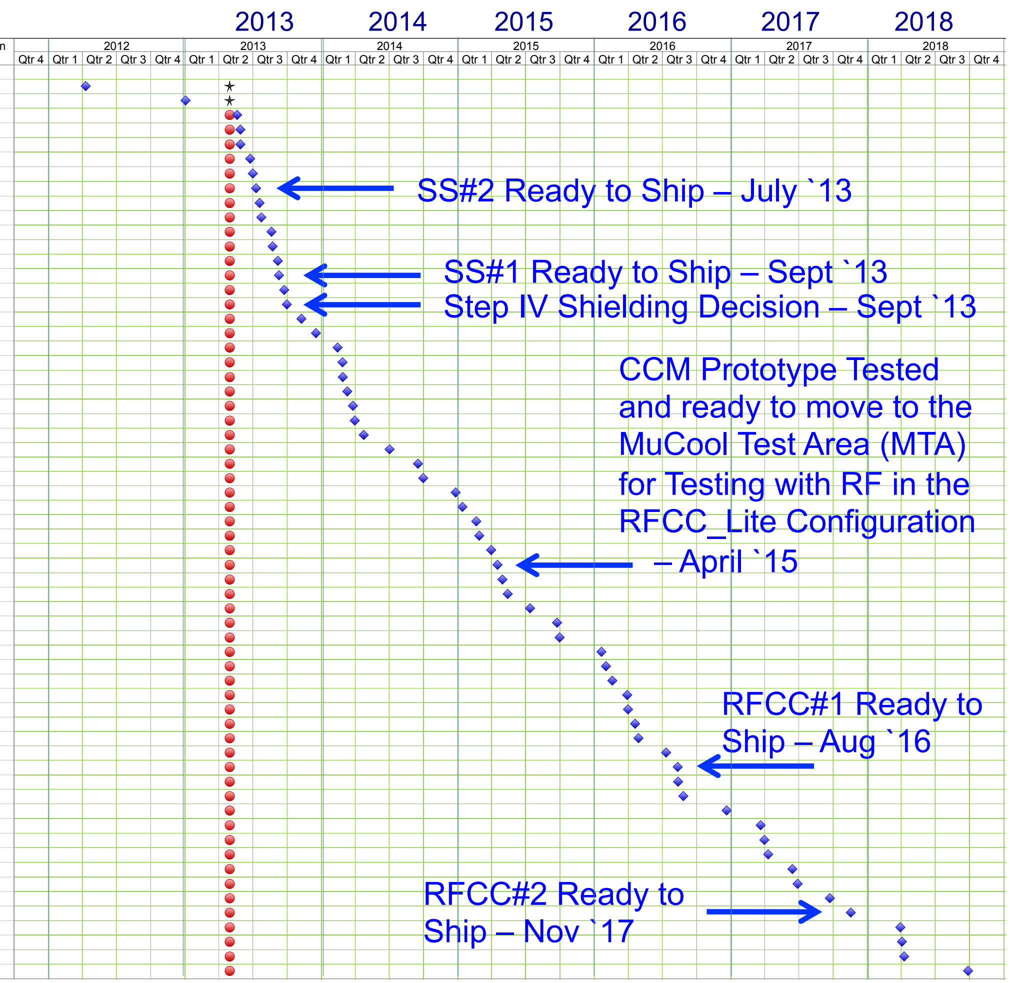
- A construction schedule has been prepared that we believe, in the *absence of major contingencies*, fits within the expected US budget profile and is roughly consistent with the UK (no-contingency) schedule
  - Base costs and activity plan (with escalation) integrate to completion as shown in the MS Project File
- Incorporation of contingency
  - Analysis: "Production" contingency costs could be integrated within roughly the same overall time frame *(will discuss this further in the budget section)*
  - Caveat: Integration of "*major*" contingencies into the plan will incur additional delays *(will discuss anticipated impact further in the budget section)*

U.S. Schedule: Assumptions (II)

- Major contingencies:
  - Sources:
    - Component R&D issues
    - Potential for major supplier disruption
  - Impact estimates (time and cost) are being supplied for these risks and they are flagged as risk "milestones" (see U.S. Risk Register)
  - ***Realistically, a significant fraction of the major contingencies will have to be integrated into the actual schedule (and budget profile)!***
  - Schedule attempts to front-load the effort to understand/mitigate such risks
  - However, front-loading of risks for later steps cannot be allowed to significantly delay delivery of the next MICE Experimental Step

