The ATLAS Transition Radiation Tracker

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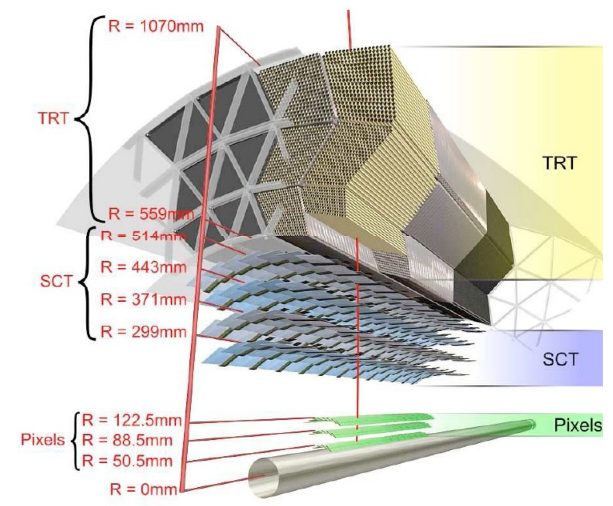
Overview



Outermost Layer of Inner Detector Tracking System

Combination of a Straw Tracker and Transition Radiation Detector

Coverage of $|\eta| < 2.0$

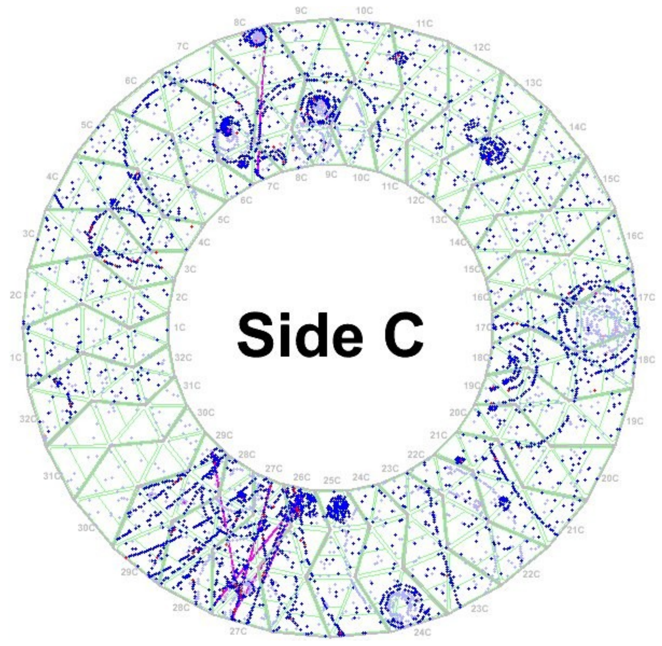
Contains over 300,000 2mm radius straws

Barrel consists of axially arranged straws 144 cm in length, divided into 96 modules, 3 layers in each of 32 phi sectors

2 End Caps each contain 20 wheels of radially arranged straws

Provide individual hit resolution of 140 μm

A Tracking Detector



The freed electrons drift toward the high voltage wire in the center, where they are collected, creating an electronic signal

Wires are read out on either side of the barrel and at the outer radius of the end caps, measuring the "time over threshold"

During reconstruction, time over threshold is converted to distance of closest approach to the straw wire, then used to create drift circles which are used for finding tracks

