Status of the TLU

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Outline

- User experience.
- Firmware Updates
  - Fixed latency triggering.
  - Busy initiated by DUT.
- Plans.
- Conclusions.

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User Experience

- TLU has been used in INFN, Uni Bonn, Uni Geneve, ULB, as well as in Bristol.
- Being used has thrown up some bugs, which is extremely valuable:
- Many thanks to all who have used the TLU and given me feedback.
- Some obvious bugs found and fixed.

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User Experience – reported problems.

- Occasional “spurious trigger”.
  - Probably due to use of unshielded cable for LVDS connection and poor grounding.
- Problems with TLU being recognized when connected to USB port.
  - Fix for some problems supplied by Bonn group. May also rebuild firmware to avoid re-enumeration.
- Trigger number out of step on different DUT outputs.
  - Probably due to bug in DAQ s/ware

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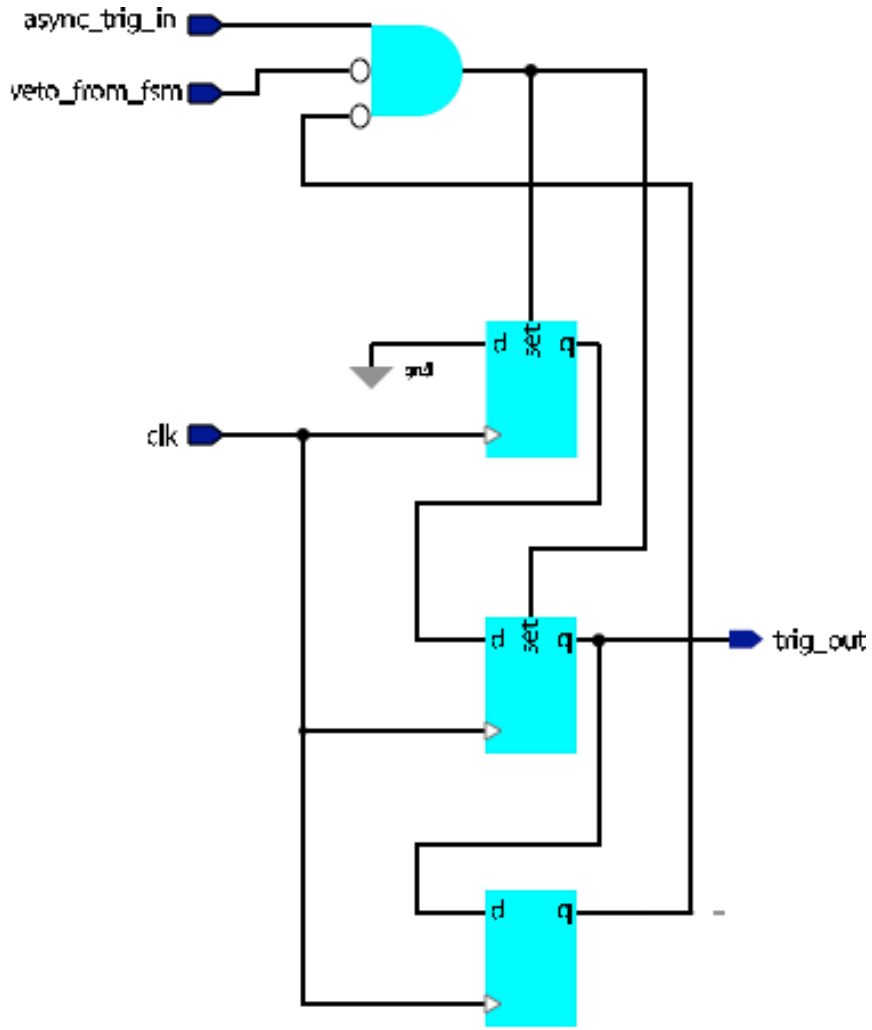
Firmware Updates

- Fixed latency trigger.
  - Useful for e.g. TPC
- DUT can initiate “busy” without waiting for trigger.
  - Useful, but introduces a race condition.
- Usability enhancements.
  - Added scalers for input triggers and pre-veto triggers

Fixed Latency Trigger

- Trigger is **set** a fixed time after incoming beam trigger, **cleared** synchronously with system clock.
  - Introduced some bugs, but these fixed.



