DESIGN OF A MARS POLAR RESEARCH BASE WITH CREW

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eSPACE
Space Engineering Center

“North Polar Layered Deposits in Head of Scarp of Chasma Boreale”
photographed by HiRISE, Mars, 2006
courtesy of NASA/JPL-Caltech/University of Arizona

Mars North Pole

1 Determine if Mars ever supported life

2 Understanding the processes and history of climate on Mars

3 Understand the origin and evolution of Mars as a geological system

4 Prepare for human exploration

Objectives

1

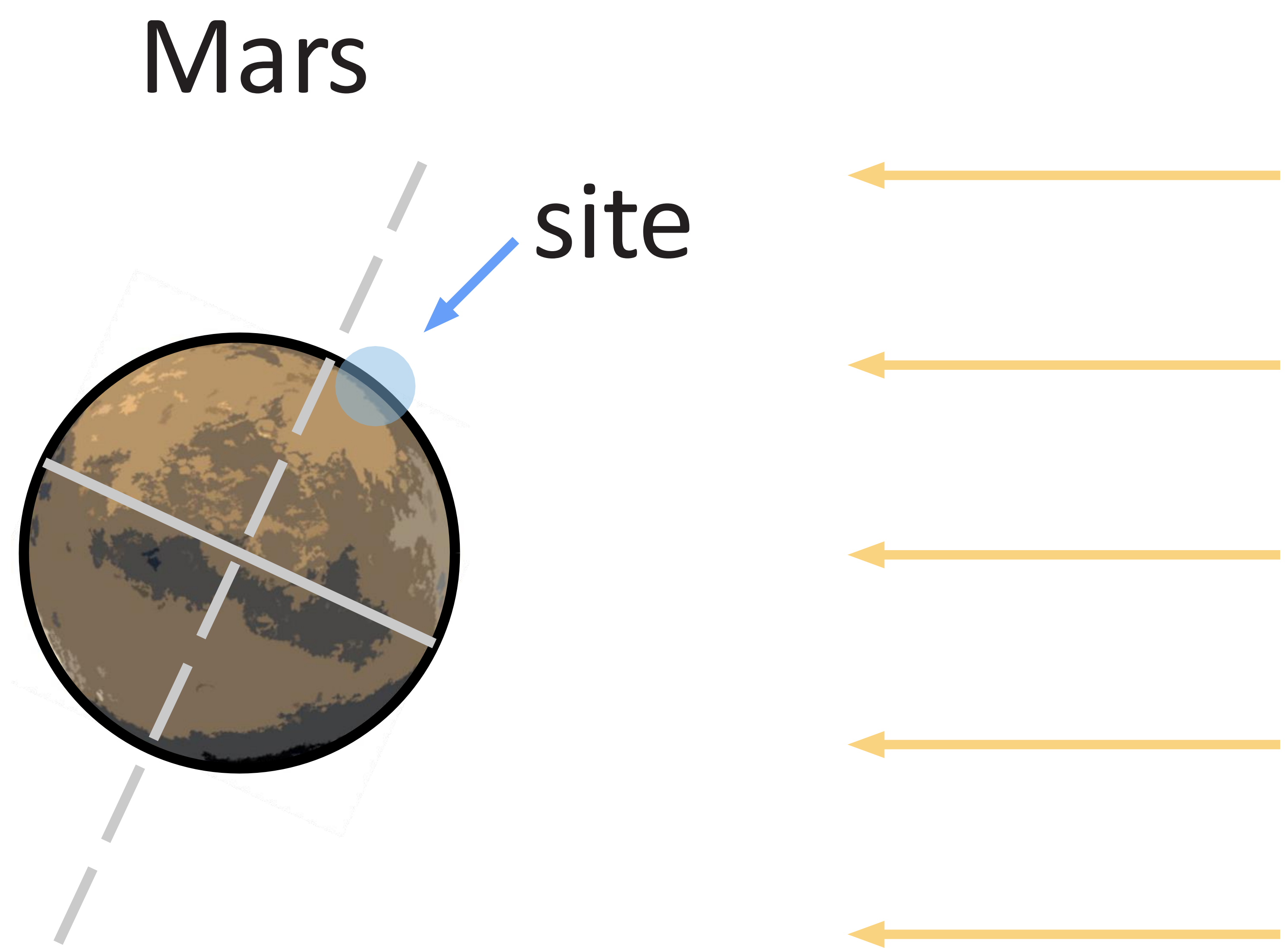
Propose a design for a 9-month manned Mars surface mission

2

Identify mission design or technology development areas

Mission Definition

- Human crew
- 288 day surface mission at Mars North Pole during constant daylight
- Drilling & analysis of Polar Layered Deposits (PLD)
- Safe return of the crew on Earth



Crew Composition

piloting & navigation

electrical & communication engineer

mechanical engineer

medecine, dentistry & psychology

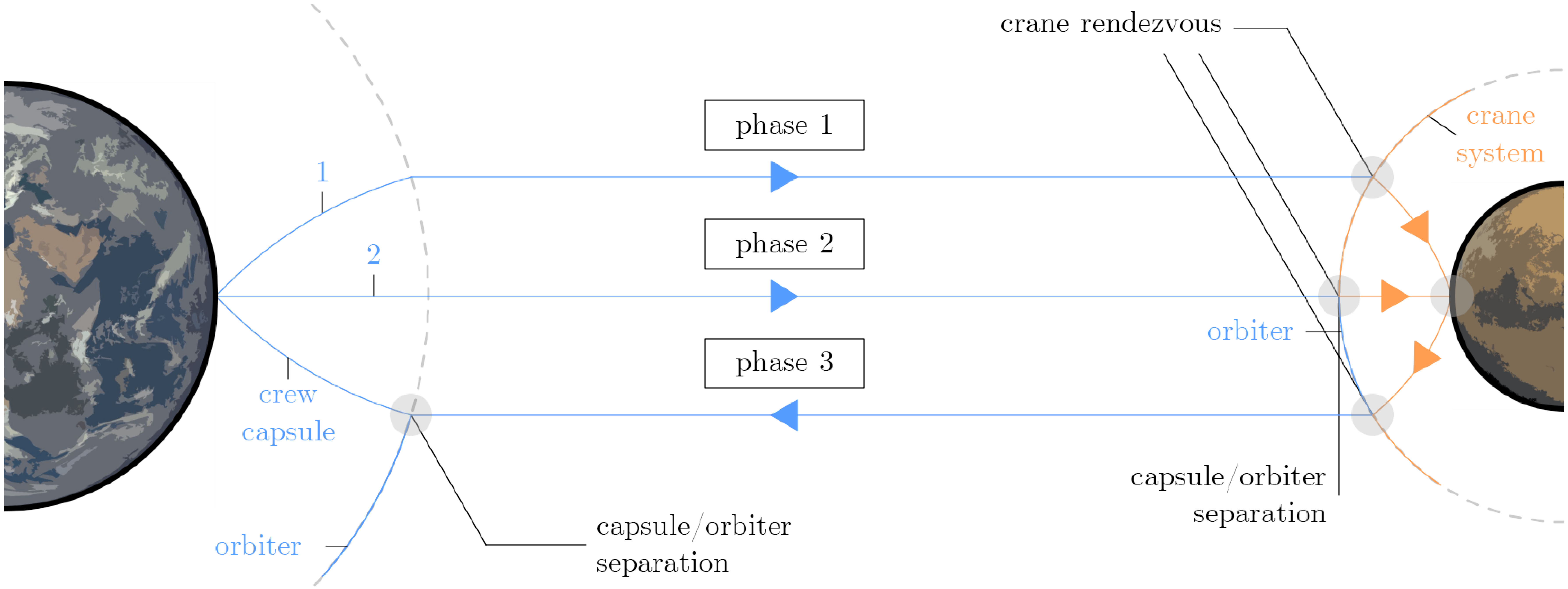
geology & data processing

biology & botany

Resources on Mars

- bricks, mortar, ice, …
- steel, aluminum, silicone
- glass, pottery
- water, oxygen, nitrogen, food complements
- ethylene based plastics
- hydrogen, carbon monoxide, methane, methanol, ethylene, ALICE (including oxide)

Mission Phases



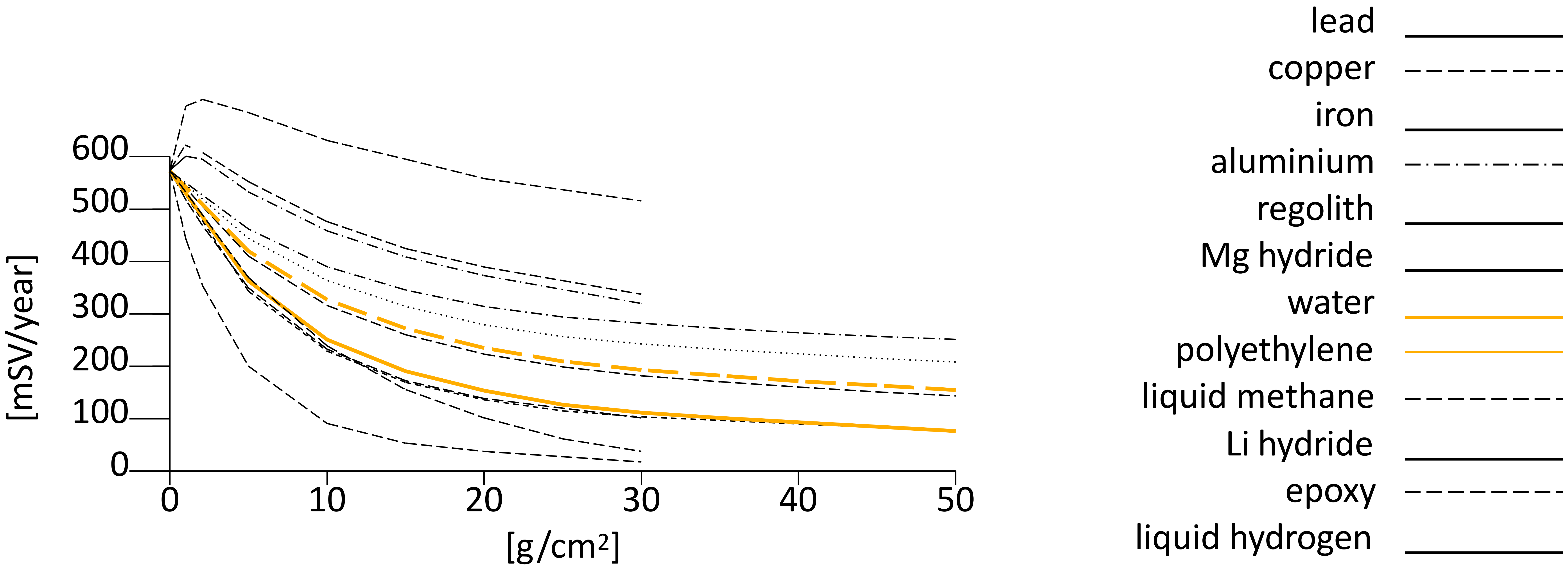
Life Support System

food energy water oxygen nitrogen

materials brought from Earth

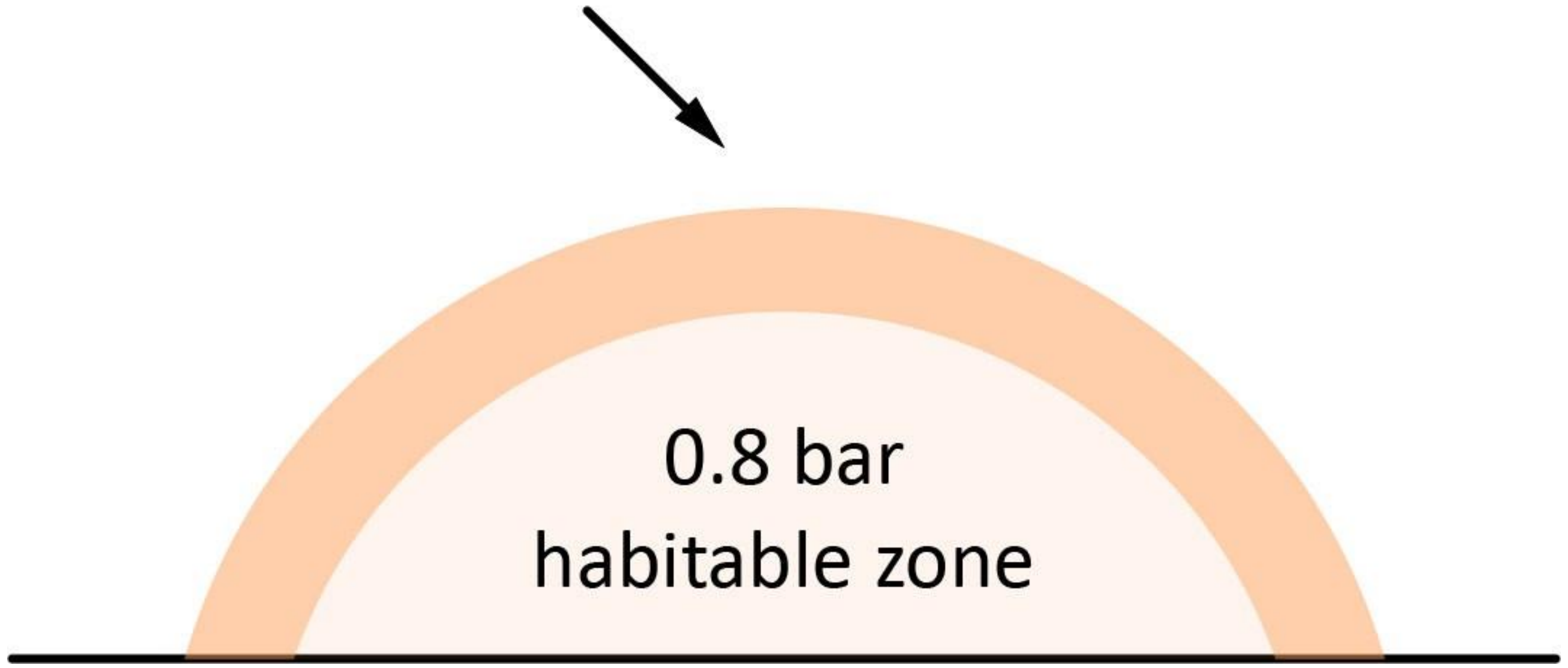
Mars in-situ collected materials

Radiation Protection

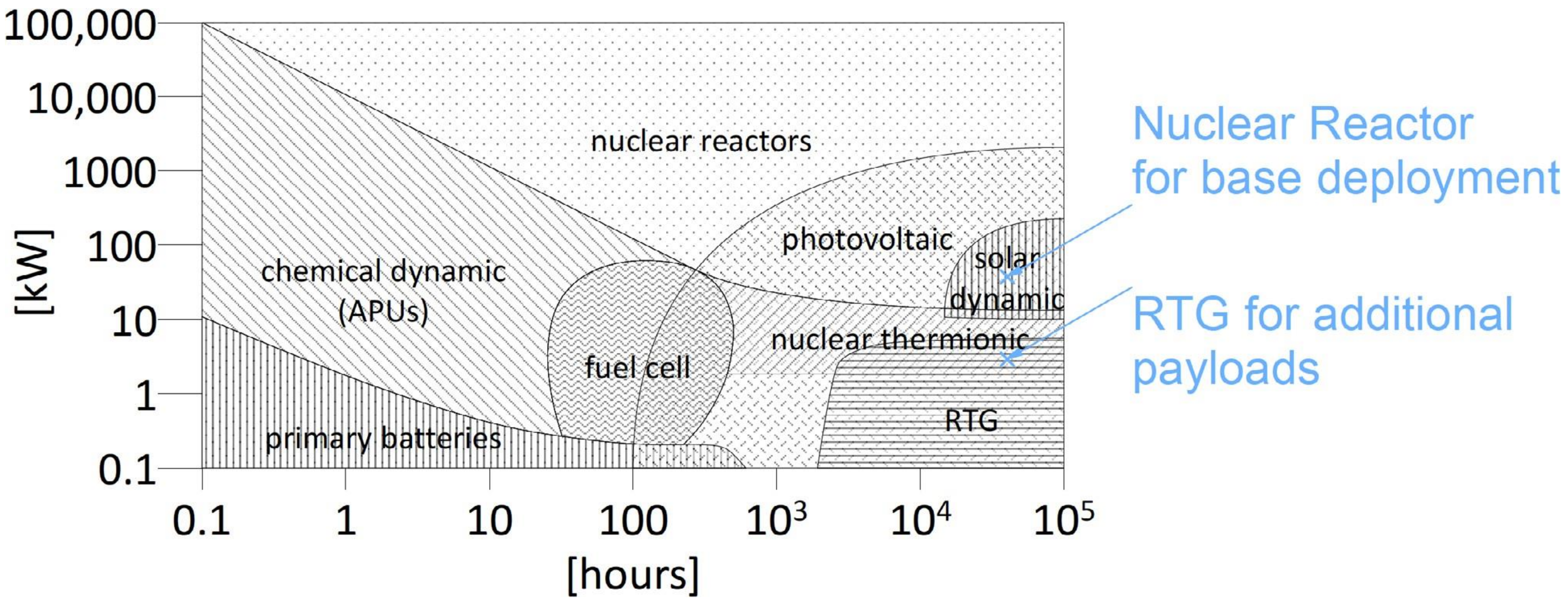


Air Pressure

in-situ minned ice as mass to compensate the pressure difference (also serves as radiation protection



