



Jet Propulsion Laboratory  
California Institute of Technology

**Mars 2020 Project**

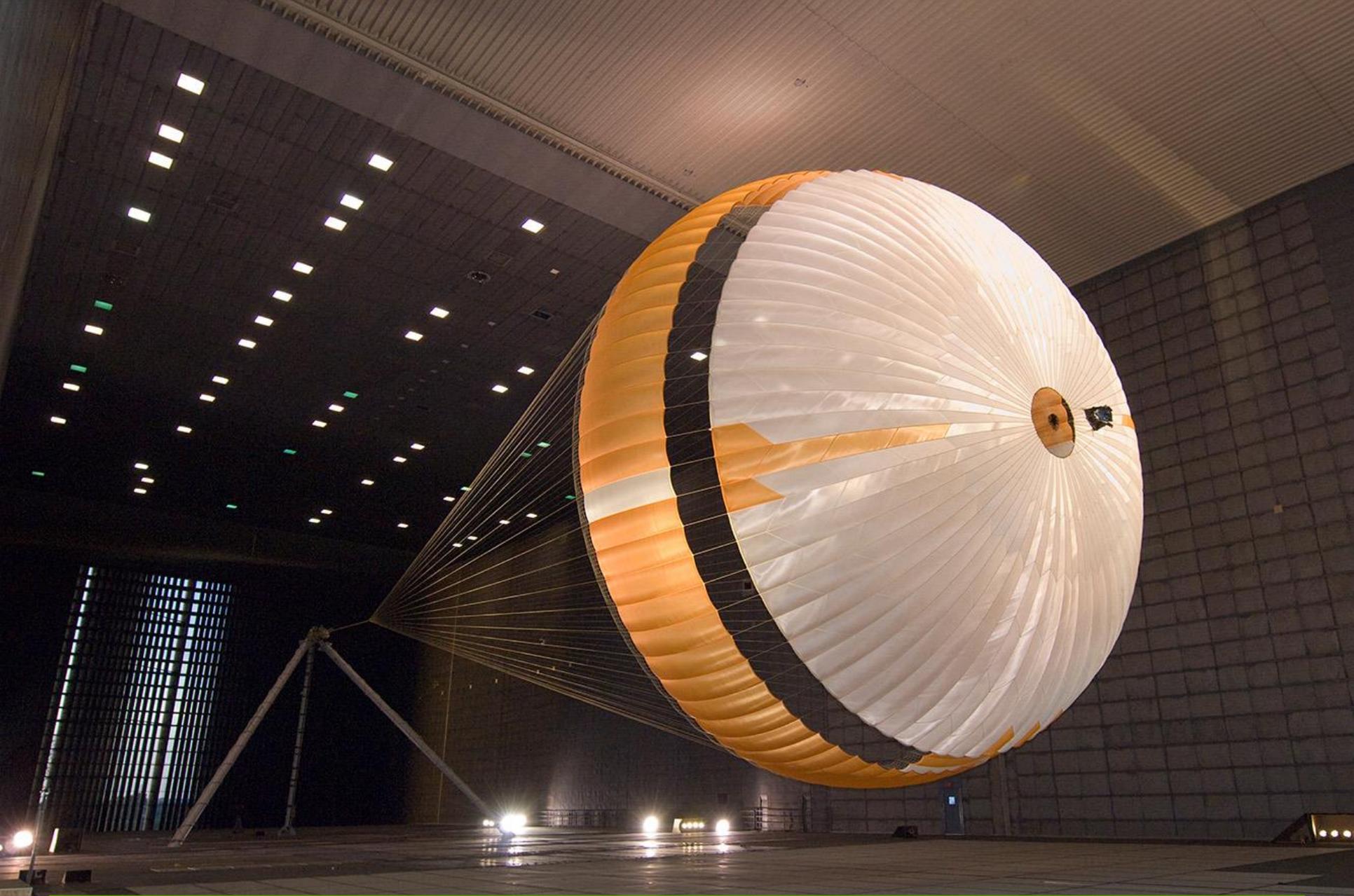
# **Mars 2020 Parachute Workmanship Wind Tunnel Testing**

**Gregory Villar, Chris Tanner**

...with contributions from many others

14<sup>th</sup> International Planetary Probe Workshop  
The Netherlands  
June 2017

