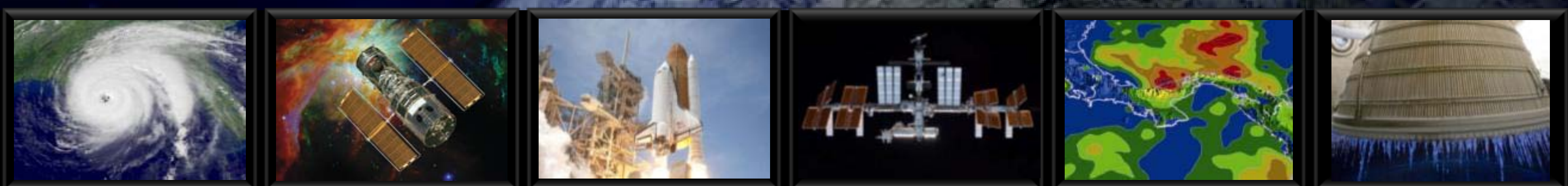
National Aeronautics and Space Administration

Marshall Space Flight Center

Launching the Future of Science and Exploration

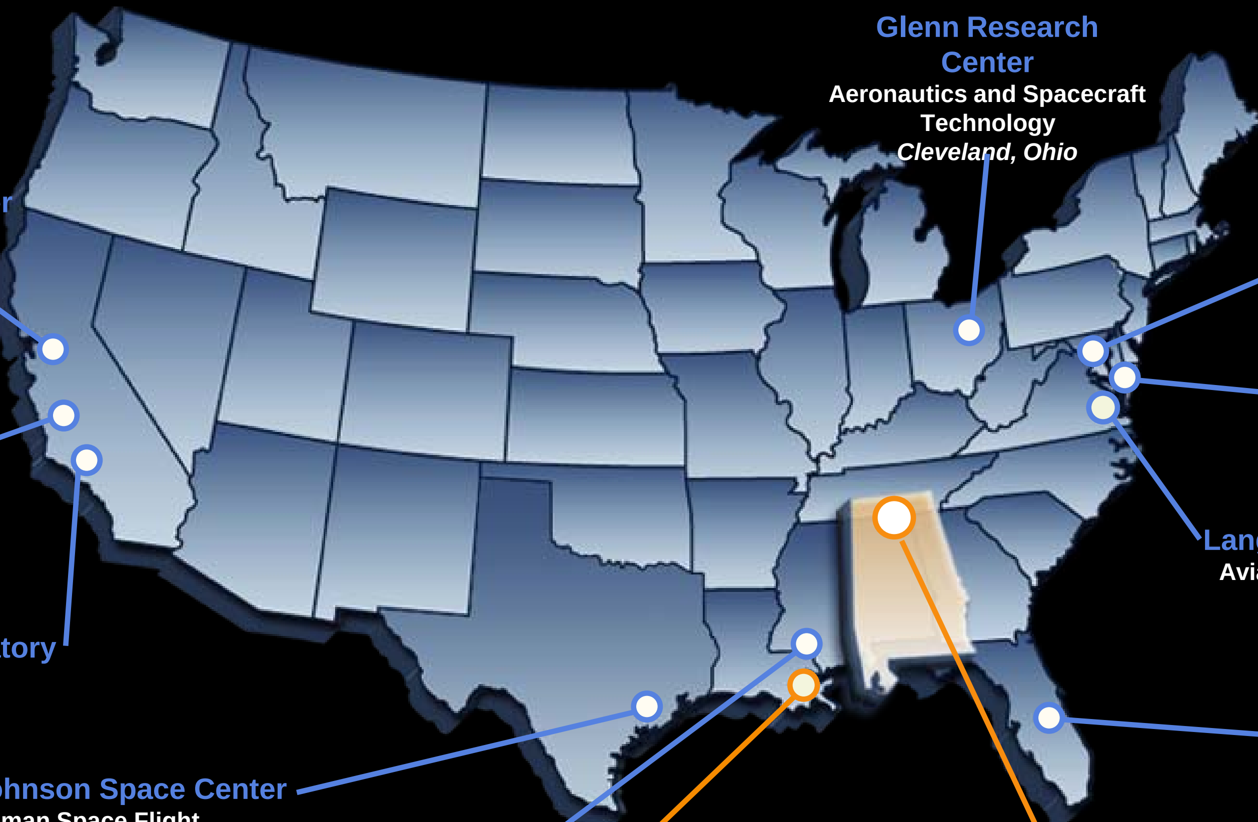


Alisa Shivers and Dr. Herbert Shivers

Alex City Kiwanis Club

August 5, 2010

NASA Around the Country



Ames Research Center
Aerospace and Small Spacecraft
Moffett Field, Calif.

Dryden Flight Research Center
Atmospheric Research and Testing
Palmdale, Calif.

Jet Propulsion Laboratory
Deep Space Robotic Rovers and Networks
Pasadena, Calif.

Johnson Space Center
Human Space Flight Operations
Houston, Texas

Stennis Space Center
Shuttle Engine Testing
Bay St. Louis, Miss.

Michoud Assembly Facility
Shuttle and Constellation Manufacturing
New Orleans, La.

Marshall Space Flight Center
Space Transportation, Systems, and Science
Huntsville, Ala.

Goddard Space Flight Center
Science Missions and Telescopes
Greenbelt, Md.

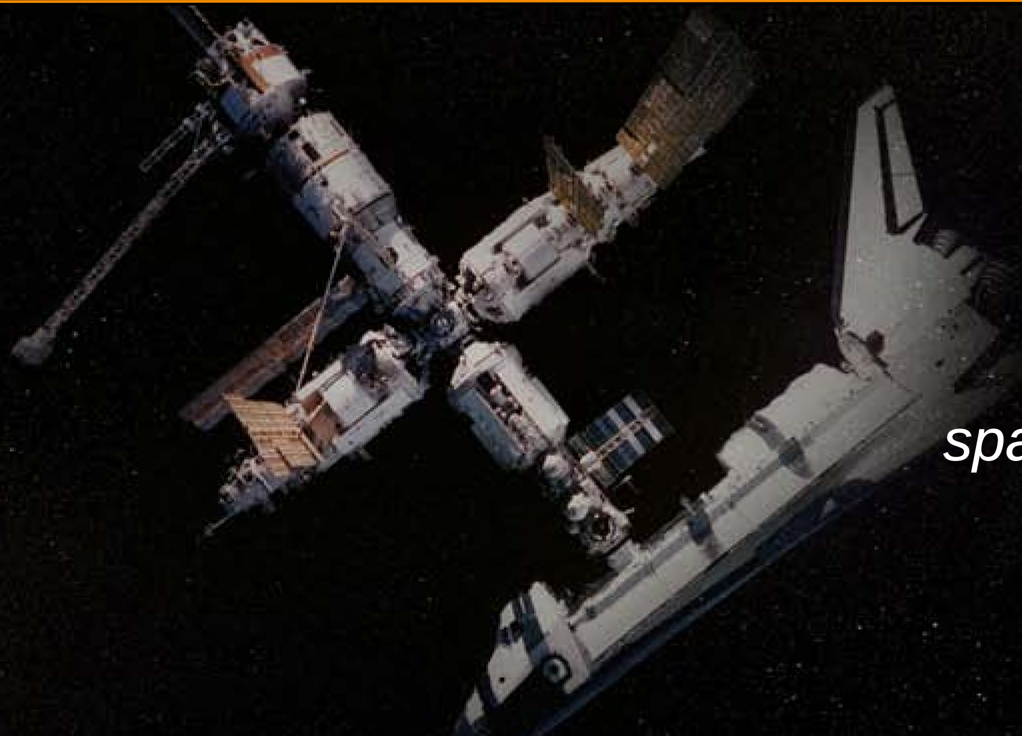
NASA Headquarters
Washington, D.C.

