MICE Status

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Outline

I Motivation

II Procedure for cooling muons

III "Aspirational" schedule

IV MICE description – steps I and II

V Status – the good, bad, and ugly

VI Results along the way

VII Summary

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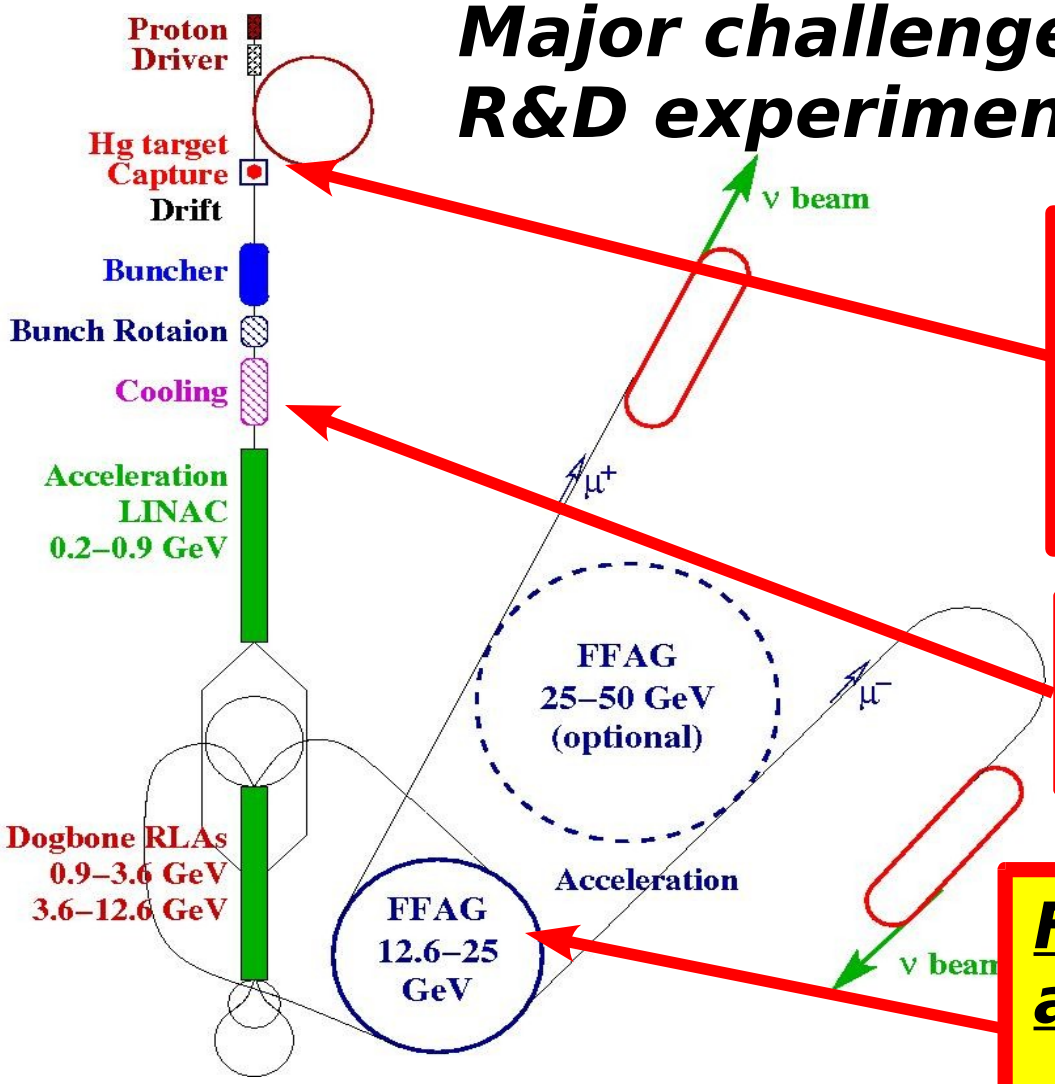
Motivation

Major challenges being met by R&D experiments



High-power target:
- 4MW
- good transmission
  - MERIT (CERN)

Fast muon cooling:
- MICE (RAL)

Fast, large aperture accelerator (FFAG)
- EMMA (Daresbury)

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Procedure: Ionization Cooling

- *"Cooling" muons refers to reducing the emittance of the muon beam.*
- *Muons are created in tertiary interactions, and so are created with large inherent emittance:* $p + N \rightarrow \pi + X$, $\pi \rightarrow \mu + X$
- *Due to short muon lifetime, the only viable option is ionization cooling. Must cool AND accelerate rapidly:*

Procedure: MICE

MICE will measure a 0.1% absolute cooling effect

create beam of muons

1) ***identify particles and reject background***
2) ***measure single particle emittance***
3) ***"cool" muons in low-Z absorber***
4) ***restore longitudinal momentum component with RF***
5) ***remeasure single particle emittance***
6) ***identify particles to reject electrons***

