NASA, Rockets, and the International Space Station

Tips and tricks on getting your dream job

Brandon Marsell

Who is this guy?

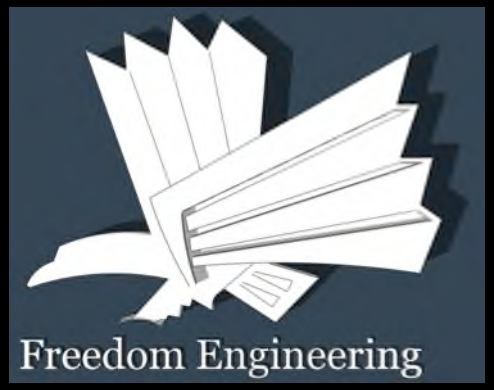
- Brandon Marsell
  - Fluid Dynamics Engineer
  - NASA Launch Services Program
  - Kennedy Space Center

Education

- Stetson University
  - Bachelor of Science in Physics
  - Quantum Mechanics track
  - 2003 – 2007
- Embry Riddle Aeronautical University
  - Master's of science in Aerospace Engineering
  - Aerodynamics / CFD track
  - 2007 - 2009

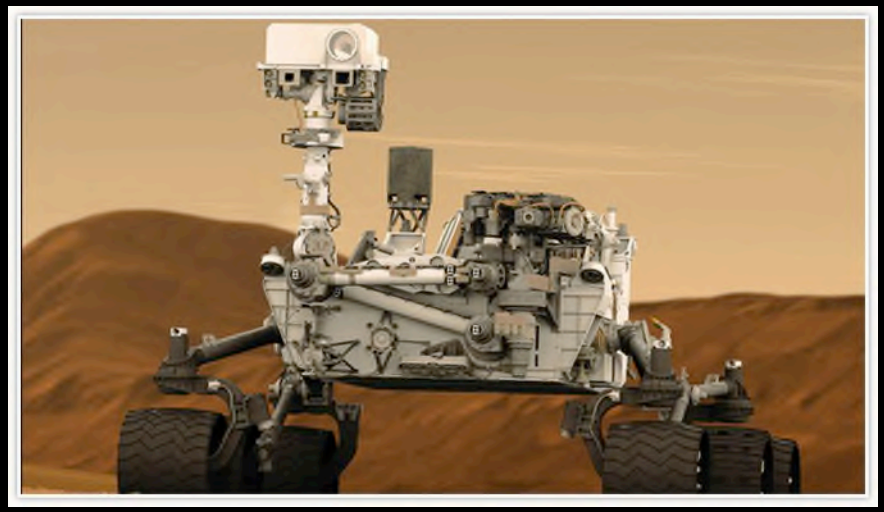
Experience

- 6 years experience with Launch Vehicles (Rockets)
- Aerospace engineer for QinetiQ-NA
  - Hired in 2009
  - ELVIS contract
- Aerospace Engineer for ai solutions
  - 2012
  - ELVIS II contract
- Hired by NASA as a civil service employee in 2013
- Started my own company
  - 2013
  - Freedom Engineering



Missions

- I have served as NASA's primary fluids engineer on the following missions
  - RBSP
  - MMS
  - MSL
  - JUNO
- Special projects
  - ISS Experiment

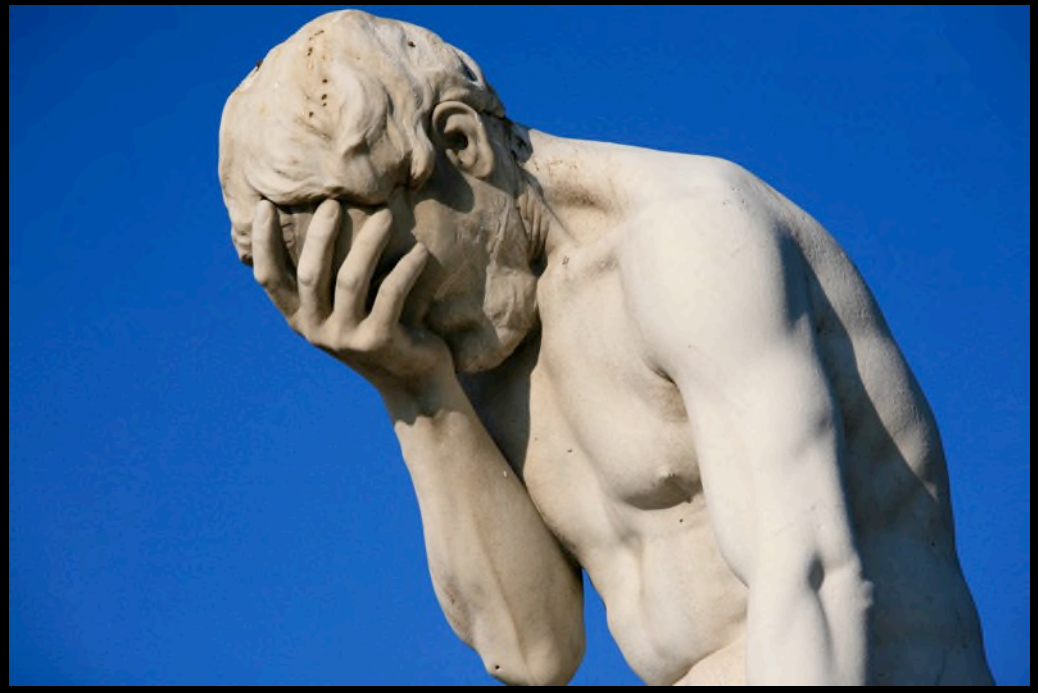


Question 1

- What was this rocket called?

NASA

- Question I get asked the most
  - Didn't they shut down NASA?



  - NASA is very much alive and well

What is NASA?

- NASA is a government agency just like
  - FDA
  - FBI
  - ATF
  - USDA
  - And many more

- Though recently most agencies have seen their budgets shrink, NASA's budget is fairly stable
- NASA's 2013 budget was ~$18 Billion

Who can work at NASA?

- Anyone!
- NASA has many centers all over the country and needs many different skills
  - Engineering
  - Accounting
  - Attorneys
  - Project managers
  - Computer programmers
  - Writers
  - Public relations
  - Human resources
  - And many more

AMES Research Center

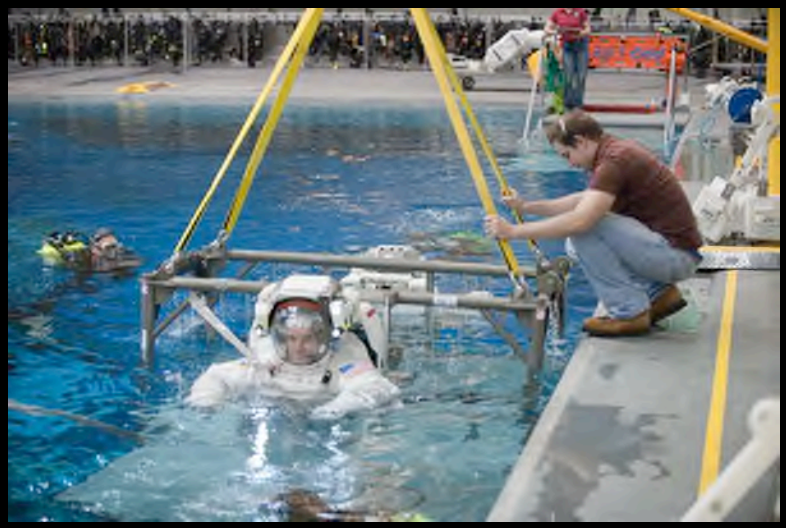
- Located in San Jose, CA
- Houses some of NASA's most powerful supercomputers
- Has huge wind tunnels
- Provides support of many space and aeronautics programs