Langley Research Center
Aviation and Space Research
Hampton, Va.

Kennedy Space Center
Shuttle Launch and Landing
Cape Canaveral, Fla.

Marshall has a key role in NASA's mission.

Launching a Legacy



The link between science and space exploration began with the launch of Explorer I in 1958.

Explorer I

Apollo Launch

Spacelab

Space Shuttle

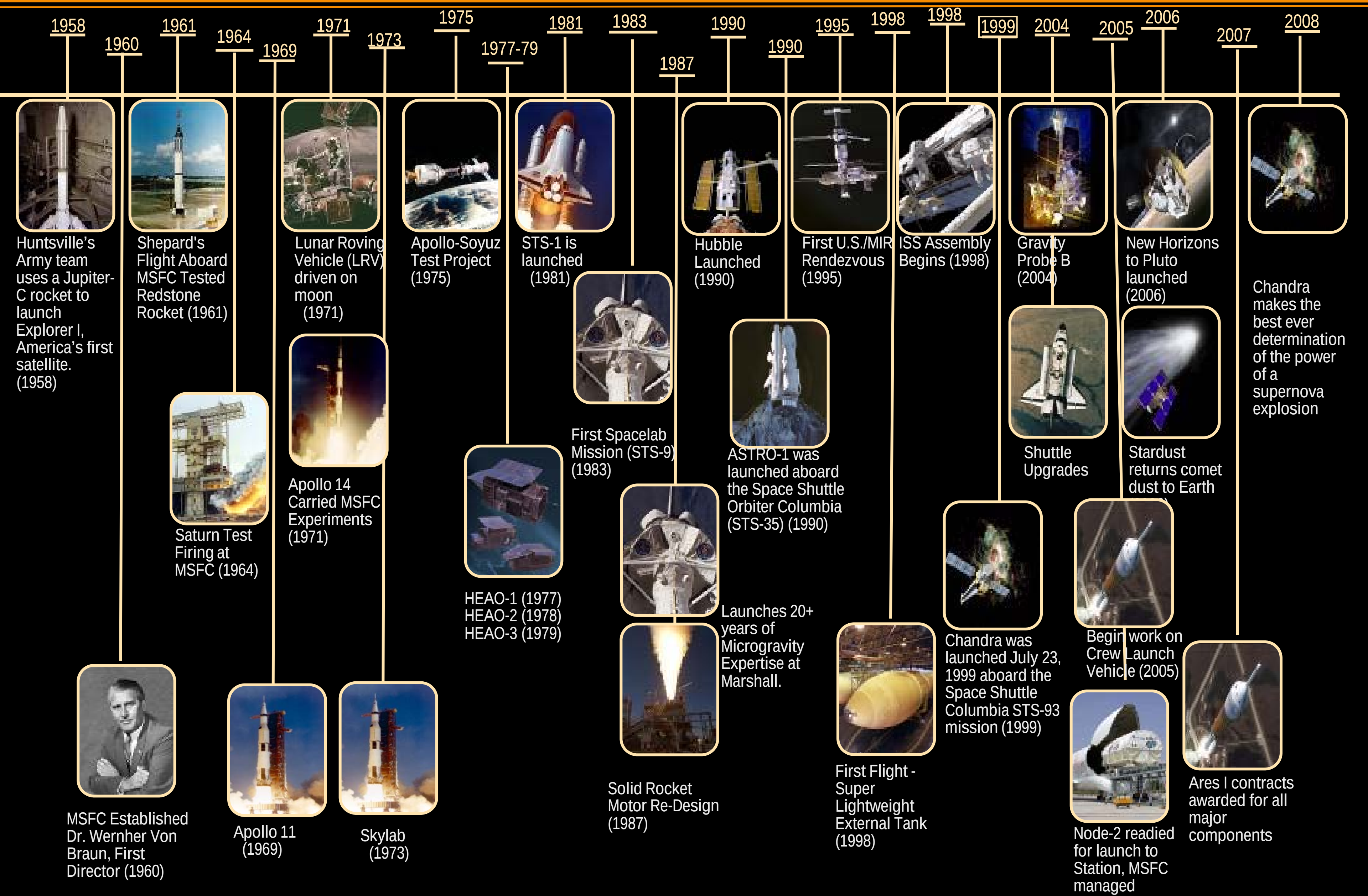
Andromeda Galaxy

Marshall: uniting science and exploration.

Marshall's Continuing Role in Space Exploration

Marshall Space Flight Center History

Proven history of end-to-end systems development and operations



Lifting from Earth

Lifting from Earth

Space Shuttle — Flying Since 1981

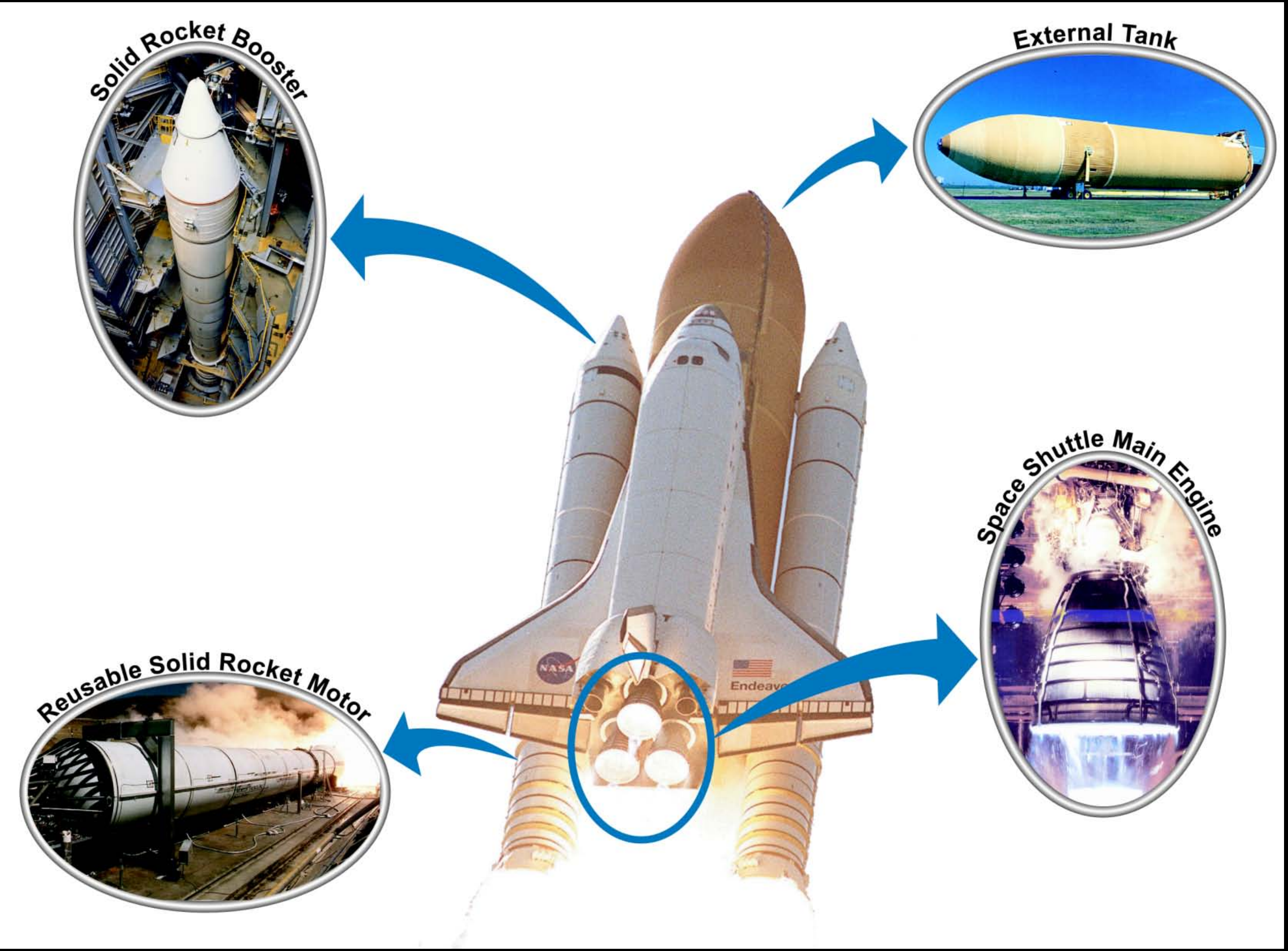
- Main engines, external tank, solid rocket boosters, payload operations
- Spacelab science transitioning to International Space Station (ISS) science for longer-term research
- Next launch: STS 133, scheduled for November.

