Hall-B Beamline and HPS Controls

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Outline

- Hall-B/HPS experimental controls
- Slow control system
- Beamline controls and monitoring
- SVT controls and monitoring
- ECal controls and monitoring
- Data quality control and monitoring
- Summary

Hall-B/HPS experimental controls

- The experimental controls consists of two main parts:
  - control and monitoring of the hardware and the beam properties (slow controls)
  - control and monitoring of the detector performance and data quality
- Software for both controls will run on the Hall-B online computer cluster, behind the firewall (hall gateway)
- Monitoring application and the control software are under password protection, only restricted list of experts can modify them
- HBLOG in JEFFERSON LAB ELECTRONIC LOGBOOK, https://logbooks.jlab.org/book/hblog, will be used for bookkeeping
- Run webpage with run documentation, special instructions and manuals is available for shift takers at -

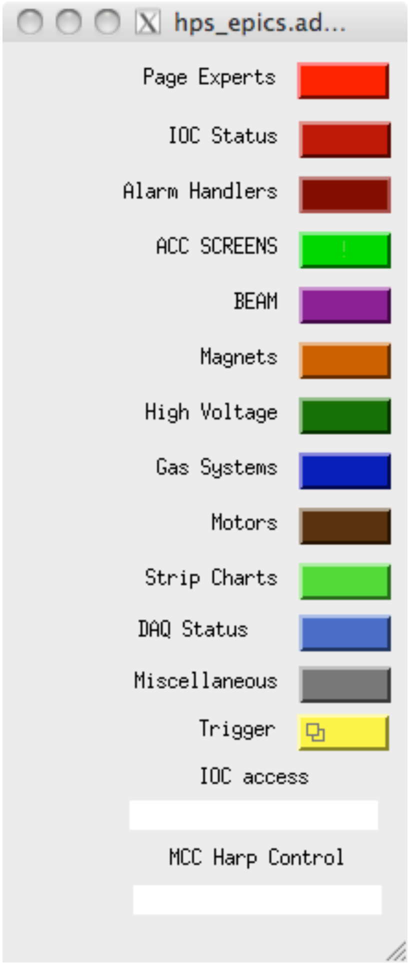
http://www.jlab.org/Hall-B/run-web/

Slow controls system

- The HPS slow controls framework is based on the system developed and used by the Hall-B collaboration during 6 GeV operations.
- The basic framework of the controls system is EPICS.
- All of the EPICS variables are served by the Input/Output Controllers (IOCs) which are processes and tasks running on various computers in Hall B and in the counting house
- The display management is using the MEDM EPICS extension package
- The EPICS Alarm Handler (ALH) package is used for alarm notifications.
- The strip charts are displayed using StripTool EPICS extension package.
- The archiving of the EPICS variables is done using MYA archiver

Starting-up EPICS controls

- The control screens for the HPS experiment can be brought up by typing ”hps_epics” on dedicated Hall-B online computers (clon01/clon02)
- All other applications can be accessed from the main EPICS GUI
- All EPICS GUIs and strip charts have option of logging
- The system has minor modifications and improvements over what was used in 2012 test run
- Most of shift takers (collaboration members) have extensive experience with running experiments in Hall-B and are well familiar with the Hall-B EPICS system



Beamline controls

- The beam is controlled by Machine Operations (MCC)
- Hall-B receives information from machine controls (BPMs, trim magnets, vacuum, BCMs …), monitors beam quality (wire harps, halo counters) and communicates issues with the MCC
- The only control Hall has on the beam delivery is through the beam fast shutdown system (FSD) designed to terminate beam delivery if conditions are not right – bad beam that may effect the data quality or may cause damage to the detectors
- From Hall-B/HPS, inputs to FSD are:
  - Chicane magnet power supplies
  - Beam halo counters
  - Beam lost monitors (BLM)
  - SVT motor limit switches
  - Vacuum gauges and valves
  - SVT protection collimator position

Beamline monitoring

No changes in Hall-B beamline monitoring since the 6 GeV:

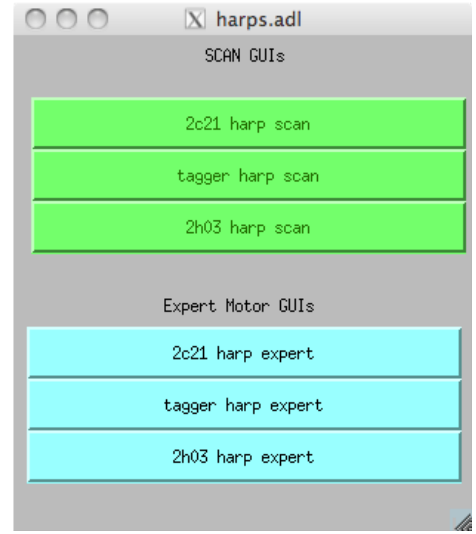
- three wire harps to measure the beam profile (two in the upstream tunnel, one in front of the HPS chicane)
- stripline and nA BPMs with new lock-in amplifiers provide beam position and beam current, which are also monitored by alarm handler
- two beam viewers (in the tagger dump and in the downstream tunnel before the electron dump)
- 11 halo counters spread over the beamline from the tagger to HPS
- Faraday cup (will be used to calibrate BPMs). During the production running FC will be blocked to prevent overheating (the same setup used for previous high current runs in Hall-B)

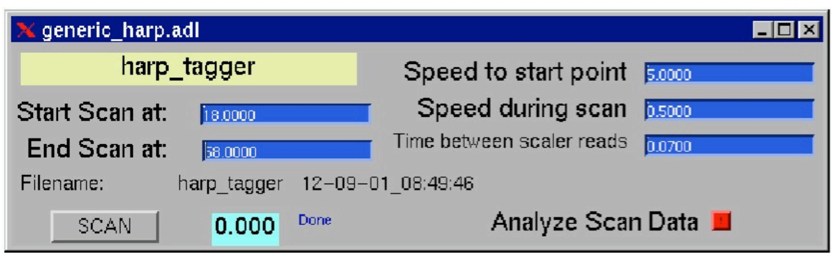
EPICS controls and GUIs for beam line devices, magnet power supplies, voltage controls …, already exist.