Jet Propulsion Laboratory

- Located in Pasadena, CA
- Builds and operates many of NASA's robotic missions
  - Curiosity (MSL)
  - Cassini-Huygens
  - Mars Exploration Rover Opportunity
  - Mars Reconnaissance Orbiter
  - JUNO
  - more

Johnson Space Center

- Located in Houston, TX
- ISS mission control
- Astronaut training



Stennis Space Center

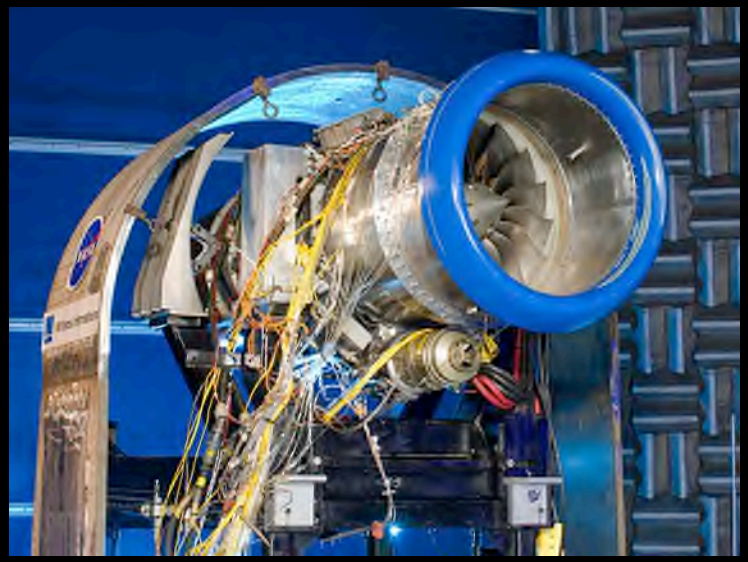
- Bay Saint Louis, MS
- NASA's largest rocket engine test facility

Marshall Space Flight Center

- Located in Huntsville, AL
- Largest NASA center
- Lead center for design of Apollo, Space Shuttle, International Space Station, and SLS rocket

Glenn Research Center

- Located in Cleveland, Ohio
- Develops science and technology for use in aeronautics and space
- Cutting edge research on jet engines and in space propulsion
- Large vacuum chambers



Langley Research Center

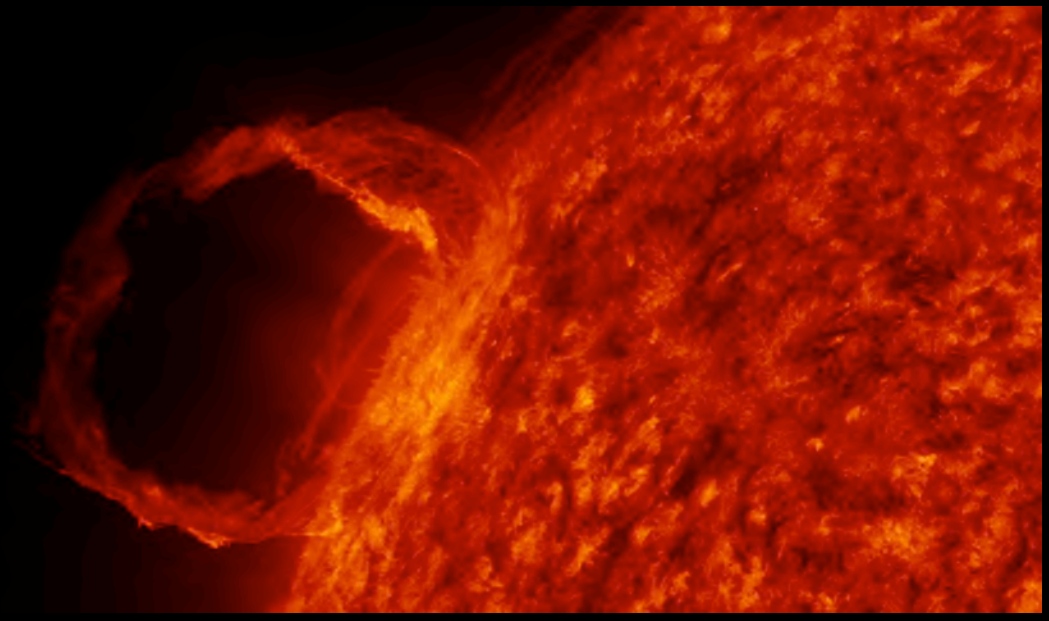
- Located in Langley, VA
- Operates many wind tunnels
- Focuses on aeronautical research

Armstrong Flight Research Center

- Located at the Edwards air force base, CA
- Lead center for aeronautics testing
- Tests some of the most advanced aircraft in the world

Goddard Space Flight Center

- Greenbelt, MD
- Develops many unmanned scientific spacecraft
- Provides management for many NASA science missions



NASA Headquarters

- Located in Washington DC
- Interfaces with the rest of the government
- Business and management

