

Reise zum Mars: Medizinische und biologische Aspekte

Augusto Cogoli

Zero-g LifeTec  *GmbH*

4. Schweizerische Fachtagung über
die Sterilisation

Fribourg

11. - 12. Juni 2008



Gegründet 1976 als Forschungseinheit der ETH Zürich
www.spacebiol.ethz.ch



Gegründet 2000 als Biotechnology Space Support Center für die Unterstützung von Projekten auf der Internationalen Raumstation. Partnerschaft: ESA, ETHZ, SSO.



Gegründet 2004 als spin-off Firma der ETH Zürich
www.zeroglifetec.ethz.ch

**Astronaut Bruce
McCandless**

1984



INHALT

- 1. Physiologische Effekte des Raumfluges auf den Menschen**
- 2. Die Mars Mission**
- 3. Hygiene und medizinische Versorgung**
- 4. Abfall Recycling**
- 5. Perspektiven / Visionen**

1. Physiologische Effekte des Raumfluges auf den Menschen

**Flüssigkeits-
Verschiebung
kopfwärts**

```
graph TD; A([Flüssigkeits-Verschiebung kopfwärts]) --> B[Erhöhte Flüssigkeit im Kopf und Oberkörper]; B --> C[Schwindel-Störung]; B --> D[Erhöhte Urin Ausscheidung];
```

**Erhöhte
Flüssigkeit
im Kopf und
Oberkörper**

**Schwindel-
Störung**

**Erhöhte
Urin
Ausscheidung**



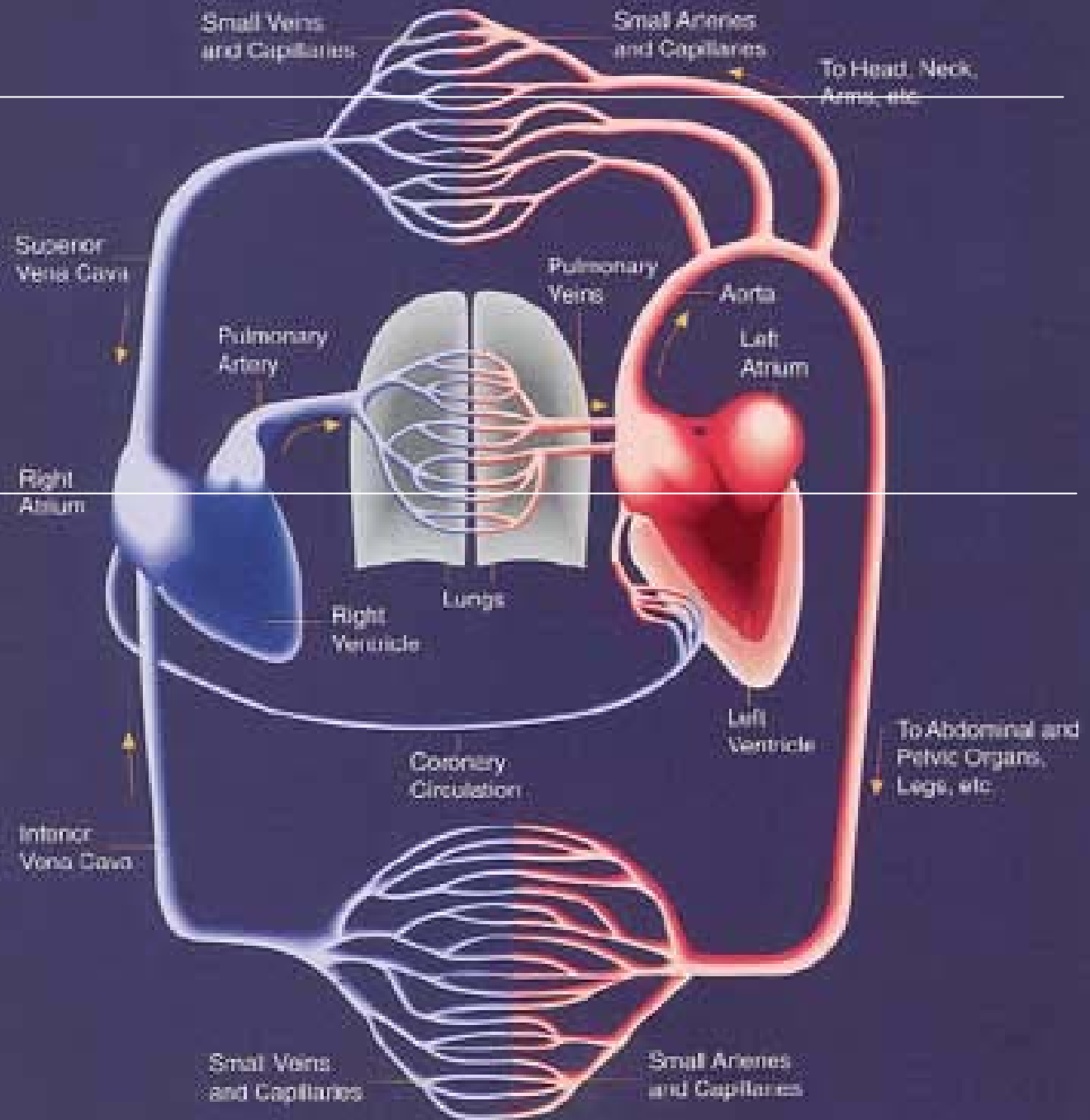
Jim Bagian

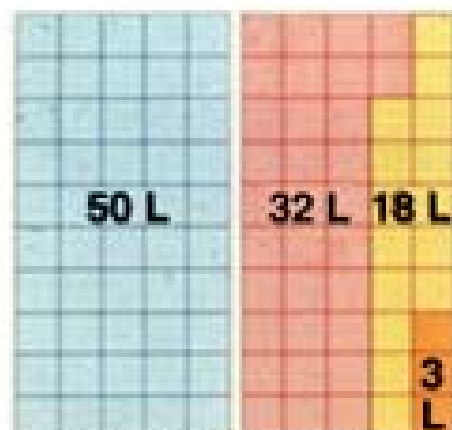


60 mm Hg

100 mm Hg

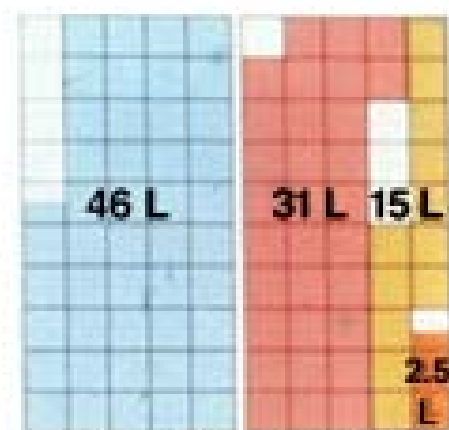
180 mm Hg





PREFLIGHT

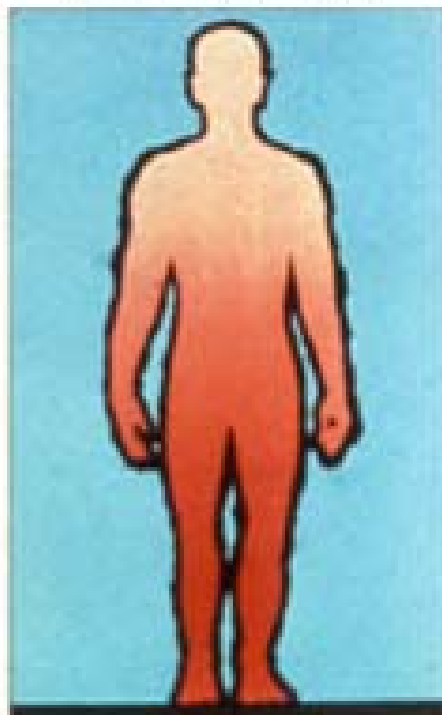
- TOTAL BODY WATER
- INTRACELLULAR FLUID
- EXTRACELLULAR FLUID
- PLASMA VOLUME



REENTRY

WEIGHTLESSNESS

BLOOD DISTRIBUTION

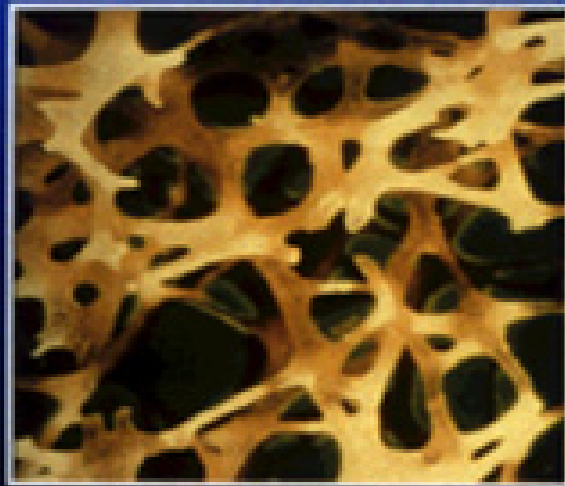


**Körpergewicht
Entlastung**

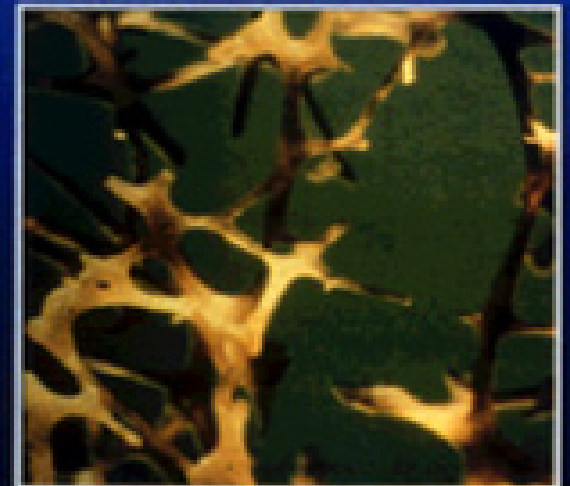
```
graph TD; A([Körpergewicht Entlastung]) --> B[Muskel-Schwund]; A --> C[Kochen-Schwund Osteoporose];
```

