CLAS12 DAQ and Trigger Upgrade

Sergey Boyarinov

Upgrade Workshop Feb 2, 2007

CLAS DAQ status

- DAQ system was upgraded significantly during last 3 years; we were running recently at event rate 9.5kHz, data rate at least 30MB/s and dead time less then 15%
- we are confident that required DAQ performance (10KHz and 100MB/sec at dead time <15%) will be achieved, however we should do better since 12GeV experimental conditions are not exactly known
- current plan to keep FASTBUS prevents us from using such solutions as free-running DAQ or multi-event readout; main improvement will come from new trigger (better events selection) and from Flash ADC usage (decreased front end busy time)
- since new trigger system is the main method to improve DAQ performance, it is very important to do trigger efficiency studies to justify entire DAQ upgrade

DAQ upgrade projects

- Flash ADC studies
- New Trigger System design
- Online Monitoring System and ROOT-based presenter (CLAS projects)

----> Lets look at FY07 plans to see where we are

Flash ADC studies for CLAS12

a) FADC boards studies <---------- DONE, EC cosmic file on raid disk (Sergey Pozdnyakov)

manpower: contract scientist

duration: 6 month

predecessors: none

work description: install and study Struck SIS3320 FADC board (12bit 200MHz 2eSST readout) in test setup and in Hall B; obtain data from CLAS detectors and compare them with Lecroy 1881M data; provide all necessary software libraries; study other FADC boards if available

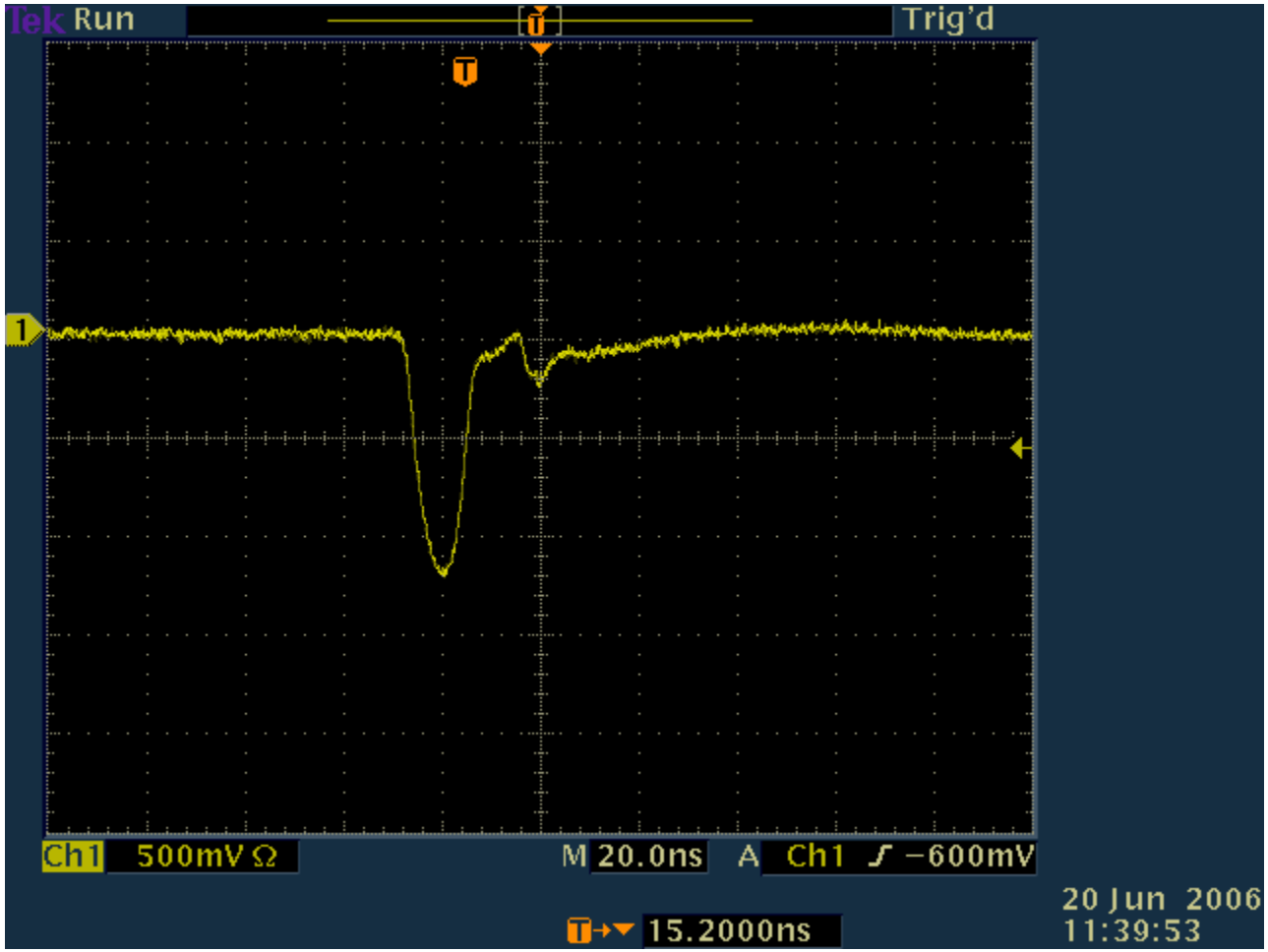
b) FADC data analysis <---------- IN PROGRESS, EC cosmic data analysis (Cole Smith)

