Psyche mission

Lindy Elkins-Tanton (PI)

November 10, 2021

Psyche Mission

Psyche Project

Program:	Discovery, PI-led
Science Goal:	Determine whether (16) Psyche is a core
Classification:	Category 2 (per 7120.5E) Risk Class B (per 8705.4) LV Risk Category 3 (low risk, per 8610.7D)

Lead Organizations

ASU	PI (*Lindy Elkins-Tanton*) and Deputy PI (*Jim Bell*) Multispectral Imager, Science Data Center
JPL	Project Mgmt, Flight System, SI&T, S&MA, Mission Ops
MAXAR	Solar Electric Propulsion (SEP) Chassis

Partners

JOHNS HOPKINS APPLIED PHYSICS LABORATORY	Gamma-Ray and Neutron Spectrometer
Malin Space Science Systems	Multispectral Imager
MIT DTU	Magnetometer and Gravity Science
NASA SPACEX	Falcon Heavy Launch Vehicle
NASA JPL	Deep Space Optical Communications *Tech Demo*

Science

Objective A: Determine whether Psyche is a core, or if it is unmelted material

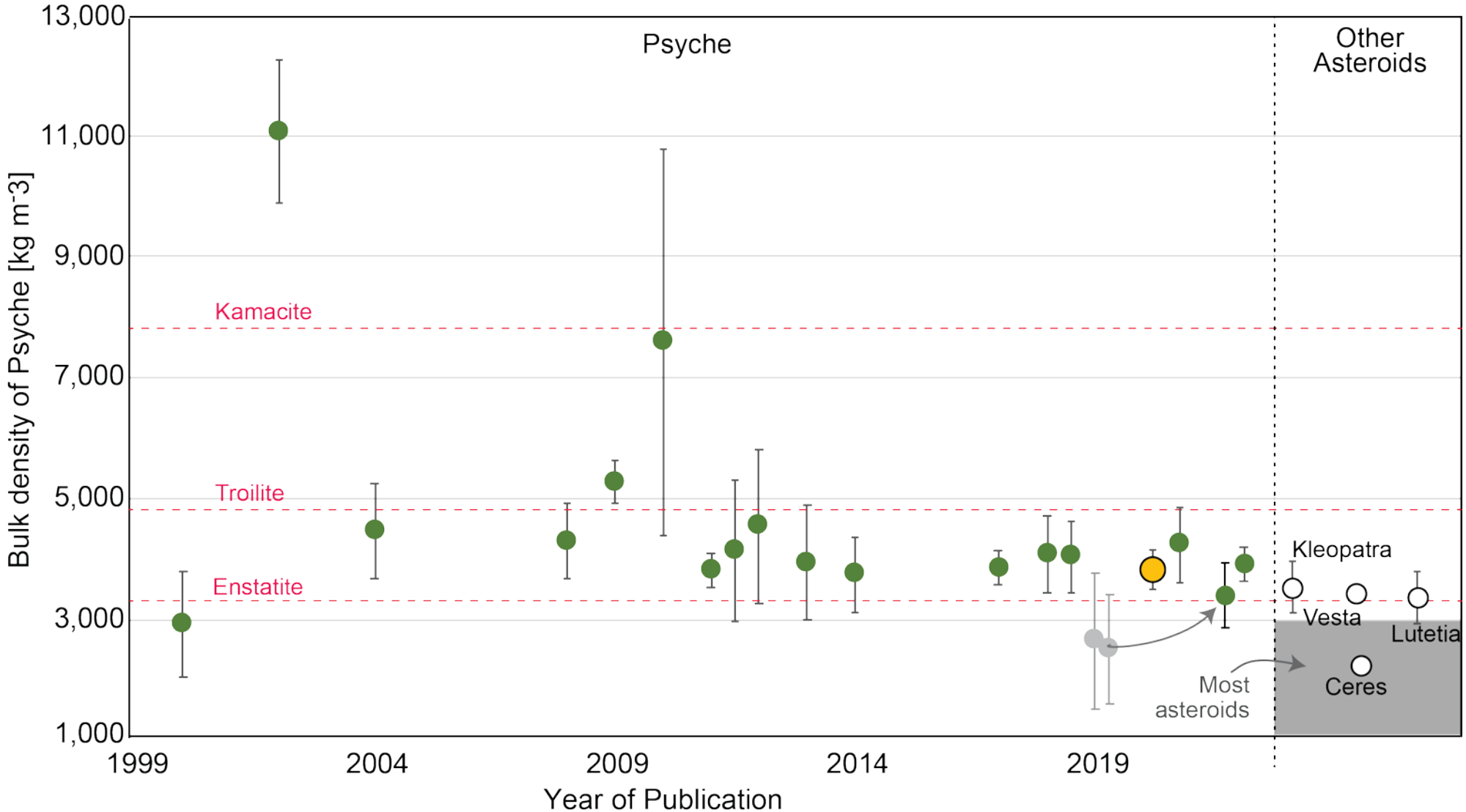
Psyche's bulk density appears to be between 3,700 kg m^{-3} and 4,200 kg m^{-3}.

Prediction: between ~25 and 60 vol% metal

From thermal, radar, and spectral data, surface appears to be fine-grained metal

Spectra indicate very low FeO content in the rock portion

Prediction: May be a low-Fe, low-Ca pyroxene, or may not be silicate rocks

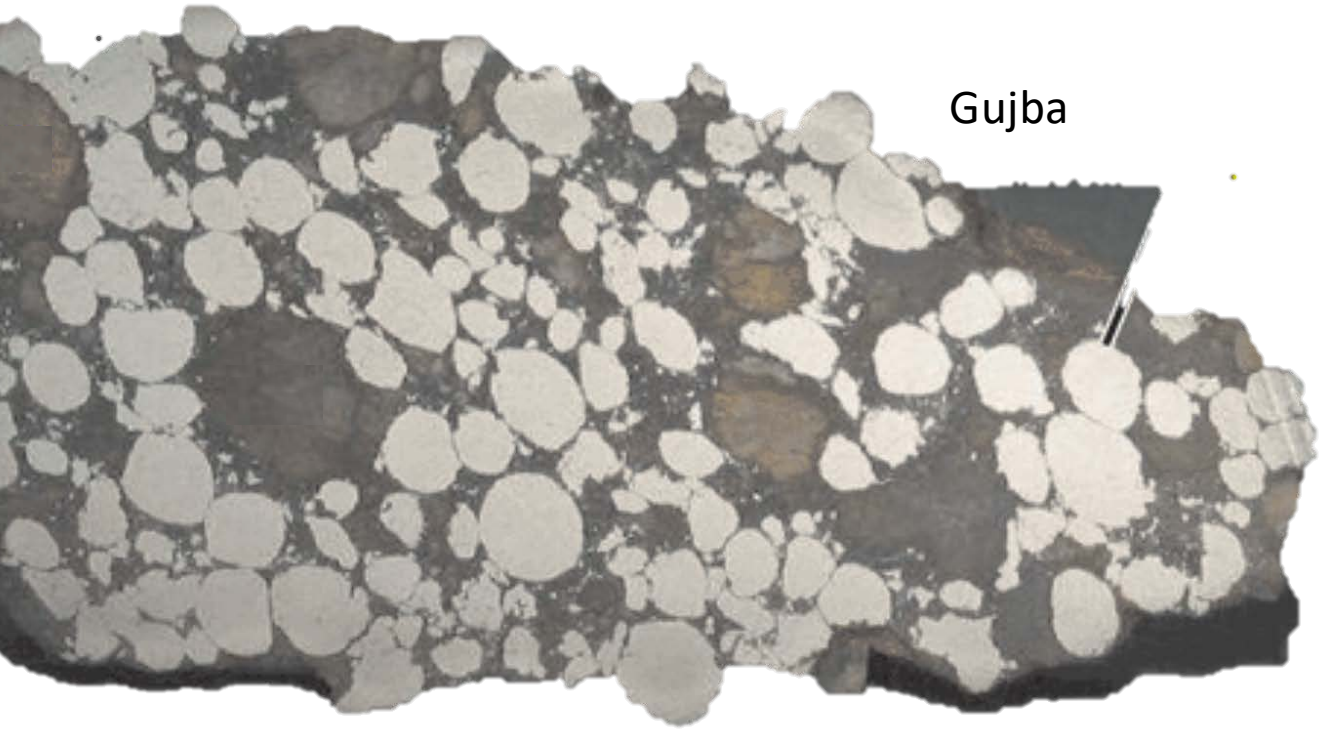


Elkins-Tanton et al., in revision

Meteorites that match Psyche's spectra:

CB Chondrites
Meteoritic iron + troilite (FeS) + low-FeO enstatite
Dibb et al. in prep.