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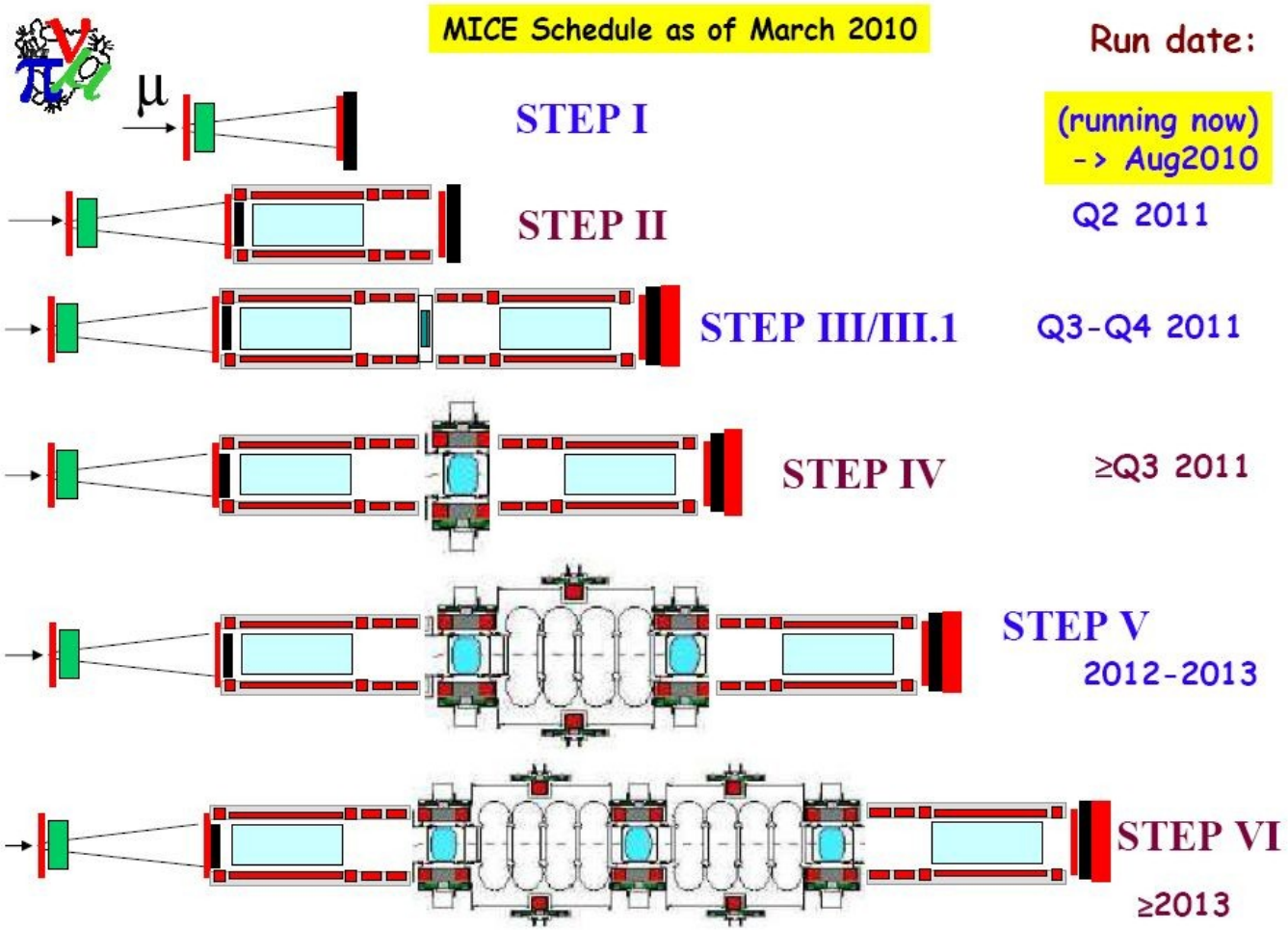
Aspirational Schedule



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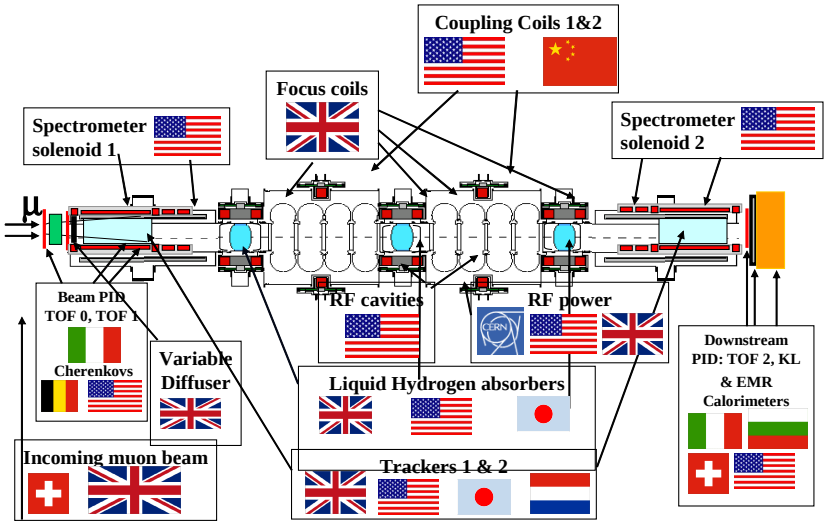
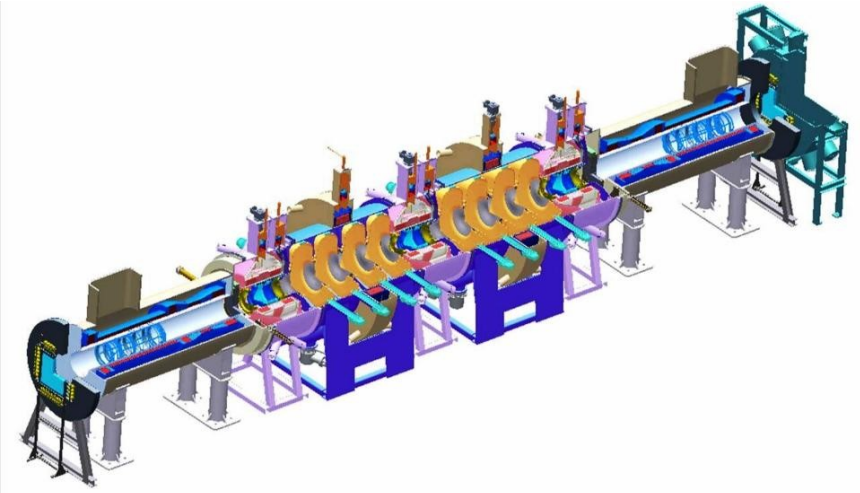
Description



