Science & Technology Facilities Council

Status of the MICE Construction Project

Resource Loaded Schedule Review

29th April 2014

Roy Preece

Content

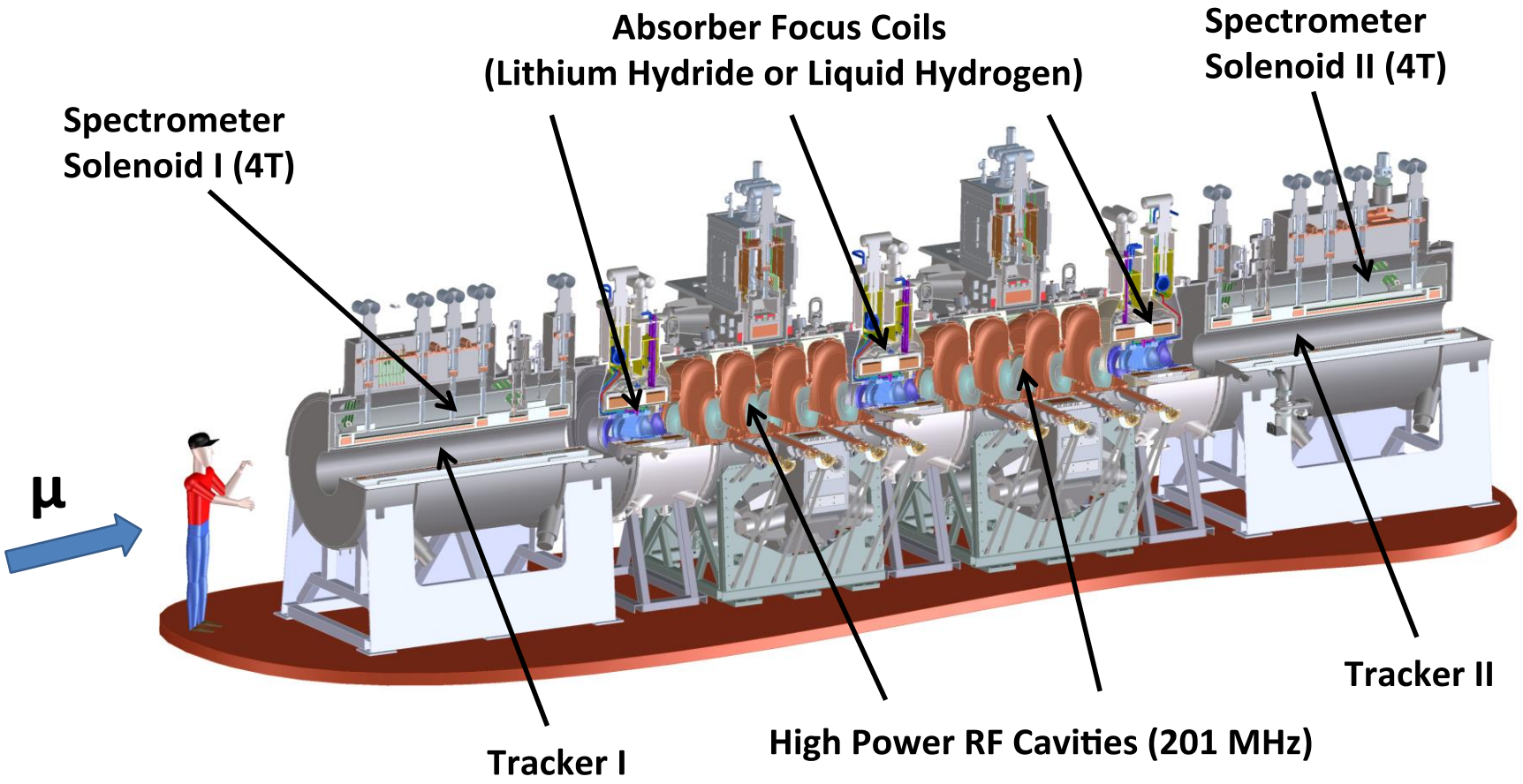
- The Construction Project
- Top Level Schedules
- Interface and decision points
- Top Level Financial Summary
- Top Level Risk Summary
- Response to recommendations

