

Safety aspects of Human Spaceflights

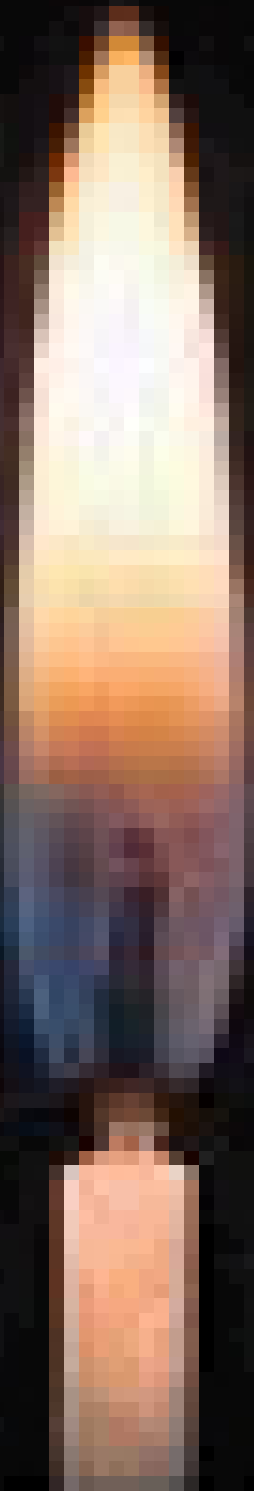
Viscount Frimout
First Belgian astronaut

Eurosafe
Brussels - 2 November 2009



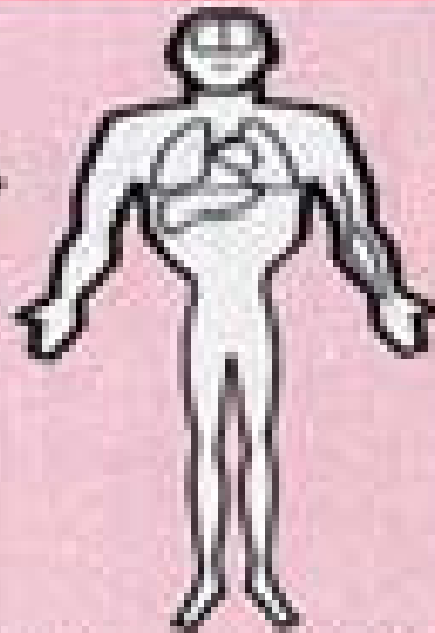
Why do we go to space?

- a. observation above the atmosphere
 - access to complete electromagnetic spectrum
 - no turbulence
 - global view on earth
- b. μ -gravity:
 - no convection
 - no sedimentation
 - no hydrostatic forces

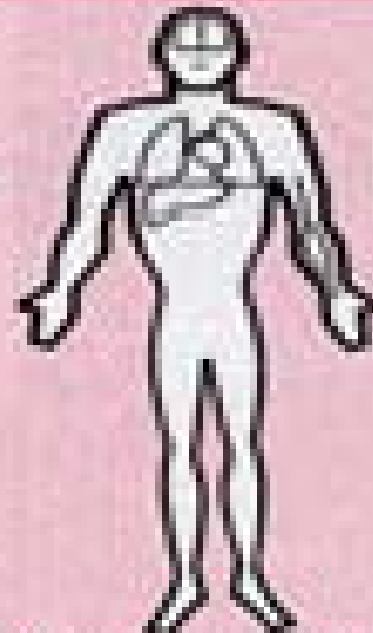




On ground
1G



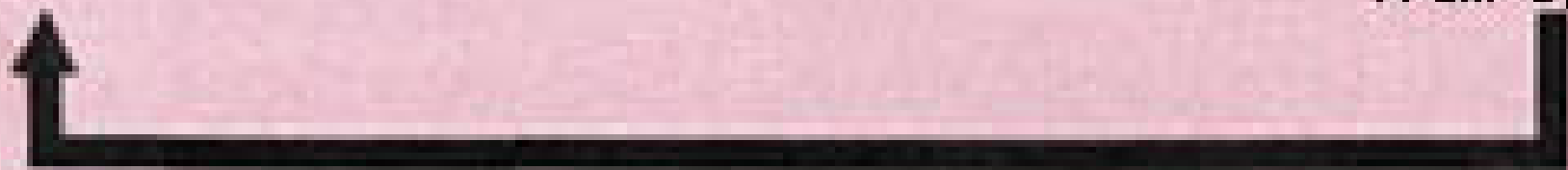
Initial stage
in space



After adapted
to microgravity



Immediately
after return
from space



Design requirements for Human Spaceflights

- Two-failure-tolerant to catastrophic hazards
- One-failure-tolerant to critical hazards
- Design for minimum risk

