The challenge of track reconstruction at a multi-TeV Muon Collider

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Muon Collider environment

Very clean final state

+ Beam Induced Background (BIB)

muon decay products interacting with the accelerator lattice

Tungsten nozzles around the beam pipe required for BIB suppression

3.6 × 10^8 particles reaching detector at every bunch crossing (BX)

leading to extreme hit density: up to 1K hits/cm² in the Vertex Detector

Unmanageable combinatorial background for track reconstruction

BIB rejection methods

Distinct features of BIB particles allow to strongly reduce the effective hit density

Late arrival time

Imposing a narrow readout time window

Easily absorbed

Displaced origin

Great reduction of the number of hits in a single event

tremendous reduction of combinatorics during track reconstruction

1 week/event → 2 days/event → 2 minutes/event

using Conformal Tracking algorithm (developed by CLIC experiment)

Further suppression of BIB hits possible based on cluster-shapes

Tracking performance

High tracking efficiency

degradation in the forward region

Simulated single muons + BIB using Regions of Interest (ROI) around true muons

reduced combinatorics

Many fake tracks in the forward region

Better rejection of BIB hits is needed in the endcaps

+ ongoing developments

• High-performance tracking using ACTS

• Realistic cluster-shape simulations

• Topology specific reconstruction sequences