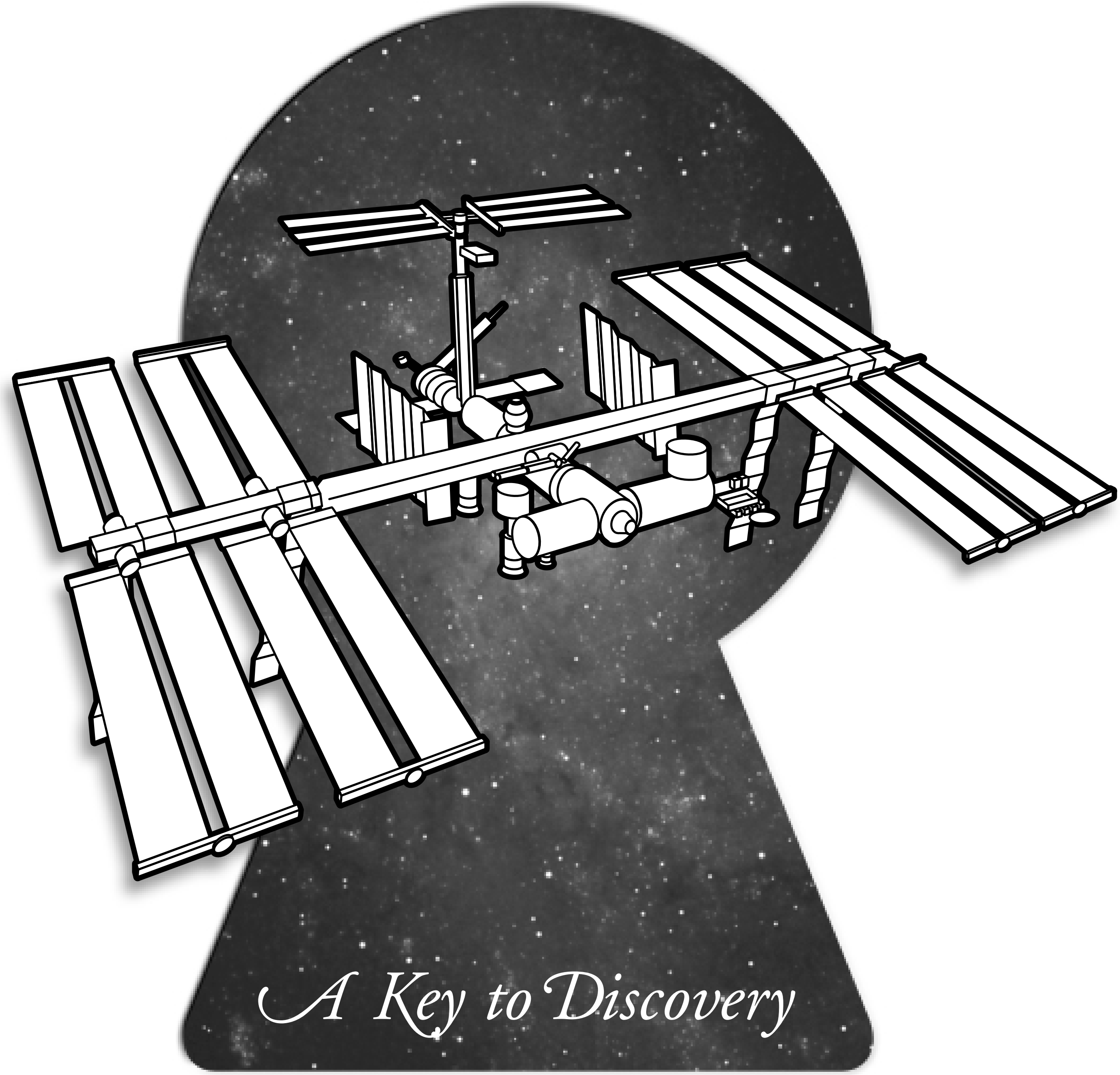


The International Space Station Fact Book

National Aeronautics and Space Administration

http://spaceflight.nasa.gov

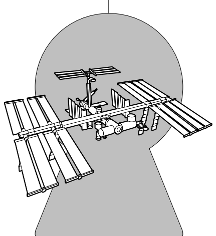
October 2000

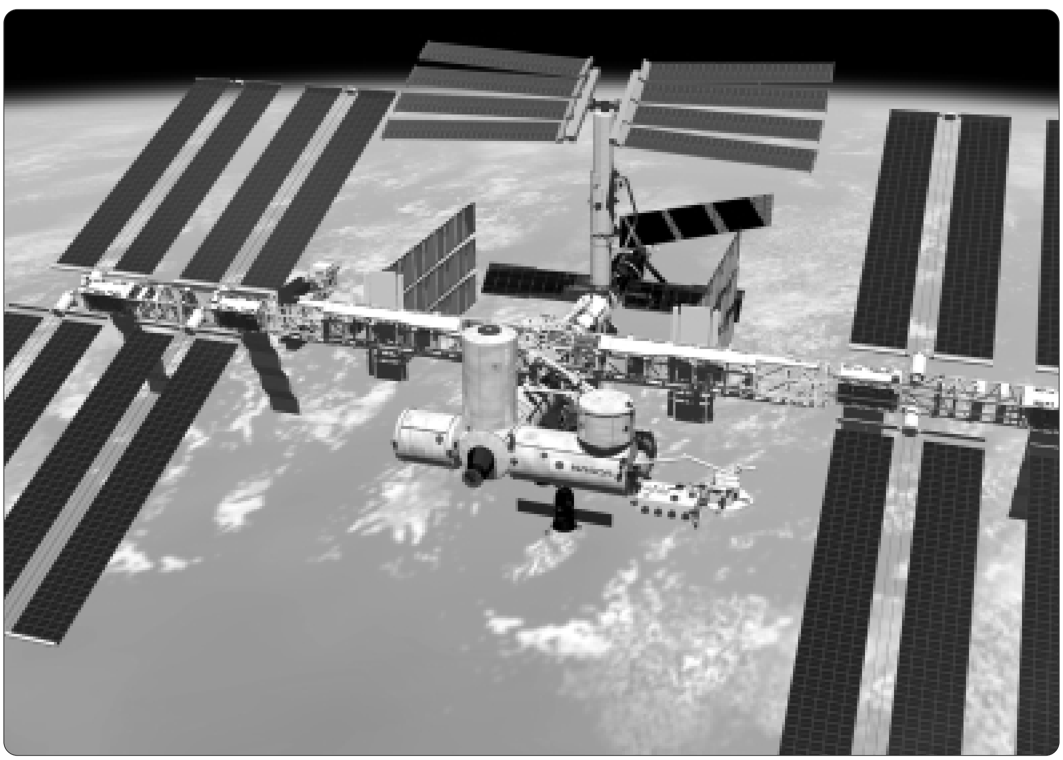
The exciting thing is that we
don't *know what lies beyond*
the unopened door . . . and each
door will open to many more
doors . . . each answer leading
to many more questions . . .
that is discovery.

$G_{\mu\nu} = \kappa T_{\mu\nu}$
NASA
International Space Station
A Key to Discovery

Why the ISS? It's about life on Earth . . . and beyond!

Exploration	The International Space Station (ISS) is an exciting gateway to new frontiers in human space exploration, meeting the deep-seated need of men and women throughout history to explore the unknown, to understand their world and the universe, and to apply that knowledge for the benefit of all here on Earth.
Leadership	The ISS sustains U.S. leadership in exploration and use of outer space that has inspired a generation of Americans and people thoughout the world.
Research	The ISS is a unique world-class laboratory providing an international platform for advances in science and technology.
Business	The ISS provides a stunning opportunity to enhance U.S. economic competitiveness and create new commercial enterprises.
Education	The ISS serves as a virtual classroom in space to the benefit of educators and students alike.





This artist's concept shows the International Space Station when its assembly sequence is completed in 2006. The 1 million pound station will have a pressurized volume equal to two jumbo jets and an acre of solar panels.

