Future R&D from UK in CALICE and EUDET

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Talk outline

- **Administrative introduction**
- **General programme of DAQ research in UK**
- **Specific research relevant for EUDET**
- **What we can provide to the EUDET project**
- **What we need to know from partners**

Administrative introduction

CALICE-UK is a group of seven institutes: those mentioned plus Birmingham and Rutherford.

Applied together for funding from PPARC: have a 3.5 year programme started on 1 October 2005.

Performing R&D in a number of areas:

- **CALICE test-beam programme**
- **Data acquisition**
- **Use of monolithic active pixel sensors**
- **Thermal and mechanical issues**
- **Simulation and physics**

Entered into EUDET specifically for DAQ work. For ease of administration UCL is the partner, with the other DAQ institutes associates. We are all responsible for this work.

DAQ system - general R&D work

Have come up with a conceptual design of a DAQ system for the ECAL:

- **Make assumptions as to what can be done in the VFE, in the FE. 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.**
- **Identify bottlenecks in this concept, effects on the 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.**

DAQ system - assumptions

The ECAL consists of 6000 slabs containing 4000 silicon diode pads of 1×1 cm^2, giving a total of 24 million pads.

The TESLA design for 800 GeV: bunch crossing every 176 ns, with 4886 crossings in a bunch train. The bunch train length is 860 μs and the period is 250 ms, giving a duty factor of 0.35%.

Assuming 100 particles/mm^2, have 10 000 mip in a 1×1 cm^2 pad, so ADC dynamic range is 14 bits.

With 2 bytes per pad per sample, raw data per bunch train is $24 \cdot 10^6 \times 4886 \times 2$ = 250 GBytes, which is 0.3 – 2.5 MBytes/ASIC (assuming each ASIC processes 32 – 256 channels).

Within a bunch train, potential data rate is 0.4 – 3 GBytes/s.

Threshold suppression and/or buffering could reduce this rate.

DAQ system - areas of R&D

Connection from the VFE to FE

- **Readout of prototype VFE ASICs**
- **Study of data baths on 1.5 m PCB**

Connection from on- to off-detector

- **Connection from on-detector to off-detector receiver**
- **Transport of configuration, clock and control data**

Off-detector receiver

- **Prototype off-detector receiver**

DAQ system - connection on- to off-detector

Assume off-detector receiver is (some largish numer of) PCI cards in PCs.

Connection off detector and receiver itself are commercial components.

Two scenarios:

- **Threshold suppression done in FE, data rate $\sim$ 5 MBytes/s, data transported via network switch.**

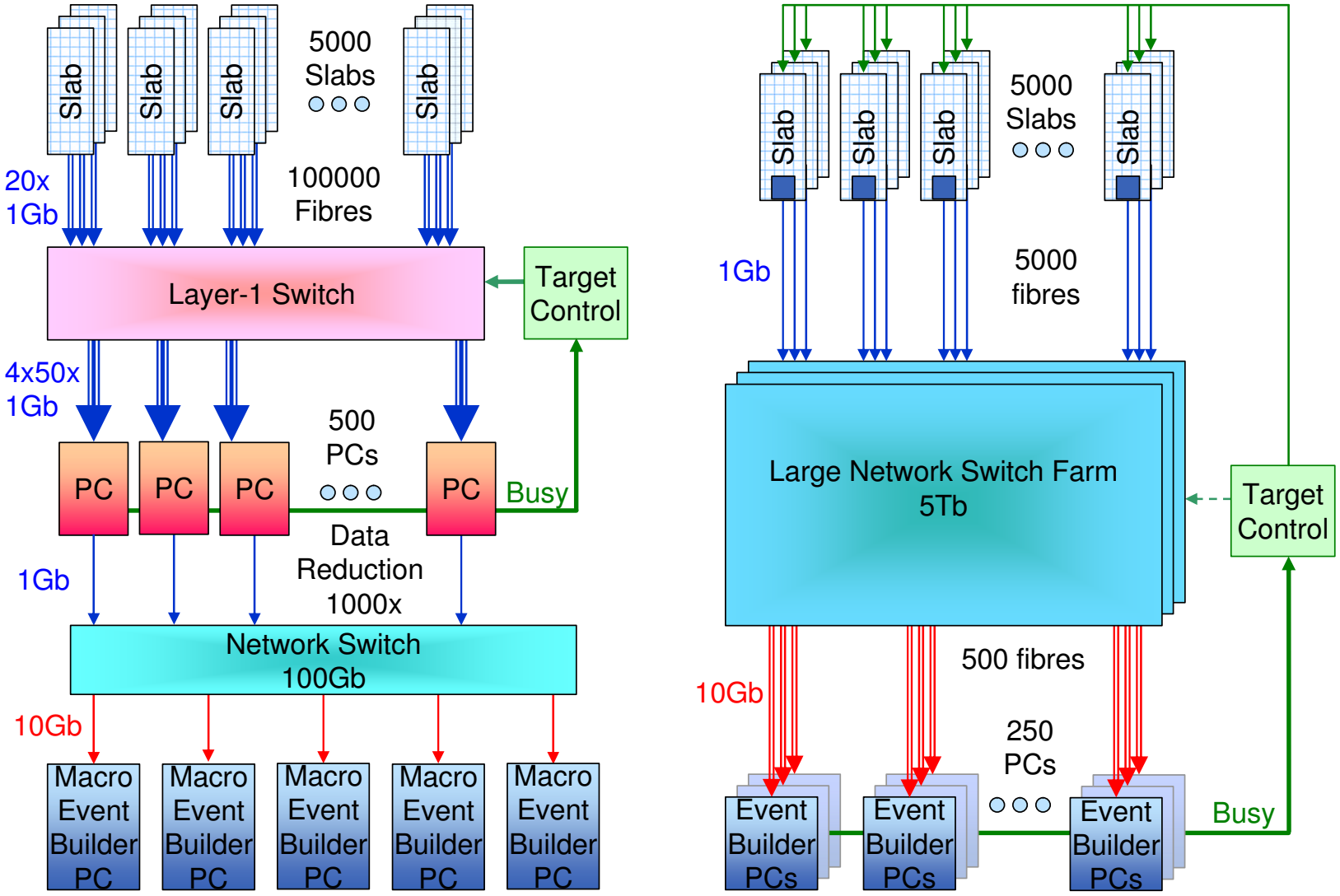
- **No FE, data directly from VFE (data rate $\sim$ 1 GBytes/s) using optical fibre, via optical (“layer-1”) switch.**

