The International Space Station (ISS)

Artists view

The International Space Station (ISS) Objective

In partnership with the United States, Russia, Japan and Canada, Europe is sharing in the greatest international project of all time - the International Space Station (ISS).

Once completed, the 450-ton International Space Station will have more than 1200 cubic metres of pressurized space - enough room for seven crew and a vast array of scientific experiments.

Current configuration

Weight
482,345 pounds i.e. 220 metric tons
Habitable Volume
14,000 cubic feet or 400 m3 (equivalent of an average Dutch house)

Dimensions

SA span	Across Solar Arrays: 256 feet i.e 78 m
Width:	S4 to P4 : 231 feet i.e. 70 m
Length:	146 feet from Destiny Lab to Zvezda; i.e 43 m without Progress
	170 feet with a Progress docked : i.e 52 m Progress is ca 8m long
Height:	98 feet without Progress on DCI i.e 30 m (107 ft resp 38m)

The construction of the International Space Station is a multi national effort involving 19 different countries over many years

1985:USA, ESA Canada and Japan were the primary partners

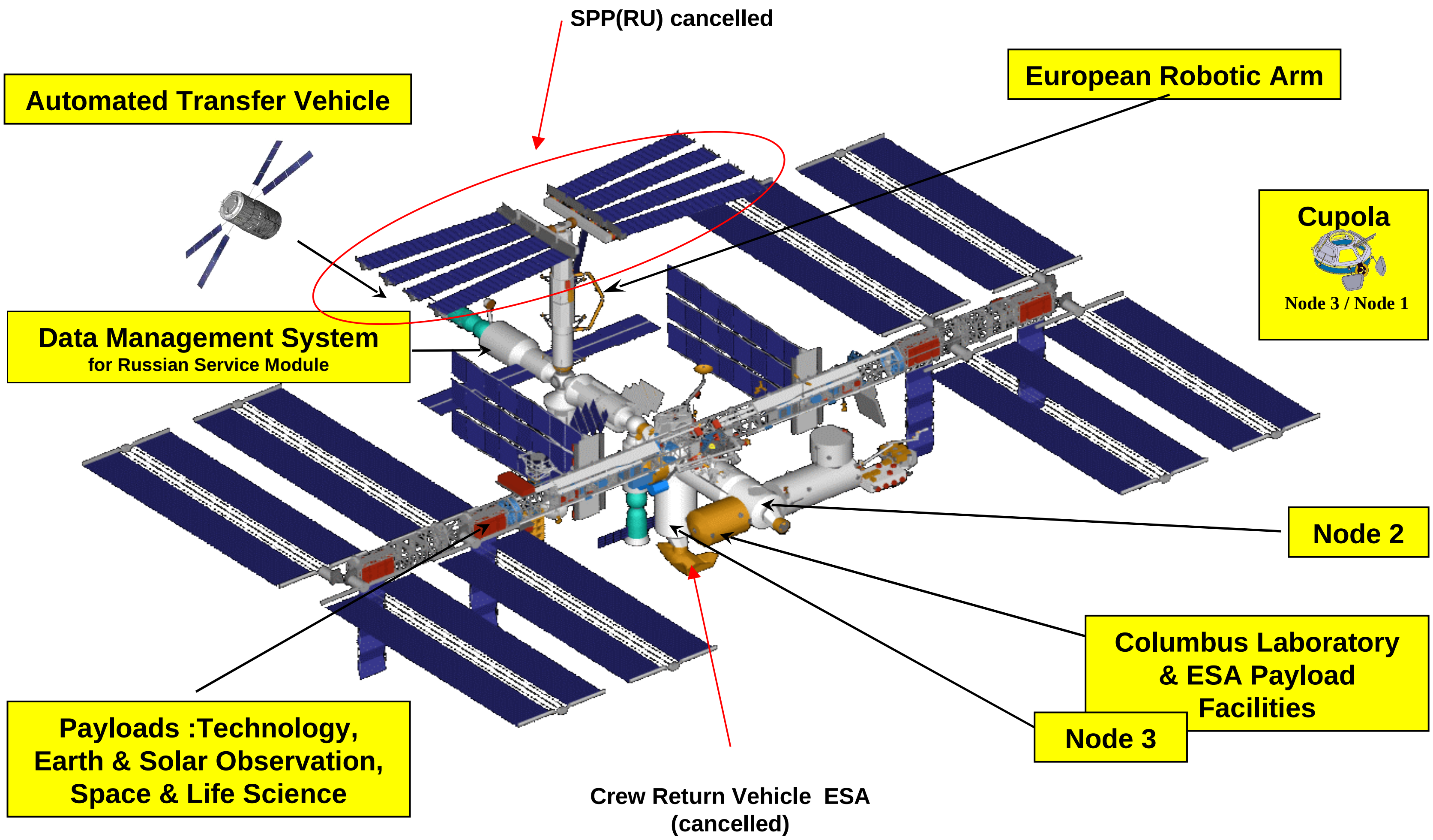
1993:With the fall of the Iron Curtain Russia became a partner instead of a competitor

NASA acts as the main Station Integrator, Prime contractor on US side is Boeing

ESA,which coordinates the space research effort of the 15 European member states, provides a laboratory module, station control facilities and cargo transportation facilities. Prime contractor varies depending on the project

RSCE (Russia) provides Station Control, lab facilities, cargo and crew upload capability. The Prime contractor on the Russian side is S.P. Korolev RSC Energia

The International Space Station (ISS) Europe's Contribution



The purpose of building the ISS is to create a laboratory in space giving scientists access to a research environment that can not be found on earth

Physiology : study how humans are affected by microgravity conditions

Material Science : fluid dynamics in microgravity, material gassification and solidification in microgravity

Biology : experiments loaded in exchangeable drawers are perfomed in 0 g and 1 g to allow comparison of the results

Experiments are conducted in microgravity conditions and can be carried out either by the crew or via remote control directly from the payload operational centres

The ISS is composed of different types of modules

* The US habitation module and the Russian Zvesda provide living quarters
* Destiny (the US lab), Kibo (Japanese lab), Columbus (European lab) provide (will provide) research facilities.
  Zvesda (RU) also provides some research capabilities
* Nodes, docking and stowage modules and docking compartments (DCs) provide docking ports for the attachment of visiting vehicles or other modules
* Soyuz vehicle has the capability to transport 3 persons to and from ISS. It stays in orbit 6 mo and also acts as a “rescue boat”

A large truss spans the width of the ISS and serves to connect the large Photovoltaic arrays which provide power.

Each Mission Control Center (MCC) has control over it’s segment.

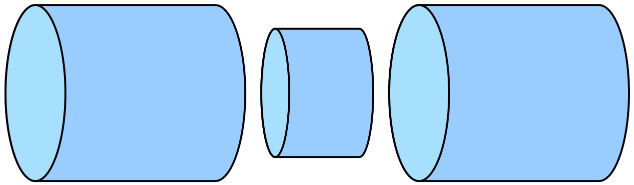
Overall responsibility is with MCC_H (Houston)

pictures

Like any laboratory the ISS consists of basic components

- structure
- power
- data handling (on board computers to manage the station itself and the experiments)
- communication with ground control centres
- guidance navigation and control system
- trained staff
- water and air
- heating
- waste management systems
- regular supplies
- an emergency exit

Structure : as simple as possible, basically cylinders connected together by special modules called nodes



The ISS structure is made with aluminium alloys which are light, corrosion resistant and have favourable electrical conductivity which aids when grounding the electrical systems

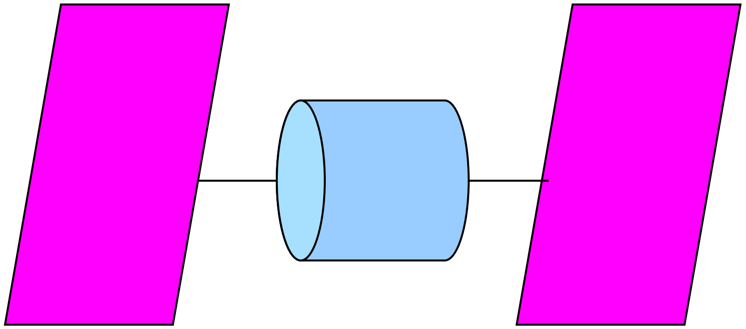
Two types : **Truss** and **Pressurised Modules (PMs)**.

Two categories: **primary** (designed to maintain the structural integrity of a pressurised element) and **secondary** (designed to transfer load to a primary structure).

The typical design of a pressurised module is ring frames with longerons (used to increase stiffness and load carrying capabilities of the shell panels).

Debris shields, docking mechanisms, berthing mechanisms, manipulators…

Power : electrical power is provided by Solar Panels which charge onboard batteries



Primary power : the large Solar Arrays (Photovoltaic Modules) => 150 – 160 Vdc.

This primary power is distributed to various locations on the ISS and converted to secondary power (ca 124 Vdc).

The reason we do this is:

- primary power at higher voltage uses smaller wires (=> less mass and more efficient)
- secondary power can be regulated to fit the user constraints
  124 Vdc actually corresponds to 124.5 +/- 0.5 Vdc
- Primary power is increased by adding new Solar Arrays
- Secondary power is increased at each assembly stage when new components are added

The International Space Station (ISS) Components

Primary power

SAW (including the previously mentioned PVs) and Betal Gimbal Assembly (BGA)

Electronics Control Unit (ECU)

Sequential shunt unit (SSU)

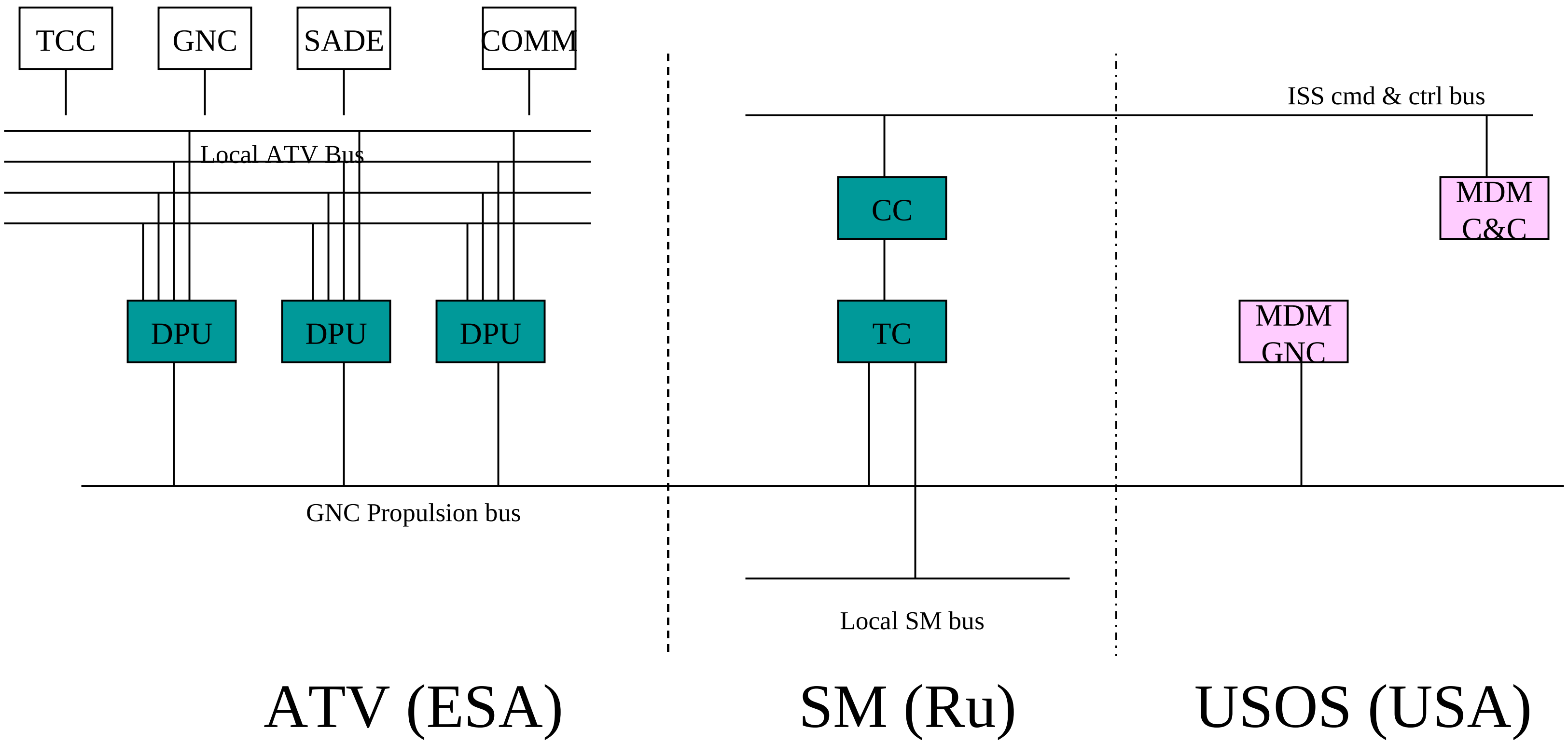
Three Battery Charge /Discharge Units (BCDUs)
Six Orbital replacement units (2 batteries per assembly)
Direct Current Switching Unit (DSCU)

Secondary power
Converters (DDCU), Power Busses (PB) and Remote Power Controllers (RPC)

Grounding
ISS uses a single point ground architecture

Difference USOS / RS
Voltage level is 124 Vdc on USOS side and 28V on RS side
USOS is grounded to the ISS structure, RS uses a floating ground

Data handling : several different types of onboard computers ensure the proper functioning of the systems and payloads



The computer system is organised in tiers:

Tier 1:

The Command and Control (C&C) computers is used to control ISS. In general tier 1 computers are 2 fault tolerant (i.e. there are three identical ones)

Tier 2 :

Computers used to control specific subsystems such as Guidance Navigation and Control, or Environmental control and Life support. In general tier 2 and 3 computers are 1 fault tolerant (i.e. there are two identical ones)

Tier 3

Computers who supply the data, i.e. the input / output of thousands of sensors and effectors on ISS. As tier 2 above, these are generally 1 fault tolerant.

