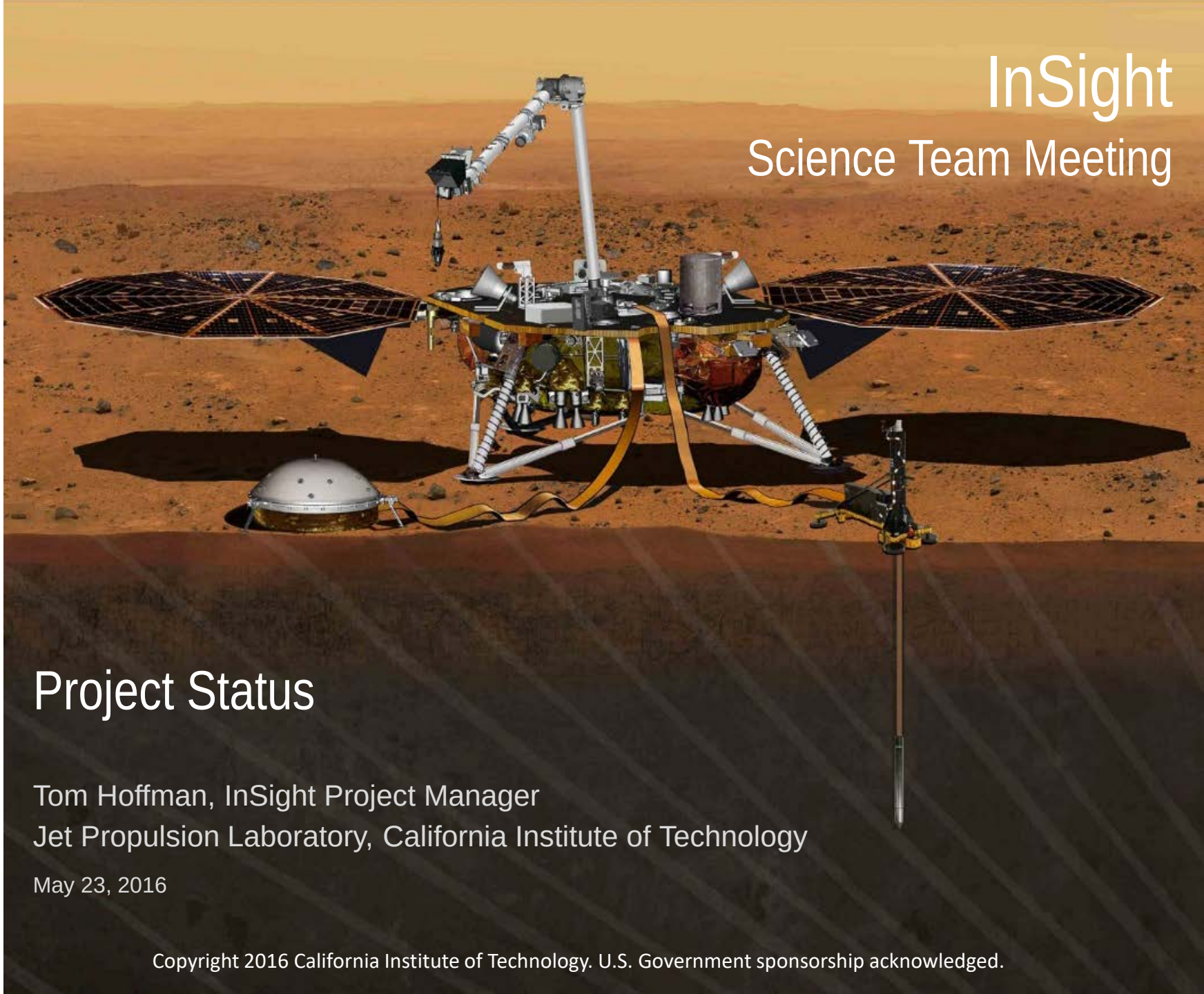

InSight
Science Team Meeting

Project Status

Tom Hoffman, InSight Project Manager
Jet Propulsion Laboratory, California Institute of Technology