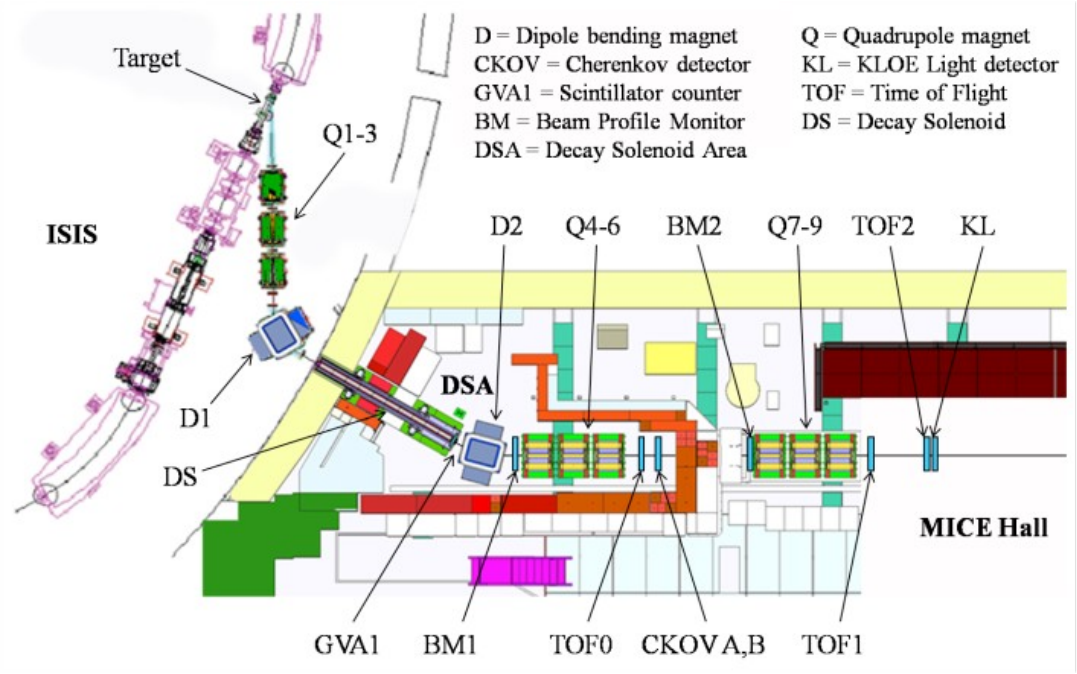
MICE Collaborators

Description: MICE

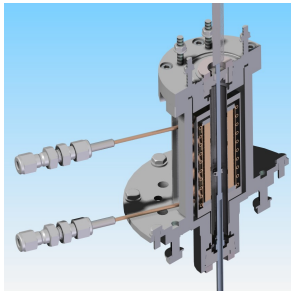
- *Beamline – create beam of muons*
- *Particle ID – verify/tag muons*
- *Tracker – measure emittance*
- *Absorber (LH2 or LiH) – cooling*
- *RF – reestablish longitudinal p_z*



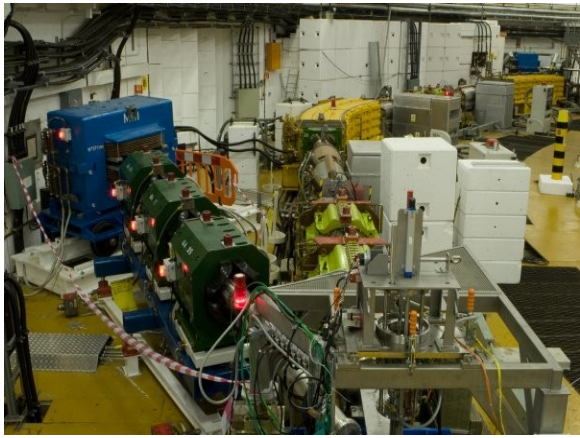
Description: Beamline



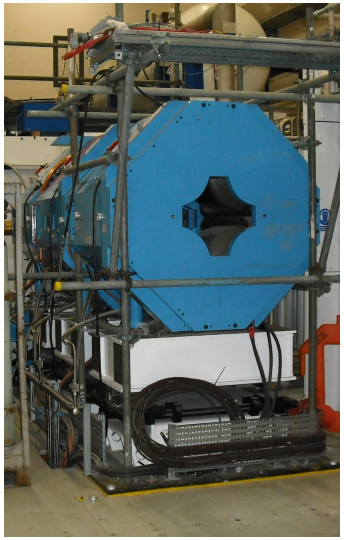
Description: Beamline



MICE Beamline consists of:



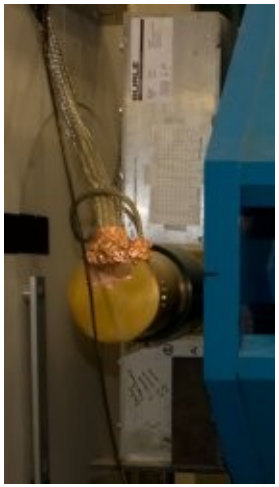
- Target
  - dips into ISIS accelerator
  - 1 Hz
- Conventional magnets
  - 2 dipoles – select pion momentum
  - select muon after pion decay
  - 3 quadrupole triplets for focusing
- Superconducting decay solenoid
  - extends pion decay path
  - 5 T
  - 5 m long

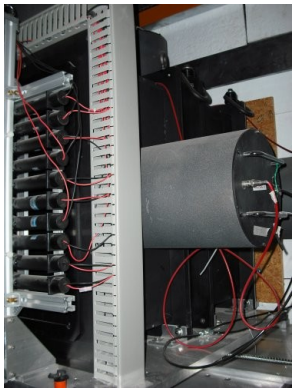


Description: Beamline (other)

- *Target – modified version under way*
- *Proton absorber – initial version tested*
- *Beamstop – finished*
- *Diffuser – under construction*
- *Radiation shutter – under construction*

