Trigger Rate Studies of the Muon Identifier Using Anode Wire Readouts

Gus Petitt and Xiaochun He
Georgia State University

(submitted: October 3, 1995)

1 Introduction

The routines in `PISORP` which simulate tracking through the muon identifier in the muon arm of PHENIX have been revised by Ken Read, Saskia Mioduszewski, and Ajit Mohanty to reflect the switch from pad readout to direct readout from the anode wires of the Iarocci tubes. This is a first report on our use of the newly revised `PISORP`.

A very brief report on the differences in trigger rates brought about by the omission of the neutron and lead shields is given. In addition, since the issue of omitting the "nosecone" was brought up by Glenn Young at the Albuquerque meeting in August, we have also studied the effect on the trigger rate of omitting both the shields and the nosecone. Normally simulations should have both shields removed and the nosecose installed.

Finally, since the tracking algorithm permits the user to simulate tracking through strip detectors without hodoscopic ambiguities we have compared the trigger rates with and without these ambiguities.

2 Test data preparation

The results presented in the following sections were obtained using the most recent version of `PISA` available to us, namely version 2.03/00 obtained from BNL in May, 1995. Both the `UA1` and `RV_JPSI` event generators were used. Three sets of output were obtained for each event generator. In one case the lead shield and neutron shield were installed; in the second case they were omitted. In the third case both the shields and the nosecone were omitted. In addition, a set of runs was made for 500 events. Due to the long running time for ua1 events this was done only for the "shields out, nosecone in" case. A partial listing of the `gffgo.dat` file used for the "shields in" case is as follows:

```
CUTS  .002  .005  .002  .005  .005 .005 .005 1.e+4 1.e+4 .002 4.e-7
GEOP 'ENDC' 'CENT' 'PIPE' 'NOSE' 'NTSH' 'PBSH'  !Passive elements
VER  'FULL' 'P_ID' 'NONE' 'NONE' 0.0  0.0       ! MVD but no hits
MUN  'FULL' 'ETOT' 'FULL' 'NCAL' 0.0 0.0 0.0 'STCK' 'NNEU'  !Muon ID
MUW  'FULL' 'ETOT' 'FULL' 'WCAL' 'NONE' 0.0 0.0 'STCK'      !Side
MUM  'FULL' 'ETOT' 'FULL' 'MCAL' 0.0 0.0 0.0 'STCK' 'NNEU'  !Muon trk
```

Note that the "NNEU" parameter suppresses storage of neutral hits. The corresponding file for the "shields out" case is identical except for the line

```
GEOP 'ENDC' 'CENT' 'PIPE' 'NOSE'
```

and for the "nosecone out"

```
GEOP 'ENDC' 'CENT' 'PIPE'
```

A partial listing of the `ua1event.par` file used for the runs is:

```
ntotal =  9000,  <-- 9000 particles emitted.  This is approximately
                     equivalent to a ``single'' HIJET event.
include = 8, 9, 18*0,  <-- Only pi+ and pi- emitted
the_minc =    3.0,  <-- Min theta = 3 degrees
the_maxc =   60.0,  <-- Max theta = 60 degrees.  This is probably
                        larger than necessary.
```

For the `RV_JPSI` generator angle and momentum filters were used to guarantee that all particles were emitted into the muon arm with sufficient momentum to penetrate beyond plane 3 of the muon identifier for the "shields in" cases. The angle range was 12^o to 25^o and the minimum momentum was 2 GeV/c. The version of `PISORP` used was downloaded from the "Soren" Silicon Graphics computer at U. T. on August 17. This is the version used by Ken Read and Saskia Mioduszewski in preparing for the Albuquerque meeting that took place on August 14-15. We have modified it to store the histograms that are shown in Figs. 2- 5. These figures show the number of events for which 1, 2, 3,..,8 roads are found such that each road produces hits in (at least) planes 1, 2, and 3 of the muon identifier. A partial listing of the `mun_digi.par` file used with `PISORP` is:

```
$nml_readout1_init
  seg_type = 2, 2, 2, 2, 2, 2,
  min_coord1 = -655.32, -655.32, -655.32, -655.32, -655.32, -655.32,
  delta_coord1 = 8.0, 8.0, 8.0, 8.0, 8.0, 8.0,
  min_coord2 = -516.8, -516.8, -516.8, -516.8, -516.8, -516.8,
  delta_coord2 = 8.0, 8.0, 8.0, 8.0, 8.0, 8.0,
  eff_neut = 0.000, 0.000, 0.000, 0.000, 0.000, 0.000,
  eff_gam = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
  eff_chrg = 1.00, 1.00, 1.00, 1.00, 1.00, 1.00,
$end
```

