GlueX Collaboration Meeting

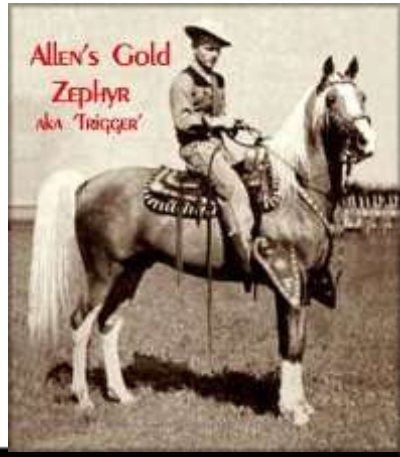
May 12-14, 2014

12GeV Trigger Electronics

R. Chris Cuevas

Trigger Hardware/Firmware Status

- Global Trigger
- Installation & Commissioning
- Summary



Trigger Hardware Status

William Gu
Ben Raydo
Bryan Moffit

- **T**rigger **S**upervisor (**TS**) - **Complete**
  - No open issues
  - '3rd' Trigger crate installed in U1-14 to support separate FDC-CDC DAq
    - ROC, TS→ SD→ TD needed in the 3rd crate
    - Fiber patch cables will be reassigned to 3rd crate TD when needed

- **T**rigger **S**upervisor **I**nput/**O**utput (TSIO) – **Complete**
  - ✓ Rear transition board tested with Densishield cable from GTP

- **G**lobal **T**rigger **P**rocessor (**GTP**) – **Complete**
  - Progress from last collaboration report includes test verification of CODA libraries before revision release. (Ben, Bryan, D. Abbott)
  - CODA process runs on embedded Linux OS on the GTP
  - Interface through Ethernet for configuration and diagnostics

Trigger Hardware Status

William Gu
B. Moffit
D. Abbott

- **TI** – **TD** **T**rigger **I**nterface – **T**rigger **D**istribution - **Complete**
  - TI-Master units installed and are permanently wired to support partial readout of large detector subsystems. (BCAL, FCAL)
  - TD firmware and TI firmware versions are stable and supported with CODA3 libraries
  - New feature added to TI ←→TD fiber optic link. ROC ID information is transferred so the fiber link source and destination is available for verification.
- **S**ub**S**ystem **P**rocessor (**SSP**) - **Complete**
  - Firmware version 1.0 and CODA3 library complete
  - New feature added to **SSP** ←→ **CTP** fiber optic link. Information is transferred so the fiber link source and destination is available for verification.
- **S**ignal **D**istribution (**SD**) - **Complete**
  - New firmware development is progressing to use VXS lanes from SD to TI for diagnostic data transfer. Other applications have been discussed.

Crate Trigger Processor

Hai Dong
Jeff Wilson

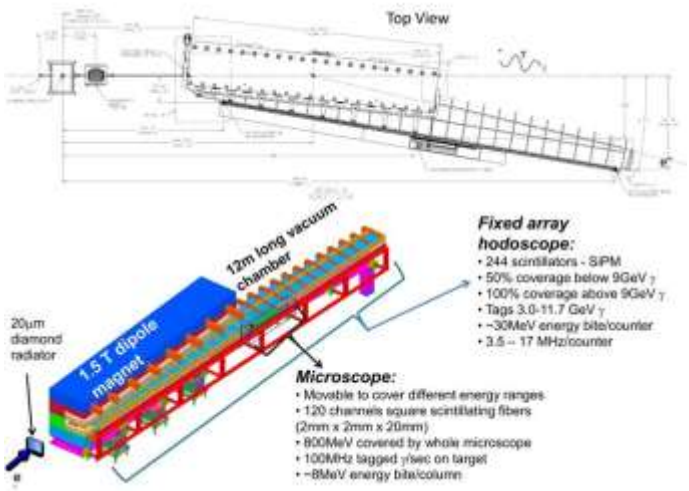
- **C**rate **T**rigger **P**rocessor (**CTP**) - **Complete**
  - ✓ Production quantities (30) for Hall D
- **All** production boards pass (FCAT)
  - **F**ull **C**rate **A**cceptance **T**esting
    - ✓ CTP boards delivered to Hall D group
    - ✓ CTP boards installed in L1 crates
      - ✓ BCAL
      - ✓ FCAL
      - ✓ TOF
      - - Tagger
        Waiting for Tagger crates and Trigger fiber optic cable installation
      - - PS, ST crates not populated yet

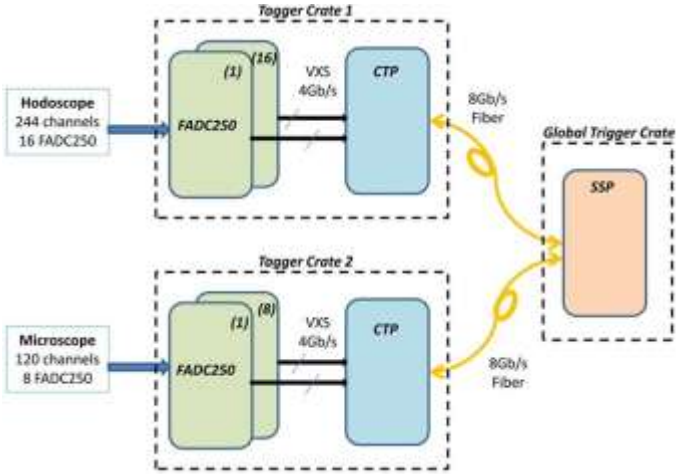
✓ Energy Sum algorithm for FCAL and BCAL has been modified to handle baseline fluctuations and noise. Channel thresholds, and baseline values are stored.

