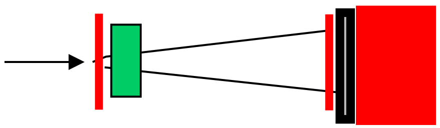
RLSR November 2013

Alain Blondel

Provisional MICE SCHEDULE
update: May 2013

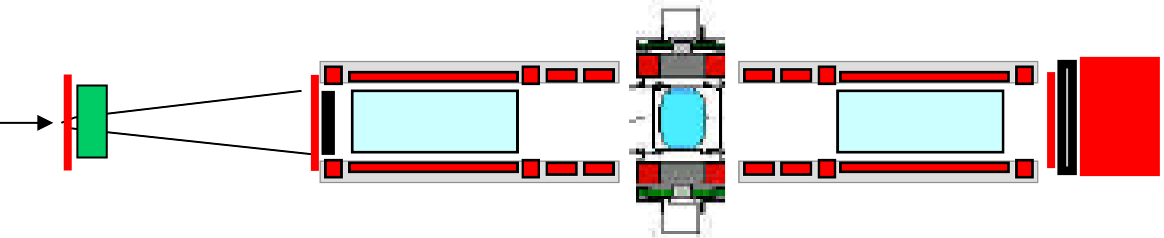
μ

Run date:



STEP I

EMR run July 2013

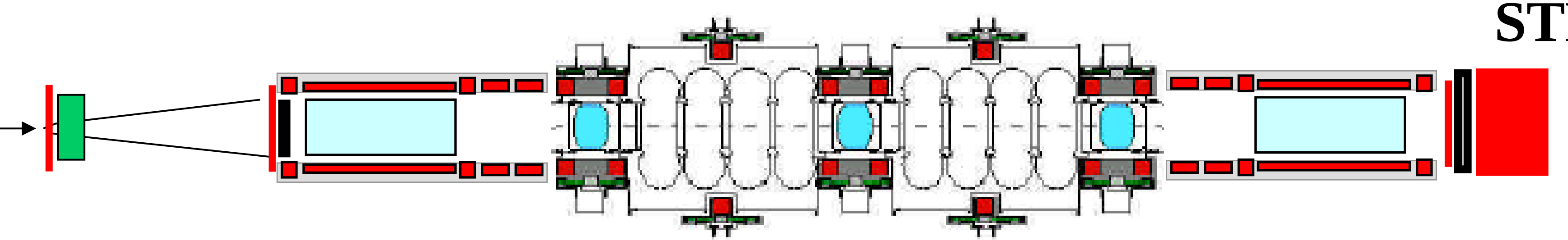


STEP IV

(Q2 2014, no field)
Q1 2015 to Q1 2016

Under construction:

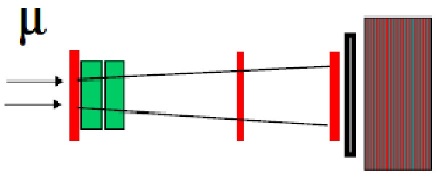
STEP VI



Possible Step V run Q4 2017
Step VI 2019

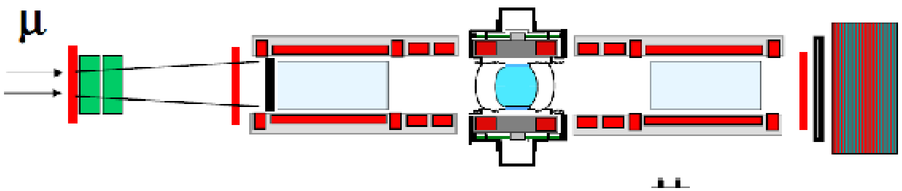
Provisional MICE SCHEDULE update: November 2013

Begin Run date:



STEP I

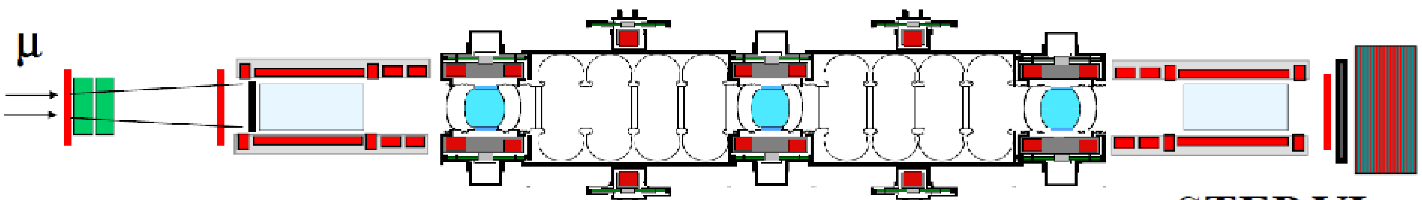
EMR run Oct 2013 done



STEP IV

(possibly : w/o field July14)
Q1/Q3 2015 to Q1/Q4 2016

possible Step V
Q3 2018/Q2 2019



STEP VI

Step VI
Q2 2020/Q1 2021

best case / worst case

A lot has happened in the last few months!

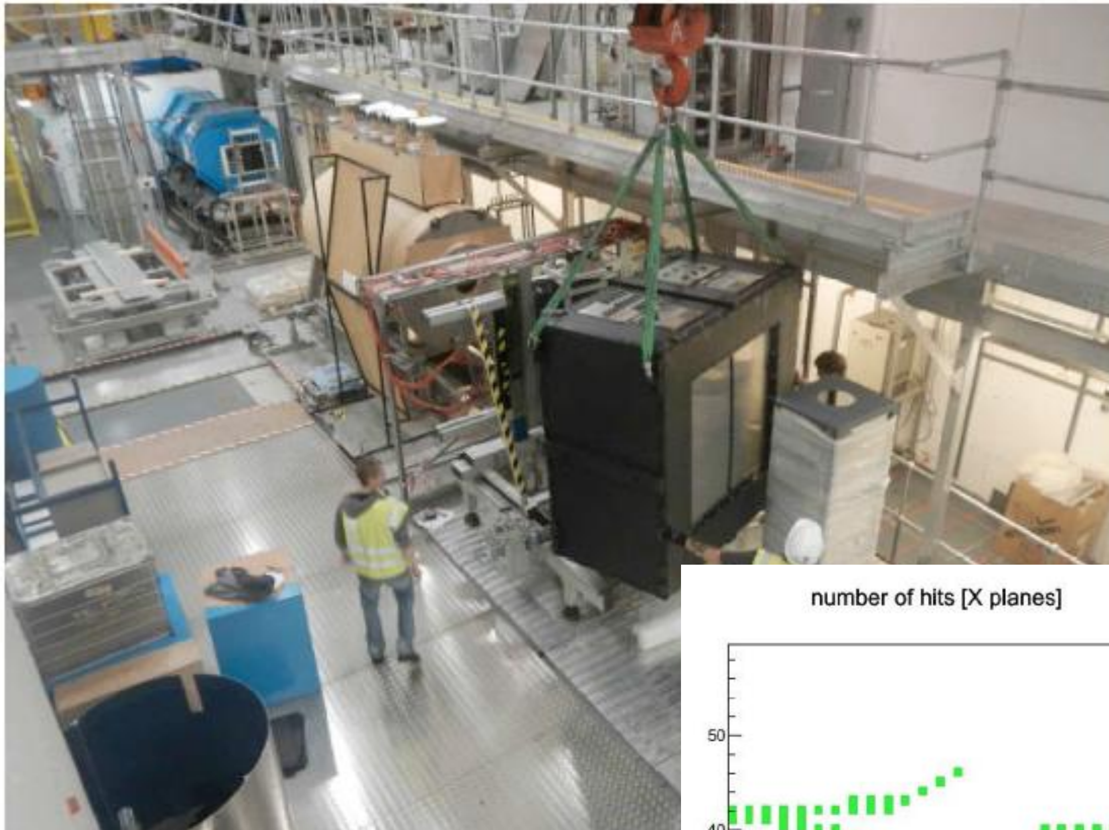
Have arrived at RAL:

-- RF amplifier
-- 11 crates of RF equipement from U-Miss
-- The EMR and all its kit
-- the Upstream Spectrometer Solenoid (USS) (aka SS2)
-- the AFC2

+ we have carried out the EMR run with beautiful results ➔
(and with all available detectors included in the DAQ)

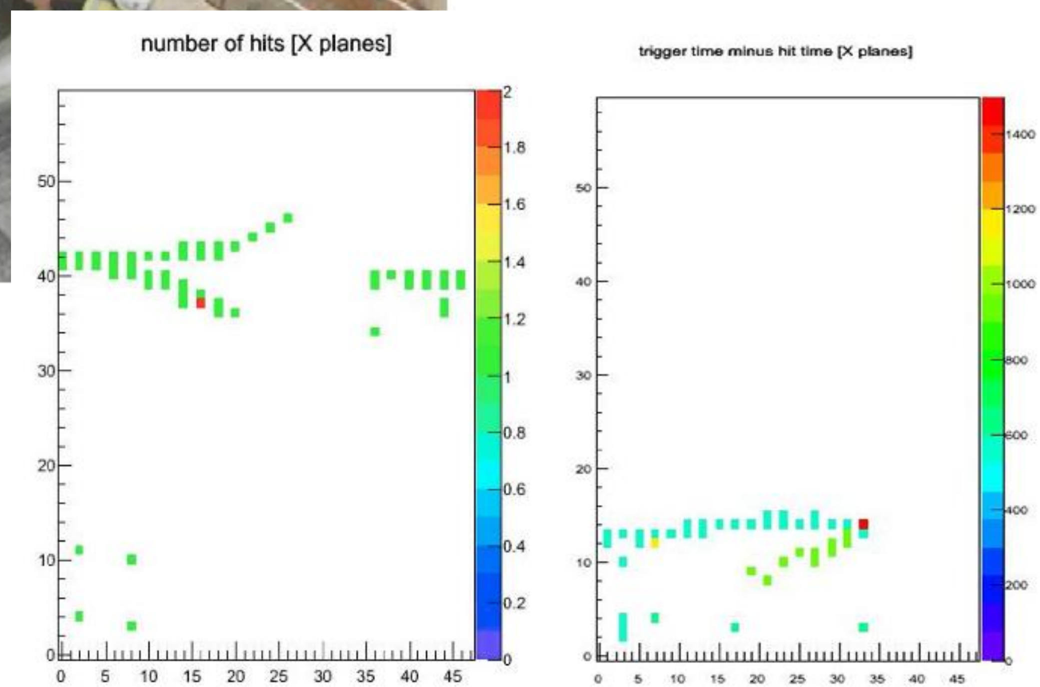
+ we have decided on the field mitigation strategy and passed a review.

+ our paper on emittance measurement of the MICE beam with TOFs is published.