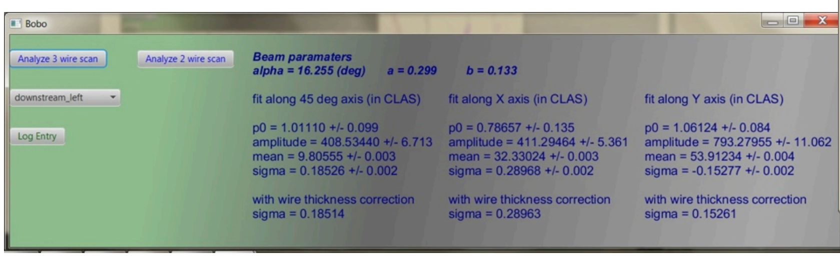
Beam profile monitors

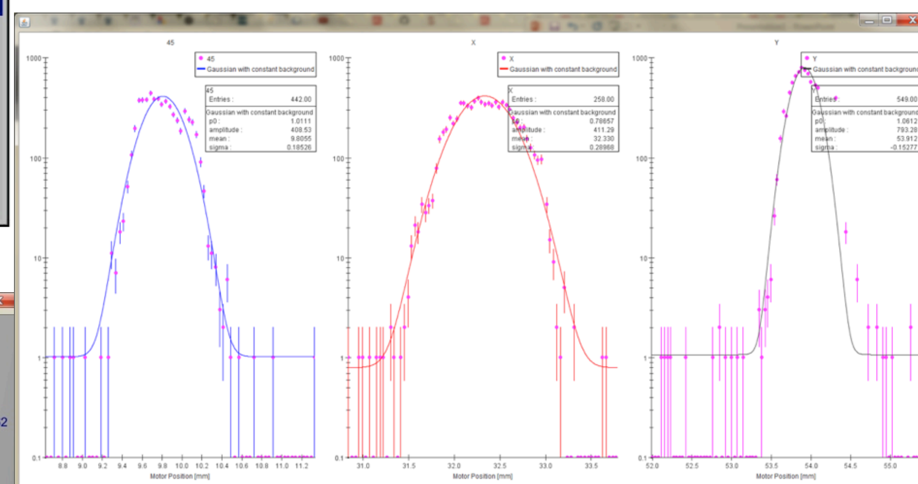
Wire harps:

- The main use is to measure beam profile
- Fast, needs low beam current (~5 nA), has large dynamic range (~10^5)
- “tagger” and 2H03 harps measure X and Y width, and the tilt angle