Science & Technology Facilities Council

Status of the MICE Construction Project

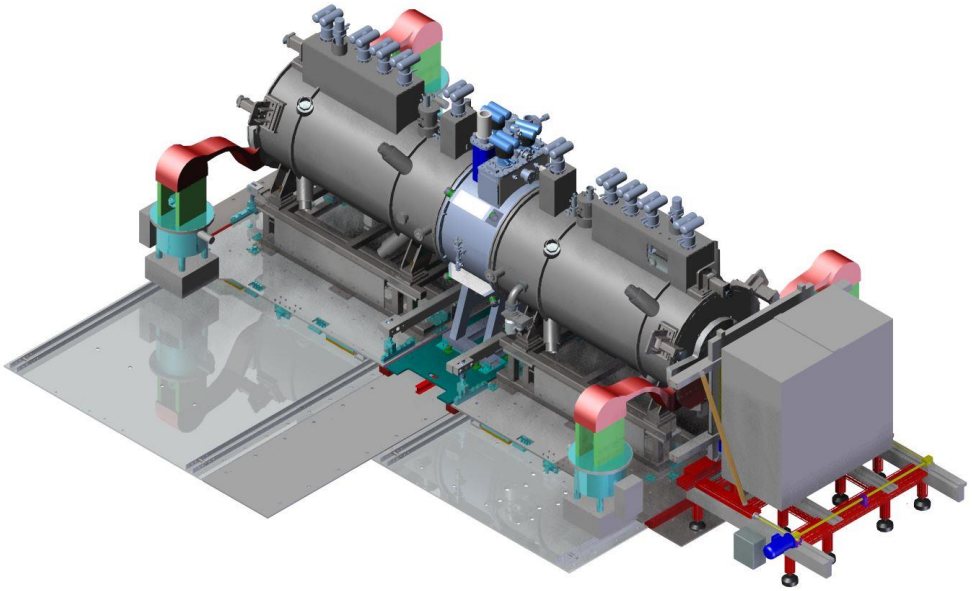
The Construction Project

Science & Technology Facilities Council



Science & Technology Facilities Council

Responsibilities for Step IV equipment

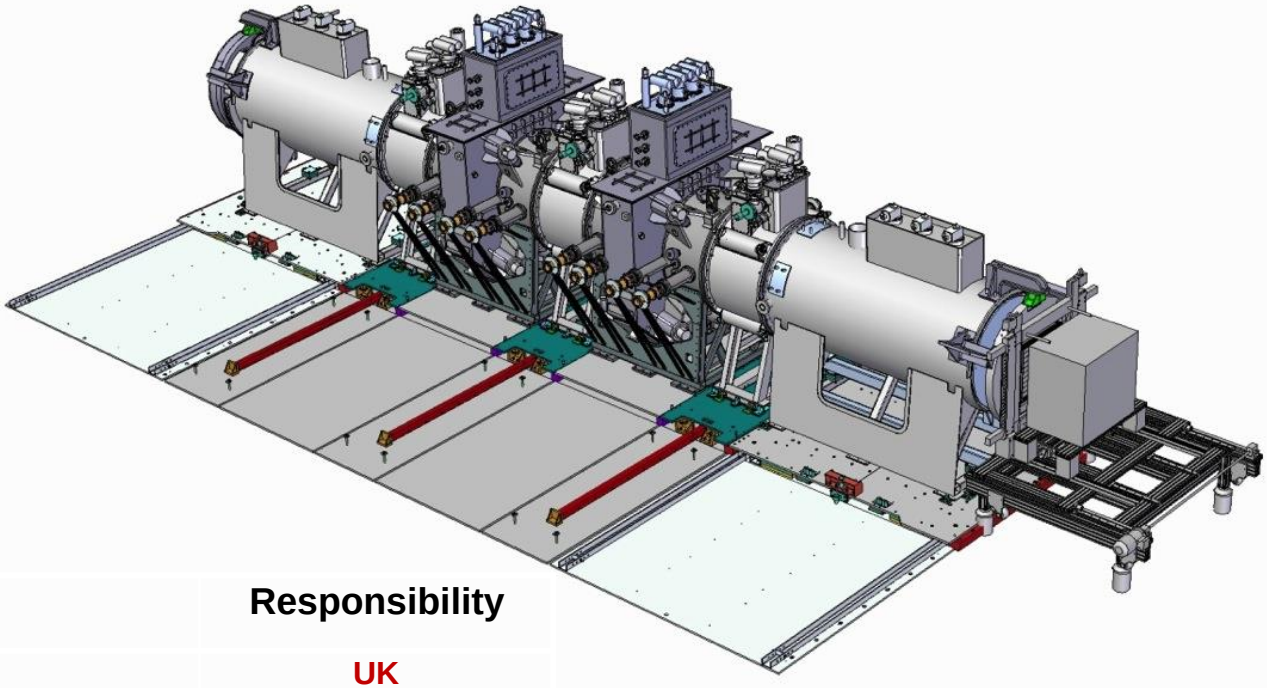


Sub-system	Responsibility
Spectrometer solenoid #2	US
Spectrometer solenoid #1	US
Fibre tracker #1 + #2	Japan, UK, US
Focus coil #1	UK
LH_2 system A	UK
Lithium hydride	US
LH2 absorber	Japan
Diffuser	UK
Virostek plate & TOF cage assy	UK, US
Substation upgrade	UK
EMR	Geneva
(Radiation shutter	*UK)*
AFC Moving platform #1	UK
SS platforms Installation	UK
Partial Return Yoke	UK, US

- Spectrometer Solenoid #1 shipping
- Focus Coil #1 being tested
- Focus Coil #2 arrive back to RAL mid May
- Lithium Hydride – shipping being arranged
- PRY – UK orders out / US very soon

