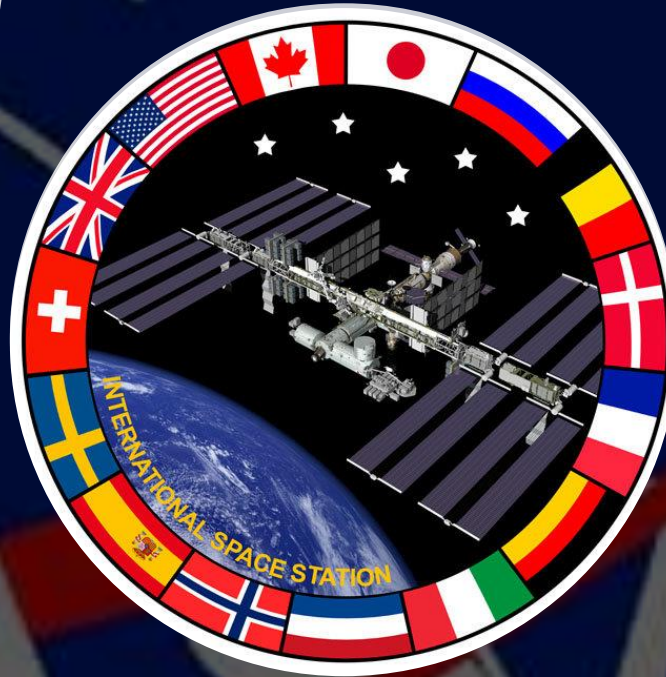




Immersive Technologies in Human Spaceflight

JSC Engineering XR Simulation and Training
Support for ISS, Gateway and Artemis
Programs
05/06/2021

Eddie Paddock

NASA/JSC Engineering VR Technical Discipline Lead

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Agenda



- JSC Engineering (ER7) Visualization Team Members
- VR Lab (VRL) History and Milestones
- VRL Overview and ISS VR Training Capabilities
 - SAFER (Simplified Aid For EVA Rescue)
 - Mass Handling
 - ISS Onboard Training
 - EVA VR On Orbit Monitoring (VROOM) Mission Control Center (MCC) Project
 - AR Training Applications
- Prototype Immersive Technologies (PIT) Lab Overview and Capabilities
- Gateway NextSTEP Support
- Artemis Lunar South Pole Surface Applications
- CKAS 6DOF Platform with Rover Simulation/VR
- XR work with ARGOS (Active Response Gravity Offload System)
- Lunar Lander Mixed Reality Simulation Proposal
- Forward Leaning XR Technologies
- Questions



JSC Engineering (ER7) Visualization Team Members



- Civil Servants

- Eddie Paddock – VR TDL and VRL/PIT Labs Manager (CACI and METECS)
- Sharon Goza – IGOAL Manager (CYFOR)
- Lee Bingham – Lead Engineer/Sim and VR Developer
- Abir Shukla – Engineer/Sim and Graphics Developer
- Geraldo Cisneros – NASA Pathways Intern

- Contractor Visualization Development Support Team

- CACI (VRL)

- Jeff Hoblit
- Brad Bell
- John Schweers
- Angelica Garcia
- Jonathan Schlueter
- Tanner Hunt
- Anand Patel

- METECS

- Frankie Graffagnino
- Nick Davis
- Davin Chernak
- Cory Foreman
- Jacob Wright

- CYFOR (IGOAL)

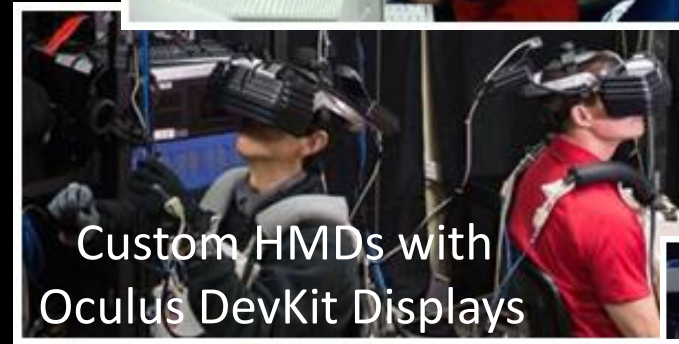
- Cheyenne Mckeegan
- Chris Raymond
- Eric Richeson



JSC VR Lab History – VR Milestones



- 1993 - STS-61 Hubble repair VR training, Robotics and mass handling
- 1994 – SAFER VR training
- 2000 – Integrated ISS/Shuttle, EVA and Robotics VR Training
- 2001 – PC/Windows Release of DOUG
 - OpenGL 3D renderer for sims and VR
- 2012 - ISS onboard VR Training
- 2016 - Moved to COTS HMDs
- 2017 – Current
 - Continued ISS Training Support
 - Gateway and Artemis Programs
 - VR & simulation support for design, analysis and early training development





JSC's Virtual Reality Lab (VRL)