Description: PID





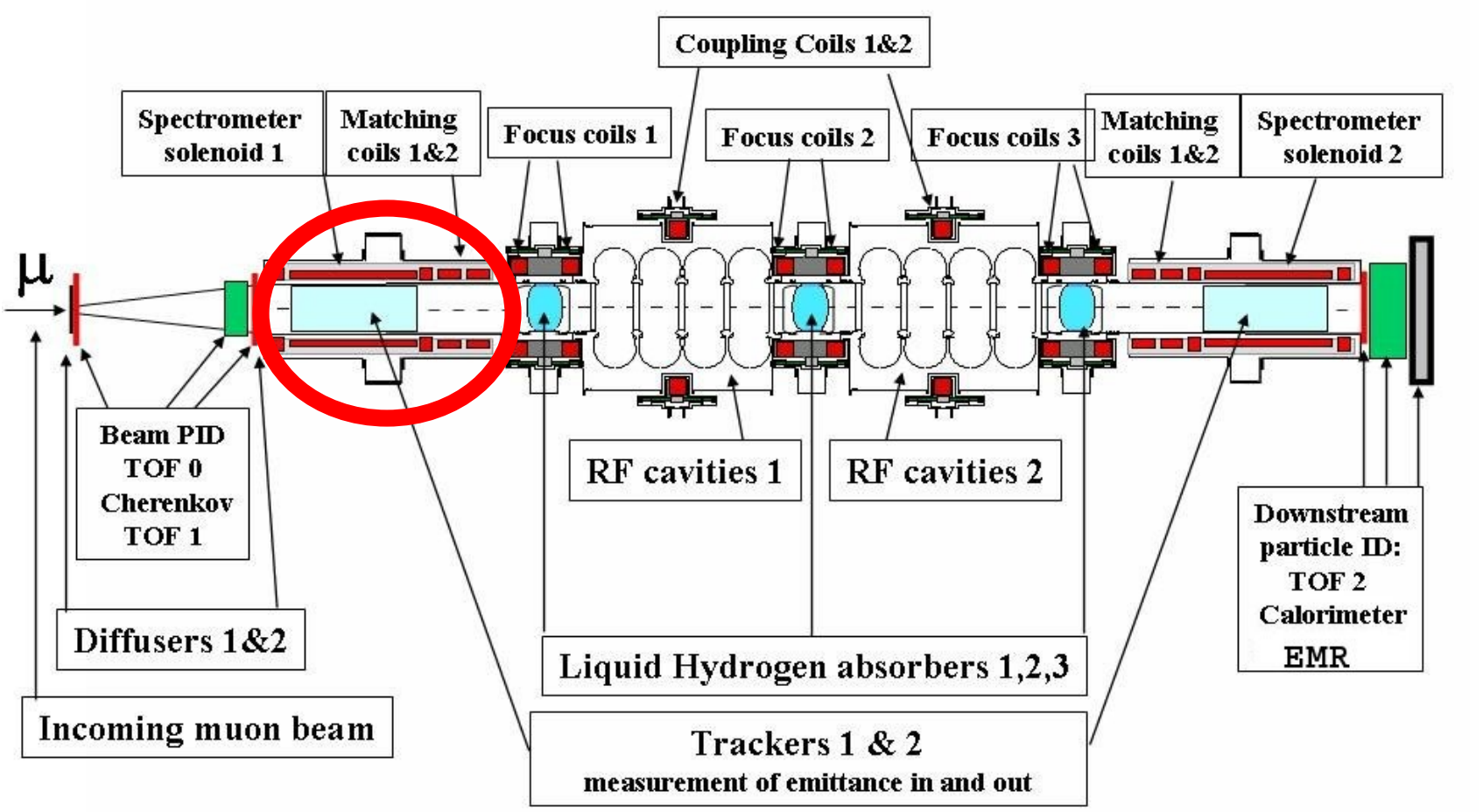
Upstream PID: discriminate p, π, μ

- Beam profile monitors
- Threshold Cerenkov
- Time of Flight – ToF0 & ToF1

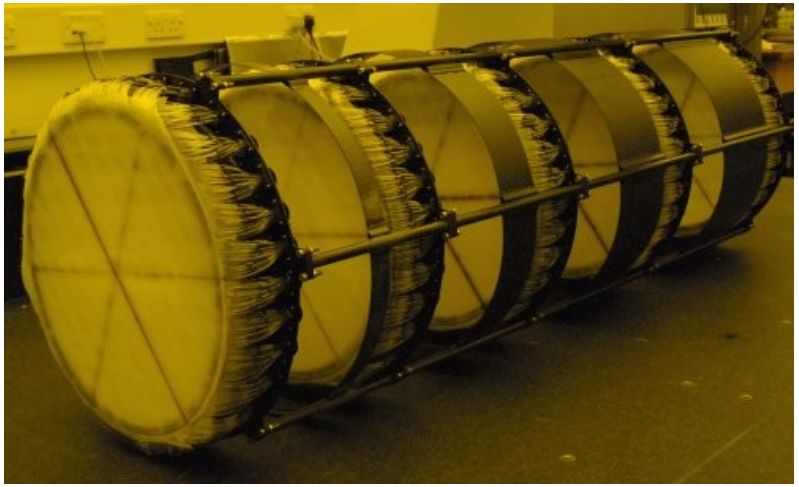
Downstream PID: reject decay electrons

- Time of Flight - ToF2
- Kloe-like Calorimeter - KL
- Electron-muon Ranger - EMR

Description: Step II



Description: Tracking



- *Two trackers – before/after absorber*
- *Measures x, y, x', y'*
- *5 stations/tracker*
- *3 stereo planes/station (U/V/W)*
- *1400 350μm fibers/plane*
  double layer, 7 fibers/group
- *<0.2% dead channels*
- *>10.5 photoelectrons/MIP*
- *430μm RMS position resolution*

- *4 T superconducting*
- *2 m long*
- *20 cm warm bore*
- *5 coils:*
  - *1 main tracker coil*
  - *2 end coils*
  - *2 matching coils*
- *closed-cycle pulse-tube cryo-coolers*

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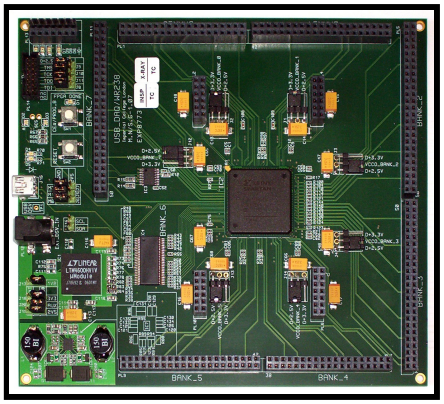
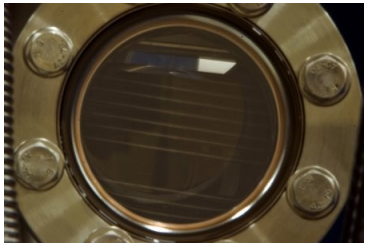
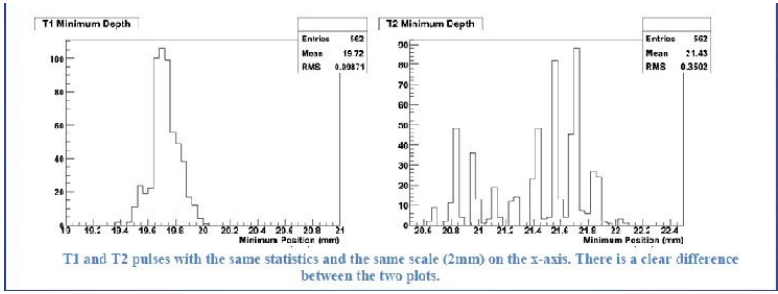
Status: Target

Since December 2008:

- new target hardware design
  - first target works flawlessly
  - demo target failed immediately
  - new demo target!
- new target DAQ (coming soon)