The computers communicate via 1553 busses. There are sufficient number of busses to ensure 2 failure tolerance for all major functions. Specific MDMs control the Payloads and these communicate on dedicated Payload busses.

There will be about 44 computers on the US side at Assembly Complete

The Russian Side

The Russian system relies on fault tolerant computers built by Europe, called FTCs. Each FTC is composed of 3 identical Data Processing Units (DPU).

The Russian side has a Central Computer (control level) and a Terminal Computer (lower level). They are interfaced with the US CDH system via 1553 busses.

The Crew interfaces the Russian computers using the same type of IBM laptop as when they interface the USOS PCS, but using different SW.

A series of displays are developed according to agreed ISS standards and show relevant data for the various Russian or ISS subsystems

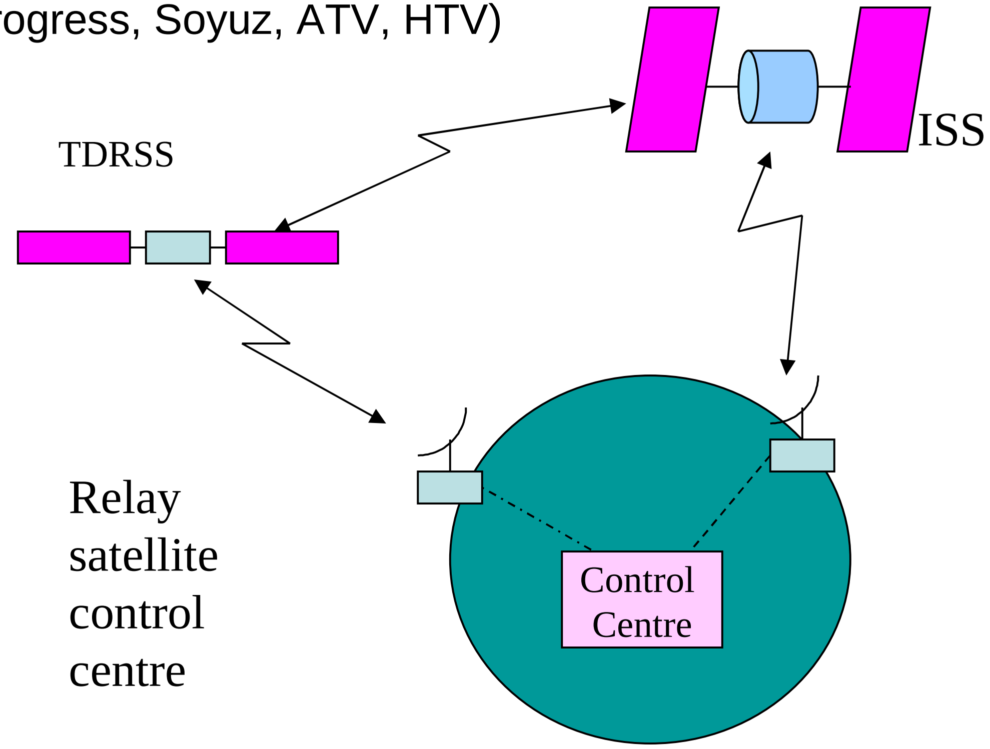
Data exchange between computers

All the units connected to the 1553 busses communicate using an agreed buscontroller / remote terminal protocol. According to this protocol, only one computer can act as bus controller (BC) for a given 1553 bus. All others are considered to be Remote Terminals (RT). There can be up to 31 RTs on a 1553 bus.

Using this protocol, each computer cyclically collects updated data from it’s remote terminals. This is done at three rates 0.1 Hz, 1 Hz and 10 Hz depending on the type of data. The Russian computers collect data also at 5 Hz.

Communication :

* 2-way audio and video communication between crew members on ISS
* 2- way audio and video communication between ISS Crew and MCC
* 1- way communication of experiment data to the P/L operations centers
* command / control of ISS from Mission Control in Houston / Moscow
* communication paths between ISS and visiting vehicles
(Shuttle, Progress, Soyuz, ATV, HTV)



Communication relies on the TDRSS data relay satellites (there are 5).
Moscow relies on the Russian Ground stations.

Communication

<u>The US side:</u>

Internal Audio System
Primary monitoring and control : S-band system via TDRSS
Ultra High Frequency Subsystem for space to space communication
Video Distribution Subsystem
Research data link: Ku-band subsystem

<u>The Russian side</u>

Relies on Russian ground stations located between the Moscow region and Vladivostock. Together they provide 15 – 20 min of com per orbit for 9 out of the 16 daily orbits. In order to have better coverage in critical situations, a subset of essential data is transmitted from the Russian to the US segment and then incorporated into the USOS downlink.

Primary monitoring and control : Regul (Ru equivalent to S- band)
Audio : Telephone and Telegraph Communication (TTC)
Very High Frequency subsystem (analogue to the US UHF)
Video System (note that this is incompatible with the US system)

The Proximity Communications System to communicate with ATV from 30 km

Guidance Navigation and Control : The ISS relies on GPS receivers to obtain position and time. The ISS downlinks position and velocity information to the Control Centre which calculates the exact orbital position. The altitude is between 350 and 450 km. Current altitude = 416km.

One orbit takes ca 90 min.

The inclination is 51.6 degrees

The visiting vehicles, such as ATV, rely on several types of sensors.

GPS receivers absolute and relative position > 250 m from ISS

VDM : relative position and attitude for RDV 250 m to docking (used by ATV GNC)

TGM : relative position and velocity 500m – docking (used by Flight Control Monitoring System (FCM) and by the Safety system (PFS) to monitor the GNC)

GNC can be divided into 6 functions

* Guidance
* State determination (navigation)
* Attitude determination (navigation)
* Pointing and Support (navigation)
* Translational Control
* Attitude Control

Guidance

Tells which route to follow from A to B. In the case of ISS this means a reboost. .

Navigation

maintains the onboard estimate of position velocity, attitude and attitude rate.

State determination answers the question “Where am I?”.

Attitude determination answers the question “How am I oriented?”

Pointing and Support answers the question “Where is everything else?”

Translational Control

The ISS maintains it’s attitude by performing regular reboosts

Attitude Control

To satisfy the operational needs (docking, communication, experiments…)

The International Space Station (ISS) Orbit

ISS Attitudes and orbit
The ISS can fly several types of attitudes depending on the power situation.
The two common ones are now LVLH and TEA

In **Local Vertical Local Horizontal (LVLH)** the x axis is along the velocity vector. This is not optimal from a fuel / microgravity point of view since the ISS is subjected to aerodynamic forces and gravity gradient.

The majority of the aerodynamic drag is due to the large solar arrays and this drag imparts a torque about the ISS center of pressure. The gravity gradient is caused by the Earths attraction on the ISS modules and creates a rotation around the ISS center of gravity.
In order to minimise the need for thruster activations, while maintaining attitude an optimal attitude known as **Torque Equilibrium Attitude (TEA)** is selected. At TEA all the torques balance out over one orbit. There are other attitudes as well but for the purpose of this description these two are sufficient.

The ISS orbit inclination is 51 degrees =?

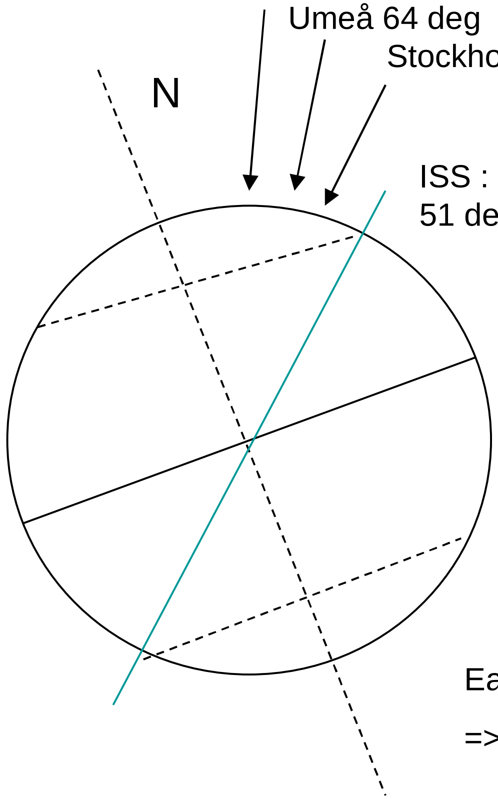
Does ISS groundtrack pass over Stockholm?

What is the speed of the ISS wrt an observer standing on Earth?

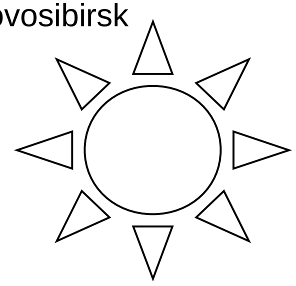
The International Space Station (ISS) Orbit

Inclination 51 degrees = the maximum latitude of the ground track of the S/C

Kiruna 68 deg
Umeå 64 deg
Stockholm ca 59



ISS : 350 – 450 km above the Earth
51 deg : Brussels, Cologne, Calais, Southampton, Novosibirsk



equator

51 deg : Falkland Islands

Earth circumference = 40,075 km => ISS Orbit = 42,300 km

=> ISS ground speed is ca 7.8 km/s

Polar circumference = 40,007 km =>

1 degree is ca 111 km
=> distance between Umeå and Kiruna is ca 450 km

Thermal Control

Temperatures on the ISS vary enormously
- 125 to + 150 deg C : temperatures close to the modules
- 185 to + 150 deg C : temp at outer limits of the truss

There are two types of thermal control :**passive** (insulation, coatings, heaters) and **active** (closed loop fluid circuits). Passive (no active fluid loop) systems are easy to implement and maintain but the active thermal control provide better control and can handle larger heat quantities. RS also uses shell heatpipes which acquire heat from the internal loop and circulates ammonia around the exterior of the pressure shell. This prevents condensation inside the Russian modules

Passive : Multi Layer Insulation, Surface coatings and paint, heaters

Active : coldplates, heat exchangers and fluid loops.
In general there are two fluid loops.
One internal (US: water, RS: triol) and one external (US:ammonia, RS: silicon).
There are heat exchangers between the two loops.
The external loop transports the excess heat to the radiators and it is emitted in to space.

Environmental control and life support systems

Water is ferried up using either the Shuttle (US), Progress (Russia) or ATV (ESA). The SM is equipped with a large water tank into which water can be pumped from (Progress/ ATV tanks). There are also 22 litre containers onboard (EDV) which can be used to store either potable water, technical water or waste. The Shuttle generates water when it produces energy. This is transferred to ISS in special cargo bags.

