SIERRA NEVADA CORPORATION®

United Nations
Dream Chaser® Mission

United Nations/Austria Symposium
"Access to Space: Holistic Capacity Building for the 21st Century"

Graz - September 4th, 2017

Luciano Saccani

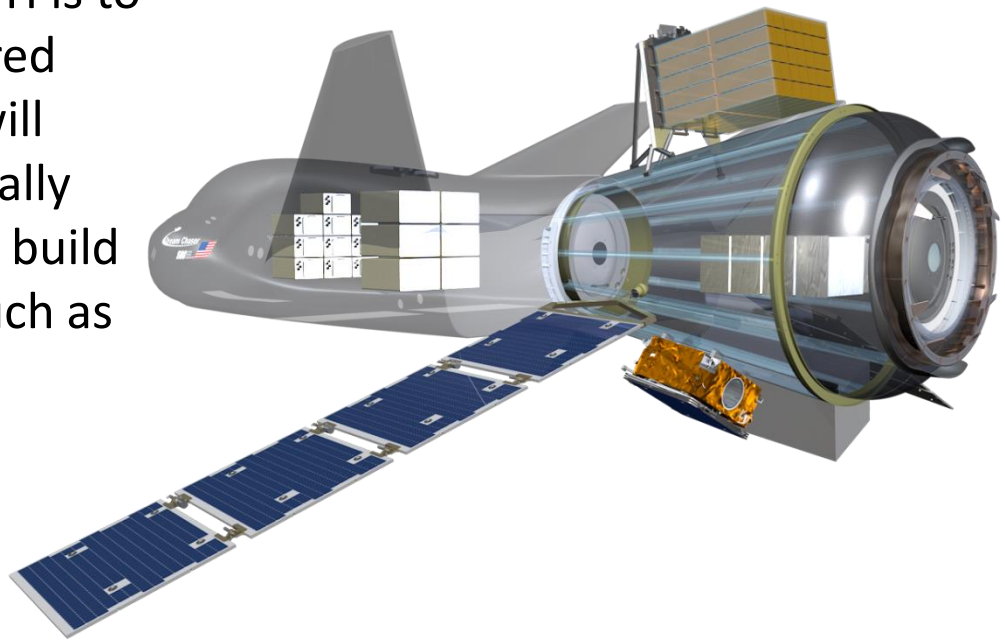
Human Space Technology Initiative (HSTI)

Three Activity Pillars

- **Promote international cooperation** in human space flight and activities related to space exploration;
- **Conduct outreach activities** to promote increased awareness among Member States of the benefits of utilizing human space technology and its applications;
- **Support capacity-building efforts world-wide** in microgravity science education and research.

United Nations Dream Chaser Mission

Most Ambitious Program under HSTI is to fly the first United Nations sponsored multi-country space mission that will provide member countries, especially developing countries, the ability to build and fly payloads for applications such as microgravity science, remote earth sensing, and space hardware qualification



MOU executed between the United Nations and SNC in June 2016 to utilize SNC's Dream Chaser space vehicle as the host to up to 25 country's payloads

