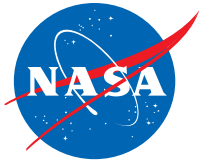

ADEPT Sounding Rocket One (SR-1) Flight Experiment Overview

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2017 IEEE Aerospace Conference

Big Sky, MT

Track 2: Space Missions, Systems, and Architectures

Session 2.03 Systems and Technologies for Landing on Planets, the Moon, Earth and Small Bodies

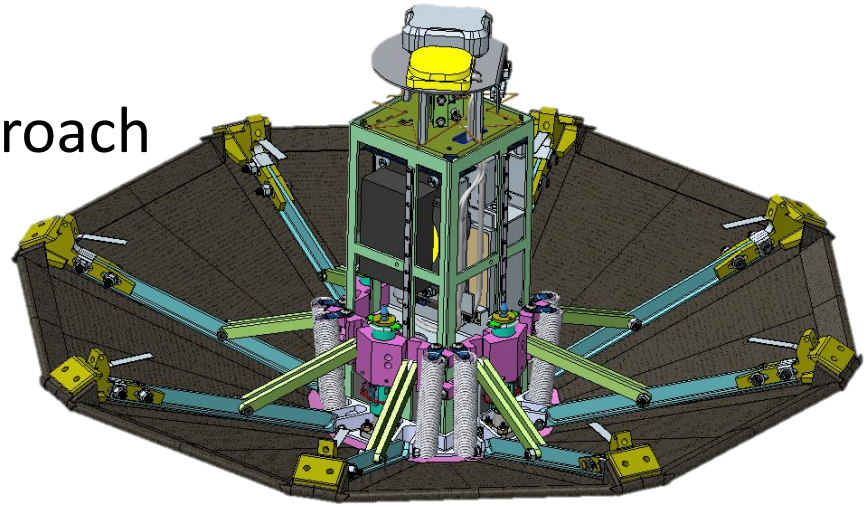
What is this talk about?

My goal is for you to walk away with an understanding of the ADEPT technology, overview of the SR-1 flight experiment, SR-1 system description and capabilities, development test summary, and longer term mission infusion

Presentation Outline

- ADEPT Technology overview
- SR-1 Flight Experiment Con-Ops
- Flight Experiment Success Criteria
- SR-1 Subsystem Description
- Risk-based Development Testing Approach
- ADEPT technology infusion options

