Rationale for Muon Triggering

- Leptons are common to many interesting physics processes

Consider the ability to trigger at high luminosity - 10^{36} $cm^{-2}s^{-1}$

- Taus require a central tracking trigger
- Electrons require central tracking and calorimetry
- Neutrinos require global calorimetry

- Muons can trigger on penetrating particles behind the calorimeter
- Muon systems can trigger on time-of-flight for slow massive particles

Muon Trigger Issues

Size and depth

- Muon system scales as r^3

  Actually scales as $(r_{outer}^3 - r_{inner}^3)$, r_{outer} is partially fixed by r_{inner}.

Trigger rates

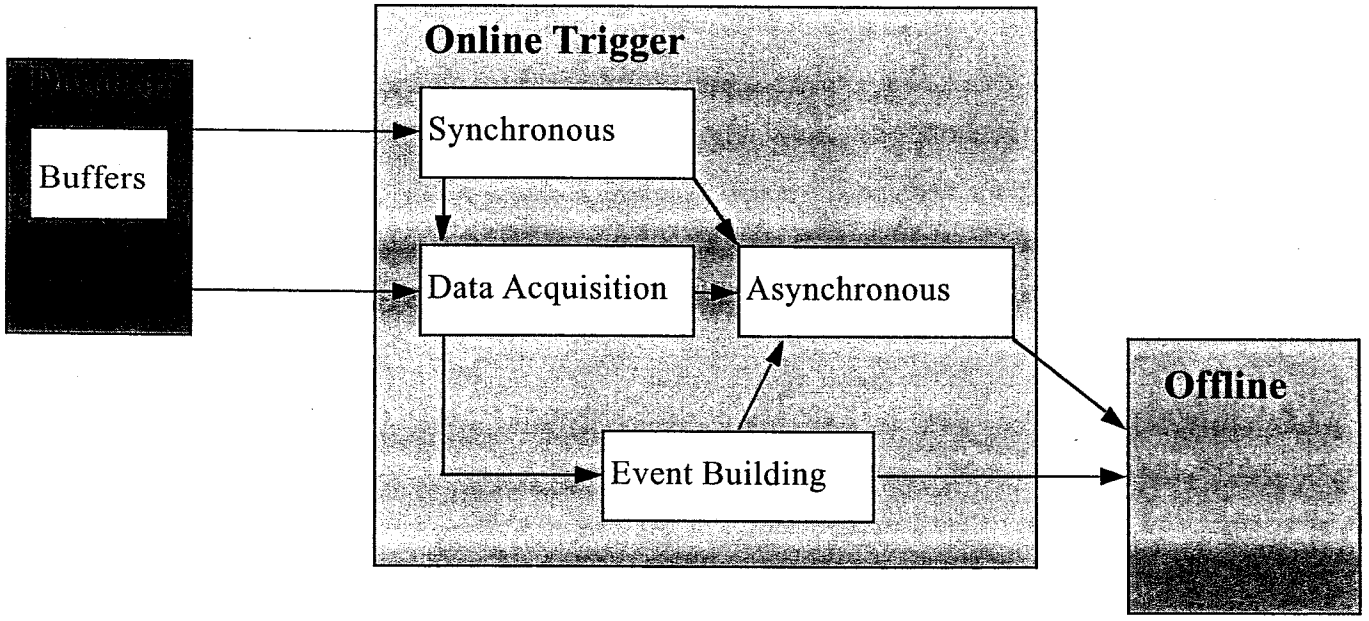
- P_T spectrum dominated by soft processes that change slowly with CM energy

Types of elements

- Shielding to block hadronic punchtrough
- Fast elements at or near bunch crossing rate
- Granularity to keep occupancy low and reduce accidentals
- Good timing measure for TOF

Typical Trigger Architecture

Trigger Block Diagram



- Detectors are capable of processing and buffering at the front end
- Online trigger is defined by a lack of database for processing
- Offline may only receive hits on tracks for fitting

Trigger Strategy & Information

Muon Information Sampling

- Hodoscopic hits
- Timing information
- Position computations
- Matching information from tracker and calorimeter

Types of Computing

- Field Programmable Gate Arrays
- Digital Signal Processors
- Microprocessors

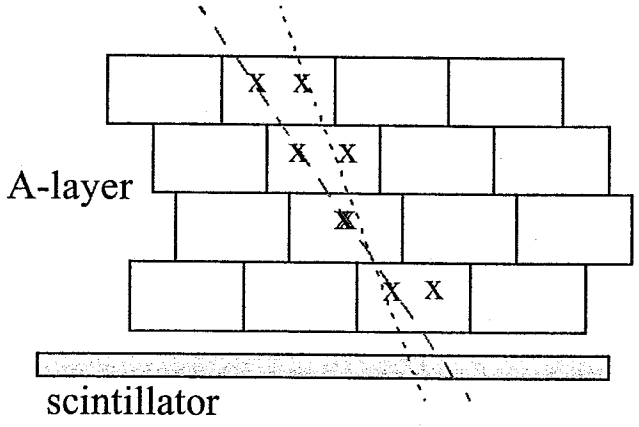
Types of Algorithm

- Track pattern lookup
- Segment and cluster finding
- Full single object reconstruction across detectors