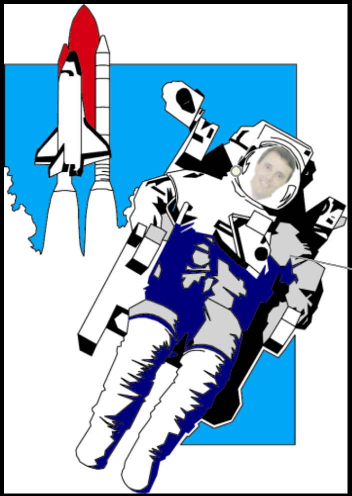
Our Next Mission STS 133

Launch Target:
4:33 p.m. EDT - Nov. 1, 2010
Orbiter:
Discovery
Mission Number:
STS-133
(133rd space shuttle flight)
Launch Window:
10 minutes
Launch Pad:
39A
Mission Duration:
11 days
Landing Site:
KSC
Inclination/Altitude:
51.6 degrees/122 nautical miles
Primary Payload:
35th station flight (ULF5),
EXPRESS Logistics Carrier 4 (ELC4),
Permanent Multi-Purpose Module (PMM)

NASA astronauts Alvin Drew and Nicole Stott, both mission specialists; Eric Boe, pilot; Steve Lindsey, commander; Michael Barratt and Tim Kopra, both mission specialists. Image credit: NASA

Space Shuttle Propulsion Systems





"Propulsion is what makes the Shuttle *GO!*"

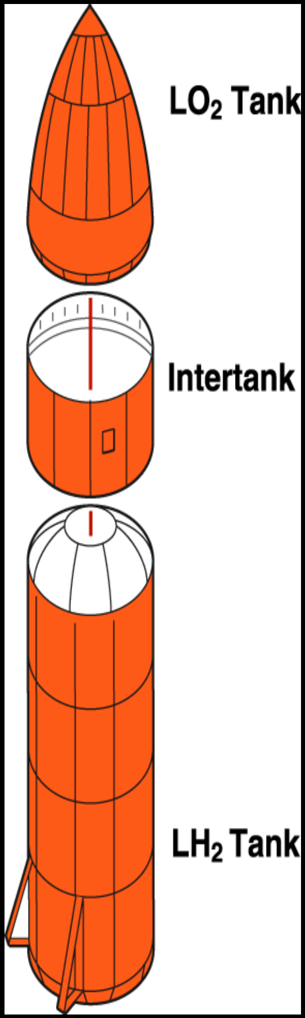
Space Shuttle Obiter Fact

The Orbiter is as long as 3 School Buses and wide as 1-1/2 School Buses

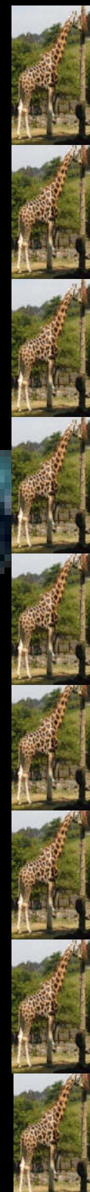
- The Orbiter carries the astronauts, tools, and satellites
- It can dock with the Space Station
- It comes back to Earth and lands like an airplane

Space Shuttle External Tank (ET) Amazing Facts

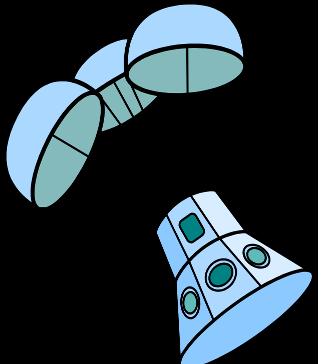
- Weighs 1.6 million pounds at liftoff: equal to 32,000 elementary school children or 107 elephants
- The ET holds the entire weight of the Space Shuttle.
- The ET is just a little bit thicker than a coke can.
- ET covered with spray-on foam insulation that keeps the LH_2 at –423° F even in the hot sun
- Only part of the Space Shuttle that is not reused

