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Test Beam Studies of the Muon System Detectors for Future Colliders

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All Experimenters Meeting

27.07.2016

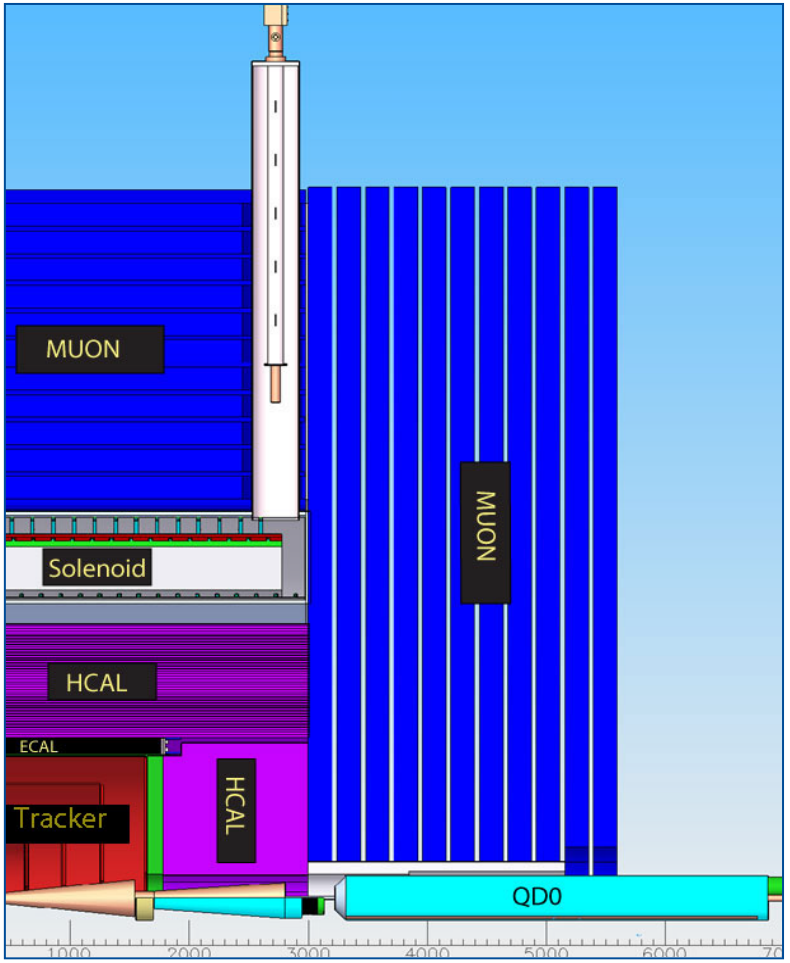
Future Colliders

- Proposed future colliders are of two types
  - e^+e^- colliders as “Higgs factory”
  - pp colliders at the next energy frontier
- Three proposals are under active discussion
  - ILC (Japan)
  - CEPC and SPPC (China)
  - FCC (CERN)
- Detectors for all of these colliders contain three major systems
  - Tracker
  - Calorimeter
  - Muon System
- Fermilab has extensive experience in design and construction of muon systems for the collider experiments
  - We decided to perform test beam studies for the future muon detectors