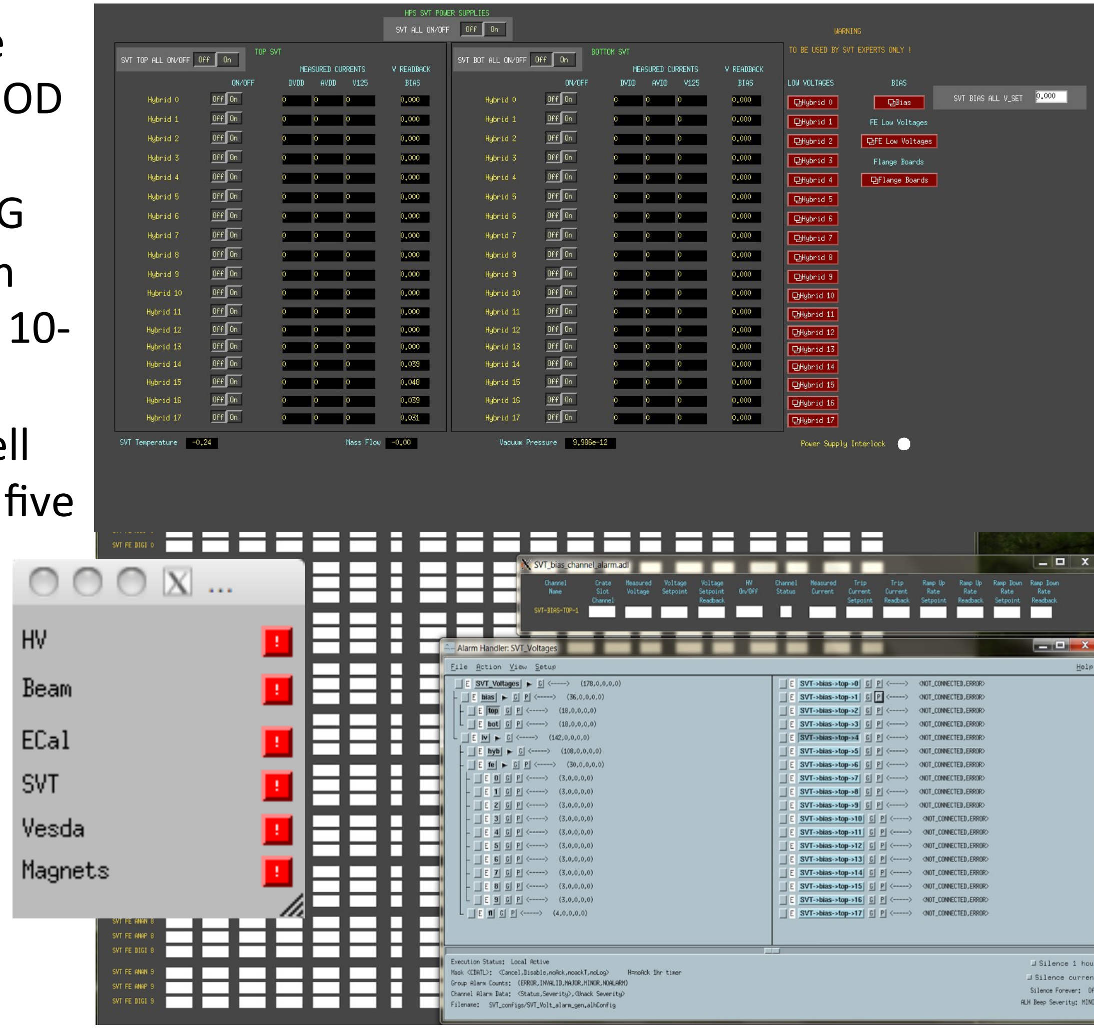




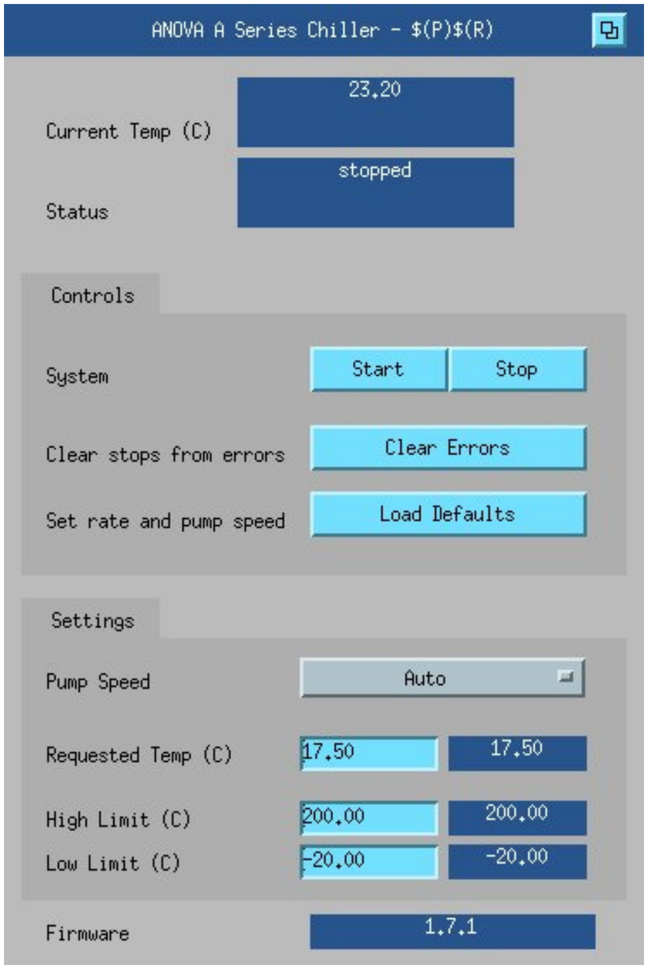


SVT power controls and alarms

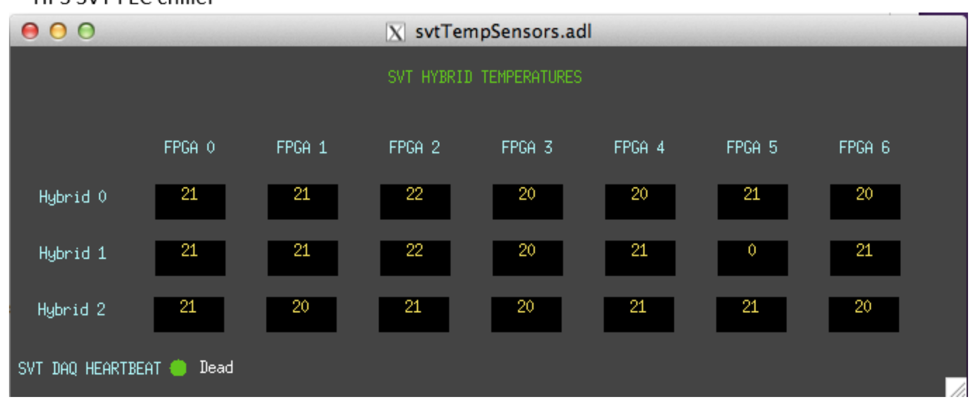
- The power needed to operate the SVT is supplied by five MPOD MPV8008I low voltage power supply modules and three ISEG EHS F201p 805F high precision high voltage modules inside a 10-slot Wiener EC crate
- The SVT power and bias as well as alarms are monitored with five principle GUI's



SVT cooling system



HPS SVT FEC chiller



SVT cooling system has two parts:

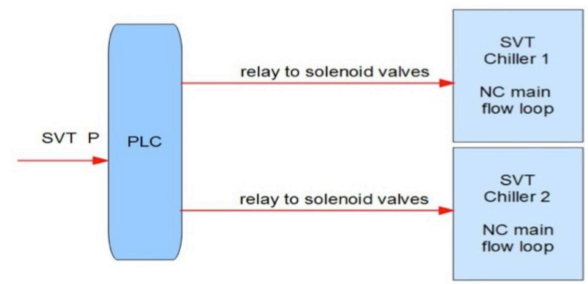
- Hybrid cooling (-20C)
- cooling of the front end electronics

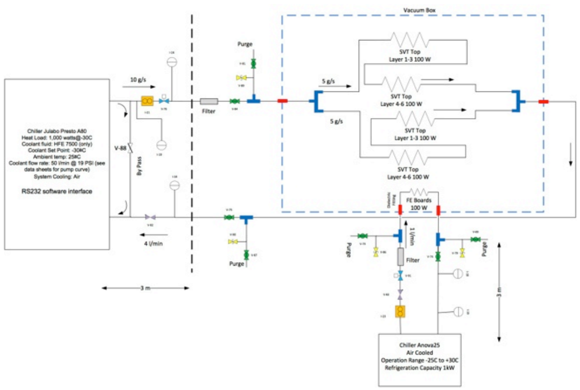
Both chillers are controlled through EPICS

Temperature readout values are input to the alarm system

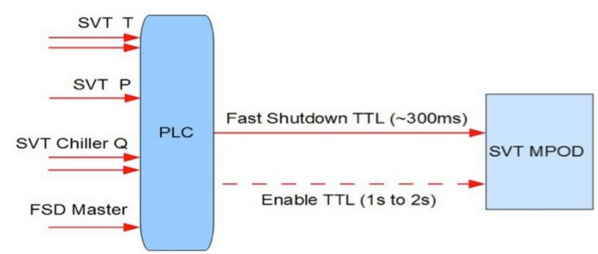
SVT interlock system

- To safely operate the SVT, the power supplies are included in an interlock system that triggers a fast shutdown of the power supply crate based on a set of conditions
- The interlock system is based on an Allen-Bradley PLC that receives input signals and performs the necessary logic to issue an interlock signal
- Input signals to interlock system
  - Hybrid and front end board temperature
  - Input and output coolant temperature of the SVT hybrid and front end board cooling loops
  - Coolant fluid pressure in the SVT hybrid and front end board cooling loops.
  - Chiller setting and status of the SVT and hybrid and front end board chillers.
  - Signal from the fast shutdown system of the accelerator.

