https://ntrs.nasa.gov/search.jsp?R=20160014799 2020-03-07T04:06:50+00:00Z

Spacecraft Life Support Systems

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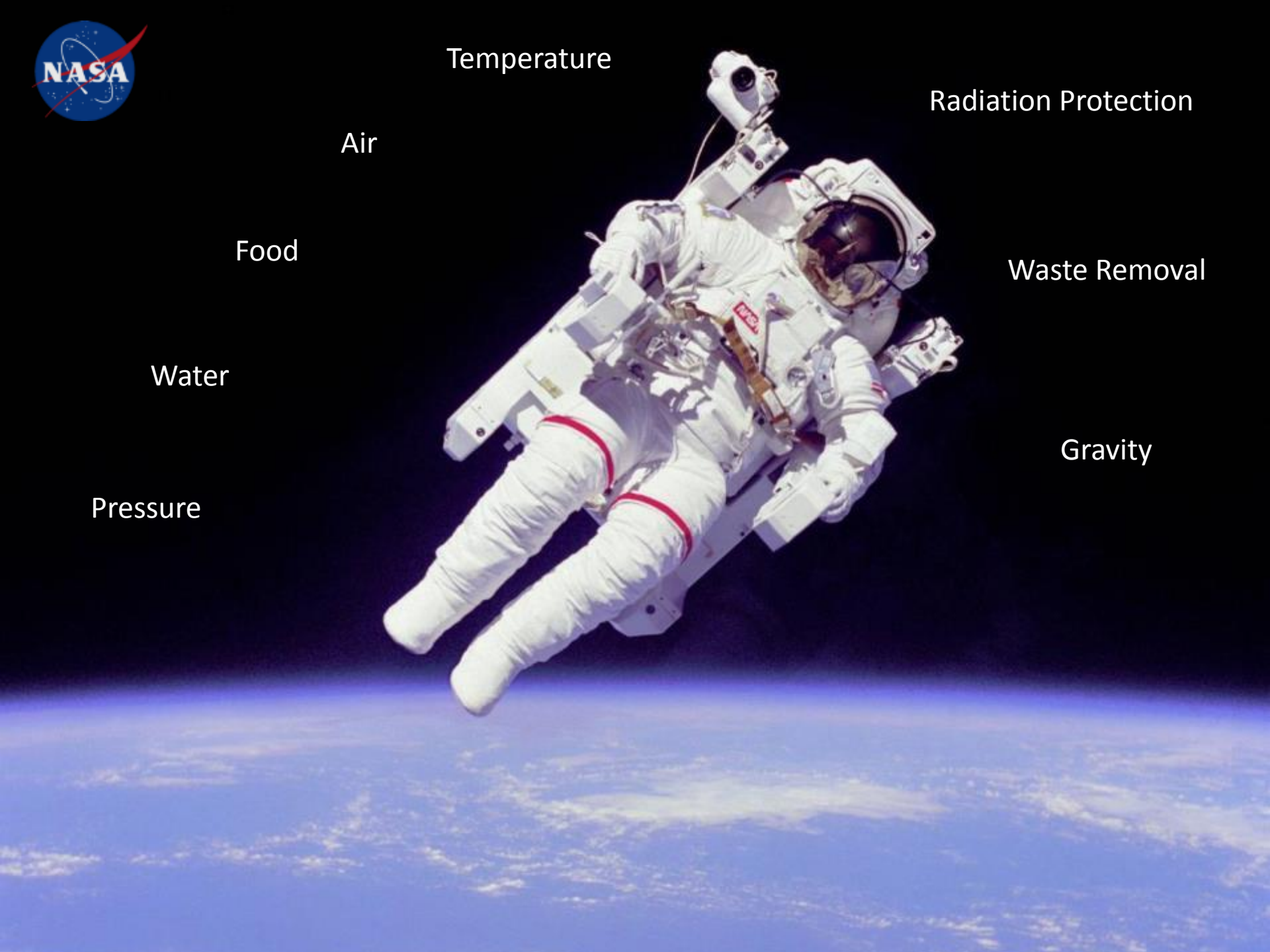
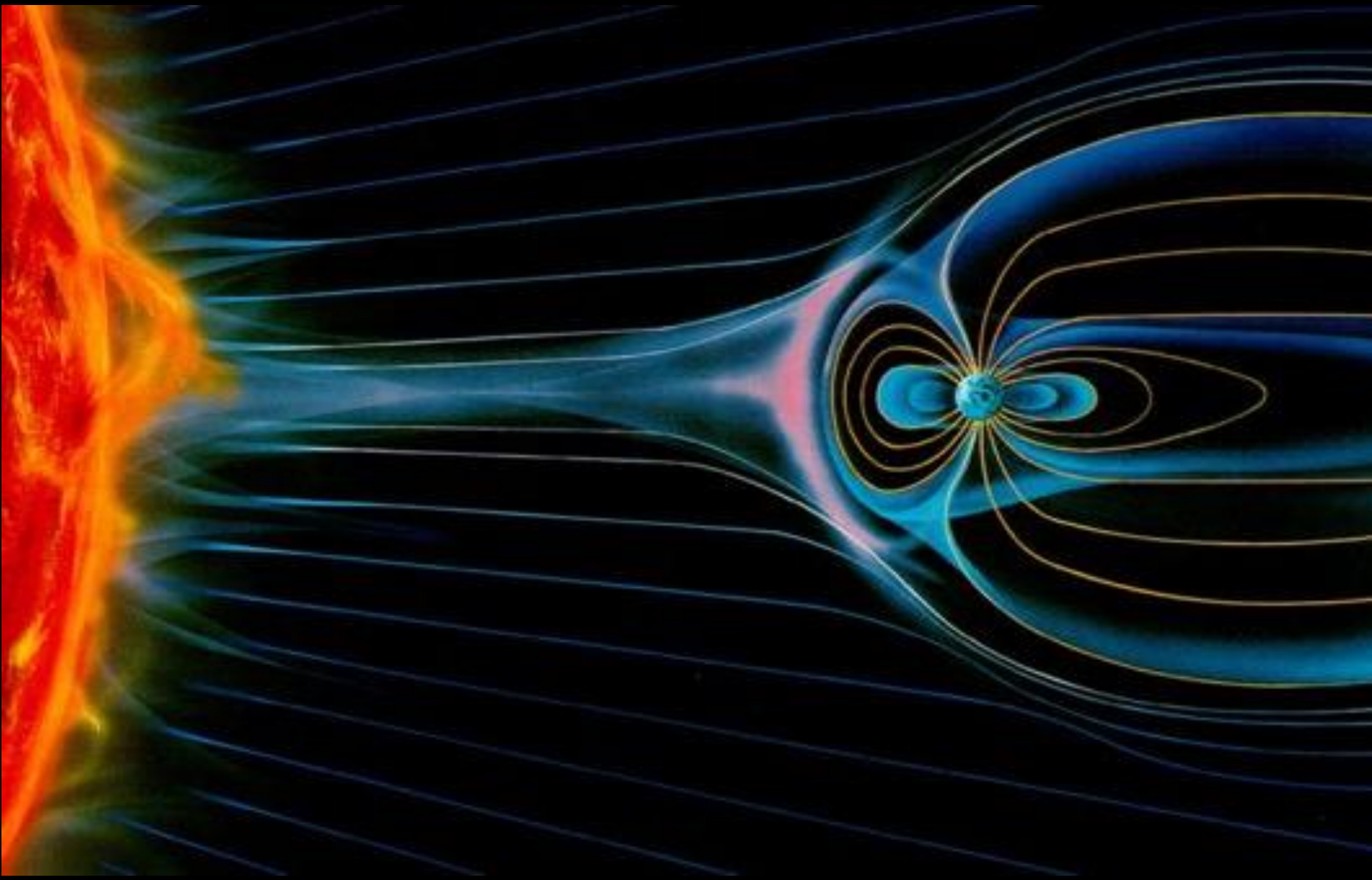