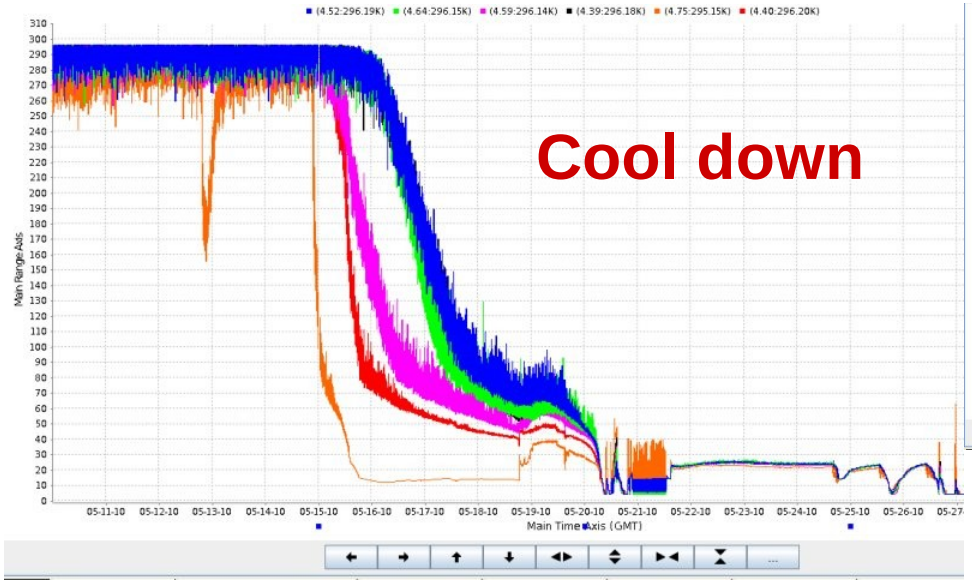


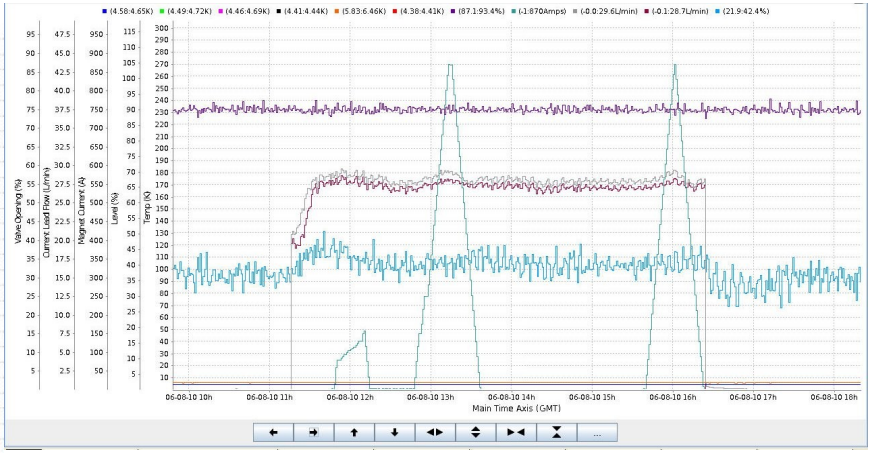
T1 and T2 pulses with the same statistics and the same scale (2mm) on the x-axis. There is a clear difference between the two plots.

Status: Decay Solenoid

Since January 2010:

- **Linde Decay solenoid compressor & cold box annual maintenance left DS inoperable – leaks, etc**
- **Leaks repaired – 10 day cool down now in 5 days!**
- **LHe level probe broken – replaced, calibrated, working**





Step I status: Where are we?

- *Target working – new design in progress*
- *Beamline conventional magnets ready*
- *Decay solenoid operational*
- *All PID detectors (not EMR), installed*
- *ToF0, ToF1, Ckov calibrated*
- *Collecting ToF2/KL calibration data*
- *Initial emittance measurements w/ToF*

Step I nearing completion!

