Designing Curiosity's Perfect Landing on Mars

Timofey Ovcharenko

NASA-Jet Propulsion Laboratory-

California Institute of Technology/CSC

Why do we go to Mars?

- **Explore neighboring planet**
- **Further our understanding of the origin of the universe and the laws that govern it**
- **Search for life beyond Earth's confines**
- **Inspire the next generation of explorers**

- **Curiosity's Overall Scientific Goal**

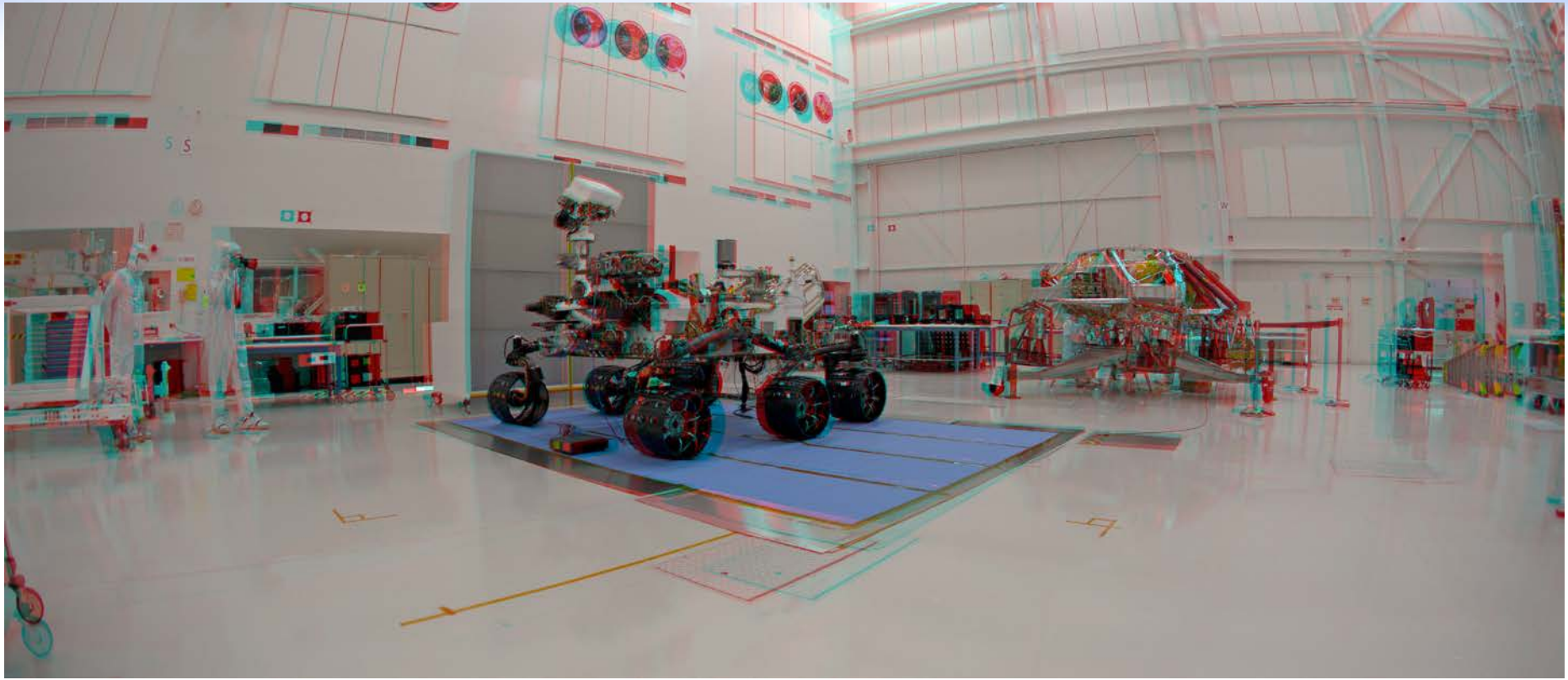
  "Explore and quantitatively assess a local region on Mars' surface as a potential for life, past or present" – Pete Theisinger

