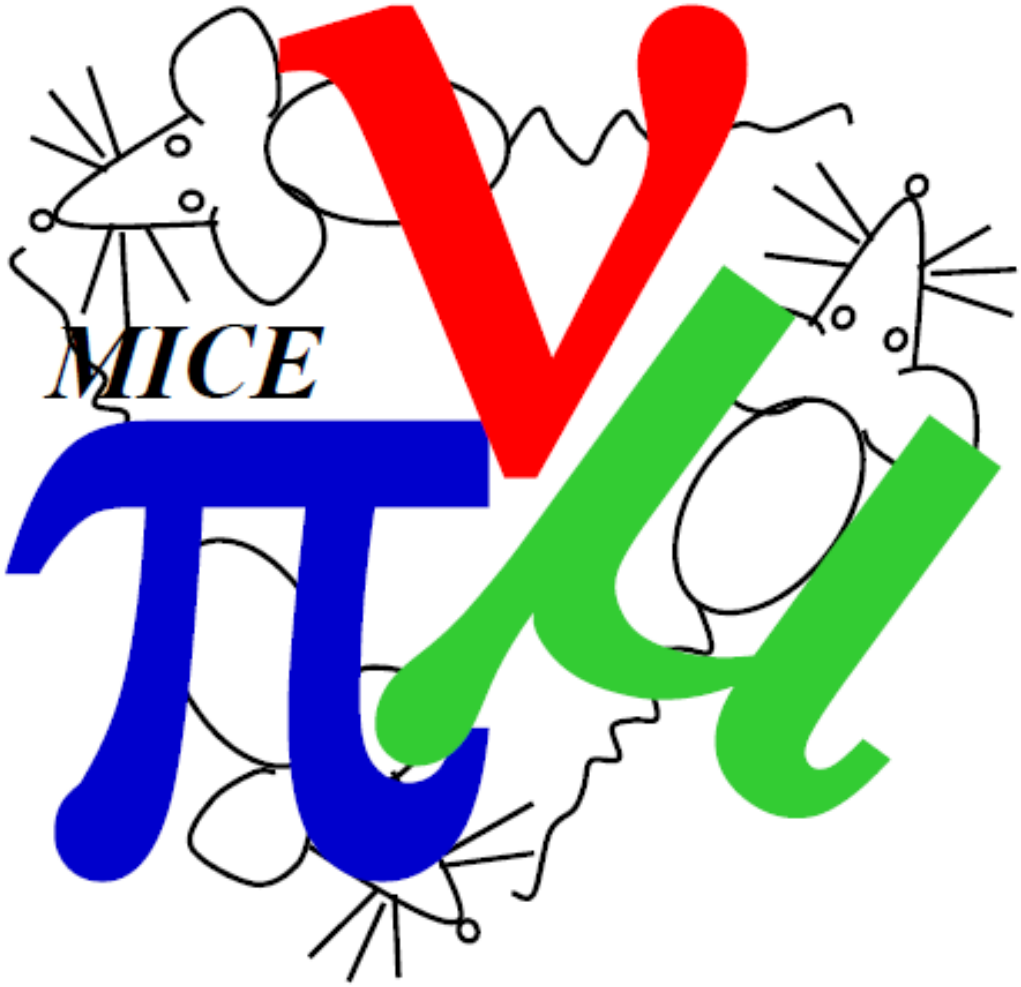
MICE Magnetic Field Mitigation Review



-- Design, engineer and build a section of cooling channel capable of giving the desired performance for a Neutrino Factory;

