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1. Following ejection from the Prox-1 spacecraft, will there be any proximity operations that in any way involve Lightsail-2, or will the two objects simply drift apart. If there will be proximity operations please provide a detailed description of the methods that will be used to avoid collisions between the two objects.

There will not be proximity operations between Prox-1 and LightSail 2 following deployment of LightSail 2 from Prox-1. Prox-1 does not have propulsive capability. The two objects will simply drift apart based upon the DV imparted to LightSail 2 by the P-POD mounted in Prox-1 (approximately 1.2 m/s).

2. The ODAR notes that, in its stowed configuration, Lightsail-2 will have an anticipated orbital lifetime of 92 years. Since compliance with the 25 year requirement therefore appears to depend on the successful deployment of the sail, please provide a detailed analysis concerning reliability of the sail deployment.

The LightSail 2 spacecraft and solar sail assembly is a build-to-print of the LightSail 1 spacecraft, which successfully demonstrated solar sail deployment on June 7, 2015. The LightSail program was initiated in 2009, and it has included a robust ground test program of the solar sail deployment event. The table below provides a summary of the deployment test history for the LightSail 1 and LightSail 2 flight units, since December 2011. It includes 20 ground tests (boom-only and sail deployment), plus the on-orbit deployment of LightSail 1. Of the 20 ground tests, 19 achieved full deployment and one achieved partial deployment due to a system reboot (following the reboot, the test team was able to command full deployment).

The solar sail deployment event requires a successful deployment of the side solar panels, followed by operation of the Faulhaber motor to deploy the solar sail booms. Solar panel deployment is initiated by a burnwire event, with an estimated reliability of 0.995. Motor-driven boom deployment has an estimated reliability of 0.98. The total probability of successful solar sail deployment is estimated to be 0.975. The reliability estimates are based upon ground testing, and are considered to be conservative.

Testing dates and results are included at the end of this document.

3. Please address whether the mission objectives could be achieved by launch to a lower initial altitude, from which, in the stowed configuration, the satellite would re-enter within 25 years.

The planned 720 km orbit is the lowest circular orbit that would allow controlled solar sailing. At lower altitudes, atmospheric drag overcomes solar radiation pressure, and the ability to demonstrate controlled solar sailing is not viable. The 720 km altitude is considered marginal for solar sailing, but it is viable for LightSail 2 because the launch will occur near a minimum in the solar cycle, resulting in fairly low atmospheric densities at orbital altitudes. An orbital altitude at which the spacecraft would deorbit within 25 years in the stowed configuration (generally, 600 km or lower altitude) would not allow solar sailing objectives to be met.

4. Assuming successful deployment of the sail, are there any possible failure modes in which the spacecraft orbital altitude would increase, rather than result in atmospheric re-entry.

There are no failure modes that will result in an increased orbital altitude. Without controlled solar sailing, the sail effectively increases the drag area of the spacecraft, accelerating deorbit. Orbit raising requires active attitude control.

5. Please provide additional information concerning the planned flight profile for the spacecraft. How high will the apogee be raised? What is the anticipated accuracy with which spacecraft trajectory can be controlled?

Closed-loop simulations of LightSail 2 solar sailing performance shows that the orbit apogee may be raised by up to 15 km (from 720 to 735 km altitude) during the first four weeks following solar sail deployment. The spacecraft uses sun sensors and magnetometers to determine the spacecraft attitude, and a momentum wheel and torque rods to control the orientation of the sail relative to the Sun. The control capability is fairly coarse--we expect to control the sail orientation within ~30 deg of the desired attitude. As such, the ability to control the amount of apogee increase is limited. An apogee increase of 15 km during the four weeks following sail deployment assumes ideal performance, and we don't expect to achieve that level of performance. Our success criterion is to achieve a "measurable" level of apogee increase due to solar pressure. An apogee increase of 1-5 km is a reasonable expectation.

6. Will spacecraft trajectory planning include screening for possible collisions with other space objects?

LightSail 2 has two active attitude control modes: (1) Z-axis pointing aligns the longitudinal axis of the CubeSat with the geomagnetic field vector, effectively doing a slow rotation of the vehicle throughout the orbit; (2) Solar sailing mode, in which the solar sail is edge-on to the Sun line when moving toward the Sun, and face-on to the Sun line when moving away from the Sun. The LightSail 2 operations team will be in communication with the 18th throughout the mission. We will also have tracking support from the International Laser Ranging System (ILRS). Should we be notified of a possible collision, LightSail 2 could transition between attitude control modes to modify the planned trajectory.