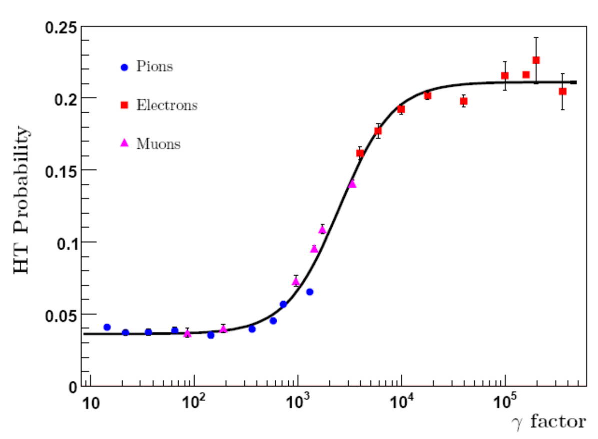
A Transition Radiation Detector

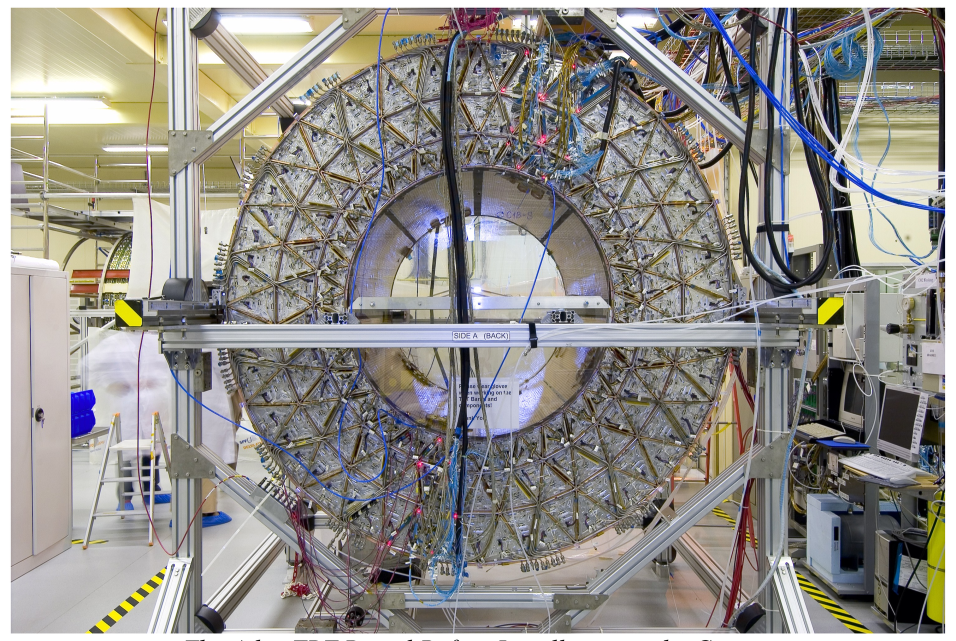
Volume in between straws contains a "radiator" material of rapidly varying dielectric constant, causing emission of x-ray photons of ~5 keV in the direction of flight by particles with high γ factors, at LHC these are almost all electrons

Active Gas in the TRT is 70% Xenon, capable of absorbing these x-ray photons

Utilizing a separate High Threshold (~20 times Low Threshold for Tracking) allows for particle identification independent of the calorimeters

Plot from 2004 Combined Test Beam, Electron and Pion Energies 2-180 GeV, Muon Energies 9-350 GeV



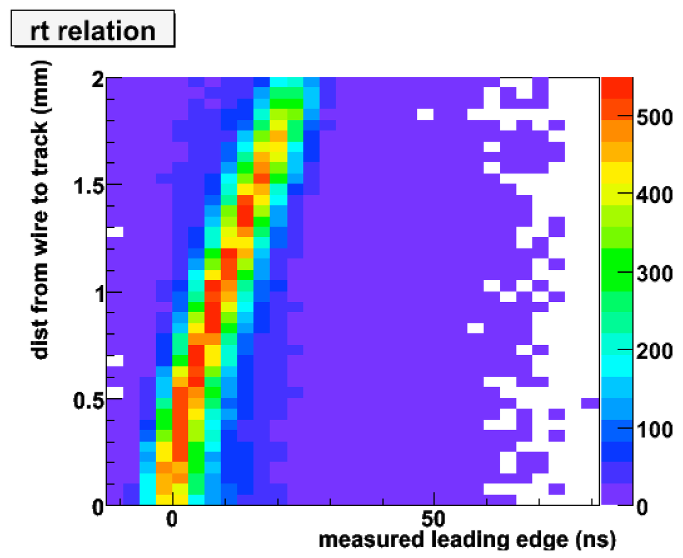


The Atlas TRT Barrel Before Installation in the Cavern

After installation, many tasks must be performed in order to prepare the detector for data taking. Some of these include determining alignment and timing constants, equalization of electronic noise, and characterization of the drift time for ionized electrons

Determination of R-T Relationship

Tracks in the TRT are defined by a set of drift circles, one for each traversed straw. To obtain a proper fit the drift circle radius must be determined from the arrival time of the ionization (r-t relation).