NASA

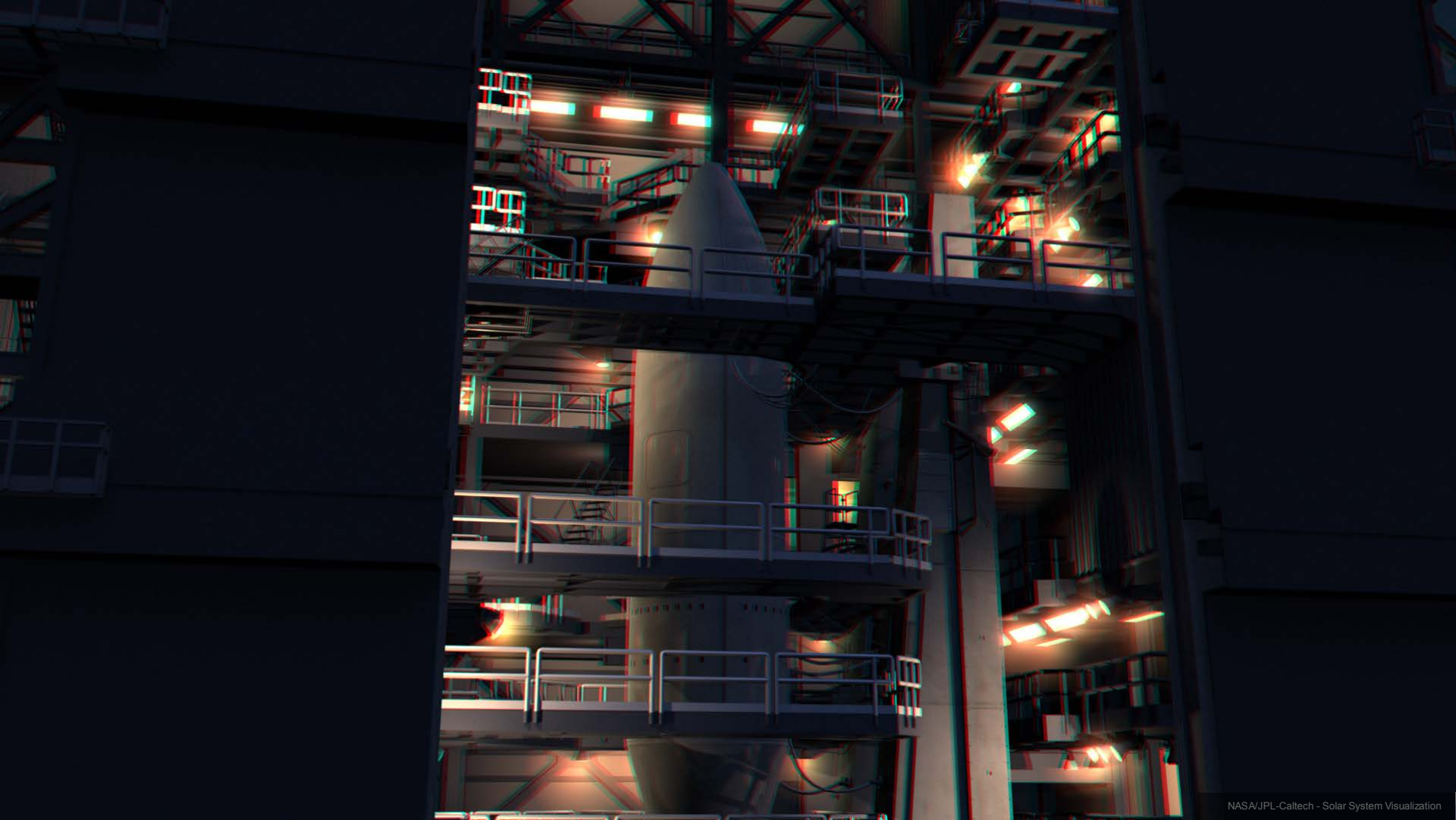
Curiosity's Mission Story

3D Glasses On

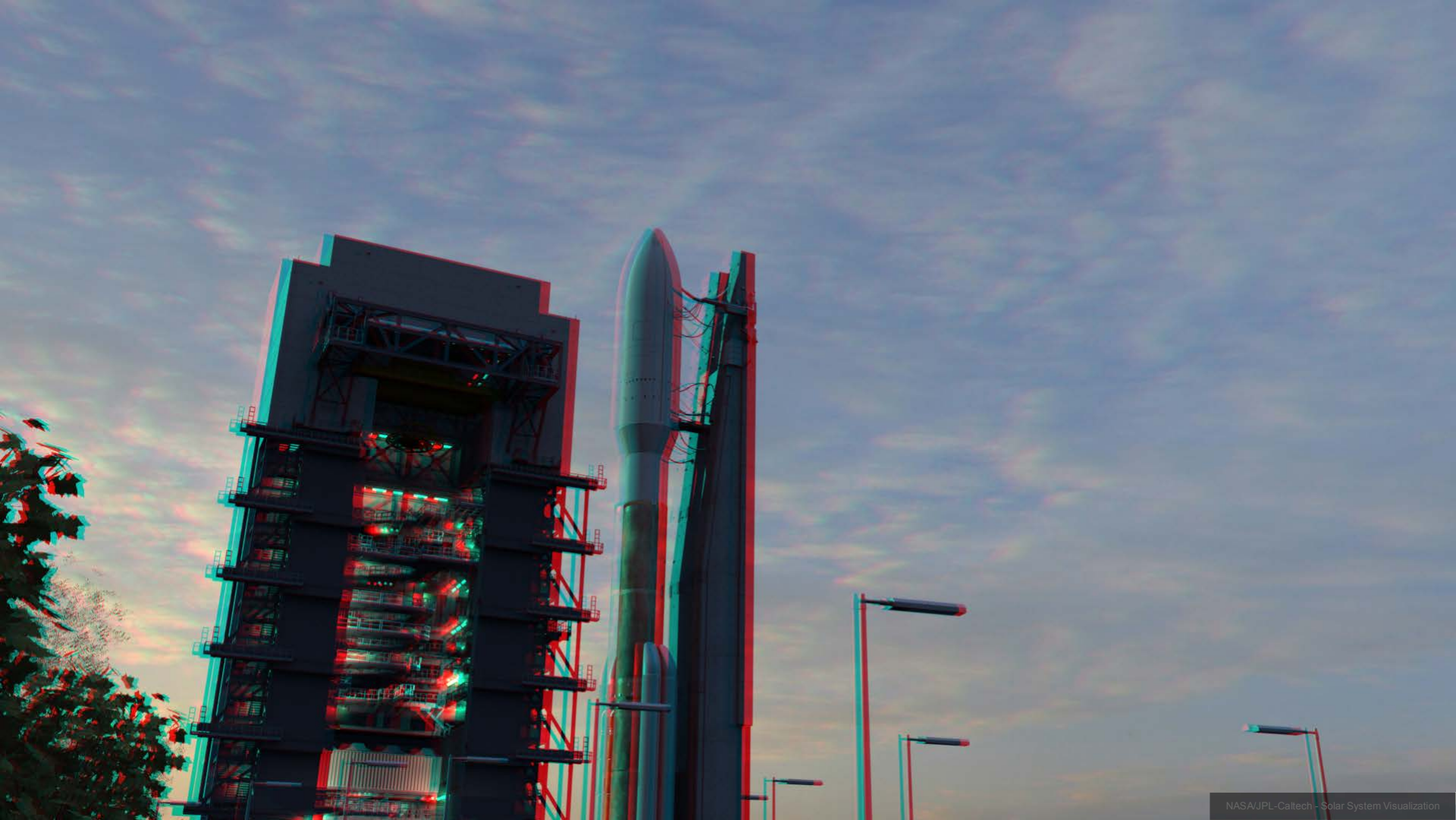
Curiosity's Mission Story



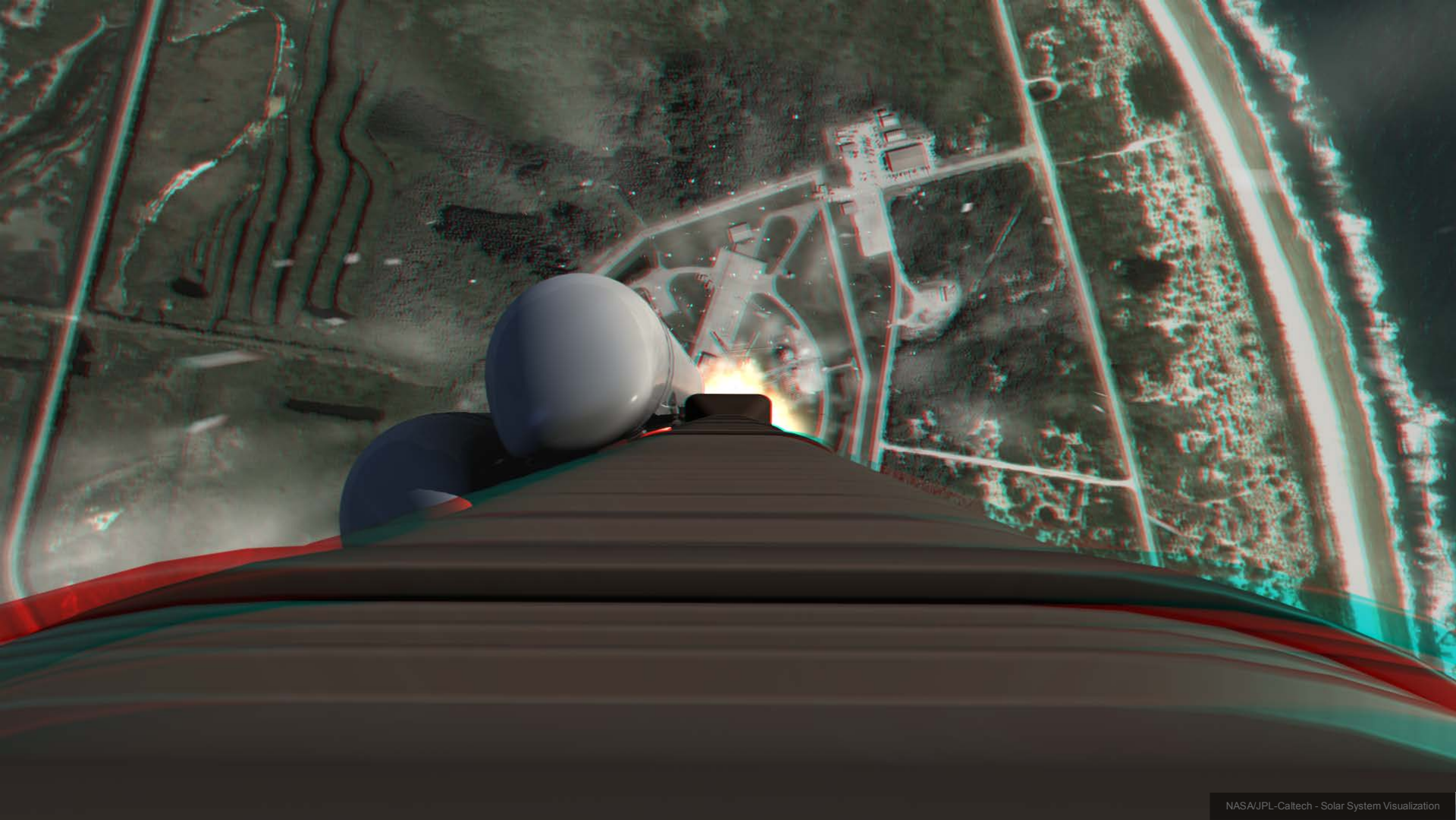
NASA/JPL-Caltech



NASA/JPL-Caltech - Solar System Visualization

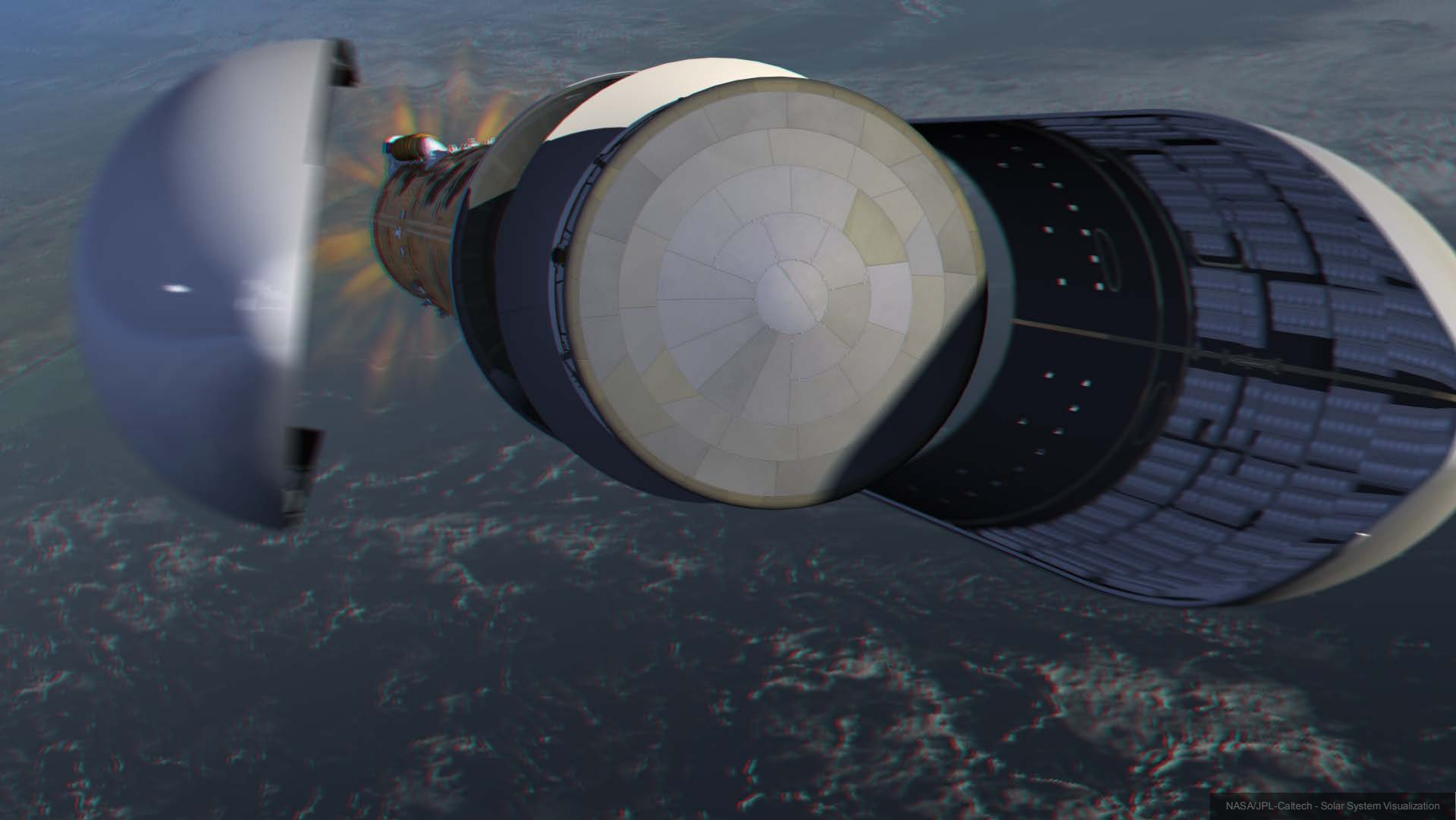

NASA/JPL-Caltech - Solar System Visualization

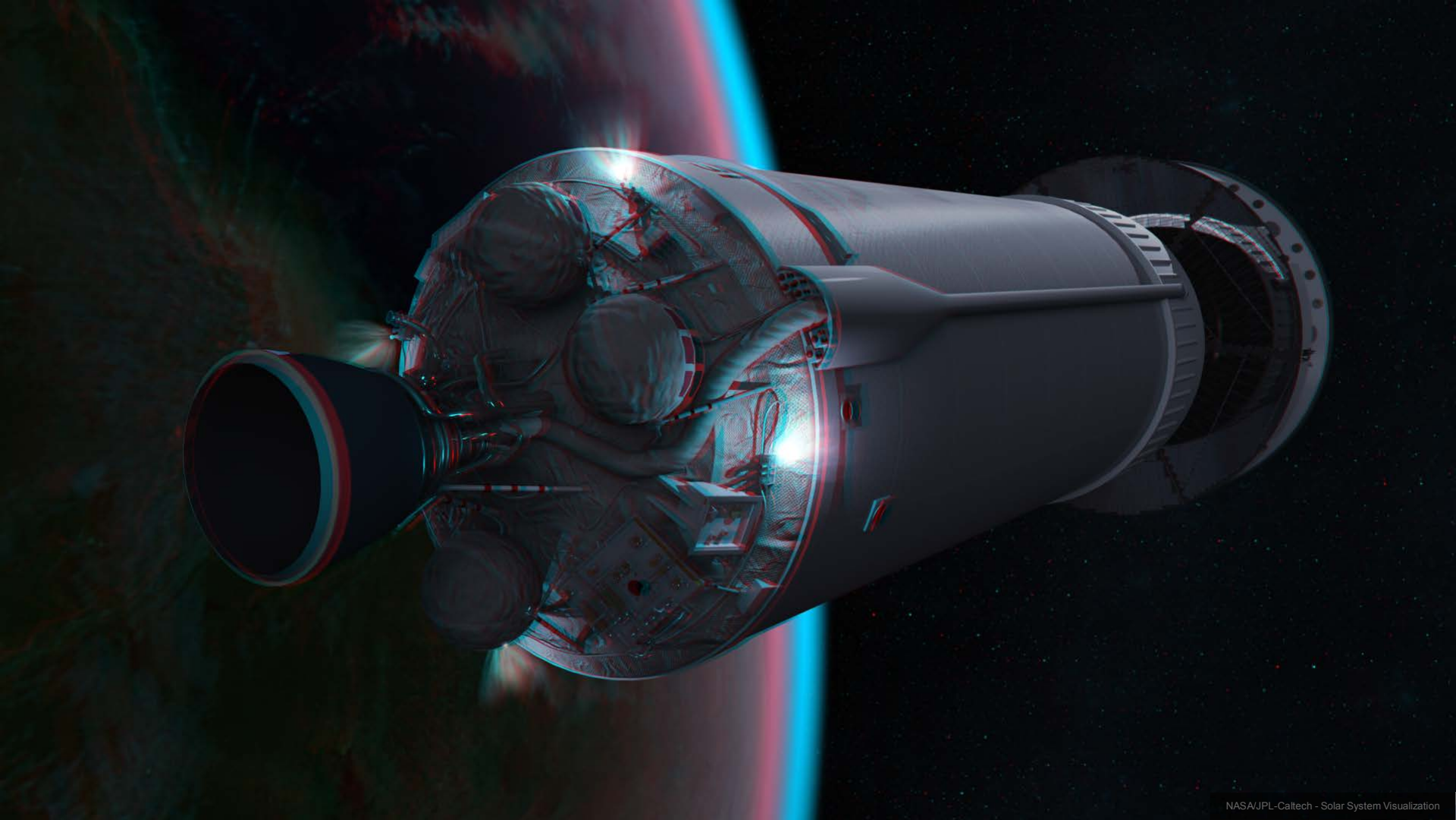
NASA/JPL-Caltech - Solar System Visualization