Science & Technology Facilities Council

Responsibilities for Step VI equipment

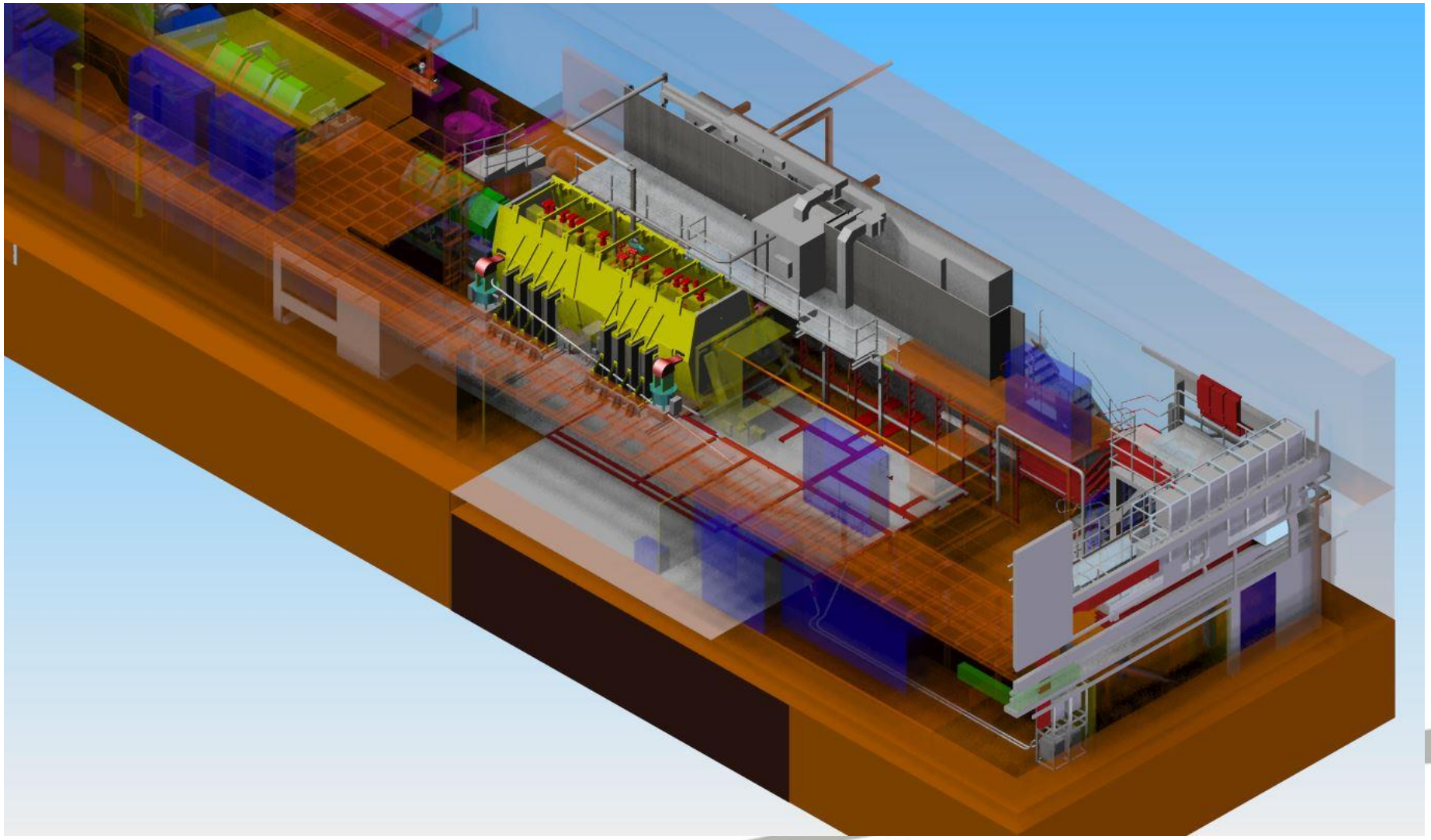


Sub-system	Responsibility
Focus coil #2 and #3	UK
LH_2 system B and C	UK
LH2 absorbers #2 and #3	Japan
RFCC modules [magnets/RF hardware]	US
RF power system	UK
AFC moving platforms #2 and #3	UK
RFCC moving platforms #2 and #3	UK
Partial Return Yoke	UK, US

- LH2 Absorber #2 ready for shipping
- Focus Coil #2 at RAL mid May

Science & Technology Facilities Council

Infrastructure



Science & Technology Facilities Council

Status of the MICE Construction Project

Top Level Schedules

Science & Technology Facilities Council

Progress

- The US deliverables schedule contain contingency and risk.
- All tasks have been analysed in detail for realistic delivery dates.
  - Partial return yoke has had significant work
- The delivery dates feed directly into the master schedule and drive the program
- Care is taken to avoid “double accounting” of time contingency
  - The delivery dates feeding into the master have 35% contingency added
  - No additional time contingency on the milestone
  - Risk does factor on the milestone – problems with shipping, customs etc…
- The master schedule contains a 35% time contingency on all task
- The contingent program is the baseline
  - “Optimistic” schedule will be in plots
    - This is the schedule where no UK contingency has been added
  - “Delayed due to Risk” schedule will be in plots
    - Risk applied to the baseline schedule (with contingency

