Sierra Nevada Corporation and The UN/*Dream Chaser*® Mission

Scientific and Technical Subcommittee on the Peaceful Uses of Outer Space (COPUOS)

"Expanding horizons: the case for industry engagement in UNISPACE+50 and beyond"

Vienna – February 6th, 2018

Luciano Saccani
Senior Director, Business Development

Sierra Nevada Corporation's
Space Systems

A Legacy of Flight Heritage and Innovation

Proven Experience

- 30 year of spaceflight heritage
- 450 space missions supported
- 4,000 products delivered on-orbit
- Launching products ~every 3 weeks
- 70+ successful NASA missions
- Supplier to nearly all flagship and interplanetary NASA missions
- Providing cargo services to the International Space Station under NASA resupply contract

Trusted Supplier to NASA for Interplanetary Missions

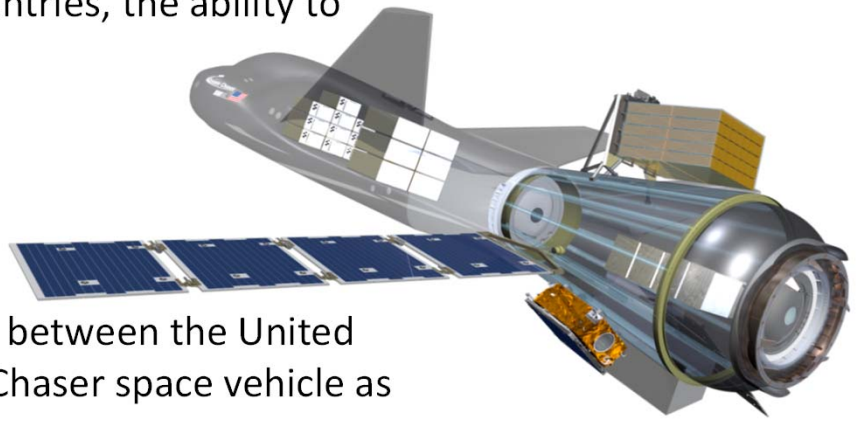
United Nations Dream Chaser Mission

UNOOSA Human Space Technology Initiative (HSTI) is based on three pillars:

- promote international cooperation
- conduct outreach activities
- support capacity building efforts worldwide

The UN/Dream Chaser mission is the most ambitious program under HSTI. It will be the first United Nations sponsored, multi-country space mission. It will provide member countries, especially developing countries, the ability to build and fly payloads for:

- microgravity science
- remote earth sensing
- hardware qualification
- assets deployment



A Memorandum of Understanding has been executed between the United Nations and SNC in June 2016 to utilize SNC's Dream Chaser space vehicle as the host for UNOOSA member country's payloads

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.

The UN Dream Chaser Mission Timeline

- ✓ Sep 2017: Issue Call for Interest (CFI to UN Member Countries)
- ✓ Nov 2017: CFI responses due
- ✓ Jan 2018: Bidder's briefing

- Plan for 2018:
  - Release of Announcement of Opportunity (AO)
  - AO responses due
- Plan for 2019:
  - Payloads selection
  - Select Landing Site
- Plan for 2022:
  - Mission Execution

Leaving no one behind …

- The mission is open to all of the 193 Member States of the United Nations.
- Institutions from emerging and developing countries are particularly encouraged to participate.
- Nobody has to be left behind
- Dream Chaser will carry experiments, payloads, or satellites provided by institutions in the participating countries.

… supporting the SDGs …

- This will be the first space mission devoted to addressing the 17 Sustainable Development Goals.
- The experiments, payloads, and satellites to be deployed are required to address at least one of the 17 Sustainable Development Goals.

… bridging the space divide
giving opportunities to develop space-related capabilities

UN Mission Call for Interest

- **Purpose**
  - To determine interest level from member countries to have a free flight mission
  - Get a preliminary understanding of the types of payload accommodations of interest
    - Internal, external, satellite deployment
- **Results**
  - Exceeded our expectations
  - 150 Responses from 75 countries
  - Variety of payload types
  - All SDGs addressed by the proposed payloads

Orbital Space Mission
UNOOSA Call for Interest

APPLICATIONS FROM: 25 SEPTEMBER - 15 NOVEMBER 2017

Important Links:

Call for Interest and Response Form

The United Nations Office for Outer Space Affairs (UNOOSA) is partnering with the Sierra Nevada Corporation (SNC) to offer United Nations Member States the opportunity to participate in an orbital space mission utilizing SNC's Dream Chaser® space vehicle. The mission will be open to all Member States of the United Nations, and developing countries are particularly encouraged to participate. The mission will carry experiments, payloads, or satellites provided by institutions in the participating countries.

