



*NASA Small Spacecraft Technology Program's
Pathfinder Technology Demonstrator Mission Series
"Enabling the Next Generation of CubeSat Missions"*

37th Annual Small Satellite Conference , Logan Utah

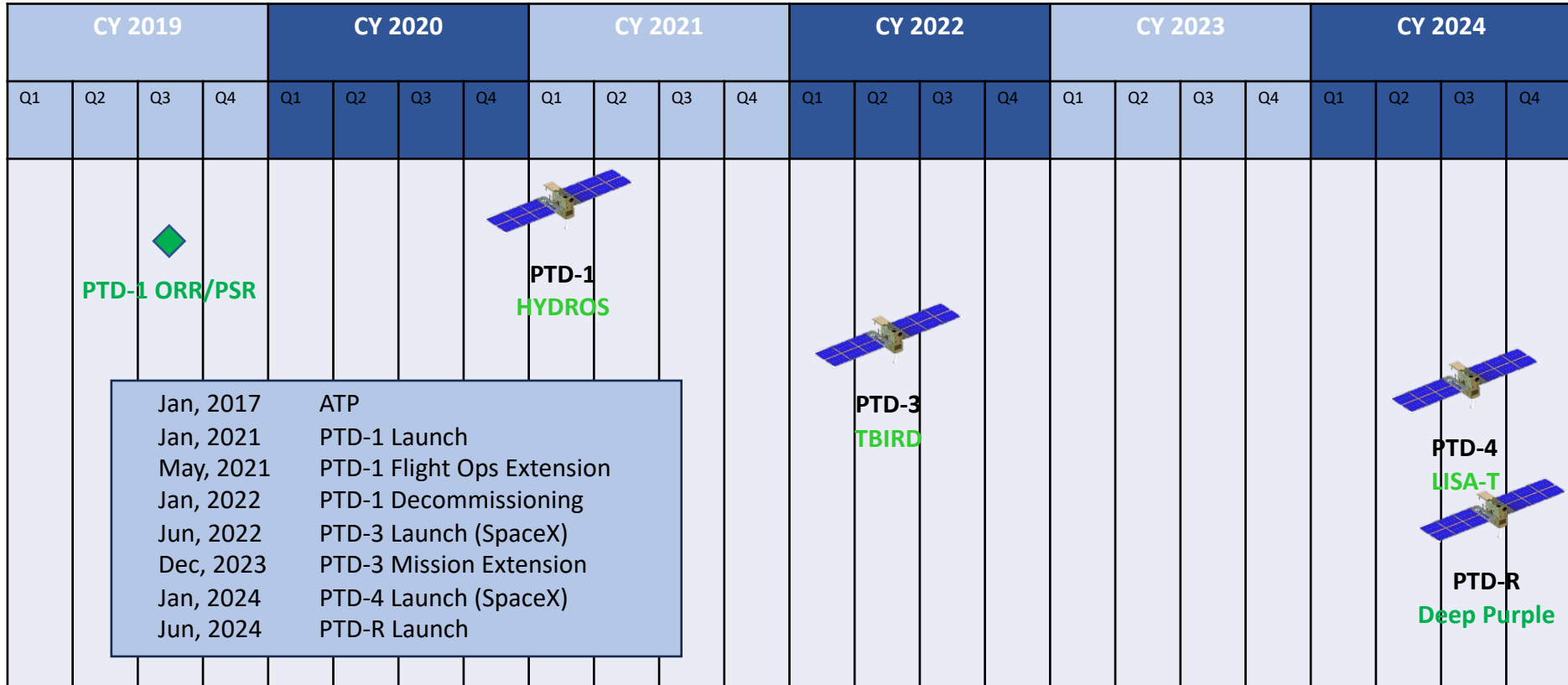
August 9, 2023

*NASA Space Technology Mission Directorate
NASA Small Spacecraft Technology Program
NASA Ames Research Center*