Gujba



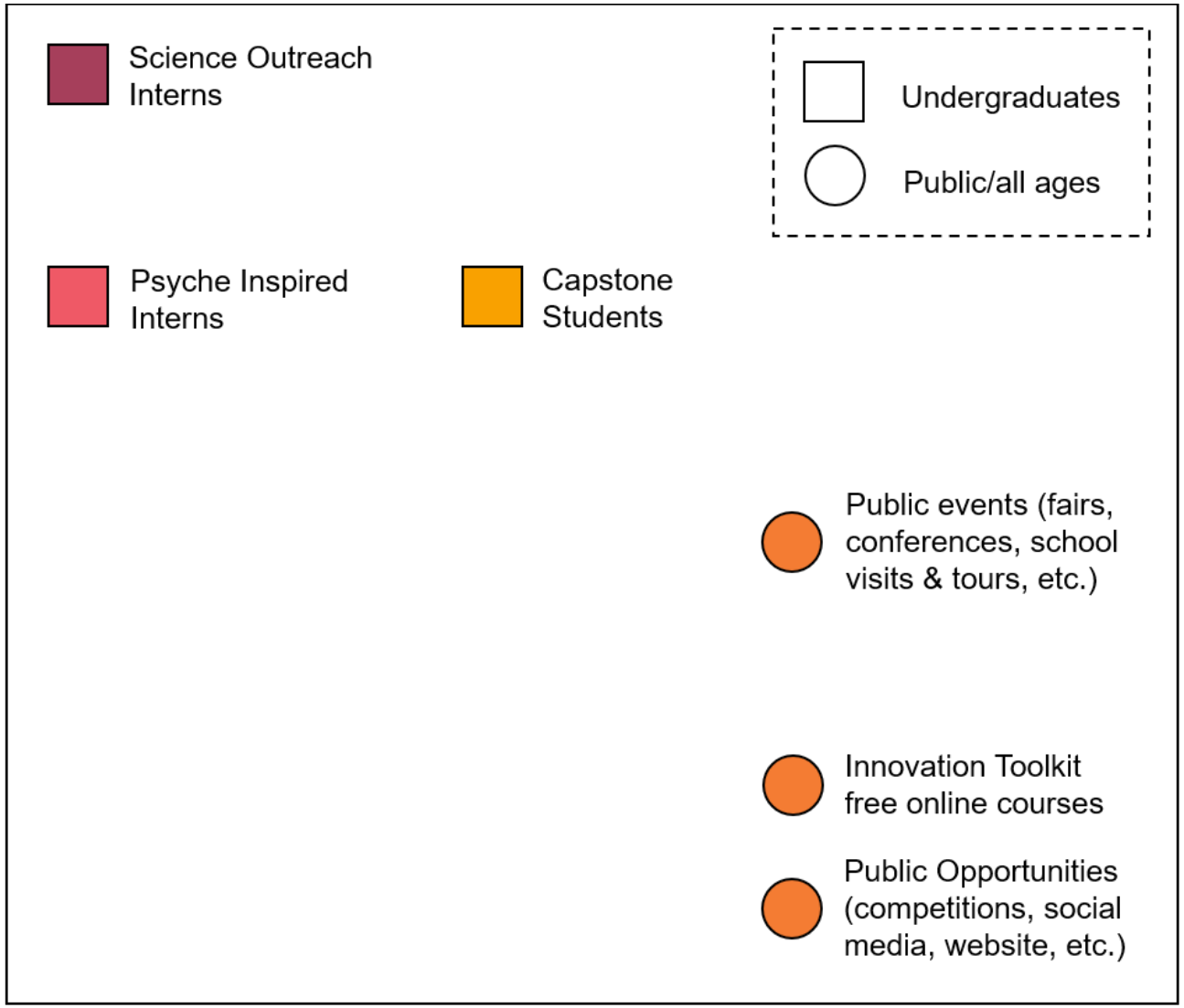
Isheyevo

Krot et al., 2005

Student collaborations

Student Collaborations

1:1 with team member



Asynchronous

Tens of students/year

Thousands/yr

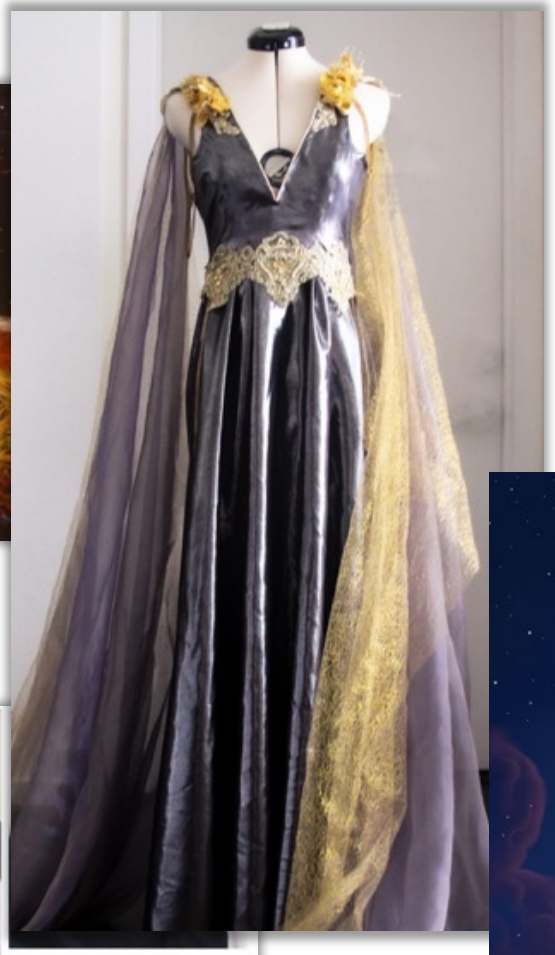
Student Collaborations

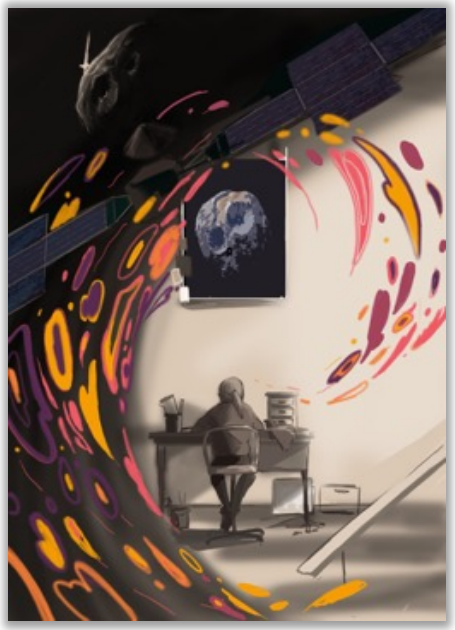
1,201 undergraduate students to date from 50+ institutions

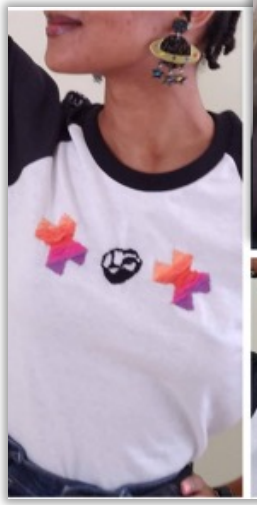
~4,000 people have taken our free online courses

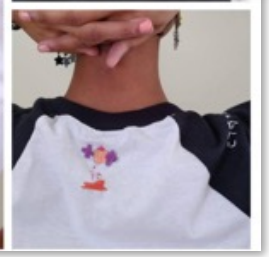
Cassie Bowman, NASA Psyche mission

Psyche Inspired









Cassie Bowman, NASA Psyche mission

Project status

IEEE aerospace (2022) *in review*

Psyche Project Implementation During the COVID Pandemic

Jennifer Maxwell, Neil Dahya, Travis Imken, Robert Mase, David Oh,
Melody Safavizadeh, Benjamin Solish, Henry Stone
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Robert.A.Mase@jpl.nasa.gov, David.Oh@jpl.nasa.gov, Melody.Safavizadeh@jpl.nasa.gov,
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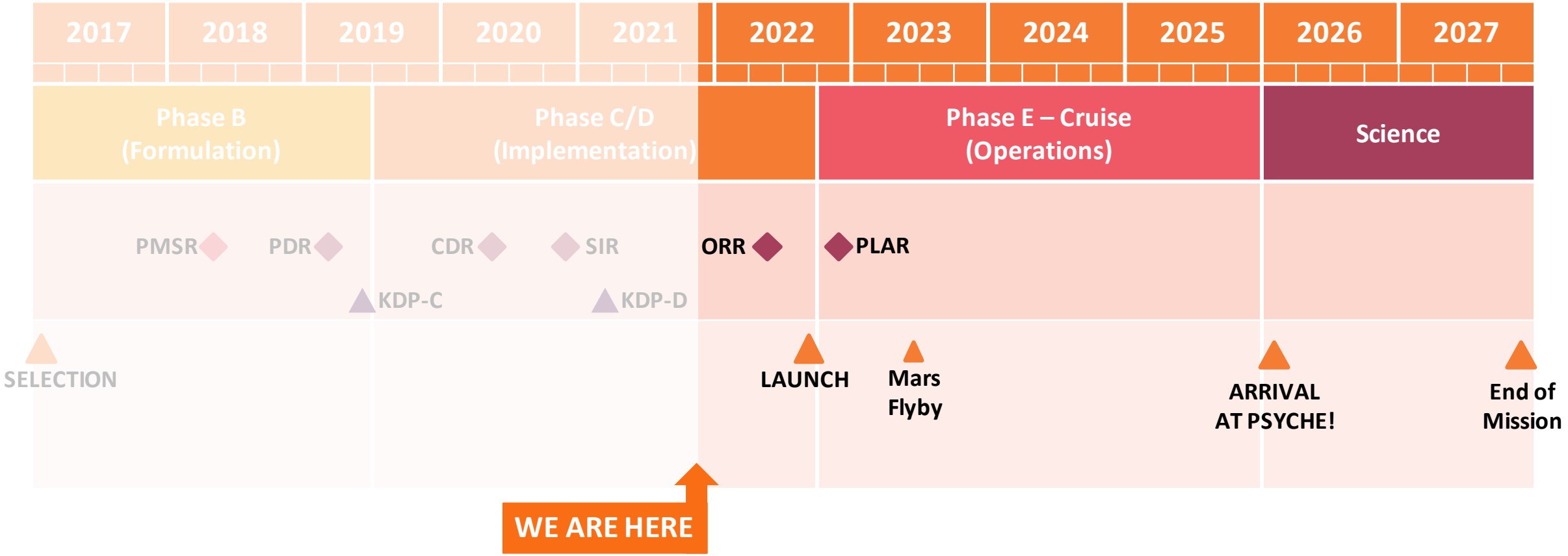
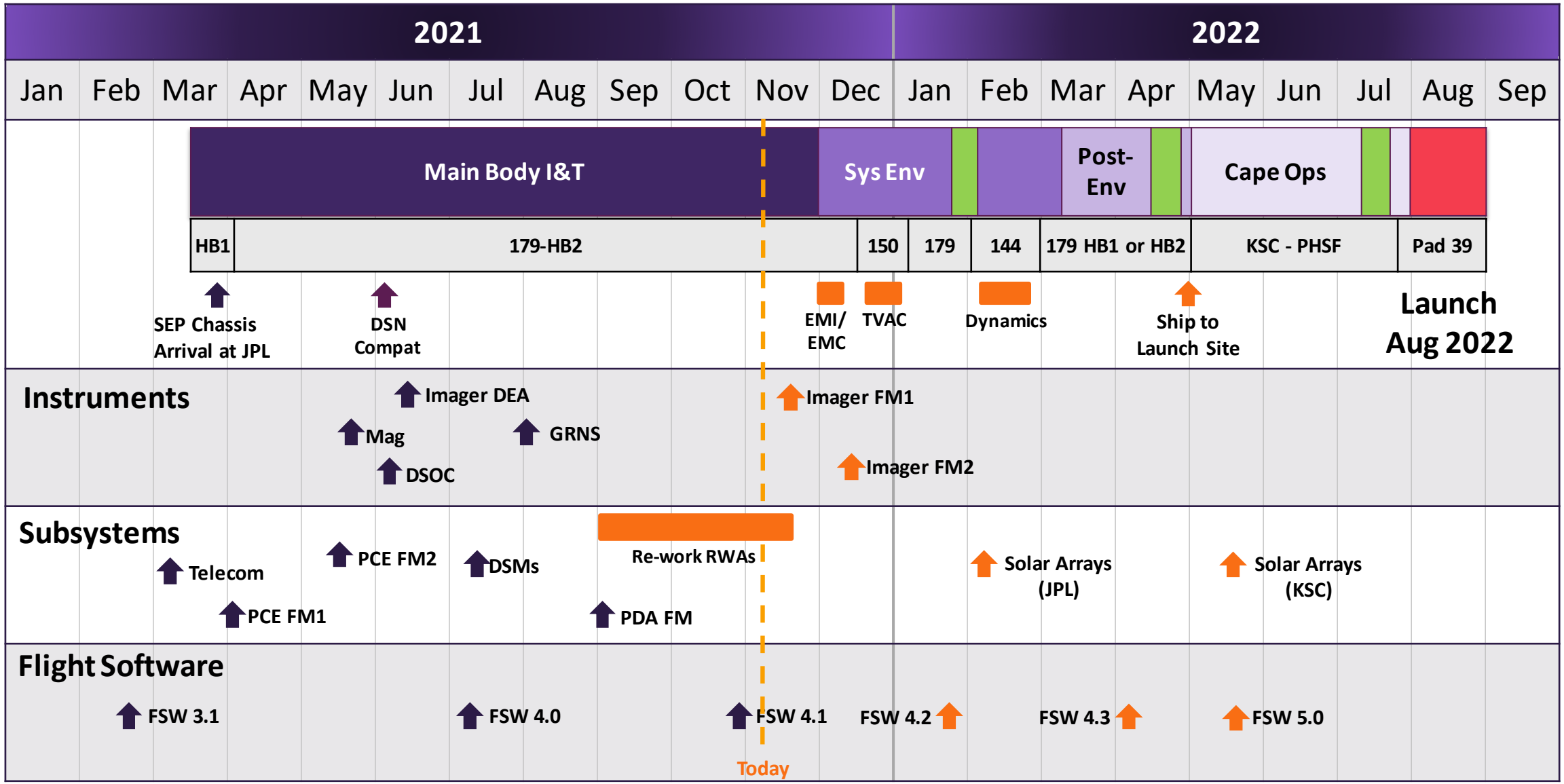
Less Than A Year to Launch!



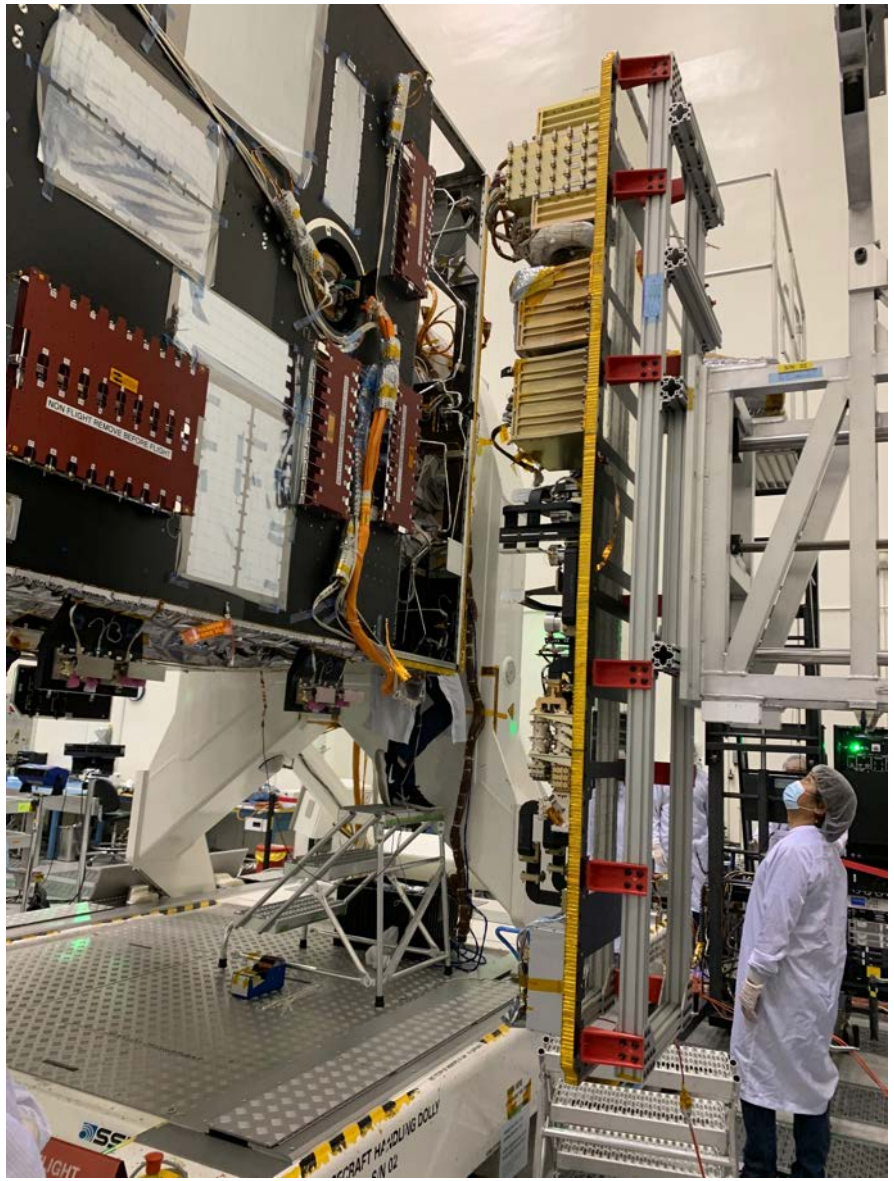
9 months to Launch!

Timeline to Launch

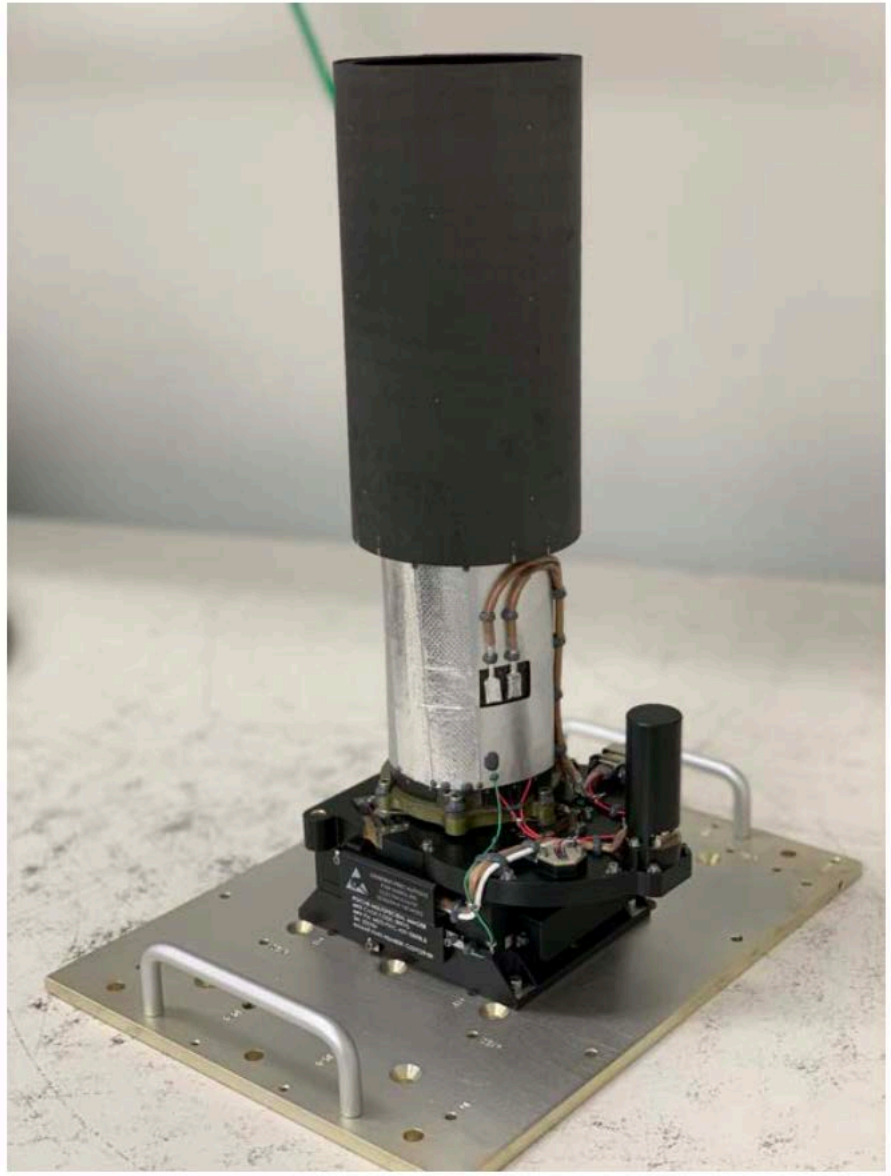


SEP Chassis Arrives at JPL (March 2021)

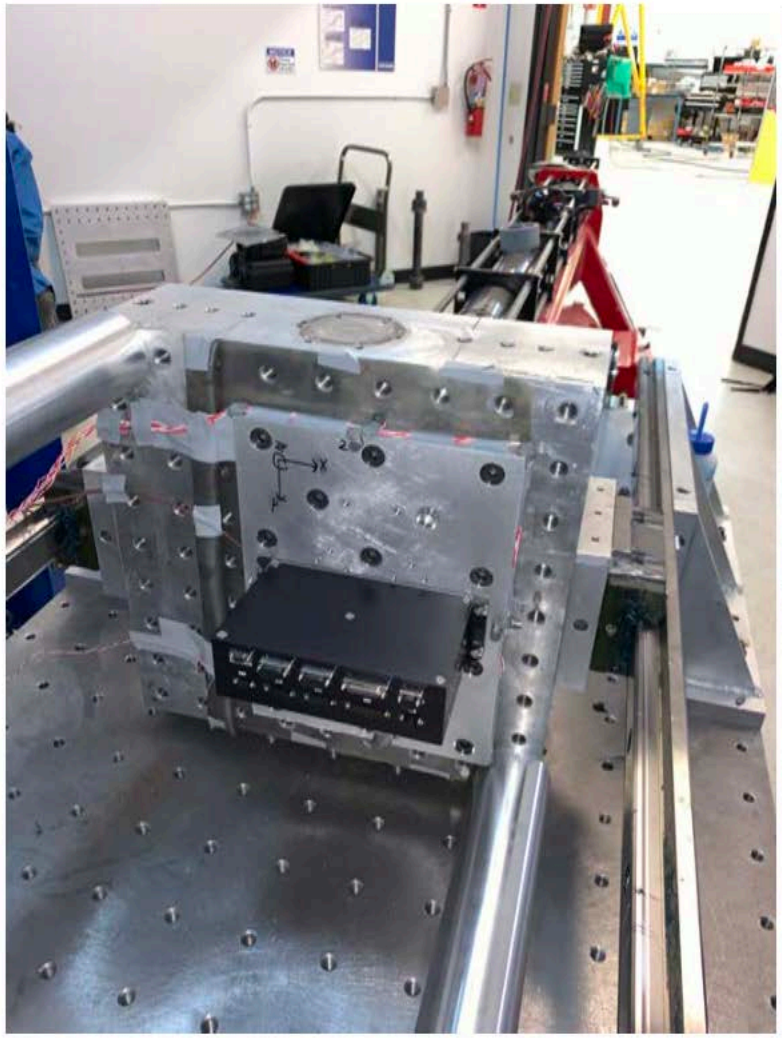
Avionics and Telecom Systems Installed (April 2021)



