Tutorial: AIDA-TLU/EUDAQ2

Lennart Huth
DESY

Thanks to P. Schütze and F. Diegritz for their help preparing the tutorial
And Tamar for helping with the shipping

28/30 Jan 2020

That's what you signed up for

- Listening to my (short) introduction
- Getting and installing all the software pieces
- Starting, initializing and configuring with EUDAQ2
- Using the TLU
- How to trigger with the AIDA-TLU
- Testing the different DUT interfaces
- A short coffee break :)

A FEW COMMENTS ON THE TUTORIAL

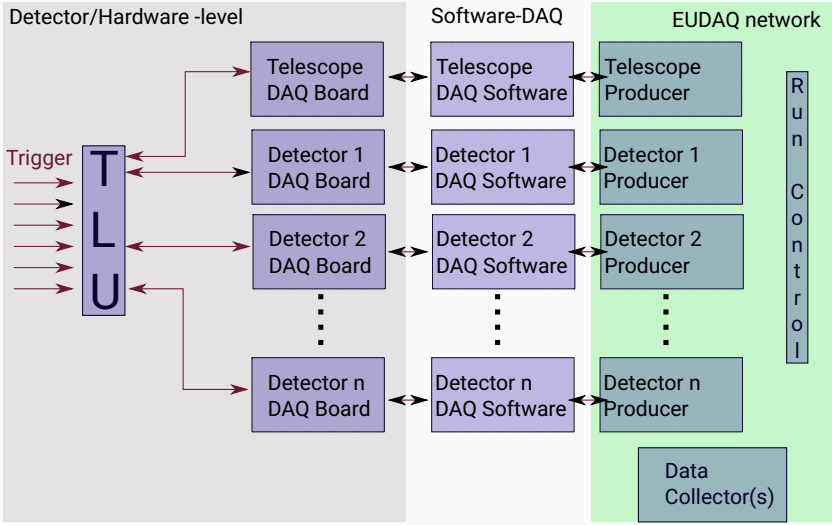
- All scripts provided should be executed from the top folder of `bttb8_daq_tutorial`
- You need to have a qt5 development version installed
- If you encounter trouble installing carefully check the cmake outputs
- For the sake of simplicity please do not change any install paths and install ipbus to `/opt/cactus/`

Introduction

- Successful test beams requires best possible knowledge about the DAQ system that will be used.
- Last years tutorial from which I took quite some stuff
- I think (hope) I've prepared too much material - if we will not finish within the time, that's nothing to worry about. If we finish faster - we can discuss more details.
- The tutorial relies on you: Ask whatever you want to ask!

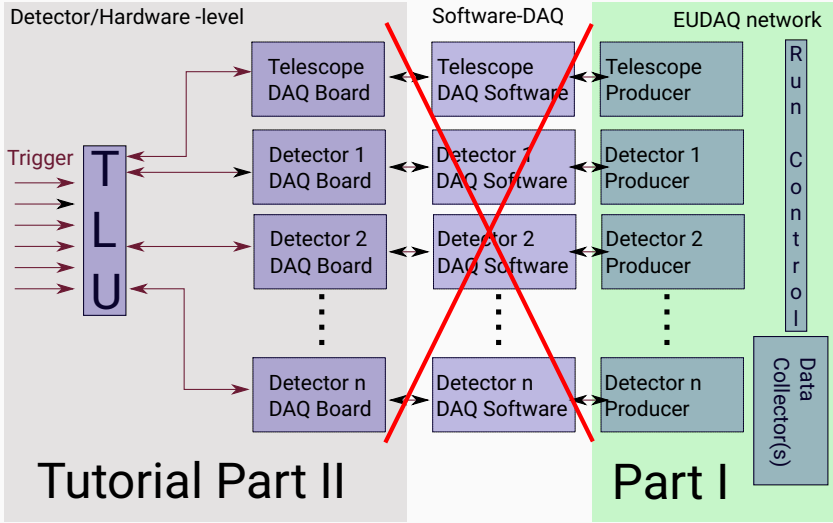
A TYPICAL TEST BEAM DAQ LAYOUT

- Reference telescope
- Triggering logic
- DAQ network
- N-DUTs



A TYPICAL TEST BEAM DAQ LAYOUT

- Reference telescope
- Triggering logic
- DAQ network
- N-DUTs
- We will ignore all device specific DAQ software
- We will assume that the DAQ Boards have an interface to the TLU