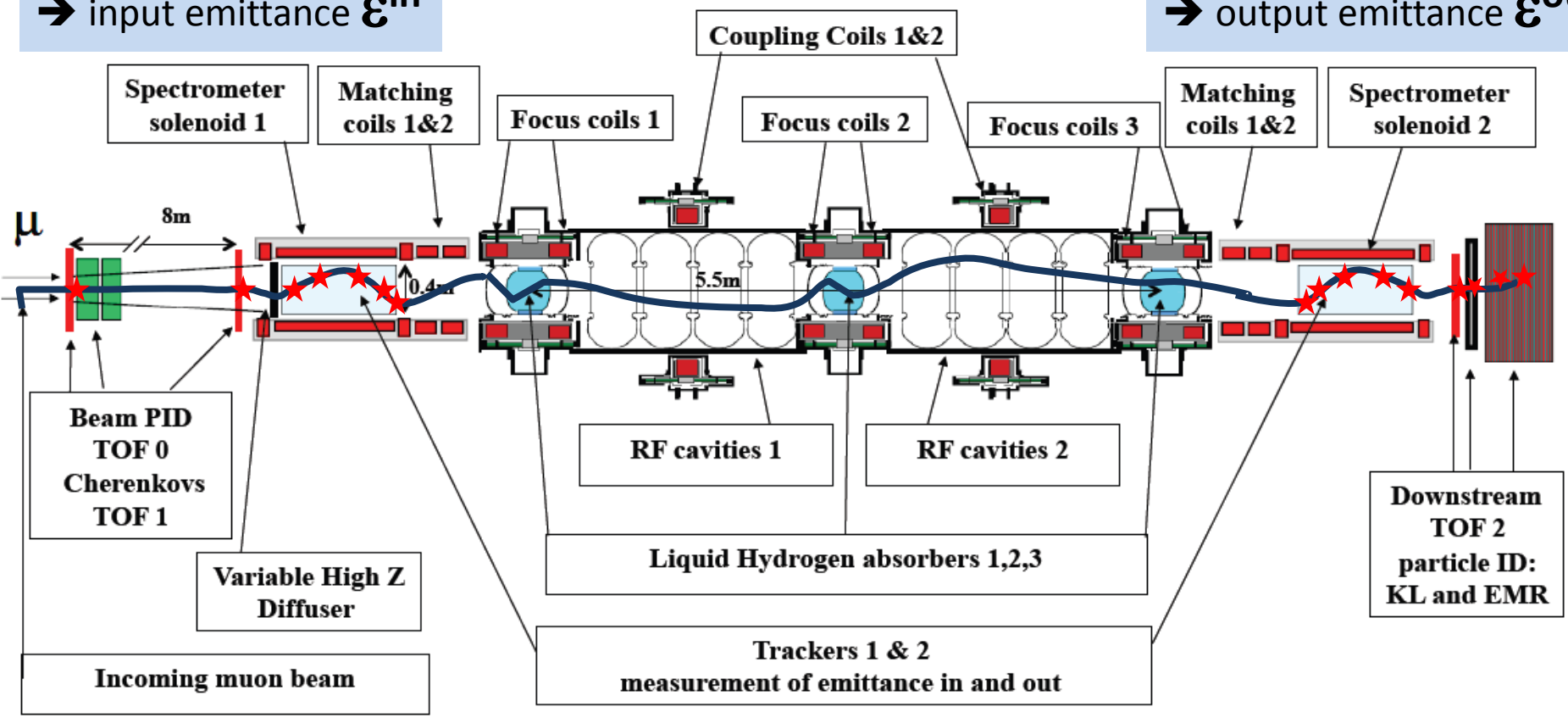
-- Place it in a muon beam and measure its performance in various modes of operation and beam conditions, thereby investigating the limits and practicality of cooling.

MICE the Muon Ionization Cooling Experiment

Measure input particle
x,x',y,y', t, t'=E/Pz
➔ input emittance ε^{in}

COOLING CHANNEL

Measure output particle
x,x',y,y', t, t'=E/Pz
➔ output emittance ε^{out}

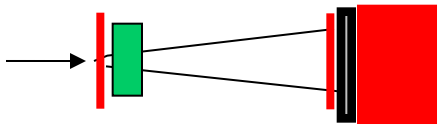


Particle by particle measurement, then accumulate few 10^5 muons
➔ $\Delta[(\varepsilon^{in} - \varepsilon^{out})/\varepsilon^{in}] = 10^{-3}$

Provisional MICE SCHEDULE
update: June 2013

Run date:

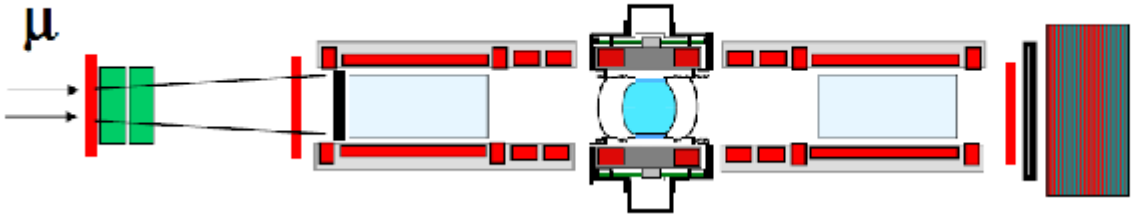
μ



STEP I

EMR run Oct 2013

μ



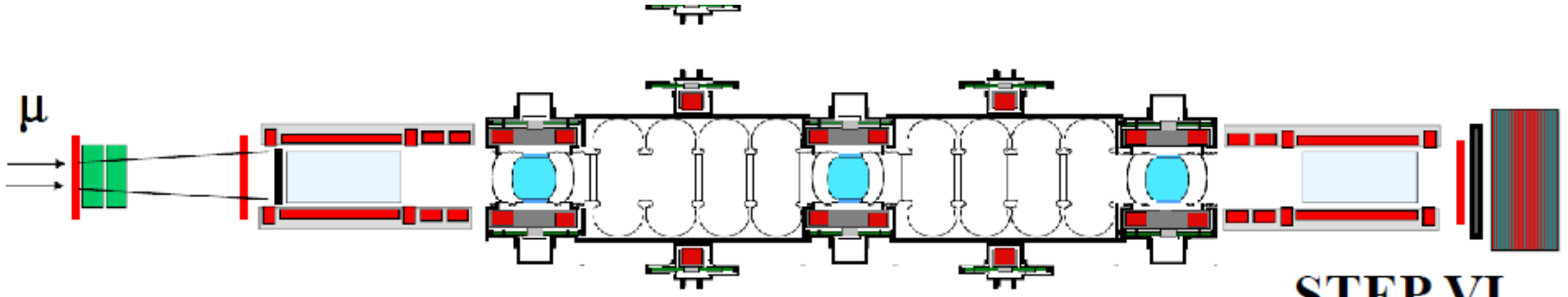
STEP IV

(possibly w/o field: Q2 2014)

Q1 2015 to Q1 2016

Under construction:

μ

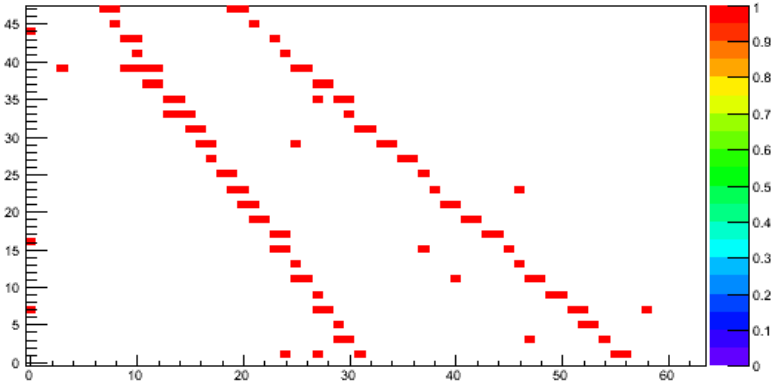


STEP VI

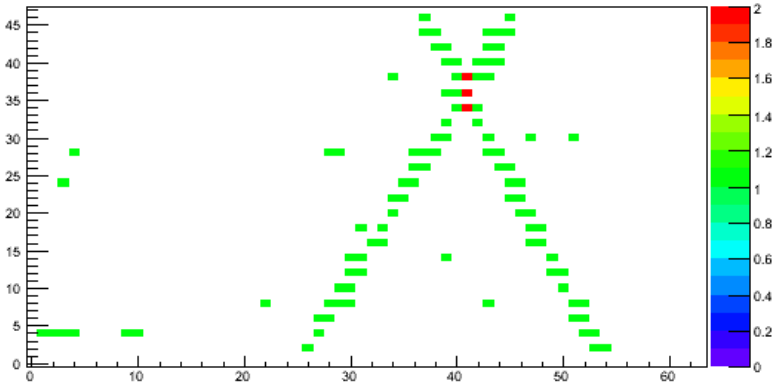
Target date Q3 2019
Step V run possible 2018