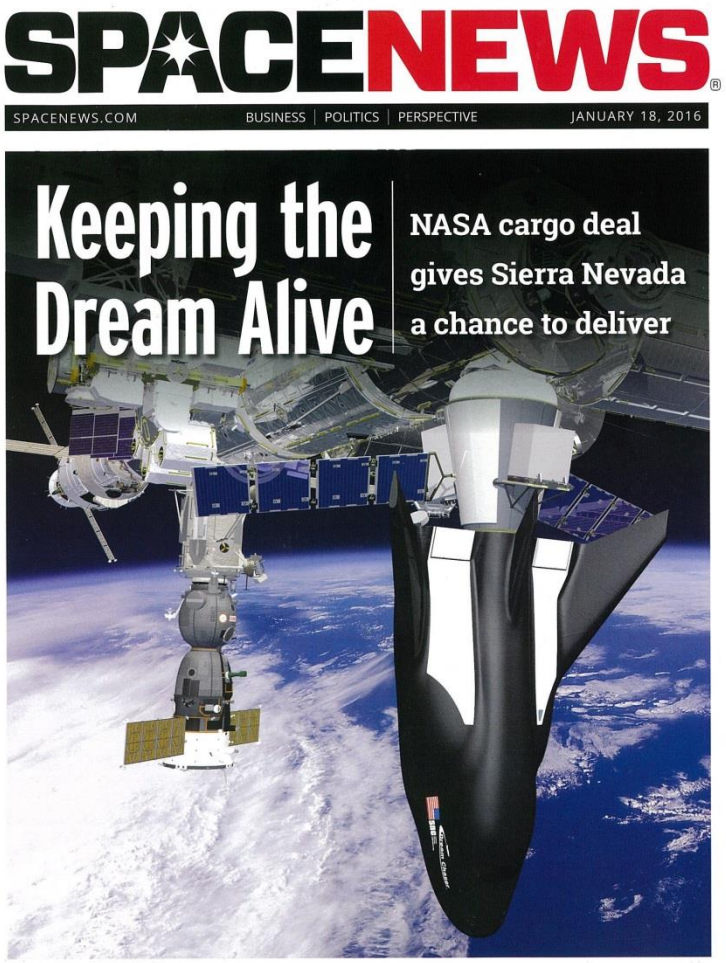
About Dream Chaser

Selected by NASA to perform cargo service missions to the International Space Station starting in 2019

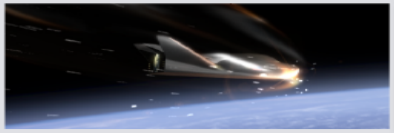
- Contract awarded January 2016
- IDIQ Contract with $14B ceiling
- Guaranteed minimum of 6 missions 2019-2024

Can be launched from the U.S., Europe or Japan

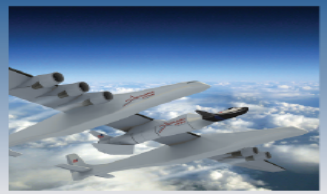
Only runway landing space vehicle in existence. Can land at commercial airports able to handle large commercial aircraft – **Anywhere in the World!**



Dream Chaser Lifting Body

	Dream Chaser	Capsules	Dream Chaser Advantages
	Low-g reentry (less than 1.5)	• High-g reentry (Soyuz nominal 4 g, emergency descent 11–15 g)	• Higher safety for cargo • Allows return of sensitive science experiments from ISS • Prevents known damages from high-g capsule entry/landing
	Runway landing (standard aircraft commercial runway >7,200 ft.)	• High speed parachute deployment • Water or land landing with recovery operations	• Higher safety without need for parachute and immediate access to cargo on landing • Immediate access to time-sensitive and environment-sensitive experiments
	Reusable with minimal processing (15+ missions per vehicle)	• Limited reusability with impact loads • Salt water corrosion • Higher reentry heat • No prior capsule has been reused	• Lower life cycle cost by amortizing vehcile cost over many missions
	No solid rocket motors or hazardous fuels	• Hazardous fuels	• Safer ground processing • Higher safety for ground operations personnel • Ability to land at any commercial runway with immediate access to cargo and science experiments
	Atmospheric flight capability provides large cross range for landings (>1,000 nmi)	• Limited atmospheric flight or cross-range capability	• Can deorbit on any orbit without waiting to line up to landing site (limited opportunities or need for multiple landing sites) • Nominal 6-hour ISS undock to landing capability for emergency situations
	Can abort to runway landing at any time from launch to orbit	• High abort loads • Water landing required • Delayed crew recovery • Potential rough sea recovery	• Higher safety runway landing and immediate access to critical cargo • Cargo never goes into the water

The Dream Chaser Advantage: Providing the Capability to Address the Broader LEO Market





