Design for DAQ system

Y. Sugaya

December 25, 1998

Abstract

In this article, preliminary DAQ design is discussed. The requirement to data digitalization and readout and the protocol between the global trigger and subsystems are listed.

1 Global trigger, subsystem and event builder

The DAQ system consists of a global trigger subsystem, detector subsystems and event builder computer.

Each subsystem sends trigger information to the global trigger, then trigger decision is made. Time limit for trigger decision should be defined (limit1). One can add new trigger without changing the trigger timing. The pulse signal to produce the gate and common stop or start is given by the global trigger after the fixed time from an interaction. Signals for ADC and TDC should wait until limit1.

The global trigger sets an event busy signal with finite width (limit2) for itself. Before finishing of the busy signal, every subsystem should return their busy signal to the global trigger.

One purpose of this article is to define the limit1 and limit2.

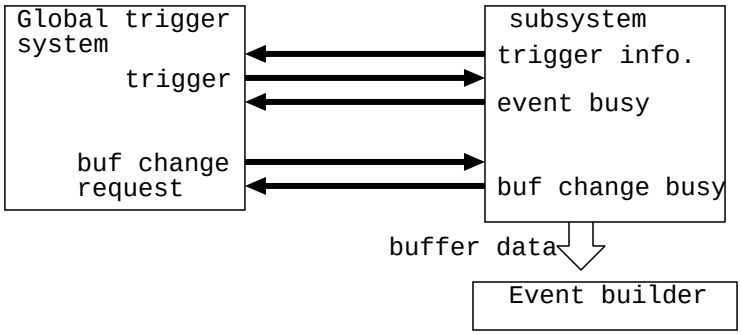

Figure 1: Communication among global trigger, subsystem and event builder.

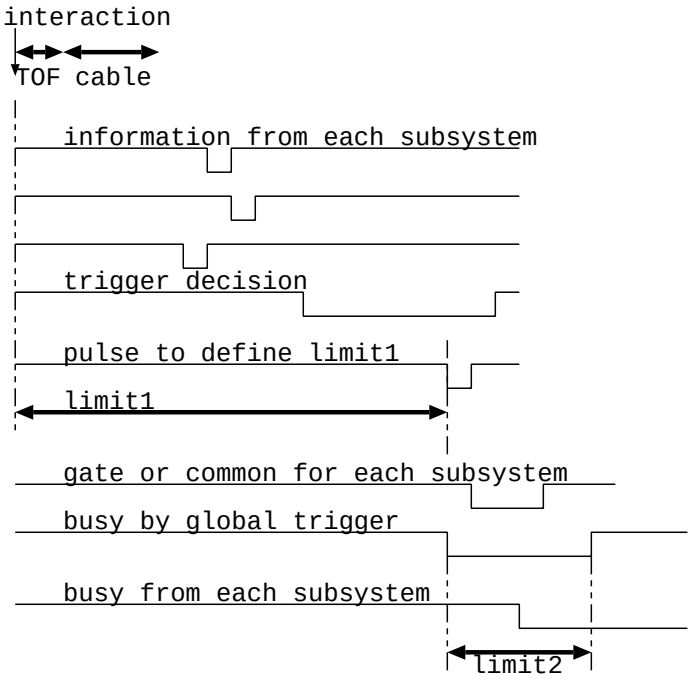

Figure 2: Signal timing for the trigger decision.

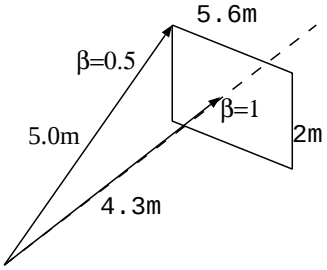

Figure 3: largest and smallest cases for TOF of a particle.

