

DIRAC Trigger performance in 2002

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1 Introduction

The trigger system of the DIRAC experiment has been constantly updated for the last few years. However for the full 2002 run period it had the same configuration and imposed the same on-line requirements for the events to be read-out. This fact allows an analysis of the trigger selection performance with relatively high statistics.

The analysis of the trigger performance is based on T1 events and the event selection marks (trigger marks) of all more advanced triggers. It is assumed that due to the simplicity of the T1 system, events selected by it have no bias or deformation of their properties. For the present study most T1 runs taken in 2002 have been evaluated. In total $1.43 \cdot 10^6$ T1 events have been analysed.

In addition to the trigger marks that represent the real hardware response of each trigger system, for DNA and RNA their software simulation was also compared to the corresponding hardware response. This comparison demonstrated that the hardware and its software simulation agree to a level of more than 99%. In addition in the cases where there was a discrepancy were completely random, without any particular bias. This is a very important result on its own needed for the processing of Monte-Carlo events.

2 Trigger performance

The most interesting variables, in the framework of the DIRAC off-line data analysis, are the relative momenta between the two particles observed and the projections in all three dimensions. In what follows the events that would be selected by DNA **OR** RNA, T4 and T4 **AND** (DNA **OR** RNA) are

Trigger Stage	Events selected	Rate reduction
T1	$1.432 \cdot 10^6$	
DNA	$0.656 \cdot 10^6$	2.18
RNA	$0.473 \cdot 10^6$	3.03
DNA OR RNA	$0.801 \cdot 10^6$	1.79
T4	$0.323 \cdot 10^6$	4.43
T4 AND (DNA OR RNA)	$0.278 \cdot 10^6$	5.15

Table 1: The various number of events selected by each FIRAC trigger stage and the corresponding rate reductions with respect to T1.

compared with the ones selected by T1. Note that the last set of events (T4 **AND** (DNA **OR** RNA)) corresponds to the standard full DIRAC trigger selection scheme. Table 1 gives the number of events each trigger accepts and the corresponding rate reduction.

The relative momentum distributions are compared between the events selected from each trigger stage. For more quantitative results the distributions are divided to the original T1 distribution to provide the corresponding acceptance distributions. Errors are indeed reported on the acceptance plots. However given the high number of events per bin and the fact that the acceptance, for the interesting relative momentum region, is very close to 1 when they are invisible it is because they are smaller than the size of the tick marker.

Several event samples are studied:

1. All events selected by the T1 trigger that have a pair of tracks reconstructed,
2. Events with Q_x and Q_y less than 3 MeV/c,
3. Only those events of the above sample that have a small relative momentum between the two particles. In particular they must have Q_x and Q_y less than 3 MeV/c and Q_l less than 30 MeV/c.

In all cases event distributions are compared with ones that satisfy the same conditions and were obtained with the T1 trigger. All figures show a well understood trigger performance, which also coincides with the one expected¹.

¹The multilevel trigger system of the DIRAC experiment, L. Afanasyev et al., Nucl. Instr. Meth. A 491 (2002), 376

