DAQ: First thoughts and to start discussion

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- General comments
- E144 experiment: detectors and DAQ
- Rates for a calorimeter
- Calibration
- DAQ Software
- Summary

General comments

- LUXE will not be a high rate experiment, with a maximum of *10 Hz* data-taking frequency.
- The detectors will generally be small.
  - Should not need a massive PC farm, huge data reduction, event triggering, etc.
- We need to consider timing and when to trigger data taking in the detectors.
  - There are clock and timing modules used for the EuXFEL megapixel detectors — re-use ?
- LUXE is more the size of detector beam test than a HEP experiment.
  - Can use software designed for this, rather than e.g. XDAQ used in CMS.
  - Re-use software, rather than writing our own ?
- Should not forget calibration.

E144 calorimeter

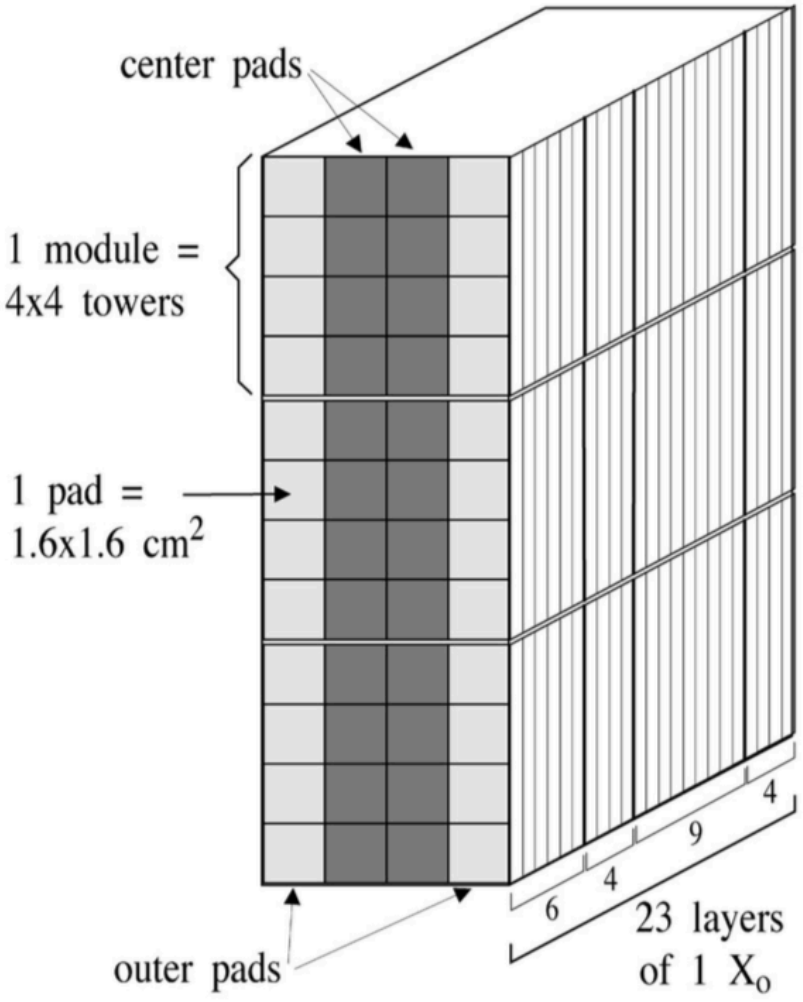

FIG. 17. The electron calorimeter (ECAL).

A silicon–tungsten calorimeter with:

- 23 layers, each with
- 12 rows and 4 columns of
- *1.6 × 1.6 cm²* active pads
- e^- and e^+ produced at the IP reached the inner columns.
- Outer columns used for backgrounds.

