

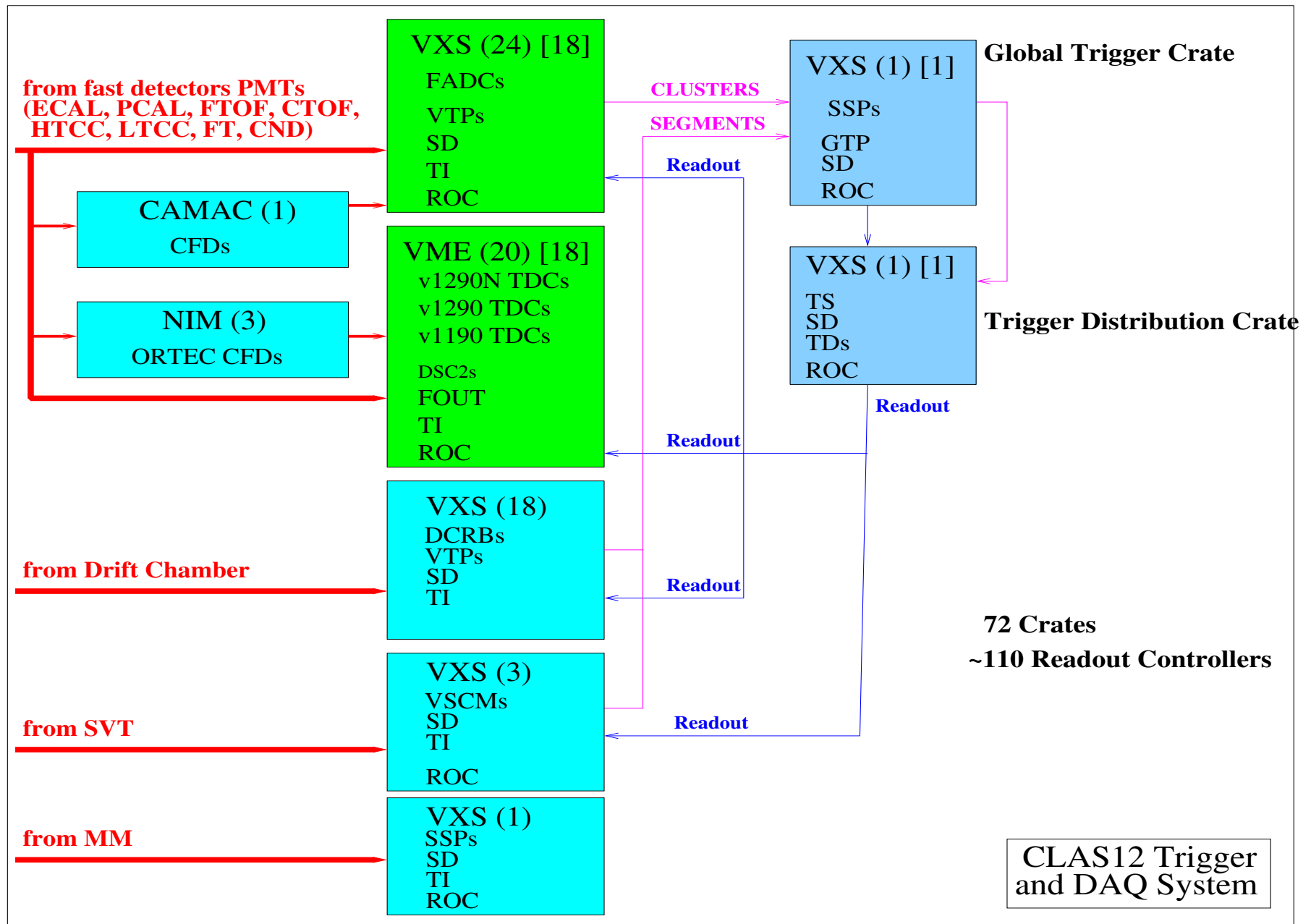
CLAS12 DAQ & Trigger Status

1. DAQ Overview
2. Trigger Hardware Status
3. Trigger Firmware Development
4. Remaining work and schedule

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DAQ/Trigger Hardware



CLAS12 DAQ Status

- Forward Carriage, **Subway(18 crates for Drift Chamber)** and Pie Tower electronics installed and operational (covers ECAL, PCAL, FTOF, LTCC and **DC**)
- Space Frame ~~and Subway~~ hardware is not installed, still in test setups (HTCC, CTOF, SVT, MM, FT), waiting for other activities to be complete; it seems we have enough boards, inventory still not finished **but we are making progress**
- Online computer cluster is 100% complete and operational
- Networking is 100% complete and operational
- DAQ software is operational, was used in HPS and in PRAD experiments, as well as in test setups, reliability is acceptable and performance exceeds CLAS12 requirements; some components still under development
- DAQ+Trigger whole system commissioning (outer detectors only) starts as soon as trigger components are installed including trigger firmware

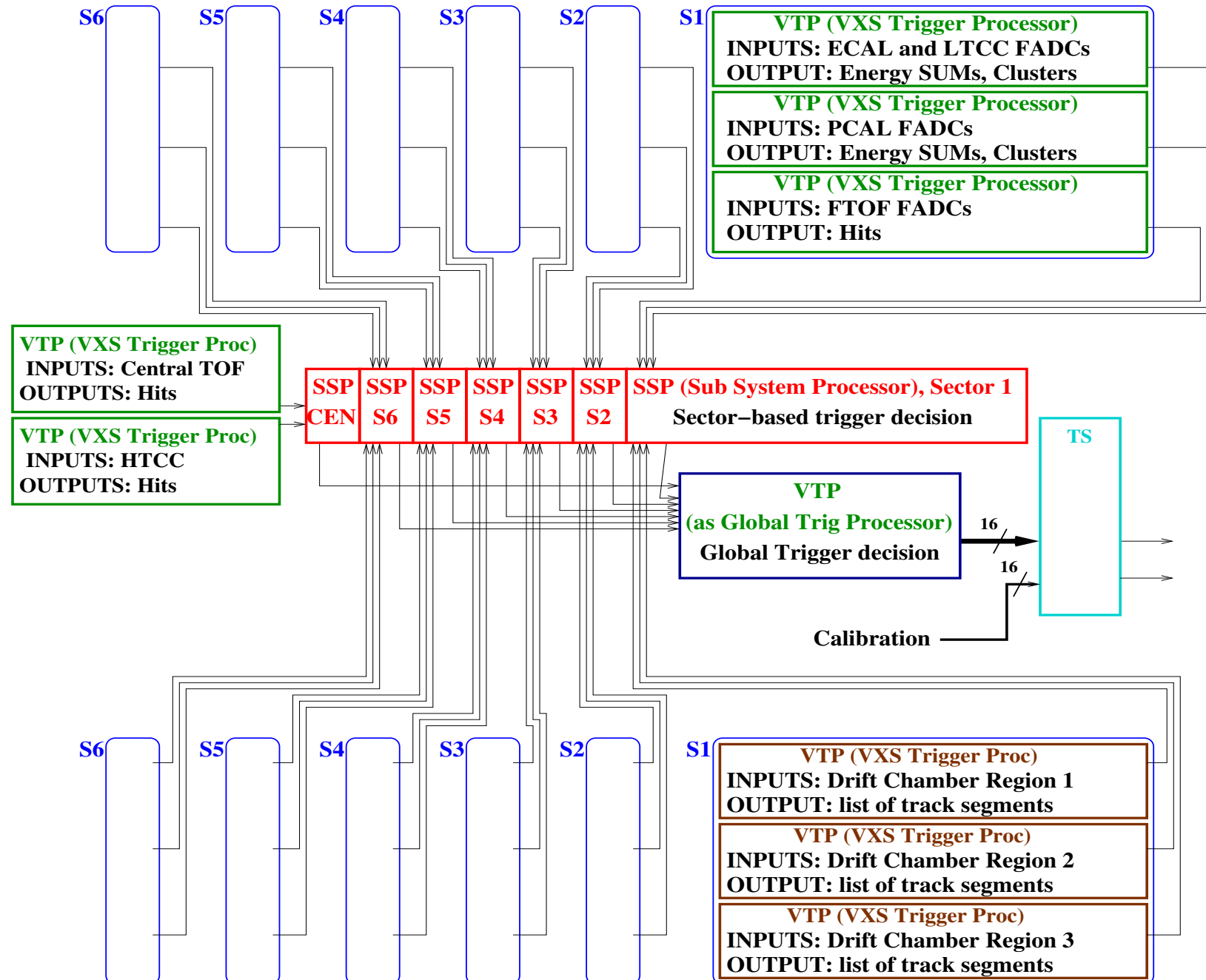
DC crates on Subway (Drift Chamber Sectors 1,2 and 6)



