MAGIC
Major Atmospheric
Gamma Imaging
Cerenkov Telescope

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060613/JCortina

Dailycheck Manual

J. Cortina
I. Oya

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Abstract

This is a manual for the daily data checker. It describes in detail the steps to fill up the dailycheck form using the plots which are automatically produced at La Palma by the automatic dailycheck software.

Contents

1 Introduction

The MAGIC experiment relies on the stability of its hardware to provide data that can be analyzed by its standard software. It is essential to monitor the performance of all its subsystems as shortly as possible after a nights datataking has finished. A number of datacheck programs are installed at the MAGIC site and run immediately after datataking. Besides the standard Mars callisto and star programs run after the datacheck and produce additional quality plots. All these plots are accessible via web at www.magic.iac.es, under the section Operating the telescope, Datacheck. This software was developed by the UCM group. The corresponding contact persons can be found at the datacheck web page. The purpose of this document is not to explain how the datacheck programs work, but rather to establish the daily procedure to fill up the report. In doing so we will concentrate on the features in the plots that are more sensitive to hardware problems, so that you can draw your own diagnosis.

2 How to fill up the dailycheck report

The dailycheck report is performed by filling the form at http://magic.pic.es/priv/dailycheck/dailycheck_form.php. In case there is not access to PIC, the last version of the dailycheck template can be found at the web page at La Palma under Operating the telescope, Datacheck.

Proceed as follows:

- Check access to data check plots from the links at PIC dailycheck form (NOT BEFORE 11:00 UTC).
- Check access to central control files at http://magic.pic.es/priv/data/.
- Read runbooks (CC *.rbk files) in http://magic.pic.es/priv/data/.
- Fill the daily check report:
  - Load the automatic dailycheck results. This will answer all the questions related to datacheck plots. Please supervise the answer by looking at each of the corresponding plot, correcting when needed and reporting at “PROBLEM SUMMARY” sections.

- In case the automatic dailycheck results have not been correctly generated, you will have to fill manually the form. Please report this at “NIGHT PROBLEM SUMMARY” section and contact datacheck experts.
- In case the PIC webpage is not accessible, you will have to directly answer the question at the previously mentioned txt file template.
- The header information are in the .rep files and the .run (or .run.html) files in http://magic.pic.es/priv/data/.
- Any problem found in the following sections must be reported in the “PROBLEM SUMMARY” section.
- Important!. Please check only the values during the data taking (the time interval between the FIRST and LAST RUN).
- The MAGIC-data check plots are linked from the PIC form. In case the PIC is not accessible, you can find them at La Palma webpage:
  - Central control plots: http://www.magic.iac.es/operations/datacheck/ccdata/ < *year* > _ < *month* > /. Download to your computer the file CC < *year* > _ < *month* > _ < *day* >.pdf file. Answer the questions on the daily check report (.txt file).
  - Super-second data check plots: http://www.magic.iac.es/operations/datacheck/daqdata/< *year* > _ < *month* > / < *year* > _ < *month* > _ < *day* >/. Download the file *TimeDif* < *year* > _ < *month* > _ < *day* > *allruns.pdffile*. Answer the questions on the daily check report (.txt file).
  - DAQ-data check plots: http://www.magic.iac.es/operations/datacheck/ CCDAQCheck/< *year* > _ < *month* > / < *year* > _ < *month* > _ < *day* >/. Download the file ChekMux < *year* > _ < *month* > _ < *day* > .pdf file. Answer the questions on the daily check report (.txt file).
  - On-site analysis problems: http://www.magic.iac.es/operations/datacheck/ CCDAQCheck /< *year* > _ < *month* > / < *year* > _ < *month* > _ < *day* > /. Download the file ErrSummary.txt file. Answer the questions on the daily check report (.txt file).
- After filling all required fields at the form, preview the daily-check output, fill the required information and use the form to save and send a mail to MAGIC online mailing list. In case PIC is down, send an e-mail with the dailycheck.txt file to magic online@mppmu.mpg.de with the subject DAILY CHECK REPORT < *year* > _ < *month* > _ < *day* >.

IMPORTANT! In the plots, the pixels are in software numbering.