	Baseline Date May 13	Oct 13	Feb 14	Mar 14	Apr 14	5	6	7	8	9	10	11	12	13
Step IV Top Level Milestones														
SS#2 Mechanically installed in MICE Hall	02/12/13	02/12/13	24/04/14	24/04/14	07/05/2014									
AFC installed in R9 ready for field mapping	10/12/13	10/12/13	23/05/14	23/05/14	30/05/2014									
Downstream Solenoid arrives at RAL	03/01/14	08/05/14	08/05/14	08/05/14	16/05/2014									
SS#1 Mechanically installed in MICE Hall	13/01/14	13/01/14	01/10/14	01/10/14	21/11/2014									
AFC#1 ready for installation in MICE Hall	16/01/14	16/01/14	18/07/14	18/07/14	14/08/2014									
West Mezz build Complete - milestone	04/02/14	04/02/14	25/03/14	19/03/14										
South side yoke material delivered	15/04/14	15/04/14	15/07/14	15/07/14	11/08/2014									
Rack Room 2 BPG work Complete	23/04/14	23/04/14	24/06/14	24/06/14	09/07/2014									
South side return yoke installation complete	04/06/14	04/06/14	03/09/14	03/09/14	12/11/2014									
Compressor services Complete	30/06/14	30/06/14	30/06/14	30/06/14	20/08/2014									
North side yoke material delivered	15/07/14	15/07/14	15/07/14	15/07/14	15/12/2014									
Compressors ready for Cooling channels tests	04/09/14	04/09/14	13/10/14	13/10/14	19/01/2015									
Rack Room Complete	12/09/14	12/09/14	13/11/14	13/11/14	02/02/2015									
North side return yoke installation complete	17/10/14	17/10/14	05/11/14	05/11/14	23/02/2015									
Combined magnet operational tests complete	30/01/15	30/01/15	18/02/15	18/02/15	13/05/2015									
MICE step IV installation complete	30/01/15	30/01/15	25/02/15	25/02/15	04/03/2015									
Step V Top Level Milestones														
LH2 absorber #2 at RAL (KEK)	28/09/12	28/09/15	28/09/15	28/09/15	28/09/15									
AFC#2 ready for installation in MICE Hall	28/10/13	28/10/13	29/10/14	29/10/14	29/10/14									
Amplfier#2 installation complete	26/08/14	26/08/14	26/08/15	26/08/15	26/08/15									
Cavity & RFCC module #1 delivered to RAL	03/01/17	06/03/18	06/03/18	06/03/18	06/03/18									
MICE step V installation complete	26/06/17	28/08/18	28/08/18	28/08/18	28/08/18									
Step VI Top Level Milestones														
Amplifier system #3 Delivered	26/11/15	26/11/15	26/11/16	26/11/16	26/11/16									
Amplifier system #4 Delivered	28/11/17	28/11/17	28/11/17	28/11/17	28/11/17									
FC module #3 at RAL	02/04/18	02/04/18	02/04/18	02/04/18	02/04/18									
Cavity & RFCC module #2 delivered to RAL	26/07/18	06/09/19	06/09/19	06/09/19	06/09/19									
AFC#3 ready for installation in MICE Hall	19/07/18	19/07/18	19/07/18	19/07/18	19/07/18									
Amplfier#3 installation complete	10/12/15	10/12/15	10/12/16	10/12/16	10/12/16									
Amplfier#4 installation complete	08/12/17	08/12/17	08/12/17	08/12/17	08/12/17									
MICE step VI installation complete	03/04/19	14/05/20	14/05/20	14/05/20	14/05/20									

Change since last update	Reduction	Date	No Change	Date	1 - 2 weeks	Date	2 - 4 Weeks	Date	1 -2 months	Date	2+ months	Date	Complete	Date

Dashboard is updated monthly and can be found
http://micewww.pp.rl.ac.uk/dashboard/

