MAGIC-TDAS 06-11
060831/RdelosReyes

MAGIC Data Check and On-Site Analysis program

R delosReyes
<reyes@gae.ucm.es>
I Oya
<oya@gae.ucm.es>

August 31, 2006

Abstract

This document is an overview of the MAGIC data check and Onsite analysis program. This program performs a continuous check and a first analysis over the whole MAGIC data.

The program checks the telescope performance and the quality of the data taken.

It consists of two different but complementary programs: the first one, called QOOSA (Quick On-Site Analysis), is the onsite analysis which analyzes the data as soon as taken. The second program, called MAGICDC (MAGIC Data Check), starts as soon as the telescope is switched off. It checks all the data reported during the night by all the subsystems of the telescope in order to detect problems and solve them before the next night.

In the coming sections we make a brief introduction to the MAGIC experiment, a detailed description of how both programs work and a brief description of all the program outputs: files and plots.

Contents

1 The MAGIC Telescope

MAGIC (Major Atmospheric Gamma Imaging Cherenkov) is a 17 m diameter Imaging Atmospheric Cherenkov Telescope (IACT) located at the Roque de los Muchachos in the Canary island of La Palma (28.8°N, 17.9°W).

It consists of a set of integrated subsystems and structures necessary for the telescope work. At the telescope place a concrete foundation and a tubular space frame supports the drive motors of an alt/az mounting, a 236 m^2 tessellated reflector, a fine granularity photo-sensor camera and the camera cooling system. The telescope has a control room in a nearby building containing the data acquisition system, the camera and calibration power supplies, the trigger system, the weather station, the GPS-time module, all the subsystems and network computing system, and various auxiliary elements needed for safety, backup, etc.

1.1 La Palma computing and network

All the computing system of the MAGIC telescope consists of a set of PC's that constitute an internal network connected to Internet through a firewall (wwwint.magic.iac.es) [4] and an external machine (www.magic.iac.es).

The internal network consists of the subsystems PCs and the onsite analysis computers. All the computers save their subsystem data locally, sharing the data through NFS access (local mount point in /remote). The subsystems computers (PC1-PC7) are software "clones" with OS Suse 7.2 connect to the internal network at 10/100 Mbytes, while the computers used for the onsite analysis (muxana, muxana2 and muxana3) are also "clones" between them but with Red Hat 4. All the subsystems data needed for the analysis are stored in the /local disk at PC15 (or /remote/disc01/pc15 for the rest of computers) while the raw data is stored at /mnt/raid1. The computers muxana, muxana2 and muxana3 have been connected with PC15 through a high speed Gigabit Ethernet connection.

The result plots are published (only for MAGIC private access) in Internet through the www.magic.iac.es machine in the /home/www/html/operations/datacheck directory.

The data check results can be accessed at the MAGICDC web page at La Palma [11] or its backup at PIC [15].

1.2 MARS

The standard analysis software for MAGIC telescope data is called MARS (Magic Analysis and Reconstruction Software). It is a set of C++ (object-oriented framework) classes based on the well known ROOT package from CERN. Basically it can be run in two modes, either inside ROOT framework using the specific containers and tasks designed to analyze the MAGIC data, or as compiled macros (MARS executables). Some of these MARS executables contains a Graphical User Interface (GUI).

In order to analyze the MAGIC data in a standard way, MARS executables have been used all through the MAGIC telescope data check chain. The executables used are the following ones, displayed inside diamonds in figure 1:

- MERPP: converts the "raw" and ASCII format of MAGIC subsystems to ROOT package format. The output files have the ".root" extension.
- CALLISTO: calibrates the data. The calibrated files have the key-name "_Y_.root".
- SHOWPLOT: displays graphical information as Postscript file format (".ps").

- STAR: calculates the Hillas parameters. The executable output files has the key-name "_I_.root". They are so called star-files.
- MELIBEA: applies the Random Forest matrices (see sec. 2.5) to the Hillas parameters files. Its output has the key-name "_Q_.root". They are the so called melibea-files.

Most of these executables have input cards to modify the analysis parameters. All the input cards have the default name of the executable name followed by the ".rc" extension. This is the case of "callisto.rc", "star.rc" and "melibea.rc".

The analysis executables, callisto, star and melibea, run based on "sequences". A sequence is defined as a set of runs to analyze.

The MAGICDC program only uses the official checked MARS release versions.

2 MAGICDC: Telescope Data check

The MAGIC telescope consists of several subsystems, or telescope elements, which perform a specific task within the normal data taking (see sec. 1). The quality of the data depends on the good functioning of the telescope and therefore the performance of these subsystems. To check their behavior and functionality a program called MAGICDC (MAGIC Data Check) has been developed which runs automatically each morning after the night data taking and extracts all the useful information about the telescope status.

The MAGICDC program consists on a set of subprograms (see fig. 1) which carries on two main tasks: the first one is the check of the data reported for each telescope subsystem, the second one is the check of the analyzed data performing a first and quick analysis of the night data. This last feature of the program has been dubbed "on-site analysis".

2.1 Steering scripts

The telescope data check program runs in muxana and belongs to user "analysis". It is located at muxana in "analysis" user home directory at ∼analysis/DataCheck/MAGICDC.

All the results and logs are saved at /local/DataCheck/Data at muxana, under different subdirectories, depending on the running job.

The MAGICDC (MAGIC Data Check) program is managed through the Linux "cron daemon" at muxana using the crontab file from user "analysis" defined at La Palma computers, which launches the MAGICDC program.

The "analysis" user crontab files launch two different jobs (C-shell scripts) (fig. 1):

- hal.csh: daily check and on-site analysis. The job is launched daily every 20 minutes from 9:00 a.m to 20:00 p.m (UTC) to look for not finished check or analysis jobs.
- monolith.csh: checks, for the last 7 days, whether the datacheck and analysis has finished properly, if it hasn't the script launches the previous job (*hal.csh*) for the failed day. The number of days to review can be modified through a variable inside the program. This job is launched everyday at 13:00 p.m (UTC). Its log file (monolith.csh.out) is written into the bin/ subdirectory of the MAGICDC program directory.

In both cron jobs *hal.csh* is launched giving as third parameter an specific date in the format "<year>_<month>_<day>" (all numerical digits). In the first one the current date is given, while

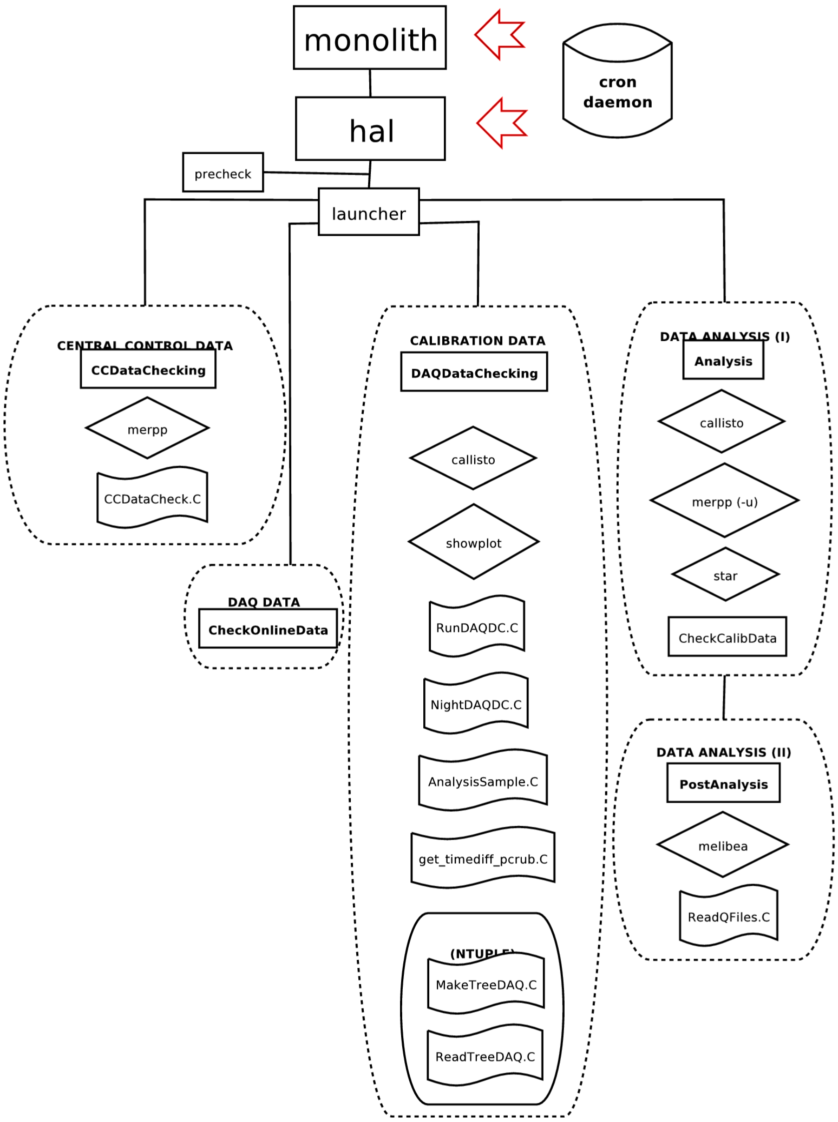

Figure 1: *MAGICDC program scheme.*

in *monolith* the specified date to *hal.csh* depends on how many days you want to check. Its log file (hal.csh.out) is written into the program bin/ subdirectory.

This *hal.csh* job calls to the *precheck.csh* script which performs the following checks: check if PC15 and wwwint computers are switched on, /local directory at muxana is available, all the subsystem data are available and which kind of data checks should be done. This last check depends on the subsystem data available and whether any of the data check jobs has been done and finished properly. The result of the *precheck.csh* script is always an exit code. In case of the first checks, or if all the data check jobs have finished properly, the program *hal.csh* exists with an error message (different for each exit code). In case of missing data check jobs or analysis, the *hal.csh* is launched with the corresponding kind of data checks that should be done.

Depending on the exit code of the *precheck.csh* script, *hal.csh* calls to the *launcher* script with a different set of parameters:

§1. Kind of data check: daq, cc, cal and ana (no excluding options).

§2. Mode: auto, manual, plot and webpage.

§3. Day: "<year>_<month>_<day>"

The *launcher* script is the main script which runs the check jobs for the different kinds of data (§1):

I. Central control data (cc option):*CCDataChecking* script (sec. 2.2).

II. DAQ data (daq option):*CheckOnlineData* program (sec. 2.3).

III. Calibration data (cal option):*DAQDataChecking* script (sec. 2.4).

IV. Analysis data (ana option):*Analysis*, *PostAnalysis* scripts and *CheckCalibData* program (see sec. 2.5).

The checking jobs mentioned above can run in different modes (§2):

- auto: corresponds to the mode launched by the "cron" daemon.
- manual: launches the data check of any day (you must specify the "Day" (§3) option).
- plot: only runs the executable/macros which creates the plots. No analysis is done.
- webpage: transfers the portable document format (.pdf) files with the result plots to the web page.

Example of how the launcher should be call:
$PROGRAM_PATH/launcher daqcccalana manual 2006_08_09
it launches the whole datacheck and analysis programs for 2006 August 9th.

While running each job all the log files are written at MAGICDC program subdirectory called logs/. When every check job is finished, the *launcher* script moves the logs files into the job working directory, it sends (by e-mail) these logs to the MAGICDC program developers ("data-checkers") and copy all the Portable Document Format (.pdf) files into the MAGIC web page at La Palma (see sec. 1.1). Its log file (launcher.out) is written into the MAGICDC program bin/ subdirectory.

All the information shown by the MAGICDC program is checked by the MAGIC "shift daily-checkers" who have to send a daily report about the MAGIC telescope status and, in case of problems, solutions should be sought and be carried out by the shifters to solve the problems for the next data taking day.

All the MAGICDC program code can be found at MAGIC CVS [10].

The MAGICDC program is synchronized with the program that transfers the raw data to the MAGIC data center and copies them to tape. Once the *monolith.csh* script checks the analysis of a given day, if it finished properly it writes an empty file into ~analysis/DataCheck/osa_finished/ called <year>_<month>_<day>.osa-finished. If this file exists, the MAGICDC program gives its approval to the MAGIC data transfer program to delete the raw data at /mnt/raid1.

2.2 Central control data

The check of the central control data is, together with the DAQ data check (see sec. 2.3), the first task to be done before any other one. This job will check the performance of all the MAGIC telescope subsystems involved in the data taking, as well as a first estimation of the night data quality.

2.2.1 Overview

All the subsystems are run and controlled independently by their own programs but they allow the access (through TCP/IP protocol) to most of their functionalities and report all the useful information, through the central control software of the MAGIC telescope (Fig. 2), called Arehucas.

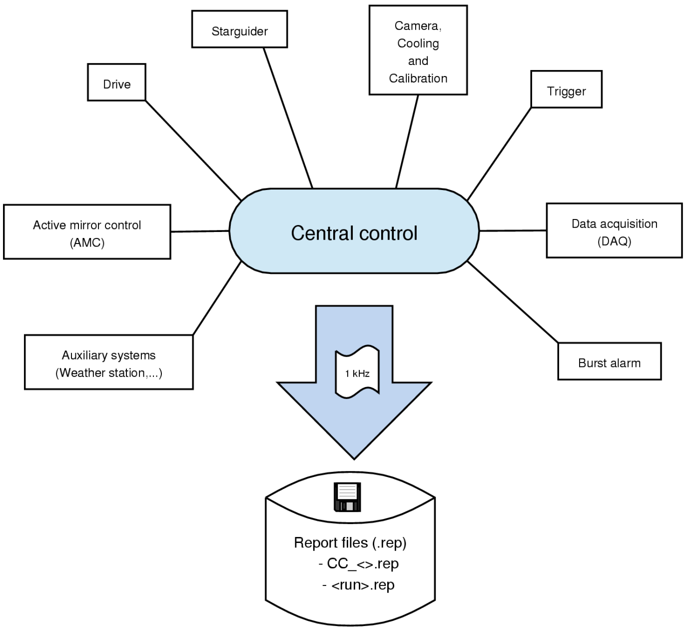

Figure 2: *The MAGIC subsystems scheme for the normal data taking.*

This program stores, at a rate of 1 kHz, all the subsystems reports in two different kind of ASCII files, both with the extension ".rep": one kind of file starts with "CC" and keeps the reports sent during the whole night, while the other kind has the run number in its name and has the subsystems reports for each single run. In addition to these reports, specifically sent to the central control, each subsystem could have its own report, log and data check files.

2.2.2 CC data check job

The part of the MAGICDC program which checks these subsystems reports is called by the script *CCDataChecking*. This script joins all the night .rep files (CC_<year>_<month>_<day>.rep), merpps the joined .rep file (CC_<year>_<month>_<day>.root) and calls a root-macro, *CCDataCheck.C*, to read the rootyfied file and displays the corresponding subsystems report plots. These plots are classified depending on the subsystem: drive, camera and cooling, trigger, star guider, weather station and time.

The check plots of this part belong to two kinds: variable versus time, to check the variable stability during the night of the subsystem, and variable versus any other variable to check previously known correlation between them.

The log file of *CCDataChecking* job, named CCDataChecking_<year>_<month>_<day>.out, is copied, together with the central control results, into the directory
/mnt/raid1/analysis/DataCheck/Data/ccdata/<year>_<month>/<year>_<month>_<day>/.

2.2.3 CC data check plots

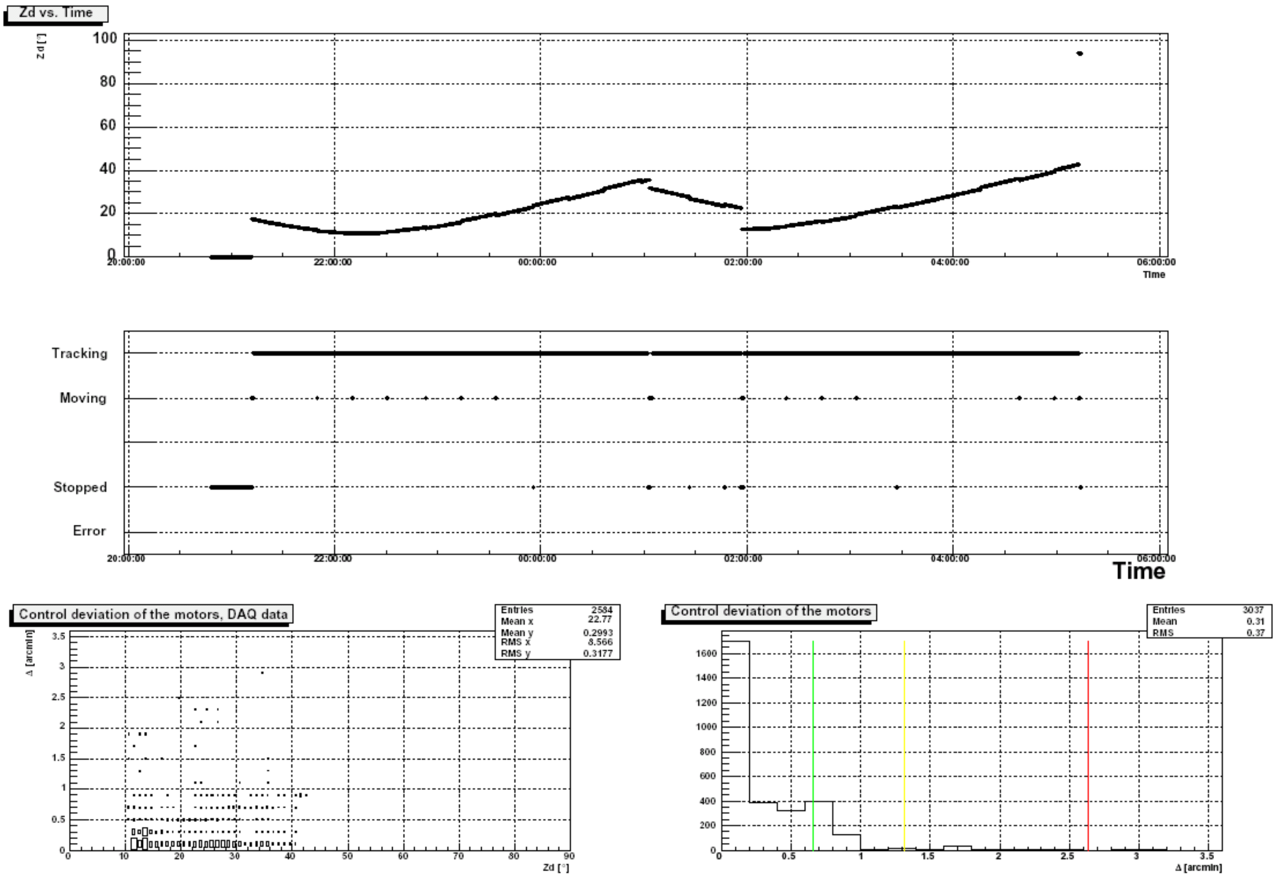

Figure 3: *Drive system report plots. From top to bottom: the zenith angle of the telescope pointing position versus time; the status reported by the system versus time; and the control deviation of the motors (data taking) versus the zenith angle of pointing position (on the left) and the distribution of the control deviation of the motors (on the right).*

Drive Figure 3 shows the plots of the drive system reports. (Top) Zenith angle of the telescope pointing position versus time. (Middle) Status reported by the system versus time. (Bottom) Control deviation of the motors during data taking ("DAQ data") versus zenith angle of pointing position (on the left) and its distribution (on the right). Three reference lines are displayed in this last plot corresponding to safety limits.

Camera The MAGIC camera is fed with HV by two external power supplies which divide the camera in two halves (A = sectors 1,2,6 and B = sector 3,4,5). The Camera and Calibration control program (La Guagua) evaluates the status of every controlled subsystem (LV, cooling, lid, calibration, etc...) from their regular reports at a given periodicity. A program routine called Sentinel protects the camera against dangerous situations and does not allow certain camera and calibration systems operations [6].

