

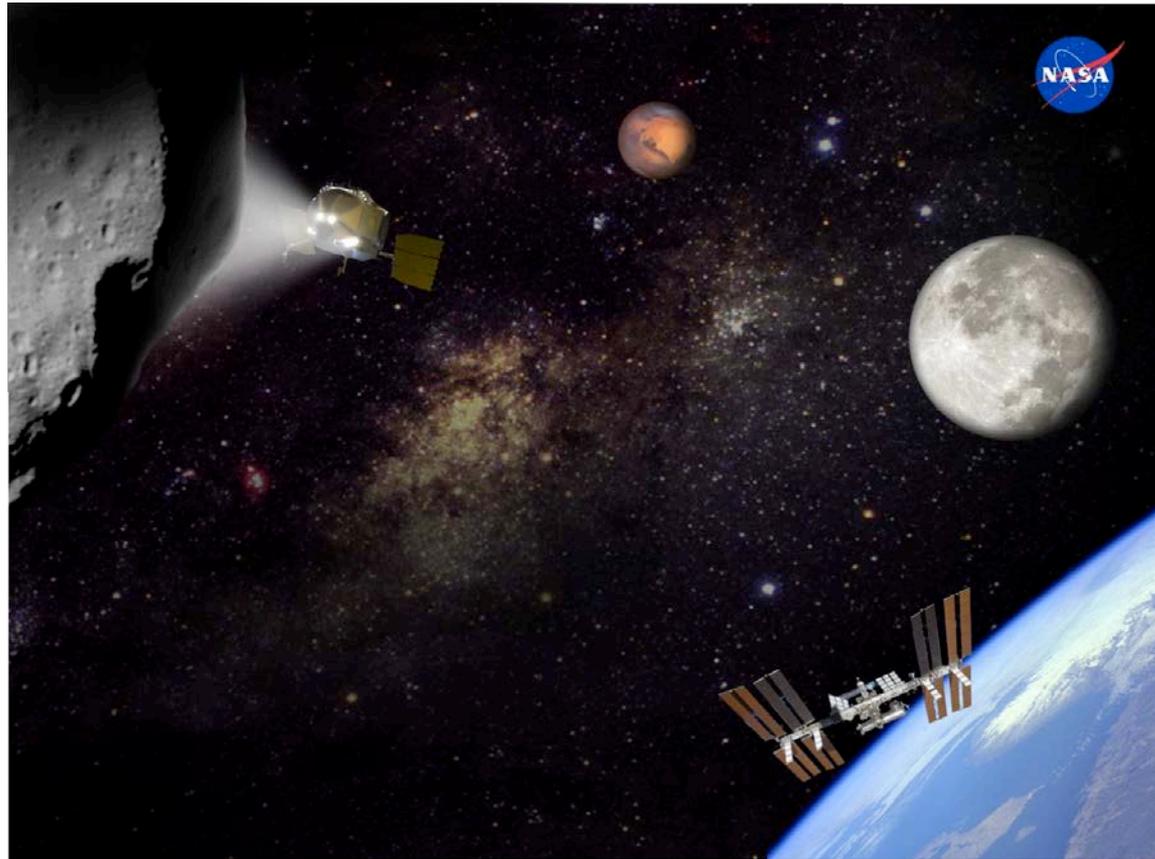


# NASA Engineering and Safety Center

Bill Prosser

February 29, 2012

## In-Space Nondestructive Inspection Technology Workshop





# Outline

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- NASA Engineering and Safety Center – Nondestructive Evaluation (NDE) Technical Discipline Team (TDT)
- Motivation for Workshop
- Examples of current in-space NDE technologies
- Workshop Goals