**Muskel-
Schwund**

**Kochen-
Schwund
Osteoporose**

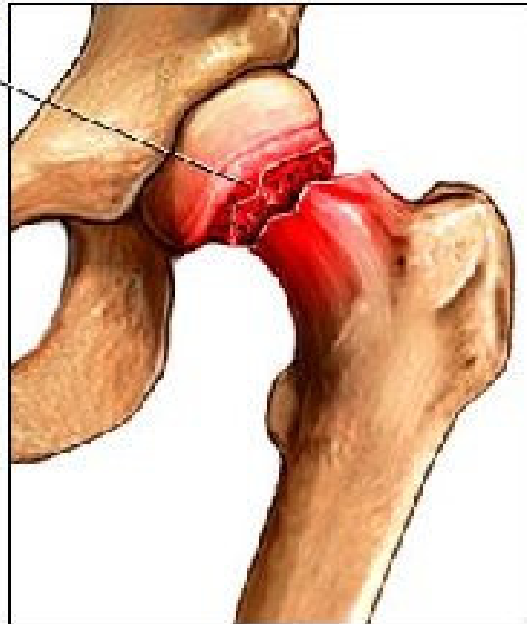


(A) Normal bone

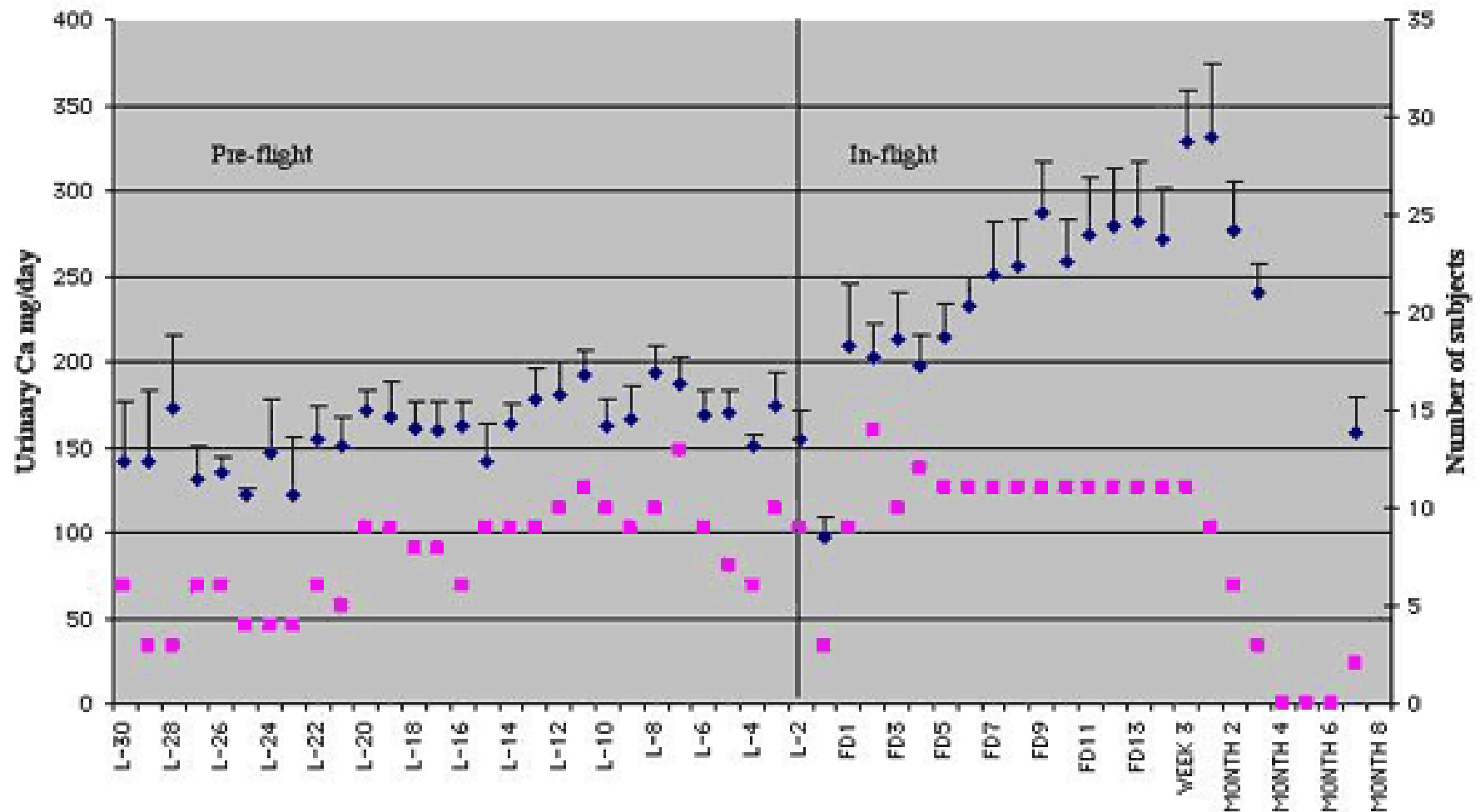


(B) Osteoporotic bone

Fracture of the
hip bone



Mean Urinary Calcium in Space

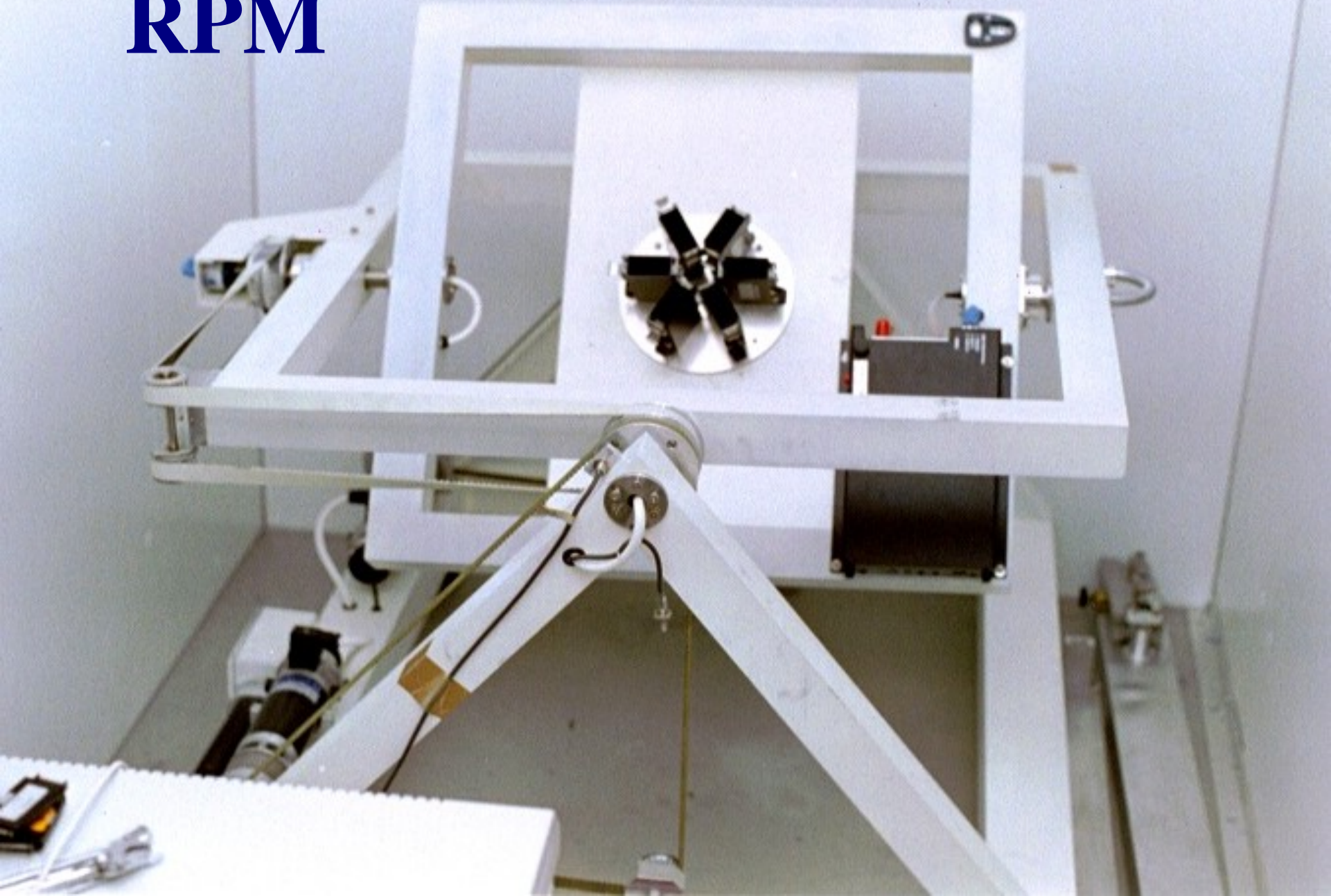


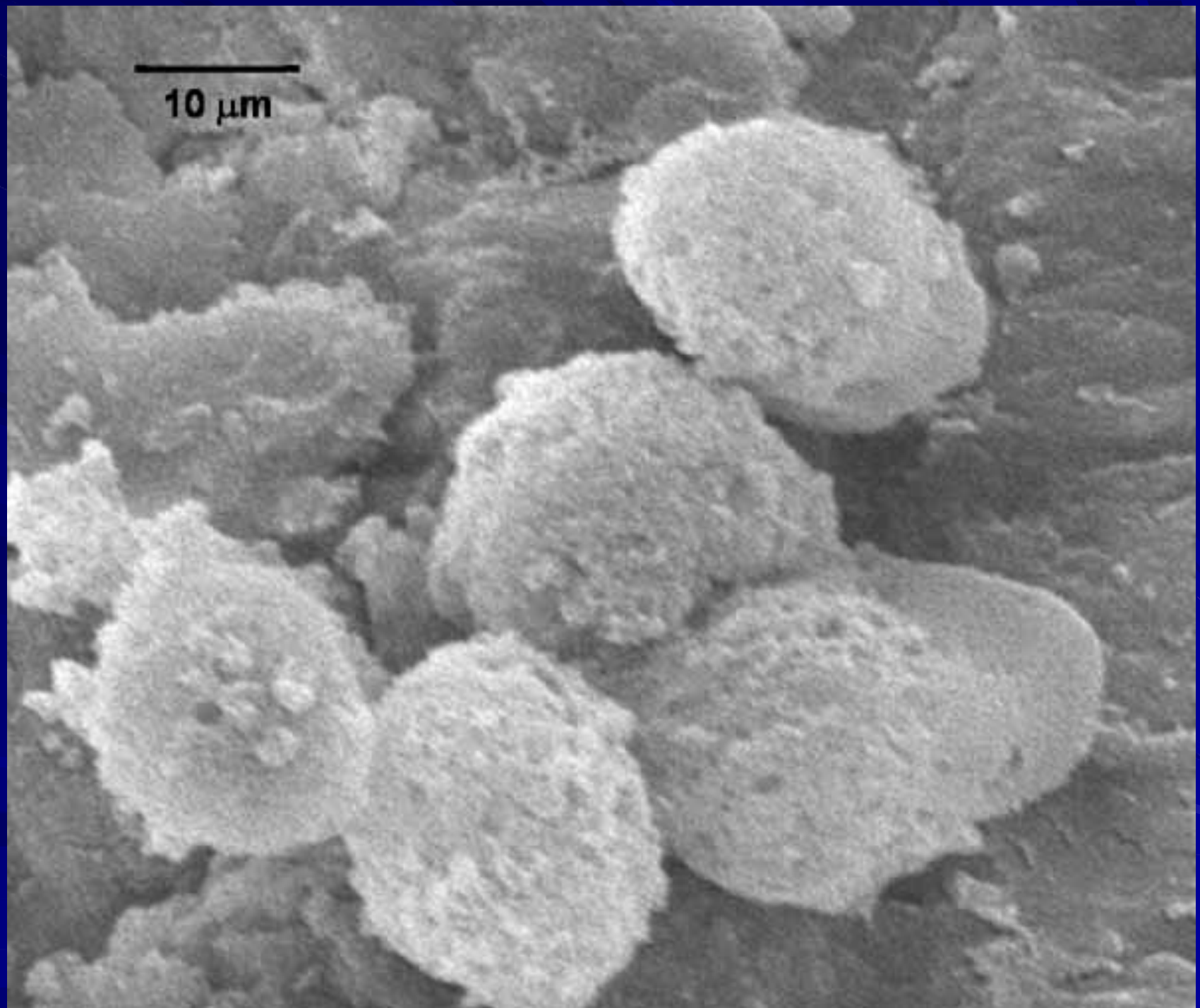
1. Compiled from Data in the Life Sciences Data Archive
2. Data from missions Gemini VII, Skylab 2-4, Shuttle, Salyut 7, Soyuz 9.
3. Life Sciences Data Archive does not independently verify results
4. L- means launch minus x days, FD means flight day

◆ Mean Urinary Calcium ■ Number of subjects



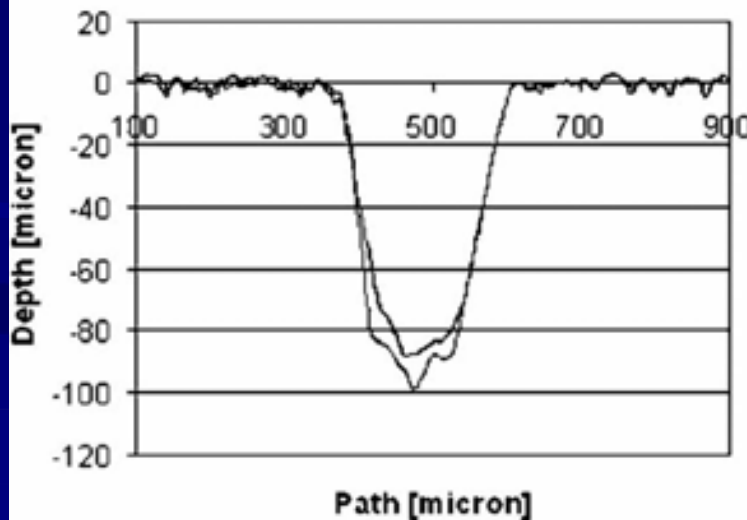
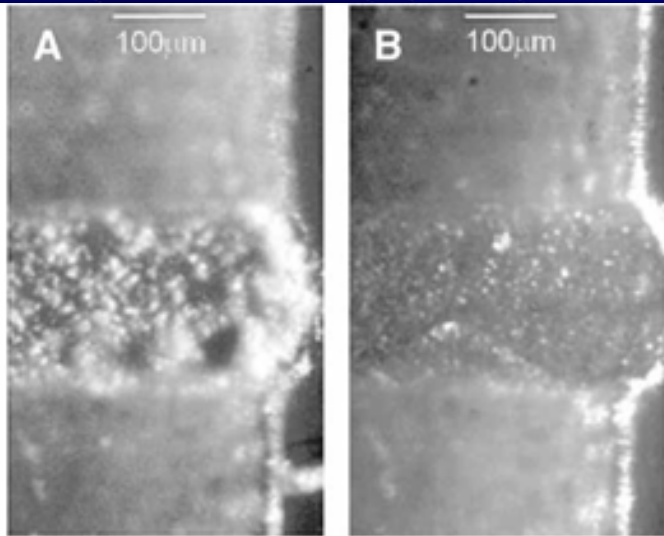
RPM





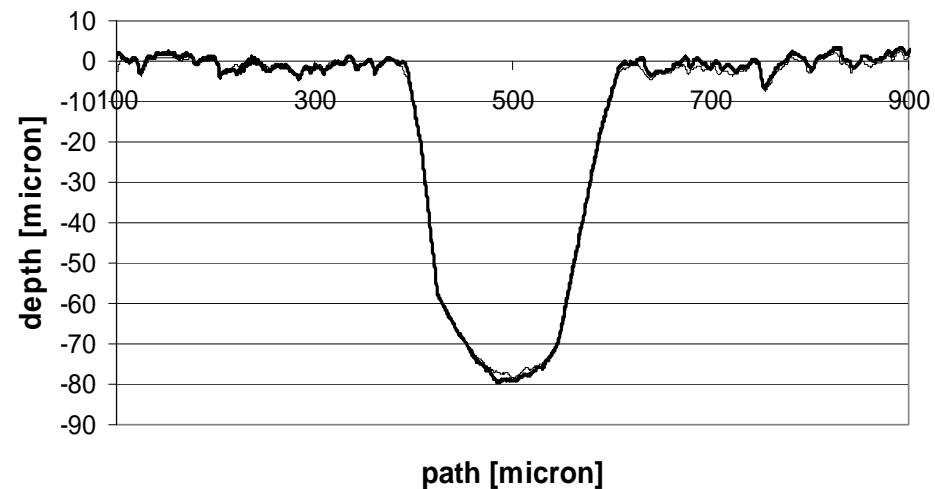
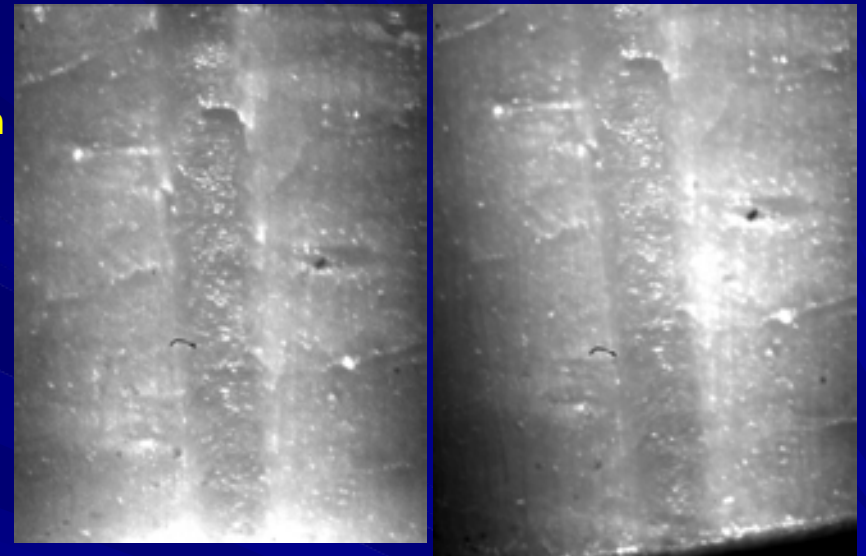
0 g Simulation, 72h