Major Milestones

WBS	Task Name	Status Date	Baseline Start	Start Variance in Working Days
	WBS5 L4 Milestones			
1.05.01.04.01	L4 - 201 MHz EP Review (Complete)	4/30/13	4/10/12	275 days
1.05.02.02.02.03.03	L4 - Cold Mass #1 Arrives at Fermilab	4/30/13	1/2/13	84 days
1.05.02.02.02.04.03	**L4 - Signoff for Further Coil Winding at QiHuan**	4/30/13	5/20/13	-14 days
1.05.02.01.01.03	**L4 - Spectrometer Solenoid Controls Operational Readiness Certification**	4/30/13	5/29/13	-21 days
1.05.02.02.02.06.03	L4 - Superconductor Preparation & Shipment to China (Cold Mass 2) Arrives at China	4/30/13	5/29/13	-21 days
1.05.01.03.04.03	**L4 - 201 MHz All parts for SC MICE test at FNAL (Prototype)**	4/30/13	6/24/13	-39 days
1.05.02.02.02.04.04	**L4 - CC Coil #1 Test Complete**	4/30/13	7/1/13	-44 days
1.05.02.01.02.05	**L4 - SS#2 Prepare for Shipment - Complete**	4/30/13	7/10/13	-51 days
1.05.02.01.03.02.05	L4 - SS#1 Training and Test at WANG - Complete	4/30/13	7/19/13	-58 days
1.05.02.01.04.01.02	L4 - SS#2 Arrives at RAL	4/30/13	7/24/13	-61 days
1.05.01.03.06	**L4 - MICE SCTS Ready**	4/30/13	8/20/13	-80 days
1.05.02.01.04.03.03	L4 - Ship Field Mapping Equipment Arrives at UK (UK Needs by 10/30/13)	4/30/13	8/23/13	-83 days
1.05.02.02.02.07.03	L4 - Superconductor Preparation & Shipment to China (Cold Mass 3) Arrives at China	4/30/13	9/6/13	-93 days
1.05.02.01.03.05	**L4 - SS#1 Prepare for Shipment from WANG to UK - Complete**	4/30/13	9/9/13	-94 days
1.05.02.01.04.02.02	L4 - SS#1 Arrives at RAL	4/30/13	9/23/13	-104 days
1.05.03.01.03.03	L4 - MICE Step IV Magnetic Shield Fabrication Decision	4/30/13	9/30/13	-109 days
1.05.02.02.02.11.03	L4 - Cold Mass #2 Arrives at LBNL	4/30/13	11/8/13	-138 days
1.05.02.02.02.08.03	L4 - Superconductor Preparation & Shipment to China (Cold Mass 4) Arrives at China	4/30/13	12/17/13	-165 days
1.05.02.02.04.02.03	**L4 - CC Cryostat #1 (CCM Prototype) Assembly Ready for Shipment to FNAL**	4/30/13	2/13/14	-207 days
1.05.02.02.05.01.03	**L4 - CC Assembly Area Operational**	4/30/13	2/26/14	-216 days
1.05.02.02.04.03.03	L4 - CC Cryostat #1 (CCM Prototype) Arrived at FNAL	4/30/13	2/27/14	-217 days
1.05.02.02.02.13.03	L4 - Cold Mass #3 Arrives at LBNL	4/30/13	3/11/14	-225 days
1.05.02.01.04.05	**L4 - SS#1 & SS#2 Spectrometer Solenoids Ready for Operations**	4/30/13	3/26/14	-236 days
1.05.03.01.05.03	L4 - MICE Step IV Magnetic Shielding Received at RAL	4/30/13	3/31/14	-239 days
1.05.02.02.02.16.03	L4 - Cold Mass #2 Arrives at FNAL	4/30/13	4/24/14	-257 days
1.05.02.02.02.15.03	L4 - Cold Mass #4 Arrives at LBNL	4/30/13	7/2/14	-306 days
1.05.02.02.02.17.03	L4 - Cold Mass #2 Ready for Use	4/30/13	9/16/14	-360 days
1.05.03.01.07	L4 - MICE IV Magnetic Shielding - Complete	4/30/13	9/30/14	-370 days
1.05.02.02.04.05.03	L4 - CC Cryostat #2 (CCM #1) Ready for Shipment to FNAL	4/30/13	12/26/14	-433 days
1.05.02.02.04.06.03	L4 - CC Cryostat #2 (CCM #1) Arrived at FNAL	4/30/13	1/13/15	-445 days
1.05.02.02.02.18.03	L4 - Cold Mass #3 Ready for Use	4/30/13	2/19/15	-472 days
1.05.02.02.05.02.03	L4 - CCM Prototype Assembly at FNAL - Complete - Operational	4/30/13	2/27/15	-478 days
1.05.01.04.07.03	**L4 - All RF Parts for RFCC#1 Ready**	4/30/13	3/31/15	-500 days
1.05.02.02.05.03.03	**L4 - CCM Prototype Testing Complete - Ready to be moved to MTA**	4/30/13	4/17/15	-513 days
1.05.01.05.02.03	L4 - RFCC #1 Vacuum Vessel Assembly & Test (Complete)	4/30/13	4/30/15	-522 days
1.05.01.05.03.03	L4 - RFCC #1 Vacuum Vessel Received at FNAL	4/30/13	5/14/15	-532 days
1.05.02.02.02.19.03	L4 - Cold Mass #3 Ready for Use	4/30/13	7/13/15	-574 days
1.05.01.04.13.03	**L4 - All RF Parts for RFCC#2 Ready**	4/30/13	9/23/15	-626 days
1.05.01.04.08.05	L4 - 201 MHz Production Cavity Assembly & Test - Complete (RFCC#1) (Production)	4/30/13	9/30/15	-631 days
1.05.02.02.05.07.03	L4 - CCM#1 Assembly at FNAL - Complete	4/30/13	1/20/16	-711 days
1.05.01.05.05.03	L4 - RFCC #2 Vacuum Vessel Assembly & Test (Complete)	4/30/13	2/1/16	-719 days
1.05.02.02.02.20.03	L4 - Cold Mass #4 Ready for Use	4/30/13	2/18/16	-732 days
1.05.01.04.14.03	L4 - 201 MHz Production Cavity Assembly & Test - Complete (RFCC#2) (Production)	4/30/13	3/29/16	-760 days
1.05.03.02.03.03	L4 - MICE Step V-VI Magnetic Shielding Detailed Engineering	4/30/13	3/31/16	-762 days
1.05.02.02.05.08.03	L4 - CCM#1 Testing at FNAL - Complete	4/30/13	4/19/16	-775 days
1.05.01.05.06.03	L4 - RFCC #2 Vacuum Vessel Received at FNAL	4/30/13	4/28/16	-782 days
1.05.02.02.02.21.03	L4 - Cold Mass #4 Ready for Use (Only Needed if Failure of Cold Mass #1, #2, or #3) No Successor	4/30/13	7/11/16	-834 days
1.05.02.02.05.09.05	**L4 - RFCC#1 Ready to Ship to RAL**	4/30/13	8/11/16	-857 days
1.05.02.02.04.08.03	L4 - CC Cryostat #3 (CCM #2) Ready for Shipment to FNAL	4/30/13	8/12/16	-858 days
1.05.02.02.04.09.03	L4 - CC Cryostat #3 (CCM #2) Arrived at FNAL	4/30/13	8/26/16	-868 days
1.05.02.02.05.11.03	**L4 - MICE RFCC#1 Arrives at RAL (UK Desired by 01/03/17)**	4/30/13	12/20/16	-950 days
1.05.02.02.05.12.03	**L4 - RFCC#1 Installation & Commissioning at RAL - Complete**	4/30/13	3/21/17	-1015 days
1.05.03.02.05.03	L4 - MICE Step V-VI Magnetic Shielding Received at RAL	4/30/13	3/31/17	-1023 days
1.05.02.02.05.06.02	**L4 - Optional: RFCC Prototype Ready to Ship to RAL**	4/30/13	4/10/17	-1029 days
1.05.02.02.05.06.04	**L4 - Optional: MICE RFCC Prototype Arrives at RAL**	4/30/13	6/14/17	-1076 days
1.05.02.02.05.13.03	L4 - CCM#2 Assembly at FNAL - Complete	4/30/13	6/28/17	-1086 days
1.05.02.02.05.14.03	L4 - CCM#2 Testing at FNAL - Complete	4/30/13	9/22/17	-1148 days
1.05.02.02.05.15.05	**L4 - RFCC#2 Ready to Ship to RAL**	4/30/13	11/17/17	-1188 days
1.05.03.02.08	L4 - MICE V-VI Magnetic Shielding - Complete	4/30/13	3/30/18	-1283 days
1.05.02.02.05.17.03	**L4 - MICE RFCC#2 Arrives at RAL (UK Desired by 04/01/18)**	4/30/13	4/3/18	-1285 days
1.05.02.02.05.19.03	L4 - Assembly Area Decommissioning - Completed	4/30/13	4/9/18	-1289 days
1.05.02.02.05.18.03	**L4 - RFCC#2 Installation & Commissioning at RAL - Complete**	4/30/13	9/27/18	-1412 days