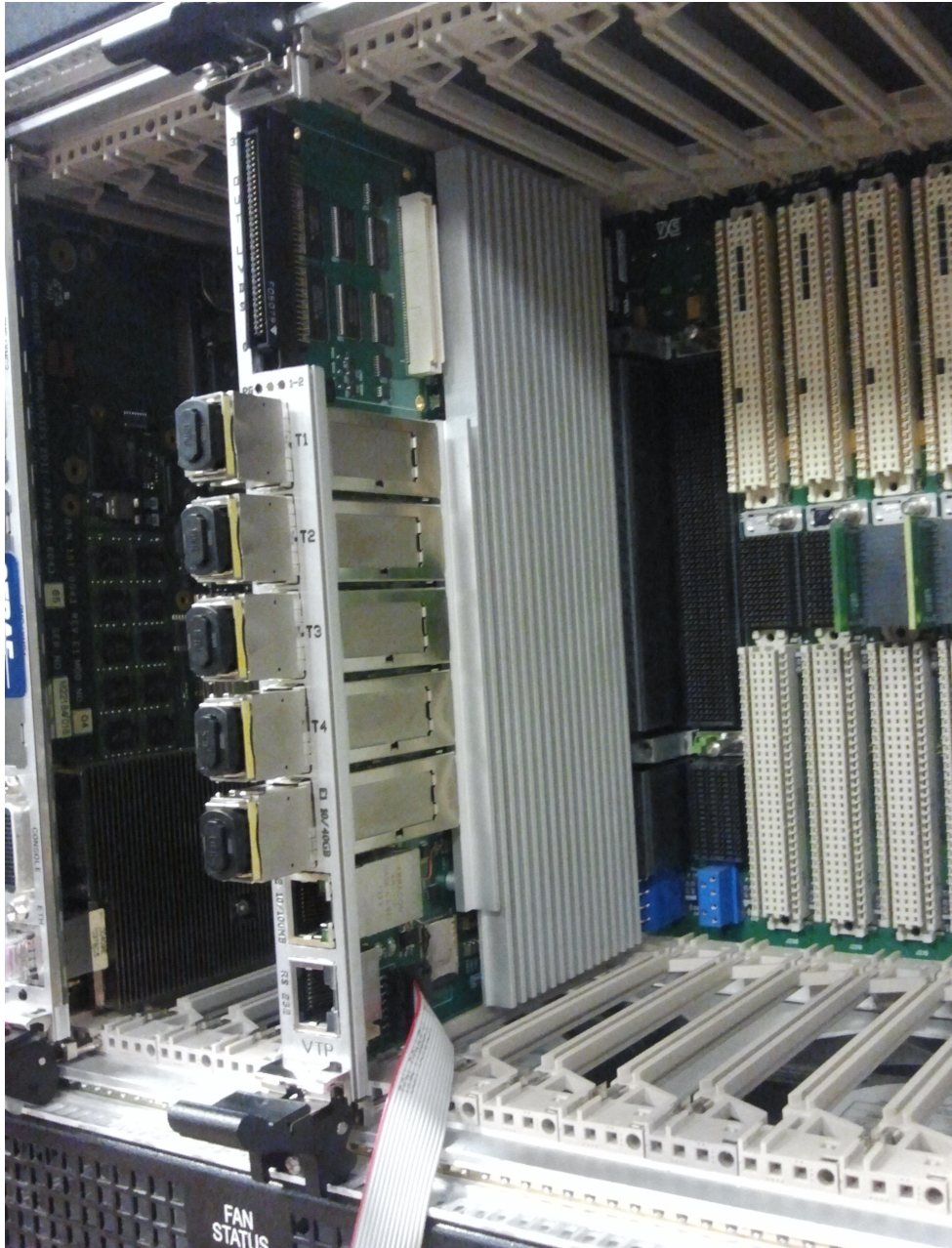
DC21 crate on Subway (Drift Chamber Sector 2 Region 1)



CLAS12 Trigger System Logic



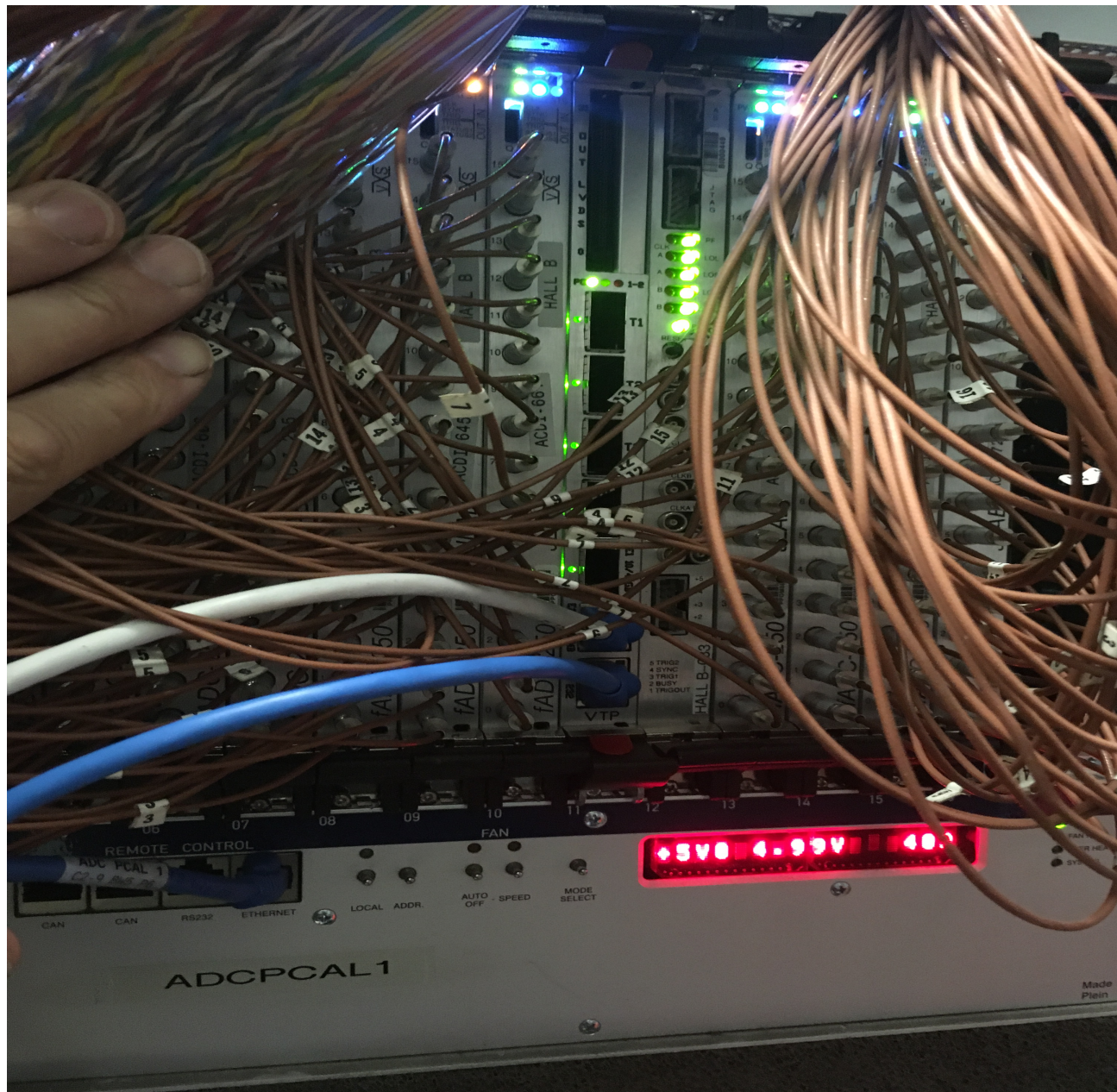
VTP (VXS Trigger Processor) - stage 1 and 3



