New York Textile Month 2017

Parsons School of Design

Fabrics in Space Architecture

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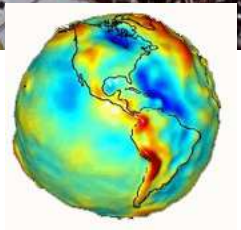
JPL

From Caltech students testing rockets to exploring the planets in our lifetime

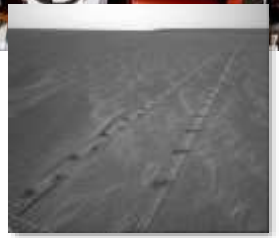
Caltech students (1936)

Missiles (1940s)

Explorer 1 (1958)



Earth Science (1978-now)



Mars Exploration Rovers (2004 – present)

Spitzer Space Telescope (2004 – present)

Towards the Future

Artist's concept of a Europa Lander

Biography

- **JPL NASA /Caltech** – System Engineer, Space Architect and technologist (since 2012)
  - Architecture & Formulation, Payload & Small Spacecraft Mechanical Engineering
  - Co-founder of JPL Atelier
  - Europa Lander Mission Concept
  - Space Technology Liaison and project lead
  - R&D Principal investigator
- **Entasis Mecanika Initiative** – Founder, since 2017
- **JPL NASA /Caltech** – JVSRP Researcher, Affiliate - NASA Habitation Team (2011-12)
- **AIAA SATC** Space Construction Subcommittee Chair (Member, since 2006)
- **XAR SIDEREAL Initiative** – Founder and director, 2008-2012
- **Technological IVAM** – Inhabiting Cosmos Int. Exhibitions – Curator, 2011
- **Space Architecture and Sustainability Int. Seminar** – Director – UCV, 2010-2012

- PhD Candidate, University of Strasbourg, France
- MSc - Master Science in Space Studies and Human Spaceflight – ISU 2011
- M.Arch - Master Architect, All specialties, UPV 2008
- Industrial Engineering Studies
- Licensed Architect and builder
- NASA Ames summer Intern, 1999
- Caja Madrid International Postgraduate Scholarship Awarded, 2010-2012
- Fulbright Commission preselected Fellow
- ESA Full scholarship award, 2010
- JPL JVSRP Fellow

Space Architecture

Mechanikoi, a constructive degree (Eastern Roman Empire):

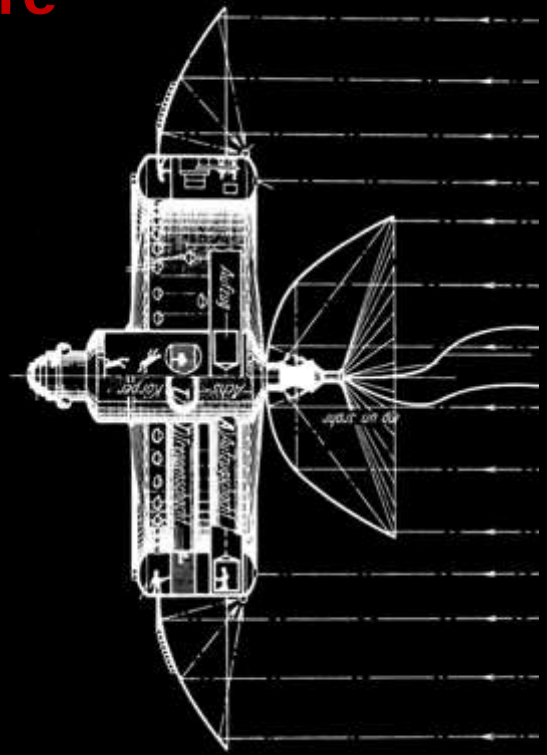
- They mastered both construction science and technology as well mathematics and astronomy
- Key architects: Isidore of Miletus (H.Sofia), Heron of Alexandria (Robotics)
- *HAGIA SOFIA (Holy Wisdom, Istanbul, 537 A.C.)*: Mathematics and science to study the cosmos allowed a better and impressive structural design… (Earthquakes)

