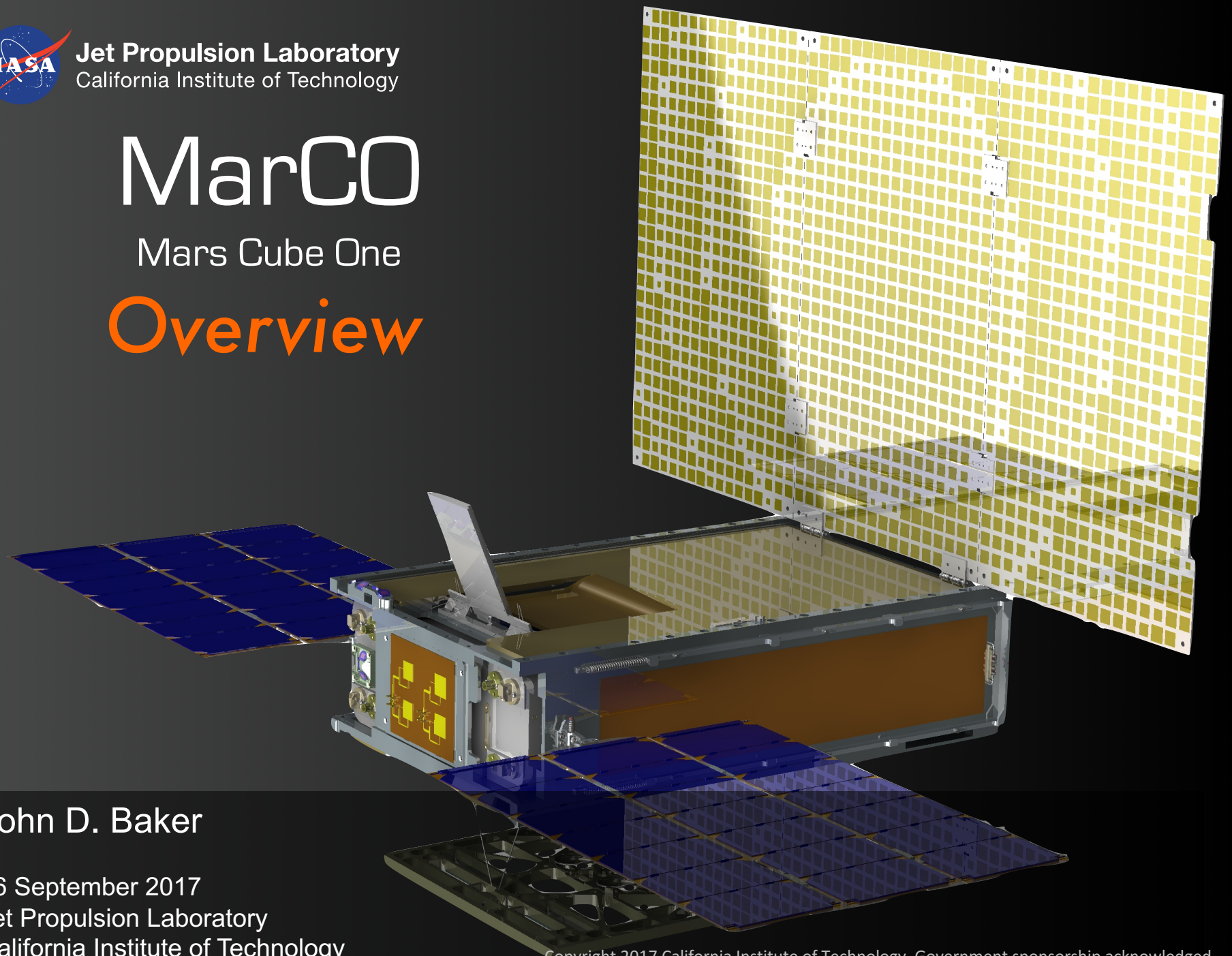
Jet Propulsion Laboratory
California Institute of Technology