1.1 The limit 1

First, a time limit for a signal in order to commit the tirgger decision is discussed. The TOF of a pion and kaon from the target to the TOF counter is 14 nsec (minimum) or 33 nsec (maximum). Here, the distance of the TOF counter from the target is 4.3 m and a size of the TOF wall is 2m×5.6m. Then, minimum and maximum flight path is 4.3 and 5 m, respectively. Speed of a slowest particle is assumed be $0.5c$. It corresponds that a momentum of a kaon is 285 MeV/c.

The length of cable from experimental area to the elec-hatch is 30 m, 150 nsec.

Next, propagation delay of the module to make the information for the trigger decision is discussed. At the first stage of the experiment, the subsystems which commits to the trigger decision are TOF, EMC and AC.

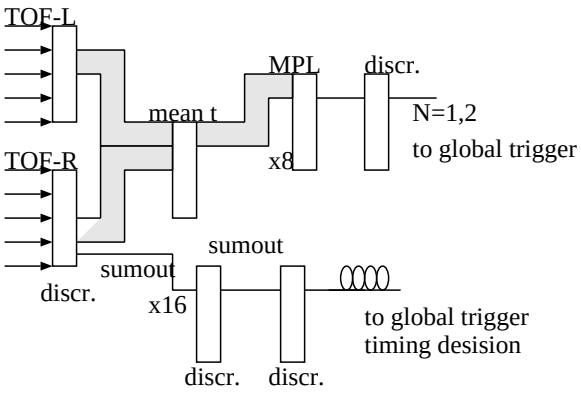

Figure 4: A circuit for trigger information of TOF.

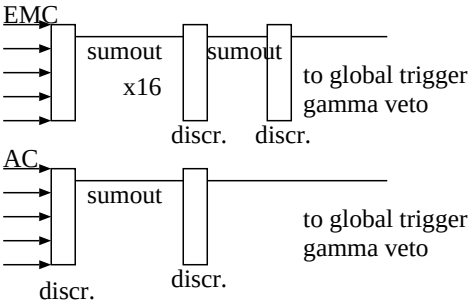

Figure 5: A circuit for trigger information of EMC and AC.

1.1.1 TOF subsystem

The pulse signal from the TOF counter is measured by TDC and ADC. The pulse signal also contributes to trigger decision.

The propagation delay of the modules for TOF measurement written in catalogs and they are 8 nsec (Discri. LR-3412), 30 nsec (mean timer CAEN-C561), 16 nsec (Majority logic LE-4532) and 10 nsec (NIM discri), and then the total is 64 nsec.

The total length of cables between modules is less than 20 nsec.

1.1.2 EMC subsystem and AC subsystem

The pulse signals from the EMC and AC are measured by TDC and ADC. The pulse signal also contributes to trigger decision as a veto. The propagation delays for gamma detector are 8 nsec (Discri. LR-3412), 8 nsec (Discri. LR-3412) and 10 nsec (width expansion, NIM), and then the total is 26 nsec.