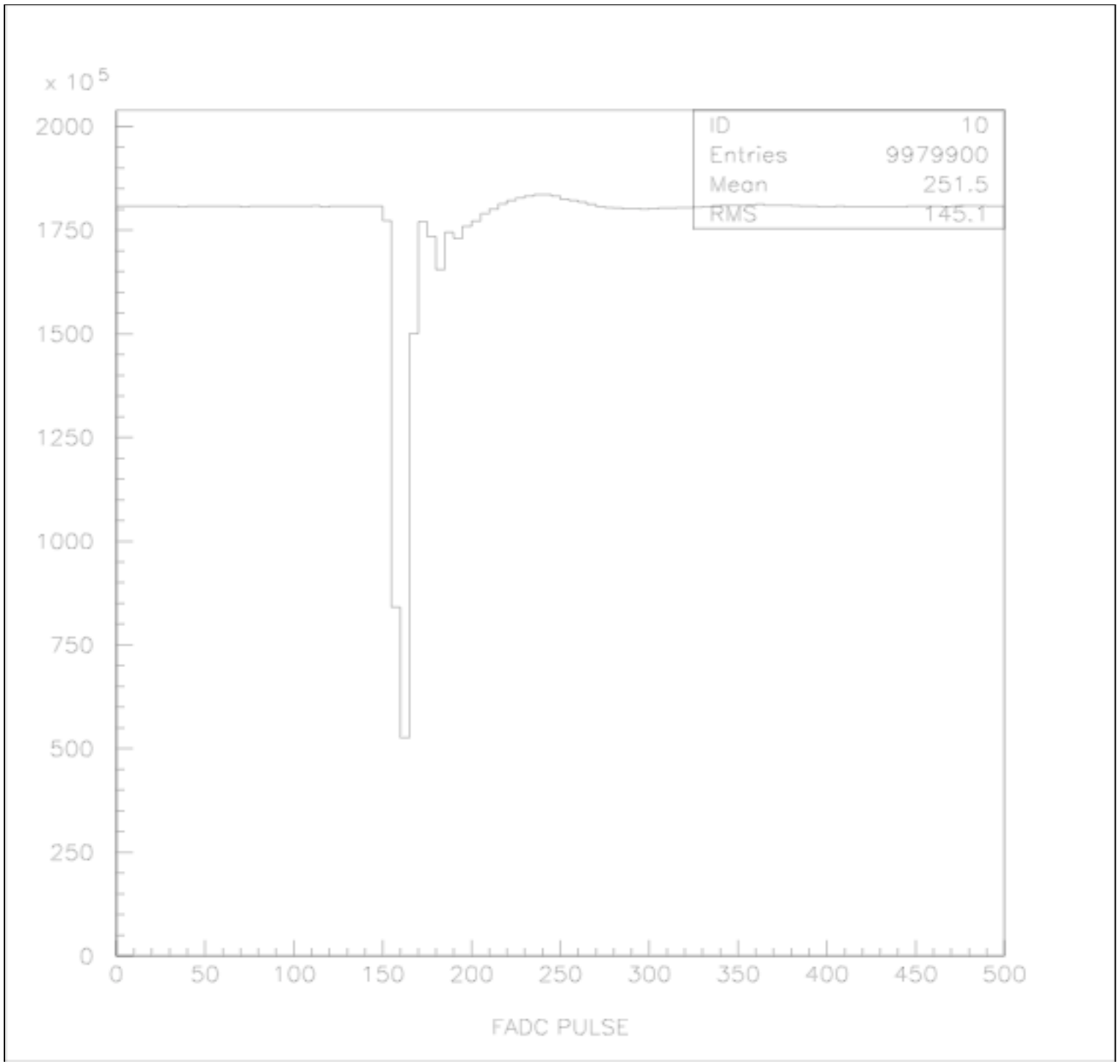
manpower: scientist

duration: 3 month

predecessors: (a)

work description: analyze FADC data offline; make decisions on data format and data processing algorithms, including recommendations for FADC sums output


Tek Run
Trig'd
Ch1 500mV Ω
M 20.0ns A Ch1 ƒ −600mV
15.2000ns