These parameters are the same as used for Ken Read's report at the Albuquerque meeting. In particular, the `segmentation_type 2, 2,...` entry corresponds to detector strips of 8 cm width with the hodoscopic ambiguities turned "on". Replacing this with `segmentation_type 1, 1,...` turns the hodoscopic ambiguities "off".

The road finding scheme used to obtain these results starts in plane 1 of the muon identifier. The beginning of a road is signified by hits in both a vertically and a horizontally mounted proportional tube. The intersection of these tubes defines the x, y coordinates of the beginning of the road. The tubes in plane two whose intersection is closest to the same θ,ϕ coordinates, measured with respect to the vertex, as the hits in plane 1 are then checked for hits. If no pair of hits is found, then adjacent tubes on either side are checked for hits. When a pair of hits is found, the algorithm continues to project forward to check plane three for hits in exactly the same fashion as for plane 2. This search area in plane 2 thus includes 9 square regions, each 8 cm X 8 cm in area. This scheme is indicated in Fig. 1.

3 Results

Figure 2 shows the effects of removing the lead and neutron shields and of removing the shields and the nosecone. The portions of the histograms that correspond to valid trigger-roads are shown cross-hatched. Note that 69 of the 100 events produce no tracks to plane 3 and 22 events produce only one track to plane 3.

As indicated by the arrows in the figure, removing the shields has only a slight effect, increasing the trigger rate from 9 to 10 %. However, removing the nosecone has a significant effect, increasing the trigger rate to 35 % or, assuming a Au + Au central collision rate of 1.4 kHz, it gives a trigger rate of 490 Hz.

Figure 3 shows the effects of turning "on" the hodoscopic ambiguities. This is shown for 500 `UA1` events run with the nosecone installed but with both shields omitted. The results for ambiguities "off" is shown by the solid lines and the results for ambiguities "on" is shown by the dashed lines. The set of histograms on the left and right hand sides of the figure are the same except the right hand side shows the distribution of roads for which the number of roads is ≥ 2. For the 500 event case the number of trigger roads with ambiguities "off" is 9 % and with ambiguities "on" the rate increases only slightly to approximately 11 %.

The results obtained for 100 J/Psi events is shown in Fig. 4. The momentum and angle cuts specified for the event generator should guarantee 100% trigger efficiency. However, for the case where the shields are installed, two of the 100 events produce only one track reaching to plane 3, presumably because multiple scattering has caused two of the tracks to be deflected to the piston or the lampshade magnet before reaching the third plane of the muon identifier. Therefore, with the shields installed the trigger rate is 98% as indicated in the upper right-hand section of Fig. 4.

When the shields are removed, however, all particles produce tracks reaching to plane 3 so that the trigger rate is 100% as indicated in the lower right hand section of the figure.

In Fig. 5 we show the result of superimposing the `UA1` and `J/Psi` events using the `MERGE` facility of `PISORP`. Now, the superposition of the `UA1` and `J/Psi` tracks produces a trigger rate of 100% in all cases.

Hodoscopic ambiguities should of course always normally be "on". We have looked at the "off" case to show how performance would vary if outside information (such as timing across a tube to provide crude horizontal resolution) were used to resolve hodoscopic ambiguities. Of course, such information would not be available to a LVL-1 trigger. Moreover, hodoscopic ambiguities will be "broken" or resolved by means of extrapolation from the muon tracker both offline and in the LVL-2 trigger.