NASA/JPL-Caltech - Solar System Visualization

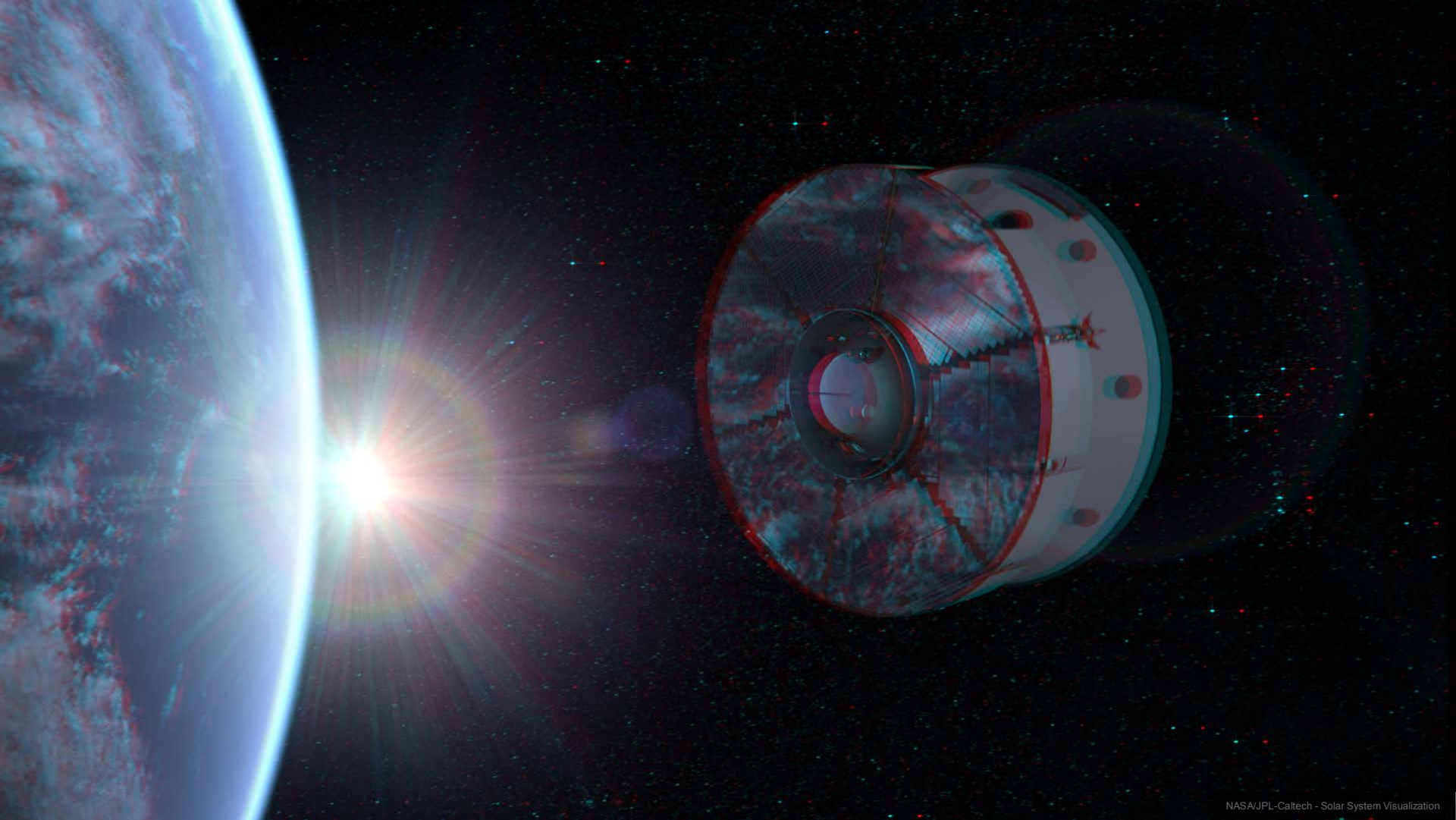
NASA/JPL-Caltech - Solar System Visualization

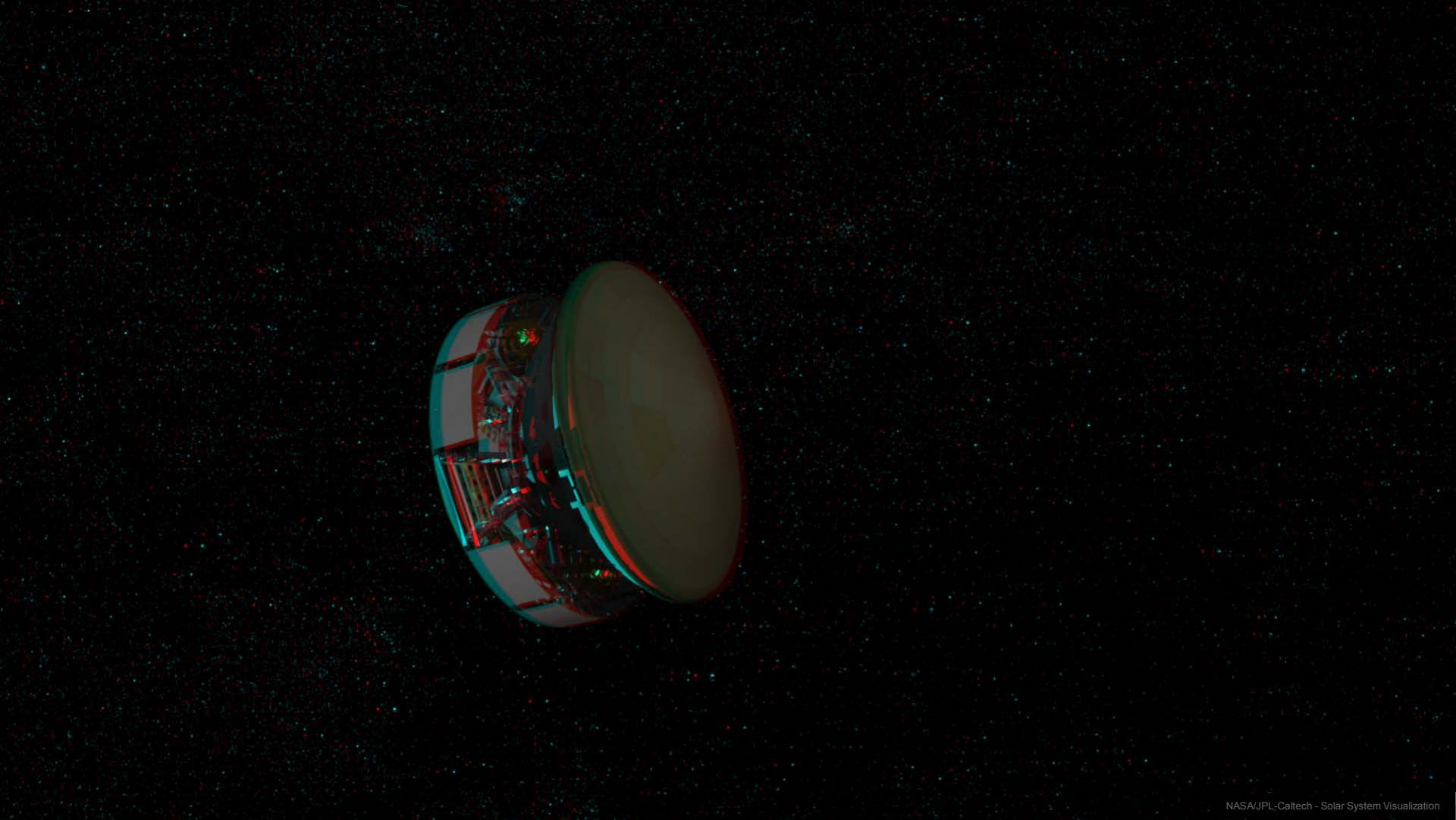

NASA/JPL-Caltech - Solar System Visualization



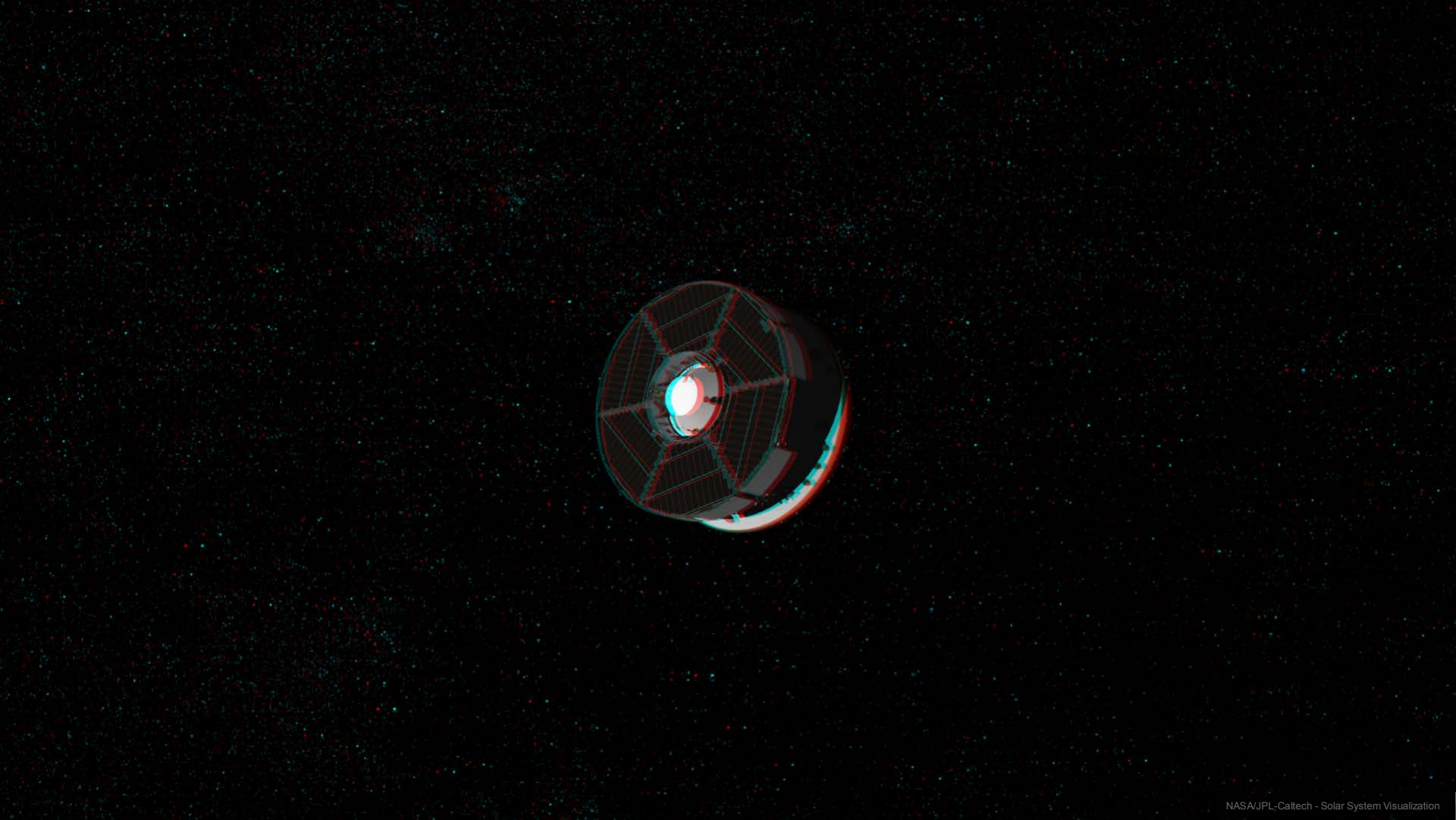
NASA/JPL-Caltech - Solar System Visualization

NASA/JPL-Caltech - Solar System Visualization

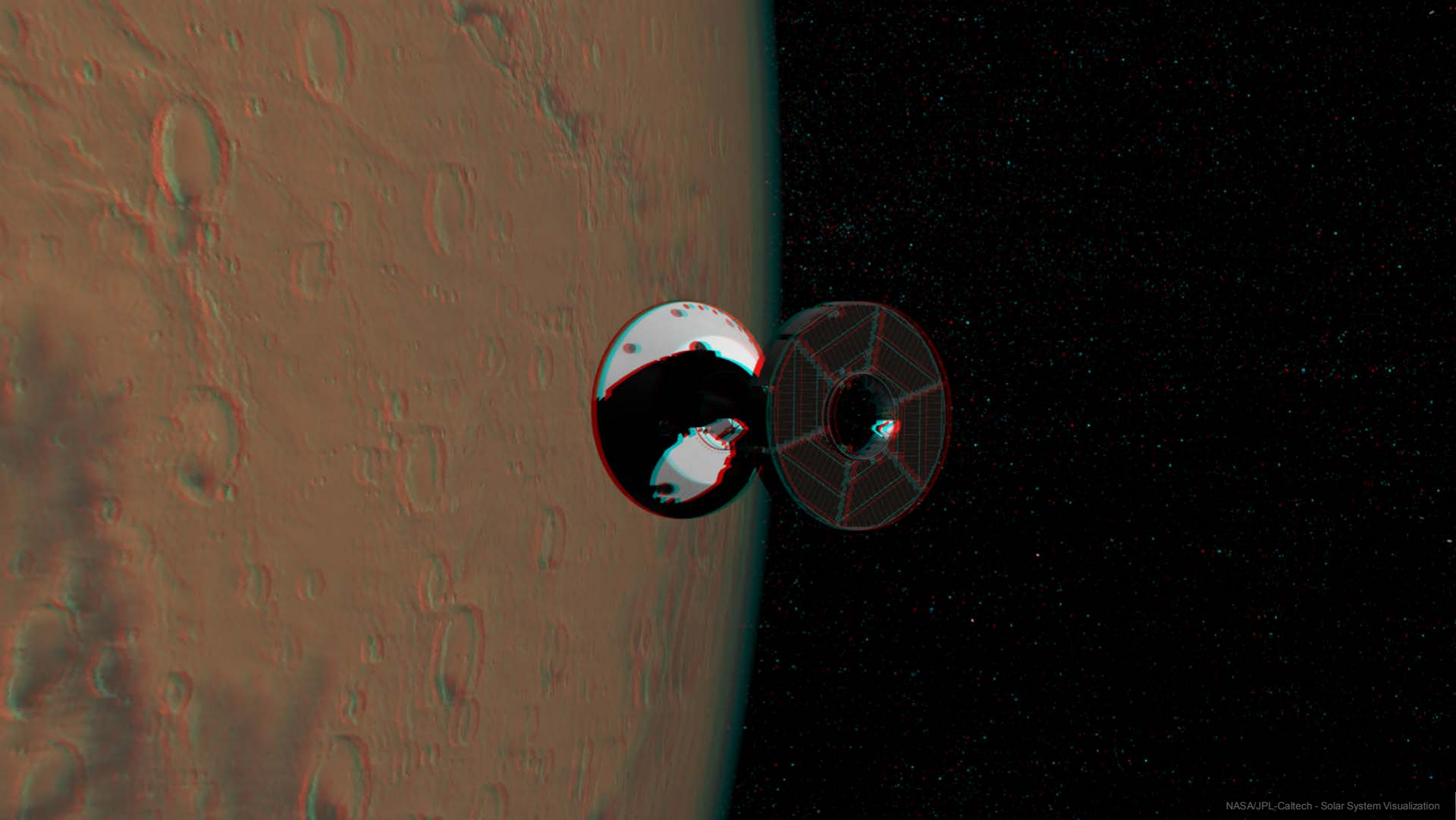

NASA/JPL-Caltech - Solar System Visualization



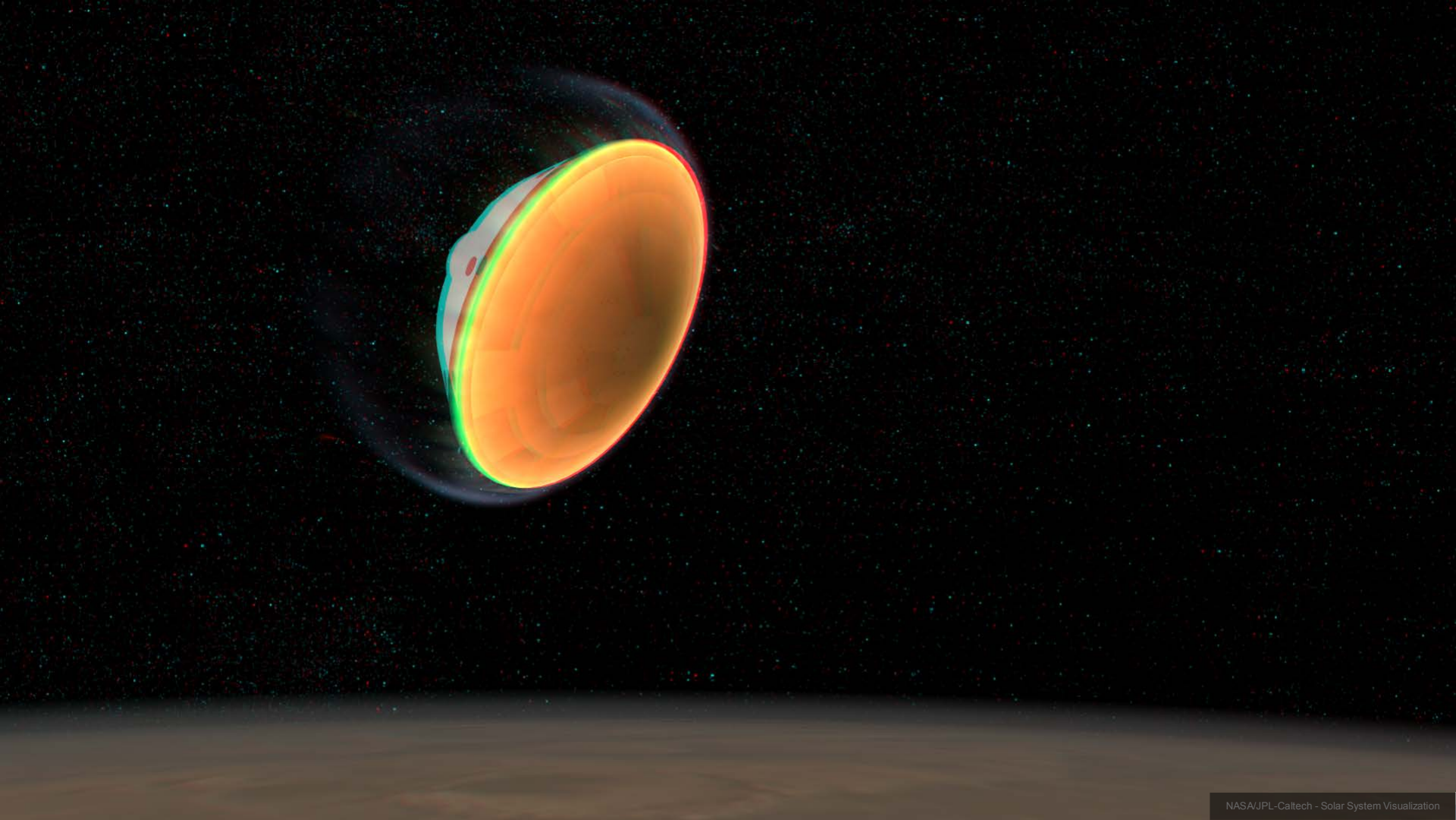
NASA/JPL-Caltech - Solar System Visualization



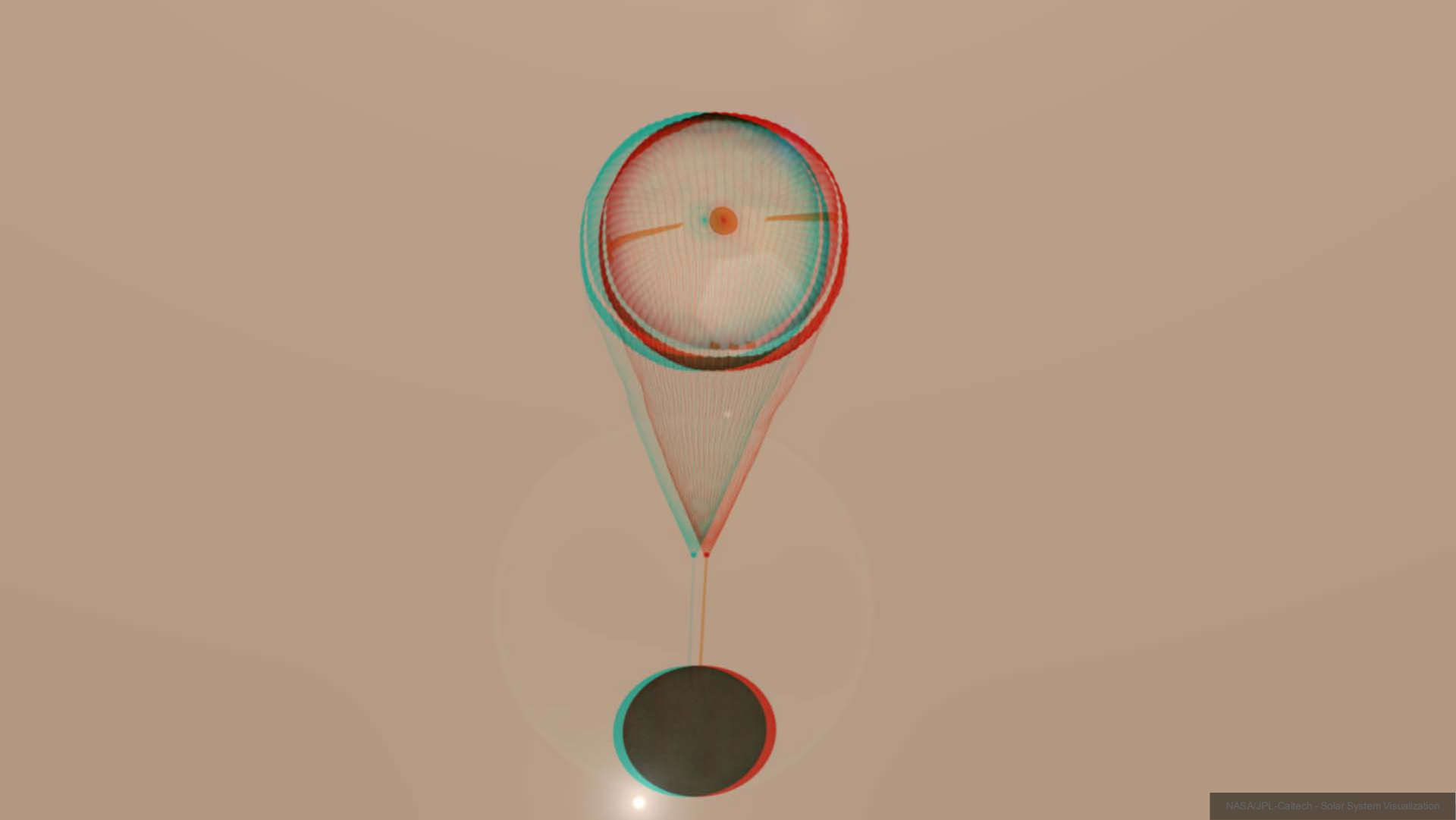
NASA/JPL-Caltech - Solar System Visualization



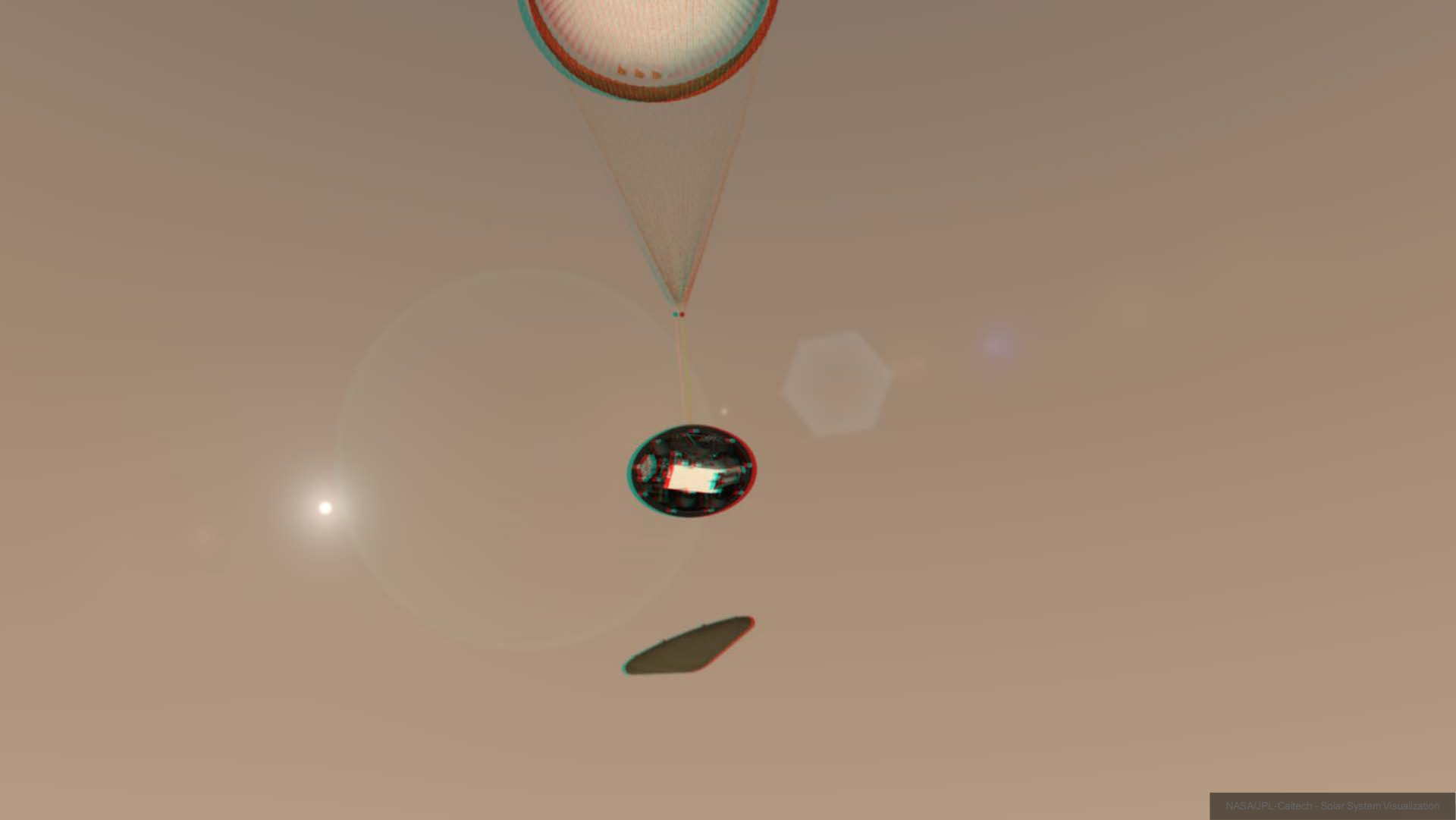
NASA/JPL-Caltech - Solar System Visualization



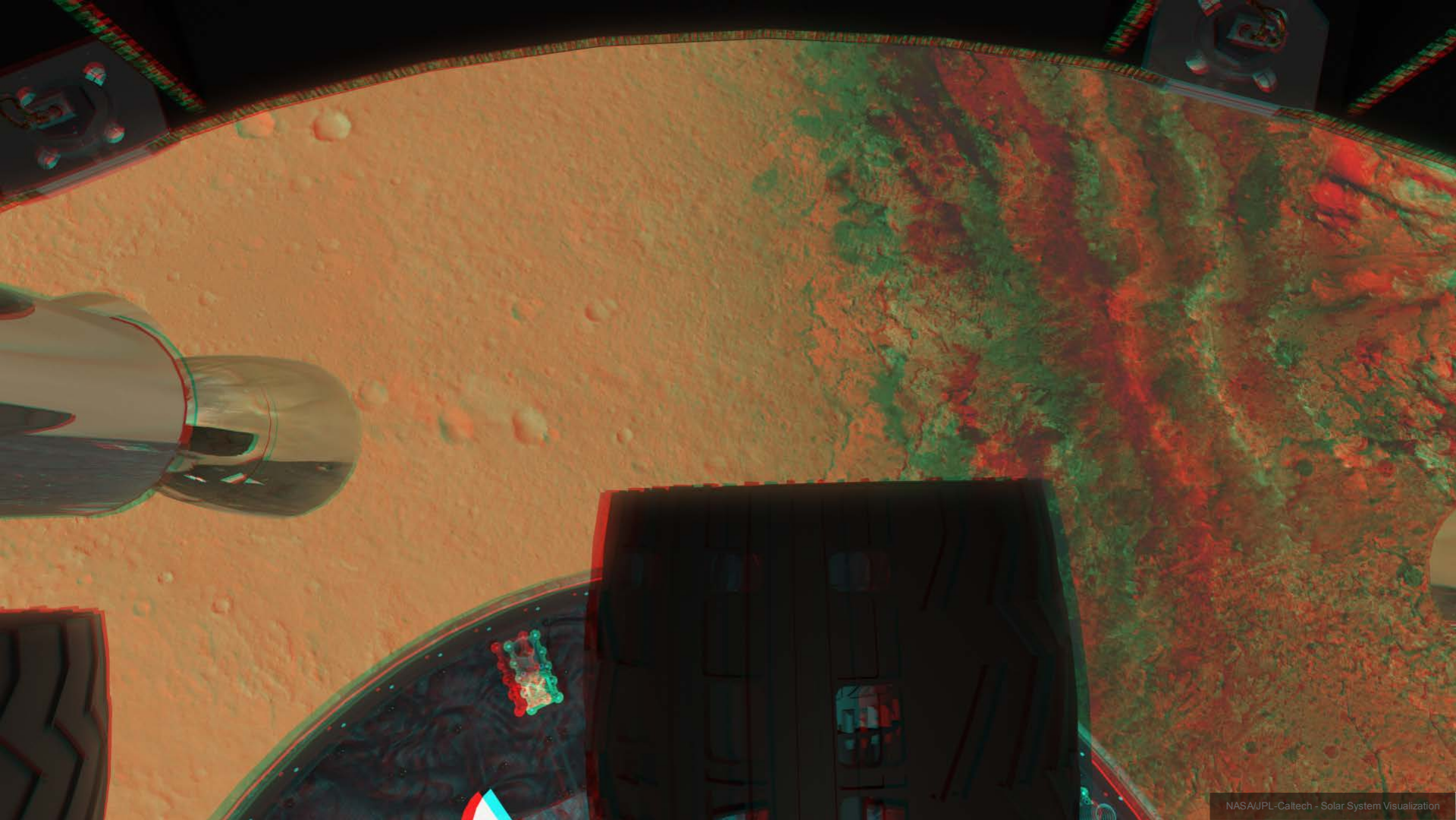
NASA/JPL-Caltech - Solar System Visualization

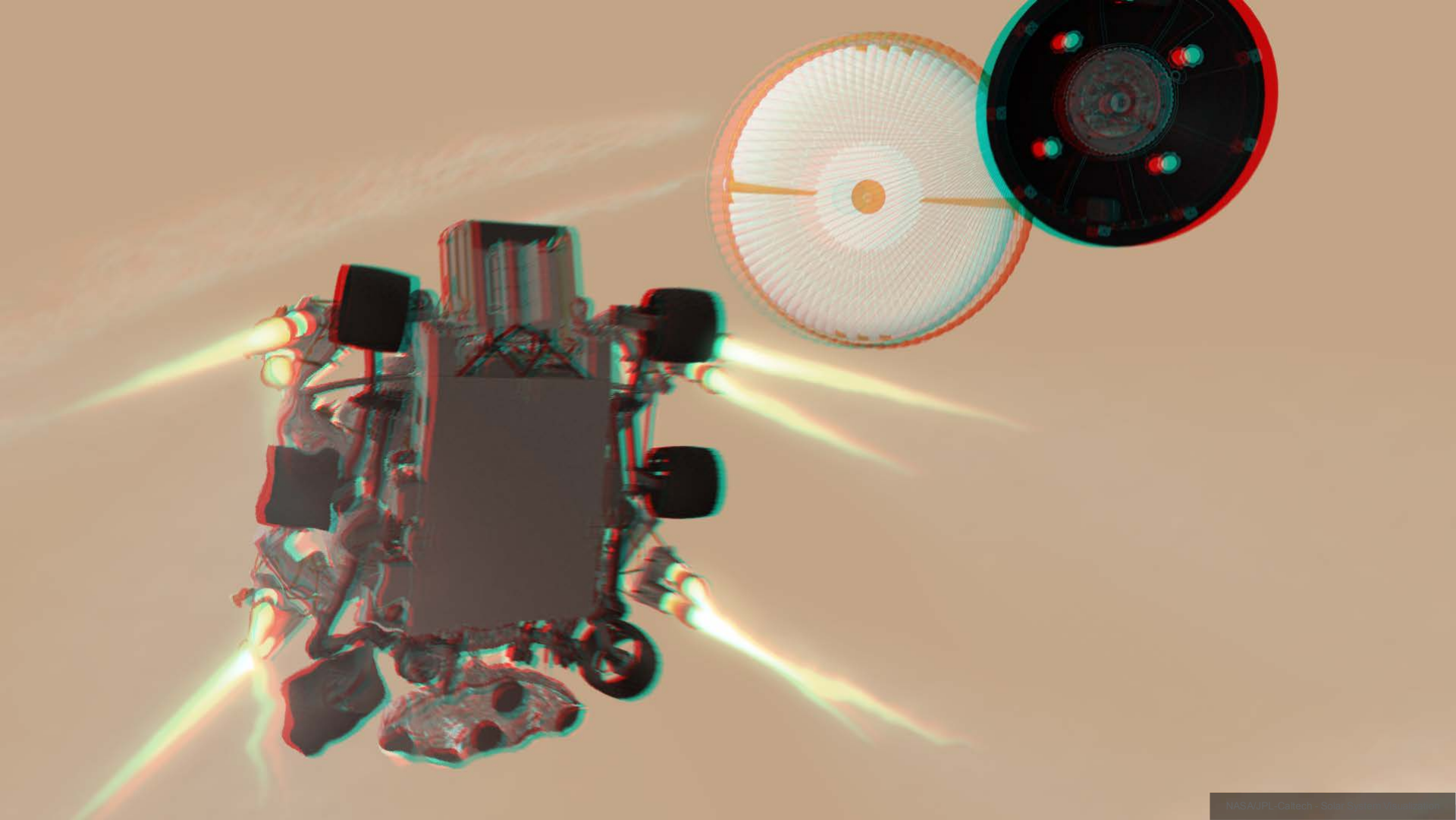


NASA/JPL-Caltech - Solar System Visualization

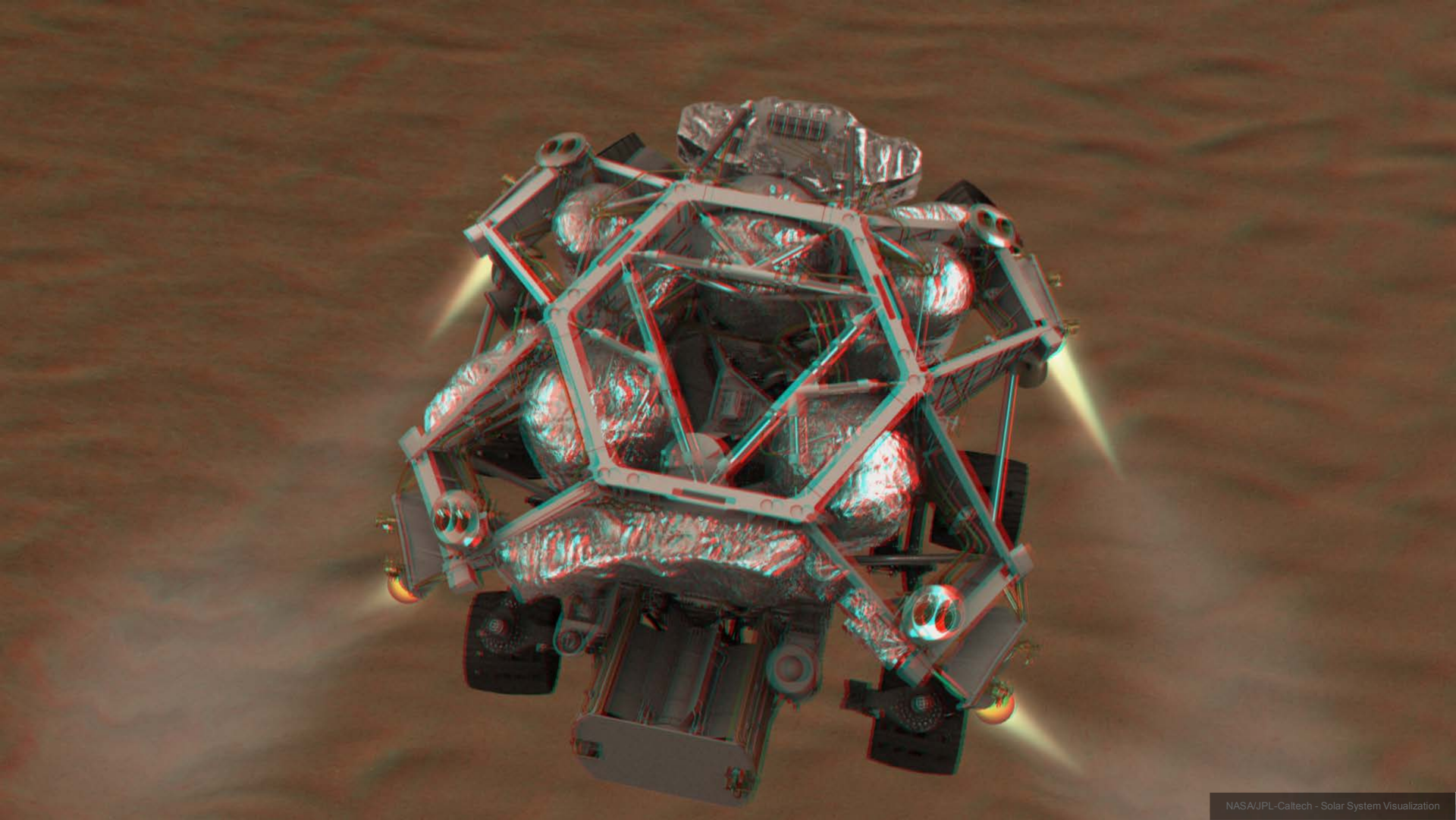


NASA/JPL-Caltech - Solar System Visualization


NASA/JPL-Caltech - Solar System Visualization