Facts and Figures

The Station:

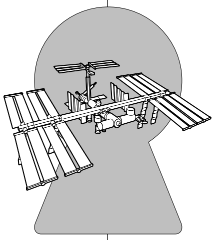
■ Wingspan Width:	356 feet (108.5 meters)
■ Length:	290 feet (88.4 meters)
■ Mass (weight):	About 1 million pounds (453,592 kilograms)
■ Operating Altitude:	220 nautical miles average (407 kilometers)
■ Inclination:	51.6 degrees to the Equator
■ Atmosphere inside:	14.7 psi (101.36 kilopascals) same as Earth
■ Pressurized Volume:	43,000 cubic feet (1,218 m^3) in 6 laboratories
■ Crew Size:	3, increasing to 7

Schedule Commitments:

- First Crew—Late 2000
- U.S. Laboratory—Mid 2001
- 7 person crew capability—January 2006 to November 2006 (range)

Total Program Costs:

■ Cost through 7 person crew capability*	$24.1–$26.4 B (range)
■ 10-year Operations Estimate	$13.0 B
■ Total Program Estimate	$37.1–$39.4 B (range)



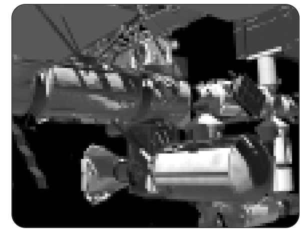
American Expenditure Statistics Compared to NASA Budget

American Consumer Expenditures**	**billions of dollars**
■ Tobacco products	66.0
■ Alcohol purchased for off-premise consumption	69.3
■ Clothing, accessories, and jewelry	397.2
■ New autos	97.3
■ Gasoline and oil	128.3
■ Airline	30.7
■ Recreation	534.9
FY 1999 NASA Budget (Total)	**13.7**
■ International Space Station	(2.3)
■ Space Shuttle	(2.9)
■ Science, Aeronautics, and Technology	(5.7)

* Estimate includes all costs (development, operations, and research) incurred through 7 person crew capability milestone.
** Source of information is the Department of Commerce Survey of Current Business, Personal Consumption Expenditures.

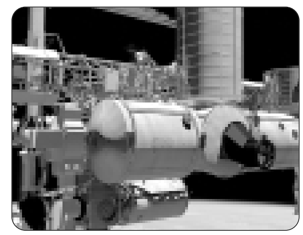
The International Space Station Fact Book

The ISS is an Earth-orbiting laboratory drawing upon the scientific and technological expertise of 16 cooperating nations: the United States, Canada, Japan, Russia, 11 member nations of the European Space Agency (ESA), and Brazil.

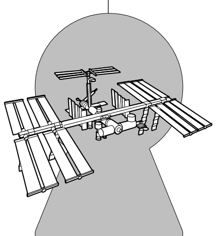


On the far left is the U.S. Lab, on the lower left is the X-38 crew return vehicle, and on the lower right is the U.S. Habitation module.

The pressurized living and working space aboard the completed ISS will be about the size of 3 average American homes (approximately 43,000 cubic feet). Its giant solar arrays will generate the electricity needed to power about 10 average American homes. An initial crew of three, increasing to seven when assembly is complete, will begin living aboard the ISS in late 2000. Inside the ISS its weightless environment will be maintained at "shirt sleeve" temperatures with atmospheric pressures similar to what we have here on Earth.



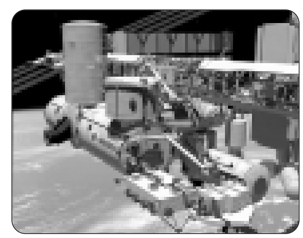
The European Space Agency's (ESA) Columbus Orbital Facility (COF) laboratory



Six main laboratories will house research facilities:

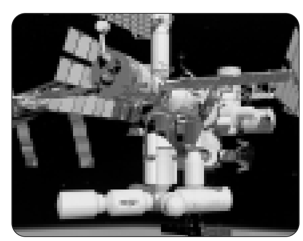
- Two U.S.—a laboratory module called "Destiny" and a Centrifuge Accommodations Module (CAM)
- One European Space Agency (ESA) laboratory named "Columbus"
- One Japanese Experiment Module named "Kibo"
- Two Russian Research Modules

The central girder, called the truss, will connect the modules and four giant solar arrays making the ISS about the size of a football field. The Canadian-built Remote Manipulator System, a 55-foot robot arm and a grappling mechanism called the Special Purpose Dexterous Manipulator (SPDM), will move along the truss on a mobile base transporter to perform assembly and maintenance work.



