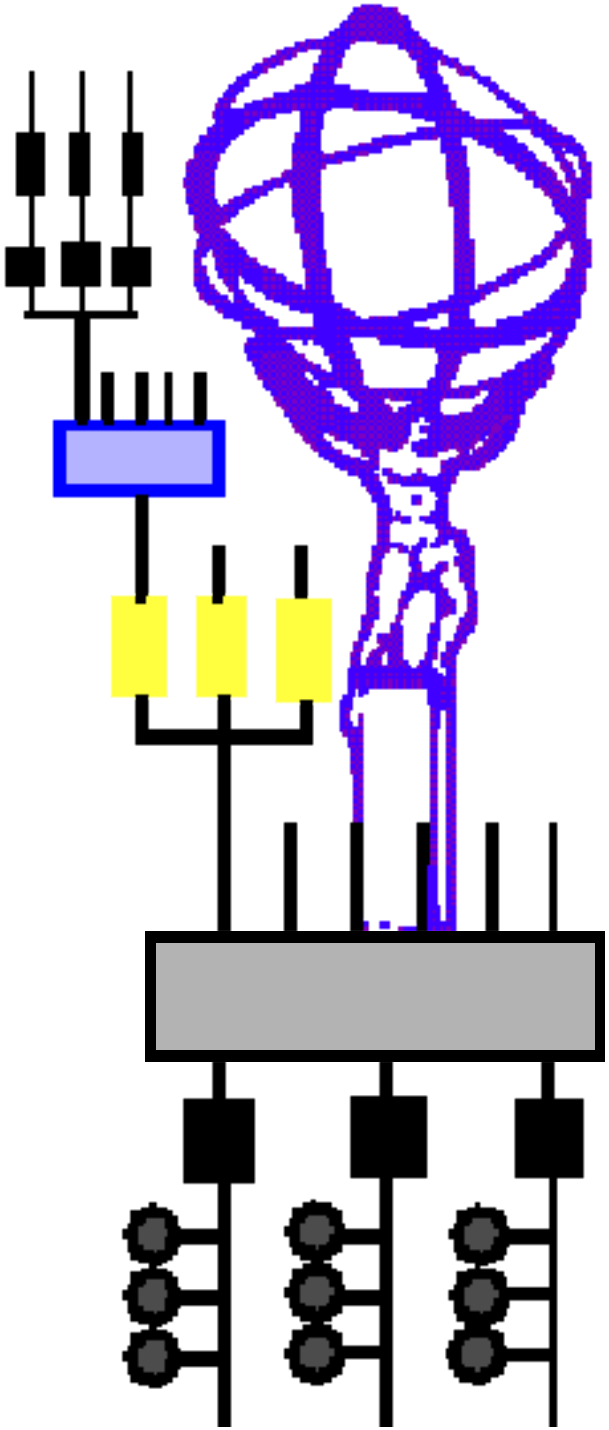
Tests of the ATLAS Trigger and Data Acquisition System

G. Lehmann Miotto, CERN-PH/ATD
on behalf of the ATLAS TDAQ Group



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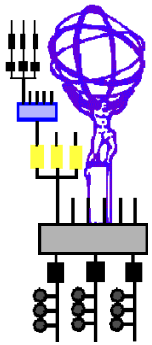
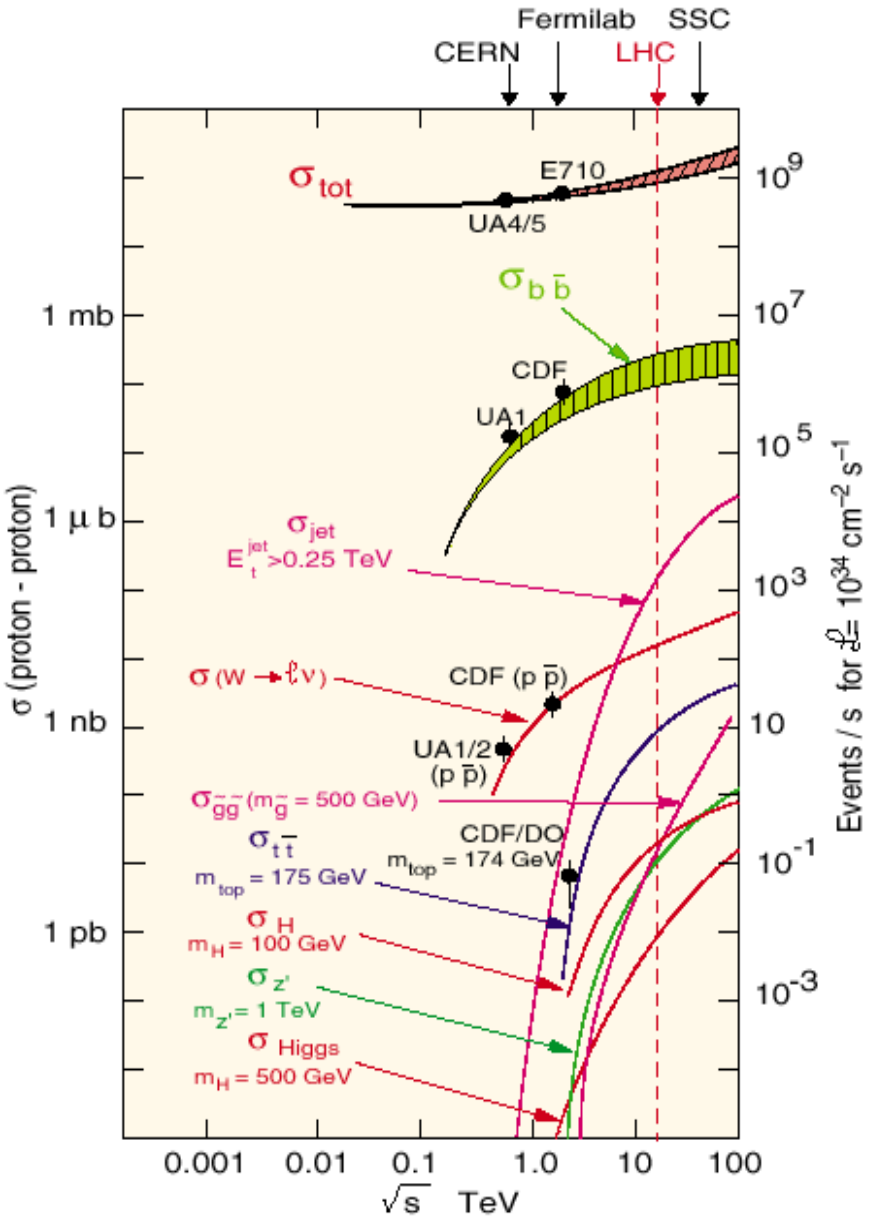
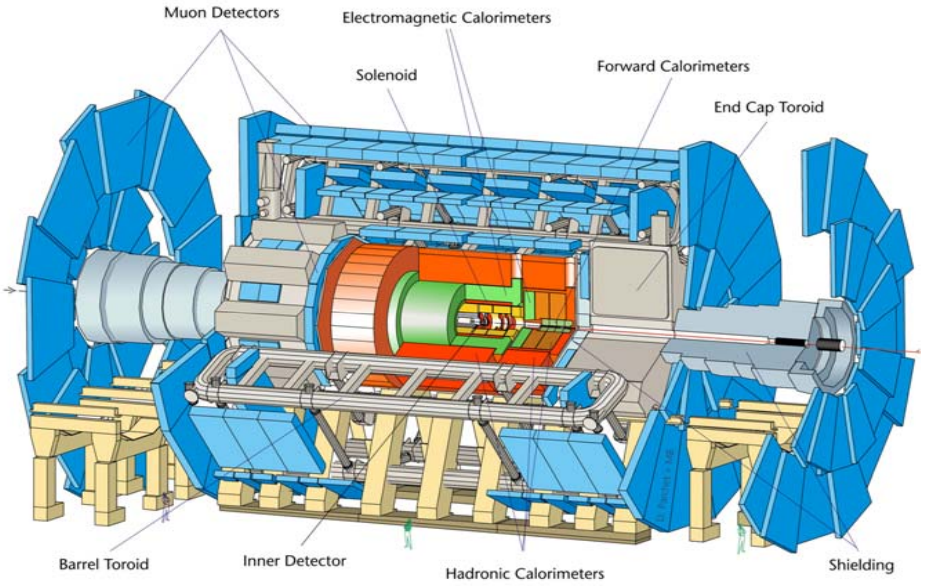
Outline

