



Trigger/Timing Logic Unit (TLU) and EUTelescope



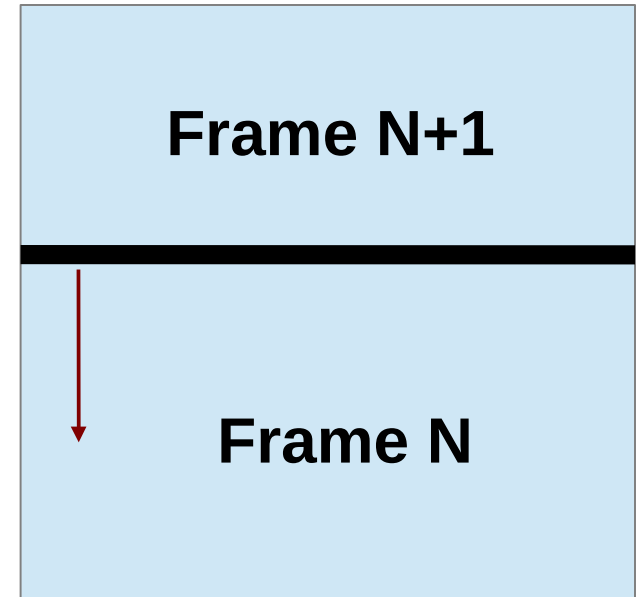
Outline

- Rolling Shutter Sensors and Triggered Readout
 - Why?
 - How?
- EUDET TLU Hardware
- Triggering Modes
 - Trigger/Busy
 - Trigger/Busy/Data
- Software (EUDAQ)
 - TLUProducer
 - TLUControl



Rolling Shutter Sensors

- MIMOSAx_x MAPS, used in EUDET and AIDA pixel beam-telescope
- Not really triggered.....
- Continuously sensitive
- Read-out continuously from one side of sensor to other





Rolling Shutter with Trigger

- Rolling-shutter sensors aren't triggered.
- EUDET/AIDA telescope has a trigger.
- Why?
- Telescope operates with other devices.
 - Often these do require a trigger to sample data (e.g. LHC sensors)
 - Will (almost) always have different clock-rate/frame rate. Need to correlate data.



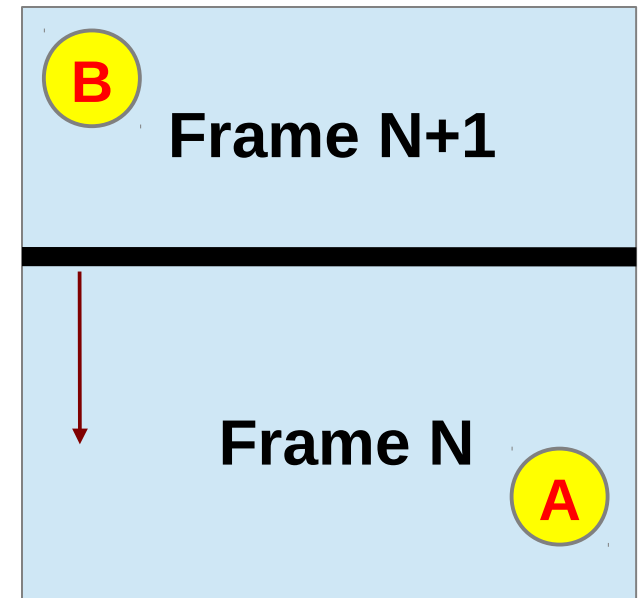
Rolling Shutter with Trigger

- Produce a trigger from scintillation detectors in beam
- Know that a particle has passed through telescope, but not which side of rolling shutter.
- ... so read out two frames for each trigger.
- Use the (simplest) approach of one trigger = one event = one pair of frames.