MICE EMR running cosmics at Geneva and ready to ship. Will arrive at RAL (this) Thursday 26 Sept. 2013

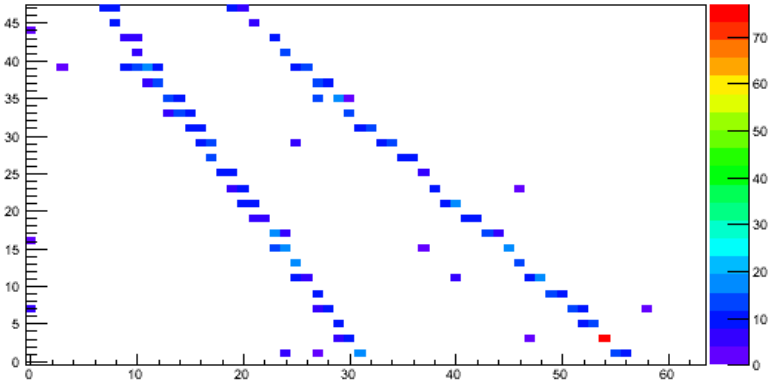
number of hits [X planes]



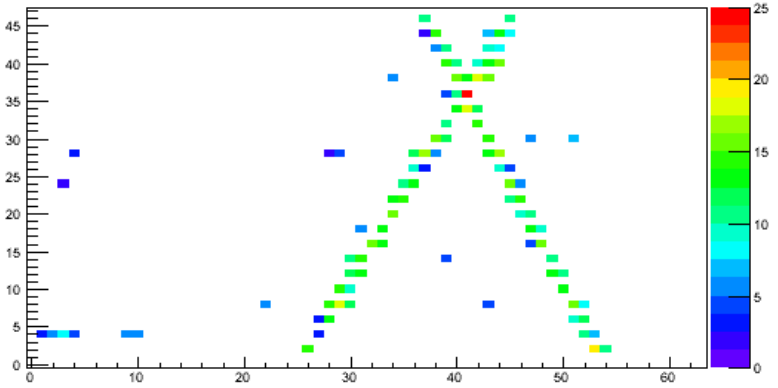
number of hits [Y planes]



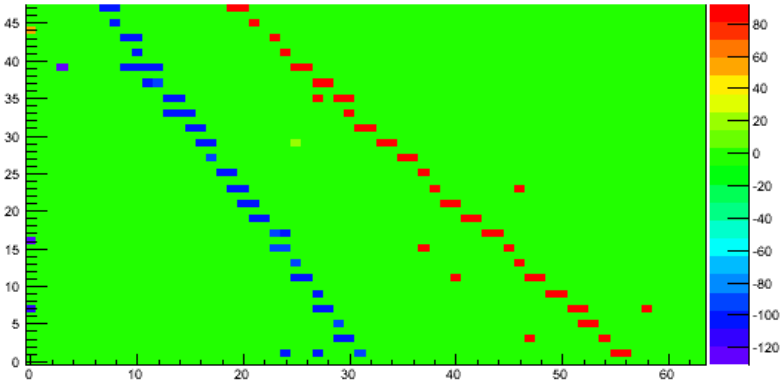
time over threshold [X planes]