Dual EVA-1 and EVA-2 VR Training



EVA DOUG Training Animations



ISS EVA, Robotics and SAFER VR Training



Mass Handling Robot



Integrated ISS Robotics Systems - RWS



SAFER Onboard VR Training
Laptop and Oculus Rift



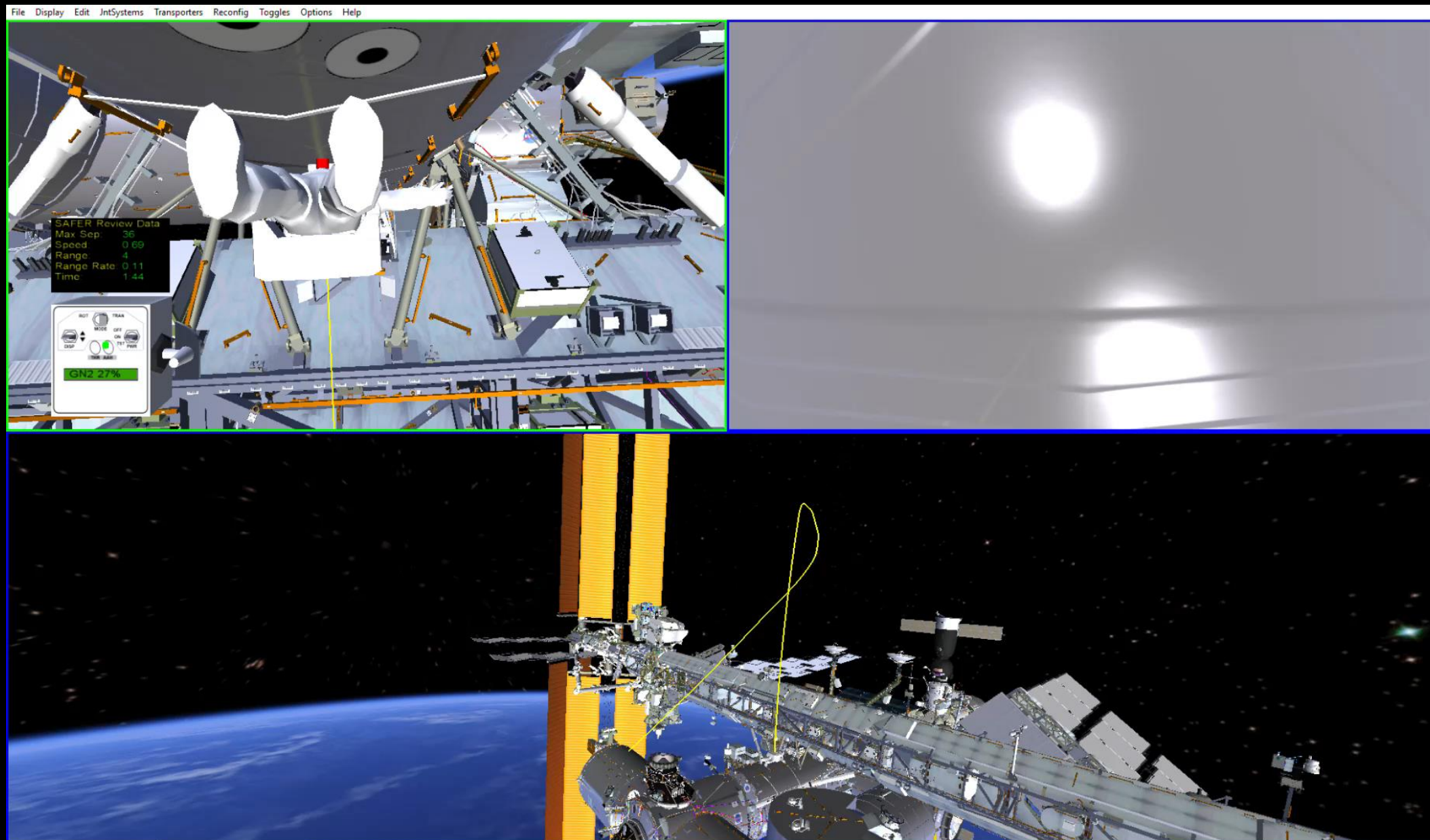
SAFER VR-MR Training

- Vive Pro - wireless
- Tracking pucks for body and hands
- Custom gloves supporting hand closure gestures
- FEU hand controller, avionics and FSW,
- Real-time human-in-the-loop Trick based simulation
 - Orbital dynamics
 - Simulated propulsion, forces and torque dynamics
- DOUG VR Graphics
- Lower fidelity trainer is available onboard ISS SSC laptop with modified Oculus Rift



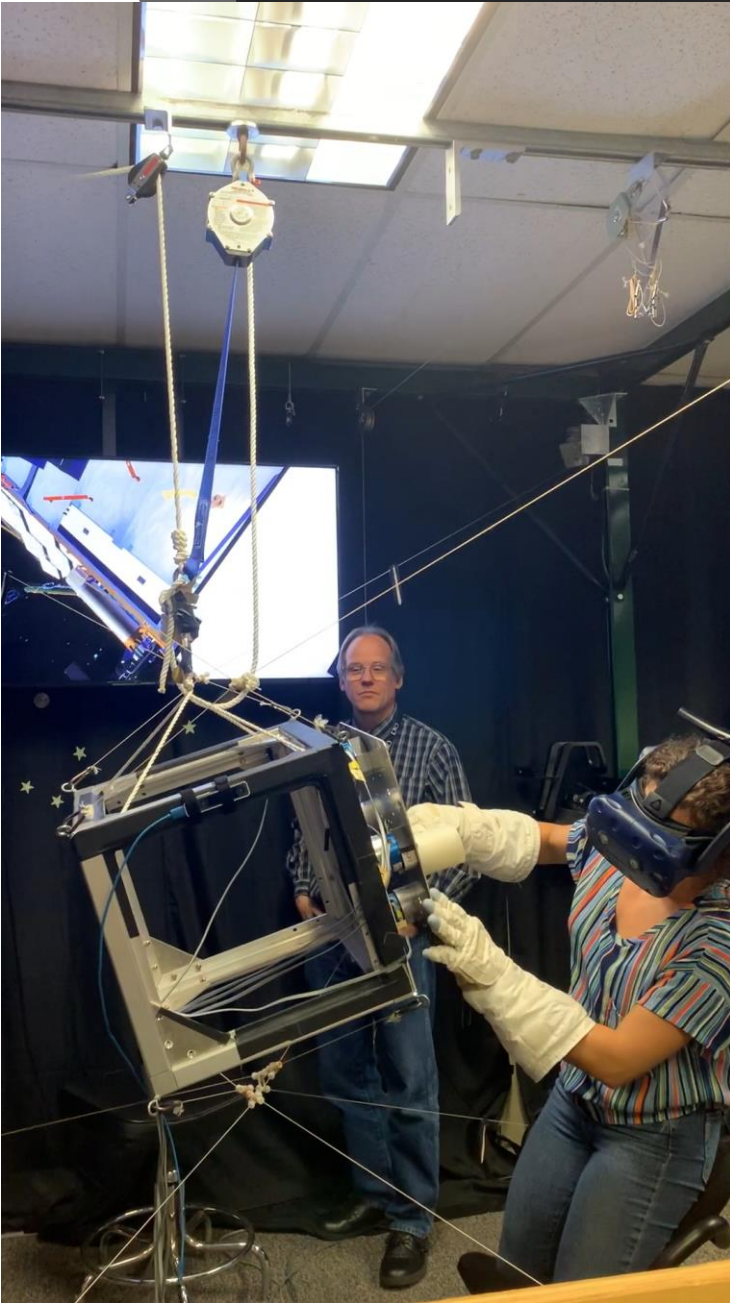


SAFER VR Training – Review Tool



Mass Handling VR-MR Training

- Vive Pro - wireless
- JR3 force/torque sensors
- Configurable payload hand holds
- Real-time (2,000 Hz) Trick based HDW-in-loop simulation
 - Simulated contact, forces and torque dynamics
- DOUG VR Graphics
- Mass Handling system is composed of two robots (EVA1 and EVA2) supporting dual integrated EVA operations on single payload
 - Mass handling training scenario can include integrated ISS Robotics with EVA astronaut on end of SSRMS





