Auxiliary data in CU6 processing

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Abstract

This Note reviews the auxiliary data used in CU6 processing

Document History

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1	7	2012-11-14	DK	Comments from GJ, CS, LC, FC, AJA, PS, GS added
1	6	2012-08-16	DK	Gantt chart updated
1	5	2012-08-09	DK	Comments from CS, FC, GJ, PS, LC added. Data model for OR3 and beyond added
1	4	2012-05-22	DK	Comments from CS, FC, GJ, PS, LC added. Sections ”Atomic and stellar data” and ”Data model” added
1	3	2012-05-03	DK	Agenda detailed
1	2	2012-04-20	DK	Sections ”APs”, ”Spectra” and ”Vr” updated
1	1	2012-02-01	DK	Section ”APs” detailed
1	0	2011-12-22	DK	Creation

Contents

1 Introduction

A large variety of auxiliary data are used in CU6 processing. This note reviews these auxiliary data, their properties and how they are processed by the CU6 system.

1.1 Applicable Documents

GJ-001	DU640 Software Requirement Specification
GJ-002	DU640 Software Design Document
Crifo et al. (2010)	Towards a new full-sky list of radial velocity standard stars
Soubiran et al. (2010)	The PASTEL catalogue of stellar parameters
Ammons et al. (2006)	The N2K Consortium. IV. New temperatures and metallicities for more than 100 000 FGK Dwarfs
Casagrande et al. (2011)	New constraints on the chemical evolution of the solar neighbourhood and Galactic disc(s). Improved astrophysical parameters for the Geneva-Copenhagen Survey

1.2 References

Ammons, S.M., Robinson, S.E., Strader, J., et al., 2006, ApJ, 638, 1004, ADS Link

[CBJ-054], Bailer-Jones, C., 2011, *CU8 Operations Manual. Running Apsis*,
GAIA-C8-PL-MPIA-CBJ-054,
URL http://www.rssd.esa.int/llink/livelink/open/3079670

Casagrande, L., Schönrich, R., Asplund, M., et al., 2011, A&A, 530, A138, ADS Link

Crifo, F., Jasniewicz, G., Soubiran, C., et al., 2010, A&A, 524, A10, ADS Link

[GJ-002], Jasniewicz, G., 2008, *WP640 Software Design Document - Radial Velocity Zero-point*,
GAIA-C6-SP-UM2-GJ-002,
URL http://www.rssd.esa.int/llink/livelink/open/2767876

[GJ-001], Jasniewicz, G., Crifo, F., Hestroffer, D., et al., 2008, *WP640 Software Requirement Specification - Radial Velocity Zero-Point*,
GAIA-C6-SP-UM2-GJ-001,
URL http://www.rssd.esa.int/llink/livelink/open/2731910

Jordi, C., Gebran, M., Carrasco, J.M., et al., 2010, A&A, 523, A48, ADS Link

Soubiran, C., Le Campion, J.F., Cayrel de Strobel, G., Caillo, A., 2010, A&A, 515, A111, ADS Link

[FT-003], Thevenin, F., Jasniewicz, G., Chiavassa, A., et al., 2011, *On the need of realistic wavelength of spectral lines for the estimation of the lambda calibration algorithm of the RVS*,
GAIA-C6-TN-OCA-FT-003,
URL http://www.rssd.esa.int/llink/livelink/open/3107139

1.3 Acronyms

The following is a complete list of acronyms used in this document. The following table has been generated from the on-line Gaia acronym list:

Acronym	Description
2MASS	Two-Micron All Sky Survey
AL	Acceptance Load
AP	Antenna Panel
BVC	Barycentric Velocity Correction
CCD	Charge-Coupled Device
CPU	Central Processing Unit
CS	Conducted Susceptibility
CU	Coordination Unit (in DPAC)
DOC	Department of Commerce (USA)
DPAC	Data Processing and Analysis Consortium
DPCC	Data Processing Centre CNES
EPSL	Ecliptic Pole Scanning Law
FC	Fibre Channel
FWHM	Full Width at Half-Maximum
FoV	Field of View (also denoted FOV)
GASS	GAia System-level Simulator
GBOG	Ground-Based Observations for Gaia (DPAC)
GIBIS	Gaia Instrument and Basic Image Simulator
GS	Ground Segment (also denoted G/S)
IDT	Initial Data Treatment (Image Dissector Tube in Hipparcos scope)
IDU	Intermediate Data Update
IGSL	Initial Gaia Source List
LSF	Line Spread Function
MATISSE	MATrix Inversion for Spectral SynthEsis
MDB	Main DataBase
NEP	North Ecliptic Pole
OBA	Optical-Bench Assembly

