Search for Hybrid Baryons with CLAS12 in Hall B

(Dated: April 13, 2016)

Contents

A. Run condition 2
B. Count rates from $K^+\Lambda$ 5

A. Run condition

We are planning to search the hybrid state at low Q^2 and the accessible range of Q^2 depends on the beam energy and torus current. Another issue that affects the selection of the best run condition is that we need good particle momentum resolution to be able to separate Λ and Σ^0 electroproduction channels and the better resolution is achieved with larger torus current. The Λ and Σ^0 separation is based on using the cuts on the missing mass of kaon. For this purpose kaon must be detected. Thus, we have to use the topologies when the final state electron, kaon and at least one of the other hadrons (p or π^+) are detected.

The run condition studies were performed with fact MC. The results are shown in Figs. 1 and 2. Table I summarizes the relevant information for different run conditions. The best run conditions correspond to the large negative torus currents, as the maximal Λ and Σ^0 separation is achieved and the gap in the Q^2 coverage is small.

TABLE I: Minimal achievable Q^2 (Q^2_{min}) and the percentage of the Λ and Σ^+ events that can be isolated from each other at different run conditions.

E_{beam}, GeV	Tor. current, A	Q^2_{min}, GeV^2	Λ separation, %	Σ^0 separation, %
6.6	+1500	0.05	33	19
6.6	−1500	0.05	86	73
6.6	+3700	0.05	32	19
6.6	**−3700**	0.05	100	100
8.8	+1500	0.1	21	8
8.8	−1500	0.1	31	16
8.8	+3700	0.1	16	8
8.8	**−3700**	0.1	100	100

