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A Study of the Transition Region in the Continuous Tracker (TRT) of the ATLAS Inner Detector.

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Abstract

The feasibility of improving the transition region between the barrel and the end–cap sectors of the TRT of the Atlas Inner detector is investigated. A possible solution is discussed.

1 Introduction.

Both the Panel and the Annecy layouts of the Atlas Inner detector are inadequate in their coverage of the transition region between the barrel and the end–cap parts of the Inner detector. They both fail to provide the minimum required number of hits for good pattern recognition in the eta range $0.7 \leq \eta \leq 1.1$. Figure 1 below, shows the number of hits in the TRT per track versus eta for 200 GeV muon tracks from a simulation using the SLUG/DICE [1] package. The dip in the number of hits in the eta region stated above is down to approximately 21 hits in the TRT, well below the 36 hit requirement elsewhere. As it has been argued that the TRT pattern recognition capability is particularly sensitive to the number of hits produced on a given track, and since an excellent pattern

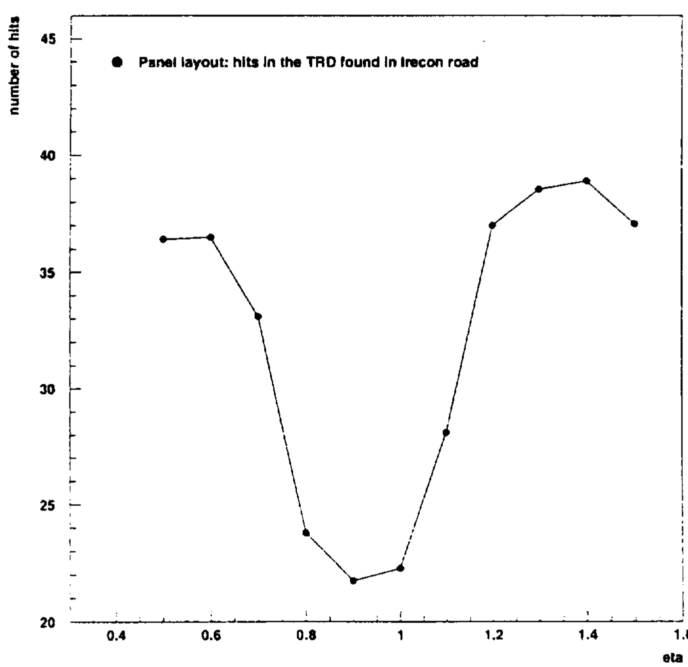

Figure 1: Hits in the TRT per track versus eta for the panel layout, Produced by the IRECON [2] reconstruction package, every point is an average over a hundred measurement. The transition region between the barrel and the end-cap produces a dip in the number of hits between $0.7 \leq \eta \leq 1.1$.

recognition is required over the full eta range it is then clear that a modification to the inner detector to improve its geometrical acceptance and consequently its pattern recognition capability in the transition region is needed.

The inability of the Panel and Annecy layouts to provide a minimum number of Continuous Tracker hits on tracks passing through the transition region arises from the existence of approximately ten centimeters of services separating the barrel and the end-cap regions of the Inner Detector. We propose a solution to improve the coverage in this eta range, decreasing the concentration of the inactive material in the transition region.

2 The Proposed Changes.

Following initial calculations [3], it is proposed that the barrel services are split into two components, the SCT and the TRT services, which are extracted to the outer radius of the Inner detector through two different gaps. This geometry is achieved by shortening the barrel TRT and moving the first end-cap TRT piece into the barrel region [1], see figure 2. Figure 3 shows the number of hits/track