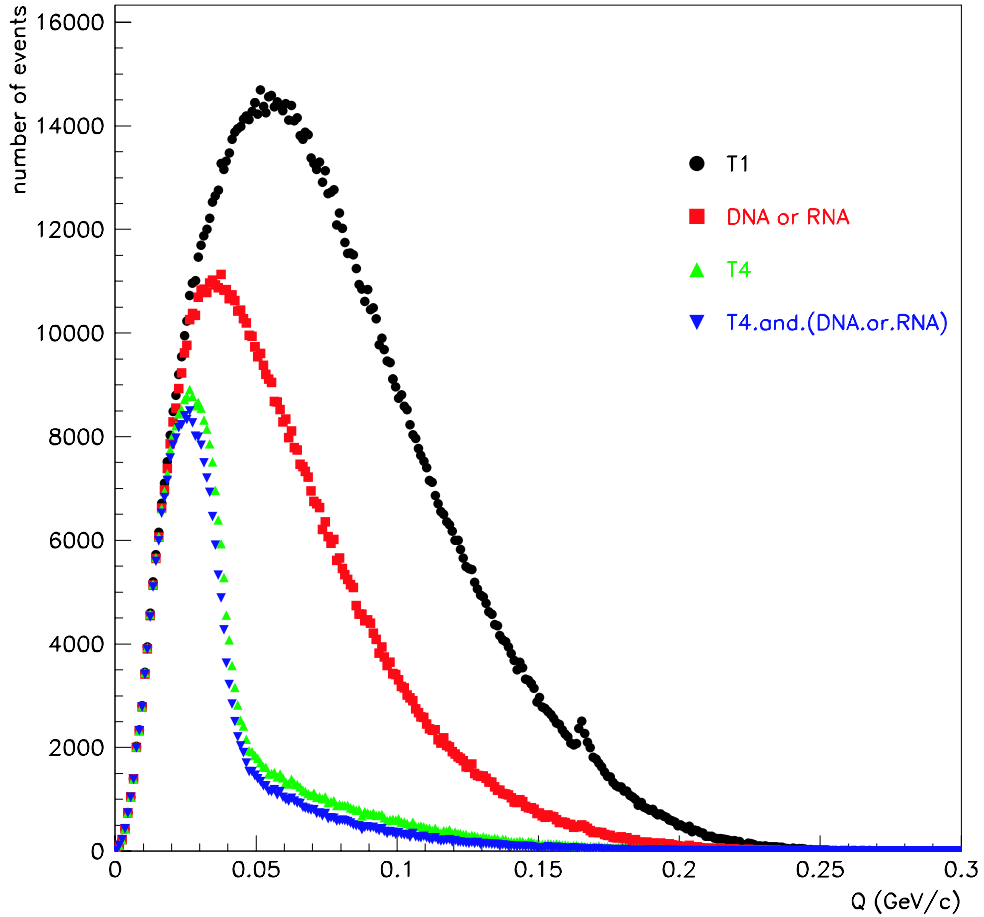


Figure 1: The Q distribution of all analysed events selected on-line with T1 trigger (in black). The distribution in red concerns the events that would be further selected by the DNA **OR** RNA combination (based on the relevant trigger marks). The one in green corresponds to the events that would be selected by T4 and the last one in blue to the full DIRAC trigger configuration (T4 **AND** (DNA **OR** RNA)).

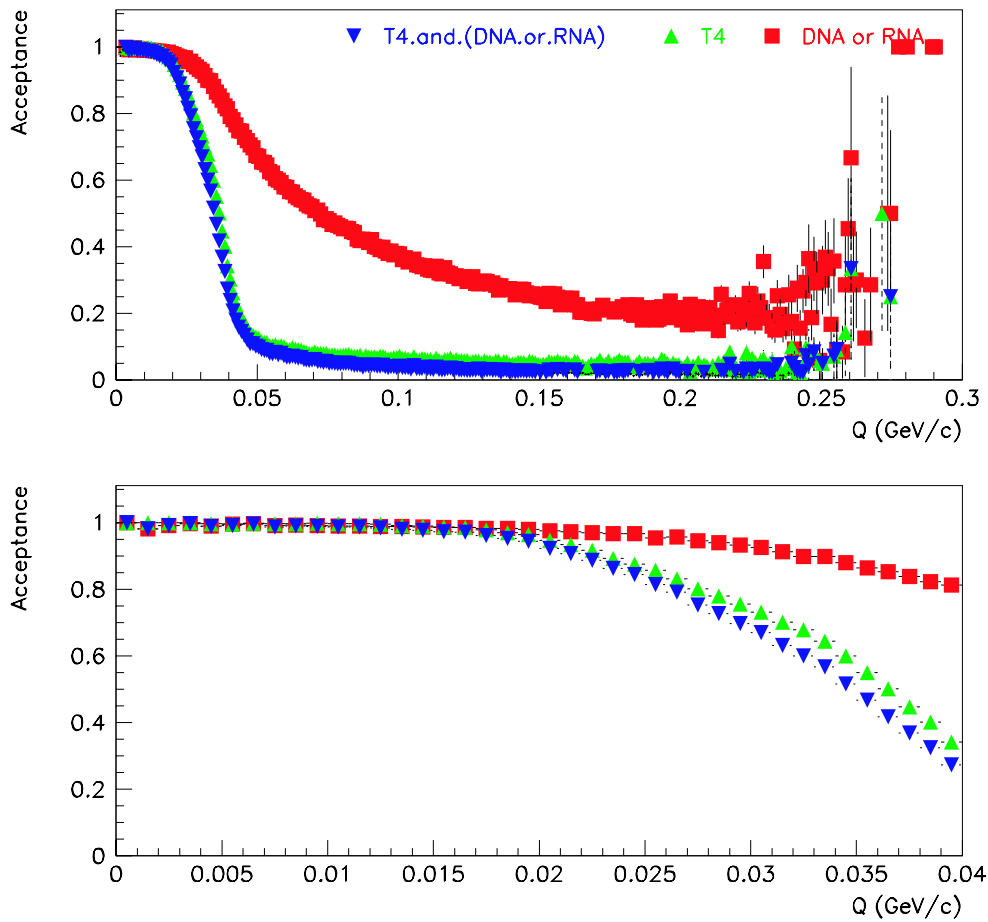


Figure 2: The acceptance of the various trigger systems as a function of the relative momentum (Q). The second figure is a zoom in the central region of the acceptance distribution around 0.

