

GEANT3 TRT Simulation Status & Recent GEANT3 TRT Studies Using 6.0.3

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TRT Meeting Software Session
June 19, 2003

Introduction / News

- There are just a few GEANT3 TRT code news items since the last report in the October TRT week.
 - The TRT GEANT3 code was frozen last July (3.2.1/DC1).
 - In February, a bug in the end-cap digitization was found.
 - In April, I ran a study on how a change in the Pixel detector services design affects the rates in the TRT.
- I have run studies to document the TRT performance and to check that ATLAS software releases did not cause problems.
 - Examples of recent changes ATLAS software changes:
 - Recently a new compiler version was made the default.
 - Also new compiler options that force tighter syntax checking were put into use.
 - I am writing a brief document on these results.
- I will continue to check future releases the same way.

End-Cap Pulse Height Digitization Bug

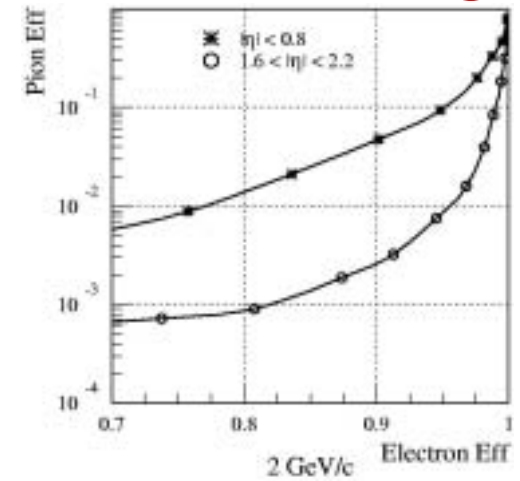
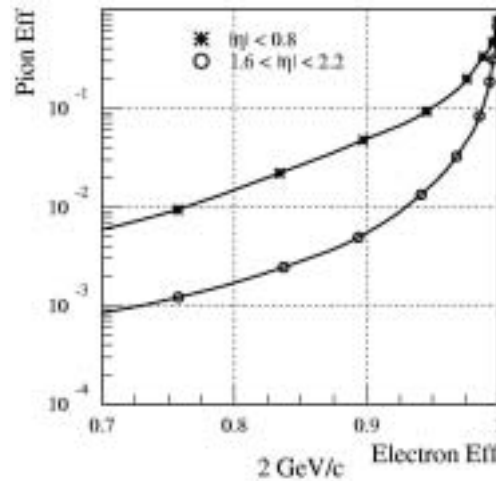
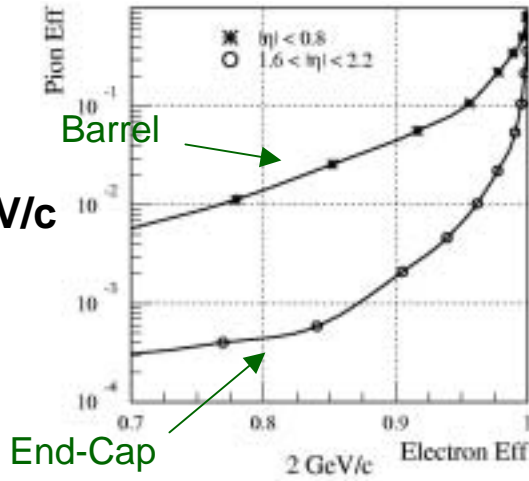
- What happened:
 - The simulated pulse height was reduced because of a miscalculation of the signal propagation time.
 - The low threshold (tracking) efficiency were OK.
 - The high threshold (particle ID) efficiency in the was understated.

The generated pion rejection in the end-cap is too low.

