Even More Thoughts on Rate Dependence

by
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Abstract

Another way of calculating and correcting the rate dependence is discussed. This method which relies solely on the data, assumes that the rate dependence is due to the extra hits in the station one drift chambers.

1 The Same Introduction as Before

The rate dependence correction is made to remove the effect of any inefficiency in our ability to detect and reconstruct events that occurs as a function of beam intensity (SEM).[1] This inefficiency is typically caused by lost hits in the single hit TDC's or by too many hits in the spectrometer confusing the trigger or track reconstruction. In simple terms

$$N_m(s) = N_t(s)\ e(s)$$

where s is the SEM for the spill, $N_m(s)$ is the number of events which are reconstructed at a given SEM, $N_t(s)$ is the number of *true* events which actually occurred and would have been accepted at that SEM. ($N_t(s)/s$ is actually a constant, independent of SEM.) Finally, $e(s)$ is the efficiency for detection and reconstruction as a function of SEM.

2 Assumptions

For this note only the data will be studied and the following assumptions are made:

- The rate dependence is solely due to the extra hits in the drift chambers.
- These extra hits are only a function of intensity (s), the y position (y) and the target (LD2 or LH2).

[1] The SEM has been corrected for its offset throughout this note.

3 Probability of an Extra Hit Occurring

A 'noise' or 'extra' hit is anything that produces a signal on a drift chamber channel so that the signal from a good track is lost. So the probability of getting an extra hit at a given location in y, is the same as the probability of loosing a good hit at the same location. This probability, $P(y, s)$ can be expressed as,

$$P(y, s) = Ap(y)p(s) \tag{1}$$

where the y and s dependences have been seperated so that

$$\begin{aligned} p(y) &= 1 + by + cy^2, & (2) \\ p(s) &= d + es + fs^2, & (3) \end{aligned}$$

A is a normalization factor and b, c, d, e and f are constants.

4 y Dependence

The y dependence of the noise [$p(y)$] can be determined by performing a second pass analysis of a DST with all of the ntuple cuts put in cuthard. This produces a new DST of only good events. Then a third pass analysis was performed on the DST of good events. This produced a histogram of hits in station one that is composed of tracks from good events and the extra hits present when a good event occurred. Then by projecting the two good tracks back to station one these good hits can be subtracted. The resulting histogram is a histogram of extra hits.

Figure 1 shows the raw hit distribution (solid line) in the Y1 drift chamber from the analysis of a DST of selected good events. (The events were selected based on mass ($3.0 < am < 3.45$) and beam intensity ($4500 <$ SEM < 6000).) Also shown are the hits from the good pair. The hits from the positive (negative) muon are shown as a dashed (dotted) line.

Figure 2 shows the noise distribution in the Y1 drift chamber that was present when a good reconstructible J/ψ event fired the trigger. This plot was made by subtracting the dotted and dashed lines from the solid line in figure 1 [2].

From the fit in figure 2 the values of b and c can be determined so that,

$$p(y) = 1 + 0.0095y + 0.0015y^2 \tag{4}$$

[2] I think that it would be more correct to subtract the good hits reduced by the chamber efficiency from the raw hit distribution. This will be a small effect.