U.S. Schedule: Ongoing Effort

- Major Items:
  - Identifying the correct team to accomplish each major activity
    - Can only execute the desired schedules if we have a well-defined team in place to fully cover the activity
    - Represents both an execution and management chain issue
  - Refining budget and schedule estimates for each major activity
  - Improving our assessment of integration requirements
    - Validating the integration plan
    - Further assessment of the personnel and M&S requirements
  - Reduction/mitigation of “interface” risks
  - Assessing impacts of surprises (ie, the major contingencies)
  - Ongoing integration with updated budget profile guidance

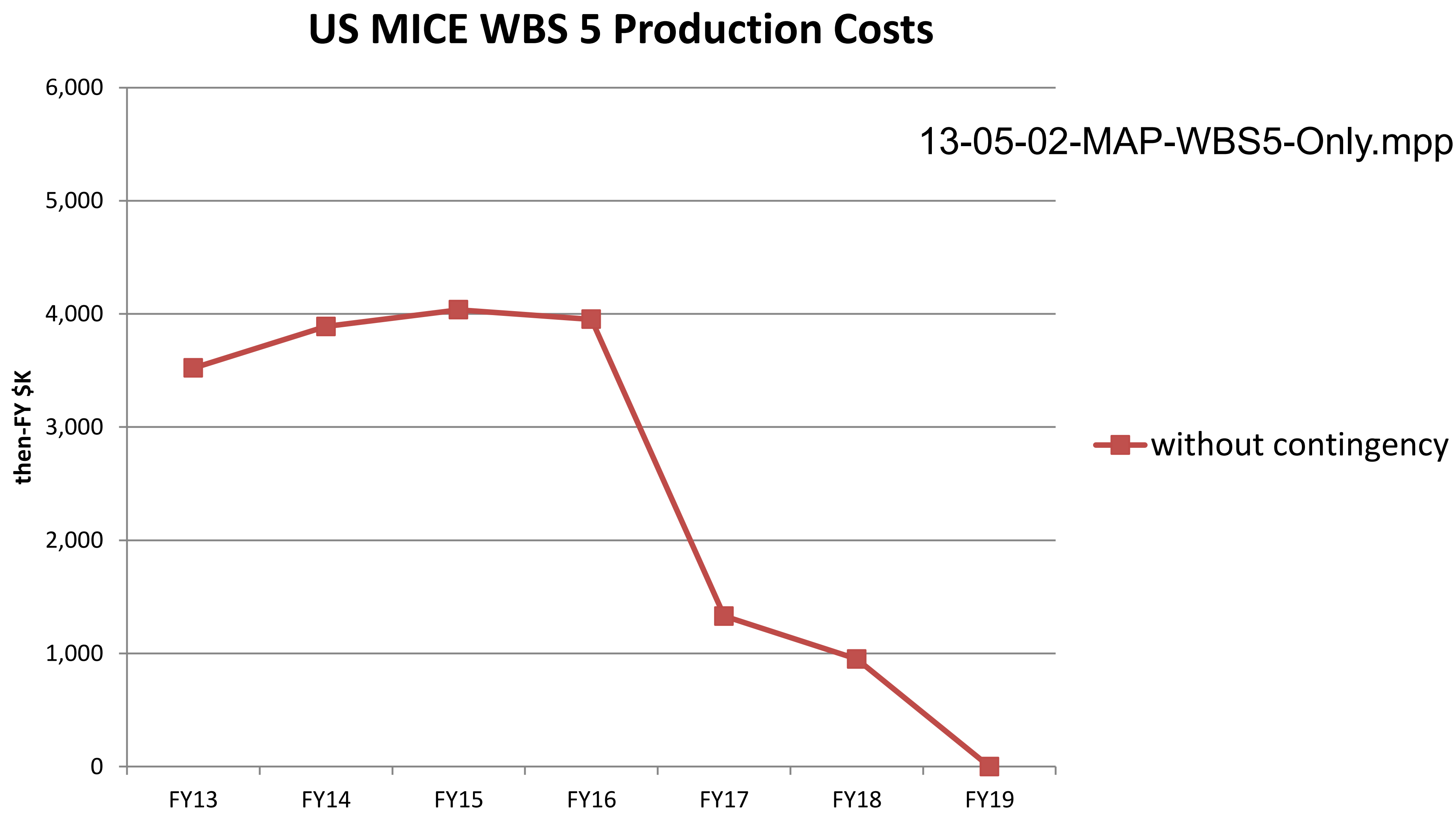
U.S. Budget: Status

- The MAP Budget Profile in the US has received significant attention
  - We are presently projecting budget increases over the next 2 years which will result in an overall 33% increase over FY12 funding levels by FY15
  - This enables us to make a much more realistic budget assessment to clear the R&D risks and complete the MICE Construction effort, while limiting negative impacts on the broader MAP effort
- Our model is to specify a roughly flat MICE construction profile to determine a realistic schedule