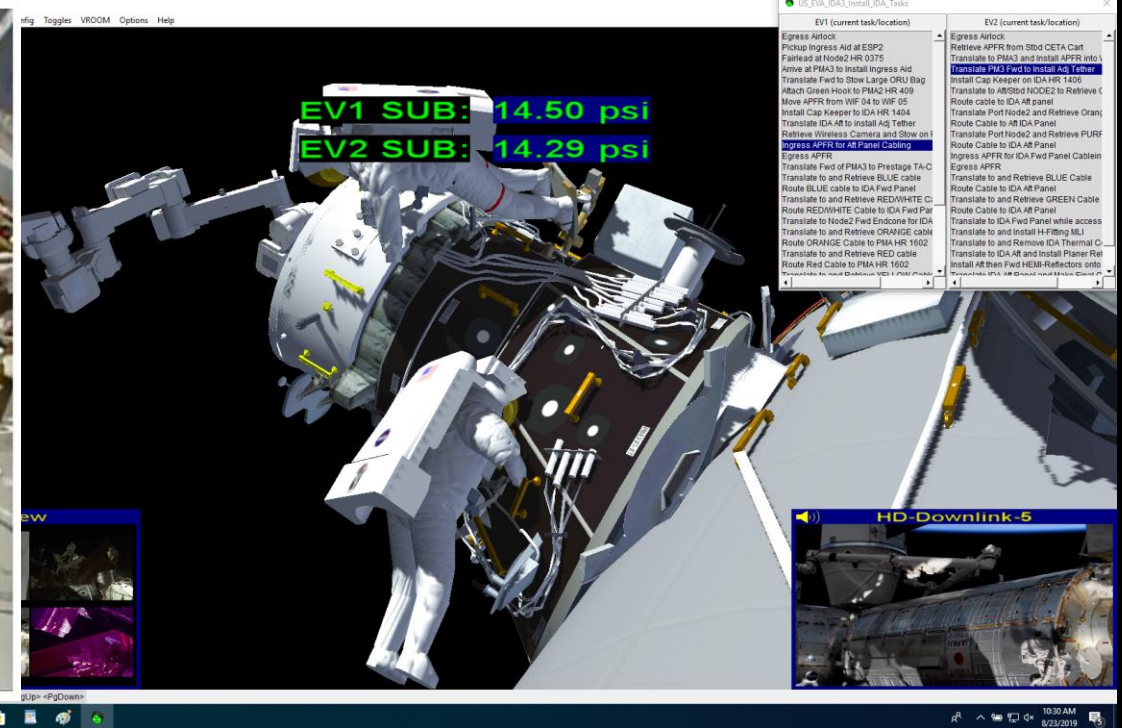
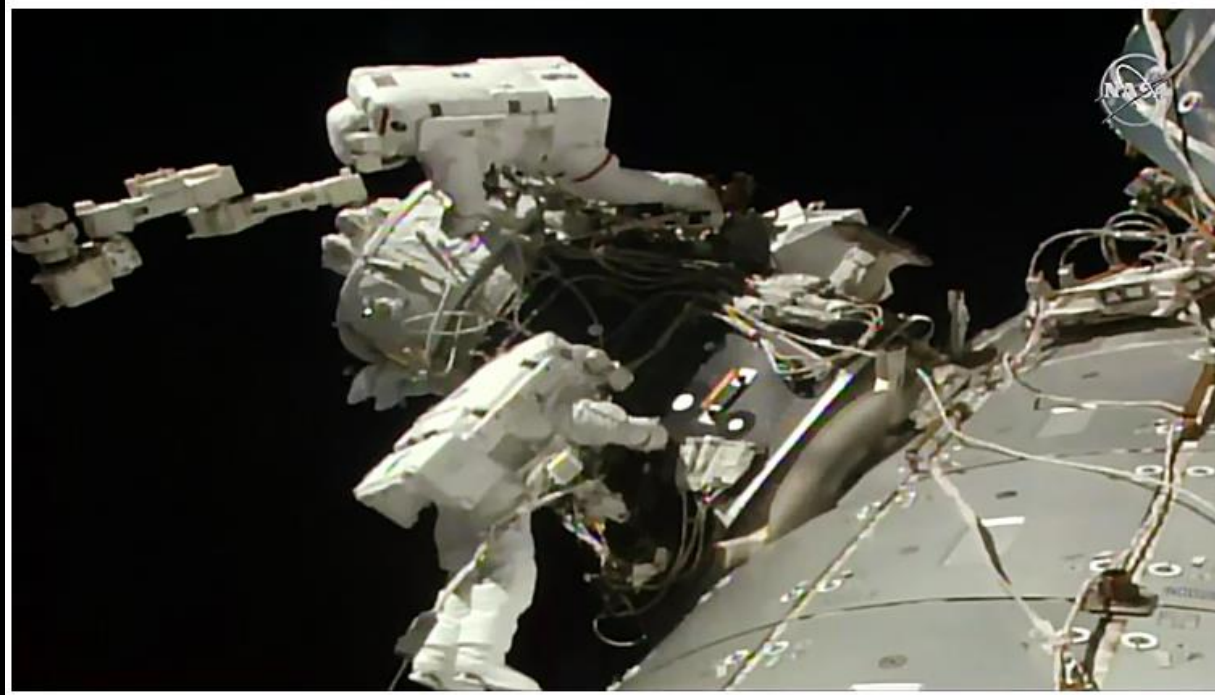
11/21/2019 ISS Integrated EVA VR and ROBoT Training in Preparation for AMS Repair EVA



