RVS Telemetry

Telemetric flows for the RVS computed by using star counts from GSC-2.2 catalogue

RVS-YV-001

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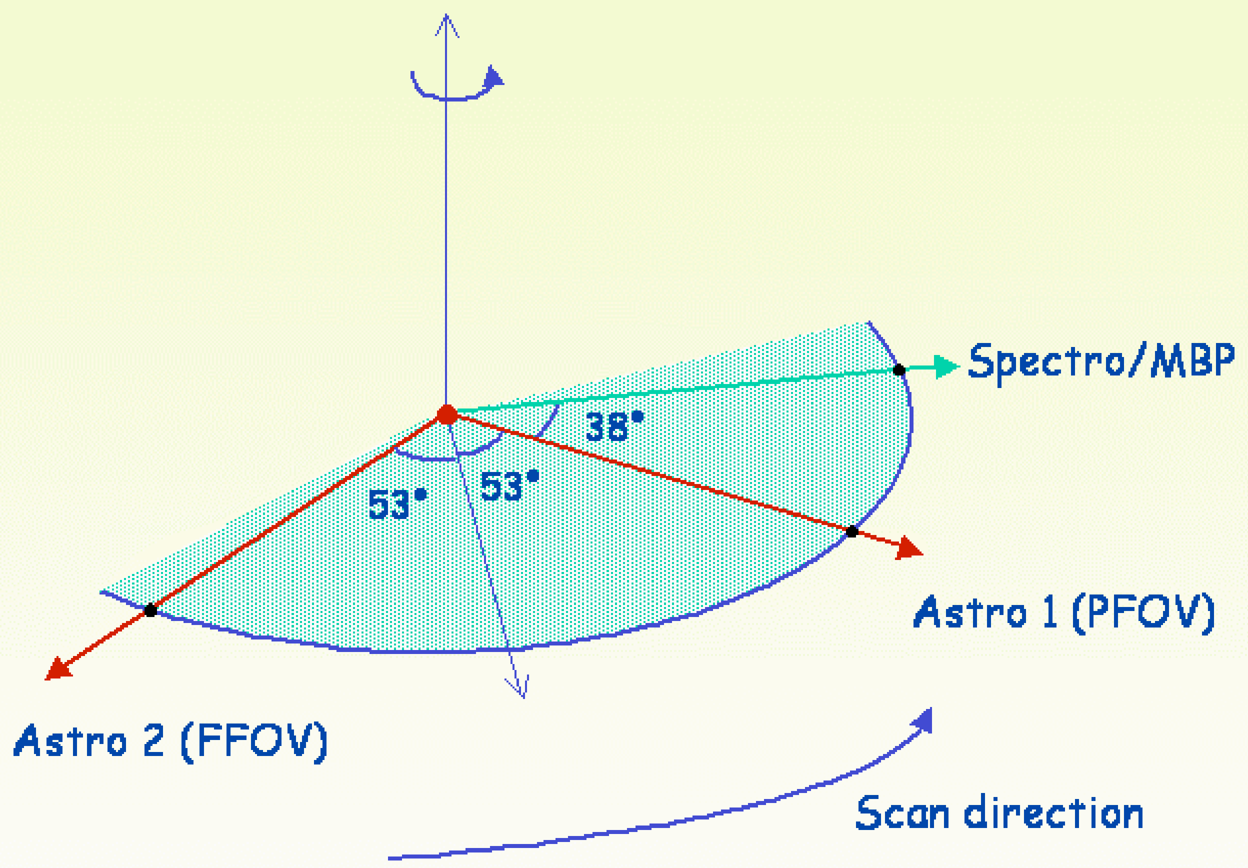
(Note for the livelink)

Telemety Budget for GAIA- RVS
RVS parameters (Vth Paris Workshop)

- Résolution = 11500 (sampling = 0.375 A/pixel)
- Size of single spectrum
  - along scan = 694 pixels
  - across scan = 1 or 2 pixels
- Detector : 3 CCD of 2020 x 3930 pixels
- Pixel size : 0.982" x 1.473"
- RVS-FOV size : 2° x 1.6°
- RVS-FOV transit time = 120 s (one GAIA rotation in 6 h)
- Whole GAIA mission = 1800 days = 7200 rotations
  = 1 296 000 successive juxtaposed RVS-FOVs

