DAQ/Online: readiness for DESY and CERN beam tests

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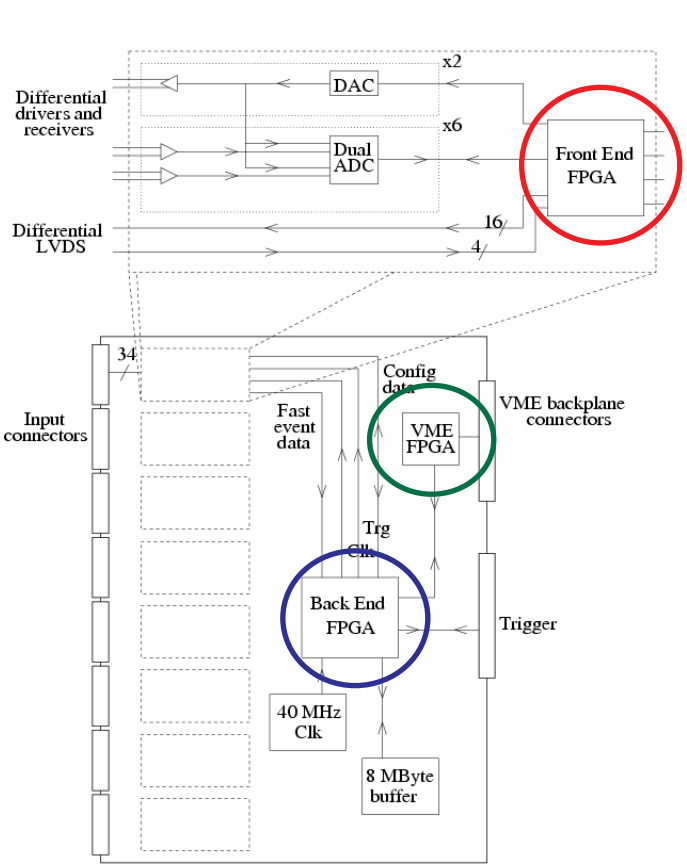
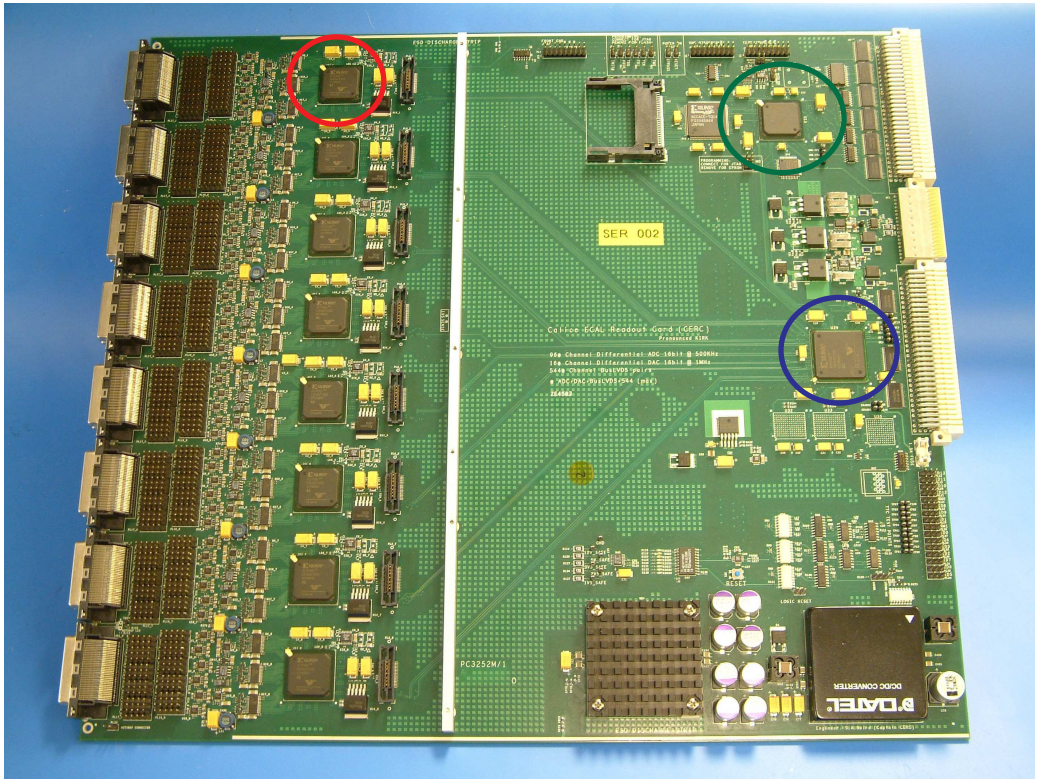
DAQ hardware

