NASA Science & Technology
NASA Glenn Research Center

Presented to

ASPRS/EGLR 2013 Fall Technical Meeting

University of Toledo

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NASA Glenn Research Center

Outline

- NASA Work/Organization
  - Aeronautics Research
  - Human Explorations and Operations
  - Science
    - Earth
    - Heliophysics
    - Planets
    - Astrophysics
  - Space Technology
- John H. Glenn Research Center
  - Programs
  - Capabilities
- NASA Opportunities

NASA Vision

To reach for new heights and reveal the unknown, so that what we do and learn will benefit all humankind

NASA Mission

Drive advances in science, technology, and exploration to enhance knowledge, education, innovation, economic vitality, and stewardship of the Earth

NASA Aeronautics Portfolio

Fundamental Aeronautics Program

Conduct cutting-edge research that will produce innovative concepts, tools, and technologies to enable revolutionary changes for vehicles that fly in all speed regimes.

Integrated Systems Research Program

Conduct research at an integrated system-level on promising concepts and technologies and explore/assess/demonstrate the benefits in a relevant environment

Airspace Systems Program

Directly address the fundamental ATM research needs for NextGen by developing revolutionary concepts, capabilities, and technologies that will enable significant increases in the capacity, efficiency and flexibility of the NAS.

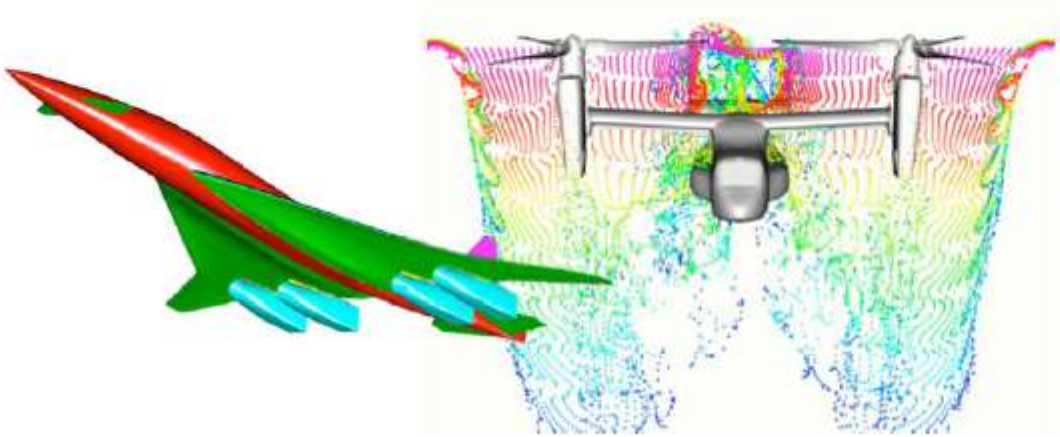
Aviation Safety Program

Conduct cutting-edge research that will produce innovative concepts, tools, and technologies to improve the intrinsic safety attributes of current and future aircraft.

Aeronautics Test Program

Preserve and promote the testing capabilities of one of the United States' largest, most versatile and comprehensive set of flight and ground-based research facilities.

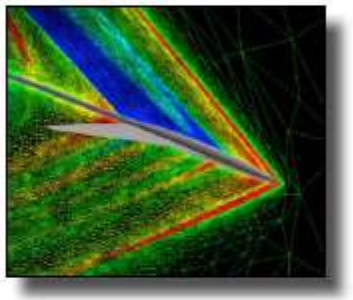
Fundamental Aeronautics Program ARMD



Fundamental Aeronautics Program: Mission Statements

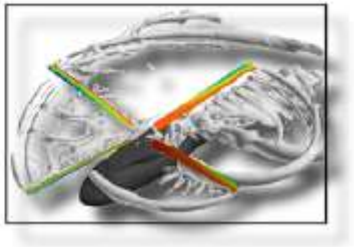
- ***Hypersonics***
  - Fundamental research in all disciplines to **enable very-high speed flight** (for launch vehicles) and **re-entry into planetary atmospheres**
  - High-temperature materials, advanced propulsion, aero thermodynamics, multi-disciplinary analysis and design, GNC, advanced experimental capabilities

- ***Supersonics***
  - **Eliminate environmental and performance barriers** that prevent **practical supersonic vehicles** (cruise efficiency, noise and emissions, vehicle integration and control)
  - Supersonic deceleration technology for **Entry, Descent, and Landing** into Mars



- ***Subsonic Fixed Wing***
  - Develop revolutionary technologies and aircraft concepts with highly **improved performance** while satisfying **strict noise and emission constraints**
  - Focus on **enabling technologies**: acoustics predictions, propulsion / combustion, system integration, high-lift concepts, lightweight and strong materials, GNC

- ***Subsonic Rotary Wing***
  - Improve **competitiveness of rotary wing vehicles** (vs fixed wing) while maintaining their unique benefits
  - Key **advances** in multiple areas through **innovation** in materials, aeromechanics, flow control, propulsion



Hypersonics: X-51A Scramjet Engine Demonstrator

NASA Ground Demonstration Engine 2 Testing

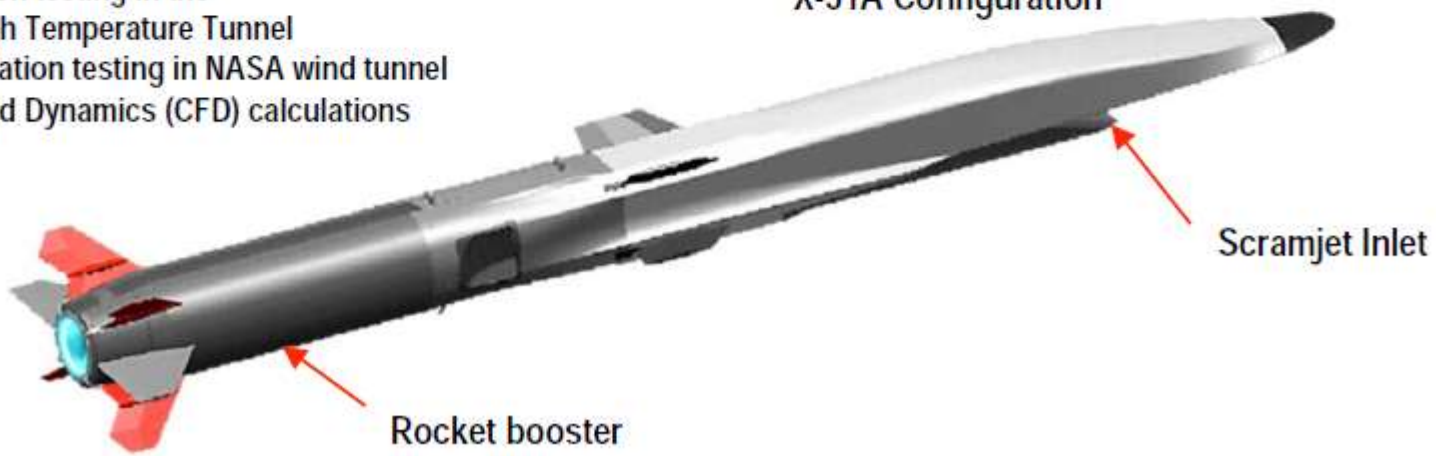
Program Overview

- Joint AFRL/DARPA/NASA flight demo
- Hydrocarbon-fueled and cooled scramjet
- Scramjet flight from Mach 4.5 to 6.5
- 5 minute-plus flight duration
- Four to eight flights (FY09 1st flight)

NASA's Role:

- Full-scale propulsion testing in the NASA 8-Foot High Temperature Tunnel
- Sub-scale configuration testing in NASA wind tunnel
- Computational Fluid Dynamics (CFD) calculations

X-51A Configuration



Supersonics : Entry, Descent and Landing

Problem Statement:

Supersonic parachute deceleration systems that have been used on recent Mars exploration missions are all based on the 30 year old Viking design. Although these systems have been successful, they are not capable of handling the larger masses required for future unmanned and manned missions to Mars. New concepts for supersonic reentry deceleration need to be explored. These concepts include inflatable aeroshells, inflatable decelerators, propulsive deceleration or improved parachutes.

Technical Approach:

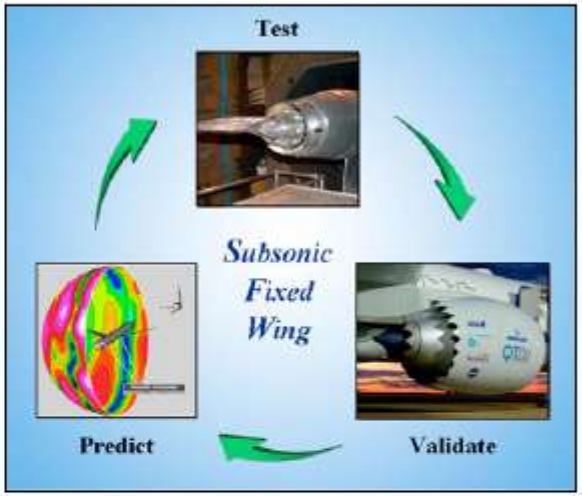
- The Inflatable Reentry Vehicle Experiment (IRVE) will be conducted in F07. This flight experiment will demonstrate aeroshell inflation and survivability. It will also assess the thermal and aerodynamic performance of the inflatable aeroshell concept.
- Improved methods for using high-speed photography and other flow visualization techniques to collect high quality engineering data during inflation and parachute deployment testing will be explored in small scale tests.
- Prediction and validation of of the aerodynamic performance and stability of advanced decelerator concepts will be advanced through computational tool development and ground based experiments.
- For propulsive deceleration, computational and experimental studies will examine the interaction between the external and internal flow during the ignition of a rocket engine at supersonic speeds.

New Concepts for supersonic planetary deceleration are shown at left. New,validated analysis and deign tools are required for the development of these concepts

The IRVE flight test vehicle is shown at left during a ground deployment test

Subsonic Fixed Wing Project

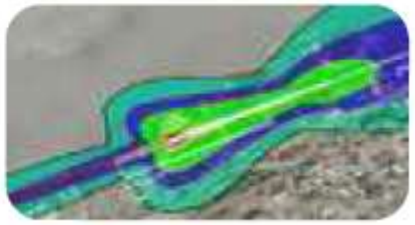
- Air travel expected to increase 2-3 x by 2025
- Current air space reaching capacity, expansion limited by congestion, noise, emissions (JPDO alignment)
  - Most travelers (~85%) pass through 64 major hubs
  - Over 5000 underutilized airports
- Develop revolutionary new technologies including:
  - -Lower emissions (e.g. 70-80% NOx reduction)
  - Confine landing/takeoff noise foot print to airport boundary
  - Increase efficiency (~15-25% less fuel consumption) by advanced lightweight materials, reduced drag
- Increased lift (double lift coefficient to ~6) to open many more airports, rapid climb-out/descent for reduced noise, smaller wing for lower drag
- Partners include: JPDO, Boeing, Northrop-Grumman, Lockheed-Martin, Pratt & Whitney, Air Force / AFRL, among others



Environmentally Responsible Aviation Project Goals

Environmentally Responsible Aviation (ERA) Project:
Technology development project, that will explore and assess new vehicle concepts and enabling technologies through system-level experimentation to *simultaneously* reduce fuel burn, noise, and emissions

- *Airframe Technology*
- *Propulsion Technology*
- *Vehicle Systems Integration*

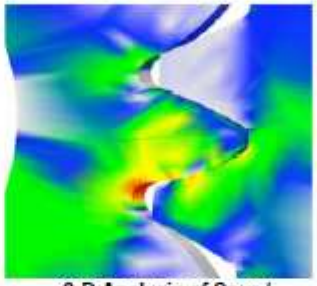


Subsonic Rotary Wing Project

Strong partnership with the US Army

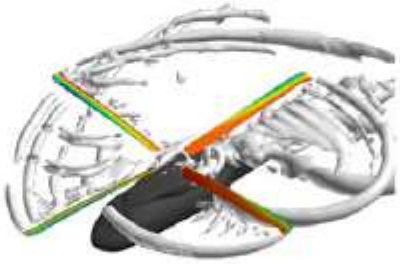
- Solving problems relevant to civil and military applications
- Researchers working side-by-side on fundamental, difficult problems
- Sharing and leveraging experimental and computational expertise

Other partners include: Bell Helicopter, Sikorsky, HeloWerks, AF, DARPA

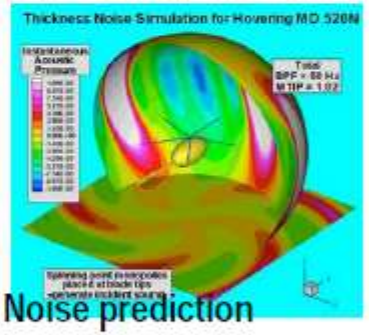


3-D Analysis of Spur / Helical Gears

14- by 22-Foot Subsonic Tunnel



First-Principles Modeling



Noise prediction

Research Areas:

Noise propagation and reduction	→	Community acceptance
Increase speed and range	→	Reduce airport congestion
Increase propulsion efficiency	→	Reduce emissions
Increase payload	→	Decrease cost, increase utility
Improve control systems	→	Safe operations for advanced concepts

Airspace Systems Program

NGATS ATM: Airspace	NGATS ATM: Airportal

Objective

Directly address the fundamental ATM research needs for the NGATS, in collaboration with the JPDO, by developing revolutionary concepts, capabilities, and technologies that will enable significant increases in the capacity, efficiency and flexibility of the NAS.

