

The ATLAS Tile Calorimeter Web Systems for Data Quality

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Abstract. The ATLAS detector consists of four major components: inner tracker, calorimeter, muon spectrometer and magnet system. In the Tile Calorimeter (TileCal), there are 4 partitions, each partition has 64 modules and each module has up to 48 channels. During the ATLAS pre-operation phase, a group of physicists need to analyze the Tile Calorimeter data quality, generate reports and update the official database, when necessary. The Tile Commissioning Web System (TCWS) retrieves information from different directories and databases, executes programs that generate results, stores comments and verifies the calorimeter status. TCWS integrates different applications, each one presenting a unique data view. The Web Interface for Shifters (WIS) supports monitoring tasks by managing test parameters and all the calorimeter status. The TileComm Analysis stores plots, automatic analyses results and comments concerning the tests. With the necessity of increasing granularity, a new application was created: the Monitoring and Calibration Web System (MCWS). This application supports data quality analyses at the channel level by presenting the automatic analyses results, the problematic known channels and the channels masked by the shifters. Through the web system, it is possible to generate plots and reports, related to the channels, identify new bad channels and update the Bad Channels List at the ATLAS official database (COOL DB). The Data Quality Monitoring Viewer (DQM Viewer) displays the data quality automatic results through an oriented visualization.

1. Introduction

The ATLAS experiment [1] is composed of four major sub-detectors: inner tracker, calorimeter, muon spectrometer and magnet system.

In the ATLAS calorimeter outer sections there are tile sensors. The Tile Calorimeter (TileCal) [2] is a barrel hadronic calorimeter that is composed of four partitions (Extended and Long Barrels, one in each side, A and C). Each partition is divided into 64 modules. There are up to 48 digitizing electronics in each module. Electronically, TileCal consists of 10,000 channels approximately.

During the commissioning phase, standard tests occur in order to identify problems with the detector. The tests simulate the operation phase that will start in 2009. Several types of runs are taken, such as Noise, Charge Injection System (CIS) and Calibration System (Laser and Cesium), for example.

The data gathered from the channels are transmitted to the Data Acquisition System (DAQ) following the assertions of the ATLAS Trigger System, composed of three levels. The TDAQ systems are responsible for handling the data when the runs are taken [3]. After that, ATLAS collaborators uses ATHENA, an offline software to reconstruct the data [4].

As soon as TDAQ starts taking data, basic runs information (such as run identifier, run date and sectors) are stored in the comminfo database [5]. The stored information is important to configure the

ATHENA reconstruction process. ATHENA generates ntuples (ROOT [6] files in a tree structure where each branch has different kinds of information) during the reconstruction period and stores it in the CERN Advanced STORage (CASTOR) system [7]. CASTOR specific commands [8] must be used to retrieve and write the ntuple files. Once the reconstruction is done, plots and histograms are generated by scripts that are executed periodically. The results are kept in local directories and in order to access them, the user needs to have a CERN account.

At this point, the physicists start analyzing all the data in a process known as offline analyses. The Data Quality [9] team (DQ team) is responsible for validating the quality of the data being acquired by the detector and diagnosing any problems in a shortest possible time. There is still a list of known problematic channels stored in the ATLAS COOL DB [10]. To keep the Bad Channels List updated is a DQ Team job as well.

The Tile Commissioning Web System was developed to support the DQ team offline analyses. It integrates the diverse data displaying the information through different tools, each one presenting a particular data view.

