



Spacecraft Life Support Systems

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Temperature

Radiation Protection

Air

Food

Waste Removal

Water

Gravity

Pressure





Earth's Life Support Systems (ELSS)

Physical/Chemical Properties & Processes

- Resource diversity/distribution/cycling
- Radiation protection – Earth's core
- Proper gravitational field
- Stable rotation
- Proper solar radiation levels
- Proper atmospheric pressure



Earth's Ecosystem Services

Water/waste
purification

Air quality
regulation

Aesthetic/Spiritual values
Recreation/Ecotourism

Crops,
Livestock,
Fisheries
Aquaculture
Wild foods

Erosion
regulation

Climate
regulation
local

Water
regulation

Genetic
resources

Pollination

Fresh
water

Biochemicals,
natural medicines,
pharmaceuticals

Timber,
Cotton, Hemp, Silk
Wood fuel

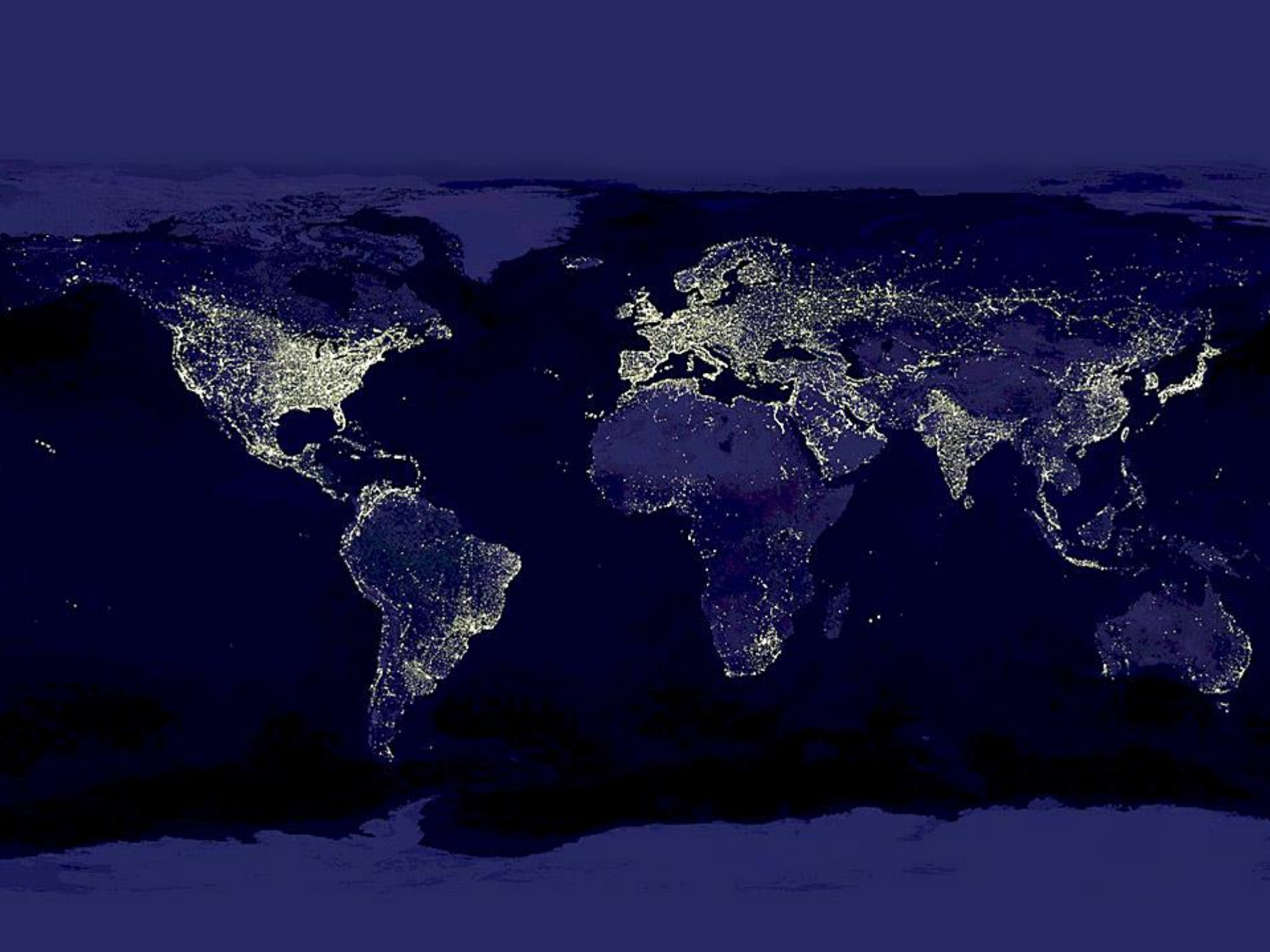
Climate
regulation
global

Pest
control

Disease
regulation

Natural hazard
regulation

Source: Millennium Ecosystem Assessment
United Nations Environment Programme (2005)