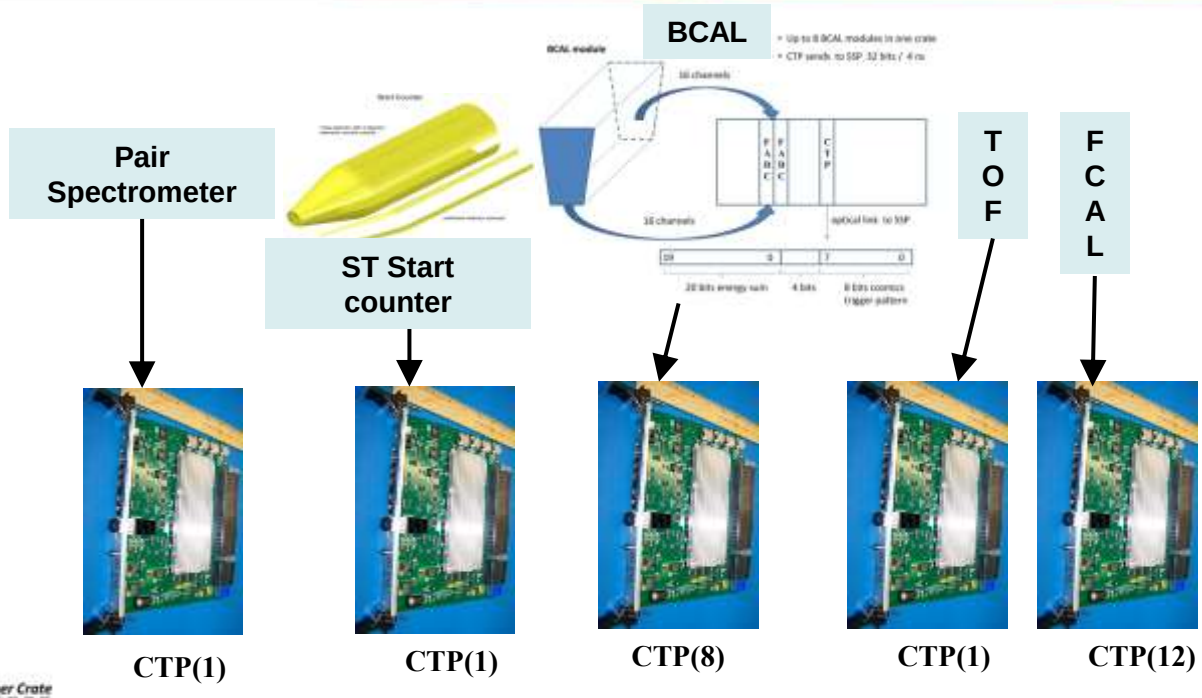
✓ BCAL cosmic trigger firmware is complete and handles channel organization from each BCAL module. 'Sliding time window' allows for pulses to be captured from each end of the module.

Crate Trigger Processor - Firmware

Hai Dong
A. Somov
B. Moffit







- Significant firmware development, simulation and testing has been completed and includes requirements for Scaler (counters) for diagnostics and histograms. PS, ST, and TOF specific trigger features are progressing nicely.
- CODA libraries are in progress, and testing is an ongoing activity.

Trigger Hardware Status

F. Barbosa
H. Dong
E. Jastrzembski
Jeff Wilson

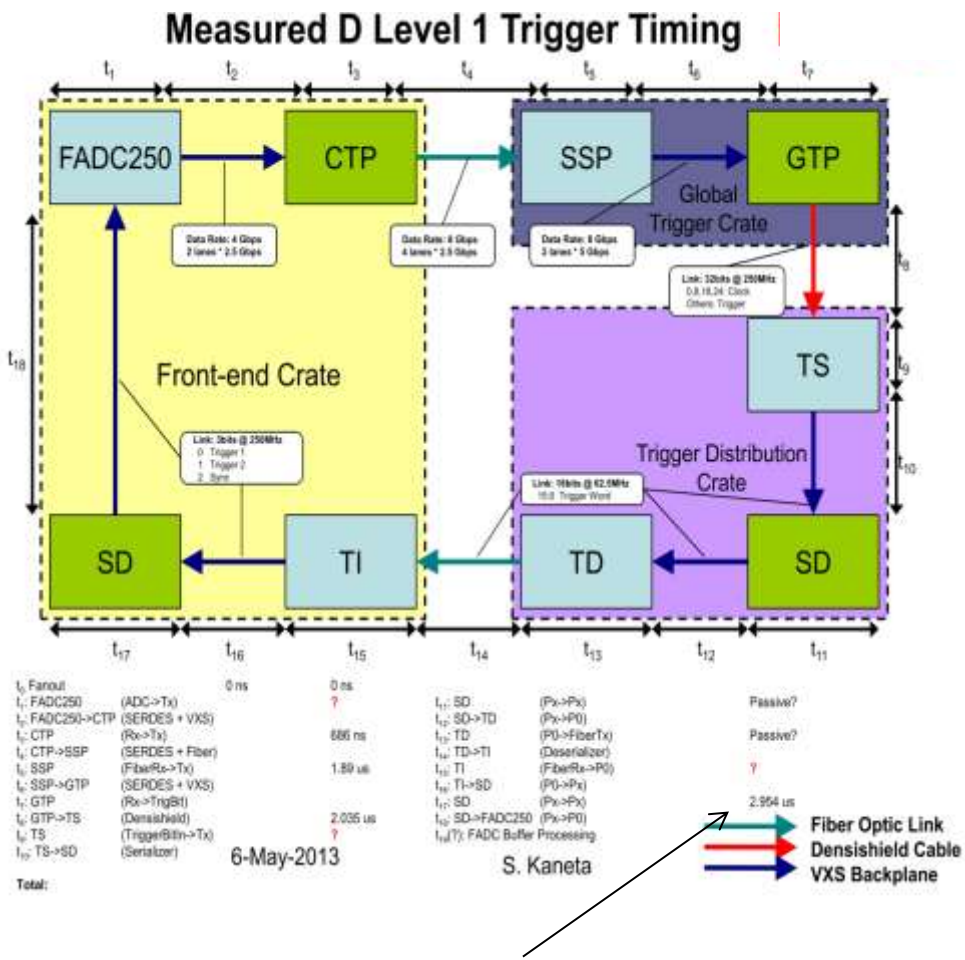
- **F**lash **ADC** 250Msps (**FADC250**)
  - *See Fernando's update also*
  - ✓ "Mode 6" (TDC algorithm) has been corrected from initial release. New firmware for this mode has been tested thoroughly.
    - Readout data includes pulse integral value and time stamp value is high resolution (LSB=62.5ps; 6-bits)
    - This mode will be used for production Physics operations and will be required for maximum trigger rate
  - Firmware iterations for Trigger applications (i.e. BCAL, Tagger, etc.) are ongoing.

