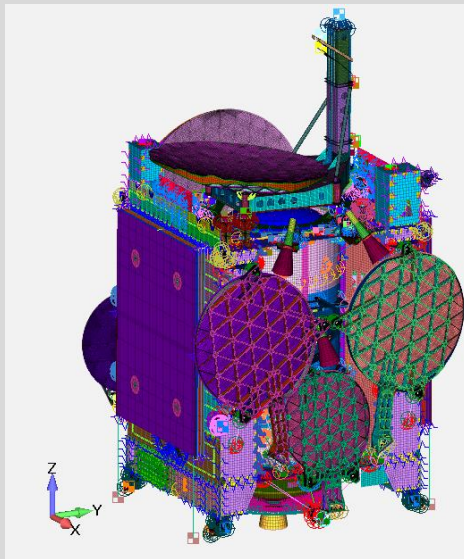


Orbital ATK Space Systems Group

Satellite Structures



*Tom Stoumbos, PhD
Director, Mechanical/Thermal Analysis & Test
Orbital ATK, Dulles, Virginia*

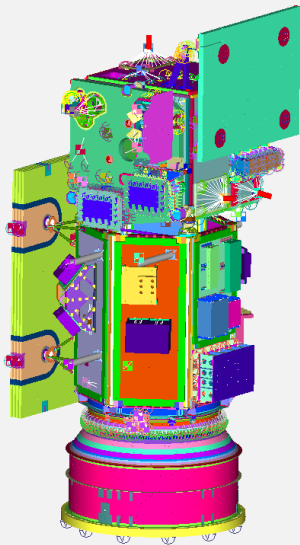


Introduction:

My name is Tom Stoumbos

Background in Computational Mechanics/Dynamics and Composite Materials

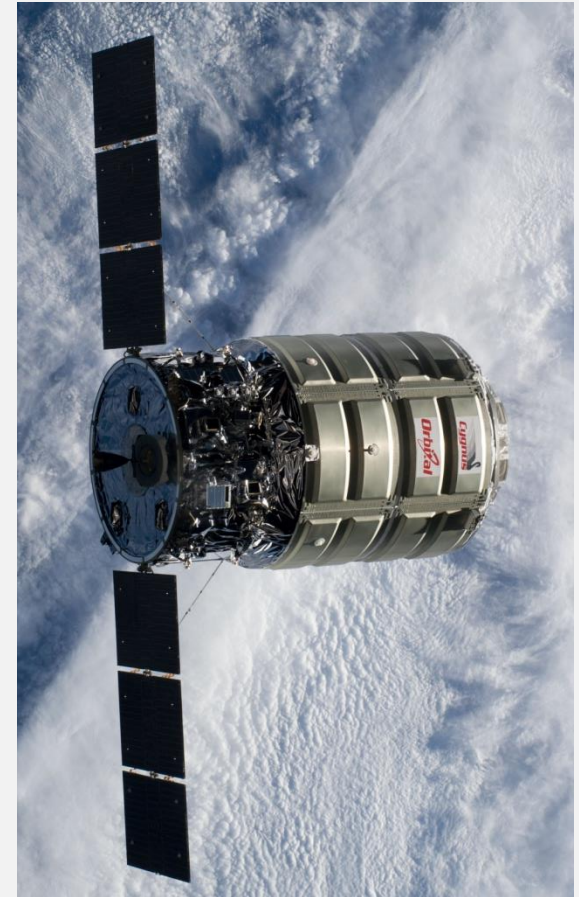
Educated in the US (PhD in Aerospace Engineering from Virginia Tech), England (UMIST, Solid Mechanics) and Greece (NTUA, Expert Systems in Marine Engineering)



Agenda

- Orbital ATK Groups
- Core Values and Guiding Principles
- Space Systems Group (SSG)
- Space Market Outlook
- Mechanical/Thermal Analysis & Test Group
- Orbital ATK SSG Products

- Q&A



Operating Groups



New order growth has been solid with firm backlog.