PS	Project Scientist
RAVE	RAdial Velocity Experiment
RVS	Radial Velocity Spectrometer
SEP	Strong Equivalence Principle
SN	Serial Number (also denoted S/N)
TBC	To Be Confirmed
TBD	To Be Defined (Determined)

2 Context

By auxiliary data, we refer here to the data necessary for CU6 processing, but that are **not** provided via the nominal processing of CU6 or of another DPAC CU. [1]

The auxiliary data can fulfil different needs:
- model/extract the information contained in the observed spectra, e.g. template spectra.
- replace some DPAC internal data until they are available, e.g. effective temperature to be provided by CU8 from MDB-02 on-ward (CBJ-054) and therefore available for CU6 from cycle 3 on-ward.
- define the zero-point of the calibration, e.g. ground-based radial velocity standard.
- validate the processing, e.g. comparison with RAVE catalogue of radial velocities.

In the following sections, the auxiliary data are reviewed by type of information:
- Atmospheric parameters and magnitudes (Sect. 3)
- Atomic and stellar data (Sect. 4)
- Spectra (Sect. 5)
- Radial velocities (Sect. 6)
- Rotational velocities (Sect. 7)

The data models to be used in OR2 and from OR3 onward (including in particular operations) are presented in Sect. 8.

Sect. 9 presents cross tables of *auxiliary data versus acquisition strategy* as well as *auxiliary data versus priority*. The tasks and schedule are summarized in a Gantt chart in Sect. 10.

[1] are not considered here as auxiliary data, e.g. the Barycentric Velocity Correction (BVC) provided by CU3 or the gravitational redshift provided by CU8.

3 Atmospheric parameters and magnitudes

3.1 Atmospheric parameters

3.1.1 Use in CU6 processing

The atmospheric parameters[2] are used to: (i) select the stars that are valid to self-calibrate the RVS, (ii) select the synthetic spectrum to model the RVS spectra and extract their radial and rotational velocities. The atmospheric parameters will be provided gradually by CU8 (CBJ-054). The effective temperature will be available in MDB-02 (i.e. about 22 months after the receipt of the first observations). The surface gravity and metallicity will be provided in MDB-05. Before CU8 delivers atmospheric parameters, the information to perform tasks (i) and (ii) above are limited to either G, G_{RVS} and integrated B_P and R_P magnitudes or to a *full* spectroscopic analysis of the spectra. The magnitudes will be affected by an unknown reddening and therefore would yield inaccurate/imprecise selection. The spectroscopic analysis would be very CPU consuming.

A library of atmospheric parameters would allow for performing the selection until CU8 delivers atmospheric parameters. It is not possible to build a 300 millions stars catalogue containing atmospheric parameters for all the RVS targets. The stars for which atmospheric parameters are the most needed are the potential RVS self-calibration stars, i.e. brighter than $V = 11$. The precision on the atmospheric parameters should be of the order of $\sigma T_{eff} \leq 200$ K, $\sigma \log g \leq 0.5$ and $\sigma[Fe/H] \leq 0.2$ dex.

In addition, the atmospheric parameters for the F-G-K radial velocity standard stars (see Sect. 6.1) should also be provided. This is to guarantee that a "good" template will be selected during CU6 operations.

3.1.2 Acquisition

The library could be assembled from public catalogues, e.g.
The PASTEL catalogue of stellar parameters - Soubiran et al. (2010)
The N2K Consortium. IV. New temperatures and metallicities for more than 100 000 FGK Dwarfs - Ammons et al. (2006)
New constraints on the chemical evolution of the solar neighbourhood and Galactic disc(s). Improved astrophysical parameters for the Geneva-Copenhagen Survey - Casagrande et al. (2011)

RAVE Data Release DR4 will include stellar atmospheric parameters (effective temperature, surface gravity, overall metallicity), radial velocities, individual abundances and distances corresponding to 228 060 spectra. The stellar atmospheric parameters are computed using a new

[2]Effective temperature, surface gravity, metallicity

pipeline, based on the algorithms of MATISSE and DEGAS. The spectral degeneracies and the 2MASS photometric informations are better taken into consideration, improving further the parameter determination. The precision is of the order required i.e. $\sigma_{Teff} < 200$ K, $\sigma_{\log g} < 0.5$ dex and $\sigma_{[Fe/H]} < 0.2$ dex. RAVE DR4 should be publicly available before the deadline for the first operational version of the atmospheric parameters catalogue (2013/05/31).

CU8 is also interested in catalogues of atmospheric parameters. This activity could therefore be mutualized with CU8.