Science & Technology Facilities Council

Integration of Step IV

Table 2 can be found on page 5 of the RLSR paper

% Complete	WBS	Task Name	Optimistic Finish	Baseline Finish	Risk Level	Risk Impact
99%	**3**	**Shipping**	**Mon 15/12/14**	**Mon 15/12/14**		
0%	**3.9**	**Return Yoke**	**Mon 15/12/14**	**Mon 15/12/14**		
0%	3.9.1	South side yoke frame steelwork delivered	Tue 15/04/14	Mon 11/08/14	(RISK)-(R2)	Contractor late delivery
0%	3.9.2	South side yoke wall material delivered	Tue 15/04/14	Fri 24/10/14	(RISK)-(R2)	Contractor late delivery
75%	**4**	**Pre Installation Work**	**Mon 18/08/14**	**Fri 29/08/14**		
83%	**4.4**	**AFC#1 Field tests R9**	**Mon 18/08/14**	**Thu 14/08/14**		
92%	4.4.4	Carry out Re-testing of FC#1	Mon 23/06/14	Fri 30/05/14		
0%	4.4.5	AFC installed in R9 ready for field mapping - milestone	Mon 23/06/14	Fri 30/05/14	(RISK)-(R3)	Tesla withdraw from rectification of AFC#1
0%	**4.4.6**	**Field Mapping at full field**	**Mon 11/08/14**	**Wed 06/08/14**		
0%	4.4.6.1	Set-up	Mon 30/06/14	Tue 10/06/14		
0%	4.4.6.2	Mapping	Mon 14/07/14	Mon 30/06/14		
0%	4.4.6.3	AFC #1 field mapping in R9 complete	Mon 14/07/14	Mon 30/06/14		
0%	4.4.6.4	Absorber installation, vacuum leak check, sensor check	Mon 11/08/14	Wed 06/08/14		
0%	**4.4.7**	**Dismantle AFC#1 in R9**	**Mon 18/08/14**	**Thu 14/08/14**		
0%	4.4.7.1	Disconnect all services	Thu 14/08/14	Tue 12/08/14		
0%	4.4.7.2	Transfer to MICE Hall	Mon 18/08/14	Thu 14/08/14		
0%	4.4.7.3	AFC#1 ready for installation in MICE Hall - milestone	Mon 18/08/14	Thu 14/08/14	(RISK)-(R2)	Need working magnet if not for stepIV then stepV
99%	**4.6**	**Tracker Installation - Upstream**	**Wed 21/05/14**	**Wed 21/05/14**		
0%	4.7	Upstream Solenoid & Tracker Assy complete	Wed 04/06/14	Mon 09/06/14	(RISK)-(R4)	Tracker installation may take longer than expected
76%	**5**	**Installation**	**Wed 11/02/15**	**Wed 18/03/15**		
75%	**5.1**	**Infrastructure**	**Fri 23/01/15**	**Thu 19/02/15**		
99%	**5.1.1**	**Mechanical**	**Wed 09/10/13**	**Wed 09/10/13**		
64%	**5.1.3**	**West Wall Mezz & Compressors**	**Tue 16/12/14**	**Mon 19/01/15**		
63%	**5.1.7**	**Electrical & Control System version Jan 2014**	**Fri 23/01/15**	**Thu 19/02/15**		
50%	**5.4**	**MICE Step IV Installation**	**Wed 11/02/15**	**Wed 18/03/15**		
0%	**5.4.5**	**Return Yoke**	**Mon 26/01/15**	**Mon 23/02/15**		
0%	5.4.5.1	Install south side return yoke frame	Fri 29/08/14	Thu 04/09/14		
0%	5.4.5.2	Fit Yoke mount services management	Fri 05/09/14	Mon 15/09/14		
0%	5.4.5.3	Fit South Mezz front edge	Fri 19/09/14	Thu 02/10/14		
0%	5.4.5.4	Fit south side yoke plates	Thu 06/11/14	Wed 12/11/14		
0%	5.4.5.5	South side return yoke installation complete	Thu 06/11/14	Wed 12/11/14	(RISK)-(R4)	Difficulties during installation
0%	5.4.5.6	Install north side return yoke	Mon 26/01/15	Mon 23/02/15		
0%	5.4.5.7	North side return yoke installation complete	Mon 26/01/15	Mon 23/02/15	(RISK)-(R4)	Difficulties during installation
0%	**5.4.6**	**AFC - Focus coil for step IV**	**Wed 11/02/15**	**Wed 18/03/15**		
0%	**5.4.6.1**	**AFC#1 Installation**	**Wed 14/01/15**	**Mon 09/02/15**		
0%	5.4.6.1.1	Installation, survey & alignment of AFC#1	Mon 01/09/14	Wed 03/09/14		
0%	**5.4.7**	**Upstream Spectrometer Solenoid & Tracker Assy**	**Tue 20/01/15**	**Mon 16/02/15**		
0%	5.4.7.1	Install & survey upstream SS & Tracker Assy in Mice Hall	Wed 25/06/14	Wed 07/05/14		
0%	**5.4.8**	**Downstream Spectrometer Solenoid & Tracker Assy**	**Mon 26/01/15**	**Mon 23/02/15**		
0%	5.4.8.1	Install & survey downstream SS & Tracker Assy in Mice Hall	Thu 13/11/14	Fri 21/11/14		
0%	5.4.9	Re-install TOF2, KL, EMR	Mon 02/02/15	Wed 04/03/15		
0%	5.4.10	MICE step IV installation complete	Mon 02/02/15	Wed 04/03/15		
0%	**6**	**Commissioning**	**Mon 18/05/15**	**Thu 23/07/15**		
0%	6.1	Spectrometer Solenoid preparation for latice operation	Mon 09/03/15	Wed 08/04/15	(RISK)-(R2)	Items found to be non operational in field ramping
0%	6.3	Combined magnet operation	Mon 13/04/15	Wed 13/05/15	(RISK)-(R2)	Extended period for training all magnets together - delay stepIV
0%	6.4	Combined magnet operational tests complete - milestone	Mon 13/04/15	Wed 13/05/15		

(RISK)-(R1) Delay 80 days
(RISK)-(R2) Delay 40 days
(RISK)-(R3) Delay 20 days
(RISK)-(R4) Delay 10 days
(RISK)-(R5) Delay 0 days

- Critical path for installation of Step IV
- Baseline schedule includes 35% time contingency.