First will work, but tests can be done. Second would need to be studied now.

FE inaccessible for long periods - need “failsafe” - able to reboot, reconfigure.

Understand clock and control and configuration of different commercial components to accelerator clock.

DAQ system - connection on- to off-detector



DAQ system - Off-detector receiver

Receiver is system of PCI cards housed in PCs. Local clustering performed on PCI cards.

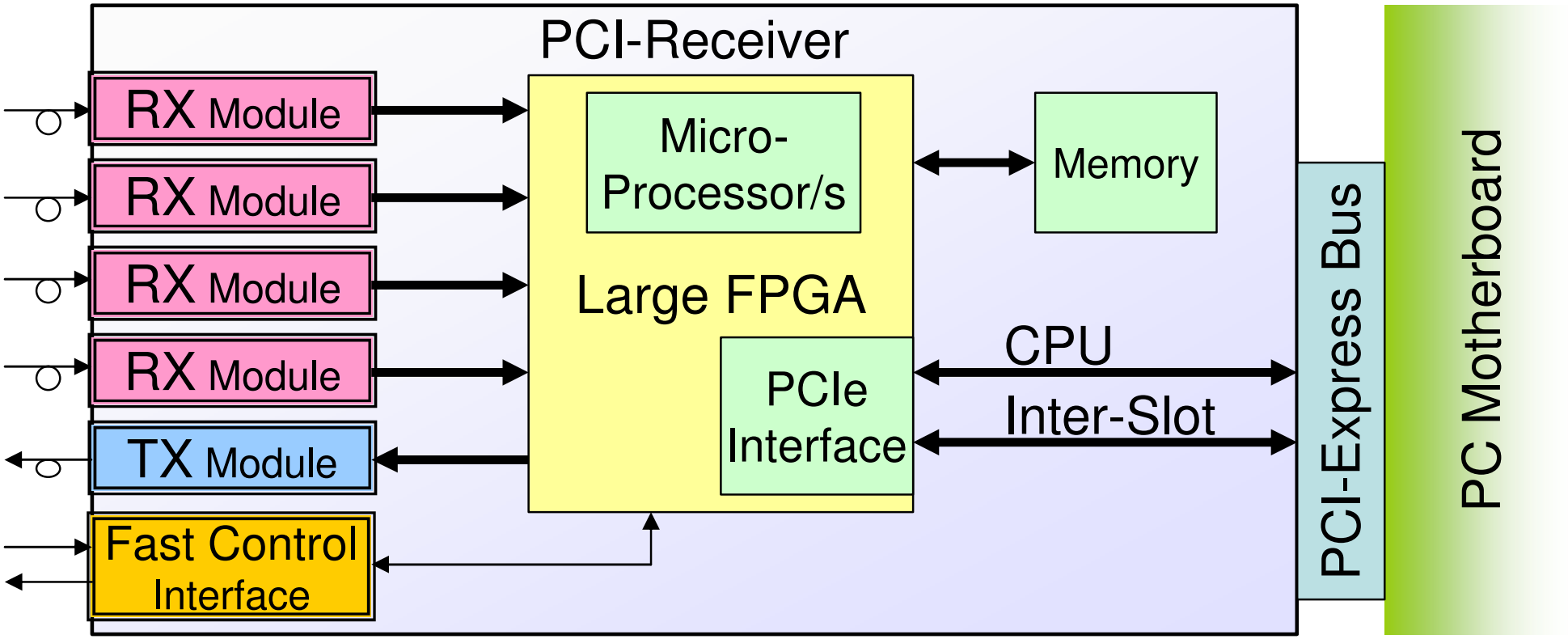
PCs can be unreliable, one may be busy - how good is switching between PCs?

How much data (i.e. how much of calorimeter) can be sent to one PC?

How much data needs to be sent to PC for local clustering to be effective?

Design our own card for maximum flexibility

DAQ system - Off-detector receiver



What can we provide for EUDET

Provide DAQ for prototype calorimeter or calorimeters

Flexible DAQ card which should be able to cope with foreseen rates and volume

Network systems, if needed, which are tested and efficient

Support for the DAQ apparatus integrated into any prototype in test-beam, etc.

What we need to know from partners

How many prototypes will be read out?

Timescale, size, number of channels, communications link betwen our DAQ card and the detector hardware.

How many cards will we need to fabricate and when?

We need to brainstorm...