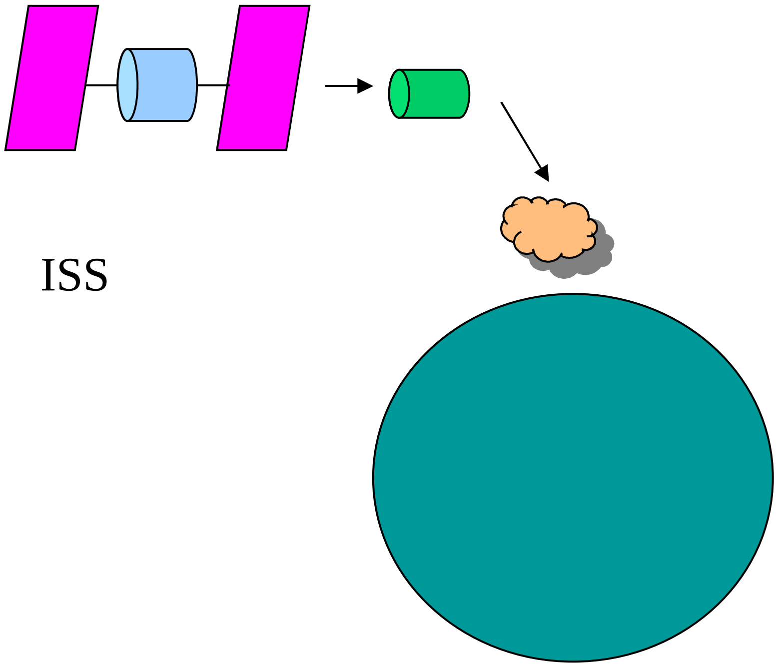
<u>Total</u> crew need for water is ca 3.8 litre per person / day. There are no showers

Air is also carried up by cargo vehicles. It is released into the cabin when needed. Air pressure is monitored by sensors throughout the ISS. There are 10 sensors in each of the Russian modules. Airflow sensors are mounted on all hatch interfaces and this allows to detect the origin of a leak, should one occur.

Carbon dioxide is removed from the atmosphere using a Russian scrubber system called Vozdukh

The International Space Station (ISS) Components

Waste management : Watery recovery systems are foreseen which reduces the amount of waste. All residual waste is packed in bags or containers. When the resupply vehicle has finished it's mission it is loaded with garbage and performs a destructive reentry



Crew Health Care

The Crew Health Care System (CHeCS) is required to maintain the health of the astronauts. It is composed of three subsystems to address each of the three major concerns associated with long duration spaceflight:

<u>counter measures to the detrimental effects of long duration space flight</u>
treadmill, cycle ergometer and resistive devices (rubber bands). The CMS includes monitoring devices (heartrate, blood pressure, cardiogram…)

<u>environmental monitoring</u>
equipment to monitor air quality, water quality, microbiology, radiation, toxicology and acoustic noise.

<u>medical care</u>
* Ambulantory Medical Pack (AMP) eqt used in regular health checks (including blood analysis) and to provide first aid in case of minor injuries.
* Crew contamination protection kit (eyewash kit, respiratory masks, gloves etc)
* Advanced life support system (cardiac life support and basic trauma life support)
* Crew medical restraint system (with spinal stabilization)
* Defibrillator
* Respiratory Support pack (automatically ventilates an unconscious crew member)

The International Space Station (ISS) Planning

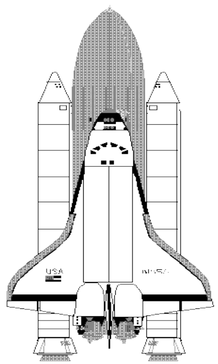
ISS Planning covers all activities related to
* ISS assembly sequence
* Resupply planning
* Maintenance activities
* Crew time allocation for specific tasks
* payload time
* Crew rotation
* Crew training
* Flight control training and coordination
* data exchange between control centres in advance of standard operations
•data exchange between control centres in advance of off nominal operations
• Testing, stand alone testing and integrated testing between one or more partners
….
Several ISS specific concepts have been developed
<u>Increment planning</u>
This covers the activities of a particular crew on ISS. Each crew is called Expedition N and the duration can vary between 1 and 6 months

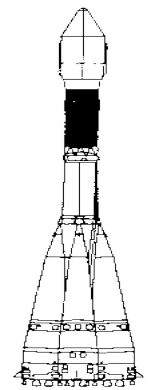
<u>Tactical Planning Period</u> : this is used by the ISS Program Office. It covers all the planning for increments covering 1 calendar year.

<u>Strategic Planning:</u> This is long range planning and covers a 5 year period

The International Space Station (ISS) Components

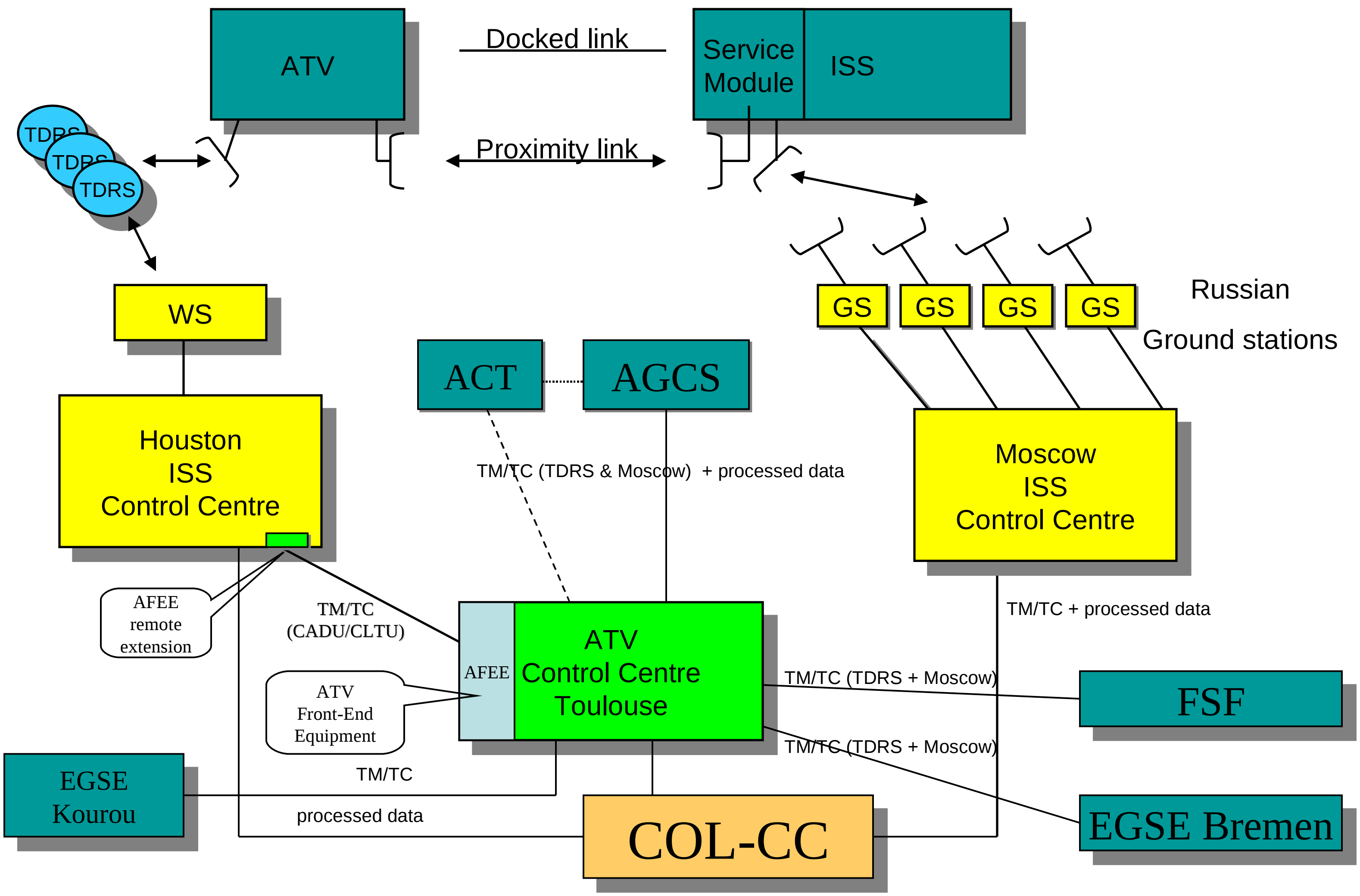
Regular supplies : Supplies are brought up by Shuttle (20t), Progress 2.5 t and by ATV 7 t. Currently there are ca 6 Progress per year and Shuttle flights have just resumed.



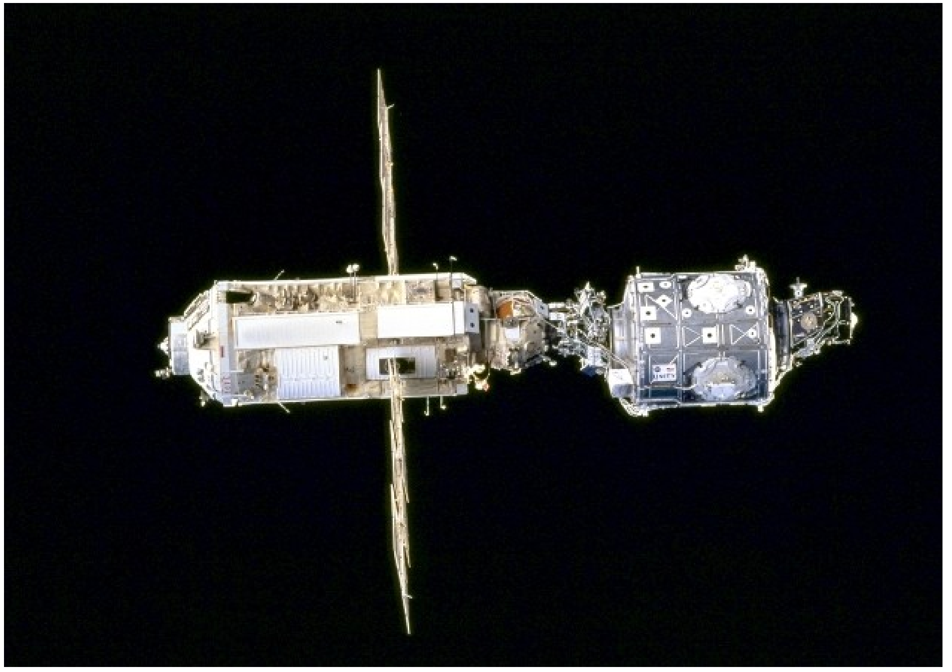


Emergency exit: In the case of emergency the crew must be able to evacuate the Station. For that pupose there is a Soyuz module docked to the ISS. It can carry 3 passengers => crew is limited to three. If the Shuttle is present then the crew can be up to 10 (3 ISS + 7 Shuttle). The in-orbit lifetime of a Soyuz is 6 months => needs to be exchanged twice / year

The International Space Station (ISS) Control Center Coordination



The International Space Station (ISS) Assembly Sequence 1: 1998



STS088-703-019 (**4-15 DECEMBER 1998**) --- The U.S.-built Unity connecting module (bottom) and the Russian-built Zarya module are backdropped against the blackness of space in this 70mm photograph taken from the Space Shuttle Endeavour. After devoting the major portion of its mission time to various tasks to ready the two docked modules for their International Space Station (ISS) roles, the six-member STS-88 crew released the tandem and performed a fly-around survey of the hardware.

The International Space Station (ISS) Assembly Sequence 2: 2000

S106-E-5319 **(18 September 2000)** --- Backdropped against Earth's horizon, the International Space Station (ISS) is seen following its undocking with the Space Shuttle Atlantis. After accomplishing all mission objectives in outfitting the station for the first resident crew, the seven astronauts and cosmonauts undocked at 3:46 GMT on Sept. 18 over Russia near the northeastern portion of the Ukraine. Scott D. Altman, pilot, performed fly around to enable the crew to document the station’s exterior.

The International Space Station (ISS) Assembly Sequence 3: 2000

STS097-704-080 **(9 December 2000)** the first imagery of the entire station with its new solar array panels deployed. Endeavour and space station had been docked 6 days, 23 hours and 13 minutes. Endeavour moved downward from the space station, then began a tail-first circle at a distance of about 500 feet (took about 1 hour). While Endeavour flew that circle, the two spacecraft, moving at five miles a second, navigated about two-thirds of the way around the Earth. Undocking took place 235 statute miles above the border of Kazakhstan and China. When Endeavour made its final separation burn, the orbiter and the space station were near the northeastern coast of South America.

