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Contents

LIST OF ABBREVIATIONS

acronym	**Explanation**
LFI	Low Frequency Instrument
TBC	To Be Confirmed
TBD	To Be Defined
FSL	First Light

1 Applicable and Reference Documents

Applicable Documents

Reference Documents

2 Scope of the document

This document describes the Telemetry Dailly Monotoring (Telemetry_DM) and REBA Dailly Monitoring (REBA_DM) operated at the LFI/DPC since the beginning of the FSL.

Both functions have the scopes of monitoring the REBA activity in order to:

1. asses the telemetry budget is respected;
2. asses the data compression does not lead at a loss of relevant information;
3. asses each of the 44 LFI detectors have an output within an acceptable range of values;
4. issue a first WARNING if any of the above conditions is violated;
5. fill an historical data base of REBA monitoring parameters in order to allow historical data analysis of REBA activity.

Note that the meaning of the WARNING is not necessarily that of a bad condition but rather that of a stimulus for the L1 staff to keep attention to some unusual condition. The Telemetry_DM and REBA_DM functions performs an early test on the properties of the input signal. Since they systematically scan the consolidated data very early as soon as they are ready. Consequently they represents a valuable source of basic information on the data and are able to generate early warnings on possible anomalies.

2.1 Limits of Applicability

This document just referes at the Telemetry_DM and REBA_DM procedures operated at the DPC.

3 Telemetry Dailly Monitoring and REBA Dailly Monitoring Generalities

Two functions are used to monitor the total telemetry budget and REBA parameters at the DPC. They are: the Telemetry Dailly Monitoring (Telemetry_DM) and REBA Dailly Monitoring (REBA_DM) which are operated dailly at the DPC on the consolidated data.

Those functions performs authomated monitoring of REBA activity in what respect the Compression Rate, the total data volume generated onboard, the REBA saturation, the processing error and any other parameter relevant to judge the REBA activity, including when the corresponding HK telemetry is activated, the onboard memroy and CPU consumption

3.1 Timing of Telemetry_DM and REBA_DM

In nominal operations both Telemetry_DM and REBA_DM are operated after the end of the DTCP and after that the data are consolidated.

The Telemetry_DM and REBA_DM shall conclude their work before the end of a new DTCP.

In nominal conditions this is assured operating Telemetry_DM and REBA_DM after 23:00 DPC local time.

3.2 AHF Files

Pointing information is not required, consequently in the current version Telemetry_DM and REBA_DM does not need to wait for the issue of AHF files to the DPC from the MOC.

3.3 Hardware dedicated to Telemetry_DM and REBA_DM

The Telemetry_DM and REBA_DM are based on LIFE and PEGASO.

They are operated at the DPC mellon.oats.inaf.it machine which is reserved for this task.

In order to asses stability of the software plateform the LIFE / Pegaso version onboard this machine can not be updated until the end of the FSL.

To overcome the impossiiblity to operate two concurrent LIFE / Pegaso threads on the same system, two independent accounts are created, one devoted to REBA_DM and the other to Telemetry_DM activities.

Not to interfere with the monitoring acrtivity any usage of LIFE / Pegaso, either local or remote outside the monitoring itself is forbidden.

Consolidated data are accessed either by directly accessing the main L1 disk through NFS, or by using the DMC.

3.4 Software Organization

Software is organized in two separated packages respectivelly in `/home/reba_dm/reba_dm` and in `/home/telemetry_dm/telemetry_dm`. Each of these directories shares the same structure, in particular they contains the following subdirectories

`db`
: containing the results and historical data base;

`cache`
: service directory containing data to be processed;

`report`

directory containing the generated reports;

all of these directories has the same structure of the L1 archive: i.e. data are organized in ODs and within each OD in hours.

3.5 Other Benefits

The Telemetry_DM and REBA_DM functions performs an early test on the properties of the input signal. Since they systematically scan the consolidated data very early as soon as they are ready. Consequently they represents a valuable source of basic information on the data and are able to generate early warnings on possible anomalies.

