

# NASA's Advanced Extra-vehicular Activity Space Suit Pressure Garment 2018 Status and Development Plan

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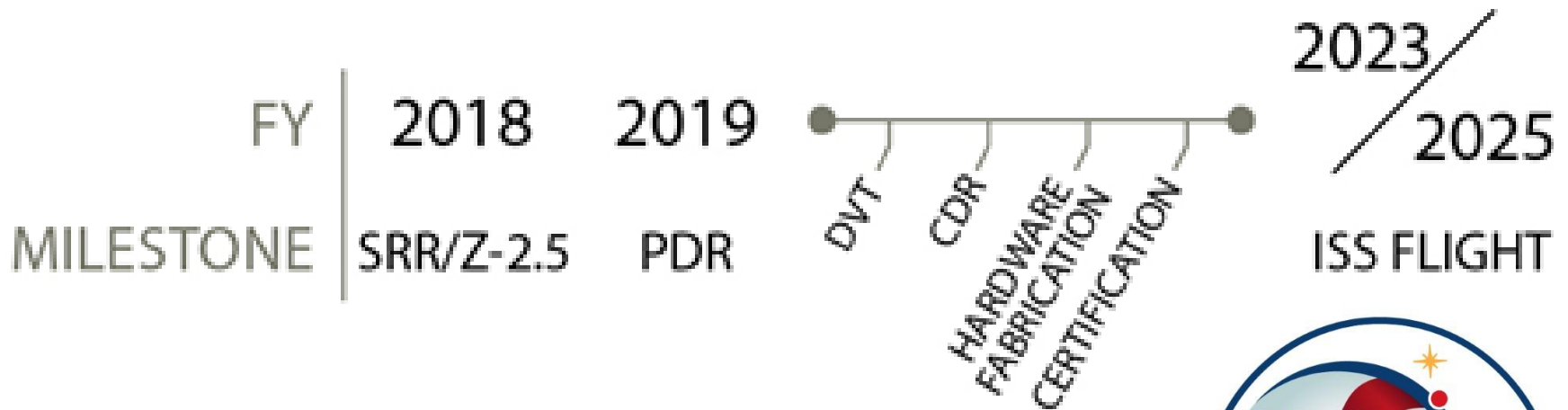
# Agenda

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- ISS Exploration EMU Demonstration (xEMU Demo) Project
  - Project plan
  - PGS Components
- Exploration EMU (xEMU) efforts
- Mars EMU (mEMU) efforts



# xEMU Demo Project Plan Milestones



SRR: System Requirements Review

PDR: Preliminary Design Review

DVT: Design Verification Testing

CDR: Critical Design Review



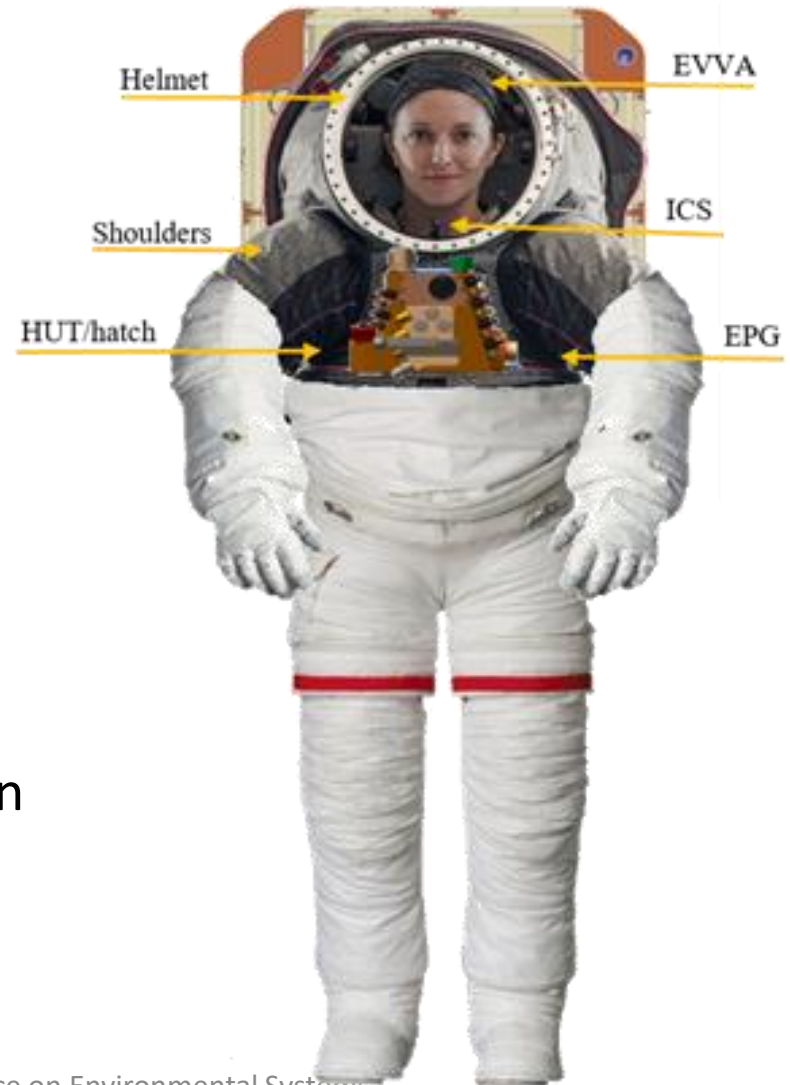
For a view of the broader plan please reference ICES-2018-54, “Methodology for Extravehicular Activity (EVA) Technology Identification, Prioritization, and Maturation,” by Blanco and Aitchison.



