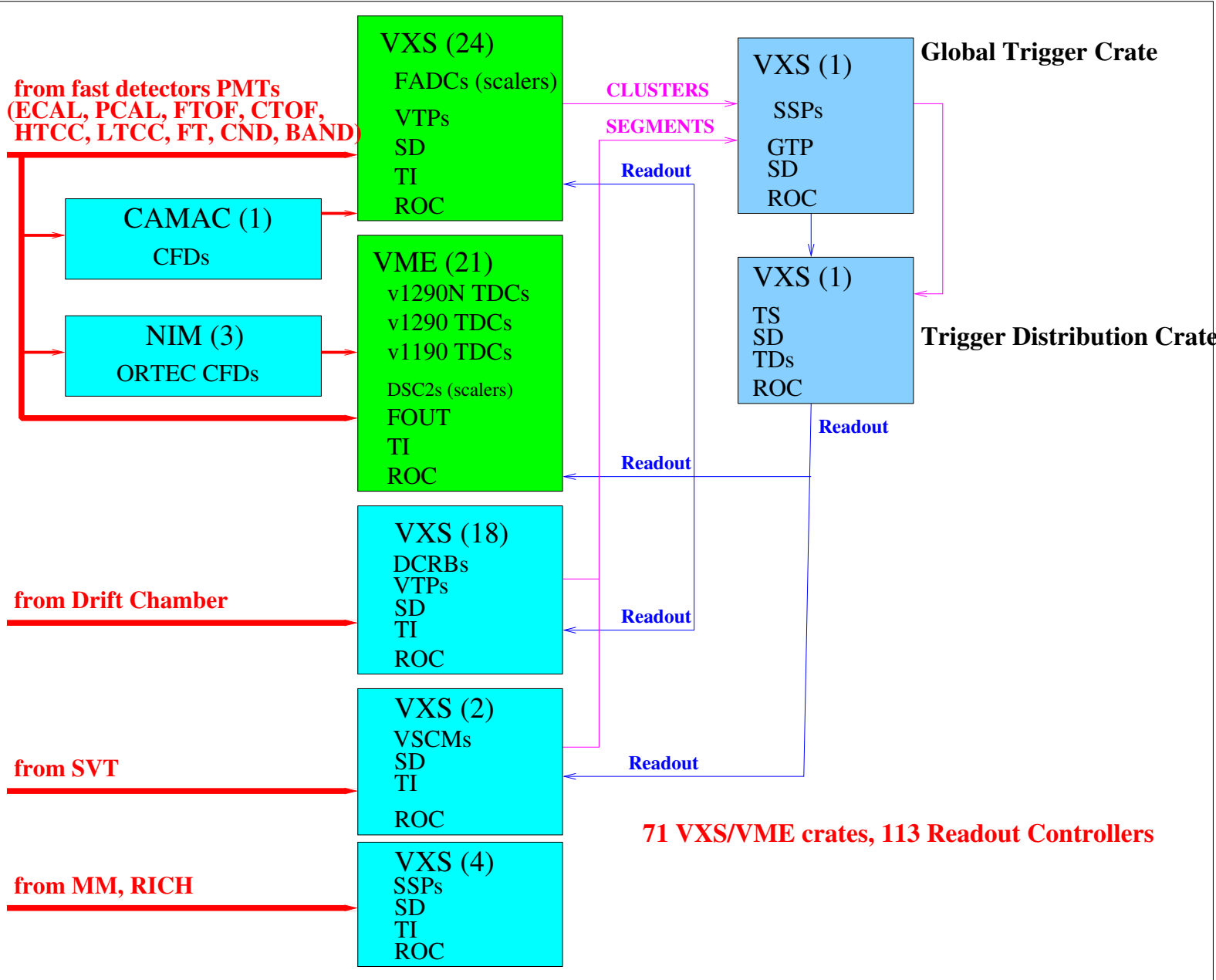


DAQ/Trigger status and planned developments

Sergey Boyarinov

Mar 5, 2019

DAQ/Trigger Hardware



Readout channels count

Detectors with dual outputs (FADCs and Discriminators/TDCs):