The Japanese Experiment Module (JEM) laboratory

External sites for mounting experiments intended for looking down at Earth and out into space or for direct exposure to space are provided at four locations on the truss structure along with 10 on the Japanese Kibo Module's back porch and 4 on the ESA Columbus Module exposed facility. These external payload sites vary as to the number of payloads that can be accommodated.



The Russian segment of the International Space Station

A three-person Russian Soyuz capsule will initially provide emergency crew return until the U.S.-built Crew Return Vehicle (CRV) is delivered to orbit allowing crew return for seven crewmembers.

A variety of vehicles will be visiting the ISS to ferry crew and supplies from Earth. Crew exchanges will be accomplished with the Space Shuttle and Soyuz. Russian Progress spacecraft, Japanese H-II Transfer Vehicle, and Europe's Autonomous Transfer Vehicle (ATV) will provide resupply and reboost.

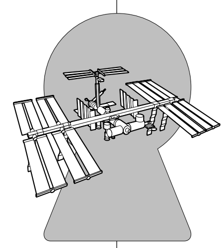
Progress To Date

The ISS has made excellent progress. The vehicle is currently orbiting the Earth at an altitude of approximately 197 nm (365 km) traveling 17,300 mph (27,842 km/h).

- Zarya, Unity, and the Zvezda Service Module, the first three elements of the ISS, are operating normally.
- Three Shuttle supply and maintenance missions have visited the orbiting ISS. STS-96 (2A.1) in May of 1999, STS-101 (2A.2a) in May 2000, and STS 106 (2A.2b) in September 2000.
- The initial Progress M1 vehicle docked with the ISS in August 2000. This on-time launch and successful automated docking served to increase confidence in Progress as a principal supplier of propellant and dry cargo resupply to the Station.
- Nearly 90 percent of U.S. hardware has been manufactured. All U.S. flight hardware for missions through flight 12A has been delivered to the launch site.

The Year Ahead

The successful launch of the Zvezda Service Module kicked off a period of rapid expansion for the International Space Station, our newest star in the night sky.



- **The Station comes to life** – Before the end of 2000, the first residents will be living aboard the station, bringing it permanently to life.
  - Truss segments – the Z1 Truss (STS-92/3A), the keystone of the structure arrives.
  - People – Expedition One crew arrives aboard a Russian Soyuz spacecraft (2R).
  - Emergency crew return – available using the Soyuz spacecraft.

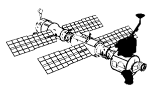
- **The Station spreads its wings** – When 2001 draws to a close, scientists will have a laboratory in space unequaled in capability and unmatched in its potential to change our lives.
  - Power – Renewable electric power provided by the first of four giant solar arrays (STS-97/4A).
  - Laboratory – Our most advanced orbiting lab to date takes flight (STS-98/5A).

- **The Station goes to work** – In the same way that the 19th century saw humans control pressure and temperature to harness steam power, the 21st century will see us control gravity to make new discoveries.
  - Experiments – Preparing for discovery with the Human Research Facility (HRF) (STS-102/5A.1)
  - Canada's Robot Arm – Giving the Station a hand with new-generation robotics (STS-100/6A)
  - Airlock – A doorway to space (STS-104/7A)

- **Next year** (after 7A) the Station will be larger and more powerful than *Mir*, and the size of a three-bedroom home with 35kW of power.

The Year Ahead—In detail (dates based on Rev-F assembly sequence)

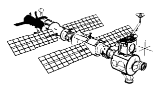
Discovery (STS-92; 3A), Truss Segments and Control Systems, October 2000.



The Keystone of the Structure Arrives: The STS-92 crew will perform four days of spacewalks to install the girder-like truss and critical electronics, including gyroscopes and communications equipment.