# Pressure Garment Subsystem (PGS) Components

PGS components being produced for xEMU  
Demo:

- Hard Upper Torso (HUT)
- Helmet
- Extra-vehicular Visor Assembly (EVA)
- Shoulders
- Auxiliary-loop Liquid Cooling and Ventilation Garment (ALCVG)
- Integrated Communication System (ICS)
- Biomedical monitoring system (Biomed)
- Dust-mitigating Environmental Protection Garment (EPG) integration



# Hard Upper Torso

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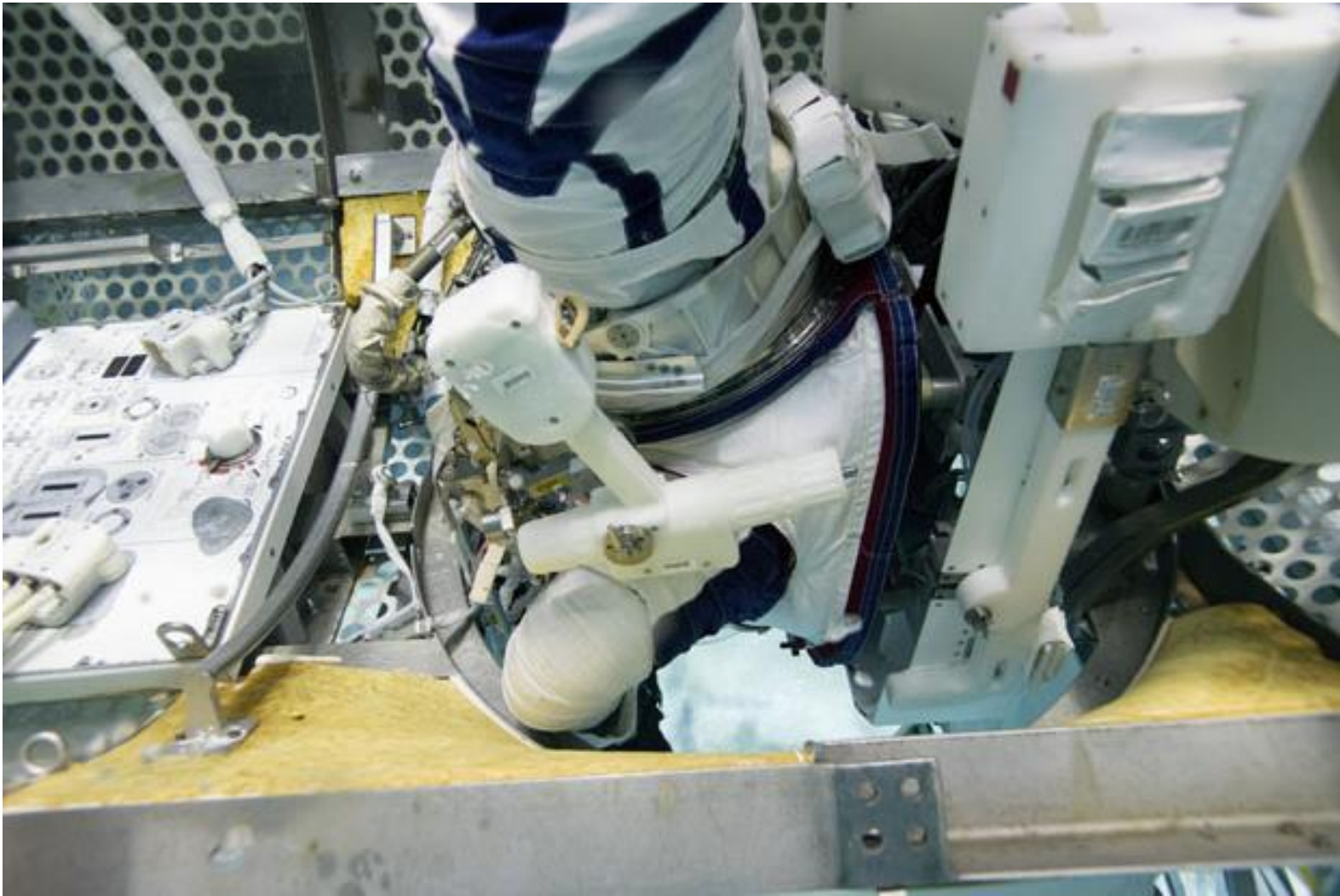
Work has been focused in 3 areas