- See Bryan Moffit's DAQ site that contains the latest Jlab Module Manuals with notes for relevant firmware version

  https://coda.jlab.org/wiki/index.php/JLab_Module_Manuals
  - Firmware change request method is working well

Ben Raydo
William Gu
B. Moffit

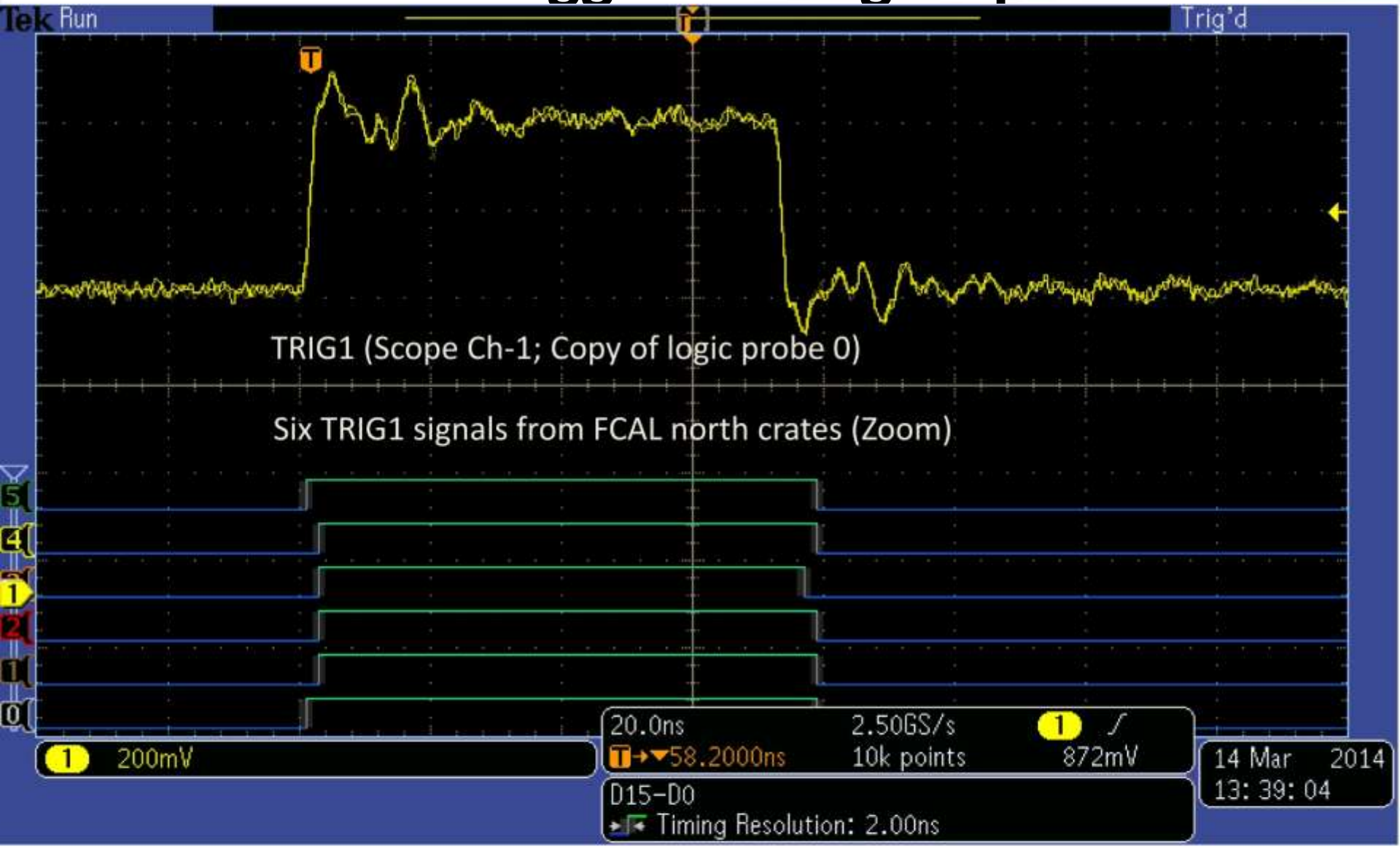
Global Trigger Testing - Update



2.954us
Measured full 'round trip' trigger latency

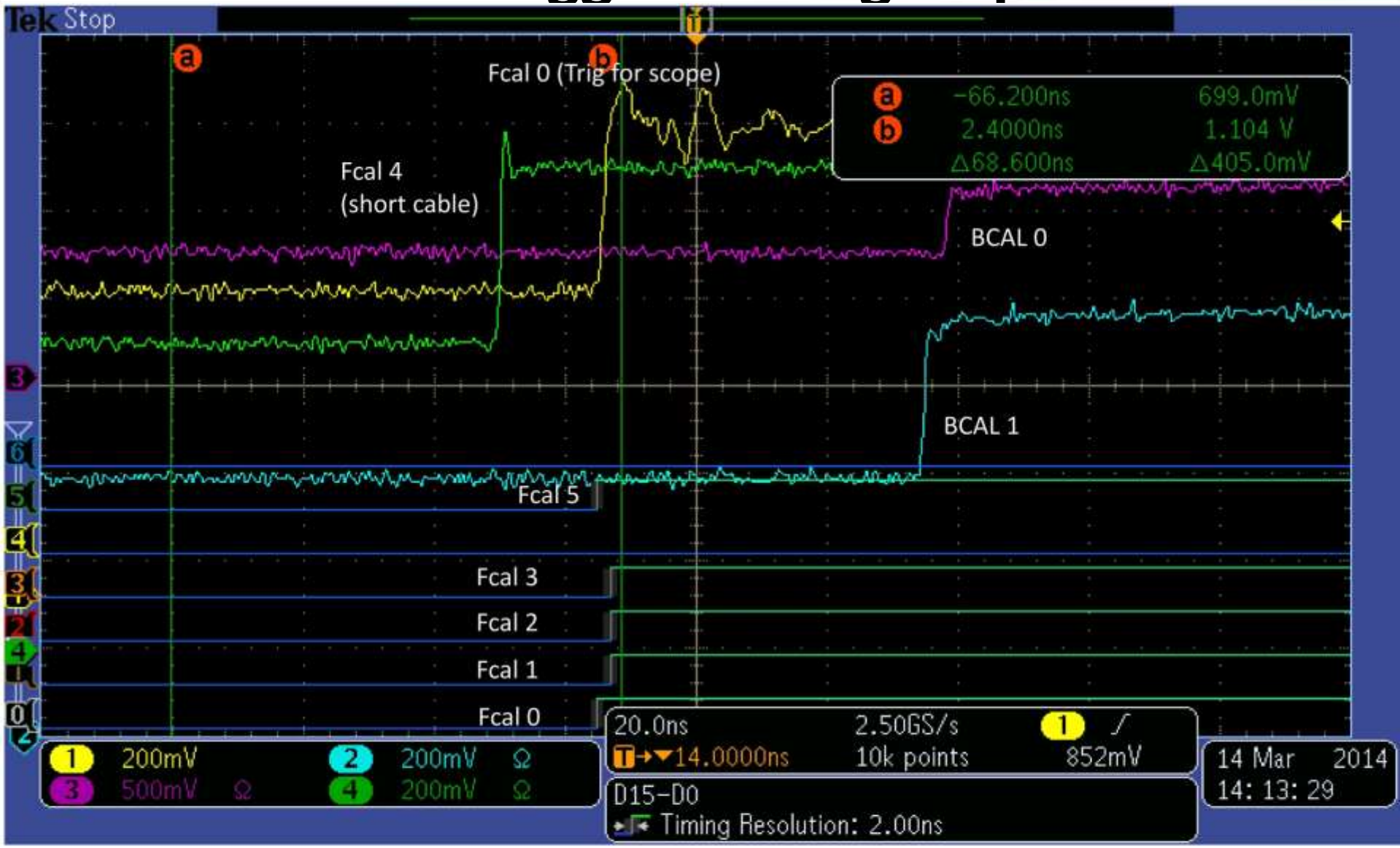
- Significant installation activities have been completed since moving the Global Trigger crate and TS⇔TD crate to the Hall on . 17-Feb-2014!
- Details:
  - FCAL, BCAL, FDC and CDC crates have all been connected to TD (TS) crate.
  - All crates have been synchronized and delays set appropriately.
    - These will need to be changed after the Tagger fiber cable is added to the system.
  - CTP ← → SSP links are established and progress continues toward running full deterministic high rate testing with ALL Trigger system modules.
    - Use "Playback" mode with high Pseudo-random Trig2 to simulate system with nominal occupancy.
    - Verify Trigger counters, alignment, and other critical parameters

Global Trigger Testing - Update



Replaced TI and all Trig1 signals are in alignment

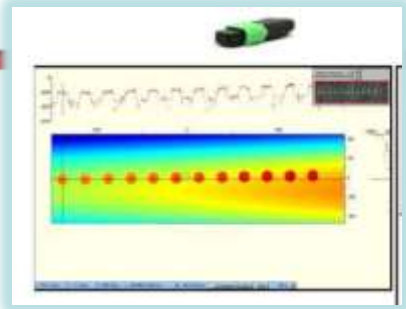
Global Trigger Testing - Update



SYNC signals for FCAL north crates and two(2) BCAL south crates
Alignment looks fine. Note additional delay for BCAL signals matches extra cable length needed for measurement

A. Stepanyan
M. Taylor

Trigger Fiber Optics



- ***Trigger System Fiber Optics*** (Q1 – FY14 procurement)
  - System diagrams have updated for Hall D
  - Thanks to Hall D group for installation help!

