Study of the Monitored Drift Tube (MDT) efficiencies for the ATLAS test beam data

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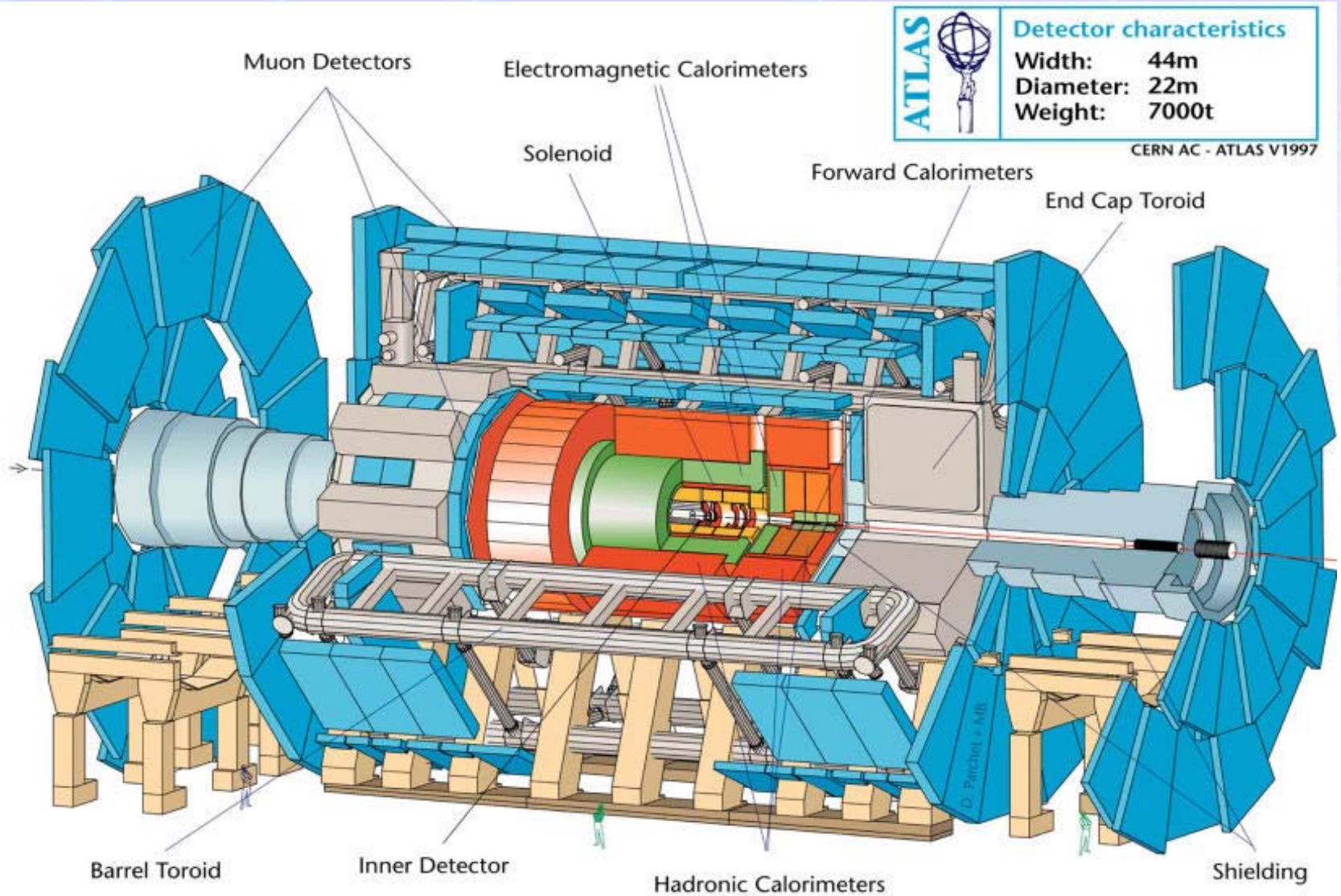
Outline

- ✓ Description of the experimental set-up
- ✓ Description of the method for the calculation of the track segment efficiency
- ✓ Results on track segment efficiency in barrel and endcap chambers
  - Efficiency versus energy
  - Efficiency versus threshold of read-out electronics
- ✓ Results on single hit efficiency in barrel and endcap chambers
- ✓ Conclusions

