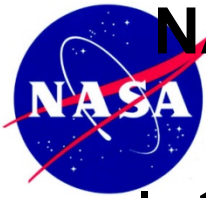




# **NASA's Behavioral Health Support for International Space Station (ISS) Missions**

Gary Beven, MD  
NASA Flight Surgeon  
Chief of Aerospace Psychiatry  
Human Space Operations Branch  
Behavioral Health & Performance Group  
Johnson Space Center

Cleveland Clinic Department of Psychiatry and Psychology Grand Rounds  
September 13, 2012



## **NASA's Behavioral Health Support for ISS Missions**

- Intro to Johnson Space Center and the Behavioral Health and Performance Group
- A brief history of long duration space flight
- The challenges of long duration space flight
- What services we provide for ISS crews
- Some lessons learned from ISS support
- Exploration mission predictions and needs



# Basic Goals

- Too much great information for a one hour presentation!
- Will only scratch the surface (sorry)
- If you come away with a greater appreciation for human spaceflight history and a basic understanding about how NASA provides behavioral health support to space station crews I will have succeeded.



# Johnson Space Center







# Mission Control Center





- **Aerospace Medicine**

- Aerospace medicine is a sub-discipline of preventive and occupational medicine that ties together physics, physiology, life support, engineering, and medicine to protect aircrew and patients in the realm of aerospace

- **Flight Surgeon**

- Operational practitioner of aerospace medicine
- Flight surgeons are physicians who are primarily responsible for the medical evaluation, certification and treatment of military aviation personnel — e.g., pilots, naval flight officers, navigators/combat systems officers, and astronauts

- **Space Medicine**

- Space medicine is the practice of medicine related to astronauts and space missions

- **Aerospace Psychiatry**

- Merging of the disciplines of aerospace medicine, space medicine and psychiatry
- Focus on maintaining peak mental/psychological fitness of aviators and astronauts in challenging circumstances and environments



## 5 NASA Civil Service Flight Surgeon/Psychiatrists in History of the Human Space Program

- Patricia Santy, MD: 1984-1991 Author of *Choosing the Right Stuff*
- Roy Marsh, MD: 1991-1996
- Chris Flynn, MD: 1996-2004 Initial long duration mission experience
- Frank Carpenter, MD: 2001-2008
- Gary Beven, MD: 2005-present
- Prior to 1984 psychiatric consultation to the space agency was performed by contractors or military psychiatrists





## JSC's Behavioral Health and Performance Group (BHP)

- BHP is a component of the JSC Human Space Operations Branch
  - **ISS mission psychological/behavioral health support**
  - Astronaut candidate psychological and psychiatric screening
  - Clinical evaluation and care of astronauts and dependants
  - Occupational mental health evaluation of NASA divers, pilots and flight controllers
  - Consultants to the JSC Human Research Program
  - Consultants to NASA flight surgeons, ISS crew surgeons, the Astronaut Office, and JSC management
  - Consultants to the JSC Employee Assistance Program Office
  - Great group of civil servants and contractors



## BHP Mission

- The JSC BHP is focused on ensuring that ISS crew members are psychologically prepared for the rigors of long duration spaceflight
- BHP provides individualized behavioral health and psychological support services directly to ISS crew members and their families before, during and after each ISS mission
- Our goal is a safe, productive, and enjoyable spaceflight experience—hopefully a peak life event
- We have a great team of civil servants and contractors, a wonderful task and do it extremely well



## JSC Behavioral Health & Performance Team





# SPACE PSYCHOLOGY AND PSYCHIATRY

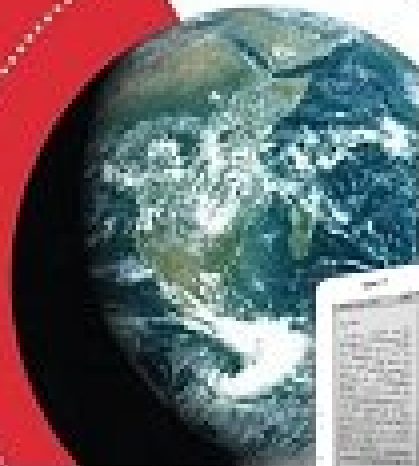
2nd Edition

1st Edition:  
*Winner of 2004 International Academy of  
Aeronautics Life Sciences Book Award*

M. Kanas and D. Manzey

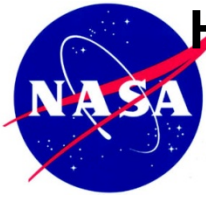


Space  
Technology  
Library



kindle edition



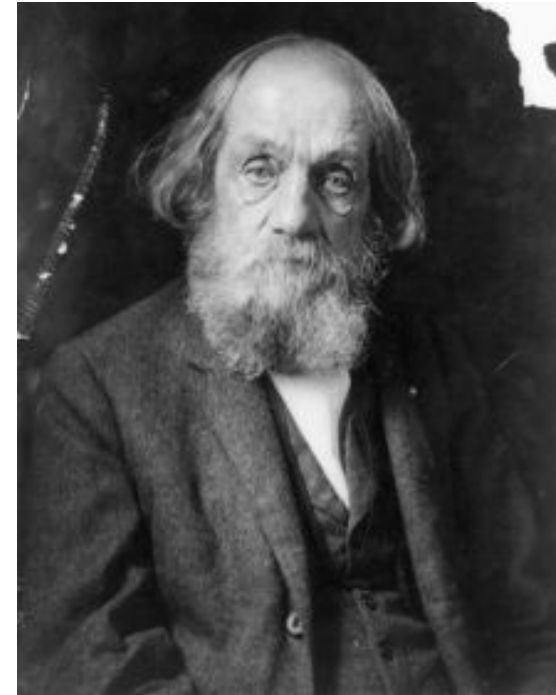


## History of Space Stations and Long Duration Spaceflight

### *Edward Everett Hale*

March 3, 1822—June 10, 1909

- American Author and Unitarian clergyman
- Wrote short story “The Brick Moon” in 1869
- Tale describes the construction and orbital launch of a 200 foot sphere made of bricks (accidentally carrying people)
- **First known fictional description of a satellite and space station**



Note: In 1865 Jules Verne had published his novel, [\*From the Earth to the Moon\*](#), which includes the notion of human spaceflight but not the idea of an artificial satellite or space station.



# Konstantin Tsiolkovsky

September 17, 1857—September 19, 1935

- **Soviet rocket scientist and pioneer in astronautic theory—*the father of human spaceflight***
- **First scientific theorist of space travel and rocket propulsion**
- **In 1903 wrote “The Exploration of Cosmic Space by Means of Reaction Devices”—58 years before Yuri Gagarin’s flight in 1961**
- **Published over 500 works including the first space station designs.**
- **“I’m absolutely sure, based on my theories, that interplanetary journeys will become a reality.”**





# V2 Rocket

## *Vergeltungswaffe 2*--"Retaliation/Vengeance Weapon 2"



- World's first ballistic missile
- First human artifact to achieve suborbital spaceflight
- Progenitor of all modern rockets and missiles
- 3000 launched in WWII causing 7500 casualties
- 20,000 slave laborers died during their manufacture



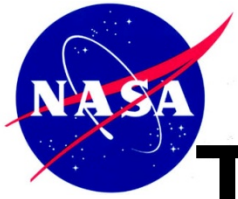
# Dr. Wernher von Braun

**Developer of the V2 and preeminent rocket scientist of the 20th Century**



- Nazi developer of V2 rocket
- Surrendered to Americans at end of WWII to prevent soviet capture
- Spent 5 years in “exile” at Ft Bliss in El Paso, TX
- Became relevant, and his Nazi past “forgiven”, due to technical needs of the cold war
- Developed the Redstone Rocket and the Saturn V
- Became Director of the Marshall Space Flight Center





# Sergei Korolev

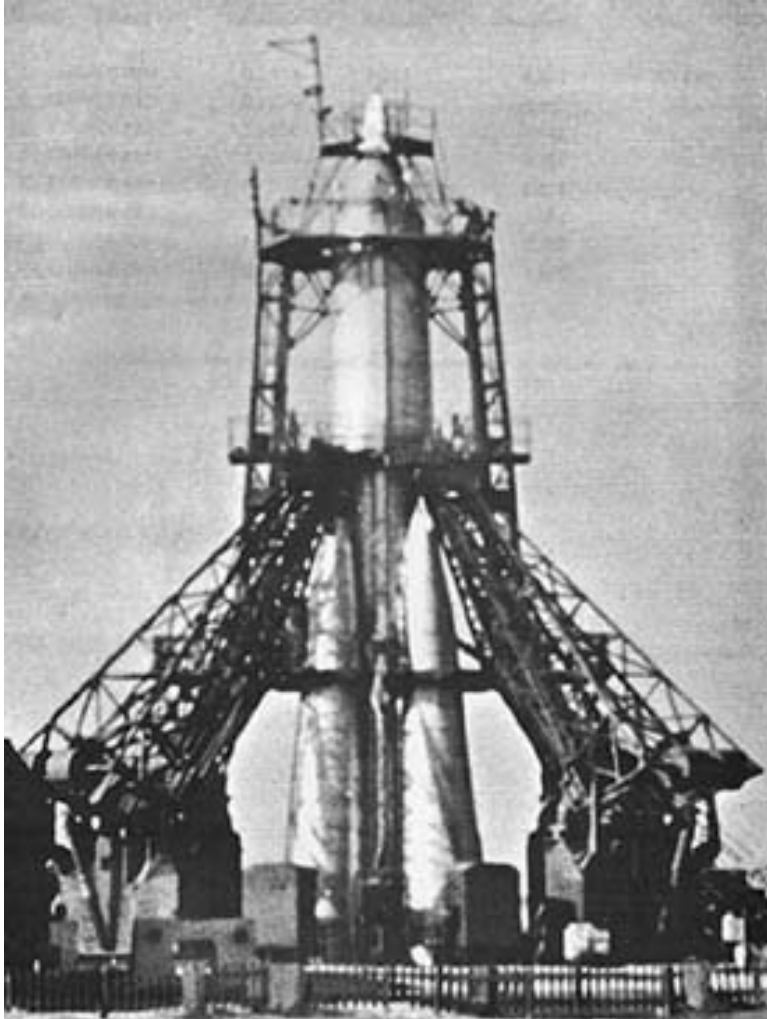
## The Soviet “Chief Designer”



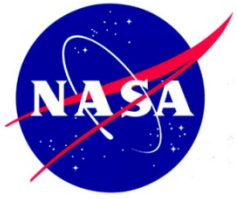
- In Soviet Gulag until start of WWII
- Sent into occupied Germany to capture V2 technology in 1945—arrived just after Americans had left
- Preeminent Russian rocket scientist of 20<sup>th</sup> century
- Developed the R7 and Sputnik