Vehicles

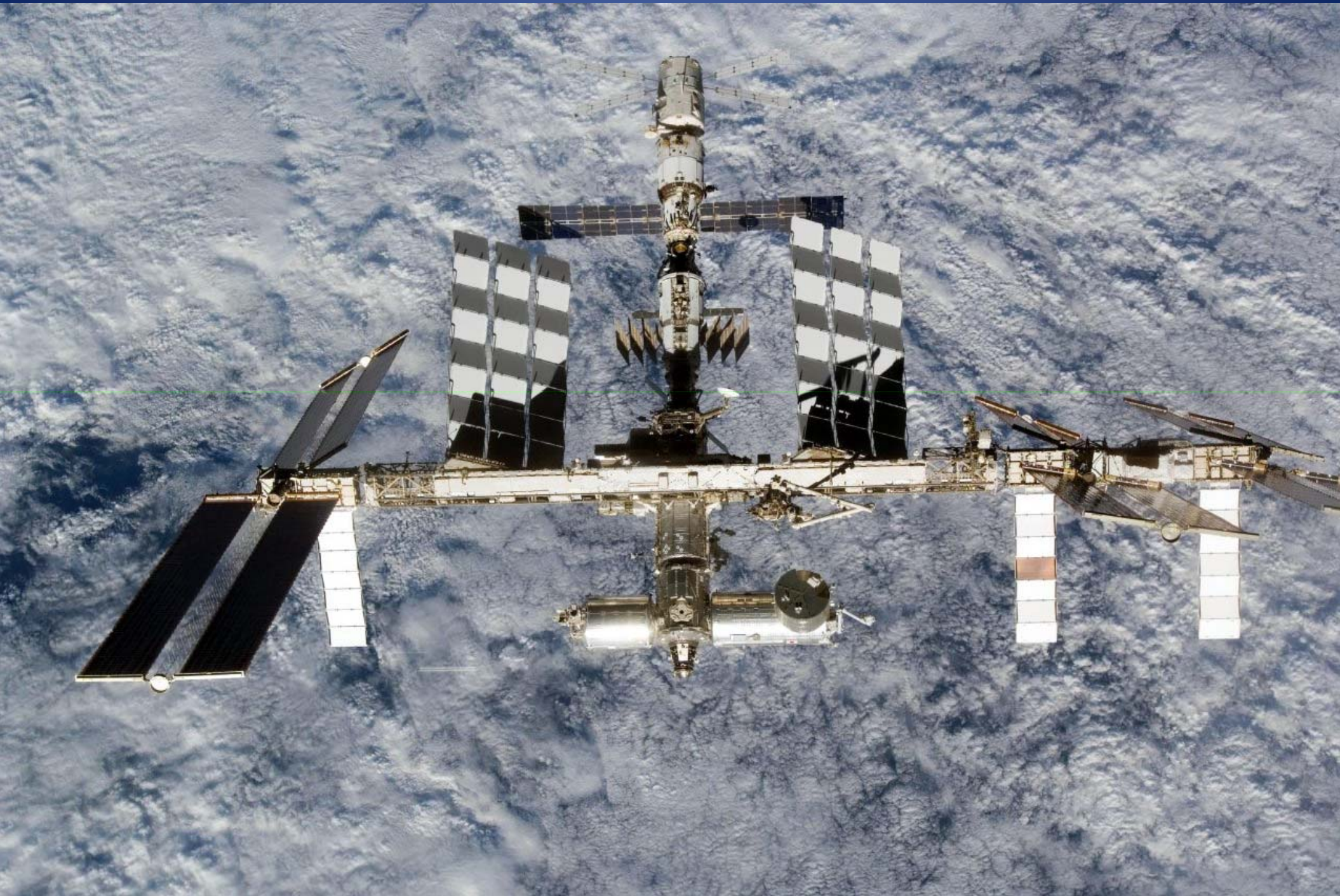
- Race to the moon: Apollo – Saturn
- Mir – Shuttle
- ISS
- Future: Constellation