3.1.3 Responsibilities and schedule

Team: C. Soubiran, P. Sartoretti, F. Crifo, G. Jasniewicz

Schedule:
- Task[Katz, 2012/05/31] Define the MDB data model. **[Completed]**
- Task[Sartoretti, 2012/05/31] Contact CU3-IDT to add a cross-match in IDT. **[Completed (*)]**
- Task[Sartoretti, 2012/06/30] Define how to integrate standards in GASS and GIBIS simulations. **[Completed (**)]**
- Task[Crifo, Jasniewicz, Soubiran 2012/09/30] Deliver a test version of the catalogue: a few 10's or a few 100's of stars. **[Completed]**
- Task[Soubiran, 2013/05/31] Deliver 1^{st} operational version of the catalogue. This is the version for cycle 00 processing and in particular for commissioning and initialization activities. A version with 40 000 (or more) stars would provide about 5.8 stars per hour, per CCD and per FoV.

(*) The CU3-IDT cross-match option has been discarded. The cross-link is now performed in CU6 (see Sect. 8).
(**) The standards will not be simulated by GASS or GIBIS, but by CU6.

3.2 Grvs magnitude

3.2.1 Use in CU6 processing

Ground-based G_{RVS} magnitudes are necessary during the commissioning phase to assess the performances of the estimation of G_{RVS} by the on-board software.[3]

During the initialisation and routine operation phases, ground-based G_{RVS} are needed to validate the DPAC estimations of G_{RVS} from R_P spectra (under CU5 responsibility) and from RVS spectra (under CU6 responsibility).

[3] the precision of the on-board software in estimating G_{RVS} has a direct impact on the proper allocation of the window class 0, 1 and 2 as well as on the RVS limiting magnitude.

During routine operations, if/when the ground-based G_{RVS} are more accurate and precise than the Gaia G_{RVS}, they could be preferred for the modelling and subtraction of the point-like contaminant spectra. For the stars brighter than V$\sim$6, there will be no Gaia observation and therefore CU6 shall rely on ground-based G_{RVS}.

The largest possible catalogue is desirable, with an accuracy/precision of $\sigma G_{RVS} \leq 0.05$, (in particular, small with respect to the on-board software expected performances). Stars brighter than V=6 shall be also included.

3.2.2 Acquisition

The G_{RVS} could be derived from other magnitudes and colour indices. Jordi et al. (2010) provide several formula to derive G_{RVS} from broad band colour indices.

3.2.3 Responsibilities and schedule

Team: TBD (see schedule).

Schedule:
The *Initial Gaia Source List* (IGSL) contains G and V magnitudes, but currently not G_{RVS}. The ecliptic poles stars catalogue of M. Altman contains G_{RVS}, but for a small fraction of the sky around each pole. What seems the best option, would be to derive the G_{RVS} magnitudes for the stars in the IGSL in a similar way as has been done for G magnitude.

- Task[Katz, Sartoretti, 2012/06/30] Contact R. Smart to see if it would be possible to add G_{RVS} to the IGSL. **[Completed (*)]**

(*) It has been decided to add G_{RVS} to the IGSL.

4 Atomic and stellar data

4.1 Stellar lines rest wavelengths

4.1.1 Use in CU6 processing

Rest wavelengths are used in the wavelength calibration module.

4.1.2 Acquisition

4.1.3 Responsibilities and schedule

Team: TBD

Schedule:

- TBD

4.2 Telluric lines rest wavelengths

4.2.1 Use in CU6 processing

The ground-based spectra (see Sect. 5.3) will be contaminated by telluric lines. These should be corrected before comparison to the RVS spectra, which are not contaminated by telluric lines.

4.2.2 Acquisition

Rosanna Sordo is currently removing telluric lines from GBOG South Ecliptic Pole spectra.

4.2.3 Responsibilities and schedule

Team: TBD

Schedule:

- TBD

4.3 Convective shifts

4.3.1 Use in CU6 processing

The convective motions in stellar atmospheres are shifting the lines in wavelengths. The amplitude and sign of the shift vary from line to line. For each line, amplitude and sign of the wavelength shift are function of the spectral type and of the luminosity class. The shifts of the different lines induce a shift of radial velocity. Grids of convective shifts will be used to correct the radial velocities.

4.3.2 Acquisition

Grids of convective shifts are calculated from 3D atmosphere models and synthetic spectra.

4.3.3 Responsibilities and schedule

Team: G. Jasniewicz, C. Zurbach, F. Thévenin, L. Bigot, A. Chiavassa, H. Ludwig.

Schedule:
- Task[Zurbach, 2013/05/31] Deliver 1^{st} operational version.

5 Spectra

5.1 Synthetic spectra

5.1.1 Use in CU6 processing

The synthetic spectra are used in CU6 processing as template: to model and subtract the point-like contaminants, for the calibration of the RVS (e.g. line correlations in wavelength calibration, line profile fitting in LSF AL calibration) and for the extraction of the radial and rotational velocities. Moreover, the smooth-templates are derived from the synthetic spectra.