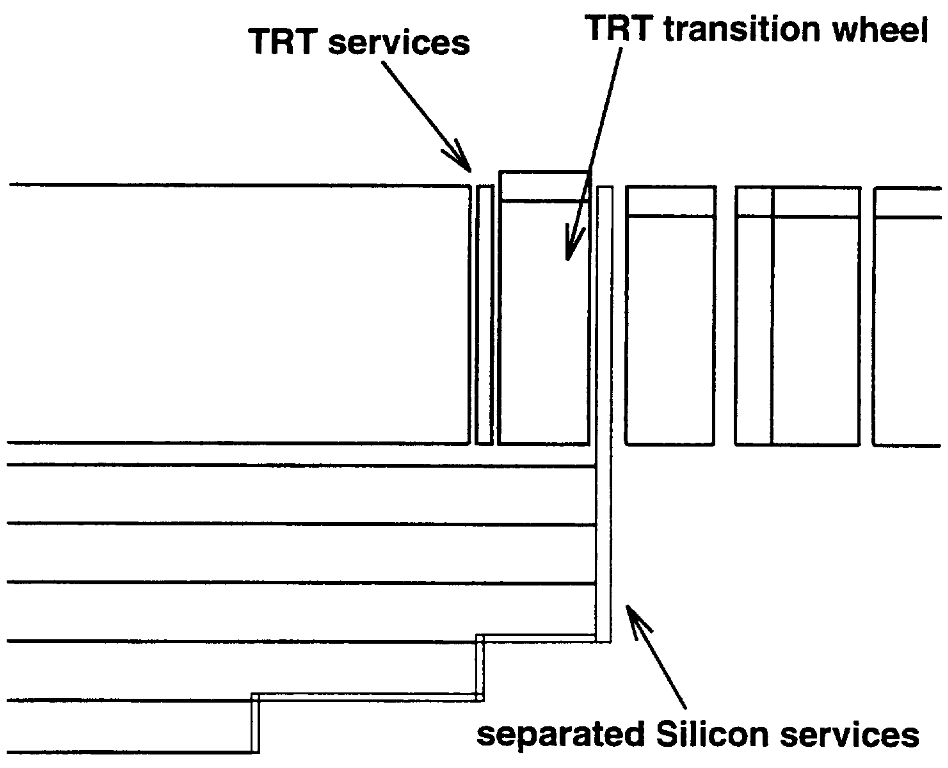

Figure 2: An R-Z section of the proposed layout (not to scale), showing the main features of the proposed layout.

in the TRT as a function of eta for the proposed layout, using straw spacing of

[1]This is referred to as the transition wheel in the following discussion.

0.526 cm and layer spacing of 0.8 cm, as in the TRT end-cap wheels of the panel layout. No improvement is gained from using such a geometry, contradicting

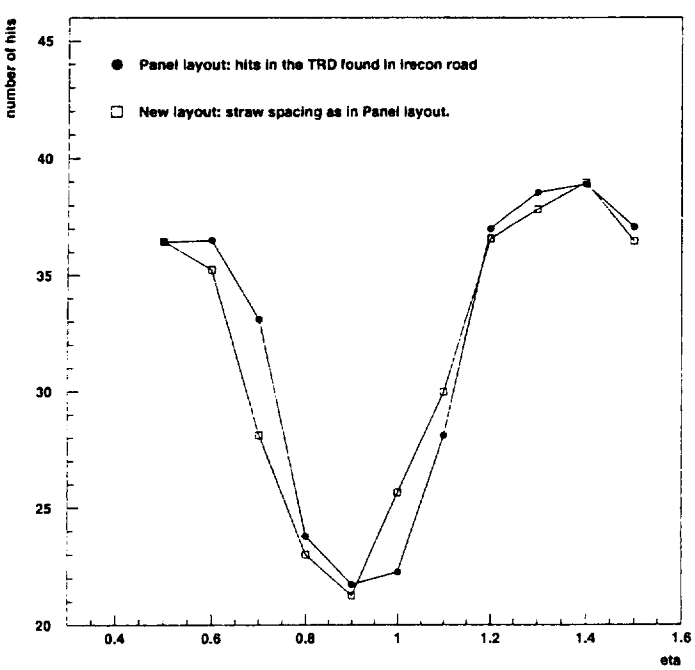

Figure 3: Comparison of the number of hits/track in the TRT between the Panel and the proposed layout, showing that no improvement was gained in the new layout.