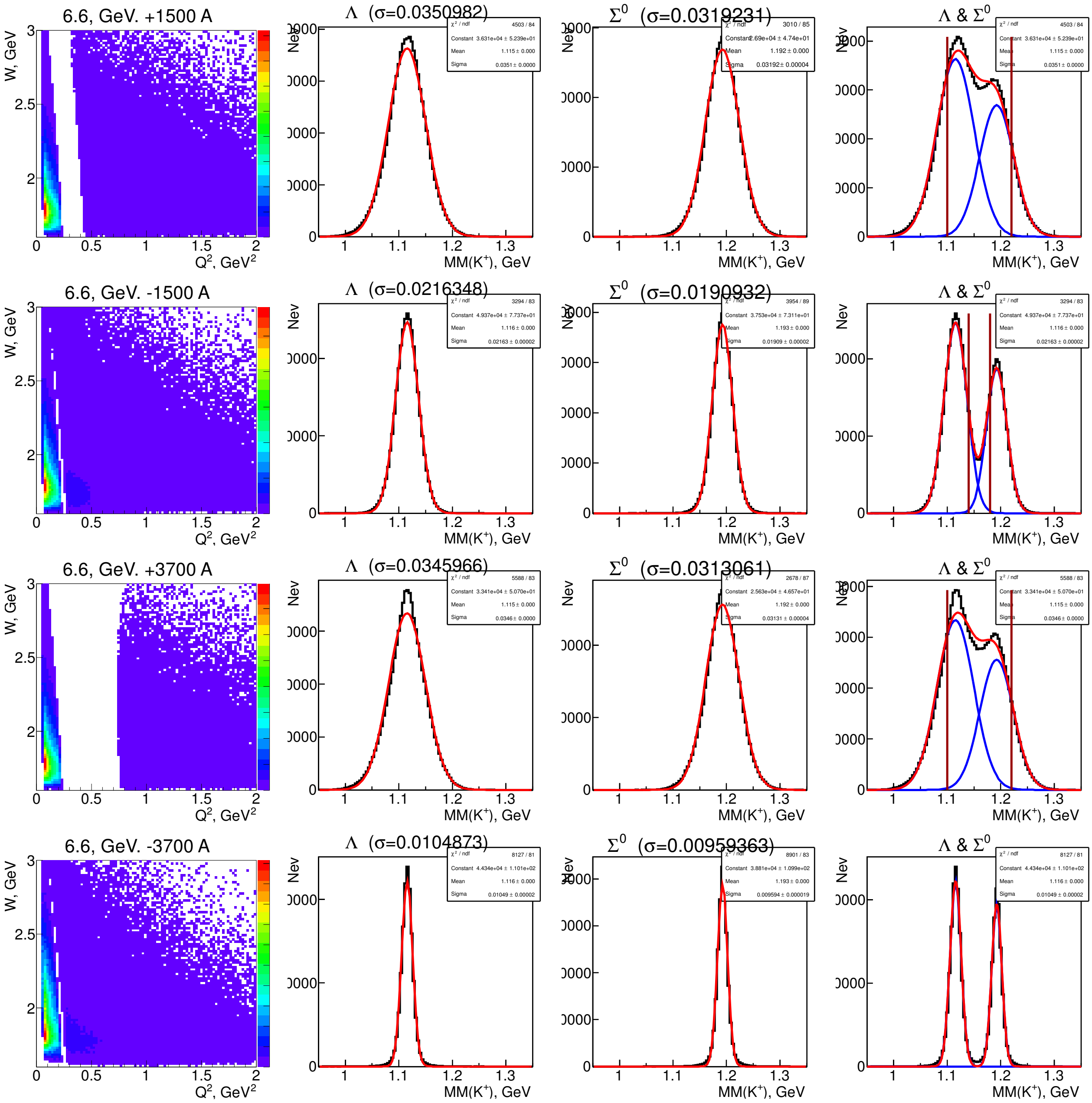

FIG. 1: The left column shows the W versus Q^2 distributions at different torus currents for $Q^2 < 2$ GeV^2 when the beam energy is 6.6 GeV. Next three columns show the distributions of the missing mass off K^+ for the corresponding torus current. The vertical lines indicate the cuts to be used to separate Λ or Σ^0 from its neighboring state. When no lines are drawn then Λ and Σ^0 are fully separated.

