Spokesman's introduction

K. Long, 2 August, 2018

Contents

A short contribution from me:

- No comments on:
  - Hall, hardware or decommissioning:
    - ISIS now have ownership of the Hall;
      - J.Govans, Hall Manager, reporting to ISIS management
    - Shipments prepared or known
- My contribution:
  - Emittance paper update (not explicitly on agenda)
  - Paper status and next steps in analysis
  - CM52

Spokesman's introduction

EMITTANCE PAPER UPDATE

Direct measurement of emittance using the MICE scintillating fibre tracker

MICE collaboration

The Muon Ionization Cooling Experiment (MICE) collaboration seeks to demonstrate the feasibility of ionization cooling, the technique by which it is proposed to cool the muon beam at a future neutrino factory or muon collider. The emittance is derived from an ensemble of muons assembled from those that pass through the experiment. A pure muon ensemble is selected using a particle identification system that can reject efficiently both pions and electrons. The position and momentum of each muon is measured using a high-precision scintillating-fibre tracker in a 4 T solenoidal magnetic field. This paper presents the techniques used to reconstruct the phase-space distributions and reports the emittance of the muon beam as a function of muon-beam momentum.

1 Introduction

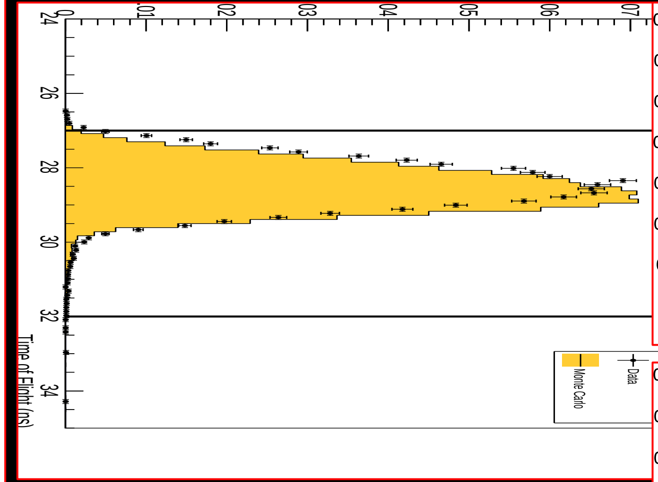
Stored muon beams have been proposed as the source of neutrinos at a neutrino factory [1, 2] and as the means to deliver multi-TeV lepton-antilepton collisions at a muon collider [3, 4]. In such facilities the muon beam is produced from the decay of pions generated by a high-power proton beam striking a target. The tertiary muon beam occupies a large volume in phase space. To optimise the muon yield for a neutrino factory, and luminosity for a muon collider, while maintaining a suitably small aperture in the muon-acceleration system requires that the muon beam be "cooled" (i.e. its phase-space volume reduced) prior to acceleration. Recently a muon-collider scheme based on the production of $\mu^+\mu^-$ pairs through the annihlation of positrons impinging on a target [5] has been proposed. The $\mu^+\mu^-$ pairs are created close to threshold which restricts the phase-space volume occupied by the muons producing beams with small emittance at an energy of $\gtrsim 20$ GeV.

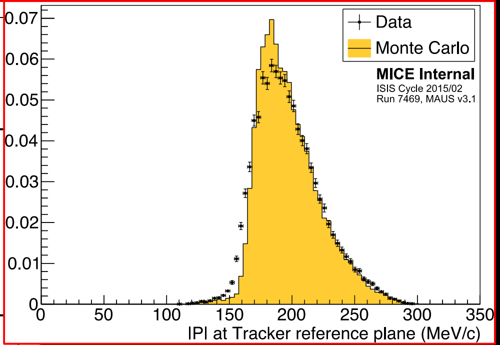
A muon is short-lived, with a lifetime of 2.2 μs in its rest frame. Therefore, beam manipulation at low energy (≤ 1 GeV) must be carried out rapidly. Four cooling techniques are in use at particle accelerators: synchrotron-radiation cooling [6]; laser cooling [7–9]; stochastic cooling [10]; and electron cooling [11]. In each case, the time taken to cool the beam is long compared to the muon lifetime. In contrast, ionization cooling is a process that occurs on a short timescale. A muon beam passes through a material (the absorber) and loses energy. The beam is then reaccelerated, cooling the beam efficiently with modest decay losses. Ionization cooling is therefore the technique by which it is proposed to increase the linear current density, for a neutrino factory, and phase-space density for a muon collider [12–14]. This technique has never been demonstrated experimentally and such a demonstration is essential for the development of future high-brightness muon accelerators.