Vorher Nachher

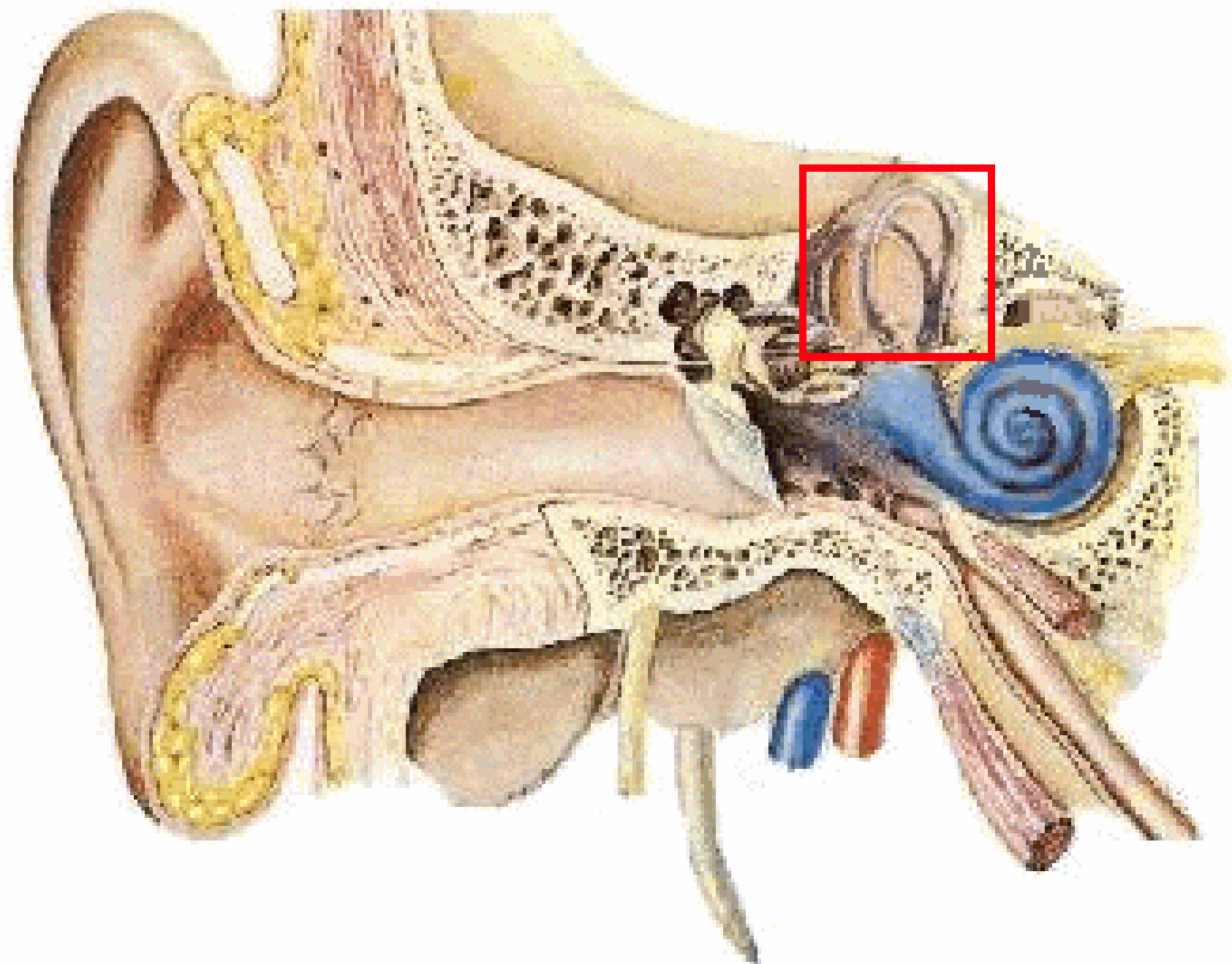


1 g Kontrolle, 72 h

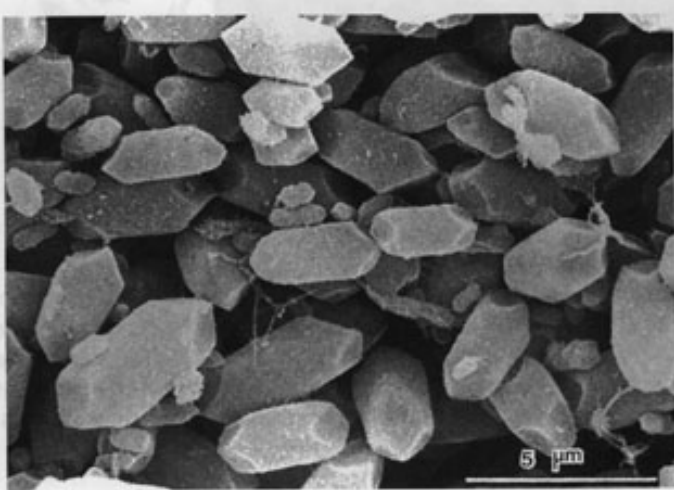
Vorher Nachher



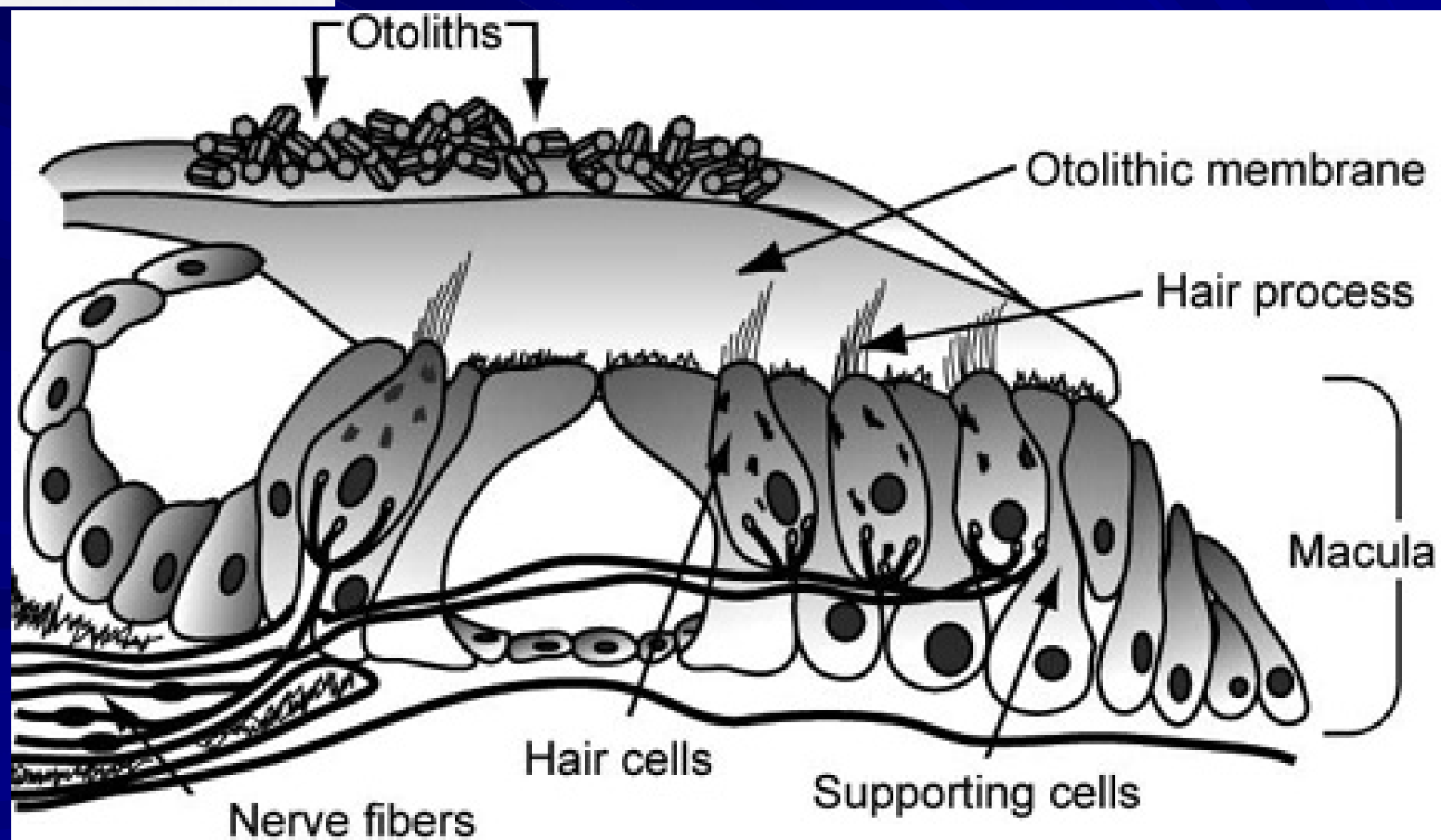
**„Weltraum-
Krankheit“**

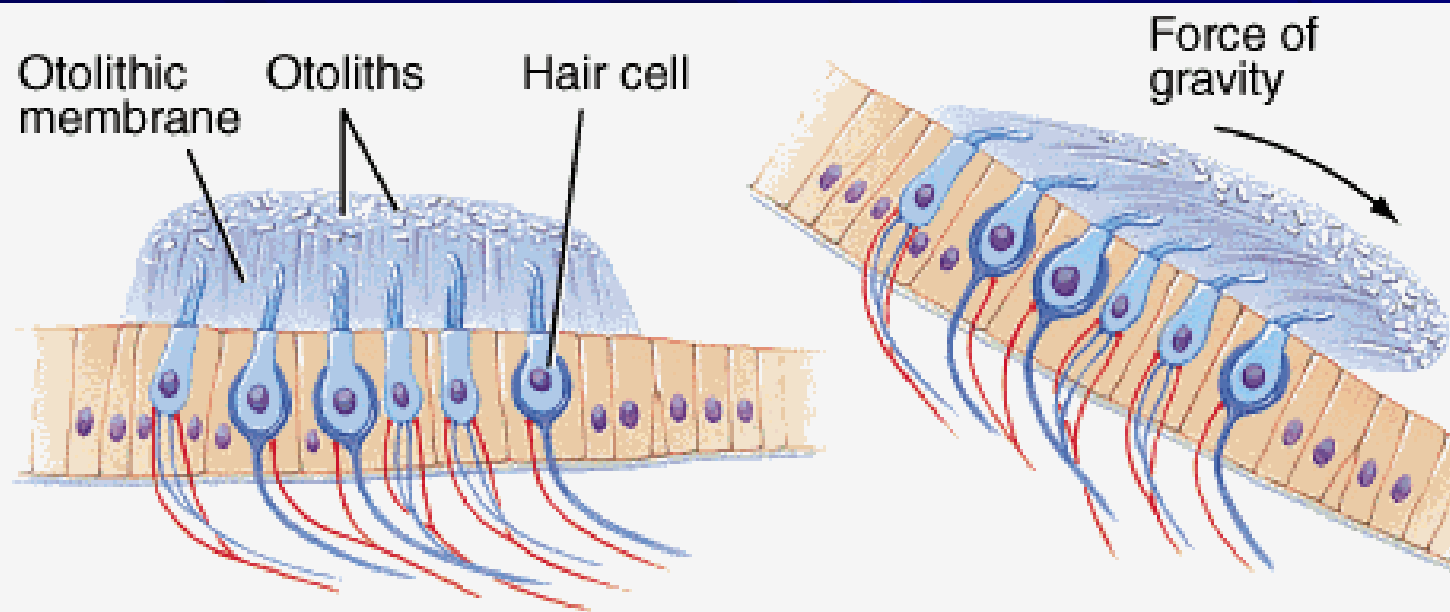






Otolithen CaCO_3

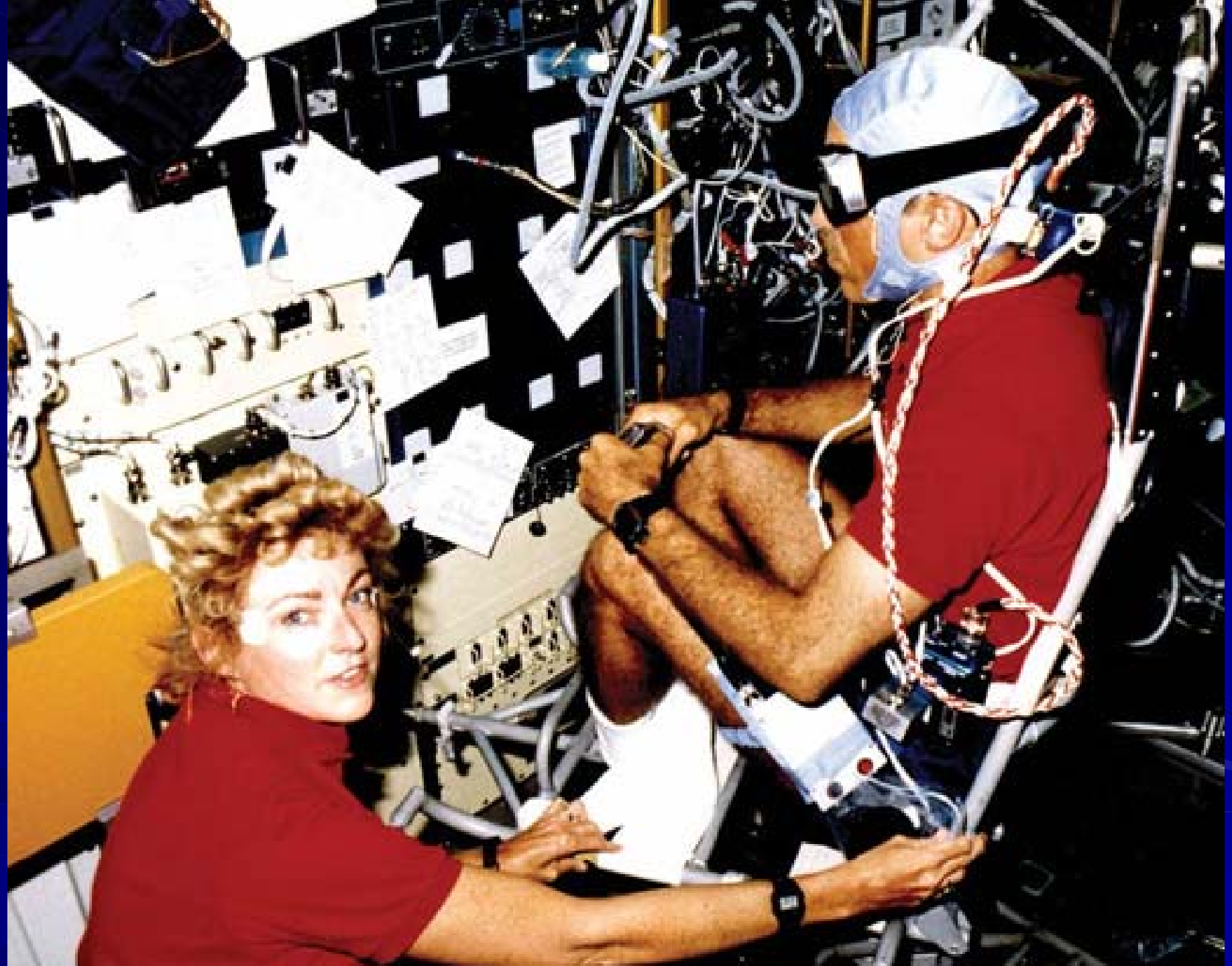




Head upright



Head tilted forward

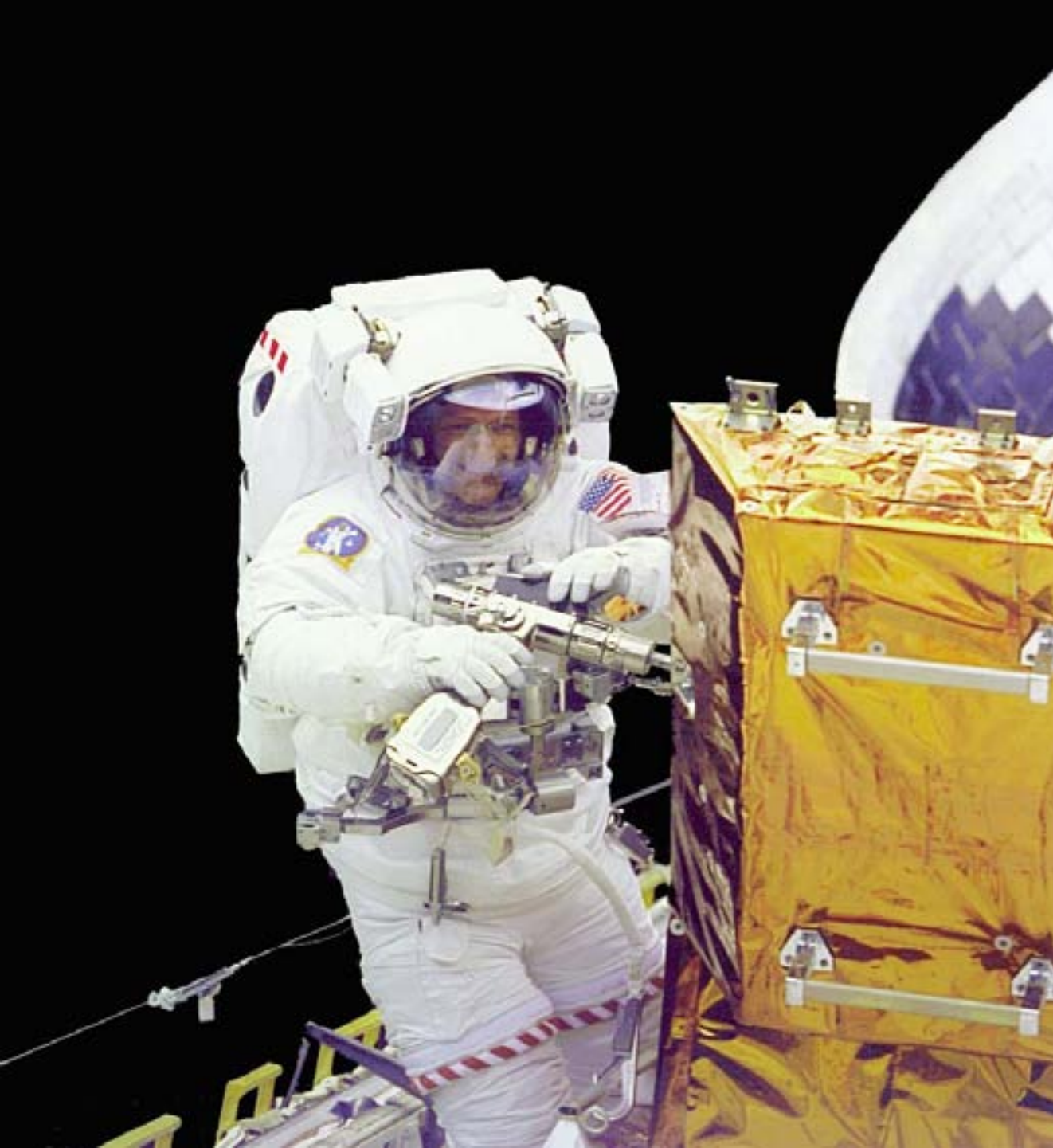


Veränderungen im Blut System

```
graph TD; A([Veränderungen im Blut System]) --> B[Verminderung der roten Blut-Körperchen]; A --> C[Abschwächung der Immun-Antwort];
```

