DIGS: Deployed Independent Greenhouse Systems

Space Apps Challenge 2013

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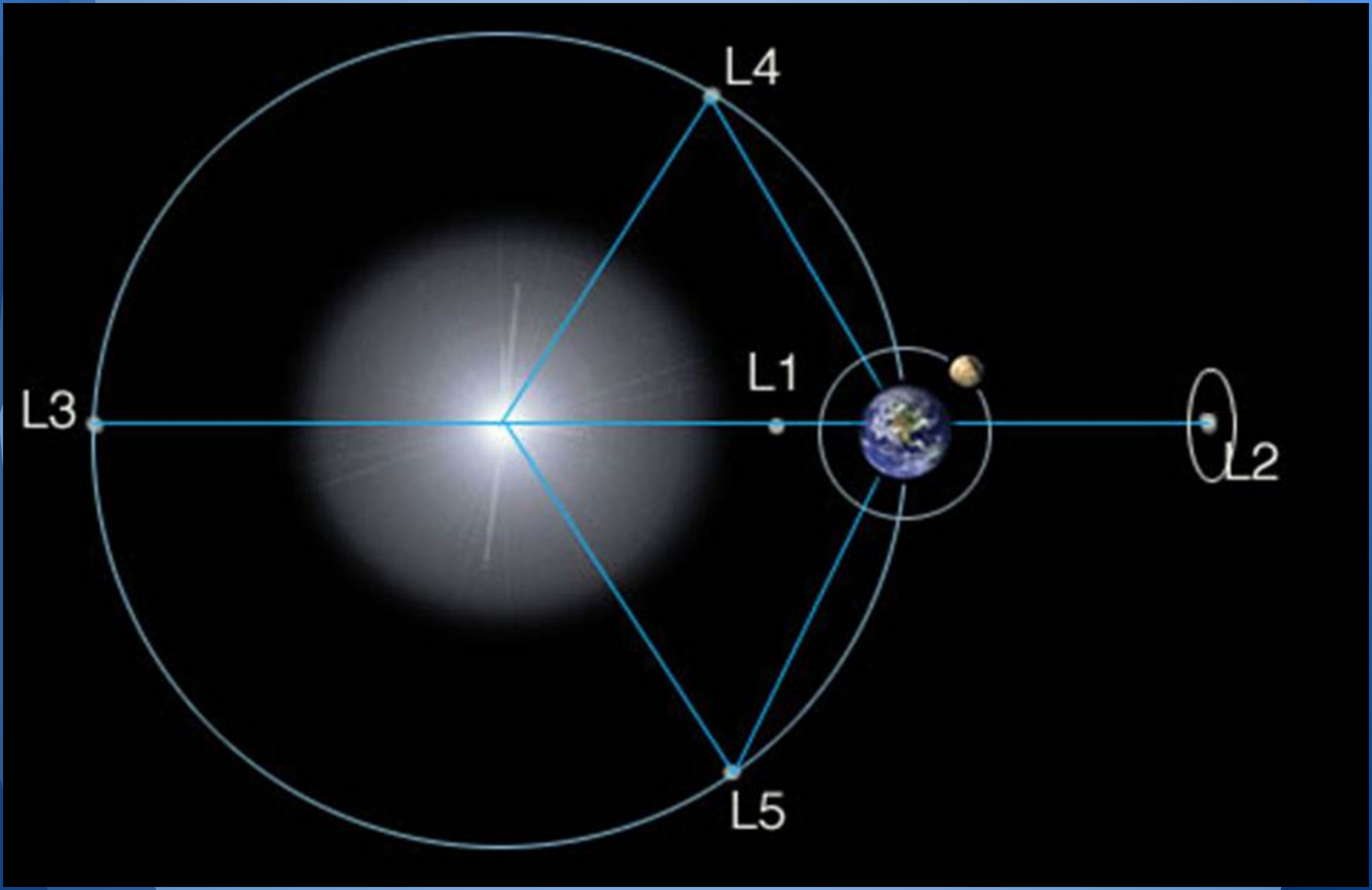
2025

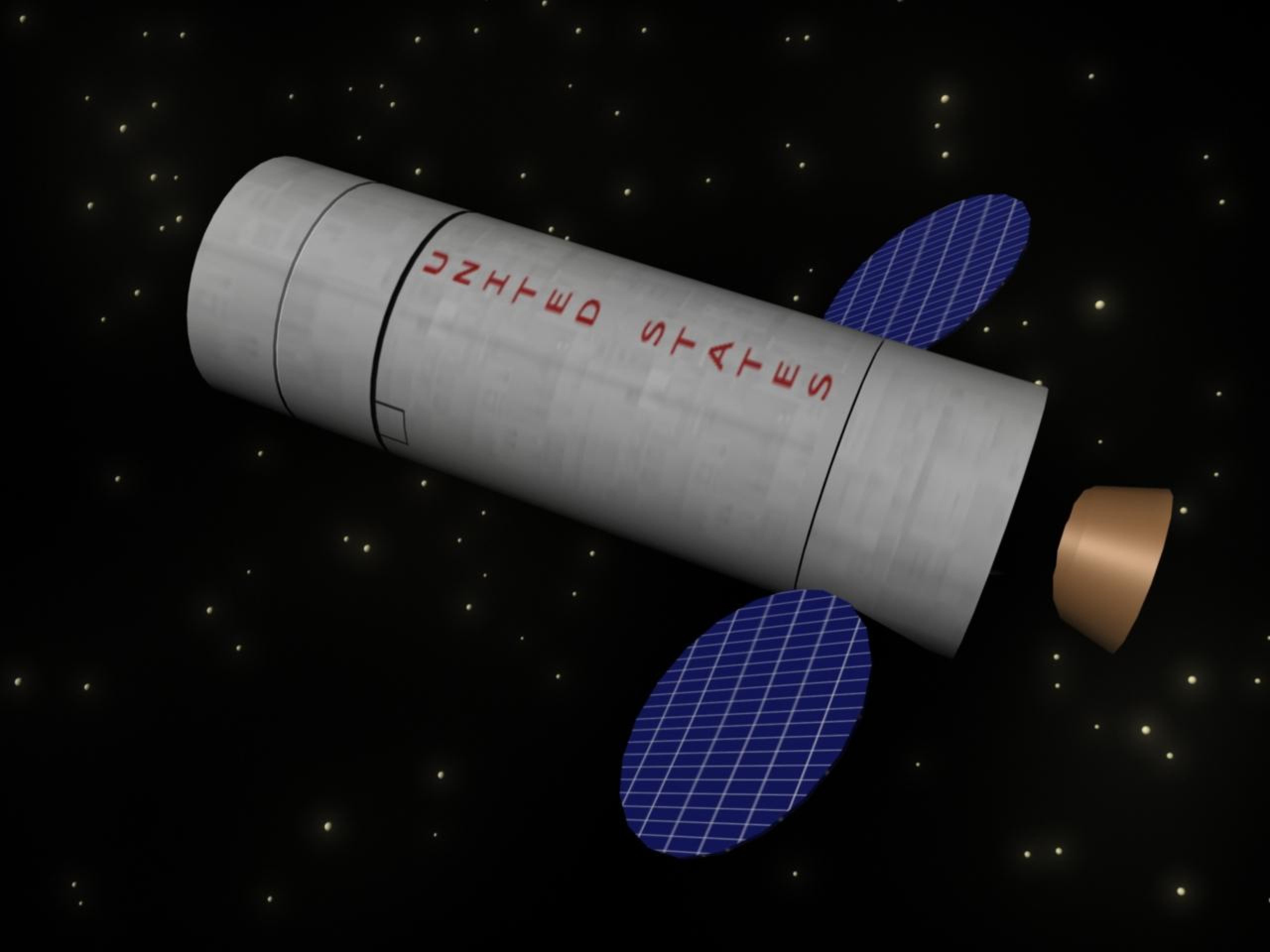

Stepping Stones
Exploring a series of increasingly challenging destinations on the way to Mars…
2031-2035
Explore Mars from Deimos
2023
Deimos Scout
2019, 2023, 2025, 2029
Humans Explore Asteroid 2008 EA9 and others
2018
Explore the Moon's Far Side
from Earth-Moon L_2 Point
2017
Human Lunar Flyby
2016
Asteroid Survey
2017
Asteroid Scout
2016
SLS Test Flight
Notional mission concepts: Lockheed Martin

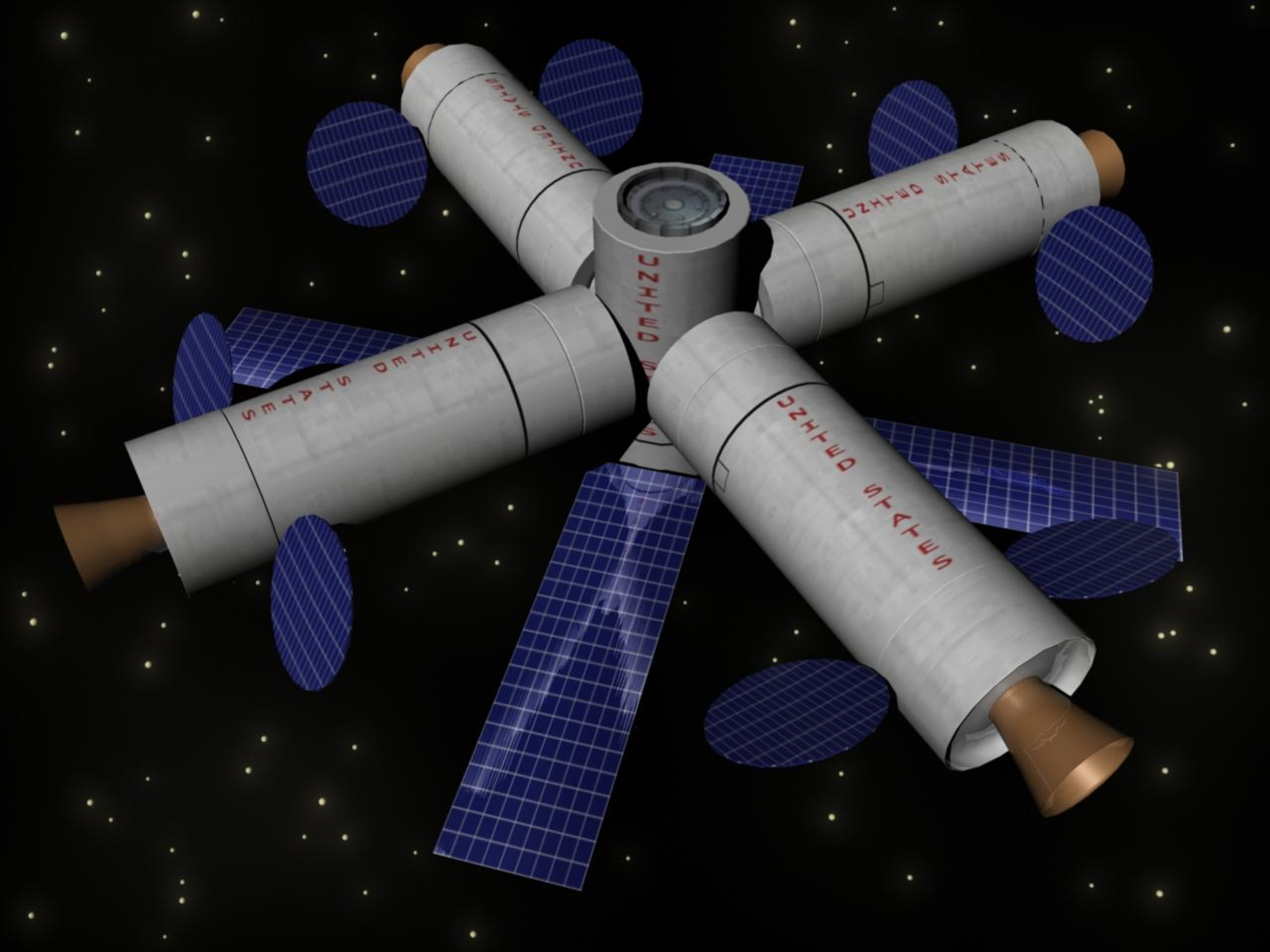
Lagrange Points



Basics

- Modular
- DIGS is center module of rocket
- Circular solar panels expand like Orion
- Thrusters for station keeping - propulsion module
- Docking connectors/airlocks


UNITED STATES

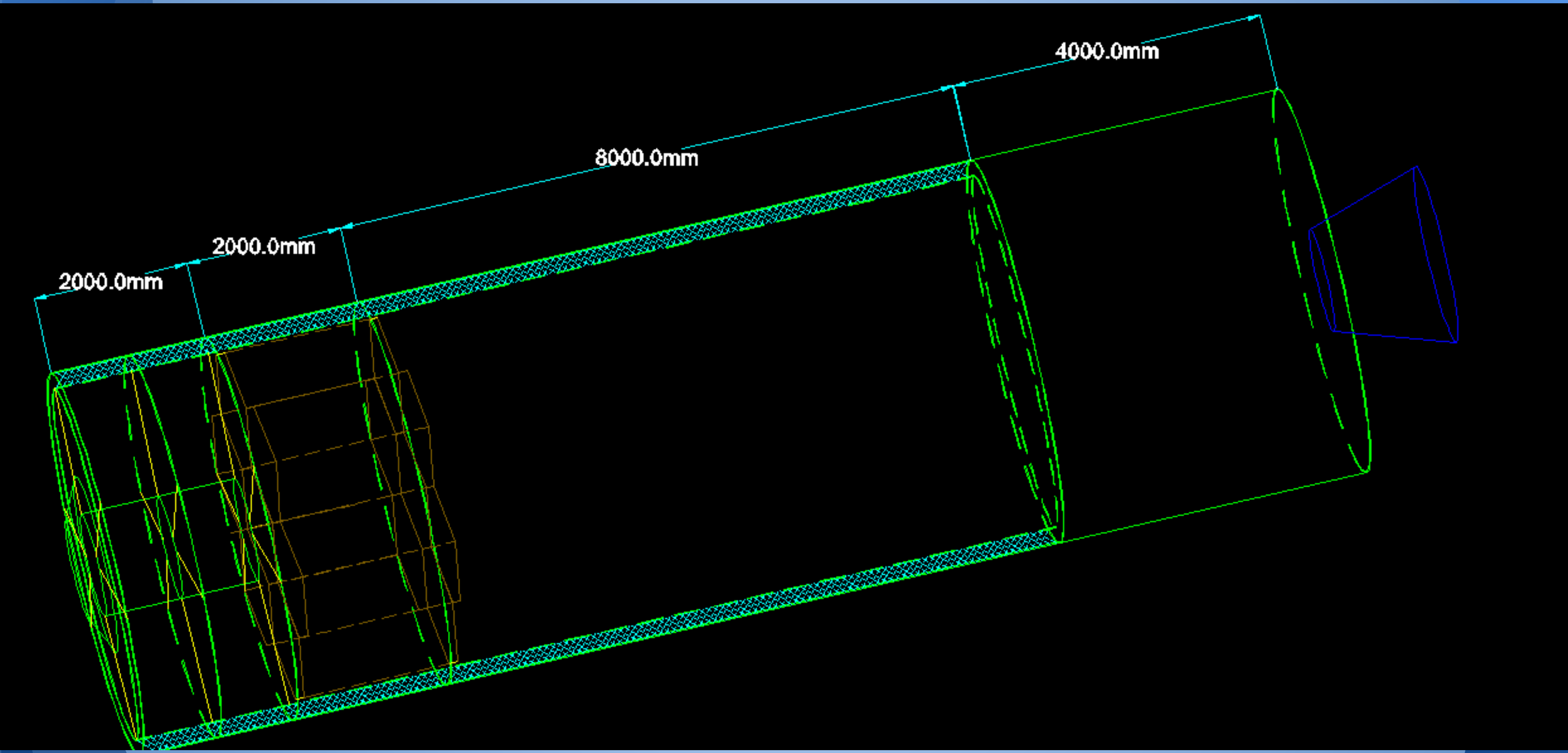

UNITED STATES
UNITED STATES

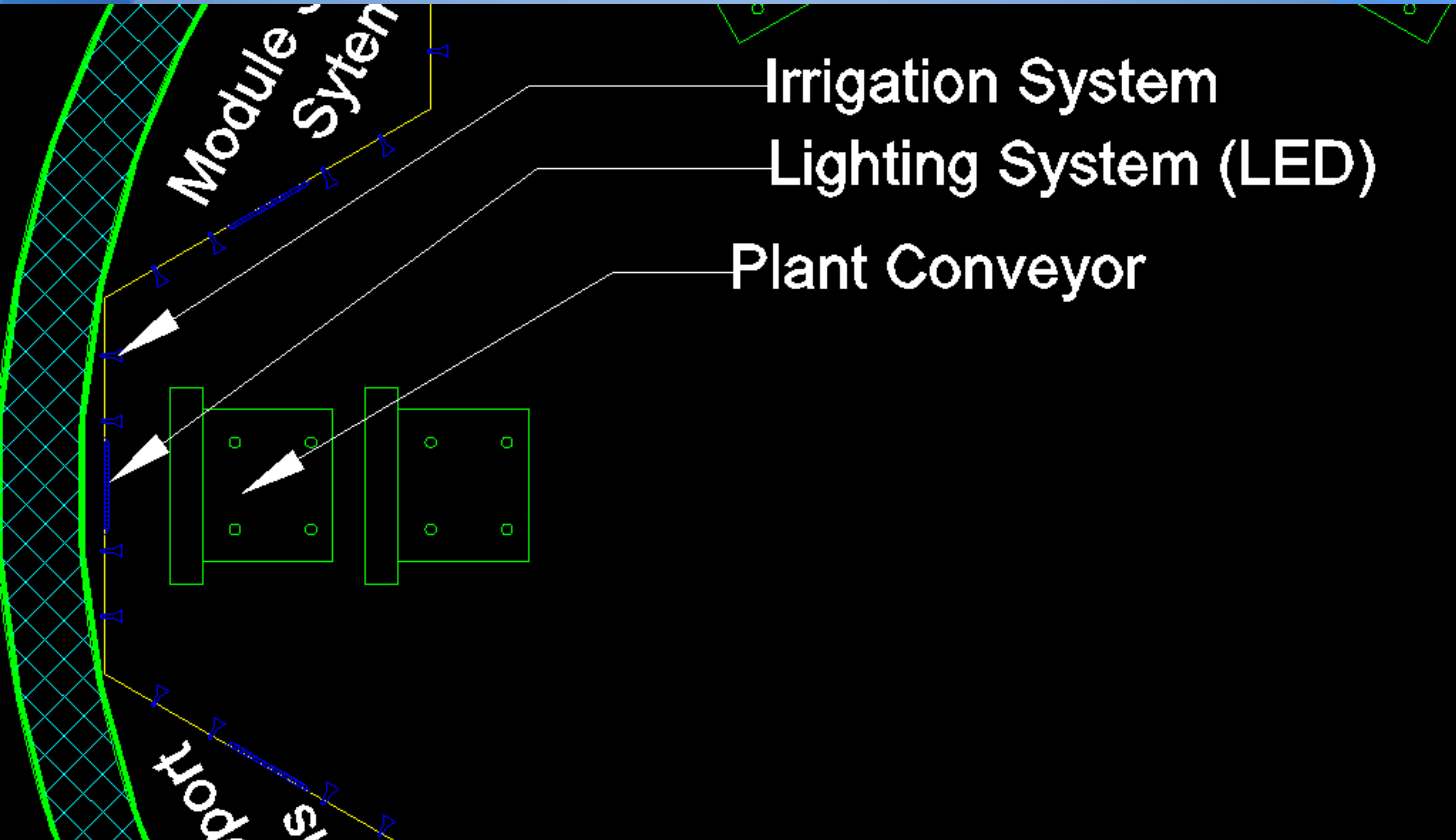
Basics Cont'd

- Pods launch ready-to-go
- In stasis using chemical agent
- Re-activate on deployment

