

High-Energy Digital X-Ray Imaging to Verify Rocket Performance

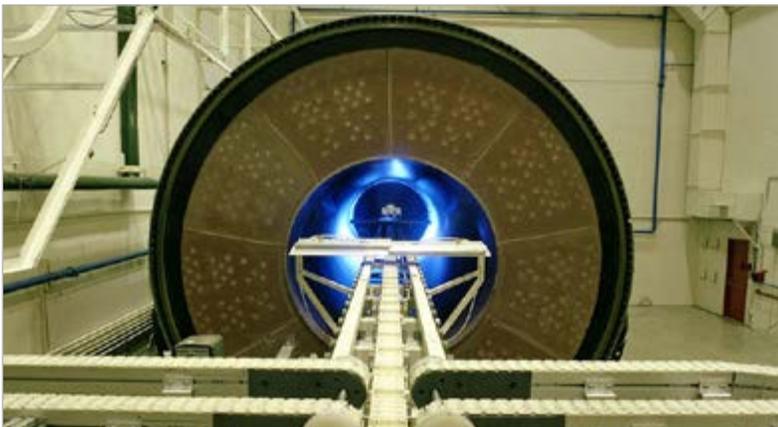
Inspecting rocket fuel and component placement to ensure functionality and protect the safety of space flight crews during lift-off

The Challenge

NASA was engaged in developing the next generation of manned spacecraft, with the stated program goals: gaining significant experience in operating away from Earth's environment, developing technologies needed for opening the space frontier, and conducting fundamental science. As part of this program—called "Constellation"—the Customer was contracted to design and develop booster rockets for launching the spacecraft on its missions.

The Customer, a leading aerospace and defense firm with decades of experience with propulsion and rocket systems, used X-ray imaging for quality control of components during manufacture. However, its X-ray image capture technology was outdated, still relying on traditional X-ray films. To meet NASA's requirements for this new project, the Customer needed to upgrade its X-ray image quality and integrate digital capture and storage capabilities for real-time inspection and analysis.

It was mission-critical to ensure quality and precision in the production of these rocket booster systems, as they were going to be deployed on manned spacecraft. A misfire or malfunction in the rockets could have disastrous consequences for the Customer's reputation, the space program, and—most of all—for the astronauts themselves. The Customer called on Adaptive Energy's expertise in system integration, digital image conversion, and high-energy radiation systems to help address this testing challenge.



Industry: Government / Aerospace

Technology: Digital Radiography

Products & Services: Component placement / Composite delamination / Crack detection and porosity / Custom radiation enclosures

Customer Profile: A world-renowned U.S. producer of solid rocket propulsion systems and a leading supplier of military and commercial aircraft structures

Business Challenge: To build rocket boosters for next-generation spacecraft, the Customer needed a cost-effective method to transition from film-based to digital imaging to achieve higher quality and consistency in its rocket fuel and component production

Solution: Development of a high-energy X-ray system integrated with LDA digital radiography imaging and system software that captures precision imaging at high speed, with an enclosure to shield the delicate electronics from X-ray damage

Benefits:

- Use of digital image format in place of older film-based X-rays provides much more precise and detailed imaging
- Consistency in the rocket fuel and component placement ensures the rockets will fire correctly and protects the safety of space crews during flight operations
- Custom-designed system assembly protects delicate electronic components from high-energy X-rays

Launch rocket containing solid fuel undergoing high-energy X-ray/LDA digital inspection

The Adaptive Energy Solution

Adaptive Energy applied its unique blend of capabilities and expertise to design and deploy a solution integrating several components. The first was a high-energy 15 MeV X-ray system with a one-percent degree of sensitivity. Although a wide variety of digital and film-based technologies were viable to satisfy the image quality indicator (IQI) requirements of the project, a digital radiography solution using a linear diode array (LDA) would provide a dramatic throughput advantage.

An LDA uses a scintillator directly coupled to a photo diode to convert X-rays into an electronic signal. This allows the system to capture much greater detail at higher speeds, ideal for longitudinal scanning with the linear accelerator for rocket inspection. LDA technology also offers a higher dynamic range to effectively scan larger and denser parts, providing improved image contrast.

In setting up the system, Adaptive Energy was able to synchronize the imaging system with the linear accelerator to correctly correlate the scans, and minimize back scatter to help reduce image noise. The precision scanning capabilities of this solution were critical to the Customer. Scanning was used during rocket production to inspect for continuity of the solid fuel inside the rocket assembly. The fuel had to be a consistent, solid mass with no cracks, air gaps or separation from the rocket body. Tangential scan shots were also used to verify correct placement of a liner and other components inside the rocket.

The combination of high-energy X-ray and LDA digital radiography provided the imaging solution the Customer needed. However, one additional challenge was how to protect the delicate electronics of the LDA system from potential damage from the high-energy X-rays during testing. Adaptive Energy designed a system assembly with the correct geometries to shield the electronics in the digital imaging device.

The Result

By capturing high quality digital images at high speeds, penetrating deep into the body of the rocket, the Company is able to conduct near real-time inspection to ensure that the rocket fuel and components are properly aligned. The solution has also helped the Customer increase efficiency by integrating with its production line.

The system requires minimal handling: a sole operator can control it through an intuitive software program, set image parameters, and manipulate scanning on multiple axes. Additionally, the software application includes a database operation for automated scan storage and report generation, and complete input/output controls.

With the precision of the scan images this system provides, the Customer is able to verify quality and manufacturing parameters to meet NASA requirements for the rockets to be rated for human flight. NASA can deploy these rockets on a live space craft with confidence that they will perform as needed to ensure the success of the mission and the safety of the crew.

About Adaptive Energy

Adaptive Energy creates customized, non-destructive material evaluation solutions to address mission-critical, time-sensitive testing needs. By combining the latest digital radiography, computed tomography, and ultrasonic imaging technologies with innovative mechanical and robotic assemblies, Adaptive Energy's integrated systems offer rapid deployment, are easy to learn and maintain, and perform reliably under pressure.

Working collaboratively with organizations in the aerospace, automotive, energy, petro-chemical, defense, infrastructure, and materials industries, our experts develop optimized solutions for flaw and crack detection, composite delamination, weld inspection, hardness testing, custom radiation enclosures and overhead gantry systems, and more.

Adaptive Energy is also the exclusive distributor in the U.S. and Canada of FORCE Technology's P-Scan ultrasonic scanners, including the P-Scan Stack with Phased Array, a next generation automated inspection system.



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