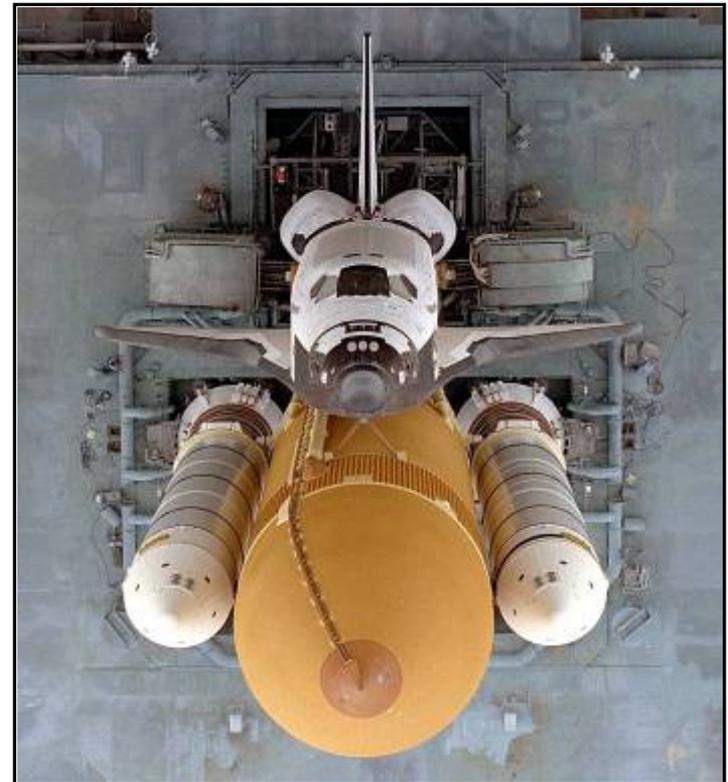


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- NESC created in wake of Columbia accident to provide independent assessment of technical issues for NASA programs and projects
- Scope
  - Independent in-depth technical assessments
  - Independent trend analysis
  - Independent systems engineering analysis
  - Mishap Investigations
  - Design and Flight Readiness Reviews
  - Support Programs
  - Focus on High Risk Programs



Space Shuttle on Mobile Launch Platform



# NASA Engineering and Safety Center

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- NESC comprised of:
  - Principal Engineers located at NASA Langley
  - NESC Chief Engineers (NCEs) located at each NASA Field Center
  - Systems Engineers located across the Agency
  - NESC Technical Fellows (TFs) for specific disciplines located across the Agency
    - Fluids/Life Support/Thermal, Flight Sciences, Guidance Navigation & Control, Human Factors, Materials, Mechanical Analysis, Mechanical Systems, Non-Destructive Evaluation, Power & Avionics, Propulsion, Software, Structures
  - Chief Scientist & Chief Astronaut
- TFs are the leaders of National teams of experts...called Technical Discipline Teams (TDTs)
  - NASA, Other Government Agencies, Industry and Academia
  - NDE TDT comprised of about 60 members



# Notable Recent NESC Assessments

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- MLAS flight demonstration, Composite Crew Module Development and Testing, Assistance to Chilean Miner Rescue, Toyota Unintended Acceleration Assessment, Shell Buckling Knockdown Factor Testing
- Shuttle – Cracked Stringer Investigation, ET Foam Loss, RCC Wing Leading Edge Coating Anomaly, FCV Poppet Cracking ...
- ISS – SARJ Problem, Reboost Anomaly, UPA Pump Failure, Node 3 Ammonia Line Flex Hose Failure ...
- Orion/Ares – Crew Module Water Landing Tests, Human Occupant Injury Factors, ARES IX USS CFS ...
- Robotic Missions – MSL Propellant Tank Inspection POD, Review of JWST Cryocooler Disturbance Models, Pluto New Horizons Tank Assessment ...
- Commercial Cargo and Crew – Review of Requirements Documents, Taurus II Launch Pad Structural Assessment, SpaceX Shock Test Specifications for Reusable Equipment