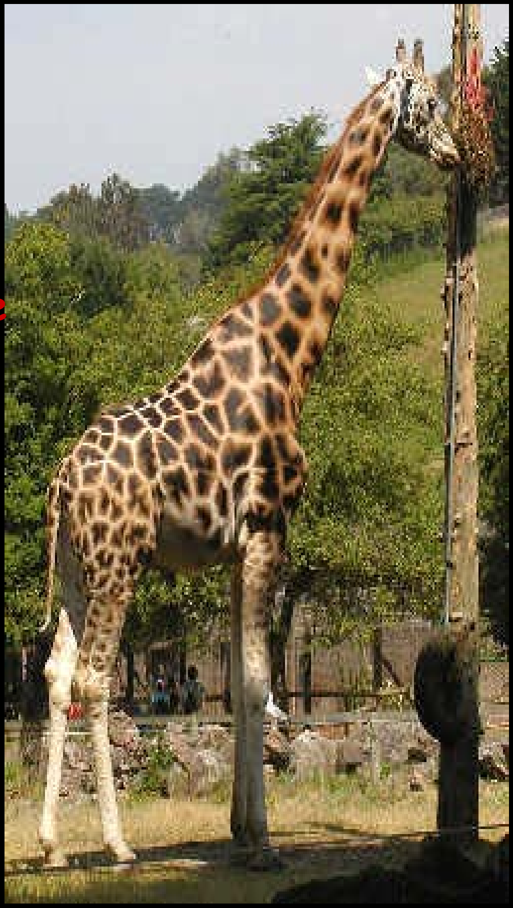


Reusable Solid Rocket Boosters Amazing Facts

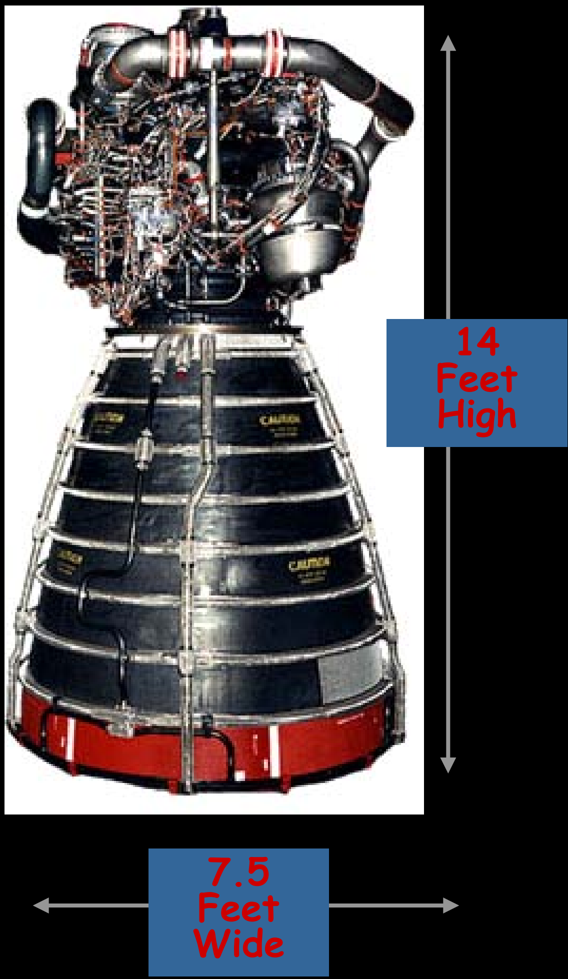


- World's largest solid rocket
- 149.1 feet high and 12.2 feet wide only 2 feet shorter than the Statue of Liberty or as tall as 9 giraffes standing on top or each other.
- Produces 2,658,000 pounds of thrust at liftoff
- Boosters go to full power in 2/10th of a second
- Heaviest object to parachute to Earth. Splash down in Atlantic Ocean.
- Boosters are recovered and
- reused.





Space Shuttle Main Engine Amazing Facts



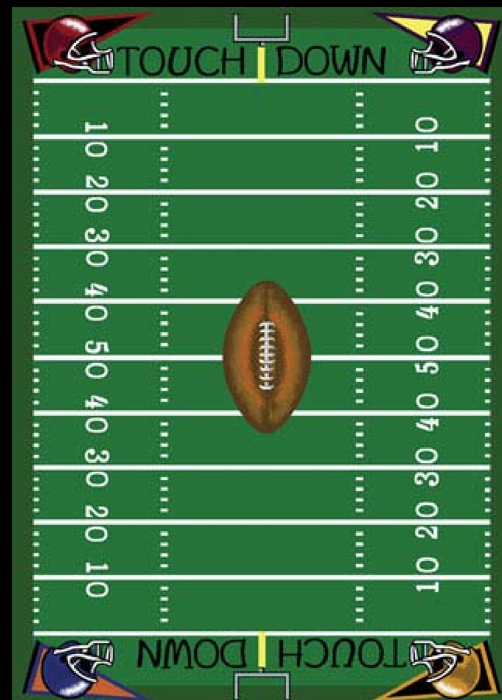
- There are  Space Shuttle Main Engines.
- Operate for 8 minutes, 40 seconds for each flight
- They use so much fuel they could drain a swimming pool in 28 seconds!

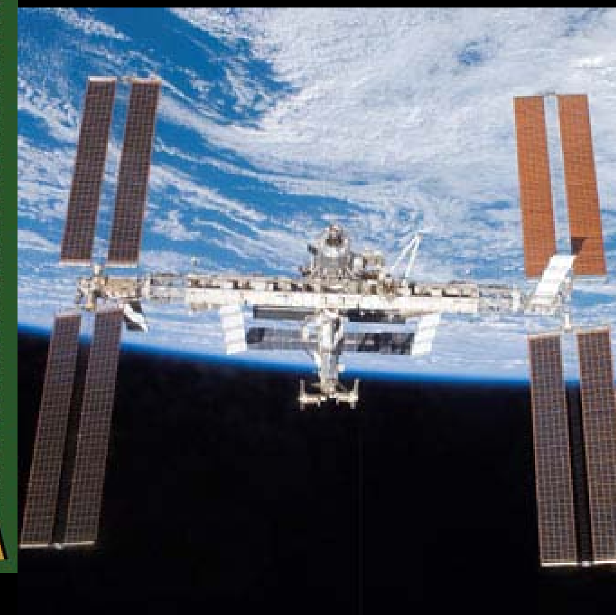
- Engine operates at temperatures from -423° F (liquid hydrogen to cool engine) to 6,000° F (hotter than the boiling point of iron!)

Nationwide Shuttle Team

Space Shuttle and the International Space Station

- The International Space Station (ISS) began assembly in 1998.
- The ISS circles the Earth every 90 minutes.
- The first crew arrived in 2000.
- The Space Shuttle is the primary vehicle for delivering ISS components to space for assembly.
- The Space Shuttle also delivers supplies and crews to the station and returns crews to Earth.
- There have been 34 Space Shuttle flights to the ISS.
- The ISS currently weighs ~1million lbs and is ~356 feet wide, ~290 feet long, and ~143 feet high.





Technologies/Materials Originally Developed For the Space Program…Cool Stuff!

- Edible Toothpaste
- Joystick Controllers
- Ski Boots
- Smoke Detector
- Aerodynamic Bicycle Wheels
- Thermal gloves and boots
- Bar Coding
- Space Pens
- Vision Screening System

- Shock Absorbing Helmets
- Ear Thermometer
- Cordless Tools
- Fire Fighter Equipment
- Failsafe Flashlight
- TV Satellite
- Invisible Braces
- Sun Tiger Glasses
- Medical Imaging

http://www.sti.nasa.gov/tto/Spinoff2009/index.html

Astronauts Come From All Over!

Astronauts come from all walks of life, all different parts of the country…there are even astronauts from Alabama!

So don't think that just because you're growing up in Alabama that space is beyond *your* reach!