The purpose of this Call for Interest (CFI) is to provide a summary of the proposed mission and to solicit information from Member States interested in providing experiments, payloads, or satellites that could be flown on this mission. The CFI also has the objective of gathering information on the interested countries so that UNOOSA may better understand the demand for this type of mission.

This mission will be the first space mission devoted to addressing the Sustainable Development Goals.

Dream Chaser Space Vehicle

- Only runway-landing Space Vehicle actively in development
  - Capable of landing at spaceports and airports that can accommodate large commercial planes
- Crewed or uncrewed transportation to and from Low Earth Orbit (LEO)
- Non-toxic propulsion for launch abort, orbital translations, attitude control, deorbit
- < 1.5g re-entry profile and >1,500 km cross-range capability
- Designed to launch on a variety of launch vehicles

Crewed Dream Chaser

Uncrewed Dream Chaser

Respect the Past…Embrace the Future

History: Dream Chaser Program

- **1982-84**: ½ scale Russian BOR-4 orbital flights
  - Recovery photographed by Australian Royal Air Force P-3 Orion aircraft
- **1983-95**: NASA Langley development of HL-20 (based on BOR-4 images)

- **2005-10**: SpaceDev (later acquired by SNC) modified the HL-20 into the Dream Chaser spacecraft
- **2010-14**: SNC awarded NASA's CCDev 1, CCDev2, CCiCap and CPC contracts to continue development
- **2014-15**: SNC modified the Dream Chaser spacecraft to become the Dream Chaser Cargo System for NASA's CRS2 program
- **2016:** SNC awarded ISS Cargo Resupply Contract
- **2017:** Successful Approach and Landing Test

Dream Chaser Cargo System Features

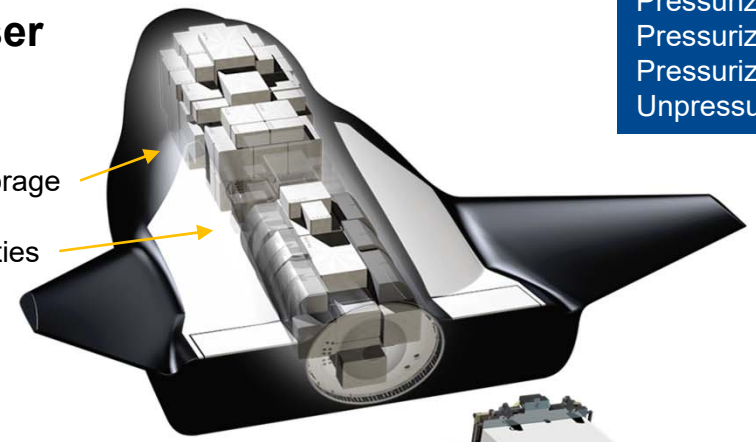
Pressurized/Unpressurized Upmass:	5,500 kg
Pressurized Return:	1,925 kg
Pressurized Disposal:	3,250 kg
Unpressurized Disposal:	1,500 kg