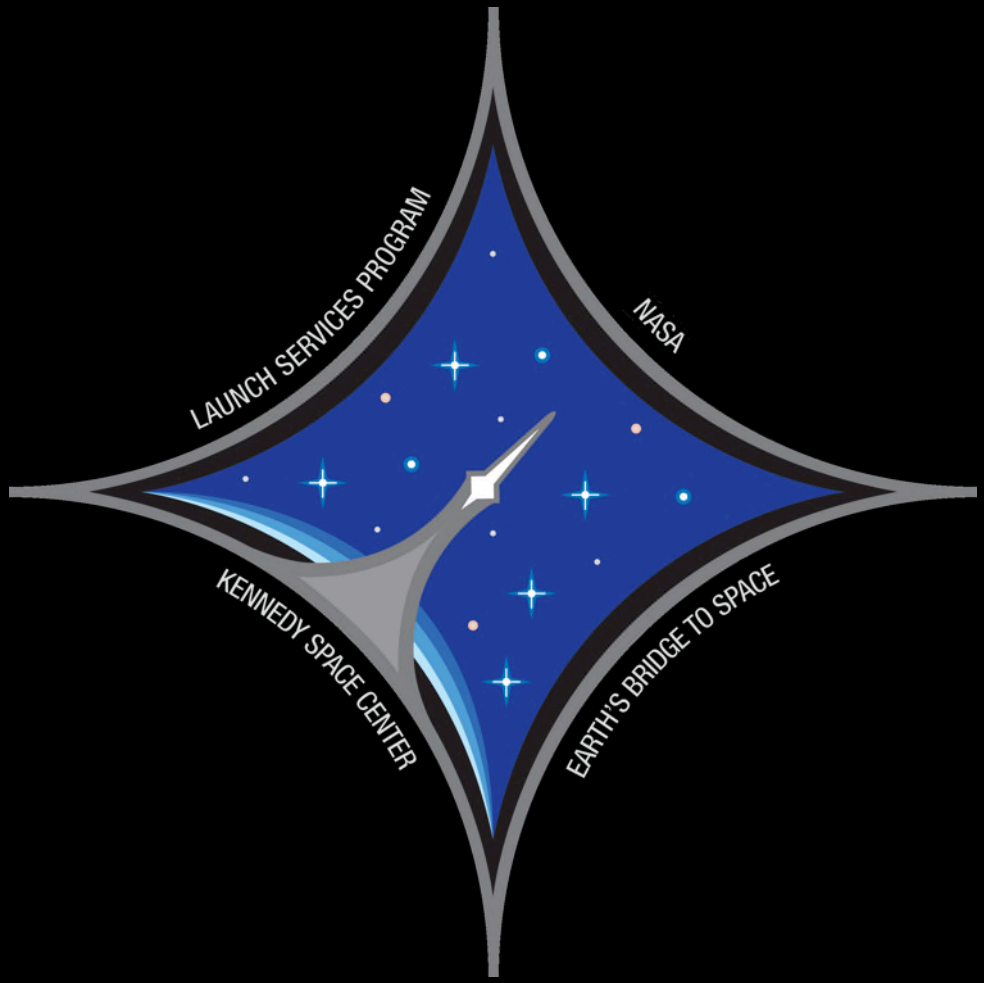
Kennedy Space Center

- Cape Canaveral, FL
- Lead center for launching vehicles
- Best center ever!

Question 2

- Who is this guy?

Launch Services Program



Earth's Bridge to Space

LSP acts as the "broker"

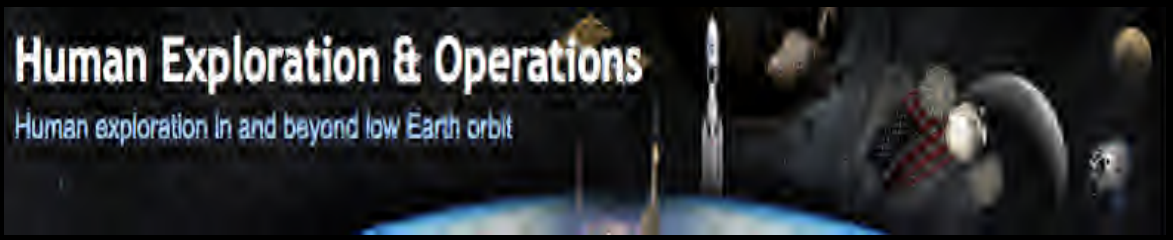
SPACEX Orbital ULA United Launch Alliance LOCKHEED MARTIN

APL The Johns Hopkins University APPLIED PHYSICS LABORATORY Goddard SPACE FLIGHT CENTER JPL

With the goal of ensuring mission success

LSP's Customers

End to End



Advisory

LSP's Current Fleet


Pegasus


Atlas V


Delta II

Antares


Falcon 9


Athena Ic


Athena IIc

Launch Sites

Potential/Emerging Vehicles



Delta IV


Falcon Heavy

Athena III
Stratolauncher

VG LauncherOne
Blue Origin

CubeSat

Student Launch System Initiative

Educational Launch of Nanosatellites (ELaNa) is an exciting initiative created by NASA to attract and retain students in the science, technology, engineering and mathematics disciplines. Managed by the Launch Services Program (LSP) at NASA's Kennedy Space Center in Florida, ELaNa reaches students by introducing educational spaceflight in high schools and colleges across the United States.

High Altitude Demonstration Missions

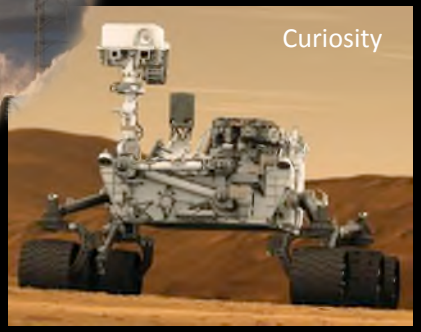
LSP Enables Human Exploration

Launch Services Program

SIRTF

OSIRIS-REX

Mars Rover- Spirit



Curiosity

Human Exploration

Determine whether life ever arose on Mars

Characterize the climate of Mars

Characterize the geology of Mars

Prepare for human exploration

Human Space Flight

LSP invest in collaborates with…

LAUNCH SERVICES PROGRAM

Advisory

Commercial Resupply Services (CRS)

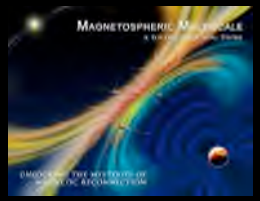
Exploration Flight Test-1

Commercial Crew Program

2015 – 2016 Manifest Outlook

2015

SMAP – Soil Moisture Active Passive



MMS – Magnetospheric MultiScale

Jason-3

2016

GOES-R – Geostationary Operational Environmental Satellite

Interior Exploration using Seismic Investigations, Geodesy and Heat Transport

OSIRIS-Rex - Origins Spectral Interpretation Resource Identification Security Regolith Explorer

