LightSail Program Update

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… and the LightSail Team

Interplanetary CubeSat Conference
Imperial College, London
2015 May 26-27

LightSail Program Scope

- **Privately funded by members of The Planetary Society**
- **Principal objectives**
  - Demonstrate feasibility of solar sailing from 3U CubeSat in Earth orbit
  - Serve as pathfinder for future solar sail missions
- **Mission plans**
  - LightSail A (2015 launch on Atlas 5)
  - LightSail B (2016 launch on Falcon Heavy)
  - Mission-control ground segments in California and Georgia

LightSail Team

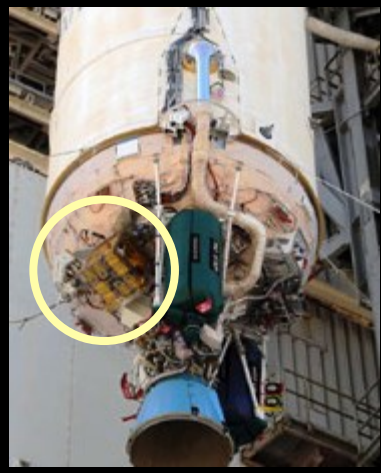
- Overall program direction; funding; outreach
- Program management
- Lead system contractor; systems engineering and I&T
- Mission management; system analyses; mission ops
- Launch integration; environmental test; mission ops
- Systems engineering; ACS; flight software
- CubeSat design; initial construction; I&T support

LightSail History

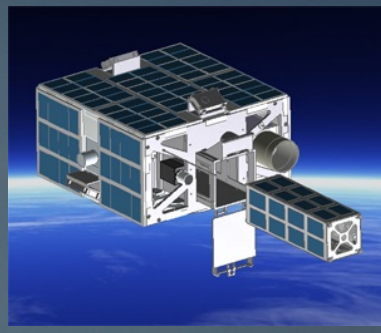
- **Follow-on to previous solar sail mission attempt by TPS**
  - Cosmos 1 (2005)
- **3U CubeSat concept defined 2009-2011**
  - Two spacecraft constructed by end of 2011 (one partly tested)
- **~18-month program pause 2012-2013**
- **Program resumed late 2013**
  - Two launch opportunities secured (LightSail-A and LightSail-B)
  - New program and technical management team
- **LightSail-A I&T completed late 2014**
- **LightSail-B I&T to be completed late 2015**

LightSail Launches

- **LightSail-A**
  - Atlas 5 / AFSPC-5 payload; from CCAFS;2015
  - NASA ELaNa slot on ULTRASat (NPS CuL Lite)
  - Low elliptical orbit
  - 2015 May 20



- **LightSail-B**
  - Falcon Heavy / STP payloads; from CCAFS
  - Embedded target for Prox-1 spacecraft
  - ~720-km LEO orbit
  - 2016 2Q-3Q



LightSail Mission Objectives

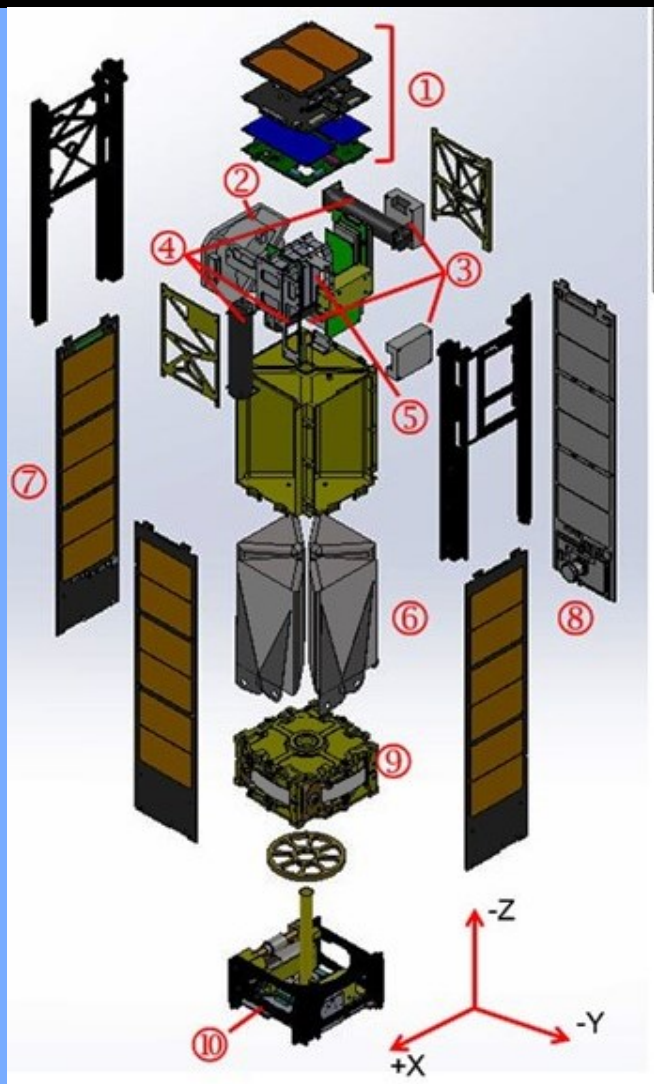
- **LightSail-A objective**
  - Successfully deploy solar sail from 3U CubeSat in Earth orbit and demonstrate key spacecraft functions (i.e., show design is sound)