**Verminderung
der roten
Blut-
Körperchen**

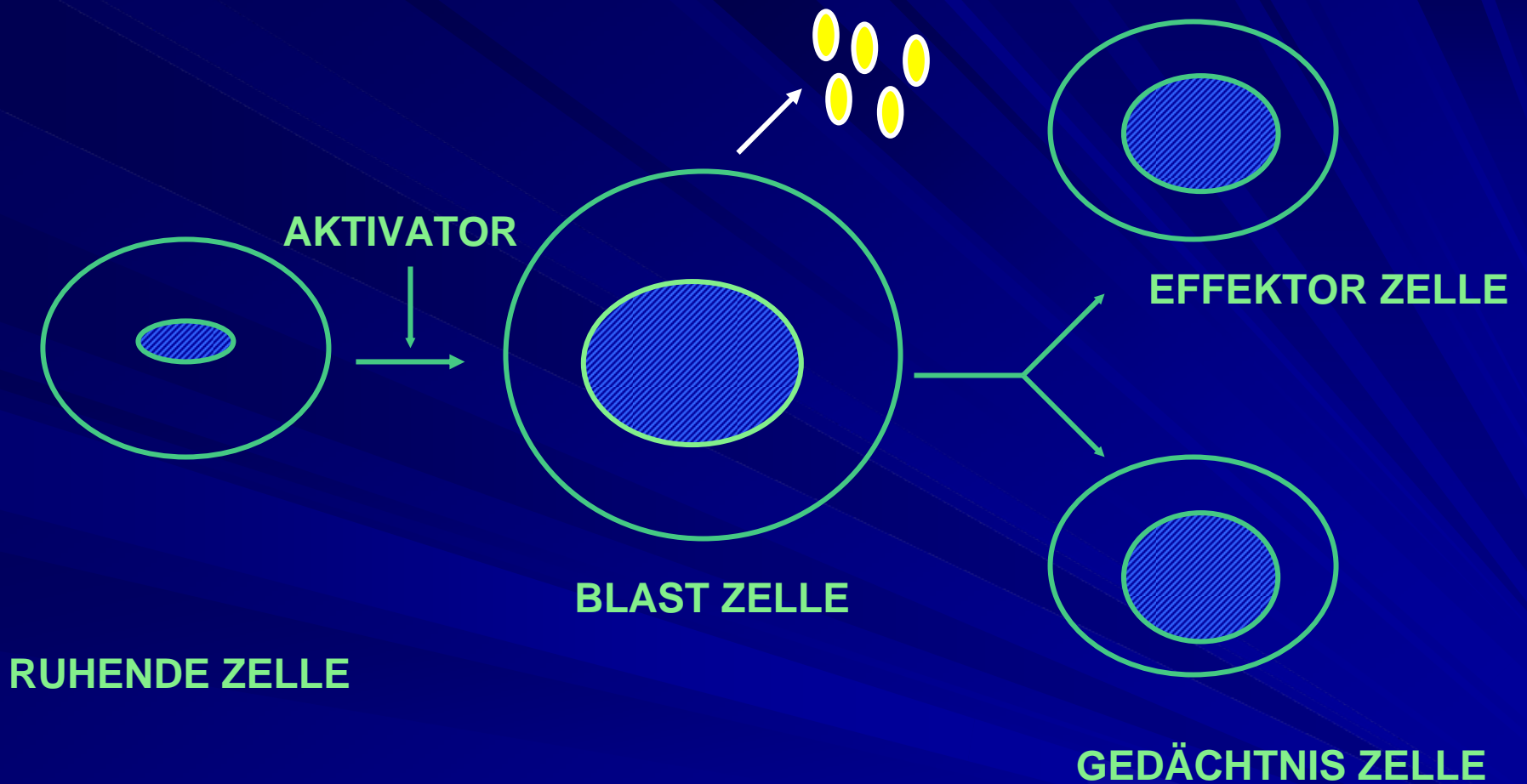
**Abschwächung
der Immun-
Antwort**



Claude Nicollier
STS-103

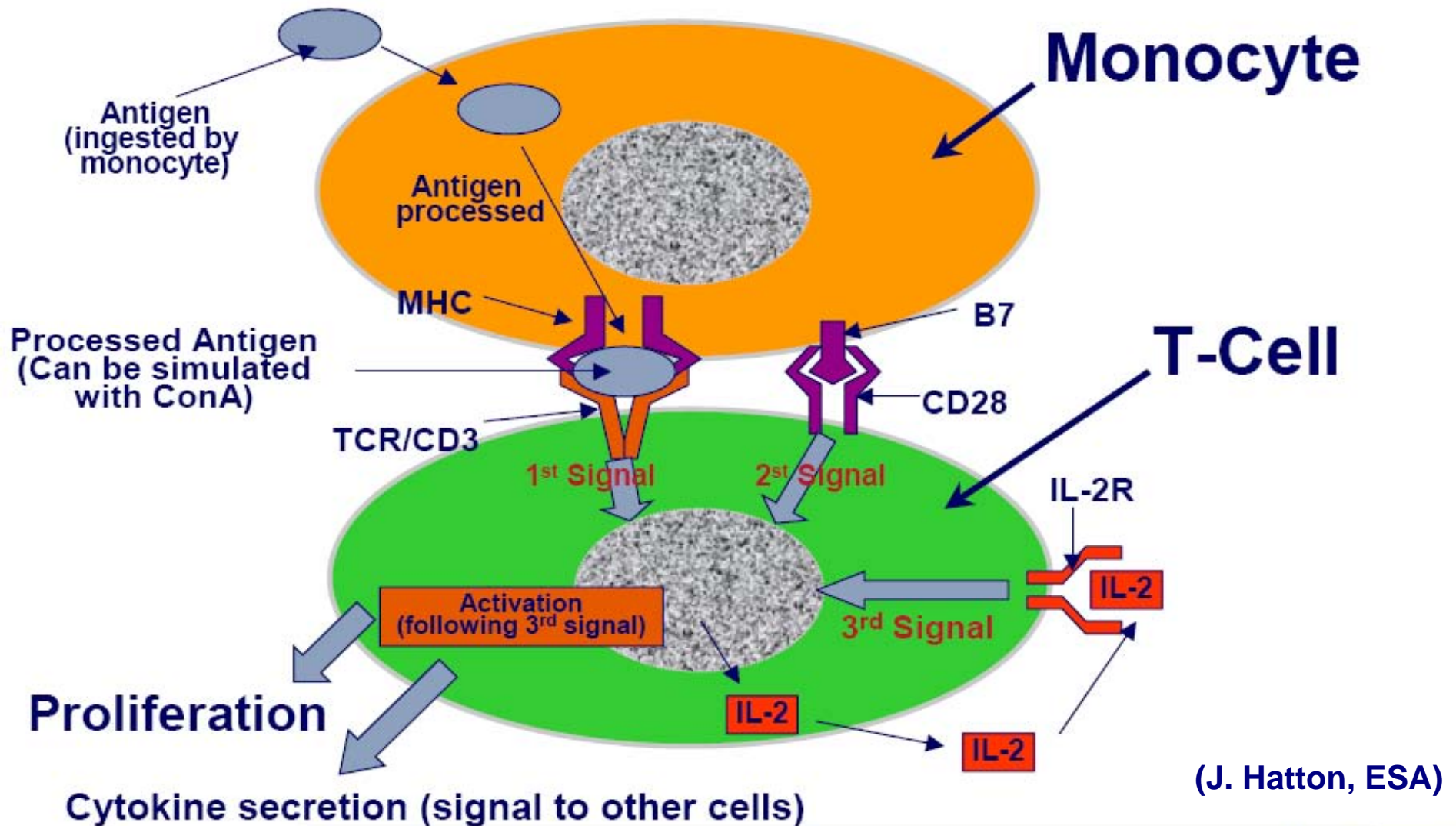
19 - 27 Dezember
1999

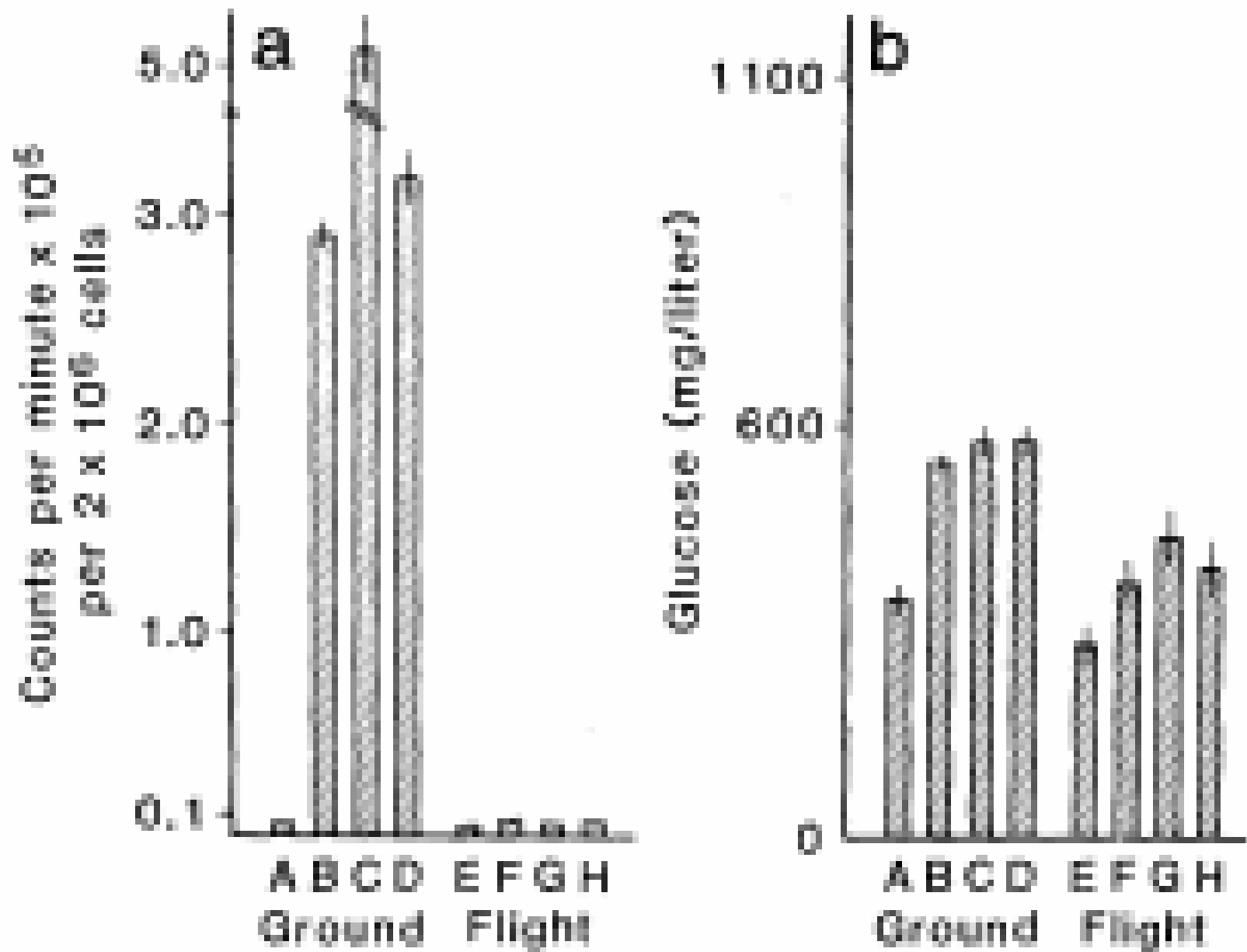
Hubble Teleskop
Reparatur



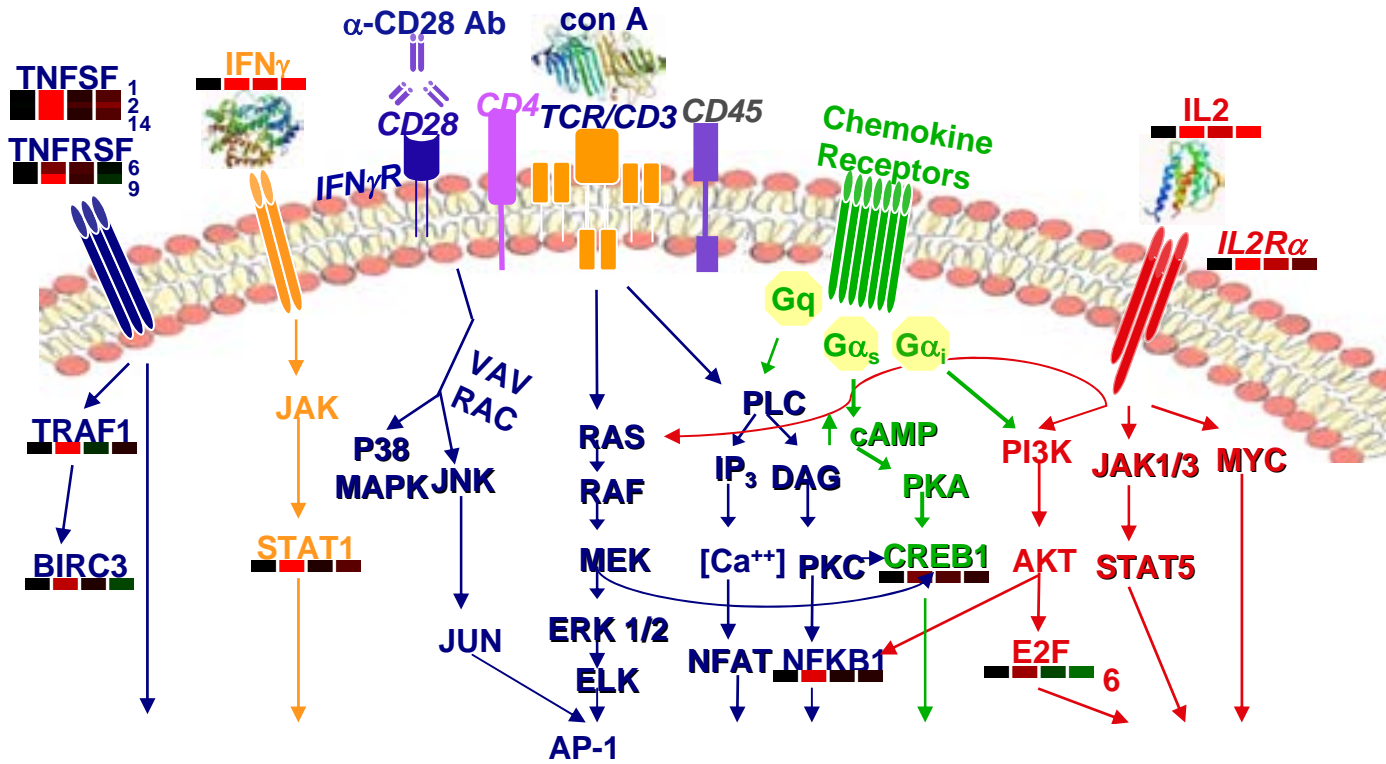
AKTIVIERUNG VON T LYMPHOZYTEN

DELIVERY OF SECOND SIGNAL



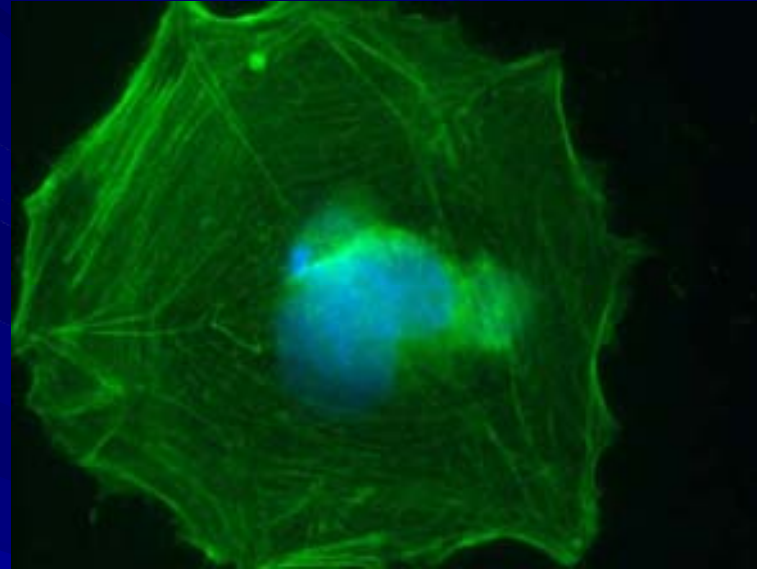
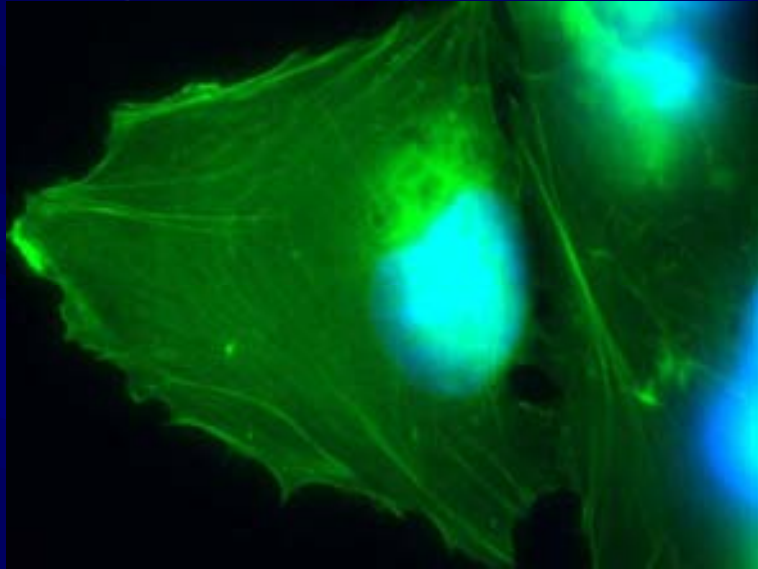


Signaling Pathways Involved in T-cell Activation

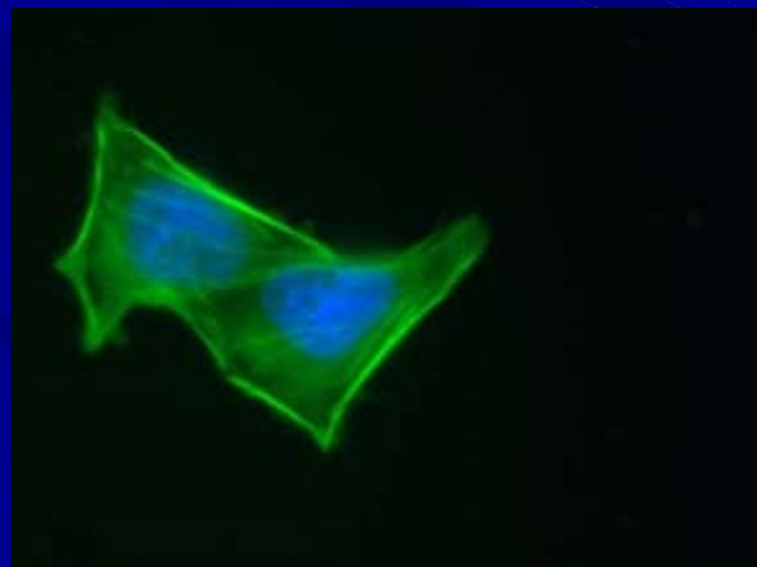
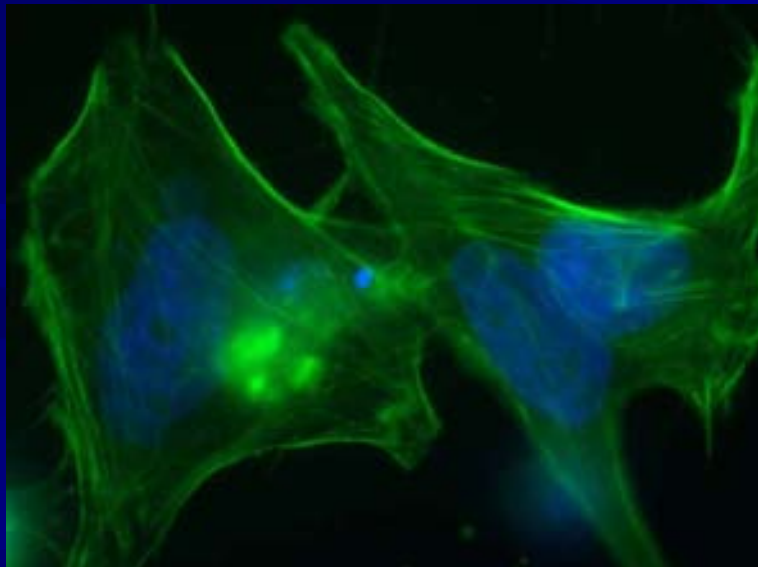


F- ACTIN IN J-111 CELLS IN KUBIK

Pani, Saba, Meloni, Galleri, M. Cogoli



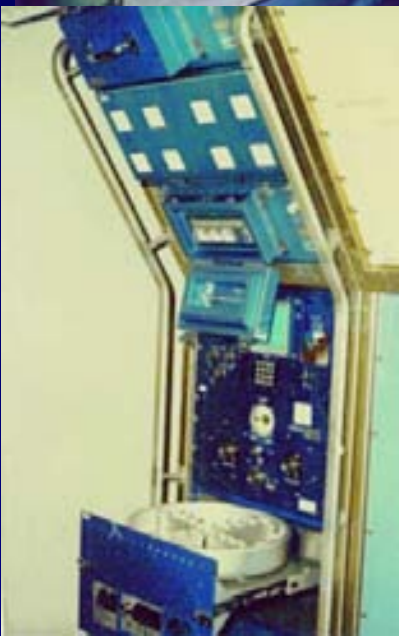
1 G



0 G

Hausgemachtes Blutentnahme-Kit für Spacelab

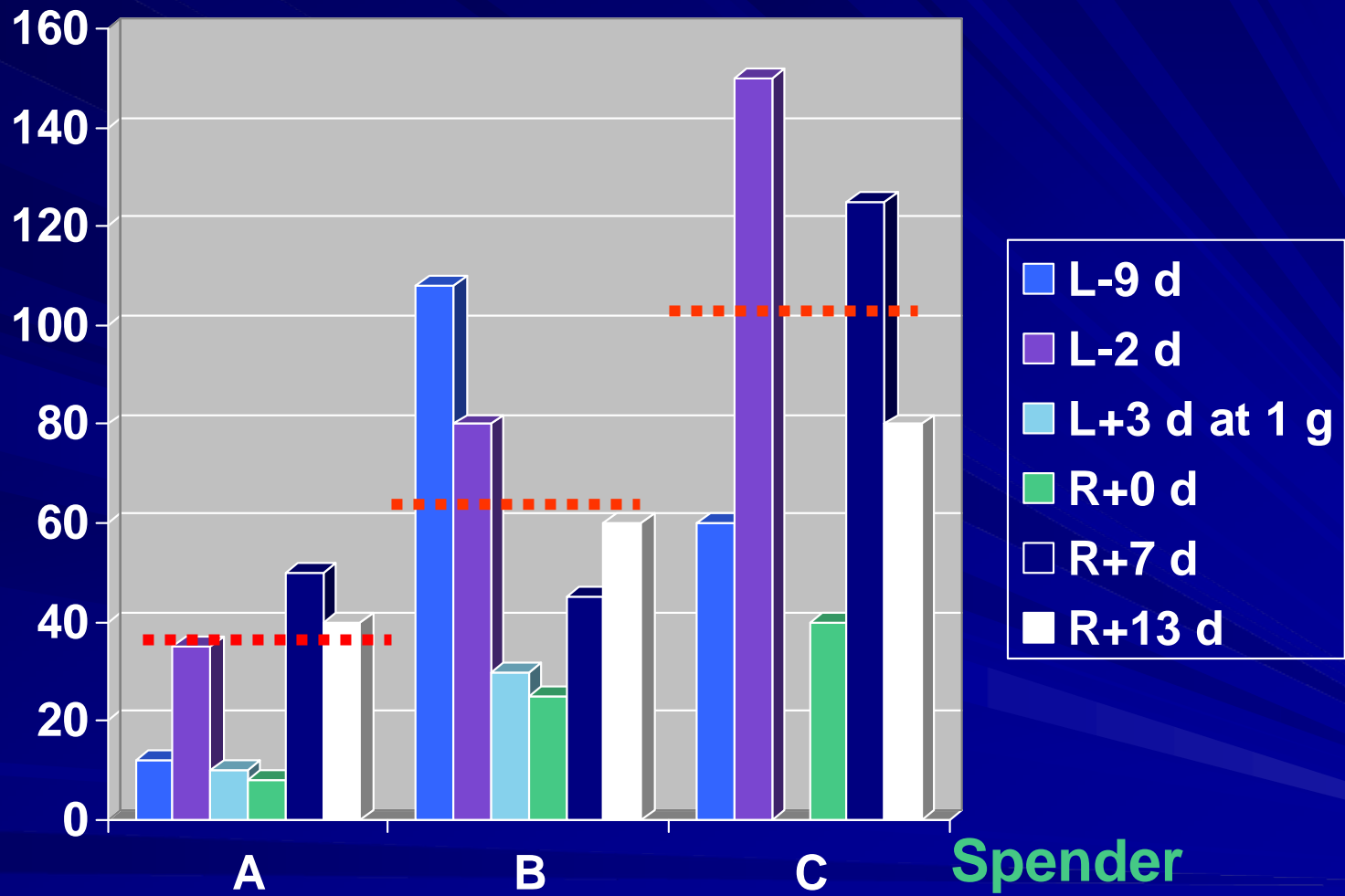




Spacelab Life Science-1 Mission, 1991

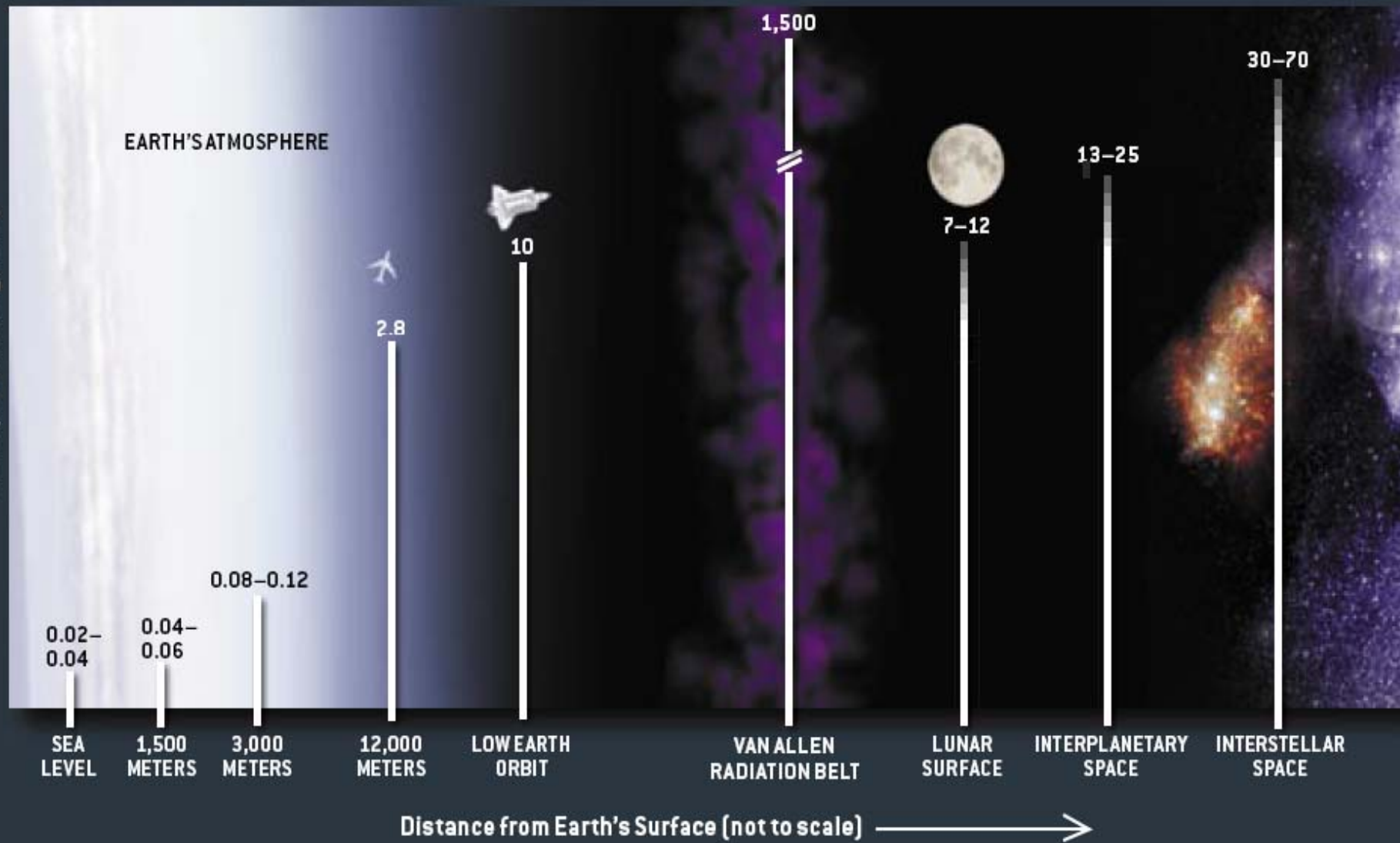
Blutentnahme nach dem Flug im KSC





Kosmische Strahlung

Rms per Year (log scale)