20 Jun 2006
11:39:53


x 10^5
2000
1750
1500
1250
1000
750
500
250
0
0
50
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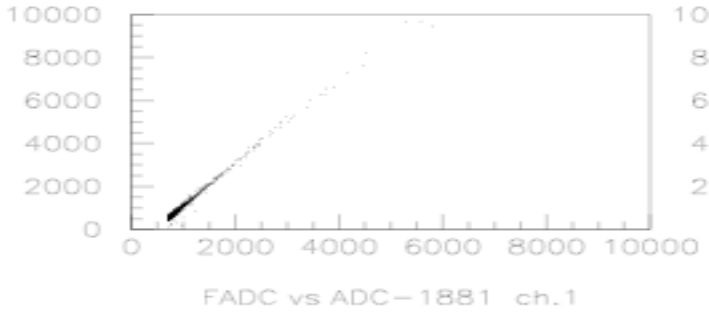
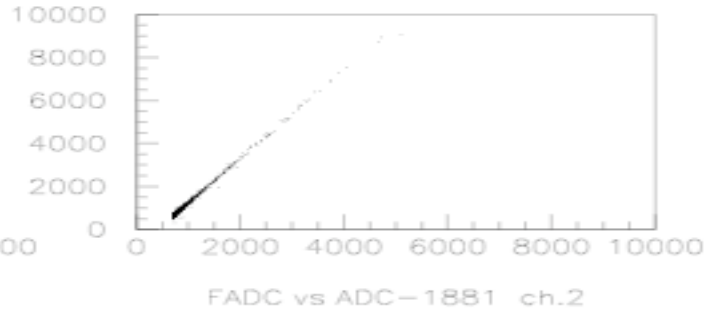
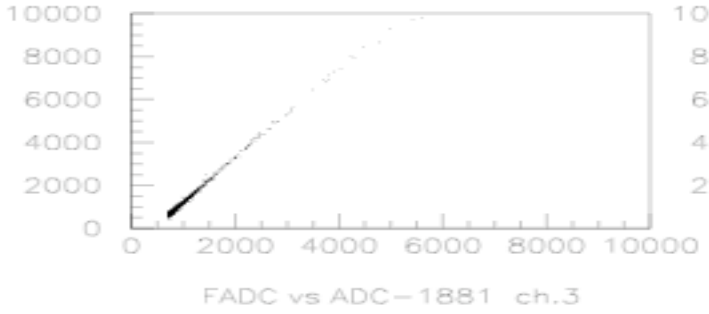
350
400
450
500
FADC PULSE
ID 10
Entries 9979900
Mean 251.5
RMS 145.1