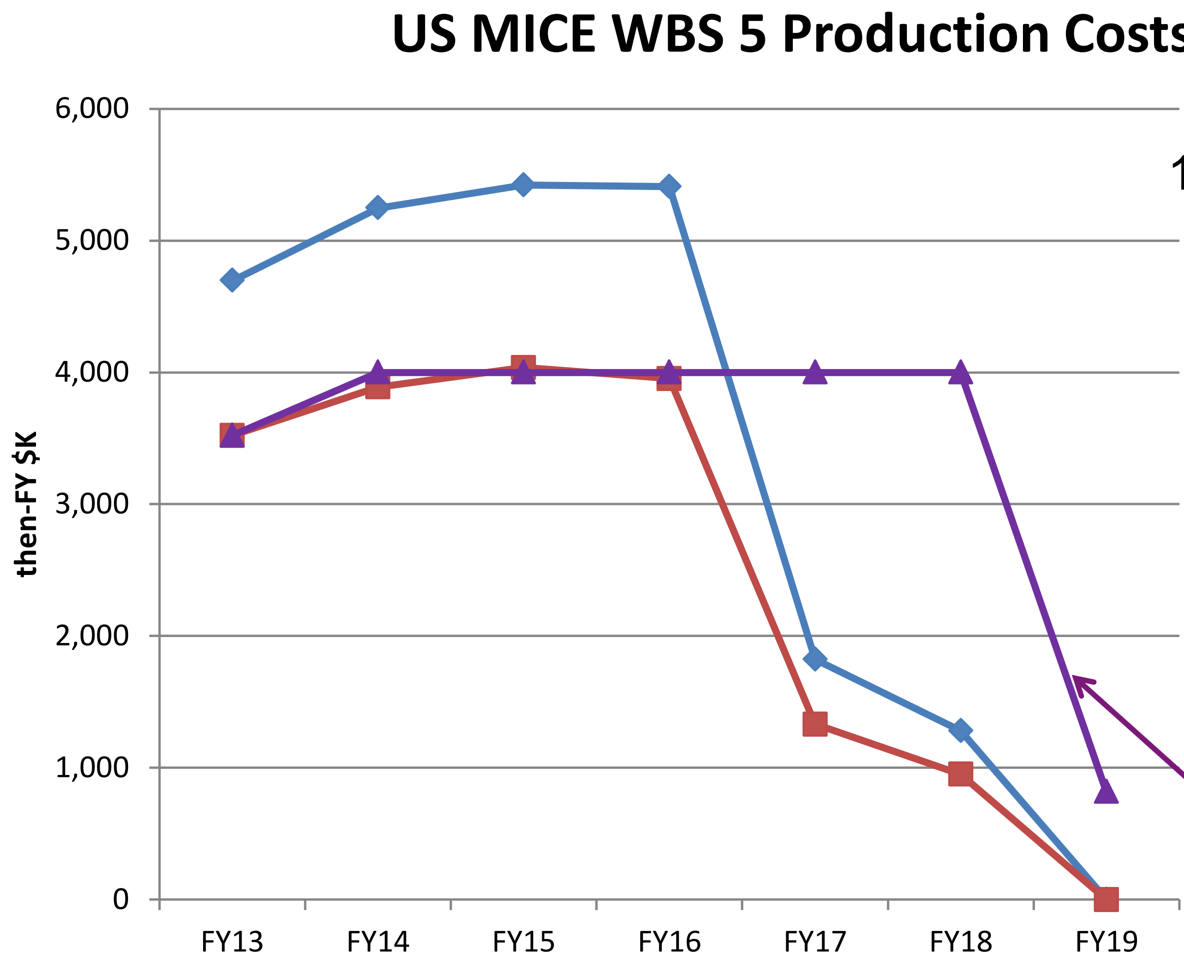
U.S. Budget: Assumptions

- What is included (or not):
  - Construction budget explicitly includes
    - ED&I for prototype and production hardware
    - Fabrication and assembly costs for prototype and production hardware
    - Initial acceptance testing of all components
    - Support for component integration into US systems
    - Support for system-level hardware integration and commissioning at RAL
  - Top-level U.S. Project Management costs (PMO + L1 management support) are born by the Program and ***not*** included in MICE costs
  - MICE-related hardware tests in the MuCool Test Area ***are treated as MTA costs (a different portion of the MAP budget)***
  - Experimental support budget treated separately from construction
- Focus initially on Base Costs (w/escalation) and compare with UK plan (which is also a base cost plan)

