

Van Allen Probes

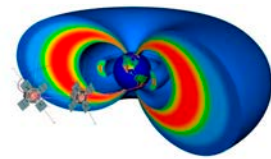
Van Allen Probes Spacecraft Mission Design

Extended Mission Options

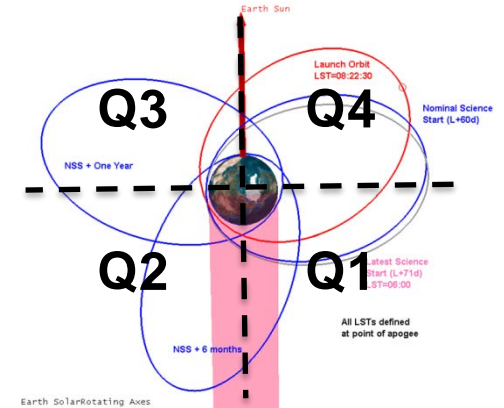
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Trajectory Status (2014-2016)



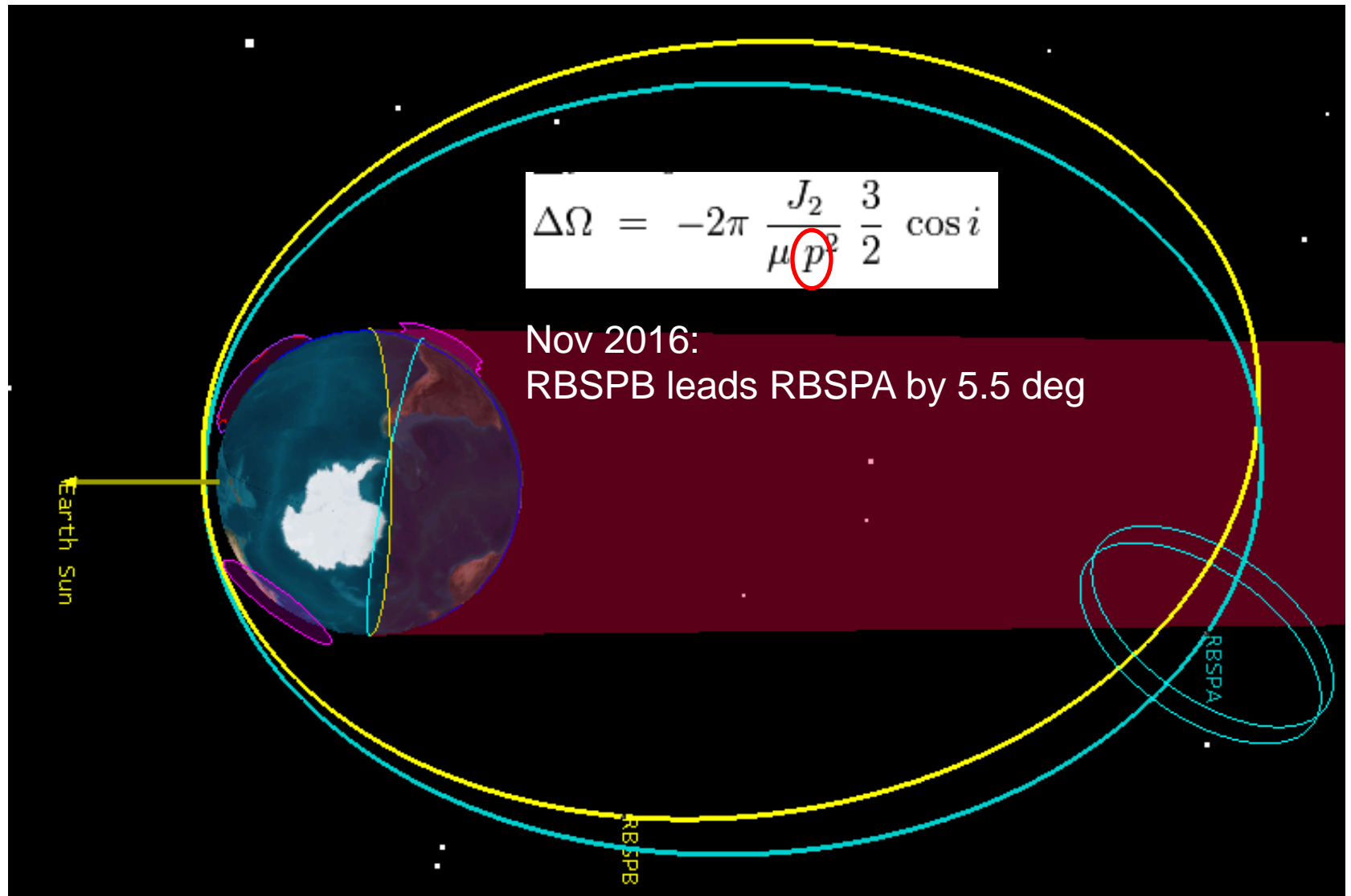
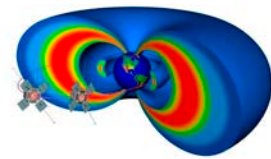
[Predicted] Lapping Rate Per Quadrant	27-Nov-2013
Q1	2.44
Q2	2.25
Q3	2.52
Q4	2.34