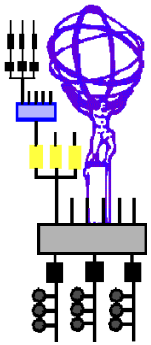


- *Overview of system requirements*
- *The ATLAS TDAQ architecture*
- *Performance and stability challenges*
- *Tests on a large general purpose computer cluster*
- *Tests on purpose build setup*
- *Conclusions*

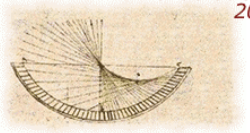
Physics and Detector



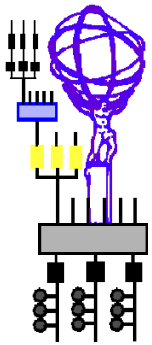




- ***No. overlapping events/25 ns*** ***23***
- ***No. particles in ATLAS/25 ns*** ***1400***
- ***Data throughput at detectors (40 MHz)***
  (equivalent to) ***PB/s***

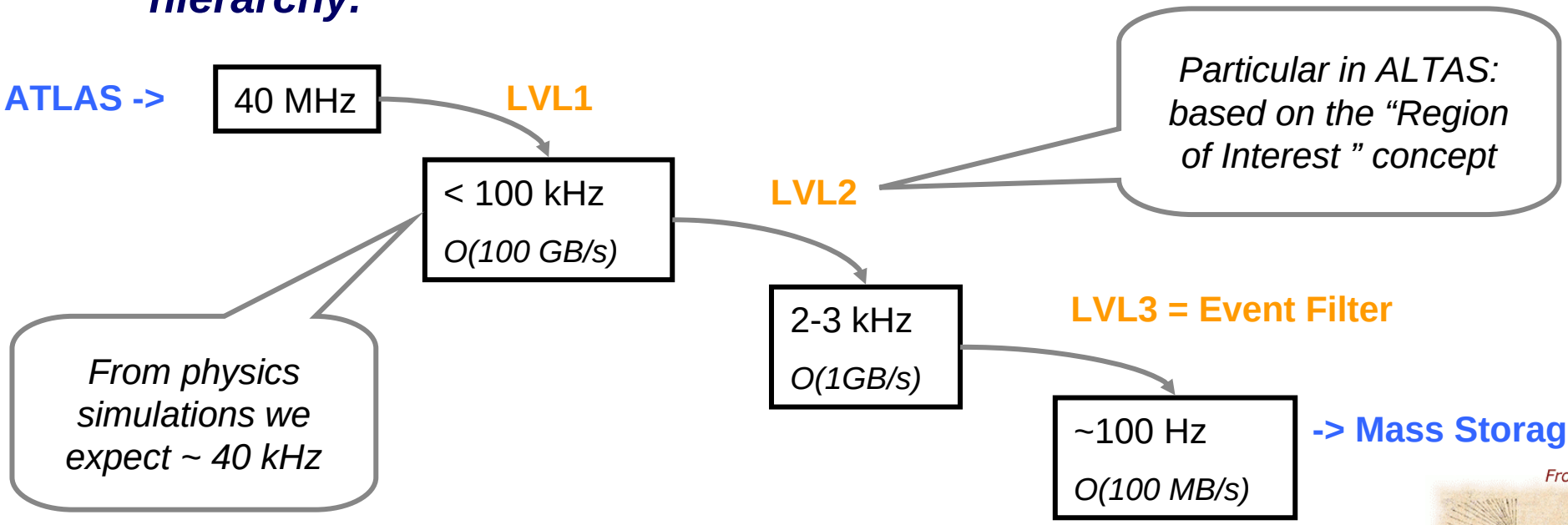


Requirements to TDAQ

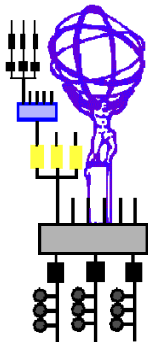


- ***Reduce the amount of data which have to be recorded for offline analysis substantially ($4x10^5$),***
  - **without dropping interesting physics signals,**
  - **nor losing the complete detector information,**
  - **with minimal spending.**