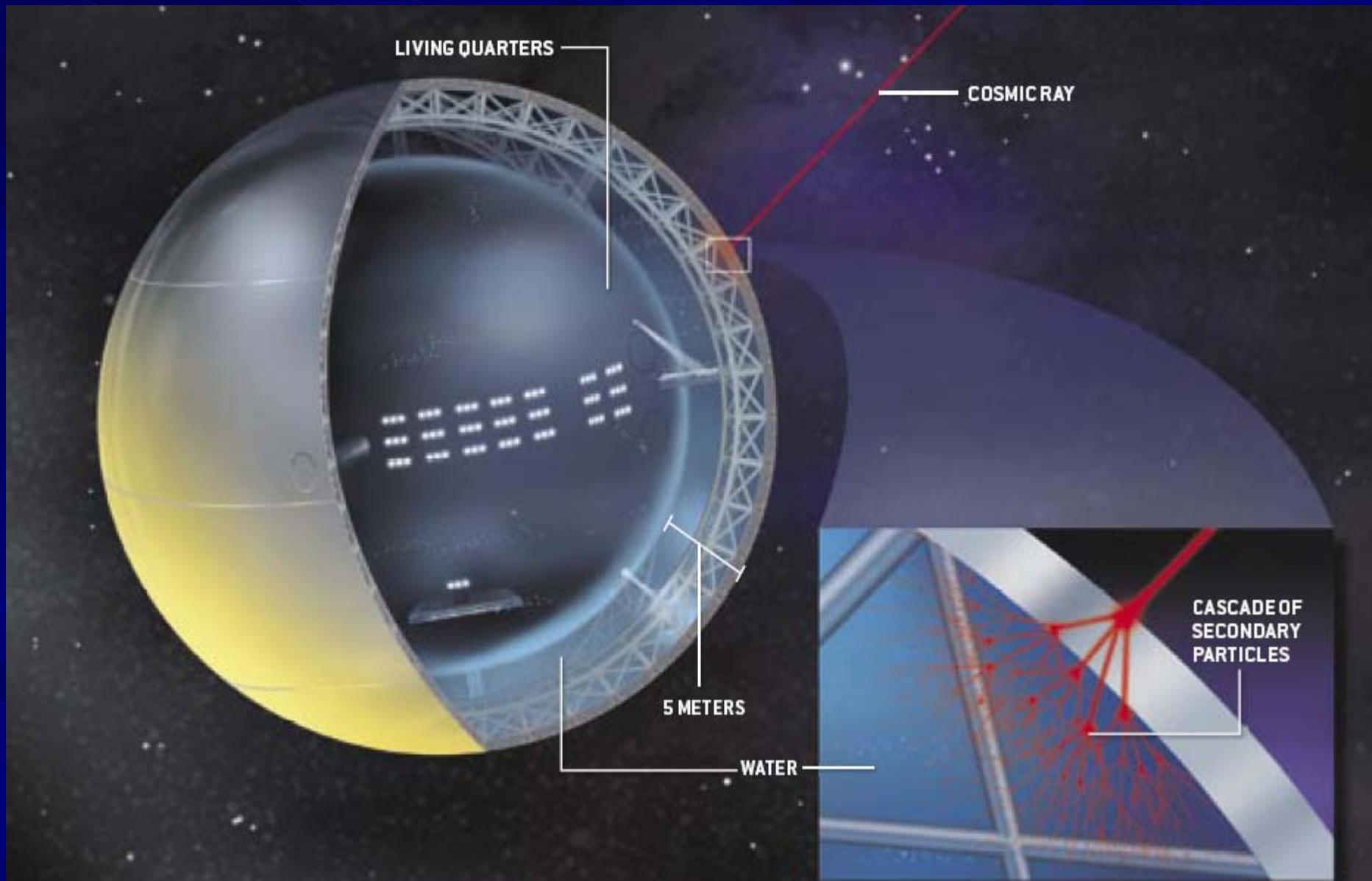
Dafür:

Sicher und zuverlässig

Plan 1: Wasser Schild

Dagegen:

Viel zu schwer



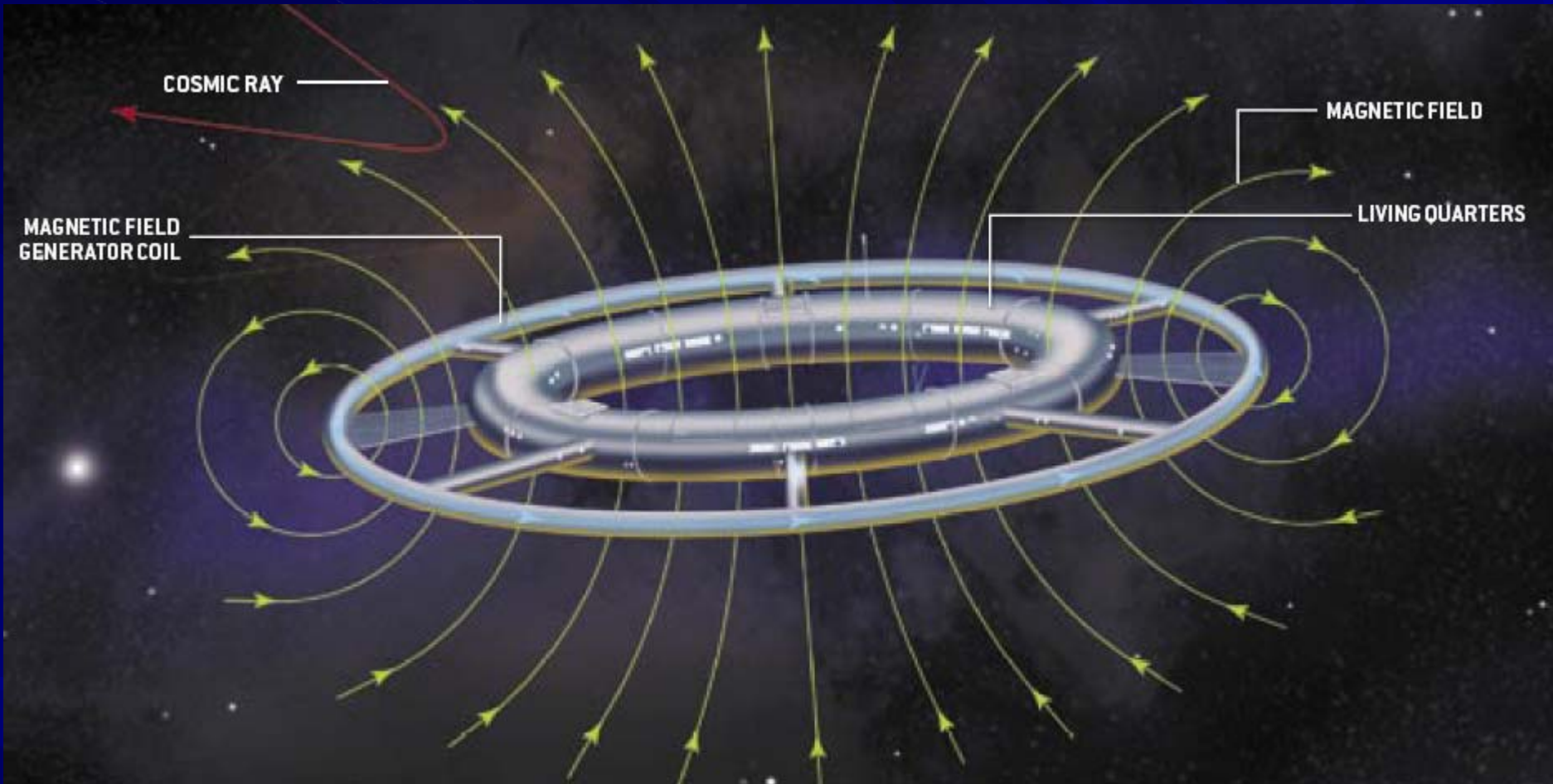
Dafür:

Viel leichter als
Wasser Schild

Plan 2: Magnetischer Schild

Dagegen:

Zu starkes Magnetfeld
Gesundheitsschädigung



Dafür:

Leicht

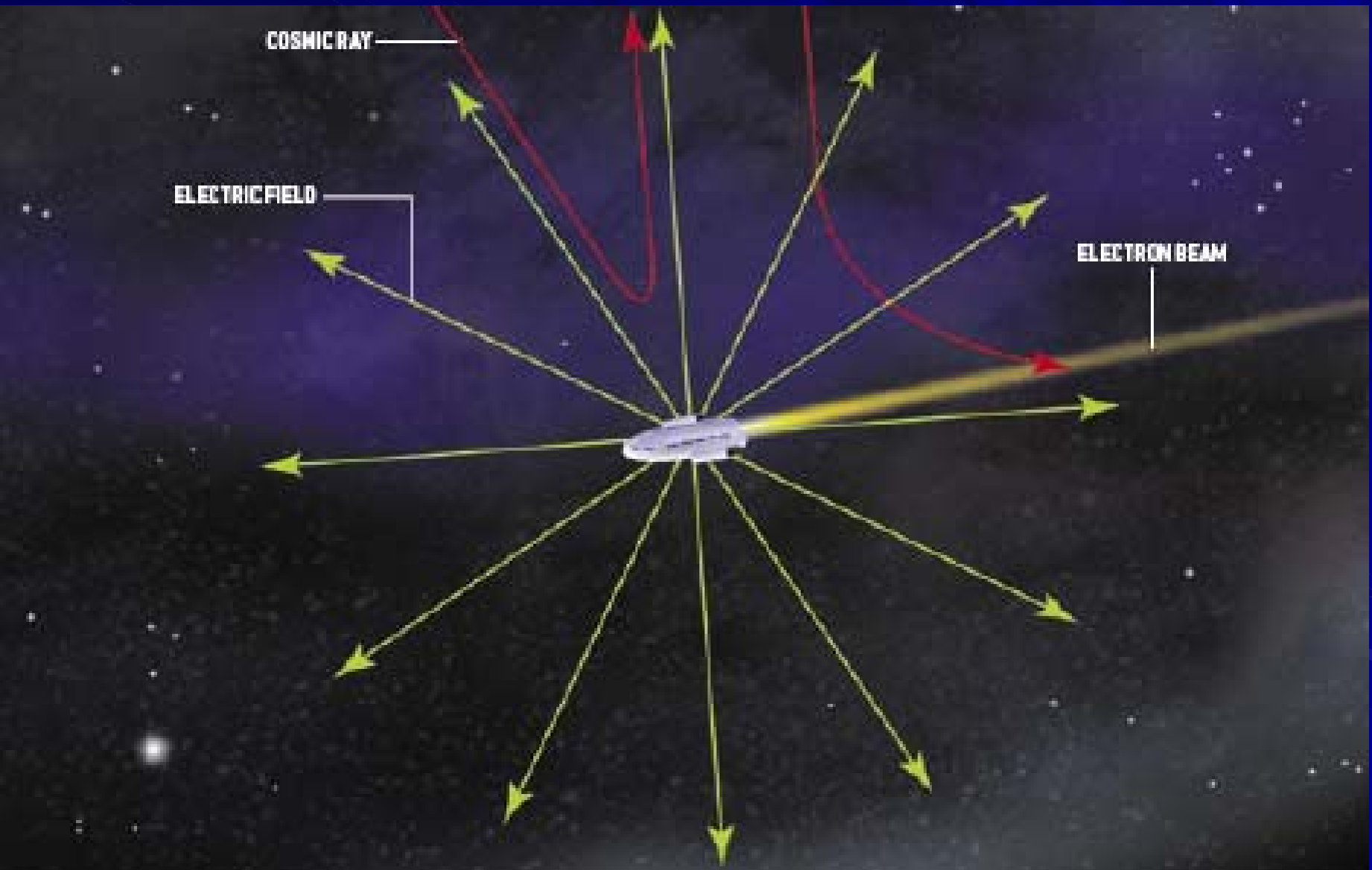
Keine Gesundheitsschädigung

Plan 3: Elektrostatischer Schild

Dagegen:

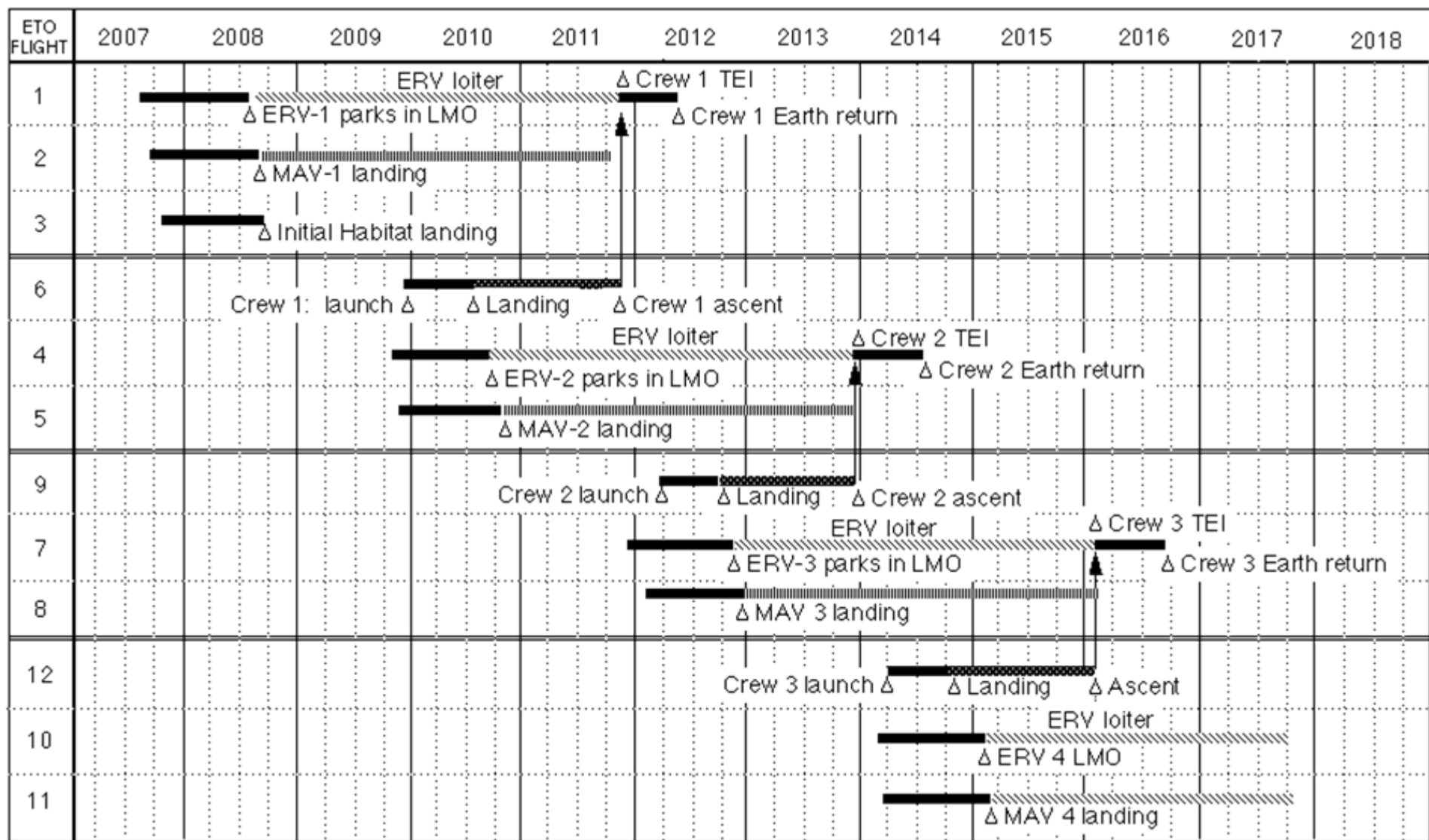
Benötigt riesige

Elektrizitätsmengen



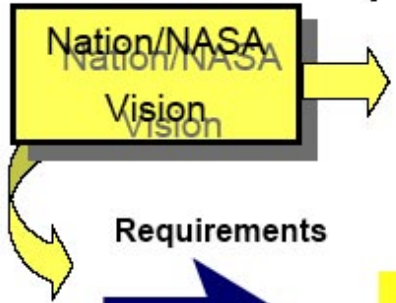
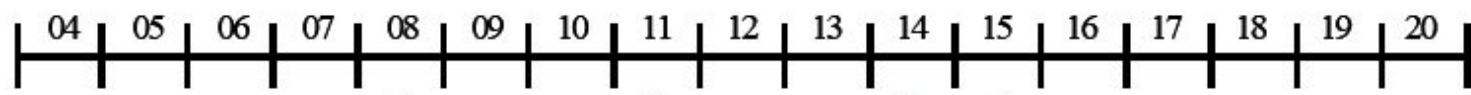
2. Die Mars Mission

Zeitplan der NASA aus der 90er Jahren

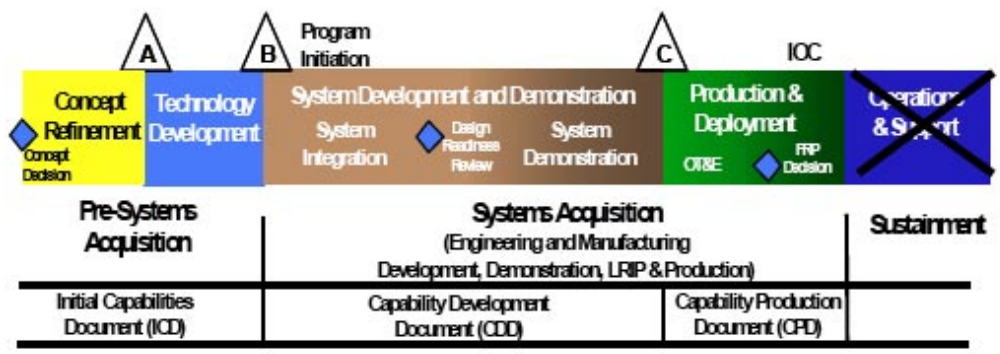




Project Constellation Timeline 4th March 2004



Level 0, 1...
Spiral 1



Unmanned Space Vehicle



Level 0, 1...
Spiral 2



Manned Space Vehicle



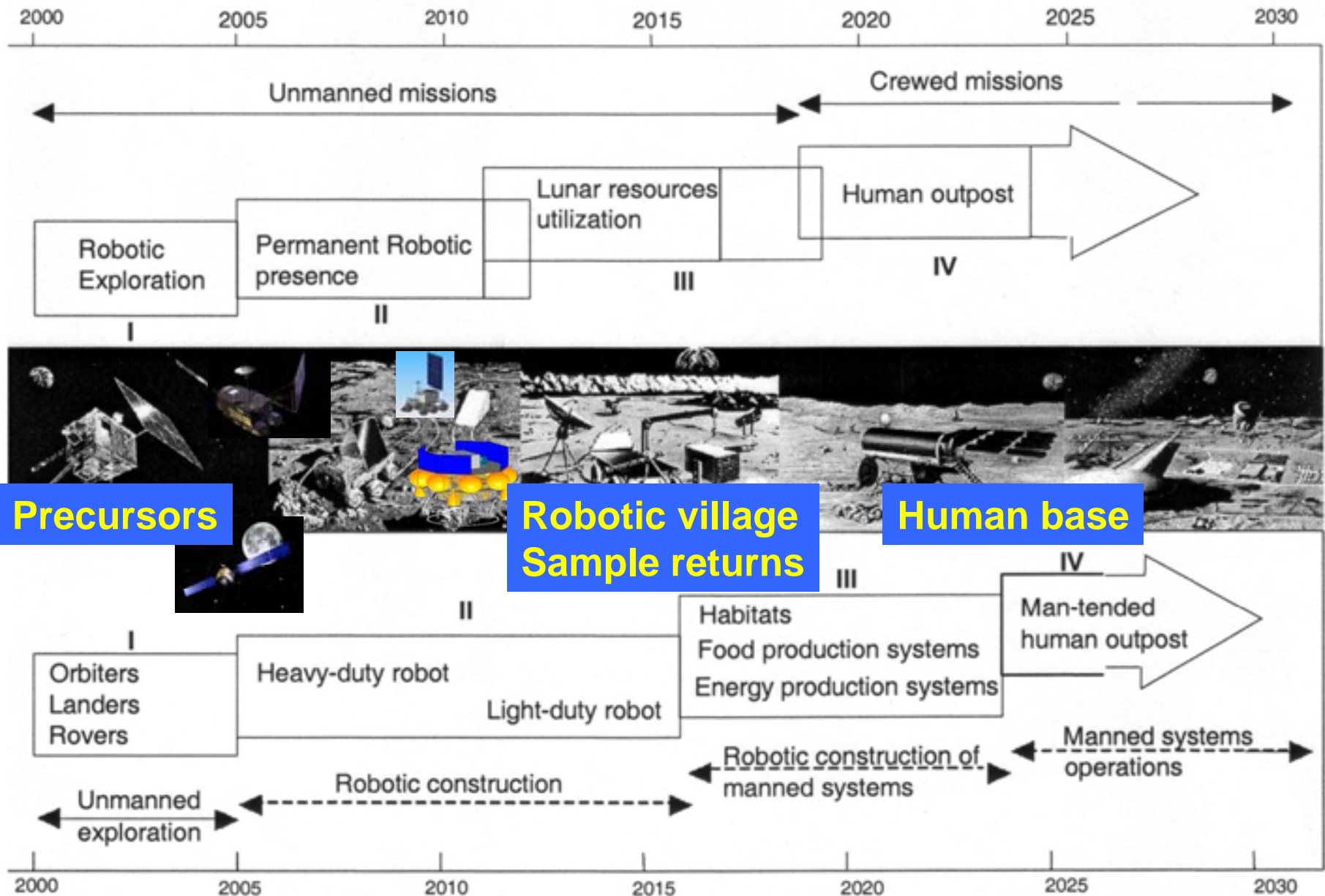
Mars (2020+)