Rolling Shutter with Trigger

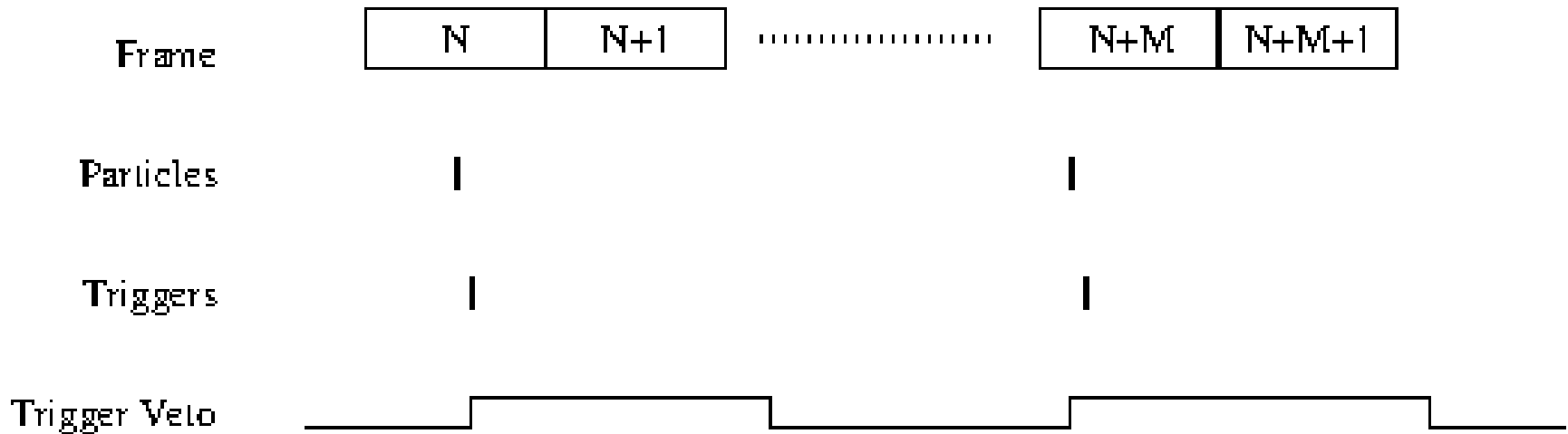
- For example, assume a particle passes through the sensor when frame-N is being read out.
- If in position “A” will be in frame N
- If in position “B” will be in frame N+1





Trigger Veto

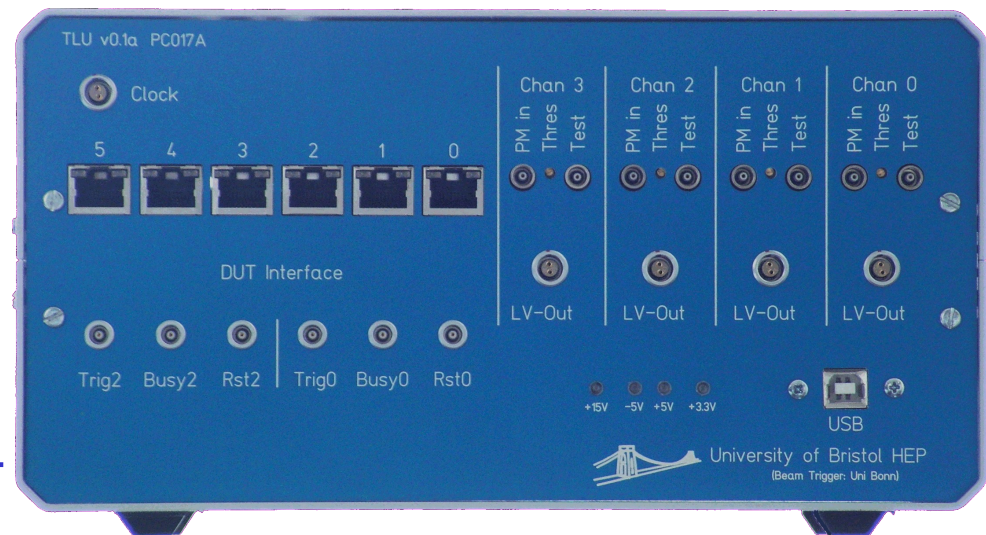
- To enforce only one trigger per frame, readout sets veto until a pair of frames has been read out:





EUDET JRA1 TLU Hardware

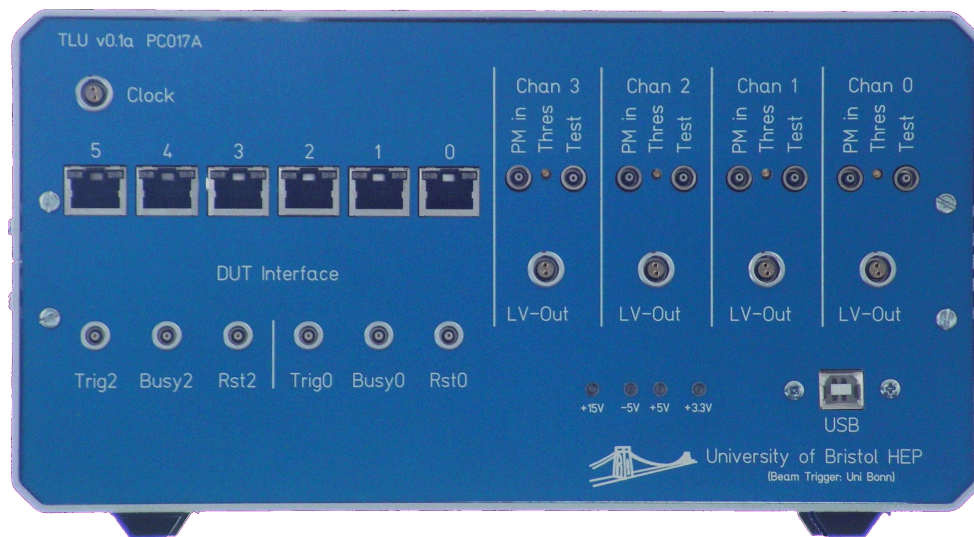
- Designed to give a simple but flexible interface to trigger/timing signals at EUDET JRA1 beam-telescope
- Produces triggers from beam scintillators.
- EUDET-Memo-2009-4





