MICE Step IV

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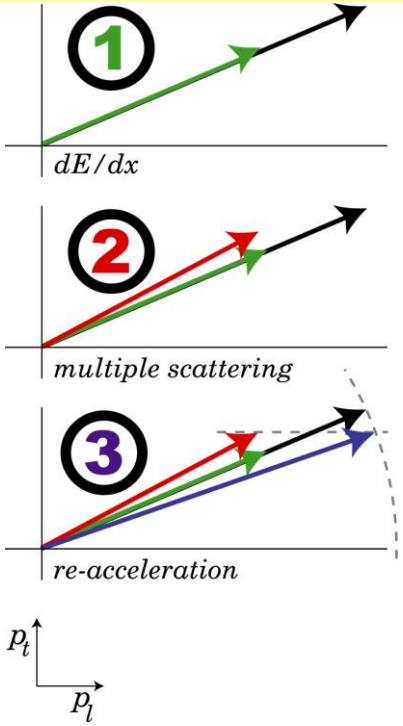
NuFact 2015

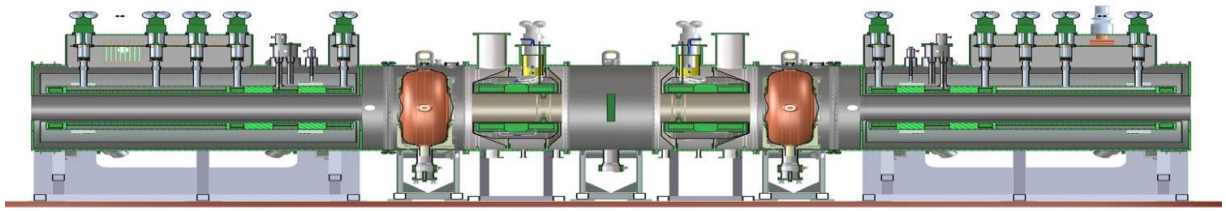
Muon Ionization Cooling

– Muon Ionization Cooling is the key technology required to be able to create useful Beam of Muons for NF, MC, etc.

Principle



Practice



Small $\beta_\perp \Rightarrow$ strong focusing

$$\frac{d\varepsilon}{dz} \approx -\frac{\varepsilon}{E_\mu \beta^2}\frac{dE_\mu}{dz} + \frac{\beta_\perp}{2m\beta^3}\frac{(13.6\,MeV)^2}{E_\mu X_0}$$