Temperature
Radiation Protection
Air
Food
Waste Removal
Water
Gravity
Pressure

Earth’s Life Support Systems (ELSS)



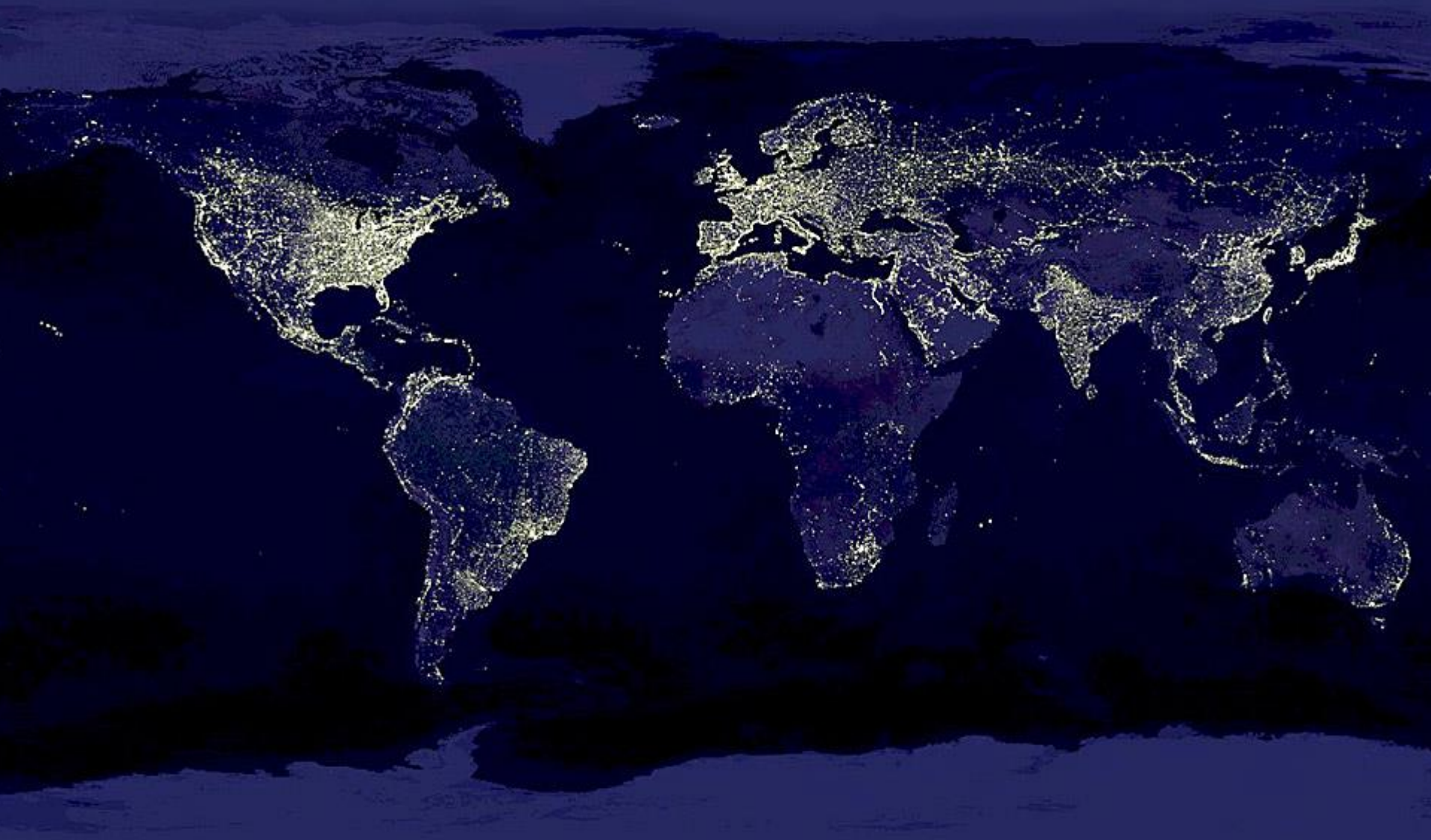
Humanity's Life Support Systems

Water/waste purification

Air quality regulation

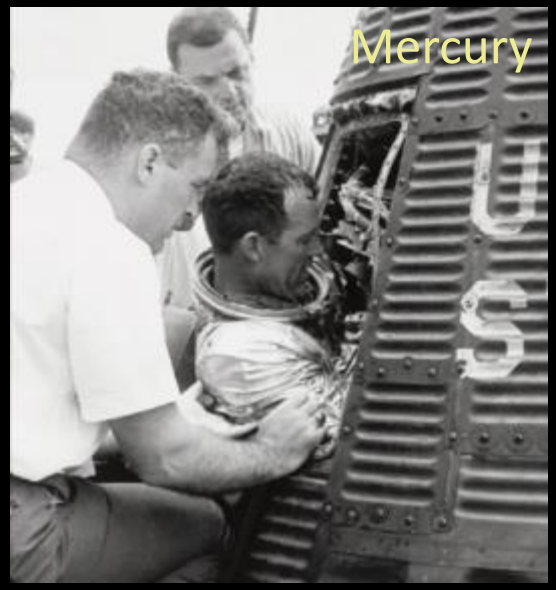
Aesthetic/Spiritual values
Recreation/Ecotourism