Power

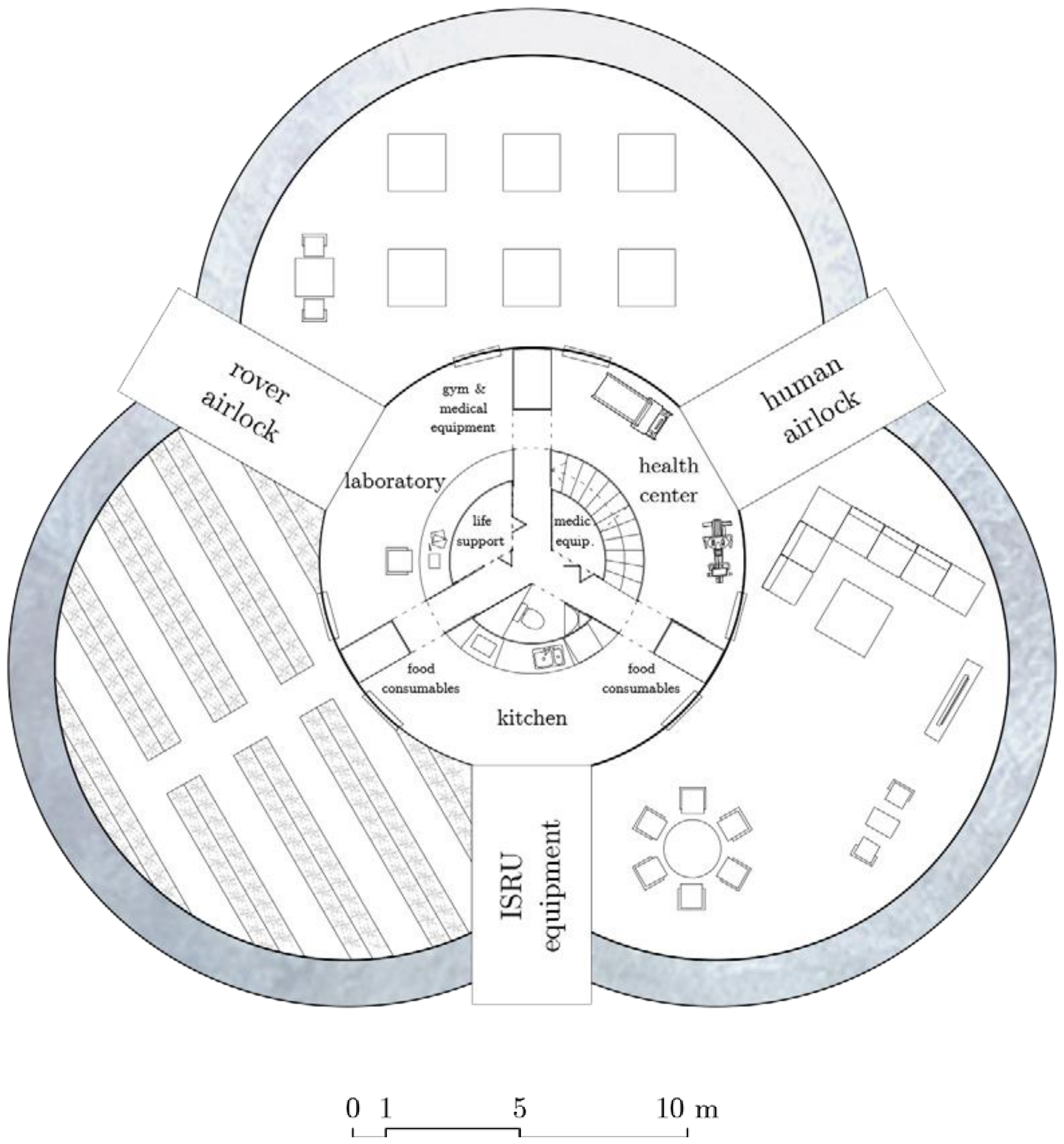

100,000
10,000
1000
100
10
1
0.1
[kW]
nuclear reactors
photovoltaic
solar dynamic
chemical dynamic (APUs)
fuel cell
nuclear thermionic
RTG
primary batteries
0.1
1
10
100
10^3
10^4
10^5
[hours]
Nuclear Reactor for base deployment
RTG for additional payloads

Strategy

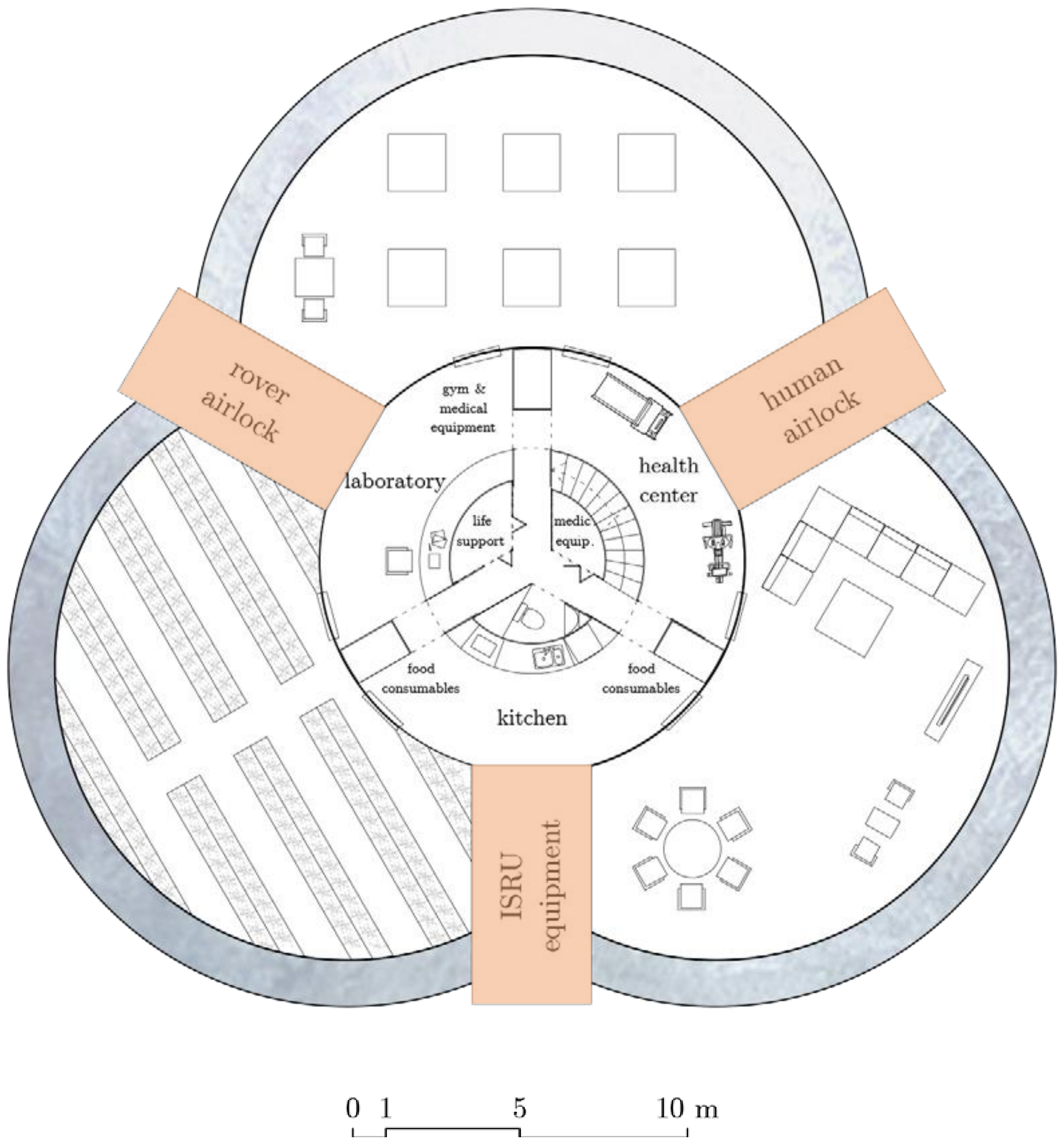
ethylene & ice

- radiation protection
- easy to produce
- from polar ice
- from atmosphere
- plastics
- fuel

