# Pyxis V2

OBD-CoCo-08
V0.3

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March 1, 2004

**Abstract**

Pyxis[1] is the software package developed for the data processing on-board Gaia. The Pyxis package encompasses the detection (`GD`), selection (`sell`), and cross-matching (`xcorr`) algorithms as well as the test environment used in the Astro and Spectro instruments. Its dual use is the evaluation of the resources needed for the Payload Data Handling Electronics contract (PDHE) and the simulation of the scientific output for the Gaia GIBIS simulator.

## 1 Introduction

The scientific algorithms to be used on-board Gaia cover a large range, from the detection, confirmation, selection and object tracking, the sky background estimation, the classification of the detected objects, to the NEO/KBO detection by cross-matching. The Gaia Payload Data Handling Electronics (PDHE) contract, started at the beginning of 2003, aims at designing the implementation architecture for the Payload Data Handling System, and to develop a representative breadboard [Armbruster, 2001]. The estimation of the resources needed on-board depend crucially on the availability of the algorithms, and a very significant effort has thus been devoted to tailoring and providing technically realistic software

The scientific requirements are to detect and download all objects down to about 20 mag, with few false detections [Babusiaux & Arenou, 2001]. This is also required for moving, saturated, double or extended objects, with a robustness with respect to crowded fields, high and varying background, and cosmic rays. The first step of the on-board data handling consists thus in detecting all these objects. In the beginning of 2003, the detection algorithm (GD) which had been developed [Chéreau, 2002] was representative of a part of the scientific needs of Gaia.

[1]Pyxis is a constellation of the Southern hemisphere also known as the "Compass", i.e. the instrument which shows the way, one of the functions of the on-board software through the scan rate determination. The new Latin word *Pyxis* comes from the Greek *Puxis* (box), and is a reference to the pixel boxes transmitted by the on-board software.

Originally a part of the former *Argo Navi* constellation, the Pyxis constellation, at the edge of the Milky Way, was named in 1752 by the Paris Observatory astronomer Nicolas-Louis de La Caille (1713-1762). During his stay at the Cape of Good Hope, he measured the positions of about 10000 stars during 110 10-hours observation sessions and named 14 constellations, among which Pyxis, to organise the measured stars.

Pyxis stands for PYXel Instrument Software, where the "Y" instead of "I" should be the only software bug...

Initially based on the APM algorithm, the GD algorithm implemented sky background estimation, object detection (stellar or extended), object centroiding, flux and shape measurements, and primitive object discrimination (star, saturated star, extended object) [Mignot, 2003a]. Although it relied on a Gaia-specific line-spread function for along-scan centroiding and buffered data to account for the Time Delayed Integration (TDI) motion, many adaptations to the Gaia case had not yet been done.

During 2003 the detection algorithm underwent profound modifications in two respects. In a first step, the algorithm capabilities were increased with the improvement of double star detection (which should be detected to as close separations as possible because the cut-off of their flux renders the astrometric reduction difficult), and the rejection of false detections on stellar spikes. With the first industrial analysis received in April [Schaefer, 2003a] and discussions on alternative algorithms [Arenou et al., 2003] it became clear that it would be difficult to implement the algorithms as they stood within the framework of the foreseen on-board data handling resources – namely to be able to handle the maximum object density in continuous mode. Beside achieving much improved stability and efficiency, most of the development has thus been focused on easing migration towards a mixed hardware/software implementation. In-depth analysis of the algorithms has led to a thorough rewrite adapted to the target architecture: the hardware part would deal with pixel-based operations, while the object-based operations would be done in software. Demonstrating the feasibility of the pixel-based operations has led to designing original methods devoted to the connected-component search [Mignot, 2003b] or to the deblending scheme for overlapping components [Mignot, 2003c]. A fast estimation of sky background has also been devised [Arenou et al., 2003]. Finally, the software has been extensively reviewed in order to provide a realistic approximation of on-board operation: data types have been tightly adjusted to suit the underlying scientific requirements, simple logic and low-level implementation have been introduced wherever a hardware implementation might be used, as have threads to fully specify the degree of interdependence of sub-tasks and emulate hardware-based processing. Iterations between the industrial implementation analysis [Schaefer, 2003b, Schaefer, 2003a] and their evaluation [Mignot & Arenou, 2003] for other possible trade-offs are still on-going. All these efforts aim at altogether limiting the complexity on the pixel side, ensuring that the data flows on the object side are reduced and providing a realistic framework for both estimating needed on-boar resources and expressing scientific requirement. In this respect, the selection algorithm also plays a significant role.

In effect, after detection, the objects must be either rejected or selected and then followed in the focal plane with an adapted windowing. Allocating windows for the detected stars does not seem to be, at first sight, a difficult problem. Several issues conspire, however, to make this selection task more complicated than simply assigning boxes of various sizes at given positions. For thermal stability reasons, the number of CCD read samples has to be kept constant to a value defined either by an assumed maximum density, or by the dimension of the CCDs. In practice, there will be cases (in particular in the spectro instrument, due to the low angular resolution) where the number of detected objects largely exceeds the available number of samples. This implies associating scientific priorities to the different objects. Because the samples cannot overlap (being electronically binned), a large fraction of the objects might not be selected in either dense fields, or simply, in double or multiple systems. Moreover, the processing being performed under stringent real-time constraints, the choice of the windows must be done on a local scale, with no possibility of changing the previous window assignments – this would back-propagate the window area conflicts. Additionally, the processing cannot make use of an image in memory of the pixels rows in order to simulate the areas covered by windows (as was done in the first version of the selection algorithm [Cira & Arenou, 2002]), as the TDI motion would require a real-time management much too demanding. Maximising the number of observations in crowded fields or for multiple systems, i.e. the scientific return, while respecting these technical constraints has been done using several ideas: favouring overlapping of windows (without overlapping of samples, as can be done in AF1), allowing a slight displacement of the windows, reducing the size of the windows when possible (AF11, BBP), or tiling several short windows to cover multiple systems. A new selection algorithm has been written this year [Chaussard, 2003], allowing a possible multi-threaded approach, and implementing all the complexity outlined above.

The complex sampling, windowing and, more generally, the scientific requirements for the on-board strategy on which the selection algorithm is based have been described in [Høg et al., 2003] and the windowing has further been refined [De Bruijne, 2003b] based on studies relative to the properties of the sky [De Bruijne, 2003a], in the average or worst-case (the Baade window) stellar densities in Astro. Together with [Chassat, 2003], these clarifications have allowed to decrease the foreseen budget of the on-board processing load.

While, in a first step, the analysis and developments concerned mostly the Astro instrument, a growing involvement now occurs for the sky mappers of the Spectro instrument. Whereas the detection and selection algorithms are developed with the goal to implement them also for the Spectro Sky Mappers (Ssm) processing, the role of the Ssm themselves had to be refined. Initially proposed in [Pouny, 2003], the dual role of star detection for further selection of spectra [Chéreau, 2003] and moving objects (Neo/Kbo) detection has led to the development of a dedicated cross-matching algorithm [Chéreau, 2004].

Beside the evaluation of the processing load on-board, the developed algorithms are directly implemented in the Gibis pixel simulator [Babusiaux, 2002] and used for the assessment of the scientific performances. [Arenou et al., 2003a, Arenou & Lim, 2003], for instance, compare Gd to various other algorithms. As these performances have to be used for further evaluations of telemetry flow and database content, a simplified model and the associated code have been developed, mostly for use within the Gass Gaia simulator [Arenou & Lim, 2003].

The various algorithms are being developed at the Observatoire de Paris, with the support of Cnes funding. The involvement now represents approximately 2.5 full-time equivalents. The resulting amount of software development in the last 18 months exceeded 20 thousand lines of source code, although the current rewriting of the software towards a hardware way of thinking probably render this last estimate hardly representative of the actual involvement. Four researchers/engineers and five students have contributed to the past and current deliveries, for a total estimated to about 6 (wo)man-year.

Several successive software versions have been delivered in 2003 and before (see Appendix for the history of changes) with a major release (1.5) in March [Arenou et al., 2003b] and an upgrade (RC2) in October. This document (updating [Arenou et al., 2003b]) stands as an announcement for the new stable 2.0 release. Except when indicated, the package meets the scientific requirements as formulated in [Høg et al., 2003]. It contains several modules. The first, and most mature one, `GD`, implements object detection and a set of measurements, the second, `sel1`, implements object selection and window assignment, finally `xcorr` performs cross-matching for Neo detection in spectro. The Swa detection algorithm [Babusiaux, 1999] is still provided, mainly for reference and comparison purposes. All are described in this document and more thoroughly in all the referenced documents. They are written in the C language to comply to the Pdhe needs and have been ported across a number of different architectures.

On-going studies and development are related to refining the set of measurements and associated methods in order to finely adjust the software part, perform classification, and implement star / cosmic ray discrimination capabilities as well as confirmation. Apart from further adapting the software to the various technical and processing constraints, while maintaining or increasing the scientific return, the general aim is to provide a complete, robust and accurate model of object management in the Astro and Spectro focal planes.

## 2 Assumptions

In the following we use the Astrium design and the corresponding CCD nomenclature, as described in [Bastian, 2003]. In summary, for what concerns the Astro instrument, the detections are thus done in the ASM1 CCD, corresponding to the Astro-1 Field of View (FOV) and in ASM2, corresponding to the Astro-2 FOV. Both detections allow for selecting the windows to be observed in AF1 (first selection). Confirmation then occurs and runs the detection again on the windows observed in AF1. Then, the objects, if confirmed, undergo a second selection for the AF2-10 observations. These objects only can be observed in AF11 and BBP1-5 later on. However, only a part of them will be observed in these instruments in cases of high stellar density, as windows are larger and additional conflicts will occur (samples must not overlap).

In the spectro instrument, the objects are detected in SSM1 and detected in SSM2, then cross-matching is performed between these two detection lists. Finally the selection procedure is applied providing the addresses of the windows to be observed in the following Spectro CCDs. Beside photometry, one of the CCDs has a special role, which is the prediction of the spectra to observe in the RVS field.

The purpose of confirmation (Astro) or cross-matching (Spectro) is primarily to remove the detections due to cosmic-rays. A cross-matching is used in Spectro as the use of windows would otherwise discard too many detections, due to crowding. Besides, the cross-matching also tries to detect NEOs, i.e. objects whose motion is significant.

The sizes of samples and windows and the processing in the various CCDs follow the requirements in GAIA-CUO-117 ([Høg et al., 2003]) and updated in [De Bruijne, 2003b], and the current assumed values can be found in the Appendix. From now on, the Gaia Parameter Database [De Bruijne et al., 2003] will supersede these values.

For the moment, we rely on FITS images to simulate the observed data. The Input/Output data exchange in the following algorithms is thus emulated the following way:

- the input to the detection algorithm is provided using a FITS image (extension `*.fits`).
- the communication between the detection algorithm (output) and the selection algorithm (input) is done with a standard unix file (`*.detect`), where each ASCII line represents a detection and contains the needed information per object;
- the communication between the first selection algorithm (output) and the confirmation algorithm (input) is done with a file (`*.AF1select`)
- the (new) confirmation algorithm is not available yet. However most of the operations can be found in the detection software, although the whole detection features are however not used: no need to compute the sky background (propagated from the ASM), or to filter the data.
- the output of the first on-board selection is a file containing the samples read for the confirmation (output, `*.samp`) and a file containing the objects confirmed and selected to follow (output, `*.select`).
- The remaining selections and tracking in the following CCDs are done as for the first selection process.

It should be mentioned:

- that the FITS reading/writing modules should not be accounted for in the evaluation of the on-board resources; that it should be replaced by a simulation of the actual CCD accesses;

- that nothing in the software is related to what is actually pre-processed (possible calibration prior to the detection), downloaded, nor post-processed (numerical binning, compression, RVS reduction of data volume, telemetry formatting, etc).

- that the dating of events (TDI) is replaced internally by a pixel number along-scan.

