Data Reduction Protocol for Ground Based Observations of SpectroPhotometric Standard Stars. III. Quality Control on SPSS Photometric Frames and Photometric Catalogues Production

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Abstract

When trying to build a large set of ground based SpectroPhotometric Standard Stars (SPSS) for calibrating Gaia BP/RP Spectra and G-Band Images to a few % in absolute flux, it is essential to maintain the maximum homogeneity in data quality, acquisition and treatment. This Data Reduction Protocol concerns the QC on the SPSS pre-reduced photometric frames and the production of aperture photometry catalogues ready to be used for the analysis. The procedures followed to both quality check the pre-reduced 2D photometric frames and to obtain aperture photometry catalogues are described step by step.

Document History

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1	0	31-Jul-2014	SMR	Corrected problems with margins, ready for Livelink
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D	0	21-Sept-2010	SMR	Creation

Acronym	**Description**
ADU	Analogue-to-Digital Unit
BFOSC	Bologna Faint Object Spectrograph & Camera
BP	Blue Photometer
CAFOS	Calar Alto Faint Object Spectrograph
CAHA	Centro Astronómico Hispano Alemán
CCD	Charge-Coupled Device
DoLoRes	Device optimized for Low Resolution spectroscopy
EFOSC2	ESO Faint Object Spectrograph & Camera
ESO	European Southern Observatory
FWHM	Full Width Half Maximum
IFP	Instrument Familiarization Plan
IRAF	Image Reduction and Analysis Facility (NOAO)
LaRuca	Rueda Cachanilla
NP	Night Point
NTT	New Technology Telescope (ESO)
PSF	Point Spread Function
QA	Quality Assurance
QC	Quality Control
REM	Rapid-Eye Mount
RON	Read-Out Noise (CCD)
ROSS	REM Optical Slitless Spectrograph
RP	Red Photometer
SM	Supermongo
S/N	Signal to Noise
SPM	San Pedro Mártir Observatory
SPSS	Spectro-Photometric Standard Star
TNG	Telescopio Nazionale Galileo

Contents

1 Introduction

Our survey contains a huge number of frames, and the precision and accuracy in reducing and analyzing them is of fundamental importance to achieve our decided accuracy (a few % in flux at most, relative to Vega). The aim of this document is to explain how to perform the QC on the pre-reduced photometric frames[1] and, at the same time, how to produce aperture photometry catalogues ready to be used for further analysis.

In order to retain only data suitable for our purposes, two automatic pipelines were produced:

- the first one is dedicated to the short term variability data (see Appendices B and D);
- the second works on night points observations of both SPSS (for absolute photometry)[2] and Landolt stars (see Appendices C and E);

All pipelines start using SExtractor (Bertin & Arnouts 1996 , see Sec.1.2) to produce one aperture photometry catalogue for each pre-reduced frame, because it can return a series of useful information, flags and parameters which are excellent to perform the QC. As a last step, the pipelines perform the QC on each catalogue and finally, depending on the result of QC, the pre-reduced frames and the corresponding catalogues should be retained and archived for further use, or rejected. Off course, both QC criteria and results are different for each pipeline and dependent on which scientific goal we want to achieve.

1.1 Downloading Data from the Archive

All data obtained in our Pilot Project (EP-001, testing phase), Main Campaign (EP-006, devoted to spectroscopic and absolute photometry observations) and Auxiliary campaign (EP-003, devoted to photometric observations, both absolute and relative) are archived in a local web server[3], so that they can be easily retrieved by all people working on them. The description of our local archive, as well as basic instruction on how download/upload data, can be found in EP-008, and in our local Wiki-Bo pages[4] . Please contact us to obtain guest credential to access Wiki-Bo and the archive server, or in case of any doubt or problem.

All the observing runs performed during our Campaigns have a dedicated page[5] in Wiki-Bo.

[1] For imaging, we term "data pre-reduction" the removal of the instrument characteristics (dark,bias, flat-field, bad-pixel mask, fringing). For more information, see SMR-001.

[2] This pipeline should be suitable for long-term night points QC as well.

[3] `http://spss.bo.astro.it/`

[4] `http://yoda.bo.astro.it/wiki/index.php/SPSS_Database_and_Archive`

[5] You can easily access these pages by clicking on a run ID in the Summary table of all our Observing Runs: `http://yoda.bo.astro.it/wiki/index.php/SPSS_Runs_Table`

Details of each observing night (logs of the observations, targets summaries, data reduction logs) can be retrieved from these pages.

The *"SPSS Reduced Data Archive"*[6] should be checked to see if the data obtained in the selected nights have already been partially or completely reduced. The detailed data reduction logs in the Wiki-Bo page of each run can also be checked to see who performed the reduction and the corresponding data upload in the Archive.

1.2 SExtractor

SExtractor is a powerful tool to perform reliable aperture and PSF photometry. In our case, since we are working with non-particularly-crowded images and we are looking for the highest possible precision, we have to perform aperture photometry by setting a radius large enough to ensure no significant light-losses. After various tests, we decided to use an aperture diameter of 6 times the stars FWHM (i.e., supposing a Gaussian PSF, an aperture radius that contains almost the total flux emitted by the stars). For each frame the needed aperture is computed automatically by the pipelines.

As mentioned before, SExtractor is a fast and robust algorithm, also useful to perform the automatic inspection and QC of fits frames. When SExtractor works on a fits frame, first of all it estimates the background, then it looks for counts excesses in order to find sources, it determines their properties (as required by the user in a parameter file) and writes them into the output catalogue. Each catalogue is composed by a list of objects reporting the measured properties for each detected source. In order to work properly, SExtractor needs a *configuration* file and an *output catalogue parameters* file. They are traditionally suffixed with *.sex* and *.param* respectively.

SExtractor is controllable (most steps can be influenced by the user) but it is strongly dependent on some settings that are crucial for both the source detection and photometry. Therefore, it is very important to carefully choose the most appropriate value of parameters for the configuration file *.sex*[7]. Depending on which telescope/instrument configuration we are working with, we prepared template *.sex* configuration files with a standard naming convention. These templates can be found on Wiki-Bo[8] and ensure the maximum homogeneity in the aperture photometry measurement procedure. We report in Table 1 the correct values of each Telescope/CCD configuration used in the *.sex* templates. Further information about the parameters in the configuration file can be found in the SExtractor manual[9].

[6] `http://spss.bo.astro.it/red.cgi/`

[7] The *.sex* file is an ASCII file with the name of the parameters and their values on separate lines. If no configuration file name is specified in the command line, SExtractor tries to load a file called *default.sex* from the local directory.

[8] `http://yoda.bo.astro.it/wiki/index.php/Photometry`

[9] `http://www.astromatic.net/software/sextractor`

The *.param* file contains the list of parameters that will be listed in the output catalogue for every detected source. This allows the software to compute only catalogue parameters that are needed by the user. A list of the parameters to use for our imaging campaigns is shown in Table 2 (actually, we are not interested in the value of MAG_AUTO parameter but in a value of FLAGS parameter that can appear only if MAG_AUTO magnitude is requested, as explained in Section 2.1). Presently, two kinds of keywords are recognized by SExtractor: scalars and vectors. Scalars, like X_IMAGE, yield single numbers in the output catalogue. Vectors, like MAG_APER(4) [10] or VIGNET(15,15), yield arrays of numbers. The order in which the parameters will be listed in the catalogue is the same as that of the keywords in the parameter list. For our purposes, in the *work.param* file the only active parameters must be only the ones listed in Table 2. This is mandatory because, otherwise, pipelines can not work properly.

Instrument	**CCD**	*work.sex* **file name**	**gain** e^-/ADU	**pixel scale** arcsec/pix
BFOSC@Cassini	EEV (before Jul 2008)	workLOIold.sex	2.13	0.58
BFOSC@Cassini	EEV (after Jul 2008)	workLOInew.sex	2.22	0.58
LaRuca@SPM1.5	SITE1 (before Oct 2009)	workSPMold.sex	1.20	0.24
LaRuca@SPM1.5	ESOPO (20 to 22 Oct 2009)	workSPMnew.sex	1.85	0.12
LaRuca@SPM1.5	Marconi1 (Oct 2009 to Dec 2010)	workSPMnew2.sex	1.80	0.12
LaRuca@SPM1.5	Marconi2 (Mar 2011)	workSPMnew3.sex	2.20	0.12
LaRuca@SPM1.5	SITE4 (from May 2011)	workSPMnew4.sex	5.08	0.24
ROSS@REM	Marconi47-10	workREMold.sex	2.0	0.575
ROSS2@REM	TBD	workREMnew.sex (TBD)	TBD	TBD
DoLoRes@TNG	E2V-4240 (before Dec 2007)	workTNGold.sex	1.0	0.252
DoLoRes@TNG	E2V-4240 (after Dec 2007)	workTNGnew.sex	1.0	0.252
CAFOS@CAHA2.2	SITE1	workCAHA.sex	2.3	0.53
EFOSC2@NTT	Loral	workNTT.sex	1.22	0.12

TABLE 1: Gain and Pixel Scale values for all Telescope+CCD configurations.

[10] SExtractor can perform aperture photometry calculation on many apertures at the same time. Therefore, in the *.param* file, (n) indicates how many apertures we are working with. For our purposes, n is always one.

Output Parameter name	what is it?	units
NUMBER	Running object number	-
FLUX_APER	Flux vector within fixed circular aperture(s)	count
FLUXERR_APER	RMS error vector for aperture flux(es)	count
MAG_APER	Fixed aperture magnitude vector	mag
MAGERR_APER	RMS error vector for fixed aperture mag.	mag
MAG_AUTO	Kron-like elliptical aperture magnitude	mag
BACKGROUND	Background at centroid position	count
X_IMAGE	Object position along x	pixel
Y_IMAGE	Object position along y	pixel
FWHM_IMAGE	FWHM assuming a Gaussian core	pixel
FLAGS	Extraction flags	-

TABLE 2: SExtractor parameters in output

1.3 The Quality Control strategy

The QC procedure on SPSS pre-reduced photometric frames is designed to take into account a multilevel approach.

The fundamental QC level is performed on stars present in each catalogue produced by SExtractor on each frame[11]. We term it *star level QC*, and all next levels are related with it: its results depend only on failure of the QC-steps a-b-c-d performed on the SPSS itself (see Sections 2.1, 2.2, 2.3, and 2.4) and are totally independent on the scientific goal pursued, i.e., they are the same for the two pipelines.

The second and third QC levels are performed on each single frame (*frame level QC*) and on a whole frame series (*series level QC*), respectively. During our photometric campaigns, four kind of series are acquired:

- when an SPSS is observed for short-term variability monitoring in one filter for approximately 1-2 hours, the observation is called *short-term time series*. As described in the observing protocol (EP-003), a time series should be formed by at least 30 frames;
- one observation of a SPSS in one night, formed by 9 frames acquired in the BVR filters (3 for each filter) is called a *relative night point* (NP). When the night is clear and Landolt standard star fields are observed, the relative NP becomes an *absolute* NP;

[11] SExtractor produces one catalogue per frame. In each catalogue all detected stars are listed.

- when we group at least 12 relative night points of the same SPSS spanning a period of at least three years, we have a *long-term time series*;
- one observation of a Landolt field in one night, formed by 9 frames acquired in the BVR filters (3 for each filter) is called a *Landolt NP*.

The result of the second and third level of QC depends on which scientific goal we want to achieve (i.e. absolute photometry, short or long variability study on the SPSS). The *frame level* results basically indicate which frames shall be used to produce each data product, while the *series level* results provide a grade of ”goodness” of the whole series. Fig. 1 shows the basic way in which the three levels work and are related.

2 The *Star Level* Quality Control

The fundamental level of QC on stars extracted from pre-reduced photometric frames is done in four steps:

- **step a**: the star is not saturated and not affected by other problems (see Sec. 2.1);
- **step b**: the star has signal-to-noise ratio larger than 100 (see Sec. 2.2);
- **step c**: the star seeing is lower than 5 arcsec (see Sec. 2.3);
- **step d**: no bad pixels are present in the aperture used to perform magnitude calculations (see Sec. 2.4).

Depending on the kind of series we are working on, the star level QC is performed on different stars in each catalogue:

- on the **SPSS** for relative and absolute NP, and for the short-term time series;
- on the **reference stars** (field stars used for relative photometry) for short-term time series and relative NP;
- on all the **Landolt stars** present in the frame for Landolt NP.

The aim of the star level QC procedure is to return a warning to the user whenever a QC substep fails. In Fig. 2 we show how the star level QC procedure works, regardless of whether it is performed on SPSS, Landolt or reference stars.

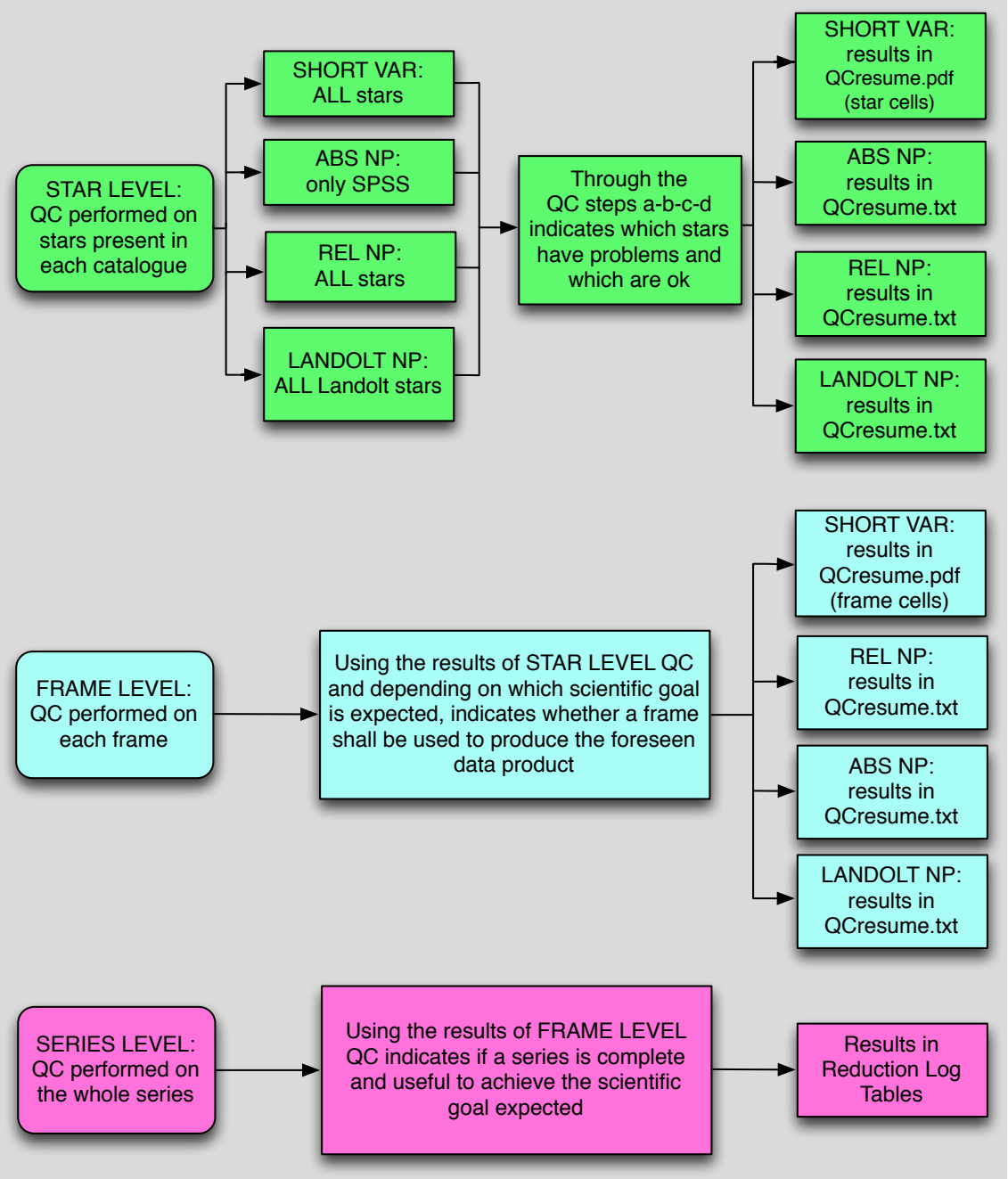

FIGURE 1: Schematic description of the QC structure. See text for further information.

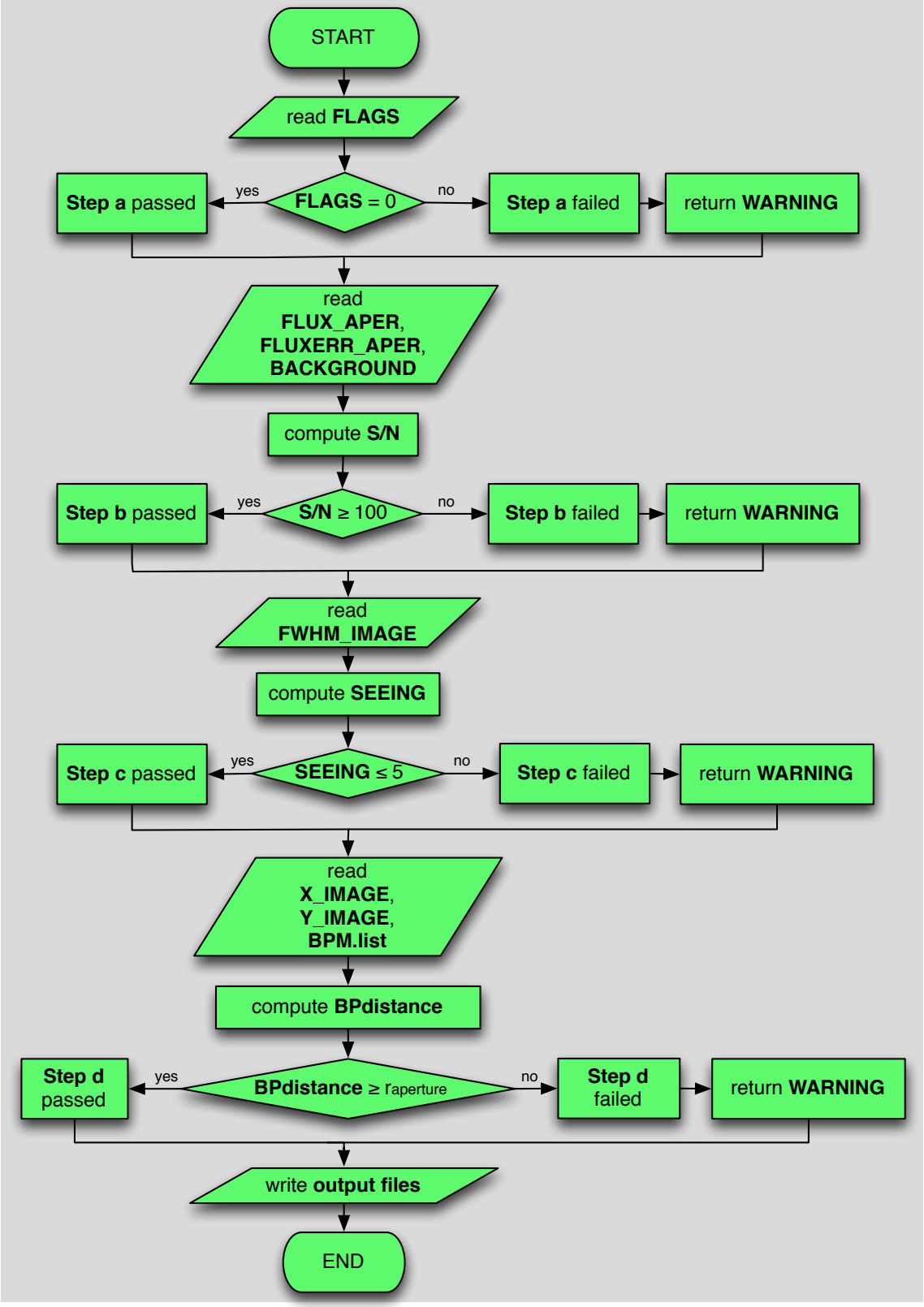

FIGURE 2: Schematic description of the star level QC.

