BIOSS - BIOLOGICAL INTENSIVE OXYGEN AND SUSTENANCE SYSTEM

REGENERATIVE ECLSS SYSTEM BASED ON ACCELERATED PLANT GROWTH AND PROCESSING OF ORGANIC WASTE

Courtesy of Azuma Makoto

Thomas Lagarde Graduate student Master thesis 2018

UNIVERSITY of HOUSTON

CULLEN COLLEGE of ENGINEERING

SICSA

Sasakawa International Center for Space Architecture

Cullen College of Engineering
University of Houston

Omega Garden™ Hydroponics Design

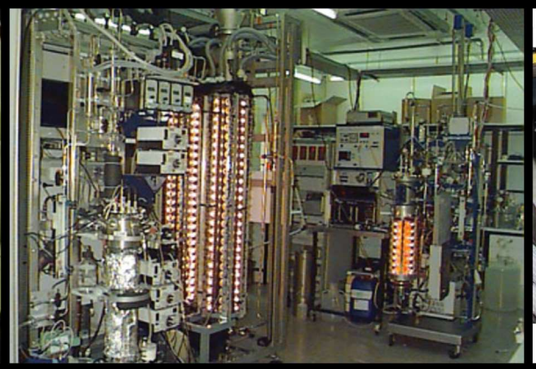
Roto-Gro™ FULLY AUTOMATED GARDEN SYSTEMS

MELISSA

BIOS-3

Institute of Biophysics in Krasnoyarsk
1965-1972

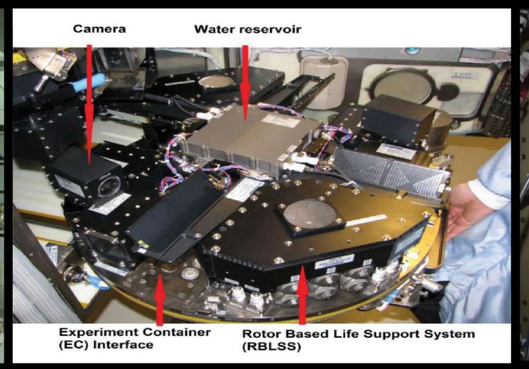
Closed Ecological Life Support Systems - Kennedy Space Center
1989-1993



MELISSA

NASA-Sierra Nevada

1989-ongoing



European Modular Cultivation System

European Space Agency

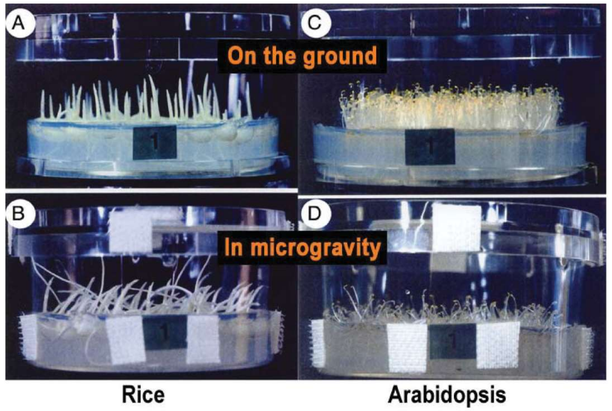
2006-ongoing

Advanced Plant Habitat

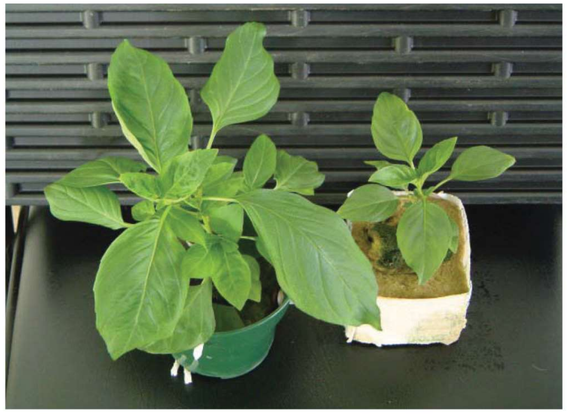
NASA-Sierra Nevada

2013-ongoing

PRECEDENTS AND ONGOING EXPERIMENTS

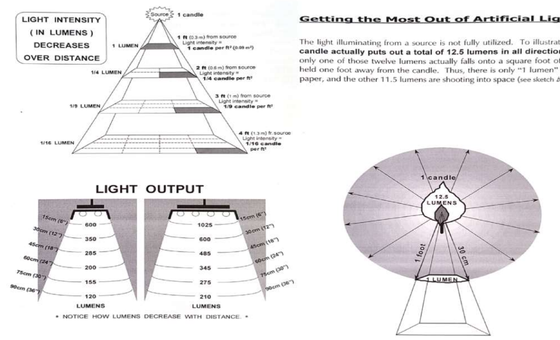


Plants don’t grow well without gravity forces



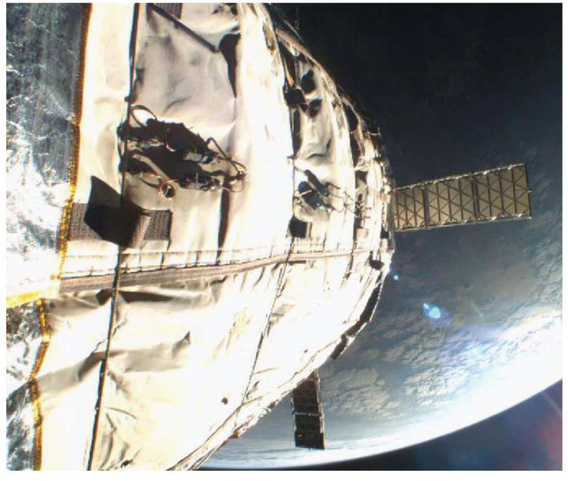
Increased gravitropism promotes plant growth and health

The rotating garden technology is well-established

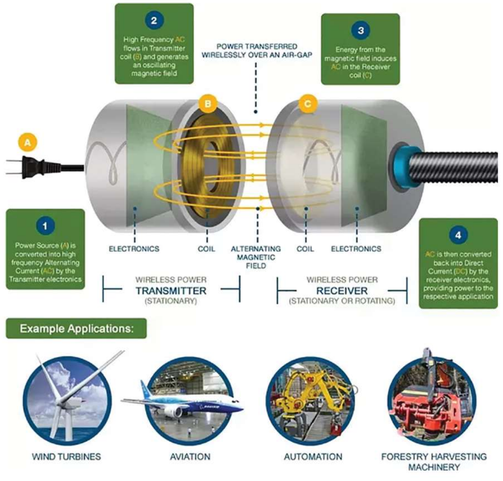


Having plants around a central light source is more efficient

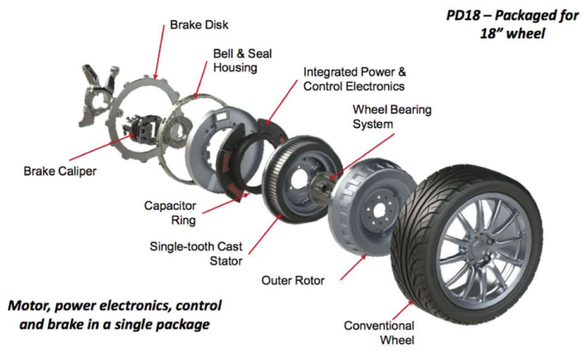
Worms behave well and reproduce normally in microgravity



Inflatables habitats have been tested and are being used



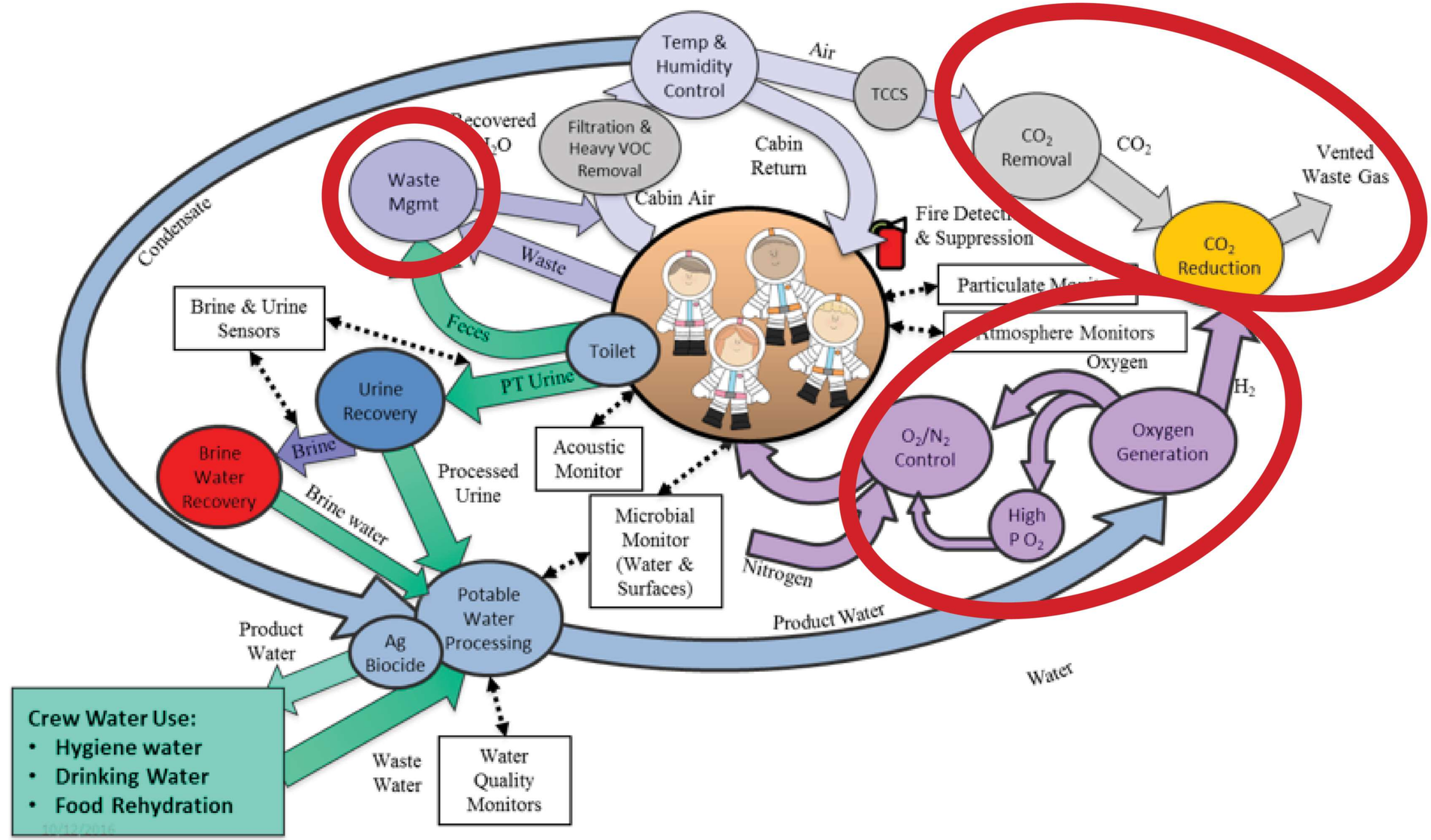
Wireless electricity transmitting is possible and is being used



