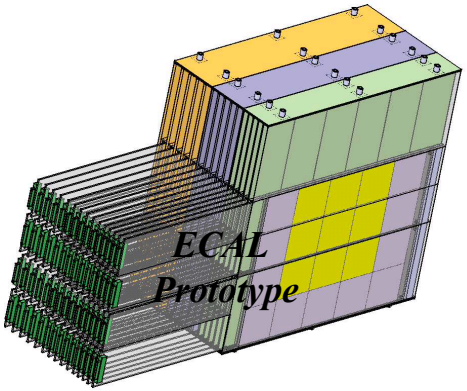
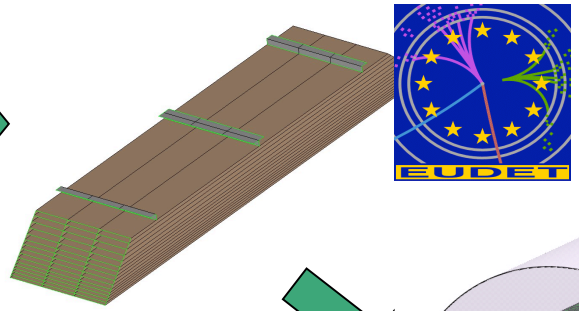
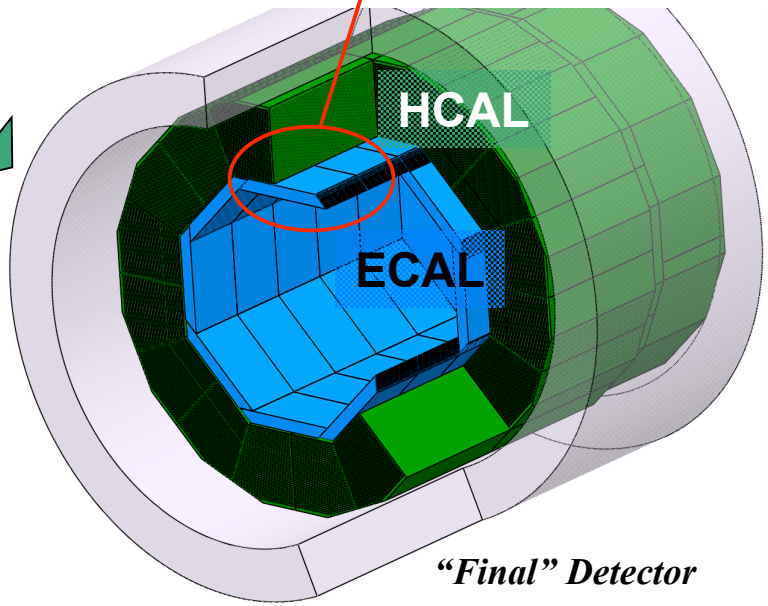
CALICE: status of a data acquisition system for the ILC calorimeters

Valeria Bartsch, on behalf of CALICE-UK Collaboration

ILC Calorimeter



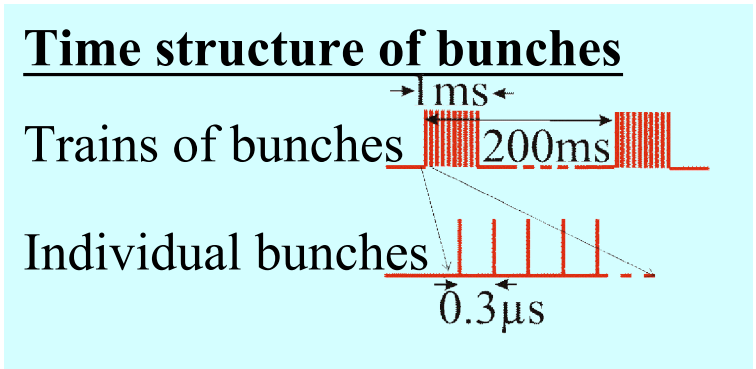




- ILC Calorimetry will use particle flow algorithms to improve energy resolution
  - => 0.5cmx0.5cm segmentation results in 100M channels with little room for electronics or cooling
- Bunch structure *interesting:*
  - ~200ms gaps between bunch-trains
  - Trains 1ms long, 300ns bunch spacing
- Triggerless