Credit: Public Domain

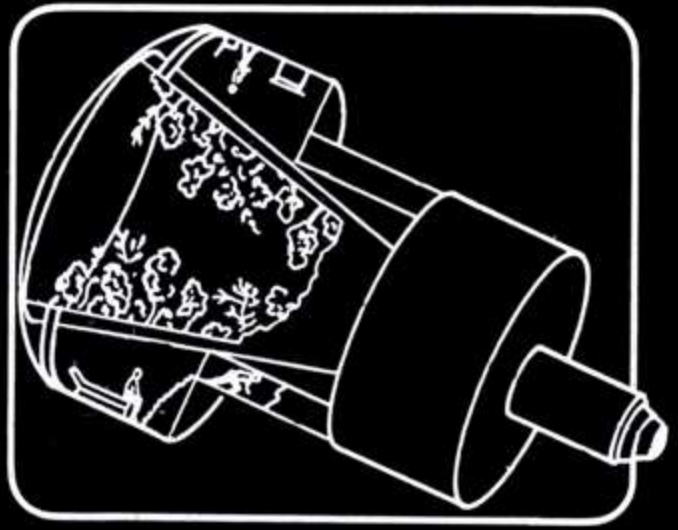
Space Architecture

First Projects Of Space Stations

Herman Potočnik Concept, 1929

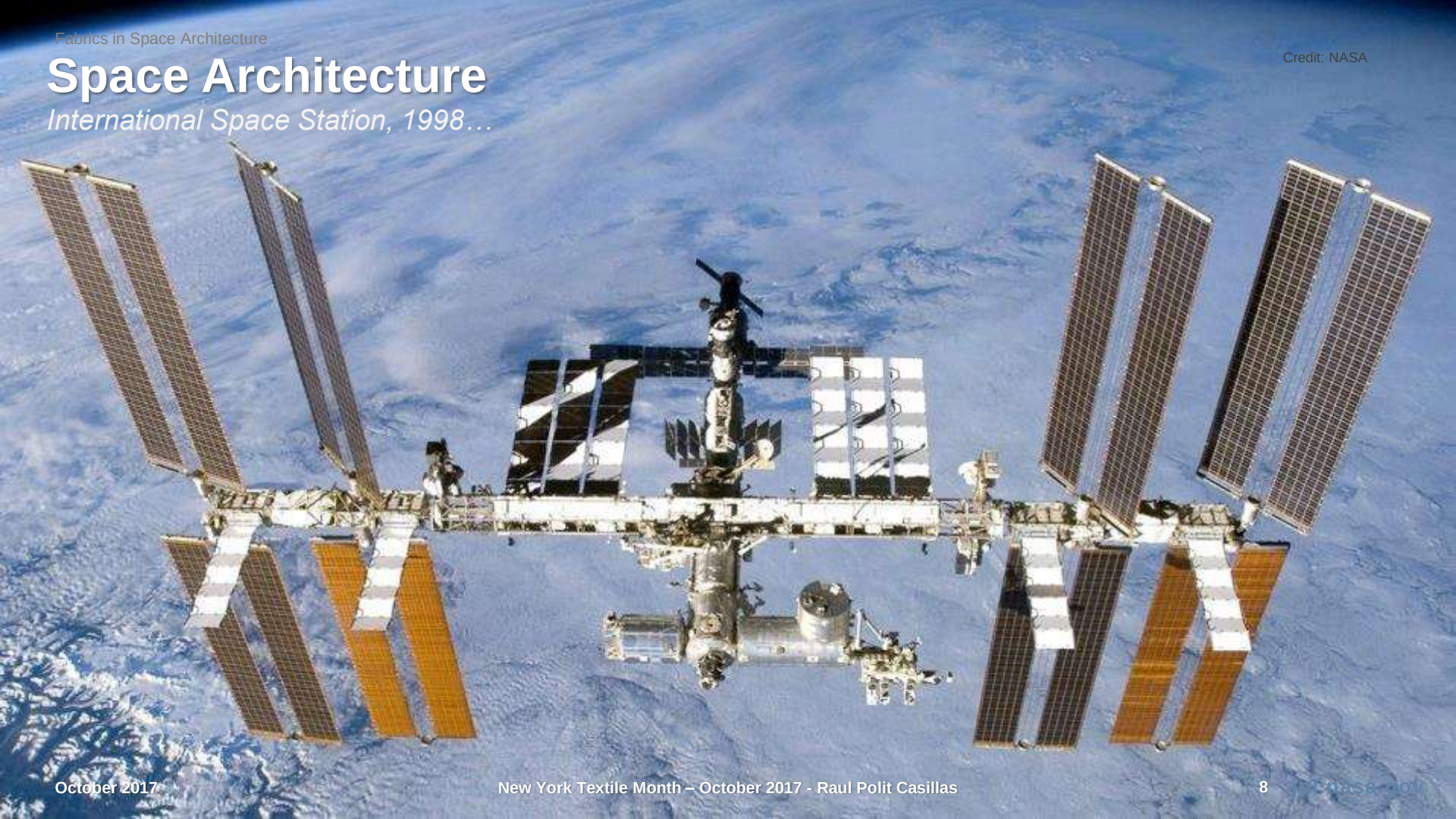


Konstantin Tsiolkovsky, Concepts (1897)