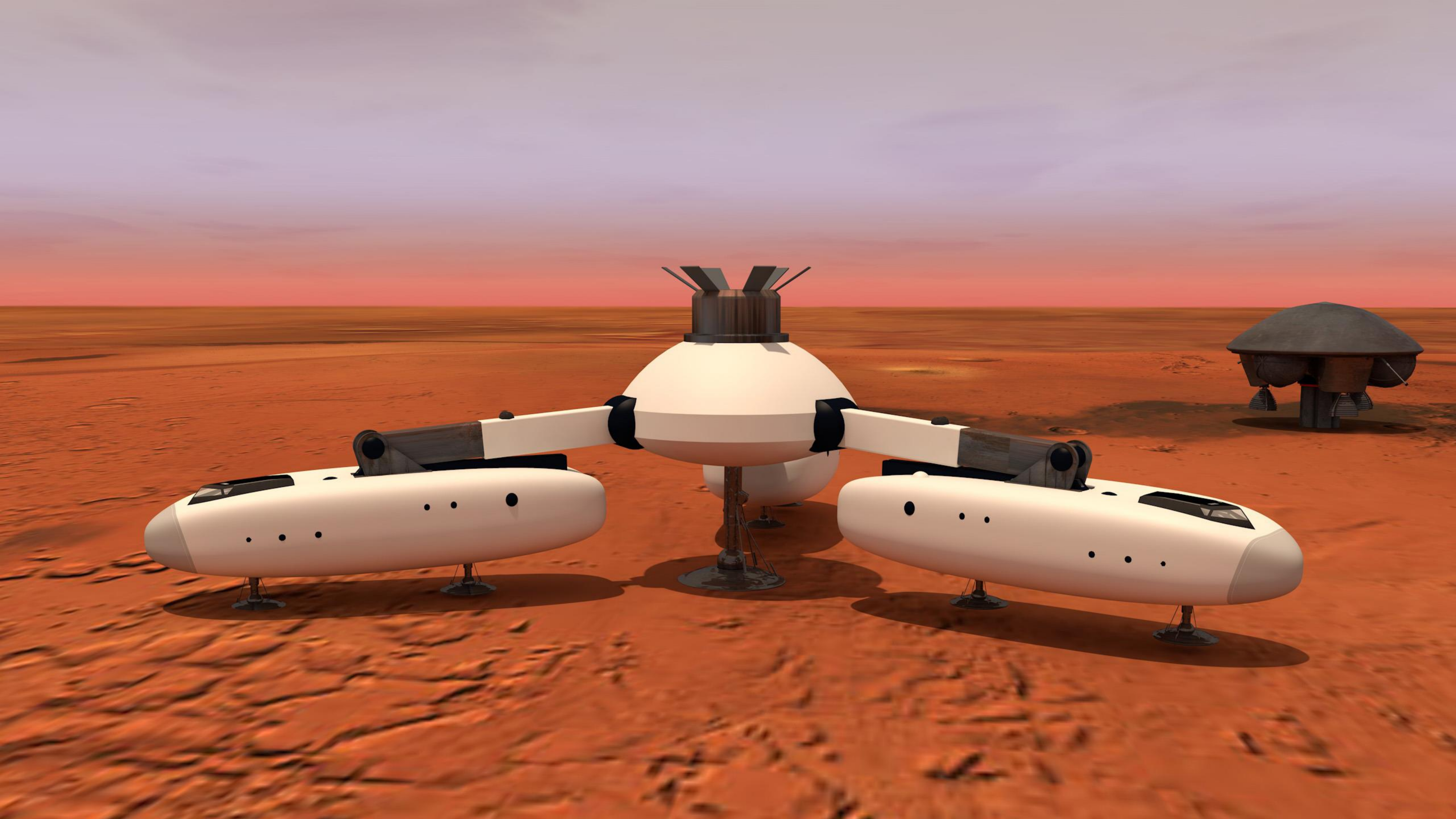
Ground floor



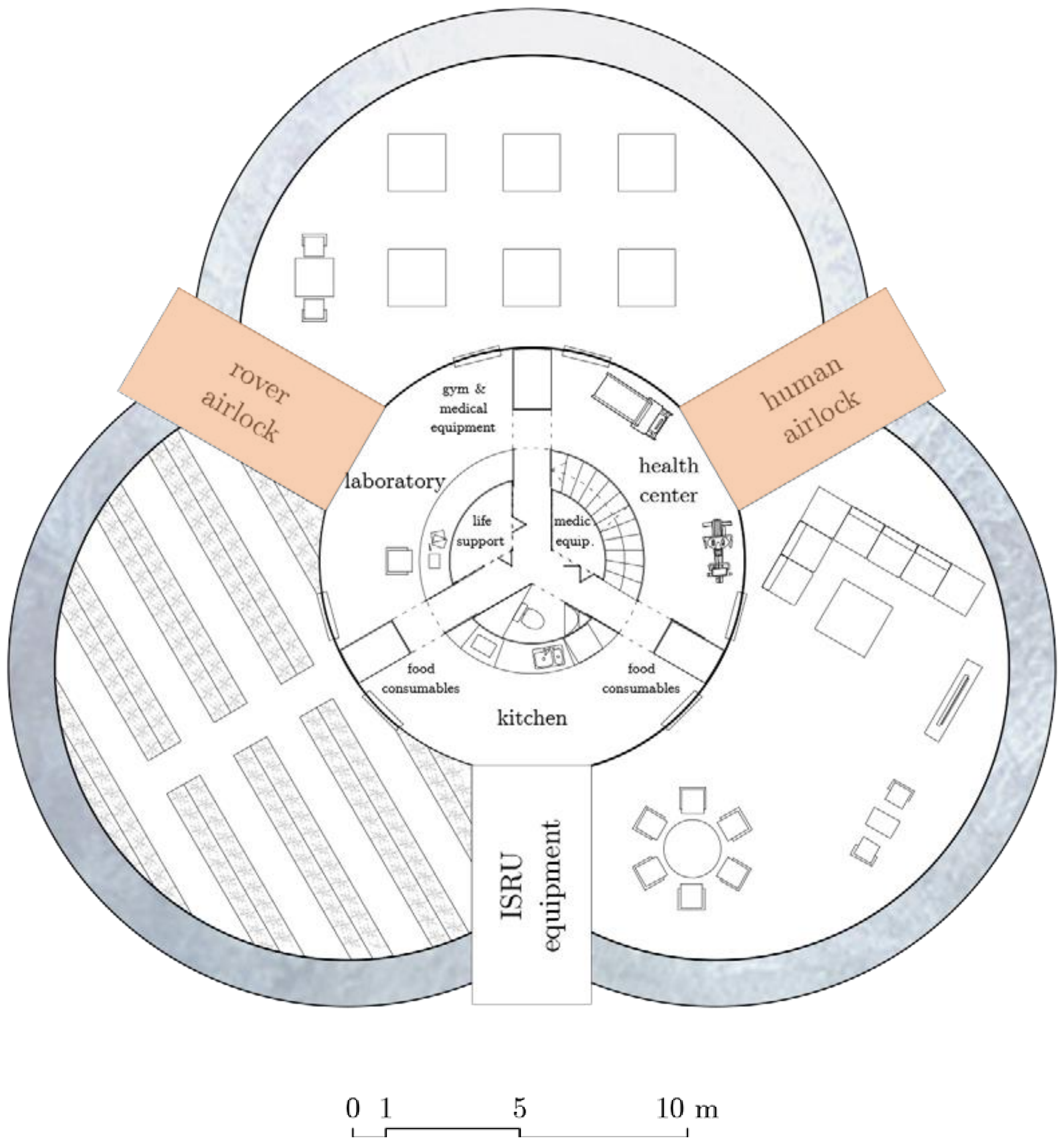
Ground floor



pods

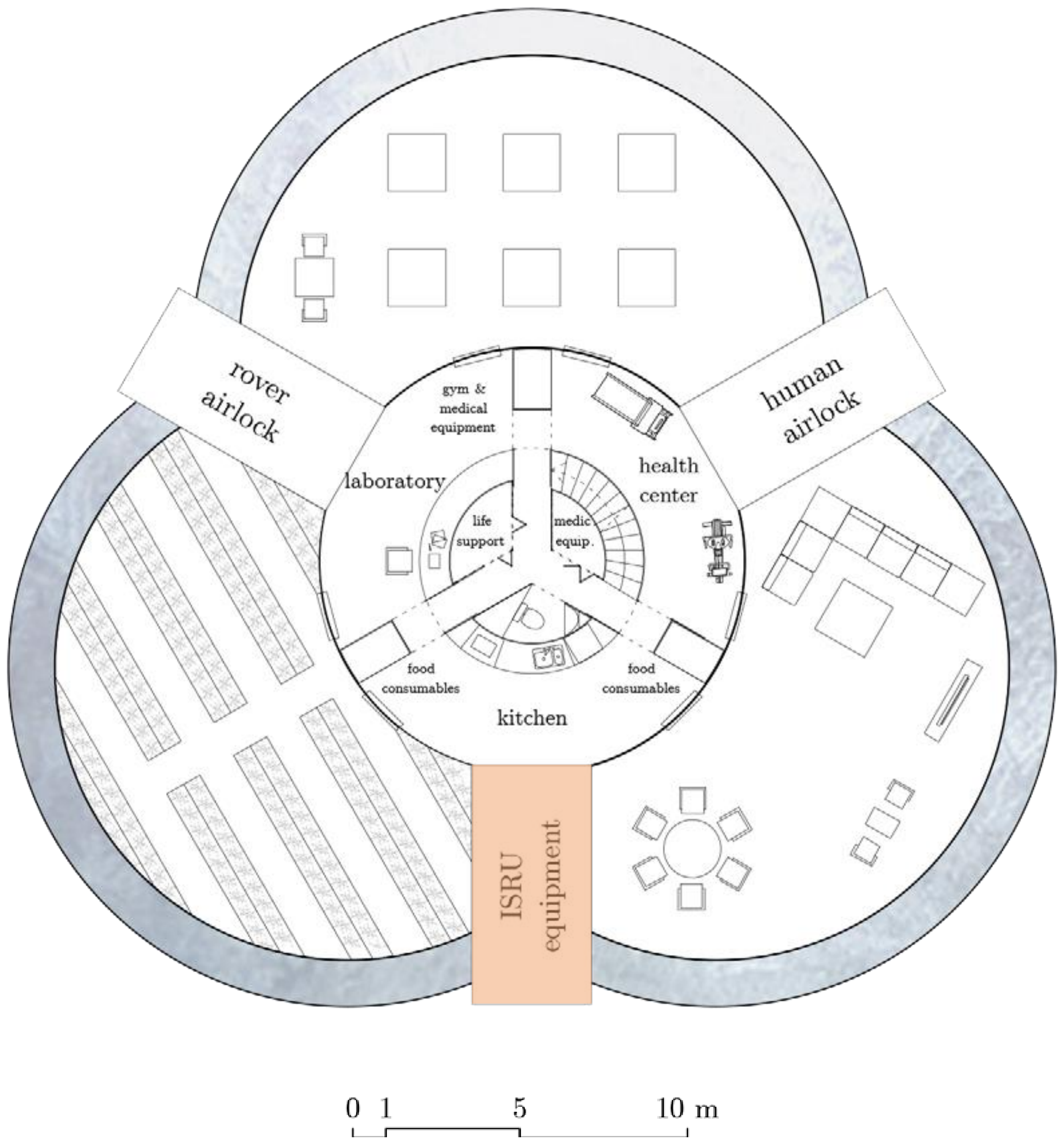


Ground floor



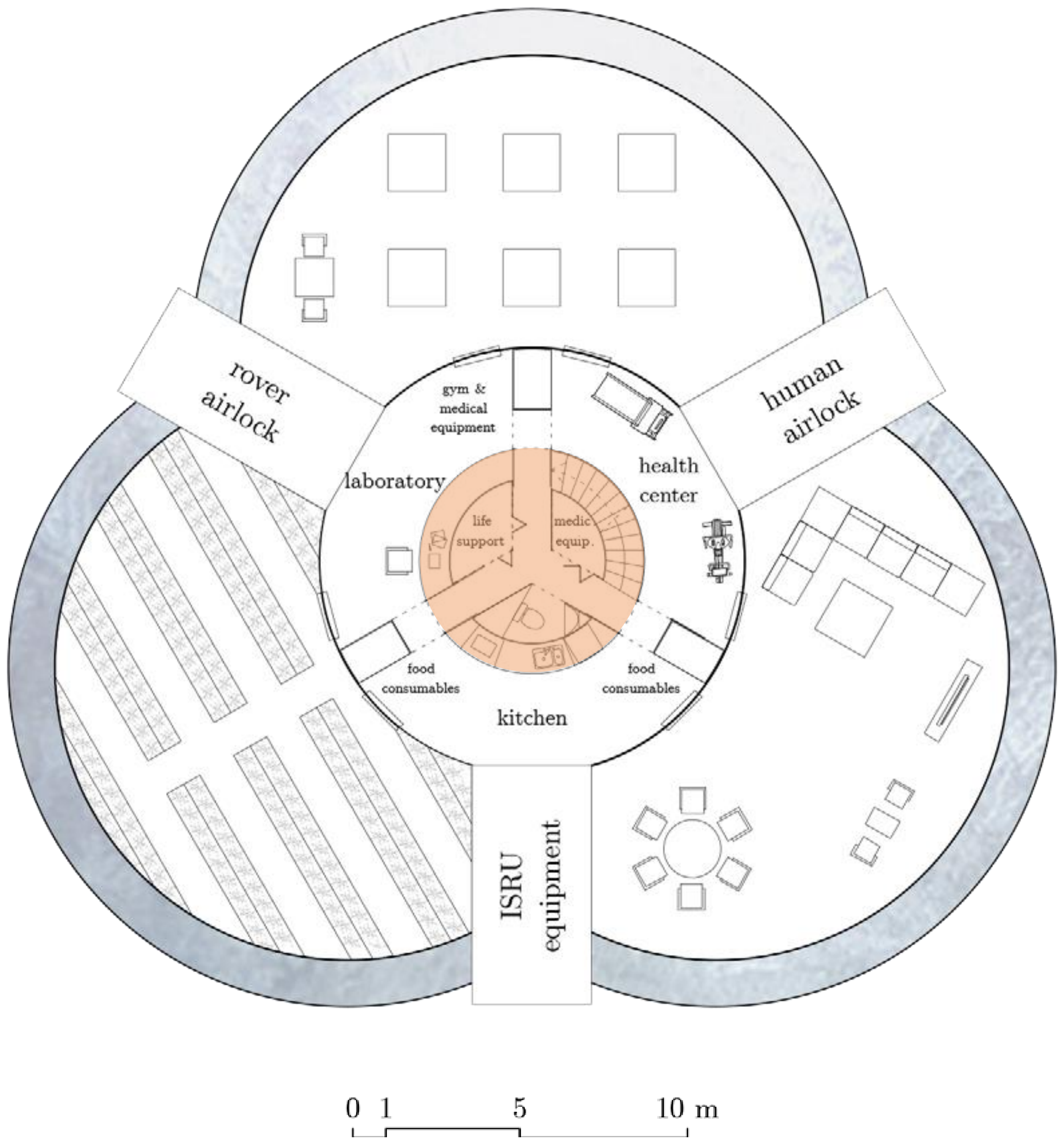
airlocks

Ground floor



ISRU equipment

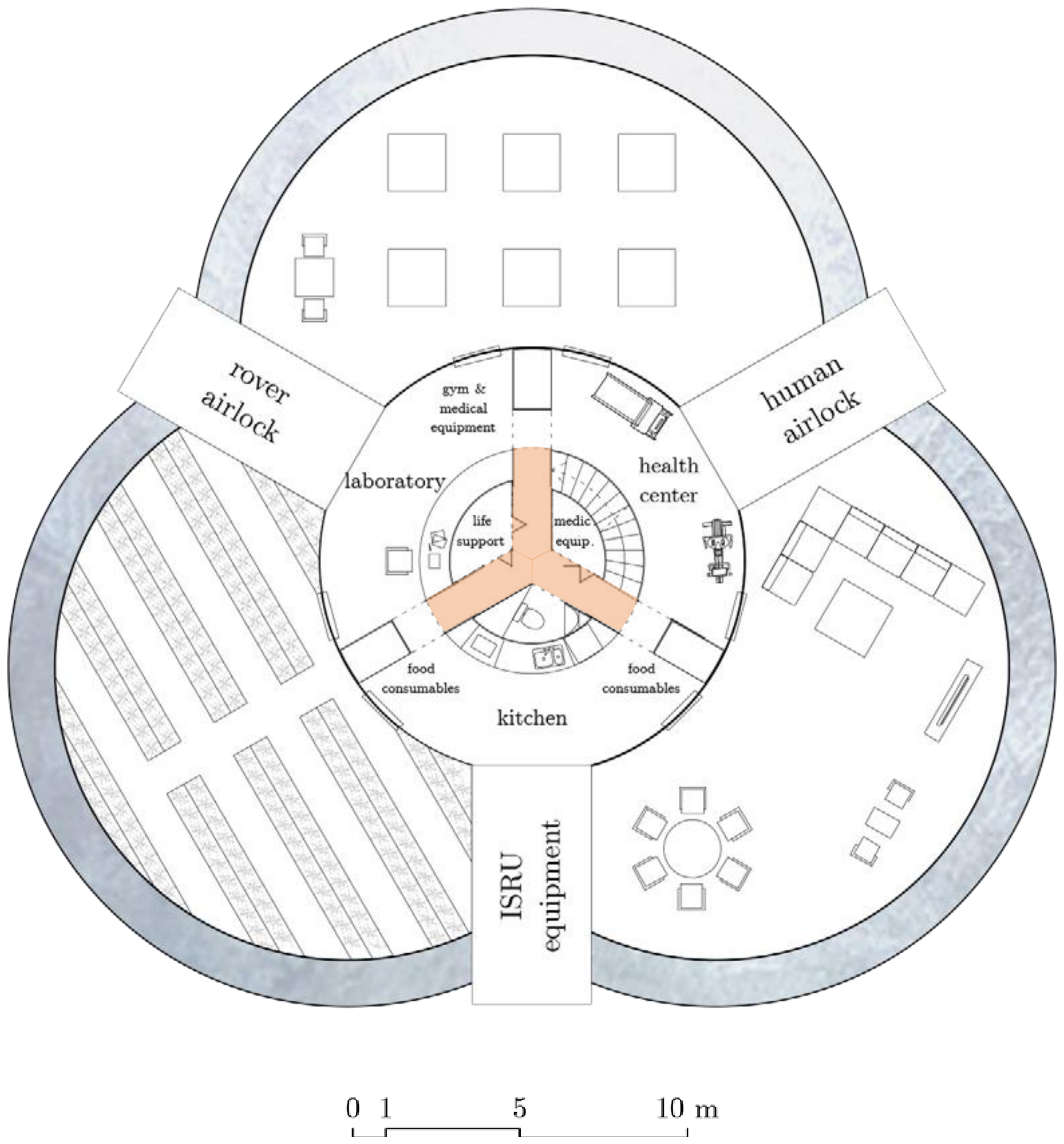
Ground floor



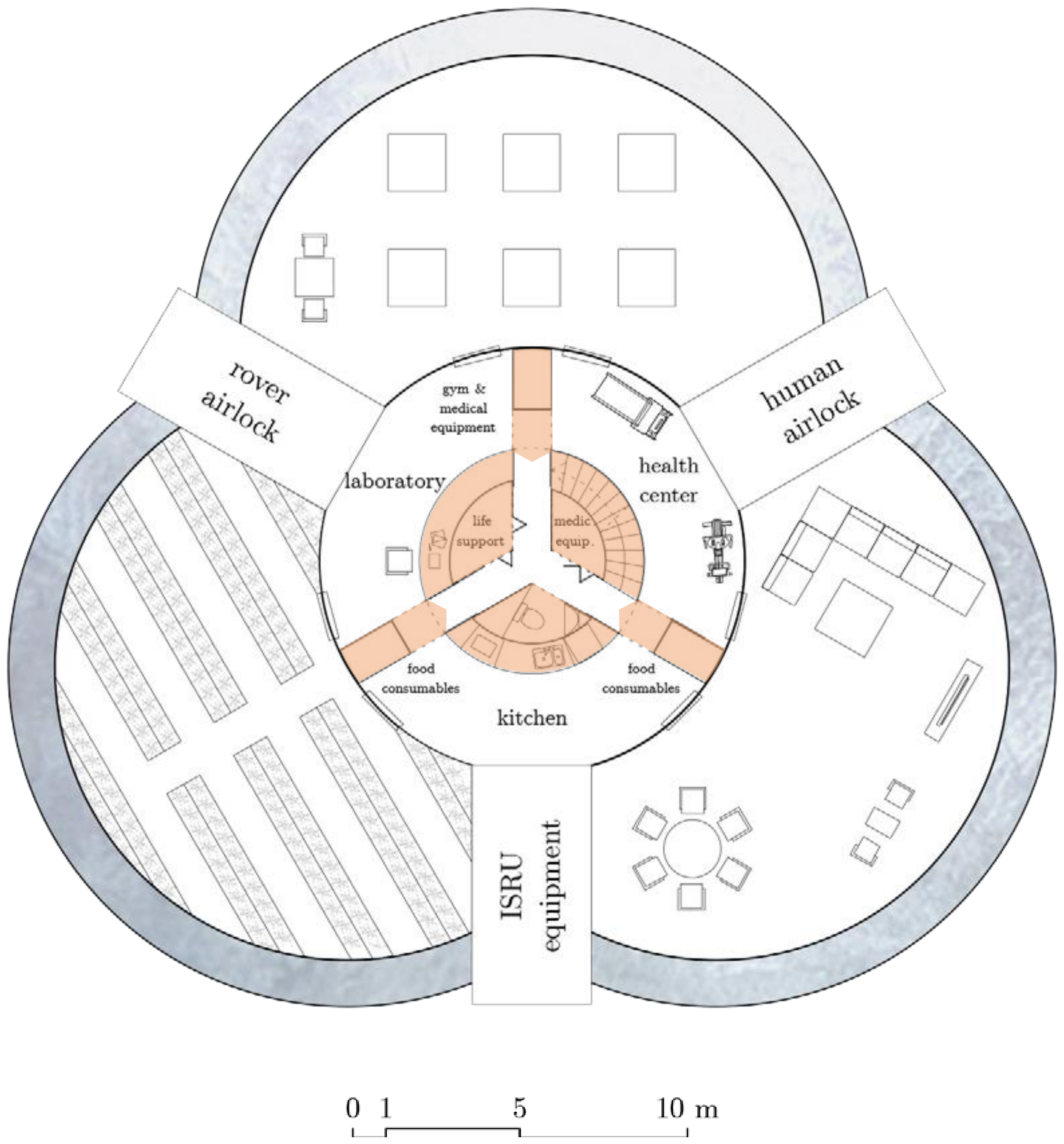
central core

Ground floor

