JWST/OTIS Shaker System

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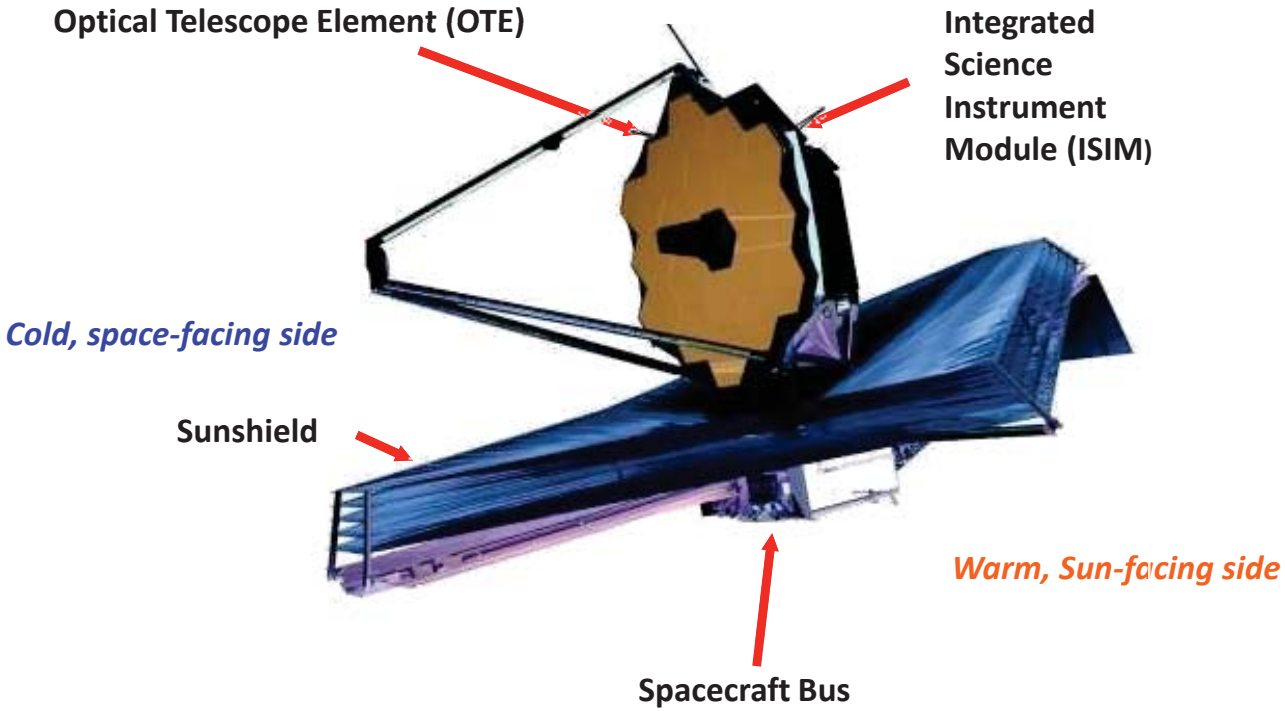
Problem

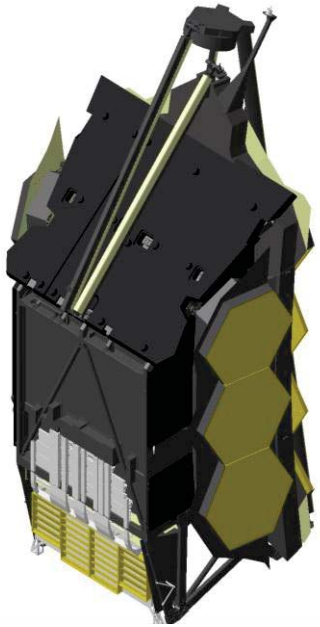
- OTIS needs to be subjected to sine vibration testing
- Current GSFC shakers do not meet OTIS requirements
  - High dynamic overturning moment (1.3 million in-lbs or 147,000 N-m) during axial testing due to cg offset
  - Stringent cross-axis input requirement (<40%)
  - Current hook height not adequate



What is OTIS?

- OTIS = OTE + ISIM
  - OTE = Optical Telescope Element
  - ISIM = Integrated Science Instrument Module

- OTIS is the cryogenic portion of JWST
  - Launched at ambient temperature
  - Height: 28’ 3” (8.6 m)
  - Mechanical Interface: 8’ 5” x 7’ 10” (2.6 m x 2.4 m)
  - Weight: 8686 lbs (3940 kg)