2.1 Step *a*: SExtractor FLAGS

The first star level QC step makes heavy use of the values which the SExtractor parameter FLAGS can assume. It is worth having a look in detail at how the SExtractor flags are defined, to give an idea on their potentialities. They are integer numbers which are the sum of all the extraction flags expressed as power of 2:

- 1 = the object has neighbours (bright and close enough to significantly bias the MAG_AUTO photometry) or bad pixels (more than 10% of the integrated area affected).
- 2 = the object is blended with another one
- 4 = at least one pixel of the object is saturated (or very close to saturation)
- 8 = the object is truncated (too close to an image boundary)
- 16 = the object aperture data are incomplete or corrupted
- 32 = the object isophotal data are incomplete or corrupted
- 64 = a memory overflow occurred during deblending
- 128 = a memory overflow occurred during extraction

For example, an object close to an image border may have FLAGS = 16, or FLAGS = 8+16+32 = 56 if it is truncated by the image border .

FLAGS equal to 0 means that the star examined does not have any problems and this step is successfully passed: only stars associated whit this FLAGS value are considered useful in order to perform photometric analysis.

The special case of FLAGS = 1 may indicate the presence of bright and close neighbours or bad pixel clusters. In order to disentangle which is the case, we need to wait for the end of the whole star level QC procedure. The presence of bad pixel clusters will be pointed out even by the QC step *d* alone (Section 2.4): if step *d* fails as well it means that more than 10% of the star is affected by bad pixel; otherwise, if step *d* is successfully passed this indicates the presence of neighbours. In this case, all frames must be investigated by eye in order to estimate the distance of neighbours: for our purposes, we do not want any neighbour closer than 10 arcsec to the SPSS, with its flux larger than 1% of the SPSS flux.

The case of FLAGS = 2 is generated when there is a saddle point in the intensity distribution (i.e., there are two separate peaks in the light distribution). In this case, SExtractor splits the object into two different entries in the catalogue and photometry is performed on both, by

dividing up the intensity of shared pixels. In order to avoid the saturation of bright stars we often have to de-focus during the observations. The resulting image could be double peaked and SExtractor could consider it as two blended objects if the DETECT_MINAREA parameter value in the *work.sex* file is too small. Therefore the image must be examined by eye in order to determine if there are actually two close objects blended or a single one out of focus. In the last case, SExtractor photometry must be repeated with more appropriate configuration parameters.

2.2 Step *b*: Signal to Noise Ratio

The S/N ratio can be easily computed using some parameters provided by SExtractor and expressed in ADU. Assuming that the local background value is the same throughout the star and that the read-out noise and dark current contribution to S/N are negligible, the S/N ratio in the used aperture can be estimated with:

$$S/N = \frac{F_*}{\sqrt{\sigma_*^2 + \sigma_{sky}^2}} \tag{1}$$

where F_* is the star flux, σ_* and σ_{sky} are the errors on the flux of the star and of the background, respectively. Using the SExtractor parameters FLUX_APER, FLUXERR_APER and BACKGROUND, and the proper value for the CCD gain g, they are obtained as follows:

$$F_* = g(\mathrm{FLUX\_APER}) \tag{2}$$

$$\sigma_* = \sqrt{g(\mathrm{FLUXERR\_APER})^2} \tag{3}$$

$$\sigma_{sky} = \sqrt{\pi r^2 g(\mathrm{BACKGROUND})} \tag{4}$$

If the S/N ratio value is lower than 100, the star fails this QC step.

2.3 Step *c*: seeing and focus

We need to ensure that the observational conditions and the telescope focus were good enough to allow for good quality data analysis. To do that, the SExtractor output parameter FWHM_IMAGE (in pixels, it is the FWHM of each star calculated assuming a Gaussian core) turns out to be a very good indicator. Since we know the pixel scale of our CCDs, the seeing θ can be easily estimated by:

$$\theta = (\mathrm{FWHM\_IMAGE})p \tag{5}$$

Where p is the pixel scale in "/pix.

We have set the seeing threshold at 5 arcsec: the examined star fails this QC step if the seeing calculated by SExtractor is worse than this value.

This step of the star level QC procedure allows us to check the image quality but also to reject objects that are not stars. In the examined frame, all stars will have roughly the same FWHM whereas a galaxy will have a higher value. So, every object showing a size in arcsecond larger than 5" shall fail this QC step.

2.4 Step *d*: search for close bad pixels

This is the only star level QC step that produces a frame warning and not a rejection. It is used to ascertain if a bad pixel falls into the aperture used to measure the magnitude for the SPSS, reference stars and Landolt stars. The correction for bad-pixel mask (BPM) is performed during the photometric pre-reduction (SMR-001) but, when the star level QC step *d* returns a warning, it is better to visually inspect the image, in order to see if the examined star is close to (or crossed by) a large cluster of bad pixels (for example, a group of bad columns). When IRAF performs the BPM correction, all the bad pixels are replaced with the average value of close good pixels so we must pay special attention to the photometry of stars affected by this problem.

3 The *Frame Level* Quality Control

In Fig. 3 we show how this QC level works, depending on both the star level QC results and the scientific goal pursued (i.e. absolute NP, Landolt NP, or relative photometry).

When we are working on SPSS observations, the procedure follows the scheme:

- if the SPSS fails either of the steps *a*, *b* or *c* (i.e., if the SPSS is saturated or too close to the edges of the frame, too faint or too much out of focus) the frame level QC fails as well;
- if the only star level QC step failed is step *d* (there can be some bad pixels or bad pixel cluster) or if all star level QC steps are successfully passed, then:
  - if the frame is part of a short-term time series or a relative NP, at least two reference stars must pass the star level QC steps *a*, *b* and *c*. Otherwise, the

frame level QC fails. If only step *d* fails on these reference stars, a warning is issued;

– if the frame is part of an absolute NP, the frame level QC procedure ends successfully without considering the presence of reference stars in the frame nor the star level QC results on them.

When we are working on Landolt NP, the frame level QC is passed if at least one of the Landolt stars passes star level QC steps, if step *a*, *b*, *c* or *d* fails, a warning is issued.

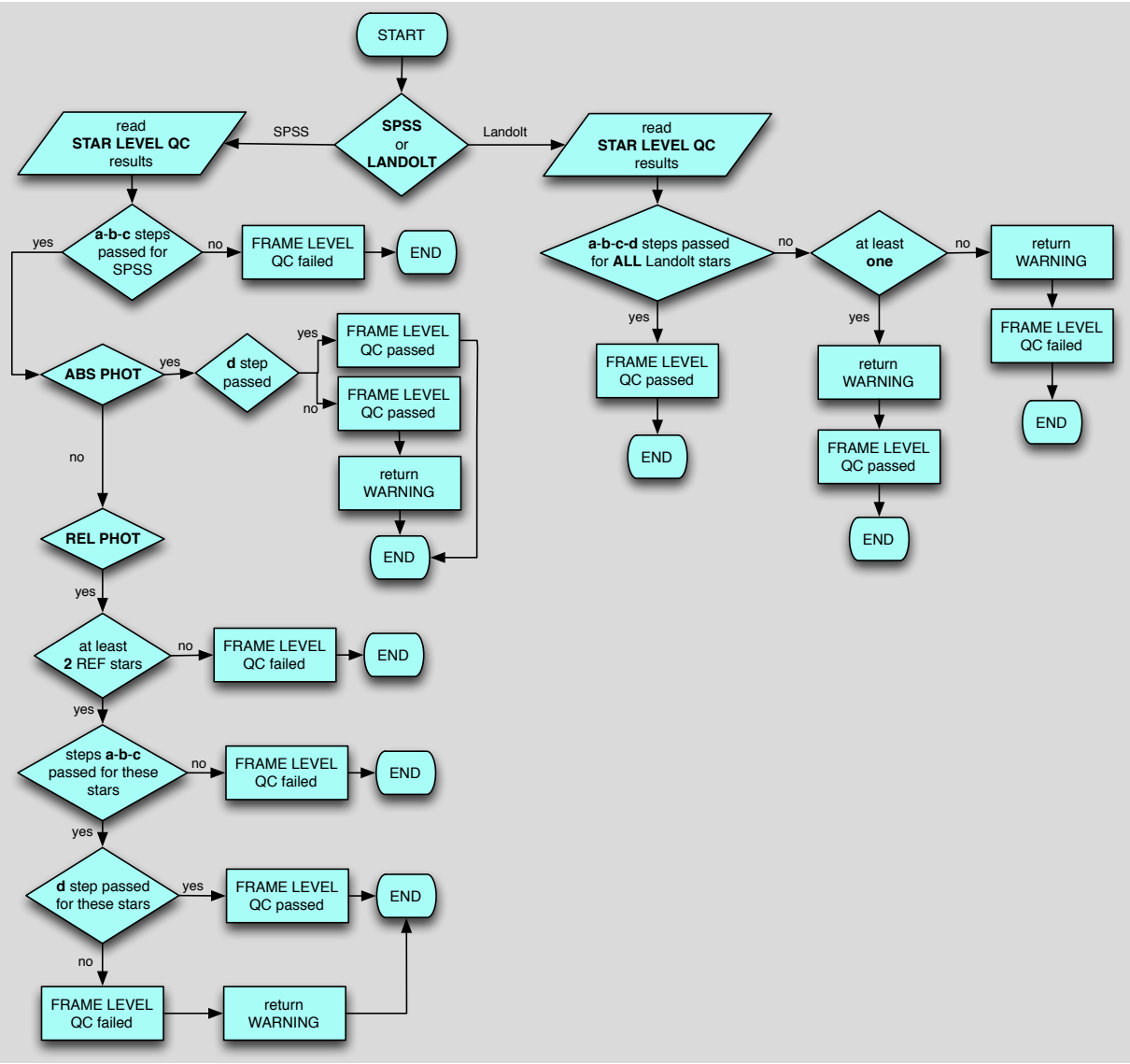

FIGURE 3: Schematic description of the FRAME LEVEL QC.

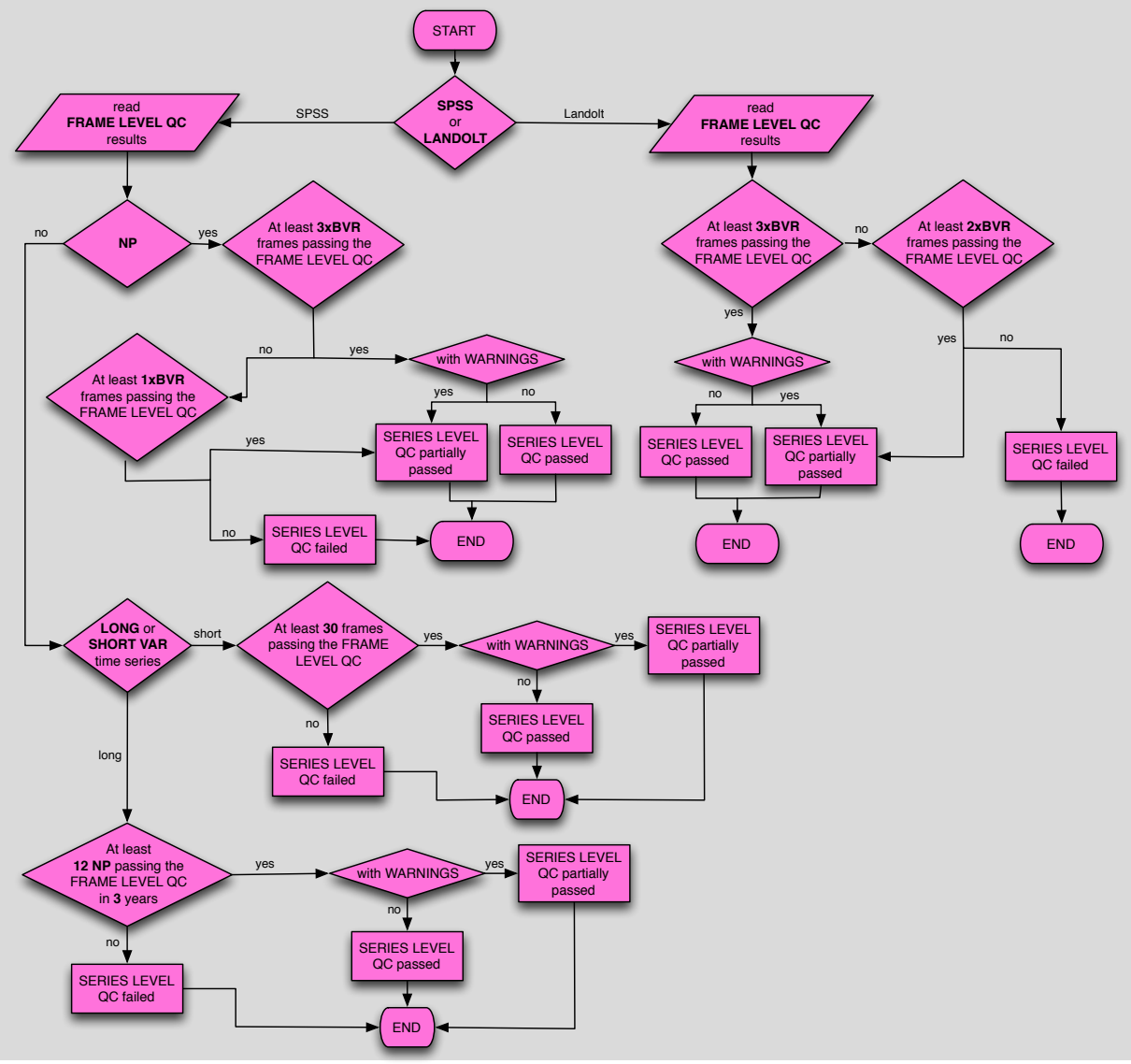

FIGURE 4: Schematic description of the Series Level QC.

4 The *Series Level* Quality Control

The aim of the series level QC procedure is to express a global judgement on a series of exposures, such as a NP or a time series.

Each type of observation has to be performed following precise protocols (i.e. filter used, minimum number of frames required, see EP-003 and EP-006): the series level QC verifies that all the observational requirements are met by the exposures surviving the frame level QC:

- a NP (absolute, or relative) fails this QC level if it is composed by less than one good exposure per filter; it is partially passed if it contains less than 9 good frames acquired in the BVR filters (at least 3 for each filter);
- a Landolt NP fails this QC level if it is composed by less than two good exposure per filter; it is partially passed if it contains less than 9 good frames acquired in the BVR filters (at least 3 for each filter);
- a short-term time series fails this QC level if it lasts less than one hour or contains less than 30 good frames; if the (at least) 30 surviving frames have warnings, this QC level is only partially passed.

More details of the validation procedure can be found in Fig. 4.

5 QC results and applications

5.1 Short term variability time series

All the results of the QC levels procedures for the short term variability time series are summarized in one file per series, called *QCrésumé* and described in details in the next section. An example of this pdf file (automatically produced by the dedicated SM macro, see App. B.4) is shown in Fig 5. All the *QCrésumé* files are linked in special Wiki-Bo tables called *Reduction Logs* in the run pages. In these Wiki-Bo tables, also the series QC level results are stored via colour coding, as explained in Sec. 5.3. The results of the QC procedures are also reported in the single SPSS pages and in the SPSS summary tables, as explained in Sec. 5.4 and 5.5, respectively. In Table 3 we show the meaning of colour codes associated to all the series QC level possible results, described above.

The colour code here is simpler, since it summarized three possible cases:

- QC passed (blue): series accepted;
- QC failed (red): series rejected and observations must be repeated. A note shall explain the reason for rejection;
- QC partially passed (purple): series partially accepted[12], special care must be used in further analysis, and observations should be repeated. A note shall explain the reason for partial acceptance.

[12]This can happen, for example, when all the frames required for a time series are present but the SPSS fails the star level QC *d* step.

STAR QC LEVEL colour codes in the QCrésumé file	
xx	QCa failed, xx = SEx Flag
xx	QCb failed, xx = SNR
xx	QCc failed, xx = seeing
cx	QCd failed cr(!)(nn) = crossed by bad pixels (bad columns) (how much) cl(!)(nn) = bad pixels (bad columns) in aperture (how much) vcl(!)(nn) = bad pixels (bad columns) very close to the star (how much) (nn) is optional
	all QCstar steps passed
T	Target Star (SPSS)
R*	Reference Stars

FRAME QC LEVEL colour codes in the QCrésumé file	
	QCframe passed –> Frame will be used
	QCframe failed –> Frame will not be used

SERIES QC LEVEL colour codes in Reduction Log Tables	
	QCseries passed –> Series accepted
	QCseries partially ok –> Series partially accepted
	QCseries failed –> Series rejected

TABLE 3: Colour Codes for all levels of QC used in the QCrésumé file built for a short term variability time series.

5.1.1 The *QCrésumé.pdf* file

The *QCrésumé* is a pdf file that summarizes the results of both star and frame QC levels on imaging frames. It can be used to easily validate the star, frame and series QC levels, as described in Sec. 2, 3 and 4, respectively.

In the table (shown in Fig. 5), each row represents one frame and each column represents one star (T is the target SPSS, R is a Reference star: the number of columns depends on how many reference stars are present in all the catalogues). For each star in a frame, the cell colour is determined by the results of star level QC: if all steps are successfully passed, the cell colour will be green. A different colour means that the corresponding step has failed. It is important to

Quality Control on SPSS139
(run V008 - Cassini Telescope - 23 sept 2008)
— filter B —

	SPSS	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12
c.lf_386.cat	vcl! (1)	16	cl (3)	5.1			5.2					6.3	6.1
c.lf_387.cat	vcl! (1)	16	5.1	5.2			5.3					6.4	6.3
c.lf_388.cat	5.4	16	5.7	5.9	5.5	5.6	6	5.4	5.4	5.2	5.4	6.9	6.7
c.lf_389.cat	vcl! (1)	16	cl (3)									5.5	5.4
c.lf_390.cat	vcl! (1)	16	5.1	5.3			5.5					6.5	6.2
c.lf_391.cat	vcl! (1)	16	cl (3)				5					6	5.8
c.lf_392.cat	vcl! (1)	16	5.4	5.5		5	5.6					7	6.9
c.lf_393.cat	vcl! (1)	16	cl (3)	5.2			5.4					6.4	6.3
c.lf_394.cat	vcl! (1)	16	cl (3)									5.4	5.3
c.lf_395.cat		16	cl (3)	5			5.2					6	5.9
c.lf_396.cat	4	16	cl (3)										
c.lf_397.cat	4		cl (2)										
c.lf_398.cat			cl (1)									5.2	
c.lf_399.cat			cl (3)									5.3	5.2
c.lf_400.cat			cl (1)									5.3	5.2
c.lf_401.cat		16	cl (2)							95.1		5.1	
c.lf_402.cat													
c.lf_403.cat		16	cl (3)							95.8		5.9	5.8
c.lf_404.cat			cl (2)							95.7		5.3	5.1

FIGURE 5: An example of QCrésumé file built for a short term variability time series: only a portion of the table is shown here. Each row represents one frame and each column represents one star (T is the target SPSS, R is a Reference star: the number of columns depends on how many Reference stars are present in the catalogue). For each star in a frame, the cell colour is determined by the results of star level QC: if all steps are successfully passed, the cell colour will be green. A different colour means that the corresponding step has failed. The first cell in each row of the table is dedicated to host the frame level QC results: if this QC level fails the cell colour will be dark grey and the corresponding frame shall not be loaded in the SPSS Reduced Data Archive.

note that in the *QCrésumé* tables only the first failed star level QC step is shown. The first cell in each row of the *QCrésumé* tables is dedicated to host the frame level QC results: if this QC level fails the cell colour will be dark grey and the corresponding catalogue shall not be used in the next steps of the analysis (see Table 3 for the exact meaning of colours).