Key focus areas

NGATS ATM: Airspace

- Dynamic Airspace Configuration
- Traffic Flow Management
- Separation Assurance
- Super Density Operations
- Performance-Based Services
- Trajectory Prediction, Synthesis & Uncertainty

NGATS ATM: Airportal

- Safe & Efficient Surface Operations
- Coordinated Arrival/Departure Operations
- Airportal Transition and Integration Management

- Both projects will conduct system-level design and analysis.
- Substantial leveraging of research across the two projects will occur.
- Results of the two projects will be integrated to ensure gate-to-gate solutions that are aligned with NGATS needs.

Aviation Safety
Project Goals

Integrated Vehicle Health Management

Reduce system and component failures as causal and contributing factors in aircraft accidents and incidents.

Integrated Intelligent Flight Deck

Produce tools, methods, concepts, principles, guidelines, and technologies for revolutionary adaptive flight deck systems that improve safety.

Aircraft Aging and Durability

Detect, predict and mitigate or manage aging-related hazards for future aircraft.

Integrated Resilient Aircraft Control

Provide onboard control resilience to ensure flight safety during adverse flight conditions.

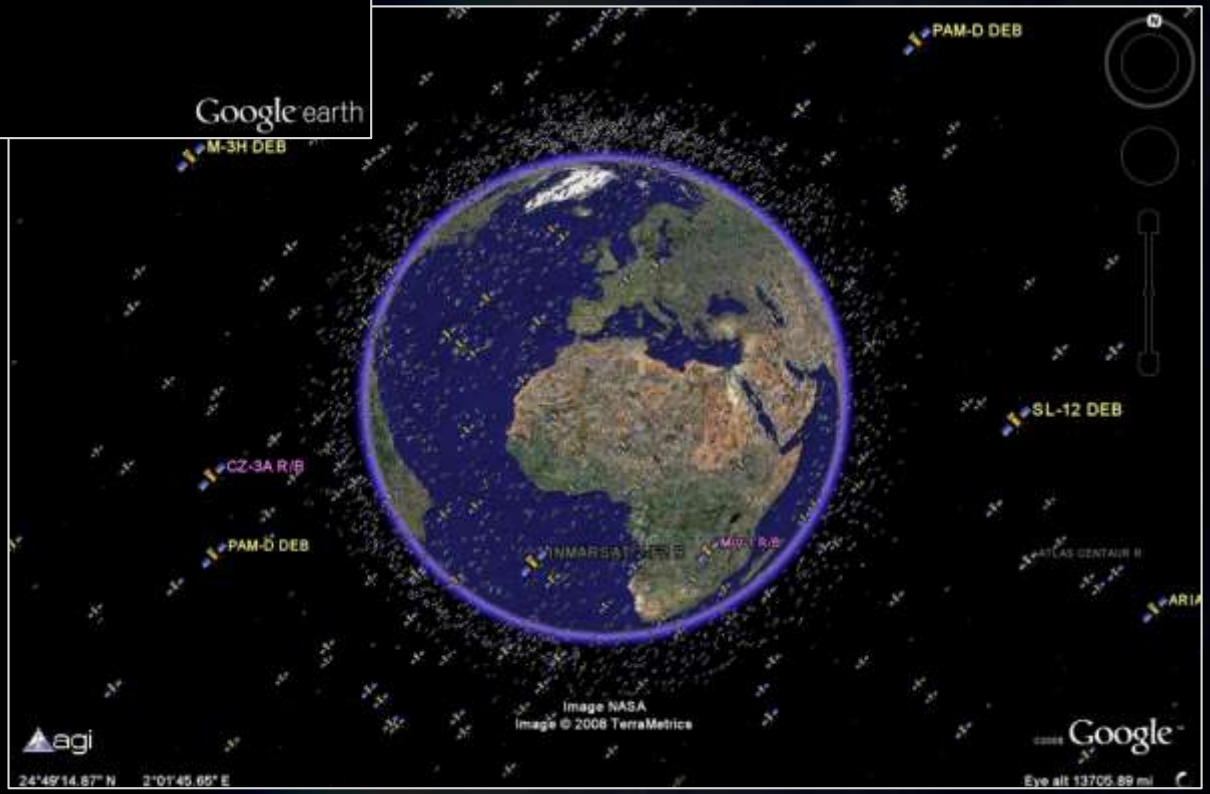
Aeronautics Test Program
Primary Facilities

- Ames Unitary Wind Tunnel
- Glenn Icing Research Tunnel
- Glenn 9x15 Subsonic Tunnel
- Langley National Transonic Facility
- Langley Transonic Dynamics Tunnel
- Langley Hypersonic Complex
- Langley 8-Ft High Temperature Tunnel
- Langley 14x22 Subsonic Tunnel
- Langley 20-Ft Vertical Spin Tunnel
- Glenn Propulsion Systems Lab. 3 & 4
- Glenn 10x10 Supersonic Tunnel

Human Exploration and Operations

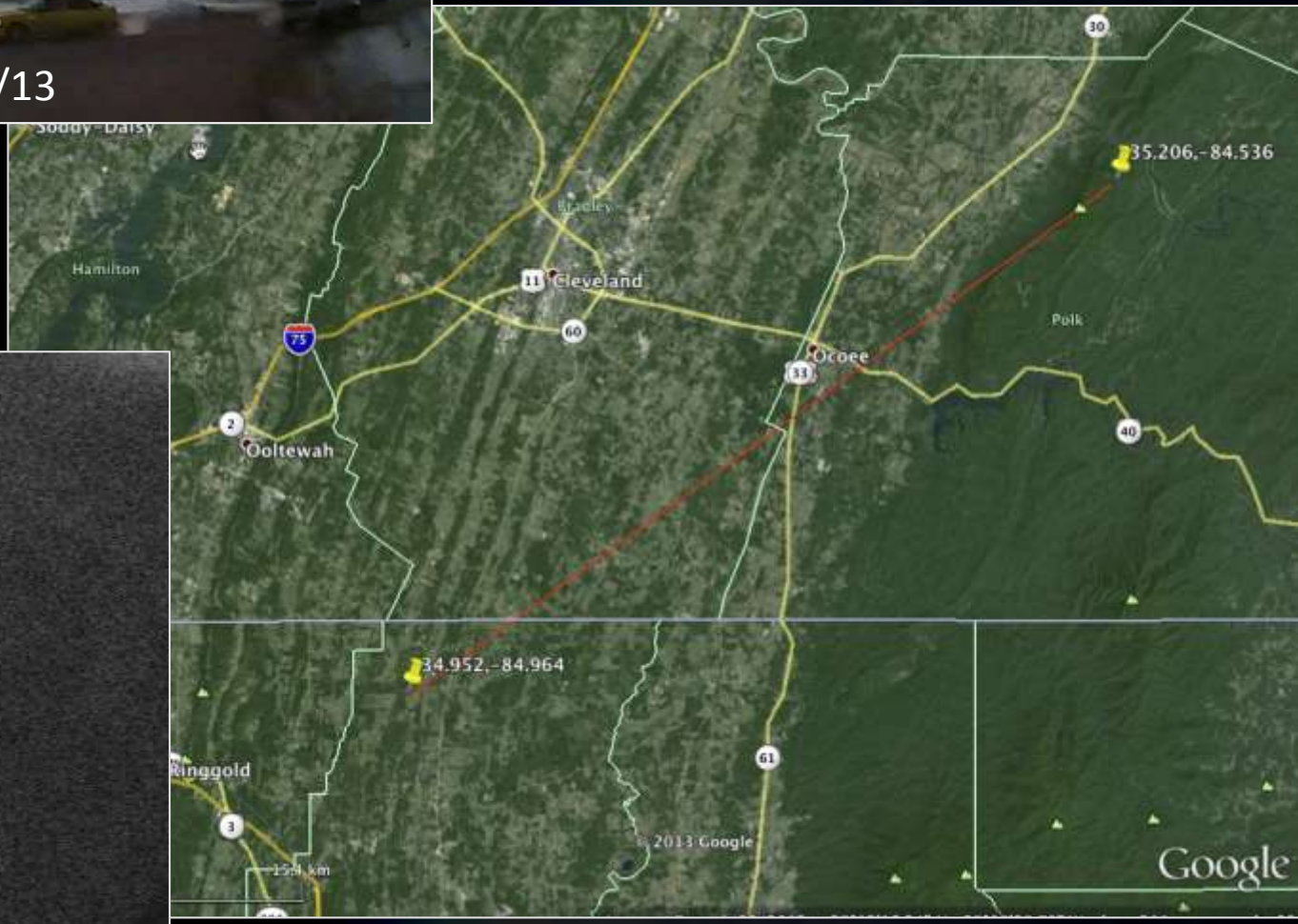
1969…

…2013



http://www.universetoday.com/17754/explore-earths-satellites-with-google-earth/

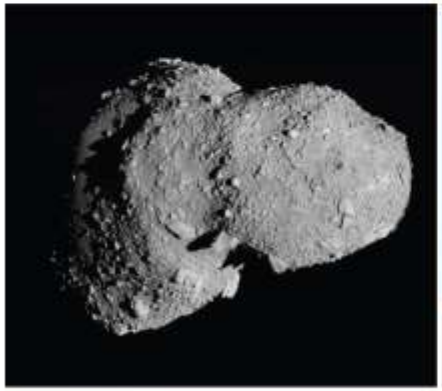
Chelyabinsk, Russia - 2/15/13



Tennessee, USA - 8/28/13

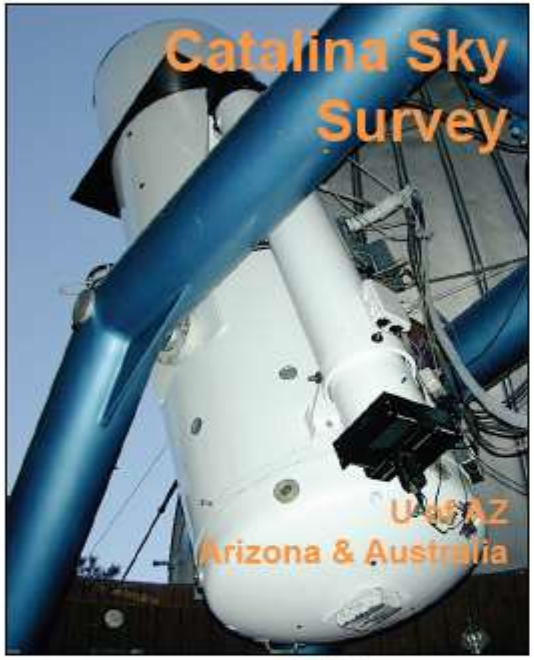
National Aeronautics and Space Administration