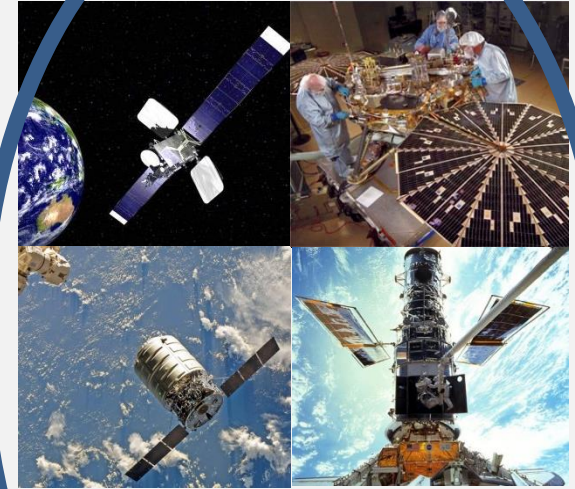
Flight Systems Group

- Launch Vehicles & Aircraft systems and subsystems



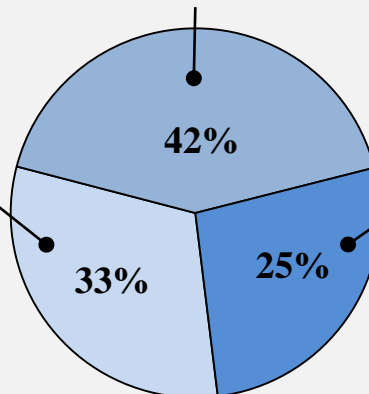
Defense Systems Group

- Armament & small caliber systems products



Space Systems Group

- Commercial communication satellites, Science & Technology, Space Exploration, ISS resupply, Robotic Missions



2017 Market Cap \$5.6 Billion

Core Values and Guiding Principles



Safety, **reliability** and **integrity** are our highest priorities, the three absolutes in all our activities. We are also intensely focused on **affordability**, achieved through continuing investment in **innovation** and sustained commitment to **execution** excellence.

For our **customers**, we will always act with **integrity** and responsiveness, working to earn and maintain their loyalty every day.

*For our **employees**, we will encourage the highest levels of **engagement**, **diligence** and **creativity**, and reward their **dedication** and **teamwork**.*



For our **investors**, we will manage our business with **discipline** and deploy its capital to enhance long-term returns to shareholders.

For our **suppliers**, we will be honest and fair, seeking opportunities for beneficial **collaboration** in long-term alliances.

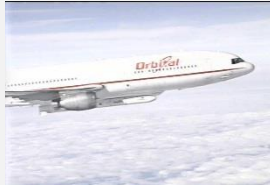
For our **country**, we are proudly **patriotic** and deeply grateful to those who defend our freedom. In addition, we are an involved and responsible corporate citizen of the **communities** where we live and work.

Space Systems Group

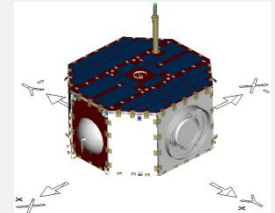


Orbital ATK pioneered several significant space industry innovations:

- Developed of the world's first privately-funded space launch vehicle, in the Pegasus rocket



- Created the industry's first modern microsattellites & produced over 30 scientific satellites for NASA and other research agencies



- Developed the industry's leading small geosynchronous communications satellites, GEOStar, in the late 1990's, and ready to launch our next generation GEOStar-3 later this year.