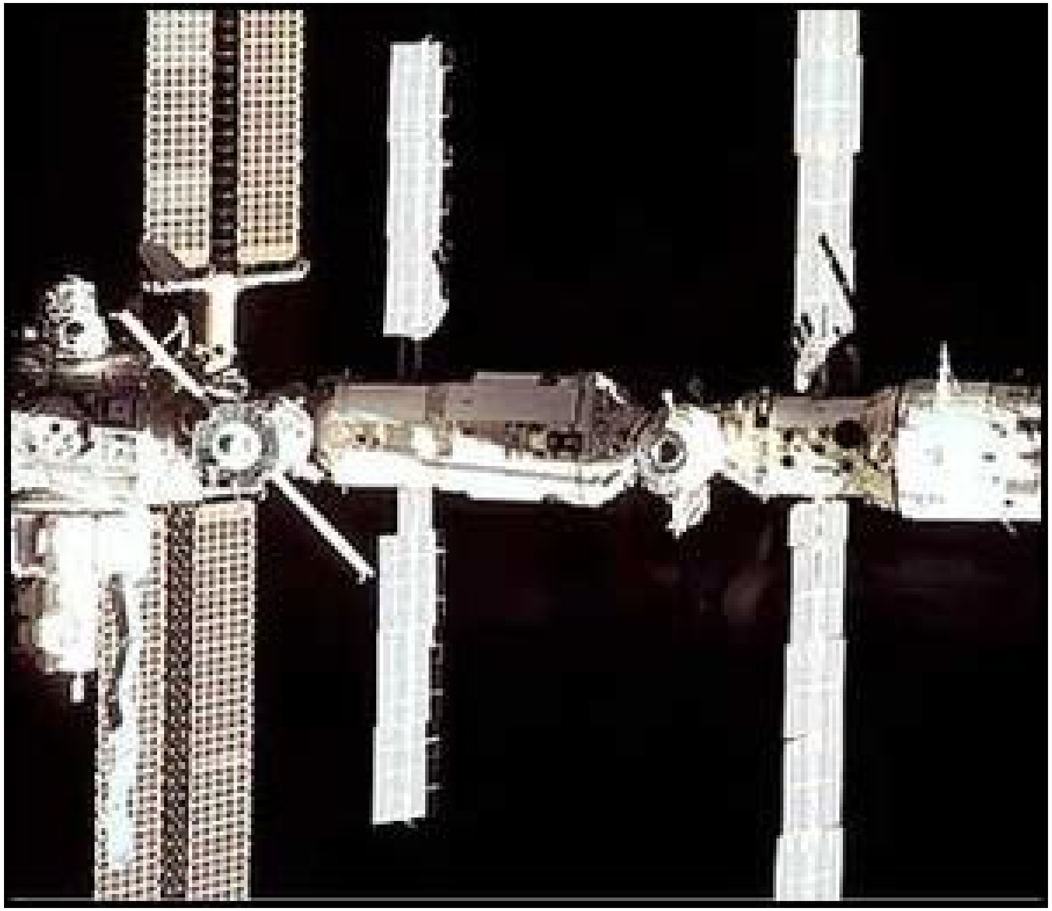
The International Space Station (ISS) Assembly Sequence 4: 2001

STS100-E-5958 **(29 April 2001)** --- Backdropped against the blue and white Earth and sporting a readily visible new addition in the form of the Canadarm2 or space station robotic arm, the International Space Station (ISS) was photographed following separation from the Space Shuttle Endeavour. With six astronauts and a Rosaviakosmos cosmonaut aboard the shuttle, the spacecraft performed a fly-around survey of the station, which was inhabited by two astronauts and a Russian cosmonaut. The image was recorded with a digital still camera.

The International Space Station (ISS) Assembly Sequence 5: 2001

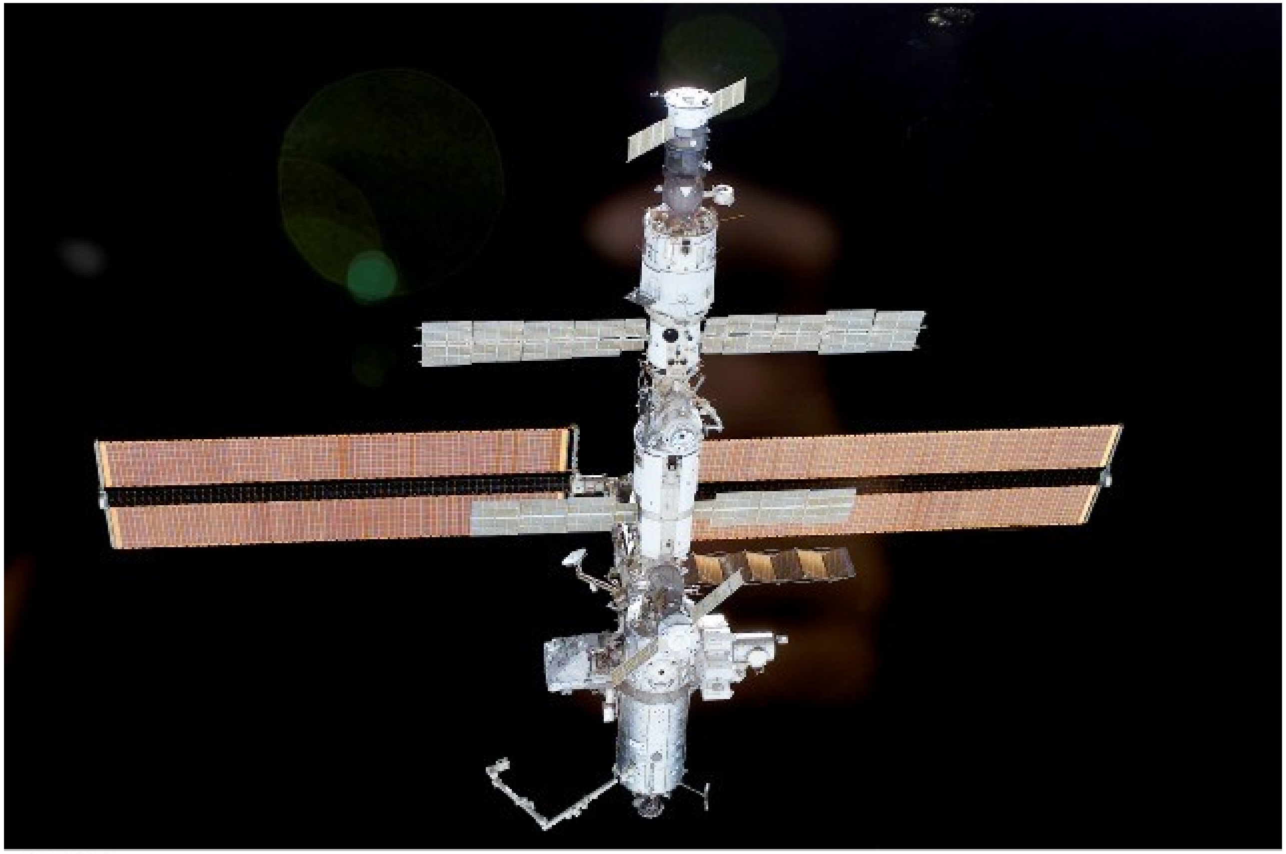
STS104-332-026 **(21 July 2001)** --- Atlantis: shows Quest airlock. The Canadarm2 or Space Station Remote Manipulator System (SSRMS) appears to be pointed toward the new airlock on the station's starboard side. The STS-104 and Expedition Two crew's joint efforts in the past several days, in which the airlock was installed and other work was accomplished, marked the completion of the second phase of the station. Within the last year (beginning in July of 2000), 77 tons of hardware have been added to the complex, including the Zvezda module, the Z1 Truss Assembly, Pressurized Mating Adapter 3, the P6 Truss and its 240-foot long solar arrays, the U.S. laboratory Destiny, the Canadarm2 and finally the Quest airlock

The International Space Station (ISS) Assembly Sequence 6: 2001



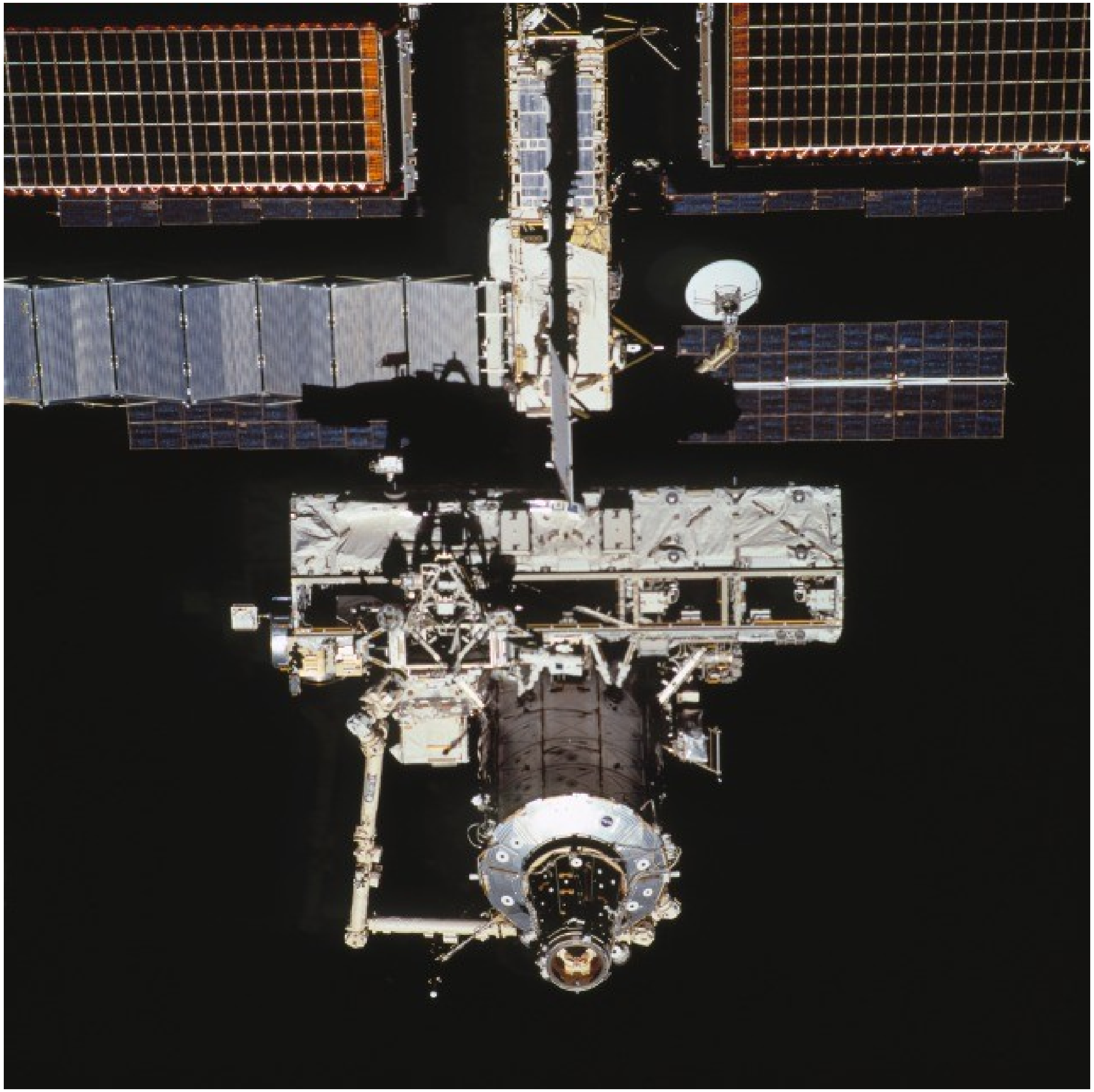
STS108-E-5635 **(15 December 2001)** --- As seen in an overall view from a digital still camera aimed through a window on Endeavour's aft flight deck, the International Space Station (ISS), now staffed with its fourth three-person crew, is backdropped against dark space. The scene was photographed during a fly-around survey by the shuttle following undocking.

