On FAME's Star Transit Rate

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- STR = Equivalent number of 1-D stars per second seen by FAME
- Use USNO-A2 catalog, red magnitudes
- Add both apertures
- 1-D FPS: 199,514 brighter than 9^{th} mag
- 2-D FPS: 42,365,500 with $9 \leq m_R < 15$ mag
- CSR DLR is 822 1-D star/sec @ 336 bits/star
  = 276 kb/sec + 84 kb/s HK $\longrightarrow$ 360 kb/s
- 2-D FPS contribution to STR is small
- $0''.2$ x $0''.2$ lookup table, $540''$ scan steps

- Model calculations done on three different grids
- high-res, medium-res and low-res
- high-res model incorporates individual CCD areas/locations
- others use 1 CCD of 0.659 square degrees
- Average are virtually identical
- Peaks STRs depend on resolution (12k versus 6k and 6k)
- Takes about 6 minutes CPU/mission day @ 1 sec intervals

resolution	grid size	τ_{step}	ϕ_{step}	$\tau_{mission}$	$N_{samples}$
high	0.2^o	1 sec	$0^o.15$	120 days	$10.4\ 10^6$
medium	1.0^o	5	$0^o.75$	1 year	$6.3\ 10^6$
low	1.0^o	25	$3^o.75$	5 years	$6.3\ 10^6$

- I use the Next 1-Gbit Average (N1GBA) rate, to determine whether the on-board buffer is full at the time of an observation.

- $N1GBA(t) = N_{1GB}/\tau_{1GB}(t)$
  where N_{1GB} = number of stars that can be stored in 1 Gbit
  and τ_{1GB} = time it takes to observe N_{1GB} stars
  τ_{1GB} is calculated from: $N_{1GB} = \int_t^{t+\tau_{1GB}(t)} dt' STR(t')$

- In ideal circumstances, the $N1GBA(t)$ is smaller or equal to the down-link rate.

- When the N1GBA rate exceeds the down-link rate, observations will be lost.