- **LightSail-B objectives**
  - Successfully deploy solar sail
  - Successfully control attitude before and after sail deployment
  - Observably change orbit parameters (e.g., inclination)
  - Capture engineering and CONOPS data relevant to future CubeSat-class solar sail missions

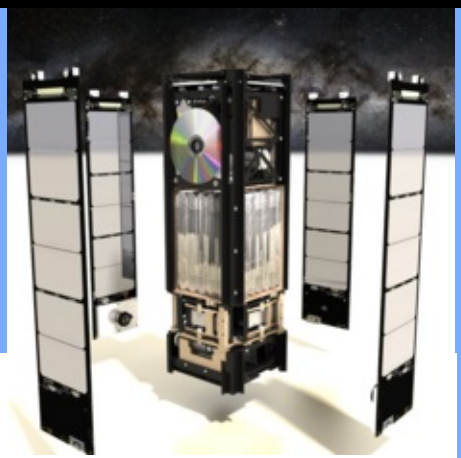
- **Mission collaborations**
  - NEA Scout
  - Lunar Flashlight

- **Plus other program objectives of TPS …**

LightSail Spacecraft



No.	Subsystem
1	Avionics
2	Momentum Wheel Mass Model
3	Gyros
4	Torque Rods
5	Battery Module
6	Stowed Solar Sail
7	Solar Panel
8	Camera
9	Sail Deployer
10	Antenna