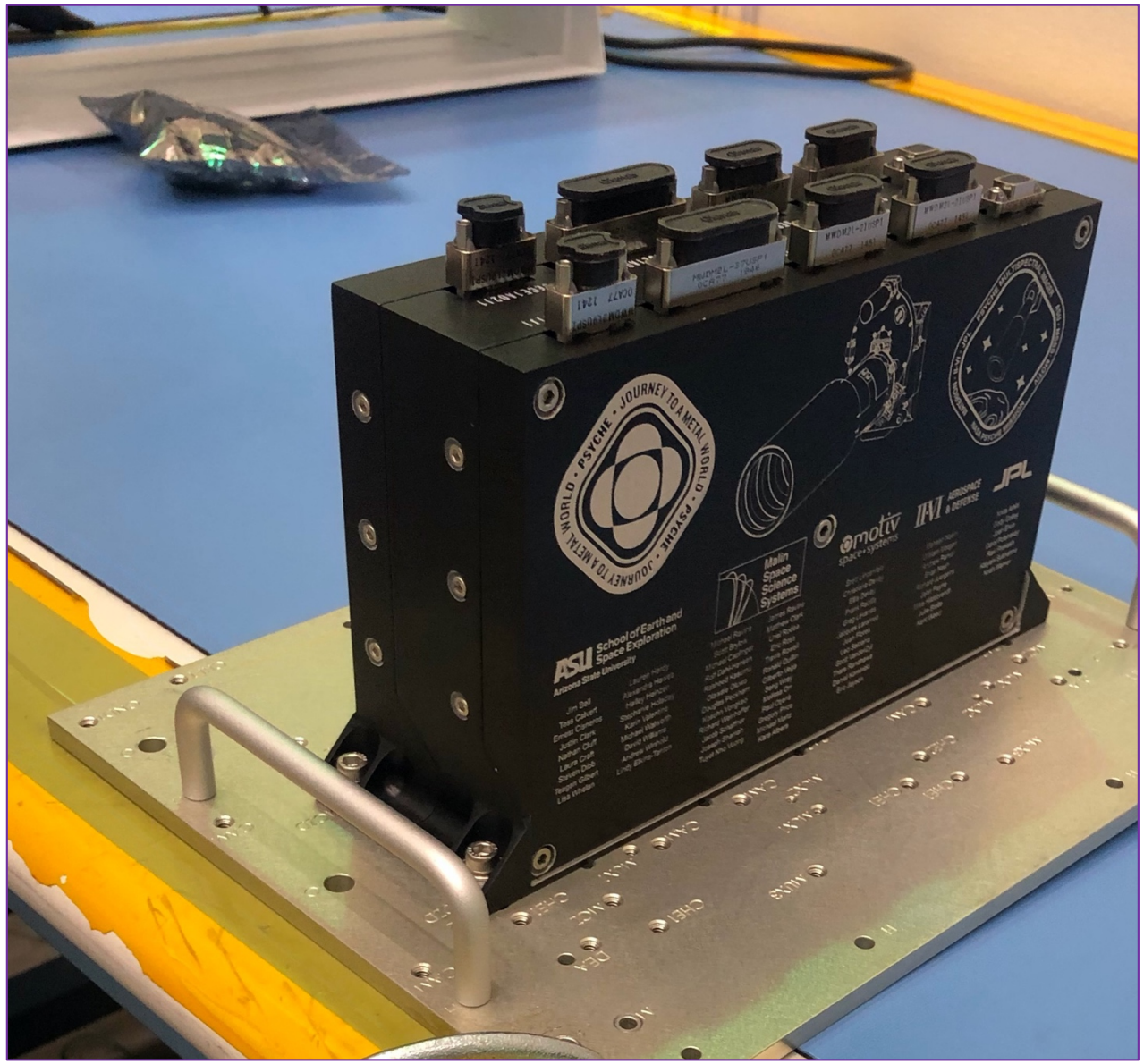
Imager – Engineering Qualification Model (April 2021)



In Pyroshock testing at Moog

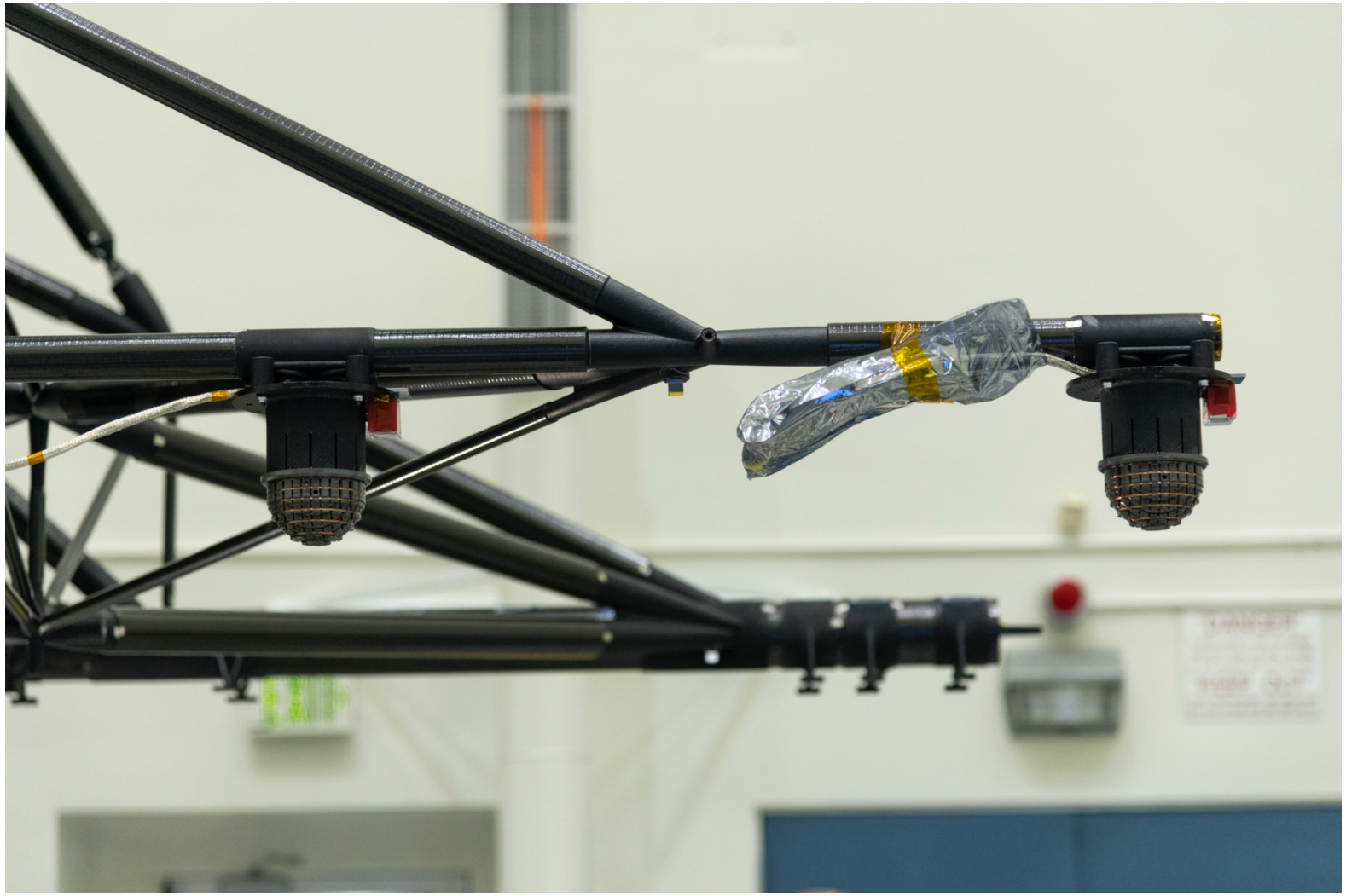


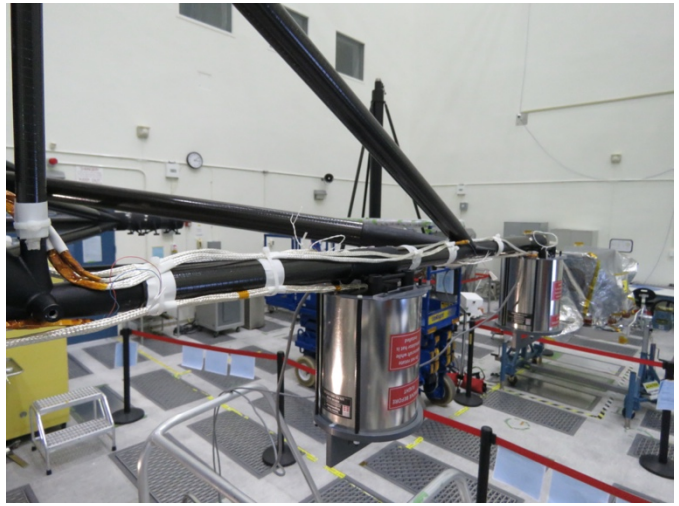
Imager Flight Electronics Installed (May 2021)



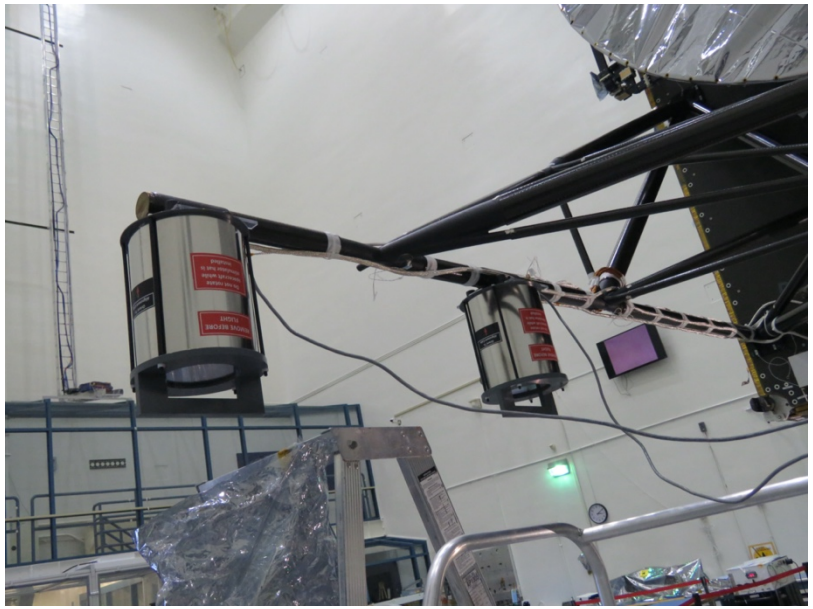
Magnetometers (FM1 and FM2) Delivered to JPL (May 2021)