MarCO

Mars Cube One

Overview



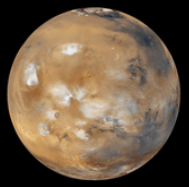
John D. Baker

26 September 2017
Jet Propulsion Laboratory
California Institute of Technology

Trajectory

Large free-space path loss

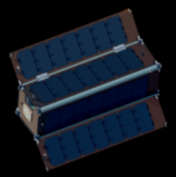
Spacecraft dynamics effects



Navigation

Outside GPS signal range

No Earth's magnetic fields



Environment

High ionizing radiation

Clock stability over mission duration

*IMAGES NOT TO SCALE

Image credit: NASA

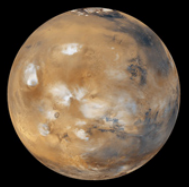
Trajectory

Large free-space path loss

Spacecraft dynamics effects

→ Large aperture antennas

Low receiver sensitivity

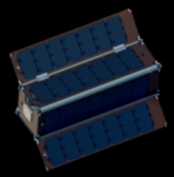


Navigation

Outside GPS signal range

No Earth's magnetic fields

→ Radiometric Navigation Techniques



Environment

High ionizing radiation

Clock stability over mission duration

→ Space-grade parts

Coherent Transponder

An equally capable ground station to support deep-space exploration needs is required.

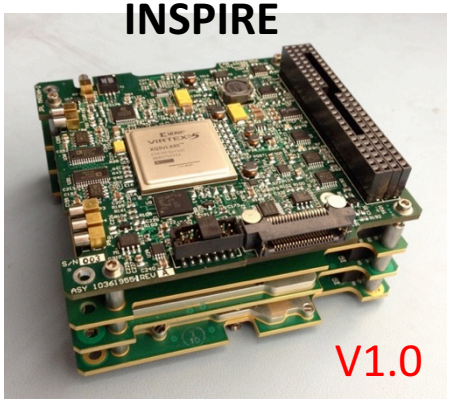
**IMAGES NOT TO SCALE*

Image credit: NASA

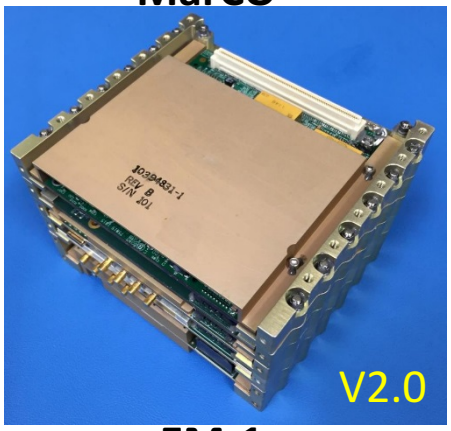
Iris Deep-Space Transponder

- CubeSat/SmallSat compatible deep-space transponder
- ~0.5U volume (100.5 x 101.0 x 56.0 mm; transponder only)
- DSN/NEN-compatible X-band uplink/downlink (7.2GHz/8.4GHz)
- Software Defined Radio with Leon3-FT softcore processor
- Provides navigational support (Doppler, Ranging, DDOR)
- Modular hardware design for other frequency bands (UHF, S-band, Ka-band)