frames

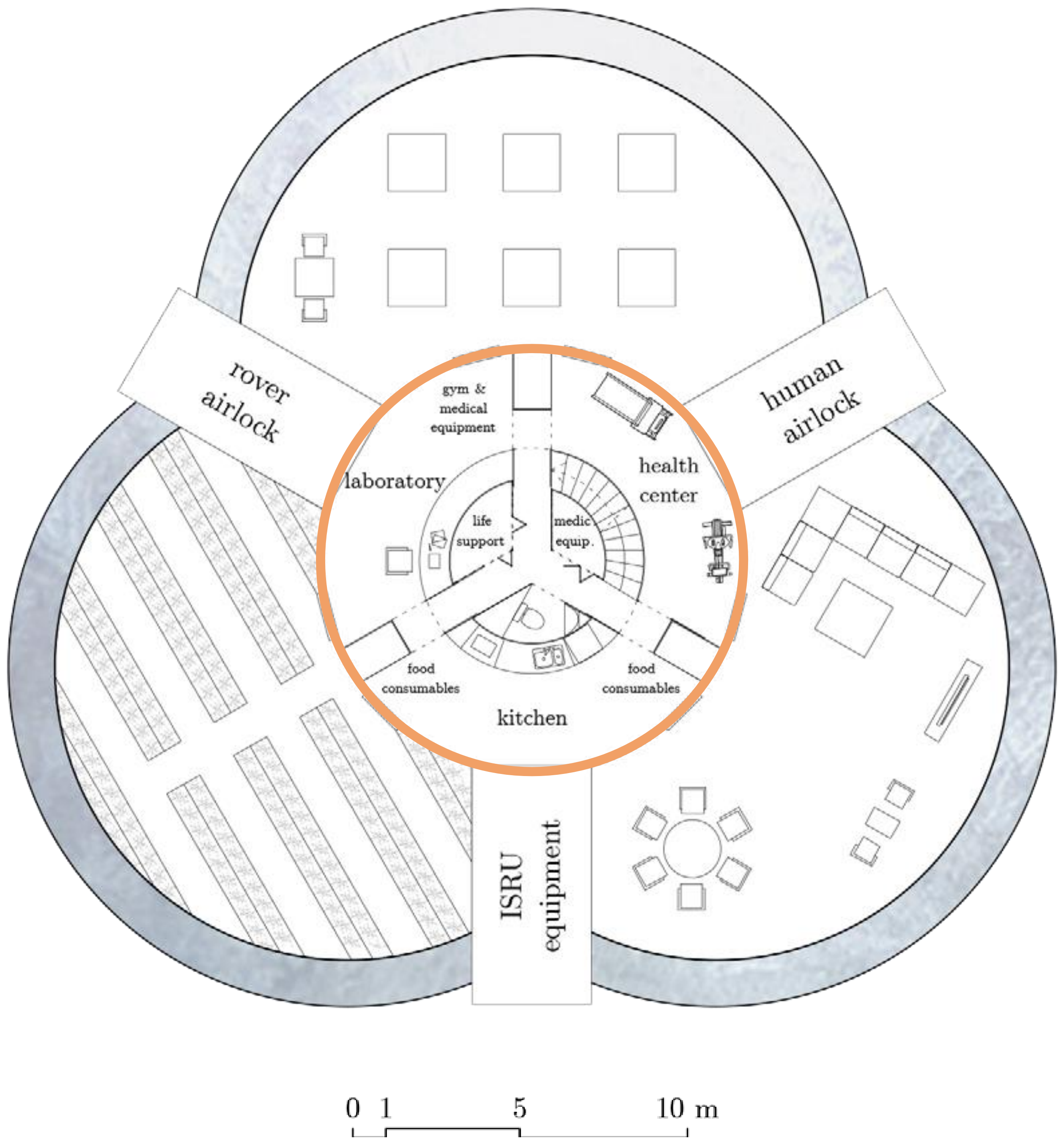


Ground floor



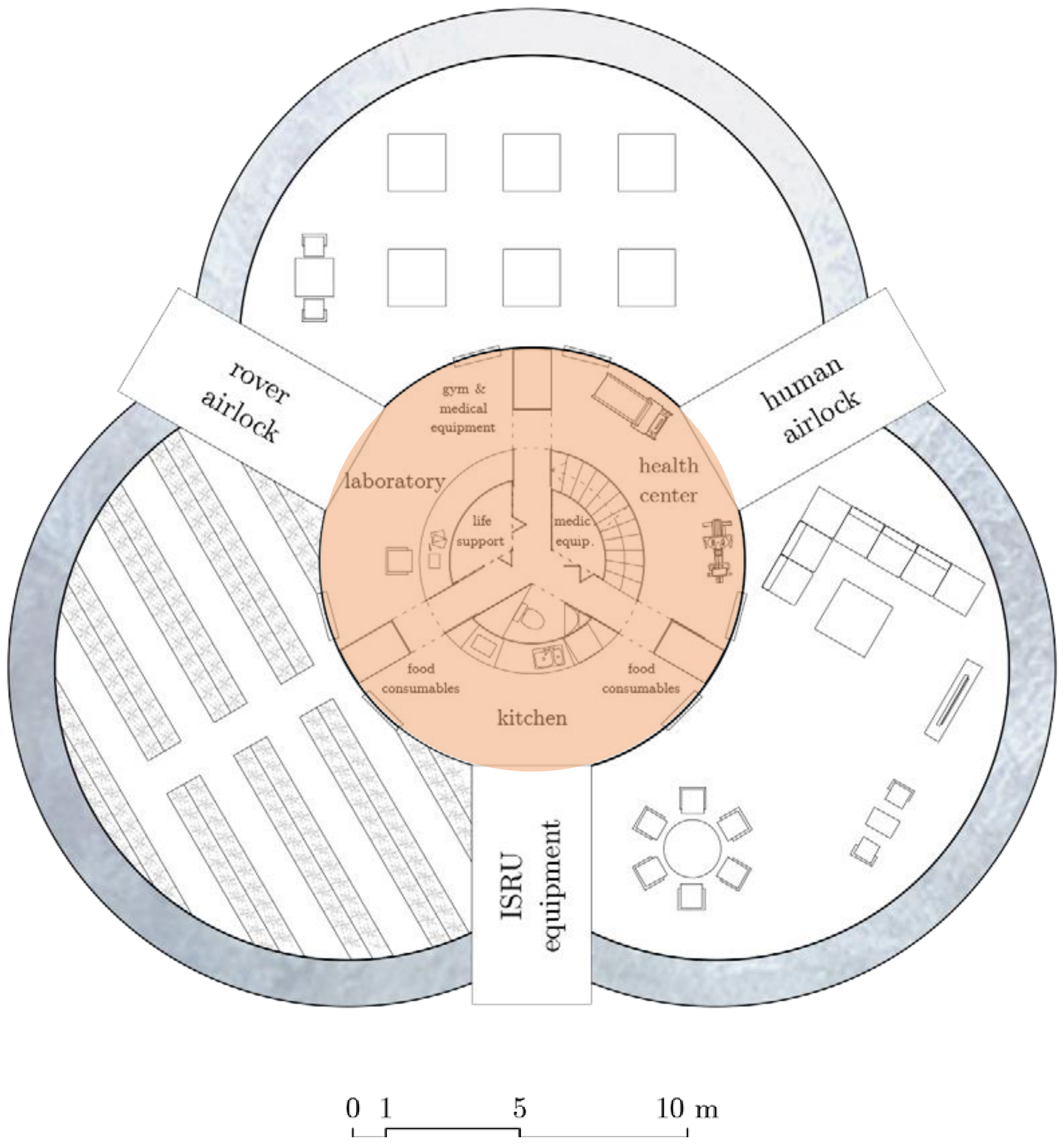
deployed
core

Ground floor



1^{st} membrane

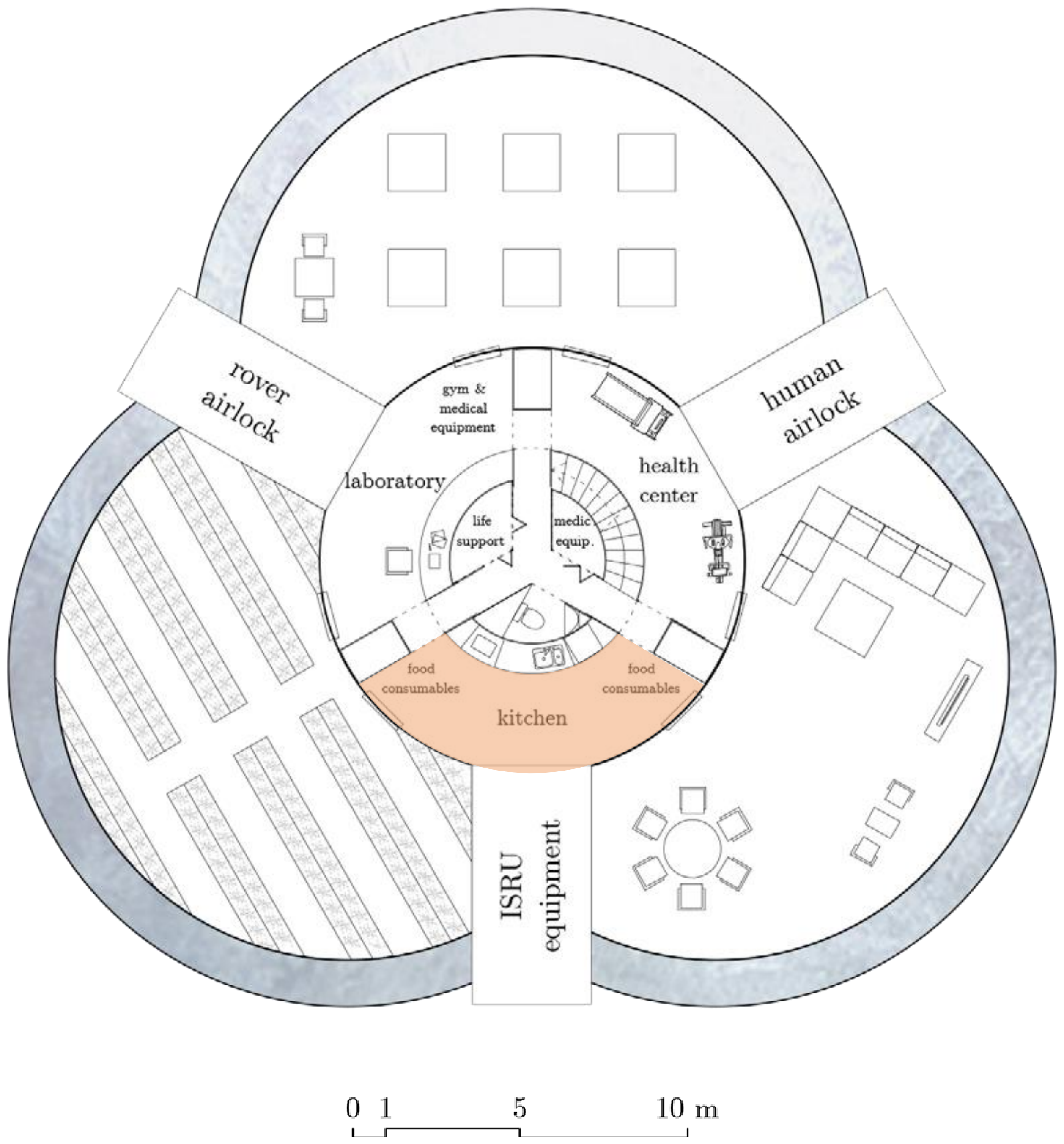
Ground floor



minimal
space

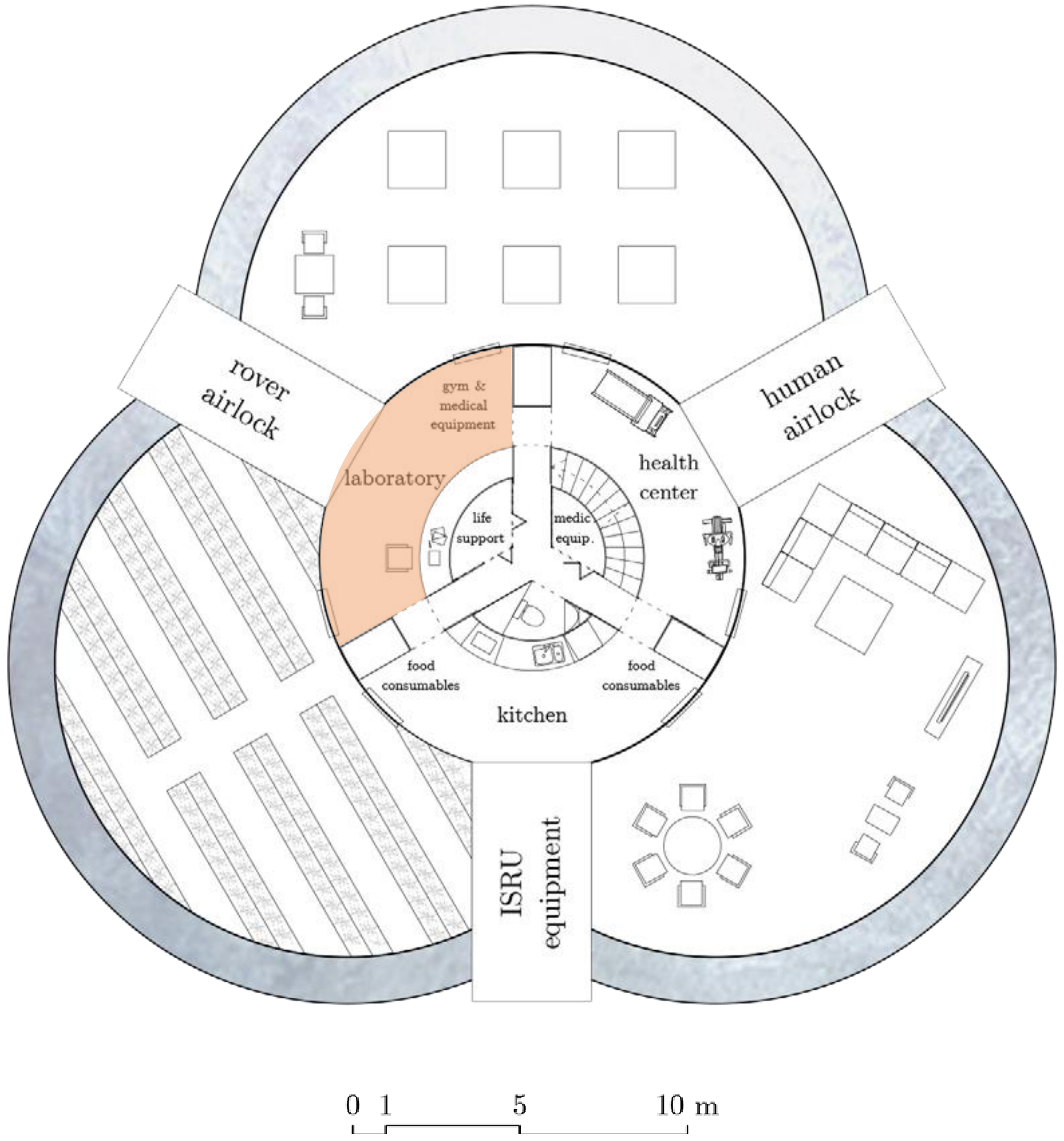
Ground floor

kitchen

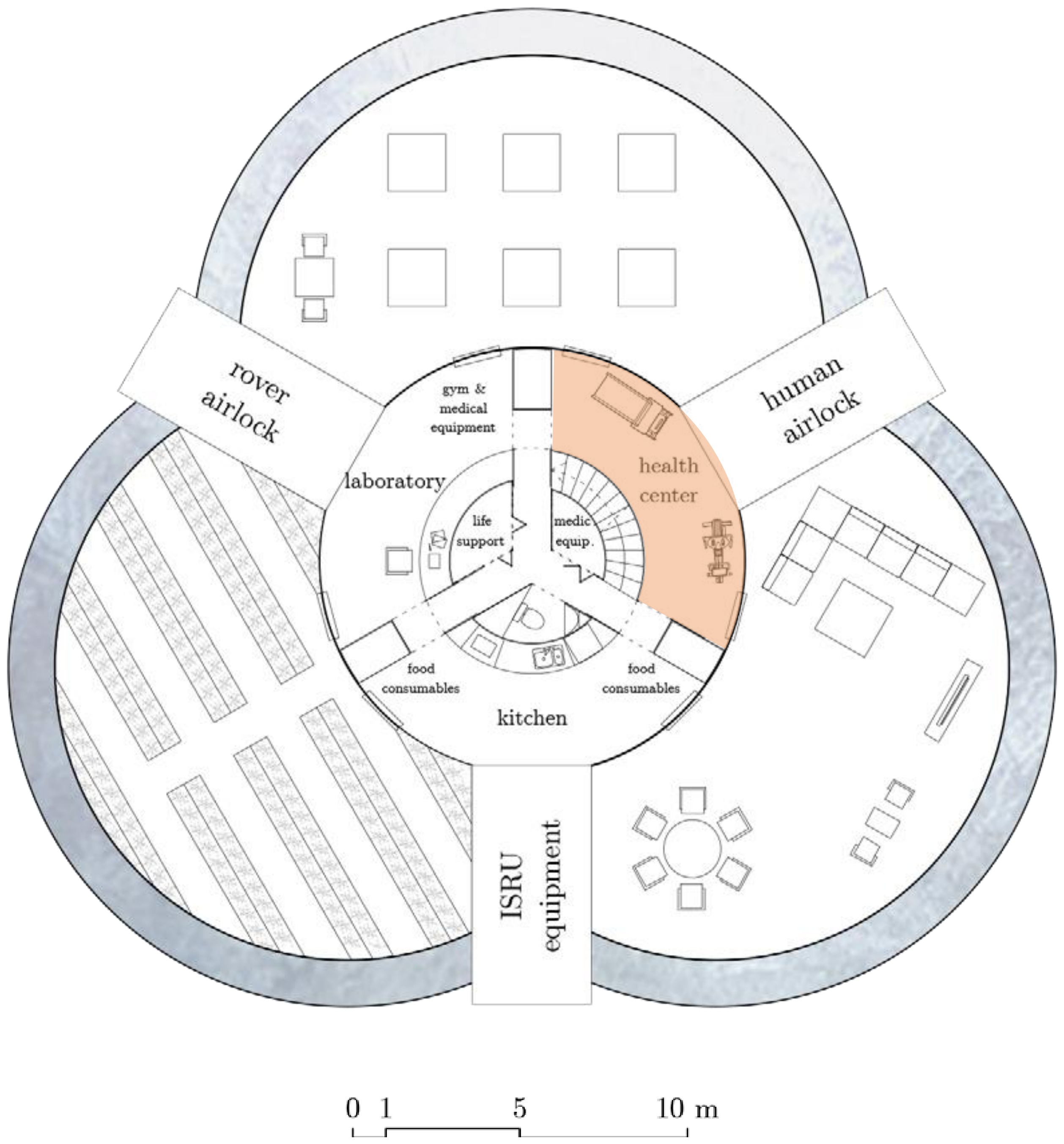


Ground floor

laboratory