# 3 The GD detection algorithm

The high-level description of the GD algorithm is given in the OBD-SM-02[Mignot, 2003a] document. The algorithm performs the following functional requirements described in section 7.A.2 of [Armbruster, 2001]:

- sky background estimation
- object detection
- star/bright star/galaxy/other object discrimination
- object centroiding, flux and shape parameters

The current status is summarised in Table 1. Both the man page and OBD-SM-004 documents are forthcoming. Significant updates have been made to [Mignot, 2003a] and [Mignot, 2003b] in the preparation of the 2.0 release.

Table 1: *GD capabilities. Future developments are those which have been partly implemented or prototyped only.*

| Function | Status | Reference |
|---|---|---|
| Streamline (follows TDI lines) | Yes | [Mignot, 2003a, OBD-SM-002] |
| Threads (background + per object) | Yes | [Mignot, 2003a, OBD-SM-002] |
| Server mode | Yes | man page |
| ADU handling | Yes | - |
| Pixel floating point operations removal | Partly | [Mignot, 2003d, OBD-SM-007] |
| Connected components for hardware | Yes | [Mignot, 2003b, OBD-SM-006] |
| One-pass deblending for hardware | Yes | [Mignot, 2003d, OBD-SM-007] |
| Deblending optimisation for DMS | Yes | [Mignot, 2003c, OBD-SM-003] |
| Fast sky background estimation | Yes | [Arenou et al., 2003a, OBD-CoCo-005] |
| Bright star numerical/CCD gating | Yes | man page |
| Saturation of bright stars (flux/centroid) | Partly | [Chéreau, 2002, OBD-FC-001] |
| LSF fitting (flux/centroid) | Partly | [Chéreau, 2002, OBD-FC-001] |
| Remove false detections on spikes ($G > 7$) | Yes | OBD-SM-004 |
| Object classification | Proto | [Chéreau, 2002, OBD-FC-001] |
| Confirmation (except detection step) | Proto | [Cira & Arenou, 2002, OBD-HC-001] |
| Optimisation of code | Yes | [Mignot, 2003d, OBD-SM-007] |

For what concerns the on-board processing requirements, some default parameters (e.g. detection thresholds) have been chosen, but are not fixed, because a compromise between scientific return, speed, and telemetry budget should be found. For example, the detection threshold have been defined such as to ensure less than one false detection per million samples in a field of average stellar density. They could be chosen smaller as the confirmation step also allows for discriminating wrong detections due to noise. One reason which prevents the thresholds to be fixed now is the uncertainty on the actual cosmic rays rate. The current adopted thresholds are given in the first lines of the `GaiaDetect.pl` script and in the `.ds9.ans` configuration file.

# 4 The selection algorithm

For this algorithm, the following functional requirements were planned in sections 7.A.2 and 7.A.3 of [Armbruster, 2001]:

- cosmic rate discrimination: no special implementation is done, it is intended to discard the objects not confirmed;
- scan rate determination: computing the time difference between ASM and AF for well-behaved stars is not yet implemented.
- acquisition of star data stream in the astro instrument: done for spectro also, and a lot of requirements [Høg et al., 2003] have been added and implemented since [Armbruster, 2001].

The `sel1` program is used for the first and subsequent selections. It uses the `SelectConfig.txt` configuration file (see below). The algorithm is described in [Chaussard, 2003] and [Arenou & Lim, 2003] and its capabilities are summarised in Table 2.

Table 2: *Selection capabilities (see [Chaussard, 2003, OBD-JC-001]).*

| Function | Status |
|---|---|
| Limited magnitude for selection | Yes |
| Maximum number of samples per row | Yes |
| Window overlapping (without sample overlap) | Yes |
| Sample and window sizes in all CCDs, all mag | Yes |
| Standard/Short window sizes on the fly | Yes |
| Move by a few pixels of windows | Yes |
| Tiling of the windows | Astro only |
| Confirmation (except detection step) | No |
| Transverse motion | No |
| Threads | Partly |
| Optimisation of code | No |

# 5 The cross-matching algorithm and other SSM processing

This algorithm, `xcorr`, used in the spectro instrument only, was not planned in [Armbruster, 2001]. It uses the `SelectConfig.txt` configuration file (see below). The algorithm is described in [Chéreau, 2004] and its capabilities are summarised in Table 3.

To this algorithm should be added the processing to be done in the CCD with the 861 filter (same s RVS) for the spectra prediction. It is still in definition phase (see [Chéreau, 2003, OBD-FC-002]).

# 6 Package description

Together with this document, the following data are given:

Table 3: *Cross-matching capabilities (see [Chéreau, 2004, OBD-FC-003]).*

| Function | Status |
|---|---|
| Cross-matching | Yes |
| NEO detection | Yes |
| False NEO detections removal | Partly |
| Transverse motion | Yes |
| Threads | No |

- GD detection software: source files, header files, configuration files (line-spread function, and magnitude correction for saturated stars, `*.spl`), Makefile, documentation.
- SWA detection software: source files, header files, configuration file (point-spread function, `psf_+1.0_13.fits` corresponding to point 13 of the astro field), Makefile, documentation.
- `sel1` selection software: source files, header files, configuration file (`SelectConfig.txt`), Makefile, documentation.
- `xcorr` cross-matching software: source files, header files, configuration file (`SelectConfig.txt`), Makefile, documentation.
- FITS images (`*.fits`) produced by the GIBIS simulator from a list of input sources (`*.cat`) containing x,y (pixel) and G magnitude. Simulation information in the `*.README`.
- a makefile to construct all this and perform tests using the `ds9/xpa` software (when available locally).

The calling procedure for these algorithms is not described here: for simplification purposes, perl scripts are also given and described below.

The configuration file (`SelectConfig.txt`, in the `tests` directory) is described in the appendix. It contains all the instrument parameter used by the selection process. It will be replaced by an output of the Gaia Parameter Database, and currently contains both the Gaia Parameter Database parameter names and those used internally, for compatibility purposes.

The given images are the following, and their filenames indicate in which sky mapper they have been simulated, together with the sample binning:

- `BaadeDupli_ASM1_2x2.fits`, represent the Baade window (HST data duplicated AC to cover a CCD), corresponding to a density of about 4 million stars per square deg. up to magnitude 20, in ASM1. This file represents about 0.5 s scanning time in the Astro field.
- `f25k_SSM*_1x1.fits`, `f50k_SSM*_1x1.fits`, `f130k_SSM*_1x1.fits`, `f1M_SSM*_1x1.fits` represent respectively 25 000, 50 000, 130 000 and 1 million stars per square degree in the spectro instrument, with a 5.5s exposure time. It should be noted that the Spectro design has just changed, but simulations are not yet implemented, and these images represent simulations of the former design in RVSM. For future compatibility purposes, we have however used the denomination `SSM`.
- `G23lb_0,25_ASM1_2x2.fits`, `G23lb_0,25_SSM1_1x1.fits`, are simulations at latitude 25°, corresponding to a density of about 25 000 stars per square deg. up to magnitude 20. They represent 1.9 s and 5.5 s scanning duration in Astro and (former) MBP fields respectively.

- `l74b0_ASM1_2x2.fits`, `l74b0_SSM1_1x1.fits`, corresponding to a density of about 50 000 stars per square deg. up to magnitude 20. They represent 1.9 s and 5.5 s scanning duration in Astro and (former) MBP fields respectively.

- `BaadeDupli_cosmic_mean_ASM1_2x2.fits`, same as above, with (unrealistic) simulations of cosmic rays.

Several among these files have a corresponding `*_nonoise.fits` which is the file without binning and without RON of the observation in the following CCDs (AF1 for ASM, MBP3 for SSM) and are used to generate samples. The files `f*_SSM*_1x1.fits` are used for testing the cross-matching.

These images represent a small satellite transit duration only (the reason being partly to save disk space), and can be duplicated several times along scan with the given software (option `--dimal` in GD) to simulate a long transit through the instruments. Note that if duplication of the images is done, it should be done both on the images with and without noise, and the list of input sources `*.cat` should also be extrapolated with the correct shift of input positions.

# 7 Porting

Just type `make`. This does the compilation and runs a test with `ds9`. All softwares have been tested on:

- Apple Powerbook PowerPC G4 (1.1) + Mac OS X (10.3.2) + gcc version 3.3 20030304 (Apple Computer, Inc. build 1495)

- Compaq XP 1000 Alpha EV6 (64 bits) + Digital UNIX V4.0E + native cc

- Dell PC server PowerEdge 4600 + Linux RedHat 7.3 + gcc version 2.96 20000731

- HP xe 4500 + Linux Mandrake 9.2 + gcc version 3.3.1

- Pentium III 600 MHz + Linux Debian testing/unstable (above version 3.0) + gcc version 3.3.2.

and should thus be ported on other architectures/OS/compilers without too much trouble. It is implicitly assumed that a `gcc` compiler, a `make` (preferably `gnumake`) is available, otherwise the call should be: `make CC=mycompiler MAKE=mymake`. Editing GD/Makefile is required to compile on Alpha architectures. Support can be provided for Unix (including Linux and Mac OS X) but not for other operating systems.

# 8 Tests

In order to ease the tests, several test procedures in perl (assuming `perl` has been installed in `/usr/bin`) are given in the `tests` directory, and should be run in this directory only. These procedures are the easiest way to do the analysis with shell commands as they use by default the adopted configuration for detection and selection. They also provide an easy way to know how to call the detection and selection software. The scripts are:

- `GaiaDetect.pl`: runs the GD detection

- `GaiaSwa.pl`: detection using SWA

- `GaiaXmatch1.pl`: runs the cross-matching (SSM only)

- `GaiaSel1.pl`: runs the first selection
- `GaiaSel2.pl`: selection and tracking in the following CCDs
- `GaiaWin.pl`: output the samples of the selected windows
- `GaiaSources.pl`: shows the input sources in `ds9`
- `GaiaStat.pl`: statistics on the detection
- `GaiaErrors.pl`: indication of false and non-detection

These scripts generally take as first argument the name (with or without `.fits` extension) of the `FITS` file. They assume more or less that the `FITS` filename contains the name of the sky mapper (ASM1, ASM2, SSM1), and the sampling (due to the sampling design in ASM which has varied with time). In general, further arguments on the command line of these scripts are passed to the relevant program (GD, etc.).

In particular, these scripts are used by the `ds9` program, and written in its analysis file `.ds9.ans`. Through its graphical interface, the program `ds9` provides the easiest way to do the analysis. Juste type `make` followed by the `FITS` filename (without the `.fits` extension), then will be `ds9` is called, and the detection/selection is done. Typing `make` alone uses `BaadeDupli_ASM1_2x2` by default. The result for the Baade window in BBP is shown in Figure 1. Then one may go to the `Analysis` menu, and several analysis are possible at the end of this menu (note that the sub-menus may be detached from the menus by clicking on the dashed line). For example, cumulative plots of the object magnitudes, or statistics on detection can be accessed this way (this calls respectively the scripts `GaiaCumMag.pl` and `GaiaStat.pl`).

Several of the program or scripts build regions which are superimposed on ds9 images. For this purpose, intermediary files are written. Their names are `*.reg` for SWA and `xcorr`, `*.ell` for GD, `*.sel` for the selection, `*.cross` for the position of the input stars.

Sscript support for other detection algorithms (`APM` and `SExtractor`) has also been included, but the corresponding programs are not given. Note that these programms my need to be modified in order to support the `BITPIX=-16` coding used in the FITS files.

## 9 Example

A typical run could be to count the number of samples to be read in the "worst" case: the Baade window file.

```
GaiaDetect.pl BaadeDupli_ASM1_2x2
GaiaSel1.pl BaadeDupli_ASM1_2x2
GaiaSel2.pl BaadeDupli_ASM1_2x2 AF2
GaiaSel2.pl BaadeDupli_ASM1_2x2 AF11
GaiaSel2.pl BaadeDupli_ASM1_2x2 BBP1
```

Finally the samples in e.g. AF11 are obtained by:

```
GaiaWin.pl BaadeDupli_ASM1_2x2 AF11
```

## 10 File formats

- `*.fits`: FITS is a widely used format in the astronomic field. Its description may be found on the WWW. FITS images contain an ASCII header followed by binary data.