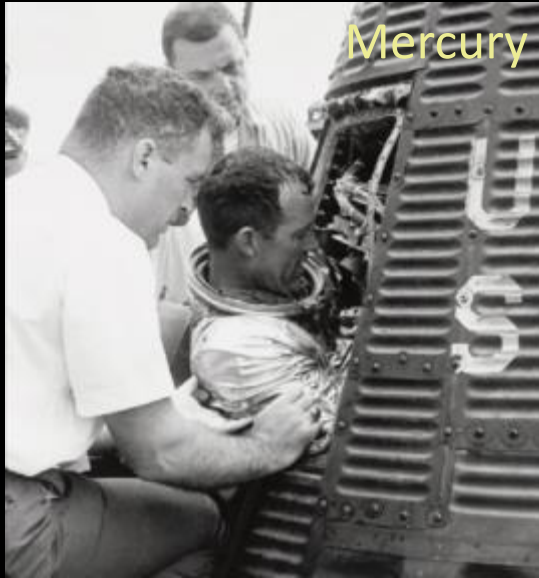


Human Space Exploration

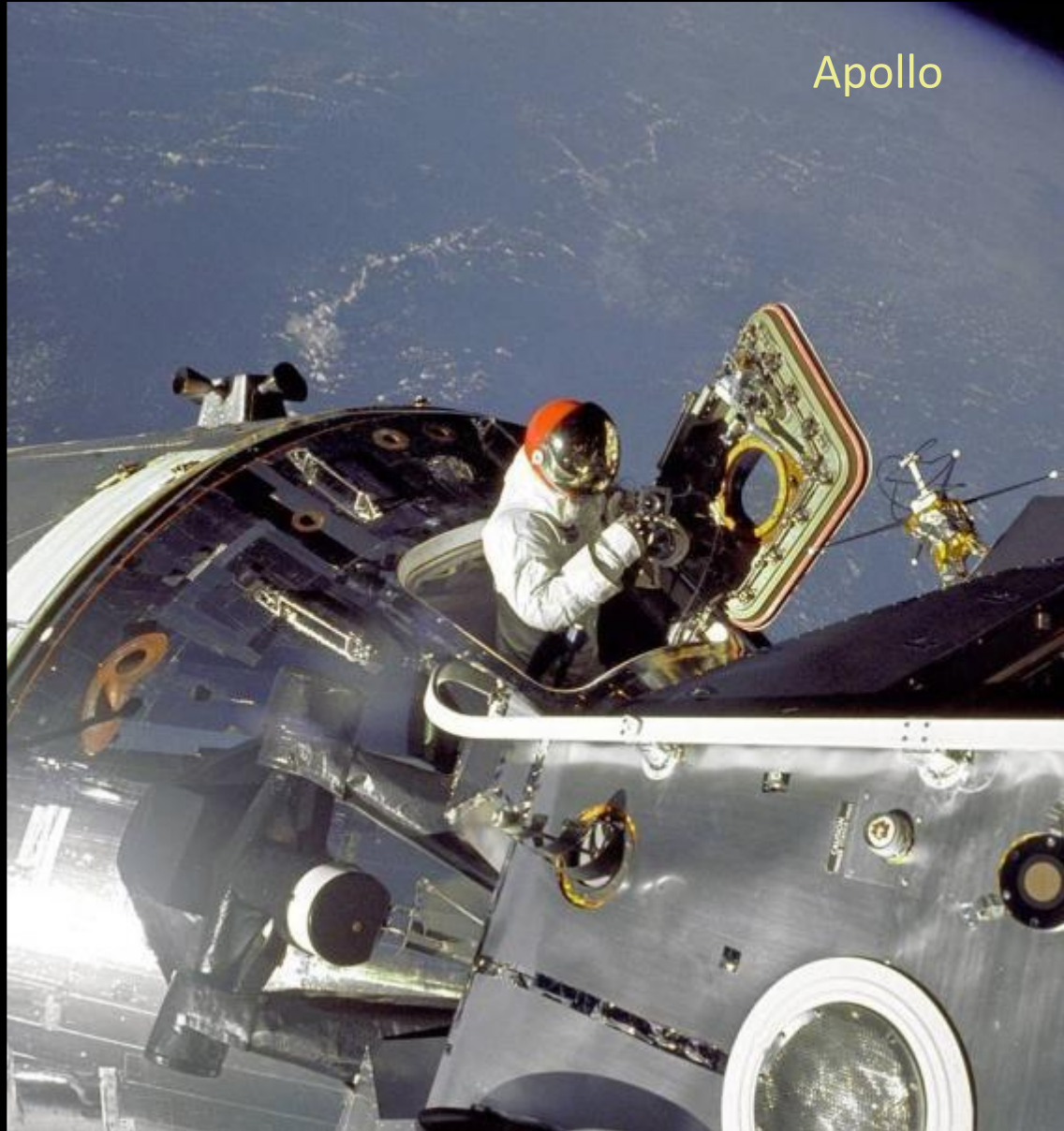




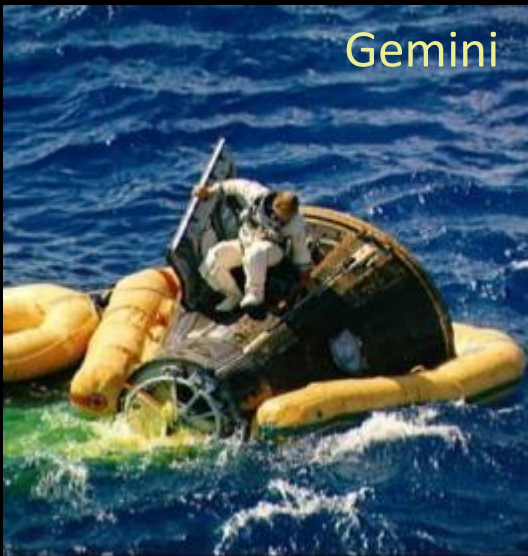
Early Missions