Robotic OnBoard Trainer
(ROBoT)



VR ON ORBIT MONITOR (VROOM) IDA#3 EVA – MCC MER AND MPSR SUPPORT



VROOM Details:

- DOUG articulated telemetry driven ISS Graphics (orbit location, robotics, solar arrays, etc.) for Laptop screen views with option for VR with Mixed Reality HMD
- Integrated selectable ISS telemetry data and downlink video
- EVA1, EVA2 or BEV virtual views
- Gamepad for configuration selection and flycam
- Integrated EVA timeline and procedures
- Client/Server design for synchronized clients (currently have 5 deployable VROOM Rigs)

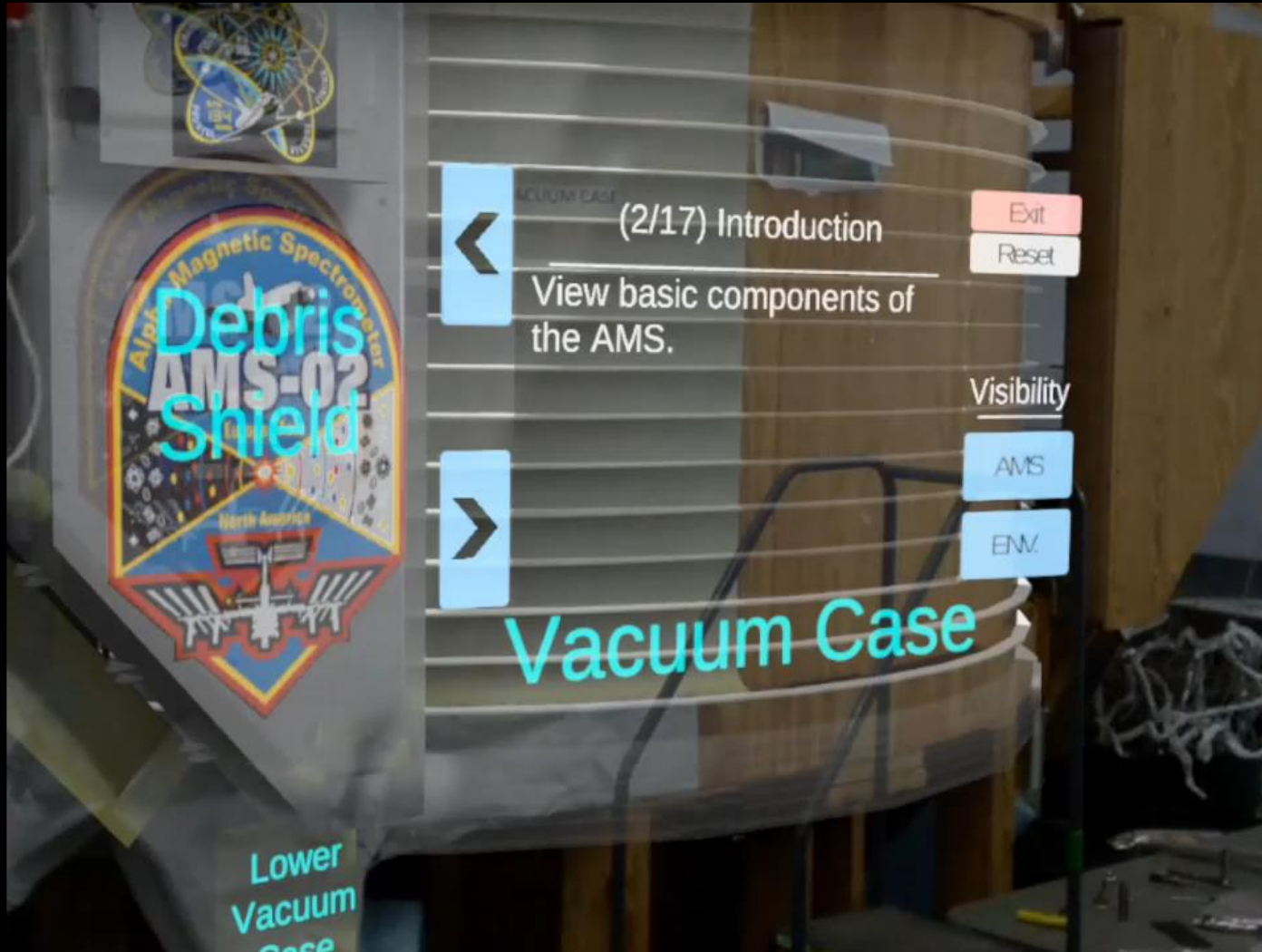




OTHER VR LAB TRAINING APPLICATIONS

AR TRAINING FOR AMS REPAIR EVA

AND ISS AR VISUALIZATION APPLICATION



Also, working with Lui Wang's group and JSC FOD training org on future AR ISS onboard operational use cases where we would train on ground in AR and use same AR tech with onboard HoloLens to aid in complex operations