5.2 Absolute, relative and Landolt stars NP

All the results of the QC star levels procedures for absolute, relative and Landolt stars NP are summarized in one ASCII file for each SPSS called *QCresume_<SPSS>_<run>_<date>.txt* , or for each Landolt field called *QCresume_<STD>_<run>_<date>.txt*.

Fig. 6 reports an example of this ASCII file. Each row represents one frame and each column

```
# QC  PG0942m029 M007 NTT 20081126
# filename      >> Stars
np.EFOSC0294.cat        4    4    0    4
np.EFOSC0295.cat      116    0    0    4
np.EFOSC0296.cat        0    0    0  124
np.EFOSC0368.cat        4    4    0    4
np.EFOSC0369.cat        0    0    4    4
np.EFOSC0370.cat        0    4    0  124
np.EFOSC0297.cat      999    4    0    0
np.EFOSC0298.cat      999    0    4    4
np.EFOSC0299.cat        0    4    0  999
np.EFOSC0371.cat      999    4    0    4
np.EFOSC0372.cat      999    0    0    4
np.EFOSC0373.cat        0    0    0  124
np.EFOSC0300.cat      999    4    0    4
np.EFOSC0301.cat        0    0    4    4
np.EFOSC0302.cat        0    4    0  999
np.EFOSC0374.cat      999    4    0    0
np.EFOSC0375.cat      999    0    4    4
np.EFOSC0376.cat        0    4    0  124
# Legend
# 1<SExFlagg> == QCa failed
# 2<SNR>      == QCb failed
# 3<seeing>   == QCc failed
# 4           == QCd failed
# 0           == all QC steps passed
```

FIGURE 6: An example of QCresume file built for a Landolt field. Each row represents one frame and each column represents one standard star.

represents one star. For Landolt fields, the number of columns depends on how many standard stars are present in the fields; for SPSS the first column is the target and the number of the remaining columns depends on how reference stars are in field. For each star in a frame, the numeric code reported in the `QCresume` file is determined by the results of star level QC: if all steps are successfully passed the number is 0, if one step is not successfully passed the first number correspond to the failed step (a=1;b=2;c=3;d=4) and the other digits host the star level QC results (described in detail in Sec. 2). It is important to note that in the `QCresume` tables only the first failed star level QC step is shown. All the `QCresume` files are linked in special Wiki-Bo tables called *Reduction Logs* in the run pages; in these Wiki-Bo tables, also the series QC level results are stored via colour coding, as explained in Sec. 5.3.

The results of the QC procedures are also reported in the single SPSS pages and in the SPSS summary tables, as explained in Sec. 5.4 and 5.5, respectively. Table 4 summarized the all QC levels, described above and the meaning of colour codes associated to the *Reduction Logs* for the QC series level.

13 Mar 2011										
SPSS	Name/Type	Setup	Photo PreRed	Photo AbsPhot	Photo ShortVar	Photo LongVar	Spectro PreRed	Spectro Wave/Ext	Spectro FluxCal	Notes
-	Bias	-	SGL	No	No	No	No	No	No	Master Bias Archived
-	Skyflat	B-V-R	SGL	No	No	No	No	No	No	Master Skyflat Archived
002	GD71	B,V,R	SGL	TBD	TBD	TBD	No	No	No	Frames Archived
010	GD108	B,V,R	SGL	TBD	SMR photQC photApertures	TBD	No	No	No	Frames Archived
011	Feige34	B,V,R	SGL	TBD	No	TBD	No	No	No	Frames Archived
028	SA105-663	B,V,R	SGL	TBD	No	TBD	No	No	No	Frames Archived
124	WD1134+300	B,V,R	SGL	TBD	TBD	TBD	No	No	No	Frames Archived
337	GJ570.2	B,V,R	SGL	TBD	TBD	TBD	No	No	No	Frames Archived
351	U1050-02779214	B,V,R	SGL	TBD	TBD	TBD	No	No	No	Frames Archived
999	PG1047+003	3xB,V,R	SGL	SGL photQC photAper	No	No	No	No	No	Frames Archived
999	Ru149	2xB,V,R	SGL	SGL photQC photAper	No	No	No	No	No	Frames Archived
999	PG1633+099	B,V,R	SGL	SGL photQC photAper	No	No	No	No	No	Frames Archived

FIGURE 7: An example of RedLog Table built for data acquired during run V-023 with LaRuca@SPM1.5 Telescope. The results of the series QC level are reported in the specific column depending on the type of observations via colour coding. The star and frame level QC results is reported in the *photQC* link, and the aperture used for photometry in the *photAper* link for the absolute NP and in the *photApertures* link for the time series.

5.3 The Reduction Logs Tables

All the observing runs performed during the Pilot Program, the Main and the Auxiliary Campaign have a dedicated page (see Sec. 1.1): in all these pages a section called *Reduction Logs* hosts a series of tables, one for each observing night. These tables are called the *reduction logs tables*: an example is shown in Fig. 7, where the reduction log of one particular night is shown.

In the RedLog tables, one column is dedicated to each kind of observations: *Photo AbsPhot* for the absolute NP, *Photo ShortVar* for the short-time variability time series, and *Photo LongVar* for the relative NP. In all these cells the *photQC* link hosts the results of the star and frame level QC (the QCrésumé file for a short var time series, for example), whereas the aperture used to perform the aperture photometry for each file is linked in the *photApertures* or *photAper* link for the short var time series and the absolute NP, respectively (see App. B and C for more details).

SPSS Absolute Nigth Points		
FRAME QC LEVEL in the `QCresume` *file*		
0	all QCstar steps passed	QCframe passed
4	QCd failed	QCframe passed with warning
1xx	QCa failed, where xx is SEx Flag	QCframe failed
2yy	QCb failed, where yy is SNR	QCframe failed
3zz	QCc failed, where zz is seeing	QCframe failed
999	no data	QCframe failed
SERIES QC LEVEL colour codes in Reduction Log Tables		
	QCseries passed	there are 3B-3V-3R with QCframe passed
	QCseries partially ok	there are at least 1B-1V-1R with QCframe passed
	QCseries failed	there are not at least 1B-1V-1R with QCframe passed

SPSS Relative Nigth Points			
FRAME QC LEVEL in the `QCresume` *file*			
SPSS	2 REF		
0	0	all QCstar steps passed	QCframe passed
0	4	SPSS ok, QCd failed for REF	QCframe passed with warning
0	not 2 stars	SPSS ok, QC failed for REF	QCframe failed
4	0 or 4	QCd failed for SPSS and/or REF	QCframe passed with warning
4	not 2 stars	QCd failed for SPSS and QC failed for REF	QCframe failed
1xx		QCa failed, where xx is SEx Flag	QCframe failed
2yy		QCb failed, where yy is SNR	QCframe failed
3zz		QCc failed, where zz is seeing	QCframe failed
999		no data	QCframe failed

SERIES QC LEVEL color codes in Reduction Log Tables	
QCseries passed	there are 3B-3V-3R with QCframe passed
QCseries partially ok	there are at least 1B-1V-1R with QCframe passed
QCseries failed	there are not at least 1B-1V-1R with QCframe passed

TABLE 4: QC levels and Colour Codes associated to the Reduction Logs for the absolute and relative night points.

5.4 Higher level logging: the individual SPSS page

In Wiki-Bo, each SPSS has a dedicated page in order to summarize the literature information available for each star and the status of both acquisition and reduction of data[13]. On each individual SPSS page, a section called *Reduced Data* summarizes the status of data reduction in a table (see Fig. 8) . When a series is reduced and all levels of QC are completed, this table is updated by adding a row (one for each observing run) in the reduction summary table.

The meaning of colour codes in this table is the same of the *Photo AbsPhot*, *Photo ShortVar*, and *Photo LongVar* column of the specific run RedLogs tables, but if there are multiple observations of the same SPSS in different nights during the same run they are merged in one single row, with the following rules:

- if at least one of the time series or night points in that run are labelled blue, the corresponding merged cell will be labelled blue; a note will explain how many NP or time series are good;
- if all the time series and night points in that run are labelled red, the corresponding merged cell will be labelled red and a note will explain why;
- in all other cases, the corresponding merged cell will be labelled purple and a note will explain why.

The reason for this choice is that it must be easy to understand if there is the need of repeating the observations for that particular star.

5.5 Higher level logging: the Primary and Secondary observations tables

For both Primary and Secondary SPSS, two tables called *Primary*[14] and *Secondary*[15] *Observations Table* summarize, for each star, the actual status of both the observing campaign and reduction process, by assigning to each cell a colour code.

These tables are very important because they allow to see immediately what has already been done and what instead is still left to do: in order to know if new observation are needed, the Primary and Secondary observations tables have to be regularly updated. A portion of the secondary observation table and the meaning of colour codes used are shown in Fig. 9, where the meaning of each colour code can be found.

[13] You can easily access these pages by clicking on a SPSS ID in the Primary or Secondary Observations Table
[14] http://yoda.bo.astro.it/wiki/index.php/Primary_Observations_Table
[15] http://yoda.bo.astro.it/wiki/index.php/Secondary_Observations_Table

Reduction Summary

Meaning of colors in the progress status tables.

No / No	Not needed or not present
XX / XX	Done by person XX (QA Still Missing)
XX / XX	Assigned to person XX
TBD / TDB	To be done
XX / XX	Quality Assurance = Rejected by XX
XX / XX	Quality Assurance = Partially Accepted by XX
XX / XX	Quality Assurance = Passed by XX

Lighter Colors mean that the reduction is preliminary or incomplete.

Run	Telescope	Photo PreRed	Photo AbsPhot	Photo ShortVar	Photo LongVar	Spectro PreRed	Spectro Wave/Ext	Spectro SecOrd	Spectro RelCal	Spectro TellCorr	Spectro AbsCal	Notes
P-003	CAHA	GA	No	No	TBD	GA	GA	TBD	TBD	TBD	TBD	-
M-001	CAHA	GVL	TBD	No	TBD	No	No	No	No	No	No	-
M-002	LaPalma	No	No	No	No	SMR/GCC	TBD	TBD	TBD	TBD	TBD	-
M-009	LaPalma	No	No	No	No	SMR/GCC	GCC	TBD	TBD	TBD	TBD	-
M-015	LaPalma	No	No	No	No	GCC	GCC	SGL	GCC	SGL	TBD	-
M-022	CAHA	GVL	No	No	TBD	No	No	No	No	No	No	-
V-002	Loiano	No	No	No	No	SMR/GCC	GCC	TBD	TBD	TBD	TBD	Data acquired only with narrow slit
V-003	SPM	SGL	No	No	TBD	No	No	No	No	No	No	24 Apr ABS degraded
V-006	SPM	SMR	No	SMR	No	No	No	No	No	No	No	-
V-018	Cassini	GVL	No	No	TBD	No	No	No	No	No	No	.
V-020	SPM	SGL	No	No	TBD	No	No	No	No	No	No	Sky Flat low or saturated or not
V-023	SPM	SGL	TBD	No	TBD	No	No	No	No	No	No	-
V-024	Cassini	GVL	No	No	TBD	No	No	No	No	No	No	.
V-027	Cassini	GVL	No	No	TBD	No	No	No	No	No	No	.
V-029	Cassini	GVL	No	No	TBD	No	No	No	No	No	No	.
V-031	Cassini	GVL	No	TBD	No	No	No	No	No	No	No	.

FIGURE 8: Portion of the *Reduced Data* section from the SPSS011 individual page.

When a time series or NP is reduced and quality checked, the colour code and text label should change into:

- *yellow* if the QC on the time-series or NP failed and there are no other observations for that star that could be used; the text label should be `Obs,Data` for the short-term series (*Short Var.* column) or `(N-1)xData`[16] for the absolute or relative NP (*Abs. Phot* or *Long Var.* columns, respectively). For the *Long Var.* column, the colour should be degraded to yellow every time the total number of NP falls below 12 or the whole group of NP covers less than 3 years. For the *Abs Phot.* column, the colour should be degraded to yellow every time the total number of NP falls below 3;

[16] `N-1` means that the actual number of NP should be reduced by one with respect to what indicated in the table. It is always advisable to double check the exact number of NP using the single SPSS pages *Observations* table.

- *aquamarine* if the QC on the time-series or NP was successfully passed but there are other observations of the same type still to reduce; the text label should be `Data` for the short-term series (*Short Var.* column) or `NxData` for the absolute or relative NP (*Abs. Phot* or *Long Var.* columns, respectively);
- *blue* if the QC on the time-series or NP was successfully passed and there are no other observations of the same type still to reduce; the text label should be `Data` for the short-term series (*Short Var.* column) or `NxData` for the absolute or relative NP (*Abs. Phot* or *Long Var.* columns, respectively).

6 Archiving frames and photometric catalogues

The *"SPSS Reduced Data Archive"*[17] and the procedure to upload both the reduced frames and photometric catalogues are described in the Wiki-Bo section SPSS Reduced Data Archive[18] and in EP-008. Please contact us to obtain the appropriate credentials to access the archive server, or in case of any doubt or problem.

[17] `http://spss.bo.astro.it/red.cgi/`
[18] `http://yoda.bo.astro.it/wiki/index.php/Wiki-Bo_Gaia_Page#SPSS_Reduced_Data_Archive`

Secondary Observations Table

No	Res	P.Res	Data	Data	Done	Obs,Data	NotYet	Rejected
Type of observations not needed for this target	Data analyzed and quality checked	Data partially reduced and analyzed	Data reduced and quality checked	Data obtained and partially reduced	Data obtained and appear complete	Data incomplete or bad, repeat observations	Observations needed but not started yet	SPSS rejected, no further observations

This table contains a summary of all the Secondary SPSS observations conducted up to now. Requirements (green mark) for each type of observation:

- **Absolute Photometry:** At least 3 independent night points : each 3B+3V+3R in clear sky conditions.
- **Short Variability:** One hour series/at least 30 exposures in one blue filter (B or V).
- **Long Variability:** At least 12 *independent* night points on 3 years, each 3B+3V+3R (or VR)). Yellow if there is at least one image.
- **Spectrophotometry:** At least three spectra (blue+red), with wide slit (6 x seeing). Narrow slit = yellow.

LAST UPDATE (18 Sept 2013) by SGL/GA Includes:

- **Pilot Observations:** all "P" runs included (**P-001/P-005**).
- **Variability/Photometry Runs:** includes runs **V-001/V-031, 033, 035**.
- **Main Campaigns:** includes runs **M-001/M-024**.
- **Ascii Observations Summary** without transits (last update 18 10 2013 by GA) - (The targets can be selected using the following commands).
- If the star's name is clickable, it leads to the **finding chart(s)**.

ID	Name	RA	Dec	B	V	Type	Abs. Phot	Short Var.	Long Var.	Spectra	Notes
101	WD0046+051	00 49 09.90	+05 23 19.01	12.93	12.39	DZ7	3xData	Data	12xData	Data	-
102	WD0134+833	01 41 28.74	+83 34 58.90	12.88	13.11	DA2	3xData	No	08xData	Done	-
103	G72-34	01 46 03.66	+35 54 49.40	13.84	12.98	K	2xData	Data	08xData	Data	High Proper Motion Star
104	WD0148+467	01 52 02.96	+47 00 06.65	12.50	12.44	DA3	3xData	Res	12xData	Data	-
105	WD0227+050	02 30 16.62	+05 15 50.68	12.75	12.80	DA3	2xData	Data	14xData	Data	Landolt phot. std.
106	WD0316-849	03 09 59.88	-84 43 21.14	11.62	10.55	DAH	Not Yet	Res	07xData	Obs,Data	magnetic WD: to be rejected?
109	WD0604-203	06 06 13.39	-20 21 07.20	11.75	11.80	DA	3xData	Res	13xData	P.Res	-
110	WD0621-376	06 23 12.63	-37 41 28.01	11.76	12.09	DA1	1xData	Obs,Data	12xData	P.Res	-
112	WD0644+375	06 47 37.99	+37 30 57.07	11.99	12.08	DA2	5xData	No	12xData	Obs,Data	Spinning Star
113	WD0713+584	07 17 36.26	+58 24 20.51	12.06	12.02	DA4	6xData	P.Res	11xData	Data	-
114	G251-54	08 11 06.24	+79 54 29.57	10.58	10.01	G0	1xData	Data	08xData	Obs,Data	CPM pair, sep. 110"
115	G114-25	08 59 03.37	-06 23 46.19	12.52	11.97	F7	3xData	P.Res	17xData	Data	-
116	G43-5	09 49 51.59	+06 36 35.64	12.90	12.48	K	4xData	P.Res	16xData	Data	-

FIGURE 9: A screenshot of the Secondary Observation Table in Wiki-Bo.

References

Bertin, E., Arnouts, S., 1996, A&AS, 117, 393, ADS Link

[SMR-001], Marinoni, S., Pancino, E., Altavilla, G., et al., 2012, *Data Reduction Protocol for Ground Based Observations of SpectroPhotometric Standard Stars. I. Imaging Pre-reduction*, GAIA-C5-TN-OABO-SMR-001, URL http://www.rssd.esa.int/cs/livelink/open/3117618

[EP-001], Pancino, E., Altavilla, G., Bellazzini, M., et al., 2008, *Protocol for Ground Based Observations of SpectroPhotometric Standard Stars. I. Instrument Familiarization Tests*, GAIA-C5-TN-OABO-EP-001, URL http://www.rssd.esa.int/cs/livelink/open/2858529

[EP-003], Pancino, E., Altavilla, G., Carrasco, J.M., et al., 2009, *Protocol for Ground Based Observations of SpectroPhotometric Standard Stars. II. Variability Searches and Absolute Photometry Campaigns Photometry Campaigns*, GAIA-C5-TN-OABO-EP-003, URL http://www.rssd.esa.int/cs/livelink/open/2908205

[EP-006], Pancino, E., Altavilla, G., Carrasco, J., et al., 2011, *Protocol for Ground Based Observations of SpectroPhotometric Standard Stars. III. Main Spectrophotometric Campaign*, GAIA-C5-TN-OABO-EP-006, URL http://www.rssd.esa.int/cs/livelink/open/3072732

[EP-008], Pancino, E., Altavilla, G., Rossetti, et al., 2011, *The local Bologna archive of SpectroPhotometric Standard Stars observations*, GAIA-C5-TN-OABO-EP-008, URL http://www.rssd.esa.int/cs/livelink/open/3081255

A Softwares

We have two different pipelines devoted to the photometric catalogues production and QC, and each of them is dedicated to a different photometric series. The first one is dedicated to short term variability time series. The second one works on both SPSS and Landolt night points. All these pipelines work using different software. Check that the following ones are properly installed on your computer:

- IRAF : available at `http://iraf.noao.edu/`;
- SExtractor : available at `http://www.astromatic.net/software/sextractor`;
- SM : available at `http://www.supermongo.net/`[19];
- CataXcorr and Catacomb: the CataPack package is available upon request contacting its author Paolo Montegriffo[20].