Mercury



Apollo

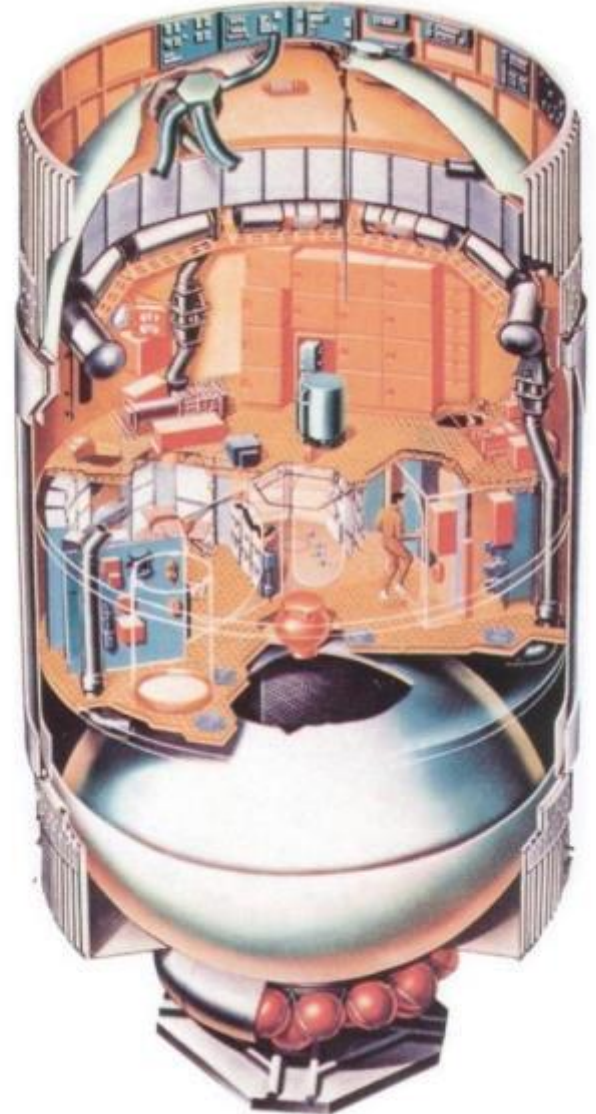


Gemini



SKYLAB

3 Missions - 28, 59, 84 days



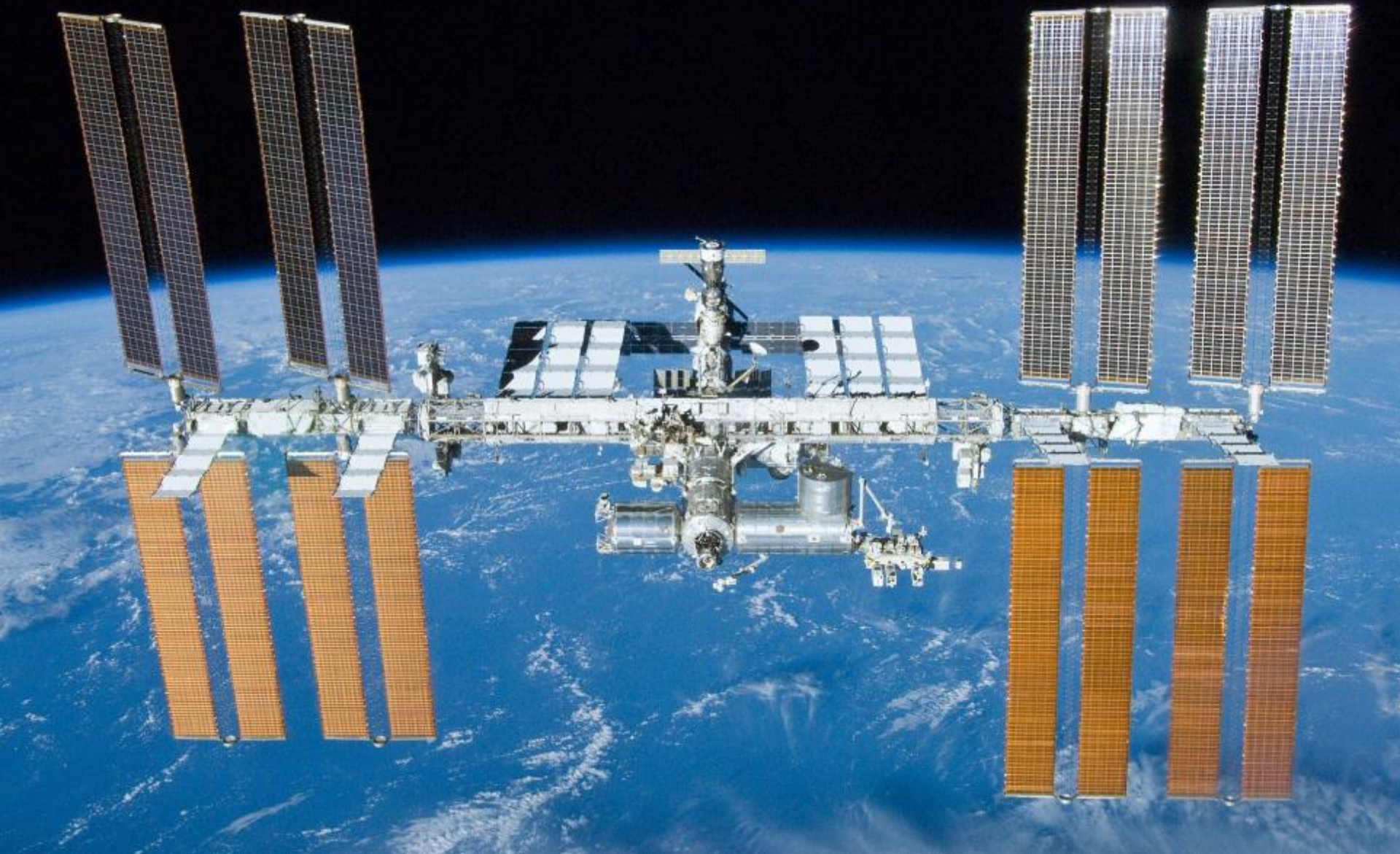


