DAQ status and perspectives

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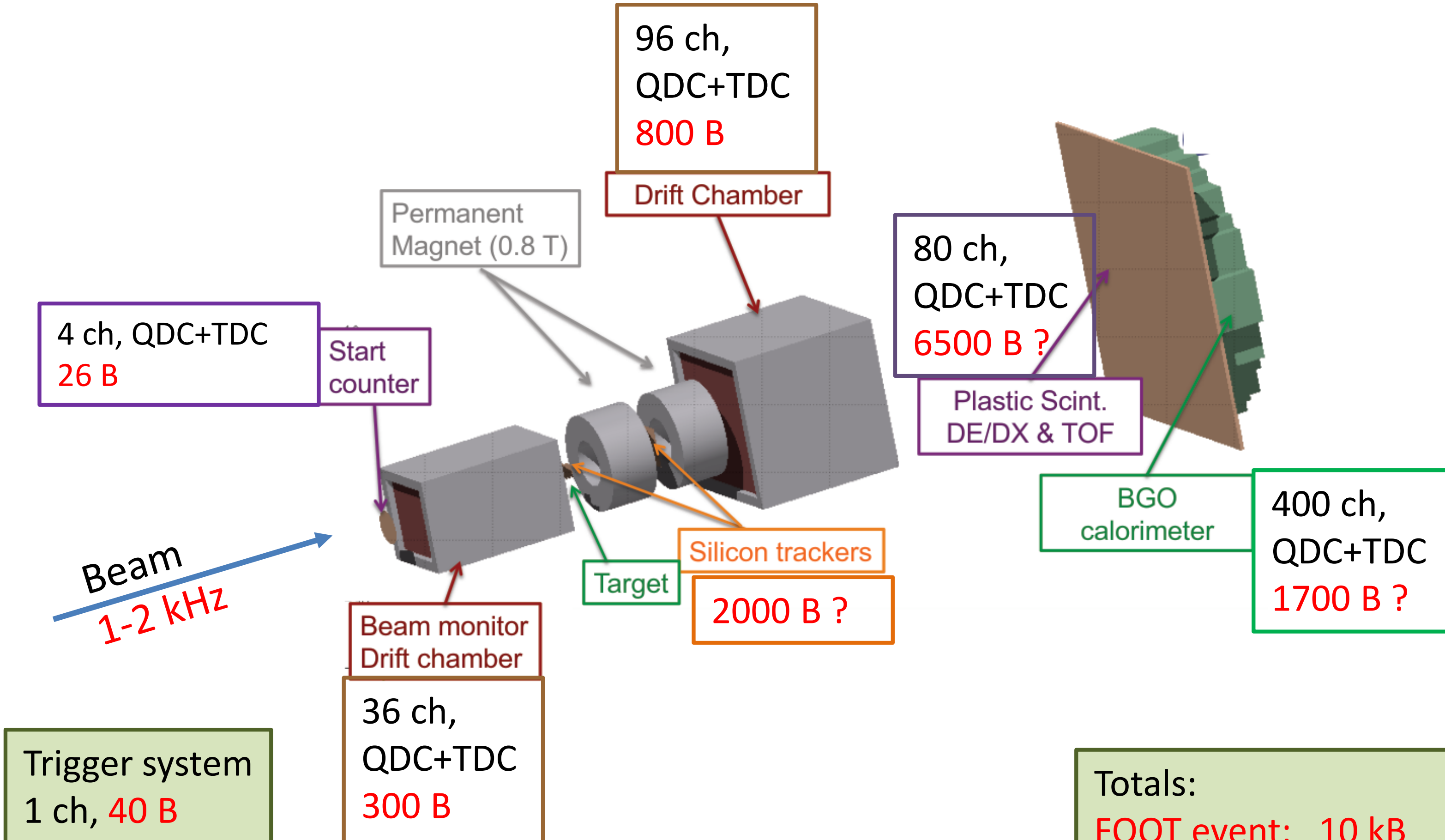
Outline

- TDAQ Structure
- Current status
- Next steps
- CDR (needs your checks!)

