Data Acquisition in the EUDET project

Joachim Mnich (DESY), Matthew Wing (UCL)
for EUDET collaborators

- The EUDET project
- Introduction to the joint research activities
- Data acquisition for individual components
- Common data acquisition
- Outlook

LCWS 06 Bangalore, 9-13 March

The EUDET project

- New additional funding (€ 7 M) and new collaboration formed. Project runs 1 January 2006 - 31 December 2009.
- EUDET: Detector R&D towards the International Linear Collider is a bid within the Sixth Framework Programme for a contract for Integrating Activity implemented as an Integrated Infrastructure Initiative (I3).
- The key idea is I3 - a DAQ system fits - need “matching” funds.
- Proposal split into:
  - Networking activities
  - Transnational access activities
  - Joint research activities
    - test beam infrastructure (JRA1)
    - infrastructure for tracking detectors (JRA2)
    - infrastructure for calorimeters (JRA3)

JRA1: test beam infrastructure

Provide a test beam with:

- Large bore magnetic field
- High precision, fast beam telescope
- Upgrading existing facility

Initial set up in one of DESY test beam areas

Infrastructure movable, so can be moved to e.g. CERN

Consists of following tasks:

1. Magnet integration
2. Pixel telescope integration: improve beam line, mounting and cooling infrastructure
3. Development of monolithic active pixel sensors for beam telescope
4. Data acquisition and evaluation software
5. Validation of infrastructure: competing pixel designs

JRA2: Infrastructure for tracking detectors

- A general purpose TPC development facility
  - Commonly available field cage
  - Readout electronics and data acquisition
- A silicon-TPC based monitoring facility
  - Construct a precision diagnostic device to measure electron cloud arriving at the readout plane of a TPC
  - Relevant for TPC project and gaseous detector R&D in general
- A silicon tracking development facility
  - Common tools to test and simulate silicon sensors
  - E.g. light and large mechanical structure, convection and conduction cooling

JRA3: Infrastructure for Calorimeters

Setup a calorimeter infrastructure:

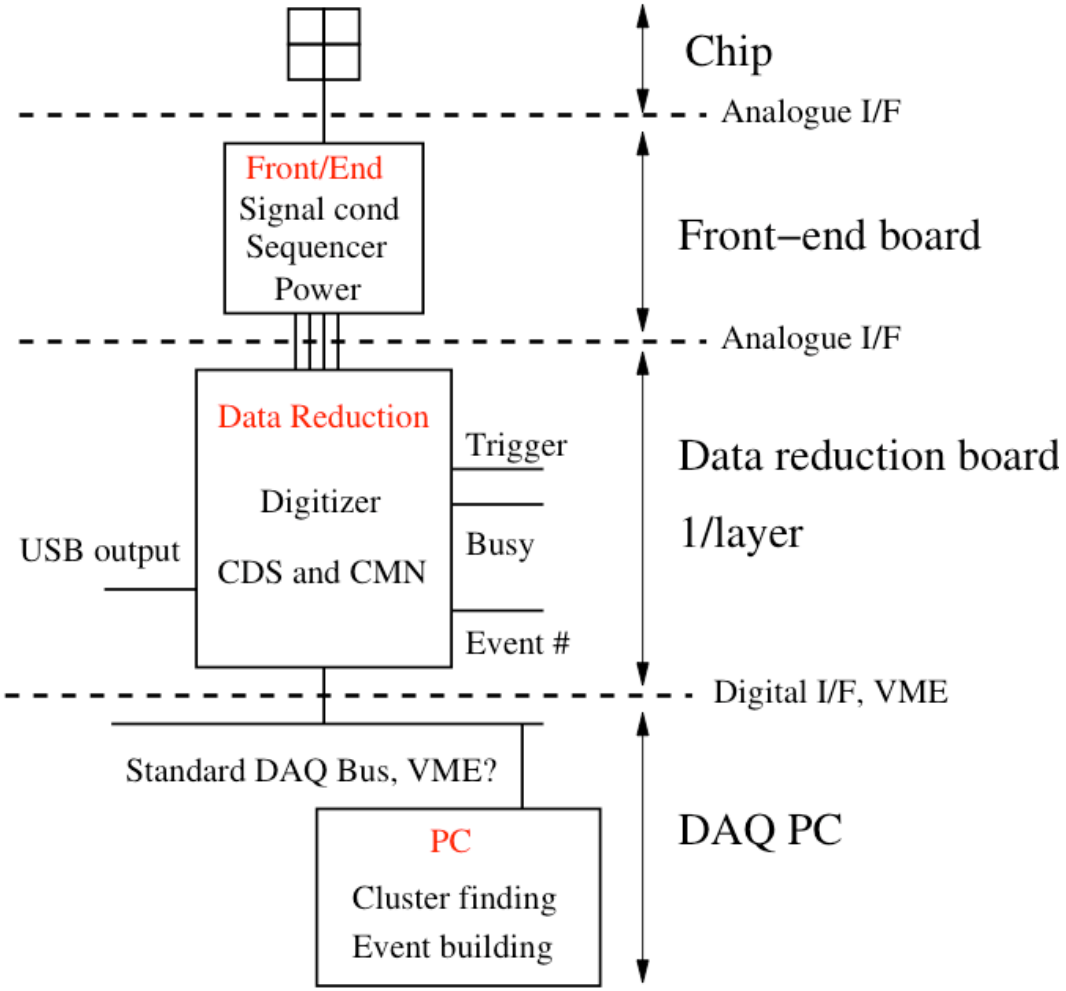
- Fully equipped electromagnetic calorimeter
- A versatile calorimeter stack for testing other technologies
- A readout system and a data acquisition system

Following tasks:

1. Build prototype electromagnetic calorimeter
2. Build hadronic calorimeter stack
3. General infrastructure, e.g. facility for linearity measurement, of very forward calorimeters
4. Generic data acquisition system which can read-out different calorimeter designs
5. Front end electronic chip design, relevant for different calorimeters

JRA1 data acquisition

(D. Haas et al.)



