Towards a new list of stars to validate the RVs from the RVS

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Abstract

This document describes the content of a new reference list, UMM (University of Montpellier Masterlist), made of several catalogs, composed with stars whose radial velocities are known with precision. The content of UMM will increase in the next months in order, mainly, to validate the RVS data during the Gaia mission and to extend, if possible, the CS15 list currently used for the RVZP.

Document History

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1 Introduction

The Radial Velocity Spectrometer (RVS) on board Gaia is not equipped with calibration lamps. RVZP should be defined with the help of star reference tables whose characteristics (RV, APs) are known in advance (see [1]). An initial list of 1420 RV-STD candidate stars, described in [2], was established for RVZP, after an initial requirement of about 1000 stars, well distributed over the celestial sphere. For the detailed requirements, see [2]. These stars were carefully selected, AND all remeasured at least 2 times before launch. The result of these measurements is published in [3]. Some objects proved to be not stable enough and were discarded ; 1371 were kept.
At the 16th meeting of the CU6 in December 2013, it was established that this standard RV list should be expanded by at least 10 000, due to the quite short "calibration units" requiring the observation of at least one standard every hour ; while with the 1420 RV-STD list, it may happen that for some particular scanning positions, like in the galactic plane, one may have to wait up to 8 hours between two consecutive standards. Several new lists were therefore built :
- one from a quick selection of lower quality but existing data (see [4]), extracted from the XHIP catalog (see [5])
- and one with new data obtained by reducing the available spectral archives. These data constitute the so-called "CS15 list" (see [6]).

Stars extracted from XHIP (see TN [4] to the selection criteria) are numerous (7730 objects), a number very useful for the reduction at the beginning ; but of slightly lower quality, and with data not controlled by our team, often mean values between different sources.
The CS15 is based on homogeneous RV measurements from ELODIE, SOPHIE, HARPS and CORALIE, all put on the common SOPHIE scale. The CS15 RV measurements come either from our own observations of the initial list of 1420 RV-STD candidates that were followed-up between 2006 and 2012, or from the archives of these instruments (note that a new observing follow-up program is currently on-going on SOPHIE and CORALIE and will bring new measurements in CS15). CS15 includes 10227 stars classified from 1 to 9 according to the number of RV measurements available, their time baseline and their stability. These Quality coefficients are fully described in several minutes of DU640 telecons (*) and in TN [6]. There are 2798 stars classified from 1 to 3 and those are currently our list of primary standards. CS15 also contains 4549 secondaries stars classified from 4 to 7, corresponding to stars which did not fulfill the requirements for being primaries : not enough RV measurements, or too short time baseline, RV scatter between 0.1 and 1 km/s, M star, Vmag > 11, no neighbouring star. Finally CS15 also contains stars, classified 8 or 9, which should not be used for validation or calibration because they have a variability larger than 1 km/s, or because of an indication of binarity in Simbad or XHIP.
Since the beginning of the work of this TN, new lists of good original data have been published, in particular Chubak et al (2011) and Worley (2012) ; and for the RVS, reliable ground-based data from sets as large as possible are very desirable. It was therefore decided to build a supplementary and larger comparison set for the RVS data, with a more sophisticated tool allowing quick and efficient comparisons with statistical tests, called "UMM list" (Université de Mont-

pellier Master List), and described in Sect. 2. It presently (Jan. 2016) contains 22901 stars and 25284 RVs.
The UMM is intended to gather all non-RVS measurements that were evaluated to be useful for calibrations and validations.
At the time this new tool was built, the CS15 list was not finished, and not included. But it will be included in the next version of UMM. This TN is only a snapshot of the current work in January 2016.
With this tool, the validation procedure of the RVS data will simply consist to compare them with the content of UMM by means of statistical tests which are described in Sect. 3.
These statisticals tests have been adjusted by using the RV-STD list and the CS15 list as "external lists".
Our parameters being established, in the following step we have compared UMM with a sample of RVS data transmitted by P. Panuzzo (see Sect. 4), to make sure everything works well. Our procedure being validated, our conclusions are given in Sect. 5 : the next version of UMM will include CS15 and other lists of interest.

In this TN, a star in any list of RV velocities is said qualified if its RV satisfies positively our statistical tests of comparison with UMM data. RVS data from the CU6 pipeline will be validated if, ideally, all RV-stable (resp. RV-variable) stars are qualified (resp. not qualified) by our procedure.

Important remarks : in this work relative to the preparation of UMM, no study on Zero-point RV has been done. Zero-point RV between catalogs in UMM will be taken into account in the UMM coming versions.
In this version of UMM, which is preliminary, there are multiple entries RVs for a set of stars, and in the final version of UMM, it will be only one RV measurement for each star.