## Soviet R7 Intercontinental Ballistic Missile Initial launch test in May, 1957



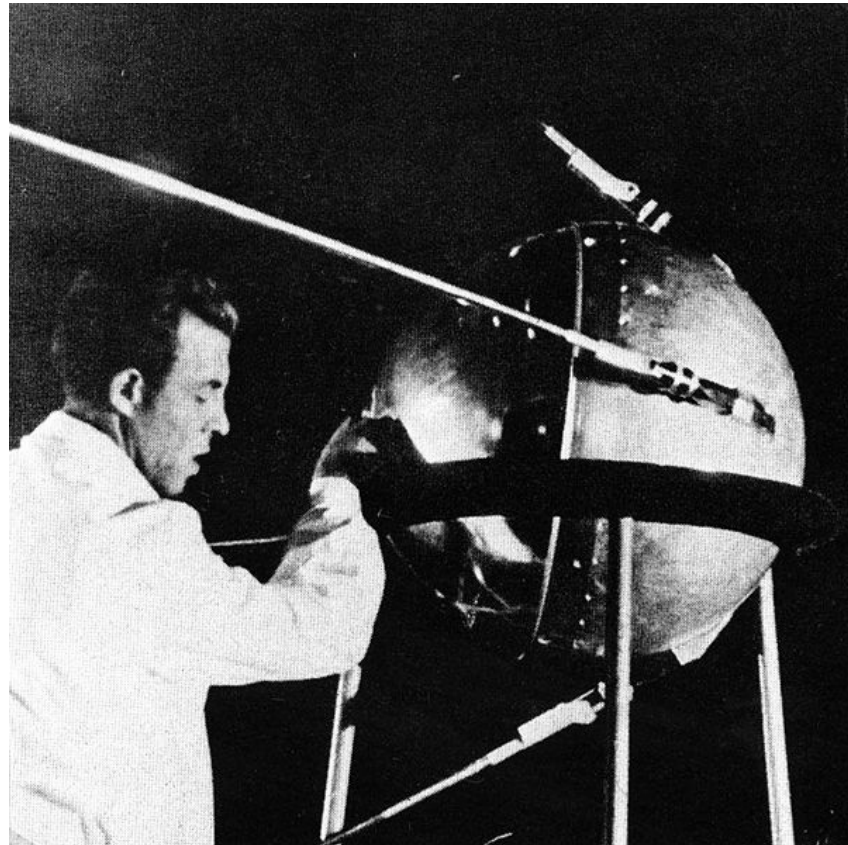
- World's first ICBM
- First two stage rocket
- 5.4 ton payload
- Single 3 megaton nuke
- 5000 mile range
- 1,000,000 lbs thrust!
- Launch vehicle for Sputnik
- Baikonur complex in Kazhakstan developed to launch the R7
- Built to neutralize huge US bomber numerical advantage (B-52's)



# Sputnik 1

"Простейший Спутник-1", or *Elementary Satellite 1*

October 4, 1957





# RED MOON RISING

Sputnik and the Hidden Rivalries  
That Ignited the Space Age



"In his exuberant narrative of the superpower space race . . . [Brzezinski] tells the story of American and Soviet decisions with remarkable dramatic—even cinematic—flair." —*The New York Times Book Review*

**MATTHEW BRZEZINSKI**



# Laika—first mammal in space

First orbital death

November 3, 1957

The first dog in space, the two-year-old Laika, blasted off on November 3, 1957. Her spacecraft, Sputnik-2, was to make a long, seven-day orbital flight and was not expected to return.





# NASA's Mercury 7

- Alan Shepard USN
- Gus Grissom USAF
- John Glenn USMC
- Scott Carpenter USN
- Wally Schirra USN
- Gordon Cooper USAF
- Deke Slayton USAF



- **Mercury Seven** was the group of seven Mercury astronauts selected by NASA on April 9, 1959.
- They are also referred to as the **Original Seven** and **Astronaut Group 1**.



# NASA Astronaut Selection

- 20 Astronaut Classes 1959 to 2009
- 339 total astronaut candidates selected
- 1996 largest class—44
- Current active astronauts: 51
- 6200 Applications for class of 2013 (currently being reviewed)



# Class of 2009 Applicants

- First astronaut selection exclusively for long duration crew members
- **3535** applications (on-line application via [usajobs.gov](http://usajobs.gov))
- **113** “semifinalists” invited to Round 1 initial Astronaut Selection ASB interview, medical history review and psychological testing
- **48** “finalists” invited back for Round 2 ASB interview, full medical testing, behavioral interview and assessment (roughly 10 per week)
- **9** Astronaut candidates chosen





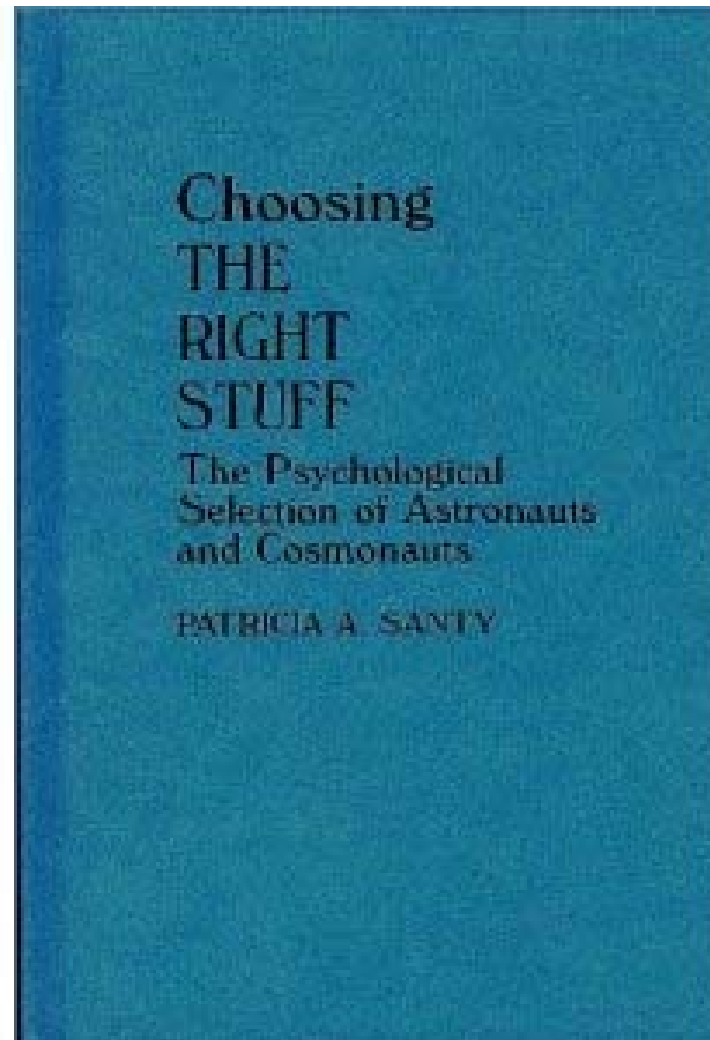
# Astronaut Candidate Selection

- **Extensive medical/psychiatric screening for all final candidates:**
  - Comprehensive history and physical examination by NASA flight surgeon
  - Examination by neurologist
  - Examination by otolaryngologist
  - Examination by optometrist
  - Hearing booth audiology assessment
  - 24 hour ECG monitoring
  - Cardiac stress testing with VO2 max
  - Echocardiogram
  - Cardiac EBCT
  - Carotid Doppler
  - Thyroid ultrasound
  - Pulmonary function tests
  - Dexascan
  - MRI and MRA of brain
  - MRI of the sinuses
  - Colonoscopy
  - CXR
  - Abdominal and renal ultrasound
  - GYN exam for females including mammogram and pelvic ultrasound
  - Extensive lab work
  - **Psychiatric/psychological examination (3 hours)**
  - **Psychological testing (4 hours)**



# Choosing the Right Stuff

Published 1994





# Yuri Gagarin—First human in space

12 April, 1961





# Yuri Gagarin Statue in Star City, Russia





# Freedom 7 Mission

## First American in Space

On May 5, 1961, Alan Shepard piloted the Freedom 7 mission

“Let’s light this candle!”





"One of the finest books ever written about the space program. On nearly every page of this fine book, I learned something new. Neal has given Shepard's unique humanity a chance to emerge from not only the legend that NASA built around him but the one he built around himself. Alan Shepard, it turns out we didn't know you, after all. Light this candle, indeed."

—HOMER HICKAM, author of *ROCKET BOYS*

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# LIGHT THIS CANDLE

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The Life & Times of ALAN SHEPARD



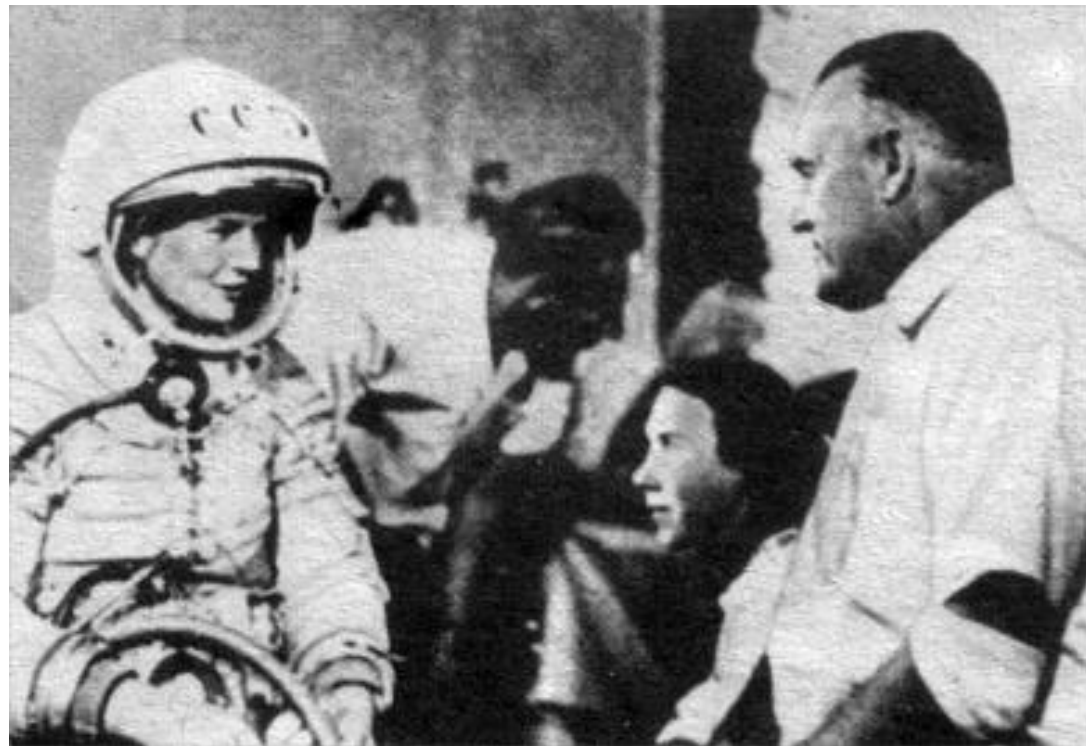
NEAL THOMPSON

With a new Foreword by Chris Kraft, bestselling author of  
*Flight: My Life in Mission Control*