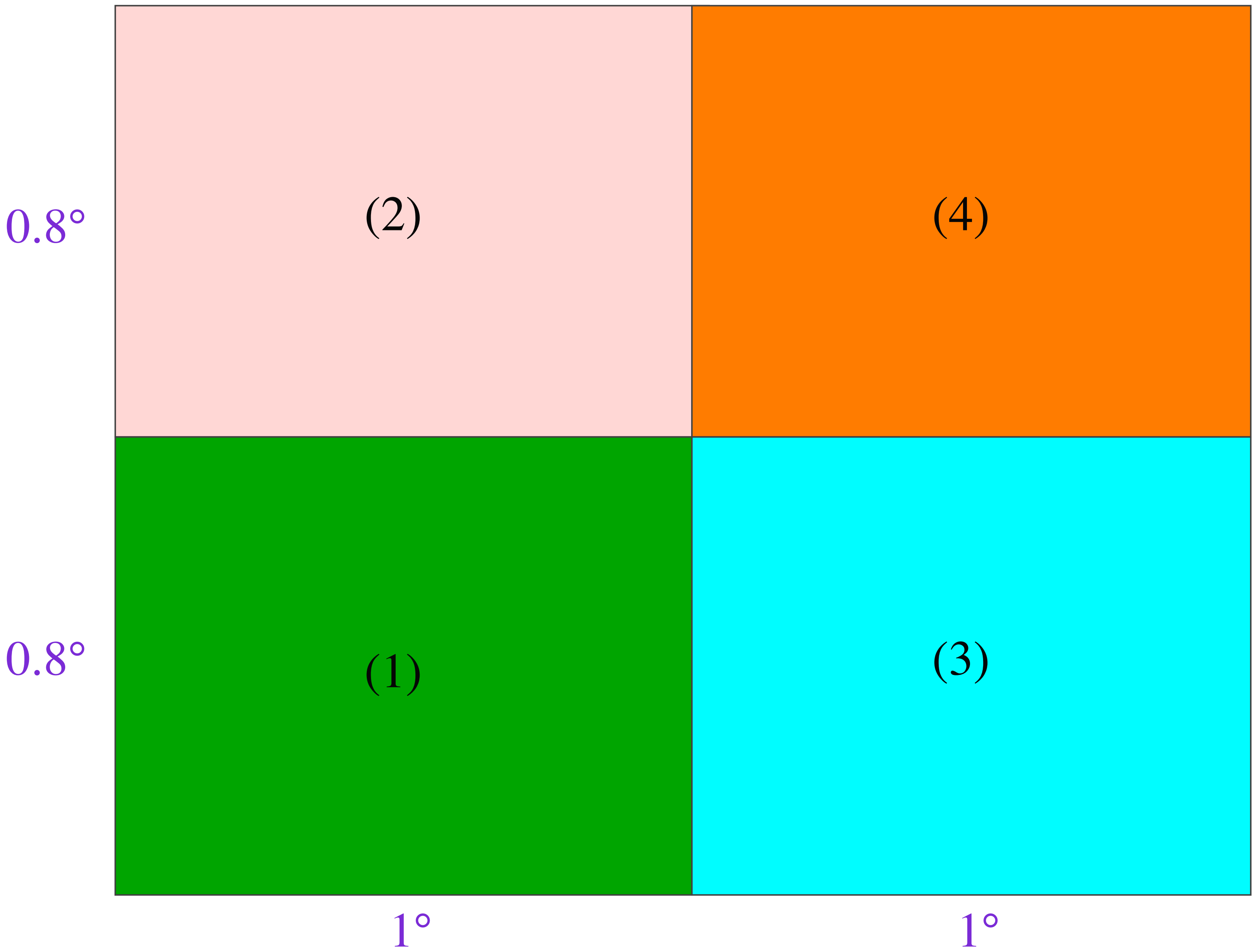
Positions of the three instruments in the GAIA Reference System (GRS)



Sequence

	Observation
t = 0	Spectro
+ 38 mn	AF1
+ 106 mn	AF2
+ 216 mn	Spectro
etc...	

RVS-FOV "pavement" or sampling



Star distribution throughout the sky : The GSC-II catalog

- 1" resolution scans of the photographic Sky Survey plates (Palomar and UK Schmidt telescopes)

- Now : version 2.2 : 445 851 237 objects
- Final (2003) version : 998 402 801 objects

- Magnitude limits (catalog complete to magnitude limit) :
  - 18.5 in photographic F bandpass ($\lambda_0 \sim 0.71$ μm)
  - 19.5 in photographic J bandpass ($\lambda_0 \sim 0.44$ μm)

- V ($\lambda_0 \sim 0.55$ μm) magnitudes available for some stars

Star counts from the GSC-II catalog

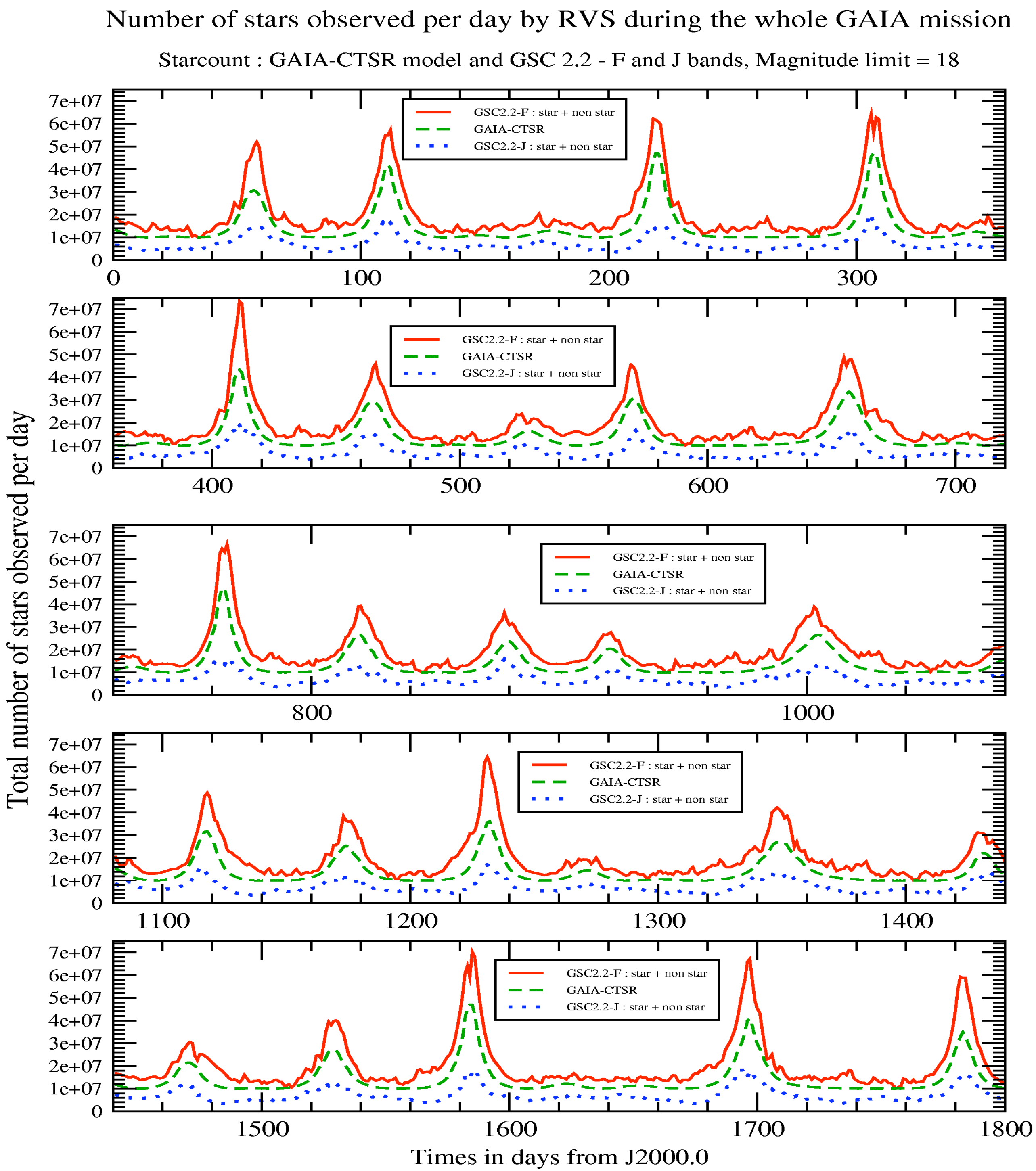
- Five class of objects (only two (in red) in present version 2.2)
  - Star / Galaxy / Blend
  - Non-star / Unclassified / Defect
- Counting of objects by magnitude interval in the three bands (F, J and V) of GSC-II catalog (up to magnitude limit of each band)
- Sky coverage : done for directions separated by 1° in the ranges
  - $-90° \leq b \leq +90°$, $0° \leq l \leq 360°$ (--> overlap of boxes)
- For each (l, b) we give the number of star per square degree and magnitude interval : ≤ 0, and every half magnitude up to magnitude limit (18.5 in F and 19.5 in J). We count :
  - Stars
  - Non stars
  - Total : stars + non stars