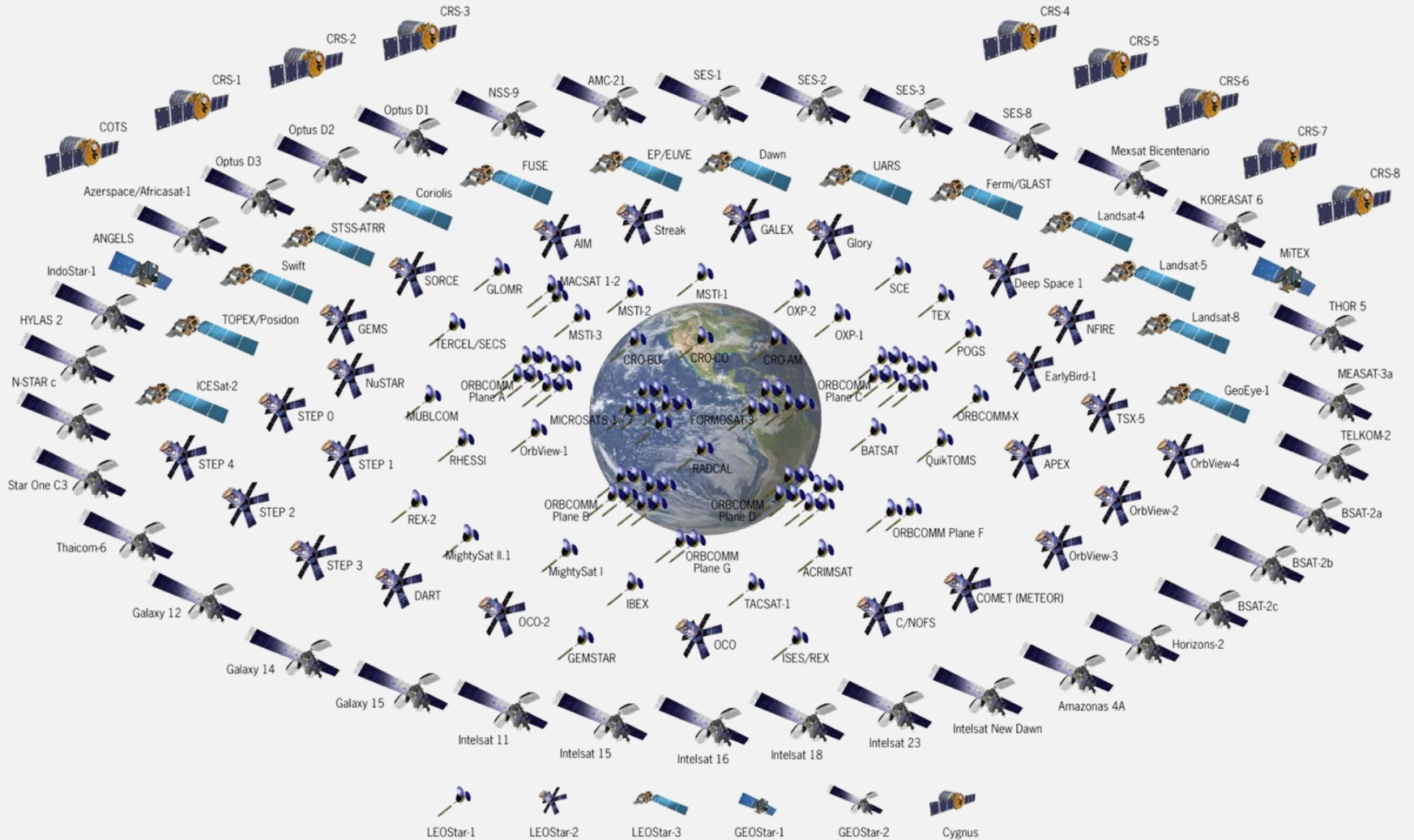
- Constructed the first two electric-propulsion planetary exploration spacecraft for NASA, the 1st rendezvoused with a comet in 2001 and the second, Dawn, is currently orbiting Ceres, a dwarf planet, for 2 years.



- Developed the Cygnus vehicle to resupply the International Space Station.



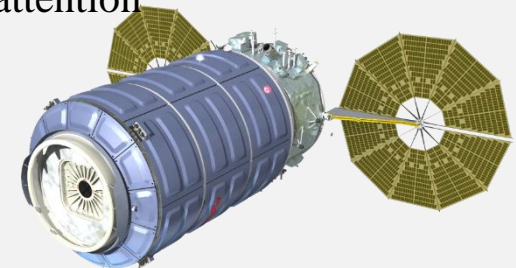
Over 165 Satellites Delivered and Another 95 in Production



