COBALT Project STMD:GCD / HEOMD:AES-LT / STMD:FO

PL&HA Technology

Extraterrestrial Autonomous Landing Systems

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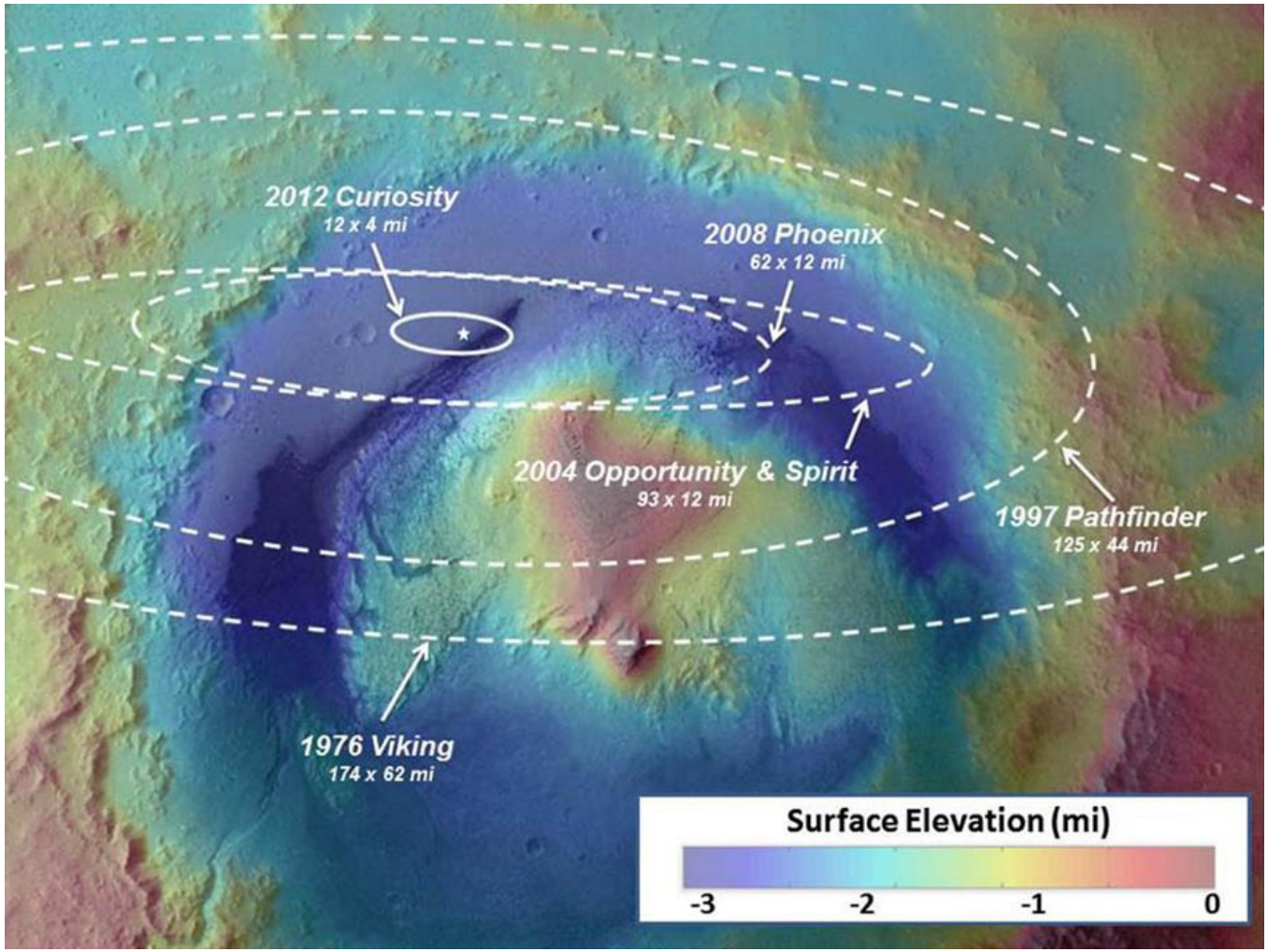
Overview

1. Today's challenges
2. COBALT
   - Mission overview
   - System architecture
   - Testing
   - Flight Campaign
3. Mars 2020 Rover – Lander Vision System (LVS)

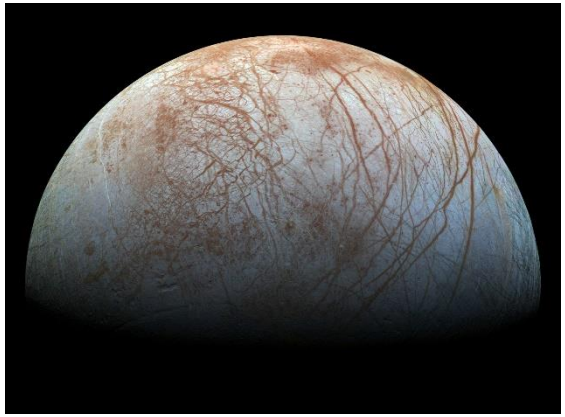
Today's Challenges

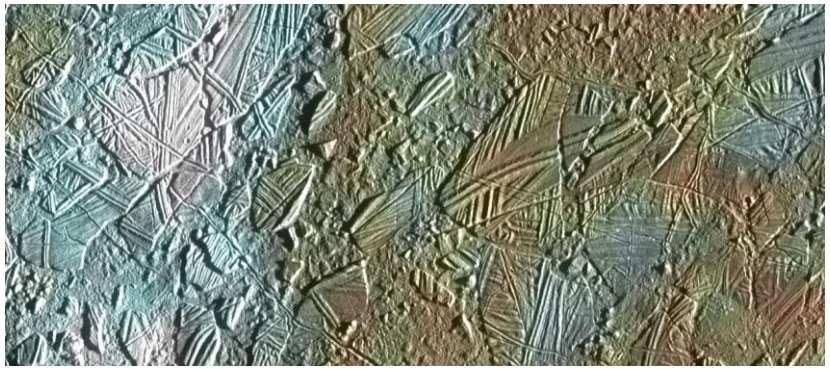
- Dead reckoning
- Large ellipse
- No pinpoint landing



Today's Challenges

- Earth landing systems are significantly easier than other bodies
  - GPS localization
  - Thick atmosphere
- Mars
  - No external localization
  - Thin atmosphere
- Europa
  - No external localization
  - No atmosphere
  - Unknown surface
  - Very cold, far from the sun
  - High-radiation environment





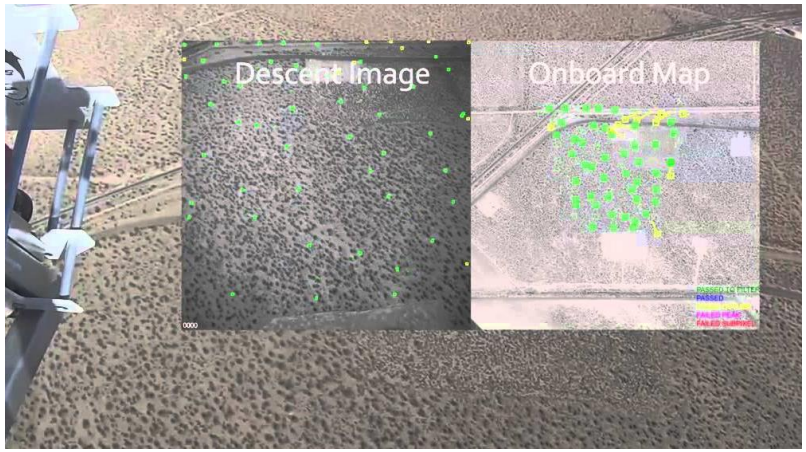
Solutions

- Ideal Solution
  - Internal sensing
  - Accurate state estimation
  - Controllable pinpoint landing
- Real Solution
  - Combine image, LIDAR, and IMU sensor data to obtain an accurate state estimation

COBALT

Fuse three sensors:

- IMU
  - **Rotation**, Translation
- Camera
  - Rotation, **Translation**, **Hazards**
- LIDAR (NDL, Navigation Doppler Lidar)
  - Rotation, **Translation**