Self-contained in-wheel motors are used in the car industry

FACTS

UNLESS OTHERWISE NOTED, METERS WILL BE USED FOR DIMENSIONS

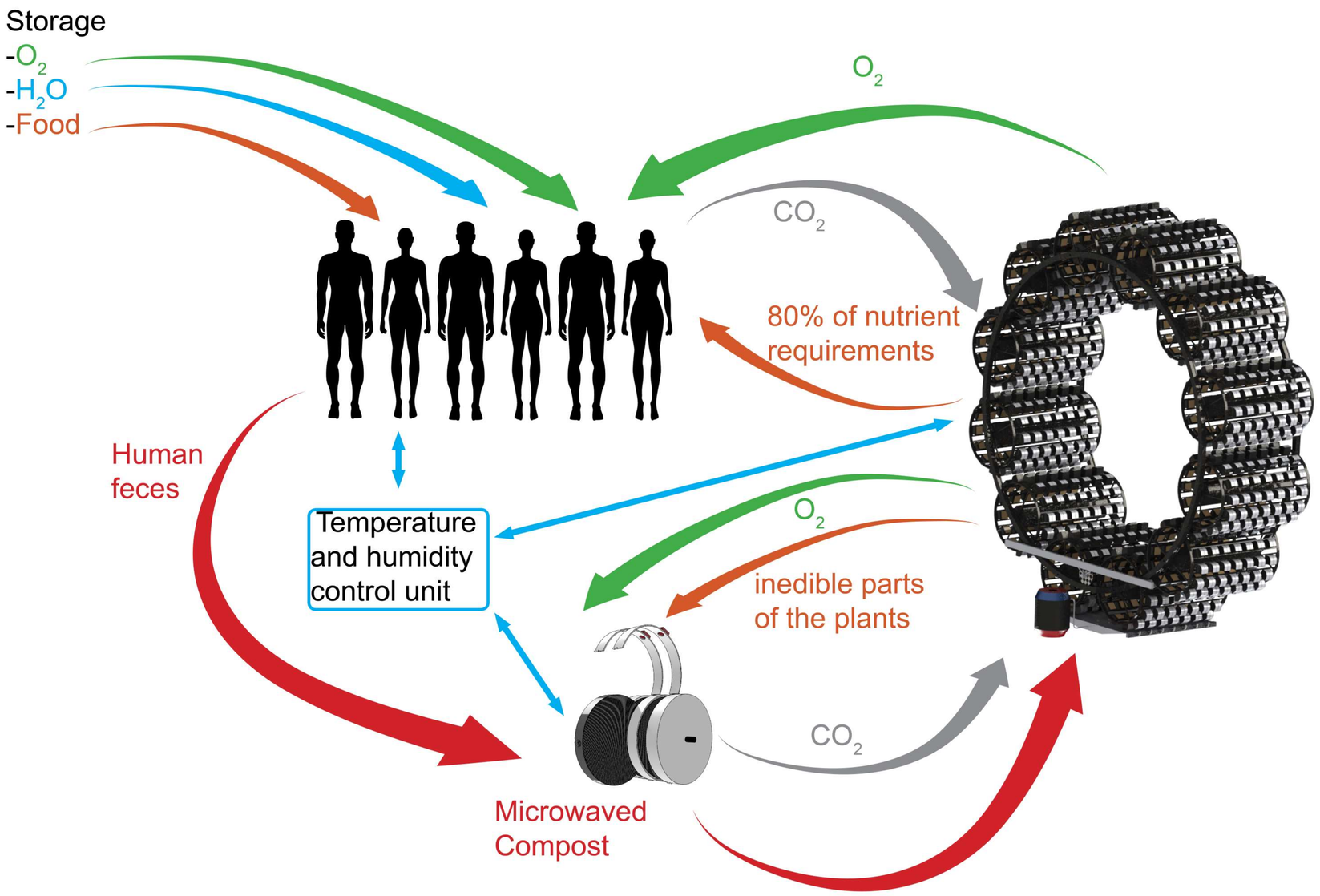


Courtesy of NASA - Molly Anderson

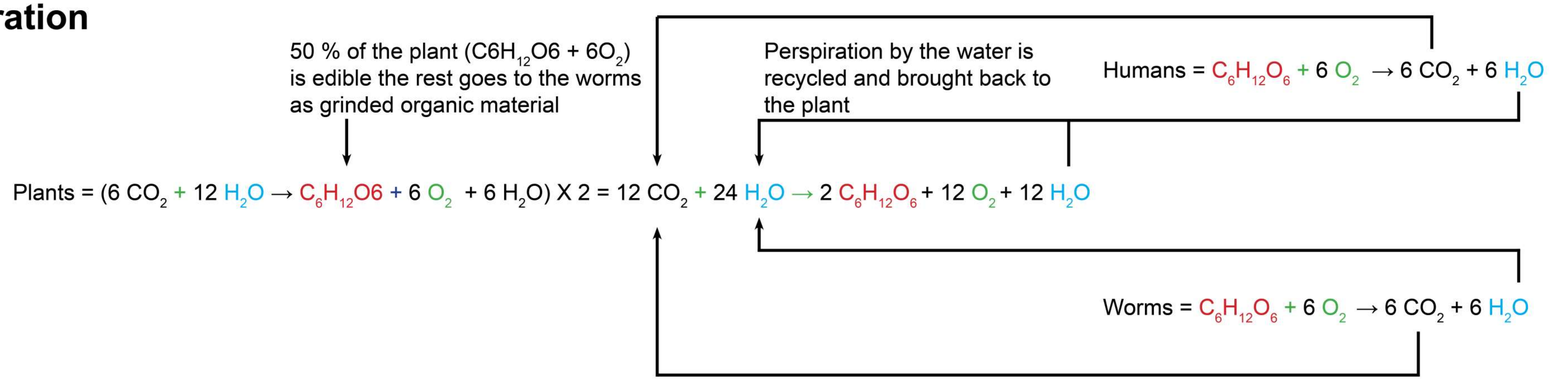
Changes in the loop

ACTUAL ISS ECLSS AND AREAS OF CHANGES

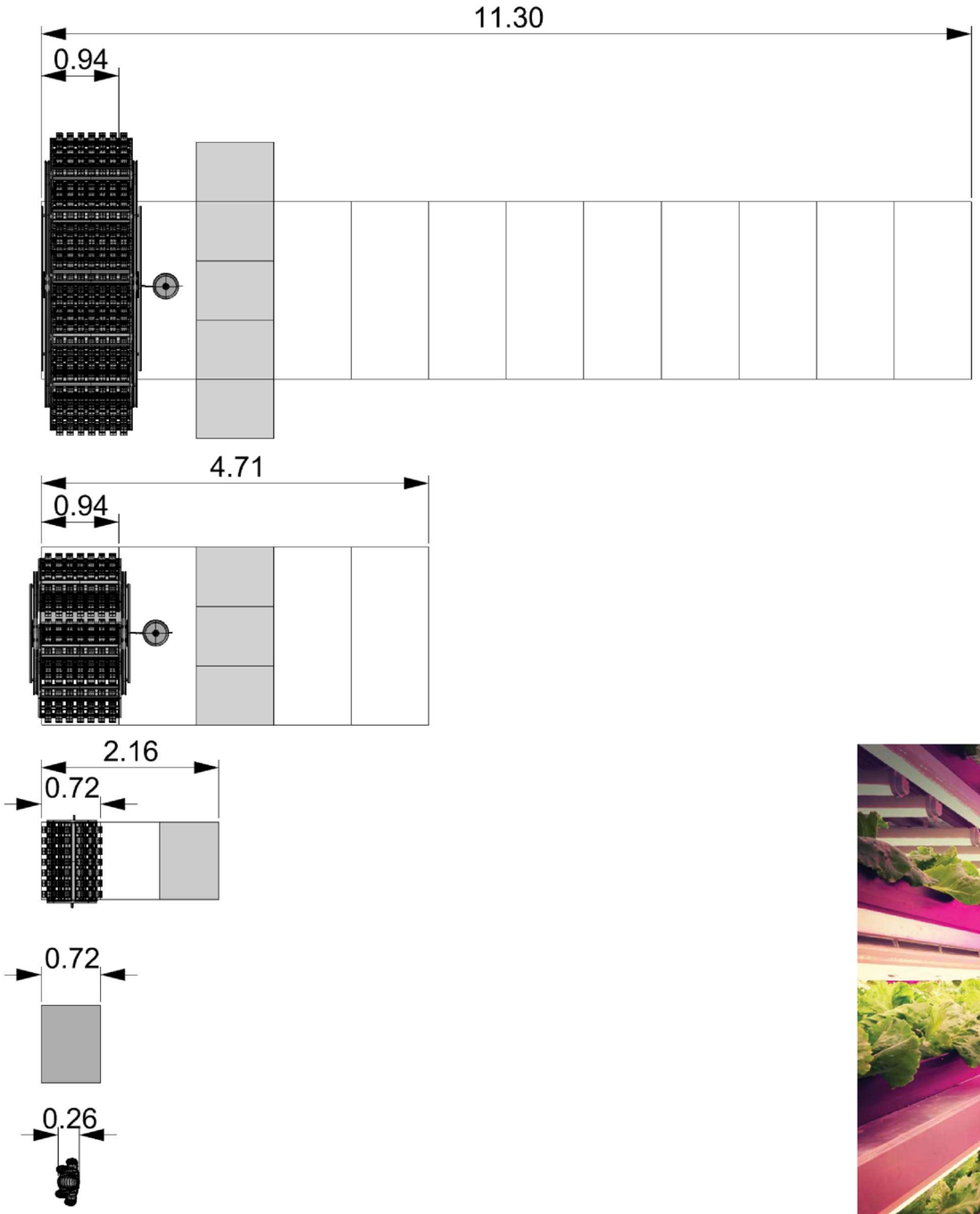
Regenerative Cycle

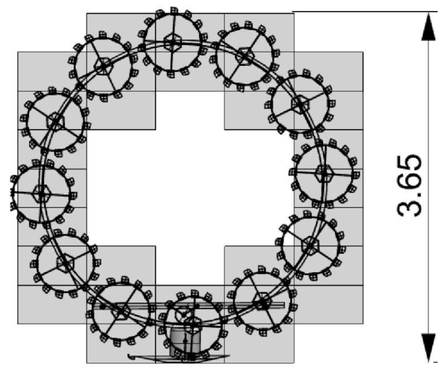


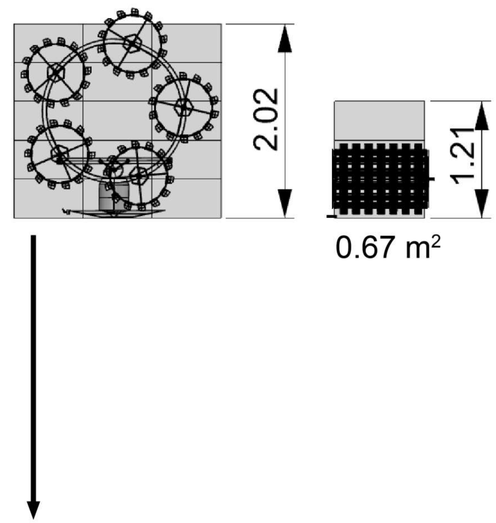
Atmopshere Regeneration

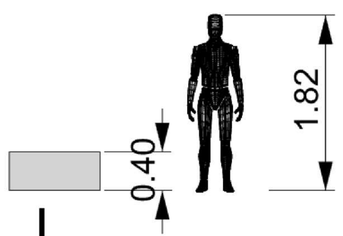


NEW CYCLES

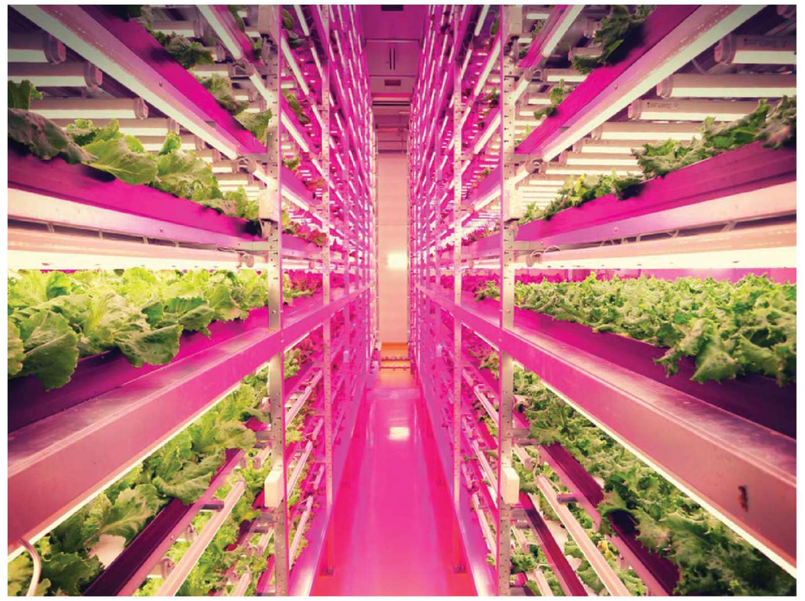








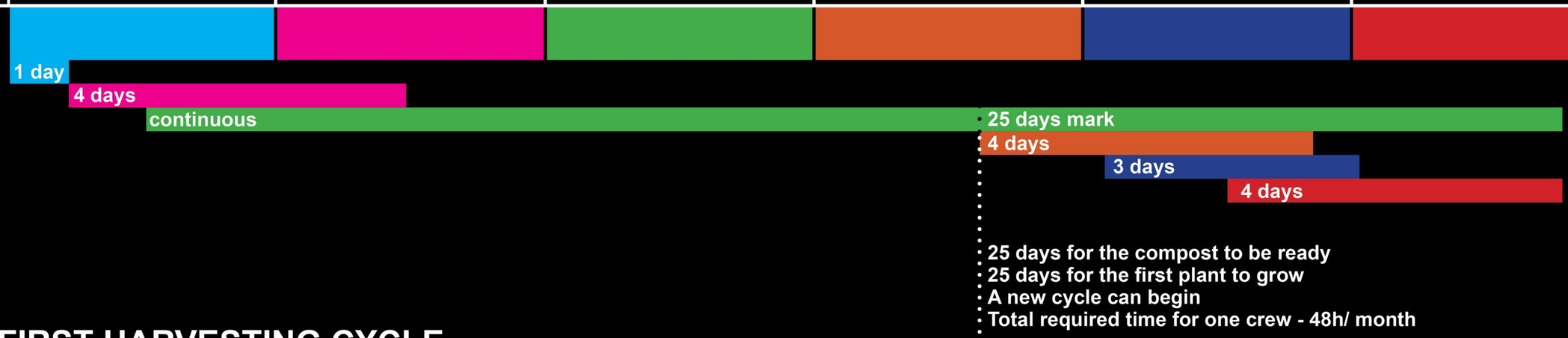
SPACE OPTIMIZATION



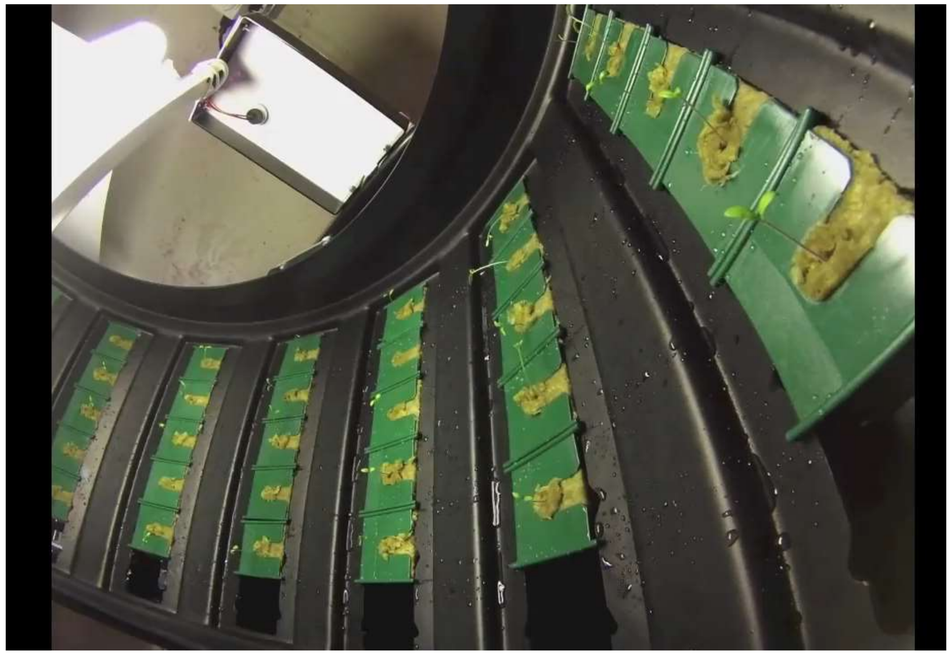
Courtesy of MIRAI

Courtesy of AeroGarden

	INSTALLATION	PLANTING	GROWING AND COMPOSTING	HARVESTING AND PREPARATION	CLEAN UP AND MAINTENANCE	SEEDS TRANSFER AND TESTING
ACTIONS	Unpacking Mounting Dry-run Testing Fixing Calibrating	Planting of first germinated seeds Transfert of first organic bags	Routine check on plants growth Routine transfer of oragnic waste bags and monitoring of worms Germination of new seeds	Roots extraction and separation of edible biomass Shredding of first