Space Architecture

International Space Station, 1998…



Credit: NASA

Space Architecture

Artist's concept

Credit: NASA

Space Architecture

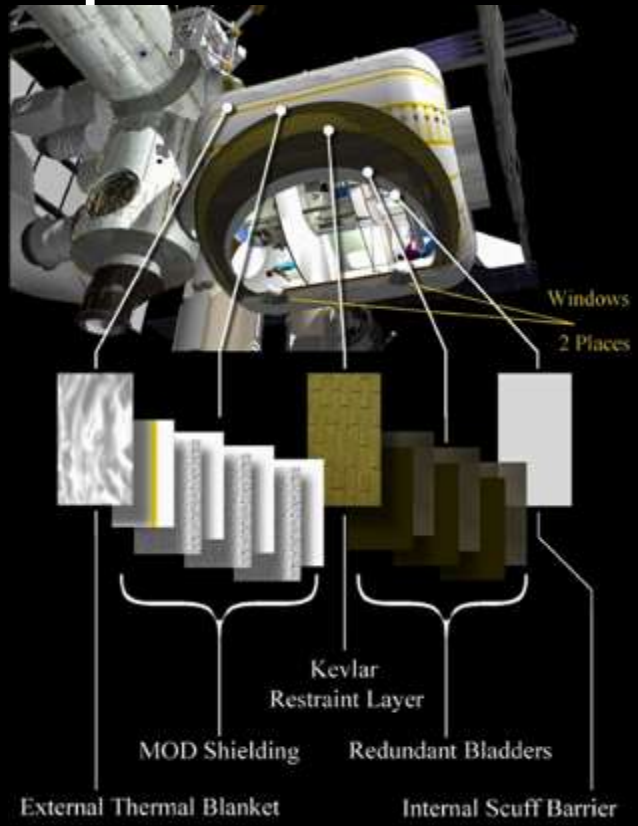
(Cortesia de NASA)