Critical Milestones during System Integration and Demonstration (Notional Only)



Non-advocacy Reviews
Independent Cost Reviews

Zeitplan der Internationalen Mond-Erkundung, 2007

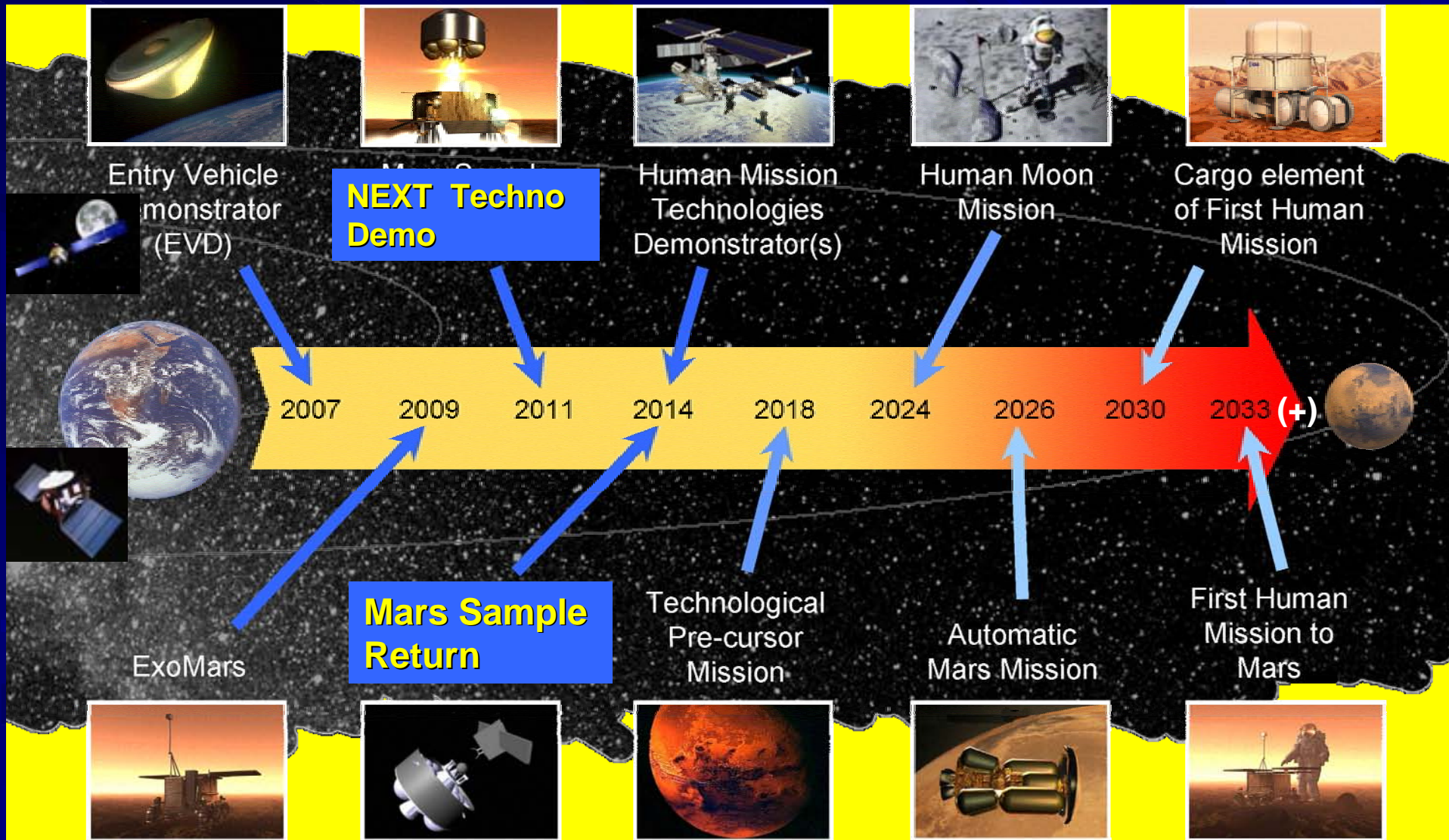


EXPLORATION BEYOND LOW EARTH ORBIT



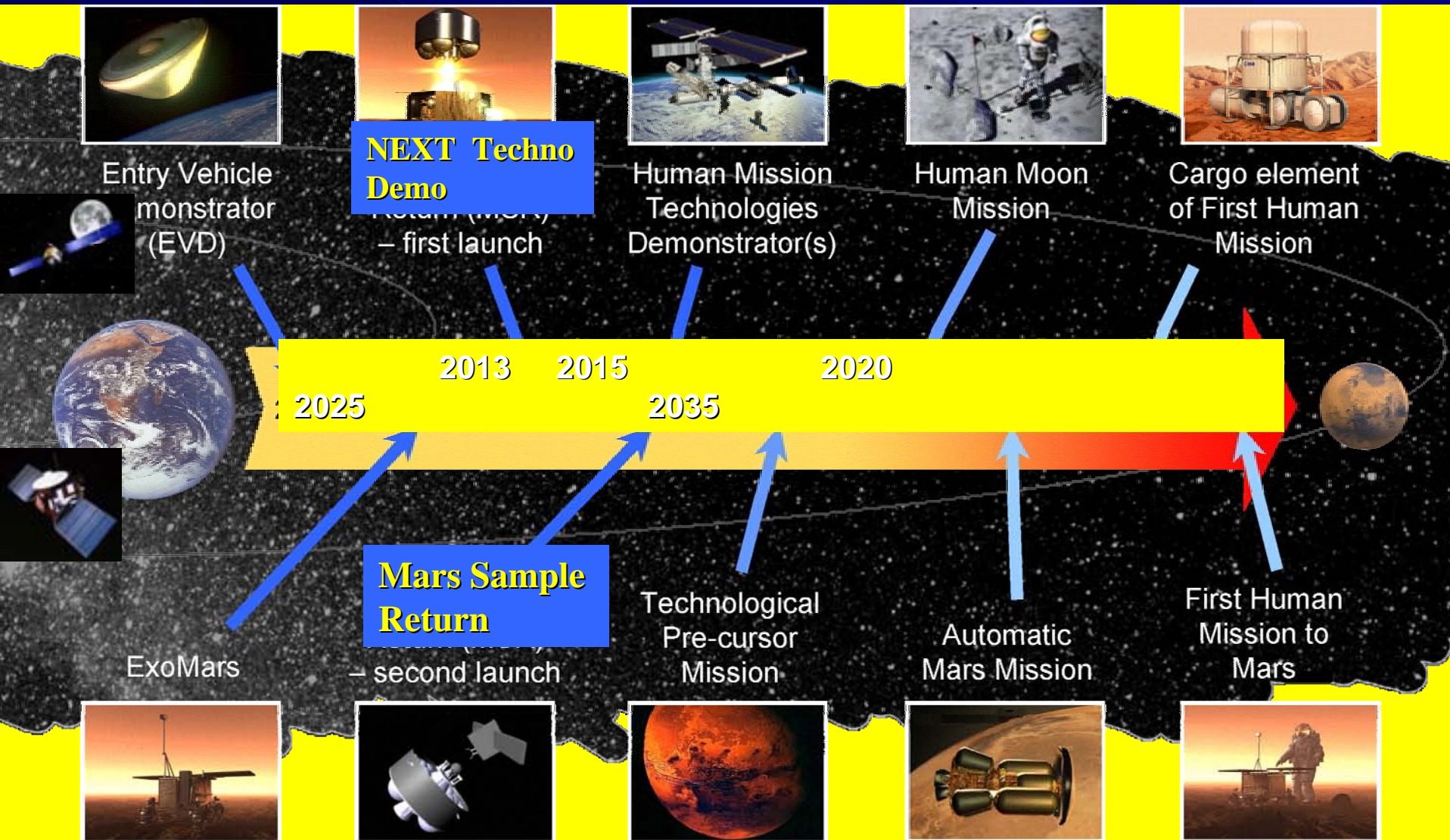
Zeitplan der Mond-Mars Erkundung

Aurora Programm, 2001



Zeitplan der Mond-Mars Erkundung

Aurora Programm, Revision 2007



Typischer Sterilisations-Prozess für eine Mars-Probe

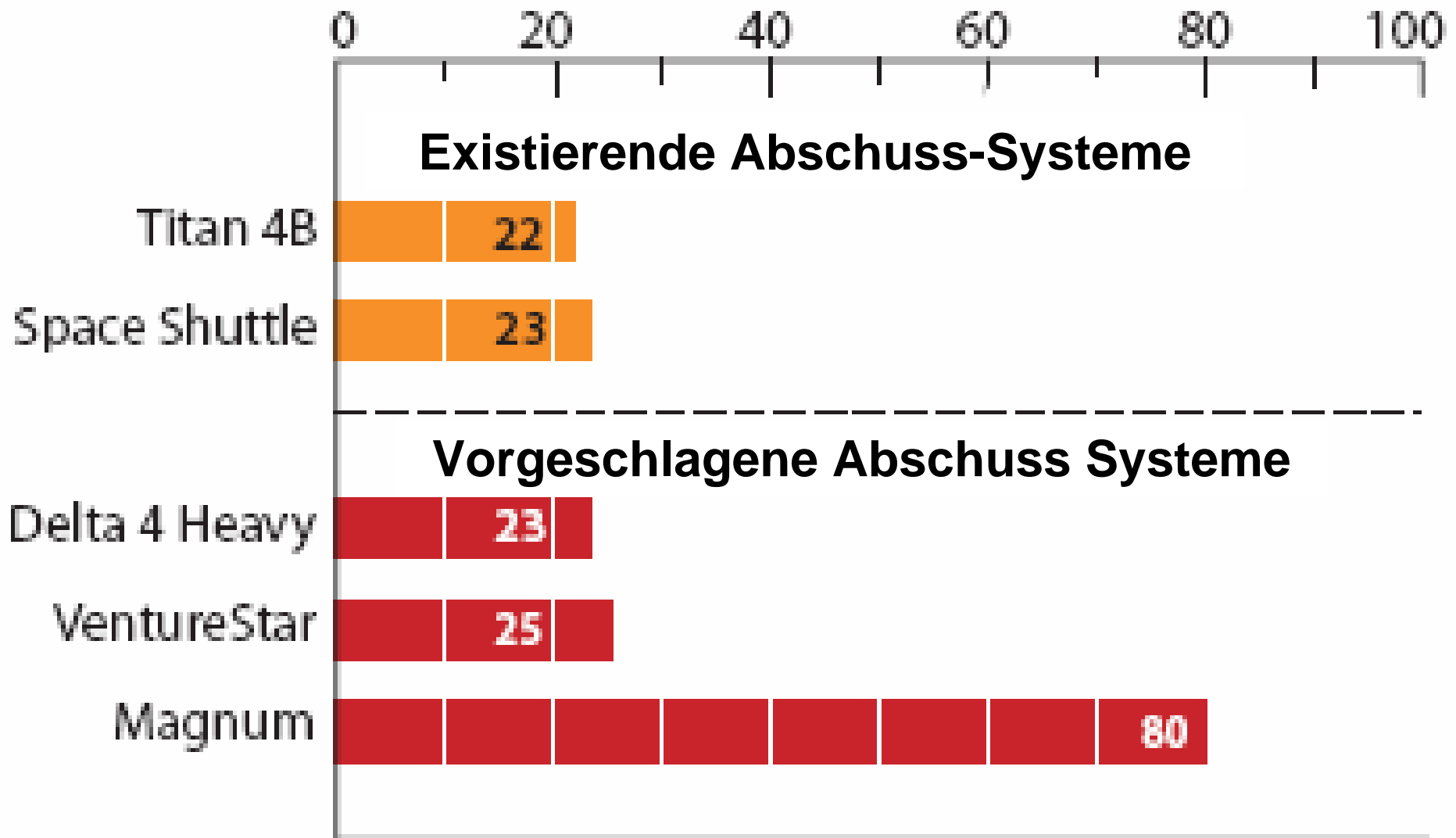


1. Chemikalien/Alcohol
„Autowäsche“

2. Ofen 120°C
für 30 Stunden

3. Ultraviolett Bestrahlung

Tonnen-Nutzlast zu einer Erdumlaufbahn



THE NASA REFERENCE MISSION

1 Two unmanned spacecraft launched, assembled in orbit and sent to Mars.

CREW
TRANSFER
VEHICLE

2 Crew transfer vehicle launched 26 months after unmanned craft. Astronauts traverse space for about six months.

HABITAT LANDER

CARGO LANDER

CREW
TRANSFER
VEHICLE

3 On arrival at Mars, astronauts move to the habitat lander, which has been orbiting the planet. They descend to the surface, touching down next to the cargo lander.

EARTH RETURN
CAPSULE

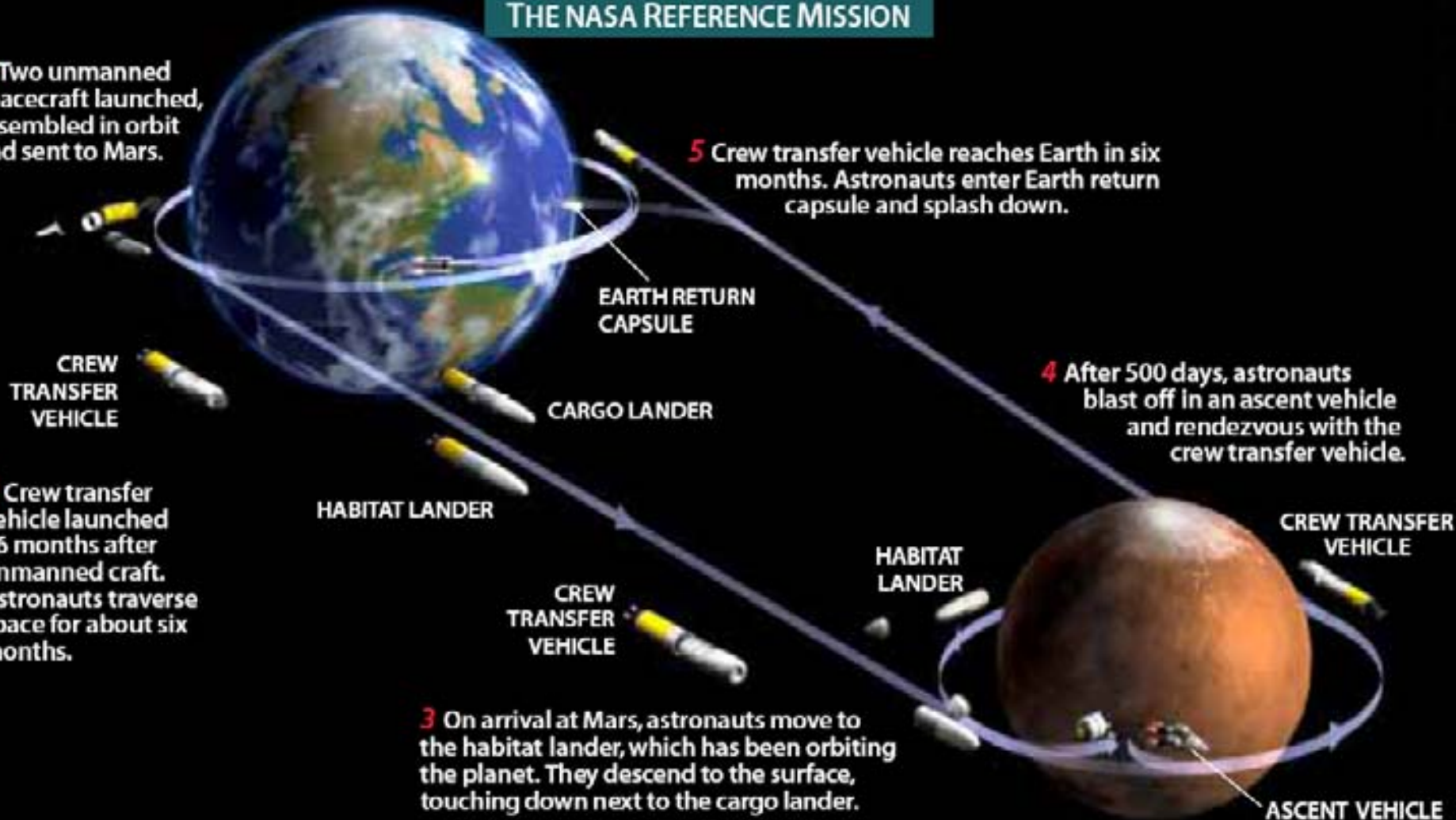
5 Crew transfer vehicle reaches Earth in six months. Astronauts enter Earth return capsule and splash down.

