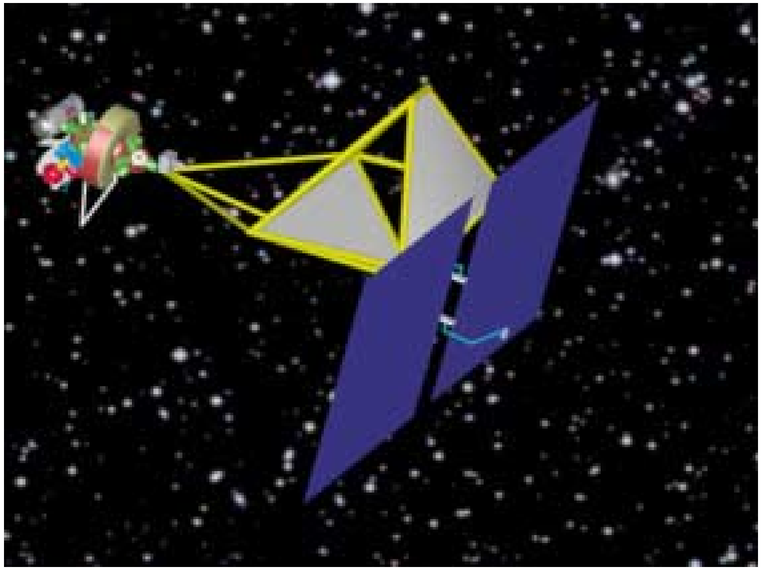
Gateway Habitat Study Update



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JSC Advanced Design Office

20 August 2001

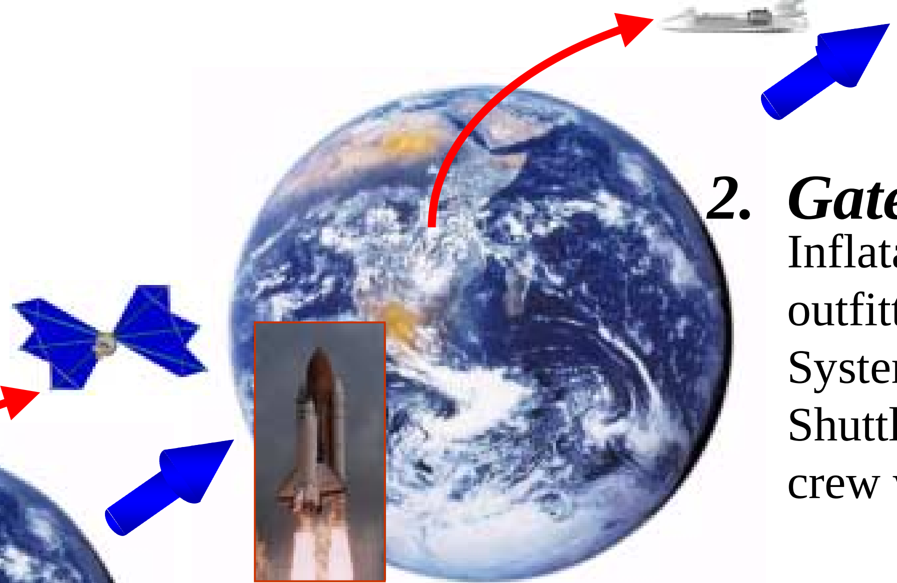
Gateway Habitat Summary

- Crew habitat/safe haven located at Lunar L1
- 15-year minimum design lifetime
- Support crews of four staging telescope construction/servicing and Lunar excursion missions
- Four missions to Gateway per year baselined due to Shuttle launch rate restrictions
- Inflatable technology used for primary structure
- Delivery via Solar Electric Propulsion (SEP) baselined for initial study
- A primary objective is to test and demonstrate technologies for future human exploration