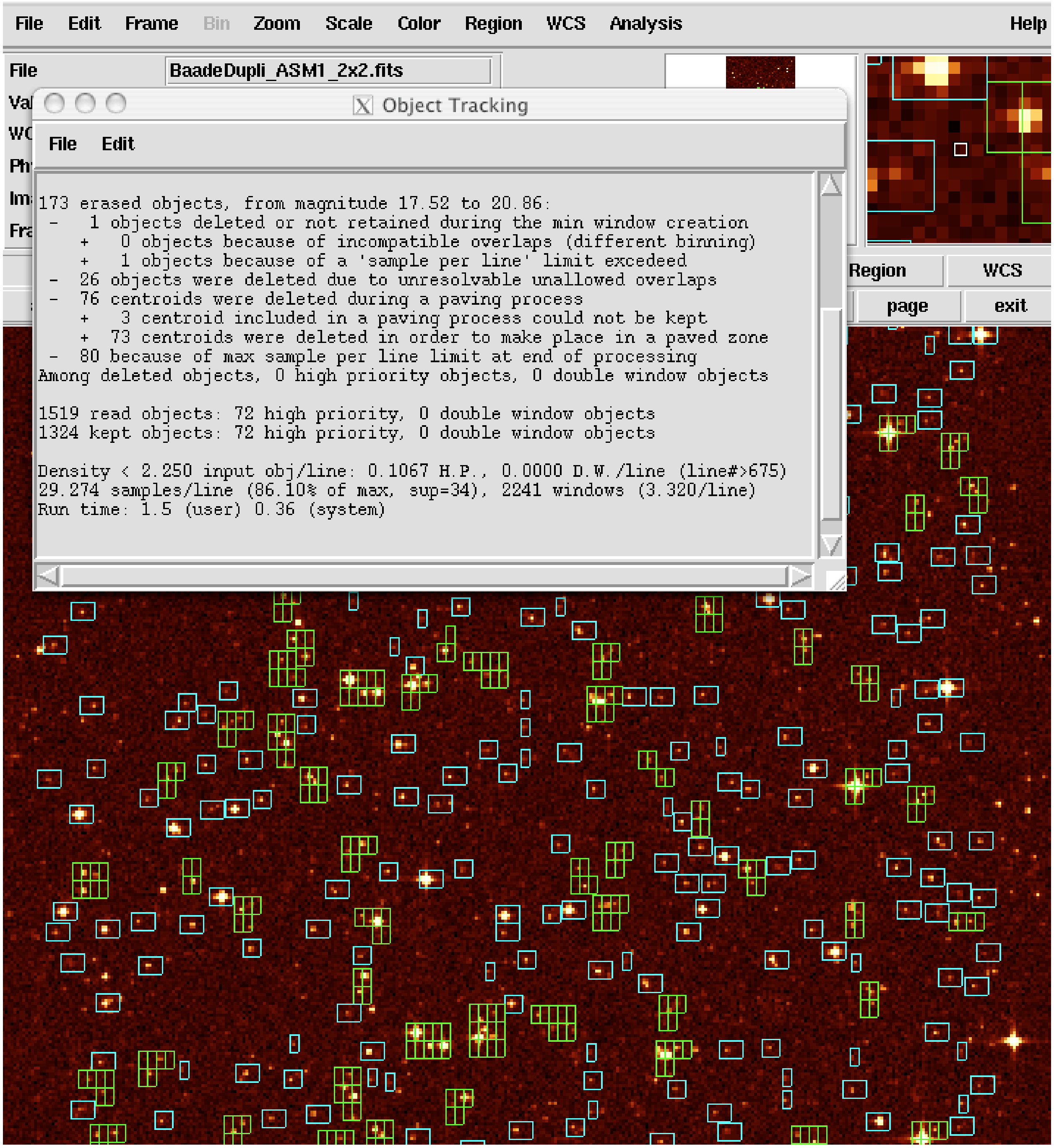


Figure 1: *Snapshot of the BBP1 selection of objects in the Baade window, using the ds9 program. Small blue windows are for very faint stars, green windows for tiling of multiple systems, the other windows for normal stars. The foregound text is the summary of the selection analysis.*

- `*.cat`: $x, y, G$ magnitude, with $x$ and $y$ in pixels
- `*.detect`: a CCD code representing the number of the CCD across-scan and the number of the ASM (11 is used here), number of object, $x$,$y$, flux, background, snr, object type, major axis, minor axis, orientation (see `Gd` documentation), with $x, y$ in sample.
- `*.select`: CCD code, identification of object (for labelling), $x, y$ etc, as above, this being the result of the selection, with $x, y$ in pixel.

- `*.samp`: starnum oldflux bgpix numsamplesAL numsamplesAC (sampleALpospix(1,j) sampleACpospix(1,j) (sampleFlux(i,j) i=1,numsamplesAL) j=1,numsamplesAC)
- `*.xmatch`: $x, y, G$, $x, y, G$, $x, y, G$, $x, y, G$ in the 4 SSM CCDs

The convention for positions is the same as the one adopted for FITS image, that is (1,1) for the center of the first pixel.

## 11 Bugs and missing features

Care has been taken to develop the detection algorithms with the required level of software quality, although portability problems may nevertheless occur. For example, no memory leaks should remain.

When using the perl scripts mentionned above, the error message "XPA$ERROR no 'xpaset' access points match template: " may appear, which simply shows that `ds9` with the image and the correct title, or the communication with `ds9` using `xpa`, is not running, but this has no impact on the selection/detection process, just on the visualisation of it.

There are also several missing features, which are indicated in the Tables above. All this means that development will continue in these directions.

## References


[Arenou et al., 2003] Arenou F., Babusiaux C., Høg E., Jordi C., Mignot S., 2003, Determination of sky background, Technical Report OBD-CoCo-007, Observatoire de Paris, http://-wwwhip.obspm.fr/gaia/obd/OBD-CoCo-07.pdf

[Arenou et al., 2003] Arenou F., Babusiaux C., Mignot S., 2003, Comments on GP-ASG-RS-0001 implementation analysis, Technical Report OBD-CoCo-006, Observatoire de Paris, http://wwwhip.obspm.fr/gaia/obd/OBD-CoCo-06.pdf

[Arenou et al., 2003a] Arenou F., Babusiaux C., Mignot S., 2003a, Detection performances in the ASM (I), Technical Report OBD-CoCo-005, Observatoire de Paris, http://-wwwhip.obspm.fr/gaia/obd/OBD-CoCo-05.pdf

[Arenou et al., 2003b] Arenou F., Babusiaux C., Mignot S., 2003b, Input to PDHE contract, Technical Report OBD-CoCo-003, Observatoire de Paris, http://wwwhip.obspm.fr/gaia/-obd/OBD-CoCo-03.pdf

[Arenou & Lim, 2003] Arenou F., Lim J., 2003, Simulation of the on-board detection, Technical Report OBD-FAJCL-001, Observatoire de Paris, http://wwwhip.obspm.fr/gaia/obd/OBD-FAJCL-01.pdf

[Armbruster, 2001] Armbruster P., 2001, Payload data handling electronics – SOW and technical requirements, Technical Report GAIA/TADG21/2001, ESA–ESTEC

[Babusiaux, 1999] Babusiaux C., 1999, SWA - Sliding Window Algorithm - V1.0 users guide, Technical report, Observatoire de Paris

[Babusiaux, 2002] Babusiaux C., 2002, Gibis, Gaia Instrument and Basic Image Simulator, Technical Report GAIA-CB-01, Observatoire de Paris, Institute of Astronomy, Cambridge, http://wwwhip.obspm.fr:8080/gibis

[Babusiaux & Arenou, 2001] Babusiaux C., Arenou F., 2001, Work reference document, Technical Report OBD-CoCo-01, Observatoire de Paris, http://wwwhip.obspm.fr/gaia/obd/OBD-CoCo-01.pdf

[Bastian, 2003] Bastian U., 2003, Reference systems, conventions and notations for Gaia, Technical Report GAIA-ARI-BAS-003, ARI Heidelberg

[Chassat, 2003] Chassat F., 2003, Note on the Astro VPU processing load, Technical Report -, EADS-Astrium

[Chaussard, 2003] Chaussard J., 2003, On-board selection algorithm for Gaia, Technical Report OBD-JC-001, Observatoire de Paris

[Chéreau, 2002] Chéreau F., 2002, Gaia_Detect documentation, Technical Report OBD-FC-01, Observatoire de Paris

[Chéreau, 2003] Chéreau F., 2003, SSM5-6 red-coated CCDs sampling strategy analysis, Technical Report OBD-FC-002, Observatoire de Paris

[Chéreau, 2004] Chéreau F., 2004, Cross-matching algorithm description, Technical Report OBD-FC-003, Observatoire de Paris

[Cira & Arenou, 2002] Cira H., Arenou F., 2002, First implementation of the selection algorithm, Technical Report OBD-HC-001, Observatoire de Paris

[De Bruijne, 2003a] De Bruijne J., 2003a, PDHE load assumptions – properties of the sky, Technical Report GAIA-JdB-009, ESA–ESTEC

[De Bruijne, 2003b] De Bruijne J., 2003b, Windowing and sampling for faint stars in Astro, Technical Report GAIA-JdB-011, ESA–ESTEC

[De Bruijne et al., 2003] De Bruijne J., Lammers U., Perryman M. A. C., 2003, A proposal for a Gaia parameter database, Technical Report GAIA-JdB-007, ESA–ESTEC

[Høg et al., 2003] Høg E., Arenou F., Mignot S., et al., 2003, Scientific requirements for the on-board processing, Technical Report GAIA-CUO-117, -, http://wwwhip.obspm.fr/gaia/-obd/CUO-117.pdf

[Mignot, 2003a] Mignot S., 2003a, Flowcharts of the SWA 2.5 and GD 1.5 detection algorithms, Technical Report OBD-SM-002, Observatoire de Paris

[Mignot, 2003b] Mignot S., 2003b, A hardware-oriented connected-component labeling algorithm, Technical Report OBD-SM-006, Observatoire de Paris

[Mignot, 2003c] Mignot S., 2003c, An improved deblending scheme for Gaia's on-board detection, Technical Report OBD-SM-003, Observatoire de Paris

[Mignot, 2003d] Mignot S., 2003d, On-board detection – a representativity and feasibility update, Technical Report OBD-SM-007, Observatoire de Paris

[Mignot & Arenou, 2003] Mignot S., Arenou F., 2003, Comments on the PDHE data package, Technical Report OBD-SMFA-001, Observatoire de Paris

[Pouny, 2003] Pouny P., 2003, SSM (RVSM) redundancy scheme, Technical Report GAIASYS.NT.00083.T-ASTR, EADS-Astrium

[Schaefer, 2003a] Schaefer C. H., 2003a, Analysis of Gaia star detection and selection algorithms from implementation point of view, Technical Report GP-ASG-RS-001, EADS-Astrium GmbH

[Schaefer, 2003b] Schaefer C. H., 2003b, PDHS requirements, Technical Report GP-ASG-RS-0002, EADS-Astrium GmbH