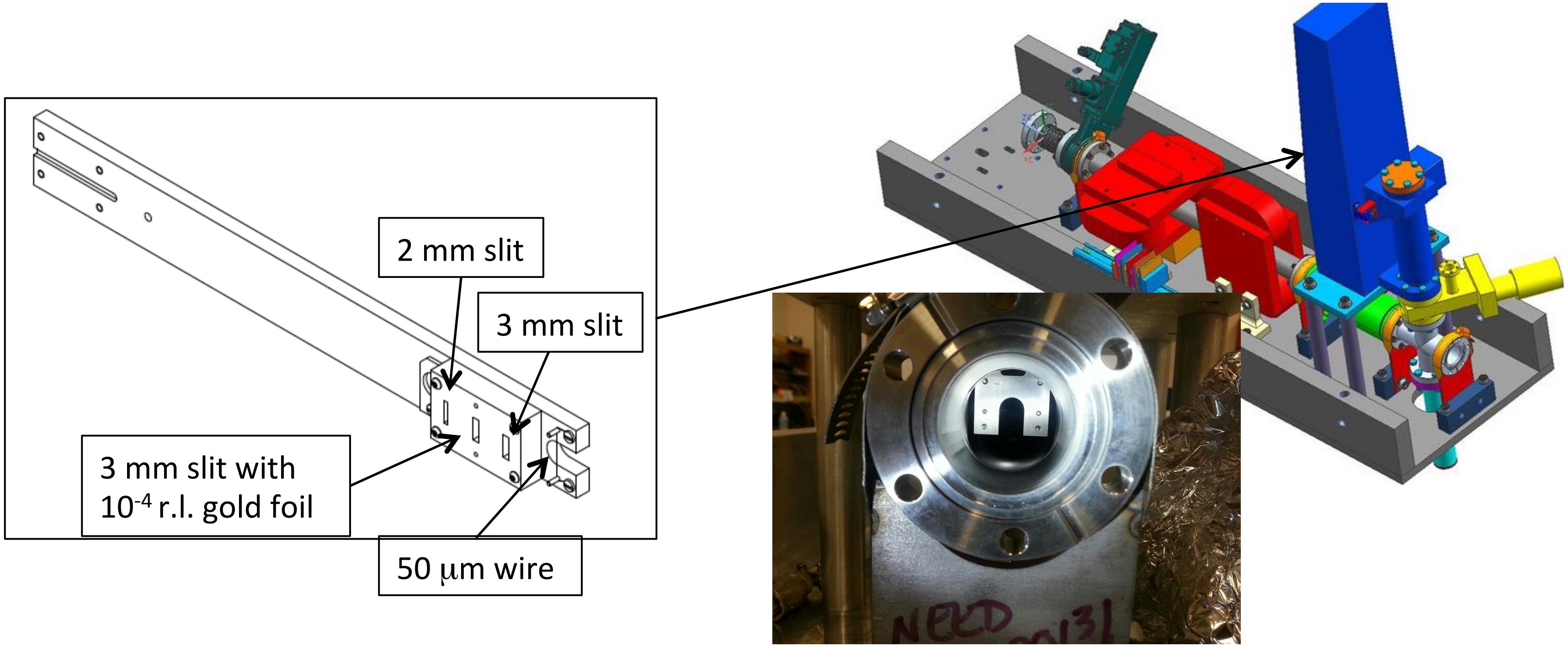




Newport XPS-Q8



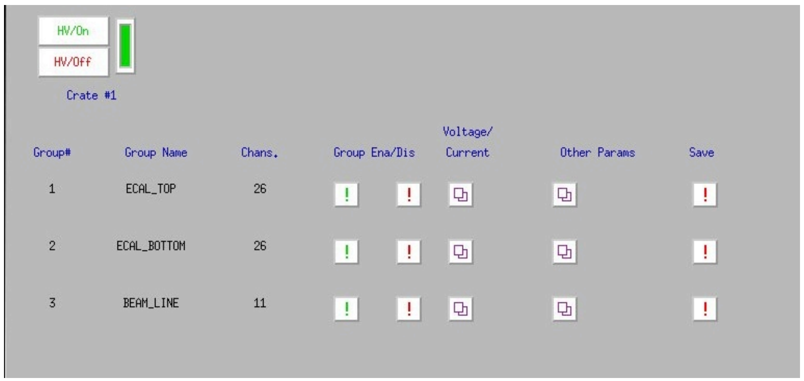
SVT protection collimator



- The physical edge of the SVT Layer-1 sensor will be at 0.5 mm from the beam plane, active edge at 1.5 mm
- SVT protection collimator is to prevent SVT active area from a direct hit
- The wire will be used to find the beam position. Then, the required slit will be centered on the beam based on the wire and the rates on halo counters when moved (*jiggled*) up and down
- For production running “3 mm slit” will be used (SVT active area is 1.5 mm from the beam plane)
- 3 mm slit with the foil will be used for “straight track” alignment runs when chicane is OFF (foil as a target)
- 2 mm slit gives extra protection, may be used based on the beam conditions

Halo counter and ECal HVs

- Ecal and PMT HV systems use CAEN power supplies controlled through EPICS
- Alarm handler will monitor read back voltage and current for each channel

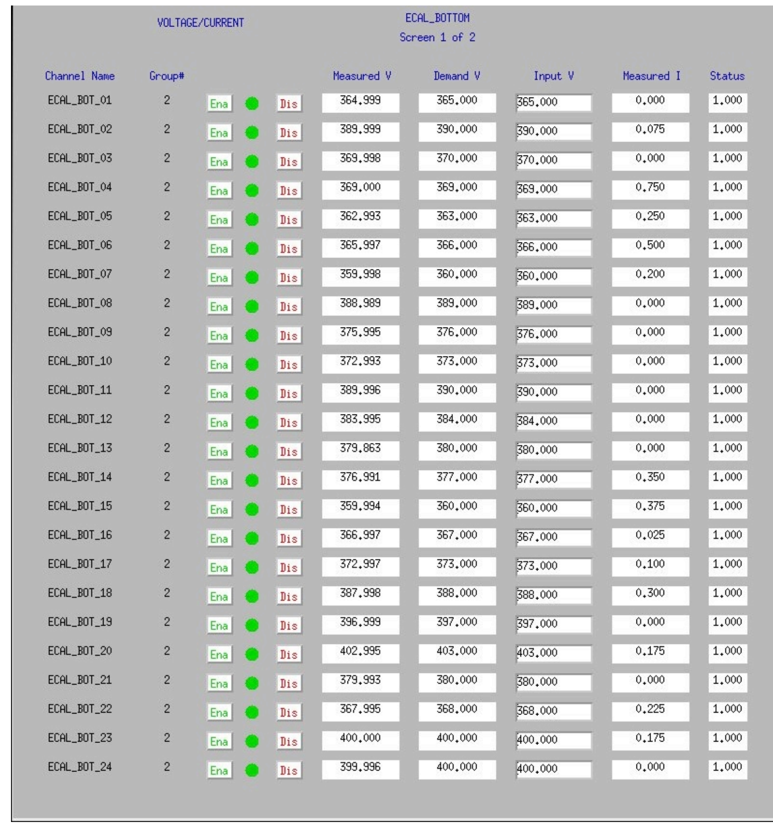


HV/On
HV/Off
Crate #1

Group#	Group Name	Chans.	Group Ena/Dis		Voltage/ Current	Other Params	Save
1	ECAL_TOP	26	!	!			!
2	ECAL_BOTTOM	26	!	!			!
3	BEAM_LINE	11	!	!			!

