“SPACE MEDICINE” Shuttle – Space Station Crew Health and Safety Challenges for Exploration

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Medical Operations
Johnson Space Center

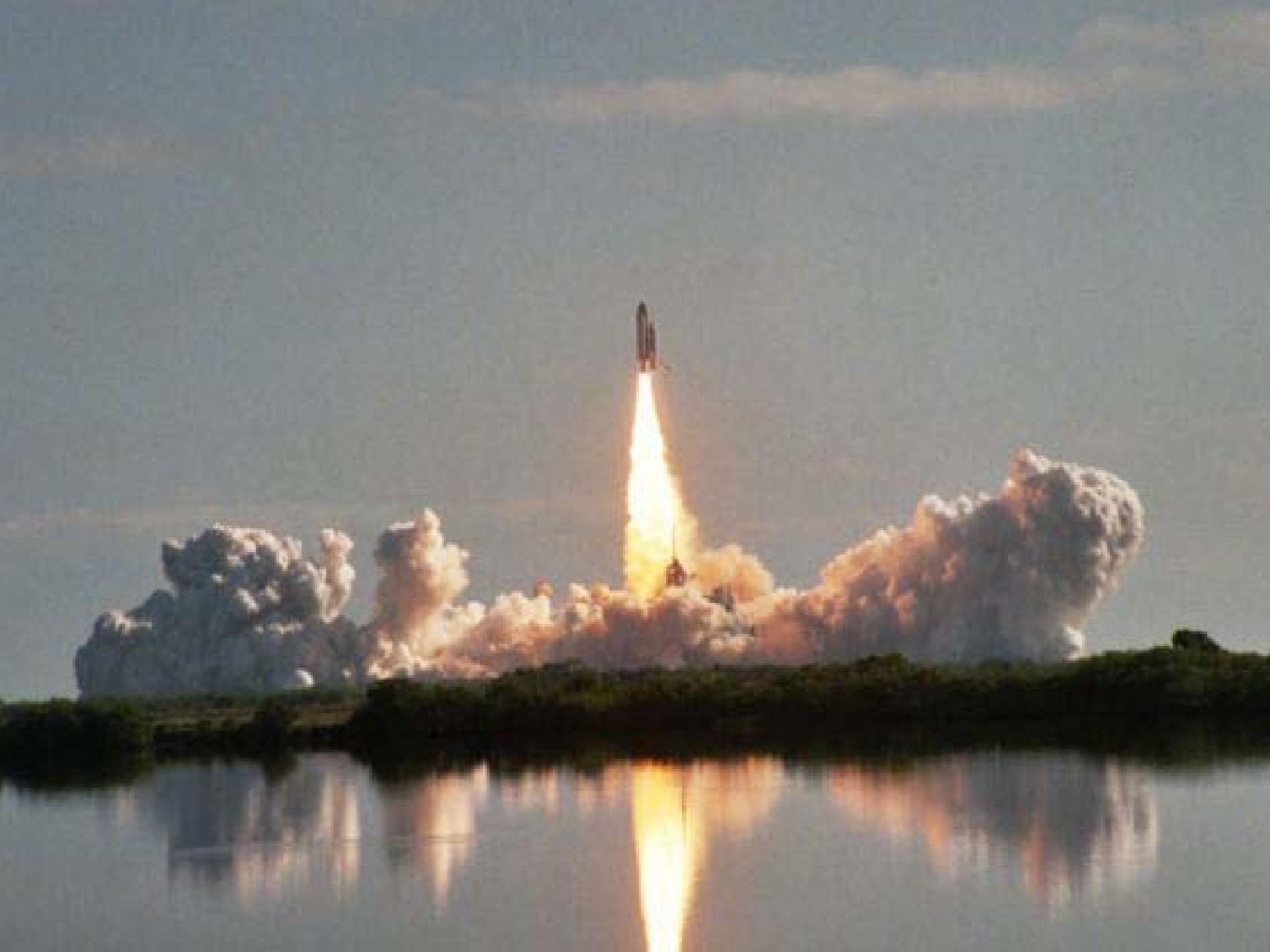
Houston

The first word from the Moon

Space Medicine & Health Care Systems Office

Medical Operations Objective

To ensure the health, safety, and well being of the astronaut corps and ground support team during all phases of space flight.

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Mission Support

On-orbit Flight Control Room (FCR) Staffing

Surgeon Console - FCR

Physiological Issues

- Space Motion Sickness (SMS)
- Cardiovascular
- Neurovestibular
- Musculoskeletal
- Behavioral/Psycho-social

Human Response to Spaceflight

Astronauts experience a spectrum of adaptations in flight and postflight

- Neurovestibular
- Cardiovascular
- Bone
- Muscle
- Immunology
- Nutrition
- Behavior

Balance disorders
Cardiovascular deconditioning
Decreased immune function
Muscle atrophy
Bone loss

Space Motion Sickness (SMS)

- **Incidence**
  - Affects approximately 70% of crewmembers
  - 10% of cases severe
- **Symptoms -** From loss of appetite to nausea and vomiting
- **Time course -** Onset from MECO to 24 hours; peak symptoms 24 to 48 hours; symptoms resolve by 72 to 96 hours
- **Causes**
  - Neurovestibular - otolith mismatch, sensory conflicts
  - Fluid shift
- **Treatment**
  - Decreased activity
  - 1-G orientation
  - Medication (Phenergan IM)

Cardiovascular

Changes in redistribution of body fluids cause inability of the body to adapt to rapid circulatory changes, producing orthostatic symptoms postflight

- **Symptoms -** Dizziness, lightheadedness,
- Time **course -** From reentry to several hours postlanding
- **Causes**
  - Fluid shifts
  - Baroreceptor
- **Treatment**
  - Fluid loading
  - On-orbit exercise benefit
  - Liquid cooling garment
  - Medications


WESTERN KENTUCKY

Behavioral/Psycho-Social

Changes in crew mood, morale, and circadian rhythm

- **Incidence** - Affects all crewmembers to some degree
- **Symptoms** - Fatigue and irritability, performance
- **Time course** - Depends on flight plan
- **Causes**
  - Work load
  - Sleep habits and facilities
  - Crew personalities, “crew space”, and cultural differences
  - Temperature
  - Noise
  - Odors
  - Atmosphere
  - Diet
  - Lack of family contact
- **Treatment** - Treat causes


Оранжерея „СВЕТ"

Space Flight Environmental Issues

- Radiation
- Toxic products and propellants
- Habitability
- Atmosphere
- Medical events

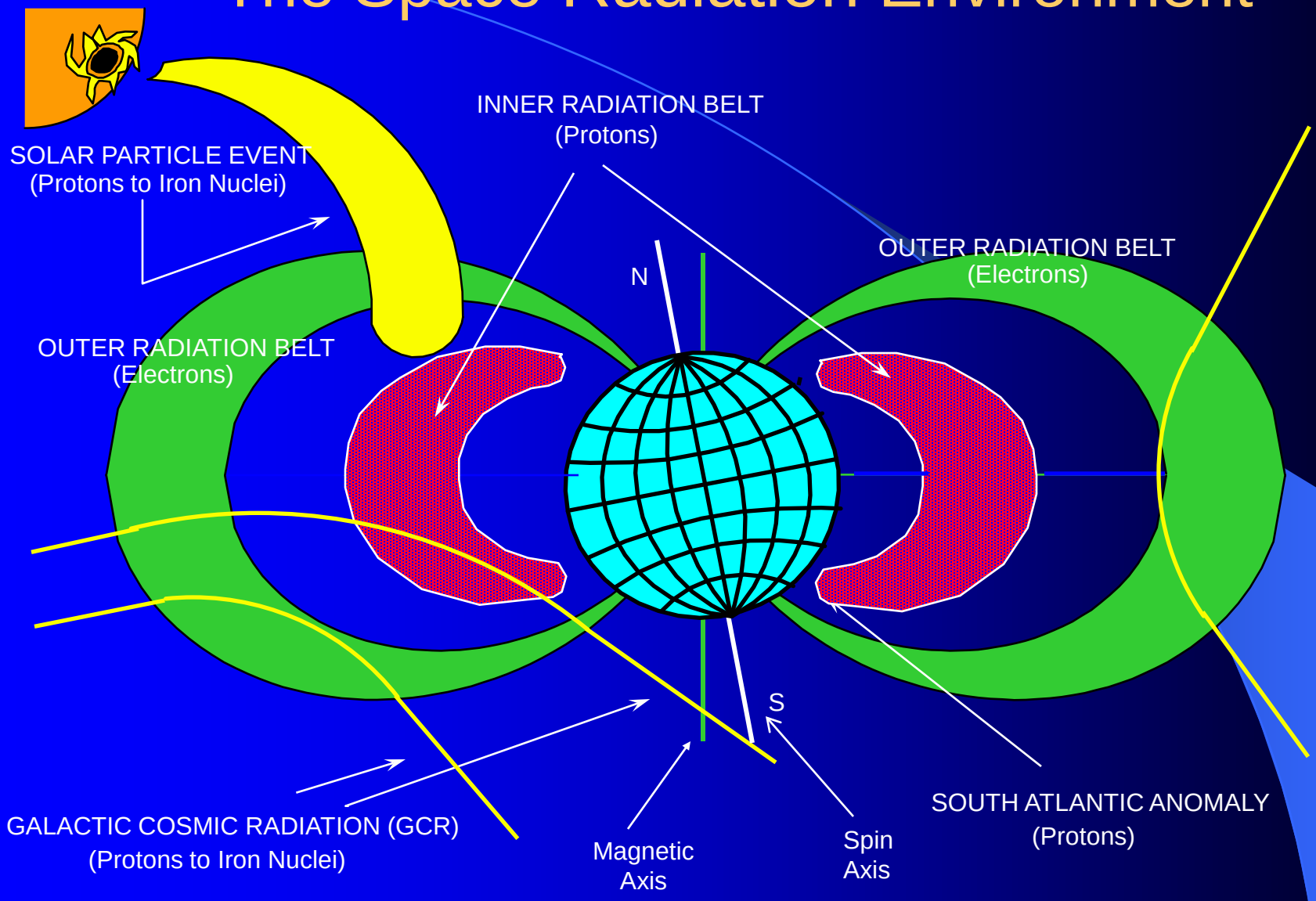
Medical events in U.S. Space Program

- Apollo 8 crew – 1st Americans to report space motion sickness
- Apollo 9 - space motion sickness caused EVA to be rescheduled (1st timeline change due to medical cause)
- Apollo 11 – Type 1 DCS in command module pilot
- Apollo 13 – Kidney infection during mission
- Apollo 15 – Cardiac dysrhythmia (PVC, PAC, bigeminy) during lunar EVA
- Apollo Soyuz Test Project – Nitrogen Tetroxide chemical pneumonitis on reentry