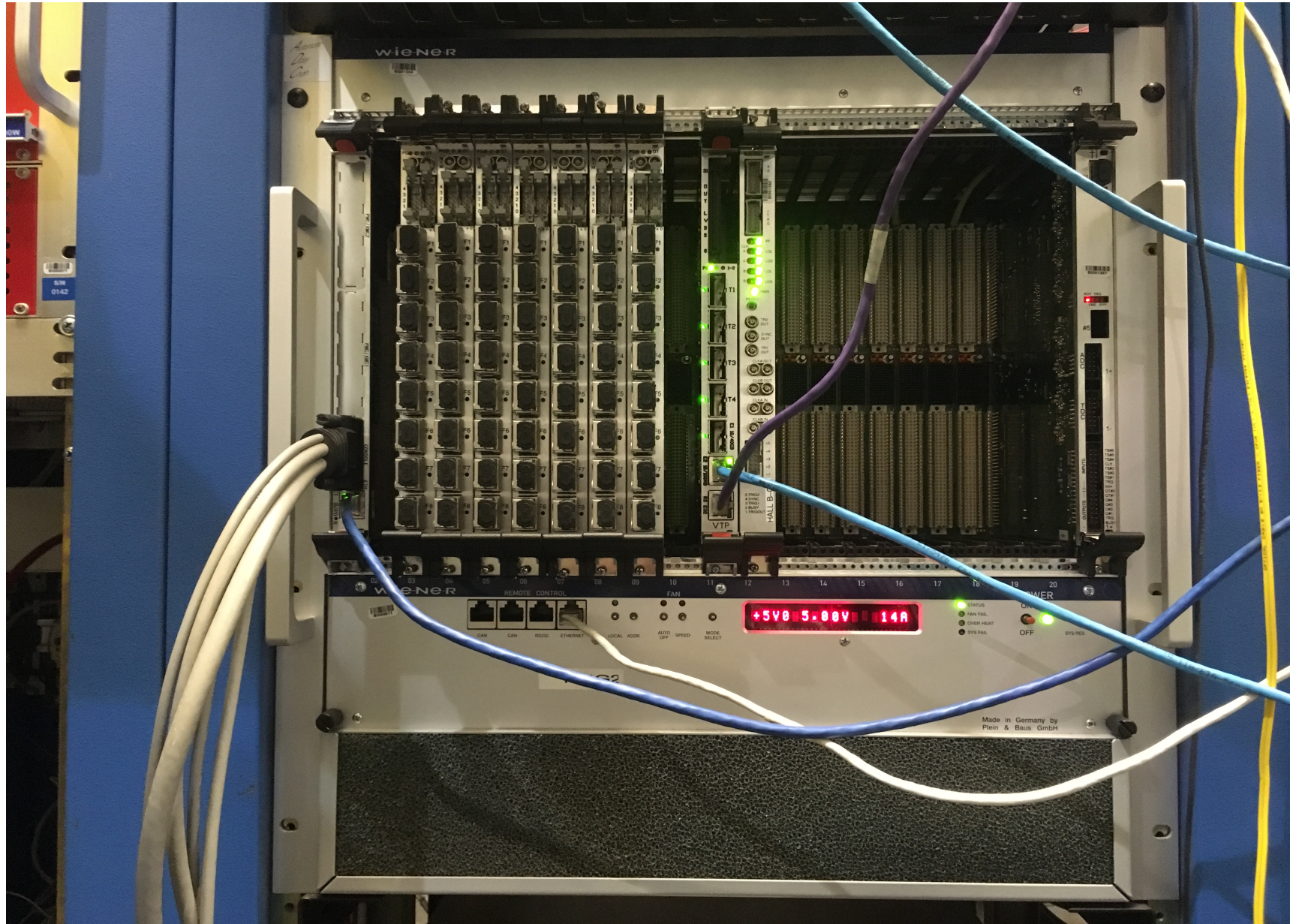
1. Four 5GBit links from each VXS slot (more bits for ADC integral, better timing resolution, possible use for readout)
2. 40GBit fiber uplinks (faster data transfer, connect several crates in parallel to form the trigger)
3. Big FPGA and 4GB memory to accommodate ECAL/PCAL clustering and Drift Chamber road finding
4. LVDS output to Trigger Supervisor, and custom IO card