US Effort Base Cost w/Escalation



Now Add Contingency and Stretch



13-05-02-MAP-WBS5-Only.mpp

"production" contingency

with <contingency> = 39%

23,918 K$

without contingency

17,716 K$

$ 4 M/yr limit w/contingency
stretchout adds another 1.9%

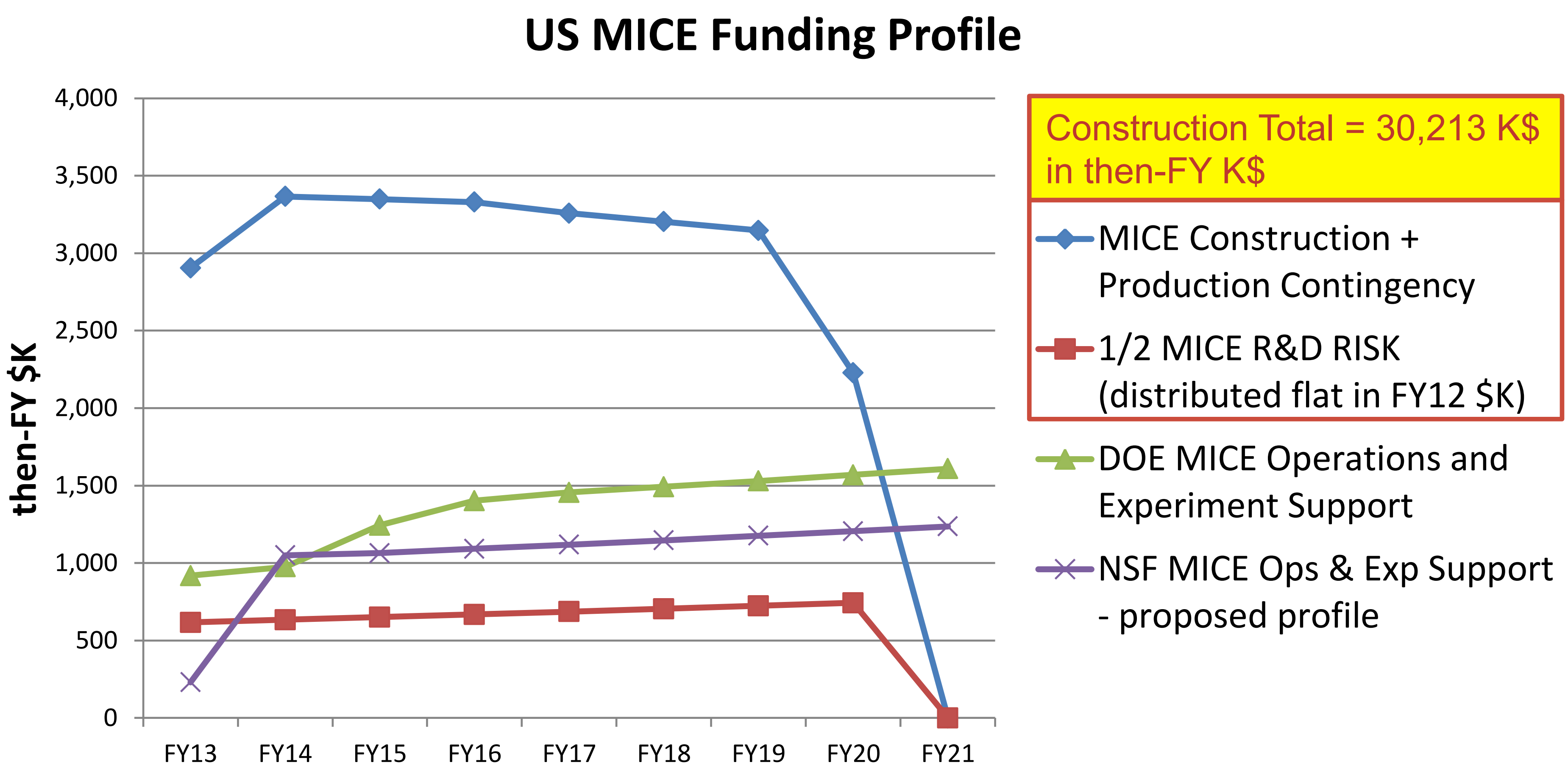
24,383 K$

Almost achieves FY18 completion – BUT…

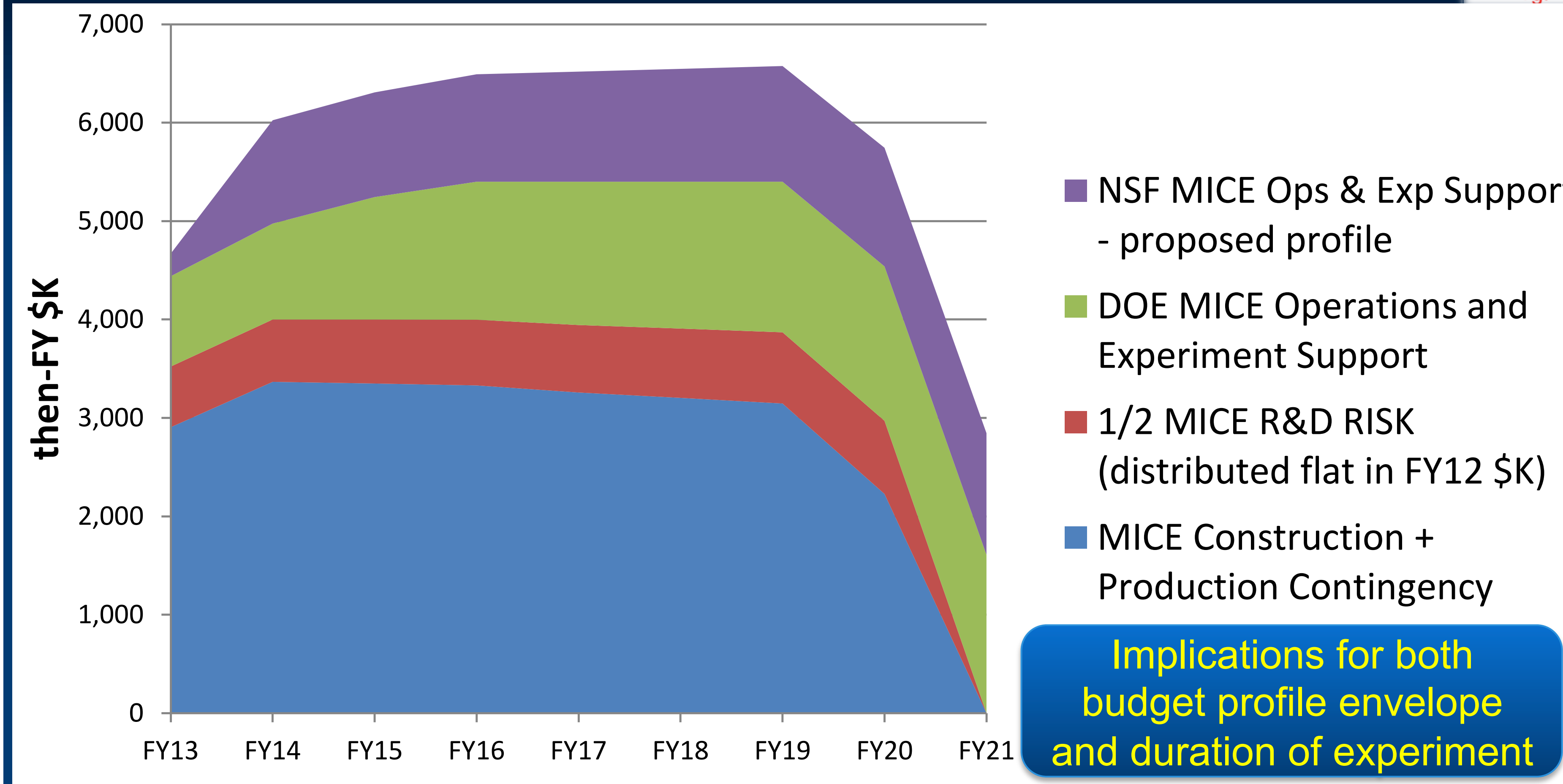
Sums of then-FY K$

US Program Subject to R&D Risk

- US Risk Register: ~$10M of active R&D-related risk
- Plot also shows funding concept for experimental effort to ensure success (further collab/agency discussion needed)