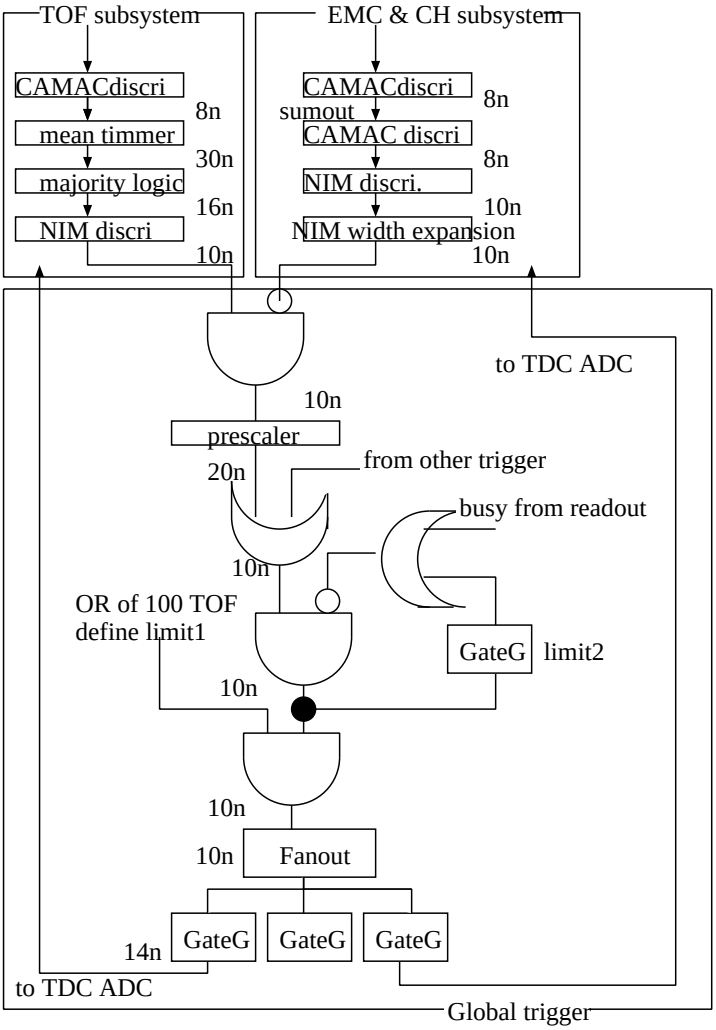

Figure 6: A trigger circuit and its propagation delay.

1.1.3 Result

The maximum TOF is 33 nsec. Moving of signals from the experimental area to the elec-hatch via calbes requires 150 nsec. A time needed from experimental area to elec-hatch is 150 nsec. The maximum time to make the trigger information is 84 nsec (TOF). Then we can get trigger information of proper detectors at 267 nsec (33+150+84) after the interaction.

Prescalers (a few tens nano second of a propagation delay), coincidences (10 nsec) and FPGA's (a few tens nano?) will be used for the trigger decision. Total propagetion delay will be about 100 nsec. Then I take the limit1 as

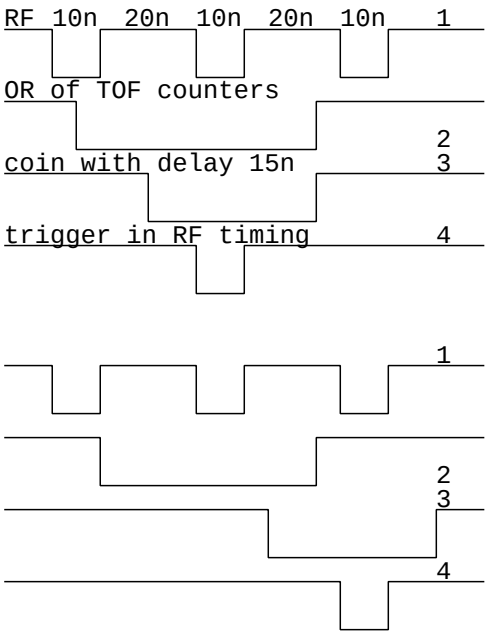

Figure 7: A trigger-timing turning method to meet to an RF.

$267 + 100 < 400$ nsec.

At the experiment, we make a coincidence after gated trigger and a delayed OR signal of 100 TOF counters. The timing of the OR signal can also be set to the RF timing. The OR signal of TOF counters is delayed so as to be 400 nsec later from the interaction at the fastest TOF case. That is, the delay is $400 - 14(TOF) - 150(cable) = 236\ nsec$ from the entrance of the TOF discri. The signal for ADC's and TDC's should be delayed by more than this value.

1.2 The limit 2

The global trigger put the event veto signal for itself before coming back of the veto from the each subsystem. I'll take the duration of veto (limit2) 10 μ second. All subsystem should return the event busy within the limit2.

2 Goal of the DAQ speed for each subsystem

The event rate of the experiment is 1 kHz and the buffer change rate is 10 Hz. If the goal of the DAQ speed set so as to deadtime correction due to an event busy as 2% and 1% for a buffer change, the dead time for one event should be less than 20 μ, and 1 msec for a buffer change. If the DAQ system achieved the required speed, one needs not make effort any more.