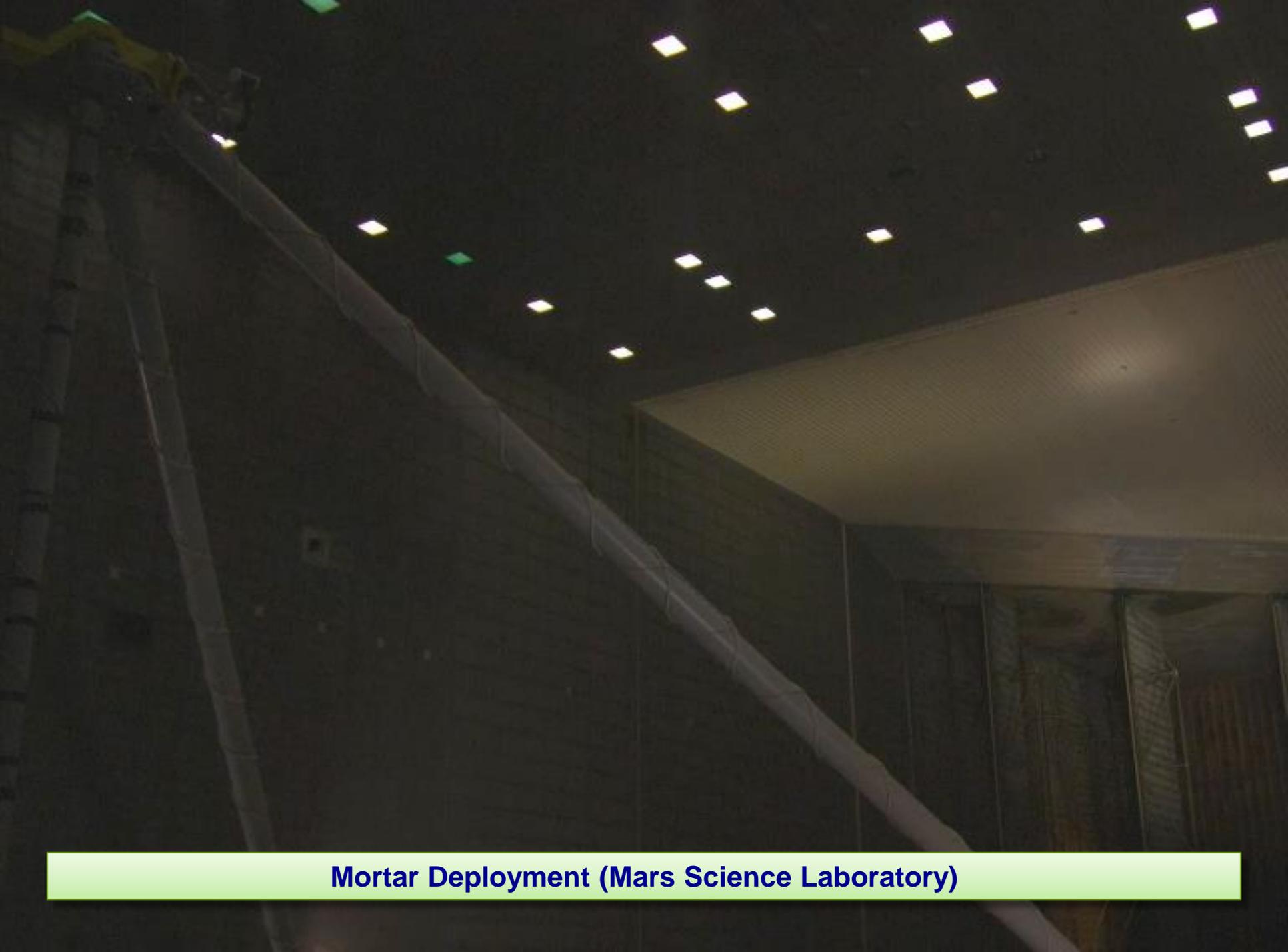
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**Mars 2020 wind tunnel testing heavily leverages the Mars Science Laboratory setup**



- **Test Objective**
  - Determine, through workmanship testing in the 80-by 120-ft National Full-Scale Aerodynamics Complex (NFAC) test section, that the flight-lot of Mars 2020 parachutes have been properly manufactured and will be sufficient for proposed supersonic sounding rocket testing and for flight.
- **Minimum Success Criteria**
  - The parachute assembly survives one (1) mortar deployed inflation at a peak axial load of at least 81,250 lbs with no damage to any component that is determined to be caused by excessive stress or loads
    - The parachute will be inspected after testing to determine if damage occurred
    - If damage occurs, the parachute team will review available data to determine severity of damage and cause of damage
    - Investigation results will be assessed and presented to the project to determine test success