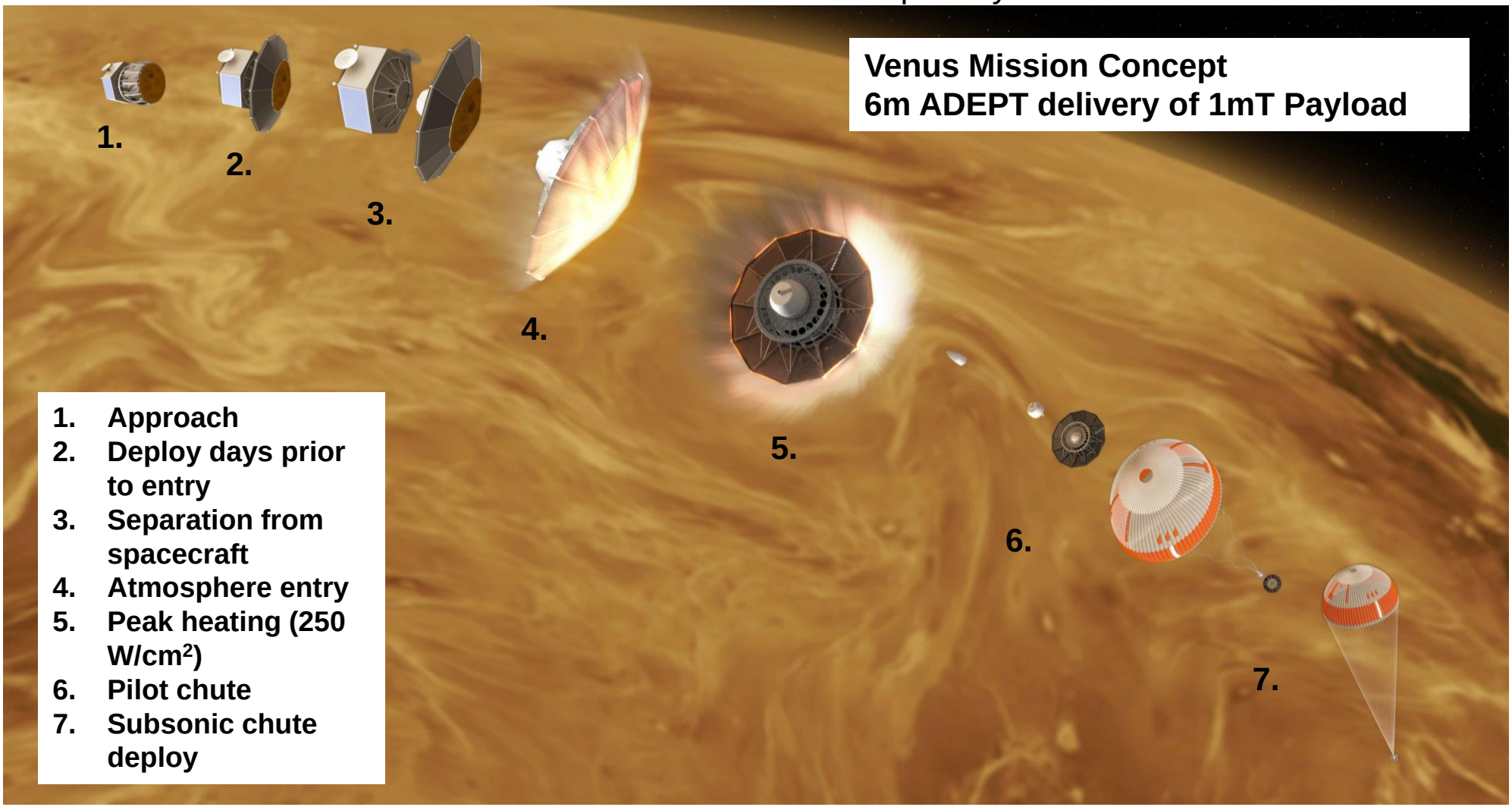
ADEPT SR-1



Adaptable Deployable Entry and Placement Technology (ADEPT)

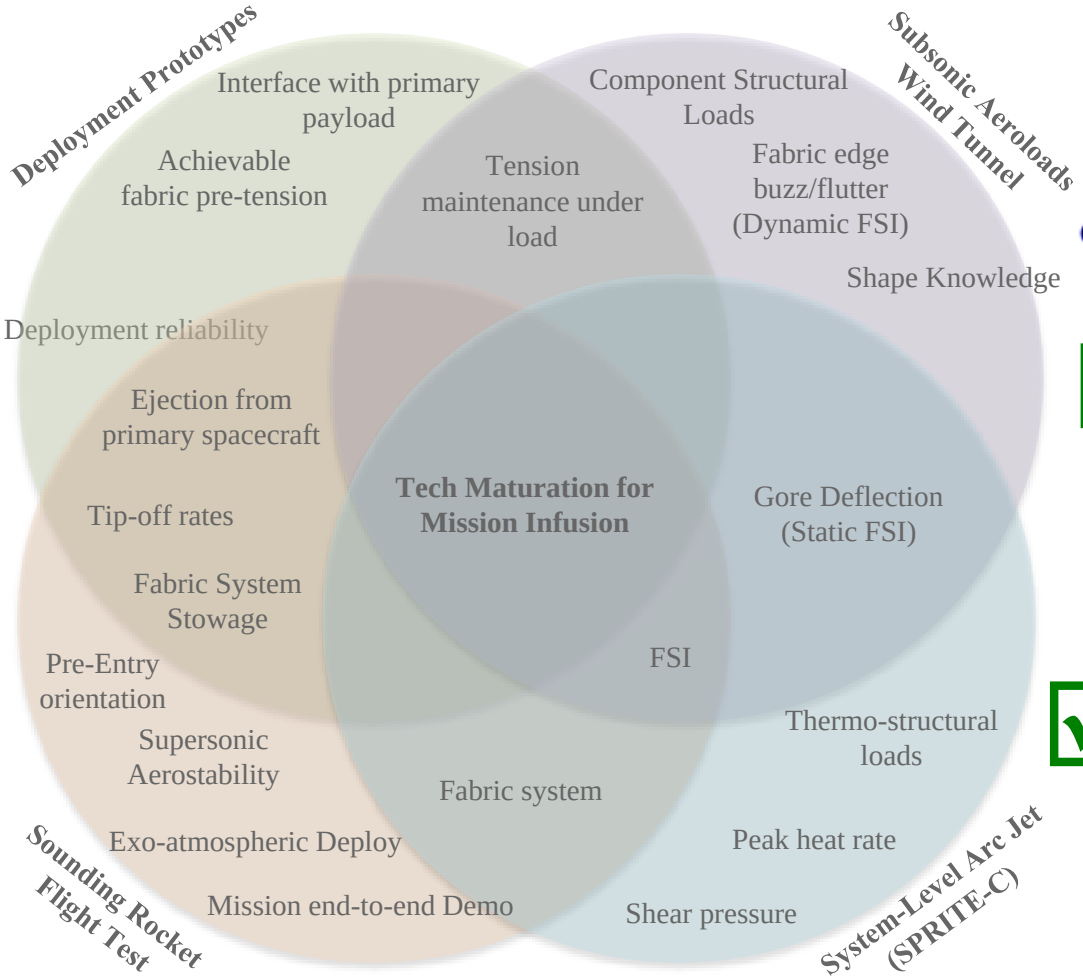
ADEPT is a novel Entry, Descent, and Landing (EDL) architecture enabled with multi-layer, flexible woven carbon fabric

