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Status of MICE, the international Muon Ionisation Cooling Experiment

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Muon ionization cooling provides the only practical solution to prepare high brilliance beams necessary for a neutrino factory or muon collider, because it is fast enough to cool the beam within the muon lifetime. The muon ionization cooling experiment (MICE) is under development at the Rutherford Appleton Laboratory (UK). The goal of the experiment is to build a section of a cooling channel that can demonstrate the principle of cooling and to prove this by measuring its performance in a muon beam. As of July 2010 the beamline and most of the detectors have been commissioned and the time of the first measurement of input beam emittance is approaching.

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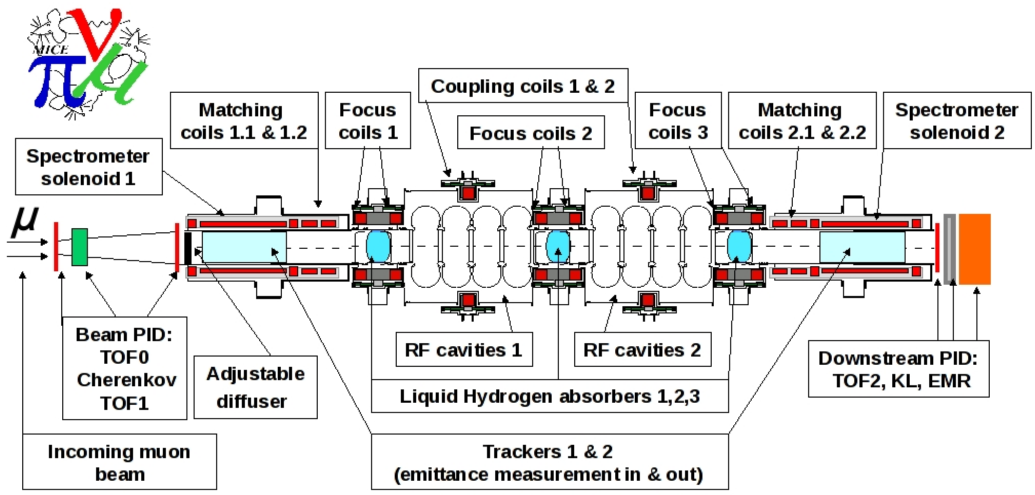

Figure 1: MICE experiment.

The Muon Ionization Cooling Experiment (MICE) [1] (Fig. 1) is under development at the Rutherford Appleton Laboratory (UK). The goal of the experiment is to build a section of a cooling channel that can demonstrate the principle of ionization cooling and to verify its performance in a muon beam. The experiment will be assembled, tested and operated in six steps (see Fig. 2). Each step will validate one part of the setup, starting with the beam line and the detectors for particle identification and then progressively introducing the spectrometers, the absorbers and the radio frequency (RF) reaccelerating cavities. The final setup will be able to measure a 10% reduction in emittance (transverse size) of the beam with a relative precision of 1% [2, 3].

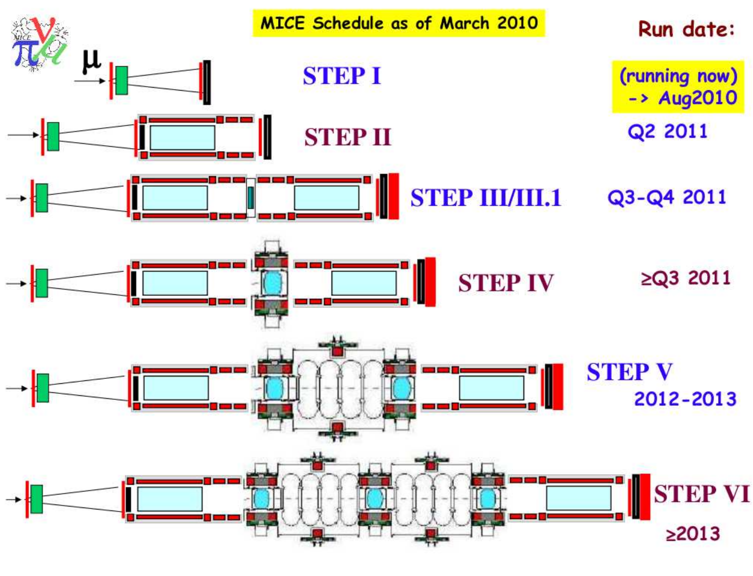

Figure 2: MICE steps and schedule.