5.1.2 Acquisition

A grid of synthetic spectra has been provided by CU8. It covers the classical stars. Additional spectra could be needed for peculiar stars (TBC).

As presented in FT-003, the convective motions in the stellar atmosphere are shifting the lines. The shift is a function of the line, of the spectral type and of the luminosity class. Until mid-2010, the baseline strategy was to correct for the convective shift, by applying a-posteriori a correction on the radial velocity. Following, FT-003, this strategy could be revised. A new grid of synthetic spectra (with the wavelength of the main lines accounting for the convection) could be used a-priori. The computation of the grid has started.

5.1.3 Responsibilities and schedule

<ins>Team:</ins> F. Thévenin, L. Bigot, A. Chiavassa, G. Jasniewicz.

<ins>Schedule:</ins>
• Task[Chiavassa, 2012/12/14] Deliver the library of synthetic spectra including the convective shifts.

5.2 Smoothed templates

5.2.1 Use in CU6 processing

The smoothed templates are used to normalize the spectra to the continuum and to model the point-source background.

5.2.2 Acquisition

The smoothed templates have been calculated from the current library of synthetic templates. There are only a few cases where the code does not find the line-free regions when there are line-free regions. Correcting this is on the to do list.

5.2.3 Responsibilities and schedule

Team: H. Huckle

Schedule:
- TBD

5.3 High resolution, high S/N observed spectra

5.3.1 Use in CU6 processing

As presented in Sect. 5.1: the spectra extraction, RVS calibration and radial velocity derivation sub-systems all rely on template spectra. The template spectra should be as similar as possible to the observed spectra. Because of (i) the limitations in the art of spectra modelling, (ii) possible non-solar abundance pattern and (iii) the uncertainty on the estimations of the atmospheric parameters of the sources, it is not possible to perfectly model a given star. The best templates that could be used in CU6 processing, are the spectra of the stars themselves, observed from the ground. This is particularly relevant for the calibration stars. In their case, the discrepancies with the templates generate errors on the calibration that propagates as systematic calibration errors to all the observations.

Moreover, in cycles 00, 01 and 02, the CU8 atmospheric parameters will not yet be available (CBJ-054). With template spectra observed from the ground, there is no need to know the atmospheric parameters.

The ground-based spectra can also be used a-posteriori to check the quality of the processing: e.g. background modelling and subtraction, de-blending and RVS calibration.

5.3.2 Acquisition

The main motivation to collect these spectra from the ground is the calibration of the wavelength dispersion law and of the *Line Spread Function* (LSF) instrumental profile of the RVS. These calibrations rely on the comparison of the observed RVS spectra with the ground-based spectra. The ground-based spectra should therefore fulfil the following specifications:
- include the RVS wavelength range [847, 874] nm, if possible with a some margin to avoid

spectrum border effects and differential radial velocity shifts.
• preferably high resolving power R>50 000 (minimum: R>30 000).
• high signal to noise, i.e. S/N=200 ratio after re-sampling to the RVS spectral sampling of 0.25 A/pixel: i.e. S/N=100 if R_{ground}=40 000 and S/N=70 if R_{ground}=80 000.
• bright stars, preferably V<10, for the stars to be usable as reference for the calibration of the RVS.

When available, it would be useful to have the APs for these stars.

As emphasized above, the ground-based spectra are particularly needed for the commissioning and calibrations of the RVS. During the 2 first months of the mission, Gaia will adopt a special scanning law, i.e. the Ecliptic Pole Scanning Law (EPSL). For 2 months, the spin axis of the satellite will be in the ecliptic plane and each telescope will observe the north (respectively the south) ecliptic pole every 6 hours. It is therefore optimal to select the ground-based spectra in the vicinity of the ecliptic poles, as these will be the stars observed the most frequently by the RVS. The ecliptic poles areas are the main targets for the selection of the observed spectra. Nonetheless, the whole celestial sphere is interesting to collect observed spectra in particular when extracting them from archives.

The ecliptic poles spectra do not exist in archives and therefore need to be observed in the context of dedicated programs. For the rest of the sky, it should be checked whether spectrograph archives (e.g. NARVAL@Pic du Midi) contain useful material. For example, for NARVAL@Pic du midi it is estimated that there should be about 200 radial velocity standards, 200 to 300 CU8 observations and 300 to 400 useful stars from the archives.

The observed spectra will be pre-processed before being delivered to the MDB:
• Wavelengths: shifted to rest frame, expressed in vacuum (not in the air), re-sampled to a constant step in wavelength.
• Fluxes: normalised to the continuum, telluric lines removed.
• Resolving power: constant full width at half-maximum (FWHM) in Angstrom (as high as possible).