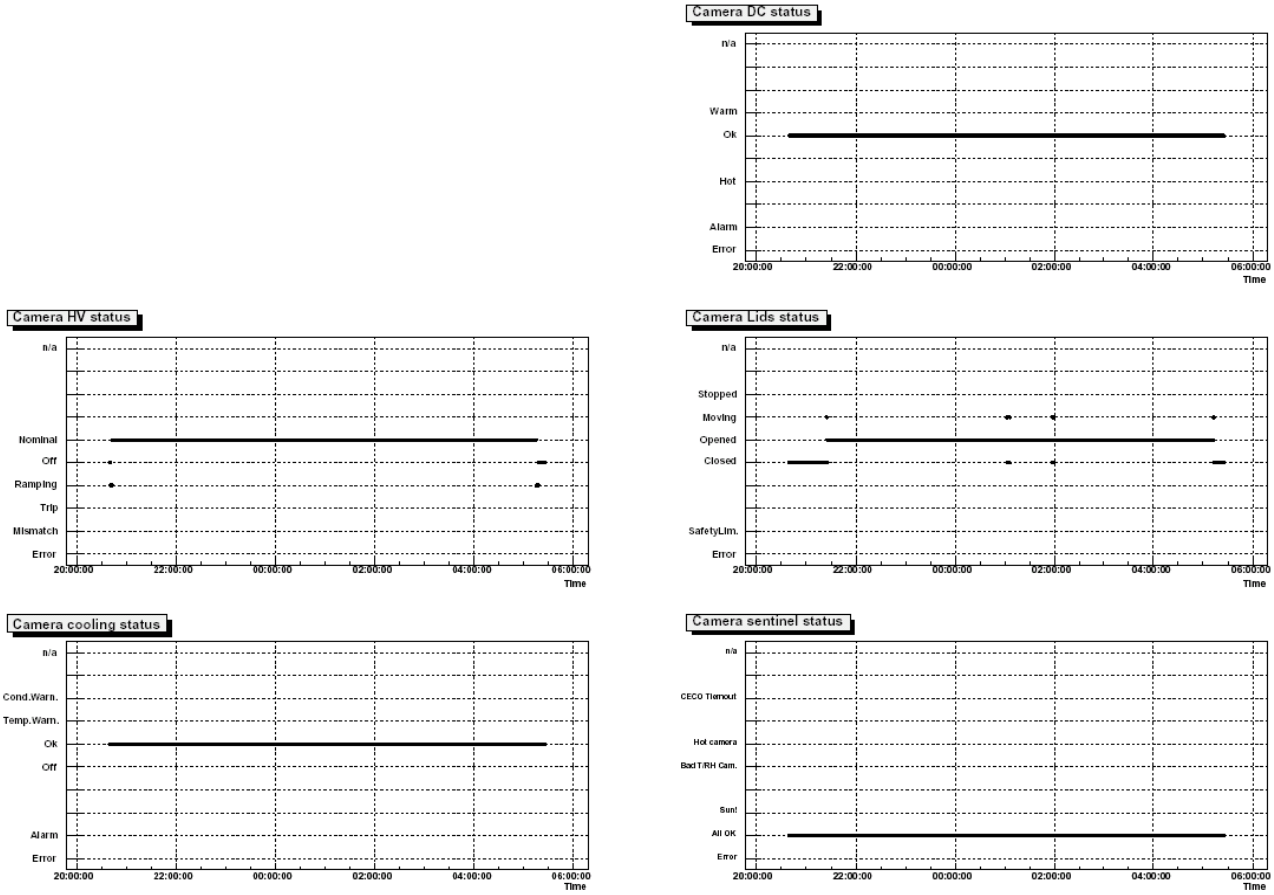

Figure 4: *Camera status report plots. Status plots of the different camera subsystems: PMT high voltages, camera lids, cooling system, PMT direct currents and camera sentinel.*

Several plots are produced related to the camera subsystem:

- The status of several monitored elements (PMT high voltages, camera lids, cooling system, PMT direct currents and camera sentinel) versus time (figure 4).
- The high voltage power supplies and applied direct current as function of time (figure 5).
- The camera mean high voltage and threshold settings as a function of time (figures 6 and 7).
- The applied low voltage and the relative humidity in the LV box as well as its general status and the status of the power supply request as a function of time (figure 9).
- The high voltage and current of the 360 V active loads and the 175V power supply of the 5th and 6th PMT dynodes versus time (figure 8).

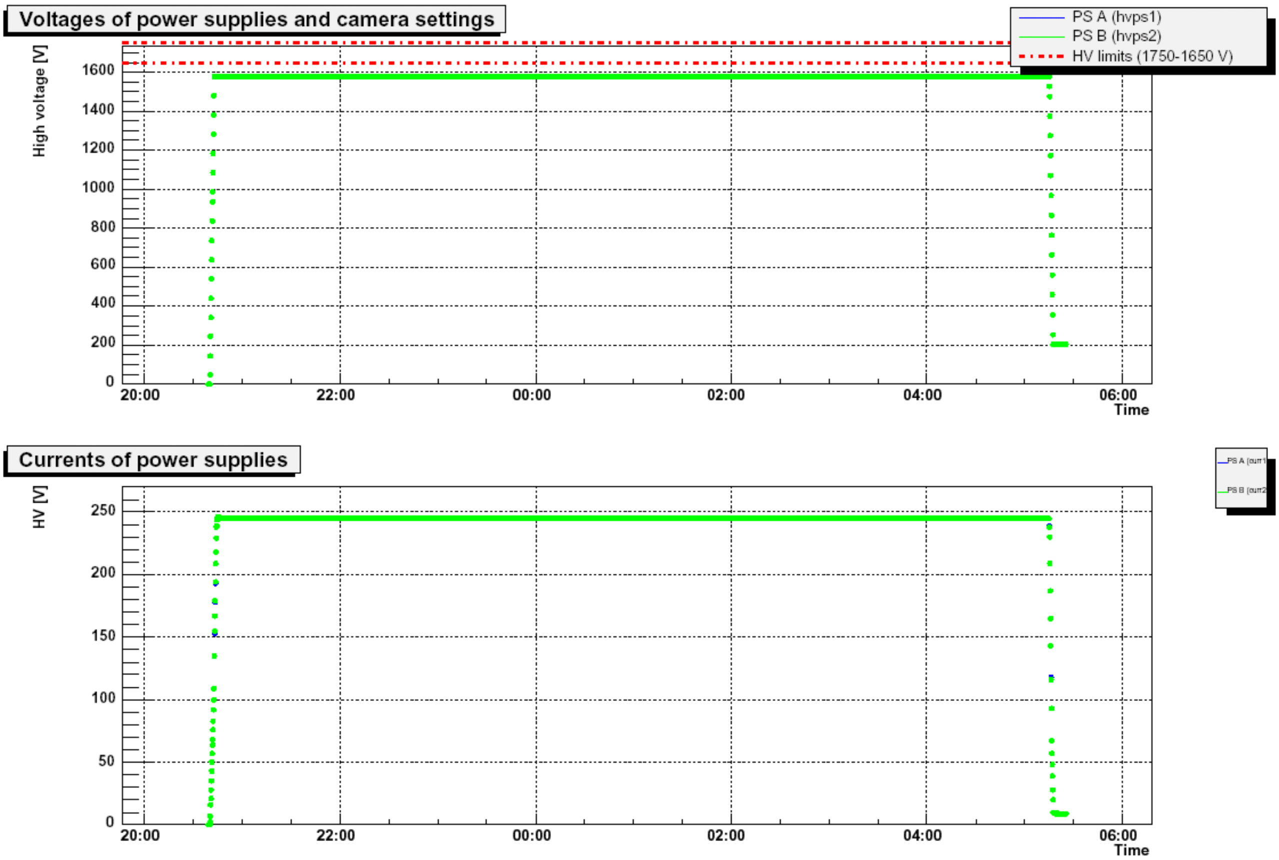

Figure 5: *Power supplies report plots. High voltage and direct current applied to power supplies (A, in blue and B, in green). The red-dotted lines are the corresponding limit values for the current HV settings.*

- The time average of the HV (figure 6) and threshold (figure 7) settings versus the pixel number.

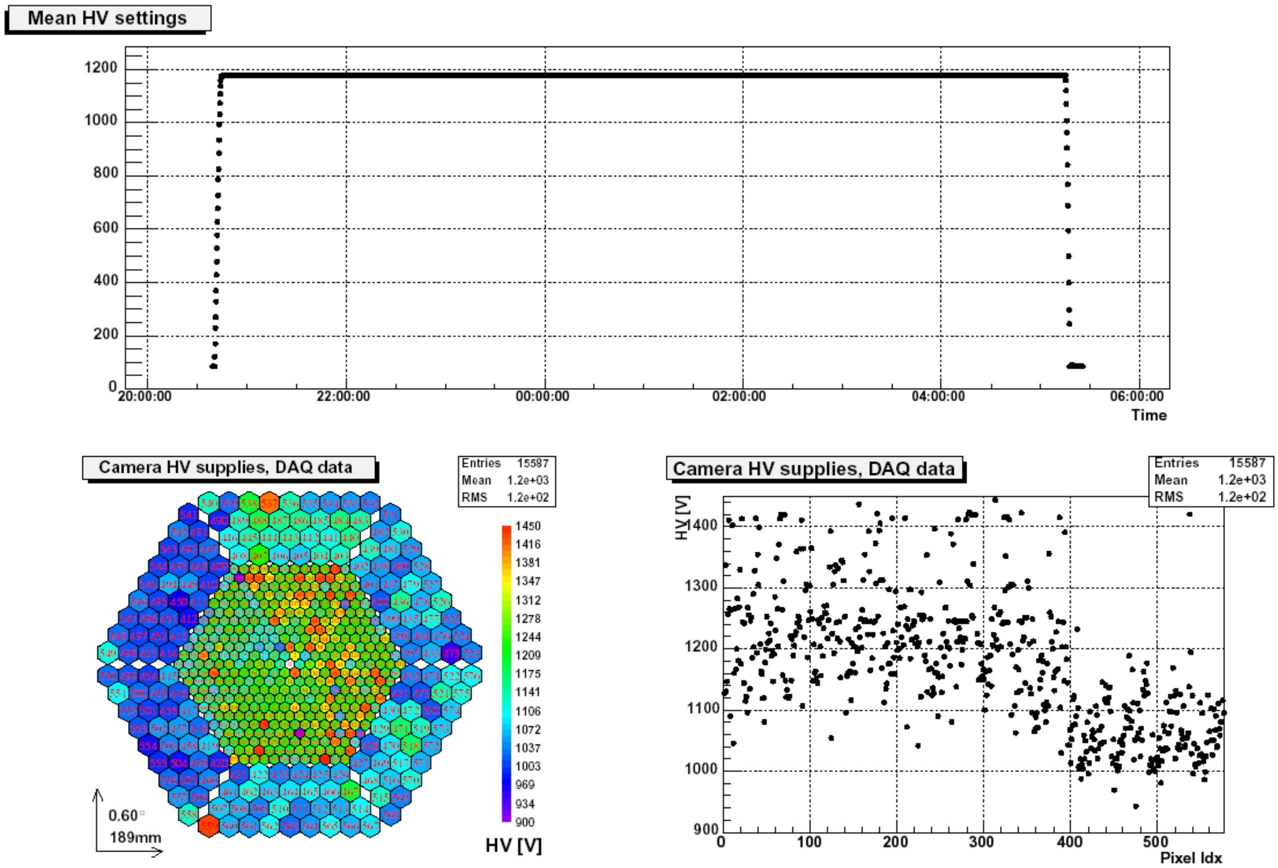

Figure 6: *HV settings report plots. Mean high voltage settings for the whole camera versus time (top) and time average per pixel (bottom).*

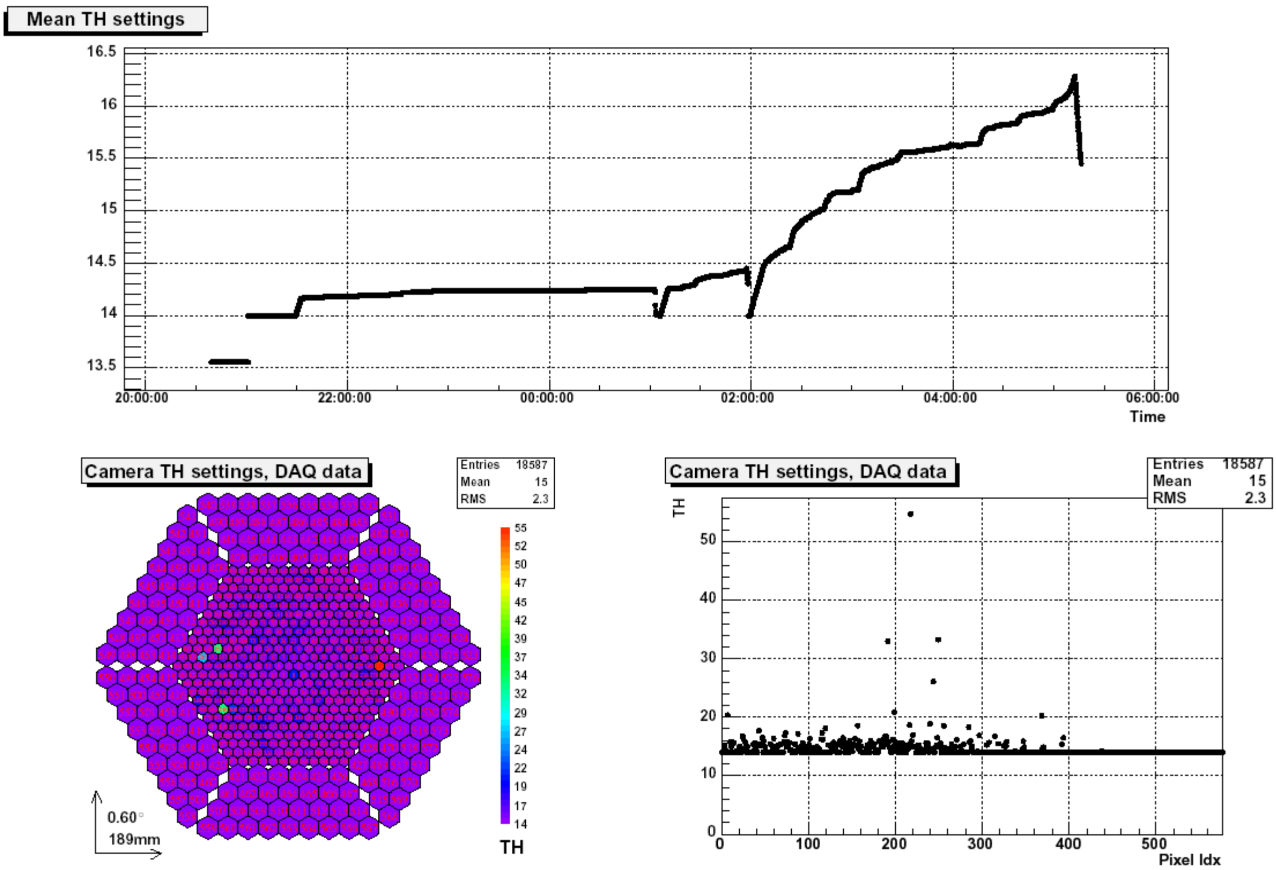

Figure 7: *TH settings report plots. Mean threshold settings for the whole camera versus time (top) and time average per pixel (bottom).*

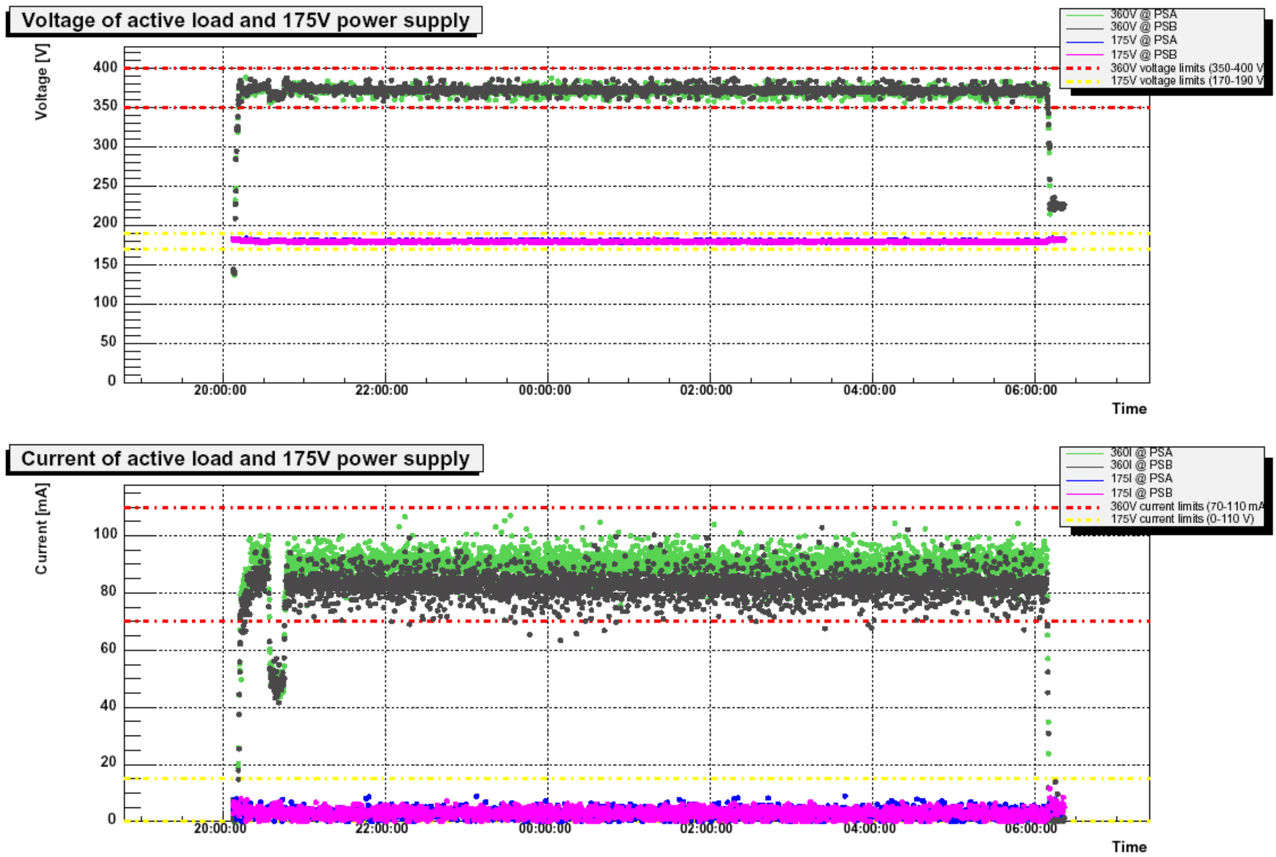

Figure 8: *Active loads report plots. High voltage and direct current applied to 360 V active loads (A (green) and B (grey)), and independent power supply of 175V (A (blue) and B (pink)). The red-dotted and yellow-dotted lines correspond to the limits to the applied fixed voltages.*

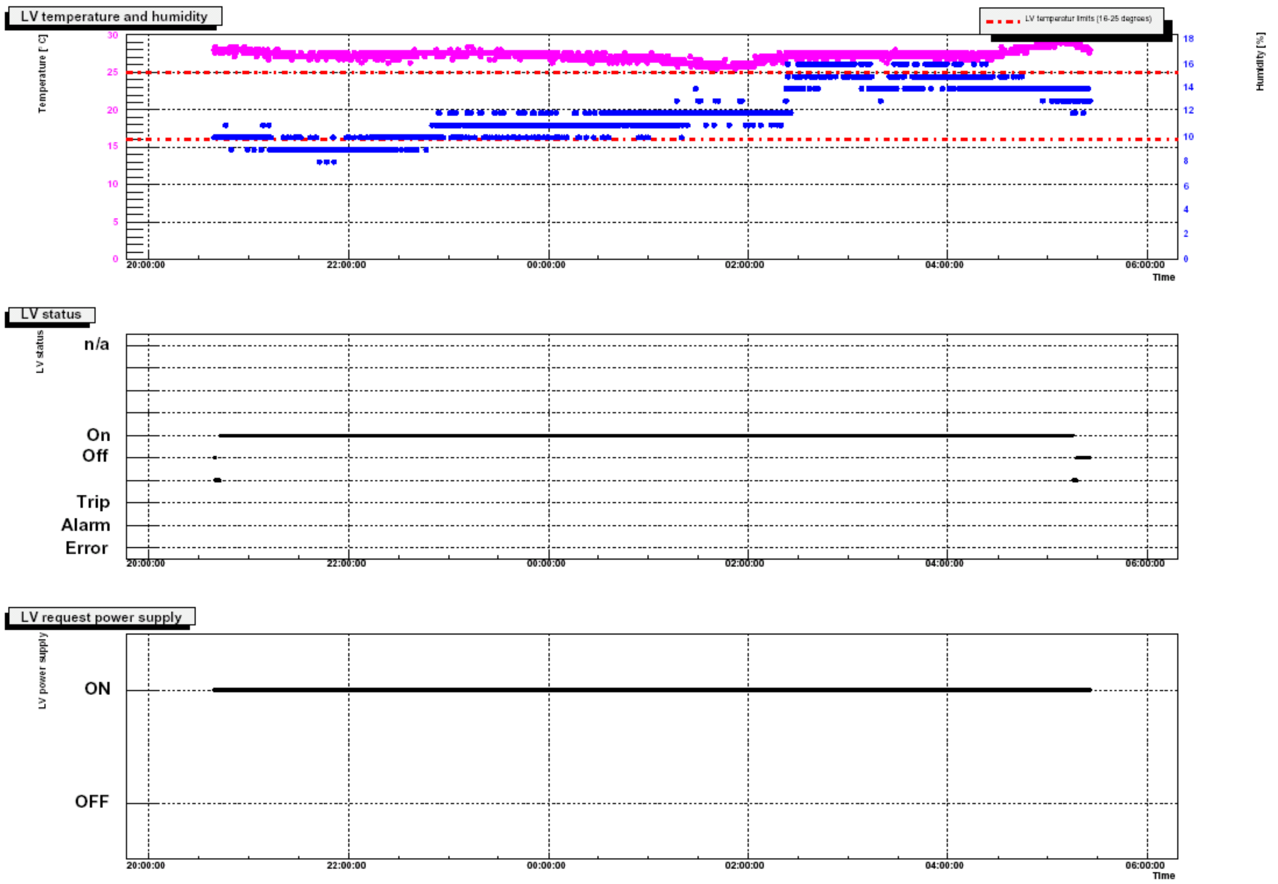

Figure 9: *Low voltage report plots. From top to bottom: Temperature and humidity in the LV box versus time; the status report of the LV system; and the report of the power supply request by the LV.*

Another part of the camera report to the central control concerns the cooling of the camera. To check its conditions the plots show the temperature at the center and the walls of the camera, the temperature of the optical links and the water deposit, as well as the relative humidity at the camera center and walls as a function of time . The distribution of the optical links temperature is also displayed but only during the data taking time (figure 10).