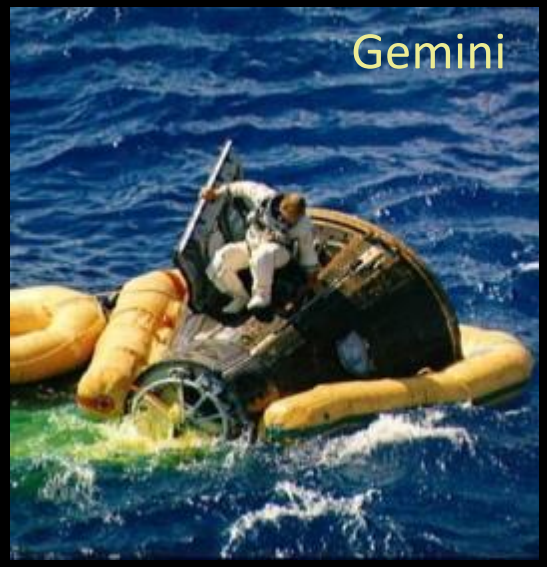
regulation

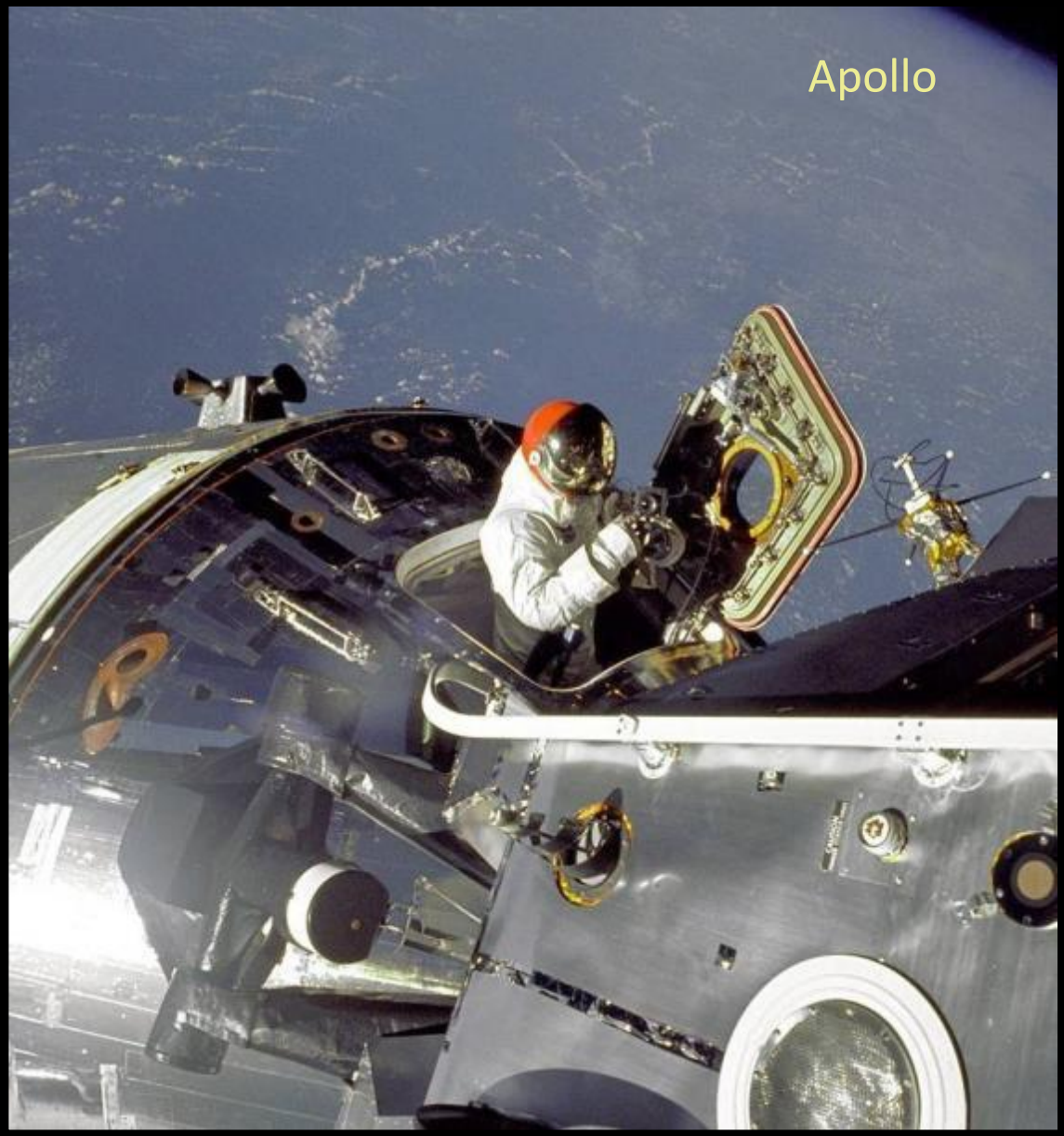


Human Space Exploration

Early Missions

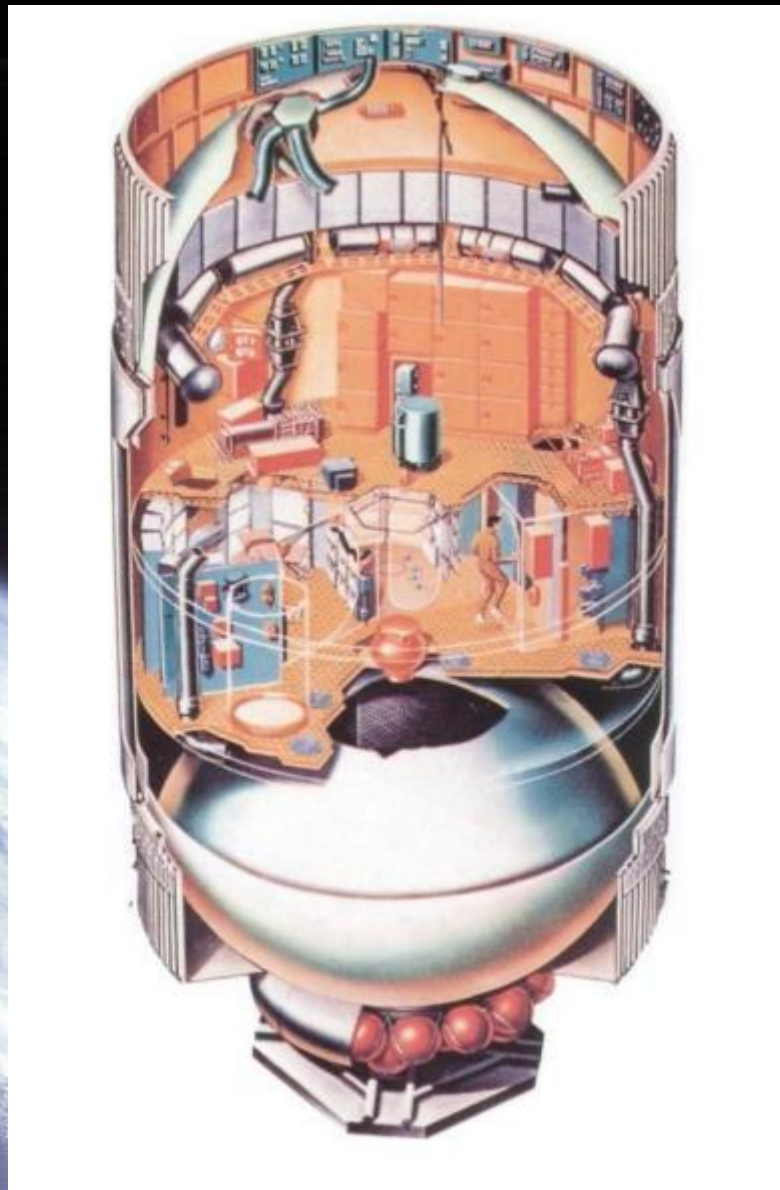






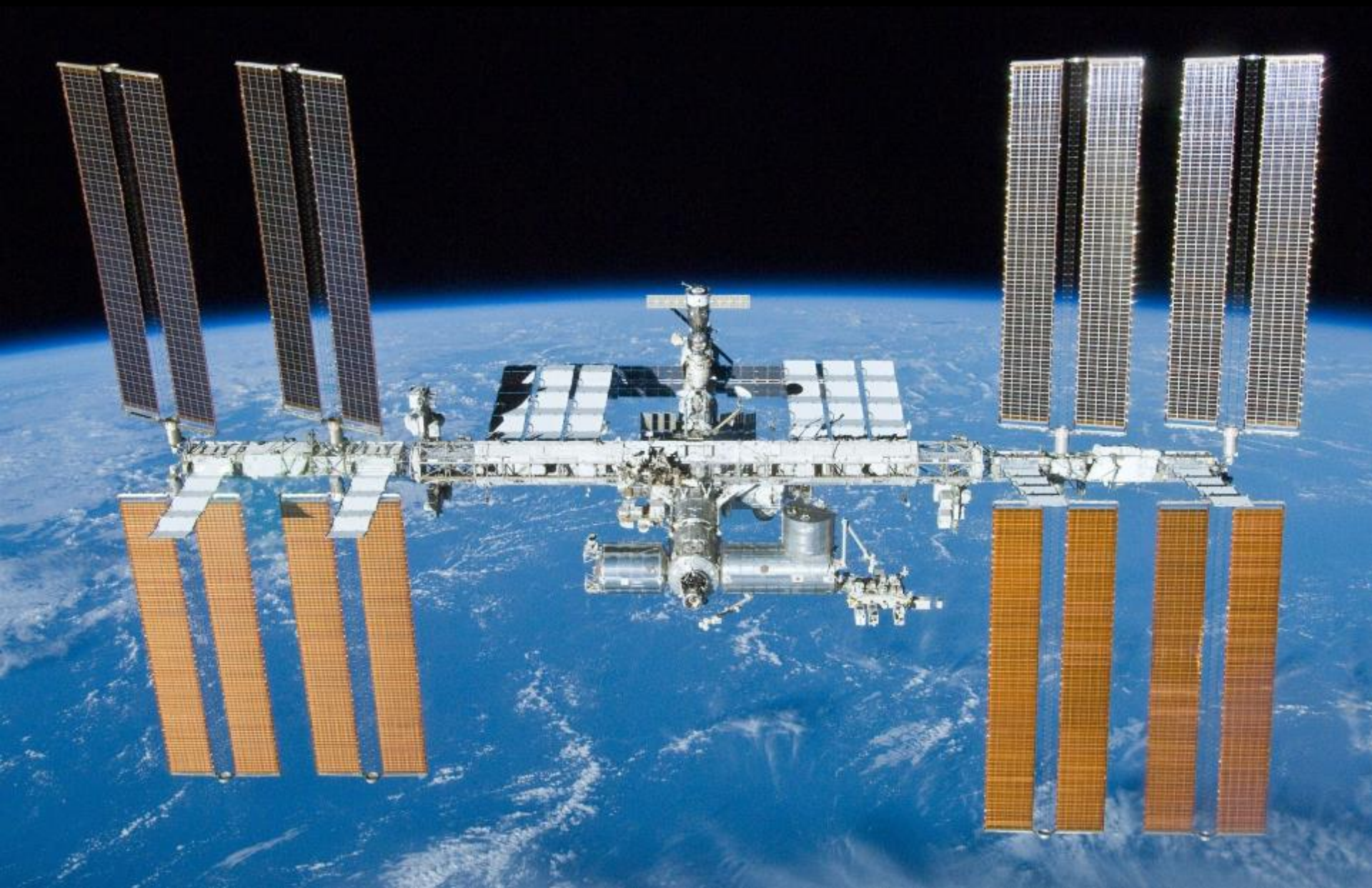
SKYLAB

3 Missions - 28, 59, 84 days