W

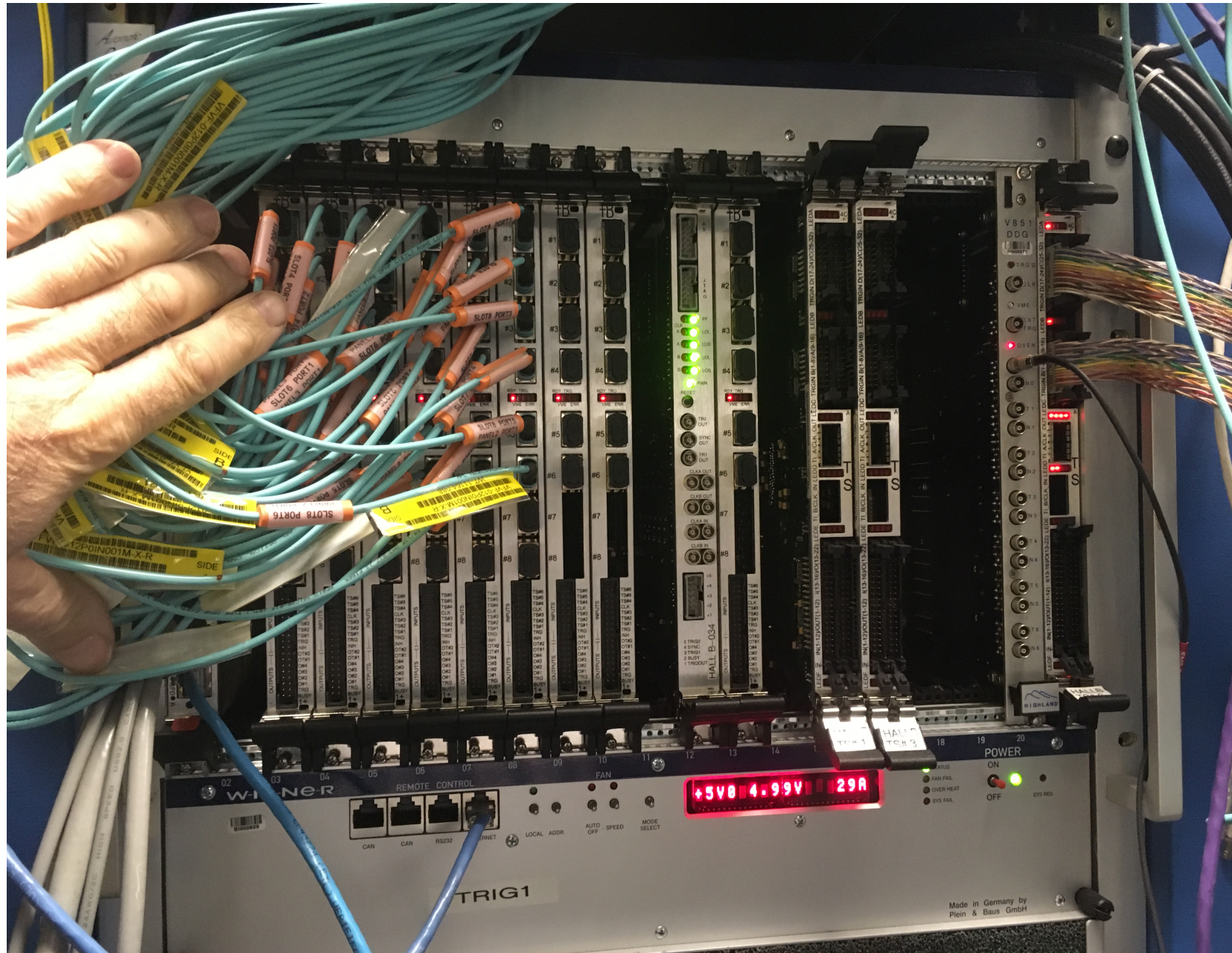
VTP (VXS Trigger Processor) in adcpcal1 (stage 1)



SSPs (Subsystem Processors) and GTP (Global Trigger Processor) – CLAS12 trigger stages 2 and 3



CLAS12 Trigger Supervisor and Trigger Distribution boards



CLAS12 Trigger Hardware Status

- All related electronics for outer detectors installed ~~except 1 and 3 stage boards (VTPs)~~ including 19 VTP boards (stage 1 and 3 of trigger system) in ECAL, PCAL, Region 3 Drift Chamber and main trigger crates; all trigger electronics (except HTCC and FT) is installed by now, wiring is in progress; 6 more VTPs are available
- ~~First VPT board was received two month ago, being evaluated by Ben Raydo, almost done, so far everything works as expected~~
- ~~Remaining 24 VTP boards will arrive in few days~~
- Linux installation on VTP is in progress (Bryan Moffit), following by CODA installation (Sergey); ~~completed in general, work continues on communication between CPU and FPGA and other components inside VTP board~~
- ~~Installation of all boards will start as soon as all features implemented including Linux and CODA installation, may take 2-3 more weeks~~ finished

CLAS12 Trigger Firmware

- Trigger algorithms development is in progress, primary goal is to deliver electron trigger (ECAL+PCAL+HTCC) with other detectors following
- Drift chamber road finding will be developed as well; it is not mandatory for the first run(s), but will do it now while manpower is available and to estimate possible VTP design change before buying 20 more boards for drift chamber crates

CLAS12 Trigger Firmware: development chain

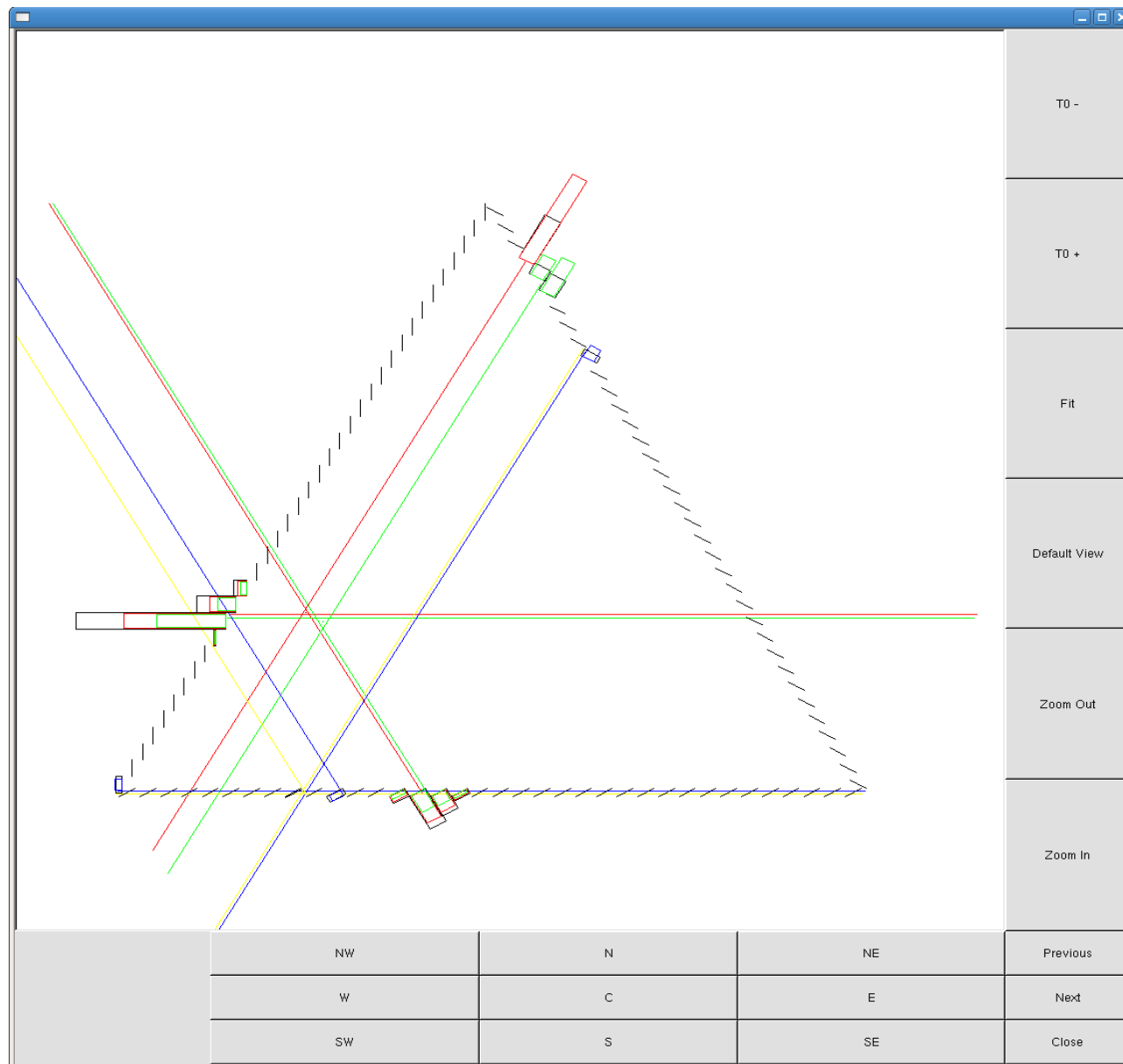
1. Existing reconstruction algorithms review – with detector group experts (Mac Mestayer for Drift Chamber, Cole Smith for ECAL/PCAL) and offline team if necessary
2. Modeling (in C using fixed point arithmetic), output comparison with offline reconstruction
3. VHDL code generation using Vivado HLS tool
4. FPGA loading and cosmic data taking (or playback if available)
5. Hardware trigger output must be identical with the one from modeling; if not, repeat steps 2-5