VOLTAGE/CURRENT
BEAM_LINE
Screen 1 of 1

Channel Name	Group#			Measured V	Demand V	Input V	Measured I	Status
Upstream_left	3	Ena	Dis	1000,250	1000,000	1000,000	0,000	1,000
Upstream_right	3	Ena	Dis	1999,250	2000,000	2000,000	0,000	1,000
Tagger_left	3	Ena	Dis	799,750	800,000	800,000	0,000	1,000
Tagger_right	3	Ena	Dis	997,250	1000,000	1000,000	0,000	1,000
HPS_left	3	Ena	Dis	1000,250	1000,000	1000,000	0,000	1,000
HPS_right	3	Ena	Dis	200,000	200,000	200,000	0,000	1,000
ECal_cosm1	3	Ena	Dis	199,750	200,000	200,000	0,000	1,000
ECal_cosm2	3	Ena	Dis	199,500	200,000	200,000	0,000	1,000
ECal_cosm3	3	Ena	Dis	200,000	200,000	200,000	0,000	1,000
ECal_cosm4	3	Ena	Dis	199,500	200,000	200,000	0,000	1,000
ECal_cosm5	3	Ena	Dis	969,750	970,000	970,000	0,000	1,000

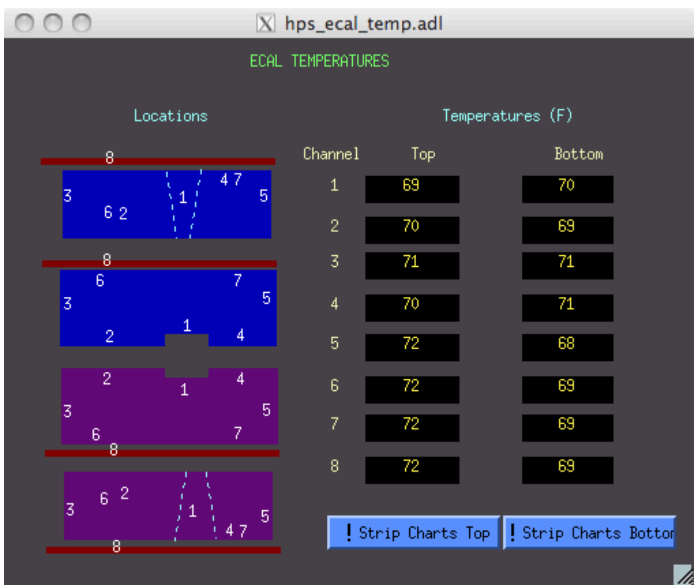


VOLTAGE/CURRENT
ECAL_BOTTOM
Screen 1 of 2

Channel Name	Group#			Measured V	Demand V	Input V	Measured I	Status
ECAL_BOT_01	2	Ena	Dis	364,999	365,000	365,000	0,000	1,000
ECAL_BOT_02	2	Ena	Dis	389,999	390,000	390,000	0,075	1,000
ECAL_BOT_03	2	Ena	Dis	369,998	370,000	370,000	0,000	1,000
ECAL_BOT_04	2	Ena	Dis	369,000	369,000	369,000	0,750	1,000
ECAL_BOT_05	2	Ena	Dis	362,993	363,000	363,000	0,250	1,000
ECAL_BOT_06	2	Ena	Dis	365,997	366,000	366,000	0,500	1,000
ECAL_BOT_07	2	Ena	Dis	359,998	360,000	360,000	0,200	1,000
ECAL_BOT_08	2	Ena	Dis	388,989	389,000	389,000	0,000	1,000
ECAL_BOT_09	2	Ena	Dis	375,995	376,000	376,000	0,000	1,000
ECAL_BOT_10	2	Ena	Dis	372,993	373,000	373,000	0,000	1,000
ECAL_BOT_11	2	Ena	Dis	389,996	390,000	390,000	0,000	1,000
ECAL_BOT_12	2	Ena	Dis	383,995	384,000	384,000	0,000	1,000
ECAL_BOT_13	2	Ena	Dis	379,863	380,000	380,000	0,000	1,000
ECAL_BOT_14	2	Ena	Dis	376,991	377,000	377,000	0,350	1,000
ECAL_BOT_15	2	Ena	Dis	359,994	360,000	360,000	0,375	1,000
ECAL_BOT_16	2	Ena	Dis	366,997	367,000	367,000	0,025	1,000
ECAL_BOT_17	2	Ena	Dis	372,997	373,000	373,000	0,100	1,000
ECAL_BOT_18	2	Ena	Dis	387,998	388,000	388,000	0,300	1,000
ECAL_BOT_19	2	Ena	Dis	396,999	397,000	397,000	0,000	1,000
ECAL_BOT_20	2	Ena	Dis	402,995	403,000	403,000	0,175	1,000
ECAL_BOT_21	2	Ena	Dis	379,993	380,000	380,000	0,000	1,000
ECAL_BOT_22	2	Ena	Dis	367,995	368,000	368,000	0,225	1,000
ECAL_BOT_23	2	Ena	Dis	400,000	400,000	400,000	0,175	1,000
ECAL_BOT_24	2	Ena	Dis	399,996	400,000	400,000	0,000	1,000

Ecal temperature controls

- Chiller (from CLAS calorimeter) and the temperature monitoring system worked well during the test run, no need for changes
- New thermocouples have been tested and mounted in the same locations