Finally, it is recognized that this study effectively utilizes on the order of 10,000 trigger road-starting x-y intersections. This is too costly and not necessary. Subsequent simulations have shown (at the October 6 Muon Arm meeting, for instance) that requiring at least two x-view trigger roads and at least two y-view trigger roads provides a more feasible LVL-1 algorithm requiring only 744 trigger roads.

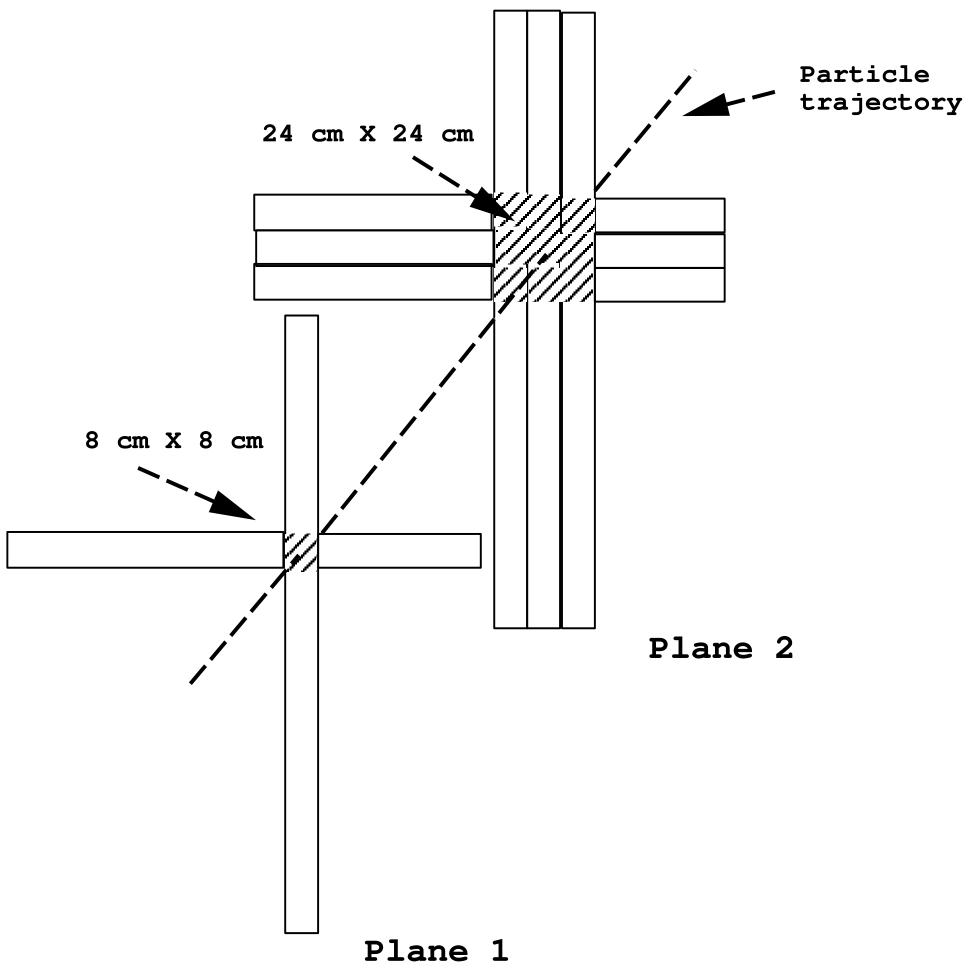

Figure 1: Schematic of the trigger road finding algorithm used in this study. The third plane of the muon identifier is searched for hits over a 24 cm X 24 cm area exactly as indicated here for the second plane.