=> ~250 GB of raw data per bunch train need to be handled

M. Anduze

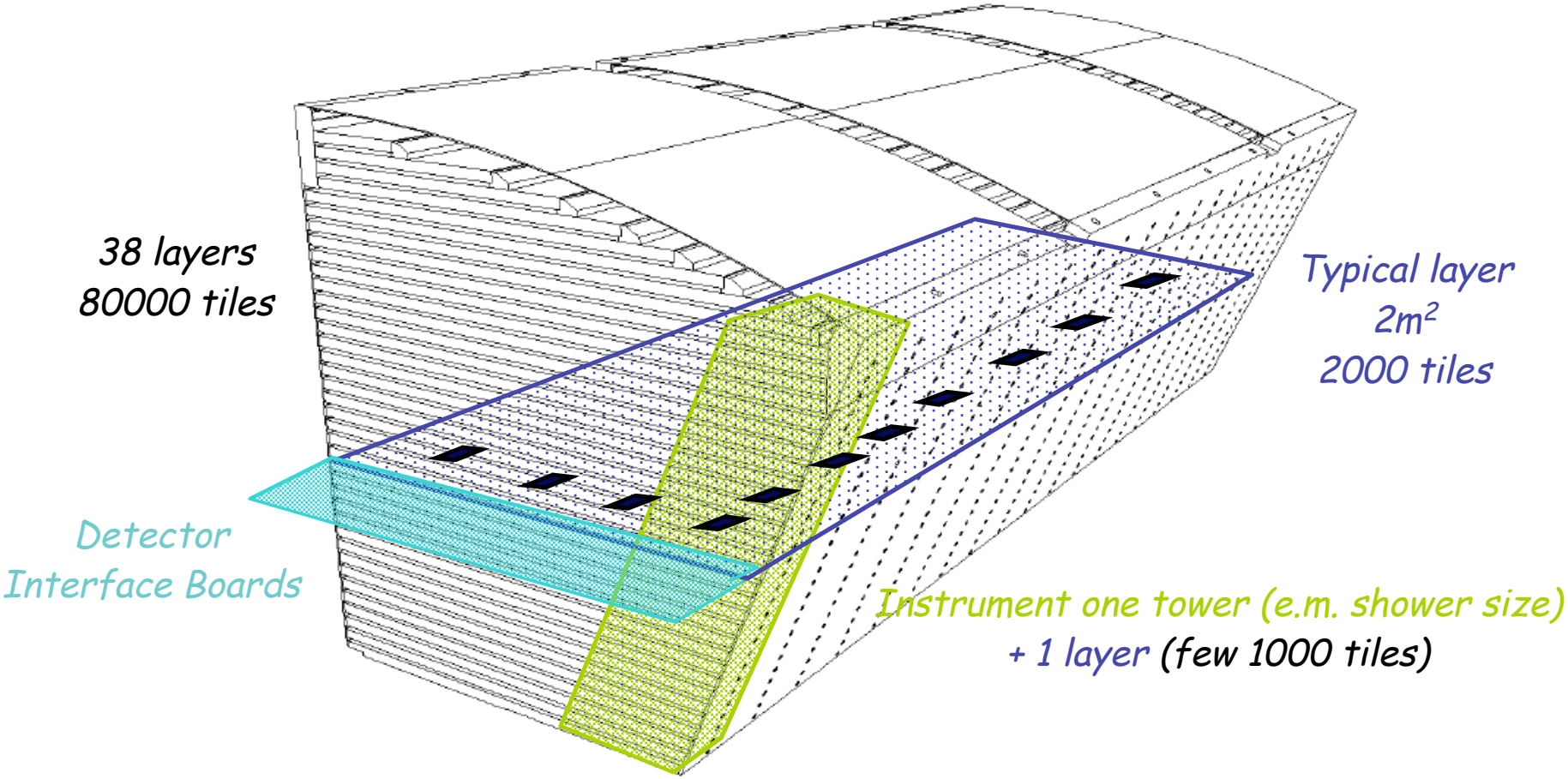


Objectives

- Utilise off the shelf technology
  - Minimise cost, leverage industrial knowledge
  - Use standard networking chipsets and protocols, FPGAs etc.
- Design for Scalability
- Make it as generic as possible
  - exception: detector interface to several subdetectors
- Act as a catalyst to use commodity hardware

⇒**PC-based receiver card is a key component in the generic DAQ design**

EUDET prototype (example AHCAL)



- 3 different detector types: ECAL, AHCAL, DHCAL
- study of full scale technological solutions
- prototype expected end of next year