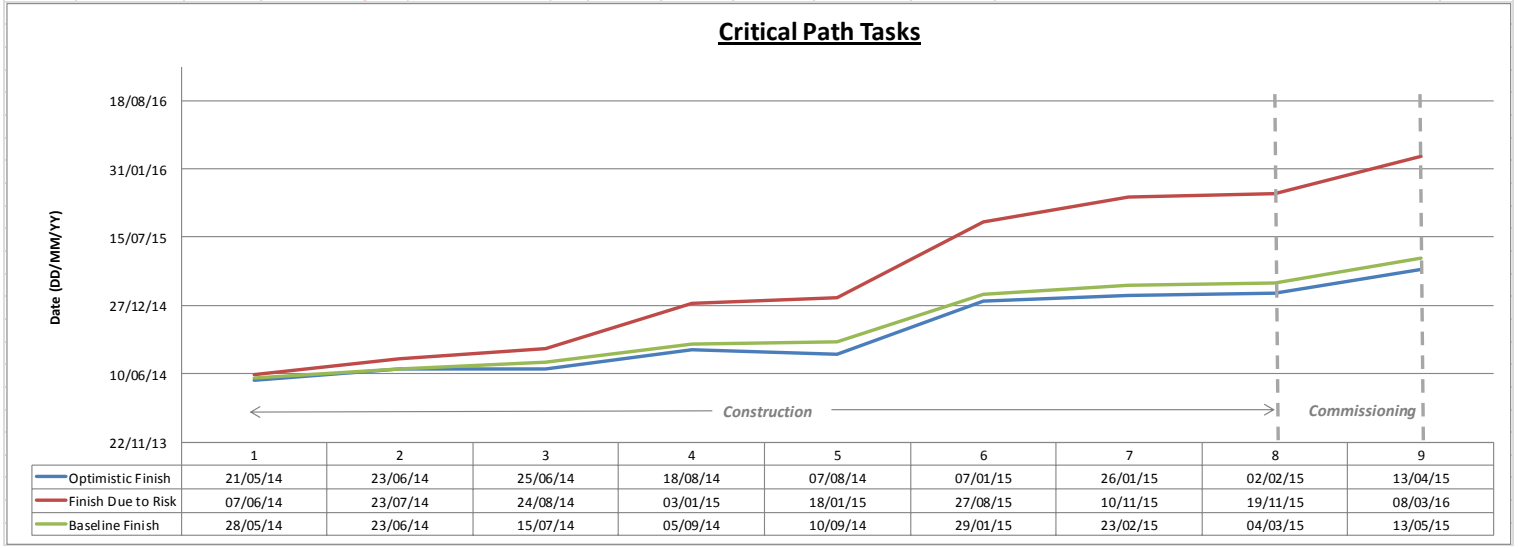
- Commissioning of the magnets now has a more detailed plan.
- Commission both of the Spectrometer Solenoids in an intensive daily operation.
- Commission lattice – unknown but analysis of induced loads and temperatures being investigated

Science & Technology Facilities Council

Integration of Step IV

Figure 1 can be found on page 3 of the RLSR paper

ID	WBS	% Complete	Name	Milestone	Critical	Optimistic Finish	Baseline Finish	Risk Level	Risk Impact	Finish due to Risk
282	5.1.3.4.9	0%	Hall Modifications Complete	Yes	Yes	21/05/14	28/05/14	(RISK)-(R4)	Contractors late making hall mods	07/06/14
92	4.4.5	0%	AFC installed in R9 ready for field mapping - r	Yes	Yes	23/06/14	23/06/14	(RISK)-(R3)	Tesla withdraw from rectification of AFC#1	23/07/14
301	5.1.3.6.7	0%	Sign Off / Complete	Yes	Yes	25/06/14	15/07/14	(RISK)-(R4)	Contractors late completing compressor services	24/08/14
101	4.4.7.3	0%	AFC#1 ready for installation in MICE Hall - mil	Yes	Yes	18/08/14	05/09/14	(RISK)-(R2)	Need working magnet if not for stepIV then stepV	03/01/15
552	5.1.7.5.3.11.8	0%	Compressors - electrically ready	Yes	Yes	07/08/14	10/09/14	(RISK)-(R4)		18/01/15
719	5.1.7.12.14.3.7	0%	Electrical & controls available for AFC#1 MICE	Yes	Yes	07/01/15	29/01/15	(RISK)-(R4)		27/08/15
912	5.4.5.7	0%	North side return yoke installation complete	Yes	Yes	26/01/15	23/02/15	(RISK)-(R4)		10/11/15
944	5.4.10	0%	**MICE step IV installation complete**	Yes	Yes	02/02/15	04/03/15			19/11/15
950	6.4	0%	**Combined magnet operational tests complete**	Yes	Yes	13/04/15	13/05/15			08/03/16



- Illustration of the Baseline evolution
- Risk evolution if ALL risk hit in sequence – not realistic due to constant mitigation actions.
- Specific Construction and Commissioning phases to deepen understanding of when the channel will be available for scientific operations.

Science & Technology Facilities Council

Status of the MICE Construction Project

Interface and Decision Points

Science & Technology Facilities Council

Table 1 can be found on page 3 of the RLSR paper

	Nov-13		Apr-14	
Description	**Delivered**	**Required**	**Delivered**	**Required**
Step IV				
Spectrometer Solenoid 2 Upstream - Complete				
Spectrometer Solenoid 1 Downstream	08-May-14	10-Jan-14	16-May-14	19-May-14
Mapping equipment	03-Jan-14	10-Dec-13	15-May-14	02-Jun-14
Focus Coil 1	03-Oct-14	10-Dec-13	07-Aug-14	12-Nov-14
Liquid Hydrogen A	16-Apr-14	16-Apr-14	09-Feb-14	04-Mar-14
Step IV integration complete	30-Jan-15	29-Jan-15	04-Mar-14	17-Mar-14
Step V and VI				
RFCC 1	06-Mar-18	03-Jan-17	06-Mar-18	03-Jan-17
RFCC 2	06-Sep-19	26-Jul-18	06-Sep-19	26-Jul-18
Liquid Hydrogen B	18-Oct-16	18-Oct-16	18-Oct-16	18-Oct-16
Liquid Hydrogen C	05-Jan-18	05-Jan-18	05-Jan-18	05-Jan-18
LH2 Absorber 2		18-Oct-16	01-Jul-14	18-Oct-16
LH2 Absorber 3		05-Jan-18		05-Jan-18
Focus Coil 2	18-Jan-17	18-Jan-17	18-Jan-17	18-Jan-17
Focus Coil 3	30-Jan-19	30-Jan-19	30-Jan-19	30-Jan-19
Step V integration complete	28-Aug-18		28-Aug-18	
Step VI intergration complete	14-May-20		14-May-20	
Decision Points				
Magnetic Sheilding decision Step IV				
Magnetic Shielding decision Step VI		01-Jun-15		01-Jun-15
Step V and Stop or Step V ahead of Step VI		01-Jun-15		01-Jun-15