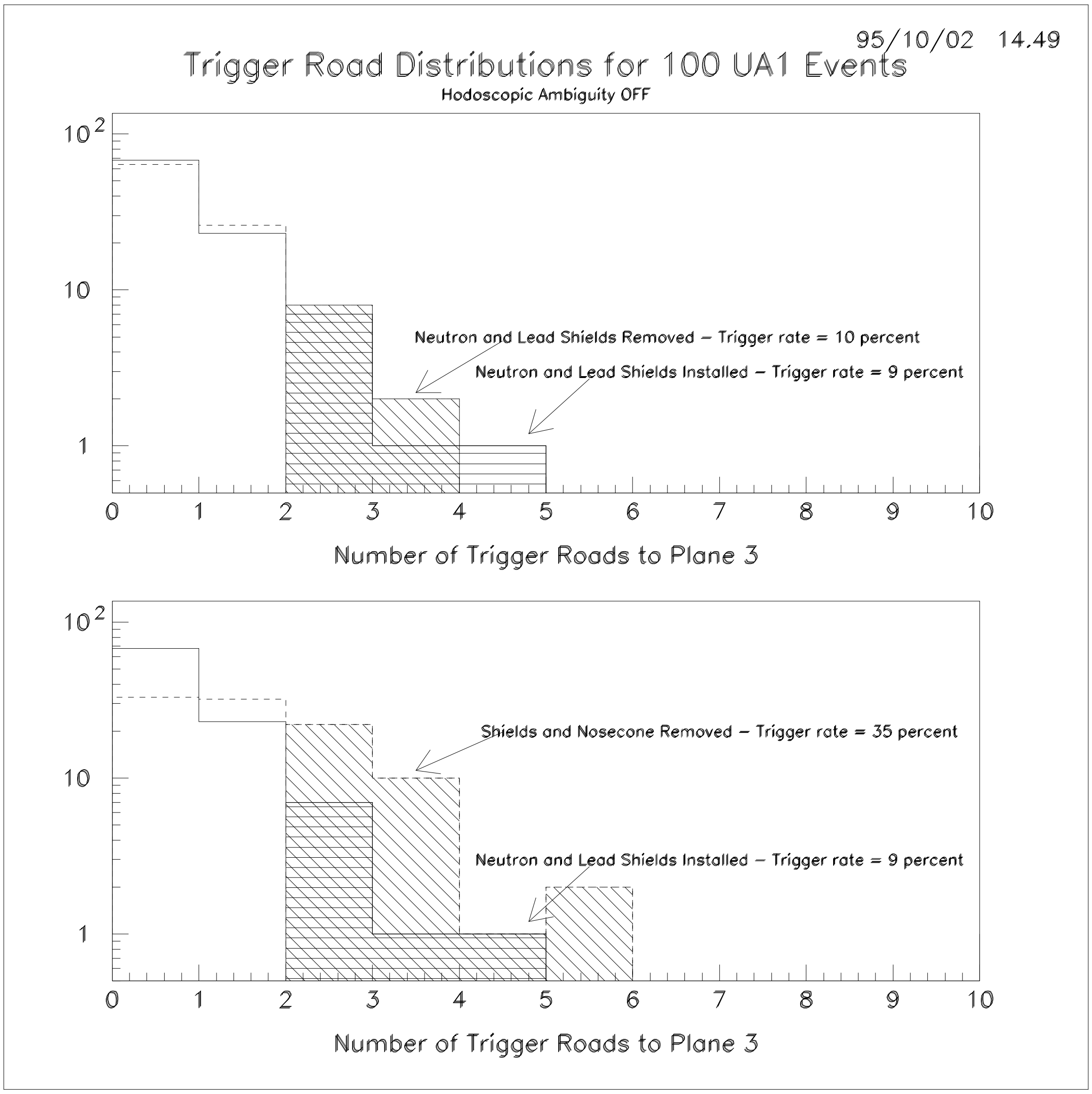

Figure 2: Distribution of trigger roads for 100 `UA1` Events. The histograms at the top show superimposed the number of trigger roads for the cases where the lead and neutron shields are installed and the number of roads produced when these shields are omitted. The histograms at the bottom show superimposed the number of roads produced when both shields and the nosecone are installed and the case where all three items are omitted. For all cases the hodoscopic ambiguities in the strip detectors are turned "off". The shaded areas represent the numbers of roads (≥ 2) that produce a trigger.