Avionics
Torque rods, momentum wheel, circuit boards

Sail storage
Four Mylar sails, 32 square meters (344 square feet) total

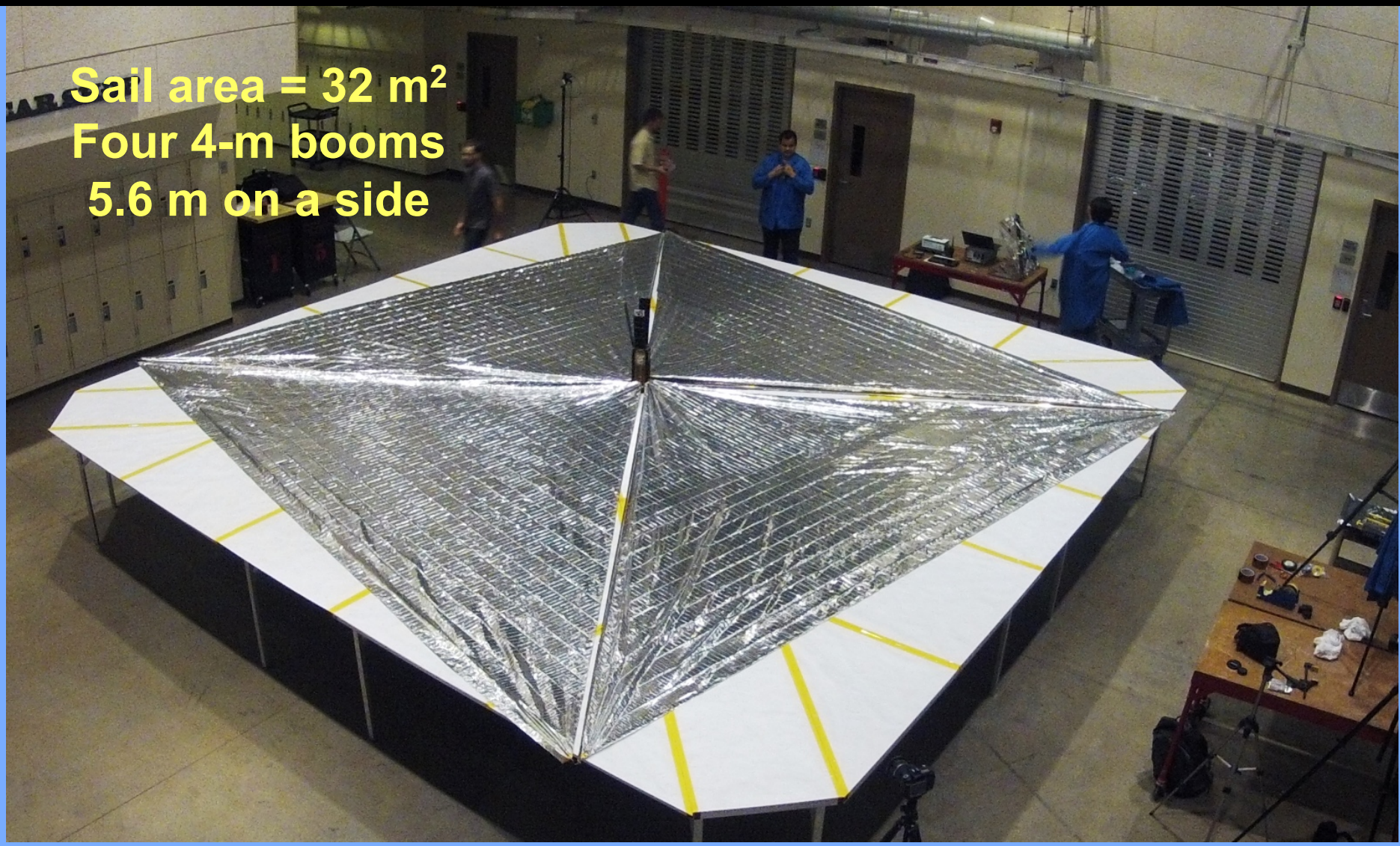
Boom storage
Four Triangular Rollable and Collapsible (TRAC) booms—the 'tape measures'

Payload
Boom deployment motor, antenna

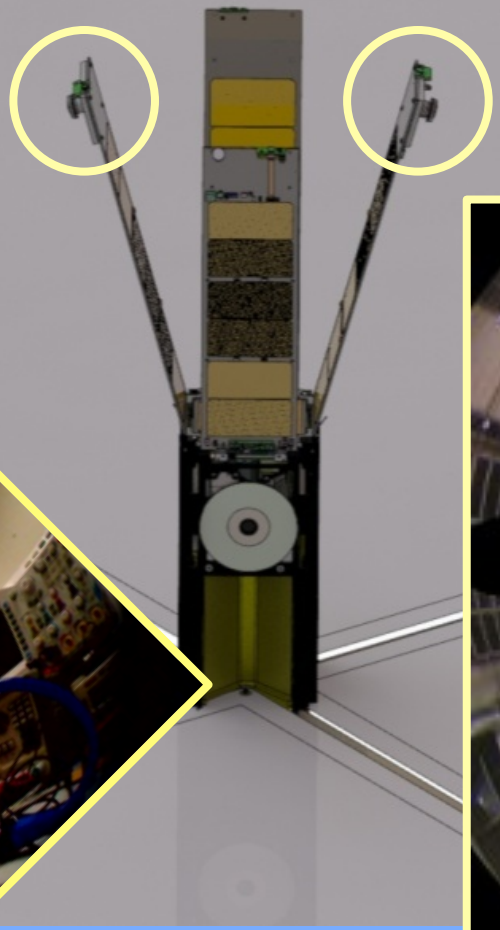
LightSail A: 4.93 kg

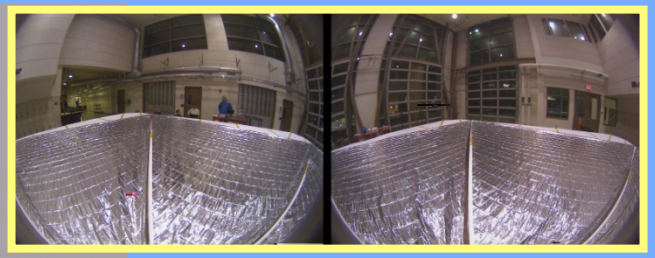
LightSail-A Spacecraft
(Mostly stowed)