INSPIRE



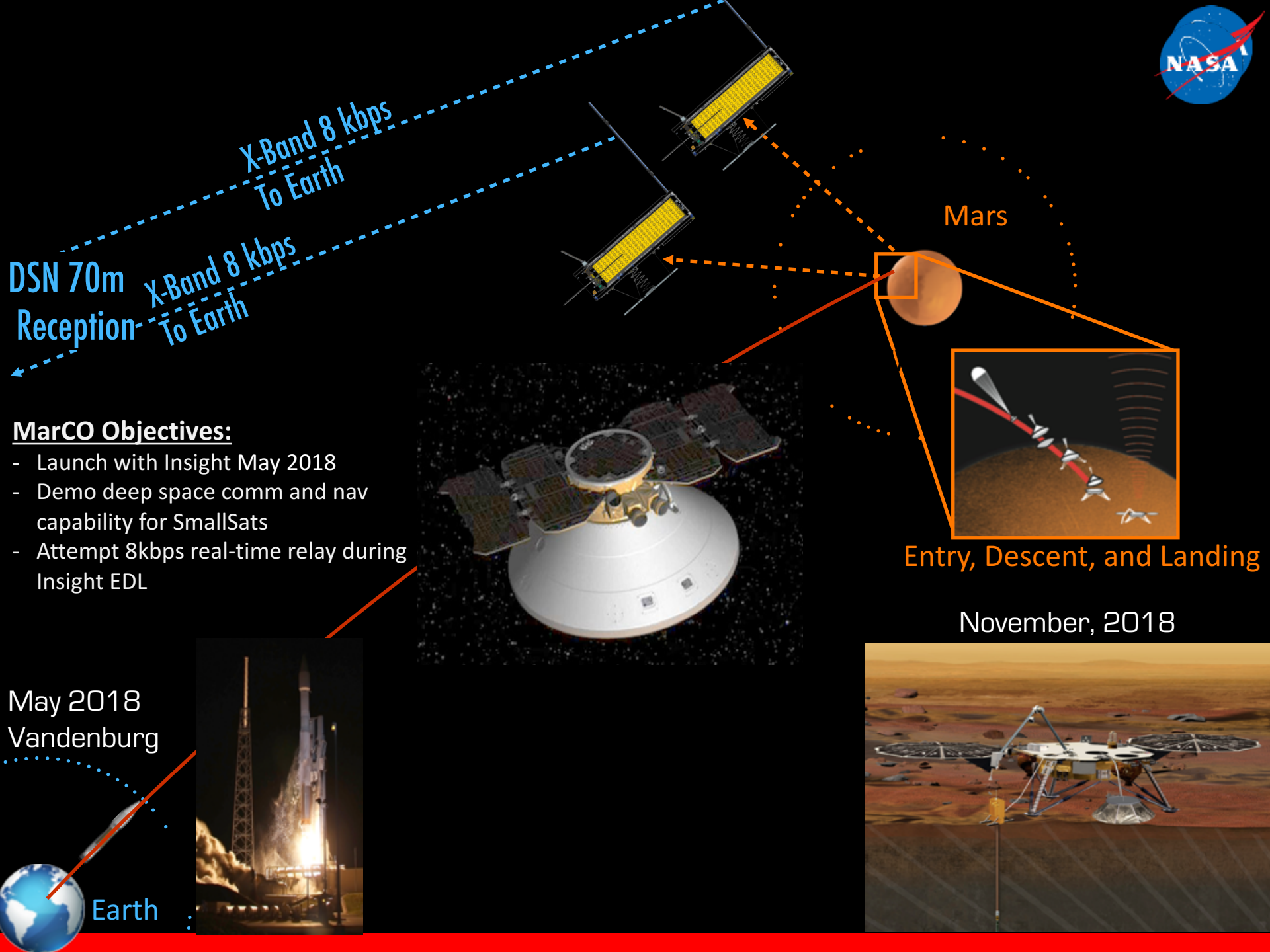
MarCO



EM-1

Iris Specification	Units	Iris V1.0 for INSPIRE	Iris V2.0 for MarCO	Iris V2.1 for SLS EM-1
Mass	grams	450 (no chassis)	1210 (w/ UHF-Rx)	< 1000 (X/X-only)
Volume	U	0.46	0.77 (w/ UHF-Rx)	0.56
Bus Input Voltage	Vdc	6.4 – 8.4	10.5 – 12.3	9.0 – 28.0
DC Power*	W	13.0	35.0	33.7
RF Output Power*	W	0.15	3.3	3.8
Receiver Noise Figure	dB	5.0 – 6.0	3.5	3.5
Receiver Sensitivity	dBm	-135 @ 70Hz LBW	-139 @ 70Hz LBW	-151 @ 20Hz LBW
Uplink Data Rate†	bps	1,000	62.5 & 1,000	62.5 – 8,000