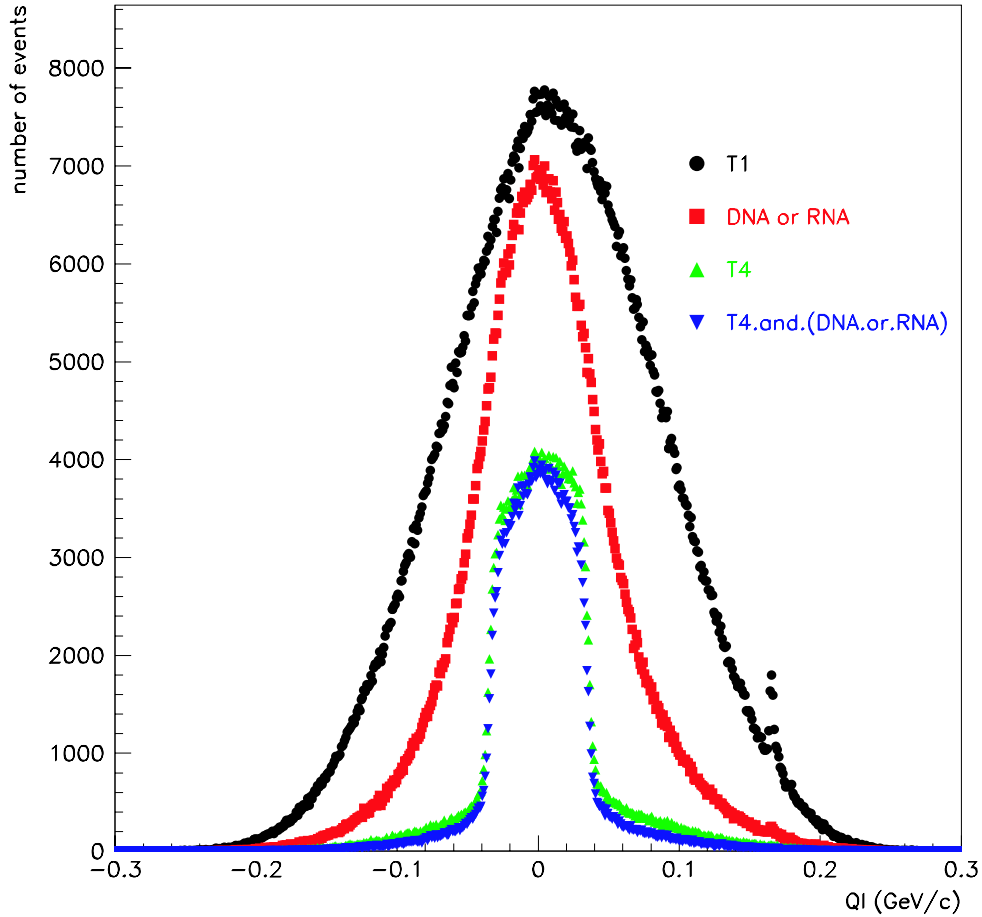


Figure 3: The longitudinal relative momentum (Q_l) distribution of all analysed events selected on-line with T1 trigger (in black). The distribution in red concerns the events that would be further selected by the DNA **OR** RNA combination (based on the relevant trigger marks). The one in green corresponds to the events that would be selected by T4 and the last one in blue to the full DIRAC trigger configuration (T4 **AND** (DNA **OR** RNA)).