7. Will data on planned trajectories be made available to the 18th SPCS and other operators?

The LightSail 2 project will coordinate regularly with the 18th, including prior to entering spacecraft modes that are expected to change the orbit. The 18th will provide two-line element (TLE) information for LightSail 2, and will monitor for possible collisions.

8. Please provide the space station and earth station antenna beam diagrams

attached and included at the end of this document

9. Provide cost recovery letter using the attached template

attached. We updated the previously submitted letter which was based on an older letter template. If you need us to use the newer template let me know and we will make the update.

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LightSail 1 and 2 deployment tests, 12/2011 - present

Test Description	Date	Unit	Result
Boom-Only Deployment	12/1/2011	F2	Success
Boom-Only Deployment	12/1/2011	F2	Success
Boom-Only Deployment	12/1/2011	F2	Success
Boom-Only Deployment	12/2/2011	F2	Success
Boom-Only Deployment	1/6/2012	F2	Success
Boom-Only Deployment	1/12/2012	F2	Success
Boom-Only Deployment	2/10/2012	F1	Success
Boom-Only Deployment	2/18/2012	F1	Success
Boom-Only Deployment	2/18/2012	F1	Success
Sail Deployment	2/19/2012	F1	Success
Sail Deployment	3/30/2012	F1	Partial deployment due to system reboot, recovered
Pre-Vibe Deployment Test	5/1/2012	F1	Success
Post-Vibe Deployment Test	5/2/2012	F1	Success
Sail Deployment	3/23/2014	F1	Success
Sail Deployment	8/29/2014	F1	Success
On-Orbit Sail Deployment	6/7/2015	F1	Success

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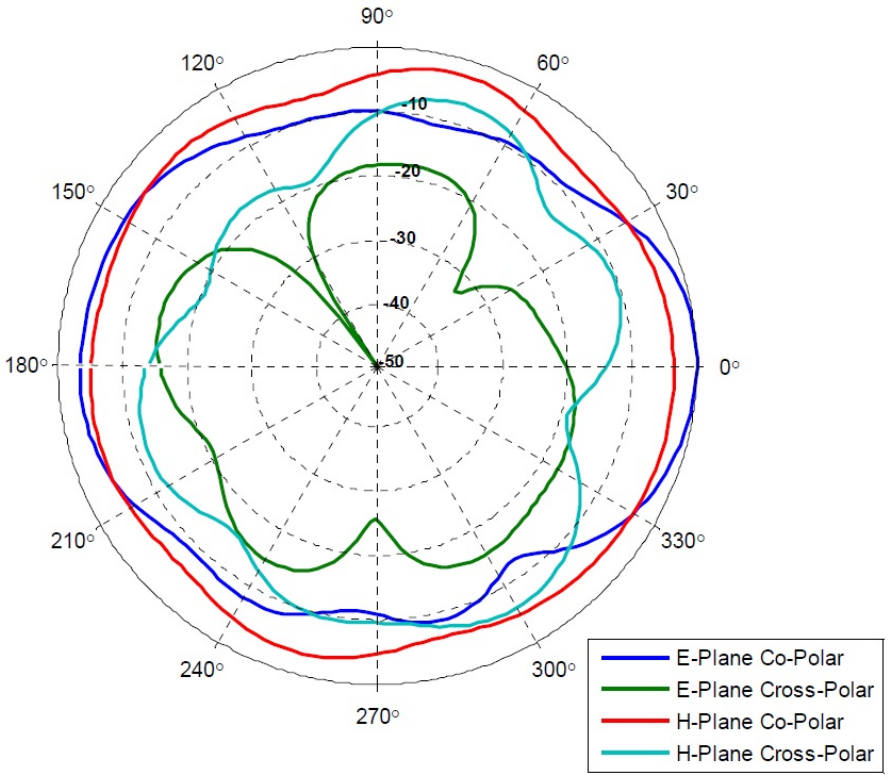
Boom-Only Deployment	1/25/2016	F2	Success
Sail Deployment	1/28/2016	F2	Success
Boom-Only Deployment	2/29/2016	F2	Success
Sail Deployment	5/23/2016	F2	Success
Boom-Only Deployment	12/5/2016	F2	Success

