

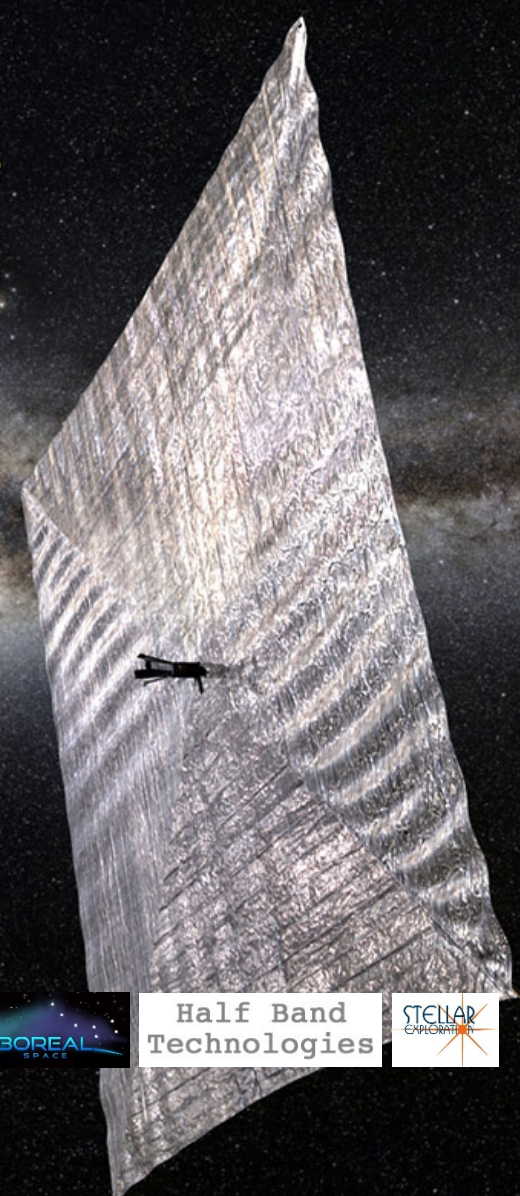
LightSail Program Update

Rex Ridenoure, CEO
Ecliptic Enterprises Corporation

Barbara Plante, President
Boreal Space

... and the LightSail Team

Interplanetary Small Satellite Conference
Santa Clara, CA
2015 Apr 27-28



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; system I&T



- Mission management; system analyses; mission ops



- Launch integration; environmental test; mission ops



- Systems engineering; ACS; flight software



- Systems engineering; system I&T support



- CubeSat design; initial construction; I&T support

LightSail History

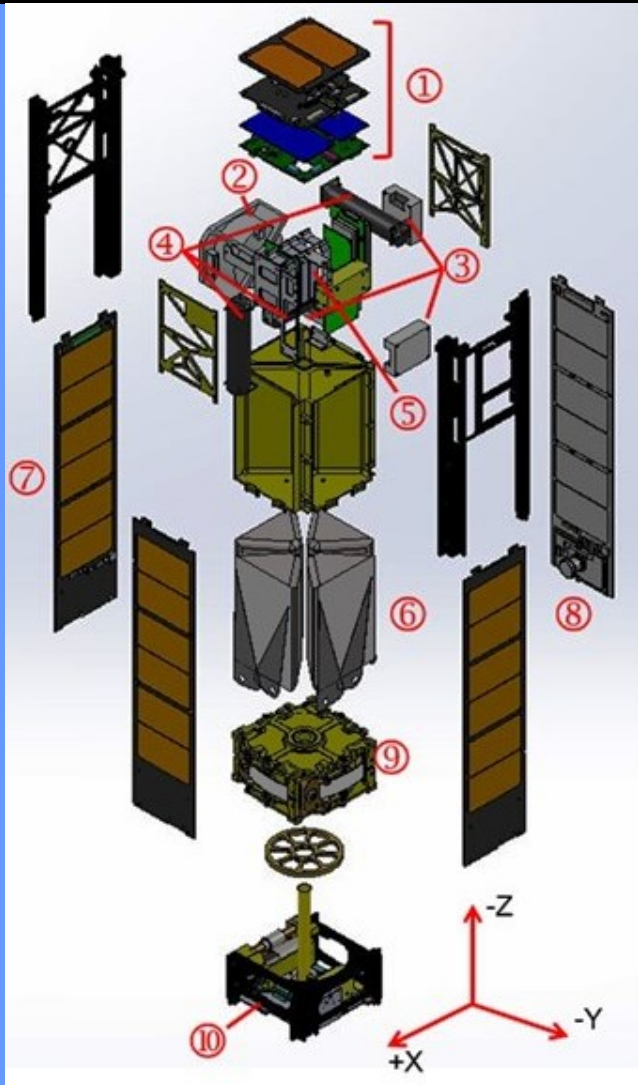
LIGHTSAIL



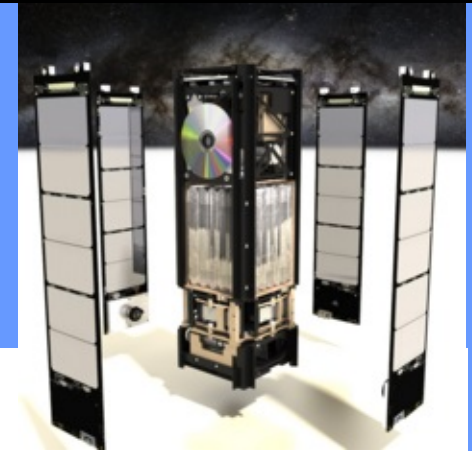
- **Follow-on to previous solar sail mission attempt by TPS**
 - Cosmos 1 (2005)
- **3U CubeSat concept defined 2009-2011**
 - Two spacecraft constructed by end of 2011 (one partly tested)
- **~18-month program pause 2012-2013**
- **Program resumed late 2013**
 - Two launch opportunities secured (LightSail-A 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 Spacecraft

LIGHTSAIL



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)