2.1 Template: header

DAILY CHECK REPORT <year_month_day>
PERIOD: <number>
NIGHT: <year_month_day> / <year_month_day>
DAILY CHECKERS: <name surname> (< group>)
OBSERVERS: <name surname> (shift leader, <group>), <name surname> (deputy shift leader, <group>), <name surname> (< group>)
FIRST RUN: <number>, <subrun>, <year_month_day>, <hour>:<min>

LAST RUN: <number>, <subrun>, <year_month_day>, <hour>:<min>

The times of the first and the last runs set the window during which the datataking has been active. All the questions below apply only to this window.

2.2 Template: summary

```
## 1.  RUN SUMMARY ####################################################
< copy here the run summary for the night from the end of the runbook >
```

You must cut and paste here the table at the end of the runbook with the number of hours that have been taken for each source, rate and range of zenith angles. It also indicates the light conditions under which the sources have been observed: moon, no moon, twilight (the time interval between civil and astronomical sunsets -about 40 minutes- and between astronomical and civil dawns -again 40 minutes-) or day (the sun is up: these runs are normally taken with closed camera for test purposes.)

2.3 Template: persistent problems

```
## 2.  PERSISTENT PROBLEMS SUMMARY ###########################################
< list here the problems, known by the experts but not solved >
```

Here you will write the list of problems that have been appearing previous nights, and that are known by the experts. Please do not write here perfectly know effects, for example, if there is transition from dark to moon conditions, it is expected that the pedestal RMS will not be constant. If you see that there is a persistent problem that is not solved nor explained by the experts, insist until it gets understood.

2.4 Template: night problems

```
## 3.  NIGHT PROBLEM SUMMARY ################################################
< list here subsystems with problems, summarize problem, suggest solution.
Exclude the persistent ones reported already above >
```

This is the most important section of the daily check report. It is like an abstract for the whole document. It summarizes all the problems that have been spotted, links the problem to the hardware part that is most probably responsible for it and makes suggestions on how to proceed to fix it.

2.5 Template: details of the subsystems

```
 ## 3.  DETAILS SUBSYSTEMS #############################################
< check plots in CC_<year_month_day>.pdf file.  Answer YES or NO. NO=problem >
```

Now we go one by one over all the subsystems. In each of the questions you have to answer YES or NO. NO points to a problem! For the first bunch of questions you have to look at the plots that can be found at the web page at La Palma under the section Central Control-data check.

```
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 SUBSYSTEMS: DRIVE(page 2:)  * Is the control deviation of the motors below 1.3 arcmin
for 80% of the time (if not how much)?
```

The telescope position in both axes is checked through the shaft encoders. A substantial deviation indicates that the drive is faulty.

```
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SUBSYSTEMS: CAMERA (plots, page 3:)  * Is the DC status ok for 90% time?
```

The state cannot be unavailable during datataking: that would indicate that Guagua or its connection with SuperArehucas was down, or that the DC monitoring subsystem was malfunctioning. None of this is acceptable during normal datataking.

```
* Is the cooling status ok for 90% time?
```

If it is not, some of the cooling elements (pump, valve, refrigerator) may be faulty. This is extremely risky for datataking as it may lead to overheating inside the camera. Please check carefully the temperatures in the camera.

```
(page 4)

* High Voltage at 1600+-70 V for both power supplies?
```

This is the global HV that is set at the power supply that powers the PMTs. This HV is then distributed and regulated for all pixels individually: it is reduced to the HV that is defined at Guagua or Arehucas. This means that the HV at the power supply must be always higher than the HV at the individual pixels. 1600+-70 V is the usual range for the current flatfielding of the pixel HV. Pay special attention for a HV below the lower limit: it may indicate that Guagua has reduced automatically the HV for safety reasons and the operators have forgot to restore it to the default values. This results in a strong reduction of the electronic gain (calibration charge, rate etc).

```
* Current above 100 mA for both power supplies?
```

A lower current may indicate that the HV has been reduced automatically (see above).

```
(page 5) * Mean inner pixels 1200 < <HV> < 1300 V?
* Mean outer pixels 1000 < <HV> < 1100 V?
```

The default HV settings are in the ranges above. If they fall below the limits it may that Guagua has reduced the global HV automatically and the operators have not restored it, or it may be that the HV failed to ramp to the nominal values and the operators did not spot the problem and went on operating normally. Too low a HV results in low calibration charges and low rates.