Medical Events in Russian Space Program

- Events not resulting in mission termination or early return
  - Spacecraft fires - 1971, 1977, 1988, 1997
  - Kidney Stone - 1982
  - Hypothermia during EVA - 1985
  - Psychological stress reaction - 1988
  - Spacecraft depressurization -1997
  - Toxic atmosphere - 1997

The Space Radiation Environment



Representation of the major sources of ionizing radiation of importance to manned missions in low-Earth orbit. Note the spatial distribution of the trapped radiation belts.


NASA
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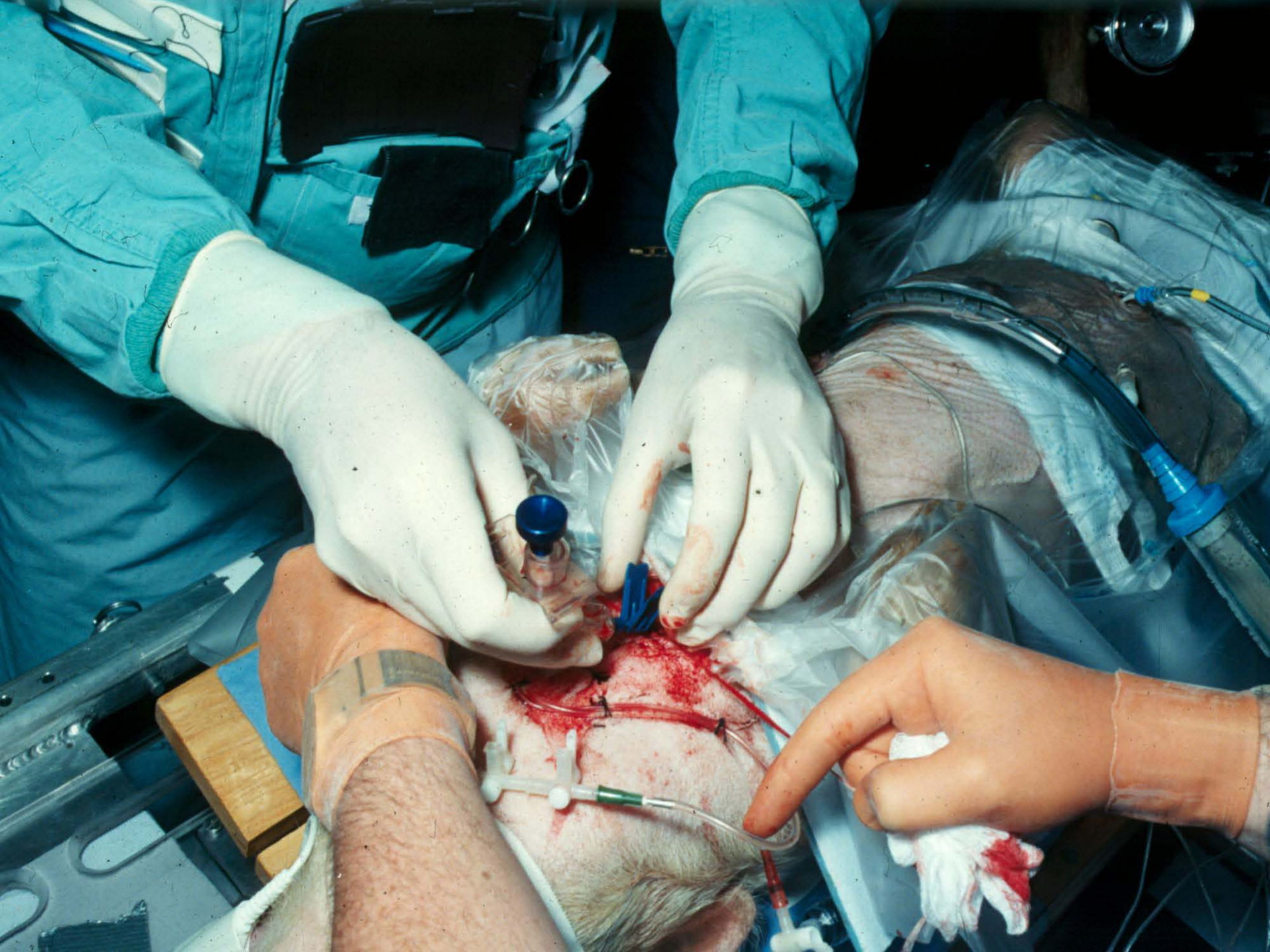
Systems & Crew Training

KC-135
"Weightless Wonder, Vomit Comet"

Hardware Testing and Procedure Validation

Developing ACLS algorithms for on-orbit use and training



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Systems & Crew Training

Shuttle Orbiter Medical System (SOMS)


SKD42104024-312
TRAUMA SUBPACK
SKD42104324-315
AIRWAY SUBPACK
SKD42103824-310
SALINE SUPPLY BAG
SKD42104224-314
S/N: 1001

DRUG SUBPACK

Systems & Crew Training

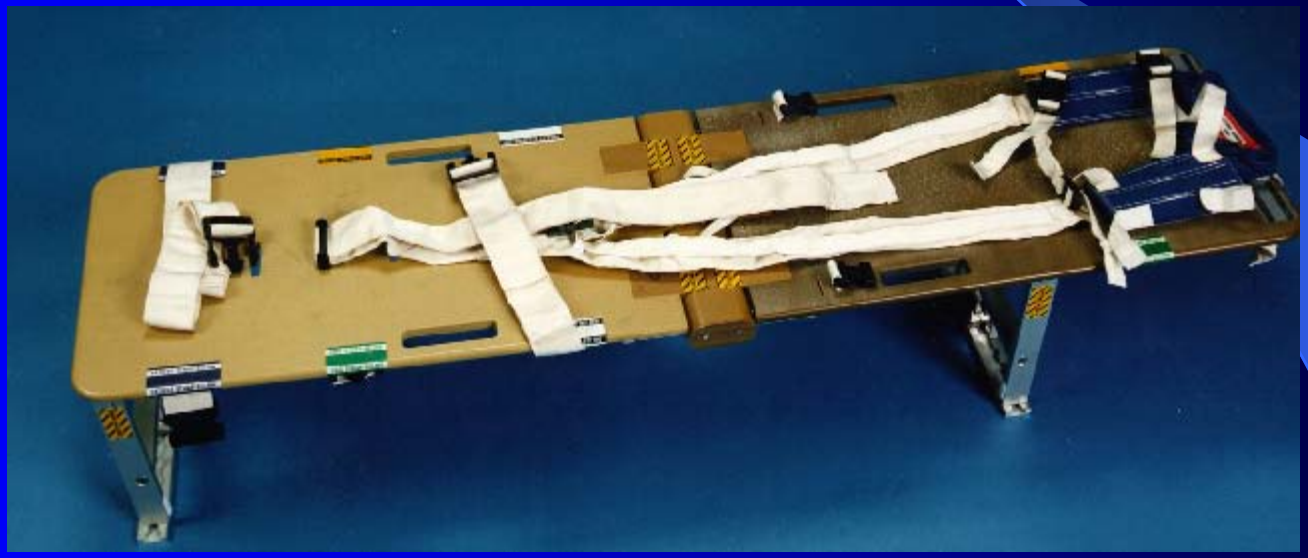
Health Maintenance System (HMS)

Defibrillator & Respiratory Support Pack (RSP)