JSC's Prototype Immersive Technologies (PIT) – XR R&D Lab



PIT Lab – Building 16, room 2115



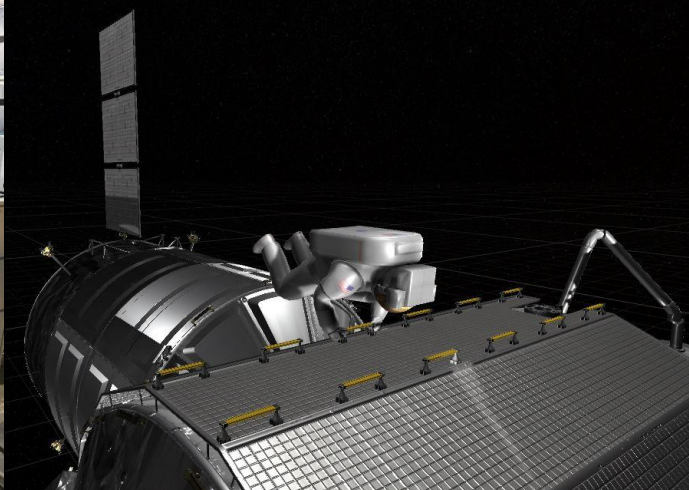
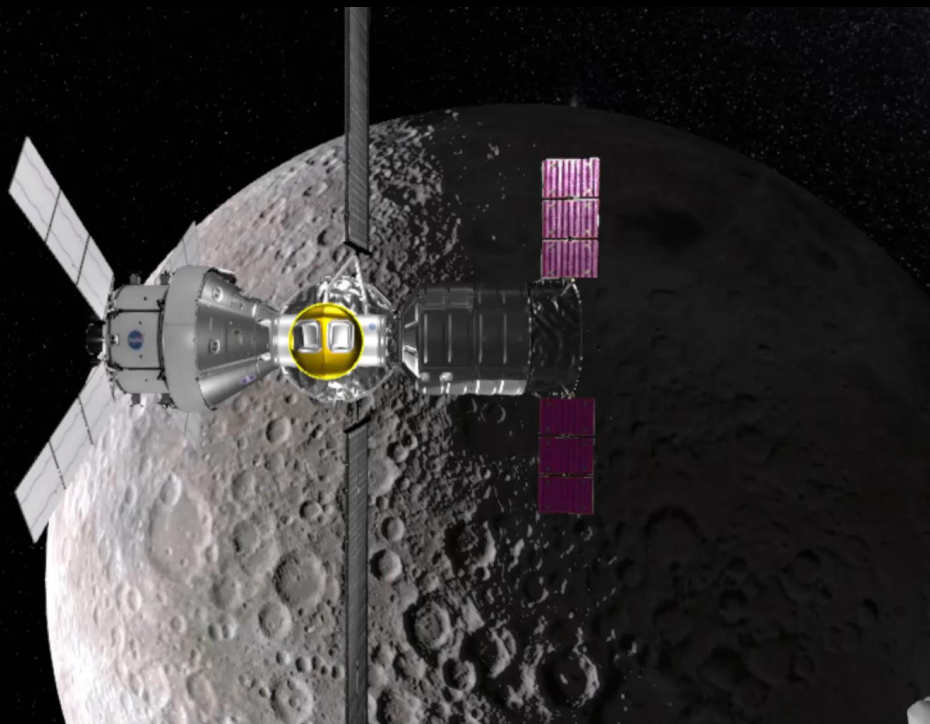
OptiTrack with Integrated Oculus VR



OptiTrack Motion Capture use with Digital Astronaut and Microgravity Exercise Device Analysis Projects



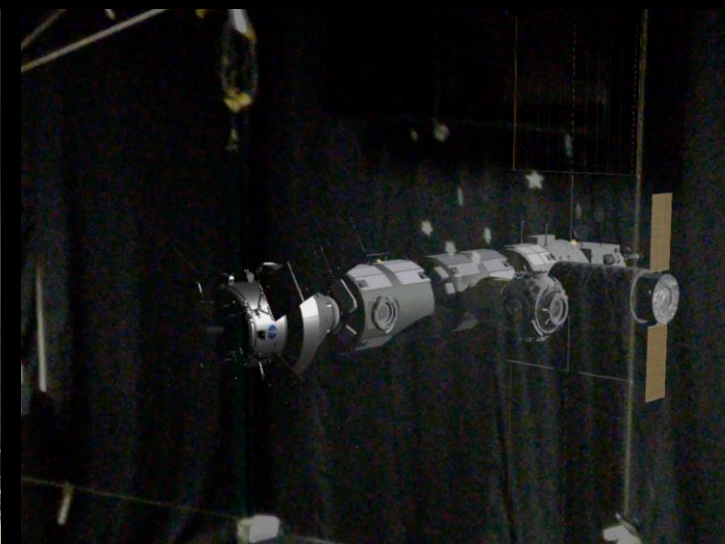
Gateway NextSTEP BAA XR Work



Gateway Onboard EVA Trainer Prototype

Gateway/Habitat Design Evaluation VR Application

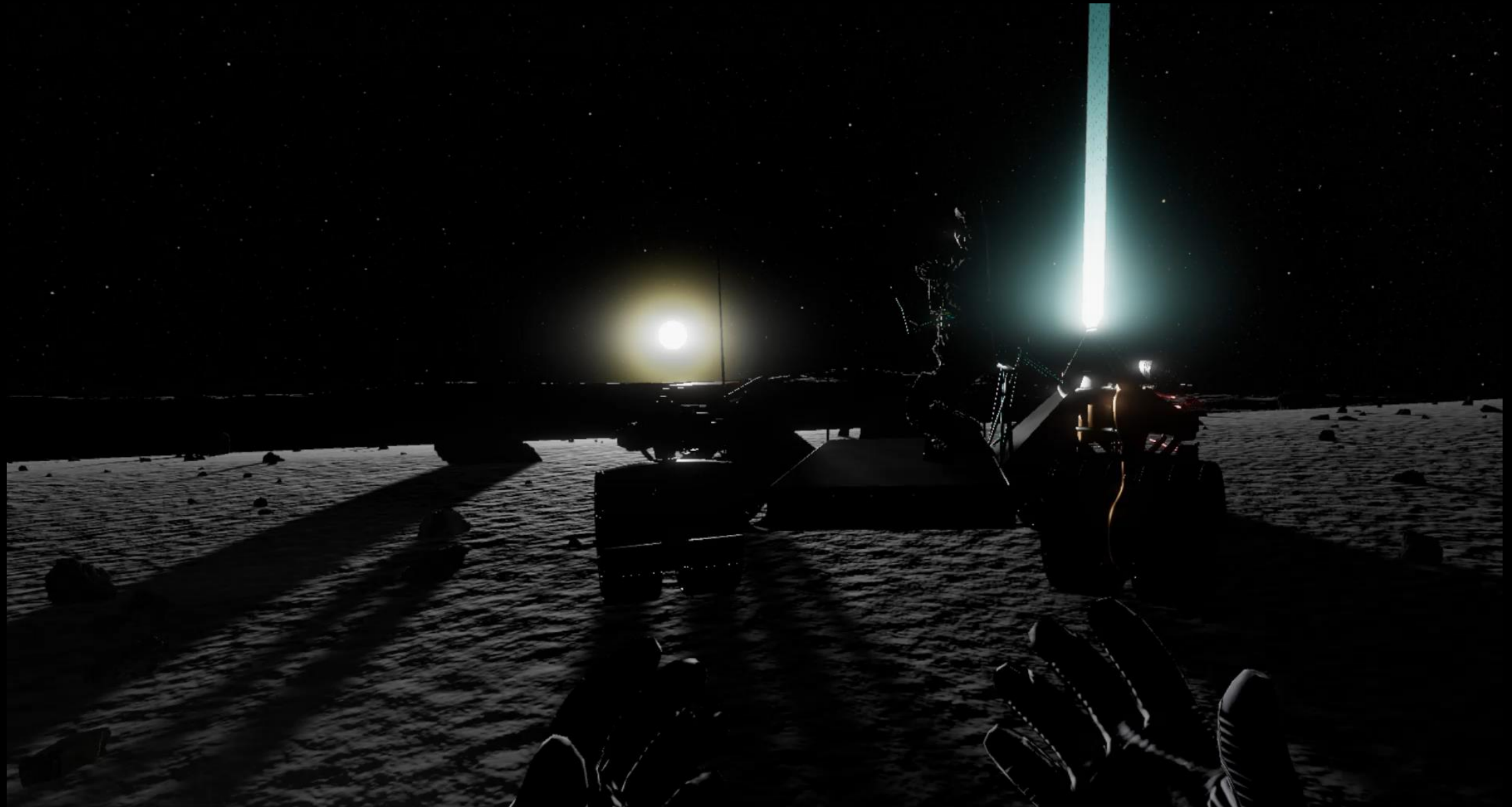
This Unity VR Application is driven by a Gateway orbital dynamics and ephemeris simulation for proposed Near Rectilinear Orbits. Besides NextSTEP BAA work, this VR application was also used by the program for Habitat window placement studies for optimal window views of the moon.