non-edible mass Preservation of worm eggs Preservation of seeds	Microwave processing of vermicast Washing of compost bags Burning of used vermicast	Transfer of germinated seeds in planters Replenishment of growing medium with compost Test of rotating garden
EQUIPMENT	General tools Power tools Sensors Motors	Plant container Base growing medium Germination machine Compost bags	Sensors Compost bags	Gardening tools Shredding machine Cold storage	Clean-up machine Microwave machine Gloves Furnace	Gardening tools Gloves Sensors Motors
DURATION	1 hour per rotating garden 3 hours for bigger centrifuge	3 hours/ crew	3 hours/ month/ crew	15 hours/ month/ crew	15 hours/ month/ crew	15 hours/ month/ crew
LOCATION	All areas	Germination machine Growing areas Compost machines Waste amangement area	Greenhouse module Waste compartment	Greenhouse module Storage module	Greenhouse module	Greenhouse module



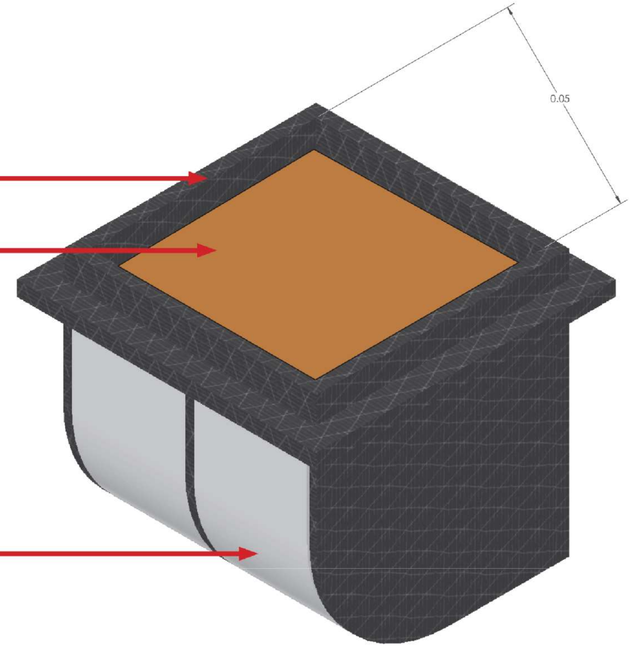
SCHEDULE FOR FIRST HARVESTING CYCLE

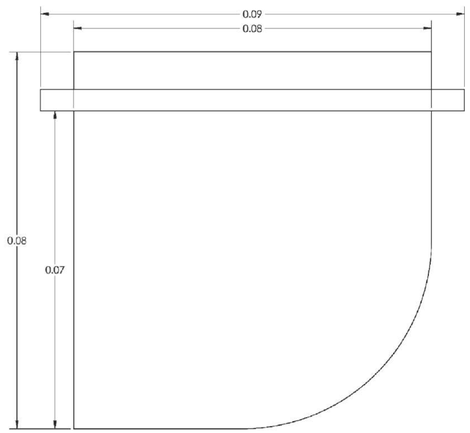


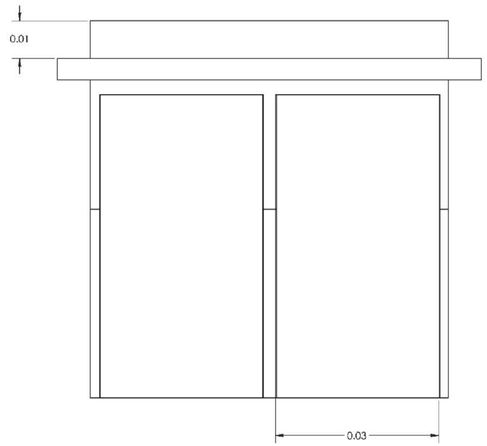
Planter structure

Growing medium:
-vermiculite
-perlite
-peat moss
-17% vermicompost
-green sand
-rock phosphate