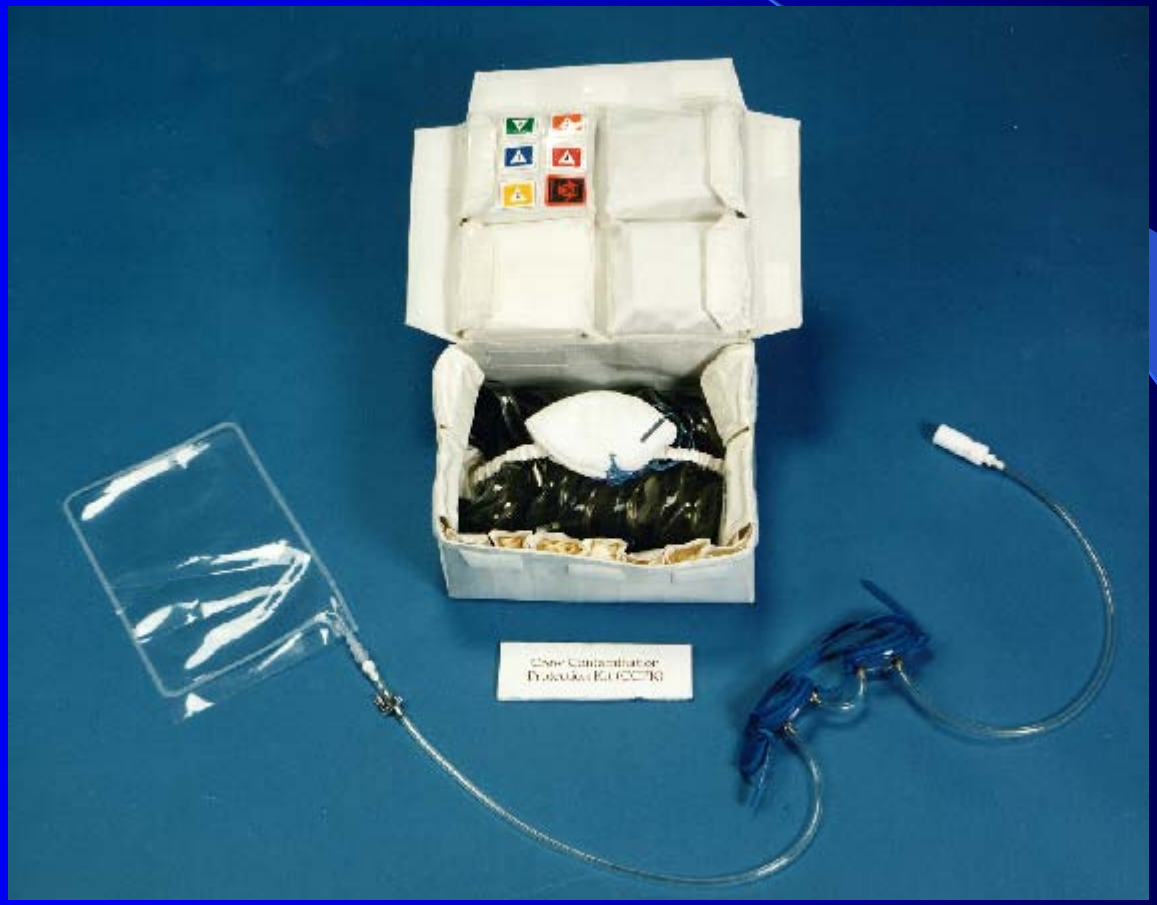
Defibrillator

RSP

Crew Medical Restraint System (CMRS)

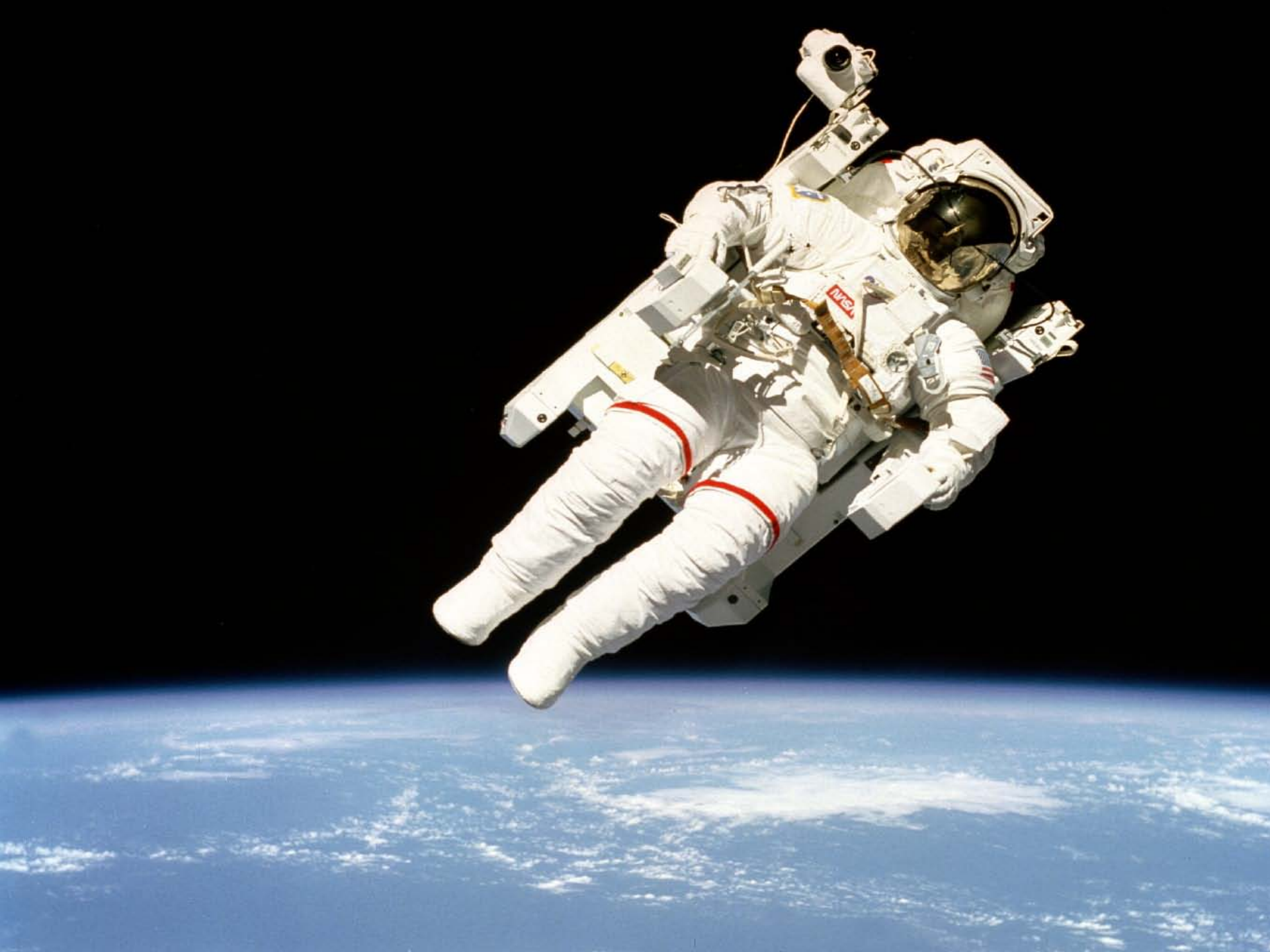


Crew Contamination Protection Kit (CCPK)



Discovery

CUT HERE FOR EMERGENCY RESCUE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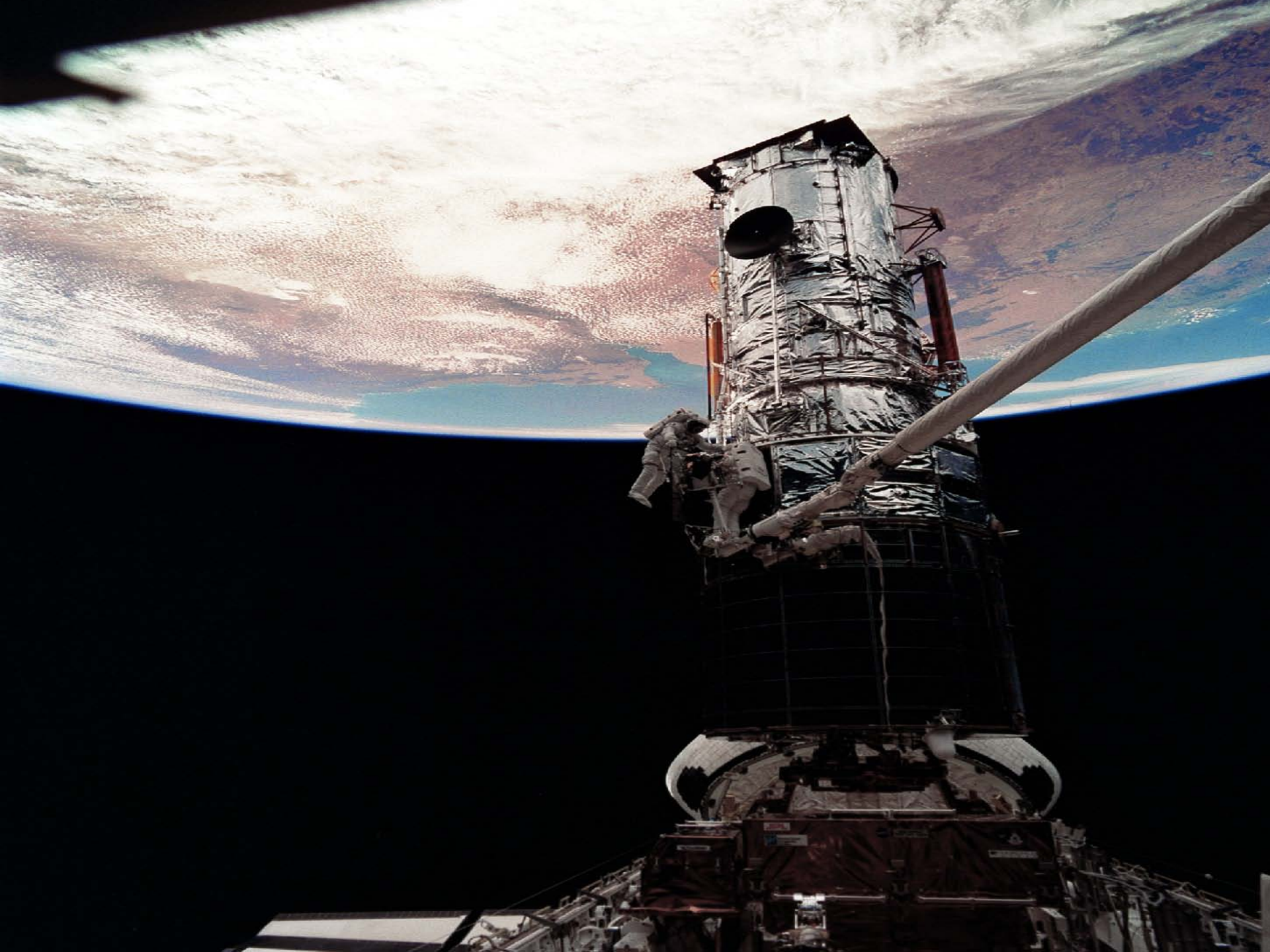
Mission Support