Gateway Hab Deployment

Two Launches Required:
1 Delta IV-Heavy (6.5m fairing)
1 Shuttle

3. *Transit to Lunar L1*



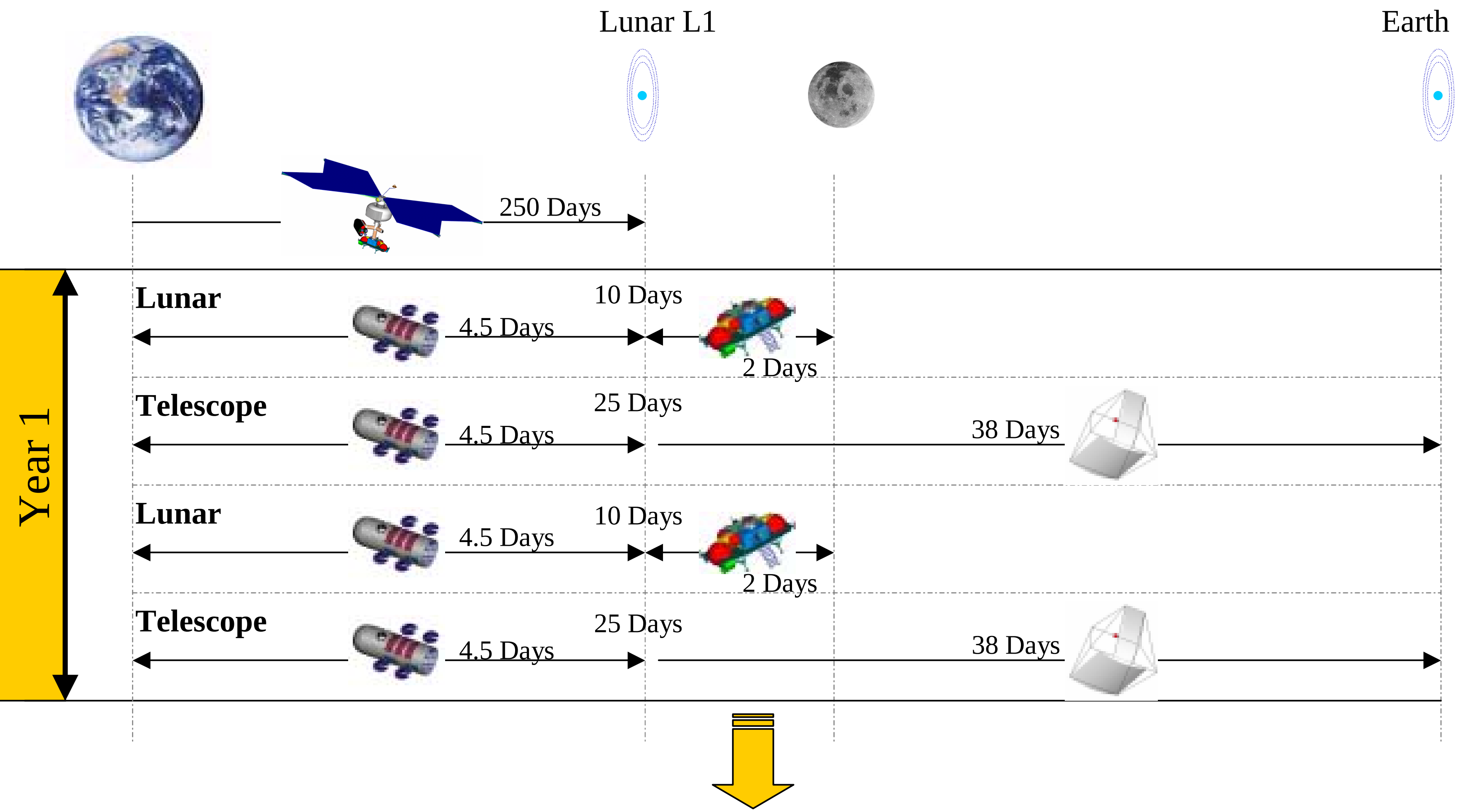
2. *Gateway Outfitting*

Inflatable spacecraft require outfitting missions prior to use. Systems stowed in inflatable core or Shuttle payload module. Shuttle crew will prepare Gateway for use

1. *Launch of Gateway and SEP*

The Gateway and SEP are currently baselined for launch on a Delta IV-Heavy to low-Earth Orbit for maximum payload volume