15 Carbon-stars have already been observed.

5.3.3 Responsibilities and schedule

Team: C. Soubiran, F. Crifo, G. Jasniewicz, L. Chemin

NEP spectra have been acquired on NARVAL. Have they all been observed and do they all have the appropriate S/N ratio?

Schedule:
• Task[Jasniewicz, 2012/09/28] Obtain the 21 SEP spectra on the 2.3m Siding Springs (Australia) telescope.
• Task[Soubiran, 2012/12/31] Extract spectra from the NARVAL@Pic du Midi archive and pre-process the spectra.
• Task[Soubiran, 2013/03/01] Extract spectra from the ESPADON@CFHT archive and pre-process the spectra.
• Task[Royer, 2013/03/29] Extract spectra from other archives (e.g. Sidding Springs, Giraffe HR21) and pre-process the spectra.
• Task[Soubiran, 2013/05/31] Deliver the library.
• Task[TBD, TBD] Derive or collect the epoch Vr of the sources.
• Task[TBD, TBD] Assess or collect the multiplicity status of the sources (single, SB1 or SB2).
• Task[TBD, TBD] Derive or collect the projected rotational velocity of the sources.

5.4 Normalised flux spectra

5.4.1 Use in CU6 processing

Absolutely calibrated observed spectra of spectrophotometric standards (low/medium resolution) are needed for estimating the magnitude zero-point.

5.4.2 Acquisition

5.4.3 Responsibilities and schedule

Team: TBD

Schedule:
• TBD

5.5 Mid-resolving power, mid-S/N spectra

5.5.1 Use in CU6 processing

For statistical validation.

Include a few blended spectra (validate de-blend)

Include a few SB2 spectra (validate STA for SB2) etc...

5.5.2 Acquisition

Telescope archives?

RAVE DR6 will be the last RAVE data release and will include all the spectra. It will likely be released after Gaia's launch, i.e. too late to be used during the first processing cycle, but interesting for a later cycle.

5.5.3 Responsibilities and schedule

Team: TBD

Schedule:

- TBD

6 Radial velocities

6.1 Ground-based standard: F, G, K

6.1.1 Use in CU6 processing

The RVS instrument is self calibrated, i.e. it is calibrated using a subset of its own observations. The wavelength calibration modules uses F, G and K reference stars to derive simultaneously the dispersion law and the radial velocities of the references. If based only on Gaia data, the method is mathematically degenerated: i.e. a shift of all the Vr can be compensated by a "shift" of the dispersion law. The degeneracy can be removed by the use of ground-based radial velocity standards which provide the zero-point of the radial velocity scale, which in turn provides the zero-point of the dispersion law.

F, G and K stars are used as references because they display deep and narrow lines whose centroids can be accurately determined.

6.1.2 Acquisition

With the RVS, we aim at a precision of 1 km/s for the bright stars. To avoid degrading the random error with too strong systematics, the aim is to have systematic calibration residuals of the order of 100 m/s. To achieve this goal, the ground-based standards should be stable to better than 300 m/s and their global zero-point should be accurate at 50 m/s (this will be achieved using ground-based observations of asteroids, see Sect. 6.4).

At least 1000 ground-based standards should be qualified as stable (to better than 300 m/s) by the start of the mission. A list of 1420 candidate standards has been established (Crifo et al., 2010). Their Vr are extracted from the existing archives (when available) and improved via a new observation campaign. The aim is to have at least three Vr well separated in time, before the start of the Gaia mission, to identify and reject the stars presenting a variability larger than 300 m/s. A 4^{th} observation should be acquired during the mission to remove the long period variables, that could be missed with a shorter time interval for the ground-based observations.

The stars should be bright, i.e. $G_{RVS} \leq 10$, to be usable as reference by wavelength calibration.

The ground-based Vr standards are compared to template spectra. In some cases the ground-based spectra will be available with a good enough S/N (and the RVS wavelength range) to be used as template. The rest of the time, the APs of the ground-based RV standards should be known in order to select a good-matching template.

6.1.3 Responsibilities and schedule

Team: DU640

All the bibliographic data have been extracted from the CORAVEL database and from the literature. The pre-launch ground-based observations are 95% completed (as of August 2012).