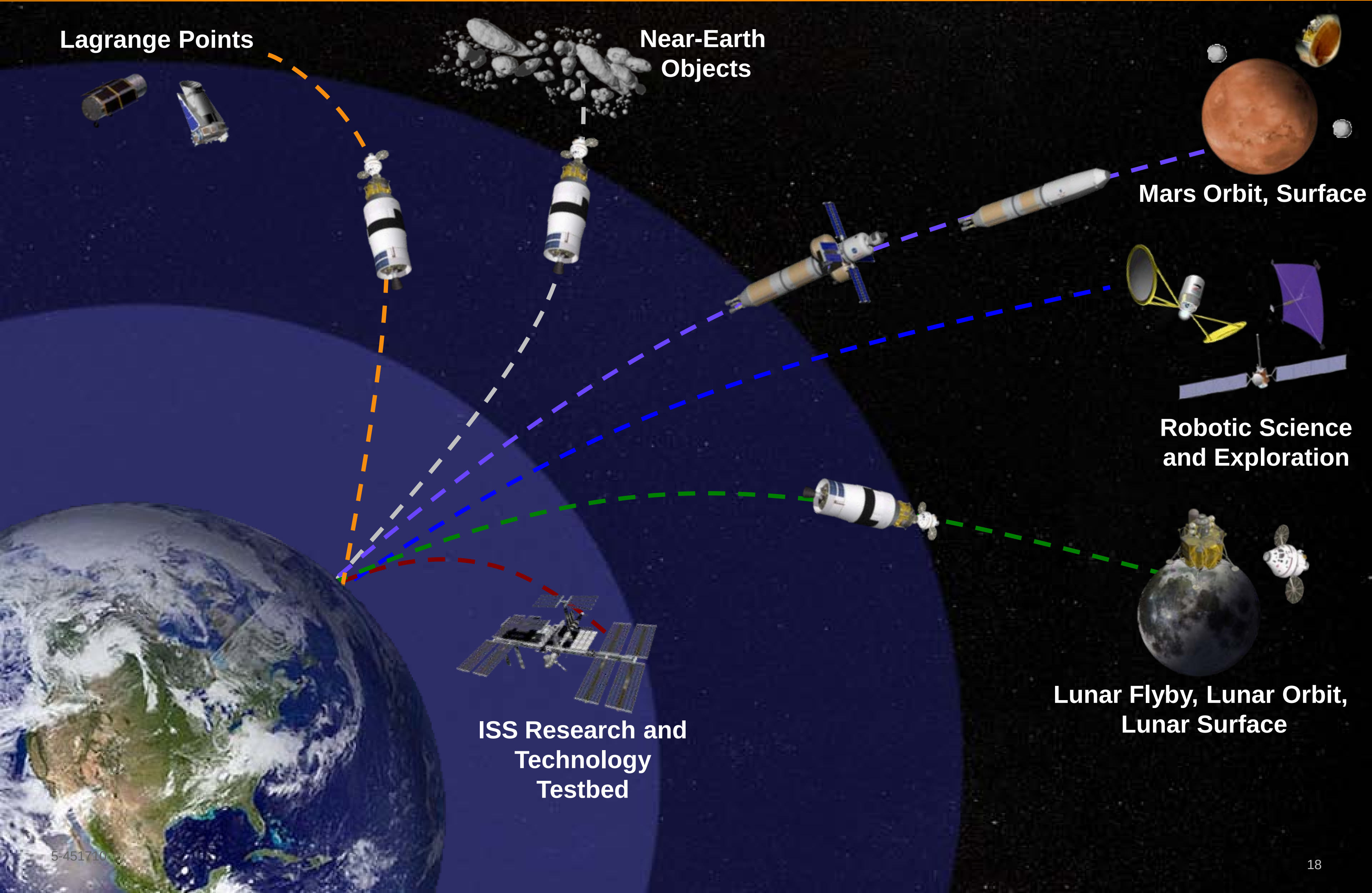
AUBURN TIGERS

Jan Davis	Tom Mattingly
Jim Voss	Hank Hartsfield
Kathy Thornton	Clifton Williams

BAMA

James (Vegas) Kelly

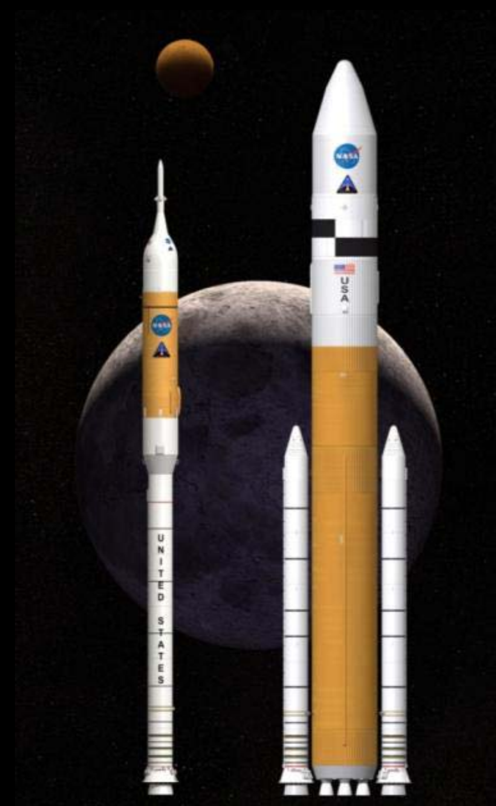
Potential Future Missions and Example Technologies



Lifting from Earth

Leveraging shuttle experience for future transportation systems

- Common boosters, upper stage engines, manufacturing, subsystem technologies, and ground facilities are all extended into building future launch vehicles.
- While we are in transition, Marshall's capabilities, and facilities are applicable and critical to future missions



Significant Accomplishments

First Stage

- Design and test – First Stage recovery systems
- Suborbital I-X first stage provided by Ares

Upper Stage

- World-class manufacturing capabilities for large, complex tanks
- Successful Flight Software Preliminary Design Review (PDR)

Upper Stage Engine

- Upper Stage Engine Test Stand A-3 structure complete
- Major gas generator and power pack testing complete

Vehicle Integration and Flight & Integrated Test

- 7,000+ hours wind tunnel testing, covering entire Mach range (Ares I flight)
- Ares I elements at or beyond PDR; upper stage engine at Critical Design Review (CDR)

Ares I wind tunnel preparation

Test Stand A-3 structure

Parachute test

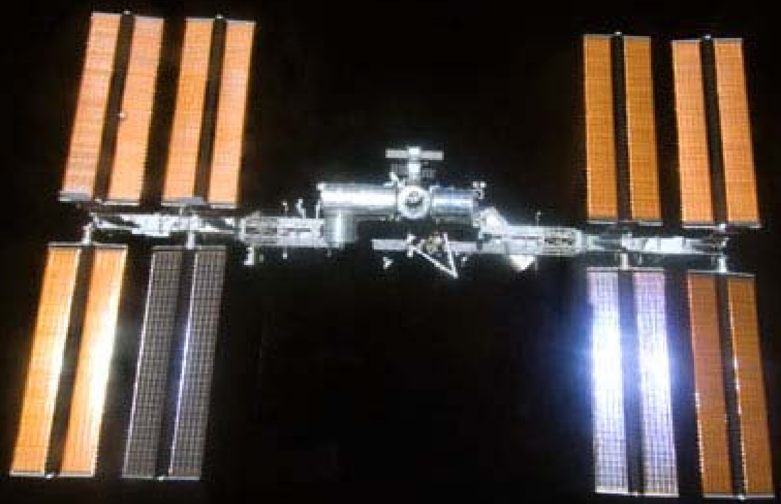
Ares I-X SRB test

Dome welding facility

Living and Working in Space

Systems and Facilities Support

- Continual human presence since 2000
- Node 2 (connector module)
- Node 3 (life support module)
- Cleaning air and recycling water
- Radiation hardened electronics



ISS Test Facility
at Marshall

Node 3
Tranquility

Environmental
Control & Life Support

Delivery of the ISS
cupola window

Working in space

Developing systems that support crews living and working on the ISS

Living and Working in Space

Science Operations, Hardware and Experiments Support

- Manage science operations around the clock
- Window Observational Research Facility
- Microgravity Science Glovebox
- Materials Science Research Rack