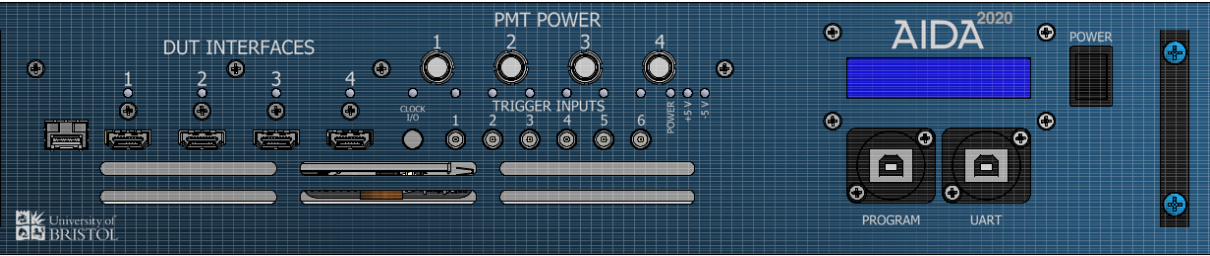


AIDA-TLU - Synchronizing different detectors

- TLU = TriggerLogicUnit
- 6 configurable inputs to create a trigger
- 4 HDMI-differntial DUT interfaces

DUT interface modes

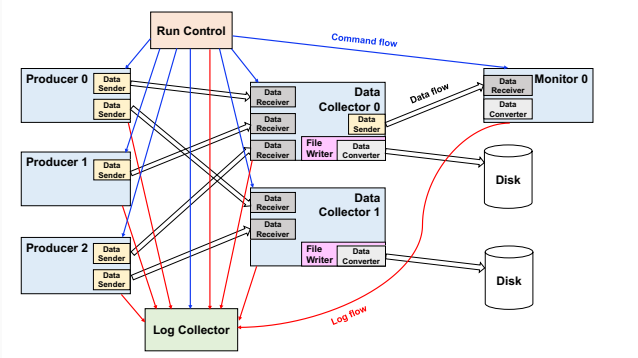
- Trigger, ID (and veto)
- Trigger, clock and T_O
- Trigger (and veto)



EUDAQ2 - The telescope DAQ software

Modular DAQ framework with components running in the same network

- One RunControl
- One (optional) LogCollector
- One Producer per hardware device
- One to many DataCollectors to store data
  - → Event-id sorted
  - → Trigger-id sorted
  - → Unsorted
- Optional Monitor



EUDAQ2 paper

User: MyFancySensorProducer and MyFancySensorRaw2StdEventConverter

Part I: EUDAQ2 in a nutshell

Installing the software

```
# if not yet done clone the repository for the tutorial
git clone https://github.com/lhuth/bttb8_daq_tutorial.git
cd bttb8_daq_tutorial

# driver to talk to the TLU
git clone https://github.com/ipbus/ipbus-software.git
#Follow instructions on https://ipbus.web.cern.ch/ipbus/doc/user/html/software/install/compile.html
# source the download_eudaq script
cd $PATH_TO_BTTB_DAQ_TUTORIAL
source download_eudaq.sh
cd eudaq && mkdir build && cd build
cmake -DUSER_TLU_BUILD=on ..
make install -j4

cd ../..
source scripts/setup.sh
```

If more than two people manage to install it all we are good for the rest of our tutorial

Getting Started

```
cd $PATH_to_EUDAQ/bin
./euRun &

./euLog &
./euCliProducer -n AidaTluProducer -t aida_tlu &
# Any other device can be added later on via
# ./euCliProducer -n <ModuleName> -t <givenName> -r <IP>:<port>
```