# 12 Appendix A: assumed configuration

The adopted configuration is the following, and may be found in the file `SelectConfig.txt` which is read by the selection algorithm and perl scripts. It contains the cross-reference between the name used in the parameter database, and the names still in use (for the moment) in the Pyxis package.

```
#+++++++++++++++
#.ID            $Id: OBD-CoCo-08.tex,v 1.2 2004/03/01 12:49:56 arenou Exp arenou $
#.LANGUAGE      None
#.AUTHOR        F.Arenou, J. Chaussard, F. Chereau, H. Cira
#.ENVIRONMENT   All
#.KEYWORDS      Gaia, selection
#.PURPOSE       These are the constants read by the window selection program
#.VERSION       1.4 mostly based on CUO-113 and DMS-SS-03 + RVS R=11500+tilt
#.VERSION       2.0 intermediate version compatible with a text output of the
#               parameter database
#.COMMENT       We now assume that the SSM confirmation is done in SSM2
#.COMMENT       Revised by ...
#
#******************************************************************************#
# Names follows the Java writing of constants and are generally under the     #
# form: KIND_WHAT_WHERE_UNITS                                                  #
#   Kind: NB (number of), SIZE, SEP (separation), LIMIT, VEL (speed)           #
#   What: CCD, WINDOW, BINNING, etc                                            #
#   Where: AL (ALong-scan), AC (ACross-scan), CCD, SATUR (saturated zone)      #
#   Units: PX (pixel), SAM (sample), SEC (of time)                             #
# Names of CCD are 3 or 4 letters, shortcuts being:                            #
#          AFX for any of the Astrometric Field CCD between 2 and 10           #
#          BBPX for BBP 2-5, RVSX for any of RVS CCDs, SSM MBP/RVS sky mapper #
#          AXX is any CCD in Astro (ASM+AF), MXX in MBP                        #
#          BXX for BBP, XXX when not relevant                                  #
# Sky mappers are rarely mentionned as the selection process occurs after     #
#******************************************************************************#

################################################################################
#                              S A T E L L I T E                              #
################################################################################

# Motion along and across-scan (AC periodic change not accounted for here)
                                        Satellite:ScanRate_Nominal        60       VEL_SCANRATE_AL_SPS  XXX
Astro:FocalPlane_StarTransitSpeed_AC_MaximumMilliArcsecondPerSecond   173.84      VEL_SCANRATE_AC_MPS  XXX
                            Satellite:ScanRate_MeasurementInterval        1       TIME_ADJUST_SCAN_S   AF1

################################################################################
#                            C C D   G E O M E T R Y                          #
################################################################################

# Number of CCDs across-scan in the focal plane #
                                        Astro:CCD_Number_AC       10              NB_CCD_AC_   AXX # CCD
                                        Astro:CCD_Number_AC       10              NB_CCD_AC_   BXX # CCD
                                  Spectro:SSM:CCD_Number_AC        2              NB_CCD_AC_   MXX # CCD

# Linear sizes of pixels in micrometer #
                                     Astro:CCD_PixelArea_AL       10            SIZE_PX_AL_MU  AXX #
                                     Astro:CCD_PixelArea_AL       10            SIZE_PX_AL_MU  BXX #
                                   Spectro:CCD_PixelArea_AL       10            SIZE_PX_AL_MU  MXX #
                                     Astro:CCD_PixelArea_AC       30            SIZE_PX_AC_MU  AXX #
```

```
                                    Astro:CCD_PixelArea_AC       30             SIZE_PX_AC_MU  BXX #
                                  Spectro:CCD_PixelArea_AC       15             SIZE_PX_AC_MU  MXX #

# Angular sizes of pixels #
                Astro:CCD_PixelAngularArea_AL_MilliArcsecond  44.1964            SIZE_PX_AL_MAS  AXX #
                Astro:CCD_PixelAngularArea_AL_MilliArcsecond  44.1964            SIZE_PX_AL_MAS  BXX #
              Spectro:CCD_PixelAngularArea_AL_MilliArcsecond 982.2134            SIZE_PX_AL_MAS  MXX #
                Astro:CCD_PixelAngularArea_AC_MilliArcsecond 132.5893            SIZE_PX_AC_MAS  AXX #
                Astro:CCD_PixelAngularArea_AC_MilliArcsecond 132.5893            SIZE_PX_AC_MAS  BXX #
              Spectro:CCD_PixelAngularArea_AC_MilliArcsecond  1473.32            SIZE_PX_AC_MAS  MXX

# CCD along-scan dimension #
                   Astro:AF:CCD_LightSensitiveArea_AL_Pixel     4500            SIZE_CCD_AL_PX  AF1 # px
                   Astro:AF:CCD_LightSensitiveArea_AL_Pixel     4500            SIZE_CCD_AL_PX  AFX # px
                   Astro:AF:CCD_LightSensitiveArea_AL_Pixel     4500            SIZE_CCD_AL_PX AF11 # px
               Astro:BBP:S01:CCD_LightSensitiveArea_AL_Pixel    4500            SIZE_CCD_AL_PX BBP1 # px
               Astro:BBP:S02:CCD_LightSensitiveArea_AL_Pixel    2600            SIZE_CCD_AL_PX BBPX # px
                 Spectro:SSM:CCD_LightSensitiveArea_AL_Pixel     336            SIZE_CCD_AL_PX SSM # px
                 Spectro:MBP:CCD_LightSensitiveArea_AL_Pixel     336            SIZE_CCD_AL_PX MBPX # px

# CCD across-scan size #
                      Astro:CCD_LightSensitiveArea_AC_Pixel     1966            SIZE_CCD_AC_PX  AXX # px
                      Astro:CCD_LightSensitiveArea_AC_Pixel     1966            SIZE_CCD_AC_PX  BXX # px
                 Spectro:SSM:CCD_LightSensitiveArea_AC_Pixel    3930            SIZE_CCD_AC_PX  MXX # px

# AL Separation between two CCDs; the format should be changed to take account of dead zones between modules
# F.C TODO : The 2 following should be later replaced by the accurate CCD position in mm in the focal plane.
# F.C The exposure time should then be computed from the CCD position and from the TDI period.
                          Astro:ASM:CCD_DeadZone_AL_MilliMeter      4.         SEP_MARGIN_CCD_MM  ASM #
                           Astro:AF:CCD_DeadZone_AL_MilliMeter      4.         SEP_MARGIN_CCD_MM  AFX #
                          Astro:BBP:CCD_DeadZone_AL_MilliMeter      4.         SEP_MARGIN_CCD_MM  BXX #
                        Spectro:MBP:CCD_DeadZone_AL_MilliMeter      1.3        SEP_MARGIN_CCD_MM  MXX # param database
                        Spectro:SSM:CCD_DeadZone_AL_MilliMeter      1.3        SEP_MARGIN_CCD_MM SSM # param database

                                 Spectro:SSM:CCD_TDIPeriod   16.370         TDI_PERIOD_MS  MXX # ms

# Integration time #
                                Astro:ASM:CCD_ExposureTime  1.91518    TIME_EXPOSURE_CCD_SEC  ASM # s
                                 Astro:AF:CCD_ExposureTime  3.31473    TIME_EXPOSURE_CCD_SEC  AF1 # s
                                 Astro:AF:CCD_ExposureTime  3.31473    TIME_EXPOSURE_CCD_SEC  AFX # s
                                 Astro:AF:CCD_ExposureTime  3.31473    TIME_EXPOSURE_CCD_SEC AF11 # s
                            Astro:BBP:S01:CCD_ExposureTime  3.31473    TIME_EXPOSURE_CCD_SEC BBP1 # s
                            Astro:BBP:S02:CCD_ExposureTime  1.91518    TIME_EXPOSURE_CCD_SEC BBPX # s
                               Spectro:SSM:CCD_ExposureTime     5.5    TIME_EXPOSURE_CCD_SEC SSM # s
                               Spectro:MBP:CCD_ExposureTime     5.5    TIME_EXPOSURE_CCD_SEC MBPX # s

# Saturation value
               Astro:CCD_PixelFullWellCapacity_ImageSection   190000        SIZE_SATUR_CCD_E-  AXX # e-
               Astro:CCD_PixelFullWellCapacity_ImageSection   190000        SIZE_SATUR_CCD_E-  BXX # e-
             Spectro:CCD_PixelFullWellCapacity_ImageSection   140000        SIZE_SATUR_CCD_E-  MXX # e-

# Read-Out Noise for detection/confirmation #
                  Astro:ASM:CCD_DetectionNoise_TypicalTotal     13.9            NB_RON_CCD_E-  ASM # e-
               Astro:AF:S01:CCD_DetectionNoise_TypicalTotal     15.8            NB_RON_CCD_E-  AF1 # e-
               Astro:AF:S02:CCD_DetectionNoise_TypicalTotal      7.7            NB_RON_CCD_E-  AFX # e-
               Astro:AF:S11:CCD_DetectionNoise_TypicalTotal      7.9            NB_RON_CCD_E- AF11 # e-
              Astro:BBP:S01:CCD_DetectionNoise_TypicalTotal      8.3            NB_RON_CCD_E- BBP1 # e-
                Spectro:SSM:CCD_DetectionNoise_TypicalTotal      8.7            NB_RON_CCD_E- SSM # e-
                Spectro:MBP:CCD_DetectionNoise_TypicalTotal      9.2            NB_RON_CCD_E- MBP1 # e-

# Magnitude zero-points #
# *JOS*: parameter database names in following block to be updated ...
                            Astro:ASM:Magnitude_ZeroPoint_G  25.5857    VAL_ZEROPOINT_CCD_MAG  ASM # mag
                             Astro:AF:Magnitude_ZeroPoint_G  25.5857    VAL_ZEROPOINT_CCD_MAG  AF1 # mag
                             Astro:AF:Magnitude_ZeroPoint_G  25.5857    VAL_ZEROPOINT_CCD_MAG  AFX # mag
                        Astro:BBP:Magnitude_ZeroPoint_GB453  25.5857    VAL_ZEROPOINT_CCD_MAG BBP1 # mag incorrect
                        Astro:BBP:Magnitude_ZeroPoint_GB561  25.5857    VAL_ZEROPOINT_CCD_MAG BBP2 # mag incorrect
                        Astro:BBP:Magnitude_ZeroPoint_GB674  25.5857    VAL_ZEROPOINT_CCD_MAG BBP3 # mag incorrect
                        Astro:BBP:Magnitude_ZeroPoint_GB803  25.5857    VAL_ZEROPOINT_CCD_MAG BBP4 # mag incorrect
                        Astro:BBP:Magnitude_ZeroPoint_GB932  25.5857    VAL_ZEROPOINT_CCD_MAG BBP5 # mag incorrect
                         Spectro:SSM:Magnitude_ZeroPoint_GS  24.6501    VAL_ZEROPOINT_CCD_MAG SSM # mag
```

```
                         *JOS*:CCD_CalibrationMagnitude_G  24.6501    VAL_ZEROPOINT_CCD_MAG MBPX # mag TBChanged

# Unit: -
# Basic, Scalar: true
# Description: serial samples read from the serial register
# Source: Gaia-JdB-011
                      Astro:AF:S01:CCD_NumberOfSerialSamples      216            NB_MAX_AC_SAM  AF1 # overlapping allowed
                      Astro:AF:S02:CCD_NumberOfSerialSamples       17            NB_MAX_AC_SAM  AFX # sample
                      Astro:AF:S11:CCD_NumberOfSerialSamples       34            NB_MAX_AC_SAM AF11 # sample
                         Astro:BBP:CCD_NumberOfSerialSamples       34            NB_MAX_AC_SAM  BXX # sample