Muon Systems for a Future Collider

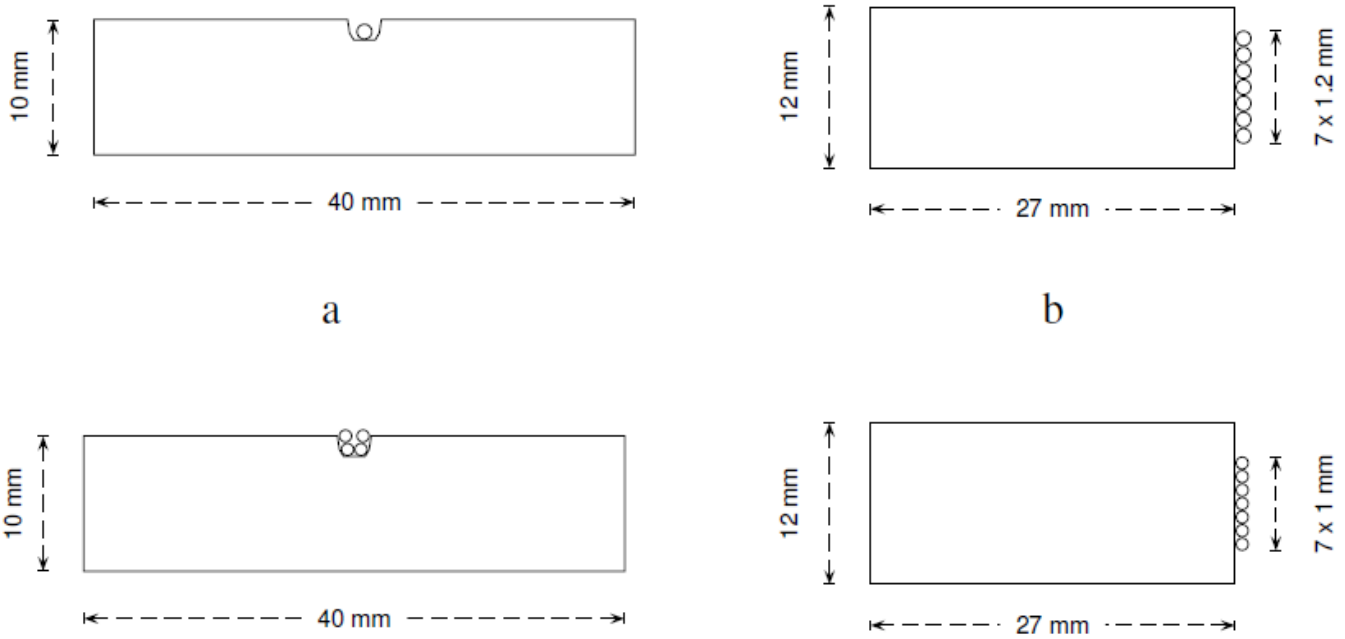
- Main requirements for the muon systems at colliders
  - Large sizes – thousands of square meters
  - Good time resolution – separation of background and muon hits
  - Coordinate resolution which matches multiple scattering of muons in the calorimeters and steel absorbers
  - Reasonable cost, high reliability, etc.
- Use of the recently developed experimental methods, such as silicon photomultipliers, has potential benefits
  - Better performance
  - Lower cost

SiD ILC Detector



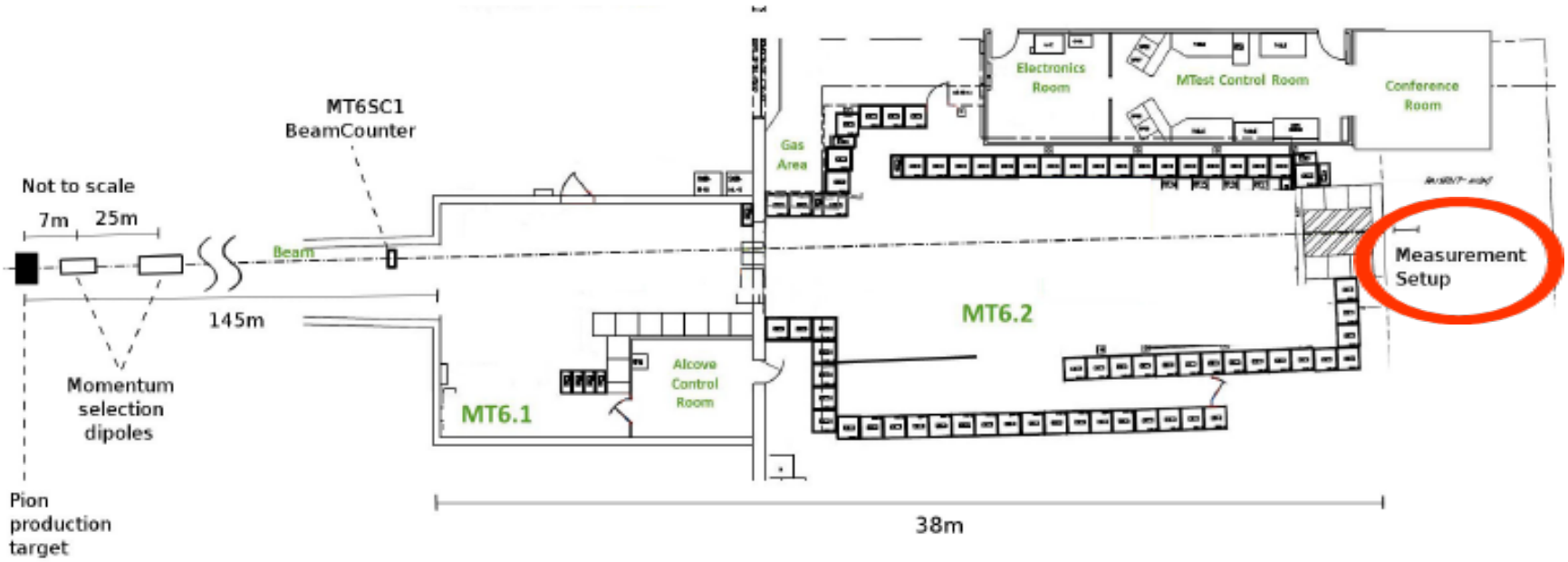
Long Extruded Scintillation Counters

- Various configuration of the scintillation counters with 1mm idiameter wave-length shifting fibers have been used
  - Light was collected on 3x3 mm^2 SiPMs
- Test beam provided an opportunity to measure parameters of the counters – light yield, time resolution, longitudinal coordinate resolution – quickly and efficiently