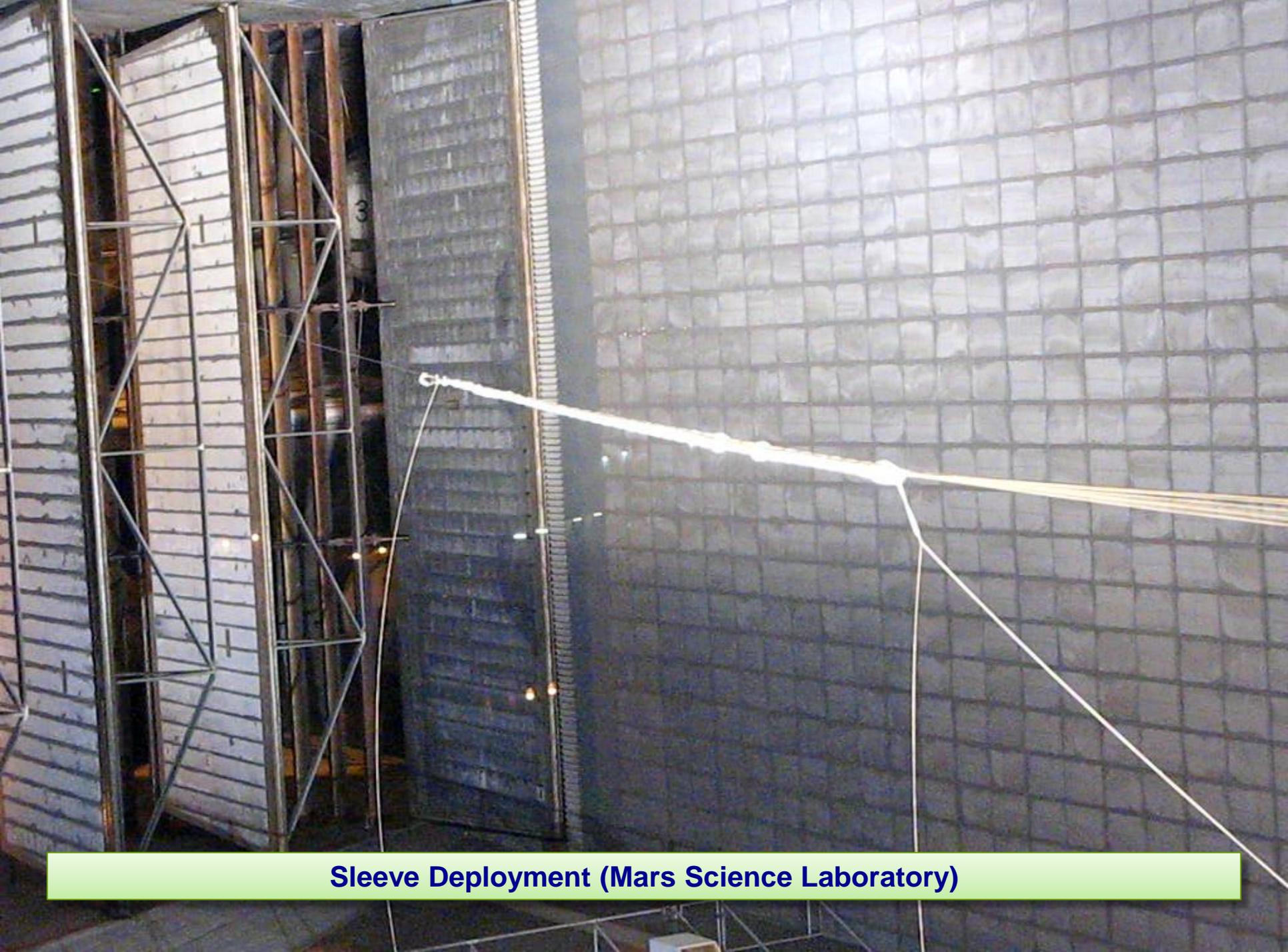


**Mortar Deployment (Mars Science Laboratory)**

- MSL performed successive sleeve deployment tests as a risk reduction experiment to discover if the parachute canopy could incur damage during repeated inflations
  - Successful sleeve deployed inflations were not required for flight
  - Ultimately, one parachute from the MSL flight lot was sleeve deployed ten (10) times at decreasing loads without concerning damage to the canopy
- Mars 2020 will perform area oscillation risk reduction experimentation to similarly discover risks associated with repeated inflations
  - Sleeve deployment success is not required as a gateway to proposed ASPIRE tests or flight
  - However, if parachute failure occurs and it is determined to be a direct result of stress and/or fatigue resulting from the inflation, then an investigation will be conducted to determine if it has implications to ASPIRE or flight