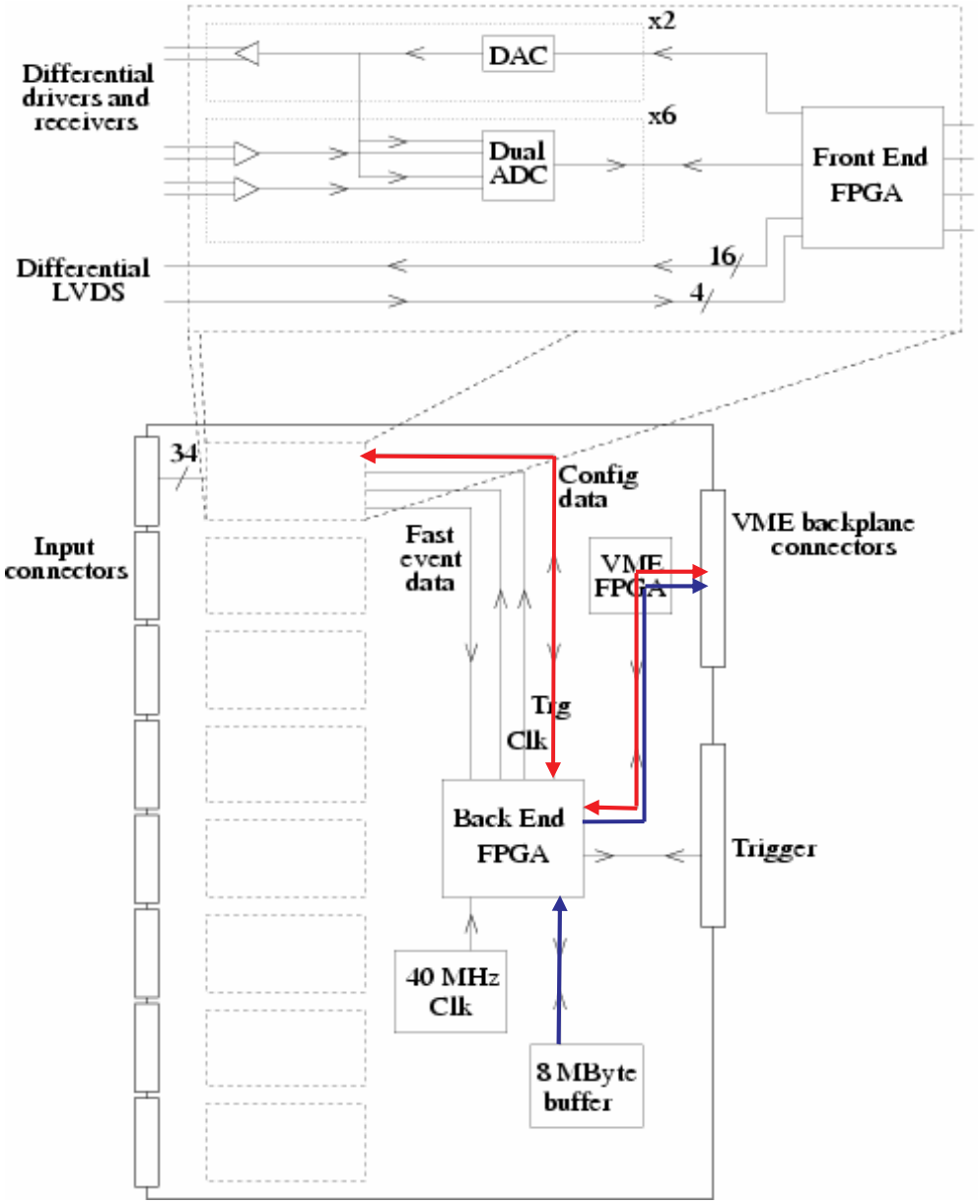
- Mainly based on Calice Readout Card (CRC) VME board
  - Modified from CMS silicon tracker readout board
  - Does very front end control, digitisation and data buffering