(*) `http://wiki.cosmos.esa.int/gaia-dpac/index.php/CU6:_GWP-S-640:_RVZP`

1.1 Referenced Documents

[1] G. Jasniewicz et al. Radial Velocity Standard Stars for the Gaia RVS. *EAS Publications Series*, 45 :195, 2011.

[2] F. Crifo, G. Jasniewicz, C. Soubiran, D. Katz, A. Sibert, L. Veltz, and S. Udry. Towards a new full-sky List of Radial Velocity Standard Stars. 2010. A&A 524,10.

[3] C. Soubiran, G. Jasniewicz, L. Chemin, F. Crifo, S. Udry, D. Hestroffer, and D. Katz. The Catalog of Radial Velocity Standard Stars for Gaia. 2013. A&A 552,64.

[4] F. Crifo, P. Sartoretti, and D. Katz. Radial Velocity Secondary Standards. 2014. FCO-002-1.

[5] E. Anderson and C. Francis. Xhip : An extended hipparcos compilation. Astronomy Letters, Volume 38, Issue 5, pp.331-346.

[6] C. Soubiran, L. Chemin, and JF. Lecampion. New Radial Velocity Standards for the RVS. Technical report, 05 2014. GAIA-C6-TN-LAB-CS-015-1.

1.2 Definitions, acronyms, and abbreviations

The following table has been generated by extraction from the current document :

Acronym	Description
AP	Astrophysic Parameters
CCD	Charge-Coupled Device
CU	Coordination Unit (in DPAC)
DU	Development Unit (in DPAC)
DPAC	Data Processing and Analysis Consortium
GEPI	Galaxies, Etoiles, Physique et Instrumentation
HARPS	High Accuracy Radial Velocity Planet Searcher
HIP	Hipparcos catalog
IGSL	initial Gaia source list
JD	Julian Date
LUPM	Laboratoire Univers et Particules de Montpellier
NSO	National Solar Observatory
OBMT	On-Board Mission Timeline
RMS	Root Mean Square
RV	Radial Velocity
RVS	Radial Velocity Spectrometer

RVZP	Radial Velocity Zero Point
UMM	University Montpellier Master list

2 Construction of the UMM list

Among the latest radial velocity data catalogs available in the literature, only those with an error on radial velocity lower than 1 km/s were selected. The RV measurements were made using different configurations (instruments, calibration lamps, software) thus involving different zero points for each catalog.

2.1 Data Input (as at January 2016)

The selection of stars for the construction of the UMM list is made from the following catalogs :

- "Radial Velocities of 889 late-type stars" (NIDEVER et al., 2002) : 745 HIP entries
Radial velocities stable stars, with RMS $\leq$ 100m / s
Remark : this catalog has been strongly investigated for the building of the 1st list of RVS Standards and 336 were kept in this first list. The stars not kept do not fill the selection criteria listed in [2].

Table 1 - Structure of selected data in the catalog NIDEVER

Bytes	Format	Units	Label	Explanations
01- 12	A12	—	Name	Primary name
14- 25	A12	—	AName	Alternative name
27- 29	A3	—	Ref[NSO M]	Stellar spectrum used as the template
31- 37	I7	JD	Date	Mean time of observation
39- 42	I4	d	DeltaT	Span of observations
44- 50	I7	m/s	RV	Mean barycentric radial velocity

- "Radial velocities for 6691 K and M giants" (FAMAEY et al., 2005) : 6690 entries
Remark : this catalog has also been investigated for the building of the 1st list of RVS Standards and 154 were kept in this first list.

Table 2 - Structure of selected of data in the catalog FAMAEY

Bytes	Format	Units	Label	Explanations
01- 06	I6	—	HIP	HIP number
08- 13	I6	—	HD	HD number
16- 23	A8	—	BD	BD designation (only when HD missing)
25- 31	F7.2	km/s	RV	Average radial velocity, or center-of-mass (COM)
33- 39	F5.2	km/s	eRV	Standard error of RV

- "The Geneva-Copenhagen Survey of Solar neighbourhood" (NORDSTROM et al., 2004) : 14133 entries
Remark : this catalog has also been investigated for the building of the 1st list of RVS Standards

and 1084 were kept in this first list.

Table 3 - Structure of selected data in the catalog NORDSTROM				
Bytes	Format	Units	Label	Explanations
01- 06	I6	—	HIP	Hipparcos number if available
08- 18	A11	—	Name	Object name (HD,BD,CD or CP)
20- 20	A1	—	fb	Flag for binaries of all types)
22- 22	A1	—	fs	Flag for cool dwarfs south of -26deg
24- 29	F6.1	km/s	RV	Mean radial velocity
31- 35	F4.1	km/s	meRV	Mean error of radial velocity
37- 42	F5.1	km/s	SRV	Standard deviation of RV measurements
44- 47	I3	—	oRV	Number of RV measurements
49- 53	I4	d	dT	Time-span of RV measurements