- Extravehicular Activity (EVA) Monitoring



esa
COLUMBUS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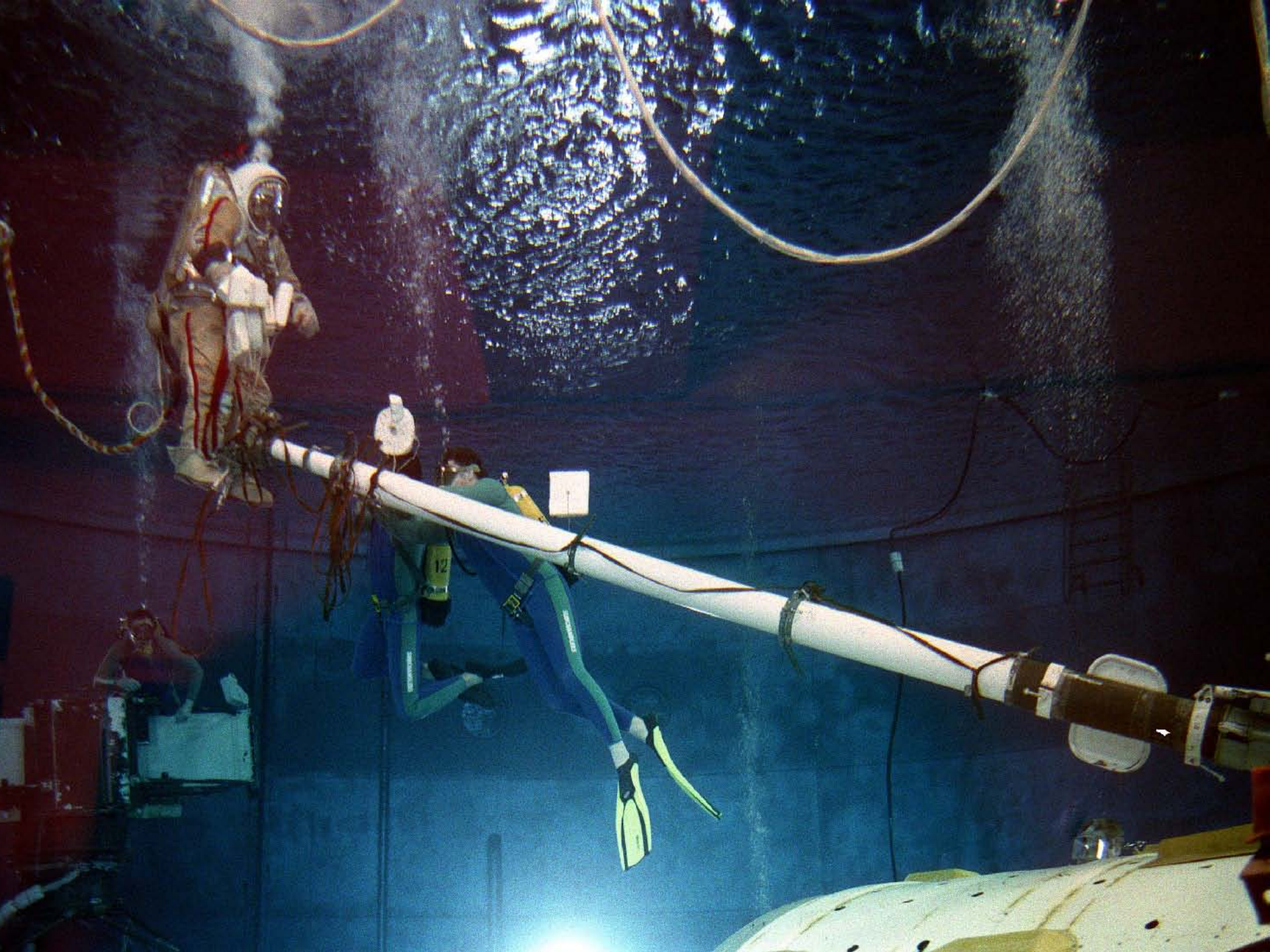