DAQ task includes:

- Design of FE and data reduction board
- Design of trigger logic unit
- DAQ software: cluster finding and event building

JRA1 components
(D. Haas et al.)

- VME based DAQ card: readout VME or USB
- Data reduction on board (not done yet)
- Trigger logic unit for trigger/busy and reset
- DAQ software based on present DEPFET ‘mini-DAQ’ - look into LHC software experiences on communication (XDAQ/SOAP)
- Readout rate 0.1 - 1 KHz

JRA2 data acquisition

- General purpose readout system applicable for different TPC end plate technologies
- Need high number of channels at low cost
- Initially based on existing digitiser (ADC and TDC) modules to provide digital output to DAQ
- Subsequent development, for compact channels, based on FADC and/or TDC and time-to-charge conversion techniques
- Other aspects of the JRA will feed into a common DAQ for this system

JRA3 data acquisition
(M. Wing et al.)

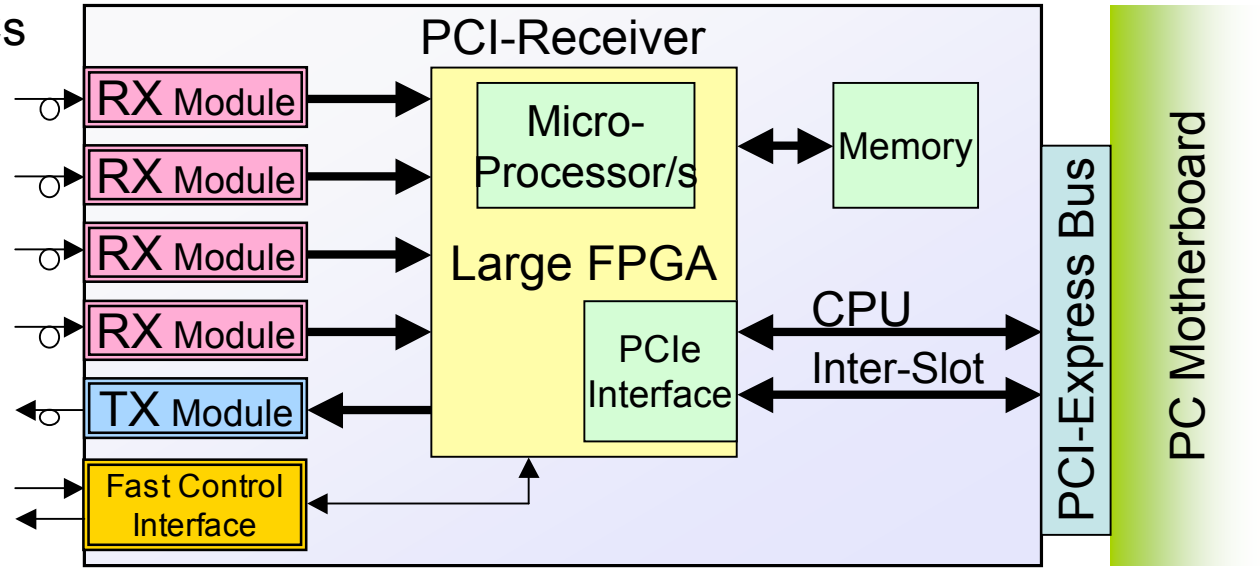
Have a conceptual design of a DAQ system for ECAL (HCAL):

- Make assumptions as to what can be done in the chip on detector and electronics at the edge of the detector. May be different options, cannot predict what will happen. So need to be flexible. Assume reading out higher volume and can definitely do anything lower.
- Using commercial, off-the-shelf products, so should be cheap, scalable and maintainable. Idea of ``backplane-less'' system.
- Identify bottlenecks in this concept, effects on calorimeter system $\Rightarrow$R&D.
- Should be applicable to HCAL - other non-calorimeter components?
- Test-bench work and demonstration of workability of concept.
- Then write chapter in Technical Design Report.
- Also practically: should be able to provide DAQ for prototype calorimeters being developed.

JRA3 Off-detector receiver

(M. Wing et al.)

- System of PCI cards in PCs
- Flexible card using:
  - different connections (fibre/copper)
  - data source and receiver
  - large FPGA for e.g. local clustering
  - PCI-Express bus
  - send config., clock and control signals



Should be a high-speed, high volume, generic data acquisition card, available for test beam and tested on bench.

Do we need a common data acquisition?

- Three separate data acquisition systems being developed for three different JRAs
- We can certainly pool resources, learn and profit from each other's ideas
- Above this do we need a common data acquisition system?
- Needed for common beam tests: will we have these?
- Pros
  - There can be some gain, e.g. precision position measurements in front of granular calorimeter.
  - Learn a lot from tests of a "complete" segment of detector
- Cons
  - Not obviously possible, e.g. calorimeter power pulsing in test beam
  - Not (planned) part of project; do we have resources?
- Will plan for common beam tests and hence integration of DAQ systems at early stage, I.e. now, so we have the possibility for such a programme

Summary

- Different DAQ systems being developed for EUDET sub-systems
- Within each sub-system, DAQ trying to be generalised
- Are now thinking of common DAQ for combined beam tests
- Different philosophies and technologies will have to be integrated
- Will aid future common DAQ for final detector
- EUDET project just started - more definite results be next workshop