B Pipeline for Short Term Variability Time Series

B.1 Preparation

The scripts useful to produce all the pipelines needed for the short term variability time series catalogues production can be found in a tar file stored in Wiki-Bo[21]. The tar file contains:

- the IRAF script *prepareTimeSeries.cl* and the shell scripts *prepareTimeSeries_<filter>.sh*[22]
  useful to produce the input file needed by the SM macro *makeQCpipe_SVTS*;
- the SM macros *makeQCpipe_SVTS.sm* and *prepara.sm* which write all the pipelines needed to the photometric catalogues production;
- all the configuration files needed by SExtractor;

To start working you should:

- create a work directory (one for each SPSS short-term variability time series);

[19] SM must be configured in double precision.
[20] paolo.montegriffo@oabo.inaf.it
[21] `http://yoda.bo.astro.it/wiki/index.php/MakeQCpipe_SVTS`
[22] Where <filter> can be B or V.

- download data from the Reduced Data Archive and put them in the work directory;
- download the pipeline-tarfile and put ALL the scripts and files in the work directory;
- open two shell terminals and one xgterm with IRAF
- in IRAF, call the pipeline with the command:

  `cl < prepareTimeSeries.cl`

  This script build files useful for next steps;
- in one shell terminal, call the needed pipeline with the command:

  `sh prepareTimeSeries_<filter>.sh`

  depending on which filter was used during the acquisition of the time series. This script build the list file *SPSSxxx.filter* (where xxx is the SPSS number ID and filter is U=0, B=1, V=2, R=3, I=4) needed as input by the macro *makeQCpipe_SVTS.sm*;
- in the other shell terminal, open sm

B.2 Photometric catalogues production: the *makeQCpipe_SVTS* macro

This SM macro builds all pipelines that are necessary for the photometric catalogues production. In sm, call the macro with the command:

```
macro read makeQCpipe_SVTS.sm
```

In this macro, the command `helppipe` give a short helpful command list (see Fig. 10). Each command listed produces one pipeline step. When created, each pipeline step must be ran in a shell terminal before proceeding with the next steps. Please, note that the order in which the user creates and runs the pipelines is important: to ensure that, all processes end successfully, the order reported in the command list must be respected.

B.2.1 *pipeQC_ape* production

In the macro *makeQCpipe_SVTS*, the command `makeape` creates the pipeline *pipeQC_ape*. This pipeline performs the sources extraction using a fixed aperture in order to measure the FWHM of all stars present in each frame. This first step is useful to compute, for each frame, the correct aperture that will be used in the photometric catalogues production. The command *makeape* builds the pipeline using the correct SExtractor configuration file for each telescope/CCD setup. In these files, all parameters are set to reliable values (based on our experience). Nevertheless, it may happen that some of these parameters need to be changed. In particular:

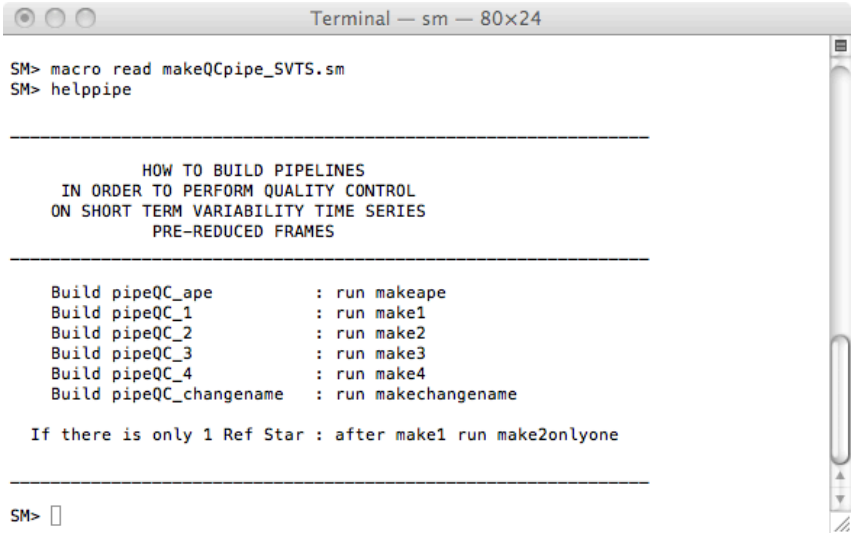

FIGURE 10: helppipe

- the *thresholds parameters* values: are useful to define the detection "strategy". For example: are there many stars in the field? You should choose to select only the brighter ones: tune the thresholds parameters in the *.sex* file accordingly, until you reach the desired result (right stars measured in most cases). Thresh holding is mostly controlled through the DETECT_THRESH and DETECT_ MINAREA keywords. DETECT _THRESH sets the threshold value. If one single value is given, it is interpreted as a threshold in units of the background's standard deviation. For example, DETEC_THRESH 1.5 will set the detection threshold at 1.5 σ above the local background. DETECT_MINAREA sets the minimum number of pixels a group should have to trigger a detection. Obviously this parameter can be used just like DETECT_THRESH to detect only bright and big sources, or to increase detection reliability.

- the *background* value: SExtractor estimates the background of the image as well as the RMS noise in that background (mapping both) and subtracts the estimated background from the photometry using the RMS to estimate errors. The parameter BACK_SIZE regulates the estimate. In an area of the BACK_SIZE pixels, the mean and σ of the distribution of pixel values is computed. Then, the most deviant values are rejected and median and standard deviation are computed again. This is repeated until all the remaining pixel values are within $\pm$ 3σ. Obviously, the choice of BACK_SIZE value is very important: too small and the background estimate will be significantly affected by the object flux, too large and small scale variation can not be taken into account. Because the BACK_SIZE parameter determines the background map, you have to estimate the average size of the objects in pixel and make sure that the BACK_SIZE is larger than that.

B.2.2 *pipeQC_1* production

In the macro *makeQCpipe_SVTS* run the command `make1` in order to build the pipeline *pipeQC_1*. This subroutine:

- computes the photometric aperture which will be applied to each single frame. To do that, the FWHM of all stars present in each single catalogue produced by the previous steps are taken into account in order to compute the mean FWHM value for each catalogue (after performing a sigma rejection on deviant values). The aperture diameter for each frame is set equal to 6 times the mean FWHM;
- build the file *photapertures.dat* useful for further analysis steps in order to easily trace the aperture used on each frame;
- writes one SExtractor configuration file (the *.sex* one) for each frame in which the correct aperture is used;
- build the *pipeQC_1* pipeline.

The *pipeQC_1* produces the photometric catalogues using the correct aperture diameter. These catalogues are the input for the next pipeline step.

B.2.3 *pipeQC_2* production

In the macro *makeQCpipe_SVTS* run the command `make2` in order to build the pipeline *pipeQC_2*. This pipeline runs CataXcorr in order to rototranslate and align all the catalogues produced previously.

The pipeQC_2 outputs are the rototranslated catalogues and one (or more, see below) coincidence table. This table is called *coinc_filter.tab* or *coinc_filter_number.tab* depending on how many times CataXcorr needs to be run. Coincidence tables are used by CataComb in the fourth pipeline step. Please, note that CataXcorr can not work with more than 64 catalogues at the same time. If the number of used catalogues is higher, the series has to be split in two (or more) parts and CataXcorr has to be run as many times as the number of catalogue groups. If CataXcorr needs to be run more than once, the reference catalogue has to be the same for each data subset. In building this pipeline, the *make2* subroutine chooses automatically as reference the catalogue which contains the lowest number of stars in order to avoid, after running Catacomb, two different groups of catalogues containing different number of objects. For safety reasons, the name of the reference catalogue is saved in the file *REFcat.dat*.

If catalogues contain less than 5-10 stars, CataXcorr will most probably not be able to find automatically the proper roto-translation transformation. In such a case, the command *-nodisplay*

has to be removed in the *pipeQC_2* and the program will be run in interactive mode. In addition, please, note that if there are only two stars in catalogues (i.e. the SPSS and only one reference star), CataXcorr can not work at all: in such a case, the command `make2onlyone` must be run. This command builds the pipeline *pipeQC_2onlyone*: the crossmatch of catalogues in this case is computed simply by identifying the SPSS in each catalogue and by rearranging the order of the stars in the output catalogues. To do that, the subroutine *make2onlyone* requires to know, as a user input, both the SPSS coordinates in the reference catalogue and a tolerance radius. You can choose a good tolerance radius by visually inspecting the reference frame and remembering that it should be smaller than the distance between the SPSS and the nearest star detected by SExtractor. When the *pipeQC_2onlyone* pipeline terminates to run, the catalogues do not need any other rehash. So, you can skip the next two steps of the pipeline and go directly to the last one (see App. B.2.6).

B.2.4 *pipeQC_3* production

In the macro *makeQCpipe_SVTS* the command `make3` creates the pipeline *pipeQC_3*. The aim of this pipeline is to rewrite all catalogues by adding the actual (X,Y) position of the stars in the fits frames. So, after running *pipeQC_3*, in all catalogues we will have 4 columns for star position: two are called *Xrot* and *Yrot* and the others *Xframe* and *Yframe*. The presence of these last two columns in all our catalogues is necessary because, otherwise, the step d of the star level QC can not be run successfully.

B.2.5 *pipeQC_4* production

In the macro *makeQCpipe_SVTS* the command `make4` build the pipeline *pipeQC_4*. This pipeline runs CataComb in order to select only the stars common to all catalogues.

The macro needs to know which star is the SPSS in order to rearrange the position of all stars listed in each catalogue because the macro devoted to perform the star level QC requires that the SPSS is always the first one. So, the subroutine *make4* requires, as an input by the user, both the SPSS coordinates in the reference catalogue and a tolerance radius. A good tolerance radius is $\simeq$10-15 pixels. The name of the reference catalogue used to run CataXcorr is stored in a file called *REFcat.dat* and produced previously by the pipeline. The *pipeQC_4* outputs are the final catalogues, almost ready to the star level QC. In these files, the target star is always in the first row, and it is caracterized by an (*Xshif,Yshift*) position equal to (0,0). The reference stars are the same in all catalogues and they have always the same position in each catalogue. We call *REF 1*, *REF 2*, *REF 3* (and so on) the objects that are in the second, thirth, fourth (and so on) row of each catalogue. Moreover, *Xshift* and *Yshift* columns allow also a further control on the performances of the procedure: the integer part of both *Xshift* and *Yshift* in the various catalogues have to be the same for each star (within ± 1 pixel).

B.2.6 *pipeQC_changename* production

In the macro *makeQCpipe_SVTS*, the command `make_changename` builds the last pipeline, called *pipeQC_changename*.

The *pipeQC_4* outputs are actually the final catalogues, but they still have a temporary working name. The *pipeQC_changename* simply changes the name of each catalogue following our naming convention: in the case of short term variability time series, the catalogues name will be *c.<filename>.cat*.

B.3 Performing the star level QC: the *QCphot_SVTS* macro

The macro which perform the QC on short term variability time series catalogues can be found in a tar file stored in Wiki-Bo[23]. This pipeline must be copied in the same directory together with the catalogues produced previously.

Run the *QCphot_SVTS.sm* macro in order to perform all the star level QC steps (see Sec. 2.1, 2.2, 2.3 and 2.4) first on the target SPSS and then on all reference stars. Run the command *helppipe* in *QCphot_SVTS.sm* for a list of detailed instructions (see Fig. 11).

For each QC level, the macro creates two files, the first reporting all the interesting parameters for each QC level, and the second reporting the QC results.

B.4 The QCrésumé file production: the *makeQCresume* macro

The *makeQCresume.sm* macro, available in WikiBo[24], builds the *QCresume.tex* template. This template must be compiled in order to obtain the *QCresume.pdf* file. Using the star level QC results, the macro automatically puts in the template all the information about steps a, b and c (see Sec. 2). If step d fails for some stars, the corresponding frame has to be checked by eye and the template completed by hand. Also the result of the frame level QC is added automatically in the template by the macro.

[23] `http://yoda.bo.astro.it/wiki/index.php/QCphot_SVTS`
[24] `http://yoda.bo.astro.it/wiki/index.php/makeQCresume_SVTS`

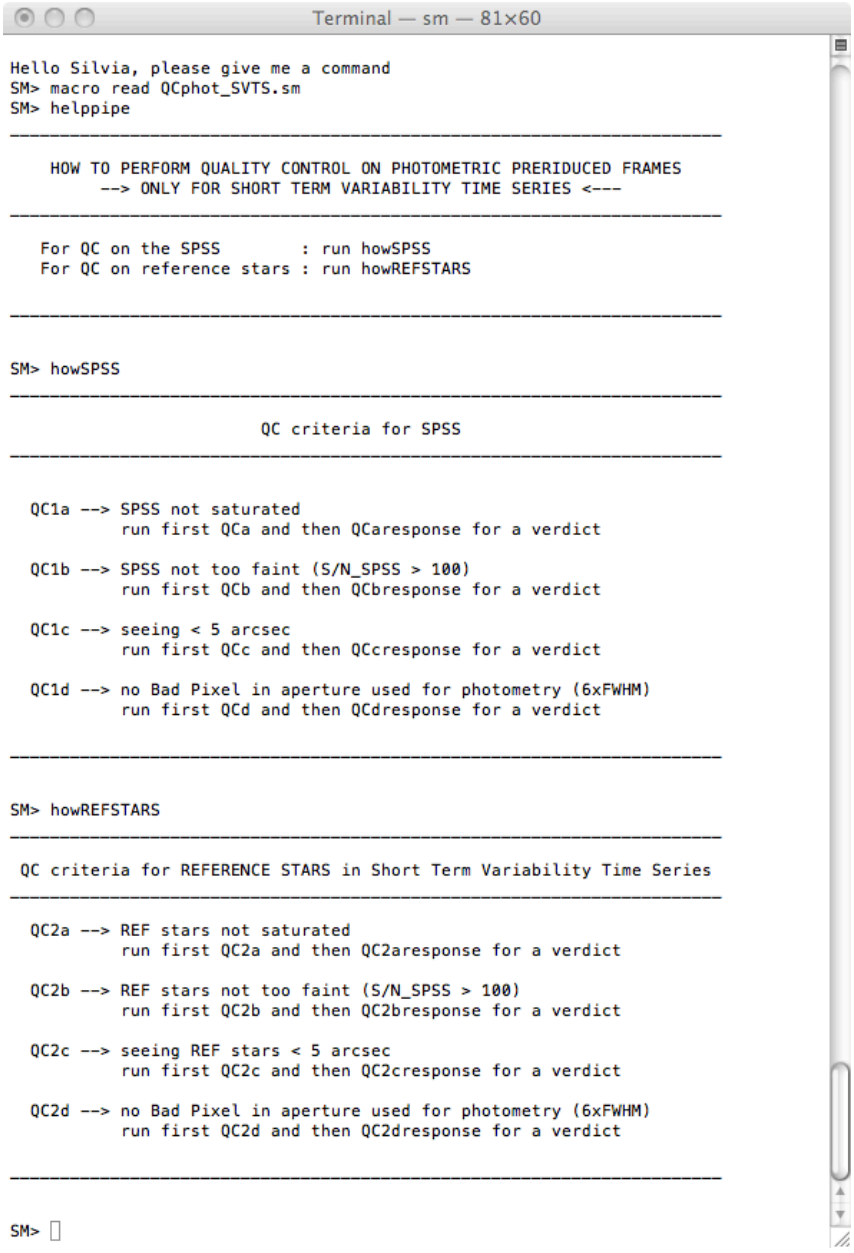

FIGURE 11: QCphot_SVTS helppipe

C Pipeline for SPSS absolute, relative and Landolt Night Points

C.1 Preparation

The scripts useful to produce all the pipelines needed for the NP catalogues production can be found in a tar file stored in Wiki-Bo[25].

The tar file contains:

- the IRAF scripts *start_file_STD.cl*, *start_file_SPSS.cl* and the shell scripts *start_file_STD.sh*, *start_file_SPSS.sh* useful to produce the input file needed by the SM macro *makeQCpipe_CAT.sm*;
- the SM macros *makeQCpipe_CAT.sm*, *prepara.sm* and *seeing.sm*, which write all the pipelines needed to the photometric catalogues production;
- all the configuration files needed by SExtractor.

To start working you should:

- create a work directory (one for each night);
- download 2D Reduced data from the Reduced Data Archive (SPSS or STD) and put them in the work directory;
- download the pipeline-tarfile and put ALL the scripts in the work directory;
- start IRAF.

First, we must create the files necessary to run the pipeline.

- In IRAF, call the script with the command `cl < start_file_STD.cl` (in the case of standard fields) or with the command `cl < start_file_SPSS.cl` (in the case of SPSS). The scripts produce the files all_B.std, all_V.std, all_R.std (in the case of standard files) or all_B.spss; all_V.spss ; all_R.spss (in the case of SPSS), containing a list of all the frames in each filter;

[25] `http://yoda.bo.astro.it/wiki/index.php/MakeQCpipe_CAT`

- in one shell terminal, call the following script with the command:
  `sh start_file_STD.sh` (in the case of standard fields) or with the command `sh start_file_SPSS.sh` (in the case of SPSS).

  The scripts build three files for each observed field needed as input for the macro MakeQCpipe (see next section). In the case of standard fields it creates, for example: stdPG1525.1, stdPG2213.1 (where 1 stands for filter B, 2 for filter V, 3 for filter R). In the case of SPSS the output file names will be, for example: SPSS135.1, SPSS135.2, SPSS135.3.

C.2 Photometric catalogue production: makeQCpipe_CAT.sm

The SM macro makeQCpipe_CAT.sm builds all pipelines that are necessary for the photometric catalogues production. In the macro there is a quick help that is obtained with the command *helppipe* (see Fig. 12). Once a particular pipeline is created (see next sections) within sm, it must be run in a shell environment before any other step is performed (i.e, before any other pipelines are created).

