Physics Program and Runs: Autumn 2011 & Step IV

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MICE Project Board, 08/03/12

Dec 2011 Run

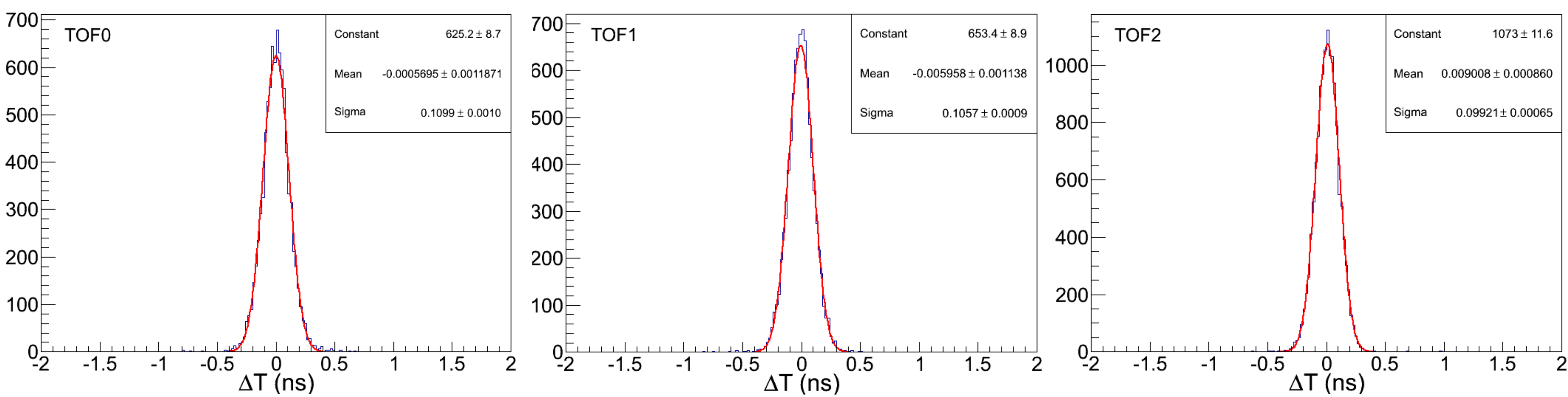
- MICE recently ran during the December ISIS User Run
- Planned and organised by Linda Coney (Online Group) and Yordan Karadzhov (MICE Operations Manager)
- Dates set early 2011
  - Run planning initiated 8th August
  - Ran 1st to 16th December
- MICE needs to know:
  - What?
  - Where?
  - When?
- Many detectors to do this
  - Upstream: TOF0, TOF1, CKOVs
  - Downstream: TOF2, KL, EMR
- Must understand our detectors
  - → Calibration

Dec 2011: TOF Performance

- Identifying time & particle species depends on timing resolution of TOFs.
  - TOF0: 55 ps
  - TOF1: 60 ps
  - TOF2: 50 ps

  (TOF0 and TOF1: rebuilt)