NASA's Asteroid Redirect Mission

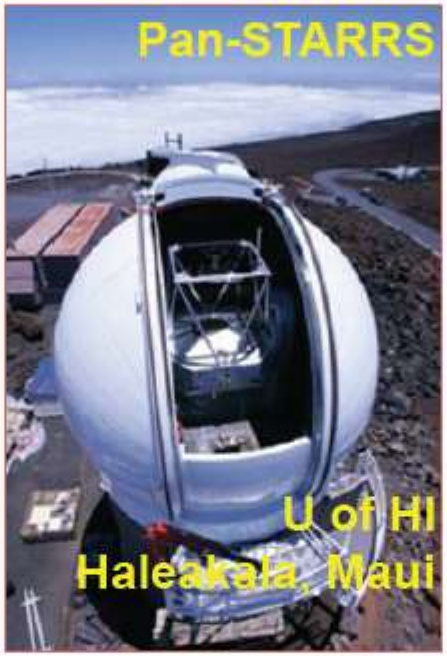



September 11, 2013

NASA's NEO Search Programs



~60%

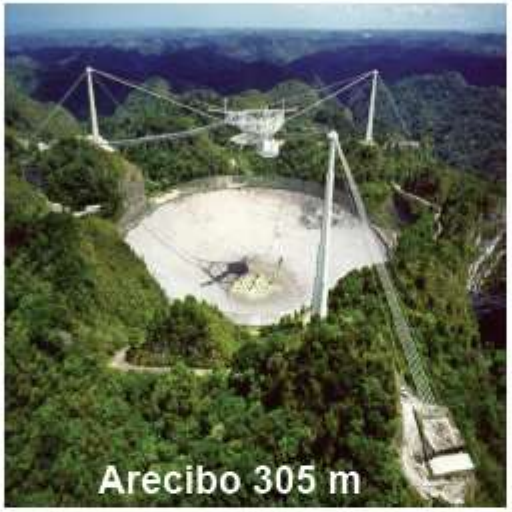


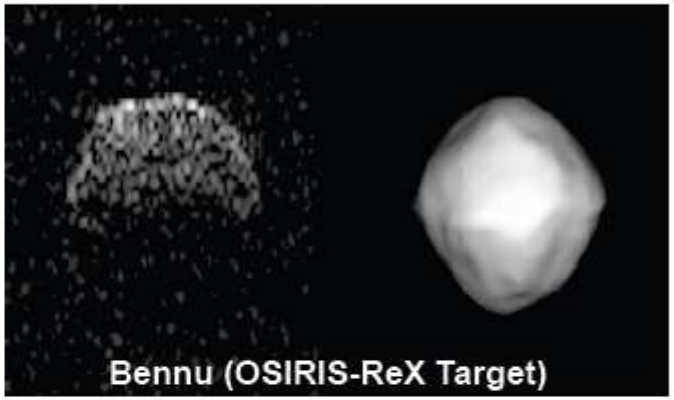
~30%

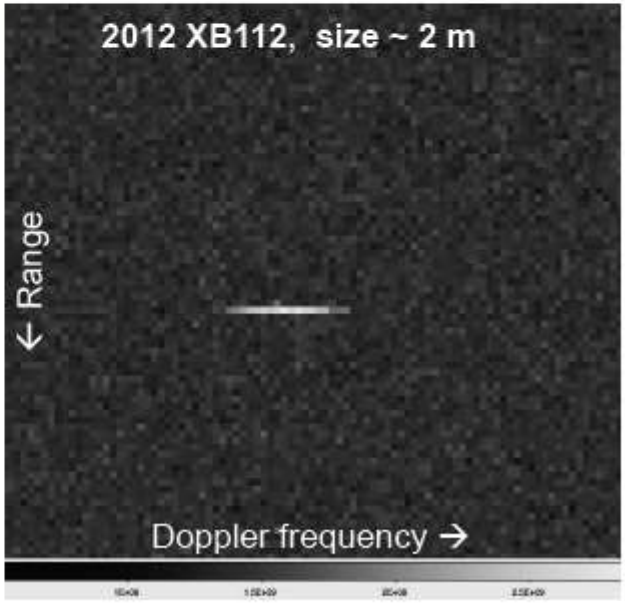
~3%

- NEO = Near Earth Object (99% are NEAs, Near-Earth Asteroids)
- Since 1998, NASA's NEO Observation Program has led the international NEO discovery and characterization effort.
- ~95% of 1-km and larger NEAs have been discovered.
- Total number NEAs now known: 10,090; increasing at ~1,000 per year.

Radar Observations of NEAs



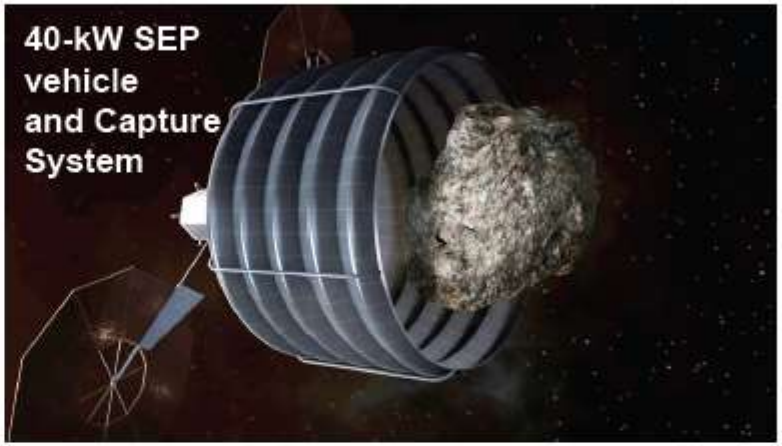




- 70-80 NEOs are observed every year.
- 10-m-class NEAs observable out to ~5 lunar distances; ~80% of the ARM candidates should be radar observable once detected.
- Radar observations can provide:
  - Size and shape to within ~2 meters.
  - High precision orbit data.
  - Spin rate, surface density and roughness.

Small Asteroid Mission Concept

- Rendezvous with small (<10m mean dia.) near Earth asteroid (NEA)
  - Examine opportunities and proof of concept
  - Capture <1000t spinning NEA and despin
  - Maneuver to stable, crew accessible lunar orbit (e.g. DRO)
- Candidate target is 2009 BD, which is <500t
  - Other targets to be discovered and characterized by radar
  - Primary constraints are target V-infinity, size, mass, spin rate, and launch date and launch vehicle



http://www.youtube.com/watch?v=lCJjTJZSFMg&feature=youtube_gdata

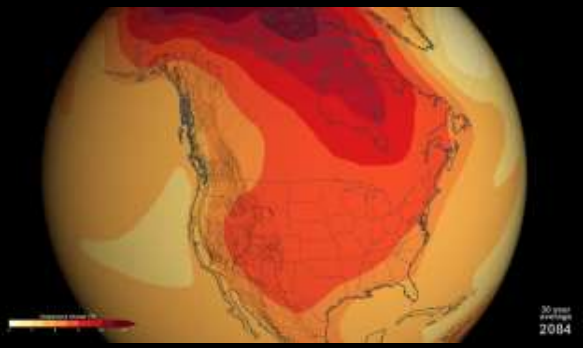
https://www.youtube.com/watch?feature=player_embedded&v=jXvsi7DRyPI

NASA Science

- Earth
- Heliophysics
- Planets
- Astrophysics

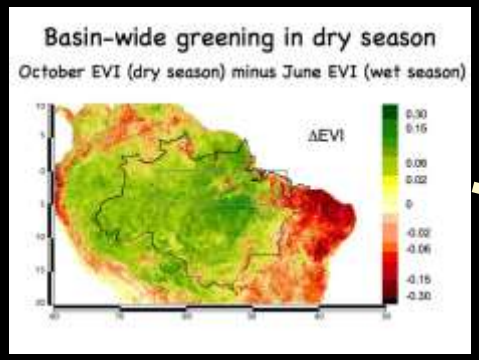
Big Questions of NASA Earth Science

- *How is* the global earth system changing?
  - Earth is currently in a period of warming…Is this warming trend a reason for concern?
  - What are the sources of change in the Earth system and their magnitudes and trends?
- *How will* the Earth system change in the future?
  - As the world consumes ever more fossil fuel energy, greenhouse gas concentrations and Earth's average temperature will continue to rise to 4˚ F to 11˚ F by the end of the 21st century.

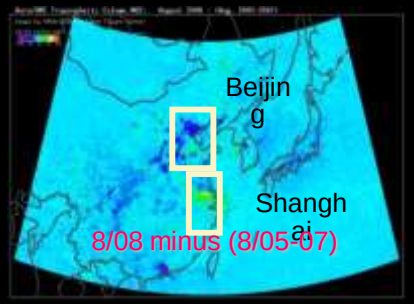


  - How can Earth system science improve mitigation of and adaptation to global change?

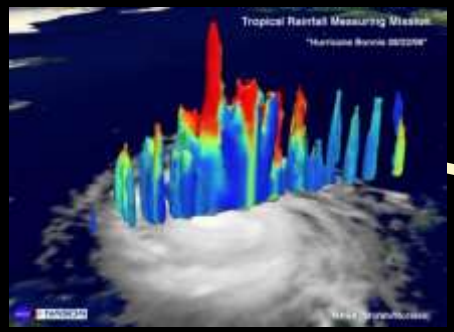
Earth Science Division Focus Areas



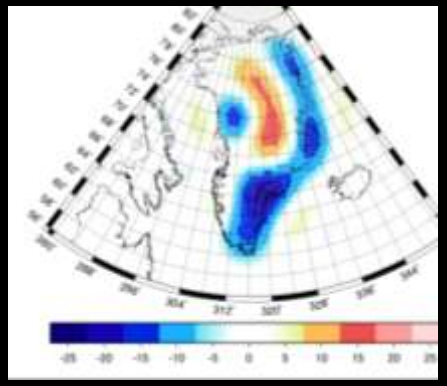
Atmospheric Composition



Carbon Cycle and Ecosystems

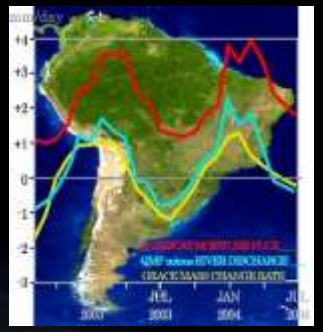


Climate Variability and Change



Weather

Water and Energy Cycle



Earth Surface and Interior

National Aeronautics and Space Administration

Airborne Science Program

Observing Platforms for Earth System Science Investigations

www.nasa.gov

Applied Sciences Program
Applications Areas (USGEO 9 SBAs)

Emphasis in 4 Applications Areas

Health
(incl. Air Quality)

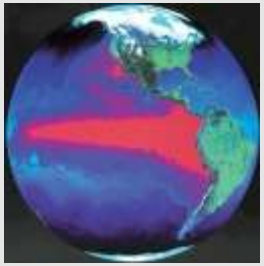
Water
Resources

Disasters

Ecosystems

Seek opportunities to expand to 5 additional areas

Agriculture



Climate

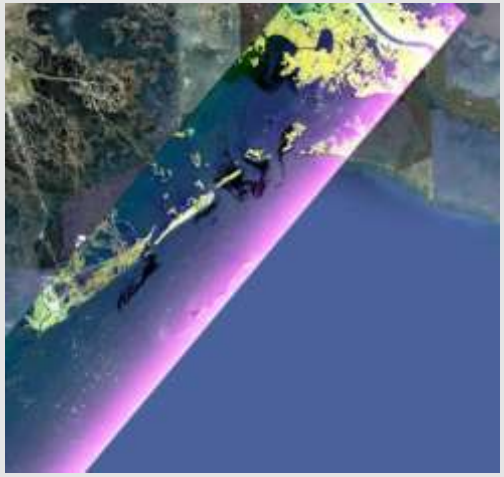
Weather

Energy

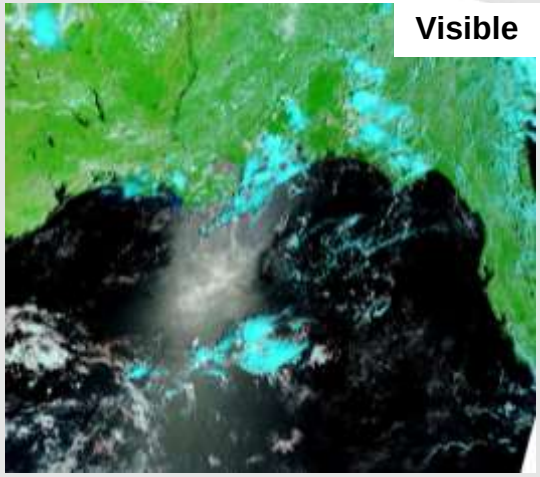
Oceans

NASA Response to Gulf Oil Spill

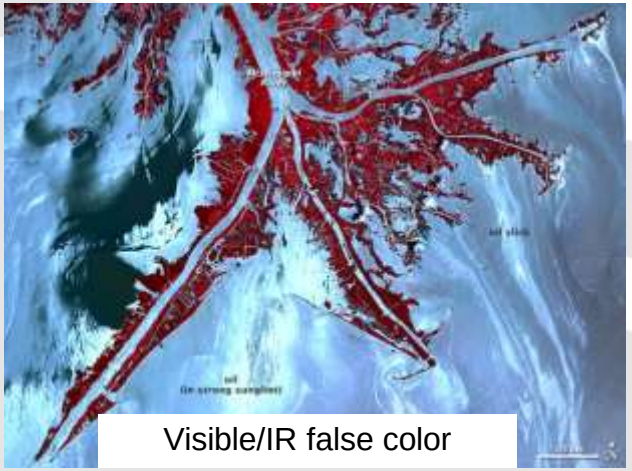
UAVSAR 23 June 2010



MODIS 31 May 2010



ASTER 24 May 2010



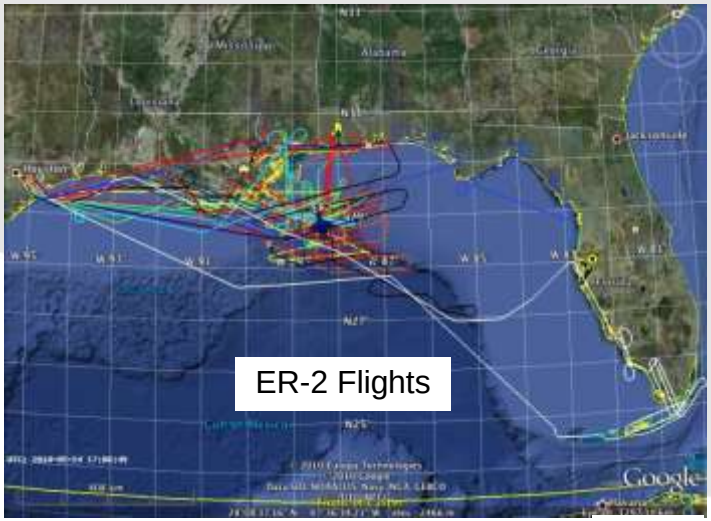
Satellite instruments: continually monitored the "extent" of the spill