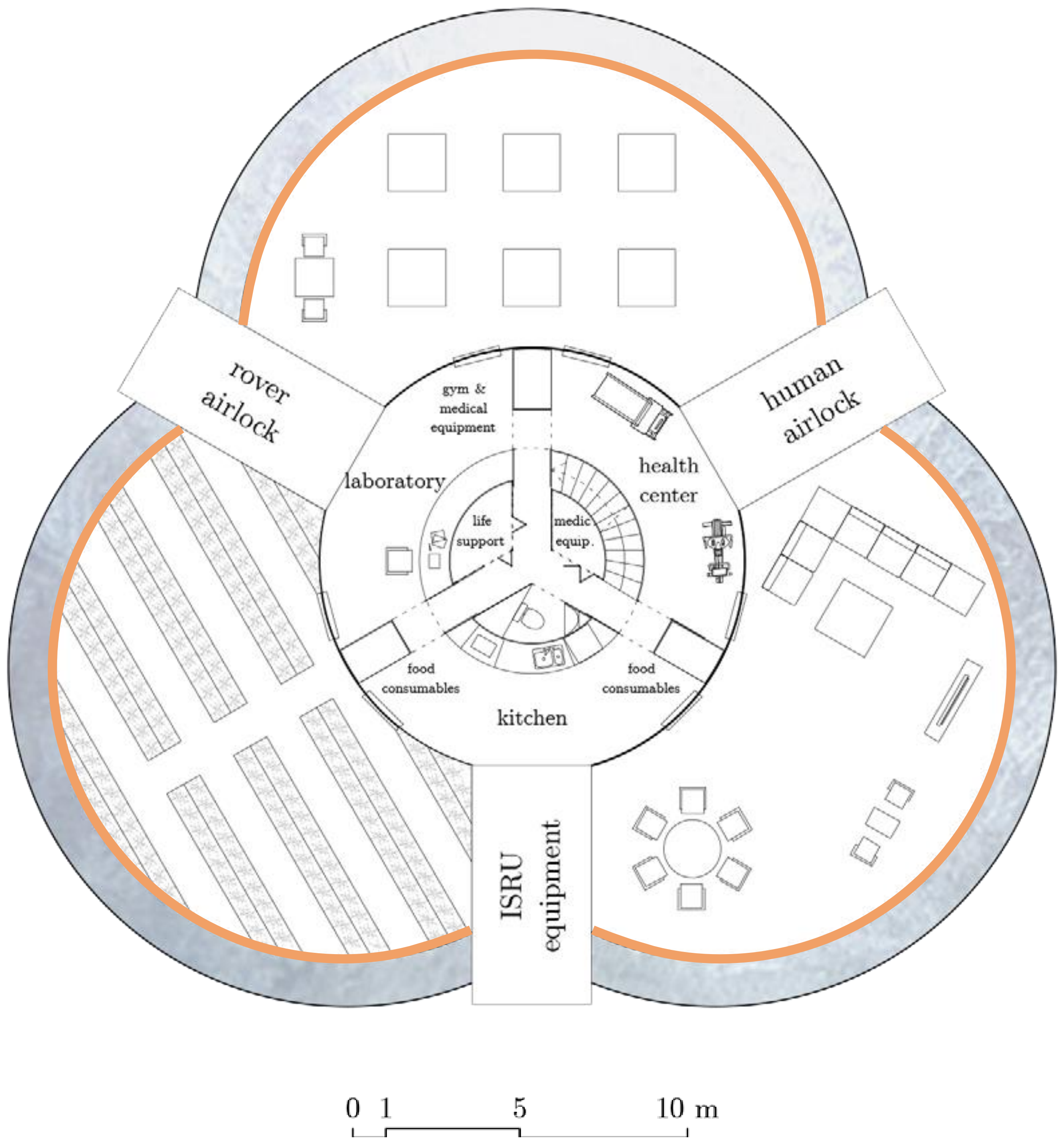


Ground floor



health center

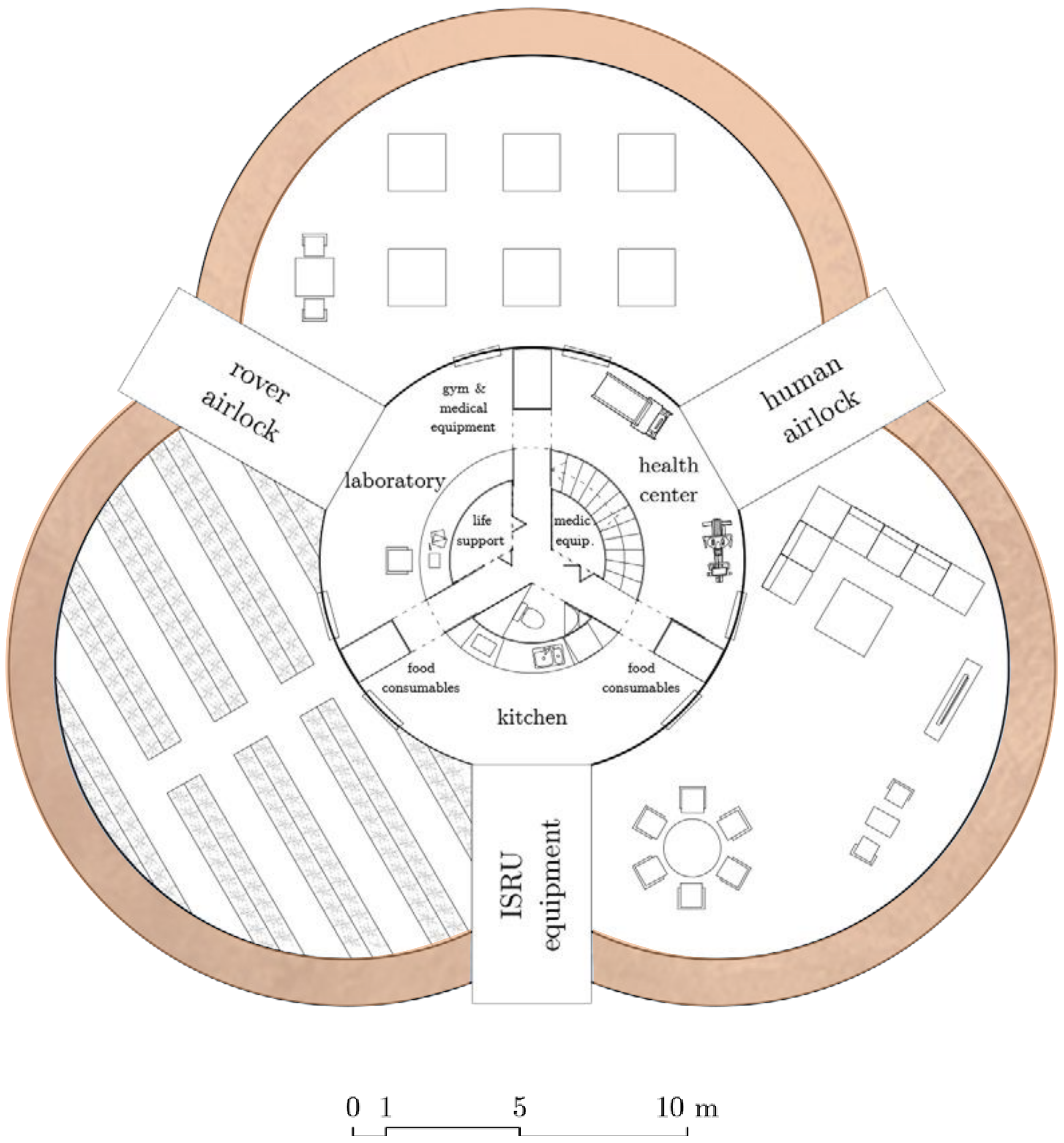
Ground floor



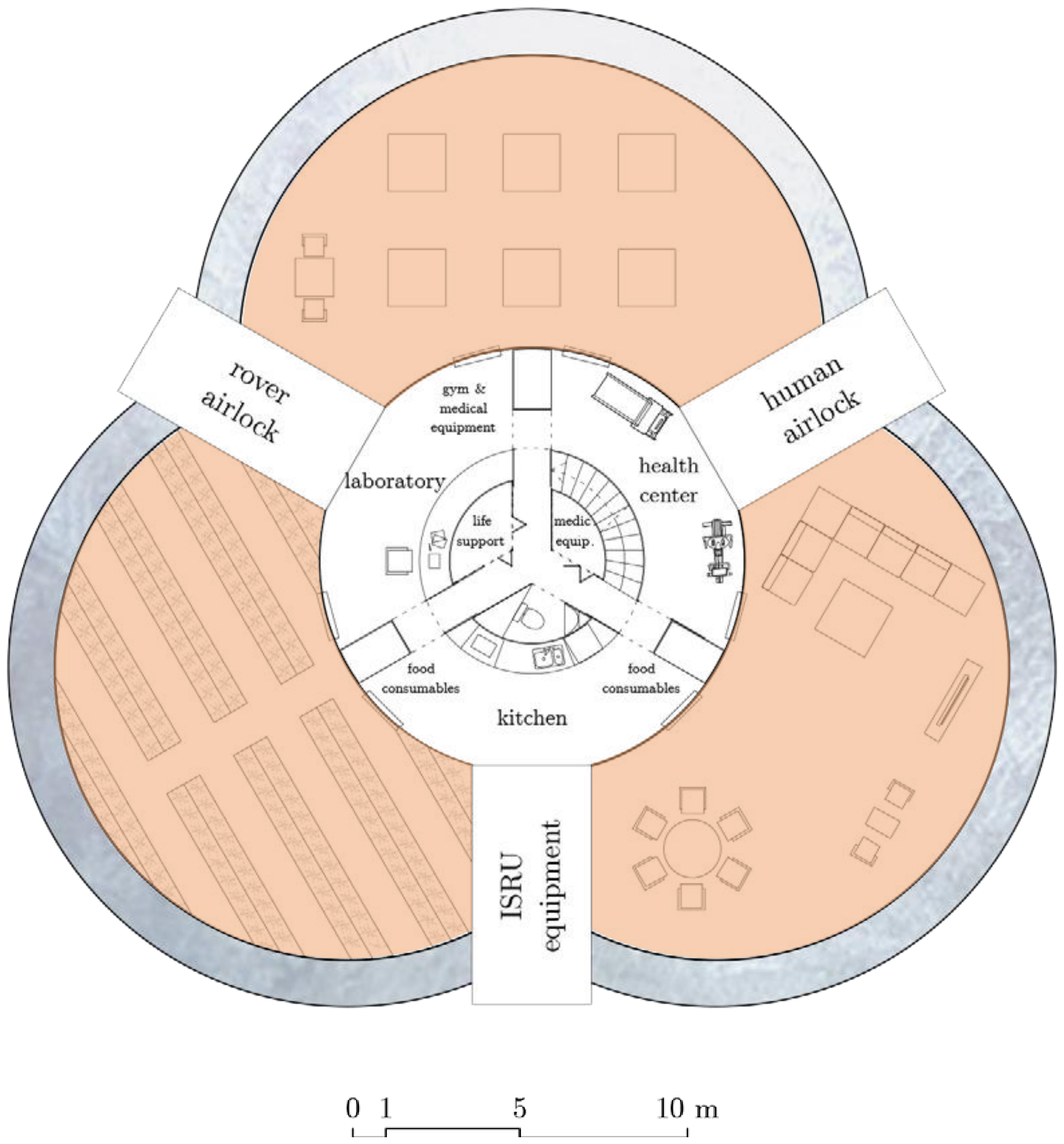
2nd membrane

Ground floor

ice dome



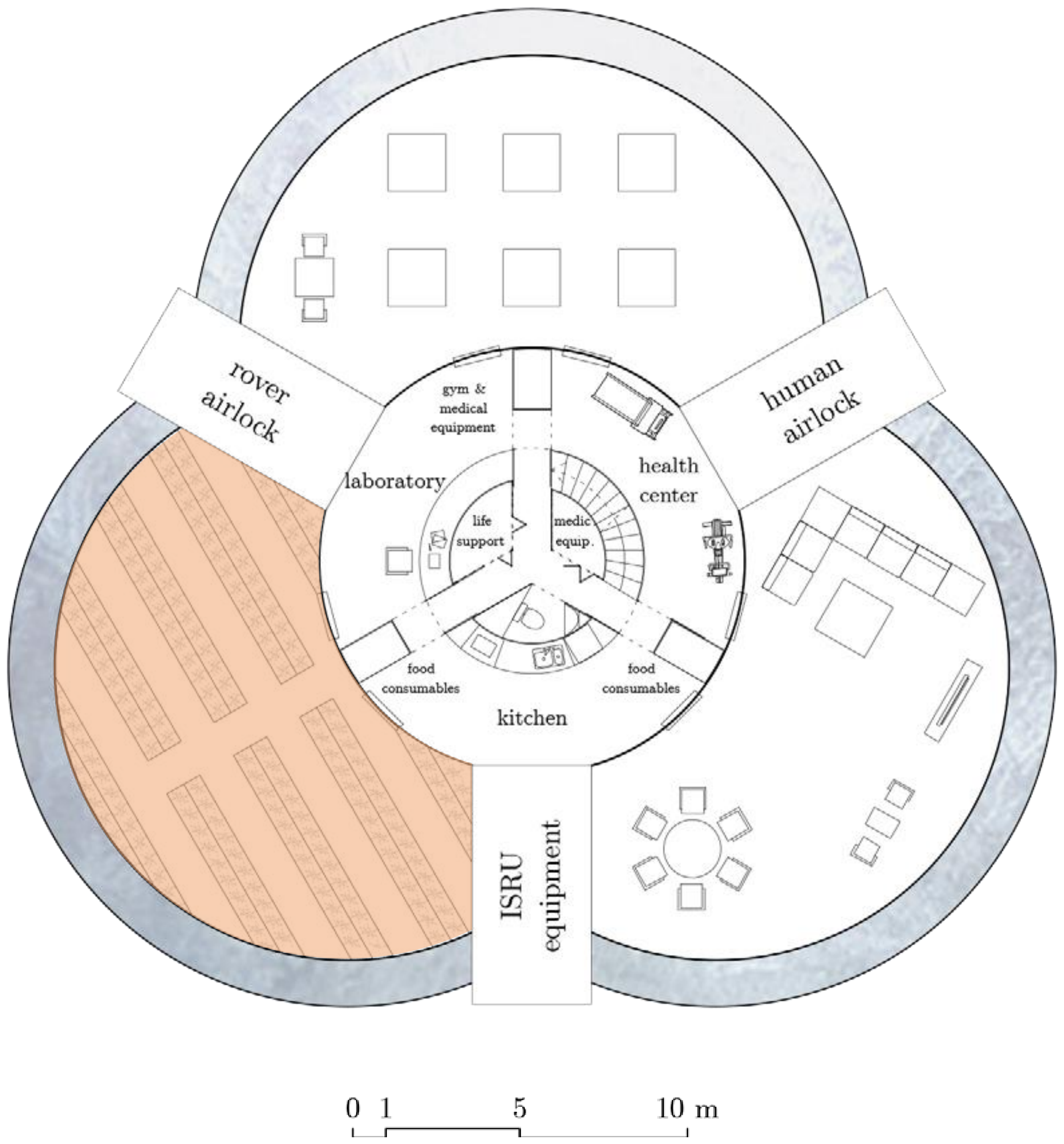
Ground floor



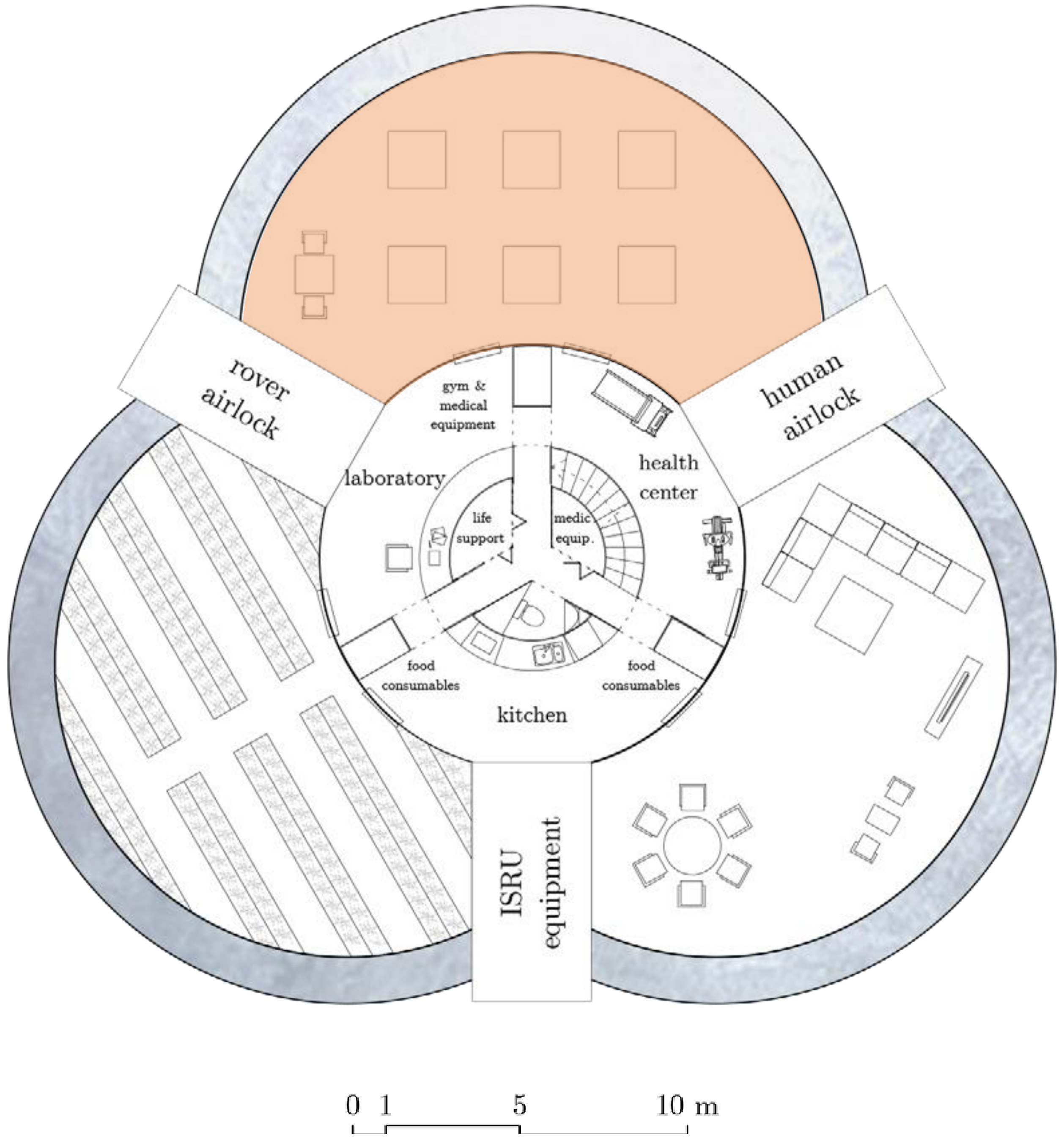
additional space

Ground floor

greenhouse



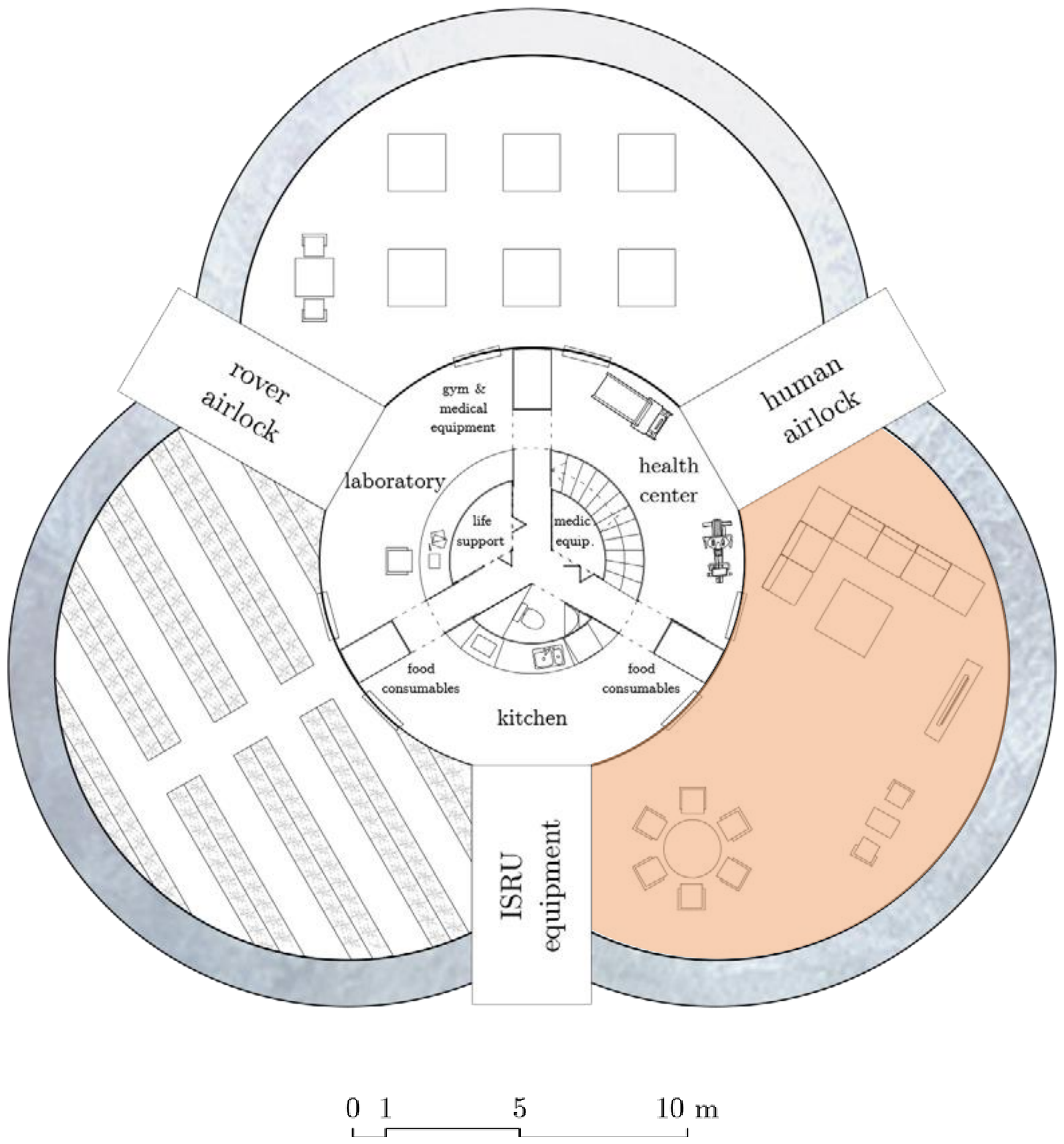