CIM-021

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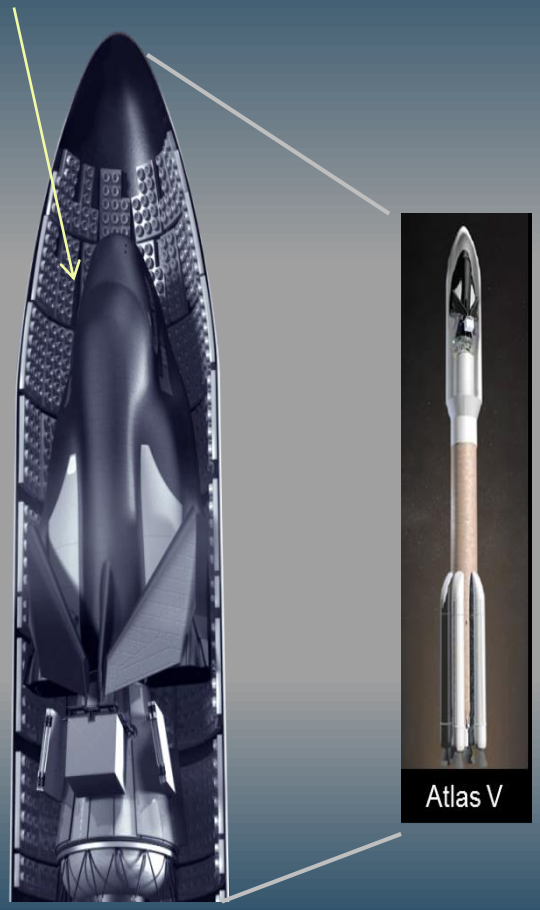
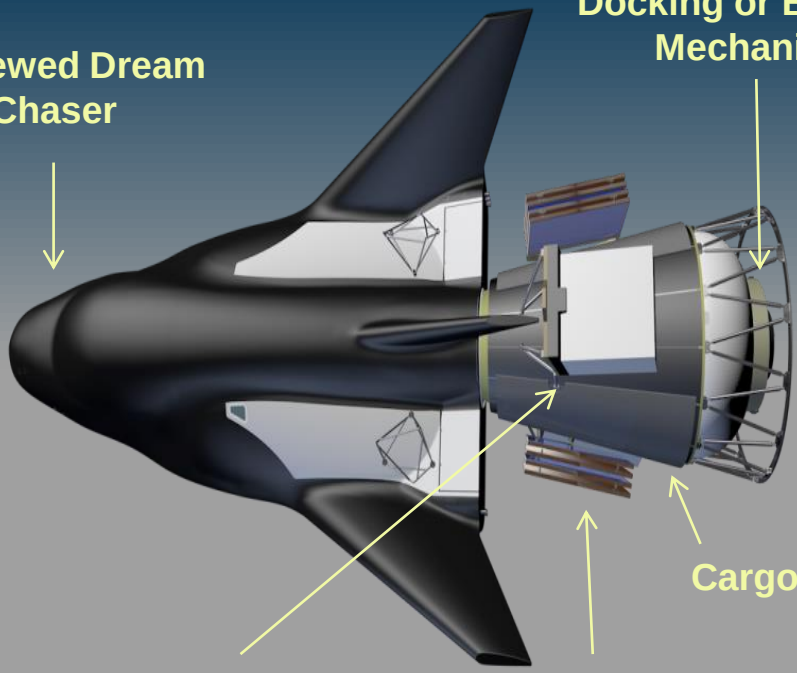
Dream Chaser Cargo System (DCCS)

Faired Launch Configuration



Uncrewed Dream Chaser

Docking or Berthing Mechanism



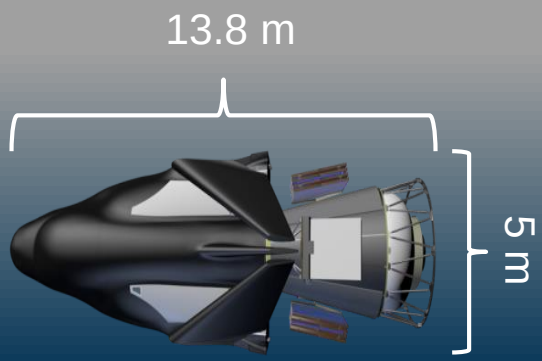
Cargo Module

Unpressurized Cargo

Solar Arrays (folded, 2)