- New calibration:
  - TOF0: 55 ps
  - TOF1: 53 ps
  - TOF2: 50 ps

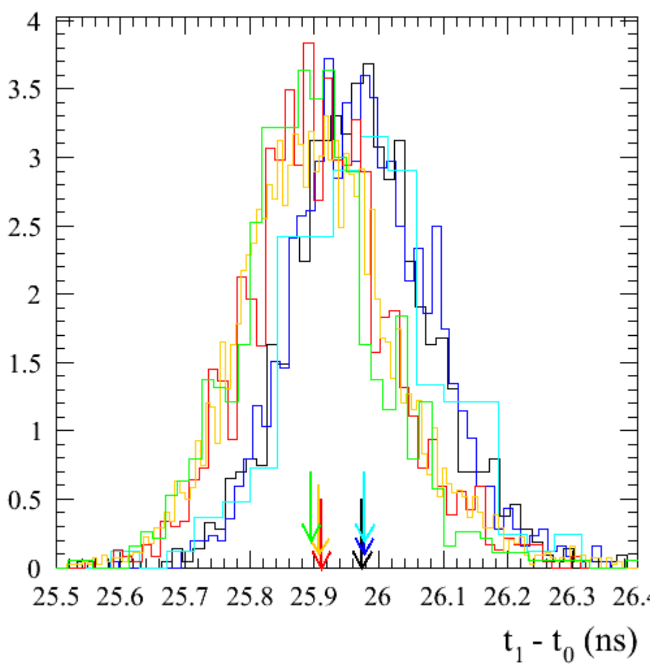


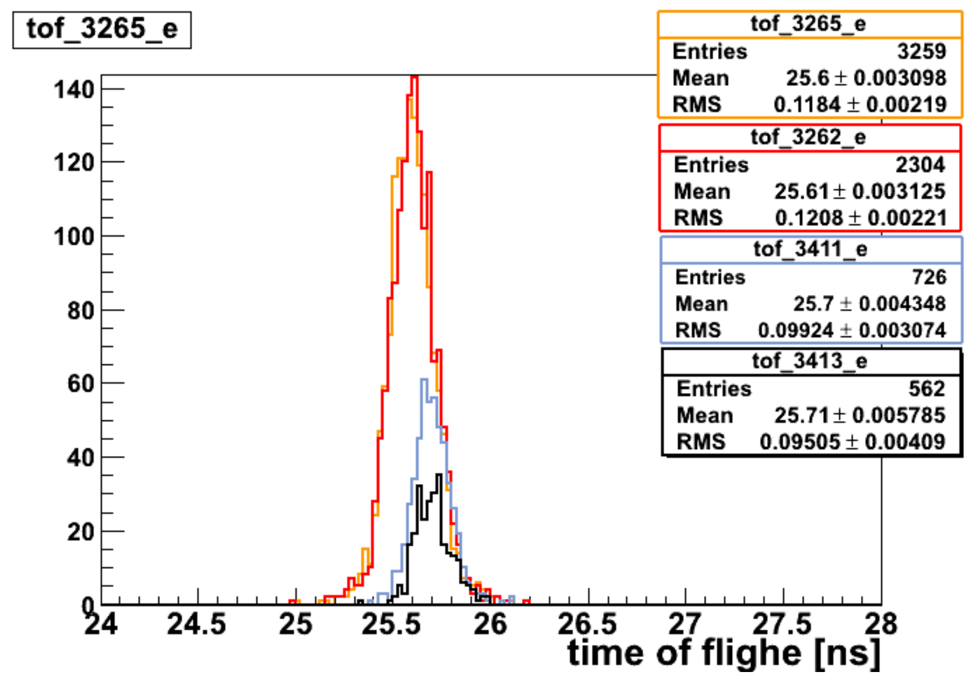
Yordan Karadzov, Durga Rajaram

Dec 2011: e^+/e^- Time of Flight

- 70 ps difference in electron/positron time of flight
- Not a path length difference

- Create 5 x more positive than negative particles
- Increased rate → overworked PMTs respond more slowly