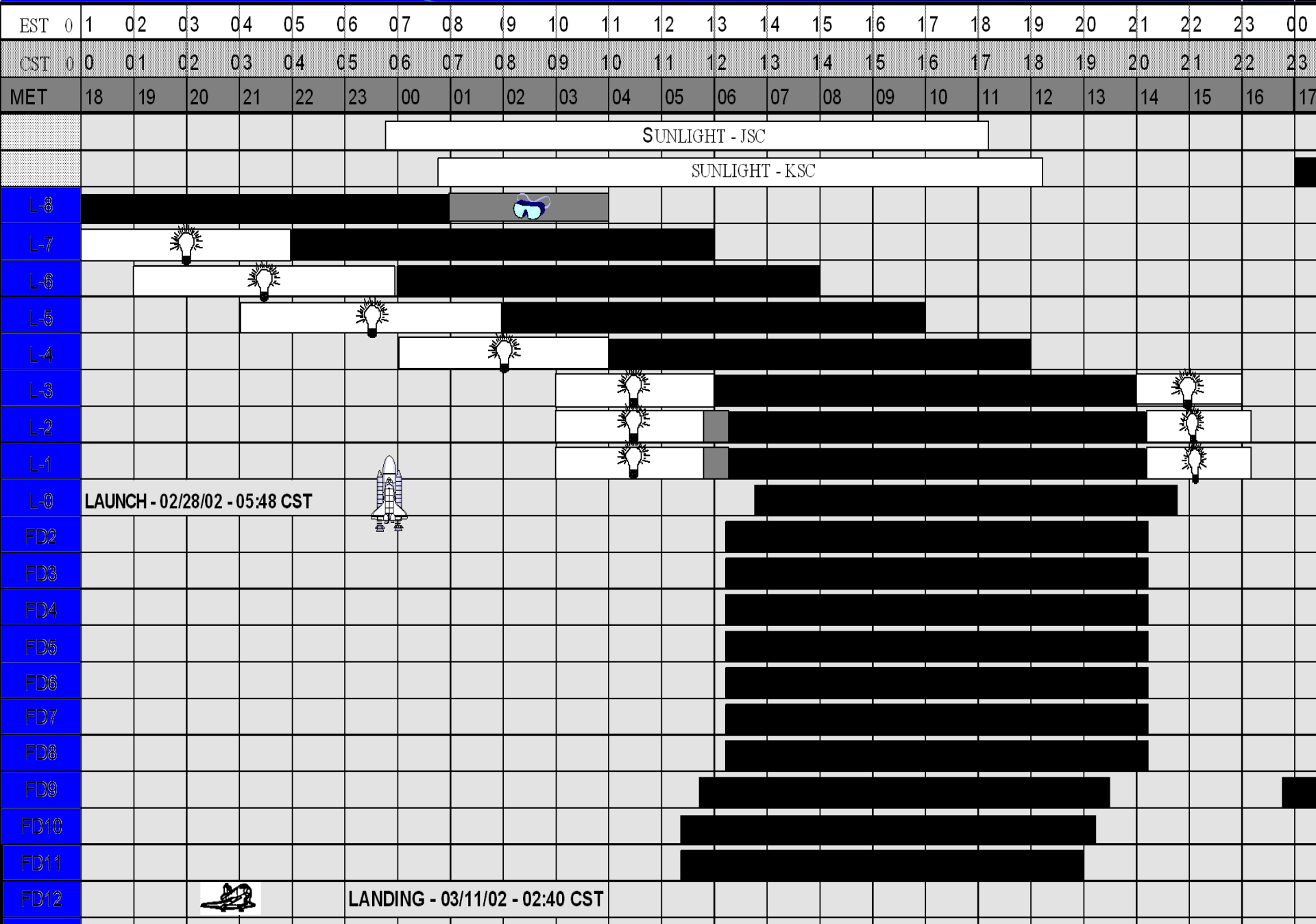
PRP EXERCISE STRATEGIES

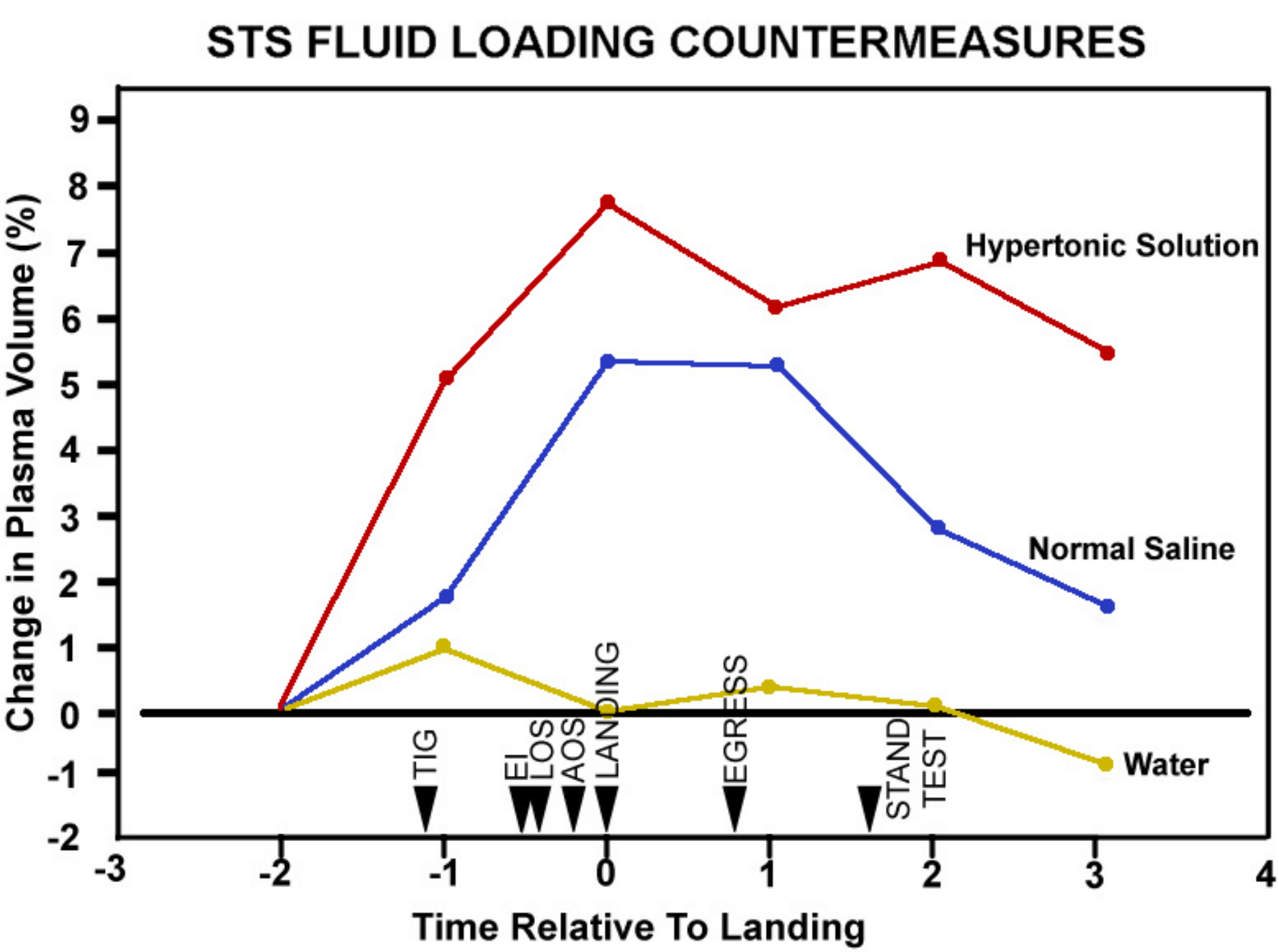
Upright dual arm and leg cycle exercise (ALE)

Semi-recumbent intermittent light exercise simulating astronaut tasks (ILE)

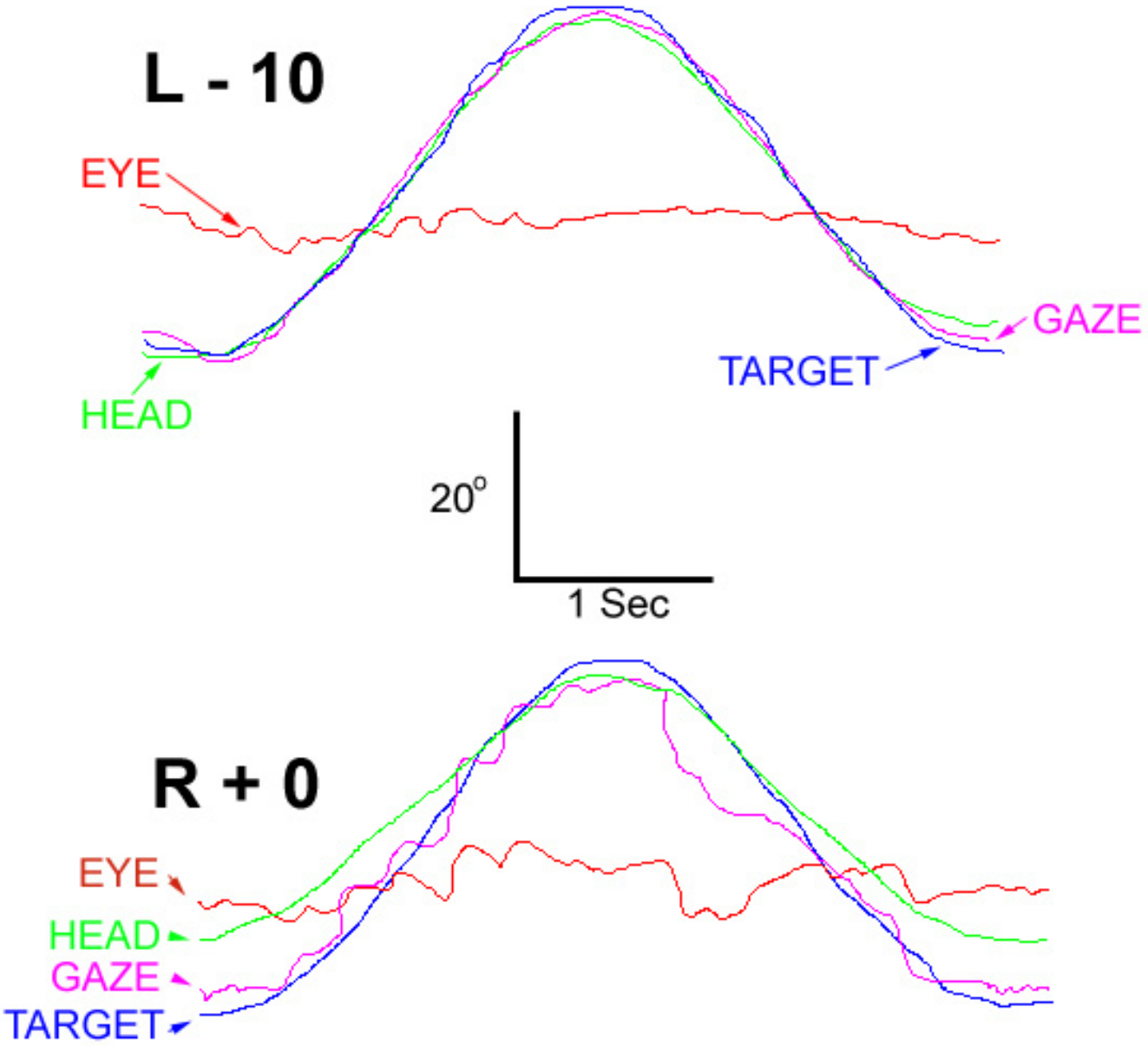
MF57E
MF71E
MF57K

STS-108 CIRCADIAN ADJUSTMENT LIGHTING SCHEDULE




STS FLUID LOADING COUNTERMEASURES
Change in Plasma Volume (%)
9
8
7
6
5
4
3
2
1
0
-1
-2
Hypertonic Solution
Normal Saline
Water
TIG
EI
LOS
AOS
LANDING
EGRESS
STAND
TEST
-3
-2
-1
0
1
2
3
4
Time Relative To Landing