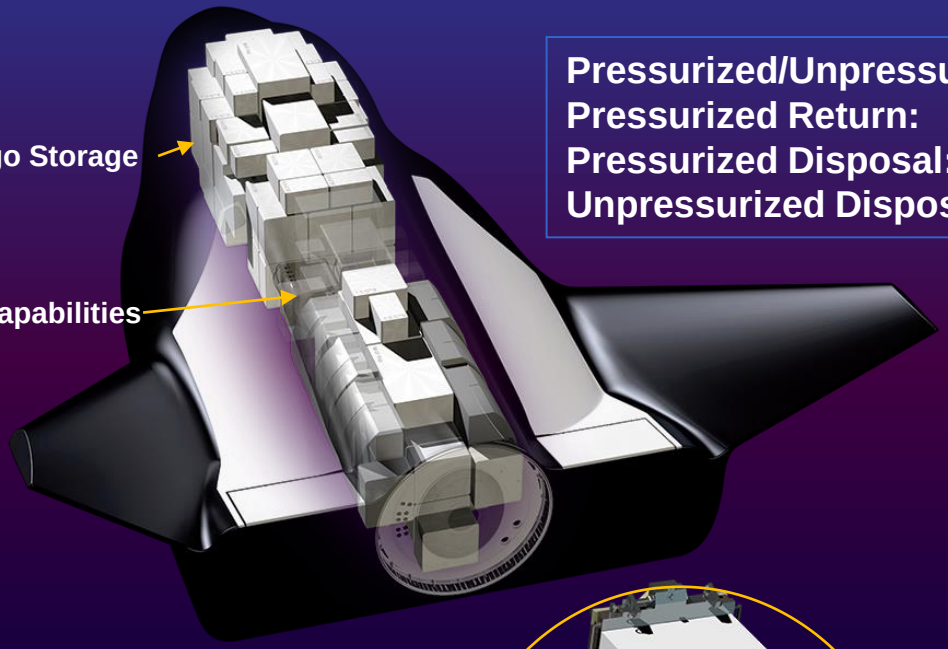
LV Options:

- Ariane 6
- H-III
- Atlas V
- Falcon Heavy
- New Glenn
- NGLV



Uncrewed Dream Chaser

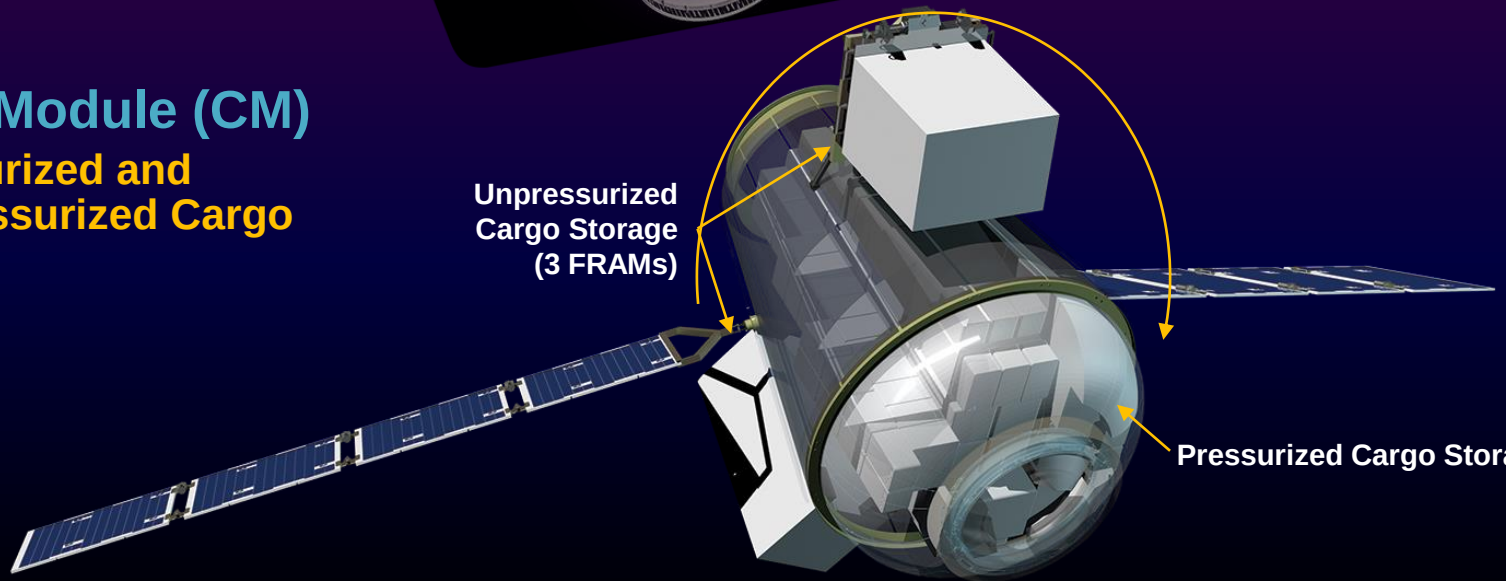
Pressurized Cargo



Pressurized/Unpressurized Upmass:	5,500 kg
Pressurized Return:	1,750 kg
Pressurized Disposal:	3,250 kg
Unpressurized Disposal:	1,500 kg

Cargo Module (CM)