Sensor	T(F)
T1	72.8
T2	73.4
T3	73.2
T4	72.8
T5	72.4
T6	72.4
T7	73.0
T8	73.0

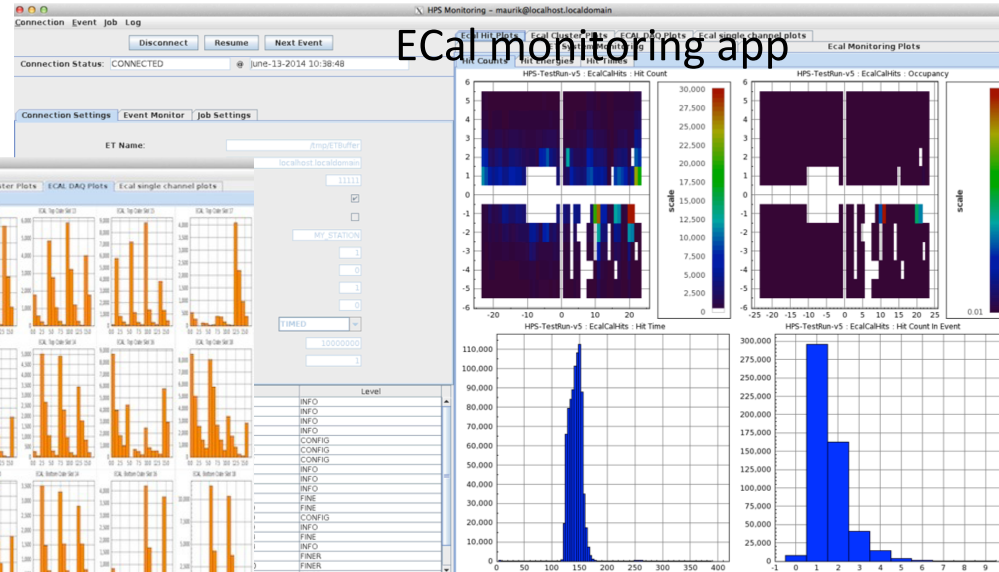
Sensor	T(F)
B1	72.4
B2	74.2
B3	73.0
B4	73.4
B5	72.8
B6	73.2
B7	73.8
B8	72.8

Data quality monitoring

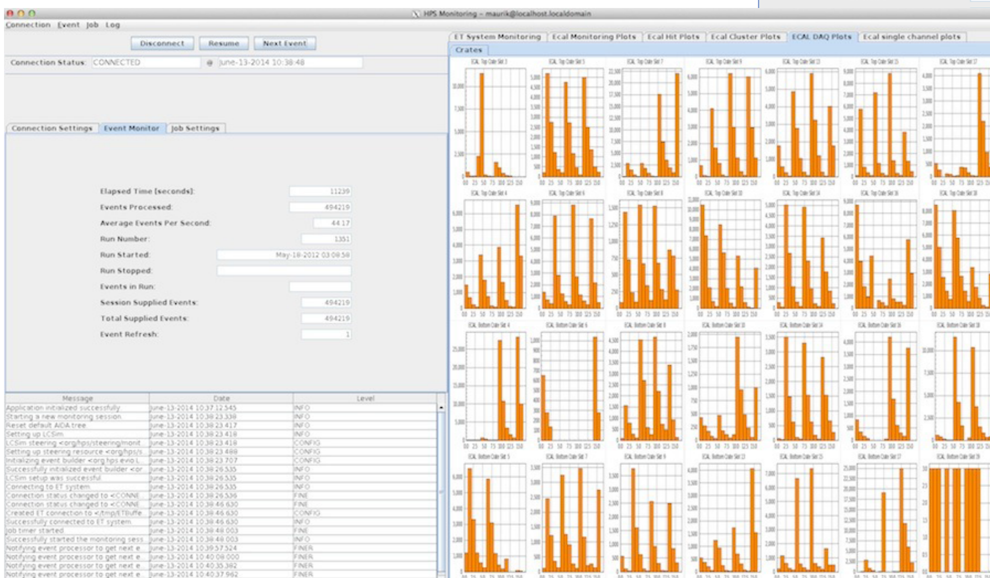
- Monitoring application written in JAVA
- Provides flexible platform to display live updating histograms
- Reads data from ET in EVIO format, converts internally to LCIO (data analysis framework file format)
- Can run multiple copies, i.e. separate ones for different sub-systems.
- Histograms can be saved at end of run.
- Reasonable data rate: ~ 100 Hz (for complicated ECAL monitor)
- Full reconstruction framework available to app to make high level plots

SVT and Ecal data monitoring

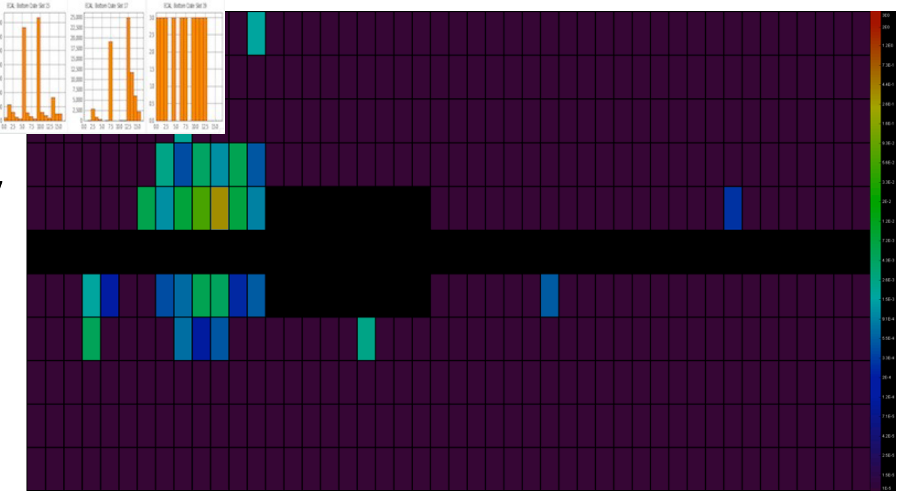
ECal monitoring app



SVT monitoring app



ECal event display



All applications run over ET ring and are able to perform full event reconstruction

Summary

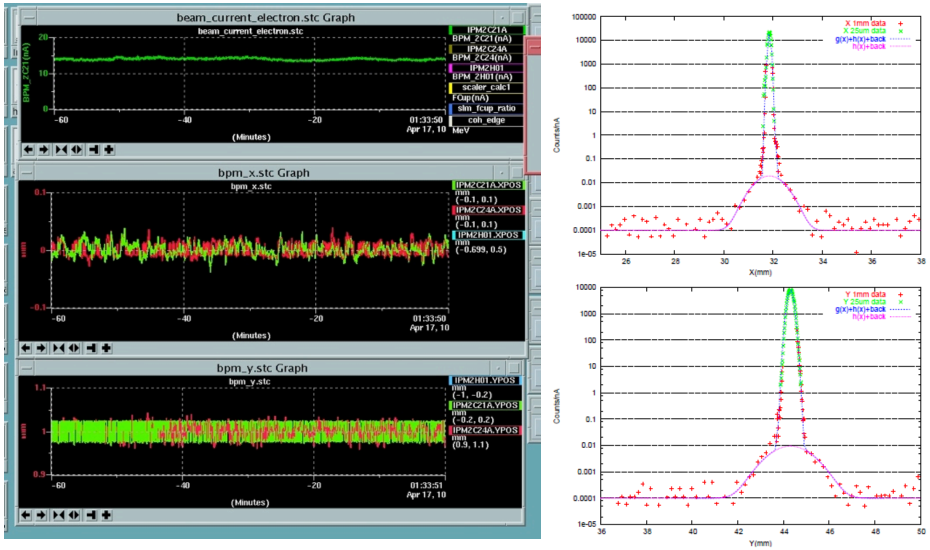
- Many components of the Hall-B/HPS hardware and data quality controls are improved versions of the software used in the test run
- Beamline monitoring and controls will use EPICS. Restoration of the Hall-B EPICS system is progressing well. The new EPICS applications are ready for commissioning
- Data quality monitoring app is fully functional and ready for run as is
- Collaboration has extensive experience with most of applications from 6 GeV Hall-B experiments. The training of collaborators and staff is ongoing