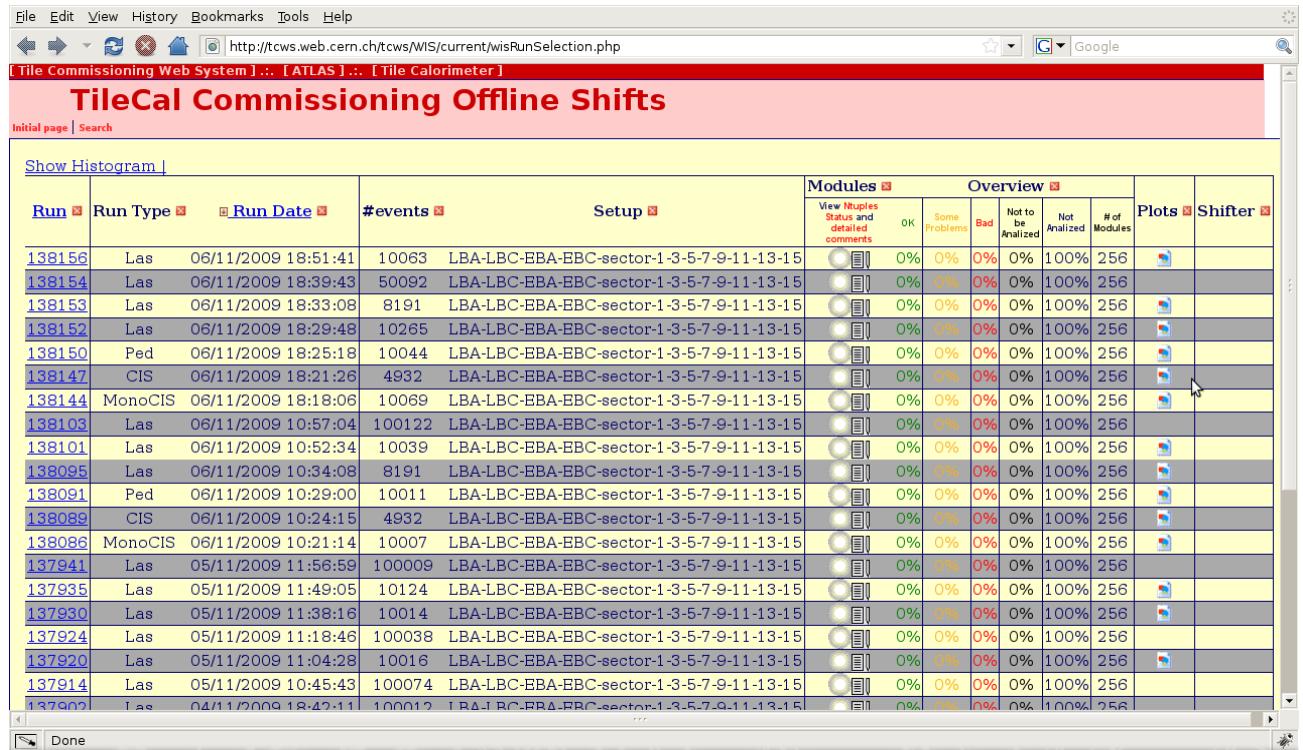
2. Tile Commissioning Web System

The DQ Team is responsible for: analyzing all the data taken and generating results as fast as possible; ensuring the data quality and diagnosing the detector's problems; updating the Bad Channels List in the COOL database when necessary; The huge amount of data stored in different locations (CASTOR, comminfo database, commissioning local directories) makes the analysis harder. Specific system expertise is also necessary to access the generated files. Updating the Bad Channels List in the COOL DB is also non-trivial since it requires at least three steps: retrieve the last list from the COOL DB; modify it inserting the new bad channels and removing the channels that do not have problems anymore; generate a SQLite file that will finally update the Bad Channel List inside COOL DB.

The Web Interface for Shifters (WIS) shows basic run information (such as run identifier, date, type, used sectors) in a table and the ntuples' locations in CASTOR in a graphical way. The TileComm Analysis shows the plots and histograms generated after the reconstruction period. The shifter can also register comments concerning the calorimeter status to find out possible new problems with the detector. The Data Quality Monitoring (DQM) Viewer displays the automatic analyses results through a tree. Finally, the Monitoring and Calibration Web Systems (MCWS) support the DQ team offline analyses at the channels level and support the Bad Channels List update.

2.1. Web Interface for Shifters (WIS)

All the data taken and the reconstruction process are monitored by the Web Interface for Shifters application. It is divided into three visualizations and each one presents the information in a different way. The first one just displays the basic run information through a table (such as run identifier, run type, run date and number of events, for example), as shown in the **Figure 1**.



Run	Run Type	Run Date	#events	Setup	Modules				Overview				Plots	Shifter
					View Ntuples	Status and detailed comments	OK	Some Problems	Bad	Not to be Analyzed	Not Analyzed	# of Modules		
138156	Las	06/11/2009 18:51:41	10063	LBA-LBC-EBA-EBC-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	0%	256		
138154	Las	06/11/2009 18:39:43	50092	LBA-LBC-EBA-EBC-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	0%	256		
138153	Las	06/11/2009 18:33:08	8191	LBA-LBC-EBA-EBC-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	0%	256		
138152	Las	06/11/2009 18:29:48	10265	LBA-LBC-EBA-EBC-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	0%	256		
138150	Ped	06/11/2009 18:25:18	10044	LBA-LBC-EBA-EBC-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	0%	256		
138147	CIS	06/11/2009 18:21:26	4932	LBA-LBC-EBA-EBC-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	0%	256		
138144	MonoCIS	06/11/2009 18:18:06	10069	LBA-LBC-EBA-EBC-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	0%	256		
138103	Las	06/11/2009 10:57:04	100122	LBA-LBC-EBA-EBC-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	0%	256		
138101	Las	06/11/2009 10:52:34	100039	LBA-LBC-EBA-EBC-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	0%	256		
138095	Las	06/11/2009 10:34:08	8191	LBA-LBC-EBA-EBC-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	0%	256		
138091	Ped	06/11/2009 10:29:00	10011	LBA-LBC-EBA-EBC-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	0%	256		
138089	CIS	06/11/2009 10:24:15	4932	LBA-LBC-EBA-EBC-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	0%	256		
138086	MonoCIS	06/11/2009 10:21:14	100007	LBA-LBC-EBA-EBC-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	0%	256		
137941	Las	05/11/2009 11:56:59	100009	LBA-LBC-EBA-EBC-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	0%	256		
137935	Las	05/11/2009 11:49:05	10124	LBA-LBC-EBA-EBC-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	0%	256		
137930	Las	05/11/2009 11:38:16	10014	LBA-LBC-EBA-EBC-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	0%	256		
137924	Las	05/11/2009 11:18:46	100038	LBA-LBC-EBA-EBC-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	0%	256		
137920	Las	05/11/2009 11:04:28	10016	LBA-LBC-EBA-EBC-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	0%	256		
137914	Las	05/11/2009 10:45:43	100074	LBA-LBC-EBA-EBC-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	0%	256		
137909	Las	04/11/2009 18:42:11	100012	LBA-LBC-EBA-EBC-sector-1-3-5-7-9-11-13-15		0%	0%	0%	0%	100%	0%	256		

Figure 1. WIS main table information

With the second visualization it is possible to monitor whether the ntuples were created and stored in CASTOR via a graphical view (**Figure 2**). To access this visualization the shifter needs to select the *Modules* column only. It is possible also to visualize detailed comments registered through the TileComm Analysis application, that will be described later. The third visualization is the timeline. Through this application, the shifter monitors the module evolution. The user can filter a period of time, a partition, a module number, a run type and a module's statuses (as *OK*, *Some Problems*, *Bad* or *Not to be analysed*). The module's statuses are defined by the physicists during the analyses. Each status is represented by a color in the time line table. Green means that the module is *OK*, yellow means that the module has *Some Problems*, red means that the module is *Bad* and blue means that the module has *Not to be analysed*. One example of the result is shown below in **figure 3**.