Know your system



Totals:
FOOT event: 10 kB
Trigger rate: 2 kHz
Bandwidth: 20 MB/s

+50 -70% uncertainties!

DAQ Structure (desired)

- Distributed system with
  - 1 run control PC: DAQ control, shifter PC
  - 1 main storage PC: event building and final storage
    → (special PC!)
    - Collects data from optical fibers & eth; writes on a RAIDx NAS
  - 1 main monitoring PC: system-wide monitoring
  - N sub-detector monitoring PC
    - Subdetector specific; Provided, used and controlled by subdetector groups
  - 1-2-3 VME Crate (6U/9U) for electronic board readout (a 64 bit Single Board Computer on board)
  - 1 optical fiber infrastructure
  - 1 ethernet infrastructure for DAQ

Shown in Milano
30/11/2016

TDAQ Next steps

From now till end of 2017

Done or almost done

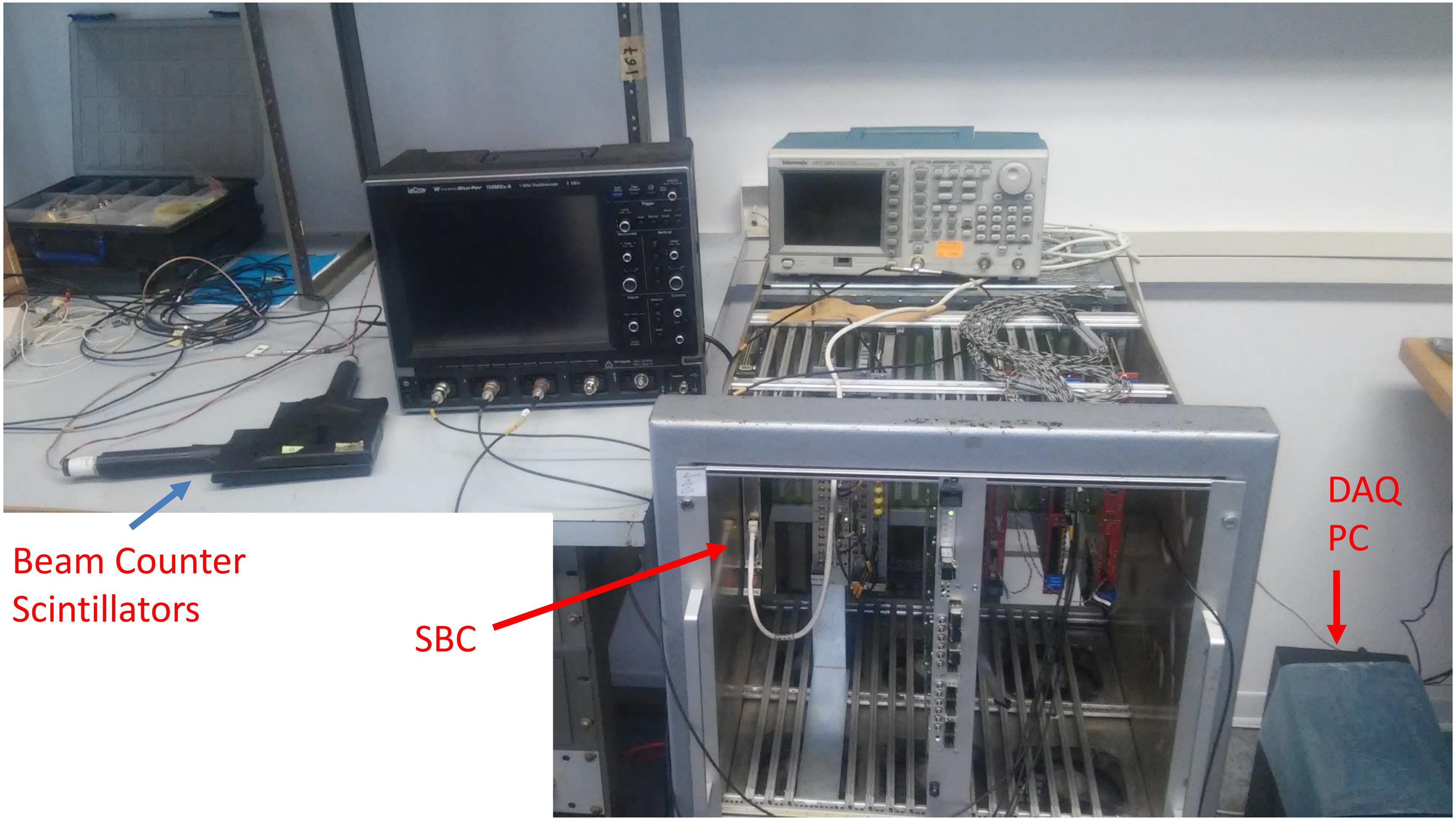
- SW installation:
  - SLC6, TDAQ, MYSQL, elog, LibreOffice/OpenOffice, ROOT, gcc, python, …
- Simple TDAQ system configuration
  - TDAQ, MYSQL, elog and much more in standalone
- Software trigger tests
- Procurement of a Single Board Computer for VME
- Firmware and software update for caen 2495 trigger module
- Software update for FADC, TDC, QDC CAEN
- Tests in hardware trigger mode on cosmics and pulsed events
- First «simple» data taking
- MIMOSA Chip simulation in DAQ
- DAQ from fiber and ethernet sources
- Other device integration in test mode (ideal: 1 piece per detector)
- FOOT monitoring software integration

