

Web System to Support Analysis of the Tile Calorimeter Commissioning

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Abstract. This article describes the set of computer systems that support the data analysis and quality control during the Tile Calorimeter commissioning phase. The Tile Commissioning Web System (TCWS) encapsulates the steps to retrieve information, execute programs, access the outcomes, register statements and verify the equipment status. TCWS integrates different applications, each one presenting a particular view of the commissioning process. The TileComm Analysis stores plots and analysis results, provides equipment-oriented visualization, collects information regarding the equipment performance, and outlines its status in each test. The Timeline application provides the equipment status history in a chronological way. The Web Interface for Shifters supports monitoring tasks by managing test parameters, graphical views of the detector's performance, and information status of all equipment that was used in each test. The DCS Web System provides a standard way to verify the behaviour of power sources and the cooling system.

1. Introduction

Currently, the ATLAS experiment [1, 2] is under commissioning [3] phase, when its subsystems are integrated and tested to ensure their correct operation. The hadronic Tile Calorimeter (TileCal) [4] detector is the central section of the ATLAS hadronic calorimetric system. It is subdivided into four partitions, each one divided in sixty-four modules. The front-end electronics, so-called super-drawers, are situated in the back-beam line region in movable girders, each containing the digitizing electronics for 48 channels. Summing up, TileCal consists of roughly 10000 channels.

These read-out electronics go through standard tests in order to identify the problematic components. These tests simulate the future data-taking operation. Different run types can be taken with TileCal during the commissioning stage. For example, the Noise run, for monitoring the level of the electronic noise, and the Charge injection run, when a charge is injected in the electronic read-out through the calibration Charge Injection System(CIS). The ATLAS Trigger and Data AcQuisition (TDAQ) system acquires and stores data for analysis. Later, this raw data is reconstructed with the ATLAS offline reconstruction software (ATHENA) [5].

The information about the run, like the run identifier and the run type, is stored in the Commissioning Database (Comminfo) [6] as soon as TDAQ starts. These data is used to configure the reconstruction jobs that run in the computing batch system. The reconstruction process generates files, known as Ntuples, containing the necessary data to execute analysis. These files are kept in tree structure where each branch holds different kinds of content. The tree storage format is optimized to reduce disk space and enhance access speed, important features due to the huge amount of data. After being produced, the Ntuples are stored into the storage management system CASTOR [7] (CERN Advanced STORage). It provides a UNIX like directory hierarchy, however it has its own set of commands which requires a particular computing knowledge to access, retrieve and write Ntuples.

Once the reconstruction is done, analysis jobs start to run generating plots and histograms to assist the offline shifter's diagnostic about the equipment behavior in a run. The collaboration members, taking shifts [8] on commissioning work, analyze the outcomes to identify potential problems. These plots are stored in computers located inside the CERN network after being produced.

The readings from the power supplies provided by the Detector Control System (DCS) [9] are also considered to perform the analysis, since it handles the actions initiated by the operator and all errors, warnings, and alarms concerning the hardware of ATLAS. The monitoring occurs in parallel to the operation enabling the safety of the detector. The TileCal main DCS system controls and monitors the Low Voltage Power Supplies (LVPS), the High Voltage (HV) and the cooling of the electronics. This is done by acquiring voltages, currents, temperatures and internal pressures. This acquisition is made through PVSS-based programs. The PVSS-II is a commercial software that offers a graphical interface to connect hardware devices and acquire data.

The LVPS provides eight voltage channels, called bricks, to one TileCal module: three bricks for the HV system (+5V, +15V, -15V) and five to the motherboard and digitizers (3V, +5V, -5V). The HV system provides a common input high voltage for each super-drawer. For each module there is a regulator system that provides fine adjustment of the voltage for each individual channel over a range of 350 V below the nominal input high voltage. The cooling system operates with water at sub-atmospheric pressure. At the level of the TileCal DCS there is only monitoring of the temperatures of the water that circulates in the electronics located inside the drawers (HV readouts) and inside the LVPS units. The TileCal DCS data is stored in the Oracle database [10].

In order to support the analysis work, four different systems were developed, each one with a particular, yet complementary, view of the commissioning progress. Together they compose the Tile Commissioning Web System. This article describes the systems, its functionalities and how they support the TileCal collaboration current activities.

2. Tile Commissioning Web System

As discussed in the previous section, at the beginning of the commissioning phases, the shifter had to know different programming and storage tools, and the location of the files, plots, histograms and parameters with the correct user permissions to access them. It is also necessary to use a computer connected to the CERN network. Without the use of a remote login client these activities would be impossible for a collaboration member outside CERN.

