

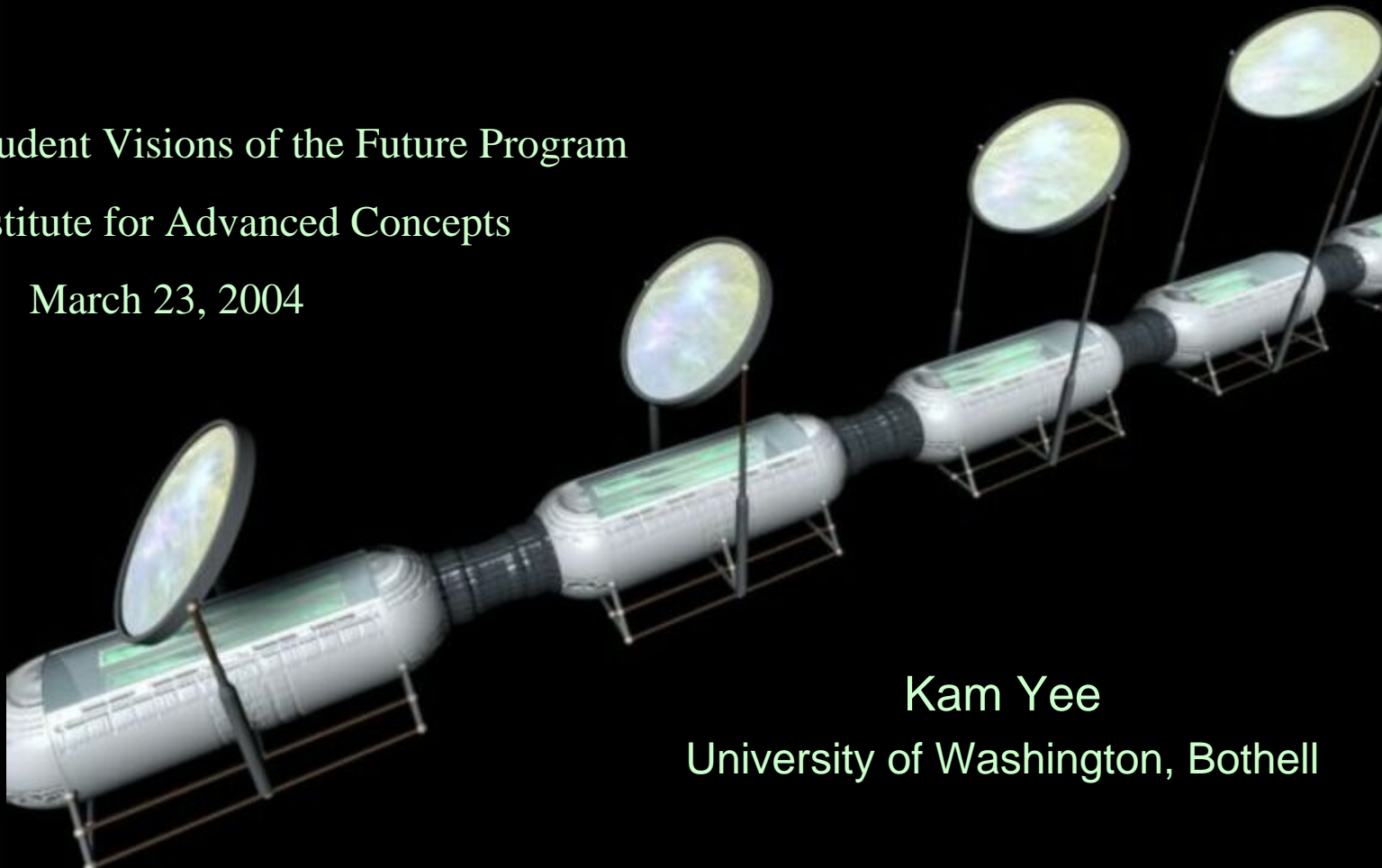
# Verde Base:

## Automated Lunar Greenhouse Concept Development and Simulated Lunar Derived Soil Vegetative Growth Experiment

Report for the Student Visions of the Future Program

NASA Institute for Advanced Concepts

March 23, 2004



Kam Yee

University of Washington, Bothell

# Underground location - Lava tubes



Photo: U.S. Department of Interior,  
U.S. Geological Survey



## Advantages:

- Radiation protection
- Meteoroid shielding
- Natural thermal insulator

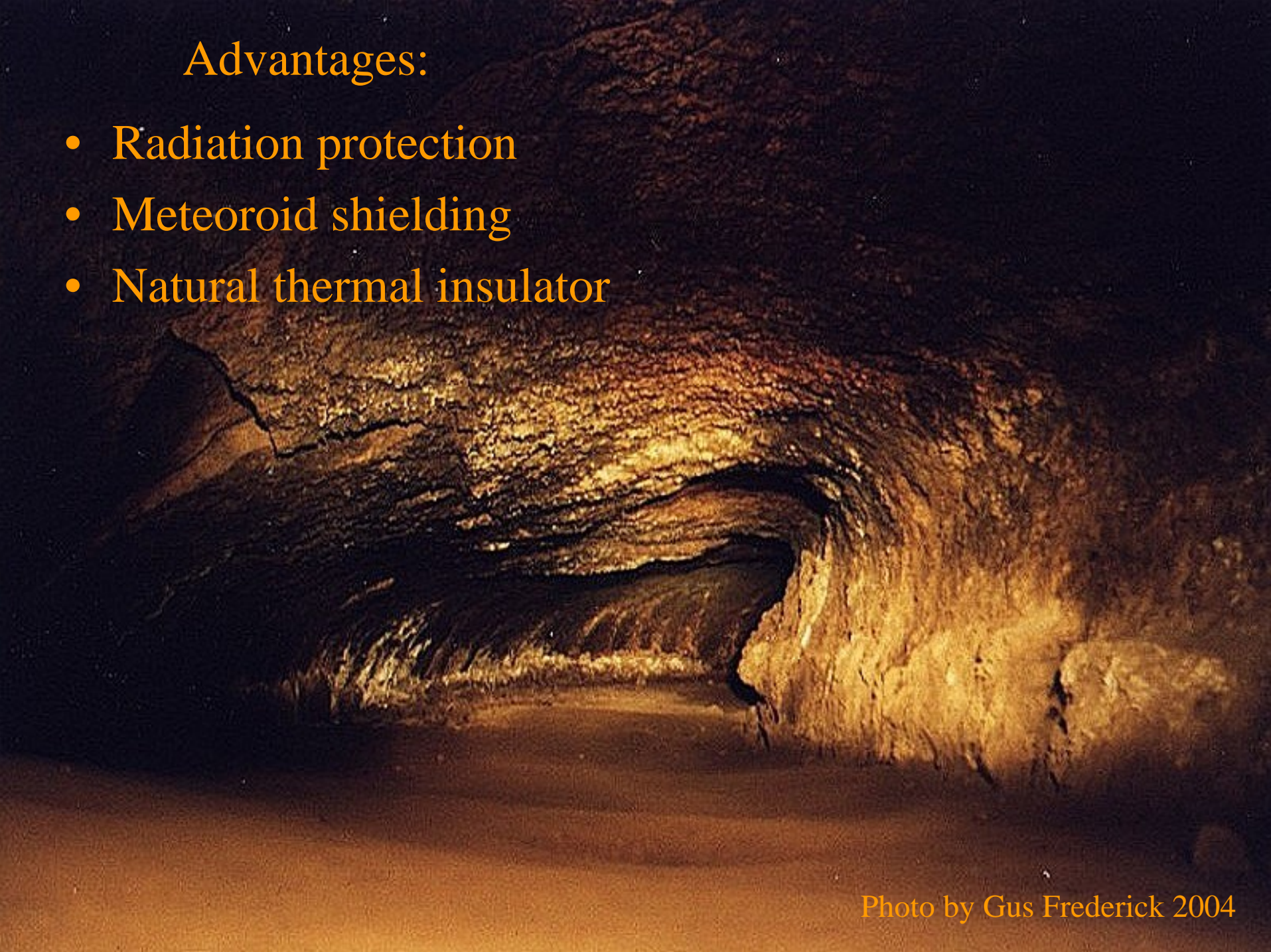
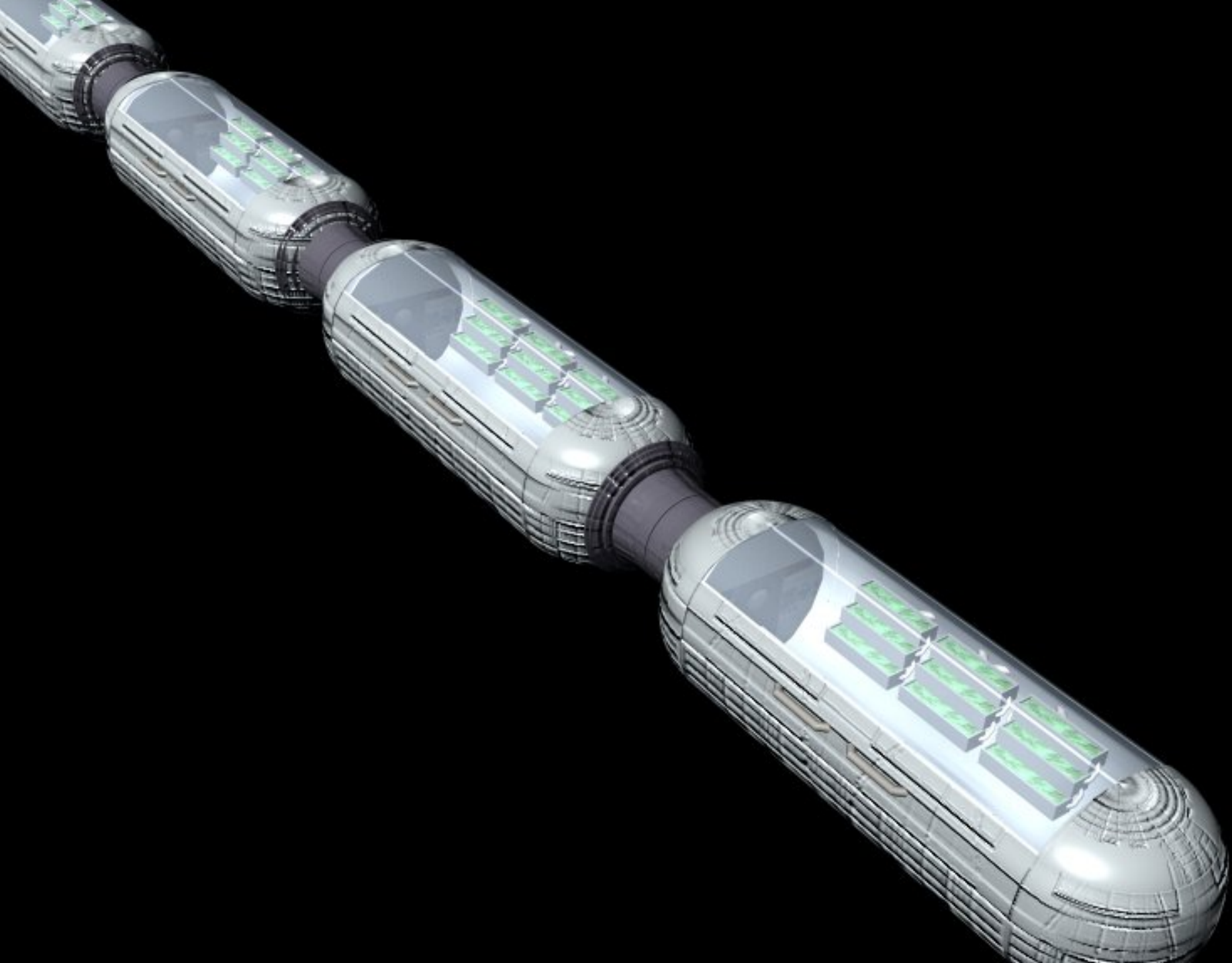
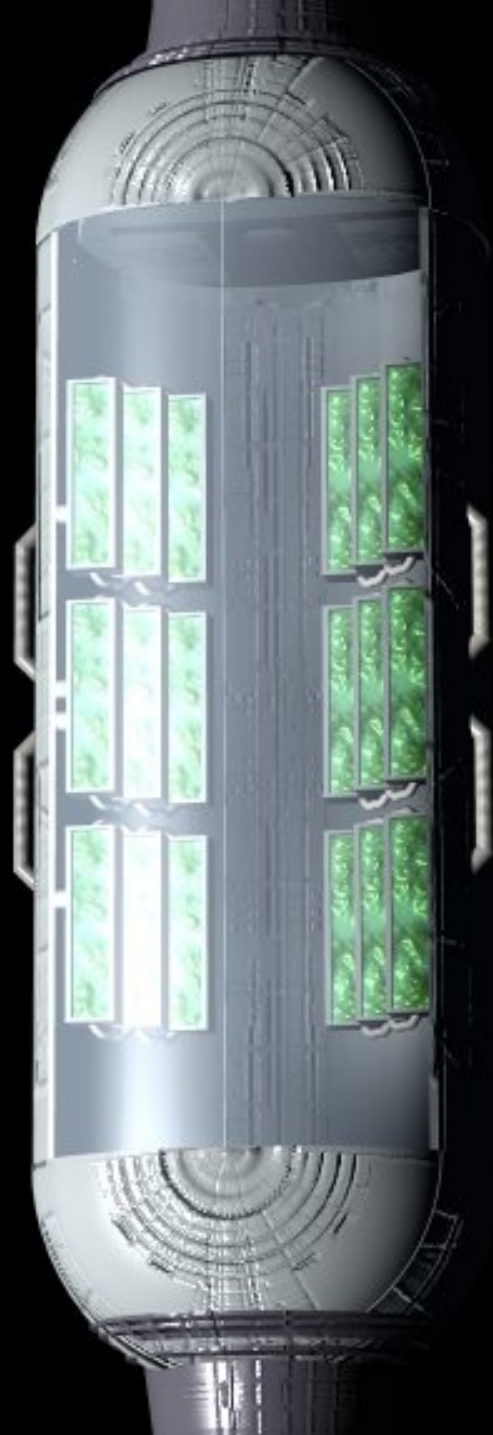