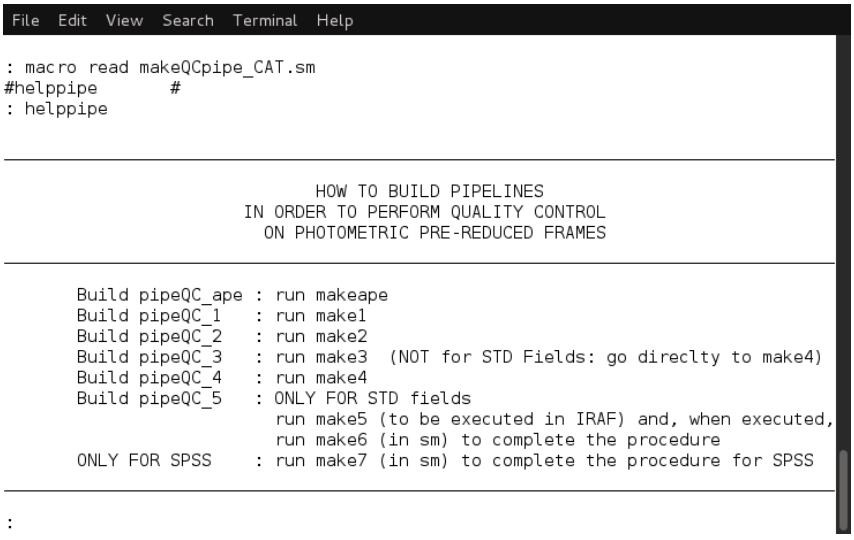

FIGURE 12: helppipe

C.2.1 *pipeQC_ape* production

In the macro *makeQCpipe_CAT* the command `makeape` creates the pipeline *pipeQC_ape* (see Fig. 13). This pipeline performs the sources extraction using the SExtractor configuration file for each telescope/CCD setup and using a fixed aperture measures the FWHM of all stars present in each frame. Next, the macro *seeing.sm* computes the mean FWHM value for each frame (after performing a sigma rejection on deviant values) and writes a file named listaper<field>.dat, containing a list of all frames for each field and the corresponding aperture diameter, set equal

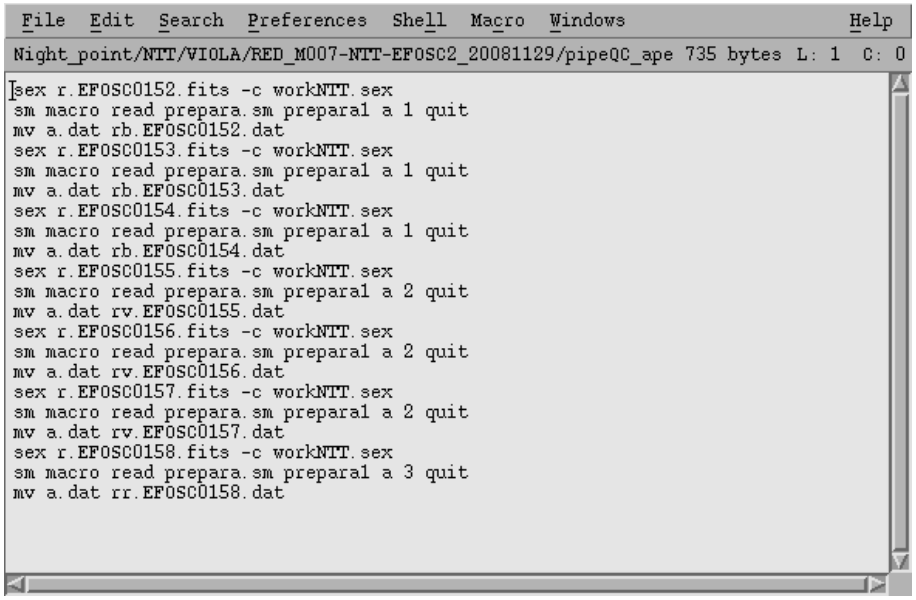

FIGURE 13: An example of the pipeline *pipeQC_ape*

to 6 times the mean FWHM. Finally, it writes a new SExtractor configuration file for each frame with the new aperture diameter. Please, note that in the SExtractor configuration file all parameters are set to reliable values (based on our experience), but it is possible to change some values in case the program has detected too many or too few stars. Please, note that these values are telescope/CCD dependent.

The parameters that usually we must be modified are:

- DETECT_MINAREA: This parameter is the minimum number of continuous adjacent pixels with flux values over the DETECT_THRESH limit. If an object does not have more than this number of high-flux pixels, then SExtractor does not count it as an object. Initial tests on the images reveal that a reasonable value is 20 pixels, and practical values range from about 5 (if we want to increase the number of detected stars) to 70 pixels (in the opposite case);
- DETECT_THRESH: This value sets the number of σ's above the local background that an object must be to be detected. The reasonable values range from 5 to 100;
- ANALYSIS_THRESH: This value is a threshold in the frame. It marks the threshold where CLASS STAR and FWHM begin to operate. The value of this parameter must be smaller than DETECT_THRESH. The reasonable values range from 3 to 50.

C.2.2 *pipeQC_1* production

In the macro *makeQCpipe_CAT*, run the command `make1` in order to build the pipeline *pipeQC_1* where the correct aperture diameter is used to run SExtractor.

The *pipeQC_1* produces the photometric catalogues for all stars present in each frame. These catalogues are the input for the next pipeline steps.

C.2.3 *pipeQC_2* production

The command *make2* builds the pipeline *pipeQC_2*, which uses the program CataXcorr in order to rototranslate and align all the catalogues produced previously. The *pipeQC_2* produces the file coinc_<field>.tab. In the SExtractor configuration file, all parameters are set to reliable values based on our experience. Nevertheless, it may happen that some of these parameters need to be changed. In particular if this step failed it is probably due to too many or too few stars in the field. In these cases the SExtractor configuration file must be modified. If the parameters are modified at this stage, it is necessary to repeat the above steps, starting from makeape (Sect. C.2.1).

C.2.4 *pipeQC_3* production

In the case of SPSS NP, in the macro *makeQCpipe_CAT* the command `make3` creates the pipeline *pipeQC_3*. This pipeline rewrite all catalogues by adding two new columns. These columns represent the actual (X,Y) position of the stars in each NP frame acquired during the series. Please, note that in case of standard fields `make3` must be skipped.

C.2.5 *pipeQC_4* production

In the macro *makeQCpipe_CAT* the command `make4` creates the pipeline *pipeQC_4*. This pipeline runs CataComb in order to select only the stars present in at least two catalogues (or frames).

In the case of SPSS NP, the macro needs to know which star is the SPSS in order to rearrange the position of all stars listed in each catalogue. So, it requires, as an input by the user, both the SPSS coordinates in the reference catalogue and a tolerance radius. A good tolerance radius is $\simeq$10-15 pixels. The name of the reference catalogue used to run CataXcorr is generally the first fits frame in B filter. This pipeline produces catalogues where the SPSS is in the first row.

In the case of standard fields, the macro creates files with only the actual (X,Y) position all stars in each frame.

C.2.6 *pipeQC_5* production

In the case of standard fields, in the macro *makeQCpipe_CAT* the command `make5` creates the pipeline *pipeQC_5*. The aim of this pipeline is to select only the standard stars among the measured stars in the catalogues. The command *make5* must be run from the IRAF prompt. So, the user must identify the standard stars from the reference image, displayed automatically by means of DS9. All finding charts are available in WikiBo[26].

C.2.7 *pipeQC_6* production

In the case of standard fields, in the macro *makeQCpipe_CAT* the command `make6` creates the final photometric catalogue np.<filemame>.cat.

C.2.8 *pipeQC_7* production

In the case of SPSS NP, in the macro *makeQCpipe_CAT* the command `make7` creates the final photometric catalogue np.<filemame>.cat.

C.3 The star level QC and the *QCresume.txt file* production

The macro which performs the star level QC for the standard fields or for SPSS NP catalogues can be found in a tar file stored in Wiki-Bo[27]. The macro *QCphot_STD.m* (in the case of standard fields) or *QCphot_NP.m* (in the case of SPSS NP) verify whether the *star level QC* steps a, b, c, and d (see Sec. 2.1, 2.2, 2.3 and 2.4) are passed. All the results are summarized in a final output ASCII file *QCresume_<SPSS>_<run>_<date>.txt* (in the case of SPSS NP) or *QCresume_<field>_<run>_<date>.txt* (in the case of standard fields). The macro needs to have the files np.<filemame>.cat, lista<field>.dat and BPMposition.list. Note that the macro works on all catalogues present in the work directory.

In the macro the command `how` gives a short help and a list of the available commands (see Fig. 14).

The main steps are listed below:

- download the pipeline into the work directory, where all the necessary catalogs (np.<filename>.cat, listaper<field>.dat) are;

[26] `http://yoda.bo.astro.it/wiki/index.php/Standard_Fields`
[27] `http://yoda.bo.astro.it/wiki/index.php/QC_Photpipe_STD` or `http://yoda.bo.astro.it/wiki/index.php/QC_Photpipe_NP`.

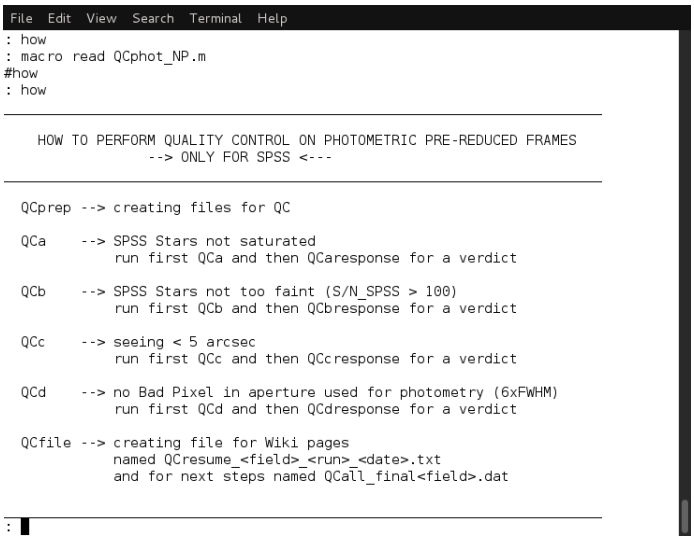

FIGURE 14: how

- in sm, call the pipeline with the command: *macro read QCphot_STD.m* (in Landolt field case) or *macro read QCphot_NP.m* (in the case of SPSS).
- the command `QCprep` produces the file spss<name>.all (in the case of SPSS), or std<field>.all (in the case of standard fields);
- the command `QCa` creates the files for QC a; `QCaresponse` creates the output files for QC a results;
- the command `QCb` creates the files for QC b; `QCbresponse` creates the output files for QC b results;
- the command `QCc` creates the files for QC c; `QCcresponse` creates the output files for QC c results;
- the command `QCd` creates the files for QC d; `QCdresponse` creates the files for QC d results; `QCd_file` creates the output files for QC d results;
- the command *QCfile* creates the final ascii file for QC star levels.

D Macros and Pipelines examples for SPSS short-time variability time series

In the following, you can find an example of the procedure to be followed in order to produce the aperture photometry catalogues and perform the QC on a short-time variability Time Series. We remember that this is a series of photometric frames acquired in order to validate a SPSS against short-term variability.

Suppose you are working on the SPSS123 time series acquired using BFOSC@Cassini during run V-024 (29 March 2011). After downloading and untarring the reduced data of the night, you have to copy in a work directory all the data you are interested in. In this same directory you have to put all the needed pipelines and macros (see App. B). Remember that you will need one working directory for each SPSS time series. Before starting the whole procedure, start IRAF and two shell terminals (one for SM macros and one for shell pipelines).

D.1 Step 0: preparation of needed files

In IRAF run the script *prepareTimeSeries.cl* :

```
ecl> cl < prepareTimeSeries.cl
```

This script builds three files lists (named *all_<filter>.spss*), grouping the frames acquired with the same filter. Open these files and remove from the directory all the frames not belonging to the time series (for example, if the time series was acquired using the B filter, remove all V and R frames). After removing these frames, remove also the corresponding all_<filter>.spss files. In our example, the time series was acquired with the B filter. So, in the first shell terminal, run:

```
mandrolisai:SPSS123_110329 silvia\$ chmod +x prepareTimeSeries_B.sh
mandrolisai:SPSS123_110329 silvia\$ ./prepareTimeSeries_B.sh
```

Now, you have the file SPSS123.1 (see B.1): this is an important input file for the *makeQCpipe_SVTS.sm* macro.

D.2 Step 1: prepare and run the pipeline *pipeQC_ape*

In the second shell terminal, open SM and start working with the *makeQCpipe_SVTS.sm* macro. The first step is to run the command `makeape` as shown in figure 15.

This command builds the pipeline *pipeQC_ape*. This pipeline performs the sources extraction using a fixed aperture in order to measure the FWHM of all stars present in each frame. This first step is useful to compute, for each frame, the correct aperture that will be used in the photometric catalogues production. The appropriate configuration file for SEXtractor (in our example *workLOInew.sex*) should be modified by the user in order to change the threshold parameters (if needed, see Appendix B.2.1).

Now, in the first shell terminal you can run the pipeline that was just created:

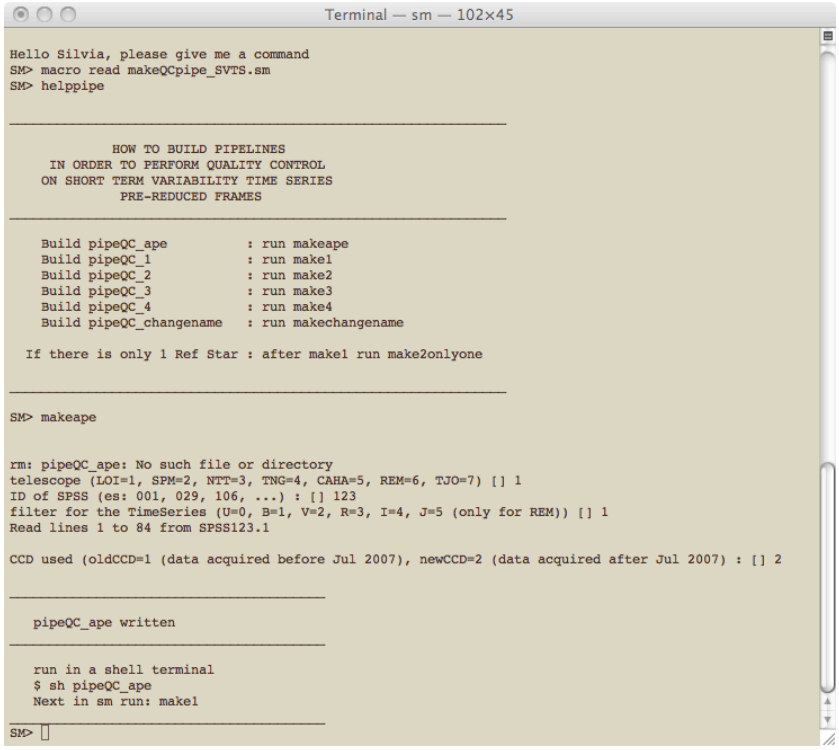

FIGURE 15: Building the pipeline *pipeQC_ape* using the *makeQCpipe_SVTS.sm* macro for the SPSS123 time series acquired with BFOSC@Cassini during run V-024.

```
mandrolisai:SPSS123_110329 silvia$ sh pipeQC_ape
```

In figure 16 you can find, as an example, few lines of the pipeline *pipeQC_ape* built for your SPSS123 time series.

D.3 Step 2: prepare and run the pipeline *pipeQC_1*

In the SM shell terminal, run the command `make1` as shown in figure 17 in order to build the pipeline *pipeQC_1* (see Appendix B.2.2).

Now, you must run the *pipeQC_1* using the command:

```
mandrolisai:SPSS123_110329 silvia$ sh pipeQC_1
```

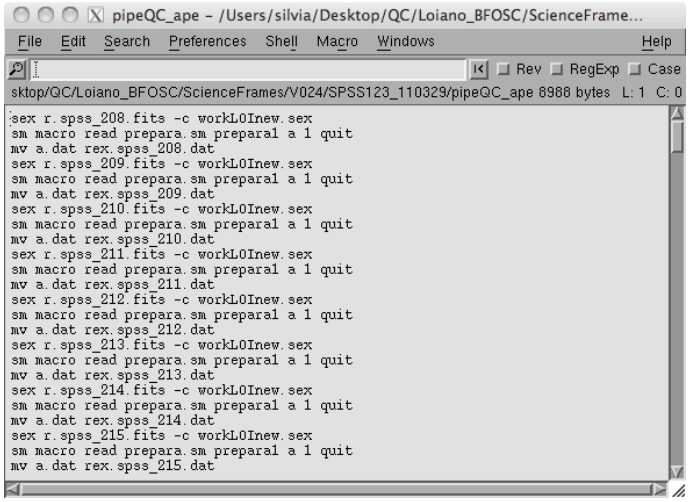

FIGURE 16: Few lines of the *pipeQC_ape* pipeline for the SPSS123 time series acquired with BFOSC@Cassini during run V-024.

This pipeline performs the source extraction using the appropriate aperture and producing one catalogue for each frame. In figure 18 you can find a few lines of the pipeline *pipeQC_1* built for your example on SPSS123 time series.

D.4 Step 3: prepare and run the pipeline *pipeQC_2*

If you have produced the SExtractor catalogues for your time series using the *pipeQC_1*, you can build and run the pipeline *pipeQC_2*. In the SM shell terminal, run the command `make2` as shown in figure 19 in order to build the pipeline *pipeQC_2* (see Appendix B.2.3).

Note that CataXcorr can not manage more than 64 files so, in cases like our example, it needs to be run more than once (obviously the number of times depends on how many frames there are in the series). To do that, the *make2* subroutine chooses as reference the catalogue containing the smallest number of detected stars, divides the catalogues in groups with less than 64 elements and renames them using a trick to write *pipeQC_2* in a simple and compact way, as you can see in figure 20.

