Mars Science Laboratory Overview
&
MSL EDL Challenges

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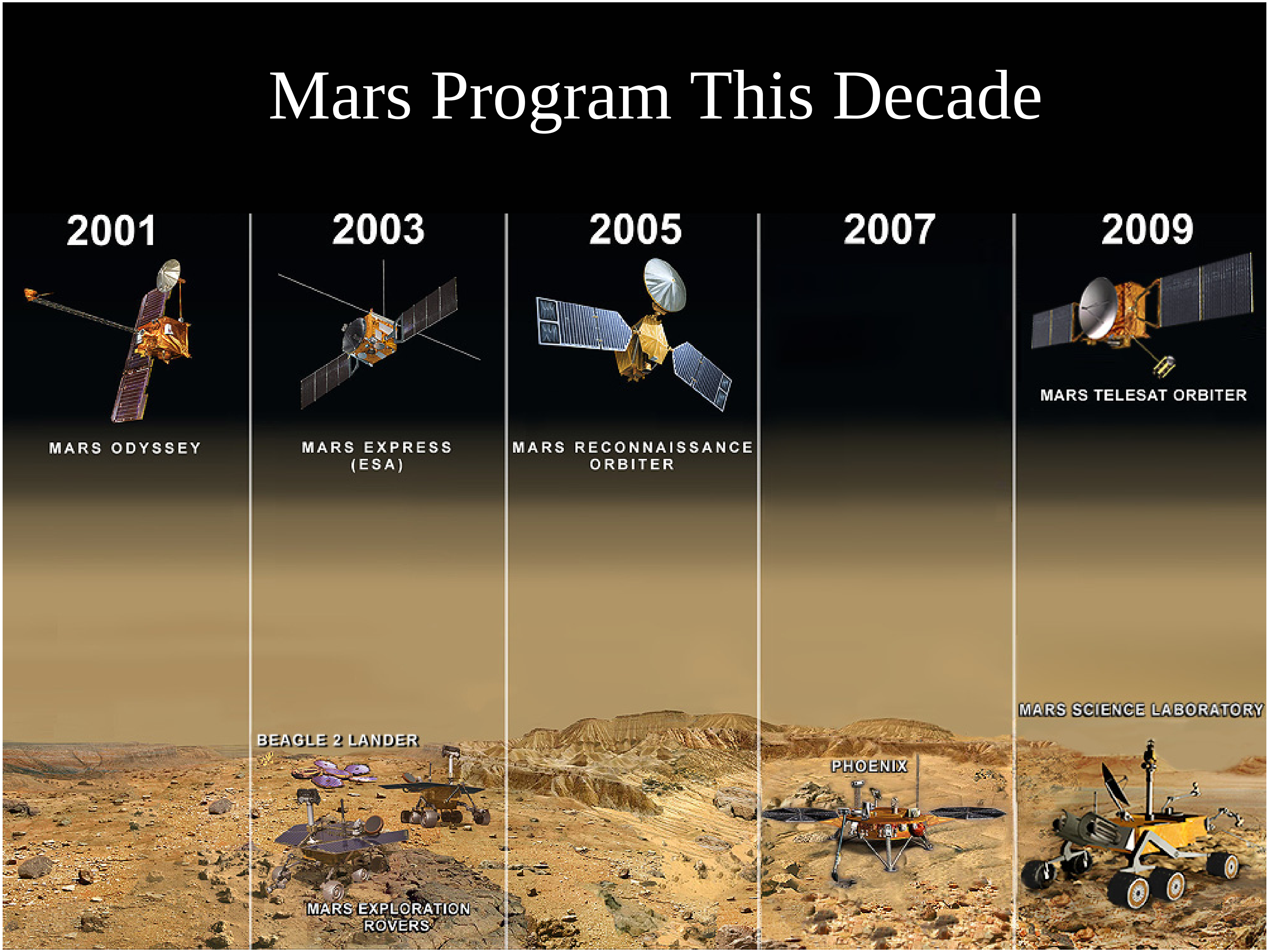

Mars Program This Decade
2001
MARS ODYSSEY
2003
MARS EXPRESS (ESA)
BEAGLE 2 LANDER
MARS EXPLORATION ROVERS
2005
MARS RECONNAISSANCE ORBITER
2007
PHOENIX
2009
MARS TELESAT ORBITER
MARS SCIENCE LABORATORY