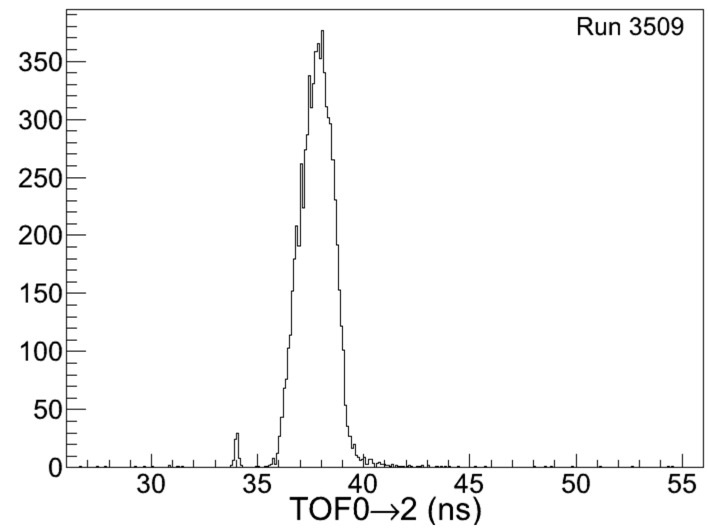


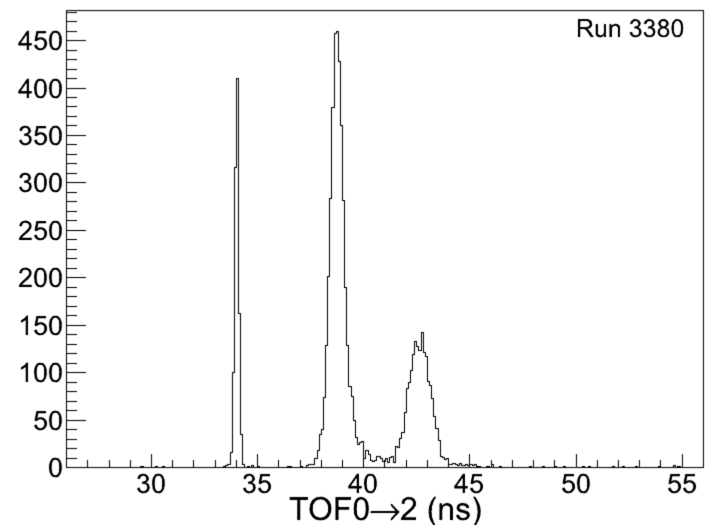


Yordan Karadzov, John Cobb

Dec 2011: π-Contamination

- (Simplistic) simulation of π-contamination in μ-beam 1-5%
- Better to make a direct measurement
- Use KL
  - π → hadronic interactions
  - μ → no hadronic interactions
- Calibrate method using a "π"-beam
  - Train using π and μ with same time of flight in π-beams of suitable momenta.

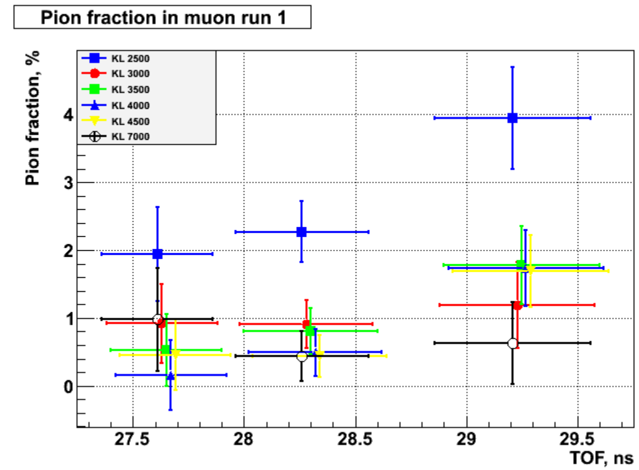




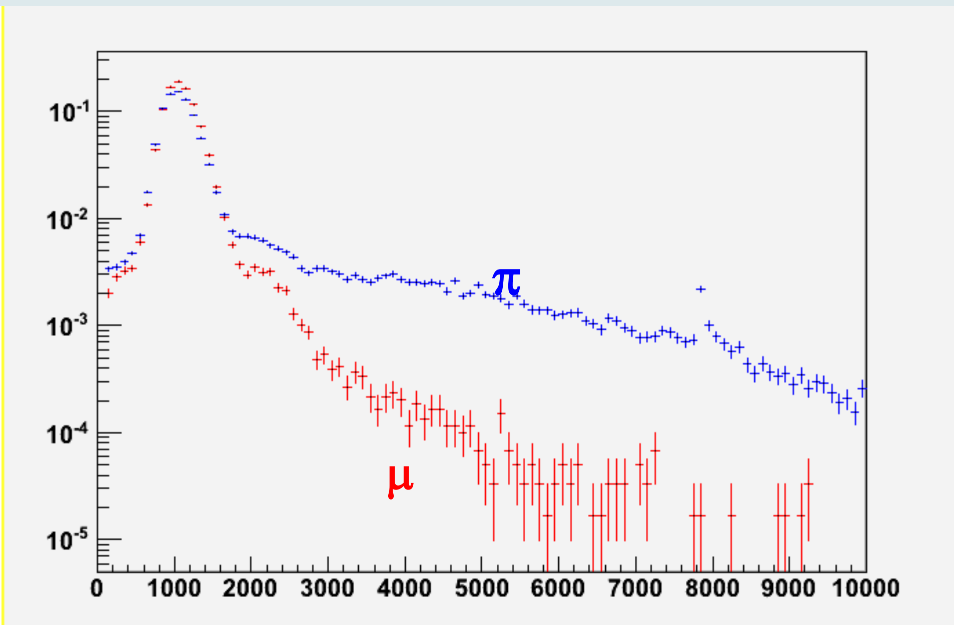
Maryian Bogomilov, Yordan Karadzov, Domizia Orestano