(page 8) (do not take into account HV rampings)
* Active load Power Supply 1+2 voltage 350 < V < 400 V (if not how much)?
* Active load Power Supply 3+4 voltage 160 < V < 190 V (if not how much)?
* Active load Power Supply 1+2 current 100 < I < 160 mA (if not how much)?
* Active load Power Supply 3+4 current 0 < I < 12 mA?

The so-called active loads provide power for one of the amplification stages of the PMTs. They must range between the above-mentioned limits or the pixel gains will change (resulting for instance in too small or too large calibration charges). Too high a current may point to an electrical problem in the active loads.

(page 9) * Is low voltage temperature 16 < T < 25 degrees?

This is the temperature at the low voltage box that is located on one of the camera sides, outside the camera itself. This box is not water-tight and its temperature is not controlled, so it gets warmer in summer and colder in winter. A temperature in the above mentioned range should be ok. Overheating may mean that one of the fans is broken or the fan window is obstructed.

(page 10) * Is the camera temperature T_center = T_link within 2 degrees?
* Is the T_center stable within 2 degrees?
* Is the T_center between 35 and 39 degrees?
* Is the camera humidity below 50%?

The amplification at the optical links depends critically on temperature. It is essential that this temperature stays constant in the above mentioned range. Check the beginning of the night: if the operators were late on switching on Guagua and the pixel HV, the temperature may not be stable on time for datataking. Check in the runbook if they have stuck to the specified operation times. It is also recommendable that the whole camera is at the same temperature so that the different pixels do not show a different response. This is guaranteed by a large fan inside the camera. A large difference between the camera center and the optical links points to problems with this fan. It may be simply that the camera was opened but the fan was left disconnected or that there is some bug in the program controlling the fan.

SUBSYSTEMS: TRIGGER (page 11) * Rate in reference line within 5% for 90% time?
* L2T rate greater than 150 Hz?

The level 2 trigger rate is the cosmic rate plus the calibration rate. Experience shows that it follows the law that is indicated by the reference line for our current discriminator threshold settings. A rate above this line may indicate that the ambient light was too strong or some pixel was hot (a star?) and that made some macrocell trigger too often. It may also be that the discriminator thresholds have been set incorrectly: for example they may be set to the extragalactic settings for a galactic position in the sky. In general this is corrected by automatically by the Individual Pixel Rate Control, so it could also be that the operators forgot to switch it on. Is the rate is too low (in particular below 150 Hz for extragalactic sources at low zenith angles), most probably the weather was bad and the atmospheric transmission was low.

`(page 12) * Average IPR` $\sim 10^5$ `Hz?`
`* All pixels` $10^4 <$ `IPR` $< 10^6$ `Hz?`

```
(page13) * Less then 8 pixels have zero rate (underflow bin) stat box upper corner /
plotted underflow bin) ?  If not how many ?
* Less then 100 pixels have a rate of 60 kHz (log rate == 1.8) ?  If not how many ?
* Less then 10 pixels have rate above 5 MHz (Overflow bin stat box, rate
distribution)
```

For the default galactic or extragalactic discriminator threshold settings, the individual pixel rates (that is, the rate at which a given pixel triggers its individual threshold) should range around the above-mentioned values. Otherwise the thresholds may be set incorrectly or the ambient light may be too strong. This most probably results in a higher global rate too. If a large number of pixels shows too high or too low IPRs, they may be faulty, or their HV may have been set incorrectly.

```
-------------------------
SUBSYSTEM: STAR GUIDER (page 14) * Is zenith mispointing 90% between 0 and 6 arcmin?
```

The starguider system compares stars in a patch of sky around the telescope pointing position and reference LEDs on the camera to determine the mispointing of the telescope drive system. The mispointing is measured in arcminutes in the sky. Six arcmin correspond to the size of one inner pixel. A larger mispointing has a non-negligible effect on the sensitivity of the gamma ray source detection. A mispointing around 9 minutes is typical when a source passes over culmination and the telescope changes direction in the elevation axis. This is the so-called culmination problem. Please always report this problem in the problem summary. As similar mispointing can take place when the telescope starts to track.

```
(page15) * Number of stars >20?
```

This is the number of stars that have been recognized by the starguider system. A low number of stars reduces the precision in the measurement of the mispointing.

```
-------------------------
SUBSYSTEM:WEATHER MONITOR (page 13)
* Is humidity always below 95%?
* Is temperature always above 0 degrees?
* Is wind speed always below 40 km/h?
```