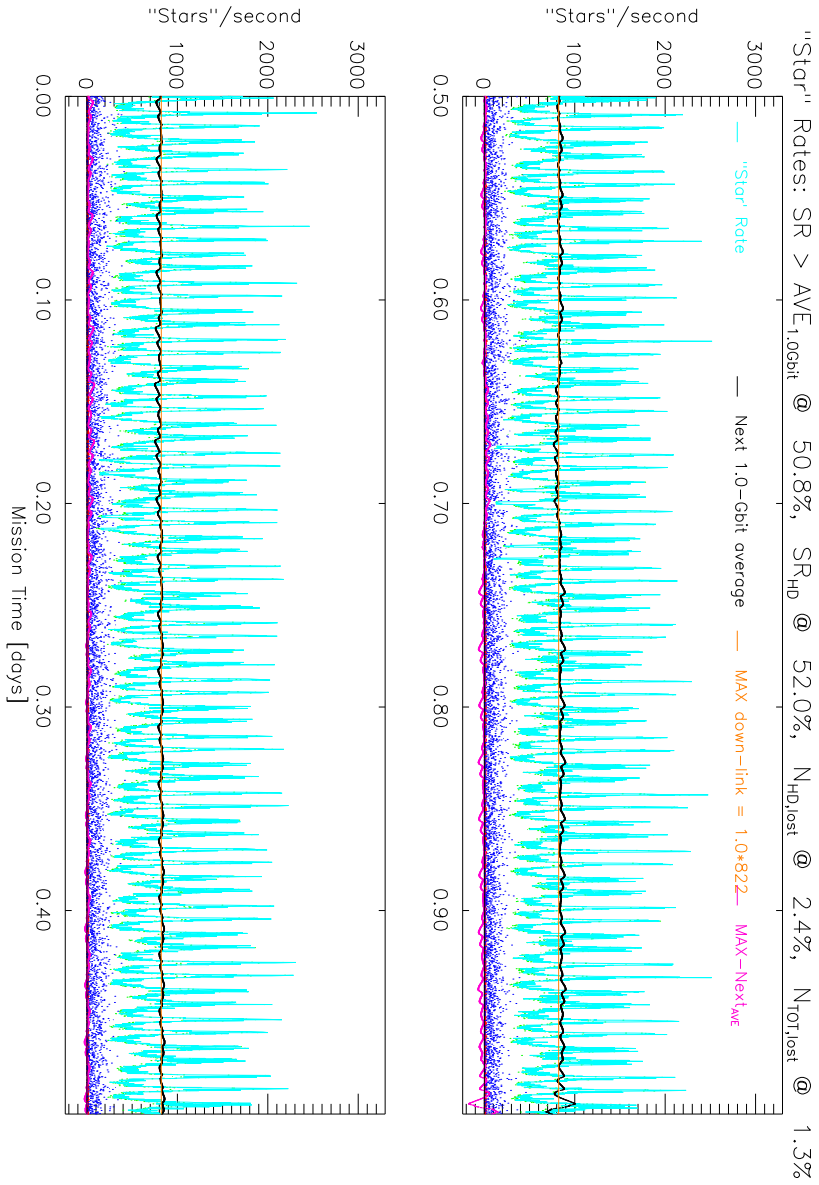

Figure 1: The one-day STR. The red (blue) points correspond to (20 times) the bright-star rate. The cyan line is the total STR. Each spike corresponds to one GP crossing. The wiggly black and magenta lines are the N1GBA rate, and the 822-N1GBA rates, respectively.