Shuttle

- Critical events:
 - Launch:
 - Intact aborts: (safe return of orbiter)
 - Abort to orbit
 - Abort once around
 - Abort transatlantic landing
 - Return to launch Site
 - Contingency aborts: (safe return of crew)
 - Loss of more than one engine during launch
 - Orbiter to be ditched
 - Use of crew escape system

Shuttle

- Landing:
 - Always resources for 3 more days
 - Day 1: KSC Florida
 - Day 2: KSC and Edwards (California)
 - Day 3: KSC, Edwards, White Sands (New Mexico)
 - 5 Computers redundant – 4 with same software, fifth with software written by other company
 - Computer controlled:-angle of attack- S-turns to lose energy- from 28000 km/h till 350 km/h at landing
 - No motor – glider
 - Manual control when sub-sonic.

Safety

- General remarks:
 - Spaceflight will remain inherently risky because of unreachable hostile environment
 - Safety built in project: better - cheaper
 - Analysis and experience
 - But... no statistical data
 - Keep same standards over whole duration of project
- Crew safety is first priority
 - Selection - Training – prevention
 - Monitoring – alarms
 - Medical support – crew surgeons
 - Contamination –microbial environment

Accidents

- MIR
 - Fire: Feb. 23, 1997
 - Collision with Progress:
June 25, 1997
- Shuttle
 - Challenger: Jan. 28, 1986
 - Columbia: Feb. 1, 2002