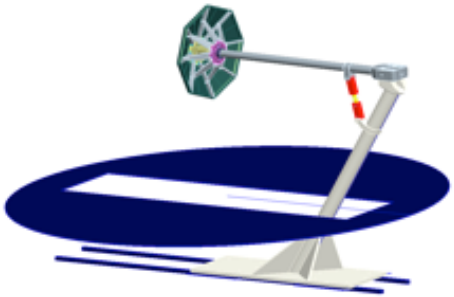
- Stowed at launch and deploys prior to atmosphere entry
- Serves as both heat shield and primary structure



Technology Maturation Strategy

Deployment Prototype Demonstrator (FY15-16) ☑

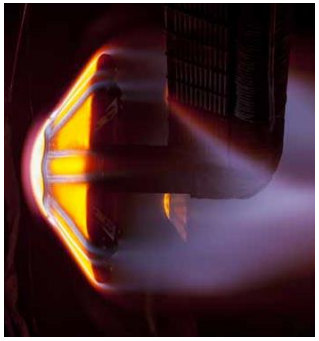




7x10 Wind-tunnel Aeroloads test (FY15) ☑

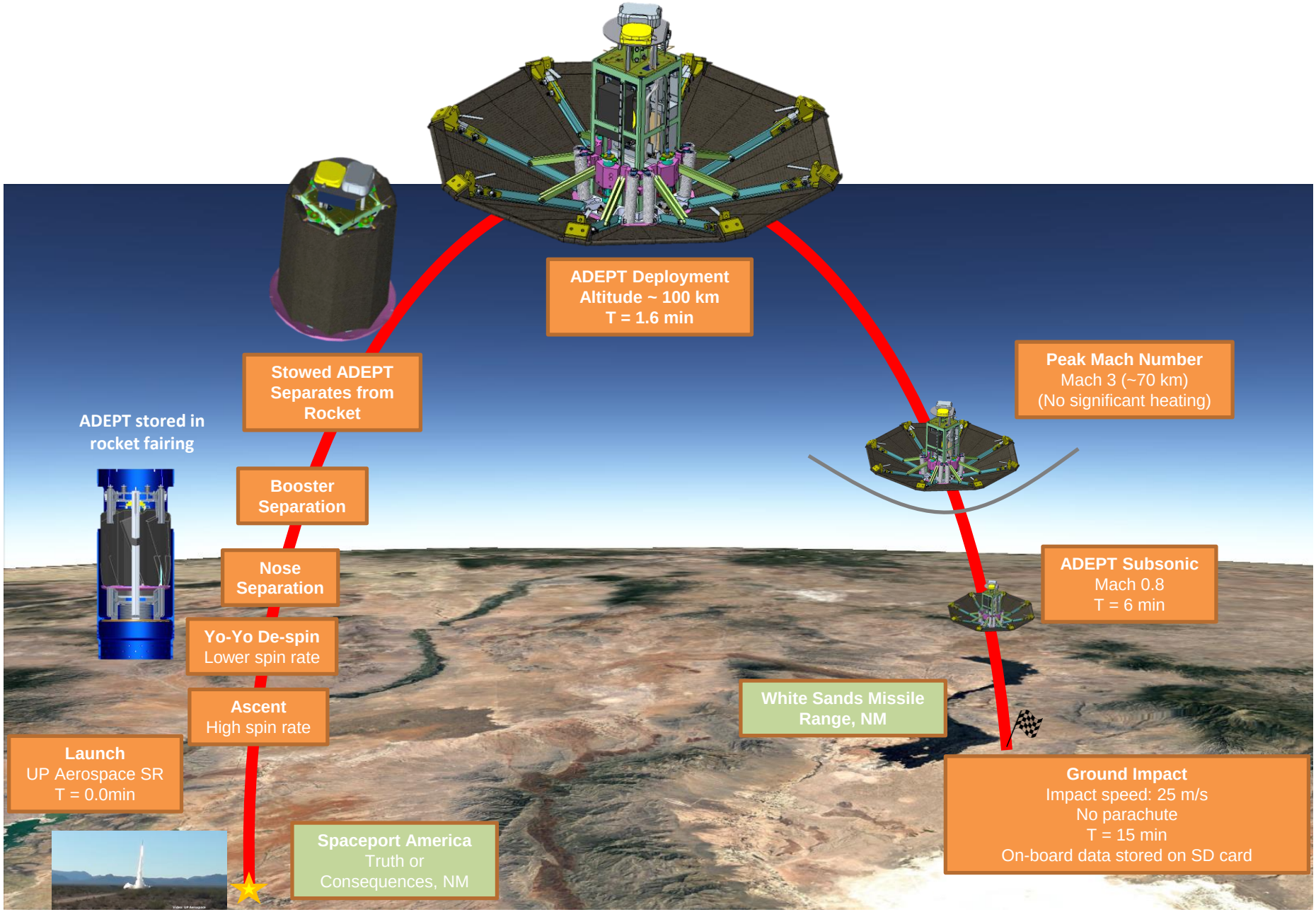
SR-1 Sounding Rocket Flight Test (FY17-18) ☐