MSL PROJECT OVERVIEW

<u>Salient Features</u>

Mobile Science Laboratory

Hundreds of days of surface operational lifetime

Discovery Responsive over wide range of latitudes and altitudes

Controlled Propulsive Landing

Precision Landing via Guided Entry

<u>Science</u>

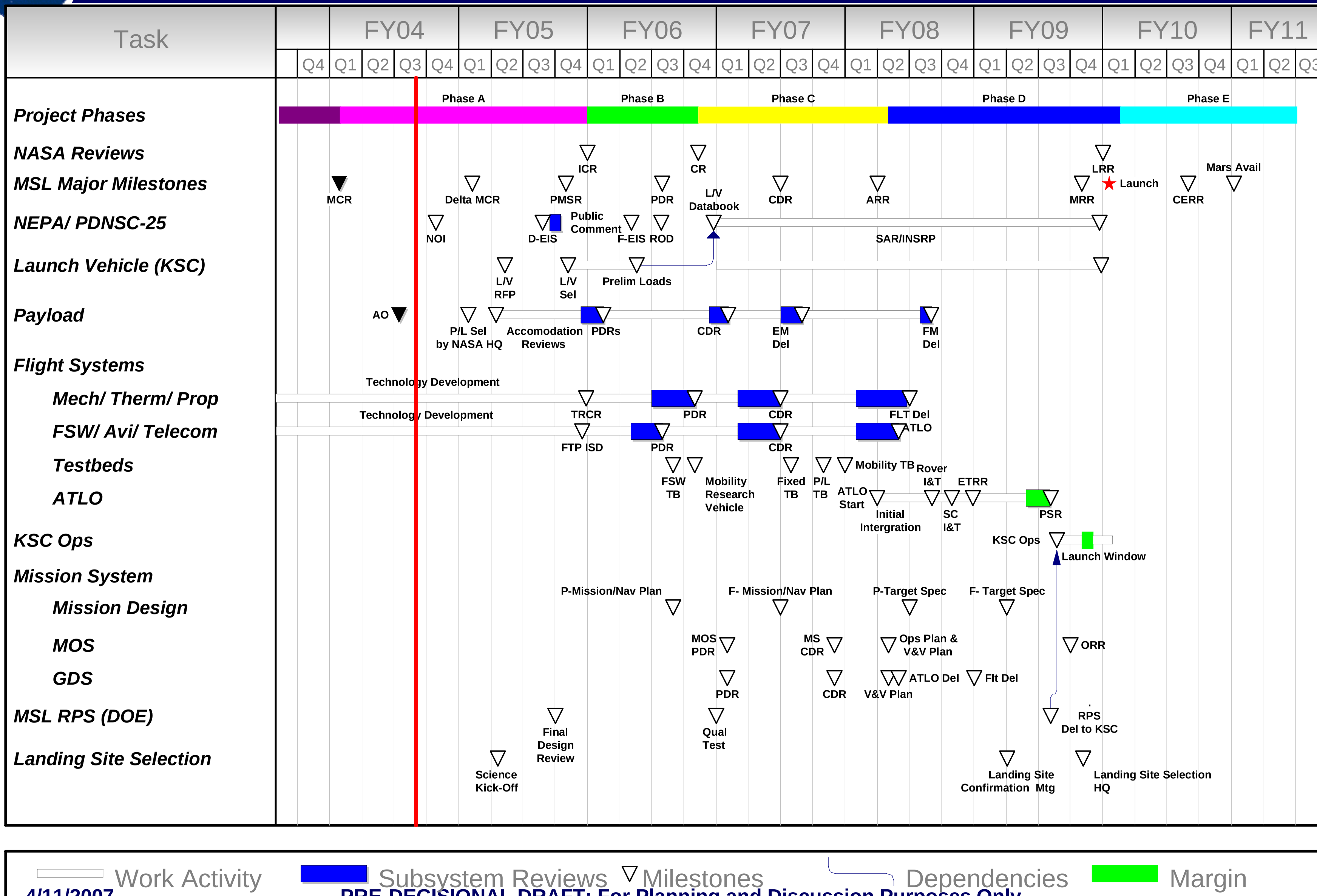
Mission science will focus on Mars habitability

Next generation in-situ science investigations – To be acquired during FY'04 / FY'05

Remote sensing/contact investigations - To be acquired during FY'04 / FY'05

Mars Science Laboratory
Top Level Schedule (Single Launch)

