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Minutes of TS meeting

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presents:

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TPC	J. May
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Timing Unit

Chris Booth, from Sheffield is now responsible for the Timing Unit.

The Timing Unit receives signals from the beam pick-up (in collider) or from the Trigger Logic (in cosmics) and produces EBX and BX for the TS and a T_0 signal for the ITC.

In order to avoid misunderstandings, all timings are given at the front panel of the Timing Unit / TS crate.

TIMING IN COLLIDER MODE

The beam pick-up signals will be available 250 ns after the beam crossing, because of cable delay.

The Trigger Logic needs to sample the HCAL signals 300 ns after the beam crossing. Its operations are started by GBX from the TS. So, GBX must be earlier than the beam pick-up signal.

The TPC starts digitizing with GBX, the TS cable delay is about 300 ns and there are other logic delays. So the TPC requests that GBX should be about 1 μs before the beam crossing.

Conclusion

BX is generated by delaying the previous beam pick-up signal. EBX will be generated 3 μs before the beam crossing. BX will be generated 2 μs later.

ECAL may request the true beam pick-up signal, if the jitter on BX interferes with the operation of its PLLs.

TIMING IN COSMIC MODE

EBX and BX are generated from the T_0 provided by the Trigger Logic, from the HCAL wires. The delay between T_0 and BX should be as small as possible.

The TS generates the EGBX level between EBX and BX. This level cannot be transmitted safely if it is too short.

Conclusion

EBX will be generated with minimal delay. BX will be generated 100 to 150 ns later.

TIMING JITTER

In this scheme, BX and EBX have comparable jitter with respect to the beam crossing: about 10 ns total (counting 1000 pulses of a 50 MHz cable clock).

The TPC requests that the delay between GBX and the beam crossing signal, will be measured to better than 2 ns. So, the Timing Unit will send BX and the beam pick-up to a TDC. This TDC will be read by the STR501 of the TS and transmitted in the L2YES broadcast. This TDC must be cleared on L1NO and L2NO. To make such a precision useful, the jitter between BX and GBX introduced by the TS and the FIO-BOXes must be less than 2 ns. For the time being, this cannot be guaranteed.

POLARIZED BEAM OPERATIONS

In this case, the bunches in LEP are not identical, the bunches must be identified in the event. The bunch identifier is available from the machine. It will be collected by the Timing Unit and transmitted to the Trigger Logic, to be introduced in the Trigger Mask.

Selection of bunches is possible on the bunch identifier. The first possibility is to select in the Timing Unit by cutting the EBX/BX generation for the discarded bunches. This imply a loss of periodicity of BX, and was found not acceptable by the detectors.

The other possibility is to do this selection in the Trigger Logic. It is obvious that this selection has be done at the level one trigger, because one cannot afford to wait for the level two. This imply the availability of the bunch identifier at the time of the level one decision and some extra hardware in the Trigger Logic. This has not yet been agreed by the Trigger.

OPERATIONS WITH INCOMPLETE BEAMS

The beam pick-up signal is always big, but in initial operations, it is important to be able to detect Beam Crossings with only one beam or with missing bunches. So the Timing Unit can be programmed to produce beam crossing signals with: pick-up right, pick-up left, OR and AND.

If a beam pick-up is not present after a BX, then the Timing Unit will generate the next EBX and BX from a dummy beam pick-up, with a jitter as small as possible. This imply that the Timing Unit will generate BX at the correct frequency in the absence of beam.

Handling of ECAL and HCAL refreshes in Cosmic mode

Refreshes are needed by many detectors in Cosmic mode.

VDET and ITC refreshes will not disturb the read-out protocol. If an event interferes with a refresh, then the data are not significant, but this can be flagged and can be tolerated.

HCAL prefers to avoid triggers during refreshes, because it is difficult to estimate the validity of an event close to a refresh.

ECAL cannot perform read-out during refreshes and need to block triggers.

REFRESH PROTOCOL

Refresh frequency for HCAL is 200 KHz, and 8 KHz for ECAL. The pause request / pause grant protocol proposed by ECAL cannot be used at 200 KHz because of cable delays to reach the TS.

It has been agreed that the TS will have a timing input receiving the pause request, now called refresh clock, for HCAL. This signal will be transmitted to the HCAL ROCs via the TS cables, on the previous pause grant line, now called GREF.

The refresh clock may be generated by ECAL, when both HCAL and ECAL are present in the main partition, to allow for synchronization of refreshes.

When ECAL needs a refresh (every 25 refreshes of HCAL) it will stretch the duration of the TS pause. It has been proposed to request this stretching by sending a request on another line of the TS cable. Another possibility, not discussed at the meeting, is to stretch the refresh clock itself.

HCAL would like that the refresh clock is suppressed for at least 800 μs after a read-out and restart at least one cycle before the ready of the TS. ECAL also needs a few refresh cycles before releasing BUSY. This imply that the refresh clock generator knows the TS state.

REFRESH TIMING

ECAL has internal guards on refreshes which add very little dead-time, because the refresh is rather long (15 μs).

HCAL has internal guard on the beginning of refresh, but needs either a minimum delay of 200 ns between the end of refresh and the next GBX, or a warning of the end of stretched refresh.

T_0 for ITC

ITC has TDCs started by wire pulses and stopped by T_0 (the beam pick-up signal). These TDCs have a range of 350 ns. In collider mode, the T_0 should be early enough. In case of L1NO, one will clear the TDCs.

In Cosmic mode, T_0 is late, but still acceptable. The problem is that T_0 is ungated, it may not be followed by an EGBX...L2YES sequence. In that case, the TDCs are stopped and unable to accept a next event.

It is not easy to provide a meaningful READY signal from the TS to the ITC. It has been suggested to clear the TDCs if a T_0 is not followed by an EGBX, this will induce a very small dead-time for the ITC.