Thus, considering the huge number of analysis, each one with thousands of channels read-outs plus the complementary data, like DCS information, a more intuitive system was developed. The Tile Commissioning Web System spread the steps to integrate information from different locations, execute programs, access the outcomes, register the shifter's technical comments and verify the current equipment status through an integration of different applications, each one presenting a particular view of the commissioning process. The TileComm Analysis stores plots and analysis results, provides equipment-oriented visualization, collects information regarding the equipment performance, and outlines their status in each test. The Timeline interface provides the equipment status history in a chronological way. The Web Interface for Shifters supports monitoring tasks by managing test parameters, graphical views of the calorimeter performance, and information status of all the equipment used in each test. Finally the monitoring of the values from the DCS is made through the tables and plots available in the DCS Web System.

2.1. Web Interface for Offline Shifters

The information for monitoring the tests are available in the Web Interface for Offline Shifter (WIS). WIS is presented in three distinct ways to ease the shifter get a full picture of the commissioning activities referred to the equipment tests. The Figure 1 presents how the system displays the relevant parameters. The identifier, the date and the type of the test, the tested super-drawers and the number of events characterize a run. They are retrieved from the commissioning database as it has already been said before.

Tile Commissioning Web System [...] [ATLAS] [...] [Tile Calorimeter]														
TileCal Commissioning Offline Shifts														
initial page Search														
Run	Run Type	Run Date	#events	Setup	Modules		Overview				Histogram	Plots	Shifter	
					View status View and download comments	OK	Some Problems	Bad	Not to be Analyzed	Not Analyzed				# of Modules
25321	Ped	21/09/2007 17:17:20	5125	LBA-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	64	21/09/2007 18:12:23		
25319	CIS	21/09/2007 17:15:38	4992	LBA-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	64	21/09/2007 18:52:13		
25318	MonoCIS	21/09/2007 17:14:25	5146	LBA-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	64	21/09/2007 18:01:24		
25315	MonoCIS	21/09/2007 16:58:30	885	LBA-sector-1-3-7-9-11-13-15		0%	0%	0%	0%	100%	56	21/09/2007 17:41:52		
25305	Ped	21/09/2007 16:38:07	5121	EBR-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	64	21/09/2007 17:21:41		
25304	CIS	21/09/2007 16:36:09	4992	EBR-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	64	21/09/2007 17:25:23		
25302	MonoCIS	21/09/2007 16:34:50	5153	EBR-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	64	21/09/2007 17:29:26		
25292	Ped	21/09/2007 16:23:32	5119	LBC-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	64	21/09/2007 17:18:09		
25288	CIS	21/09/2007 16:21:48	4992	LBC-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	64	21/09/2007 17:34:58		
25286	MonoCIS	21/09/2007 16:20:32	5145	LBC-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	64	21/09/2007 17:34:14		
25282	Ped	21/09/2007 16:15:19	5128	EBR-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	64	21/09/2007 17:18:03		
25281	CIS	21/09/2007 16:13:38	4992	EBR-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	64	21/09/2007 17:31:51		
25280	MonoCIS	21/09/2007 16:12:16	5145	EBR-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	64	21/09/2007 16:58:52		
25264	LED	21/09/2007 15:03:35	8589	LBC-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	64	21/09/2007 17:10:16		
25212	LED	21/09/2007 12:53:23	10000	LBC-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	64	21/09/2007 17:06:51		
25207	LED	21/09/2007 12:42:17	10001	EBR-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	64	21/09/2007 17:29:57		
25192	CIS	21/09/2007 11:13:18	4992	EBR-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	64	21/09/2007 12:04:44		
25195	CIS	21/09/2007 11:10:12	4992	EBR-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	64	21/09/2007 12:04:40		
25194	Ped	21/09/2007 11:09:25	2322	EBR-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	64	21/09/2007 11:30:57		
25164	Ped	20/09/2007 15:30:50	5126	EBR-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	64	20/09/2007 16:05:00		
25163	CIS	20/09/2007 15:29:08	4992	EBR-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	64	20/09/2007 16:11:30		
25162	MonoCIS	20/09/2007 15:27:53	5142	EBR-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	64	20/09/2007 16:11:55		
25136	Ped	19/09/2007 19:23:00	5117	LBA-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	64	20/09/2007 09:06:18		Ulrike BLUMENSCHNEIN
25135	CIS	19/09/2007 19:21:20	4992	LBA-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	64	20/09/2007 09:35:54		Ulrike BLUMENSCHNEIN
25133	Ped	19/09/2007 19:15:48	5136	EBR-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	64	20/09/2007 09:05:31		Lawrence NODULMAN
25132	CIS	19/09/2007 19:14:04	4992	EBR-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	64	20/09/2007 09:14:34		
25131	MonoCIS	19/09/2007 19:12:45	5146	EBR-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	64	20/09/2007 09:38:39		
25049	Ped	18/09/2007 17:55:39	5118	EBR-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	64	18/09/2007 23:23:39		
25048	CIS	18/09/2007 17:53:57	4992	EBR-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	64	18/09/2007 23:55:44		
25047	MonoCIS	18/09/2007 17:52:42	5149	EBR-sector-1-3-5-7-9-11-13-15		23%	7%	9%	41%	0%	64	18/09/2007 23:36:12		
Pages: 1 2 3 4 5 6 7 8 9 10 Next >														