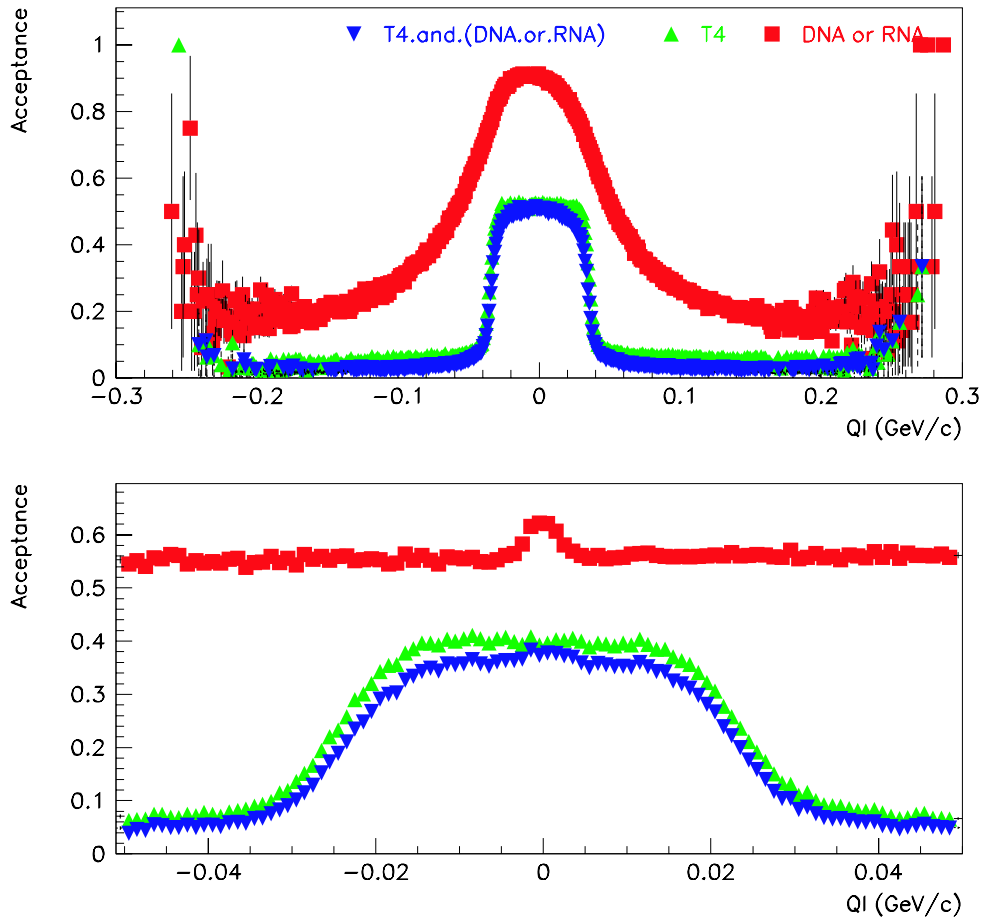


Figure 4: The acceptance of the various trigger systems as a function of the longitudinal relative momentum (Q_l). The second figure is a zoom in the central region of the acceptance distribution around 0.