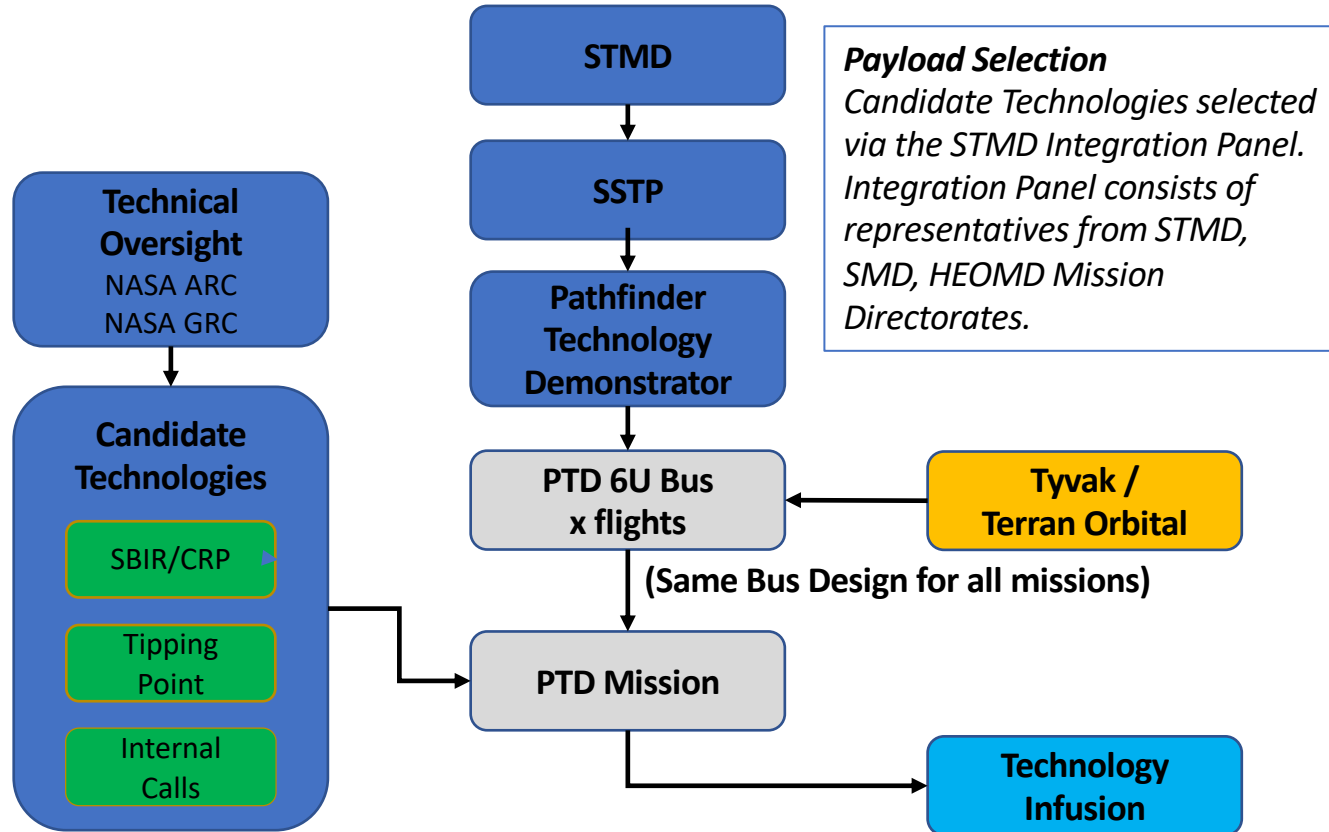


PTD MISSION SERIES TIMELINE






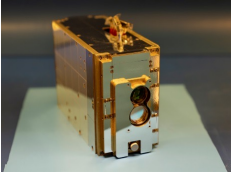


PTD MISSION DEVELOPMENT





PTD MISSION TECHNOLOGY SUITES



Mission		Payload	Utility
PTD-1		TUI HYDROS	Water based safe, high I_{sp} propulsion
PTD-1 Extension		FSW Updates	Improved Terran ADCS software
PTD-3		MITLL TBIRD	200 Gbps laser communications for small spacecraft
PTD-4		MSFC LISA-T	Large Deployable solar array with integrated X-Band high gain antenna
PTD-R (replacement for PTD-2 Mission)		DOE / LLNL	Monolithic UV/SWIR/VIS Camera