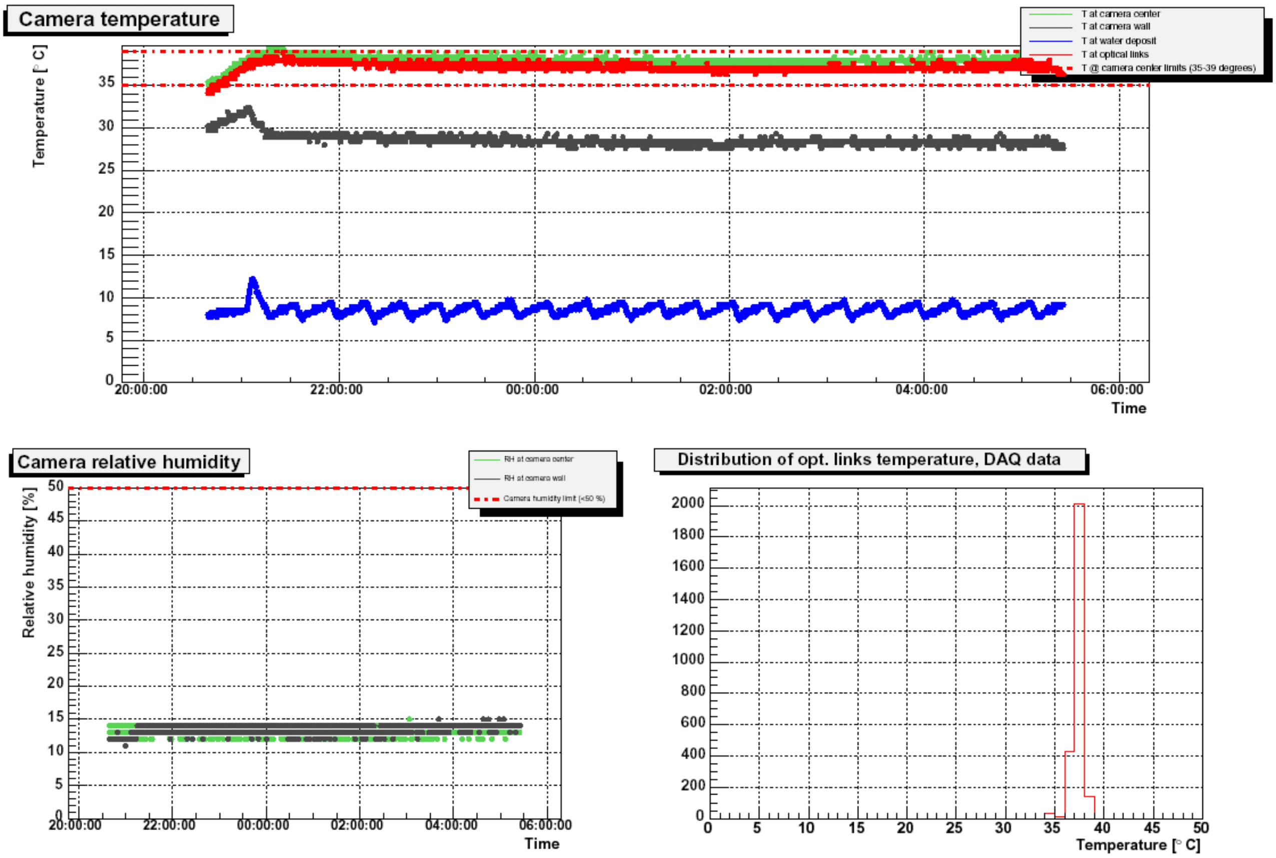

Figure 10: *Cooling system report plots. From top to bottom: temperature versus time of the camera center (green), wall (grey), water deposit (blue) and optical links (red);(on the left) the relative humidity of the camera at center (green) and walls (grey); and (on the right) the distribution of the optical links temperature during the data taking. The red-dotted lines correspond to upper and lower limits for the stability during the data taking.*

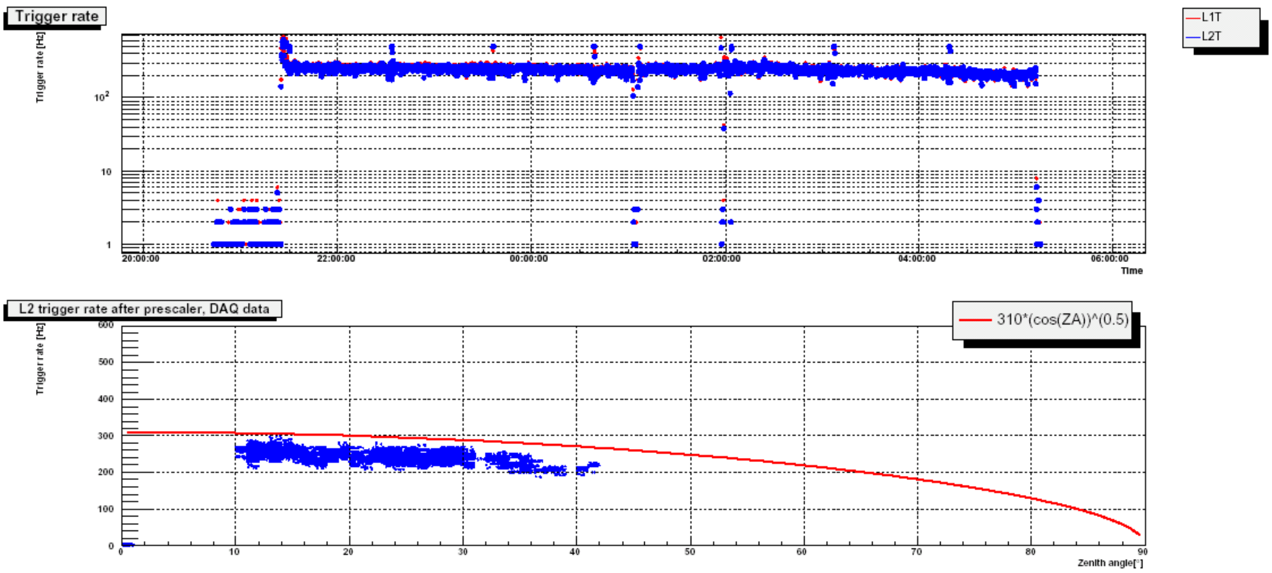

Figure 11: *L1T and L2T report plots. Top: L1T (red) and L2T (blue) rate (Hz) versus time. Bottom: L2T rate (Hz) versus pointing zenith angle (°) during data taking. The red line corresponds to the expected L2T rate(interlaced events included) for the different zenith angles.*

Trigger To check whether this system behaves properly and to check the quality of the data, figures 11 and 12 show the first and second level trigger versus time, the second trigger level rate versus zenith angle and the night-mean (and rms) of the individual pixel rate (IPR) per pixel.

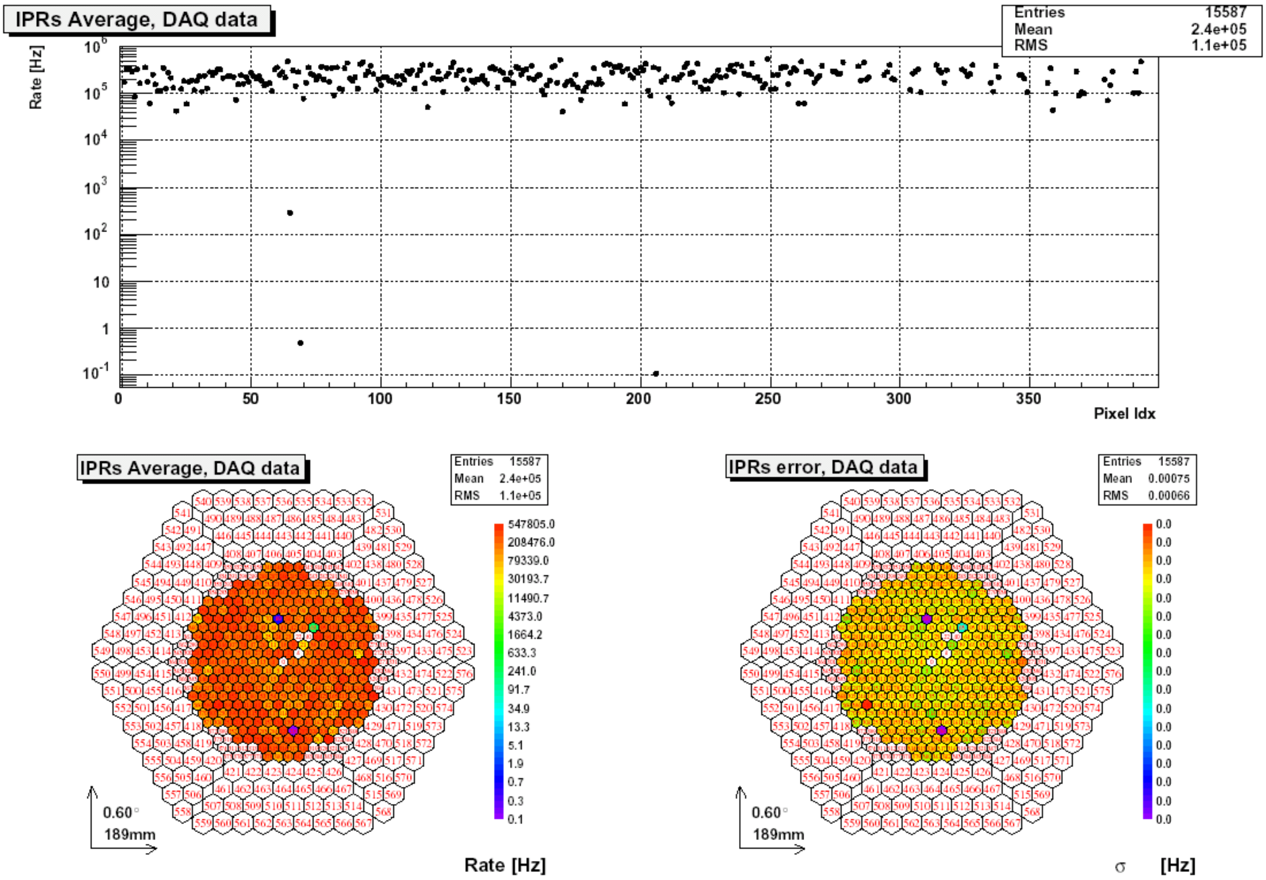

Figure 12: *IPR (Individual Pixel Rate) report plots. Top: time average of the IPR (Hz) versus pixel number. Bottom: (left) time average of the IPR (Hz) in camera display and (right) time rms of the IPR (Hz) in camera display. The plots include the values during data taking.*

Star guider This subsystem improves the pointing accuracy of the telescope. Its reports will indicate whether if the drive system is pointing properly and will be important in the data analysis.

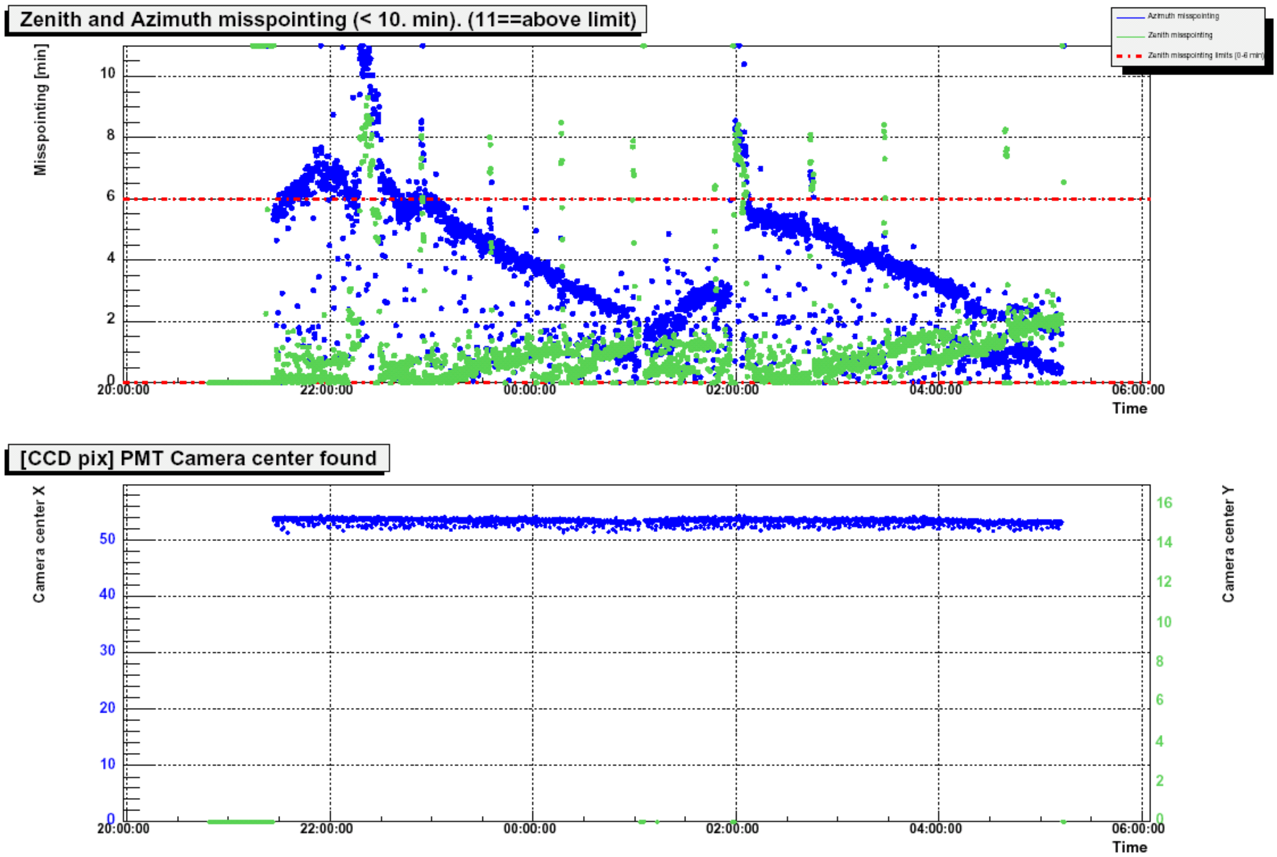

Figure 13: *Star guider report plots. Top: Absolute value of the zenith and azimuth miss-pointing (arc-min.) versus time. Bottom: The X and Y position in the CCD camera of the PMT camera center versus time. The red-dotted line corresponds to a miss-pointing within 1 camera pixel.*

To check the telescope pointing stability, figure 13 displays the zenith and azimuth miss-pointing, the CCD camera pixel (X and Y) for the PMT camera center versus time. Figure 14 the number of correlated stars and the sky brightness from the CCD camera versus time. The red-dotted lines correspond to reference lines in all plots.

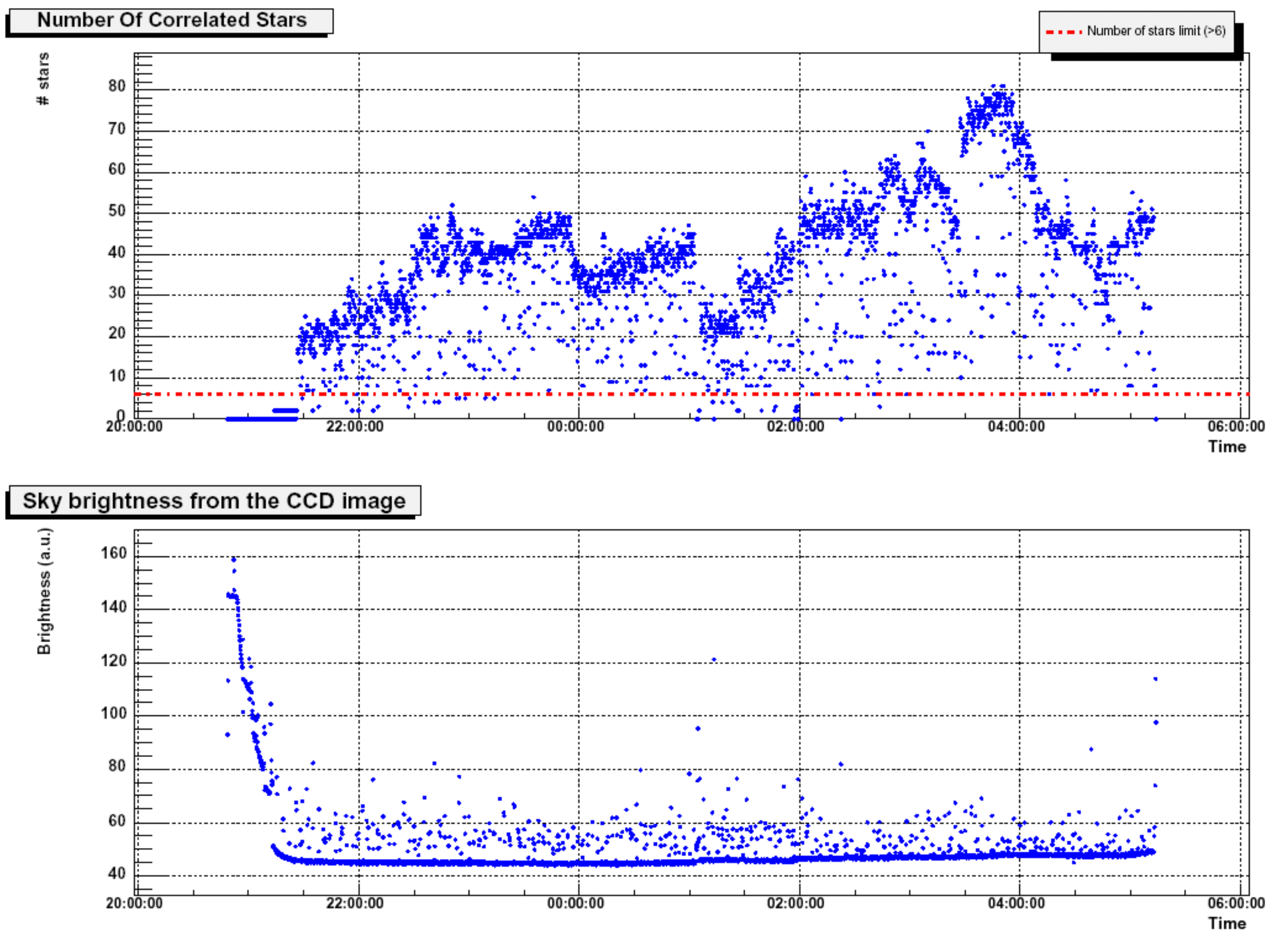

Figure 14: *Star guider report plots. On top: Number of stars correlated with catalog positions of stars versus time. On bottom: Sky brightness (in arbitrary units) from the CCD image versus time. The red-dotted line corresponds to the minimum value of correlated stars by the star guider system for a good miss-pointing estimation.*

Weather station MAGIC telescope has its own weather station, located in the experiment vicinity. The station is read out every 40 seconds and the weather values are sent to a graphical display over the web in different time scales. This web page can be accessed publicly. As the other subsystems, the weather station also sends a report to the central control with all the weather information.

The weather could affect the data but also to the telescope own integrity since the telescope is not protected by any dome. To check the weather conditions outside, the telescope data check program plots the humidity, the temperature and wind speed against the time (figure 15), together with its corresponding safety limits of operation.