The International Space Station (ISS) Assembly Sequence 7: 2002



STS110-E-5918 **(17 April 2002)** --- This is one a series of digital still images of the International Space Station (ISS) recorded by the STS-110 crew members on board the Space Shuttle Atlantis . ISS, newly equipped with the 27,000 pound S0 (S-zero) truss, is visible in this image. S0 is the first segment of a truss structure which will ultimately expand the station to the length of a football field.

The International Space Station (ISS) Assembly Sequence 8: 2002



STS111-708-057 **(15 June 2002)** --- Backdropped by the blackness of space, this close-up view of the International Space Station (ISS) was photographed by a crewmember on board the Space Shuttle Endeavour following the undocking of the two spacecraft over western Kazakhstan.

The S0 (S-zero) Truss with the newly added Mobile Base System (MBS) is visible center frame

The International Space Station (ISS) Assembly Sequence 9: 2002

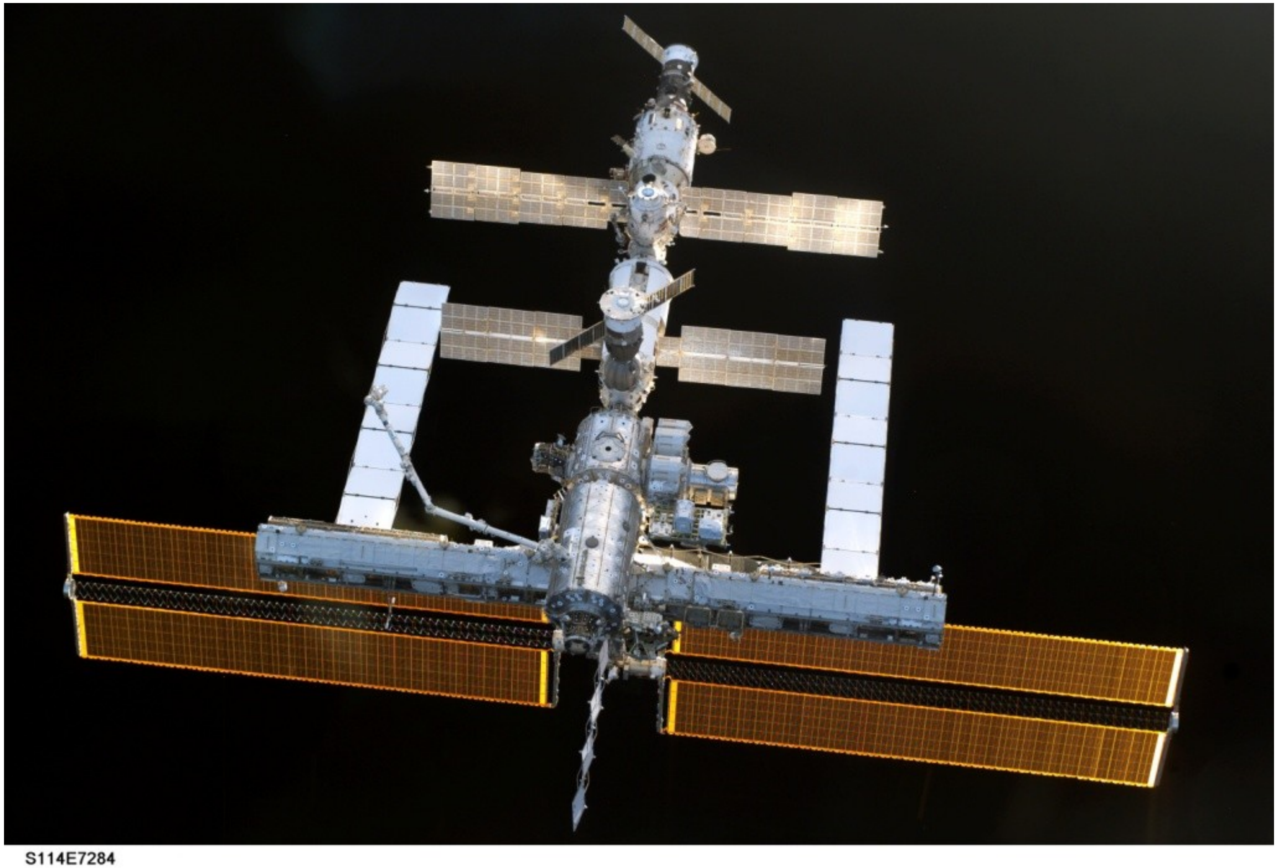
STS112-E-05814 **(16 October 2002)** --- Backdropped by a dark blue and white Earth, this full view of the International Space Station (ISS) was photographed by a crewmember on board the Space Shuttle Atlantis following the undocking of the two spacecraft. The newly added Starboard One (S1) Truss is visible in center frame.

The International Space Station (ISS) Columbia Crew: STS 107 Jan 2003 Feb 2003

From the left are Ilan Ramon (Israeli Space Agency), payload specialist; William C. McCool, pilot; along with David M. Brown and Kalpana Chawla, both mission specialists; Michael P. Anderson, payload commander; Laurel B. Clark, mission specialist; and Rick D. Husband, mission commander.

Between October 2002 and Aug 2005 no Shuttle flights to the ISS took place due to the Columbia disaster in Feb 2003. No major components could be lifted into space. Flights to the ISS continued using Russian vehicles (Soyuz to exchange the crew and Progress to bring up supplies). Crew was reduced to two people since Shuttle was one of the main water providers

The International Space Station (ISS) Assembly Sequence 10: 2005



(6 August 2005) --- The International Space Station photographed from the Space Shuttle Discovery. Earlier, the crews of the two spacecraft concluded nine days of cooperative work. As the Shuttle moved away to a distance of about 400 feet, astronaut James M. Kelly, pilot, begin a slow fly-around of the Station, while cameras on each spacecraft captured video and still images of the other. Undocking occurred at 2:24 a.m. (CDT), August 6, 2005 .

The International Space Station (ISS) Assembly Sequence 11 2005

Exp 11

ISS011-E-11330 (Apr – Oct 2005) --- Cosmonaut Sergei Krikalev, representative of Russia's Federal Space Agency and commander for Expedition 11, retrieves supplies from the Multi-Purpose Logistics Module Raffaello, which was brought to Earth orbit by the seven-member crew of the Space Shuttle Discovery

The International Space Station (ISS) Assembly Sequence 12 2005

ISS011E11312

Exp 11 Apr – Oct 2005: ISS011-E-11312- Astronaut James M. Kelly, STS-114 pilot, controls the Space Station Remote Manipulator System (Canadarm2) from the U.S. Lab, Destiny, on the International Space Station

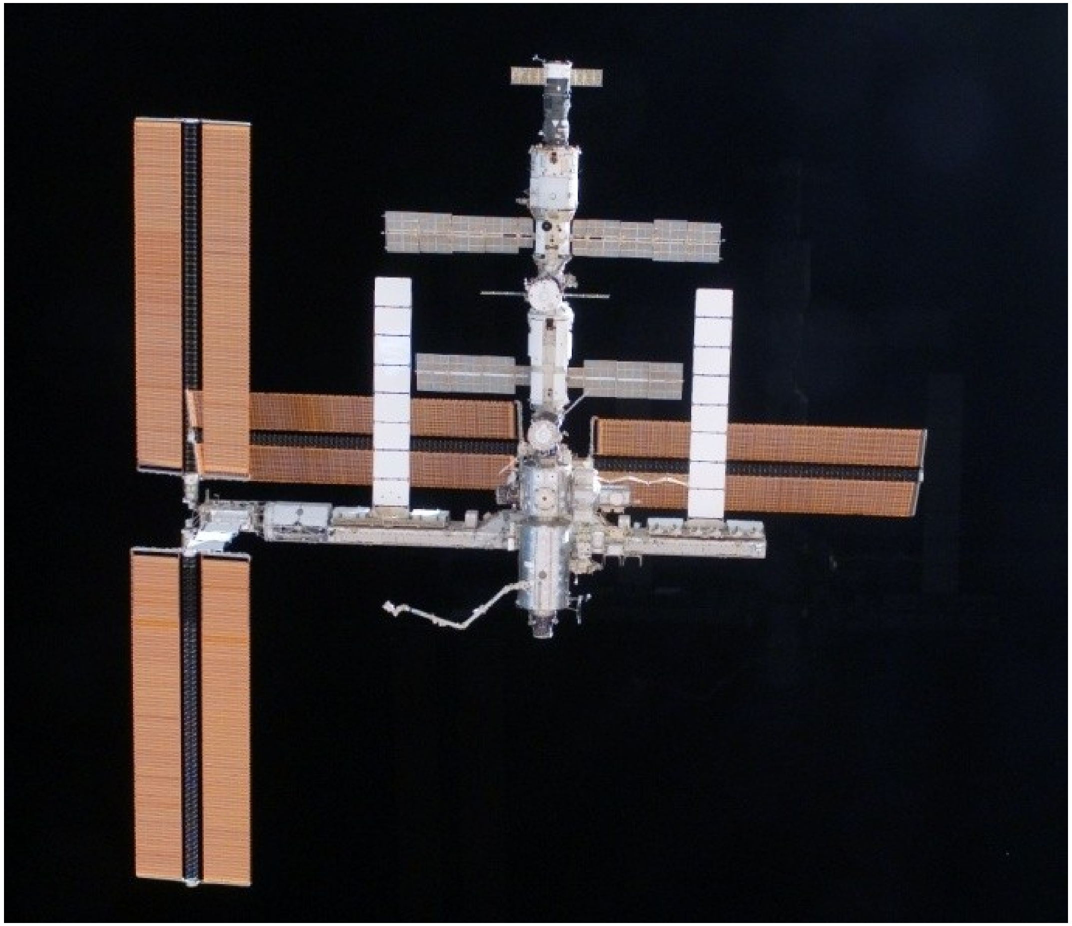
The International Space Station (ISS) Assembly Sequence 13 2006

ISS013E56052

ISS work after arrival of STS 121 (Discovery) July 2006. For the first time since May 2003, the International Space Station has a three-member crew.

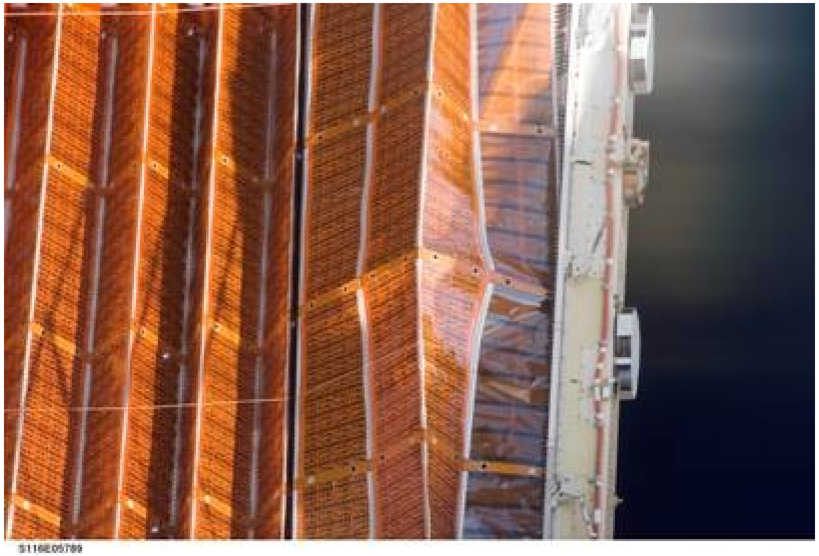
ISS013-E-56052 (23 July 2006) --- European Space Agency (ESA) astronaut Thomas Reiter, Expedition 13 flight engineer, works with sample tubes in the Zvezda Service Module of the International Space Station.

The International Space Station (ISS) Assembly 14: 2006



S115-E-06723 (17 Sept. 2006) --- Space Shuttle Atlantis undocked after six days of joint operations with the station crew. Atlantis left the station with a new, second pair of 240-foot solar wings, attached to a new 17.5-ton section of truss with batteries, electronics and a giant rotating joint. The new solar arrays eventually will double the station's onboard power when their electrical systems are brought online during the next shuttle flight, planned for launch in December.

The International Space Station (ISS) Assembly 15: Problems



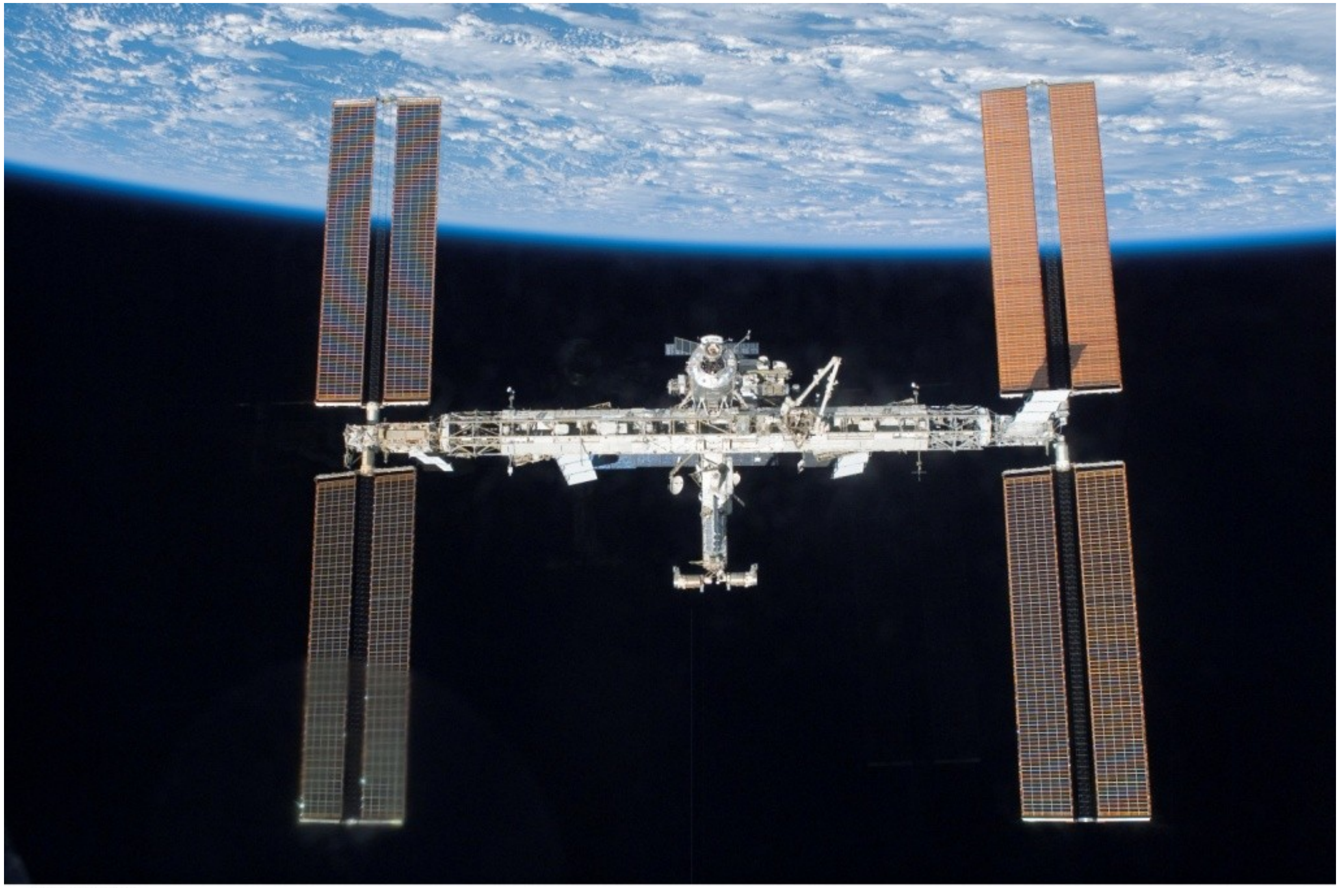
All did not go smoothly during STS 116 in Dec 2006…..
Problems with folding P6 led to an extra spacewalk.

By shaking the array astronauts managed to deblock it, allowing to retract is as planned.

The International Space Station (ISS) Assembly 16: 2006

S116-E-07106 (19 Dec. 2006) Discovery after eight days of cooperative work => a new P5 spacer truss segment and a fully retracted P6 solar array wing. During their stay on orbital outpost, the combined crew installed the newest piece of the station's backbone and completely rewired the power grid over the course of four spacewalks.

The International Space Station (ISS) Assembly 17: June 2007



S117E08003

Current layout of the ISS following STS 117's mission with Atlantis. Photovoltaic modules S3 and S4 were installed. Starboard part of P6 was retracted.

The International Space Station (ISS) Aug 8, 2007

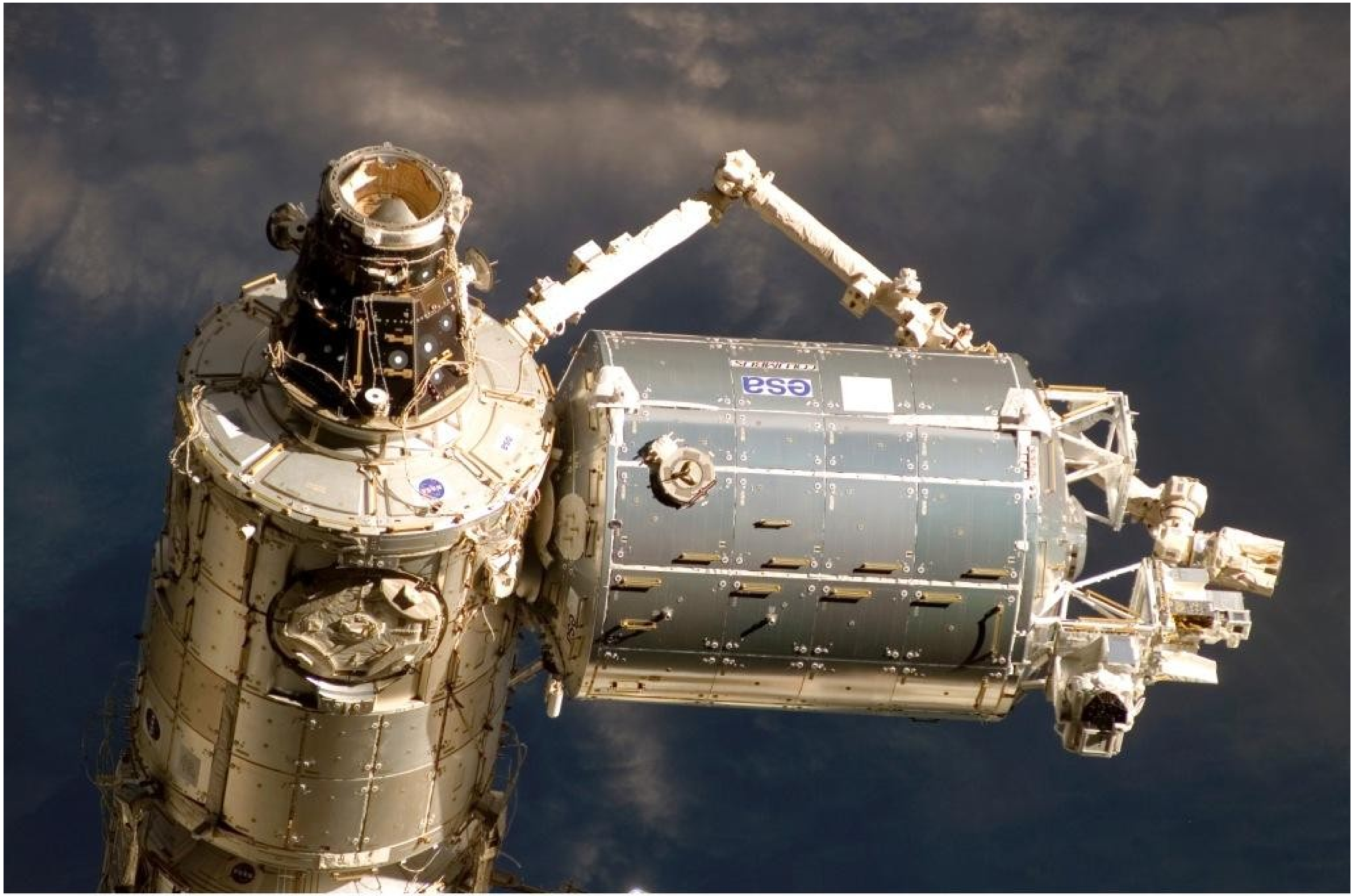
STS 118: Endeavour: The flight placed seven astronauts, a space station segment and 5,800 pounds of cargo and supplies into orbit and on the way to the International Space Station. The 11-day mission calls for attachment of the space station S5 segment, transfer of the cargo and supplies and a test of a new power transfer system. If the system works, the mission would be extended to 14 days.

The International Space Station (ISS) Feb 2008

STS 122 : The ESA Columbus laboratory is installed on the ISS

The International Space Station (ISS) 2008

View of Columbus attached to the ISS



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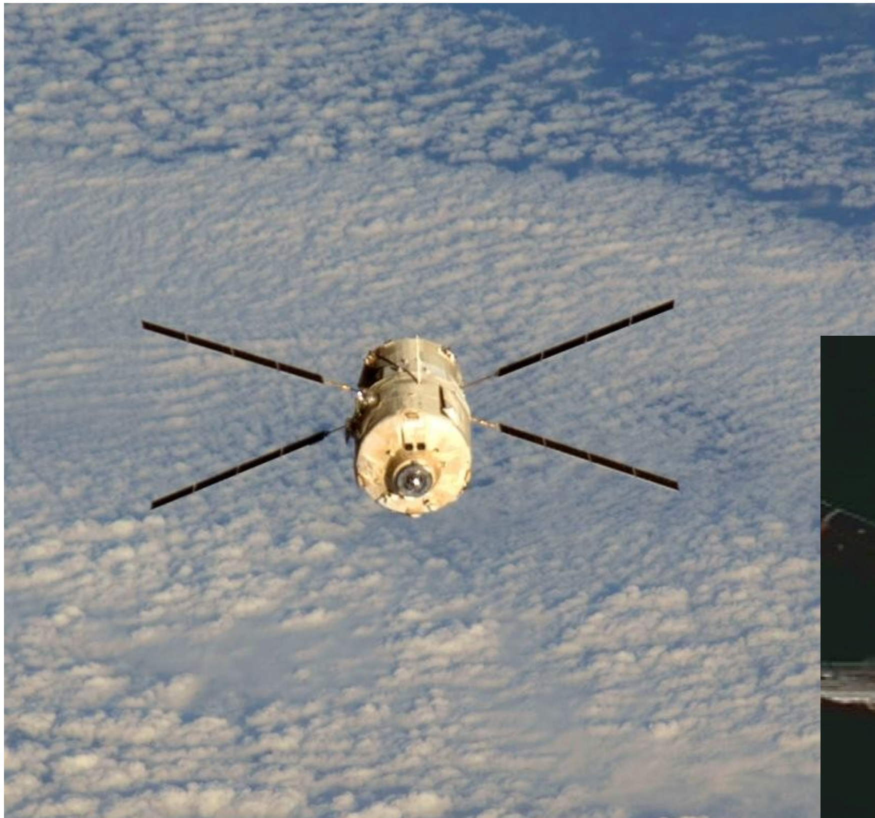
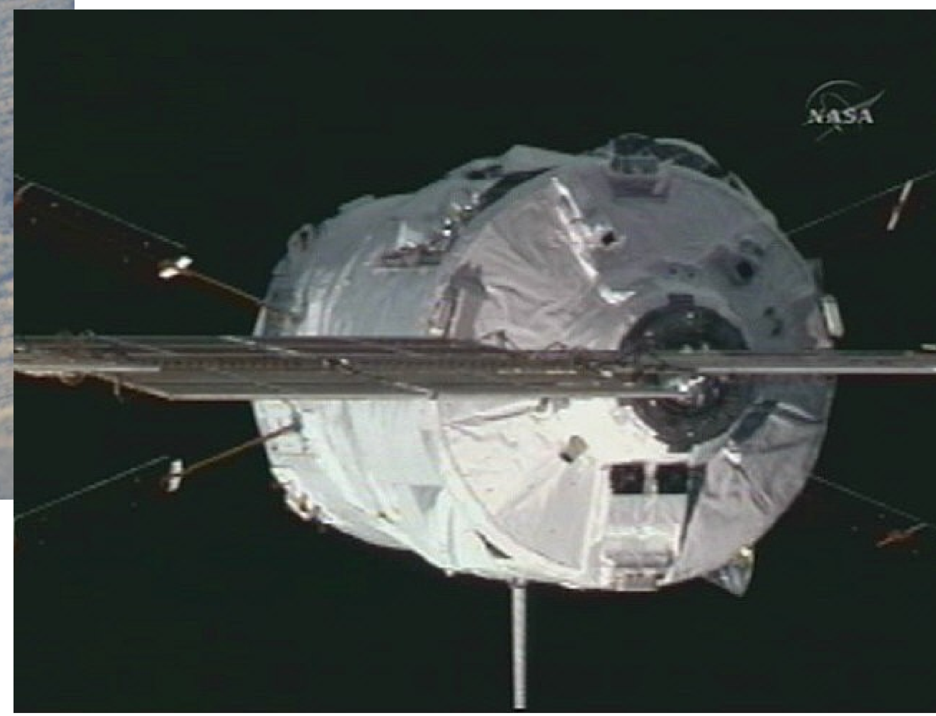
The International Space Station (ISS) March – Sept 2008