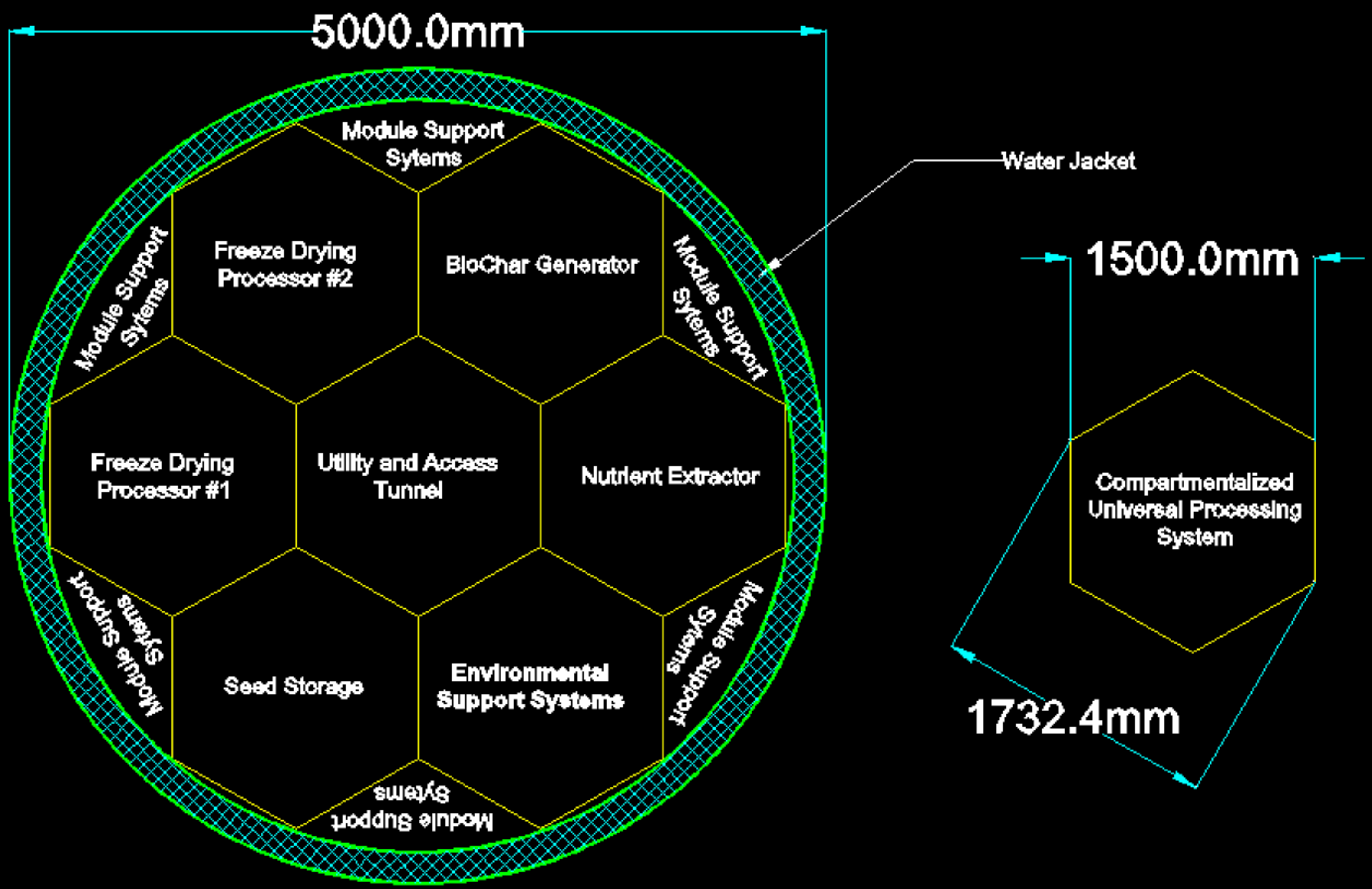
DIGS Dimensions

- Total DIGS length: 16m
- Total DIGS diameter: 5m
- Storage module length: 2m
- Processing module length: 2m
- Growing module length: 8m
- Propulsion module length: 4m