Cyclone Global Navigation Satellite System

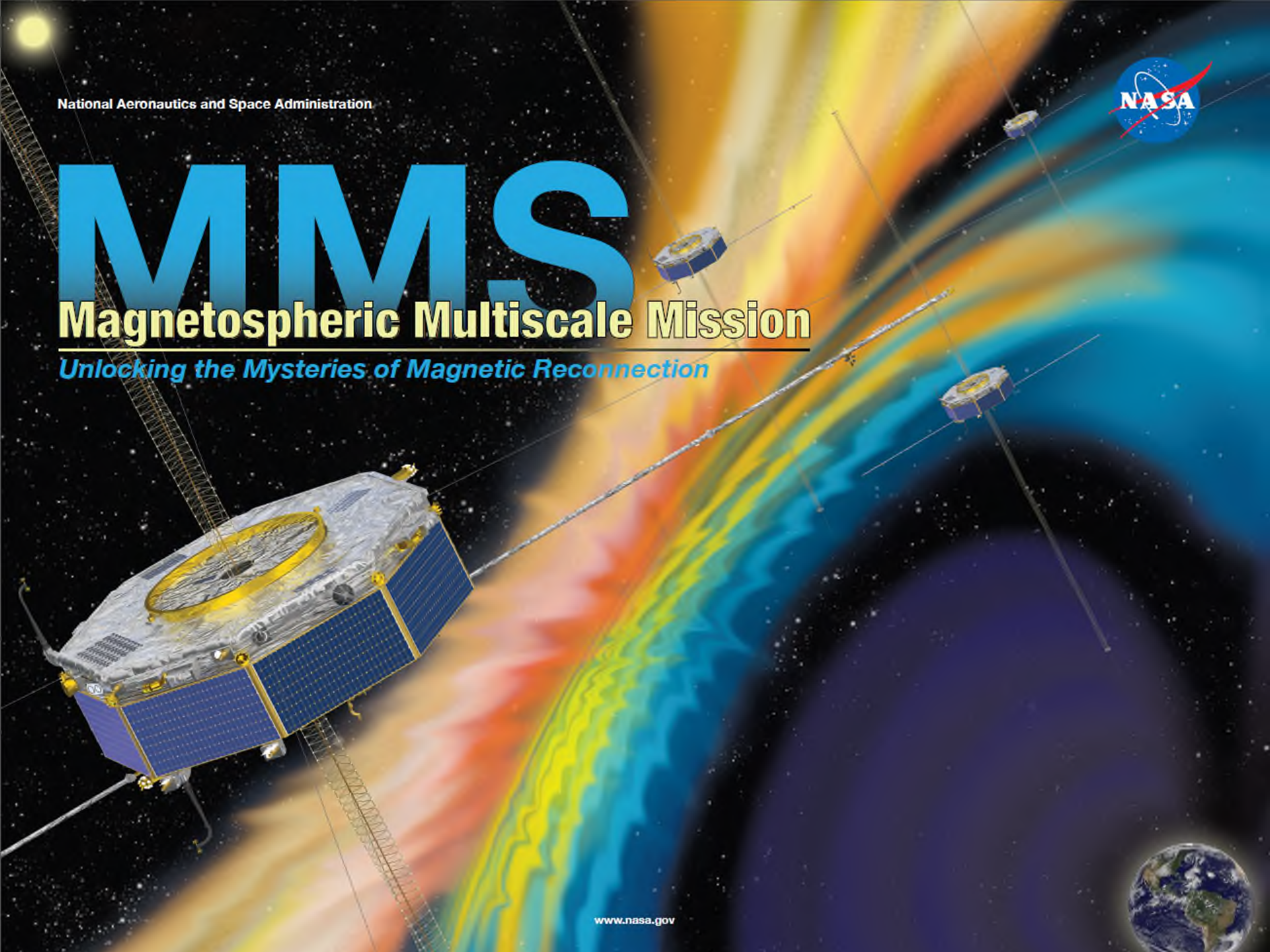
JPSS-1 – Joint Polar Satellite System

National Aeronautics and Space Administration

MMS

Magnetospheric Multiscale Mission

Unlocking the Mysteries of Magnetic Reconnection



www.nasa.gov

Question 3

- Who is this guy?

What do I do

- NASA
  - NASA headquarters, DC
    - Kennedy Space Center
      - Launch Services Program
        - Mission Analysis Division
          - Environments and Launch Approval Branch
            - Fluids Group
              - Brandon

Fluids Group

- This is one of the smaller groups consisting of 4 engineers
- Responsible for any fluid dynamics related analyses required during the launch integration process
- It really is “rocket science!”
  - So what does this mean?

Example 1

- Compartment venting
  - As the rocket increases in altitude, the air pressure decreases (pretty quickly)
  - How do you make sure the pressure inside doesn't cause the fairing to break open?
  - The fairings have vent holes
  - We run a large set of analyses that predict the pressure inside the fairing during the ascent
  - These predictions ensure the payload wont be damaged from depressurizing too quickly/slowly

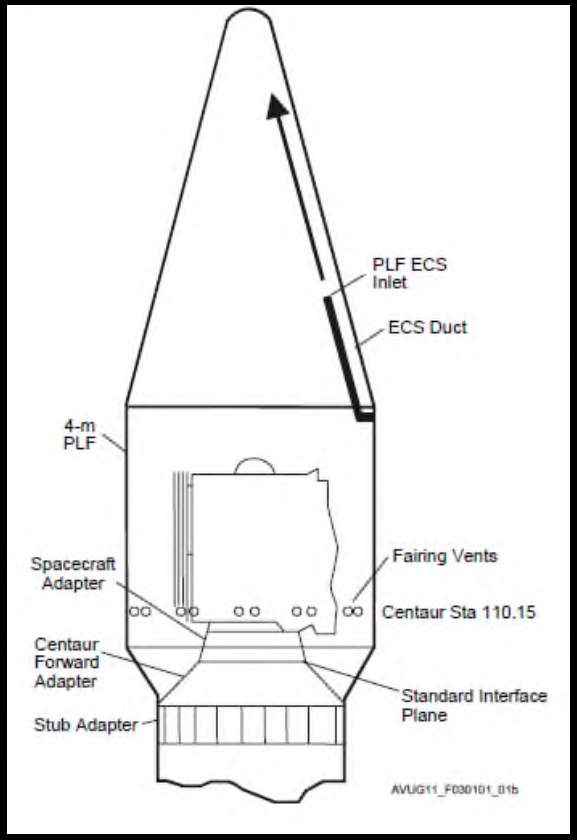
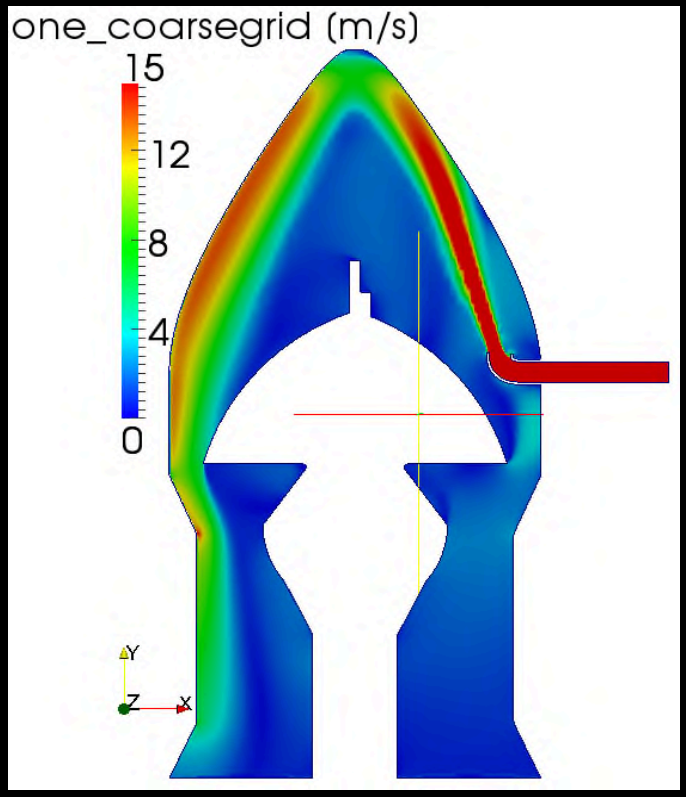


Image: ULA Atlas V User's Guide (http://www.ulalaunch.com/uploads/docs/AtlasVUsersGuide2010.pdf)

Example 2

- Payloads sitting inside the fairing are supplied with air conditioning to ensure they remain dry and cool as they wait for launch
- Some payloads have stringent cooling requirements (like on batteries etc…) that drive us to run sophisticated Computational Fluid Dynamics (CFD) analyses to predict heat transfer coefficients and air temperatures



Example 3

- Before NASA entrusts a private company with a multi-million (sometimes billion) dollar spacecraft, LSP must certify the vehicle
- LSP pours over many engineering documents to ensure the rocket is safe and reliable
- As part of these certification efforts, we independently generate aerodynamic coefficient tables for use in control system simulations