initial calculations [3]. However, this result is explained by taking into account the density of the straws in the TRT end-cap wheels, which falls off as (1/Radius). Increasing the density of the straws in the TRT transition wheel results in a dramatic improvement in the number of hits/track recorded in the TRT in this region. Figure 4 shows the number of hits/track in the TRT as a function of eta for the proposed layout, using equal straw and layer spacings of 0.48 cm in the TRT transition wheels. It should be noted here that such a change would mean a loss of TR function in the TRT transition wheels, because of the smaller spacings between straws and a smaller volume of radiator. However, as shown in figure 4 the number of hits/track in the TRT is increased to a minimum level of approximately 30 hits improving the most important aspect of pattern recognition. Furthermore, both the Panel and the Annecy layouts have seriously degraded TR function in the eta range $0.7 \leq \eta \leq 1.1$.
It was checked whether the same increase in straw packing density in the first

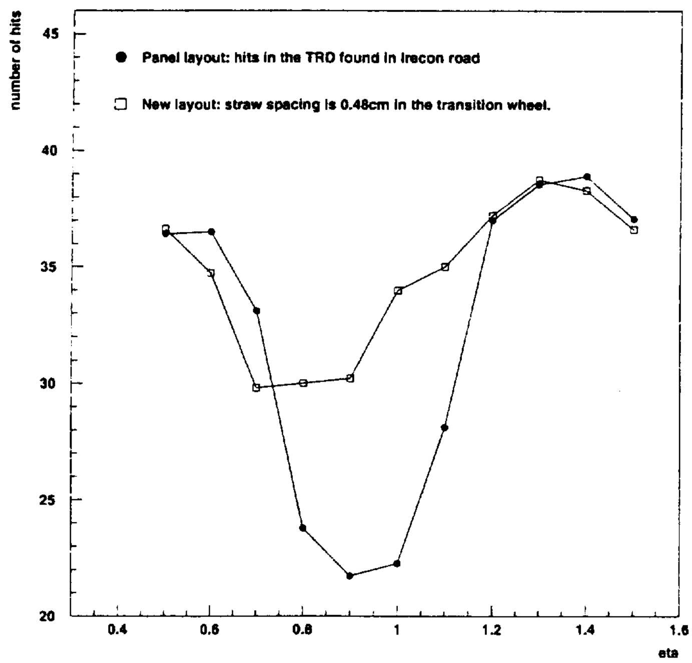

Figure 4: Comparison of the number of hits/track in the TRT between the Panel and the proposed layout, after increasing the density of straws in the transition TRT wheel. An increase of approximately 10 hits/track in the transition region is obtained over the Panel layout.

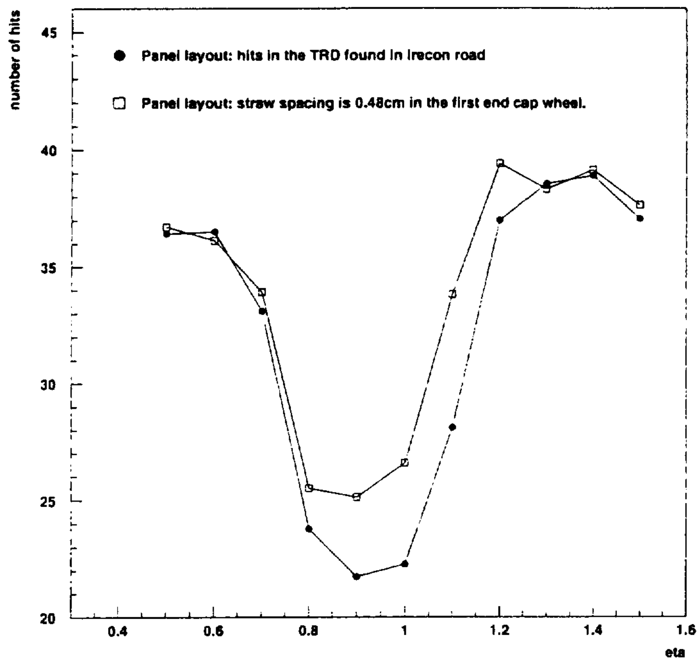

Figure 5: Comparison of the number of hits/track in the TRT between the Panel layout and a modified panel layout where the straw density in the first End–Cap wheel was increased to 0.48cm.

end–cap wheel of the Panel layout would result in a similar substantial increase in the number of hits/track. Figure 5 shows this scenario compared with the unchanged panel geometry case. It is clear that a small improvement is obtained in the number of hits/track, but this is well below that provided by the proposed layout.