- ”Precise radial velocities of 2046 nearby FGKM stars and 131 standards” (CHUBAK et al. 2011) : 1916 entries
Radial velocities stable stars FGKM with RMS $\leq$ 100 m.s$^{-}1$

Table 4 - Structure of selected data in the catalog CHUBAK				
Bytes	Format	Units	Label	Explanations
01-09	A9	—	HIP	Star ID
11-19	A8	—	HD	Star ID
20-21	A1	—	T	Template
23-26	A4	—	DT	DeltaT (Days)
28-35	A8	—	RV	Mean Radial Velocity
37-41	A4	—	OBS	Observations
43-47	A4	—	SRV	Standard deviation of RV (km s-1)

- ”Calculation of standard gaps and medium RV by DU640, from the catalog WORLEY (2012), built from spectroscopic measurements obtained with the instrument FEROS, Chile” : 1378 entries

Table 5 - Structure of selected data in the catalog WORLEY				
Bytes	Format	Units	Label	Explanations
01-12	A12	—	HIP	Star ID
13-23	A11	—	HD	Star ID
24-27	A4	—	OBS	Observations
29-39	A11	—	RV	Mean Radial Velocity
41-51	A11	– -	SRV	Standard deviation of RV (km s-1)

- Catalog built by Caroline Soubiran from the HARPS achive of ESO. ”HARPS is extracted from the ESO archive HARPS spectrograph installed on the ESO telescope 360 at La Silla.” : 422 entries

Table 6 - Structure of selected data in the catalog HARPS				
Bytes	Format	Units	Label	Explanations
01- 03	A3	–	CAT	Catalog of origin
04- 06	A3	–	HIP	HIP prefix
07- 12	I6	–	HIPnum	HIP number
14- 17	A3	–	CAT	Catalog of origin
18- 19	A2	–	HD	HD prefix
20- 25	I6	–	HDnum	HD number
27- 42	A16	–	2MASS	2MASS number
44- 54	A11	–	TYC	TYCHO number
56- 59	I4	–	DLT	Delta time (in days) from first to last observation
61- 63	I3	–	OBS	Number of observations
65- 74	A8	–	RV	Average VR (km/s)
76- 81	A6	–	eRV	Estimated error of RV (km/s)
83- 88	A6	–	SRV	Standard deviation of RV (km/s)

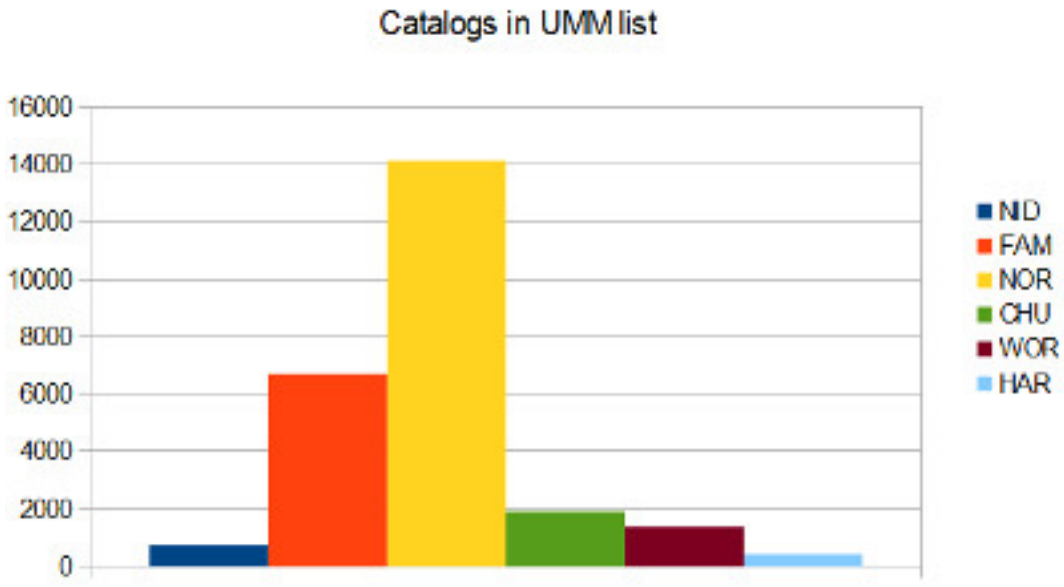

Figure 1 - The contents of UMM : number of RV measurements for each of the 6 catalogues in UMM