Photo by Gus Frederick 2004

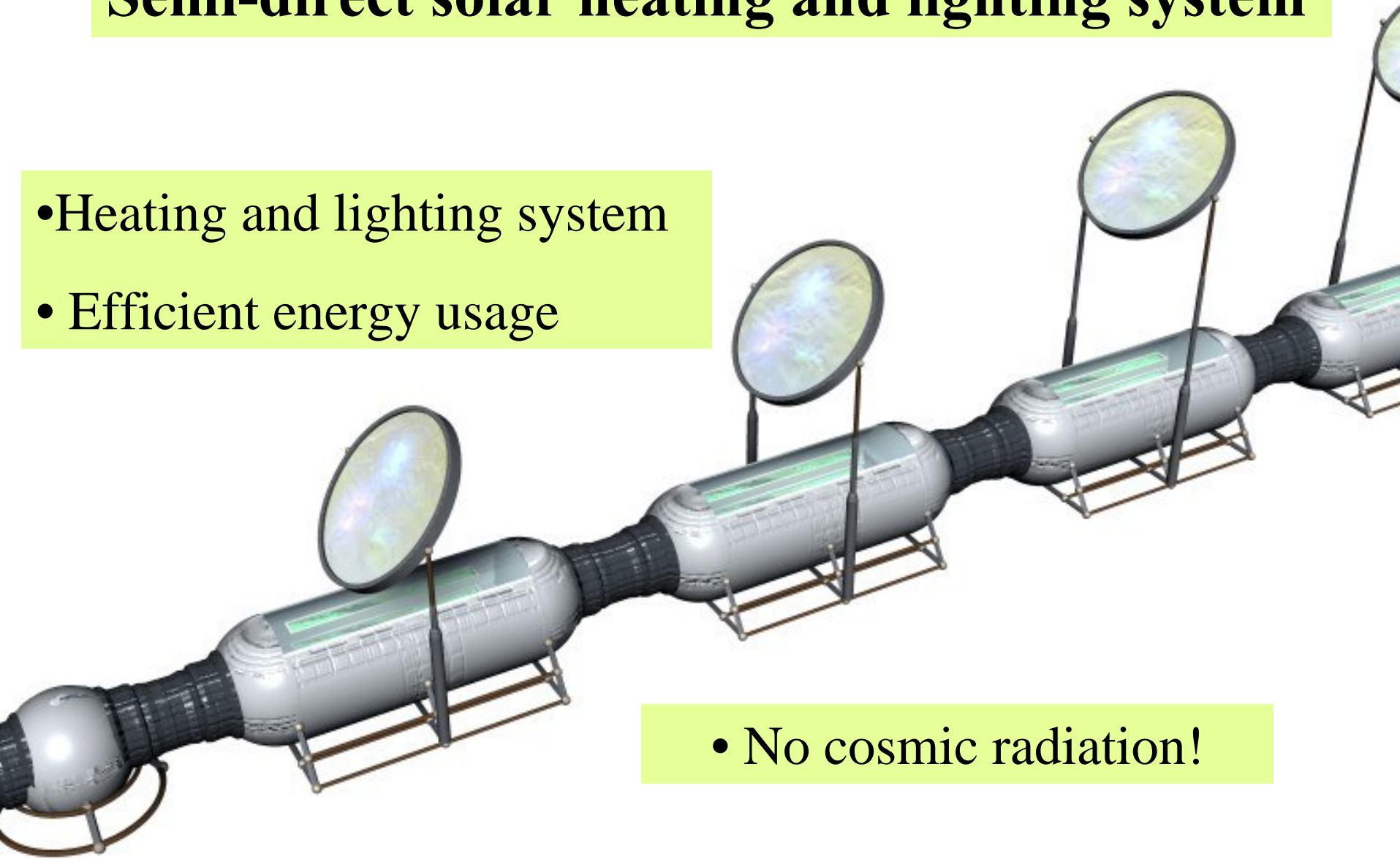




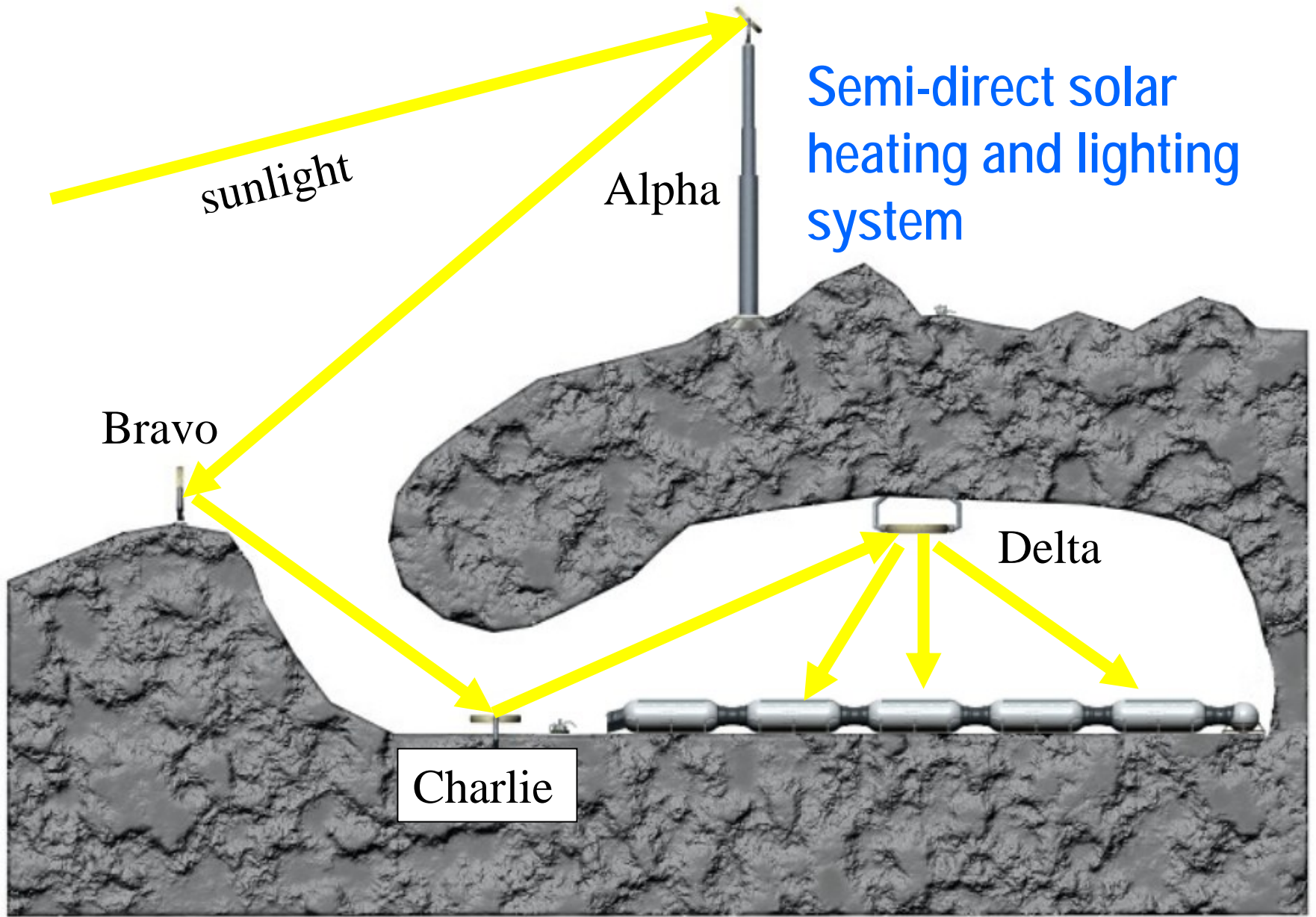


# Semi-direct solar heating and lighting system

- Heating and lighting system
- Efficient energy usage



- No cosmic radiation!



Semi-direct solar  
heating and lighting  
system

sunlight

Alpha

Bravo

Delta

Charlie

# Alpha reflector and tower

Alpha reflector/tower at 30 meters high  
Seen 10 km away

$$\text{Reflector Size} = \frac{P_{\text{tot}} (1.05)^{\text{nr}}}{L_{\text{sun}}}$$