Dec 2011: π-Contamination

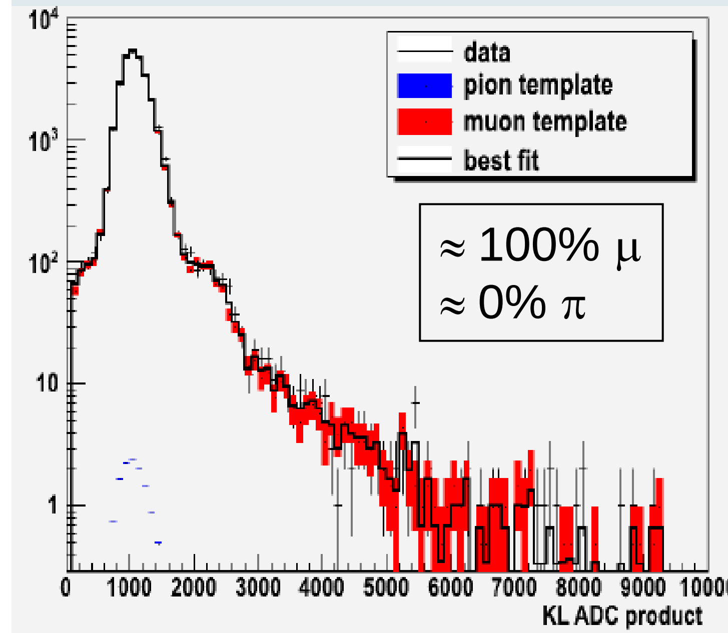
- Found that π make up less than 1 – 2 % of our μ–beam
- Further analysis needed to understand systematic errors and improve precision