3.6 Definitions

In the following we will make use of some, not obvious definitions resumed here

Data Volume

the amount of data produced in the reference period, epressed in bytes per OD

Data Rate

the amount of data produced in a time unit, usually expressed in bits/second;

Reference Period

a reference period of time, usually a single OD;

4 Telemetry Dailly Monitoring

4.1 Scopes

The Telemetry_DM has the scopes of

1. Asses the Compression rate for COM5 data is respected.
2. Asses the telemetry budget for each detector in AVR1 or COM5 is respected.
3. Asses the overall telemetry budget (i.e. telemetry budget of any kind of scientific, diagnostic or HK data) is respected.
4. Test against REBA saturations.
5. Test against variations of statistical properties of COM5 data.
6. Test against lack of AVR1 or COM5 data.
7. Issue a warning whether one or more of the above conditions is violated.
8. Automatically generate a dailly report.
9. Fill an historical data base of REBA monitoring parameters in order to allow historical data analysis of REBA activity.

4.2 Dailly Input

The Telemetry_DM takes in input COM5 data either by the DMC or through the NFS.

The Telemetry_DM explores systematically all of the COM5 data in the selected reference period.

In addition Telemetry_DM scans the the headers of all of the HK LFI in order to compute the amount of HK telemetry.

4.3 Dailly Output

Dailly outputs are:

`SaturationTable.csv`

table of metrics for the REBA saturation and compression rate;

it includes also a number of statistics for COM5 data such as average values, rms, and so on;

data are organized for detector (DSA) and hour within the OD;

`DaillyDataVolumesTable.csv`

table of data volumes for detector and PType;

`DaillyDataRatesTable.csv`

table of data rates for detector and PType;

`LFIHKTable.csv`

table of data volumes for HK telemetry;

`data rate plots`

plots of Cr (Fig. **??**), data rate and data volumes for each detector, comparing the measured data with the expected data;

`saturation plots`

plots of saturation metrics;

`Green Light Plots`

a plot giving detector by detector the list of tests passed or not passed and wether, for a given detector, warnings are issued or not;

A selection of these plots is in Fig. 1. In particulat saturation metrics are metrics determining wether a REBA saturation could occur or not. The most important are:

`min(Q1), max(Q1), min(Q2), max(Q2)`

extremal values of mixed quantized data, they should never exceed $\pm 2^{14}$ adu.

`mean(Q1), mean(Q2)`

averaged values of mixed quantized data, they should never exceed some $\pm 10^3$ adu and their sum should never exceed some 10 adu;

`min(sky), max(sky), min(ref), max(ref)`

extremal values of demixed dequantized data in adu, they should never be negative and should never exceed 15000 adu;

Apart from saturation, other parameters are monitored:

`rms(Q1), rms(Q2)`

rms of mixed quantized data, they should never be smaller than some adu;

Number of NaNs

whether or not there are NaNs in the TOIs;

rigorously NaNs are not denoting an error in the TOIs, but their presence has to be accounted for in the subsequent REBA_DM analysis.

4.4 Resuming and Reporting

At the end of the dailly monitoring a set of resumes is generated, in particular

`Resume Table`

a resume table of the data rates, classified for PType and HK data, listed ODs by OD and a corresponding plot;

Resume Green Lights

a plot listing OD per OD which tests are passed and whihc are not. A light for a test is green if the test is passed by all the detectors red in the other cases.

