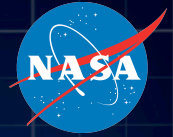


National Aeronautics and Space Administration



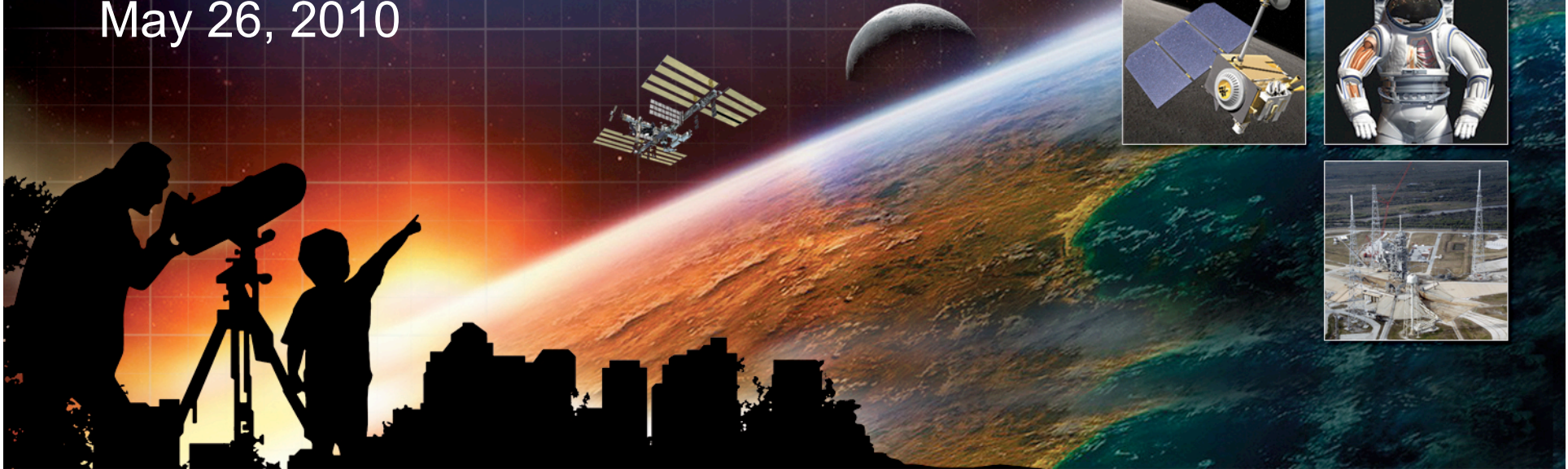
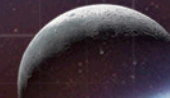
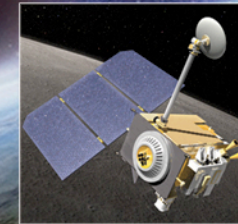
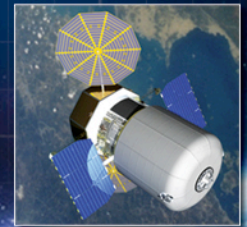
A New Space Enterprise of Exploration

Tony Sang

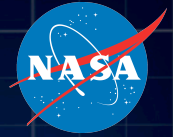
Gary Spexarth

FTD #3: Inflatable Module Mission

May 26, 2010

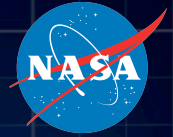


Disclaimer



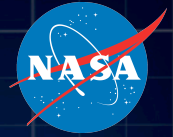
- This chart set was presented on May 26, 2010 at the NASA Exploration Enterprise Workshop held in Galveston, TX. The purpose of this workshop was to present NASA's initial plans for the potential programs announced in the FY2011 Budget Request to industry, academia, and other NASA colleagues. Engaging outside organizations allows NASA to make informed decisions as program objectives and expectations are established.
- The following charts represent at "point of departure" which will continue to be refined throughout the summer and the coming years. They capture the results of planning activities as of the May 25, 2010 date, but are in no way meant to represent final plans. In fact, not all proposed missions and investments fit the in budget at this time. They provide a starting point for engagement with outside organizations (international, industry, academia, and other Government Agencies). Any specific launch dates and missions are likely to change to reflect the addition of Orion Emergency Rescue Vehicle, updated priorities, and new information from NASA's space partners.

Agenda



- Road Map
- NGOs
- RFI Description
- Point of Departure
- Mission Scenario Concept
- Final Comments and Questions
- Contacts

Inflatable Module Mission Statement



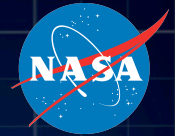
The Inflatable Mission Module provides the demonstration of a human-rated flexible, deployable module for habitation & storage in the space environment under full structural and human applied loads.

Begins as structural demonstrator, evolves to advanced systems accommodation module, AR&D, ECLSS, EVA suitport, and other interfaces.