The ATLAS detector

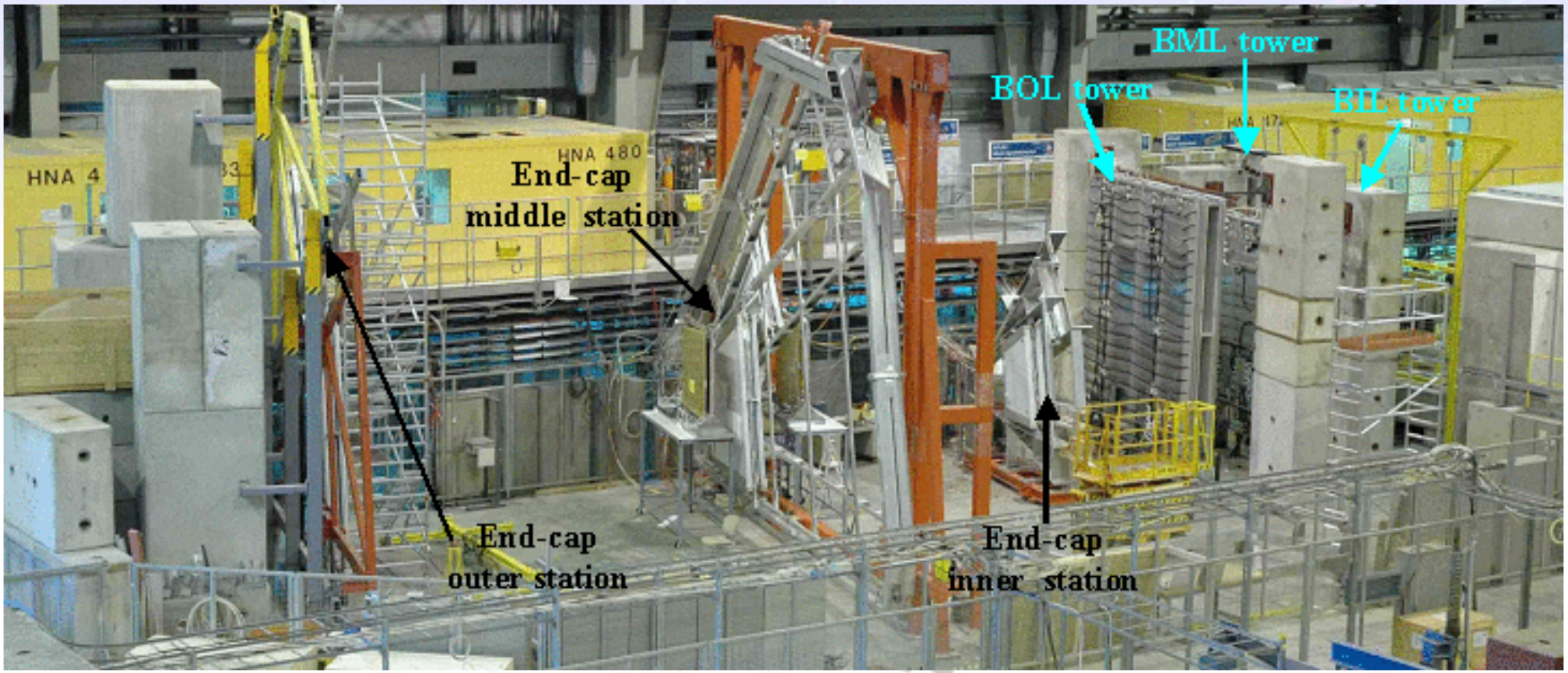


Introduction

- A large scale test stand of the ATLAS detector and the muon spectrometer in particular has been set up at CERN on the H8 beam line
- The main goal of the system is to study and integrate the different aspects of the ATLAS detector.
- For the muon spectrometer the following items are considered:
  - Integration of different detector technologies (MDTs, RPCs, TGCs and CSCs)
  - Study of the alignment and the detector control system
  - Development and optimization of different software tools (e.g. track reconstruction and data acquisition)

The target of these integration tasks is to achieve the best possible resolution for the muon momentum measurement

Experimental H8 setup of the ATLAS muon spectrometer



The aim of this study

The main goal of this study is to measure the muon reconstruction efficiency

A muon track is composed of three different segments in ATLAS (one in each MDT station).

The reconstruction program makes the individual segments, from the MDT hits, and combines them to a single track.

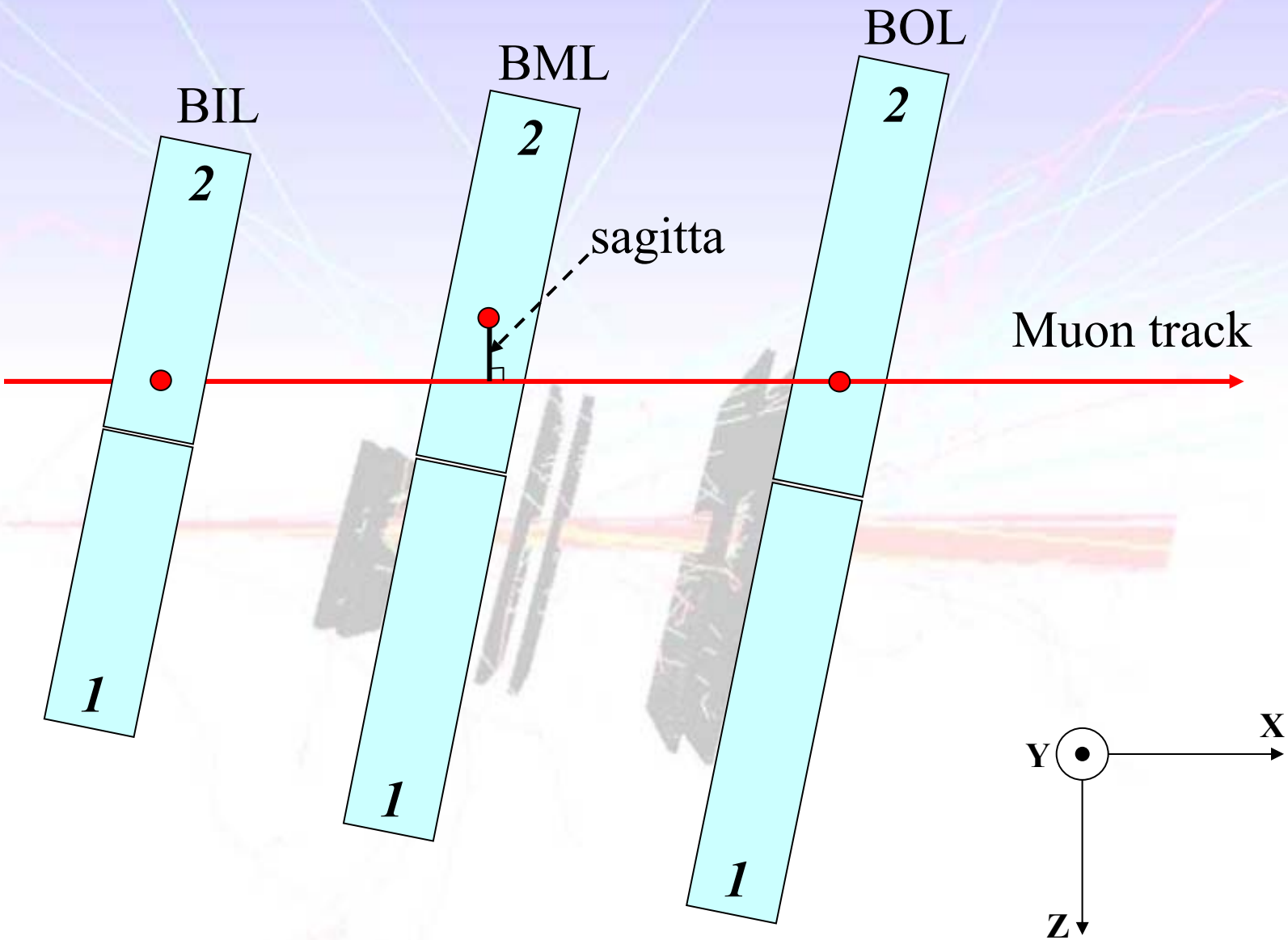
The track reconstruction efficiency shows the performance of the detector and the reconstruction software.