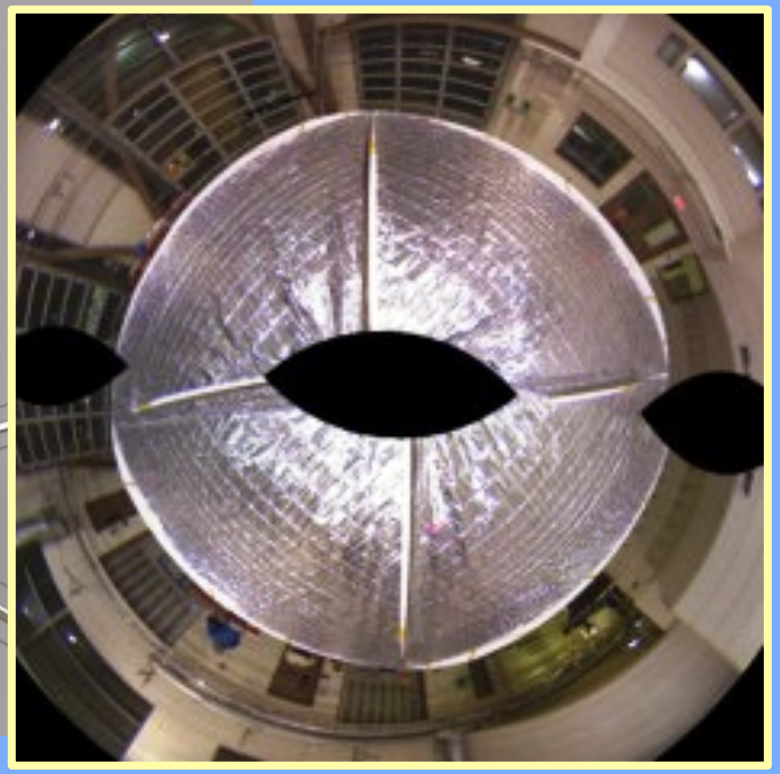
LightSail-A Spacecraft
(Fully deployed)