2015 Apr 27-28

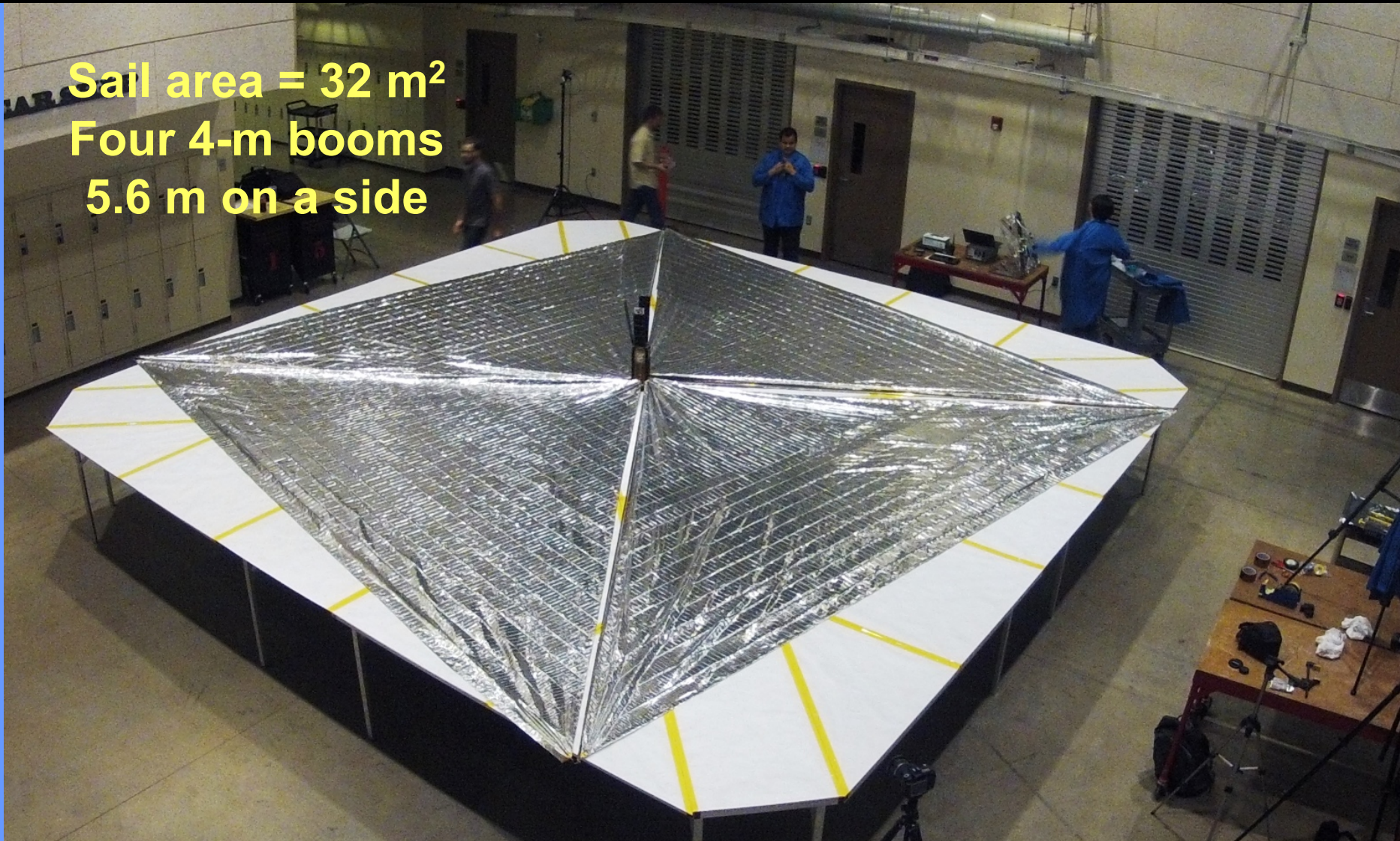
ISSC -- Santa Clara

LightSail-A Spacecraft

(Fully deployed)