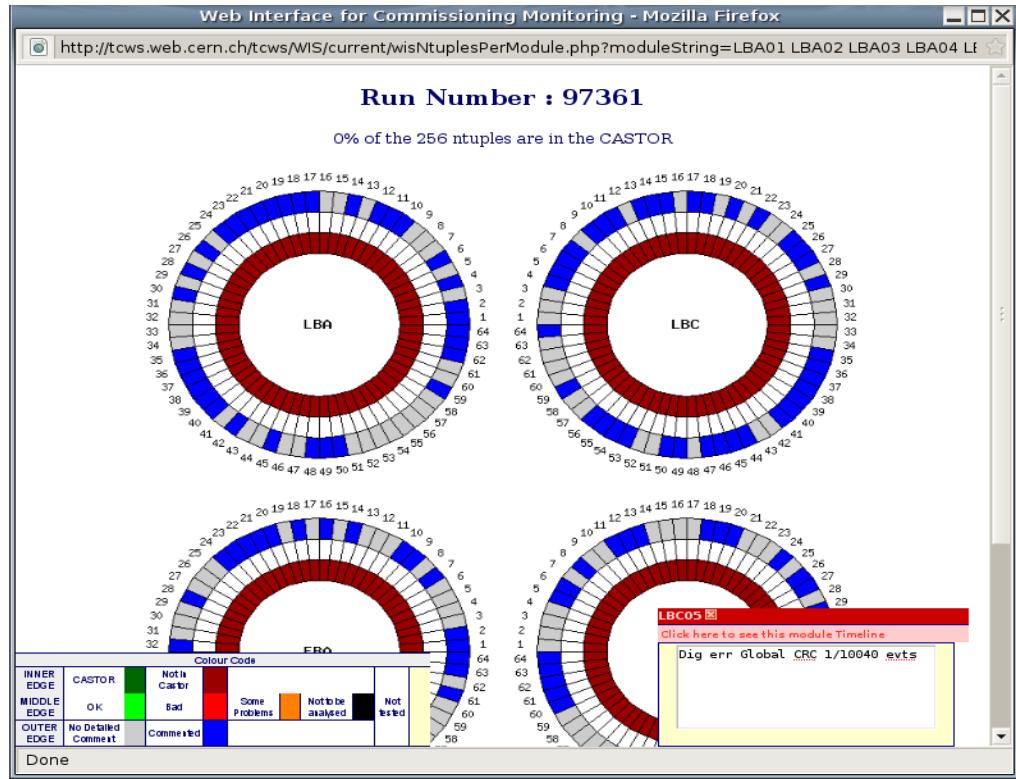


Figure 2. WIS Graphical Overview

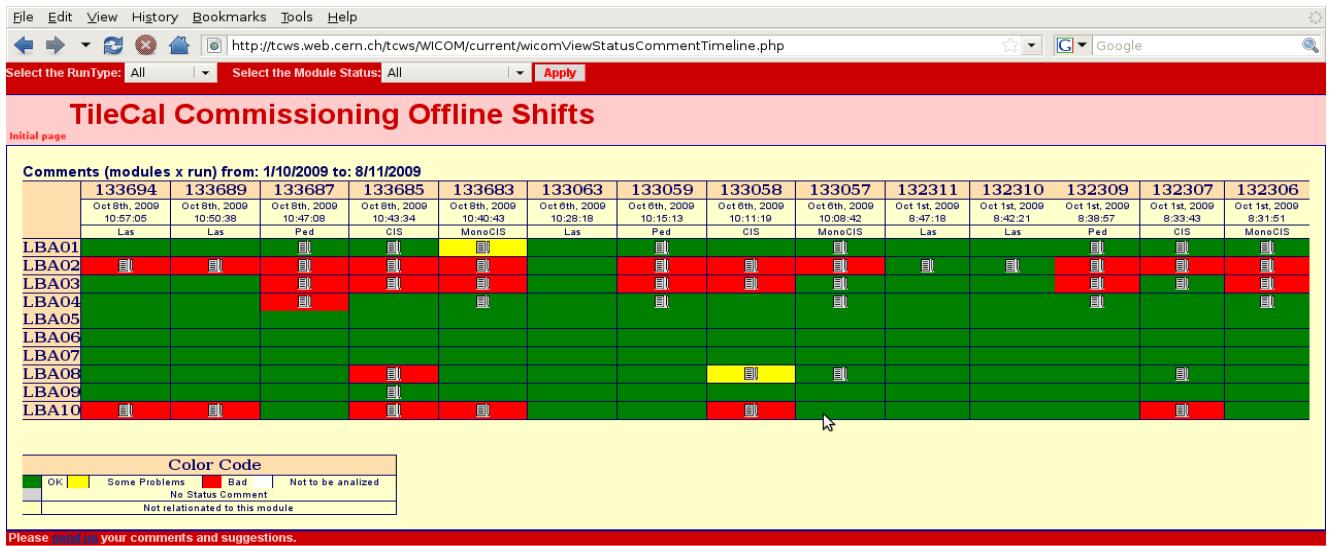


Figure 3. WIS Timeline

2.2 TileComm Analysis

Once the reconstruction process is done, the plots and histograms are associated to the runs parameters and displayed in the TileComm Analysis (**Figure 4**). The system retrieves the information from the comminfo database and stores the results in its own database (known as tbanalysis). It searches the generated plots and histograms under the commissioning local directories and inserts their paths into tbanalysis database as well. After analyzing all the data, the shifter should diagnose calorimeter problems. In TileComm Analysis there are two kinds of comments: one concerns the detector status (Status Comment), where the shifter sets a summarized comment (such as *Ok*, *Some problems*, *Bad* and *Not to be analysed*); the other is known as Detailed Comment, where the shifter explains in more details the module's problem found analyzing the data.

Run	Module	Date	Run Type	Plot	Detailed Comments	Status Comments	DQM	Shifter
133694	EBA01	2009-10-08 10:57:05	Las	... Select a Plot ...			●	Yuri KOULTCHITSKI
133694	EBA02	2009-10-08 10:57:05	Las	... Select a Plot ...	Module EBA02 CH04: LG STUCK BIT AT 2; CH10: EDPS BAD; CH04: LG NOISY	●	●	Yuri KOULTCHITSKI
133694	EBA03	2009-10-08 10:57:05	Las	... Select a Plot ...			●	Yuri KOULTCHITSKI
133694	EBA04	2009-10-08 10:57:05	Las	... Select a Plot Select a Plot ... All dig_errors.png dig_noise.png dsp_amp.png fit_amp.png	Module EBA04 CH00: LG EDSP BAD Run submit cancel		●	Yuri KOULTCHITSKI
133694	EBA05	2009-10-08 10:57:05	Las	... Select a Plot ...			●	Yuri KOULTCHITSKI
133694	EBA06	2009-10-08 10:57:05	Las	... Select a Plot ...			●	Yuri KOULTCHITSKI
133694	EBA07	2009-10-08 10:57:05	Las	... Select a Plot ...			●	Yuri KOULTCHITSKI
133694	EBA08	2009-10-08 10:57:05	Las	... Select a Plot ...			●	Yuri KOULTCHITSKI

Figure 4. TileComm Analysis

Through TileComm Analysis it is possible to check the automatic analyses generated results (Data Quality Results) but this will be described in the next section (DQM Viewer).

2.3 Data Quality Monitoring Viewer (DQM Viewer)

The ATLAS Data Quality Monitoring Framework (DQMF) is used to check and automatically verify the histograms produced during the reconstruction process.