ECAL: 1296

PCAL: 1152

FTOF: 1080

CTOF: 96

CND: 144

HTCC: 48

LTCC: 144

BAND: 256

=== $4,216 \times 2 = 8,432$

Detectors with single output:

Drift chamber: 24,192

SVT: 21,504

MM: 24,576 (currently less)

RICH: 25,024

FT: 564

=== 95,860

===== Total in CLAS12: 104,292

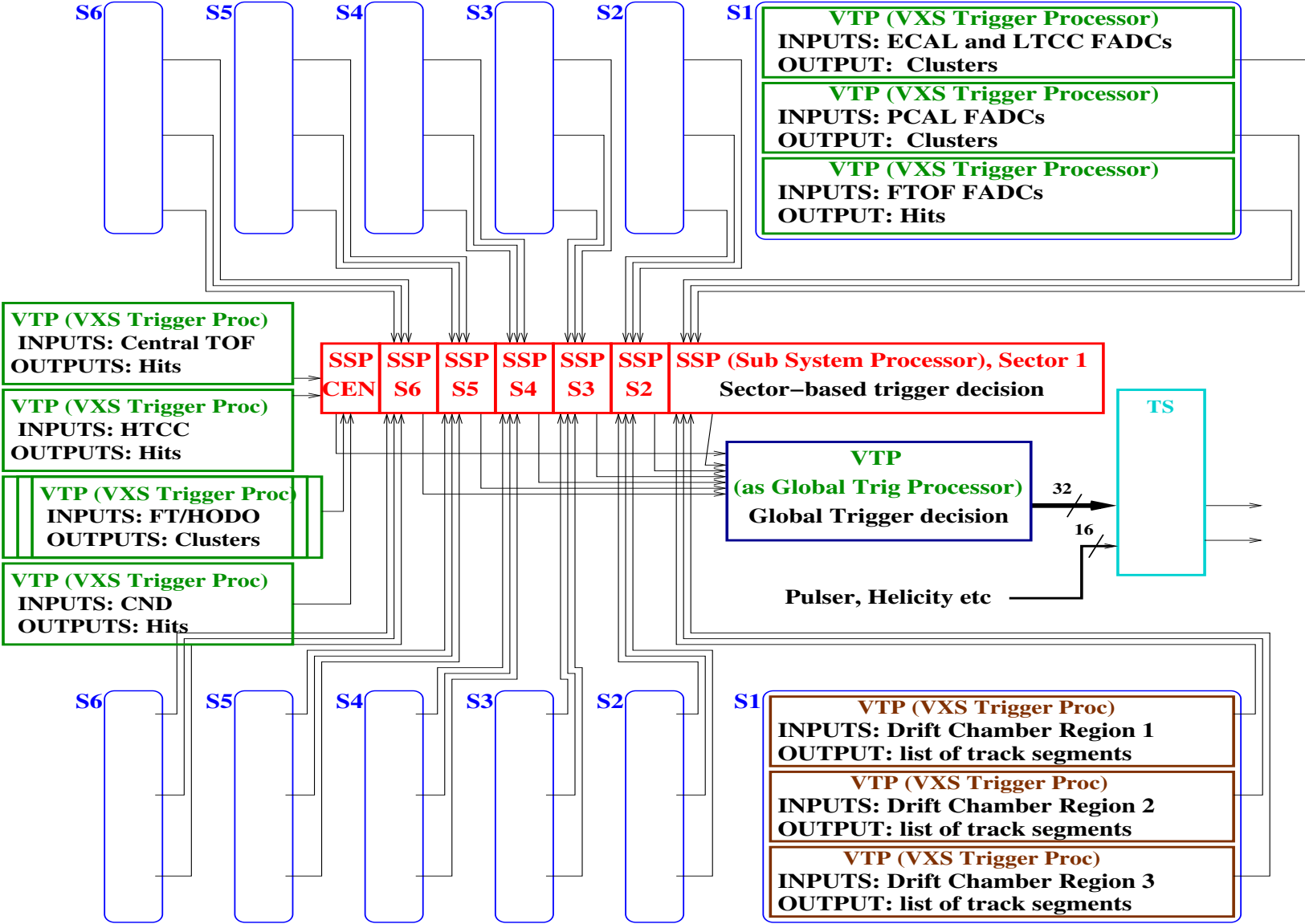
Most of channels have built-in scalers, they are reported to EPICS. Few channels are recorded into data stream (such as helicity-marked Faraday Cup)

In addition we have trigger system containing 42 VTP boards, all but one being read out.