May 23, 2016

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Project Status

- Project was unable to deliver the SEIS Instrument in time for the 2016 Launch
  - Technical issue was a leak in the sphere that would compromise the capability to achieve the Science Requirements

- Project put together a plan for a 2018 Launch Opportunity
  - Resolve the technical issues within SEIS
  - Reduce as much as reasonable risks in other areas
    - Project conducted an intensive risk review across all areas of the project and determined the set of activities to perform before 2018
  - This plan was presented to NASA in March and was accepted
    - Still need to get final approval in October 2016 for full funding

Project Replan Overview

- Project work effort to 2018 launch has three timeframes:

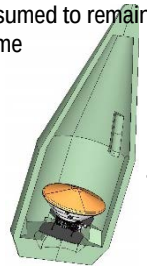
1. 2018 Launch planning activities (Jan –May ‘16)
   - Completed Risk Assessment Activity
   - Started SEIS work
   - Complete close-out paperwork from InSight 1.0 prior to workforce off-loading
2. Hiatus Period (SEIS Work, Project Risk Reduction) (Jun ‘16-Jun ’17)
   - Deliver SEIS Instrument to ATLO
     - Full Flight Instrument in April and Flight Spare sphere to follow
   - Complete other risk reduction activities
   - Complete design work for the 2018 Mission, including:
     - Mission Design & EDL for the new launch opportunity
     - Surface operations preparation esp. deployment activities
   - Reduce JPL & LM WF level for LOE work during this period
3. ATLO 2.0 (July ‘17-May ‘18)
   - Well defined and robust based on ATLO 1.0 experience and lessons learned
   - Execute plan for WF transition from “bathtub” LOE level to ATLO level

Mission Overview

LAUNCH

May/June 2018

Launch vehicle and launch coast selection assumed to remain the same



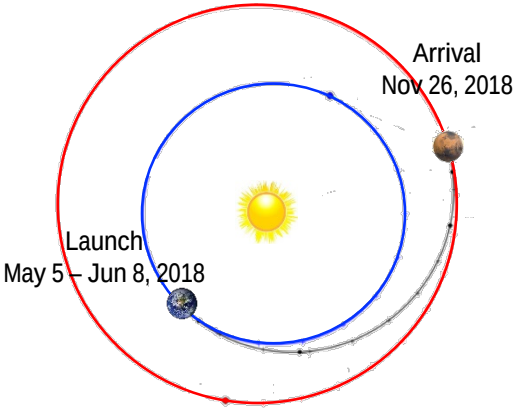
InSight Stowed in 4-m Payload Fairing

Vandenberg Air Force Base (Western Test Range)

Atlas V 401

INTERPLANETARY CRUISE

171 days to 205 days

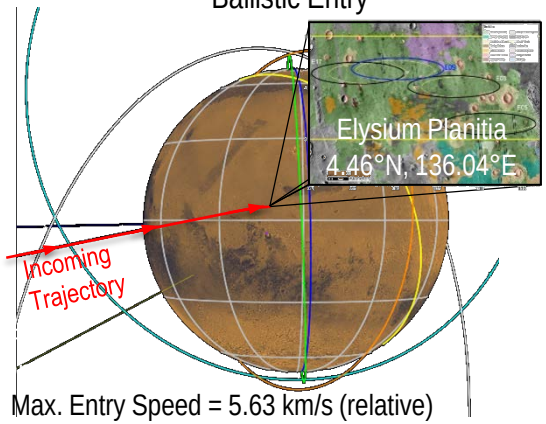


Type 1 Trajectory

Max C_3 = 14.3 km^2/s^2, max DLA = -40.8 deg

APPROACH & EDL

Ballistic Entry



Max. Entry Speed = 5.63 km/s (relative)

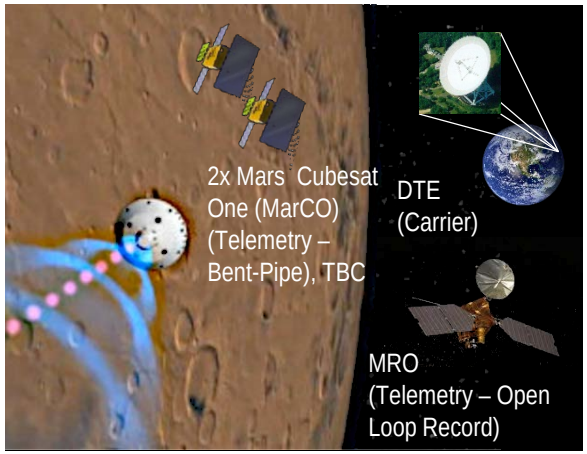
Ls = 296 deg (dust storm season)