This talk focuses on the measurement of the track segment efficiency

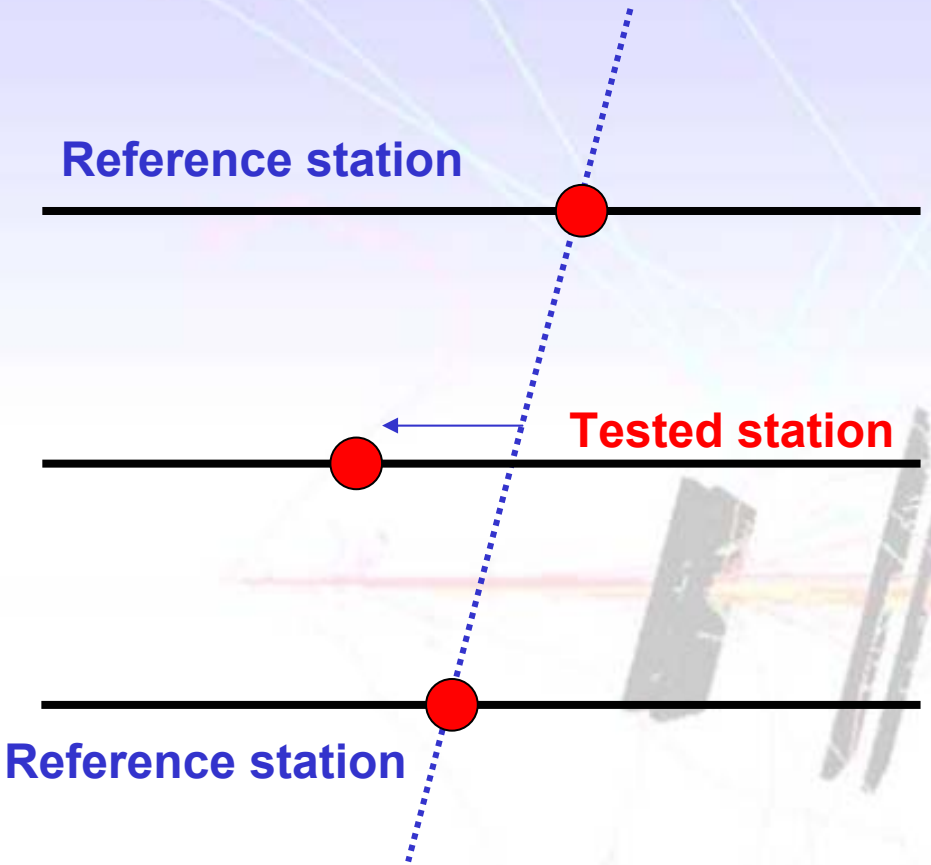
Data Samples

- Different runs for different energies and MDT thresholds were analyzed
- Framework of analysis:
  - Atlas reconstruction framework adapted to the H8 setup
  - Muons were reconstructed with the reconstruction package Muonboy

