FERMILAB-MISC-1992-03

E760 Memo July 1992

Estimate of the trigger inefficiency due to extra hits in H1 and H2, using clean χ_2 events

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An accurate study of the inefficiency of the trigger selection criterium based on the multiplicity of hits in the two hodoscopes has been done using χ_2 events taken during the 1991 run, selected requiring that both electron tracks were associated to a Cherenkov hit (so that no multiplicity requirement at trigger level was asked), and a χ^2 probability for the kinematic fit bigger than 0.01.

In the next table we show the number of events found for different multiplicities in the two hodoscopes.

	NH1=2	NH1=3	NH1=4	total
NH2=2	1265	177	16	1458
NH2=3	228	73	7	308
NH2=4	30	15	8	53
total	1523	265	31	1819

Therefore we have 554/1819 = 30.5±1.3% of the events with extra-hits in the two hodoscopes, and we can think of 3 possible sources for this effect:

- accidental δ rays due to the interactions of the beam halo inside or against the walls of the beam pipe give an extra activity on H1 that should be uncorrelated to the hits due to real tracks;

- δ rays at large angles emitted by the electrons interacting with the inner layers of the detector, so that we expect extra-hits close to the real tracks;

- the conversion of the γ inside the beam pipe and in the inner detectors can give an extra-hit in H2 or H1 and H2: this also doubles the number of sources of δ rays, so that a big number of these events have 4 H2 firing.

Extra hits in H1

Looking at the extra-hits in H1 only, we can check the ratio between those events with one extra-hit adjacent to the good hit, and those having the extra-hit far from both hits: if the extra-hits in H1 are un-correlated, we expect to find 4/2=2, and we find 130/47=2.8±0.5, a little bit higher. In order to see if the excess we found is really due to a correlation between the 2 hits, we also checked if, when the hit H1 module is adjacent to the one module associated to the good track, the H2 hit by the good track is closer to H1 extra-hit or not.

We found respectively 50 out of 130 events with the electron passing in the H2 module closest to the extra-hit H1, (the average on the other 3 H2 modules is 23) therefore we may estimate that 27 extra-hits in H1 can be correlated to the good tracks.

We finally estimate a (10.4±0.8)% probability of having an extra-hit in H1 due to an accidental δ ray, and a 0.9% probability (PER TRACK, in our case it's 1.8%) of having a δ ray correlated to a charged track.

Recoil photon conversion in one e^+e^- pair

We have then checked the number of events with extra-hits in H2, correlated to the recoil photon, and the results are summarized in the following table:

	NH1=2	NH1=3	NH1=4
NH2=3	75	31(19)	2(2)
NH2=4	22	12(10)	5(5)

(in parenthesis, the number of events where the extra-hit in H1 can be associated to the photon track).

Asking for no extra-hits in H1, we can estimate the probability of having the photon conversion betweem H1 and H2; from 97/1362, we got then 7.1± 0.7%. From the number of events with NH1=3, we have that at least 29 recoil photons should have converted before H1, so that we can estimate a 2.1% probability. The overall probability of having the photon conversion before H2 is then 9.2 ± 0.9 %.

We can also notice that the fraction of events with 2 extra-hits, when the photon converts, is very big , and this can be explained if we take into account the increase in probability of producing δ rays, due to a double number of charged tracks.

Of course, this source of inefficiency should not affect the events with the photon outside the acceptance of the hodoscopes.

δ rays in H2

For the events with 1 extra-hit in H2, uncorrelated to the recoil photon, we checked the angle (in H2 units) between the extra-hit and the closest electron track. A large fraction of extra-hits (61%) is in the H2 module adjacent to the one associated to the electron track, and about 80% falls within the two closest H2 modules, as you can see from the following table, where the distance between the extra-hit and the closest H2 associated to an electron is shown. This confirms the hypothesis of explaining most of the extra-hits as correlated to the good tracks.

min-$\|H2_{extra}$-$H2_e\|$	1	2	3	4	5	6	7	8	TOTAL
events	94	29	8	10	7	2	2	1	153

At last, a probability of 10.7±0.9 % (5.4% per track) is attributed to this process, due to the emission of a δ ray caused by the interaction of the electron with the inner tracking detectors.

In the case of a photon conversion, we see that we have then a high probability (21.4%) of producing a δ ray, that is nicely consistent with the ratio (NH2=4)/(NH2=3,4)=22/97=22.6% found in the analysis of the events with the conversion of the recoil photon.

Concluding remarks

The probability of having an extra-hit on the hodoscopes is given by the sum of three contributions, calculated in the previous sections:

δ rays in H1 (mainly accidental)	11.3±0.9%
γ conversion before H2	9.2±0.9%
δ rays in H2 (emitted by the tracks)	10.7±0.9%
total	31.2±1.6%

This sum is consistent with the overall fraction of events with extra-hits we found (30±1.3%) in the first section.