STS



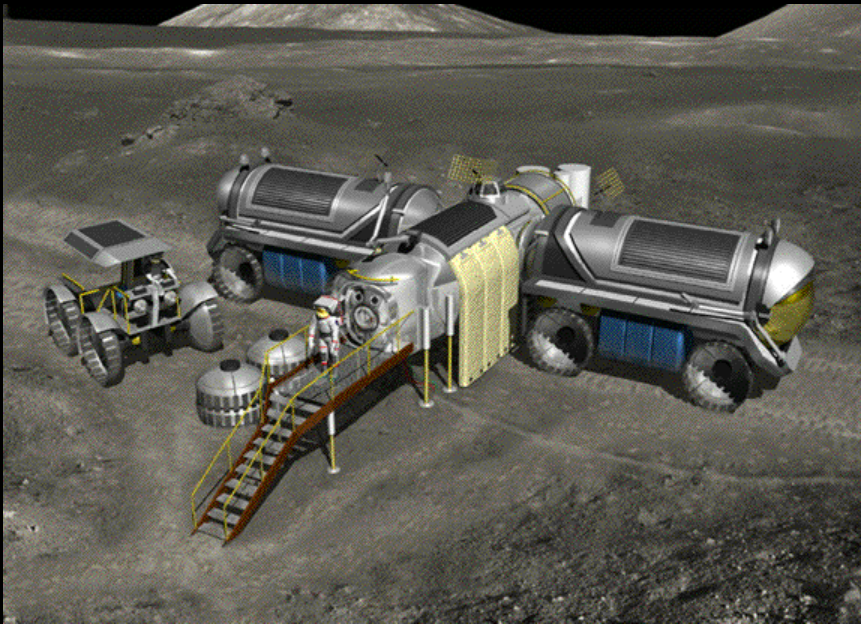


International Space Station



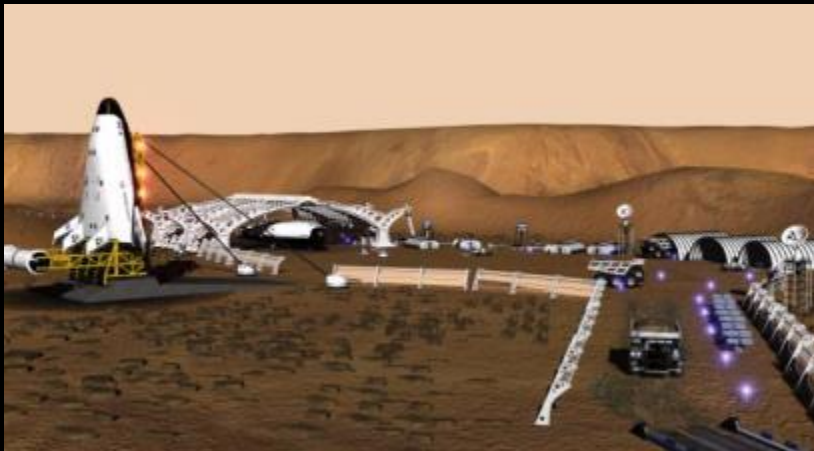
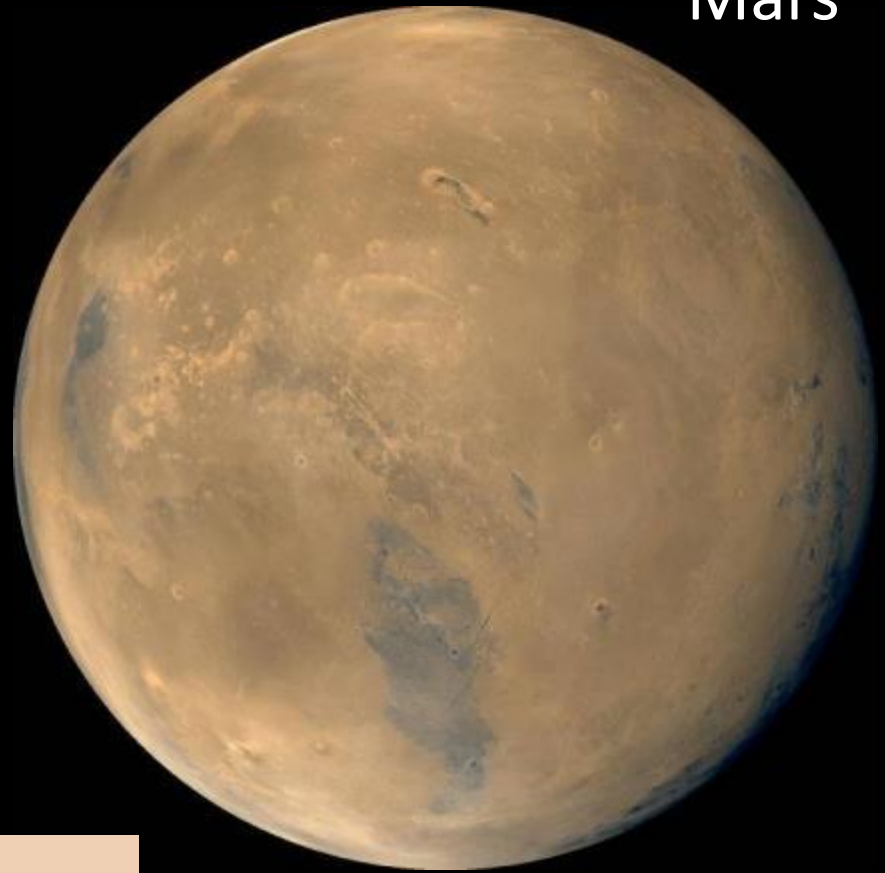