Ground floor



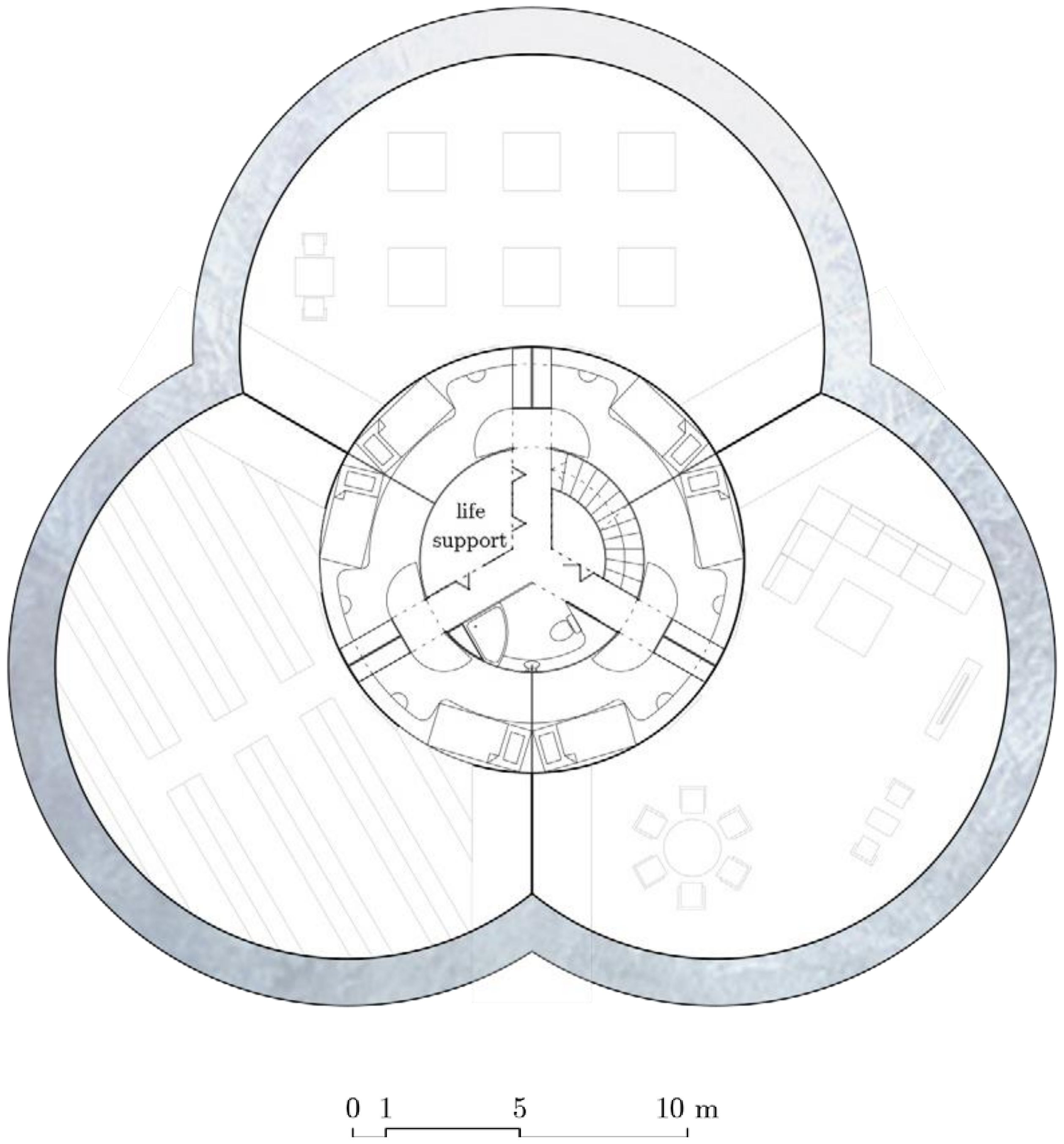
laboratory extension

Ground floor

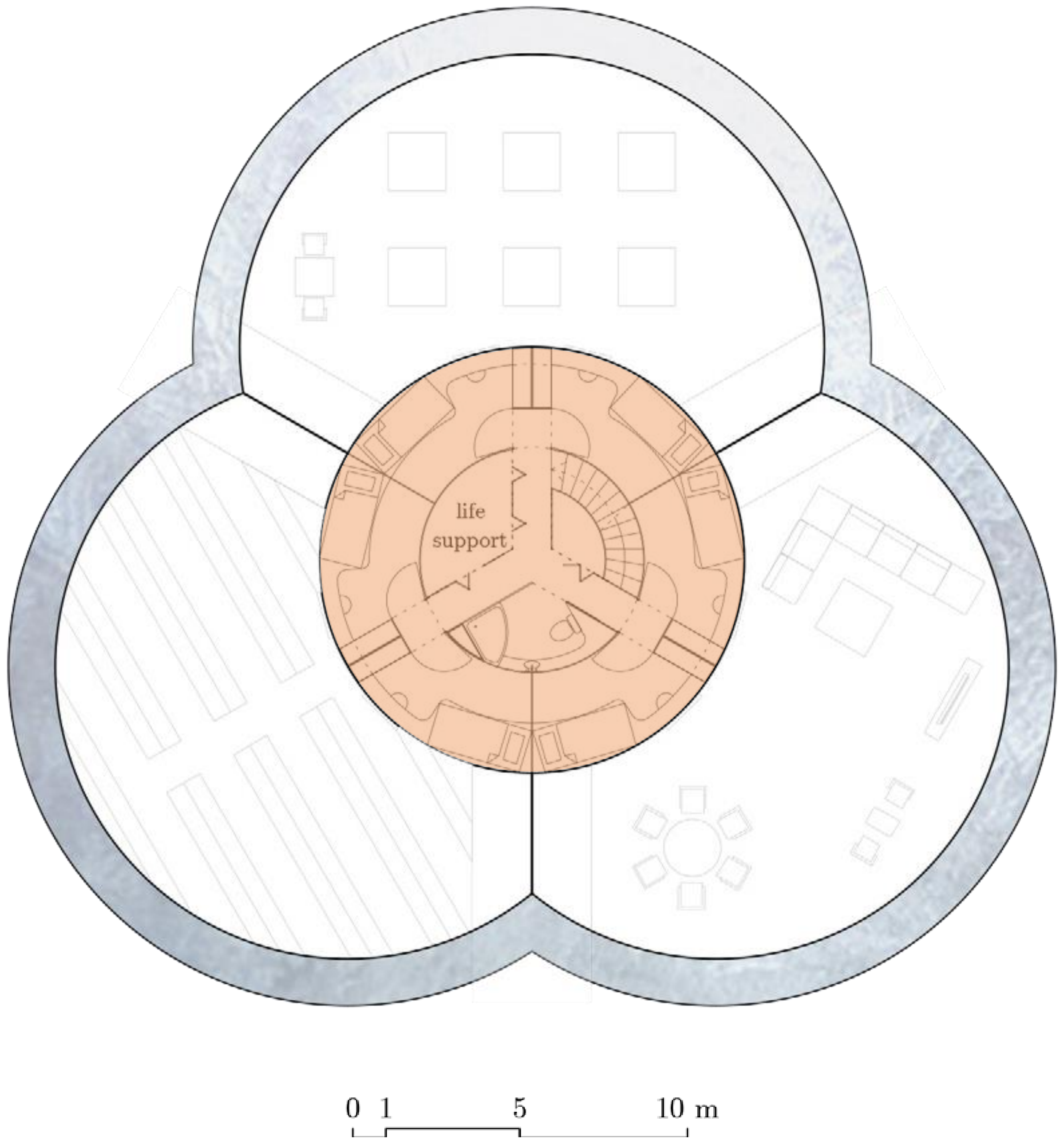
living



First Floor

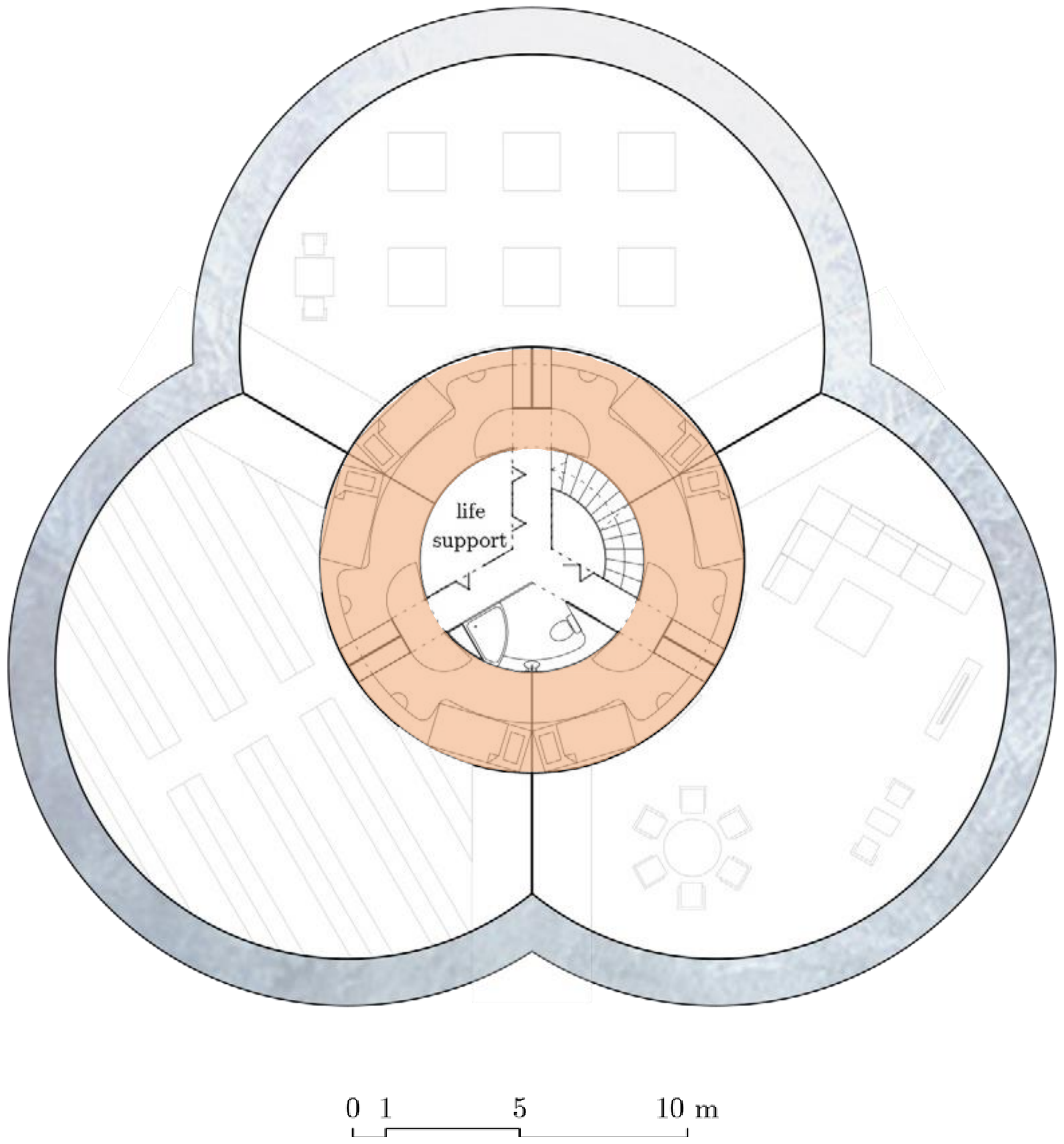


First Floor



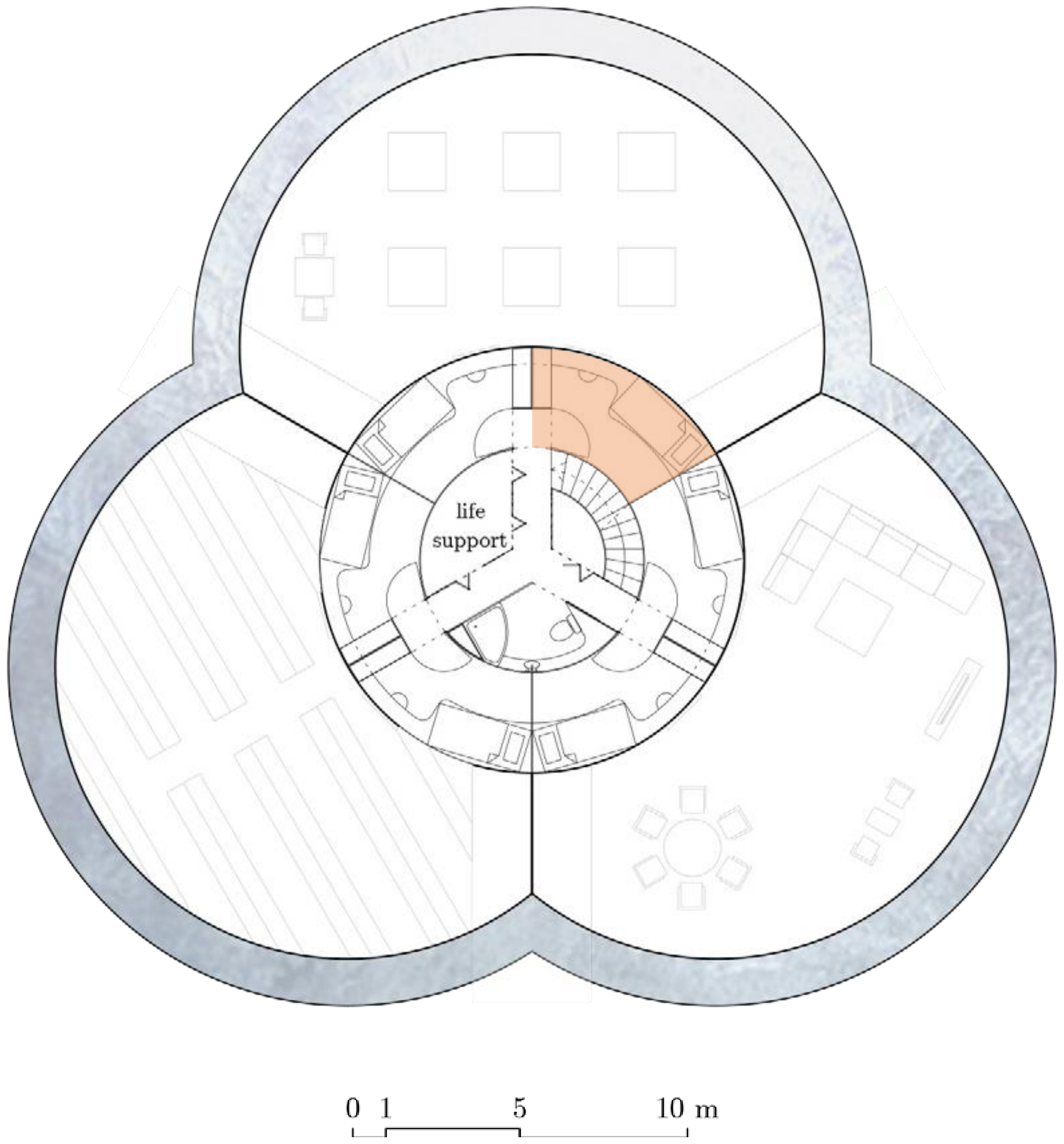
central core

First Floor



crew quarters

First Floor

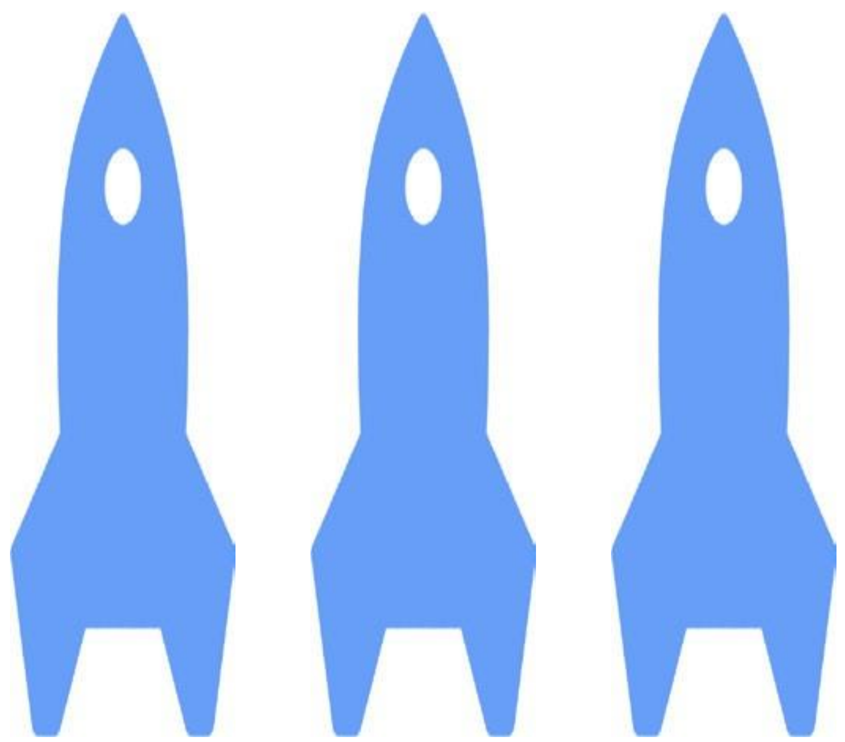


individual
crew
quarter