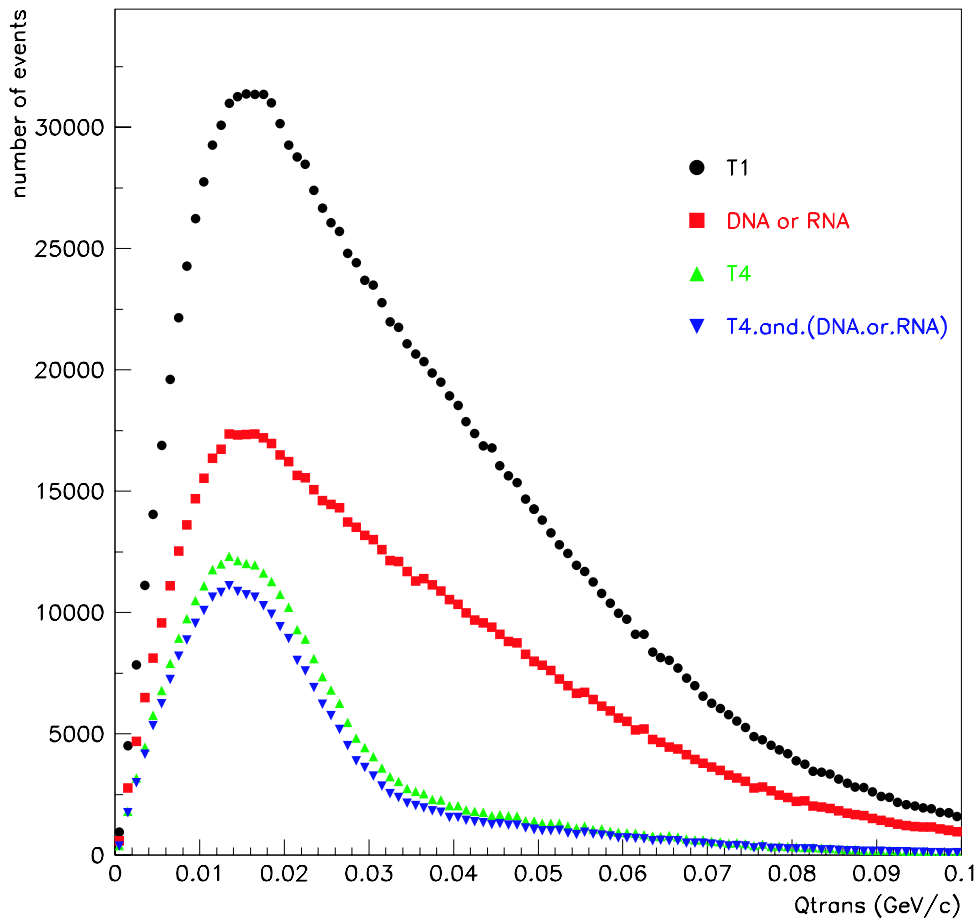


Figure 5: The transverse relative momentum (Q_{trans}) distribution of all analysed events selected on-line with T1 trigger (in black). The distribution in red concerns the events that would be further selected by the DNA **OR** RNA combination (based on the relevant trigger marks). The one in green corresponds to the events that would be selected by T4 and the last one in blue to the full DIRAC trigger configuration (T4 **AND** (DNA **OR** RNA)).

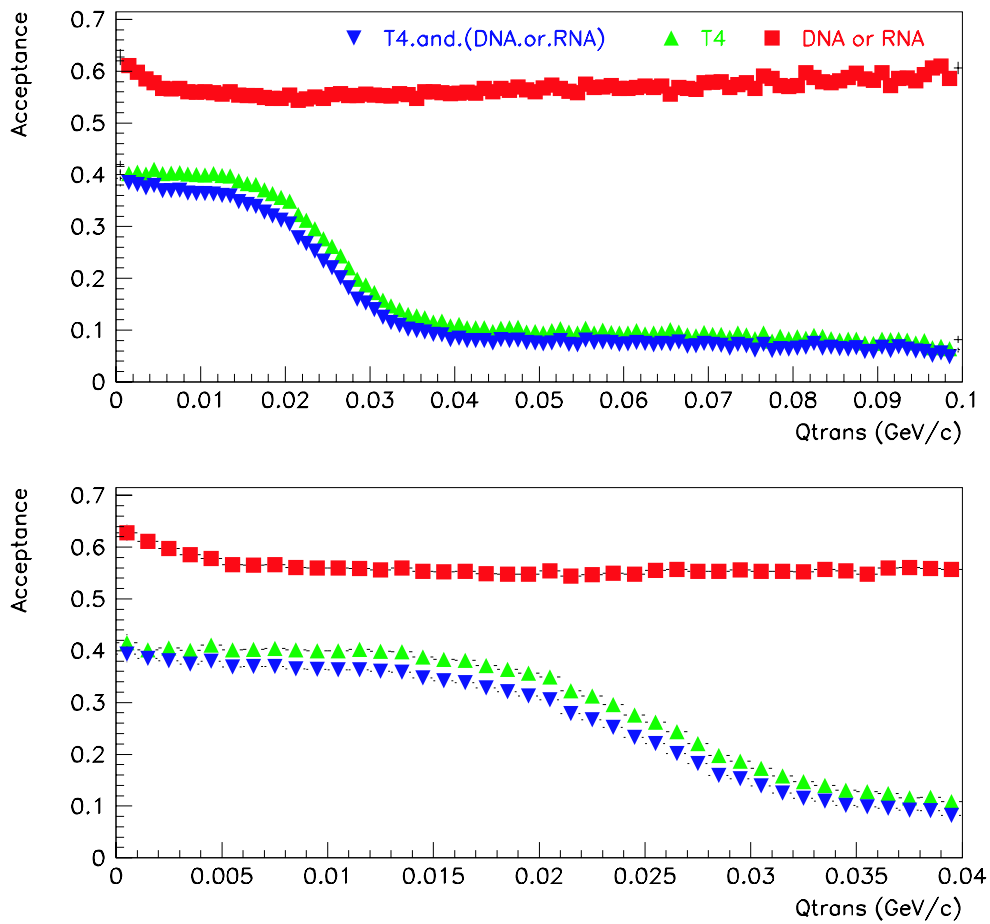


Figure 6: The acceptance of the various trigger systems as a function of the transverse relative momentum (Q_{trans}). The second figure is a zoom in the central region of the acceptance distribution around 0.

