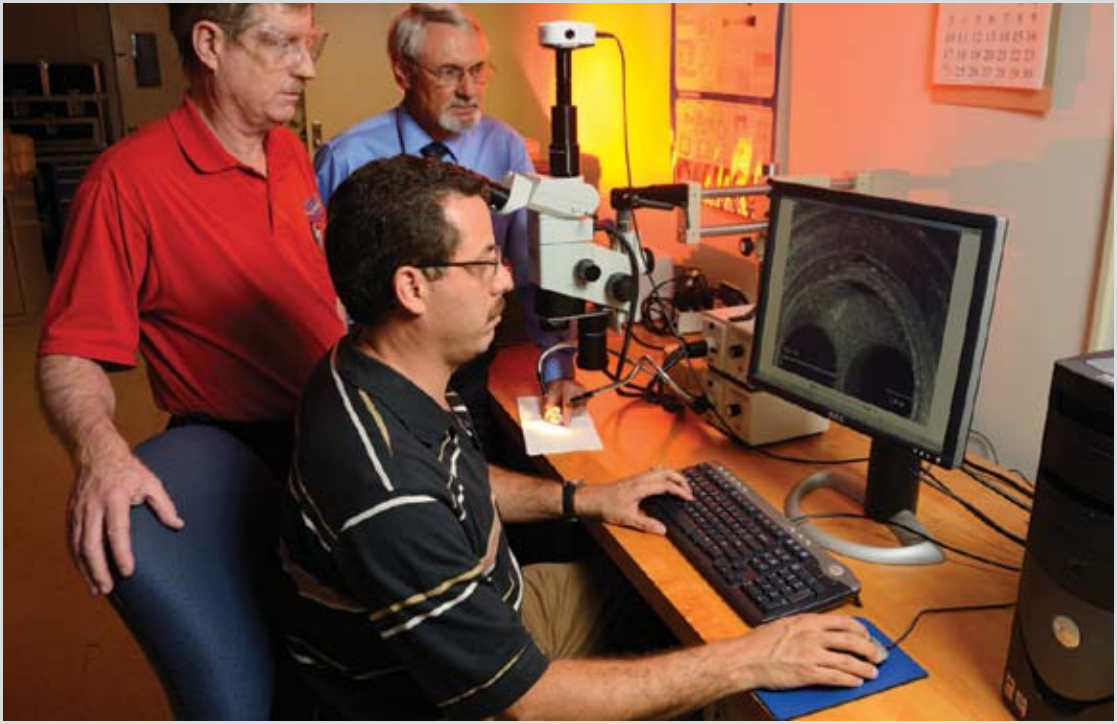
Pyrovalve Booster Interface Temperature Measurement

Problem: The Mars Science Laboratory (MSL) Project is using pyrovalves with stainless steel primer chamber assemblies with a "V" channel shape (V-PCA) rather than the heritage aluminum design with a "Y" channel shape (Y-PCA). The design was changed to reduce flame channel melting/erosion, eliminate potential obstructions at the channel intersection, and reduce variability. MSL qualification testing of the V-PCA design demonstrated faster booster ignition and little or no melting/erosion. However, further testing was needed to quantitatively compare the two designs.

NESC Contribution: The WSTF developed a specialized method to compare the two PCAs. The method used high-speed infrared pyrometers (6μs response) and video cameras (20,000 frames per second) to observe the underside of the booster cover (propellant interface) through a sapphire window. Other tests also evaluated the effects of larger diameter flow channels and varying skews between the firing of the redundant initiator firings.

Result: The new PCA design delivered an average propellant interface peak temperature of 315 C (600 F) higher than the aluminum design in about one-half the time and produced pressures that were several thousand psi greater. However, dual simultaneous firings of both PCA types reduced the maximum temperature several hundred degrees below the threshold needed to ignite the booster. This potential failure mode occurred even with flow paths with four times the original cross-sectional area. These data will help future NASA projects to properly evaluate the selection and use of PCAs.



Benjamin Gonzalez, Jacobs Scientist (seated) shows close-ups of post-firing PCAs to project leader, Steve McDougle (left), and assessment lead, Regor Saulsberry.