Datataking is forbidden beyond these limits. A higher humidity may produce shortcircuits and damage the electronics. A sustained wind speed above the limit could damage the structure. Gusts may be even stronger. In any case such a strong wind makes the camera oscillate and effectively introduces a changing mispointing that cannot be corrected for. The operators should park the telescope and secure it using the bolts.

```
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```

SUBSYSTEM: ABSOLUTE TIME (page 14) * Is the time difference between GPS and rubidium time 1.2 <deltaT < 1.7 us?

The reference time that is recorded with every event comes from an atomic rubidium clock. This clock is extremely stable at short time scales of minutes to days but drifts at longer time scales, so it needs to be corrected using another reference time that stays accurate over periods of months and years. In our case we rely on a radio receiver that synchronizes the rubidium time to the GPS time. A time difference beyond the above-mentioned limits may point to problems in the GPS receiver (it may have been reset or adjusted to the wrong time zone, its antenna may have been damaged), a problem in the electronics that cares for the synchronization (the corresponding NIM crate may be switched off) or the rubidium clock itself.

SUBSYSTEM: RECEIVER TEMPERATURE

(page 18)
* Is the receiver temperature within the limits?
* Is the receiver temperature stable within 5 deg for the whole night?

The receivers have many temperature dependent components. A fast change on the temperature at the electronics room may have a direct effect on the response of these devices. For example, it has been seen that sudden temperature changes produce correlated changes on the pedestals and charges.

(page 19)
* Is the mean Trigger Delay between 100 and 130 for the whole night?

The trigger delays function is to compensate both the slightly different length of the optical cables and the transit time differences in the different PMTs due to construction and operation voltage differences. The trigger delays settings, fixed by experts are saved to non-volatile memories in the receiver boards. It may happen that these memories get deleted, for example, after a power cut.

2.6 Template: details data time

5. DETAILS DATA TIME (super-second)
< check plots in TimeDif_<year_month_day>.pdf file. (page 1)
* Is the percentage of data runs with a time mismatch lower than 1 second higher than 10% (if not how much)?

The previous check about GPS and Rubidium clock only checks the under-second time synchronization of these both systems. It may happen that there is a mismatch of exactly 1s multiples between them. The time difference between the GPS time of the first recorded event of a run, and the PC time when this run starts to be written gives an estimate of the difference between the absolute time and the PC time that is synchronized over Internet. Having a high percentage of runs with a mismatch above 1s will warn us if there is need to synchronize the rubidium clock.

2.7 Template: details data calibration

4. DETAILS DATA AND CALIBRATION

< check plots in CheckMux<year_month_day>_allruns.pdf file. Answer YES or NO. NO=problem >

For the last bunch of questions you have to look at the corresponding plots linked from the form, or in case of need, that can be found at the web page at La Palma under the section "DAQ Online Check".

(page 1) * Mean calibration charge 16500 ± 2000 counts (Look at stat box left upper corner)?

This is the mean charge in FADC counts of a calibration pulse in a calibration run or interleaved in a data run. It corresponds only to 10Led UV pulses which are our standard calibration color and intensity. If the operators have used some other color for test purposes they should have indicated it at the runbook. Unfortunately the pulser is sensitive to the external temperature so this charge is only stable within a range of 60 counts. A mean charge well below these limits indicates that there was something wrong with the calibration pulser (it may have not been switched on correctly -must be reset) or that the PMTs have not reached their nominal HV.

* How many pixels are below 8000 counts?

Such pixels most probably have hardware problems. In general less than 10 pixels should be in this situation. A higher number may point to a more general problem: e.g. some HV regulator master card or some FADC module have broken.

* Is the hit fraction of signal events for inner pixels 0.005 - 0.009?
* Is the distribution of hit fractions symmetric?

This has nothing to do with the calibration. A pixel hit fraction is the fraction of the total number of events for which this pixel is part of a shower. In general this number is 0.005 - 0.009. The hit fraction should be symmetric in the camera. If a certain part of the camera exhibits a low hit fraction it could be that the response of the pixels is low, that some trigger macrocell in the area is faulty (malfunctioning or triggering too early or too late.)

(page 2) * Is the arrival time for calibration events 35 < Tcal < 46 FADC slices for all pixels (if not how much) ?

* Is the arrival time for signal events 32 < Tcal < 38 FADC slices for all pixels (if not how much) ?

The arrival time for either calibration and signal events should be contained inside these ranges to prevent the pulses from being truncated. If a pixel shows too low or high arrival time value this may point to a hardware problem.

(page 4) * Is mean inner 15000 < Q < 20000 counts?
* Is mean outer 15000 < Q < 20000 counts?
* Are the mean Q for inner and outer pixel constant along the datataking night within 5%?

Again we are referring to the mean charge of the calibration pulses, but this time separately for the inner and the outer pixels. Here we concentrate on the stability of the calibration pulses along the night. This stability may be affected by changes in the temperature (especially in the optical links) or the HV that is supplied to the PMTs.

* Is for both inner and outer pixels 0.5 < pedestal RMS < 5? *
Is the pedestal RMS constant along the datataking night within 5%?

Too low a pedestal RMS may point to too low HV (decreased by mistake), or problems with the data acquisition. The pedestal RMS increases noticeably during moon observations, in particular when we take data close to full moon. The pedestal RMS is correlated to the square root of the DC, so you may want to check if both parameters change coherently.

(page 5) * Is the arrival time for calibration events 38 < Tcal < 50 FADC slices?
* Is the arrival time for signal events 32 < Tcal < 44 FADC slices?

It is essential that both arrival times are in these ranges or the pulses will be truncated. Unfortunately the calibration arrival time is sensitive to the ambient temperature and the signal arrival time to the temperature in the electronics room. For some time of the year it may be necessary to adjust the time window in the FADCs so that the pulses do not break these limits.

(page 6) * Is the calibration 25 < N_phe < 35 phe?

This is the number of photoelectrons that are produced at the PMT photocathode. They are calculated using the F-Factor method over calibration runs. These are the correct values for the standard calibration script 10Led UV. If outside the limits, there may be a problem with the calibration box.

* Is the conversion factor for inner pixels 1.5E-3 < cphe < 2.5E-3 phe/count?
* Is the conversion factor for outer pixels 1.5E-3 < cphe < 2.5E-3 phe/count?

These are the standard conversion factors between photoelectrons and counts in the FADCs. If it is outside the limits, the PMTs may not be at their standard settings.

* Are the conversion factors for inner and outer pixels constant along the datataking night within 5%?

The conversion factors may change in case the HV changes or there is a strong temperature effect either at the camera or at the electronics room.