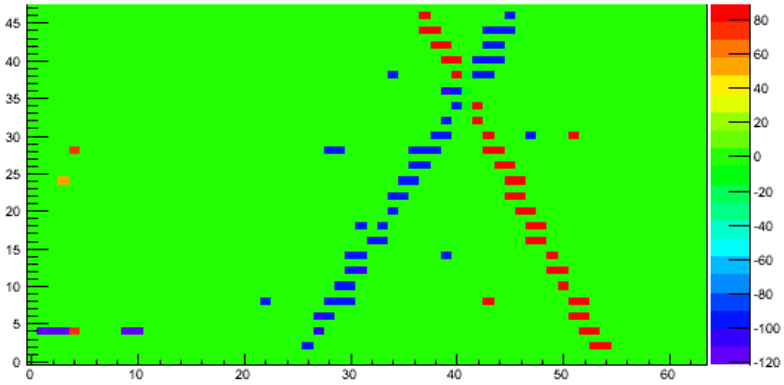
time over threshold [Y planes]



trigger time minus hit time [X planes]

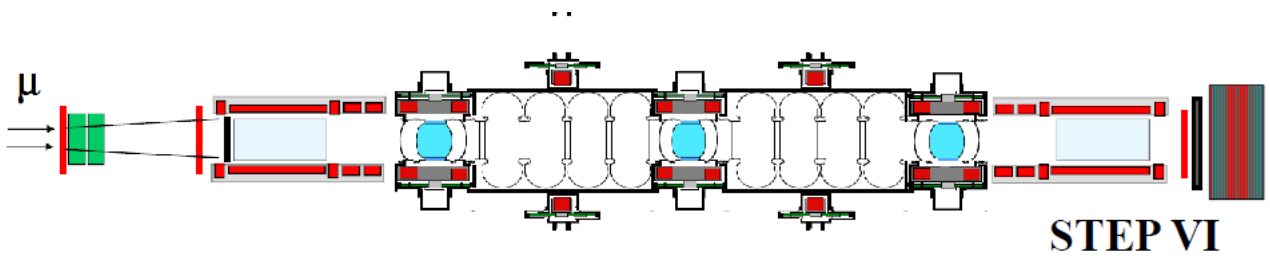


trigger time minus hit time [Y planes]



Flashback: The MICE magnets

Are simple superconducting coils *without return yokes*



From MICE proposal: (2003):

The baseline MICE magnetic channel does not include either active or passive magnetic shielding in the vicinity of the experiment and generates a significant magnetic field in the experimental hall.
This design feature cannot be modified very easily since the focusing properties of the coils in the cooling section originate from the fringe fields themselves.
Therefore, it has to be checked that the field within the MICE experimental hall, as well as the stray field in the nearby buildings, in particular the ISIS linac and control room, are below the required safe levels.

This was done and led to the installation of shielding walls around the experiment

Individual equipement owners were deemed to worry about effect of magnetic field (this is what TOF and EMR did for instance by designing large shieding plates)

In 2011 (at the occasion of an RF equipment review) it was realized that the issue needed to be revisited.

A small working group (Blackmore, Courthold, Preece, Zisman) was asked to review the effect of stray magnetic fields on equipment in the MICE hall.

Report in June 2012. red alarm: local shielding of equipements such as compressors for cryocoolers affects field map and problem is 'run-away'.

Magnetic Field Mitigation group (Bross, Long et al) took on problem energetically

Two solutions studied in parallel on the two sides of Atlantic

two possible solutions for step IV field mitigation

1. "baseline" solution

take everything sensitive away from the high field region.

++ hope to be able to maintain goal of running before August 2014 (7 month ISIS shut down)

++ led to increase of space for experiment (new rack room and excellent use of west wall)

-- a number of magnetically sensitive elements cannot be moved and must be shielded individually (tracker VLPC readout system among others)

-- the risk of having forgotten something is perceived as high and very dangerous,

-- possible degradation of performance of some components

-- the MICE hall remains a high magnetic field region

-- this is not a viable solution for step V/VI

2. Partial Return Yoke (PRY):

provide a return yoke to the experiment to contain the field around the magnets

++ reduces fields in the hall to small level and solves problem of risk to individual equipment