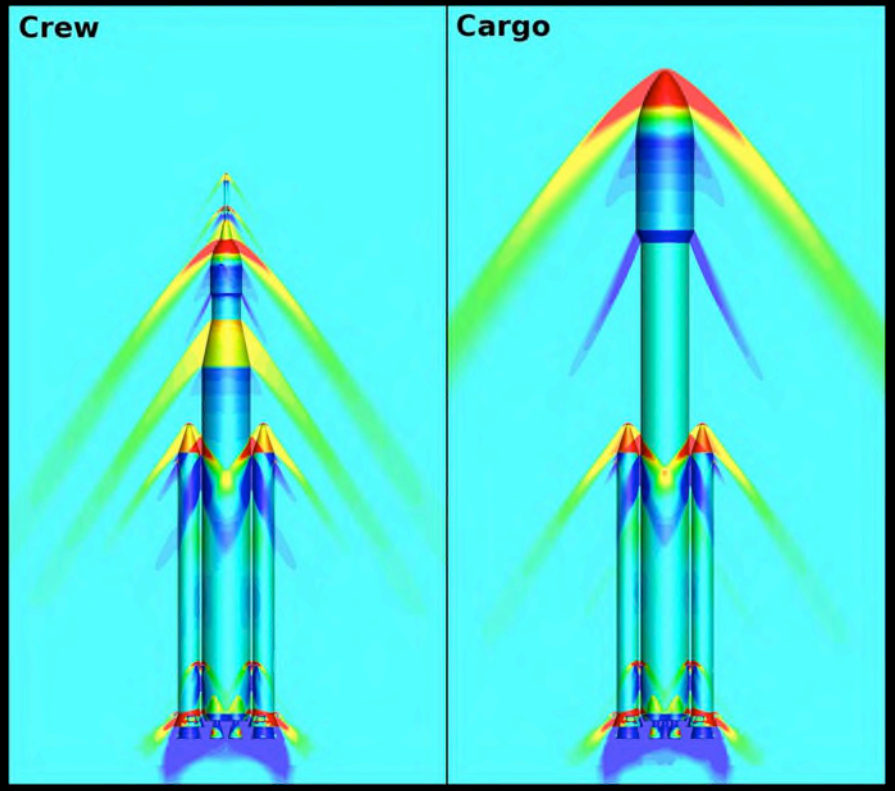


Image: NASA @science
http://www.nas.nasa.gov/SC11/Kiris_SLS-CFD_Backgrounder.html

I love my job

- I often find myself stepping back and thinking
  - "I can't believe I am actually working on something that's going to space!"
  - It is very rewarding
- Not only are these problems super interesting, challenging, and important… they are also fun!

How did I get here?

- Always knew I wanted to work in the space industry
  - Wanted to work on things that go to space
  - Didn't specifically set my sights on NASA until grad school
- I chose physics because it was fundamental, interesting, and allowed me to specialize later
  - Physics allowed me to chose from a wide variety of engineering disciplines
  - I chose Aerospace Engineering

Realize how lucky you are

- I was always very disciplined and realized how lucky I was to be able to go to college and get a degree from a great university.
- Not many people get the opportunity to even go to college
  - Seriously, look it up
  - http://www.bls.gov/news.release/hsgec.nr0.htm
  - Though I had a lot of fun, school always came first

Internships

- These are very important!
- Do as many as you can
- You will meet many people in many different fields
- These folks may hire you one day

High Altitude Observatory

- During my Junior year I completed my first internship
  - National Center for atmospheric research
  - High altitude observatory
  - Scattering Polarization Experiment
- Met many scientists
  - They were working on a satellite that was set to launch in the next year
  - This is when I decided to do something similar

Grad School

- Good grades, internship experience and physics degree got me into grad school at Embry Riddle Aeronautical University (ERAU)
  - Since it was not an engineering degree they required a couple pre-requisite classes
  - Finished them over summer after graduating from Stetson

Grad School TIP

Just because a course is called something different, doesn't mean it is Example: linear algebra could be called matrix methods or numerical engineering. Different engineering schools have different lingo and advisors/ professors won't always know what you have already taken. Use your old textbooks to prove you have taken classes.

Get a Good Advisor and Project

- I chose the thesis option
  - Thesis option = less class-work but requires thesis
  - Non-Thesis option = more class-work but no thesis
- Thesis option allowed me to specialize and immerse myself in the world of Computational Fluid Dynamics (I recommend it)
  - Favorite class was fluid dynamics
  - Asked professor for a thesis project
  - He gave me one!

Grad School TIP

Get help from your advisor, but realize he won't do it all for you. Once in grad school, it's up to you! Take ownership of your project and make it the best that it can be. Apply for grants and find someone to pay for your school!

Thesis project

- Advisor was involved in the NASA Graduate Student Researcher's Program (GSRP)
  - Studying the way fluids move in containers
  - Project was for the Launch Services program
  - https://intern.nasa.gov/ossi/web/public/main/
- Once accepted, I took over for the previous student
  - NASA grant covered grad school as well as living expenses
  - Weekly teleconferences gave me exposure to the folks at NASA

Getting Hired

- Grad school flew by
  - Finished my Master's in 2 years
  - Started looking for jobs
- Use "shotgun" technique
  - I applied to more than 30 job openings
  - Posted my resume everywhere

Marketing TIP

Go to technical conferences in your field and present as much as possible. Also, take many copies of your resume and post them on the open boards at the venue.

Question 4

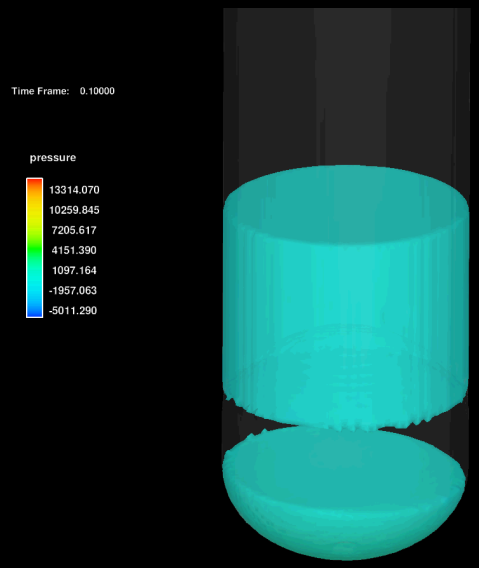
- How long did it take Mars Science Laboratory to get to Mars?

ISS Slosh Experiment

- At the Launch Services Program we are lucky to have a small budget for research and development
  - Normally used for small research projects
  - Also used to buy advanced equipment
- I am heavily involved in research projects
- I was assigned to lead the ISS Slosh Experiment in 2011

What is slosh?

- Liquid propellant movements within rocket tanks can cause loss of mission
- Must predict the magnitude and frequency of slosh forces to properly tune vehicle control systems