Luna





Mars





Atmosphere Management



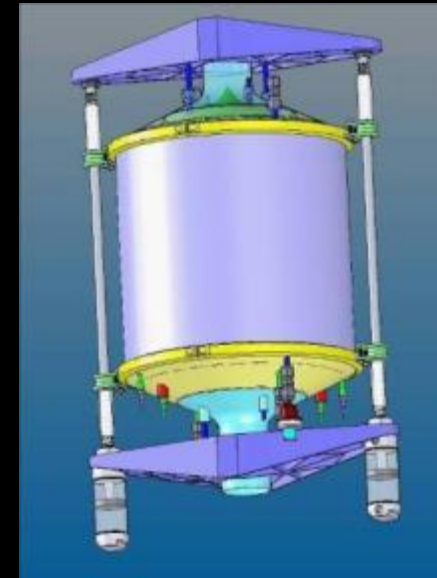
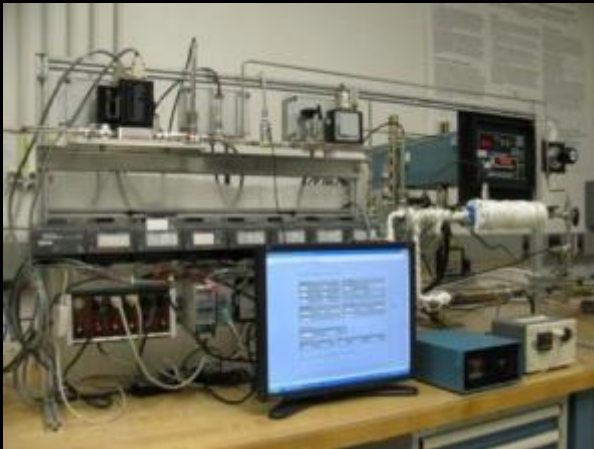
Air Revitalization