Payload Operations Center at Marshall

WORF – Window Observational Research Facility

EXPRESS Racks for Destiny Module

Microgravity Science Glove Box

Materials Science Research Racks

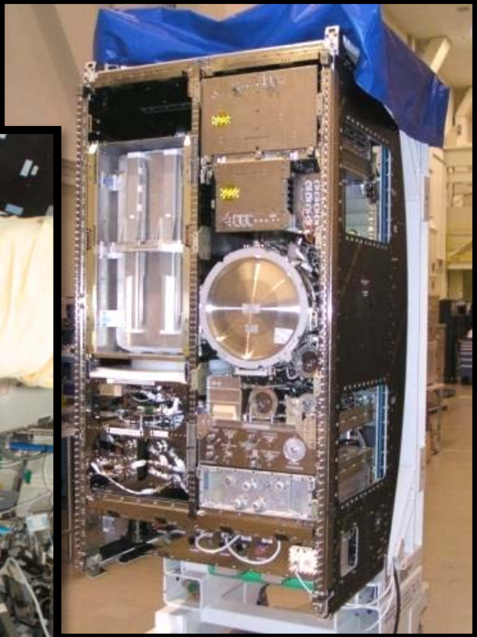
Making ISS science experimentation possible

Living and Working in Space

Materials Science Research Rack (MSRR)

Basic materials research

- New or improved materials
- New applications for existing materials
- Accommodates diverse material types:
    - metals
    - alloys
    - polymers
    - semiconductors
    - ceramics
    - crystals
    - glasses



Crew installs the Materials Science Research Rack-1 in the ISS Destiny laboratory (9/09).

Understanding Our World

Environmental Monitoring

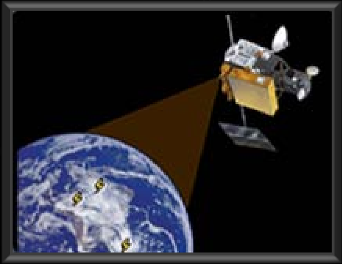
- Understanding climate change and weather patterns

Weather Prediction

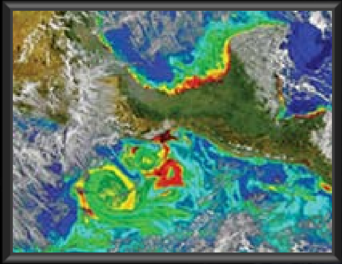
- Improving forecasts and weather warning times

Hurricane Research

- Predicting the intensity and dynamics of storms



Global Hydrology & Climate Center



HIRAD

SPoRT

SERVIR

Environmental Monitoring

Marshall Earth Science – improving our lives and our planet.

Understanding Worlds Beyond

Learning about our universe

- Scientific instruments to reveal information about activity in deep space
- Management, design and construction

Learning about our solar system

- Spacecraft to study and analyze the sun, planets, comets and asteroids
- Program management and instrument development

Chandra

James Webb Space Telescope

Discovery/ New Frontiers

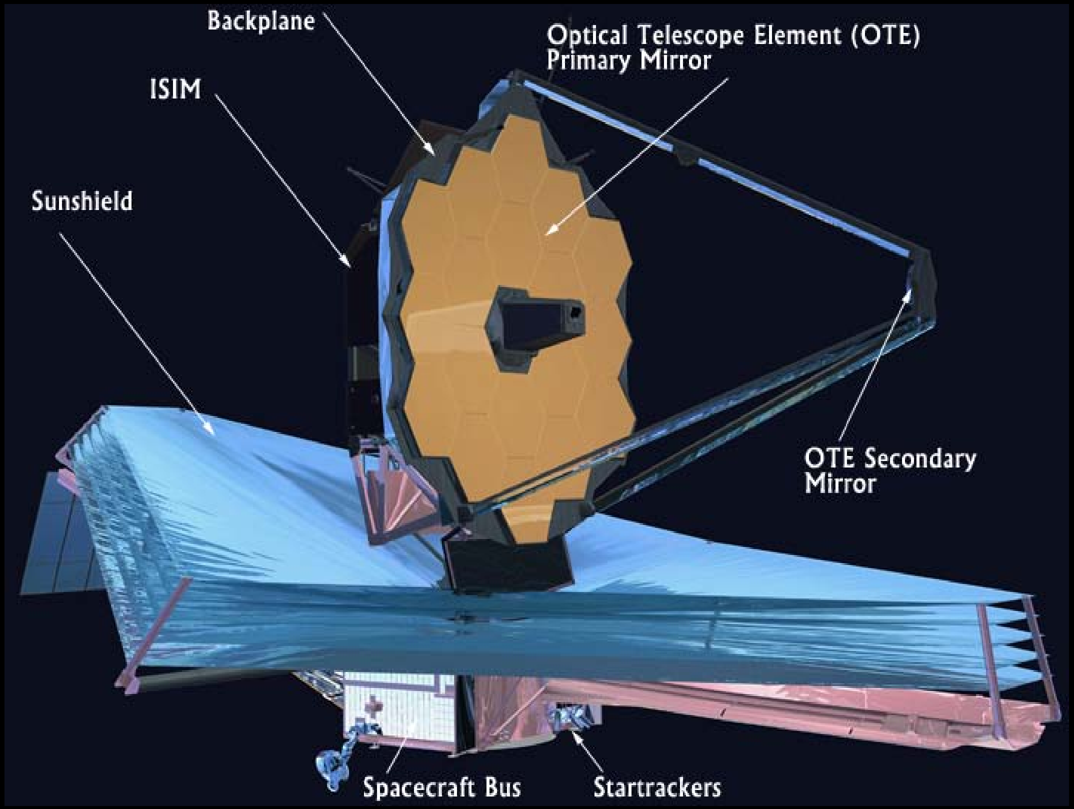
HINODE

LCROSS

Marshall scientific discoveries uncover mysteries about our moon, solar system, and universe.

Understanding Worlds Beyond

James Webb Space Telescope
Optical Testing at Marshall's X-Ray & Cryogenic Facility



- Optical measurements are made of the surfaces of all 18 primary mirror segments and one development unit to verify:
  - Ability of the mirror segments to resist physical change in extreme temperature
  - The optical figure of the mirror segments at space operating temperatures (-400º F)

JWST testing at Marshall will continue through summer 2011

From Exploration to Innovation

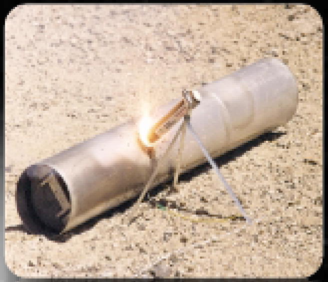
From clean water
on the space station
to clean water
in remote areas

From lunar robotics to
life-saving tools
for soldiers

From mechanical engineering
of propulsion systems to
faster rehabilitation

Marshall's technology and innovation benefit life on Earth.

From Exploration to Innovation



From fueling rocket engines
to defusing land mines

From space satellite imagery
to crime-solving imagery

Marshall's technology and innovation benefit life on Earth.

Inspiring the Next Generation

- Educational outreach programs
  - Great Moonbuggy Race
  - Student Launch Initiative
- Visitor Information Center at the U.S. Space & Rocket Center
  - Home of Space Camp
  - Historic Artifacts
  - Interactive Exhibits





Inspiring a new generation through education and outreach.

Space Economy

- Infrastructure
- Applications
- Transactions
- Commerce

Video to Photo

GPS

Eye Power

Climate Monitoring

HEALS

A full array of economic & scientific benefits derived from the exploration and utilization of space.