Gateway Vehicle Model AR Eval Prototype

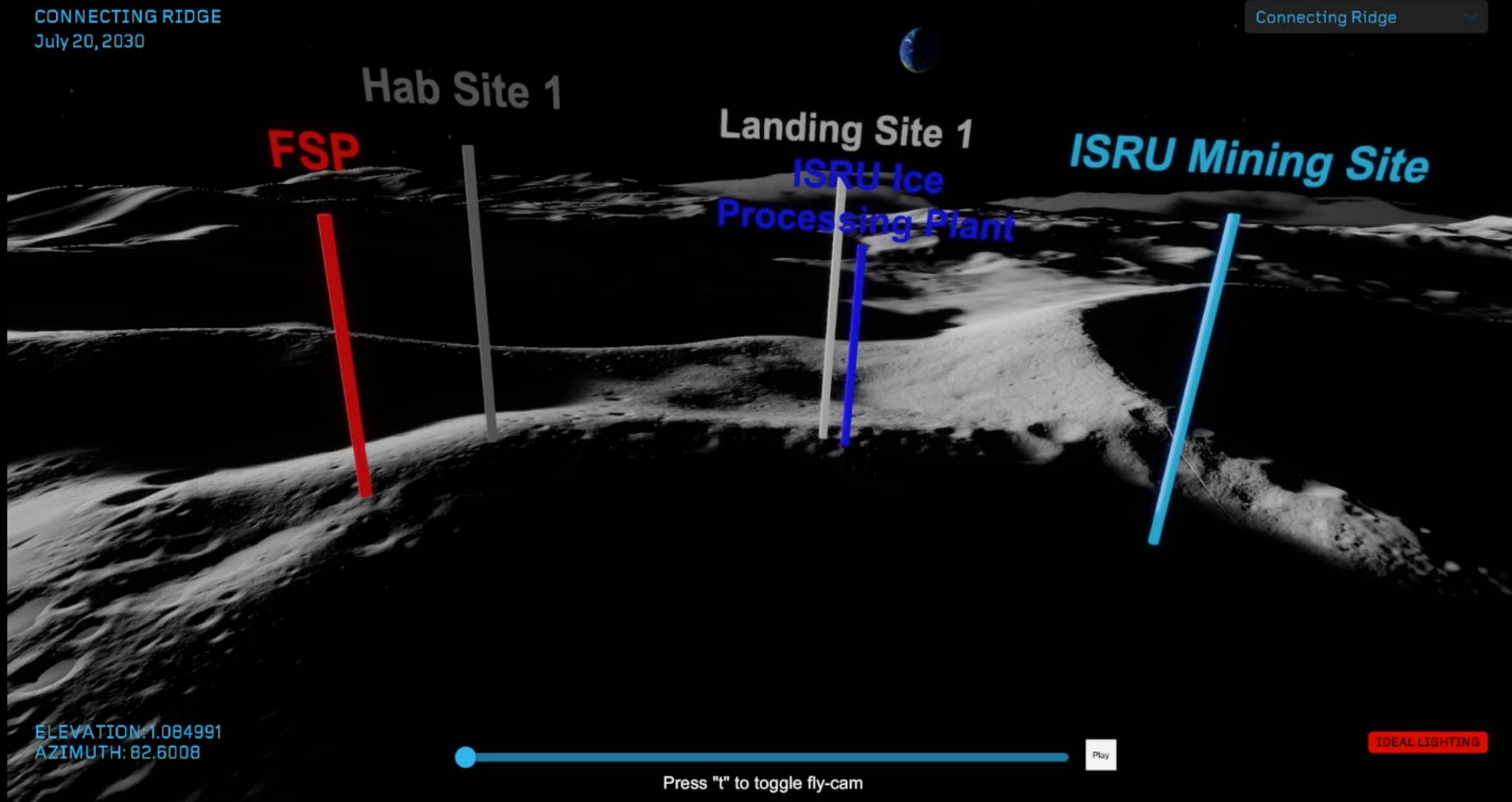


Lunar Surface Unity/Photon Multi-Player VR





Unity based Lunar Visualization Tool – Lunar Basecamp Study





Unity based Lunar Visualization Tool – Lunar Basecamp Study

CONNECTING RIDGE
September 16, 2030

Connecting Ridge



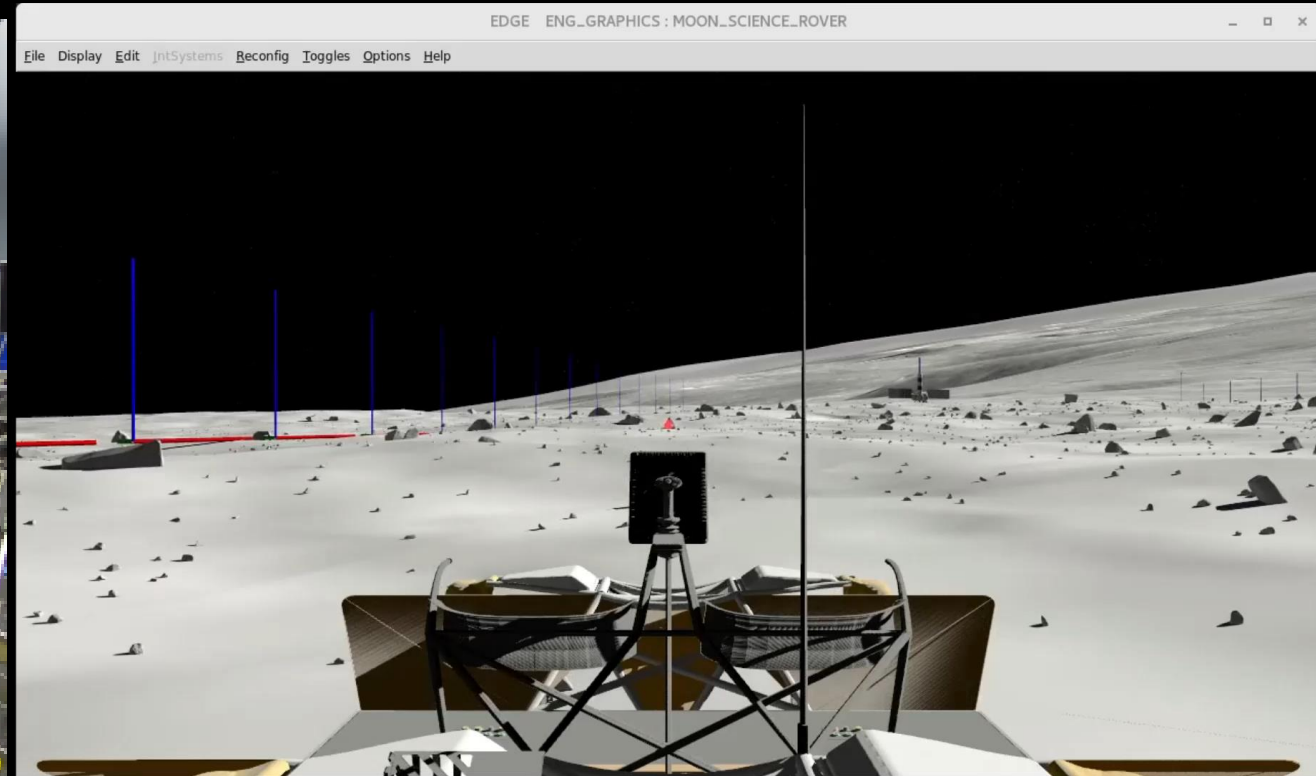
ELEVATION: 1.50592
AZIMUTH: 93.6752

Press "t" to toggle fly-cam

IDEAL LIGHTING