CLAS12 DAQ Status

- Detectors supported: ECAL, PCAL, FTOF, LTCC, DC, HTCC, CTOF, CND, SVT, MM, FT/HODO, RICH, **BAND**
- Online computer cluster: 30+ computers, 4 DAQ servers (2 in use and 2 hot swap)
- Networking: 1 router, 20+ switches, 40GBit to CC
- DAQ is operational, performance exceeded requirements, working to improve reliability

CLAS12 Trigger System Logic



CLAS12 Trigger System recent changes: segment and road finding

- Drift chamber segment finder was improved by segments sorting and by keeping one segment with biggest number of hits, it decreased segment position uncertainty
- Drift chamber road dictionary generation procedure was significantly improved (most work is done by offline group), both simulation-based and data-based dictionaries were generated and its efficiency was checked and confirmed
- Generated DC roads contains now information about matching HTCC, FTOF, PCAL and ECAL clusters, allowing more selective geometry match in trigger
- For rg-b trigger, road dictionary was generated for the momentum range starting from 1GeV which decreased dictionary size and allowed to decrease road size by 2 cells in all 3 regions
- Trigger firmware was regenerated using new road dictionaries

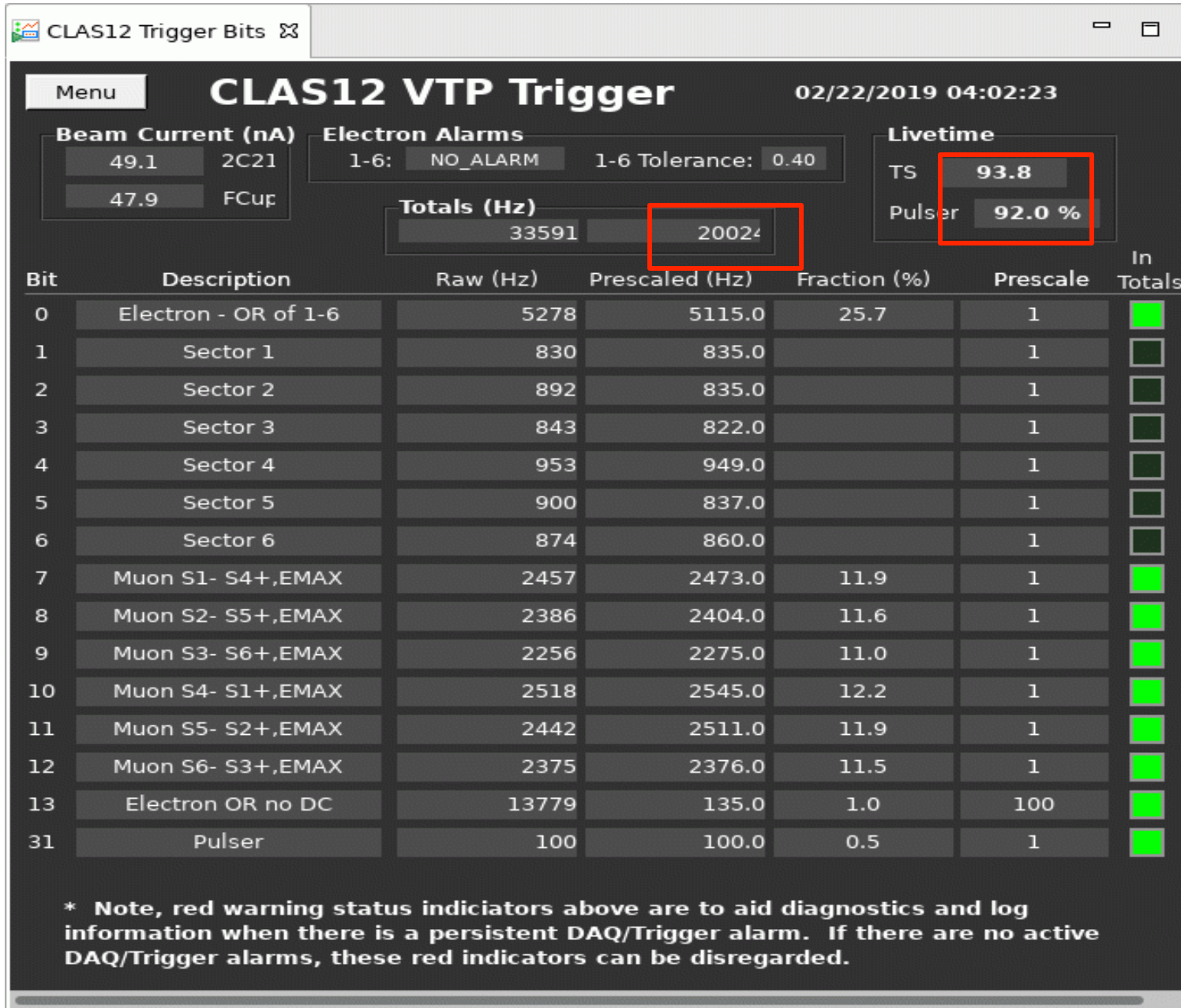
CLAS12 Trigger System recent changes: geometry match