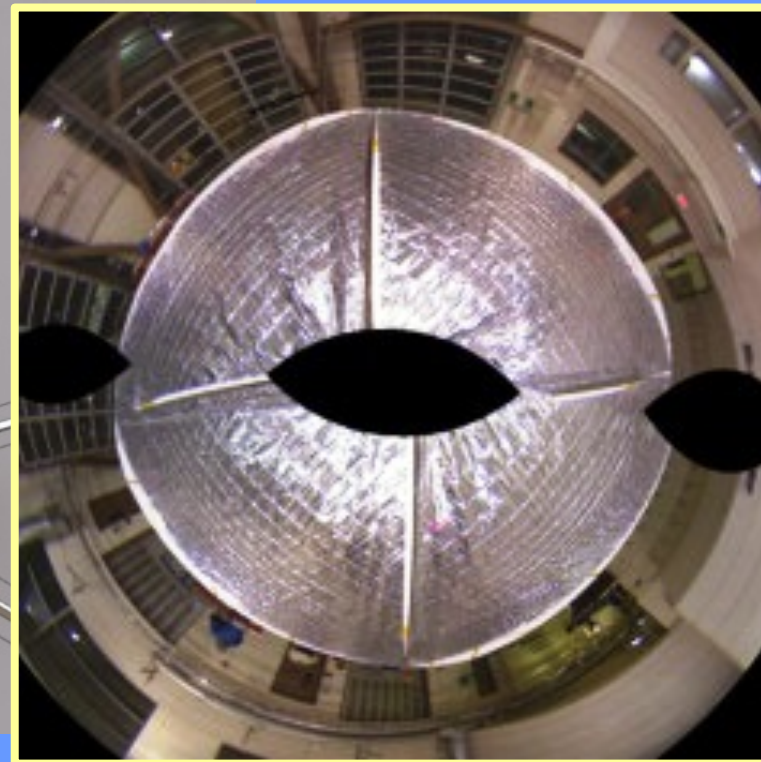
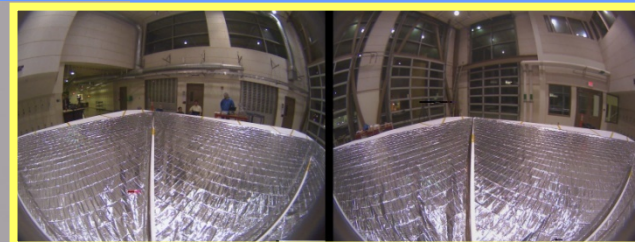
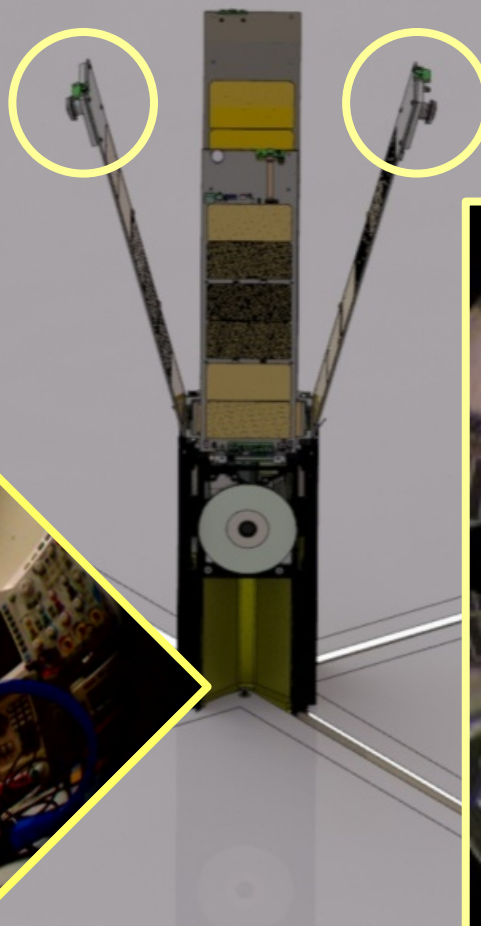