Definition of sagitta



Track segment efficiency - Method



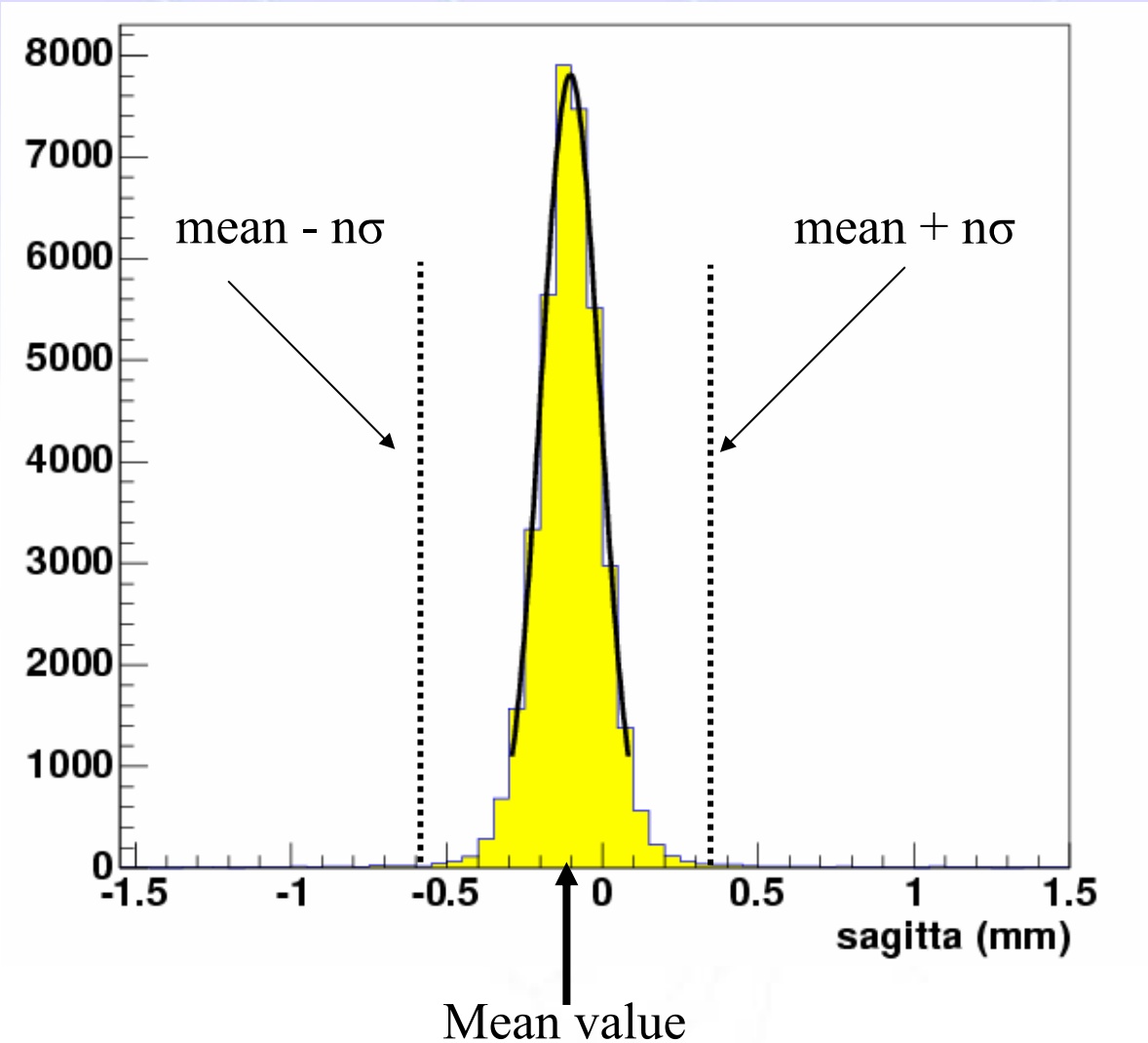
- Create a reference sample

Select events with only one good (nhits $\geq$max-1) track segment in the two reference stations

- Compute sagitta

Create the sagitta distribution of the station to be tested

Track segment efficiency



- Create regions of interest

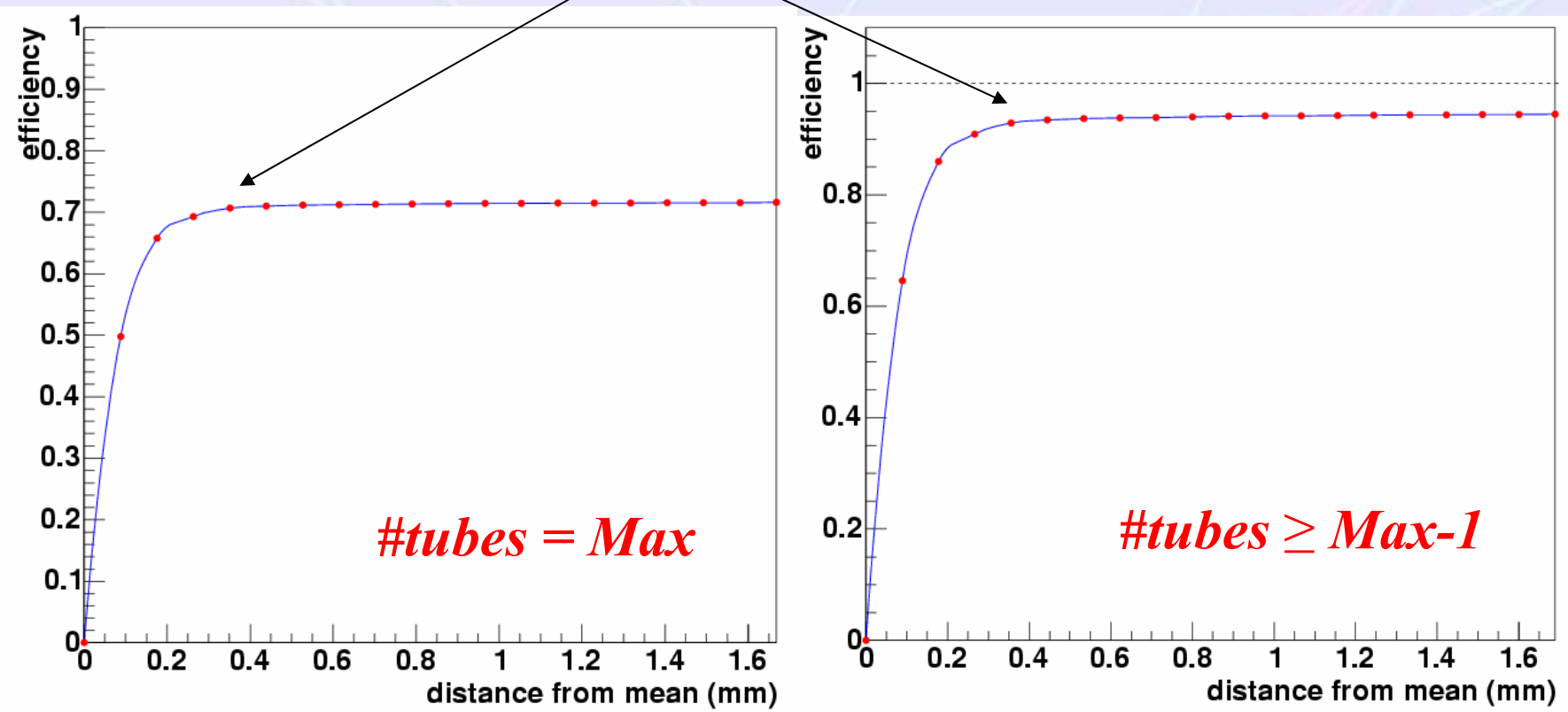
Define nσ regions around the mean of the sagitta

- Compute efficiency

Count events in the tested station with good segment in the regions of interest

Track segment efficiency

The plateau of this distribution is reached at the level of 4σ



The plateau is fitted with a horizontal line and the efficiency is obtained by the parameter of the fit.