# Valentina Tereshkova

- First woman to fly in space
- Launched June 16, 1963 on Vostok 6





# Yuri Gagarin & Valentina Tereshkova

First man and woman in space







# Boris Yegorov

First Physician in Space  
Flew on Voskhod 1 Mission  
October 12, 1964



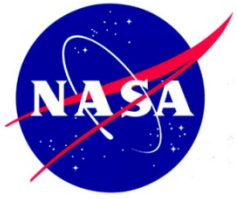


# Joseph A Walker

The first American civilian to fly in space on July 19, 1963  
An unsung hero of human spaceflight



- The first NASA pilot to fly the X-15
- Flew the X-15 24 times, including the only two flights that exceeded 100 kilometers
- Walker became the first human to fly into outer space twice



# Sally Ride

First American Woman in Space  
Flew June 18, 1983 on STS-7





Spaceflight is inherently dangerous





# Spaceflight Deaths

- 18 crew deaths during spaceflight
  - 1967 Soyuz 1—1 death
    - Trauma from Earth surface impact
  - 1971 Soyuz 11—3 deaths
    - Asphyxia from cabin breach
  - 1986 Space Shuttle Challenger—7 deaths
    - Trauma from Earth surface impact (mission never reached space)
  - 2003 Space Shuttle Columbia—7 deaths
    - Asphyxia from cabin breach or trauma from object impact



# Vladimir Mikhaylovich Komarov

## First inflight human fatality in history of spaceflight April 23, 1967

Just before impact, Soviet premier Alexey Kosygin told Komarov his country was proud of him. An American NSA listening post in Istanbul noted Komarov's reply was inaudible, though persistent rumours stated that Komarov died cursing the spacecraft designers and flight controllers.





# Space Stations

- No major propulsion system
- No landing system
- Other space vehicles are required for transport to and from
- **Monolithic stations** (Salyut stations and Skylab) constructed and launched in one piece, then manned later by a crew
- **Modular stations** (Mir and ISS) have a core unit and additional modules with different purposes were added later
- Question: How many space stations have their been in history?



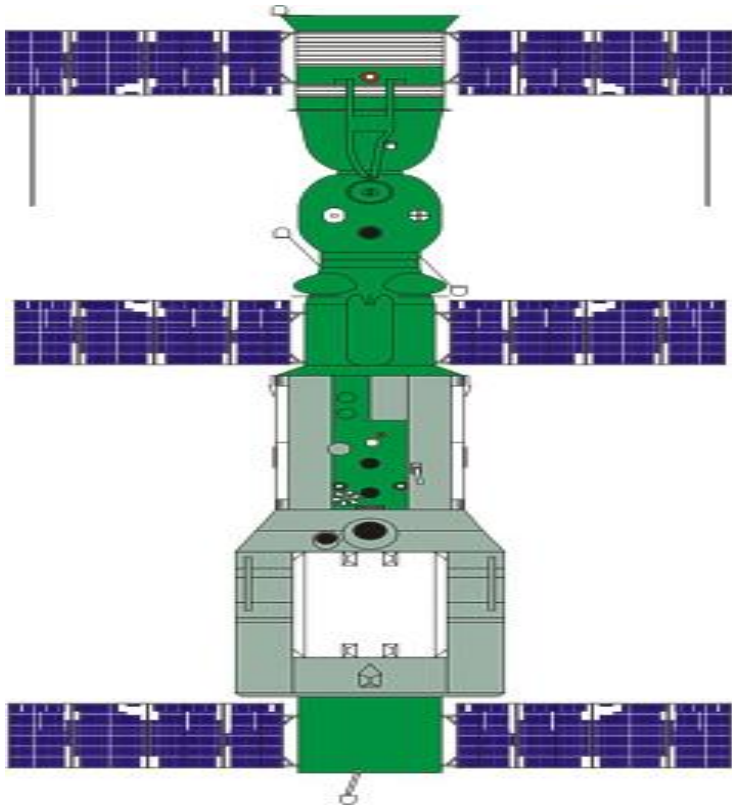
# History of Long Duration Spaceflight

- 41 years of space station operations (1971-2012)
- Space Stations (10 total):
  - **Salyut stations 1—7 (Russia)** April 19, 1971—February 7, 1991; 38 Missions (11 long duration) *Note: Salyut 2 was never manned*
  - **Skylab (US)** May 14, 1973—July 11, 1974; 3 missions (2 long duration)
  - **Mir (Russia)** February 20, 1986—March 23, 2001; 39 missions (28 long duration)
  - **International Space Station (ISS)** November 20, 1998—present; (32 long duration missions so far)





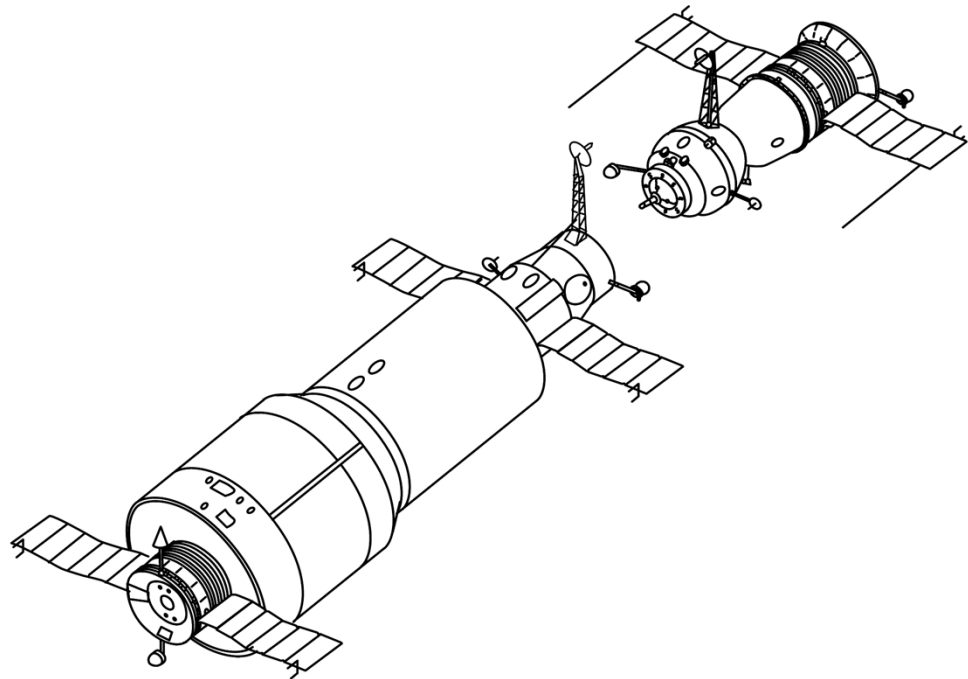
# Salyut 1—the World's 1<sup>st</sup> Space Station (April 19, 1971)





# Salyut 1

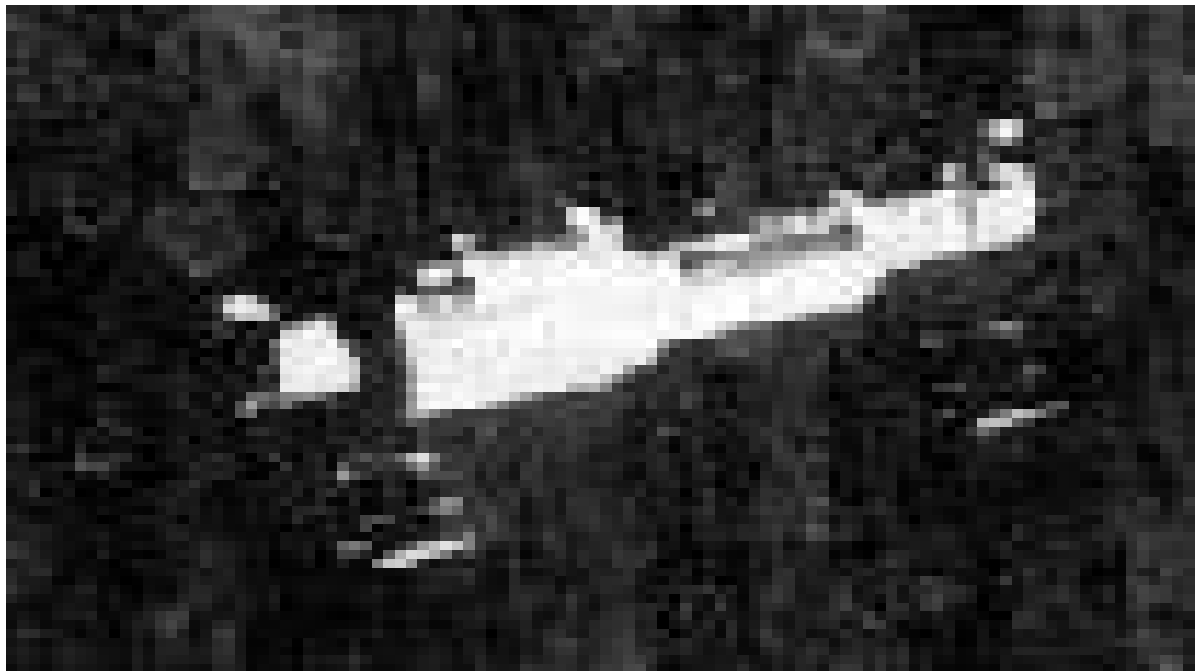
- Soyuz 10 crew unable to board due to docking mechanism failure
- Soyuz 11 crew spent 23 productive days on orbit
- Tragedy on reentry





# Salyut 1

- First space station crew died during Soyuz 11 reentry on 24th day in space secondary to decompression (and no pressure suits) on June 30, 1971. It was de-orbited in October, 1971 before it could be revisited.