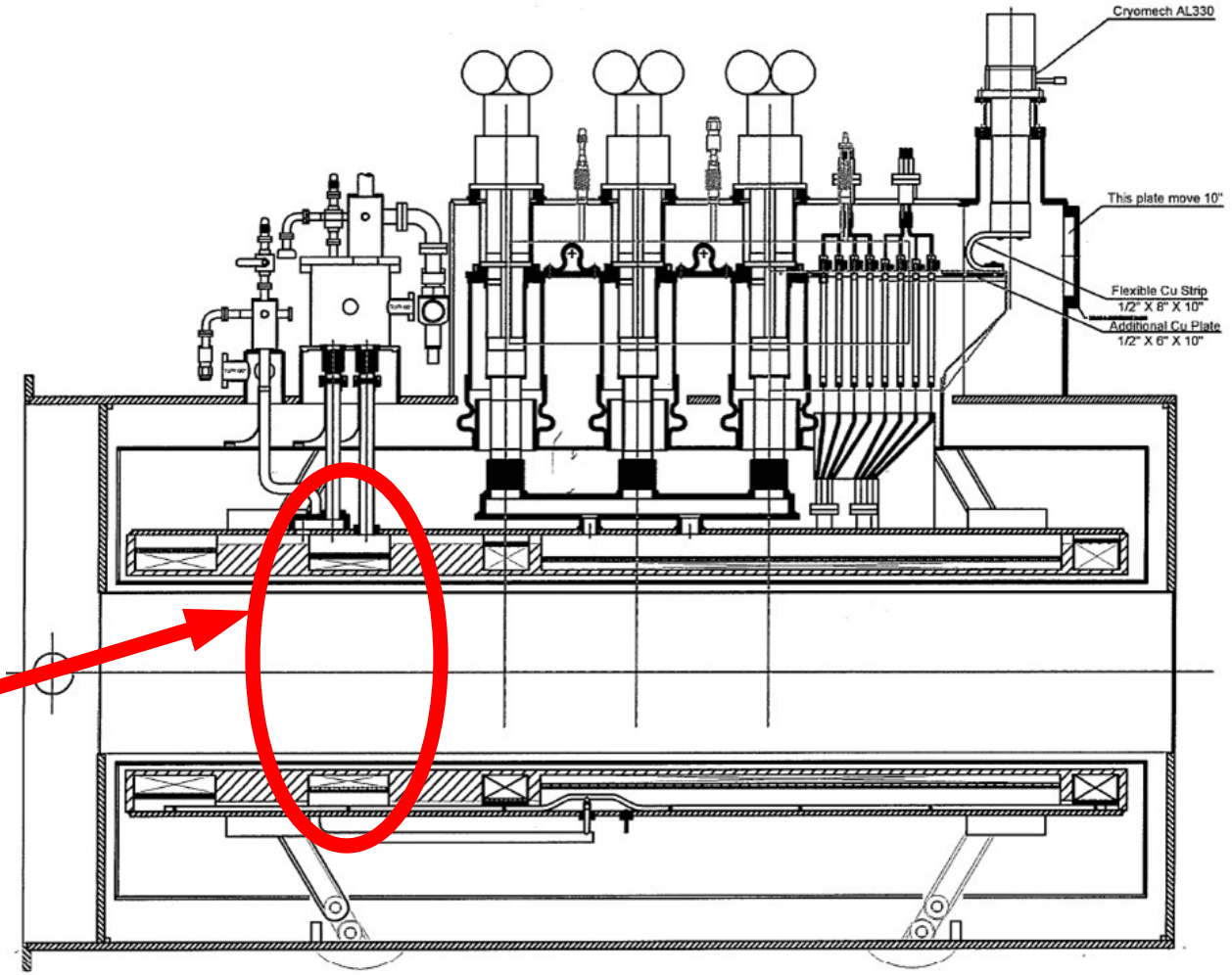
Status: Tracker

Steps II and III require trackers for first emittance measurements

- ***Both trackers ready and tested with cosmic rays***
  - ***High efficiency tracking***
- ***Delays in spectrometer solenoids – critical path***

Status: Tracker Solenoid

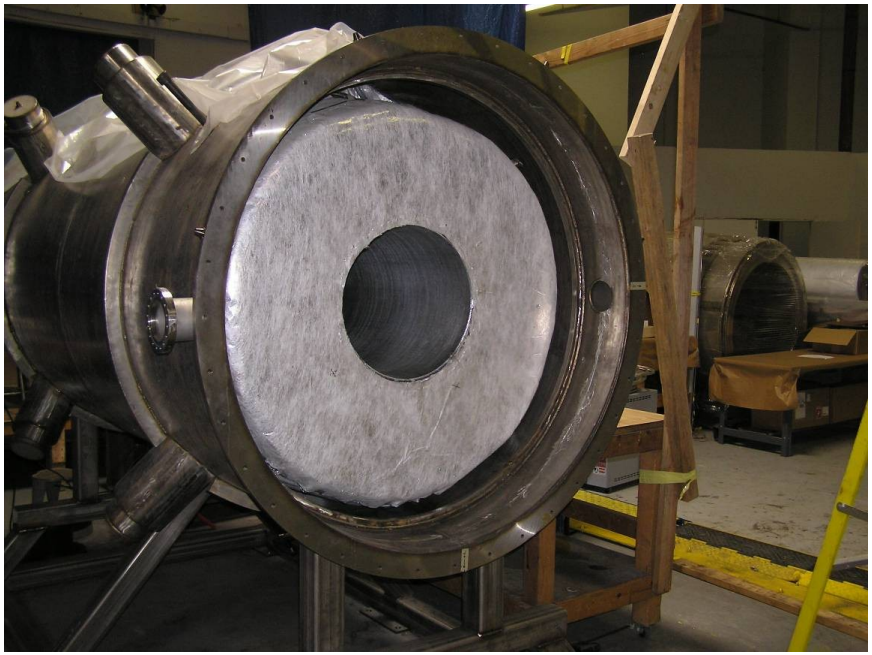
- Additional cryo-cooler added
- HTS leads enlarged
- Additional instrumentation
- 6 successful training runs
- circuit to M2 coil opened
- continued to train E1, C, E2



Status: Tracker Solenoid

- **Magnet 2 disassembly is continuing**
  - being worked on full time by tech
- **Tower has been completely removed**
  - along with items protruding above vacuum vessel envelope
  - fill and vent lines ground off

Status: Tracker Solenoid



- Matching coil opened during testing
- Open was determined to be in cold mass region
- Requires complete dismantling
- Heat load determined to be higher than in original design
- Experts investigating