Uncrewed Dream Chaser

Pressurized Cargo

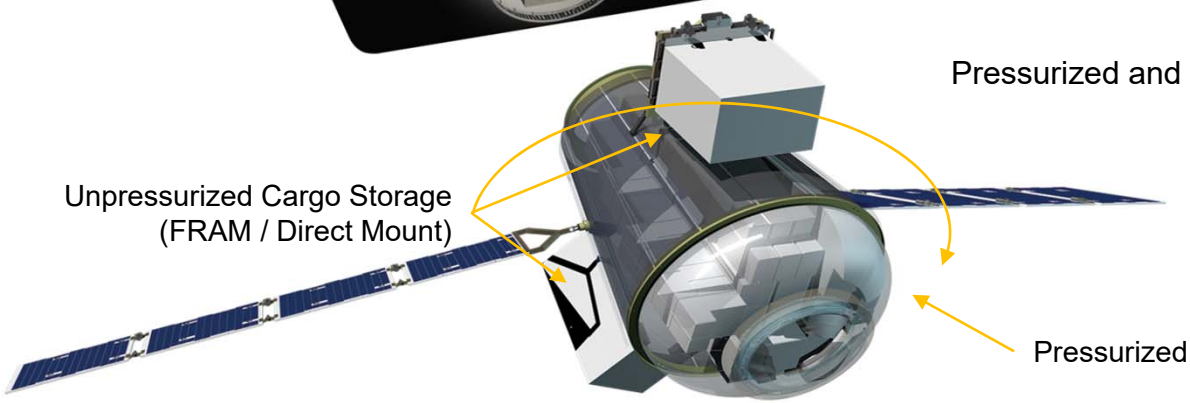
Pressurized Cargo Storage

Powered Payload Capabilities



Cargo Module

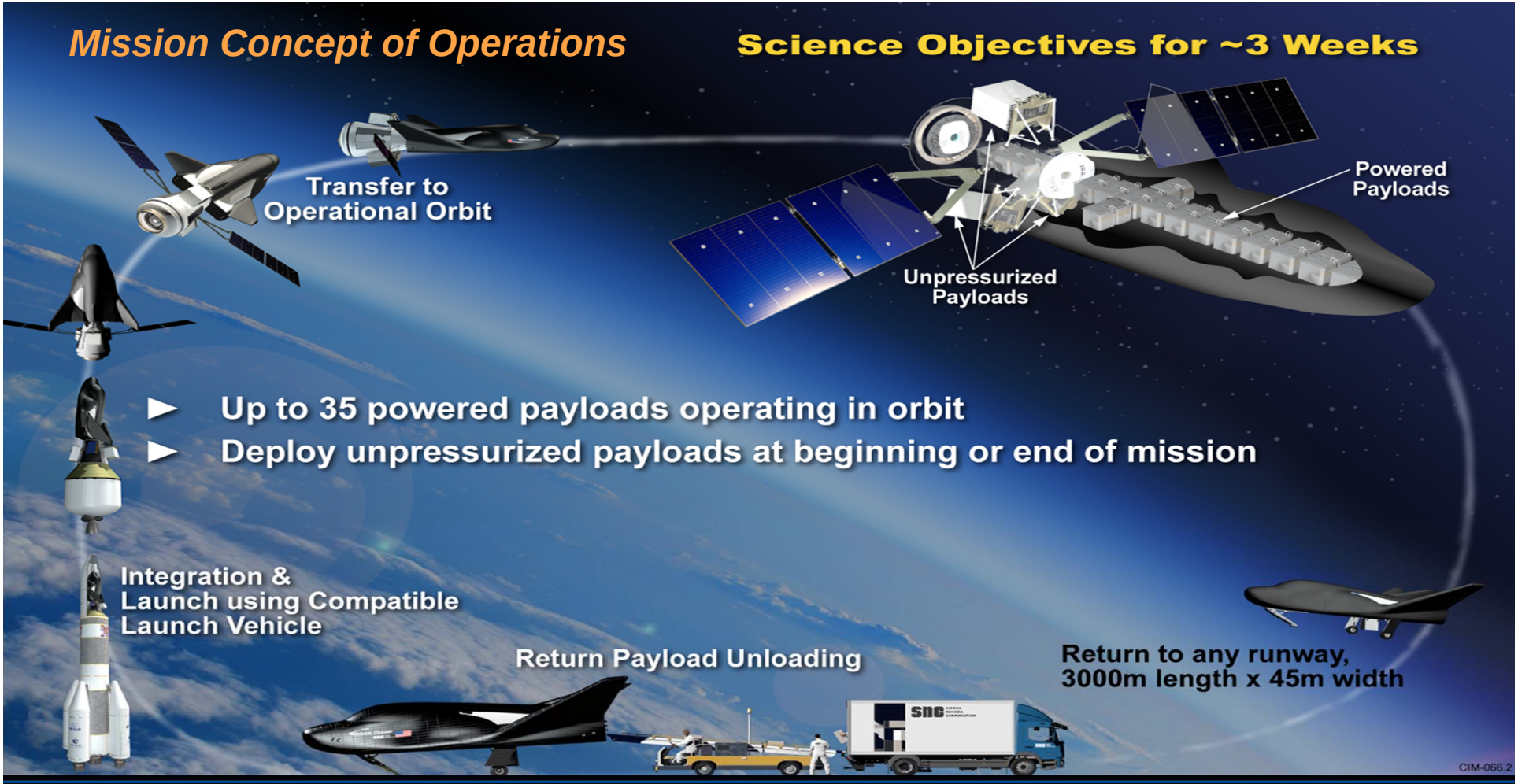
Pressurized and Unpressurized Cargo



Unpressurized Cargo Storage
(FRAM / Direct Mount)