# Source: GAIA-CUO-117, 31/03/2003, Table 9
                       Spectro:MBP:CCD_NumberOfSerialSamples      450            NB_MAX_AC_SAM MBPX # sample
                       Spectro:SSM:CCD_NumberOfSerialSamples     3930            NB_MAX_AC_SAM SSM # sample

###############################################################################
#       D E T E C T I O N   /   C O N F I R M A T I O N    S T E P        #
###############################################################################

# Unit: pixel
# Basic: yes (depends on the asymmetry of the PSF)
# Scalar: true (but we should have one value for each of the 10 ASM1 and ASM2)
# Description: adopted signal/noise threshold for detection/confirmation algorithm
# Source: this document (TBC)
          Astro:ASM:Detection_Threshold_SNRPixel      1.45          NB_SNR1_CCD_  ASM #
       Astro:AF_S01:Detection_Threshold_SNRPixel      1.            NB_SNR1_CCD_  AF1 #
    Spectro:SSM:S01:Detection_Threshold_SNRPixel      1.45          NB_SNR1_CCD_ SSM # ? no PSF available yet
    Spectro:SSM:S02:Detection_Threshold_SNRPixel      1.            NB_SNR1_CCD_ MBP1 # ? no PSF available yet

        Astro:ASM:Detection_Threshold_SNRPObject      4.3           NB_SNR2_CCD_  ASM #
     Astro:AF:S01:Detection_Threshold_SNRPObject      5             NB_SNR2_CCD_  AF1 #
  Spectro:SSM:S01:Detection_Threshold_SNRPObject      4.3           NB_SNR2_CCD_ SSM # ? no PSF available yet
  Spectro:SSM:S02:Detection_Threshold_SNRPObject      5             NB_SNR2_CCD_ MBP1 # ? no PSF available yet

# Unit: pixel
# Basic: yes (depends in fact on the asymmetry of the PSF)
# Scalar: true (we should have one value for each of the 10 ASM1 and ASM2)
# Description: correction to the confirmation position
# Source: this document (TBC)
         Astro:ASM:Detection_CorrectiveShift_AL_Position    0.118         SIZE_SHIFT_AL_PX  ASM # px
      Astro:AF:S01:Detection_CorrectiveShift_AL_Position    0.124         SIZE_SHIFT_AL_PX  AF1 # px
   Spectro:SSM:S01:Detection_CorrectiveShift_AL_Position        0         SIZE_SHIFT_AL_PX SSM # ? no PSF available yet
   Spectro:SSM:S02:Detection_CorrectiveShift_AL_Position        0         SIZE_SHIFT_AL_PX MBP1 # ? no PSF available yet

         Astro:ASM:Detection_CorrectiveShift_AC_Position     0.02         SIZE_SHIFT_AC_PX  ASM # px
      Astro:AF:S01:Detection_CorrectiveShift_AC_Position   0.0115         SIZE_SHIFT_AC_PX  AF1 # px
   Spectro:SSM:S01:Detection_CorrectiveShift_AC_Position        0         SIZE_SHIFT_AC_PX SSM # ? no PSF available yet
   Spectro:SSM:S02:Detection_CorrectiveShift_AC_Position        0         SIZE_SHIFT_AC_PX MBP1 # ? no PSF available yet

# Unit: pixel
# Basic, Scalar: true
# Description: Tolerance between detection and confirmation of an object (maximum difference in pixel)
# Source: this document (TBC) (provisional until implementation of strategy taking account of duplicity and NEO)
           Astro:FoV1:S01:Confirmation_Threshold_AL_Position       3         SEP_DETCONF_AL_PX  AF1 # px *JOS* For ASM1-AF1
           Astro:FoV2:S01:Confirmation_Threshold_AL_Position       3         SEP_DETCONF_AL_PX  AF1 # px *JOS* For ASM2-AF1
          Spectro:SSM:S02:Confirmation_Threshold_AL_Position       3         SEP_DETCONF_AL_PX SSM # px

           Astro:FoV1:S01:Confirmation_Threshold_AC_Position       3         SEP_DETCONF_AC_PX  AF1 # px *JOS* For ASM1-AF1
           Astro:FoV2:S01:Confirmation_Threshold_AC_Position       3         SEP_DETCONF_AC_PX  AF1 # px *JOS* For ASM2-AF1
          Spectro:SSM:S02:Confirmation_Threshold_AC_Position       6         SEP_DETCONF_AC_PX SSM # px

# Unit: -
# Basic, Scalar: true
# Description: Tolerance between detection and confirmation of an object (maximum relative e- difference)
# Source: this document (TBC) (provisional until implementation of strategy taking account of duplicity and NEO)
                     Astro:FoV1:S01:Confirmation_Threshold_Flux    2.        DELTA_DETCONF_FLUX  AF1 # ratio e- *JOS* For ASM1-A
                     Astro:FoV2:S01:Confirmation_Threshold_Flux    2.        DELTA_DETCONF_FLUX  AF1 # ratio e- *JOS* For ASM2-A
                    Spectro:SSM:S02:Confirmation_Threshold_Flux   10.        DELTA_DETCONF_FLUX SSM # ratio e-

# the following (not yet defined) parameters would be needed for SSM cross-matching...
Nature:NearEarthObject_VelocityDistributionStandardDeviation_AL  30.0   SIGMA_NEO_SPEED_MASS XXX  # The sigma of the NEO speed d
                 Spectro:SSM:Detection_ObjectSize_AL_Maximum      256   MAX_DETECTEDOBJECT_AL_SIZE_PX SSM # The maximum object A
```

```
      Spectro:SSM:CrossMatching_Threshold_AL_SNRPosition         2     SIGMACLIP_DETECTED_POS_PX SSM # Two objects distant of m
      Spectro:SSM:CrossMatching_Threshold_AC_SNRPosition         2     *JOS*
             Spectro:SSM:Detection_Precision_AL_Position         0.4   SIGMA_AL_DETECTED_POS_PX SSM # The sigma AL on the centr
             Spectro:SSM:Detection_Precision_AC_Position         0.4   SIGMA_AC_DETECTED_POS_PX SSM # The sigma AC on the centr

################################################################################
#                       W I N D O W   S T R A T E G Y                          #
################################################################################

# Unit: mag
# Basic, Scalar: true
# Description: Limiting magnitude above which a star is not considered at all for on-board selection
# Source: Gaia-JdB-011 (or F. Arenou, 8 Nov 03, private communication)
               Astro:AF:S01:MagnitudeRange_Maximum_Selection      22          LIMIT_MAGNITUDE  AF1
               Astro:AF:S02:MagnitudeRange_Maximum_Selection      22          LIMIT_MAGNITUDE  AFX
               Astro:AF:S11:MagnitudeRange_Maximum_Selection      20          LIMIT_MAGNITUDE AF11
                  Astro:BBP:MagnitudeRange_Maximum_Selection      22          LIMIT_MAGNITUDE  BXX
                Spectro:SSM:MagnitudeRange_Maximum_Selection      22          LIMIT_MAGNITUDE SSM
                Spectro:MBP:MagnitudeRange_Maximum_Selection      22          LIMIT_MAGNITUDE MBPX

# Unit: mag
# Basic, Scalar: true
# Description: fainter magnitude for this class of object
# Source: GAIA-CUO-117, 31/03/2003, Fig 1
                     Astro:MagnitudeRange_Maximum_VeryBright       8     LIMIT_SUPBRIGHT_MAG  AXX # magnitude limit super-brigh
                     Astro:MagnitudeRange_Maximum_VeryBright       8     LIMIT_SUPBRIGHT_MAG  BXX #
               Spectro:MBP:MagnitudeRange_Maximum_VeryBright       0     LIMIT_SUPBRIGHT_MAG  MXX #

                         Astro:MagnitudeRange_Maximum_Bright      12     LIMIT_BRIGHTMED_MAG  AXX # magnitude limit bright-inte
                         Astro:MagnitudeRange_Maximum_Bright      12     LIMIT_BRIGHTMED_MAG  BXX #
                   Spectro:MBP:MagnitudeRange_Maximum_Bright       9     LIMIT_BRIGHTMED_MAG  MXX #

                         Astro:MagnitudeRange_Maximum_Medium      16     LIMIT_MEDFAINT_MAG  AXX # magnitude limit intermediate
                         Astro:MagnitudeRange_Maximum_Medium      16     LIMIT_MEDFAINT_MAG  BXX #
                   Spectro:MBP:MagnitudeRange_Maximum_Medium      14     LIMIT_MEDFAINT_MAG  MXX #

                          Astro:MagnitudeRange_Maximum_Faint      20     LIMIT_FAINTVFAINT_MAG  AXX # magnitude limit faint-ver
                          Astro:MagnitudeRange_Maximum_Faint      20     LIMIT_FAINTVFAINT_MAG  BXX #
                    Spectro:MBP:MagnitudeRange_Maximum_Faint      20     LIMIT_FAINTVFAINT_MAG  MXX #

# Unit: -
# Basic, Scalar: true
# Description: Does objects have two possible window AL size in this zone? (0=NO, 1=YES)
# Source: GAIA-CUO-117, 31/03/2003, Table 7
                     Astro:AF:S01:CCD_WindowSize_AL_Variable       0         TWO_WINDOW_SIZES  AF1
                     Astro:AF:S02:CCD_WindowSize_AL_Variable       0         TWO_WINDOW_SIZES  AFX
                     Astro:AF:S11:CCD_WindowSize_AL_Variable       1         TWO_WINDOW_SIZES AF11
                        Astro:BBP:CCD_WindowSize_AL_Variable       1         TWO_WINDOW_SIZES  BXX
                          Spectro:CCD_WindowSize_AL_Variable       0         TWO_WINDOW_SIZES  MXX

# Unit: mag
# Basic, Scalar: true
# Description: Magnitude limit between 2 vertical half-windows (to avoid saturation) and one window
# Source: GAIA-CUO-117, 31/03/2003, Fig 1B
                     Astro:MagnitudeRange_Maximum_Saturation      12      LIMIT_TWO_ONE_WINDOW  AXX #
                     Astro:MagnitudeRange_Maximum_Saturation      12      LIMIT_TWO_ONE_WINDOW  BXX #
                   Spectro:MagnitudeRange_Maximum_Saturation       0      LIMIT_TWO_ONE_WINDOW  MXX #

# Unit: mag
# Basic, Scalar: true
# Description: Magnitude limit between a high priority star and a low priority one
# Source: OBD-JC-01
             Astro:AF:S01:MagnitudeRange_Maximum_LowPriority      16   LIMIT_HIGH_LOW_PRIORITY  AF1 #
             Astro:AF:S02:MagnitudeRange_Maximum_LowPriority      16   LIMIT_HIGH_LOW_PRIORITY  AFX #
             Astro:AF:S11:MagnitudeRange_Maximum_LowPriority       0   LIMIT_HIGH_LOW_PRIORITY AF11 # Erik: no priority for bri
                Astro:BBP:MagnitudeRange_Maximum_LowPriority      16   LIMIT_HIGH_LOW_PRIORITY  BXX #
                  Spectro:MagnitudeRange_Maximum_LowPriority      16   LIMIT_HIGH_LOW_PRIORITY  MXX #

# Unit: -
# Basic, Scalar: true
# Description: tiling strategy is adopted for multiple objects (0=FALSE, 1=TRUE)
```

```
# Source: OBD-FAJCL-01
                             Astro:AF:S01:CCD_WindowPavement        0          ACTIVATE_PAVING  AF1 #
                             Astro:AF:S02:CCD_WindowPavement        1          ACTIVATE_PAVING  AFX #
                             Astro:AF:S11:CCD_WindowPavement        0          ACTIVATE_PAVING AF11 #
                                Astro:BBP:CCD_WindowPavement        1          ACTIVATE_PAVING  BXX #
                                  Spectro:CCD_WindowPavement        0          ACTIVATE_PAVING  MXX #

# Unit: mag
# Basic, Scalar: true
# Description: faintest magnitude where the tiling strategy can be used
# Source: OBD-FAJCL-01
                 Astro:MagnitudeRange_Maximum_WindowPavement       20         MAX_MAG_PAVEMENT  AFX # mag
                 Astro:MagnitudeRange_Maximum_WindowPavement       20         MAX_MAG_PAVEMENT  BXX # mag
               Spectro:MagnitudeRange_Maximum_WindowPavement       20         MAX_MAG_PAVEMENT  MXX # mag