COBALT

COBALT Project

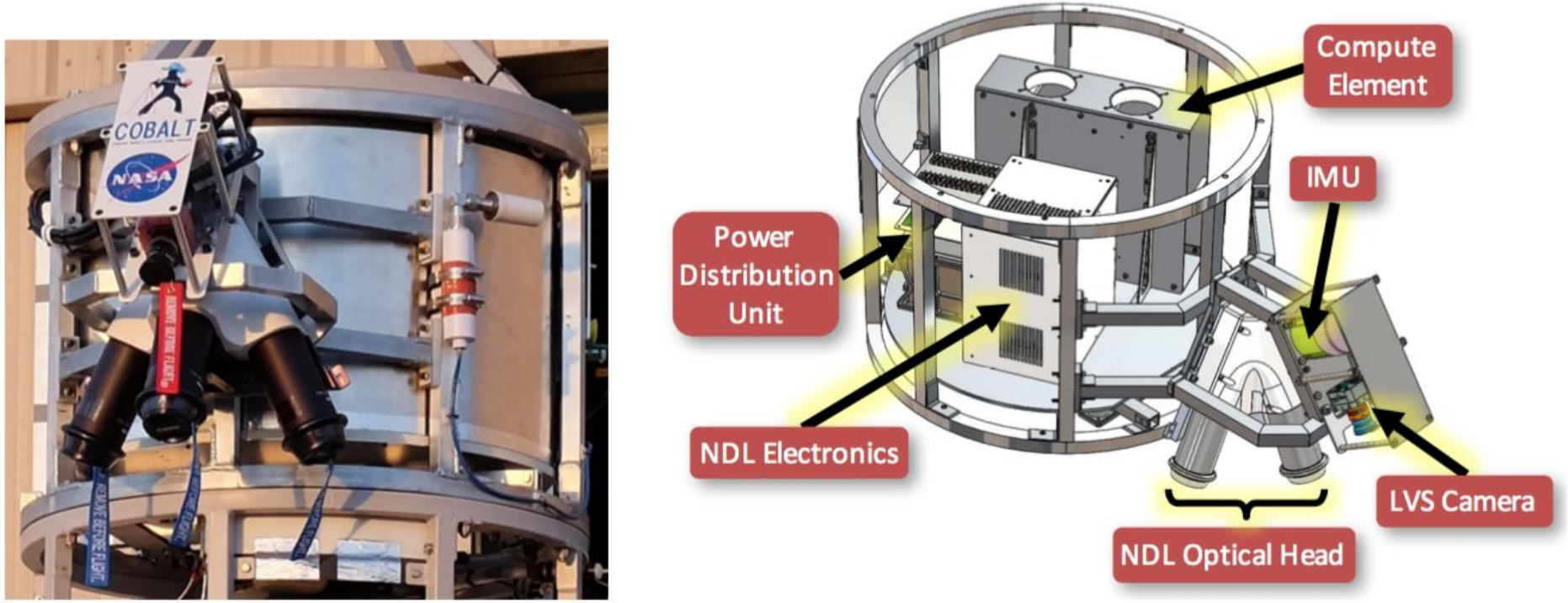


Figure 1. COBALT payload: (left) final assembly; (right) annotated illustration.

Our Ride: Masten Xodiac

Figure 3. Xodiac vehicle: (left) with COBALT integrated; (right) annotated illustration (courtesy MSS).

Cobalt Mission Overview

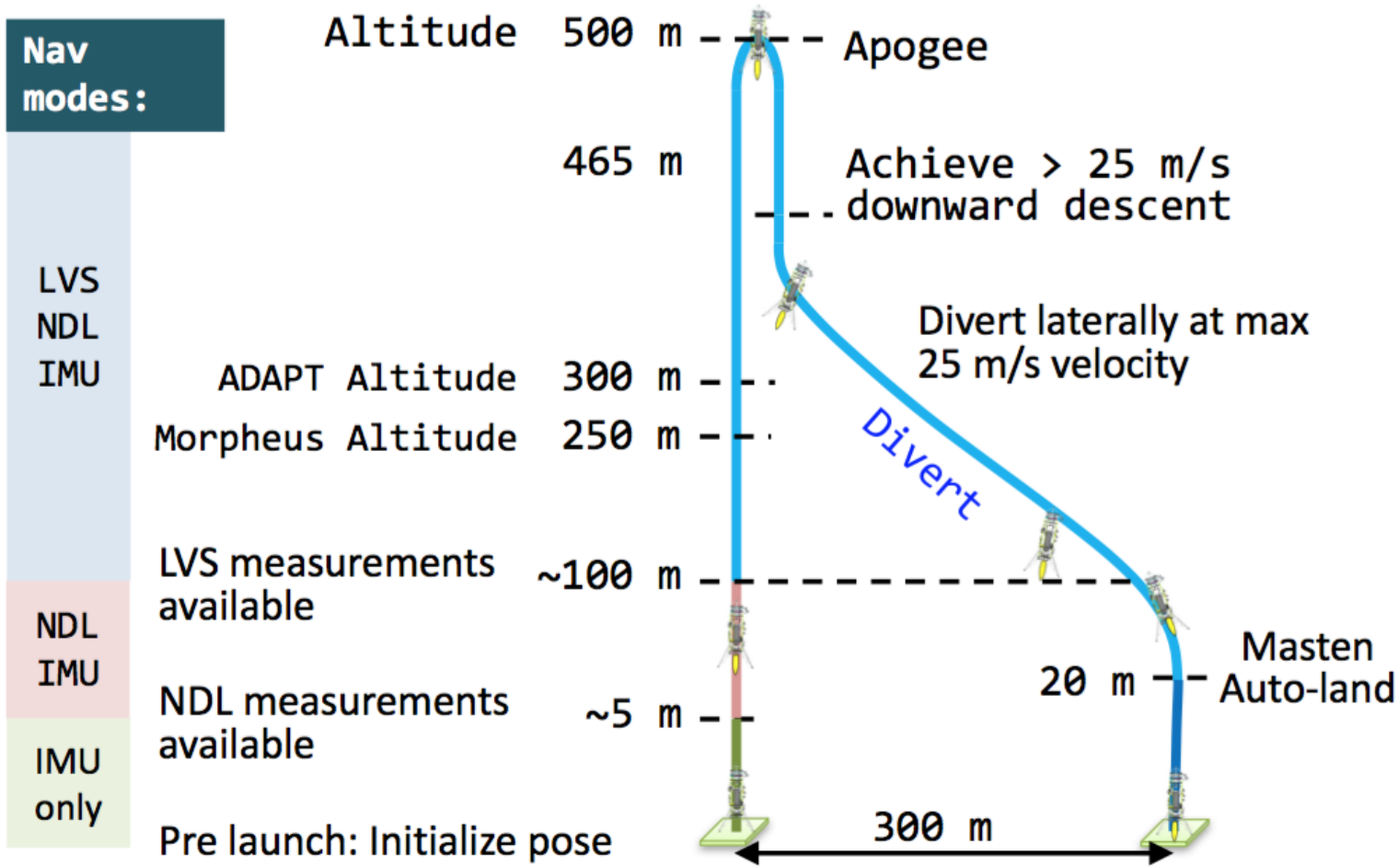
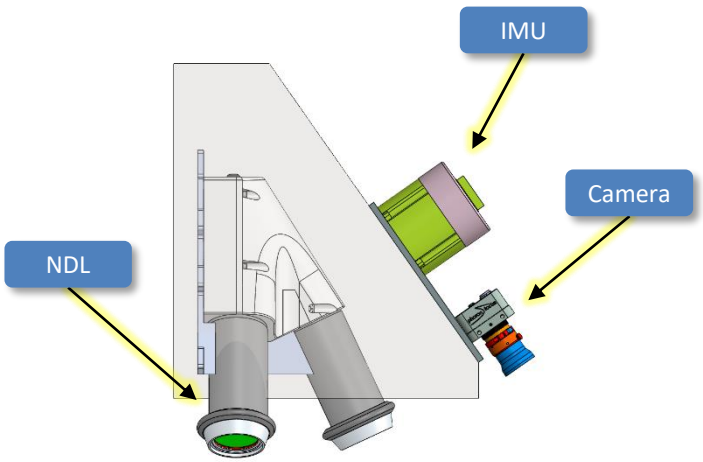
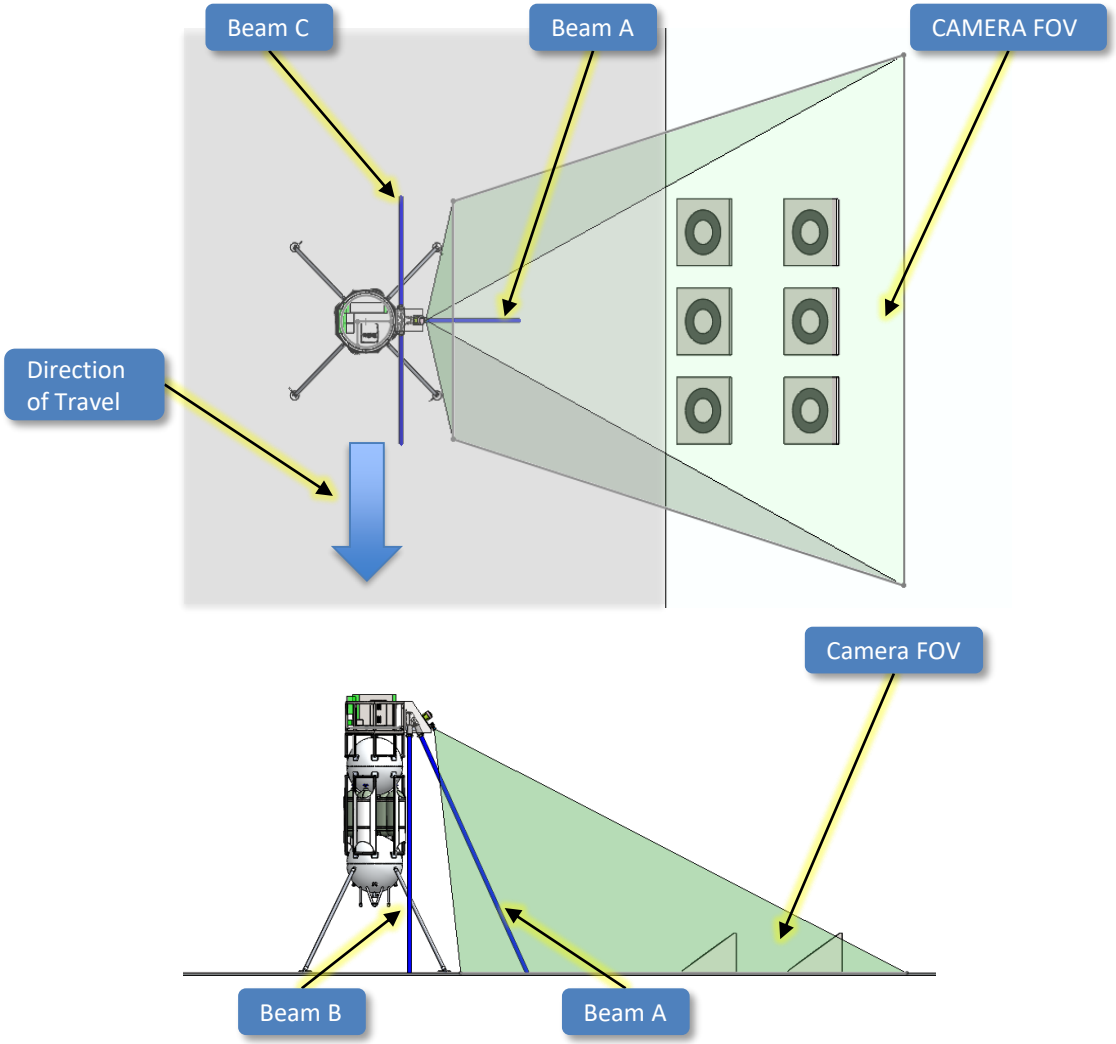