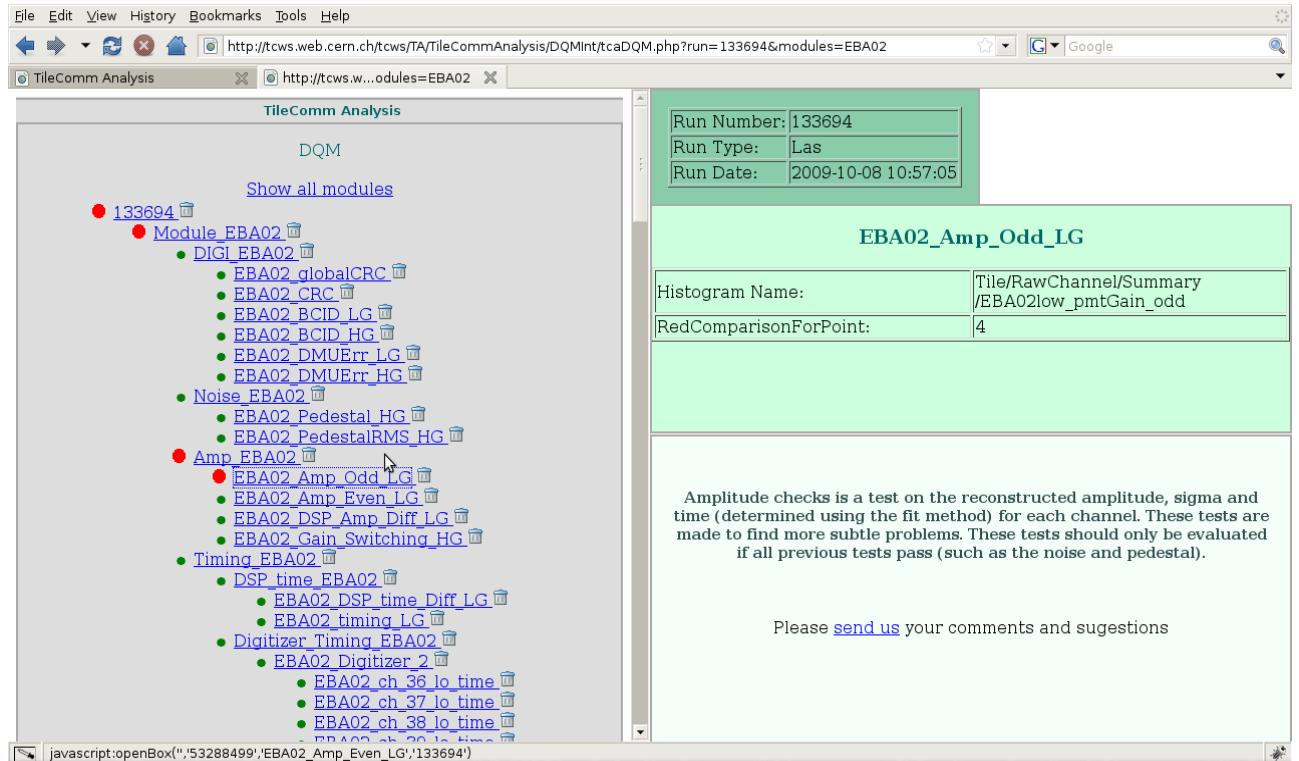


Figure 5. DQM Viewer structured tree

A test algorithm is performed in each histogram and the results (Green, Yellow or Red) are stored in an XML file (known as *tcafle*). The *tcafle* is parsed by a script known as *TCAParser* and the results are stored in *tbanalysis* database. Once the information is inside the system's own database, it can be visualized in the DQM Viewer (**Figure 5**). The system organizes the results in a structured tree according to the calorimeter parameters.

2.4 Monitoring & Calibration Web System (MCWS)

All the systems described until now were developed to analyze data at module level. In order to increase the granularity, the MCWS was created so that the Data Quality team (DQ team) could analyze data at channel level. At this level, the DQ team analysis consists in three steps: the first one occurs when the run is being taken. At this moment, the shifter needs to access quickly the known problematic channels list in order to diagnose new problems; after the reconstruction process, the shifter analyzes all the channels' information taken and reports the results to the DQ team leader; The leader takes the reports and updates the problematic channels list. The system is composed basically of three applications that are described below.