SPRITE C System level Arc-jet testing (FY15) ☑



- **GCD approved (Aug 2016) SR-1 Sounding Rocket Flight Experiment**
  - **Demonstrating exo-atmospheric deployment and supersonic stability**
  - **Aggressive schedule -> 1 year between PDR and Launch!**
  - **Launch in late CY 2017**

SR-1 Flight Experiment Overview



SR-1 Animation movie

ADEPT SR-1 Flight Experiment
Key Performance Parameters and Success Criteria

KPP-SR1-1: *Exo-atmospheric deployment to an entry configuration*

Project Goal: Full, locked deployment before reaching 80 km altitude on descent, to 70º forebody cone angle

KPP-SR1-2: *Aerodynamic stability without active control*

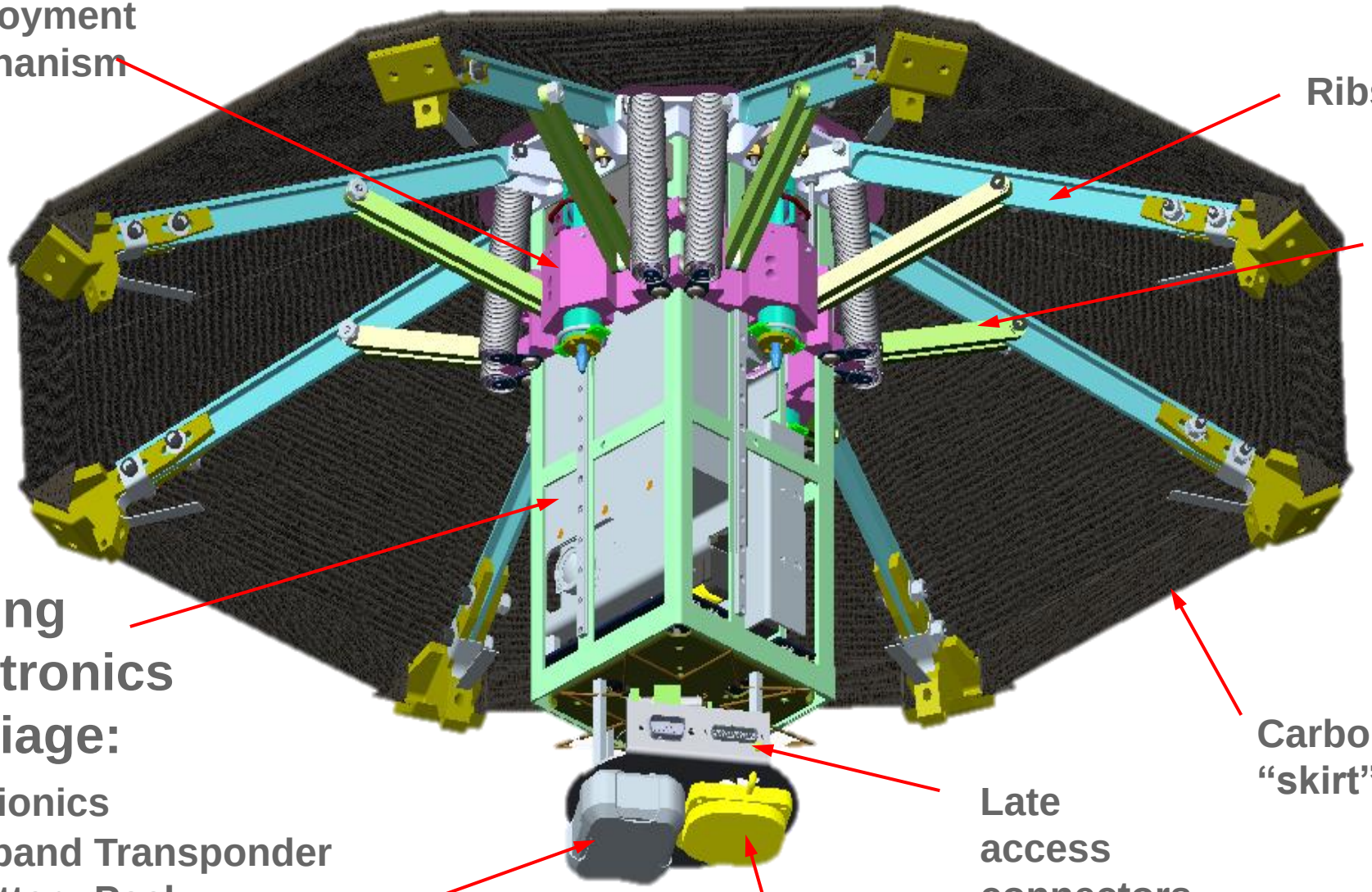
Project Goal: Does not tumble before ground impact;