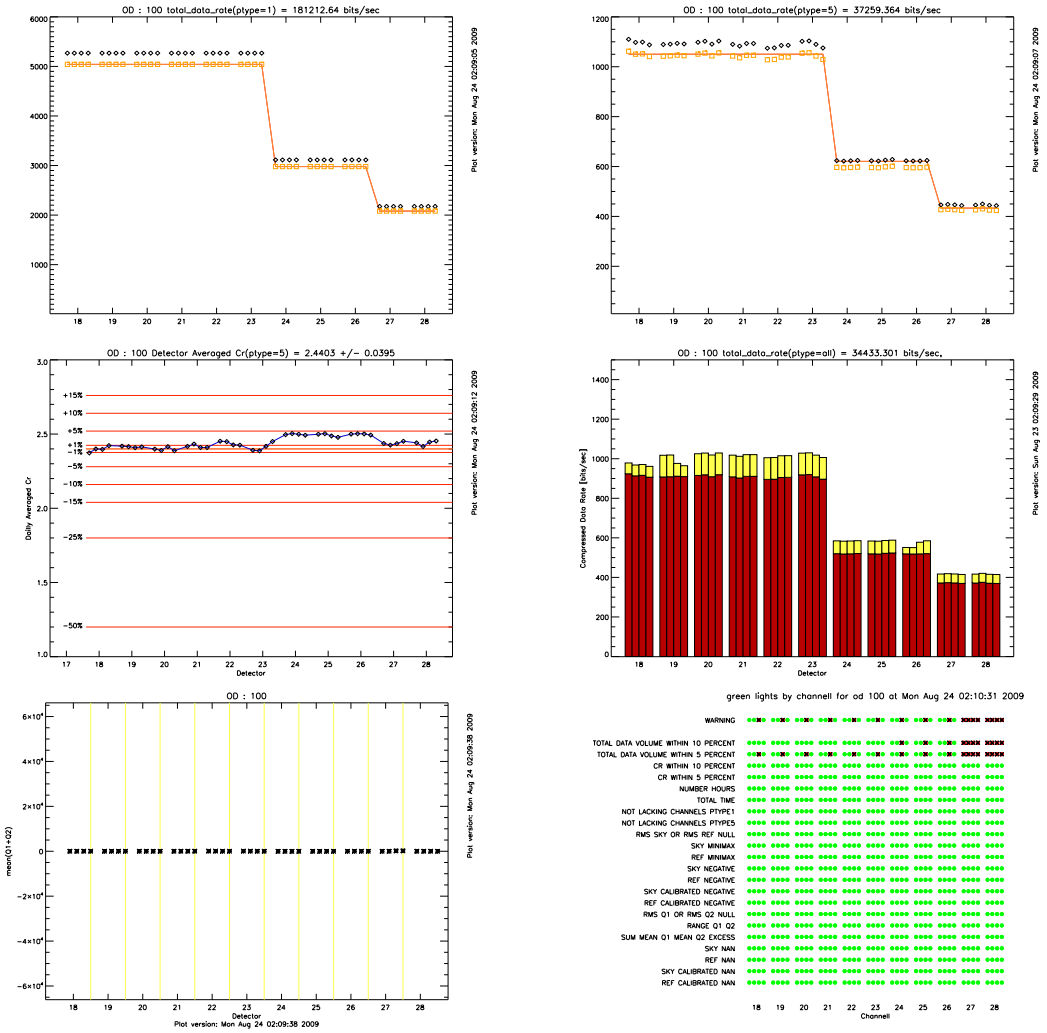

Figure 1: Examples of dailly plots from Telemetry_DM for the reference case OD100. Top: Data rates [bits/sec] for AVR1 and COM5, as a function of the detector. Full line: theoretical expectation, □ measured data rate without packets headers, ◇ measured data rate with packets headers Middle left: compression rate for each detector. The red lines delimits deviations from the nominal Compression Rate 2.4. Middle right: Data volumes [bytes/od] for COM5 (red) and AVR1 (yellow) data for each detector. Bottom Left: values of $\mathrm{mean}(Q_1) + \mathrm{mean}(Q_2)$ for each detector. Bottom Right: Green lights by channel for OD 100. Each green spot is a test passed for the specified detector, red is not passed.