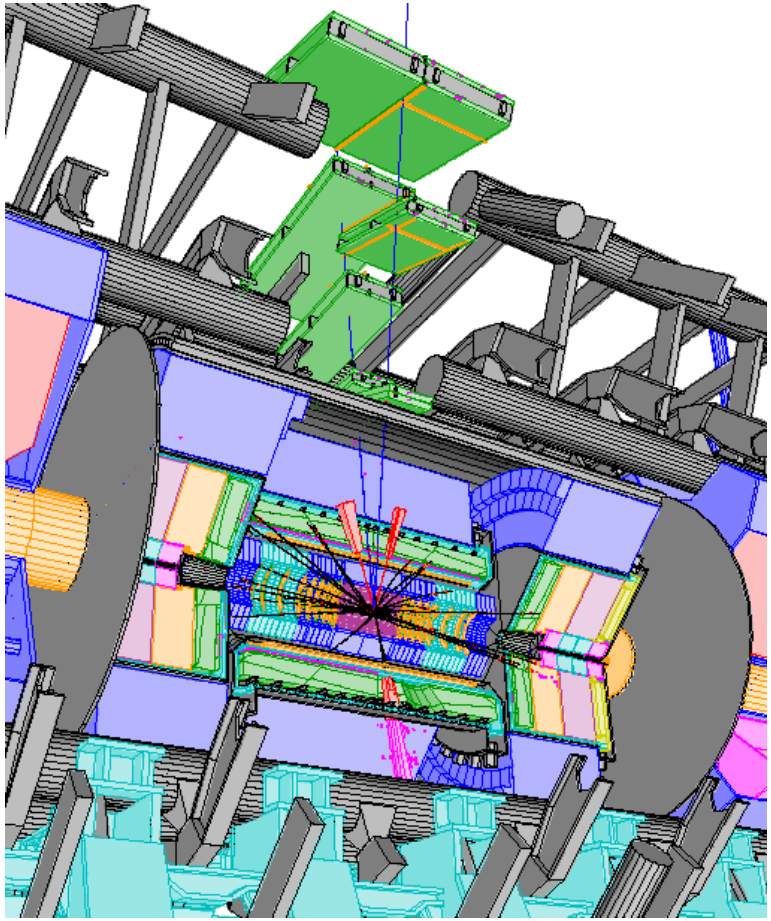
- ***The ATLAS TDAQ architecture is based on a three level trigger hierarchy.***



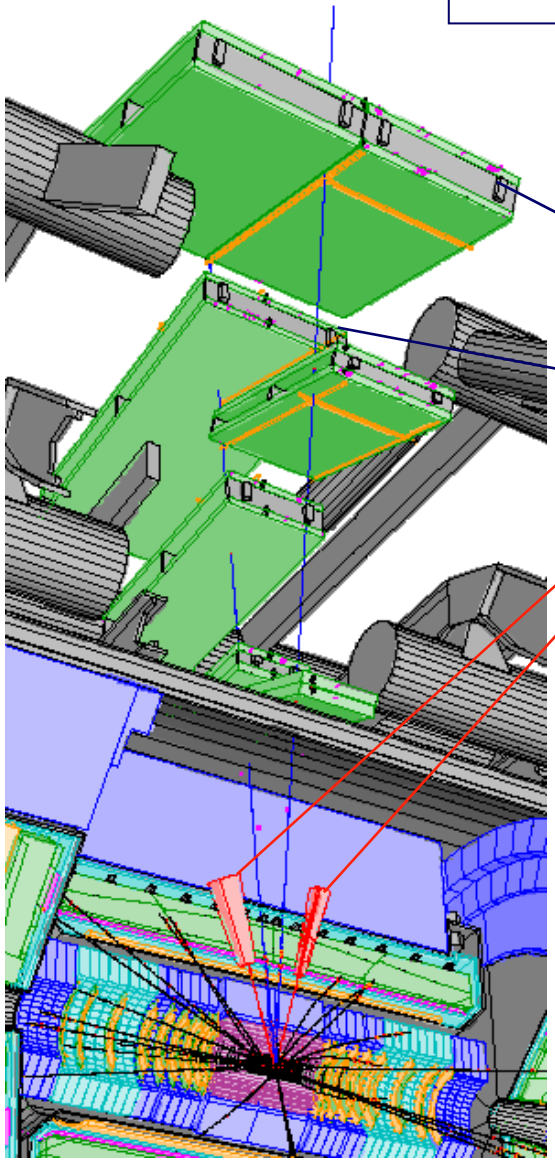
Region of Interest - Why?

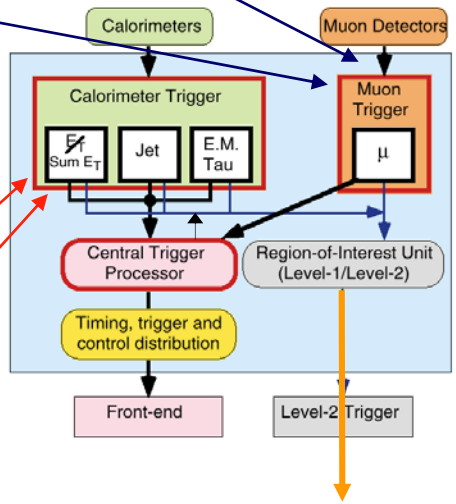


- ***The Level-1 selection is dominated by local signatures***
  - **Based on coarse granularity (calo, mu trig chamb), w/out access to inner tracking**
  - **Important further rejection can be gained with local analysis of full detector data**
- ***The geographical addresses of interesting signatures identified by the LVL1 (Regions of Interest)***
  - **Allow access to local data of each relevant detector**
  - **Sequentially**
- ***Typically, there is 1-2 RoI per event accepted by LVL1***
  - **<RoIs/ev> = ~1.6**
- ***The resulting total amount of RoI data is minimal***
  - **a few % of the Level-1 throughput**



