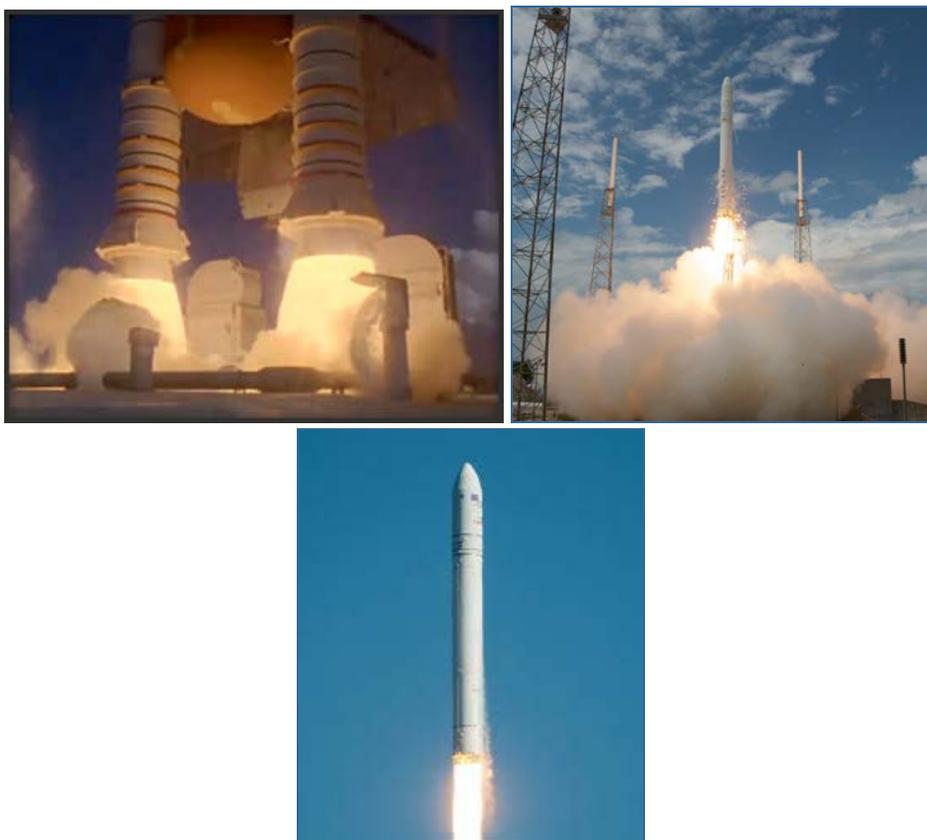


## *Imagery Integration Team*

*Tracy Calhoun, Dave Melendrez*

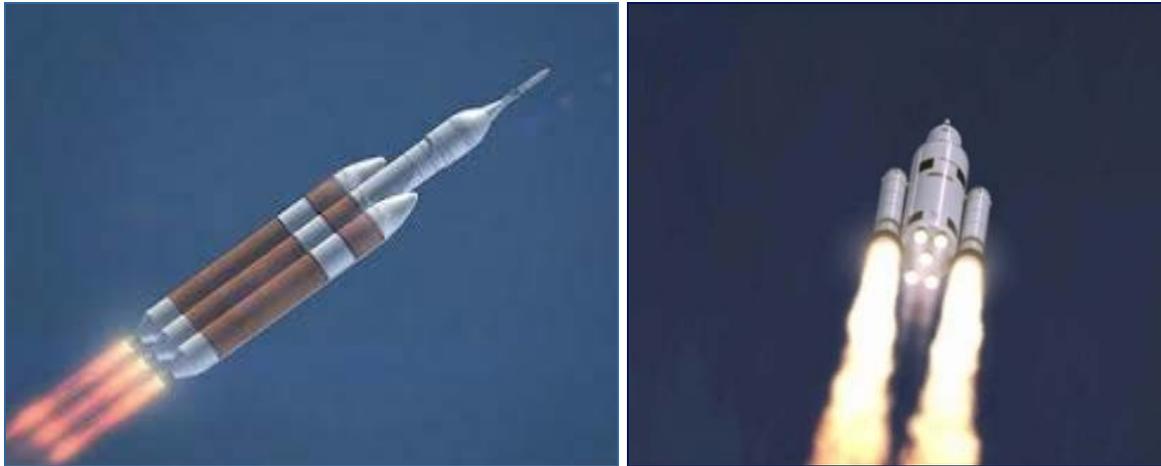
The Human Exploration Science Office (KX) provides leadership for NASA's Imagery Integration (I<sup>2</sup>) Team, an affiliation of experts in the use of engineering-class imagery intended to monitor the performance of launch vehicles and crewed spacecraft in flight. Typical engineering imagery assessments include studying and characterizing the liftoff and ascent debris environments; launch vehicle and propulsion element performance; in-flight activities; and entry, landing, and recovery operations. I<sup>2</sup> support has been provided not only for U.S. Government spaceflight (*e.g.*, Space Shuttle, Ares I-X) but also for commercial launch providers, such as Space Exploration Technologies Corporation (SpaceX) and Orbital Sciences Corporation, servicing the International Space Station.



*Figure 1.— Examples of launch imagery for (clockwise from top left) the Space Shuttle, SpaceX Falcon 9, and Orbital Antares.*

The NASA I<sup>2</sup> Team is composed of imagery integration specialists from JSC, the Marshall Space Flight Center (MSFC), and the Kennedy Space Center (KSC), who have access to a vast pool of experience and capabilities related to program integration, deployment and management of imagery assets, imagery data management, and photogrammetric analysis. The I<sup>2</sup> team is currently providing

integration services to commercial demonstration flights, Exploration Flight Test-1 (EFT-1), and the Space Launch System (SLS)–based Exploration Missions (EM)-1 and EM-2. EM-2 will be the first attempt to fly a piloted mission with the Orion spacecraft.



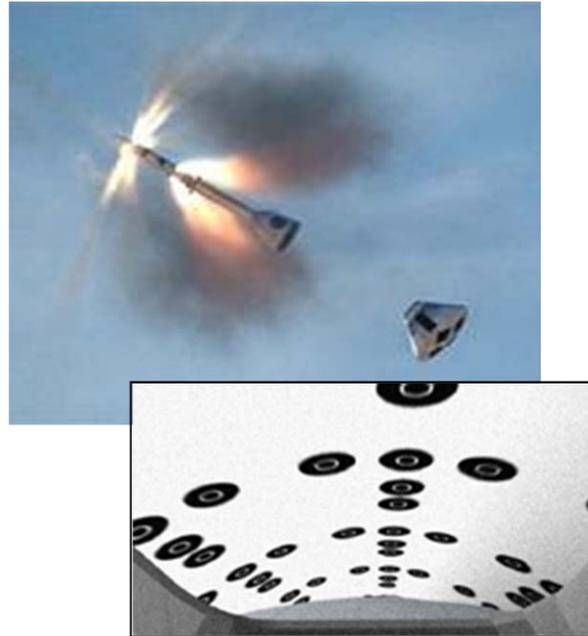
*Figure 2.– (Left to right) Notional views of the EFT-1 launch vehicle and SLS.*

The I<sup>2</sup> Team provides the customer (both commercial and Government) with access to a wide array of imagery options – ground-based, airborne, seaborne, or vehicle-based – that are available through the Government and commercial vendors. The team guides the customer in assembling the appropriate complement of imagery acquisition assets at the customer’s facilities, minimizing costs associated with market research and the risk of purchasing inadequate assets. The NASA I<sup>2</sup> capability simplifies the process of securing one-of-a-kind imagery assets and skill sets, such as ground-based fixed and tracking cameras, crew-in-the-loop imaging applications, and the integration of custom or commercial-off-the-shelf sensors onboard spacecraft.