Under These Assumptions…



Implications for both budget profile envelope and duration of experiment

Note: no approved NSF Funding for Ops & Exp beyond FY13

DOE Operations & Experimental support still under development

U.S. Budget: Ongoing Effort

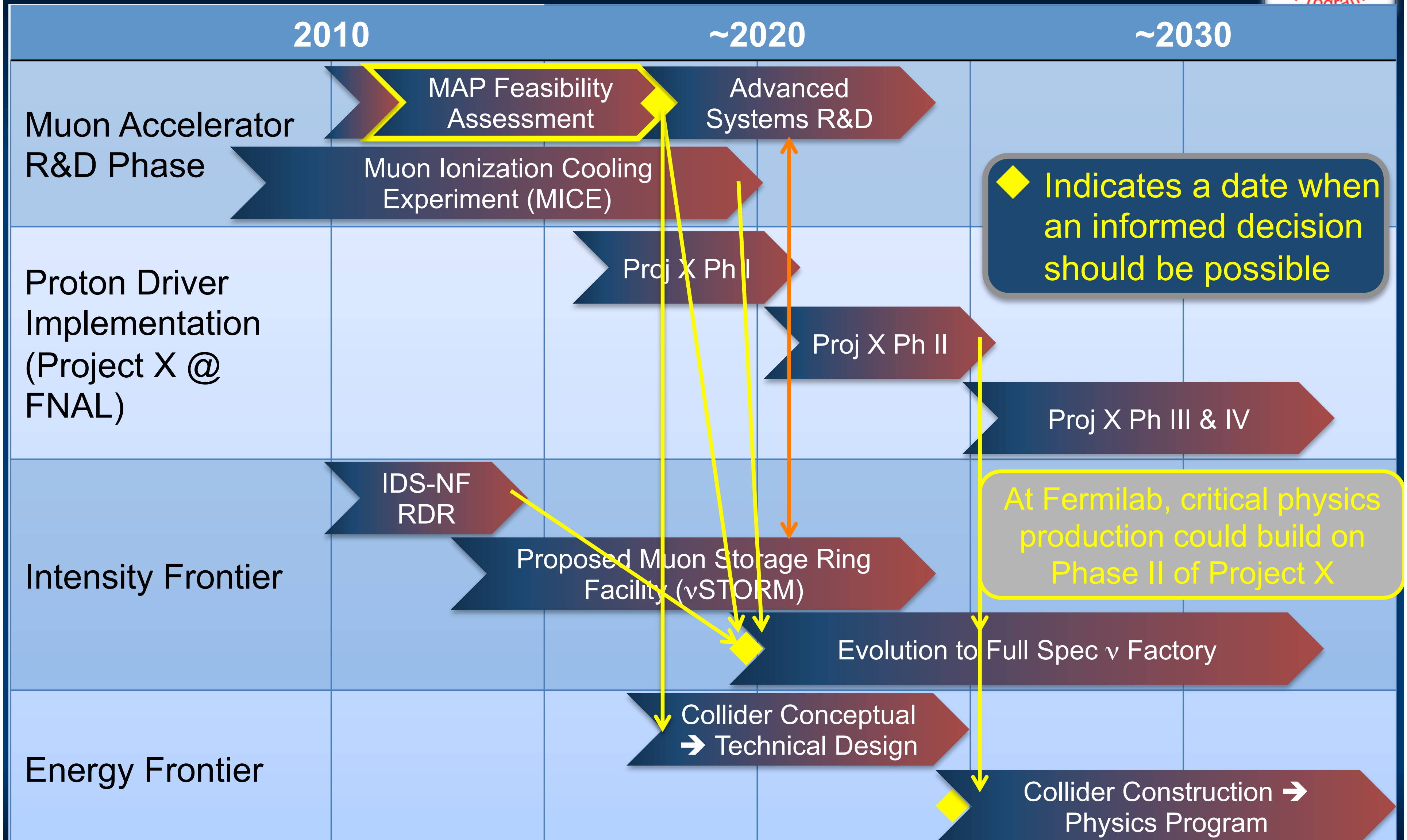
- Continue to work towards
  - Improved budget estimates
  - Assessing completeness of proposed work
  - Identification of any missed contingency items
- An evolving discussion with DOE on budget profile
  - Incorporating a significant ramp upwards in overall MAP budget for next 2 years
  - Have focused primarily on construction project cost so far
  - **Contingencies need to be properly included in plan**
  - **Need to guarantee working experimental configurations**
  - **Need to determine a realistic experimental schedule and provide the necessary support for a viable and efficient experimental effort**
- Continue to review scope (but contingency is the cost driver)
  - Step IV – muons interacting with materials (absorbers)
  - Technology Demonstrations (RFCC Modules)
  - Step V (partial cooling cell, with some inherent beam optics limitations) ***versus***
  - Step VI (full cooling cell enabling detailed beam characterizations)