Pressurized Cargo Storage

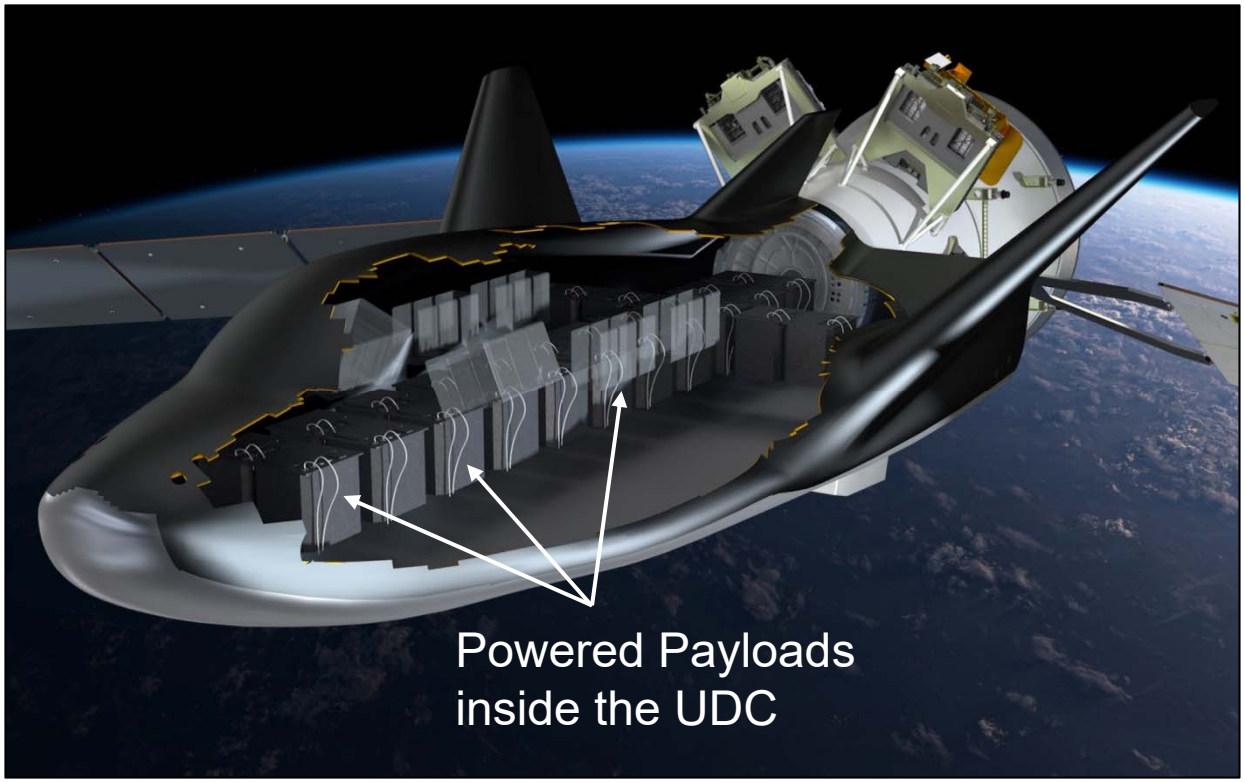
Mission Concept of Operations



Mission Assumptions

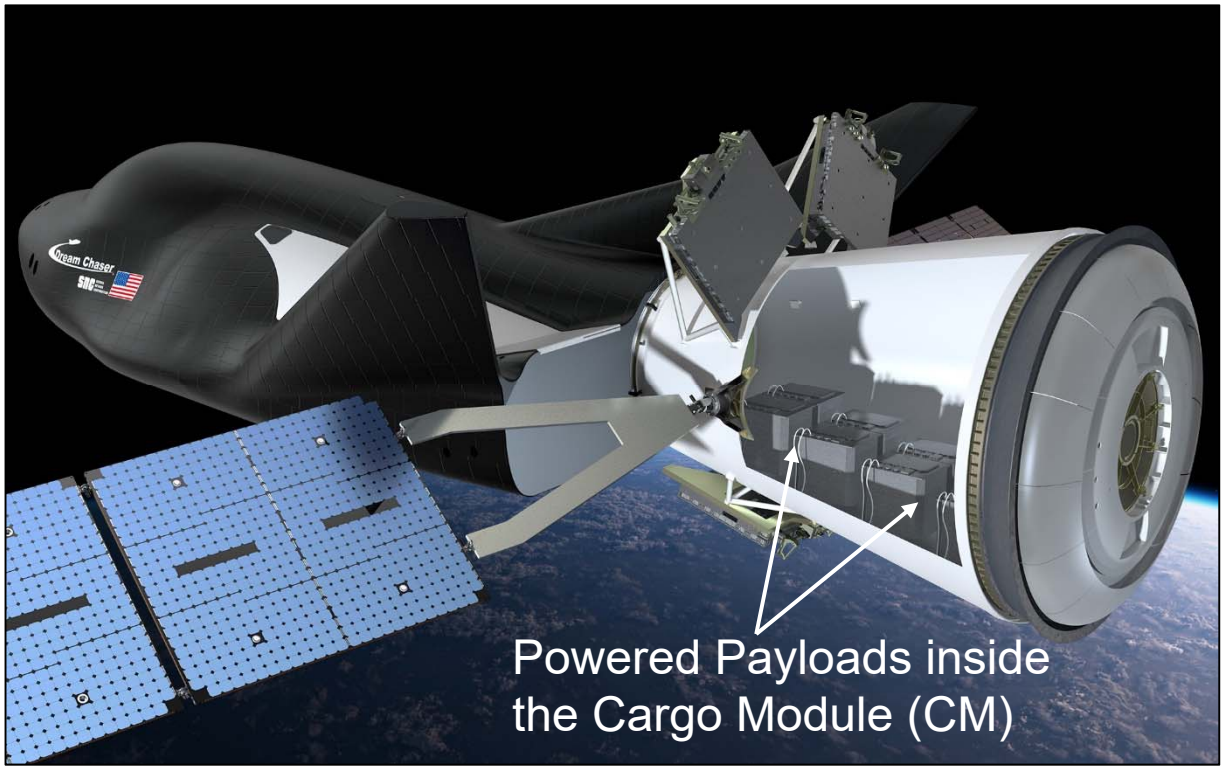
- Targeting a 500km circular orbit
- Between 0 – 35 degrees inclination
- Around 35 payloads hosted on board
- 2-3 weeks on orbit (to be defined after AO responses)
- The mission is un-crewed. Payloads will need to autonomous
  - Commands can be sent to the payloads periodically from the ground
  - All data will be recorded and downlinked as available
- Launch vehicle and to be decided
- Landing site to be decided