# Salyut 2

- Launched April 4, 1973
- Salyut 2 was never manned due to depressurization and flight control failure after achieving orbit





# Skylab—NASA's First Space Station (1973-74)

Skylab 2 (May 25, 1973) was the first NASA space station mission

28 days in space

Joe Kerwin, Pete Conrad, Paul Weitz

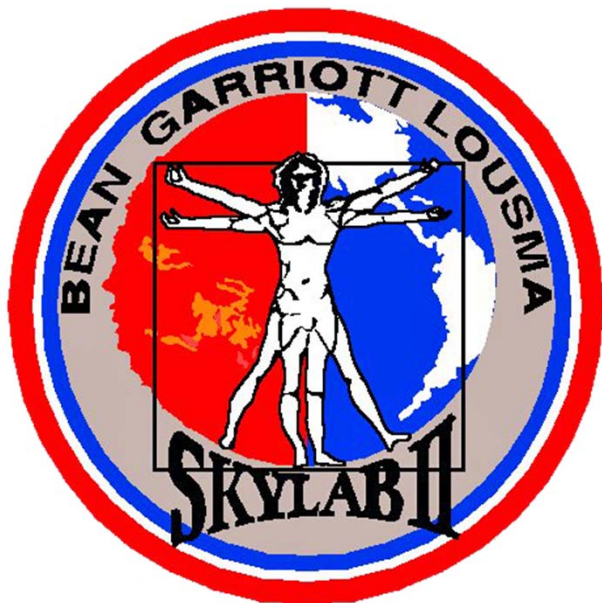




# Skylab—NASA's First Space Station (1973-74)

Skylab 3 (July 28, 1973) was the first long duration crew in History—59 days in space

Owen Garriott, Jack Lousma, Al Bean





## Skylab—NASA's First Space Station (1973-74)

Skylab 4 (November 16, 1973) was the second long duration crew in History—84 days in space

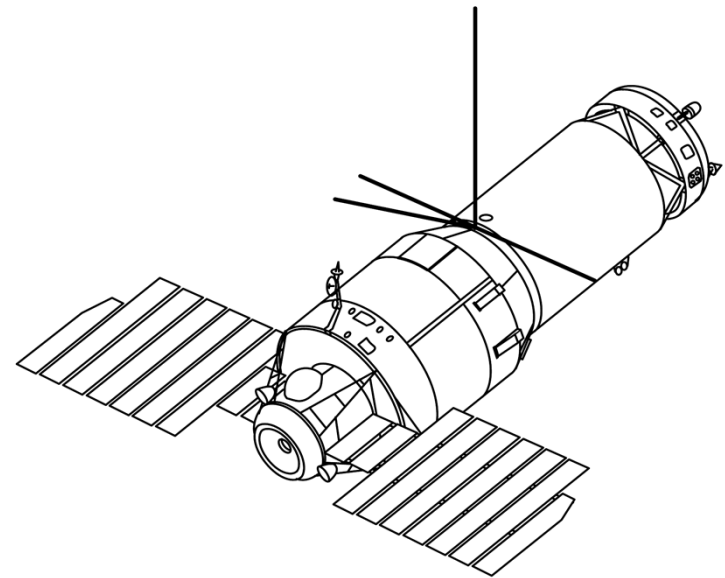
Gerald Carr, William Gibson, Edward Pogue





# Salyut 3 (1974-75)

- One 16 day mission
- Launch June 25, 1974
- No further NASA space station  
Missions until mid 1990's on Mir

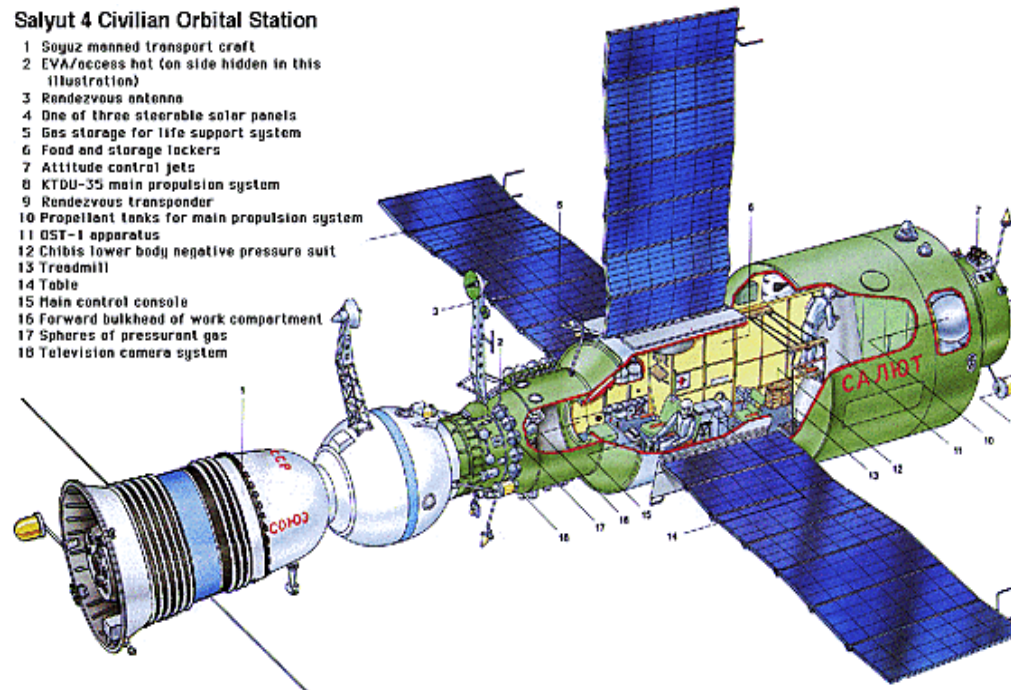






# Salyut 4 (1974-77)

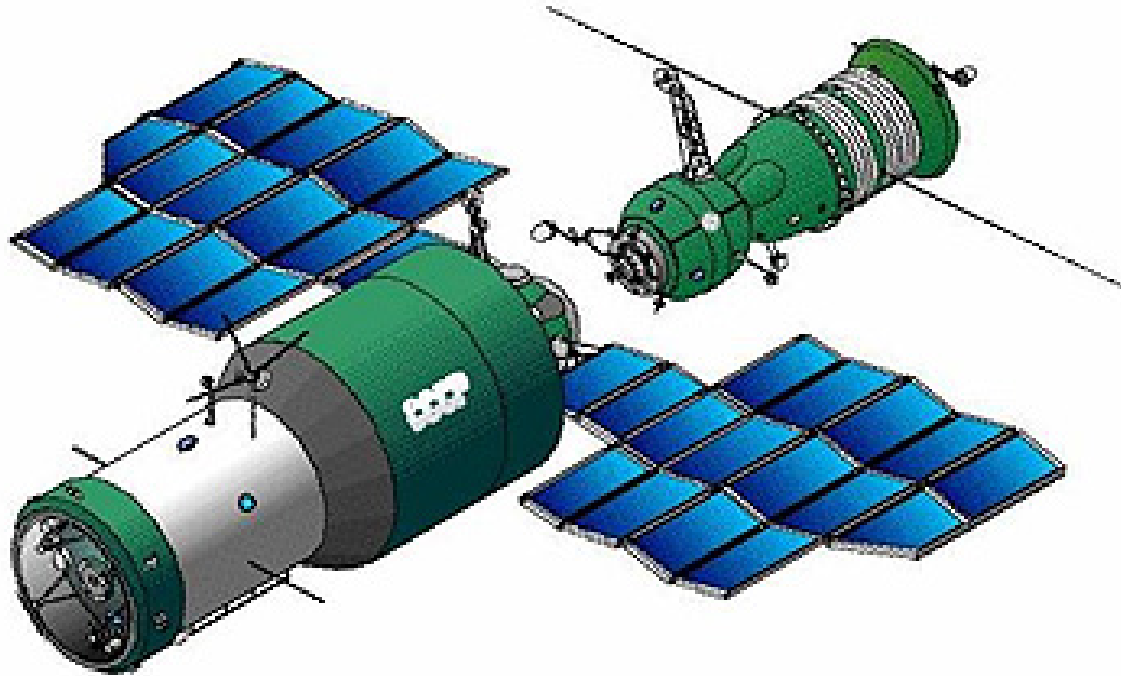
- First Russian long duration space mission (63 days) in 1975
- Two expeditions (3<sup>rd</sup> failed due to launch abort)





# Salyut 5 (1976-77)

- Two missions including Soyuz 21 Expedition of 49 days



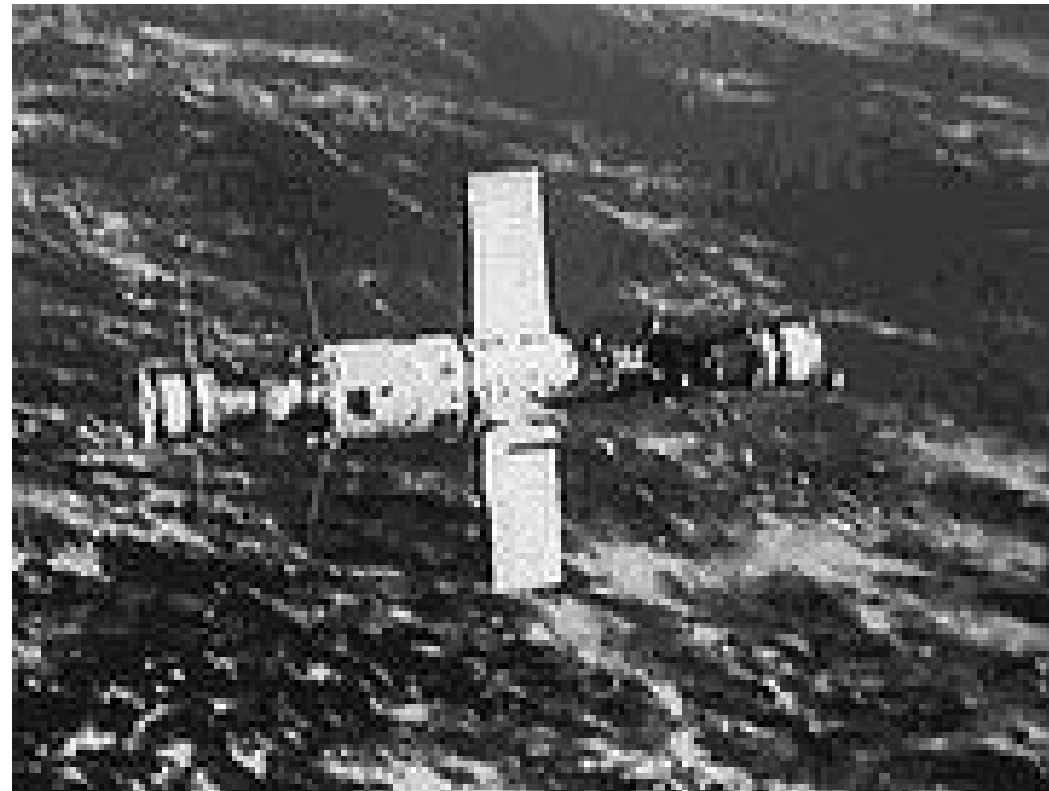


# Salyut 6 (1977-82)

First Space Station involving ultra-long expeditions

17 Expeditions 1977-1981

Five long duration missions including 1980 EO-expedition of **185 days (first 6 month mission)**