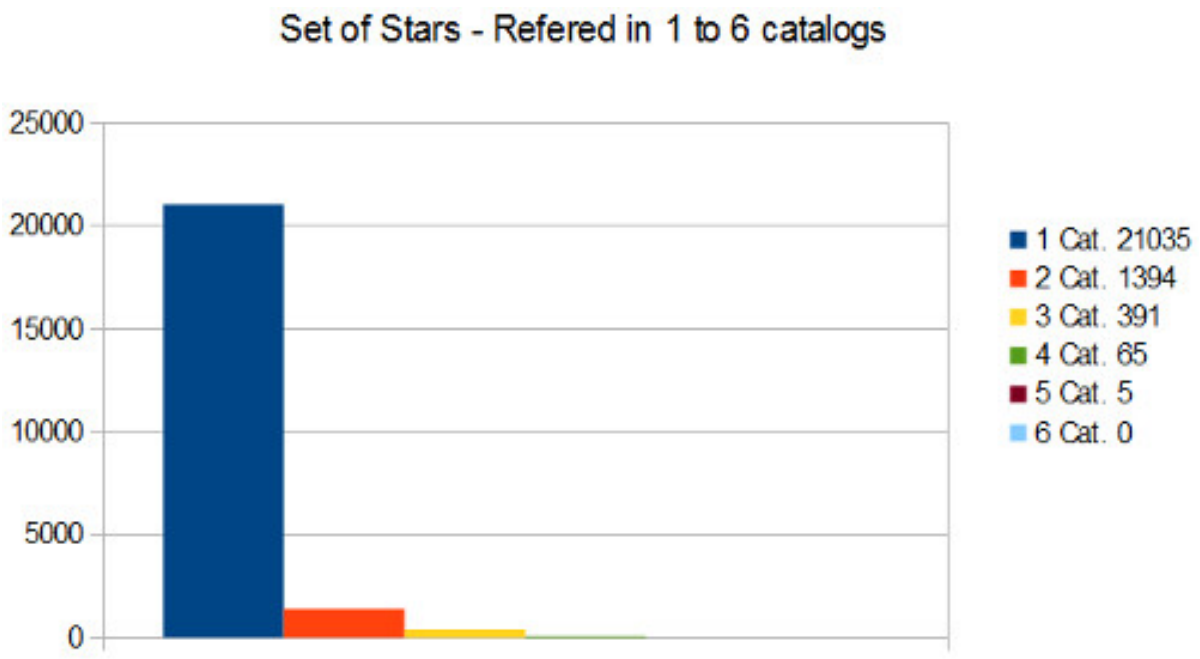

Figure 2 - The contents of UMM : number of stars which appear in several catalogues (from 1 to 6) within UMM

We recall here that the contents of UMM described above are on the date of January 2016. These contents will evolve with time (see Sect. 5) ; CS15 will be soon integrated in UMM and consequently other catalogues (Nidever, Norstrom, HARPS) will disappear.

2.2 Cross-identification with Simbad (HIP, HD, TYCHO, 2MASS)

In order to test the stars to qualify used in RV catalogs, each entry of the pre-mentioned catalogs - NIDEVER, FAMAEY, NORDSTROM, CHUBAK, WORLEY, HARPS - was explored for identifiers HIP, HD, TYCHO and 2MASS, extracted with CDS tools (TAP-VizieR, Simbad).

2.3 Structure of the UMM list

UMM list includes 25284 entries corresponding to 22901 stars.

The number of stars is less than the total of the input star catalogs, as a number of stars are present in at least two catalogs.

Table 7 - Structure of data in UMM

Bytes	Format	Unit	Label	Explanations	Example 1	Example 2
01- 03	A3	—	CAT	Catalog origin	FAM	NOR
04- 06	A3	—	HIP	HIP prefix	HIP	HIP
07- 12	I6	—	HIPnum	HIP number	36647	36654
14- 17	A3	—	CAT	Catalog origin	FAM	NOR
18- 19	A2	—	HD	HD prefix	HD	HD
20- 25	I6	—	HDnum	HD number	59684	60517
27- 42	A16	—	2MASS	2MASS number	7321290+2707308	7322054-4950530
44- 54	A11	—	TYC	TYCHO number	1919-01610-1	8141-00229-1
56- 59	I4	Day	DLT	Delta obs	..	2189
61- 63	I3	—	OBS	Num obs	..	5
65- 74	A8	km/s	RV	Average VR	61.7	16.9
76- 81	A6	km/s	eRV	Estimated error	..	0.1
83- 88	A6	km/s	RV	Standard deviation	0.26	0.20

A quality flag will be added in the next UMM version.

3 UMM list and Quality Control

As explained in the Introduction, we describe in this Section the comparison algorithm between a list of stars including RV data with UMM. Then in the following subsections, we test our procedure and adjust the choice of the parameters in our tests in comparing the 1420 RV-STD and CS15 lists with UMM. Of course we expect a good qualification of these lists because they have been built mainly from catalogues which are within UMM ! But these lists contain new RV measurements that have obtained by DU640 at OHP (spectrograph Sophie), Pic du Midi (spectrograph Narval) and ESO La Silla (spectrograph Coralie installed at the swiss telescope), and we compare them with the older catalogues within UMM. These comparisons are meaningful because the time spans of observations are not identical, and because, for any one star, our statistical tests take into account all catalogues in UMM which contain that star.

