LUXE

DESY.

FEEDBACK ON DAQ FROM CHERENKOV TEST BEAMS.

LOUIS HELARY, STEFAN SCHMITT

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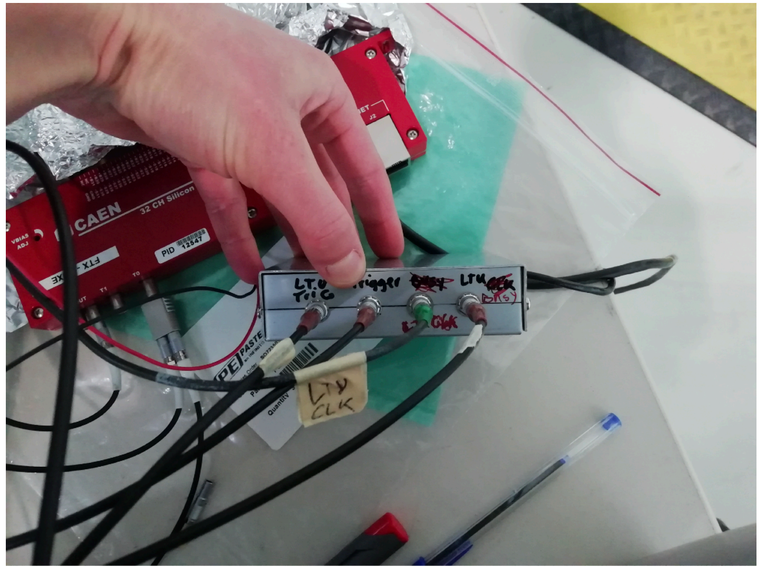
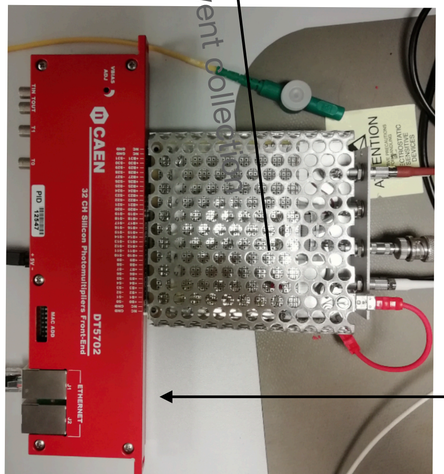
HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

FTX

CHERENKOV STRAW TEST BEAM (2021)

- First DESY test beam with Cherenkov straw (filled with oil because of low event rate).
- Electron triggered by scintillator fingers connected to TLU that redistribute trigger signal.
- Straws signal collected by SiPMs, and readout using CAEN DT5702 (ADC with max finding).
  - Board stores signal in internal buffer, that can only be readout asynchronously by ethernet, and has a huge dead time.
  - Need to introduce large delay to collect signal.
  - Implementing this board in EUDAQ did not appeared trivial, so no attempt to do it.
- Never managed to synchronised the readout online.
  - Possible to perform some machine offline based on the event timestamps, but not convenient, and no guaranty to introduce errors.
    - During the week, tried to improve situation by adding Arduino board to counts the events and TLU trigger numbers and holds the trigger after 256 events to give the DT5702 enough time to get the events out of the buffer.
    - Worked, but still needs to match events offline, introduce even larger dead-time.



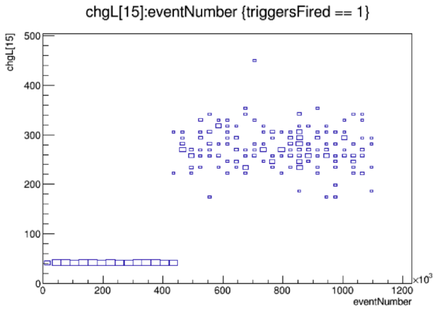


LEAP CRYSTAL CALORIMETER TEST BEAM (2022)

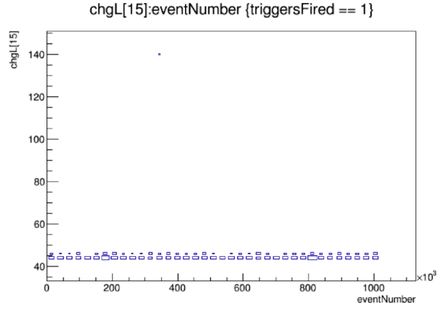
- In context of LEAP project (create polarized electron beam with Laser Wakefield accelerator in DESY), use TF1 crystal (as in LUXE backscattering calorimeter) signal recorded by PMT.
  - Exposed in DESY test beam in December 2022 to make an attempt of calibration.
- PMT are readout by charge integration device (QDC) connected to DAQ PCs.
- Scintillator triggers signal sent to discriminator in NIM Logic, then distributed to QDC and TLU.
- QDC board already implemented in EUDAQ, but had to tune the software to have it under control.
- Need to make sure that number of events recorded is the same in both DAQ PCs:
  - Lost synchronisation ~10% of the runs.
  - Even if synch not lost, no automatic event building to match events (and no unique Event number).
    - Need to match events by hands essentially.
    - In order to help resynchronisation use LED calibration to inject signal pattern in the data taking to split events in blocks.
      - Helps the resynchronisation offline.