SR-1 Flight Test Success Criteria

A. ADEPT separates from the sounding rocket prior to apogee
B. ADEPT does not re-contact any part of the launch vehicle after separation
C. ADEPT reaches an apogee greater than 100 km.
D. ADEPT achieves fully deployed and locked configuration prior to reaching 80 km altitude on descent
E. Obtain video of deployed ADEPT to observe fabric response and flight dynamics during entry
F. Obtain data necessary to reconstruct ADEPT 6 DOF descent trajectory

- **Data Sources to Verify Success Criteria**
  - **On-board data (Avionics data and GoPro camera) stored for post-launch recovery**
  - **White Sands Missile Range (WSMR) ground tracking data**

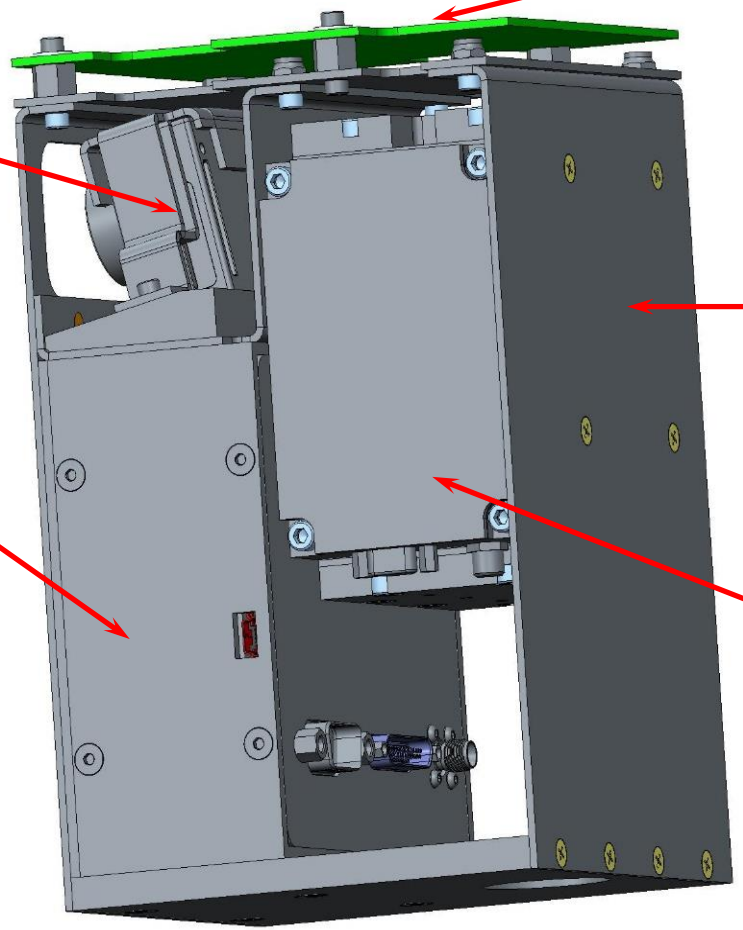
SR-1 Layout and Subsystems



SR-1 Electronics Carriage

GoPro Camera
- Hero 3
- Data (µSD)

Affordable Vehicle Avionics (AVA)
- IMU
- Accelometers
- GPS
- Data (µSD)