Star density per square degree

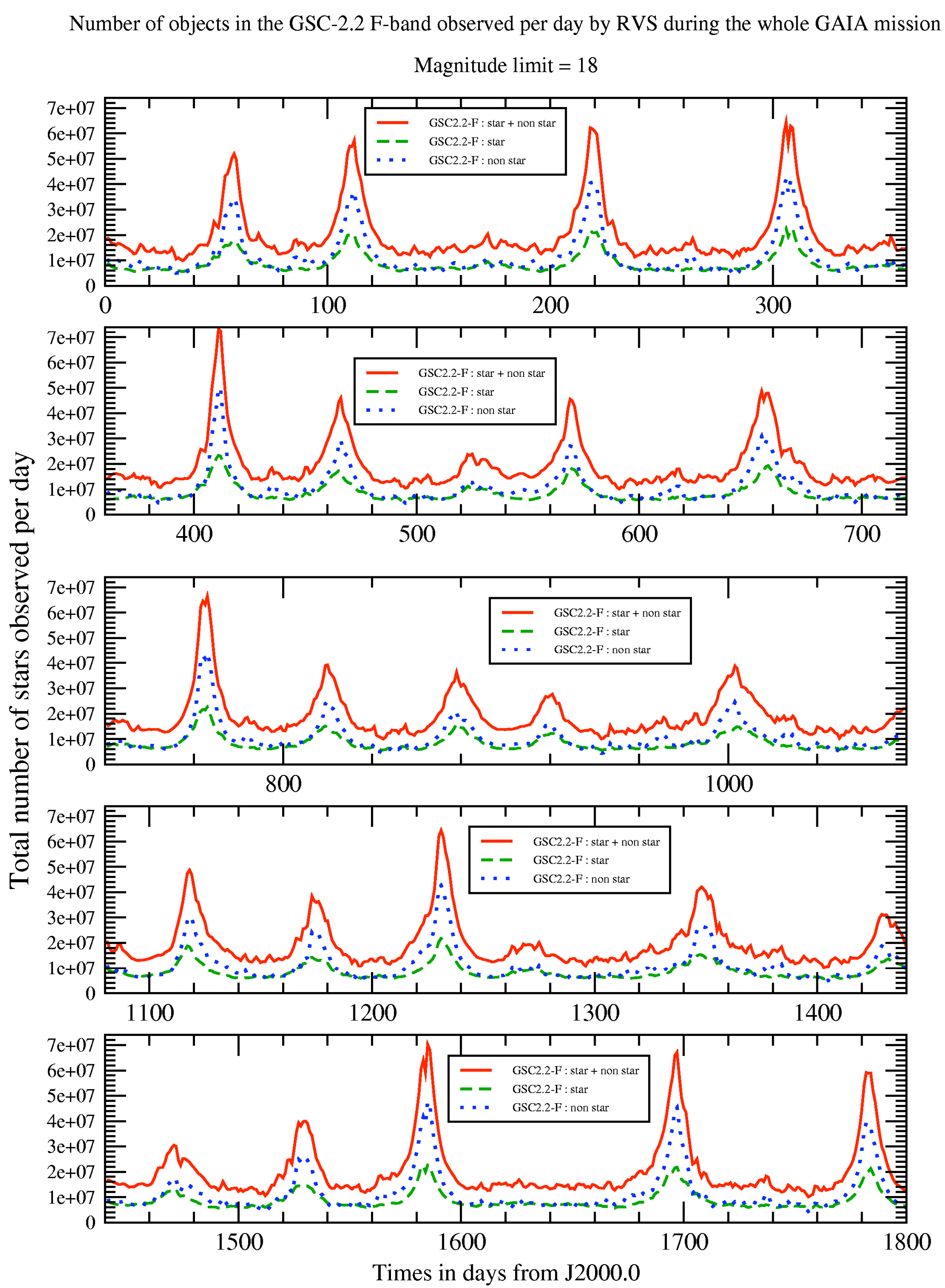
GAIA - CTSR Galaxy Model - Table 6.6, p. 282 + interpolations