EMR run took place
4 week-ends
Thursday 13:00 to Monday night

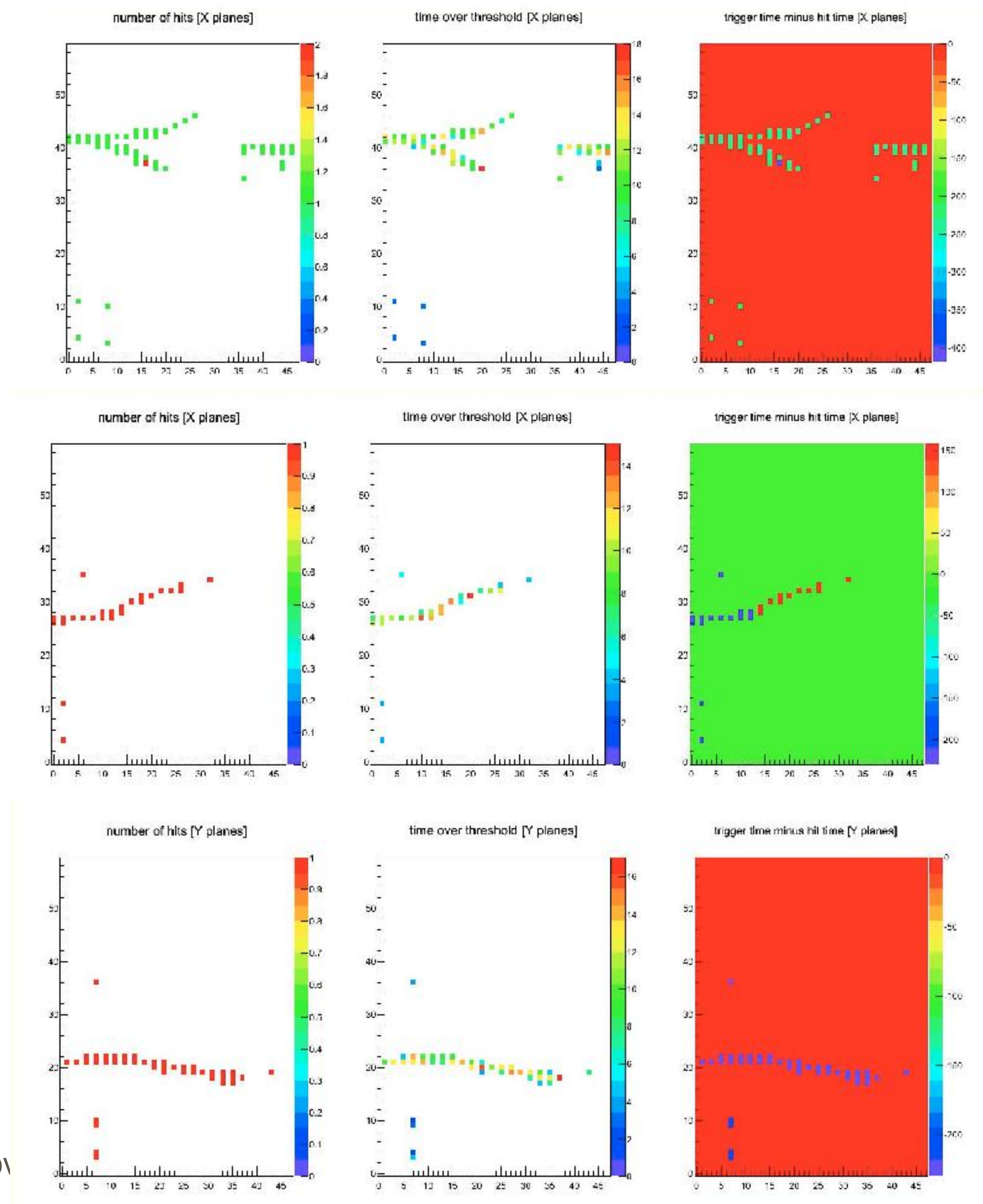
MOM: Ryan Bayes



e^-

μ^-

π^-



number of hits [X planes]
time over threshold [X planes]
trigger time minus hit time [X planes]
number of hits [X planes]
time over threshold [X planes]
trigger time minus hit time [X planes]
number of hits [Y planes]
time over threshold [Y planes]
trigger time minus hit time [Y planes]

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The European Physical Journal C
October 2013, 73:2582,
Open Access

Characterisation of the muon beams for the Muon Ionisation Cooling Experiment

D. Adams, D. Adey, A. Alekou, M. Apollonio, R. Asfandiyarov, J. Back, G. Barber, P. Barclay, A. de Bari, R. Bayes, ... show all 146

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Abstract

A novel single-particle technique to measure emittance has been developed and used to characterise seventeen different muon beams for the Muon Ionisation Cooling Experiment (MICE). The muon beams, whose mean momenta vary from 171 to 281 MeV/*c*, have emittances of approximately 1.2–2.3 π mm-rad horizontally and 0.6–1.0 π mm-rad vertically, a horizontal dispersion of 90–190 mm and momentum spreads of about 25 MeV/*c*. There is reasonable agreement between the measured parameters of the beams and the results of simulations. The beams are found to meet the requirements of MICE.

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Within this Article

» Introduction
» The MICE Experiment
» Characterising the MICE beams
» Results of the measurements and comparison with simulations

Magnetic shielding review panel endorsed MICE proposal... with caveats:

Recommendations

- The committee endorses the strategy of improving the shielding prior to installation of Step IV to avoid the risk of losing beam time due to having to shield individual items.
- The concept of the Partial Return Yoke is sound, and it should perform as required, but some simplification may be possible, and it must be verified that the new shielding does not increase the risk of failure of a magnet.
- FE modelling should continue with the accent on providing information for the specification of the magnetic characteristics and tolerances of the steel shiel... components, and on the conceptual shielding for Step VI.
- RAL should consider building a platform on the north side of ... plate on the "weak" concrete, partially supported o...) so that the shielding support structure can be identi...
- The design should be modified to ma... e target and access the magnets (e.g. to fix a leak), w... the mezzanine extension.
- It should be verified t... rchased is compatible with the shielding for Step VI. T... a conceptual design of the shielding for Step VI.
- A com... hould be devised to ensure personnel safety when the ... on, and to test that PRY performance is as predicted by the models.
- ...ed for Step IV should be validated and used to bench-mark the ...ons, so as to refine the result of modelling for the design of the PRY for Step VI.
- ...n order to converge rapidly on the final design for Step IV it is recommended that Steve Plate (BNL) spend a week with the engineers at RAL.
- A close watch should be kept on the schedule.

Principle has been reviewed and decided.
next steps : implementation, while taking into account comments of review panel
➔ towards PRReview

Changes

1. New spokesperson : Ken Long

We are working together to ensure a smooth transition.

ABlondel will be Collaboration Board chair for next two years.

2. Project manager will now be Roy Preece

Andy Nichols will continue as Project Engineer

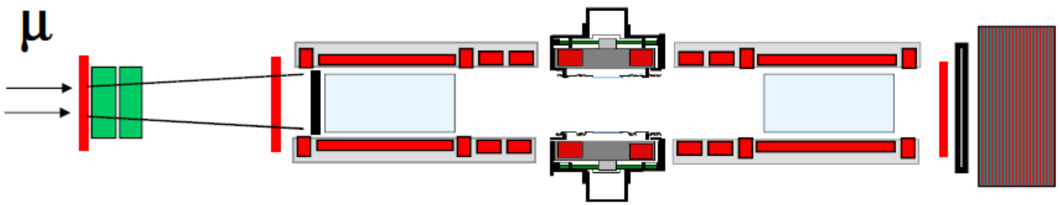
3. Linda Coney has moved on

-- Ian Taylor is now the head of the online group

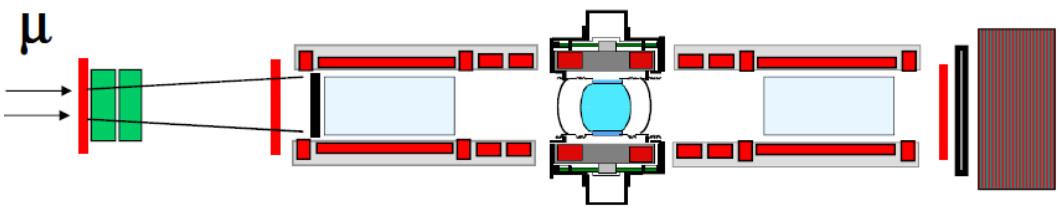
-- new MICE Operations Coordinator will be needed

LOOKING FORWARD TO STEP IV

STEP IV EXPERIMENTS (2015-2016)