An initial FOOT DAQ System

- Main PC for data registration
  - 64 bit PC, 64 GB ram, 1 TB raid 1, 1 TB SSD, slot PCI 32 bit, 3 slots PC-express, USB 3.0
- DAQ Control PC

  (control and SW, FW development)
  - PC standard 64 bits, 32 GB ram, 1 TB
- A VME crate with PC
  - PC rented from CERN Pool
  - QDC, FADC caen modules
- Data sources:
  - Scintillators, PMTs
  - Demo boards
  - Trigger module available

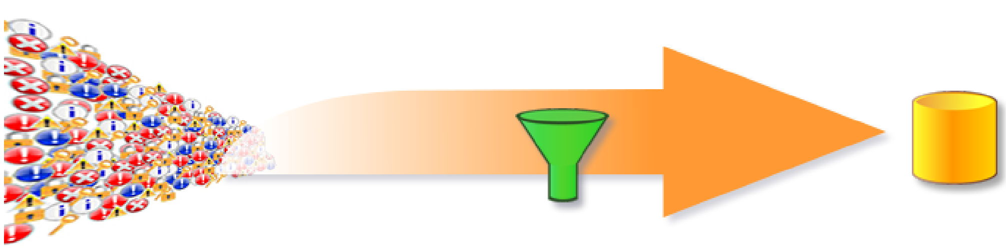
An initial setup

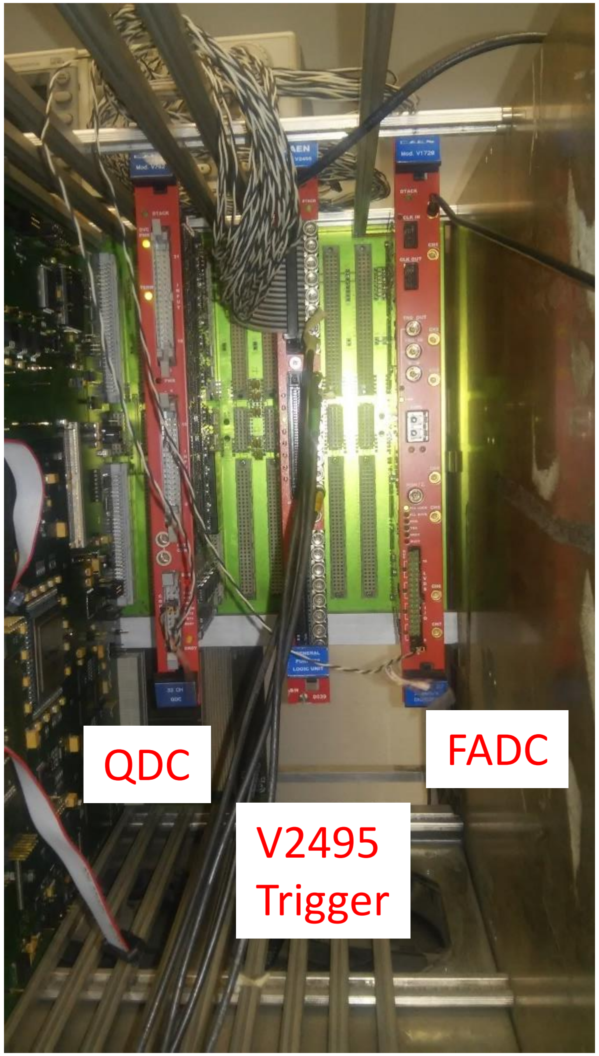


Exercising the system

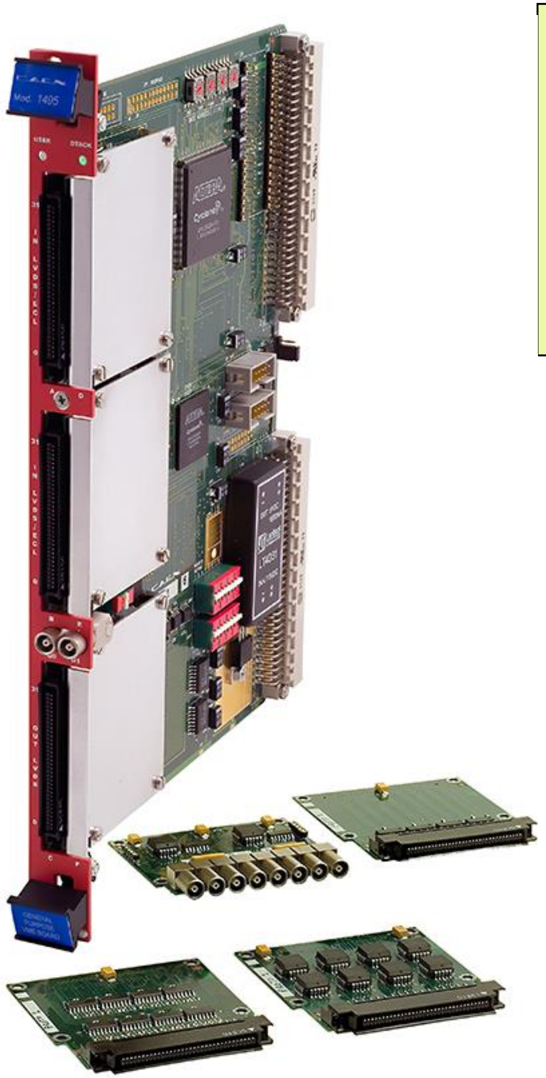
Minimal set-up:
- 2 scintillators for trigger
- Other PMTs for signals
- Trigger Board
- Dummy data fragment providers

Goals:
- Validation of the trigger logic
- Validation of the data fragment collection
- Validation of the event building system





Trigger: CAEN 2495 board



- Generic trigger generation based on 4 PMT signals;
- Handling of **trigger (4)**, **gates**, **busy (36)** and synchronization signals (3- 2 for timing, 1 for DAQ status)

- FPGA project done as bachelor thesis work of A. Savarese (electronic engineering)

VHDL code

- Almost all fully simulated
- 25 entities; 5 klines of code
- 200 MHz clock

Trigger event fragment

From board

```
struct TrgEvent {
  u_int liveTime;
  u_int timeSinceLastTrigger;
  u_int clockCounter;
  u_int eventCounter;
  u_int BCOofTrigger;
  u_int spillNrAndTrgFineDelay;
  u_int PMTsAndBusy;
};
```