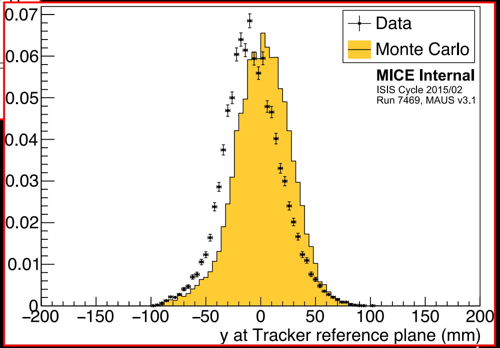
The international Muon Ionization Cooling Experiment (MICE) has been designed [15] to perform a full demonstration of transverse ionization cooling. Intensity effects are negligible for most of the cooling channels conceived for the neutrino factory or muon collider [16]. This allows the MICE experiment to record muon trajectories one particle at a time. The MICE collaboration has constructed two solenoidal spectrometers, one placed upstream, the other downstream, of the cooling cell. An ensemble of muon trajectories is assembled offline, selecting an initial distribution based on quantities measured in the upstream particle identification detectors and upstream spectrometer. This paper describes the techniques used to reconstruct the phase-space distributions in the spectrometers and presents a measurement of the emittance of a variety of momentum-selected muon ensembles.

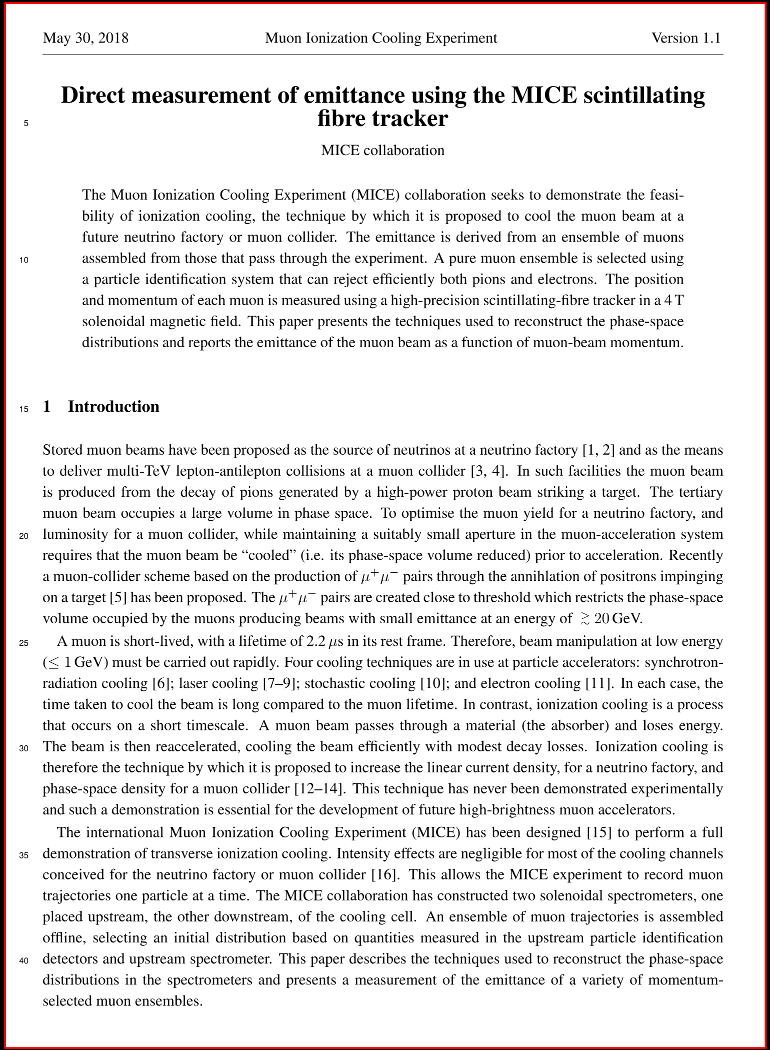
Emittance paper:

- VB has addressed all textual commens
- CM51 comment re data/MC agreement:
  - Being addressed by C.Hunt with a 'hybrid MC' approach








May 30, 2018 Muon Ionization Cooling Experiment Version 1.1

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- **CM51 comment re data/MC agreement:**
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P. Franchini, V. Blackmore:

- **Virtual planes along d/s beam line (Q4 – Q9):**
  - **Strong indication that aperture limitation in quads changes *P* distribution, we know there is dispersion;**
  - **Beam at Q9 offset to –ve x;**
- **Rotation as beam enters/travels through SSU explains y shift?**

C. Hunt:

- **Take G4BeamLine distribution at exit of D2, shift by -10MeV:**
  - **Appears to improve *P* (and so TOF) distribution**
  - **Now trying to generate 'hybrid MC' to see if agreement is improved:**
    - **Hampered by 'overwrite'! Watch this space.**