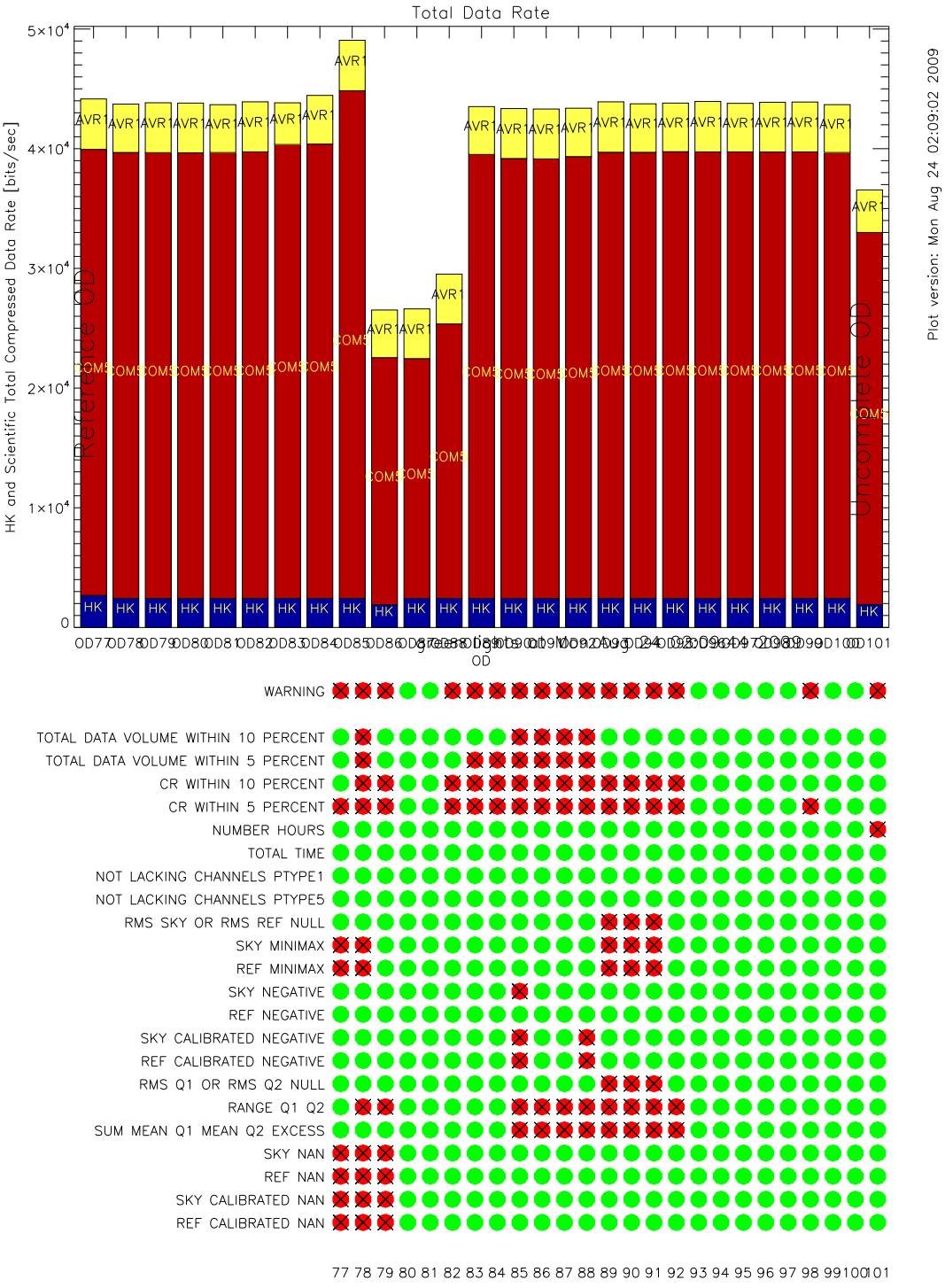

Figure 2: Examples of dailly resume plots from Telemetry_DM for the reference case OD100. Top: For each OD the data rates: blu HK, red COM5 , yellow AVR1. Bottom: For each OD green lights.