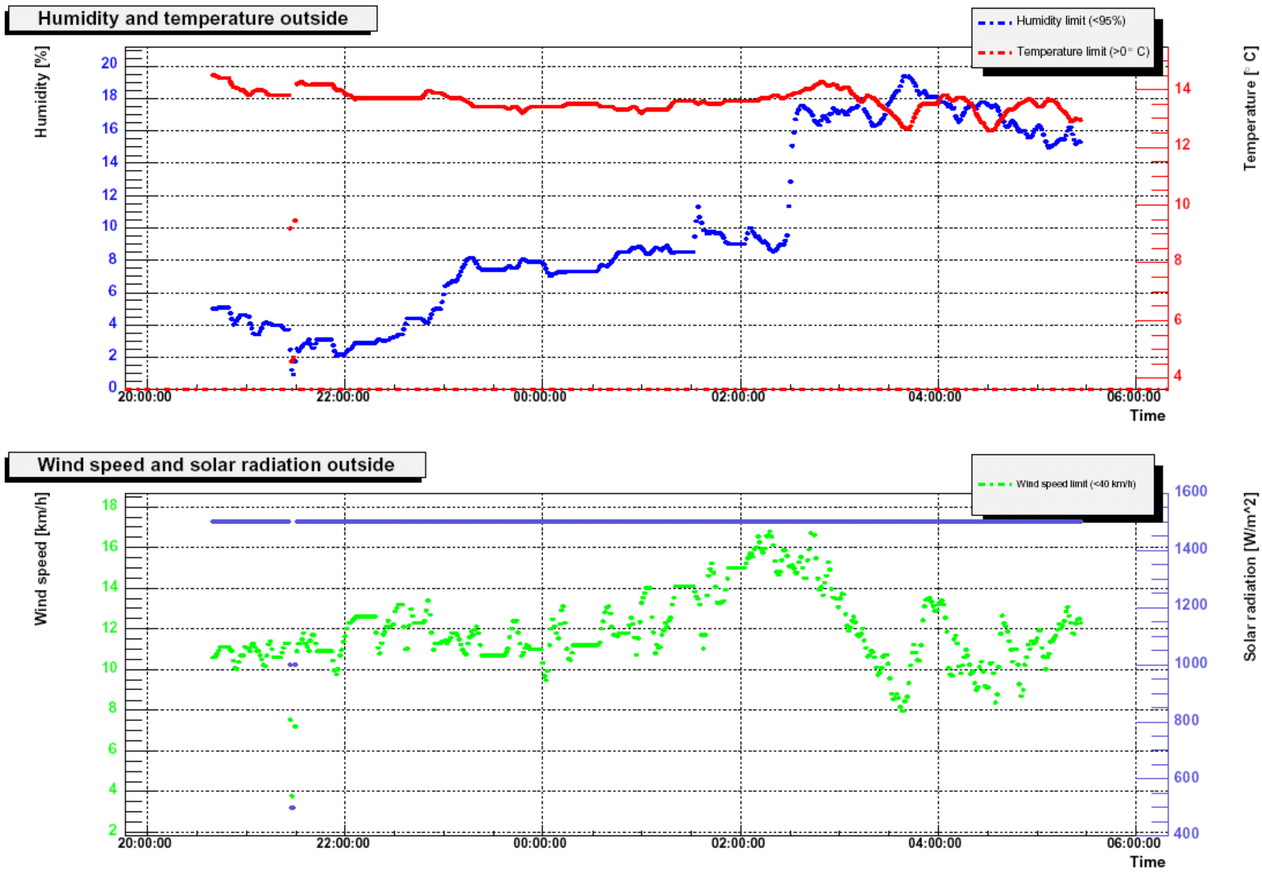

Figure 15: *Weather station report plots. On top: Humidity (blue) and temperature (red) outside versus time. On bottom: Wind speed (green) and solar radiation (violet) (currently not functioning) versus time. The dotted lines correspond to upper limits for a safety telescope operation. Above them the telescope must be parked.*

Time The date and time information of a triggered event is determined on an absolute time scale, UTC (Universal Time) and added to the data in the DAQ readout process. The time accuracy is achieved with a calibrated atomic clock (Rubidium clock), a MAGIC specific module called TIC (Time Interval Counter), a HM8125 GPS Time/Frequency Standard and sub-sec NIM modules. The Rub-clock exhibits an unavoidable course error, which has been corrected connecting the atomic clock with the GPS. The Rub-clock is adjusted in frequency and phase to the GPS clock pulse in a closed automatic control loop.

The MAGIC SSC (Sub-Second Counter) is based on the HEGRA 5MHz TIC. The formal CAMAC unit is adapted to a NIM cassette and provided with LVDS drivers for transmitting the information to the MAGIC DAQ system. The 5 MHz input signal is used as clock for a counter chain, composed by 3 8-bit binary counters with output registers.

Another NIM module is used to measure the difference in time between the Rub-clock and the GPS receiver. This information is sent to the central control as report and displayed by the MAGICDC program for the daily check. This difference must be always within 1.5-1.75 ms. In case of a larger difference the GPS-Rubclock must be synchronized manually. This is what figure 16 shows versus time.

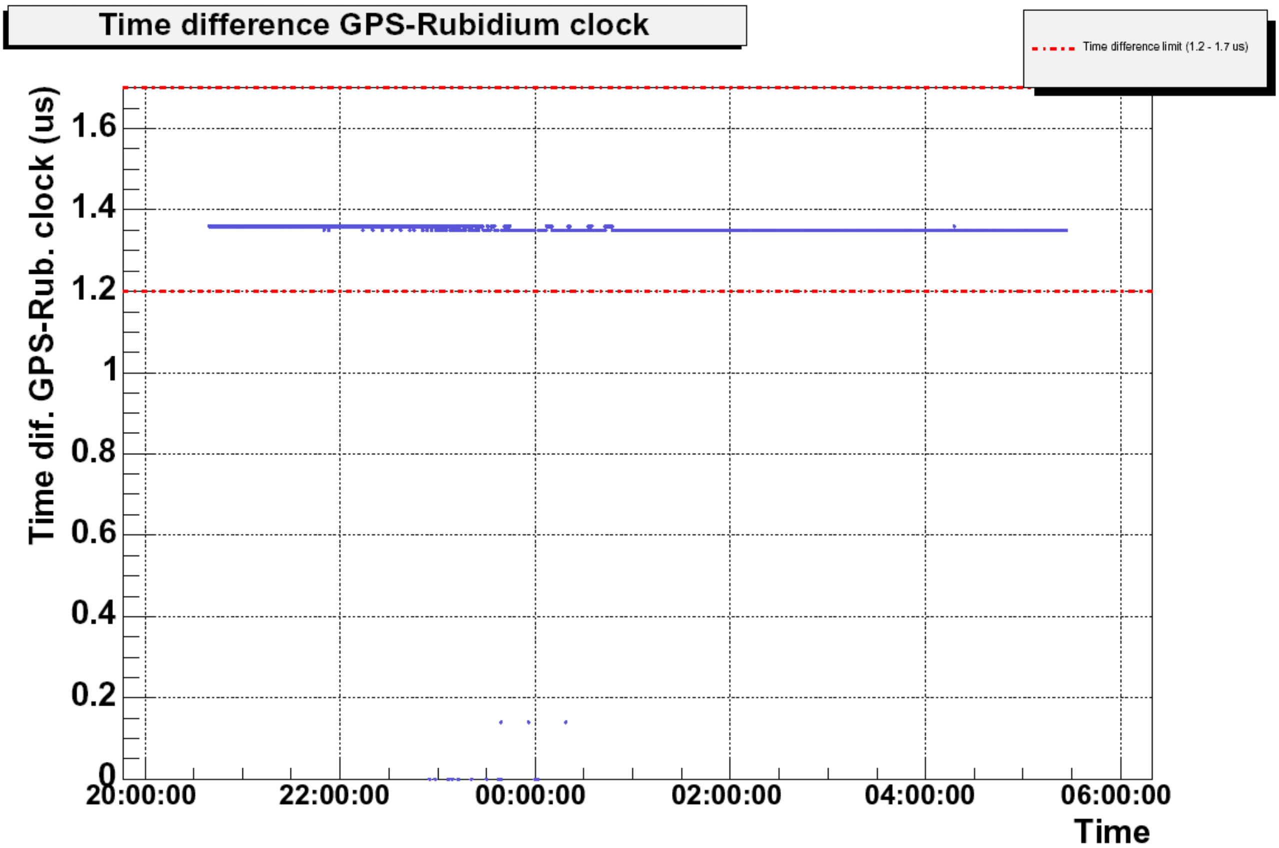

Figure 16: *Time report plot. Time difference (µs) between GPS and rubidium clock. The red-dotted lines are upper and lower limits.*

2.3 DAQ data

During the telescope data taking, the DAQ subsystem performs a simple analysis from the recorded events. This analysis determines an average pedestal ("from low gain") and the signal charge and arrival time for each event and channel. These values are sent as a report to the central control (sec. 2.2) and written to an ASCII file (/remote/home/pc2/daq/MAGICReadout/stat/dcheck_<date>.txt) at the end of each run [8].

Up to now this *DAQOnlineDatacheck*[1] can not be processed as the rest of the other subsystems report information. So another program has been developed which reads (run based) these ASCII files written into a local DAQ program subdirectory joining it with other subsystems reports (through central control report files and displaying the DAQ data check information [16].

This kind of data check is run giving the "daq" option to the *launcher* script. This option launches an script called *CheckOnlineData* which launches the main program "checkdaq". This program copies all the results into /mnt/raid1/analysis/DataCheck/Data/analysis/<year>_<month>/<year>_<month>_<day>/CCDAQCheck/ together with its log file, named as dcheck_<year>_<month>_<day>.list.log.

This program does not reside in the MAGICDC program directory but in the "analysis" user HOME directory on muxana (∼analysis/CheckOnline/).

The DAQ data check results files extracted from this program run by the MAGICDC are the following [16]:

- dcheck_<year>_<month>_<day>_allruns_BadPixels.txt: statistics file of individual pixels.
- dcheck_<year>_<month>_<day>_allruns_RunQuality.txt: run quality list.
- dcheck_<year>_<month>_<day>_allruns_summary.root: ntuple with the information read from the input files plus some derived information and averages over camera sectors and areas.
- dcheck_<year>_<month>_<day>_allruns_correlations.ps: postscript file containing plots with correlations of variables. This file is only written when central control data are also processed.
- dcheck_<year>_<month>_<day>_allruns.ps: postscript file containing all plots with averages versus run number and camera displays.

A more detailed explanation about the contents of each output file and the program can be found at [16].

[1] Program developed by P. Liebing (MPI, München)

2.4 Calibration data

The next step is to check the response of the whole light-detection and amplification chain to get the correspondence between the digitalized information and the incident photons from the Cherenkov light. This is done through the data calibration process which determines the conversion factor between digitized FADC counts and incident photons, and the arrival time delay for each pixel. More information can be found in [7].

2.4.1 The calibration system

The MAGIC telescope requires a precise and regular calibration system of the camera and the readout chain over a large dynamic range. This is achieved with a number of ultrafast and powerful LED pulsers inside a pulser box. A pulsating mode (pulser box) is used to calibrate the detector response to Cherenkov light with 2 ns pulses, while a continuous mode is used to calibrate the response of the DC readout to background light (star and moonlight). The absolute light flux is calibrated using three blind pixels hosted at the camera and a calibrated PIN diode located at 1.1 m distance from the pulser box.

For the calibration process two kind of runs are taken consecutively: the first one is a pedestal run, which consists of 1000 events triggered by a random signal sent by the calibration box to L2T. These events should contain nearly no Cherenkov pulses. The second one is a calibration run, which contains 4096 events sent by the calibration box following a number of actions predefined by a calibration script.

In a first stage, the MAGIC camera itself was used to measure the absolute amount of photons emitted by the light pulser and calibrate the data, using the so-called “F-Factor” method. But the results of this method change with the unknown degradation of the PMTs. For this reason two more methods are now used to calibrate the individual camera pixels with respect to the amount of photons produced in each calibration light pulse, they are the so-called “blind pixel” and “PIN-diode” methods.

Several signal reconstruction algorithms have been studied to extract the charge and arrival time from the calibration and data runs with the highest resolution and minimum effect of the noise [7][2]. The best extractor algorithm for low energies and timing information is the so-called “Digital Filter” [1]. This is currently the default in the corresponding MARS release version used in the data-check program.

2.4.2 Calibration data check job

The script which takes care about the calibration data check is named *DAQDataChecking* (fig. 1) and is called through option “cal” on *launcher* main script. It consists of three logical parts:

I. The first task of the *DAQDataChecking* script is to define the callisto-sequences (sec. 1.2). To do this the script reads the central control .run files (joined in CC_<year>_<month>_<day>.run file) which contains a summary of the night data taking. Then a night summary file (NightSummary_<year>_<month>_<day>.txt) is created with the variables needed by the program. From this night summary file we extract run information to constitute the analysis sequences.

   As it has been explained before, to extract and check the calibration constants it is necessary to have a pedestal-calibration pair of runs. With each of these pairs we define a sequence for the *callisto* MARS executable.

   Then *callisto* is run on the sequence, it calculates the calibration parameters and saves them into a “calib<SequenceNumber>.root” file. This file is then read by the MARS executable *showplot* making the calibration data check plots (see next section for a description) and saving them as a Postscript file.

Finally, for each sequence the *RunDAQDC.C* macro is run and saves all the sequence information from pixel calibration into an ASCII file, named as
"BadCalPixels_<Source>_<PedestalRun>_<CalibrationRun>.dat".

II. The second step is to run a set of macros to perform several other checks over all the night calibration constants calculated already (calib.root files of all sequences):

- *NightDAQDC.C*: Plots the calibration parameters evolution versus time. It can be used to see the evolution of these values over the whole night [18]. The plots are stored in the file named as
"AllNightDataCheck_<year>_<month>_<day>.pdf".
- *AnalysisSample.C*: Creates an ASCII file called "samples.txt" with all the information of the night sequences. It will be used in the analysis data check (sec. 2.5).
- *get_timediff_pcrub.C*: Calculates the time difference between the PC and the Rubidium clock for each calibration event. The results are displayed in a Postscript file named "TimeDiff_<year>_<month>_<day>.pdf" and in an ASCII file named "TimeSummary_<year>_<month>_<day>.dat".

All the mentioned Postscript files are converted to Portable Document Format (.pdf) files and saved all together at
/remote/disc01/datacheck/analysis/DataCheck/Data/daqdata/<year>_<month>/<year>_<month>_<day>/.
Here it is also saved the job log file CALDataChecking<year>_<month>_<day>.out.

III. The last set of macros (see fig. 1) corresponds to the manipulation of a ntuple which accumulates and stores relevant information about the calibration (*MakeTreeDAQ.C* macro) and then it is plotted (*ReadTreeDAQ.C* macro) into a Postscript file named "DAQCntuple.ps". These last result plots are saved into a separate directory
/remote/disc01/datacheck/analysis/DataCheck/Data/ntuple/ [18].

2.4.3 Calibration data check plots

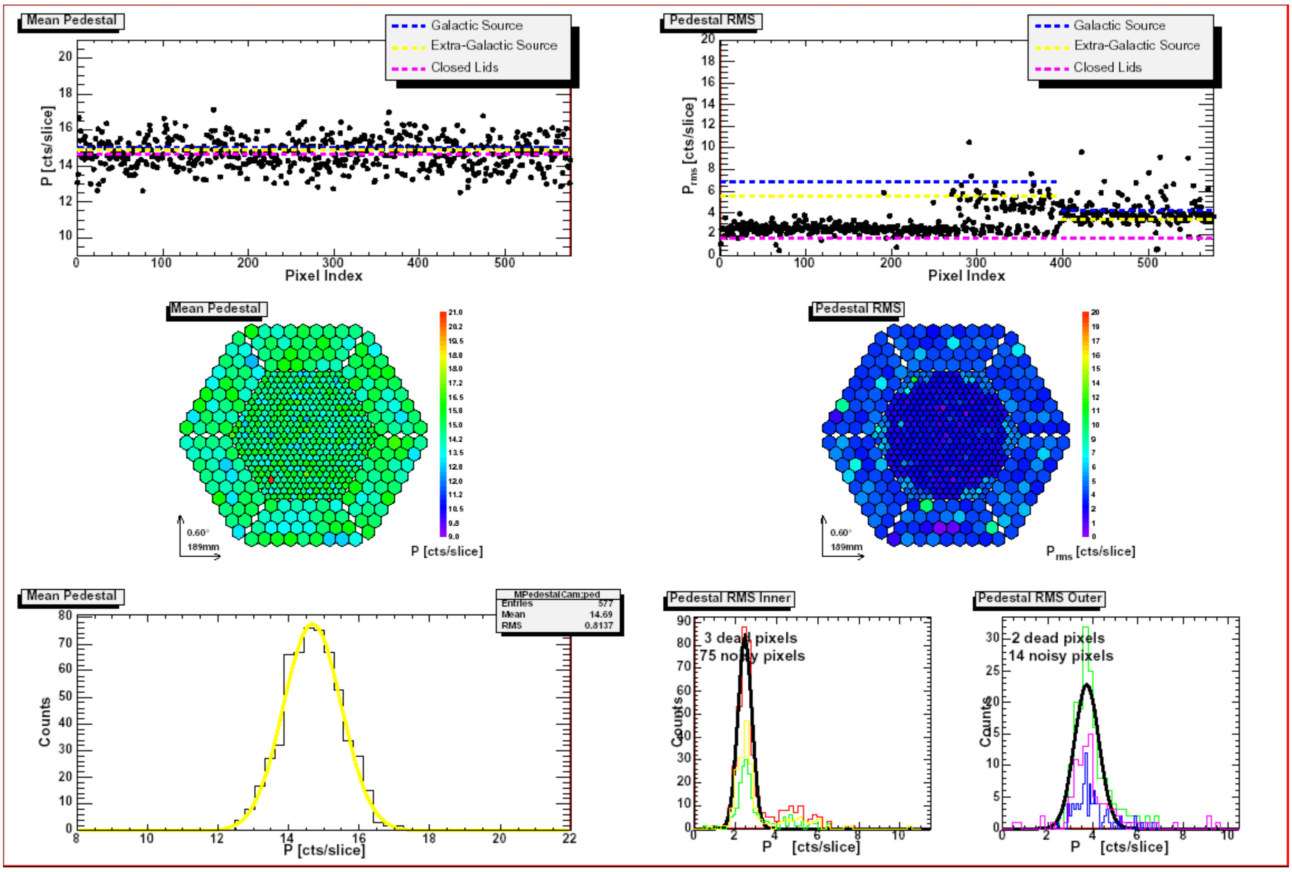

Figure 17: *Pedestal Mean and RMS (from pedestal run). From top to bottom: pedestal mean (left) and rms (right) versus pixel index in profile and camera displays; and the mean and rms distributions together with the Gaussian fits. The reference lines correspond to the pedestal values pointing to galactic (blue) and extragalactic (yellow) source and with closed lids (pink).*

Pedestal from pedestal run Figure 17 displays the mean and rms of the pedestal charge distribution for each pixel versus the pixel index as a profile and as a camera display, and also their camera distributions. The mean and rms camera distributions are fitted to a Gaussian. In the case of the rms we distinguish between the inner and outer part of the camera (or pixels) and we integrate the number of pixels lying 4σ away from the distribution mean. Those pixels at -4σ are the so called “dead” pixels and those at $+4\sigma$ are the “noisy” pixels.

The reference lines correspond to the values “RefPed{ClosedLids/ExtraGalactic/Galactic}” and “RefPedRms{ClosedLids/ExtraGalactic/Galactic}{Inner/Outer}”
specified in the .rc file MJPedestalC1.ReferenceFile on “callisto.rc”.

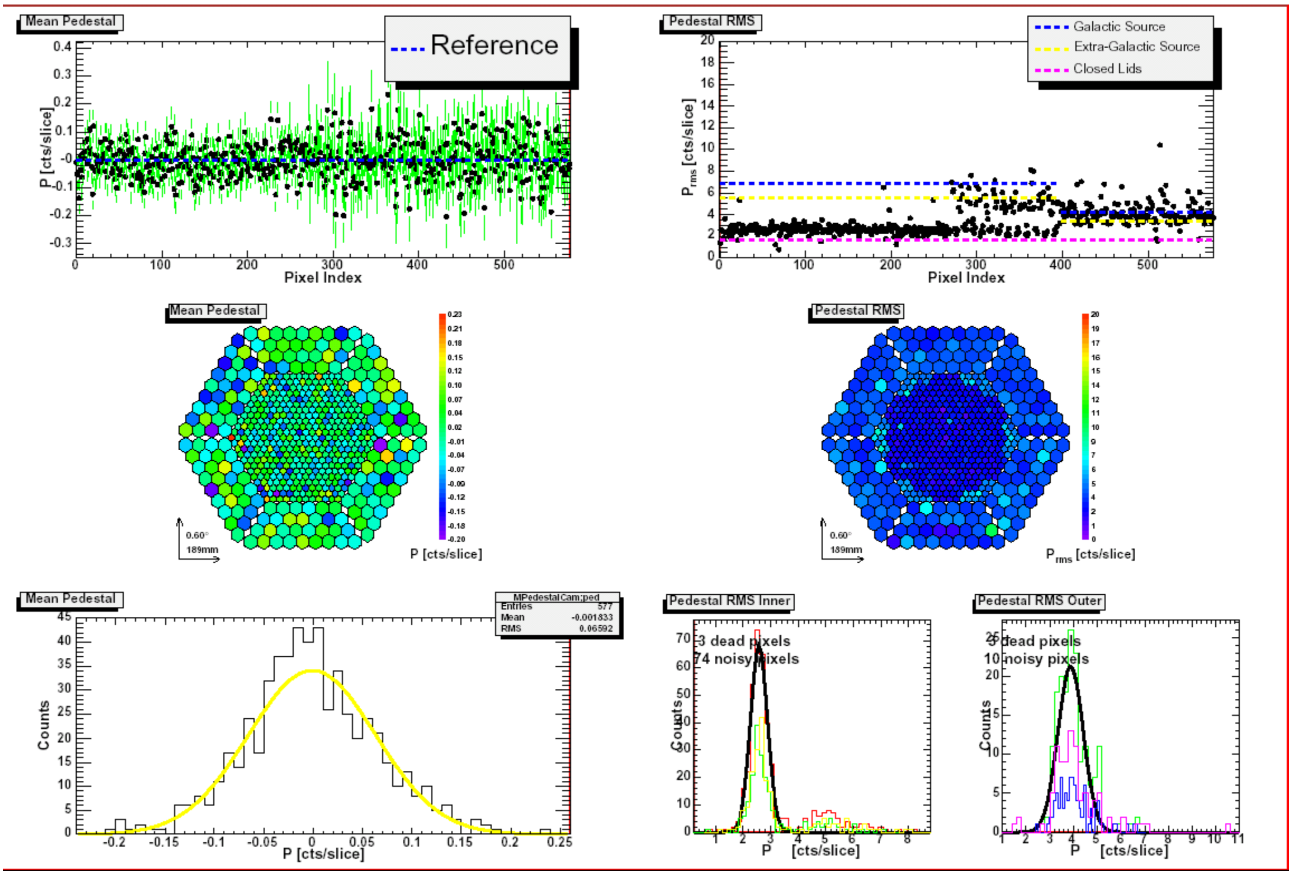

Figure 18: *Pedestal Mean and RMS (from calibration extracted run). From top to bottom: pedestal mean (left) and rms (right) versus pixel index in profile and camera displays; and the mean and rms distributions together with the Gaussian fits.The reference lines correspond to the pedestal values pointing to galactic (blue) and extragalactic (yellow) sources and with closed lids (pink).*

Pedestal from signal extractor The Digital filter extractor [1] uses the events for which the difference between the maximum and minimum FADC slice content is less than 40 FADC counts, as pedestal ones. The extracted pedestal is updated every 500 of these "pedestal events". As in figure 17, figure 18 displays the mean and rms of the pedestal charge distribution but from the calibration extracted signal where the pedestal has already been substracted. Therefore the plots are similar to those in figure 17 but in this case the mean pedestal is expected to be 0 (blue reference line) for all pixels (top-left plot) and the camera pedestal distribution (bottom-left) is centered at 0.