3.1 Description of the comparison algorithm

The following test is applied to each star of the input catalog :

- calculating first the difference in absolute value A, between the average radial velocities (VR values in UMM and corresponding VR in the entry list)
- comparing this difference with B = 3 * sqrt (rms [UMM] ** 2 + rms [input] ** 2) + Cte, then this for each list in UMM

Initially, tests were implemented with Cte = 0 (so-called test1), then also with Cte = 0.09 = 0.3^2 (so-called test2) to take into account a typical zero point offset of 0.3 km.s^{-1}.

If A $<$ B, for each list in UMM, then the test is positive, and the star is said qualified. The corresponding entry in the entry list in RV is compatible with UMM.

The A and B variables are not used anymore thereafter.

Note that this test is a necessary condition, but not a sufficient one, to assert the RV stability of the star. In other words, a star could be qualified without being RV-Stable, but any stable star has to be qualified.

3.2 Comparing the 1420 RV-STD list with UMM

This list includes originally 1420 primary standard stars, and later reduced to 1371 after elimination of double and variable stars found in the observing campaign.

Table 8 - Data structure of the output file concerning the ”list of RV primary standards” Crifo1

Bytes	Format	Units	Label	Explanations	Example 1	Example 2
01- 06	A6	–	HIP	HIP Number	000296	000407
08- 10	A3	–	ummCat	Catalog in UMM	CHU	NOR
12- 18	A7	km/s	criRv	Standard RV	10.963	12.351
20- 26	A7	km/s	ummRv	UMM RV	10.869	12.100
28- 34	A7	km/s	criSrv	Standard SRV	0.0117	0.0130
36- 42	A7	km/s	ummSrv	UMM SRV	0.069	0.200
44- 47	A4	–	ummObs	UMM num obs	9	4
49- 49	A1	–	test1	Test 1 (*)	1	1
51- 51	A1	–	test2	Test 2	1	1

(*) 1 : ok, 0 : bad, 2 : no calcul

Comments :

In the case of star HIP000296 in CHUBAK, the ”Average VR ’values between RV Standard (10.963 km/s) and UMM (10,869 km/s) are quite near, as the SRV values (0.0117 m/s and 0,069 m/s). The data come from 9 observations, and both quality tests 1 and 2, as described in 3.1, are positive (value twice to 1).

Table 9 - Final results concerning the comparison between the ”list of RV Standards” and UMM

Number of stars in the list ”RV Standard” :	1371
Star tested UMM list :	1359 (99.1% of the full list)
Total positive tests :	1216 (89.4% of tested stars)

The ”RV standard” list includes measurements made by DU640. Table 8 shows that 1216stars are positively tested, as 143 are rejected. The investigation on theses rejections was reported on the comparison with the CS15 list.
The UMM and RV Standard lists are compatible and self-coherent, on the bases of 89.4% of positive tests (C.f Table 9).
For the 10.6% of negative tests, it may concern : variable stars, stars for which the error in UMM is underestimated, and list of stars for which the zero point in UMM is underestimated.

3.3 Comparing the ”CS15” list with UMM

Here we test our procedure with the CS15 list. As explained in the Introduction, the final goal is to introduce CS15 into the new version of UMM, but here we use it only to validate our procedure.
Quality control has been applied to CS15 list ([6]) established by Soubiran et al. (2014). This list includes 10227 star data. For information, the 1420 RV-STD stars of [3] are in CS15.

This new list includes a ”Quality flag” ranging from 1 to 9, assigning a status to the stars : there are primaries (RV stable stars with high accuracy on measurements), secondaries (RV stable stars, but with less data and smaller time span than for primary stars), and rejected stars (RV variable stars, whatever reason for variability). The number of stars in CS15 for each quality flag is given in Table 14.

Structure of CS15 data (10227 stars, one entry per star) is given in Table 10.

Table 10 - ”Structure of CS15 data”

Bytes	Format	Units	Label	Explanations
2- 25	A24	—	Id	HIP/TYC/2MASS identifier
27-27	I1	—	Qflag	Quality flag (1)
29- 30	I2	h	RAh	Right ascension (J2000)
32- 33	I2	min	RAm	Right ascension (J2000)
35- 41	F7.4	s	RAs	Right ascension (J2000)
44-44	A1	—	DE-	Declination sign
45- 46	I2	deg	DEd	Declination (J2000)
48- 49	I2	arcmin	DEm	Declination (J2000)
51- 57	F7.4	arcsec	DEs	Declination (J2000)
59- 64	F6.3	mag	Vmag	Magnitude in Johnson V
66- 71	F6.3	mag	B-V	Johnson B-V colour
73- 83	A11	—	SpType	Spectral type
85- 92	F8.3	km/s	RV	Mean Radial Velocity in SOPHIE scale
95-101	F7.4	km/s	I-RV	Internal error of RV
104-110	F7.4	km/s	s-RV	Standard deviation of RV
113-119	F7.4	km/s	u-RV	Uncertainty of RV
122-128	F7.4	km/s	d-RV	Maximum deviation of RV
130-134	I5	days	T-base	Time baseline of the N observations-
136-140	I5	days	JD-mean	Mean Julian Day of observations (- 2400000)
142-146	I5	days	JD-max	Julian Day of last observation (- 2400000)
148-151	I4	—	N	Number of RV measurements