Internal Powered Payloads – Return



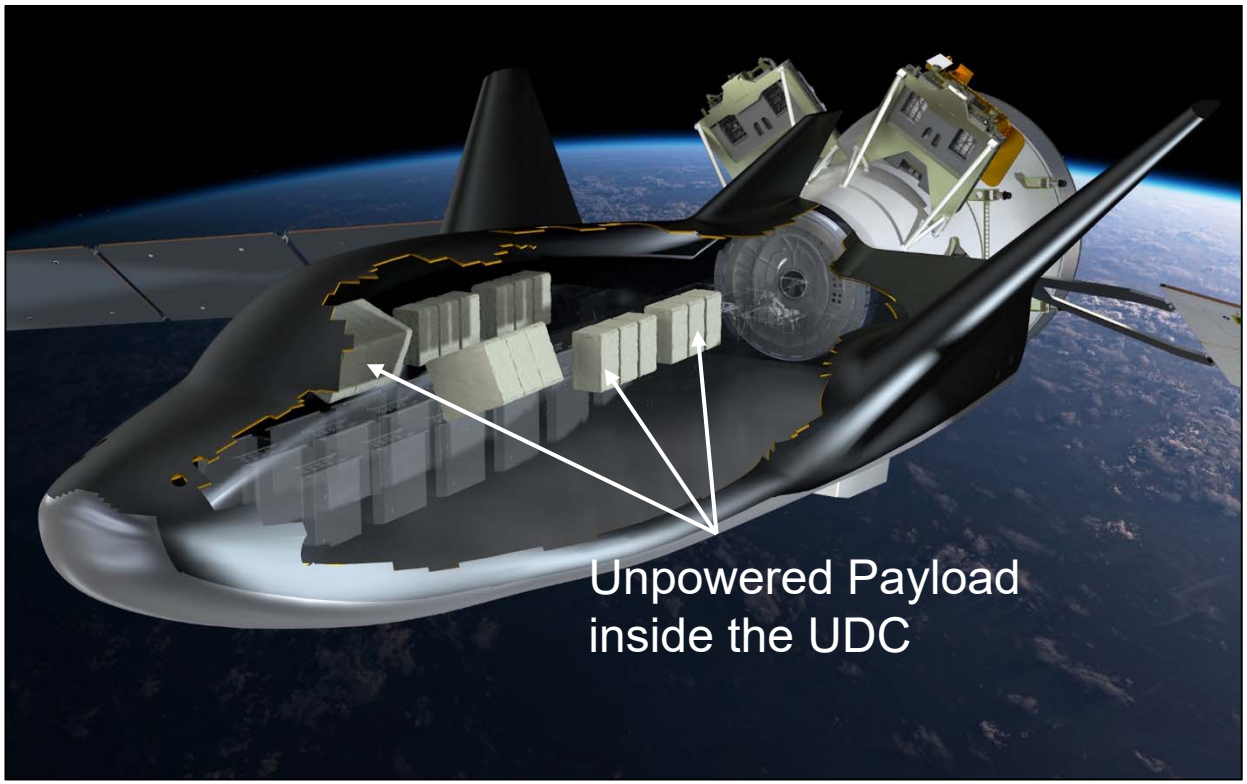
- Powered Payload Lockers
  - Single or Double
- Payload **returned** to earth in the Dream Chaser
- Data recorded and downlinked

