EVA Training and Development Facilities

Scott Cupples
EVA Hardware Development Engineer
EVA Office/XX4
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Overview

- Vast majority of US EVA training and EVA hardware development occurs at JSC
- EVA training facilities used to develop and refine procedures and improve skills
- EVA hardware development facilities test hardware to evaluate performance and certify requirement compliance
- Environmental chambers enable testing of hardware from as large as suits to as small as individual components in thermal vacuum conditions

EVA Training Facilities

Space Vehicle Mockup Facility

- Varying fidelity of full scale mockups of space flight vehicles including all ISS modules and US Airlock
- Replica ISS LAN (SSC Network)
- Multi-System PTT interfaces with ISS mockups
- Integration across training facilities
  - Comm and video subsystems
- Orbital and SpaceX stowage mockups
- Two full scale low fidelity Orion mockups
- Reserved space for Commercial Crew Mockup(s)
- Precision Air Bearing Floor

Precision Air Bearing Floor

ISS Crew Module Mockups

ISS Crew Training

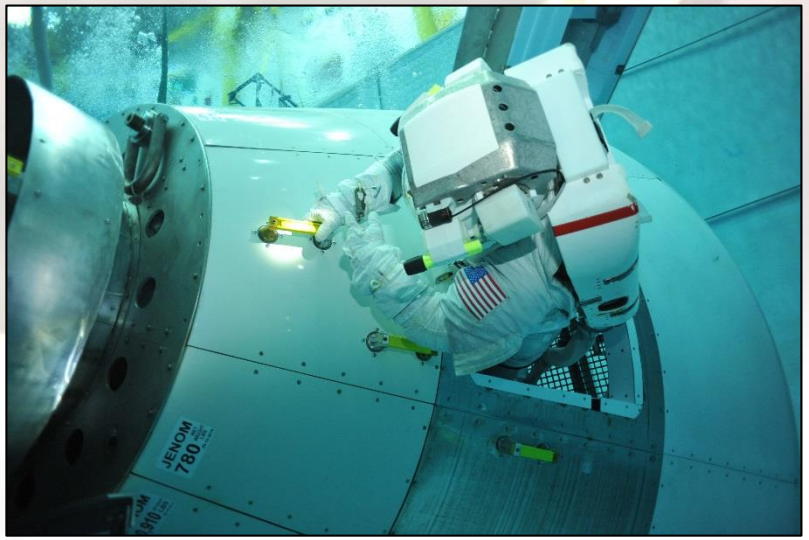
Orion Mockups

POGO - MBSU testing

EVA Training Facilities

Neutral Buoyancy Laboratory

- Varying fidelity of full scale mockups for EVA training
- Utilized primarily for ISS EVA training and development
- Evaluations of Orion conducted for develop of potential EVA interfaces
- Has been utilized to evaluate hardware and tools before NEEMO
- Utilized for testing con ops associated with Asteroid
- Critical system maintenance and operation
  - Life support, Human-rated robotics, SCUBA, Clean room, Animation, Nitrox production, etc.
- External Customer Operations
  - Water survival (e.g HUET), Oil and Gas (ROV), Non-destructive under water testing
- Future Vehicle Support
  - Orion, MACES/ARCM, Z2 prototype spacesuit
- Retrieval Crewed Mission (ARCM)
- Engineering design, analysis and fabrication



Simulator Facilities

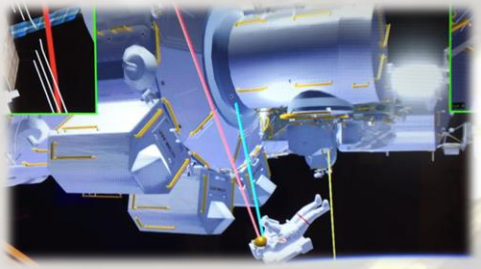
Active Response Gravity Offload System (ARGOS)

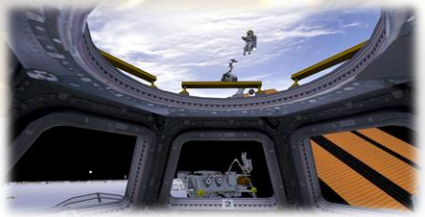
- 41’ x 24’ x 25’ structure which allows 37’ x 17’ x 15’ of travel
- Gravity fields simulated from 1g – 0g
  - Active robotic system allows very realistic motions in X, Y, Z, and yaw
  - Force error is minimized
- 750 lb maximum offload
- Accommodates unsuited or suited subjects
- Virtually all tools can be utilized
- Ability to utilize different regolith
- Mass handling capabilities
- Able to evaluate EVA hardware and operations
  - Vehicle interfaces
  - Sample collection tools and science sampling protocols
  - Translation hardware

Simulator Facilities

Virtual Reality Laboratory

- Space walks for ISS sustaining including robotics ops
- SAFER (Simplified Aid For EVA Rescue) operations
- EVA Mass Handling
- VRT (Virtual Reality Trainer) - Onboard ISS