1. Template of KL pulse height in π-beam

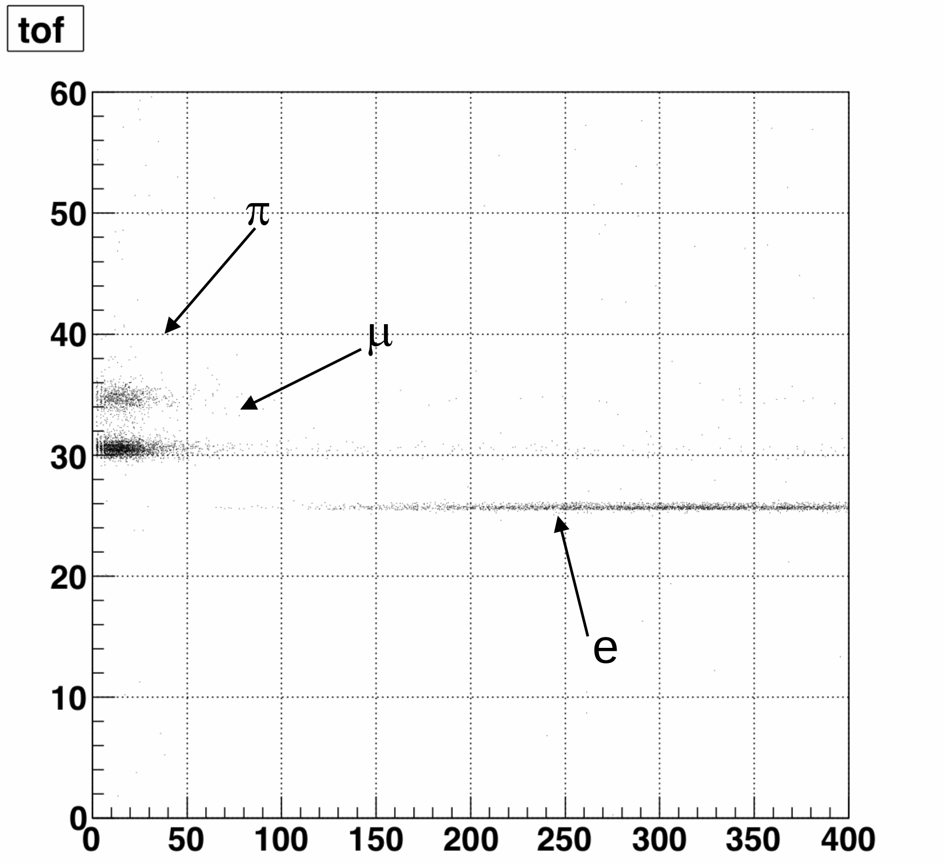


2. Apply to μ-beam



Dec 2011: Cherenkov Studies

- CKOV count vs. TOF for a low momentum π–beam
  - >40 photoelectrons per electron transit
  - 1 – 2 photoelectrons per π/μ transit
  - Good separation identifying particles
- Analysis underway
- Next: high momentum beams!