DAQ architecture

Detector Unit: ASICs

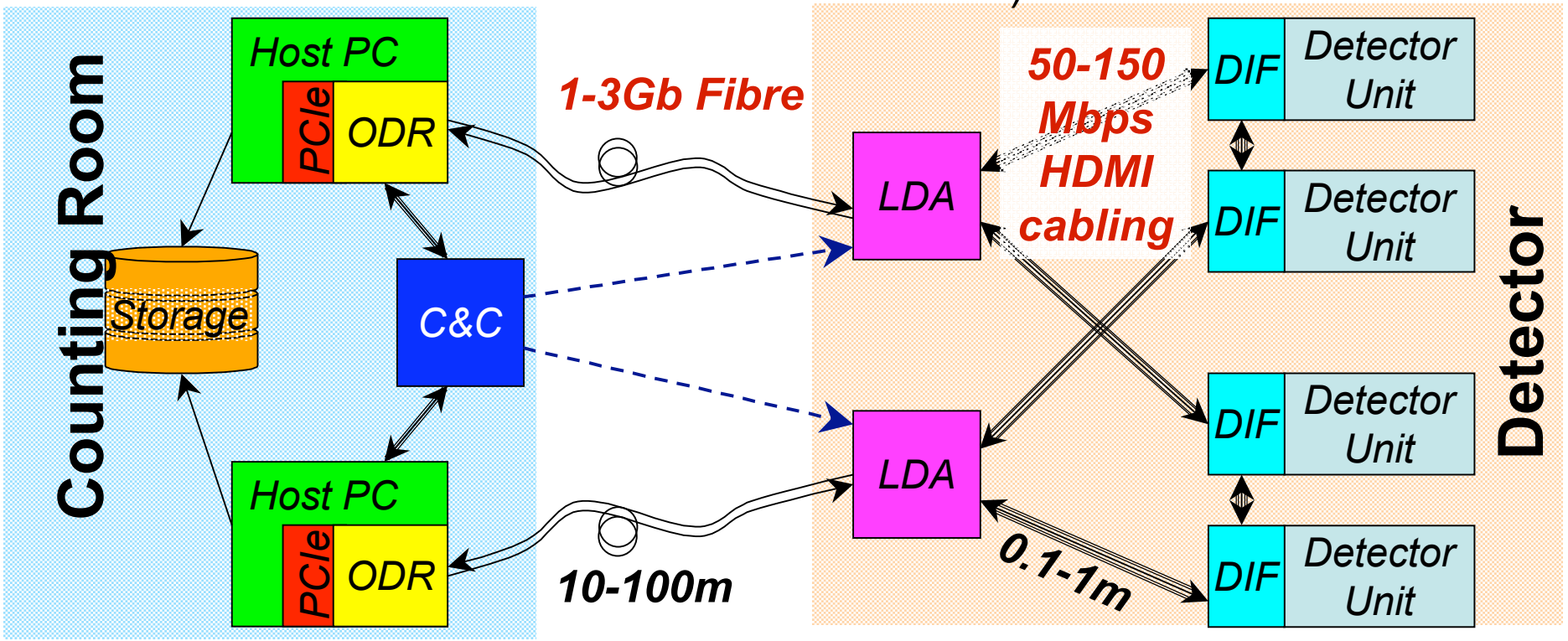
DIF: Detector InterFace connects Generic DAQ and services

LDA: Link/Data Aggregator – fanout/in DIFs and drives link to ODR

ODR: Off Detector Receiver – PC interface for system.

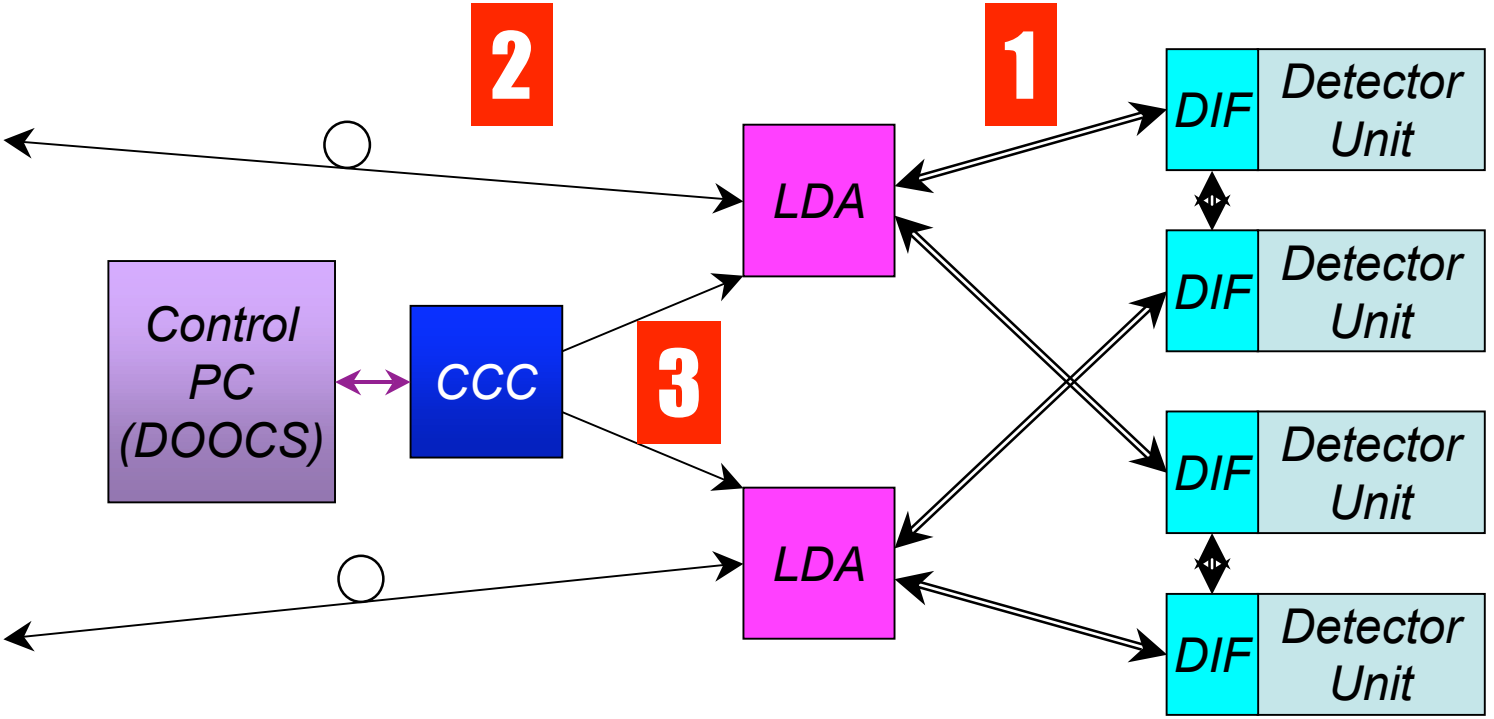
CCC: Clock & Control Card: Fanout to ODRs (or LDAs)