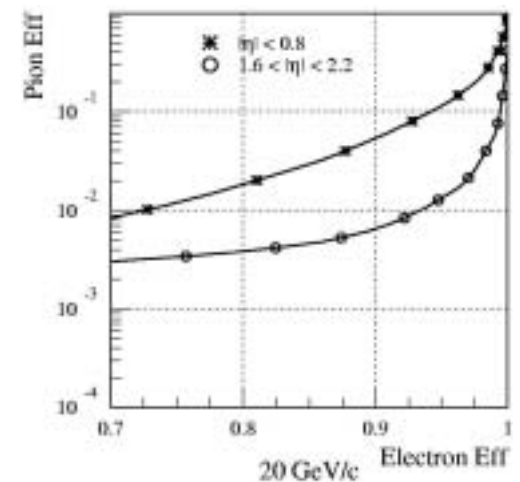
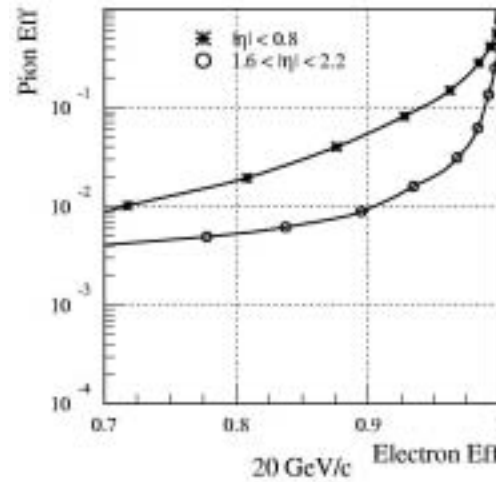
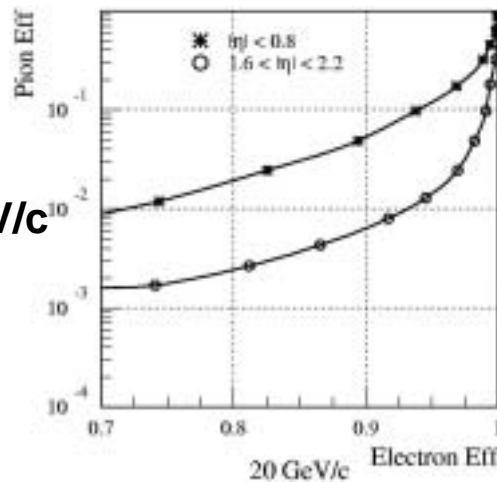
- When the fix was introduced:
 - Fixed code was in release 5.3.0 (February 18, 2003) and the bug had entered the code in release 3.2.1 (July 8, 2003).
- What needs to be done:
 - Data sets generated prior to the fix do not need to be **regenerated** because the bug does not affect the hits.
 - Data sets generated prior to the fix should be **redigitized**, if the TR is being used for electron identification

End-Cap Pulse Height Digitization Bug

2 GeV/c



20 GeV/c



No TOF – No Bug

TOF - Bug

TOF – Bug Fixed

Note: Pion efficiency axis is logarithmic.

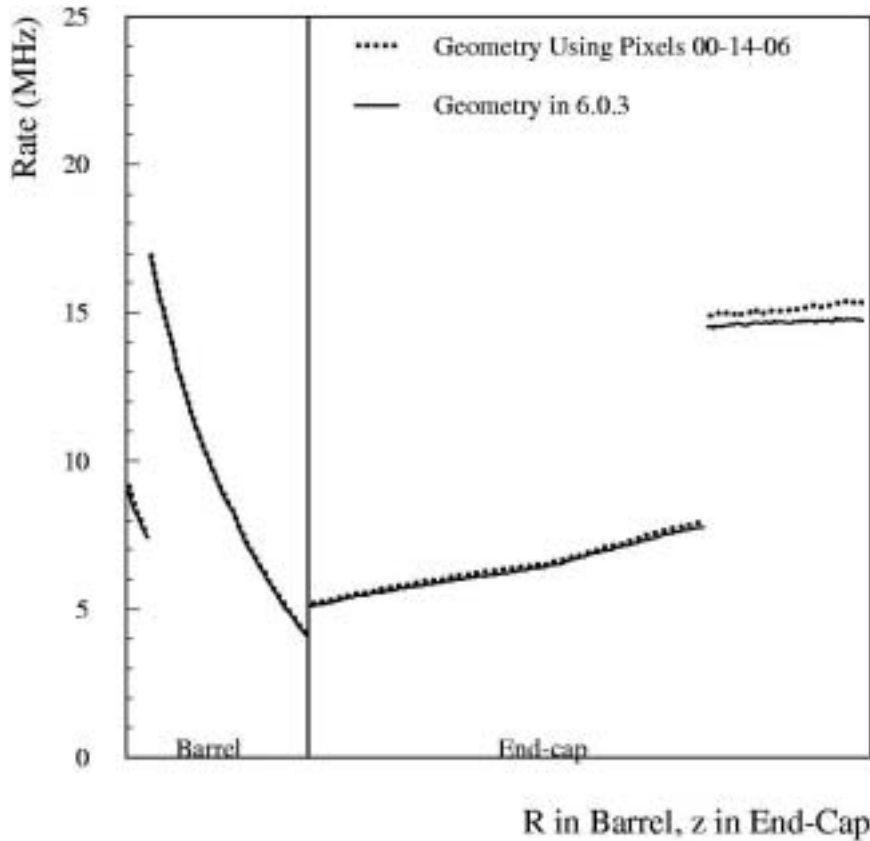
End-Cap Pulse Height Digitization Bug

- At Monika Wieler's request, I have looked into how to correct datasets digitized with the old code without redigitizing (time consuming for pile-up).
 - The simplest correction is to scale the number of high threshold hits on end-cap tracks.
 - For $1.0 \text{ GeV}/c < Pt < 20 \text{ GeV}/c$ these scaling factors are approximately:
 - 1.22 for electrons
 - 1.29 for all other tracks.
1. The net effect of the bug is the loss of about half an order of magnitude in pion rejection in the end-cap.
 2. Even with the bug, the end-cap pion rejection is better than the barrel pion rejection.