Schedule:
- Task[Jasniewicz, 2012/05/31] Define the data-model **[Completed]** (see Sect. 8)
- Task[DU640, 2012/12/14] Complete the observations.
- Task[Chemin, 2012/08/30] Deliver catalogue test version. **[Completed]**
- Task[Chemin, 2013/05/31] Deliver the 1^{st} operational version of the catalogue. This will be the version for cycle 00 processing and in particular for commissioning and initialization activities.
- Task[DU640, 2018] Re-observe each standard once during the mission. Since the aim is to detect long term trends, it will be more efficient to conduct the observation campaign during the last 2 years of the Gaia mission.
- Task[Crifo/Soubiran/Jasniewicz] Derive or collect the APs for the ground-based RV standard. **[Completed]**

6.2 Ground-based standard: O, B, A, M

6.2.1 Use in CU6 processing

The spectral lines present in the RVS wavelength range are a strong function of the temperature of the stars. Therefore, the lines available/used to derive the radial velocity will be function of the spectral type. The consequence, is that the zero-point of the radial velocities will be function of the spectral type. The zero-point for the F, G and K stars will be provided by the ground-based standards observed for the wavelength calibration (see Sect. 6.1). Complementary ground-based standards should be observed to fix the radial velocity zero-point of the O, B, A and M stars.

6.2.2 Acquisition

From 10 to a few 10s of stars per spectral type are needed to define the zero-points. The stability criterion should be the same as for the other ground-based standard: $\sigma_{Vr} < 300$ m/s.

Some M stars have been observed.

CU8 has a list of OBA ground-based targets. It should be seen if these stars could be mutualized with CU6.

6.2.3 Responsibilities and schedule

Team: DU640 or CU8 (TBC)

Schedule:
- Task[DU640, 2012/05/31] Define the data-model. **[Completed]**
- Task[DU640 or CU8, 2012/12/14] Complete the observations.
- Task[DU640 or CU8, 2012/08/30] Deliver catalogue test version.
- Task[DU640 or CU8, 2013/05/31] Deliver the 1^{st} operational version of the catalogue. This will be the version for cycle 00 processing and in particular for commissioning and initialization activities.
- Task[DU640 or CU8, 2018] Re-observe each standard once during the mission. Since the aim is to detect long term trends, it will be more efficient to conduct the observation campaign during the last 2 years of the Gaia mission.

6.3 Stellar verification velocities

6.3.1 Use in CU6 processing

The radial velocities of these stars will be statistically compared to the RVS results.

6.3.2 Acquisition

As the comparison will be statistical, the precision does not need to be excellent, i.e. $\sigma_{Vr} <$ 2 to 5 km/s. The systematics should be reasonable to take benefit of a large statistics (i.e. average, at least partly, the random errors) and allow to estimate the RVS systematics, i.e. $\mathrm{Sys}_{Vr} < 1$ to 2 km/s.

Bibliography, e.g. RAVE.

6.3.3 Responsibilities and schedule

Team: TBD

Schedule:
- TBD

6.4 Asteroids validation velocities

6.4.1 Use in CU6 processing

Detailed individual validation.

6.4.2 Acquisition

Ground-based observation for validation/fine-tuning of the concept.

6.4.3 Responsibilities and schedule

Team: DU640

Schedule:
- Task[DU640, 2012/12/14] Define Vr absolute zero-point

7 Rotational velocities

7.1 Calibration stars

7.1.1 Use in CU6 processing

The relation CC-peak versus rotational velocity needs to be calibrated.

7.1.2 Acquisition

Can we rely only on bibliographic data or do we need observations?

7.1.3 Responsibilities and schedule

Team: TBD

Schedule:
- TBD

8 Data model

8.1 For OR2

The tables to store the F-G-K ground-based standards are defined in the dictionaryTool in the folder mdb.cu6.auxiliarydata. The first table *RvsStdCatalog* describes the properties of the ground-based standard, while the second table *RvStdMatch* allows to match the Hipparcos identificator *hipId* with the Gaia identificator *sourceId*. Both tables will be generated by CU6 in advance of OR2.

RvStdCatalog	
long	solutionId
long	hipId
double	alpha
double	delta
double	radVel
double	radVelError
boolean	isValidStandard
double	muAlpha
double	muDelta
double	varPi
double	vMag

RvStdMatch	
long	solutionId
long	hipId
long	sourceId

Note: A table RvStdCatalog describes one ground-based radial velocity standard (GBRVS). The catalogue of GBRVS is made of the sum of all the records of this table.

8.2 From OR3 and beyond

The CU6 auxiliary data are structured in 8 tables, corresponding to:

- One summary table of the observed quantities and 4 catalogues:
  - Summary
  - Grvs magnitude
  - Atmospheric parameters
  - Radial velocities
  - Observed spectra
- Three libraries for synthetic data:
  - Convective shifts
  - Reduced library of synthetic spectra (**)
  - Reduced library of smoothed templates (**)

(**) The reduced libraries contain about 30 spectra.