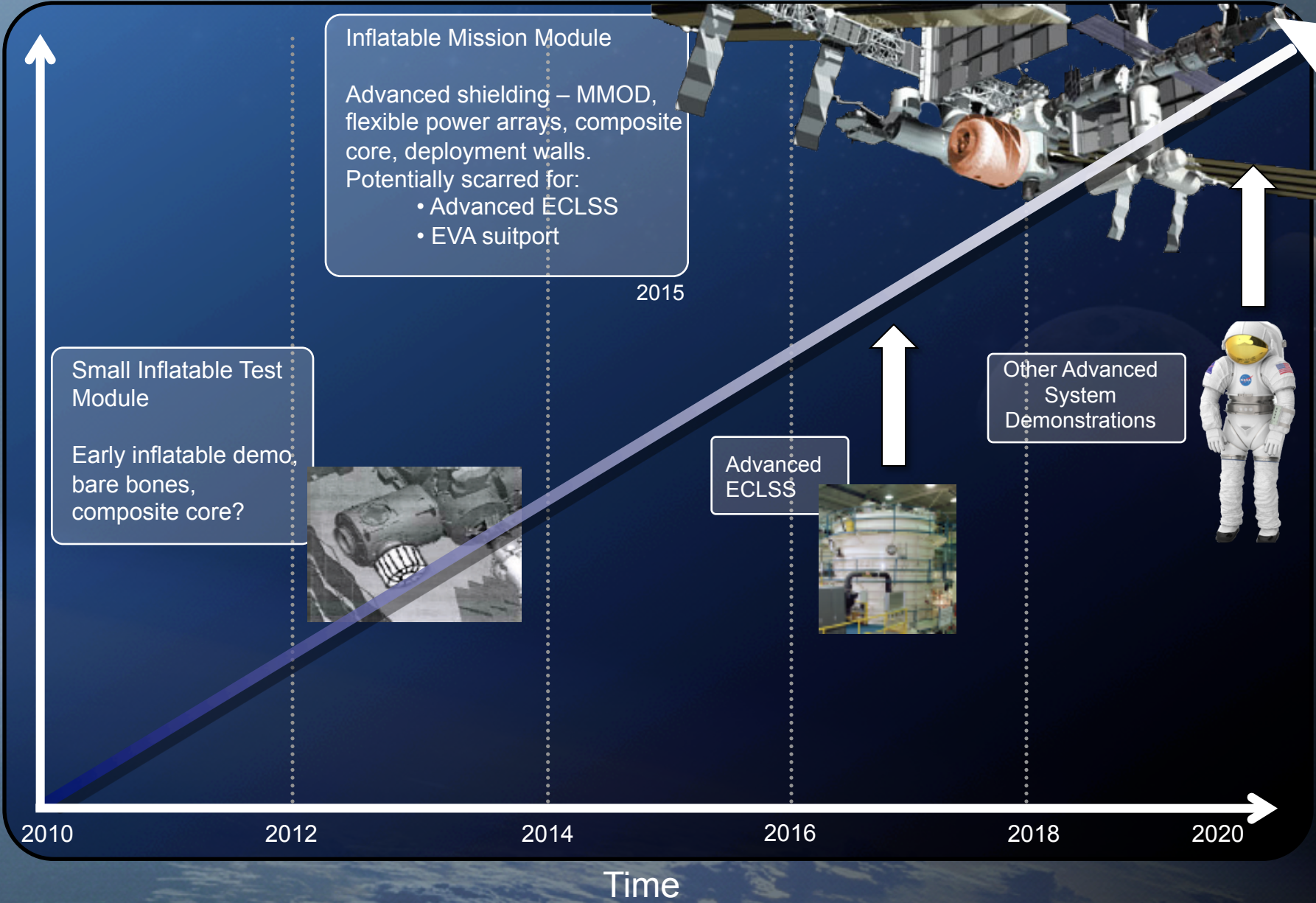
- **Notional Key Mission Milestones:**

- Start-up 2011
- *Small Structural inflatable on ISS (2013) TBD*
- Large Inflatable mission module launched and attached to International Space Station in 2015
- ECLSS closed-loop system delivered post 2015
- Mission Duration: end of ISS life (2020)

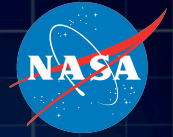
Inflatable Module Mission Capability Roadmap