Initialize the system

Take a look at the `configs/example.init`, load it and click init

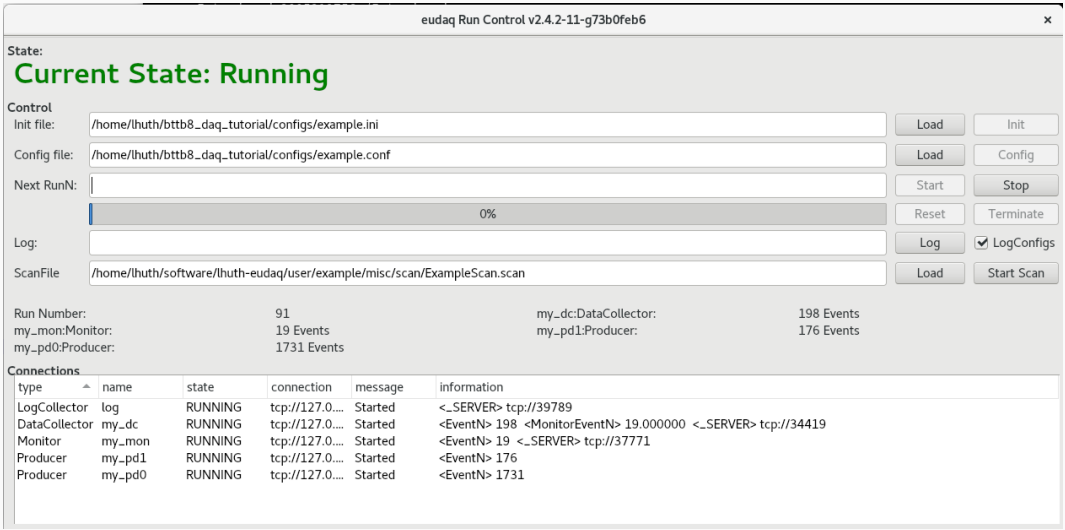
```
[RunControl]
#Nothing to be done here

[LogCollector.log]
EULOG_GUI_LOG_FILE_PATTERN = myexample_$12D.log

[Producer.my_pd0]
EX0_DEV_LOCK_PATH = /tmp/mydev0.lock

[Producer.my_pd1]
EX0_DEV_LOCK_PATH = /tmp/mydev1.lock
```

Configure the system

Take a look at the `configs/example.conf`, load it and click conf

```
[RunControl]
EX0_STOP_RUN_AFTER_N_SECONDS = 60
EUDAQ_CTRL_PRODUCER_LAST_START = my_pd0
EUDAQ_CTRL_PRODUCER_FIRST_STOP = my_pd0

[Producer.my_pd0]
EUDAQ_DC = my_dc # used data collector
EX0_PLANE_ID = 0
EX0_DURATION_BUSY_MS = 10
EX0_ENABLE_TRIGERNUMBER = 1
EX0_DEV_LOCK_PATH = mylock0

[DataCollector.my_dc]
EUDAQ_MN = my_mon #monitor that receives data
EUDAQ_FW = native
EUDAQ_FW_PATTERN = run$3R_$12D$X
EUDAQ_DATACOL_SEND_MONITOR_FRACTION = 10

[Monitor.my_mon]
```

Start/Stop a run



Scanning - Automated data taking

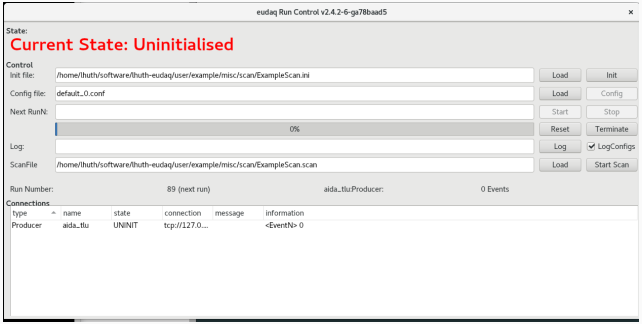
```
[global]
repeatScans = 1
allowNested = 0 # overwrites local nested arguments
#configPrefix = "path/to/folder/scanned" // optional
timeBasedScan = 1 # 1 = true :)
timePerStep = 10 #in second
nEventsPerStep   = 200

[0]
default = 0
start = 1
stop = 2
step = 1
name = Producer.my_pd0
#eventCounter = Producer.my_pd0
parameter = EX0_PLANE_ID

[4]
nested = 1
default = 0
```

Part II: The AIDA Trigger Logic Unit

Getting started

- We need be two groups from now on
- And we need one laptop that connects to the TLU network
- Each team will have one TLU
- TLU-IP: 192.168.200.30
- Laptop-IP: 192.168.200.1
- Try to ping the TLU
- Start EUDAQ+TLU

```
cd $PATH_to_EUDAQ
./startup_tlu.sh
```



