Trigger performance study for $pn \to p\Lambda$ experiment

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To study the weak hyperon-nucleon(YN) interaction, the $pn \to p\Lambda$ experiment is proceeding at RCNP [1]. This reaction is the direct weak production of strangeness. In the $pn \to p\Lambda$ experiment, we can use highly polarized proton beam so that precise measurements of spin dependent observables such as asymmetry parameter are possible [2] and energy dependence of its cross section can be measured.

The experimental setup is shown in Fig.1,2. The detectors consist of trigger counters, cylindrical drift chamber(CDC) and vertex detector. They are installed in the solenoidal magnet of 3kG magnetic field. To reduce vast amount of background from target, a heavy metal collimator is used. The collimator is designed to shield all detectors from particles which come from target directly and only decay particles of Λ can reach detectors because Λ's life is 2.6×10^{-10} s and Λ flies several cm from target(see Fig.1).

The cross section of this reaction is estimated about $10^{-39} cm^2$ [3,4] and very small compared to strong interaction backgrounds. Therefore, it is very important to develop the effective trigger system for realizing this experiment. The Λ creation events are selected by detecting proton and negative charged pion from its decay $\Lambda \to p\pi^-$. The trigger counters consists of two layers of plastic counters, the one is outer counters, which are placed at all around of outer side of CDC, the other is inner counters, at inner side. Coincidence of these two kind of counters are required. The outer counters are specialized to detect negative charged pion by following way. Inclining outer Counters a certain angle in the magnetic field, only negative charged particle hits three or more adjacent counters but positive charged or neutral particle hits only two or less counters as shown in Fig.2. Requiring hits of three continuous outer counters, we can efficiently select π^- events.

To estimate our detector system's performance, a test experiment was performed using

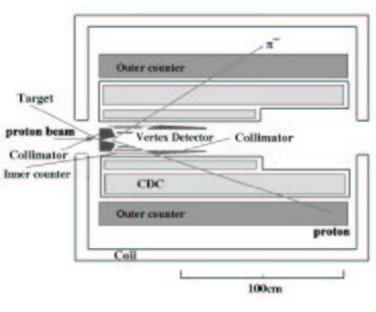

Figure 1: Side view of detector setup.

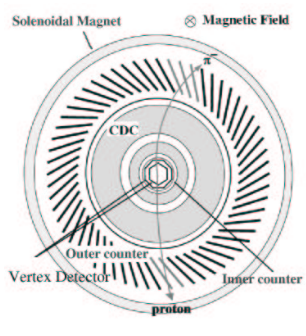

Figure 2: Front view of detector setup.

392MeV proton beam and 0.1nA beam intensity. The target was 50μm Cu and the CDC and a half of trigger counters were installed. Detecting π^- from strong interaction considered as $pn \rightarrow pp\pi^-$, the trigger efficiency was tested and the collimator was not installed.

Table.1 shows trigger rate of each trigger type. After requiring three coincidence of outer counters, the rate is reduced to 3.1k/215k=1.4% of simple OR trigger. The transverse momentum distribution on each trigger condition is shown in Fig.3, the only proton peak is seen on simple OR trigger(left) and the π^- peak is appeared on outer three coincidence trigger(center). But there still remain proton events on some level. It is considered that these proton events come from multiple scattering on the outer counters and accidental coincidence. Proton's energy deposit on the outer counters are higher than pion's because of its incident angle and momentum, so we set upper limit of pulse hight of outer counter(Upper Veto) to reduce them. Consequently, trigger rate is reduced to about 0.4% and proton events are cut down as shown in Fig.3(right).

Our aim is 0.1% of simple OR trigger so that we have to decrease trigger rate to about 1/4 of current status. To achieve this goal, several means are considered, such as adjusting Upper Veto more efficiently, requiring two particles events by trigger counters' hit pattern, requiring proper correspondence of trigger counters' hit modules and CDC hit wires.

trigger type	trigger rate (counts/0.1nQ)
1. simple OR	215 k
2. outer 3 coin.	3.1 k
3. 2 $\otimes$ Upper Veto	0.90 k

Table 1: Trigger rates of Cu 50μm target on each trigger condition

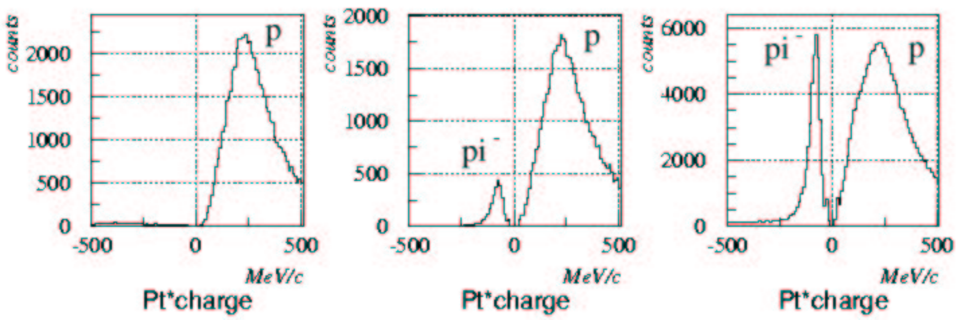

Figure 3: Pt distribution of each trigger type. From left to right, trigger type 1, 2 and 3.

References

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