Credit: NASA

Fabrics in Space Architecture: EXT

Credit: NASA

Space Architecture



Credit: NASA

Artist's concept

Space Architecture

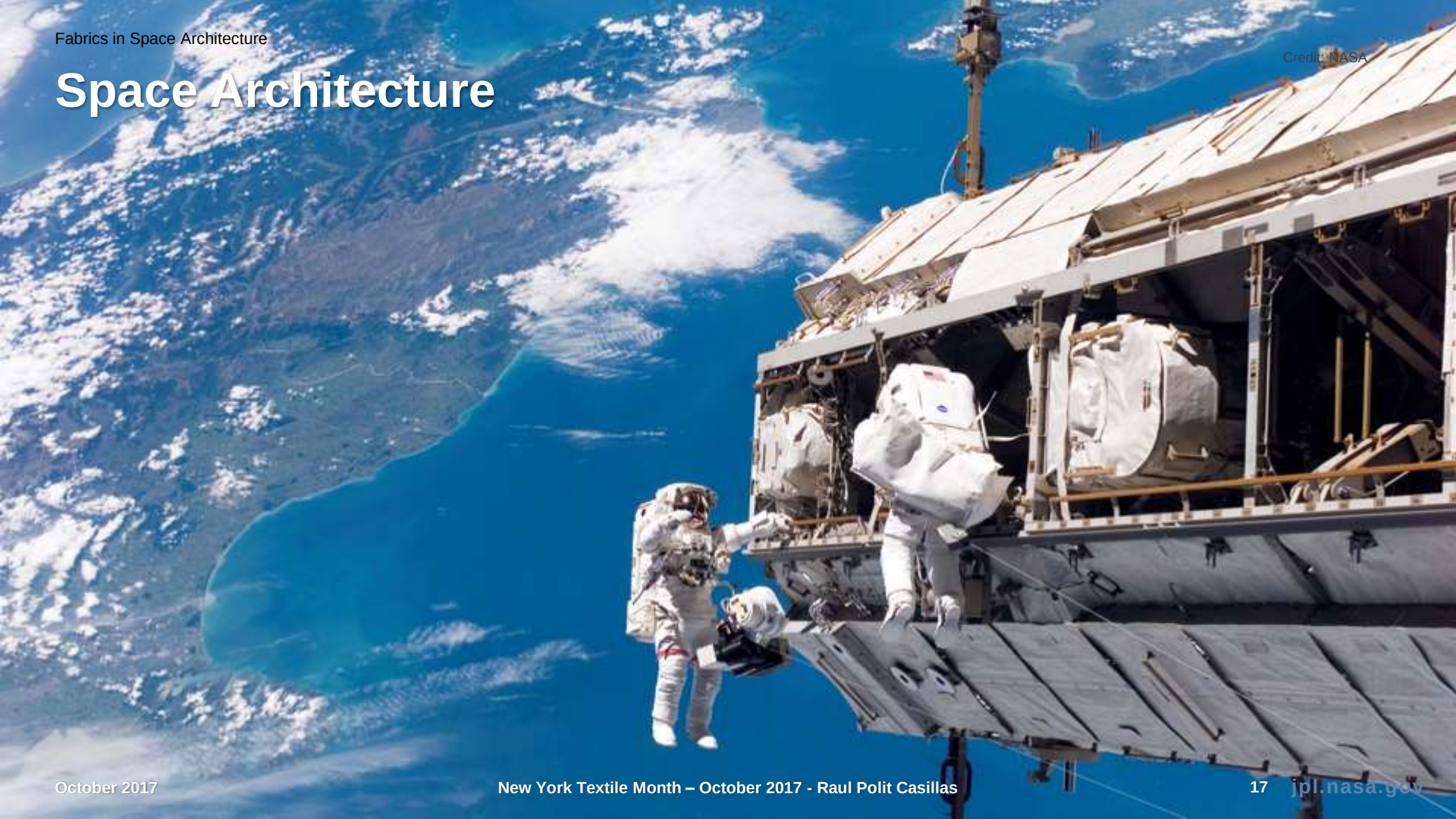
Credit: NASA

Space Architecture

Credit: NASA

Space Architecture

Space Architecture



Credit: NASA

Artist's concept

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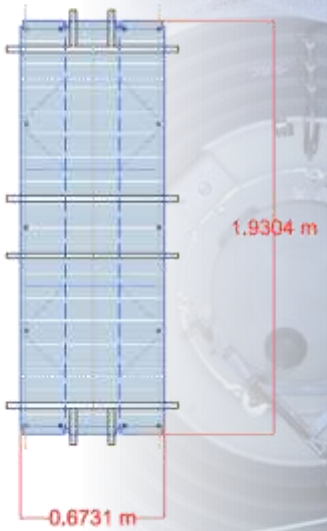


Cargo Transfer Bags (CTB):

- Current logistics elements
- Could be use as *waterwalls* (waste & water treatment)
- Deep Space Mission: 200-500 CTBs
- Made of polymer (high H content)
- Radiation shielding capabilities
- Flexible

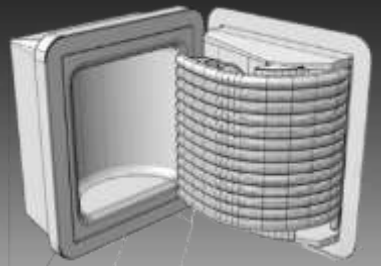
Space Architecture

HDU Micro-Hab Hygiene Module

Credit: NASA

Artist's concept

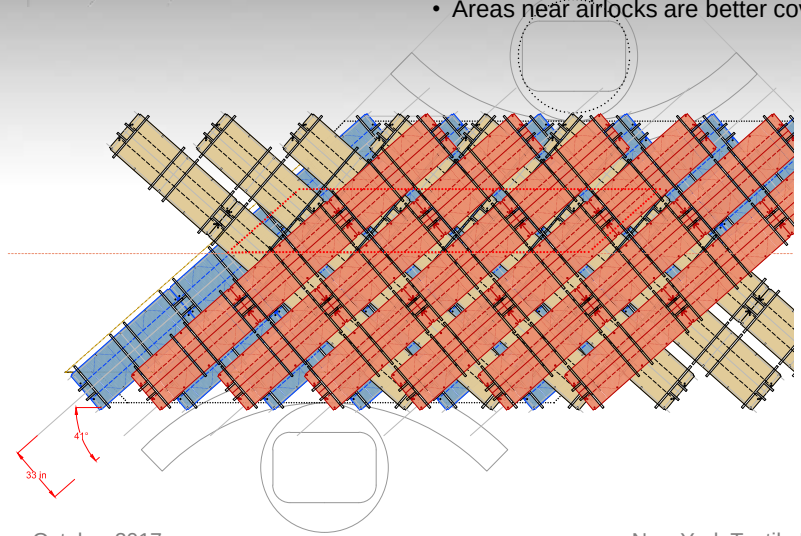
Space Architecture

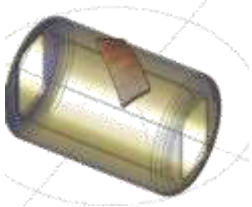


Number of bags by layer: 18
Separation: 840 mm (33 in)
Angle (with respect to axe): 41º