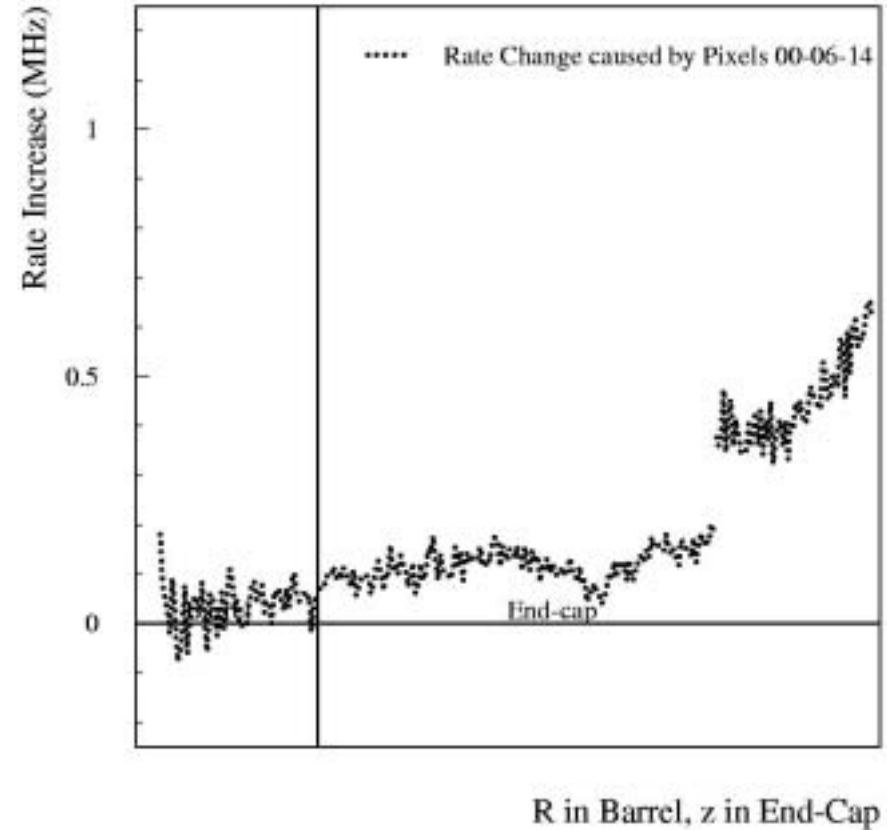
Pixel Services Study

- Dario asked for a study of the TRT rates with a new pixel services layout. The new layout increases the amount of material inside the TRT.
- The study found that the increase looked tolerable (results shown on the next slide).
 - I forwarded results of the study to Daniel and Fido for final discussion in the Inner Detector Steering Group.

Pixel Services Increase Study



Plot of raw hit rates with the default DC1 geometry and the increased pixel service material geometry.



The maximum hit rate increase is ~0.5 MHz in the type C wheels.