GSC 2.2 catalog - F band (stars + non stars)

Magnitude limit	Number of stars per square degree									
	Galactic latitude $0 \leq \lvert b \rvert \leq 5$		Galactic latitude $5 \leq \lvert b \rvert \leq 10$		Galactic latitude $10 \leq \lvert b \rvert \leq 20$		Galactic latitude $20 \leq \lvert b \rvert \leq 30$		Galactic latitude $30 \leq \lvert b \rvert \leq 90$	
	GAIA-CTSR	GSC2.2 F-band	GAIA-CTSR	GSC2.2 F-band	GAIA-CTSR	GSC2.2 F-band	GAIA-CTSR	GSC2.2 F-band	GAIA-CTSR	GSC2.2 F-band
14	700	1 537	600	1 320	360	674	240	349	170	162
15	1 600	3 744	1 400	3 173	800	1 528	500	759	300	331
16	3 800	8 356	3 200	6 984	1 800	3 129	1 000	1 475	500	612
17	9 100	16 747	7 400	13 804	3 900	5 949	2 100	2 648	900	1 059
17.5	13 600	**	11 000	**	5 500	**	2 800	**	1 100	**
18	20 300	29 229	16 300	23 905	7 800	10 894	3 700	4 517	1 500	1 790



Number of stars observed per day by RVS during the whole GAIA mission
Starcount : GAIA-CTSR model and GSC 2.2 - F and J bands, Magnitude limit = 18
GSC2.2-F : star + non star
GAIA-CTSR
GSC2.2-J : star + non star
Total number of stars observed per day
Times in days from J2000.0



Number of objects in the GSC-2.2 F-band observed per day by RVS during the whole GAIA mission
Magnitude limit = 18
GSC2.2-F : star + non star
GSC2.2-F : star
GSC2.2-F : non star
Total number of stars observed per day
Times in days from J2000.0

RVS "Configurations" (parameters sets)

(From discussions in Vth RVS-WG meeting)

- Two magnitude limits F = 17 and F = 18
- Sum of 3 CCDs before sending data to the ground

1) Spectrum width = 2 CCD rows ==> 1388 pix/spectrum for all objects up to the limiting magnitude

2) Spectrum width = 1 row 50 % observing time and 2 rows the other 50 %

   A full spectrum sent for F ≤ 16

   Only CaII lines, i.e. half spectrum, sent for F > 16

CCD filling in crowded FOVs

- Lower limit of star density that fills the CCD :

Ncrit = Sccd(pix) / (Sccd(deg) x n(pix/object))

- Assumes :

  1) uniform distribution

  2) no overlap of spectra

Sccd(pix) = 2020 x 3930 = 7 938 600 pix

Sccd(deg) = 0.551 x 1.608 = 0.886 square degree

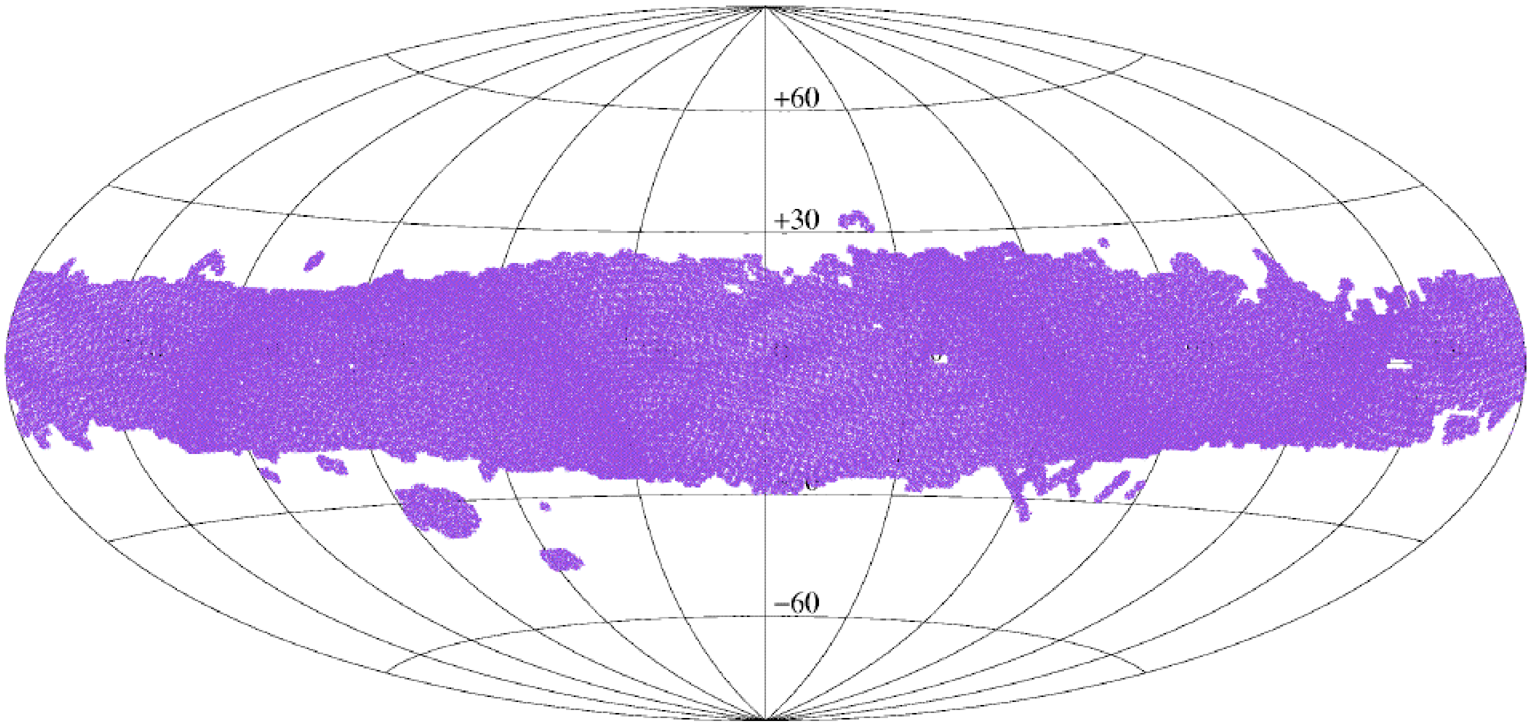
GAIA - RVS "configurations" and CCD "filling"