CONTROL PC: DOOCS GUI (run-control)



Links and protocols

1. **DIF-LDA:** 80-160 MHz serial link. 8b/10b encoded synchronous data transfers
2. **LDA-ODR:** Gbit ethernet (or possibly TLK2501) over optical fibre
3. **CCC-LDA:** trimmed version of DIF-LDA link



Detector Interface (DIF) status

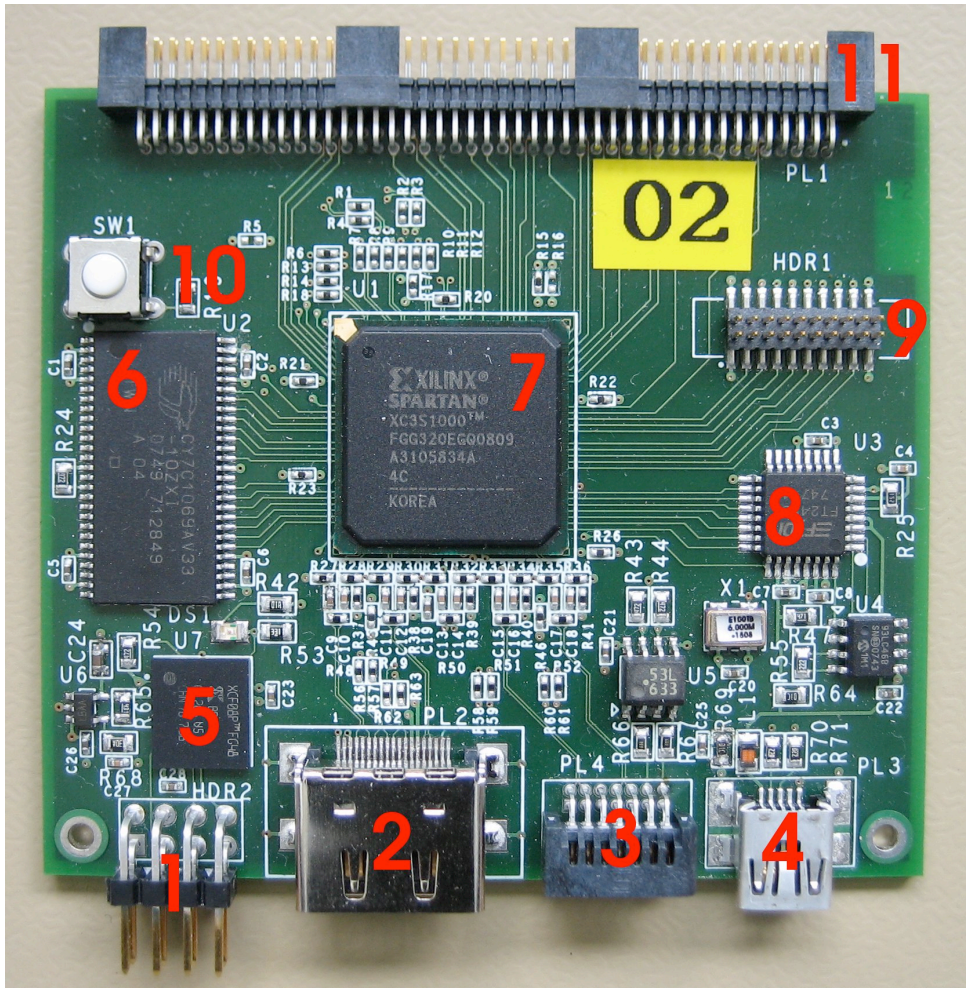
The DIF concept is generic in firmware, running on detector-specific hardware.