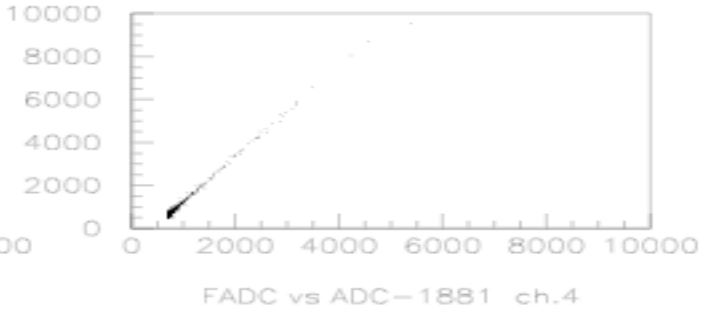
FADC vs ADC−1881 ch.1



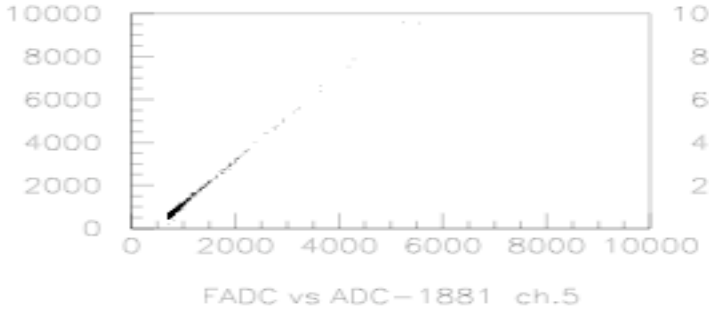
FADC vs ADC−1881 ch.2



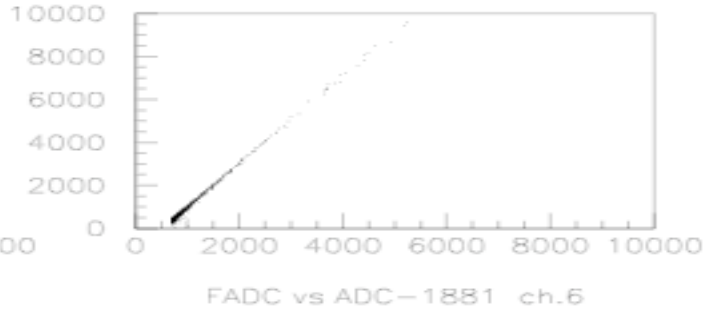
FADC vs ADC−1881 ch.3



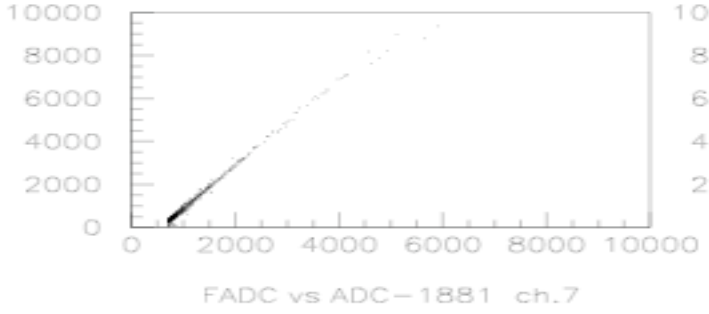
FADC vs ADC−1881 ch.4



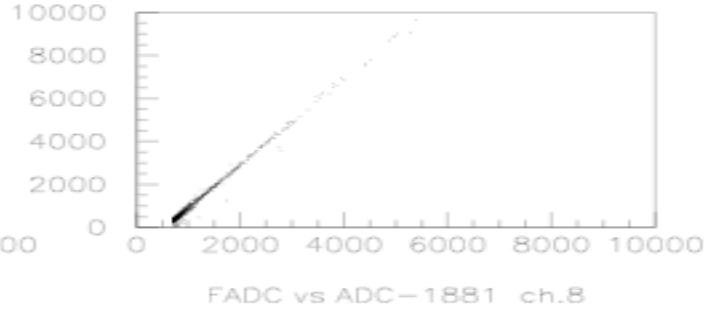
FADC vs ADC−1881 ch.5



FADC vs ADC−1881 ch.6



FADC vs ADC−1881 ch.7



FADC vs ADC−1881 ch.8

Possible contributions to CLAS12 projects: Flash ADC studies

Analyze Flash ADC data and make recommendations on data format, data processing procedures, Flash ADC outputs to Trigger System, Flash ADC parameters (frequency, resolution) etc. We have to:

- learn how to use Flash ADCs data
- learn how to produce information for trigger system

Since Cole Smith is working already, he may complete a job

CLAS12 Trigger System

a) Trigger System Conceptual design (physics level) <--- IN PROGRESS (several meetings held)

manpower: scientist

duration: 3 month

predecessors: none

work description: evaluate current Trigger System and its limitations; make a list of new components which can improve a trigger system; present the list of proposed components as a combination of level1 and level2 subsystems communicating to each other; include both existing and proposed detectors into the system; consider good electron identification as primary goal for entire Trigger System

b) Trigger System simulation, Level 1 (physics level)

manpower: scientist

duration: 3 month

predecessors: (a)

work description: study the efficiency of proposed components based on CLAS data analysis for existing detectors and simulation results for proposed CLAS12 detectors (if available); the list of components must include cluster finding in calorimeters and matching between different detectors incorporated into Level 1 trigger logic; fixed execution time must be provided for any trigger component; make final list of components which should be included into CLAS12 Level 1 trigger system

CLAS12 Trigger System (cont.)

c) Trigger System simulation, Level 2 (physics level)

manpower: scientist

duration: 6 month

predecessors: (a)

work description: study the efficiency of proposed components based on CLAS data analysis for existing detectors and simulation results for proposed CLAS12 detectors (if available); the list of components must include segment finding and road finding in tracking detectors, as well as matching of level1 and level2 outputs; fixed execution time must be provided for any trigger component; make final list of components which should be included into CLAS12 Level 2 trigger system