2/17/2014

Cuevas

Hall D - Global Trigger System				
Fiber Optic Cable Routing				
Source Rack#	Destination Rack#	Notes - Detector Sub-System	Length(Feet)	Notes
U1-14	T1-2	Tagger Tunnel	380	Received, not installed
	U1-A-2	Target, Gas, Cool, BCAL LED	TBD	To Be Determined
	US1-2	Collimator, Pair Spectrometer	TBD	To Be Determined
	U1-B-7	Pair Spectrometer/Start Counter	35	Installed; Tested
	U2-A-4	Forward Drift Chamber	35	Installed; Tested
	U2-B-7	Central Drift Chamber	50	Installed; Tested
	N1-4	Barrel Calorimeter	60	Installed; Tested
	S1-4	Barrel Calorimeter	55	Installed; Tested
	D2-A-2	Forward Calorimeter/TOF	215	Installed; Tested
	D2-B7-P1	Forward Calorimeter/TOF Patch1	215	Installed; Tested
	D2-B7-P2(Spare)	Forward Calorimeter/TOF Patch2	225	Installed; Tested

What's next?

- Activity 2543115 – Performance Testing
- Establish trigger distribution connections (Fiber) to all crates
  - ✓ Main FO trunk lines and patch panels installed
  - ✓ Install TD and TS boards in TD crate
  - ✓ Set required delays for each TI fiber length and measure trigger signal alignment between crates in each subsytem
- Global Crate
  - ✓ Establish CTP ⇔ SSP fiber link connections
  - o Run deterministic test patterns to measure and verify L1 trigger alignment and scaler counts.
  - o Measure and verify other Global Trigger system functions
- Cosmic ray commissioning is ongoing for each detector
  - Use BCAL to trigger FDC (and CDC?) (Is this a milestone?)
  - Many other commissioning tests omitted here,

Summary

- Global Trigger and Trigger Distribution crates are installed
- FO trunk lines are installed and tested
  - Tagger, PS/ST crates still need to be installed and connected to patch cables
- Firmware released for all boards, including new updates for FADC250 “TDC” feature
- Significant firmware development for BCAL cosmic ray trigger, and energy summing developments have been prioritized. (See example below)
  - → Tagger “Hit Count” algorithm, TOF, and Pair Spectrometer applications
  - → Scaler (counters) have been updated for diagnostics and histogram applications
- Essential CODA library development and library release is complete for almost every board.
- Check out 12GeV Trigger hardware progress: https://halldweb1.jlab.org/wiki/index.php/Electronics_Trigger_Meetings

Questions?

Backup Slides

All sorts of cool stuff

All Trigger Modules Delivered!

L1 Trigger 'Data'
MTP Ribbon Fiber

Global Trigger Crate
- **Sub-System Processor**
- **Global Trigger Processor**

Trigger 'Link" Control
Clock, Sync
MTP Ribbon Fiber

Front End Crate
- **FADC250, (FADC125), (F1TDC)**
- **Crate Trigger Processor**
- **Signal Distribution**
- **Trigger Interface**

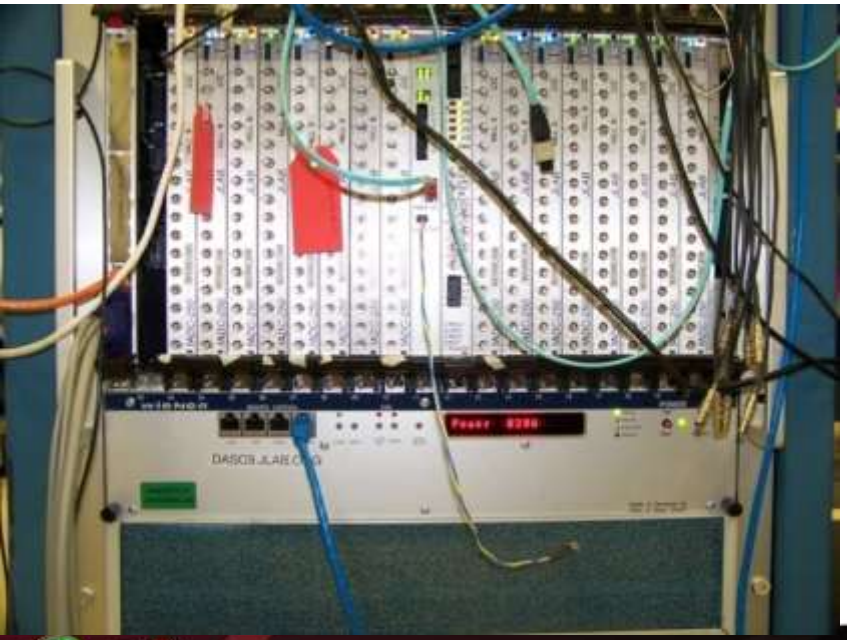
Trigger Control/Synchronization
- **Trigger Supervisor**
- **Trigger Distribution**

Bryan Moffit
Et al.