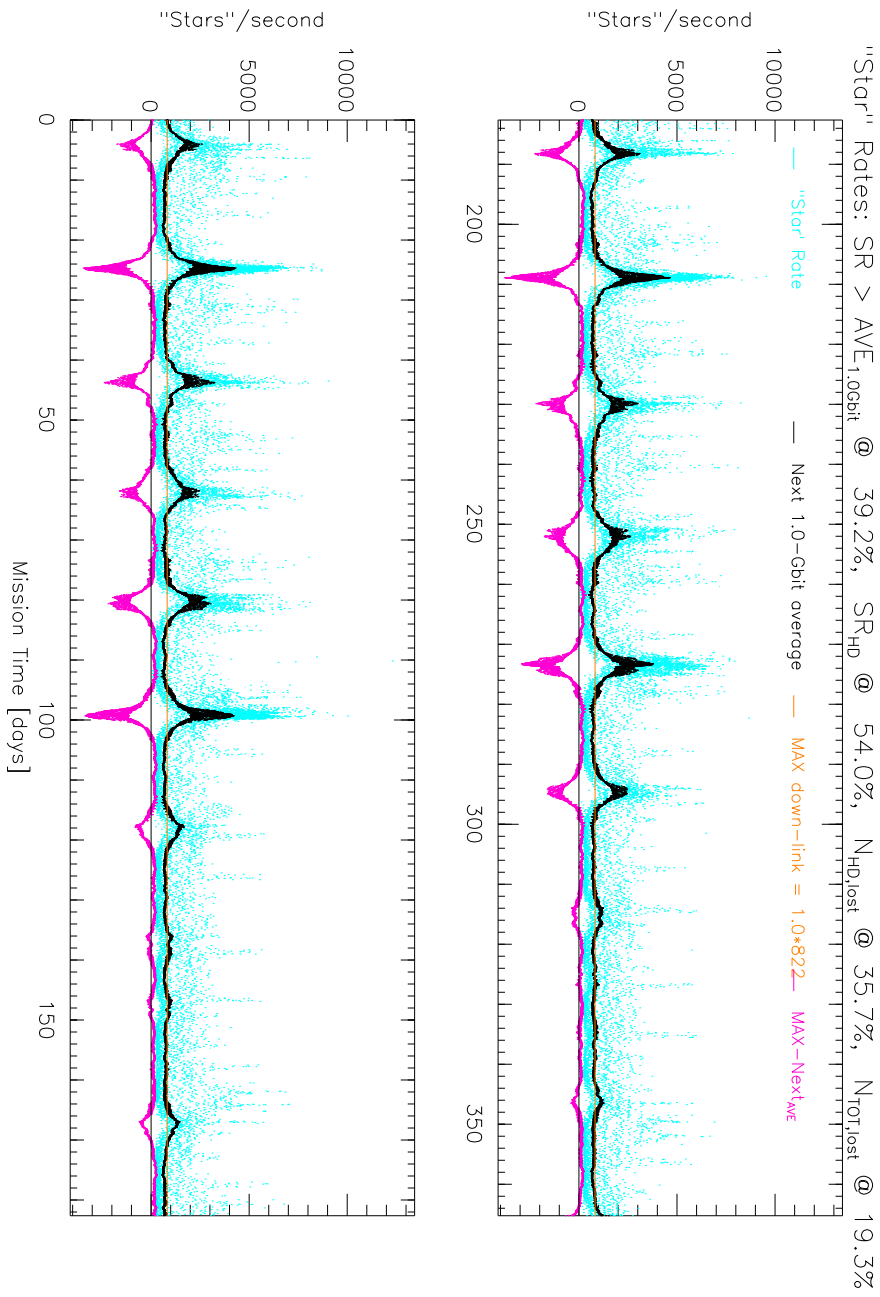

Figure 2: Like figure 1, but for 1 year period.