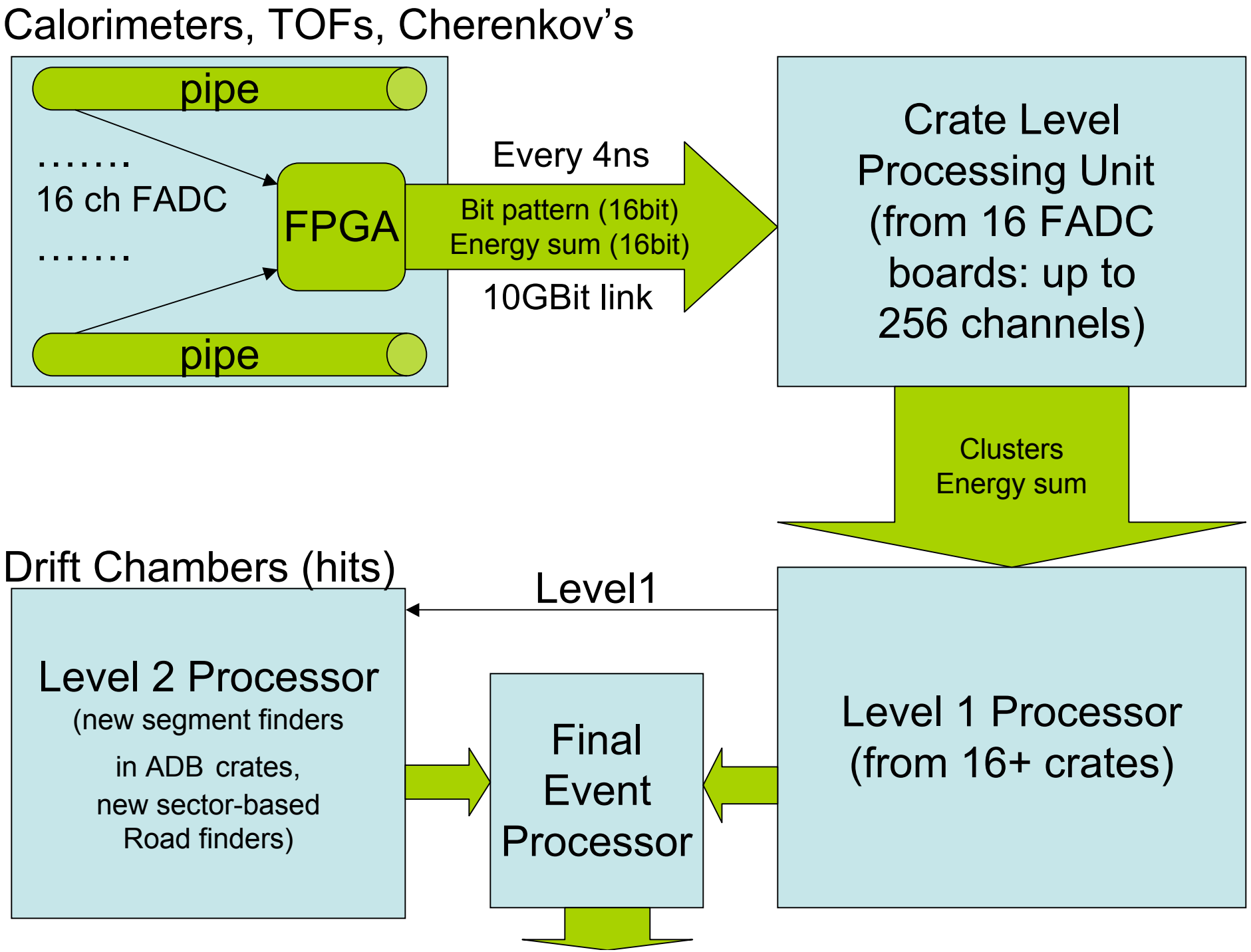
d) Trigger System Technical design (electronics level) <--- IN PROGRESS (Ed, Chris, Dave, Sergey, …)

manpower: scientist, electronic engineer

duration: 3 month

predecessors: (b)(c)

work description: study the possibility of implementation of the proposed trigger components on electronic level; redesign proposed algorithms if necessary to make them suitable for available electronics; analyze FADC sums and tracking detectors output requirements; present the first version of CLAS12 Trigger System Technical design


Calorimeters, TOFs, Cherenkov's
pipe
.....
16 ch FADC
.....
pipe
FPGA
Every 4ns
Bit pattern (16bit)
Energy sum (16bit)
10GBit link
Crate Level Processing Unit (from 16 FADC boards: up to 256 channels)
Clusters Energy sum
Drift Chambers (hits)
Level1
Level 2 Processor (new segment finders in ADB crates, new sector-based Road finders)
Final Event Processor
Level 1 Processor (from 16+ crates)

Missing part: Trigger Efficiency studies

- Electron identification using energy cuts and cluster finding in both calorimeters in conjunction with hits in time-of-flight and cherenkov counters (using both old and new detectors)
- Possible electron identification improvement using level 2
- Possible triggers for experiments without electron identification and for multi-particle experiments

Looking for person(s) with experience in CLAS data analysis or/and GEANT experience. No special online-related knowledge is required, all necessary help will be provided. Level of knowledge about offline/simulation software should be sufficient to let person(s) extract intermediate information not included into final Ntuples.

Trigger Project timeline

- Preliminary design: Dec 2006 - Jan 2007
- Efficiency studies: Jan-May 2007
- Electronics design: Feb-May 2007

Possible contributions in CLAS12 projects: Trigger System

1. We need to make a list of algorithms, new or currently used by offline analysis and online reconstruction, which can be useful in CLAS12 trigger system. At that point we do not worry about program language, algorithm complexity etc, we rather need good ideas. Clear understanding of future experiments is required (electron trigger only, multi-particle trigger, multi-level trigger, special conditions etc).