JWST/OTIS Stowed Configuration

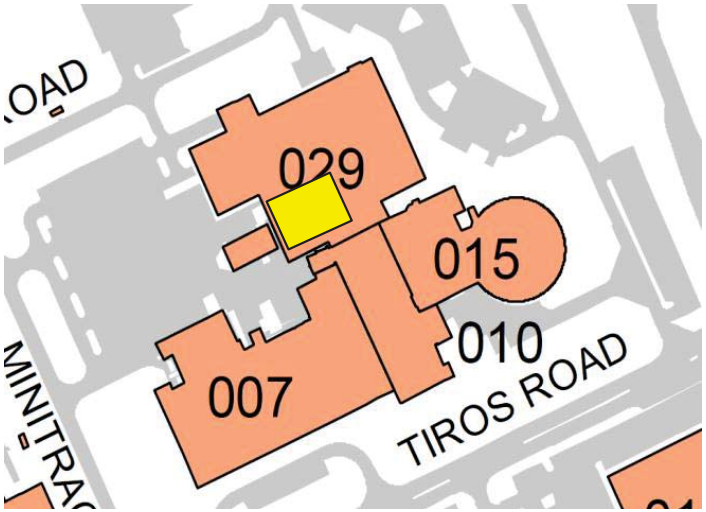
OTIS
Stowed Configuration

JWST Observatory
Stowed Configuration

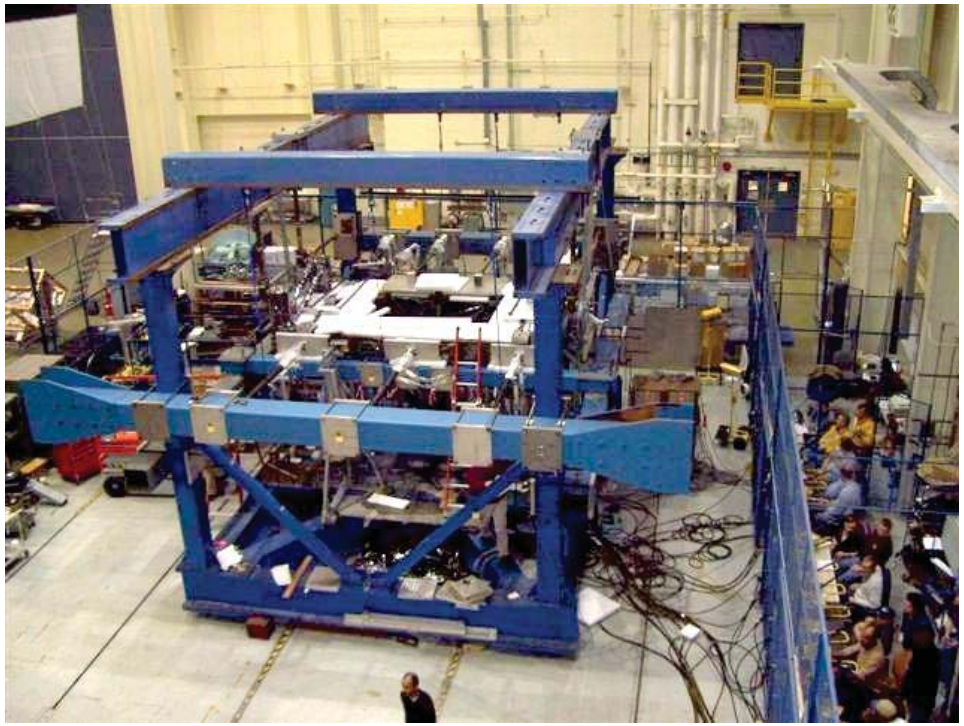
JWST Observatory
In Fairing

Solution