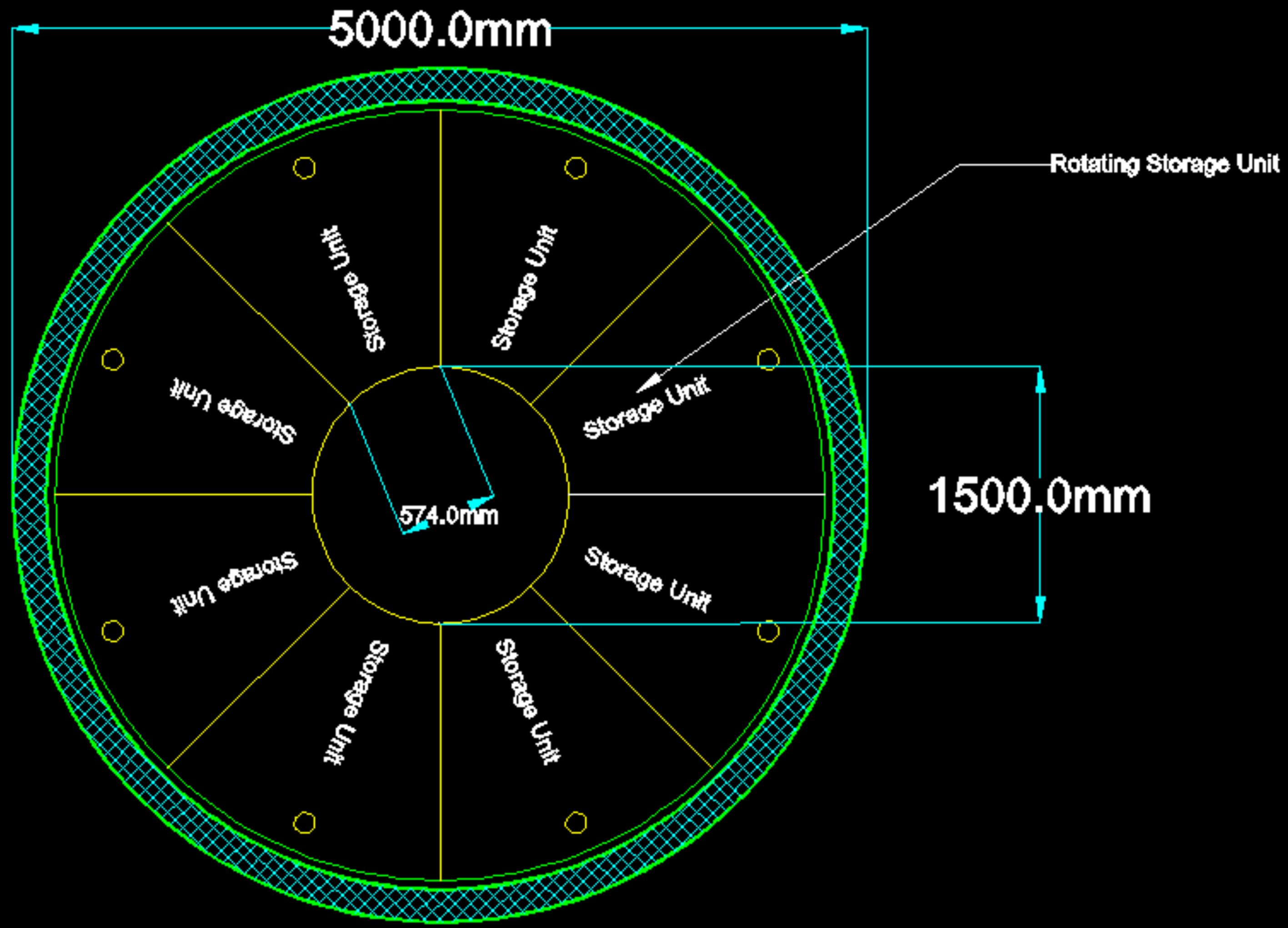

4000.0mm
8000.0mm
2000.0mm
2000.0mm



Irrigation System
Lighting System (LED)
Plant Conveyor
Module
Syten



5000.0mm
Module Support Sytems
Module Support Sytems
Freeze Drying Processor #2
BioChar Generator
Module Support Sytems
Freeze Drying Processor #1
Utility and Access Tunnel
Nutrient Extractor
Module Support Sytems
Seed Storage
Environmental Support Systems
Module Support Sytems
Module Support Sytems
Water Jacket
1500.0mm
Compartmentalized Universal Processing System
1732.4mm


5000.0mm
Rotating Storage Unit
1500.0mm
574.0mm
Storage Unit
Storage Unit
Storage Unit
Storage Unit
Storage Unit
Storage Unit
Storage Unit
Storage Unit

Possible Launch Vehicle Dimensions

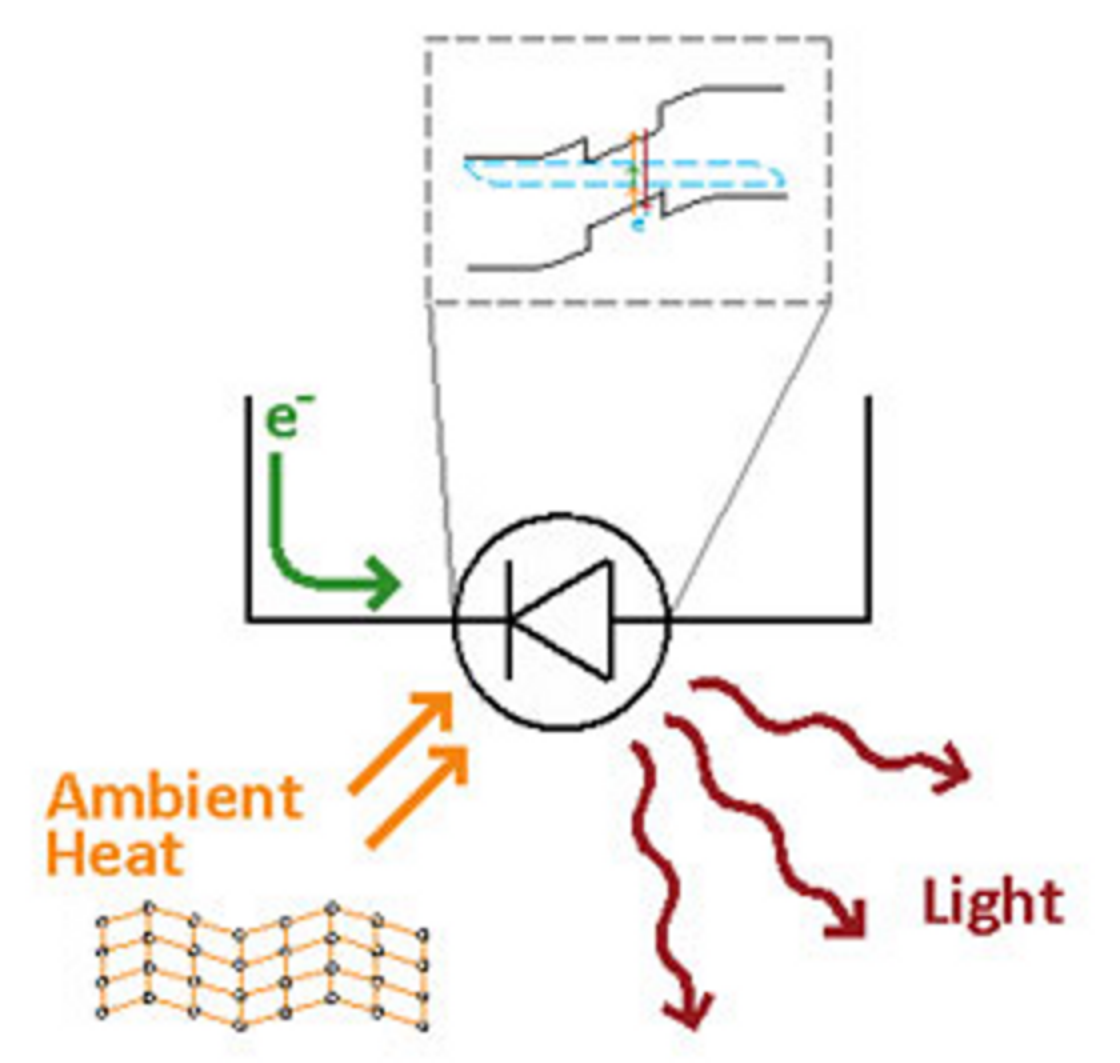
- Delta IV Heavy fairing: 19.8m x 5m
- Falcon Heavy fairing: 6.6m x 5.2m (can be requested/ordered longer)
- SLS Heavy-Lift fairing*: 10m x 7m