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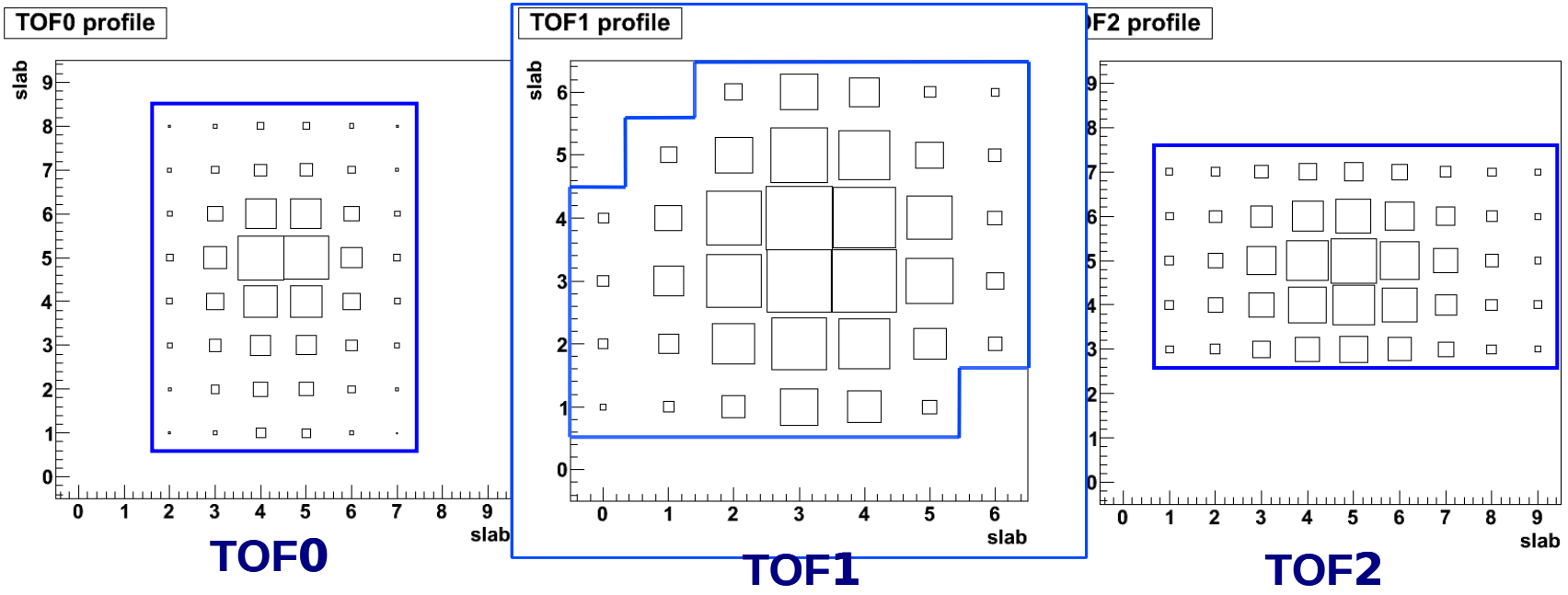
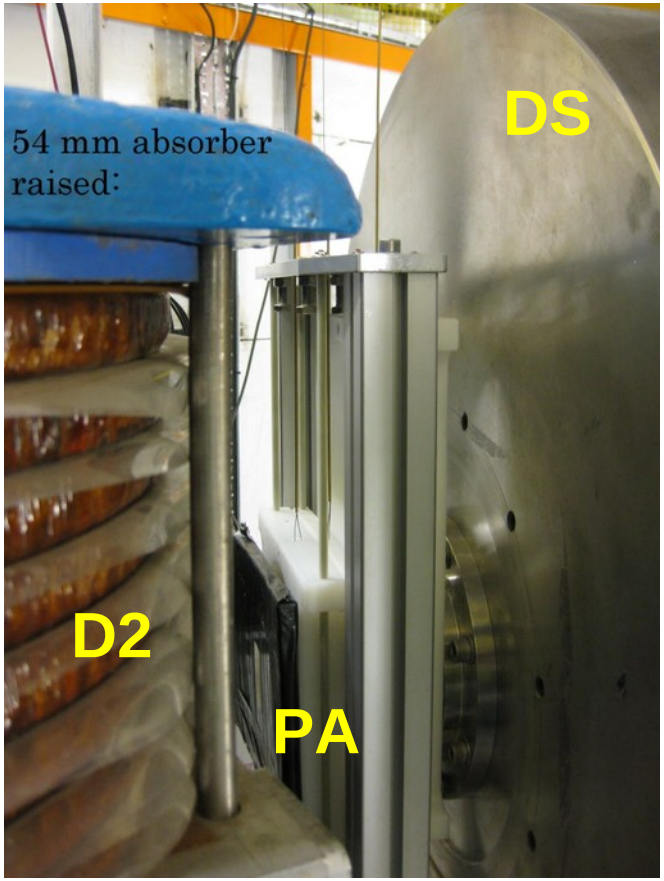
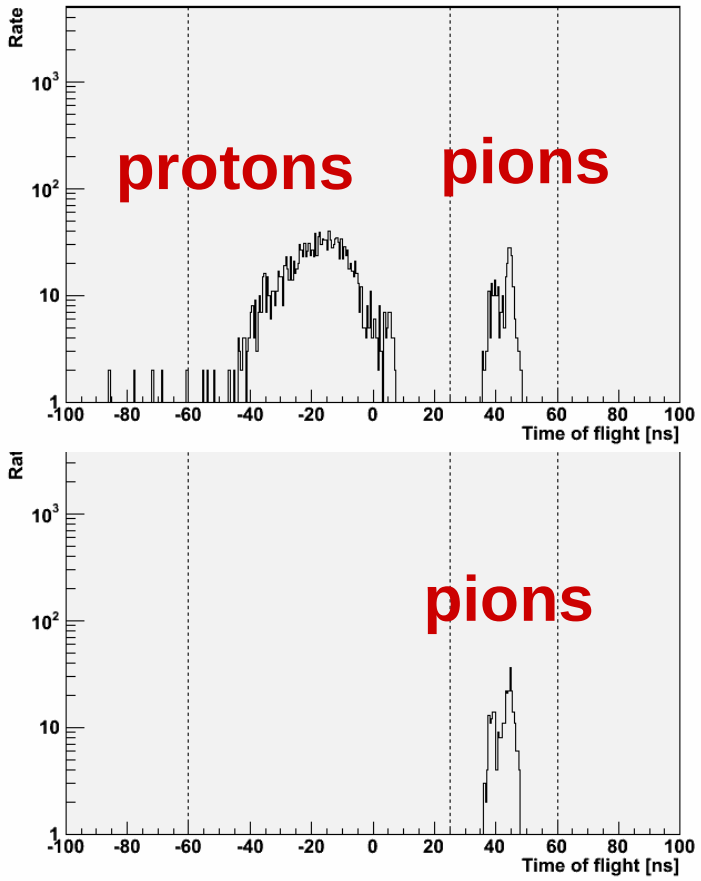


The blue line encloses the calibrated area in the TOF stations.