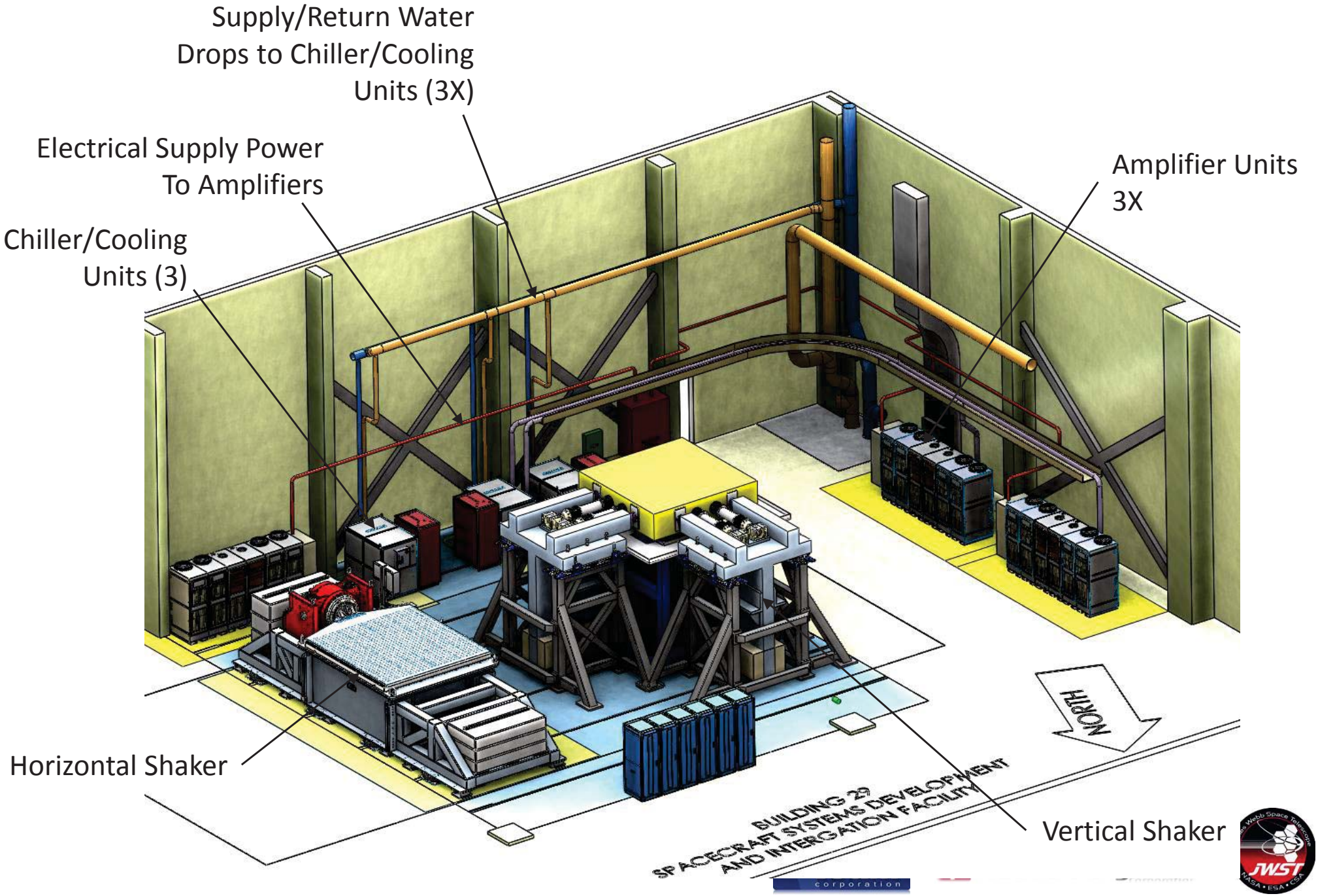
- Procure a Large Vibration Test System (LVTS)
- Install it in Building 29 on the 30” thick floor where the Universal Static “Blue” Test Facility is “currently” located