- Terra & Aqua / MODIS – visible and infrared daily synoptic
- Terra / ASTER – visible, near IR and thermal IR high res
- EO-1 / Advanced Land Imager and Hyperion – highest res
- Terra / MISR
- CALIPSO / CALIOP

Airborne instruments: measuring *surface* extent and volume

- ER2 / AVIRIS and DCS: **18 sorties, >120 flight hours**
- Twin Otter / AVIRIS: **32 sorties, 107 flight hours**
- B200 / HSRL: **5 sorties, 16 flight hours**
- UAVSAR: 22-24 June, **4 sorties, 21 flight hours**

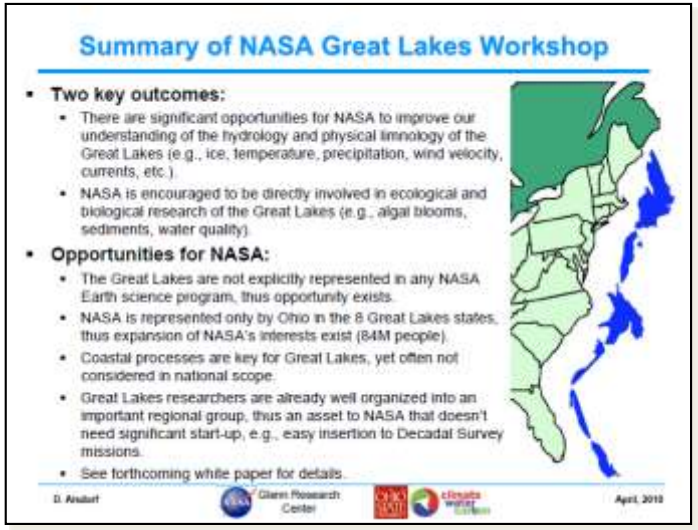
Data and provided to USGS for use by first responders; NOAA used radiances to initialize trajectory model; USGS for oil concentration



NASA
Earth Science Missions in Operation

Recent Earth Science Activities @ GRC

- **Recent Great Lakes Workshop conducted by GRC/HQ's/OSU to identify gaps for NASA involvement**
- **Forming community & concepts for fresh water research**
- **Proposed to ROSES12 element: "Remote Sensing of Water Quality"**

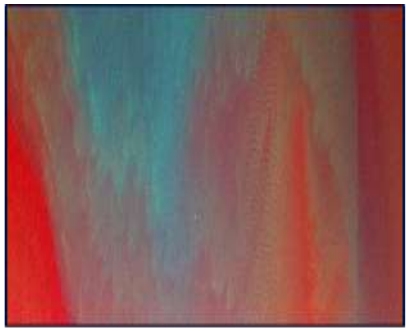


Freshwater & Water Resources

A Recent Effort

- Title: **GRC Airborne Hyperspectral Imager**
- Significance: **GRC and NOAA GLERL have demonstrated HSI capable of detecting HABs in low concentrations - key capability for bloom prediction**

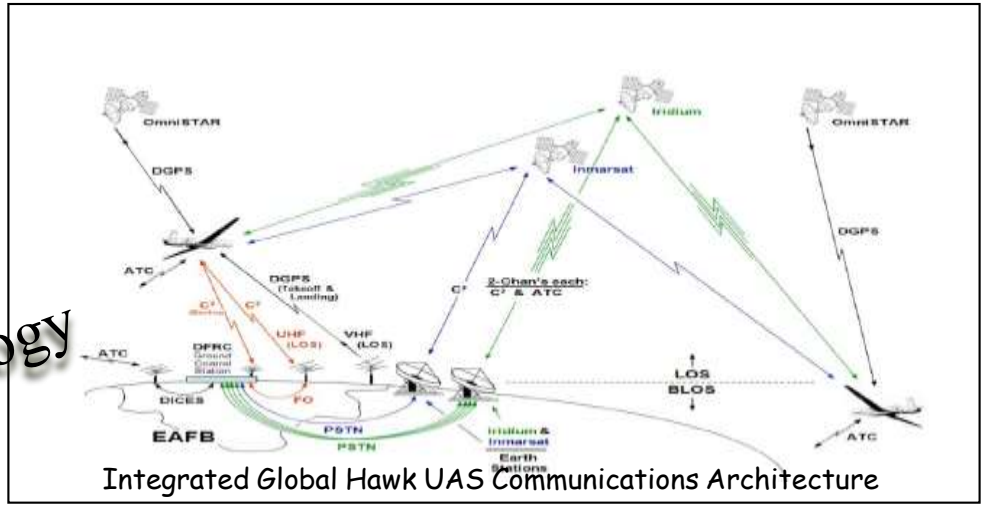
The Great Lakes contain 18% of the world's fresh surface water and 90% of the U.S. supply



Processed HSI data of Microcystis Bloom with higher concentrations indicated by red and sediment is in blue (0.8 km x 1.4 km)

Recent Activities @ GRC

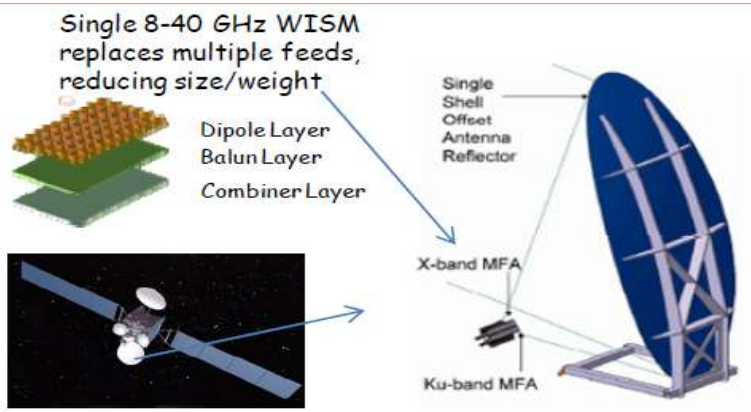
- Title: **Advanced Information System Technology (Transport Protocol)**
- **Program:** ESD
- **Prior activity:** Integrated tests of **Global Hawk communications system**
- **GRC FY12 Tasks (Closed Out in May 2012):**
  - Real-Time and Store-and-Forward Delivery of Unmanned Airborne Vehicle Sensor Data
  -- GRC P. Paulsen & W. Ivancic, ARC)



Integrated Global Hawk UAS Communications Architecture

Communication Technology

- Title: **Instrument Incubator (Current Sheet Antenna Testing)**
- **Program:** ESD
- **Tasks:** (GRC Felix Miranda & Harris Corp)
  - Summer 2012 receipt of engineering model of antenna
  - Perform basic measurements to refine metrology approaches and determine antenna properties
  - March to May 2013: receipt of final model; characterization in X, Ku, and Ka bands



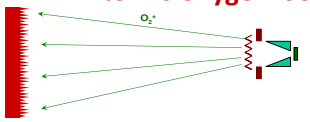
WISM sensor is a new capability, offering a broadband, multi-function, software reconfigurable payload.

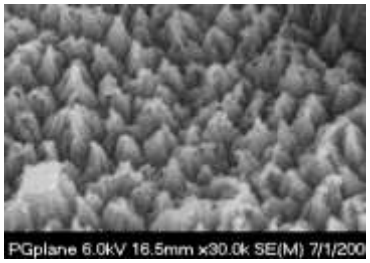
Current Activities @ GRC

- Title: **CERES Follow-on Bolometer Study**
- **Program:** SAA w/ NOAA via LaRC
- **Tasks:** Develop and deliver a functionally equivalent CERES bolometer with improved performance utliinzing microfabrication capabilities
- **GRC –** John Lekki, Viet Nguyen, Larry Liou
- **LaRC** – Kory Priestly, Audra Bullock, Nural Abedin

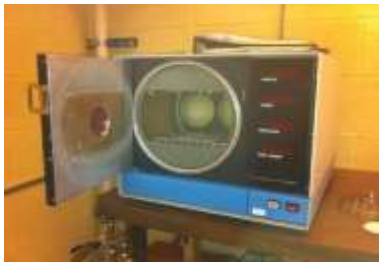
Atmosphere & Energy

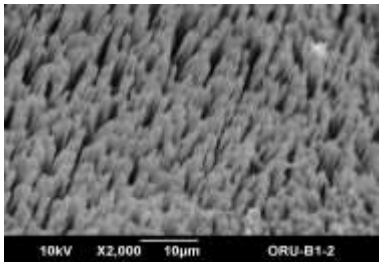
End Hall Hyperthermal Atomic Oxygen Source

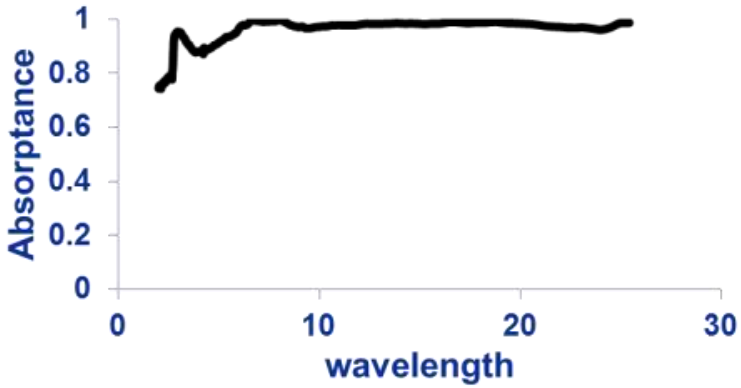




Large Thermal Energy Plasma Asher







Prototype Delivered in 2013

Current Activities @ GRC (continued)

- Title: **Airborne Science I**
- **Tasks:** Flight test Portable Remote Imaging Spectrometer (PRISM_ and Short Wave, Infrared Radiometer (SWIR); perform tests at Ivanpah, Lake Tahoe and Monterey
- Title: **Airborne Science II**
- **Tasks:** Supply aircraft, engineering, technical support for integration, pilots for test flight, fuel, hangar, and GSE

Airborne Earth Science & Technology

Learjet Model 25

Twin Otter DHC-6

S-3B Viking

T-34 Mentor

GRC Offers Aerial Monitoring of Bodies of Water

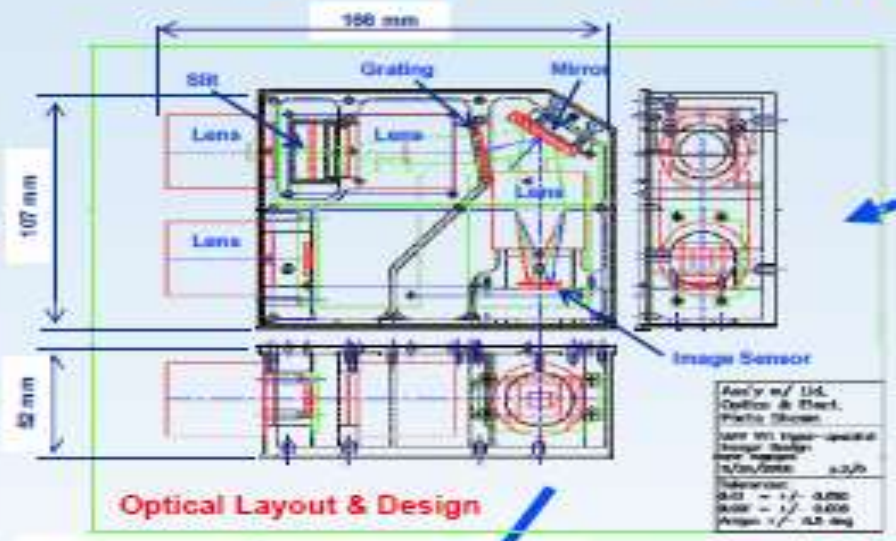
Comparison to State-of-the-Art Monitoring Methods & Limitations

- **Satellite Remote Sensing**
  - Limited in resolution
  - Limited on-demand performance
  - Limited by cloud cover
  - Slow upgrades to instrumentation
- **In Situ Measurements**
  - Ship born measurements, sporadic and costly
  - Shore Measurements, regular monitoring of beaches but delayed results (usually 1 day)

Method	Frequency of Observation	Resolution	Measurement Flexibility
Satellite Landsat TM	Once every 8 days	30 meter	none
Satellite MODIS	2/day	1km	none
Satellite AVHRR	3/day	1km	none
Satellite SeaWiFS	1/day	1km	none
In-Situ	1/day	20X20 Km^2	Yes
Aerial Monitoring	Hourly	Down to 1m	Yes