ATV Jules Verne





The International Space Station (ISS) March – Sept 2008

ATV Jules Verne and Columbus both attached to the ISS

The International Space Station (ISS) Feb 2009

STS 119 Feb 2009

Crew: Commader Archambault, Pilot Tony Antonelli and Mission Specialists Richard Arnold, Joseph Acaba, John Phillips, Steve Swanson and Koichi Wakata of the Japan Aerospace Exploration Agency. Wakata will stay aboard the station after Discovery docks -- becoming the first JAXA station crew member

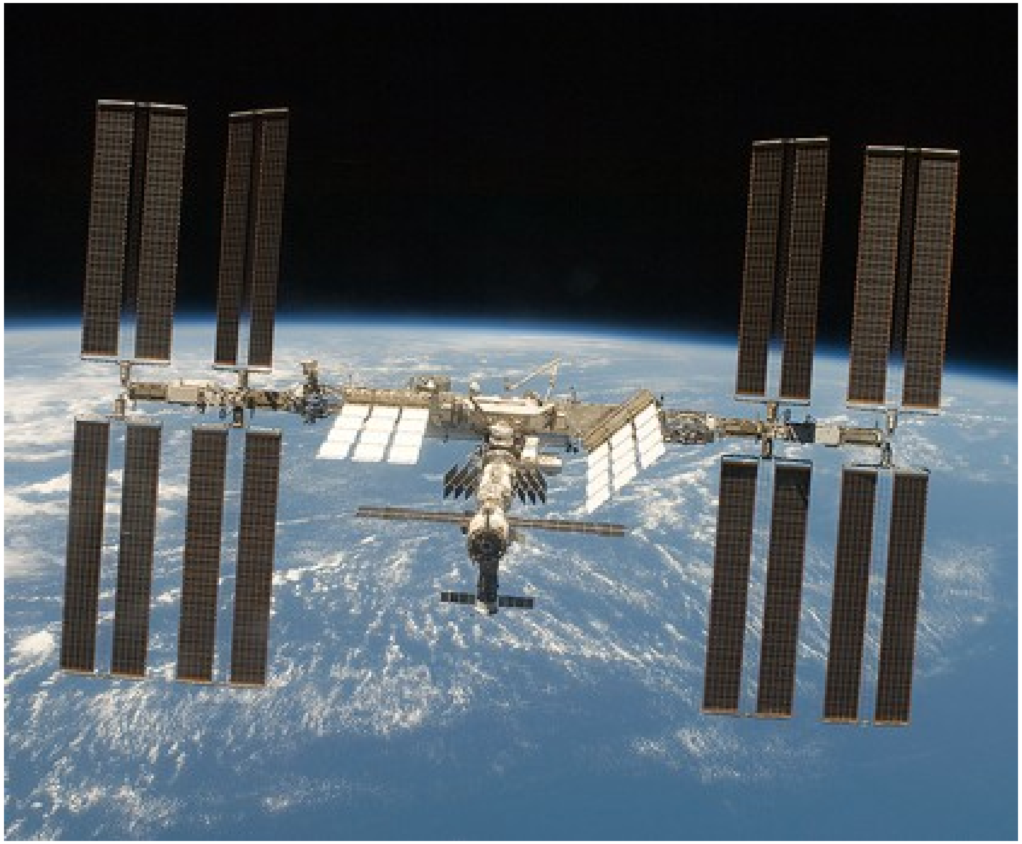
The set of solar arrays that the STS-119 crew will be bringing up includes two solar array wings, each of which has two 115-foot-long arrays, for a total wing span of 240 feet, including the equipment that connects the two halves and allows them to twist as they track the sun. Altogether, they can generate 66 kilowatts of electric power, enough for 20 2,800 ft2 homes.

The objective is to increase ISS crew support capabilities to 6 during 2009

The International Space Station (ISS) Feb 2009

STS 119: Mission Specialist Richard Arnold participates in the third spacewalk as construction and maintenance continue on the International Space Station. Phillips and Magnus used the station's robotic Canadarm2 to grapple the 31,000-pound, 45-foot-long S6 truss segment carefully out of the shuttle's payload bay and over to the shuttle's robotic arm operated by Antonelli and Acaba.

The International Space Station (ISS) Feb 2009



STS 119:Backdropped by the blackness of space and Earth's horizon, the International Space Station is seen from Space Shuttle Discovery as the two spacecraft begin their relative separation .

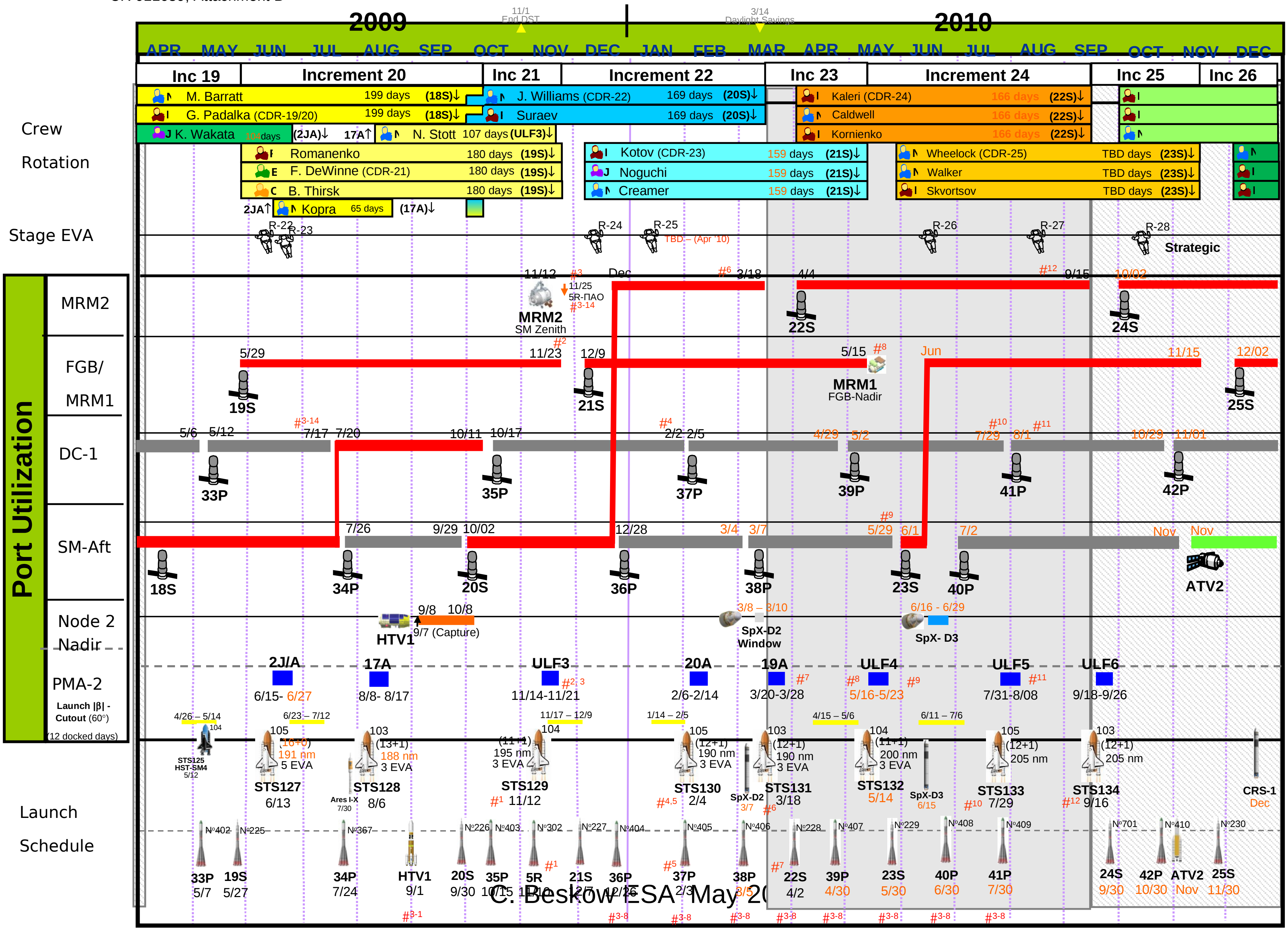
Recent and upcoming Expeditions

Exp 17	0804 – 0810	S. Volkov (cmdr) O. Kononenko
Exp 17 / 18		G. Chamitoff
Exp 18	0810 – 0904	M. Fincke (cmdr), Y. Lonchakov, Magnus
Exp 18 / 19	0902 – 0905	JK Wakata
Exp 19	0904 – 0905	M. Baratt, G. Padalka (cmdr), N. Kopra
Exp 20	0905 – 0910	R. Romanenko, F. De Winne, B. Thirsk
Exp 21	0911 – 0912	F. De Winne (cmdr), R. Thirsk, R. Romanenko, N. Scott, M. Suraev, J. williams (Exp 13)

Exp 18 : Flight Engineer Koichi Wakata, Commander Gennady Padalka and Flight Engineer Michael Barratt

Exp 20/21 : ESA astronaut Frank De Winne

CR 011639, Attachment B



The International Space Station (ISS) Europe's Contribution

Europe, working through ESA, is exclusively responsible for two key station elements: the Columbus Orbital Facility and the Automated Transfer Vehicle (ATV).

The Columbus Orbital Facility represents a substantial part of the station's research capability. Fitted with 10 interchangeable payload racks, Columbus is a multifunction laboratory that will specialise in research into fluid physics, materials science and life sciences. Europe's second biggest contribution is the Automated Transfer Vehicle (ATV), a supply ship lifted into orbit by the Ariane-5 launcher.

The ATV will carry up to nine tonnes of cargo including provisions (food, water, gas), scientific payloads and rocket propellant. Once docked, the ATV will use its engines to maintain the ISS in its orbit, counteracting the faint drag from the Earth's atmosphere.

The International Space Station (ISS) Europe's Contribution

DMS-R : The Data Management System (Russian), developed as part of a barter agreement with RSCE, has been a key part of the station's 'brain' since its July 2000 launch aboard the Russian Zvezda Service Module.

Nodes : Europe will build two of the three nodes that link station components

Cupola : a dome-like structure that will be the crew's panoramic window on space and a control room for astronauts operating station equipment. **(Jan 2010 STS 132)**

ERA : The European Robotic Arm will service payloads on a later Russian external platform

Multi Purpose Logistics Modules (MPLM) built by Aleniaspazio (IT) pressurised transfer modules - Leonardo, Raffaello and Donatello - will be used by the Shuttle to carry pressurized cargo to and from the station.

Inside the United States Destiny research module, for instance, Europe will mount, among other equipment, a specialized material science rack and freezer units. The Japanese Experiment Module will also use a European freezer

The International Space Station (ISS) Europe’s Contribution

Europe will also be providing people. European astronauts have flown in space since 1983 and since 1998 the European Astronaut Centre in Cologne has concentrated on training men and women for future ISS missions.

The first European to serve a tour of duty on the ISS, Umberto Guidoni, went on mission to the ISS in April 2001.

Only a tiny fraction of the Europeans working on the ISS will ever visit space of course. Just because the ISS is growing into the brightest object in the night sky - after the moon - it is easy to forget that much of the project's people and hardware are based not out in space but firmly on the ground.

European mission control centres will share station command with Russia and the United States and direct on-board experiments. The astronaut/researchers on the ISS will always be part of a much larger scientific team on Earth.