Vertical Pursuit Tracking With Head and Eye




United States


United States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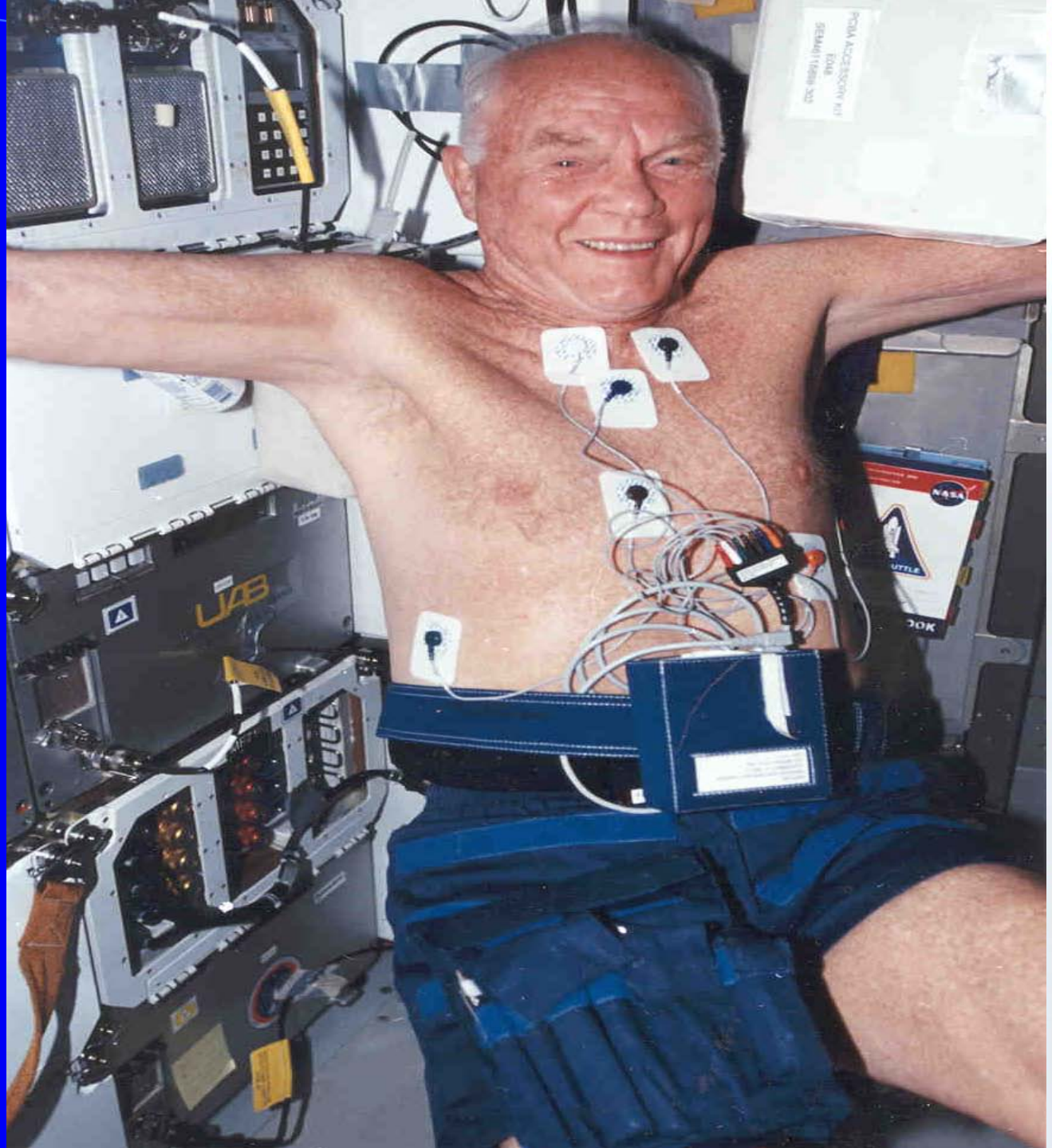
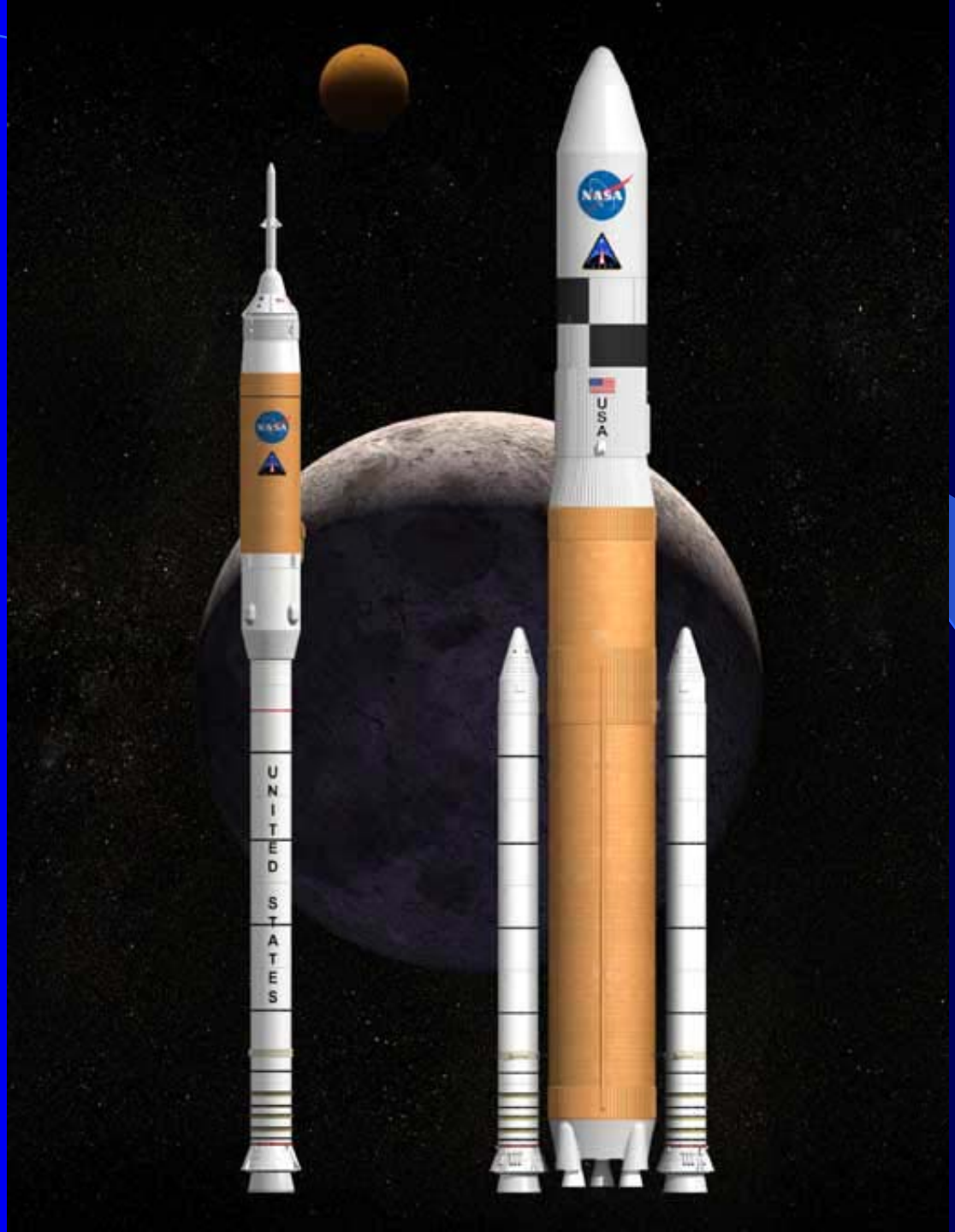
Astronaut Health

