USAF Life Support Systems Scientific Test, Analysis, and Qualification Lab (LSS STAQ Lab)

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Outline [1/1]

- Need for LSS STAQ Lab [3]
- LSS STAQ Lab Capabilities [8]
- Past Testing Successes [7]
- Future Aims [1]
- Questions/Discussion [1]

Need for LSS STAQ Lab [1/3]

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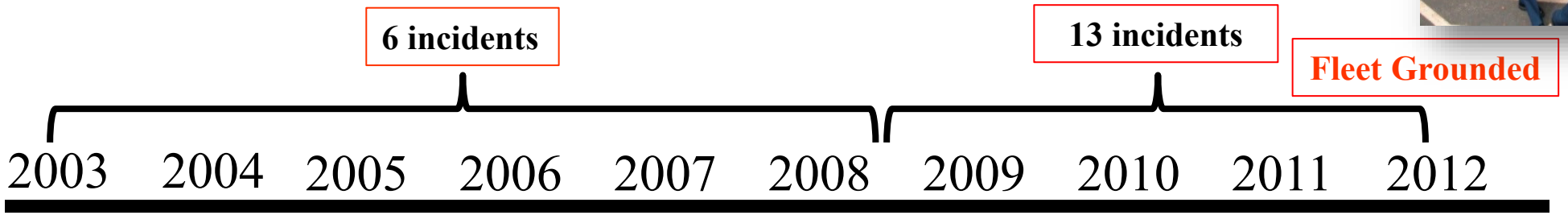
- **High Altitude System Testing Need**
  - **The USAF needs more tools to explore high altitude LSS testing to enable warfighters to focus on the mission and aid program offices supporting the platform**
  - **Example: Hypoxia Events Timeline F-22**
    - **Dizziness, disorientation, cough, Unexplained Physiological Episodes (UPEs), resulting in the entire Raptor fleet being grounded May 2011**
    - **Nov 2010: Capt Haney's fatal crash at Elmendorf AFB**
    - **May 2011 F-22 fleet grounded**



Ref 1

Need for LSS STAQ Lab [2/3]

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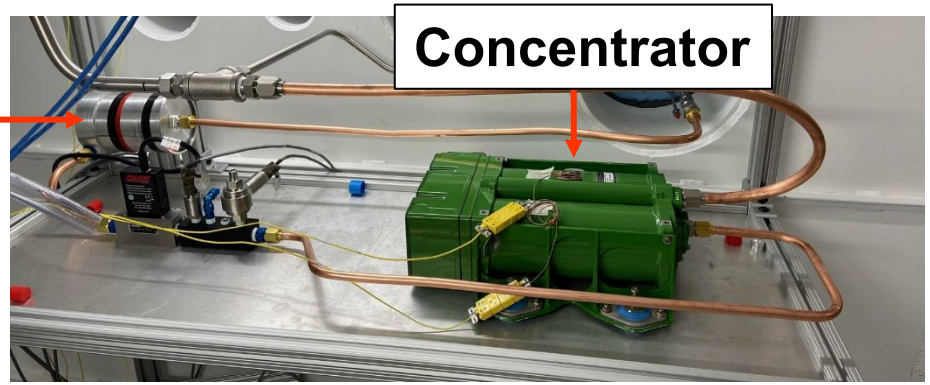
Other Aircraft LSS Incidents

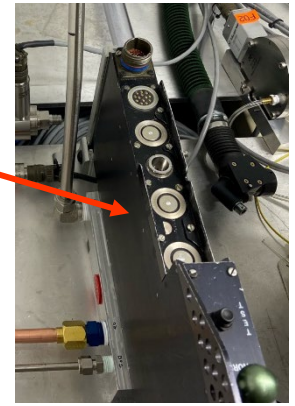
- T-6A
- F-35
- F-16
- F-18
- C-17

Reference 1, 8, 9

Need for LSS STAQ Lab [3/3]