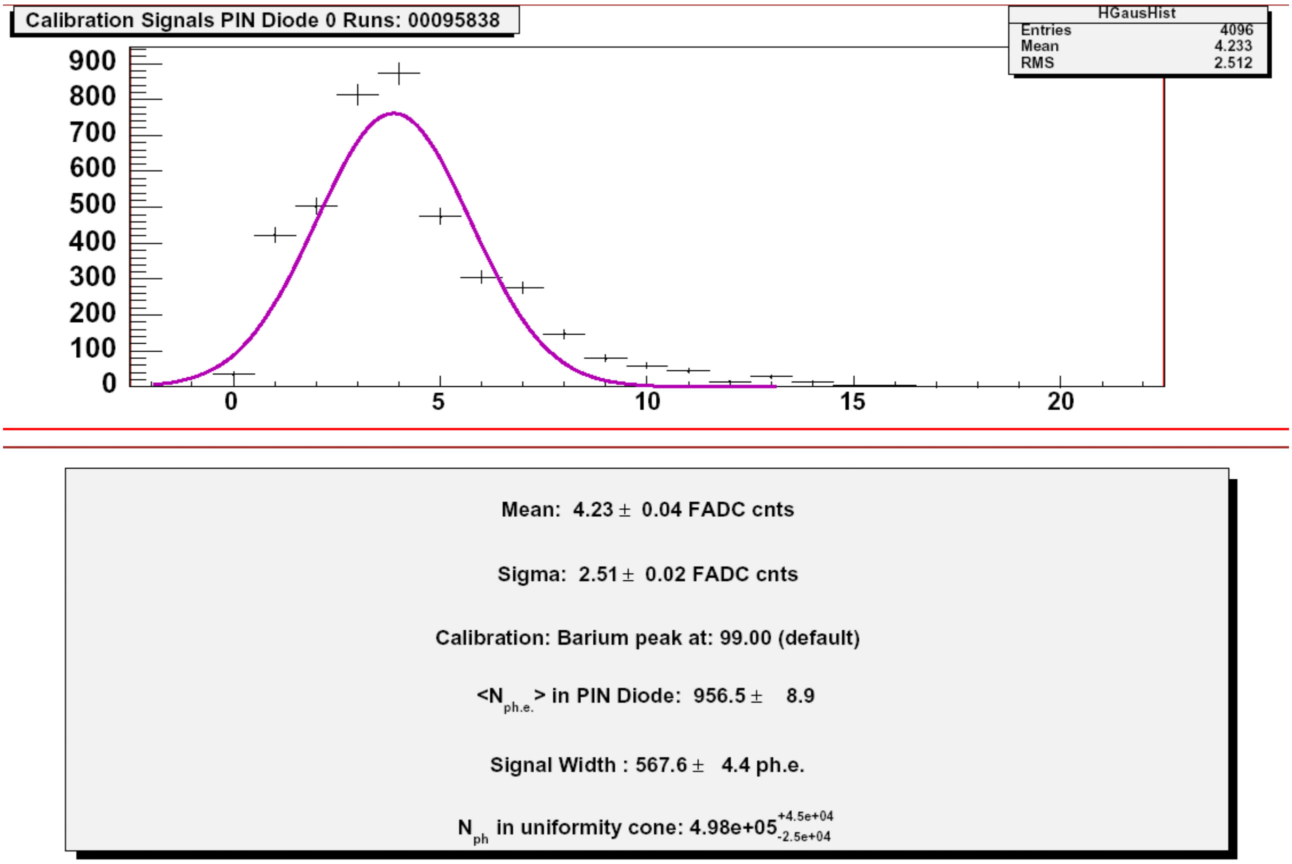

Figure 19: *Charge of the calibrated PIN diode. Calibration charge distribution (FADC counts) with a fit to a Gaussian (purple line) and its results legend.*

PIN Diode Figure 19 displays the PIN diode calibration charge distribution (FADC counts) with a Gaussian fits and its results.

The PIN diode measures the absolute light flux produced by the calibration pulses, independently of the variations of the plexiglass transmission coefficient and the uncertainties in the knowledge of the PMT QE.

Once the PIN diode is calibrated, using two radioactive γ-emitters, the total amount of photons can be know from the mean FADC counts collected by the PIN diode per calibration pulse, extracted from the fit (purple line).

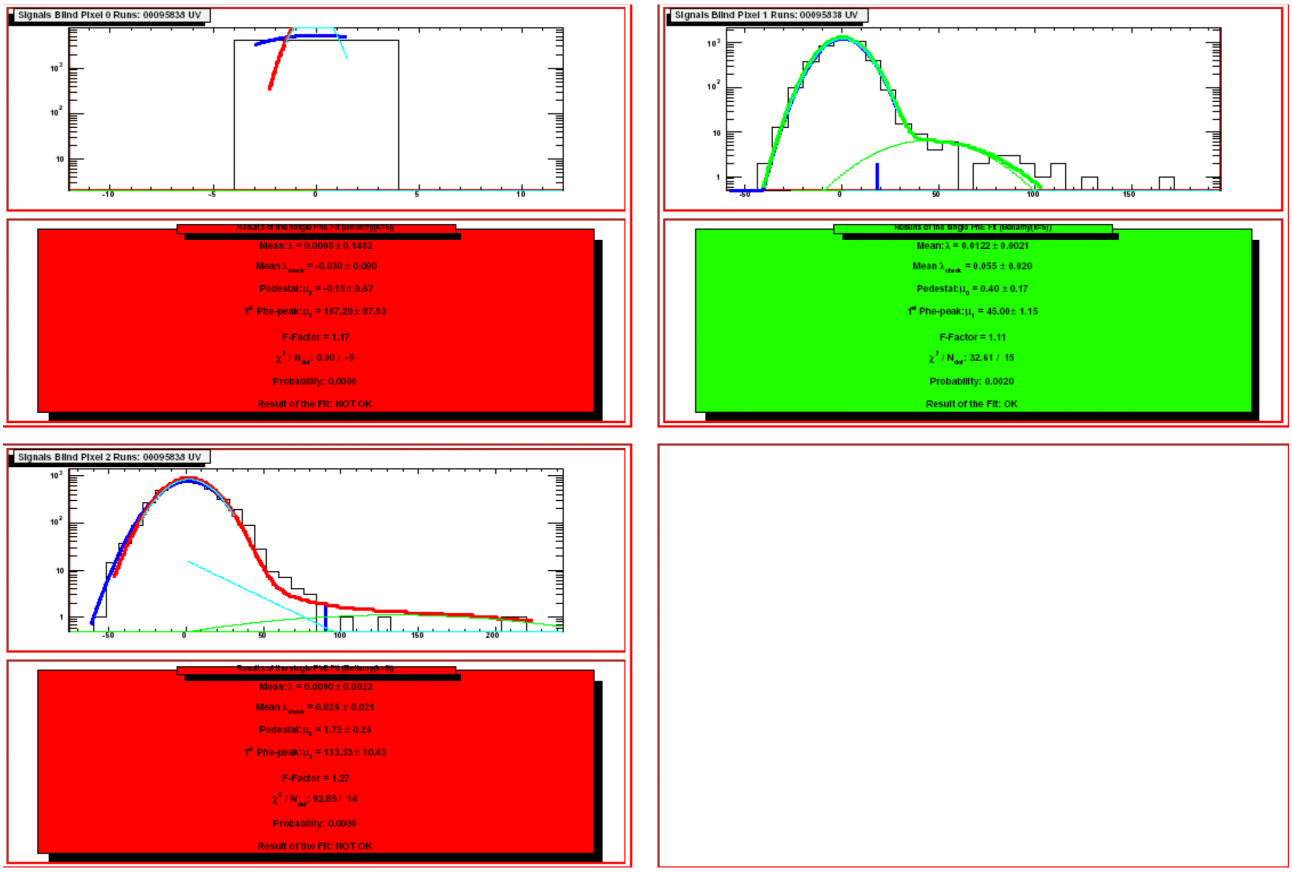

Figure 20: *Charge calibration of the blind pixels. Charge distribution, Poisson formulae fit and fit result s's legend for the three blind pixels.*

Blind pixel Figure 20 shows the charge distribution of the three blind pixels with a legend with the fit results. Due to the design characteristics of each blind pixel it is expected that its charge follows a Poisson distribution. Therefore we can obtain from the fit the mean number of photo-electrons and the F-Factor [7].

Currently only two of the blind pixels have a filter installed, whereas the third one has a diaphragm of 0.5 mm Ø.

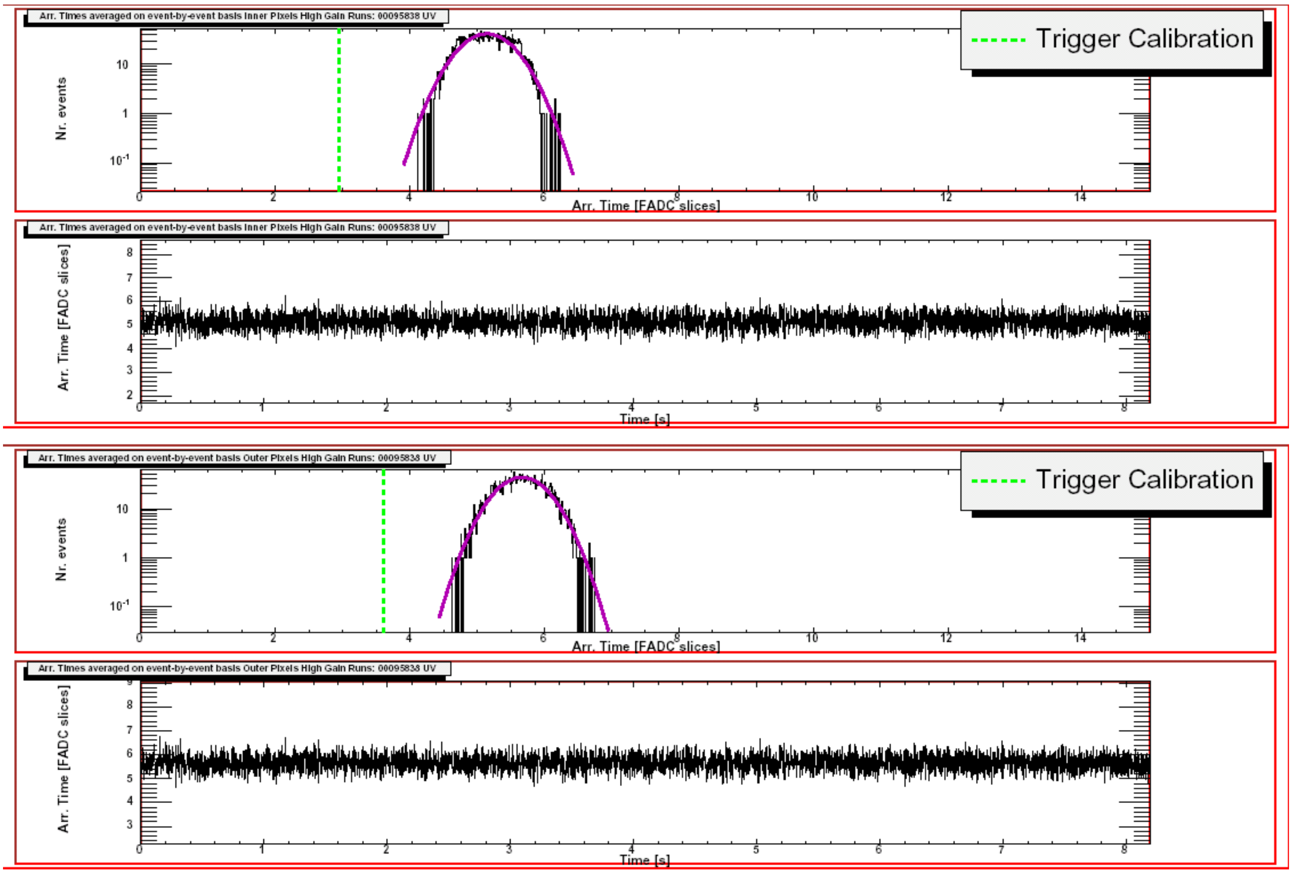

Figure 21: *Mean arrival time (FADC slice). From top to bottom: mean arrival time distribution for inner pixels (first 2 plots) and outer pixels (last 2 plots) high gain digitized slices. The second and third plot shows this mean arrival FADC slice versus time for both inner and outer pixels.*

Arrival time Figure 21 represents the distribution of mean arrival times of the calibration signal events, defined as the FADC slice of the signal maximum, as well as its behaviour versus time (sec.). The plot is separated in inner and outer pixels.

The reference line corresponds to the reference default values ("{Inner/Outer}RefTime") on .rc MJ-Calibration.ReferenceFile file of "callisto.rc" file of the MARS release version.

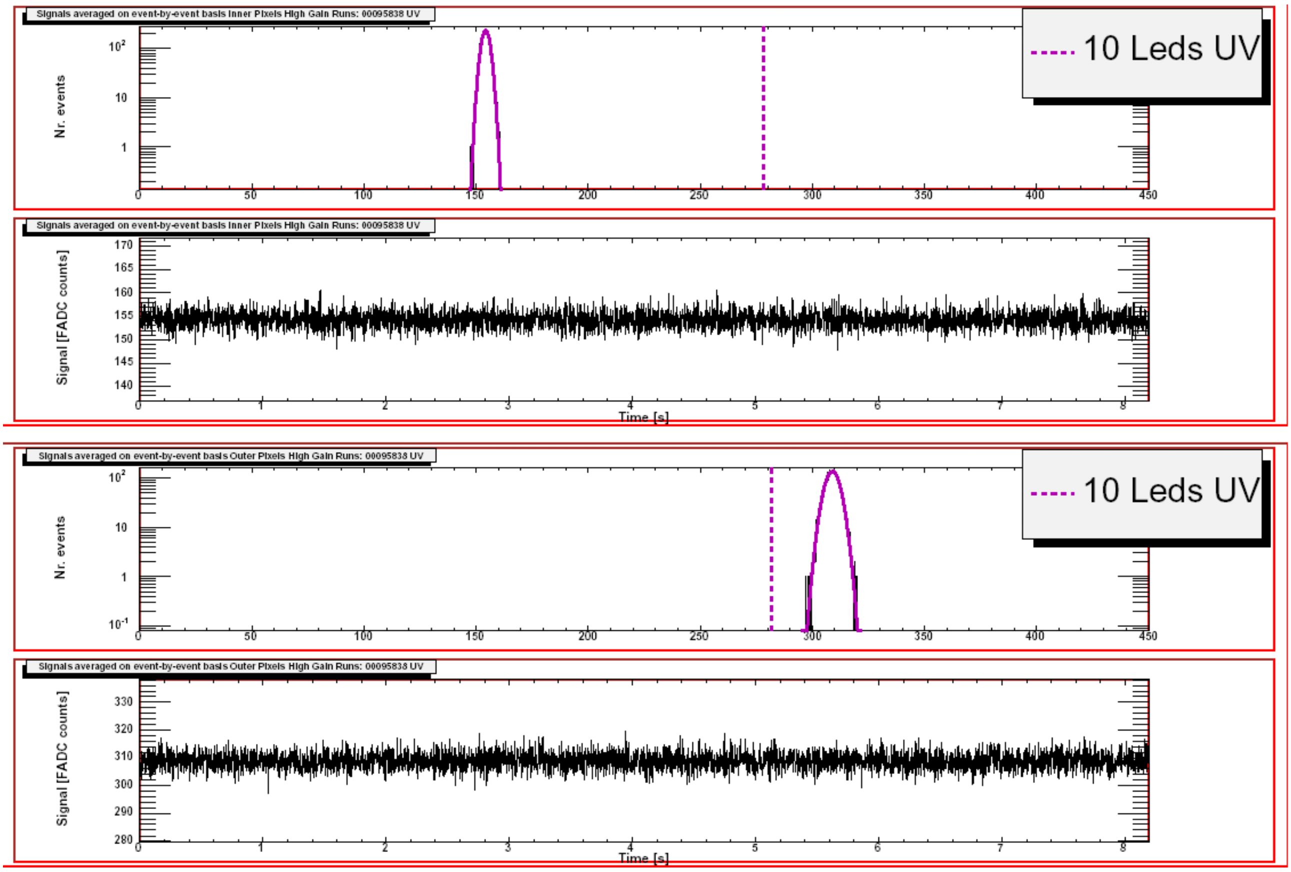

Figure 22: *Calibration signal charge (FADC counts). From top to bottom: mean calibration signal charge (FADC counts) distribution for inner (first 2 plots) and outer pixels (last 2 plots). The second and fourth plot shows this mean charge versus time (s) for both inner and outer pixels. The reference lines correspond to the expected light for the specific calibration script.*

Calibration signal charge Figure 22 shows the distribution of the calibration signal mean charge (in FADC counts) and its behaviour versus time (sec.) for inner and outer pixels. A reference line with the charge of the corresponding calibration script (values "{Inner/Outer}RefCharge" of the MJCalibration.ReferenceFile) is plotted on it.

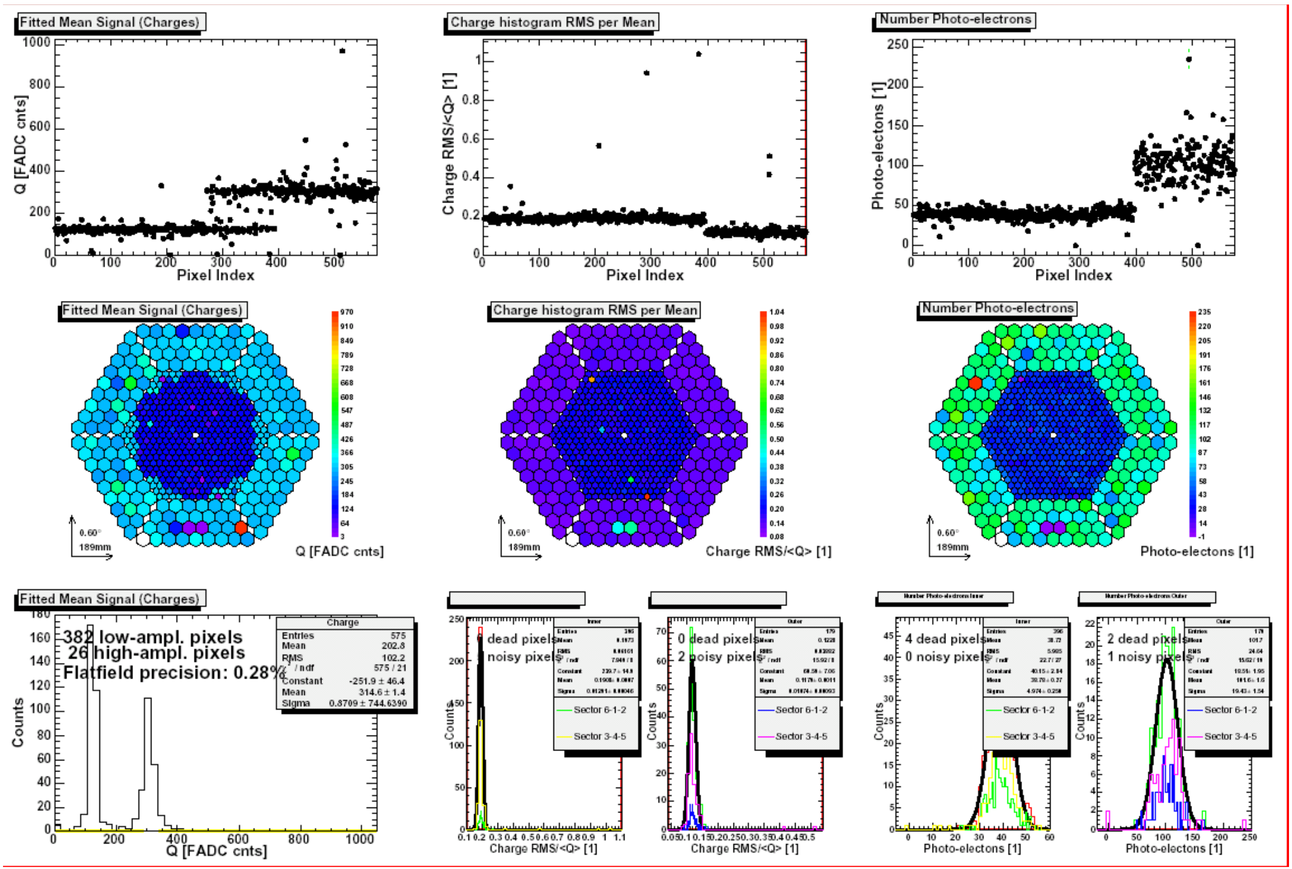

Figure 23: *Fitted charge (FADC counts) and* N_{phe}*. From top to bottom: the average versus pixel index as profile and camera display, and the distribution for the following variables: fitted mean charge and rms, and the number of photo-electrons.*

Fitted charge In figure 23 the mean (in FADC counts) and rms of the fitted signal charge versus camera pixel number is plotted as a profile and as a camera display. It also shows the distribution of the fitted mean charge with labels with the number of "low" and "high" gain pixels and the flat-field precision, and the distributions of the rms (for inner and outer pixels) with the number of dead and noisy pixels. The "low" and "high" gain as well as the dead and noisy pixels are the integral of the distributions at $\pm\ 4\sigma$ of the fitted distribution. The flat-field precision is defined as the distribution fit of the mean signal charge divided by its fitted mean multiplied by a factor 100. The number of photo-electrons is computed by the F-factor method.