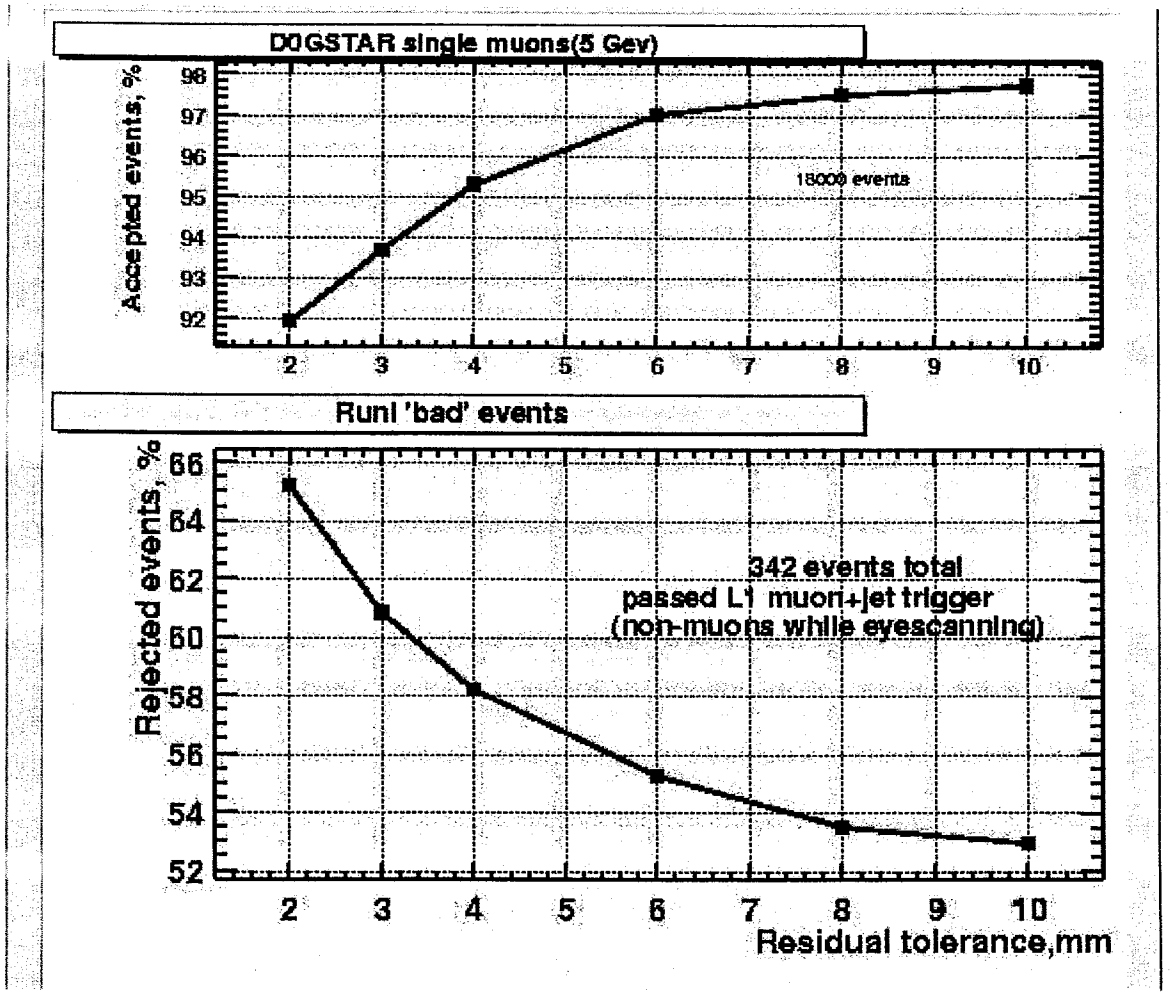
Muon Trigger Algorithm

D0 Trigger Algorithm

1. Use lookup table to test for valid combination of hits (3 wires).
2. Loop over valid 3-wire segments.
   a) Get wire locations and offsets.
   b) Calculate middle wire residual.
   c) Store position and θ-angle if lowest residual.
3. Tag segment with the ϕ-direction.
4. Find valid scintillator hit and store time of flight.



Algorithm Performance



Computational Issues

Computational requirements of the muon trigger processor

Muon trigger processor receives front end data.

Timing available for time-of-flight.

Position data available to construct 3-dimensional tracks.

Segment finding and scintillator tagging are local tasks.

Muon data can be divided geographically and processed in parallel.

Global trigger formation

Match segments from same muon

Correct scintillator times, determine time of flight

Determine muon quality