From Exploration to Opportunity

$2.88 billion (FY2009)
impact to
Alabama economy

Approximately 7,000
(civil service and
contractor employees)

4.5 million square feet
of space occupied
in Huntsville

2nd largest employer
in the Huntsville -
Madison County area

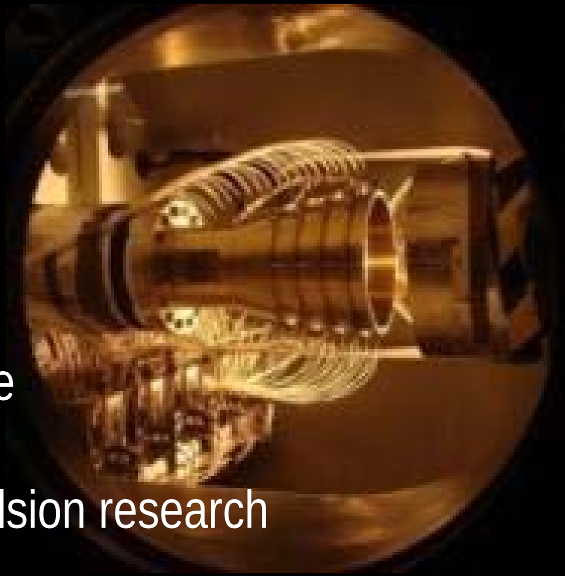
$2.9 Billion
FY2010 MSFC Budget
Submit to OMB
FY2011 Center Allocations TBD

2.2 million square feet
of manufacturing space at
Michoud Assembly Facility

Marshall is an engine of opportunity.

New Program Assignments

Heavy Lift and Propulsion Research and Development Program Office



- $559M in FY11 and 3.1B over five years
- Broad scope of R&D activities to support next-generation space launch propulsions technologies
- Target R&D activities include new approaches to first-stage launch propulsion; in-space advanced engine technology development and demonstrations; and foundational propulsion research

Exploration Robotic Precursor Program (XPRP) Program Office

- Approximately $105 M in FY11 and $2.6 B over five years
- New program will send robotic precursor missions to the Moon, Mars, and its moons, Lagrange points, and nearby asteroids to scout targets for future human activities

New Program Assignments

Space Technology Demonstrations Program Office

- $75M in FY11 and 1.4B over five years
- Program will support and oversee flight testing of crosscutting aerospace technologies
- Focus is the execution of space flight demonstrations, including designing the test flight program, building the hardware, and performing a mission

Centennial Challenges Program Office

- $10M in FY11 and $50M over five years
- Prize program will seek innovative solutions to technical problems that can drive progress in aerospace technology
- Will encourage participation from independent teams, individuals, student groups, and private companies

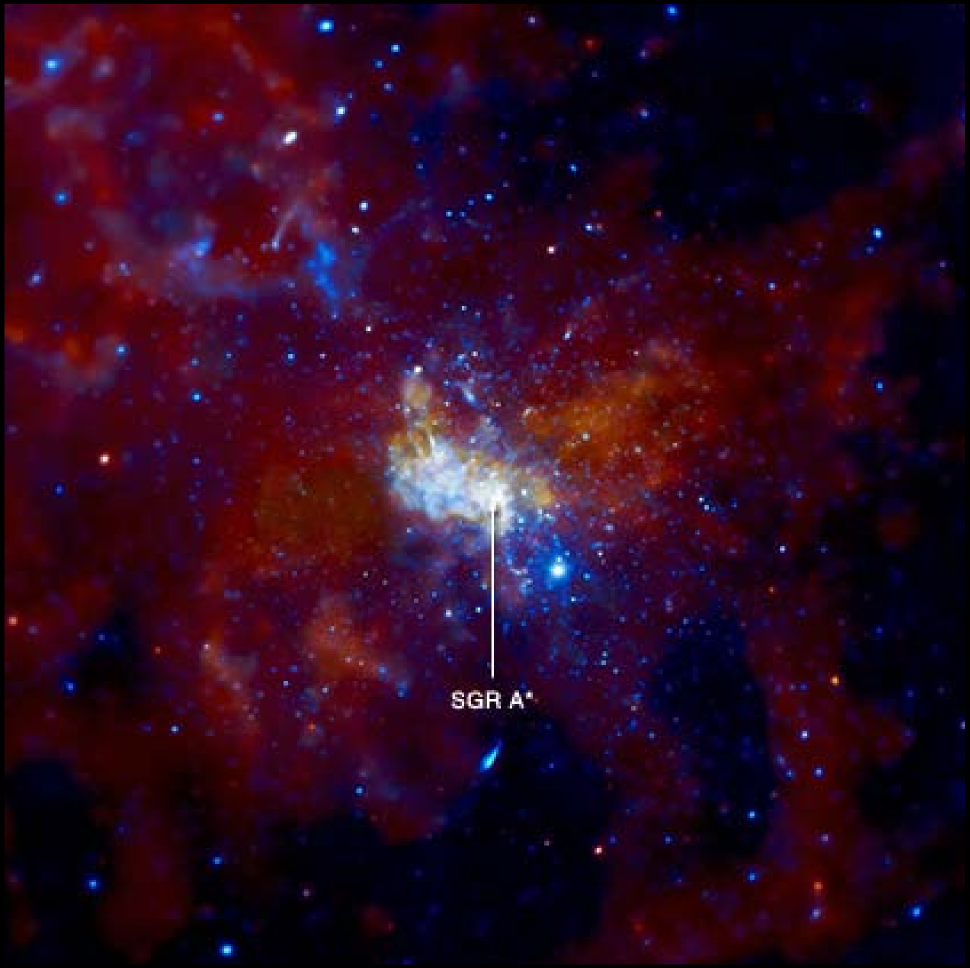
Education: NASA Can, and Must, Make A Difference

NASA relies on well-educated U.S. citizens to carry out its far-reaching missions of scientific discovery that improve life on Earth

- The Cold, Hard Facts
  - Many U.S. scientists, engineers, and teachers are retiring
  - Fewer high school seniors are pursuing engineering degrees
  - China produces 6 times more engineers than the U.S.
- The Stakes Are High
  - U.S. students score lower than many other nations in math, science, and physics
  - We spend over $440 billion on public education, more per capita than any country except for Switzerland
- Potential Solutions: Well-Qualified, Motivated Teachers and a National Commitment
  - The highest predictor of student performance is teacher knowledge
  - The teacher's passion for the subject transmits to students
  - Education is the foundation of NASA's and the nation's success as a technological enterprise