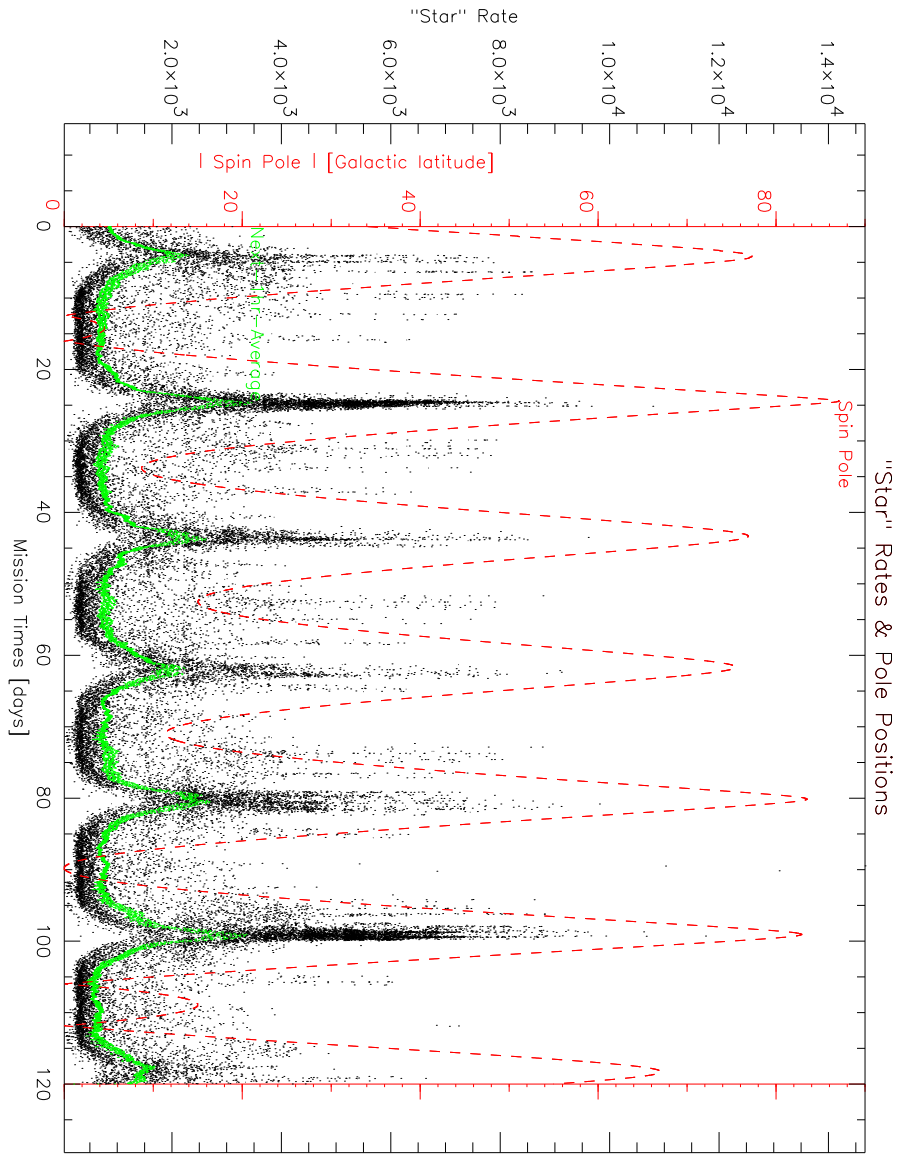

Figure 3: The STR for $9 \leq m_R < 15$ stars (black dots) superimposed on the absolute value of the instantaneous position of the pole of the S/C's spin axis (red dotted line, in Galactic coordinates). The N1GBA rate is also plotted (green dots).