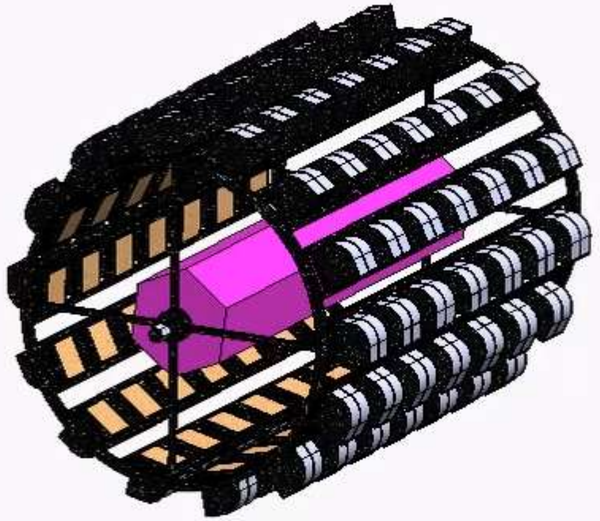
Wick mesh made of nylon

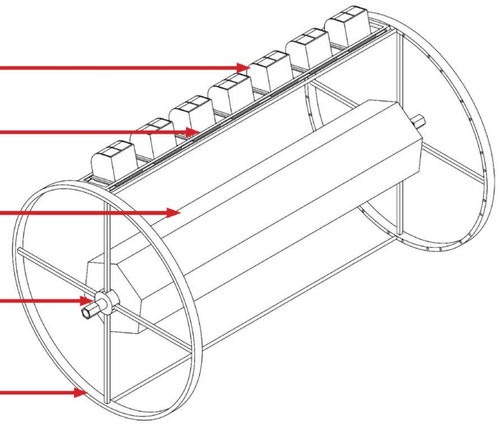


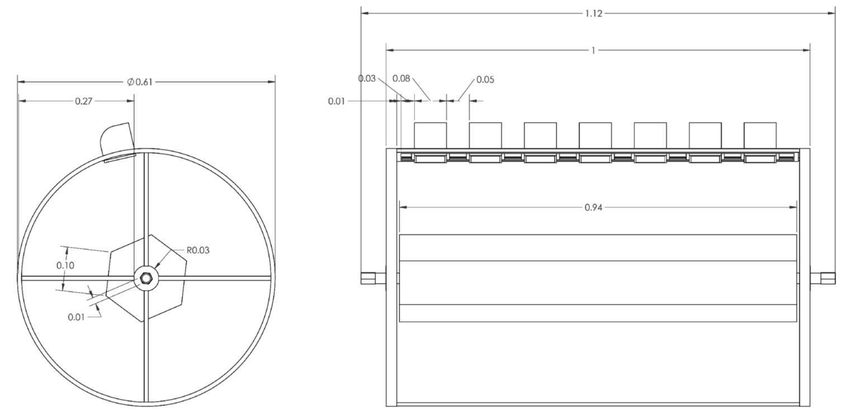




SMALLEST UNIT - PLANTER







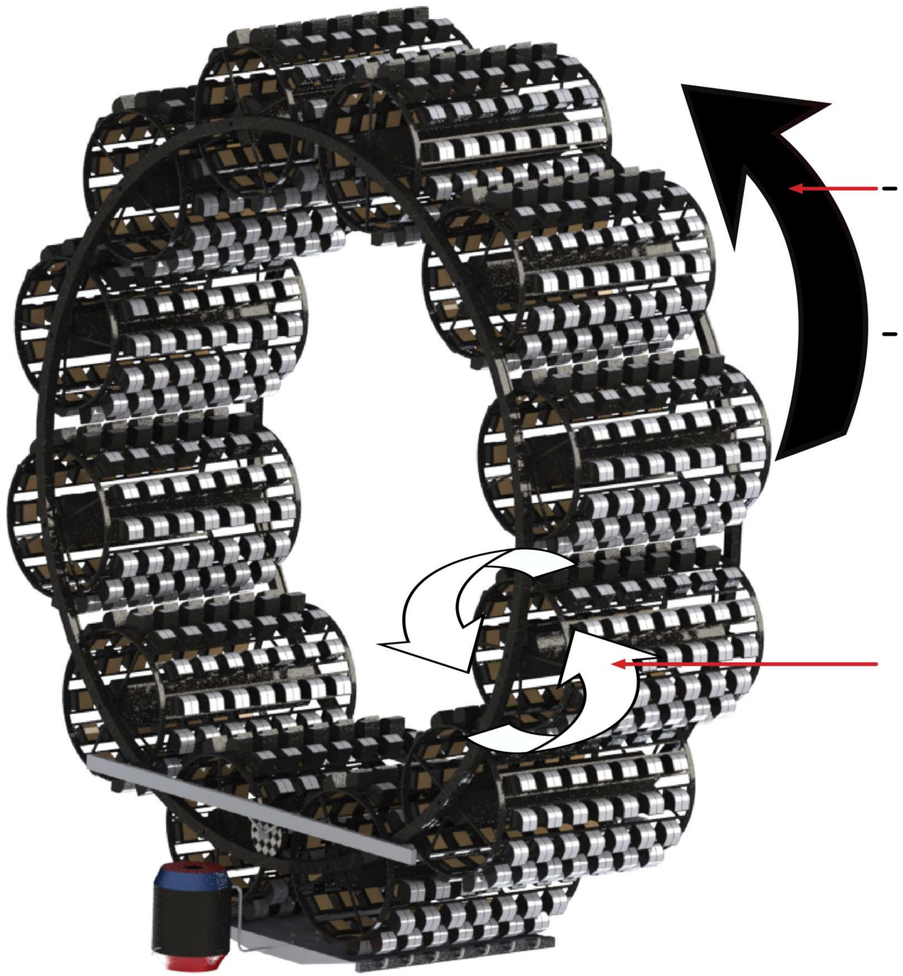
	Quantity (cup)	Weight (g)	Calories	Protein (g)	Fat (g)	Carbs (g)	Time to grow (days)	Height (cm)
Goal			2200	56	61	390		
Lentil	1	198	230	18	0.8	40	90	40
Green pea	1	145	117.45	8	0.6	21	68	140
Tomato (1)	1	123	22.14	1.1	0.2	4.8	60	90
Strawberry	1	144	47	1	0.4	11	90	40
Soybeans	2	372	1660	136	74	112	97	91
Kale	1	67	33	2.9	0.6	6	110	30
Khorasan wheat	2	344	502	22	3.2	104	120	70
Red sweet pepper	1	92	28	0.9	0.3	6	119	60
Total		1485	2639.59	189.9	80.1	304.8		








OGU - OMEGA GARDEN UNIT

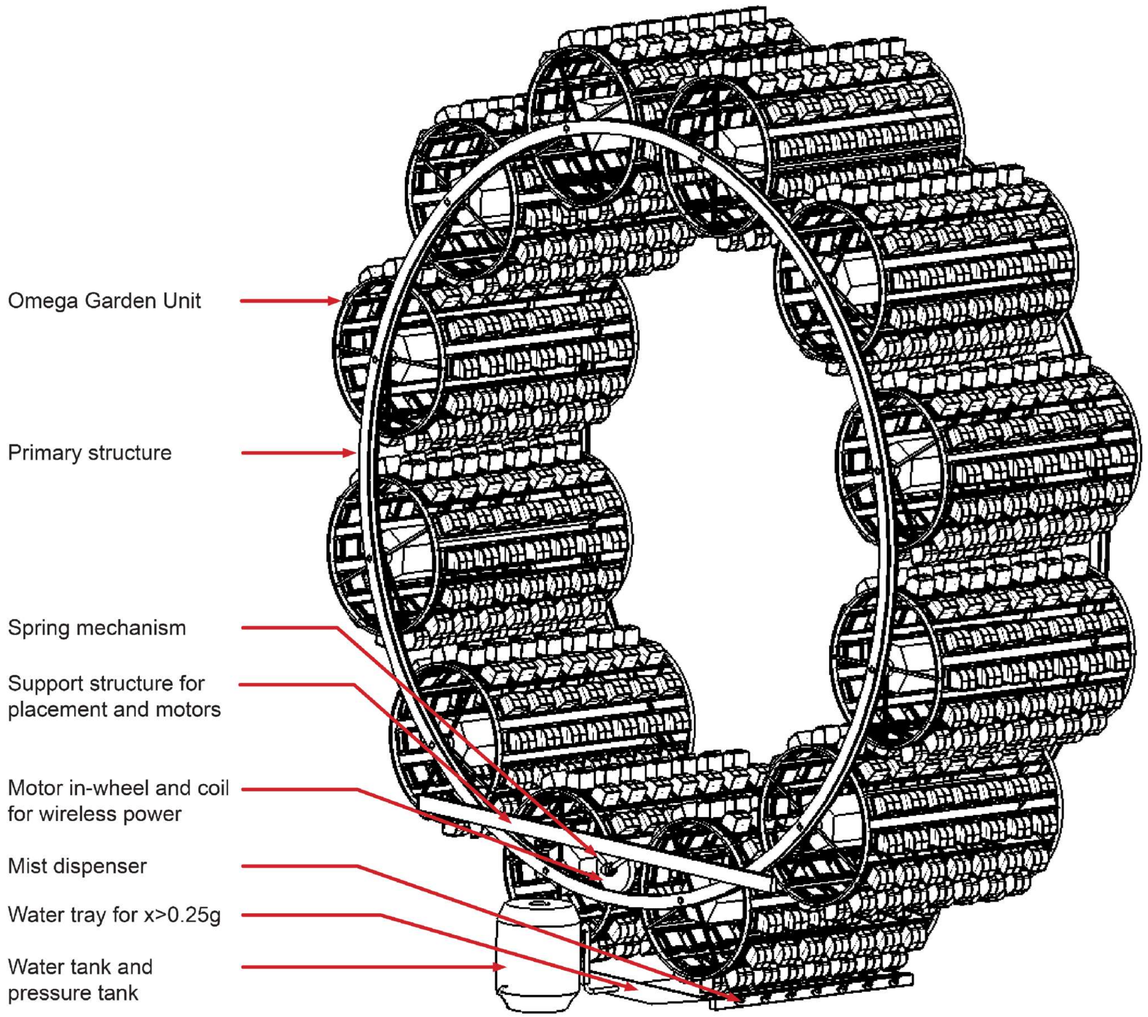


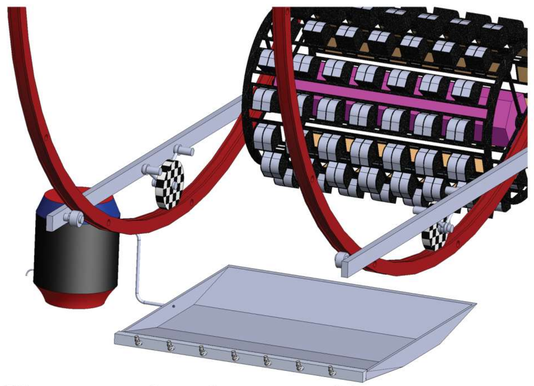
- gravity < 0.25G
  9 rotations every
  1 minutes (9 RPM)
- gravity > 0.25G
  1 rotation every
  5 minutes (0.2 RPM)