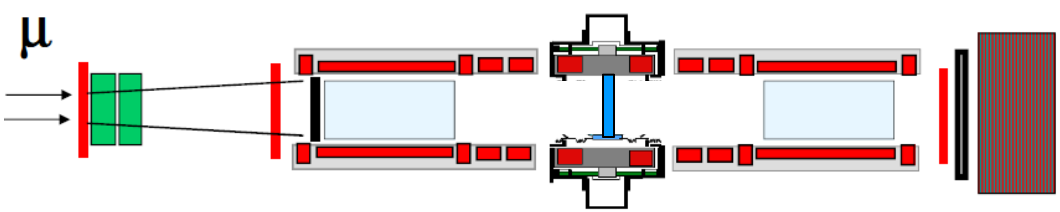


STEP IV No or empty absorber
Alignment
Optics studies

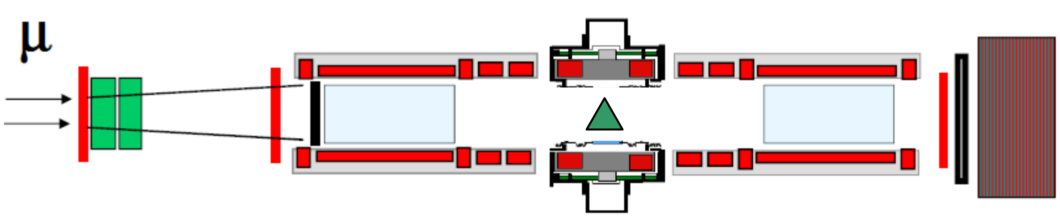


STEP IV Liq H_2 absorber (full/empty)

Multiple scattering
Energy loss
➔ Cooling



STEP IV Solid absorber(s)
LiH
Plastic
C, Al, Cu



STEP IV LiH Wedge absorber
Emittance exchange

MICE-Note-Gen-432
October 2013
Alain Blondel

Criteria for successful experiment at Step IV

MPB (May 2013): Establish a set of criteria for the demonstration of the successful conclusion of Step IV.

Summary:

The criteria for the demonstration of the successful conclusion of Step **IV** can be listed as follows.

- Successful operation the cooling channel and of the instrumentation, of its controls and monitoring, and of the system designed to deliver the data and to record them.
- Ability to provide before data taking: operational online reconstruction, standard calibration procedures and simulation of the experiments.
- Ability to execute a data taking campaign leading to the following results:
    - Demonstration of transmission and emittance measurements to required precision of 10^{-3}
    - Demonstration of the reduction of particle amplitudes and beam emittance of a μ^+ beam, for a nominal setting of {momentum, beta function at the absorber, input emittance}, in both “flip mode” and “solenoid mode”, and for one of the minimal set of absorbers: Liquid Hydrogen, LiH, plastic. (At present this nominal setting is 200 MeV/c, 42cm, 6mm emittance).
    - As a consequence, demonstrate that one can increase the number of muons within a given $\{r\text{-}p_{\perp}\}$ acceptance by ionisation cooling.
    - As a by-product, correlated measurements of multiple scattering and energy loss as function of momentum will be performed.
    - For each of the absorber materials the extraction of equilibrium emittance will be achieved by varying the input beam emittance.
    - Further exploration of a {3x3} matrix of momentum (up to 240 MeV/c) and beta functions (down to the minimal achievable) for each of the absorber materials.
    - If rates and time permit repeat measurements for negative beam polarity.
- Results will be published.

The following provides more details on the run plan and on the criteria for success.

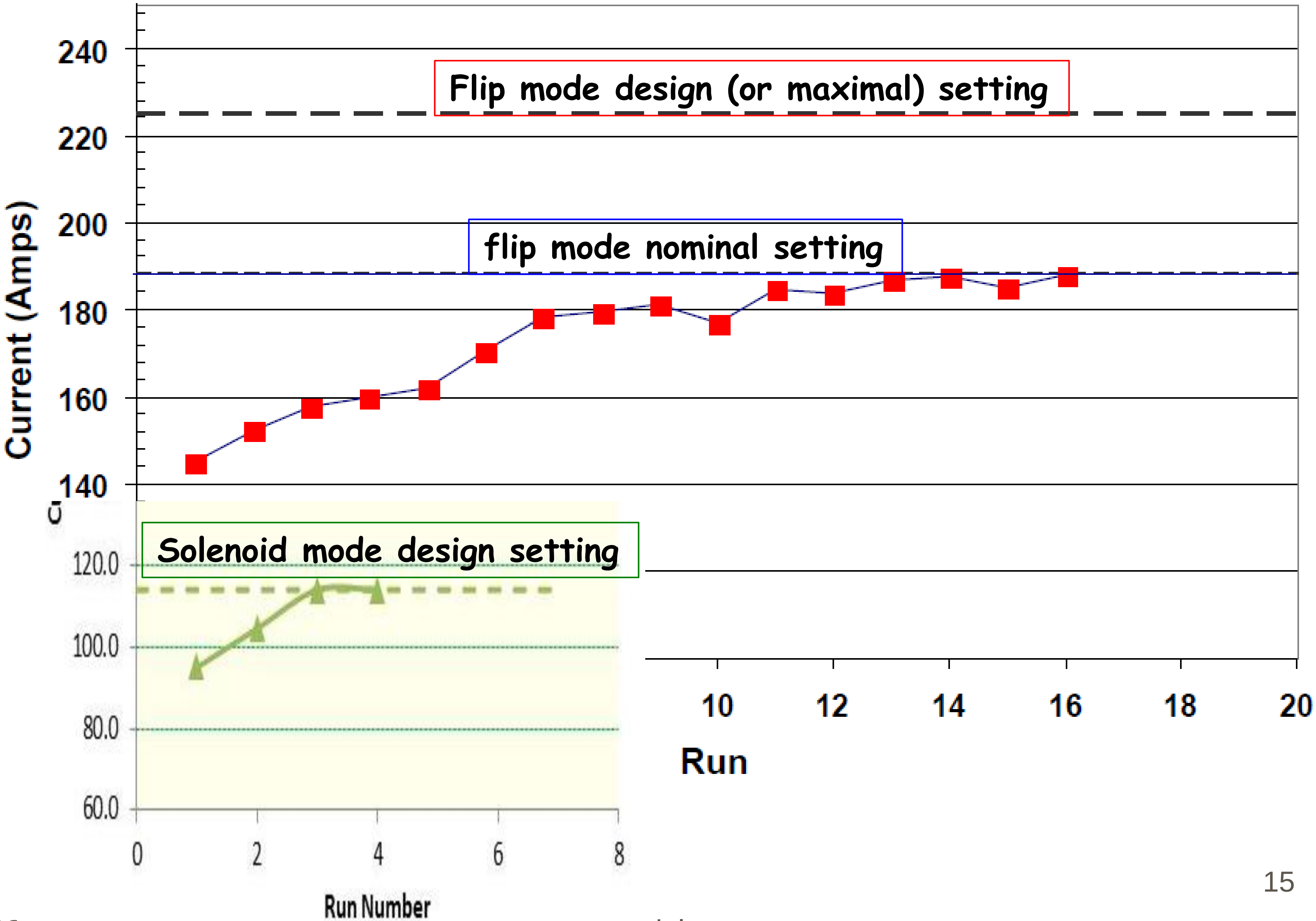
HOWEVER ... a lot will depend on what the magnets can deliver
we will know only when the beamline is assembled

the Upstream Spectrometer Solenoid USS (SS2) was tested and passed for all requested curents.