During Step I MICE has operated as a stand-alone experiment and also parasitically during standard ISIS user runs. A target mechanism inserts a small titanium target into the circulating ISIS beam during the last 2 ms before extraction. The current MICE target was installed in September 2009. Since then, it has performed exceptionally well. Target operation and the effect of varying the current in the beam line magnets have been studied in order to optimize the beam performance.

The particle content of the muon beam has been measured by using time-of-flight detectors (TOF0, TOF1, TOF2) [4], Cherenkov detectors and KL (KLOE Light) calorimeter that provide precise muon, pion and electron identification [5]. Time-of-flight detector timing resolutions of 52 ps for TOF0, 60 ps for TOF1 and 54 ps for TOF2 were achieved. Fig. 3 shows two typical spectra of the time-of-flight between TOF0 and TOF1.

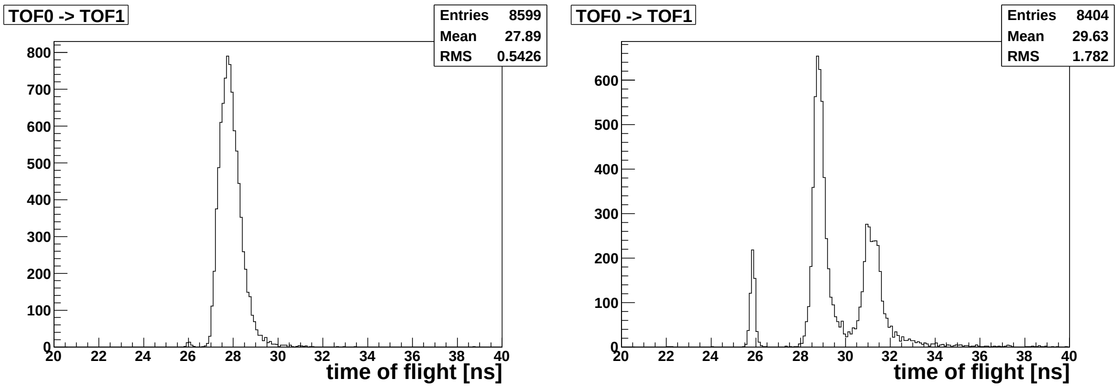

Figure 3: Time-of-flight distributions. Left: high emittance muon beam with small contamination of electrons and pions will be used to demonstrate ionization cooling. Right: low emittance beam for calibration of the detectors. Electrons, muons and pions fall into three well defined peaks.

Preparation for the next steps is in progress. The Electron Muon Ranger (EMR) is under construction now. Tests of a single module have shown a high efficiency and good spatial resolution. The full detector, with 40 modules, will be ready for installation in MICE in early 2011. Both trackers are presently being commissioned in a cosmic-ray test stand and are ready to be installed [6] each in its spectrometer magnet. Delivery of the first magnet will start Step 2. The cooling test of the first liquid H_2 absorber was finished in December 2009. Assembly of the second absorber is in progress. The fabrication of the first five RF cavities and their beryllium windows has been completed. Measurements of the electromagnetic properties of the cavities are in progress.

References

[1] MICE web site *http://mice.iit.edu* contains detailed information about the experiment.

[2] The International Muon Ionization Cooling Experiment (MICE) proposal to the Rutherford Appleton Laboratory, 10 January 2003.

[3] V. Verguilov, Measurement of emittance and emittance reduction in MICE, these proceedings.

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[5] M. Bonesini, The MICE PID instrumentation system, these proceedings.

[6] M. Ellis et al., The design, construction and performance of the MICE scintillating fibre trackers, arXiv:1005.3491.