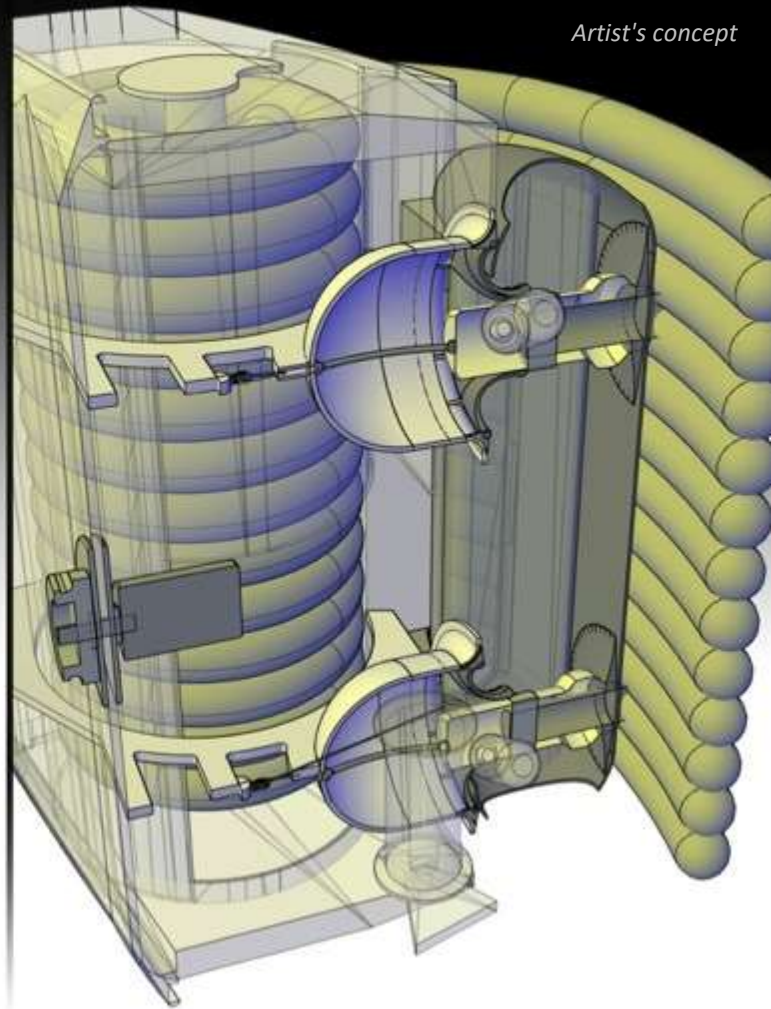
Alignment of bags: One direction
Drawbacks: Different directions / curvatures
Benefits:

- Supporting points are better distributed
- It uses a fewer or equal number of bags
- % Ae in second layer is lower
- Better resistance against physical impacts
- Areas near airlocks are better covered