Technology Maturation and Closure

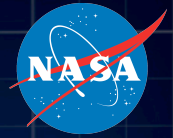


Mission Technical Goals



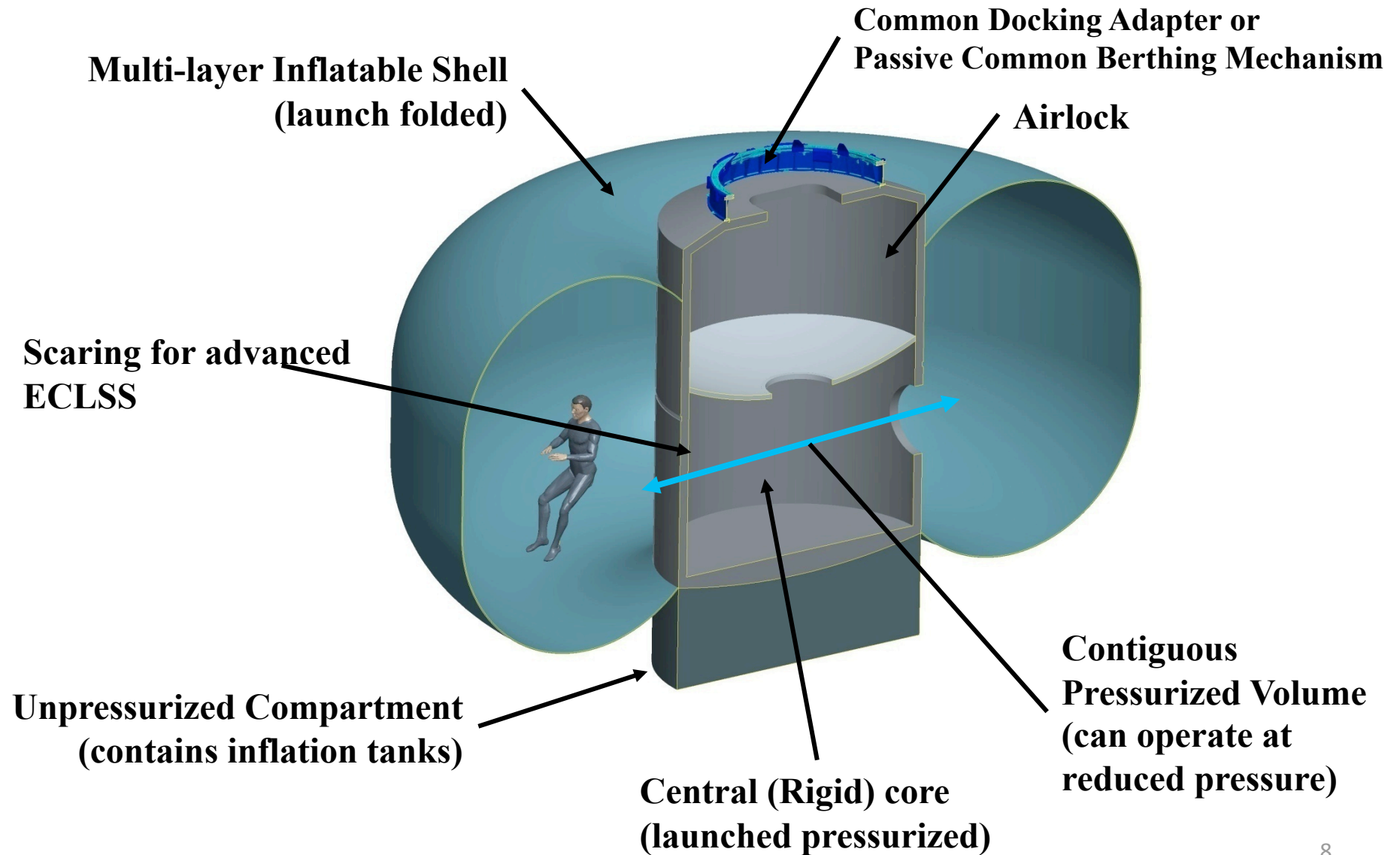
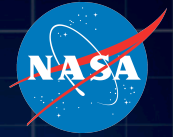
- Technology Goal 2: Advance, demonstrate and integrate technologies needed for lightweight/inflatable modules
- Technology Goal 3: Advance, demonstrate, integrate, and certify technologies needed for Automated/Autonomous Rendezvous and Docking.
- Technology Goal 4: Advance, demonstrate and integrate technologies needed for closed loop life support

Goals and Objectives

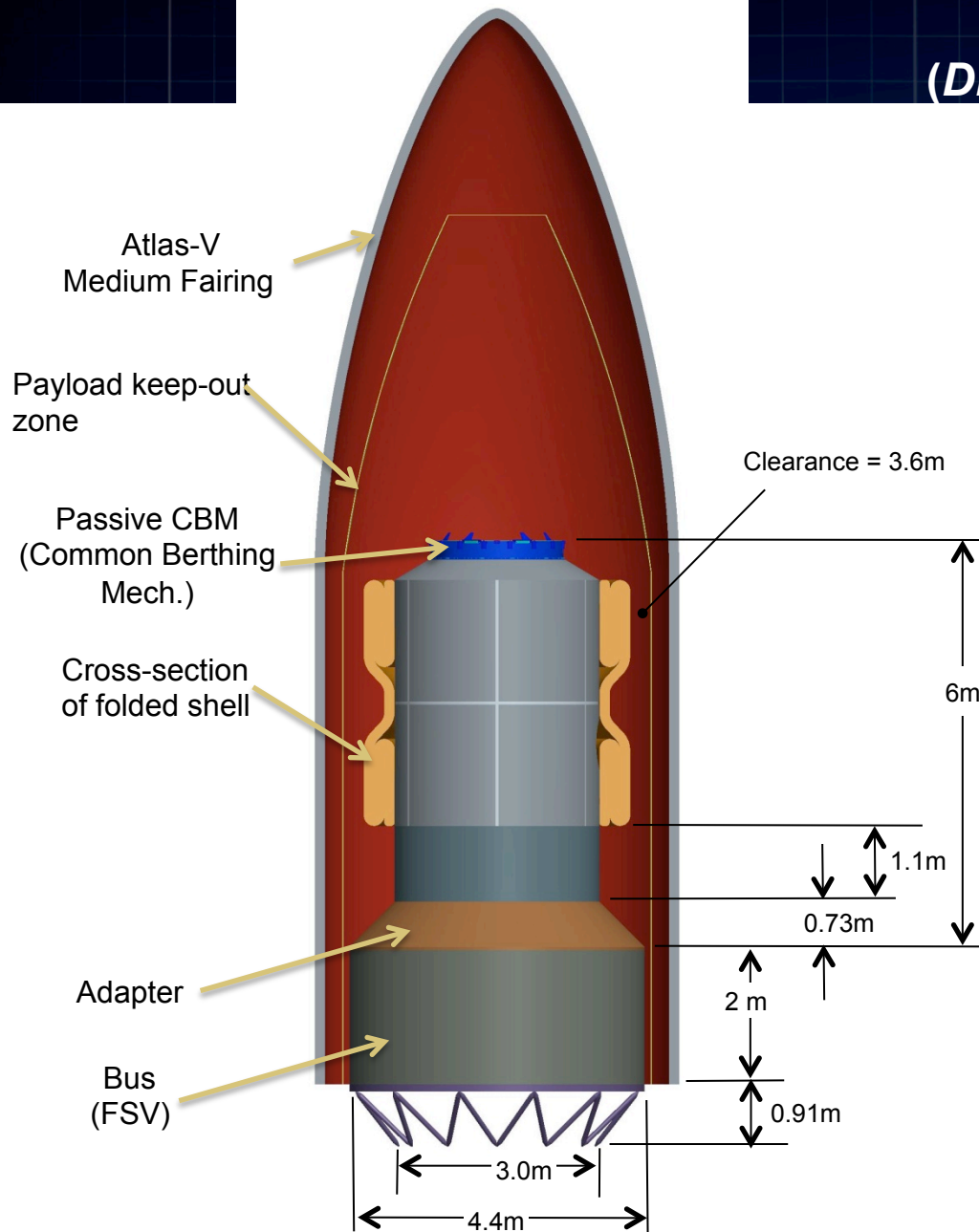
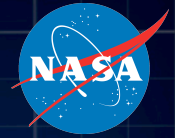