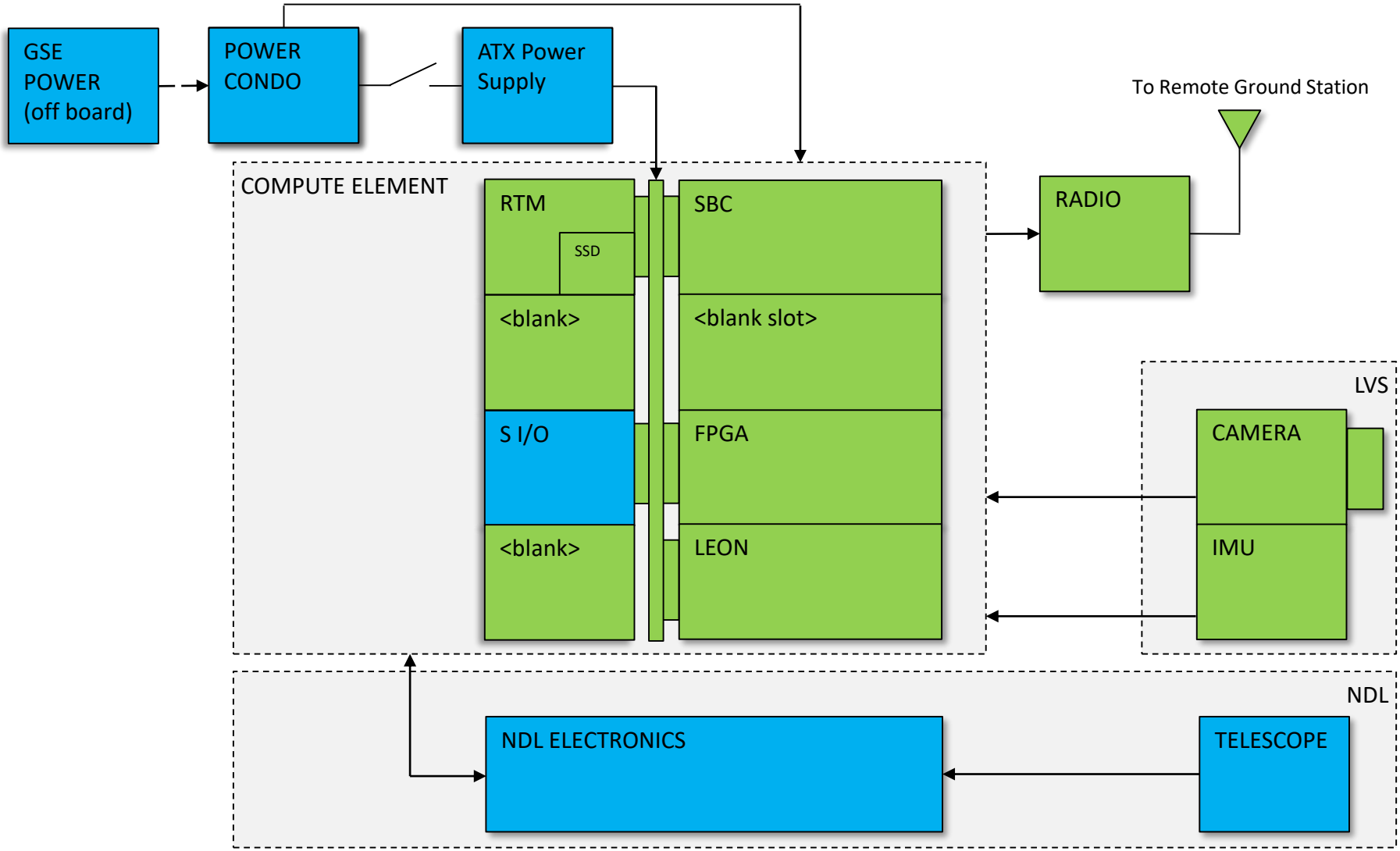
Figure 4. Illustration of COBALT flight profile and ConOps