# Unit: -
# Basic, Scalar: true
# Description: Allowing window overlapping (0=FALSE, 1=TRUE)
# Source: GAIA-CUO-117, 31/03/2003, Sect. 7.4
                              Astro:AF:S01:CCD_WindowOverlap        1            ALLOW_OVERLAP  AF1 #
                              Astro:AF:S02:CCD_WindowOverlap        0            ALLOW_OVERLAP  AFX #
                              Astro:AF:S11:CCD_WindowOverlap        0            ALLOW_OVERLAP AF11 #
                                 Astro:BBP:CCD_WindowOverlap        0            ALLOW_OVERLAP  BXX #
                               Spectro:MBP:CCD_WindowOverlap        0            ALLOW_OVERLAP  MXX #

# Unit: pixel
# Basic, Scalar: true
# Description: for a double-star strategy 1B2S, one big window only is taken below this separation
# Source: DMS-SS-02
                     Astro:AF:S02:CCD_WindowSeparation_Faint        8         SEP_FAINT_DMS_PX  AXX # max separation between do
                        Astro:BBP:CCD_WindowSeparation_Faint        8         SEP_FAINT_DMS_PX  BXX # max separation between do
                      Spectro:MBP:CCD_WindowSeparation_Faint        0         SEP_FAINT_DMS_PX  MXX # nothing special in MBP

                     Astro:AF:S02:CCD_WindowSeparation_Medium      12         SEP_MED_DMS_PX    AXX # max separation between do
                        Astro:BBP:CCD_WindowSeparation_Medium      12         SEP_MED_DMS_PX    BXX # max separation between do
                      Spectro:MBP:CCD_WindowSeparation_Medium       0         SEP_MED_DMS_PX    MXX # nothing special in MBP

###############################################################################
#             W I N D O W   A N D   S A M P L E   S I Z E S                  #
###############################################################################

# Unit: pixel
# Basic, Scalar: true
# Description: size of samples, hardware binning
# Source: GAIA-CUO-117, 31/03/2003, Fig 1
                    Astro:ASM:CCD_NumberOfPixelsPerSample_AL        2          SIZE_SAMP_AL_PX  ASM # px
                    Astro:ASM:CCD_NumberOfPixelsPerSample_AC        2          SIZE_SAMP_AC_PX  ASM # px
                  Spectro:SSM:CCD_NumberOfPixelsPerSample_AL        1          SIZE_SAMP_AL_PX SSM # px
                  Spectro:SSM:CCD_NumberOfPixelsPerSample_AC        1          SIZE_SAMP_AC_PX SSM # px

# Unit: sample
# Basic, Scalar: true
# Description: size of read windows
# Source: GAIA-CUO-117, 31/03/2003, Fig 1
     Astro:AF:S01:CCD_NumberOfSamplesPerWindow_AL_ReadVeryBright       16   SIZE_SUPERWINDOW_AL_SAM  AF1 #
     Astro:AF:S01:CCD_NumberOfSamplesPerWindow_AC_ReadVeryBright        6   SIZE_SUPERWINDOW_AC_SAM  AF1 #

# Unit: pixel
# Basic, Scalar: true
# Description: size of read samples, hardware binning
# Source: GAIA-CUO-117, 31/03/2003, Table 6
      Astro:AF:S01:CCD_NumberOfPixelsPerSample_AL_VeryBright        1      SIZE_SUPERSAMP_AL_PX  AF1 #
      Astro:AF:S01:CCD_NumberOfPixelsPerSample_AC_VeryBright        4      SIZE_SUPERSAMP_AC_PX  AF1 #

# Unit, Basic, Scalar, Description, Source: see above, except for *_VeryFaint where Source: this document (TBC)
         Astro:AF:S01:CCD_NumberOfSamplesPerWindow_AL_ReadBright   16  SIZE_BRIGHTWINDOW_AL_SAM  AF1 #
         Astro:AF:S01:CCD_NumberOfSamplesPerWindow_AC_ReadBright    6  SIZE_BRIGHTWINDOW_AC_SAM  AF1 #
          Astro:AF:S01:CCD_NumberOfPixelsPerSample_AL_Bright        1  SIZE_BRIGHTSAMP_AL_PX  AF1 #
          Astro:AF:S01:CCD_NumberOfPixelsPerSample_AC_Bright        2  SIZE_BRIGHTSAMP_AC_PX  AF1 #

         Astro:AF:S01:CCD_NumberOfSamplesPerWindow_AL_ReadMedium   12  SIZE_MEDIUMWINDOW_AL_SAM  AF1 #
```

```
         Astro:AF:S01:CCD_NumberOfSamplesPerWindow_AC_ReadMedium    6  SIZE_MEDIUMWINDOW_AC_SAM  AF1 #
          Astro:AF:S01:CCD_NumberOfPixelsPerSample_AL_Medium        1  SIZE_MEDIUMSAMP_AL_PX  AF1 # px
          Astro:AF:S01:CCD_NumberOfPixelsPerSample_AC_Medium        2  SIZE_MEDIUMSAMP_AC_PX  AF1 # px

          Astro:AF:S01:CCD_NumberOfSamplesPerWindow_AL_ReadFaint   12  SIZE_FAINTWINDOW_AL_SAM  AF1 #
          Astro:AF:S01:CCD_NumberOfSamplesPerWindow_AC_ReadFaint    6  SIZE_FAINTWINDOW_AC_SAM  AF1 #
           Astro:AF:S01:CCD_NumberOfPixelsPerSample_AL_Faint        1  SIZE_FAINTSAMP_AL_PX  AF1 # px
           Astro:AF:S01:CCD_NumberOfPixelsPerSample_AC_Faint        2  SIZE_FAINTSAMP_AC_PX  AF1 # px

      Astro:AF:S01:CCD_NumberOfSamplesPerWindow_AL_ReadVeryFaint   12  SIZE_VFAINTWINDOW_AL_SAM  AF1 #
      Astro:AF:S01:CCD_NumberOfSamplesPerWindow_AC_ReadVeryFaint    6  SIZE_VFAINTWINDOW_AC_SAM  AF1 #
       Astro:AF:S01:CCD_NumberOfPixelsPerSample_AL_VeryFaint        1  SIZE_VFAINTSAMP_AL_PX  AF1 # px
       Astro:AF:S01:CCD_NumberOfPixelsPerSample_AC_VeryFaint        2  SIZE_VFAINTSAMP_AC_PX  AF1 # px

# Unit, Basic, Scalar, Description, Source: see above
     Astro:AF:S02:CCD_NumberOfSamplesPerWindow_AL_ReadVeryBright   16  SIZE_SUPERWINDOW_AL_SAM  AFX #
     Astro:AF:S02:CCD_NumberOfSamplesPerWindow_AC_ReadVeryBright    6  SIZE_SUPERWINDOW_AC_SAM  AFX #
      Astro:AF:S02:CCD_NumberOfPixelsPerSample_AL_VeryBright        1  SIZE_SUPERSAMP_AL_PX  AFX #
      Astro:AF:S02:CCD_NumberOfPixelsPerSample_AC_VeryBright        4  SIZE_SUPERSAMP_AC_PX  AFX #

         Astro:AF:S02:CCD_NumberOfSamplesPerWindow_AL_ReadBright   16  SIZE_BRIGHTWINDOW_AL_SAM  AFX #
         Astro:AF:S02:CCD_NumberOfSamplesPerWindow_AC_ReadBright    6  SIZE_BRIGHTWINDOW_AC_SAM  AFX #
          Astro:AF:S02:CCD_NumberOfPixelsPerSample_AL_Bright        1  SIZE_BRIGHTSAMP_AL_PX  AFX #
          Astro:AF:S02:CCD_NumberOfPixelsPerSample_AC_Bright        2  SIZE_BRIGHTSAMP_AC_PX  AFX #

         Astro:AF:S02:CCD_NumberOfSamplesPerWindow_AL_ReadMedium   12  SIZE_MEDIUMWINDOW_AL_SAM  AFX #
         Astro:AF:S02:CCD_NumberOfSamplesPerWindow_AC_ReadMedium    1  SIZE_MEDIUMWINDOW_AC_SAM  AFX #
          Astro:AF:S02:CCD_NumberOfPixelsPerSample_AL_Medium        1  SIZE_MEDIUMSAMP_AL_PX  AFX # px
          Astro:AF:S02:CCD_NumberOfPixelsPerSample_AC_Medium       12  SIZE_MEDIUMSAMP_AC_PX  AFX # px

          Astro:AF:S02:CCD_NumberOfSamplesPerWindow_AL_ReadFaint    6  SIZE_FAINTWINDOW_AL_SAM  AFX #
          Astro:AF:S02:CCD_NumberOfSamplesPerWindow_AC_ReadFaint    1  SIZE_FAINTWINDOW_AC_SAM  AFX #
           Astro:AF:S02:CCD_NumberOfPixelsPerSample_AL_Faint        1  SIZE_FAINTSAMP_AL_PX  AFX # px
           Astro:AF:S02:CCD_NumberOfPixelsPerSample_AC_Faint       12  SIZE_FAINTSAMP_AC_PX  AFX # px

      Astro:AF:S02:CCD_NumberOfSamplesPerWindow_AL_ReadVeryFaint    6  SIZE_VFAINTWINDOW_AL_SAM  AFX #
      Astro:AF:S02:CCD_NumberOfSamplesPerWindow_AC_ReadVeryFaint    1  SIZE_VFAINTWINDOW_AC_SAM  AFX #
       Astro:AF:S02:CCD_NumberOfPixelsPerSample_AL_VeryFaint        1  SIZE_VFAINTSAMP_AL_PX  AFX # px
       Astro:AF:S02:CCD_NumberOfPixelsPerSample_AC_VeryFaint       12  SIZE_VFAINTSAMP_AC_PX  AFX # px

# Unit, Basic, Scalar, Description, Source: see above
     Astro:AF:S11:CCD_NumberOfSamplesPerWindow_AL_ReadVeryBright   16  SIZE_SUPERWINDOW_AL_SAM AF11 #
     Astro:AF:S11:CCD_NumberOfSamplesPerWindow_AC_ReadVeryBright    6  SIZE_SUPERWINDOW_AC_SAM AF11 #
      Astro:AF:S11:CCD_NumberOfPixelsPerSample_AL_VeryBright        1  SIZE_SUPERSAMP_AL_PX AF11 #
      Astro:AF:S11:CCD_NumberOfPixelsPerSample_AC_VeryBright        4  SIZE_SUPERSAMP_AC_PX AF11 #

         Astro:AF:S11:CCD_NumberOfSamplesPerWindow_AL_ReadBright   16  SIZE_BRIGHTWINDOW_AL_SAM AF11 #
         Astro:AF:S11:CCD_NumberOfSamplesPerWindow_AC_ReadBright    6  SIZE_BRIGHTWINDOW_AC_SAM AF11 #
          Astro:AF:S11:CCD_NumberOfPixelsPerSample_AL_Bright        1  SIZE_BRIGHTSAMP_AL_PX AF11 #
          Astro:AF:S11:CCD_NumberOfPixelsPerSample_AC_Bright        2  SIZE_BRIGHTSAMP_AC_PX AF11 #

         Astro:AF:S11:CCD_NumberOfSamplesPerWindow_AL_ReadMedium   68  SIZE_MEDIUMWINDOW_AL_SAM AF11 #
         Astro:AF:S11:CCD_NumberOfSamplesPerWindow_AC_ReadMedium    1  SIZE_MEDIUMWINDOW_AC_SAM AF11 #
          Astro:AF:S11:CCD_NumberOfPixelsPerSample_AL_Medium        1  SIZE_MEDIUMSAMP_AL_PX AF11 # px
          Astro:AF:S11:CCD_NumberOfPixelsPerSample_AC_Medium       14  SIZE_MEDIUMSAMP_AC_PX AF11 # px

          Astro:AF:S11:CCD_NumberOfSamplesPerWindow_AL_ReadFaint   68  SIZE_FAINTWINDOW_AL_SAM AF11 #
          Astro:AF:S11:CCD_NumberOfSamplesPerWindow_AC_ReadFaint    1  SIZE_FAINTWINDOW_AC_SAM AF11 #
           Astro:AF:S11:CCD_NumberOfPixelsPerSample_AL_Faint        1  SIZE_FAINTSAMP_AL_PX AF11 # px
           Astro:AF:S11:CCD_NumberOfPixelsPerSample_AC_Faint       14  SIZE_FAINTSAMP_AC_PX AF11 # px

      Astro:AF:S11:CCD_NumberOfSamplesPerWindow_AL_ReadVeryFaint    6  SIZE_VFAINTWINDOW_AL_SAM AF11 #
      Astro:AF:S11:CCD_NumberOfSamplesPerWindow_AC_ReadVeryFaint    1  SIZE_VFAINTWINDOW_AC_SAM AF11 #
       Astro:AF:S11:CCD_NumberOfPixelsPerSample_AL_VeryFaint        1  SIZE_VFAINTSAMP_AL_PX AF11 # px
       Astro:AF:S11:CCD_NumberOfPixelsPerSample_AC_VeryFaint       14  SIZE_VFAINTSAMP_AC_PX AF11 # px

# Unit: pixel
# Basic, Scalar: true
# Description: alternate AL size of read windows
# Source: GAIA-CUO-117, 31/03/2003, Table 7
 Astro:AF:S11:CCD_NumberOfSamplesPerShortWindow_AL_VeryBright      16  SIZE2_SUPERWINDOW_AL_SAM AF11 #
```

```
    Astro:AF:S11:CCD_NumberOfSamplesPerShortWindow_AL_Bright       16  SIZE2_BRIGHTWINDOW_AL_SAM AF11 #
    Astro:AF:S11:CCD_NumberOfSamplesPerShortWindow_AL_Medium       12  SIZE2_MEDIUMWINDOW_AL_SAM AF11 #
# Source: OBD-CoCo-07 (Arenou et al., V 1.1), Sect. 4.1
     Astro:AF:S11:CCD_NumberOfSamplesPerShortWindow_AL_Faint       12  SIZE2_FAINTWINDOW_AL_SAM AF11 #
 Astro:AF:S11:CCD_NumberOfSamplesPerShortWindow_AL_VeryFaint        6  SIZE2_VFAINTWINDOW_AL_SAM AF11 #

# Unit: sample
# Basic, Scalar: true
# Description: size of read windows
# Source: GAIA-CUO-117, 31/03/2003, Fig 1
        Astro:BBP:CCD_NumberOfSamplesPerWindow_AL_ReadVeryBright       16   SIZE_SUPERWINDOW_AL_SAM  BXX #
        Astro:BBP:CCD_NumberOfSamplesPerWindow_AC_ReadVeryBright        6   SIZE_SUPERWINDOW_AC_SAM  BXX #

# Unit: pixel
# Basic, Scalar: true
# Description: size of read samples, hardware binning
# Source: GAIA-CUO-117, 31/03/2003, Table 6
         Astro:BBP:CCD_NumberOfPixelsPerSample_AL_VeryBright        1     SIZE_SUPERSAMP_AL_PX  BXX #
         Astro:BBP:CCD_NumberOfPixelsPerSample_AC_VeryBright        4     SIZE_SUPERSAMP_AC_PX  BXX #