Figure 1. Main parameters shown in WIS.

WIS also presents whether the reconstruction has already been performed, displaying the current location of the correspondent Ntuple in CASTOR. The histogram generated during the reconstruction has its creation time displayed in the main interface.

The second way of visualization, on Figure 2(a), shows a graphical representation of the calorimeter performance for a test and the status of the tested equipment. While the first way

is oriented to the commissioning progress this is a equipment-oriented visualization. In other words, it focuses on the electronics' performance. This way, the user can quickly identify which super-drawers present problems.

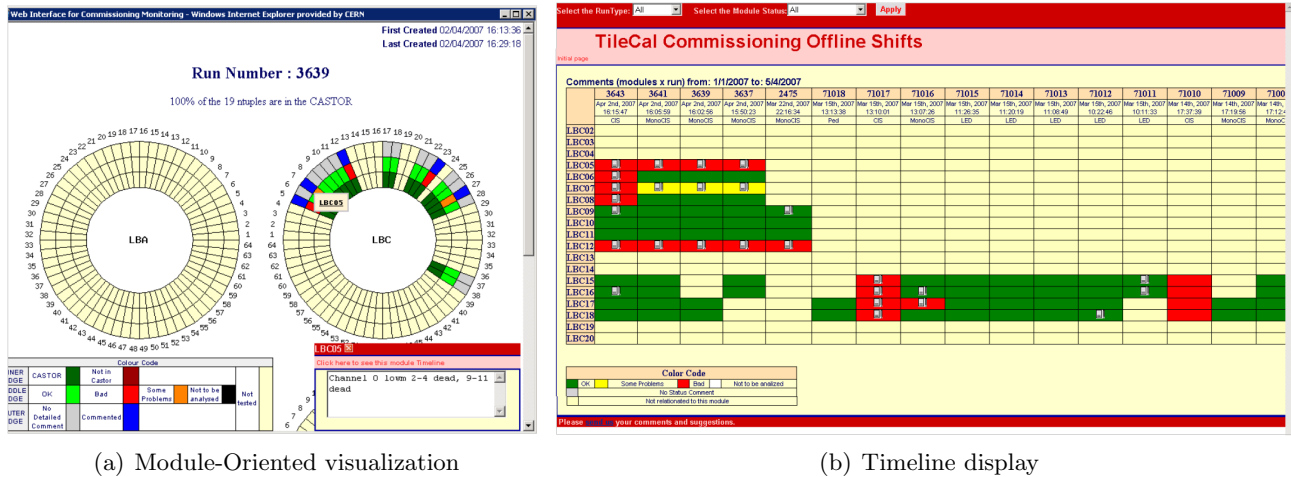


Figure 2. Other ways to visualize the data.

The third viewing is the Timeline display which is responsible for the module monitoring for a given timestamp. This functionality allows the user to follow the commissioning progress throughout time. It's possible to select the period of time, the drawer, the test type and the drawer state which could be GOOD, BAD or SOME PROBLEMS. Each state is represented by one color in the time line. The Figure 2(b) shows the result of a user's search.

3. TileComm Analysis

The plots are associated with their parameters after runs are reconstructed through TileComm Analysis. The system retrieves the data from CommInfo database and inserts it into its own database. Then it looks for the plots and histograms in local directories storing the paths found. After that, TileComm allows different kinds of navigation, or it presents all the test for a module or all modules for a run.