Spectrum width	Magnitude limit	Mean number of pixels per spectrum	Number of stars per square degree that fills a CCD
2 CCD rows	17, 18	1 388	6 450
2 rows (50%), 1 row (50%) Half spectrum for F > 16	17	781	11 470
2 rows (50%), 1 row (50%) Half spectrum for F > 16	18	651	13 740

RVS−FOV−cells filling from J = 0 to J = 1800

Galactic coordinates, Magnitude limit = 18, R = 11500, Row/spectrum =2

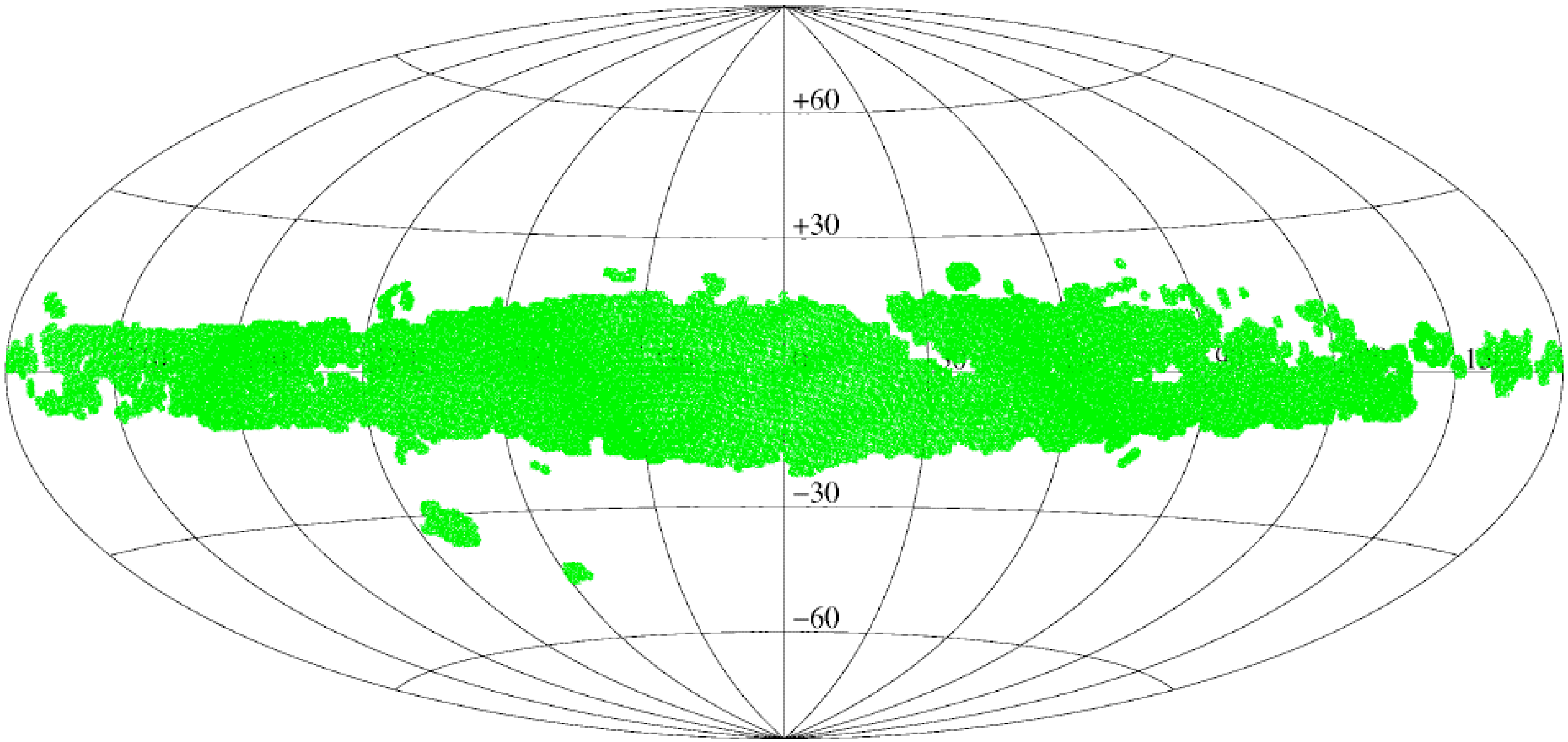
Fraction of FoV−cells full = 0.33



RVS−FOV−cells filling from J = 0 to J = 1800

Galactic coordinates, Magnitude limit = 18, R = 11500, Row/spectrum =

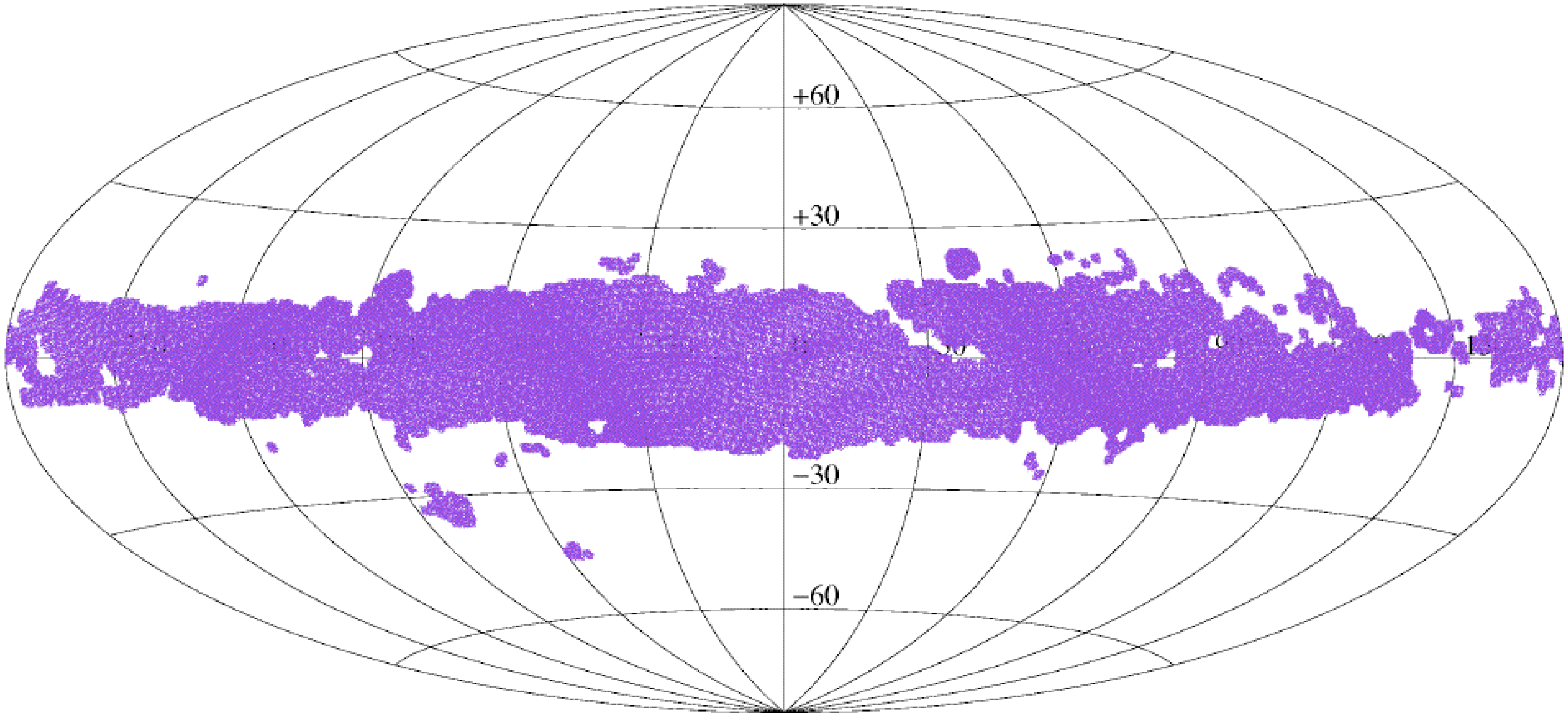
Fraction of FoV−cells full = 0.19