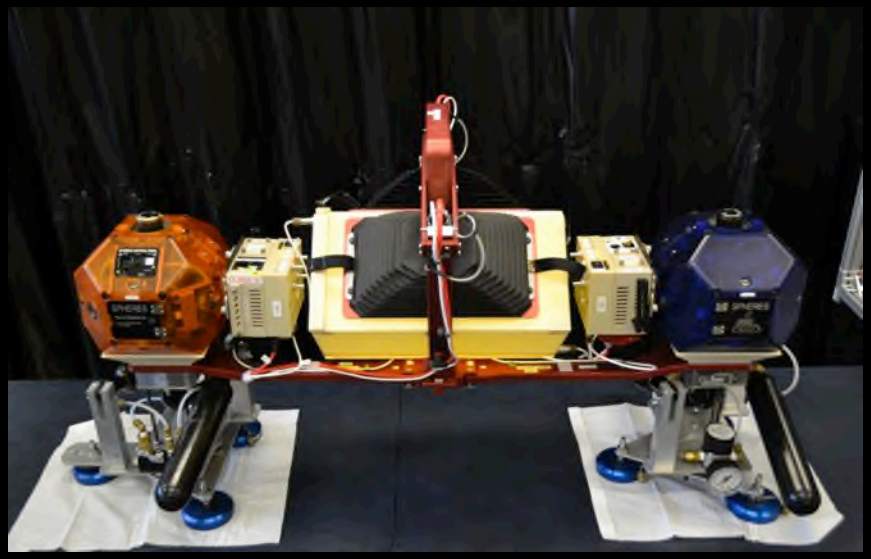
The Problem – The Solution

The Problem

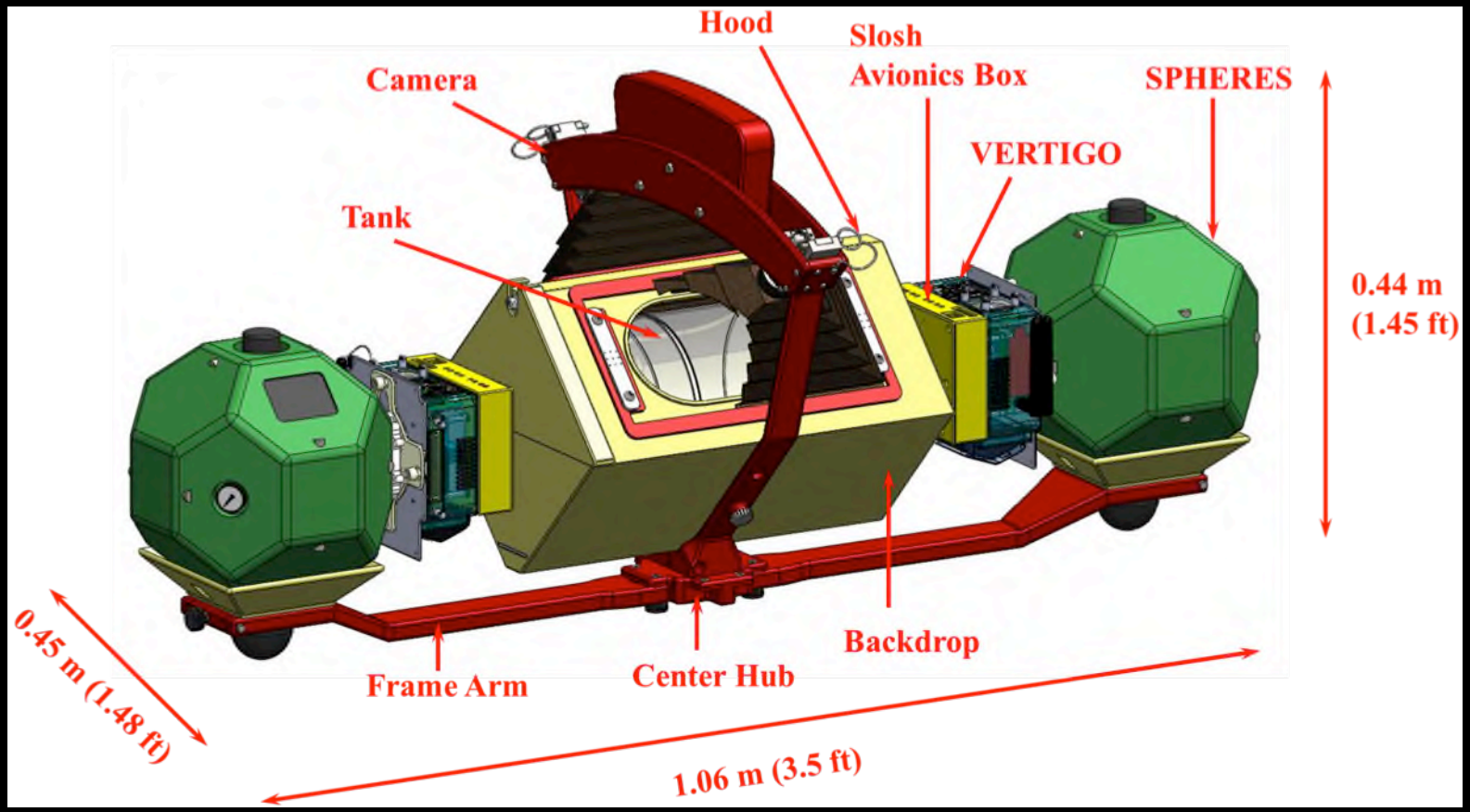
- NASA lacks experimental data to validate liquid slosh behavior in a microgravity environment
- Many computer models claim to accurately predict liquid motion inside a propellant tank
- These models are only validated under 1g conditions
- None have been validated in the surface tension-dominated microgravity environment of space

The Solution

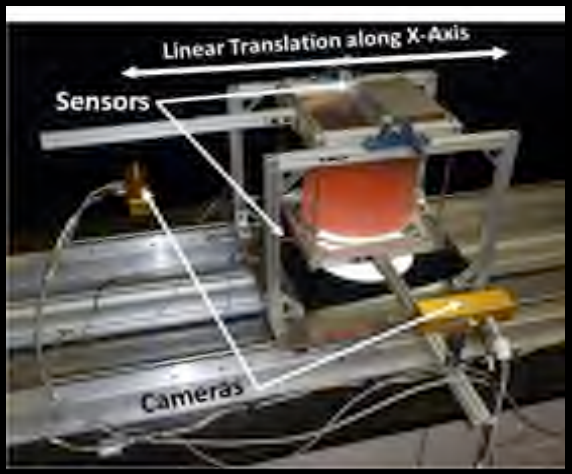
- An experiment has been built that takes advantage of the microgravity environment of the International Space Station (ISS)
- Scaled, clear, liquid filled tank
- Cameras
- Inertial measurement units