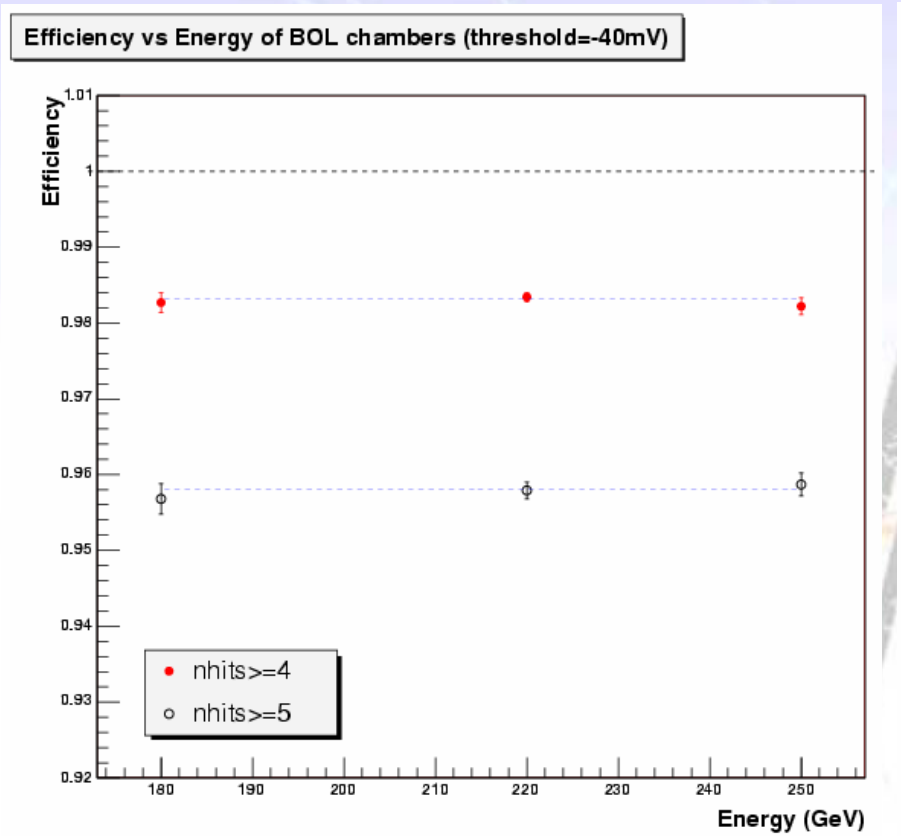
Track segment efficiency

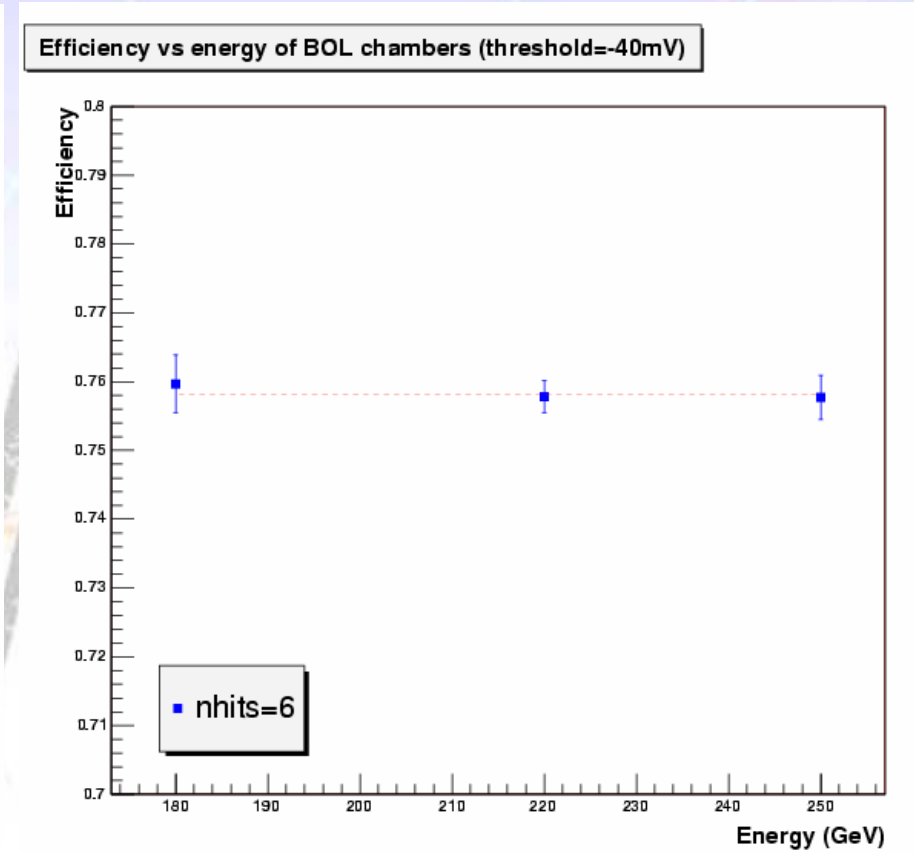
Barrel chambers			
N-hits	**Effi BIL (%)**	**Effi BML (%)**	**Effi BOL (%)**
≥ max-2	98.1 ± 0.1	98.2 ± 0.1	98.3 ± 0.1
≥ max-1	92.7 ± 0.2	94.3 ± 0.1	95.6 ± 0.2
= max	67.9 ± 0.3	71.5 ± 0.3	75.9 ± 0.4

Endcap chambers			
N-hits	**Effi EIL (%)**	**Effi EML (%)**	**Effi EOL (%)**
≥ max-2	96.5 ± 0.1	98.6 ± 0.1	98.7 ± 0.1
≥ max-1	90.5 ± 0.2	95.6 ± 0.2	96.1 ± 0.1
= max	63.9 ± 0.3	75.1 ± 0.4	76.3 ± 0.2

