

Control signals: trigger signal to detector electronics and CRU, busy signal to CTP, CTP trigger protection mechanism

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Readout scheme from TDR

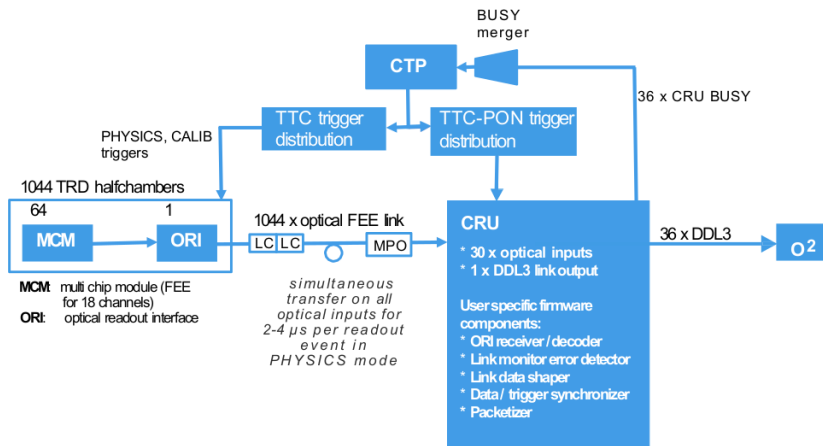


Figure: Readout scheme from TDR

Interaction with CTP

- PHYSICS readout: LM triggers will be sent in parallel to the FEE via the TTC-A-channel and to the CRU via TTC-PON
- CALIBRATION readout (after programmable number of n LM triggers): A special trigger sequence (CALIBRATION trigger) will be sent to trigger both, tracklet and raw data readout
- CTP independent mode with alternation of PHYSICS and CALIBRATION based on local counters available
- The calibration trigger will have both physics and calibration TType bits set in the PON trigger message
- After each trigger, TRD is protected by CTP for a programmable time interval, or longer in case the CRU signals BUSY to the CTP
- CRUs take care of preceding the data with headers containing the correct trigger IDs (attribution on a time basis)
- The CRUs also transmit the HB trigger message ACK to CTP (handled by common firmware)

Timing for PHYSICS readout

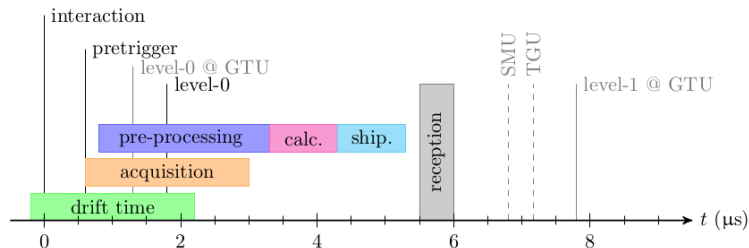


Figure 4.2: Trigger timing relative to the interaction. All FEE timings are determined by the pretrigger and configured with respect to it. The latency of the pretrigger determines the position of the sampling window (green). The acquisition (orange) of the delayed signals starts with the pretrigger. The pre-processing (blue), tracklet calculation (magenta), and tracklet shipping (cyan) start with a small offset. The GTU-related timings are shown in grey.

Figure: Source: Jochen Klein, Jet Physics with A Large Ion Collider Experiment at the Large Hadron Collider

Absolute maximum event sizes per PHYSICS trigger

- Every MCM can at maximum send 4 tracklets (=16 Byte)
- max. 64 MCMs per optical link (half chamber)
- \Rightarrow Max. PHYSICS event size per link: 256 tracklets = 1kB
- Effective link transmission rate: 16bit@120MHz
- \Rightarrow Max. transmission time: $4.27\mu\text{s}$

Busy distribution from the CRUs to the CTP/LTU

- Send 36 individual CRU busys via TTC-PON network and let CTP do the merging (oring)
- Latency depends on the number n of CRUs per optical TTC-PON network and on the distance of the CRUs:

$$\text{Latency}_{\text{TTC}} = 125 \text{ ns} \cdot n \text{ (CRU-LTU multiplexing)} \\ + 375 \text{ ns (LTU-CTP multiplexing)}$$

$$\text{Latency}_{\text{cable}} = 600 \text{ ns (placement in CR1 with respect to cavern)}$$

- \Rightarrow Possibility of placing the CRUs in the cavern: see next slide

Costs for TRD

- Costs for TRD: 650 USD per OLT + splitters - 650 USD

Example calculation:

- 1 network, $5.475\mu\text{s}$ Latency, 0 USD
- 2 networks, $3.225\mu\text{s}$ Latency, $650\text{ USD} + 2 \times 350\text{ EUR} \approx 1300\text{ EUR}$
- 4 networks, $2.1\mu\text{s}$ Latency, $3 \times 650\text{ USD} + 4 \times 132\text{ EUR} \approx 2150\text{ EUR}$
- 9 networks, $1.475\mu\text{s}$ Latency, $8 \times 650\text{ USD} + \text{splitters} \approx 5500\text{ EUR}$

Backup

Possibility of the GTU as additional Busy Generation Unit

- Maintenance and manpower issues in case the GTU remains a critical component
- Very high complexity of system
- System must be capable of running without the GTU \Rightarrow Therefore current proposal does not involve the GTU
- GTU electronics does not show signs of ageing
- No major hardware faults occurred yet
- Spares are still available
- Optical repeater operation of GTU possible, but risky because this makes it a critical component
- Optical splitters could allow a completely independent operation with full redundancy
- \Rightarrow As the GTU stays in the cavern, we might have the option to improve the system performance in the future without taking any risks with respect to basic data taking capabilities