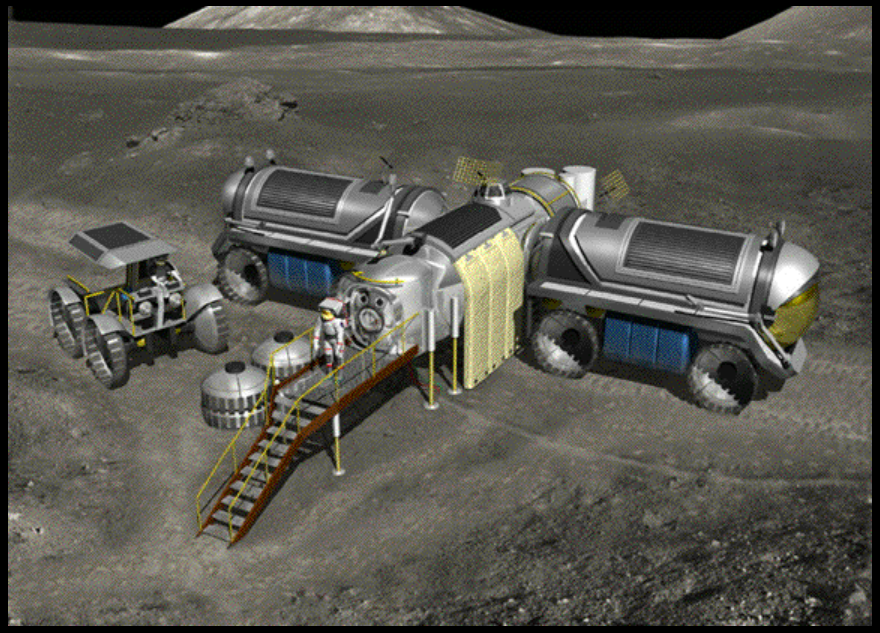


STS

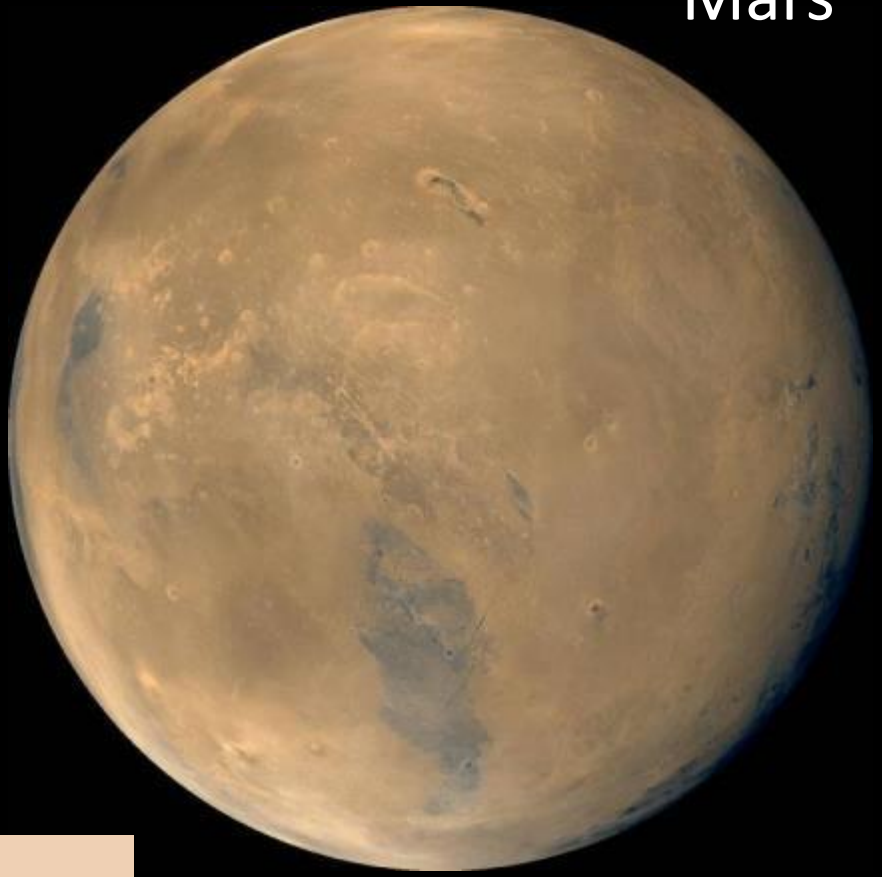
International Space Station

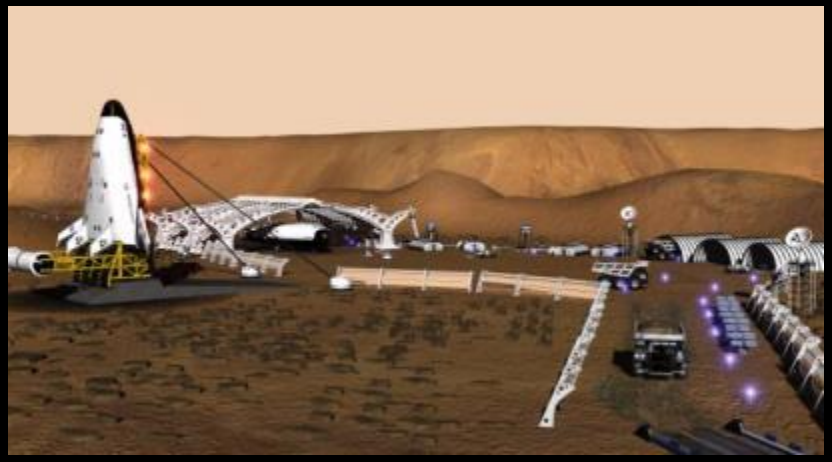


Luna



Mars



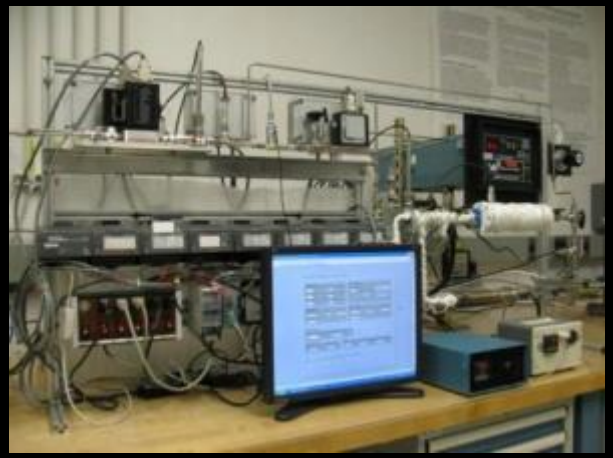


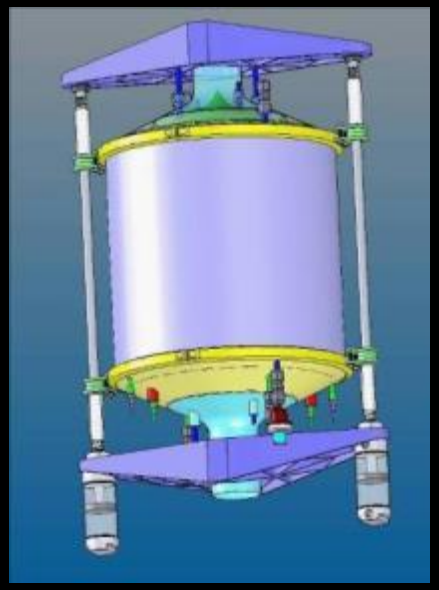
Atmosphere Management

Air Revitalization