Ionization: cooling term

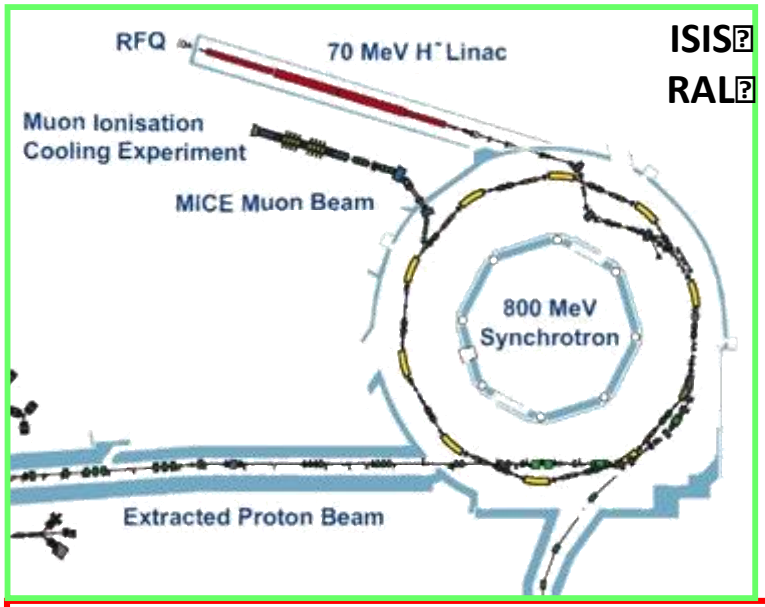
Multiple scattering: heating term

Collaboration

MICE is International Collaborative Effort

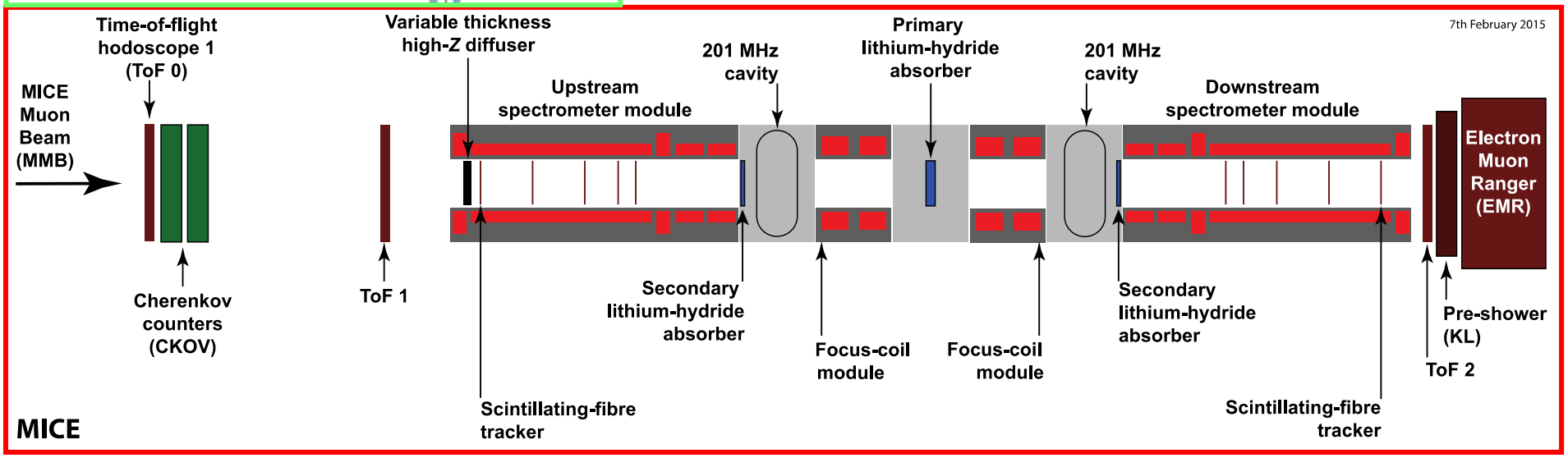
- Of more then 80 Physicists & Technical Professionals
- From 27 Institutions:
- 9 Counties (Bulgaria, China, Italy, Japan, Nederland, Serbia, Switzerland, UK, USA)
- 3 Continents (North America, Europe and Asia)

