Plan for MICE During ISIS User Run 2016/2

Change History

Version	Changes	Author	Date
1	First draft	C. Rogers	02/06/2016
2	More detail; settings for standalone magnet alignment.	C. Rogers	29/06/2016
3			
4			
5			

DRAFT

1 ISIS User Run 2016/2

During ISIS user run 2016/2, MICE intends to commission the magnet channel in beam and, if time permits, begin “empty absorber” physics runs.

1.1 ISIS User Run Dates

The most up-to-date ISIS run plans are available from [ISIS Beam Status]. MICE is not expected to operate in any machine physics period.

User run cycle	**Start**	**End**	**Maintenance day**
Run-Up for 2016/02	Monday 13 June	Sunday 26 June	
2016/02	Tuesday 28 June	Friday 29 July	Wednesday 13 July
Machine Physics	Friday 29 July	Sunday 31 July	
Run-Up for 2016/03	Monday 29 August	Sunday 11 Sept	

Table 1: ISIS schedule

1.2 Magnet Hardware Commissioning

The MICE magnet commissioning plan is planned to take at least the first week of user run 2016/02, and possibly the second week as well. The operations team expect to have no availability for running during the day time in the first week; evening (one shift) availability in the second week of the user run; and night (two shift) availability in the third week of the user run. So about 60 shifts.

1.3 Expected Data Rate and Trigger

ISIS is expected to be operational at 800 MeV. The target is expected to dip at 50/64 Hz at a maximum 2 Vms. The Decay Solenoid (DS) is expected to be operational. The beamline will be operated in a “pionic” mode, such that the beam has a large sample of pions. MICE will seek to demonstrate pion rejection at the required level during this user run.

2 Detector Calibration and Alignment

The TOF detector requires a regular recalibration. The PID detectors have been moved and hence will require realignment. Two shifts are reserved for this, with an additional shift of contingency.

2.1 TOF Calibration

Measurement Coordinator: Durga Rajaram

TOF calibration is a standard procedure. About half a shift can be reserved for this.

2.2 TOF Rate Studies

Measurement Coordinator: Antonio? Maurizio?

The beam rate is likely to be higher from the pion running, and this can introduce a systematic into the TOF measurement. It would need some beam time to understand this issue. How much time? Say 4 shifts + 2 contingency?

2.3 Detector Alignment

Measurement Coordinator: Francois Drielsma

The detector alignment has been performed twice during previous runs. See, for example, the shift plans for 23rd and 24th February 2016. 1000k TOF1 triggers were requested at 300 MeV/c in pion mode, 250k TOF1 triggers at 200 MeV/c muon mode and 250k TOF1 triggers at 400 MeV/c in pion mode. Rates were 100k triggers per hour at 300 MeV/c in pion mode and 10k triggers per hour at 200 and 400 MeV/c, running without DS. The 400 MeV/c run was poorly aligned, indicating a slight mismatch in the dipole currents.

In the light of the results on beam purity using a pion beam, for this user run it is planned to do the alignment using pions only. Three runs are requested at 200, 300 and 400 MeV/c with 1000k TOF1 triggers for each. The 400 MeV/c run should be performed with a better matching in the dipoles. the Assuming a factor 3 improvement in rate with DS, we require 3 hours at each setting (1 shift). An additional 8 hour shift is foreseen to enable optimisation of the 400 MeV/c setting. MICE may require an accelerator expert on shift to perform this optimisation.

3 Beamline Commissioning

Measurement Coordinator: Jaroslaw Pasternak? Paolo Franchini?

Discussion with Paolo: Run with every setting; compare with G4BL; evaluate pion contamination (requires at least SSU); play with quad currents?