Internal Powered Payloads - Disposal



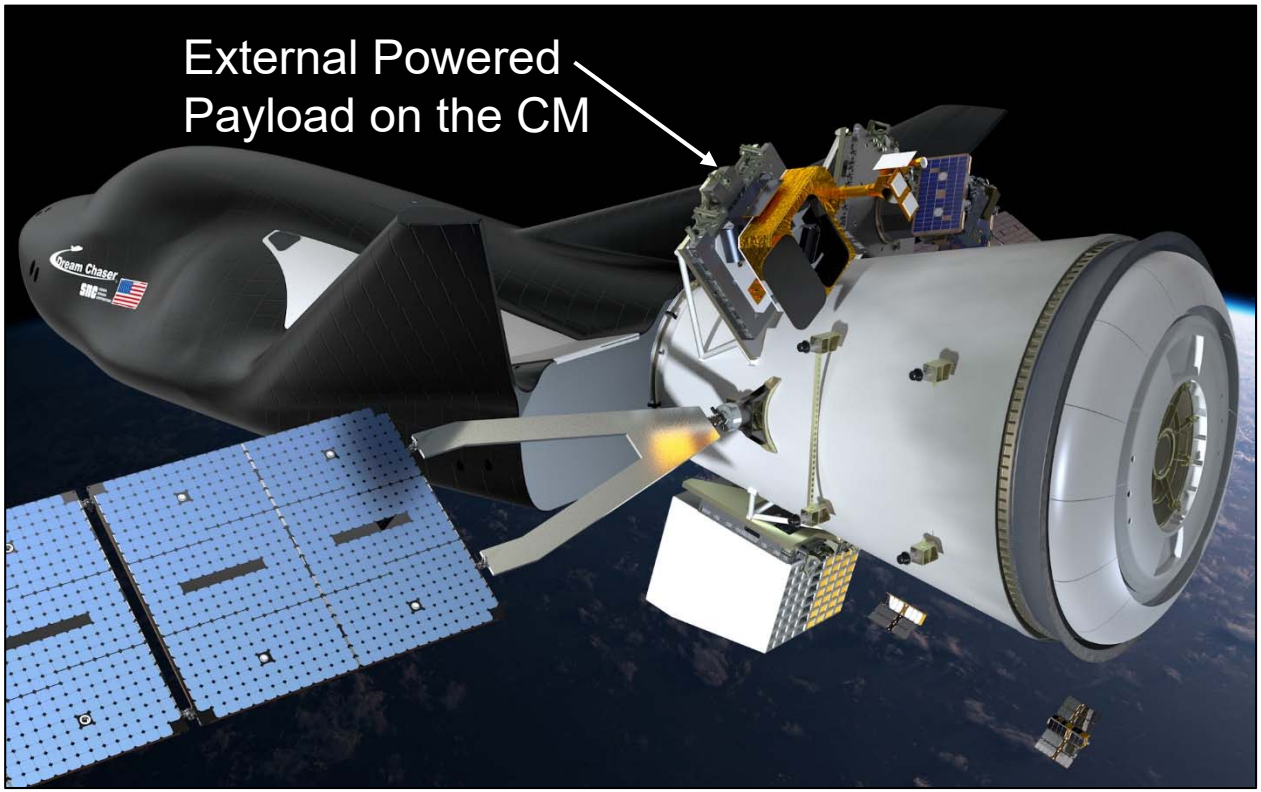
- Powered Payload Lockers
  - Single or Double
- Payload **disposed** in the CM on reentry
- Data recorded and downlinked

Internal Unpowered Payloads - Return



- **Unpowered** Payload
  - Varying bag sizes
- Payload **returned** to earth in the UDC
- **No** data recorded or downlinked
- Good for passive experiments that need exposure to microgravity