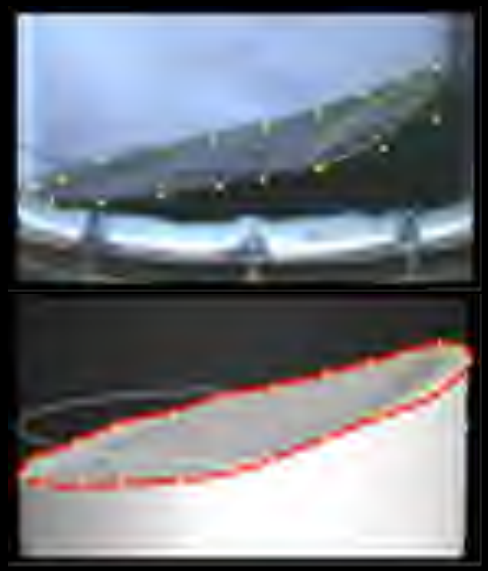


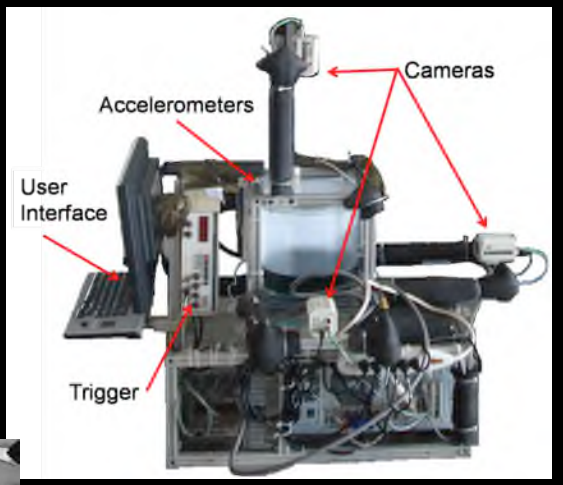
Overview

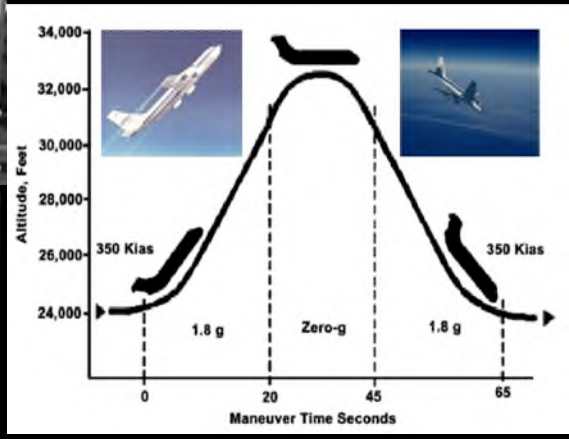

Hood
Slosh
Avionics Box
SPHERES
Camera
VERTIGO
Tank
0.44 m
(1.45 ft)
Backdrop
Frame Arm
Center Hub
0.45 m (1.48 ft)
1.06 m (3.5 ft)

Where we have been



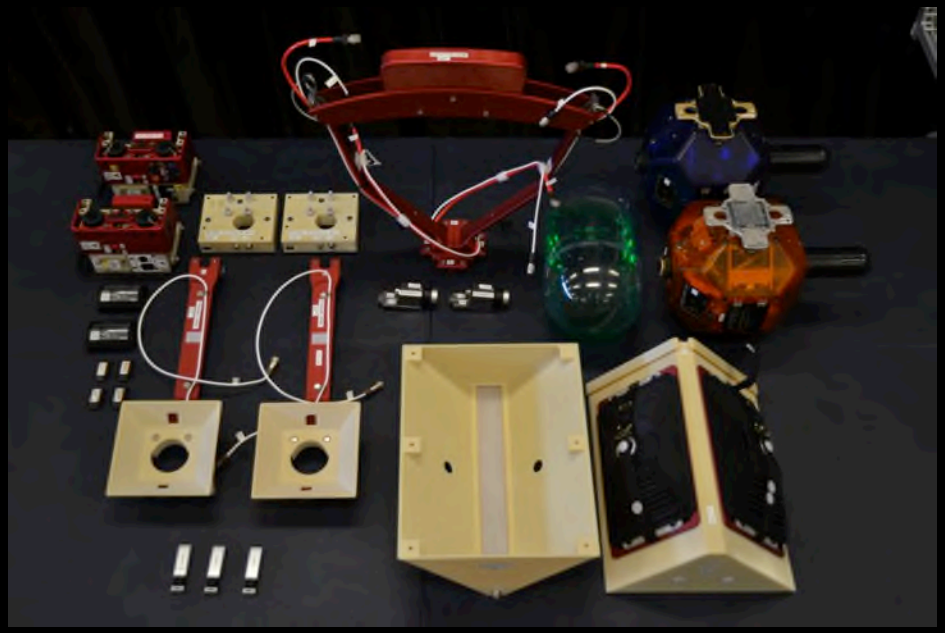


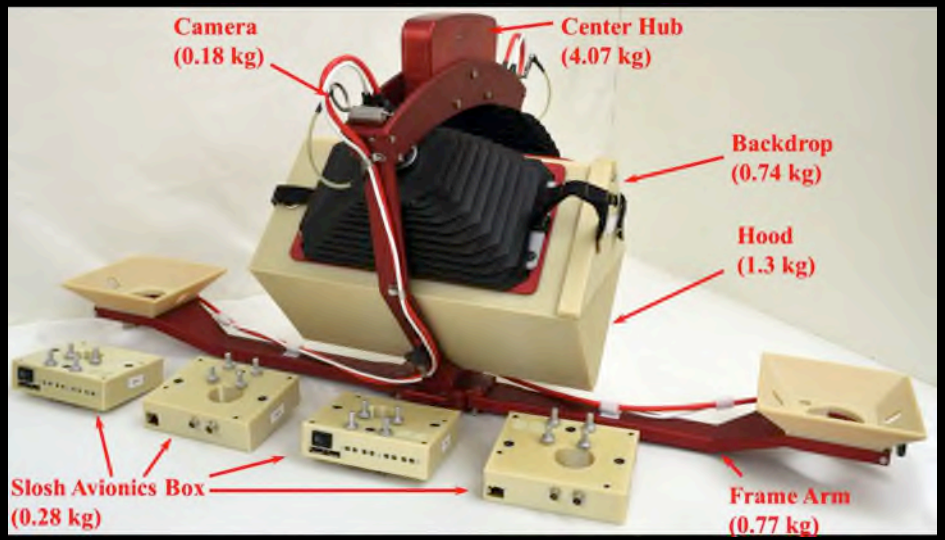




Student Participation

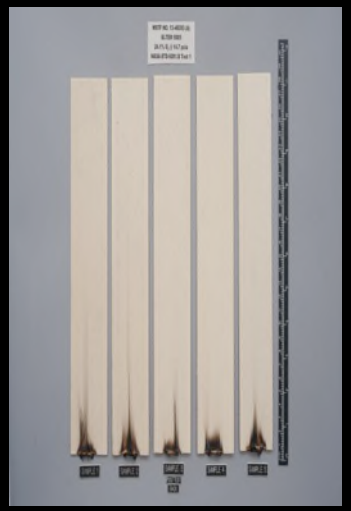
- Students at the Florida Institute of Technology (FIT) designed and fabricated the entire experiment
  - Machined all aluminum parts
  - Used CAD to design all 3D printed components
  - Fabricated all custom cabling
  - Designed all custom printed circuit boards used in the avionics boxes
  - Ran analyses for ISS safety certification





Qualification testing

- ISS Safety Testing
  - Vibration testing
    - Qualtest, inc. (Orlando, FL)
    - Tested in stowed configuration
  - Electromagnetic Compatibility testing
    - MSFC EMI test facility
    - Full unit tested along with two SPHERES ground units
  - Offgass testing
    - White Sands Test Facility
    - Tested all 3D printed materials
  - Flammability testing
    - White Sands Test Facility
    - Tested all 3D printed materials
  - Touch temperature testing
    - Florida Institute of Technology
  - Pressure testing
    - Florida Institute of technology



Launch

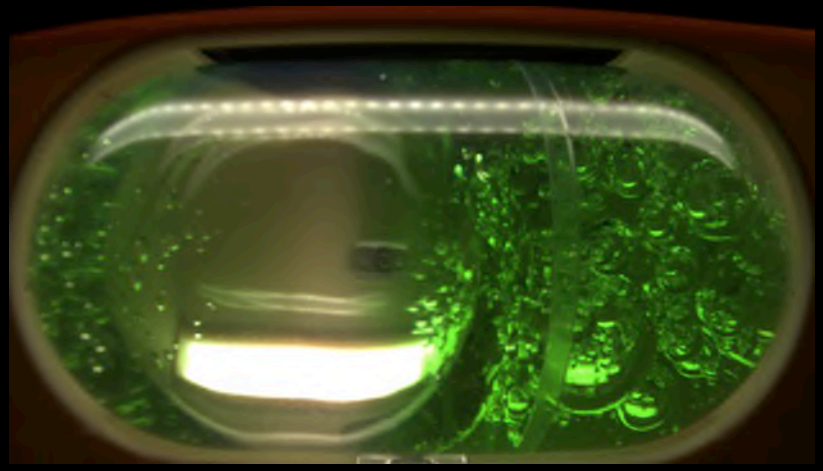
- Launch aboard the Orb-1 Commercial Resupply to Station mission
  - Launch Jan 09, 2014
  - Dock to ISS January 12, 2014
  - Launched on an Orbital Sciences Corp. Antares Launch Vehicle
  - Launched from Wallops Flight Facility
- First ISS cargo flight for this vehicle
- First 3D printed experiment aboard the ISS