Full DAq Crate Testing Plans

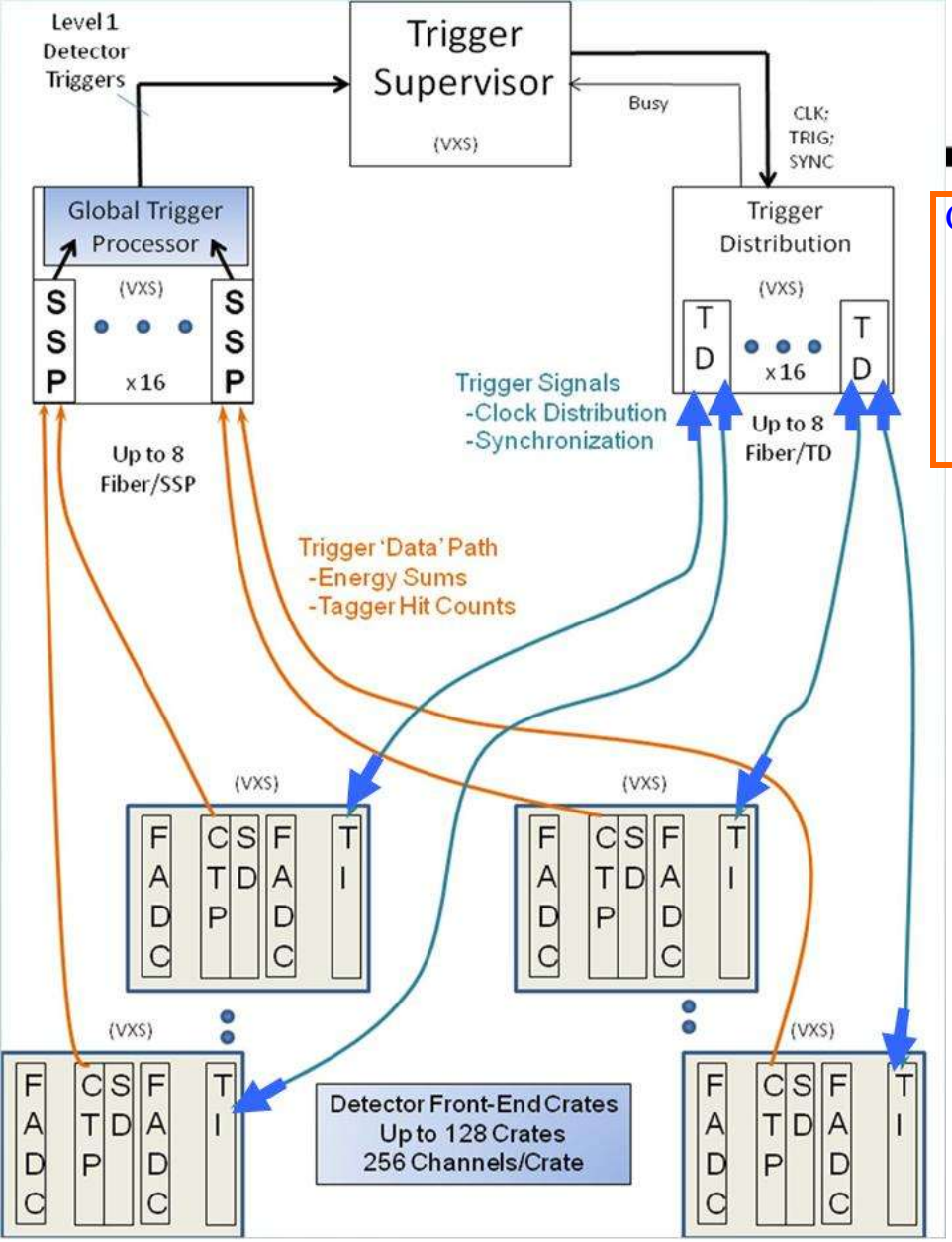
- Before deploying full crates with all required modules:
  - Will test using “Playback” mode and CODA
  - No input cables necessary; User defined signals loaded in front-end FPGA
  - Deterministic test for all channels and Gigabit serial lane alignment check
  - Verify TI → SD → Payload Board Synchronization and Clock
  - **Re-Use these tools for Hall commissioning effort**

- Test station used for FINAL firmware verification and software ‘library’ development
  - Bryan Moffit has created a preliminary plan and list of test functions
  - See wiki link → https://halldweb1.jlab.org/wiki/index.php/Full_Crate_Acceptance



This full crate test station in EEL109 is an essential infrastructure element needed to test and verify the front end and trigger hardware/software before installation in the Halls.

System Description



CTP -> SSP -> GTP
L1 Trig_Data
Uni_Directional

Energy Sums

TS -> TD -> TI
Link
1.25Gb/s
Bi-Directional

BUSY
Trigger Sync
Trig_Comnd

Trigger Supervisor (Distribution)

Global Trigger Processing
Sub-System Processing
(Multi-Crate)