Magnetometers Installed on the Spacecraft





MAG Harness Routing

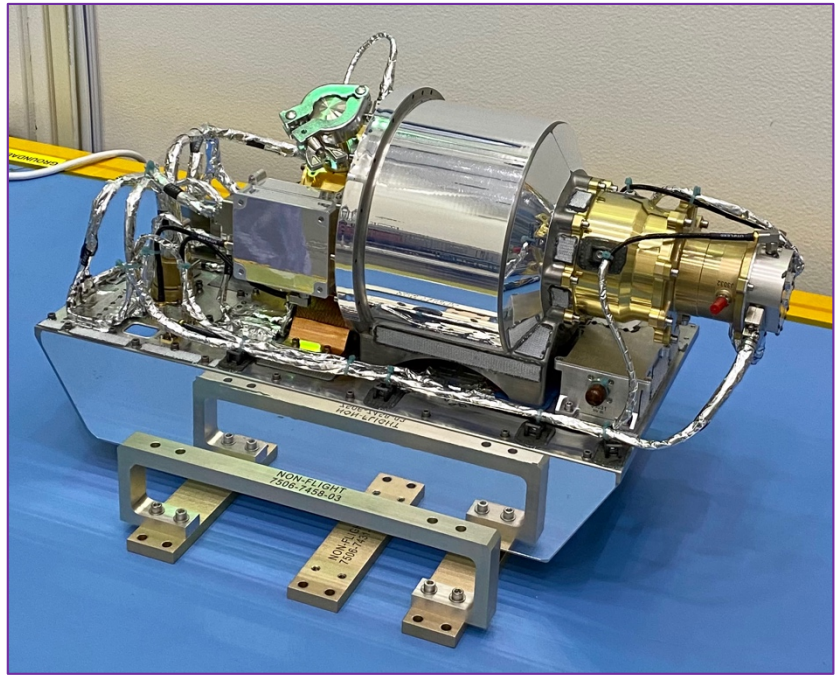


MAG with stimulators installed

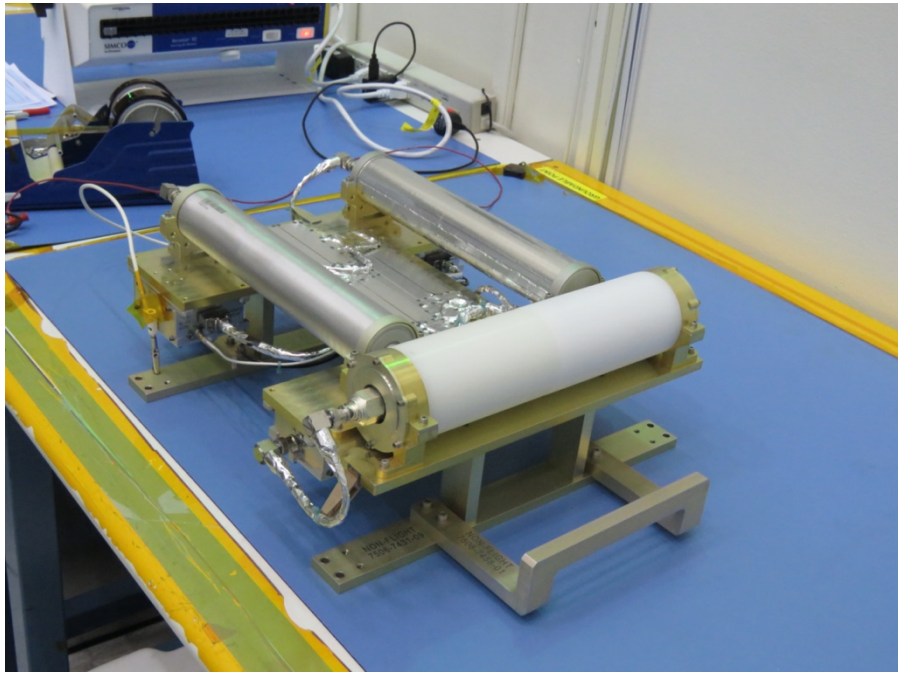
Deep Space Optical Comm (Tech Demo) Installed (July 2021)

One Year to Launch (Aug 2021)

GRNS Delivered (Aug 2021)



Gamma Ray Spectrometer

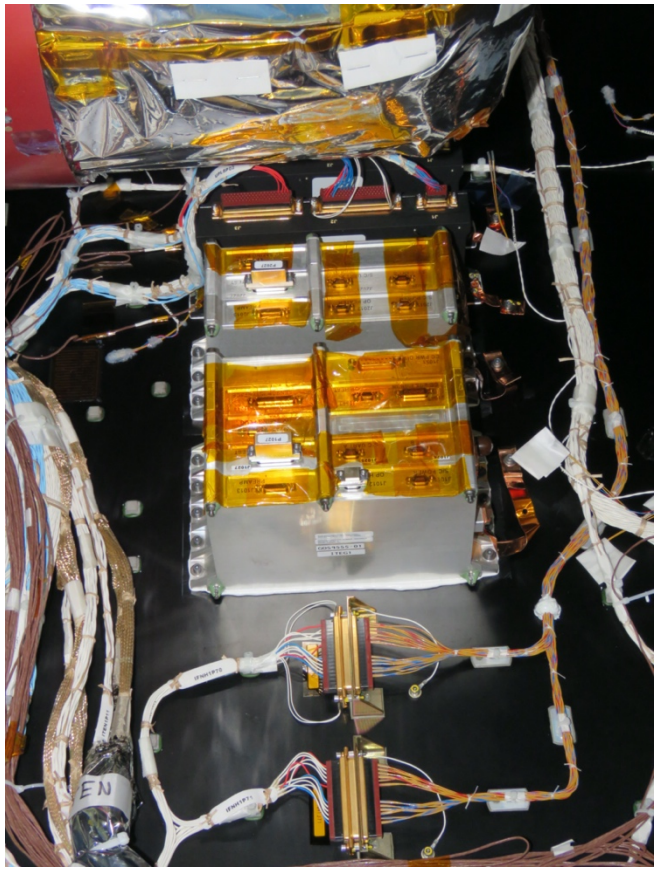


Neutron Spectrometers

GRNS Installed (Aug 2021)

Sensors

Electronics



Hall Thrusters Installed (Aug 2021)

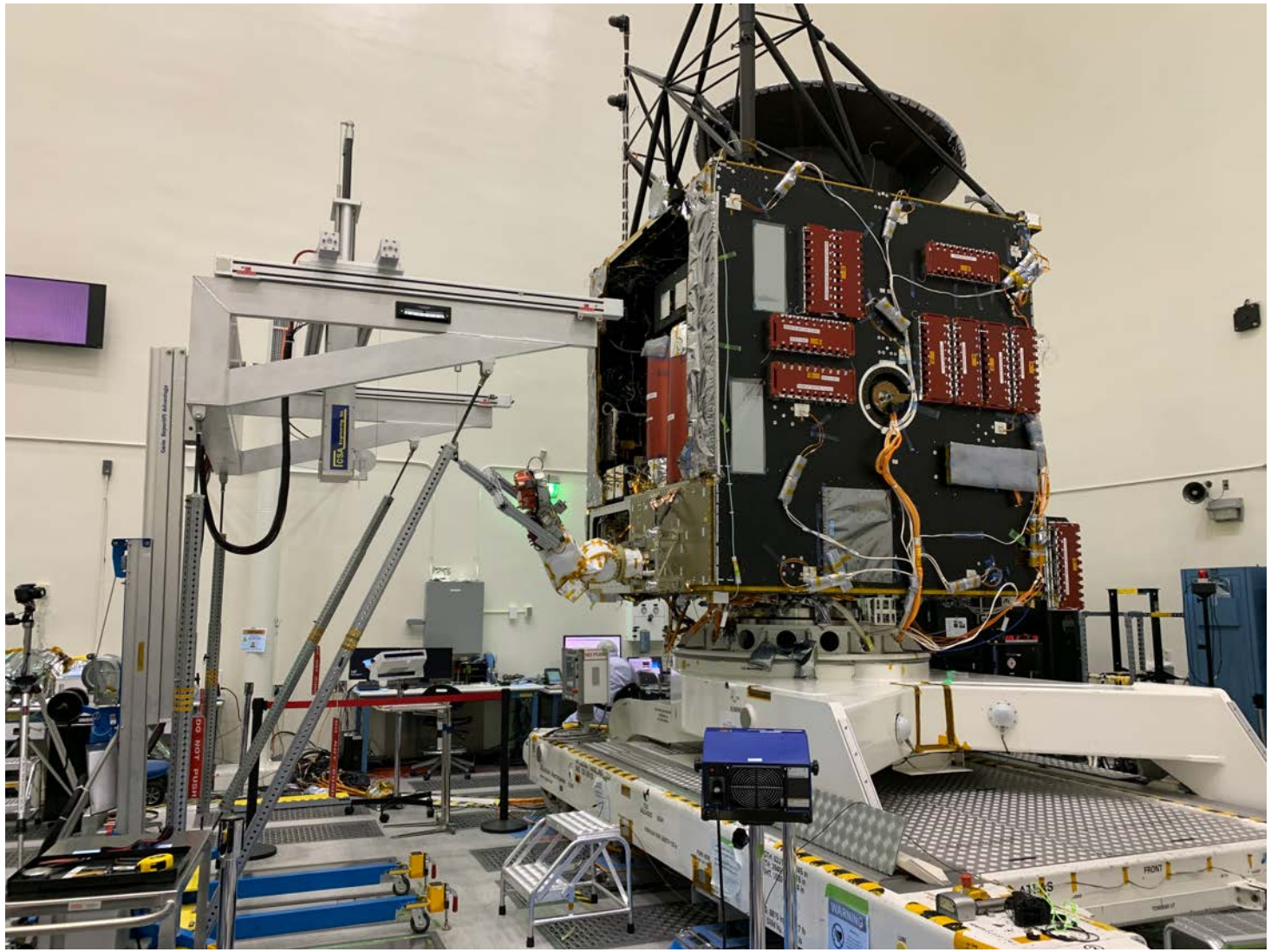
Solar Electric Propulsion Makes NASA's Psyche Spacecraft Go

NASA's Psyche spacecraft is photographed in July 2021 during the mission's assembly, test, and launch operations phase at JPL. Hall thrusters – two of which are visible beneath red round protective covers – will propel the spacecraft to its target in the main asteroid belt.
Credits: NASA/JPL-Caltech

Engineers at NASA's Jet Propulsion Laboratory work to integrate Hall thrusters into the agency's Psyche spacecraft in July 2021. One of the thrusters is visible on the side of the spacecraft underneath a red protective cover.
Credits: NASA/JPL-Caltech

At NASA's Jet Propulsion Laboratory, engineers prepare to integrate four Hall thrusters (beneath the red protective covers) onto the agency's Psyche spacecraft. The thrusters will propel Psyche to its target in the main asteroid belt.
Credits: NASA/JPL-Caltech

Articulating the Hall Thrusters (Aug 2021)



Psyche In The News (Oct 2021)