```
(page 7)
* Is the absolute value of the time difference between calibration and signal events
< 4.5+-2 FADC slices?
```

This is the ideal situation: both pulses are essentially at the some position inside the FADC digitization window so that both suffer from the same systematic effects (is any!). If the difference is systematically larger for several nights, there may be problems with the trigger (see above for temperature effects). Get in contact with the experts for them to correct the digitization window manually.

```
(page 8)
* Are the values of T_cal-2*RMS_T_cal > 20 FADC sl.  and T_cal+2*RMS_T_cal < 44 FADC sl.
for inner pixels (if not, how much)?
* Are the values of T_cal-2*RMS_T_cal > 20 FADC sl.  and T_cal+2*RMS_T_cal < 44 FADC sl.
for outer pixels (if not, how much)?
```

The arrival times at the FADC should be correctly set in order to be sure that the pulses are never truncated. The best criterion to decide if these arrival times are correctly set has to take into account their mean and RMS, and the physical time evolution of the showers. We have decided impose a lower and upper limit on a combination of the mean and the RMS of the arrival times, according to the rules in the questions. These take into account also that the first and last 15 slices are affected by the switching noise.

```
* Is the number of bad pixels < 20?
```

The number of bad pixels cannot exceed this value. A pixel can be bad for a long number of reasons, including a dead PMT, faulty HV regulation, faulty optical transmitter or receiver, broken optical fiber or faulty FADC channel. If many pixels are in this situation there may be a general failure of a more general component (see above).

3 Acknowledgments

We are grateful to all of you who have sent remarks, made us aware of typos and errors and warned us when a certain check or problem has become obsolete. We would like to thank in particular Raquel de los Reyes for her always useful remarks about the procedure, and the Madrid members of the collaboration for taking the first daily check shift. You are all invited to send us more comments.