- Changes to HUT geometry
- Composites development
- Preliminary HUT-focused fleet sizing study

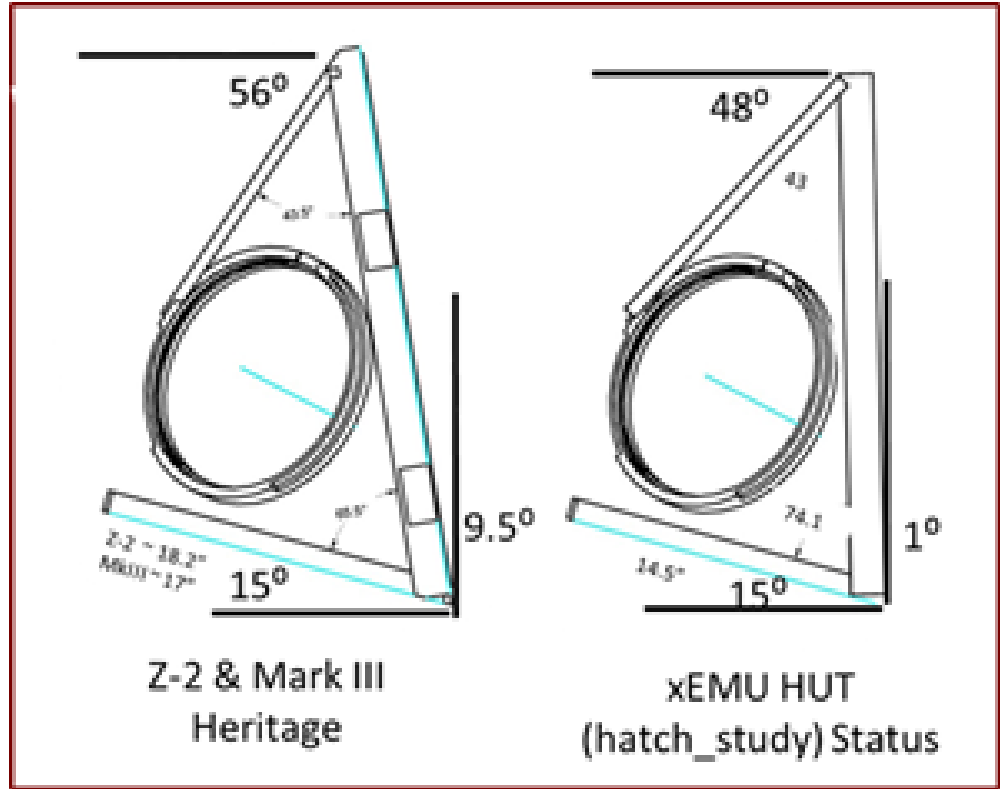
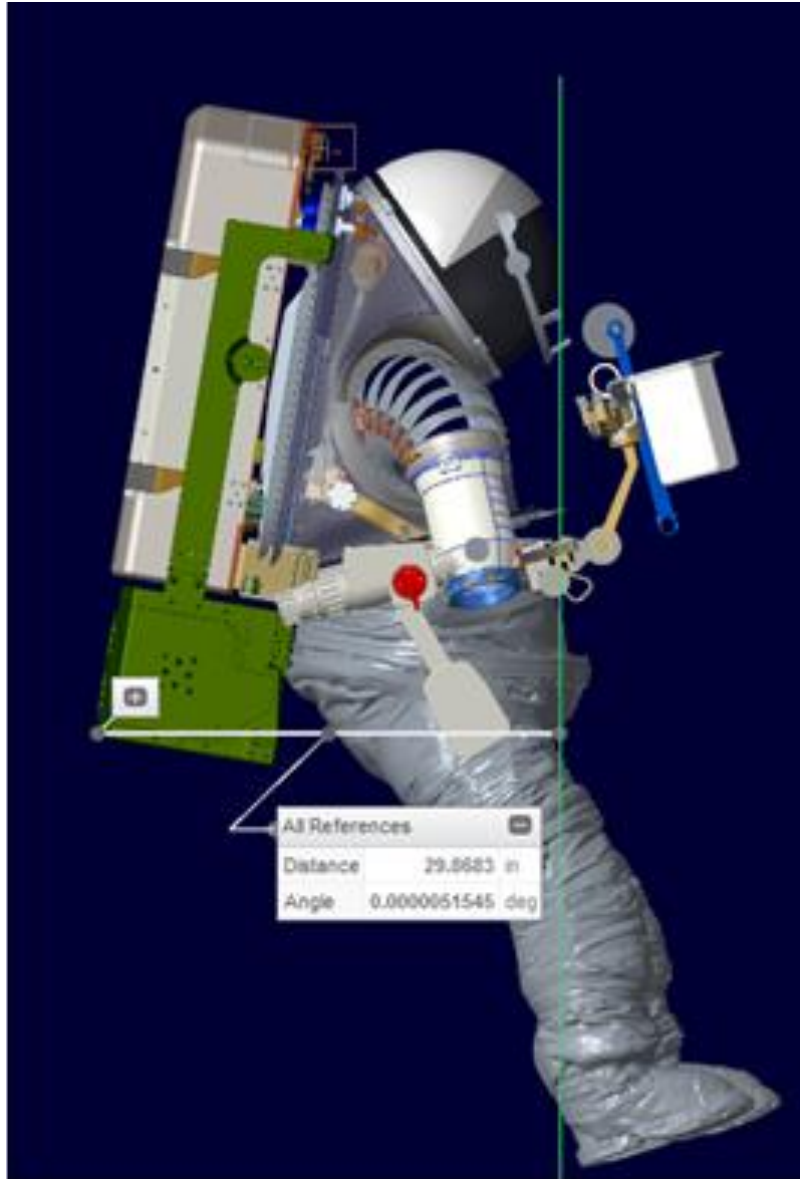


# HUT: Geometry

Geometry changes were predicated on the need to reduce the front-to-back dimension of the xEMU Demo. Z-2 NBL testing confirmed the need to address.