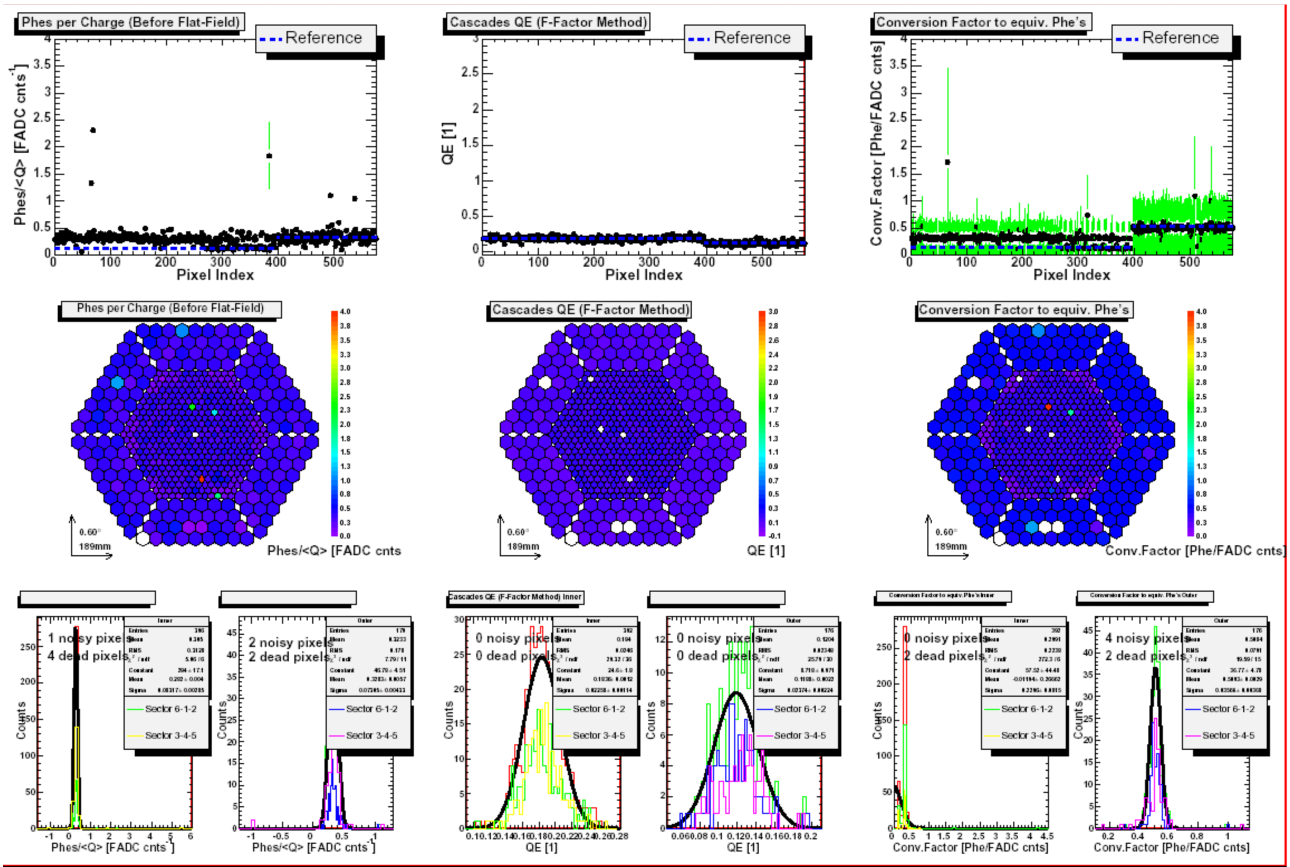

Figure 24: *Calibration constants. From top to bottom: the average versus pixel index as profile and camera display, and the distribution for the following variables: number of photo-electrons per charge ($FADCcounts^{-1}$), QE and conversion factor (phe/FADC counts).*

Conversion factor Figure 24 shows the average versus pixel number in profile and camera display, and the distribution (inner and outer pixels) of three calibration constants: the conversion factor from F-Factor method, the mean quantum efficiency for cascades obtained with the F-Factor method and conversion factors from equivalent Phes. This last constant is the conversion factor from F-Factor method normalized over the Cherenkov showers spectrum [12].

The reference lines correspond to the reference default values 'Ref{FADC2Phe/QE/ConvFADC2Phe}{Inner/Outer (MJCalibration.ReferenceFile on "callisto.rc").

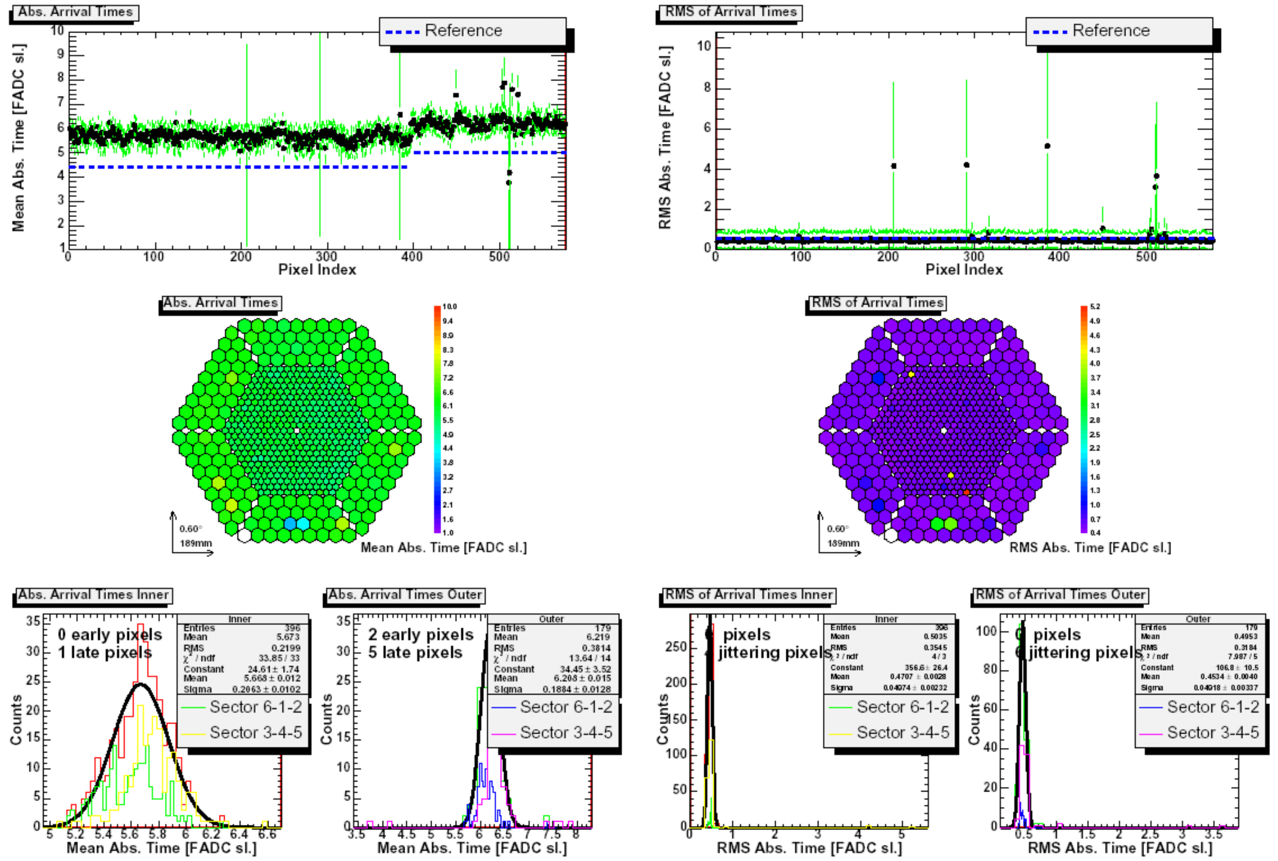

Figure 25: *Arrival times (FADC slice). From top to bottom: Mean and RMS of arrival FADC slice in profile and camera display and their distributions (for inner and outer pixels).*

Absolute times Figure 25 shows the mean and rms values of the arrival FADC slice of the calibration events versus pixel number in a profile and camera display. It also displays the distribution of the rms for inner and outer pixels together with the corresponding outliers: “early” and “late” pixels (pixels at $\pm 4\sigma$ of the fitted mean of the mean arrival time per pixel), and “too stable” and “jittering” pixels (at $\pm 4\sigma$ of the average of the mean arrival time rms).

The reference lines correspond to the reference default values “RefArrivalTime{Inner/Outer}” and “RefArrivalTimeRms{Inner/Outer}” (MJCalibration.ReferenceFile on “callisto.rc”).

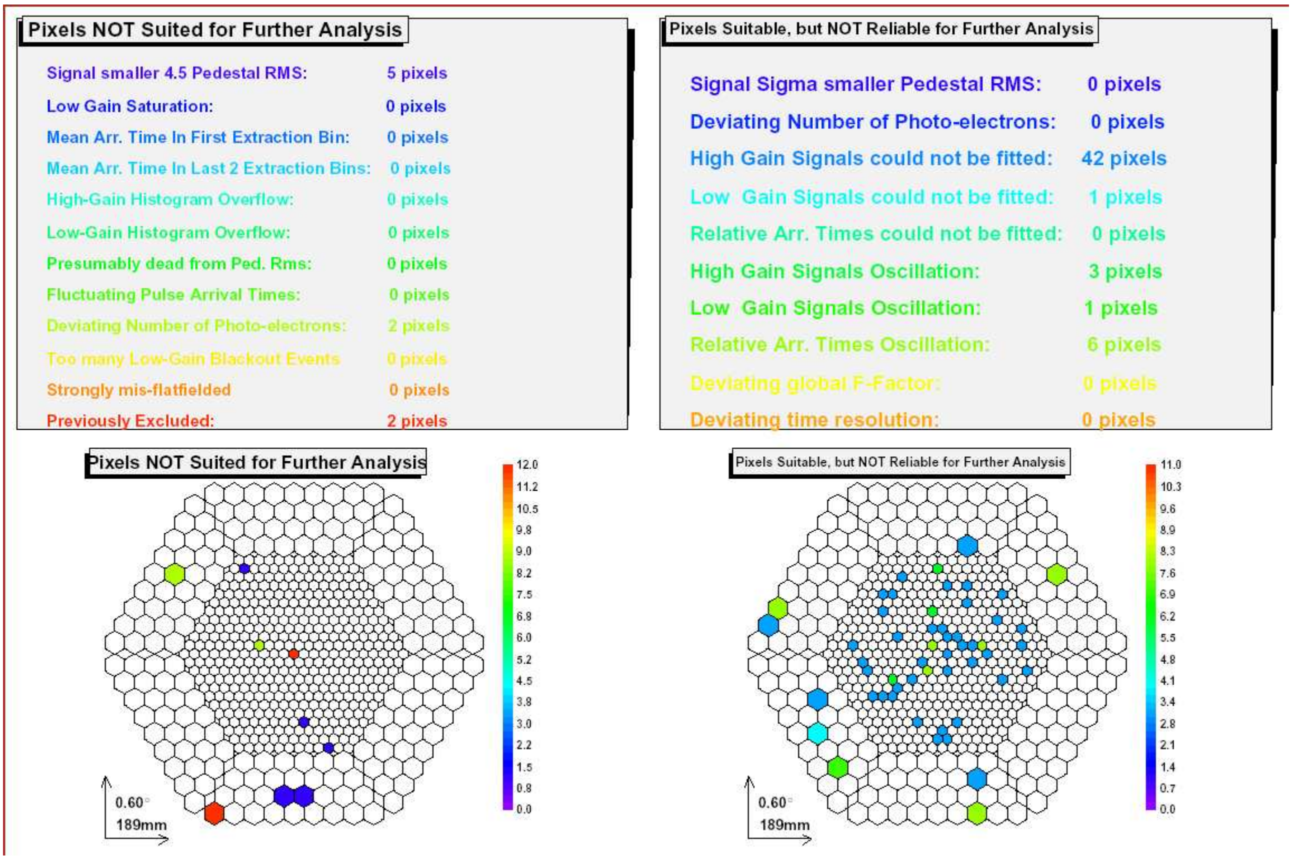

Figure 26: *Defective pixels. Legend with information about the calibrated defective pixels and a camera display showing the corresponding pixel on a color-defect criteria. On the left the "non suited pixels" and on the right the "non reliable" pixels.*

Defective pixels Figure 26 shows the defective pixels found in the calibration process. A legend is shown with the criteria (in different colors) to classify the pixels into "non suited" and "non reliable" pixels [7]. They are shown with the same color criteria in a camera display.

The pixels marked as "non suited" are not used in the further analysis to build the images, while the "non reliable" pixels will be replaced in the image cleaning analysis process by the mean signal of their surrounding neighbors.

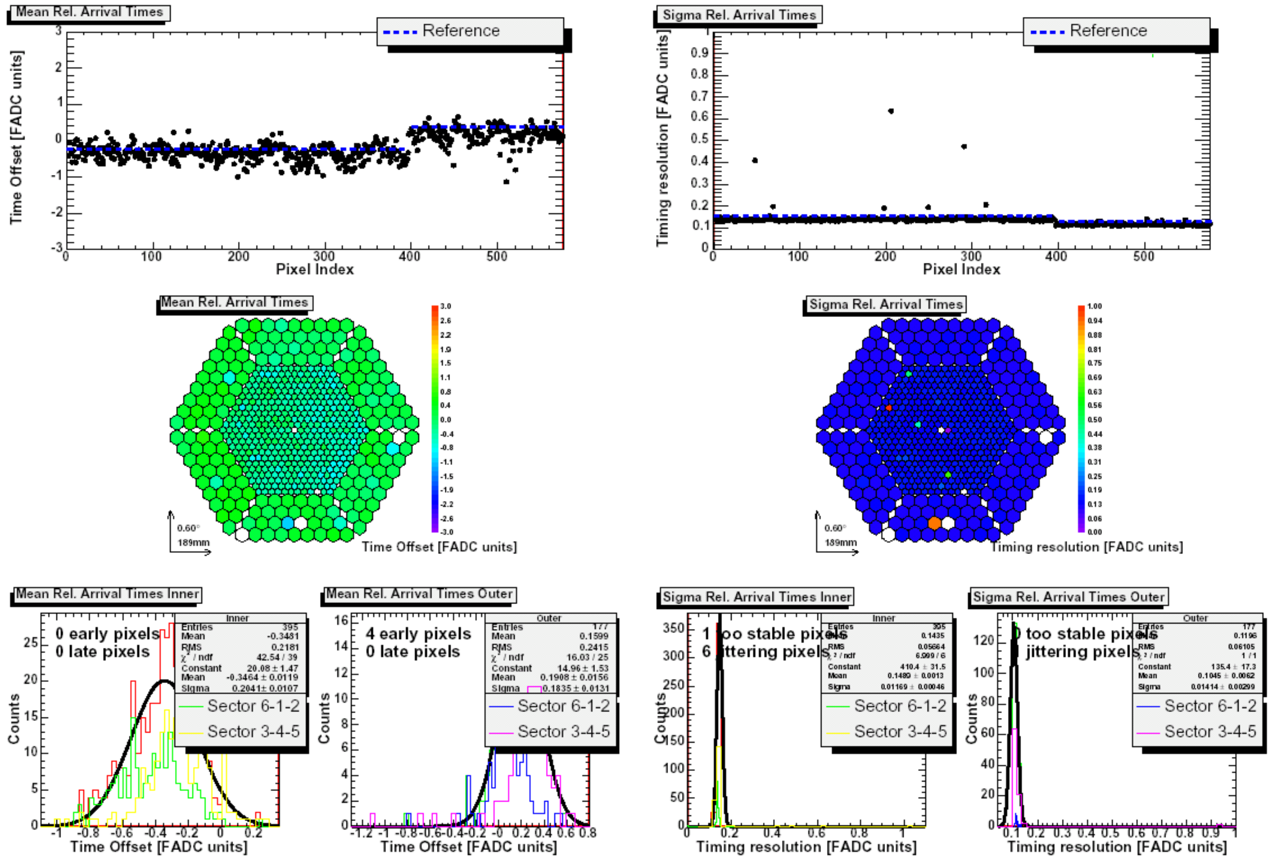

Figure 27: *Relative arrival time (FADC slice). From top to bottom: mean and rms of relative arrival FADC slice in profile and camera display and their distributions (for inner and outer pixels).*

Relative times Figure 27 displays the mean time delay (FADC slice) and its rms per pixel in a profile and camera display. The distribution of the camera mean and rms for inner and outer pixels is also shown with the number of early and late pixels, and the "too stable" and "jittering" pixels. All the relative times are calculated with regard to pixel number 1 (hardware number = 2).

The reference lines correspond to the reference default values "RefTimeOffset{Inner/Outer}" and "RefTimeResolution{Inner/Outer}" (MJCalibration.ReferenceFile on "callisto.rc").

2.5 Analysis data

In order to have a first idea about the quality of the night MAGIC data, it is needed to analyze the data in a robust and fast way. This is done by the so-called "on-site-analysis". It will extract calibration and analysis parameters to check the quality of the data as well as display the first analysis plots.

2.5.1 Analysis process

The first step in the data analysis is to calibrate the data runs. In section 2.4 it was explained the extraction of the calibration parameters (mean N_{phe}, conversion factors and time delay) from a first pair of pedestal-calibration runs. The signal extractor algorithm is the same for calibration and data runs and calculates the total charge and its arrival time for each pixel. The extractor algorithm subtracts the pedestal from the non-signal region, extracts the signal from a given sample range and finds the time of the signal maximum (see sec. 2.4).

Because of observed variations in the gain of the electronic chain at very different time scales, an external calibration trigger has been included to be able to update all the conversion factors during the data taking, it consists of 50 Hz calibration events interlaced with normal data. In this way during the data taking the calibration constants are updated within the current data file and applied to the next one. The time delay is only calculated once whereas the conversion factors are updated every 500 interlaced calibration pulses (every 10 seconds of data taking) and the mean N_{phe} is updated every 5000 pulses.

At the end of the sequence the last updated information is saved in a "signal.root" file which will be used for the consecutive sequence if it hasn't any previous calibration-pair runs. The DAQ takes care to start a data run every time that a predefined file size (954MBytes) is reached. When the sequence duration is over, another sequence starts with a new set of data runs, but no calibrations if they are not strictly necessary.

The second step is to clean as much background noise as possible and parameterize the image using the Hillas parameters [9]. To remove the background contribution we have to reach to a signal-noise compromise performing a three-step image cleaning process. In the data-check program it is used the default image cleaning in the "star.rc" configuration file of each MARS release version (currently Standard Absolute 10-5).

The third step is to classify the events in γ-like and hadron-like through a γ/hadron discrimination method. The separation criteria is based in the different distributions of the image parameters for γ-ray and hadronic showers. The highest background rejection is achieved by the statistical learning methods. The standard method used in the MAGIC collaboration is the Random forest (RF) [3]. Through this method a hadronness parameter value is computed for each event of real data and included as another image parameter for analysis cuts. For computing time optimization reasons the analysis data check program applies already tested RF matrices for different zenith angle ranges.

2.5.2 Analysis data check job

As shown in section 2.1, the scripts *Analysis* and *PostAnalysis* perform the analysis data check part on the MAGICDC program calling the *launcher* with the "ana" option.

The *Analysis* script reads the night sequences information saved by the *DAQDataChecking* script into the "samples.txt" ASCII file.

A sequence is constituted by a set of consecutive data runs belonging to the same source and observation mode (project name). As explained before, for the calibration it is needed the pedestal-calibration pair of runs taken immediately before the first data run of the sequence. If this pair doesn't exists the calibration parameters updated from the last run of sequence and saved at "signal<RunNumber>.root" file are used.

For each sequence set of data runs, the *Analysis* script runs the following MARS executables: *callisto* to calibrate the data), *merpp* (with -update option) to include all the subsystems information into the calibrated .root files, and *star* to calculate the image parameters. This script also launches the *CheckCalibData* script which we will describe in the next section (2.5.3).

Finally the *PostAnalysis* script is launched. It will run the *melibea* MARS executable and execute the *ReadQFiles.C* macro to display the first source results. The result plots correspond to the same project name. These plots are commented in section 2.5.4.

The log files of the *Analysis* and *PostAnalysis* scripts are named respectively Analysis_<year>_<month>_<day>.out and PostAnalysis_<year>_<month>_<day>.out and saved together with all the *Analysis* results into /mnt/raid1/analysis/DataCheck/Data/analysis/<year>_<month>/<year>_<month>_<day> while the *PostAnalysisResults* are saved into a subdirectory in the same tree called Melibea/.