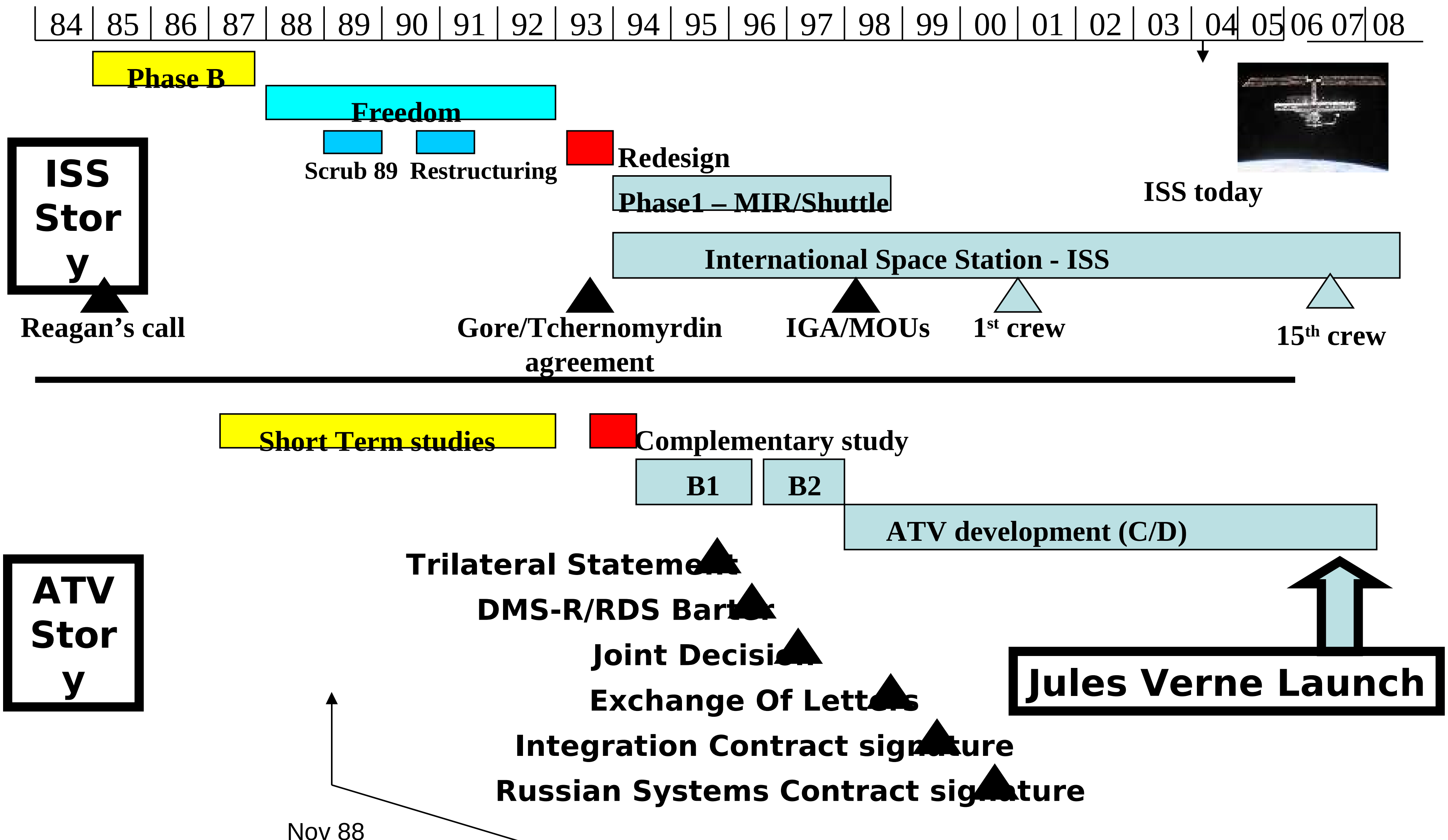
And now, as of

February 2008 : Europe contributes with Columbus (permanently attached) &

March 2008 : Europe contributes with ATV

The International Space Station (ISS)

History of ISS and ATV



Expeditions on the ISS

How many expeditions so far?
How many nationalities ?
How many Europeans?
How many women?
How many visitors (tourists)?

Williams and Glovebox

Expeditions on the ISS

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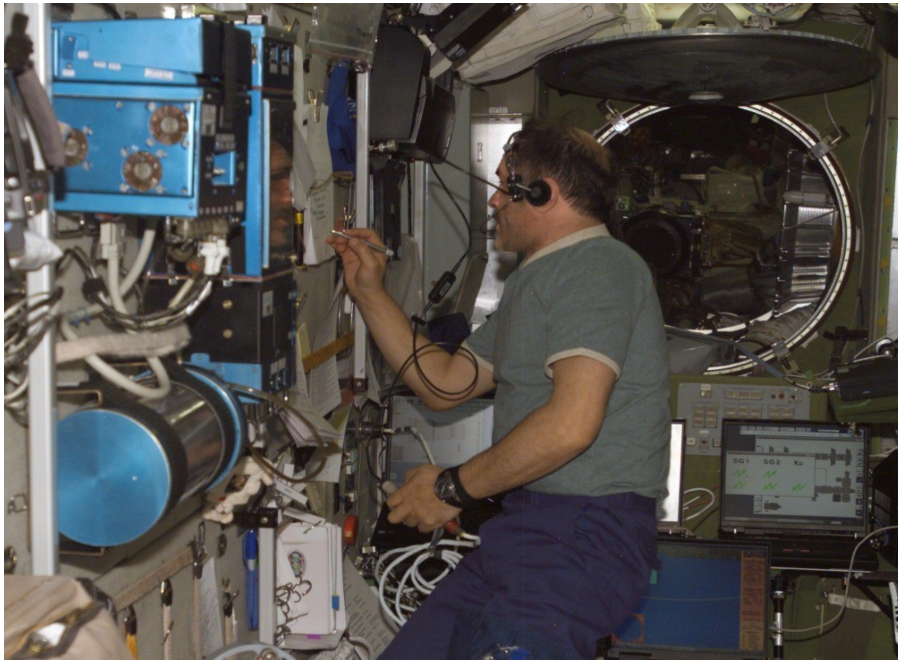
Williams and Glovebox

Expeditions on the ISS

How many expeditions so far? 18
How many nationalities? 4 (counting only Expedition crews, (16+ RU, 16+ USA, 1 DE, 1 JA)
How many Europeans? 1 (Reiters DE).
F de Winne (BE) will fly Exp 20 (May 09) and will command Exp 21 (1st European commander!!)
7 others have flown Taxi flights (Soyuz) Guidoni, Vittorix2 (IT), Haignere, Perrin (FR), de Winne (BE), Duque (ES), Kuipers (NL).
Fuglesang (SE) flew Shuttle mission STS 116 and will fly STS 128 in Aug+ 09
How many women? 3 (Susan Helms (2), Peggy Whitsun (5 &16), S. Williams (15))+C. Haignere
How many visitors? 6 (D.Tito, M.Shuttleworth, G. Olsen, A. Anshari, C. Simonyi, Sheikh M. Shukor)

Vinogradov and SM comm. system



GEOPHYSICS RESEARCH : MOLNIYA-SM EXPERIMENT

Investigation of optical emissions in the Earth atmosphere and ionosphere associated with thunderstorm and seismic activity

TASKS:

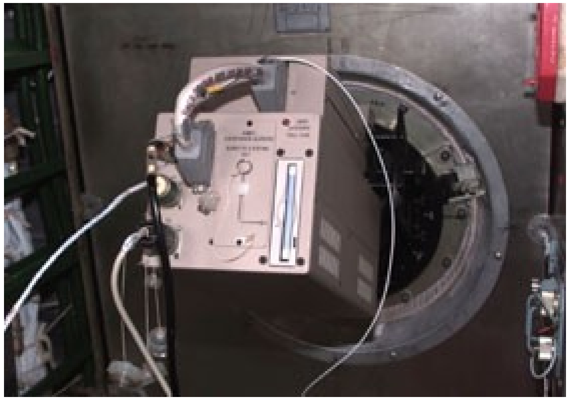
Development tests of methods for monitoring of thunderstorm activity, optical emissions of the Earth atmosphere and ionosphere under different geographic and geophysical conditions.

Obtaining statistical data on global distribution of thunderstorm activity in lower and middle latitudes.

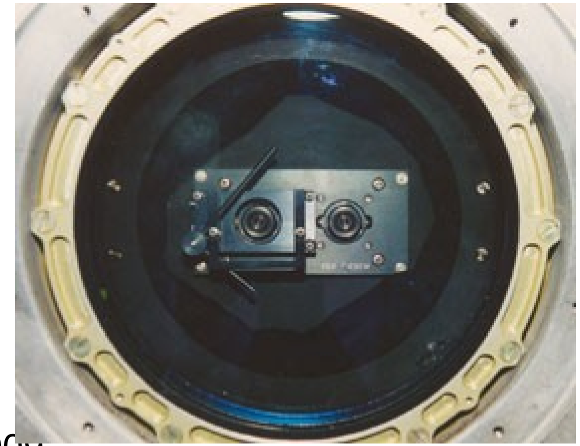
Investigation of night sky luminescence over areas of seismic activity.

VFS-3M video photometry system

LSO equipment



microcamera on rotary bracket



Human Life Research : PROGNOS

Development of a real-time prediction method for radiation loads on the crew.

TASKS:
Acquisition and processing of experimental data on a daily-average dose rate, solar activity parameters and investigation of their relation to orbit ballistic parameters

- Dosimeter R-16
for measuring an absorbed dose of
ionizing radiation
Dose sensitivity of 50 mGy/pulse

TECHNICAL RESEARCH   "F/PKE" EXPERIMENT ("PLASMA CRYSTAL 3")

A study of growth of plasma-dust structures in zero gravity.

A study of particle clouds behavior and internal flow structure in plasma-dust crystals..

TASKS:

Conducting two series of measurements that are needed to study the physics of the particles contained in low-pressure plasma, and to study quasi-stable plasma structures formed out of these particles.

experimental unit "Plasma crystal 3";

two TEAC video tape recorders, included in the on-board "Telescience" equipment.

Expedition 18 :The Exposing Specimens of Organic and Biological Materials to Open Space (Expose-R) experiment was installed on the universal science platform mounted to the exterior of the Zvezda Service Module

The International Space Station (ISS) : Expedition 19

Expedition 19 : Expedition 19 crew (from left: Flight Engineer Koichi Wakata, Commander Gennady Padalka and Flight Engineer Michael Barratt)

Technical Reseach : The first contract research activity to be performed on the ISS Russian Segment is ESA-provided Global Time System experiment.

It has become necessary to receive high-precision time signals by various users, i.e. Institutes of Nuclear Physics.

A possibility of precise time signals downlink from a low-orbit vehicle several times per day is first provided. In so doing, virtually all densely populated areas of the Earth are covered.

Thanks to the original software and signal modulation it is possible to receive time codes depending on the time zone.

The experiment tests time signal and data signal receiving conditions on the ground by dedicated receivers. The time signal will have a dedicated code which enables the receiver to determine a local time in any location on the Earth with no user involvement

CONTRACT ACTIVITIES : EXPERIMENT GTS (for ESA)

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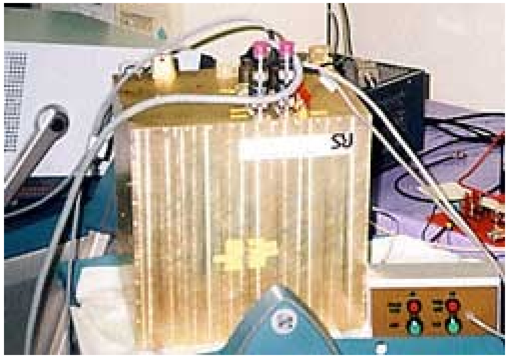
CONTRACT ACTIVITIES : EXPERIMENT GTS (for ESA)

Tasks:
Installation of electronics unit and connection of the GTS equipment to the ISS service systems, performance of test activation of the GTS electronics unit and transmitters, as well as long-duration (for 658 days) activation of the GTS equipment with a 400 MHz transmitter.
Testing of time signal generation conditions using special ground receivers.
Checking the quality of the signal generated on the ground and data transfer rates.
Measuring disturbing effects of Doppler shift, retroreflections, shading and angle of elevation on the time signal.

Transmitters of 400 MHz, 1.5GHz band ,
Receiver of 450 MHz band



Antenna unit with attachment mechanism