RoI mechanism - Implementation





4 RoI
η- ϕ addresses

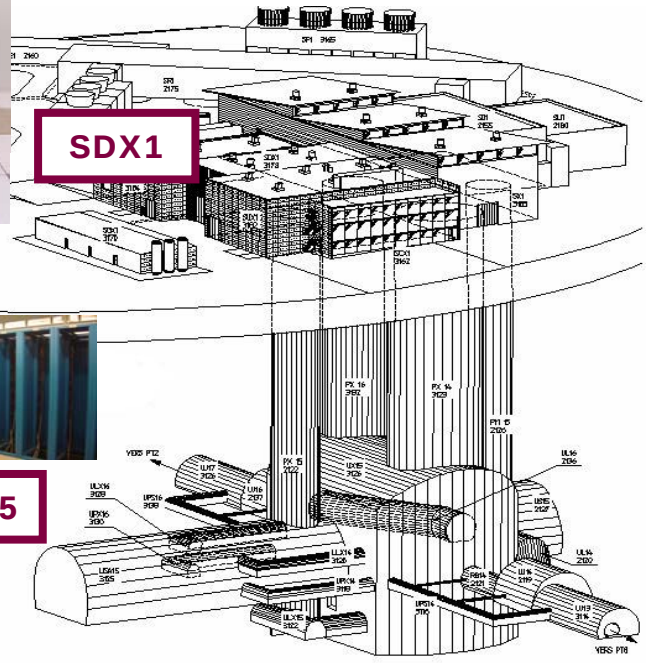
- ***There is a simple correspondence η- ϕ region <-> read-out buffer(s) containing the data***
- ***This mechanism provides a powerful and economic way to add an important rejection factor (> 30) before full Event Building***

--> the ATLAS RoI-based Level-2 trigger

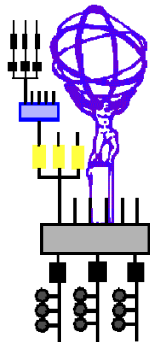
… ~ one order of magnitude smaller ReadOut network …
… at the cost of a higher control traffic …

Note that this example is atypical; the average number of RoIs/ev is ~1.6

ATLAS Trigger / DAQ DataFlow

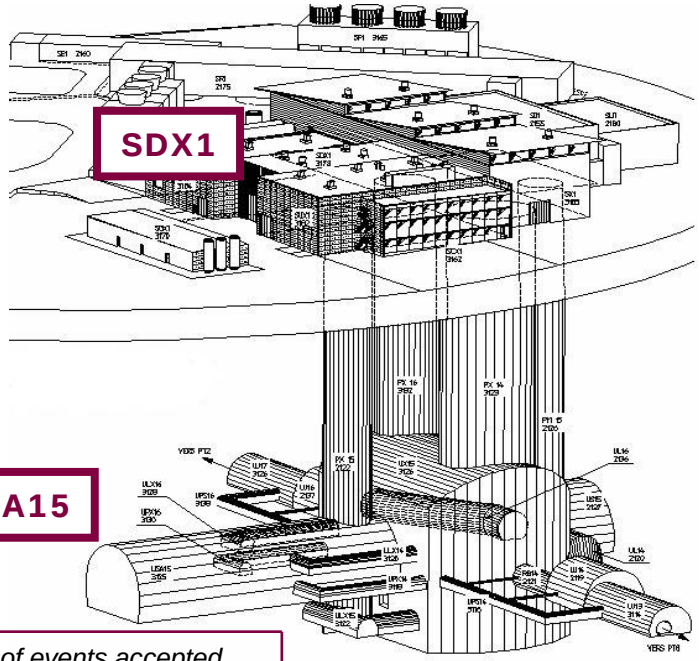


ATLAS Trigger / DAQ Data Flow



Second-level trigger

pROS stores LVL2 output



Requested event data

Event data requests

Delete commands

Gigabit Ethernet

Regions Of Interest

USA15

~150 PCs

1600 Read-Out Links

Data of events accepted by first-level trigger

VME

Dedicated links

Read-Out Subsystems (ROSs)

Read-Out Drivers (RODs)

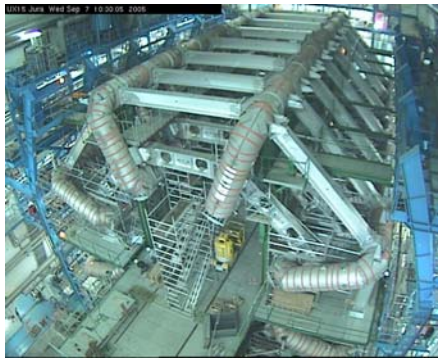
ATLAS detector

First-level trigger

RoI Builder

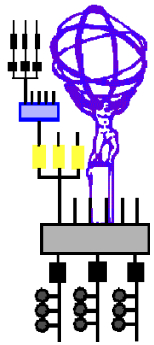
Timing Trigger Control (TTC)

