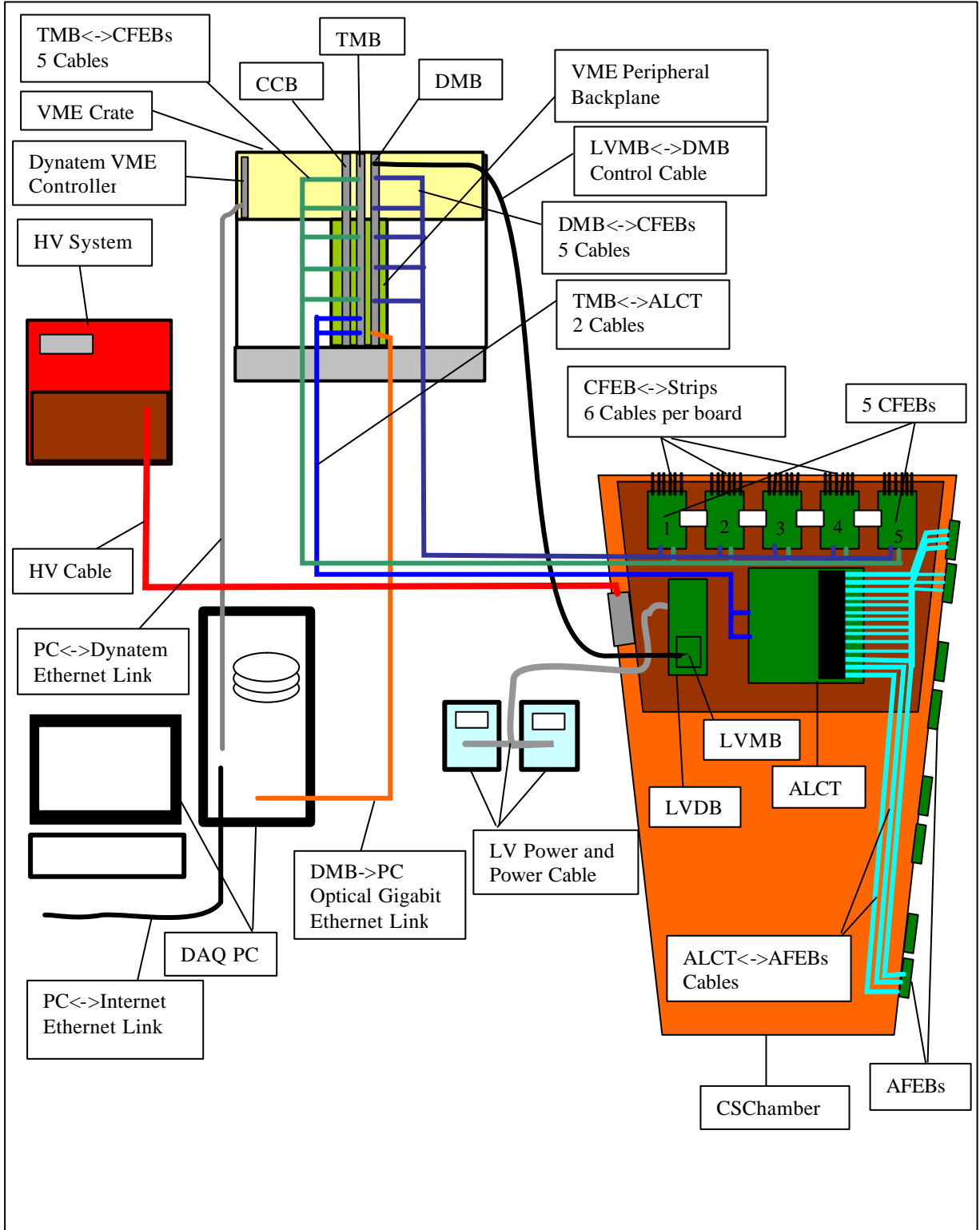


Description of chamber testing procedure at CERN ISR



FAST DAQ Setup Scheme

Initial pre-DAQ-tests setup

Set new chamber on the test stand

Check that HV turned off

Check that LV power supplies outputs turned off

Check that VME crate turned off

On PC close all DAQ related programs

Dismount CFEBs cover and visually check if data skew-clear cable connectors' screws are tightened up.

If some screws are not tightened up, partially dismount CFEB from cooling plate and tighten screws.

Apply some special paint on screws to lock them.

Check that CFEB input cables connected to correct layers of chamber

Check that AFEBs are properly

Connect gas mix supply to chamber

Put grounding label on chamber

Connect LV cable to LVDB

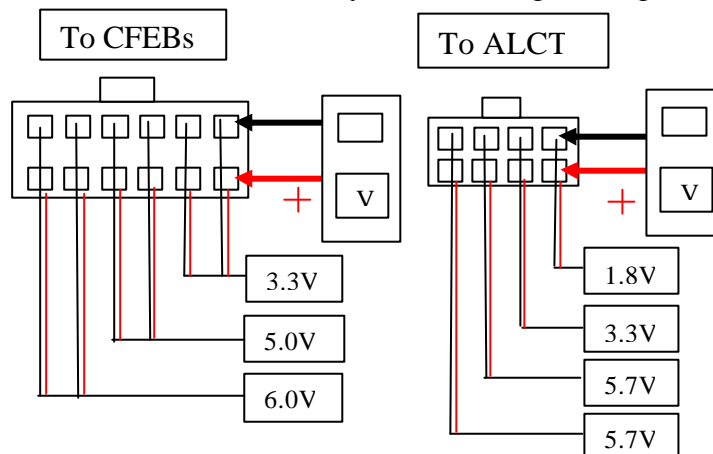
Check that power supply cables between LVDB and ALCT and CFEBs are appropriate type (with labels).

If older cables found, replace them with required set of cables.

Set switches on LVMB in Up position

Connect LV cables only to LVDB

Check new cables for correct layout and voltages using voltmeter



Connect 6 ALCT test pulse cables with LEMO connectors to chamber according to labels on cables and chamber

Connect 5 CFEB<->TMB and 5 CFEB<->DMB skew clear cables to CFEBs, starting from CFEB #5 down to CFEB #1 (Connect DMB cable first, then TMB cable for each CFEB)

NOTE: For ME1/3 completely disconnect 5-th CFEB<->DMB and CFEB<->TMB cables from DAQ setup.

Connect 2 ALCT<->TMB skew clear cables to ALCT (Connect cable labeled ALCT1 first, then connect ALCT2 cable)

Connect DMB<->LVMB control cable to LVMB

Connect HV cable to chamber

Check that set of switches on LVMB are in down position

Switch on LV power supplies output

Check that two green LEDs on LVDB light on

Check that voltages displayed on power supplies are near 7.5V and currents are near 0A.

Turn on VME crate (All 4 DMB's front panel LEDs should be turned on)

Check that voltages displayed on power supplies are near 7.5V and currents on one of them near 9.5A and on another near 2.8A

Basic set of required DAQ Tests

Check connection with Dynatem VME controller using “telnet ucquice” command.

Check connection with ALCT via TMB by checking that it’s possible to read slow control ID code from ALCT using “actp --ID” command (check that Slow Control ID is not ‘0’s)

Check connection with LVDB-LVMB via DMB by checking that it’s possible to read voltages and currents from LVDB using “lvmbctp --show” command

See “FAST Site DAQ installation instructions” on common test task as “Run test” and “Analyze results”

If it’s not specially specified in instructions use default parameters for the tests.

Test #9 Slow Control Functions of LVDB-LVMB, ALCT, CFEBs

Purpose: Perform self-tests of boards and their slow control functions.

Method:

1) LVDB-LVMB slow control functions and parameters to be readout.

* Call a standalone LVMB-test program that performs the following checks:

- Measure via DMB Vin, Vout, Iout for all LV inputs and outputs

- Switch off/on individual boards via DMB and check all Vout, Iout (turned off channels should be zero, while others must remain within specs)

- Repeat the cycle 5 times

2) ALCT SLOW and FAST control selftests:

* Call an ALCT SLOW and FAST self-test sub-programs and verify that the returned codes are OK

3) CFEB slow control selftests (TBD)

* Call an CFEBs self-test sub-program and verify that the returned codes are OK

To start:

Reprogram ALCT with supplied Firmware using cfeb_control

See “Downloading the FPGA Configuration” for ALCTs in “FAST Site DAQ installation instructions”

Switch LVDB power Off/On to reload firmware from EPROM into FPGA by selecting “Stats->LV Brd (extern)-> LV Reg off” and “...->LV Reg on”

Run “test9 NN”, where NN – chamber number

Run “lvmbctp +v --test --chamtype 4 –csc NN” from command line version or choose “Perform LVDB Test” from menu-based version of “lvmbctp”

Reprogram ALCT EPROMs with supplied Firmware using cfeb_control

Run ALCT slow control self-test using “alct +v --alcttype 384(288,672) --test” command

Run “cfeb_eprom_loader” to reprogram CFEBs with testing firmware which perform slow control self-test

Reprogram CFEBs EPROMs with supplied Firmware using cfeb_control

See “Downloading the FPGA Configuration” for CFEBs in “FAST Site DAQ installation instructions”

Switch LVDB power Off/On to reload firmware from EPROM into FPGA by selecting “Stats->LV Brd (extern)-> LV Reg off” and “...->LV Reg on”

Read installed CFEBs board numbers using cfeb_control and check it with information from database, especially CFEBs on-chamber installation order

In cfeb_control select form menu “Stats->ID Codes->FEBS PROM userid”

Open Web browser

Go to <http://cmsdoc.cern.ch/cms/CSC/CERN/db.html>

Go to Electronics Tracking

Click on “Boards on CSC”

Select “csc_type”, “csc_number” and “board_type”->CFEB

Execute Query

Compare order of CFEBs in results from database query and read back values from cfeb_control

Calculating CFEBs SCA pedestals

Run Test #15 with disabled file writing in run_control

Press "Update Online pedestals" in run_control

Select from menu "File->Re-read online pedestals" from menu in event_display

Test #16 CFEB Connectivity

Purpose: Check that all cathode preamps are connected to strips.

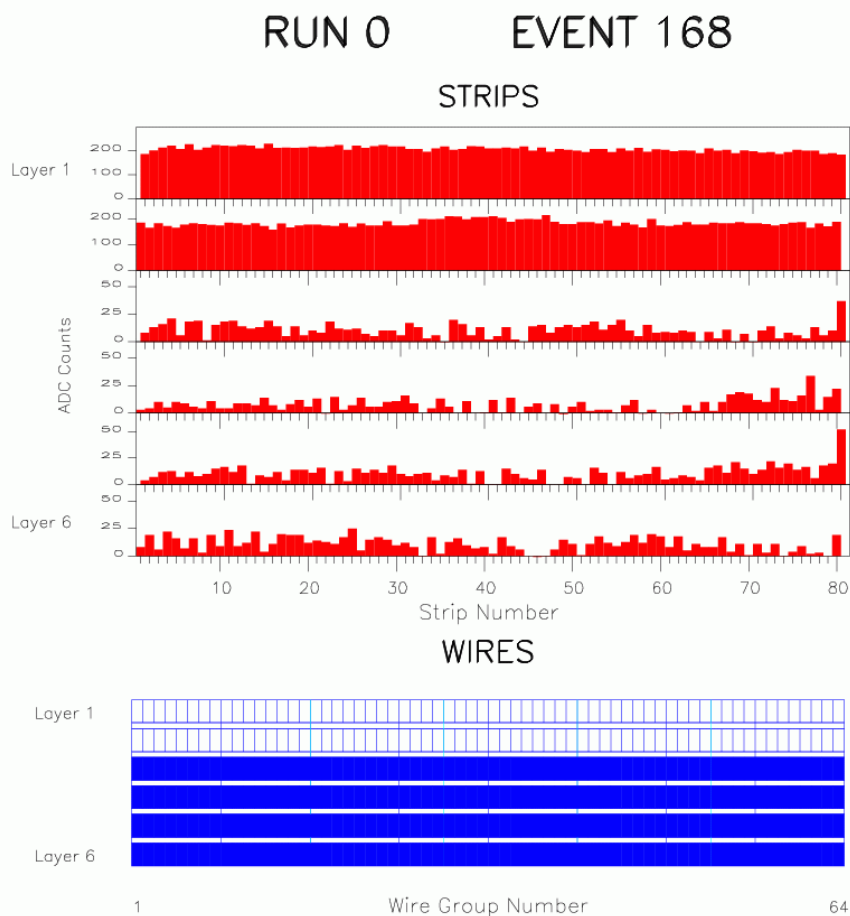
Method: Use ALCT test pulse generator to apply maximum amplitude test pulses to all wire groups of all layers simultaneously, which induces signals directly to strips due to capacitive coupling between wires and strips. AFEs must be turned off (via ALCT) to achieve the maximum effect.

Check the response of each strip to verify connectivity.

To start: Run test #16

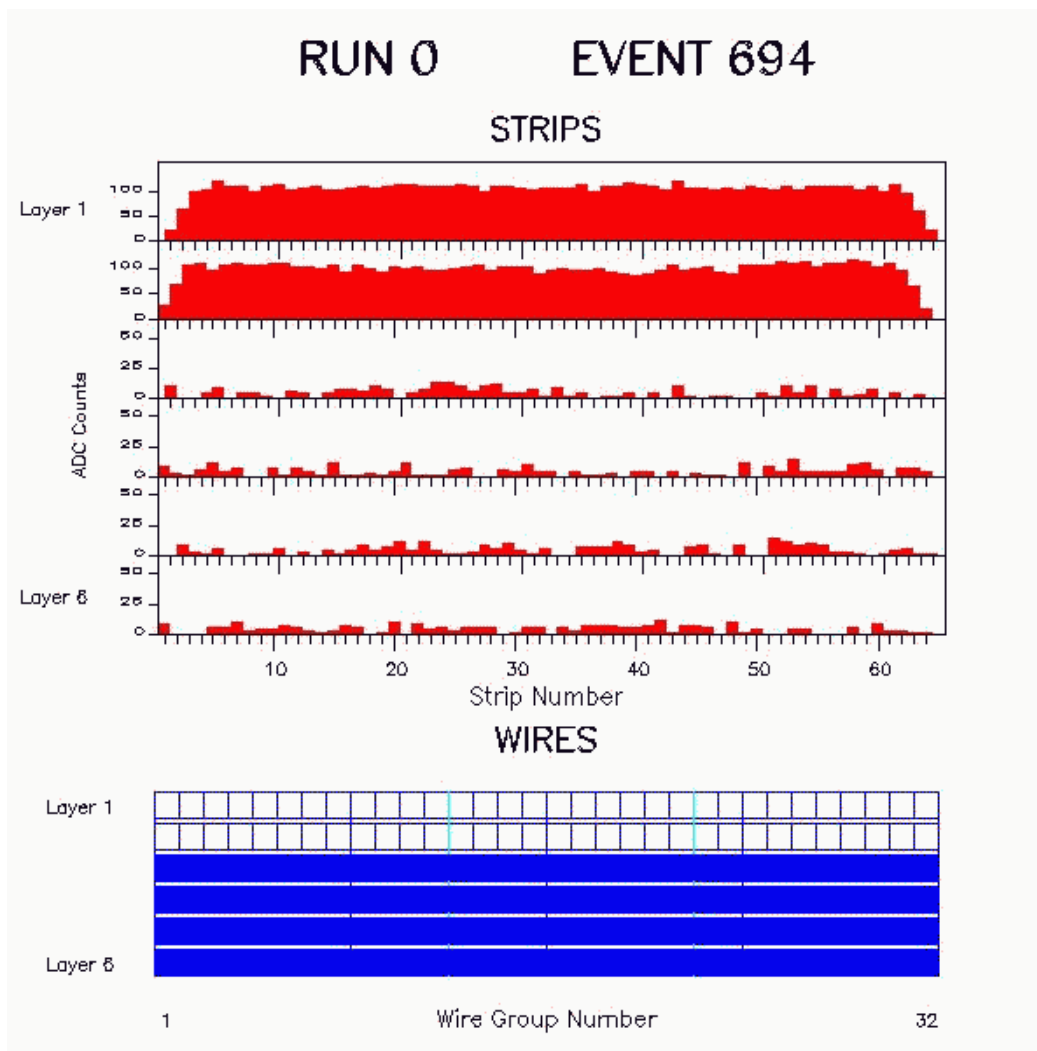
Analyze data and generate results files

Check for errors and compare with results from other FAST sites



event_display screen during test

NOTE: In test 16 and 17 for ME1/3 only, a few strips will show decreased amplitude on the edges.



Test #16 Swapped CFEB input cables

Purpose: Check that all cathode input cables are connected to proper layers and are not swapped.

To start:

1. Take data for test 16b (module_config_4161, afeb_config_4161), write the file, 60 events.
2. Start event_display program.
3. In Configure dialog(event_display program), uncheck Strips Autoscale button. This will disable autoscale in Strips and Wires display
4. Choose the file for test 16b.
5. Print in file the events number:
 - ev#3 into file test_16b_11.ps
 - ev#13 into file test_16b_12.ps
 - ev#23 into file test_16b_13.ps
 - ev#33 into file test_16b_14.ps
 - ev#43 into file test_16b_15.ps
 - ev#53 into file test_16b_16.ps
6. Check that the pattern is matching for each layer.
7. Save the results files in proper directory.
8. Print the files and save them in folder.

The samples of test_16b*.ps results files are on the webpage:

http://www.phys.ufl.edu/cms/emu/fast/test_16b/

run 597 - files for chamber with correct cabling,

run 598, 599 -example for chamber with swapped cables.

Test #13 AFEB Thresholds and Analog Noise

Purpose: To measure the threshold and noise of each wire group (using ALCT test pulse generator).

To start: Run test #13

Get AFEBs capacitances data from database:

Open Web browser

Go to <http://cmsdoc.cern.ch/cms/CSC/CERN/db.html>

Go to Chamber AFEB connection

Select chamber type and chamber number and submit

Save results into text file with name AFEB_0NN.txt in \$DATADIR/anode_thresh/ directory, where NN – chamber number.

Analyze data and generate results files

Check for errors and compare with results from other FAST sites

Copy \$DATADIR/test_results/temp/test_13_13.result into

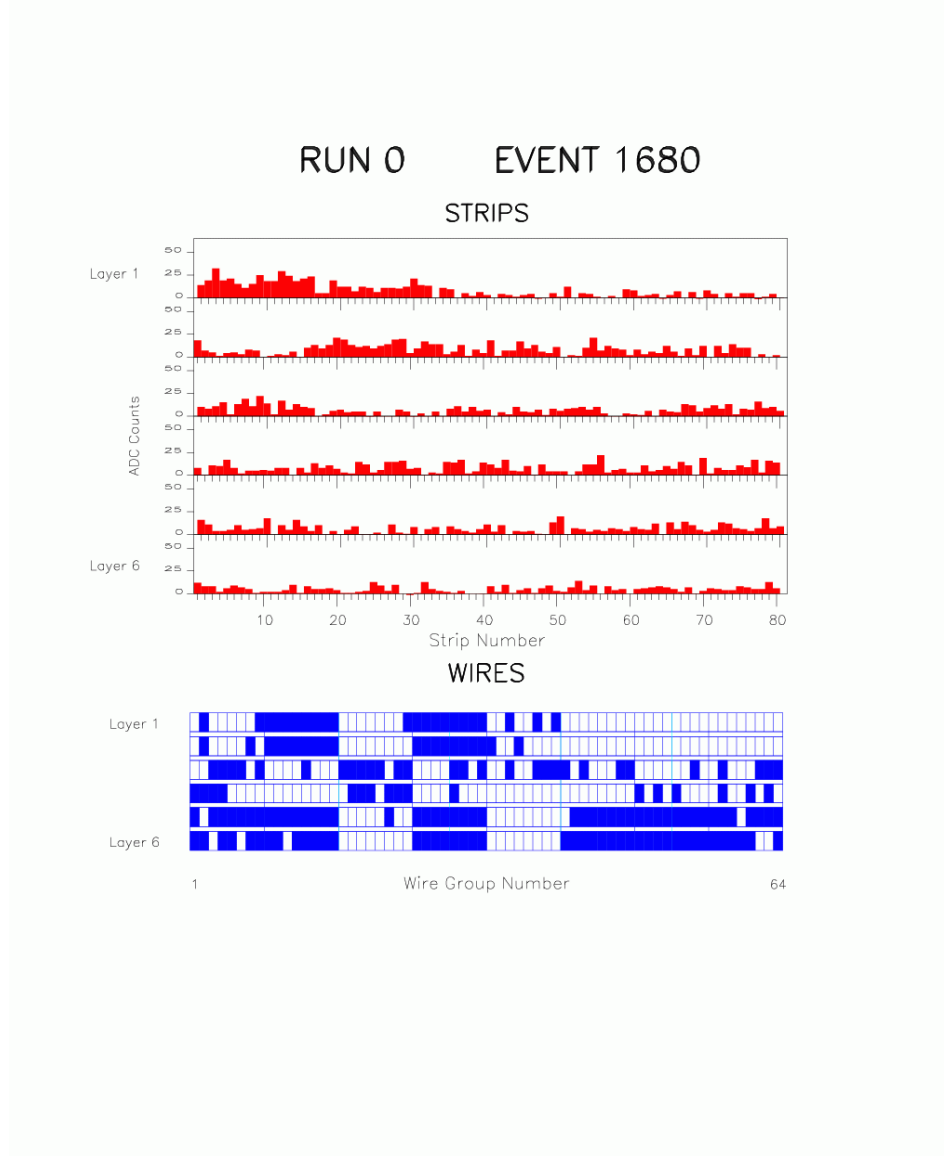
\$DATADIR/anode_thresh/anode_thresh_XX-00NN,

Where XX – chamber type ('22' for ME234-2) , NN – chamber number

Select and save new anode thresholds file in run_control ("AThr" configuration parameter)

Test #13b

Run "threshtest NN TT", where NN - chamber number, TT – chamber type



event_display screen during test

Test #12 AFEB Connectivity

Purpose: To check that AFEBs are all alive and connected to the wires. Also, check for absence of plane-to-plane cross-talks (note that plane pairs 1&2, 3&4, 5&6 share AFEB chips and may be prone to have cross-talk). Cable connections mixed between planes will be easily identified.

Method: One uses the ALCT test pulse generator (triggered by an external test pulse) to apply test pulses to the test strips of each layer in turn.

The test pulse amplitude for ME23/2 chambers is fixed at Test Signal Code = 30.

Signals should be seen on all wire groups of one layer. For all wire groups, check for cross-talk in paired planes (e.g, probability of signals in layer 1 when layer 2 is pulsed, probability of signals in layer 2 when layer 1 is pulsed, probability of signals in layer 3 when layer 4 is pulsed, etc.) and non-pair planes (e.g., probability of signals in layer 1 when layers 3, 4, 5, or 6 are pulsed).

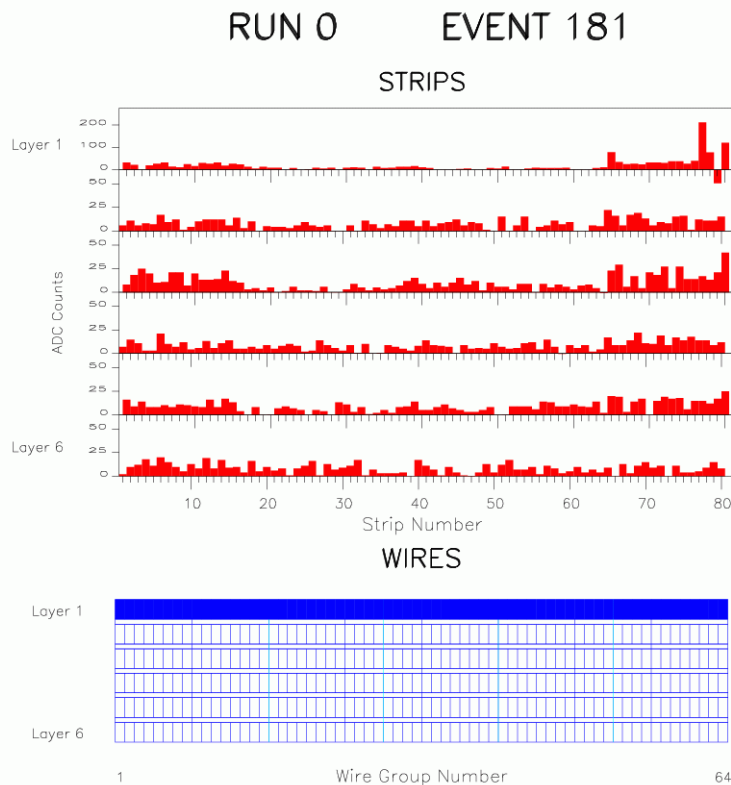
Note: Set parameter "tp_dac" in AFEBs configuration file

\$(DATADIR)/afeb_config/afeb_config_4120 to appropriate for particular chamber type value: ME234/2 – 30; ME3/1, ME4/1, ME2/1, ME1/2 – 100; ME1/3 - 25

To start: Run test #12

Analyze data and generate results files

Check for errors and compare with results from other FAST sites



event_display screen during test

Test #15 CFEB DAQ-Path Noise

Purpose: Measure CFEB pedestals, their stability (from one SCA cell to another, from one time sample to another, drift over ~10 hours) and allinclusive noise for each strip. Check SCA block occupancy.

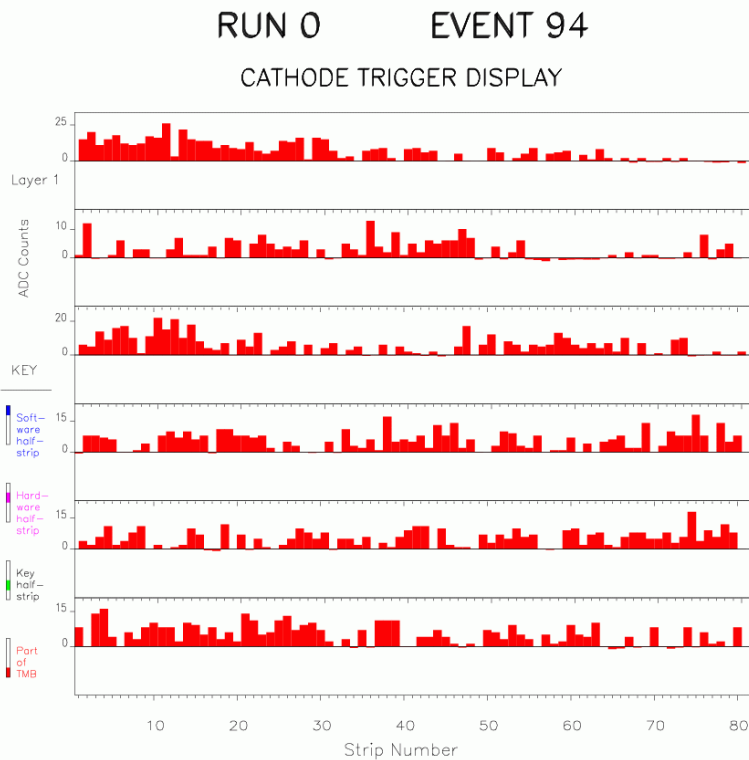
Method: Take data with a random software trigger. Calculate the pedestal of each strip (all-inclusive: one entry for each event and each time sample), of each SCA capacitor of each strip, of each timesample of each strip). Calculate all-inclusive RMS, RMS of SCA pedestals, RMS of timesample pedestals. The last measurement evaluates contribution of cross-talks synchronous with read-out.

The run is repeated at low trigger frequency overnight: bad RMS of all-inclusive pedestals averaged over short-term periods is an indication of substantial drifts.

To start: Run test #15

Analyze data and generate results files

Check for errors and compare with results from other FAST sites



event_display screen during test

Test #11 AFEB Counting Noise without HV

Purpose: Check efficiency of grounding fixes

To start: Run test #11 without HV for 30-60min

Check that there is no more than 1-3 events counted

Tests which require High Voltage

Check operational gas mix supply to chamber

Using HV Control Program on PC or VT200 terminal attached to HV system:

Set HV to 3600V

Turn on HV channel for chamber

Test #11 AFEB Counting Noise

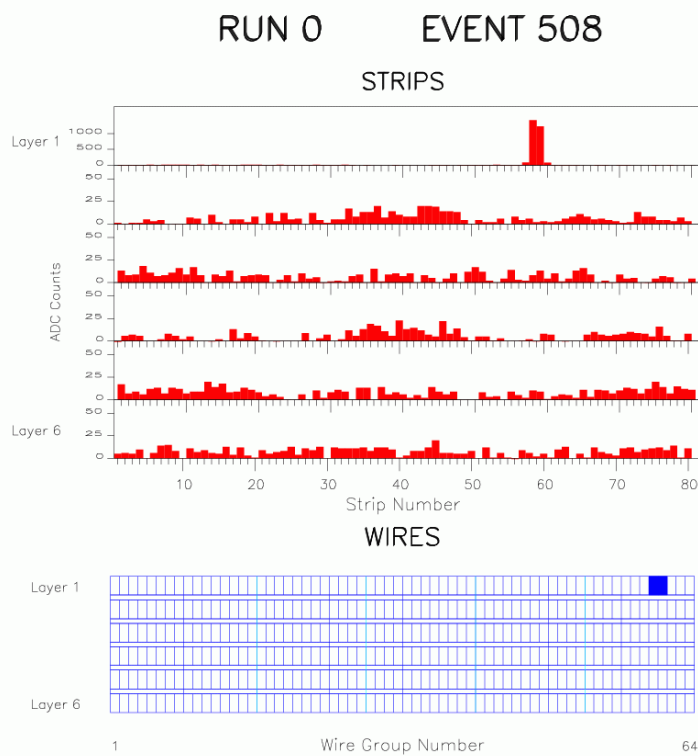
Purpose: Look for noisy wire groups. Also, look for short circuits (or significant cross-talks between wire groups) and chamber after-pulsing probability.

Method: Trigger on any AFEB hits (ALCT single-plane self-trigger mode). Count all wire groups with at least one hit anywhere within ALCT time window. Measured rates are to be as expected for each wire group. Look for short circuits or highly-coupled wire groups by measuring the probability of getting exactly one hit. Note that rates are to be corrected for DAQ readout dead time by measuring the actual ALCT rate with a CCB events counter. The test is done at nominal and increased high voltages: 3600 V and 3800 V. AFEB thresholds (DAC values) are set to $Q_{\text{threshold}} \sim 20$ fC using calibration data.

To start: Run test #11 with HV 3600V

Analyze data and generate results files

Check for errors and compare with results from other FAST sites



event_display screen during test

Test #18 CFEB Comparator Counting Noise

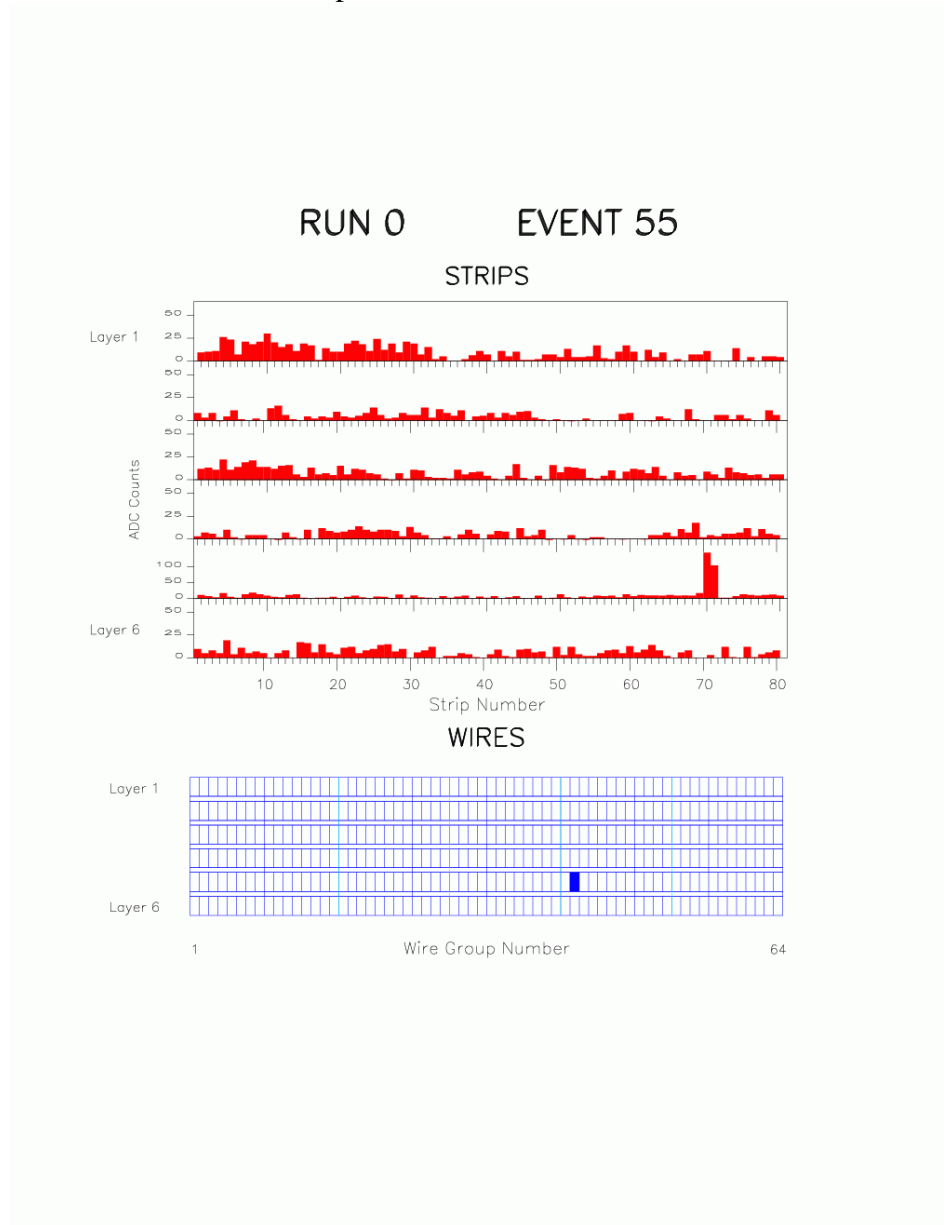
Purpose: This test looks for noisy comparators.

Method: Take data in CLCT self-trigger mode, with only one layer required (i.e., a single-hit trigger). Measure the trigger rate of each strip. The test is done two times: HV=3600 V, and 3800 V.

To start: Run test #18 with HV 3600V

Analyze data and generate results files

Check for errors and compare with results from other FAST sites



event_display screen during test

Other tests

If chamber has fixed or replaced CFEBs, AFEBs, ALCT during tests at ISR additional extended set of tests is required:

Test #17a CFEB Calibration (delay scan)

Purpose: To check the response of CFEBs on test pulse and measure calibration parameters and check that they are within specifications.

Method: Use the DMB test pulse generator to generate strip calibration signals. Scan over test pulse delays. The delay scan allows one to measure: Buckeye gain for fixed Qin, uniformity of output pulse timing, pulse shape uniformity, cross-talk levels in nearby and far-away strips.

To start: Run test #17a (switch to CLCT display in event_display)

Analyze data and generate results files

Check for errors and compare with results from other FAST sites

Test #17b CFEB Calibration (amplitude scan)

Purpose: To check the response of CFEBs on test pulse and measure calibration parameters and check that they are within specifications.

Method: Use the DMB test pulse generator to generate strip calibration signals. Scan over test pulse amplitudes. The amplitude scan data is used to calibrate Buckeye.

To start: Run test #17b (switch to CLCT display in event_display)

Analyze data and generate results files

Check for errors and compare with results from other FAST sites

Test #19 CFEB-Comparator Thresholds and Analog Noise

Purpose: To measure the offsets and noise of the threshold comparators in the comparator chips.

To start: Run test #19 (switch to CLCT display in event_display)

Analyze data and generate results files

Check for errors and compare with results from other FAST sites

Test #20 CFEB-Comparator Output Timing

Purpose: This test is designed to check the simultaneity of the comparator outputs.

To start: Run test #20 (switch to CLCT display in event_display)

Analyze data and generate results files

Check for errors and compare with results from other FAST sites

Test #21 CFEB-Comparator Logic

Purpose: To check the half-strip logic and the trigger test pulse system.

To start: Run test #21 (switch to CLCT display in event_display)

Analyze data and generate results files

Check for errors and compare with results from other FAST sites

Test #14 AFEB-ALCT Time Delays

Purpose: Measure the constants needed to equalize the arrival times at the ALCT of the anode raw hits. (Equalization can only be done chip-by-chip.)

This will remove delay spread in AFEB boards themselves and variations due to differences in AFEB-ALCT cable lengths. Also, verify that

there are no mixups in AFEB-ALCT interconnections and that all cables are of the correct length.

To start: Run test #14

Analyze data and generate results files

Check for errors and compare with results from other FAST sites

Test #25 ALCT Self-Trigger (with HV)

Purpose: Check the ALCT trigger rate at different conditions.

Method: Check the ALCT0 rates for each key wire group for 1-of-6, 2-of-6, 3-of-6, 4-of-6, 5-of-6, and 6-of-6 plane coincidence requirements. Measure 4/6-ALCT0 rate, 4/6-ALCT1 rate, average 4/6-ALCT-quality, and number of raw hits vs. high voltage.

To start: Run test #25

Analyze data and generate results files

Check for errors and compare with results from other FAST sites

Test #26 CLCT Self-Trigger (with HV)

Purpose: Check the CLCT trigger rate at different conditions.

Method: Check the CLCT0 rates for each key half-strip for 1-of-6, 2-of-6, 3-of-6, 4-of-6, 5-of-6, and 6-of-6 plane coincidence requirements. Measure 4/6-CLCT0 rate, 4/6-CLCT1 rate³³, average 4/6-CLCT-quality, and number of raw hits vs. high voltage.

To start: Run test #26 (switch to CLCT display in event_display)

Analyze data and generate results files

Check for errors and compare with results from other FAST sites

Test #28 ALCT and CLCT rate vs. HV (with HV)

Purpose: Measure plateau of ALCT and CLCT rates on cosmic rays

Method: Both ALCT and CLCT are programmed to trigger on 4/6 and rate of their decisions is measured vs HV with the help of CCB internal event counter.

To start:

Set HV to 3700V

Select in "run_control" Test #11 and do "Init"

Close "run_control"

Run "read_scalers"

 don't "Do DAQ Initialization"

 "Do Trigger Setup" and select pre-trigger 2 and trigger 4

 run trigger rate counting

 decrease HV down to 3200V with 50V step

 write down trigger rate

Close "read_scalers"

Set HV back to 3700V

Select in "run_control" Test #18 and do "Init"

Close "run_control"

Run "read_scalers"

 don't "Do DAQ Initialization"

 "Do Trigger Setup" and select pre-trigger 2 and trigger 4

 run trigger rate counting

 decrease HV down to 3200V with 50V step

 write down trigger rate

Close "read_scalers"

Measure plateau of ALCT and CLCT rates and make the chart in spreadsheet editor (Excel)

Post DAQ Tests actions

If not done automatically, copy test results files from \$DATADIR/test_results/temp directory into appropriate chamber's test results directory on DAQ PC

(\$DATADIR/test_results/MExxx.x.xxx) and also put results on dedicated Web server

Go into \$DATADIR/test_results/MExxx.x.xxx directory and run

```
"scp * fastdev@lxplus:/afs/cern.ch/cms/MUON/csc/fast/test_stat/Results/MExxx.x.xxx/"
```

Enter password.

Turn off HV on chamber and wait till HV drops down to zero before disconnect HV cable

Turn off VME crate

Turn off output of LV power supply
Disconnect DMB<->LVMB control cable from LVMB
Disconnect 2 ALCT<->TMB skew clear cables from ALCT
Disconnect 5 CFEB<->TMB and 5 CFEB<->DMB skew clear cables from CFEBs
Disconnect 6 ALCT test pulse cables with LEMO connectors from chamber
Disconnect HV cable from chamber
Disconnect LV cable from LVDB

Log Book

Testing should be documented in paper version of the log book.

Suggested format of log book records:

Header:

- Chamber number
- Date when chamber's testing was started
- Names of persons who perform tests

Test Info:

- Test number
- Starting time of test
- Run number (if available)
- Status of test (passed, failed)
- Description of test problems found

Summary:

- List with the numbers of performed tests
- Status of chamber testing (chamber passed, failed)
- Other notes (list of replaced boards with serial numbers, descriptions of fixed and existing problems, etc.)
- Date when chamber's testing was finished
- Signatures of persons who performed tests

Post testing documentation

Printed tests results from CERN ISR should be provided along with the initial documentation supplied with chamber from FAST Sites.

Testing time estimation for one chamber

Fast pre-tests gas mix filling	-	24 hours
1. Initial pre-DAQ-tests setup	-	150 min
2. Basic set of DAQ tests	-	270 min
a. Test #9	-	25 min
b. Test #16	-	10 min
c. Test #13	-	35 min
d. Test #12	-	15 min
e. Test #15 (normal rate)	-	65 min
f. Test #11 (without HV)	-	30 min
g. Test #11 (3600V only)	-	50 min
h. Test #18 (3600V only)	-	40 min
3. Other tests		270 min
a. Test #14	-	15 min
b. Test #17a	-	15 min
c. Test #17b	-	20 min
d. Test #19	-	50 min
e. Test #20	-	10 min
f. Test #21	-	10 min
g. Test #25	-	40 min
h. Test #26	-	70 min
i. Test #28	-	40 min
<u>Total tests time:</u>	-	<u>690 min (11.5 hours)</u>
Fixing small problems time:	-	20%
<u>Total time for onechamber:</u>	-	<u>830 min (~14 hours)</u>

Failed units replacement procedure and spare units handling

Contact repair committee members and experts in case of previously unknown and not-documented units problems (No repair works should be done by not-authorized persons)

Uninstall failed unit after experts permissions

Install spare unit

Repeat appropriate for unit's type set of tests

Pack failed unit and supply document, which describes problem (add some plots if available)

Depending on the failed units handling policy send unit for repairs or accumulate it for later batch shipment.

Provide record in the log book about reason of unit change and description of problem

Update appropriate database, by adding records, which describe performed operations (unit is dismantled, spare unit is installed, unit sent for repair)

There should be maintained set of spare units at ISR.

Quantity of the available spare units of each type should be set according to the unit's failure statistics and should be enough to prevent stops in FAST site chamber testing operation.

Persons responsible for chamber testing should immediately inform ISR FAST site coordinator in case of spare units shortage and orders for additional units should be placed as soon as possible.

All spare units operations should be put under inventory control.

Troubleshooting

General problems:

DAQ Hang-ups

Try to do “ping ucquicc” which checks connection between PC and VME Crate controller

Close all DAQ related programs manually (recommended) or using “killdaq” script, switch off and on VME crate with 15 second interval and try to restart DAQ programs.

DAQ hangs when trying to access DMB (LVMB). PC could freeze. Top-left LED on DMB doesn't light.

Checks all skew-clear cables and CFEB boards connectors for broken pins and damaged sockets.

Test run failures

If test failed to start, try to close “run_control” using close button or Cntl-C in terminal window where “run_control” was started. Then check that connection with VME controller exists and restart “run_control”. Switch off/on VME controller in case of lost connection with VME controller.

Test stops during run

Check that diskpace for raw data files is not full using “df”. If filesystem is 100% full remove some of the older data files in /csc_data directory

Test results failed

Try to restart “run_control” and rerun test. If problem still exists more detailed analysis is required which depends on the nature of problem. Contact experts via e-mail or phone and supply detailed information about problem.

Typical already known problems:

Test #9

LVMB part:

“lvmbctp” utility stops

Exit “lvmbctp” using Ctrl-C

Check that LVMB-DMB cable is properly attached.

Check that switches on LVMB are in “down” position

Check that “run_control” is not running and close it's so.

If not sure execute “killdaq” script to close all DAQ related programs

Check connection with VME Controller using “ping ucquicc” or “telnet ucquicc”

Voltages and currents out of range:

If difference between read values and reference +/- tolerance value is less than 100mV, 100mA error messages could be ignored.

If there is few times difference between read and reference values on one of the channels, check that power supplies show that power consumption is normal. If it's so then replace LVMB, because most probable reason of problem is failed ADC channel on LVMB.

Test #12

High pair-planes crosstalk on AFEs.

Dismount side cover and check that AFEs are tightened up and cables are latched into connector

Visible gaps in ALCT data on event_display

Check AFE cables connectors.

Test #16

Visible single strip gaps in CLCT data on event_display

Check and replace CFEB input cables.

FAST DAQ Software Directory layout

/ - root of the Unix filesystem

/csc_data – FAST DAQ tests readout data files storage

/cern/pro - CERN Library package (env variable \$CERNDIR)

/home/fastdev – Home directory for FAST DAQ user (env variable \$HOME)

\$HOME/bin – executables files and scripts for testing tools and utils

\$HOME/data – base directory for FAST DAQ configuration files (env variable \$DATADIR)

\$DATADIR/afeb_config – tests configuration files for ALCT and AFEB

\$DATADIR/anode_delay – configuration files for ALCT delays

\$DATADIR/anode_hot_mask – configuration files for ALCT anode hot channel mask

\$DATADIR/anode_pattern – configuration files for ALCT patterns

\$DATADIR/anode_thresh – configuration files for AFEB thresholds

\$DATADIR/cable_map – cable mapping configuration file

\$DATADIR/cath_hot_mask – configuration files for cathode hot channels mask

\$DATADIR/cath_thresh – configuration files for cathode thresholds

\$DATADIR/daqmb_config – configuration files for DAQ MB and setup specific parameters

\$DATADIR/histo_display – configuration files for histo_display program

\$DATADIR/logbook – system specific log files

\$DATADIR/module_config – main tests specific configuration files

\$DATADIR/pedestals – files with calculated pedestals for current chamber

\$DATADIR/test_info – additional configuration files for FAST DAQ software

\$DATADIR/test_results – base directory for FAST DAQ tests results

\$DATADIR/test_results/temp – current chamber test results

\$DATADIR/test_results/ME###.#.### - archive with test results for specific chamber

\$DATADIR/trig_setup - trigger configuration files

\$HOME/fast_daq – base directory for sources of FAST DAQ Software (env variable \$DAQHOME)

\$HOME/.bashrc and \$HOME/.bash_profile – shell profiles which set specific to FAST DAQ shell variables and parameters

In **bold** printed directories, which are very important for correct functioning of FAST DAQ software. Files from these directories are most frequently used, processed, viewed and edited during FAST DAQ test runs.

- **FAST DAQ executables (located in \$HOME/bin)**

actp - standalone tool for testing and monitoring of ALCT slow control functions (for test 9)

cfeb_control – standalone tool to control DAQ hardware, also used as IPC server during tests runs

cfeb_eprom_loader– standalone tool for testing CFEBs slow control part (for test 9)

ddu_b_daemon– DAQ Specific server to get readout data from DMB

event_analysis – DAQ Specific program to do online event analysis during test runs

event_analysis_offline – DAQ Specific program to do offline event analysis

event_display – general event display

fcvs – CVS access script

histo_display – general front-end for displaying of histograms

lisa_test_manager– general test data analysis program, which generates results

loader2 – standalone tool for programming ALCT and TMB firmware

lvmbctp– standalone tool for testing LVDB-LVMB slow control functions (for test 9)

message_window– general tool for displaying DAQ related log messages

readout_control – DAQ Specific program for configuration and control of test runs

read_scalers – tool for reading event counter from CCB (for test 28)

run_control – Java GUI front-end to control tests runs

show_buffer – debugging tool for displaying readout event dump

virtex2 – standalone tool for testing ALCT trigger logic functionality

test9 – script to run test #9

killdaq - close related to DAQ programs

- **Links**

CMS Endcap Muon Electronics:

<http://www.physics.ohio-state.edu/~cms/elec/>

FAST Site at University of Florida (UF)

<http://www.phys.ufl.edu/cms/emu/fast/>

FAST Site at University of California (UCLA)

http://www-collider.physics.ucla.edu/cms/fast/index_mig.html

FAST-DAQ Setup and Software

<http://www.phys.ufl.edu/cms/emu/fast/fast-daq-soft.shtml>

FAST Site DAQ installation instructions - there are some details and troubleshooting hints that can help

<http://www.phys.ufl.edu/~madorsky/fast/FASTum.pdf>

Tests instructions and descriptions

<http://www.phys.ufl.edu/cms/emu/fast/fast-site-test.shtml>

Chambers test results at CERN (ISR)

http://cmsdoc.cern.ch/cms/MUON/csc/fast/test_stat/Results

Chambers test results at UCLA

http://www-collider.physics.ucla.edu/cms/fast/index_test.html

Chambers test results at UF

<http://www.phys.ufl.edu/cms/emu/fast/Results/>