- O₂ Generation
- CO₂ Removal
- Contaminant Control
- Particulate Control

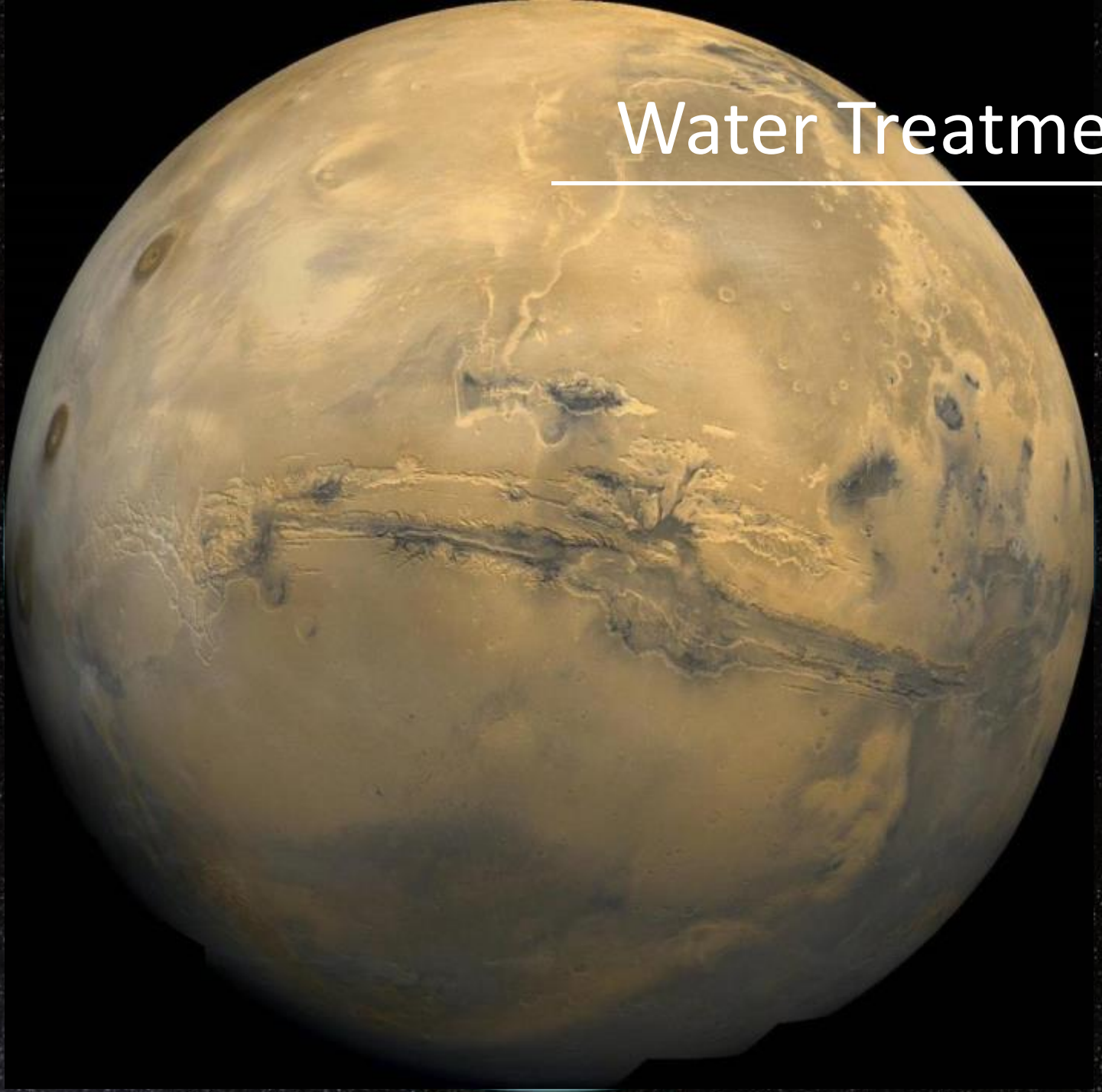


CO₂ Capture and Sequestration



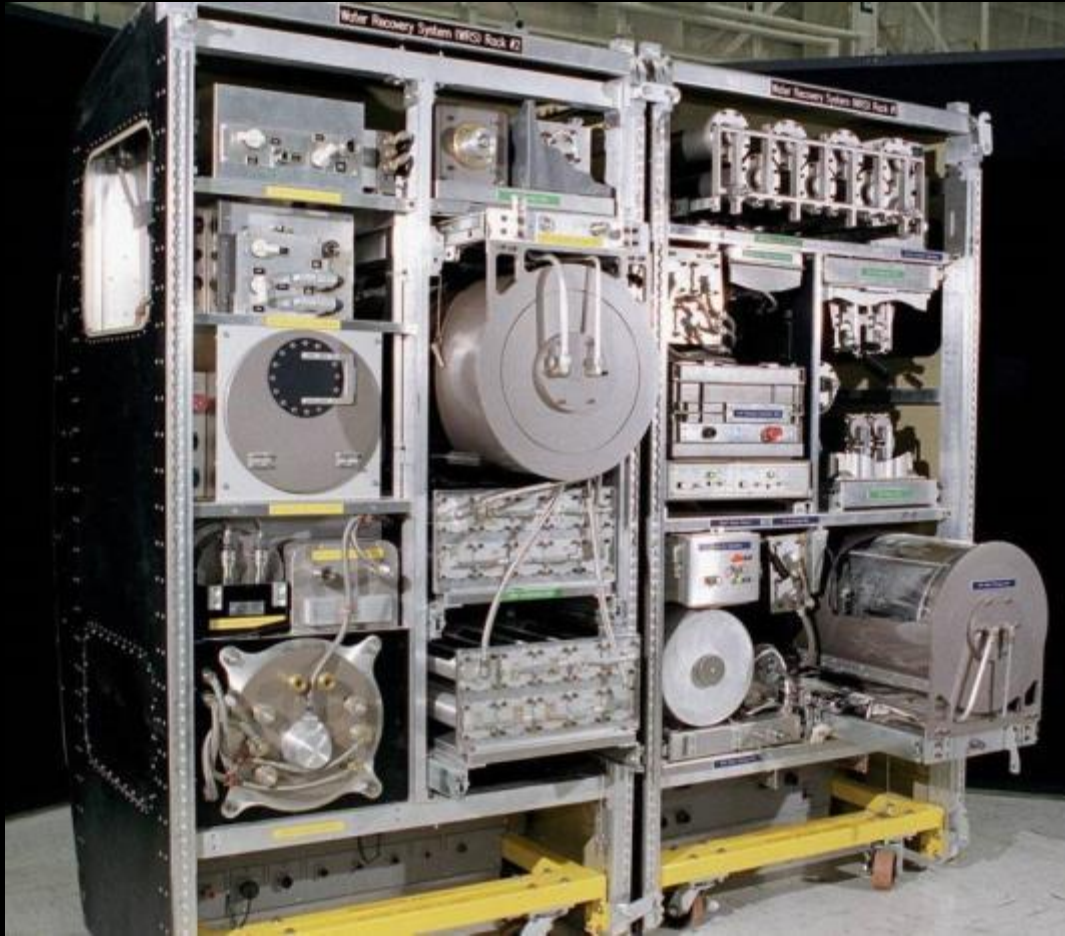


Water Treatment





Wastewater to Drinking Water

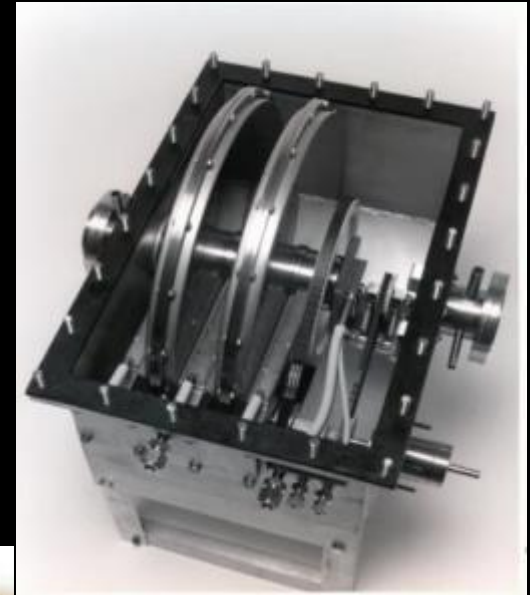