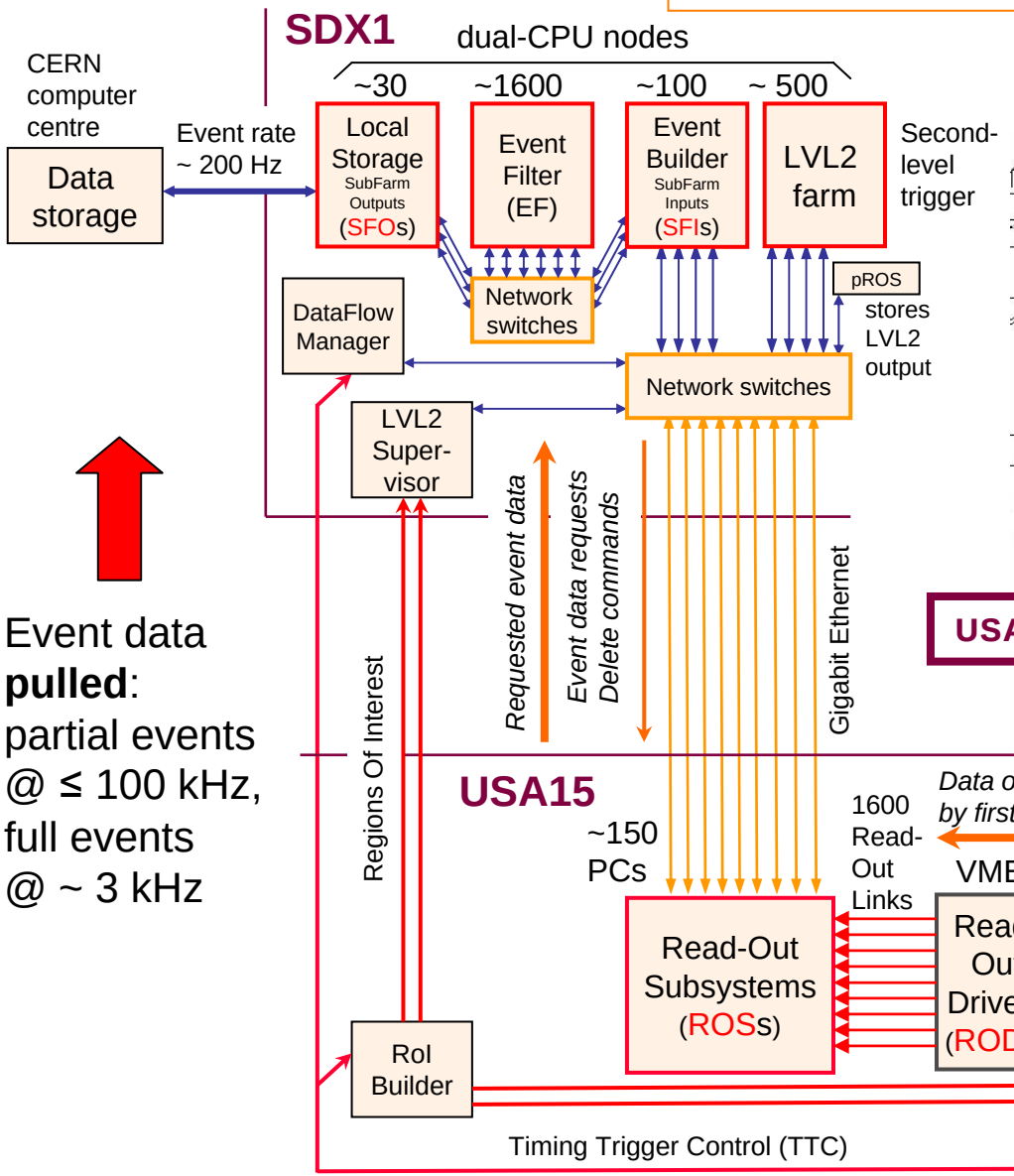
UX15

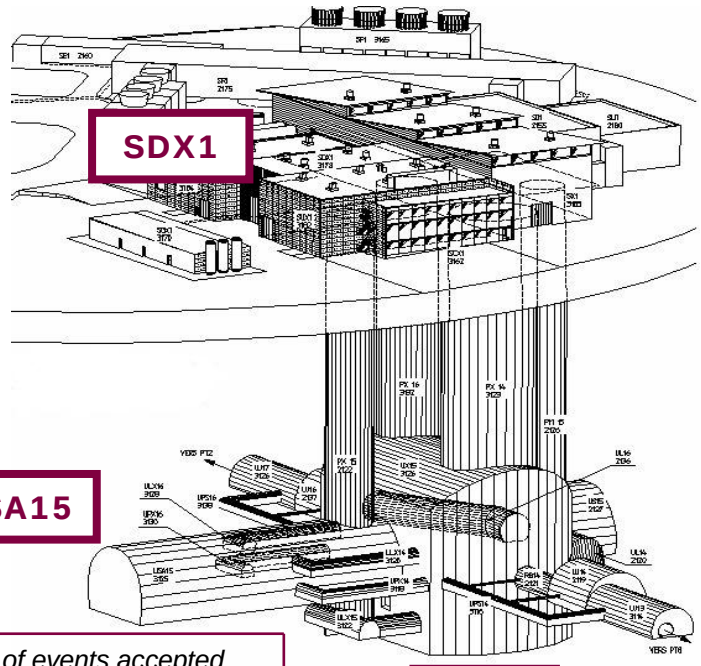


Event data **pushed** @ ≤ 100 kHz,
1600 fragments of ~ 1 kByte each

ATLAS Trigger / DAQ Data Flow



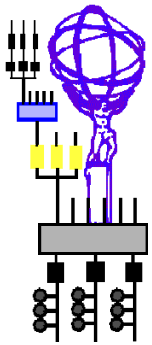




Event data **pulled**:
partial events
@ ≤ 100 kHz,
full events
@ ~ 3 kHz

Event data **pushed** @ ≤ 100 kHz,
1600 fragments of ~ 1 kByte each

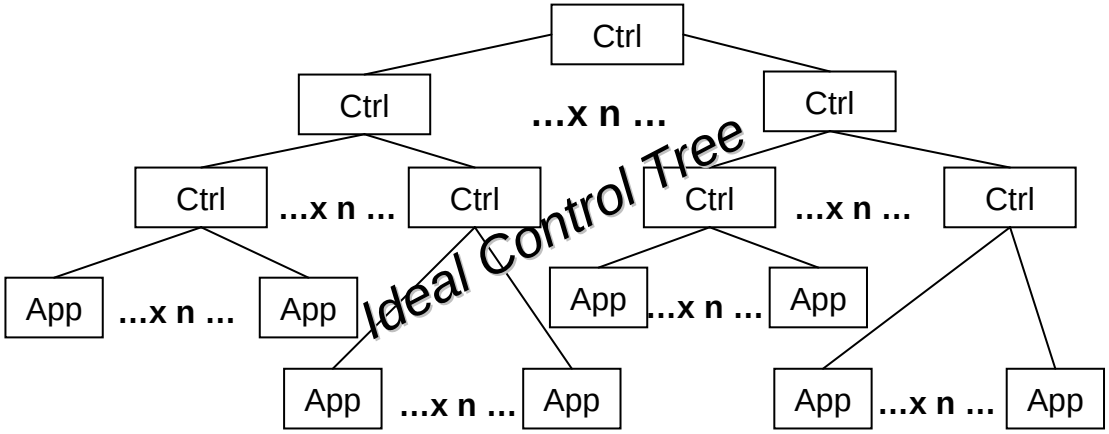
The TDAQ Challenges

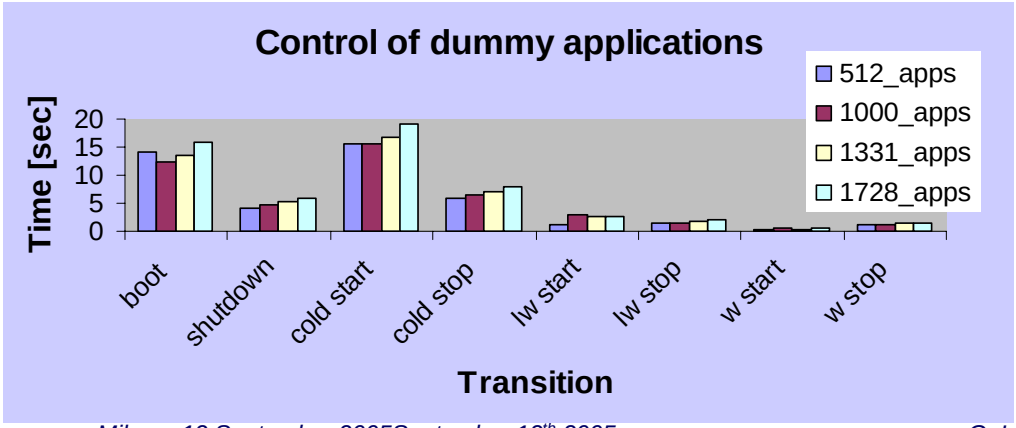


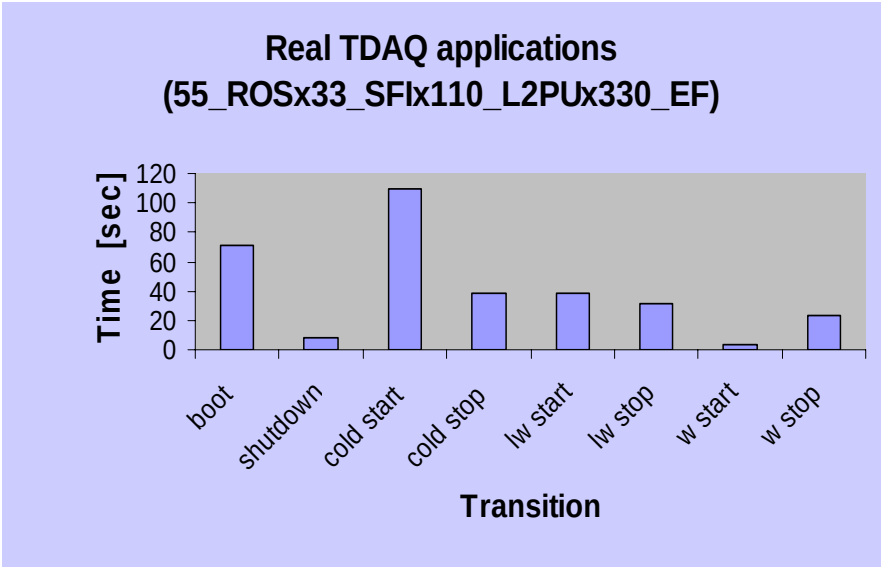
- ***Control and Configuration of a huge distributed and inhomogeneous computing system***
  - **Test software on largest possible computing clusters.**
- ***Performance and scaling of the data flow elements***
  - **Reproduce the ATLAS flow of data on a reduced scale using realistic elements (both computers and networks) in a dedicated laboratory.**

The 2005 Large Scale Tests

- *Use of the CERN/IT lxshare cluster (up to 700 nodes) for 6 weeks*
- *Scope: measure performance of Run Control, Configuration DB, operational monitoring, etc…*