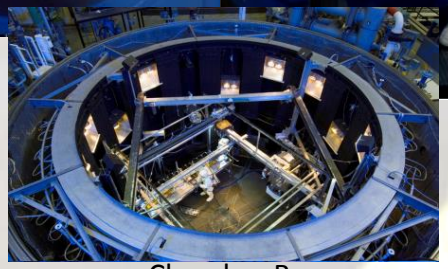


Vacuum Chambers

Vacuum Chambers

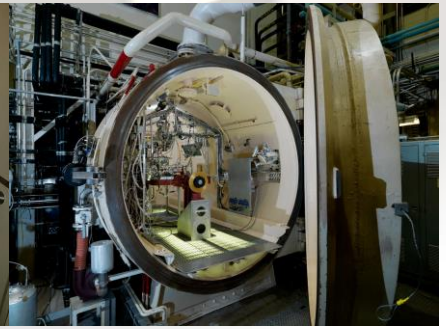
- Human Rated
  - Chamber B
    - Thermal vacuum chamber for human testing
  - Space Station Airlock Test Article
    - Functional mockup of ISS Airlock
    - EVA hardware testing, Crew training
  - 11’ Chamber
    - Space suit development and advanced life support testing
- Non-human-rated
  - Dual Glove Box
    - Small thermal chamber with access ports for test operations that use lower arms and gloves
  - 8’ Chamber
    - Human metabolic simulator for life support systems

SSATA



Chamber B

Dual Glove Box



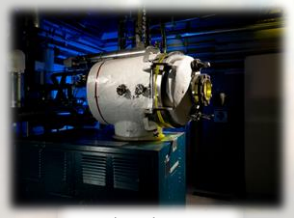
8’ Chamber

Vacuum Chambers

Small Thermal Vacuum Chambers

- Used for testing various articles and subassemblies
- Vacuum chambers not human rated
- Characteristics:
  - Pressure range: 1x10-6 – 760 torr
  - Temperature range: varies by chamber, but all chambers can reach -280F – 300F
- Uses:
  - Materials outgassing
  - Accelerated electrical and electronic component burn in and life cycle testing
  - Determination of design factors
    - Operating temperatures
    - Combined thermal and pressure-load distortions
    - Changes in absorptive or emissive properties of thermal coatings


Chamber E


Chamber G

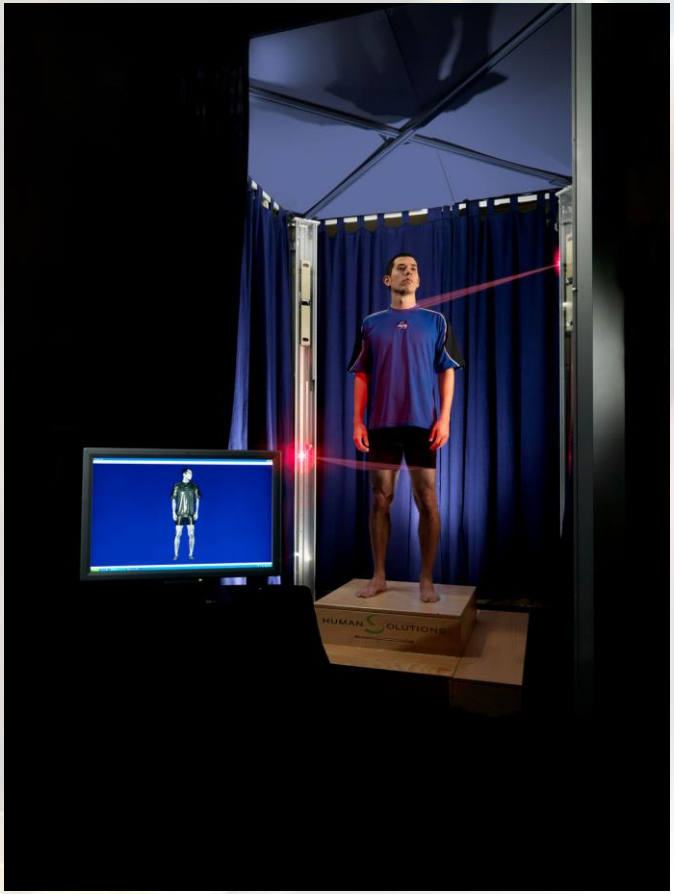

Chamber K


Chamber N

Human Factors

Anthropometrics and Biomechanics Facility

- Provides analysis, evaluation, and usability testing of human interfaces
- Can identify occupational biomechanical problems and recommend solutions
- Laser scanning
- Multi-joint motion tracking capability
- Maintains anthropometric database for crewmembers and test subjects



Collaboration

- JSC has developed customer-friendly agreements to streamline business relationships and is eager to share our unique facilities and expertise with new customers
- Submit direct inquiries regarding application or adaptation of JSC capabilities to satisfy special requirements to jsc-ea-partnerships@mail.nasa.gov
- Briefings on general or specific subjects of mutual interest can be arranged at JSC or at your business site

For more information

- JSC Capabilities Fact Sheets
  - http://www.nasa.gov/centers/johnson/partnerships/jsc-capabilities-fact-sheets
- Neutral Buoyancy Laboratory
  - http://www.nasa.gov/centers/johnson/pdf/736186main_FS-2013-NBL_WEB.pdf
- Space Vehicle Mockup Facility
  - http://www.nasa.gov/centers/johnson/pdf/748457main_FS-2013-Space%20Vehicle%20Mockup.pdf
- Extravehicular Activity Systems
  - http://www.nasa.gov/centers/johnson/pdf/728895main_EVA%20Fact%20Sheet.pdf
- Environmental Control and Life Support Systems
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- Vacuum Test Facilities
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- Thermal Testing
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- Anthropometrics and Biomechanics Facility
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