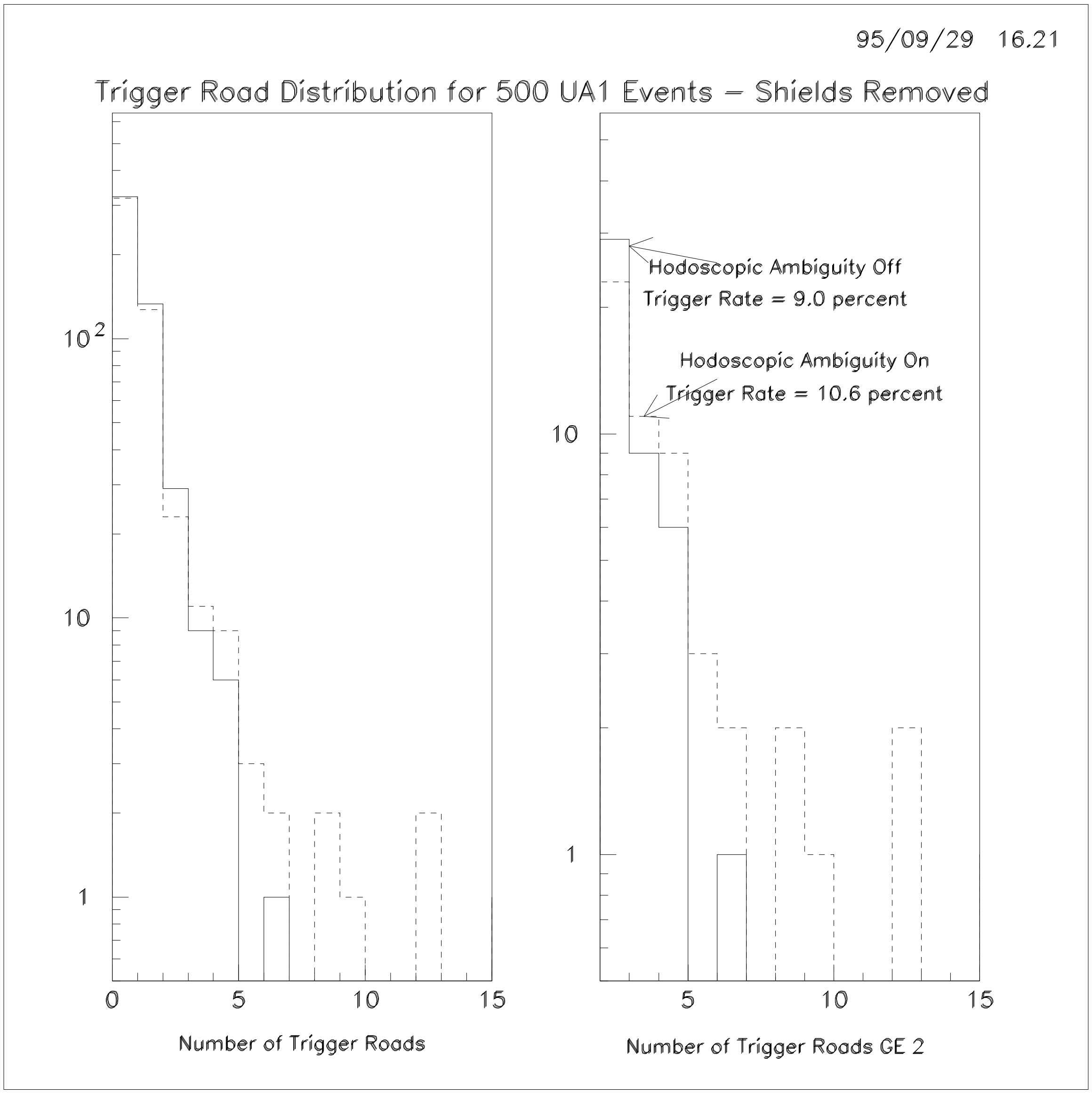

Figure 3: Distribution of trigger roads for 500 `UA1` Events. The histograms on the left and right are the same, except that the one on the right shows only the cases where the number of trigger roads equals at least 2. Both the lead and neutron shields were removed for the `PISA` run used to generate this data.