In the CataXcorr command the presence of `-nodisplay` indicates that CataXcorr preforms the cross-correlation automatically. If you want (or if you need) to run CataXcorr interactively, it is enough to remove `-nodisplay` from the command. When the *pipeQC_2* is written and ready, you only need to run it with the command:

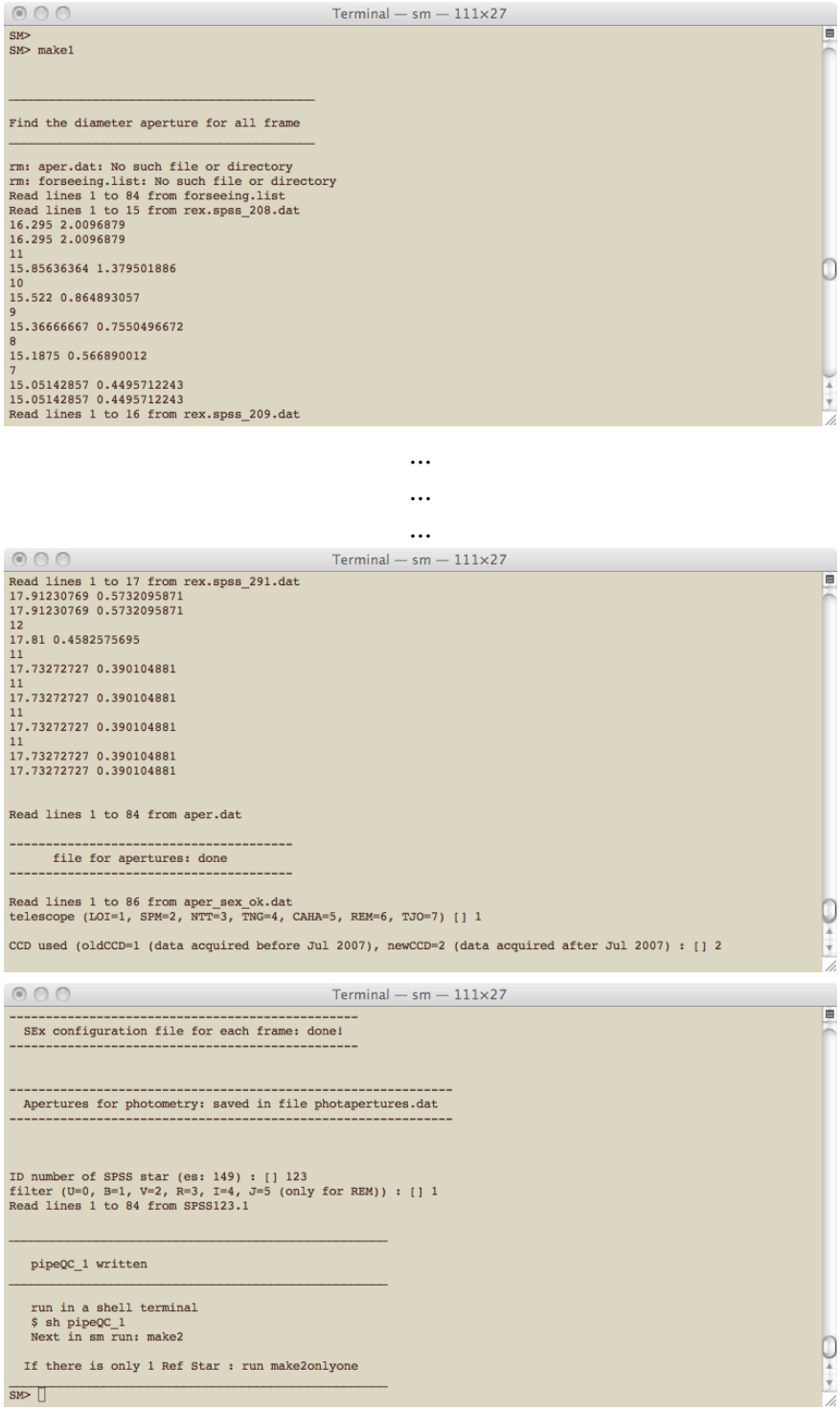

FIGURE 17: Building the pipeline *pipeQC_1* using the *makeQCpipe_SVTS.sm* macro for the SPSS123 time series acquired with BFOSC@Cassini during run V-024.

```
mandrolisai:SPSS123_110329 silvia$ sh pipeQC_2
```

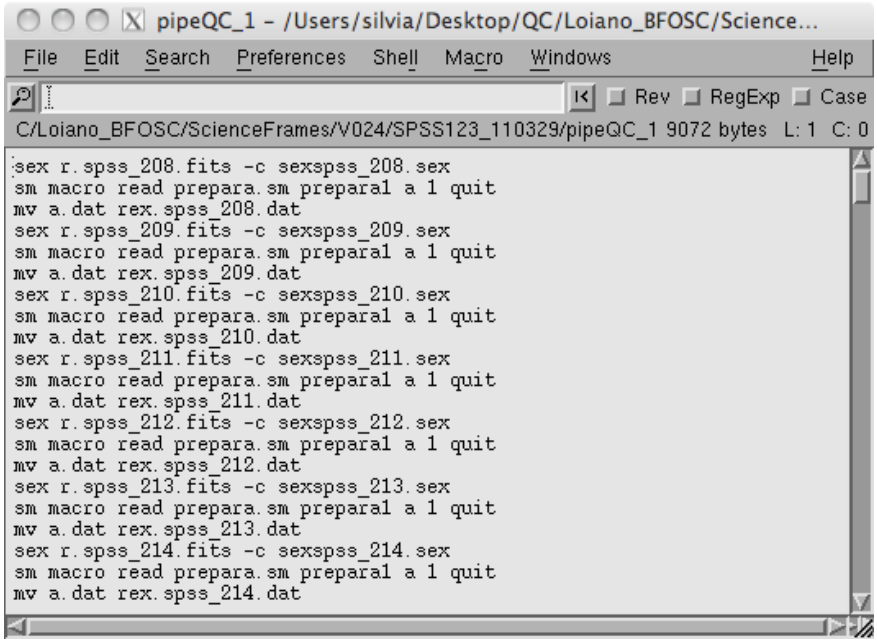

FIGURE 18: Portion of the *pipeQC_1* pipeline for the SPSS123 time series acquired with BFOSC@Cassini during run V-024.

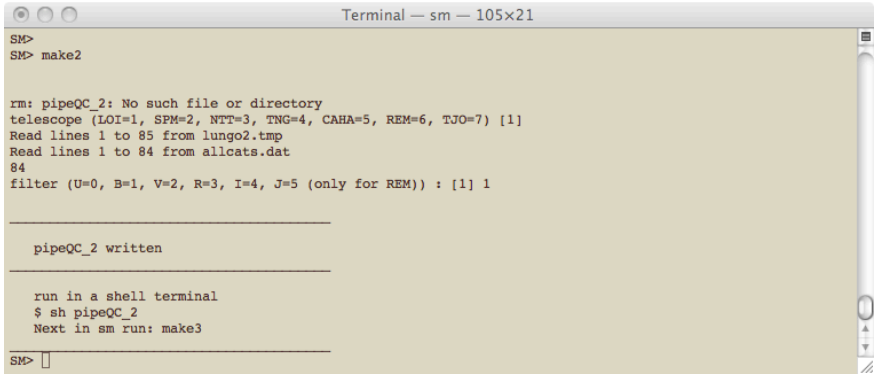

FIGURE 19: Building the *pipeQC_2* pipeline using the *makeQCpipe_SVTS.sm* macro for the SPSS123 time series acquired with BFOSC@Cassini during run V-024.

CataXcorr will produce all .rot catalogues and all coincidence tables (two, in our example).

D.5 Step 4: prepare and run the pipeline *pipeQC_3*

The task of pipeline *pipeQC_3* is to rewrite all catalogues by adding the columns showing the

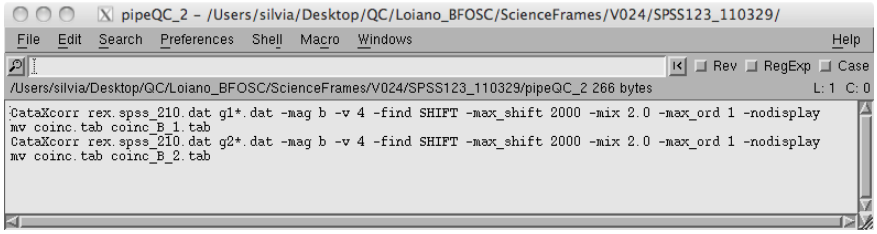

FIGURE 20: Portion of the *pipeQC_2* pipeline for the SPSS123 time series acquired with BFOSC@Cassini during run V-024.

actual position of the stars in each frame acquired during the series (see appendix B.2.4). This information is needed by the QC pipeline to perform the QC star level step d (see section 2 and appendix B.3). In order to build this pipeline, run the command `make3` in the SM shell terminal, as shown in figure 21.

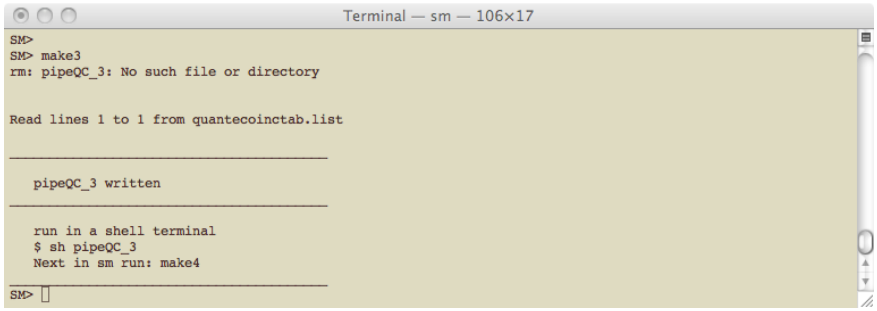

FIGURE 21: Building the *pipeQC_3* pipeline using the *makeQCpipe_SVTS.sm* macro for the SPSS123 time series acquired with BFOSC@Cassini during run V-024.

The *pipeQC_3* is very simple, as shown in figure 22. To run this pipeline you only need to run the command:

```
mandrolisai:SPSS123_110329 silvia$ sh pipeQC_3
```

D.6 Step 5: prepare and run the pipeline *pipeQC_4*

The pipeline *pipeQC_4* is the real reason for the existence of the *makeQCpipe.sm* macro: the command that runs CataComb has a very complex form and it is very easy to make mistakes if you have to write it by hand (see appendix B.2.5). The aim of this pipeline is to select from each

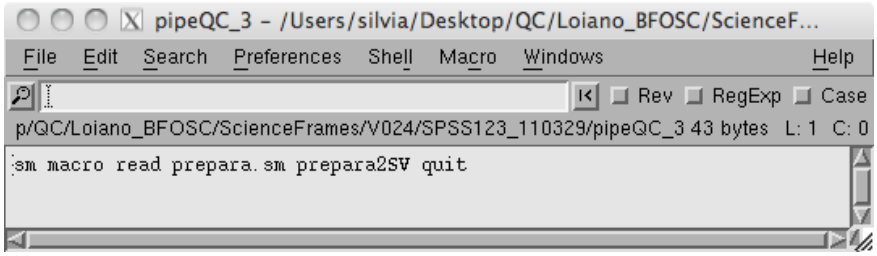

FIGURE 22: The *pipeQC_3* pipeline for the SPSS123 time series acquired with BFOSC@Cassini during run V-024.

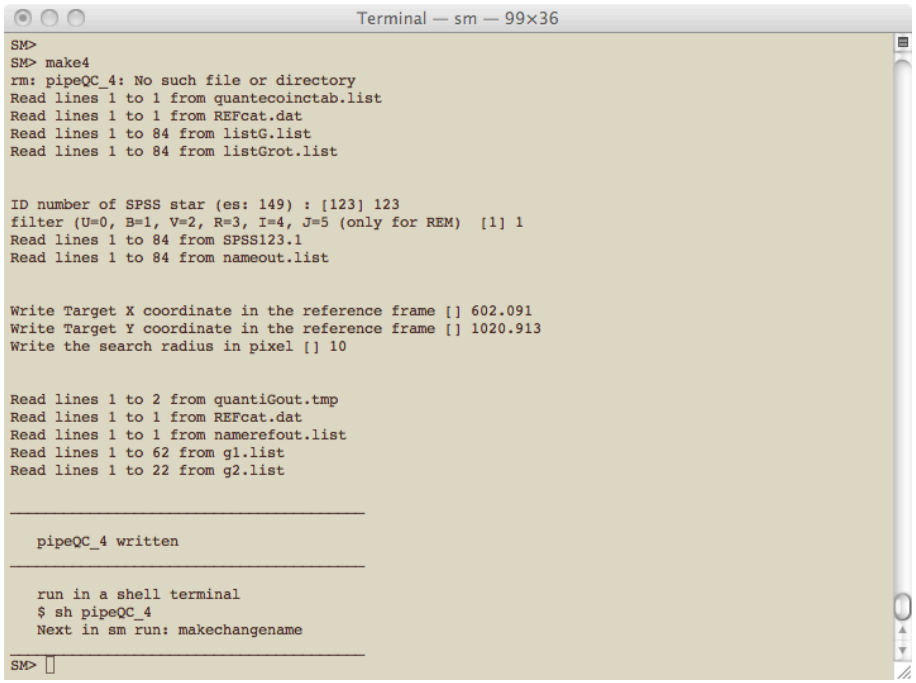

FIGURE 23: Building the *pipeQC_4* pipeline using the *makeQCpipe_SVTS.sm* macro for the SPSS123 time series acquired with BFOSC@Cassini during run V-024.

catalogue only the stars in common. In order to build this pipeline, run the command `make4` in the SM shell terminal, as shown in figure 23.

In figure 24 you can find a few lines of the pipeline *pipeQC_4* built for your example on SPSS123 time series. To run this pipeline the command is, as usual:

```
mandrolisai:SPSS123_110329 silvia$ sh pipeQC_4
```

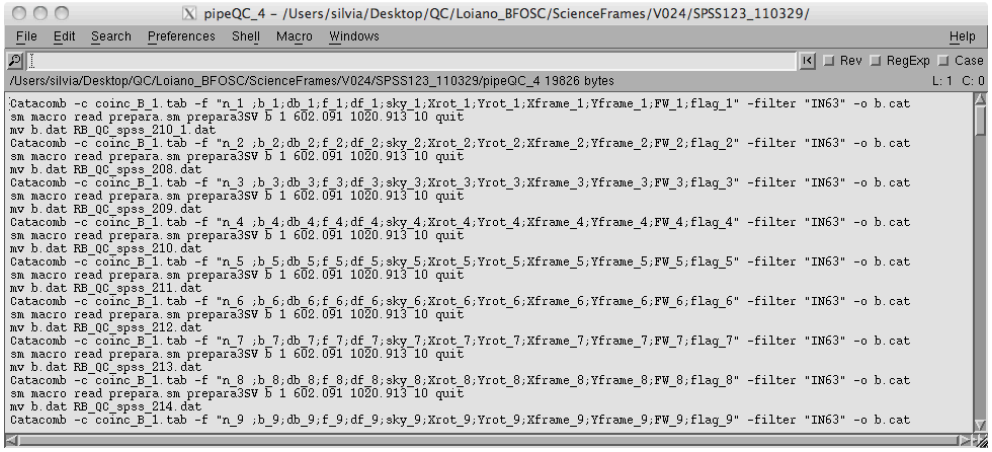

FIGURE 24: Portion of the *pipeQC_4* pipeline for the SPSS123 time series acquired with BFOSC@Cassini during run V-024.

D.7 Step 6: prepare and run the pipeline *pipeQC_changename*

The last step of the procedure is simple: because all our data product follow a naming convention, the aim of this last pipeline is to rename correctly all catalogues produced using *pipeQC_4* (see App. B.2.6). In order to build the *pipeQC_changename* pipeline (that you can see in figure 26), run the command `makechangename` in the SM shell terminal, as shown in figure 25.

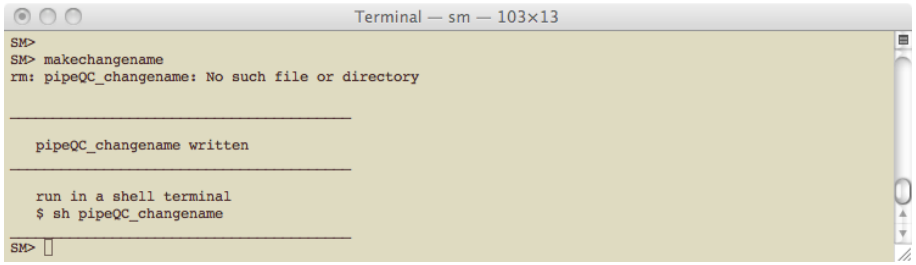

FIGURE 25: Building the *pipeQC_changename* pipeline using the *makeQCpipe_SVTS.sm* macro for the SPSS123 time series acquired with BFOSC@Cassini during run V-024.

As usual, the command to run this pipeline is:

```
mandrolisai:SPSS123_110329 silvia$ sh pipeQC_changename
```

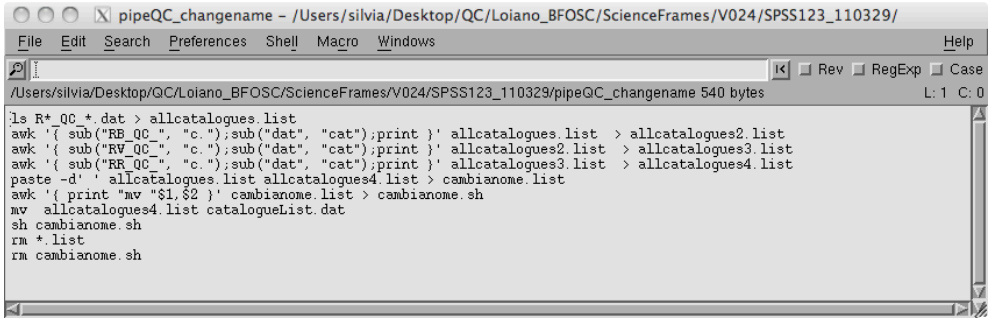

FIGURE 26: The *pipeQC_changename* pipeline. This pipeline does not change depending on the time series.

D.8 Step 7: perform the star level QC using the *QCphot_SVTS.sm* macro

All the time series photometric catalogues produced using the procedure described up to now must be quality checked. The *QCphot_SVTS.sm* macro allows to perform all steps of the star level QC on these catalogues. In order to run this macro (in the SM shell terminal) you need to follow the procedure shown in figure 11 (see appendix B.3). First of all, you have to run all star level QCsteps on the SPSS (see figure 27), and then on all reference stars (see figure 28). For each star level QC step, the macro produces two files: one named *QCNx.dat* and one named *QCNx_response.dat* (where N can be 1 or 2 and x can be a, b, c or d). The first ones (only for step a, b and c) are needed in order to produce the *QCrésumé.pdf* file (see appendices B.4 and D.9). The second ones are useful to see, step by step, the results of the star level QC (as noted in section 5.1.1, in the *QCrésumé.pdf* file only the first failed star level QCstep is shown) .

D.9 Example for *QCrésumé.pdf* file production for short-term variability time series

In order to produce the *QCrésumé.pdf* (see App. B.4), collect in the same directory:

- the files QC1a.dat, QC1b.dat, QC1c.dat, QC2a.dat, QC2b.dat QC2c.dat and forQC.list produced by the QC macro (see Appendix D.8);
- the *makeQCresume.sm* macro

In order to run this macro (in the SM shell terminal) you need to follow the procedure shown in figure 29.