LightSail Cameras







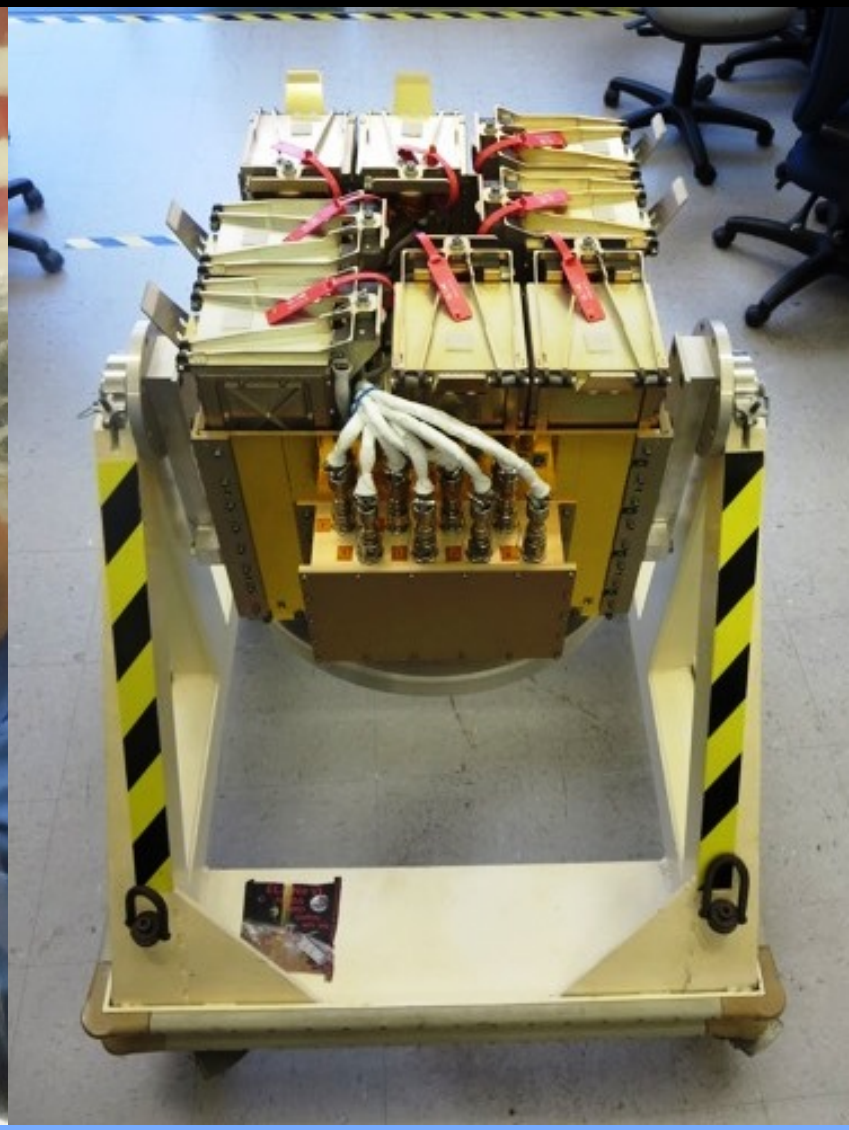
LightSail-A Issues Resolved
(Partial List)

- **Hardware**
  - Re-design payload interface board (re-spin)
  - Upgrade and mod flight computer board
  - Upgrade and mod radio board
  - Replace blown radios
  - Re-tune/match and replace RF antenna
  - Fix camera housing interference
  - Stiffen solar panels
  - Wire staking
  - Fastener staking
  - Mod burn wire install
  - Mod spectraline routing
  - Re-grease motor
  - Fix cracked cells
  - Fix solar panel switch
- **Software**
  - Major re-do of ACS CONOPS and software
  - Resolve various telemetry issues
  - Work mode transitions
  - Fix motor drive counter
- **Test**
  - Fix vibe failures of burn wire assembly
  - Deployment table facility
  - Breakout board issues
- **Ops-related**
  - Lower duty cycle of motor drive
  - Ground tracking

LightSail Schedule
(Since program pause in late 2011)

- 2012 Aug — Program resumption assessment
- 2013 Aug — Preliminary program review
- 2013 Dec — Program review – and resumption
- 2014 Jan-Aug — LS-A build-up, mods, functional testing
- 2014 Sep — LS-A day-in-the-life test
- 2014 Oct-Nov — LS-A system environmental testing
- 2014 Dec — LS-A Mission Readiness Review
- 2015 Jan — LS-A P-POD/ULTRASat integration; ship to Cape
- 2015 Apr — LS-A ORT-1 and ORT-2
- 2015 May 20 — LS-A launch
- 2015 thru Jun 27 — LS-A mission ops
- 2015 Jan-Dec — LS-B I&T
- Mid-2016 — LS-B launch (expected) and mission ops

LightSail-A Final Integration
(January)