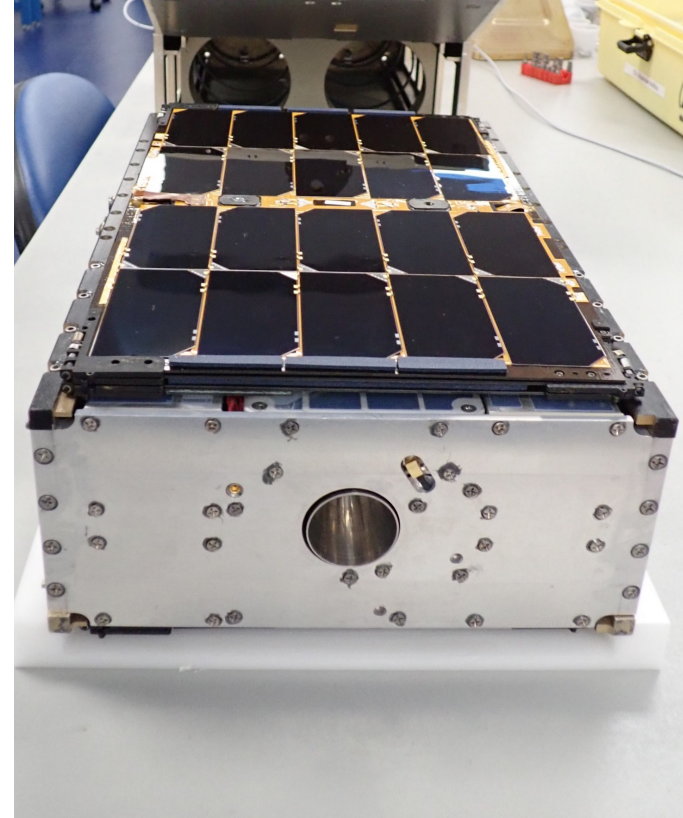


PTD-1 MISSION RESULTS



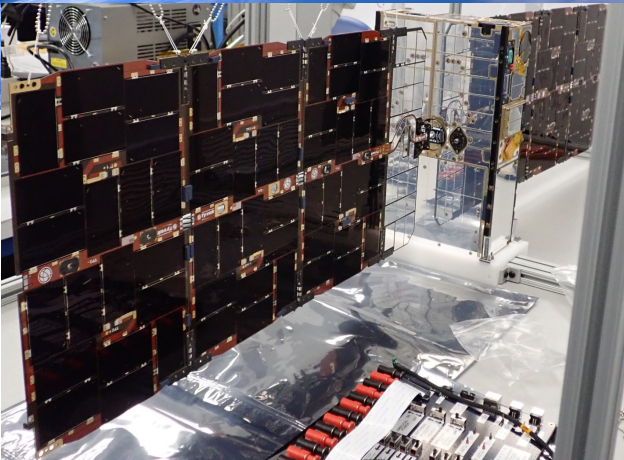
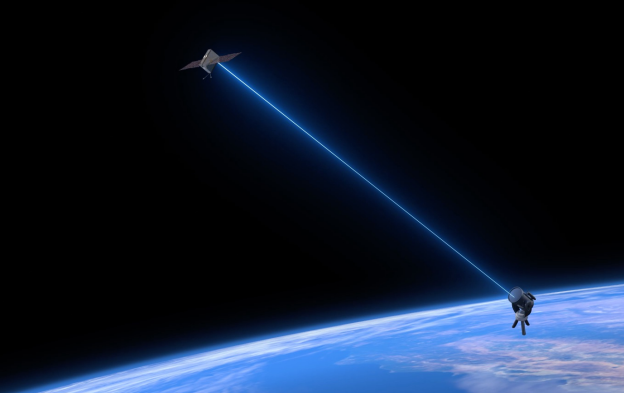
Mission Highlights

- Flight operations from Jan – May, 2021
- Demonstrated electrolysis of water into H₂ and O₂
- Demonstrated successful hotfire of thruster
 - Thrust identified by PTD IMU
- Extended Mission Operations
 - Flight test of PTD-3 ADCS algorithms
 - Demonstration of code uploads on PTD spacecraft





PTD-3 Mission Overview



Pathfinder Technology Demonstrator – 3 (PTD-3) *TeraByte InfraRed Delivery (TBIRD)*

Launched May 25, 2022, SpaceX Transporter-5 mission

Metric	Target
Form-factor	CubeSat compatible
Data Rate	200 Gbps: Achieved
Pass Data Vol	>2 TB/pass: Exceeded
Ground Station	To date: JPL/OCTL (1 m)/ Fall 2023; OGS-2 LCRD: Haleakala, HI
High-rate buffer & transceiver electronics	
Transceiver design leverage's COTS Parts	

PTD-3/TBIRD is a collaborative effort between NASA, *Massachusetts Institute of Technology Lincoln Laboratory*, and *Terran Orbital Corporation*. Animation Credit: NASA / Image Credit: Terran Orbital Corporation



PTD-3 T-BIRD – MISSION STATUS



Pathfinder Technology Demonstrator – 3 *TeraByte InfraRed Delivery (TBIRD)*

Mission Objective: Demonstrate high data optical downlink rate

Milestone	Date
Payload Delivered	January 2022
Launch	May 25, 2022
First Light:	June 28, 2022
100Gbps: (0.65TB in a single pass)	June 30, 2022
200 Gbps (3.6TB pass)	April 28, 2023
> 4.8 TB single pass	May 17 th , 2023
Life Demonstration	18 months in space to date