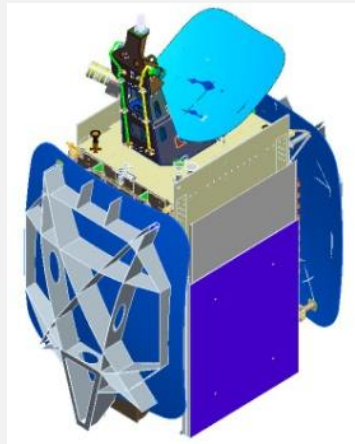
Space Market Outlook



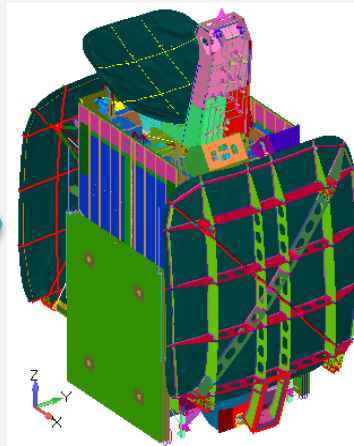
- Aerospace & Defense Industry is looking at moderate growth after three years of moderate declines
- Civil Space Outlook: NASA budget cuts marginal at \$0.2B & Commerce Department somewhat considerable at -\$1.5B
 - Orbital ATK has been collaborating in numerous efforts and teaming with DoD, NASA and Environmental Agencies to conceive and launch new programs (Deep Space Habitats, Weather Monitoring, Cis-lunar orbiting laboratory, Robotic Missions, Deep Space Missions, Small Explorers)
 - NASA cargo missions to continue re-supplying the International Space Stations
 - New GEOStar-3 commercial satellite product first launch second half of 2017.
- Defense Space Outlook: Pentagon spending boost by \$52B
 - Cost Savings Through Block Buys & Emphasis on Affordability and Resilience
 - Focus is on Space and Cyberspace (modernization/enhancement of defense weapons systems)
 - Orbital ATK working closely with DoD on key missions over the next few years
 - Orbital ATK continues to evolve the products and attract DoD attention
- Missile Defense Outlook: Budget Flat for MDA
 - Concerns Persist About North Korea and Iran Missile Threats
 - Continued Interest in GMD and Testing



Satellite System Design-Integration-Test and On-Orbit Performance



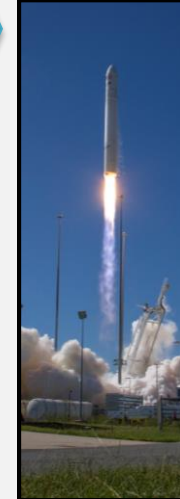
CAD



CAE



I&T

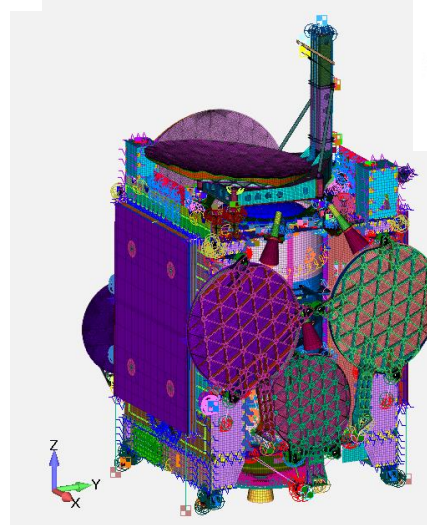
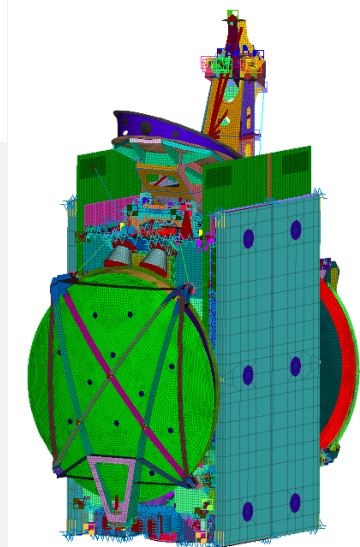
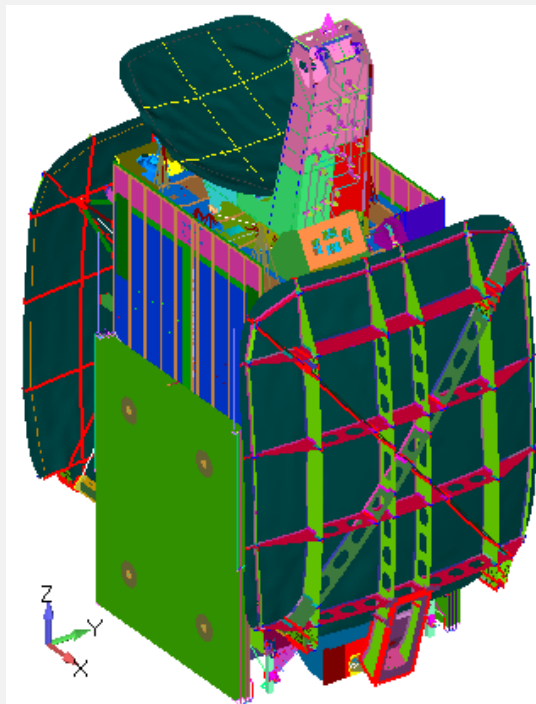