- O_2 Generation
- CO_2 Removal
- Contaminant Control
- Particulate Control

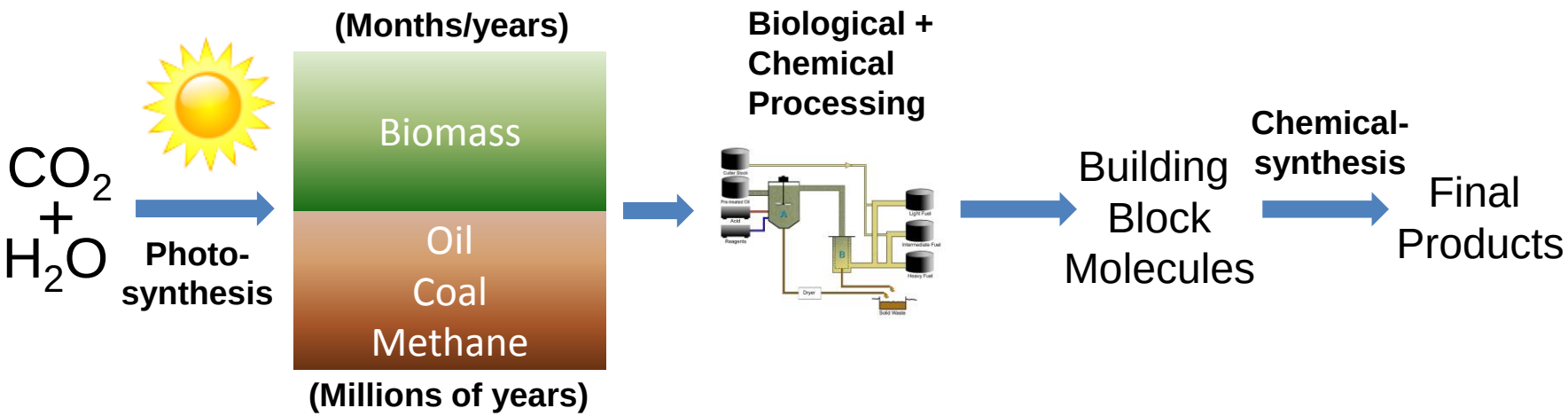
CO_2 Capture and Sequestration



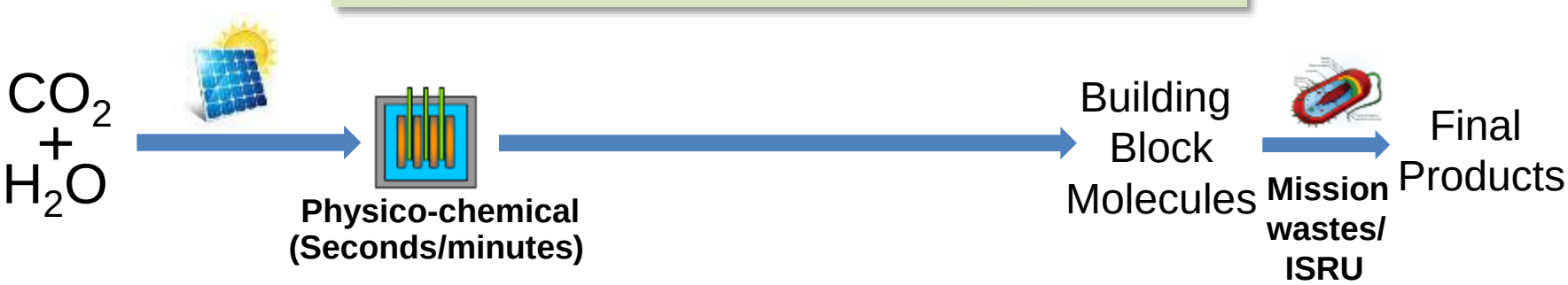


CO_2-Based Manufacturing Approaches

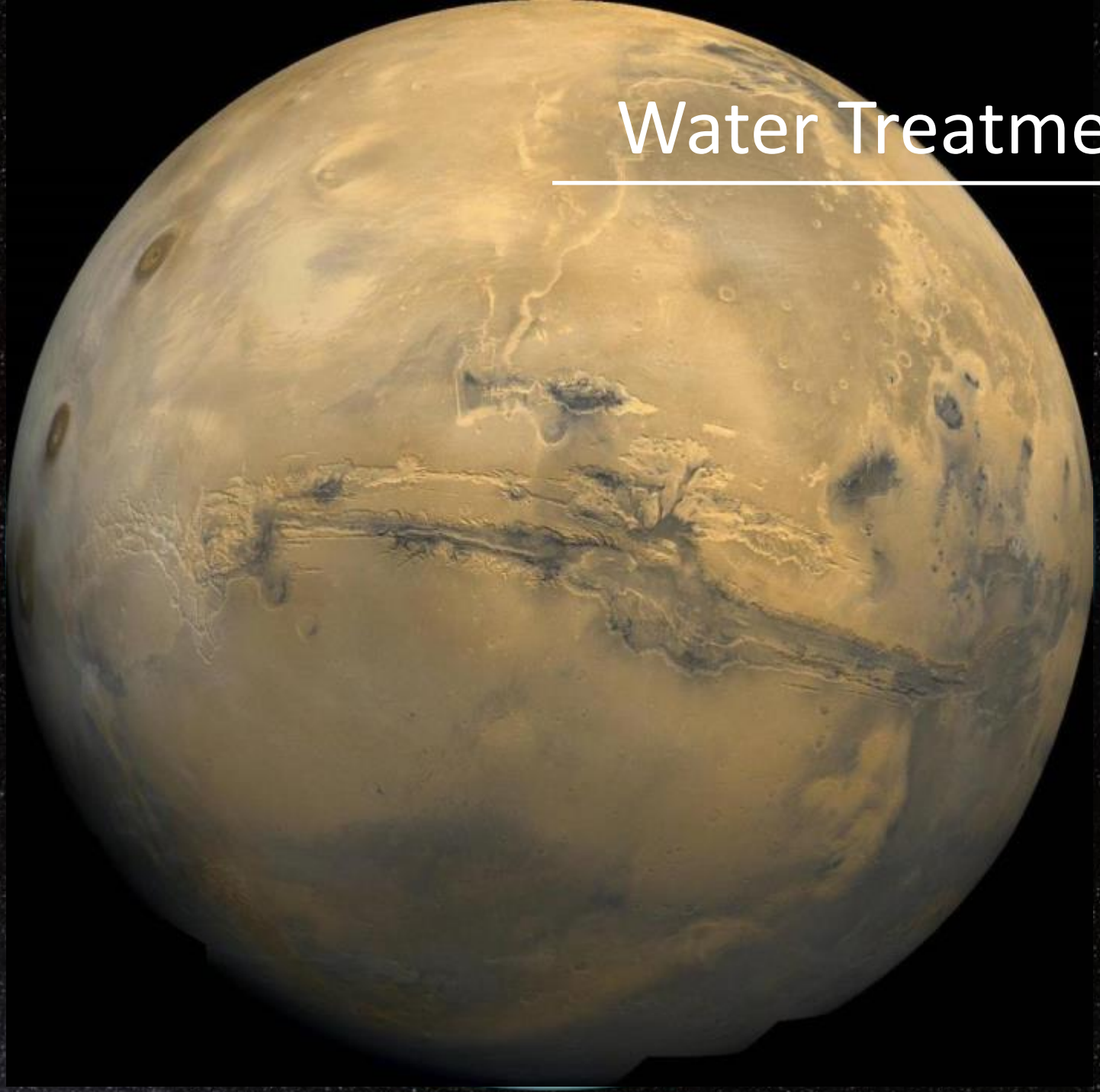