MICE, demonstration of ionization cooling

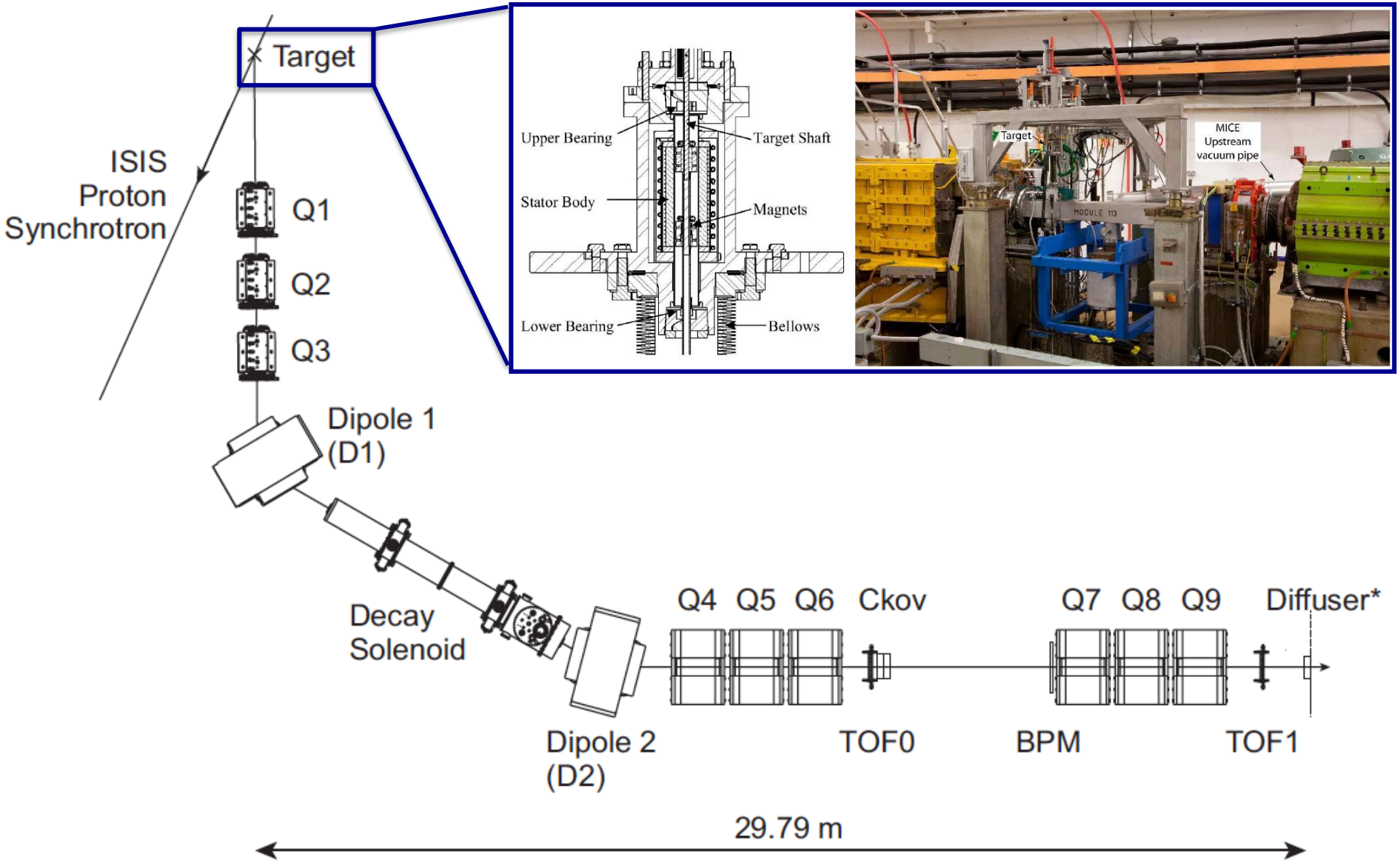


MICE home is RAL and it is approved to:

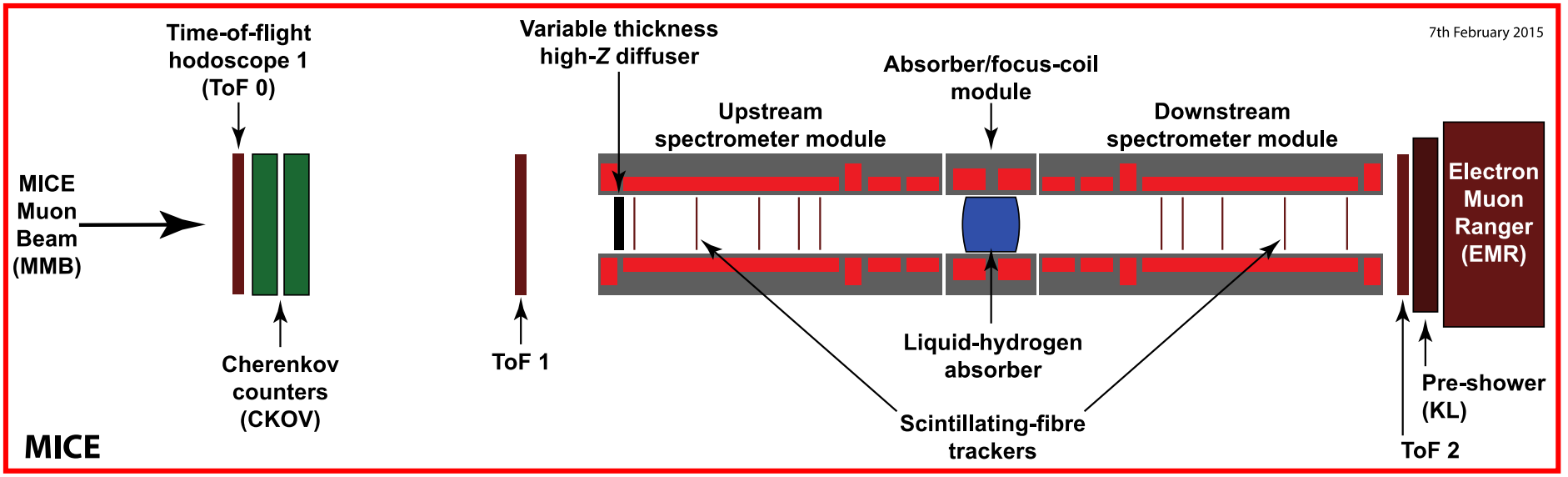
- **Design, build, commission and operate a realistic section of cooling channel**
- **Measure its performance in a variety of modes of operation and beam conditions**
  - **Results will allow Neutrino Factory [and Muon Collider] complex to be optimized**
- **Normalized transverse emittance: 0.1%**
  - **Requires selection of 99.9% pure muon sample**



MICE Muon Beam



Step IV; Study of factors that affect cooling (materials, momentum & emittance)



Emittance:

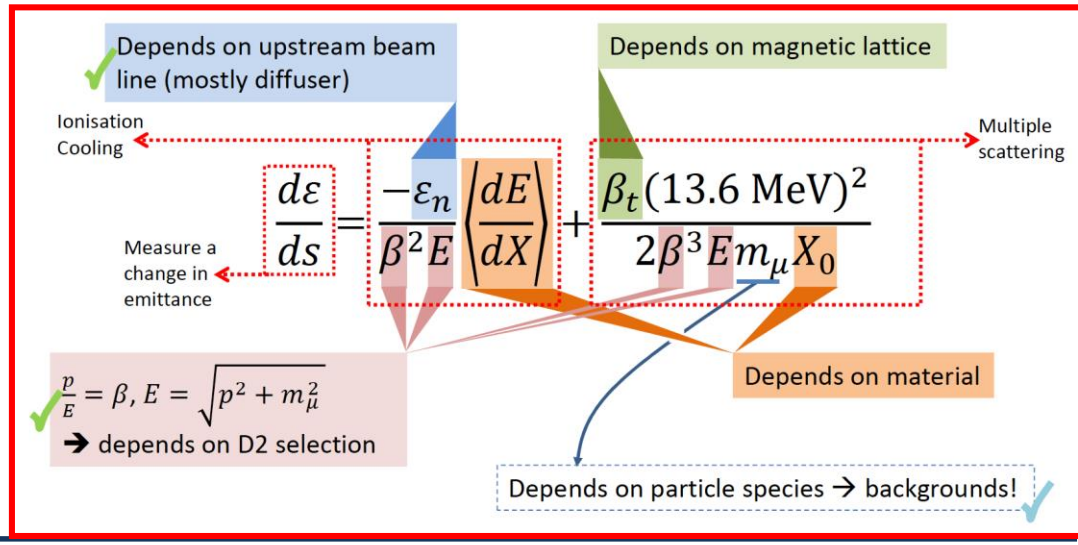
Varied through MICE Muon Beam optics and diffuser settings

Material:

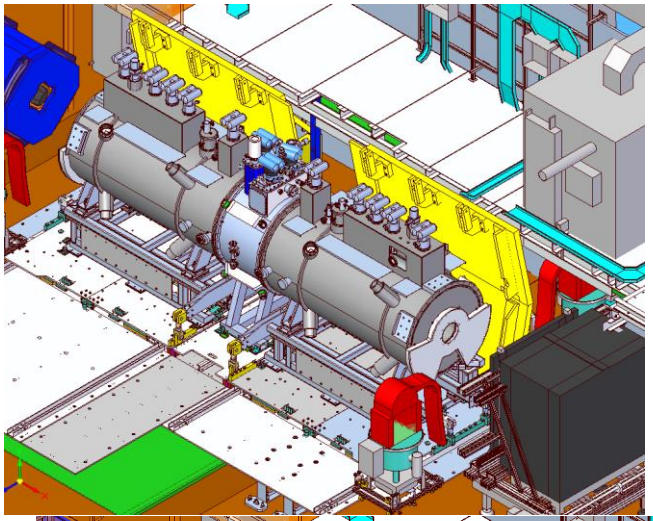
Absorber change (LH2; LiH);

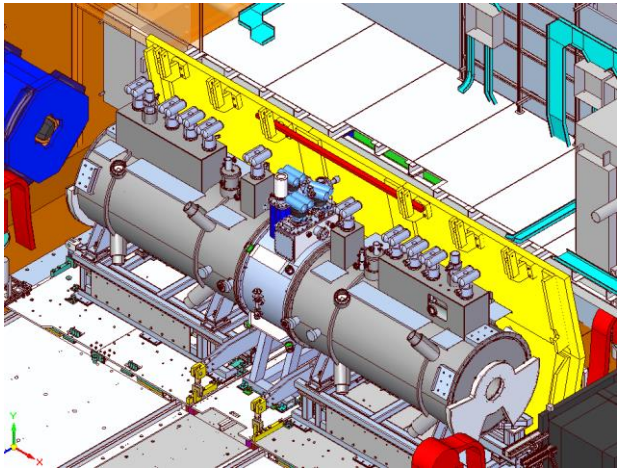
p, *E* and β:

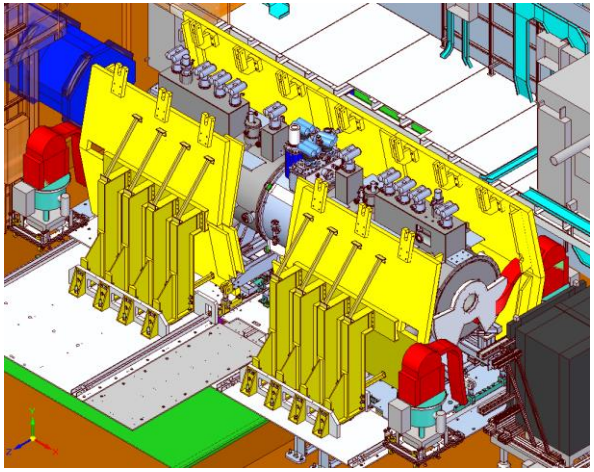
Vary beam momentum, optics

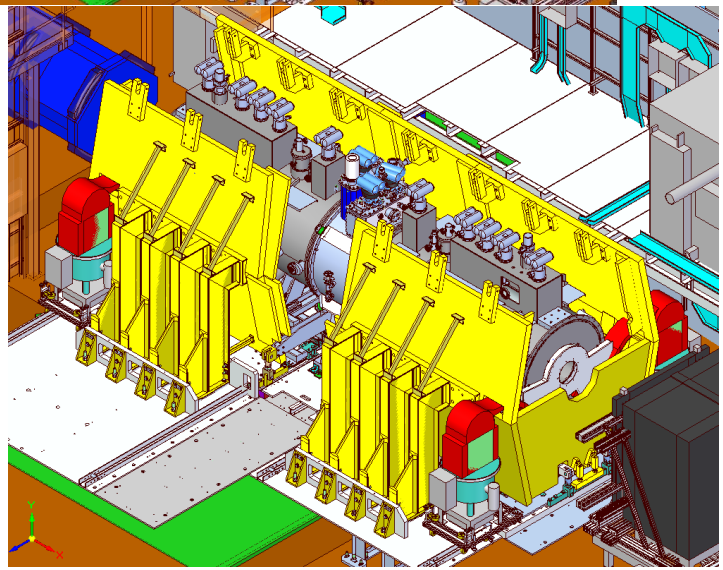


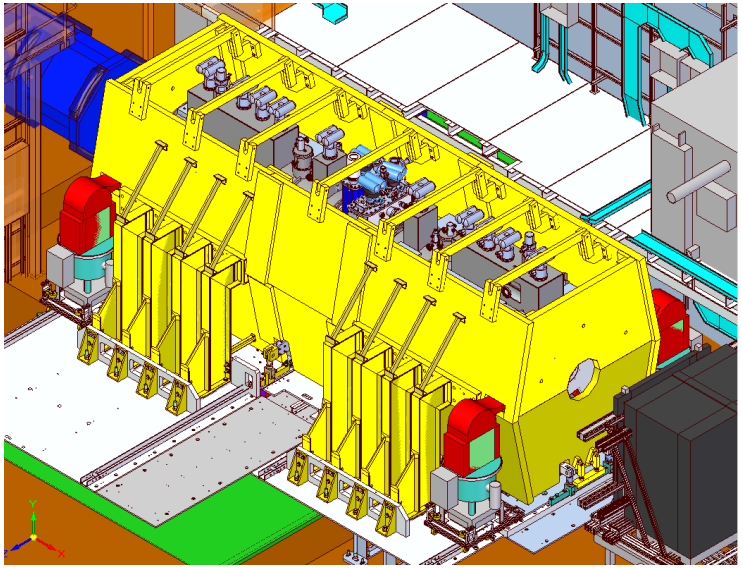
Final Installation Sequence, Step IV



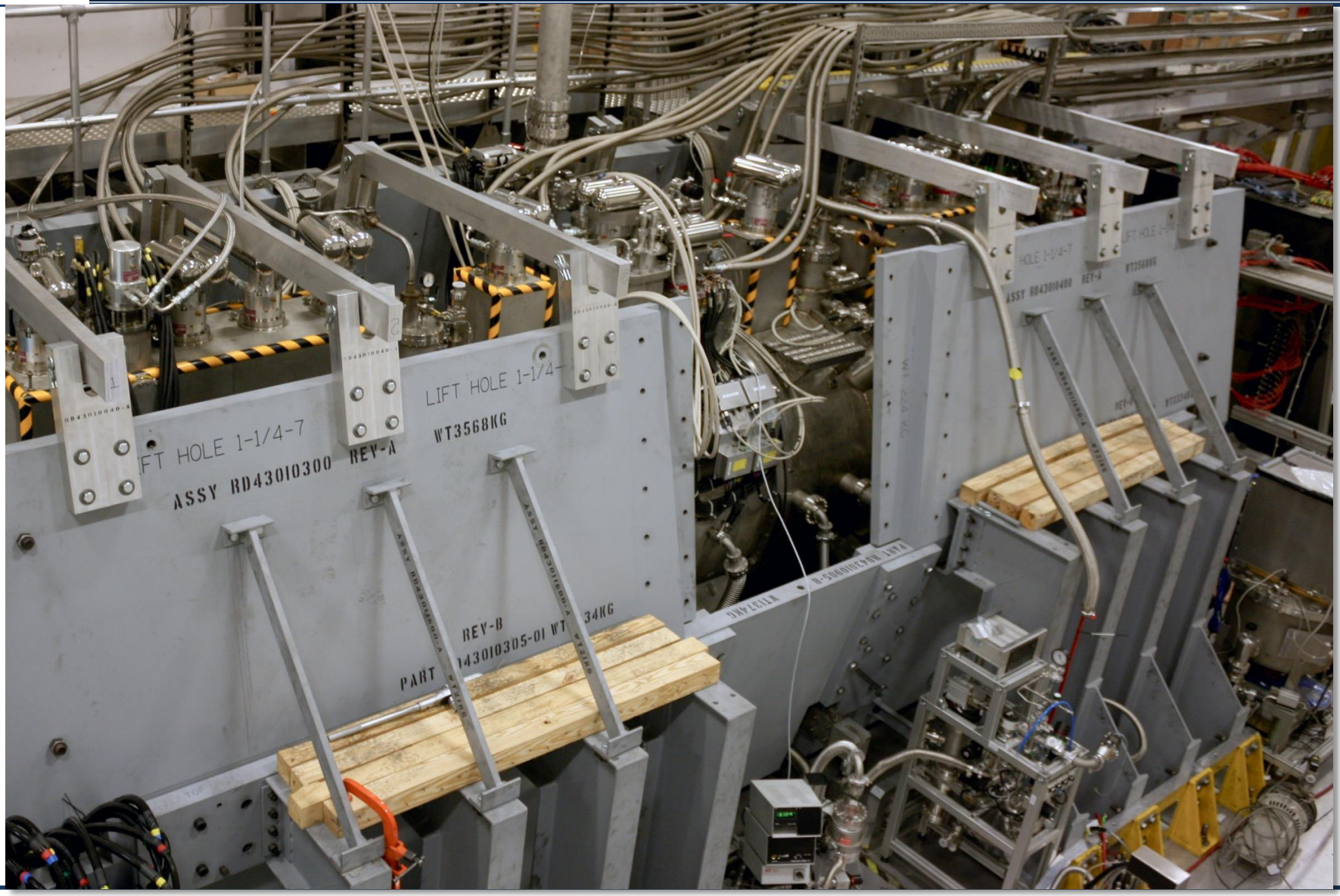






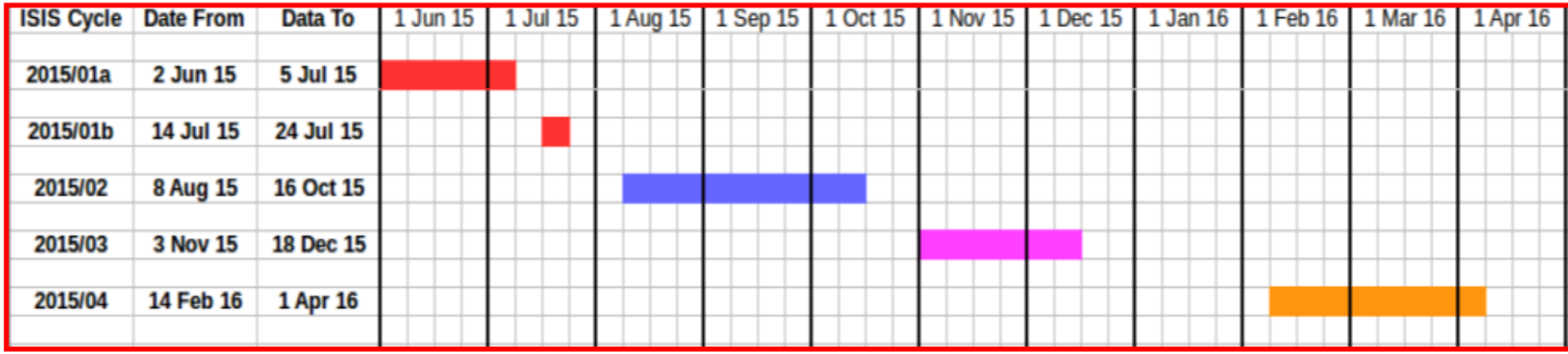


Step IV installation



Status as of August 5th

Step IV: Time Table, Operations & Status



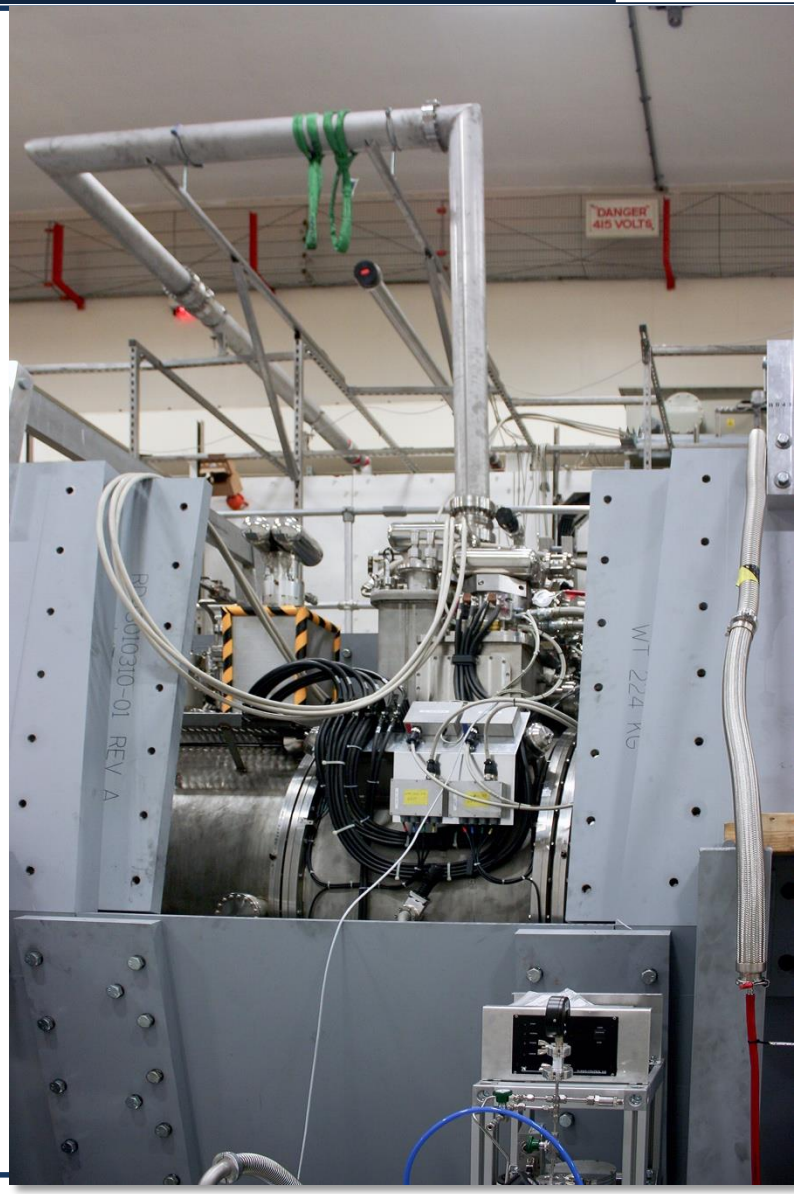
- **Cycles 2015/01a,b (March/July 2015):**
  - Data taking interleaved with commissioning
  - Calibration
  - Field-off data for mechanical alignment
  - Data with field on (100A) in downstream solenoid to check magnetic axis

Magnet Status

- Upstream solenoid:
  - Issues identified in initial commissioning addressed