The data structure of the output file concerning the comparison between the ”CS15 list” and UMM is given in Table 11. An extract of this file is given here as an illustration. The percentage of stars within CS15 which are found in catalog UMM is 50% (5137 over 10227).

Table 11 - ”Comparison ”CS15 list” with UMM							
Bytes	Format	Units	Label	Explanations	Ex. 1	Ex. 2	Ex. 3
01- 06	A6	—	HIP	Hipparcos Num.	117776	117836	117878
08- 10	A3	—	ummCat	Ref. in UMM	nOR	FAM	FAM
12- 18	A7	km/s	CS15Rv	Av. VR in CS15	19.564	16.918	6.146
20- 26	A7	km/s	ummRv	Av. VR in UMM	19.300	16.76	5.700
28- 34	A7	km/s	CS15sRv	Std. dev. RV in CS15	0.0031	0.0389	0.0433
36- 42	A7	km/s	ummRms	Std. dev. RV in UMM	0.800	0.220	0.200
44- 46	A4	—	CS15Obs	Num. obs. in CS15	4	2	3
48- 50	A4	—	ummObs	Num. obs. in UMM	3	..	3
52- 52	A1	—	qFlag	Quality flag in CS15	1	3	2
54- 54	A1	—	test1	Quality test 1 (*)	1	1	1
56- 56	A1	—	test2	Quality test 2	1	1	1

(*) (1 : ok, 0 : bad, 2 : no calcul)

About 50% of stars of CS15 are in common with UMM. Their numbers relative to the CS15 Quality flag are given in Table 12.

Table 12 - Quality flags in CS-015, and found in UMM			
Flags	Nbr in CS-015	% on Total CS-015	Nbr UMM found
Primary 1 :	1702	16	1480 (87% of 1702)
Primary 2 :	618	7	420 (68% of 618)
Primary 3 :	478	5	423 (88% of 478)
Secondary 4 :	634	6	273
Secondary 5 :	1295	13	456
Secondary 6 :	266	2	126
Secondary 7 :	2354	23	660
Rejected 8 :	673	6	167
Rejected 9 :	2207	22	1132

The average of difference between RV of tested stars and RV in UMM are show in Table 13.

Table 13 - Average and standard deviation for RV differences between CS-015 and UMM			
Test	Test number	Average RV diff. km/s	Standard deviation
All :	6379 (1)	1.263	7.158
Validated :	6118 (2)	0.850	4.648
Rejected :	261	10.932	27.313

(1) Tests with positive result as negative result, excluding stars untested (result : 2/2, as no sRV in UMM)
(2) Tests with positive result

Quality test (see Sect. 3.1) :
CS15 versus UMM catalog
(test1/test2,
if 2/2 -> no calculation)

Table 14 - Quality flags CS-015 ver. UMM		
Flags	Nbr	%
Test 0/0 :	261	4%
Test 0/1 :	610	9%
Test 1/0 :	0	0%
Test 1/1 :	5508	78%
Test 2/2 :	621	9%
Total tests :	7000	..
Positive tests :	6118	87%
Tested stars :	5137	..
Validated stars :	4524	86%

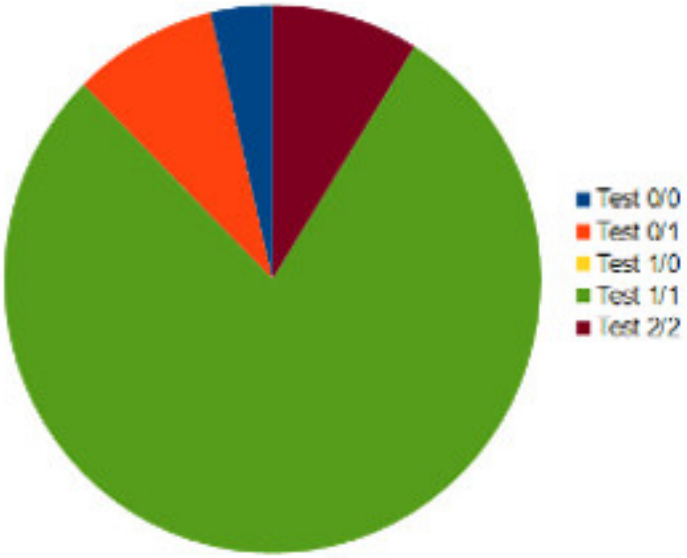

Figure 3 - CS15 : Col(3) percentage from Table 14

More than one test could be applied to one star, depending of the number of references for this same star in UMM. Even if only 5137 CS-015 stars are tested, the amount of tests is 7000, from which 6118 are positive.