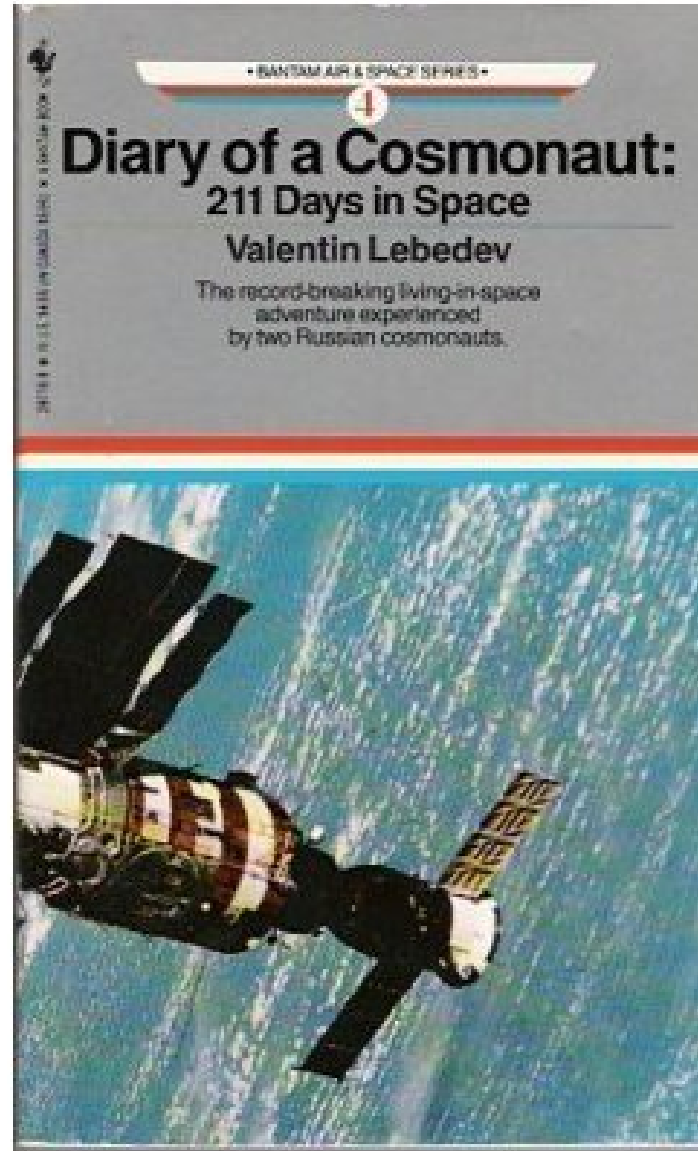
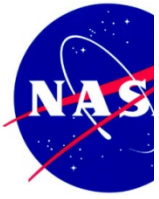




# Salyut 7 (1982-91)

- Six long duration missions
- 12 Expeditions
- EO-3 Expedition in 1984  
of **237 days!**







# Mir (1986-2001)

## First Modular Space Station

- 28 long duration missions
- 3 cosmonauts completed single missions greater than one year in duration
- Shuttle—Mir Program (1995-1998)
- Manned continuously for 8 days shy of ten years (1989-1999)





## Shuttle—Mir Crew Members 1995-1998

NASA's First Modern Era Long Duration Astronauts

Norman Thagard, Shannon Lucid, Dave Wolf  
John Blaha, Jerry Linenger, Michael Foale, Andy Thomas



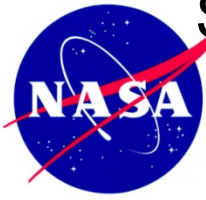


# Valeriy Vladimirovich Polyakov, MD

- Single spaceflight duration record holder—**437.7 days on Mir!**
- January 1994 to March 1995
- Russian cosmonaut
- Medical doctor
- Two Mir missions totaling 679 days





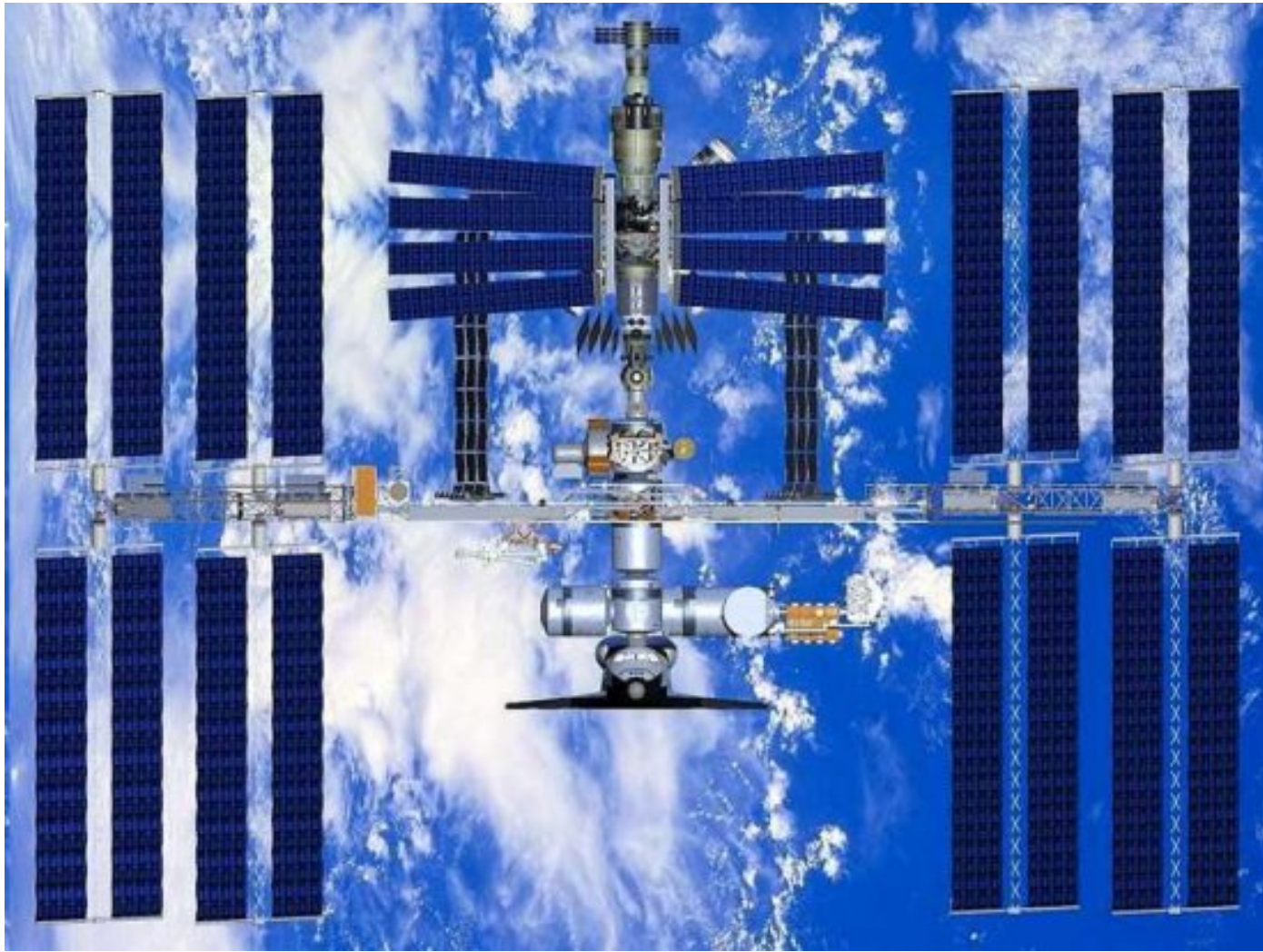


# Spaceflight History—STS 114 Commander Eileen Collins & ISS 16 Commander Peggy Whitson





# International Space Station





# The International Space Station

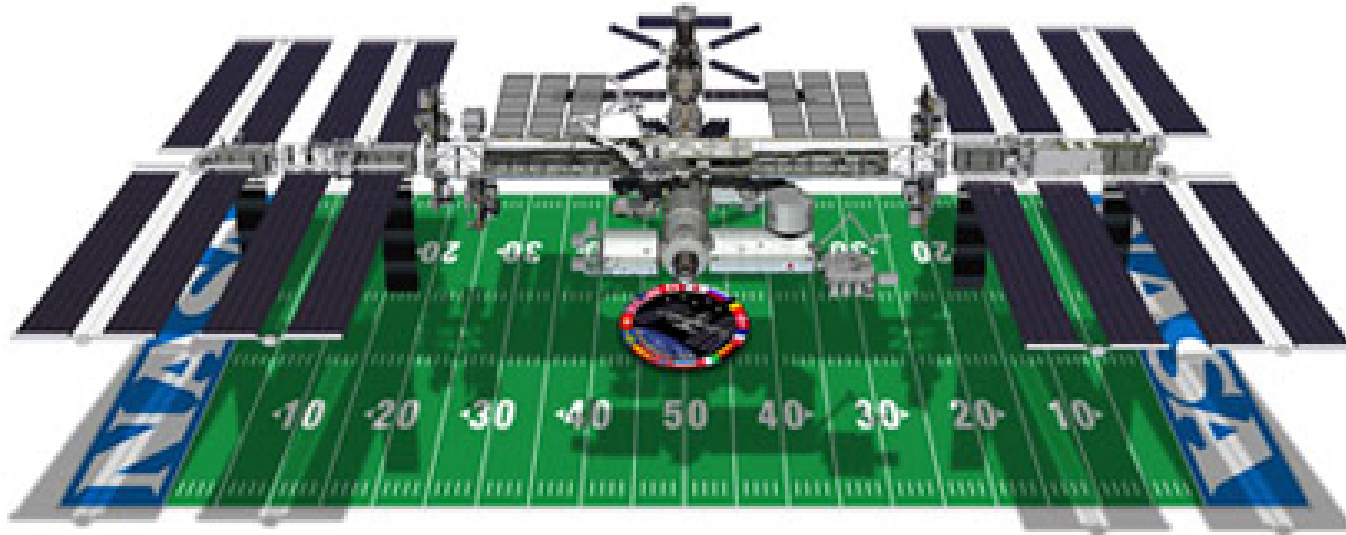
- **ISS Basic Facts:**

- **Mass 924,739 pounds**
- **Habitable Volume: 13,696 cubic feet**
- **Pressurized Volume: 32,333 cubic feet**
- **Module Length: 167.3 feet (51 meters)**
- **Truss Length: 357.5 feet (109 meters)**
- **Solar Array Length: 239.4 feet (73 meters)**
- **191 ft long x 146 ft wide x 90 feet height (current size)**
- **Power Generation: 8 solar arrays = 84 kilowatts**
- **Orbit—180 nautical miles**
- **Speed—17,239.2 mph (15.79 orbits per day)**
- **Estimated cost \$100 billion**
- **Continuously occupied since 2000**
- **36 NASA long duration crewmembers to date**
- **Maximum crew of six (began June 2009)**
- **First female space station commander Peggy Whitson (ISS Expedition 16)**





# Relative Size of ISS





# ISS Expedition 1 Crew

- NASA astronaut Bill Sheperd, the first ISS Commander with cosmonauts Yuri Gidzenko and Sergei Krikalev