Mission

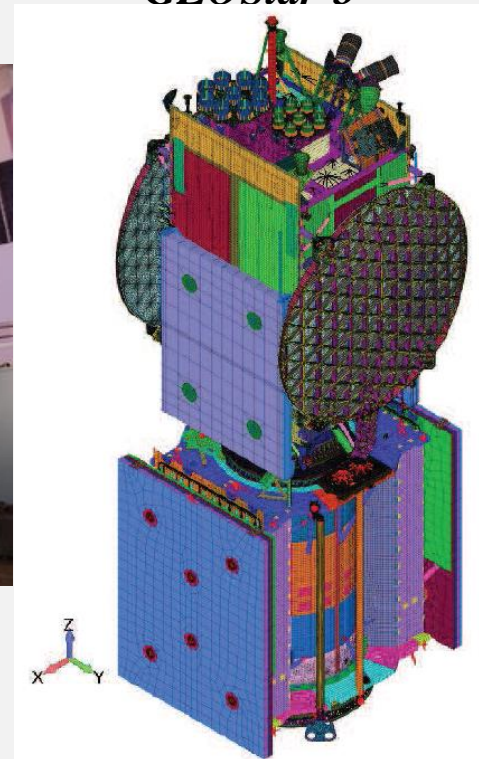
Commercial Communication Satellites



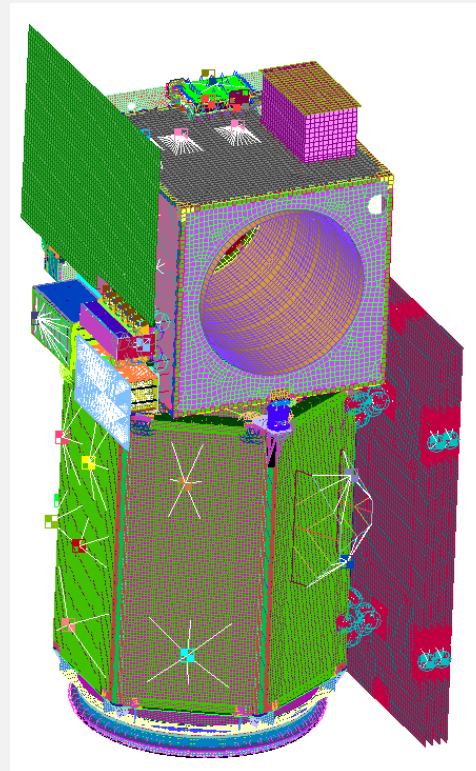
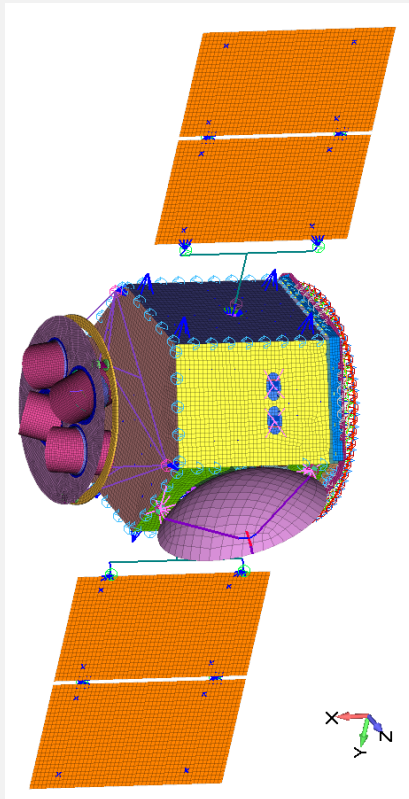
GEOSTar-2.4e