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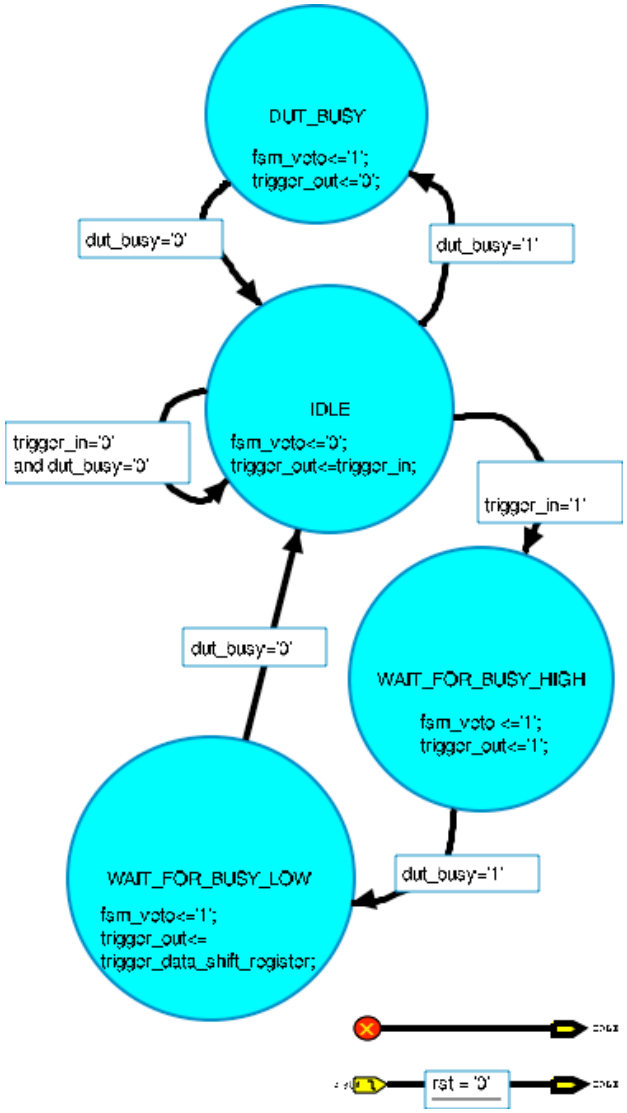
Fixed Latency Trigger



- Each DUT interface connected to FSM
- Trigger output connected to Mux.
- In IDLE state, async trigger connected to trigger outputs.

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Measured Trigger Latency and Jitter.

- Latency between incoming beam trigger and trigger to DUT measured as 27.3 ± 3ns
  - Uncertainty is due to different delay at different DUT outputs and predicted variation due to temperature variations.
  - 13ns of delay is from FPGA, 14ns discriminator.
- Jitter measured as 24 ± 5 ps.
  - Better than expected -but FPGA is “quiet” except during readout.
  - Fixed height. Timing walk if different pulse sizes.

DUT Initiated Busy

- In TLU specification, the only way a DUT can veto triggers is to respond to a trigger and keep BUSY line high.
- Have introduced a mode where DUT can raise BUSY line and veto triggers.
  - Asked for by LCFI collegues.
  - Introduced race condition (TLU sends trigger simultaneously with DUT sending busy)

Usability Enhancements

- Trying to make a NIM crate unnecessary...
- Added scalers on beam-trigger inputs (16 bit).
  - Will add scalers on pre-veto trigger, to allow dead-time to be measured.
  - Will increase width of scalers to 32 bits.

Plans (things that will get done)

- Continue with "usability enhancements"
- Select between internal and external clock sources.
  - Clock input present and tested. Firmware needs work (crossing clock domains)
- Improve time-stamp resolution from 20ns to 2.5ns (firmware change)

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Plans (things that might get done if enough interest)

- Minor hardware changes:
  - Some HDMI connectors as well as RJ45
    - Shielding **much** better on HDMI
  - More inputs and outputs.
  - Switchable NIM/TTL I/O (straightforwards)
- Modify TLU hardware to allow stand-alone operation:
  - Stand-alone configuration of FPGA.
  - Switches to allow control by front panel.
  - Display of trigger counts and TLU status.

Plans

- Make more TLUs, but ....
  - Paying for them is not straight-forwards:
    - Probably by yearly adjustment to payments.
    - … or find a friendly company to make them.
  - Which hardware version?
  - Could implement TLU in different form factor, e.g. VME or perhaps more likely PCI (but TLU is already pretty small)

Conclusion

- TLU is still being developed.
- Is in use for LCFI beam-tests, so maintenance will continue for a least a few more years.
- How it develops depends to some extent on what needs are.
- Many thanks to “beta-testers”.

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