  - Commissioning coo-down and commissioning restart 10 August 2015
- Downstream solenoid:
  - Trained to 203A (operating current 283A);
  - Training will resume late August 2015
- Focus coil:
  - Thermal issue identified during initial training of downstream solenoid
  - Warm-up to allow diagnosis and repair underway

Absorber for Step IV

- Safety review of LH2 system Jan15:
  - Part of safety “sign-off to operate Step IV” process
  - Required:
    - Additional safety-window burst tests; and
    - Enlarged emergency H2-gas evacuation line
- Status of implementation:
  - Burst-tests complete; satisfactory
  - Enlarged relief line agreed and installed
- Next steps:
  - Demonstrate satisfactory operation with He gas
  - Obtain permission to operate with LH2
  - H2 safety review scheduled for 6Sep15



Detectors Status

All detectors are now commissioned and are being used in the alignment/magnetic axis studies

Conclusions

- Muon ionization cooling is the key technology required to make Neutrino Factories and Muon Colliders viable
- Significant investment, effort (and patience) from all the funding agencies have been paramount in achieving the construction of the Muon Ionization Cooling Experiment at RAL
- MICE is ready (almost) to commence its Step IV data taking in order to observe reduction of transverse normalised emittance and characterise the parameters that affect cooling performance

Conclusions

The End