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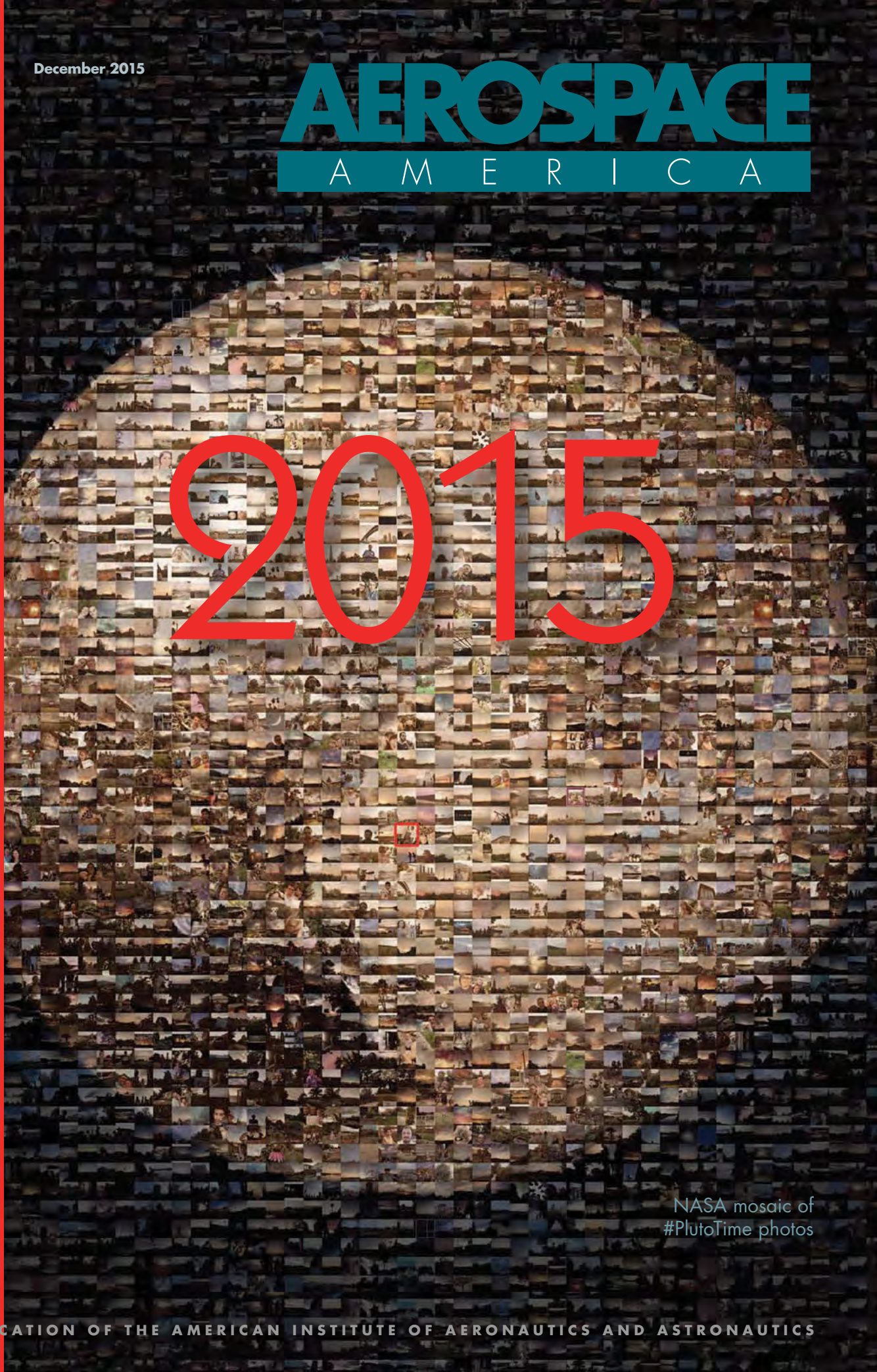

NASA mosaic of #PlutoTime photos

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Preparing for manned and unmanned space exploration

by William G. Tomek and Daniel W. Kwon

*The **Space Systems Technical Committee** fosters the development, application, and operation of space systems and addresses emerging issues in the field.*

While NASA and industry pursue a domestic crew-transportation capability for low-Earth orbit, advances have been made in exploration-mission planning and launch-vehicle and spacecraft development for manned and unmanned systems.