RVS−FOV−cells filling from J = 0 to J = 1800

Galactic coordinates, Magnitude limit = 17, R = 11500, Row/spectrum =

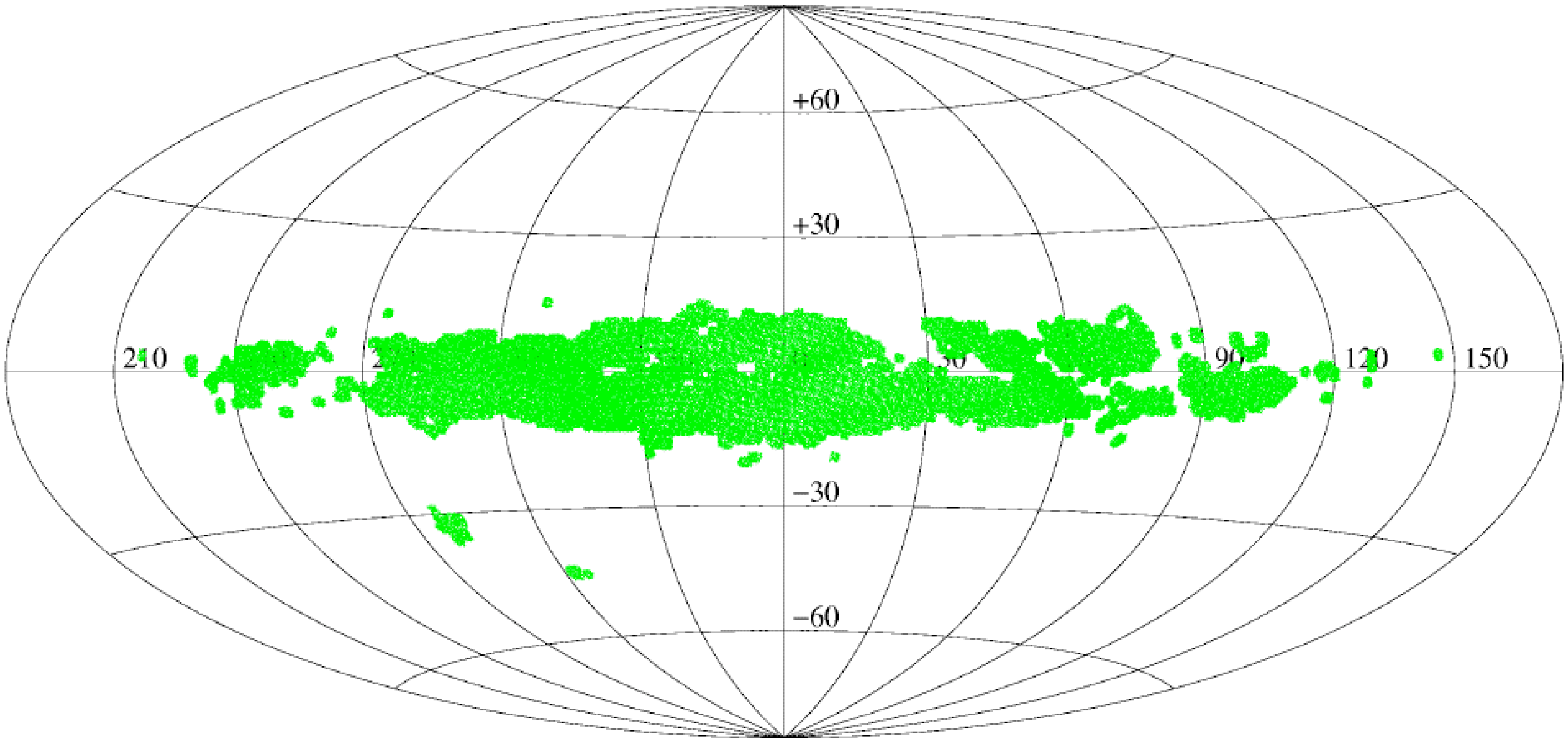
Fraction of FoV−cells full = 0.21



RVS−FOV−cells filling from J = 0 to J = 1800

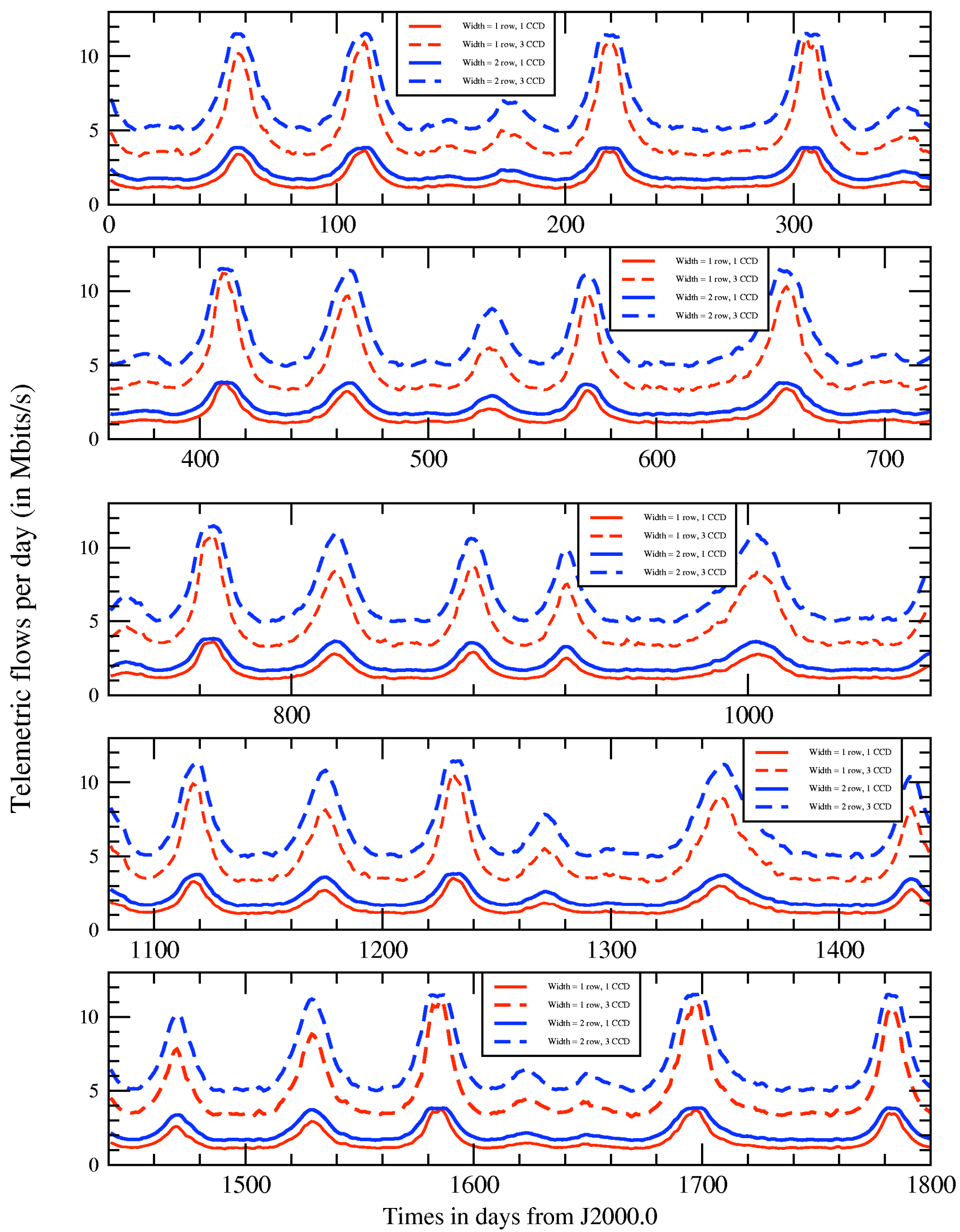
Galactic coordinates, Magnitude limit = 17, R = 11500, Row/spectrum =1