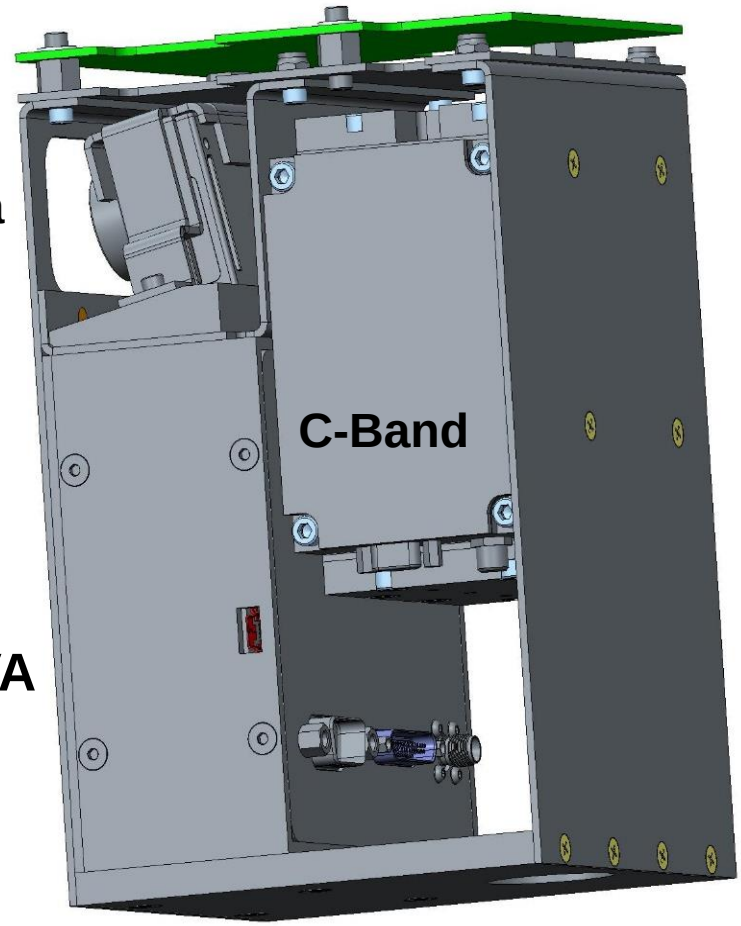
EPS Board
- Power regulation and distribution
- Simple events timing
- LED event indicator

Battery Pack (Behind Transponder)
- Panasonic Li-Ion Cells
- Size 18650
- Qty 6

C-Band Transponder
- TTC 520-XPDR
- 25W Unit

Electonics Carriage
- **Supports on-board data collection and storage**
- **Supports Ground Tracking facilities**

How SR-1 Data Sources will be Used



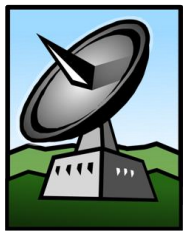
GoPro® Camera on Launch Vehicle
Deployment Confirmation LED

USE: Confirm full and locked deployment

Primary IMU
Backup IMU
Magnetometer
GPS Receiver
GoPro® Camera on ADEPT
C-Band Transponder
Atmospheric Pressure and Temperature Measurement with Weather Balloon

USE: Trajectory reconstruction for dynamic stability assessment and FF-CFD simulation validation

WSMR Ground Tracking Stations



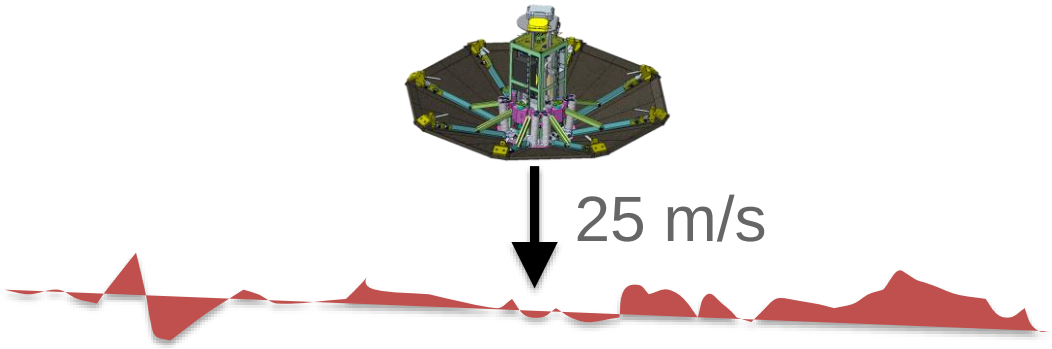
SPOT Trace®
C-Band Transponder
Ground Tracking Radar