SO FAR: Items 1-3 (first pass) completed for ECAL and PCAL

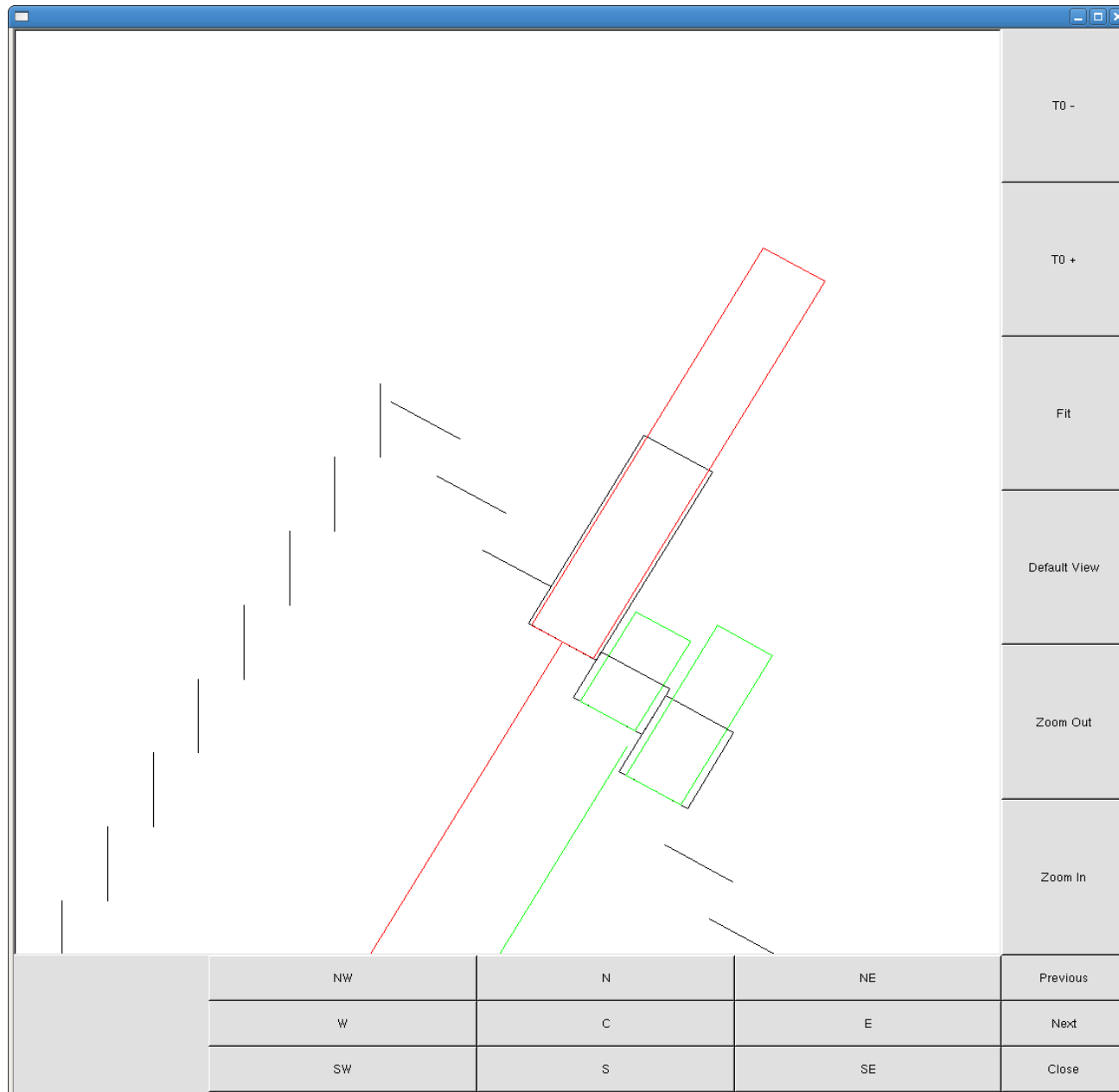
CLAS12 Trigger Firmware: recent progress

- GEANT-based data files being generated to be used for ECAL/PCAL trigger development (Cole)
- EVIO banks conversion procedures were developed to produce DAQ-like data banks from GEANT banks, and extract necessary information from ECAL/PCAL offline reconstruction for comparison purposes (Sergey)
- ECAL/PCAL offline reconstruction banks were modified by adding extra information (U-V-W coordinates) to make possible direct comparison with trigger results (Gagik)
- ECAL cluster finding and energy correction algorithm was developed, implemented in C and synthesized using Vivado HLS tool (Cole, Sergey)
- ECAL trigger output was compared with offline reconstruction (5GeV electrons, no PCAL) and shows good agreement (see following slides)
- Current version of ECAL trigger algorithm is ready for hardware implementation (Ben), several iterations will be needed
- ~~Work started on PCAL trigger~~ cluster finding algorithm for PCAL is complete and tested using GEANT and cosmic data; FPGA implementation is in progress
- close peak resolution and energy separation procedures for shared peaks were added into cluster finding algorithms for both ECAL and PCAL
- Work started on Drift Chamber road finding dictionary (Dave Heddle)