BREAKING NEWS

WFDA



**SHUTTLE FOLLOWED BY MULTIPLE
VAPOR TRAILS OVER TEXAS**

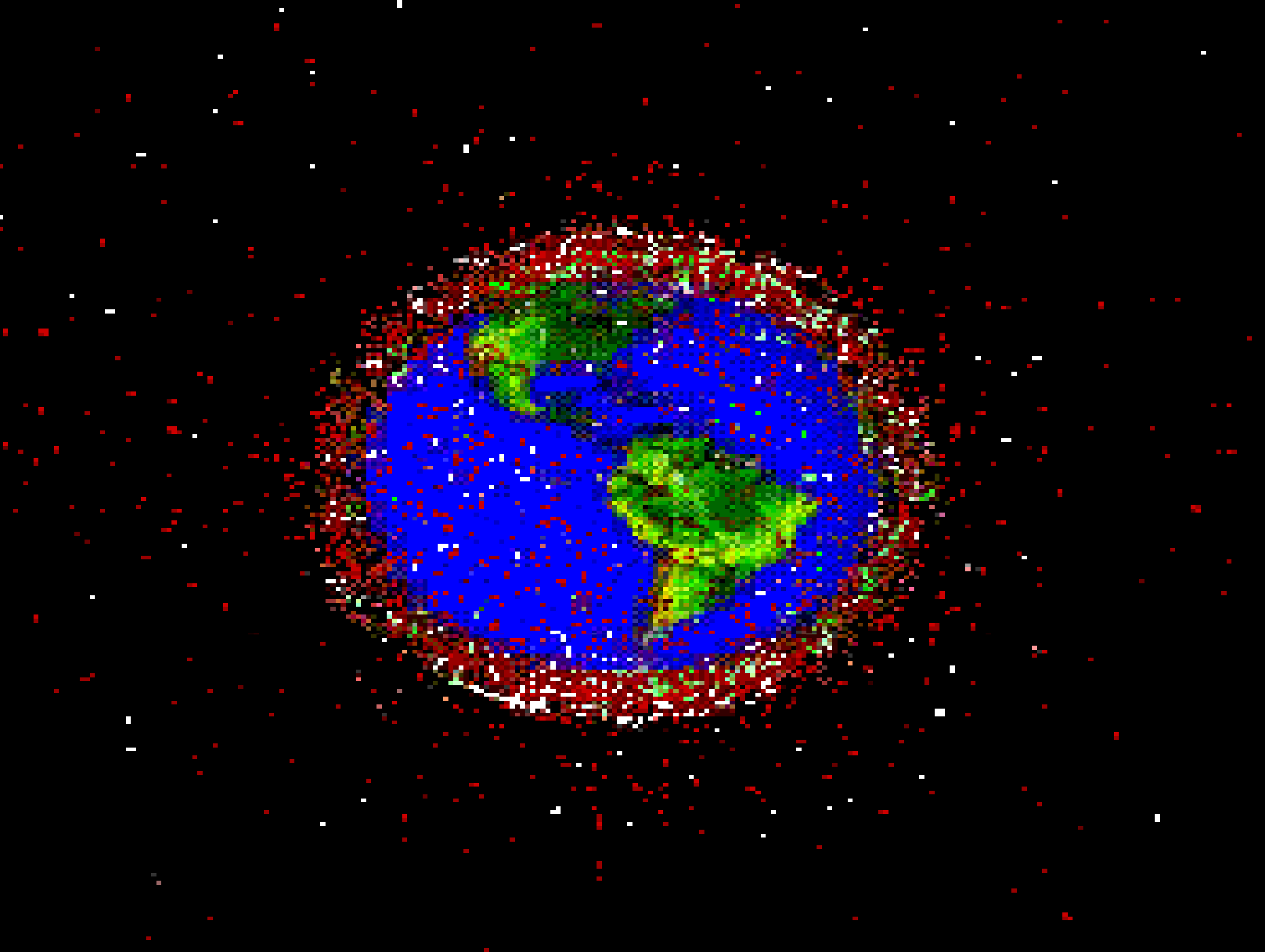
ORTH CENTRAL TEXAS AFTER CONTACT WITH SPACE SHUTTLE

Safety Hazards ISS:

- ISS is robust orbit vehicle
- Design:
 - International program
 - with contribution of 16 countries
 - Mating with hardware that is since more than 10 years in space
- Management:
 - Keep competent management team
 - Program risk: logistics
- Verification – configuration control:
 - Flight electrical and data cabling
 - Fluid connections