- Delivery of the SS#1 underway – arrival in UK scheduled for 30th April.
- Two Focus Coils – decision following tests for which to use and at what level of operation.
  - More detail during the MPB Focus Coil presentation.
- Decisions for advancing to Step VI may be taken out of the hands of the project
  - Information from programme offices, US / UK, in the coming months
  - Removal of RFCC2, Liquid Hydrogen C, Focus Coil 3, LH2 Absorber 3 and two RF systems.
  - More detail of pressures / scenarios in later talks.

Science & Technology Facilities Council

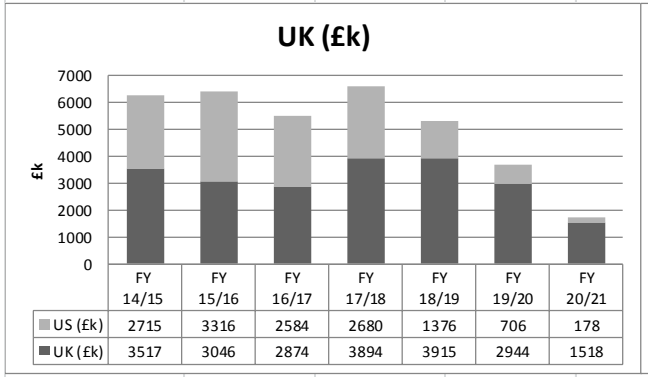
Status of the MICE Construction Project

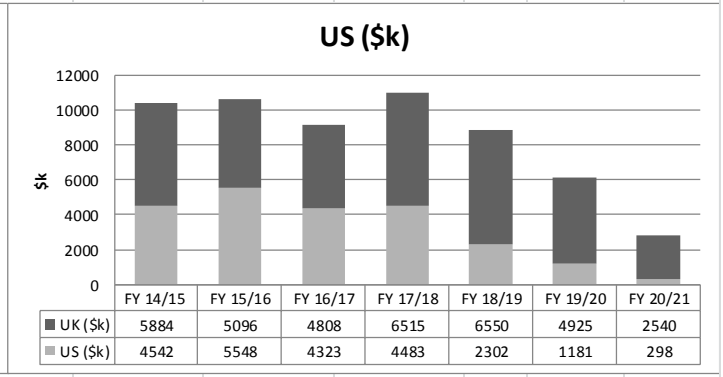
Top Level Financial Summary

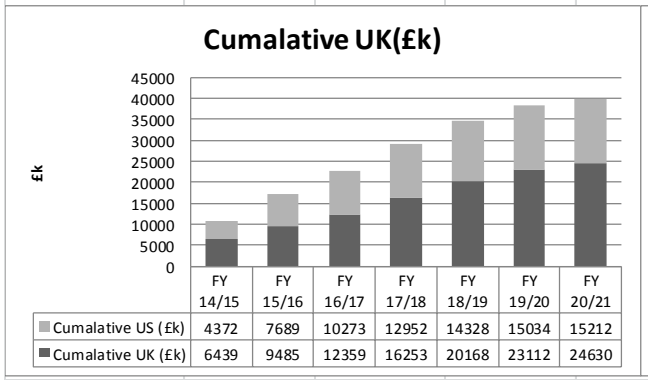
Science & Technology Facilities Council

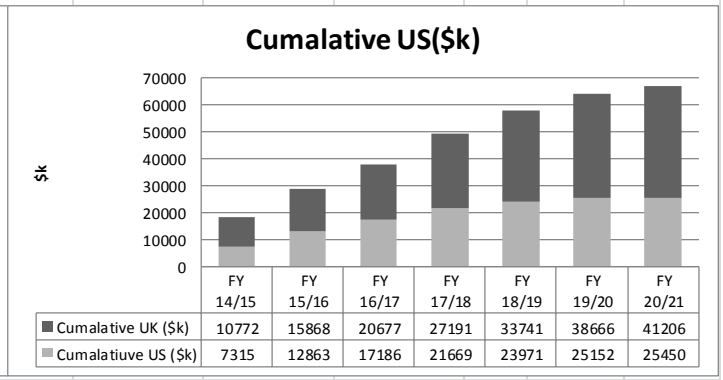
	FY 14/15	FY 15/16	FY 16/17	FY 17/18	FY 18/19	FY 19/20	FY 20/21
UK (£k)	**3517**	**3046**	**2874**	**3894**	**3915**	**2944**	**1518**
Cumalative UK (£k)	**6439**	**9485**	**12359**	**16253**	**20168**	**23112**	**24630**
UK ($k)	*5884*	*5096*	*4808*	*6515*	*6550*	*4925*	*2540*
Cumalative UK ($k)	*10772*	*15868*	*20677*	*27191*	*33741*	*38666*	*41206*
US ($k)	**4542**	**5548**	**4323**	**4483**	**2302**	**1181**	**298**
Cumalatiuve US ($k)	**7315**	**12863**	**17186**	**21669**	**23971**	**25152**	**25450**
US (£k)	*2715*	*3316*	*2584*	*2680*	*1376*	*706*	*178*
Cumalative US (£k)	*4372*	*7689*	*10273*	*12952*	*14328*	*15034*	*15212*