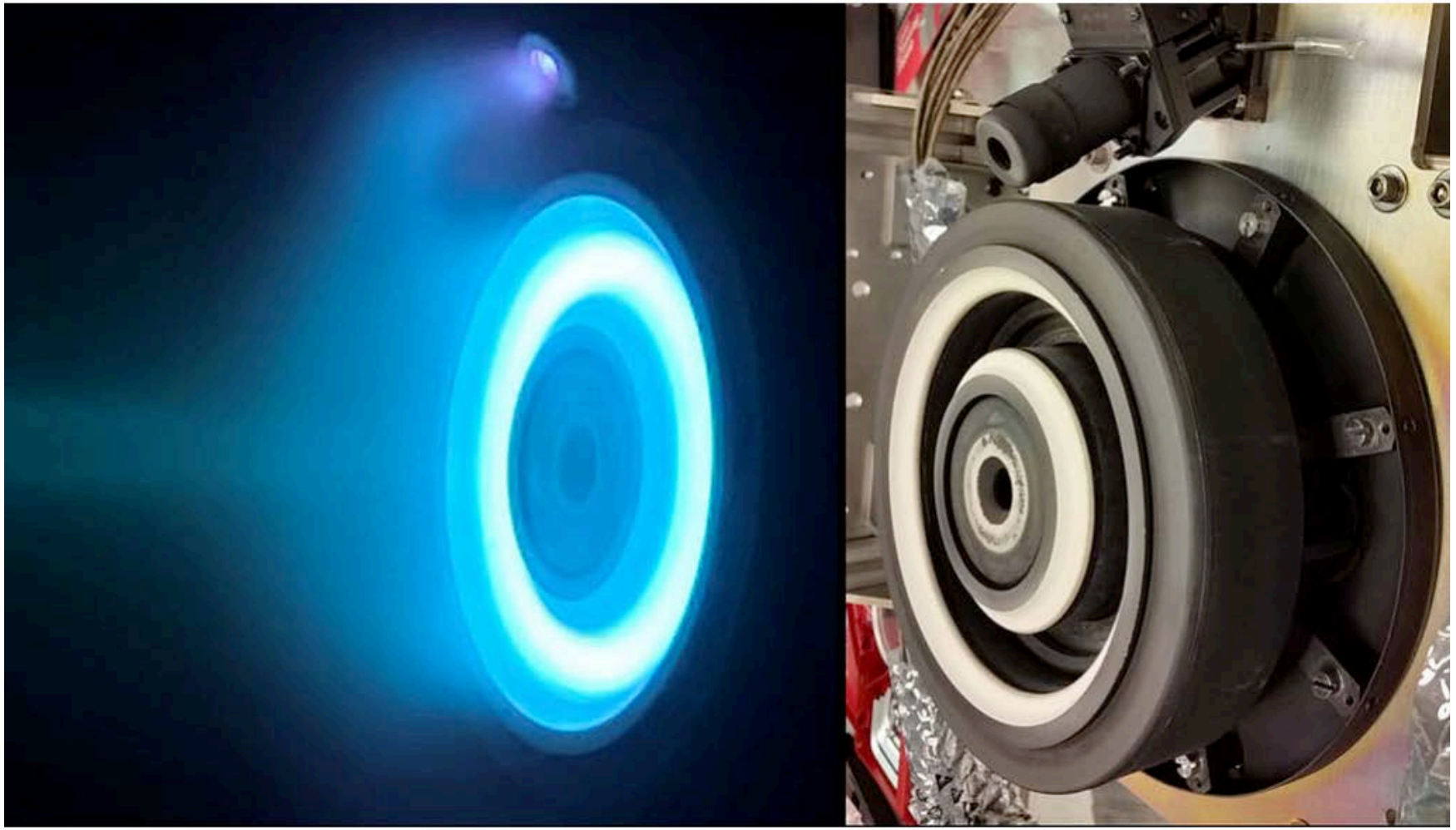
Science of Psyche: Unique Asteroid Holds Clues to Early Solar System

At NASA's Jet Propulsion Laboratory, engineers integrate a gamma ray and neutron spectrometer into the agency's Psyche spacecraft. The instrument will help determine the elements that make up its target, an asteroid also named Psyche.
Credits: NASA/JPL-Caltech

Engineers at NASA's Jet Propulsion Laboratory in Southern California integrate the magnetometer instrument into the agency's Psyche spacecraft on June 28, 2021. The instrument will help determine if the Psyche asteroid is part of a planetesimal, the building block of an early planet.
Credits: NASA/JPL-Caltech

NASA Image Of The Day (Oct 2021)

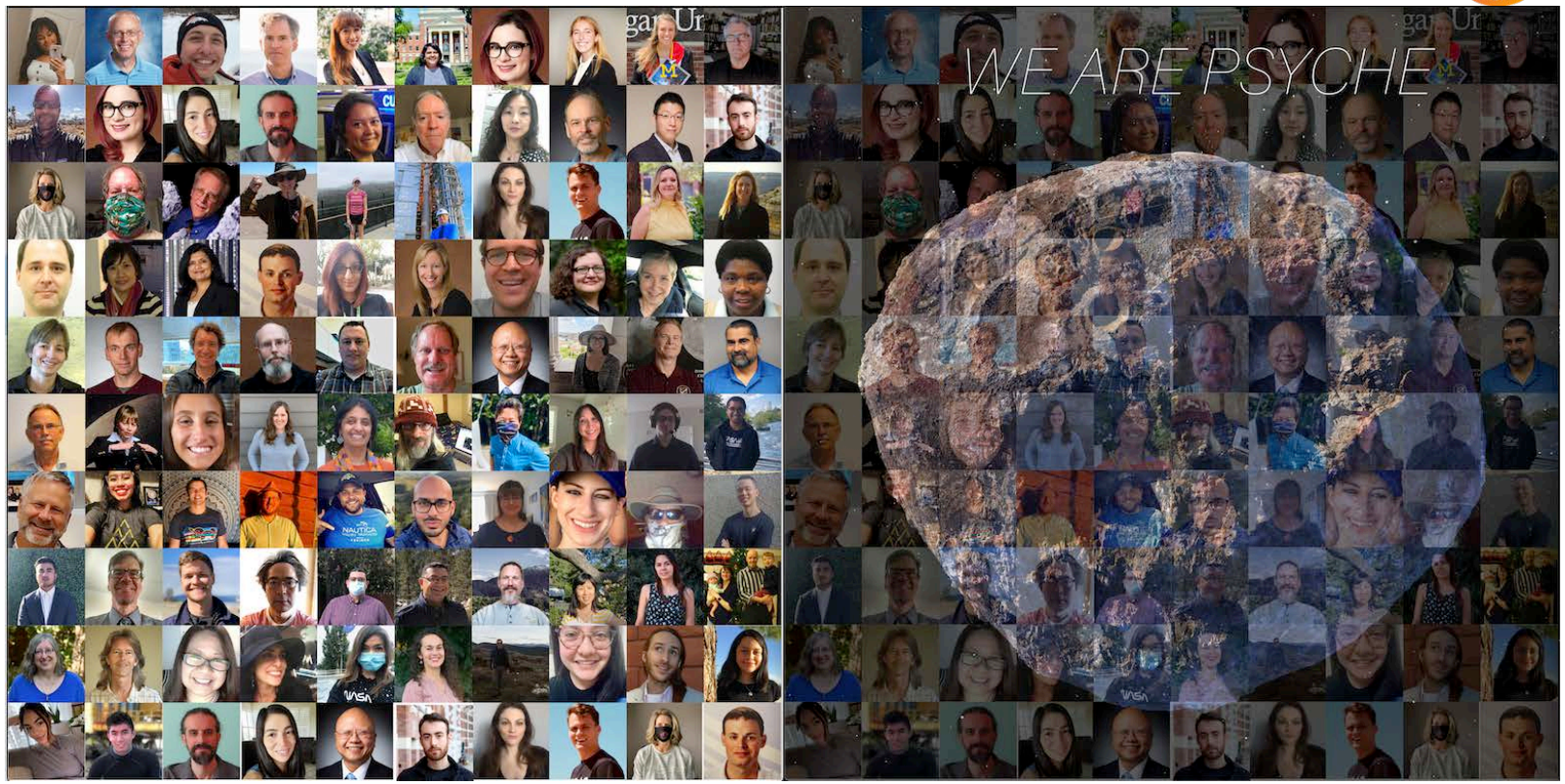
Psyche Mission to an Asteroid: Electric Propulsion Comes of Age



Preparing for System Environmental Testing (Oct 2021)

Lindy Visits the Testbeds and the Spacecraft

The Psyche Team



Psyche Payload Deliveries

Payload Element	PSR (IDR/HRCR) Date	Delivery Date/Due Date	Status
Imager DEA	April 23, 2021	May 4, 2021	Complete
DSOC SEM/LTA/Harness	April 28, 2021	June 14, 2021	Complete
MAG FM1/FM2	May 19, 21, 2021	May 22, 2021	Complete
DSOC COPA	May 27, 2021	June 14, 2021	Complete
GRNS	July 26-27, 2021	Aug 2, 2021 (arrival at JPL)	Complete
Baby Sara de Soria		August 22, 2021	Complete
Imager CH	November 2021 (TBC)	November 2021 (TBC)	
Baby Girl Amiri		October 14, 2021	

Mila

Sara

Brian Bone and Lindy Inspecting The Spacecraft (Apr 2021)

Additional Information

Project Organization

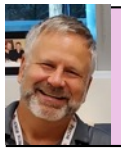
NASA	MAXAR
ASU	APL
JPL	DTU

Science Mission Directorate (SMD)
Planetary Science Division (PSD)
Planetary Missions Program Office (PMPO)

Project Advisory Board
ASU, JPL, Maxar

Principal Investigator
PI, *L. Elkins-Tanton*
Deputy PI, *J. Bell*

Science Team
(various locations)



Project Office
Manager, *H. Stone*
Deputy Manager, *R. Mase*
Project Scientist, *C. Polanskey*

Project System Engineering
PSE/ETA, *D. Oh*
Deputy PSE, *J. Maxwell*

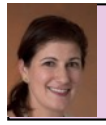
Business Office
Manager, *B. Johnson*

Safety and Mission Assurance
MAM/SMA TA, *R. Menke*
Deputy MAM, *D. Michaels*

Payload Office
Manager, *K. Sukhatme*
Deputy Manager, *N. Warner*

DSOC Accommodation
Manager, *K. Sukhatme*

Flight System Office
Manager, *M. Brown*
Deputy Manager, *N. Dahya*



Mission System Office
Manager, *D. Bass*
Deputy Manager, *T. Weise*

System Engineering
J. Ervin

Imager
Mgr, *J. Bell*

GRNS
Mgr, *M. Cully*

MAG
Mgr, *J. Jørgensen*

System Engineering
R. Prakash

DSOC
Mgr, *W. Klipstein*

Power
PDM, *E. Merida*

Avionics
PDM, *B. Theberge*

Telecom
PDM, *K. Bruvold*

GN&C
PDM, *S. Lisman*

FS System Engineering
FSSE, *P. Meakin*
Dep FSSE, *D. Marsh*
Dep FSSE, *S. Malone*