# ISS Expedition 32 Crew

## Currently in Orbit





# The International Space Station

- ISS NASA crew members—36 long duration astronauts thus far (3 have flown twice)
  - Expedition 1 Bill Sheperd--2000
  - Expedition 2 Jim Voss & Susan Helms (first female)
  - Expedition 3 Frank Culbertson
  - Expedition 4 Dan Bursch & Carl Walz
  - Expedition 5 Peggy Whitson
  - Expedition 6 Ken Bowersox & Don Pettit (STS 107 disaster)
  - Expedition 7 Ed Lu
  - Expedition 8 Michael Foale
  - Expedition 9 Mike Fincke
  - Expedition 10 Leroy Chiao
  - Expedition 11 John Phillips
  - Expedition 12 William McArthur
  - Expedition 13 Jeffrey Williams
  - Expedition 14 Michael Lopez-Alegria & Suni Williams
  - Expedition 15 Clay Anderson



# The International Space Station

- **ISS NASA crew members (34 total so far)**
  - Expedition 16 **Peggy Whitson (#2) & Dan Tani**
  - Expedition 17 **Garrett Reisman & Greg Chamitoff**
  - Expedition 18 **Mike Fincke (#2) & Sandy Magnus**
  - Expedition 19/20 **Mike Barratt, Tim Kopra & Nicole Stott**
  - Expedition 21/22 **Jeff Williams (#2) & TJ Creamer**
  - Expedition 23/24 **Tracy Caldwell Dyson; Doug Wheelock; Shannon Walker**
  - Expedition 24/25 **Scott Kelly**
  - Expedition 25/26 **Cady Coleman**
  - Expedition 26/27 **Ron Garan**
  - Expedition 27/28 **Mike Fossum**
  - Expedition 29/30 **Dan Burbank**
  - Expedition 30/31 **Don Pettit (#2)**
  - Expedition 31/32 **Joe Acaba (in orbit)**
  - Expedition 32/33 **Suni Williams (in orbit--#2)**





# ISS 20 First Six Person Crew (we are still pretty new at this)





Russian Soyuz being moved by rail to the launch site







# Launch of ISS 20 Crew





# Soviet R7 Launch in late 1950's

Looks a lot like the modern Soyuz!





# 500<sup>th</sup> Man in Space

Chosen for the honor by his STS 127 crew

**Chris Cassidy**



**EXPERIENCE:** Ten years as a member of the U.S. Navy SEAL Teams. Specialized tactics include long range special reconnaissance (vehicular and foot patrols), direct action building assaults, non-compliant ship-boardings, desert reconnaissance patrols, combat diving, underwater explosives, and a variety of air operations, to include parachuting, fast roping, and rappelling. Awarded the Bronze Star with combat 'V' and Presidential Unit Citation for leading a 9-day operation at the Zharwar Kili cave complex – a national priority objective directly on the Afghan/Pakistan border two weeks after 9/11



## Why do crews need BHP Support?

The challenges of long duration spaceflight are many

- Prolonged training period (approx 2.5 years with single flow to launch)
  - Prolonged microgravity and its physical consequences (bone and muscle loss)
  - Solar radiation exposure
  - Sleep and circadian cycle difficulties including sleep shifting
  - Isolation/separation from family and friends
  - Closed environment with limited privacy
  - No fresh air or fresh food
  - No running water (no showers)
  - Incessant background noise
  - High workload
  - Multiple languages (English, Russian, Japanese, European languages)
  - Cultural differences among international crew members
  - Potential for crew-crew conflict and crew-ground conflict
  - Prolonged post mission rehabilitation period
- *ISS astronauts are exceptionally skilled, intelligent and fit (physical and mental) individuals doing what they have long dreamed of and prepared for, but work and live in an extremely challenging and unforgiving environment*



# The challenges of long duration spaceflight—It's a marathon, or perhaps a long series of sprints

ISS missions require entirely different training, expectations, pace, and mission requirements

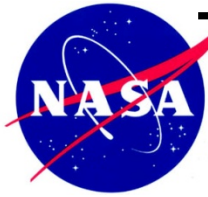
*ISS Mission*



*Space Shuttle Mission*







# The Challenges of ISS Mission Training

- Long duration spaceflight mission training is long challenging
- 2.5 years of basic astronaut skill training following astronaut selection and then 2.5 years of ISS mission training
- Total span of initial training to post flight period end is 6 years
- Fluency in Russian
- Half of training in Russia and other overseas locations including Europe, Canada and Japan (continual sense of jet lag)
- Russian Soyuz training for launches, landings, emergency egress and survival



# The Challenges of ISS Mission Training

- In depth training in all ISS systems (medical, environmental, electrical, propulsion, communications, computers, etc.)
- Robotics training
- EVA training (space walk)
- Extensive medical screening
- Challenging for families—especially those with small children
- Postflight rehabilitation



# The Challenges of ISS Mission Training

- Aerial view of Star City, Russia and the Gagarin Cosmonaut Training Center (GCTC)





# Gagarin Cosmonaut Training Center (GCTC)



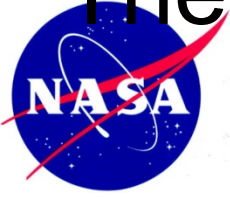


# The Challenges of ISS Mission Training

- ISS 16 Commander US astronaut Peggy Whitson training in Baikonur, Kazakhstan in preparation for her Soyuz TMA-11 launch



# The Challenges of ISS Mission Training



- ISS 14 Commander US astronaut Michael Lopez-Alegria during Soyuz training at the Gagarin Cosmonaut Training Center





# The Challenges of Long Duration Spaceflight

Long Duration Missions: Physically and Emotionally Exhausting



ESA Cosmonaut Jean-Pierre Haignere upon landing from Mir after 188 days



# The Challenges of Long Duration Spaceflight



**Soyuz Landing Site in Kazakhstan (after 4 to 8 Gz orbital reentry)**





# The Challenges of Long Duration Spaceflight

## ISS 6 Crew recovery from Soyuz landing in Kazakhstan





# The Challenges of Long Duration Spaceflight

Arthur C. Clarke's 2001: A Space Odyssey



The way long duration space travel was envisioned back in 1968....spacious, clean, relaxing, aesthetically pleasing



# The Challenges of Long Duration Spaceflight



ISS018E011485

Sandy  
Magnus  
and Yuri  
Lonchakov  
on ISS 18



# The Challenges of Long Duration Spaceflight



ISS015E07540

ISS 15  
Commander in the  
Zvezda  
Service  
Module



## Sample Events That Have Occurred During Long Duration Missions over past 39 years (Russian & US)

- death of family members and friends
- depressed mood
- crew friction
- excessive sleep shifting
- hot or noisy cabins
- mixed/same gender crews
- dark and crowded station
- work underload/overload
- anger with ground team
- periods of low motivation
- mild anxiety
- delayed return to Earth
- onboard fire (Mir)
- Depressurization (Mir)
- over scheduling and insufficient timeline control
- physical reactions to stress
- frustration
- inappropriate or incorrect direction from ground
- language difficulties
- isolation
- cultural misunderstandings
- persistent system and comm failures
- terrorist activities (9/11)
- But for the most part-- excitement, contentment, joy, exhilaration, fulfillment...



## Long Duration Mission Stressors Have Impact

- 3 early Russian flights curtailed with psych issues as part of cause (eg, psychosomatic illness)
- Long duration space flight is qualitatively & quantitatively, different from short duration flight
- Long duration environment
  - Latent stressors (e.g., confinement, separation from home and family, social tedium, procedural snafus)
  - Gradual, chronic abrasion over time
  - Events on orbit
  - Events on earth
  - Similar to extended polar, undersea, military deployments



**Previously reported and known behavioral events during spaceflight  
Note—all are historical events, anecdotal in nature with no objective data**

*Acute Behavioral Change*

STS Payload specialist despondent when experiment failed, crew concerned about potential for dangerous behavior

*Acute Grief Reaction*

Mir 18 – Crewmember's mother died, mission control did not tell him, when he eventually found out he withdrew for 1 week

*Minor Depression*

Shuttle-Mir 3, Salyut 7

*Significant Crew-Crew Interpersonal Conflicts*

Soyuz 21, Soyuz T14, Soyuz TM 2

*Significant Crew-Ground Control Team Conflicts*

Skylab 4, Shuttle-Mir 4

*Source: Jon Clark, MD, former NASA flight surgeon*



# Reported Behavioral Issues During Spaceflight

- **Russian psychologists have identified a behavioral syndrome afflicting cosmonauts during previous long duration missions called “spaceflight asthenia”**
- **Asthenia has included the following characteristics:**
  - **Physical and emotional fatigue or weakness**
  - **Hypoactivity**
  - **Irritability and tension**
  - **Emotional lability**
  - **Appetite and sleeping problems**
  - **Attention and memory deficits**
  - **Withdrawal from others and territorial behavior**
- **Not thus far objectively identified in US ISS crewmembers. The question remains open as to whether or not asthenia occurs and if so whether or not its manifestations are affected by cultural factors**

**Kanas, N and Manzey D, *Space Psychology and Psychiatry*, 2003, Microcosm Press & Kluwer Academic Publishers**





# “Space Fog”

- Anecdotally reported, subjectively experienced, cognitive decrement during spaceflight (long and short duration)
  - Not yet objectively measured
  - No operational impacts noted/measured
  - Reported by a minority of short and long duration crew members
  - Primarily noted during period of spaceflight acclimatization
  - Problems with concentration, short-term memory, multitasking abilities, organizational skills forcing need to ultra-concentrate and perform tasks slowly and deliberately
  - Not generally reported on ISS during period of mastery (after 4-6 weeks)
- Proposed comprehensive neurocognitive inflight study has just been awarded that may help to answer questions about this phenomenon.



# What has not been reported as occurring during space flight

- Physical confrontation/aggression
- Psychosis (hallucinations/delusions)
- Major depression or suicidality
- Mania
- Delirium (anoxia, head injury, illness)
- Panic attacks
- Use of psychiatric medication (e.g., antipsychotics or antidepressants)
- Intoxication or withdrawal
- Any other major psychiatric disorders (panic disorder, obsessive compulsive disorder, etc.)



# What is currently commonly report by ISS crew members during the “average” mission

- Very good morale and crew cohesion
- Collegial and friendly cross cultural relations
- Supportive ground teams
- Personal enjoyment of mission
- Feeling of accomplishment
- Cheerful and optimistic mood (predominate mood)
- Feeling of connectedness with friends and family at home
- Periodic significant fatigue
- Not enough time to sleep as much as one wishes to (6.5 hour average during week)
- Very high workload
- Occasional and infrequent “typical” frustration and interpersonal friction caused by superficial personality differences, high workload, fatigue, lack of sleep, food, things that break (toilet), etc...