GRC's Hyperspectral Imaging System

GRC Designed & Built UAV Hyperspectral Imager Optical System



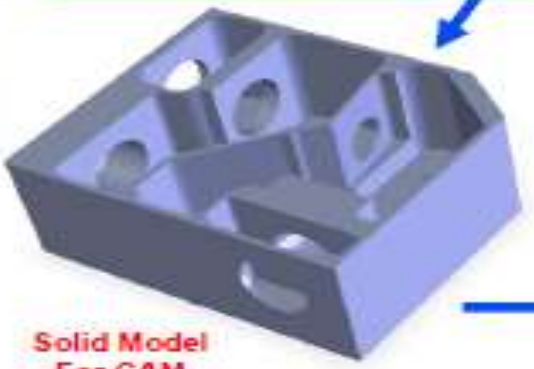
Optical Layout & Design

Design Requirements

- CMOS 1280x1024 (native) sensor
- 405 – 867 nm spectral range
- 2 nm spectral resolution
- 3 m spatial res. at 1830 m (6000 ft)
- 3 frame/sec imaging rate
- 125 mm x 150 mm x 175 mm envelope
- < 3 kg total system mass, 35 W max

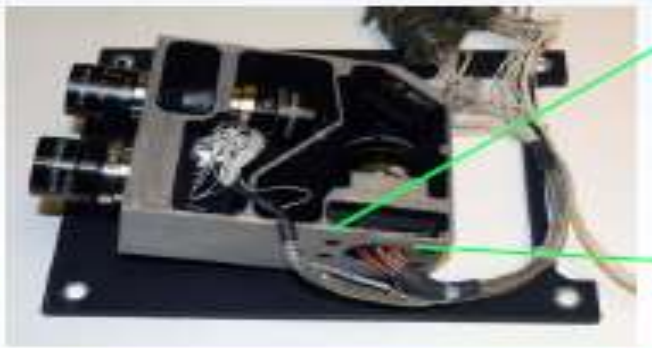
Final Optical System Specifications

- 23 mm imaging lenses (f/2.8 system throughput)
- 35 mm f/1.9 spectrograph lenses
- 400 line/mm vol. phase holo. grating (custom)
- 13 micron x 7 mm optical slit
- 360 – 960 nm, 0.9 nm spect. & 1.5 m spatial res.
- 166 mm x 107 mm x 52 mm, 1.13 kg mass



Solid Model For CAM

Assembled Optical Bench with Image Sensors



Spectral Imaging of Neon Cal. Lamp (red)

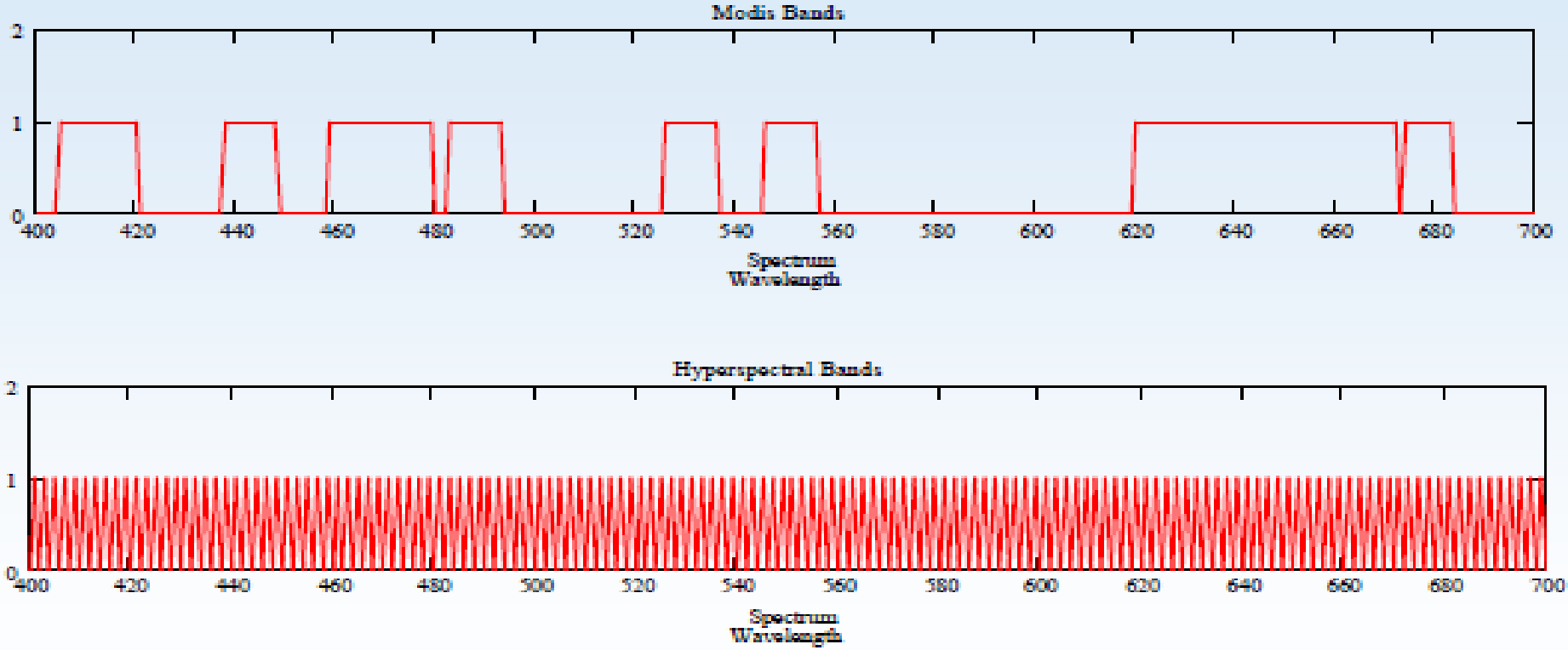
Great Lakes Environmental Research Lab

Glenn Research Center at Lewis Field

Q.V. Nguyen (GRC-RTB)

Hyperspectral Imager Offers Expanded Imaging & Sensing Capability

Comparing MODIS data to Hyperspectral data



From 9 multispectral bands to 500 hyperspectral bands covering the same wavelength range

Workshop on Remote Sensing of Water Quality

Purpose for the Workshop

To identify scientific and technological gaps in remote sensing of inland water quality

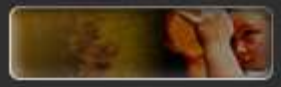
- Science and technologies continue to progress, although not necessarily in a coordinated way or addressing the current needs, and
- The climate and anthropogenic factors continue to change

Earth Science Forward Work

- Joint studies and field campaigns
- Regional coordination
  - Workshop on remote sensing of water quality
  - The Cleveland Water Alliance
    - LakeStat Dashboard Committee…
- Future
  - Respond to proposals calls (RSWQ, Terrestrial Ecology, AITT, SmallSat, ESTO,
    - Earth Venture S-2: CHASER Airborne, Meltpond
  - CERES Bolometer follow-on
  - CASI follow-on
  - Airborne campaign
  - HICO commercial application—potential ISS connection

Heliophysics

Big Questions



What causes the sun to vary?

How do the Earth and Heliosphere respond?

What are the impacts on humanity?

Focus Areas

Missions

Heliophysics Data and Models

Senior Review Reports

Multimedia Links

Sounding Rockets

Working Groups

NASA's Next Science Mission: Radiation Belt Storm Probes

Big Questions

What causes the sun to vary?

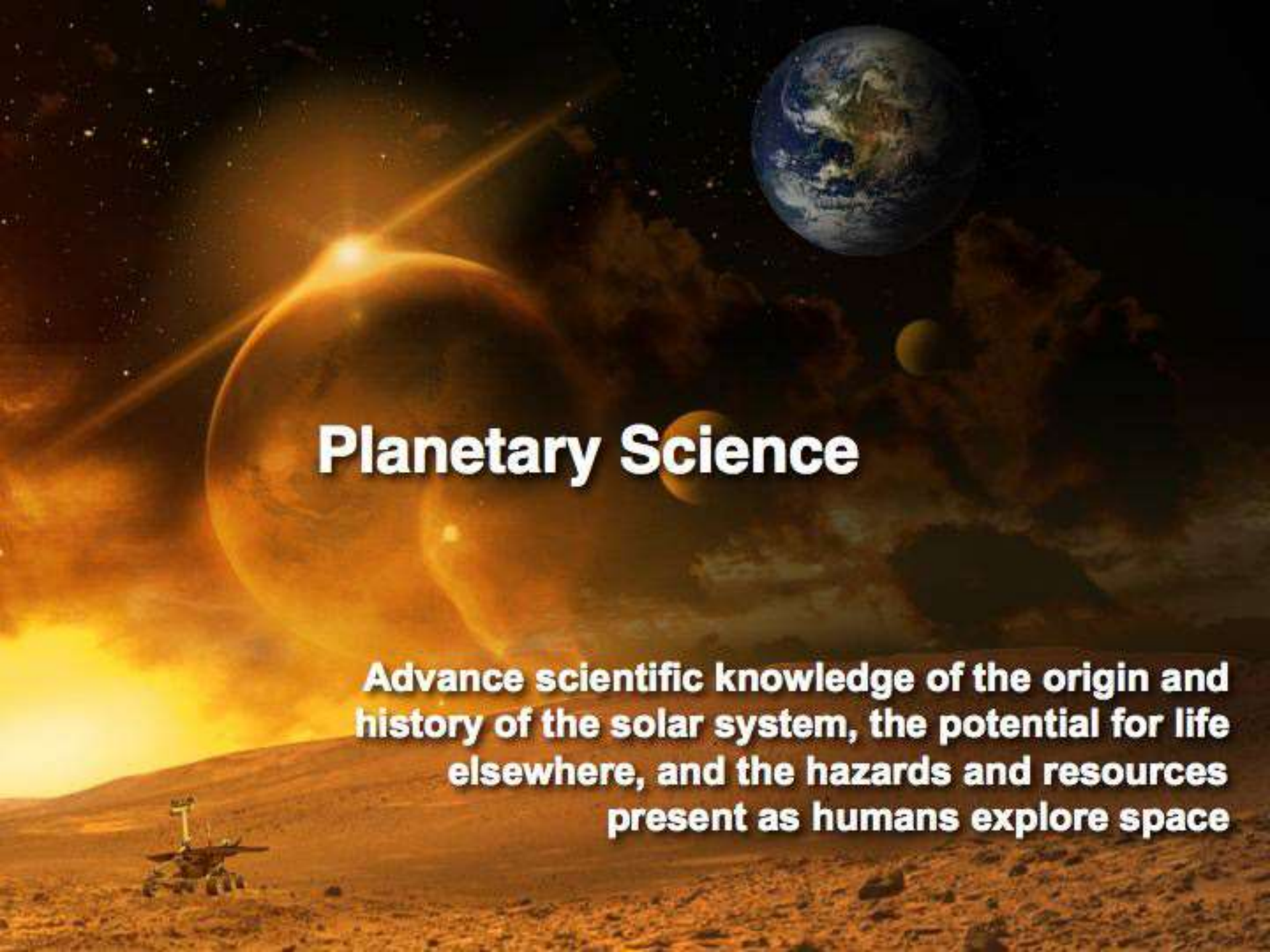
We live in the extended atmosphere of a magnetic variable star that drives our solar system and sustains life on Earth. Our Sun varies in every way we can observe it. The Sun gives off light in the infrared, visible, ultraviolet, and at x-ray energies, and it gives off magnetic field, bulk plasma (the solar wind) and energetic particles moving up to nearly the speed of light, and all of these emissions vary.