SEP Chassis
Mgr, *S. Scott*
Dep, *P. Lord*

System I&T
Mgr, *B. Bone*

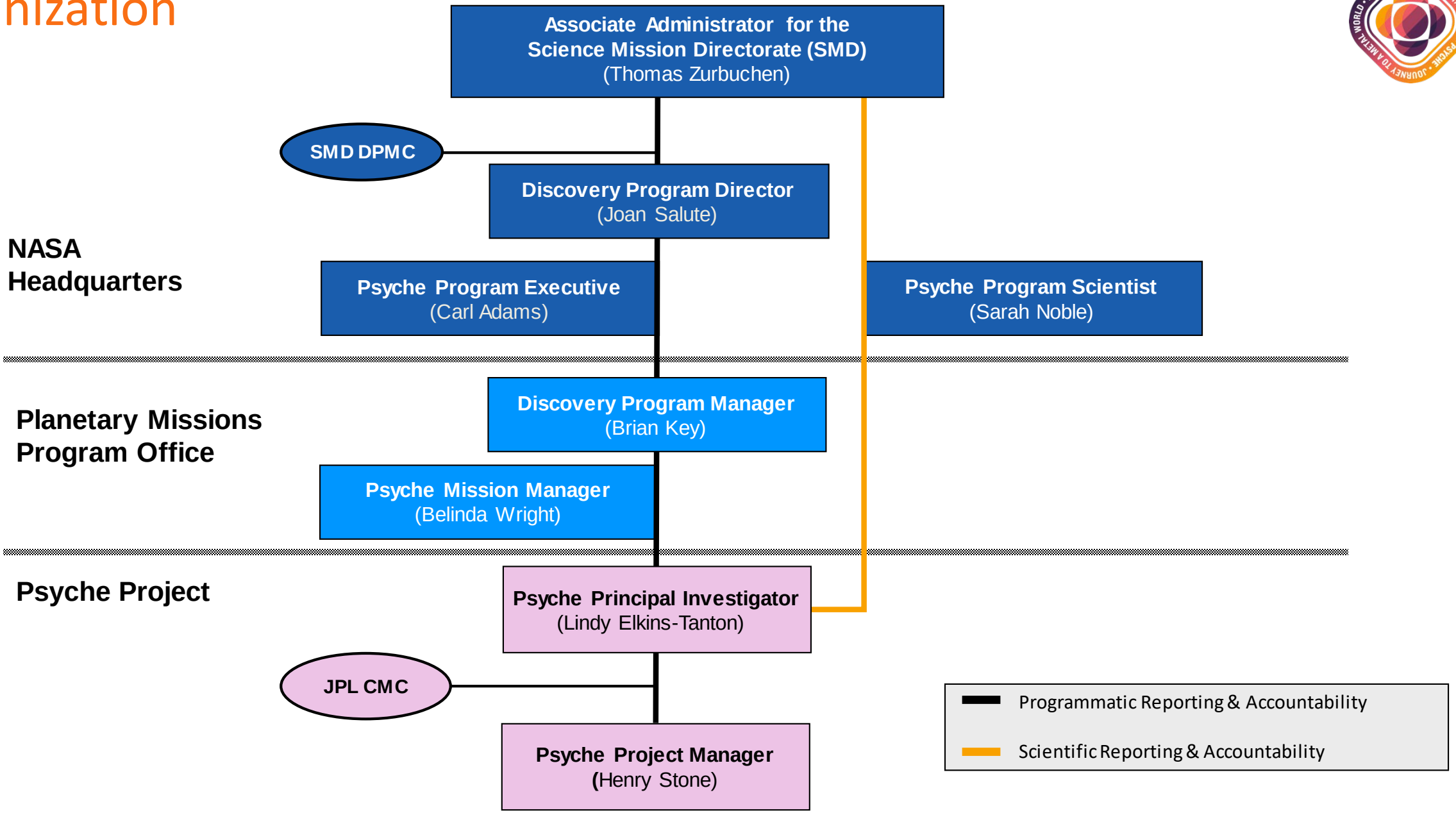
MOS
MOSE, *D. Seal*

GDS
Mgr, *M. Thornton*

SDC
Mgr, *E. Cisneros*

MDNAV
Mgr, *D. Han*

Organization



Partners, Roles & Responsibilities

Primary Lead Organizations	
Arizona State University	PI and Deputy PI, Communications and Outreach Multispectral Imager Development and Operations, Science Data Center
Jet Propulsion Laboratory, California Institute of Technology	Project Management, Mission Assurance Flight System Development, Integration, and Test Mission and Science Operations
MAXAR	SEP Chassis Provider
Science, Instrument, and Strategic Partners	
Malin Space Science Systems	Psyche Multispectral Imager (PMI) Provider
Johns Hopkins Applied Physics Laboratory	Gamma Ray and Neutron Spectrometer Development and Operations
Massachusetts Institute of Technology	Magnetometer Science and Operations Gravity Science
Technical University of Denmark	Magnetometer Provider
NASA	Deep Space Optical Communications (DSOC) Tech Demo Solar Electric Propulsion and Power System Technical Consulting (GRC)
NASA SpaceX	Launch Services – LSP (KSC) Falcon Heavy Launch Vehicle Provider - SpaceX

Key Recent Accomplishments

System Integration Review	Dec 2020
KDP-D	Jan 2021
Began System I&T (ATLO)	March 2021
SEP Chassis shipped from Maxar to JPL	March 2021
Received Magnetometers	May 2021, now integrated
Received the DSOC Technology Demonstration	Jun 2021, now integrated
Received GRNS instrument	Aug 2021, now integrated

Science Payload

Multispectral Imager

- ASU lead/MSSS built
- Redundant units
- MSL Mastcam & MCO MARCI heritage

2 Imagers

Digital Electronics Assembly

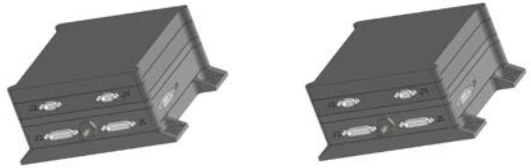
ASU Arizona State University

Malin Space Science Systems

Magnetometer

- MIT lead/DTU built
- 2 sensors and electronics units
- SWARM heritage

2 Vector Field Magnetometer Sensors



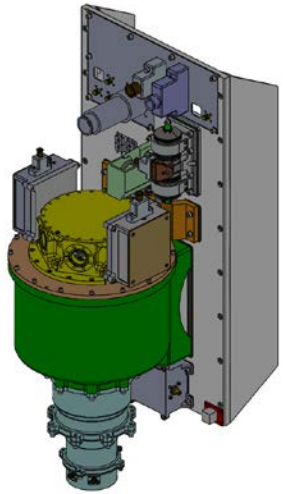
2 Electronics Units

Massachusetts Institute of Technology

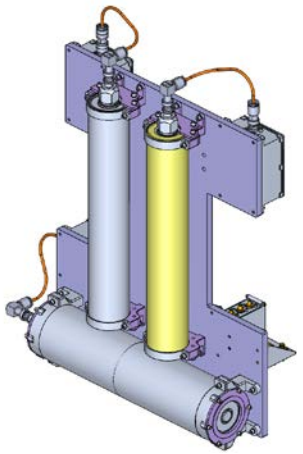
Technical University of Denmark DTU

Gamma-Ray and Neutron Spectrometer

- APL provided
- High Purity Ge detector
- 3 He^3 sensors (thermal neutrons)
- MESSENGER heritage (GRS)
- Lunar Prospector heritage (NS)