Pressurized and Unpressurized Cargo

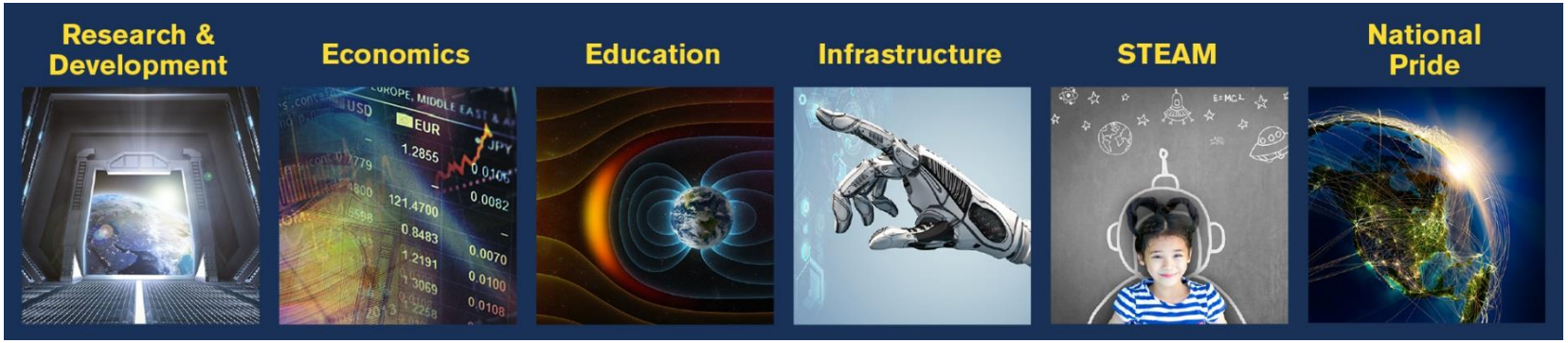


The UN Dream Chaser Mission Preliminary Timeline

- Sep 17: Issue Call for Interest (CFI to UN Member Countries)
- Nov 17: CFI responses due
- Dec 17: Bidder's briefing
- Mar 18: Release of Announcement of Opportunity (AO)
- Sep 18: AO responses due
- Dec 18: Payload selections
- Late 2021/Early 2022
  - Launch to low-Earth orbit
  - Stay on orbit for up to 14-21 days
  - Perform runway landing in a selected country

Benefits for Participating Countries

- **Research & Development:** of new space-related knowledge-based industries to support space science understanding and development of experiments in diverse economic sectors.
- **Economic:** growth in high technology fields.
- **Education:** formation of academic centers of excellence to study various aspects of space: space sciences, environmental sciences, atmospheric physics, etc.
- **Infrastructure:** creation of the supporting infrastructure for development of experiments, robotics for manipulating experiments and providing ground operations for (their) space missions.
- **STEAM:** inspire participation in the space program, encouraging education and work in science, technology, engineering, arts and mathematics (STEAM).
- **Pride:** of supporting international cooperation and global promotion of peaceful uses of outer space.



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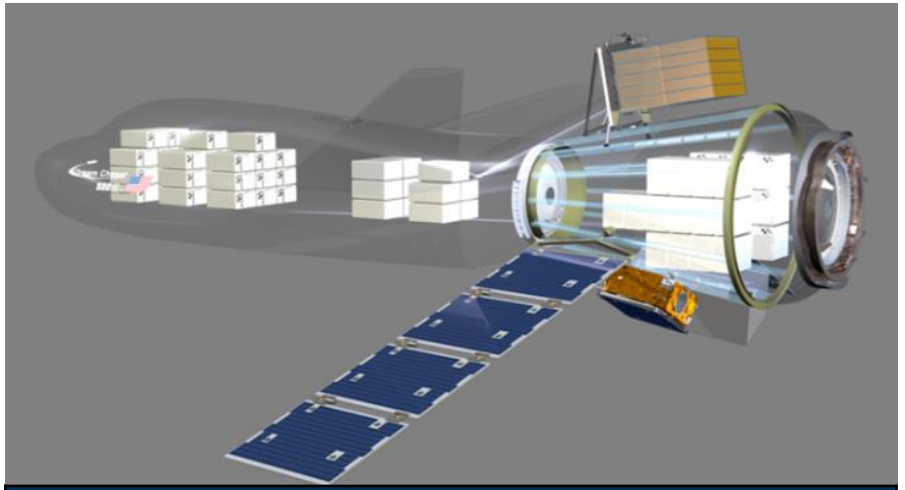
Conceptual UN Dream Chaser Mission