* Proposed

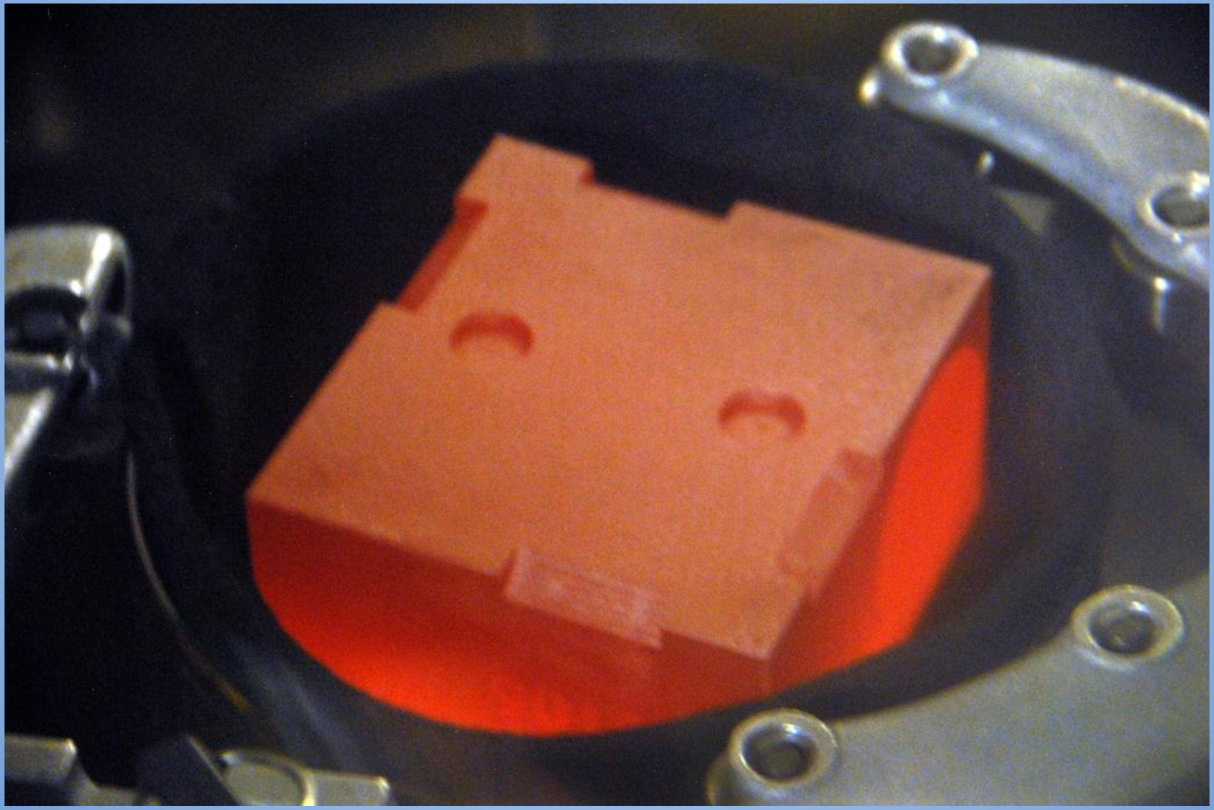
Pod Interior

- Aeroponics on conveyer system
  - multiple layers of conveyors
  - multiple stationary robots
  - enclosed sprayer with water/nutrients

Illumination and Energy



Radioisotope Thermoelectric Generator (RTG)



Normal Operations

- Optical/Infrared sensors for ripeness
- Freeze-dry edibles
- Override for storage of fresh produce orders