Technology Goals	Technology Objectives
<p><u>Technology Goal 2:</u> Advance, demonstrate and integrate technologies needed for lightweight/inflatable modules</p>	<p>Objective 2-1: Demonstrate ability to deploy a human scale inflatable structure in space</p>
	<p>Objective 2-2: Demonstrate long duration of an inflatable habitat in space environment (MMOD, thermal, <i>radiation</i>) while being occupied daily by humans</p>
	<p>Objective 2-3: Demonstrate integration of advanced technology systems such as for ECLSS and habitation systems which reduced logistics and protects the crew</p>
	<p>Objective 2-4: Demonstrate advanced materials as appropriate that are necessary to advance lightweight or inflatable technologies</p>

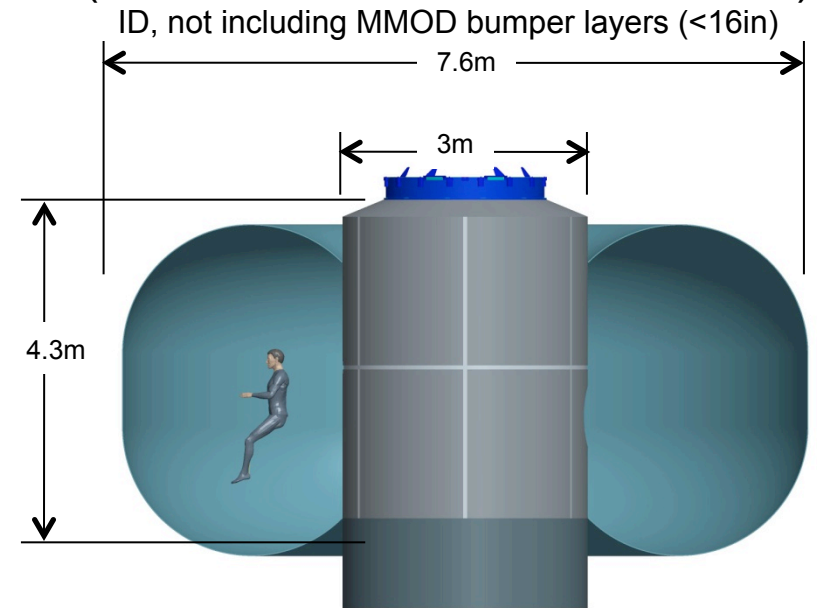
Point of Departure Design Concept



POD Design (DRAFT DIMENSIONS)



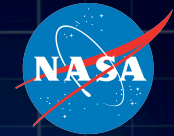
On-Orbit Configuration. (Shell Inflated, *cross-section view*)