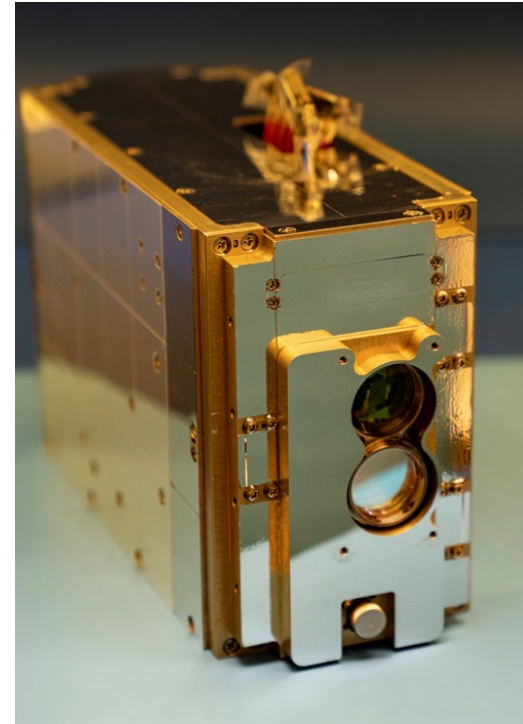


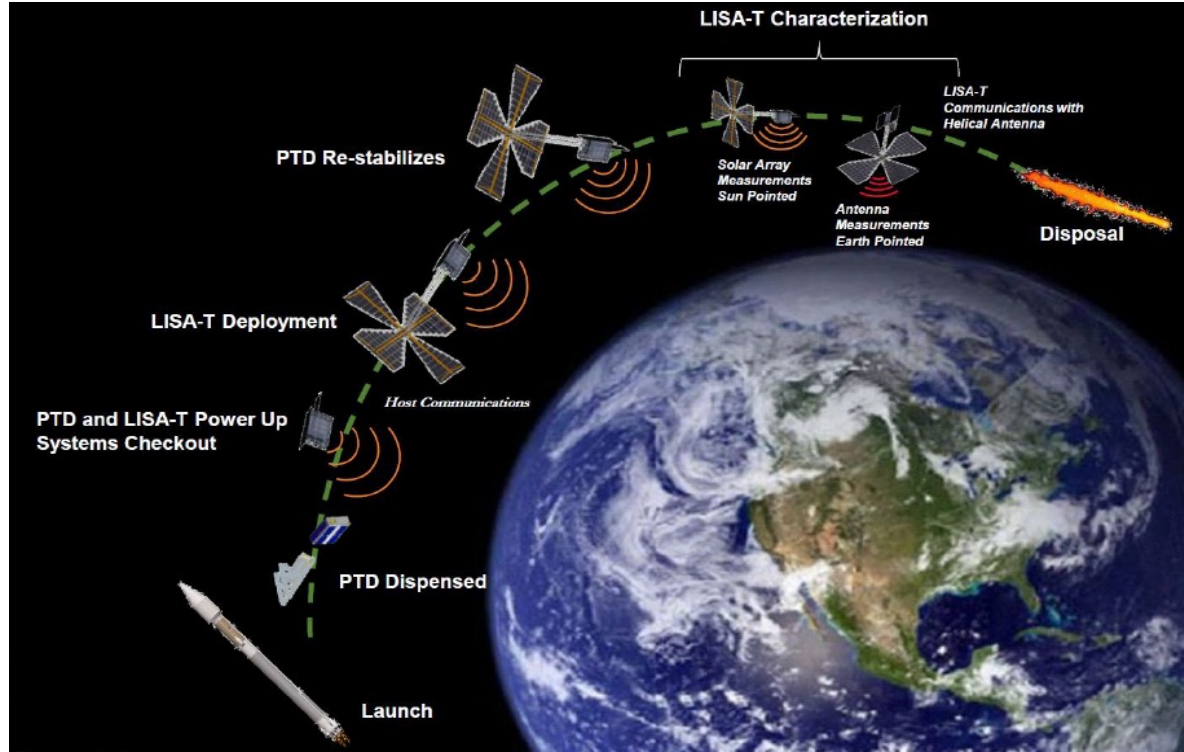
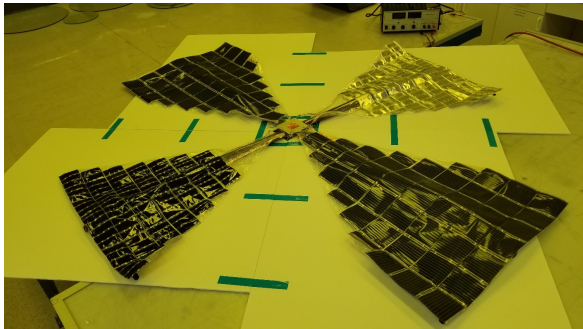
Image Credit: Massachusetts Institute of Technology Lincoln Laboratory



