NP04 CTB Update

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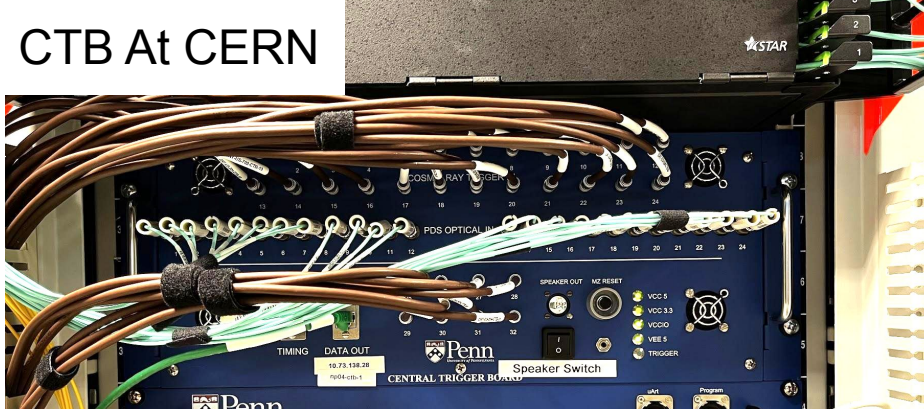
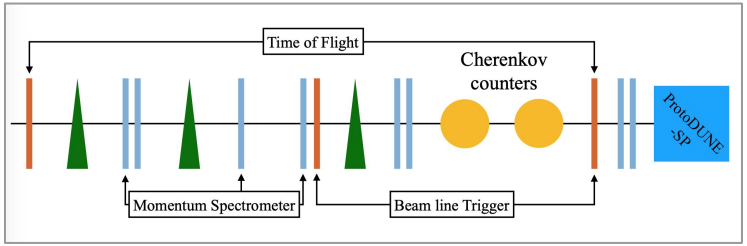
Central Trigger Board

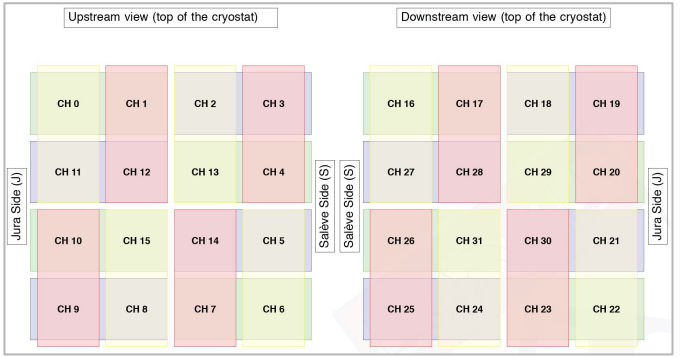
RUN 1:

- Forming trigger based on:
  - Beam Instrumentation
  - Cosmic Ray Tagger (CRT)
  - Photon Detection System (PDS)