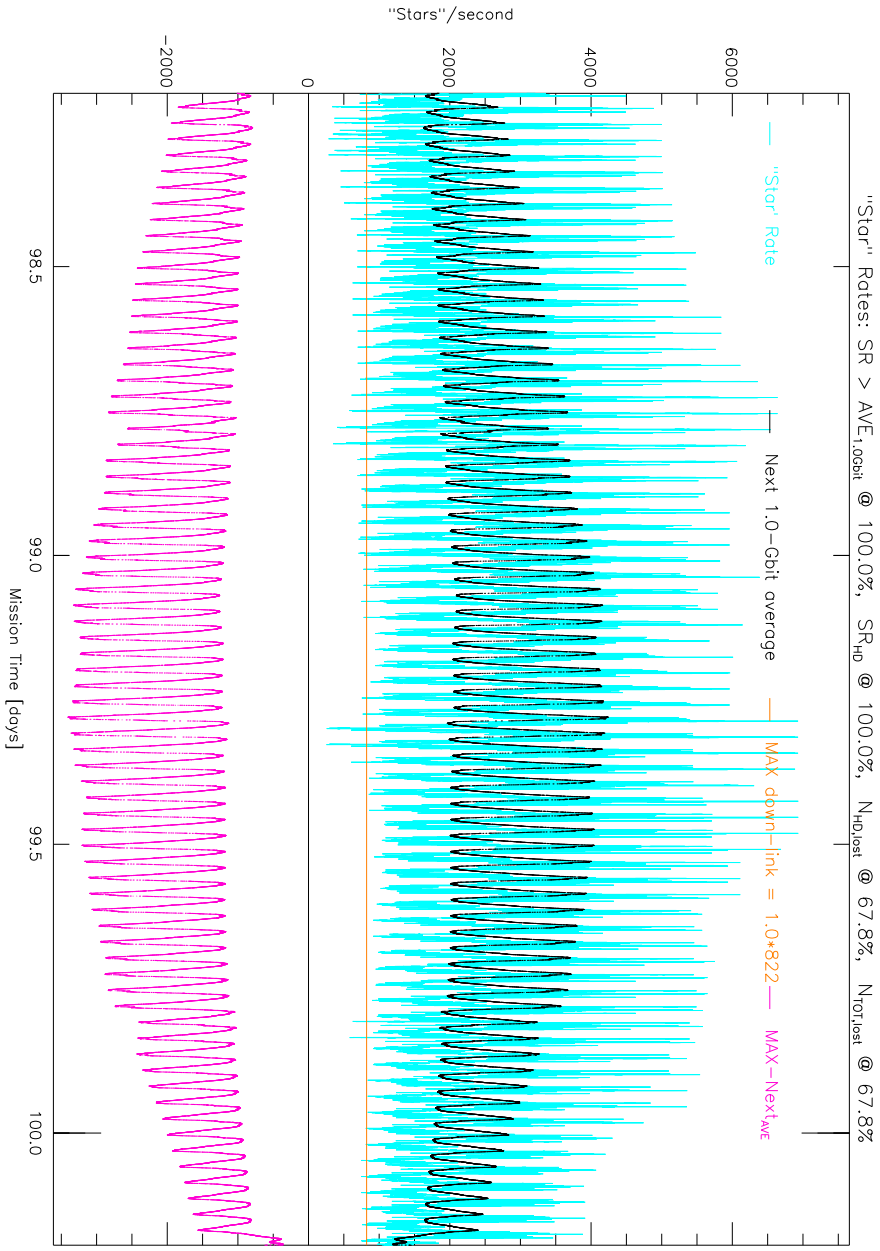

Figure 4: A zoomed version of fig. 3 around the GPR at day 99.

Lost Observations

in high density regions (HDR)

(where $N1GBA \geq NDLR$)

NDLR	D_{mul}	τ_{HDR}	P_{HDR}	P^{lost}_{HDR}	P^{lost}_{tot}
(1)	(2)	(3)	(4)	(5)	(6)
822	1.00	39.47	54.30	35.61	19.34
822	1.20	24.50	39.98	34.85	13.93
822	1.40	16.98	31.43	33.00	10.37
822	1.60	12.58	25.59	30.36	7.77
822	1.80	9.87	21.53	26.90	5.79
822	2.00	7.76	17.98	23.55	4.23
822	2.20	5.78	14.31	21.24	3.04
822	2.40	4.27	11.23	19.18	2.15
822	2.60	3.05	8.53	17.68	1.51
822	2.80	2.08	6.21	17.00	1.06
822	3.00	1.42	4.53	16.59	0.75

(1) Nominal down-link rate (star $\sec^{-1}$)
(2) DL-multiplier,
(3) percentage of time spent in HDRs,
(4) percentage of mission-total observations made in HDRs,
(5) percentage of observations lost, in HDR,
(6) percentage of observations lost, mission-total.

Info needed from a data-reduction perspective? (1-D postage stamps)

- 1) 120 bits for the intensity values
- 2) 2 bits for the gain setting of the A/D converter
- 3) 6 bits for the 48 CCD identifiers
- 4) 10 bits for the start CCD column number
- 5) 4 bits for the number of cross-scan pixels
- 6) 34 bits for the time stamp
- 7) (16 bits for the star # within IC box $[N_B]$)
- 8) (16 bits for the Input catalog box # $[B_{IC}]$)
- 9) (4 bits for a data-format identifier)

- $\Sigma_1^6 = 176$ bits $= BPS_{CSR}/1.9$
- $2^{34} \times 5\ nsec = 85$ seconds.
  Down-link less significant bits with 2-D FPSs
- Recover B_{IC} on the ground from attitude info
- To be safe: include 16 N_B bits
  $\Sigma_1^7 = 192$ bits total $= 24$ bytes
  $= BPS_{CSR}/1.75 \longrightarrow 1438$ stars/sec $\longrightarrow 70\ 10^6$ stars

Conclusions

- Minimum STR ∼ 0 "stars" per second
- Median STR ∼ 721
- Average STR ∼ 984
- RMS STR ∼ 734
- Maximum STR ∼ 12,000, both apertures in Galactic plane (GP)
- 14 Galactic Plane Rolls (GPRs) per year, each 9 days (@ 822 sec^{-1})
- 50% of observations in GPRs, 19% lost
- 12 GPRs per year, each 2 days (@ 1644 sec^{-1})
- 17% of observations in GPRs, 4% lost
- $\lesssim$ 192 bits need to be downloaded for data-reduction purposes