- At fall time rg-a trigger was using two geometry matches: Forward Tagger ECAL – Hodoscope, and Forward TOF – Preshower Calorimeter U plane
- With recent road finder upgrades, geometry match between Drift Chamber road and U-coordinate of PCAL cluster was included into trigger logic
- DCroads x FTOF and DCroads x HTCC match is in road dictionary, but not in firmware yet
- Trigger firmware has also CND-CTOF geometry match which was implemented in firmware but never used

CLAS12 Trigger System recent changes: misc

- In a process of trigger firmware upgrade we introduced a bug, which was found by our standard validation procedure using random pulser data, and subsequently fixed; every time trigger changed we run validation procedure which proven to be efficient; normally it takes few days to validate a trigger, depending mostly on data cooking time
- Another bug (not effecting trigger decision) was found in recently added HTCC stage 1 data readout, it was fixed and we are checking stage 1 data banks from other components
- RG-B is using maximum energy cut on calorimeter clusters trying to select MIPs; cluster finding procedure was not designed for that but it seems works
- BAND detector is equipped with hit-based trigger, similar to PCAL hit-based one, so in addition to our sophisticated FADC-based trigger, hit-based still can be useful in some situations

RG-B rates: one of preliminary triggers



RG-B rates: one of preliminary triggers

File Preference

Run control Buttons

Control: **Cancel**, **Reset**, **Disconnect**

Transition: **End Run**

Static parameters

Database: clasrun Session: clasprod Configuration: **PROD66** rcServer: clonda6.flab.org

Session status

Data file name: /data/stage_in/clas

Config file name: /usr/local/release/1.3.2/parms/trigger/rgb_v3.cnf

Run status

Run number: 5224 Run status: active

Start time: Feb 14 13:02:08 End time:

Limits

Events: 0 KBytes: 0

Run progress

Events this run: **5240706** Read From: ERDAQ6

Rates	Events/S	Rate (KB/S)
Integrated	13820.4367	2180.4814
Differential	19308.0000	700815.3600

```

INFO : adcecal2 go.....
INFO : tdftof1 go.....
INFO : adftof1 go.....
INFO : tdepcall go.....
INFO : adpcall go.....
INFO : tdcecall go.....
INFO : adcecall go.....
INFO : ETDAQ6 go.....
INFO : trig1 go.....
INFO : transition Go succeeded !
        
```

Help
Statistics
Options
sodaedit
dbedit
foos

Event Rate (Hz)

2 Sec. update

Data Rate (KB/Sec)

2 Sec. update

Event Size (Bytes)

2 Sec. update

Livetime (percent)

2 Sec. update

RG-B rates: production trigger

The RunControl interface is divided into several sections:

- Control Buttons:** Includes 'Cancel', 'Reset', 'Disconnect', and 'End Run' buttons.
- Static parameters:** Shows Database (clasrun), Session (clasprod), Configuration (PROD66), and rcServer (clondaq6.jlab.org).
- Session status:** Displays Data file name (/data/stage_in/clas) and Config file name (/usr/clus12/release/1.3.2/parms/trigger/rgb_v9.cnf).
- Run status:** Shows Run number (6385), Run status (active), Start time (Mar 4 06:40:24), and Limits (Events: 0, KBytes: 0).
- Run progress:** Shows Events this run (14348227) and Read From (ERDAQ6).
- Rates Table:**

Rates	Events/S	Rate (KB/S)
Integrated	9138.9981	4957.6020
Differential	13920.0000	448310.6560
- Event Rate (Hz):** A line graph showing event rate over time, fluctuating between approximately 12000 and 15000 Hz.
- Data Rate (KB/Sec):** A line graph showing data rate over time, fluctuating between approximately 300000 and 500000 KB/Sec.
- Event Size (Bytes):** A graph showing event size over time, currently at 0 Bytes.
- Lifetime (percent):** A graph showing lifetime percentage over time, currently at 0 percent.
- Log:** Shows system messages such as 'transition Go succeeded!'.

CLAS12 Trigger System and streaming DAQ

- Streaming (or free-running) DAQ concept is under discussion and development in the lab; it assumes that it will be no trigger system, and DAQ will stream data into some kind of event building/processing facility where data will be reduced, organized and recorded with data reduction factor 100 or more
- In CLAS12, we are making trigger system more and more complex trying to reduce event rate on trigger level to help offline data processing, so we are moving to direction opposite to streaming DAQ
- It may indicate that more efforts should be spend to develop processing facility for the data coming out of DAQ event builder, rather than further level 1 trigger improvements; it will benefit both current data processing and future DAQ designs

CLAS12 DAQ/Trigger plans

- Current CLAS12 Level 1 trigger components will remain basically the same for upcoming runs, with small additions like extra geometry matches etc
- New “Level 3” component was recently added to the data taking chain between event builder and event recorder
- Currently it corrects helicity for delay reporting, in future it will perform online data processing for event rate and data rate reduction

CLAS12 Level3 Component

The screenshot shows the net_Editor interface with a network diagram and a 'Component Attributes' dialog box. The dialog box contains the following information:

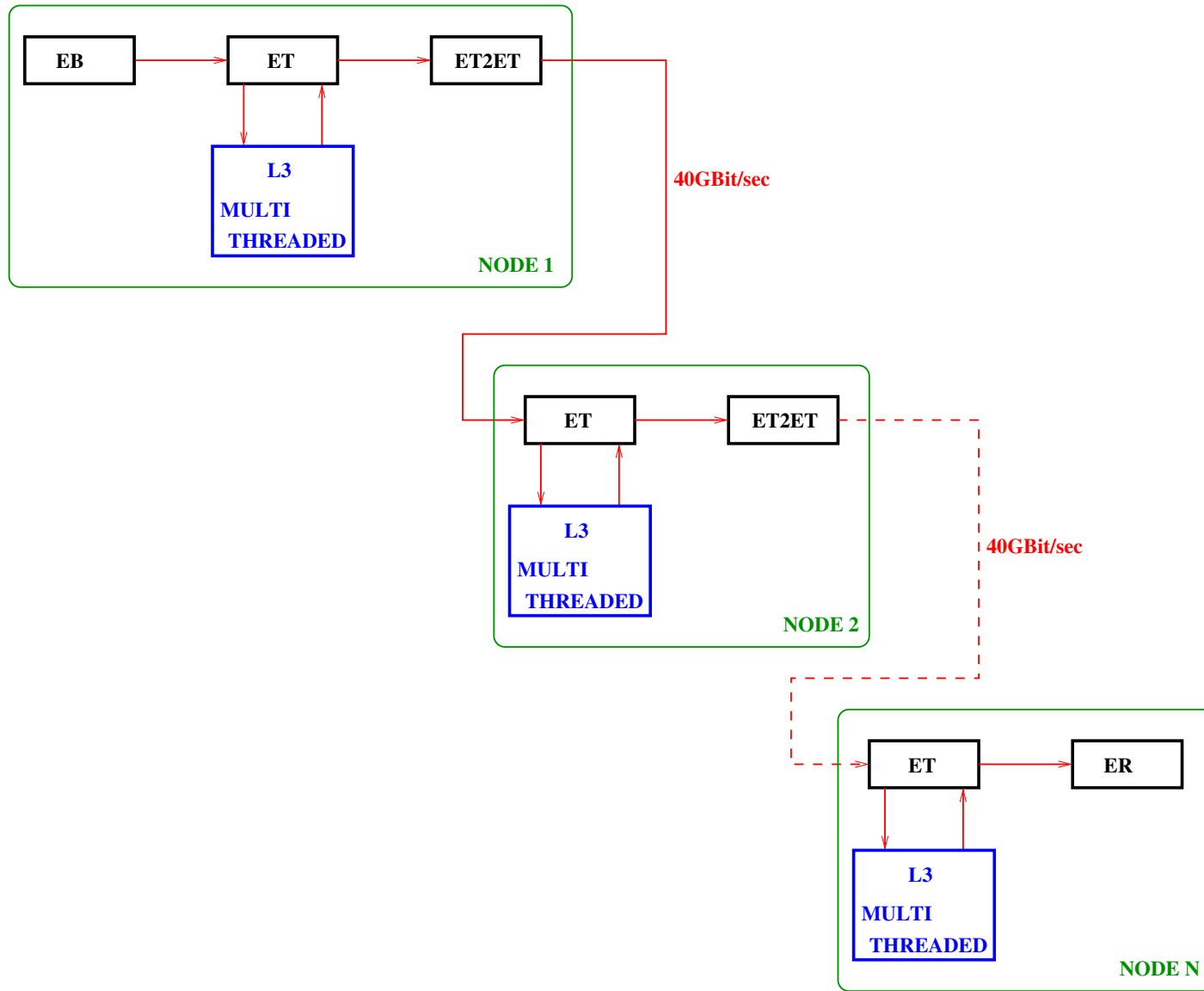
- Name: L3DAQ6
- Ethernet Host: clondaq6
- Id Number: 922
- Booting String: coda_l3
- Chunk size: 100

The dialog box has 'Ok', 'Dismiss', and 'Scripts...' buttons. The background network diagram shows a central node 'L3DAQ6 clondaq6' connected to 'ETDAQ6 ET clondaq6' and 'clas SUBDIR Coda file'. A table at the bottom of the diagram lists components:

Component	Type	Host
dc13vtp	ROC	dc13vtp
dc21vtp	ROC	dc21vtp
dc22vtp	ROC	dc22vtp
dc23vtp	ROC	dc23vtp

The status bar at the bottom indicates 'Database clasrun' and 'Run Type PROD66'.

CLAS12 Level3 Data Path



CLAS12 Level 3 current status

- Standard CODA component, can be placed into DAQ configuration using 'codaedit', the same way as any other DAQ component
- Attached to Event Transfer (ET) system in blocking mode: every event goes through it
- One L3 per node to have maximum ET performance
- Multi-threaded to utilize entire node; very similar component is multi-stream multi-threaded event recorder
- Multiple nodes can be connected sequentially
- C/C++ library allows to find bank(s) in event and to create new bank(s) in the end of event, all in EVIO format

CLAS12 Level 3 development tasks

- Improve data bank access, speed up bank search (dictionary ?) and allows data bank drop and garbage collection operations (EVIO4 ?)
- Algorithms development: better segment finder, single width roads dictionary etc - anything which can bring down event rate and/or data rate
- FPDA-based cards can be designed to speed up processing, this way we can use algorithms developed already for Level 1
- Contributions welcome !

Conclusion

- DAQ, computing and network works as expected meeting current performance requirements
- Reliability improved but some problems still remains – work in progress
- Trigger system works as expected; improvements of the Level 1 trigger are reaching its limits, further development will be concentrated on Level 3