- **High Altitude System Testing Need**
  - The USAF needs more tools to explore high altitude LSS to enable warfighters to focus on the mission and aid program offices supporting the platform
  - AF already had an OBOGS Lab for research purposes
  - Gap: a T&E lab which can accurately simulate real-world high-altitude conditions, establish system baselines to get ahead of incident investigations, aid in incident investigation, ect.
    - Need expressed by pilots, PMs, and Congress





OBOGS = On-Board Oxygen Generation System

Lab Capabilities [1/8]

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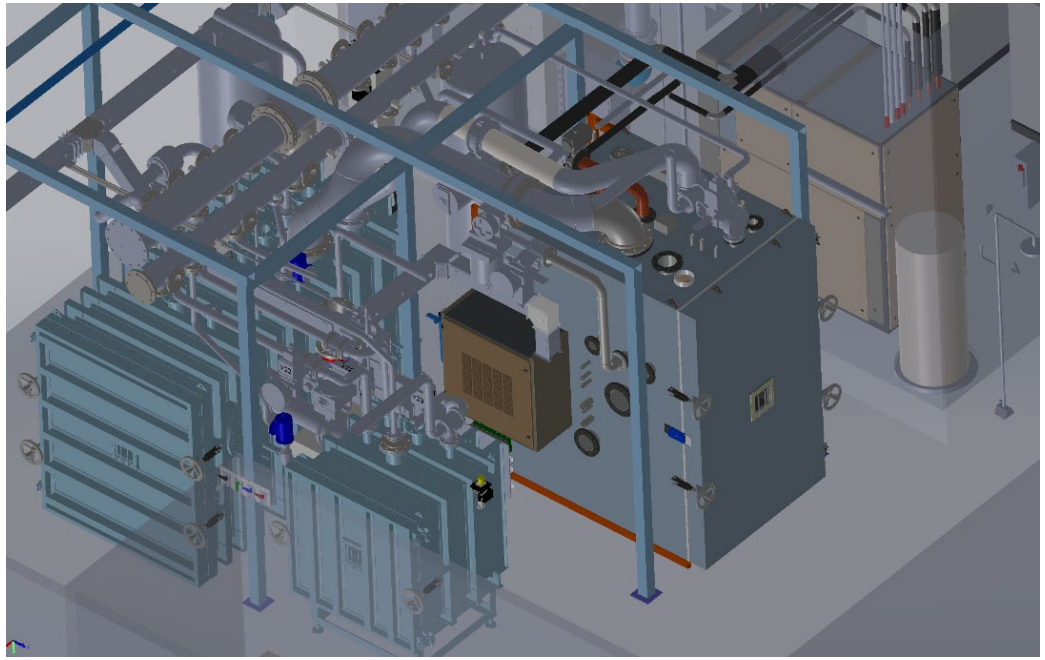

- **Design custom OBOGS setups to match testing and development needs before receiving equipment**
- **Collaborate with development team to design custom, 3-D printable models/digital twins**
- **Replicate aircraft system layout (atmospheric exposure, orientation, plumbing lengths, and connectors) accurately**

Lab Capabilities [2/8]