Predecisional Draft



EDL Challenges

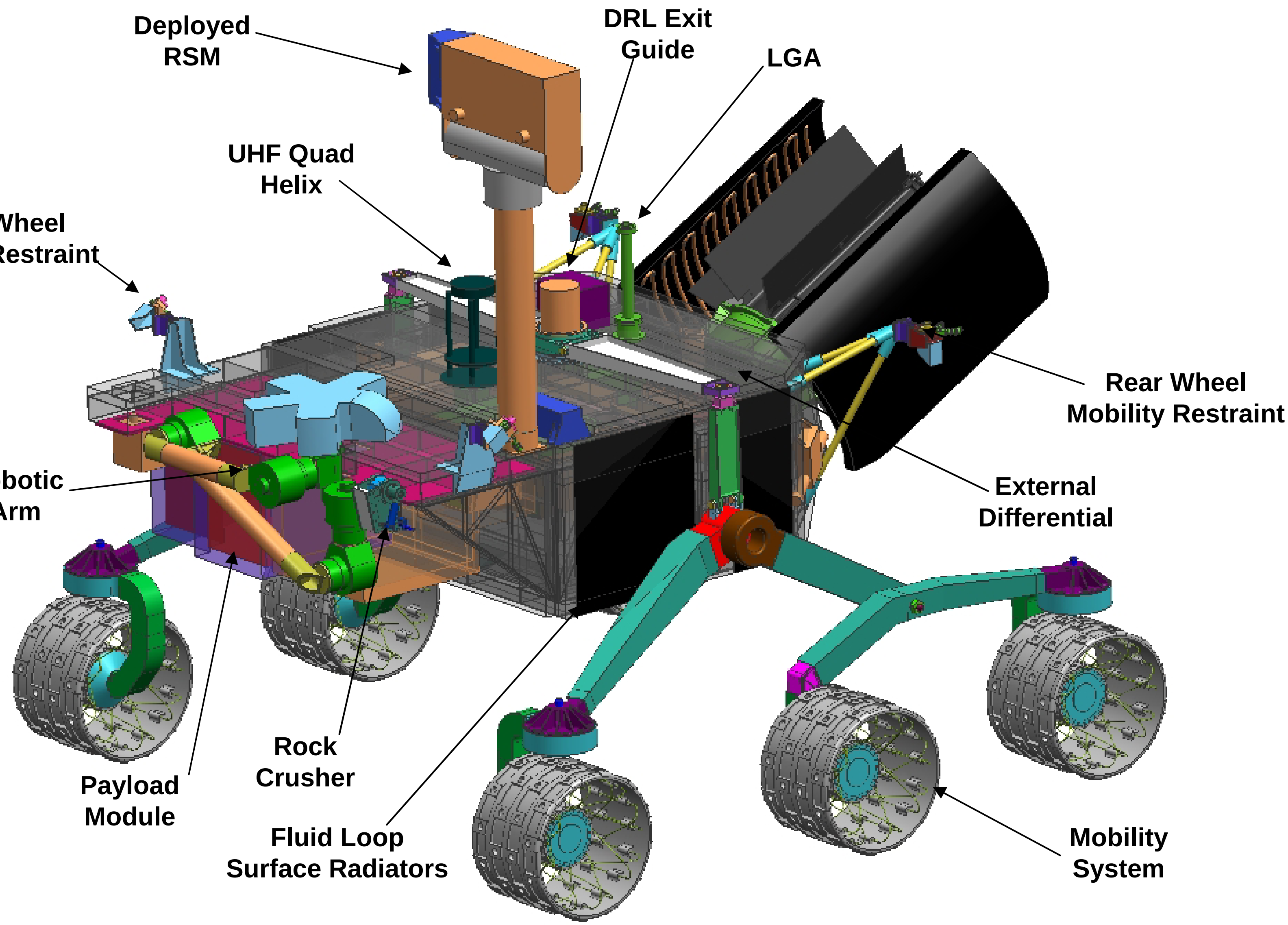
Desires

- Significantly larger landed payload
  - Mass: 550 kg max
- Global access to Mars
  - Up to +2.5 km (MOLA)
  - Broad latitude range
- Smaller landing ellipse
  - ~ 20 km major axis
- EDL communication coverage
- Generalize EDL for future missions

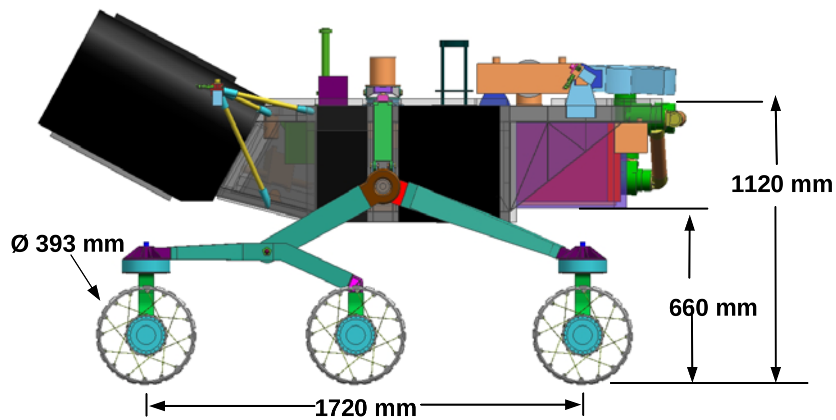
Realities

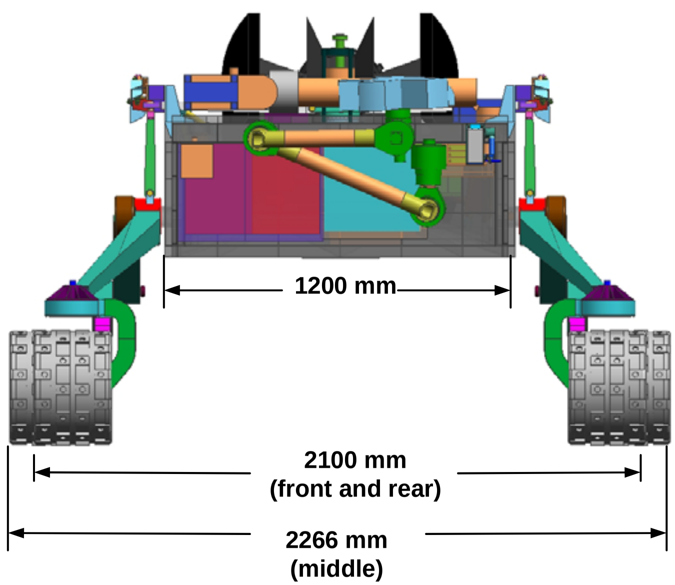
- Each EDL design is somehow different
  - Different mission design
    - Entry velocity
  - The Martian atmosphere is different at each opportunity
    - Due to atmospheric pressure cycle
  - Different landing site
- Many uncertainties associated with the atmosphere
- EDL design is highly coupled
- EDL communication requirements introduce many constraints and variables