As of August 2012, 8 tables are defined covering the main auxiliary data. A few more should be defined to store, e.g. the stellar lines rest wavelengths, the telluric lines rest wavelengths, etc...

8.2.1 Catalogues of observed data

The (observed) catalogues will be prepared by CU6. They will be defined in mdb.cu6.auxiliarydata

In each (observed) catalogue, the sources will be identified by a sourceId. Initially, this sourceId will be the same as the one used in the IGSL catalogue. The cross-link between the sourceId and the transitId will be provided by the mdb.cu3.idt.xm.match table that will be transmitted daily to DPCC, as well as by the mdb.cu3.idu.xm.match table, transmitted after each IDU run.

DPCC will daily identify the stars with sourceId (provided by the table cu3.idt.xm.match) that match the sourceId of CU6 auxiliary data.

auxCatalogues	
long	solutionId
long	sourceId
boolean	auxGrvs (1)
boolean	auxAtmParam (1)
boolean	auxRadVel (1)
boolean	auxObsSpe (1)
short	isMultiple (2)

(1) 0 = the star is not contained in the catalogue; 1 = the star is contained in the catalogue. These 4 booleans are meant to speed-up the incorporate information task. The task will only read a catalogue when the corresponding boolean is equal to 1.
(2) 0 = single star; 1 = SB1; 2 = SB2.

auxCatalogues contain no (pre-Gaia) information on the coordinates (alpha, delta) or proper motions of the sources. These informations are contained in mdb.cu3.auxdata.igsl and are available via mdb.cu1.integrated.completesource.

auxGrvs	
long	solutionId
long	sourceId
double	gbMagGRvs
double	gbMagGRvsError
boolean	isValidPhotomStandard

auxAtmParam	
long	solutionId
long	sourceId
short	refLevel (3)
double	gbTeff[] (*)
double	gbTeffError[] (*)
double	gbTeffOrig (**)
double	gbLogg[] (*)
double	gbLoggError[] (*)
double	gbLoggOrig (**)
double	gbFeH[] (*)
double	gbFeHError[] (*)
double	gbFeHOrig (**)
double	gbVSinI[] (*)
double	gbVSinIErr[] (*)
double	gbVSiniIOrig (**)

(3) reference level: 1 = benchmark stars; 2 = primary references; 3 = secondary stars.
(*) The dimension is equal to the number of components.
(**) These fields trace the origin of the parameters: i.e. article reference(s) and/or method(s) used to derive the parameters.

auxRadVel	
long	solutionId
long	sourceId
double	gbRadVelSpeBar (***)
double	gbRadVelSpeBarError (****)
boolean	isValidVrStandard

auxObsSpe	
long	solutionId
long	sourceId
calibratedSpectrumConstStep	obsSpe

(***) Mean (over time) spectroscopic barycentric radial velocity.
(****) Total error on the mean (over time) spectroscopic barycentric radial velocity.
The term "spectroscopic" is used here by opposition to the term "kinematic". It is the radial velocity measured from a spectrum and not corrected for effects like gravitational red-shift or convective motions in the stellar atmosphere.

Note: the prefix "gb" in many attributes stands for "ground-based" (to differentiate them from the same quantities derived from Gaia data in DPAC processing).

Note: The tables auxCatalogues, auxGrvs, auxAtmParam, auxRadVel and auxObsSpe describe one star (or one system in case of SB2). A catalogue is made of the sum of all the records of a table.

8.2.2 Libraries of synthetic data

libRedSynthe

long	solutionId
short	speId
starNormal	synthSpe

libRedSmooth

long	solutionId
short	speId
smoothedTemplate	smoothTemp

The synthetic spectra and smoothed templates stored in the libRedSynthe and libRedSmooth tables are also stored in the full libraries. The reduced libraries are about 100 time smaller than the full libraries. The overhead due to the redundancy is therefore modest. On the other hand, the duplication should greatly simplify the management of the data.

Note: The tables libRedSynthe and libRedSmooth describe one synthetic spectrum or smoothed template. A library is made of the sum of all the records of a table.

9 Cross-table

Auxiliary Data	Acquisition: Computation	Acquisition: Archives	Acquisition: Observations	Priority: P0	Priority: Cycle P1
Atmospheric parameters		Y		Y	
G_{RVS}		Y		Y	
Synthetic spectra	Y			Y	
Convective shifts	Y			Y	
High R, SN obs spectra		Y	Y	Y	
Normalised flux spectra					
Mid-R, SN obs spectra		Y		Y	
Vr F-G-K		Y	Y	Y	
Vr O-B-A-M		Y	Y	Y	
Vr verification		Y		Y	
Vr Asteroids	Y		Y	Y	
v sin i		?	?		Y