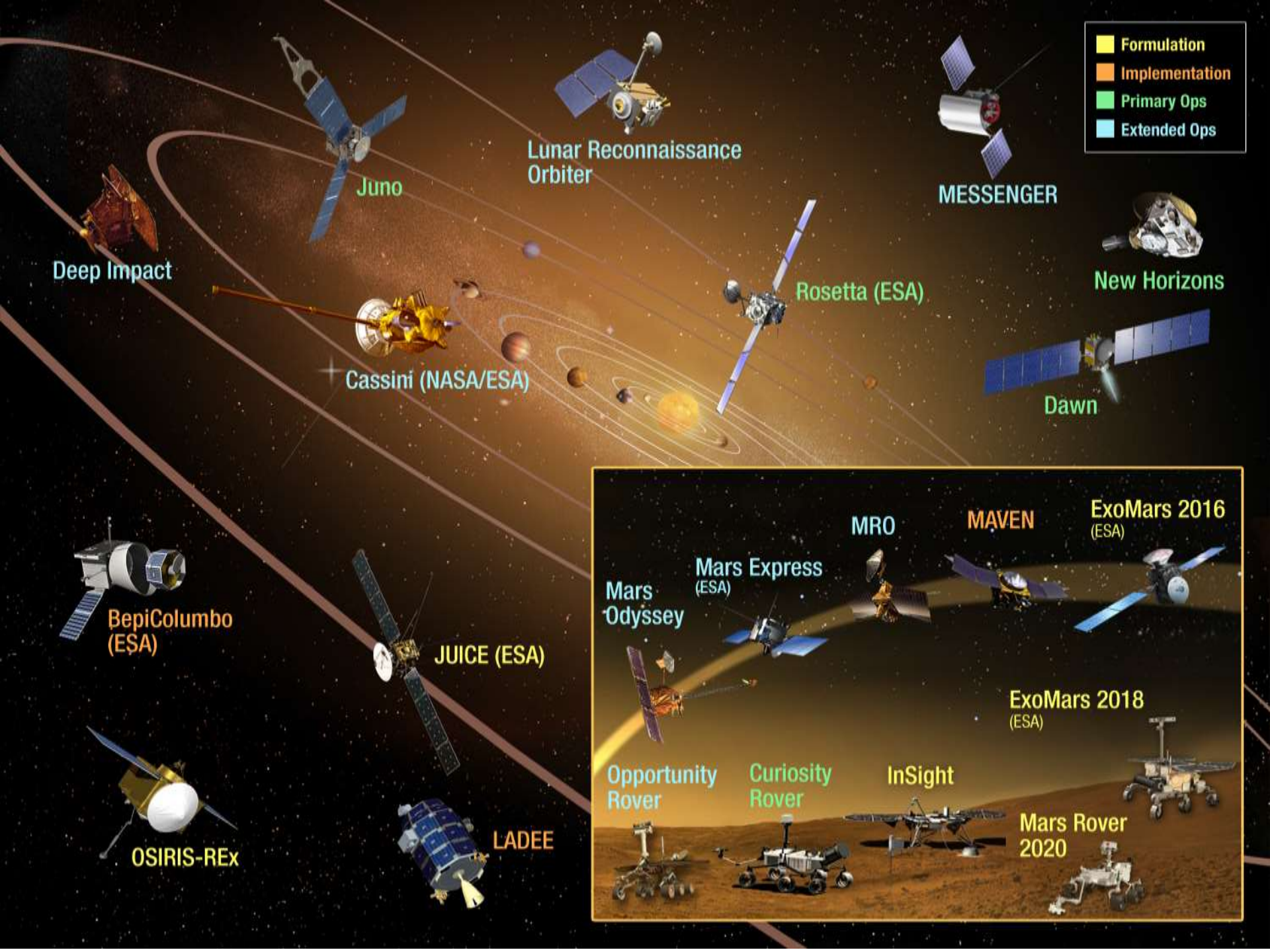
How do the Earth and Heliosphere respond?

Our planet is immersed in this seemingly invisible yet exotic and inherently dangerous environment. Above the protective cocoon of Earth's lower atmosphere is a plasma soup composed of electrified and magnetized matter entwined with penetrating radiation and energetic particles.

What are the impacts on humanity?

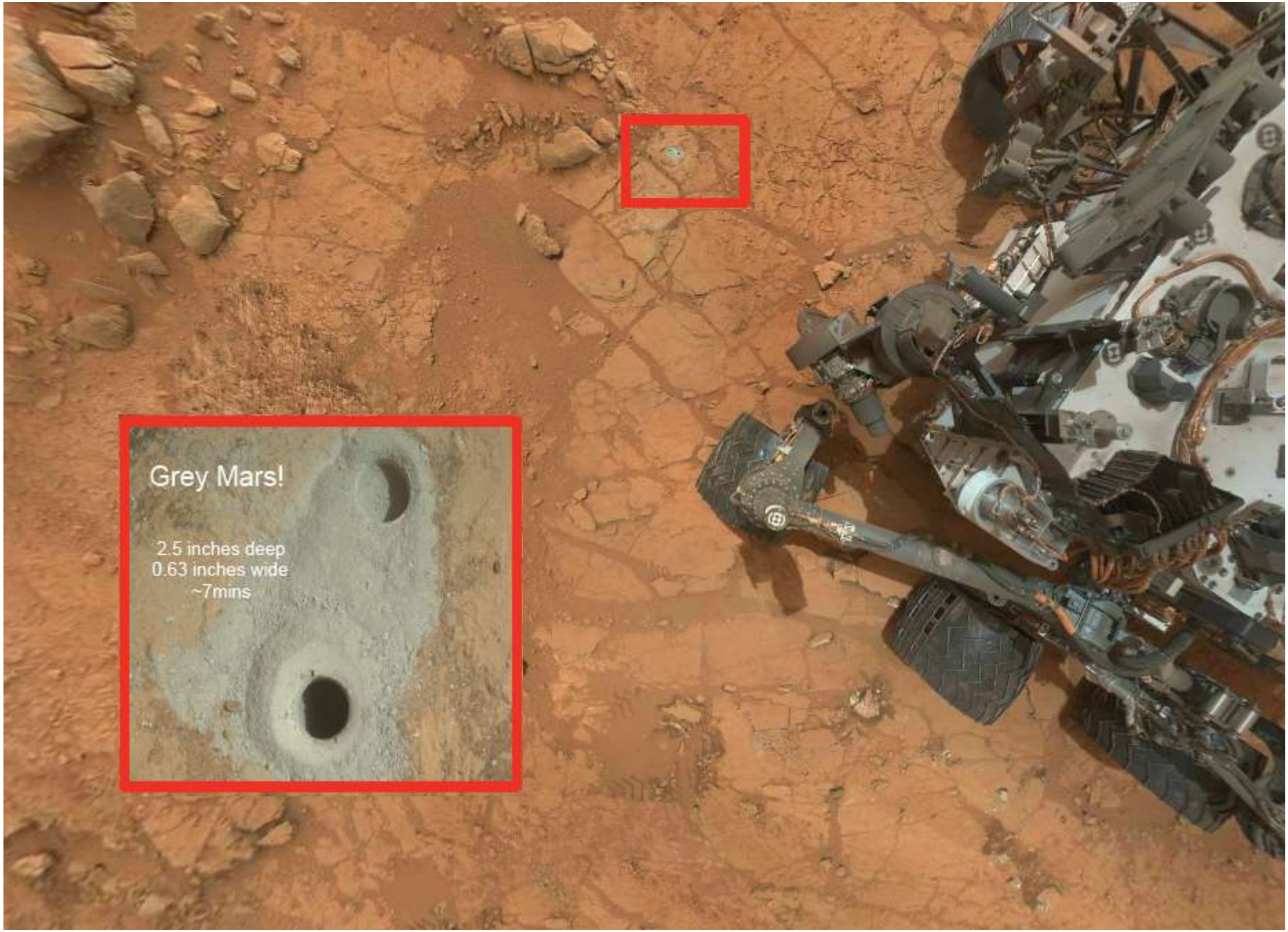
Modern society depends heavily on a variety of technologies that are susceptible to the extremes of space weather — severe disturbances of the upper atmosphere and of the near-Earth space environment that are driven by the magnetic activity of the Sun. Strong electrical currents driven in the Earth's surface during auroral events can disrupt and damage modern electric power grids and may contribute to the corrosion of oil and gas pipelines.


Planetary Science
Advance scientific knowledge of the origin and history of the solar system, the potential for life elsewhere, and the hazards and resources present as humans explore space


Formulation
Implementation
Primary Ops
Extended Ops
Juno
Lunar Reconnaissance Orbiter
MESSENGER
Deep Impact
New Horizons
Rosetta (ESA)
Cassini (NASA/ESA)
Dawn
MRO
MAVEN
ExoMars 2016 (ESA)
Mars Express (ESA)
Mars Odyssey
BepiColumbo (ESA)
JUICE (ESA)
ExoMars 2018 (ESA)
Opportunity Rover
Curiosity Rover
InSight
Mars Rover 2020
OSIRIS-REx
LADEE

Mars Rover “Curiosity”

http://solarsystem.nasa.gov/multimedia/video-view.cfm?Vid_ID=1823


Grey Mars!
2.5 inches deep
0.63 inches wide
~7mins

Curiosity Science Payload

- A suite of instruments named Sample Analysis at Mars
  - Gas chromatograph
  - Mass spectrometer
  - Tunable laser spectrometer
- CheMin: An X-ray diffraction and fluorescence instrument
- MHLI: Mars Hand Lens Imager
- Alpha Particle X-ray Spectrometer
- Mast Camera
- ChemCam
- Radiation Assessment Detector
- Mars Descent Imager
- Rover Environmental Monitoring Station
- Dynamic Albedo of Neutrons

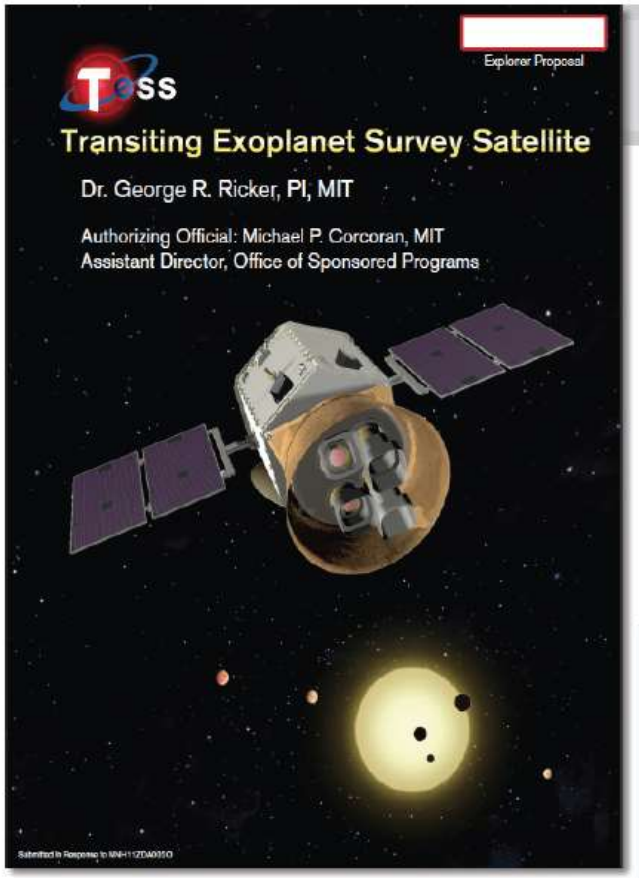
NASA Astrophysics

Goals

We seek to understand the universe and our place in it

Three broad scientific questions

How does the Universe work	How do matter, energy, space, and time behave under the extraordinary diverse conditions of the cosmos?
How did we get here?	How did the universe originate and evolve to produce the galaxies, stars, and planets we see today?
Are we alone?	What are the characteristics of planetary systems orbiting other stars, and do they harbor life?



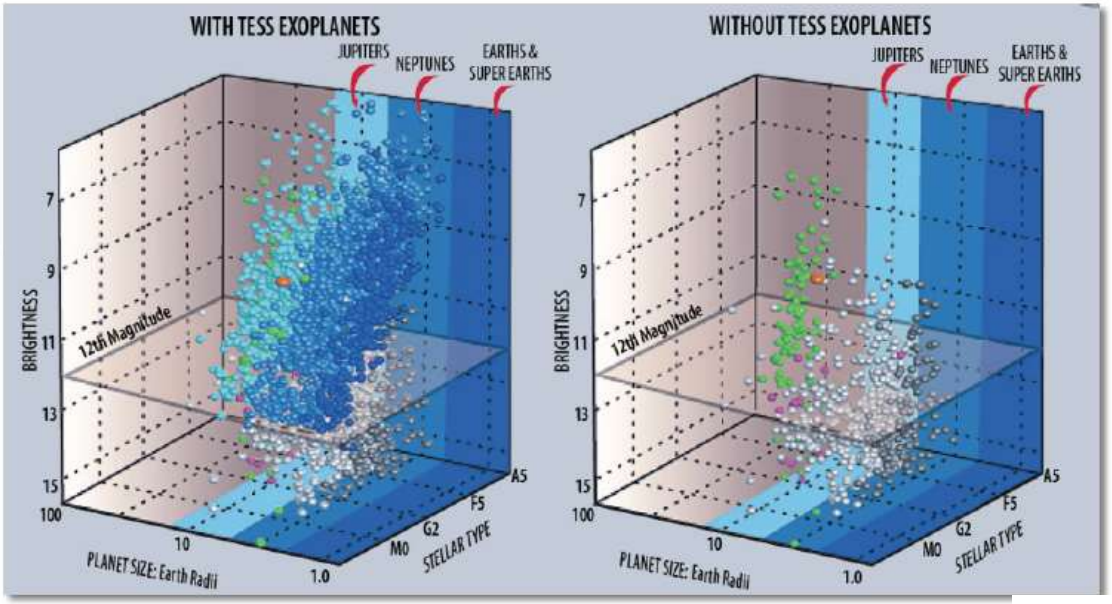
Transiting Exoplanet Survey Satellite

All-Sky, Two-Year Photometric Exoplanet Mapping Mission

Discover new worlds transiting the nearest and brightest stars

- **All-sky survey** of transiting extrasolar planets
- **Monitor >500,000 main-sequence stars**, focus on dwarfs of types F5 to M5.
- **Discover more than 2,000 new planets**, approximately 300 of which are expected to fall in Earth ($R_p \leq 1.25\ R_E$) and super-Earth ($R_p \leq 2.0\ R_E$) categories.
- **Provide the target list for JWST** future follow-up observations and future exoplanet characterization missions

Instrument: Four WFOV CCD cameras with overlapping FOV of 23x90deg mounted in a common lens hood. Passively-cooled 600-1000nm 4096x4096 pixel FPA



Space Technology Mission Directorate

The nation's investments in space technology enable NASA to make a difference in the world around us. The Space Techr Mission Directorate (STMD) is responsible for developing the crosscutting, pioneering, new technologies and capabilities needed by the agency to achieve its current and future missions.