*Sleeve Deployment Sequence  
(MSL Heritage)*

| Minimum Load (lbs) | No. of Deployments |
|--------------------|--------------------|
| 81,250             | 3                  |
| 75,000             | 4                  |
| 65,000             | 3                  |



**Sleeve Deployment (Mars Science Laboratory)**



- **Imaging**
  - Numerous high speed, high resolution cameras in the facility
  - 3x high speed, high resolution cameras on instrumentation ring
  - Photographers taking stills
- **Load Measurements**
  - 3x load pins on instrumentation ring
  - 3x load cells on launch arm
- **Test Condition Measurements**
  - Wind velocity
  - Dynamic pressure
  - Weather conditions (humidity, temperature, wind speed and direction)

### Instrumentation Ring

- 3x load pins
- 3x HS,HR cameras

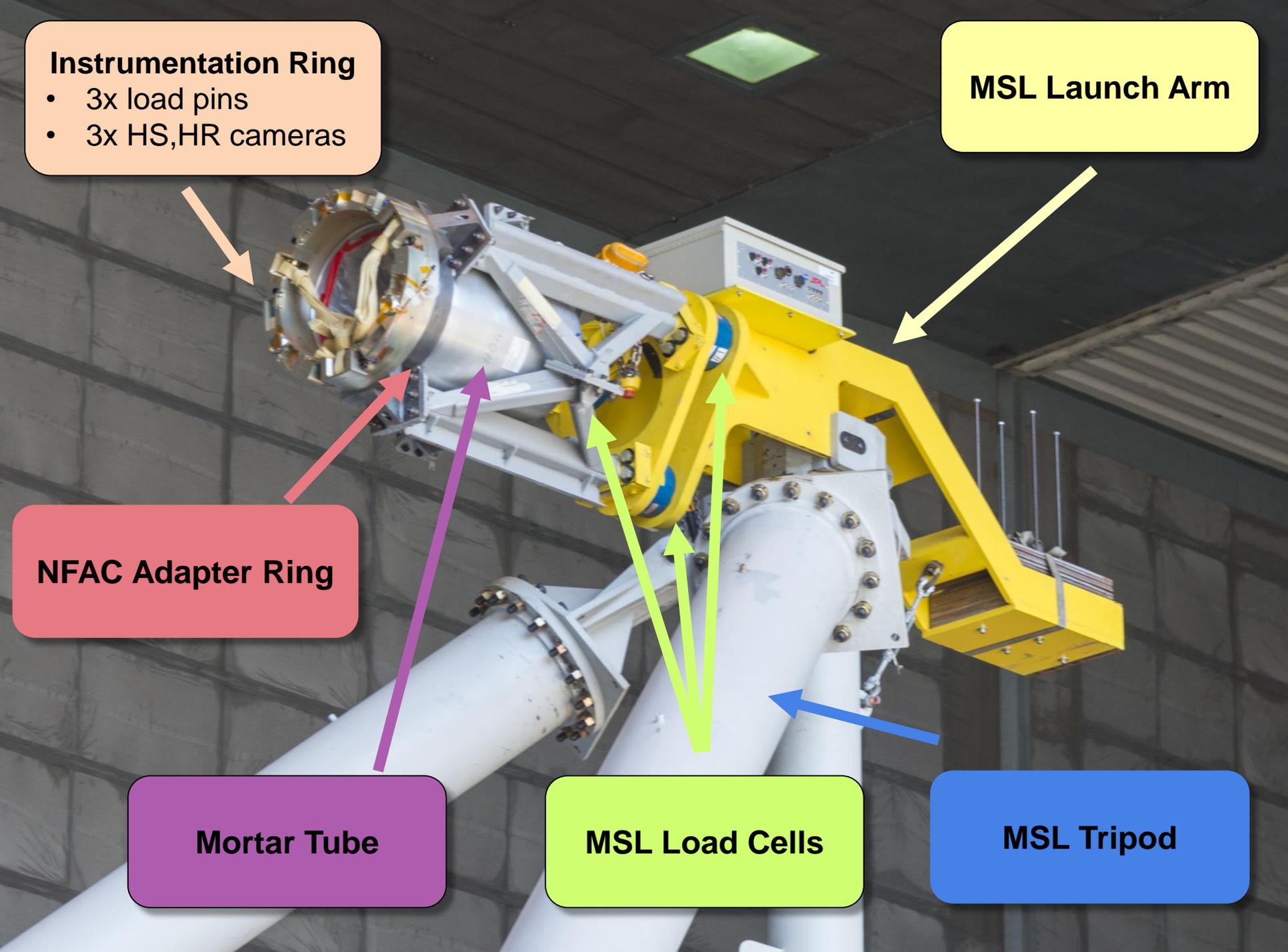
### MSL Launch Arm

### NFAC Adapter Ring

### Mortar Tube

### MSL Load Cells

### MSL Tripod



# Camera Layout

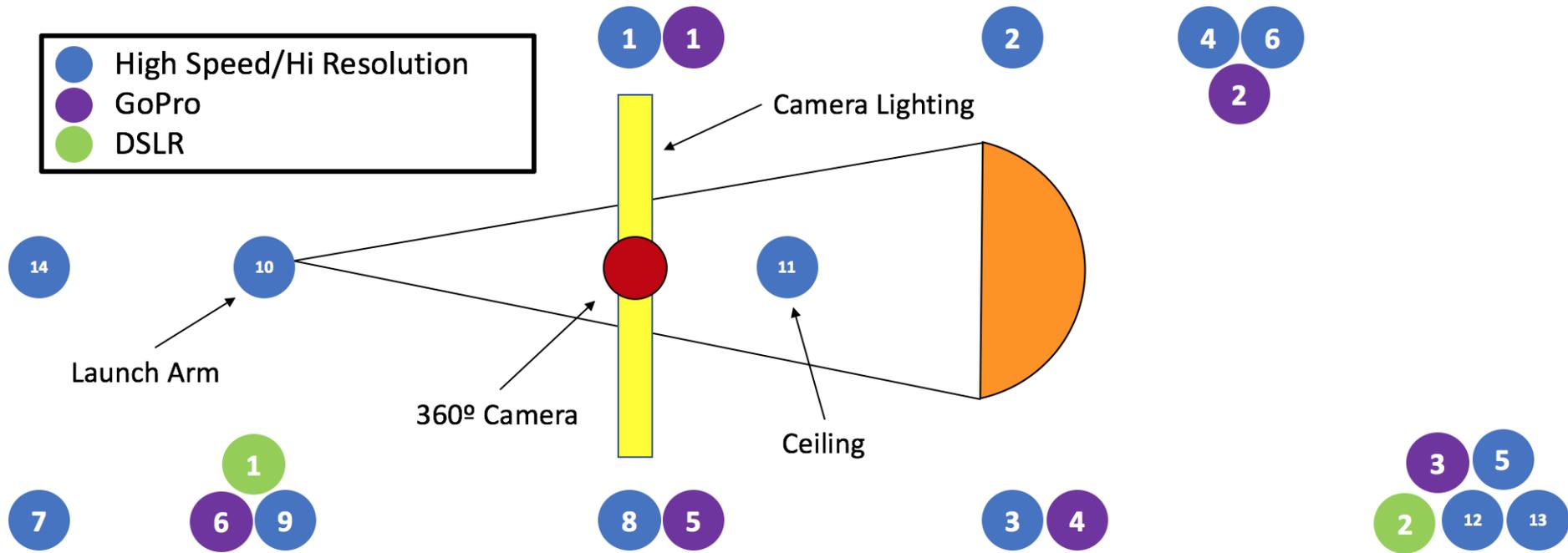


## Cameras positioned to capture key parachute events

- Mortar Fire
- Bag Strip
- Line Stretch
- Inflation

## Cameras provided by several teams

- NASA Ames Imaging
- JPL Photo Lab
- JPL Media





**Wind tunnel setup completed on May 31, 2017  
Parachute testing will occur throughout June 2017**

- **Wind tunnel setup completed on May 31, 2017**
- **Parachute testing will occur throughout June 2017**
  - 3 mortar deployments (1 per day)
  - 20 sleeve deployments (2 per day)
- **Test infrastructure removal begins July 5, 2017**

**Mars 2020 is ready to execute Parachute Workmanship Wind Tunnel Testing**