AFC1 passed for the maximum requested current in «solenoid mode», but not in «flip mode» where the 'nominal setting' (center of 3x3 matrix) is barely achieved.

Situation may be worse (or better) when all magnet are powered in step IV configuration.

FC 1 TRAINING



Effect of reduced focus coil current on MICE steps IV and VI

MICE Note 434

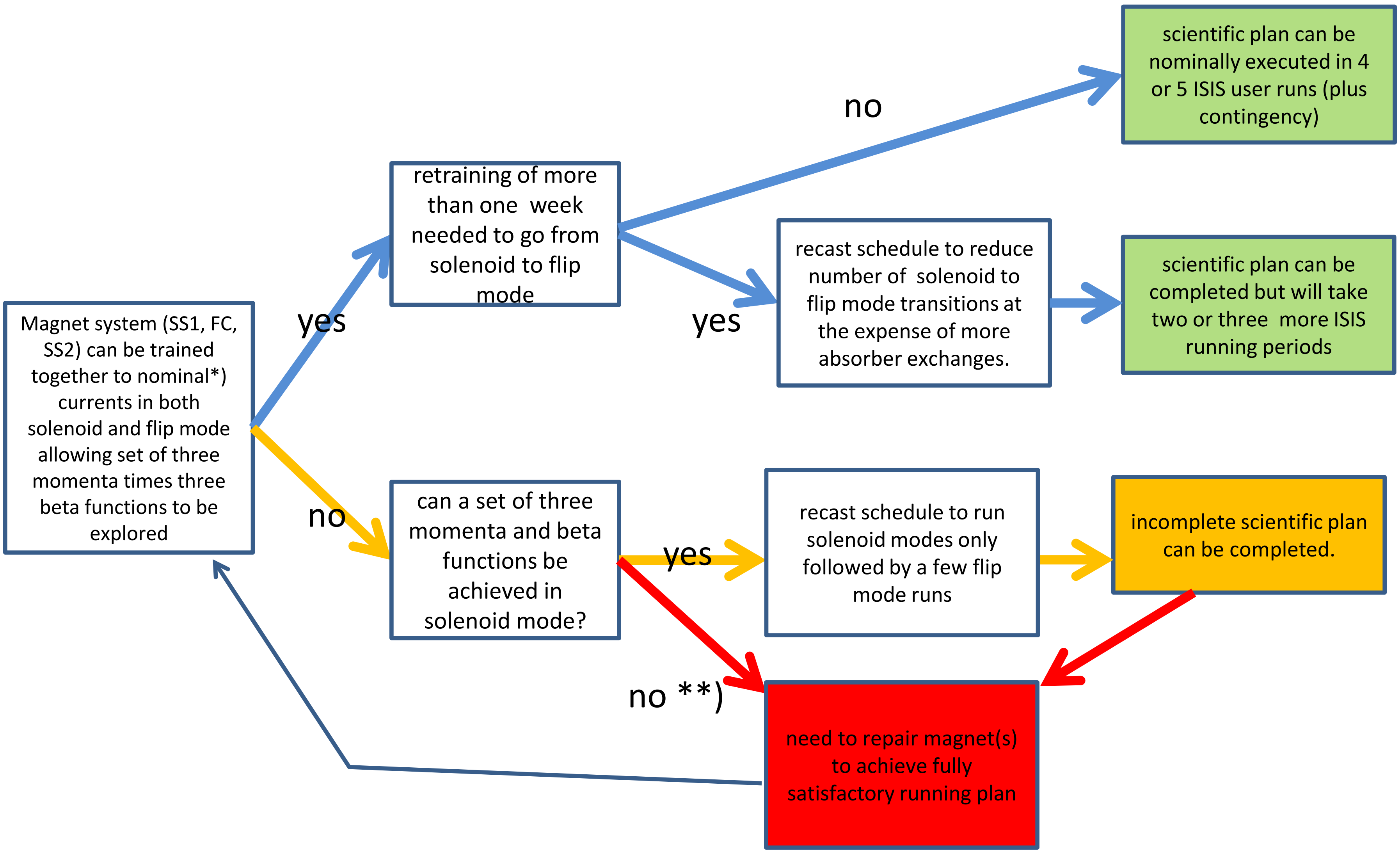
C. T. Rogers

Abstract

During the commissioning of MICE focus coil 1, it was found that the focus coil failed to reach the specified currents. In particular, the focus coil failed to reach the current required for nominal running at 200 MeV/c, considered to be the MICE baseline. In this note, the consequences of operating the focus coil with reduced current are studied.

Momentum	Focus coil current [A/mm^2]		
MeV/c	102.56	113.95	136.74
140	104-332, 700-925	75-252, 456-979	32-92, 269-849
160	146-365	116-298	64-168, 469-601
180	186-407	155-342	100-229
200	224-450	192-385	136-278
220	257-493	226-425	169-319
240	356-535	306-463	215-356

Tab. 2: Range of matched β functions [mm] that can be achieved for different momenta and focus coil currents. Note that for low momentum settings there are two distinct β ranges that can be accessed.