ENGINEERING CKAS 6DOF VR ROVER PROJECT





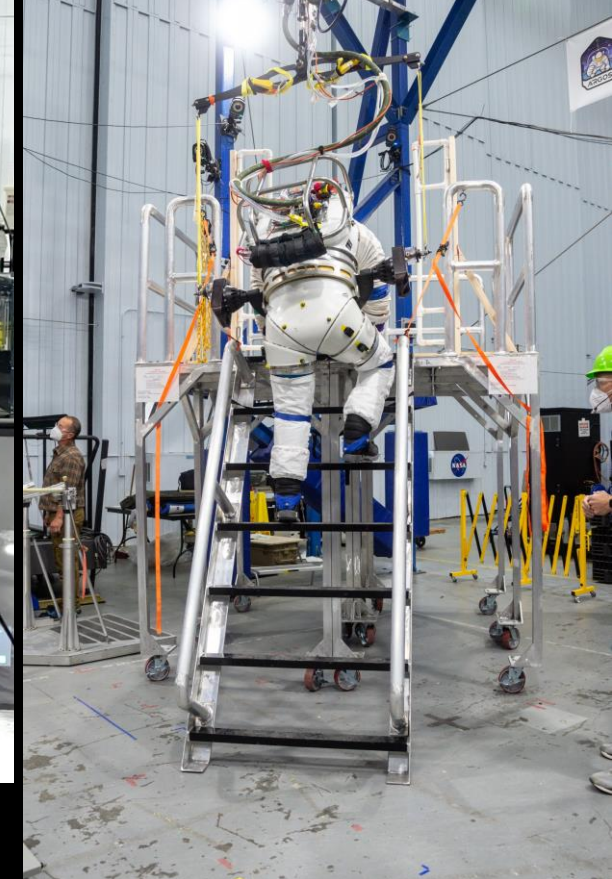
CKAS 6DOF Rover/VR Simulation Prototype





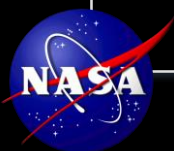
VR and ARGOS (Active Response Gravity Offload System)





XR and ARGOS CIF Lunar Lander Egress/Surface EVA Project

Currently integrating and testing for “short sleeve” XR egress with platform and ladder, Vive pucks with full body tracking (Unity Final IK), and BeBop gloves for Hand and Finger Tracking