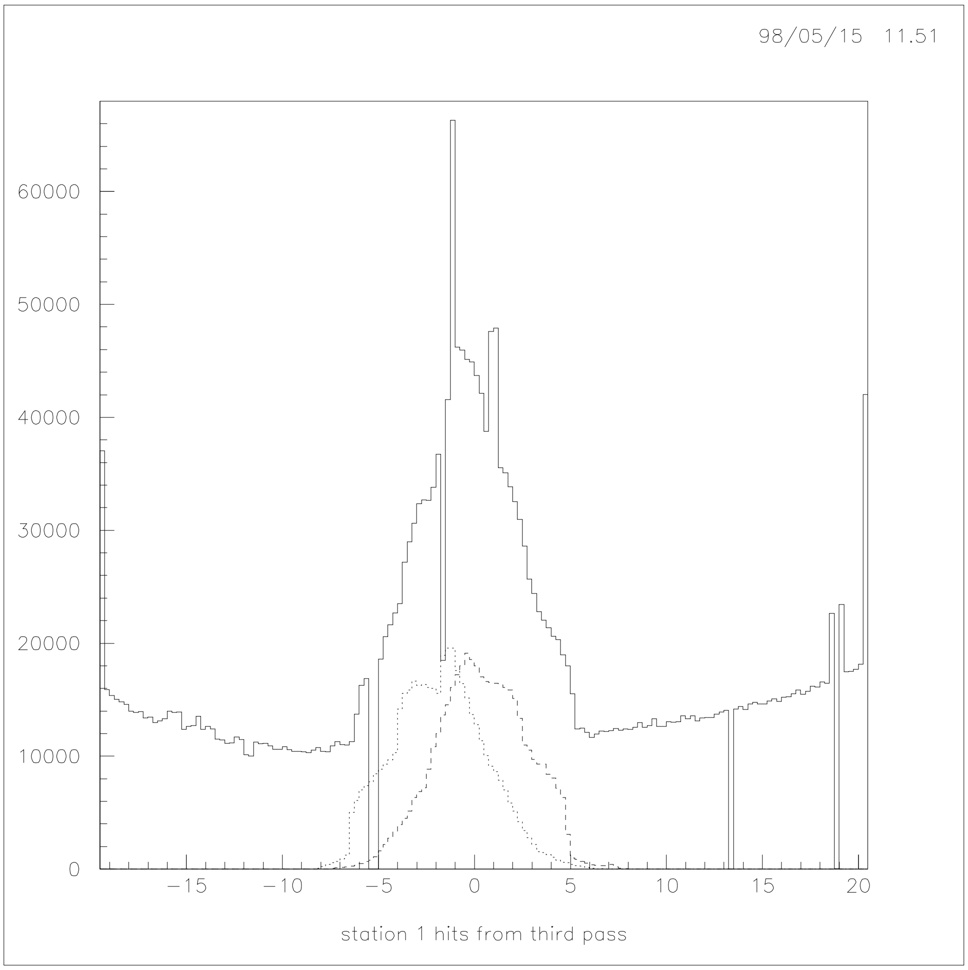

Figure 1: The solid line shows the raw hit distribution of hits in Y1. The hits from the positive (negative) muon are shown as a dashed (dotted) line. All events shown here are reconstructed J/ψ events.

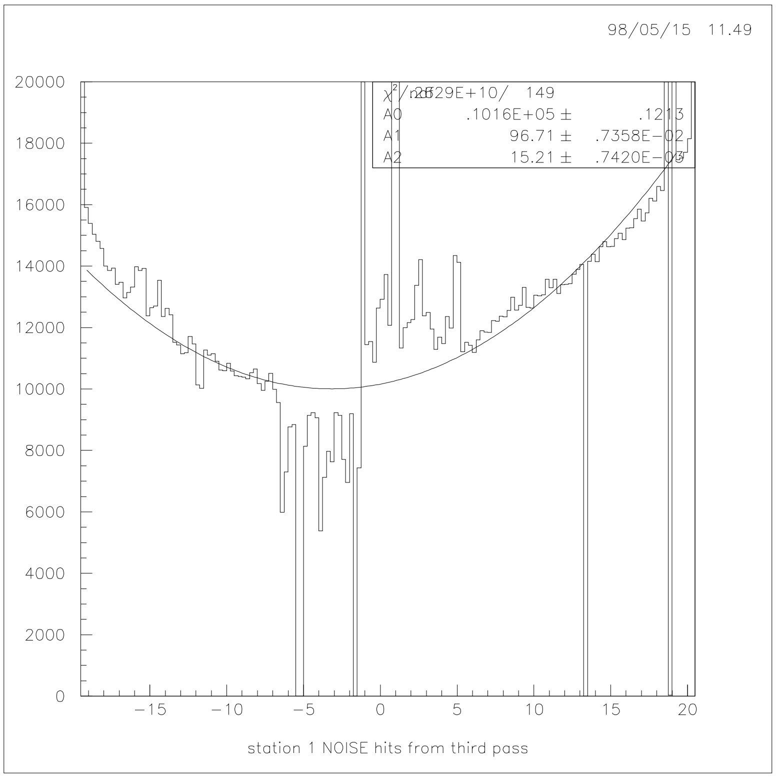

Figure 2: Shown here are the extra hits in Y1 fitted with a second order polynomial.

5 Normalization

The over all normalization, A can be calculated separately or it can be combined with the y dependence. To calculate the normalization independent of $p(y)$, let $N|_s$ be the total number of extra hits on a plane per event (multiplicity − good hits) at a given SEM. Then

$$N|_s = \int Ap(y)p(s)dy\Big|_s \tag{5}$$

so that the normalization factor at a given SEM is

$$A|_s = \frac{N}{p(s)\int p(y)dy}\Bigg|_s . \tag{6}$$

We believe that A will be independent of SEM.

6 Normalization and y Dependence

There is also a second approach of determining the normalization and y dependence as a single function. After producing a distribution of the noise hits at station one (figure 2) normalize it by dividing the histogram by the number of good events. Then the fit to this histogram would be $Ap(y)$.

Figure 2 is the noise from 446,449 events. Therefore,

$$Ap(y) = \frac{10160(1 + 0.0095y + 0.0015y^2)}{446,449}. \tag{7}$$

This also implies that

$$A = \frac{10160}{446,449} = 0.0228 . \tag{8}$$

This should be check for agreement with the value of A calculated from section 5.

7 SEM Dependence

Then the SEM dependence can be determined by comparing the noise multiplicity at different beam intensities.

8 Rate Dependence Correction

Since $P(y, s)$ is the probability that an extra hit will replace a good hit, then the survival probability of a single track is

$$SP_{\text{track}} = 1 - \frac{P(y, s)}{2}. \tag{9}$$

The factor of 2 is due to the fact that half of the time the extra hit arrives after the good hit. Therefore the survival probability for a good event is

$$SP_{\text{event}} = \left[1 - \frac{P(y1p, s)}{2}\right] \times \left[1 - \frac{P(y1n, s)}{2}\right]. \tag{10}$$

So each event should be weighted by this factor. Instead of each event having a weight of one, each event should have a weight of

$$\frac{1}{\left(1 - \frac{P(y1p,s)}{2}\right) \times \left(1 - \frac{P(y1n,s)}{2}\right)} \tag{11}$$