2.4.1 COOL DB Display

COOL is an API for reading and writing conditions data. It aims to provide a common solution for the storage and management of the conditions data of ATLAS experiments. In this context, TileCal stores several kinds of conditions data inside the COOL database. One of them is the known problematic channels list, also called the Bad Channels List. The COOL DB display application was created to

simplify the Bad Channels List visualization when the runs are being taken. As already described before, one of the DQ team jobs is to assure the quality of the data as quickly as possible. It is extremely important that the shifter identifies new problems based on a list with the known problematic channels.

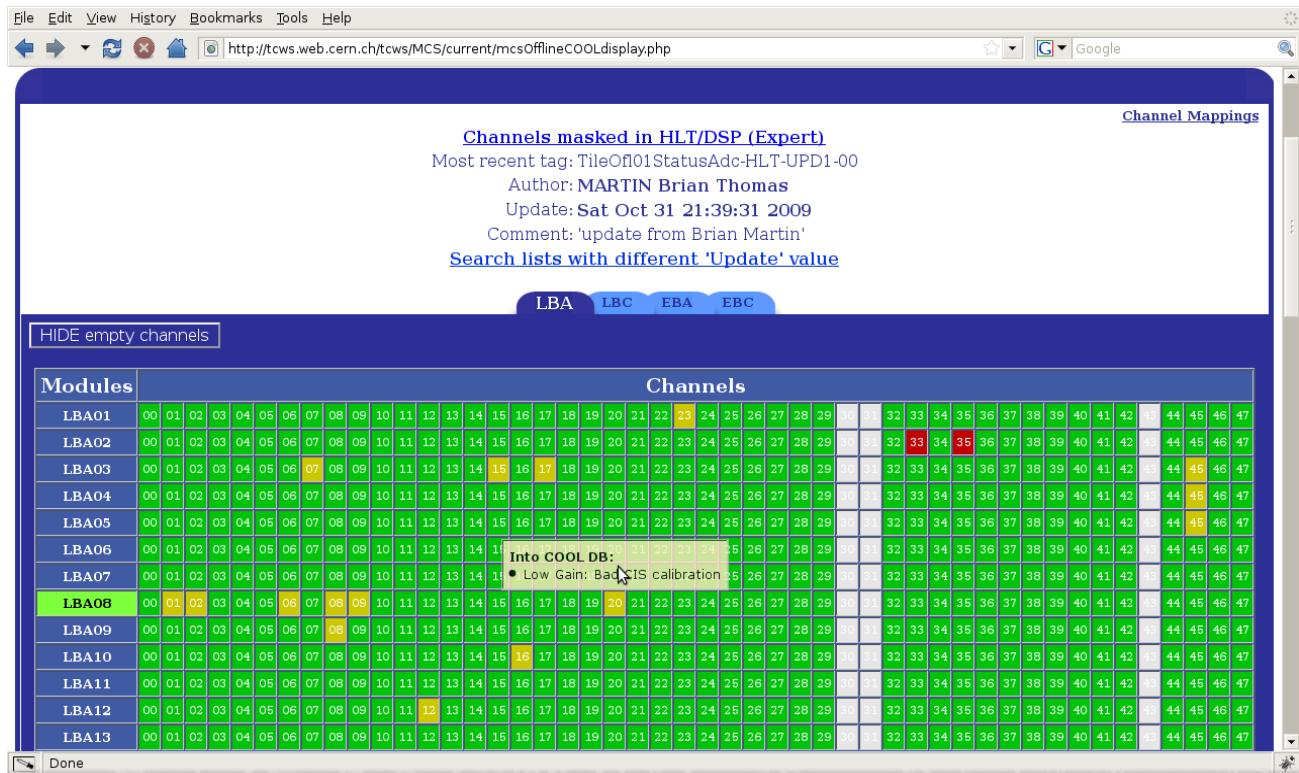


Figure 6. COOL database display

The application consists of a table displaying the channels statuses (**Figure 6**). Each status is represented by a color: *Green* means that the channel does not have problems at all; *Yellow* means that the channel has at least one problem, but it is not serious; And *Red* means that the channel has at least one serious problem.