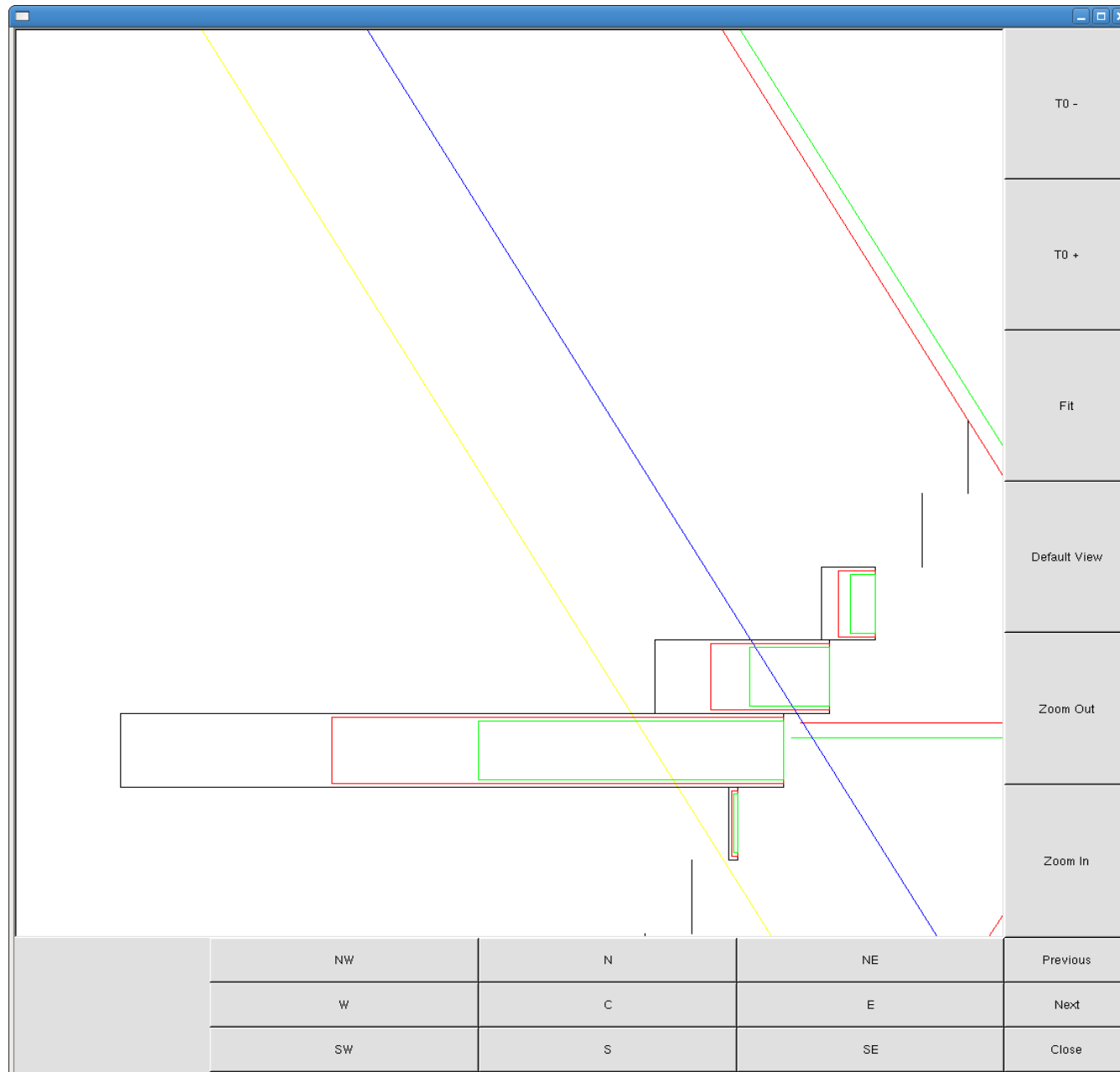
ECAL cluster finding: event with double peak and energy sharing (1)



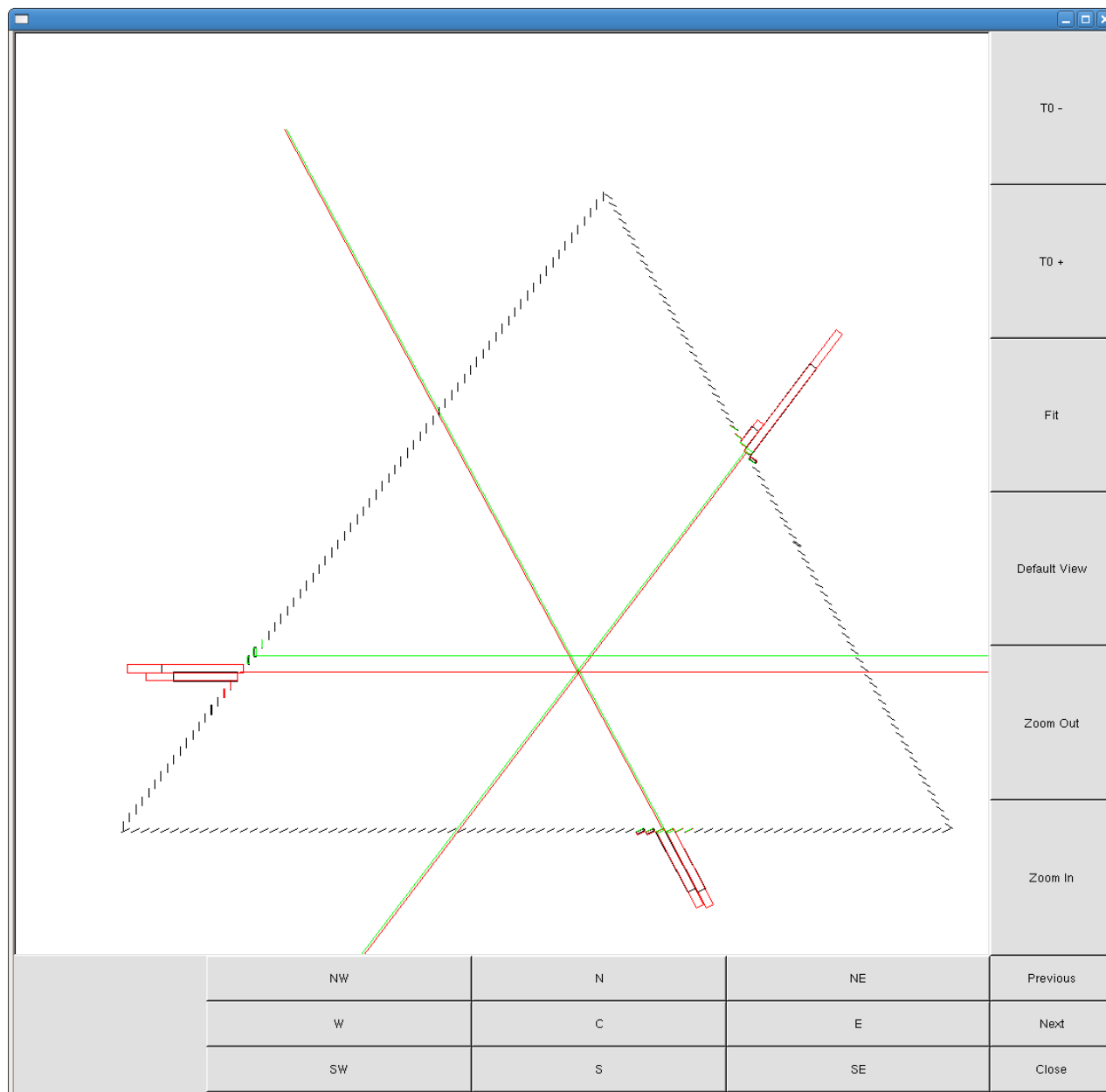
ECAL cluster finding: event with double peak and energy sharing (2)