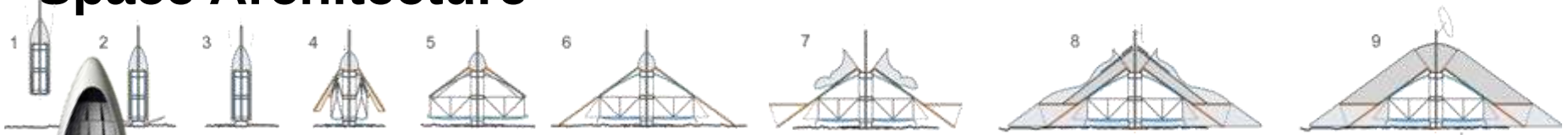


Artist's concept



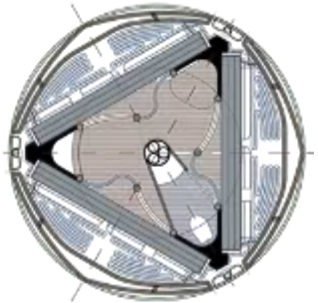
Artist's concept

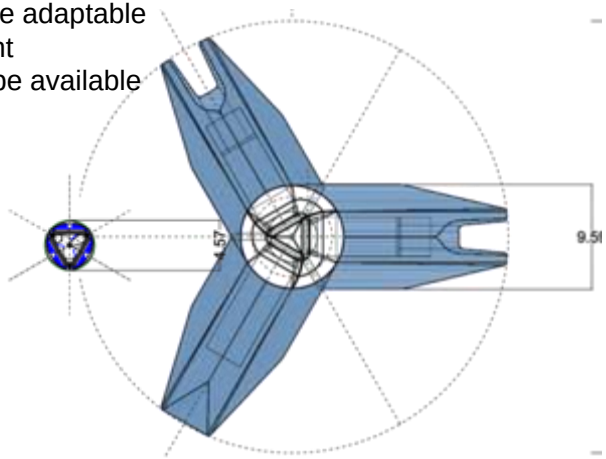
Space Architecture

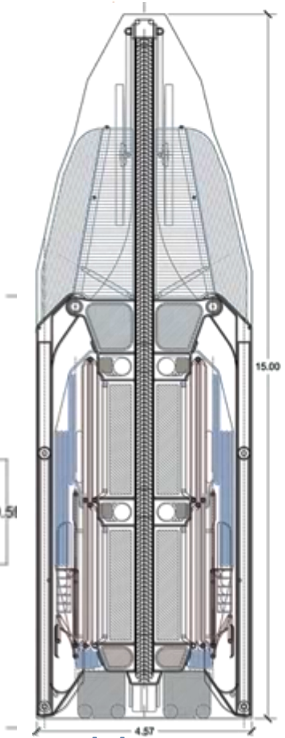


Reducing mass, volume and energy budgets using fabrics

- **In situ resources Utilization (ISRU):** Using regolith as construction element
- **Radiation protection:** ESA 1992 – shielding of 400 g/cm2 recommended during solar flares
  - 2 - 3 meters would suffice, while 4 to 5 meters will protect even during solar flairs
- **Volume:** It has to fit in an Ariane V fairing. Adaptable architecture
- **Mass:** Reduce mass budget to the maximum. Increase multipurpose elements
- **Terrain**: Flat or flatten terrain, however the system has to be adaptable
- **Human Factors**: Respect to basic habitability measurement
- **Simulation and testing**: Feasible testing methods should be available