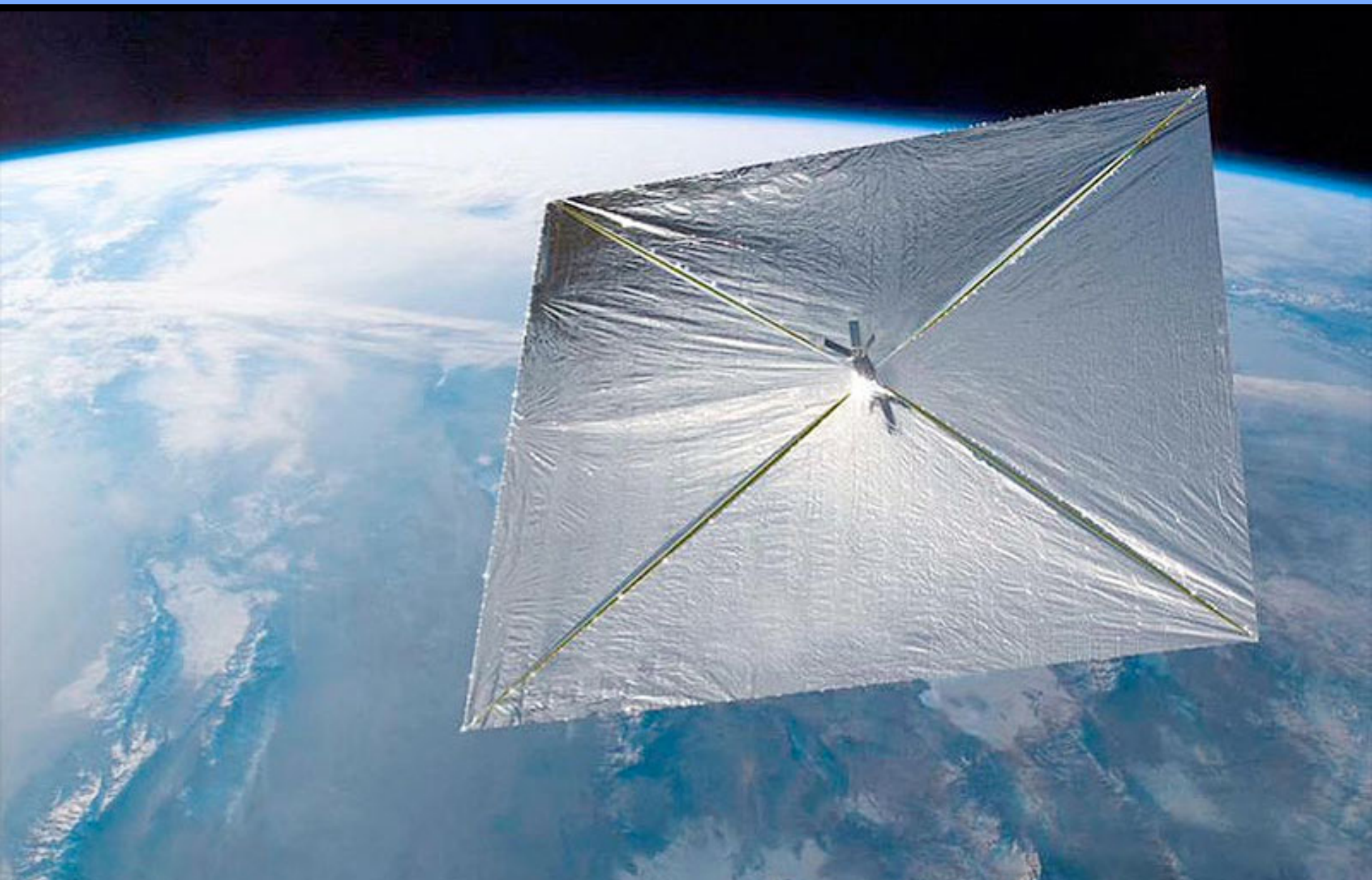


LightSail-A Launch
(May 20)

Initial LightSail-A Status
(As of May 27@ 5 pm London time)

- ✓ **Launch and orbit insertion**
- ✓ **Ejection from P-POD @ L+2 hr**
  - ✓ Tip-off rates low
- ✓ **Power-up / boot-up @ Eject+15 sec**
- ✓ **RF antenna deploy @ Eject+55 min**
- ✓ **Initial telemetry passes successful**
  - ✓ Most telemetry nominal
  - ✓ Gyros ON; commanded to OFF
  - ✓ Solar panels indicate DEPLOYED; likely not
  - ✓ Power and battery trending initiated
- X **Gyro and camera checkout (May 24)**
- ? **Solar panels, solar sails deployment, imaging (Jun 17)**
- ? **Confirmation of sail deployment; extended mission (days)**
- ? **Atmospheric entry (~Jun 20-27)**

Look For It June 17!



Prox-1 / LightSail-B CONOPS
(Mid-2016)

LightSail Information

- **Intro**
  - http://sail.planetary.org/
- **Solar sail deployment (PSCAM view)**
  - planet.ly/unfurl
- **TPS updates by Jason Davis**
  - http://sail.planetary.org/missioncontrol