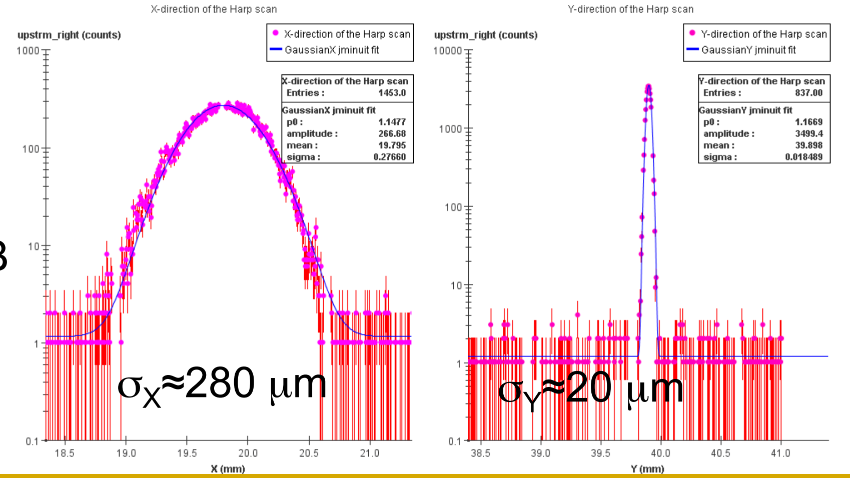
Additional slides

Required Beam Parameters

Parameter	Requirement			Unit
E	1100	2200	6600	MeV
δE/E		$< 10^{-4}$		
Current	<200	<400	<500	nA
Current Instability		< 5		%
σ_X		< 300		µm
σ_Y		< 50		µm
Position Stability		< 30		µm
Divergence		< 100		µrad
Beam Halo (> 5σ)		$< 10^{-5}$		