3.1 Diffuser Settings

Run 200 MeV/c beamline with SSU powered. Close each of the irises in turn, keeping quads and dipole constant. Look at the resultant beam distributions and momenta. Say 2 hours at each setting (few 100k events at each setting). 4 irises plus one empty – say 1.5 shifts

1.5 shifts including contingency

3.2 Proton Absorber

2 shifts

4 Magnetic Module Beam-Based Alignment

Measurement Coordinator: Chris Rogers

The magnet module alignment will be measured by running each of the magnets in positive and negative polarity. The alignments are assumed to be independent of the individual coil currents (e.g. motion due to forces are negligible).

Setting	E2	CC	E1	M2	M1	FC	FC	M1	M2	E1	CC	E2
4.1	189.50	205.50	175.50	0.00	190.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	175.50	205.50	189.50
4.3	0.00	0.00	0.00	0.00	0.00	50.00	50.00	0.00	0.00	0.00	0.00	0.00
4.4	0.00	0.00	0.00	0.00	0.00	100.00	-100.00	0.00	0.00	0.00	0.00	0.00

Table 2: Run settings for standalone module alignment. *Trim coils need trimming*

4.1 FC alignment

The focus coil can be aligned in solenoid mode and flip mode. In flip mode, the optics is approximately uncoupled between x and y. Less current is required in solenoid mode. The relative sensitivities to different misalignments (positional, tilt) is likely to be different. The alignment procedure will be performed in both settings.

Flip mode alignment took 3-4 shifts, without decay solenoid. However, the statistics collected was a bit below desired. Assume 2 shifts with Decay Solenoid for each of flip and solenoid mode, i.e. 4 shifts + 1.5 contingency.

4.2 SSU and SSD alignment

SSU and SSD alignment will proceed in a couple of ways; the magnet alignment to the tracker inside will be deduced by examining the trajectories of tracks in the tracker; and also by examining the trajectories of tracks between both trackers and the TOFs.

The match coils will be set up to yield a good transmission; the ECE coils will be set up to yield sufficient field for the tracker reconstruction to work. The solenoids will be operated in positive and negative polarities to provide systematics reduction.

As per FC alignment, guess 2 shifts for each of SSU and SSD i.e. 4 shifts + 1.5 contingency

Setting	E2	CC	E1	M2	M1	FC	FC	M1	M2	E1	CC	E2
1	192.45	211.26	187.11	0.00	0.00	55.98	55.98	0.00	0.00	132.95	150.11	136.74

Table 3: Coil currents [A] for full magnetic lattice validation with no match coils powered. ***ECE downstream is too low… trims need trimming… FC needs some optimisation***

What match coil currents?

5 Full Magnetic Lattice and Optics Validation

Measurement Coordinator: Ao Liu

Once the magnets have been commissioned independently, commissioning will begin in concert. Initially, it is planned to run a magnetic which has not-too-demanding currents, good reconstruction performance and good transmission.

Setting	E2	CC	E1	M2	M1	FC	FC	M1	M2	E1	CC	E2
1	192.45	211.26	187.11	236.83	135.21	55.98	55.98	0.00	0.00	132.95	150.11	136.74

Table 4: Coil currents [A] for full magnetic lattice validation with M2U and M1U powered. ***M2U is too high; ECE downstream is too low… trims need trimming***

5.1 No match Coils

Initially the coils will be run with no match coils powered, in order to minimise coupling between the magnets. The optics performance of the cooling magnets will be checked. The spectrometer solenoids will be operated with currents corresponding to 3 T.

Assume 50 % transmission; say we go with 4 settings on each coil pack with half a shift on each setting; we don't need “good muons”, rather just some throughput; say 300k TOF1 triggers per hour, of which 70k to 80k are transmitted muons; if we require 100k muons per setting, say 4 settings per shift – 3 shifts?

5.2 M1U, M2U powered

Now we can power M1U and M2U. We will not power M2D yet. The spectrometer solenoids will be again operated with currents corresponding to 3 T. It may be worth checking in a bit more detail the response of the modules. Say we scan on a coil-by-coil basis now, 4 settings on each coil - 7 shifts?

5.3 Dynamic Aperture Check

Measurement Coordinator: Tanaz Mohayai

One of the issues troubling for MICE is non-linear emittance growth and dynamic aperture issues. We would like to excite the emittance growth and check that we can predict the resultant behaviour.

Assume 1-2 shifts; settings TBD.

6 Zero Absorber Data

The above data will complete commissioning of the cooling channel magnets. Assuming all is good, the next step is to take zero absorber data.

6.1 Material Physics Settings

Measurement Coordinator (energy loss): Scott Wilbur

Measurement Coordinator (scattering): ?

It is desired to perform Lithium Hydride scattering measurements at 140 MeV/c, 172 MeV/c, 200 MeV/c and 240 MeV/c, with field on, to provide a complementary measurement to the “field off measurements” that were performed in Feb-March of this year. It is also desired to perform energy

Setting	E2	CC	E1	M2	M1	FC	FC	M1	M2	E1	CC	E2	Notes
6.2.1	179.79	197.37	174.80	80.00	158.14	172.05	-172.05	0.00	0.00	-137.87	-155.67	-141.81	Flip 140
6.2.2	177.26	194.59	172.34	125.73	133.93	88.85	-88.85	0.00	0.00	-125.56	-141.77	-129.15	Flip 200
6.2.3	164.60	180.69	160.03	172.39	242.20	56.15	56.15	0.00	0.00	140.33	158.45	144.34	Sol 140
6.2.4	192.45	211.26	187.11	236.83	135.21	55.98	55.98	0.00	0.00	132.95	150.11	136.74	Sol 200
6.2.5	164.60	180.69	160.03	158.43	132.32	64.11	64.11	0.00	0.00	140.33	158.45	144.34	Sol 240

Table 5: Cooling settings for empty absorber runs without M2D. Need a flip 240? Assume we don't modify settings to account for no energy loss in the absorber.

loss measurements in a similar regime. It is noted that minimum ionising for the MICE lithium hydride absorber is around 400-500 MeV; measurements in this range would be of interest but it may be not possible to get a good rate at this energy with reasonable resolutions.

Optics settings would be for good resolution in the tracker region (>= 3 T) with FC and match coils optimised for transmission – probably compatible with the "Optics validation" settings above. Assume 1 shift per setting? => 8 shifts.

Need channel settings

6.2 Cooling Settings

Measurement Coordinator: Chris Rogers?

We would also like to take an empty data set for the channel with ionisation cooling settings, in order to provide a baseline data set for data that can be analysed with the absorber installed during subsequent data runs. For each cooling channel optics settings, we would like to set the beamline for three different emittances (historically we aim for 3 mm, 6 mm and 10 mm emittances).

Quote Steve Boyd CM44 talk – 3 days = 6 shifts per setting; factor 3 improvement from pionic beamline makes this 2 shifts per setting; 15 settings => 30 shifts including contingency, so say 20 + 10 shifts.

7 Summary of Required Data

Task	**Number of 8 hour Shifts**	**Contingency**
Detector calibration and alignment	6	3
Beamline commissioning	10	3
Magnet alignment	8	3
Baseline magnetic lattice	10	3
Dynamic Aperture Check	2	1
Material physics settings	8	4
Cooling settings, if time	20	10
Total	**64/60**	**91/60**

Table 6: Expected shift requirement for data taking.

8 Bibliography

[ISIS Beam Status] outline schedule available at http://www.isis.stfc.ac.uk/beam-status/

[Magnet and Beam Commissioning at Step IV] Magnet and beam commissioning plan is at http://micewww.pp.rl.ac.uk/documents/96

[2014-06-29 Run] A sample Cerenkov commissioning and TOF calibration run plan is available at http://micewww.pp.rl.ac.uk/projects/operations/wiki/RunPlan20140629

[Rogers CM41 Talk] An order of magnitude estimate of transverse kick due to residual fields is

given at https://indico.cern.ch/event/360388/session/0/contribution/44/material/slides/1.pdf