2.4.2 Data Quality Validator Application

After the reconstruction process, a shifter from the Data Quality team (known as the *DQ Validator*) analyzes all the data taken and diagnoses channels' problems to the Data Quality team leader. The Data Quality Validator application summarizes different kinds of information to support the DQ Validator reports. During the analysis, the shifter should store comments and mask (or unmask) the channels according to the results. The application displays the automatic analysis results (DQ Results), the problematic channels stored inside the COOL DB (Bad Channels List), the channels that were commented and masked by the DQ Validator and the plots that are generated through the web system by demand. An example of this application is shown in **Figure 7**.

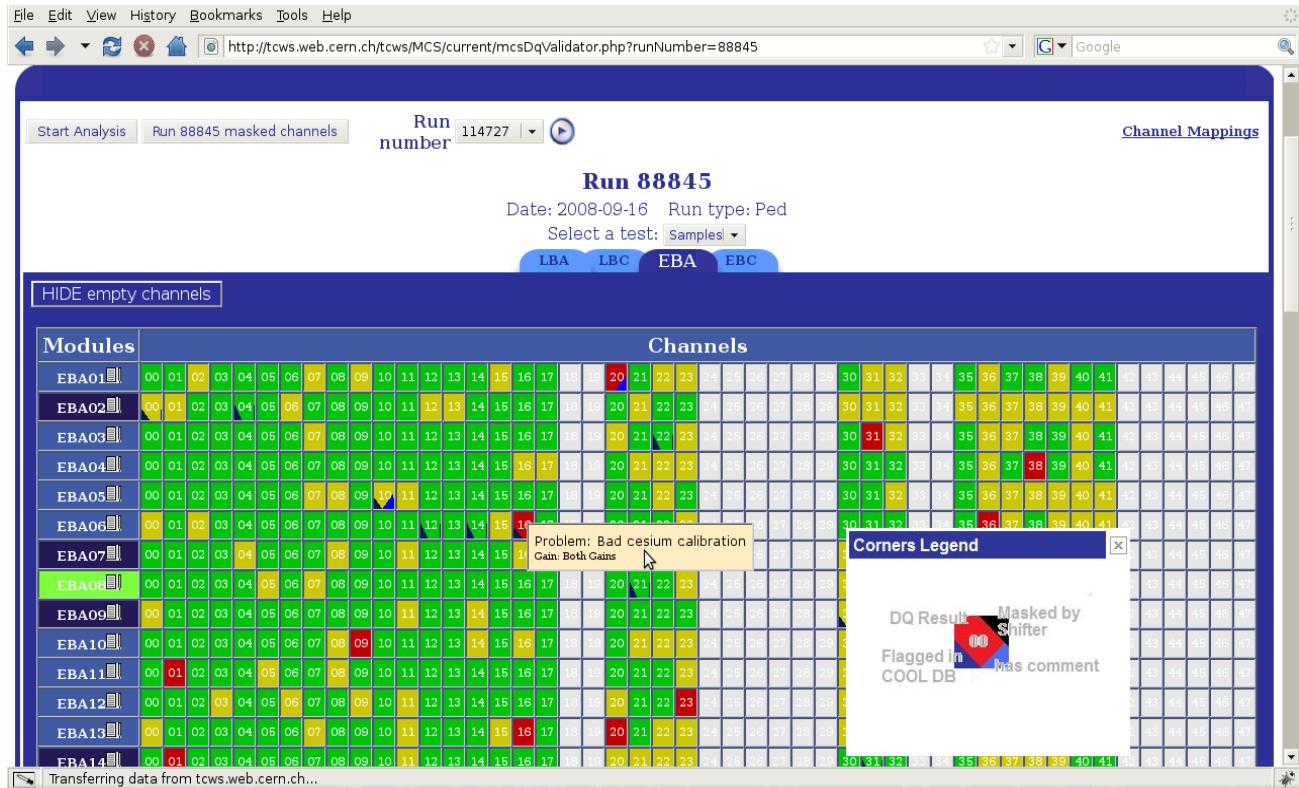


Figure 7. DQ Validator main table

2.4.3 Data Quality Leader Application

Once the DQ Validator finishes the analyses, the DQ Leader can start the Bad Channels List update inside the COOL DB. The Data Quality Leader application summarizes the DQ Validators reports and the channels that are already inside COOL DB (**Figure 8**).