Current Terrestrial Biorefinery Model



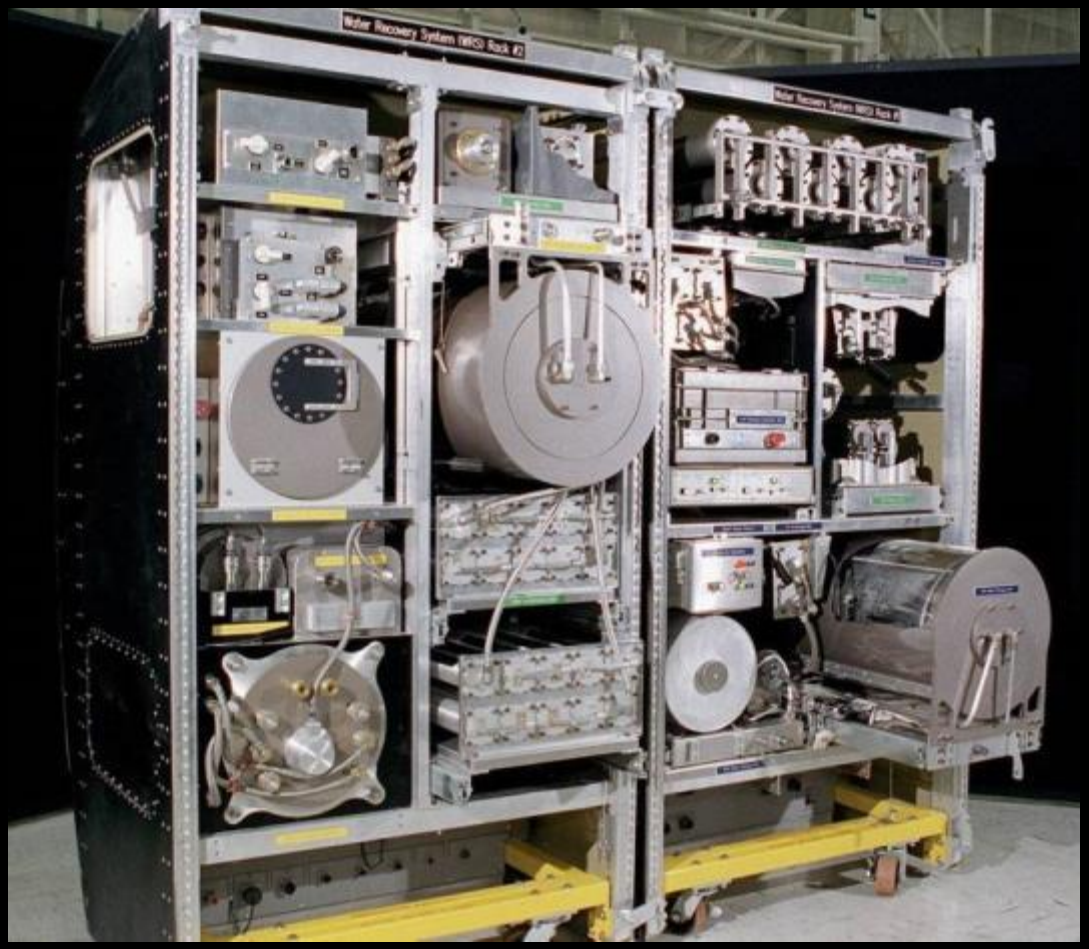
Space Bio-Manufacturing Model



Water Treatment



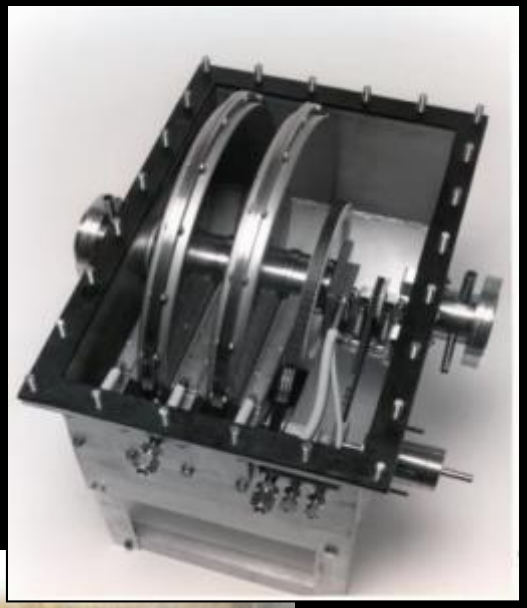
Wastewater to Drinking Water

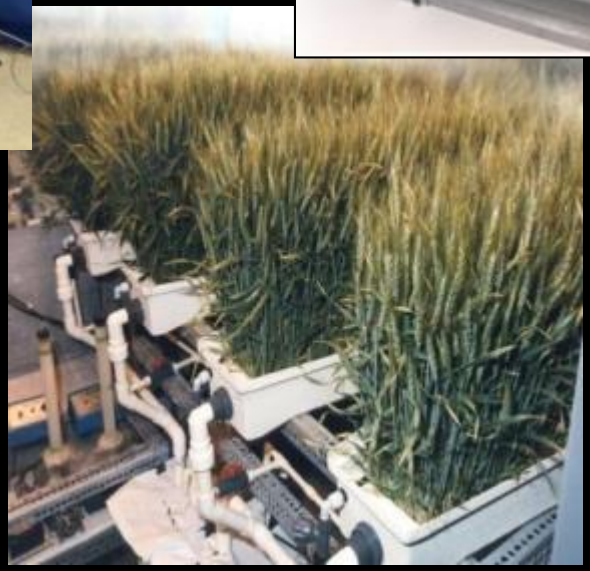


ISS Water Recovery Subsystem

- Disinfection
- Organic Removal
- Inorganic Removal
- Maximize Recovery

Closed-Loop Water Treatment





Waste Management

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

- Volume Reduction
- Odor Control
- Sanitize
- Generate H_2O, O_2, CO_2, Fuel, Nutrients, Building Materials