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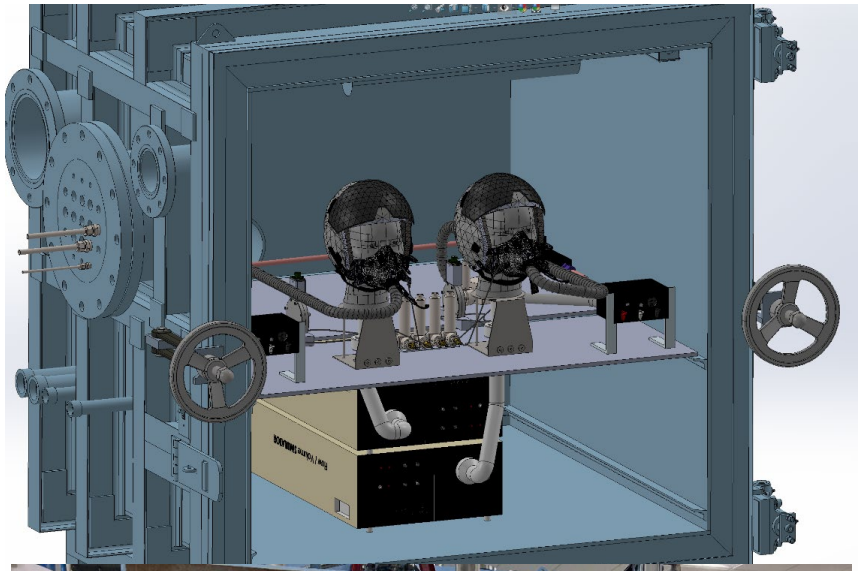
- **Aircraft Chamber (10'x5'x6')**
  - 100,000 Ft max altitude
  - ~90,000 Ft / minute max ascent rate
- **Cabin Chamber (4'x4'x4')**
  - 100,000 Ft max altitude
  - ~300,000 Ft / minute max ascent rate
- **Combined Capabilities:**
  - Interactions between equipment in aircraft fuselage vs. cabin
  - Rapid Decompression



Lab Capabilities [3/8]

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- **Env Chamber (4'x4'x8')**
  - **100,000 Ft max altitude, -85°- 257°F, 10-95% RH**
  - **~81,000 Ft / minute max ascent rate**
  - **Simulate preflight conditions, such as sitting on the runway during hot, humid Texas summers or frigid Alaskan winters**
  - **Test with realistic fuselage temperature conditions throughout the flight**
  - **Test equipment that needs to withstand harsh environments (parachutist O2 bottles, winter weather gear, etc.)**

Lab Capabilities [4/8]

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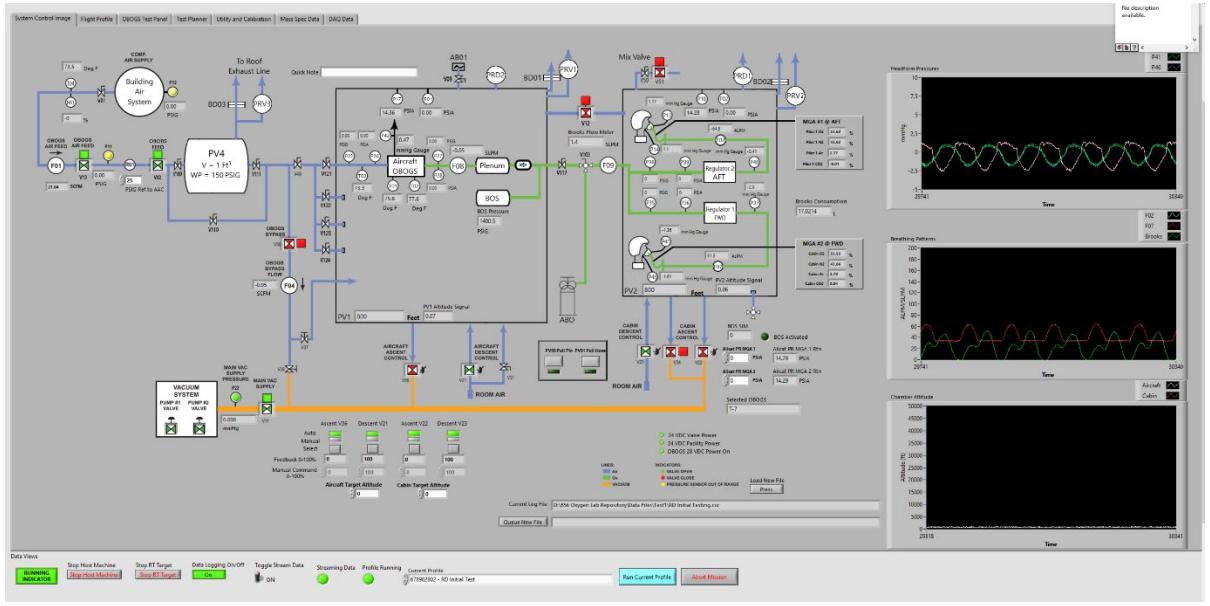
- **Over 100 data collection channels to lab sensors**
  - **Thermocouples: Detect if system overheats and measure mask air temperatures**
  - **Pressure Transducers: Measure inlet/outlet air pressures and mask pressure**
  - **Flow Meters: Detect system air leaks and supply air flows**
  - **Mass Spectrometers: Measure O2, CO2, Ar2, and N2 gas levels**
  - **Specialized Sensors: Connect to any specialized sensors a client requires**
  - **Display and log data every 50 ms**