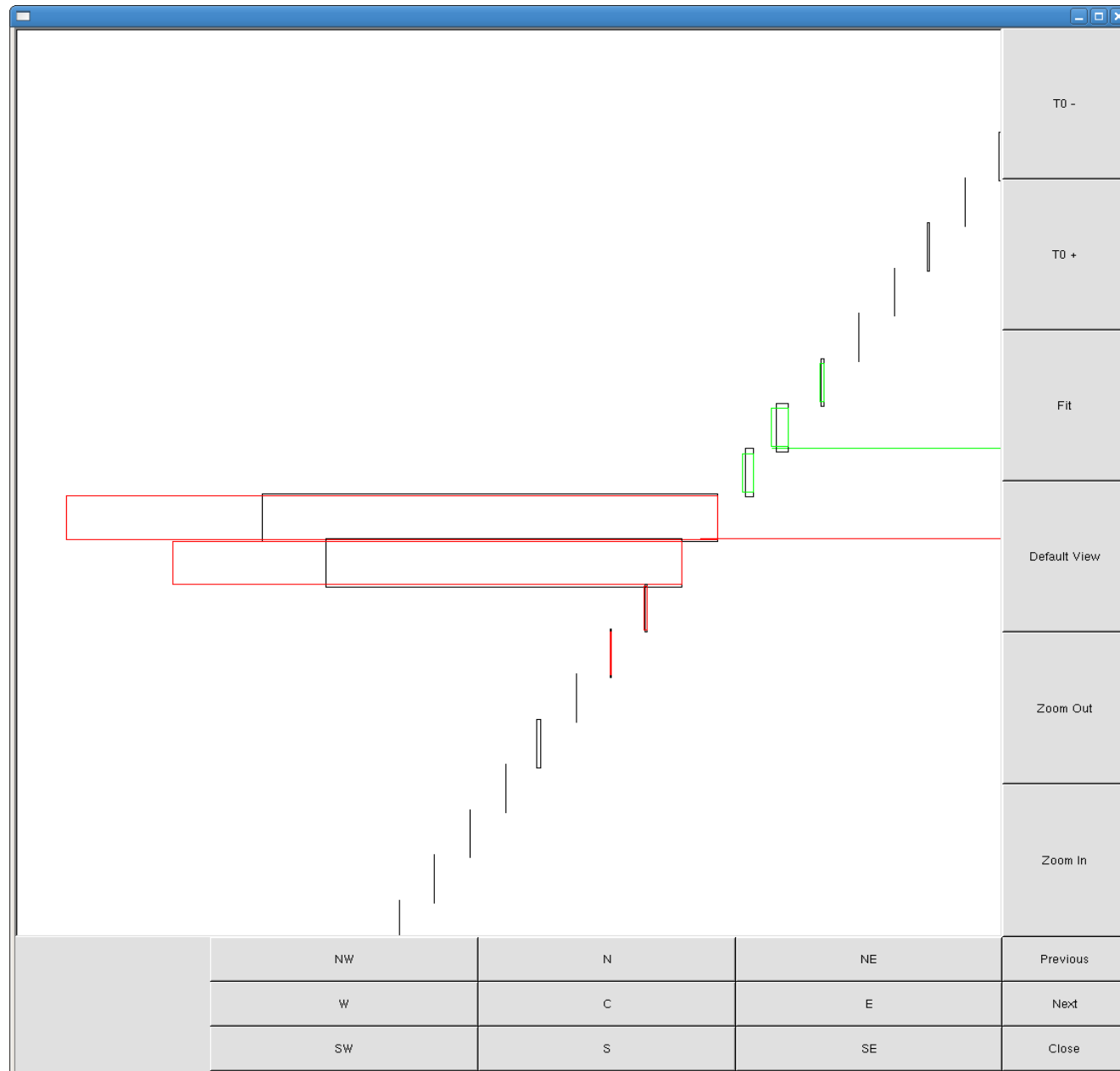
ECAL cluster finding: event with double peak and energy sharing (3)



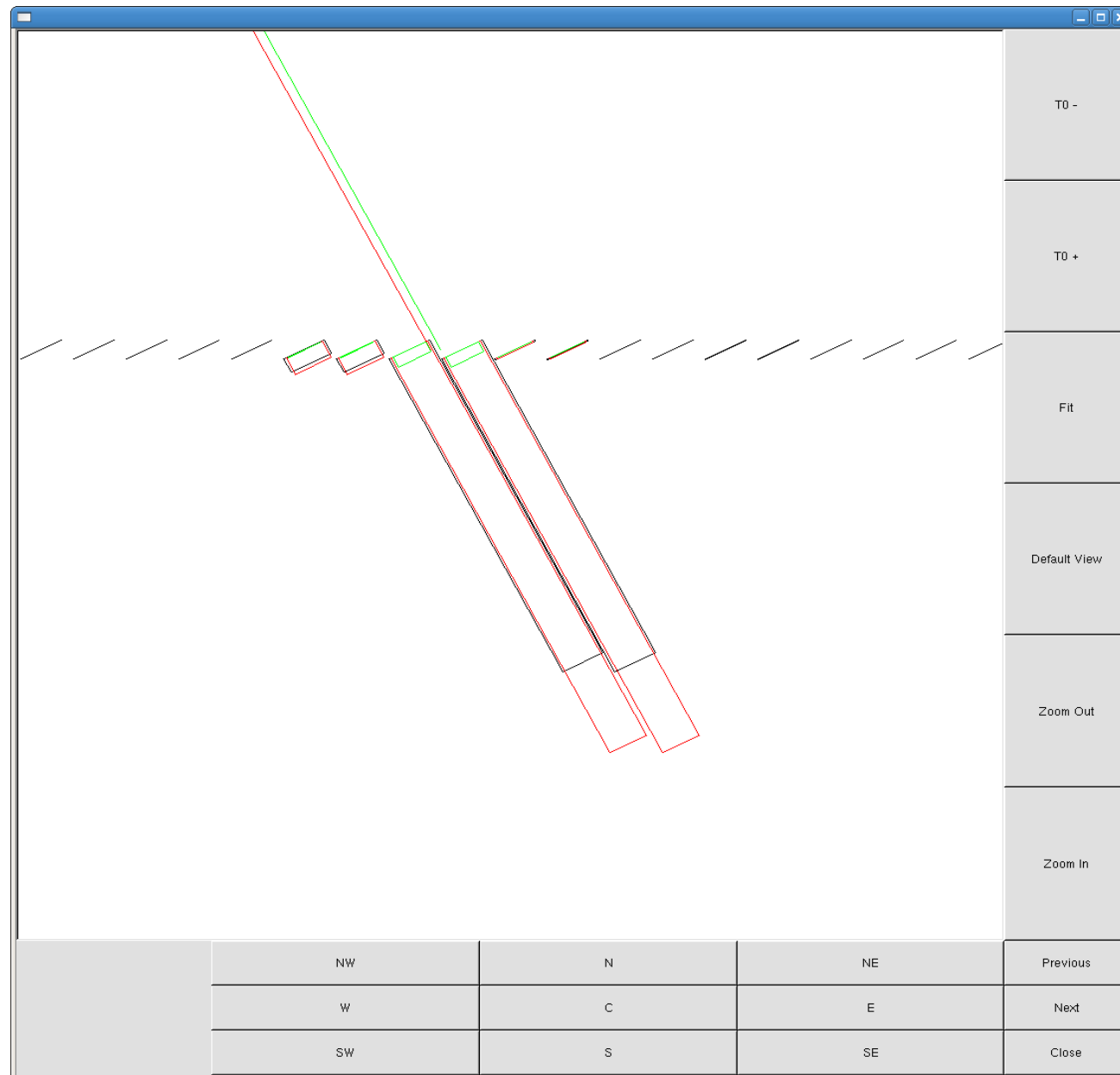
PCAL cluster finding: event with double peak and energy sharing (1)