Dream Chaser UN Mission Preliminary Configuration

- Payloads
  - Internal and external payloads
  - 20-35 total standard payloads, options to customize
  - FRAMs utilization for payloads deployments
- Power
  - 28 V (internal), 120 V (external FRAM sites)
  - > 750 W continuous payload power
  - Up to 1500 W with additional batteries / ops constraints
- Cooling
  - Maximize use of radiator though optimal thermal attitude profiles
  - Internal ducting for air cooling payloads
- Data
  - Commanding and SOH data via 1553 and Ethernet
  - Mission data recorders for experiment data
- Internal Volume = ~15.3 m^3 (Dream Chaser and Cargo Module)
- External CM Volume = ~ 7.2 m^3 (total of 3 locations)
- Delta v: ~270 m/s
- Duration: 2-3 weeks



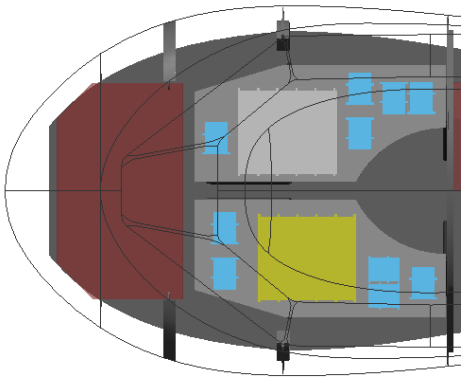
Dream Chaser Cargo System Capability (no payload outfitting)	
Pressurized Upmass (Dream Chaser & Cargo Module)	Up to 5000Kg
Unpressurized Upmass (Cargo Module)	Up to 1500Kg
Maximum Combined Upmass	5500 kg
Return/Disposal	
Pressurized Return Mass (Dream Chaser)	Max 1,750 kg
Pressurized Disposal Mass (Cargo Module)	Max 3,250 kg
Unpressurized Disposal Mass (Cargo Module)	Max 1,500 kg