Achieving Success with MICE

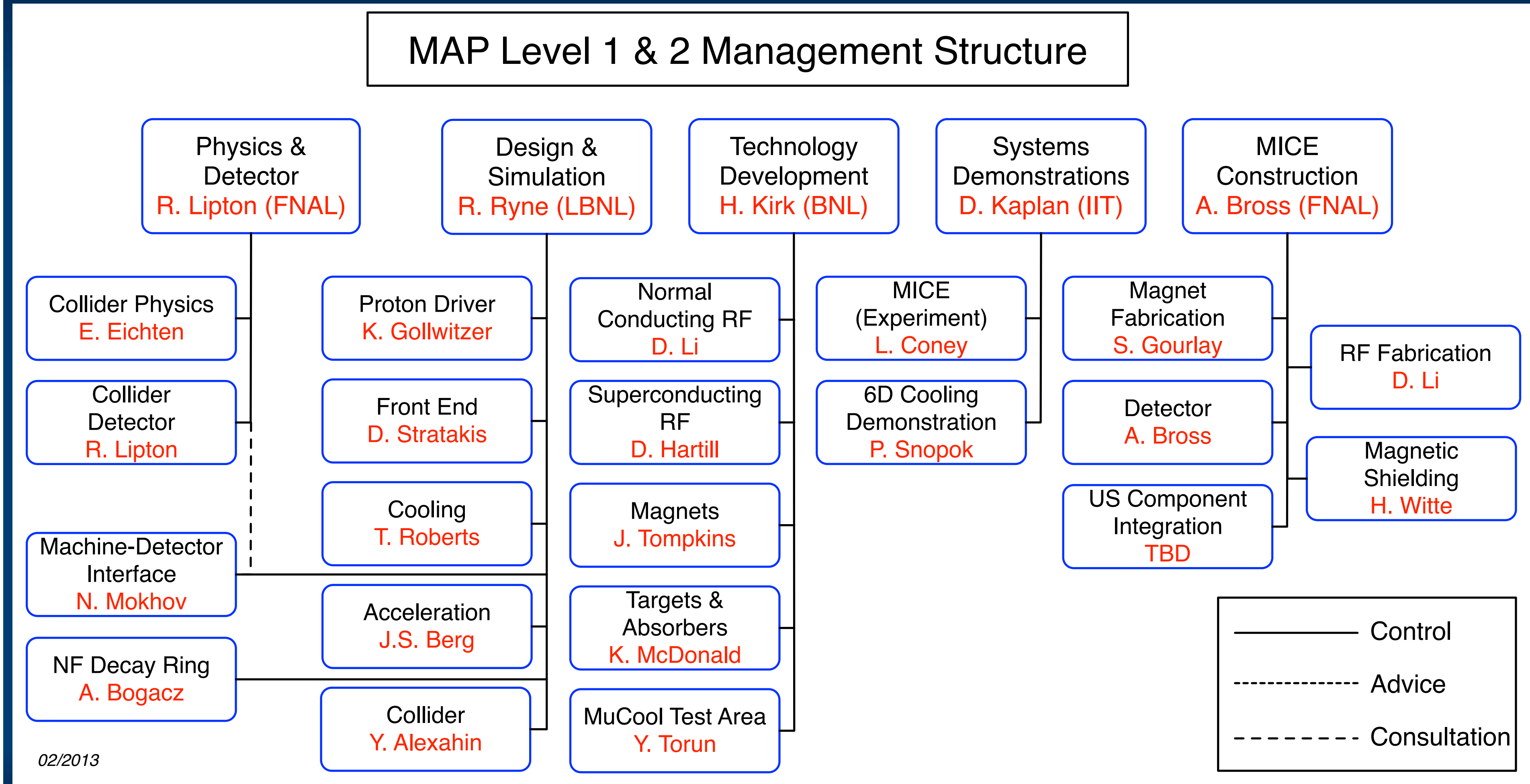
- To help enable the International High Energy Physics Community to properly consider a Muon Accelerator option, it is crucial to provide MICE results in timely fashion
  - MAP would like to have these results in hand before the end of this decade
  - But it requires a realistic assessment of cost and risk implications to the schedule
- The current exercise represents an important step to achieving this goal
  - Constructive feedback from this committee is crucial
  - Developing a ***coordinated plan with the funding agencies*** to ***effectively manage the schedule and contingencies*** as we move forward is also required

BACKUP SLIDES

The Muon Accelerator Program Timeline



Muon Accelerator Program Org Chart (L1 and L2)



MICE & MICE-supporting activities in blue

Muon Accelerator Program WBS: Feasibility Evaluation Phase I					
L1	L2	L3	Task Description	WBS Coordinator	Description
			Muon Accelerator Program	M. Palmer	Level 0 Roll-Up for U.S. Activities
01			Program Management	M. Palmer	Overall coordination of activities associated with the Muon Accelerator Program
01	*01*		*Program Coordination and Activities*	*M. Palmer*	*Coordination of program activities - Includes: management effort (Levels 0 and 1); and management and special program travel.*
01	*02*		*Program Management Office*	*P. Garbincius*	*Program Management Office - Includes: program planning, scheduling, web-site, EDMS, and outreach and communications support.*
01	*03*		*Collaboration Coordination*	*M. Palmer*	*Coordination of MAP collaboration with other closely allied national and international research efforts; support for workshops, conferences and reviews; support for guests and visitors hosted by the program.*
01	*04*		*R&D Advisory Committees*	*J-P. Delahaye*	*Support for program directory appointed advisory committees and working groups - includes salary support, meetings and travel.*
02			Design and Simulations	R. Ryne	Coordination of design and simulation activities for the accelerator complex needed for a neutrino factory and/or a muon collider
02	*01*		*Proton Driver*	*K. Gollwitzer*	*Design and simulation activities for the Proton Driver*
02	*02*		*Front End*	*D. Stratakis*	*Design and simulation activities for the Front End*
02	*03*		*Cooling*	*T. Roberts*	*Design and simulation activities for the Cooling Channels*
02	*04*		*Acceleration*	*J. Scott Berg*	*Design and simulation activities for Acceleration Stages*
02	*05*		*Collider*	*Y. Alexahin*	*Design and simulation activities for Collider Rings*
02	*06*		*Machine-Detector Interface*	*N. Mokhov*	*Design and simulation activities for the Machine-Detector Interface*
02	*07*		*NF Decay Ring*	*A. Bogacz*	*Design and simulation activities for a Muon Decay Ring for neutrino beam production*
03			Technology Development	H. Kirk	Coordination of all activities to design, build and test the technologies deemed essential to demonstrating the feasibility of the neutrino factory and muon collider concepts
03	*01*		*Normal Conducting RF*	*D. Li*	*Normal Conducting RF Design, Fabrication and Testing*
03	*02*		*Superconducting RF*	*D. Hartill*	*Superconducting RF Design, Fabrication and Testing*
03	*03*		*Magnets*	*J. Tompkins*	*Muon Accelerator Magnet Design, Fabrication and Testing*
03	*04*		*Targets & Absorbers*	*K. McDonald*	*Target and Absorber Design, Fabrication and Testing*
03	*05*		*MuCool Test Area*	*Y. Torun*	*Development and Operation of the MuCool Test Area*
03	05	01	Facility, Operations & Experimental Program	Y. Torun	Development of and support for the facility, operations and experimental program
03	05	02	Beamline	J. Volk	Maintainenance, development and operation of the proton beamline to the MTA
03	05	03	Vacuum Cavity R&D	R. Pasquinelli	Vacuum RF in magnetic fields R&D program
03	05	04	High Pressure Cavity R&D	K. Yonehara	High pressure RF in magnetic fields R&D program
03	05	05	MICE Component Testing Support	Y. Torun	Support for tests of the Coupling Coil and MICE RF hardware in preparation for the MICE Step V/VI experimental program
04			Systems Demonstrations	D. Kaplan	Coordination of large-scale systems demonstrations for the feasibility assessments of the Neutrino Factory and Muon Collider concepts
04	*01*		*Muon Ionization Cooling Experiment (MICE)*	*L. Coney*	*Support for the Muon Ionization Cooling Experiment (MICE)*
04	*02*		*6D Cooling Demonstration*	*P. Snopok*	*Development of Experimental Concepts and Hardware Specifications necessary to validate the feasibility of 6D Ionization Cooling*
05			MICE Construction	A. Bross	Coordination of all construction activities in support of the Muon Ionization Cooling Experiment (MICE)
05	*01*		*RF Design, Fabrication and Testing*	*D. Li*	*MICE RF Design, Fabrication and Testing*
05	*02*		*Magnet Design, Fabrication and Testing*	*S. Gourlay*	*MICE Magnet Fabrication*
05	02	01	Spectrometer Solenoids	S. Virostek	Design, Fabrication, Controls Development and Testing of the MICE Spectrometer Solenoids
05	02	02	Coupling Coils	S. Gourlay	Design, Fabrication, Controls Development and Testing of the MICE Coupling Coil Magnets
05	*03*		*Magnetic Shielding*	*H. Witte*	*Design and Fabrication (as necessary) of Partial Yoke Shielding for MICE Cooling Channel Beamline for Step IV and Step V/VI activities*
05	*04*		*Detector Design, Fabrication and Testing*	*A. Bross*	*Design, Fabrication and Testing for Detector and Experimental Hardware for MICE*
05	*05*		*US Component Integration*	*TBD*	*Integration and Commissioning of US hardware Components into MICE Beamline and Interfacing to MICE Control and Data Acquisition Systems. Also includes effort for integration of the Coupling Coil Magnet and RF Cavities into the RFCC.*