# HUT: Geometry



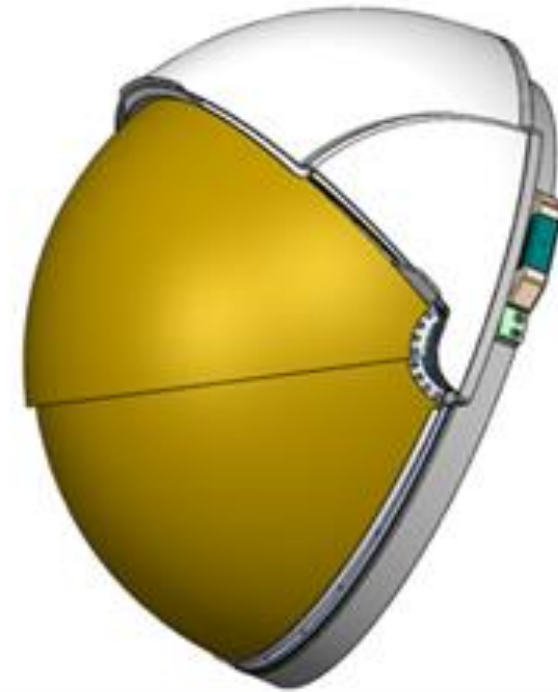
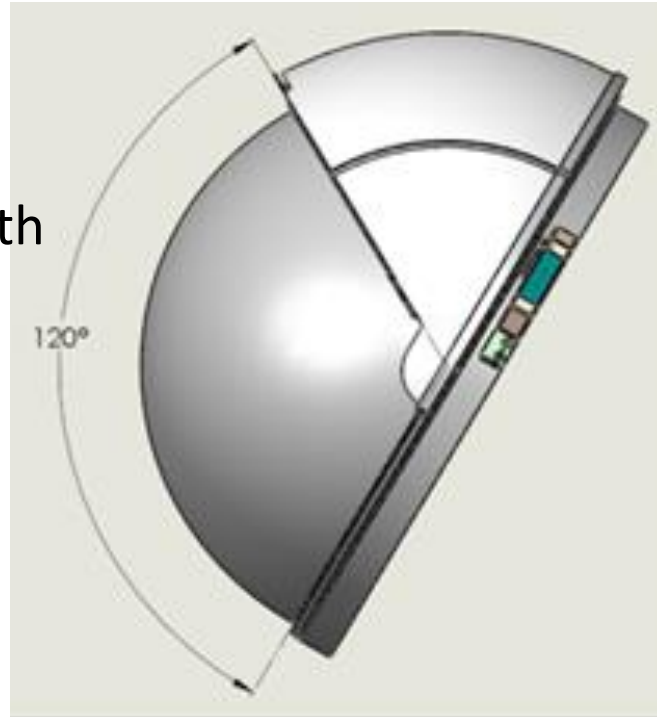
Geometry changes were incorporated into the Z-2.5 design for pre-PDR NBL testing

# Helmet and EVVA

Helmet:

Ellipse 10"X13"

- Z-2 was 11"x13"
- Change made to reduce helmet depth



EVVA:

Mechanical design for  
xEMU Demo

- Effort to maximize  
visibility
- Z-2.5 EVVA is the first  
prototype

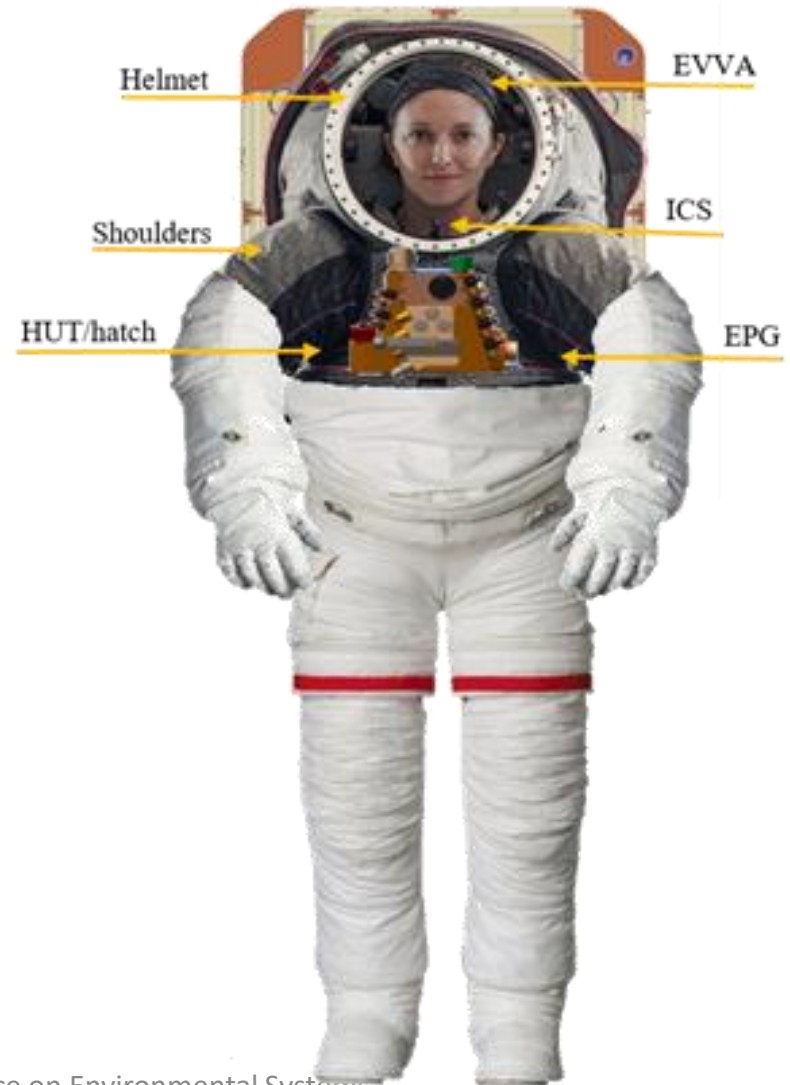




# Shoulders

Shoulder effort focused on design maturation for DVT:

- Address Z-2 NBL feedback
  - Move crewmembers forward in the suit
    - Reduced scye bearing depth
- Incorporate design feature to meet xEMU Demo requirements
  - Redundant seals
  - Modify secondary axial brackets
- Incorporate exploration-forward design features
  - Dust mitigating EPG integration interface



# ALCVG

## Modifying Constellation ALCVGs for use in Z-2.5 NBL testing

- Removed ventilation system and replaced with EMU vent tubes and plenum
- Adding a layer of mesh for ease of padding integration

## Extensive ALCVG design effort to support both xEMU Demo and xEMU configurations

- Water tube material and cross-section selection
- Garment fabric(s)
- Water tube layout
- Aux water tube connector
- Design review completed in June
- Prototype fabrication



# ICS

New unit to be tested in Z-2.5 addresses Z-2 testing comments with:

- Improved speakers
  - Addressing comments on 'tinny' sound quality
- Improved digital microphones
  - To improve EMI interference resistance
- Alternate speaker and microphone locations
  - To increase in-helmet space and improve ICS volume
- Design to address potential for feedback
- Fabricating ground-based version of the Space-to-Space Advanced EMU Radio (SSAER)
  - Serves as sign processor for the ICS
  - Interfaces the ICS with ground facility communication systems
  - Used to test the ICS evaluation of proposed audio compression and automatic gain control features



# Biomed

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The Biomed is being completely redesigned.

- Requirement is to sense heart rate.
- A market survey of commercially-available Biomed sensing hardware options is being performed.
- A prototype unit will be completed for PDR.



# EPG Integration

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For xEMU Demo baseline:

EMU TMG lay-up

Dust-mitigating EPG interfaces

Performing fit checks with prototypes

Includes: HUT, Shoulder, DCU, PLSS, EVVA (if needed)

For xEMU:

Investigating new material lay-up options



# xEMU

- DVT testing will exceed xEMU Demo operation life/cycle requirement (shoulders)
- Self don/doff feature designs are being explored as able
- In discussion with STMD GCD regarding proposed work on composites and EPG
- Phase IIx SBIR following “Contact Stress and Design Parameters for Titanium Bearings” was awarded.
  - Address bearing issues regarding
    - Operational life
    - Dust and other environmental protection
- Overguides funding received to work on anti-shock coating for xEMU Demo
- 2 SBIRs awarded on EVVA sun visor topic
- Efforts continue to obtain funding for a mobile lower torso



# mEMU

- Mars 2020 Calibration Target flight hardware fabrication underway
- ARGOS interface hardware design work continues
- EPG work considering all exploration missions
- Determined format for publishing PGS Technology Development Plan



# Acknowledgements

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The hard-working Advanced PGS Team.

Our branch and project management for their active support.

The ISS Program and STMD for supporting and funding this work.

The SBIR Program and contractors with whom we have worked to find new solutions to old problems.