E144 DAQ

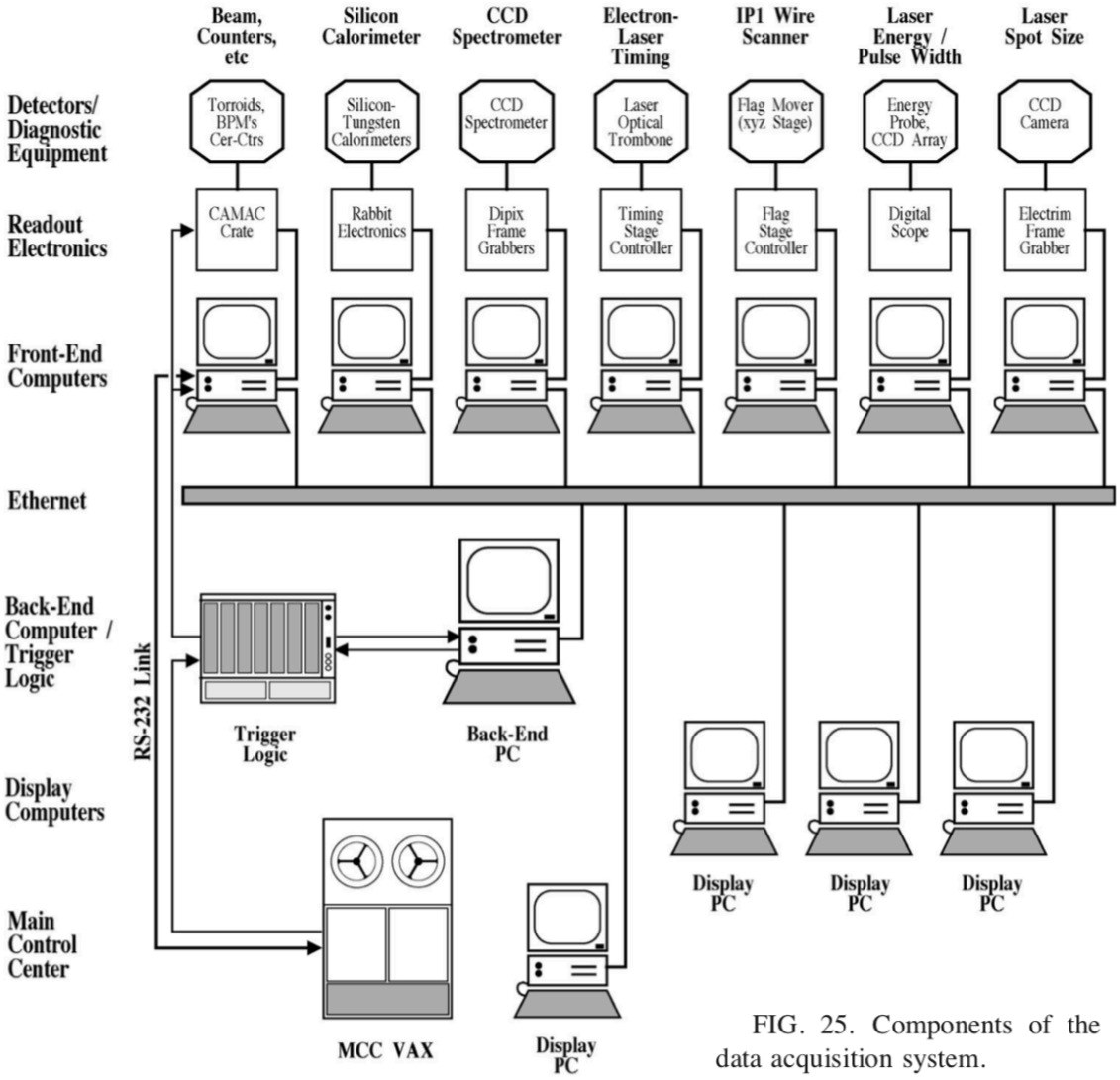

FIG. 25. Components of the data acquisition system.

- The data taking was *0.5 Hz*.
- Electron beam pulses recorded prior to laser shot.
- Events recorded to measure pedestal and noise.
  - All seems reasonable.
- PCs connected by local ethernet.
- One back-end and dedicated front-end PCs.
  - Again seems reasonable.

Rates for a calorimeter

Assume something similar to E144, but a bit more granular:

- 20 layers, each of 8 × 50 cm^2.
- Have active pads/cells of 0.5 × 0.5 cm^2
  - Gives 16 × 100 = 1600 pads/cells per layer
  - or 32000 pads/cells in total calorimeter
- Assume 2 bytes per pad per sample
  - Gives 64000 bytes per bunch crossing
  - or 640 kB/sec for 10 Hz running
- This is a low data rate and can be handled by a simple PC ethernet connection.
- These are example numbers; depending on the exact layout, we can simply recalculate the rates.

What are the data rates for other detectors ? Will any detector be significantly higher ?

- Assume tracker with much smaller pads will have (much) larger data size. How much ?

Calibration

- As with E144, we will want to calibrate when no laser shot and when we have no beams at all.
- I would suggest that we then run at 10 Hz in time with the Eu.XFEL bunch structure even if our laser is < 10 Hz.
- We then have n / n_e / n_{empty} events where
  - n is the number of electron–laser events
  - n_e is the number of electron bunch (with no laser) events
  - n_{empty} is the number of events with no bunches (i.e. did not kick out an electron bunch)
- Do we want to take cosmics ?
- Do we need any other calibration schemes or runs ?

DAQ software

- Plenty of DAQ softwares already exist, e.g. XDAQ, DOOCS, … some dedicated to an experiment, some designed to be more generic.
- A development as part of a large EU detector project, AIDA-2020, is a software EUDAQ2.
  - Developed for linear collider detector beam tests which are similar size to LUXE.
  - Can cope with different triggering or detector readout schemes.
  - Been used by other detectors for beam tests, e.g. CMS HGCAL, ATLAS ITK.
  - EUDAQ/EUDAQ2 has been in use for 10+ years.
  - In-house expertise.

Summary

- The LUXE DAQ should have lowish data rates.
  - Need to assess when we have more solid detector designs. Would be good to discuss numbers already.
  - In particular trackers with e.g. 50 μm pads will have many channels.
- Need to think about calibration.
- Need to think about triggering.
- Develop/propose a software, although I think we can use what is already available.