10 Tasks and schedule summary

N°	Nom de la tâche	Durée	Début	Fin
1	**Auxiliary data**	**248 jours**	**Mar 01/05/12**	**Ven 31/05/13**
2	**Atmospheric parameters**	**248 jours**	**Mar 01/05/12**	**Ven 31/05/13**
3	Define data model	20 jours	Mar 01/05/12	Jeu 31/05/12
4	Plan IDT cross-match	20 jours	Mar 01/05/12	Jeu 31/05/12
5	Plan simulations	38 jours	Mar 01/05/12	Ven 29/06/12
6	Deliver library test version	57 jours	Jeu 31/05/12	Jeu 30/08/12
7	Deliver library 1st op version	171 jours	Ven 31/08/12	Ven 31/05/13
8	**Grvs magnitude**	**38 jours**	**Mar 01/05/12**	**Ven 29/06/12**
9	Clarify interfaces	38 jours	Mar 01/05/12	Ven 29/06/12
10	**Stellar lines rest wavelengths**	**0 jour**	**Mar 01/05/12**	**Mar 01/05/12**
11	TBD	0 jour	Mar 01/05/12	Mar 01/05/12
12	**Telluric lines rest wavelengths**	**0 jour**	**Mar 01/05/12**	**Mar 01/05/12**
13	TBD	0 jour	Mar 01/05/12	Mar 01/05/12
14	**Convective shifts**	**248 jours**	**Mar 01/05/12**	**Ven 31/05/13**
15	Deliver 1st op version	248 jours	Mar 01/05/12	Ven 31/05/13
16	**Synthetic spectra**	**143 jours**	**Mar 01/05/12**	**Ven 14/12/12**
17	Deliver library	143 jours	Mar 01/05/12	Ven 14/12/12
18	**High R SN obs spectra**	**248 jours**	**Mar 01/05/12**	**Ven 31/05/13**
19	Obtain 21 SEP spectra	95 jours	Mar 01/05/12	Ven 28/09/12
20	Datamine Narval archive	152 jours	Mar 01/05/12	Ven 28/12/12
21	Datamine ESPADON archive	191 jours	Mar 01/05/12	Ven 01/03/13
22	Datamine other archives	209 jours	Mar 01/05/12	Ven 29/03/13
23	Deliver 1st op version	248 jours	Mar 01/05/12	Ven 31/05/13
24	Collect Vr	0 jour	Mar 01/05/12	Mar 01/05/12
25	Collect multiplicity	0 jour	Mar 01/05/12	Mar 01/05/12
26	Collect vsini	0 jour	Mar 01/05/12	Mar 01/05/12
27	**Norm flux spectra**	**0 jour**	**Mar 01/05/12**	**Mar 01/05/12**
28	TBD	0 jour	Mar 01/05/12	Mar 01/05/12
29	**Mid-R SN spectra**	**0 jour**	**Mar 01/05/12**	**Mar 01/05/12**
30	TBD	0 jour	Mar 01/05/12	Mar 01/05/12
31	**Vr F-G-K**	**248 jours**	**Mar 01/05/12**	**Ven 31/05/13**
32	Define data model	20 jours	Mar 01/05/12	Jeu 31/05/12
33	Complete observations	143 jours	Mar 01/05/12	Ven 14/12/12
34	Deliver test version	57 jours	Jeu 31/05/12	Jeu 30/08/12
35	Deliver 1st op version	171 jours	Ven 31/08/12	Ven 31/05/13
36	2nd observation campaign	0 jour	Mar 01/05/12	Mar 01/05/12
37	Derive Aps	143 jours	Mar 01/05/12	Ven 14/12/12
38	**Vr O-B-A-M**	**248 jours**	**Mar 01/05/12**	**Ven 31/05/13**
39	Define data model	20 jours	Mar 01/05/12	Jeu 31/05/12
40	Complete observations	143 jours	Mar 01/05/12	Ven 14/12/12
41	Deliver test version	57 jours	Jeu 31/05/12	Jeu 30/08/12
42	Deliver 1st op version	171 jours	Ven 31/08/12	Ven 31/05/13
43	2nd observation campaign	0 jour	Mar 01/05/12	Mar 01/05/12
44	**Vr verification**	**0 jour**	**Mar 01/05/12**	**Mar 01/05/12**
45	TBD	0 jour	Mar 01/05/12	Mar 01/05/12
46	**Vr Asteroids**	**143 jours**	**Mar 01/05/12**	**Ven 14/12/12**
47	Define Vr absolute zero-point	143 jours	Mar 01/05/12	Ven 14/12/12
48	**V sin i**	**0 jour**	**Mar 01/05/12**	**Mar 01/05/12**
49	TBD	0 jour	Mar 01/05/12	Mar 01/05/12