CTB At CERN





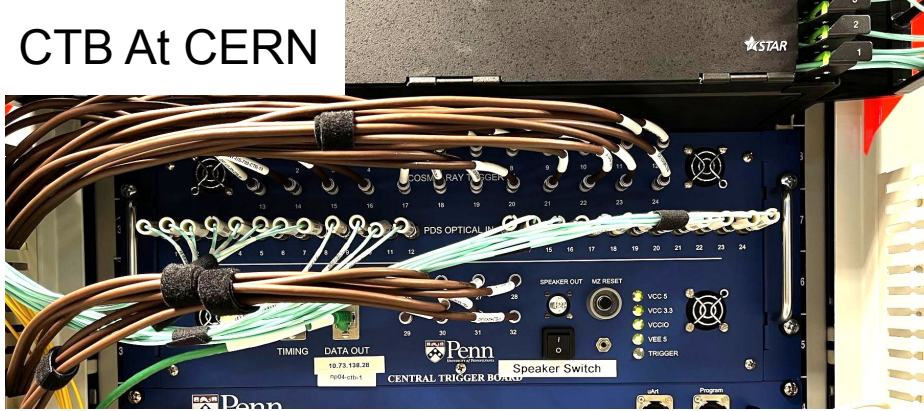


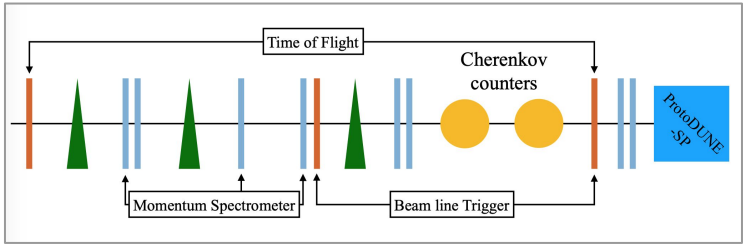
Central Trigger Board

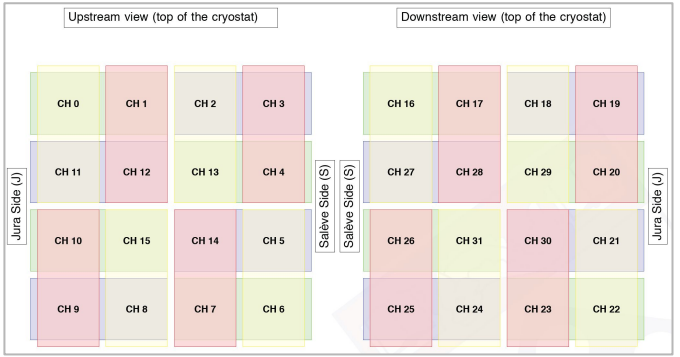
RUN 2:

- Forming trigger based on:
  - Beam Instrumentation
  - Cosmic Ray Tagger (CRT)
  - ~~Photon Detection System (PDS)~~
- Act as a Hardware Signal Interface (HSI) for the software trigger.