Table 15 - CS15 : test results relative to CS15 Quality flag			
Flags (1)	Qualified (2)	UMM/CS15 (3)	% on UMM (4)
Primary 1 :	1415	1480	96%
Primary 2 :	381	420	91%
Primary 3 :	373	423	88%
Secondary 4 :	248	273	91%
Secondary 5 :	364	456	80%
Secondary 6 :	92	126	73%
Secondary 7 :	516	660	78%

(1) Flags in CS15 list
(2) Number of positively tested (or 'qualified') stars ; see Sect. 3.1
(3) Number of stars, corresponding to the flag and found in UMM list
(4) % of qualified stars over column (3)

Concerning the stars with a primary flag and affected with a negative test result, the majority of these cases relates to less than 2 km/s and the NORDSTROM and FAMAEY catalogs based on

CORAVEL data.
It is expected that we find some discrepances between CS-015 and catalogs within UMM, because there are some problems of RV zero-point in NORDSTROM and FAMAEY, that will be solved in the next UMM version.

Table 16 gives the repartition of the qualified stars (see Sect. 3.1), versus the number of catalogs which are involved in UMM.

Table 16 - CS15 : stars vs UMM catalogs

Nbr cat.	Nbr stars	% Total
1 cat	3412	75,5%
2 cat	795	17,5%
3 cat	280	6.1%
4 cat	43	0.9%
5 cat	2	0%
6 cat	0	0%
Total stars :	4532	..

A CS15 star could be qualified conformingly to 1, 2, 3, 4 , 5 or 6 catalogs in UMM.

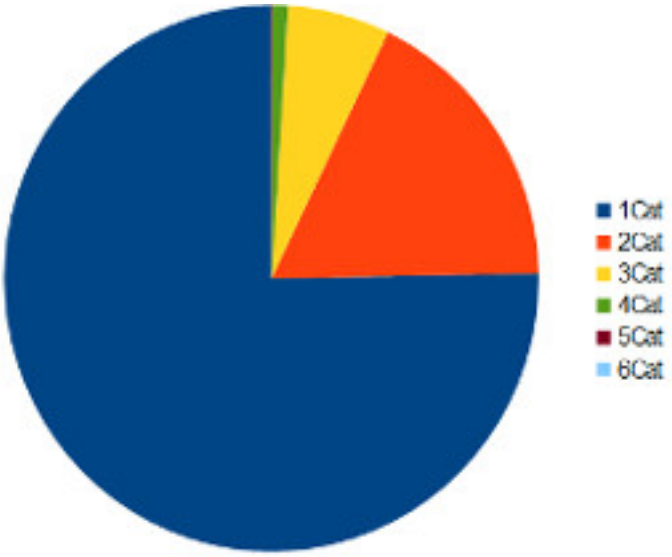

Figure 4 - CS15 : Col(3) % from Table 16

We note that a large majority of the positively tested CS15 stars, are qualified with only one catalogue in UMM.

In summary, the quality control applied to CS15 [6] validates more than 85% of stars referenced in both the CS15 list and the UMM list (the recovery is 50%). However we remind that following our strategy described in the Introduction, CS15 will be included in the next version of UMM.

4 Test of RVS measurements

We have checked in the previous section that our comparison tests of the 1420 RV-STD list and CS15 with UMM are self-consistent. Now we aim to test that our procedure is also reliable to validate the RVS data, at least of course for the stars which belong to UMM. A set of RVS measurements has been given by Pasquale Panuzzo (GEPI, Meudon) to the DU640 team. The data structure of RVS measurements (at least three individual measurements per star, or 14618 entries, corresponding to 2903 stars) is given in Table 17.

Table 17 - Data structure of RVS measurements given to DU640 by P. Panuzzo

Bytes	Format	Units	Label	Explanations
01- 19	A19	—	sceId	source Identification (IGSL number)
21- 37	A17	—	traId	transit Identification
39- 39	A1	—	origin	1=Crifo's prim, 2=Crifo's sec, 6=Soubiran's prim
41- 47	A6	—	grvs	Grvs from IGSL
49- 56	A8	—	mRV	RV measured from the RVS data (km/s)
58- 65	A8	—	catRV	RV in the catalog (km/s)
67- 74	A8	—	diffRV	drift measured RV versus catalog (km/s)
76- 83	A8	—	obmt	the time OBMT
85- 85	A1	—	tel	GAIA embedded telescope (1 or 2)
87- 88	A2	—	row	CCD row
90- 92	A3	—	coord	the AC AF1 coordinate
94- 101	A8	—	baryc	the barycentric correction

In the first step, the data from individual measurements are used to calculate a standard deviation (SRV) of measures RV, after insertion of the corresponding identifiers catalogs : HIP, TYCHO and 2MASS.