Downlink Data Rate†	bps	62.5 – 64,000	62.5 & 1,000 & 8,000	62.5 – 256,000
Telemetry Encoding		Conv & Reed Solomon	Turbo-1/6 only	Conv, Reed Solomon, Turbo 1/2, 1/3, 1/6
Radiation Tolerance	krads	N/A	15.0 TID	23.0 TID
S/C Interface		1 MHz SPI	1 MHz SPI	1 MHz SPI

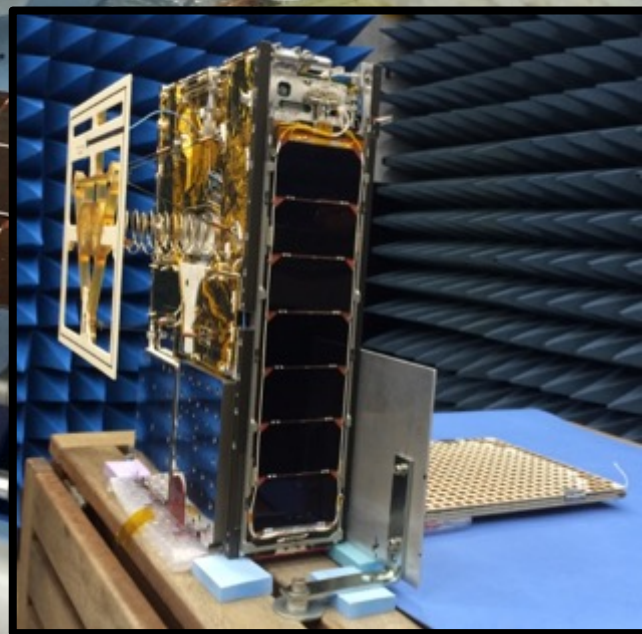
* Nominal at ambient
† Subject to link margin



MarCO Objectives:

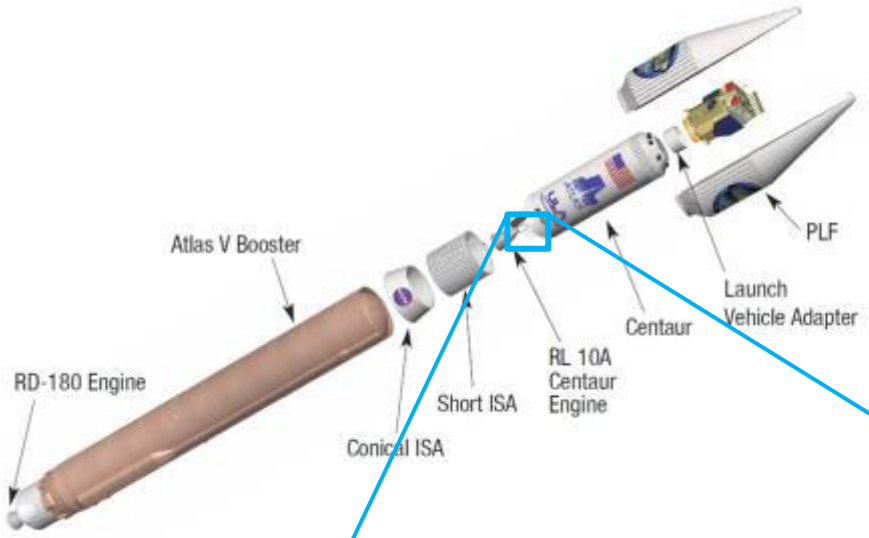
- Launch with Insight May 2018
- Demo deep space comm and nav capability for SmallSats
- Attempt 8kbps real-time relay during Insight EDL