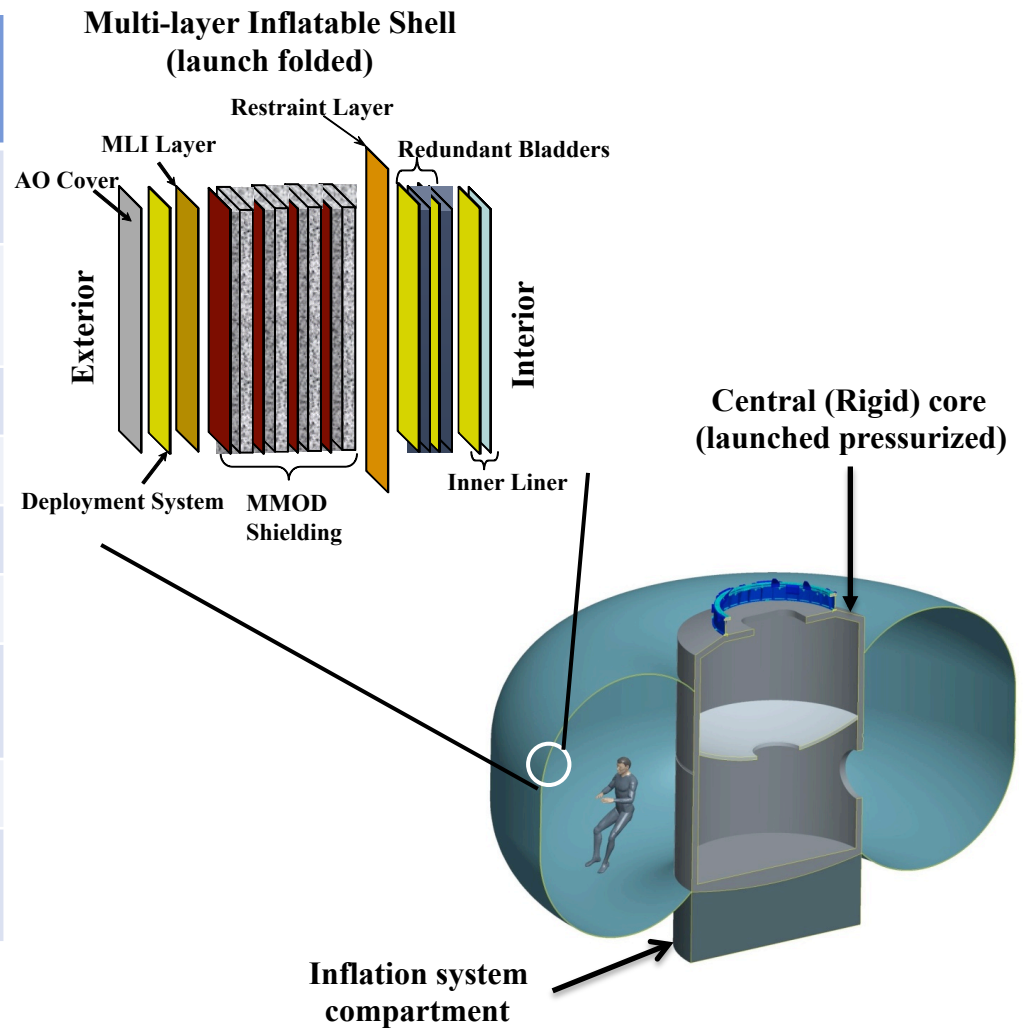
Pressurized Volume (m ³)	
Central Core	25
Inflatable Shell	175
TOTAL	200

Reference: US Lab Pressurized Volume = 125 m³

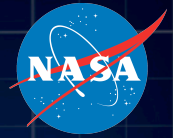
System Breakdown (current best estimate)



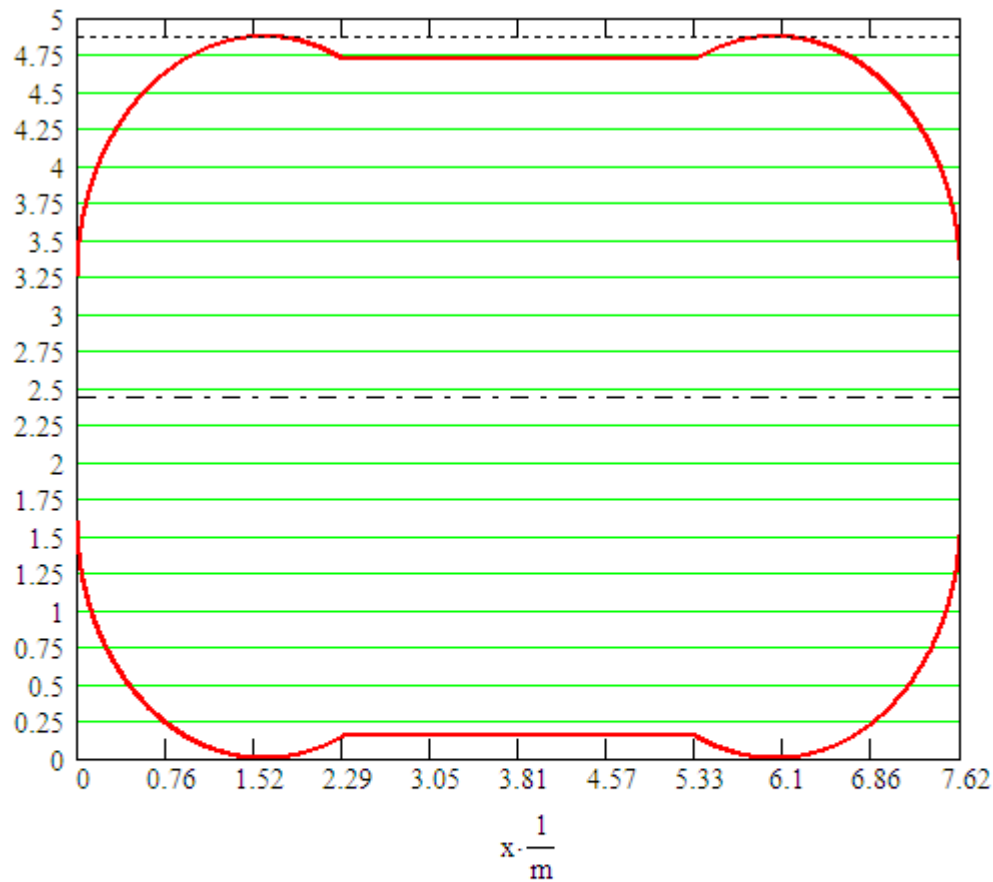
	Mass (kg)	Growth	Total (kg)
Central Core	2,450	30%	3,185
Inflatable Shell	2,916	20%	3,499
Inflation System	311	20%	373
Avionics	714	20%	857
ECLSS	500	20%	600
Power	686	20%	823
Crew Accommodations	147	20%	176
Fluids / Air	386	20%	463
Total	8,110	23% (aggregate)	9,977



Inflatable Shell Overview (*working dimensions*)