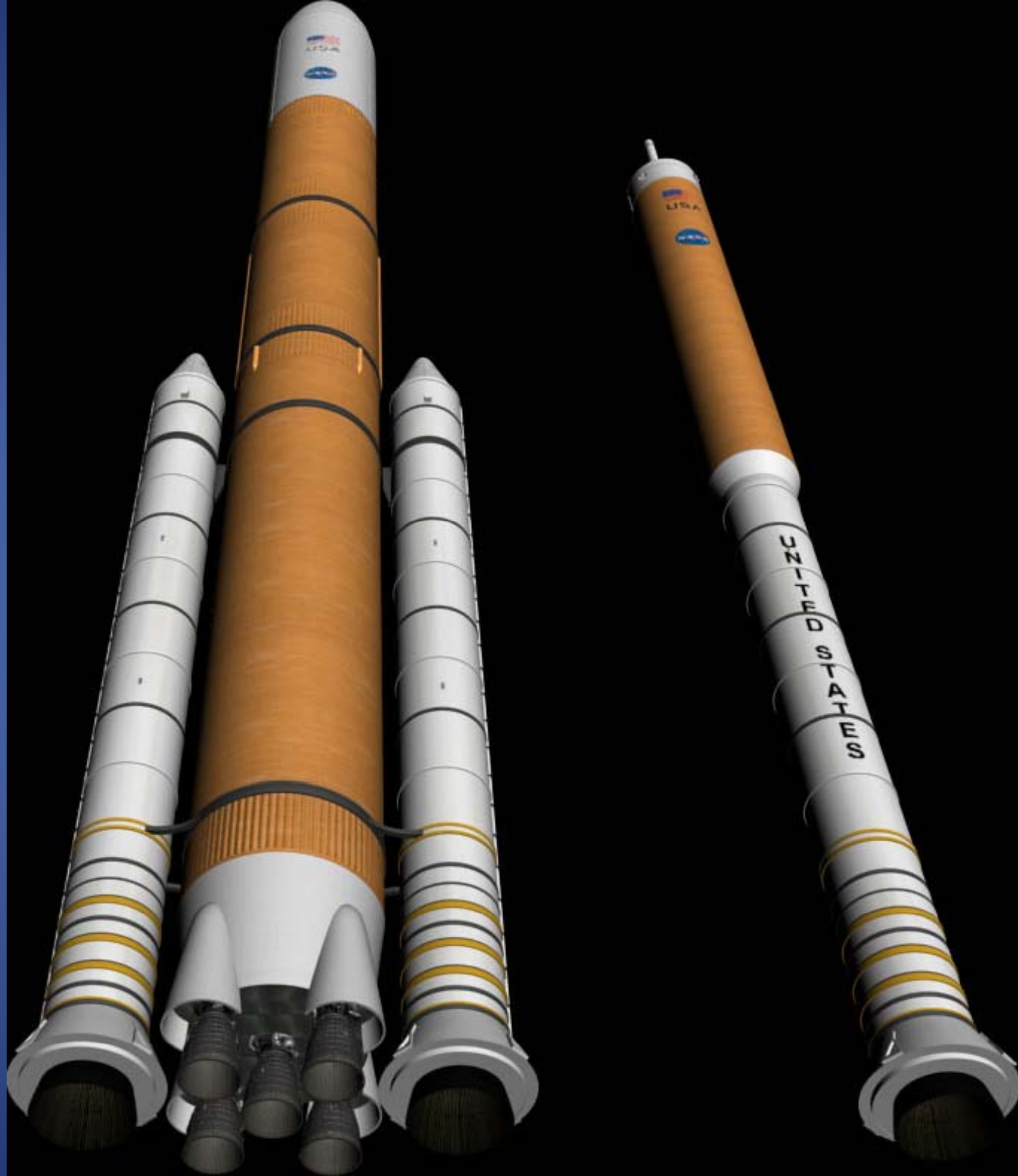
Threats and vulnerabilities of ISS

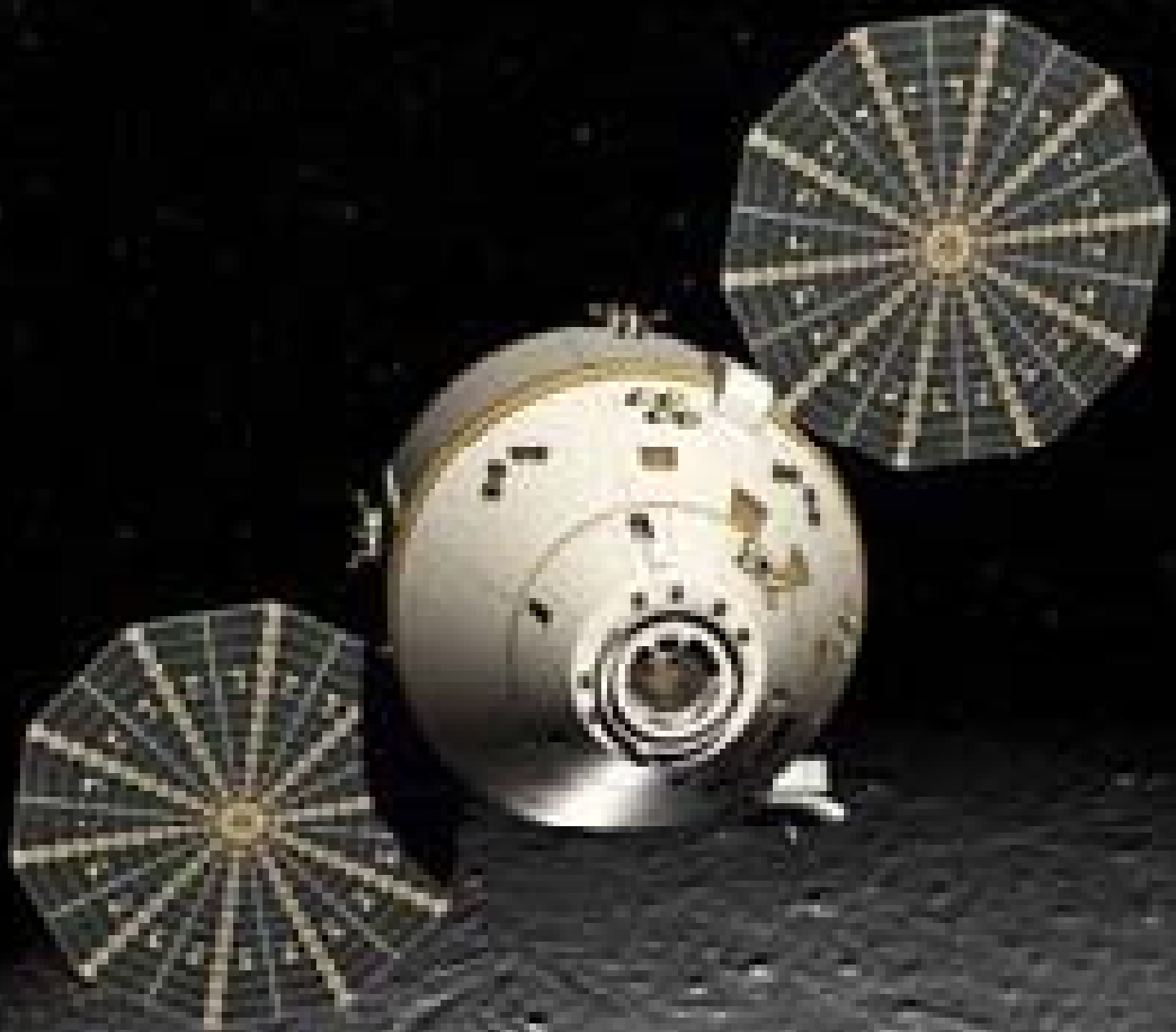
- MMOD penetration of the ISS pressure wall
- a catastrophic collision with the ISS
- an on-board fire
- a toxic spill in the crew-habitable volume
- a catastrophic system failure
- a hardware or software design flaw
- a crew member becoming separated from the Station during an EVA
- a deliberate attack using ground assets
- an inadvertent critical command from the Mission Control Center (MCC)