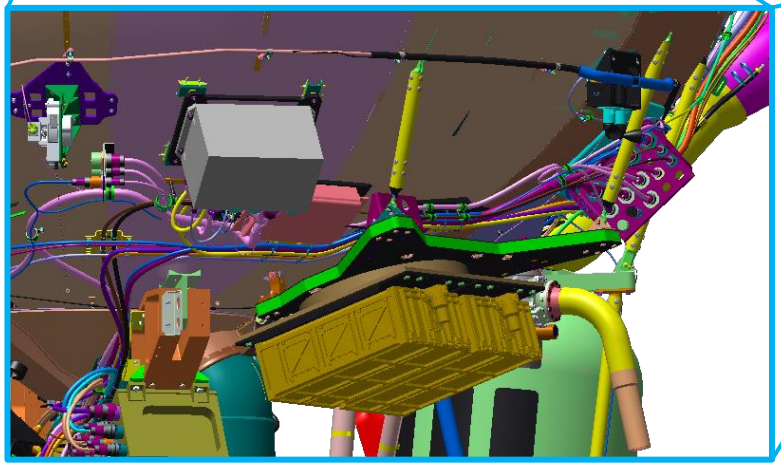
FM1 in Cubesat Lab 1 December 2015

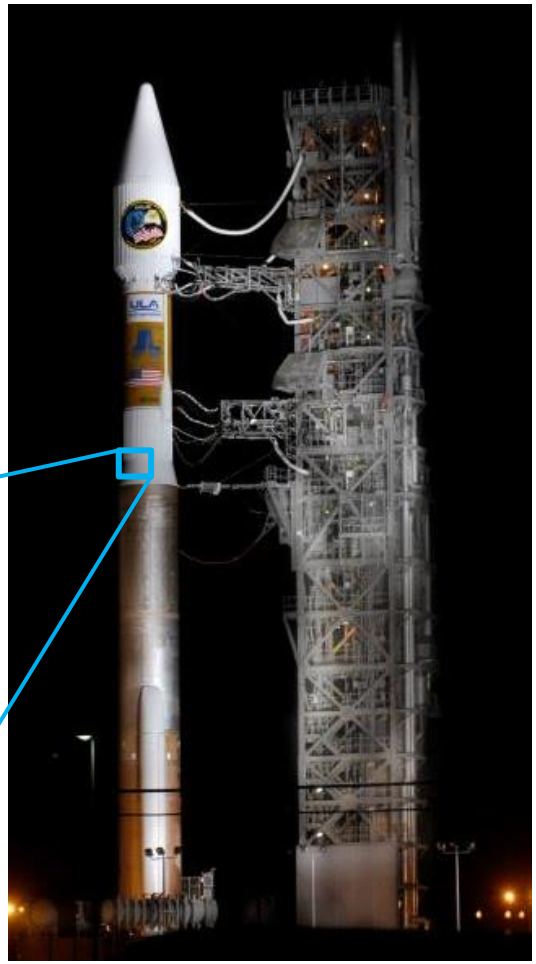