Mission Profile



Cycle Assumed to Repeat for Program Lifetime

* Shuttle launch rate restrictions dictate number of LTV missions per year

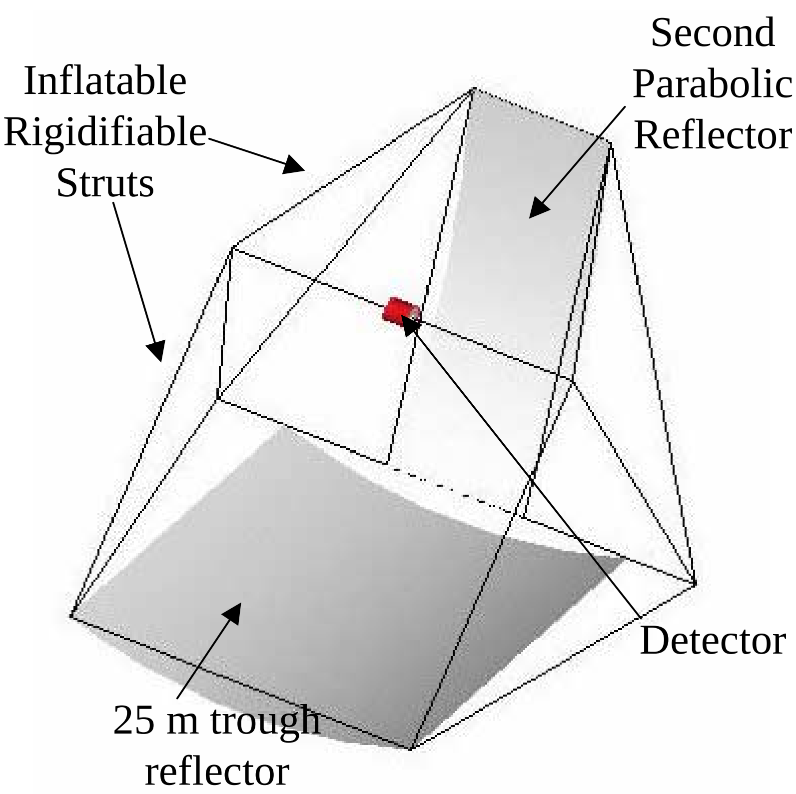
Telescope Construction

Hardware Support

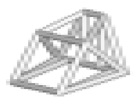
- Docking for crew transfer vehicle and telescope component delivery module
- SSRMS-class large manipulator
- Small, dexterous robot to aid inspections and assembly/maintenance tasks
- EVA Airlock and teleoperator control station
- Unpressurized partially enclosed work area
- Structure/platform to restrain the telescope during work
- EVA and robotic-compatible storage areas for tools and telescope components

Mission Support

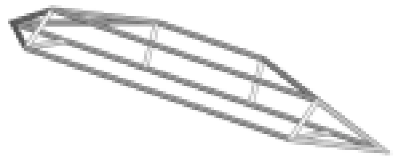
- Complete assembly at Lunar L1: **2 weeks** for **2 teams** of EVA crew; **6-8 EVA sorties**
- For telescope maintenance missions, assume **1 team** of EVA crew for **2 weeks**
- **Total Mission Time at Gateway: 25 days**



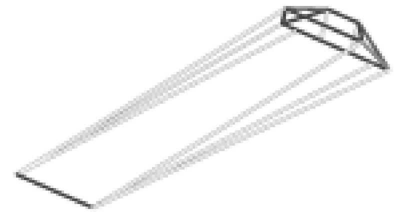
Telescope Construction



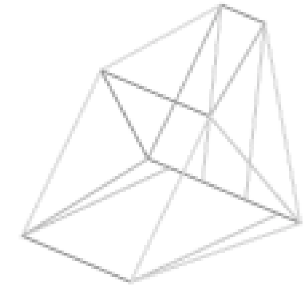
1. Assemble 1/10 Scale Uninflated Truss



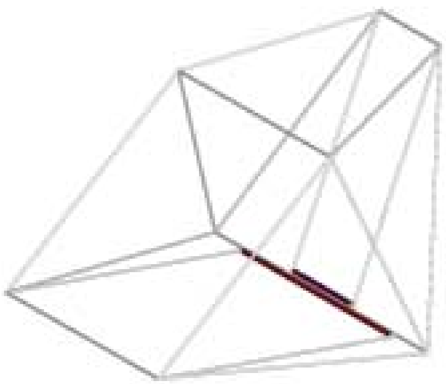
2. Inflate and Rigidify y-axis Beams (3)