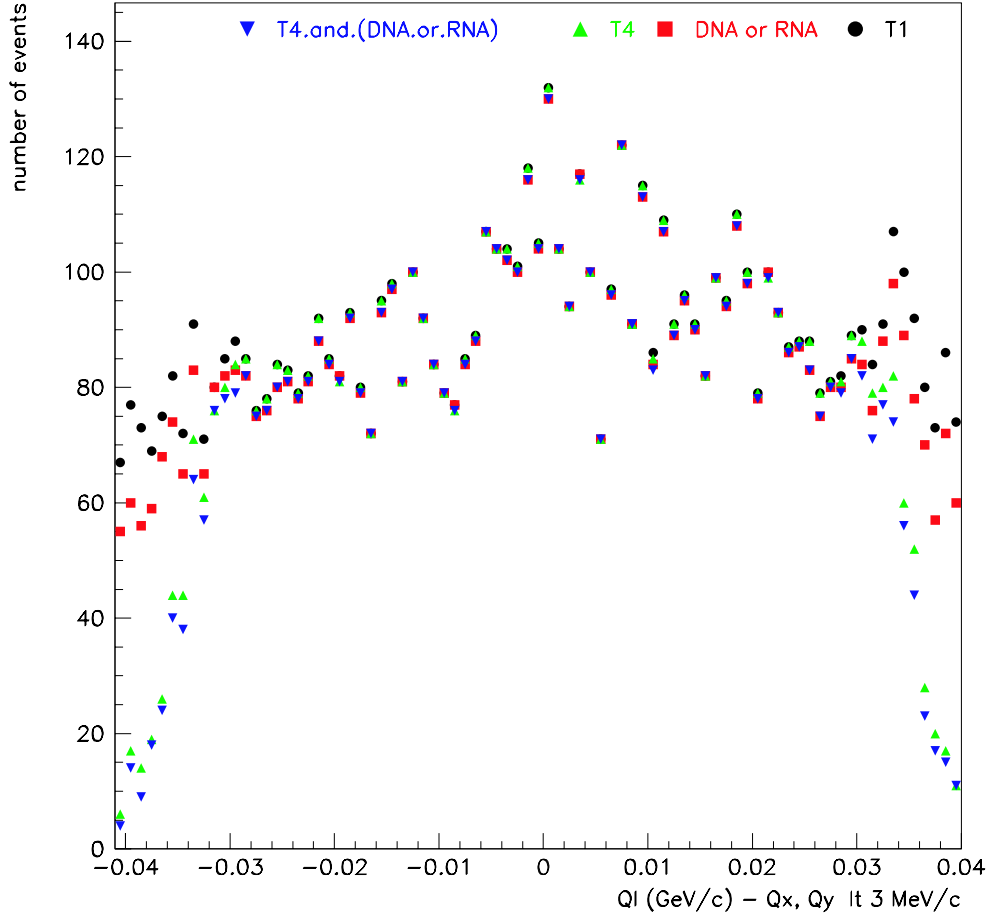


Figure 7: The longitudinal relative momentum distribution (Q_l) of events with Q_x less than 3 MeV/c and Q_y less than 3 MeV/c selected on-line with T1 trigger (in black). The distribution in red concerns the events that would be further selected by the DNA **OR** RNA combination (based on the relevant trigger marks). The one in green corresponds to the events that would be selected by T4 and the last one in blue to the full DIRAC trigger configuration (T4 **AND** (DNA **OR** RNA)).