The Dailly Telemetry Bullettin

an authomatically generated circular resuming the most relevant informations for the ODs;

the circular is authomatically sent by email to a list of relevant paersons;

the plots for a reference day OD100 are shown in Fig. 2. If the full historical series of data rates from OD 77 up to OD 101. The data of OD101 have been not completelly received at the epoch the plto have been generated. It is interesting to see how the data rate reacts at the deactivation of the 4K–cooler, OD85, the reduction of the gains in OD86, OD87, OD88. While the saturation occuring between OD 89 and OD 92 of channel 2411 is well seen in the bottom plot [1]. The red light in OD 98 signaling a Cr outside the 5% limit is due to a random noise fluctuation affecting detector 2511. The problem disappeared the next days. At last the red spot in OD 101 denoting lacking of data is expected since the OD where not completelly downloaded at the epoch the plot have been generated. The green lights in the resume plot are switched to red whenever the corresponding test is not passed even for one of the detectors. The only exceptions are the total compression rate and data volumes which are based on averages computed all over the detectors and the compression rates. This explain why a red spot in the compression rate or data volume messages in Fig. 1 does not causes the appearence of red spots in Fig. 2 since small positive, negative fluctuations compensates.

4.5 Performances

The typical time to perform a complete run of the Telemetry_DM over the whole COM5 data is 2 hours, if data are accessed by the NFS and about 20 Hours for DMC access.

The typical time for scanning the HK telemetry over a single run of Telemetry_DM is 5 sec the maximum time never exceeds 20 sec.

[1] The early warning of a problem in channell 2411 comes from the analysis of these dailly plots when the Telemetry_DM has been turned on at OD90.

5 REBA Dailly Monitoring

5.1 Scopes

The REBA_DM has the scopes of

1. Asses the goodness of fit of default REBA parameters on a detector by detector basis by using the AVR1 data.

2. Asses the stability of quantization errors, r factor, compression rate and any other relevant parameter.

3. Asses against possible REBA saturations by processing AVR1 data.

4. Test against variations of statistical properties of the data, issuing allarms if strange statistical properties appears.

5. Issue a warning whether one or more of the above conditions is violated.

6. Dailly identify the best REBA parameters by using the AVR1 data and compare them with the default.

7. Fill an historical data base of REBA monitoring parameters in order to allow historical data analysis of REBA activity.

5.2 Dailly Input

The REBA_DM takes in input the AVR1 data copied through the NFS.

5.3 Dailly Output

The output of the REBA_DM in the historical daabase for each day is

Dailly AVR1 Block Table

Table of time slices containig for each detector a chunck of AVR1 data good enought to be processed with OCA2;

In addition this table contains all the statistical information on the TOIs such are: mean , variances and covariances of sky and ref for AVR1 data, the r_factor computed without quantization and so on;

Nominal REBA Parameters Verification Table

Saturation, Cr and quantization errors for AVR1 data processed by OCA2 with the nominal REBA parameters;

Optimized REBA Parameters

REBA Parameters optimized for each AVR1 data chunck with related saturation, processing error and Cr;

5.4 Resume Output

Dailly outputs are used to generate historical series of the kinds represented in Fig. 3 For each ODs AVR1 data have been processed, quantization errors for sky (to–left), ref (top–right) and differentiated data (middle–left) are evaluated together with the r_factor directly evaluated without quantization (bottom–left), the compression rate (middle–right) and the sautration index named Quack factor (bottom–right). Red lines are used to denote time intervalls where lack of AVR1 data of sufficient quality prevents to perform the simulated processing.

In general the processing errors on sky and ref are quite stable, even when data are severely perturbed, as it is the case of OD 84 up to 89. This is not the case for differentiated data, since the processing error is a function of the r_factor, so that a perturbation in the data asking a change in the r_factor could cause the processing error for differentiated data to be severelly affected. Even the compression rate is quite stable, apart from when the data have been severely perturbed, at last some data from detectors from 2400 up to 2511 have been probably saturated in ODs around 84 to 89.

A more quantitative analysis of historical series of REBA activity is outside the scope of this report.

--- TO BE COMPLETED ---

5.5 Performances

The typical time to complete the analysis of an ODs is 8 hours.