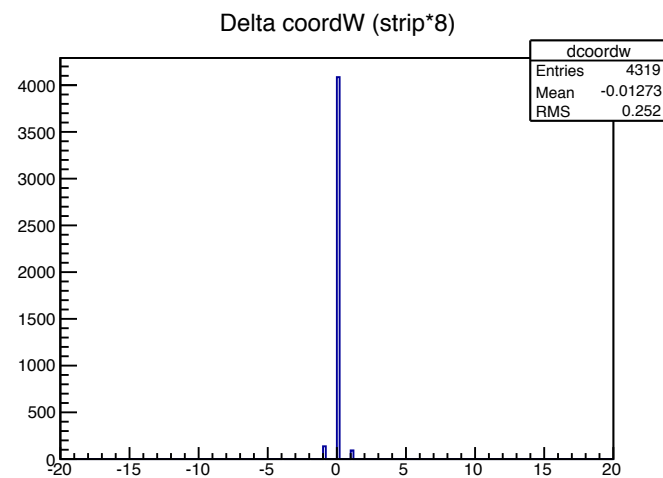
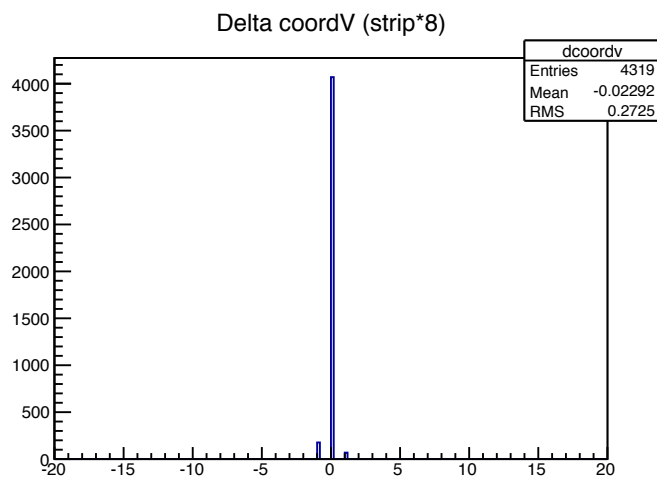
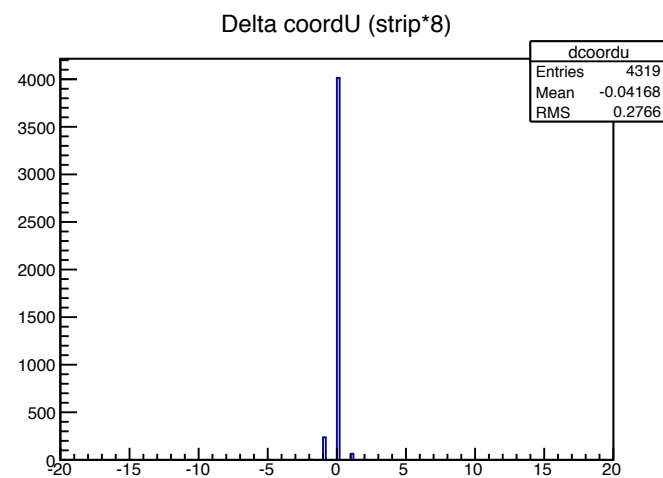
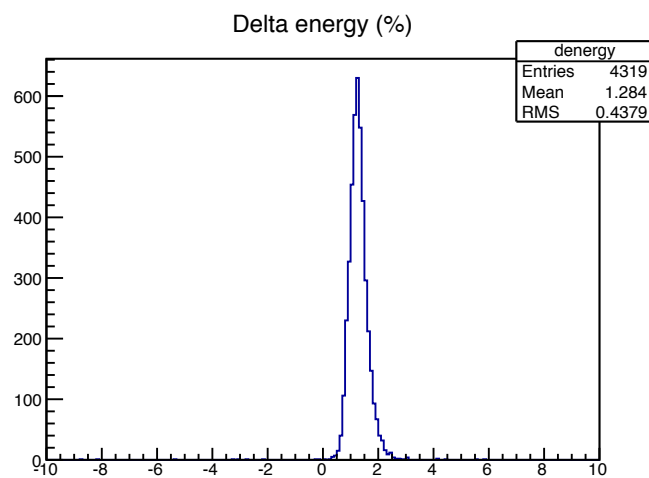
PCAL cluster finding: event with double peak and energy sharing (2)



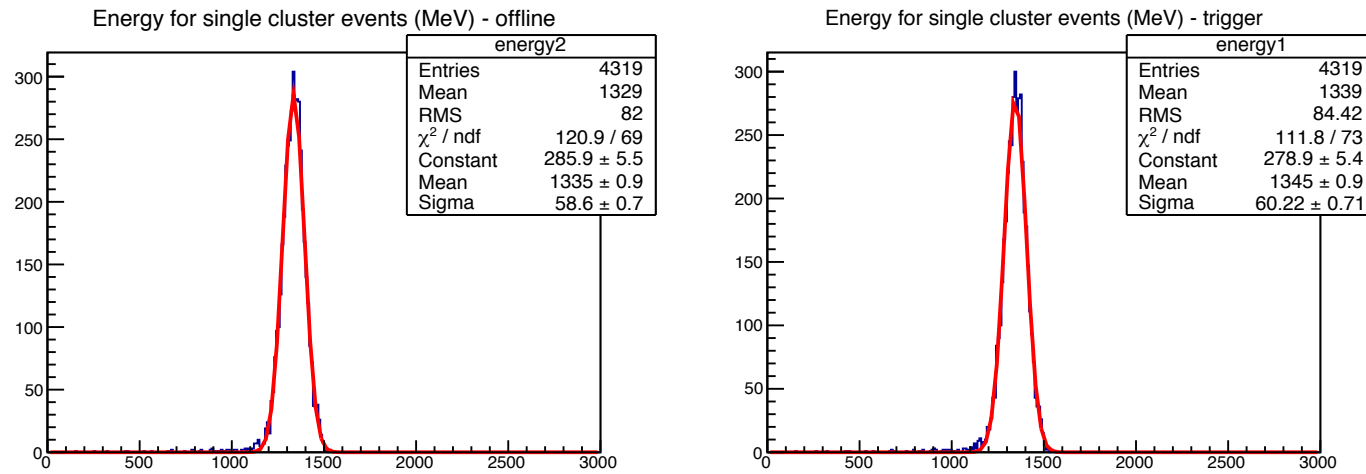
PCAL cluster finding: event with double peak and energy sharing (3)



ECAL cluster finding: difference offline-trigger model



ECAL cluster finding: 5GeV electron, no PCAL, energy deposition in offline and trigger model



Sampling fraction 27%

CLAS12 Trigger: Drift Chamber hit-based segments

Segment angle (-45..+45deg)

```

7> -----
6> -----X X-----
5> -----X XX-----X-----
4> -----XX-----XX-----
3> -----XXX-----XX-----
2> -----XXX-----XXX-----
1> -----XX-----XX-----
0> -----XX-----XX-----
-1> -----X-----XX-----
-2> -----X-----
-3> -----X-----XX-----
-4> -----XX-----X-----
-5> -----X-----
-6> -----XX-----
-7> -----X-----
-8> -----

```

Hardware Trigger

7>							
6>							
5>						X	
4>						XX	
3>						XX	
2>						XXX	
1>						XX	
0>						XX	
-1>						XX	
-2>						X	
-3>							
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-6>							
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Modeling

Wire number (112..1)

Remaining Work

- ~~VTP trigger board: first board studies, 25 boards installation and commissioning~~
- VTP/SSP/GTP boards trigger algorithms development: ECAL/PCAL/DC models, hardware implementation
- DAQ & Trigger electronics commissioning on Forward Carriage, Subway and Pie Tower
- ~~Space Frame DAQ electronics installation: remaining crates, boards, cabling, configuration~~
- Whole DAQ & Trigger System commissioning

Conclusion

- Main priority is trigger boards algorithms/programming: work in progress, finishing first model (ECAL **and PCAL**) and starting testing in hardware, following by ~~PCAL~~, Drift Chamber and ECAL+PCAL+HTCC **+Reg3DC with possibility for FT** decision
- ~~Significant~~ part of hardware (DAQ on ~~Subway~~ and Space Frame) still in installation stage, depends on other activities in the Hall, completion time cannot be set as that moment; good news is the all electronics is running in test setups
- Following months will be used to develop and install trigger system, and perform DAQ+Trigger commissioning for outer detectors and Drift Chamber if operational