*Figure 3.– (Left) Tracking cameras monitor ascent performance and separation events. (Right) The Ares 1-X test launch in October 2009.*

For spaceflight applications, the I<sup>2</sup> Team leverages modeling, analytical, and scientific resources along with decades of experience and lessons learned to assist the customer in optimizing engineering imagery acquisition and management schemes for any phase of flight – launch, ascent, on-orbit, descent, and landing.



*Figure 4.– Modeling of separation event to evaluate the locations of photogrammetric targets.*

The I<sup>2</sup> Team guides the customer in using NASA’s world-class imagery analysis teams, which specialize in overcoming inherent challenges associated with spaceflight imagery sets. Precision motion tracking, two-dimensional (2D) and three-dimensional (3D) photogrammetry, image stabilization, 3D modeling of imagery data, lighting assessment, and vehicle fiducial marking assessments are available.



*Figure 5.– Modeling of spacecraft on-orbit inspections prior to entry.*

During a mission or test, the I<sup>2</sup> Team provides oversight of imagery operations to verify fulfillment of imagery requirements. The team oversees the collection, screening, and analysis of imagery to build a set of imagery findings. It integrates and corroborates the imagery findings with other mission data sets, generating executive summaries to support time-critical mission decisions.

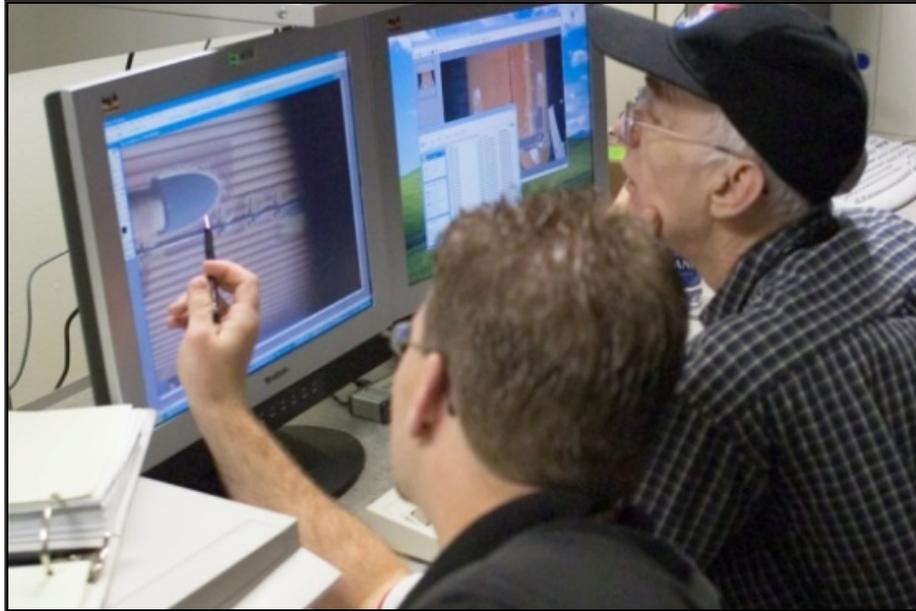


Figure 6.— Screening and analysis.

## *Advancements in Capsule Parachute Analysis*

*David Bretz*

The Image Science and Analysis Group (ISAG), a subgroup within the ARES Directorate, has provided image analysis support of the Capsule Parachute Assembly System (CPAS) testing being conducted at the Yuma Proving Grounds by JSC Engineering. The work being done by ISAG is a continuation of photogrammetric analysis that began in 2010, which is expected to extend through 2014 with the development and analysis of parachutes for the Multi-Purpose Crew Vehicle (MPCV) being developed at JSC.

At the request of the engineers, ISAG developed methods for converting video imagery into parachute flight performance parameters, such as fly-out angles, parachute skirt diameters, and drogue mortar deployment speeds. This information (along with many other parameters measured with a variety of instruments) is used by engineers to understand and accurately model parachute behavior, drag coefficient, and rate of descent. Good models will improve the fidelity of MPCV simulations of roll control and splashdown impacts.