In Situ Manufacturing

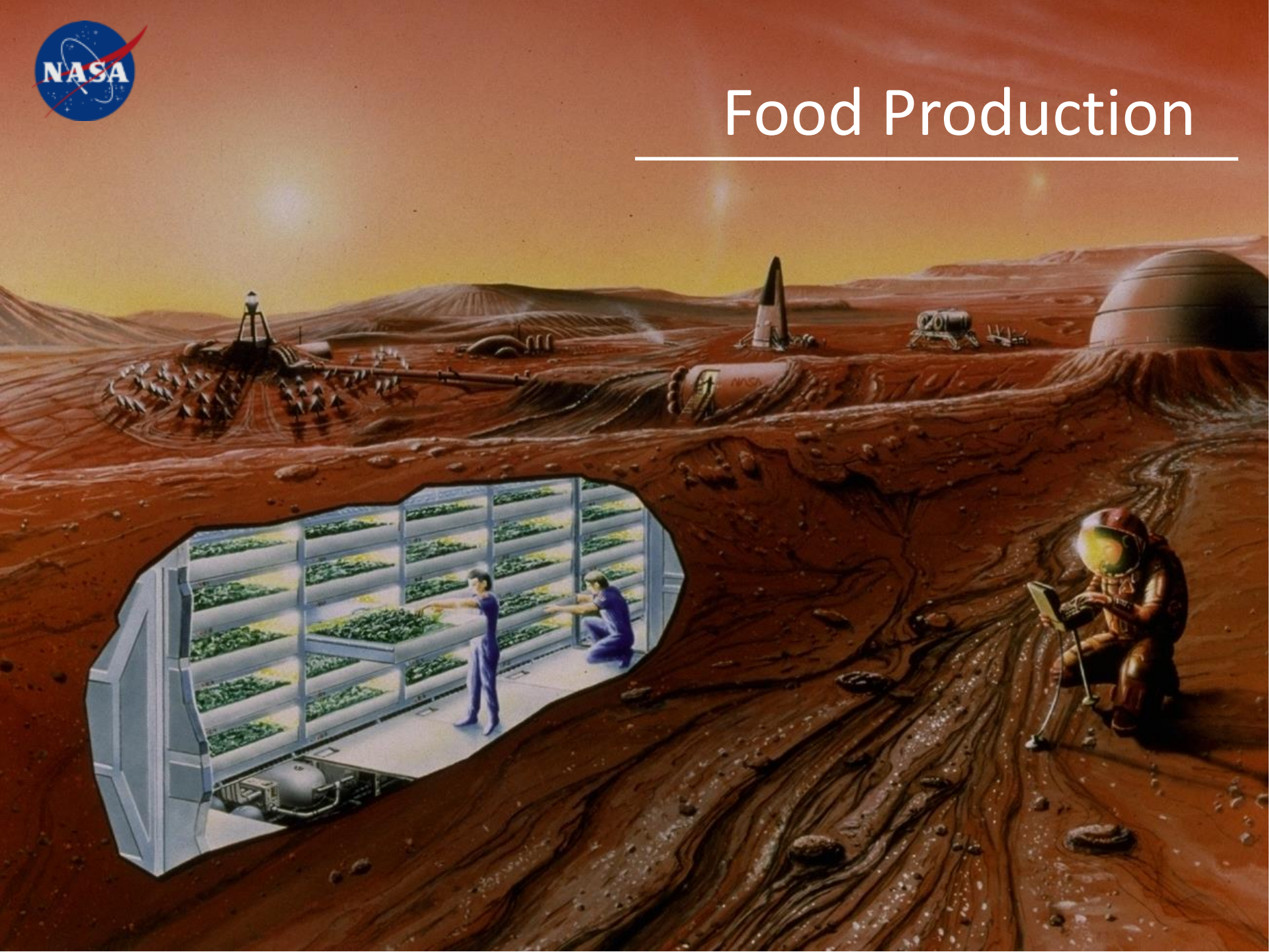
Utilize unusable mission materials and *In situ* resources to generate products needed for sustainable systems.

Concept Example:

$CO_2 + H_2$

P/C Conversion System → Microbial Medium → Growth System → Products

Food Production

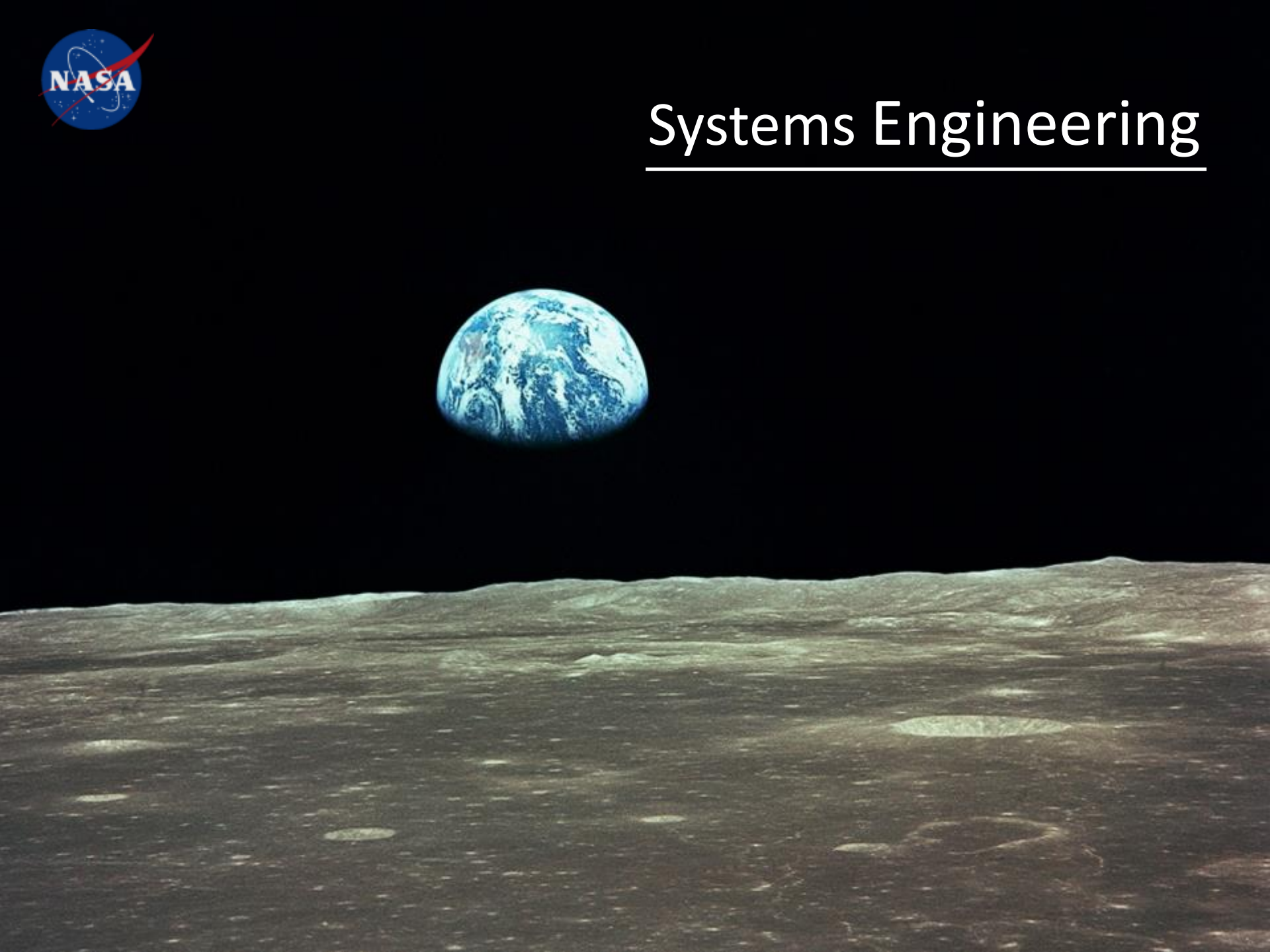


Closed System Agriculture

- 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

ELSS-RQ35484-C

Earth Systems Program

Earth Life Support Systems Requirements Document

ESD – 34794

Earth Systems Directorate
Requirements Division

August 2006

International Earth Systems Program
Mountain View, CA 94035

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Rev1

NASA Systems Engineering Handbook

Thank You