System Architecture

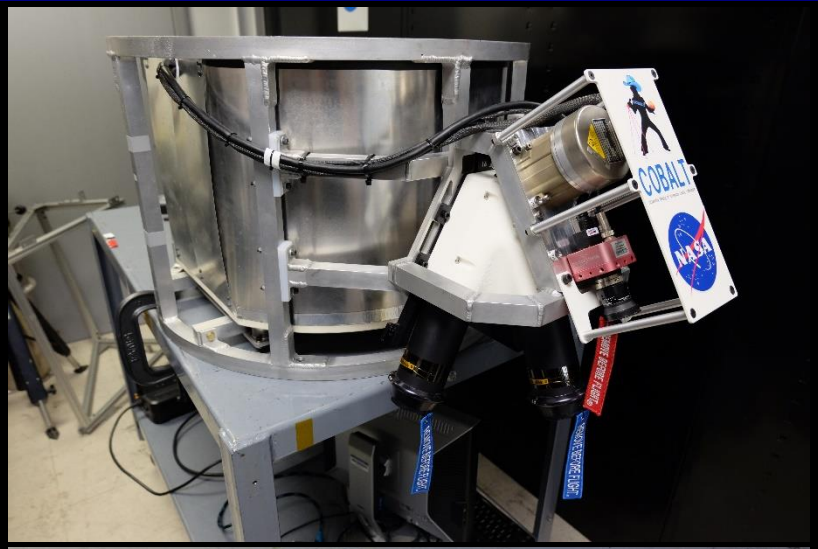


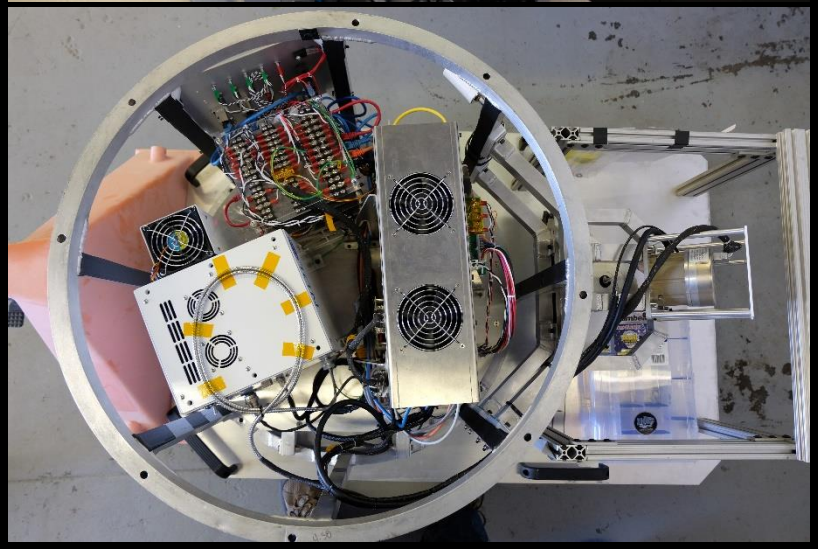


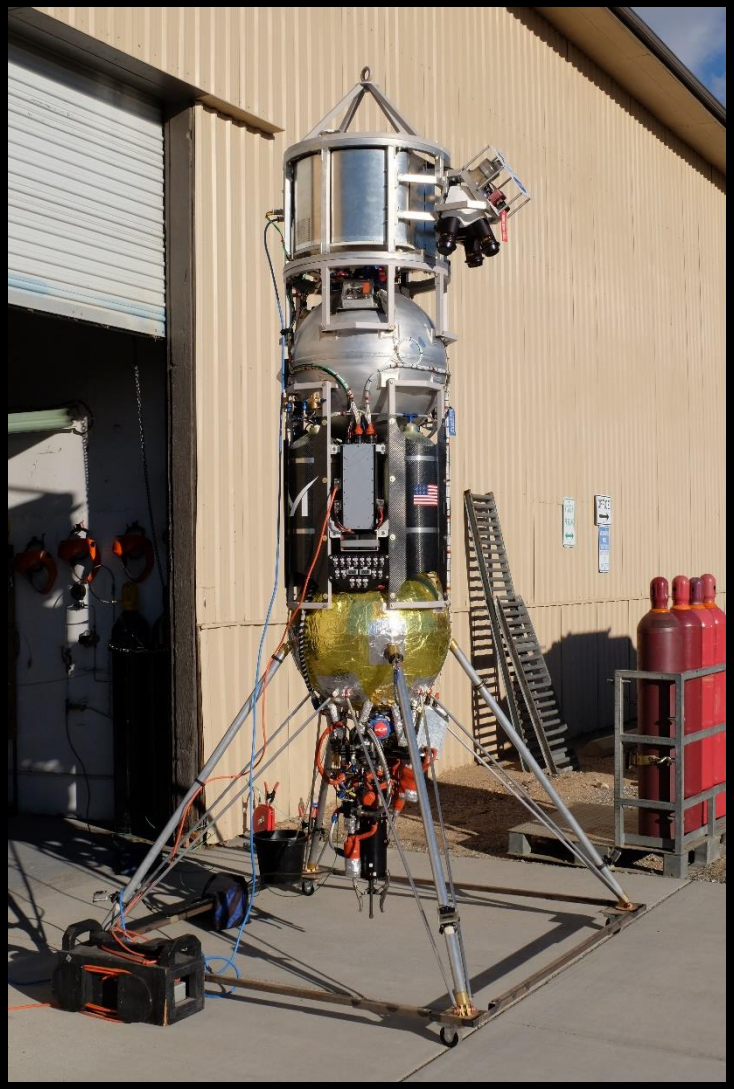
System Architecture



System Architecture