Quadrant Entry/Exit Dates	RBSPA	RBSPB
Enter Q1	18 Aug 2014 12:00	13 Aug 2014 10:00
Enter Q2	03 Feb 2015 01:00	26 Jan 2015 12:00
Enter Q3	03 Jul 2015 04:00	28 Jun 2015 01:59
Enter Q4	21 Dec 2015 09:00	12 Dec 2015 07:00
Exit Q4	30 May 2016 13:00	20 May 2016 00:00

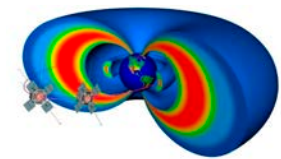


Trajectory Status (2014-2016)





Options

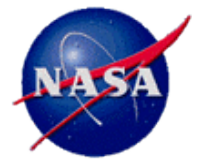


Option	ΔV RBSPA (m/sec)	Fuel Used RBSPA (kg)	Mission EOL Estimate** RBSPA	ΔV RBSPB (m/sec)	Fuel Used RBSPB (kg)	Mission EOL Estimate** RBSPB	Angle Between Apse Lines in May 2016 (deg)
Do nothing	0	0	5/1/2019	0	0	4/1/2019	5.5
Swap Apogee and Perigee Altitudes	4.5	1.4	2/1/2019	4.5	1.4	1/1/2019	0.0
Increase RBSPB Apogee to 6.0 Re	0	0	5/1/2019	25.7	8.2	10/1/2017	19.9
Increase RBSPB Apogee to 6.2 Re	0	0	5/1/2019	50.3	15.9	5/8/2016	33.3
Increase Delta Apogee by 100%*	3.2	1.0	3/1/2019	3.2	1.0	3/1/2019	9.2
Increase Delta Apogee by 200%*	6.4	2.0	1/1/2019	6.4	2.0	1/1/2019	12.9
Increase Delta Apogee by 300%*	9.6	3.0	11/1/2018	9.6	3.0	11/1/2018	16.6

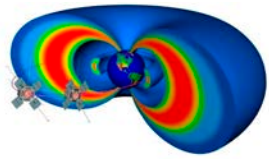
*Current delta between apogee altitudes is ~140 km

**End of life estimates are based on continuing our nominal spacecraft operations and projecting current propellant usage forward. Lifetime of spacecraft components due to environment, based on radiation modeling and measurements, is predicted to be 12/1/2019 For reference: prime mission ends 11/1/2014.

Predicted angle between apse lines at end of prime mission is 2.25 deg



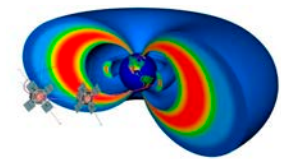
Backup



Backup



Options

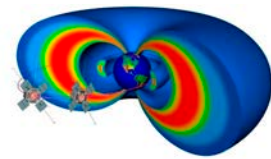


Option	ΔV RBSPA (m/sec)	Fuel RBSPA (kg)	Mission EOL Estimate* RBSPA	ΔV RBSPB (m/sec)	Fuel RBSPB (kg)	Mission EOL Estimate* RBSPB
Do nothing – allow natural orbit perturbations	0	0	5/1/2019	0	0	4/1/2019
Swap Apogee and Perigee Altitudes	4.5	1.4 kg	2/1/2019	4.5	1.4 kg	1/1/2019
Increase RBSPB Apogee to 6.0 Re	0	0	5/1/2019	25.7	8.2 kg	10/1/2017
Increase RBSPB Apogee to 6.2 Re	0	0	5/1/2019	50.3	15.9 kg	5/8/2016
Increase RBSPB Apogee to 6.4 Re	0	0	5/1/2019	73.5	23.1 kg	1/15/2015

*End of life estimates are based on continuing our nominal spacecraft operations and projecting current propellant usage forward. Lifetime of spacecraft components due to environment, based on radiation modeling and measurements, is predicted to be 12/1/2019 For reference: prime mission ends 11/1/2014.



On-board Propellant Usage



- **Van Allen spacecraft propellant predicted to last until Nov 2018**
 - Assuming nominal operations continue
 - Maintains EOM de-orbit burn and COLA propellant budget as is
- **24 kg propellant adequate for a four year extended mission**
 - G&C Precessions predicted to take <10 kg for 2 years
 - Spinup/down expected to be minimal (<0.1 kg for 2 yrs)

Spacecraft A - 657 kg launch mass

Propellant Budget	ΔV	Used (111313)	Propellant planned (kg)
Phasing/Collision Avoidance	2.4 m/s	0.294	0.7
G&C - Precession 11/13/13		5.48	11.16
G&C - Spinup/Spindown		0.52	0.6
EOM Off sun precession			1
EOM Deorbit Burn	59.6 m/s		17.8
Total - 2.2 Year Mission			31.26
Residual Propellant			0.6
Total Propellant Loaded			56.5
Total GN2 Pressurant Mass			0.6
Uncertainty			0.035
Available propellant for extended mission			24.605

Spacecraft B - 676 kg launch mass

Propellant Budget	ΔV	Used (111313)	Propellant planned (kg)
Phasing/Collision Avoidance	2.4 m/s	0.28	0.7
G&C - Precession 11/13/13		5.51	11.16
G&C - Spinup/Spindown		0.51	0.6
EOM Off sun precession			1
EOM Deorbit Burn	59.6 m/s		18.3
Total - 2.2 Year Mission			31.76
Residual Propellant			0.6
Total Propellant Loaded			56.5
Total GN2 Pressurant Mass			0.6
Uncertainty			0.035
Available propellant for extended mission			24.105

Propellant on-board to support a four year mission extension