Major Risk Milestones

WBS	Task Name	Status Date	Baseline Start
	Level 2 - Risk Milestones (Red - Highest Affects)		
1.05.02.01.01.04	(RISK)-(R2) - Spectrometer Solenoid Controls Operational Readiness Certification	4/30/13	5/29/13
1.05.02.02.04.05	(RISK)-(R2) - CC Coil #1 Test	4/30/13	7/1/13
1.05.01.03.07	(RISK)-(R2) - 201 MHz Assembly MICE SC Test System (Prototype)	4/30/13	8/20/13
1.05.02.02.04.03.04	(RISK)-(R2) - CC Cryostat #1 (CCM Prototype) Arrived at FNAL	4/30/13	2/27/14
1.05.02.02.05.05.03	(RISK)-(R2) - RFCC Prototype (RFCC_Lite) (Single Cavity Test)	4/30/13	12/10/15
1.05.03.02.03.04	(RISK)-(R2) - MICE Step V-VI Magnetic Shielding 2 Week Review Window	4/30/13	3/31/16
1.05.05.03.03	(RISK)-(R2) - MICE-US CC Component Integration	4/30/13	7/18/17
	Level 3 - Risk Milestones (Yellow - Medium Affects)		
1.05.02.01.02.01.04	(RISK)-(R3) - SS#2 Re-Train and Re-Test	4/30/13	3/22/13
1.05.02.01.03.02.04	(RISK)-(R3) - SS#1 Train and Test	4/30/13	7/19/13
1.05.03.01.03.04	(RISK)-(R3) - MICE Step IV Magnetic Shield Fabrication Decision	4/30/13	9/30/13
1.05.02.02.02.10.03	(RISK)-(R3) - Cold Mass #2 Winding (China)	4/30/13	10/4/13
1.05.05.04.03	(RISK)-(R3) - MICE-US Shielding Step IV Component Integration	4/30/13	3/30/15
1.05.05.02.03	(RISK)-(R3) - MICE-US SS Component Integration	4/30/13	4/29/15
1.05.01.04.08.06	(RISK)-(R3) - 201 MHz Production Cavity Assembly & Test (RFCC#1) (Production)	4/30/13	9/30/15
1.05.05.04.07	(RISK)-(R3) - MICE-US Shielding Step V Component Integration	4/30/13	3/30/18
	Level 4 - Risk Milestones (Green - Low Affects)		
1.05.02.01.02.03.04	(RISK)-(R4) - SS#2 Operation Failure with Iron Shield	4/30/13	6/11/13
1.05.02.01.03.03.04	(RISK)-(R4) - SS#1 Operation Failure with Iron Shield	4/30/13	8/9/13
1.05.02.02.02.12.03	(RISK)-(R4) - Cold Mass #3 Winding (China)	4/30/13	2/4/14
1.05.02.02.02.14.03	(RISK)-(R4) - Cold Mass #4 Winding (China)	4/30/13	5/28/14
1.05.02.02.02.17.04	(RISK)-(R4) - Cold Mass #2 Preparation & Test (FNAL)	4/30/13	9/16/14
1.05.02.02.05.03.04	(RISK)-(R4) - CCM Prototype Testing	4/30/13	4/17/15
1.05.02.02.02.19.04	(RISK)-(R4) - Cold Mass #3 Preparation & Test (FNAL)	4/30/13	7/13/15
1.05.05.01.03	(RISK)-(R4) - RFCC_Lite Component Integration	4/30/13	2/26/16
1.05.01.04.14.04	(RISK)-(R4) - 201 MHz Production Cavity Assembly & Test (RFCC#2) (Production)	4/30/13	3/29/16
1.05.05.01.06	(RISK)-(R4) - RFCC#1 Component Integration	4/30/13	8/10/17