ND efficiency study based on T2 and T3 trigger information.

To determine ND efficiency and its dependence on luminosity we performed the following analysis. We choose T2(electron arm trigger) events based on T2 TDC information and have good W value: $0.8 < W < 1.15$. For those events we found the portion of events that don't have T3 signal. We interpret that portion as ND inefficiency. Results are presented in table 1.

Run #	$< I > (\mu A)$	N_{T2}	N^W_{T2}	N_{T2noT3}	N^W_{T2noT3}	$R = N^W_{T2noT3}/N^W_{T2}, (\%)$
4427	2.54	25368	2973	18570	1595	53.6 ± 1.7
4597	4.71	6257	497	3803	219	44.1 ± 2.2
4596	5.78	5484	419	3005	181	43.2 ± 2.4

Table 1:

N_{T2} - number of T2 events.
N^W_{T2} - number of T2 events, with cut on W: $0.8 < W < 1.15$.
N_{T2noT3} - number of T2 events that do not have T3.
N^W_{T2noT3} - number of T2 events that do not have T3, with cut on W: $0.8 < W < 1.15$.
$R = N^W_{T2noT3}/N^W_{T2}(\%)$ - ND inefficiency.

Correction on ND geometry.

Some part of the N_{T2noT3} is due to the proton is missing the geometry of ND, and not due to ND inefficiency. Taking into account that correction we obtained ND inefficiency for 3 runs. Results are shown in table 2.

Run #	$< I > (\mu A)$	N^W_{T2}	N^W_{T2noT3}	N_{out}	$N^{W,corr}_{T2noT3}$	$R = N^{W,corr}_{T2noT3}/N^W_{T2}, (\%)$
4427	2.54	2973	1595	435	1160	39.0 ± 1.7
4597	4.71	497	219	51	168	33.8 ± 2.2
4596	5.78	419	181	50	131	31.3 ± 2.4

Table 2:

N^W_{T2} - number of T2 events, with cut on W: $0.8 < W < 1.15$.
N^W_{T2noT3} - number of T2 events that do not have T3, with cut on W: $0.8 < W < 1.15$.
N_{out} - number of N^W_{T2noT3}, that are missing the geometry of ND.
$N^{W,corr}_{T2noT3}$ - N^W_{T2noT3}, corrected on events that are missing the geometry of ND.
$R = N^{W,corr}_{T2noT3}/N^W_{T2}(\%)$ - ND inefficiency corrected on events that are missing the geometry of ND.

Correction on ND geometry and accidental coincidence.

Some of N_{T2noT3} lost because of accidental coincidence and accounted in $N_{T2withT3}$(T2 events with T3 signal present). Therefore the real number of T2 events that don't have T3 - N^{real}_{T2noT3} is bigger than we observed.

$$N^{obs}_{T2} = N^{obs}_{T2notT3} + N^{obs}_{T2withT3} \tag{1}$$

$$N^{obs}_{T2withT3} = N^{real}_{T2withT3} + N^{accid}_{T2withT3} = N^{real}_{T2withT3} + N^{obs}_{T2} \cdot f_{T1} \cdot \tau, \tag{2}$$

where f_{T1} - T1 trigger rate, τ - coincidence interval.

$$N^{obs}_{T2} = N^{obs}_{T2notT3} + N^{real}_{T2withT3} + N^{obs}_{T2} \cdot f_{T1} \cdot \tau \tag{3}$$

$$N^{real}_{T2notT3} = N^{obs}_{T2notT3} + N^{obs}_{T2} \cdot f_{T1} \cdot \tau \tag{4}$$

Using equation 4 we obtained corrected $N^{W,real}_{T2noT3}$ and corrected ND inefficiency values for three different τ values. Results are presented in table 3.

				$\tau = 80ns$		$\tau = 100ns$		$\tau = 120ns$	
Run #	$f_{T1}(MHz)$	N^{W}_{T2}	$N^{W,corr}_{T2noT3}$	$N^{W,real}_{T2noT3}$	$R(\%)$	$N^{W,real}_{T2noT3}$	$R(\%)$	$N^{W,real}_{T2noT3}$	$R(\%)$
4427	1.06	2973	1160	1412	47.5 ± 1.7	1475	49.6 ± 1.7	1538	51.7 ± 1.7
4597	2.35	497	168	261	52.5 ± 2.2	285	57.3 ± 2.2	308	62.0 ± 2.2
4596	2.81	419	131	225	53.7 ± 2.4	249	59.4 ± 2.4	272	64.9 ± 2.4

Table 3:

N^{W}_{T2} - number of T2 events, with cut on W: $0.8 < W < 1.15$.

$N^{W,corr}_{T2noT3}$ - N^{W}_{T2} corrected on events not hitting ND.