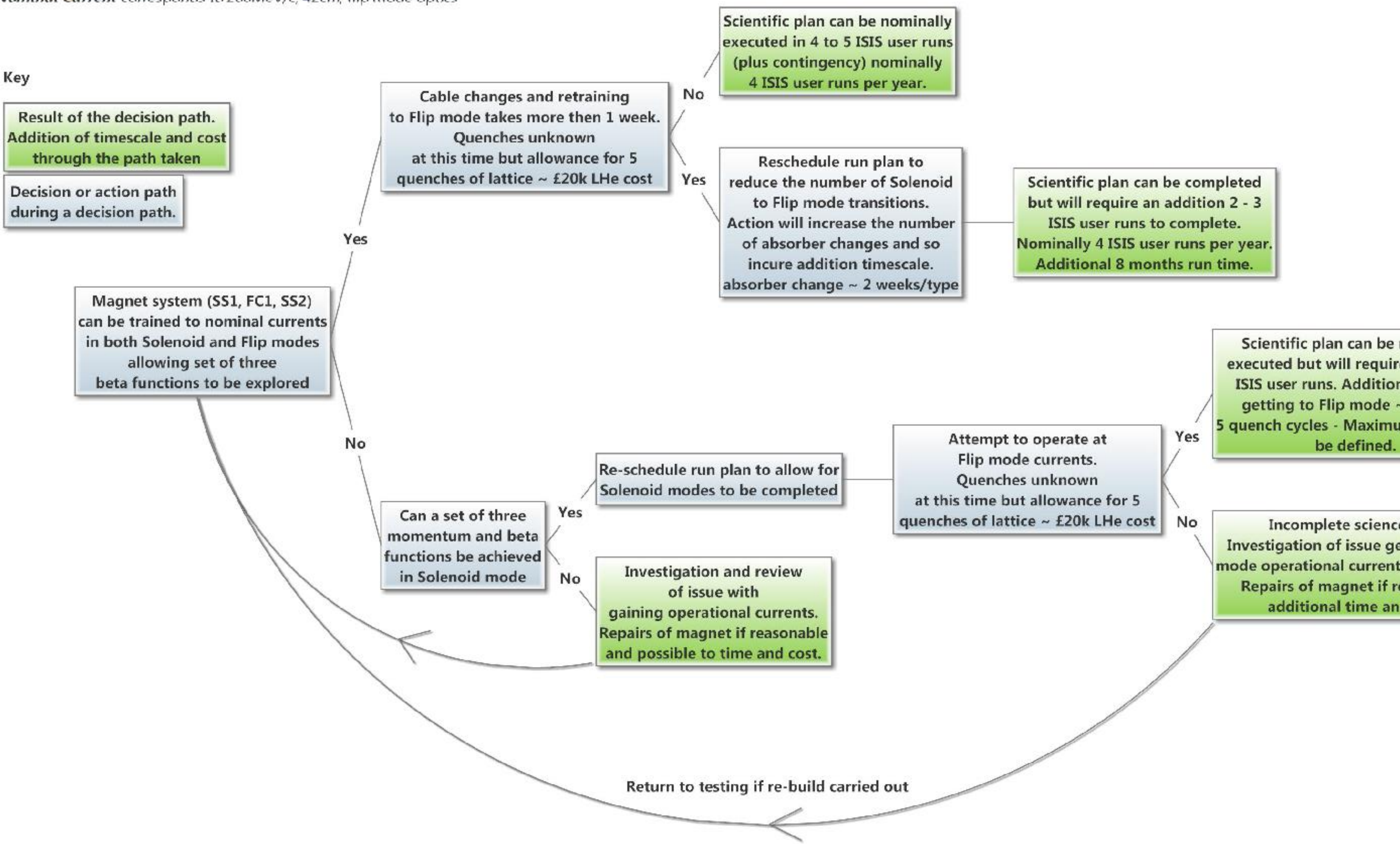


*) nominal currents correspond to 200 MeV/c, 42 cm, flip mode optics

**) more precise assessment of the situation is needed before following red routes (which currents are achieved and what optics can be reached, etc..)

in the RLSR document:

Nominal Current corresponds to 200MeV/c, 42cm, flip mode optics



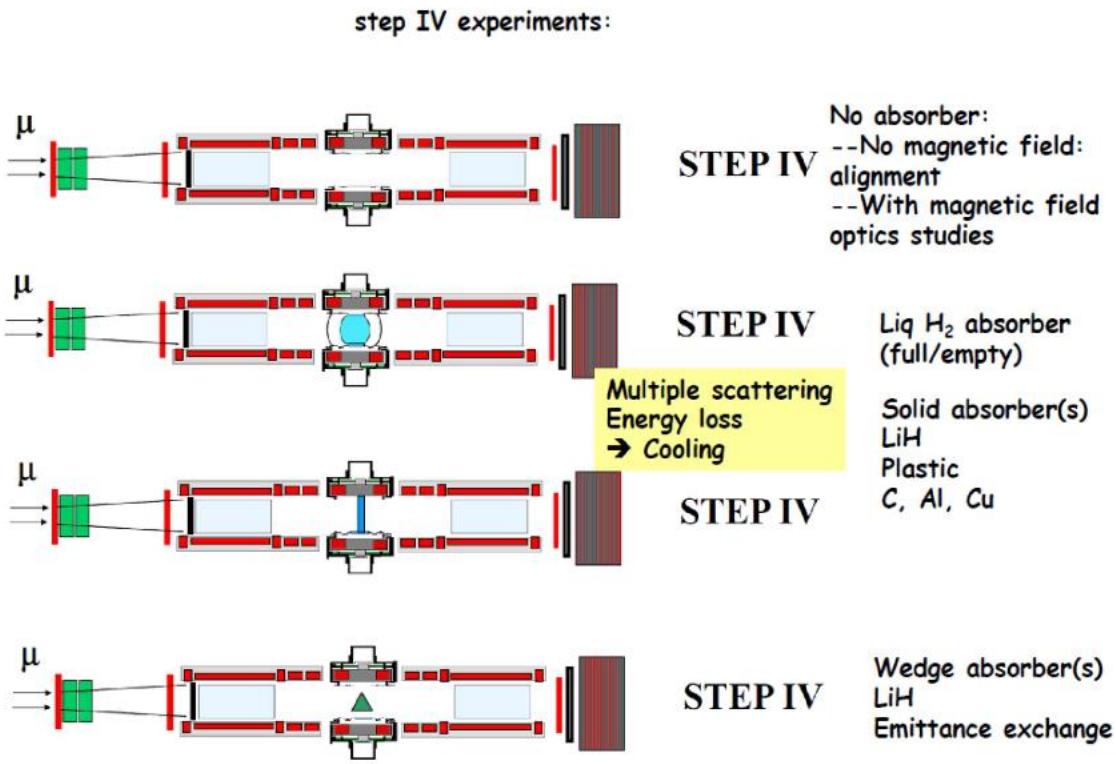


Figure 1 : MICE step IV experimental programme.

Normally, the measurements will proceed in the order described in Figure 1. This implies that the full program of measurements, including the exploration of a matrix of momenta and beta functions, and for both flip and solenoid mode, has to be performed for each absorber setting before moving to the next one. There remains an unknown in this run plan: whether the change-over from solenoid to flip mode requires a full re-training of the magnets. If this were the case, the run plan would have to be modified (and certainly lengthened) accordingly.