EUDET JRA1 TLU Hardware

- FPGA configuration is loaded every time TLU starts
- Outgoing trigger has fixed latency w.r.t. Scintillator triggers
- Can provide clock, but usually asynchronous trigger/busy handshake





EUDET TLU Hardware Signals

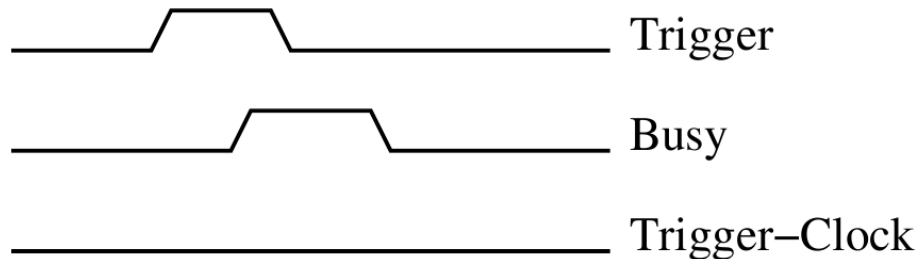
- TLU 0.2c has six DUT interfaces.
 - Four can be switched between RJ45 and LEMO (two with TTL, two with NIM levels). Two RJ45 only.
- RJ45 connectors have four signals
 - Trigger (TLU->DUT)
 - Busy (DUT->TLU)
 - DUT-Clock (DUT->TLU)
 - Reset (TLU->DUT. Not normally used)



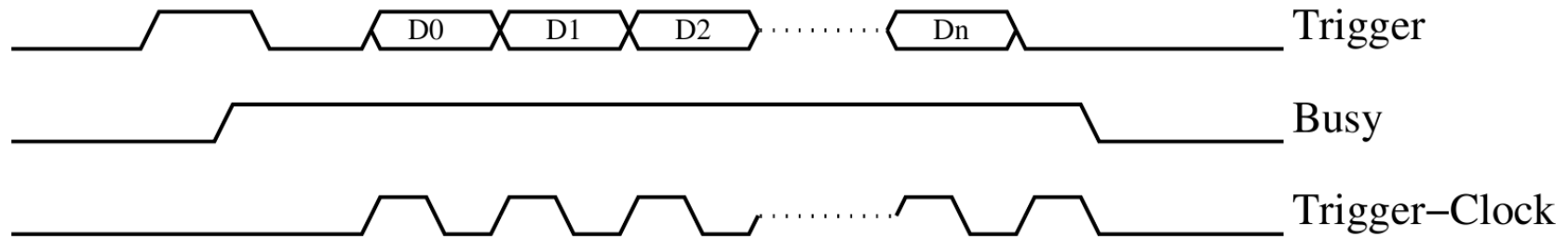
JRA1 TLU Interface

- Different triggering modes:

- Trigger-Busy handshake



- Trigger Data handshake





JRA1 TLU Interface

- Trigger-Busy+Data handshake protects against telescope and device-under-test becoming de-synchronized.
- Trigger number can be read out for each event.
- N.B. The DUT controls if trigger-number is read out.



JRA1 TLU Interface

- Triggers can be vetoed by DUT raising TRIGGER_CLOCK line.
 - Can be combined with simple trigger/busy handshake for “dead-time free” readouts that send a continuous stream of data.
 - Send “buffer almost full” signal.
- Time-stamp stored for each trigger.



EUDET TLU Hardware Signals

- For RJ45 connections, use screened (e.g. Cat-6) cables.
 - Signals not “DC-balanced”, so unlike Ethernet can't use magnetic/capacitive rejection of common mode signals.



TLU Readout Software

- EUDET TLU communicates to host-PC using USB 2.0
- Records a time-stamp for each trigger issued.
- TLUProducer.exe runs with EUDAQ and controls TLU (loading firmware, trigger configuration , starts triggers, stops triggers , controls internal triggers)
- To run TLU stand-alone use TLUControl.exe (no interface to EUDAQ)