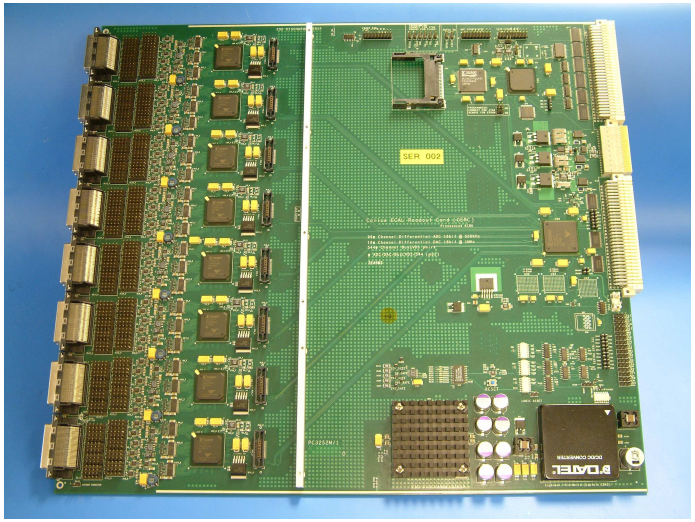


CRC readout

- Two VME data paths
  - Serial path: slow
    - Read and write directly to all FPGAs
    - Used for all configuration data loading and readback
    - Also used for temperature and power monitoring
  - Vlink path: fast (i.e. VME block transfer)
    - Read only from 8MByte memory (via BE)
    - Used for event data only



CRC hardware status



- Need 13 CRCs total (for DESY)
  - ECAL requires 6 (4) CRCs
  - AHCAL requires 5 (1) CRCs
  - Trigger (probably) requires 1 (1) CRC
  - Tail catcher requires 1 (1) CRC
- Status
  - 18 exist: 2 prototype, 9 ECAL production, 7 AHCAL production
    - Prototypes less reliable; will only be used if necessary
  - Of 9 ECAL production, 6 have all channels working so far
    - Others need further rework by Adam Baird; next few weeks
    - The 2 oldest have developed connector problems; need to be more careful with handling. Hope to fix by resoldering
  - Of 7 AHCAL production, 4 have all channels working, others not yet tested
    - Need to finish tests and rework in the UK before moving to DESY
    - If smooth, should be done by end of Jan, worst (?) case end Feb.

Firmware status

- Three different FPGA firmware designs needed
  - VME: can use CMS version directly; no work needed
  - FE: completely new, but effectively finished
  - BE: two parts to this
    - "Standard" BE: data handling on all CRCs
    - "Trigger" BE: specific for CRC being used for trigger control
- Standard BE firmware needs more work
  - Occasional duplicated event readout; can fix in software
  - Can only buffer up to 500 events, but need 2000
  - Can only buffer in 2MBytes of memory, but need 8MBytes
  - Not needed for DESY as no spill structure, but must be done for CERN
- Trigger BE firmware in better shape
  - Trigger data (including detection of multi-particle events) can now be read via fast Vlink: allows ~100Hz readout including these data
  - Further design iterations will adapt trigger logic for spills at CERN

Slow controls/readout status

- Various slow controls and readout data are collected by DAQ
  - This is the route to the LCCD database for long-term storage
- ECAL power and temperatures
  - Read out via stand-alone PC; I saw this for first time at DESY last week
  - Will need to interface to DAQ; nothing exists yet
  - Who is contact for this?
- ECAL stage position
  - Stage controlled by stand-alone PC
  - Readout interface to DAQ tested and working
  - Passive read from DAQ only; are we sure we don't ever want control?
- AHCAL slow data and stage position (for CERN only)
  - All centralised in stand-alone PC (running H1 slow control program)
  - Readout and control interface to DAQ tested; stage position controllable
  - No other data sent yet; needs more work to be complete