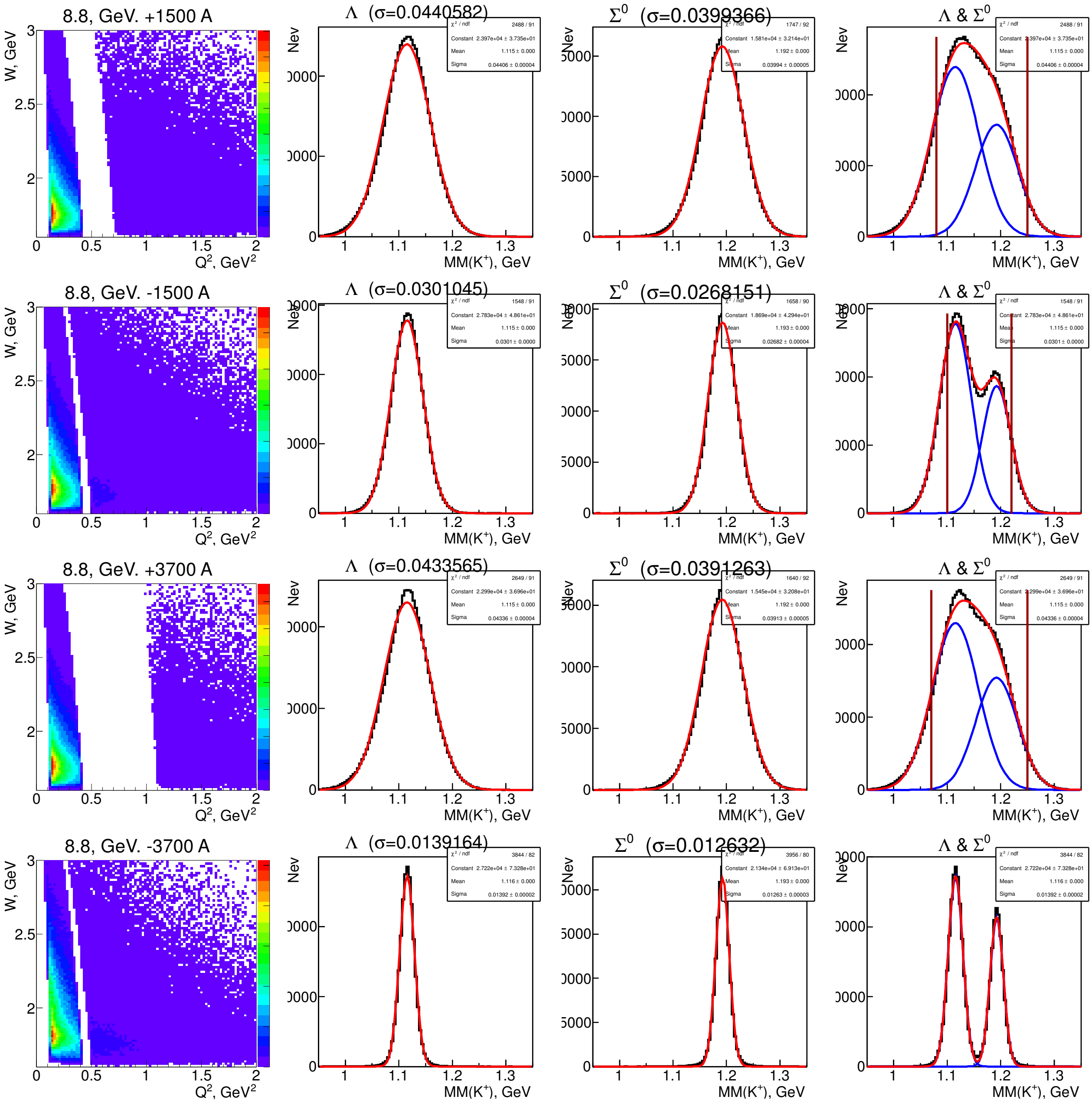

FIG. 2: The left column shows the W versus Q^2 distributions at different torus currents for $Q^2 < 2$ GeV^2 when the beam energy is 8.8 GeV. Next three columns show the distributions of the missing mass off K^+ for the corresponding torus current. The vertical lines indicate the cuts to be used to separate Λ or Σ^0 from its neighboring state. When no lines are drawn then Λ and Σ^0 are fully separated.

B. Count rates from $K^+\Lambda$

...To add at the end of the section "Count rates from $K^+\Lambda$"...

... The maximal total event rate is therefore expected to be 240x100 = 24 kHz for the trigger condition described above.

...**Should we add the next paragraph as a kind of cross check for the count rate calculation?**

The count rate also can be estimated in the following way. Suppose, the maximal inclusive event rate is 20 KHz, which is limited by the data acquisition. Then under the rough assumption that Λ event rate is about 1% with respect to the inclusive event rate we can estimate the Λ event rate to be $\approx$ 200 Hz. This number is in a reasonable coincidence with the previously obtained value of 240 Hz.

However, the studies in the section A showed that the preferable run conditions are achieved if using large negative torus currents, as Λ and Σ^0 can be fully separated.

The rate of the "separated" Λ or Σ^0 events when the beam energy is 6.6 GeV and the torus current is -1500 A is expected to be 240 Hz $\times$ 86% $\approx$ 200 Hz (see section A). When the beam energy is 6.6 GeV and the torus current is -1500 A the same rate is 112 Hz $\times$ 100% $\approx$ 100 Hz. However, we have to take into account: first the total event rate of 24 kHz may not be feasible due to the limitations of the data acquisition and secondly the momentum resolution may differ from what is predicted by fast MC, and in this case the percentage of the separated Λ or Σ^0 events can become smaller.

The obtained event rate should be reduced by 8%, as 8% of the events do not have reconstructed kaon and by 34%, since the Λ decay branching fraction to the channel (p, π^-) is 64%. Assuming the Λ electroproduction rate is 100 Hz, we expect to collect in 40 days of the beam time 100 Hz $\times$ 34% $\times$ 64% $\times$ 40 days $\approx 2 \times 10^8$ events.