- Luminosity/live time information
- Clock ticks since last trigger
- Board clock
- Progressive event number from board
- Time in us from common reference
- More timing info
- PMTs and Busy signals near trigger

From VME SBC

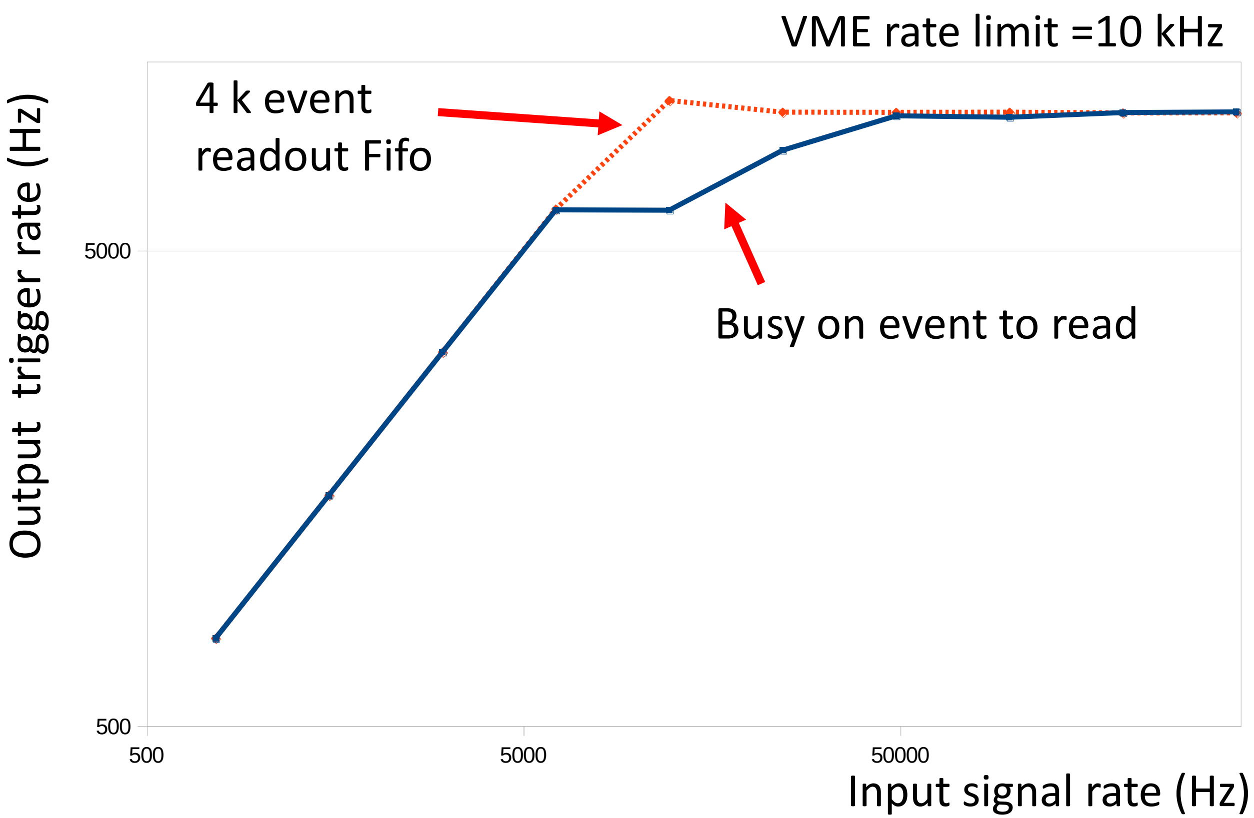
```
Struct TrgEventFragment {
  u_int Nevent;
  time_t  time;
  TrgEvent evt;
};
```