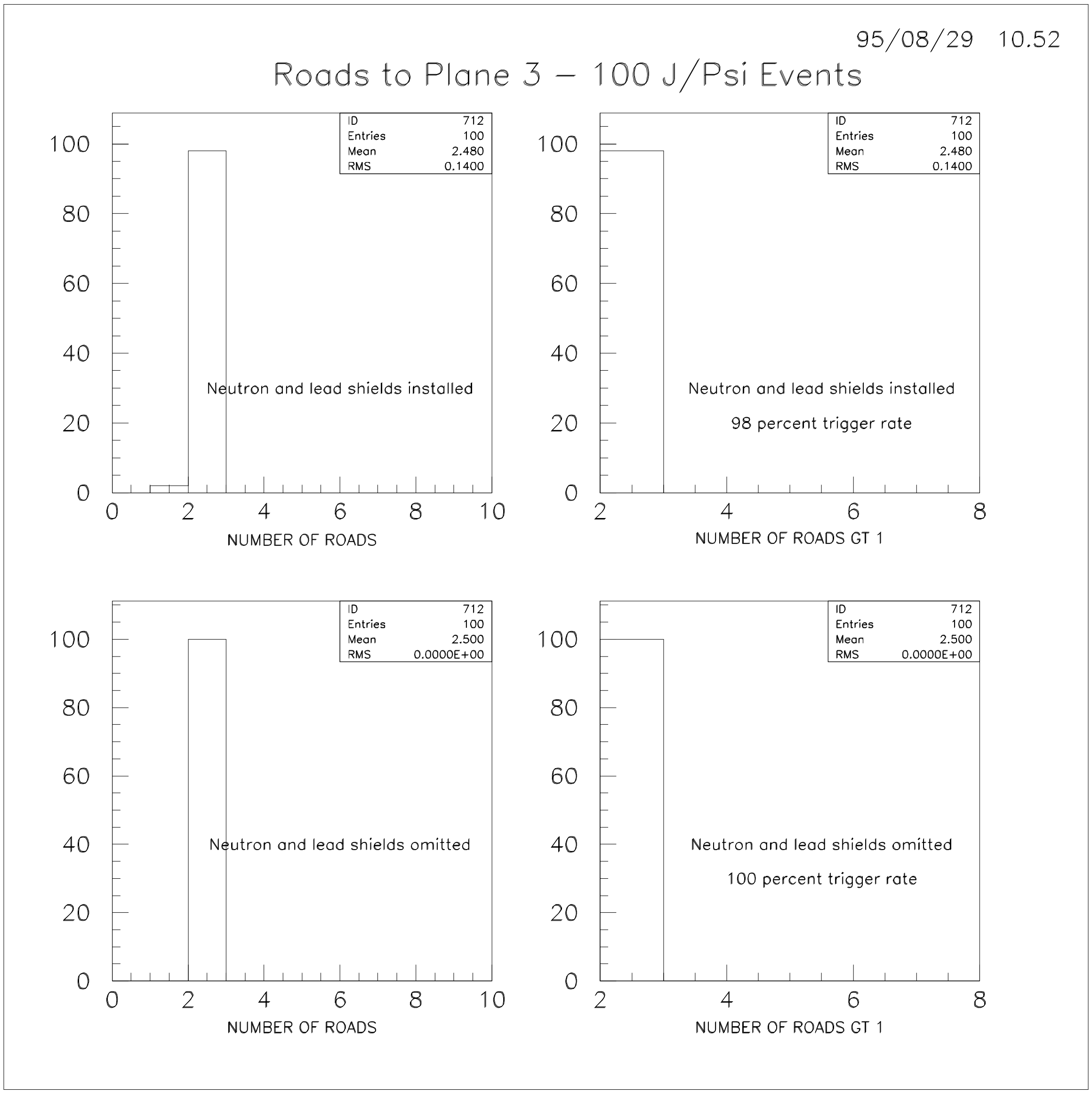

Figure 4: Distribution of trigger roads for 100 `J/Psi` events. The two upper histograms show the same results except that the one on the right shows only the distribution where there are at least two roads. A similar remark applies to the two lower histograms. In all cases the nosecone is installed and hodoscopic ambiguities are "on".