Location

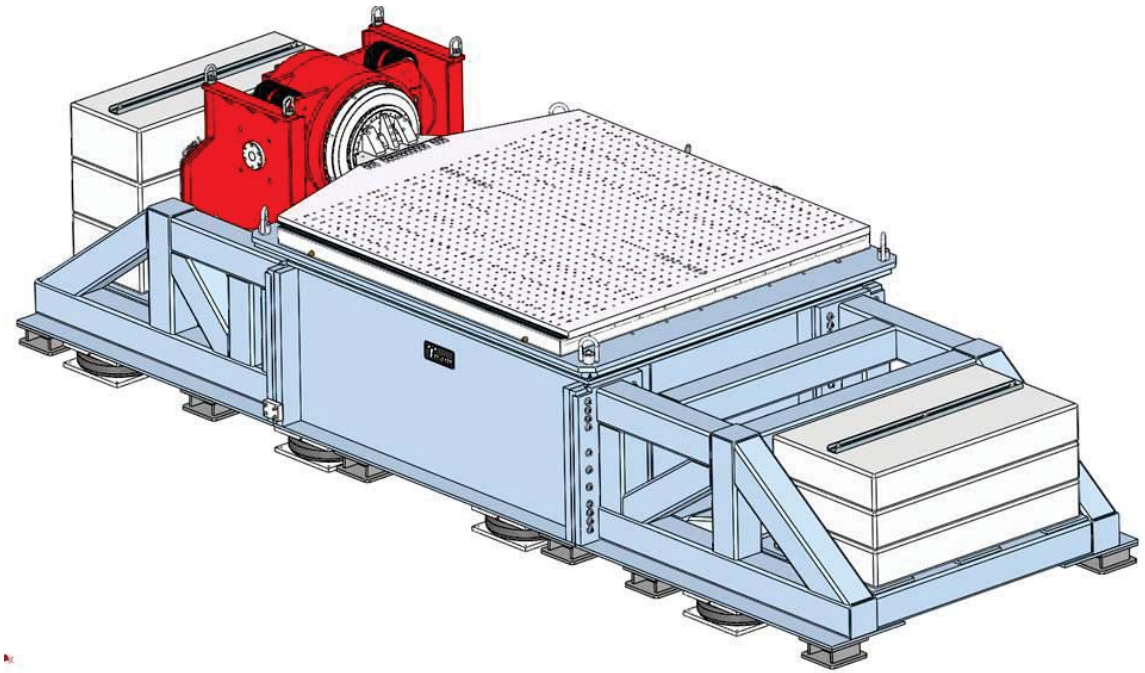


Shaker Configuration in Building 29



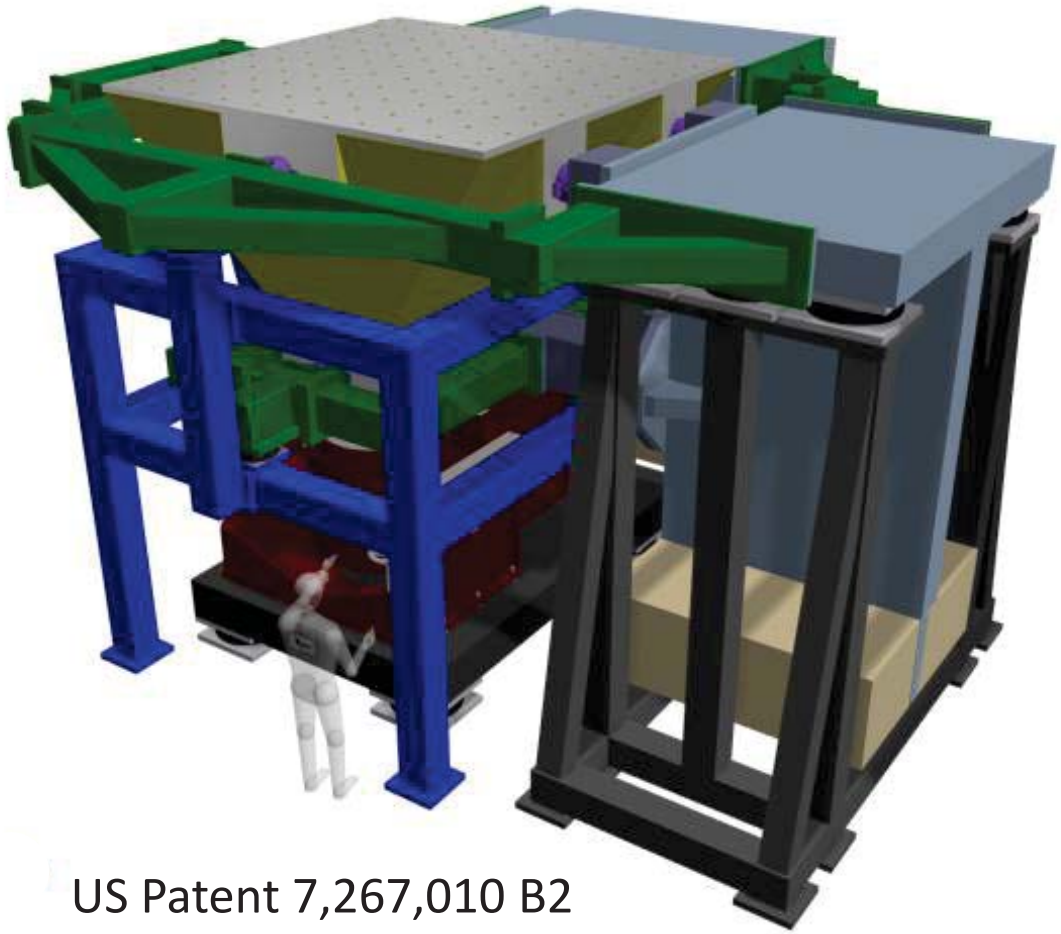
Horizontal Vibration System

- Design Concept:
  - Expansion of standard Team T-Film Table to accommodate extremely large overturning moments
  - High rotary inertia reaction base
- Design Components:
  - Electrodynamic Shaker
    - Single 50,000 lbf (222 kN) Data Physics SignalForce shaker
    - Air isolated trunnion mount
  - T-Film Table
    - Hydrostatic Bearings
    - Couples overturning moments into base
  - Reaction Base
    - High rotary inertia
    - Air isolated