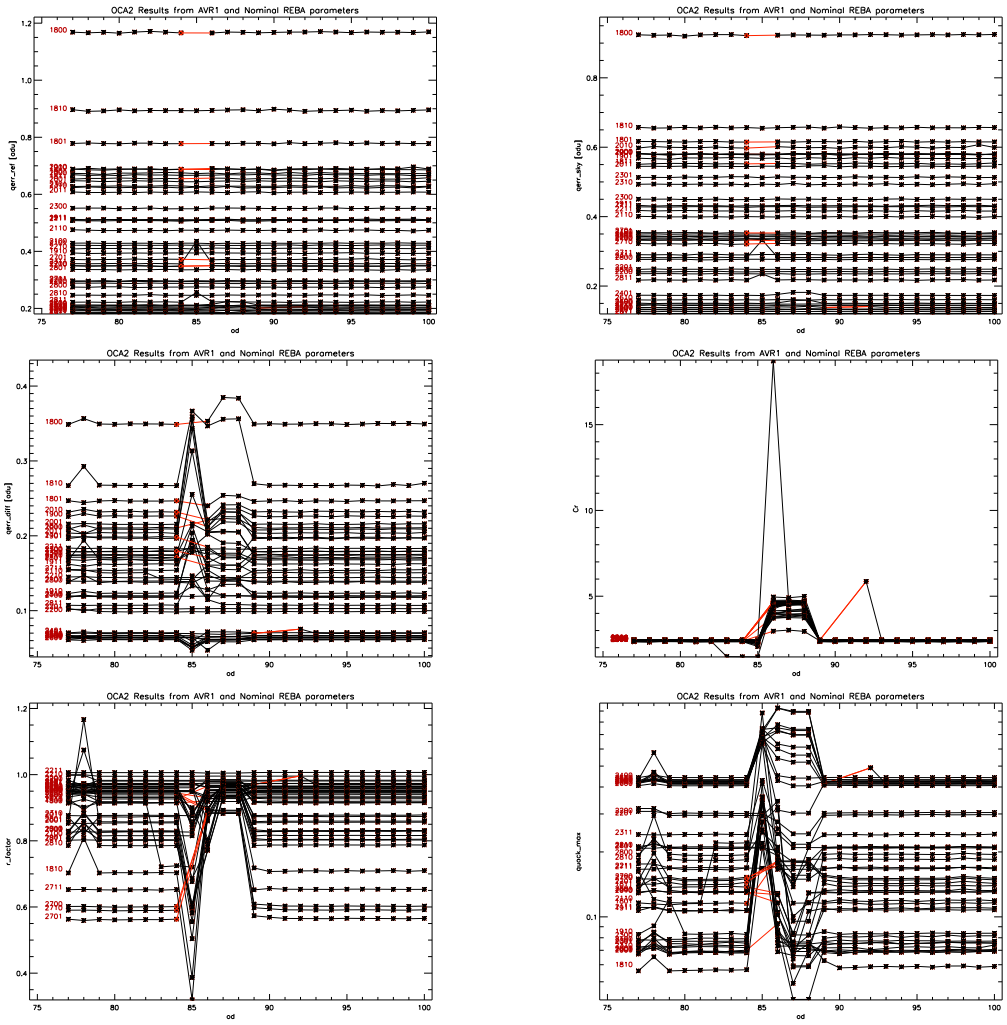

Figure 3: Examples of historical plots from REBA_DM as a function of the OD, showing the effect of the nominal REBA parameters on the AVR1 data from the calibration channell. Top: Quantization errors for sky and ref [adu]. Middle left: quantization errors for differentiated data [adu]. Middle right: Compression rates for AVR1 data processed with nominal data. Bottom Left: estimated r_factor from AVR1 data. Bottom Right: quack factor (saturation) for processed AVR1 data.

A Early warning statistical learning

This appendix describes an early warning test for variations in the statistical properties of the compressed detectors COM5.

COM5 are characterized by having in the data base Q_1 and Q_2 data. The whole information needed to decide wether a detector whent out of equilibrium is contained into the bivariated distribution of Q_1 and Q_2, a significant variation of the statistical properties of the signal produced by the detector will reflect into permanent changes of the bivariated distribution $P(Q_1, Q_2)$. Then a simple χ^2 test could be used to decide whether the distribution of Q_1, Q_2 values is significantly different from a reference distribution. In addition, having already a quantized distribution it is very easy to compute the Shannon entropy for the joined distribution.

--- TO BE COMPLETED ---