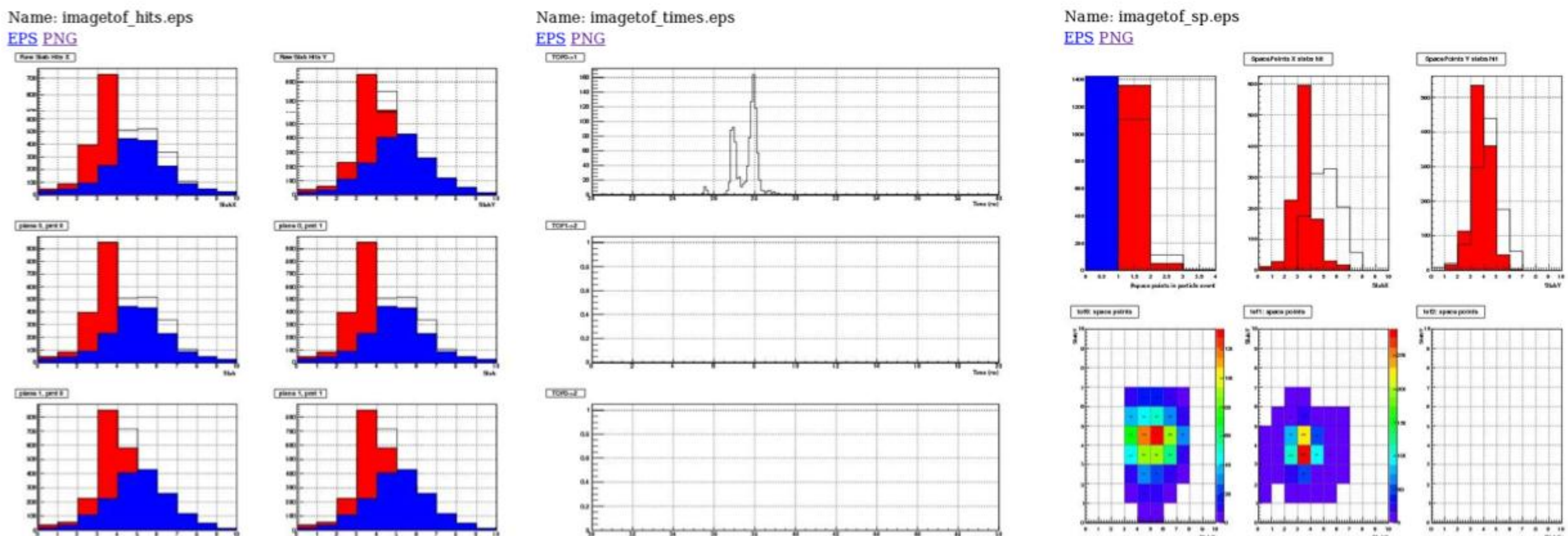


Lucien Cremaldi, Gene Kafka

Dec 2011: Summary

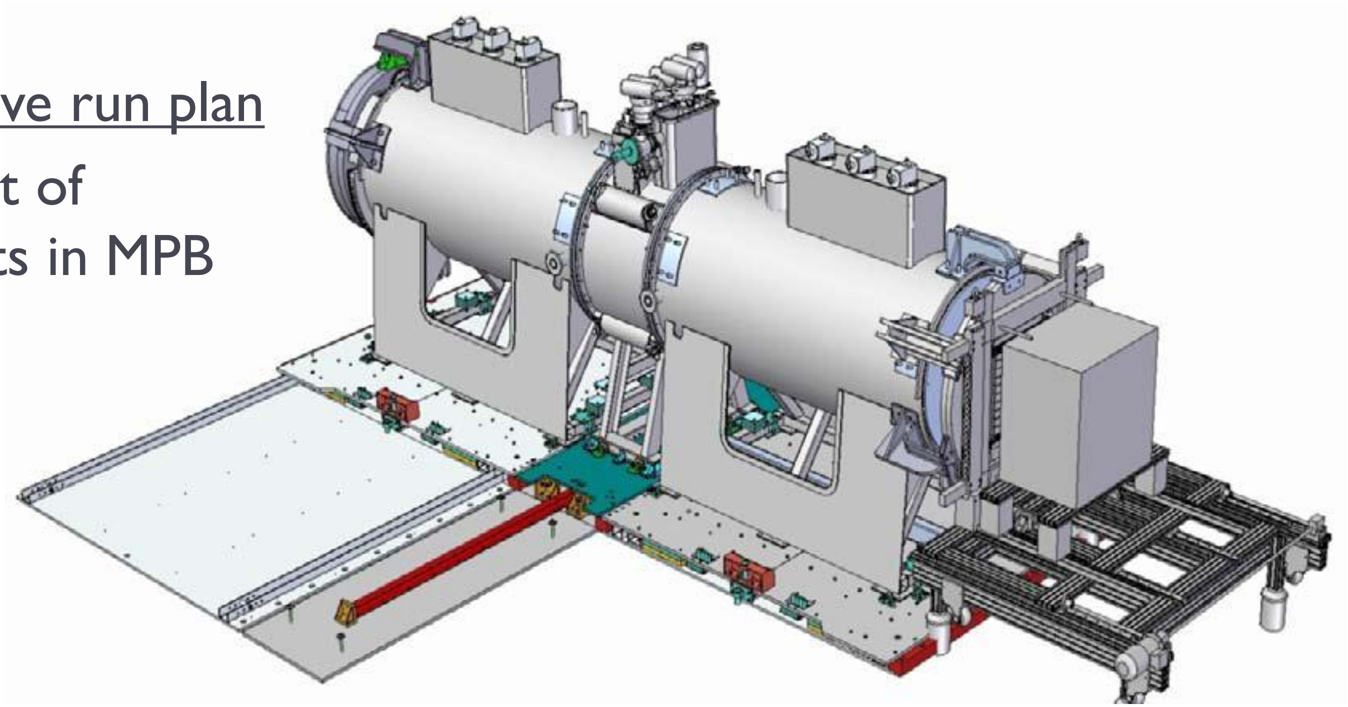
- Excellent organisation = efficient run
- Online reconstruction available made the run very successful
- Lots learnt from >250 GB of data taken (~50 μ/s)
  - Calibrations, rate effects, contamination…
  - More to learn upon further analysis