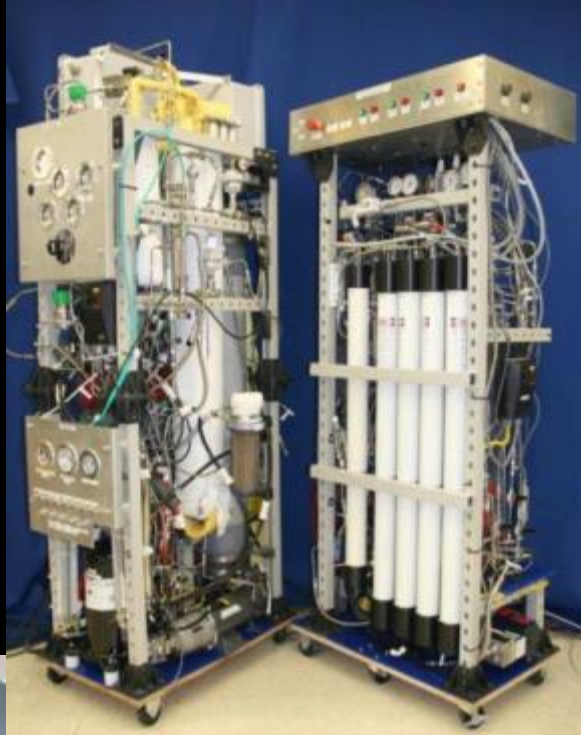


- Disinfection
- Organic Removal
- Inorganic Removal
- Maximize Recovery

ISS Water Recovery Subsystem



Closed-Loop Water Treatment





Waste Management





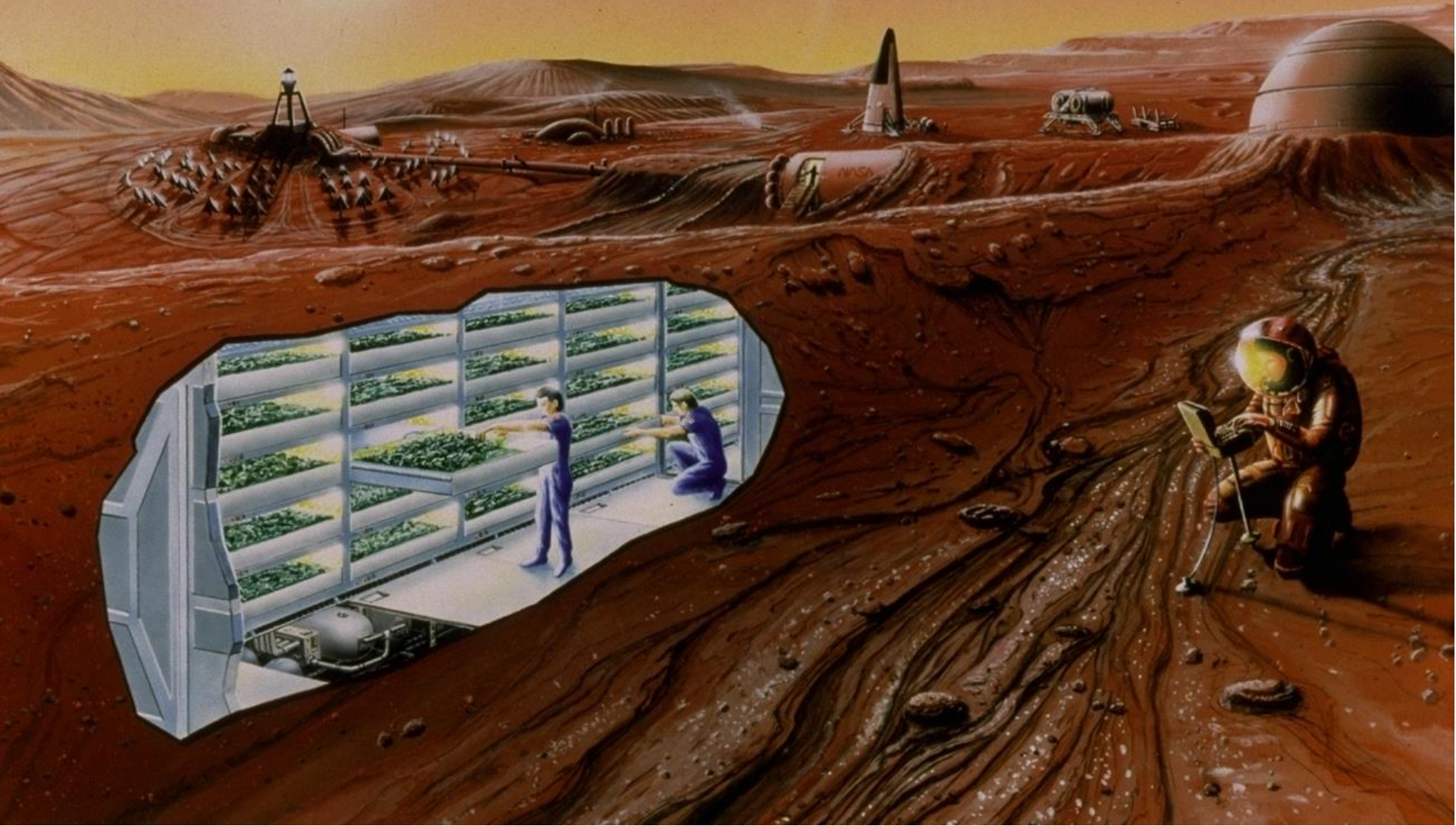
“Waste” Conversion and Reuse (“Cradle to Cradle” Approaches)