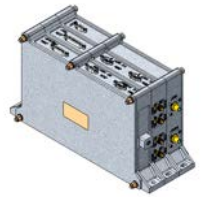


Gamma-Ray Spectrometer

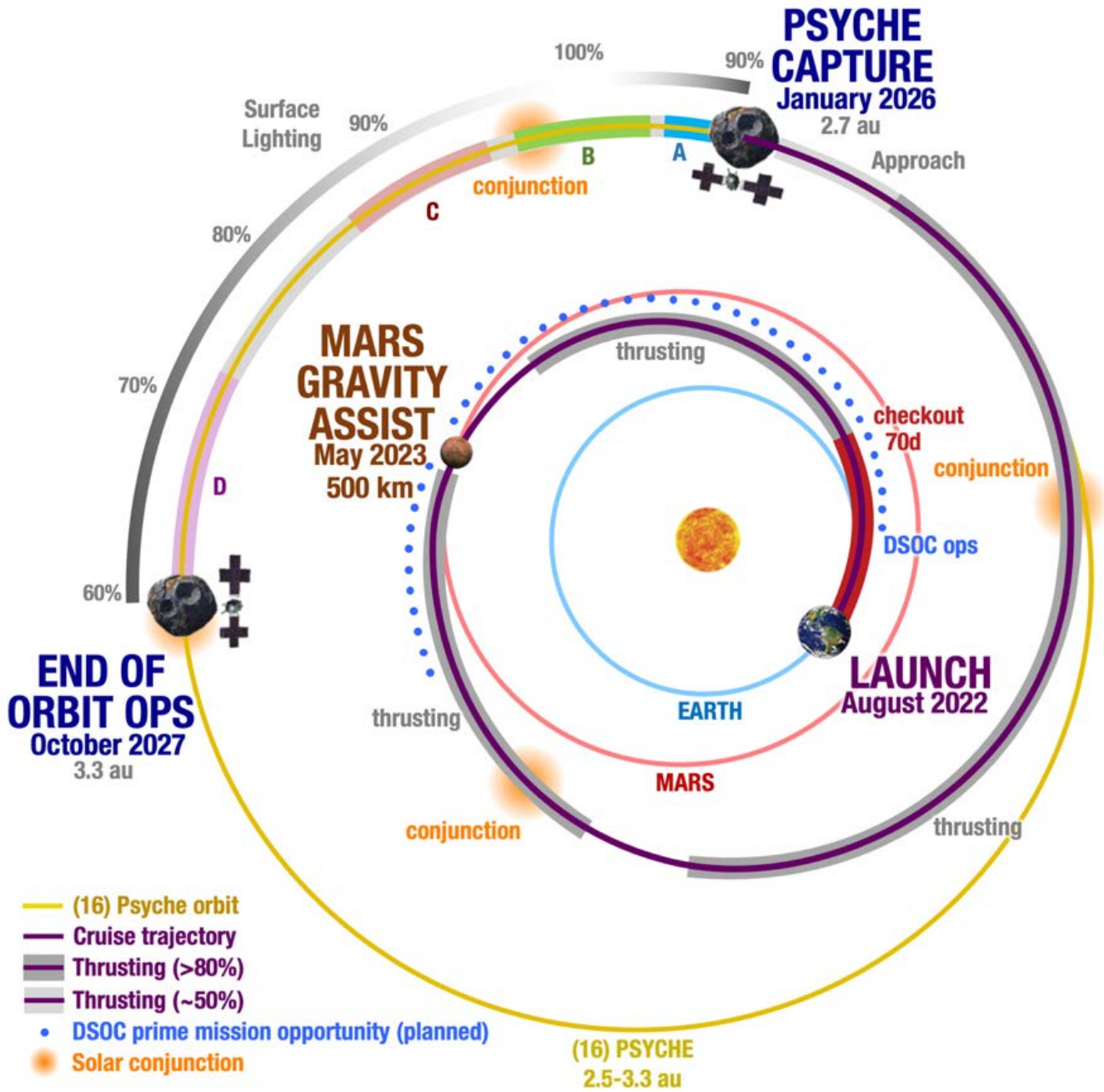


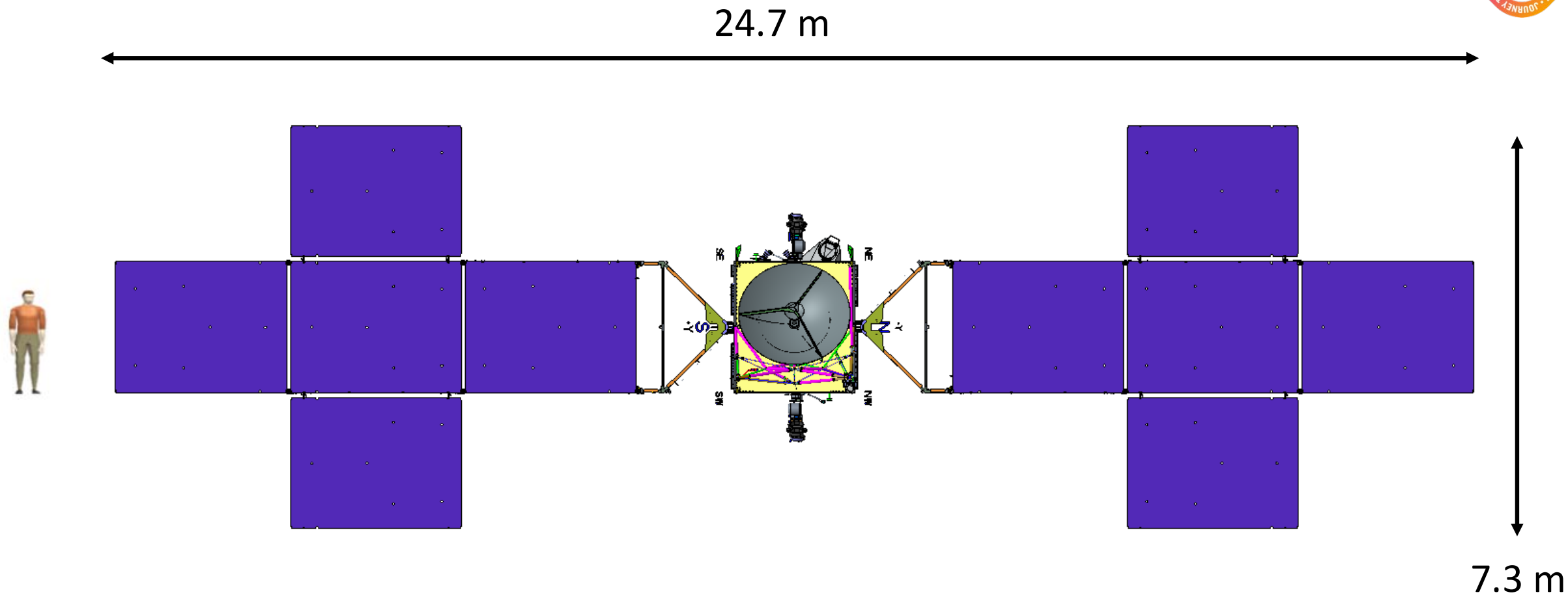
3 Neutron Spectrometers

Digital Processing Units

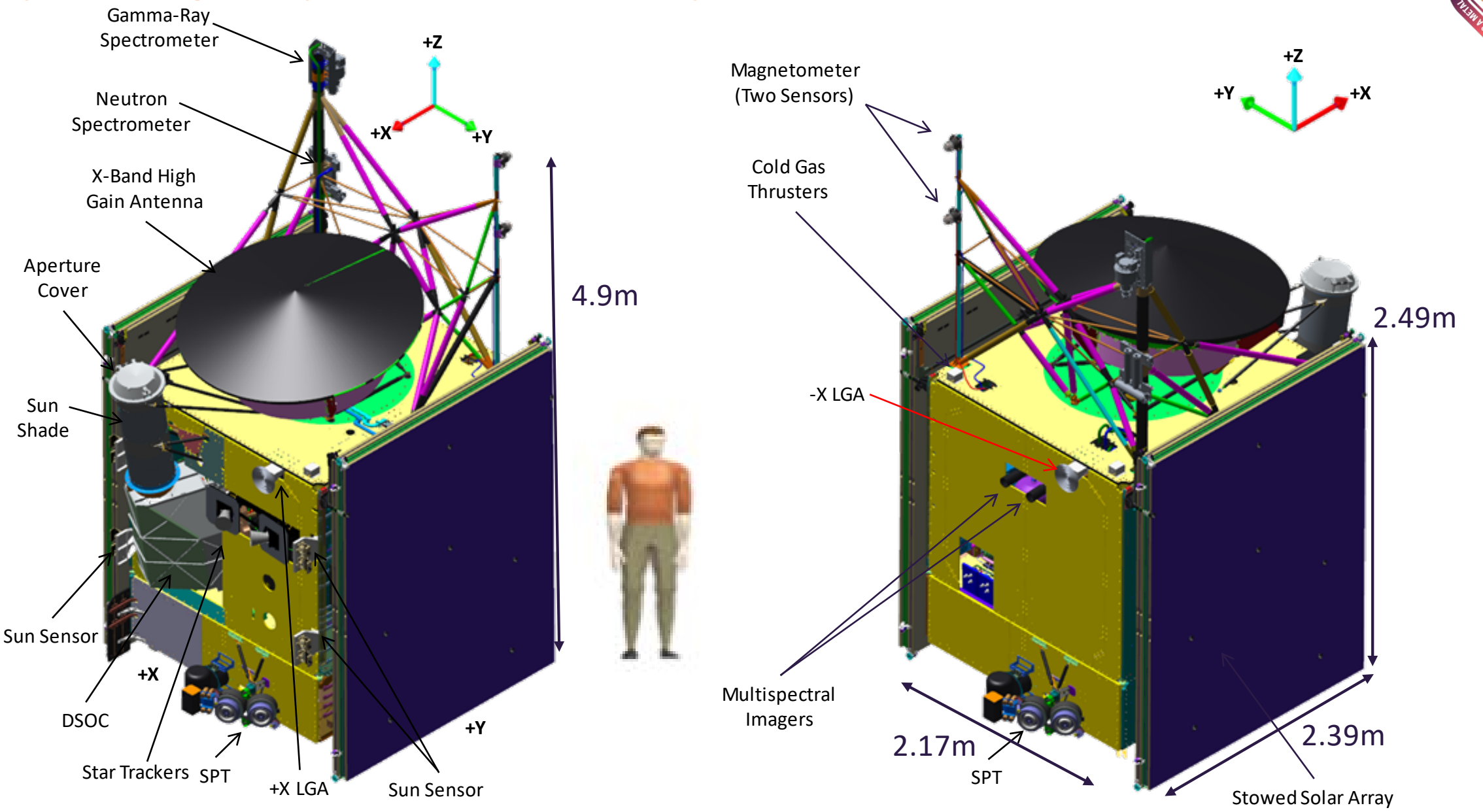


APL Johns Hopkins Applied Physics Laboratory





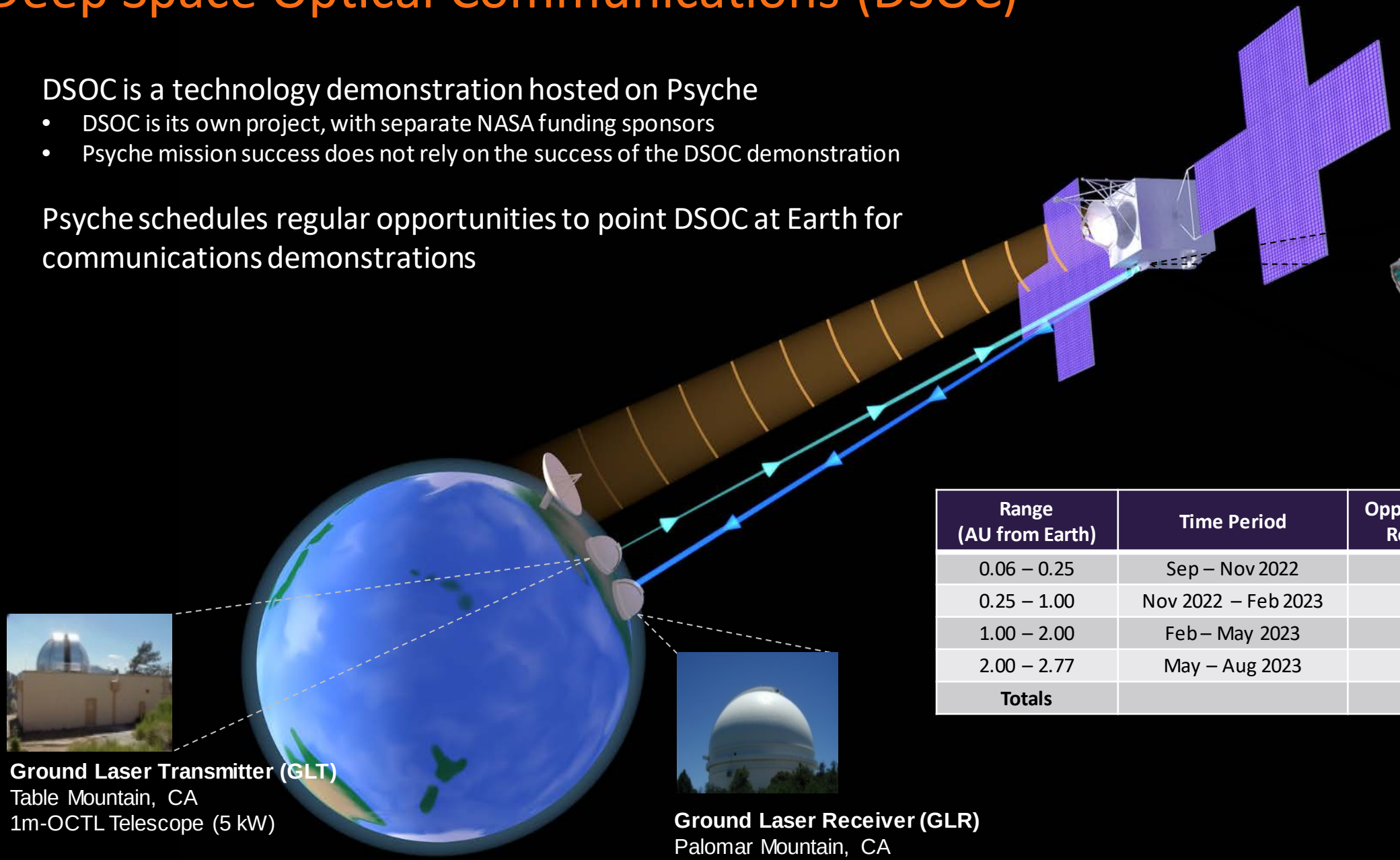
Psyche Flight System (Solar Arrays Stowed)

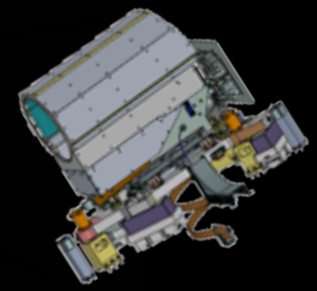


Deep Space Optical Communications (DSOC)

DSOC is a technology demonstration hosted on Psyche
- DSOC is its own project, with separate NASA funding sponsors
- Psyche mission success does not rely on the success of the DSOC demonstration

Psyche schedules regular opportunities to point DSOC at Earth for communications demonstrations





Flight Laser Transceiver (FLT)

Ground Laser Transmitter (GLT)
Table Mountain, CA
1m-OCTL Telescope (5 kW)

Ground Laser Receiver (GLR)
Palomar Mountain, CA
5m-dia. Hale Telescope

Range (AU from Earth)	Time Period	Opportunities Required	Opportunities Provided
0.06 – 0.25	Sep – Nov 2022	8	14
0.25 – 1.00	Nov 2022 – Feb 2023	10	16
1.00 – 2.00	Feb – May 2023	10	15
2.00 – 2.77	May – Aug 2023	10	13
Totals		**38**	**58**