Landing elevation ~ -2.7 km

Landing LMST = ~2:05 PM – 2:25PM

EDL COMMUNICATIONS

Ultra-High Frequency Link

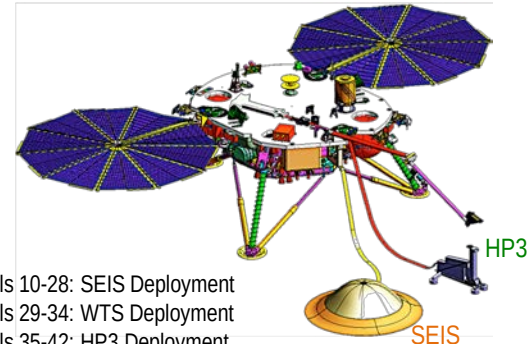


DEPLOYMENT

44 Sols

Sols 0-4: Lander Initialization

Sols 5-9: Instrument Placement Site Confirmation



Sols 10-28: SEIS Deployment

Sols 29-34: WTS Deployment

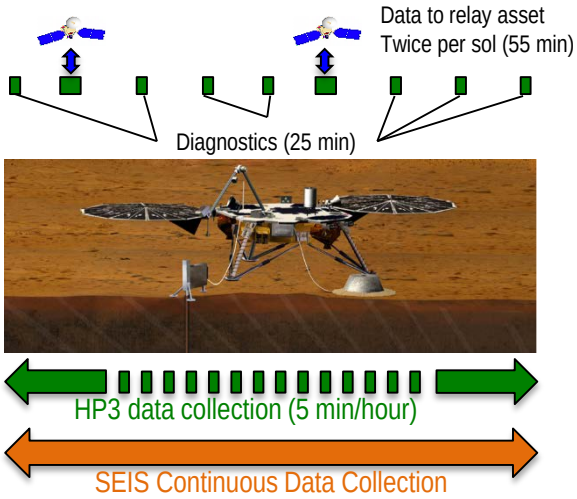
Sols 35-42: HP3 Deployment

Sols 43-86: HP3 Hammering

Sols 87-709: Science Monitoring

SCIENCE MONITORING

One Martian Year (sol 87 – sol 709)



2016 vs 2018 Opportunities from the EDL perspective

- **Significant changes**
  - Max entry velocity (atmosphere-relative): 6.02 km/s → 5.63 km/s
    - Reduces heating
  - Arrival L_s: 232° → 296°
    - Early global dust storm season → late global dust storm season
      - Equivalent pressure cycle, so atmospheric conditions are effectively the same
  - EDL communications via MRO at 3 PM (no move by MRO)
    - DTE via UHF also maintained as for 2016 opportunity

- **What has not changed?**
  - Landing location (still E9 ellipse in Elysium Planitia)
  - Entry mass

- **2018 overall is an excellent EDL opportunity**

2018 Energy Margins

- Arrival later in the Martian year has shifted most of the risk of large, global, dust storms to the end of the mission.
  - Global dust storms do not occur every year, but when they occur they do so during the same relative time period in a Martian year
  - Risk of the global dust storm was split between the beginning of mission/end of mission for the 2016 opportunity
  - A worse case global dust storm at the end of the 2018 mission will potentially result in negative energy margins for several sols
  - Project will continue analysis to determine possible mitigations

- Deployment time period during 2018 will occur roughly 5C cooler than the 2016 opportunity
  - Driving assessments of deployment arm and SEIS sensor assembly thermal limits/heater energy usage
  - Will require some updates to Environmental Requirements and associated test program for SEIS