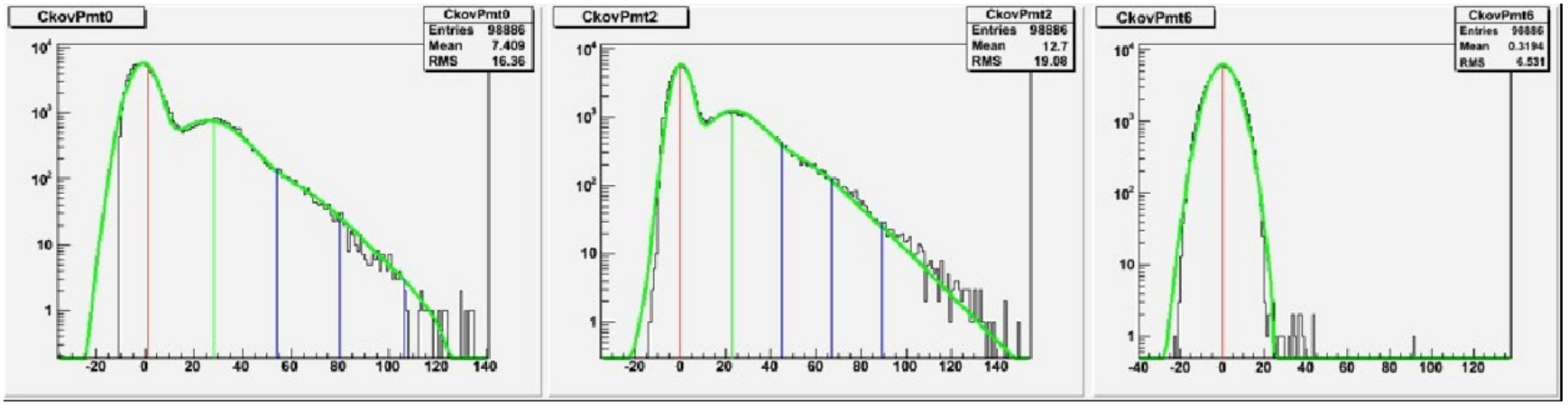
Results: proton absorber

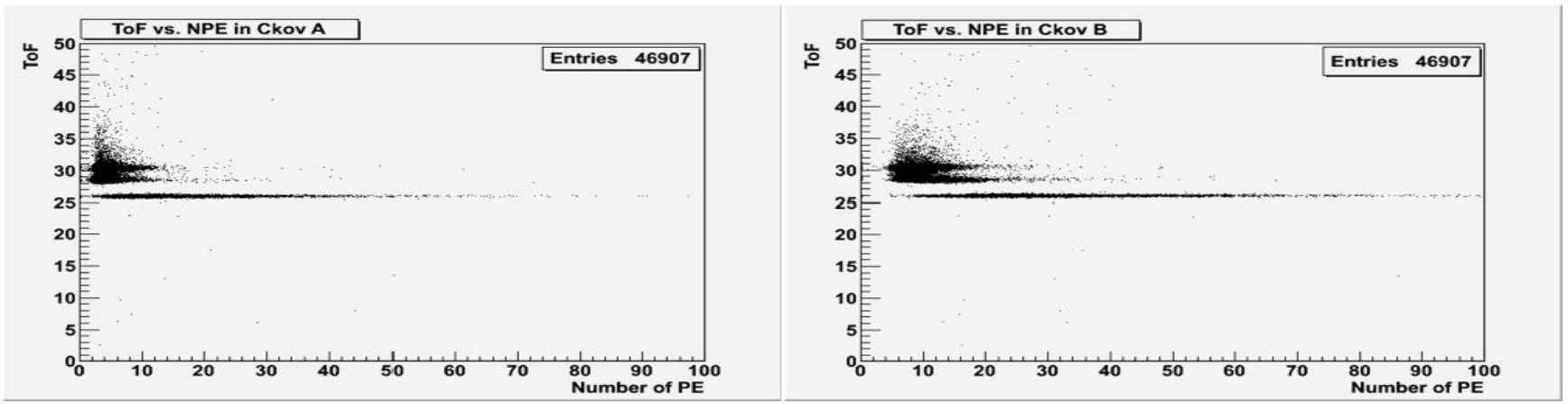




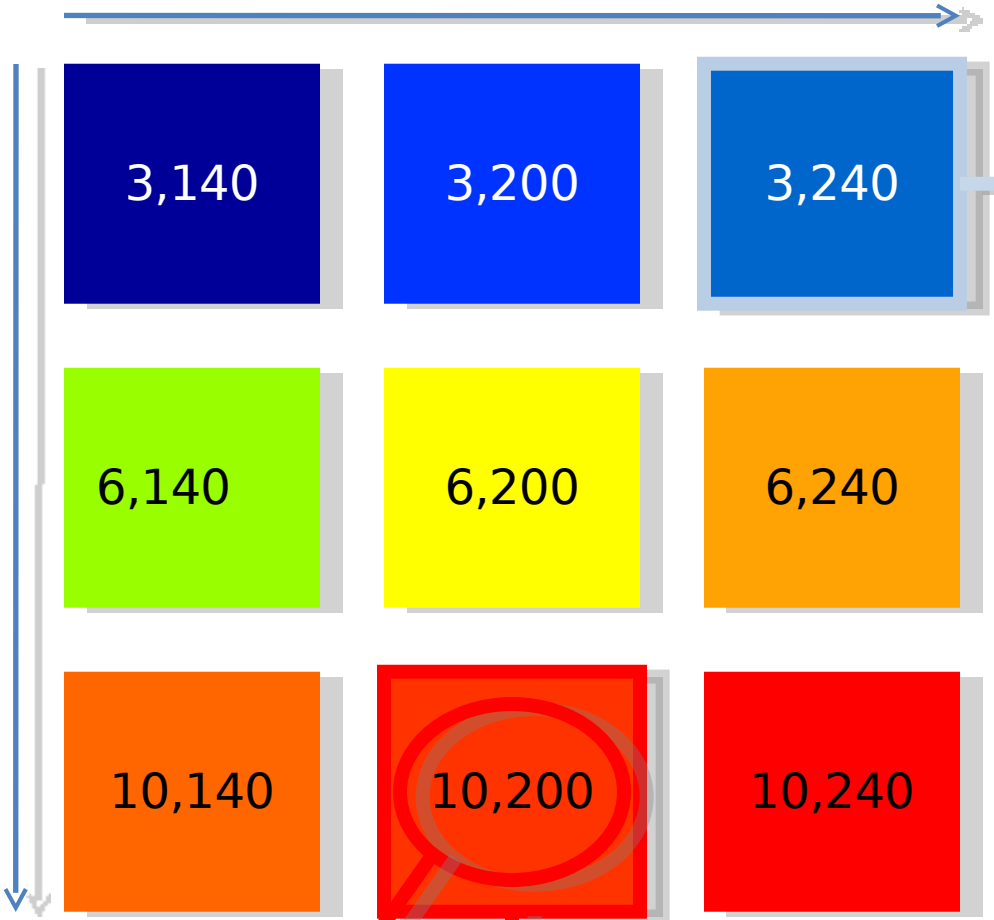
ToF distributions

Results: Ckov calibration





Early results: Where are we?



- finding the element (3,240) means to find the BL optics that matches the MICE optics for a beam of 3 mm rad at a P=240 MeV/c

- the element (10,200) is the BL optics matching a MICE beam with 10 mm rad at P=200 MeV/c

This pair is our goal: how do we get it?

Summary: Summer run plan

- 13 June – 16 hour activation run, beam loss 4V, negatives
  - muon beam studies
  - begin emittance-momentum matrix studies
- 15 June – Particle Rate vs Beam Loss (negative particles)
  - 5.0V – 0.5V in steps of 500mV
- 16 June – Particle Rate vs Beam Loss (positive particles)
  - 5V to 1 V losses, etc
  - Beam Bump Study
- 22-25 June – Start of User Run
  - 2—3 days of ToF calibration
  - 1 day KL calibration
- Monday June 28 - August 12
  - data taking for muon beam emittance - measure 9 points on e-p matrix
  - vary & optimize upstream beam line
  - vary D1 to modify incoming beam
  - vary D2
  - modify downstream quads as triplets and individually to compare w/simulation
  - need to understand clearly what beam looks like at the face of the diffuser in order to appropriately tune for cooling measurement
  - estimate 2-3 days/point on the matrix
  - do for negative polarity and then switch and do for positive polarity

Summary

- ***Muons observed at MICE!***
- ***Target and Decay Solenoid operational***
- ***PID detectors in place and being calibrated***
- ***Tracker working***
- ***Begin emittance studies with ToF***
- ***Step I is well underway!***
- ***Delay in spectrometer solenoids***