Conclusions

1. MICE is in happy shape, looking forward to step IV!
   -- With new Spokesperson, Project Manager, Project Engineer
   -- Several important milestones have been passed
   -- Schedule uncertainties have been reduced
   but some remain due to magnets and budget

2. Decision was made to implement the Partial Return Yoke
   -- schedule will be more predictable

3. Next large uncertainty concern the performance of the magnets when powered all together

   -- we are preparing to adapt to peformance being lower than design but above the 'nominal point'. (modify beta function at absorber)

   -- however if performance were below the 'nominal point' MICE would force more drastic questionning to know how to go forward with the experiment.

Construction

All elements of MICE step IV hardware have to independently operate to specifications beforehand.

Commissionning and operations

Magnetic channel

- All magnetic configurations will be tested with complete apparatus; magnet currents well in excess of what is required for the {200 MeV/c, β=42cm} optics should be achieved, both in solenoid and in flip mode;
- magnetic field mitigation satisfactory for step IV should be in place;
- change-over from solenoid to flip mode should be tested.

Liquid Hydrogen absorber

- liquid hydrogen integrated in AFC and safe operation demonstrated;
- absorber change-over tested (from full to empty and vice versa, from liquid to solid).

Note that the change-overs of AFC&SS1 polarities as well as absorber exchanges are to be tested before data taking in order to ensure that no modification to the apparatus will be needed after the start of data taking.

Beam line, detectors, DAQ and controls

- beam line delivering a goal of 100 muons per ISIS spill at 140, 200, 240 meV/c settings and post-diffuser emittances of 3,6 10 mm (this has already largely been achieved);
- detectors and DAQ able to acquire data at or near that rate (this has not yet been achieved with tracker and EMR included);
- online reconstruction, as well as routine detector calibration procedures, tested and operational. To this effect a dry run without magnetic fields in 2014 would be highly beneficial;
- Controls and monitoring should be operational to safely and reliably control the magnets of the beamline and of MICE, the particle detectors and tracker, as well as the cooling channel elements.

Software and simulation: before going to physics runs the simulation software and analysis should be able to:

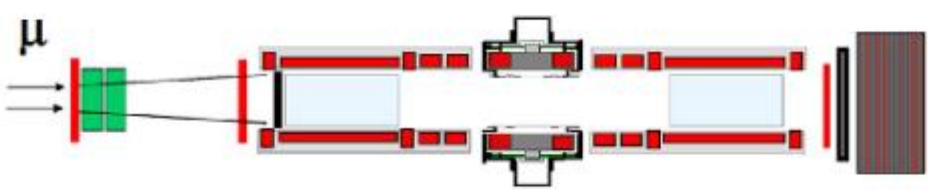
- Simulate the configurations that will be tested and provide a first prediction of the results;
- Ensure operational online reconstruction and calculation of results;
- Ensure proper archiving of data, their dissemination in the collaboration, and off-line analysis.

Data taking and physics results

The following goes through the experimental program of step IV and describes the accelerator and particle-matter interaction physics goals, whose achievements will constitute the gauge of success of MICE step IV.

Physics run with empty diffuser and absorber and no magnetic field: (IV.0)

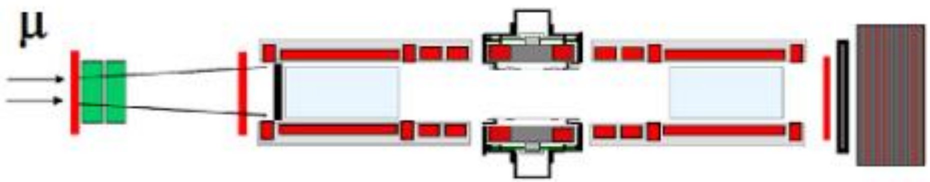
- successful operation of all detectors simultaneously up to a goal of 100 particles per ISIS spill
- alignment of tracker with straight particles going through to EMR
- successful global reconstruction
- verify Particle ID and particle selection



STEP IV

No absorber:
--No magnetic field: alignment
--With magnetic field optics studies

THEN we can do the physics!



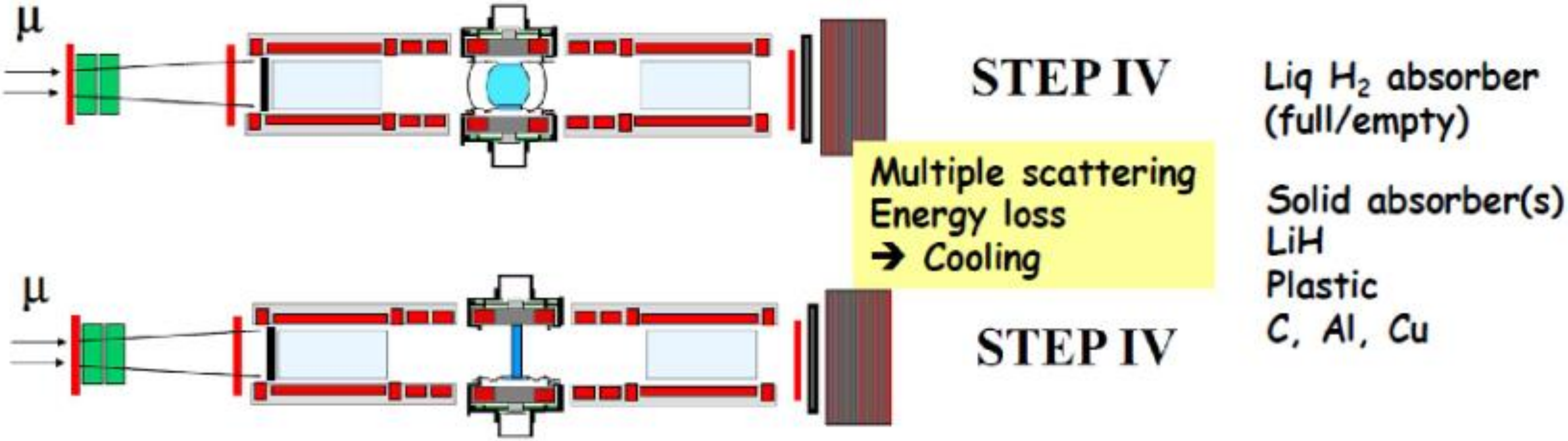
STEP IV

No absorber:
--No magnetic field: alignment
--With magnetic field optics studies

Run with diffuser and no or empty absorber and magnetic field: (IV.1)

This particular experiment reproduces the physics goals formerly assigned to 'step III'. The baseline configuration will normally be a 200 MeV/c positive muon beam with 6mm emittance generated in the diffuser, running through the channel in flip mode, 200MeV/c, 42cm optics.