Exchange rates	
UK - US	1.673
US- UK	0.598









- Spend profile according to the current understanding of advancing to Step VI
- *Delivery of RFCC#1 FY 17/18 – MTA magnet would move the spend profile*

Figure 3 can be found on page 8 of the RLSR paper

Science & Technology Facilities Council

Status of the MICE Construction Project

Top Level Risk Summary

Science & Technology Facilities Council

Inability to recruit a full operations team in time to begin Step IV operations.	Delays to Step IV operations (3-6 months)	4	4	16	MICE - UK	Discussions with the ISIS operations team have progressed and a direction for supply of operational cover has been layed out.	2	4	8	Operations team construction under way. RF, Cryogenic and Operational manager posts filled. Additional operational resource will come from ISIS operational teams.	3		RETIRED

- ISIS operations team has been agreed.

Extended period of re-training for the lattice of magnets for Step IV - SS1/AFC/SS2.	Timescales for the training period, cost of the amount of LHe required to carry out the training the avaiability of the Lhe. Expert personnel required to be available for magnet operations over a pretracted period of time.	4	5	20	MICE-UK / MAP	Discussions with BOC (or suplier) to agree delivery timescales and availablity during heavy use periods. Magnet integration task force to define commisioning method to keep schedule and cost to a minimum.	4	4	16	Each re-cool and fill of the Spectrometer Soenoid can take upto 500l LHe, AFC around 100L. Each full lattice quench could cost in the region of £7K. Initial investigations with BOC show that the predicted amount of LHe will be available during the commisioning period.	1	100	End step IV

- Commissioning of the lattice is an un-known entity
  - Logistics of having large quantities of LHe on hand – Interaction with BOC
  - Number of people to carry out an intensive period – expert knowledge (SS and FC)
  - Interaction of the magnets – Loads and Cold mass inductive heating causing quench of whole channel.

AFC Module #2 has the same type of fault as AFC module #1	Extended delay and uncertain cost burden.	4	5	20	MICE - UK	Bring forward test of module #2. Shorter timescale for training runs. Purchase of additional Lhe if required to shorten timescale	4	5	20	During testing of Module #2 a thermal heat leak was found. It has now been rectified and will be back on the test stand at RAL during May 14. Testing of the magnet will continue.	0.2	15	Oct-14

- Not reaching acceptance criteria
  - Run at de-rated current
  - Impact on the operational current for Step V – re-working of magnets will be required

Magnetic field effecting operation of electrical equipment relating to the continued operation of the cooling channel magnet systems and detectors.	Inability to operate the cooling channel	5	5	25	MICE - UK / MAP	Installation of a partial return yoke has mitigated the major risk. Movement of the control and power supply equipment to a dedicated room outside of the magnetic field.	1	4	4	Much work has been completed and provision of additional rack room has enabled the majority of the sensetive equipment to be moved away from the hall. The PRY has not yet been installed and so has not been tested, the residual risk still applies. Significant investment from UK and US to mitigate risk.	5	500k	End of project

- Low level risk of an un-known electronic / electrical item

Science & Technology Facilities Council

Status of the MICE Construction Project

Response to recommendations

Science & Technology Facilities Council

1. *Complete the first action from the previous meeting. While the panel appreciates the work to date it feels there is a need for more coherence between the two side, especially embedding of risk-contingency into schedule.*
2. *Produce a coherent single project plan that takes into account the schedule above by the next meeting.*

- I feel the recommendations have been answered during the previous slides.
- The interaction points are well known - shipping, magnet training periods
- Updates and discussion of the schedule, and risks, are discussed in the MIPO meetings held every two weeks

- *Identify known technical issues that may affect the schedule for MICE termination at Step IV, Step V and at Step VI*

Stop at Step IV	Stop at Step V
Release the construction team End of FY 14/15	Focus Coil #3 – no longer required Require both FC#1 and FC#2 to be operational at acceptance criteria.
PRY design and manufacture removed	LH2 system #3 – No longer needed
LH2 system #2 procurement – No longer needed	Additional design and procurement for PRY Changes to current infrastructure to accommodate larger PRY
RF amplifier system #2 commissioning and installation – No longer needed	RFCC #2 winding, testing and cryostat – not required
RFCC Magnet – No shipping or installation	
No need to fix FC#1 / #2	
A great deal of investment made for Step V operational equipment *RF equipment* *Focus Coil #2* *Absorber #2* *RF Cavities*	
Zero benefit could be gained from the investment so far	
Physics deliverable insufficient to support serious development of future technologies	
Nearly all investment made would be wasted	