ANT1: Satellite TX Antenna



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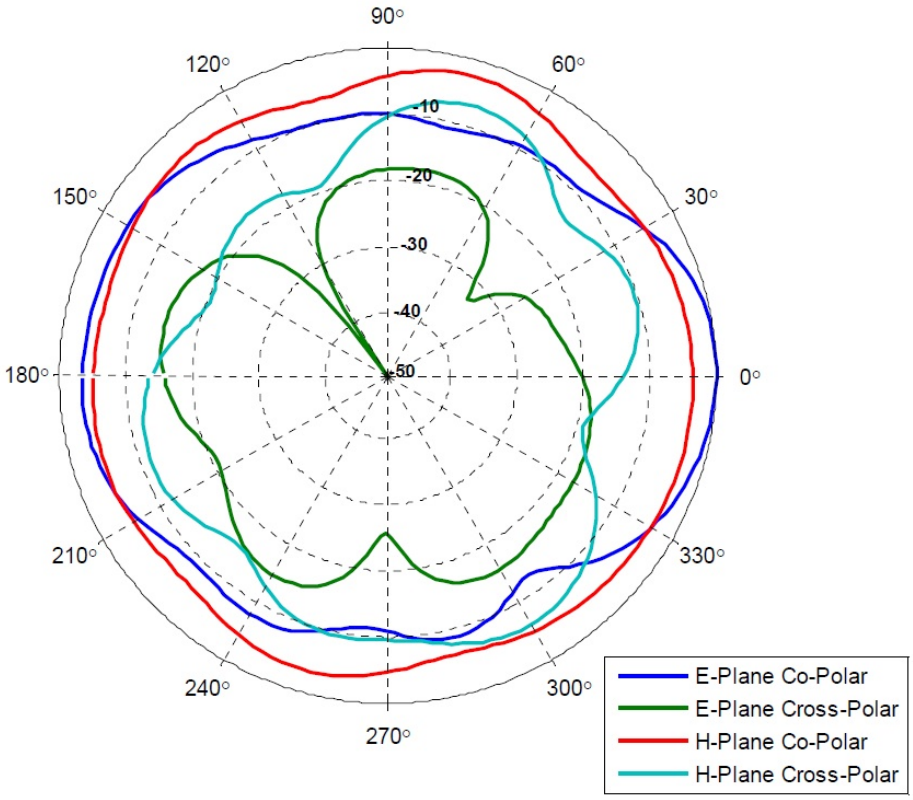
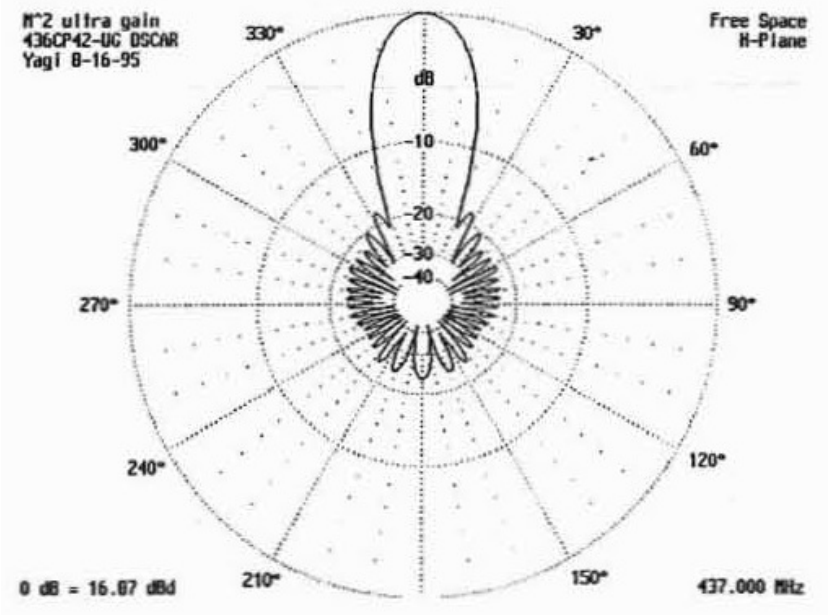
ANT2: Satellite TX Antenna



ANT3: Earth Station RX Antenna



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ANT4: Earth Station TX Antenna