In July, experts from around NASA completed an 11-week-long critical design review of the Space Launch System launch vehicle at Marshall Space Flight Center in Alabama. The review focused on **SLS Block 1**, the version of the rocket that will launch an Orion crew capsule on Exploration Mission-1, an unmanned flight to demonstrate the seamless integration of the crew spacecraft and rocket. A key SLS milestone was achieved in March, when a test version of the vehicle's solid rocket motor roared to life in the desert scrub of Orbital ATK's Promontory, Utah, facility. Orbital ATK disassembled and inspected the rocket, called Qualification Motor-1, and declared the static test a "resounding success."

Progress continued on the **liquid-hydrogen-fueled RS-25 engines** for SLS. Test firings on an initial version of these upgraded space shuttle engines were conducted at Stennis Space Center in Mississippi in anticipation of the first ground tests with flight engines.

In the world of commercial launch vehicles, SpaceX tried a second time to land a Falcon 9 first stage on a platform in the Atlantic Ocean. The company planned to make a third attempt once the Falcon 9s were cleared to fly again after the June failure of a cargo mission to the space station. In April, United Launch Alliance announced development of a new rocket to be called Vulcan, whose Blue Origin-provided BE-4 engines eventually will be recovered and reused. Airbus this year unveiled plans to return rocket engines to Earth inside a winged vehicle to be called **Adeline**. Aerojet Rocketdyne and Blue Origin conducted research toward allowing the U.S. to launch rockets independently of Russian technology.

In the small-satellite industry, firmer plans emerged for several proposed low-Earth-orbit constellations. In June, OneWeb announced that Airbus will build more than 900 satellites for its planned constellation of broadband satellites, with the first to be launched in 2018. OneWeb also placed the largest commercial launch order to date, contracting with Arianespace and Virgin Galactic for a combined total of 60 satellite launches worth about $500 million. That same month, Seattle-based BlackSky Global announced plans for a 60-satellite Earth imaging system, with the first launches planned for late 2015. In July, Planet Labs acquired BlackBridge of Berlin, Germany, and its RapidEye constellation of satellites to accelerate its growth in the Earth observation market.

The emerging marketplace for commercially operated weather satellites saw San Francisco-based Spire send four cubesats to orbit in September to detect **automatic-identification-system beacons** from ships under the company's plans to deliver maritime services, including weather data.

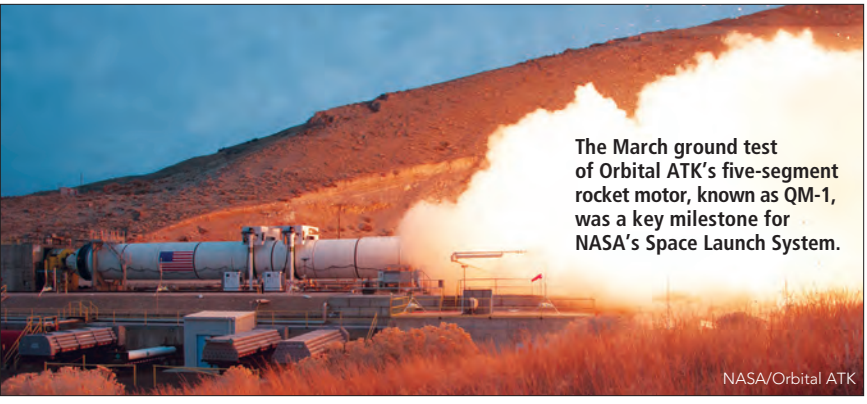
While early planning continued for a human journey to Mars in the 2030s, NASA managers are analyzing possible interim missions between low-Earth orbit and Mars. To set the stage for more detailed Mars exploration, the **Curiosity rover** continued ground-breaking science on the surface of the planet. Those findings will sharpen planning for future robotic sample return missions and manned missions after that.

NASA's Space Launch System is undergoing wind-tunnel tests, including at the Langley Unitary Plan Supersonic Wind Tunnel in Virginia.

On the **Asteroid Redirect Mission**, NASA chose to capture a boulder off a large asteroid and deliver it to a lunar retrograde orbit for rendezvous with a subsequent human mission via the SLS and Orion.

A study is underway on a possible unmanned mission to **Jupiter's moon Europa**, whose icy exterior is thought to cover an ocean of liquid water that could harbor a simple form of life.

After traveling through space for almost 10 years, the **New Horizons spacecraft flew by Pluto** and its moon, gathering images and data that will continue to arrive well into 2016.



The March ground test of Orbital ATK's five-segment rocket motor, known as QM-1, was a key milestone for NASA's Space Launch System.