External Power Payloads - Disposal

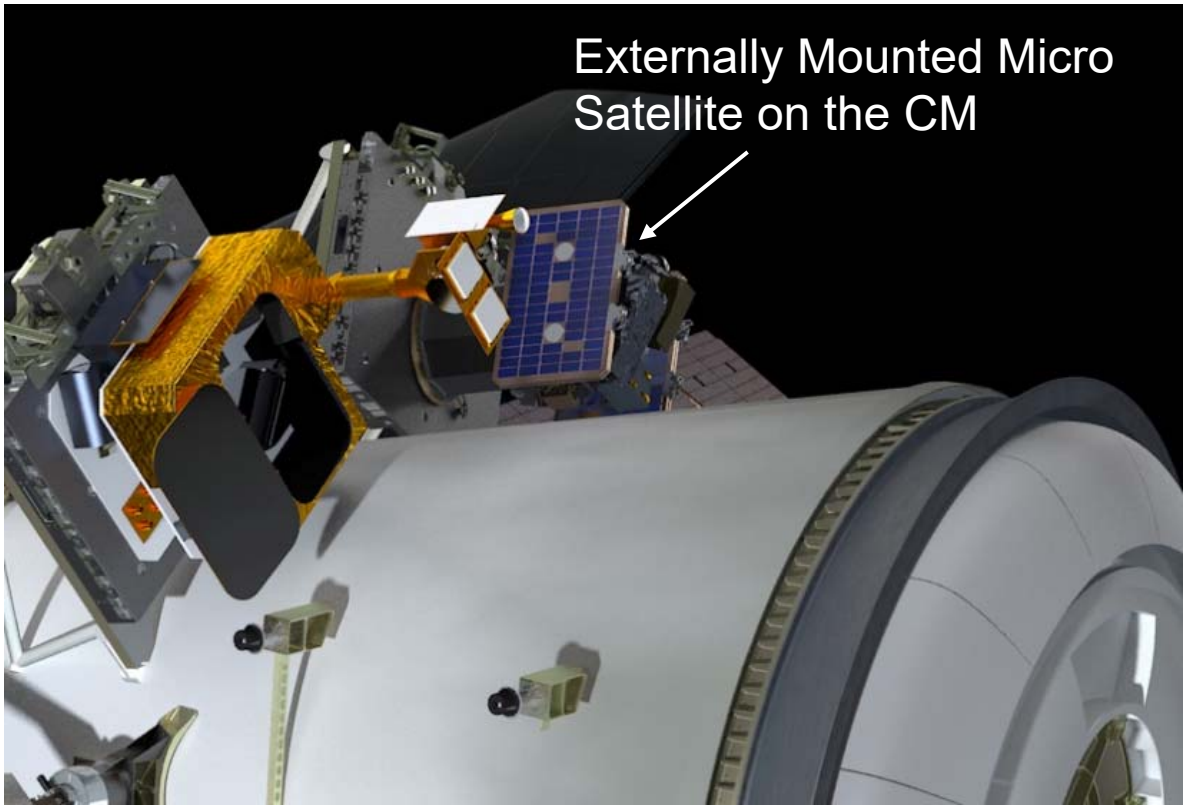


- **Externally** Mounted Payload
  - Integrate on a standard plate
- Payload **disposed** on the CM during reentry
- Data recorded and downlinked

External Payload Deployment – CubeSats

- **Externally** Mounted deployer
- Payload **Deployed** on orbit
- **No** data recorded and downlinked
- CubeSats launched in an ‘off’ mode

External Payload Deployment – Micro Satellite



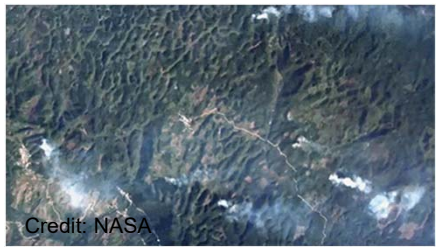
- **Externally** Mounted Micro Satellite
- Payload **Deployed** on orbit
- **No** data recorded and downlinked
- Micro Satellite launched in an ‘off’ mode

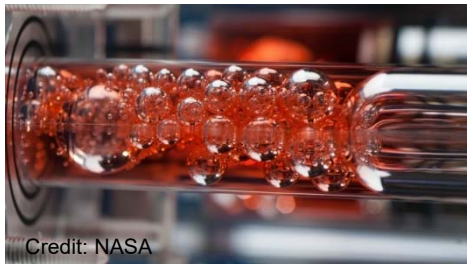
Example of science and developments supported by the mission

- Vegetable growth
- Effect of microgravity on DNA
- New materials
- Supporting water purification efforts worldwide
- Growing high-quality protein crystals
- Developing improved vaccines and medications
- Providing students opportunities to conduct
- Monitoring water quality from space
- Monitoring natural disasters from space
- Describing the behavior of fluids to improve medical devices
- …