MSL Surface System



MSL Surface System



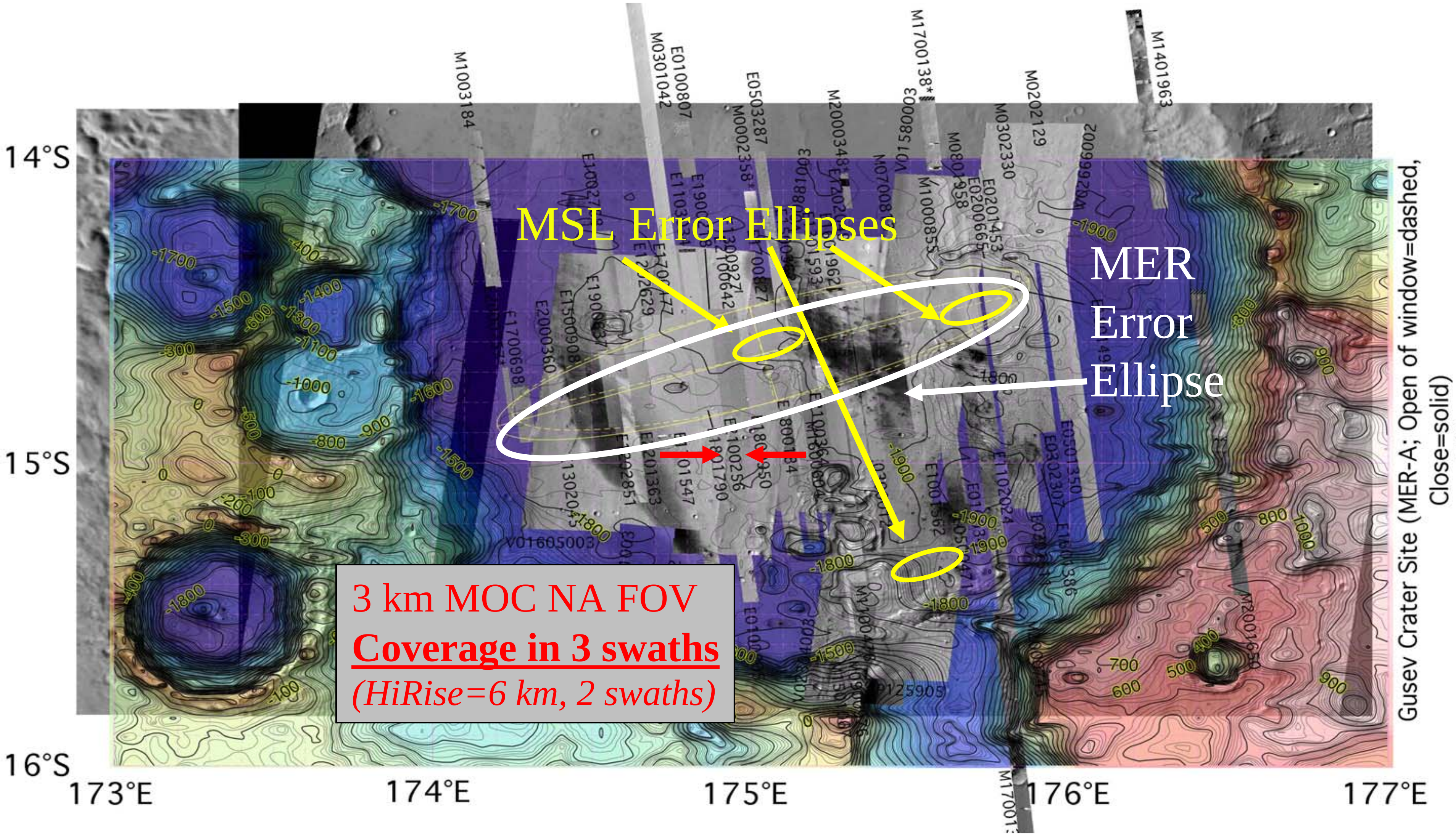


- Current Mobility Details:
  - Wheels – 393 mm dia
  - Ground clearance – 660 mm static
  - Wheel base – 1720 mm
  - Track – 2100 mm
  - Middle Wheel is located 83 mm outside of front and rear wheels