# Current ISS Configuration

- Best long-duration environment in history, at a good point in its lifetime
  - High volume, low social density
  - All new and everything working pretty well
  - Plenty of spares and sufficient upmass transport
  - Multiple excellent audio & video comm avenues
  - Numerous diverse leisure outlets onboard
  - Moderate crew control over schedule
  - Well-understood flight, sleep, work & psych parameters
  - Stable international partner relations



# ISS BHP Operations Support Team

- 5 BHP Ops personnel assigned to each ISS crew member
- Specific and separate team for each ISS crew member
- 1 Psychiatrist/flight surgeon
- 1 Operational Psychologist
- 1 Psychologist for WinSCAT neurocognitive test training and analysis
- 2 psychological support providers (Wyle)—prime and backup
- Example: Tracy Caldwell-Dyson ISS 24 support team:
  - Gary Beven, MD, Al Holland, PhD, Kim Seaton PhD, Brooke Loofboro and Shannon Hartman



# BHP Operational Service Components

- **Operational Psychology Services**
  - What we provide to the crew—like movies, music, family contacts, special events, etc.
  - These are services the crews universally enjoy
- **Behavioral Medicine Services**
  - What we gather from the crew including personal information such as—”How much are you sleeping...How are you getting along with the rest of the crew...etc.”
  - WinSCAT neurocognitive testing
  - These are medical requirements (and not as much fun for the crew)
  - All behavioral medicine components are considered private medical records



# ISS Behavioral Medicine Services

- Crew Medical Officer BHP Training
  - L-18 months
- Preflight psych evaluations (three 60 min mtgs)
  - L-12 months
  - L-6 months
  - L-30-60 days
- Private Psychological Conferences (PPC)
  - Every two weeks on orbit (15 min)
- WinSCAT (Space Flight Cognitive Assessment Tool for Windows)
  - Baseline established before launch
  - Every month on orbit
- Postflight psych evaluations
  - R+3, R+14 and R+30—60 (three 60 min mtgs)

# International Consensus for ISS BHP Services



- **BHP assessment services to all crewmembers is decided upon by international agreement**
- **The ISS Spaceflight Human Behavior and Performance Working Group (SHBPWG) meets annually in Moscow or Houston to discuss and implement a common behavioral monitoring and countermeasures program for all ISS crewmembers**

## **2006 SHBPWG Meeting Toasts at the Institute for Biomedical Problems, Moscow**







# ISS Crew Medical Officer Training

- ***Crew medical officer training*** highlights possible “worst case” scenarios—delirium, complicated bereavement, common symptoms of major mood and anxiety disorders, and familiarization with treatment options on the ISS
  - ***ISS Medkit Meds:*** Abilify (PO and IM); sertraline; venlafaxine; diazepam; lorazepam; Ambien; Sonata; Provigil
  - ***Reference:*** ISS Medical Checklist section on “Behavioral Emergency”
  - ***Note:*** Crews would ordinarily provide any emergency or even routine care under real time guidance by the flight surgeon or psychiatrist
  - ***For exploration class missions this would be greatly expanded into a schedule and format TBD***



# ISS Behavioral Medicine Services



“Do you think you’re ready for your ISS mission?”



# ISS Preflight Assessments (L-365/180/30)

- Principle **pre-flight** evaluation topics:
  - Training issues including perception of mission readiness
  - Training workload and fatigue levels
  - Family or personal relationship issues
  - Crew-crew training interactions, familiarity and concerns
  - NASA management issues or concerns
  - Mood and anxiety
  - Mission goals, desires, challenges and risks
  - Post mission rehabilitation or family concerns
  - Emergency notification method—bad news from whom?



## *Neurocognitive Assessment with WinSCAT (Space Flight Cognitive Assessment Tool for Windows)*

**WinSCAT is a brief neurocognitive test that provides a baseline level of cognition. This baseline can be used following a neurological injury on the ISS to judge severity and gage recovery**



**Neurocognitive Assessment with WinSCAT**

Activity	Duration	Preflight	In Flight	Postflight
Training	60 minutes	L-120 days		
Neurocognitive Assessment Baseline (MAT)	60 minutes	L-100 days		
	45 minutes	L-90 days		
	30 minutes	L-60, L-30, L-7 days		
Routine Monitoring	30 minutes		Every 30 days	
Postflight	30 minutes			R+14*, R+30 days * If clinically indicated



- Subtests are from the Automated Neurological Assessment Metrics (ANAM)
  - ANAM has been used extensively in neuropsychological research and is the result of 30+ years of psychological test development by the US Dept. of Defense
- In 11 to 15 minutes, WinSCAT assesses:
  - response time
  - sustained attention/concentration
  - visual working memory
  - verbal working memory

Virtually the same test as the military pre AOR TDY neuropsych screen given to all service members (TBI baseline)



# Private Psychological Conference (PPC's)

- **The Russians developed the PPC as a standard psychological countermeasure beginning with Salyut 6 and continued to use them on Salyut 7 and Mir**
- **NASA began using audio/video PPC's in 2000 with ISS Expedition 1**
- **Performed every two weeks during ISS expeditions (all crew members)**
- **Private video conference between the ISS astronaut and the NASA psychiatrist or psychologist that ordinarily takes place Tue or Wed**
- **Typically lasts 10-20 minutes depending on subject matter discussed and mission phase**
- **Contents are non-recorded private and confidential events**
- **Written notes placed in astronaut's private behavioral medicine record**



# **ISS Private Psychological Conferences (PPC's)**

- **The following topics are covered each PPC and these reflect the main clinical/operational concerns:**
  - **Sleep (duration and quality) and sleep shift issues**
  - **Fatigue level**
  - **Workload and pace of work**
  - **Individual and crew morale**
  - **Crew relationships**
  - **Crew-ground relationships**
  - **Mood**
  - **Cognition**
  - **Family and personal relationships**
  - **Environment and habitability issues, including food**
  - **Operational psychology issues or requests**
  - **Preparation for important tasks, such as EVA's**



# ISS Private Psychological Conferences

From ISS Daily Time Line Sunday 16 SEP 07 at [www.nasa.gov](http://www.nasa.gov)

09:30-10:30 FE-2 Physical Exercise (RED)

09:30-09:50 Private Family Conference (*S+Ku-band*)

10:30-11:30

CDR

Physical Exercise (VELO+RED), day 3

10:55-11:15 Private Family Conference (*S+Ku-band*)

11:30-13:00

FE-1

Physical Exercise (TVIS), day 3

12:30-12:45 FE-2 Private Family Conference (*S+Ku-band*)

13:00-14:00 . LUNCH

14:00-14:40 CDR COЖ Maintenance

14:00-14:05 FE-2 Connect LAB LTL QD's for CDRA Activation

14:40-15:40 CDR,FE-1 Install Progress 360 Docking Mechanism

15:45-16:45 FE-1 Physical Exercise (VELO+RED), day 3

15:45-17:15 FE-2 Physical Exercise (CEVIS)

**16:10-16:20 CDR Private Psychological Conference (*VHF*)**

16:45-18:15 CDR Physical Exercise (TVIS), day 3

17:25-17:40 FE-2 Crew Discretionary Conference (*S + Ku-band*)

**17:40-17:55 FE-1 Private Psychological Conference (*VHF*)**





# ISS PPC's

A chat with a colleague in space

The screenshot shows a Windows XP desktop environment. On the left, the Start menu is open, displaying icons for My Computer, Microsoft Outlook, Internet Explorer, My Network Places, My Bluetooth Places, IMS, IMS 2 Client, Accessories, Windows Explorer, and Recycle Bin. The desktop background features a NASA-themed graphic with the text "TO NOD".

Open applications include:

- My Video:** A video window showing a man in a red shirt smiling, with an American flag patch on his sleeve. The background shows the interior of the International Space Station (ISS).
- OSTPV 3.0 - Microsoft Internet Explorer:** A web browser window displaying a flight schedule. The address bar shows <http://fserver/apps/ostpv/>. The page includes a table with columns for flight type, destination, and status.
- NetMeeting - 1 Connection:** A video conference window showing two men sitting at a desk in an office. The office has a red "Houston" banner and a blue banner with the NASA logo and the text "KOPPELMAN ANDERSON KOTOB". The NetMeeting interface includes a "Name" list with "ISS BME" and "SSC Client A31p ISS", and a "In a call" status bar.

The taskbar at the bottom shows the Start button, several application icons, and the system tray with a 97% battery level and the time 19:40.



# ISS Postflight Assessment

R+3; R+14; R+30-45

## *ISS Behavioral Medicine Evaluation Topics:*

- Principle **post-flight** evaluation topics:
  - Mission in retrospect—level of personal satisfaction
  - Greatest challenges, frustrations, joys during the mission
  - Retrospect review of fatigue level prior to critical events such as EVA's
  - Family reintegration issues
  - Postflight mood, anxiety and cognition
  - What are short and long-term career plans?
  - What worked and didn't work from a BHP standpoint?
  - What BHP services need improvement or change?



# Operational Psychology

- Direct psychological support services for ISS Crews and Families
- Meetings and briefings with crew member and family begin just after assignment—approximately 2.5 years before flight
- All products are private, personalized and provided via individualized, concierge—like service
  - Private Family Conferences (PFC)—weekly
  - Crew Care Packages (CCP)
  - Entertainment and News
  - ISS Ground Based Family & Friends Web Page
  - ISS Crew Personal Webpage
  - Crew Discretionary Events (CDE)—2 per mission
  - Private Special Conferences (PSC)—3 per mission
  - IP Phones
  - Musical instruments (guitar, keyboard, trumpet)
  - 100 Day Celebration Event



- All inflight support services are optional
- Crewmembers are free to select the services that meet their personal needs as well as their families
- BHP strives to customize support activities whenever feasible



## Internet Phone (IP Phone)

- The IP Phone runs on a software program that is dependant on KU-Band satellite coverage
- There are currently 8 units on ISS
- Can be used as non-scheduled communication
- Using the IP Phone ISS crewmembers can dial any number in the world but can not receive calls

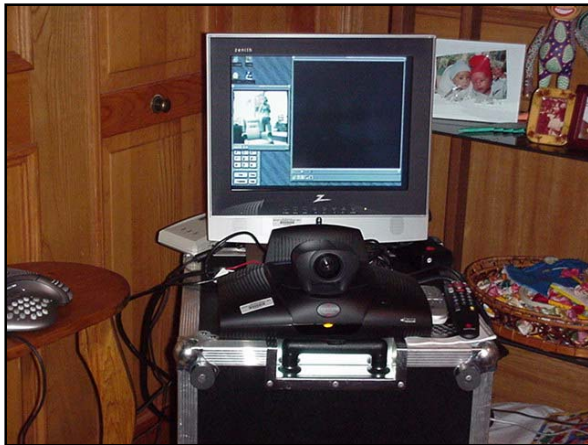


Expedition 4 Flight Engineer, Carl Waltz, using the IP Phone.