2.5.3 Analyzed data check plots

At the end of the *Analysis* script, the *CheckCalibData* [2] script is launched. This script runs the *checkcalib* ROOT-compiled macro which processes the calib.root and signal.root files produced during the calibration (see sec. 2.5.1) to check the calibration parameters used in the analysis.

This program, as well as *CheckOnlineData*, can be found at ∼analysis/CheckCalib/ at muxana.

The data check over the calib.root files calculates the average of the calibration parameters for each part of the camera (inner and outer) and each group of pixels (suitable and reliable). Applying additional cuts (see [17]), the quality of the calibration runs is checked and set the corresponding flag. The results are saved in the following files:

- calibcheck_<year>_<month>_<day>_inner_suitable.dat: the average calibration values for all suitable pixels of the inner pixels.
- check_<year>_<month>_<day>_outer_suitable.dat: idem as previous one but for the outer pixels.
- check_<year>_<month>_<day>_inner_reliable.dat: the average calibration values for all reliable pixels of the inner pixels.
- check_<year>_<month>_<day>_outer_reliable.dat: idem as previous one but for the outer pixels.
- check_<year>_<month>_<day>_runflag.dat: information flags and other summarizing information for both inner and outer pixels, and a quality flag.

The same kind of analysis, as in the case of the calib.root files, is performed for the signal.root files, with the following results:

- check_<year>_<month>_<day>_inner_signal.dat: averages of cosmic and interlaced events over the inner part of the camera.

[2] Program developed by P. Liebing (MPI, München)

- check_<year>_<month>_<day>_outer_signal.dat: idem as previous one but for the outer part of the camera.
- check_<year>_<month>_<day>_signal_pixels.dat: the statistics of bad pixels in the data runs as well as a detailed list of quality flags set during the quality check.
- check_<year>_<month>_<day>_pixels.dat: comparison of bad pixels from this files (signal.root) and the ones from calib.root files.
- check_<year>_<month>_<day>_inner_interleaved.dat: averages of the calibration values over the interlaced events updates along the sequence for the inner pixels.
- check_<year>_<month>_<day>_outer_interleaved.dat: idem as the previous one but for the outer pixels.
- check_<year>_<month>_<day>_updates_interleaved.dat: statistics for the interlaced events updates.

All the previously calculated variables stored into ASCII files are saved also in a ntuple in the root file calibcheck_<year>_<month>_<day>_ntuple.root. The values of the ntuple are displayed in a Postscript file (check_<year>_<month>_<day>.ps) with the macro *plotcalibcheck.C* located in the program directory.

The last results file created is a Postscript file containing plots showing the time dependence of the interlaced events, called check_<year>_<month>_<day>_interleaved.ps

All the output files of this macro are saved into /remote/disc01/p16/analysis/DataCheck/Data/analysis/<year>_<

2.5.4 Analysis results plots

For each source and observation mode (also called as "project name") the results of a rough analysis are extracted in order to check the quality of the taken data and possible indications of source detection.

As it has been pointed out in section 2.5.1 the program applies always the same standard image cleaning (Absolute 10,5) and performs the same analysis cuts. These are:

- Basic cuts:
  - Sparks: log10(Conc2)$<$(1.75-log10(Size))*0.369
  - Camera geometry: Leakage 1 < 0.1
  - 4NN trigger topology: NumCorePixels > 5
- γ/hadron separation cuts:
  - Analysis energy slide: Size > 300 phe
  - $0.2^{o} <$ Dist $< 1.0^{o}$
  - Dist $< 1.2 + 0.3$*(log10(Size) - 3)
  - Hadronness < 0.15
  - NumIslands < 3
  - Width/Length < 0.7

A very basic cut of Size $>$ 60 phe is applied to all analysis result plots. This information about the cuts is printed in the first page (see fig. 28) of each project results Postscript file.

A description about the analysis results plots is shown next.

Date: 29 : 07 : 2006

Observation time (min): 76.250

Source name: PKS2155-304

Project name: PKS2155-304-W0.40+180

α (source): 21.981111 h

δ (source): -30.225556 °

Telescope (21.950250 h, -30.223928 °)

Zenith ~ 64 °

Azimuth ~ 205 °

Runs: 96835 - 96867

Cleaning: Absolute, Lvl1 = 10.0, Lvl2 = 5.0

MHillas.fSize>60.0

Basic Cuts:

Sparks: log10(MNewImagePar.fConc)<(1.75-log10(MHillas.fSize))*0.369

Leakage: MNewImagePar.fLeakage1<0.100

Number of core pixels: MNewImagePar.fNumCorePixels > 5

Cuts:

Size: (MHillas.fSize>300.00) && (log10(MHillas.fSize)<6.00)

Dist: (MHillasSrc.fDist*0.003370>0.200) && (MHillasSrc.fDist*0.003370 < (1.2 + 0.3*(log10(MHillas.fSize) -3))) && (MHillasSrc.fDist*0.003370 < 1.000)

Hadronness: MHadronness.fHadronness<0.150000

Number of islands: MImagePar.fNumIslands < 3

MHillas.fWidth/MHillas.fLength < 0.7

Figure 28: *Project information.*

Information The first page (figure 28) shows information about the analysis parameters of the project: date, observation time (min), source and project names, source and telescope coordinates (right ascension and declination), mean alt-az coordinates, data runs range, cleaning method and levels and basic and γ/hadron separation cuts.

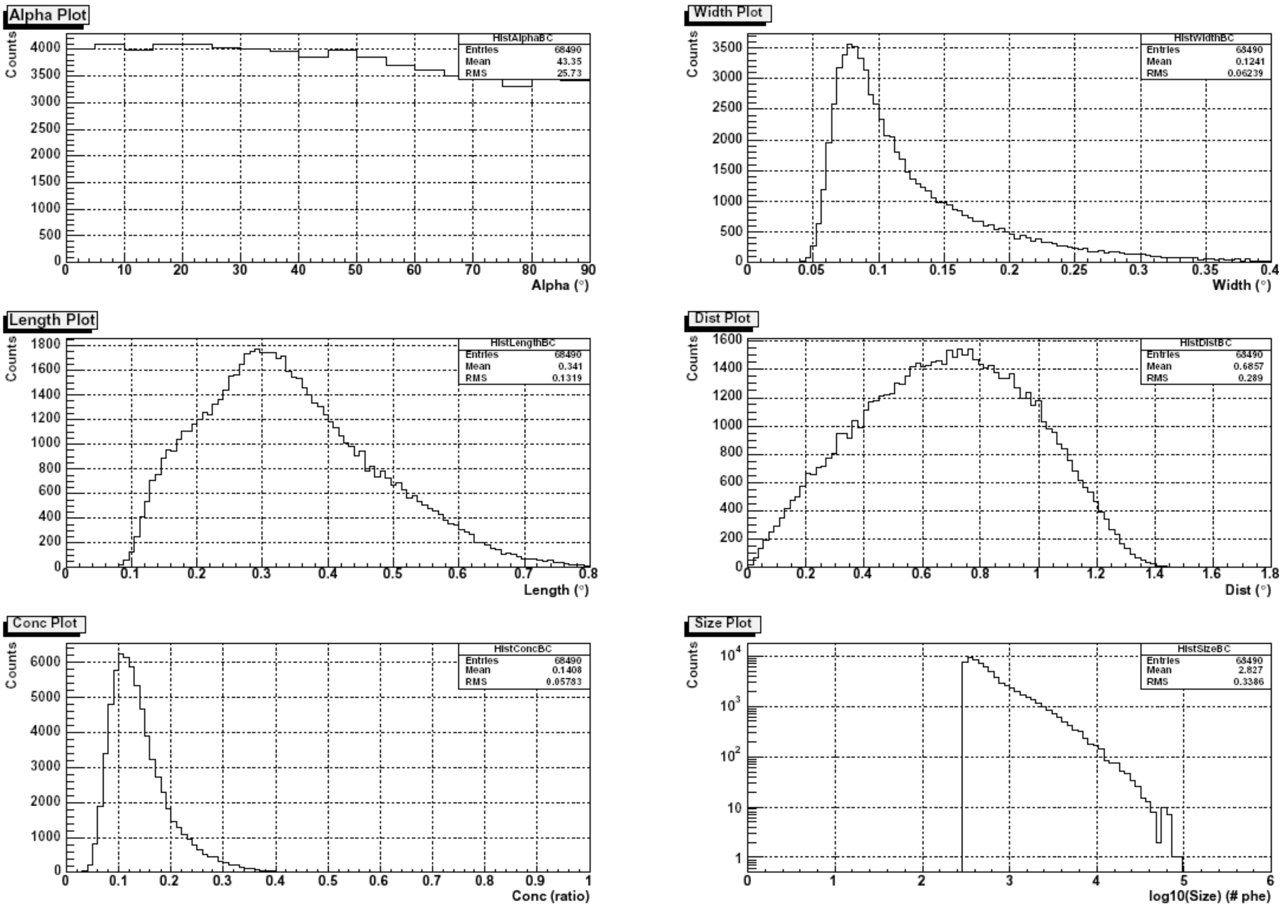

Figure 29: *Hillas parameters distributions after basic cuts. From top to bottom and left to right: Alpha (°), Width (°), Length (°), Distance (°), Conc2 and logarithm of Size (# phe)*

Hillas param. after basic cuts The second page, shown in figure 29, displays the distributions of the image parameters: Alpha (°), Width (°), Length (°), Distance (°), Conc2 and logarithm of Size (# phe in the image), before basic cuts.

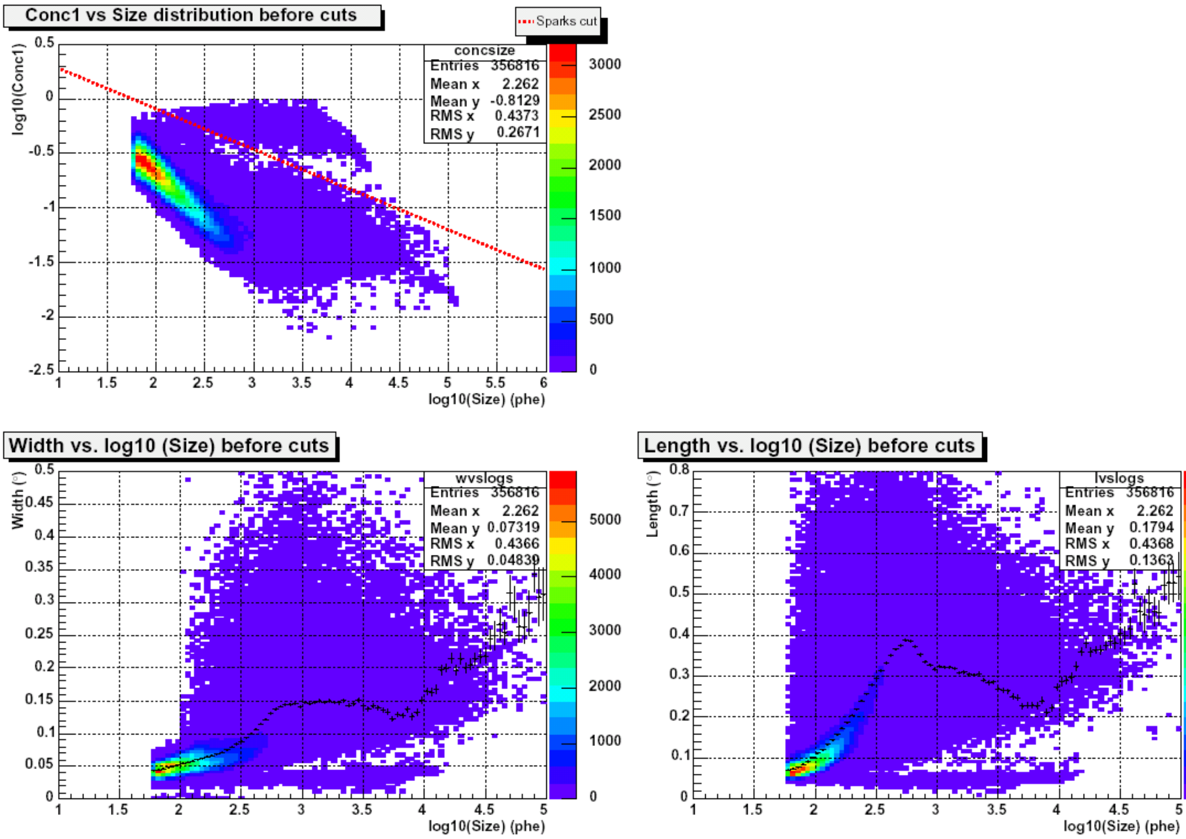

Figure 30: *Data-check plots before basic cuts. Distributions versus logarithm Size (phe). From top to bottom and from left to right: Conc1, Width (°) and Length (°).*

Data check plots before basic cuts Figure 30 shows the distributions versus logarithm Size (phe) of the Conc1, Width (°) and Length (°) image parameters. The distribution of Conc1 (top on the left) shows the sparks events generated between the photo-cathode and the first dynode of the PMT [6]. The sparks events correspond to those points above the "sparks cut" red dotted line also plotted in the distribution plot and its formulae is displayed in the information figure 28.

A cut of Size > 60 phe has been applied to these plots.

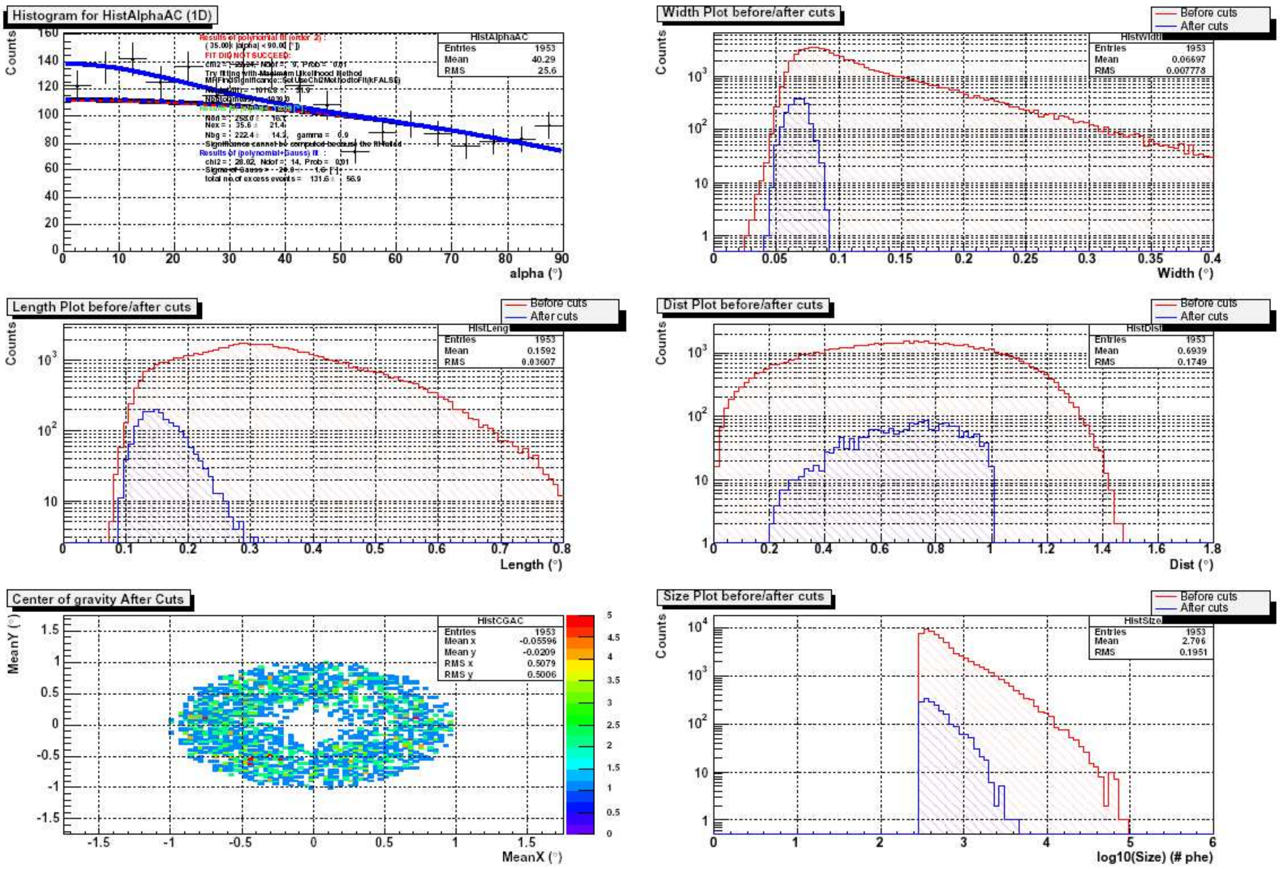

Figure 31: *Image parameters distribution before (red) and after (blue) γ/hadron separation cuts. From top to bottom and from left to right: Alpha (^{o}), Width (^{o}), Length (^{o}), Distance (^{o}), center of gravity (^{o}) and logarithm of Size (# phe).*

Image parameters before and after γ/hadron separation cuts Figure 31 shows the Hillas parameters distributions Width (^{o}), Length (^{o}), Dist (^{o}) and logarithm Size (phe) before (red) and after (blue) γ/hadron separation cuts (see fig. 28). On the left-top plot only the alpha parameter distribution after cuts is displayed, together with a fit and a summary of the significance of the signal with regard to the camera center. On the left-bottom the events center of gravity is also displayed only after γ/hadron separation cuts.

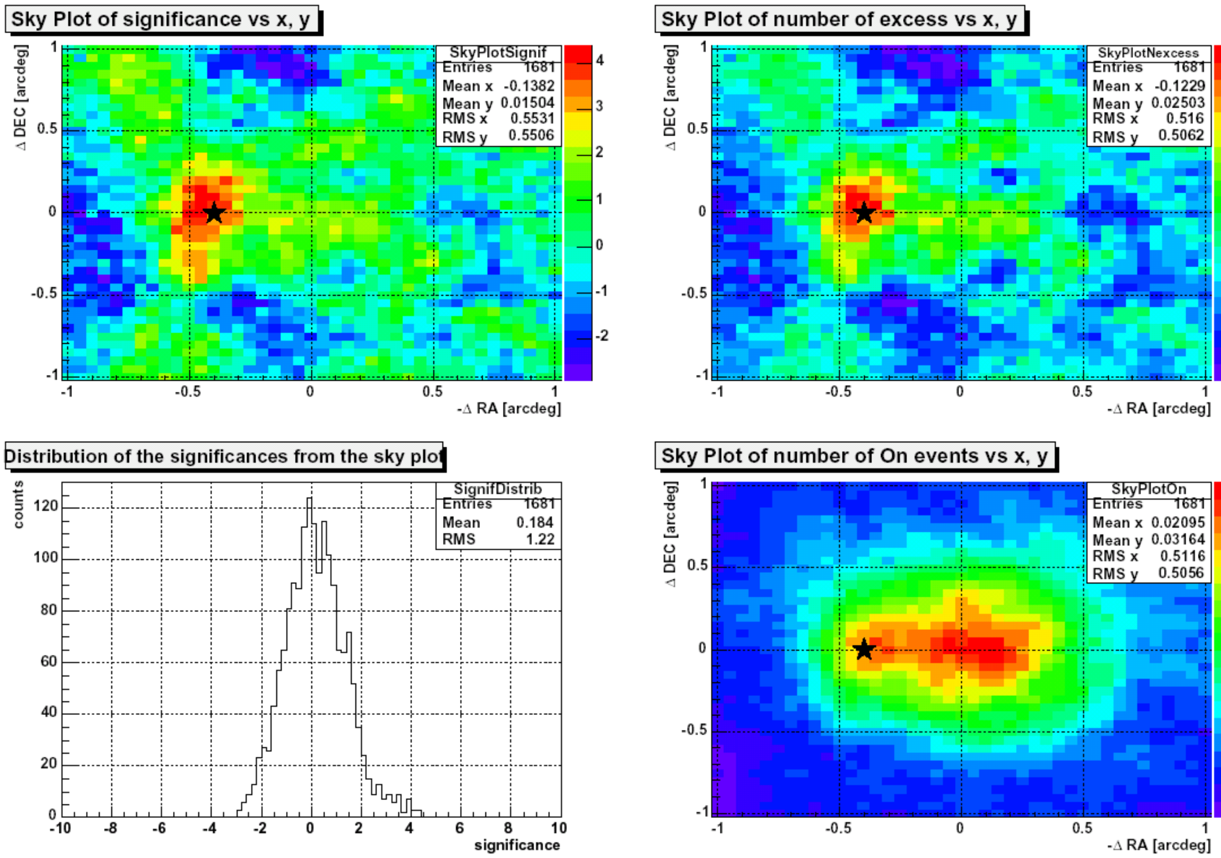

Figure 32: *False source plots on sky coordinates (hour angle and declination) with regard to the telescope position. From top to bottom: significance versus sky point (left), number of excess events (right), significance distribution (left) and number of ON events (right). In the last plot the star corresponds to the source position in the sky.*

False source plot Figure 32 displays the false source plots on sky coordinates (hour angle and declination) with regard to the telescope position (point 0,0 on the sky). These plots are calculated computing the significance (top-left), the number of excess (top-right) and number of ON events (bottom-right) of the alpha distribution for each sky position. The background is taken from the alpha distribution between 30-90 degrees while the signal is extracted with alpha $<$ 15 degrees. The distribution of significances is also displayed (bottom-left) to check that the distribution of significances in the false source plot is indeed a Gaussian centered at cero and rms ~ 1.