Beam line equipment

- Major issue of last run was flammable gas in drift chambers
  - Required 24 hour shift cover by two people, even when no beam
- Using non-flammable gas has been raised
  - Different drift velocity so would need recalibration
  - Can we really use it? What is needed? Who can do it?
- With flammable gas, need significant shift coverage
  - Must organise well in advance; post rota early enough to get flights
  - Needed even if not using flammable gas!
- At CERN, will need different electronics
  - Wire chamber for tracking provided in beam line
  - We must provide electronics to buffer and read out 12 (?) channels
  - Need to purchase when spec known (and when run approved)
  - Same will be needed for CERN Cherenkov detectors
  - Significant work needed here

Run structure

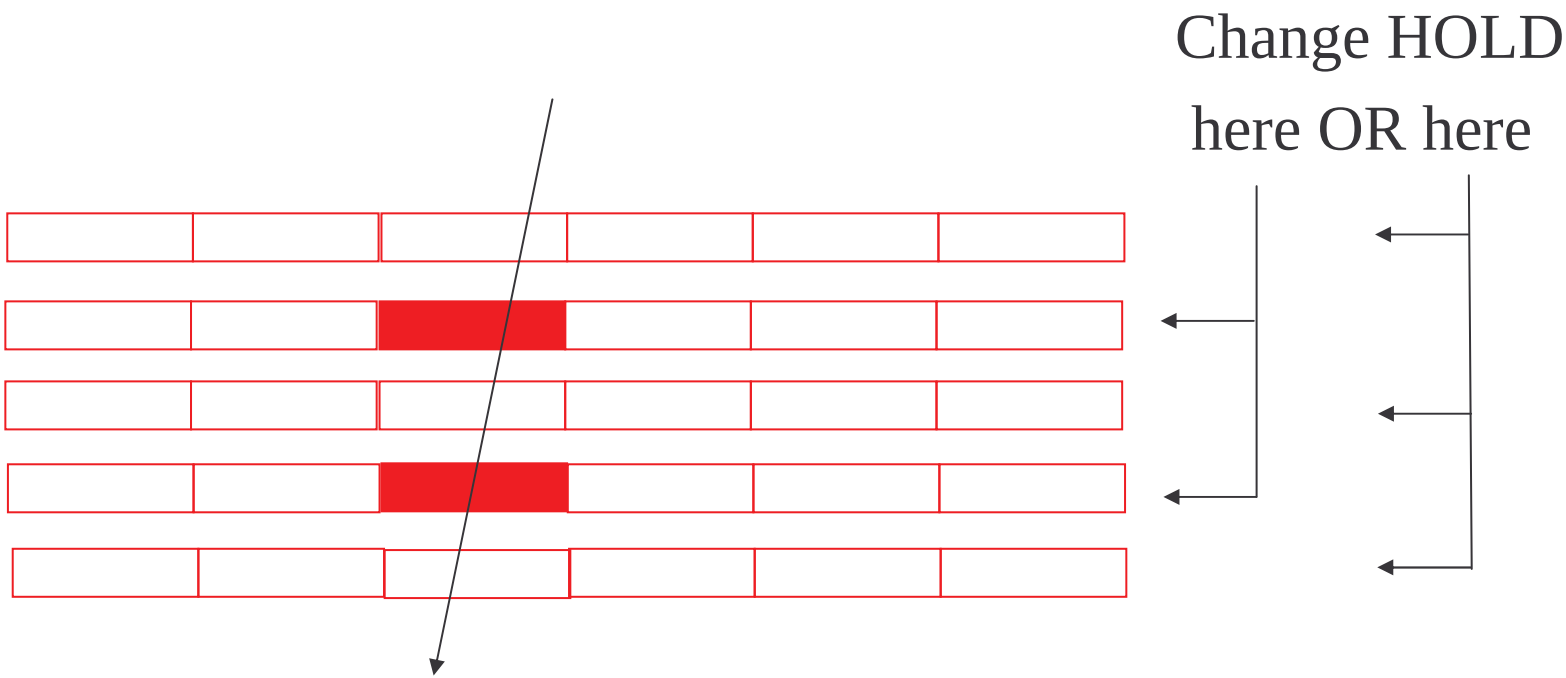
- AHCAL needs both pedestals and LED calibration data
  - Throughout beam and cosmics runs, at least every 5 minutes
  - Approx 500 events of each; takes ~ 10 secs (1 spill) ~ 3% beam dead time