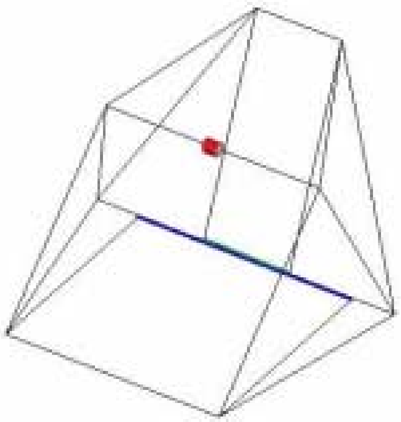
3. Inflate and Rigidify Lower Prow Beams (2)



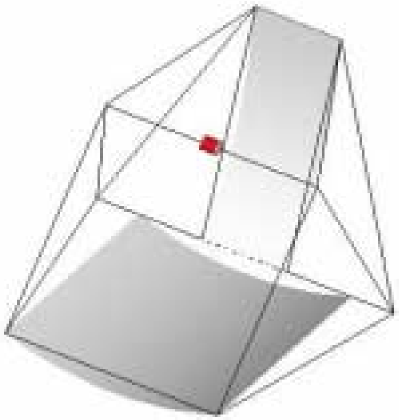
4. Inflate and Rigidify Upper Prow Beams (2)



5. Install Stowed Rolls of Mirrors (2)



6. Integrate ORU's on Truss Nodes



7. Deploy Stowed Rolls of Mirrors (2)

- L2 Filled Aperture Infrared Reflector (FAIR) Telescope
- **Note**: The intent is not to come up with a telescope design, but rather to scope the tasks, tools, and number of EVAs required!!
- Total EVA: 6-8 sorties, 2 weeks for 2 teams of EVA crew
- Source: Richard Fullerton, JSC/XA

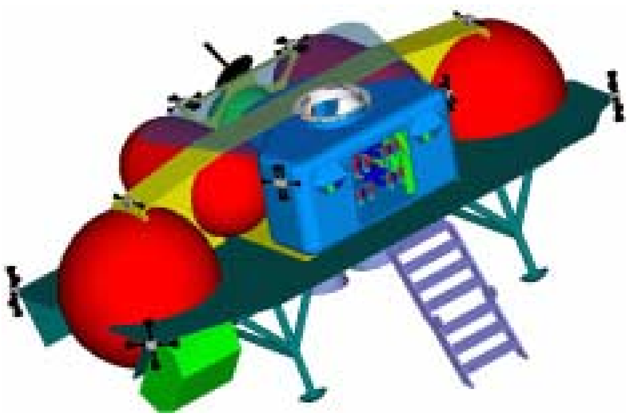
Lunar Mission

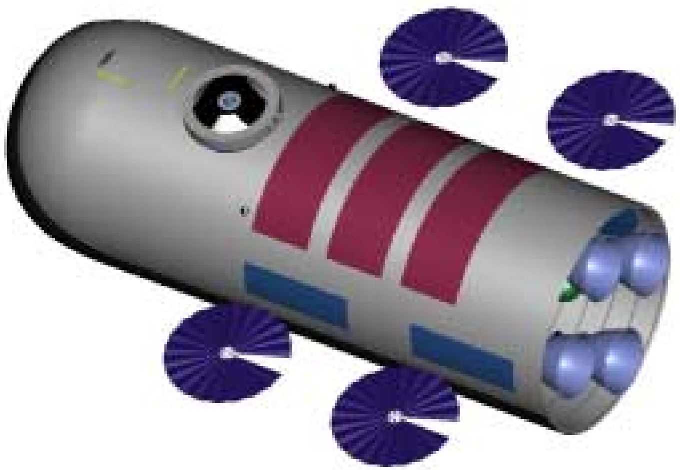
Hardware Support

- Docking for crew transfer vehicle and 3-day Lunar Lander
- Small manipulator for relocating assets?
- EVA Airlock?