$N^{W,real}_{T2noT3}$ - corrected $N^{W,corr}_{T2noT3}$, by taking into account accidental coincidence.

$R = N^{W,real}_{T2noT3}/N^{W}_{T2}(\%)$ - ND inefficiency corrected on events that are not passing through ND and on accidental events.

Rate of T1 trigger is determined by scaler. Sometimes we have double pulses, which are also counted by scaler. Therefore the real T1 rate is smaller than the one that we observed in scalers. That should be taken into account in calculation of accidentals. When leading edge of T1(neutron arm) trigger comes within 80ns - width of T2(electron arm trigger), then we have not to count coincidence caused by double pulses. When leading edge of T1 comes before leading edge of T2, we have to count coincidence comes from both real T1 and double pulses. The number of accidentals can be calculated by following equation:

$$N_{T2withT3}^{accid} = N_{T2}^{obs} \cdot f_{T1}^{sc} \cdot \tau_1 + N_{T2}^{obs} \cdot f_{T1}^{corr} \cdot \tau_2, \tag{5}$$

where f_{T1}^{sc} - T1 rate observed in scaler, f_{T1}^{corr} - T1 rate without double pulses, τ_1 - T1 signal width, τ_2 - T2 signal width. To determine the fraction of T1 triggers counted due to double pulses, and the calculate f_{T1}^{corr} we use distribution of time difference between 1-st and 2-nd hits of TDC T1 signals. That distribution is shown on figure 1.

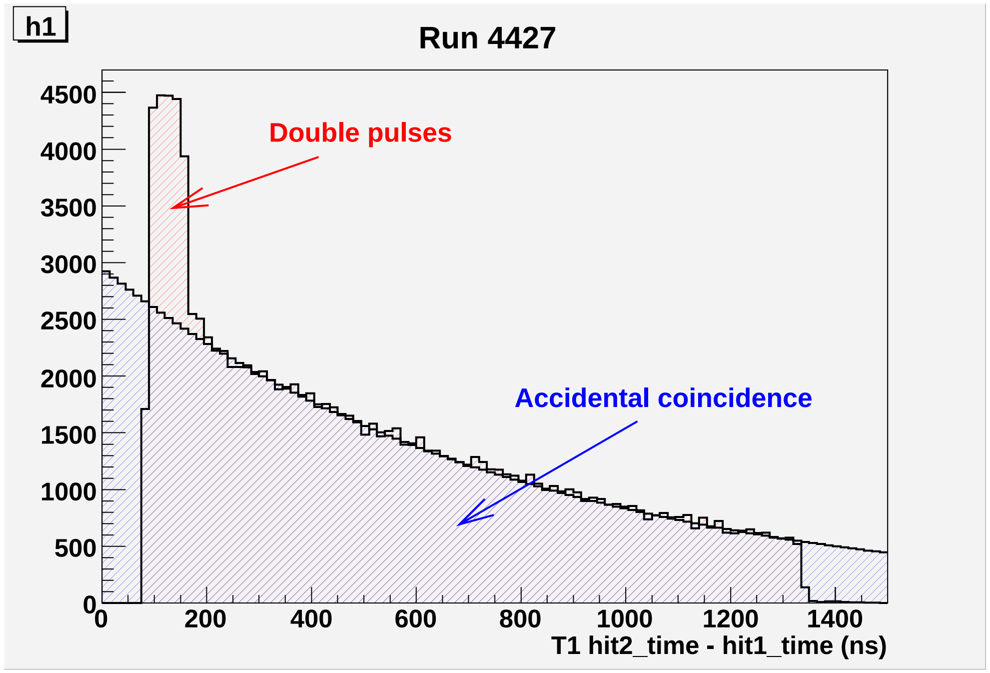

Figure 1:

Correction ND geometry, accidental coincidence and double pulses.

Using distribution on figure 1, we found actual T1 rates. Based on that actual rates, we recalculated N^W_{T2noT3} and ND inefficiency values. Results are presented in table 4.

N^W_{T2} - number of T2 events, with cut on W: $0.8 < W < 1.15$.
N^W_{T2noT3} - number of T2 events that do not have T3, with cut on W: $0.8 < W < 1.15$, corrections applied: events not hitting ND, accidental events, double pulses.
$R = N^W_{T2noT3}/N^W_{T2}(\%)$ - ND inefficiency.

				$\tau = 120ns$	
Run #	f_{T1}	$f^{corr}_{T1}(MHz)$	N^W_{T2}	N^W_{T2noT3}	$R(\%)$
4427	1.06	1.00	2973	1524	51.3 ± 1.7
4597	2.35	2.14	497	300	60.4 ± 2.2
4596	2.81	2.49	419	262	62.5 ± 2.4

Table 4: