# ASTROBOTIC TERRAIN RELATIVE NAVIGATION

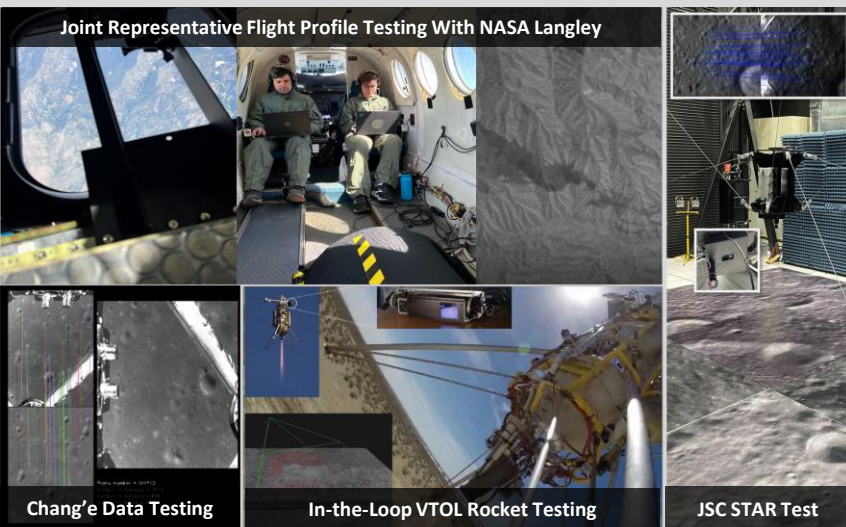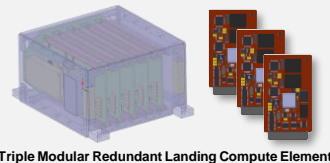## HIGH-MATURITY, HIGH-PERFORMANCE NAVIGATION FOR PLANETARY SPACECRAFT

SAFER, MORE PRECISE LANDINGS

Astrobotic has developed visual terrain relative navigation to enable precise and safe planetary landings on the Moon, Mars, and beyond. We were the first commercial company to use TRN and hazard detection to guide a suborbital rocket to a safe landing site. Our Generation 1 TRN system is integrated onto the Peregrine Mission 1 lunar lander after a full design, space qualification, flight test, and V&V campaign, including IV&V from JPL; our Gen. 2 systems adds additional robustness/assurance for Griffin Mission 1, which will deliver SMD's high-priority VIPER lunar rover.

Our TRN consists of a camera element and a compute element. The camera captures images of the planetary body and relays them to the compute element, where our software compares them to Astrobotic-generated maps of the planetary surface to determine the precise pose of the camera, which is fed to the landers GNC, providing low-latency, autonomous DDL navigation.

Heritage Gen 1 Astrobotic TRN Suite (OPAL)

Obscured

Passive TRN **LCAM** **TRN Compute**
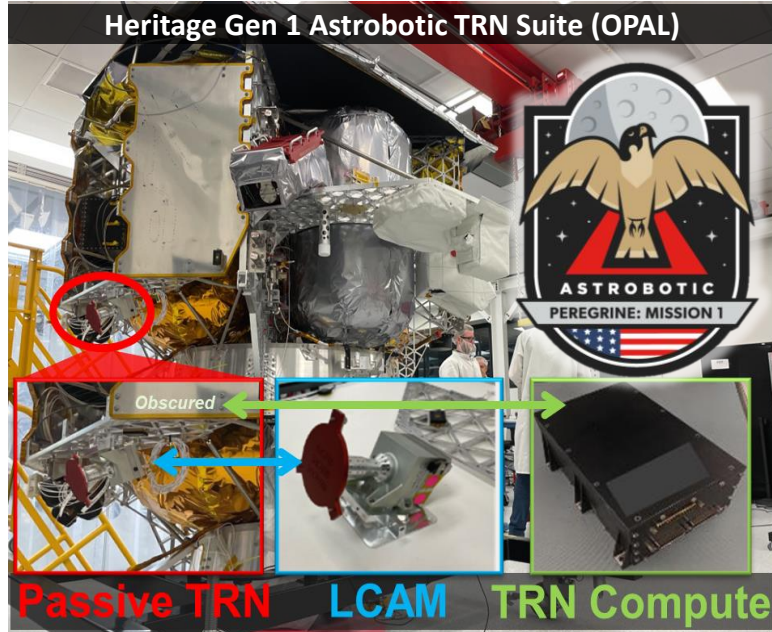
Astrobotic Gen. 2 TRN System Used for >$750M Griffin / NASA VIPER Landing
Adds additional robustness functionality and flight testing

Triple Modular Redundant Landing Compute Element

Joint Representative Flight Profile Testing With NASA Langley

Chang'e Data Testing   In-the-Loop VTOL Rocket Testing   JSC STAR Test

MATURE, FLIGHT-TESTED SOLUTION

Our extensive testing campaign includes:

- Full aerial flight test over DDL-representative flight profile with flight- representative TRN suite
- In-the-Loop navigation with VTOL Rockets
- SWIL testing with simulated and actual landing video
- Testing at multiple JSC sensor testbeds
- JPL IV&V of software; independent assessment from senior NASA SMEs; third-party map certification

ASTROBOTIC TRN FEATURES

Complete TRN Solution

Safe, Precise Planetary Landings

Low Size, Weight, & Power (SWaP)

Simplified Spacecraft Integration

Engineering Model and Support Hardware Available

EDL/DDL Software Tools and Analysis Support

Full Mission Lifecycle Support

Experienced Team