Efficiency versus Energy

Barrel chambers

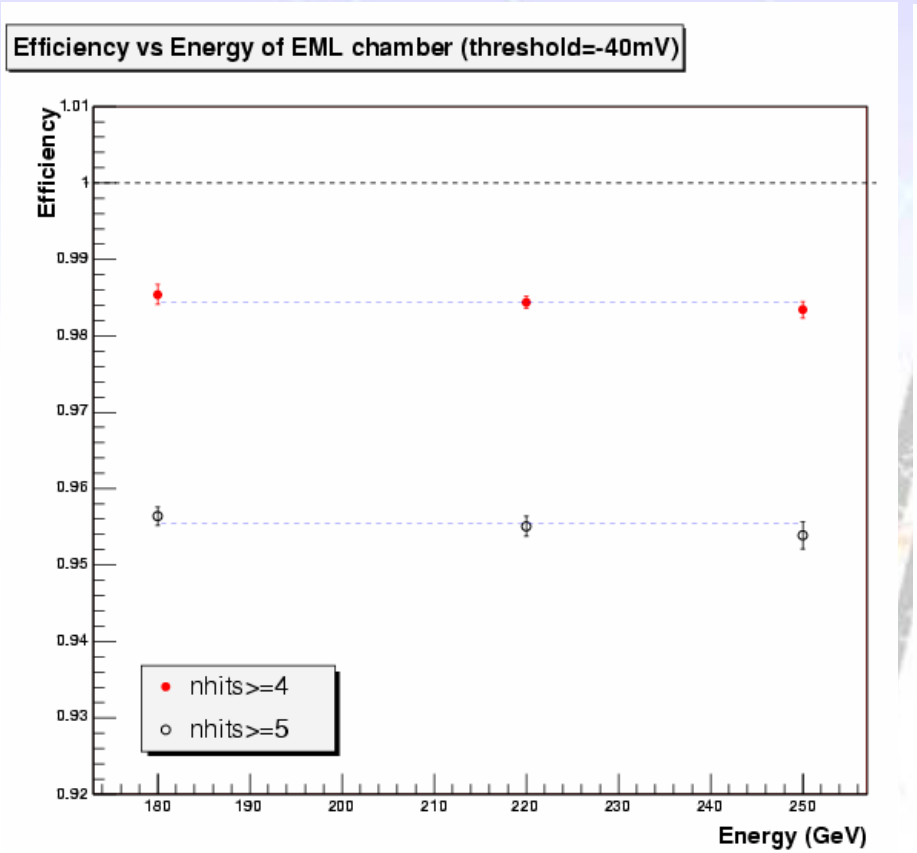


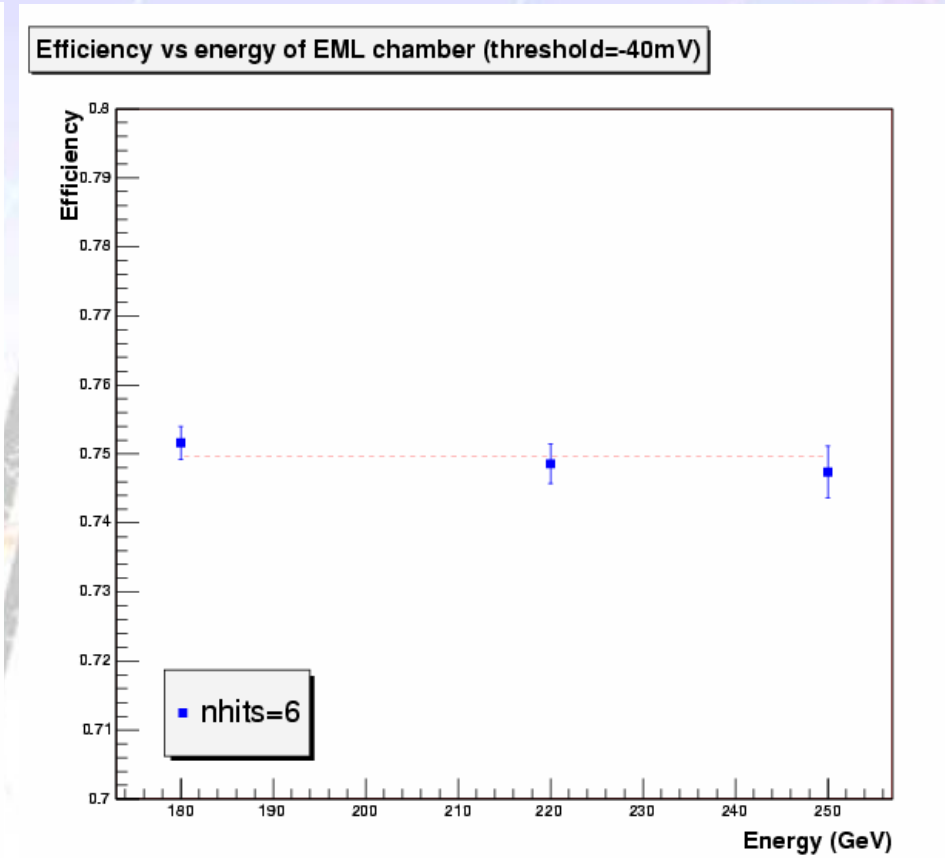


The efficiency remains stable for all the energies.