3 Material Distributions.

The proposed changes also have the desirable property of distributing the materials more evenly in rapidity. Figure 6 shows the material distribution[2] versus η for the Panel and the proposed layout. The proposed layout shows a flatter distribution as expected, being lower than the Panel layout above η=0.8 and higher in the region $0.6 \leq \eta \leq 0.75$.

[2] All detectors in the Inner tracker were used in the materials survey as well as the inactive materials representing the services.

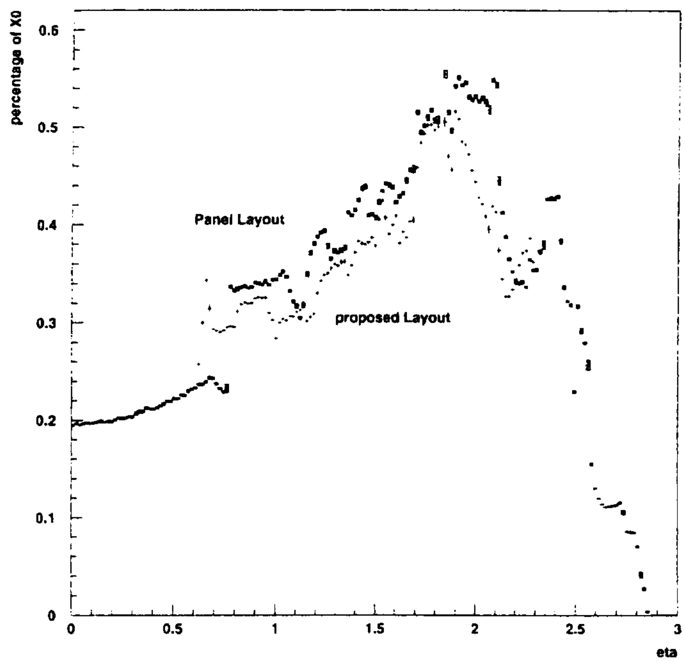

Figure 6: Material distribution versus eta for the panel layout and the proposed layout.

4 Conclusion

It has been shown that a significant improvement to the number of hits recorded by the TRT for tracks in the transition region between the barrel and forward detectors, is achieved using the proposed layout shown in figure 2, the specifications of which are shown in table 1. This improvement fills a serious gap in the performance of the TRT in the transition region covering 0.8 units of rapidity.

Inner detector component	Length in Z
TRT Barrel	140 cm
Straw spacing in barrel TRT	0.68 cm
Layer spacing in the barrel TRT	0.68 cm
TRT transition wheel	15 cm in Z, starting at 75 cm
Straw spacing in the TRT transition wheel	0.48 cm
Layer spacing in the TRT transition wheel	0.48 cm
First TRT end–cap wheel	15.2 in z, starting at 95.2 cm
Straw spacing in the first TRT end–cap wheel	0.526 cm
Layer spacing in the first TRT end–cap wheel	0.8 cm
Other end–cap TRT wheels	Same as for the Panel layout
SCT layers at R=40, 50and 60 cm	180 cm
SCT layer at R=30cm	144 cm

Table 1: Main geometrical dimensions of the proposed layout.

References

[1] SLUG/DICE package. The official ATLAS simulation software package.

[2] A reconstruction package for the ATLAS Inner Detector.
written by Pavel Nevski.

[3] A presentation by G. N. Taylor, on a proposed solution for the transition region between the barrel and the end–cap regions of the Inner detector.
Inner Detector meeting.
Annecy, LAPP, June 1994.