Trigger logic for the SπRIT experiments

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The SπRIT experiments[1)] require a trigger to select central collisions in order to probe the nuclear equation of state at high densities using heavy ion collisions. Central collisions are studied via a Time Projection Chamber (TPC) surrounded by ancillary detectors and triggered by suitable multiplicities of charged particles in the Kyoto plastic scintillators located on the sides of the TPC and KATANA plastic scintillator paddles located downstream of the TPC. A more extensive description of the KATANA array is provided[3)]. The trigger was vetoed by the presence of a projectile-like fragment in the three KATANA veto scintillators, which are downstream of the TPC and centered about the beam trajectory, or if there is a hit in the active collimator that shadows the target frame from the incident beam.

The ultimate trigger decision was made by an FPGA in a "trigger box", shown in Fig. 1. The internal trigger logic of this trigger box is not shown. It required a signal from the beam in a Start Counter scintillator located upstream, a multiplicity signal from the EASIROC module servicing the Kyoto multiplicity array or a multiplicity in the KATANA plastic that exceeds a user selected threshold multiplicity. For regular data runs, the trigger condition required a multiplicity greater than four in the Kyoto array and the KATANA multiplicity was ignored. Moreover, this trigger was vetoed in the trigger box if heavy fragments hit any of the three KATANA veto scintillators located around the beam axis downstream of the TPC or if the beam hit the active collimator upstream therefore not going through the target. To obtain minimum bias events and to study the trigger bias of this event selection, the values of the Kyoto multiplicity, the KATANA trigger multiplicity, and the KATANA beam veto paddle thresholds were varied in separate minimum bias runs for further analysis.

To avoid a loss of track information in the TPC, a quick Fast Trigger decision was made. This Fast Trigger AND, shown in the figure, required the Start Counter, none of the three KATANA veto signals and a NOT BUSY signal. This opened the gating grid driver (GGD)[2)] via a TTL_open signal generated by the latch G&D 2. The width of TTL_open is normally terminated by G&D 1 after 11 μsec but can be shortened by the arrival of a random beam particle in one of the KATANA veto paddles or the lack of a trigger signal from the trigger box. The TTL_open signal defines the opening of the GGD. The 11 μsec maximum length of the gate is calculated from the 9 μsec drift length of the TPC plus some safety margin to make sure all the volume of the TPC is included in the accepted time window. The TTL_close signal, generated by the G&D 4, starts on the trailing edge of the TTL_open signal and defines the closing of the GGD. The 5 μsec width of the TTL_close gate is calculated as the maximum drift time in the TPC for a heavy fragment to avoid these tracks from producing a signal in the next event.

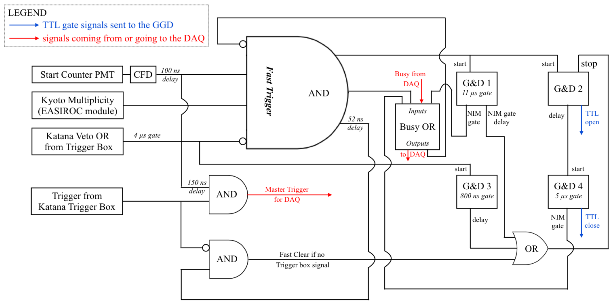

Fig. 1. Schematic circuit diagram of the trigger logic used during the SπRIT experiments.

Three data acquisitions (DAQ) are coupled during the experiment to write data from the TPC (SπRIT), the beam tracking counters and Kyoto array (RIKEN) and the KATANA array (KATANA). The BUSY signal is generated from an OR of the three DAQ BUSY signals plus the TTL_open and TTL_close. The trigger sent to the DAQ systems is a coincidence of the trigger from the trigger box, a NOT BUSY signal, and a delayed Start Counter signal in order to keep the Start Counter as the reference time for the DAQ.

During the experiment, the data acquisition was performed successfully with on average 800 μs dead time and a selection of heavy ion collisions. Analysis of data runs will quantitatively determine the average impact parameter of the heavy ion collisions in our setup and a further study of the minimum bias runs will constrain the bias of our experimental detection system.

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