- DAQ progressive event
- CPU time
- V2495 TrgEvent

Trigger tests

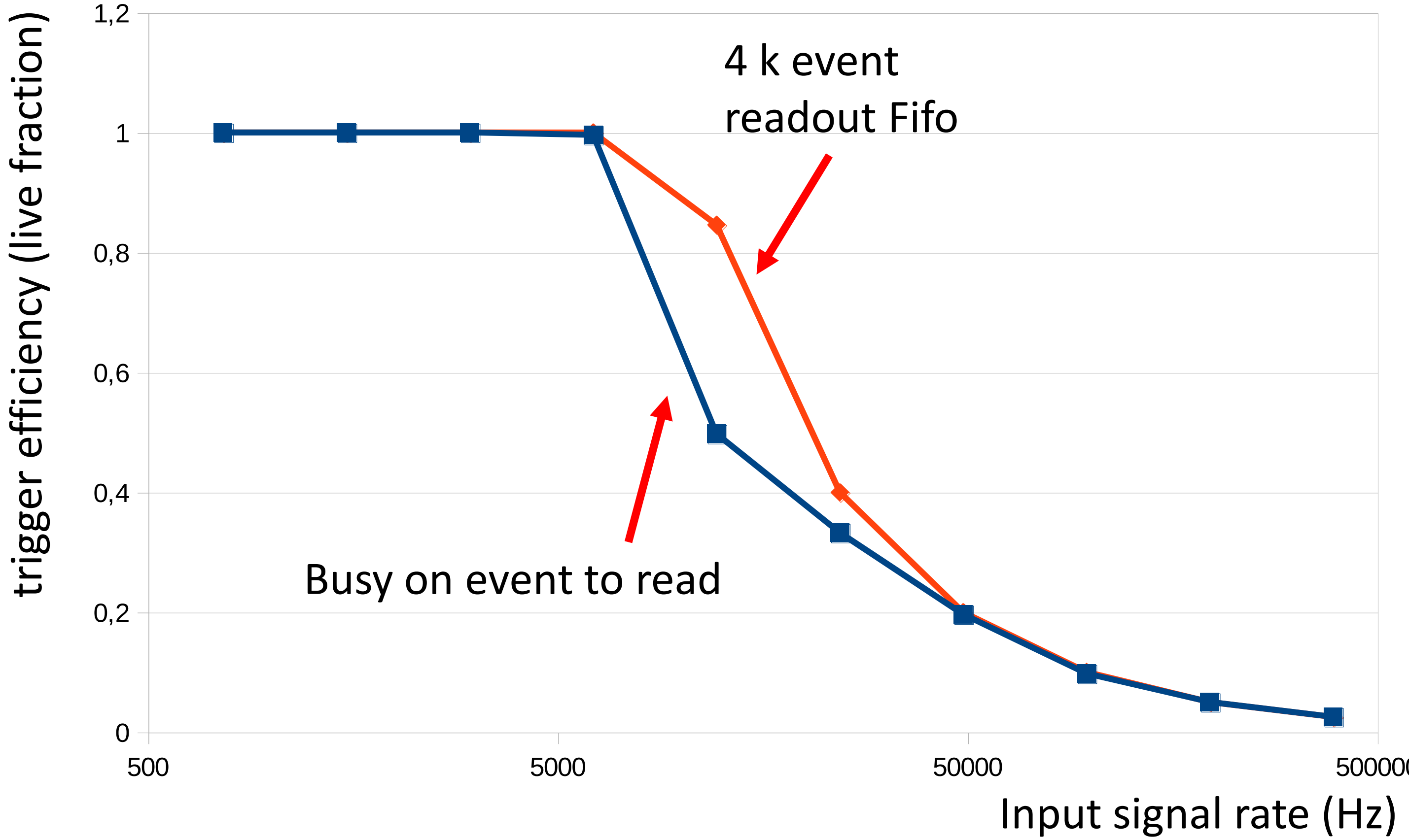
- Tests with pulser without full DAQ system

