PROBLEMS ON TRIGGERING

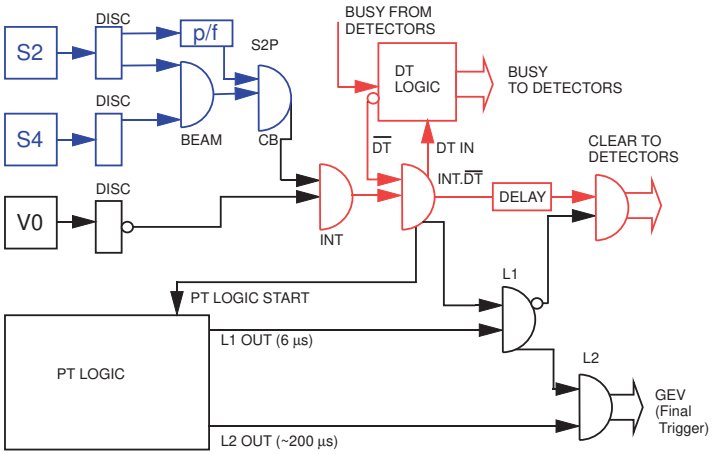

Figure 1: Simplified version of the WA77 logic.

1. In the CERN WA77 experiment, two scintillators S2 and S4 were placed in the beam upstream of a Be target. A third scintillator, V0, was placed several metres downstream of the target. Beam particles which interacted in the target would not hit V0, while those that did not interact would hit it. A simplified version of the trigger logic is shown in the figure. A past-future protection circuit rejected beam particles that arrived less than 60 ns apart. The past-future protection system was applied to the output of the S2 counter, so that it generated both an unprotected (S2) and past-future protected S2p signal. A coincidence CB.$\overline{\text{DT}}$ (not shown) counts the Clean Beam (CB) (i.e. with past-future protection) when Dead Time (DT) is off. A more complicated logic (not shown in detail) produces two additional levels of trigger. The scintillator system described shows that an interaction has taken place, L1 indicates that at least one particle in the interaction has $p_T > 0.6$ GeV/c, and L2 indicates that there are three particles, at leas one of each charge, with p_T above a programmable threshold $p_T^{(2)}$. In the experiment $p_T^{(2)}$ was set to 0.9 GeV/c.

   The counts for one burst, recorded on 11th August 1987, are given in Table 1. Using these figures,

(a) estimate the efficiency of the two counters S2 and S4,

(b) estimate the fraction of dead time under the prevailing conditions,

(c) estimate the thickness of the target as a percentage of an interaction length.

Table 1: Counts per Burst

Signal	counts/burst
S2	14297754
S4	13880148
V0	13147923
BEAM	12484346
CB	10431484
CB.$\overline{\text{DT}}$	6215454
INT	1027819
INT.$\overline{\text{DT}}$	618016
L1	1303
L2	208

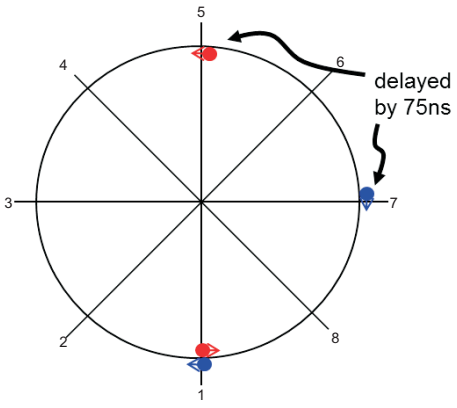

Figure 2: Position of bunches for an LHC configuration. There are two bunches at point 1 (ATLAS), and the other points are numbered clockwise from there. ALICE is at point 2, CMS at point 5 and LHCb at Point 8.

2. In a certain filling of the LHC, there are two bunches in each beam, arranged as shown in figure 2. Explain how this arrangement leads to exactly one set of colliding bunches at each interaction point, and none anywhere else. How does it cope with the slight displacement of the LHCb interaction point with respect to octant symmetry.

   The interaction rate as measured at ALICE is 110 Hz. Estimate the overall rate for pile-up events, that is, those events with more than one interaction per bunch crossing.

   The collision rate can be increased in three different ways.

   (a) adding more protons to each beam,

   (b) squeezing the beams to reduce the diameter of the beam spot,

   (c) increasing the number of bunches.

   What is the effect on the pile-up rate for each of these three strategies. If the aim is to increase the interaction rate by a factor 5, estimate the new pileup rate in each case.