Dimension = Meters



Diameter is ID of inflatable

(does not include MMOD bumper layers
(<0.5 m))

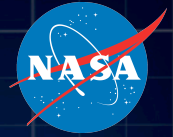
Volume	195 m³
Compare to ISS Lab Volume	125 m³
Surface Area	158 m²

$$h_{\text{core}} = 4.57 \text{ m} \quad \theta_{\text{lwr}} = 65 \text{ deg} \quad r_{1\text{lwr}} = 1.52 \text{ m}$$

$$h_{\text{cyl}} = 1.66 \text{ m} \quad \theta_{\text{upr}} = 65 \text{ deg} \quad r_{1\text{upr}} = 1.52 \text{ m}$$

$$b_{\text{upr}} = 1.61 \text{ m} \quad r_2 = 3.81 \text{ m}$$

FTD #3 Mission Scenario

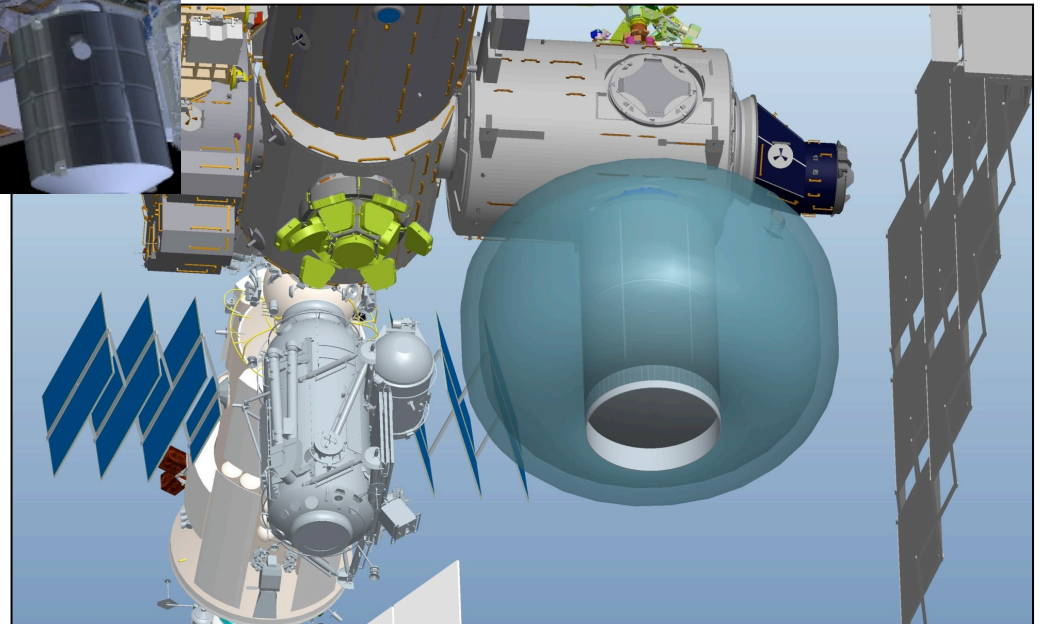
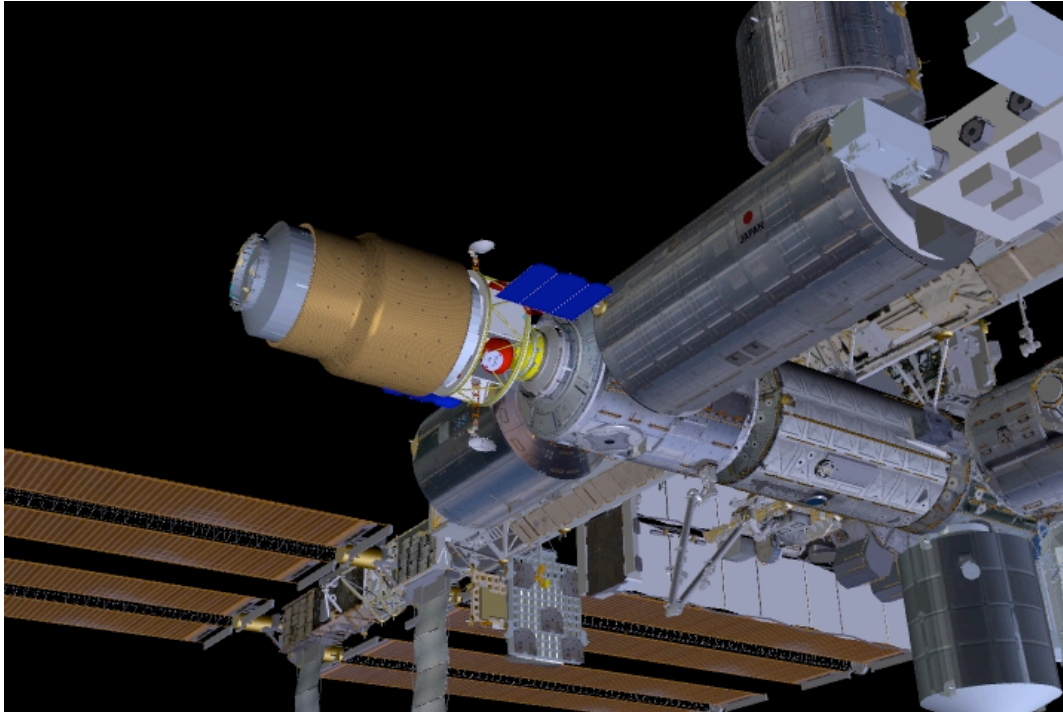
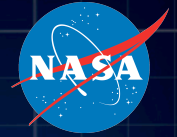