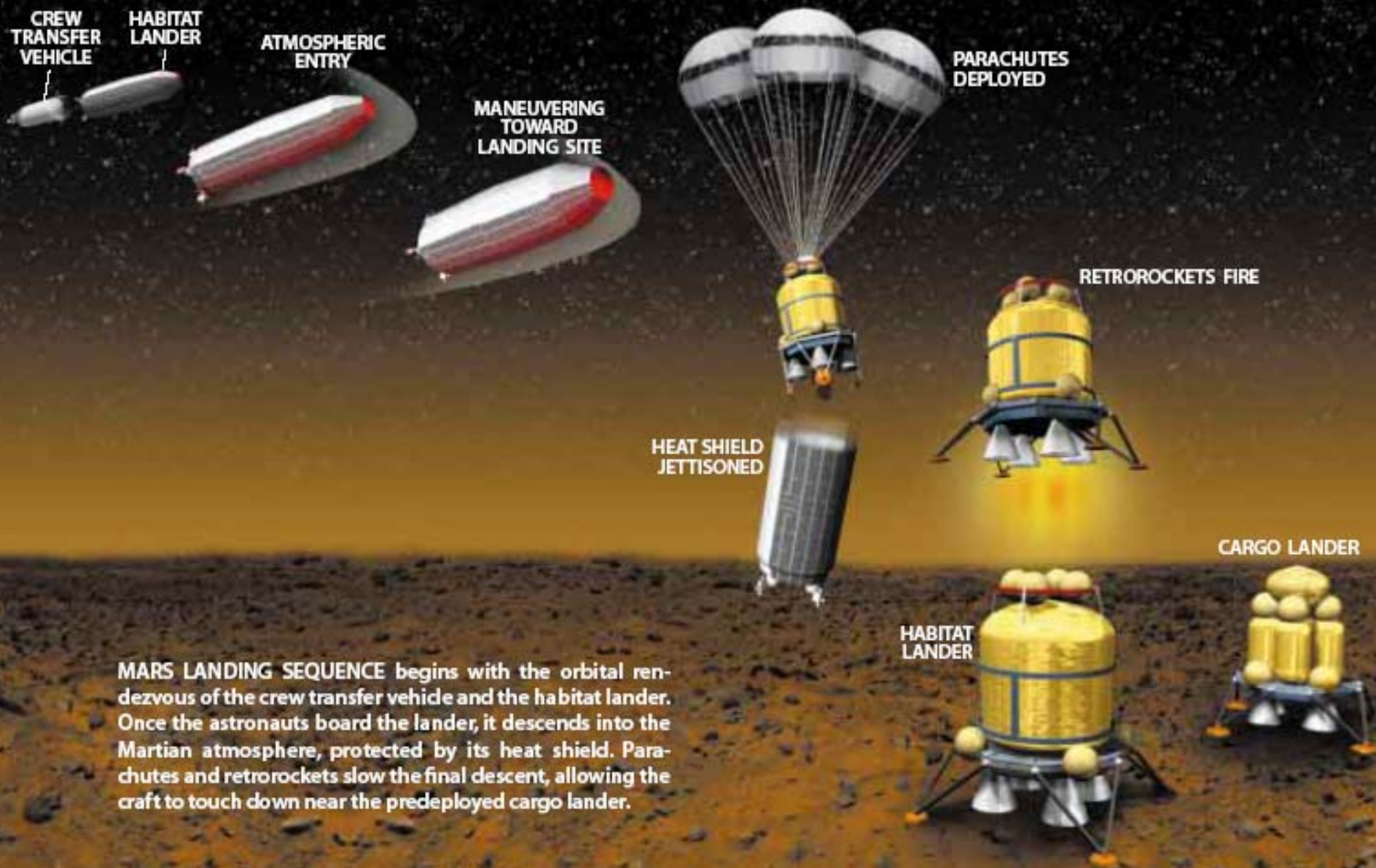
4 After 500 days, astronauts blast off in an ascent vehicle and rendezvous with the crew transfer vehicle.

CREW TRANSFER
VEHICLE

HABITAT
LANDER

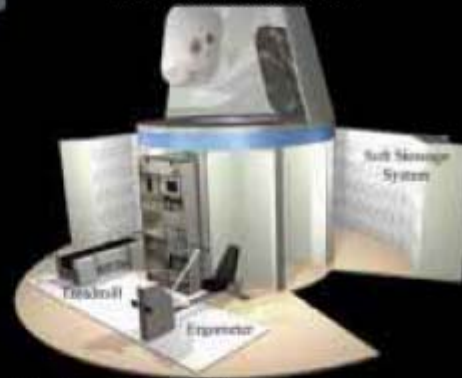
ASCENT VEHICLE



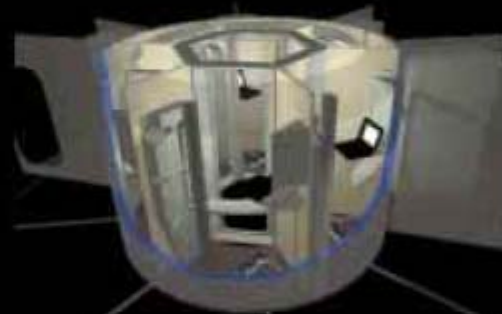


TransHab

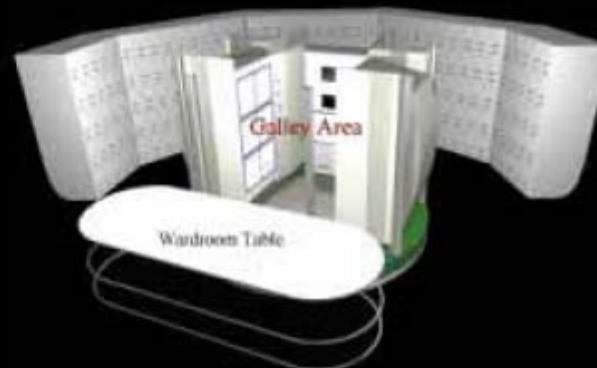
LEVEL 4 –
Pressurized tunnel area



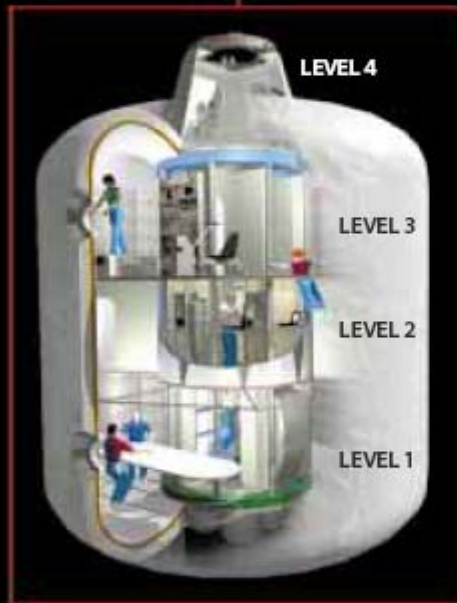
LEVEL 3 – Crew health care area



LEVEL 2 – Mechanical room and crew quarters

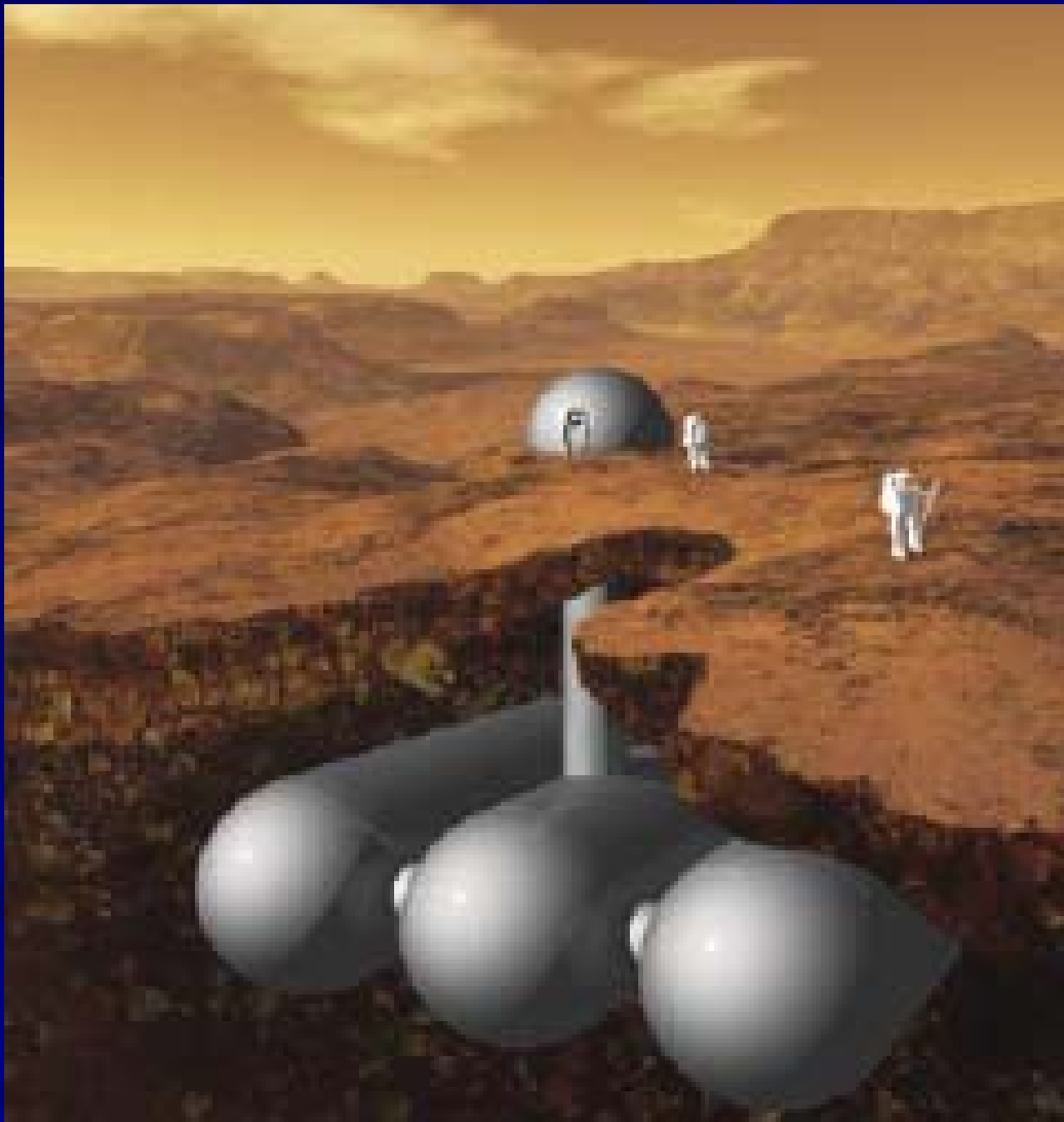


LEVEL 1 – Wardroom and galley area









Sonnenuntergang auf dem Mars

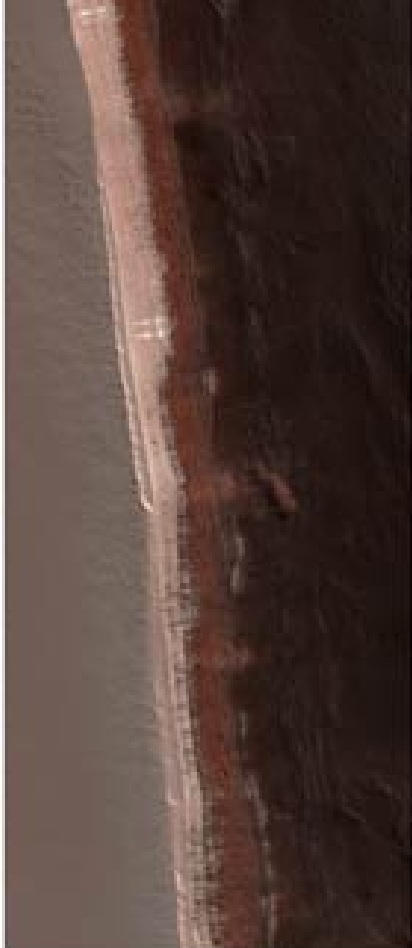
Viking, 1975



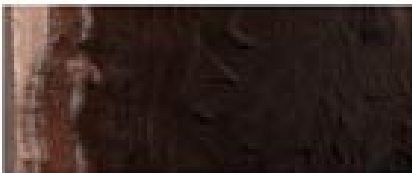
Spirit, 2005



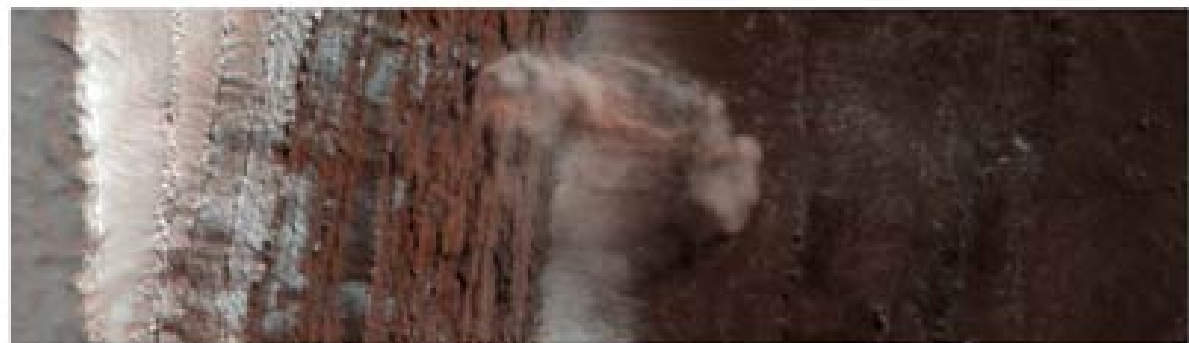
PSP_007338_2640



"Ingrid's
Avalanches" 2008 Feb 19



83.7N 235.8E



Schnee und Fels Lawine auf dem Mars



Mars Science Laboratory, NASA

Start: Herbst 2009, Ankunft: Oktober 2010

3. Hygiene und medizinische Versorgung







Ozonisator



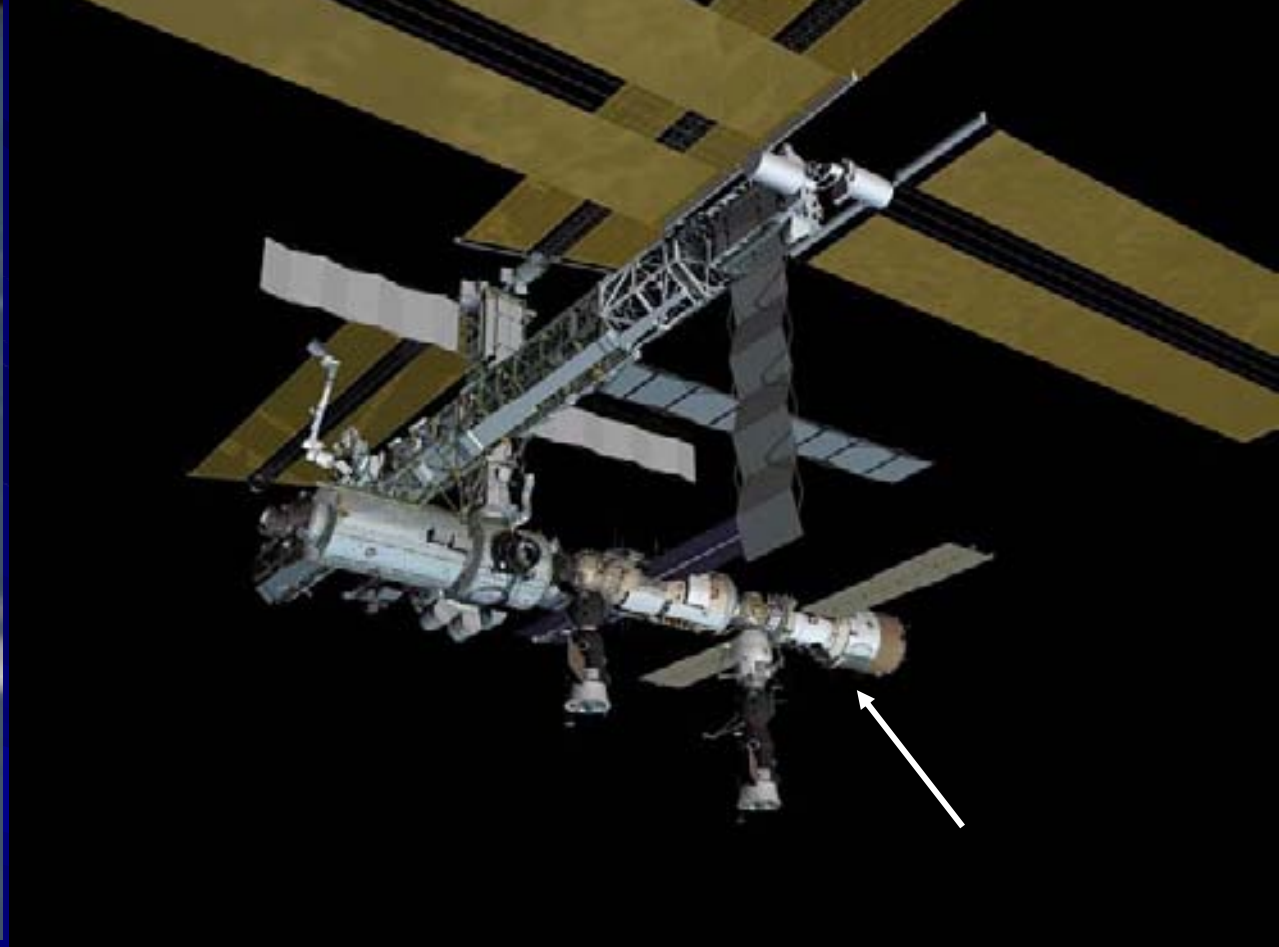
Sterile glovebox

Surgery and Recovery in Space

Authors

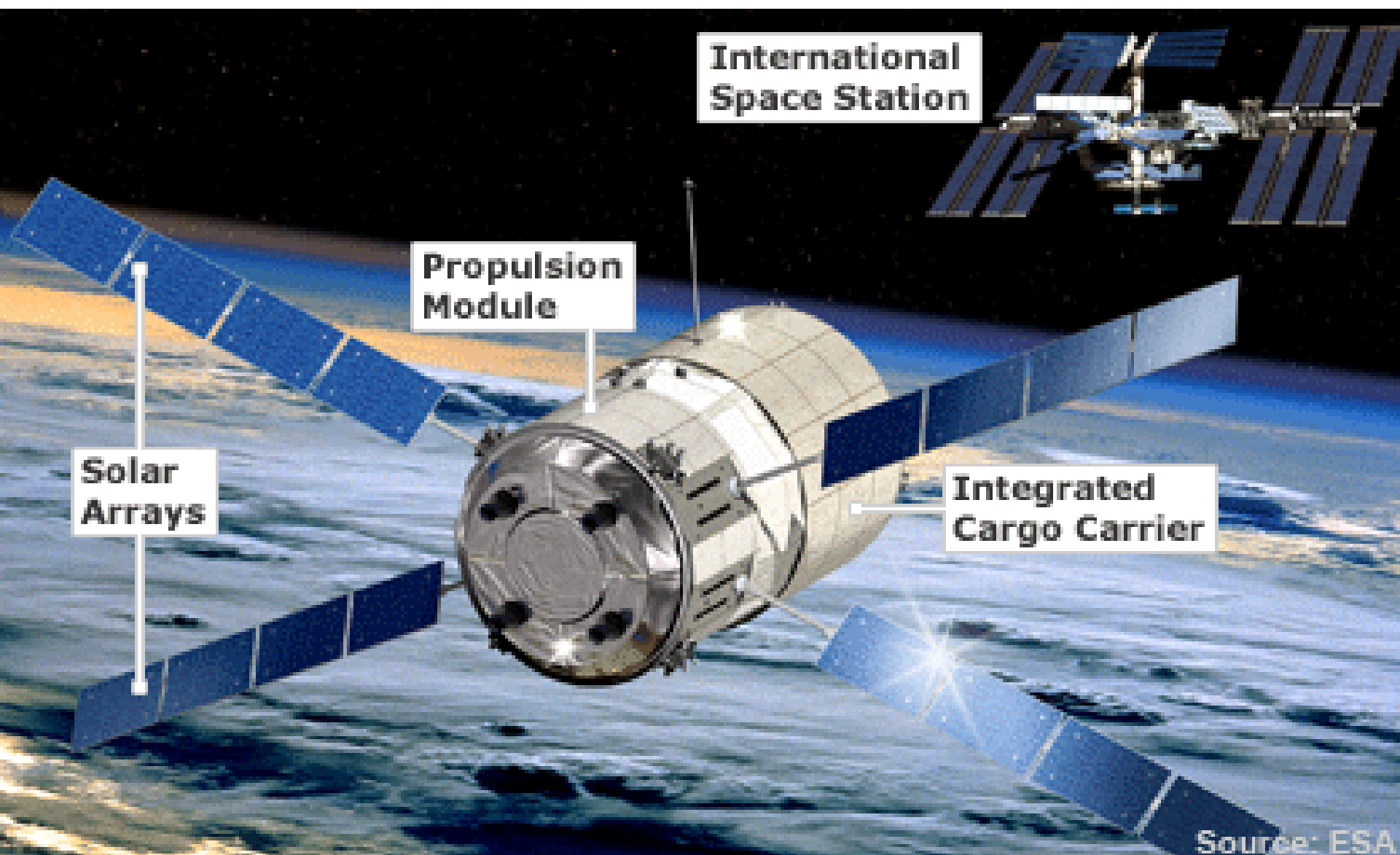
Jay C. Buckey, Jr., Dafydd R. Williams, Danny A. Riley