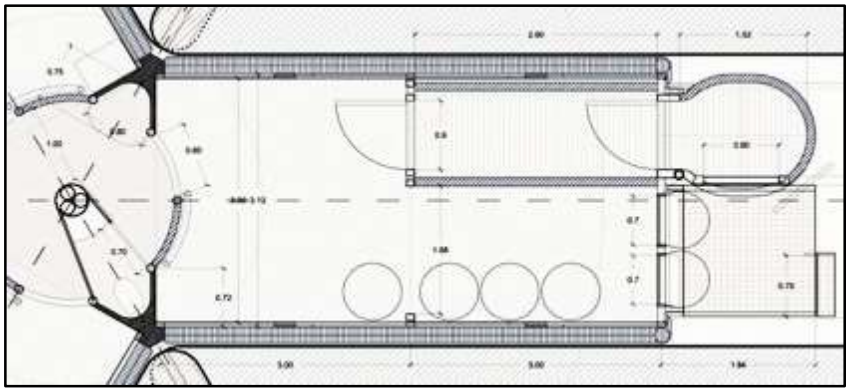


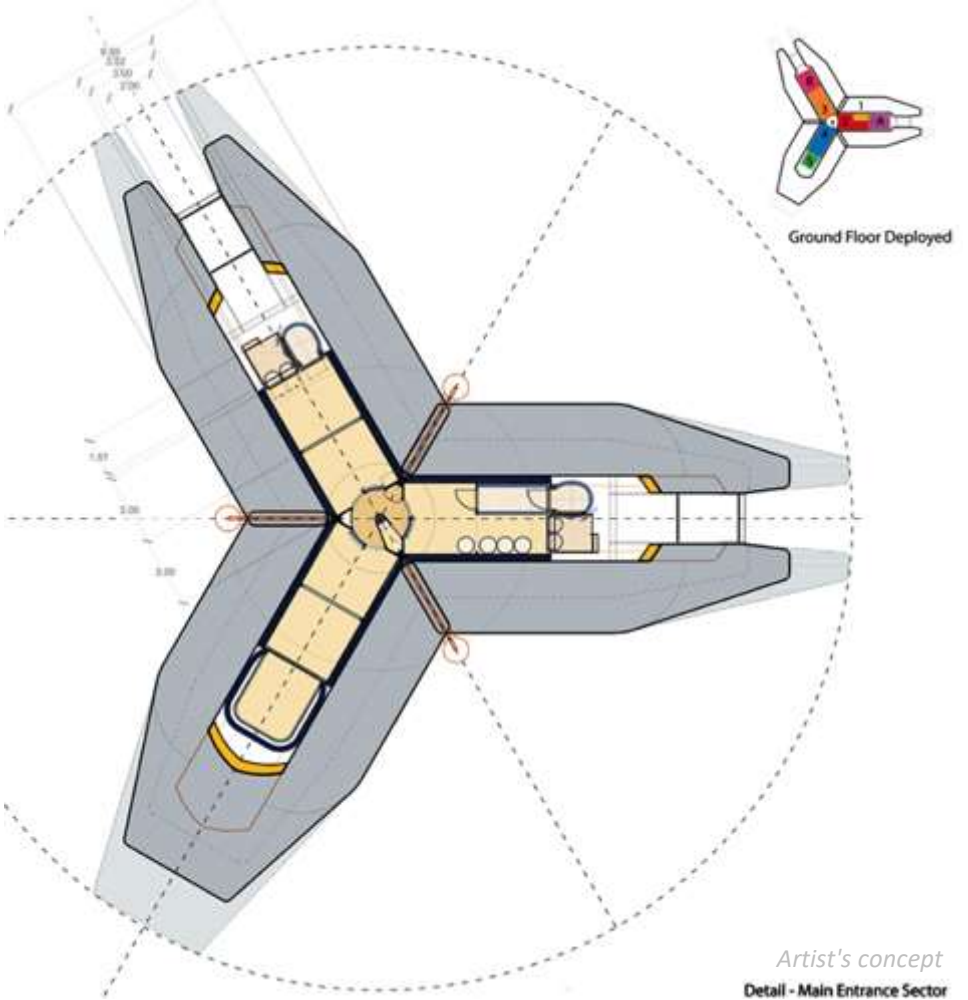


Space Architecture

PROGRAMME DISTRIBUTION	
A MAIN ACCESACCESS	12 m²
B SECONDARY ACCESS	12 m²
1 DUST CONTROL	3.2m²
2 ACCESS OPERATIONS/STORAGE	14 m²
3 LIVING AREA / KITCHEN	18 m²
4 SCIENCE AREA	18 m²
5 GREEN HOUSE	10 m²
COOMMON AREAS/BATHROOM	4.8 m²
TOTAL	92 m²

Lower deck





Artist's concept

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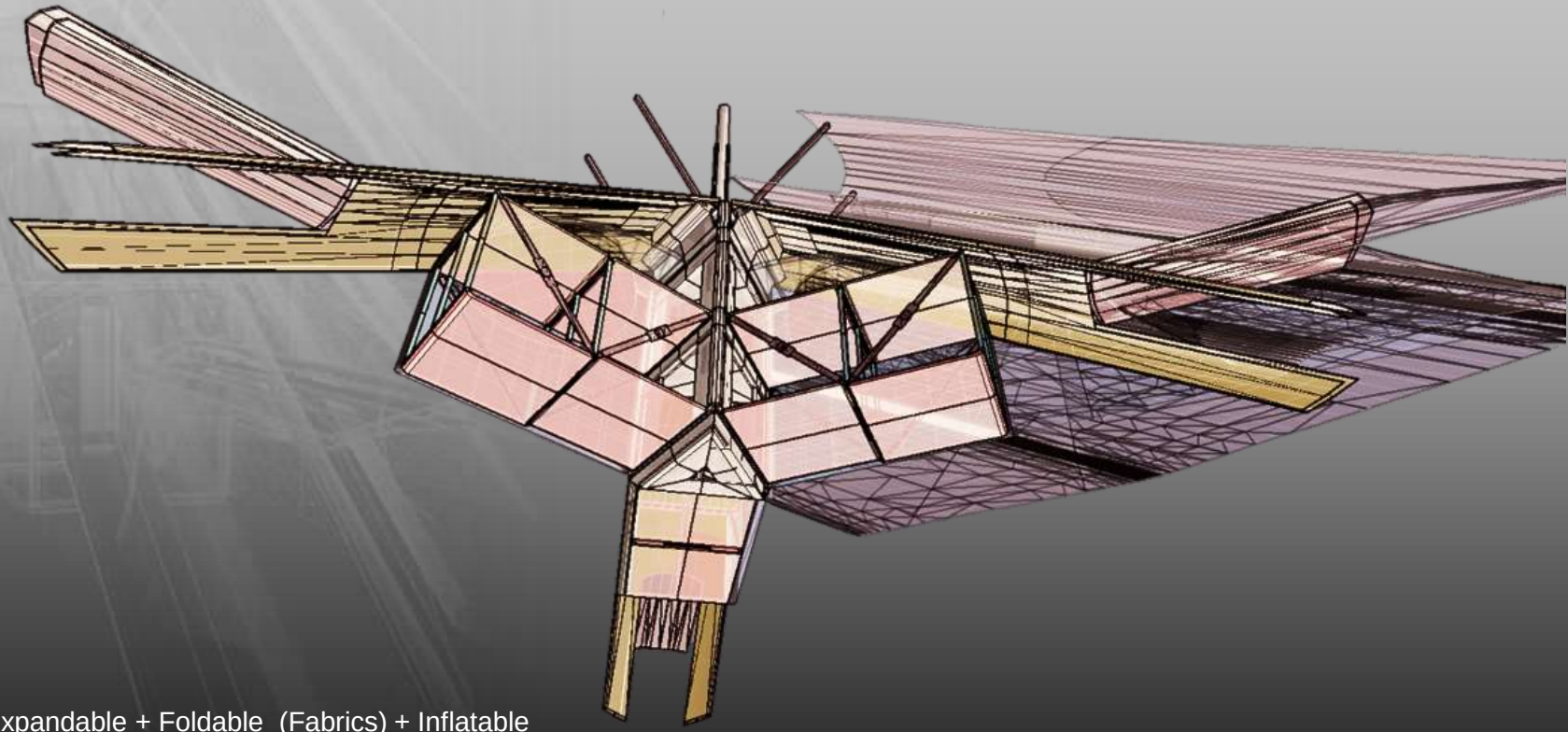
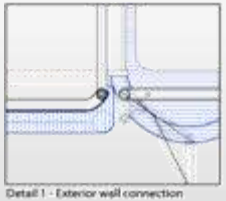