Testing

- Swing
- Bump
- PIP
- ATV + Xodiac Sim

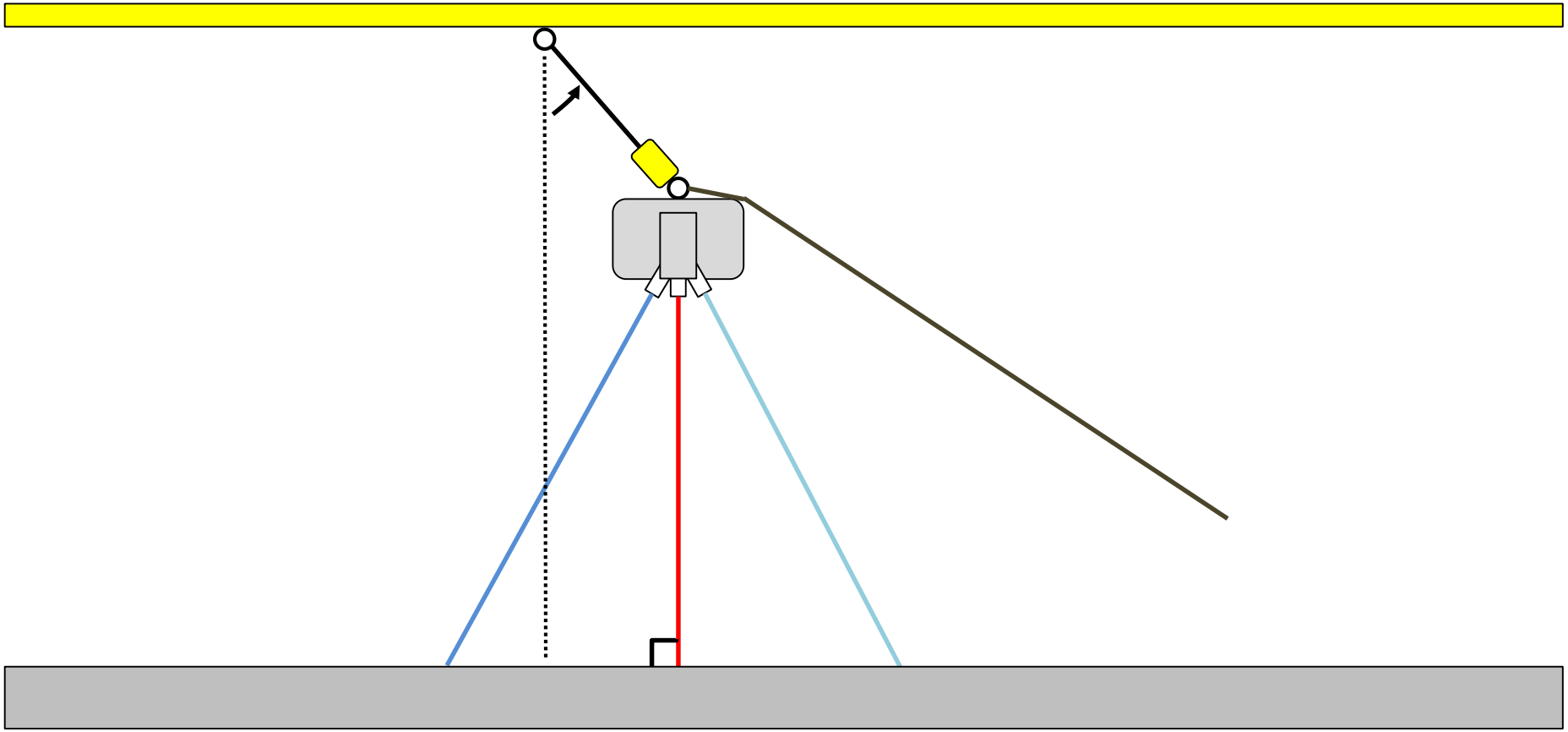
Synchronize

Initialize

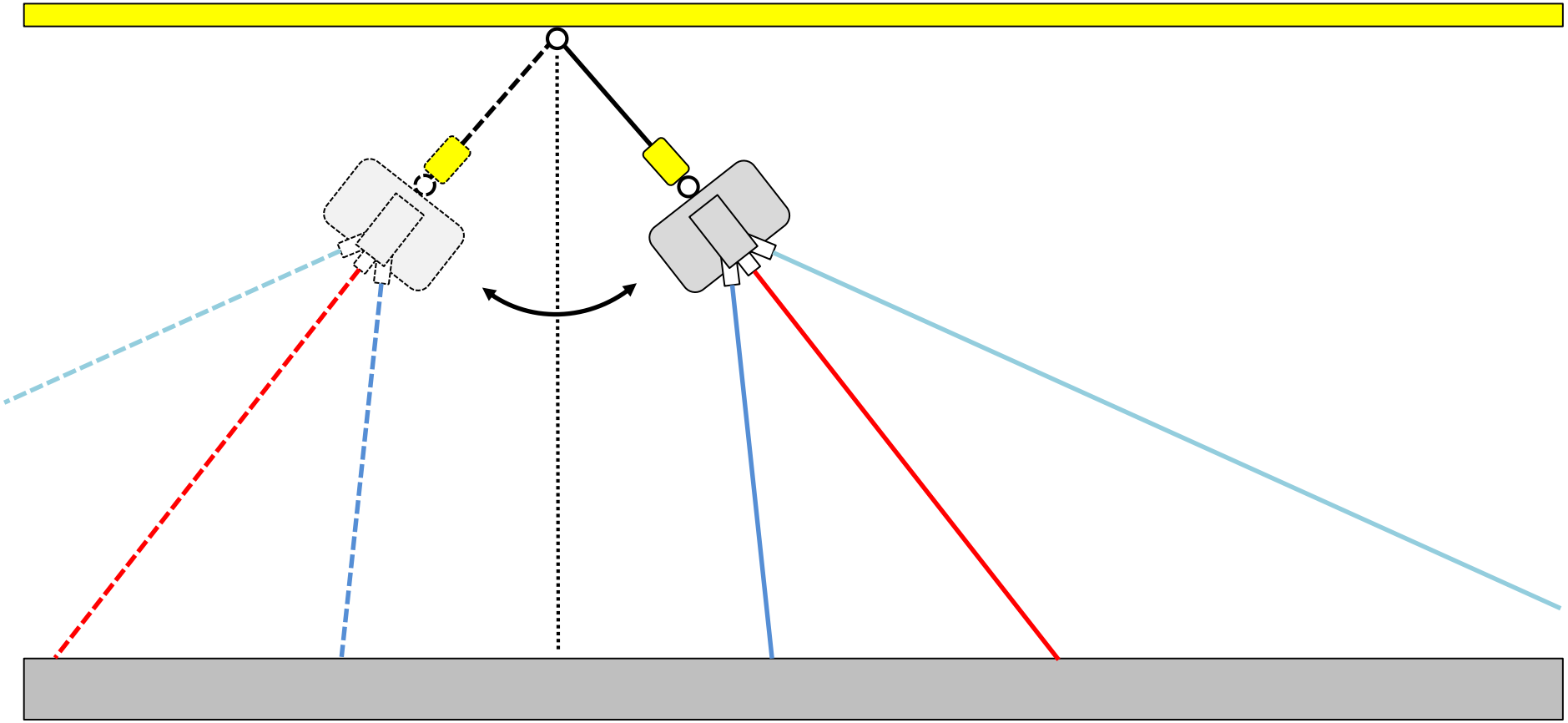
Full Test

Swing Test

Loaded Position:

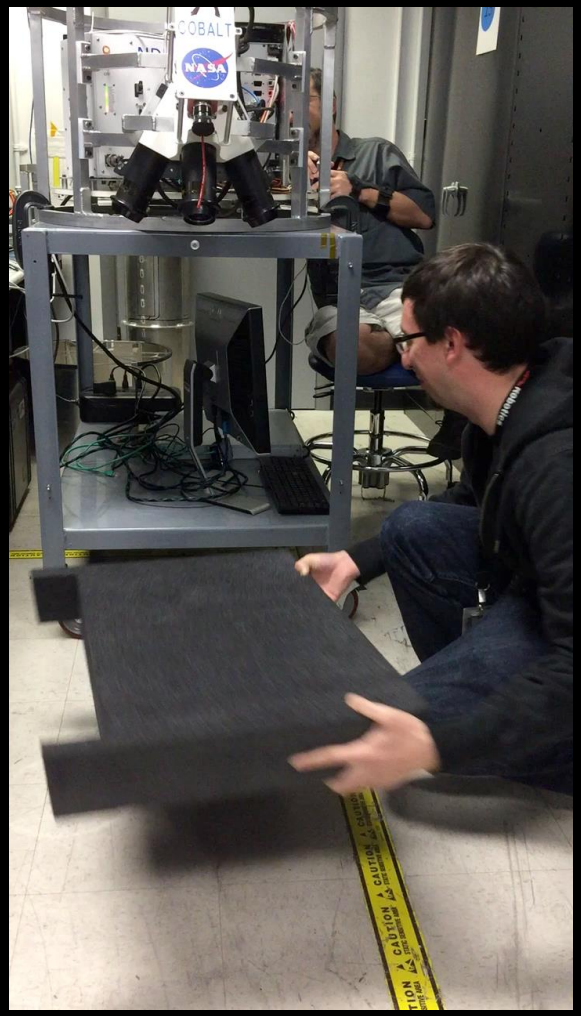


Swing Test

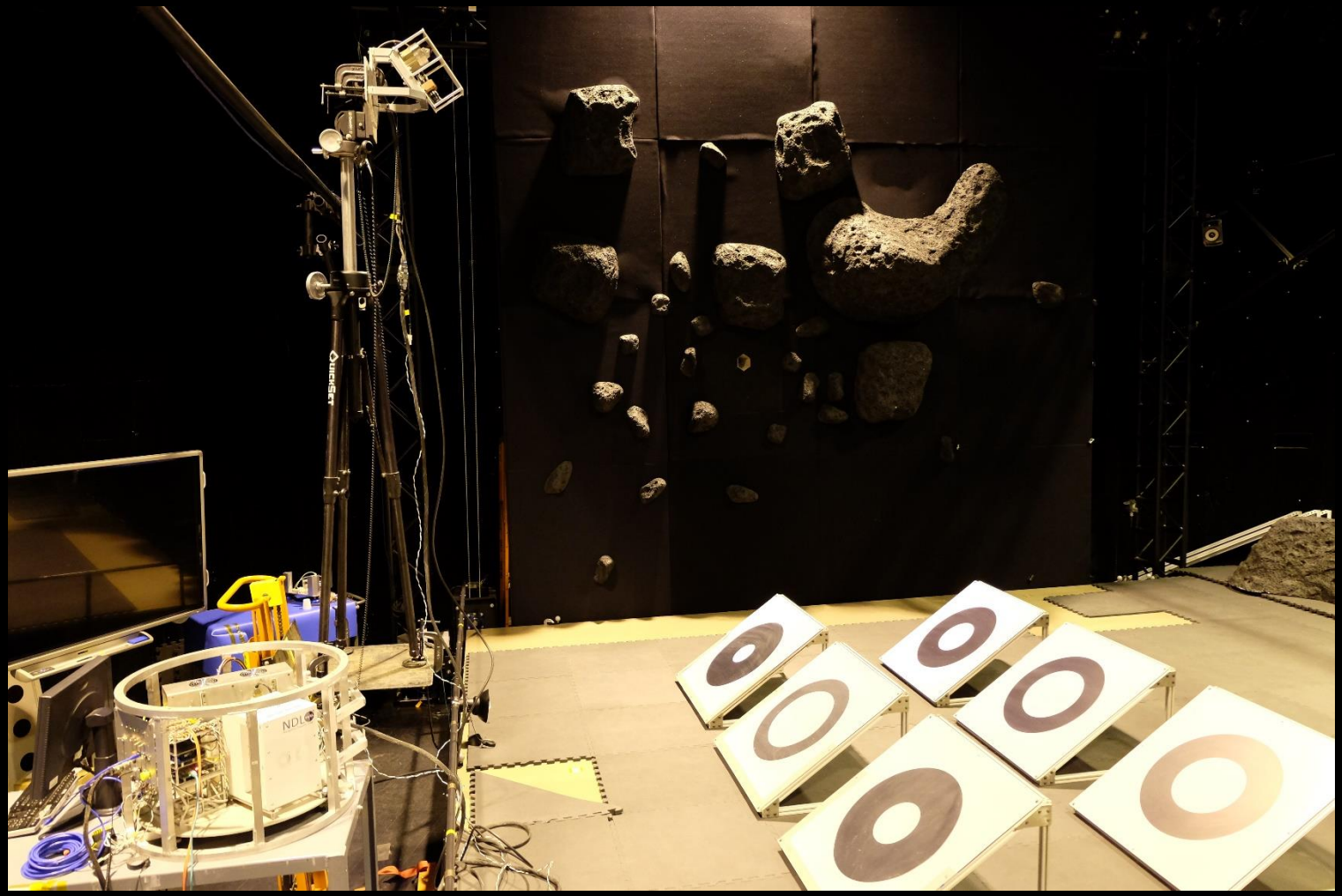


Swing Test

Bump Test



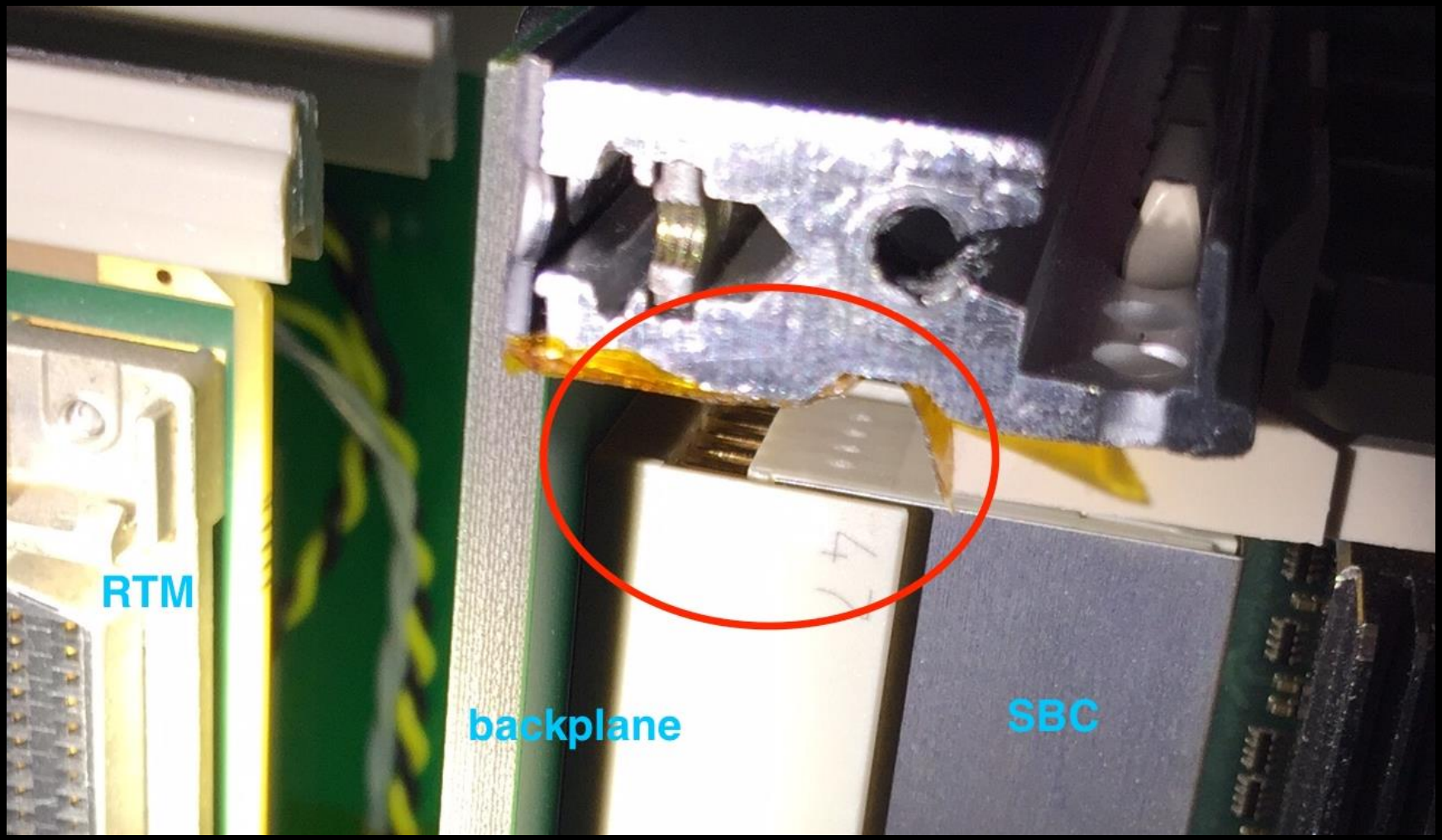
PIP Testing in Formation Control Testbed