Future program NASA Constellation

- Ares I
- Ares V
- Altair
- Orion

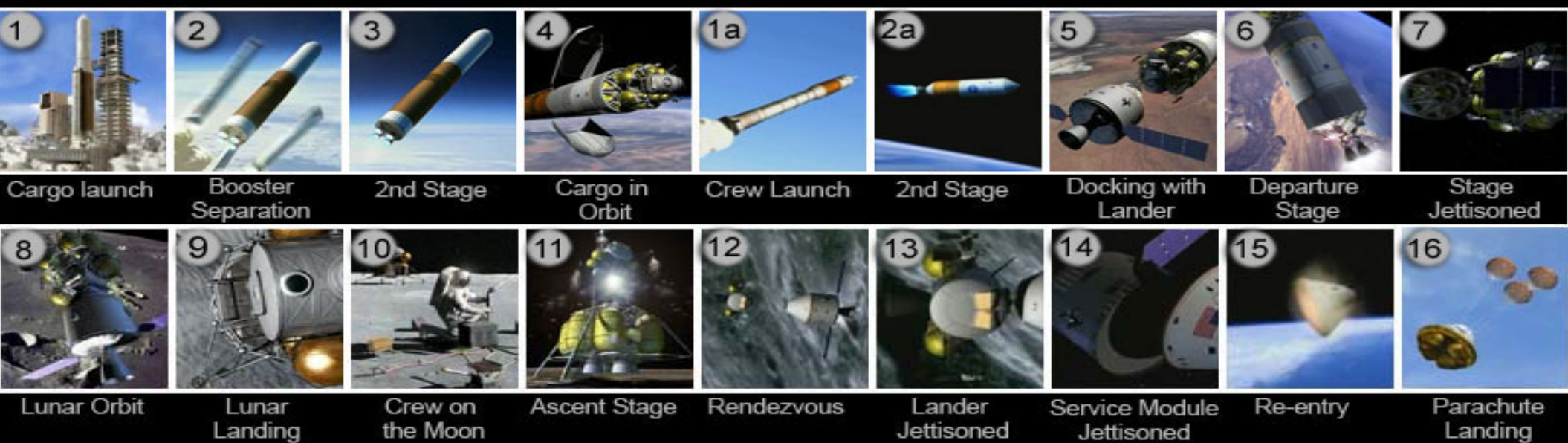








LUNAR FLIGHT PLAN



A cargo vehicle lifts off (1), ejects its boosters (2) and uses its second stage (3) to put cargo like the lunar lander in orbit (4). The crew vehicle lifts off (1a) and uses its second stage (2a) to reach orbit where it docks with the lander (5) and heads for the Moon using a departure stage (6). The departure stage is jettisoned (7) and the craft goes into lunar orbit (8). Four astronauts land (9), explore the surface for seven days (10) and blast off in an ascent stage (11). They rendezvous and dock (12) with the crew capsule and head back to Earth. The lunar ascent stage (13) and service module are jettisoned (14), the capsule re-enters Earth's atmosphere (15) and lands with parachutes (16).

Mars

- Why?
 - Detection of life in space
- When?
 - Earliest in 2030
- How?
 - With actual technology: about 3years
 - With plasma motors 190 days (90+10+90)

Mars

- Challenges:
 - Health of crew
 - Duration of trip
 - Radiation
 - Micro meteorites
 - Communication delay

Conclusion

- Impossible to make spaceflight 100% safe
- Most important challenges:
 - MMOD's
 - Radiation
 - Crew's health
 - Launch and landing