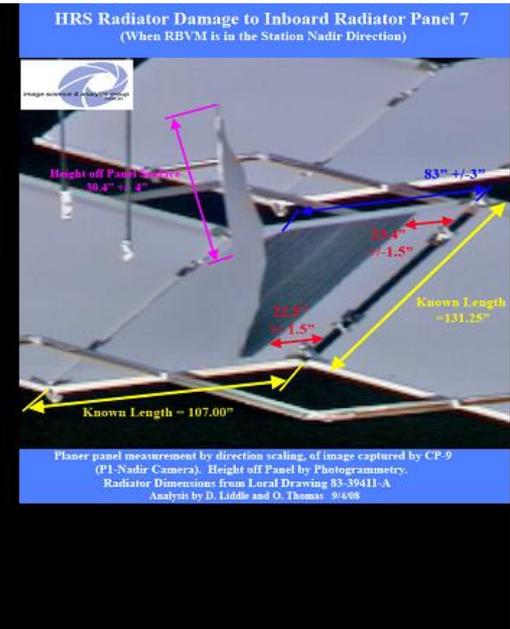
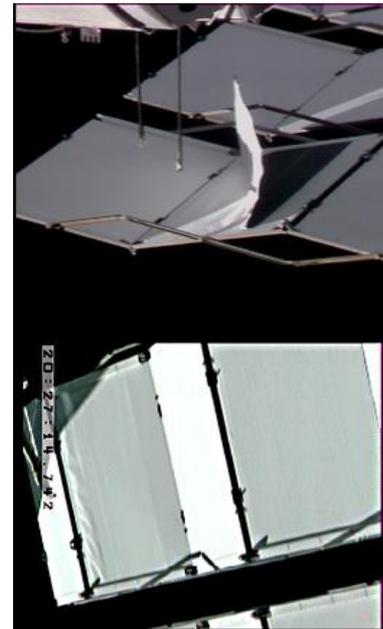
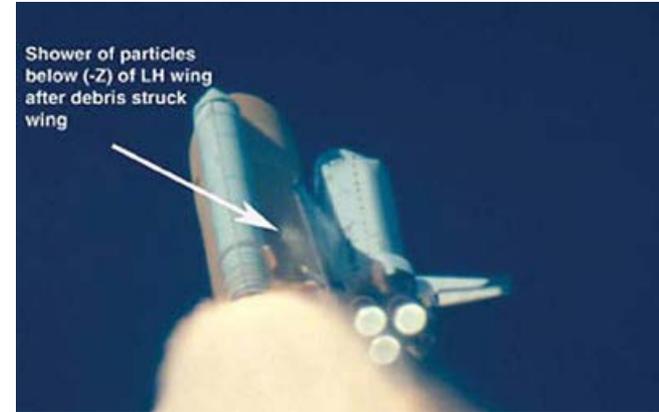


# Why In-Space NDE?

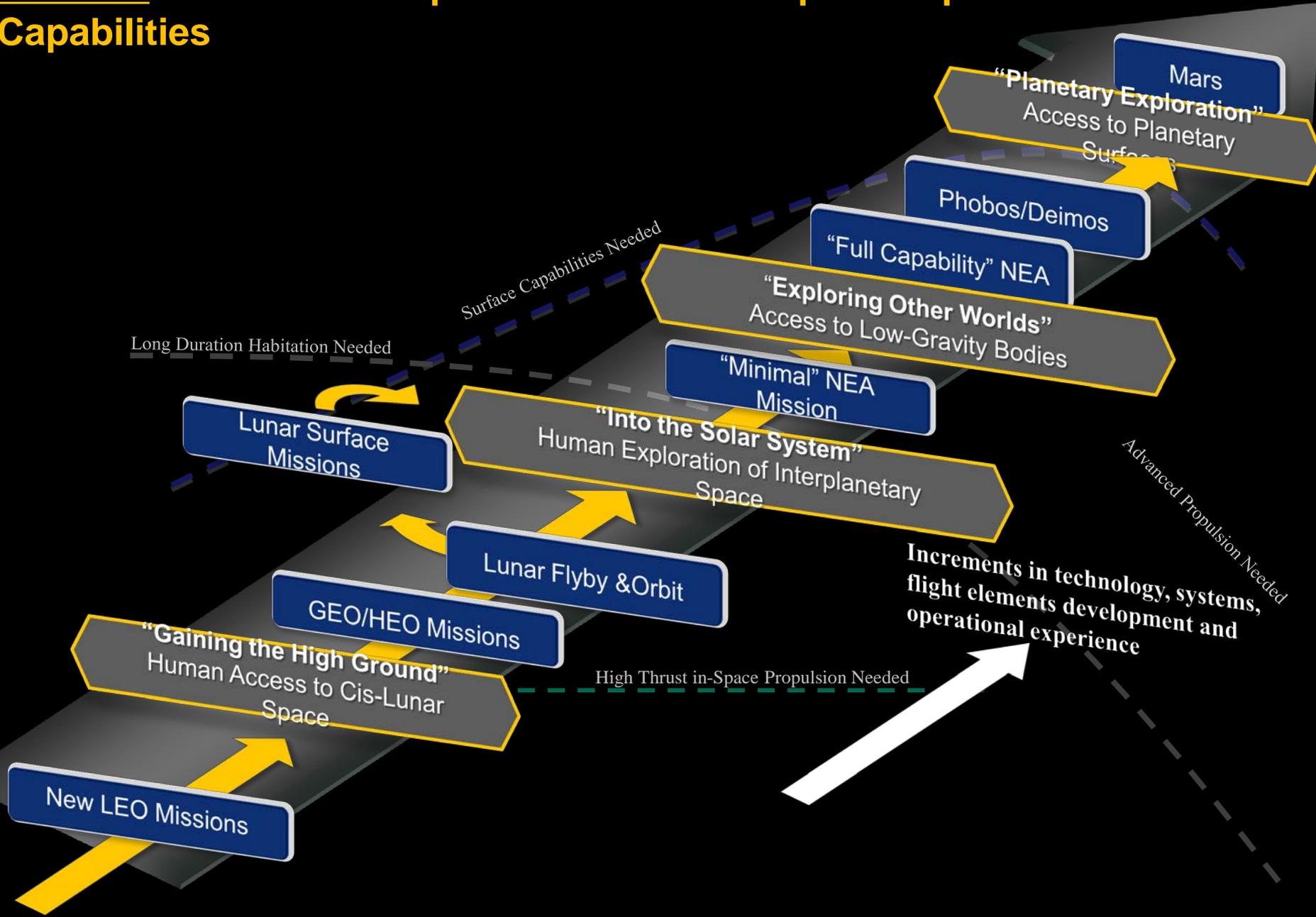
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- Apollo 13 – tank explosion
- Mir – vehicle collision
- Shuttle Columbia – debris impact
- ISS
  - MMOD impacts
  - Reboost anomaly
  - Radiator panel face sheet failure
  - SARJ problems
  - Life extension
- Future Vehicles and Missions
  - Longer durations
  - Increased distances