2. Efficiency studies must be completed for those algorithms using real data (or simulated data for new detectors). We have to make sure that we are not loosing 'good' events, and rejection factor for 'bad' events is reasonably high. Results are important to justify CLAS12 DAQ upgrade.

3. Future program implementation of those algorithms must satisfy trigger system requirements: have constant execution time, be suitable for electronic implementation etc. Electronic group personal must be involved, and other groups experience have to be studied.

‘After CD2’ plans
(CLAS projects)

Online Monitoring System upgrade (CLAS project)

a) Standardization of physical components information <--- IN PROGRESS (3.14 EPICS, soft ioc's)

manpower: scientist(s)

duration: 6 month

predecessors: none

work description: in cooperation with CLAS detector groups, summarize all previous troubleshooting experience for every CLAS detector; make a list of EPICS CA records sufficient to deliver all necessary monitoring information, enforcing convenient channel naming scheme; implement data quality controlling IOC, as well as any other IOCs required to deliver all necessary information; implement monitoring functions only, but make sure it will be easy to add controlling functions in future; perform extensive test to check IOCs reliability and performance

b) Logic diagrams development

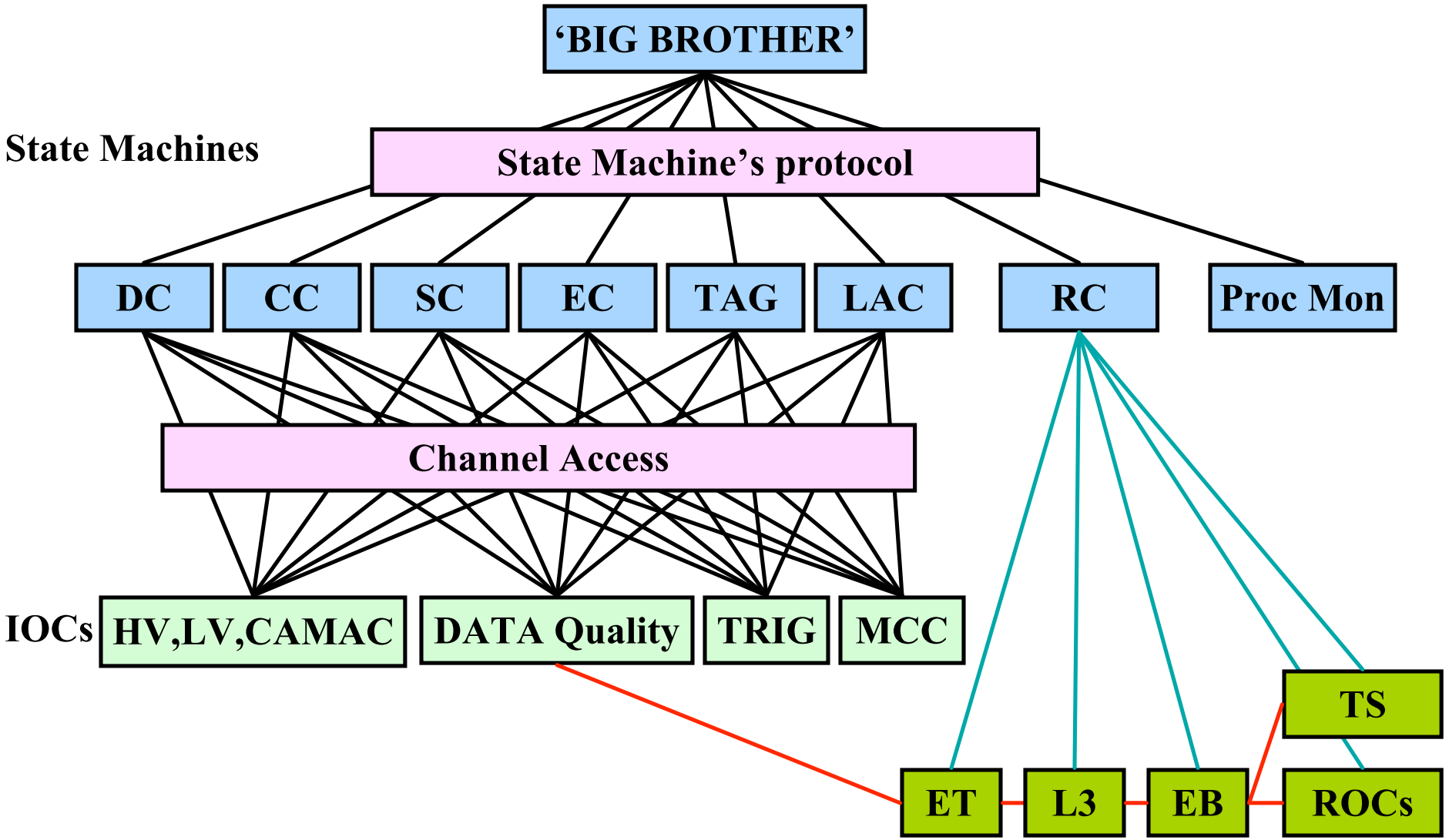
manpower: scientist(s)