Different DIF flavours for ECAL, HCAL

ECAL DIF status:
- Test hardware in place
- Firmware development started

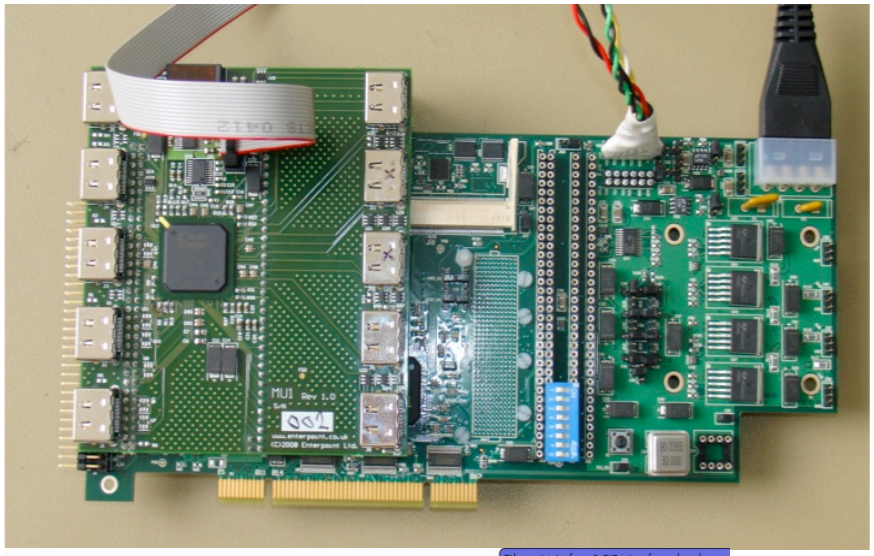
ECAL DIF prototype:
65x72mm, 8 layers

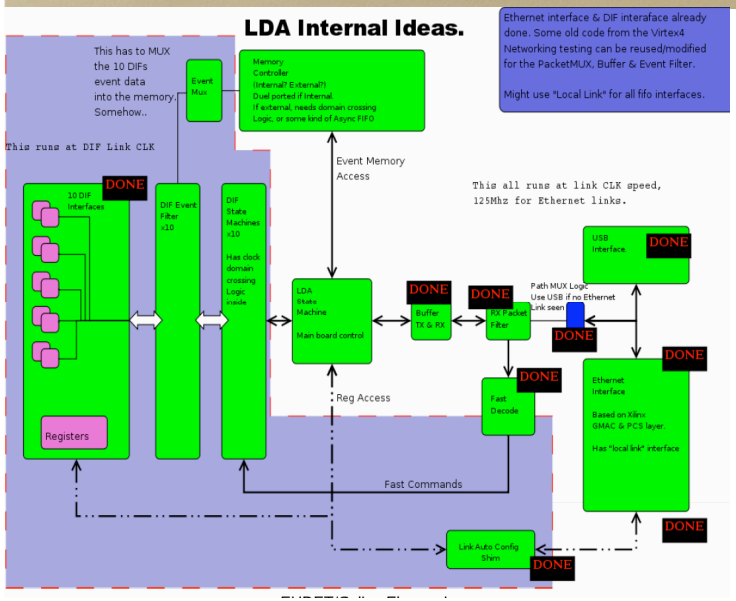
1. JTAG programming header
2. LDA link HMDI connector
3. DIF link connector
4. mini-USB connector
5. Xilinx PROM
6. Cypress 2MB 10ns SRAM
7. Xilinx Spartan3-1000 FPGA
8. FDTI FT245R USB controller
9. 20p user header connector
10. reset pushbutton
11. 90pin SAMTEC IB connector



M. Goodrick, B. Hommels, R. Shaw

ILC Calorimeter DAQ: LDA





M Kelly

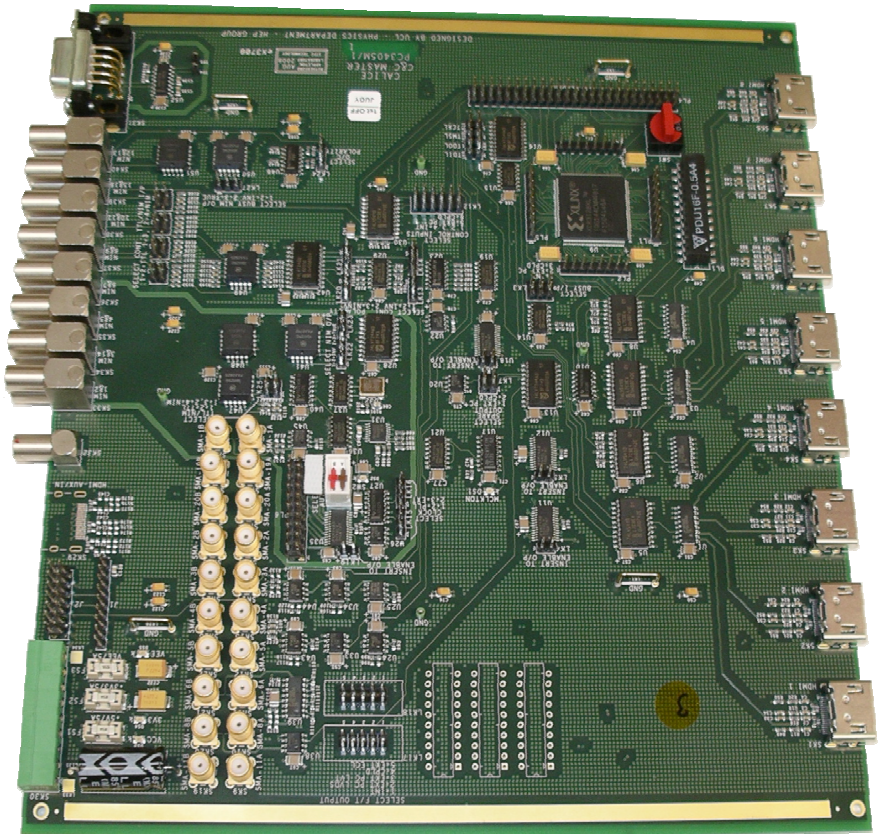
- Aggregate data from many DIF links and send to ODR over Gbit Ethernet link
- LDA should serve 10 DIFs
- Using commercial board from Enterpoint, with semi-custom add-on boards
- However, board came back with problems acknowledged by manufacturer - re-spin now
- Major firmware development underway
- ODR-LDA protocol progressing
- LDA-DIF link being documented