Crewed Mars Missions

Phase	Mass
Phase 1 - base	51,390 kg
Phase 2 - crew	57,685 kg
Total	109,075 kg

Crewed Mars Missions



3 Mars orbit-to-surface descends minimum

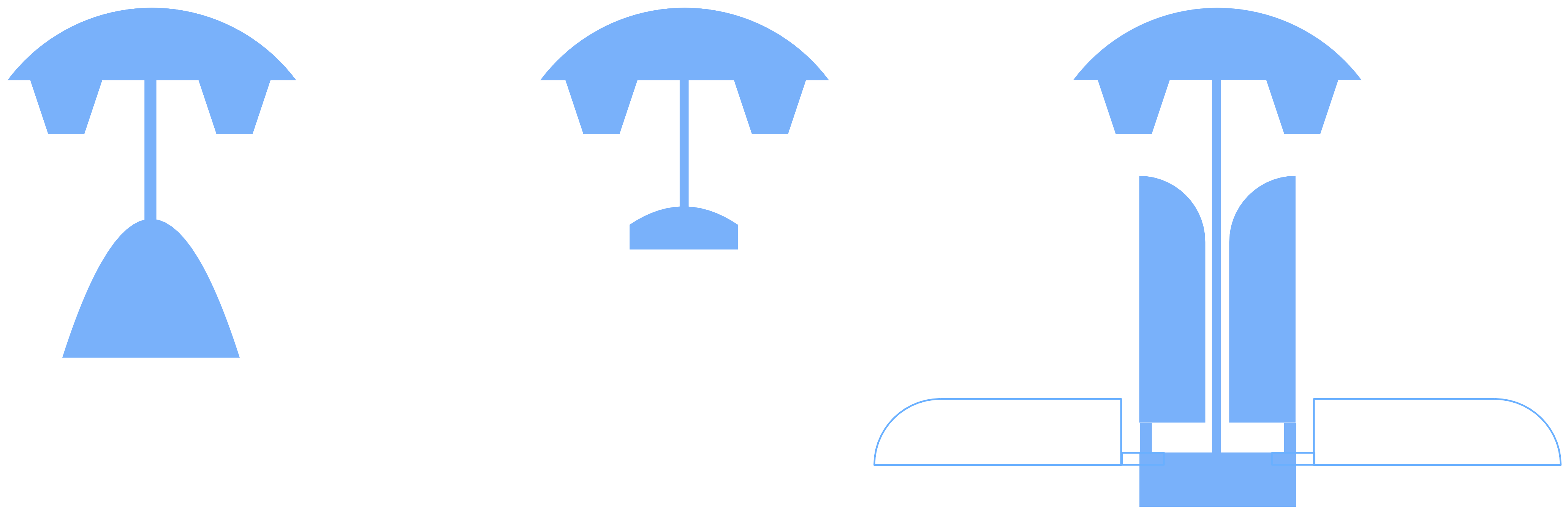
Robotic Mars Missions

SkyCrane for Curiosity
image courtesy of
NASA/JPL-Caltech

Features

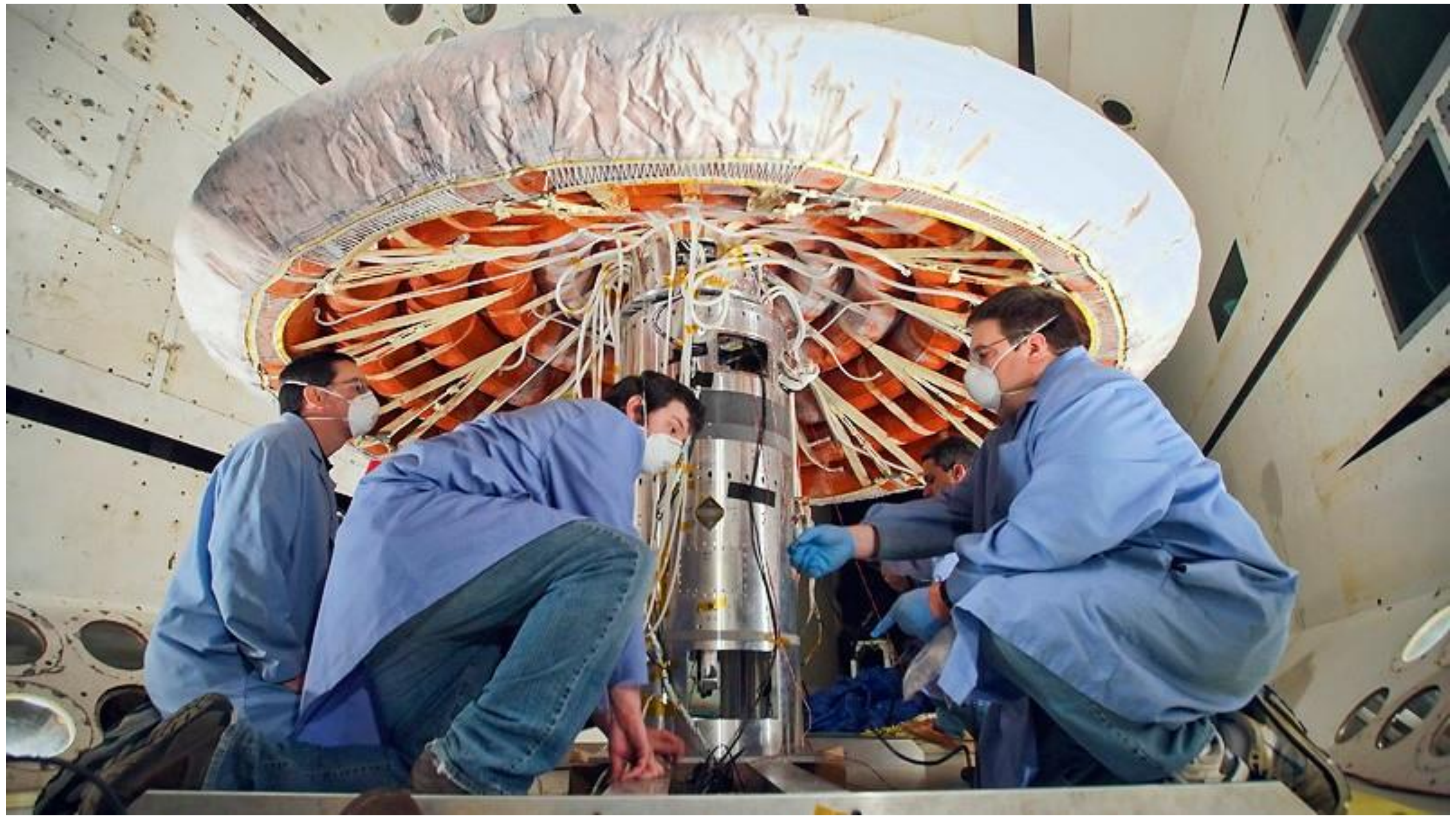
1 Modular capacity
2 Reusable
3 Refuellable