++ does not modify field along the beam line significantly

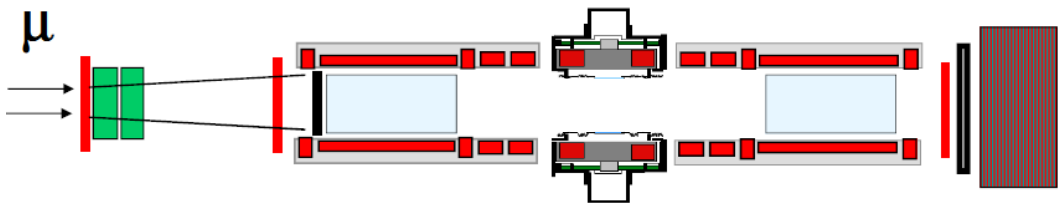
++ is a first step towards the solution for step V/VI

-- new development

-- installation, cost, risk and schedule implications need to be understood

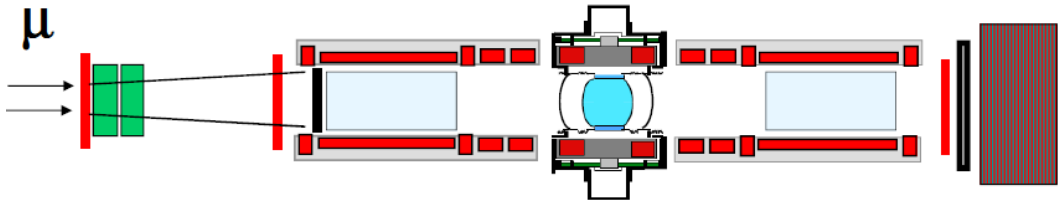
-- must allow interchange of absorbers in reasonable time for the step IV running

STEP IV EXPERIMENTS (2015-2016)



STEP IV

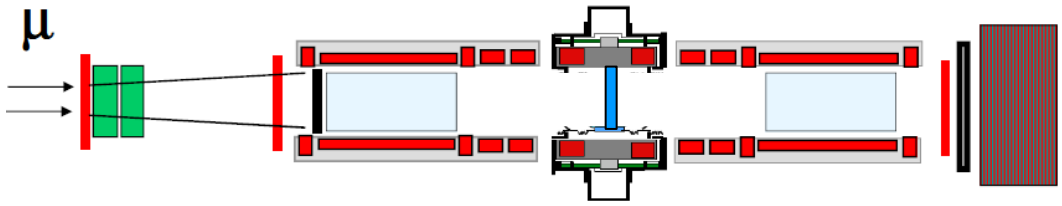
No absorber
Alignment
Optics studies



STEP IV

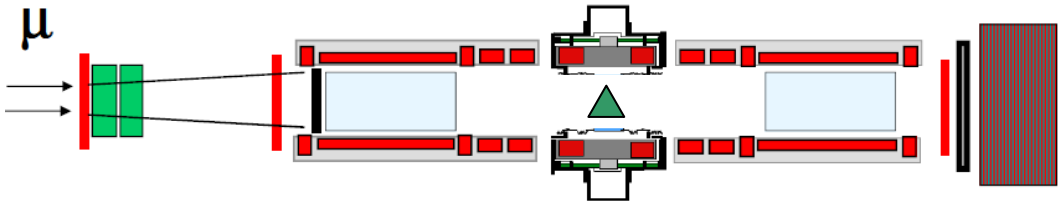
Liq H_2 absorber
(full/empty)

Multiple scattering
Energy loss
➔ Cooling



STEP IV

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



STEP IV

LiH Wedge absorbe
Emittance exchange

Collaboration boundary condition that a solution be decided by August 2013 and to hold a review in September 2013. **NOW**.

MICE Project Board requested (as action) the same of us. (May 2013)

Since then:
-- initial aim of having step IV installed and running usefully before August 2014 is now out of reach in any configuration
-- still not certain that all magnetically sensitive elements can be identified and shielded without PRY

The collaboration :
++ praises the hard work and excellent analysis of the problem by the Magnetic Field Mitigation group
++ endorses the recommendation of PRY implementation

➔ the PRY is the solution that the committee is asked to review today

Possibility to install all step IV equipment for a dry run before August 2014 would be a very welcome asset as it will save time and risk towards step IV