Mars Rover Wheel Family Tree

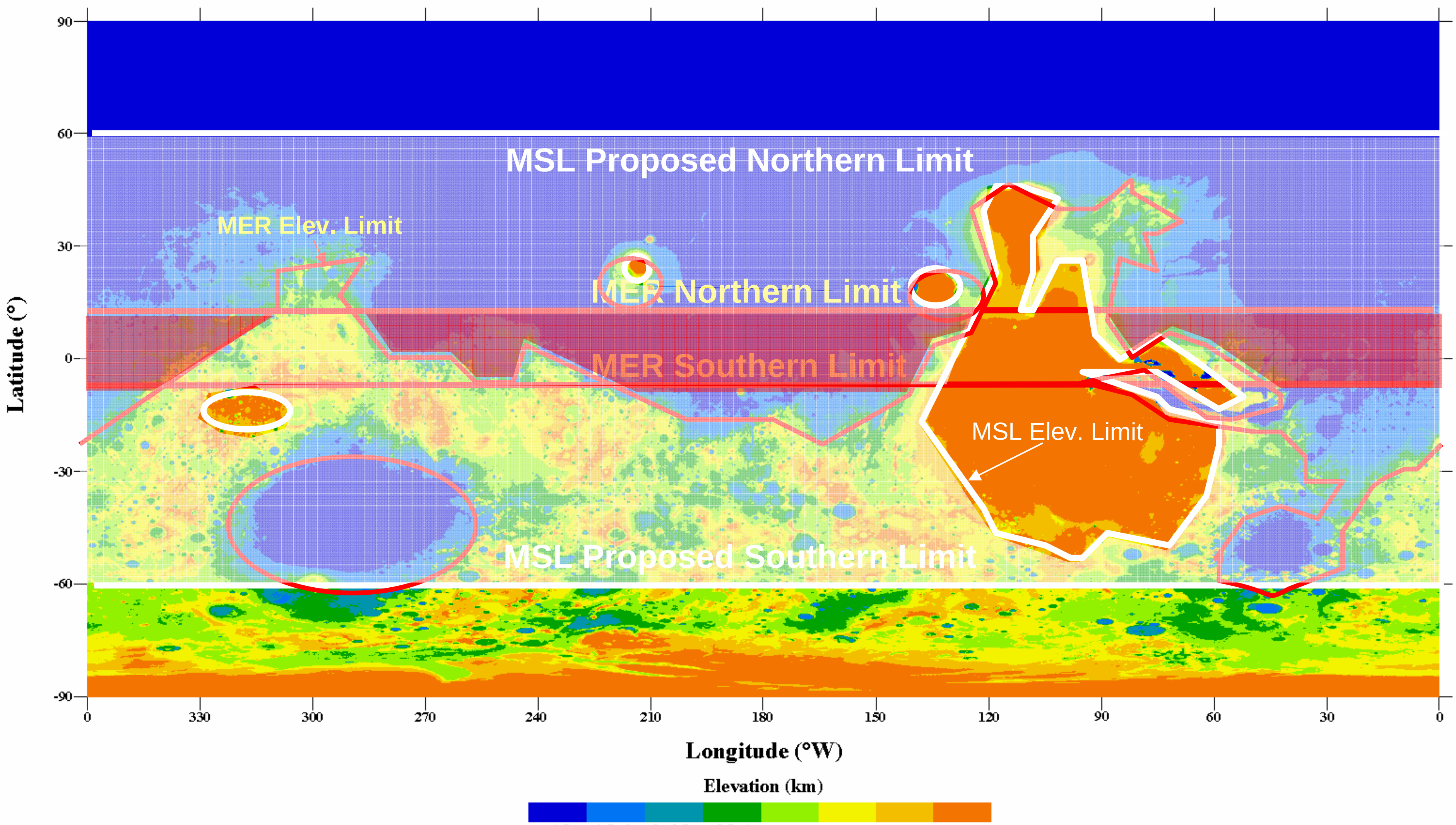
MSL: ø400 mm   MER: ø250 mm   MPF: ø127 mm