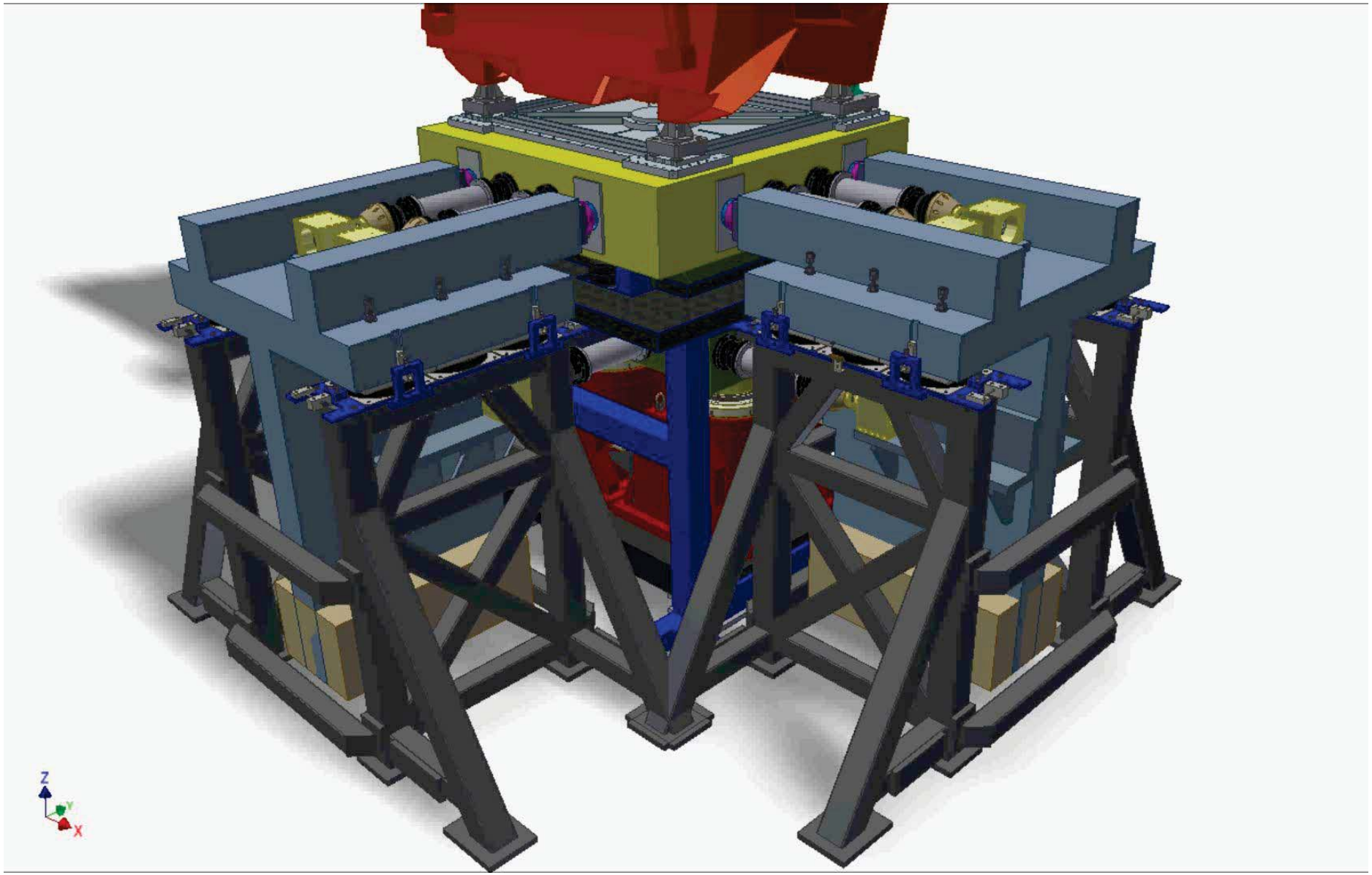
Vertical Vibration System

- Design Concept: Inertial Mass Guided Head Expander
  - Expansion of a patented system delivered to Orbital Sciences in support of the Dawn Program
  - Reduced Cross-Axis motion from 250% down to 14%
- Design Components:
  - Electrodynamic Excitation
    - Dual 50,000 lbf (222 kN) Data Physics SignalForce shakers
  - Guided Head Expander
    - Transmits energy from shaker to test article
  - Inertial Masses
    - Reacts moments generated by spacecraft
  - Tension Rods and Hydrostatic Pad Bearings
    - Provides short, stiff load path into inertial masses
  - Air Isolated Supports
    - Isolates vibration system from facility