TRT GEANT3 Code Performance

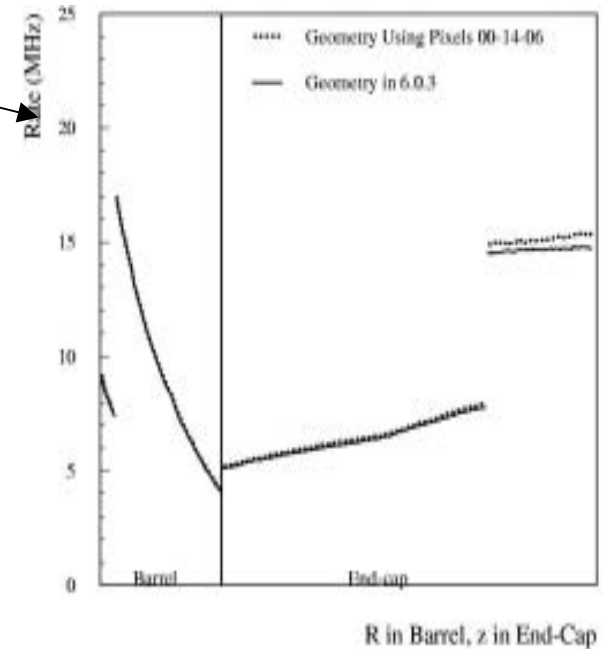
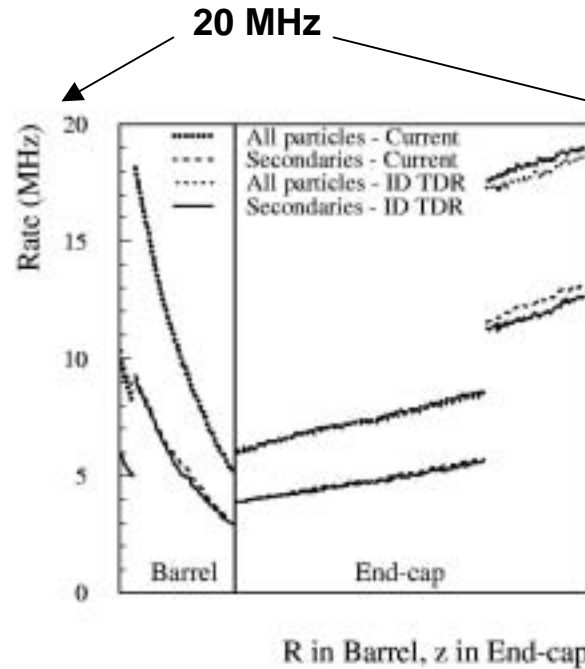
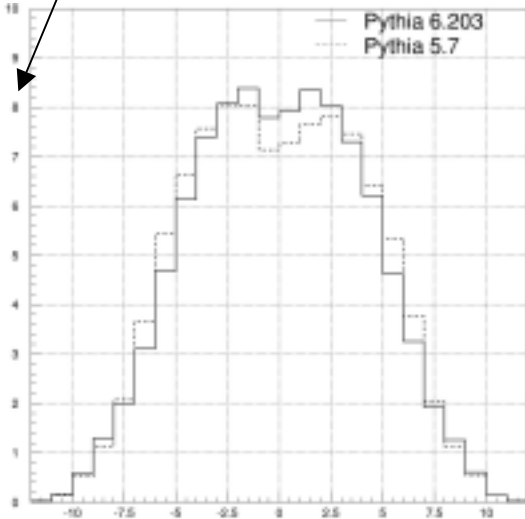
- At Daniel's request, I ran series of studies to document the TRT GEANT3 code performance. These studies used release 6.0.3 (almost the code that will be used for the HLT TDR work).
 - Rates in the TRT.
 - Pion rejection using transition radiation.
 - Single muon track finding.
 - Track finding and fake track rates in the inner detector.
- All studies were done with GEANT3 and xKalman running under atlsim.
- I am writing a note on these results.

TRT Hit Rates

- The current TRT hit rates are similar to those for the Physics TDR because of two compensating effects:
 - The amount of material that tracks pass through has **increased**.
 - The active length of the TRT straws has **decreased**.
- The hit rates are also changed because the standard model group has selected a new version of Pythia to generate the minimum bias events.
 - The new version of Pythia generates the a more central distribution of charged tracks.
 - At the last software week it was announced that there will be another Pythia version change.
 - I have not yet studied the affect of this latest version on the hit rates.

TRT Rates in 6.0.3

8 Tracks/ η



Comparison of number of charged tracks per unit of pseudo-rapidity for Pythia version used for ID / Physics TDRS (5.7) and currently used version (6.203)

ID and Physics TDR

(includes neutrals)

Current and New Pixel Svcs

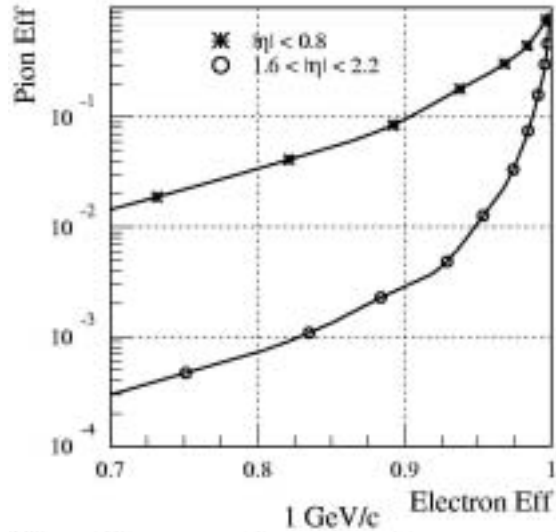
(no neutrals)

Pion Rejection Study

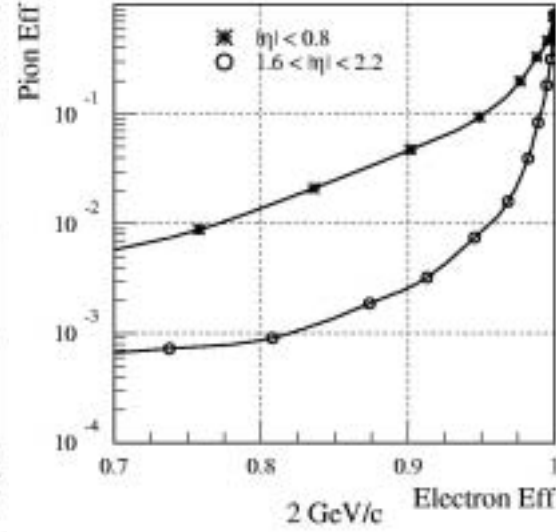
- Pion rejection obtained using single electrons and pions (no pile-up) was studied.
 - Four p_T values were studied: 1 GeV/c, 2 GeV/c, 5 GeV/c and 20 GeV/c.
 - Unlike many previous studies, all GEANT interactions are turned on.
 - The physics TDR results had real problems and are not shown for comparison.