Gusev Comparisons

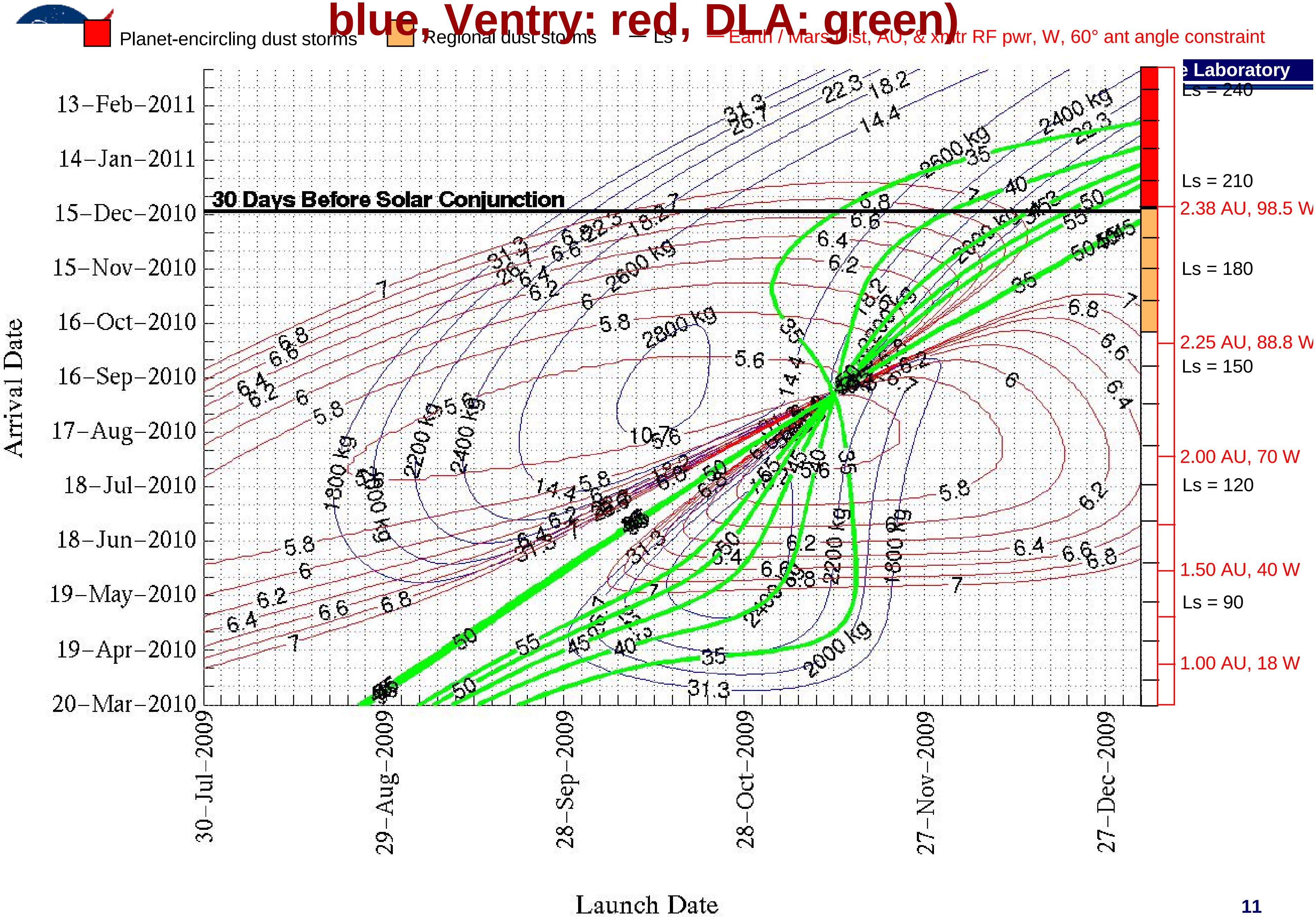


Mars Surface Accessibility

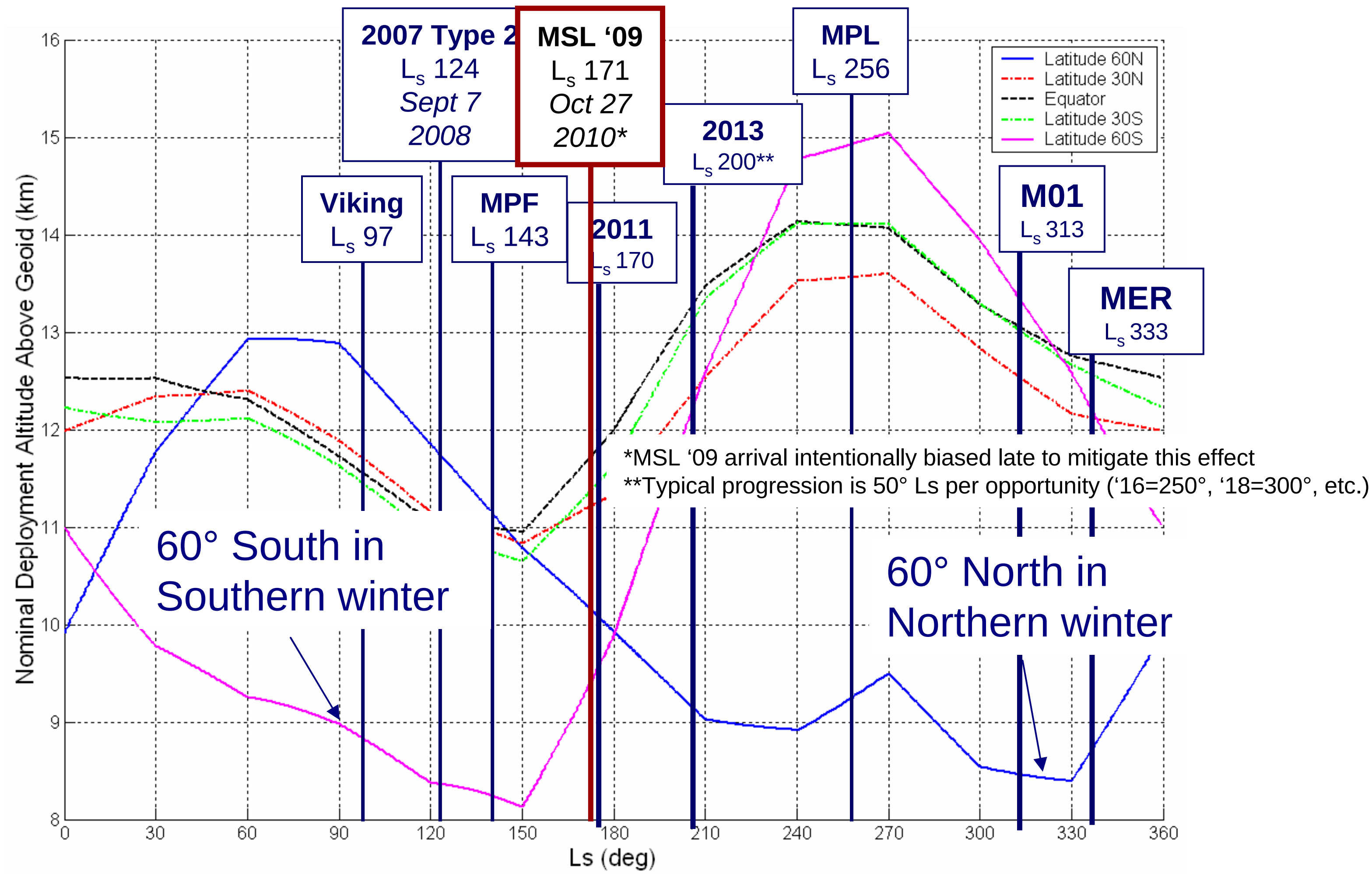
MOLA 1/4° Gridded Topography



Atlas V 401 Launch Performance (C3: blue, Ventry: red, DLA: green)