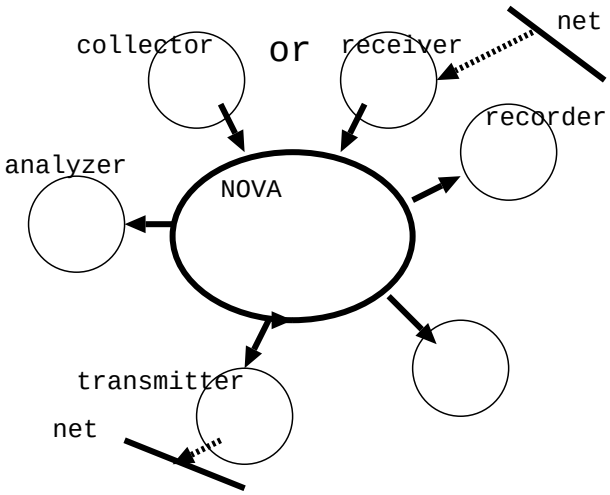

Figure 8: UNIDAQ. The NOVA and processes.

3 Buffer change procedure

The buffer change request is given by the global trigger. The global trigger puts the request once in one hundred events (this number is temporary). The subsystem should catch the request pulse. Then the subsystem changes buffer and sends data to the event builder through network.

4 Headers in the buffer

Buffer header should include a buffer sequential number and a number of events in the buffer. The event header should include event sequential number.

5 DAQ software

The software for DAQ is made by modifying UNIDAQ. The UNIDAQ consists of a buffer manager (NOVA) and processes; collector, receiver, trancemitter, analyzer and recorder. The processes put or get buffers from NOVA.

However NOVA could not manage the event sources (collector or receiver) more than two.

The function of the software in the subsystem is to get data from a digitizer and to put the data as a buffer though network to NOVA on the event builder.

In the event builder, the same number of NOVA's as that of subsystems are running. Therefore we have to prepare the builder process which gets buffers from each NOVA obay to the subsystem and puts a buffer to NOVA of the event builder. The buffer number in the buffer header is checked in the builder process.

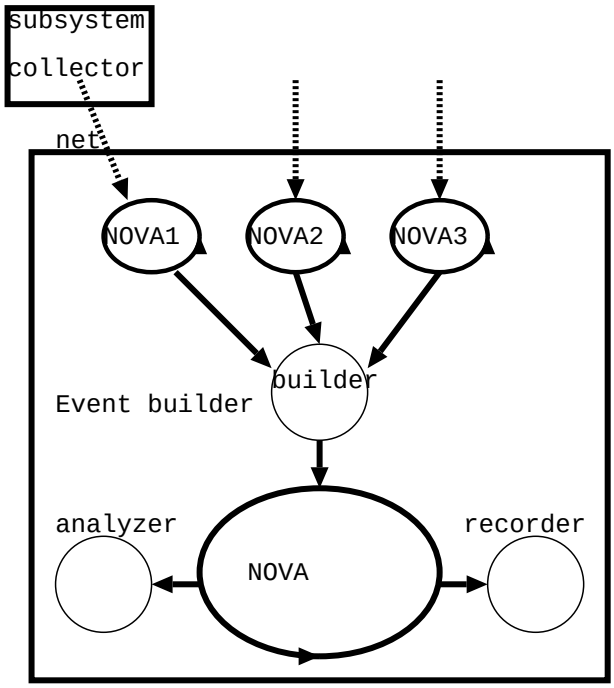

Figure 9: New UNIDAQ with an event builde process.

6 Run start stop

The run can be started and stopped by the global trigger. That can be done by sending commands from the event builder computer to the 7V via 'rsh'. The run start and stop buffers are send to the process of analyzer and recorder. This is a function in standard UNIDAQ.