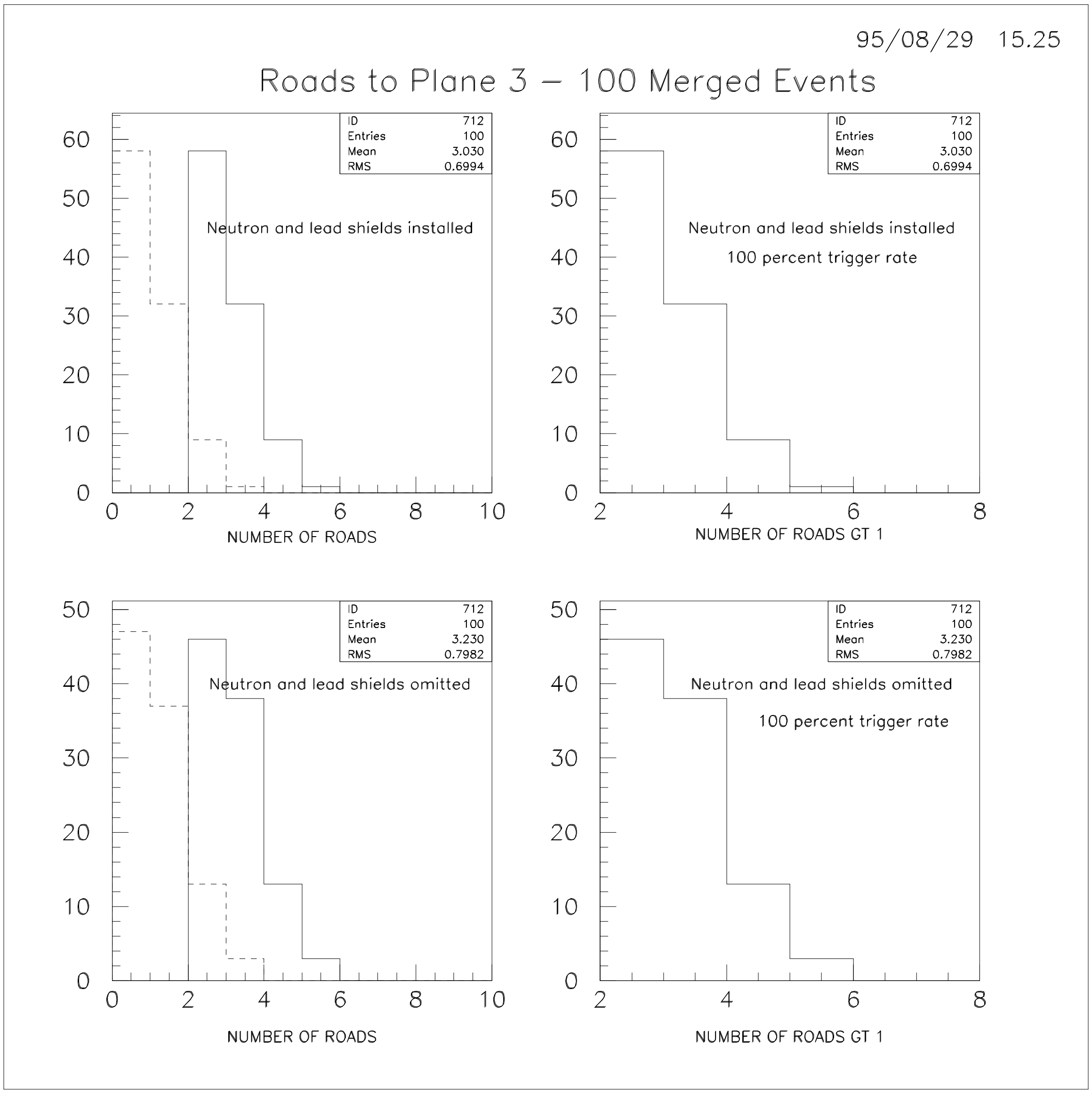

Figure 5: Same as Fig. 3 but with each event being a superposition of one `UA1` and one `J/Psi` event. The dashed histograms are the `UA1` event distributions. They are identical to the superimposed distributions but shifted to the left by two roads.