# Notional Incremental Expansion of Human Space Exploration Capabilities



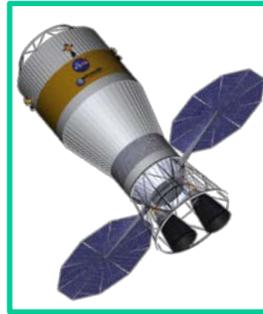
# Notional HAT Architecture Elements



Space Launch System (SLS)-HLLV



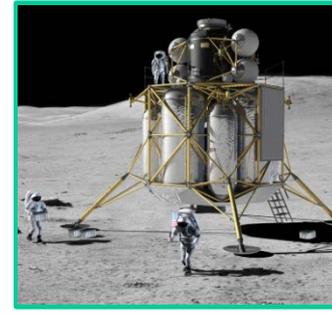
Multi-purpose Crew Vehicle (MPCV)



Cryogenic Propulsion Stage (CPS)



Solar Electric Propulsion (SEP)



Lander



Mars Elements

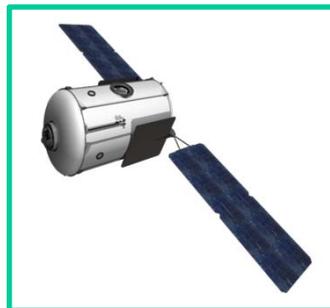
Graphics are Notional Only – Design and Analysis On-going



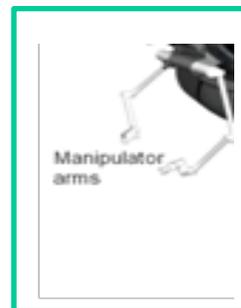
EVA Suit



Multi-Mission Space Exploration Vehicle (MMSEV)



Deep Space Habitat (DSH)



Robotics & EVA Module (REM)



Kick Stage



NEA Science Package

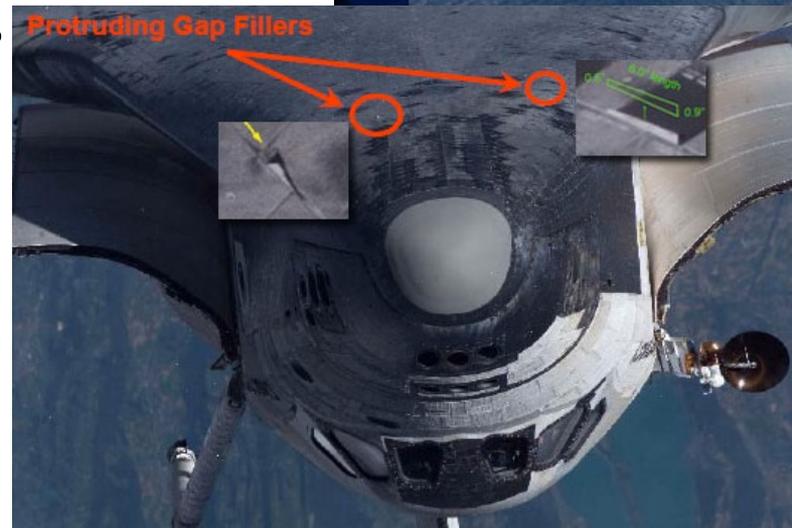
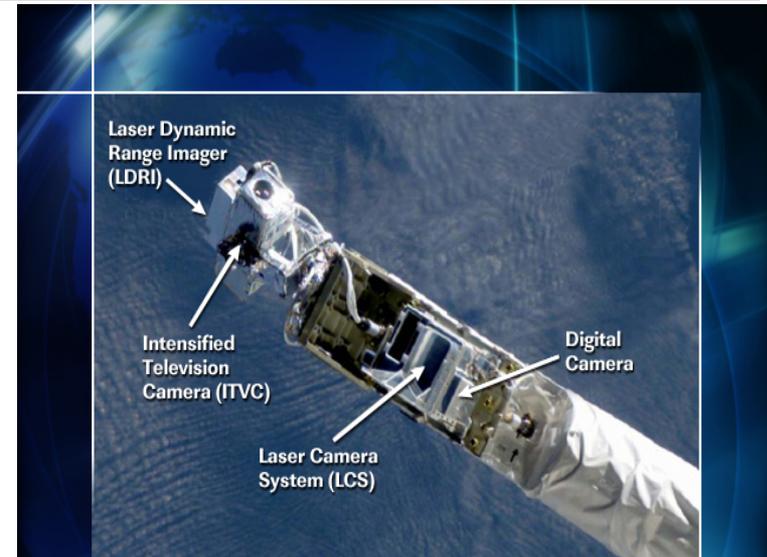