After the shifters perform an analysis, they should save their comments about the analyzed modules. Hence, TileComm Analysis offers two options. The first is the Status Comments that summarizes the module performance as GOOD or BAD. The other option is the Detailed Comments, that describes the situation of the module. The Figure 3 represents the TileComm Analysis main visualization.

Currently, the drawer status can be automatically set by default algorithms analysis created with the Data Quality Monitoring (DQM) Framework. The module histograms are analyzed by their respective algorithms and each one produces a qualified result that is stored in XML files. These files are parsed and their contents are stored in the TileComm Analysis database. Later, TileComm Analysis displays the DQM results for modules and, through the DQM Viewer, shows all algorithm status that defines a module status. Figure 4 shows the hierarchical results on DQM Viewer interface.

4. The DCS Web System

The main goal of DCS Web System is to determine a standard analysis procedure for the data stored by DCS and, this way, replace the list of tasks needed to guarantee the power supplies

Run	Module	Date	Run Type	Plot	Status Comments	DQM	Shifter
21951	LBA01	2007-09-04 16:57:13	CIS	---	OK	●	Brian Thomas MARTIN
21951	LBA02	2007-09-04 16:57:13	CIS	emp_ratio.ps dig_errors.ps dig_noise.ps fit_time.ps	OK	●	Brian Thomas MARTIN
21951	LBA03	2007-09-04 16:57:13	CIS	emp_ratio.png dig_errors.png dig_noise.png fit_time.png	Not to be analyzed	●	Brian Thomas MARTIN
21951	LBA04	2007-09-04 16:57:13	CIS	---	Bad	●	Brian Thomas MARTIN
21951	LBA05	2007-09-04 16:57:13	CIS	---	OK	●	Brian Thomas MARTIN
21951	LBA06	2007-09-04 16:57:13	CIS	---	OK	●	Brian Thomas MARTIN
21951	LBA07	2007-09-04 16:57:13	CIS	---	OK	●	Brian Thomas MARTIN
21951	LBA08	2007-09-04 16:57:13	CIS	---	Some problems	●	Brian Thomas MARTIN
21951	LBA09	2007-09-04 16:57:13	CIS	---	OK	●	Luca FIORINI, Brian Thomas MARTIN
21951	LBA10	2007-09-04 16:57:13	CIS	---	Some problems	●	Brian Thomas MARTIN

Figure 3. TileComm analysis main table.

Run Information	
Run Number:	21951
Run Type:	CIS
Run Date:	2007-09-04 16:57:13

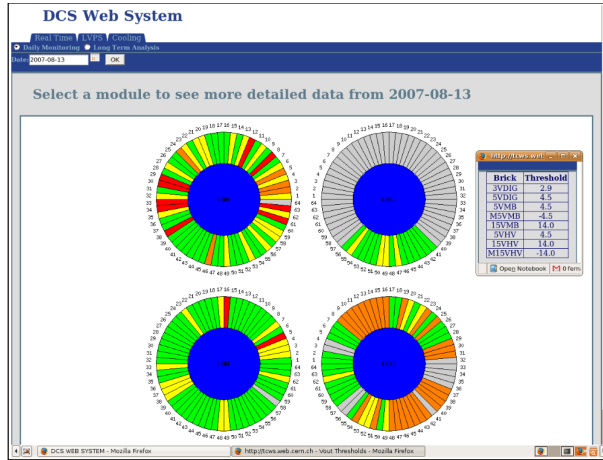
LBA02_globalCRC	
Histogram Name:	Tile/Digits/Summary/LBA02_CRC_global
TotalIntegral:	4802
SideBands:	0
Plot:	dig_errors.png

Figure 4. DQM Viewer.

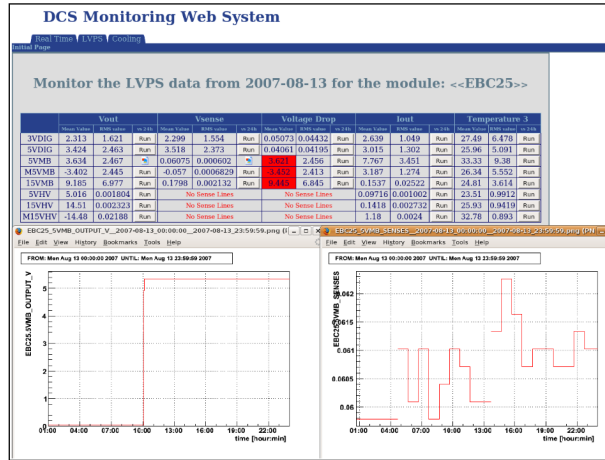
safe operation. The tasks includes the data retrieval from Oracle database, the production of Ntuples and the execution of ROOT macros. Different plots are generated. Another DCS Web System's goal is to assign the parameters that qualify the voltage sources status. Thus, the voltage readout inside the super-drawer, labeled sense line, and its difference against the brick output are considered the major qualifying factors.