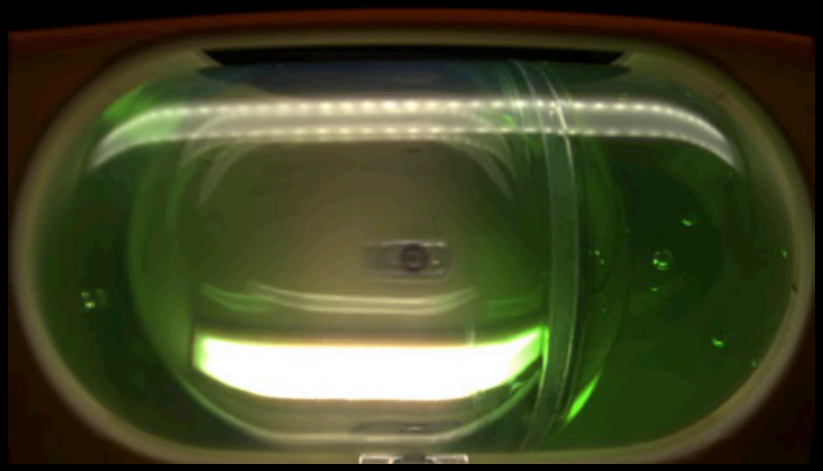
How to run the experiment

- Grab the experiment
- Power it up (2 switches)
- Place in center of the module
- Float over to computer
- Click on run
- Wait until maneuver is complete (~2 minutes)

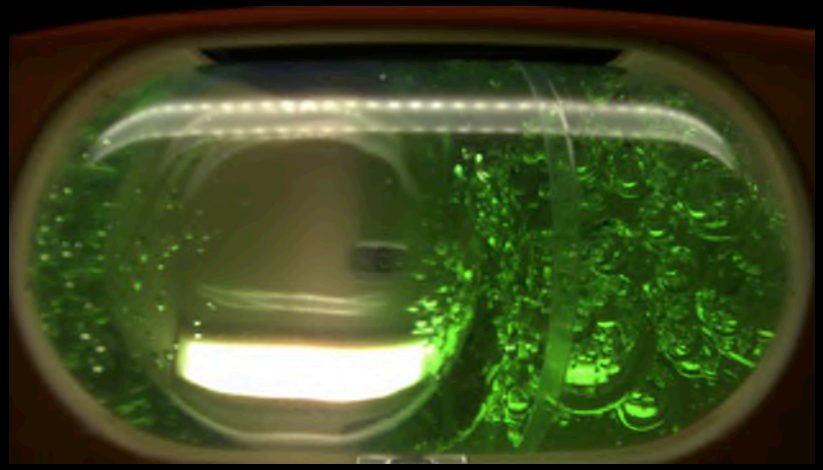
Science

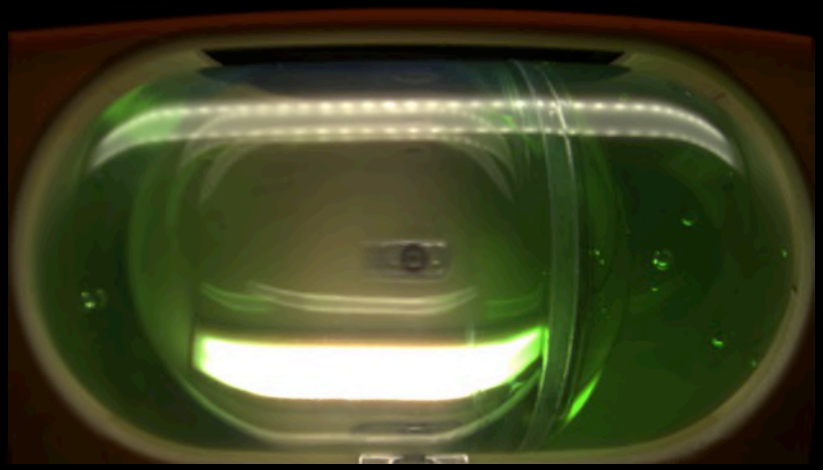
- Sessions completed to date
  - Checkout
  - Science #1
  - Science #2
  - Science #3
- Sessions take roughly 6 hours to complete
  - 2.5 hours for set-up
  - 1.5 hours for science
  - 2 hours for break-down





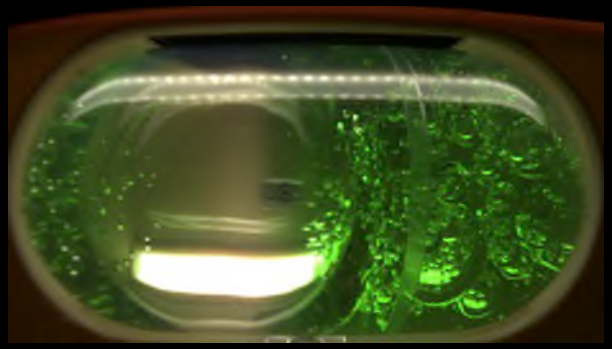
Initial Condition





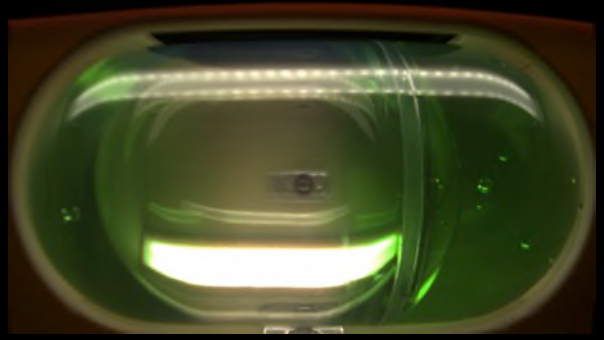
Initial Condition

Checkout



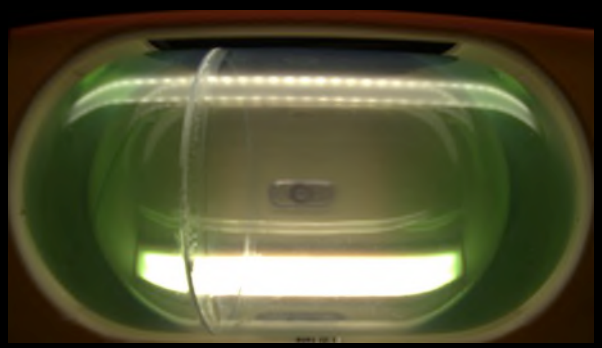
Bad initial condition

Science #1



Good initial condition
40%

Science #2



Good initial condition
20%

Liquids in Space

Conclusion

- Thank you very much for inviting me
- Good luck!