Performance of the trigger system at the HypHI Phase 0 experiment

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The first experiment of HypHI project, phase 0, has been performed at October 2009 to detect hypernuclei produced by a 2.0 *A* GeV ^{6}Li beam impinging on a ^{12}C target, by identifying the mesonic decay modes, $^{3}_{\Lambda}$H $\rightarrow ^{3}$He + π^-, $^{4}_{\Lambda}$H $\rightarrow ^{4}$He + π^- and $^{5}_{\Lambda}$He $\rightarrow ^{4}$He + p + π^- [1]. A high intensity beam of 10^6 $\sim 10^7$ particles per second and a target with a thickness of 8 g/cm^2 were used to overcome small production cross sections expected to be of the order of 0.1 μb. The challenge of the trigger system was to derive a fast trigger signal with a event rate up to 3 kHz under the experimental conditions.

Table 1: The conditions for the each trigger, the minimum-bias trigger (MBT), the reaction trigger (RT), the hypernuclear trigger(HT) and the He hypernuclear trigger (HeHT).

Trigger		MBT	RT	HT	HeHT
Vertex	Mul.$\geq$1			on	on
	Mul.$\geq$2				on
TR012	Mul.$\geq$1	on	on	on	on
TR1	Mul.$\geq$2		on	on	on
TOF+	Mul.$\geq$1		on	on	on
	Mul.$\geq$1 for He			on	on
TOF-	Mul.$\geq$1			on	on
TOFs	Mul.$\geq$1	on	on	on	on
	Mul.$\leq$2			on	on
Scaling factor		1.5×10^{-5}		1	
Mixed Trigger 1		on	on	on	
Mixed Trigger 2		on	on		on

The main feature of the trigger system is to select events with decay vertices located 20 cm in average behind the target (Vertex)[2]. It has been realized by applying sophisticated coincidence conditions to three layers of the fiber detector, TR0, TR1 and TR2 [3] using 38 VUPROMs [4]. The all three decay modes are associated with a pion and a helium, which was also utilized by requesting larger energy deposit by a helium on positive side of the TOF wall (TOF+) and at least one hit at negative side (TOF-)[5]. Furthermore, the TOF start counter[5] participated in the trigger system to define the beam and to veto events with more than 2 particles due to high beam intensity (TOFs). The conditions applied for the each detector are summarized in Table 1. The data have been stored with 2 types of the mixed trigger. One is for all decay modes with some calibration data (Mixed Trigger 1) and the other is focused on the He hypernuclei with higher beam intensity requesting 2 tracks from decay vertices (Mixed Trigger 2). The trigger rate by 'Mixed Trigger 1' gave typically the rate of 2.6 kHz with the beam intensity of 3.2×10^{6} per second and that by 'Mixed Trigger 2' gave 0.66 kHz with the beam intensity of 8.2×10^{6} per second.

The figure 1 shows the hit position distribution along the y-axis on TR2. The trigger system judged the hits plotted in the dashed histogram as ones by particles from the target, while the hits in the filled histogram as ones from decay vertices. It is appropriate that the peak by the Li beam is counted as the particles from the target. The decisions by the trigger have been compared with offline analysis applying the same coincidence matrix used for trigger. The results show that 79 % of trigger decision are consistent and 0.75 % are inconsistent. There are 20 % cases difficult to judge because of lacking information at intermediate stage of coincidence, however it is enough to conclude that there were no mistakes one might expect, i.e. the order of channels, the coincidence matrix, cabling and timing. The trigger system has achieved the experimental request and been successfully operated during the Phase 0 experiment.

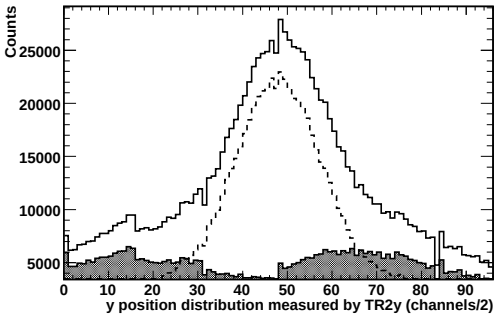

Figure 1: The hit position distribution along the y-axis on TR2, all hits (the solid histogram), particles scattered from the target (the dashed histogram), particles from the decay vertices (the filled histogram).

References

[1] T.R. Saito *et al.* in these reports.

[2] S. Minami *et al.* GSI Scientific report 2008 p51

[3] D. Nakajima, B.Özel-Tashenov *et al.* Nucl. Inst. Meth. A 608 (2009) p287

[4] J. Hoffmann *et al.* GSI Scientific report 2007 p256

[5] C. Rappold *et al.* GSI Scientific report 2007 p221

[6] S. Bianchin *et al.* GSI Scientific report 2008 p233

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