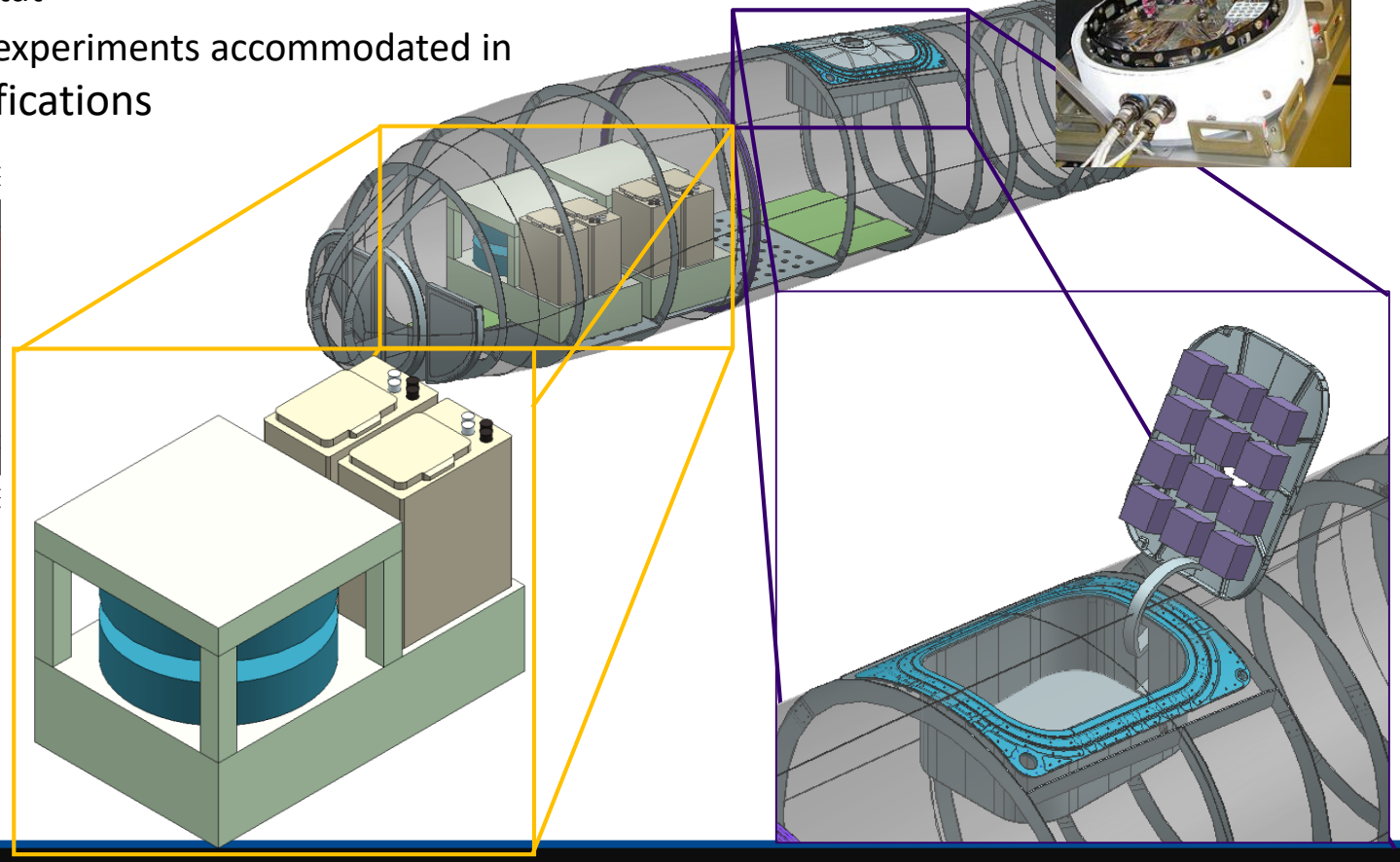
Standard Science Payload Locker

- Current microgravity science is standardized to “mid-deck locker equivalents” (MLEs)
  - Heritage from shuttle, currently broad standard used on ISS
- Single locker:
  - 20.32 x 18.1 x 10.8 in
  - 75 W power @ 28 V and cooling budget
  - Ethernet data
  - Commanding
- Double locker is the equivalent of 2 single lockers\
- Custom payloads are possible but these are used as a well defined starting point.

Non-Standard Payloads Examples

- Payload Examples
  - Custom structures and mounting
  - VEGGIEs
  - Advanced Plant Habitat
  - Rodent habitat
  - BIOPan like experiments accommodated in hatch modifications

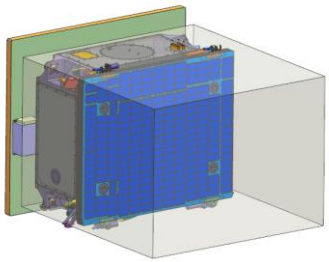




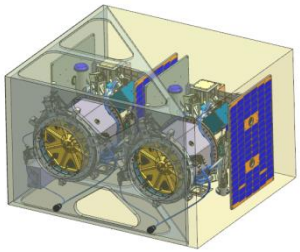
External Payload Examples

- External Accommodations:
  - Cargo Module (CM) supports three external, unpressurized payloads that attach via standard Flight Releasable Attachment Mechanism (FRAM)
  - External Volume = ~ 256 ft3
    - 102”x81”x35” at upper location
    - 49"x34"x46“ at each of 2 lower locations
  - FRAM power and data interfaces can be used to support a secondary satellite deployment mechanism
    - Up to 150 W per location, 450 W total
  - Multiple small sat / cube sat configurations that meet FRAM mass/volumetric constraints

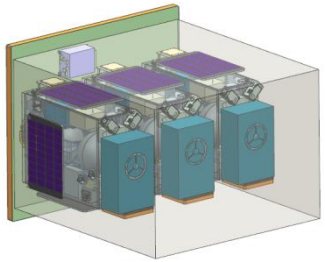
FRAM



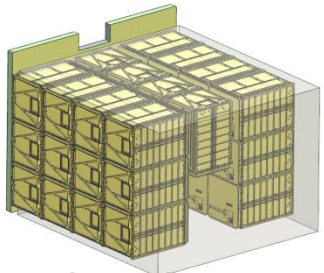
SN100 Class
OG2 SV = 180 kg



SN 50 Class
STPSat-5 SV = 105 kg x 2 = 210 kg



SN30 Class
SV = 76kg x 3= 228 kg



Cubesat Class
28x 12U Volume constraint
~18 x 12U Mass (24 kg each)

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United Nations *Dream Chaser®* Mission

Thank you

Questions?