Synchronisation check between the telescope and calorimeter data

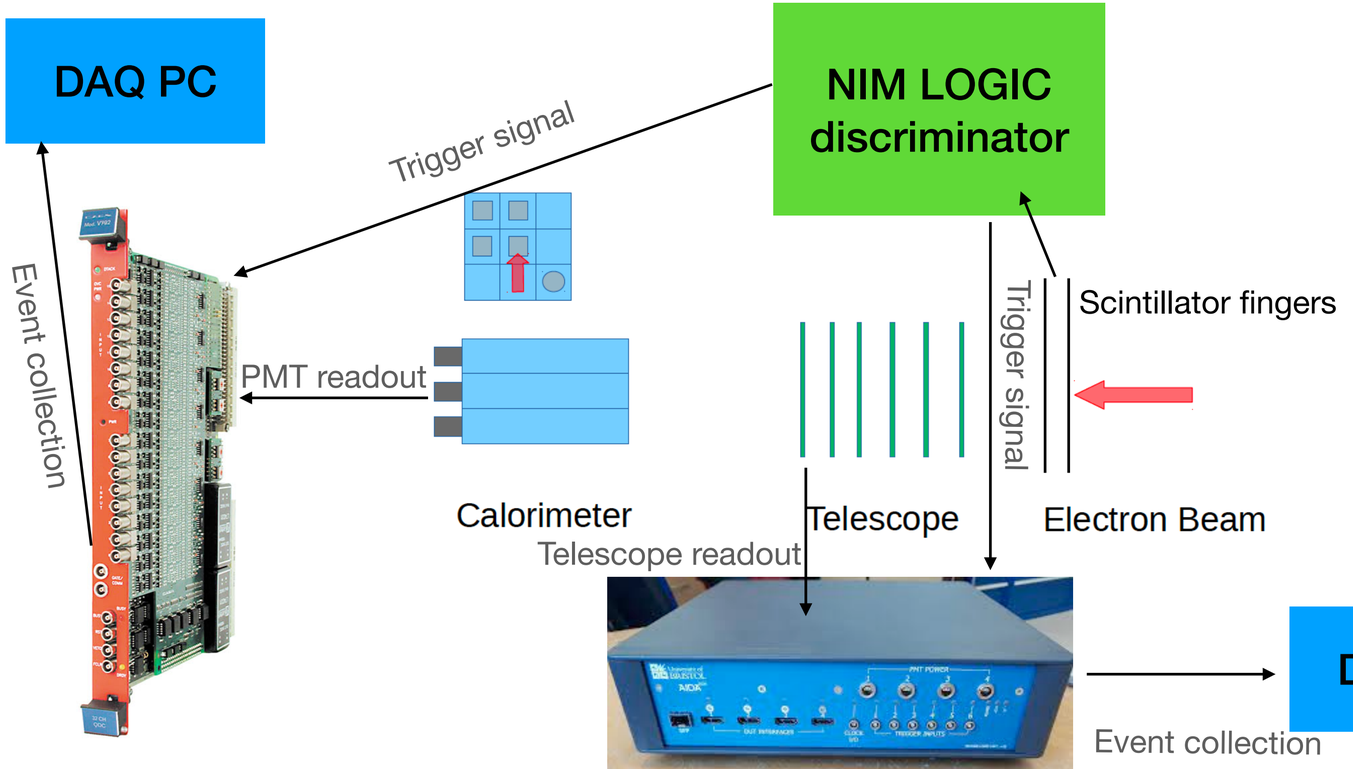
Run 200508 (#QDCevents ≠ #TLUevents)



Run 200509 (#QDCevents = #TLUevents)



events with #QDCevents ≠ #TLUevents are not synchronised (5 in total)



WHAT DID WE LEARNED SO FAR?

Here is my take-away from the testbeam:
- we use the TLU only because we have to (for the telescope)
- the TLU is not useful for triggering the Cherenkov at the testbeam, because the TLU trigger output does not have a usable timing (large delay and jitter)
- we did not have a 100% reliable setup for synchronising events at the trigger level, and the TLU did not help much
  (1) because we do not have hardware to properly decode the TLU signals (for hardware timestamps)
  (2) because the TLU does not keep track of the DUT busy signals in its readout
- we used EUDAQ to record events, but now have to assemble the events from different detectors offline, which is a pain.

For next test beam:
- would have to use additional hardware to decode all TLU signals and to provide hardware timestamps for reliable synchronisation
- can we use some event-building feature by EUDAQ (if it exists)?
- Also plan to use different hardware (either 14bin digitizer partially implemented in EUDAQ), or DT5550W which is not implemented at all yet (and only runs on Windows).

For LUXE:
- TLU has to be synchronised with beam clock to avoid jitter effects
- TLU will have to know the beam trigger a few 100 ns before the beam actually arrives, otherwise the distributed trigger signal will be too late for the subdetectors.
- all subdetectors should have a dedicated board or device to decode the TLU signals (trigger number and trigger timestamp). The trigger number and timestamp have to be integrated in the readout of that subdetector.
- all subdetector have to report back a busy signal
- detectors sensitive to timing (laser, perhaps Cherenkov, etc) will need extra logic to create a fast trigger signal with stable timing (avoid TLU jitter effects)
- in addition to the TLU we also need logic to handle the “BUSY” signals
- the TLU could perhaps provide that logic, but the present firmware seems to be insufficient

Corrolar: with the present firmware, and for the Cherenkov testbeam, the TLU is complicating things instead of simplifying them.
I am afraid it will be similar for LUXE. We have to look in the TLU firmware to see whether it can be turned into a useful device.