duration: 3 month

predecessors: none

work description: develop logic diagrams necessary to describe all possible situations in CLAS detector operation: production data taking, calibration runs, DAQ test runs, troubleshooting, recovery etc; two-level concept shown on following figure should be used as guideline but final scheme can be different; consult with CLAS detector groups to make sure all possible situations are covered; both monitoring and control logic must be developed; final diagrams can be presented in any appropriate form

Online Monitoring System upgrade: possible implementation



Online Monitoring System upgrade (cont.)

c) Program implementation of new monitoring system

manpower: scientist

duration: 6 month

predecessors: (a)(b)

work description: implement new CLAS Online Monitoring System based on information scheme provided in (a) and using logic diagrams developed in (b); monitoring part only have to be implemented but it must be possible to add controlling functions later; system must include at least error alarms and error logging; one of the available frameworks such as CODA AFECS, CERN/BaBar SMI++, CERN Exp. Control (SCADA PVSS & SMI++) and probably commercial tools should be considered as framework candidates; extensive tests must be performed, focusing on false alarm prevention; beam time will be provided

ROOT-based presenter (CLAS project)

a) Develop standard ROOT-based presenter for CLAS Online System

manpower: scientist

duration: 6 month

predecessors: none

work description: develop ROOT-based server, which can accept information from ET system, CA and ROOT-based clients, create current run histograms and provide access to them, create and store histogram files for every run; revise 'mini-hbook' package used to create histograms and send them over ET system; modify Event Recorder to prevent histogram banks from going into data file; develop ROOT GUI(s) to be used in Counting House to display information from ROOT server and ROOT files; provide two methods to access ROOT objects from outside of Counting House: locally installed ROOT GUI and web-based interface (consider Carrot project); provide user-friendly ROOT GUI configuration files to define the number of GUI pages and their layout, the list of histograms to be presented on every page, histogram view (histogram/timeline/scalers etc), accumulating mode etc

b) Incorporate existing PAW-based and ROOT-based applications into new presenter

manpower: scientist

duration: 3 month

predecessors: (a)

work description: develop generic CLAS-oriented ROOT client framework which can accept data from ET system and CA, create histograms and deliver them to ROOT server using ROOT communication facilities; develop new event_monitor program using ROOT client concept and preserving old version functionality; include existing ROOT presenter(s) into new scheme

Conclusion

- Trigger System and Flash ADCs are main missing parts of CLAS12 DAQ System and under active development
- CLAS12 Trigger system efficiency studies is one of the most important projects and is not covered yet
- Contributions to CLAS projects (Online Monitoring System and new ROOT-based presenter) are welcome