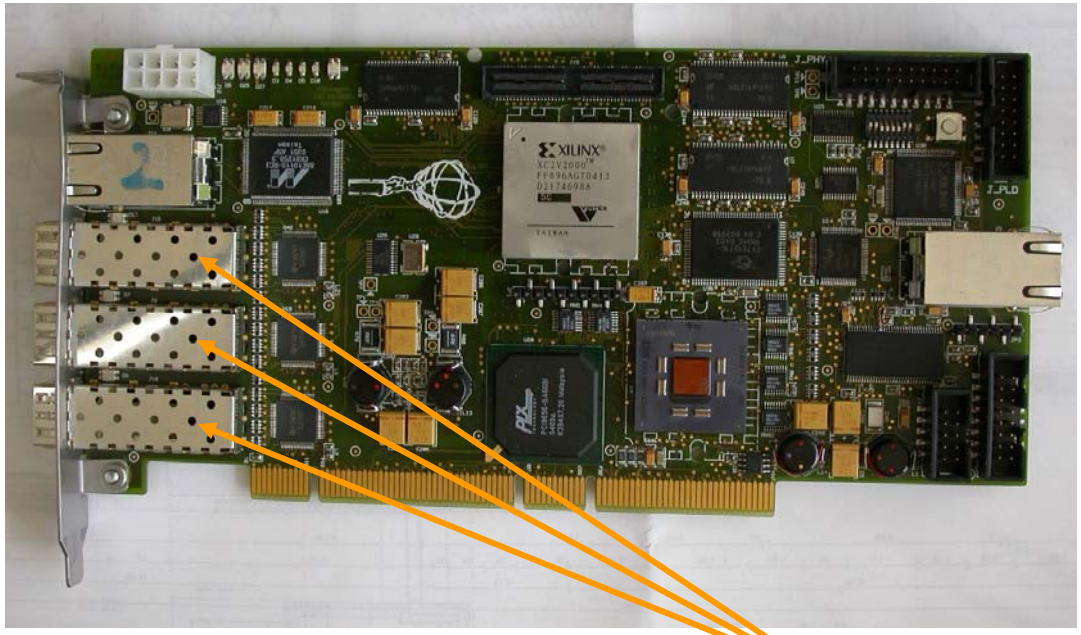




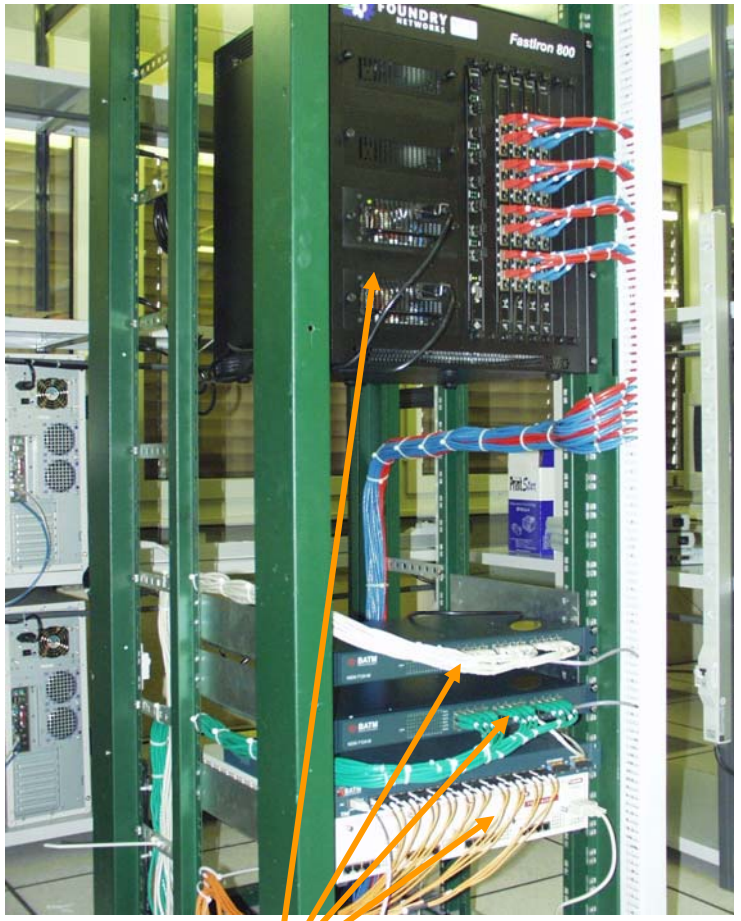


Data Flow Performance on Dedicated HW

- *Use of ATLAS TDAQ test bed at CERN/Bdg-32*
- *Purpose: verify that critical components deliver the requested performance and scale*

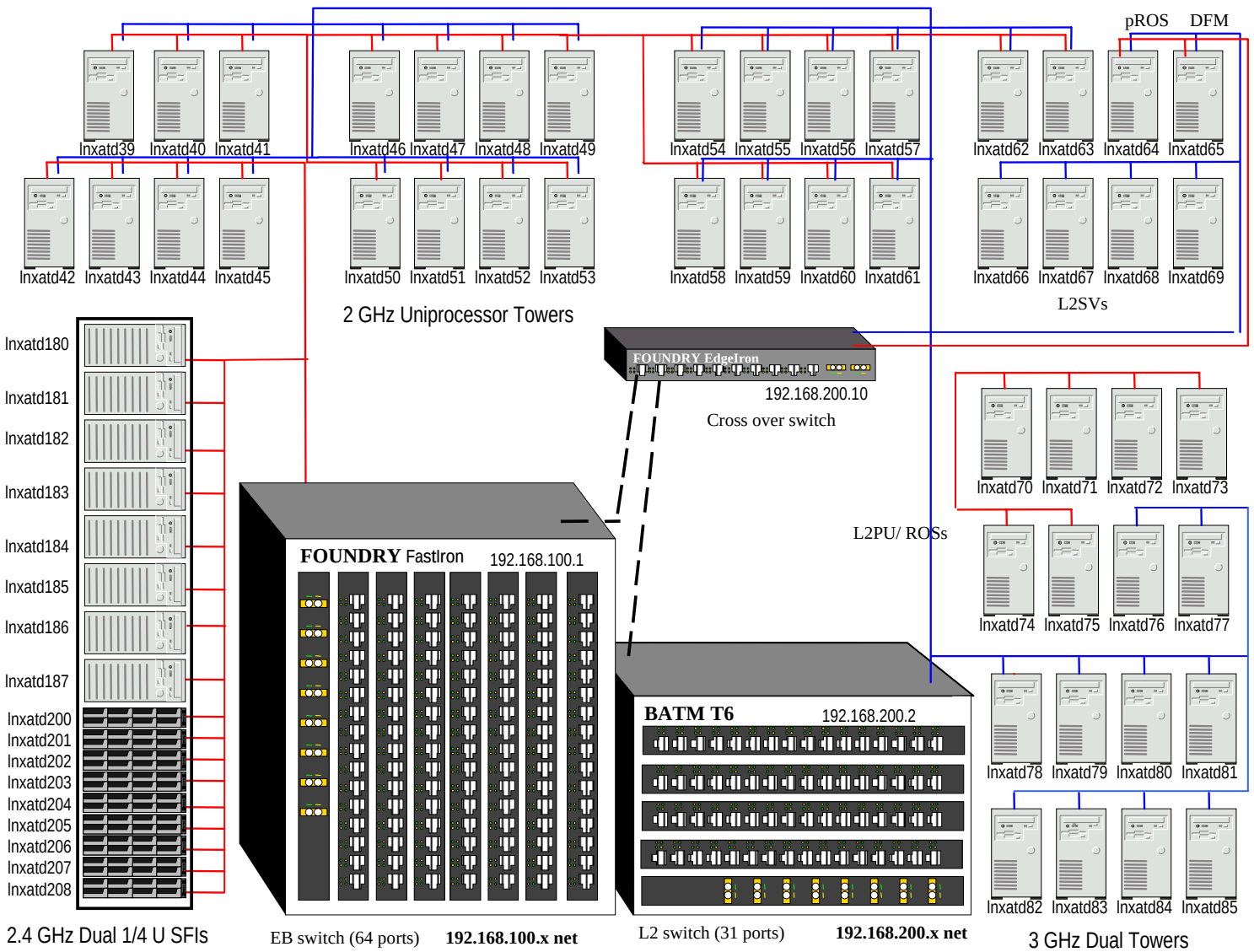


3 read-out buffers on 1 PCI card (4 such cards per ROS PC)