ILC Calorimeter DAQ: CCC

Tasks:

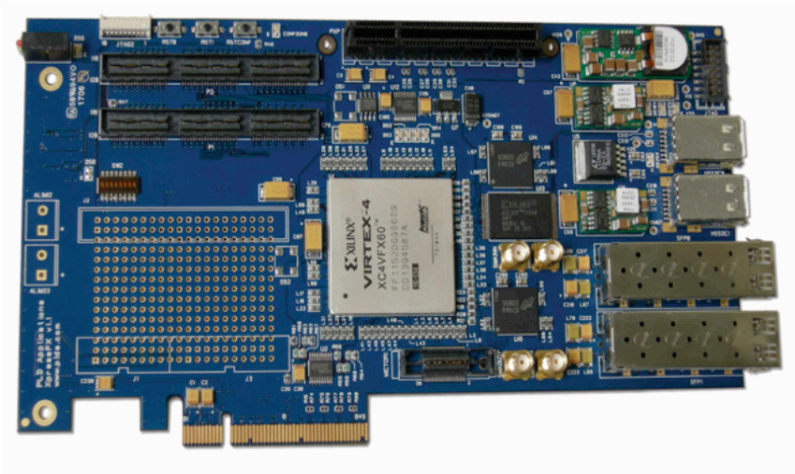
- Synchronise all subsystems upon pre-spill warning
- Act as reliable global clock source for fast clock, and phase-aligned ILC machine clock
- Distribute asynchronous fast trigger and/or busy signals
- Capable to run stand-alone in tandem with DIF

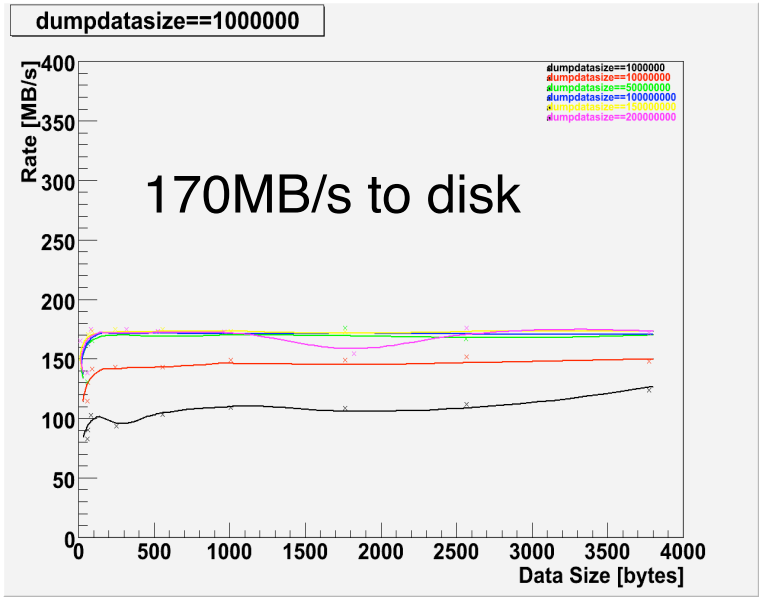
CPLD-based for implementation of complex logic.
Routing to/fro many sources and destinations possible