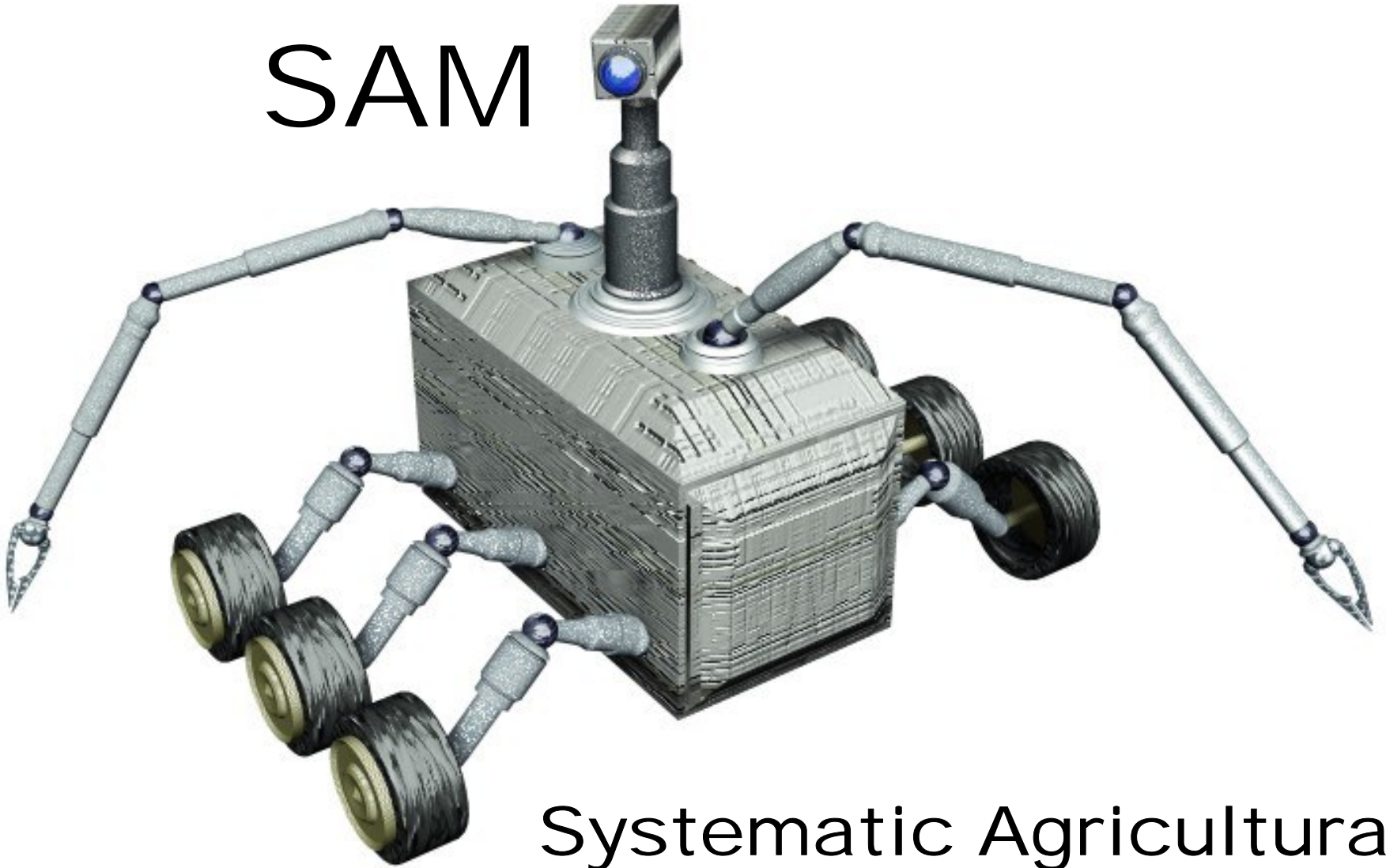
Reflector size  $\geq 4.56 \text{ m}^2$

a) 2.14 m x 2.14 m

b) diameter of 2.4 m



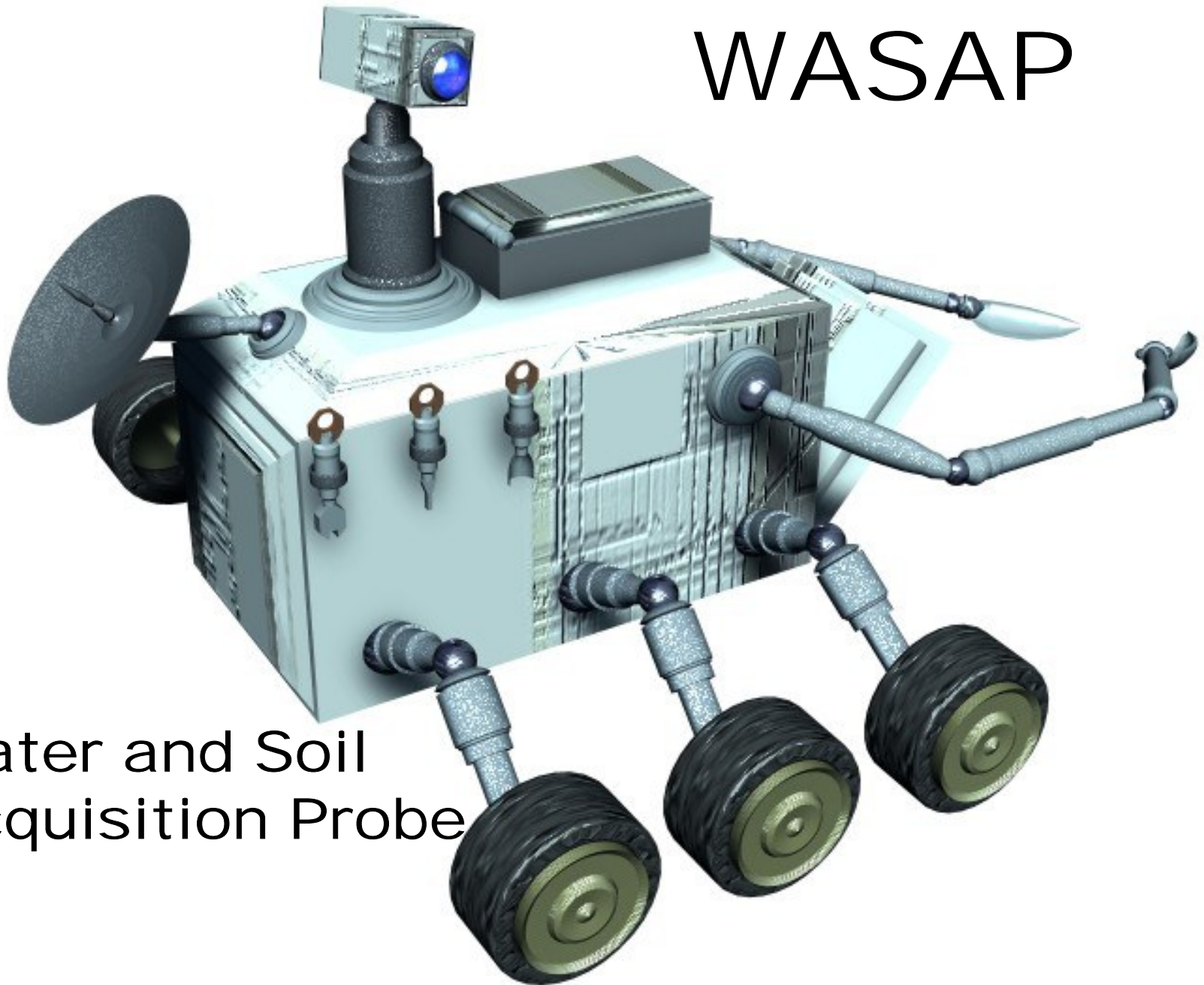
SAM



Systematic Agricultural  
Machine

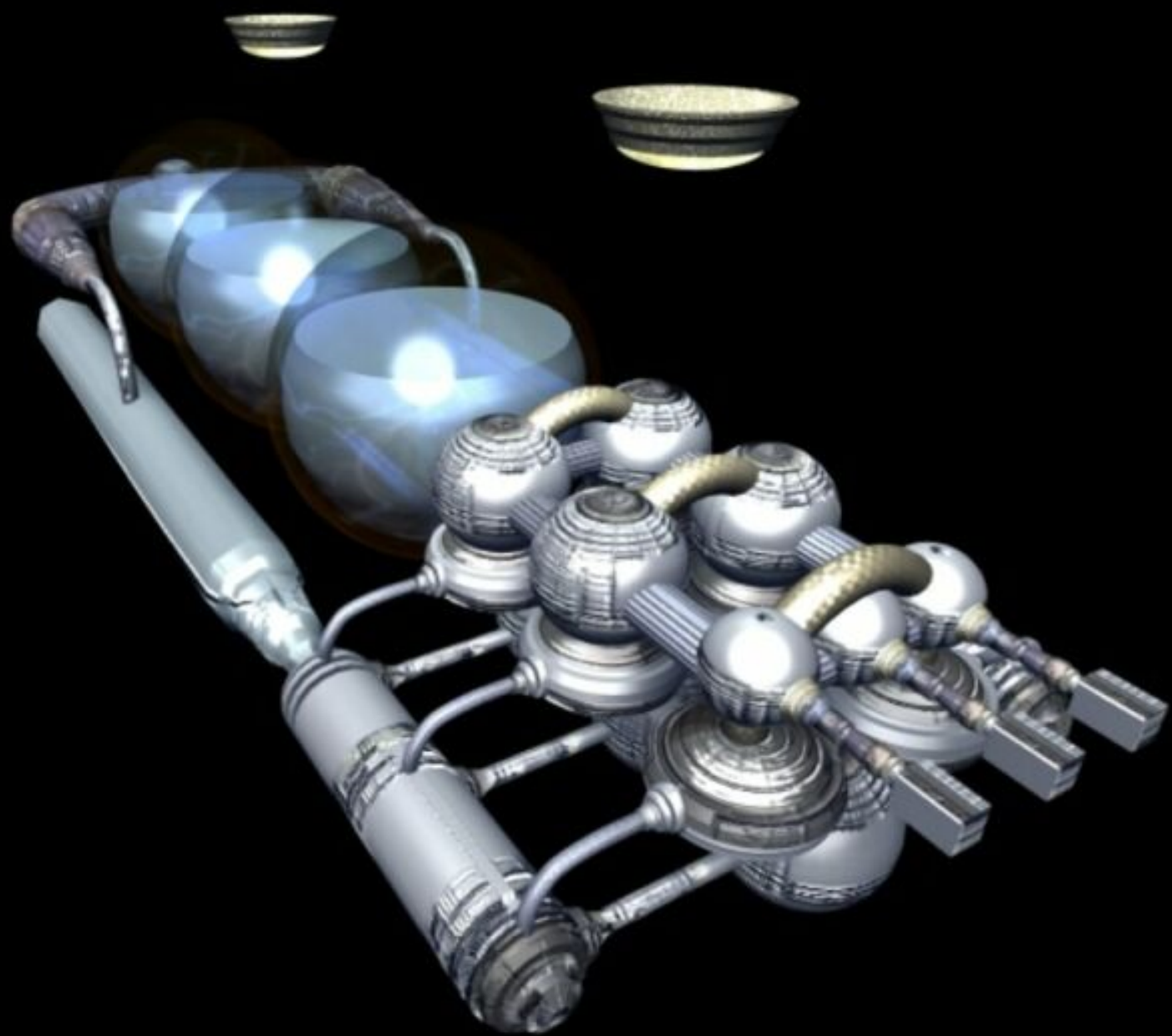
# WASAP

Water and Soil  
Acquisition Probe









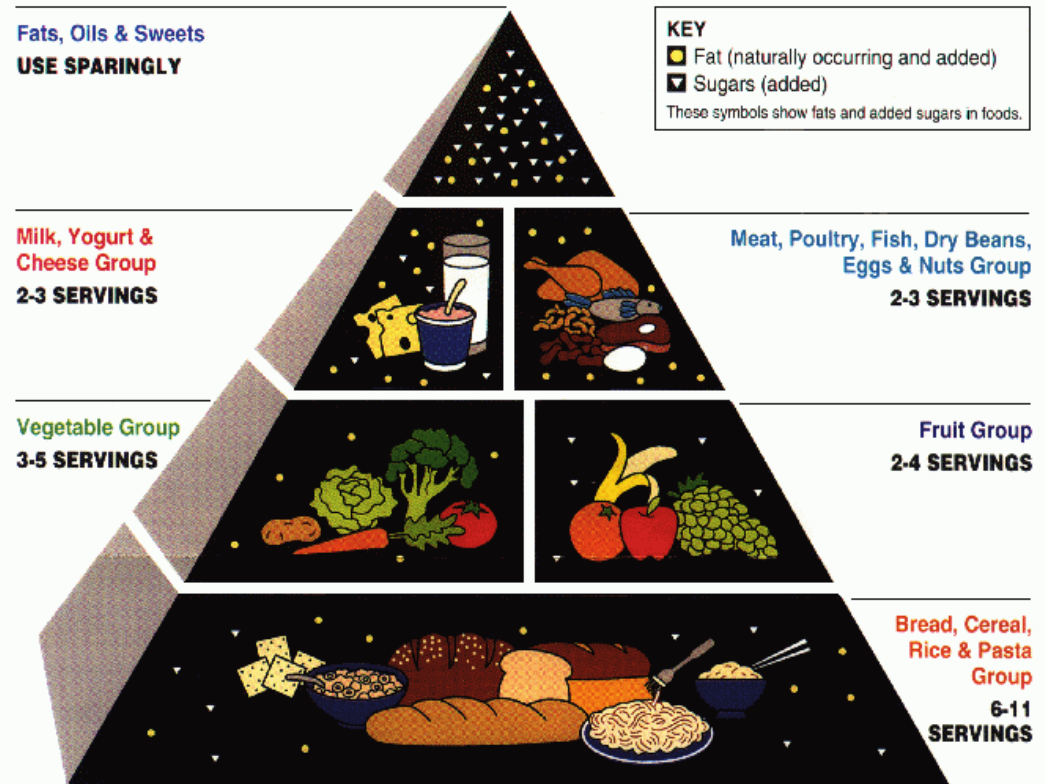


# Starchy Food Requirement

- 6-11 servings of bread group per day/per adult
- 15 grams per serving = 170 grams per person/per day

Grain ~ 1000 – 1500 g/m<sup>2</sup>

Space of 1 module = 30 m<sup>2</sup>



# Food supply duration

8 person crew	1 cycle's yield	1 year's yield
4 Modules	3 ½ months	13 months
6 Modules	5 ½ months	19 months

12 person crew	1 cycle's yield	1 year's yield
6 Modules	3 ½ months	13 months
8 Modules	5 months	17 months



# Lunar-derived soil

## Composting:

- Recycles scarce organic material  
(waste management)
- Produces carbon dioxide
- Gives off heat during decomposition

# Radishes at one week





# Radishes at one month









## Causes?

- Insufficient watering
- Spacing
- High temperature





# Future Work



Undergraduate research



Better simulated lunar-derived soil



Change crop

# Special thanks to:

NASA Institute for Advanced Concepts

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The Museum of Flight

South Seattle Community College

Paul Unwin, Gus Posey, Meredith Hale,  
Dr. Colin Danby, Marjie Vittum-Jones,  
Marty Hale-Evans, Jay Unwin, and my  
family.

**3-D Rendering: Gus Posey**



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