PTD-4: LIGHTWEIGHT INTEGRATED SOLAR ARRAY AND TRANSCEIVER



Metric	Target
Stowed Form-factor	0.6U, 0.85 kg
RF Band	Ka
Power Density	>300 W/kg achievable
Power/Volume Ratio	>400 W/m ³ achievable
4 Petal Planar Array	



John Carr, LISA-T Project Manager (john.carr@nasa.gov)



DEEP PURPLE PAYLOAD FOR PTD-R

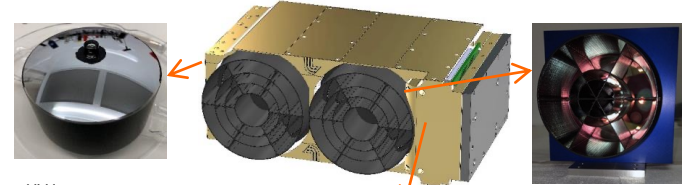
PTD-R will demonstrate a new type of UV and SWIR Telescope that may be used in a wide range of applications

Description

- Two co-boresighted imaging channels
 - UV: 220-280nm
 - VIS/SWIR: 500-1700nm
- Fixed focus
- Standard USB3 interfaces
- Two-piece carbon fiber housing for mass savings & thermal stability

Objectives

- Technology maturation
 - 1st flight demonstration of UV and SWIR monolithic telescopes
 - 1st flight demonstration of UV optimized CMOS sensor
 - 1st flight demonstration of small pixel InGaAs sensor
 - 1st flight demonstration of compact electronics module
 - 1st flight demonstration of carbon fiber monolithic telescope housing
- Mission area capability demonstrations
 - Synoptic monitoring of UV star intensity fluctuations
 - UV and SWIR signatures of hypersonic vehicles from space



UV Imager

- V3 monolithic optic
- Sony IMX487 UV camera
- 230-280nm bandpass filter

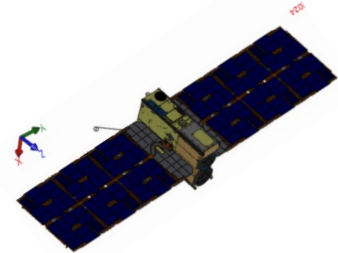
Payload Electronics integrated into unit providing image processing and control

VIS/SWIR Imager

- V3 monolithic optic
- Sony IMX990 InGaAs camera
- 500-1700 nm range

PAYLOAD PROPERTIES	UV	VIS/SWIR
Boresight body axis	Z	Z
Telescope	V3U	V3S
Clear aperture (cm)	8.5	8.5
Focal ratio (f-number)	f/3.6	f/3.6
focal length (m)	0.306	0.306
Obscuration by area (%)	12.5	12.5
Light collection area (cm ²)	50	50
Focal plane array	IMX487	IMX990
type	CMOS	InGaAs
pixel pitch (micron)	2.7	5.0
x pixels	2848	1096
y pixels	2848	1032
camera	Alvium Custom	Alvium 1800 U-130
shutter type	Global	Global
max bits	12 bits	12 bits
interface	USB 3.0	USB 3.0
dimensions (mm)	38 x 29 x 29	38 x 29 x 29
mass (g)	65	65
imaging		
IFOV (urad)	8.8	16.3
GSD (m) @ 500km	4.4	8.2
X FOV (degrees)	1.44	1.09
Y FOV (degrees)	1.44	0.97

Total Payload Mass 5kg





SST IS INFUSING KEY NEW TECHNOLOGIES FOR THE SPACE COMMUNITY

- HYDROS (PTD-1) demonstration of water propulsion complete
- TBIRD (PTD-3) flight demonstration of high data rate communications has achieved its level one objectives and is continuing.
- LISA-T (PTD-4) demonstration of compact integrated solar array / antenna flight scheduled for 2024 (Delayed by mishap / redesign)
- Deep Purple, The fourth PTD mission (PTD-R) is at CDR Level: will demonstrate a SWIR/VIS Monolithic Camera (DOE/ LLNL)