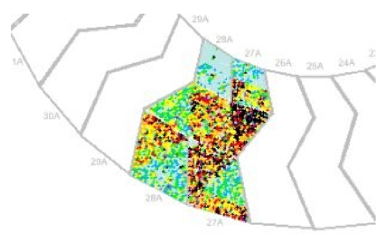


Basically determining drift velocity, 2 sets of values must be found, for B-field on and off

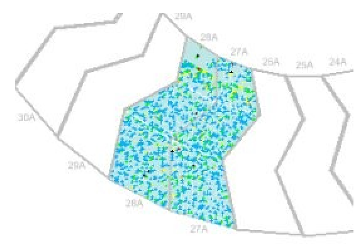
Cosmic tracks passing through the TRT are fit using a preliminary r-t relation.

The r-t relation is then varied and the tracks are refit. The procedure is iterated to minimize the residuals

Equalization of Noise Occupancy



Noise Occupancy Before Equalization



Noise Occupancy After Equalization

Must equalize the noise rates across the TRT to ensure consistent measurement across the detector

The noise level can be changed by adjusting the electronic energy level needed to register a "hit"

Scan the detector for noise levels on each straw and adjust the threshold to give 2% noise occupancy

After calibration the noise level is homogeneous throughout the TRT

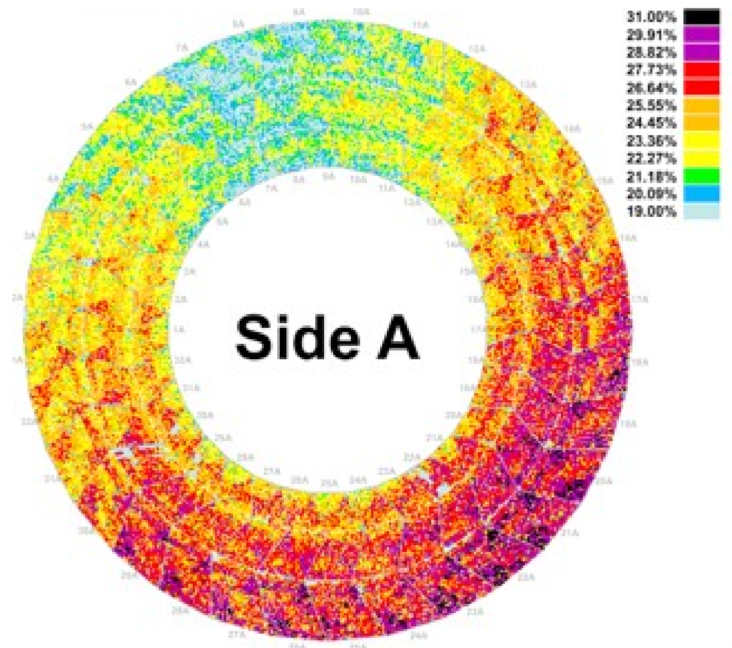
Current Status

After much work to commission and calibrate the TRT, it is ready for Data Taking

Preliminary alignment, timing and r-t relationships have been found with cosmic ray data (to be refined with collision data)

Optimal Thresholds and Voltages have been determined

The Full Read Out Chain from detector to offline reconstruction have been tested



Beam Splash Event From LHC Start up September 10th, 2008

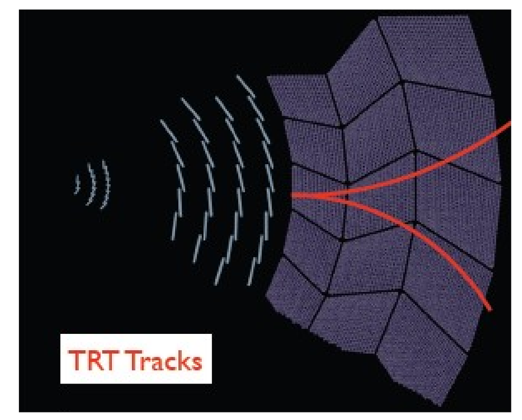
Timing constants had been determined using cosmic ray data, the colors show that these constants included the time of flight effect for particles moving from top to bottom

Photon Conversion in the TRT

High Energy Photons are important for New Physics Searches and for Higgs-Finding

On average ~40% of Photons will convert to electron-positron pairs in the Atlas Inner Detector (even higher in some eta ranges)

TRT is integral in the finding and recovery of these photon conversions by providing electron identification and allowing for many track measurements after the conversion, aiding in secondary vertex finding



Special Thanks to the TRT Collaboration
especially the Penn Quaker Army
and
The 65th Scottish Universities Summer School in Physics