Muon Beam

- Location of the test setup was outside of the test beam enclosure
  - Easy access during beam time
  - With pions in the main test beam, fraction of them decays to produce muons
    - Muon fluxes a few thousand muons per spill obtained
  - Muon momenta are 50%-100% of the pion momenta
  - Beam diameter is ~10 cm^2

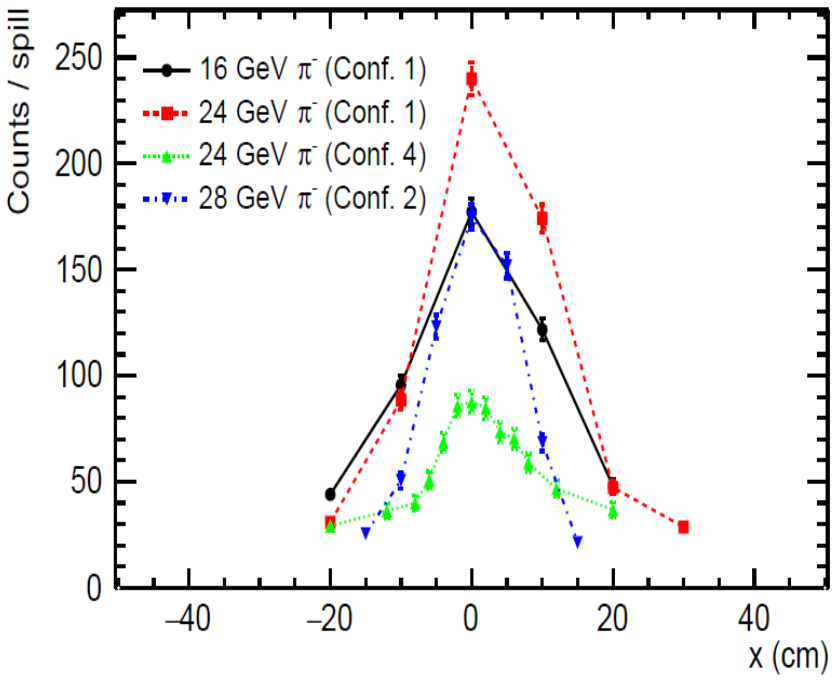


Test Beam Counters Behind Shielding Wall

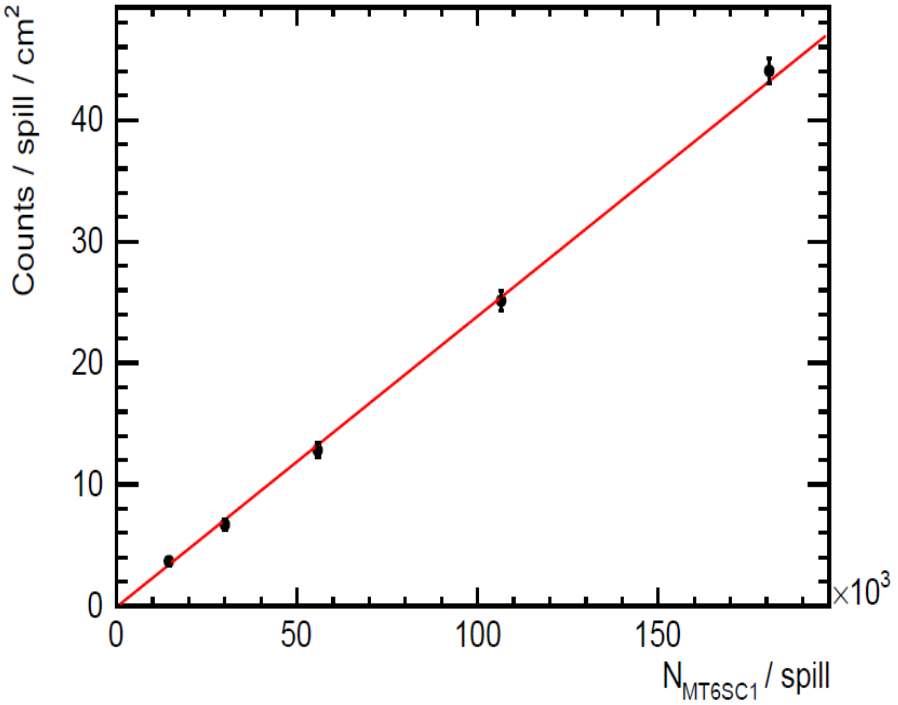
Muon Beam Technical Note

- Parameters of the muon beam behind the shielding are described in the FermilabTM-2627E