- Volume Reduction
- Odor Control
- Sanitize
- Generate H₂O, O₂, CO₂, Fuel, Nutrients, Building Materials



Food Production





Closed System Agriculture



- Maximize Yield
- Low Water
- Efficient Lighting
- Use recovered nutrients



*Wheat - 3-4 x World Record
Potato - 2 x World Record
Lettuce-Exceeded Commercial
Yield Models*



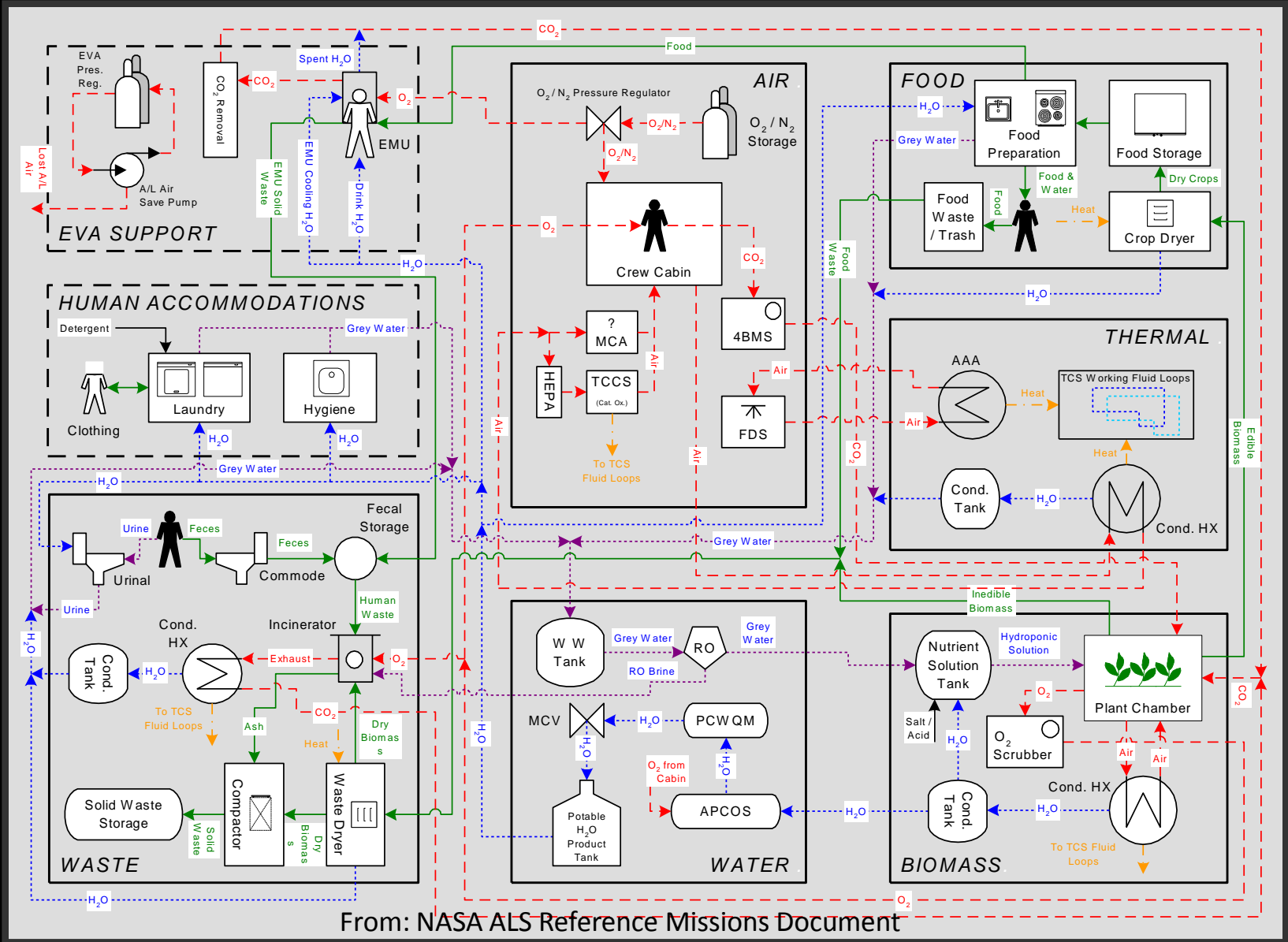


Systems Engineering





Systems Engineering



From: NASA ALS Reference Missions Document



Thank You