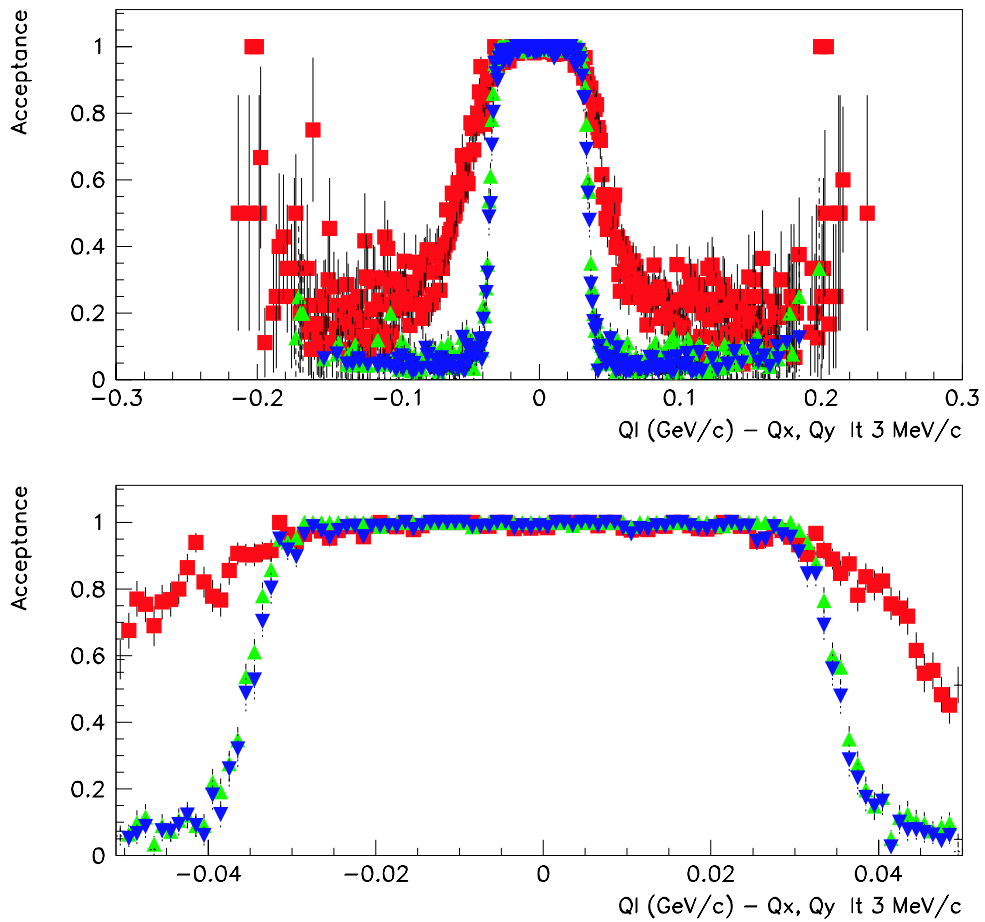


Figure 8: The acceptance of the various trigger systems as a function of the longitudinal relative momentum (Q_l) for events with Q_x less than 3 MeV/c and Q_y less than 3 MeV/c. The second figure is a zoom in the central region of the acceptance distribution around 0.

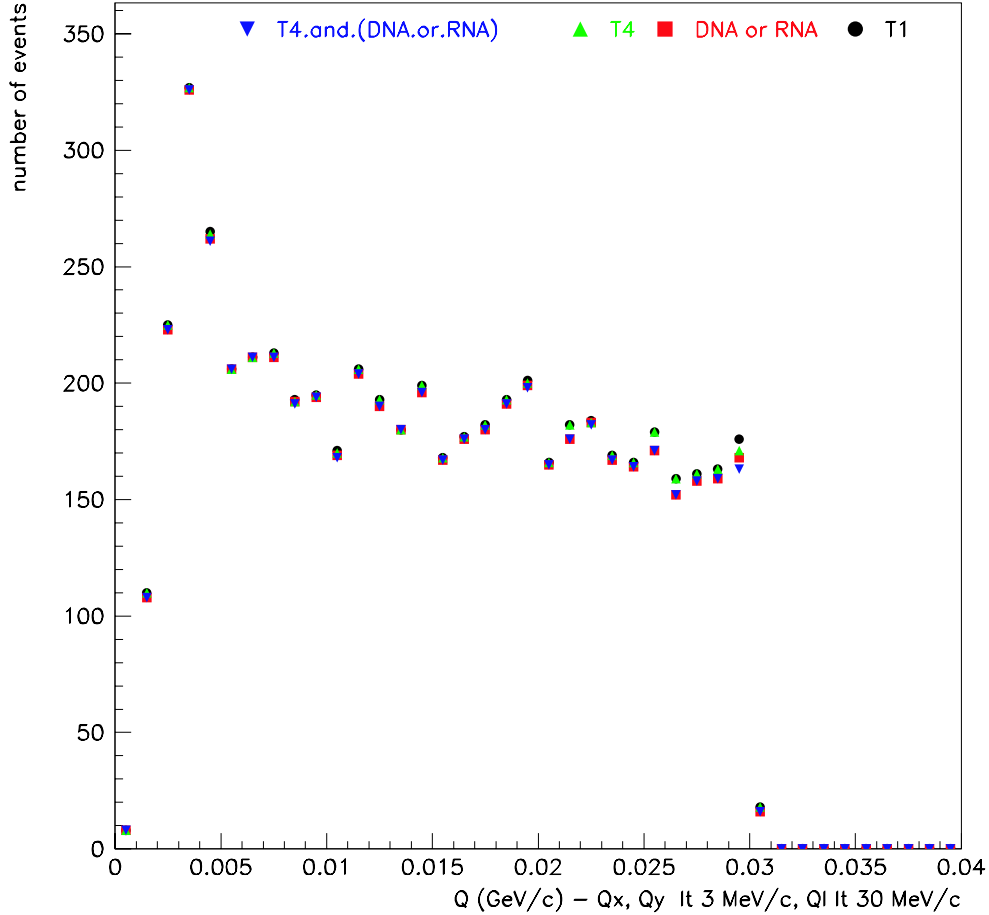


Figure 9: The relative momentum (Q) distribution of events with Q_x less than 3 MeV/c and Q_y less than 3 MeV/c and Q_l less than 30 MeV/c selected on-line with T1 trigger (in black). The distribution in red concerns the events that would be further selected by the DNA **OR** RNA combination (based on the relevant trigger marks). The one in green corresponds to the events that would be selected by T4 and the last one in blue to the full DIRAC trigger configuration (T4 **AND** (DNA **OR** RNA)).