            Astro:BBP:CCD_NumberOfSamplesPerWindow_AL_ReadBright   16     SIZE_BRIGHTWINDOW_AL_SAM  BXX #
            Astro:BBP:CCD_NumberOfSamplesPerWindow_AC_ReadBright    6     SIZE_BRIGHTWINDOW_AC_SAM  BXX #
             Astro:BBP:CCD_NumberOfPixelsPerSample_AL_Bright        1     SIZE_BRIGHTSAMP_AL_PX  BXX #
             Astro:BBP:CCD_NumberOfPixelsPerSample_AC_Bright        2     SIZE_BRIGHTSAMP_AC_PX  BXX #

            Astro:BBP:CCD_NumberOfSamplesPerWindow_AL_ReadMedium   16     SIZE_MEDIUMWINDOW_AL_SAM  BXX #
            Astro:BBP:CCD_NumberOfSamplesPerWindow_AC_ReadMedium    1     SIZE_MEDIUMWINDOW_AC_SAM  BXX #
             Astro:BBP:CCD_NumberOfPixelsPerSample_AL_Medium        1     SIZE_MEDIUMSAMP_AL_PX  BXX # px
             Astro:BBP:CCD_NumberOfPixelsPerSample_AC_Medium       12     SIZE_MEDIUMSAMP_AC_PX  BXX # px

             Astro:BBP:CCD_NumberOfSamplesPerWindow_AL_ReadFaint   16     SIZE_FAINTWINDOW_AL_SAM  BXX #
             Astro:BBP:CCD_NumberOfSamplesPerWindow_AC_ReadFaint    1     SIZE_FAINTWINDOW_AC_SAM  BXX #
              Astro:BBP:CCD_NumberOfPixelsPerSample_AL_Faint        1     SIZE_FAINTSAMP_AL_PX  BXX # px
              Astro:BBP:CCD_NumberOfPixelsPerSample_AC_Faint       12     SIZE_FAINTSAMP_AC_PX  BXX # px

         Astro:BBP:CCD_NumberOfSamplesPerWindow_AL_ReadVeryFaint   16     SIZE_VFAINTWINDOW_AL_SAM  BXX #
         Astro:BBP:CCD_NumberOfSamplesPerWindow_AC_ReadVeryFaint    1     SIZE_VFAINTWINDOW_AC_SAM  BXX #
          Astro:BBP:CCD_NumberOfPixelsPerSample_AL_VeryFaint        1     SIZE_VFAINTSAMP_AL_PX  BXX # px
          Astro:BBP:CCD_NumberOfPixelsPerSample_AC_VeryFaint       12     SIZE_VFAINTSAMP_AC_PX  BXX # px

# Unit: pixel
# Basic, Scalar: true
# Description: alternate AL size of read windows
# Source: Gaia-JdB-011 (or Arenou, 18 November 2003, priv. comm)
        Astro:BBP:CCD_NumberOfSamplesPerShortWindow_AL_VeryBright   16  SIZE2_SUPERWINDOW_AL_SAM   BXX #
        Astro:BBP:CCD_NumberOfSamplesPerShortWindow_AL_Bright       16  SIZE2_BRIGHTWINDOW_AL_SAM  BXX #
        Astro:BBP:CCD_NumberOfSamplesPerShortWindow_AL_Medium       12  SIZE2_MEDIUMWINDOW_AL_SAM  BXX #
        Astro:BBP:CCD_NumberOfSamplesPerShortWindow_AL_Faint        12  SIZE2_FAINTWINDOW_AL_SAM   BXX #
        Astro:BBP:CCD_NumberOfSamplesPerShortWindow_AL_VeryFaint     6  SIZE2_VFAINTWINDOW_AL_SAM  BXX #

# Unit: sample
# Basic, Scalar: true
# Description: size of read windows
# Source: GAIA-CUO-117, 31/03/2003, Fig 1
      Spectro:MBP:CCD_NumberOfSamplesPerWindow_AL_ReadVeryBright        8   SIZE_SUPERWINDOW_AL_SAM MBPX #
      Spectro:MBP:CCD_NumberOfSamplesPerWindow_AC_ReadVeryBright        7   SIZE_SUPERWINDOW_AC_SAM MBPX #

# Unit: pixel
# Basic, Scalar: true
# Description: size of read samples, hardware binning
# Source: GAIA-CUO-117, 31/03/2003, Fig 1
       Spectro:MBP:CCD_NumberOfPixelsPerSample_AL_VeryBright        1     SIZE_SUPERSAMP_AL_PX MBPX #
       Spectro:MBP:CCD_NumberOfPixelsPerSample_AC_VeryBright        2     SIZE_SUPERSAMP_AC_PX MBPX #

          Spectro:MBP:CCD_NumberOfSamplesPerWindow_AL_ReadBright    8     SIZE_BRIGHTWINDOW_AL_SAM MBPX #
          Spectro:MBP:CCD_NumberOfSamplesPerWindow_AC_ReadBright    7     SIZE_BRIGHTWINDOW_AC_SAM MBPX #
           Spectro:MBP:CCD_NumberOfPixelsPerSample_AL_Bright        1     SIZE_BRIGHTSAMP_AL_PX MBPX #
           Spectro:MBP:CCD_NumberOfPixelsPerSample_AC_Bright        2     SIZE_BRIGHTSAMP_AC_PX MBPX #

          Spectro:MBP:CCD_NumberOfSamplesPerWindow_AL_ReadMedium    8     SIZE_MEDIUMWINDOW_AL_SAM MBPX #
          Spectro:MBP:CCD_NumberOfSamplesPerWindow_AC_ReadMedium    3     SIZE_MEDIUMWINDOW_AC_SAM MBPX #
```

```
         Spectro:MBP:CCD_NumberOfPixelsPerSample_AL_Medium        1     SIZE_MEDIUMSAMP_AL_PX MBPX # px
         Spectro:MBP:CCD_NumberOfPixelsPerSample_AC_Medium        5     SIZE_MEDIUMSAMP_AC_PX MBPX # px

         Spectro:MBP:CCD_NumberOfSamplesPerWindow_AL_ReadFaint    8     SIZE_FAINTWINDOW_AL_SAM MBPX #
         Spectro:MBP:CCD_NumberOfSamplesPerWindow_AC_ReadFaint    1     SIZE_FAINTWINDOW_AC_SAM MBPX #
          Spectro:MBP:CCD_NumberOfPixelsPerSample_AL_Faint        1     SIZE_FAINTSAMP_AL_PX MBPX # px
          Spectro:MBP:CCD_NumberOfPixelsPerSample_AC_Faint        5     SIZE_FAINTSAMP_AC_PX MBPX # px

     Spectro:MBP:CCD_NumberOfSamplesPerWindow_AL_ReadVeryFaint    8     SIZE_VFAINTWINDOW_AL_SAM MBPX #
     Spectro:MBP:CCD_NumberOfSamplesPerWindow_AC_ReadVeryFaint    1     SIZE_VFAINTWINDOW_AC_SAM MBPX #
      Spectro:MBP:CCD_NumberOfPixelsPerSample_AL_VeryFaint        1     SIZE_VFAINTSAMP_AL_PX MBPX # px
      Spectro:MBP:CCD_NumberOfPixelsPerSample_AC_VeryFaint        5     SIZE_VFAINTSAMP_AC_PX MBPX # px

###############################################################################
#                          W I N D O W   S H I F T                            #
###############################################################################

# Unit: pixel
# Basic, Scalar: true
# Description: The AL and AC window shift admitted for selection
# Source: this document (TBC)
                Astro:AF:S01:CCD_WindowShift_AL_VeryBright        2   SHIFT_AL_SUPERWINDOW_PX  AF1 # px
                    Astro:AF:S01:CCD_WindowShift_AL_Bright        2  SHIFT_AL_BRIGHTWINDOW_PX  AF1 # px
                    Astro:AF:S01:CCD_WindowShift_AL_Medium        2  SHIFT_AL_MEDIUMWINDOW_PX  AF1 # px
                     Astro:AF:S01:CCD_WindowShift_AL_Faint        2   SHIFT_AL_FAINTWINDOW_PX  AF1 # px
                 Astro:AF:S01:CCD_WindowShift_AL_VeryFaint        2  SHIFT_AL_VFAINTWINDOW_PX  AF1 # px
                Astro:AF:S01:CCD_WindowShift_AC_VeryBright        0   SHIFT_AC_SUPERWINDOW_PX  AF1 # px
                    Astro:AF:S01:CCD_WindowShift_AC_Bright        0  SHIFT_AC_BRIGHTWINDOW_PX  AF1 # px
                    Astro:AF:S01:CCD_WindowShift_AC_Medium        0  SHIFT_AC_MEDIUMWINDOW_PX  AF1 # px
                     Astro:AF:S01:CCD_WindowShift_AC_Faint        1   SHIFT_AC_FAINTWINDOW_PX  AF1 # px
                 Astro:AF:S01:CCD_WindowShift_AC_VeryFaint        1  SHIFT_AC_VFAINTWINDOW_PX  AF1 # px
                Astro:AF:S02:CCD_WindowShift_AL_VeryBright        2   SHIFT_AL_SUPERWINDOW_PX  AFX # px

                    Astro:AF:S02:CCD_WindowShift_AL_Bright        2  SHIFT_AL_BRIGHTWINDOW_PX  AFX # px
                    Astro:AF:S02:CCD_WindowShift_AL_Medium        2  SHIFT_AL_MEDIUMWINDOW_PX  AFX # px
                     Astro:AF:S02:CCD_WindowShift_AL_Faint        1   SHIFT_AL_FAINTWINDOW_PX  AFX # px
                 Astro:AF:S02:CCD_WindowShift_AL_VeryFaint        1  SHIFT_AL_VFAINTWINDOW_PX  AFX # px
                Astro:AF:S02:CCD_WindowShift_AC_VeryBright        0   SHIFT_AC_SUPERWINDOW_PX  AFX # px
                    Astro:AF:S02:CCD_WindowShift_AC_Bright        0  SHIFT_AC_BRIGHTWINDOW_PX  AFX # px
                    Astro:AF:S02:CCD_WindowShift_AC_Medium        0  SHIFT_AC_MEDIUMWINDOW_PX  AFX # px
                     Astro:AF:S02:CCD_WindowShift_AC_Faint        1   SHIFT_AC_FAINTWINDOW_PX  AFX # px
                 Astro:AF:S02:CCD_WindowShift_AC_VeryFaint        1  SHIFT_AC_VFAINTWINDOW_PX  AFX # px

           Astro:AF:S11:CCD_ShortWindowShift_AL_VeryBright        2  SHIFT2_AL_SUPERWINDOW_PX AF11 # px; shift of alternative
               Astro:AF:S11:CCD_ShortWindowShift_AL_Bright        2 SHIFT2_AL_BRIGHTWINDOW_PX AF11 # px; shift of alternative
               Astro:AF:S11:CCD_ShortWindowShift_AL_Medium        2 SHIFT2_AL_MEDIUMWINDOW_PX AF11 # px; shift of alternative
                Astro:AF:S11:CCD_ShortWindowShift_AL_Faint        1  SHIFT2_AL_FAINTWINDOW_PX AF11 # px; shift of alternative
            Astro:AF:S11:CCD_ShortWindowShift_AL_VeryFaint        1 SHIFT2_AL_VFAINTWINDOW_PX AF11 # px; shift of alternative

                   Astro:BBP:CCD_WindowShift_AL_VeryBright        2   SHIFT_AL_SUPERWINDOW_PX  BXX # px
                       Astro:BBP:CCD_WindowShift_AL_Bright        2  SHIFT_AL_BRIGHTWINDOW_PX  BXX # px
                       Astro:BBP:CCD_WindowShift_AL_Medium        2  SHIFT_AL_MEDIUMWINDOW_PX  BXX # px
                        Astro:BBP:CCD_WindowShift_AL_Faint        2   SHIFT_AL_FAINTWINDOW_PX  BXX # px
                    Astro:BBP:CCD_WindowShift_AL_VeryFaint        2  SHIFT_AL_VFAINTWINDOW_PX  BXX # px
                   Astro:BBP:CCD_WindowShift_AC_VeryBright        0   SHIFT_AC_SUPERWINDOW_PX  BXX # px
                       Astro:BBP:CCD_WindowShift_AC_Bright        0  SHIFT_AC_BRIGHTWINDOW_PX  BXX # px
                       Astro:BBP:CCD_WindowShift_AC_Medium        0  SHIFT_AC_MEDIUMWINDOW_PX  BXX # px
                        Astro:BBP:CCD_WindowShift_AC_Faint        1   SHIFT_AC_FAINTWINDOW_PX  BXX # px
                    Astro:BBP:CCD_WindowShift_AC_VeryFaint        1  SHIFT_AC_VFAINTWINDOW_PX  BXX # px
              Astro:BBP:CCD_ShortWindowShift_AL_VeryBright        2  SHIFT2_AL_SUPERWINDOW_PX  BXX # px; shift of alternative
                  Astro:BBP:CCD_ShortWindowShift_AL_Bright        2 SHIFT2_AL_BRIGHTWINDOW_PX  BXX # px; shift of alternative
                  Astro:BBP:CCD_ShortWindowShift_AL_Medium        2 SHIFT2_AL_MEDIUMWINDOW_PX  BXX # px; shift of alternative
                   Astro:BBP:CCD_ShortWindowShift_AL_Faint        0  SHIFT2_AL_FAINTWINDOW_PX  BXX # px; shift of alternative
               Astro:BBP:CCD_ShortWindowShift_AL_VeryFaint        0 SHIFT2_AL_VFAINTWINDOW_PX  BXX # px; shift of alternative

                 Spectro:MBP:CCD_WindowShift_AL_VeryBright        2   SHIFT_AL_SUPERWINDOW_PX  MXX # px
                     Spectro:MBP:CCD_WindowShift_AL_Bright        2  SHIFT_AL_BRIGHTWINDOW_PX  MXX # px
                     Spectro:MBP:CCD_WindowShift_AL_Medium        2  SHIFT_AL_MEDIUMWINDOW_PX  MXX # px
                      Spectro:MBP:CCD_WindowShift_AL_Faint        2   SHIFT_AL_FAINTWINDOW_PX  MXX # px
                  Spectro:MBP:CCD_WindowShift_AL_VeryFaint        2  SHIFT_AL_VFAINTWINDOW_PX  MXX # px
                 Spectro:MBP:CCD_WindowShift_AC_VeryBright        0   SHIFT_AC_SUPERWINDOW_PX  MXX # px
```

```
          Spectro:MBP:CCD_WindowShift_AC_Bright        0  SHIFT_AC_BRIGHTWINDOW_PX  MXX # px
          Spectro:MBP:CCD_WindowShift_AC_Medium        0  SHIFT_AC_MEDIUMWINDOW_PX  MXX # px
           Spectro:MBP:CCD_WindowShift_AC_Faint        1   SHIFT_AC_FAINTWINDOW_PX  MXX # px
       Spectro:MBP:CCD_WindowShift_AC_VeryFaint        1  SHIFT_AC_VFAINTWINDOW_PX  MXX # px
```