Adaptability = Expandable + Foldable (Fabrics) + Inflatable

Artist's concept

Space Architecture



Detail 1 - Exterior wall connection

Detail 2 -Upper connection

3D Printed Fabric

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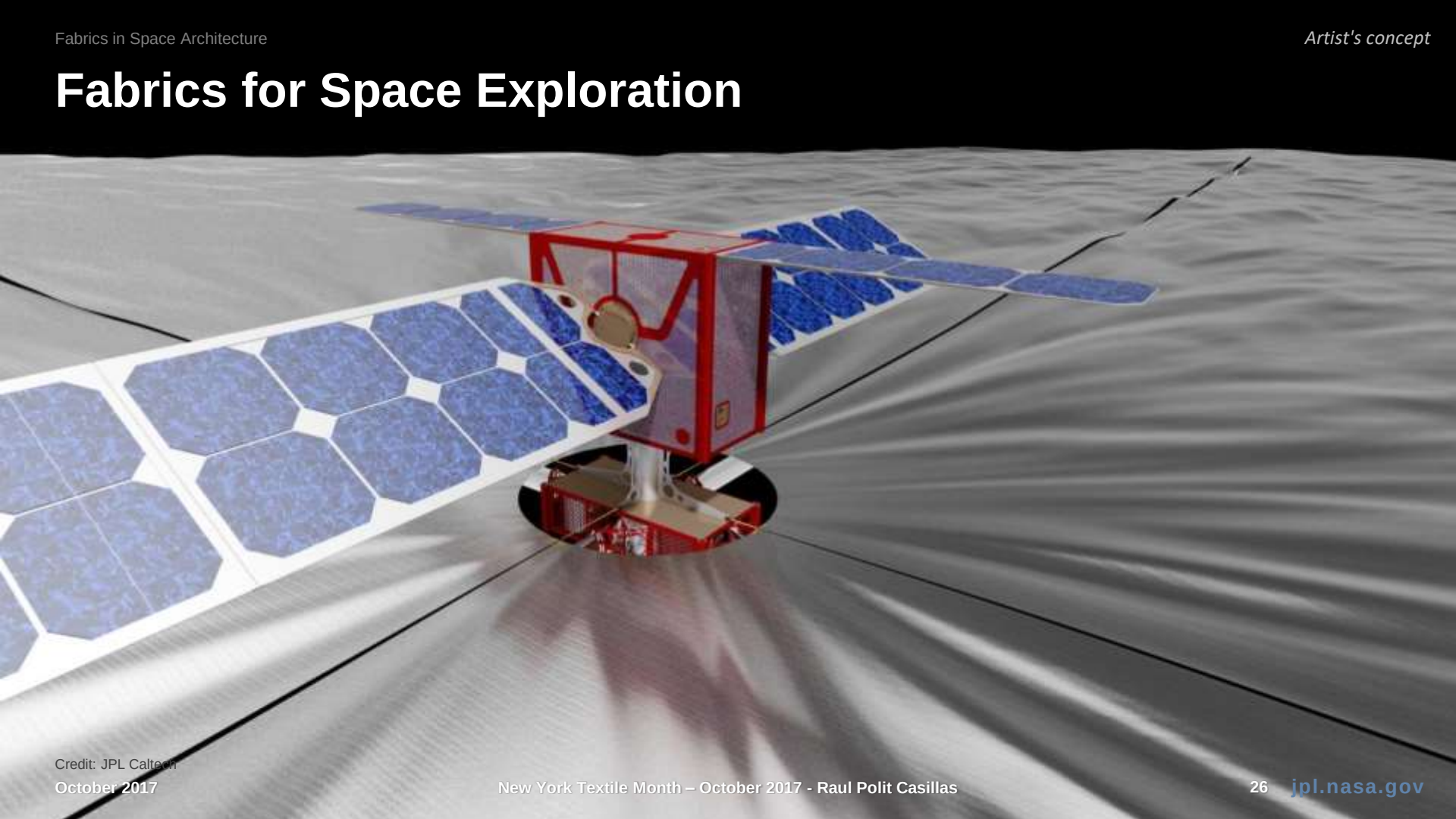
Artist's concept

Fabrics for Space Exploration



Credit: JPL Caltech

Space Architecture

Credit: NASA

THANK YOU…

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California Institute of Technology

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