Credit: NASA

Credit: NASA


Credit: NASA

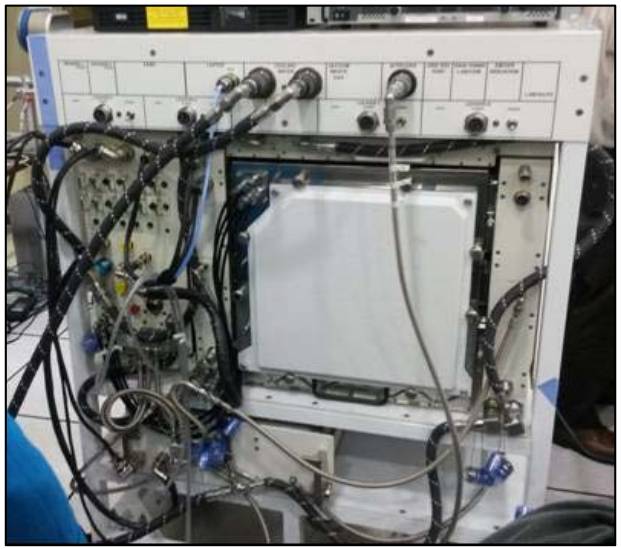

Credit: NASA

Advanced Plant Habitat

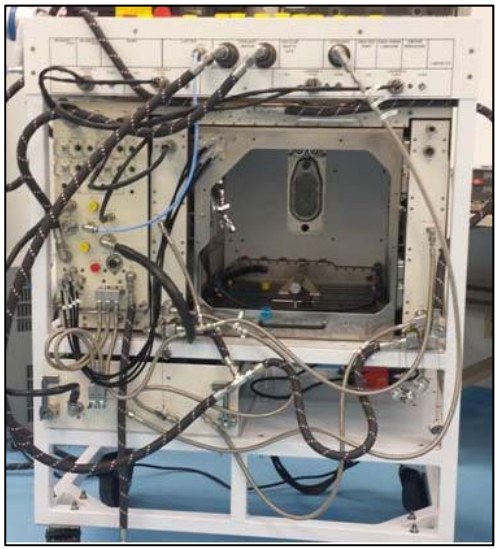
Plant growth in Plant Habitat Engineering Development Unit

- Plant Habitat (PH) → Installed in EXPRESS Rack 5 on ISS in 2017
  - PH is quad-locker payload designed for mounting in ISS EXPRESS Rack
  - PH will be largest plant growth chamber yet developed for ISS
  - The PH design is open architecture
    - Allow critical subsystems to be removed and replaced on-orbit
    - Accommodate future updates for custom applications
  - PH contains more than 188 sensors in baseline configuration
  - PH designed to facilitate interaction between crew on-orbit or scientists on the ground with plant specimens and their environment

Advanced Plant Habitat (cont.)



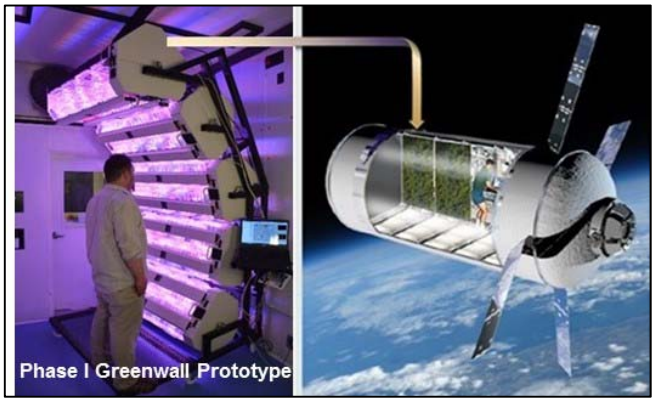
PH FU1 with door cover in place over Growth Chamber



PH FU1 with door cover removed showing GC interior

PH EDU during testing showing plants in GC

GreenWall – Apply Space Food Production on Large Scale for Extended Missions



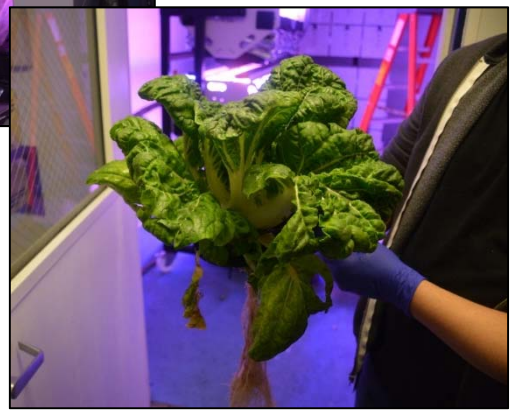
GreenWall Long-Duration Application

Plant Modules within GreenWall Section

Prototype for Test & Evaluation

GreenWall Plant Growth Experiments

Pak Choi



Dwarf Tomatoes