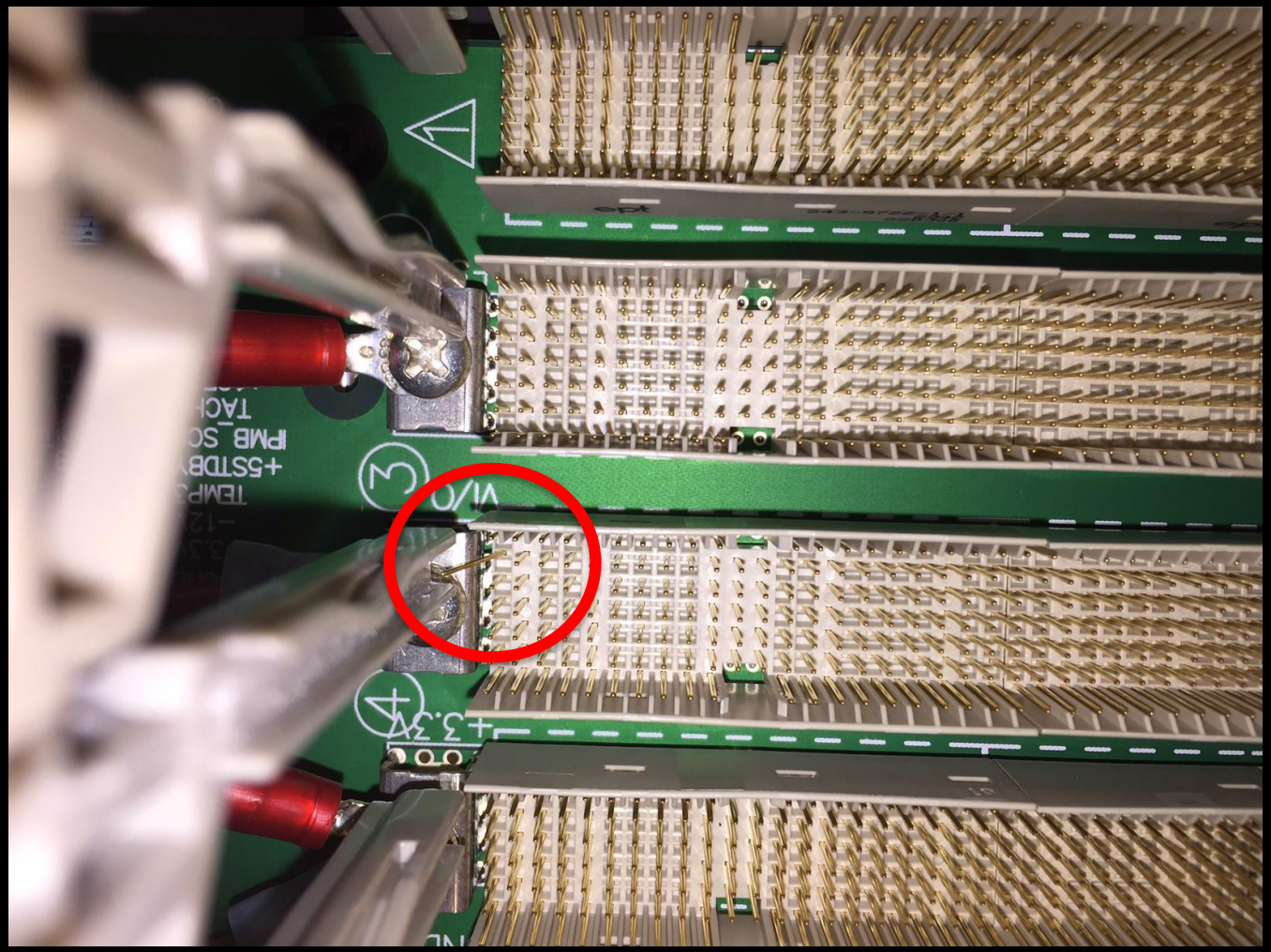
Testing PIP

Our Old Alignment Friend

Nothing ever goes smoothly

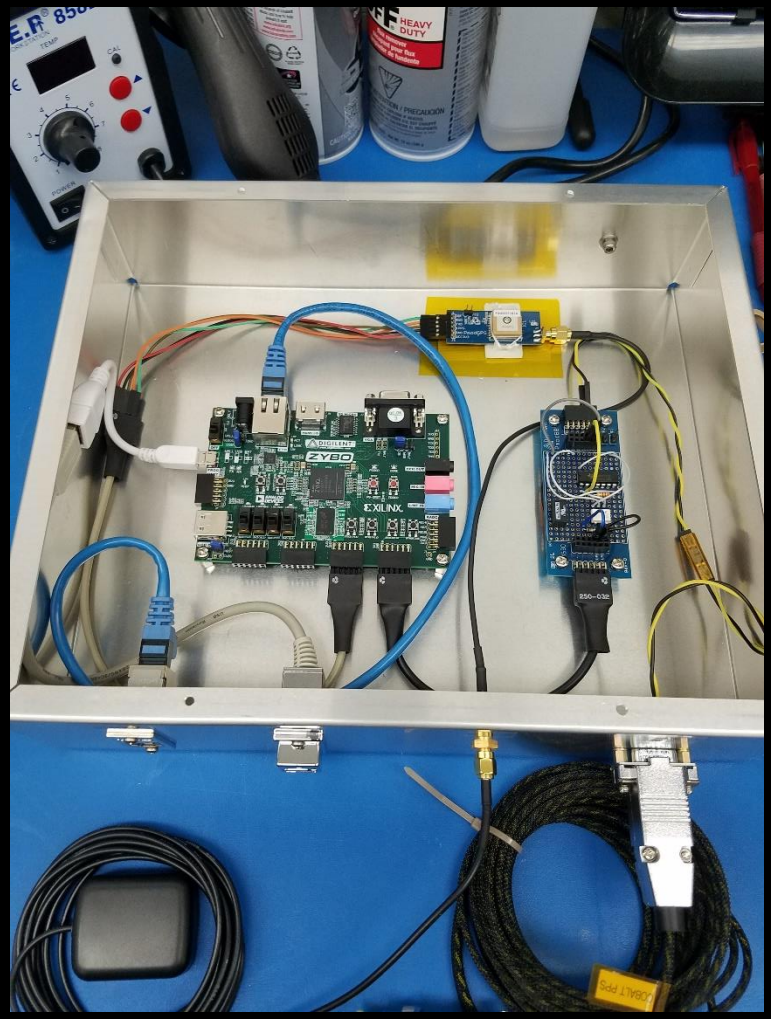


Nothing ever goes smoothly 2



ATV Testing

ATV Testing

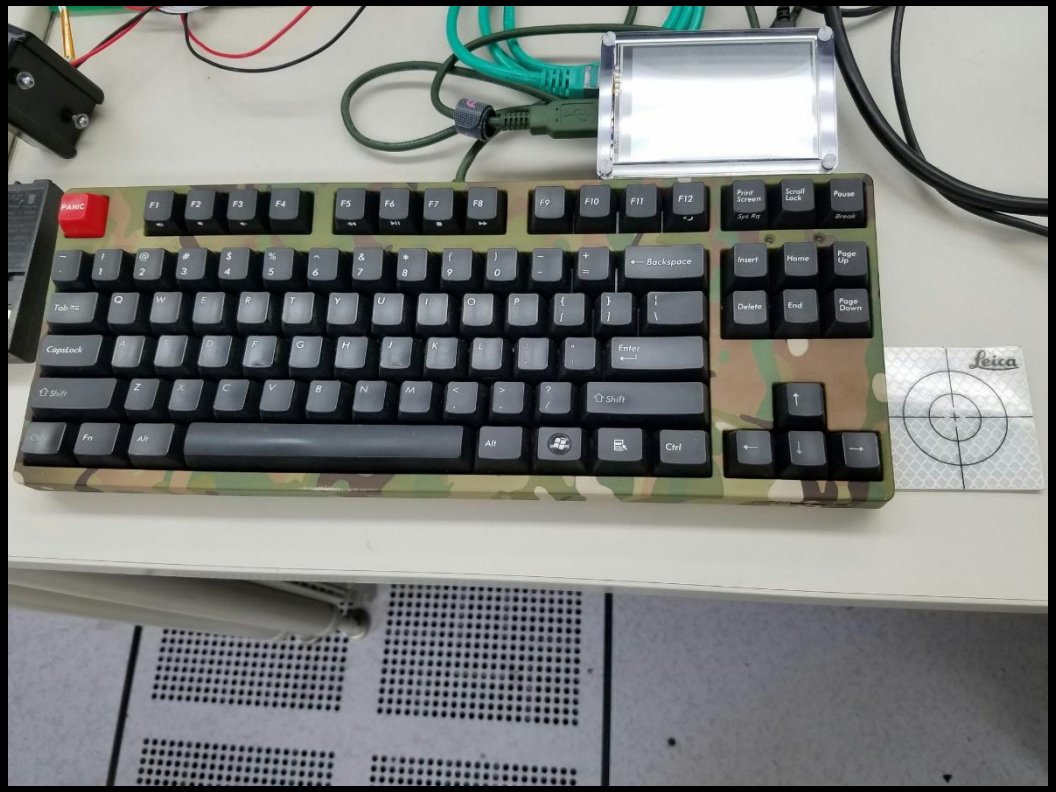


ATV Testing

ATV Testing

ATV Testing

Quick Health Monitoring



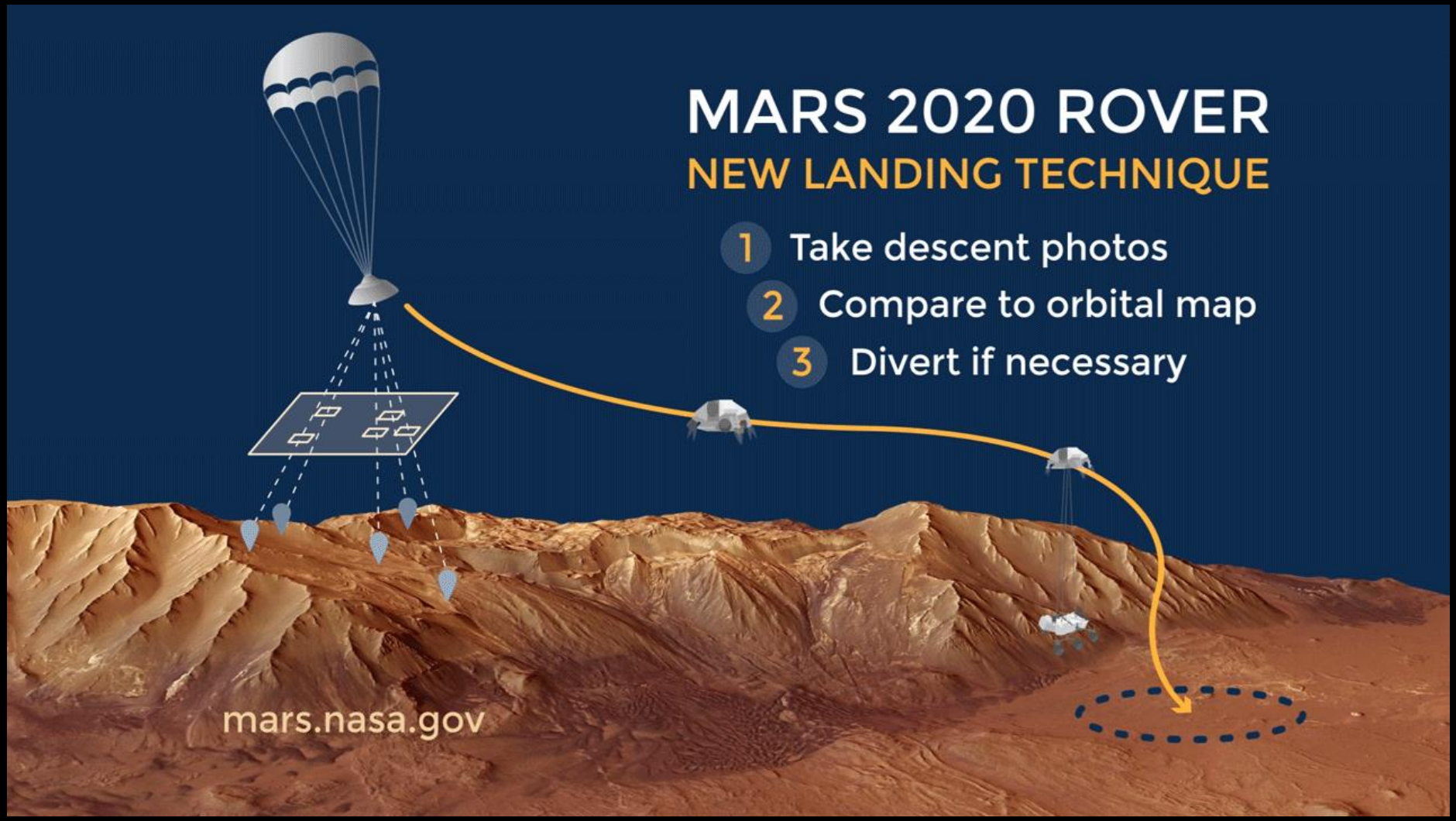
Tethered Flight

Free Flight

Free Flight

The Team

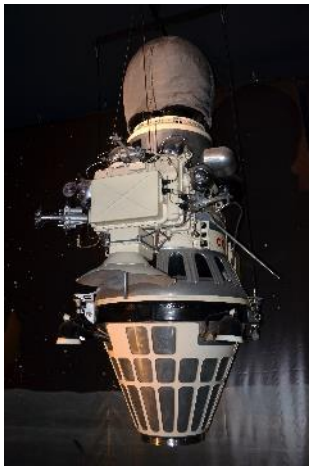
Mars 2020 – Lander Vision System



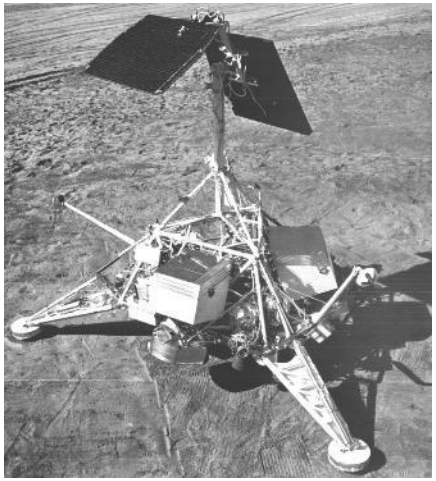
FIN

History of Lander Technology

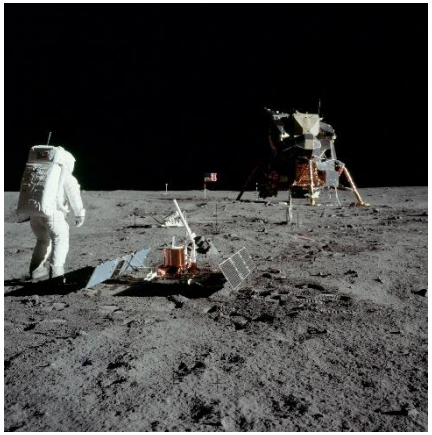
SOFT



Luna 9 (Feb 1966)



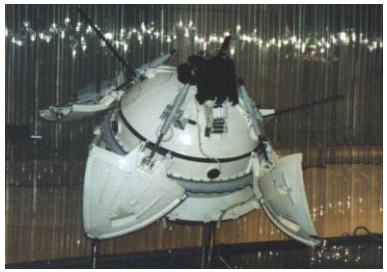
Surveyor 1 (June 1966)



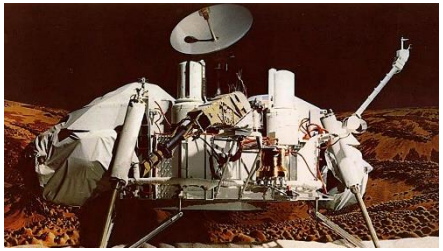