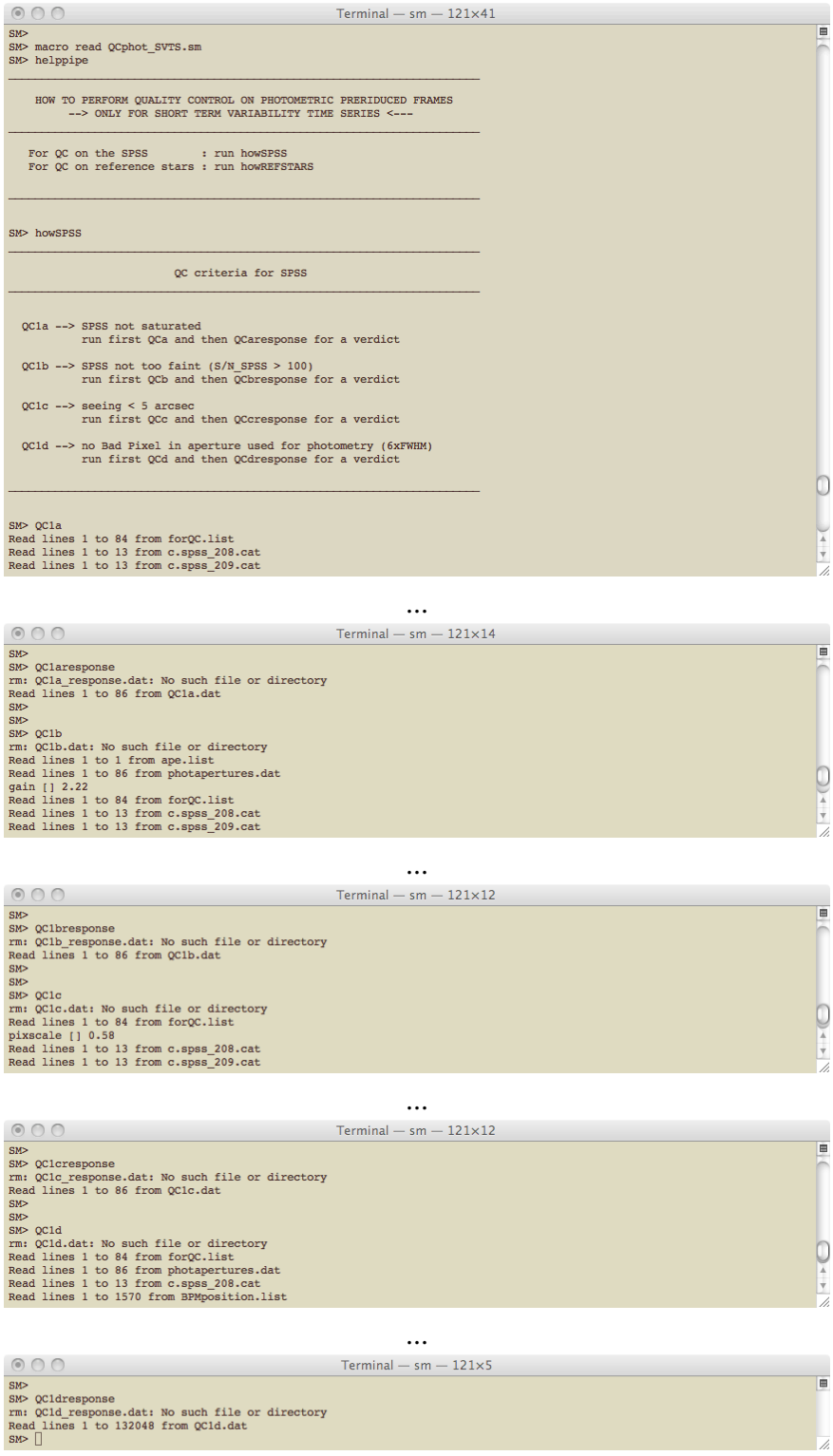

FIGURE 27: Running the *QCphot_SVTS.sm* macro on the SPSS123 time series catalogues produced using data acquired with BFOSC@Cassini during run V-024.

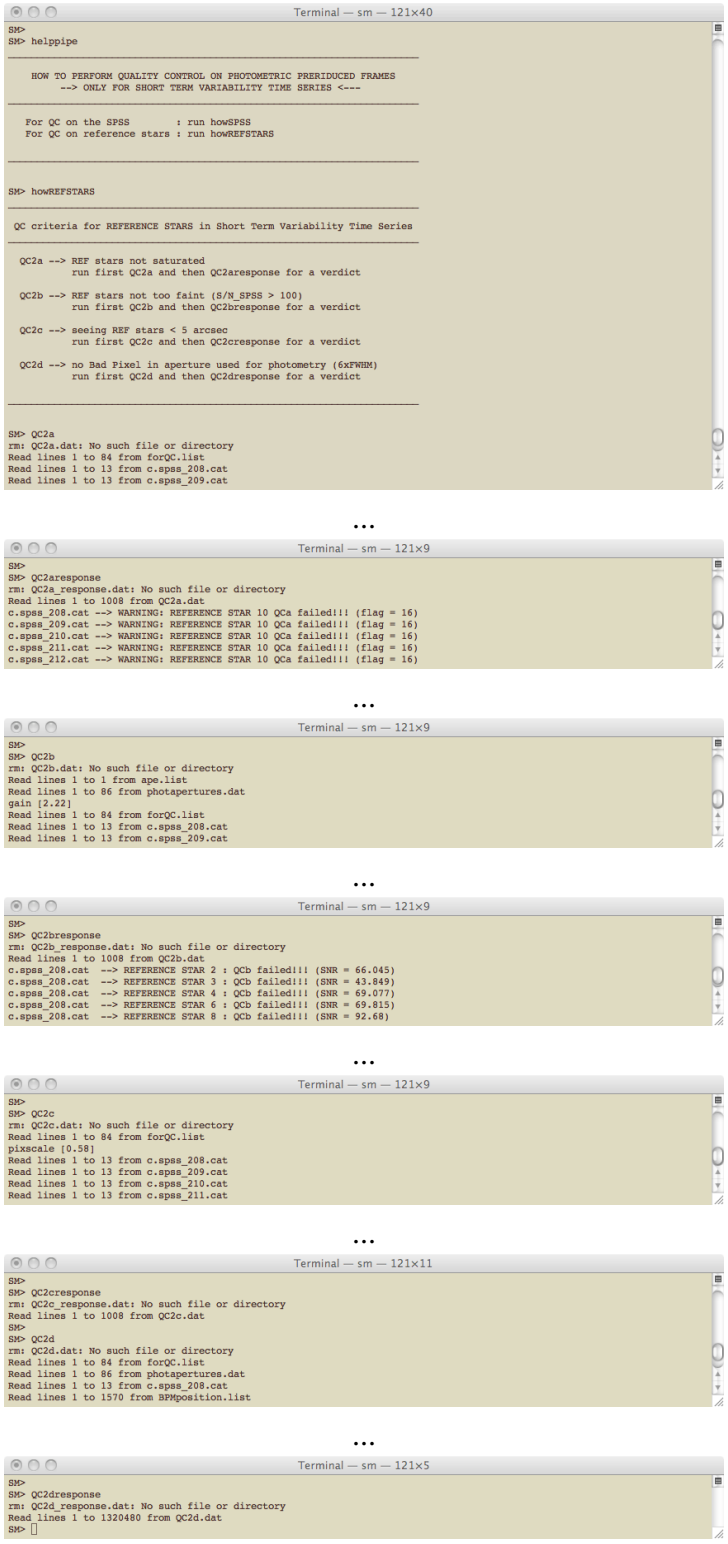

FIGURE 28: Running the *QCphot_SVTS.sm* macro on the SPSS123 time series catalogues produced using data acquired with BFOSC@Cassini during run V-024.

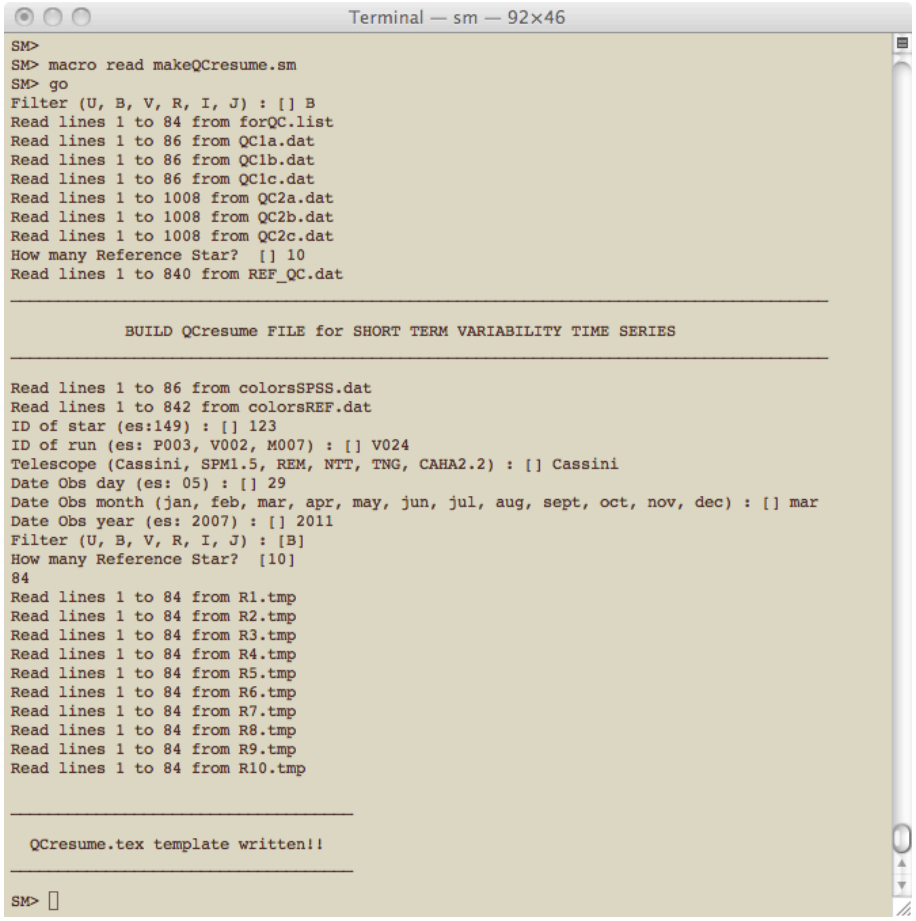

FIGURE 29: The *makeQCresume.sm* macro. This macro built the *QCrésumé.tex* template. In this example we udes the SPSS123 time series catalogues produced using data acquired with BFOSC@Cassini during run V-024.

When the latex template is built, it must be compiled in order to produce the pdf counterpart. We remember here that the step d QC results, if needed, have to be included by hand in the latex template after a visual inspection of each frame.

E Macros and Pipelines examples for SPSS and Landolt Night Points

In the following, you can find an example of the pipelines that you have to build in order to produce the aperture photometry catalogues. All the pipelines are built using the *make-QCpipe_CAT.sm* macro.

E.1 Case of SPSS

Suppose you are working on NTT data of SPSS taken the 29 November 2008. After downloading and untarring the data you have the directory RED_M007-NTT-EFOSC2_20081129. In this directory, you should copy all necessary macros and the configuration SExtractor file (workNTT.sex, see App. C).

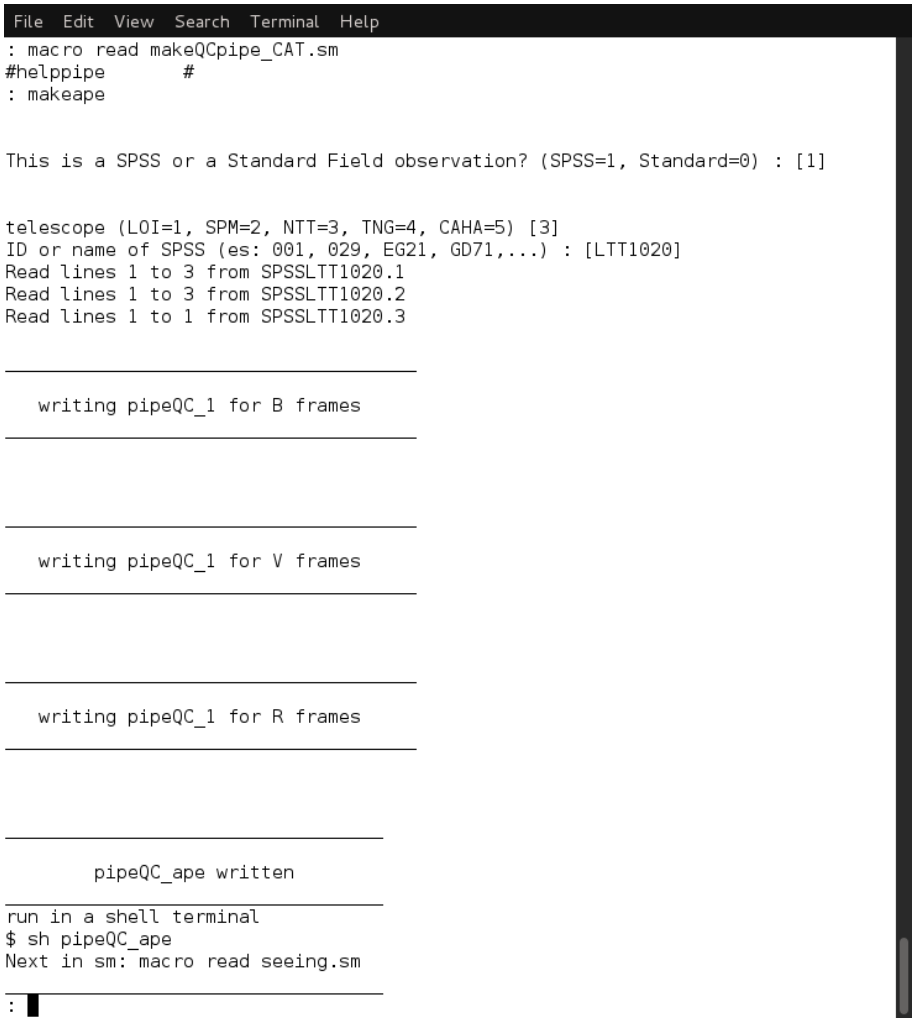

FIGURE 30: Creating the pipeline *pipeQC_ape*.

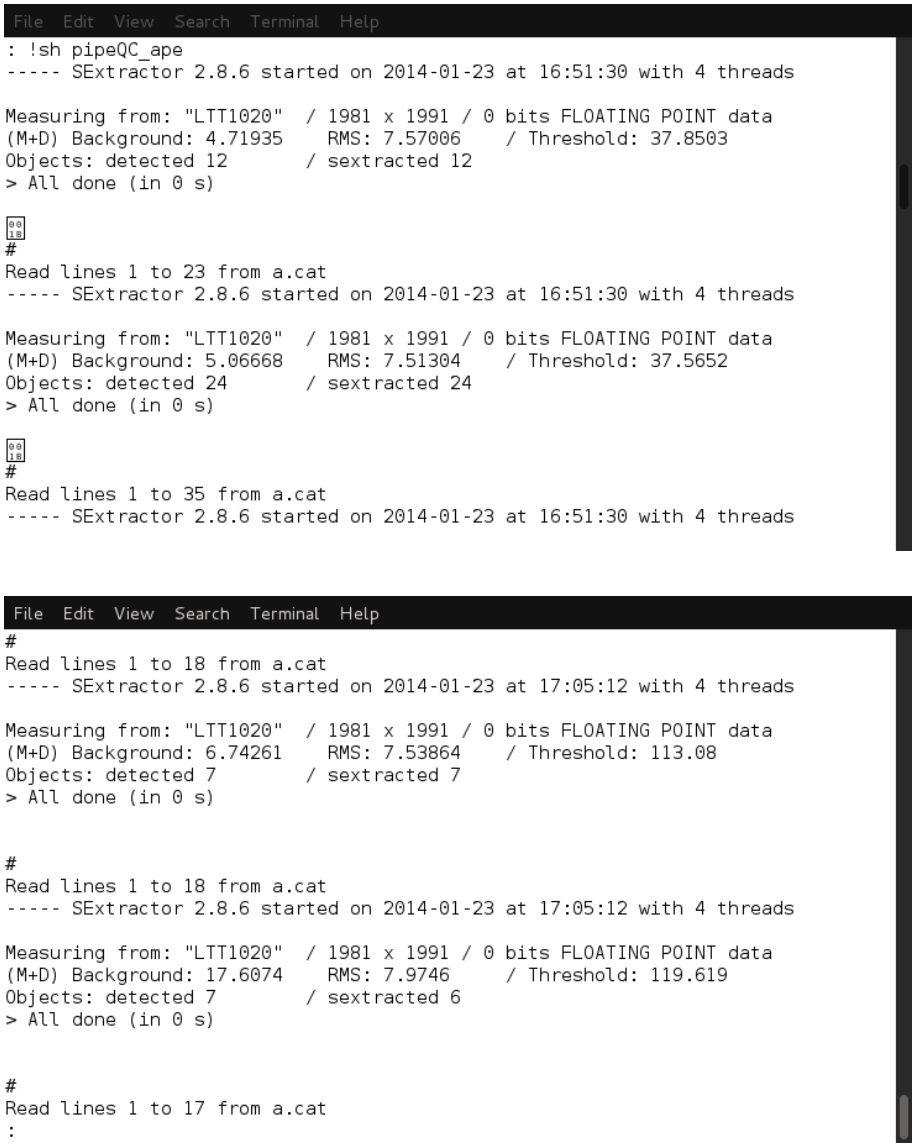

FIGURE 31: First and last lines of the *pipeQC_ape* command.

E.1.1 Step 0. Files preparation

Start IRAF.

```
cl>  cl < start_file_SPSS.cl
cl> !sh start_file_SPSS.sh
```

Now, you have the files, for example, SPSSLTT2415.1, SPSSLTT2415.2 and SPSSLTT2415.3 (see App. C).

E.1.2 Step 1. Create and run the scripts *pipeQC_ape* and *pipeQC_1*

Start SM. Read the *makeQCpipe_CAT.sm* macro and run the command `makeape` as shown in figure 30.

```
File  Edit  View  Search  Terminal  Help
: macro read seeing.sm go
#go
#find the seeing for aperture photometry
rm: cannot remove `aperB.dat': No such file or directory
rm: cannot remove `forseeing.list': No such file or directory
Read lines 1 to 3 from forseeing.list
Read lines 1 to 8 from rb.EFOSC0152.dat
65.124 3.750743926
65.124 3.750743926
4
66.585 2.127745286
4
66.585 2.127745286
4
66.585 2.127745286
4
66.585 2.127745286
4
66.585 2.127745286
66.585 2.127745286
Read lines 1 to 11 from rb.EFOSC0153.dat
50.8725 19.64247566
50.8725 19.64247566
```

```
File  Edit  View  Search  Terminal  Help
Read lines 1 to 1 from forseeing.list
Read lines 1 to 8 from rr.EFOSC0158.dat
83.244 7.053203527
83.244 7.053203527
4
86.115 3.373321805
4
86.115 3.373321805
4
86.115 3.373321805
4
86.115 3.373321805
4
86.115 3.373321805
86.115 3.373321805
name of Standard Field or SPSS (es:PG0231p051, PG0942m029, 035, 135): [] LTT1020
Read lines 1 to 1 from aperR.dat
You really shouldn't use a %f format for LONG vector apea
  filter R done
Read lines 1 to 13 from aper_sex.dat
telescope (LOI=1, SPM=2, NTT=3, TNG=4, CAHA=5) [3]
  end
:
```

FIGURE 32: First and last lines of the *seeing.sm* macro.

You have created the script shell file *pipeQC_ape*. An example is show in figure 13. Next, when you run the script *pipeQC_ape* in SM remember to precede it by '!' (see figure 31).

Next, in SM run the command `macro read seeing.sm go` as shown in figure 32. Now the macro has found the diameter aperture for all frames in listaperLTT1020.dat. The `make1` command creates the script *pipeQC_1*.

Now, you just need to run the pipeline *pipeQC_1*: SExtractor will produce a catalogue for each frame in the NP.