Pion Rejection Study

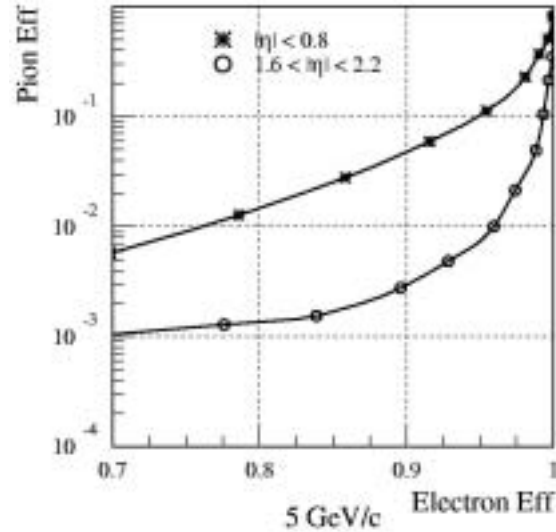
1 GeV/c



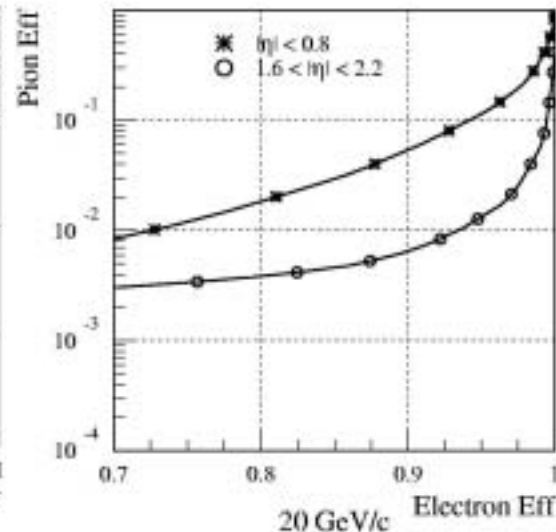
2 GeV/c



5 GeV/c

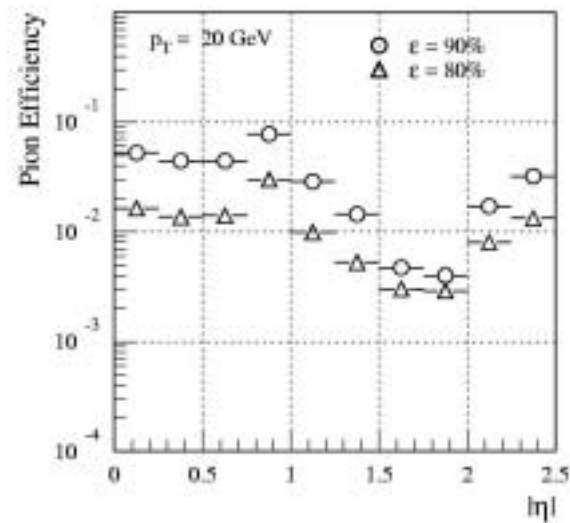
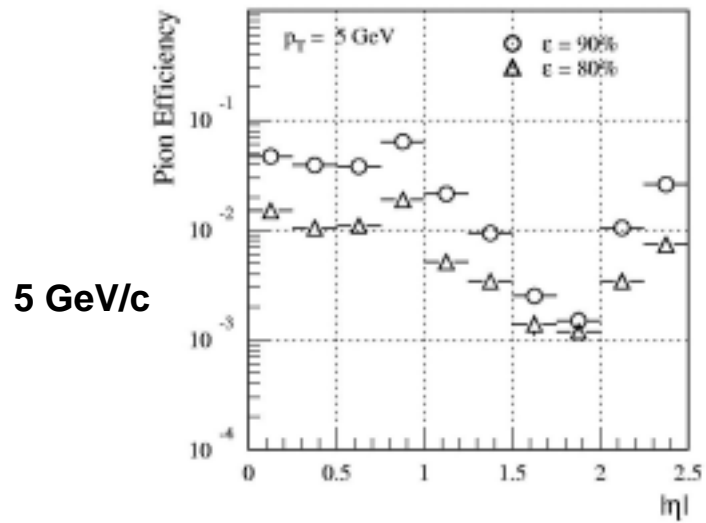
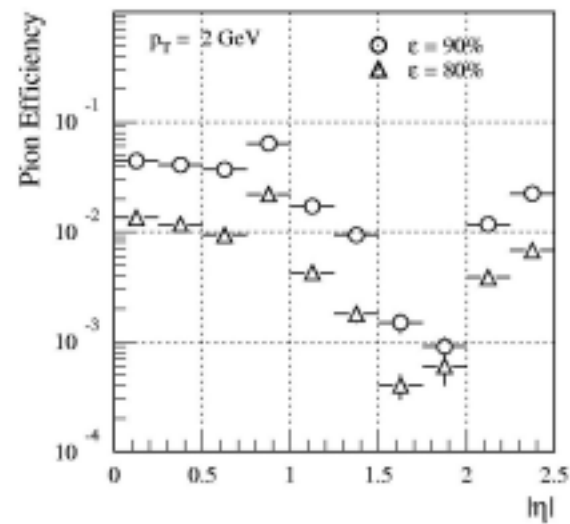
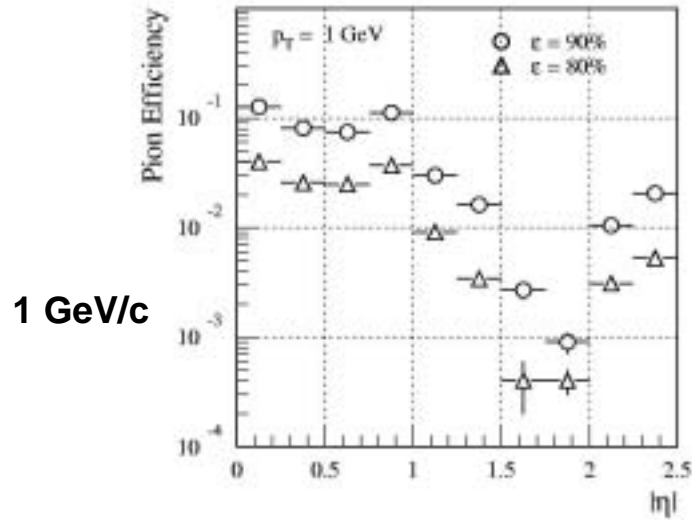


20 GeV/c



Interactions On, TOF

Pion Rejection Study



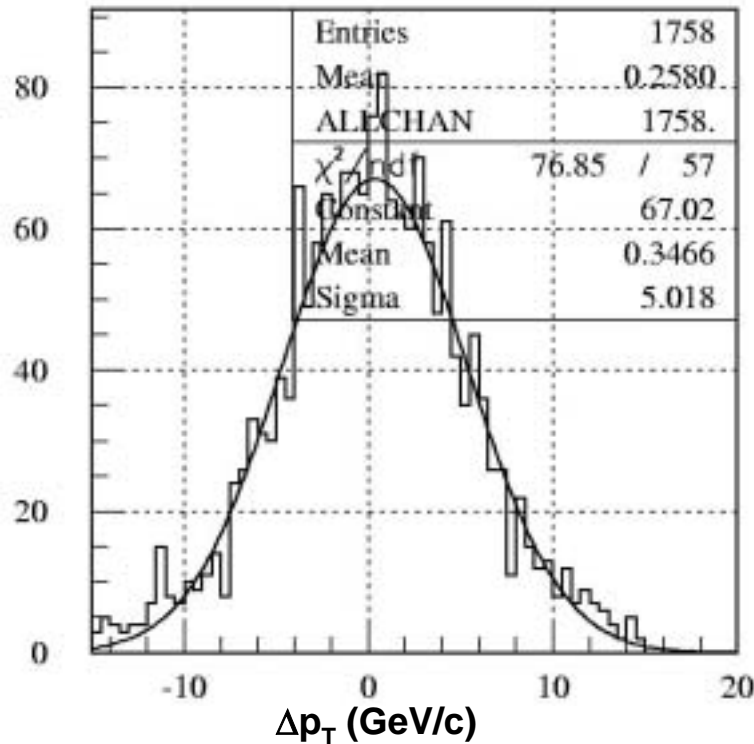
Interactions On, TOF

Muon Track Finding in Pile-Up

- This study is based on a request from Pavel to validate that 6.0.0 release code produced reasonable results.
 - Pavel supplied me with 2000 stiff track muon events (100 GeV/c p_T muon) with and without full pile-up.
- The events were reconstructed with xKalman running under atlsim.
- The results were reasonable (see plots on next slide).