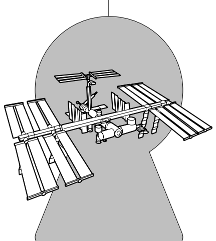
Crew: Brian Duffy (Cmdr); Pam Melroy (Pilot); Leroy Chiao (MS/EVA); Michael Lopez-Alegria (MS/EVA); Bill McArthur (MS/EVA); Jeff Wisoff (MS/EVA); Koichi Wakata (MS).

Expedition One/Soyuz (TM; 2R), Test Flight and Assembly, October 2000.

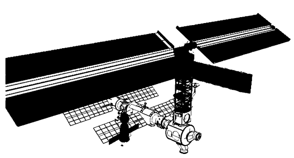


The Station Comes to Life: The Station's first residents, the Expedition One crew, will test systems and assist with assembly during their four-month stay. Two spacewalks will be conducted using a Zvezda compartment as an airlock.

Crew: Sergei Krikalev (ISS Flt Engineer); Bill Shepherd (ISS Cmdr); Yuri Gidzenko (Soyuz Cmdr/ISS Pilot).



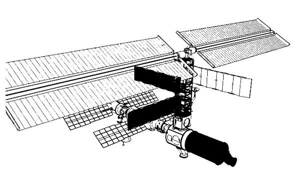
Endeavour (STS-97; 4A), PV Arrays and Batteries, November 2000.



The Station Spreads its Wings–More Power: The STS-97 crew will install the first of four solar arrays, which ultimately will cover over one-half acre of surface area and provide 60 times the power of Russia's *Mir*. This initial power source sets the stage for the arrival of the first laboratory.

Crew: Brent Jett (Cmdr); Michael Bloomfield (Pilot); Joseph Tanner (MS/EVA); Carlos Noriega (MS/EVA); Marc Garneau (MS).

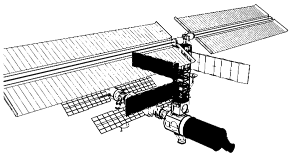
Atlantis (STS-98; 5A), U.S. Destiny Laboratory Module, January 2001.



Our Most Advanced Orbiting Lab Ever Takes Flight: The STS-98 crew will perform three spacewalks to install the Station's first laboratory which will become the centerpiece for scientific research activities.

Crew: Kenneth Cockrell (Cmdr); Mark Polansky (Pilot); Bob Curbeam (MS/EVA); Thomas Jones (MS/EVA); Marsha Ivins (MS).

Discovery (STS-102/5A.1) Expedition Two, Crew Exchange/Leonardo MPLM Laboratory Equipment, February 2001.



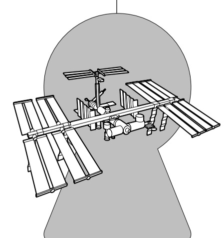
Preparing for Discovery (Expedition Two): The STS-102 crew will deliver and install equipment racks to outfit the Destiny Laboratory, using the Italian-built, reusable Leonardo logistics module. Expedition Two will replace the Expedition One crew, which will return on Discovery.

Shuttle Crew: James Weatherbee (Cmdr); James Kelly (Pilot); Andy Thomas (MS/EVA); Paul Richards (MS/EVA)

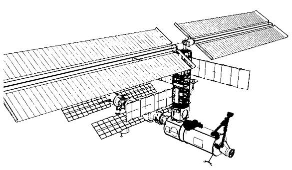
ISS Crew: Yury Usachev (ISS Cmdr); James Voss (ISS Crew); Susan Helms (ISS Crew/EVA).

Soyuz (TM; 4R), Russian Docking Ports, April 2001.

Creating Room to Grow: Unmanned Soyuz delivers a new docking port and Strela boom. The new gear provides another door (or airlock) to go in and out of the Station for Russian-based spacewalks and a docking port for Soyuz and Progress vehicles.



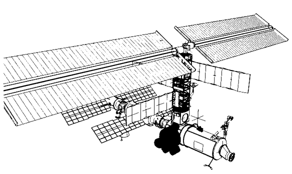
Endeavour (STS-100; 6A), Rafaello MPLM and Canada Arm, April 2001.



New-Generation Robotics Give the Station a Hand: The STS-100 crew will install the station robotic arm and, using Italy's Rafaello MPLM, deliver interior equipment to further outfit the U.S. lab. The Canada Arm will assist with most future assembly activities.

Crew: Cmdr (TBD); Pilot (TBD); Chris Hadfield (MS/EVA); Scott Parazynski (MS/EVA); Umberto Guidoni (MS).

Atlantis (STS-104; 7A), Airlock, May 2001.



A Doorway to Space: The installation of the Airlock by the STS-104 crew marks the completion of early on-orbit assembly and signals readiness for full-fledged research in the U.S. Lab. Using the Airlock, Station crew can conduct spacewalks using both Russian and U.S. spacesuits.

Crew: Cmdr (TBD); Pilot (TBD); Michael Gernhardt (MS/EVA); James Reilly (MS/EVA).

Research on the International Space Station

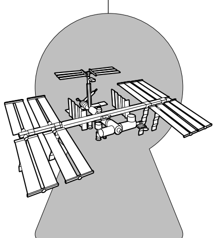
The ISS represents a quantum leap in our capability to conduct research on orbit. It will serve as a laboratory for exploring basic questions in a variety of disciplines, and as a testbed and springboard for exploration. Research on the ISS will include commercial, scientific, and engineering research in the following areas:

Early Research Disciplines:

Biomedical Research and Countermeasures: Researchers seek to understand and control the effects of the space environment on space travelers (e.g., muscle atrophy, bone loss, fluid shifts).

Long-term Benefits: Enhance the safety of space travel; develop methods to keep humans healthy in low-gravity environments; advance new fields of research in the treatment of diseases.

Fundamental Biology: Scientists study gravity's influence on the evolution, development, growth, and internal processes of plants and animals. Their results expand fundamental knowledge that will benefit medical, agricultural, and other industries.



Long-term Benefits: Advance understanding of cell, tissue, and animal behavior; use of plants as sources of food and oxygen for exploration; improved plants for agricultural and forestry.

Biotechnology: Current technology indicates that a weightless environment may enable researchers to grow three-dimensional tissues that have characteristics more similar to tissues in the body than has ever been previously available and to produce protein crystals for use in drug development.

Long-term Benefits: Culture realistic tissue for use in research (cancerous tumors, organ pieces); provide information to design a new class of drugs to target specific proteins and cure specific diseases.

Fluid Physics: The behavior of fluids is profoundly influenced by gravity. Researchers use gravity as an experimental variable to explain and model fluid behavior in systems on Earth and in space.

Long-term Benefits: Improved spacecraft systems designs for safety and efficiency; better understanding of soil behavior in Earthquake conditions; improved mathematical models for designing fluid handling systems for powerplants, refineries, and innumerable other industrial applications.

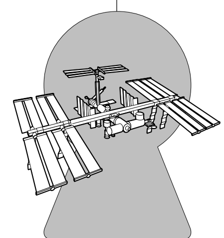
Later Research Disciplines:

Advanced Human Support Technology: Researchers develop technologies, systems, and procedures to enable safe and efficient human exploration and development of space.

Long-term Benefits: Reduce the cost of space travel while enhancing safety; develop small, low-power monitoring and sensing technologies with applications in environmental monitoring in space and on Earth; develop advanced waste processing and agricultural technologies with applications in space and on Earth.

Materials Science: Researchers use low gravity to advance our understanding of the relationships among the structure, processing and properties of materials. In low gravity, differences in weight of liquids used to form materials do not interfere with the ability to mix these materials opening the door to a whole new world of composite materials.

Long-term Benefits: Advance understanding of processes for manufacturing semiconductors, collids, metals, ceramics, polymers, and other materials; determine fundamental physical properties of molten metal, semiconductors, and other materials with precision impossible on Earth.



Combustion Science: The reduction of gravity allows scientists to simplify the study of complex combustion (burning) processes. Since combustion is used to produce 85 percent of Earth's energy, even small improvements in efficiency and reduction of soot production (a major source of pollution on earth) will have large economic and environmental benefits.