2016 Vs. 2018 High Level Comparison

Parameter	2016 Baseline	2018 Baseline	Delta
Launch Site	VAFB	VAFB (expected)	→
Launch Period	22 days	35 days	↓
L + 36 d Coverage	9-hour tracking gaps filled by ESA	9-hour tracking gaps filled by ESA	→
Flight Time	6 months	6 months	→
Mars Entry Accuracy	Required ESA tracking to meet req't	Does not require ESA to meet req't	↓
EDL communications	Required MRO's node move to 2:30 PM	Does not require MRO's node change	↓
Mars Entry Velocity	6.0 km/sec	5.6 km/sec	↓
EDL Performance	Meets requirements	Meets requirements	→
Landing Safety	>99%	>99%	→
Landing Season	Before peak density	After peak density	↓
Energy Margin	Adequate throughout mission	WC Margin impacts end of mission	↑
Surface Mission	1 Martian year	1 Martian year	→

Project Risk Mitigation Process

- Identified current risks across the entire project
  - Look beyond SEIS for any other needed risk reduction
  - Comprehensive review of P/FRs, waivers, risk list, etc.

- Determined risk mitigation strategy
  - For each risk decided to mitigate or not, how and where to do the work and associated decision rationale
  - Some minor impact items are pending analysis or test results
    - Decision to take initial action have been made, results pending
  - Developed initial plan for new Phase C and ATLO restart
    - Based on keeping the minimal needed core team at JPL and LM
    - Additional resources applied to defined risk mitigation activities

- Held Risk Assessment Reviews with external board
  - Board reviewed project risk decisions and plans

Non-SEIS Risk Reduction Plans

- Spacecraft
  - Complete USM switch fix
  - Additional component level test/analysis to reduce risk
- HP^3
  - Will need a redesign of the back-end of the mole to address test issues
  - Need to complete mole life test on new design
  - Will implement new design on Flight Spare mole and (likely) keep flight unit as is
- IDS (Instrument Deployment System)
  - Relubrication of grapple, procure new frangibolts, repair cal target
  - Repair of EM Arm
- Other payload elements to be placed in correct long term storage conditions
- Deployment
  - Test program to better characterize operation and develop work arounds for issues found during test campaign

SEIS Plan (1/2)