1 rotation every
45 minutes (0.02 RPM)

2 of those units is enough for 80% of the nutrient requirements of one person = 16.08 m^2

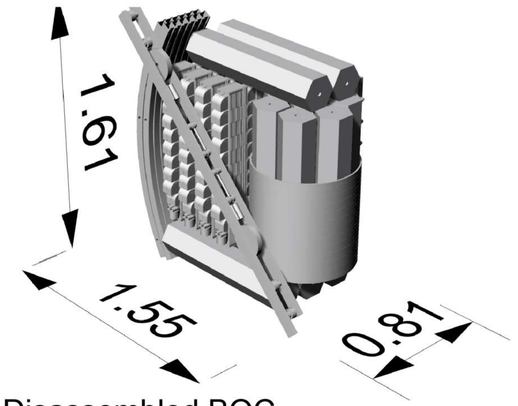
BOC - BIG OMEGA CENTRIGUE





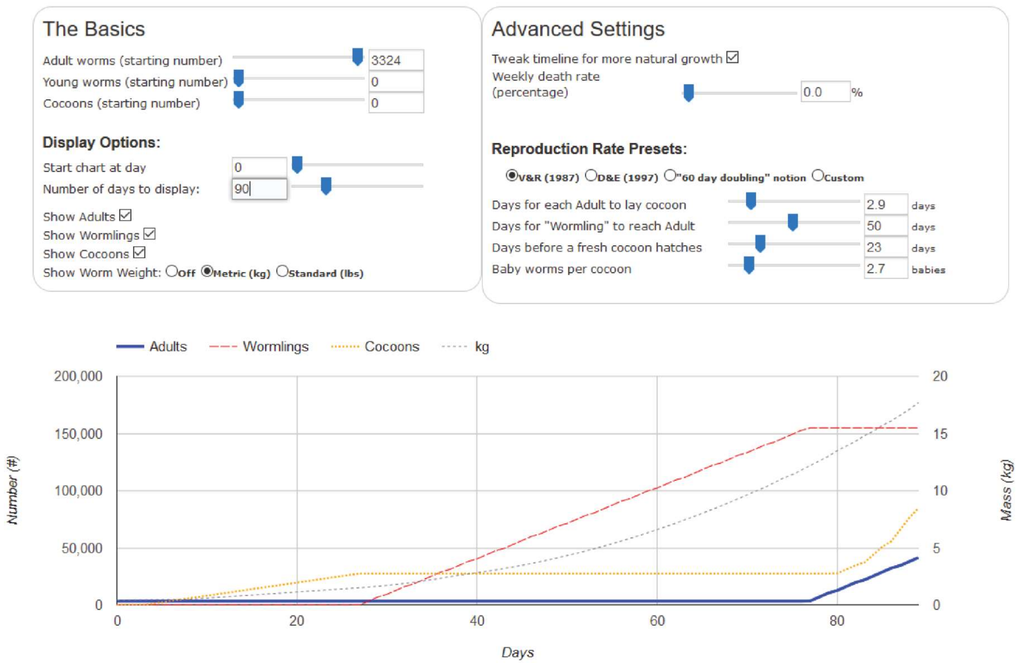
Close up of main assembly

Commercially available lamp



Disassembled BOC

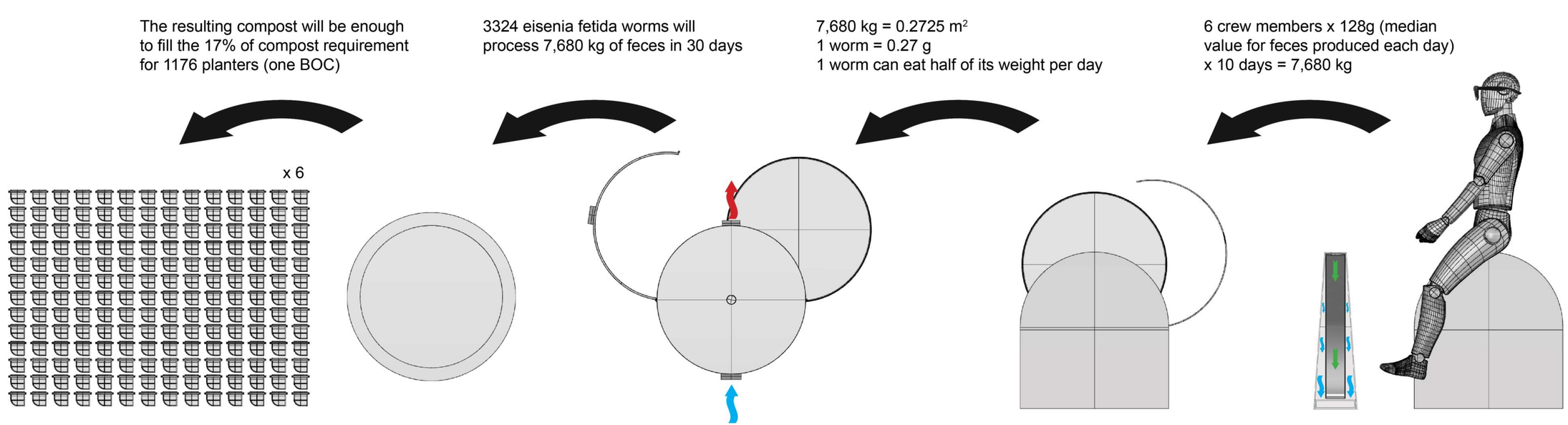
BOC - BIG OMEGA CENTRIGUE



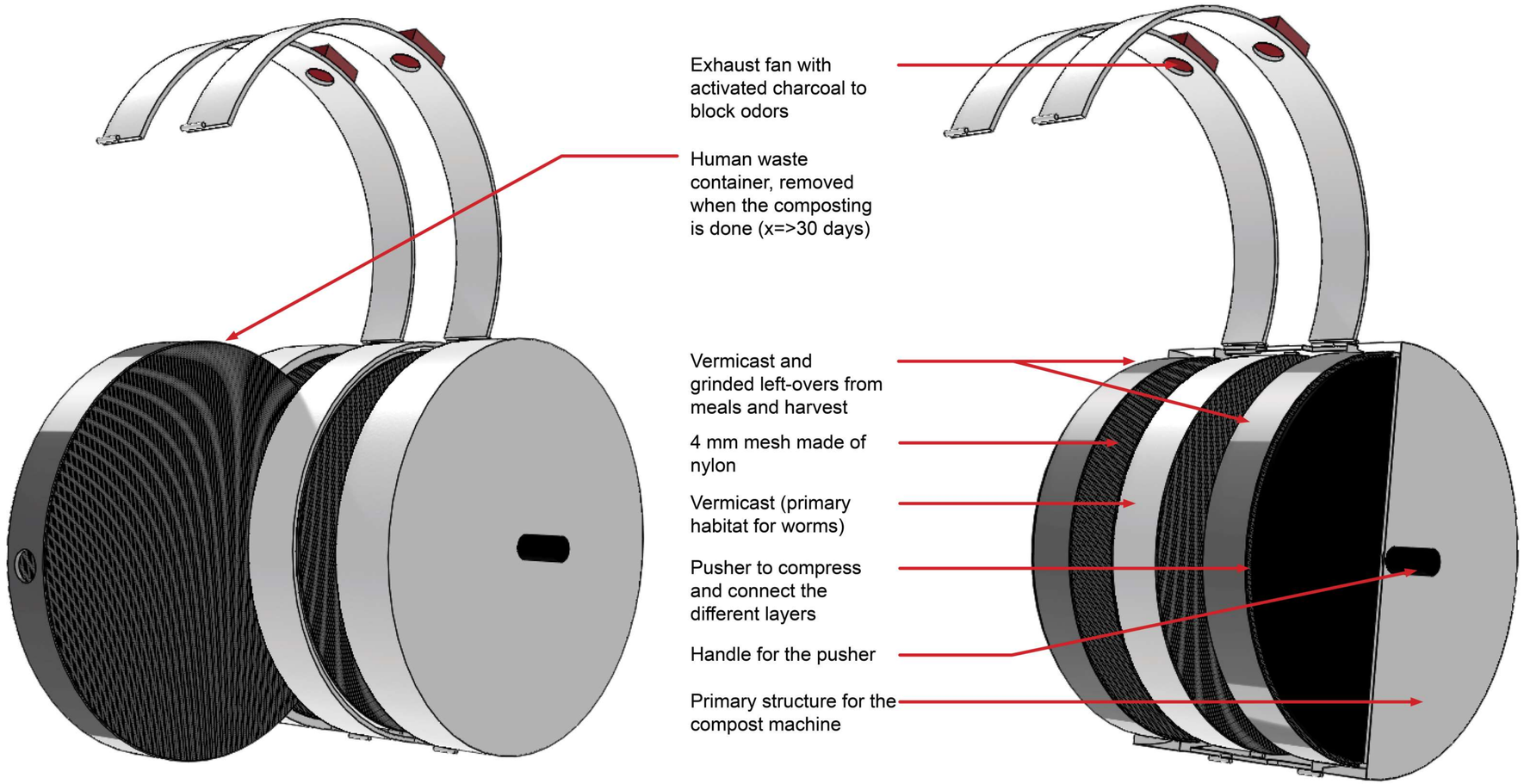
Courtesy of NASA

Courtesy of ESA

Courtesy of AVANI