GROUND PROCESSING PHASE (Design, Development, Manufacturing, and Launch Site Processing)

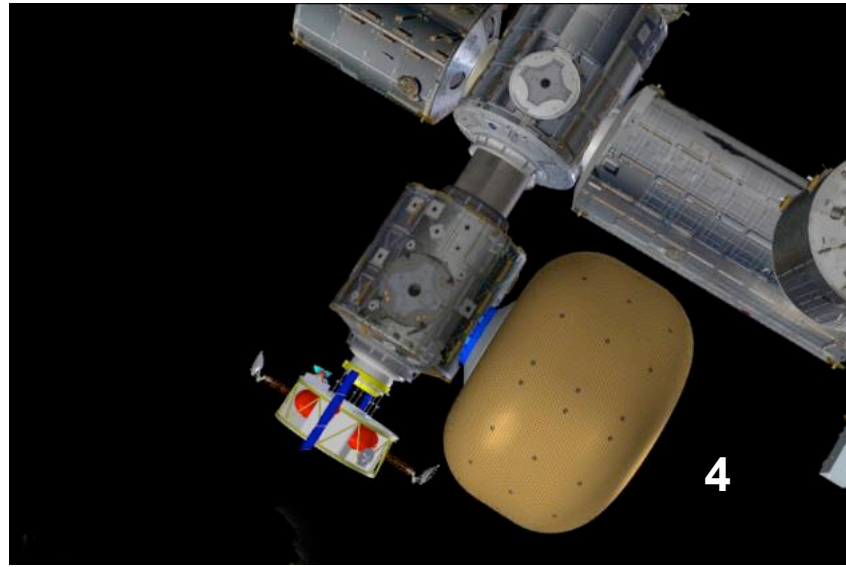
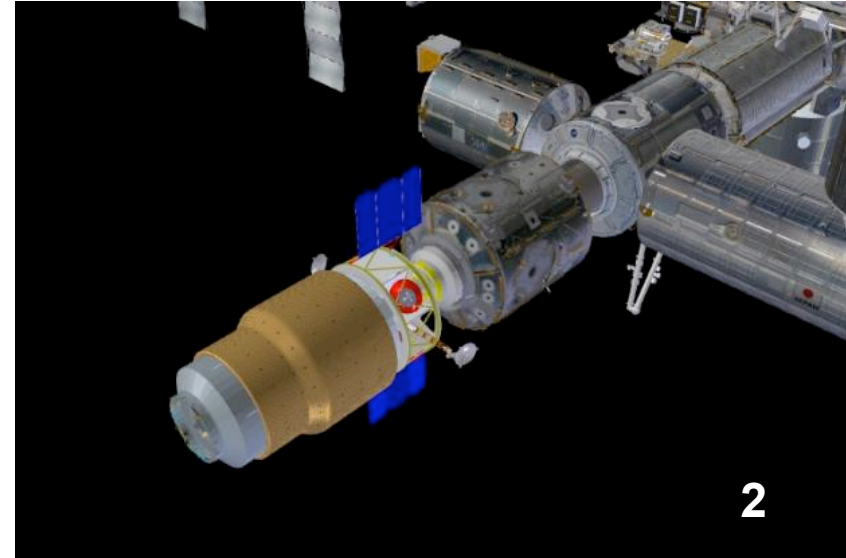
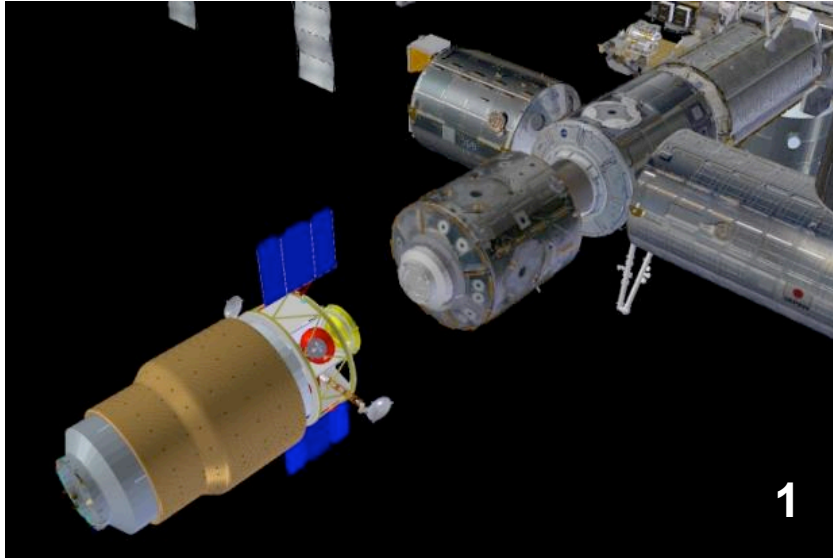
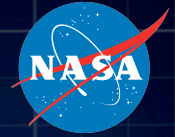
– Options

1. Fully integrated/tested inflatable module to be installed on Expendable Launch Vehicle (ELV) at NASA launch site.
 - “Ship and shoot” philosophy: minimum ground processing at launch site.
 - Vehicle stack includes inflatable module and AR&D Vehicle
 2. Major components shipped to central point for final assembly and testing, then integrated module shipped to launch site for ELV integration.
- In either case, Inflatable Module delivered in launch (“folded”) configuration.
- May need to purge module on the ground with clean dry air for trace contaminant loading on ISS.
 - Inflatable Module delivered to launch site for integration onto a service vehicle (AR&D)