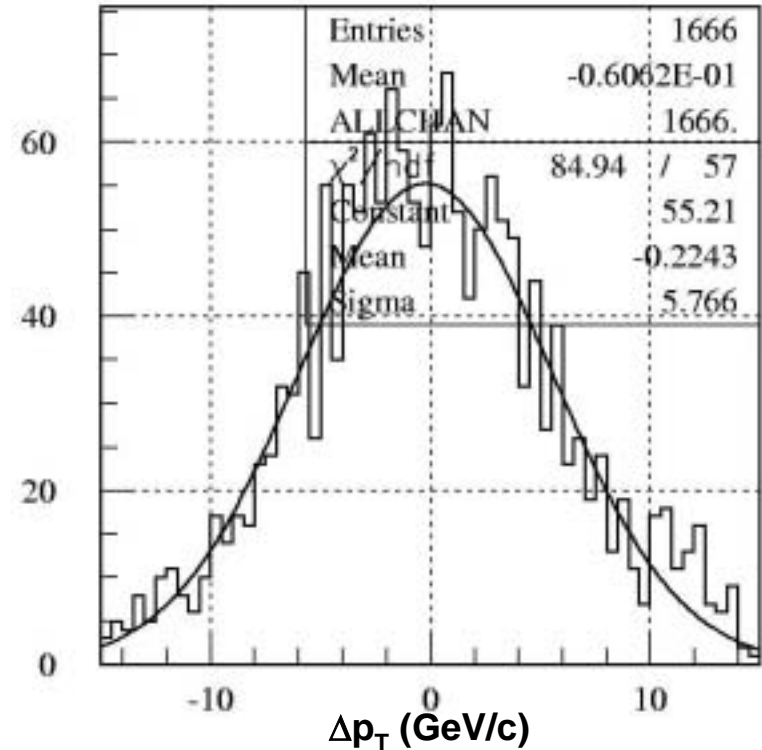
Muon Track Finding in Pile-Up

- These results were done with release 6.0.3 and are the same as the original study done with release 6.0.0



No Pile-Up

Efficiency is ~96% and σ is ~5.0 GeV/c.



Full Luminosity ($10^{34} \text{ cm}^{-2}\text{s}^{-1}$)

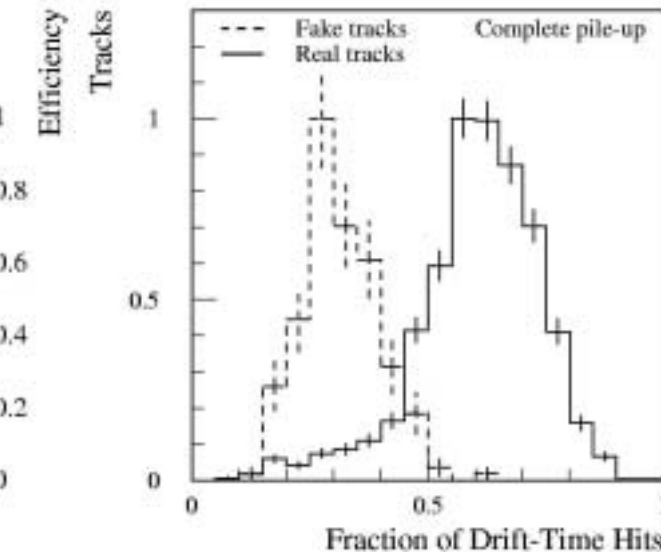
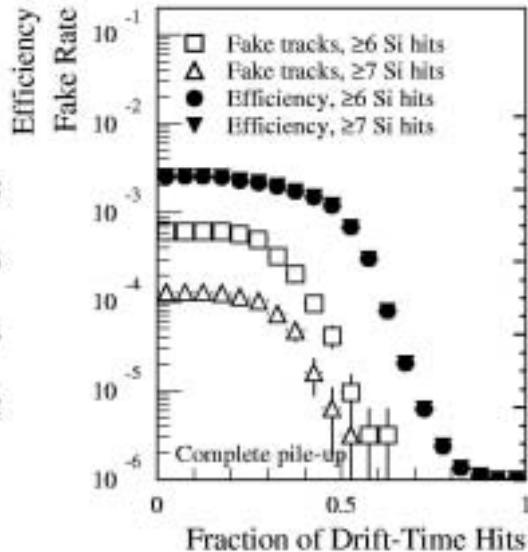
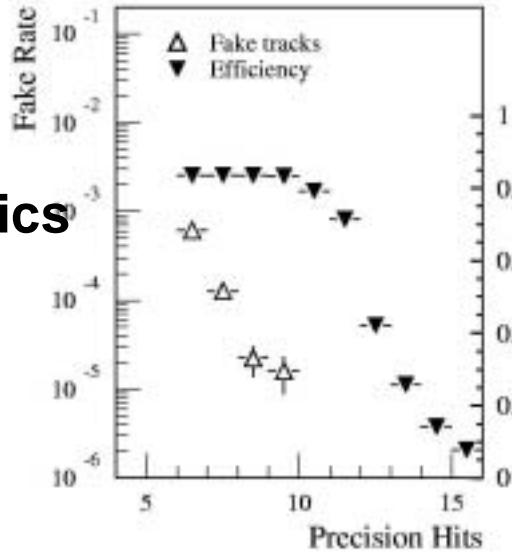
Efficiency is ~90% and σ is ~5.8 GeV/c.