STMD rapidly develops, demonstrates, and infuses revolutionary, high-payoff technologies through transparent, collaborat partnerships, expanding the boundaries of the aerospace enterprise. STMD employs a merit-based competition model wi portfolio approach, spanning a range of discipline areas and technology readiness levels. By investing in bold, broadly applicable, disruptive technology that industry cannot tackle today, STMD seeks to mature the technology required for NAS future missions in science and exploration while proving the capabilities and lowering the cost for other government agen and commercial space activities.

Research and technology development takes place within NASA Centers, in academia and industry, and leverages partne

Challenges for Deep Space Exploration

Communication

Environment Control & Life Supporting Systems

Logistics

Power Generation & Storage

Navigation

Entry, Descent & Landing

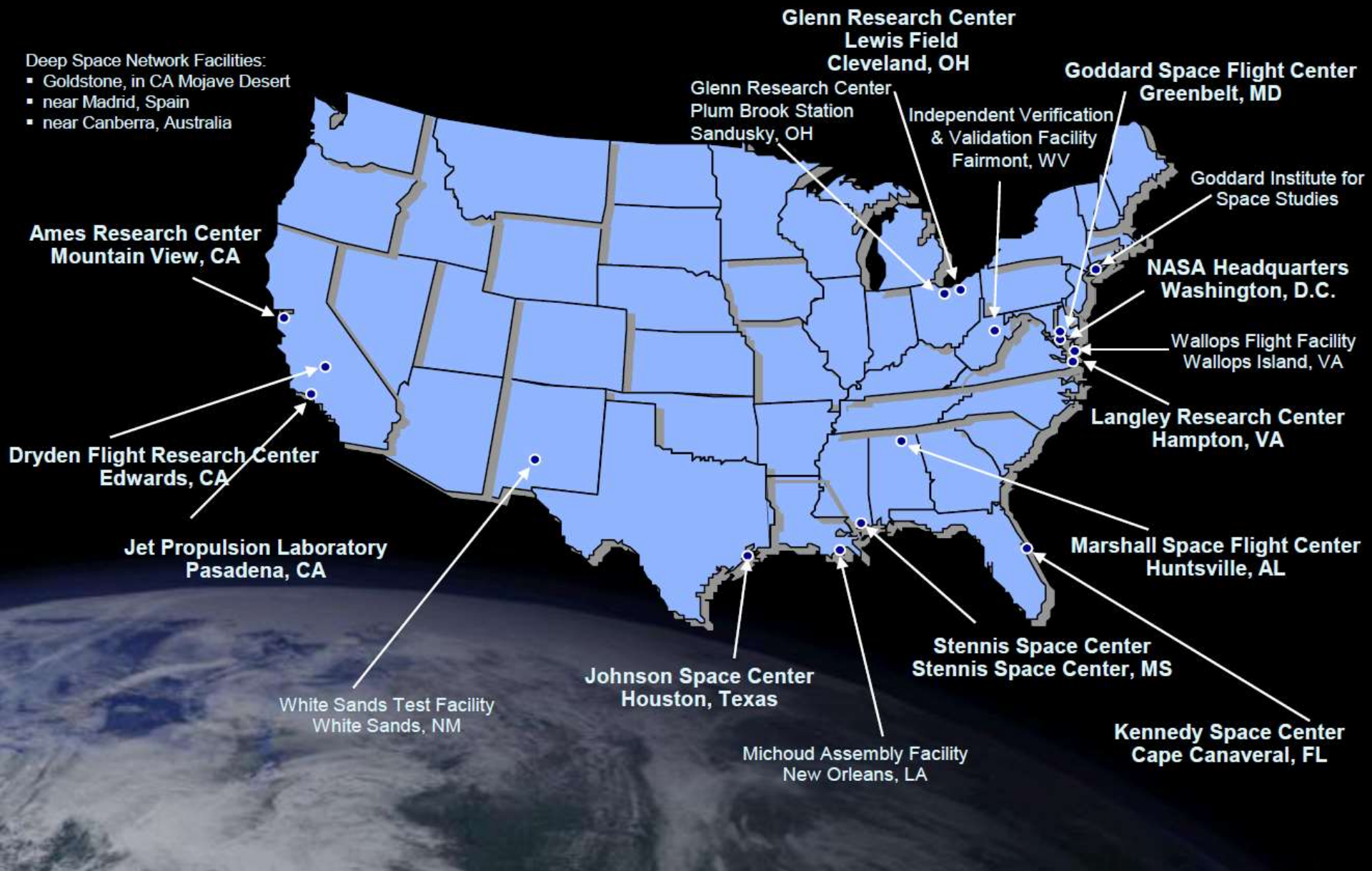
Manufacturing In Space & For Space

Radiation Mitigation

Propulsion

National Aeronautics and Space Administration

NASA Centers and Installations

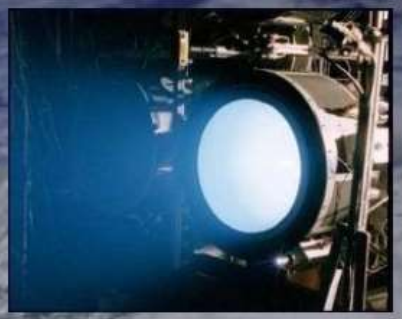


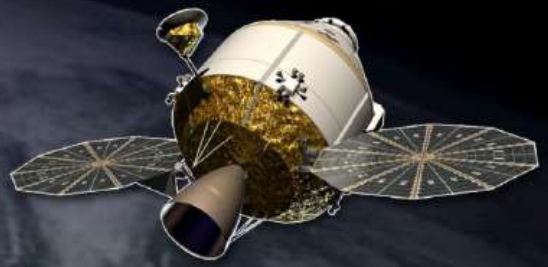
Vision and Mission

- **NASA Vision**: To reach for new heights and reveal the unknown, so that what we do and learn will benefit all humankind

- **NASA Mission**: Drive advances in science, technology, and exploration to enhance knowledge, education, innovation, economic vitality, and stewardship of the Earth

- **Glenn's Mission**: We drive research, technology, and systems to advance aviation, enable exploration of the universe, and improve life on Earth





Glenn Research Center

Lewis Field

(Cleveland)

- 350 acres
- 1626 civil servants and 1511 contractors

Plum Brook Station Test Site

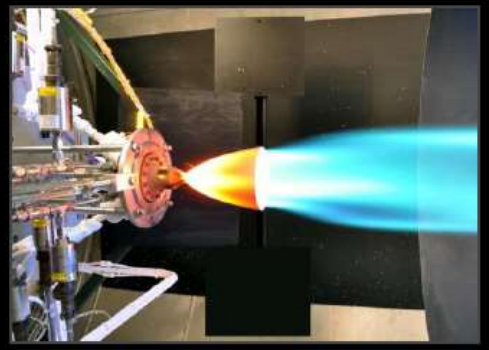
(Sandusky)

- 6500 acres
- 11 civil servants and 102 contractors

as of 1/2013

Glenn Core Competencies

Air-Breathing Propulsion



In-Space Propulsion and Cryogenic Fluids Management

Physical Sciences and Biomedical Technologies in Space

Communications Technology and Development

Power, Energy Storage and Conversion

Materials and Structures for Extreme Environments

National Aeronautics and Space Administration

NASA Aeronautics Programs



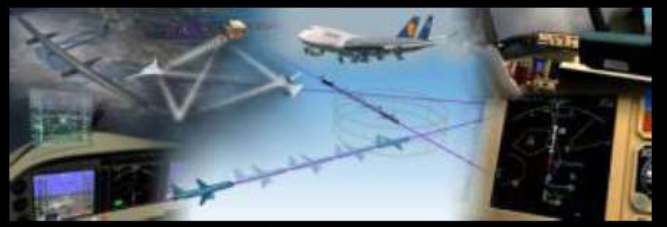

Fundamental Aeronautics Program

Conduct fundamental research that will generate innovative concepts, tools, technologies, and knowledge to enable revolutionary advances for air vehicles.

Integrated Systems Research Program

Conduct research at an integrated system-level on promising concepts and technologies and explore/assess/demonstrate the benefits in a relevant environment





Airspace Systems Program

Directly address the fundamental ATM research needs for NextGen by developing revolutionary concepts, capabilities, and technologies that will enable significant increases in the capacity, efficiency and flexibility of the NAS.


Aviation Safety Program

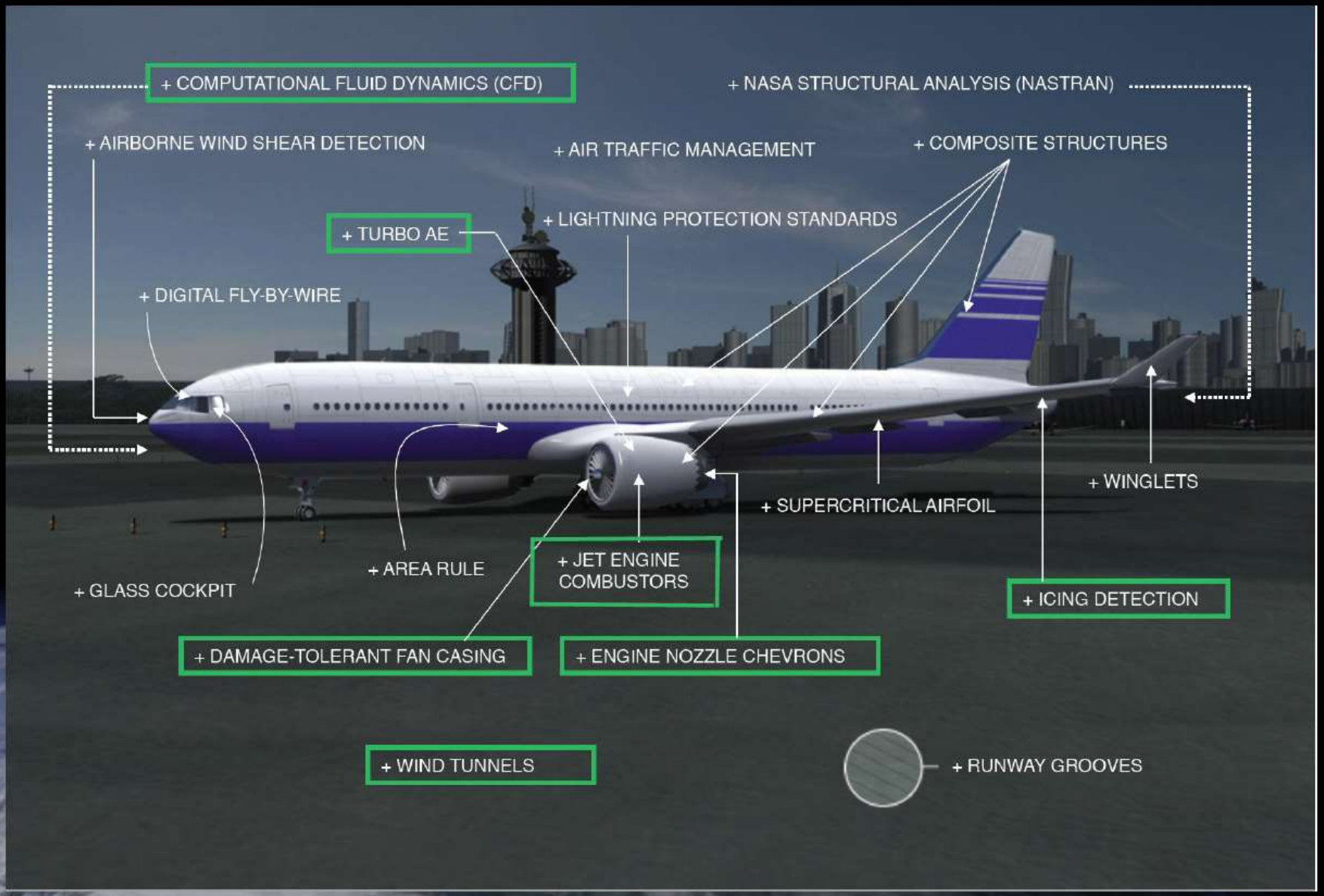
Conduct cutting-edge research that will produce innovative concepts, tools, and technologies to improve the intrinsic safety attributes of current and future aircraft.