4. Abfall Recycling



Progress, das Russische Versorgungs- und Entsorgungs-Raumschiff

AUTOMATED TRANSFER VEHICLE (ATV)

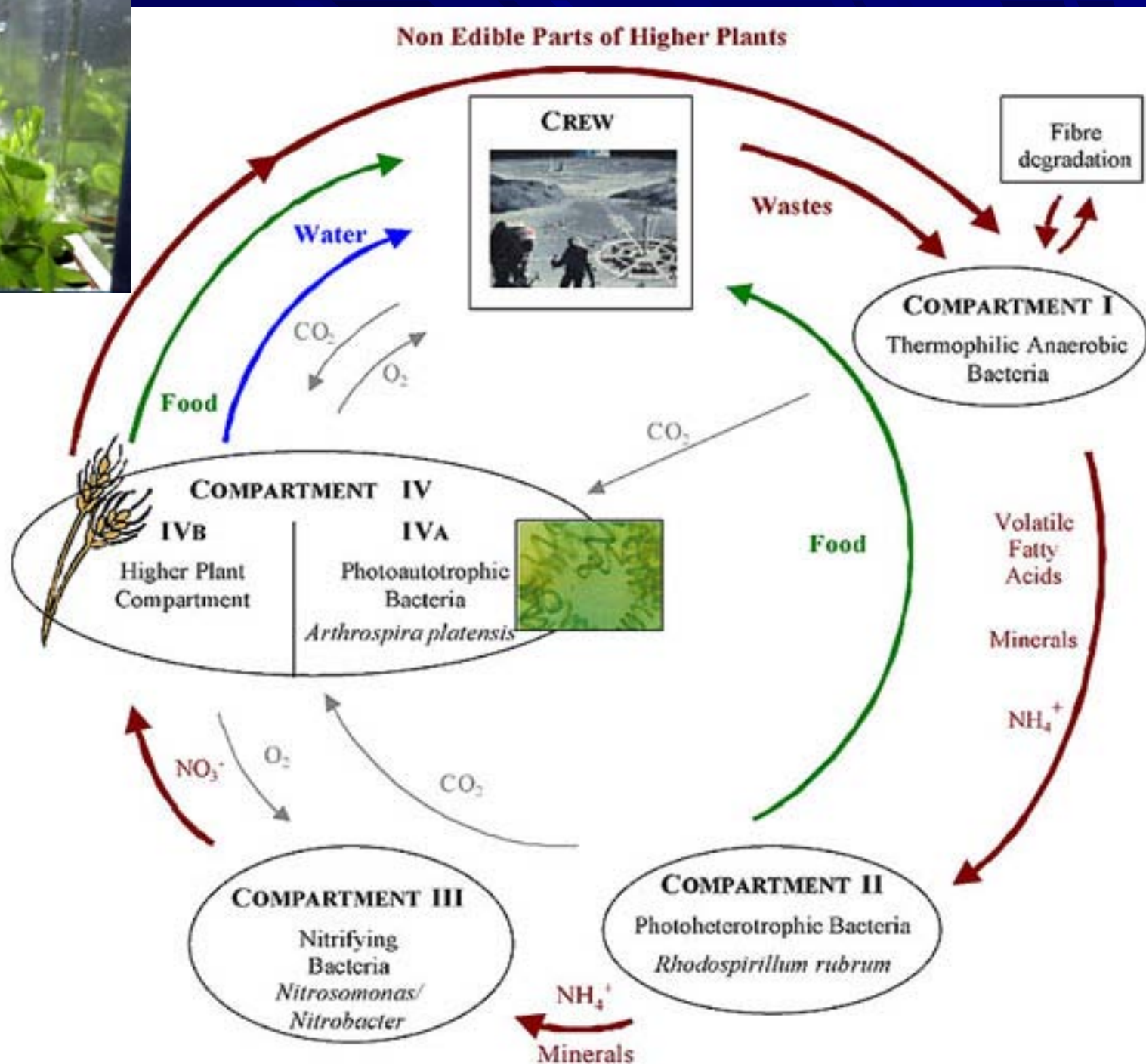


ATV, das Europäische Versorgungs- und Entsorgungs-Raumschiff

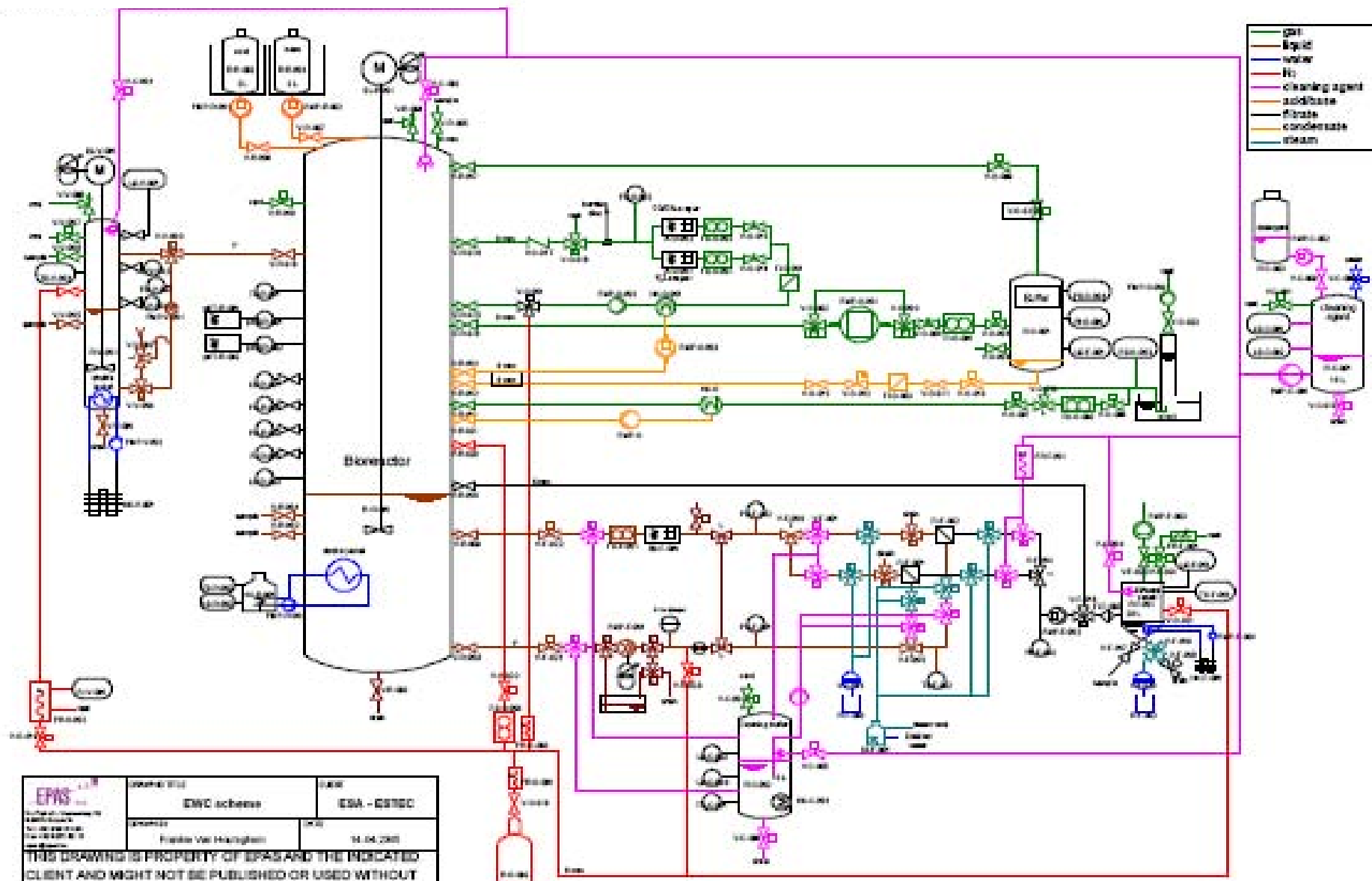


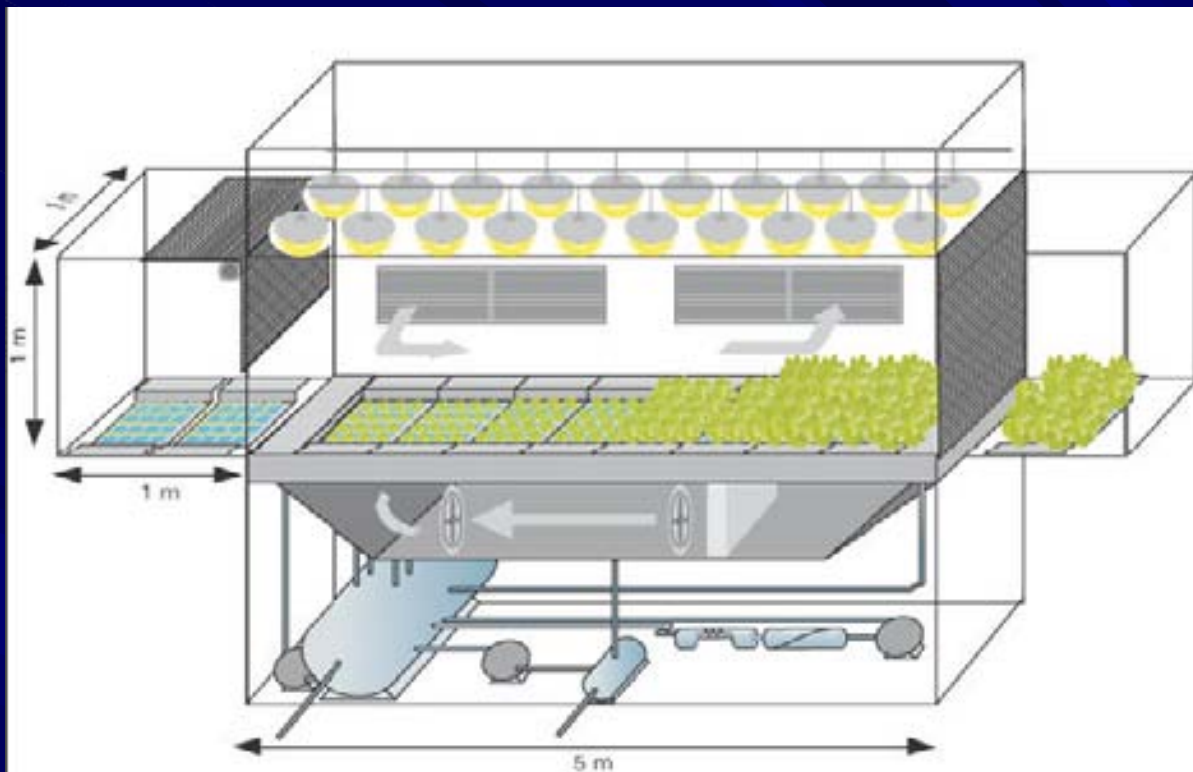
MELISSA
Konzept

Micro-
Ecological
Life
Support
System
Alternative









5. Perspektiven

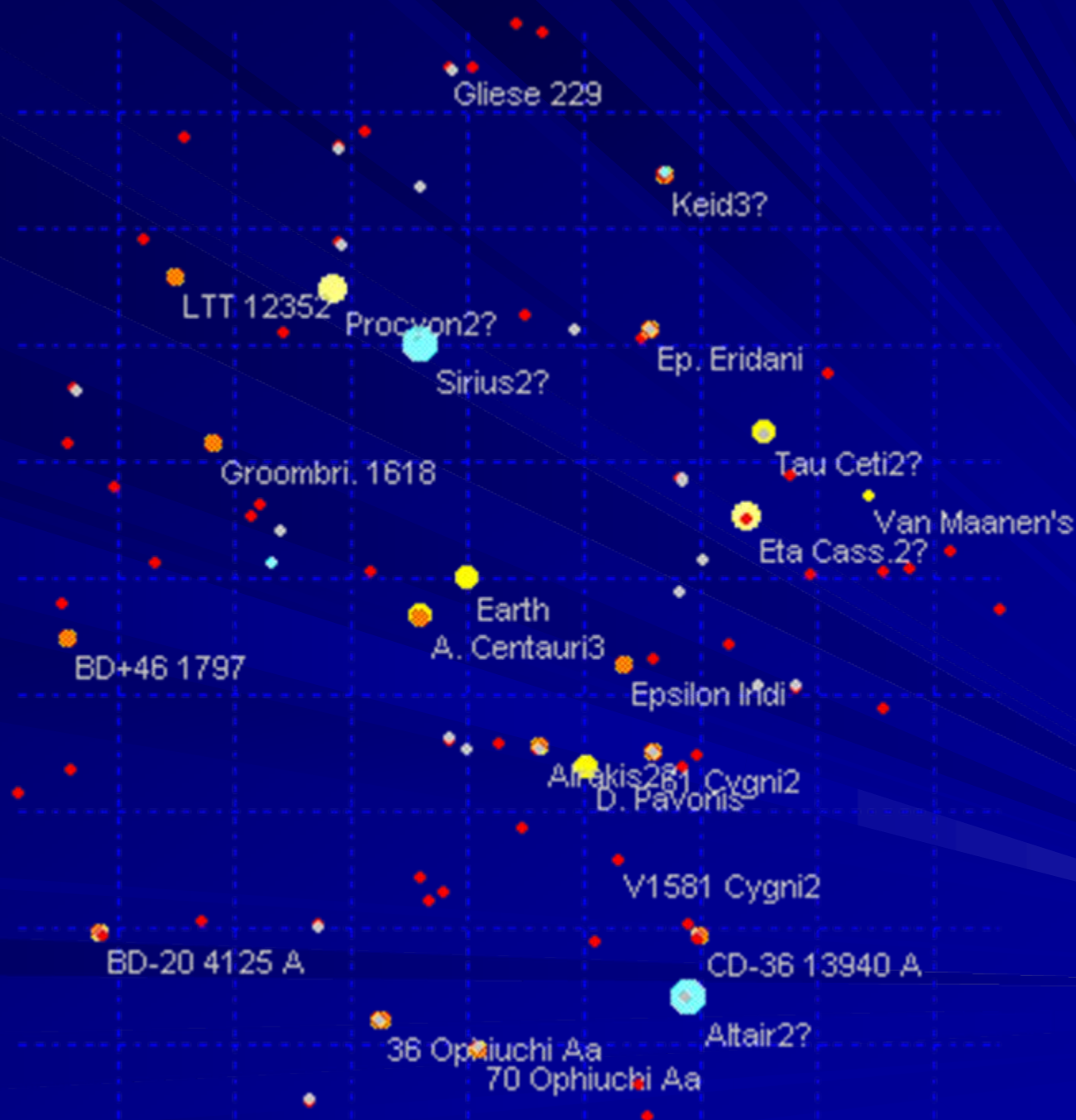
nature

INTERNATIONAL WEEKLY JOURNAL OF SCIENCE

Volume 352 No. 6335 8 August 1991 £2.50



BRINGING MARS TO LIFE

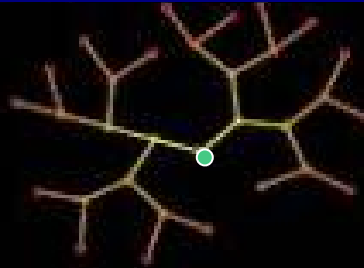


Nach 1500 Jahren

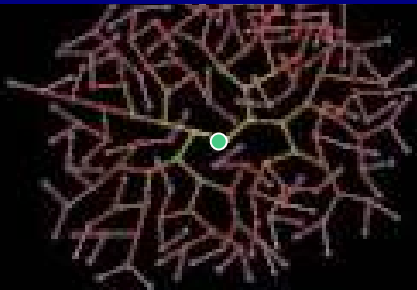
Heimatplanet



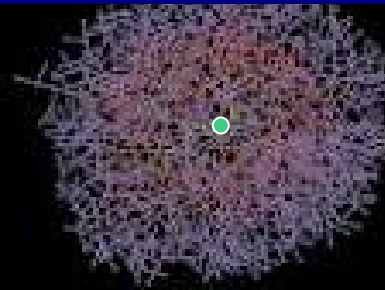
Nach 2000 Jahren



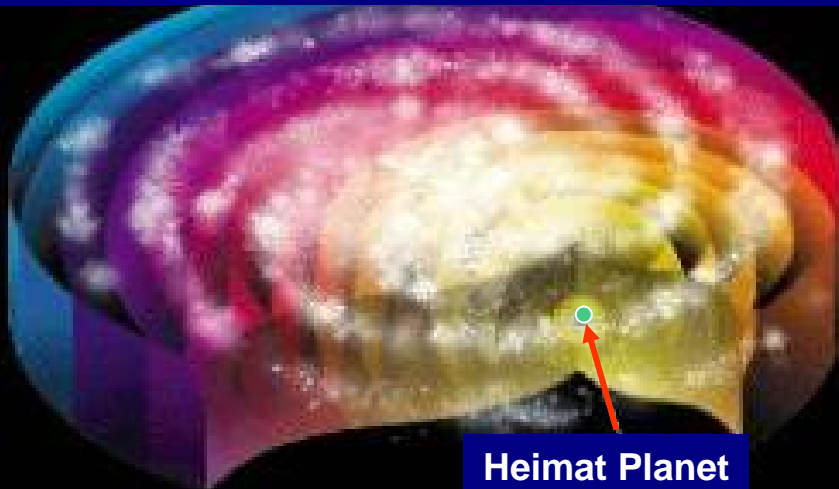
Nach 3500 Jahren



Nach 5000 Jahren



Nach 3.75 Million Jahren ist unsere
Galaxie vollständig besiedelt



Heimat Planet

Aus

J. Crawford

Sci. Am., July 2000

Vielen Dank für Ihre Aufmerksamkeit