Sail area = 32 m²
Four 4-m booms
5.6 m on a side



LightSail Cameras

LIGHTSAIL



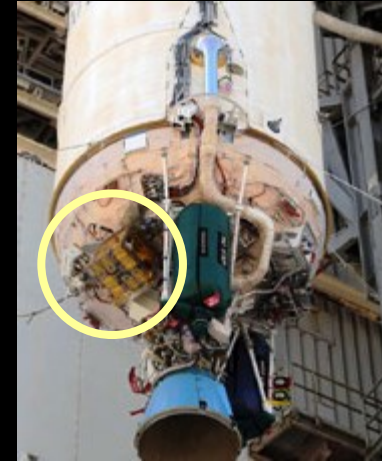
LightSail Launches

LIGHTSAIL



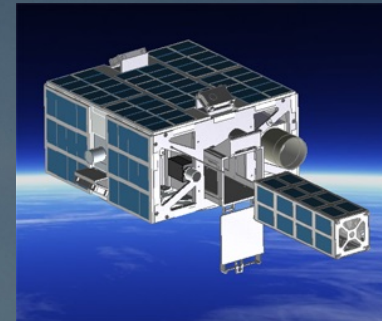
- **LightSail-A**

- 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-A Mission Operations

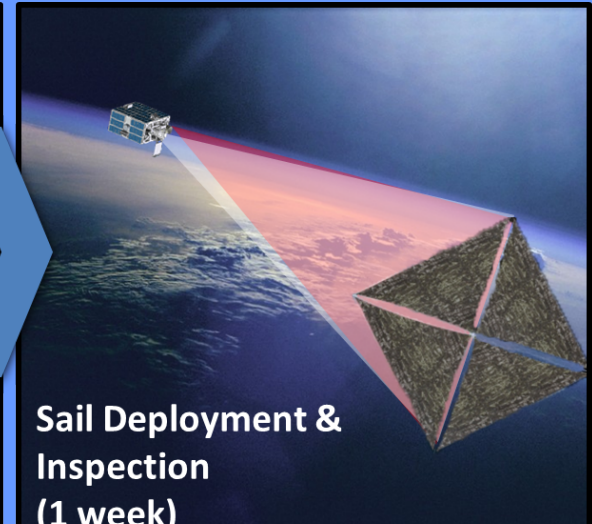
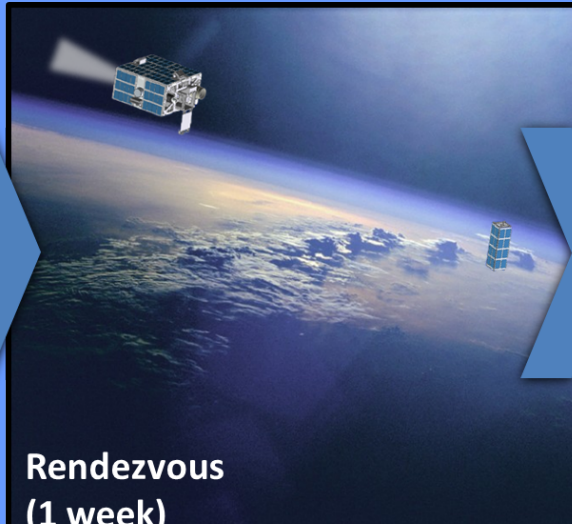
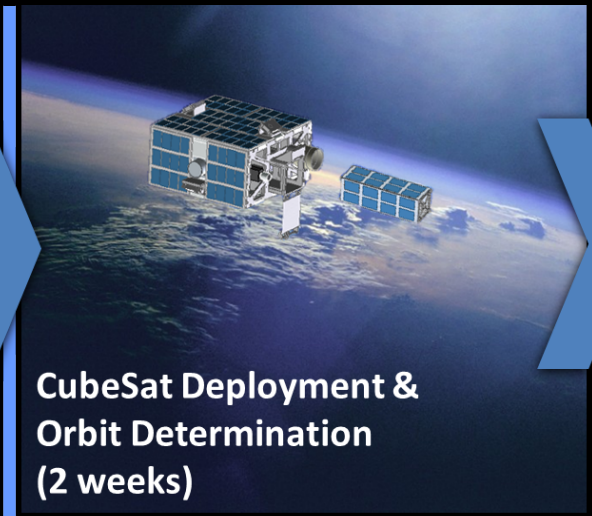