Beam Sizes



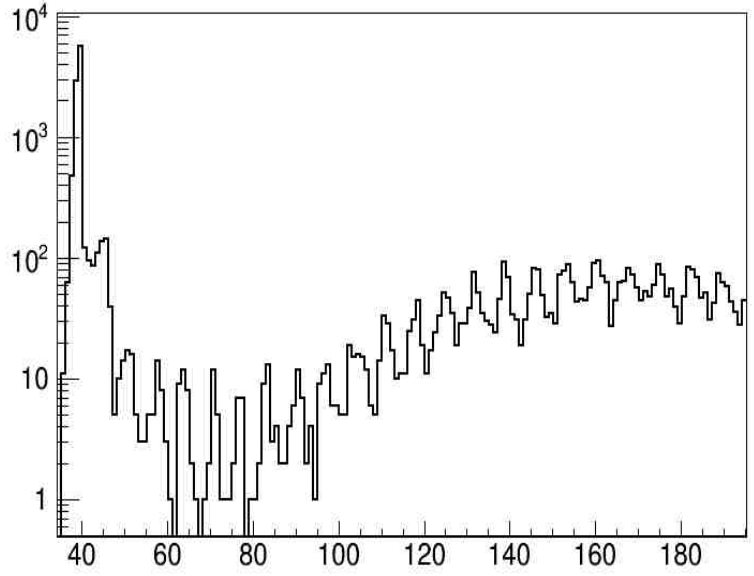
Muon Beam vs Pion Beam Intensity



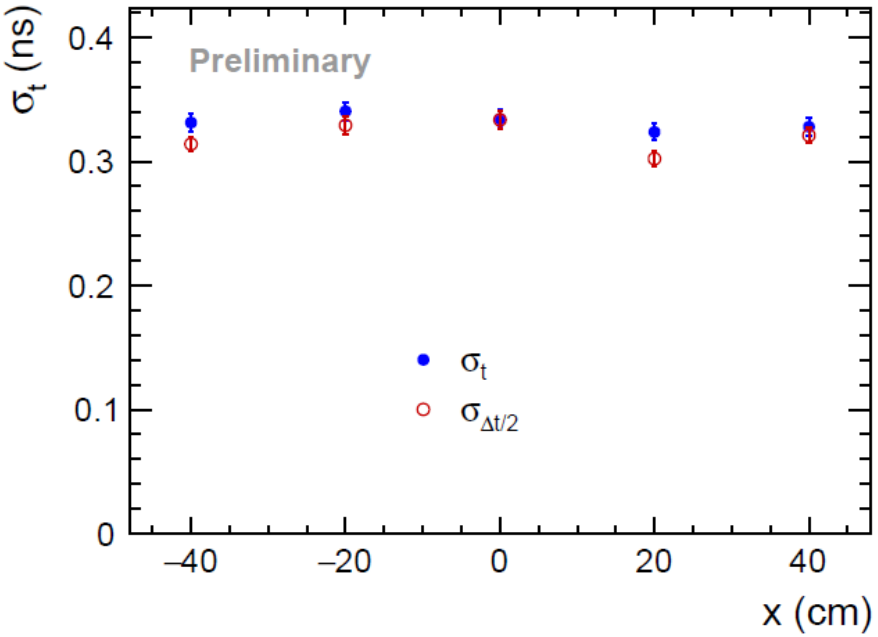
Preliminary Results

- Main counters parameters measured
  - Up to ~50 photo-electrons per side of the counter
  - Time resolution is ~0.3 ns
  - Longitudinal coordinate resolution is ~5 cm

ADC Spectrum for Beam Muons



Time Resolutions



Summary

- Test beam studies of muon detectors for future colliders provided important information quickly and efficiently
  - ~45 days from start of the activities to finishing measurements (including ORC paperwork)
  - NIM paper preparation in progress
- Interesting ideas how to improve counters design have been developed based on the results obtained
  - Plans for test beam activities next year developed
- Muon test beam (behind shielding wall) could be used for studies of various tracking and other detectors prototypes
  - Studies can be done in parallel with other users and access to the test apparatus is easy