COMPOST MACHINE



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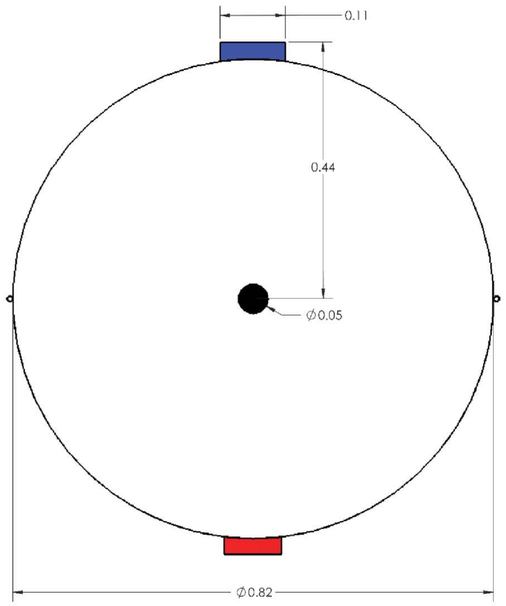
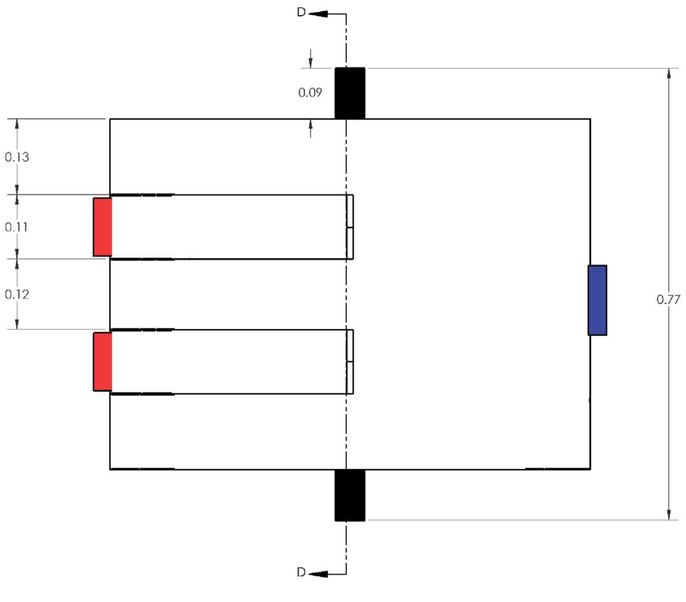
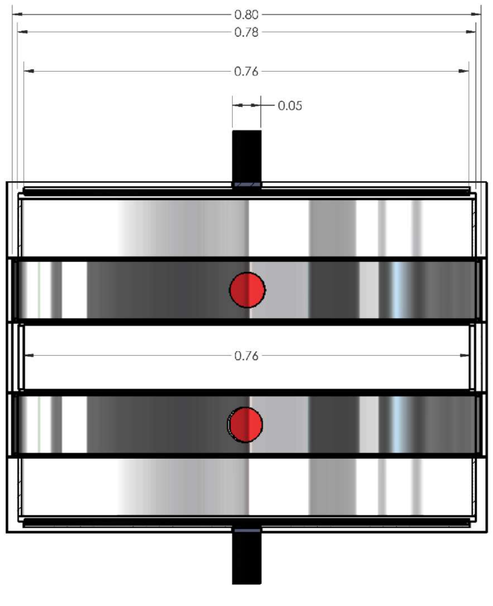






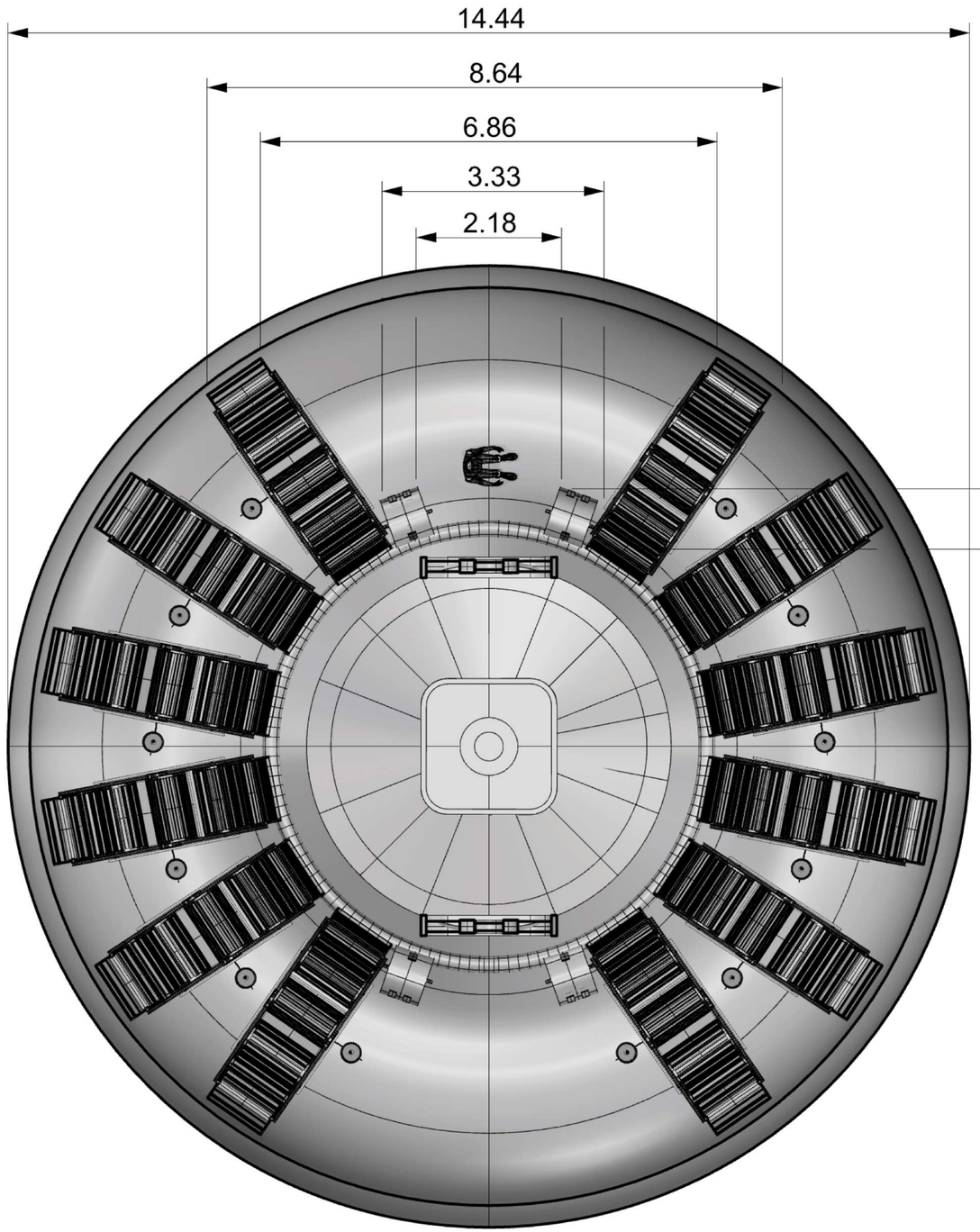
SECTION D-D

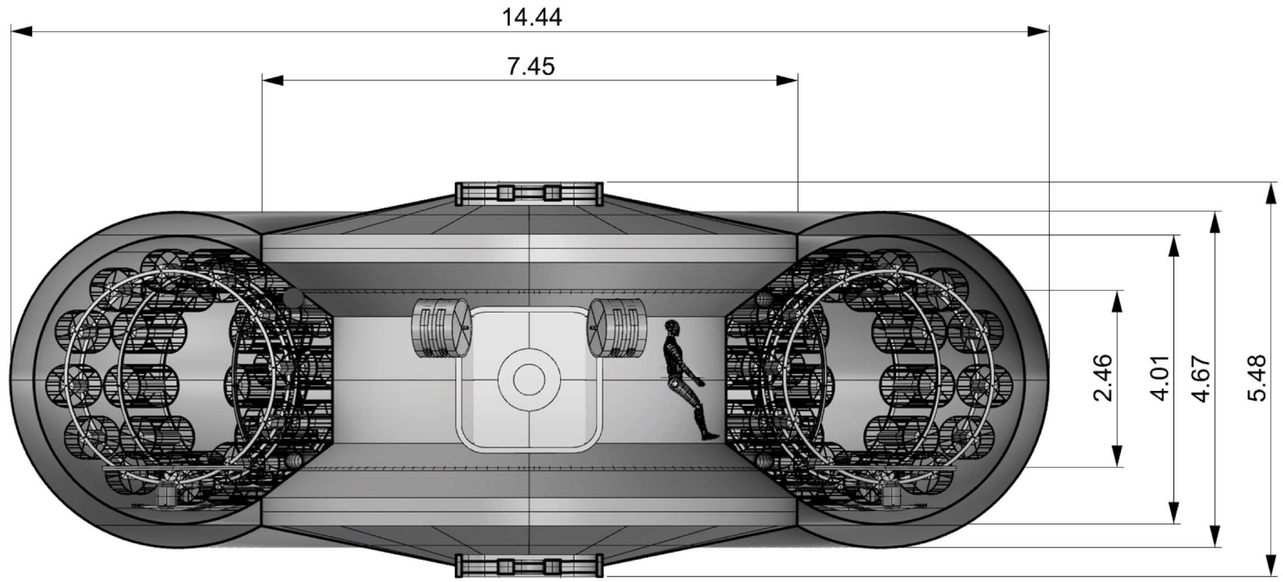
Vermicast Characteristics

Nitrogen
Phosphorous
Sulphur
Potassium
Sodium
Calcium
Magnesium

Type A biosolid
No smell (after being processed)
Improves water holding
Improves aeration
Improves PH neutralization