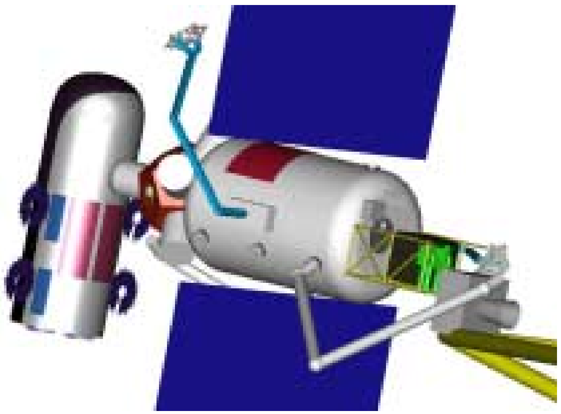
Mission Support

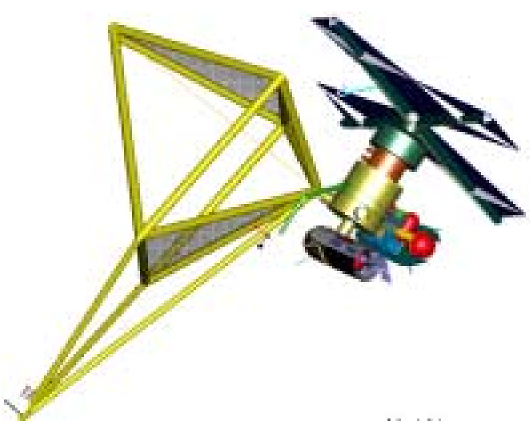
- **3-Day** Lunar surface excursion: **Crew support for 10 days**, LTV support for 18 days
- **30-Day** Lunar surface mission: **Crew support for 12 days**, LTV support for 47 days
- Dormant Lunar Lander support for up to six consecutive months

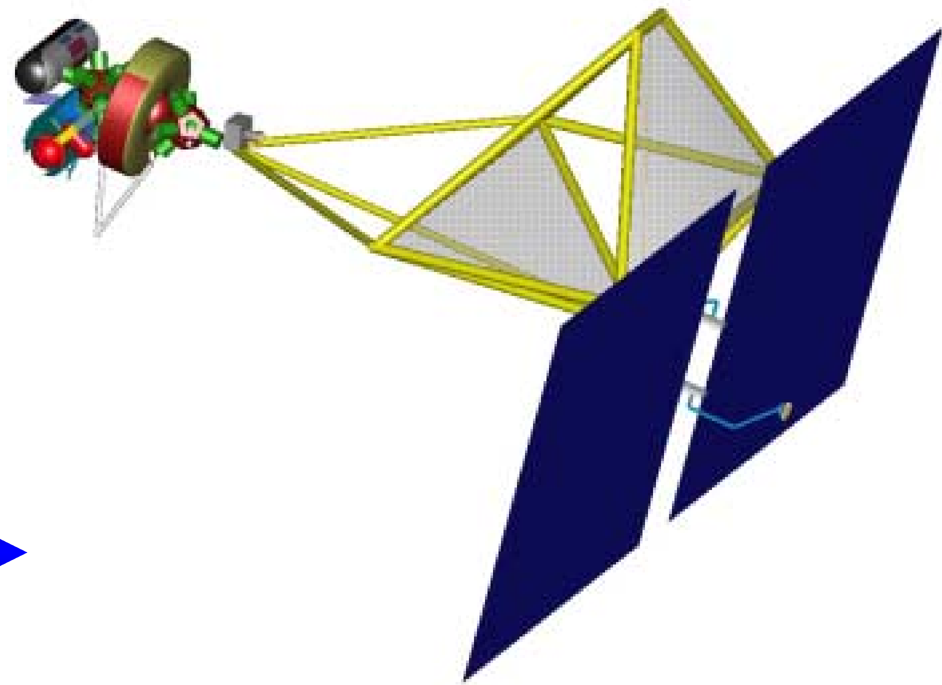




Evolution of Concept



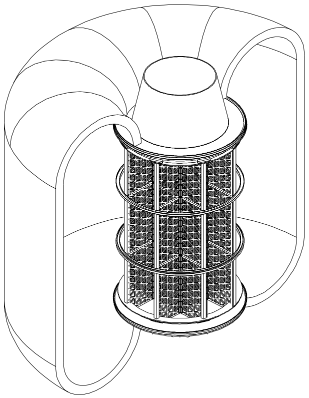




The Advanced Design Team will investigate a hybrid concept which utilizes both inflatable and rigid materials for the external structure