- Physical training and rehabilitation


UAB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UNITED STATES
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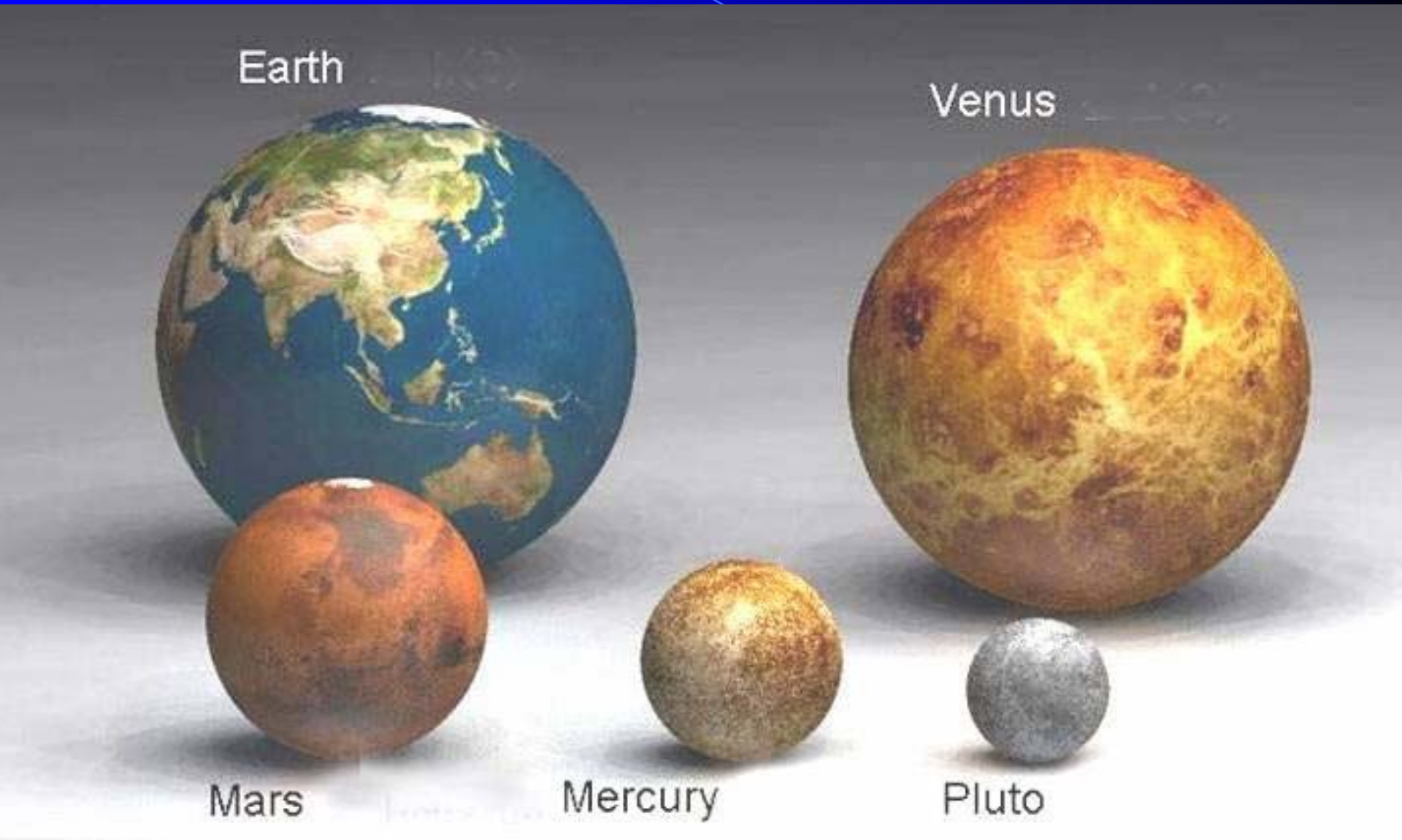
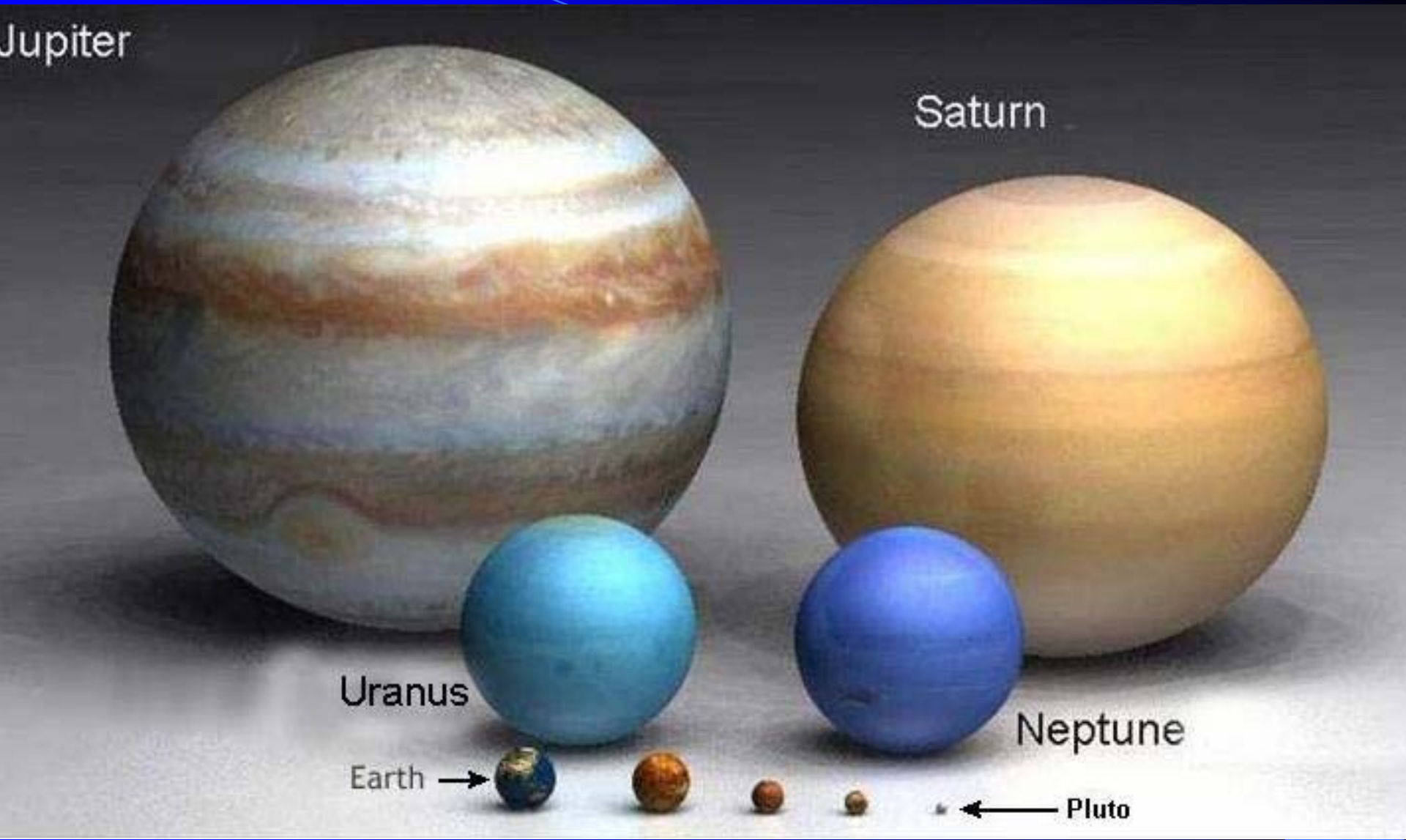
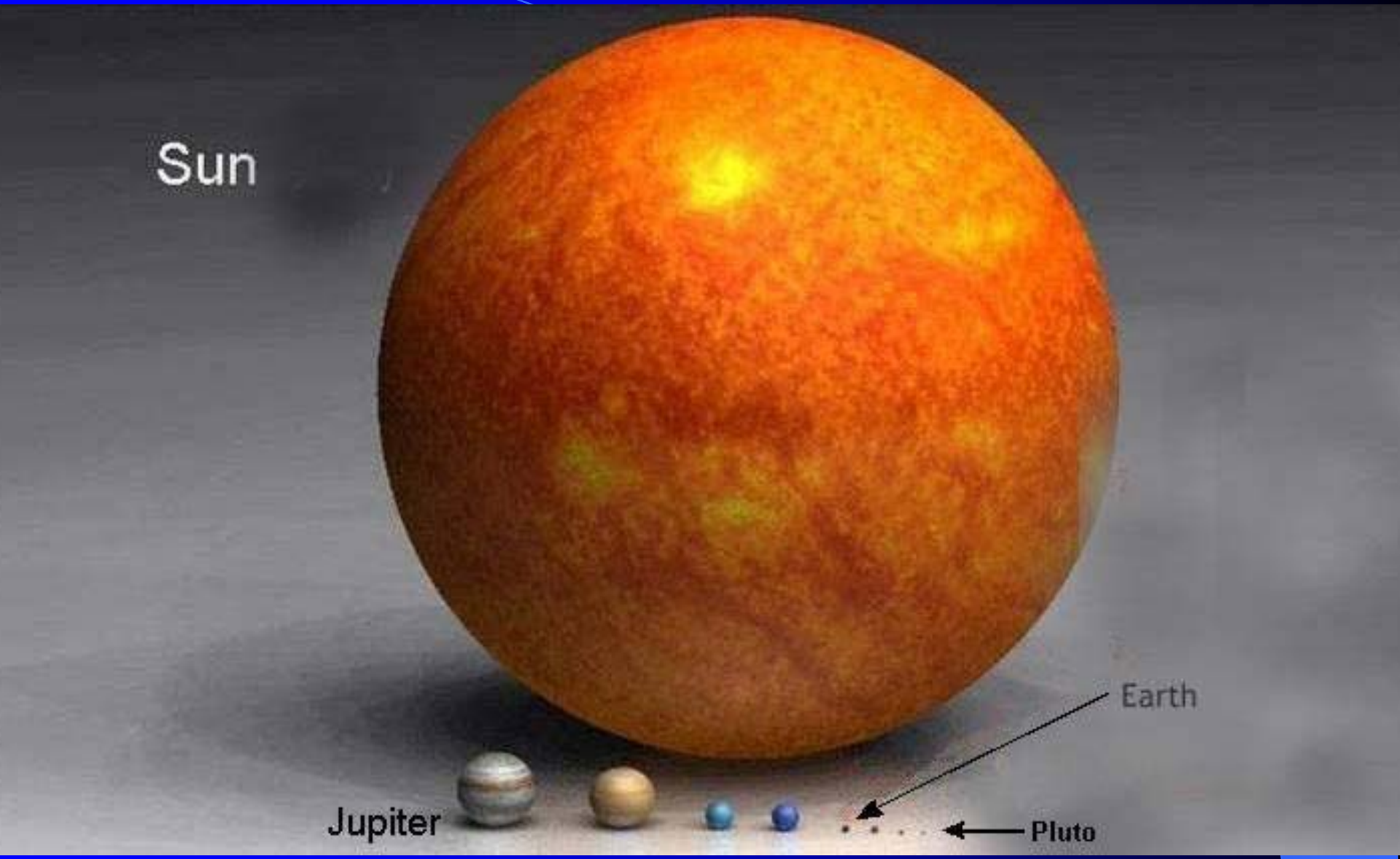
USA