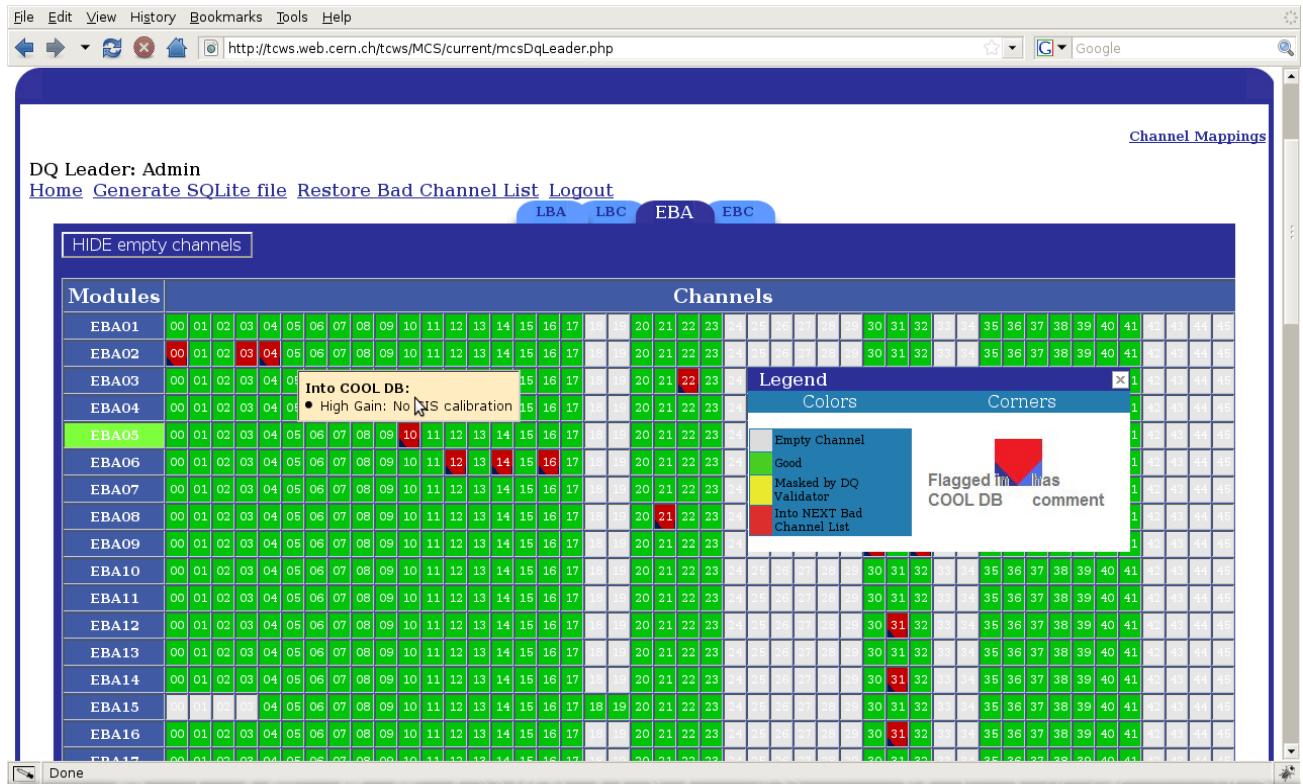


Figure 8. DQ Leader main table

With this information, the leader can prepare the Bad Channels List update, editing and inserting new problematic channels or removing channels that do not have problems anymore (**Figure 9**). After the new Bad Channel List preparation, the leader generates an SQLite file via the web interface (**Figure 10**) that will finally update the new conditions data inside the COOL Database.