Technologies

➢ A Primary Objective of the Gateway Habitat is to Demonstrate and Test Technologies for Future Human Exploration



Inflatable Structures may prove valuable for future exploration by reducing mass and packaging volume while providing large crew volumes Gateway Habitat will demonstrate:

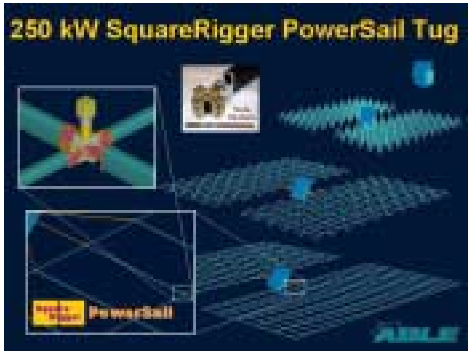
•Inflatable materials

•Operation of inflatables across all mission phases

Robotic Manipulator Systems can be used to assemble and maintain large astronomical facilities in deep space, or to aid humans in complex EVA tasks

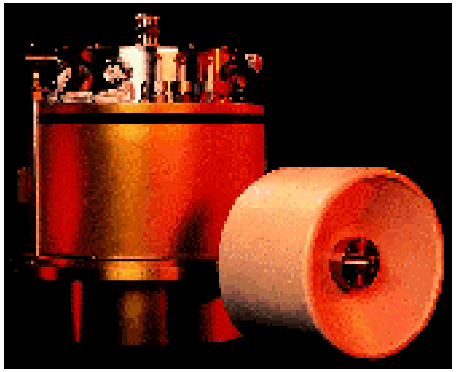
Robonaut, a small, dexterous robot, may assist humans by performing repetitive EVA tasks and remote operation/maintenance of spacecraft systems

Technologies (Cont.)



Advances in **Photovoltaics** promise increased radiation hardness, efficient packaging, lower mass, and greater conversion efficiencies. Human exploration missions will require high power generation for complex systems

Efficient electric propulsion systems like **Hall Effect Thrusters** may be used to deliver large unmanned payloads, thus reducing propulsive requirements and total architecture mass



Flywheels may provide coupling of energy storage and attitude control systems, thus reducing total vehicle mass, cost, and complexity

Dedicated energy storage technologies such as **Thin Film Lithium-Ion Batteries** are needed for meeting the significant power requirements of HEDS applications. 6x reductions in mass can be expected

Technologies (Cont.)

Inflatable Airlocks can provide routine EVA capability and atmosphere reclamation while reducing volume and mass requirements