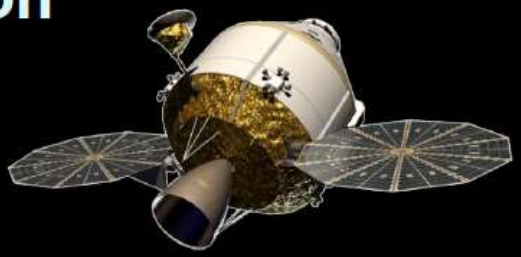
Aeronautics Test Program

Preserve and promote the testing capabilities of one of the United States' largest, most versatile and comprehensive set of flight and ground-based research facilities.


Aeronautics Contributions



Human Exploration



Orion Multi-Purpose Crew Vehicle (MPCV)

- Co-Lead Crew & Service Module with JSC
- ESA Service Module Integration

Space Launch System (SLS)

- Lead Payload shroud/fairing development
- Power, thrust vector control, and other subsystem support

Commercial Crew/Cargo

- Reimbursable Space Act Agreements for engineering support and facilities for testing

Space Environmental Test Project

Delivering One-of-a-kind environmental testing capability at ONE location: The Space Power Facility

The World's Largest Space Environmental Simulation Chamber Contains:

- **Reverberant Acoustic Test Facility (RATF): the most powerful reverberant acoustic chamber in the world**
  - ✓ Capable of reaching an overall sound pressure level of 163 dB
  - ✓ Can accommodate 34' wide by 57' high test article
- **Largest space simulation vacuum chamber in the world**
  - ✓ 800,000 ft3 volume, 100 foot diameter, 122 feet high
  - ✓ Features 40 x 40 ft. cryogenic cold shroud, and 7 MW power for solar simulation
  - ✓ Electromagnetic Environmental Effects (E3) Reverberant-mode EMI/EMC test capability
- **Highest capacity Mechanical Vibration Facility (MVF) in the world**
  - ✓ 18' diameter test table, expandable to 32'
  - ✓ Test article mass up to 75,000 lbs
  - ✓ Actuators are used to perform vibration testing in 3 axes expandable to 6DOF

Space Operations

International Space Station (ISS)

- Develop and Operate ISS Microgravity Experiments
  - Fluid physics and combustion science research
- Human Research Program
  - Human Health and Countermeasures
  - Exploration Medical Capability
- ISS Electrical Power System
  - Sustaining Engineering & Analysis

Space Communication & Navigation (SCaN)

- Software defined radios (SCaN Testbed)
- RF propagation & RF/Optical hybrid technology
- Network Services Compatibility Testsets
- Program Systems Engineering
- Spectrum Management

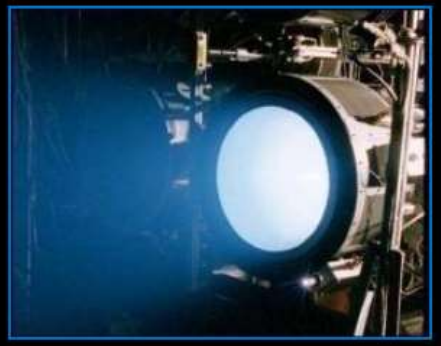
Space Science

Radioisotope Power Systems

- Advanced Stirling Radioisotope Generator (ASRG)

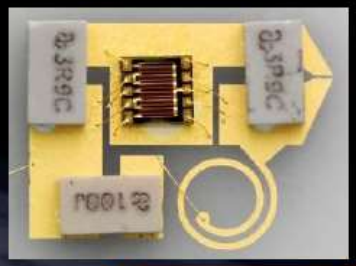
In-Space Propulsion

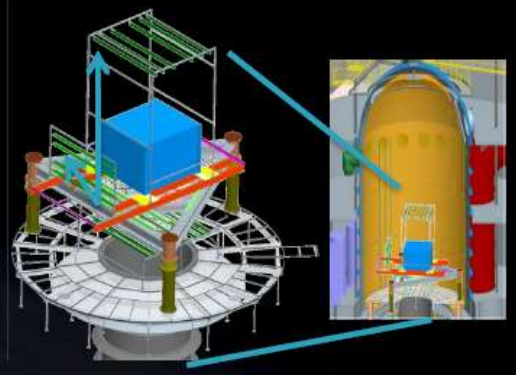
- Solar Electric Propulsion (SEP) capabilities
- NASA Evolutionary Xenon Thruster (NEXT)
- Hall effect thrusters



Planetary Science

- Extreme environment instruments and testing facilities
- Balloon platforms
- Mission planning (Mars/Other)





Space Technology

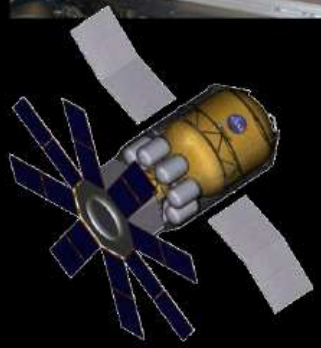
Advanced Exploration Systems (AES)

- Modular power systems
- Spacecraft fire safety
- EVA flight technologies

Space Technology Program

- Cryogenic Propellant Storage and Transfer (CPST) technology flight demonstration
- Solar Electric Propulsion (SEP)
- Space power generation & storage
- Nuclear systems
- Nanotechnology
- Manufacturing innovation

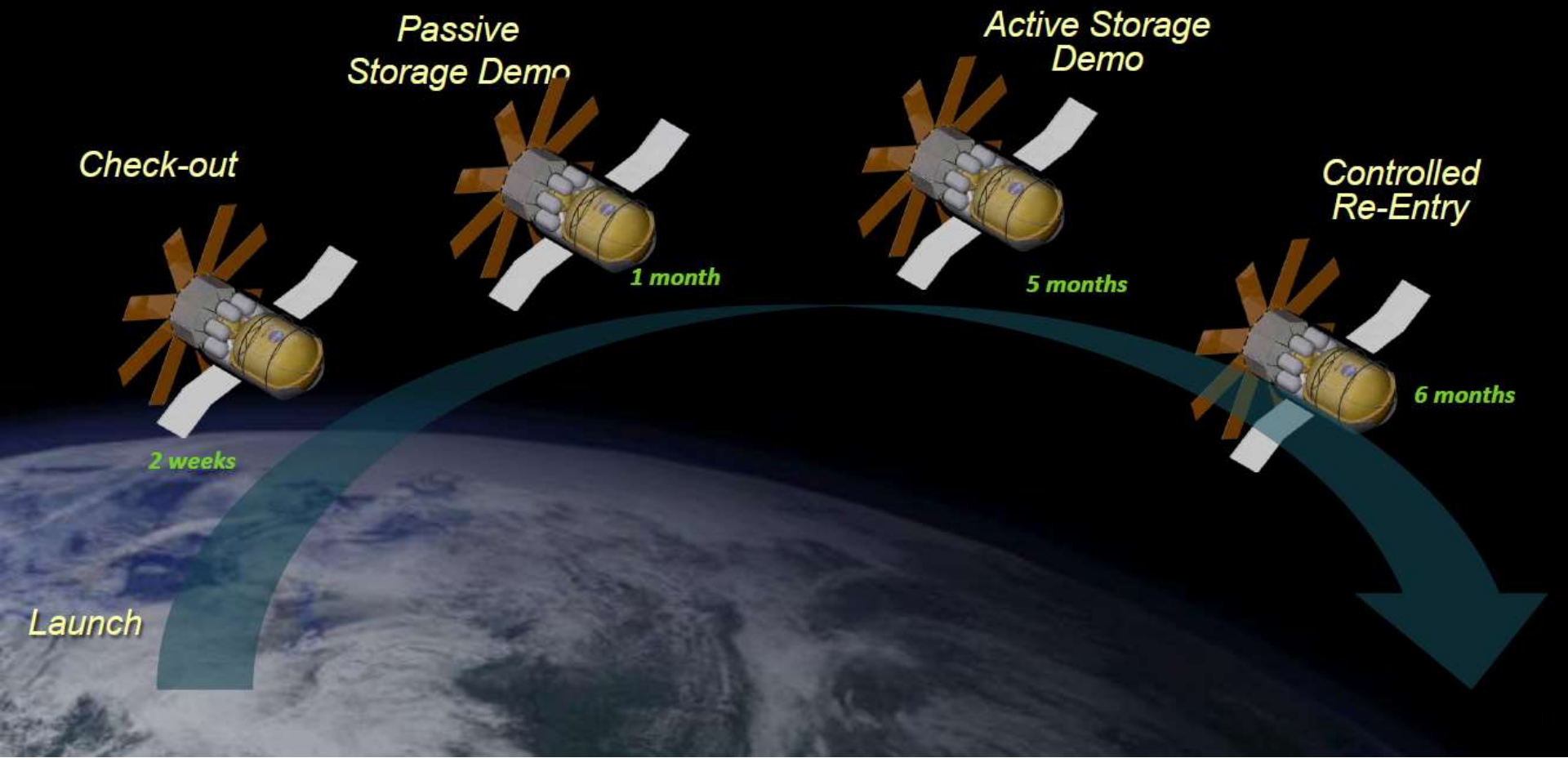






Cryogenic Propellant Storage and Transfer (CPST)

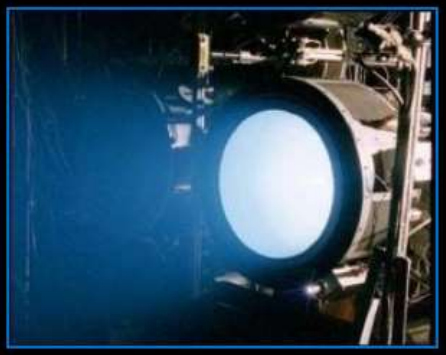
NASA is undertaking a demonstration mission to advance cryogenic propellant storage and transfer technologies that will enable exploration beyond Low-Earth Orbit



30kW-Class Solar Electric Propulsion (SEP)

NASA is developing high performance SEP capability to enable future in-space exploration missions

- High propellant efficiency
- Reduced launch mass
- Lower mission cost



NASA Glenn Visitor Center Relocated to the Great Lakes Science Center

We're now where the people are!

- 330,000 visitors / yr (5X previous, onsite location)
- 950 school groups / yr (4X previous)
- 75,000 students / yr (7X previous)

NASA Opportunities

- Collaboration is the norm
- NASA Opportunities
  - ROSES
  - NRA
  - Other “Commerce Daily” announcements for >$25,000
  - Non solicited proposals
  - CASIS example

N.A.S.A. Solicitation and Proposal Integrated Review and Evaluation System

Home NASA Research Help Login

NSPIRES Time: Oct 24, 2013 12:52PM EDT

NSPIRES will be unavailable on Saturday October 26 from 7:00am ET until approximately 11:30am ET so system maintenance can be performed.

NSPIRES Home

Solicitations

Getting Started

NSPIRES Help

Getting an Account

Help Desk

If you need help or have any questions regarding the NSPIRES website, please contact the NSPIRES Help Desk at (202) 479-9376 Monday through Friday, 8:00 AM to 6:00 PM EST/EDT, or by email at nspires-help@nasaprs.com.

NASA Web Sites
Click for Links

NASA Research Opportunities

Supporting research in science and technology is an important part of NASA's overall mission. NASA solicits this research through the release of various research announcements in a wide range of science and technology disciplines. NASA uses a peer review process to evaluate and select research proposals submitted in response to these research announcements. Researchers can help NASA achieve its national research objectives by submitting research proposals and conducting awarded research. This site facilitates the search for NASA research opportunities.

NASA Research

Solicitations

Search for and view open, closed, and future NASA research announcements. The full text of the solicitation announcements can be viewed and downloaded.

Solicitations and selected proposals for years prior to NSPIRES implementation, January 1, 2005, were entered manually; therefore, some postings for years 2000-2004 may not be as complete as those posted through the NSPIRES system from 2005 to the present.

Getting Started

To submit a research proposal to NASA, individuals and the organizations with which they are affiliated must be registered in NSPIRES. Individuals may register at any time.

Organizations are required to have a valid registration with the System for Award Management (SAM) before they can register in NSPIRES. See Registration Information for more details on user and organization registration.

Research.gov

Research.gov is a partnership of federal research-oriented grant making agencies. Research.gov is led by the National Science Foundation.

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This is a U.S. Government computer. By accessing and using the computer system, you are consenting to the use of system monitoring. Unauthorized use of, or access to, this computer system may subject you to disciplinary action and criminal prosecution.

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Registration Information

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SEARCH
HOME
ABOUT
NEWS & EVENTS
SUPPORT
OPPORTUNITIES
OPPORTUNITIES
Flights
Solicitations
RFP - Protein Crystallization
RFP - Materials Science
RFI - Hyperspectral Imaging
RFP - Stem Cells Research
RFI - Your Idea In Space
RFP - Remote Sensing
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REQUEST FOR PROPOSALS
Remote Sensing from the International Space Station
Welcome to the CASIS Request for Proposals
Remote Sensing from the International Space Station
RFP No. CASIS 2013-3 | RFP Issued October 17, 2013 | Proposals Due: December 19, 2013
The Center for the Advancement of Science in Space (CASIS) is pleased to announce a Request for Proposals (RFP)
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