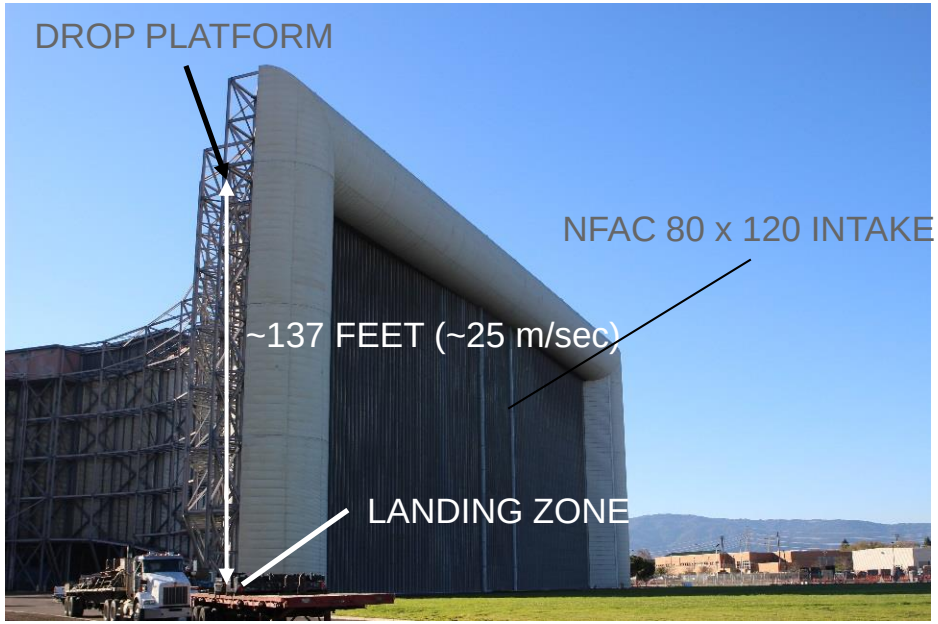
USE: Locate SR-1 after ground impact

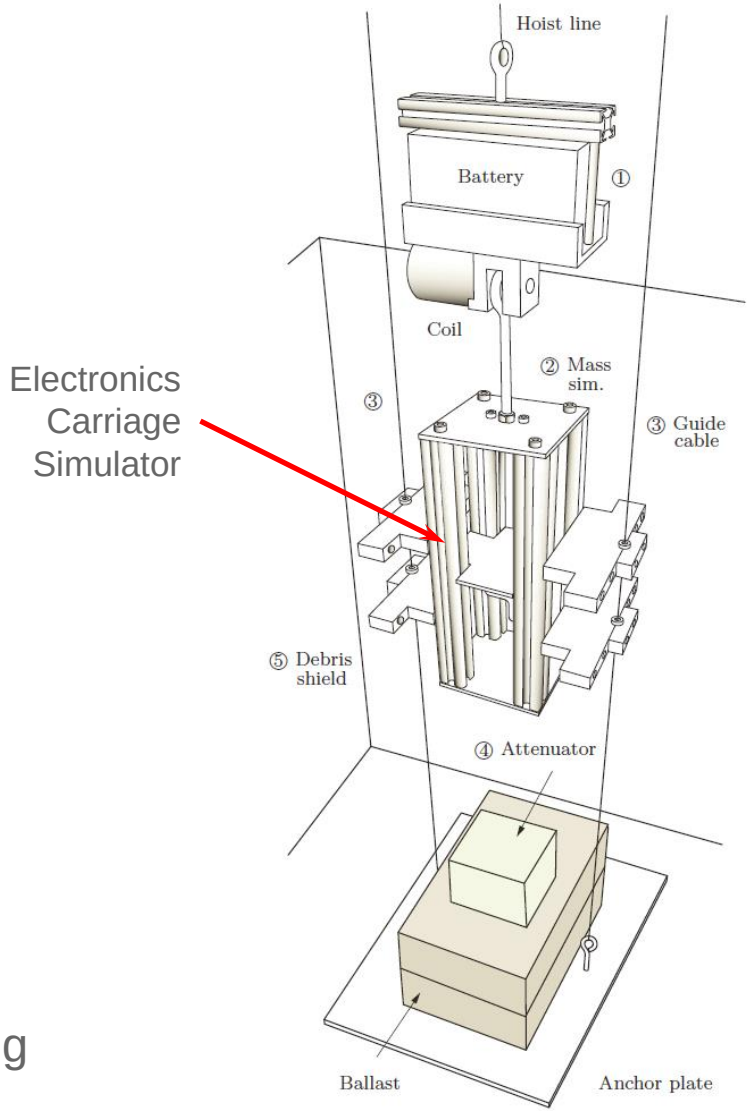
Electonics Carriage

- **SD cards must survive ~ 25 m/s (54 mph) impact velocity!**

Shock Testing of SD Cards
(Drop Testing to Assess Impact Survival)