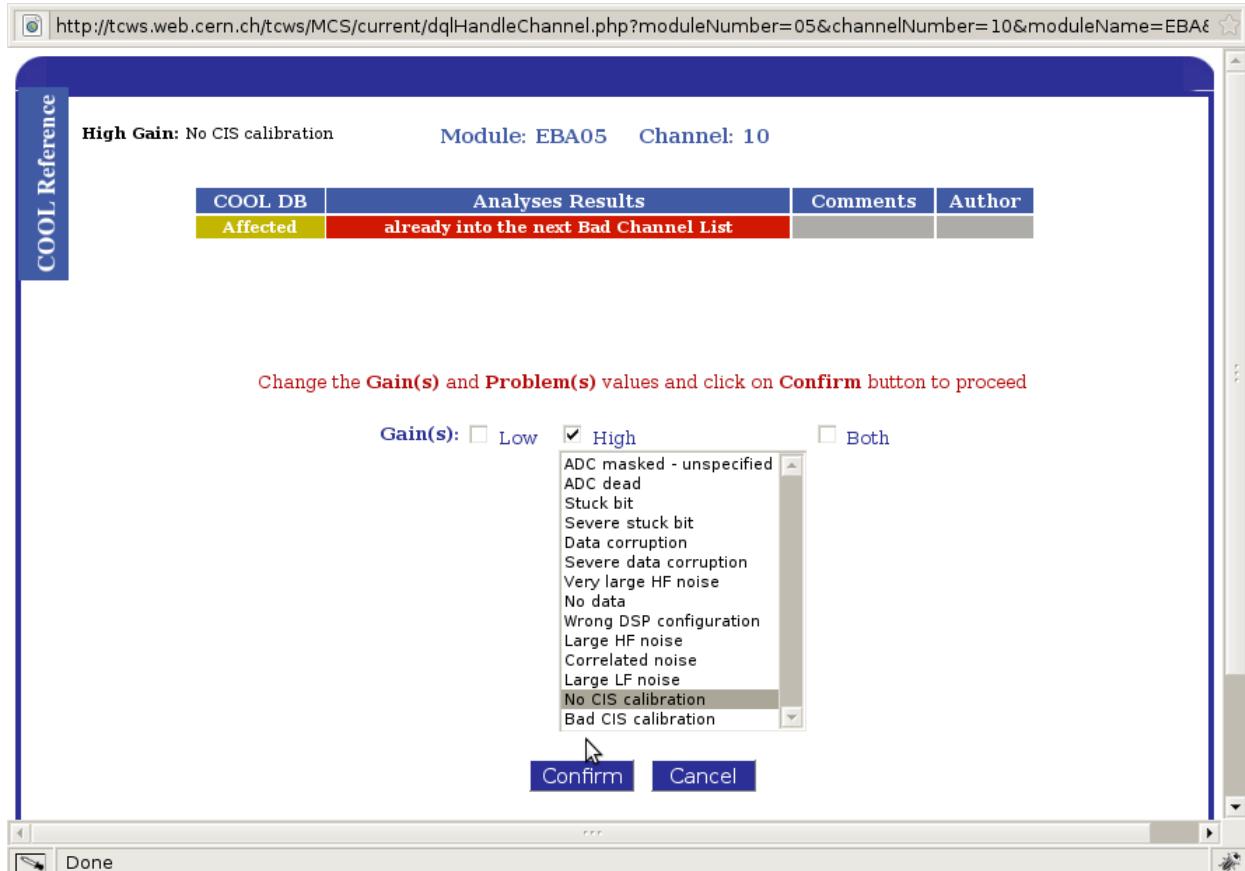


Figure 9. DQ leader can handle channels

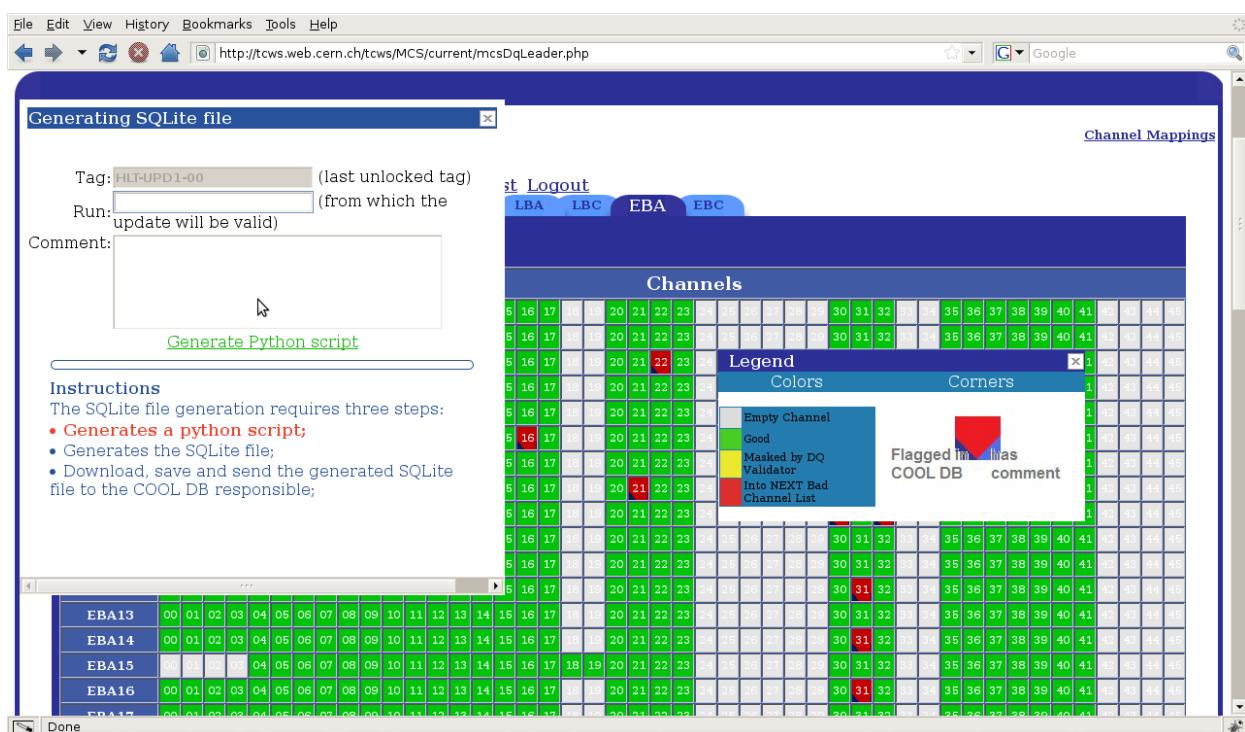


Figure 10. DQ leader can generate an SQLite file

3. Conclusion

The Tile Commissioning Web System integrates different applications that were developed to support the Data Quality team analyses. With the system, it is easier to monitor, analyze and update precious information concerning the detector status.

The Web Interface for Shifters (WIS) summarizes the taken runs displaying: general run information (such as run identifier, run date, number of events and sectors, for example) in a table; the ntuples' CASTOR location in a graphical way; the modules' evolution in a time line table; TileComm Analysis stores: plots and histograms generated after the reconstruction period; detailed comments written by physicians concerning the analyses results; modules' statuses (*Ok, Some Problems, Bad and Not to be analyzed*) defined by the shifter as well; The DQM Viewer displays the automatic analyses results through a tree and the MCWS supports the DQ team analyses at channels level.

They are web systems, so all the ATLAS members can access the applications and they do not need to install local software, only a web browser is necessary. The analysis is largely automated in this process which reduces the probability of storing invalid data. TCWS proved during the commissioning phase that it is ready to be used during the operation phase.

4. References

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