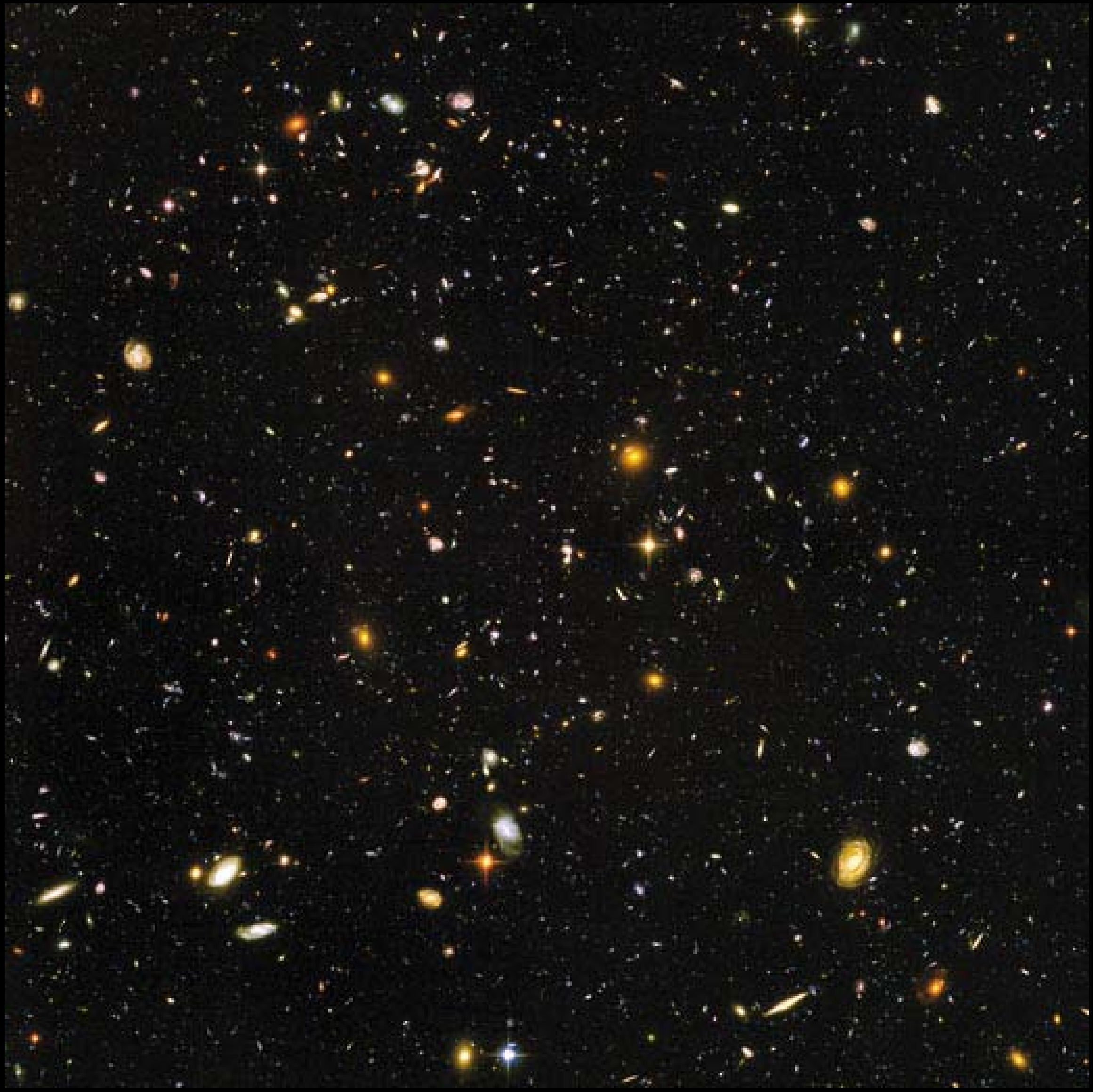
Composite of Galaxy with Black Hole
Hubble, Chandra, and Very Large Array, March, 2010

Sagittarius A, Chandra , 2010



"Pillars of Creation," 1995, Hubble

ULTRA DEEP FIELD, HUBBLE, 2004



Back ups

ISS Quick Look:

November 20, 1998 First Element Launch (Zarya) atop a Russian Proton launcher
Nov. 2, 2000 START OF PERMANENT HUMAN PRESENCE ON ISS (EXP. 1)
May 2009 At 7:34 a.m CDT on 5/29/09, ISS crew increased from three to six
Visitors: 193 different people representing 15 countries (through STS-131 arrival) (includes "newest" visitors Naoko Yamazaki, Dottie Metcalf & Jim Dutton)
"Firsts" aboard from 15 countries
1-USA (Robert Cabana) 7-South Africa (Mark Shuttleworth) 13-Sweden (Christer Fuglesang
2-Russia (Sergei Krikalev) 8-Belgium (Frank De Winne) 14-Malaysia (Muszaphar Shukor)
3-Canada (Julie Payette) 9-Spain (Pedro Duque) 15-South Korea (So-Yeon Yi)
4-Japan (Koichi Wakata) 10-Netherlands (Andre Kuipers)
5-Italy (Umberto Guidoni) 11-Brazil (Marcos Pontes)
6-France (Claudie Haignere) 12-Germany (Thomas Reiter)

Down-to-Earth Comparisons

• The ISS effort involves more than 100,000 people in space agencies and at 500 contractor facilities in 37 U.S. states and in 16 countries. That's almost half of the entire population of North Dakota.
• Building the ISS in space is like trying to change a spark plug or hang a shelf, wearing roller skates and two pairs of ski gloves with all your tools, screws and materials tethered to your body so they don't drop.
• Living and working on the ISS is like building one room of a house, moving in a family of three and asking them to finish building the house while working full time from home.

Spacecraft Comparisons:

Celebrating 48 years of Americans in orbit – Feb.20, 1962 – November 2009 (and continuing)

STEPPINGSTONES AND BRIDGES

From MERCURY to the INTERNATIONAL SPACE STATION

MERCURY/ATLAS 6 (J. Glenn) SPACE SHUTTLE SPACE STATION (ISS)

Length: 6 ft, 10 inches 122 feet 240 feet (pressurized)

Width: 6 ft, 2 ½ inches 78 feet (wingspan) 357 feet (end-to-end)

Height: N/A 56 feet 45 feet

Volume: 50 cubic feet 2,600 cubic feet 29,561 cubic feet

Weight: 3,500 pounds 200,000 pounds 815,703 pounds

Computers: 0 5-10 (incl pyld laptops) 52 (incl pyld laptops)

Flight: 4 hrs, 55 min, 23 sec 12 days (average

ISS at Completion

- The ISS solar array surface area could cover the U.S. Senate Chamber three times over.
- ISS eventually will be larger than a five-bedroom house.
- ISS will have an internal pressurized volume of 33,023 cubic feet, or equal that of a Boeing 747.
- The solar array wingspan (240 ft) is longer than that of a Boeing 777 200/300 model, which is 212 ft.
- Fifty-two computers will control the systems on the ISS.
- More than 80 space flights will have been conducted on five different types of launch vehicles over the course of the station's construction.
- More than 100 telephone-booth sized rack facilities can be in the ISS for operating the spacecraft systems and research experiments
- The ISS is almost four times as large as the Russian space station Mir, and about five times as large as the U.S. Skylab.
- The ISS will weigh almost one million pounds (925,627 lbs). That's the equivalent of more than 320 automobiles.
- The ISS measures 357 feet end-to-end. That's equivalent to the length of a football field including the end zones (well, almost – a football field is 360 feet).
- 2.6 million lines of software code on the ground supports 1.5 million lines of flight software code.
- 8 miles of wire connects the electrical power system.
- In the International Space Station's U.S. segment alone, 1.5 million lines of flight software code will run on 44 computers communicating via 100 data networks transferring 400,000 signals (e.g. pressure or temperature measurements, valve positions, etc.).
- The ISS will manage 20 times as many signals as the Space Shuttle.
- Main U.S. control computers have 1.5 gigabytes of total main hard drive storage in U.S. segment compared to modern PCs, which have 20-40 gigabyte hard drives.
- The entire 55-foot robot arm assembly will be able to lift 220,000 pounds, which is the weight of a Space Shuttle orbiter.
- The 75 to 90 kilowatts of power for the ISS is supplied by an acre of solar panels.

Improving Lives Through Space Exploration