CTB At CERN

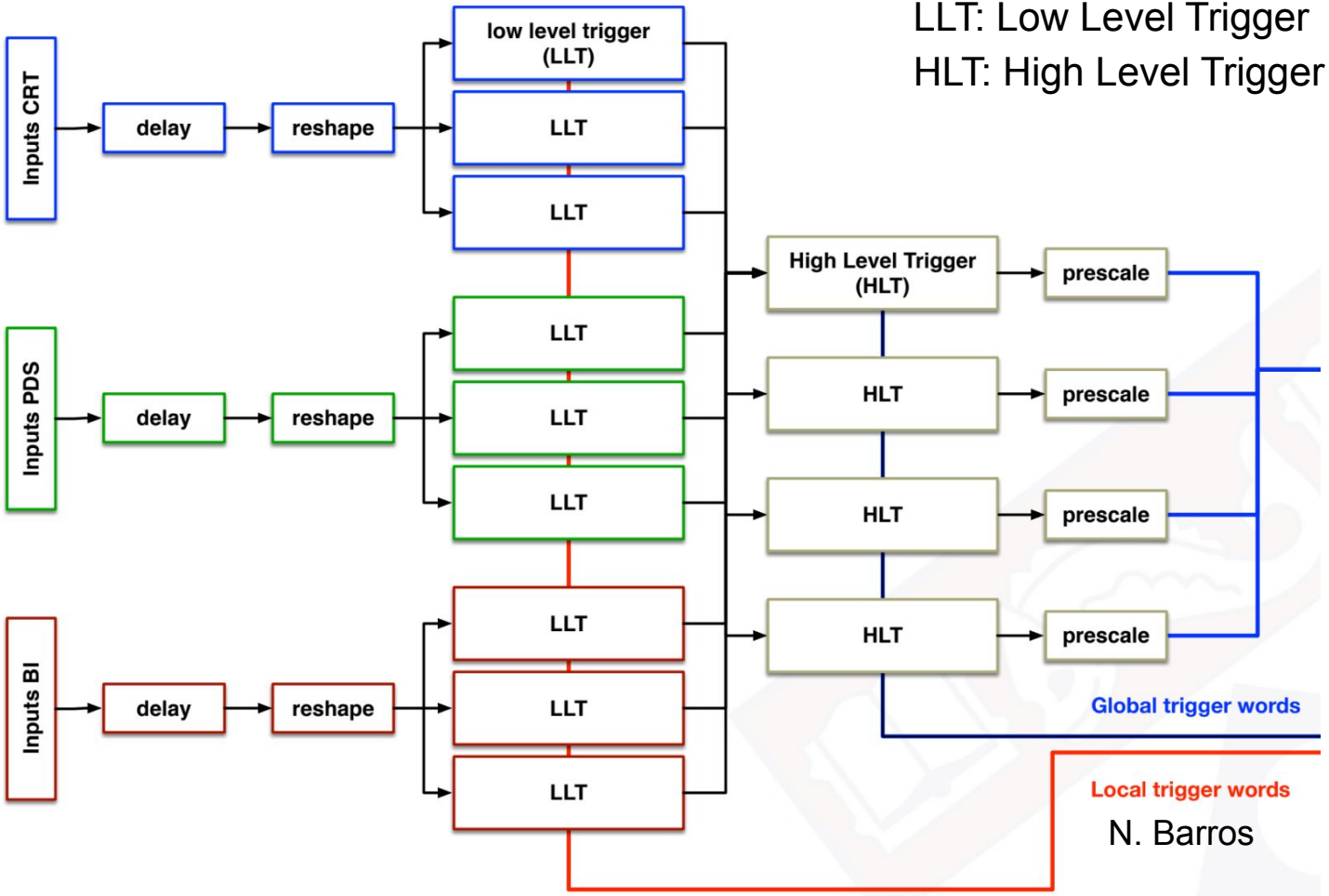






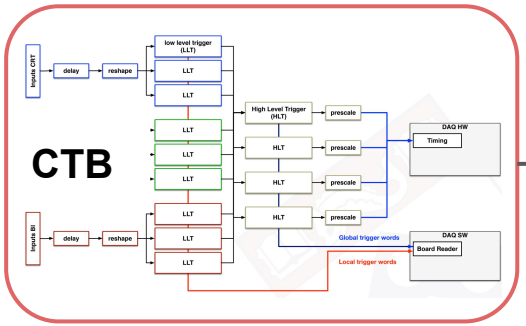
Firmware

LLT: Low Level Trigger
HLT: High Level Trigger



N. Barros

Data Path



CTB Module

To Data Selection as TCs

IF **HLT**

HSI Raw Data

HSI Event Data

IF **LLT**

IF **HLT**

LLT Latency Buffer

HLT Latency Buffer

HSI: Hardware Signal Interface

HSI **Raw** Data Format (Saved in Data stream)

- HSI data format shared by timing and CTB.
- Format reflects input → trigger processing step.
  - e.g. input channel → LLT or LLT → HLT

```
typedef uint32_t word_t;
word_t version : 6, detector_id : 6, crate : 10, slot : 4, link : 0;
word_t timestamp_low : 32;
word_t timestamp_high : 32;
word_t raw_input_low : 32;
word_t raw_input_high : 32;
word_t trigger : 32;
word_t sequence : 32;
```

LLT or HLT?

Why are we triggering?

Types of trigger emitted

HLT -> TC Maker

- Each HLT corresponds to a TC Word in the software trigger:
- HLT 0: Fake fixed-frequency trigger
- HLT 1-9: Beam triggers with fully enumerated PID selection using the Cherenkov detectors
  - E.g. **kCTBBeamChkvHL**: Beam trigger, requiring coincidence with both Cherenkov detectors.
  - **kCTBBeamChkvLx:** Beam trigger, vetoed by low pressure Cherenkov detector.
- HLT 10-12: CRT Triggers:
  - HLT 10: Offspill cosmics
  - HLT 11: Offspill cosmics, Jura (beam) side only
  - HLT 12: all cosmics
- HLT 13-16: Custom Triggers:
  - Customizable triggers for any other scenarios. E.g. PDS tests with specific CRT panels, diagnostic runs, etc.
  - HLT 16 is connected to a signal repeater, emitting 10 HLTs at 83Hz.
- Full mapping at: https://twiki.cern.ch/twiki/bin/view/CENF/TriggerBasicOp

Integration with software trigger

- Multiple HLTs can be emitted with the same timestamp and within the same event window. Corresponding TCs should be ***merged***, resulting in a single trigger record with multiple CTB HSI Frames and multiple TCs.
  - Tested with both fake trigger and CRT.
  - HLT/TCs can be used as a pre-selection tag for PID, muons that cross the APA, early calibration, etc..
- ***Prescaling*** can currently be done either on the CTB or via the software trigger. *However, sw trigger* can only apply a global pre-scale on all CTB-emitted triggers, not per TC Type.
  - Prefer using pre-scaling on software rather than CTB, since extra TCs will be stored in the datastream.

Configs generated for the current run

- Beam starts tomorrow at 6PM CERN time.
- Standard beam trigger (beam spill gate + coincidence of tof detectors)
- Offspill cosmics: 1Hz fake trigger, due to readout issues with the CRT.
  - Configs for higher frequency is prepared so that a global pre-scaling can be used to reduce the beam rate.
- Configs with both standard beam trigger and beam trigger with cherenkov selection turned on.
  - Software trigger is free to either trigger on all beam events (with Cherenkov coincidence tagged), or only on the events with Cherenkov selection.
  - As of right now, we are unclear whether the Cherenkovs will be operational. Beam Instrumentation Group plans on fixing it by Thursday.