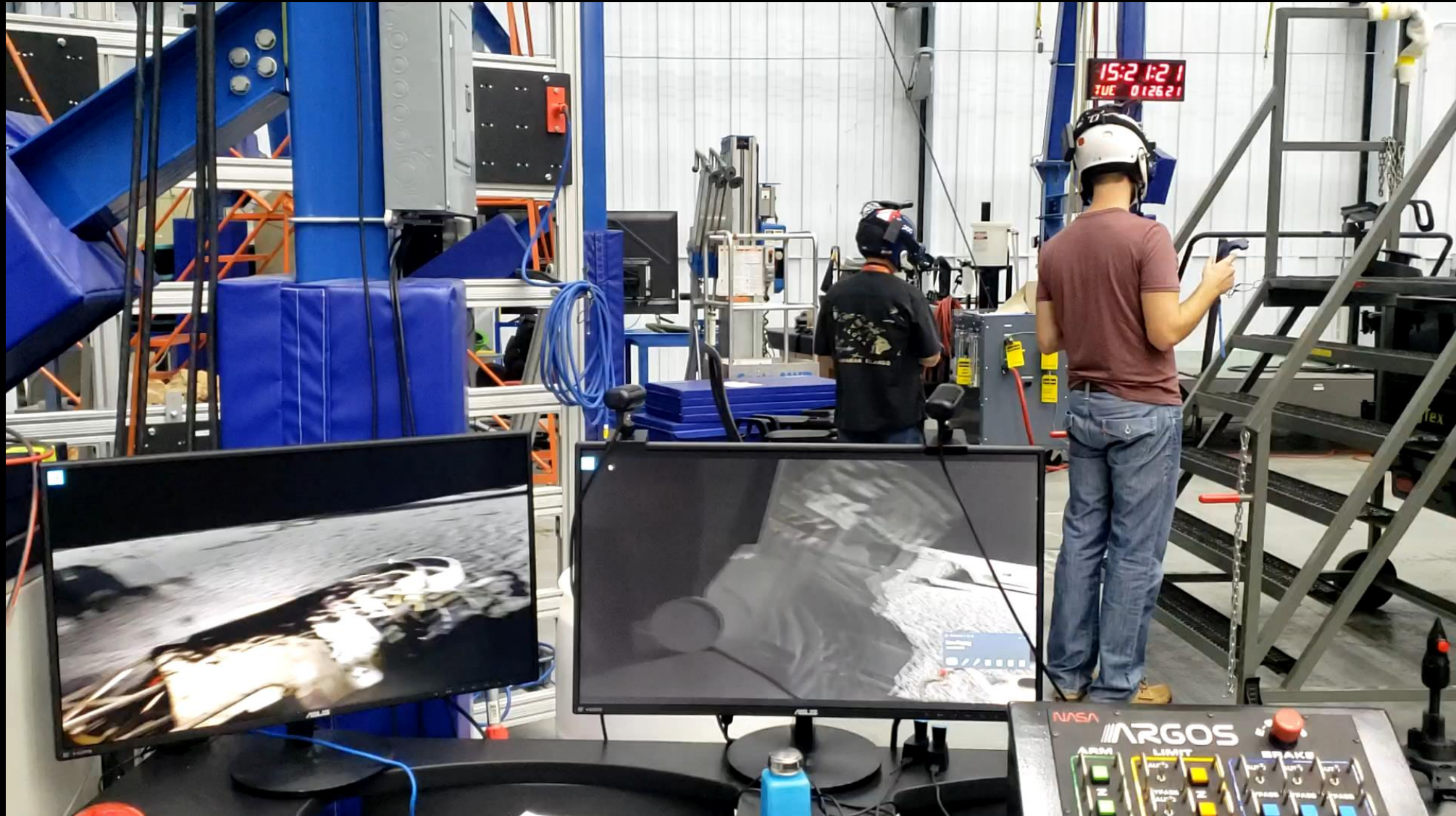


VR and ARGOS – CIF Lunar Lander Egress/Surface EVA Project



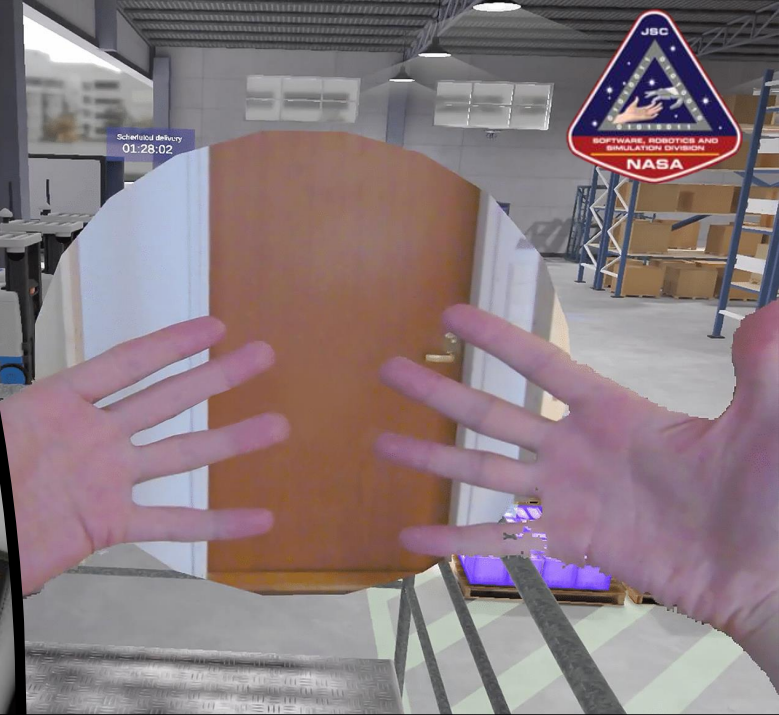


VR and ARGOS – CIF Lunar Lander Egress/Surface EVA Project





Lunar Lander Mixed Reality Simulation Proposal





Forward Leaning XR Related Technologies

- XR EVA monitoring for ISS and Lunar Missions
 - 360 camera and video downlink capability for VR immersion
 - Translational and rotational tracking sensors for suits
 - relative GPS and gyro systems
- XR for Lunar Surface EVA Risk reduction
 - Analysis of south pole landing sites and lighting/shadows
 - Validation, earth shine, synthetic rocks and craters
 - Integration of XR into Mockups, ARGOS and 6DOF platforms
 - Ascent/lander egress
 - Rovers
 - Mixed Reality with vehicles, tools, rocks and soil
 - Soil interaction – Footprints and rover tracks
- XR systems for early space vehicle design analysis
- Reliable hand and finger tracking systems
- Onboard XR training and operations systems
 - XR systems that work in space microgravity environments
 - Onboard high performance GPU designs
 - AR operations with integrated procedures and multimodal interfaces such as speech, pen, touch, manual gestures, and gaze





Questions?