MarCO location on Launch Vehicle

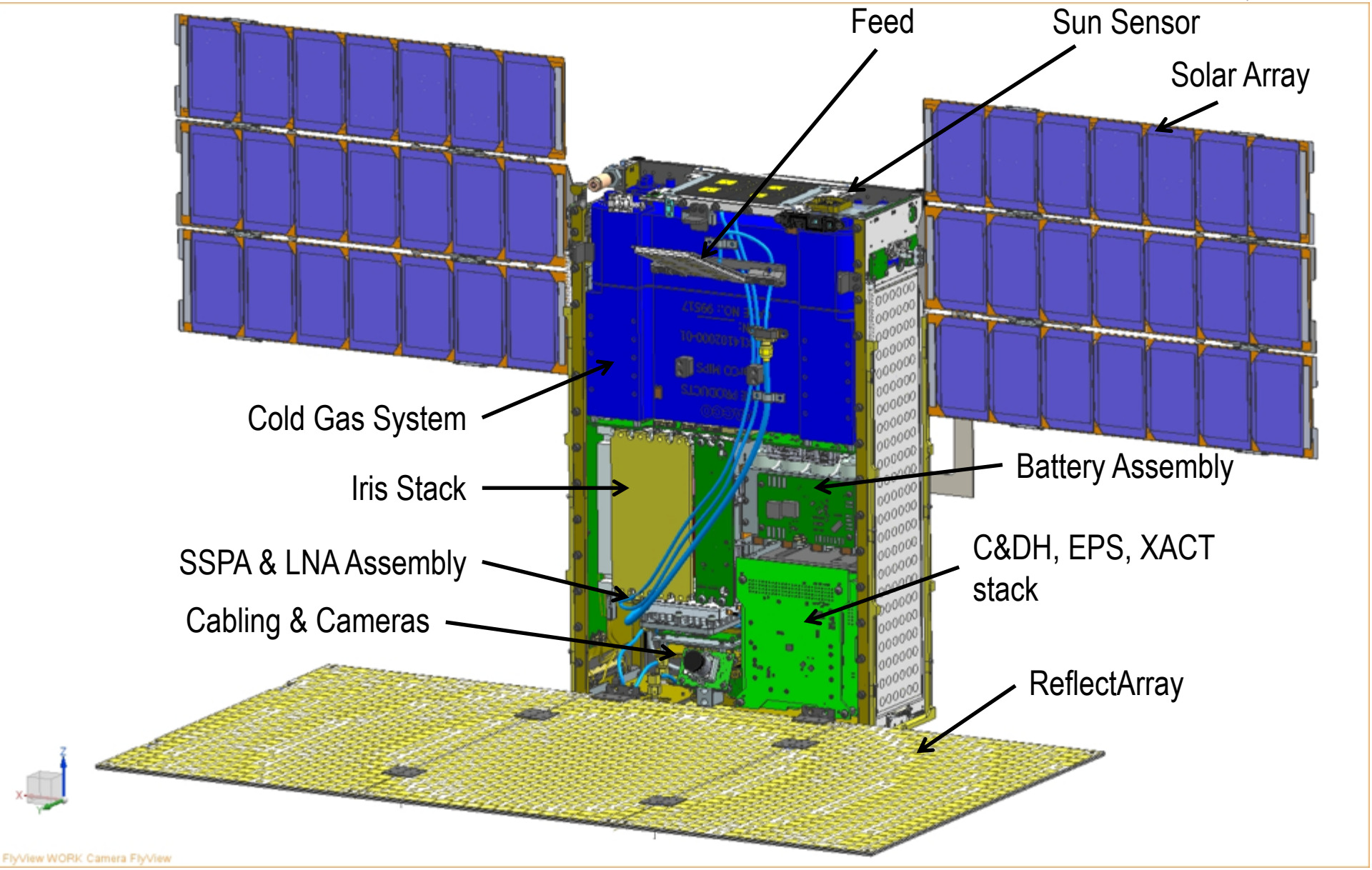
- The MarCOs will be isolated from the InSight faring (4-meter)