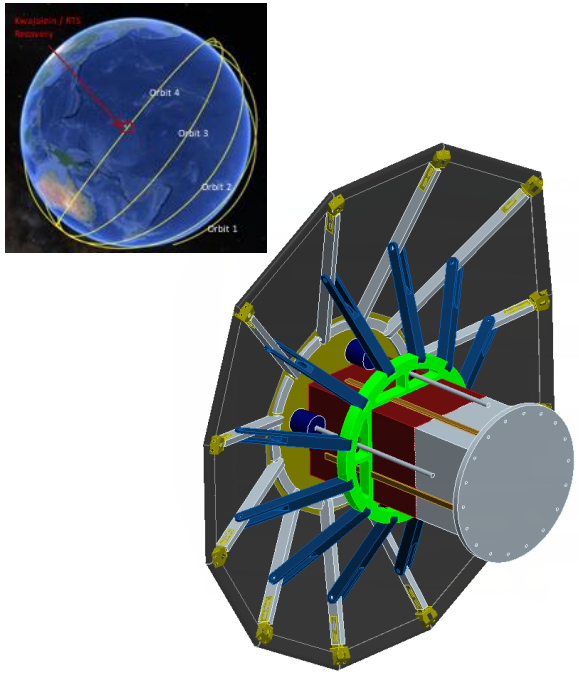
- Drop test location allows matching of flight article impact velocity
- Drop test configuration allows controlled impact testing of impact attenuator and SR-1 electronics carriage

Shock Testing of SD Cards
(Drop Testing to Assess Impact Survival)

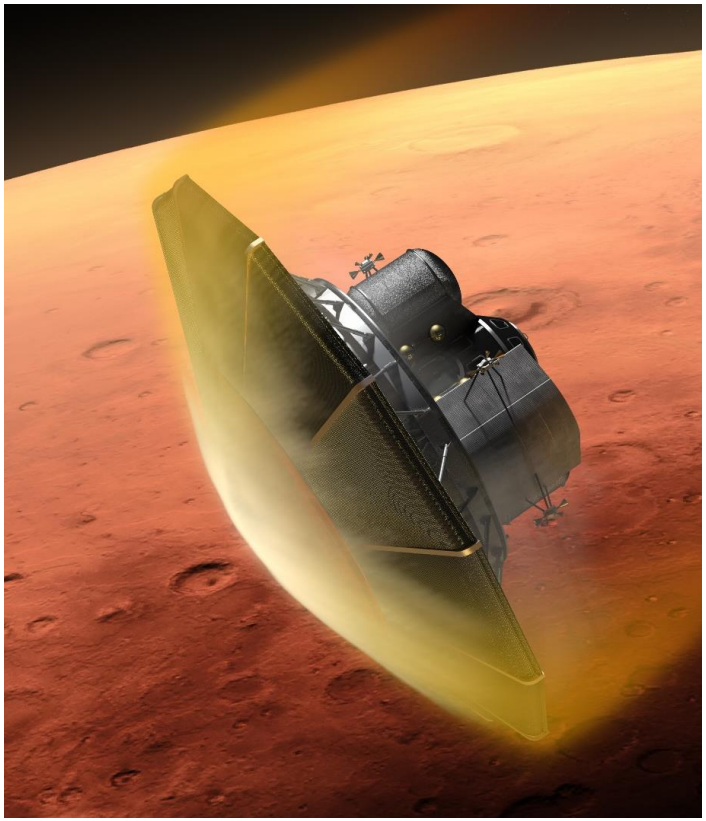
Summary

- **ADEPT SR-1**
  - "First step" Flight experiment demonstrating ADEPT
- **Looking beyond SR-1…**
  - Small spacecraft by using an ADEPT EDL system to overcome volume limits
  - Secondary payloads to Venus, Mars, and LEO entry are feasible near-term applications
  - Nano-ADEPT provides technology development extensible to large ADEPT applications

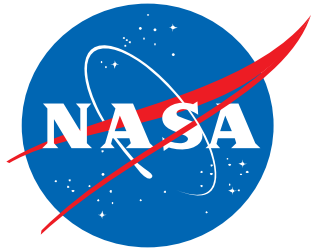
1m ADEPT Mars Lander
Malin SSS Concept (2014)



1.5m Lifting ADEPT LEO Flight Test Concept
NASA Ames & JHU-APL Study (2016)



16m Lifting ADEPT Human Exploration


NASA