MAUS histograms



Step IV: Run Plan

- Step IV physics objectives and running discussed during CMs and analysis meetings
  - Current understanding of desired measurements given here
  - Not a definitive run plan
  - Exhaustive list of measurements in MPB report

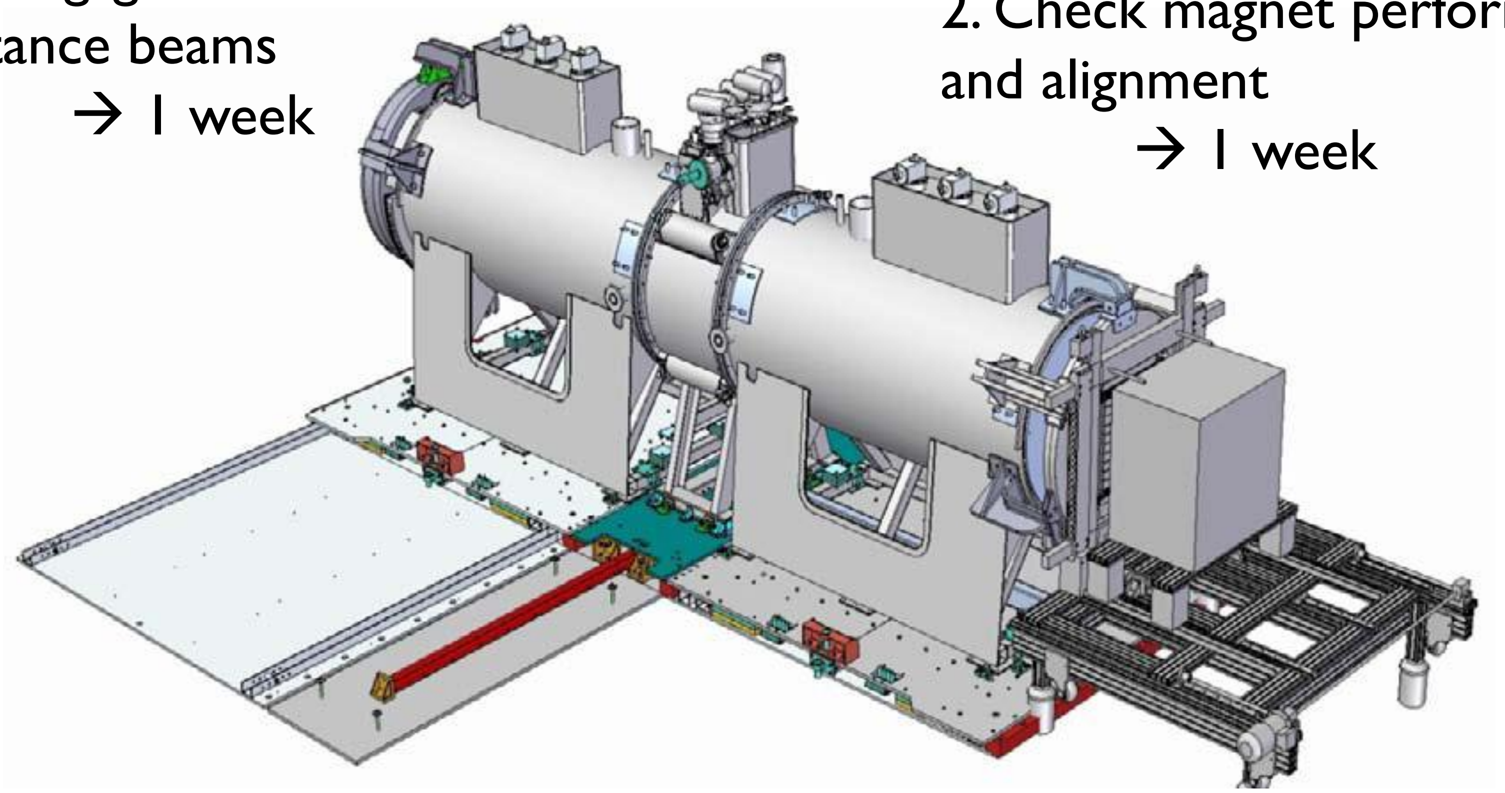


Steps II and III in Step IV

100’000 μ / 2 hours

4. Understand beam line matching, generate correct emittance beams
→ 1 week

2. Check magnet performance and alignment
→ 1 week



3. Check forces between coils
→ 2 days
→ ramp up system!

1. Commission & calibrate detectors, check alignment
→ 1 week

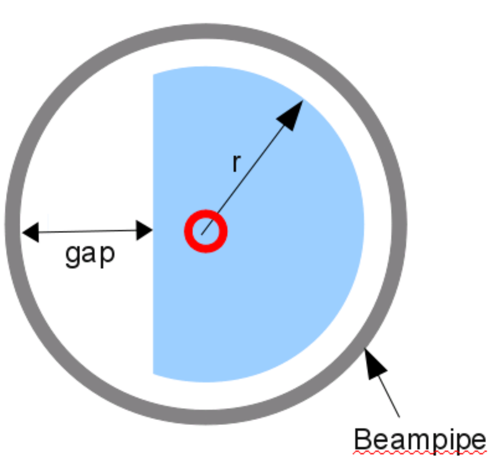
Step IV

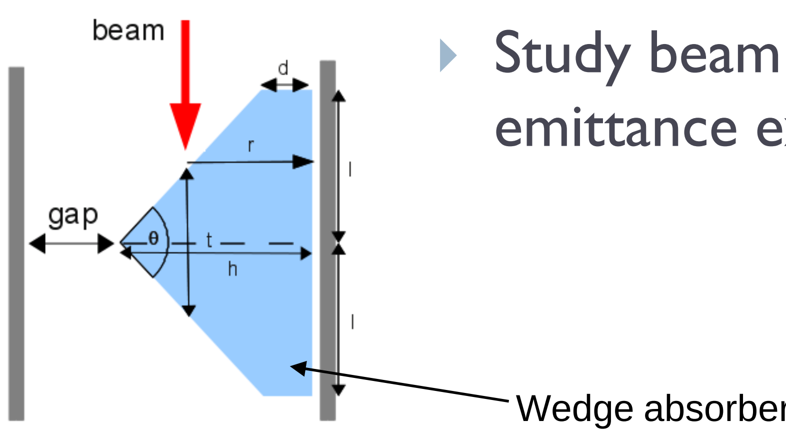
- Understanding MICE optics; momentum acceptance, aperture
  - Empty channel, baseline beam settings
  - Momentum scans
  - Different β-functions
  - Different ε
  - Different field configurations.
  - Then compare with simulations!
- Time consuming, but necessary
  - 3 momenta, 3 emittances, 2 field configurations, 4 β-functions, 72 measurements
  - Approximately 140 hours (for 100k μ) + time to change beam settings
- Finally, exercise the cooling formula!

$$\frac{d\varepsilon_n}{dz} = \frac{-\varepsilon_n}{\beta^2 E}\left\langle\frac{dE}{dX}\right\rangle + \frac{\beta_t\left(0.014\ \text{GeV}\right)^2}{2\beta^3 E m_\mu X_0}$$

Step IV

- First demonstration of μ cooling in MICE
  - Liquid H or LiH disc
  - 3 momenta, 3 emittances, 4 β-functions, 2 field configurations = 72 measurements
- Then move to other solid absorbers
  - Al, C
  - Verify material dependence
  - Measure multiple scattering, energy loss, cooling
- Finally investigate wedge absorbers
  - Study beam dispersion, emittance exchange





Step IV: Timeline

ISIS User Runs:

Feb – March 2013	• Commission and calibrate detectors, check alignment • Magnet performance and alignment • Diffuser and beam matching • Empty channel measurements
May 2013	• First demonstration of cooling • Empty absorber, Liquid Hydrogen absorber • Full set of measurements
July, 2013 October, 2013	• Cooling measurements with LiH solid absorber • Verification of cooling formula with different solid absorbers • Multiple scattering, energy loss
November, 2013	• Wedge and half-wedge absorbers