- **LightSail-A**

- ~Launch+1 hr: Eject from ULTRASat
- Eject+15 sec: Boot-up complete; ACS ON
- Eject+55 min: RF antenna deploy; start beacon TLM
- Eject+4 days: Gyros and camera checkout
- Eject+28 days: Deploy solar panels, solar sails; image sail deployment and download images
- Sail deploy+2 to 10 days: Enter atmosphere

Prox-1 / LightSail-B CONOPS

LIGHTSAIL



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**

- Lower duty cycle of motor drive
- Ground tracking

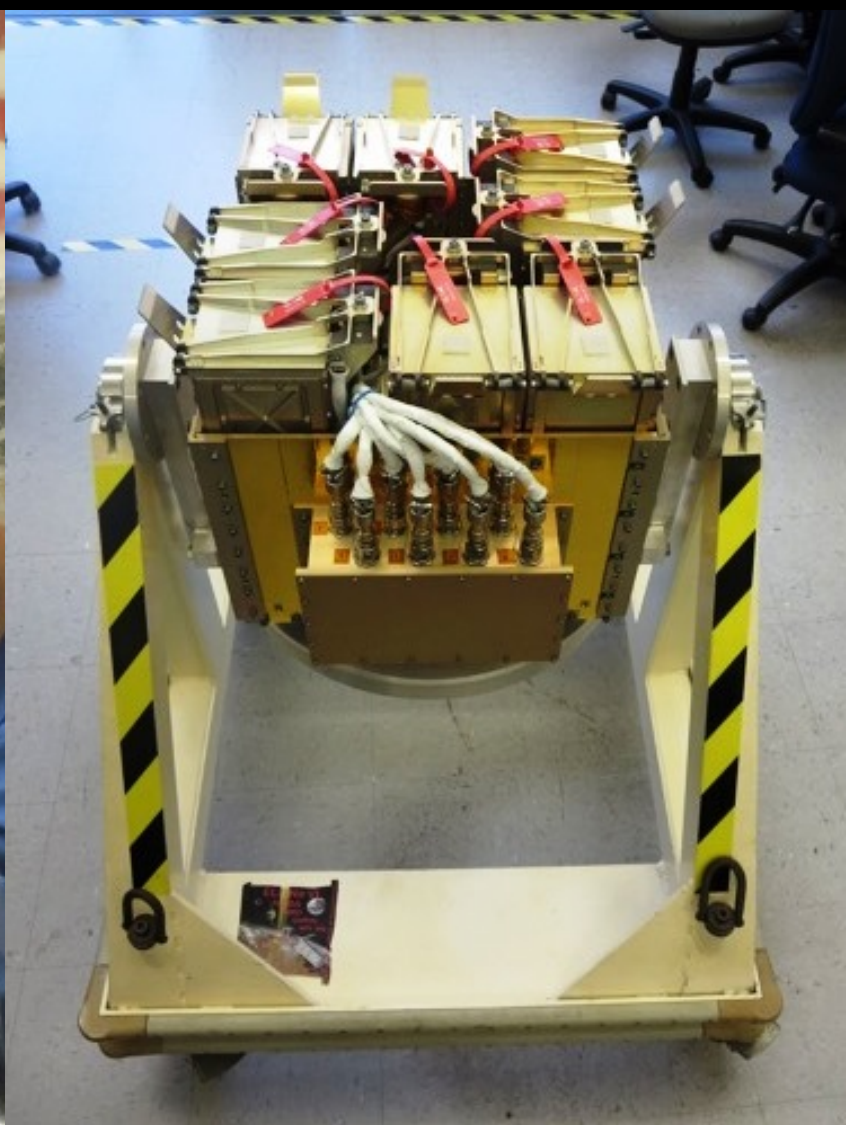
LightSail Schedule

(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 LS-A launch (expected)
- 2015 Jun LS-A mission ops
- 2015 Jan-Dec LS-B I&T
- Mid-2016 LS-B launch (expected) and mission ops

LightSail-A Ready for Launch!



LightSail Information



- **Intro**
 - <http://sail.planetary.org/>
- **Solar sail deployment (PSCAM view)**
 - planet.ly/unfurl
- **TPS updates by Jason Davis**
 - <http://www.planetary.org/explore/projects/lightsail-solar-sailing/project-updates.html>
- **And talk to us at the Ecliptic booth!**
 - Rex Ridenoure (Ecliptic)
 - Barbara Plante (Boreal Space)
 - SWAG -- !