Initialize the TLU

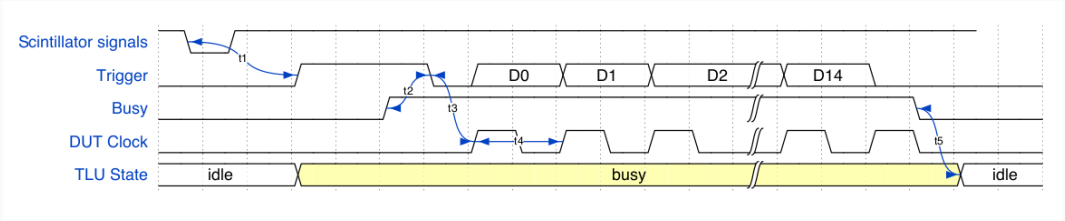
```
[Producer.aida_tlu]
# you can use this to track your changes, e.g. using the date
initid = 20180925
TLUmod= "1e"
# Path on the PC with TLU Producer and relative path is starting path euRun!
ConnectionFile = "file:///home/lhuth/bttb8_daq_tutorial/eudaq/user/eudet/misc/hw_conf/aida_tlu/aida_tlu_connection.xml"
# ControlHub is recommended for Ubuntu, the name is the name in the conncetion file
DeviceName = "aida_tlu.controlhub"
#DeviceName = "aida_tlu.udp"


# Set CONFCLOCK to 1 to configure clock, which is necessary after a power cycle
CONFCLOCK = 1
# Path to clock file
CLOCK_CFG_FILE = "/home/lhuth/bttb8_daq_tutorial/hw_conf/aida_tlu/aida_tlu_clk_config.txt"
skipini = 0 # Set skipini to 1, if you want to skip the init-step
```

Configure the TLU

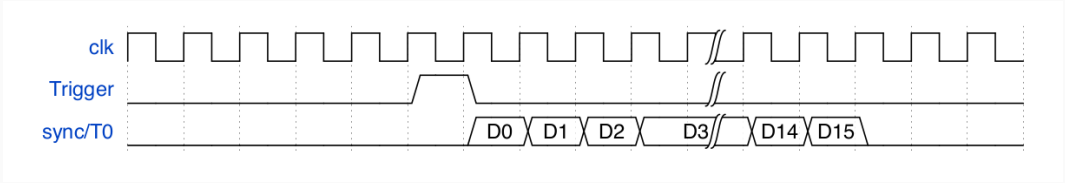
```
1
2  [Producer.aida_tlu]
3  verbose = 0
4  confid = 20181002
5  skipconf = 0
6
7  # delay start in ms
8  delayStart = 0
9
10 ######################################################
11 # DUT IN/OUTPUT
12
13 # Mask: 0 CONT, 1 SPARE, 2 TRIG, 3 BUSY (1 = driven by TLU, 0 = driven by DUT)
14 # EUDET mode: 7
15 HDMI1_set = 0x7
16 HDMI2_set = 0x7
17 HDMI3_set = 0x7
18 HDMI4_set = 0x7
19
20 # same as above for the clock line, 1 = AIDA mode, 2 = FPGA
```

DUT-Inferface modes

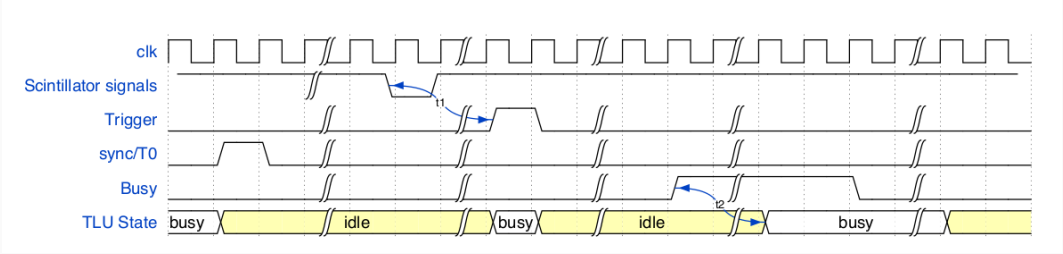
Classical EUDET-mode



Mixed-mode



Full AIDA-mode



Testing the trigger modes I

”Simply” connect the TLU to the signal, configure auto-triggers and study the impact on the oscilloscope. We have two little HDMI to LEMO converters that you can use