500 Ped 500 LED 5mins data 500 Ped 500 LED etc

- In combined runs, ECAL must have similar run structure
  - Is this often enough for the ECAL pedestals? (I hope so…)
  - What does ECAL do during "extra" LED configuration period? More pedestals?
  - Suggest DESY runs have same structure so easy to analyse together
- Can do VFE calibration runs using CRC DACs
  - Are these needed? If so, how often? Once per hour/day/week?
  - For previous DESY run, taken approx daily but never analysed AFAIK
  - Should we use "extra" AHCAL configuration periods for this?

HOLD scan cosmic runs

- Initially, need to find HOLD time to sample at VFE shaper peak
  - Suggest same run structure for these data
  - Only move HOLD in alternate layers to allow easier analysis?



- How should we the HOLD scan for beam runs?
- Are we set up to do such an analysis? Result is needed quickly

ECAL “Read19” issue

- Effect when reading through multiplexer exactly 18 times
  - Output line left floating; drifts to position with high current
  - AHCAL has different driver, does not see same effect
  - See Jean-Charles and Julien for more details
- Drift is “slow”; timescale of ~0.1sec
  - Time between readout of multiplexer and next event can change pedestal
  - Variation in time looks like noise
  - Different for cosmics (1Hz) and beam (100Hz)
- Best solution would be to always read 19 times
  - Last sample gives no channel data, just baseline so must be ignored
  - Adds ~4% to ECAL data volume and readout speed, ~2% overall
  - Should we do this?
- Will implement a “panic” reset run also in case of problems
  - In case system left in odd state

Using ILC_PHY4

- Newest version of VFE ASIC chip
  - Allows analogue readout (effectively) compatible with existing chip
  - But also allows digitisation using in-chip ADC and digital readout
  - Main extra feature is power-cycling for ILC operation
- There may be two layers made with these chips
  - Needs extra wafers, so not available before CERN
- Readout would be possible with CRC
  - Need minor firmware changes in FE for analogue readout (?)
  - Need major firmware changes in FE for digital readout
  - Have discussed doing both to cross-check but doubles data volume so would slow event readout rate by factor two
- What is realistic timescale for needing this?
  - Osman Zorba resident at CERN for 6 months so not easy to organise

LCIO issues

- How ready is LCIO for analysis of DESY data?
  - Conversion needs a little work due to DAQ software changes
  - But more major structural issues also
- To analyse e.g. just pedestal configuration periods is not efficient
  - To identify configuration periods, need to read every event and see if configuration (from LCCD database) has changed
- Better solutions under discussion
  - E.g. have header flags for each event; allow to skip to next event
  - One flag bit should indicate first event of configuration
  - No further than discussion; nothing implemented (yet)
- Run size also an issue
  - In November Tech Board review, decided to allow large runs > 2GBytes
  - But LCIO file sizes limited to < 2GBytes by dCache
  - Chop runs into smaller chunks? Into configuration periods???

LCIO monitoring

- Need rapid monitoring
  - Previous run had histogramming
  - But running it slowed data rate so not used!
- Real-time online histograms and event display from event stream
  - Done via memory-mapped ROOT file
  - Careful testing for speed impact on run
  - Limited, predefined histograms
- Separate PC with data disk visible to run on binary files
  - Independent PC prevents interaction with ongoing run
  - Primarily run LCIO converter
  - Allows any/all offline code to be run on output file…
  - …but need to wait for converter to finish first
- Install binary analysis software on this PC also?
  - Would allow immediate “offline” monitoring
  - But need to write the analysis jobs for this format

Summary

- Hardware is ready for DESY
  - More work needed on CRCs for CERN
  - Final DAQ system cannot be shipped to DESY until Feb
- Firmware is usable for DESY
  - Duplicated event readout should be fixed if possible
  - More work needed for CERN beam run and ILC_PHY4 use
- Other items for DESY runs
  - Slow controls and readout needs work
  - Beam line equipment needs work
- Decisions needed on run structures
  - Changing later will make analysis more complex
- Are we ready and able to do LCIO analysis?