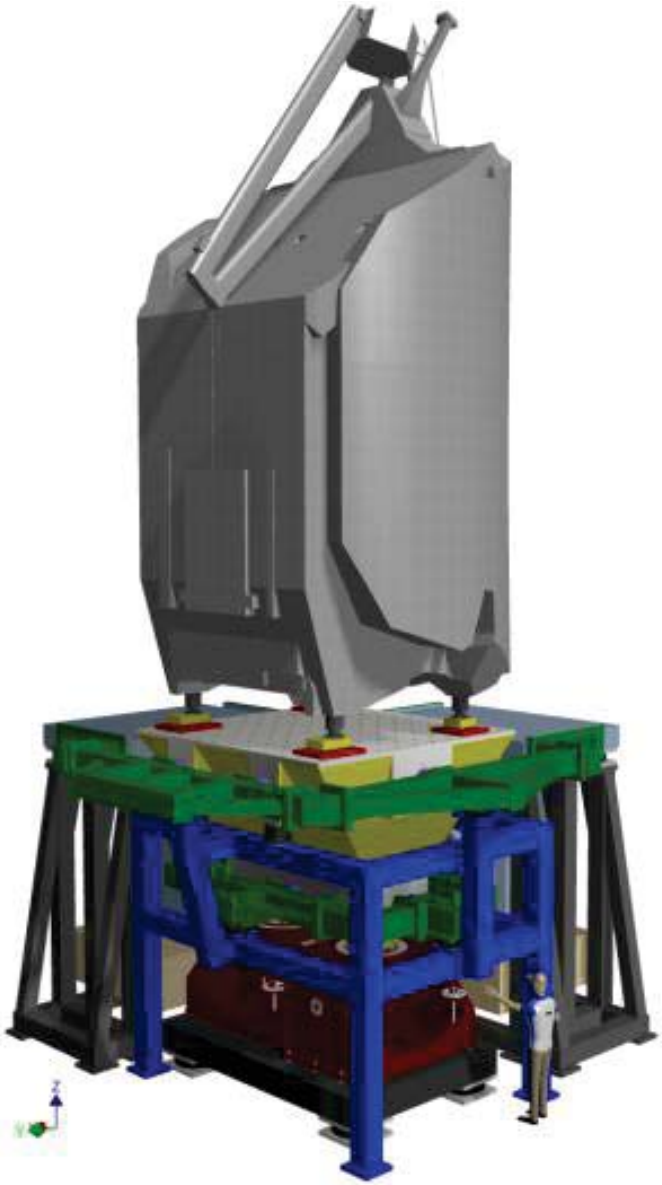
US Patent 7,267,010 B2

Vertical Vibration System

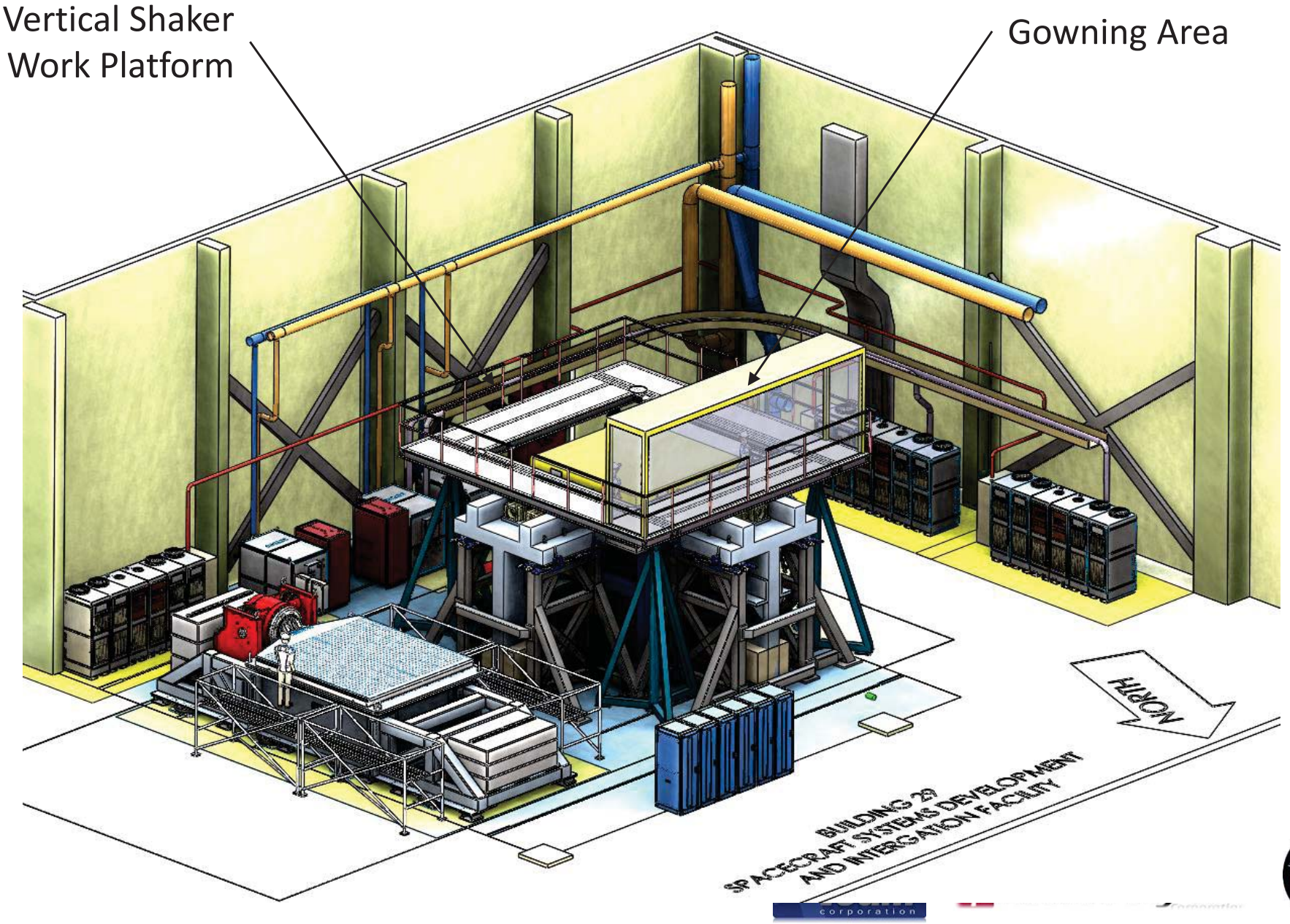


US Patent 7,267,010 B2

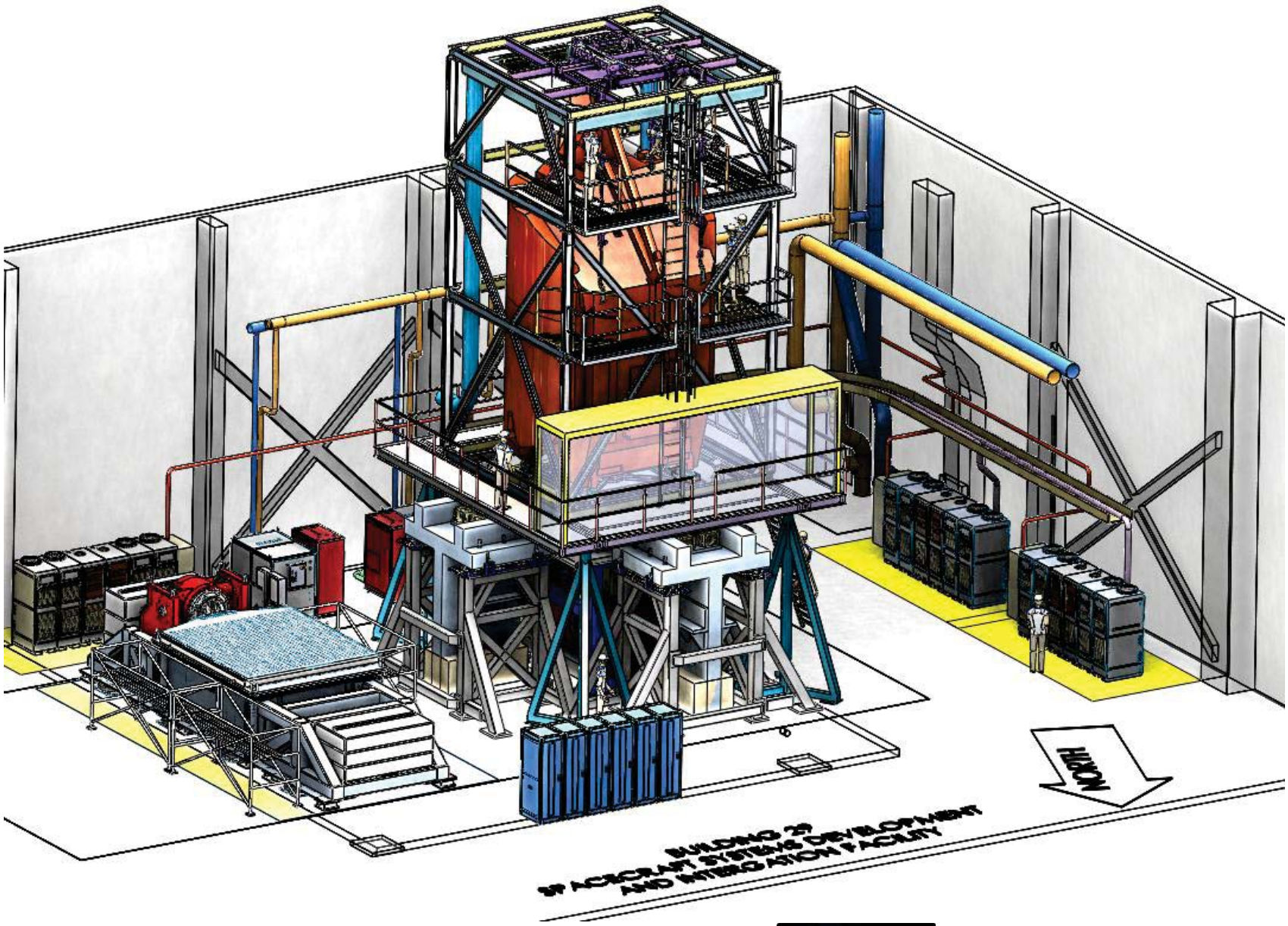
OTIS Shown on Shaker Systems



Vertical Shaker Work Platform



OTIS Vertical Test Configuration



Unique Items

- Firsts for Goddard
  - Multi-shaker drive (vertical facility)
  - Multiple Input Multiple Output (MIMO) control system
- Unique in Industry
  - Inertial mass guided head expander of this size