Part II-a: Setting trigger thresholds and control voltages

Setting up scintillators

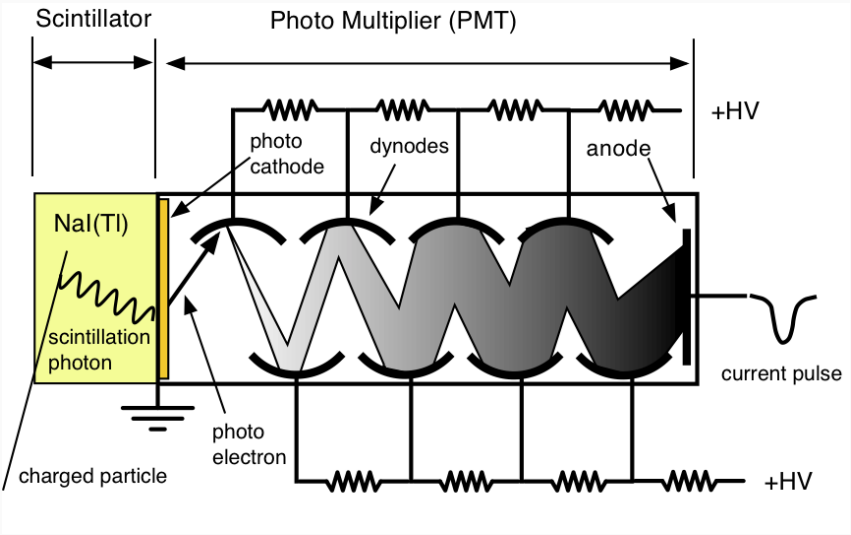
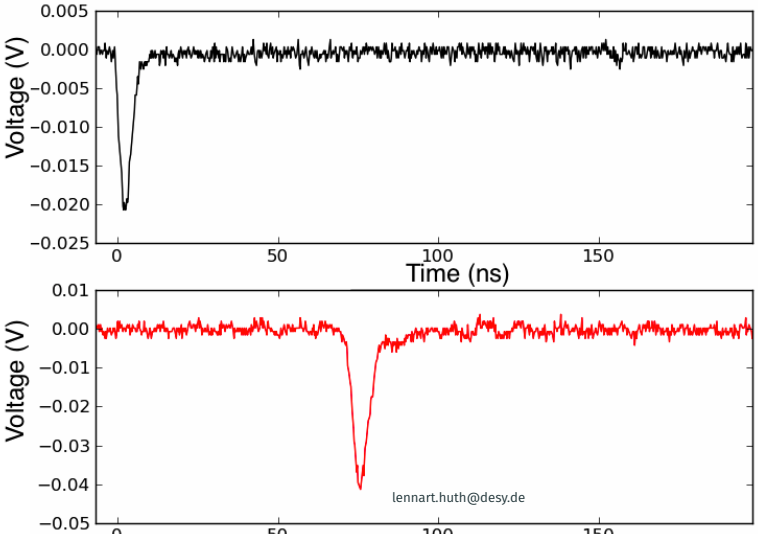


Image credit: http://wanda.fiu.edu/teaching/courses/Modern_lab_manual/_images/PMT.png

Setting up scintillators



lennart.huth@desy.de

Configuring the PMTs

- `PMTX_V` to define the control voltage - ranges from 0-1V and should be 0.8V as a default
- `DACThresholdX` to set the threshold in V, typically 0.04V

```
PMT1_V =0.8
PMT2_V =0.8
PMT3_V =0.8
PMT4_V =0.8

DACThreshold0 = -0.04
DACThreshold1 = -0.04
DACThreshold2 = -0.04
DACThreshold3 = -0.04
DACThreshold4 = -0.20
DACThreshold5 = -0.20
```

Setting valid trigger inputs

The TLU has 6 inputs, resulting in $2^6 = 64$ potential trigger combinations $\rightarrow$ 2 32 bit words for configuration.

Find the configuration to trigger on:

- Only $I_0 + I_1$
- $I_0 + I_3 + I_5$ OR $I_1 + I_4$
- $\bar{I_0} + I_1 + I_3$
- $I_0 + I_3 + I_5$ AND $I_1 + I_4$

Now let's see what the following combinations will trigger on (only LSBs):

- 0x105
- 0xC

Setting valid trigger inputs - solutions

- Only $I_0 + I_1$
- $I_0 + I_3 + I_5$ OR $I_1 + I_4$
- $\bar{I_0} + I_1 + I_3$
- $I_0 + I_3 + I_5$ AND $I_1 + I_4$

- 0x105
- 0xC

Part II-b: Raspberry Pi as DUT

Using the auto trigger

- connect via: `ssh pi@192.168.200.111(113)`
- execute `sudo ./DutDummy 21 <Busy time> 20 0`

Check the rates for different modes with different delays on the raspberry pi