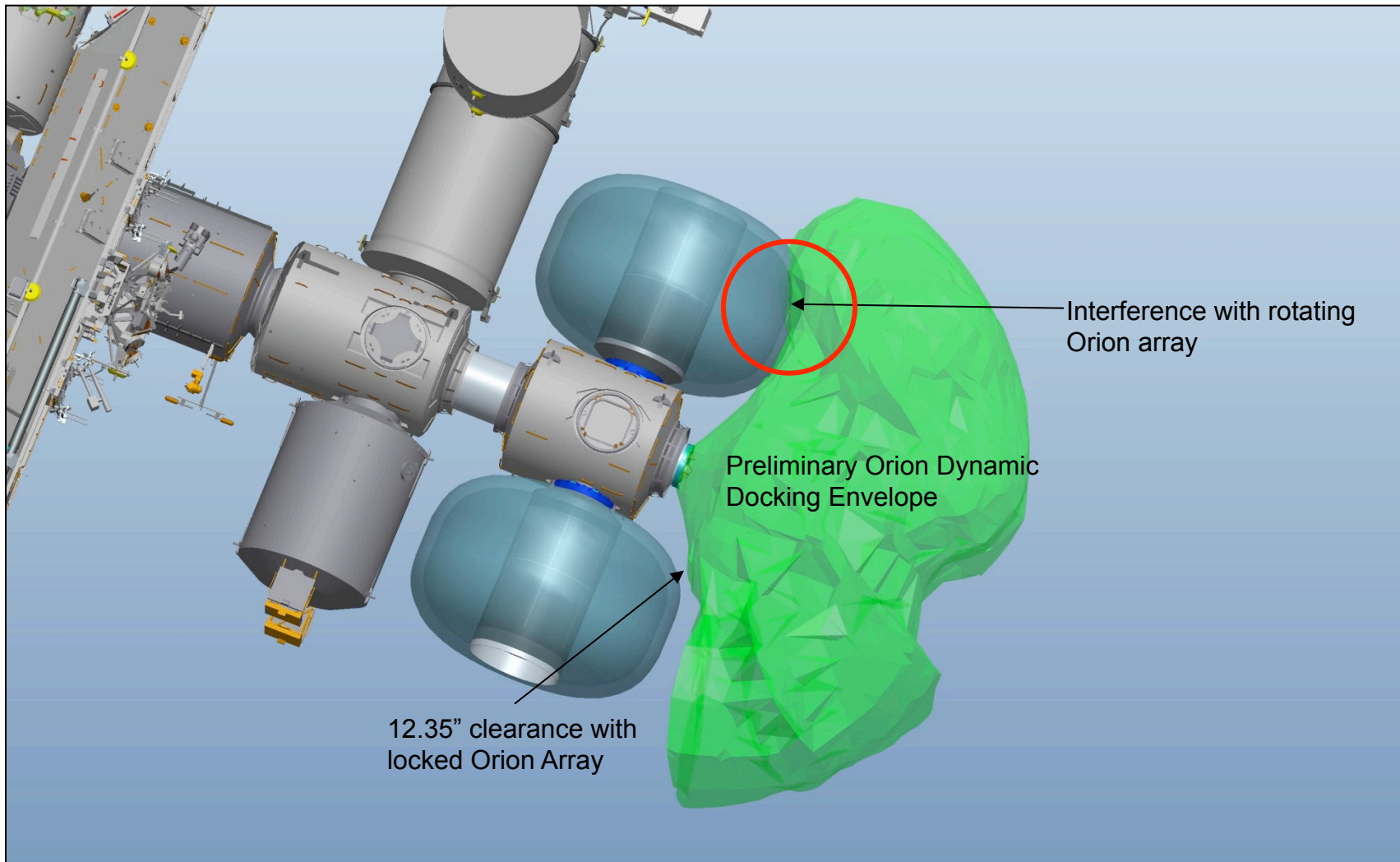
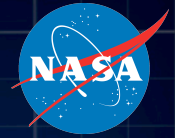
Preliminary Node 3 Option



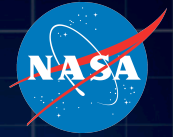
Mission Concept: Orbit Operations Preliminary ISS Node-4 Location Option



Preliminary Node 4 Location Analysis

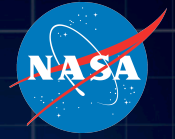


Request for Information Philosophy



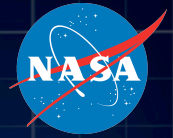
NASA is seeking information which provides an integrated Inflatable Module concept based on functional capabilities.

Functional Area	Challenges
Inflatable Shell	<ul style="list-style-type: none">• Light weight, flexible under extreme environment• Bladder• Soft goods design/manufacturing• Micro Meteoroid Orbital Debris Shield layer• Thermal Insulation Protection• Radiation Protection• Atomic Oxygen
Core Shell	<ul style="list-style-type: none">• Light weight material• Interface sealing design to the inflatable shell• Structural supports for outfitting with Advanced Closed Loop ECLS hardware• Suitport integration
Subsystems	<ul style="list-style-type: none">• Environmental Control and Life Support• Thermal Control• Electrical Power• Avionics and Software



Comments and Questions?

Contact Information



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- gary.r.spexarth@nasa.gov