Currently this web system has two distinct approaches to deal with DCS data. The monthly analysis and the daily monitoring. Both present a summary table with the mean values and the standard deviation of the voltages, currents and temperatures for the LVPS bricks.

In the daily monitoring display, a graphical representation of the calorimeter shows the power supplies current operating state according to the voltages drops thresholds. The problematic cases, where the measurements are higher than the set threshold, are colored in three different ways. Yellow when just one brick fail, red in case of two failed bricks and orange if the box has low sense lines levels. The Figure 5(a) presents the system's first panel.



(a) DCS daily monitoring.

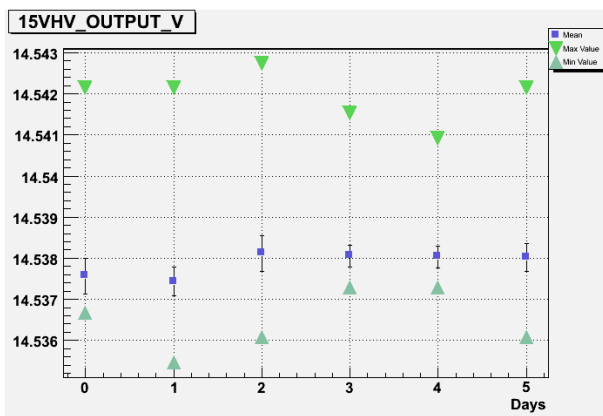


(b) Summary table and plots for a drawer.

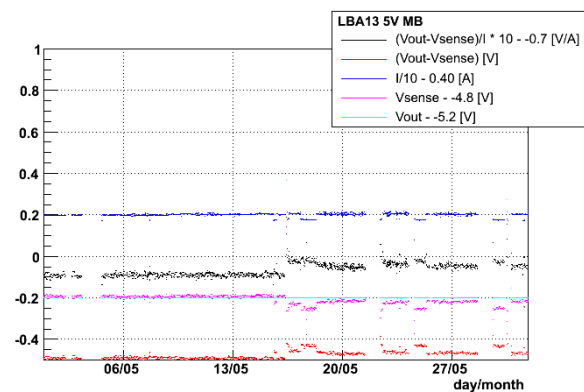
Figure 5. DCS Web System.

When a module from the wedge barrel is clicked, a summary table (Figure 5(b)) with the calculated values is displayed. The system allows the user to generate plots beyond the selected statistics values view. These plots present the LVPS progress over twenty-four hours. The dangerous cases for the detector operation are highlighted according the previous qualifying, red for the voltages drops over-thresholds and orange for the voltage senses lower than the correct value.

The monthly analysis also displays the mean and RMS values, for a whole month though. It presents statistic plots that help to predict possible future problems too. For example, the first plot in Figure 6(a) describes the LVPS progress showing the mean, the maximum, the minimum and the RMS values for every day during one month. The second one (Figure 6(b)) display the correlation between the currents, voltages and resistances.



(a) Plot with the mean, maximum, minimum and the RMS values.



(b) Correlation plot between voltages, currents and impedances.

Figure 6. Example of monthly analysis plots.

5. Conclusion

During the Tile Calorimeter commissioning phase, a full set of tests in the electronics are made and they must be monitored and analyzed. This process involves a list of predefined tasks, like the execution of programs and macros, the retrieval of information from databases, the generation of plots and the report of problems. TCWS implementation automatizes these tasks through the integration of different applications. Each one presents a view of the commissioning progress. Together, they provide a complete overview of this progress though.

The shifter accesses the Web Interface for Shifters looking for new runs. As soon as the tests are reconstructed, the analysis could be made through the TileComm Analysis. Their comments and statements will be registered in the TileComm Database and it will be available in the Timeline system. In parallel, the DCS data is monitored guaranteeing the safe drawer operation and validating previous tests.

It is foreseen the HV integration in the DCS Web System and automatic fill of the status comments in the Tilecom Analysis according the DQM status. The possibility to add functionalities to analyze calibration and physics runs is being studied. These runs will be more frequent after the beginning of LHC operation and this function would be integrated with WIS and TileComm Analysis.

6. References

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