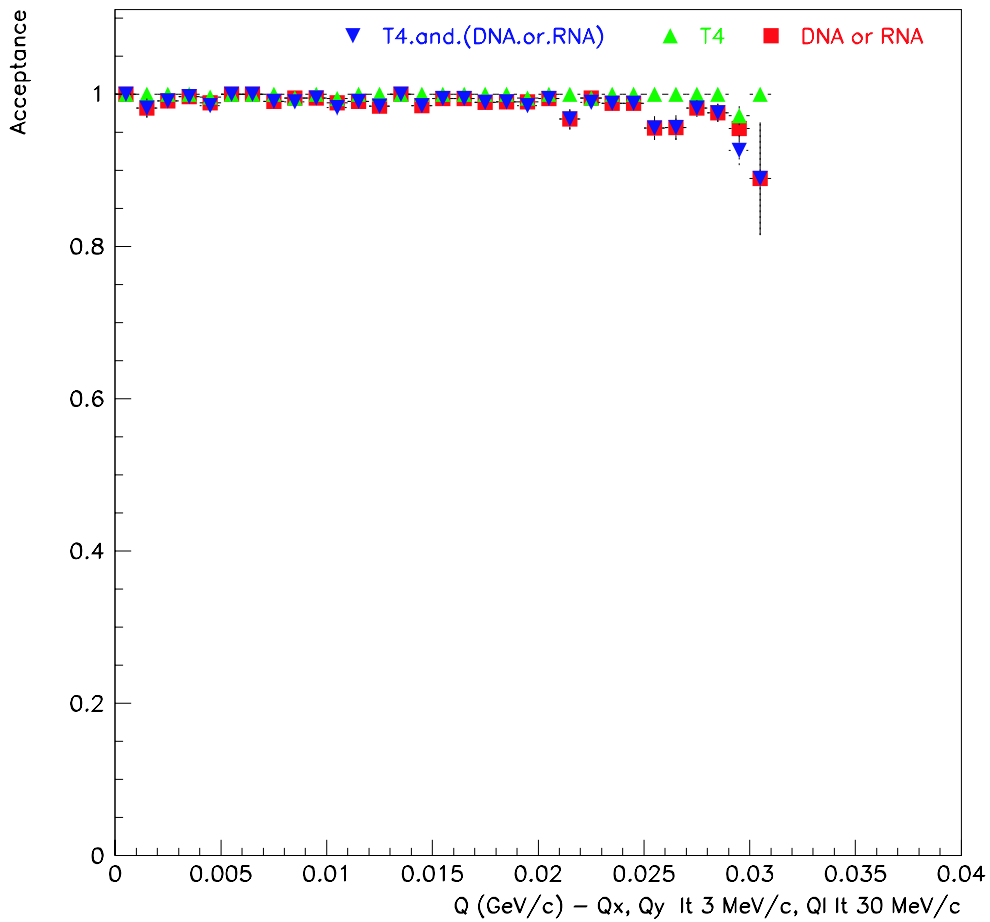


Figure 10: The acceptance of the various trigger systems as a function of the relative momentum (Q) for events with Q_x less than 3 MeV/c and Q_y less than 3 MeV/c and Q_l less than 30 MeV/c. The second figure is a zoom in the central region of the acceptance distribution around 0.

3 Conclusions

The performance of the DIRAC trigger system in 2002 was exceptional. As far as reliability is concerned no major part needed any intervention. As an example it is cited that some of the electronics (DNA–RNA) have been switched on and loaded at the beginning of the 2002 period (April) and remained operational all the way until the end (in September 2002). (However for quality assurance reasons they have been reloaded approximately systematically once a month without any malfunction observed in advance.) As far as event selection is concerned, the whole trigger has been performing as expected. The study presented here is in complete agreement with the published trigger performance in the DIRAC trigger paper. In addition the high statistics used here allowed a detailed study of possible biases introduced by the trigger system. No deformation of any interesting distribution has been observed and the quality of the events selected, especially those with low relative momentum, is exceptional.

It is therefore proposed to maintain the same trigger configuration for the 2003 run.