Efficiency versus Energy

Endcap chambers

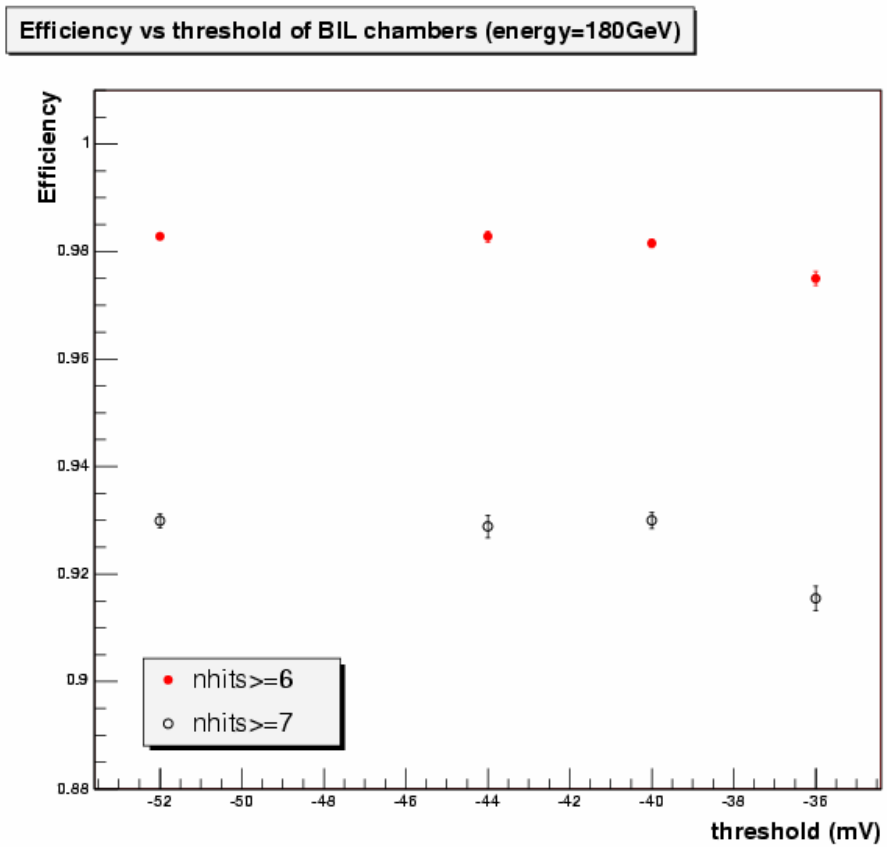


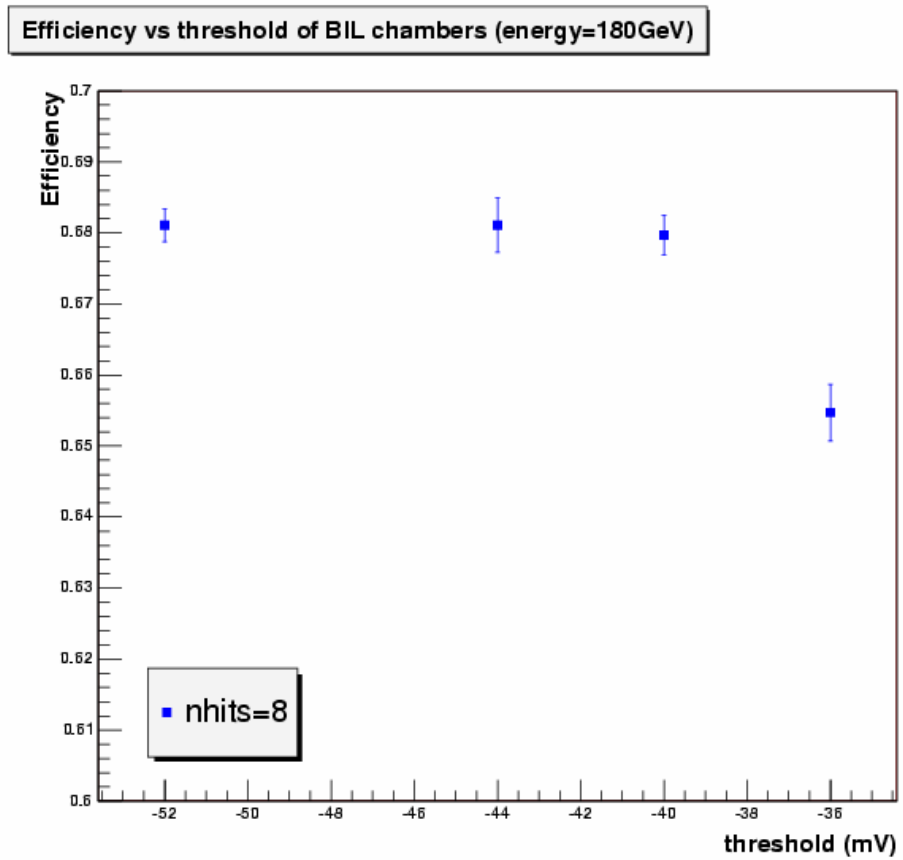


Similar behavior for the Endcap chambers

Efficiency versus MDT threshold

Barrel chambers

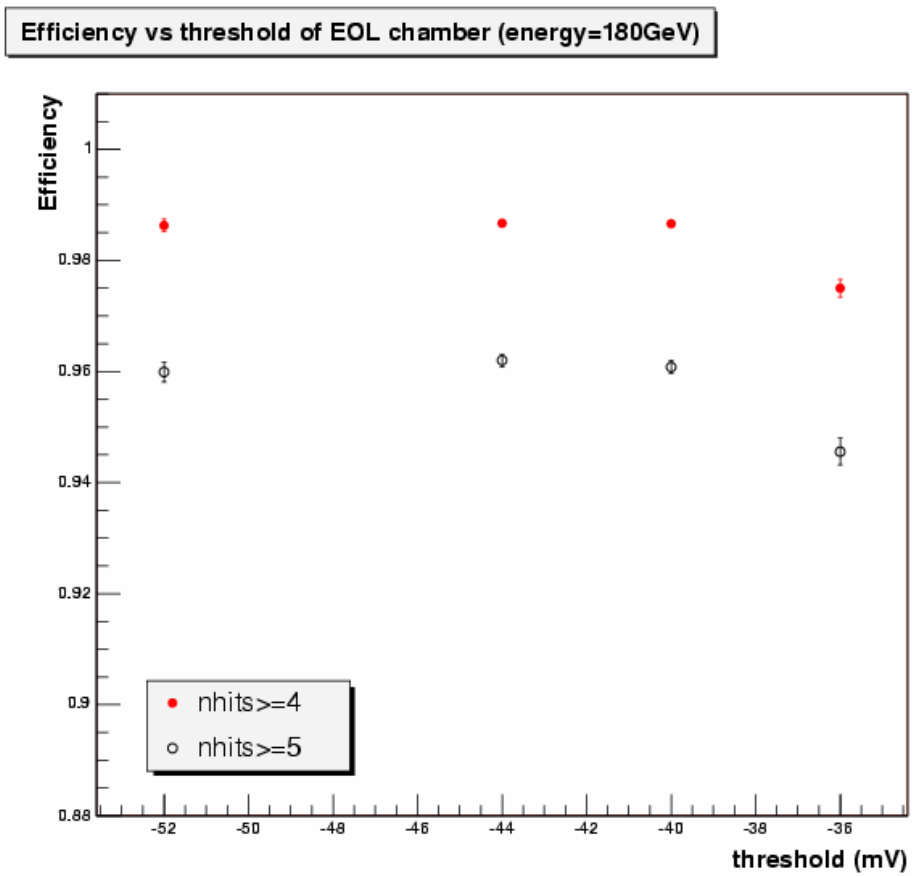


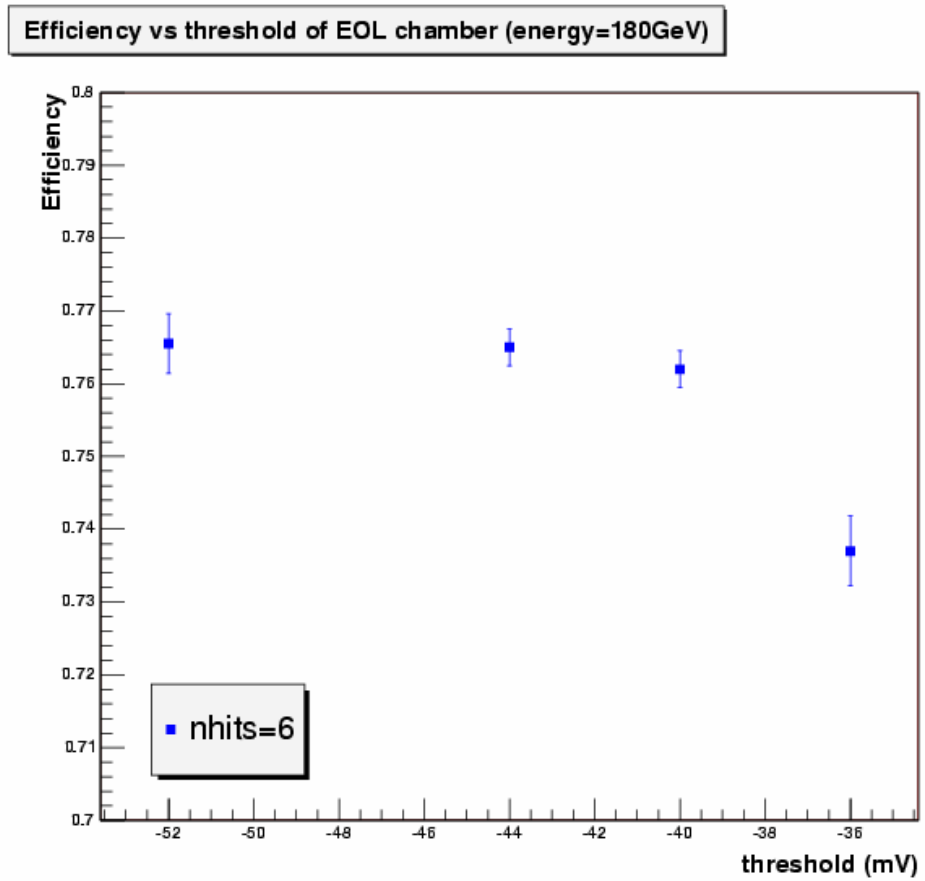


The efficiency is stable for all the thresholds above the nominal one (40mV), but for the lower one

Efficiency versus MDT threshold

Endcap chambers





Again decrease at the low threshold

Single hit efficiency

From the track segment efficiency, the single hit efficiency can be derived.

If ε_t is the single hit efficiency then the expected efficiency for a chamber with n layers for n, and (n-1) hits is computed by the following formulas

$$\varepsilon_{n\text{-hits}} = \left(\varepsilon_t\right)^n$$

$$\varepsilon_{(n-1)\text{-hits}} = \frac{n!}{(n-1)!\cdot 1!}\left(\varepsilon_t\right)^{(n-1)} \cdot \left(1-\varepsilon_t\right)$$

Single hit efficiency

Barrel chambers			
N-hits	**Effi BIL (%)**	**Effi BML (%)**	**Effi BOL (%)**
= max-1	95.6 ± 0.1	95.1 ± 0.2	95.8 ± 0.2
= max	95.3 ± 0.1	94.6 ± 0.1	95.5 ± 0.1

Endcap chambers			
N-hits	**Effi EIL (%)**	**Effi EML (%)**	**Effi EOL (%)**
= max-1	95.3 ± 0.1	95.8 ± 0.2	95.9 ± 0.2
= max	94.6 ± 0.1	95.3 ± 0.1	95.6 ± 0.1

Conclusions

- The muon track segment efficiency in ATLAS is measured with test beam data
  - It is found the same for both barrel and endcap chambers
  - It is independent of the muon energy.
  - It is stable for thresholds above the nominal (40mV) and falls for lower thresholds
- The single hit efficiencies for barrel and endcap chambers were derived from the track segment efficiency. They are of the order of 95% for both of them.