In case of a detection the maximum of the significance distribution should be at the source position in the sky. In case of ON-OFF observation mode the source is at the telescope pointing direction (the center of the false source plot). However, in wobble observation the telescope does not point to the source so the maximum is not expected at the center. To check a possible source detection at wobble mode a star corresponding to the source sky coordinates is also displayed.

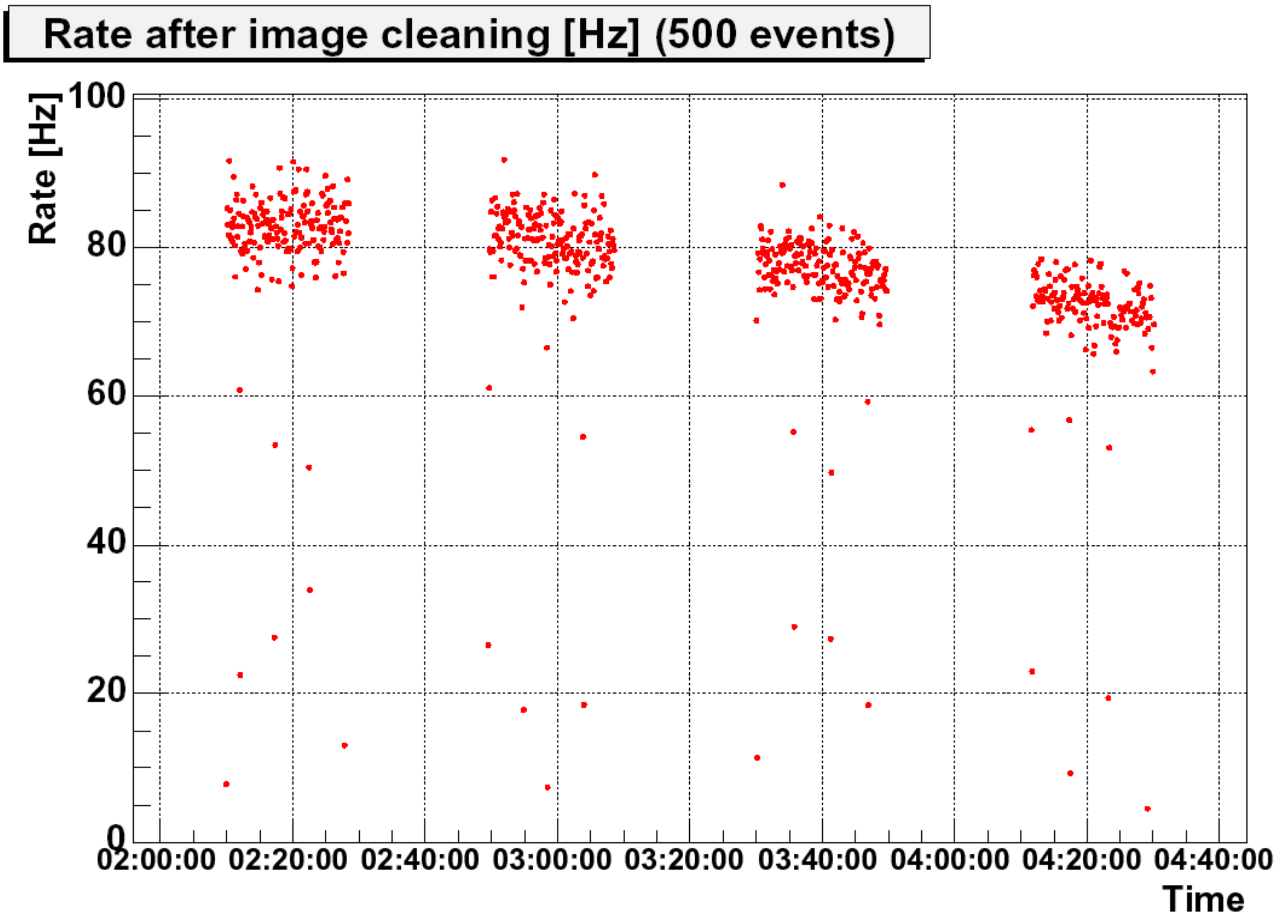

Figure 33: *Source rate after basic cuts. Mean source rate (Hz) versus time applying basic cuts.*

Source rate after basic cuts Figure 33 is a plot of the mean (for the first 500 events of each run) source rate (Hz) versus time after basic cuts. Only the cut of Size > 60 phe is applied.

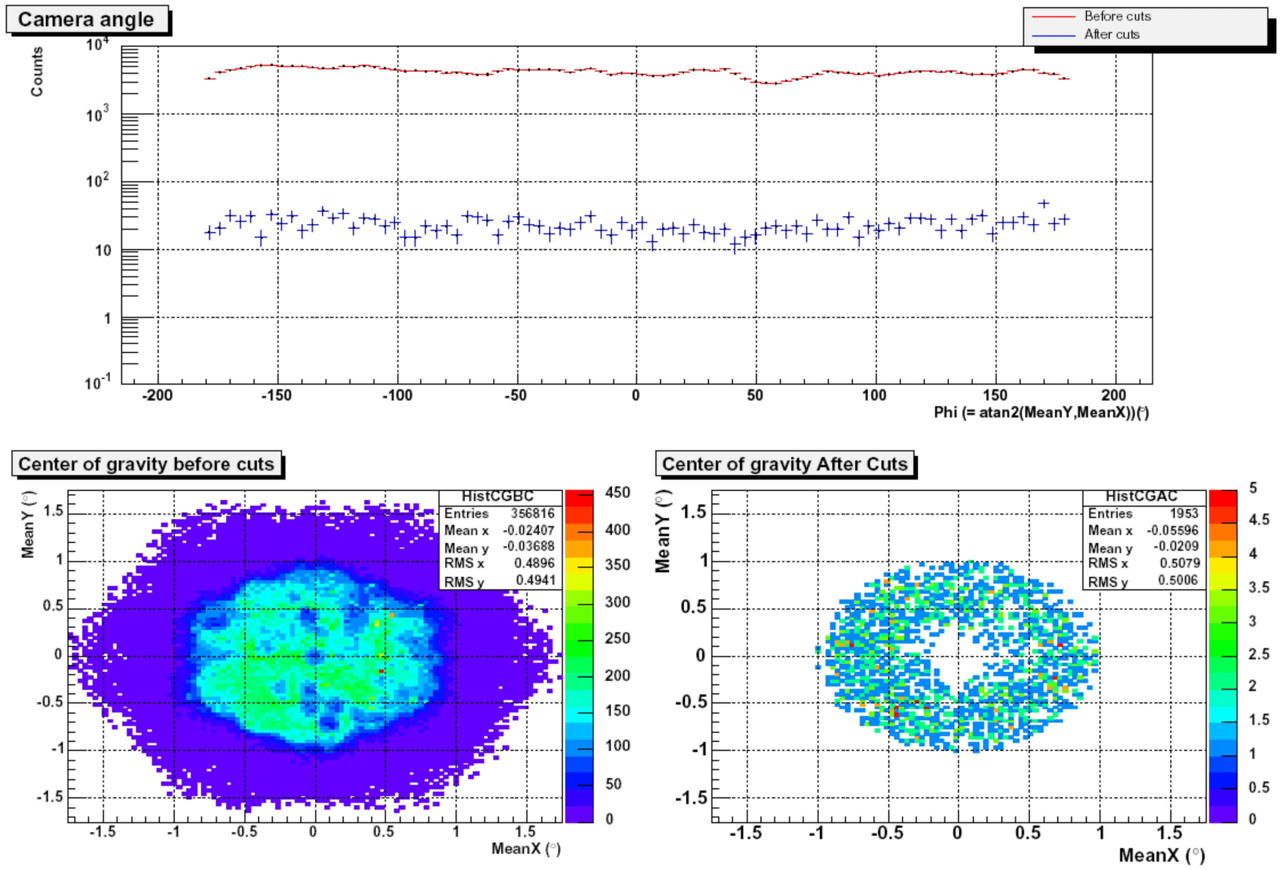

Figure 34: *Camera homogeneity. Top: Number of events versus camera angle ϕ before (red) and after (blue) cuts. Bottom: Center of gravity before (left) and after (right) cuts.*

Camera homogeneity Figure 34 checks the camera homogeneity. (Top) The number of events before (red) and after (blue) cuts versus the camera angle defined as $\phi = atan2(MeanY, MeanX)$. (Bottom) The center of gravity and the distribution of events versus camera position of the shower center, before and after cuts, is shown.

The cut Size $>$ 60 phe is only applied to all plots.

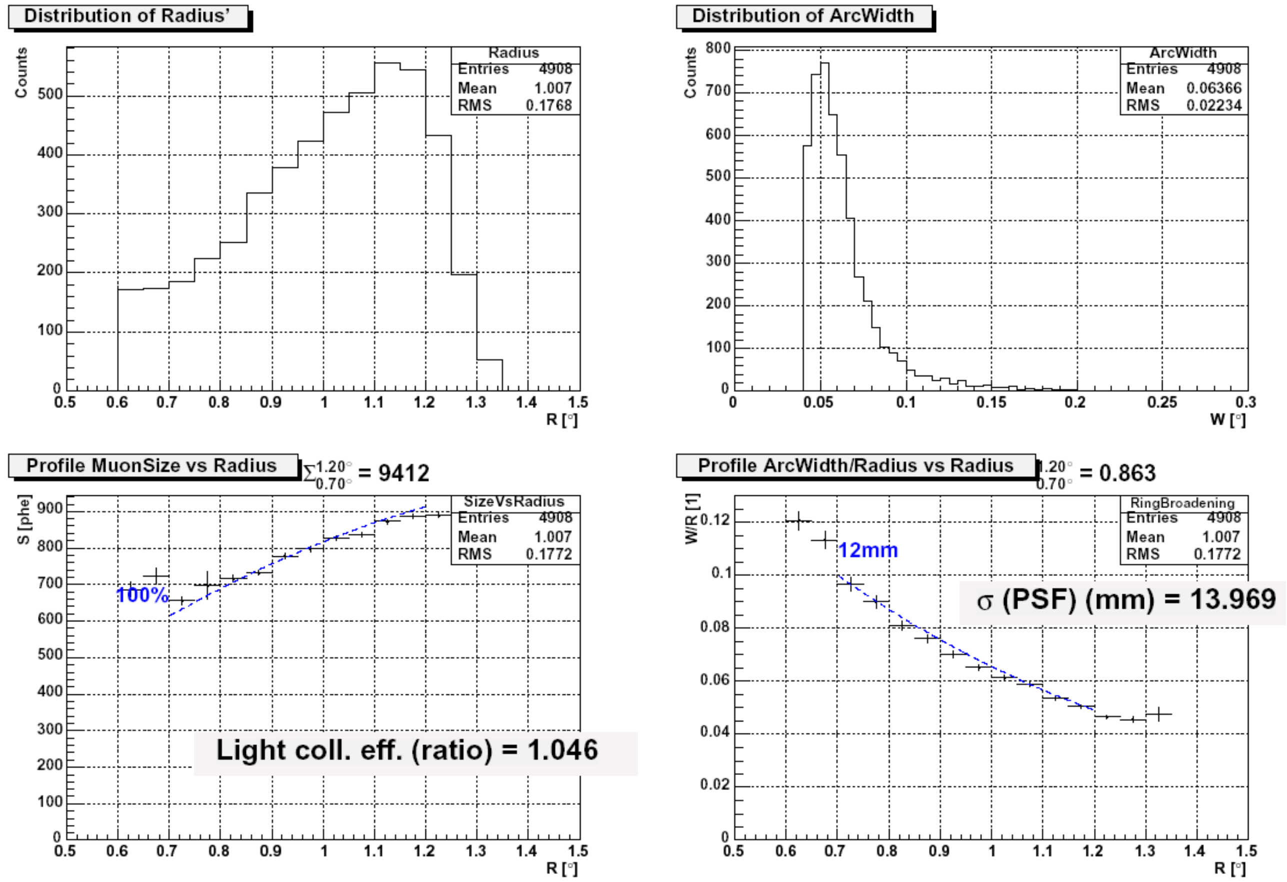

Figure 35: *PSF with Muons. Top: Distribution of the radius (°)and arc width (°) of the muon rings. Bottom: Profiles of the distribution of muon ring size (phe) versus the radius (°) and the distribution of the arcwidth/radius versus radius (°). The labels on the bottom plots correspond to the light collection efficiency and the PSF (mm).*

Muons analysis results The last figure 35 shows the absolute calibration of telescope characteristics through the use of muons images parameters. It displays the distributions of the radius (°) and the arc width (°) of the moun circles identified in the data. The profile of the muon size (phe) versus the muon ring radius (°) allows the calculation of the telescope collection efficiency through a fit to MC data. The profile fit of the "arc width/radius" versus the the radius (°) gives an estimation of the telescope PSF (Point Spread Function) [13].

3 QOSA: Quick Onsite Analysis

Due to the large amount of time taken by the analysis to process all the night data, an analysis program has been developed which process the data during the data taking. This program allows us to see the quality of the taken data during the data taking and also to check the activity of sources as soon as possible and monitor several periodical-flaring sources to perform alerts.

3.1 Program description

The MAGIC Quick Onsite Analysis (QOSA) program is based on the analysis part ("on-site analysis") of the previously described MAGICDC (sec. 2.5.1).

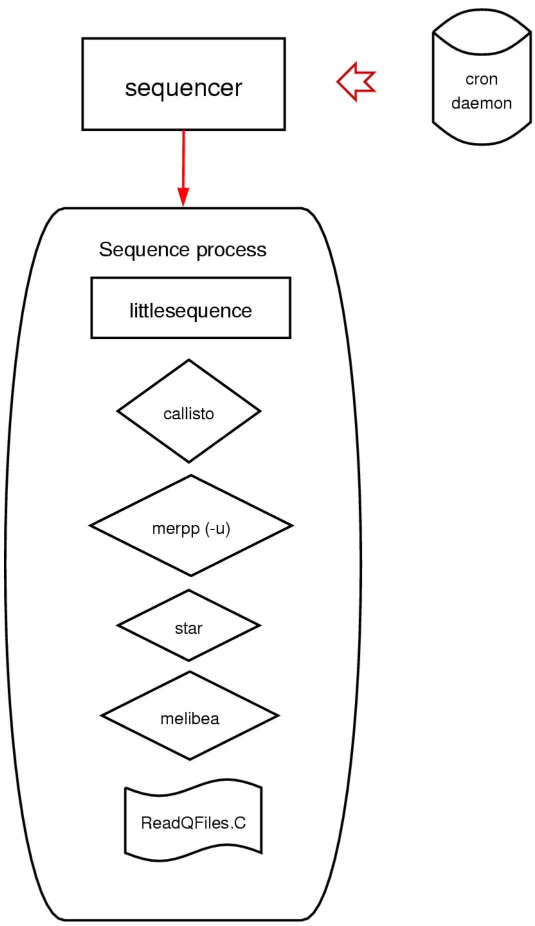

Figure 36: *QOSA program scheme.*

It is managed with the Linux "cron" daemon of "analysis" user on muxana. The program is located at "analysis" user HOME directory on muxana (/remote/home/muxana/analysis/Datacheck/QOSA/) and the logs and results are saved into the MAGICDC analysis directory (/mnt/raid1/analysis/DataCheck/Data/analysis/<year>_<month>/<year>_<month>_<day>). The purpose of writing the results and logs files into the MAGICDC analysis directory is to allow the "on-site analysis" to complement and/or fix the morning after the analysis already done by the "quick onsite analysis".

While the MAGICDC program runs only in muxana, the QOSA program is programmed to use muxana, muxana2 and muxana3 alternatively to save the time taken by *callisto* (∼2 times the data taking time) to calibrate the data. The rest of the analysis process (*star*, *melibea*, etc..) is shorter than *callisto*.

The "analysis" user crontab launches the *sequencer.csh* every 10 minutes from 21:00 p.m to 9:00 a.m (UTC). The log file (sequencer.out) is written into QOSA/bin directory.

The *sequencer.csh* script(see fig. 36) controls all the analysis and performs all the checks that allow or forbid to analyze the data.

I. First of all it sets the day of the data taking and checks whether the "on-site analysis" has run already. In this case the QOSA is not launched.

II. Then it creates the night summary (NightSummary_<year>_<month>_<day>.txt) from up to now created central control .run files (CC_<year>_<month>_<day>.run)(see sec. 2.4).

III. The next step is to create the sequences of the data already taken. It is done with the same criteria as in sec 2.5. The program will wait until the next sequence starts, or until the night finishes, to analyze the finished sequence.

IV. Once the sequence is created, the program checks for the last signal.root file created in case it needs it (sec. 2.5) and if the sequence has been already analyzed. In this case the program will not analyze the sequence. If the sequence has to be analyzed or has not finished, then the program determines which computer is the corresponding one for the analysis based on a roun-robin policy. It depends on the computer load. If the current sequence is already running in any of the computers the analysis will not take place.

V. Once all these checks and variables set have been performed, the script launches the *littlesequence.csh* script. This script will be in charge of performing the sequence analysis.

The *littlesequence.csh* script (see fig. 36) is a summary of the previously seen *Analysis* and *PostAnalysis* scripts. It calibrates the data, joins the subsystem information, extracts the image parameters, joins the standard RF matrices and plot the analysis results in the same way described in sec. 2.5.1 with the same macro as the "on-site analysis" (*ReadQFiles.C*). For a description of the plots see section 2.5.4.

Once the *littlesequence.csh* script has finished the analysis plots are updated with the new analyzed data and transfered to the MAGIC web page.

The *killer.csh* script can be used by the shifters to write an empty file (killbill<year>_<month>_<day>.out at ∼analysis/DataCheck/ola_finished/) which is checked by the *sequencer.csh* and in case of existence of this file any quick onsite analysis process will not run. This is a safety program just in case the analysis process is interfering with the MAGIC data taking, since the QOSA program reads from the disc (/mnt/raid1) where the data taken are stored and this may cause delays in the data taking.

All the QOSA program code can be found at MAGIC CVS [14].

4 Program report and outlook

Since its installation on January 2004, the data check program has improved and increased the number of systems to check and therefore the number of plots. The increase has been due to the addition of new reports to the central control, improvements in the software and, most of all, the feedback from users abd system responsibles about known/unknown new subsystem features.

The union of both programs (MAGICDC and QOSA) allows us to know any system failure before 11:00 (UTC) and, whether everything has gone right, to have a first standard analysis of night data before 12:00 a.m (Europe local time).

In the coming future there are plans to perform more improvements for the optimization of the program itself:

- Read the DAQ report information within the central control report files, and display DAQ data check plots.
- Update the DAQ data check program including the improvements in the reading of the DAQ information within MARS standard software.
- Calculate run constants for the MAGIC database.
- Compute the RF matrices for each source within the "on-site analysis", including the energy estimation (now not calculated).
- Include the Disp method and replace the "false source plots" by "sky maps".
- Integrate and update the source signal day by day (this would need more computing power).
- In order to avoid possible problems within a sequence (already detected), change the QOSA program to make it run-based, instead of sequence-based.

Finally we would like to thanks all of you for your comments and suggestions that have helped to the program improvement and very specially to those involved more directly in any part of the program development: J.A. Coarasa, J.L. Contreras, J. Cortina, R. Firpo, M. Gaug, F. Goebel, P. Majumdar and D. Mazin.

References

[1] Bartko H. et al, 2005, *FADC Pulse Reconstruction Using a Digital Filter for the MAGIC Telescope*, Towards a Network of Atmospheric Cherenkov Detectors VII, Palaiseau, 27-29.

[2] Bartko H. et al, 2005, *Comparison of Signal Reconstruction Algorithms for the MAGIC Telescope*, MAGIC internal documentation, TDAS 05-03.

[3] Breiman L., 2001, Machine Learning, 45, 5-32.

[4] Coarasa J.A., 2005, *Online PC Farms for MAGIC-II and Data Transfer*, MAGIC Collaboration Meeting, Tenerife.

[5] De los Reyes R., PhD Thesis, Universidad Conmplutense de Madrid.

[6] Flix Molina J., PhD Thesis, Universitat Autonoma de Barcelona, April 2006.

[7] Gaug M. , PhD Thesis, Universitat Autonoma de Barcelona, March 2006.

[8] Goebel F., 2005, *Users guide and reference manual for the Data Acquisition and the FADC system of the MAGIC telescope*, MAGIC internal documentation, TDAS 04-01.

[9] Hillas A.M., 1985, *Cherenkov Images of EAS produced by primary gamma rays and by nuclei*, Proc. 19th ICRC (La Jolla), 3, 445.

[10] http://cvs.ifae.es/cgi-bin/viewcvs.cgi/MagicSoft/MAGICDC/

[11] http://www.magic.iac.es/operations/datacheck/

[12] http://cvs.ifae.es/MAGIC/Software-Releases/Mars/htmldoc_V0-12-3/MCalibrationQEPix.html (MAGIC private URL)

[13] Meyer M., 2005, *Calibration of the MAGIC telescope using muon rings*, MAGIC internal documentation, TDAS 05-10.

[14] http://cvs.ifae.es/cgi-bin/viewcvs.cgi/MagicSoft/OLA/

[15] http://magic.pic.es/ (MAGIC private URL)

[16] http://www.magic.iac.es/operations/datacheck/docu_dcheck.pdf (MAGIC private URL)

[17] http://www.magic.iac.es/operations/datacheck/docu_calcheck.pdf (MAGIC private URL)

[18] Oya, I., Diploma thesis, UCM, September 2006.