  VME limits (10 kHz) well above specifications



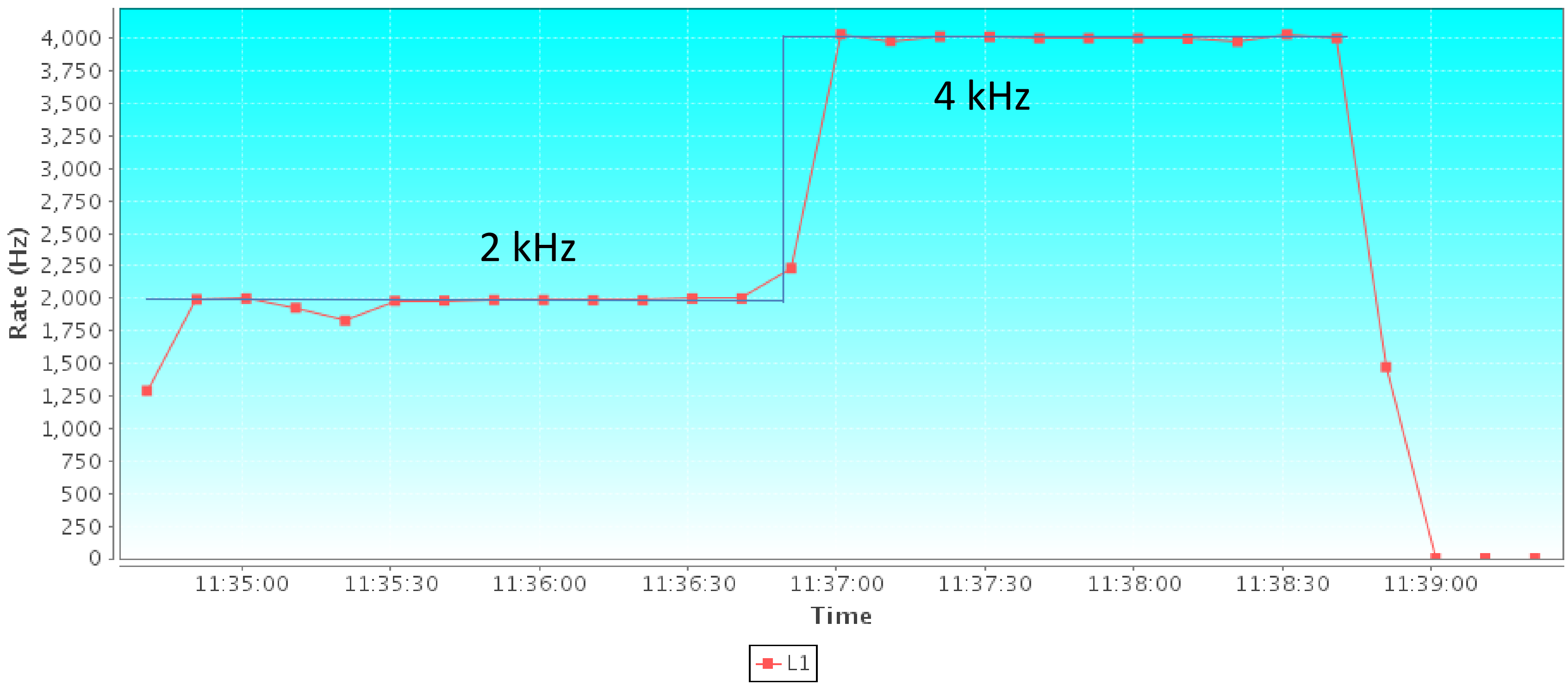
Trigger tests (II)

- Tests with pulser without full DAQ system
- High efficiency up to **6 kHz** input rate
- To be done: Multi-event reading with VME Block transfer