Schedule

- Vibration Test System Contract
  - Contract Awarded: 12/31/13
  - Kickoff meeting: 2/6/14 at GSFC
    - Updated electrical power requirements to FMD
    - Finalizing test system layout with vendors.
  - Horizontal System CDR: April 17 at Team Corp
  - Vertical System CDR: October 2014
  - Hardware installation to begin: May 2015
  - System check out complete and facility turned over to GSFC: October 2015

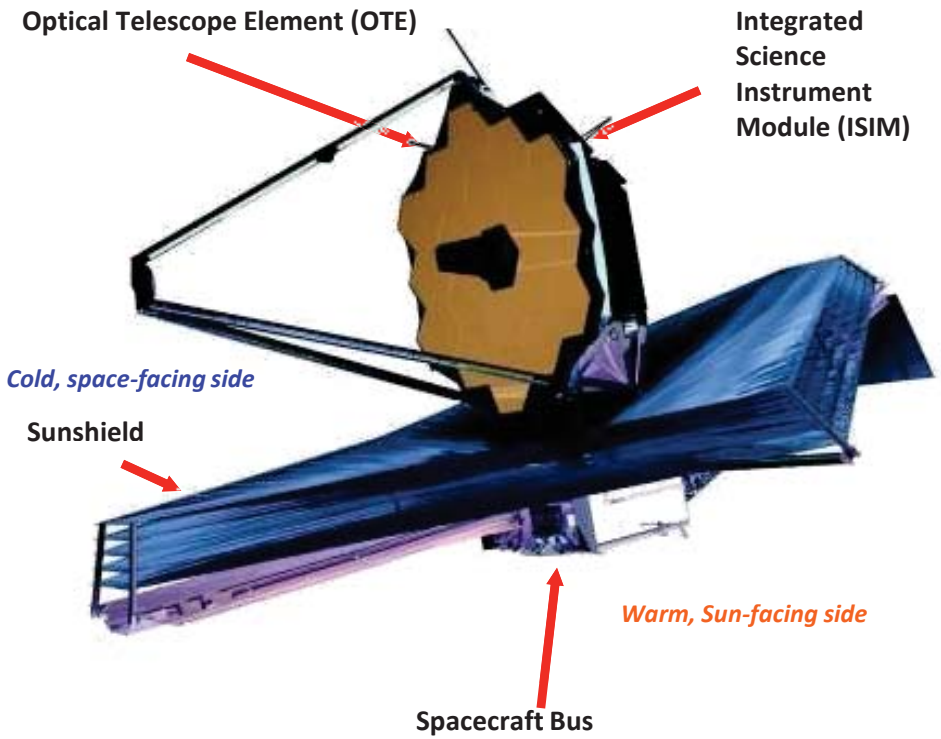
James Webb Space Telescope (JWST)

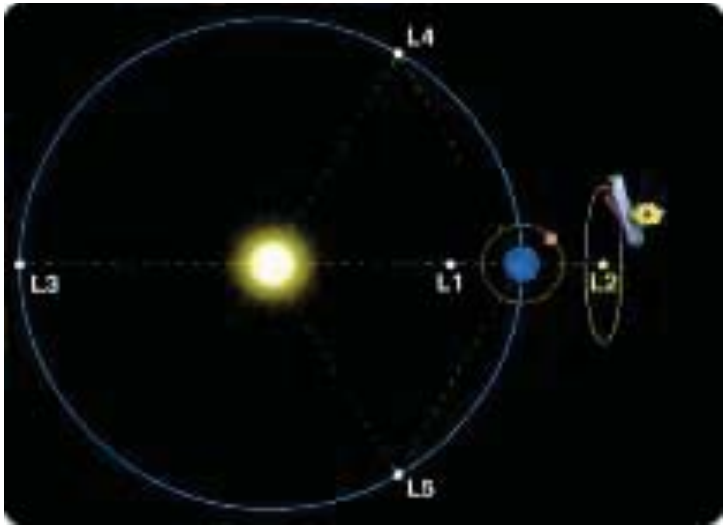
Mission Objective

- Study the origin and evolution of galaxies, stars and planetary systems
  - *Optimized for infrared observations (0.6 – 28 μm)*

Organization

- Mission Lead: Goddard Space Flight Center
- International collaboration with ESA & CSA
- Prime Contractor: Northrop Grumman Space Technology
- Instruments:
  - Near Infrared Camera (NIRCam) – Univ. of Arizona
  - Near Infrared Spectrograph (NIRSpec) – ESA
  - Mid-Infrared Instrument (MIRI) – JPL/ESA
  - Fine Guidance Sensor (FGS) – CSA





Description

- Deployable telescope w/ 6.5m diameter segmented adjustable primary mirror
- Cryogenic temperature telescope and instruments for infrared performance
- Launch on an ESA-supplied Ariane 5 ECA rocket to Sun-Earth L2