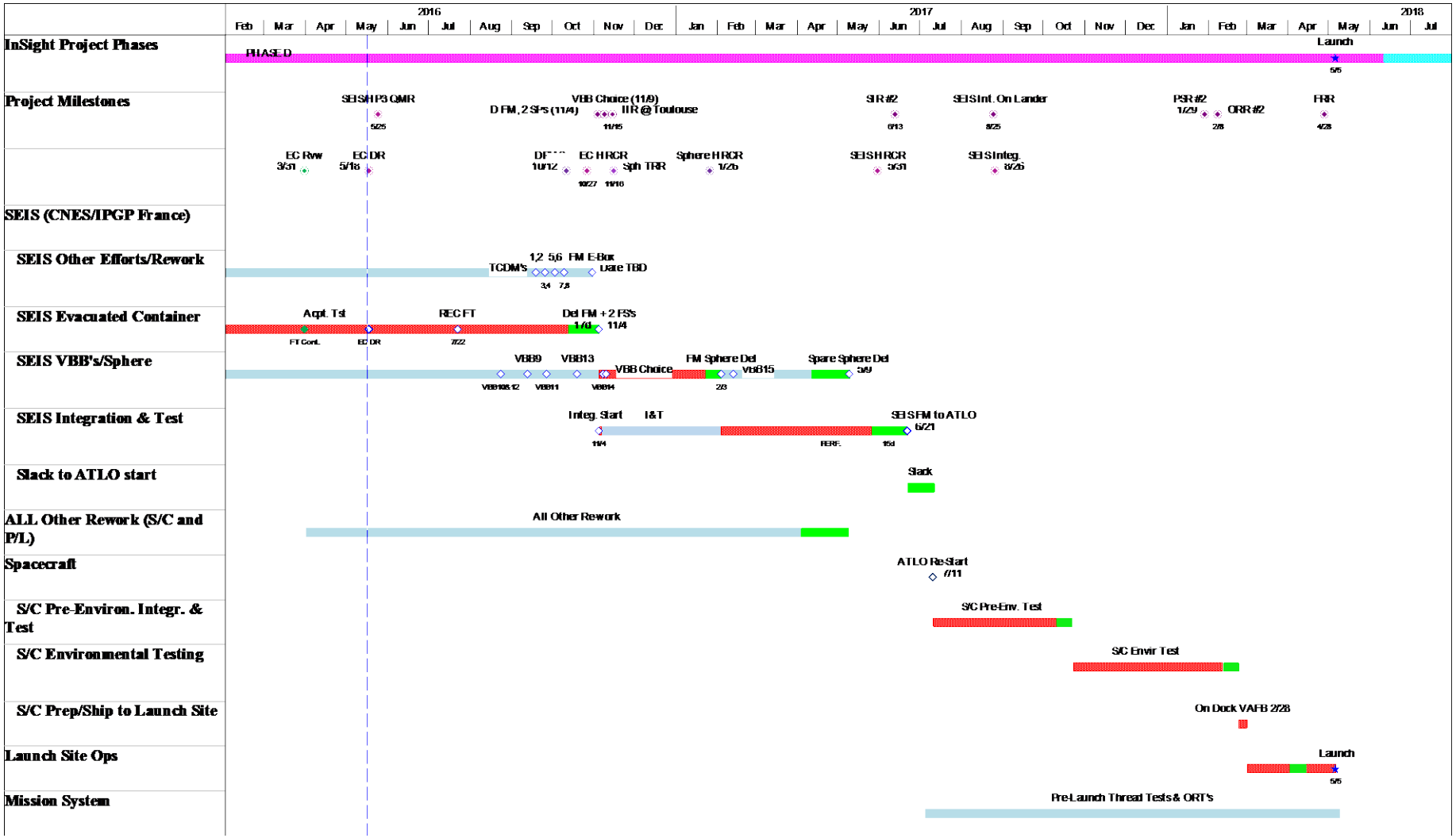
- Key Attributes of plan
  - Project Policy: Always have 3 flyable VBBs
    - Three existing VBBs need cleaning and minor rework after removal from the sphere
  - Defined the work scope and implementation approach
    - Sphere build/test, 3 VBB and 3 SP spares, EBox mod, complete FSW
  - Take advantage of each organizations proven strengths
    - CNES: Focus on instrument level integration and test
      - Lead overall SEIS Delivery effort with all partners
      - Integrate and Test and then delivery Flight Instrument to ATLO
    - JPL: Verify design and complete design updates/build/test work
      - JPL to build, qualify and deliver spheres to SODERN
      - JPL to do needed mechanism rework on TCDM (thermal compensator)
    - SODERN: Focus on production
      - They will do the VBB build and rework, integrate these to the sphere and test the integrated sphere prior to delivery to CNES
      - Will have on-site support from CNES and JPL

SEIS Plan (2/2)

- Other SEIS plans for Risk Reduction
  - Build flight spare sphere populated with flight VBBs
  - SEIS FSW: Determine the best plan for implementing handful of known changes, plan for likely additional changes found during test campaign
  - SPs: Complete flight testing of current lot, build & test spare lot
  - E-Box: minor component changes to boards to improve science margin, additional testing
  - CNES resident at JPL and JPL residents in France to enhance communications

- Test Program Adjustments
  - Complete test program at instrument level including 3 TVAC cycles, EMC/EMI, and Vibration
  - PQV and life time adjustments for longer time from now to launch
  - Adjust test temperature range to provide mission margin