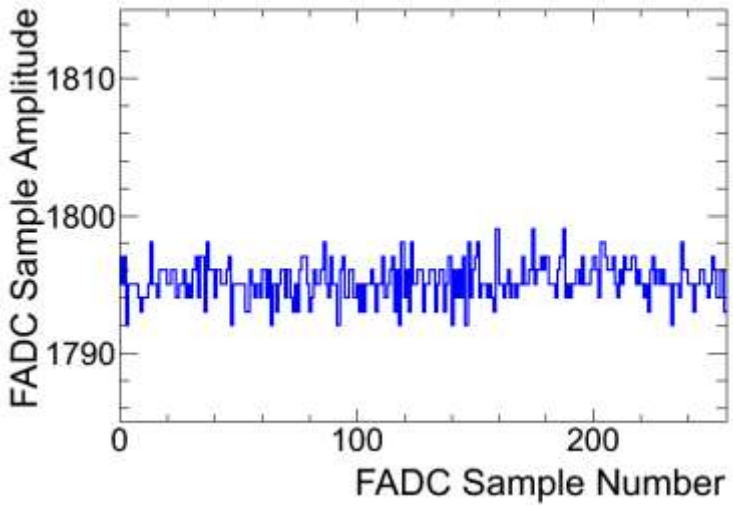
Crate Trigger Processing

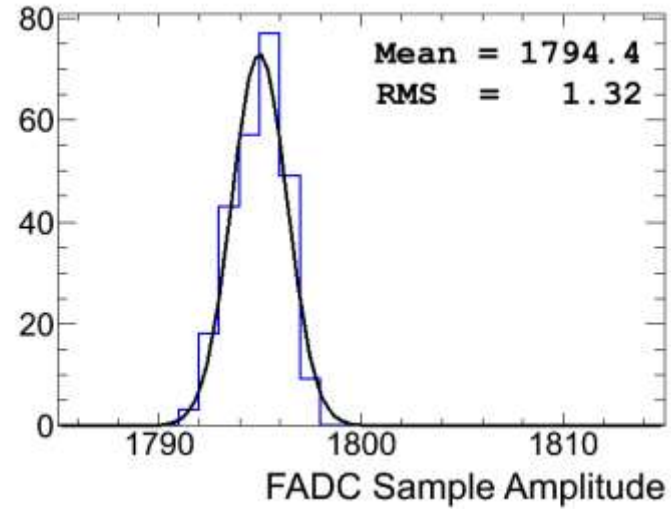
Flash ADC Modules

Detector Signals

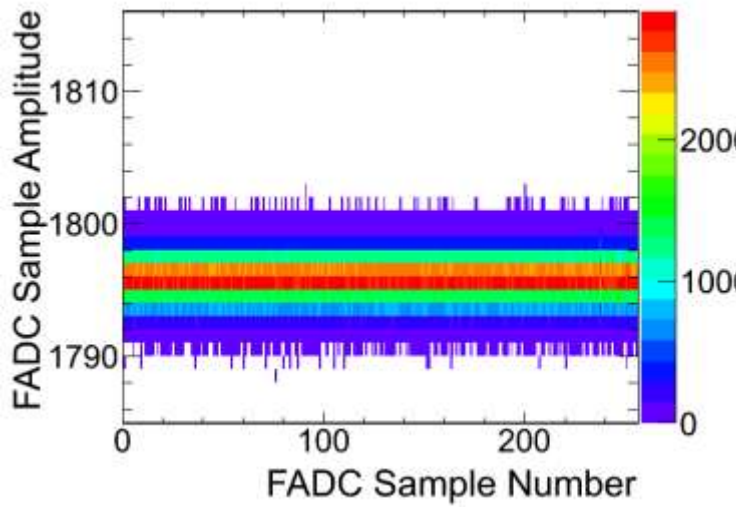
Noise in the FADC (No Readout during data taking)

