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Proposal to transmit the L0 signal over the TTC optical link

(Proposal approved by the ALICE Technical Board on 12 July 2005)

At a glance

- The ALICE sub-detectors for which the **L0** latency is not critical could benefit from an alternative scheme that transmits both the **L0** and the **L1** signals over the TTC optical link.
- The option would be an *add-on* feature, selected by the control software; there would be no changes of the currently available **L0** distribution.
- The **L0** latency of the option would be up to 100 ns longer than the latency of the standard scheme.

Introduction

The latency of the **L0** signal is a critical parameter for most of the ALICE sub-detectors, and one of the main design objectives of the ALICE trigger system has been to reduce the latency time to a practical minimum:

- the Central Trigger Processor (CTP) electronics has been located in the experimental cavern, as close as possible to both the sources of trigger inputs and the readout sub-detector front-ends;
- the **L0** is transmitted as an individual signal, with a possibility to use special cables with low propagation delay;
- the signal is not re-synchronised on the LTU board (Local Trigger Unit);
- *etc*. .

For some readout sub-detectors, on the other hand, the latency of the **L0** is not critical (SPD, TRD, TPC, *etc*.), and the distribution of the **L0** signals over separate electrical cables is an unnecessary burden; they could benefit from an *alternative scheme that transmits both the **L1** and the **L0** signals over the TTC optical link*. The option is presented in the following section.

The proposal *fully preserves currently available **L0** distribution*: there shall be no logic/electrical/timing changes; sub-detectors shall not be required to modify their existing designs. The option, if adopted, would be an *add-on* feature, selected by the control software as part of the LTU configuration.

Proposal

In the current design, the **L1** trigger is transmitted *via* the *Channel A* of the TTC optical link; when selected, the proposed scheme would use the *Channel A* for transmission of *both* the **L0** and the **L1** signals.

Transmission code

The signals would be encoded:

- *"1,0"* in two consecutive BC intervals would be used for the **L0** transmission;
- *"1,1"* would imply the **L1** signal.

Decoding options

Option A:

A state machine - part of the readout logic - can be used to recognise the **L0/L1** code; this is the *simplest and the safest* method, but it adds one BC interval (25 ns) to the latency of *both* **L0** and **L1**.

Option B:

In the ALICE trigger sequence, the **L1** signal is *always* preceded by the corresponding **L0**; the delay between the two is *constant*; no other **L0** signal is possible in the **L0**-**L1** interval. As a result, the sub-detector logic can "predict" whether the next signal on the shared link is **L0** or **L1**, and the signal can be "decoded" upon the arrival of the first code-bit (always logic "*1*") without any delay; the second bit of the code could be used to verify the correct operation of the prediction/decoding logic, or for recovery from a possible error. No additional delay is incurred.

Timing considerations

In the following text, the **L0/L1** latency of the proposed option (when selected) is compared with the latency of the "normal"/current configuration.

***L1** latency*:

When the decoding *Option B* is used, no additional latency is incurred; in case of *Option A*, one BC interval (25 ns) is added to the "normal" **L1** latency.

***L0** latency*:

- In the proposed scheme, the **L0** signal needs to be re-synchronised on the LTU board; the additional delay is either 12.5 ns or 25 ns, depending upon the phase difference between the BC clock of the CTP and the local BC clock on the LTU board.

- Signal coding on the TTCex board and the decoding performed by the TTCrx chip introduce an additional delay of about 70 ns.[1]

- The propagation delay of the optical fibre at 1310 nm is 4.9 ns/m.[2] This is somewhat higher than the delay of the cable selected for transmission of ALICE LVDS signals (4.7 ns/m) and considerably higher than the delay of special, fast electrical cables (~ 4.3 ns/m).

As a result, depending upon other timing settings and the length of the optical fibre, the **L0** latency of the proposed scheme could be as much as *100 ns longer* than the latency in case of **L0** distribution over electrical cables.

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[1] TTC web site, section *L1A Latency*: "The delay from the L1A input socket of a TTCex laser encoder/transmitter module to the L1A output pin of the TTCrx timing receiver ASIC at a destination (when using the HFBR-2316T photodiode + preamp) is 68 ns plus the propagation delay of the external optical fibre network. ... (The delay with the TRR-1B43 photodiode + preamp has not yet been measured and may be expected to be somewhat greater. The measurements were made with the DMILL 100 BGA version of the TTCrx, not the latest 144 fpBGA version.)

[2] TTC web site, section *L1A Latency*.