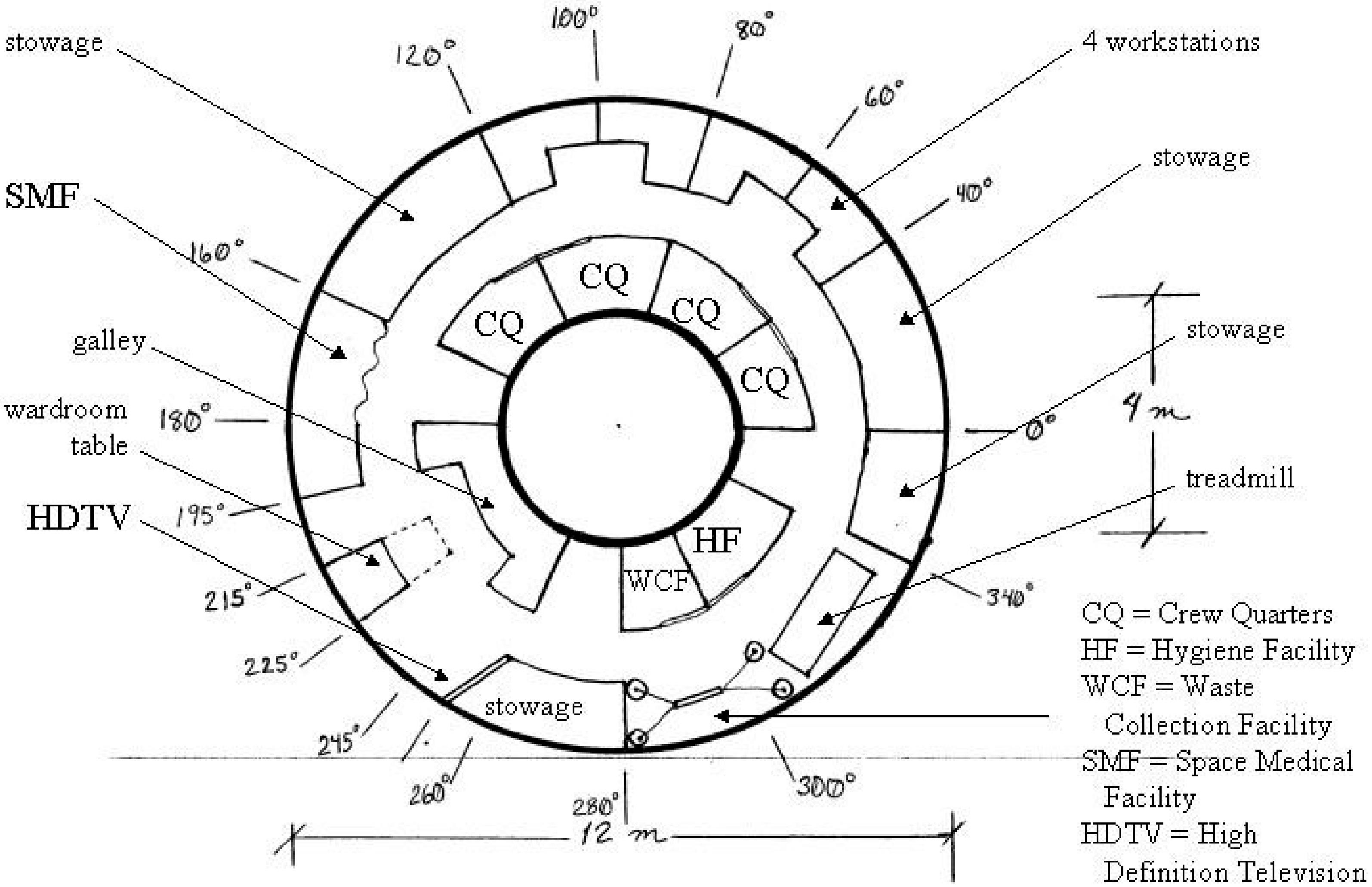
Closed-Loop Life Support is needed for long-duration human exploration to reduce total mass. Areas include atmosphere revitalization, water reclamation, and waste processing

For future exploration, advances in **EVA** technologies are needed for mobile, dexterous operations. Suit designs for Lunar and Martian surface exploration can be used at the Gateway

Efficient **Thermal Radiators** are needed to reject heat from high power, large volume exploration spacecraft. Flexible radiators offer mass reduction and increased placement options

High bandwidth requirements of long-distance communication are met with **Inflatable Antenna** technologies. These structures offer mass and packaging savings over traditional antennae

Interior Layout



Where We Are

- Gateway Requirements
  - Developed top-level requirements to meet mission objectives
  - Developed N^2 chart to identify inter-dependencies between sub-systems
  - Developed sub-system requirements
- Gateway Configuration
  - Performed trade study of inflatable vs. rigid structures
    - Study will investigate inflatable option first
    - Possible Hybrid design?
- Gateway Sub-system Technologies
  - Identify cutting-edge technologies capable of meeting sub-system requirements and beneficial for future human exploration
- Gateway Sub-system Detailed Design
  - Identify the optimal technology for each sub-system
  - Perform parametric sizing of each sub-system

What We Need

- Detailed Telescope Concept
  - Need better-defined program requirements; i.e. total number of telescopes to be built, construction rate, telescope component delivery concept
  - JPL Team X sessions August 29-31 can be used to provide inputs from EVA and Robotics discipline leads
- Solar Electric Propulsion (SEP) Vehicle Configuration
  - GRC Team will provide this design to JSC
  - Final configuration is needed to determine launch and outfitting operations
  - SEP and Gateway Habitat design should be an iterative process
- Gateway Science Definition
  - To be considered after first Gateway Habitat design iteration?

Requirements

See attached documents,
Gateway_Requirements_v3_0.doc and
Gateway_FAM.xls,
for detailed Gateway Habitat requirements