Then we extract new identifications with CDS tools : (http ://tapvizier.u-strasbg.fr/TAPVizieR)

Finally the structure of the "RVS calculated data" (2903 stars, one entry per star) is given in table 18, and some examples are given as illustration in Table 19.

Table 18 - ”RVS measurements”				
Bytes	Format	Units	Label	Explanations
01- 19	A19	—	sceId	source Identification (IGSL number)
21- 37	A17	—	traId	transit Identification
39- 44	A6	—	HIP	Hipparcos identification
46- 55	A10	—	TYC	Tycho identification
57- 72	A16	—	2MASS	2MASS identification
74- 74	A1	—	origin	1=Crifo’s prim, 2=Crifo’s sec, 6=Soubiran’s prim
41- 47	A6	km/s	avRv	average RVS
49- 56	A8	km/s	sRv	standard deviation of RV
58- 60	A3	—	obsNb	number individual measurements
62- 68	A7	day	dTime	Delta time
70- 78	A9	—	JD1	JD time first measurement
80- 88	A9	—	JD2	JD time last measurement

Table 19 - ”Calculated RVS data” : 2 examples						
sceId			traId	HIP	TYC	2MASS	origin
5478621009596653312			...	031399	8895001841	06345480-6042504	2
avRv	rmsRv	obsNb	dTime	JD1	JD2		
3.381	1.427	11	271.62	56819.657	57091.273		
sceId			traId	HIP	TYC	2MASS	origin
5479606584332214144			...	033720	8549005201	07001826-5957408	2
avRv	rmsRv	obsNb	dTime	JD1	JD2		
9.405	0.477	7	1.83	56836.17	56837.995		

The comparison between the ”RVS measurements” and UMM has been carried out with the same algorithm used in the previous Section.

Table 20 - Comparison ”RVS measurements” with UMM							
Bytes	Format	Units	Label	Explanations	Ex. 1	Ex. 2	Ex. 3
01- 06	A6	—	HIP	Hipparcos Num.	003859	003869	003909
08- 10	A3	—	ummCat	Ref. in UMM	NOR	FAM	CHU
12- 18	A7	km/s	mRv	Av. RV in RVS	-16.627	-67.247	7.85
20- 26	A7	km/s	ummRv	Av. RV in UMM	-17.300	-67.580	8.303
28- 34	A7	km/s	msRv	Stand. dev. in RVS	1.129	0.405	0.981
36- 42	A7	km/s	ummsRv	Stand. dev. in UMM	0.400	0.220	0.135
44- 47	A4	—	mObs	Num. obs. in RVS	4	4	5
48- 51	A4	—	ummObs	Num. obs. in UMM	2	..	3
53- 53	A1	—	test1	Quality test 1	1	1	1
55- 55	A1	—	test2	Quality test 2	1	1	1

(*) 1 : ok, 0 : bad, 2 : no calcul

Table 21 - Test results from the list of ”RVS measurements”	
Number of stars in the RVS list :	2903
Stars tested in the UMM list :	2413 (83% on the total)
Total positive tests :	2372 (98% of the tested stars)
”Bad” stars in the RVS list :	112
”Bad” stars in the RVS list, excluded by UMM list :	111

After this set of RVS measurements were confronted with the UMM values, the 112 stars considered with too large difference comparing to the referenced values for RVZP ([3]), were all confirmed as ”bad” by the comparison procedure with UMM.
In other words, all RV stable (resp. not RV stable) according to Panuzzo are qualified (resp. not qualified) by our statistical test of comparison.

RVS data are thus validated by our procedure.

5 Conclusion

The quality control procedure to validate RVS values with UMM is operating. This procedure was first successfully tested by using two well-known ”external” lists. Then we have been able to validate a restricted sample of RVS data.
The next step is to build an extended list for calibrations and validation of Gaia RVS, integrating in UMM other lists of stars with RVs.
The CS15 list will of course be included in UMM (and suppressing by the same way older lists such as Nordstrom, Nidever, and Harps from which CS15 has been built)
Lists of potential lists to be added in UMM :
- IAU standard stars which were discarded originally because of small RV variations ($< 1\mathrm{km.s}^{-1}$) but would be included with caution
- lists of faint stars such as cluster stars referenced by Mermilliod
- list Latham et al. 2012 - RAVE stars for which there are at least 2 measurements, etc...
We also foresee to add a quality factor of all stars added in UMM.

UMM should be finally a uniform catalog with only one entry by star and with a uniform ZP, which is not yet the case in this first version.