Example Industrial Freeze-Dryer

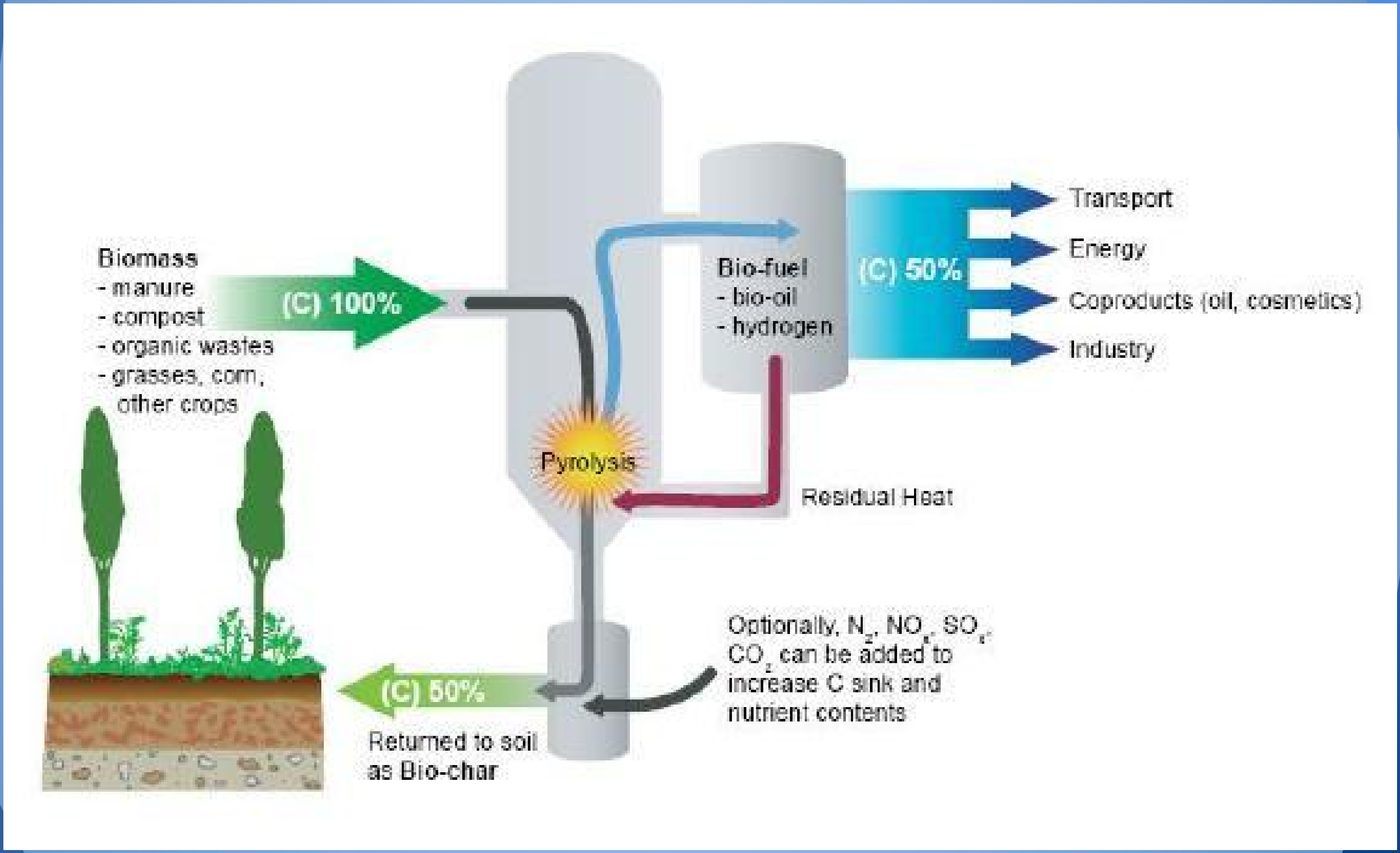
Heto PowerDry LL1500 Freeze Dryer Specifications

Technical Specifications	Heto PowerDry LL1500 Freeze Dryer
Cat. no. 230V/115V	88001500/88001550
Required power supply	230V/50 Hz or 115V/60 Hz
Condenser capacity/ 24 hours	1.5 kg
Total ice capacity	2.6 kg
Condenser volume	3.8 L
Condenser diameter x height	Ø 160 x 190 mm (6.3 x 7.5")
Lowest condenser temperature	< -110°C
Refrigerants	R507/R1150
Status indicator (Alarm / Wait / Okay)	Yes
RS232-C interface	Yes (when used with HSC500 PLUS controller)
Digital temperature display	Ambient to <-120°C (-184°F)
Ambient temperature	+5 to +32°C (+41 to +89.6°F)
Noise level	<51 dBA
Ice condenser material	AISI 316 Stainless Steel
External dimensions DxWxH	480 x 800 x 335 mm (18.9 x 31.5 x 13.2")
Weight	53 kg (116.8 lbs)

Non-Edible Waste

- Non-edible plant materials have nutrients extracted through enzymatic process
- Remaining material is converted to Biochar
    - Biochar is stored for filtration on module and passing vehicles
    - Biofuels created as by-product of Biochar process

Biochar



Biomass
- manure
- compost
- organic wastes
- grasses, corn,
other crops
(C) 100%
Pyrolysis
Bio-fuel
- bio-oil
- hydrogen
(C) 50%
Transport
Energy
Coproducts (oil, cosmetics)
Industry
Residual Heat
Optionally, N_2, NO_x, SO_x, CO_2 can be added to increase C sink and nutrient contents
(C) 50%
Returned to soil as Bio-char

Proposed Crops

- Aloe Vera
- Basil
- Berries
- Broccoli
- Carrots
- Grapes
- Mint
- Onions
- Oregano
- Peas
- Peppers
- Radishes
- Rosemary
- Soy & Legumes
- Stevia
- Sugar Beets
- Tomatoes
- Tubers

Aeroponics

Contingency Plans

- Redundancy in multiple robots and conveyors
- Failure Level 1
  - Pause crops using chemical similar to existing tech for tissue samples, but on large scale
- Failure Level 2
  - Freeze-dry whole pod

Pre-Launch Test Sites

Future Locations

- Moon
- Mars
- International Space Station
  - DIGS are removable- can be picked up and tugged to another location
- Space Tourism

Future Pods

- Larger Crops
  - Bamboo
  - Rubber
  - Rice
  - Wheat
  - Algae
- Animals
  - Tilapia
  - Chickens
  - Ducks

Future Work

- Chemical to "pause" plants on larger scale
- Chemical to reactivate "paused" plants
- Robotic harvesters
- Satellite communication to L2
- Advances in solar panel technology
- Advances in LED technology

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