M Warren, M Postranecky

ILC Calorimeter DAQ: ODR



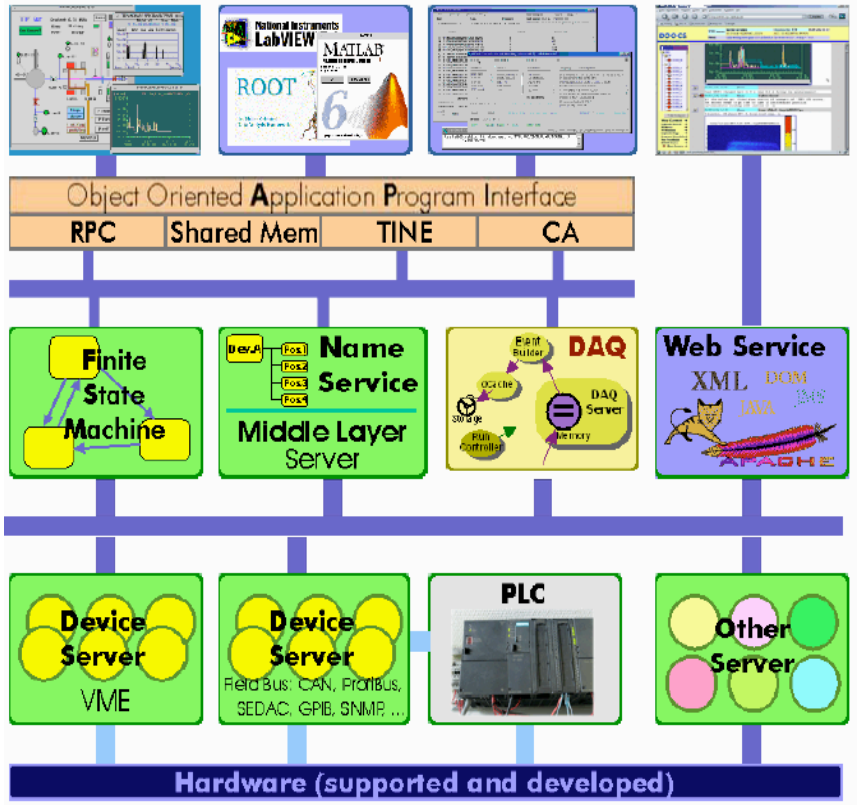


B. Green, A. Misejuk

ODR is the use-case for the PC-based DAQ interface card:

- Commercial board with custom firmware and software
- Task-specific performance optimisation
- System-specific extensions: decode LDA event data headers, etc.

ILC Calorimeter DAQ: Software



Software to follow system architecture:

- Modularity
- Generic nature with specific interfaces
- Scalability

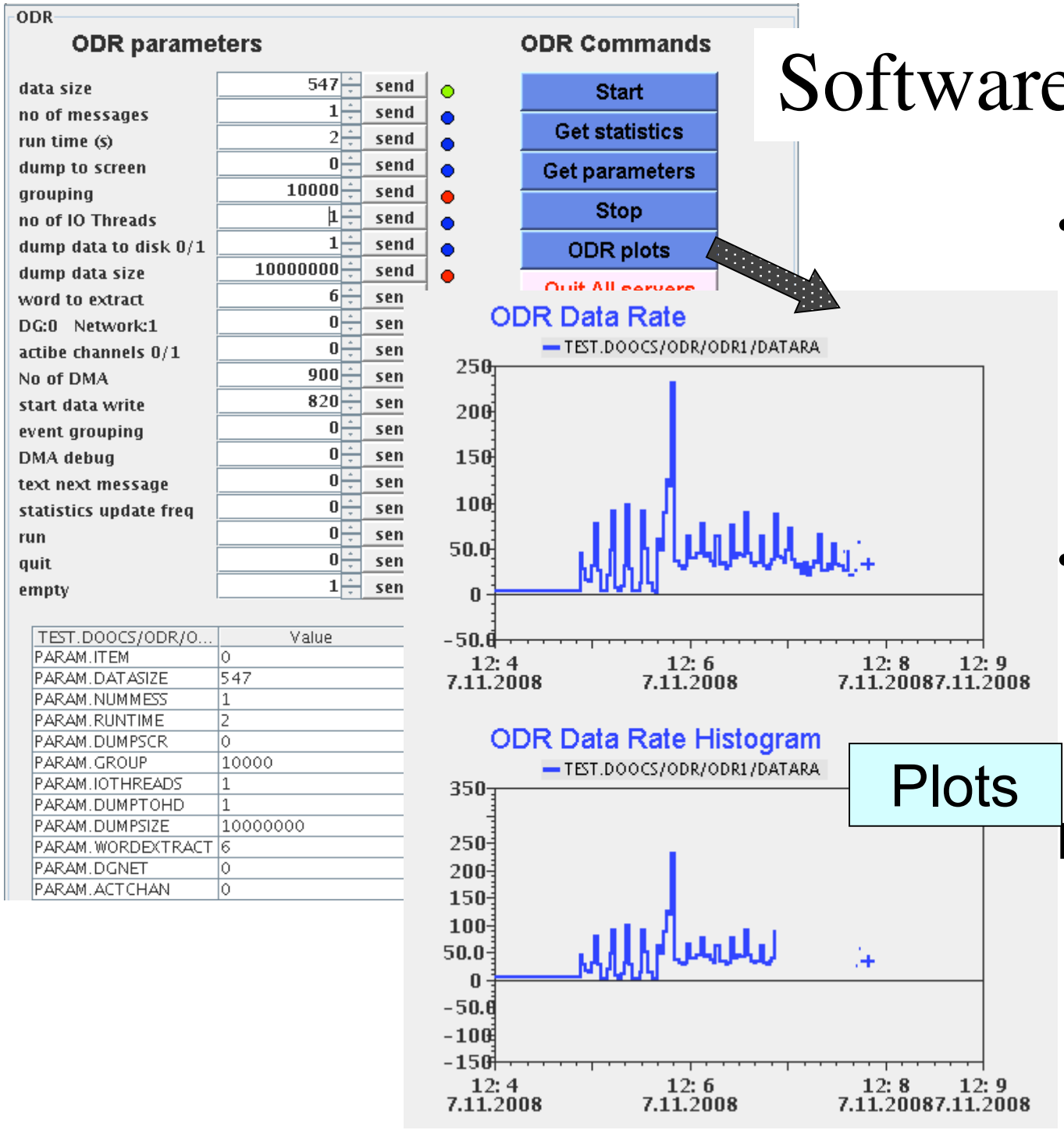
DAQ software requirements in ILC calorimetry:

- Support for several calorimeter types, each of significant complexity: $O(10^4)$ channels, $O(10^3)$ ASICs, $O(10^2)$ electronics boards
- Preferably use existing DAQ software (framework)
- Chose DOOCS being developed at DESY for XFEL

`tesla.desy.de/doocs/doocs.html`

V. Bartsch, T. Wu

Software application



- Starting from DAQ-ODR interface: first hardware layer & most advanced
- Have set-up LDA emulator and passed data in this system:

PC->ODR->LDA

V. Bartsch, T. Wu

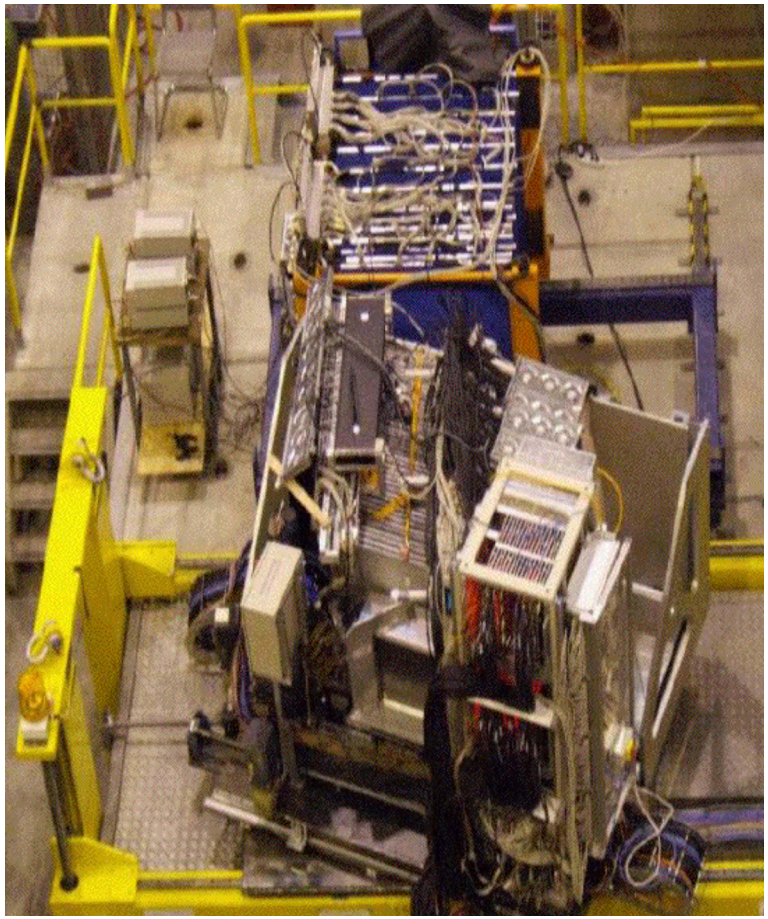
ILC Calorimetry DAQ: CALICE

CALICE: physics prototype of ILC calorimeter detector segment: ECAL + HCAL

First demonstrator for newly developed DAQ:

CALICE testbeam in 2009

DAQ components: Software, ODR, CCC, LDA, DIF prototyped



DAQ for future calorimetry at ILC: summary

Aim is to develop a DAQ system that is generic in nature, using commercial components where possible

The DAQ system should be modular and scalable

ILC Calorimeter sub-detectors demonstrators serve as the first well-described ‘use-case’ for the DAQ

All DAQ components prototyped in hardware, ready to merge into a full fledged DAQ system through firmware and software development.

First serious test opportunity: testbeam in 2009