Apollo 11 (July 1969)

(Moon)

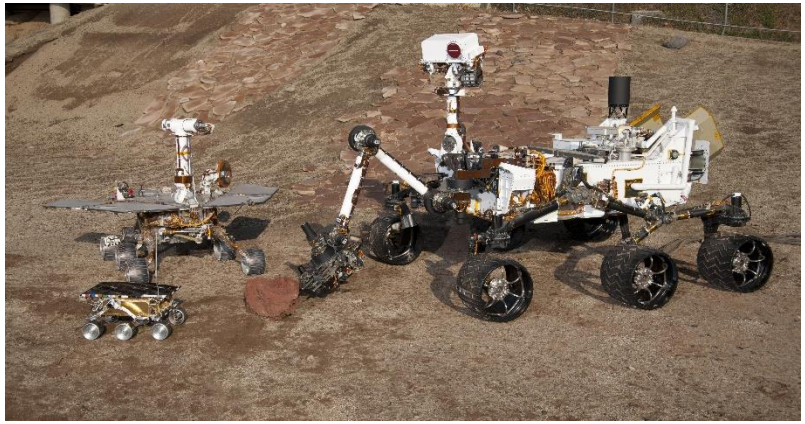
History of Lander Technology



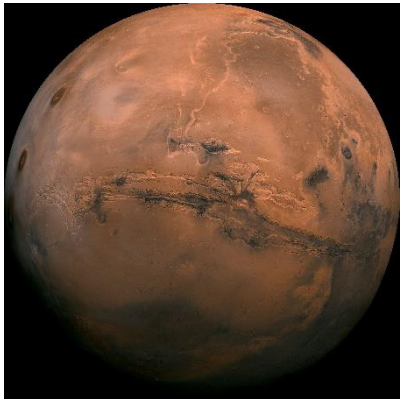
Mars 3 (1971)



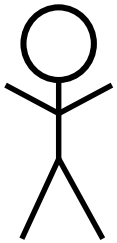
Viking 1 (1976)



Pathfinder/Sojourner, Spirit, Opportunity, Phoenix, Curiosity
(1997 – Present)



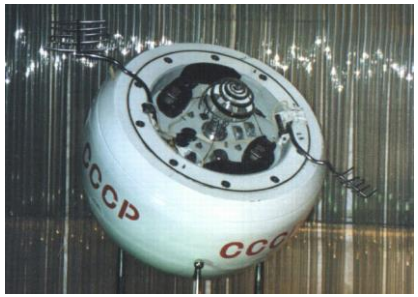
(Mars)



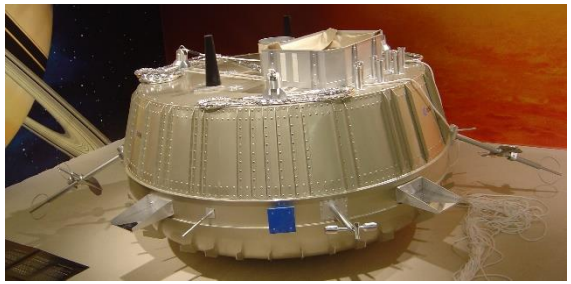
Humans
(¯_(ツ)_/¯)

History of Lander Technology

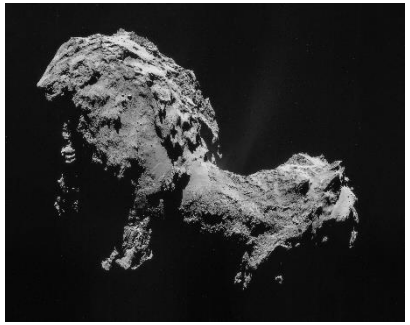
Philae (2014)



Venera 8 (1972)

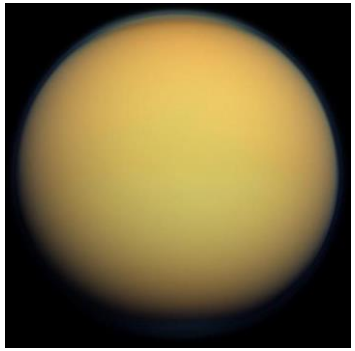


Huygens (2005)



(Comet)

(Venus)



(Titan)

Work Environment

The Team

ATV Testing

COBALT

Goal: Develop a platform to test GN&C hardware and software for pinpoint landings