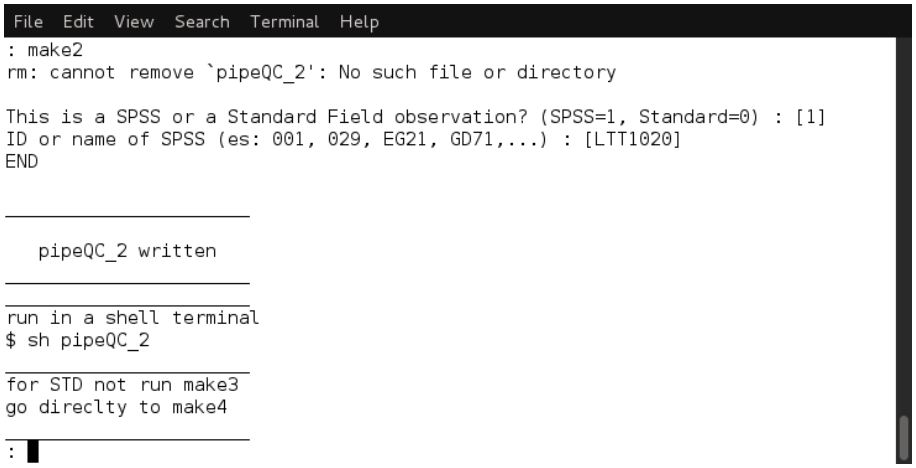

FIGURE 33: Creating the pipeline *pipeQC_2*.

E.1.3 Step 2. Create and run the script *pipeQC_2*

This steps builds and runs the pipeline *pipeQC_2*. In SM run the command `make2` as shown in figure 33. *pipeQC_2* launches CataXcorr command in non-interactive mode. An example of good run is shown in figure 34. If this step fails, it is probably because you have too many or too few stars, thus you need to reconfigure the SExtractor parameters, following the guidelines in Appendix C.2.3, until the result is satisfactory.

E.1.4 Step 3. Create and run the script *pipeQC_3*

In this step the macro writes the pipeline *pipeQC_3*. In SM, run the command `make3` and then run the script `!sh pipeQC_3`. Remember that in case of standard fields this step is not required.

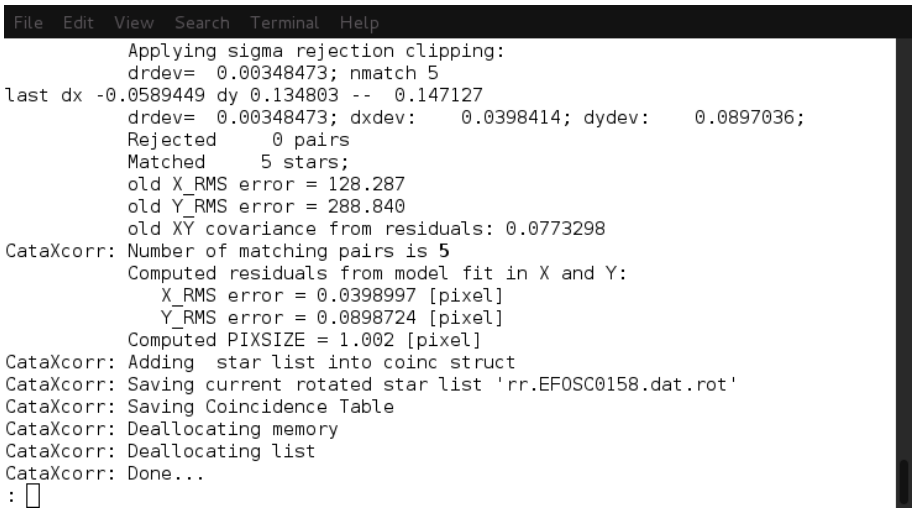

FIGURE 34: Last lines of the *pipeQC_2* command.

E.1.5 Step 4. Create and run the script *pipeQC_4*

This step runs CataComb in order to select only the stars appearing in at least two catalogues. If you are working on SPSS NP, like in our example, remember that you need to know the coordinates of the SPSS in the reference frame[28] before running `make4`. Open DS9 and with IRAF, display the reference frame. Now, mark the stars to obtain their X and Y coordinates. In SM run the command `make4` as shown in figure 35 and then run the script *!sh pipeQC_4*.

E.1.6 Step 5. Final NP catalogues

In SM run the command `make7` as shown in figure 36. This step is only for SPSS NP and it changes the output names of the catalogues for archiving. Note that before running the macro for another SPSS you must remove all temporary files. The *makeQCpipe_CAT.sm* macro moves automatically, if desired, all temporary files in a backup directory named `work` and the macro creates a directory named `QC` that is necessary for QC.

E.2 Case of standard fields

In case of Landolt standard fields, different steps will need to be followed. The steps E.1.1, E.1.2, E.1.3, E.1.5 are the same as for the SPSS NP. When running the *pipeQC_4* script, in case of standard fields, DS9 is opened.

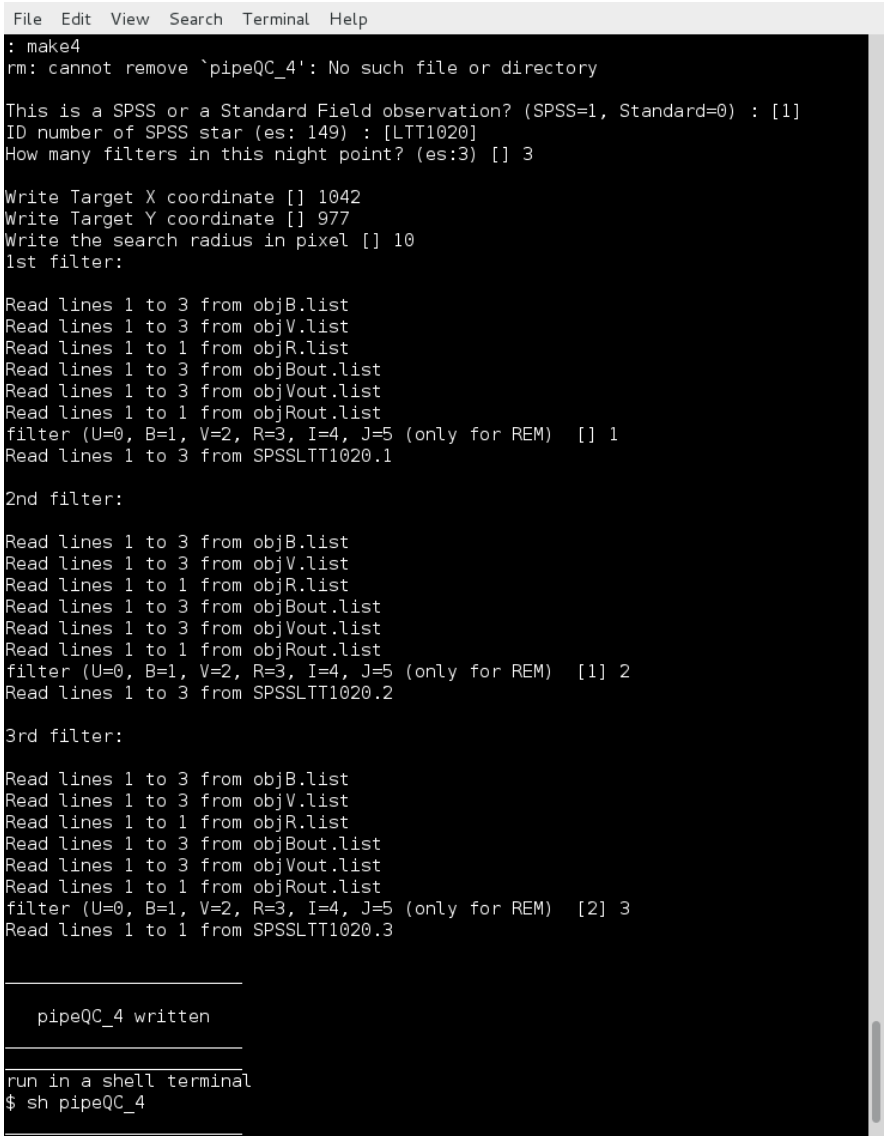

FIGURE 35: Creating the pipeline *pipeQC_4*.

E.2.1 Step 5. Create and run the script *pipeQC_5*

The `make5` command writes the pipeline *pipeQC_5* as shown in figure 37. The script *pipeQC_5* must be run in IRAF:

```
cl > cl < pipeQC_5
```

[28]The reference frame is always the first one.

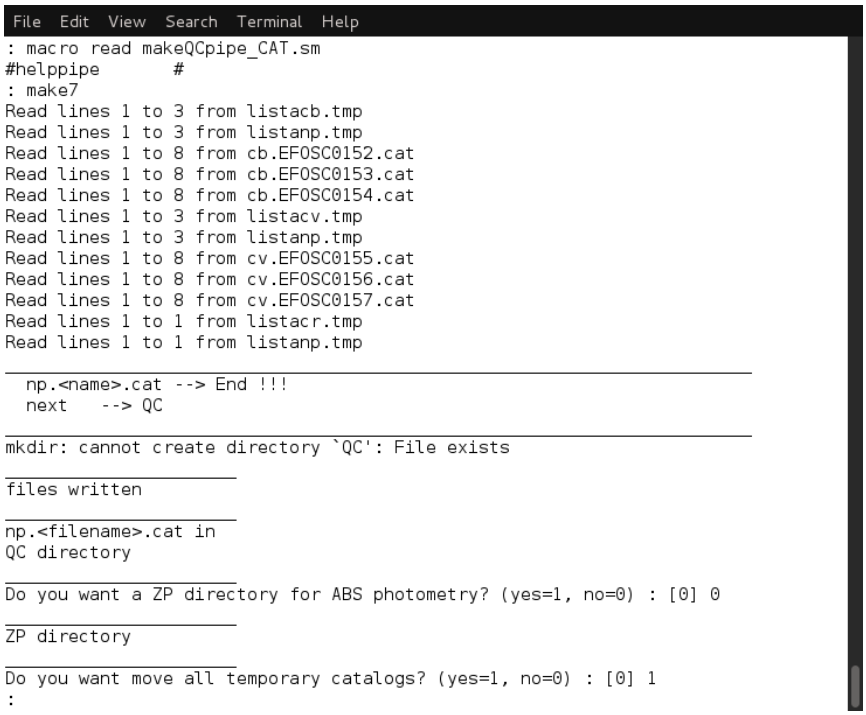

FIGURE 36: The `make7` command.

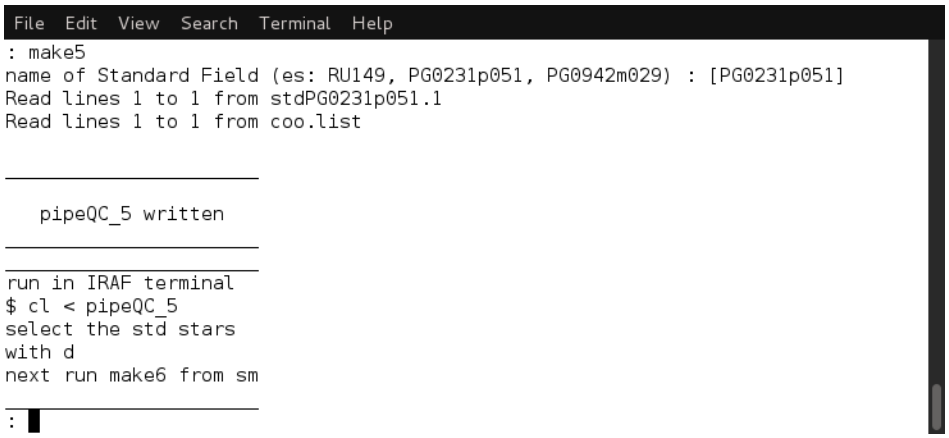

FIGURE 37: The `make5` command.

On the DS9 image display, you can now select the standard stars in the field. So, the first fits frame in B filter is displayed in DS9 automatically. Now, select the standard stars with the command `d` moving the cursor to the centre of the star. To do this you need a finding chart of the standard field in order to identify all stars of interest [29].

[29] `http://yoda.bo.astro.it/wiki/index.php/Standard_Fields`

```
File  Edit  View  Search  Terminal  Help
: QCprep

Read lines 1 to 12 from lista.tmp
Read lines 1 to 12 from lista2.tmp
rm: cannot remove `lista1.tmp': No such file or directory
rm: cannot remove `lista2.tmp': No such file or directory
rm: cannot remove `listaperLTT1020.dat.tmp': No such file or directory
rm: cannot remove `listaperLTT2415.dat.tmp': No such file or directory
rm: cannot remove `listaperLTT377.dat.tmp': No such file or directory
rm: cannot remove `listaperWD0109m264.dat.tmp': No such file or directory
rm: cannot remove `listaperWD0123m262.dat.tmp': No such file or directory
rm: cannot remove `listaperWD0435m088.dat.tmp': No such file or directory
rm: cannot remove `listaperWD0455m282.dat.tmp': No such file or directory
rm: cannot remove `listaperWD0501m289.dat.tmp': No such file or directory
rm: cannot remove `listaperWD0552m041.dat.tmp': No such file or directory
rm: cannot remove `listaperWD0604m203.dat.tmp': No such file or directory
rm: cannot remove `listaperWD0621m376.dat.tmp': No such file or directory
rm: cannot remove `listaperWD0646m253.dat.tmp': No such file or directory
rm: cannot remove `lista.tmp': No such file or directory

  QCprep --> End !!!
  next   --> QCa

: 
```

FIGURE 38: The `QCprep` command.

E.2.2 Step 6. Final NP catalogues

As a final step `make6` changes the output name of the catalogues for archiving and, if desired, removes all temporary catalogues and the macro creates a directory named `QC` that is necessary for QC.

E.3 Example of star level QC

All the aperture photometry catalogues produced using the described procedures have to be submitted to the QC. The *QCphot_NP.m* macro for SPSS or *QCphot_STD.m* for STD allows to perform all QC steps. These macros work for all catalogues present in the directory named `QC`. Download the pipeline from Wiki-bo[30] into the `QC` directory. In order to run this macro you need to follow the procedure described in Appendix C.3. All the QC steps results are saved in two ASCII files. In SM run the command `QCprep` as shown in figure 38. Next, run all commands as described in Appendix C.3. A portion of the `QCa` and `QCaresponse` commands are shown in figure 39.

The final step reads all the created files for each QC level and summarizes them in one single file called *QCresume_<SPSS<_<run>_<date>.txt* in case of SPSS, and *QCresume_<STD<_<run>_<date>.txt* in case of standard fields. In SM run the command

[30] `http://yoda.bo.astro.it/wiki/index.php/QC_Photpipe_STD` or `http://yoda.bo.astro.it/wiki/index.php/QC_Photpipe_NP`.

`QCfile` as shown in figure 40.

```
File  Edit  View  Search  Terminal  Help
Read lines 1 to 15 from np.EFOSC0296.cat
Read lines 1 to 15 from np.EFOSC0297.cat
Read lines 1 to 15 from np.EFOSC0298.cat
Read lines 1 to 15 from np.EFOSC0299.cat
Read lines 1 to 15 from np.EFOSC0300.cat
Read lines 1 to 15 from np.EFOSC0301.cat
Read lines 1 to 15 from np.EFOSC0302.cat
Read lines 1 to 15 from np.EFOSC0303.cat
Read lines 1 to 15 from np.EFOSC0304.cat
Read lines 1 to 15 from spssWD0646m253.all
Read lines 1 to 8 from np.EFOSC0349.cat
Read lines 1 to 8 from np.EFOSC0350.cat
Read lines 1 to 8 from np.EFOSC0351.cat
Read lines 1 to 8 from np.EFOSC0352.cat
Read lines 1 to 8 from np.EFOSC0353.cat
Read lines 1 to 8 from np.EFOSC0354.cat
Read lines 1 to 8 from np.EFOSC0355.cat
Read lines 1 to 8 from np.EFOSC0356.cat
Read lines 1 to 8 from np.EFOSC0357.cat

  QCa    --> End !!!
  next    --> QCaresponse

:
```

```
File  Edit  View  Search  Terminal  Help
np.EFOSC0304.cat --> WARNING: SPSS STAR 4 : QCa failed!!! (flag = 16)
np.EFOSC0304.cat --> WARNING: SPSS STAR 6 : QCa failed!!! (flag = 999)
Read lines 1 to 72 from QCa_spssWD0646m253.all.dat
np.EFOSC0349.cat --> WARNING: SPSS STAR 4 : QCa failed!!! (flag = 999)
np.EFOSC0349.cat --> WARNING: SPSS STAR 5 : QCa failed!!! (flag = 999)
np.EFOSC0350.cat --> WARNING: SPSS STAR 4 : QCa failed!!! (flag = 999)
np.EFOSC0350.cat --> WARNING: SPSS STAR 5 : QCa failed!!! (flag = 999)
np.EFOSC0351.cat --> WARNING: SPSS STAR 4 : QCa failed!!! (flag = 999)
np.EFOSC0351.cat --> WARNING: SPSS STAR 5 : QCa failed!!! (flag = 999)
np.EFOSC0352.cat --> WARNING: SPSS STAR 4 : QCa failed!!! (flag = 999)
np.EFOSC0352.cat --> WARNING: SPSS STAR 5 : QCa failed!!! (flag = 999)
np.EFOSC0353.cat --> WARNING: SPSS STAR 4 : QCa failed!!! (flag = 999)
np.EFOSC0353.cat --> WARNING: SPSS STAR 5 : QCa failed!!! (flag = 999)
np.EFOSC0354.cat --> WARNING: SPSS STAR 4 : QCa failed!!! (flag = 999)
np.EFOSC0354.cat --> WARNING: SPSS STAR 5 : QCa failed!!! (flag = 999)
np.EFOSC0355.cat --> WARNING: SPSS STAR 1 : QCa failed!!! (flag = 4)
np.EFOSC0356.cat --> WARNING: SPSS STAR 1 : QCa failed!!! (flag = 4)
np.EFOSC0356.cat --> WARNING: SPSS STAR 4 : QCa failed!!! (flag = 999)
np.EFOSC0357.cat --> WARNING: SPSS STAR 1 : QCa failed!!! (flag = 4)

  QCaresponse    --> End !!!
  next           --> QCb

:
```

FIGURE 39: Last lines of the `QCa` and `QCaresponse` commands.

```
File  Edit  View  Search  Terminal  Help
Read lines 25 to 30 from QCb_responsespssWD0646m253.all.dat
Read lines 25 to 30 from QCc_responsespssWD0646m253.all.dat
Read lines 25 to 30 from QCd_bisspssWD0646m253.all.dat
Read lines 31 to 36 from QCa_responsespssWD0646m253.all.dat
Read lines 31 to 36 from QCb_responsespssWD0646m253.all.dat
Read lines 31 to 36 from QCc_responsespssWD0646m253.all.dat
Read lines 31 to 36 from QCd_bisspssWD0646m253.all.dat
Read lines 37 to 42 from QCa_responsespssWD0646m253.all.dat
Read lines 37 to 42 from QCb_responsespssWD0646m253.all.dat
Read lines 37 to 42 from QCc_responsespssWD0646m253.all.dat
Read lines 37 to 42 from QCd_bisspssWD0646m253.all.dat
Read lines 43 to 48 from QCa_responsespssWD0646m253.all.dat
Read lines 43 to 48 from QCb_responsespssWD0646m253.all.dat
Read lines 43 to 48 from QCc_responsespssWD0646m253.all.dat
Read lines 43 to 48 from QCd_bisspssWD0646m253.all.dat
Read lines 49 to 54 from QCa_responsespssWD0646m253.all.dat
Read lines 49 to 54 from QCb_responsespssWD0646m253.all.dat
Read lines 49 to 54 from QCc_responsespssWD0646m253.all.dat
Read lines 49 to 54 from QCd_bisspssWD0646m253.all.dat

  QCfile   --> End !!!
  QCresume Done

:
```

FIGURE 40: Last lines of the `QCfile` command.