Project Top Level



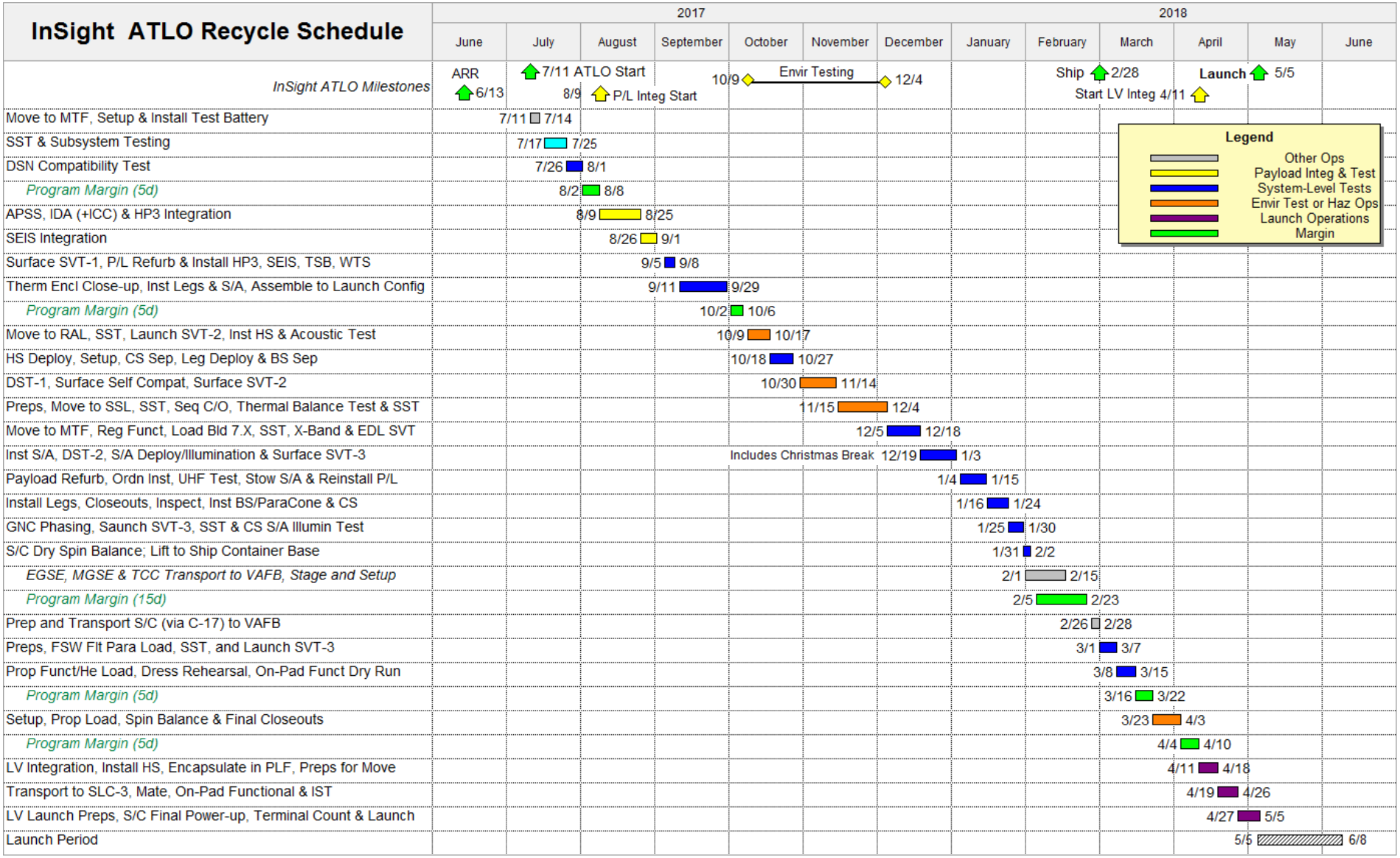
ATLO-2 - General Overview

- Spacecraft has been environmentally qualified in Phase 1 ATLO, Phase 2 ATLO will perform one-each workmanship environment test of the Launch configuration (Acoustic) and the Lander configuration (Thermal)

- Surface radiated self-compatibility will be conducted with SEIS to verify SEIS performance in an electromagnetically shielded environment

- Will also perform 1 complete vehicle deployment/separation set of tests (except LV sep) as assembly-level “workmanship” tests

- Work calendars
  - 5 day work weeks, all holidays off (exception Thermal Balance Test)
  - Margin: 35 days (Denver – 25, Launch Site – 10)

- Misc. Info
  - FSW Loads: Build 7.0 (start of ATLO), Build 7.1 (post-Tvac), Build 7.1.1 (VAFB; parameters)
  - System Verification Test (SVT) count: 3 Launch, 1 EDL & 3 Surface

2018 ATLO Schedule