Spokesman's introduction

PAPERS & NEXT STEPS IN ANALYSIS

The liquid-hydrogen absorber for MICE

V. Bayliss[1], J. Boehm[1], M. Courthold[1], S. Harrison[1a], M. Hills[1], P. Hodgson[2], S. Ishimoto[3], A. Kurup[4], W. Lau[5], K. Long[1,4], A. Nichols[1], D. Summers[6], M. Tucker[1], P. Warburton[7], S. Watson[1b], C. Whyte[8,9,10]

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a. *Now at: AS Scientific Products Ltd, 2 Barton Lane, Abingdon, OX14 3NB, UK*
b. *Now at: Astronomy Technology Centre, Royal Observatory, Blackford Hill, Edinburgh, EH9 3HJ, UK*

Abstract

The Muon Ionization Cooling Experiment (MICE) has been built at the Rutherford Appleton Laboratory to demonstrate the principle of muon beam phase-space reduction via ionization cooling. Muon beam cooling will be required at a future proton-derived neutrino factory or muon collider. Ionization cooling is achieved by passing the beam through an energy-absorbing material, such as liquid hydrogen, and then re-accelerating using RF cavities. This paper describes the hydrogen system constructed for MICE including: the liquid-hydrogen absorber, its associated cryogenic and gas systems, the control and monitoring system, and the necessary safety engineering. The performance of the system in cool-down, liquefaction, and stable operation is also presented.

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Submitted to JINST

Now waiting for referees' comments

Papers

		02-Aug-18	v7
Title	**Contact**	**Target date**	
		Final	**Preliminary**
Direct measurement of emittance using the MICE scintillating-fibre tracker	V. Blackmore	Jun18 CM51	
The MICE liquid-hydrogen absorber	C. Whyte/J. Boehm	Jun-18	Apr18 w/s
The MICE Analysis and User Software framework	D. Rajaram	Jun18 CM51	May18 w/s
Phase-space density/emittance evolution; rapid communication	C. Rogers	Jun18 CM51	Apr18 w/s
Measurement of multiple Coulomb scattering of muons in lithium hydride	J. Nugent	Jun18 CM51?	
Performance of the MICE diagnostic systems	S. Wylbur/P. Franchini		Jun-18
Beam-based alignment	C. Hunt		Jun-18
Muon Ionization Cooling Experiment (h/w)	C. Whyte/P. Franchini		Jun-18
Phase-space density/emittance evolution review paper	C. Hunt		
Phase-space density/KDE/6D-emittance evolution	T. Mohayai		Jun-18
Measurement of multiple Coulomb scattering of muons in LH2	J. Nugent		
Field-on measurement of multiple Coulomb scattering	A. Young		

Comments

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Emittance paper:
- Bug fix! Then move to second collaboration draft.

MAUS paper:
- Need to move to submit to JINST special issue asap.

'Cooling' rapid communication:
- Seek referees meeting asap:
  - KL to organise; CR 'conflicted'

MCS LiH paper:
- This VC

System performance paper:
- This VC

H/w overview paper:
- CW/KL have dropped the ball; need to push now

Next steps

- **This summer (sic) seek to have:**
  - **Submitted emittance-measurement paper;**
  - **Prepared final iteration of LiH scattering and be close to submission**
  - **Submitted MAUS paper;**
  - **Completed review of ‘cooling MICE note’ to move to paper;**
  - ***Initial draft of h/w overview paper***
- **Spotlight from September 2018:**
  - **Long emittance paper**
  - **Emittance exchange paper**
  - **LH2 scattering paper**
  - **Other papers noted on previous slide**

Fixed points in analysis work

- Analysis w/s:
  - Week commencing: 27Aug18
  - 9, 10, 11 October 2018, in preparation for CM52
- CM52:
  - Plenary: 11Oct18 (afternoon) – 13Oct18 (morning)
  - RAL:
    - WWW page: https://indico.cern.ch/event/745868/

MICE CM52

11-13 October 2018
Other Institutes
Europe/London timezone

Search...

- Overview
- Timetable
- Participant List

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The 52nd Muon Ionization Cooling Experiment (MICE) Collaboration Meeting will be held at the Rutherford Appleton Laboratory from Friday 12th October to Saturday 13th October 2018 inclusive.

Registration: £45 **Collaboration Dinner: £35**

Payment method: via Bucksnet link below NO CASH FACILITY

Starts 11 Oct 2018, 13:00
Ends 13 Oct 2018, 14:00
Europe/London

Other Institutes
Conference Rooms 12 and 13 Building R68
STFC, Rutherford Appleton Laboratory
Harwell Oxford Campus
Chilton
Oxfordshire OX11 0QX UK

www.stfc.ac.uk

Attendees from outside of the UK please click

Pay for CM52

Phone conference information:

The usual MICE phone-conference connection will be used. Please see:

MICE phone bridge