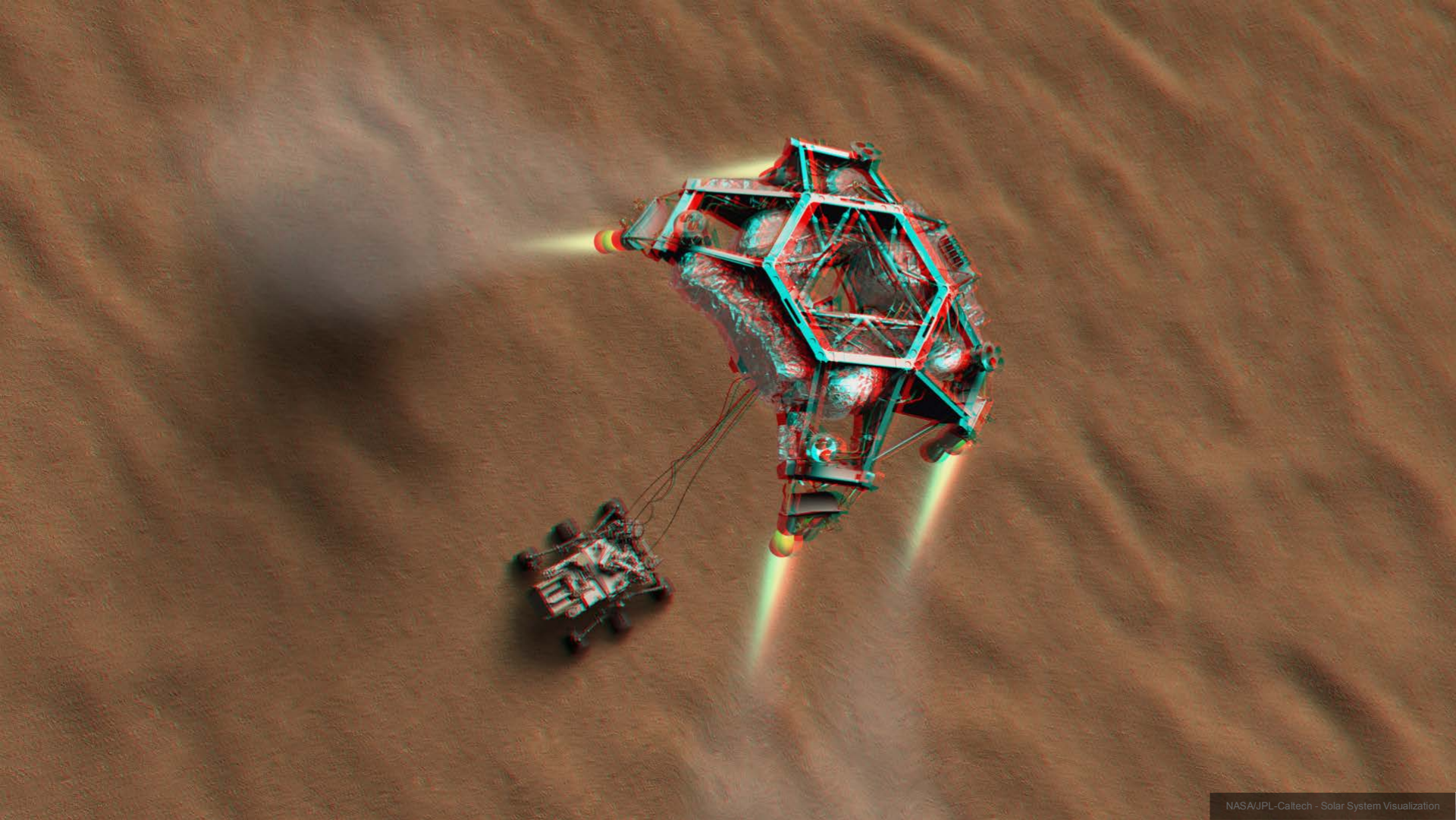


NASA/JPL-Caltech - Solar System Visualization

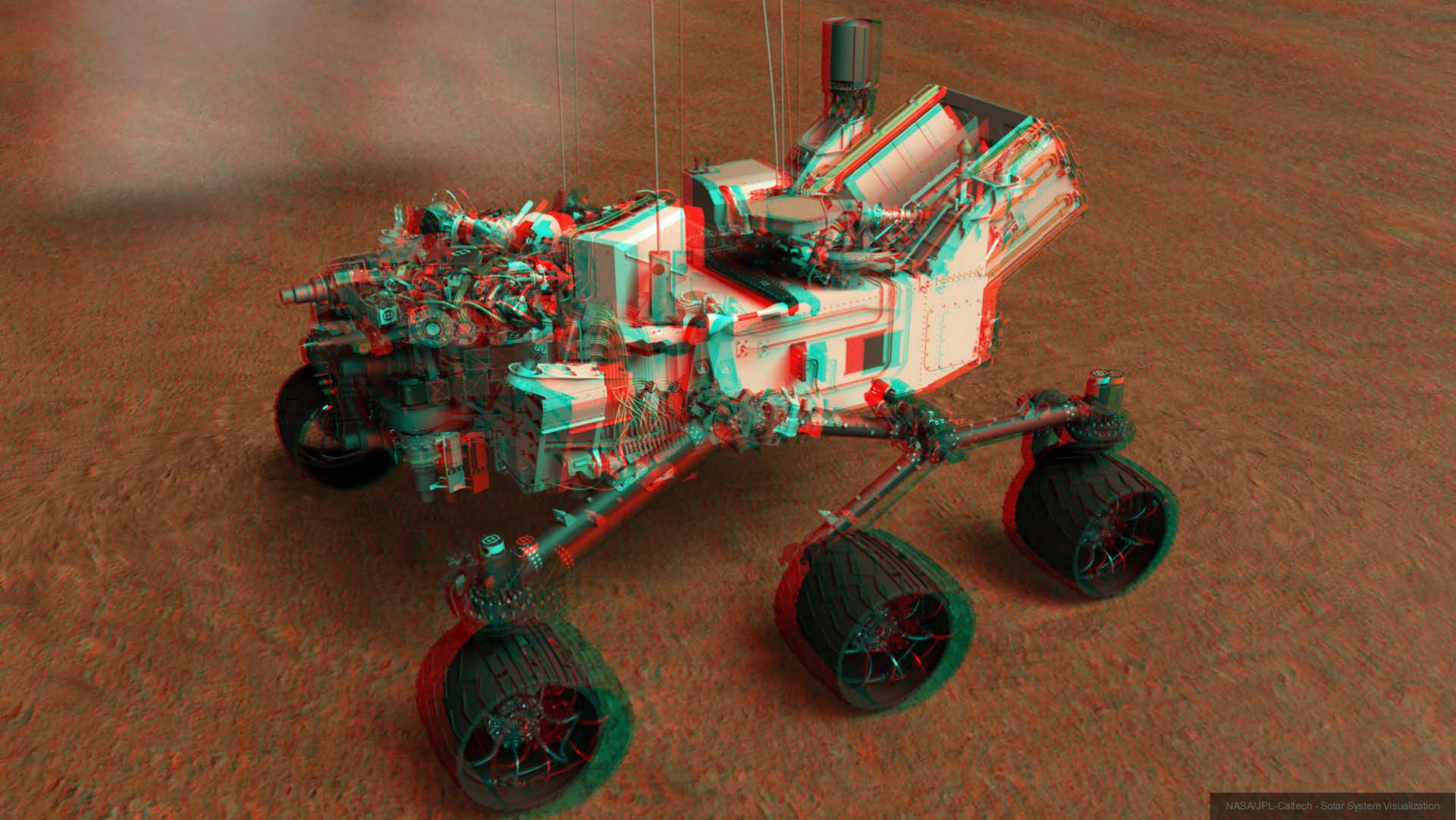


NASA/JPL-Caltech - Solar System Visualization

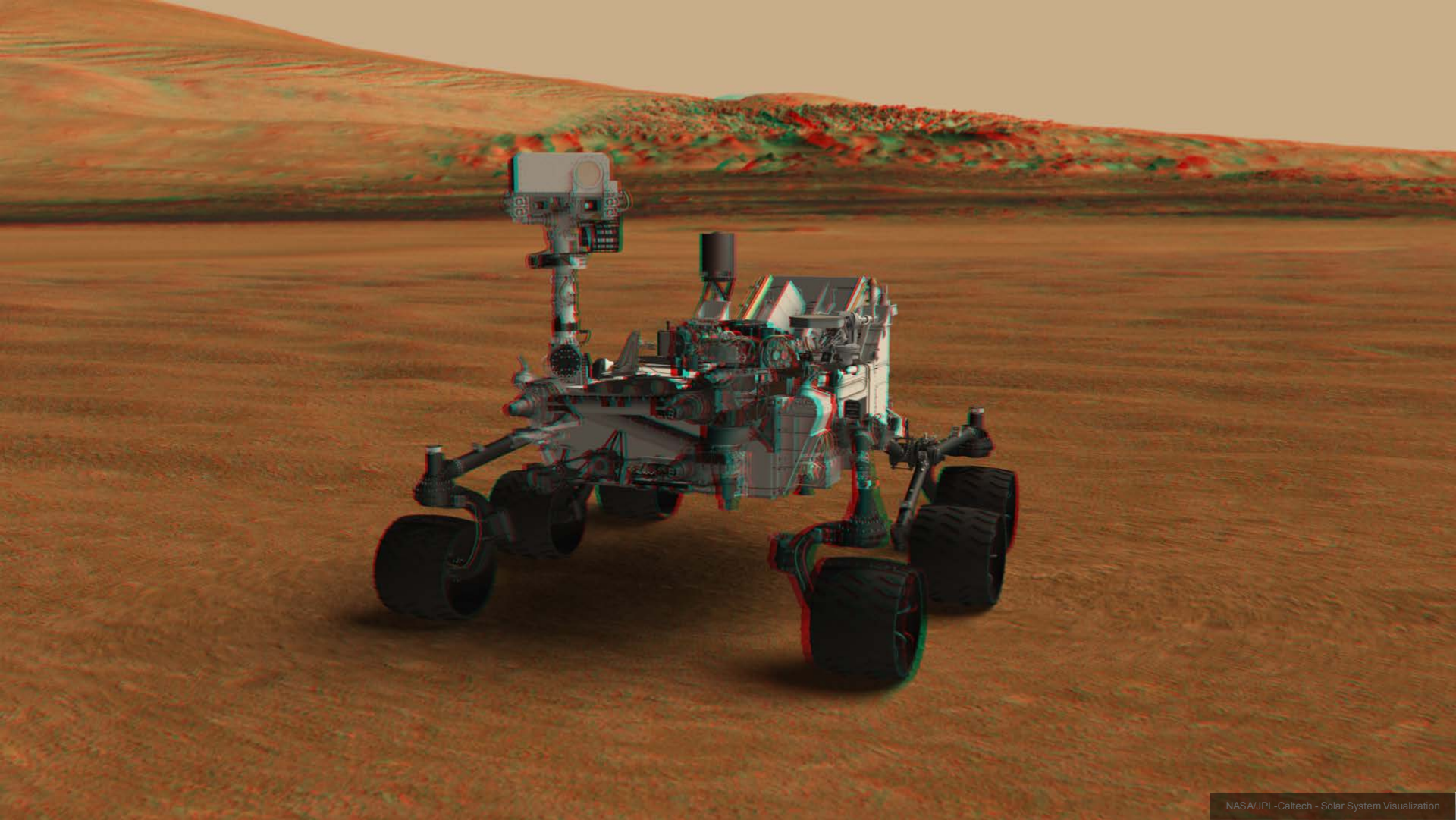
NASA/JPL-Caltech - Solar System Visualization