Long-term Benefits: Enhance efficiency of combustion processes; enhance fire detection and safety on Earth and in space; improve control of combustion emissions and pollutants.

Fundamental Physics: Scientists use the low gravity and low temperature environment to slow down reactions allowing them to test fundamental theories of physics with degrees of accuracy that far exceed the capacity of Earthbound science.

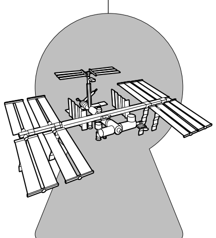
Long-term Benefits: Challenge and expand theories of how matter organizes as it changes state (important in understanding superconductivity); test fundamental theories in physics with precision beyond the capacity of Earth-bound science.

Earth Science and Space Science: Space Station will be a unique platform with multiple exterior attach points from which to observe the Earth and the universe.

Long-term Benefits: Space Scientists will use the location above the atmosphere to collect and search for cosmic rays, cosmic dust, anti-matter and "dark" matter. Earth scientists can obtain global profiles of aerosols, ozone, water vapor, and oxides in order to determine their role in climatological processes and take advantage of the longevity of ISS to observe global changes over many years.

For the latest information on the International Space Station, go to:

http://spaceflight.nasa.gov



NASA's space flight Web site brings your the most up-to-the-minute information available on the International Space Station, including:

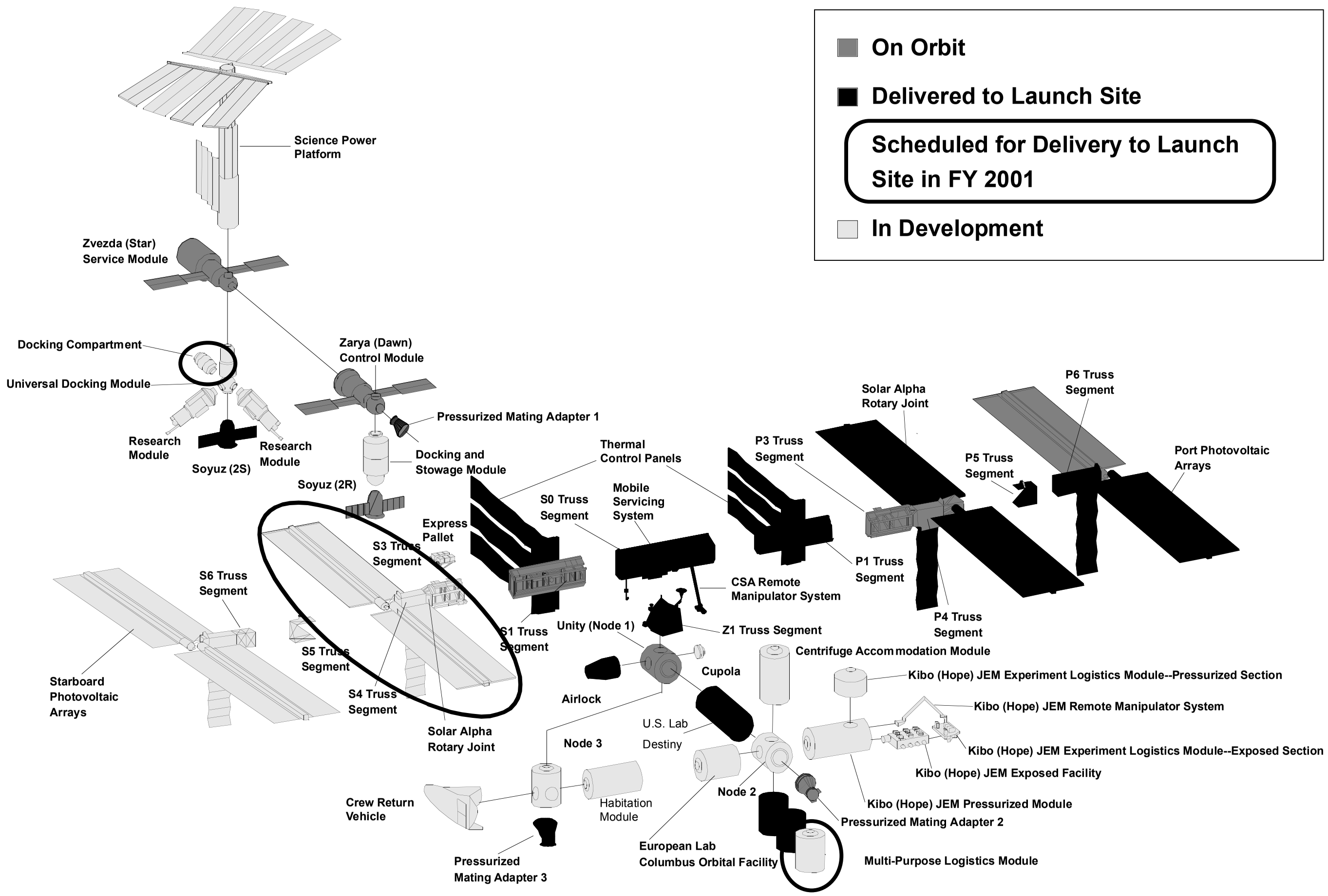
- Sighting information
- Realtime data
- Shuttle mission
- Assembly status
- The latest images
- Live docking video
- Crew information and training
- News and interviews
- Time on orbit
- Scientific findings

And coming soon . . .

Live video of life and work in orbit, once the station comes to life in October 2000 with the crew of Expedition One.

International Space Station Assembly

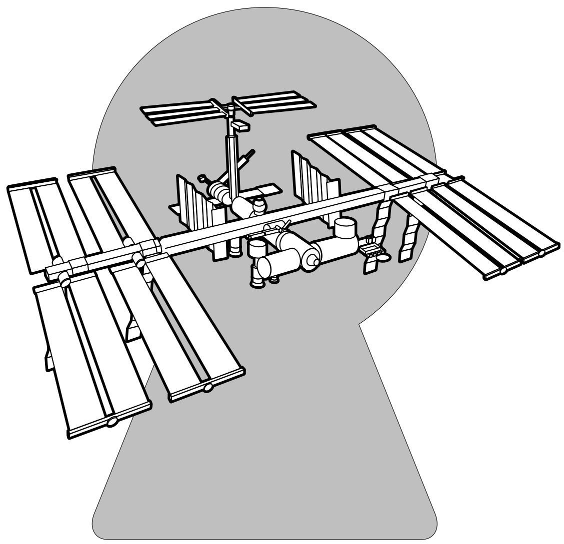
Hardware Delivery Status as of October 2000



Assembly Sequence as of October 2000

Calendar Year	1998	1999	2000	2001	2002	2003	2004	2005	2006
Launch Summary	2	1	5	7	7	7	5	10	4
Shuttle Launches*	**1**	**1**	**4**	**6**	**7**	**5**	**5**	**8**	**3**
Assembly	(1)	(1)	(4)	(5)	(5)	(4)	(4)	(6)	(2)
Utilization	(0)	(0)	(0)	(1)	(2)	(1)	(1)	(2)	(1)
Russian Assmebly Launches**	**1**	**0**	**1**	**1**	**0**	**2**	**0**	**2**	**1**
Major Milestones									
"Zarya" (FGB) *1st element launch*	11/98								
"Unity" (Node1) *1st U.S. element launch*	12/98								
"Zvezda" Service Module			7/00						
Soyuz 3-Person Permanent			10/00						
U.S. "Destiny" Lab launch				1/01					
Canadian Robotic Arm launch				4/01					
Utilization Flights				10/01	2/02, 6/02	10/03	9/04	2/05, 6/05	4/06
Japanese Kibo launch							5/04		
ESA Laboratory launch							10/04		
Russian Research Modules	**to be scheduled**								
U.S. Hab Module launch								9/05	
7-Person Crew Capablity									1/06

* Shuttle launches of partner elements are included in U.S. assembly line (Japan's Kibo, ESA's COF, Canadian SSRMS, Russian SPP).
** Russian assembly launches excludes logistics, resupply, and crew exchange flights.



National Aeronautics and
Space Administration