COMPOST MACHINE

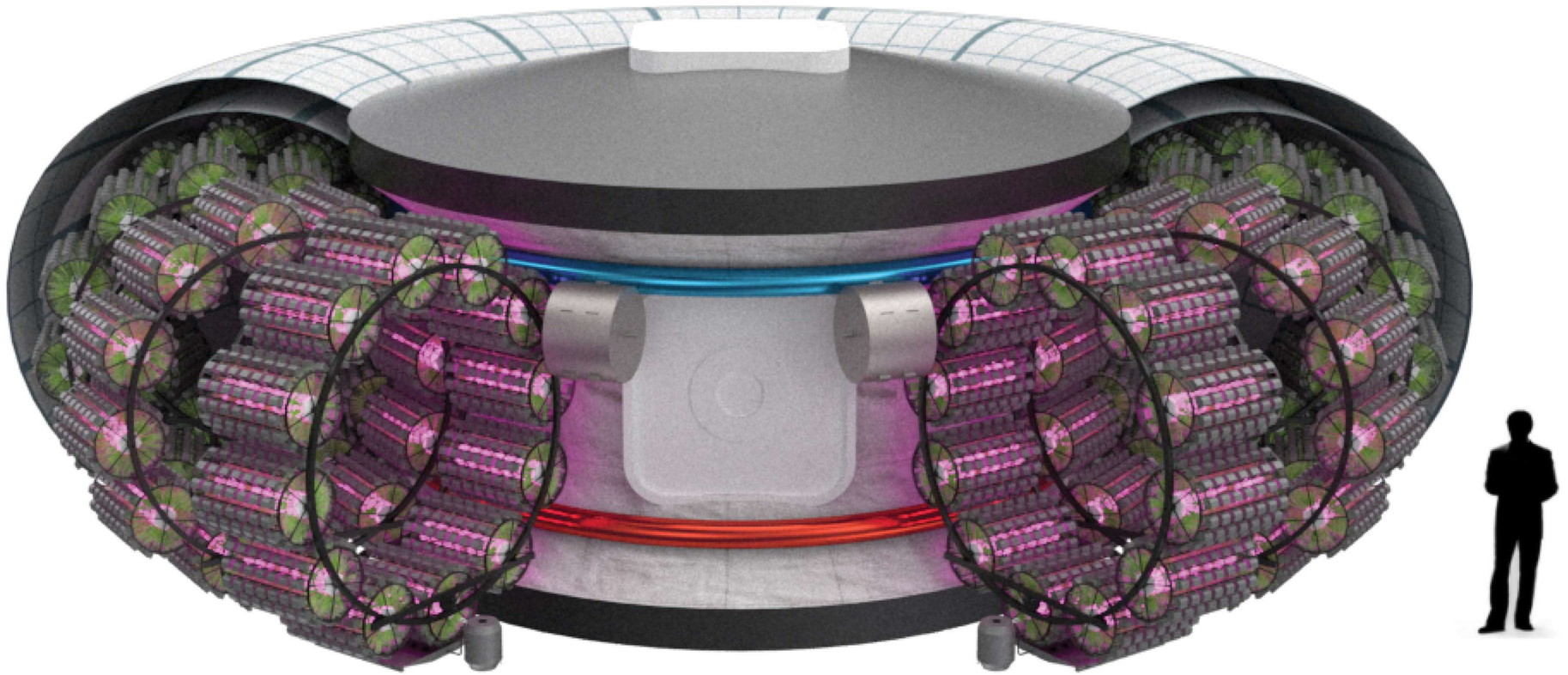




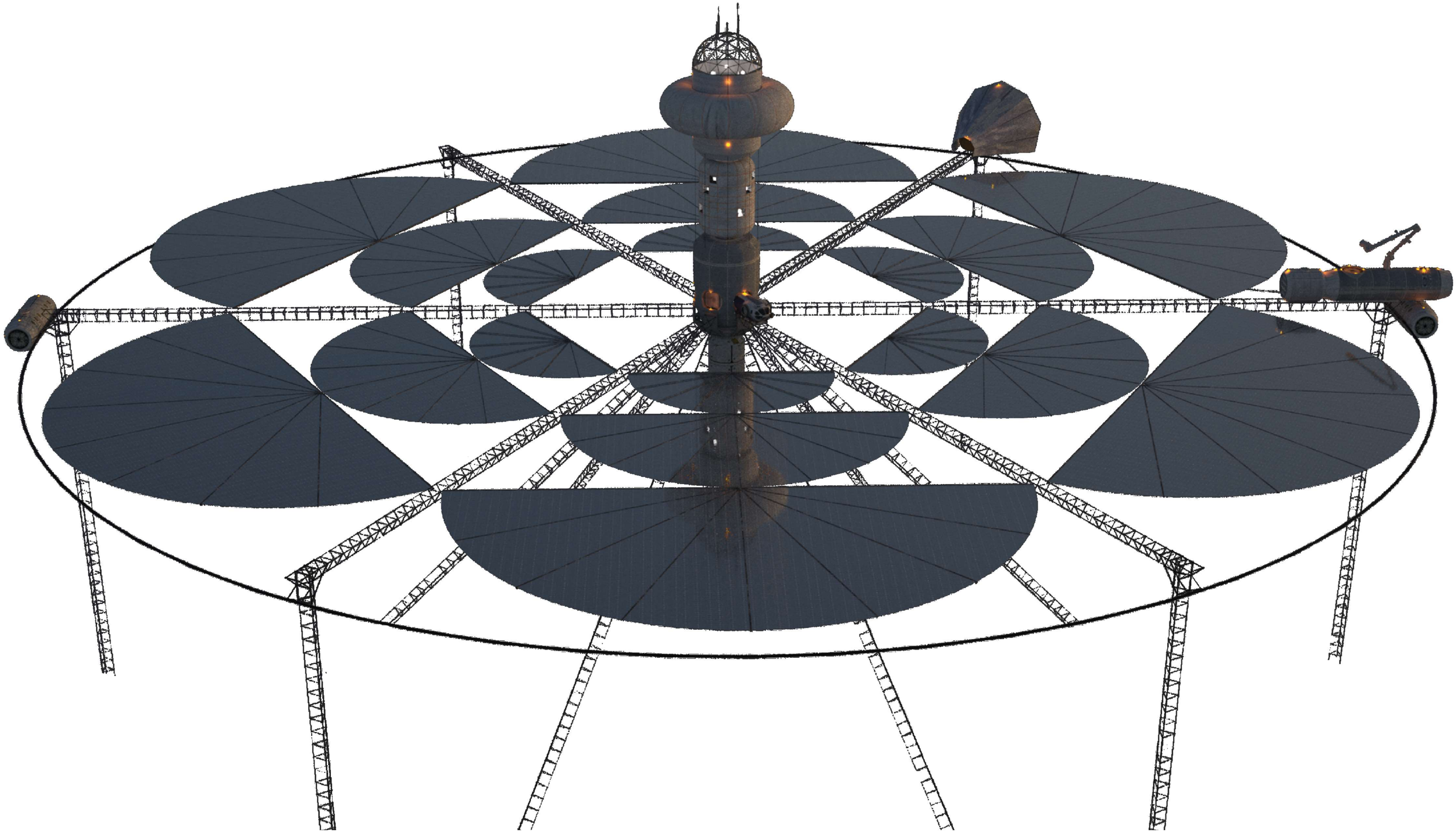
Total weight of the system including =

BOC (w planters)	440	kg
Compost Machine	92	kg
Fans	10	kg
Grinding Machine	15	kg
Furnace	10	kg
Total	5944	kg