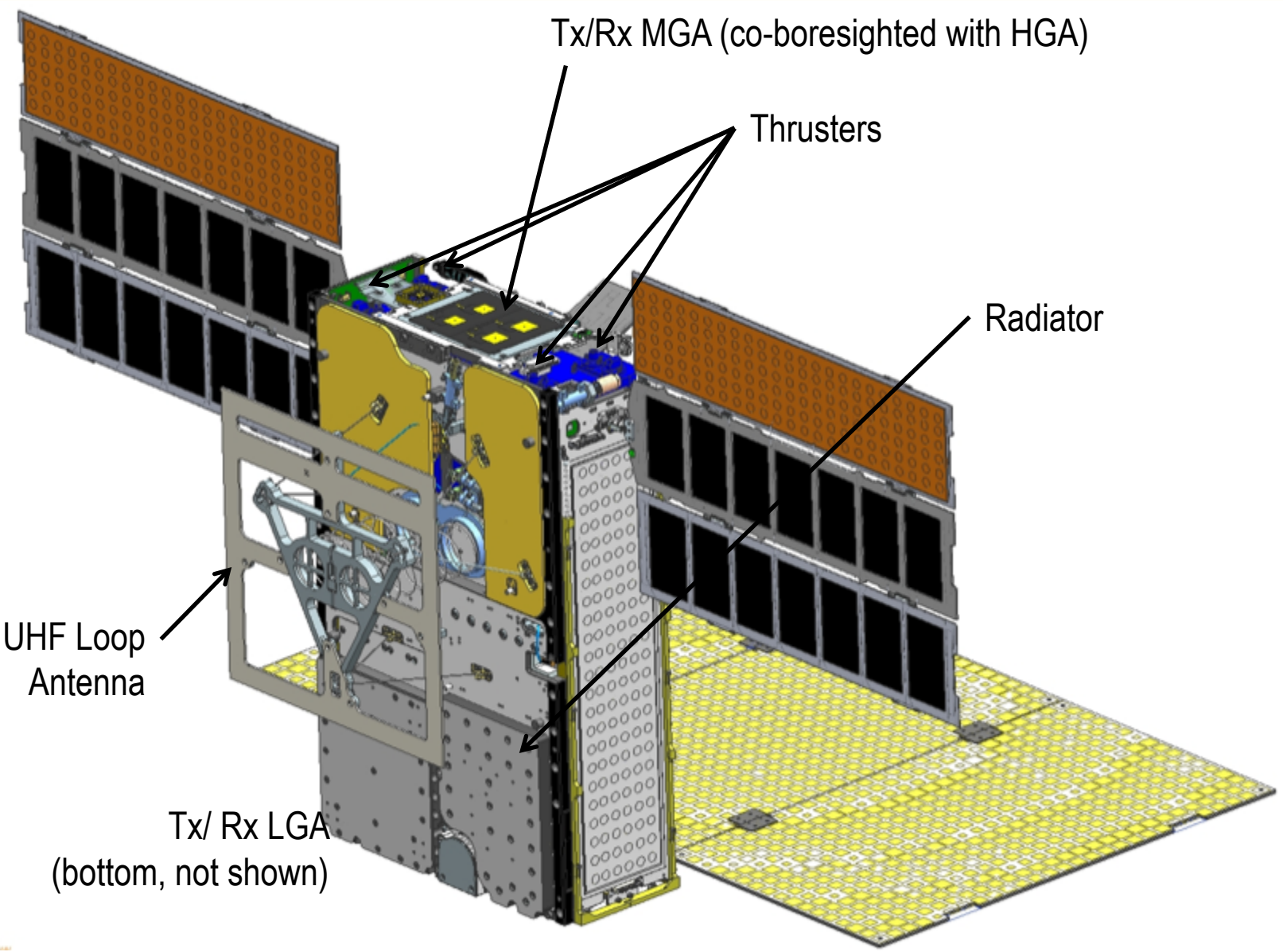




Mechanical Configuration: Deployed



Mechanical Configuration: Deployed



Milestones-to-go

Nov	Complete assembly and test of FM2
Dec	Internal JPL FRR
Dec-Jan	Brief status to NASA HQ
Late Feb	Ship S/C to Tyvak for Dispenser I&T
mid/end Feb	KSC Reviews (MRR, Pre-integ, Pre-Install)
Mar	Installation on Launch Vehicle (VAFB)
~mid-Feb	internal JPL ORR
5 May	Insight Launch period open