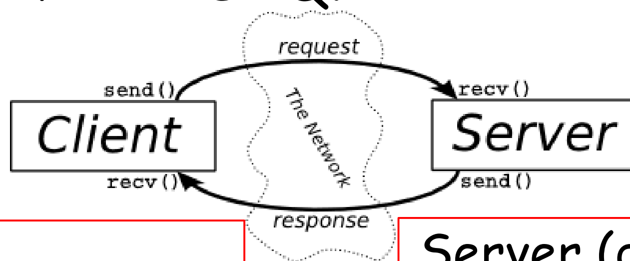
Tests with the full DAQ infrastucture

2 data sources;
2 pulser settings: 2 kHz, 4 kHz
Data collected from a VME crate and a PC are merged on a third PC (400 B/event)



Currently working on

- **Generic DAQ module** for handing ethernet data sources
- Designing a client (FootDAQ) – server (detector side) system to be integrated in the FOOT DAQ.



Client (DAQ):

- Know the detector configuration
- Defines transitions

  idle->configuration->running->stop
- Configure the server
- Ask for monitoring data
- Received trigger data

Server (detector side):

- Receives the needed configuration parameters
- Receives and responds to global transitions
- provides monitoring data on requests
- Provides trigger data

Trigger Board

- Receives the trigger signal
- Receives sync data
- Provides a busy signal

Currently working on (II)

- The generic DAQ module can then be costumized for different detectors:

  Tracking sistems, De/Dx

Next real application: Vertex detector

To be read with demo boards

Example: DE0-nano-soc

Used by Eleuterio;
One available in BO for tests

FPGA+ Arm Cortex A9

1 GB ram
1 GB/s ethernet
40 GPIO pins
1 micro SD (4-8-32 GB)
Yocto Linux on board

On this part:
Enrico Vezzali
(bachelor thesis
on electronic engineering)

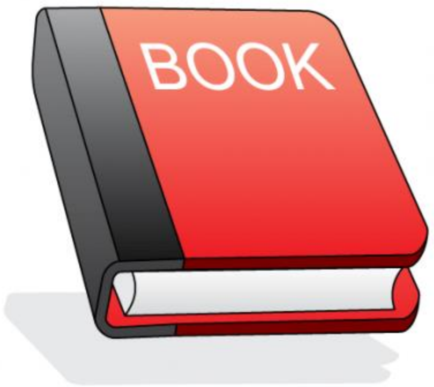
Silvia Biondi
(post-doc)

TDAQ Next steps

From now till end of 2017 (not in order)

- Purchase of 2 Single Board Computers for VME
- Software update for TDC, QDC CAEN
- Reading of RAW files and interface with reco software
- Generic DAQ module
- MIMOSA Chip simulation in DAQ
- Performance improvements: VME Block transfer, optic fibers
- Other device integration in test mode
  - If not standard, a copy of the sub-det system is needed in BO- (ideal: 1 piece per detector)
- Tests for performances and realiability of week-end long runs
- SW installation: Elog
- Simple TDAQ system configuration: MYSQL, elog
- FOOT monitoring software integration

CDR writing - 2.5/3 pages



TDAQ is described in the CDR.
Only 2.5 pages.
A figure is still missing.
Comments are welcomed, expecially on the table below!

Table 1 – DAQ components, rates and bandwidths.

Detector	Board(s)	DAQ channels	max event rate (kHz)	Event size (bytes)
Trigger	V2495	1	10	40 B
Start Counter	TDC	4	5	26 B
Start Counter	QDC	4	5	26 B
Beam Monitor	TDC	36	5	150 B
Beam Monitor	QDC	36	5	150 B
MIMOSA	MIMOSA28	$5x10^6$	2	450 B
Drift Chamber	TDC	96	5	400 B
Drift Chamber	QDC	96	5	400 B
$\Delta E/\Delta x$	DW	80	2	6.5 kB
Calorimeter	QDC	400	2	1.7 kB
Totale DAQ	Storage PC	-	> 10	10 kB

Conclusions

- Several pieces of the final DAQ system are in place

- Still several parts are missing or not known
  → it's a long way to reach the final point
  → we're keeping several options opened

- Pieces/samples/copies of «non standard» DAQ systems will be needed in Bologna for a successful FOOT DAQ integration.

The end

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