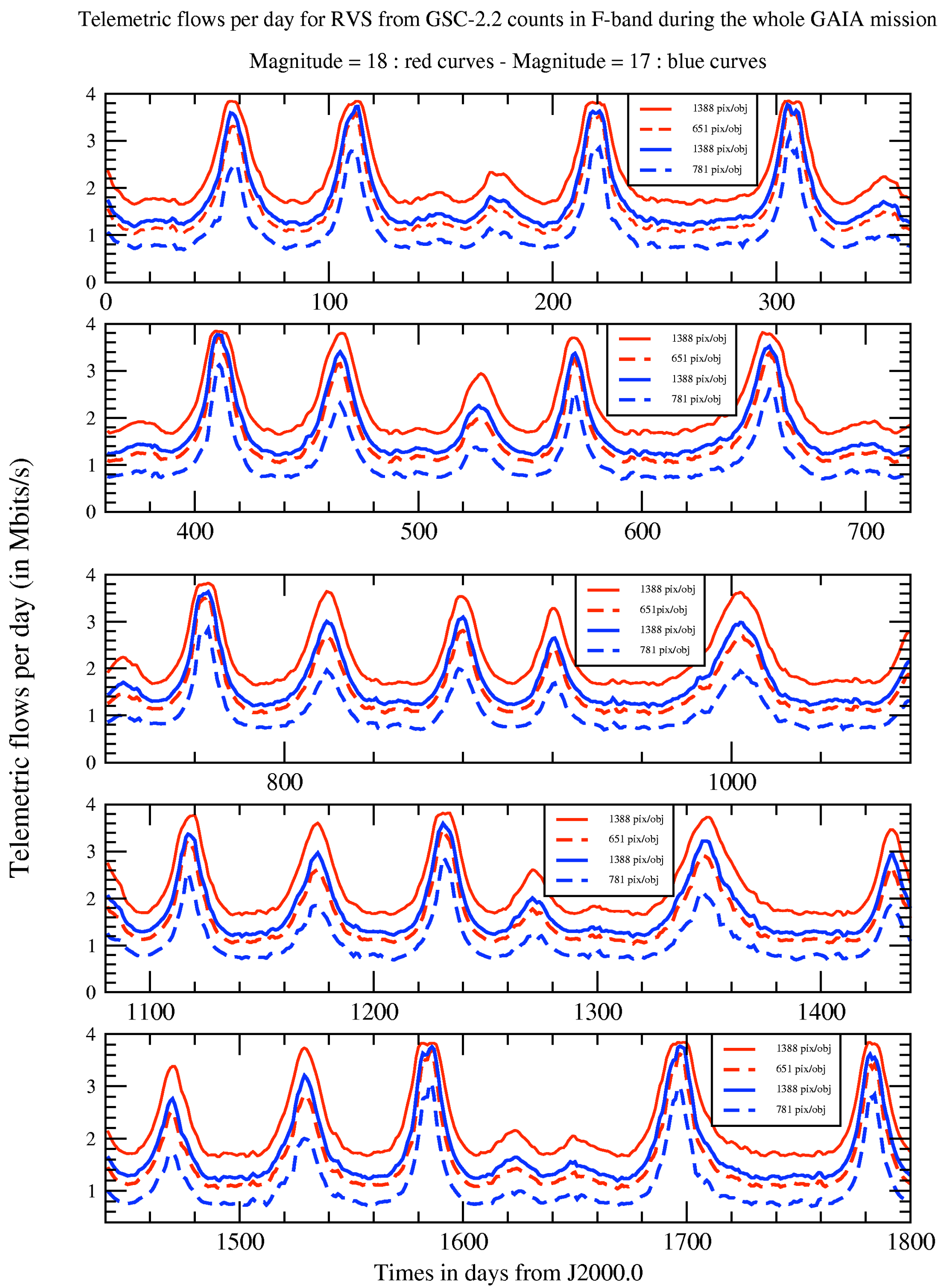
Fraction of FoV−cells full = 0.09



Telemetric flows per day for RVS from GSC-2.2 counts in F-band during the whole GAIA mission

Magnitude limit = 18. Four RVS "configurations" (spectrum width 1 or 2 rows, 1 or 3 CCD)





Telemetric flows per day for RVS from GSC-2.2 counts in F-band during the whole GAIA mission
Magnitude = 18 : red curves - Magnitude = 17 : blue curves
1388 pix/obj
651 pix/obj
1388 pix/obj
781 pix/obj
Telemetric flows per day (in Mbits/s)
Times in days from J2000.0

GAIA - RVS : Fraction of data saved versus compression factor

gscII-Fband (star + non star)

Telemetry budget allocated to RVS = 0.25 Mbits/s

Compression factor	F =17		F =18	
	n(pix/obj) 1388	n(pix/obj) 781	n(pix/obj) 1388	n(pix/obj) 651
1	14,5%	20,4%	11,2%	16,3%
2	28,9%	40,8%	22,5%	32,5%
3	43,4%	61,2%	33,7%	48,8%
4	57,8%	77,2%	45,0%	65,0%
5	72,2%	84,7%	56,2%	77,6%
6	80,8%	89,6%	67,4%	84,0%

Conclusion : Future work

(1) Improve telemetry budget within each FoV-cell

- Statistical study of the degree of crowding versus stellar density
- Spectrum overlap between close objects

  # occurs well below the densities that fills the CCD, in fact at any density

  # increases the effective stellar density that fills the CCD

  # reduces the telemetric flow per FoV-cell
- ==> mean number of occupied pixels within each FoV as a function of stellar densities (galactic coordinates)

Conclusion : Future work

(2) Check the impact of data pre-processing on telemetry budget

- Check feasibility of proposed pre-processing operations
- Refine distribution of spectrum position and profile with respect to CCD rows ==> extraction of 1 or 2 rows
- Possible various pre-processing according to magnitude ==> telemetry budget function of magnitude (distribution get from catalogues)

(3) Stars selection strategy

- Impact on selection algorithms (fifo, adopt different magnitude limit of objects sent to the ground according to density...)on telemetry budget

Conclusion : Future work

(4) Translate GSC-II F photographic magnitudes into RVS-band magnitude ==> star counts and telemetry budget in this band

(5) Telemetry budget using other star catalogues : e.g point sources DENIS catalogue (Advantage : I magnitude corresponds to RVS bandpass), USNO-B1

(6) Star counts with higher spatial resolution on the sky : 6'x6' (instead of 1°x1°) for $|b| \leq 10°$

Telemetry budget for other GAIA instruments (Astro 1 and 2, MPB) (Star counts + extrapolation down to G = 21