# 13 Appendix B: history of changes

This may be found in the file HISTORY:

```
01-Mar-04       Version 2.0
                + Delivered to ESTEC

        GD:
                A major rewrite
                + multi-threaded support for concurrent processing
                  and specifying the degree of interdependence of tasks
                + line-based processing (on the pixel-side):
                        ColumnsPack structure suppressed
                        line-based connected component (CC) labeling
                        removal of object-parts meging
                        reduced buffering
                + updated thresholds for filtering out false
                  detections on bright stars
                + valid port to alphas and Mac
                + server mode to pipeline successive tasks and
                  control TDI
                + new options:
                        bright star windowing
                        setting max AL size of CCs
                        setting max number of simultaneous CCs
                        backgroung pixel size (AL & AC)
                        setting the number of threads for object processing
                - removed old selection and confirmation
                  (incompatible with the new detection framework)
                + standard GNU processing of options

    selection:
                + bug corrections, for bright windows smaller than medium
                  in AF11 causing superposition of windows, values in constant.h
                  too small for SSM, error messages for SPL in BBP, reading
                  input now ignores whats remains at the end of the line,
                  superposition of windows for super stars
                + assuming now coordinates in pixel not sample as input
                + switched to SSM designation instead of MBSM

    xcorr: this is a new cross-matching program (see OBD-FC-03)

-------------------------------------------------------------------------------


01-Oct-03       Version 2.0RC1
              + Update (not a full delivery) delivered to ESTEC

        GD:
              + conversion of code to integers
              + deblending now done towards an hardware implementation
                see OBD-SM-06
              + a lot of optimizations...
                see OBD-SM-07

        selection: this is a new selection program (see OBD-JC-01)
```

```
--------------------------------------------------------------------------------

25-Mar-03       Version 1.5.1
              + Delivered to ESTEC

1.5->1.5.1
        GD:
              + removed the call to rintf not supported by the systems
                which are not C99 compliant and replaced with a local
                routine

--------------------------------------------------------------------------------

21-Mar-03       Version 1.5
                + Delivered to ESTEC

1.4 -> 1.5

        GD:
              + (major modif) suppress false detections on spikes
              + (major modif) implemented a one-pass efficient deblending
                scheme using unfiltered data to improve DMS detection
              + fixed all memory leaks
              + rewrote the merging of bodies from different column packs
                to handle complex geometries (bidirectional merging)
              + moved the discarding of truncated sources to selection
              + various optimisations and profiling

        SWA:
              + removed spurious double peak due to discretisation
              + added option for peak test

        select:
              + one neglectible correction

        common:
              + exclude odd psf oversampling (for SWA)

        tests:
              + simulations use Gibis 1.3, with bias added (BZERO) and
                motion accounted for - in astro only, not in MBP/RVSM!
              + GaiaStat now as a function of colour, position, sub-pixel
              + plot*.pl procedures added
              + support for sextractor and APM added (softwares to be obtained
                separately from the authors, and modified to be able to read
                FITS files with BITPIX=-16)
              + best thresholds used (to get less than 1 false/1 million samp)

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8-Jan-03       Version 1.4.1
                + Delivered to ESTEC

1.4.1   This release corrects issues related to portability + e-/ADU conversion

        GD:
              + correction of never finishing recursion due to float precision
              + detection thresholds changed
              + more than 2 objects are managed when compound object
              + negative background due to mirror at CCD edge suppressed

        select:
              + memory bug at beginning of program corrected. EDA structure now
```

```
                dynamically allocated.
              + star leak when duplication seem to have been resolved

        common:
              + manages bitpix=-16 for FITS reading

        tests:
              + simulations now follow Gibis 1.2 with ADU and gain - Spectro
                aberrations not yet included
              + bitpix=-16 to cope with bright stars
              + confirmation thresholds in SelectConfig changed

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12-Dec-02       Version 1.4
              + Delivered to ESTEC

1.3 -> 1.4

        GD:
              + major modification of source deblending
              + added duplication on the fly (-dimal and -dimac options)
              + several memory leaks corrected
              + put Fits reading and khistat in a common directory
              + 3-sigma clipping on background
              + replaced background/source by background/pixel on output +
                number of object pixels added

        SWA:
              + added duplication on the fly
              + put Fits reading in a common directory

        select:
              + hack to limit RVS spectra to brighter than faint_mag only
              + shift in position corrected
              + added duplication on the fly
              + put Fits reading and khistat in a common directory

        common:
              + directory created due to avoid source duplication
              + files replaced by logical links in directories above
              + correction for e- -> ADU in FITS reading

        tests:
              + SelectConfig modified for new RVS design
              + added GaiaErrors.pl which shows false and non-detections
              + GaiaStat.pl and .ds9.ans have pos/mag tolerance as arguments
              + .cat file correction in GaiaDupli.pl

        docs:
              + OBD_SM_02, bug SNR SWA, arguments of V2.4 added
              + OBD-HC-01, final version

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1.2 -> 1.3      Major changes:
        select:
              + takes into account MBP and RVS case (no special treatment)
              + uses an image with no noise and makes the binning
                and noise on the fly
              + overlapping bug in AF2 (and others) correcting
```

```
        + WY00 windows bug (0 separation between half windows accepted)
        + oversizes memory allocation to cope with RVS patches
        + isolated input/output in inputoutput.c

  tests:
        + complete redefinition of constants names in SelectConfig.txt
        + adding MBP and RVS constants in SelectConfig.txt
        + allow 2x2 in SM
        + adding images in MBSM and RVSM
  docs:


  Minor changes:
  GD:
        + RFits.c may read images with bitpix=-16
        + log into stdout, not stderr
        + one slight correction of syntax
        + changed version number to be consistent with documentation

  SWA:
        + inputs changes, no default value, pixThres added
        + image read in float
        + bitpix=-16 accepted
        + writes ds9 regions

  tests:
        + remove files before creation in perl programs
        + installation of logical links to cope with CVS
        + added a statistics analysis in .ds9.ans

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10-Oct-02       Version 1.2
              Preliminary version sent to ESTEC
              includes GD 1.2, SWA, select 1.0, extrapolation
              draft documentation


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Software items sent to ESTEC before:
06-Apr-02       APM translated to C
19-Sep-01       SWA (C) and APM (Fortran), documents OBD-CoCo-01,OBD-CoCo-02
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