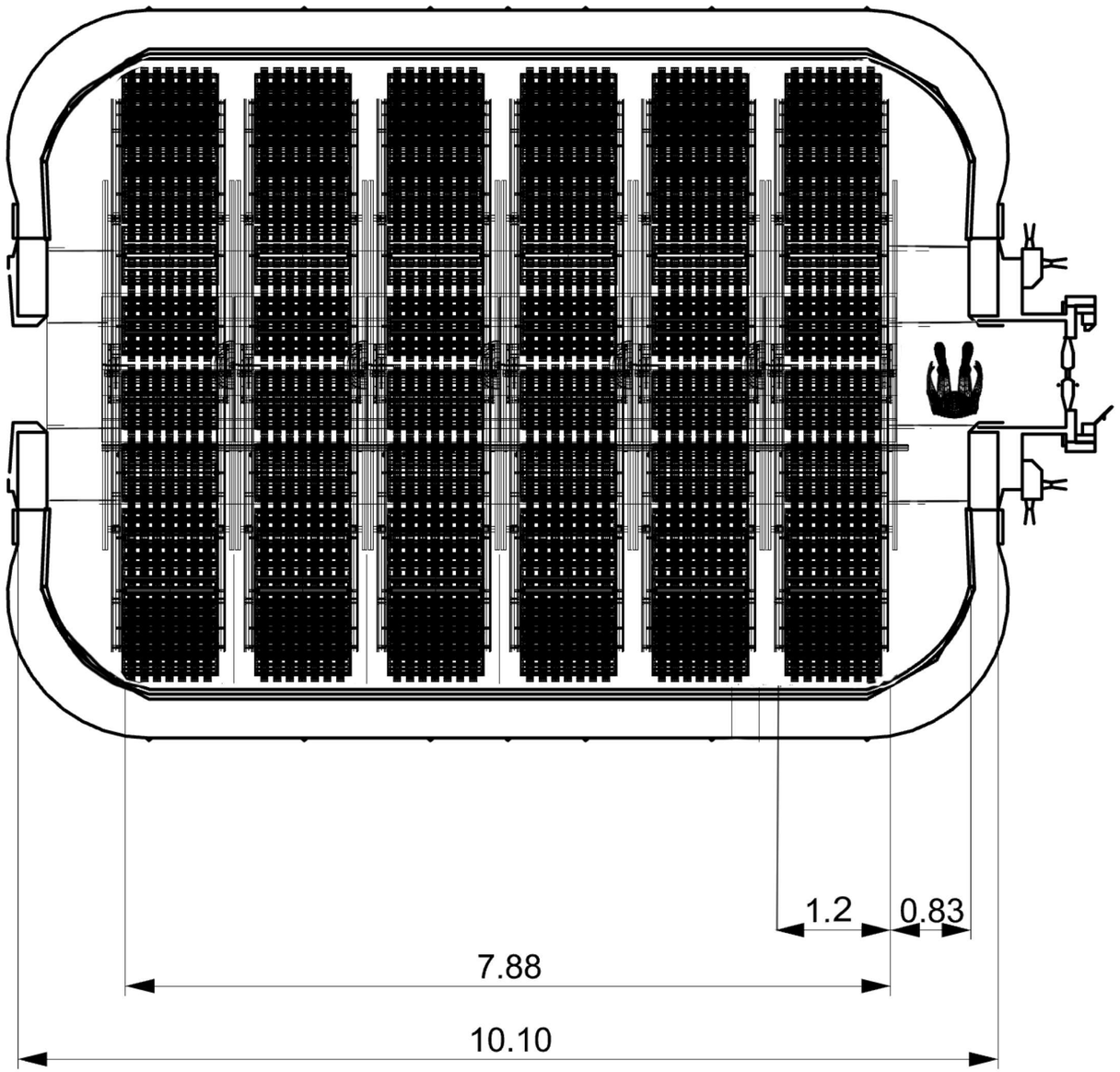
TORUS MODULE WITH BIOSS

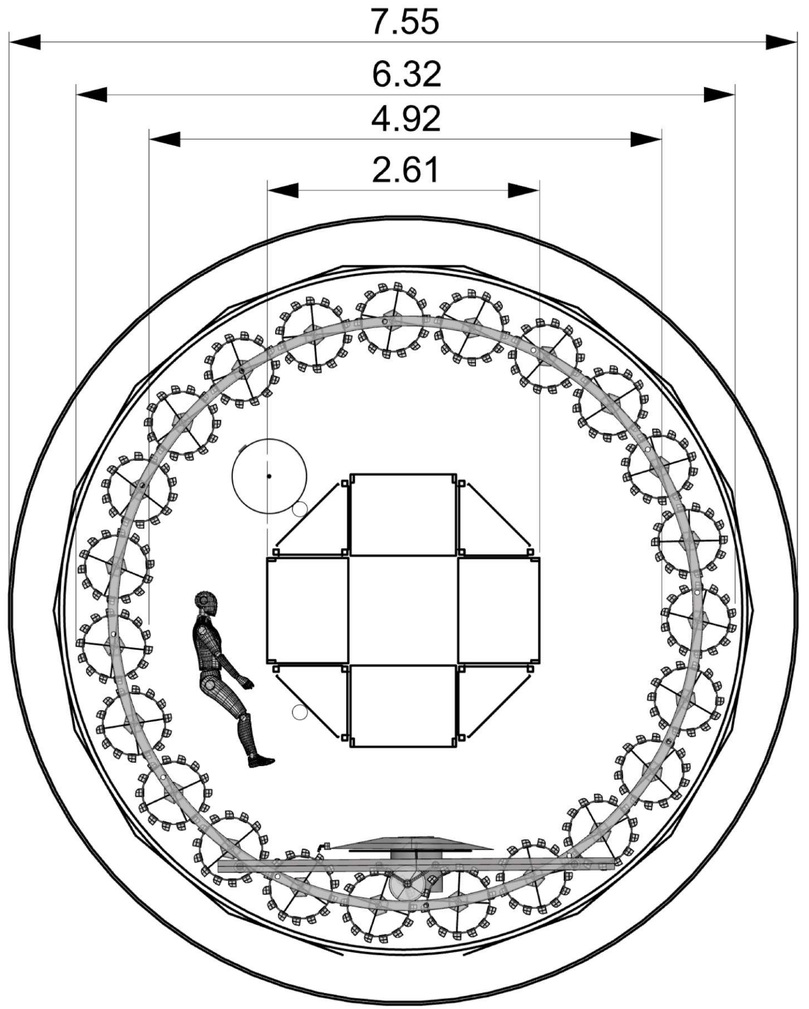


TORUS MODULE WITH BIOSS

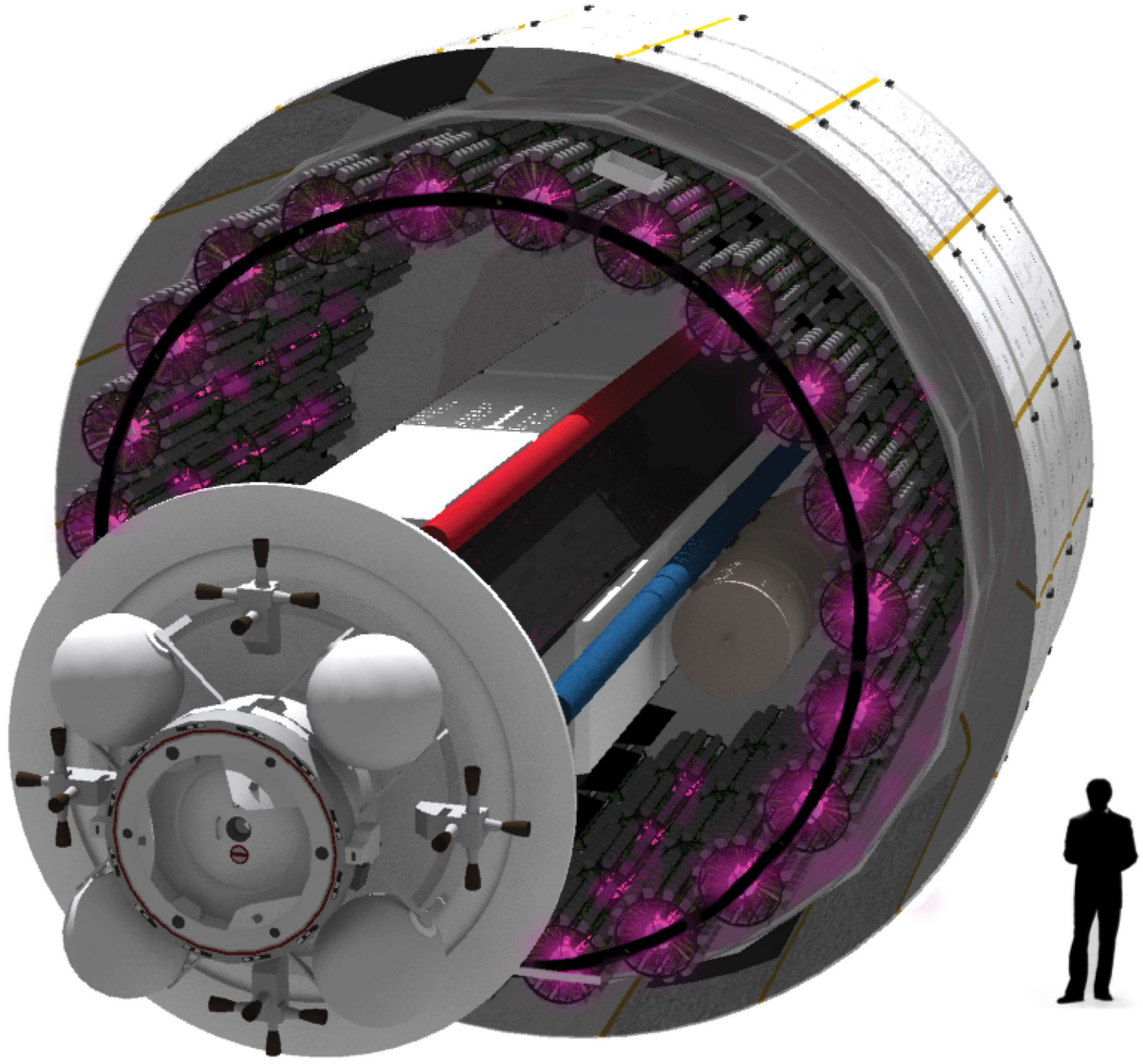


TORUS MODULE WITH THE PHARI BASE

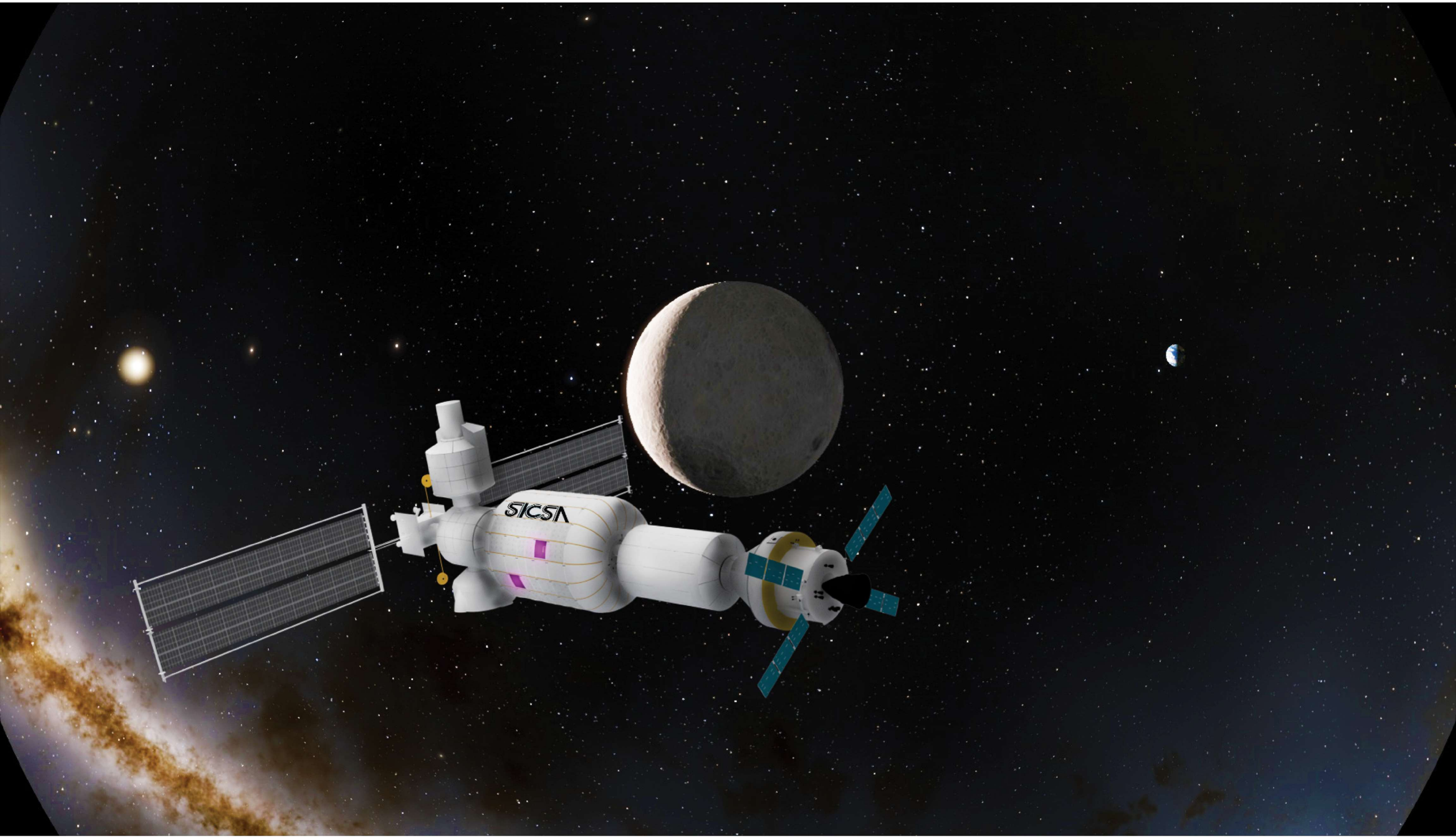




B330 MODULE WITH BIOSS



B330 MODULE WITH BIOSS



LUNAR ORBITAL PLATFORM-GATEWAY WITH BIOSS MODULE

Thank you to all the SICSA department, the University of Houston and the many professionals in the space industry

Special thanks to my wife and my family for supporting me during the course of my study and listening to my stories about rocket landings

IT’S NEVER OVER

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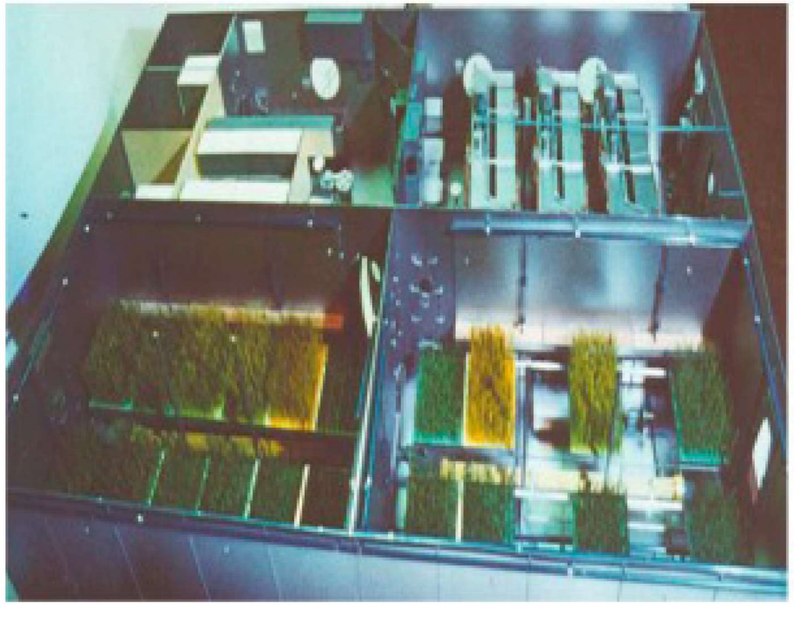
Type Thomas Lagarde

Join me for a presentation at IAC 2018

THANK YOU

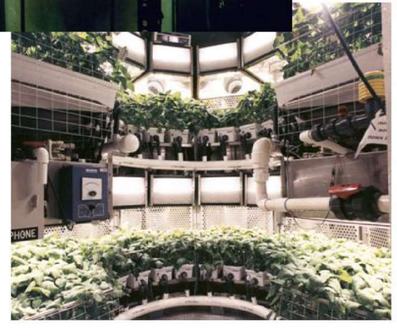


Past NASA Testing in Closed Systems

Ames Research Center
Closed Chamber System

Purdue
University
Minitrons

Johnson Space Center
Variable Pressure Growth Chamber



Kennedy Space Center
Biomass Production Chamber

APPENDIX