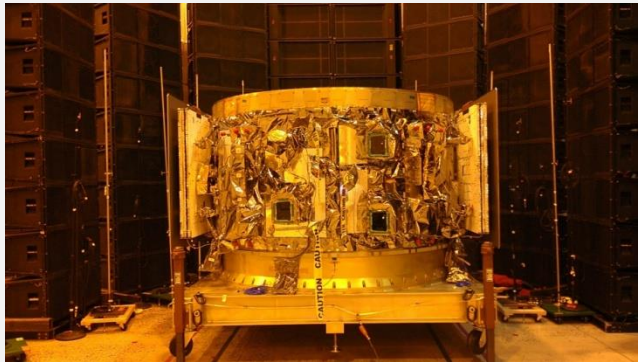
GEOSTar-3



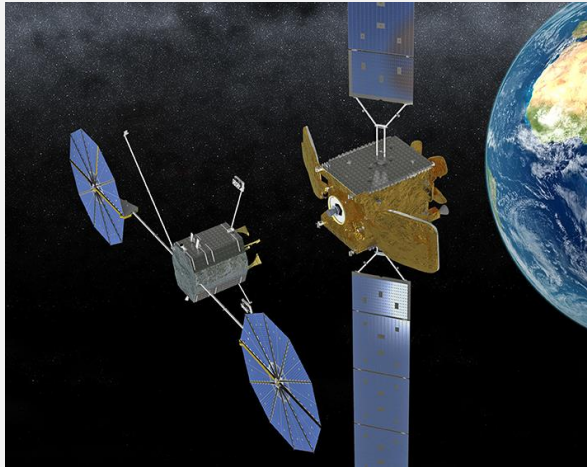
LEOStar Product Line



Commercial Orbit Transfer System ISS Resupply missions



Missions Extension Vehicle

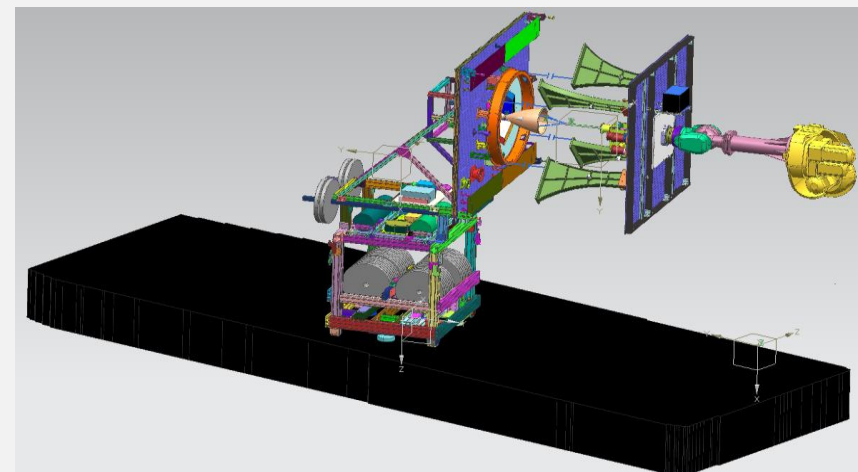


- Full MEV Docking laboratory test is being conducted to acquire the test data used to correlate the analytical model.
- Key items that will be studied:
 - Contact/restitution characteristics (friction, stiffness, damping/restitution)
 - Motor drive/reaction characteristics
 - Capture success rate
 - System loads

MEV Docking Test in RPOD Lab:



RPOD Lab Correlation MBD Model:



Simulation & Test Process



- The design-analysis-Test process is complex
 - Proper control/flow of data is critical
 - Model Fidelity & Correlation
 - Modal & Thermal Vacuum Testing
 - Test-as-you-fly philosophy
- Technical challenges can be alleviated using simulation:
 - Mission requirements drive challenging designs
 - Mass uncertainty (as actual mass become available) or increase (design evolution)
 - Complex structures/joints driven by payload/mission
 - Drawing checks, interference checks, design feasibility studies
 - Developmental testing
 - Thermal/structural hardware



Questions?