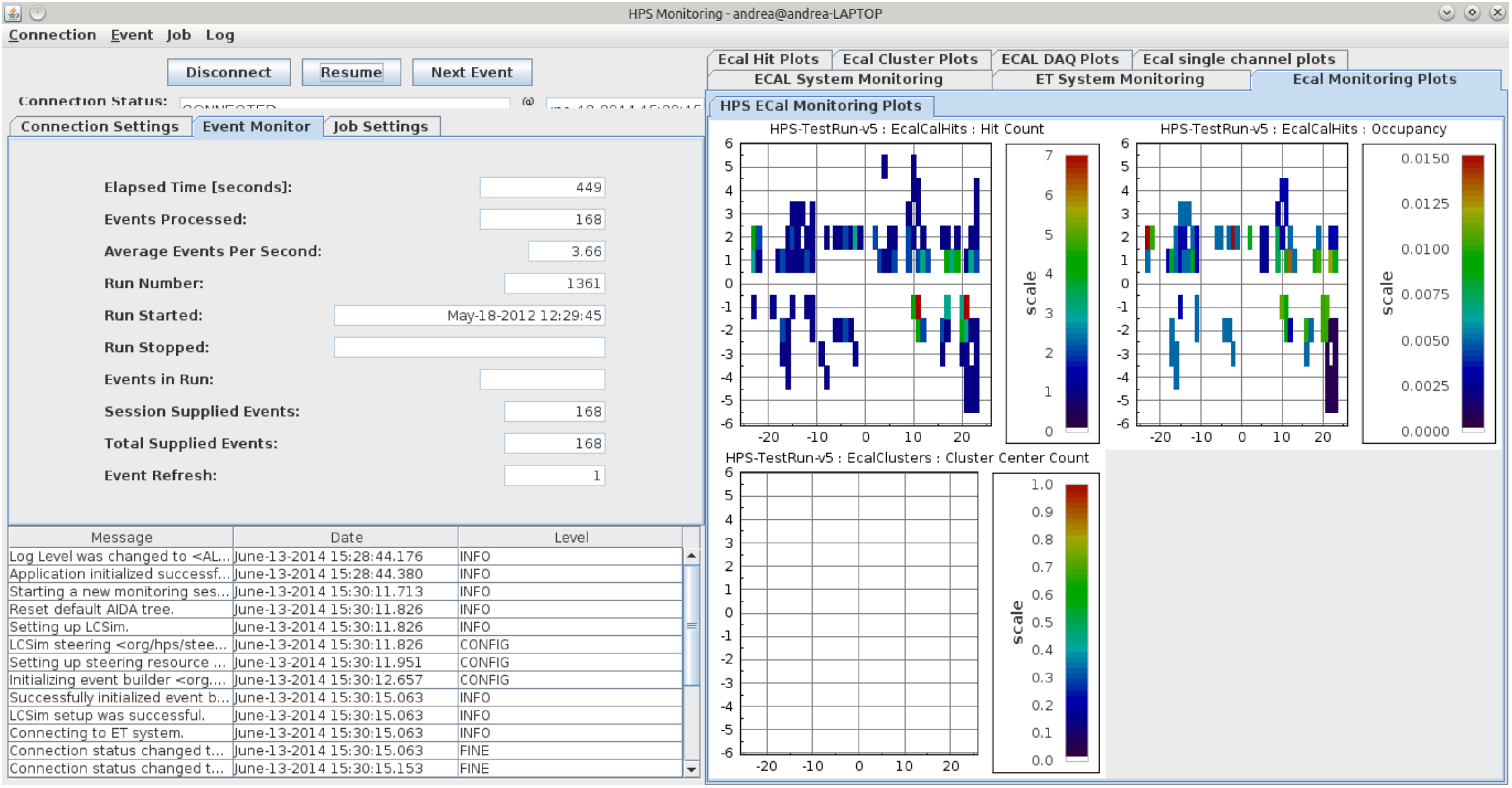
6-GeV machine

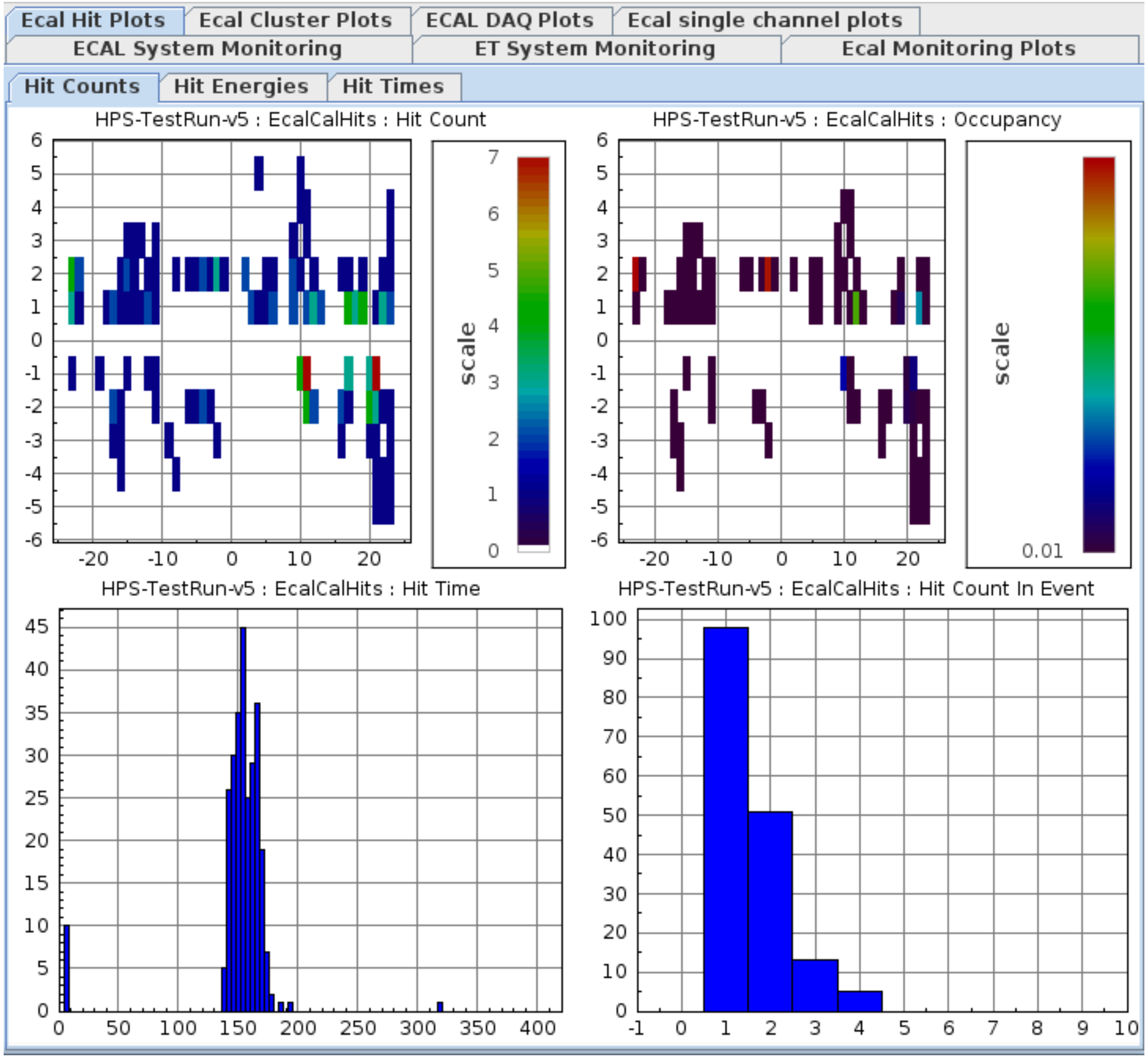




- Nothing extraordinary, Hall-B run experiments with close to these requirements
- Optics optimization test showed that stable, "*ribbon*" beams are available for HPS in Hall-B

But, this was in 6 GeV era!


HPS Monitoring - andrea@andrea-LAPTOP
Connection Event Job Log
Disconnect
Resume
Next Event
Connection Status:
Connection Settings
Event Monitor
Job Settings
Elapsed Time [seconds]: 449
Events Processed: 168
Average Events Per Second: 3.66
Run Number: 1361
Run Started: May-18-2012 12:29:45
Run Stopped:
Events in Run:
Session Supplied Events: 168
Total Supplied Events: 168
Event Refresh: 1
Message | Date | Level
Log Level was changed to <AL... | June-13-2014 15:28:44.176 | INFO
Application initialized successf... | June-13-2014 15:28:44.380 | INFO
Starting a new monitoring ses... | June-13-2014 15:30:11.713 | INFO
Reset default AIDA tree. | June-13-2014 15:30:11.826 | INFO
Setting up LCSim. | June-13-2014 15:30:11.826 | INFO
LCSim steering <org/hps/stee... | June-13-2014 15:30:11.826 | CONFIG
Setting up steering resource ... | June-13-2014 15:30:11.951 | CONFIG
Initializing event builder <org.... | June-13-2014 15:30:12.657 | CONFIG
Successfully initialized event b... | June-13-2014 15:30:15.063 | INFO
LCSim setup was successful. | June-13-2014 15:30:15.063 | INFO
Connecting to ET system. | June-13-2014 15:30:15.063 | INFO
Connection status changed t... | June-13-2014 15:30:15.063 | FINE
Connection status changed t... | June-13-2014 15:30:15.153 | FINE
Ecal Hit Plots
Ecal Cluster Plots
ECAL DAQ Plots
Ecal single channel plots
ECAL System Monitoring
ET System Monitoring
Ecal Monitoring Plots
HPS ECal Monitoring Plots
HPS-TestRun-v5 : EcalCalHits : Hit Count
HPS-TestRun-v5 : EcalCalHits : Occupancy
HPS-TestRun-v5 : EcalClusters : Cluster Center Count
scale



Ecal Hit Plots
Ecal Cluster Plots
ECAL DAQ Plots
Ecal single channel plots
ECAL System Monitoring
ET System Monitoring
Ecal Monitoring Plots
Hit Counts
Hit Energies
Hit Times
HPS-TestRun-v5 : EcalCalHits : Hit Count
HPS-TestRun-v5 : EcalCalHits : Occupancy
scale
HPS-TestRun-v5 : EcalCalHits : Hit Time
HPS-TestRun-v5 : EcalCalHits : Hit Count In Event