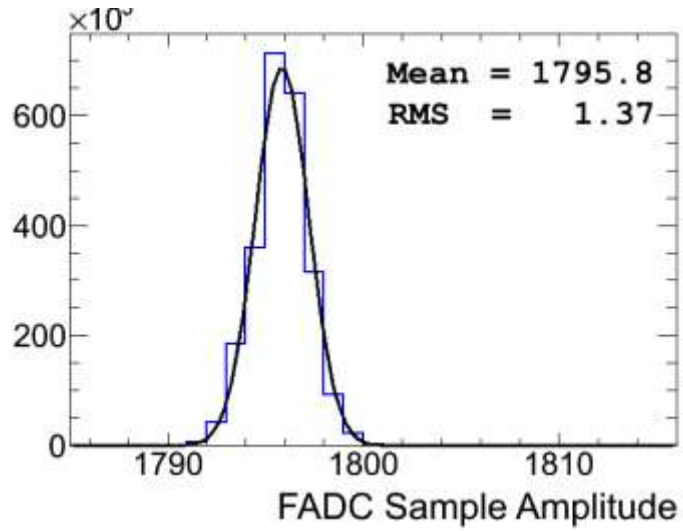
Single Event





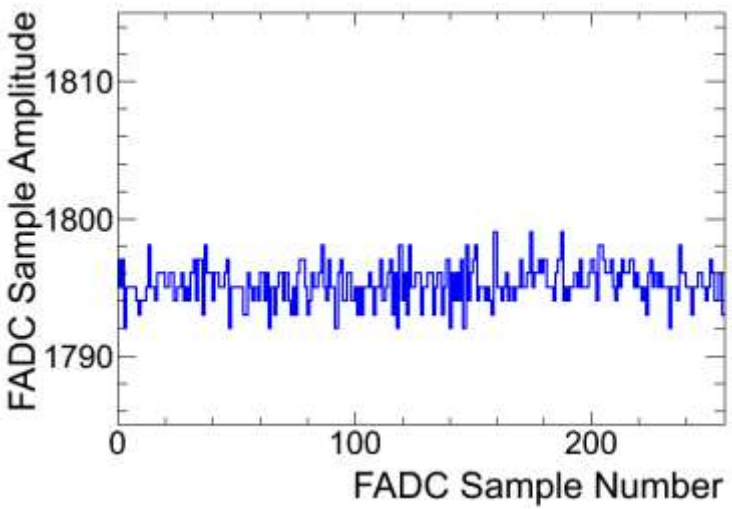
All Events

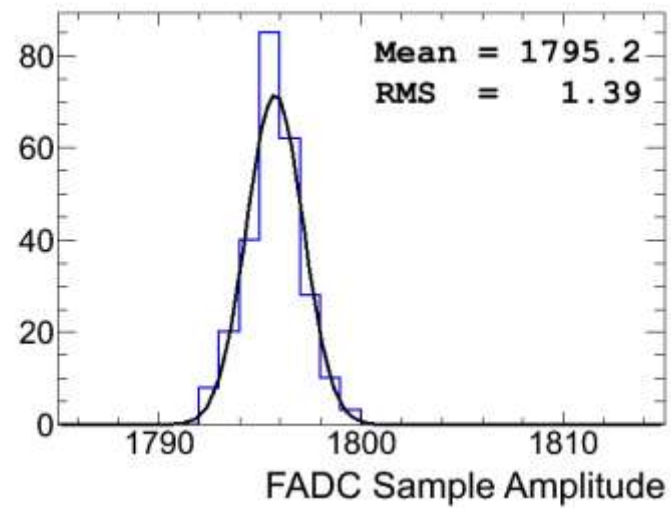




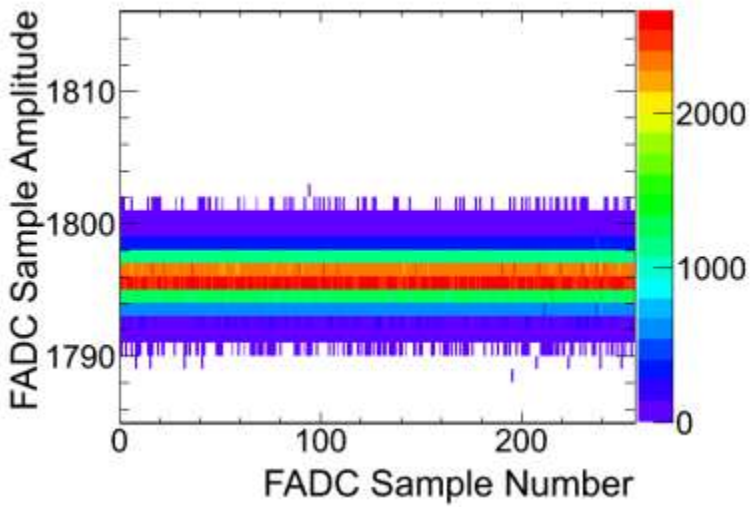
Noise in the FADC (Readout during data taking)

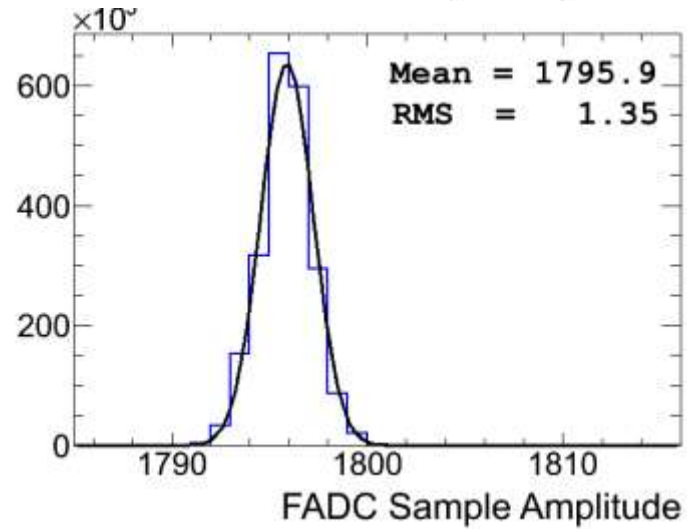
Single Event





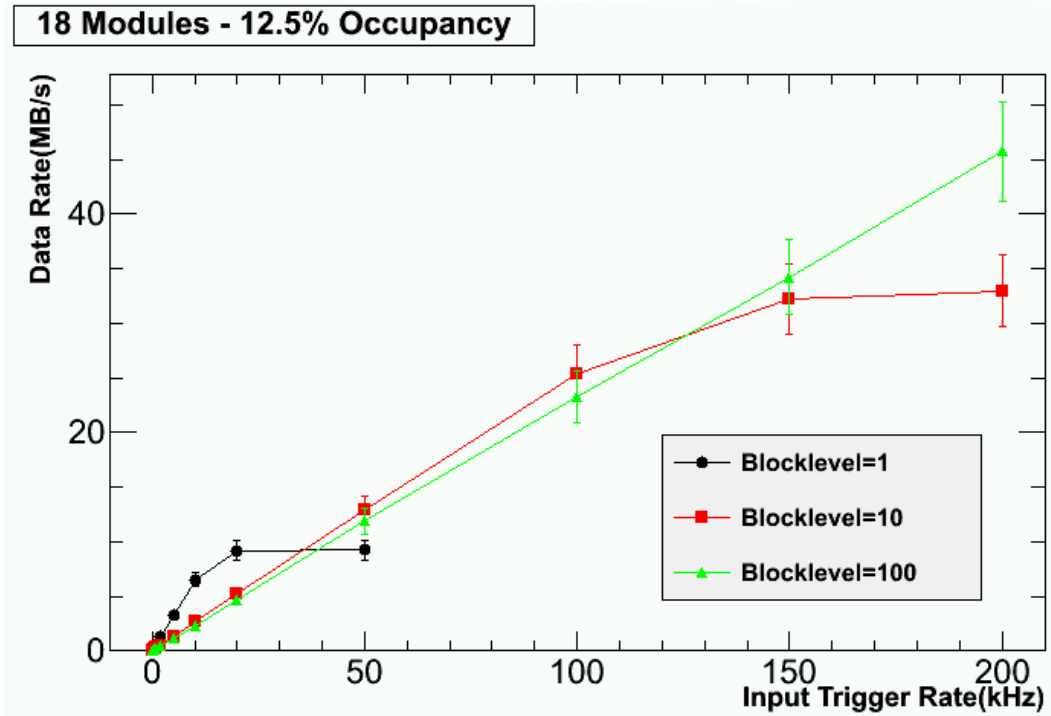
All Events





Two DAQ Crate Testing: FY11

- Pre-Production and 1st article boards have been received and tested
- Significant effort for circuit board fabrication, assembly and acceptance testing
- System testing includes:
  - Gigabit serial data alignment
    - ✓ 4Gb/s from each slot
    - ✓ 64Gb/s to switch slot
    - ✓ Crate sum to Global crate @8Gb/s
  - Low jitter clock, synchronization
    - ✓ ~1.5ps clock jitter at crate level
    - ✓ 4ns Synchronization
  - Trigger rate testing
  - Readout Data rate testing
  - Bit-Error-Rate testing
    - -Need long term test (24 - 48 hrs)
  - Overall Trigger Signal Latency
    - ✓ ~2.3us (Without GTP and TS)



200KHz Trigger Rate!

Readout Controller Capable of 110MB/s
- Testing shows we are well within limits