Parachute Deployment Altitude Variation with Time of Year and Latitude

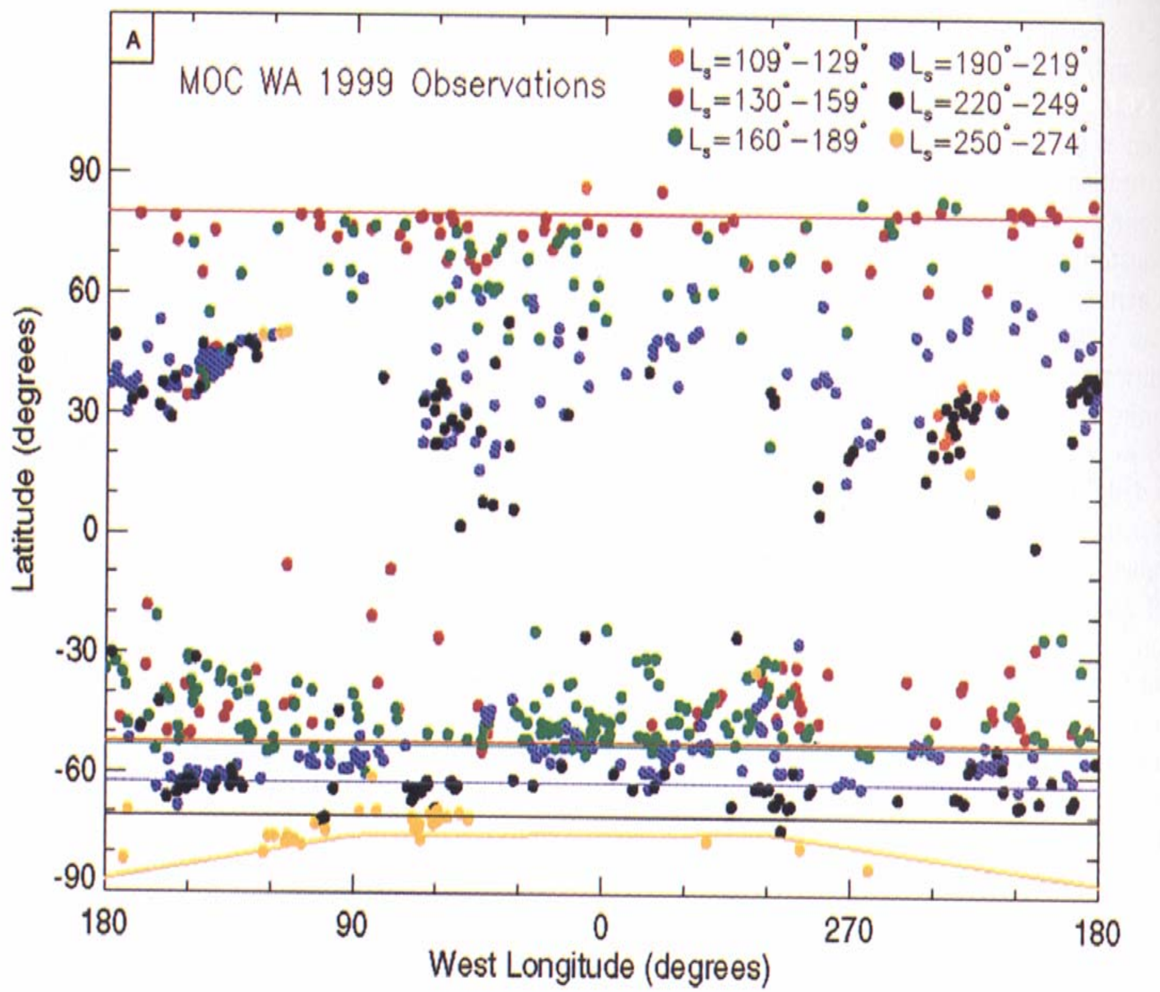


Northern	Summer	Winter
Southern	Winter	Summer

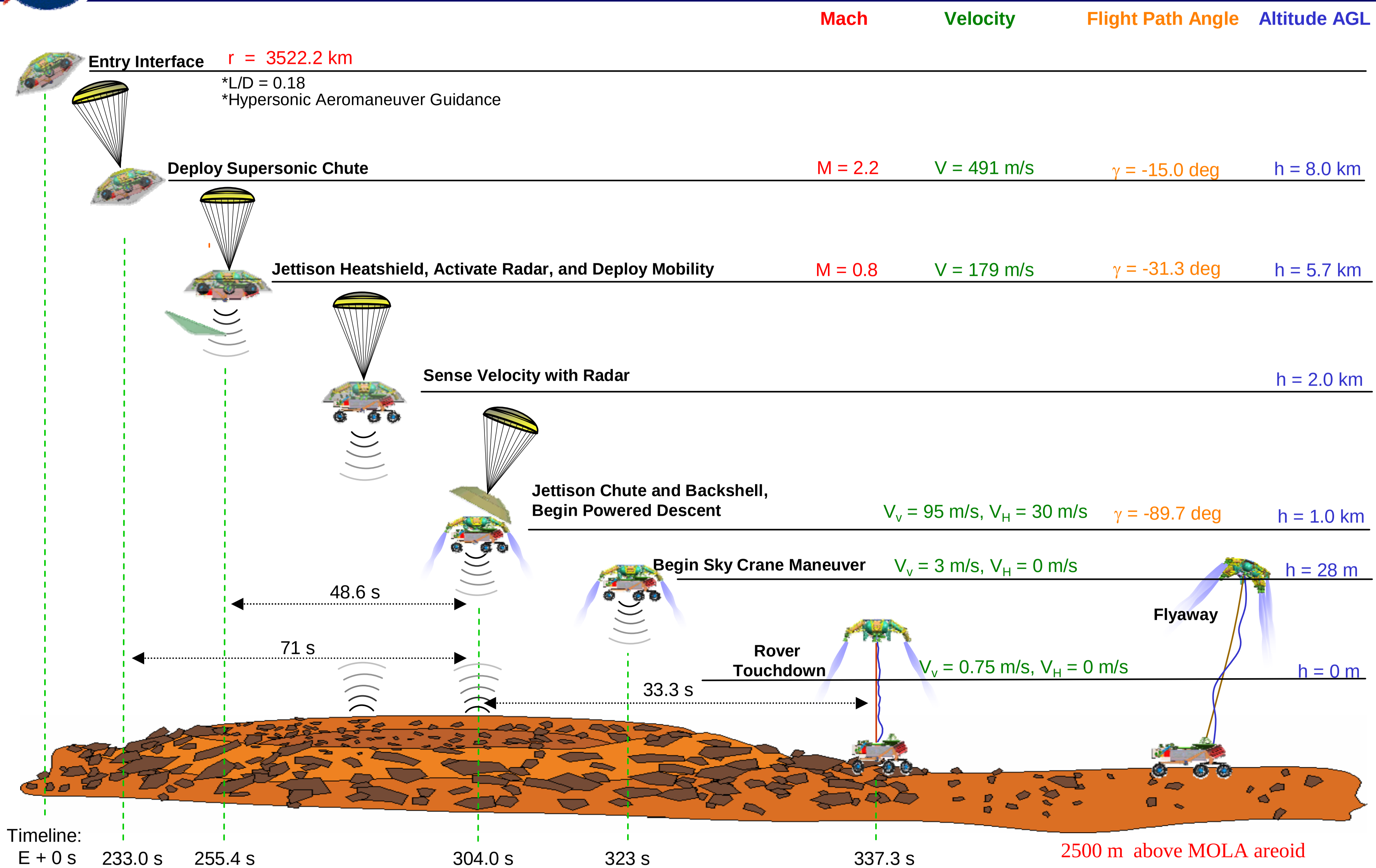
Dust Storms and Winds

- **Increased dust (higher dust tau) reduces landing altitude capability**
  - Higher atmospheric temperatures
  - Pushes column of air "up"
  - Results in higher chute deployment floor, reduced capability
  - Dust tau nominal range 0.1 – 0.9, 0.45 assumed to be typical
  - Designing to survive dust storm tau = 2.0
- **Winds model based on MarsGRAM 2001 and Chia-Yen Peng dispersed wind model**

MSL Landing Season (green)



Nominal MSL EDL Timeline



Specific EDL Challenges

- Entry
  - Aerothermal environment definition (i. e. TPS requirements)
  - TPS material selection and risk evaluation
  - Entry guidance reinvigoration, entry guidance last used on Viking
- Descent
  - Parachutes are never off the shelf
- Landing
  - Sky-crane lander is a new landing concept
  - Terminal Descent Sensor (landing radar)
  - Throttle-able propulsion system