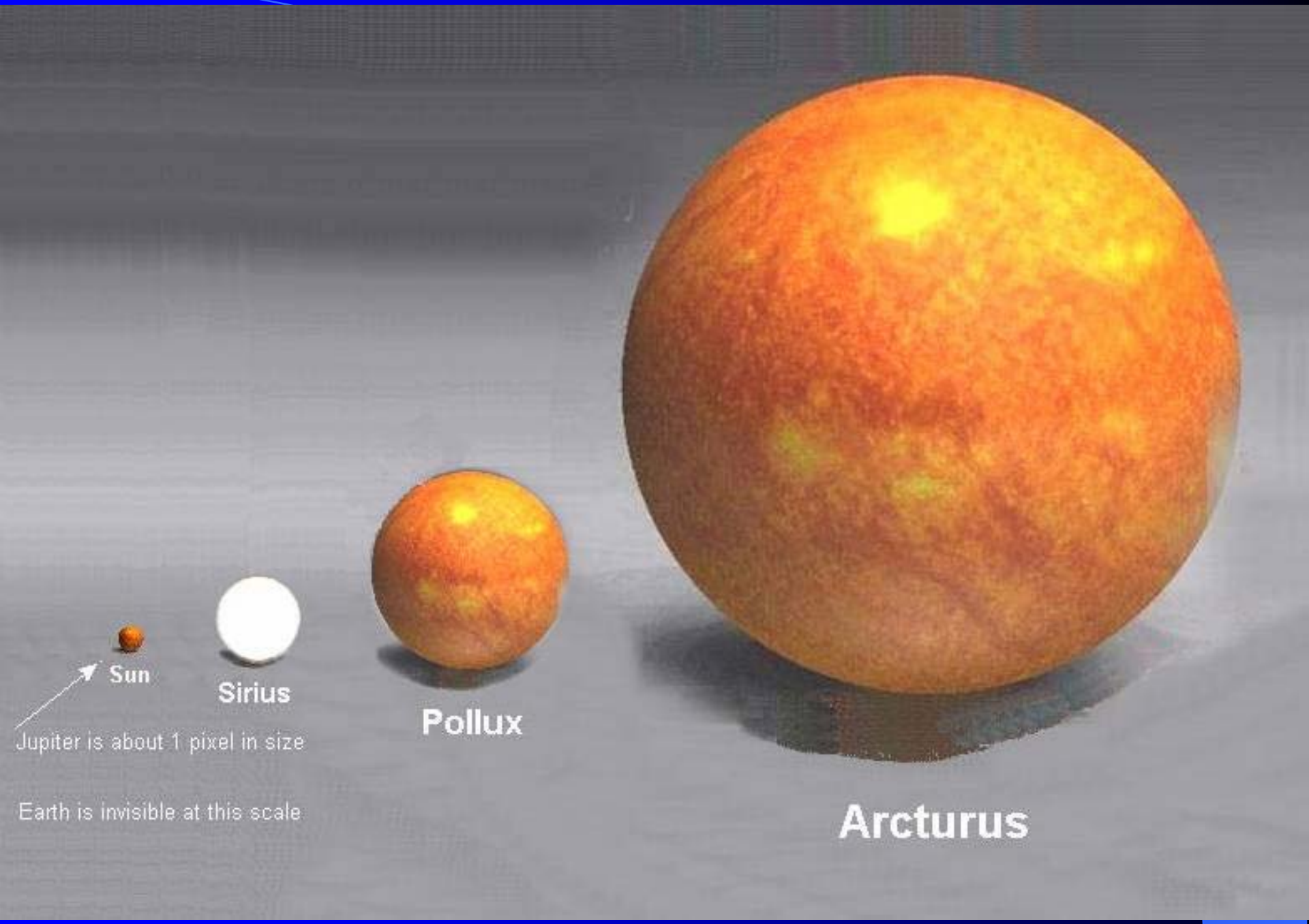

USA
NASA

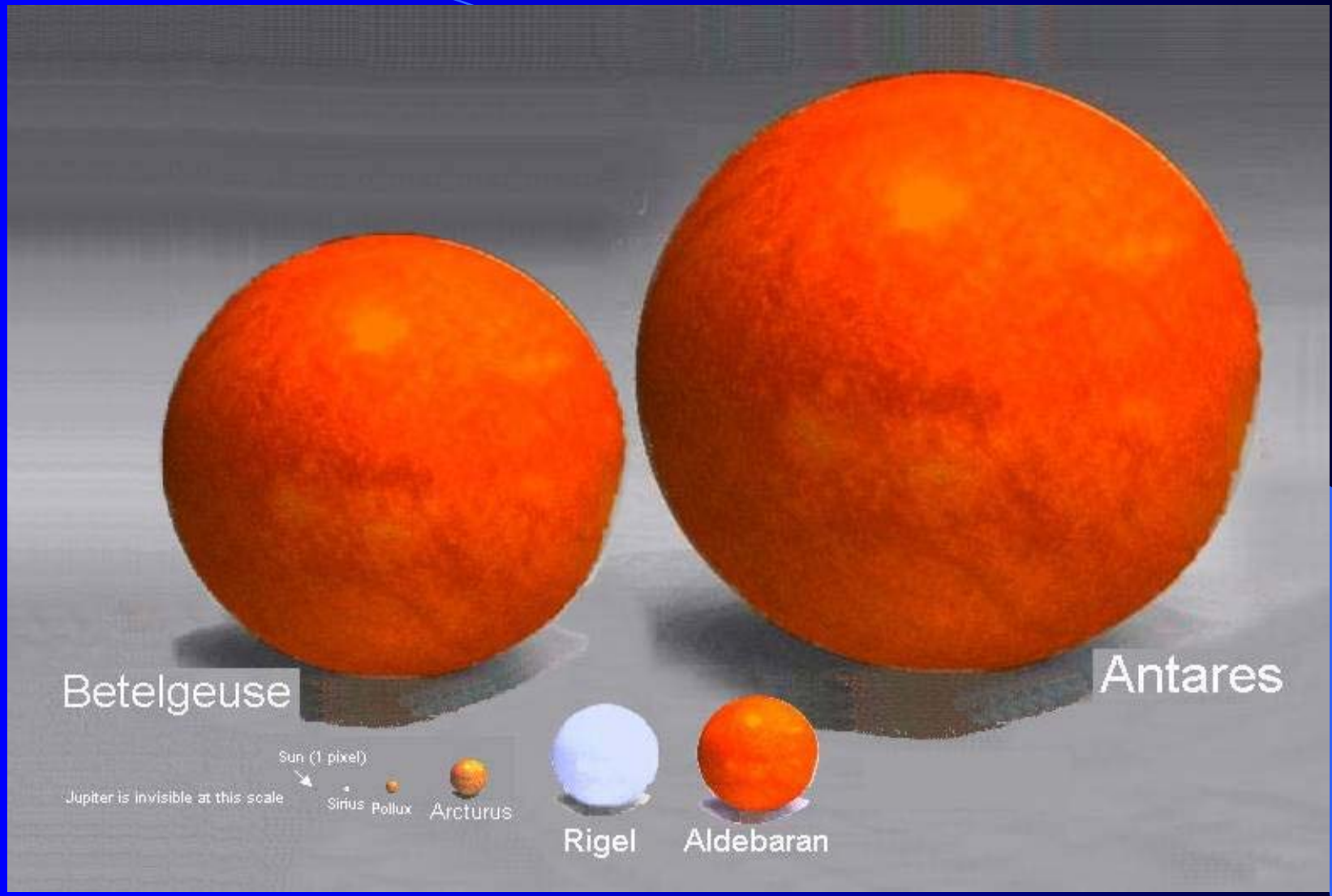
Perspective




Jupiter
Saturn
Uranus
Neptune
Earth
Pluto


Sun
Earth
Jupiter
Pluto


Sun
Sirius
Pollux
Arcturus
Jupiter is about 1 pixel in size
Earth is invisible at this scale


Betelgeuse
Antares
Sun (1 pixel)
Jupiter is invisible at this scale
Sirius
Pollux
Arcturus
Rigel
Aldebaran


YOU ARE HERE

Morbidity Associated With Shift Workers[1-4]

- Gastrointestinal disorders (eg, peptic ulcer disease)
- Hypertension/cardiovascular disease
- Psychological distress
- Work-related strain
- Drug/alcohol dependency
- Disruption in social/family life

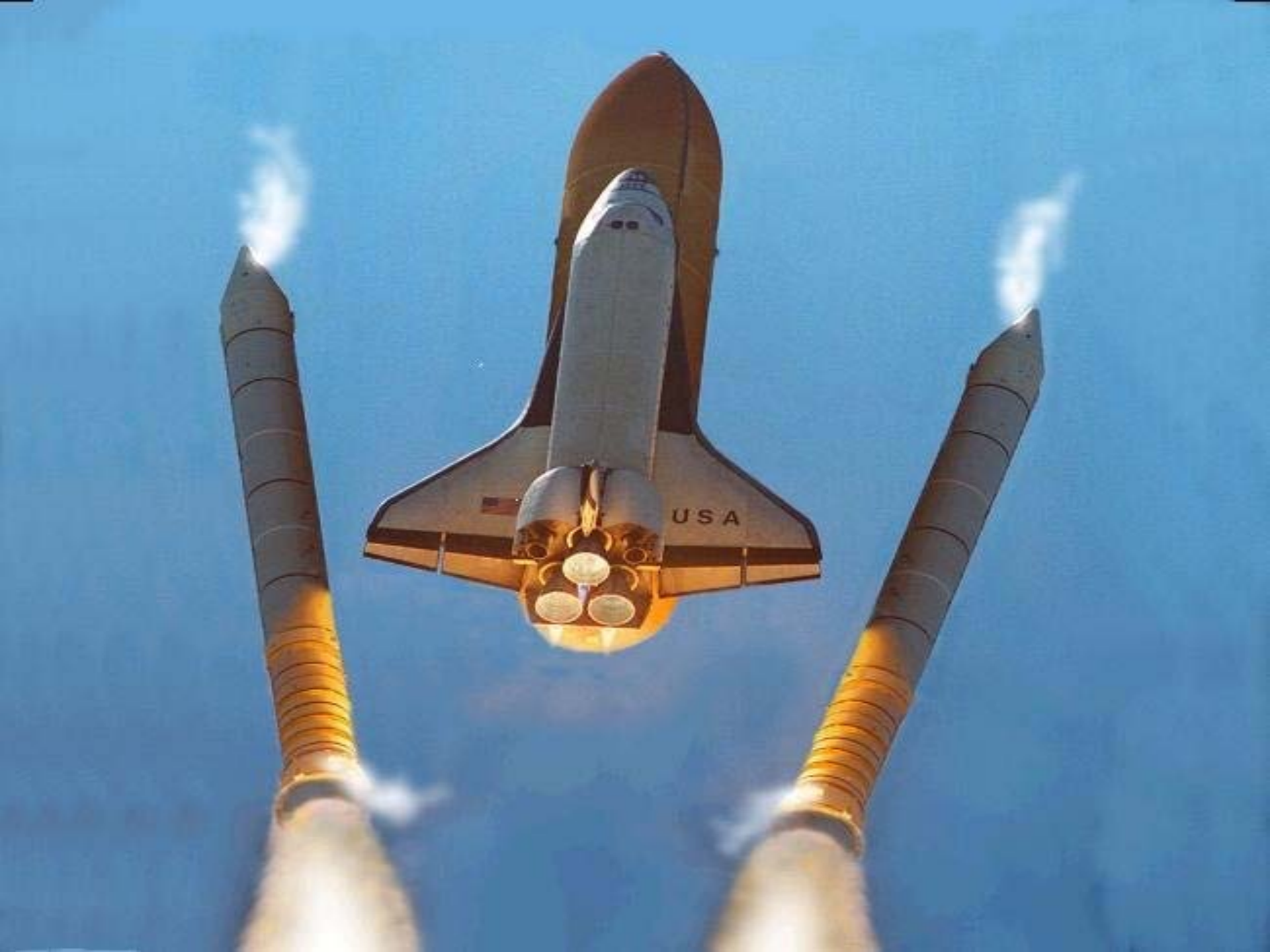
1. Shields M. *Health Rep*. 2002;13:11-33.
2. *ICSD. Revised*. Rochester, Minn: ASDA; 1997.
3. Boggild H, et al. *Scand J Work Environ Health*. 1999;25:85-99.
4. *Shiftwork Practices 2004*. Circadian Technologies, Inc.; 2003.

Medical Care in

High Performance Environments

HOUSTON

FIRST WORD FROM THE MOON


USA


USA
NASA
Atlantis

Medical Care in

High Performance Environments

Really High Performance Environments


КРИКАЛЕВ
11
PHILLIPS

Neurovestibular

In-flight changes in neural feedback function that produce postural imbalance and loss of coordination postflight

- **Incidence** - All crewmembers are affected to some degree
- **Symptoms** - From vertigo and unstable gait to nausea and vomiting
- **Time course** - From landing to 48 - 72 hours postlanding
- **Causes** - Neurovestibular-otolith and proprioception readaptation
- **Treatment**
  - Avoid rapid head movements
  - Slow but progressive increase in activity
  - Medication (Phenergan, Antivert)