## Private Family Conferences (PFC)

- Family communication is facilitated through the use of e-mail, IP Phone and two-way video teleconferences
- Video Private Family Conferences (PFC's) are scheduled on a weekly basis
- BHP installs video conferencing equipment in the crewmembers home
- Laptop with video camera now being used on ISS 28



Equipment in the home



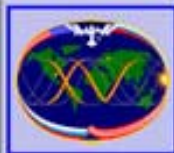
Astronaut Clay Anderson  
conducting a PFC onboard ISS



# ISS Ground Based Family & Friends Web Page

- By invitation only, a format where crewmembers can send down videos, photos and diaries of their experiences on ISS

This eliminates the burden for crew and family to continuously provide the same information and allows family and friends to follow the mission.



# Expedition 15 Crew Web Page

Wednesday, October 24th, 2007

Houston 12:09:04  
Moscow 20:09:04



- [News](#)
- [Magazines](#)
- [MP3s](#)
- [Sports](#)
- [Photo Album](#)
- [Greetings](#)
- [Cartoons](#)
- [Core Package of News](#)
- [Family and Friends Events](#)
- [Miscellaneous](#)
- [Video On Demand](#)
- [Movies \(coming soon\)](#)

## Recent World News Headlines

**[Warren Buffett posts want ad for successor](#)** OMAHA, Neb. - Legendary investor Warren Buffett renewed speculation about who will replace him at Berkshire Hathaway Inc., saying Thursday in his annual shareholder letter that he plans to hire at least one young investment manager to help succeed him. [Full Story...](#)

**[Madame Tussauds wax museum set for D.C.](#)** WASHINGTON - Abraham Lincoln is coming back to life just a block away from Ford's Theatre. [Full Story...](#)

**[Snowstorm shuts down Midwest highways](#)** MINNEAPOLIS, Minnesota (AP) -- A deadly winter storm walloped parts of the Plains and Midwest, keeping highways and schools closed, knocking out power and piling up huge snow drifts Friday. [Full Story...](#)

**[Total lunar eclipse Saturday night](#)** LONDON, England (AP) -- The moon will turn shades of amber and crimson Saturday night as it passes behind the Earth's shadow in the first total lunar eclipse in three years. [Full Story...](#)

[Other Headlines...](#)



**[Houston, Tx](#)**  
2007-10-23  
51°F 11°C  
Pty Cloudy 71% Humidity

**[Moscow](#)**  
2007-10-23  
48°F 9°C  
Pty Cloudy 87% Humidity

**[Cologne](#)**  
2007-10-23  
48°F 9°C  
Pty Cloudy 58% Humidity





# News, Information & Music

- **BHP Contributions:**
  - **NY Times Digest** – Electronic News provided every uplink. All ISS crewmembers will be subscribed through BHP, unless otherwise indicated
  - **Houston Chronicle** – sent 7 days per week to crewmembers
  - **Video Nightly News file** – sent 5 days per week to crewmembers
  - **Magazine articles** – magazine articles from crewmember's preferred magazines can be scanned and uplinked
  - **Information from websites** frequently visited by crewmembers uplinked in .pdf format
  - **Digital Magazine Subscriptions** – see [www.zinio.com](http://www.zinio.com) for availability of magazines
  - **Video News Clips** – video clips (approx 30 minutes) are uplinked to crewmember twice per week. (e.g. TV shows, News, ESPN, etc...)
  - **Audio News Clips** – Audio files up to 3 hours each are uplinked twice per week (e.g. NPR)
  - **Podcasts** – Audio/video Podcasts are sent to crewmembers twice per week.
  - **MP3s** – Crewmembers can provide CDs to be converted to MP3s prior to flight and captured to DVD and/or uplinked as requested during flight via their personal webpage.
  - **E-Books** – Uplinked as requested (see [www.MobiPocket.com](http://www.MobiPocket.com) or [www.fictionwise.com](http://www.fictionwise.com))
  - BHP can also uplink **home video clips** at family's request



# ISS Private Video Conferences

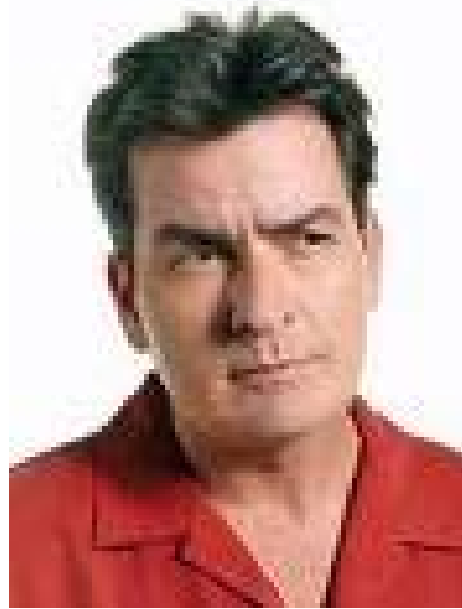
- Expedition 5 – Peggy Whitson talks with friends in the NASA offices in Star City, Russia





## Crew Discretionary Events (CDE's)

- Private audio or video contacts with celebrities such as actors, professional athletes, authors, comedians, etc., for the purpose of building crew morale. These are private events and not publicized.
- *Who would you choose to talk to?*



Winning!



# Music for Recreation on ISS

- Expedition 3 – Frank Culbertson playing his trumpet



- Expedition 5 – Treschev playing the ISS Guitar



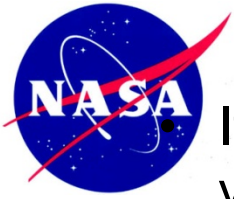
- Expedition 4- Carl Walz playing the ISS keyboard



# ISS 17 Greg Chamitoff Playing Guitar

- 





## Crew Care Package (CCP)

Items that are packed in a CCP are limited by both weight and volume. Currently the maximum weight is 10 pounds per crewmember.

- Contents for the CCP are usually supplied by family, friends and BHP for all ISS crew members.
- Care Packages are launched on all, and the European Space Agency (ESA) ATV, JAXA (HTV) vehicles and new US Commercial vehicles





## Crew Care Package (CCP)



Astronaut Jeff Williams, Expedition 13, opening a CCP on-orbit.

Greg Chamitoff on ISS 17 enjoying a very popular recreation activity



ISS018E006428







# Tracey Caldwell—Dyson in the Cupola

This great photo was a suggestion by Al Holland during a PPC





Photography—a favorite hobby for many





Nicole Stott on ISS treadmill  
Exercise is a vital crew morale tool  
Nearly as vital as sleep for some





## Dinner Time on ISS

Communal meals are an important for crew cohesion





# Other Support Tools

## Holidays in Space

Crewmembers enjoy bringing Holiday cheer to the ISS. Each crew that visits the ISS during the Holidays receives a Stocking filled with goodies. The Stockings are provided by BHP and the Soft Goods Lab at Wyle. All stockings are made of fire retardant Nomex and artwork on each stocking is hand drawn and personalized.







# ISS Ham Radio Equipment

Used primarily for school contacts (1:6 ratio)





# ISS Crew Video Downlinks

- Clay Anderson participates in a Nebraska football game via a pre-recorded downlink message played during half-time.







# ISS Crew 100 Day Party!

- Celebration for family, friends and coworkers on the ground celebrating 100 days on the ISS
- ISS crewmembers call the event and speak to attendees while the attendees are photographed with the “flat” crewmember
- “Flat” Clay Anderson and Gary Beven, MD at JSC the week prior to his 100 Day Party





# Mission Metrics + Personal Crew Web Page Typical ISS Mission

Activity		Metrics
Space-to-Ground w/ CDR from Home (pre-mission)		1
Private Family Conferences		21
Private Special Conferences		3
Crew Discretionary Events		2
Crew Webpage	# of Files	1675
Sports Video	2	
Greetings	6	
Personal Videos	20	
Books	24	
Special Dates to Remember	25	
Magazines	58	
Miscellaneous	63	
Photo Album	87	
Podcasts	103	
Internet Radio	110	
Personal Music	131	
TV Programs	204	
Movies	265	
News	577	

All of this requires a lot of work to do it right



# Recipe for Success

## • Critical steps in the ISS BHP support services chain

- Cadre of well trained clinicians with operational experience and dedicated support personnel



- Clinicians begin relationship with future crews at time of astronaut selection



- Astronaut—BHP familiarity grows over time and throughout training (e.g., annual evaluation)



- Assignment of BHP team to crew member (and their family) at time of mission assignment



- Adequate time with individual crew members before, during, and following spaceflight



- Use of previous operational experience to better assist current and future crews



# Challenge

- How do we transform our BHP knowledge and experience from a rich and large spaceflight environment to an exploration mission such as Mars?



=  
?





# The Future—Mars and other Exploration Missions

- Much greater distance from Earth—250 million miles (Mars)
- Much greater mission length—2.5 years
- Significantly greater risk—unable to return to Earth in an emergency
- Far greater consequence of hardware failure, illness, injury, or behavioral degradation
- Communication delays with Earth will make real time contact/conversation difficult or impossible (Mars round trip signal delay up to 44 minutes)
- Far greater importance will be placed on crew compatibility and psychological screening/preparation



# Exploration Mission

- **Life on board a smaller, perhaps more automated, vehicle for a much longer period will feel more confined and sterile—less rich and stimulating**
- **Exploration missions will require a greater degree of personalized service from the BHP operations support team to counterbalance the environment**
  - Time delay issues
- **Sleep and fatigue issues are unlikely to play as great a role, especially during outbound and inbound journeys**
  - May still occur during times of critical operations such as EVA's
- **The workload would be expected to be less—particularly on the outbound and inbound journeys. Productive activity will need to occur in order to avoid boredom and a sense of feeling trapped**
  - Timeline struggles are unlikely to be as much of a significant concern



# Exploration Mission

- **The first six weeks, the arrival and activity at destination, and the final six weeks are likely to be mission high points**
- **Privacy concerns will be more of an issue, especially with a mixed gender crew**
- **The infrequent crew friction seen on ISS, especially that borne of personality trait differences, may grow to intolerable levels on an exploration mission**
  - **Crew selection and preparation will be critical**
- **The transient neurocognitive decrement noted by some ISS crews requires objective investigation prior to an exploration mission**



# Exploration Mission

- **ISS crew members who thrive on ISS may not have the optimal personality traits for an exploration mission**
  - **What are the optimal traits for either mission?**
- **The crew medical officer will require extensive training in the identification and treatment of behavioral health problems**
- **The crew will need to function autonomously and the ground will have to accept this but not allow the crew to feel abandoned**





If you remain interested and want to  
get involved

## **Aerospace Medical Association**



[www.asma.org](http://www.asma.org)

## **Space Medicine Association**

[www.spacemedicineassociation.org](http://www.spacemedicineassociation.org)



- Thank you to:
  - Greg Collins, MD for inspiring me to enter the field of psychiatry
  - Edwin Beven, MD, for showing me through a lifetime of dedication and service to the family and the Cleveland Clinic what it really means to be a physician