Modular Capacity



Launch Escape System
image courtesy of NASA

Reusable



IRVE-3
image courtesy of NASA

Refuellable

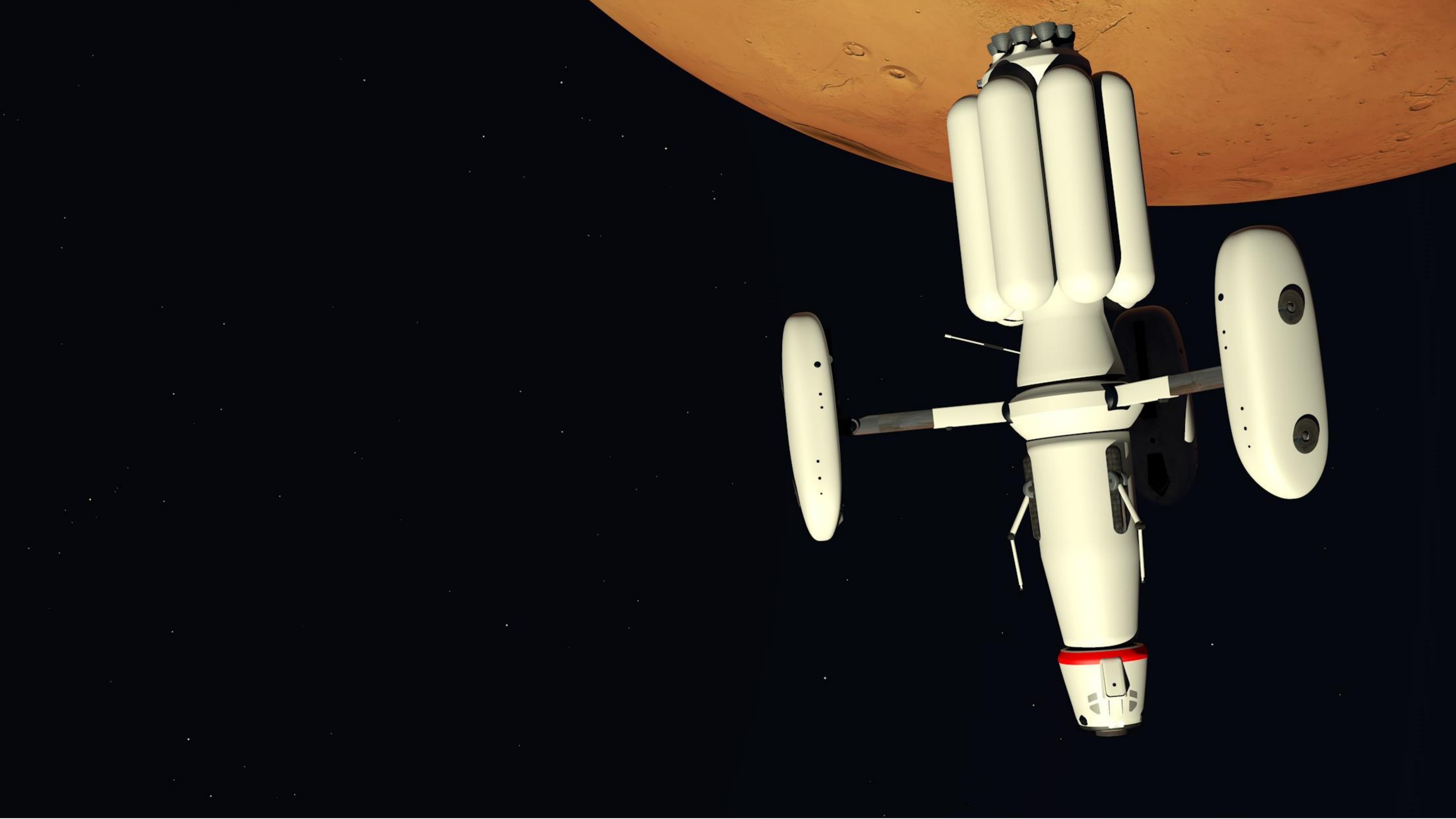
surface
base
orbit

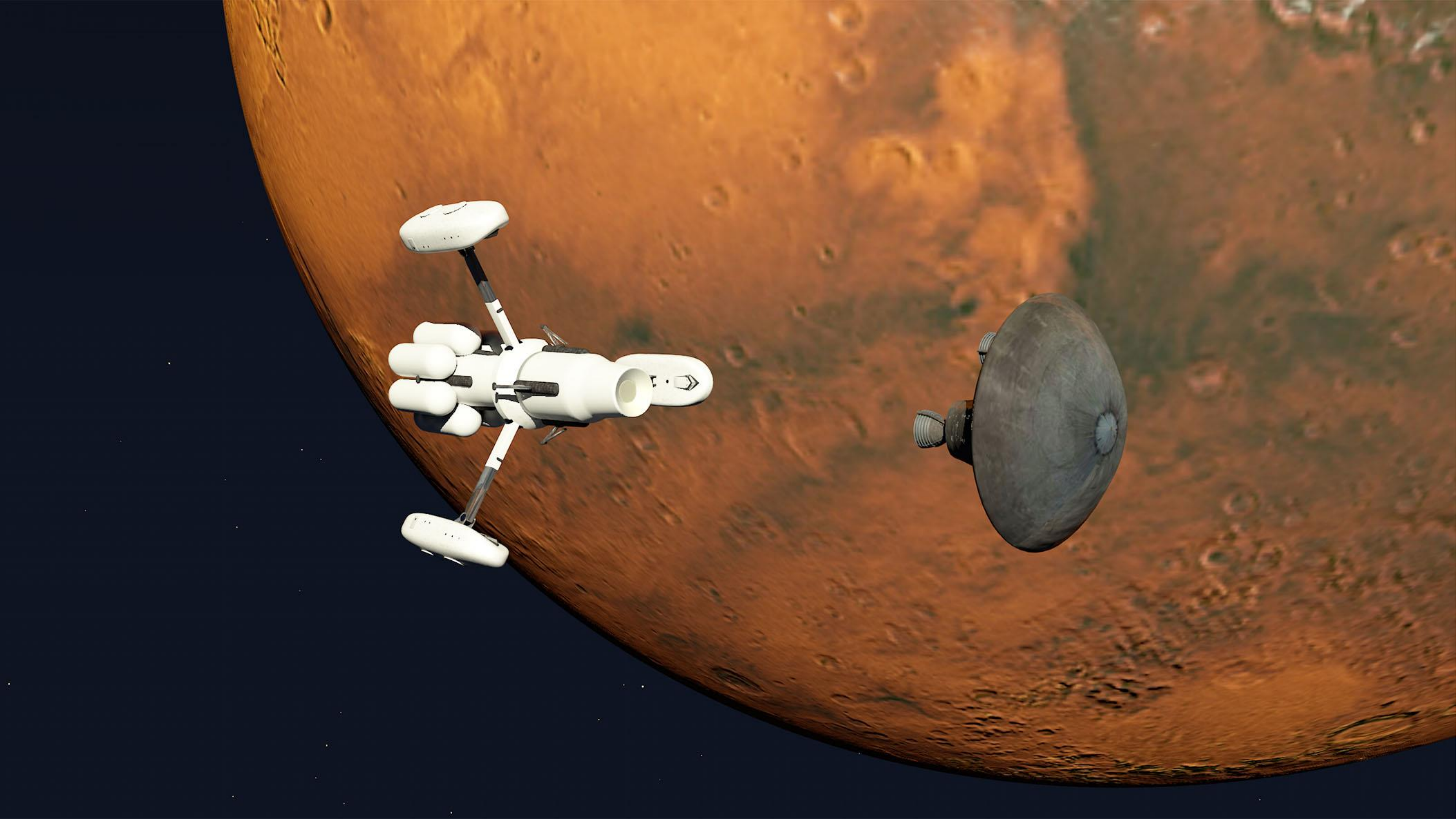
Launch Capacity to Mars

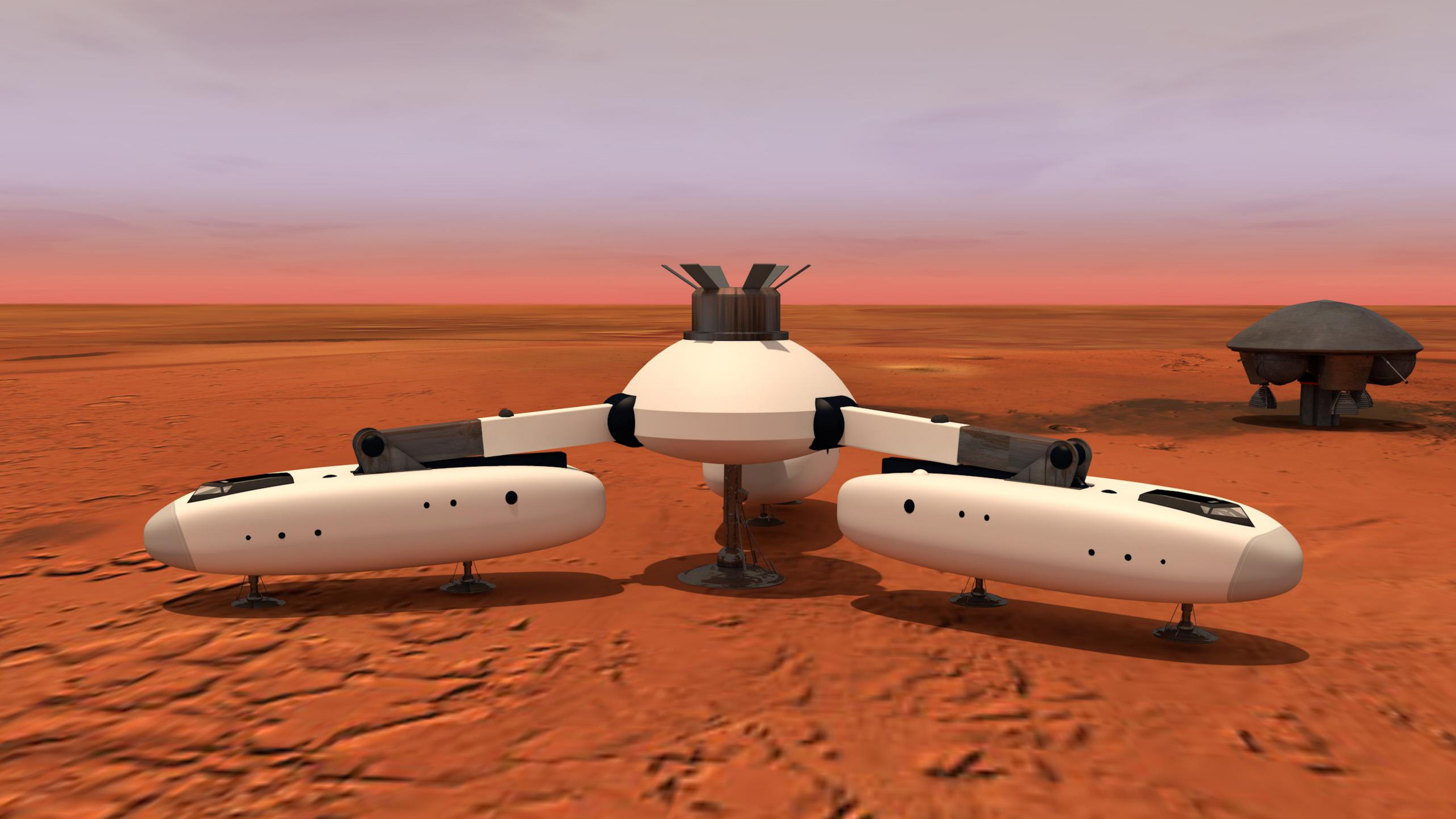
NASA
Space Launch
System

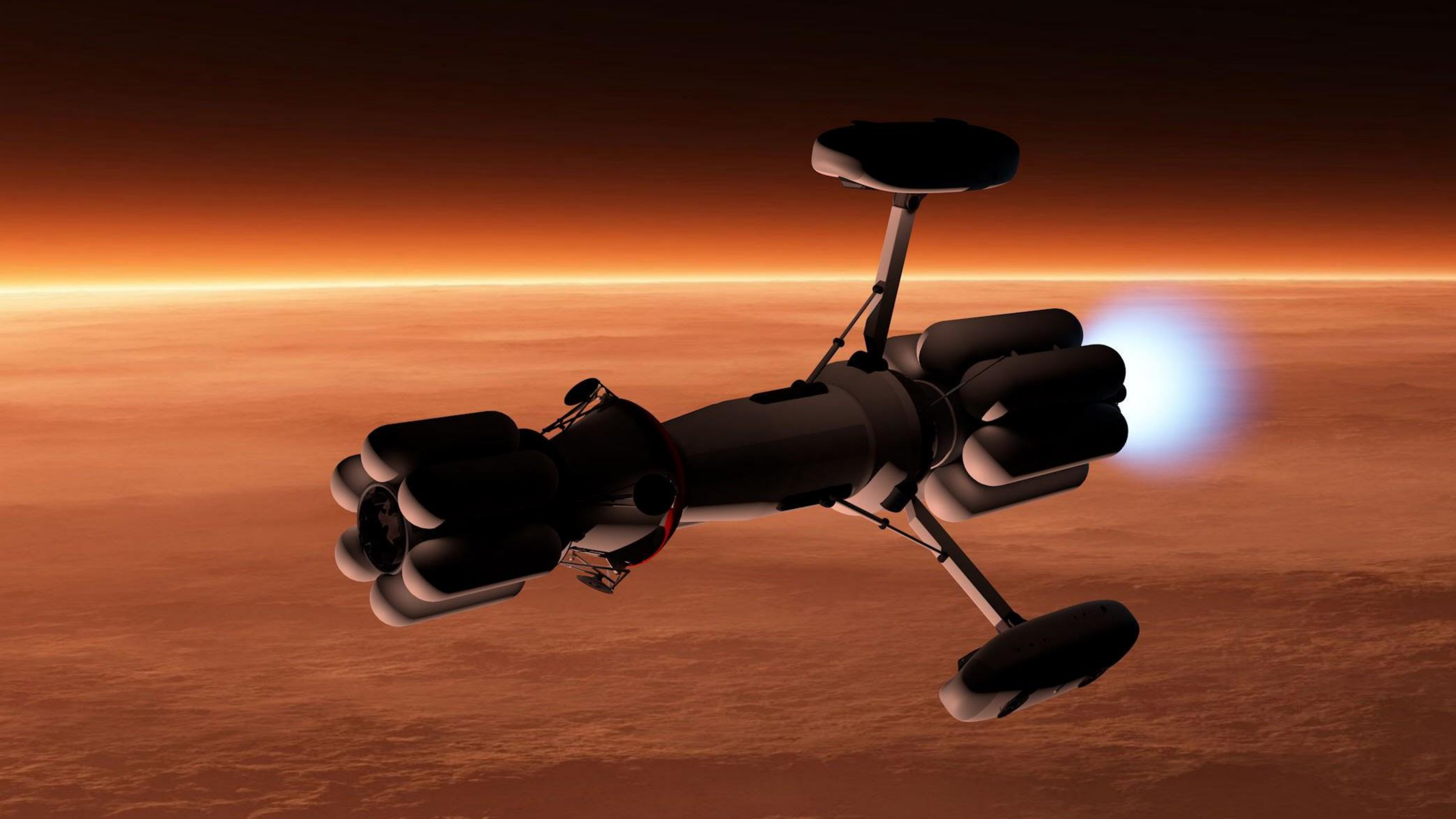
31-35
tons

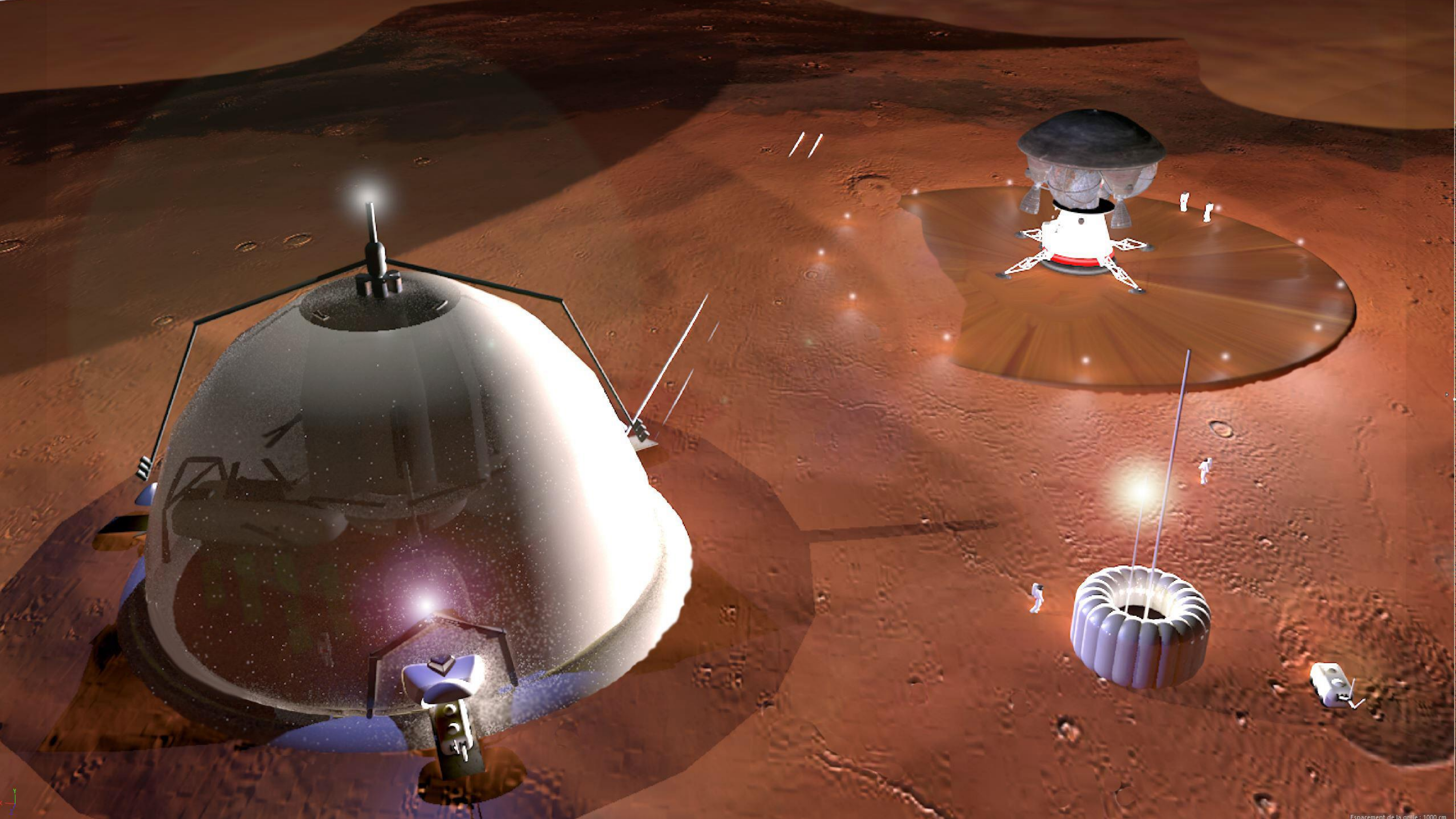
image courtesy of NASA/MSFC
image courtesy of SpaceX





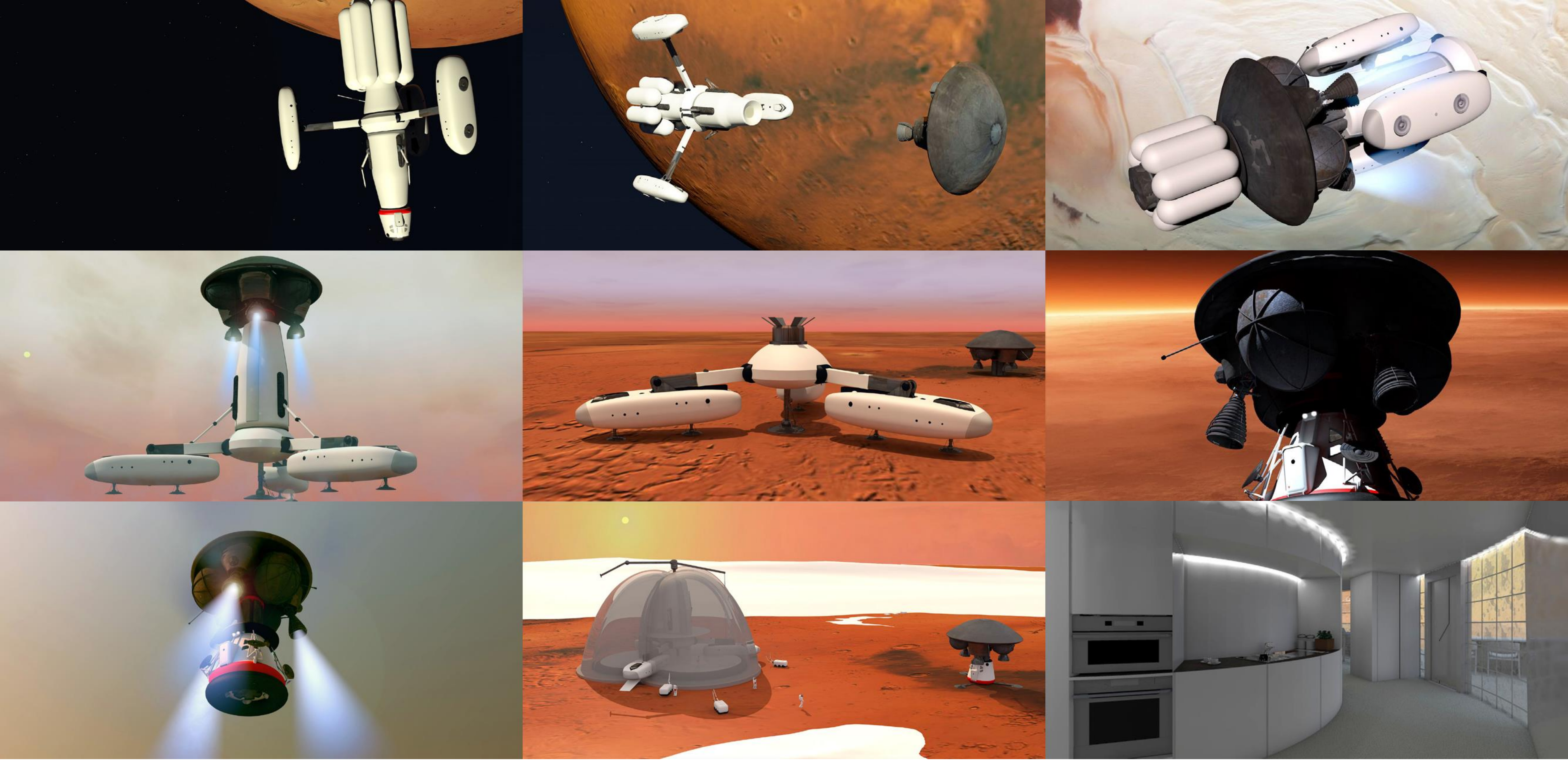





Espacement de la grille : 1000 cm

Conclusions

- Identification of potential in-situ resource utilization strategy based on ethylene and ice
- Recommendation to develop deployable structures
- Identification of limits to autonomy from Earth and follow-up recommendation to include greenhouse and energy production in-situ testing
- Recommendation to develop Mars crane system



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