- successful tracker reconstruction in magnetic field
- successful global reconstruction
- verify Particle ID and particle selection with a purity of 10^{-3}.
- comparison of tracker 1 and tracker 2 → determine detector resolutions;
- benchmark momentum scales of beam line, trackers, Time-of-flight and EMR range.
- determine properties of beam (alignments, momentum, dispersion, emittance)
- verify understanding of propagation through focus coil
- measure the transmission of the system starting from particles reconstructed in the first tracker within a given 'fiducial' acceptance.
- reconstruction of emittance 1, emittance 2 and comparison
- evaluation of systematic errors on measurement of amplitude reduction and emittance ratio
- goal: systematic errors should be below 10^{-3}
- test other diffuser and magnetic configurations



Run with diffuser and LiqH2 absorber : (IV.2)

This is the nominal step IV.

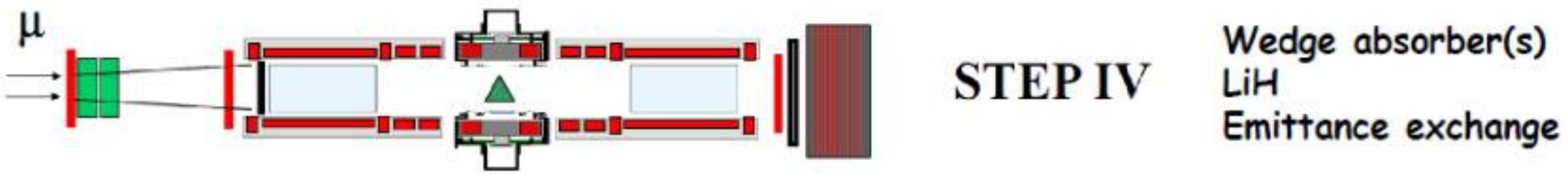
- take data with empty and full absorber
- measure transmission
- compare beam properties before and after absorber
- measure energy loss and its variance
- measure angular scattering and its variance
- measure energy-angle correlations
- measure particle amplitudes and emittance ratio
- determine equilibrium emittance by varying input beam emittance generated by diffuser
- explore results over a {3x3} matrix of momentum and beta function
- repeat for a matrix of emittances, momenta and beta functions, flip and non-flip modes.

Run with diffuser and solid absorbers : (IV.3)

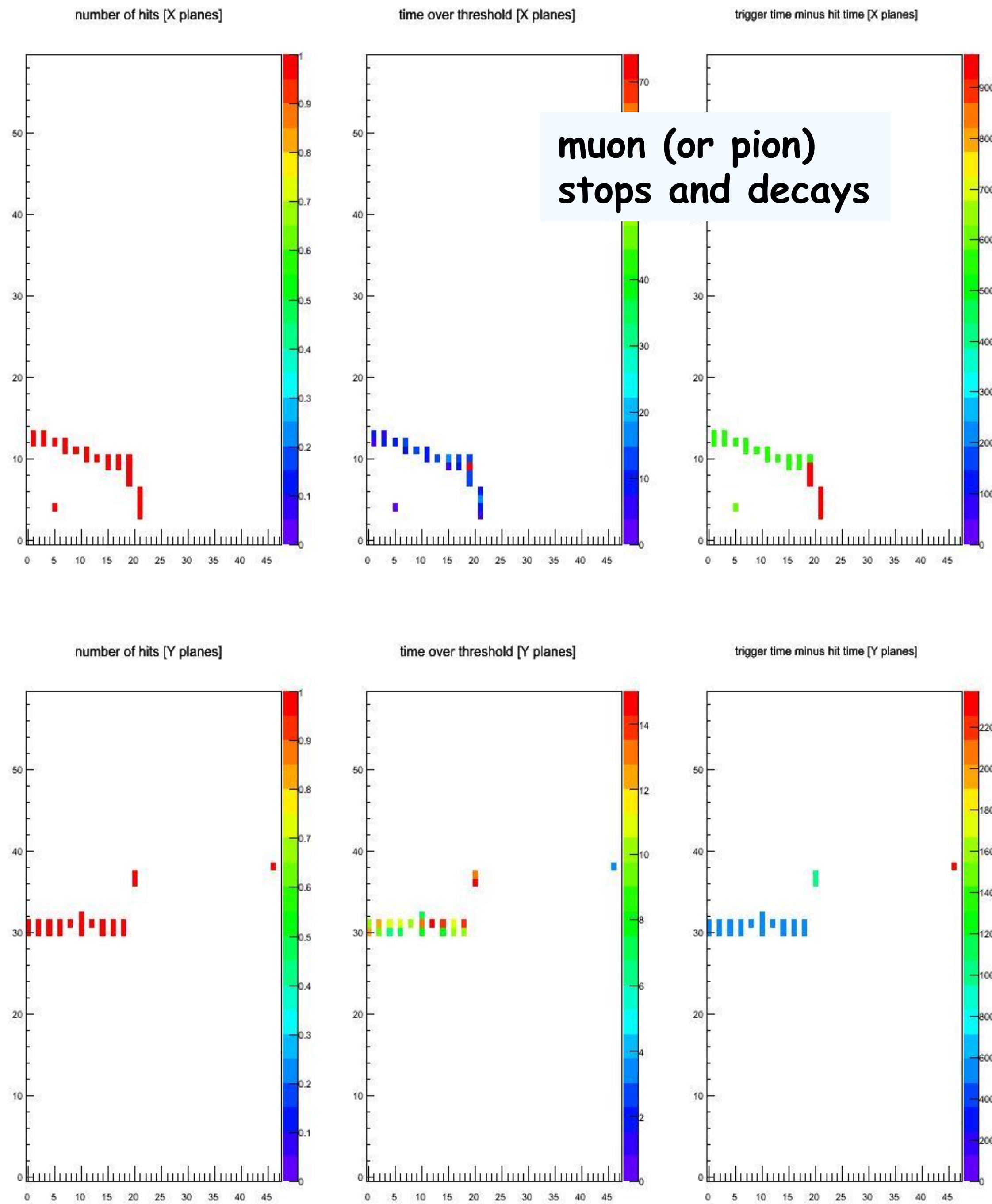
same as above

Run with wedge absorber IV.4

- Requires a dedicated measurement of the beam horizontal dispersion and disposition of the wedge in such a way as to reduce it significantly.
- measure beam energy spread before and after wedge; establish 6D emittance change
- Verify the principal of emittance exchange by comparison with simulations.
- The experiment can be repeated for various optical configurations in solenoid mode.



MICE beam



Successful run in Oct'13

but rate limited because DS has a burned LTS lead (to be fixed during the winter shut down)