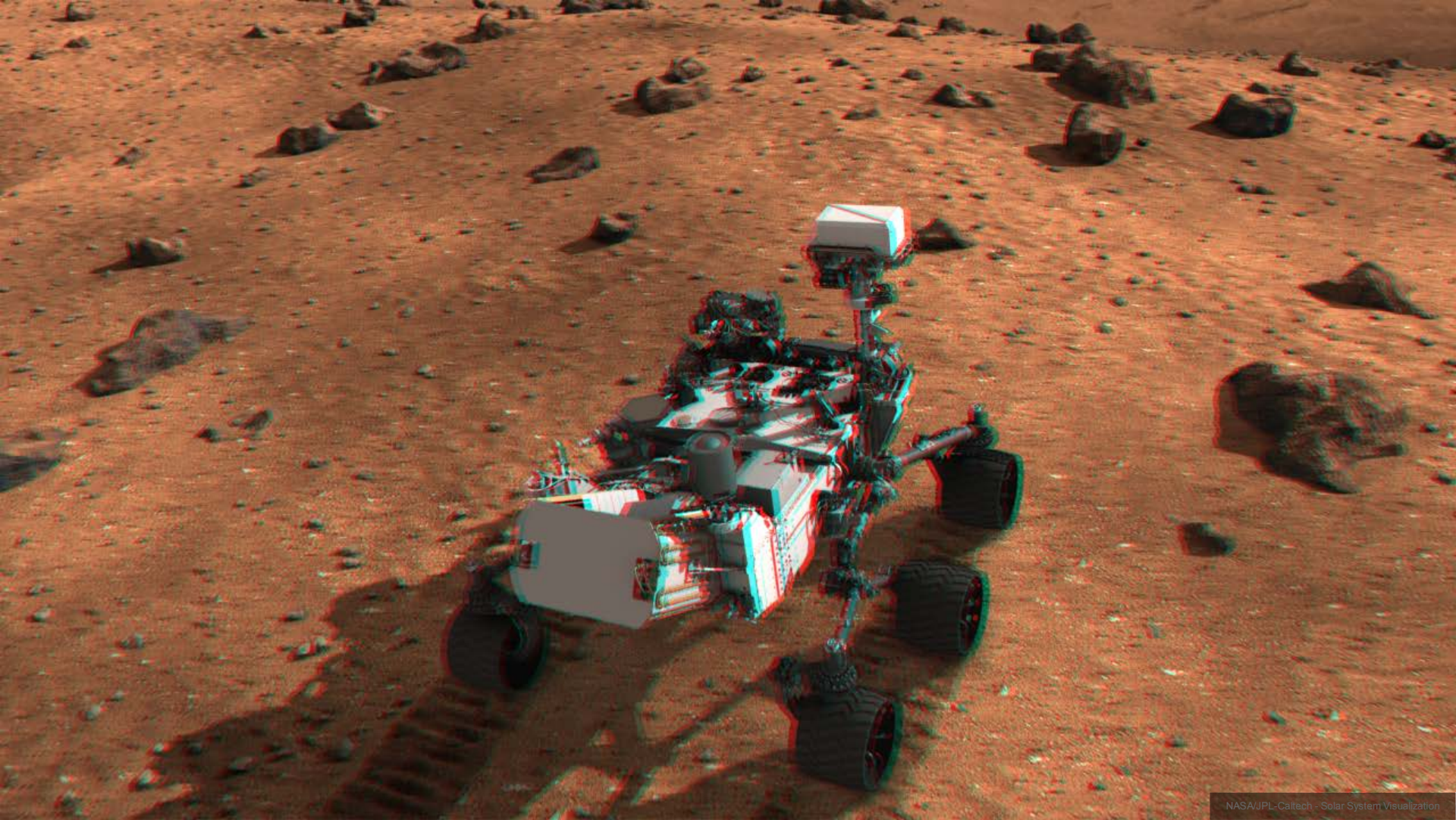


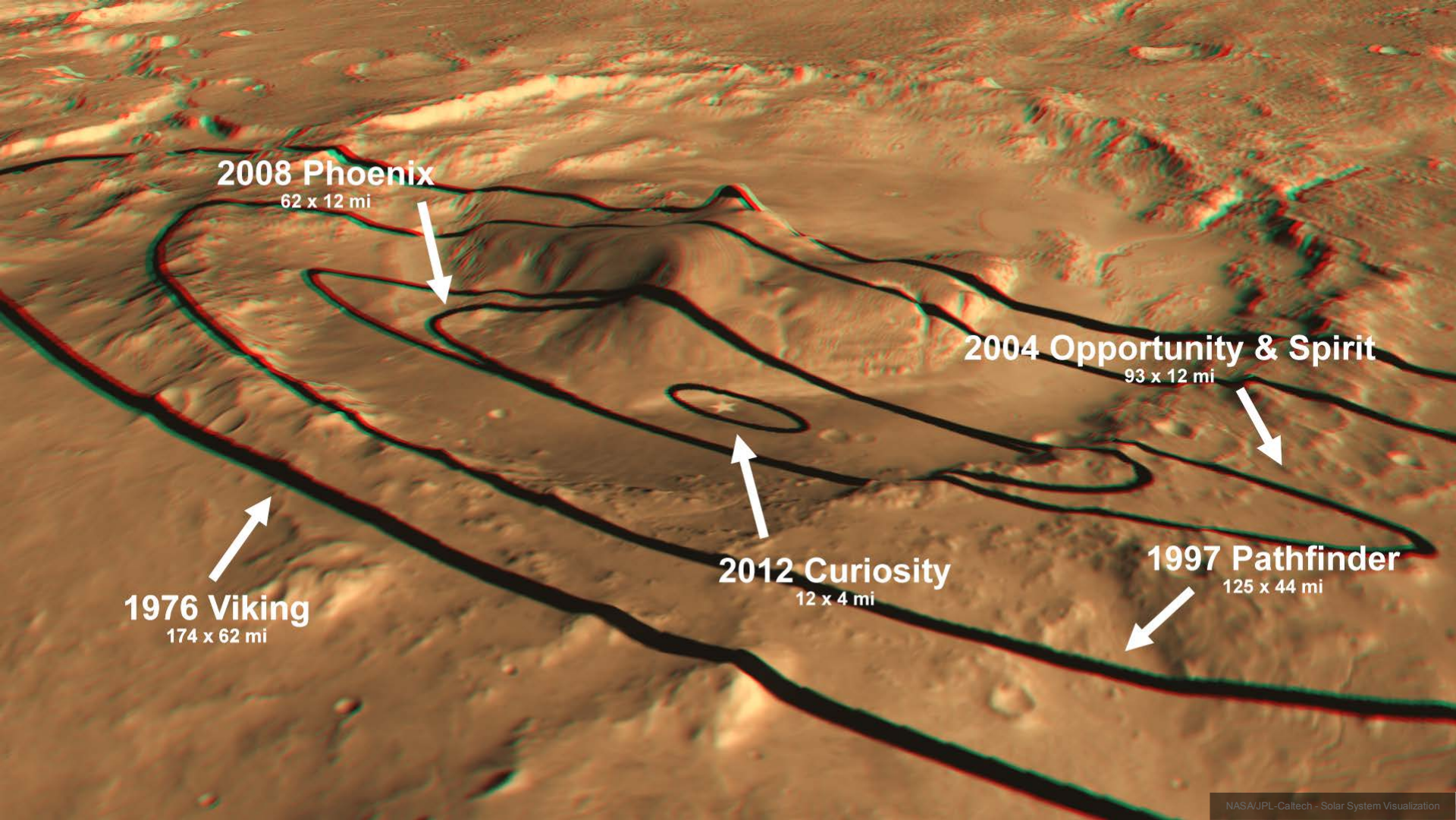
NASA/JPL-Caltech - Solar System Visualization



NASA/JPL-Caltech - Solar System Visualization


NASA/JPL-Caltech - Solar System Visualization


NASA/JPL-Caltech - Solar System Visualization

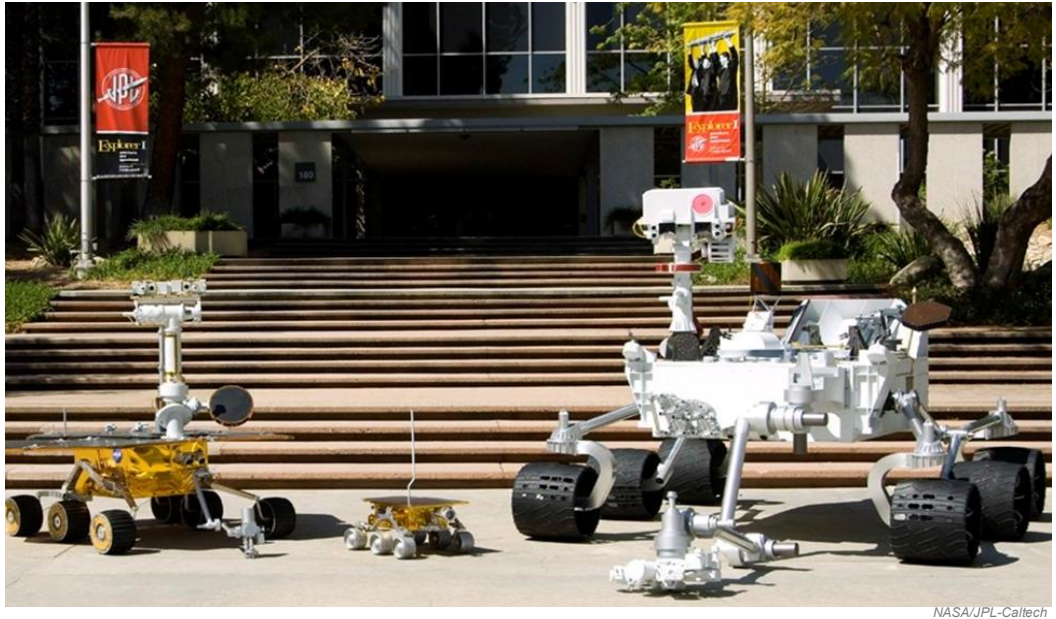

2008 Phoenix
62 x 12 mi
2004 Opportunity & Spirit
93 x 12 mi
2012 Curiosity
12 x 4 mi
1997 Pathfinder
125 x 44 mi
1976 Viking
174 x 62 mi
NASA/JPL-Caltech - Solar System Visualization

Curiosity's Mission Story

3D Glasses Off

Curiosity's Challenges

How hard is it to land a spacecraft the size of a Mini Cooper into an area of 37.7 square miles on Mars?



NASA/JPL-Caltech

Curiosity's Challenges

How do you test a Martian landing in an environment that is nothing like Mars?

- **Divide & Conquer**
- **Test each piece separately**
- **Put everything together with a supercomputer**

Test at NASA Dryden of Radar System for Next Mars Landing - NASA

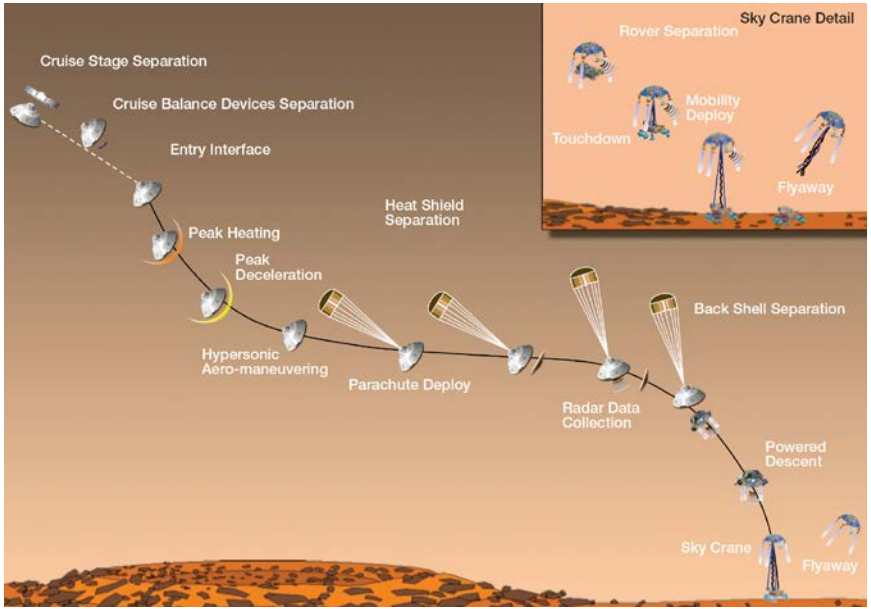
Airborne Testing for Mars Landing Radar by Dryden F/A-18 - NASA/JPL-Caltech

Preparing for a Mars Radar Test - NASA

Curiosity's Challenges

How do you verify that your spacecraft is on course to a safe landing?

- **Monte Carlo simulations**
- **8,001 separate high-fidelity trajectory integrations**
- **90 minute run-time for each simulation**
- **6 trajectory correction maneuvers allowed**



Timeline of Major Mission Events During Curiosity's Landing - NASA/JPL-Caltech

Curiosity's Challenges

How do you deliver the Supercomputing Environment that Curiosity needs?

- Fly what you know
- Development system
- Tight version control
- Automated rebuild & patch system
- Bug & enhancement tracking system

JPL Supercomputing Team – JPL/Timofey Ovcharenko

Follow Curiosity

Self-Portrait by Curiosity- NASA/JPL-Caltech/Malin Space Science Systems

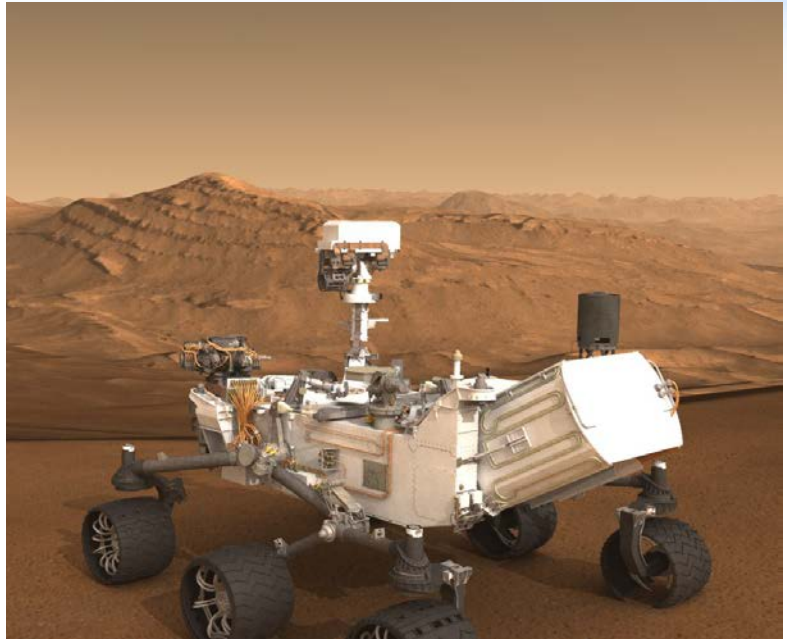
mars.jpl.nasa.gov/msl

Twitter: @MarsCuriosity

Be A Martian!

beamartian.jpl.nasa.gov

www.nasa.gov/msl



Artist's Concept - *NASA/JPL-Caltech*