The L2 and EB networks

Layout of Bdg 32 Test Bed



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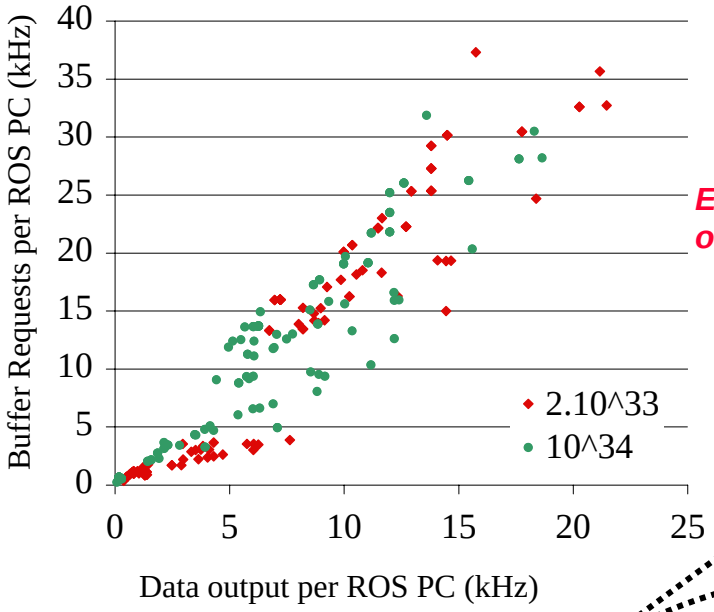
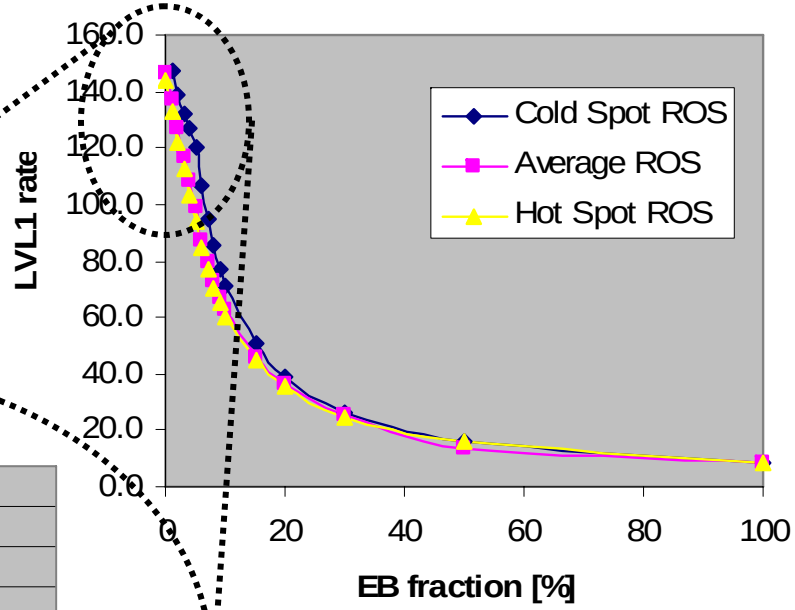
The DAQ Performance

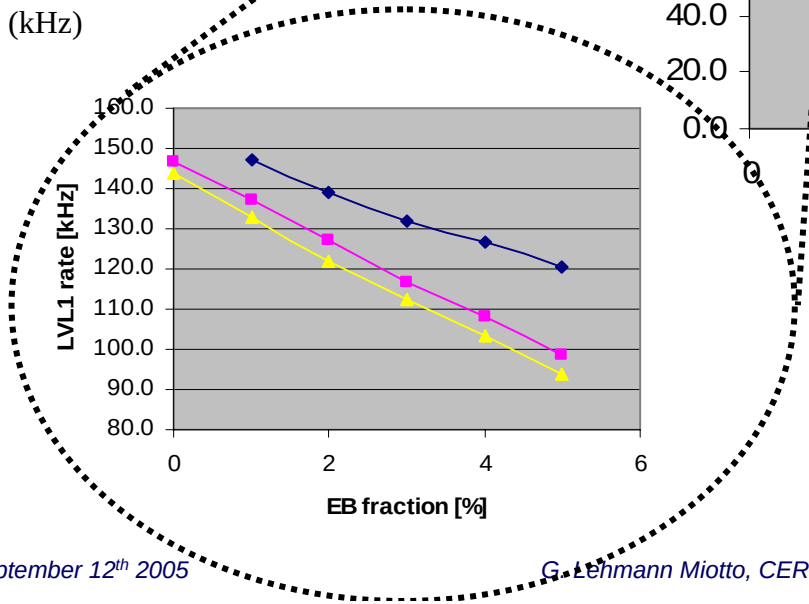
Simulation for first level trigger accept rate of 100 kHz



Each dot represents one of the ROS PCs

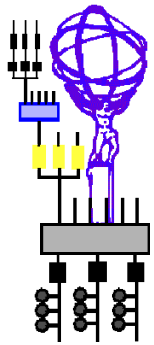
ROS performance as a function of EB fraction





Max LVL1 rate = 100 kHz
EB rate ~ 2-3 kHz

Conclusions



- ***The ATLAS Trigger and DAQ architecture is well established***
  (a prototype implementation is already used for the commissioning of the detector)

- ***Focus is now moved to detailed testing and debugging of all hardware and software components***
  - **Large computer clusters have been successfully used to (im)prove the functioning of the control and configuration aspects of the TDAQ**
  - **A dedicated test bed has been setup to measure and optimize the performance of the critical data flow components**

- ***Routine testing of the TDAQ has been proven to be essential to consolidate and optimize such a large software project***