Track Finding Efficiency / Fake Rates

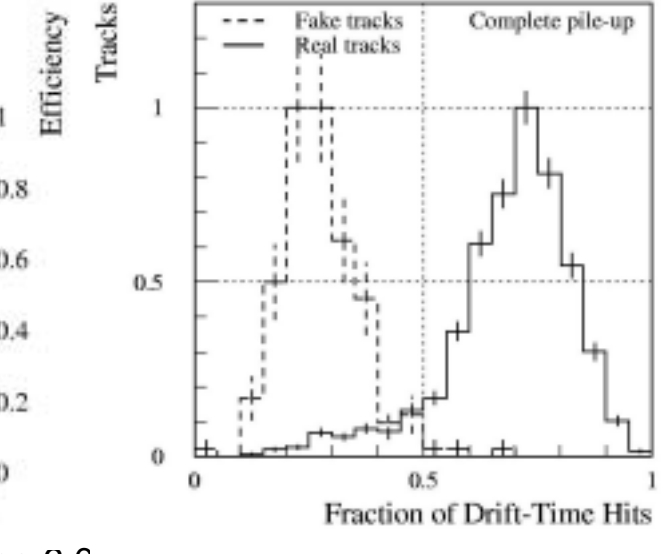
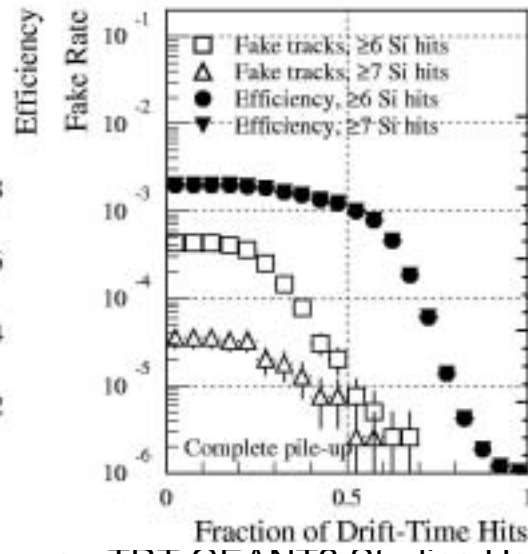
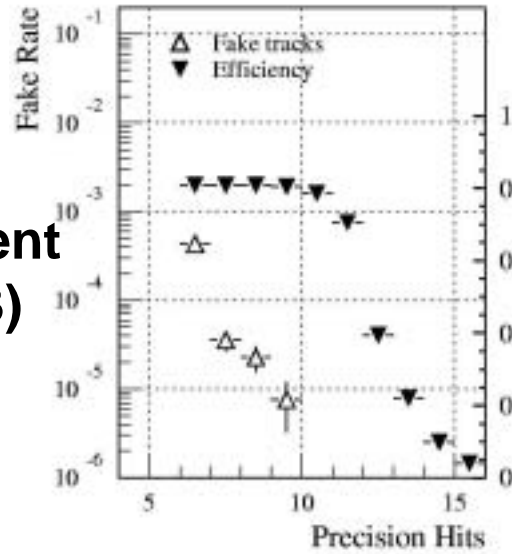
- The Physics TDR tracking finding and fake track rate studies have been repeated with 6.0.3.
- The study method is:
 - Minimum bias events are generated for the inner detector.
 - xKalman is used to reconstruct tracks in the events.
 - The efficiency is calculated by looking at the fraction of real tracks with $p_T > 3.0$ GeV/c in the events that are found.
 - The fake rate calculated by looking at the number of found tracks with $p_T > 2.0$ GeV/c that have less than half their hits contributed by a single real track.
 - The fake rate is normalized to the number of calorimeter towers.
- Owing to improvements in xKalman and the cuts, the current study produces a lower fake rate than the Physics TDR study.

Track Finding Efficiency at Full Lumi

Physics
TDR



Current
(6.0.3)



Future Plans

- Continue to run the battery of studies against future software releases.
- Calculate changes in the amount of service material caused by recent design work and enter revised values into the software.
 - In particular, the mechanical design of the barrel electronics and its associated cooling should be final soon.
- Compare GEANT3 and GEANT4 codes for generating transition radiation.
- Model this summer's testbeam setup using GEANT3.