# In-Space Inspection Examples

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- Shuttle Orbiter Boom Sensing System (OBSS)
  - Developed for inspection of Shuttle Thermal Protection System (TPS) during flight
  - Laser Dynamic Range Imager
  - Laser and Digital Cameras
  - Intensified TV Camera

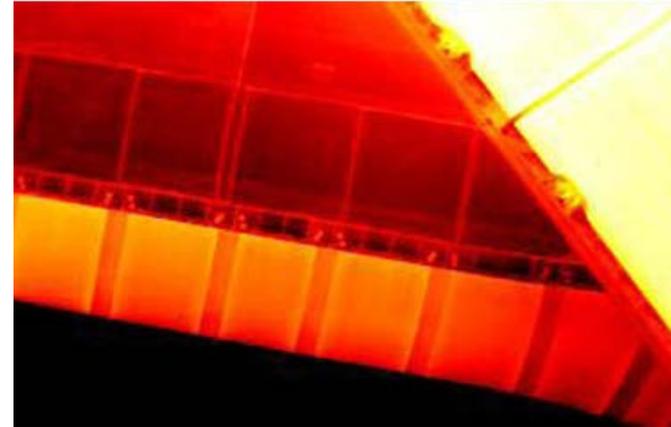




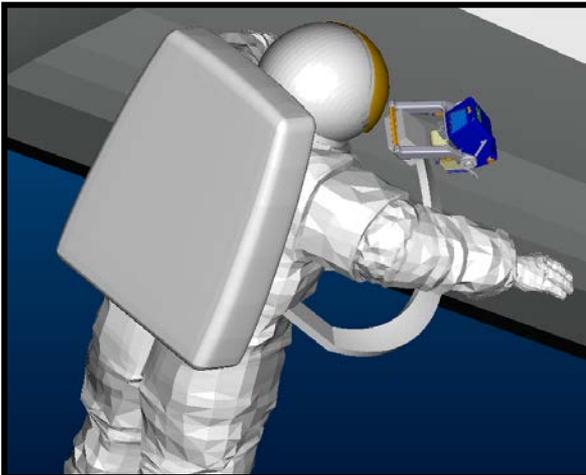
# On-Orbit IR Thermography

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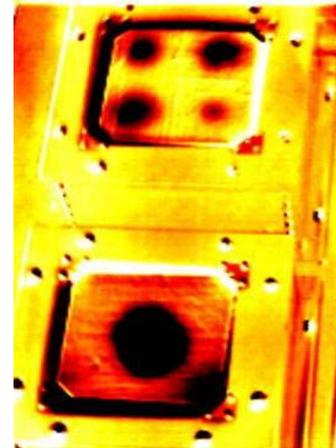
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Images of Shuttle wing leading edge



Illustrations of on-orbit thermal camera deployment



Images of RCC samples in payload bay



# Workshop Goals

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- Assess In-Space NDE technologies and needs - current & future spacecraft.
- Discover & build on needs, R&D & NDE products in other industries and agencies.
- Stimulate partnerships in & outside NASA to move technologies forward cooperatively.
- Facilitate group discussion on challenges and opportunities of mutual benefit.