Lab Capabilities [5/8]

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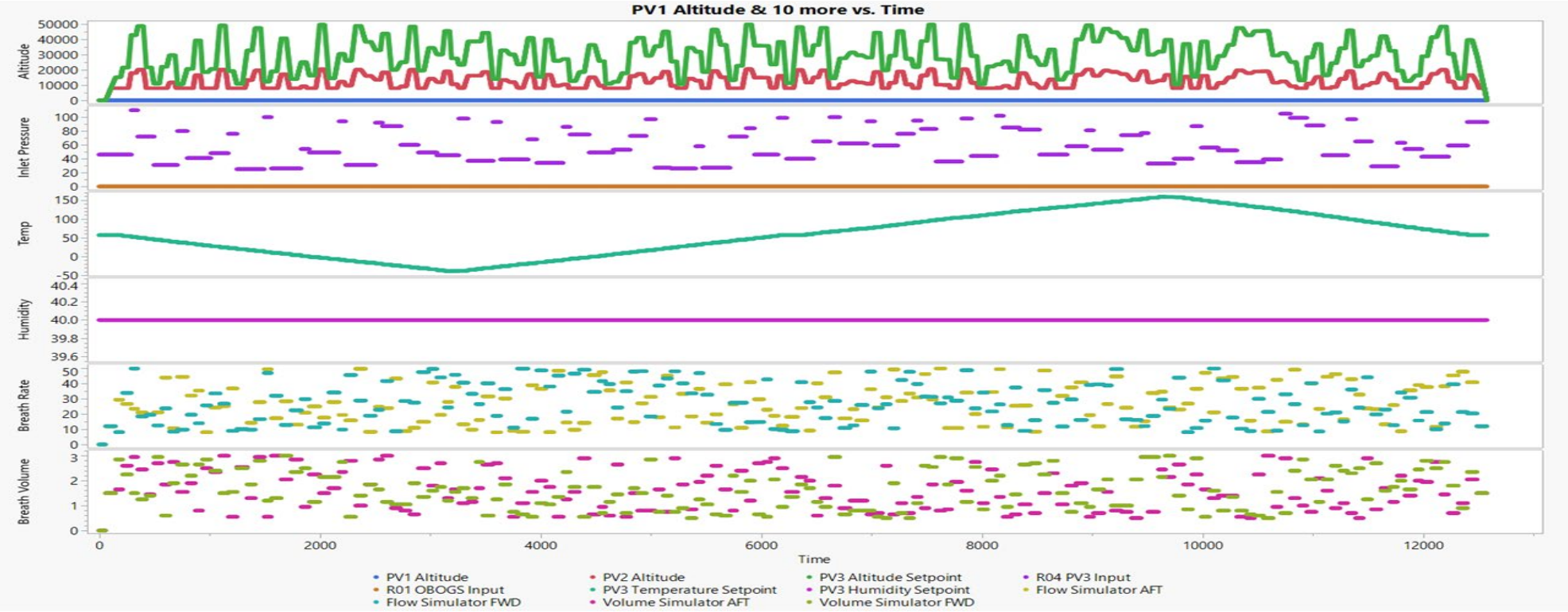
- **Automatic profile generator for controlling these lab settings:**
  - **Chamber Environment: Altitude, Temperature, Humidity**
  - **Breathing Profiles: Breathing rates, breathing patterns (sinusoidal, G-breathing, etc.)**
  - **Inlet Air Pressures: Simulate normal or critically low OBOGS inlet supply air**



Lab Capabilities [6/8]

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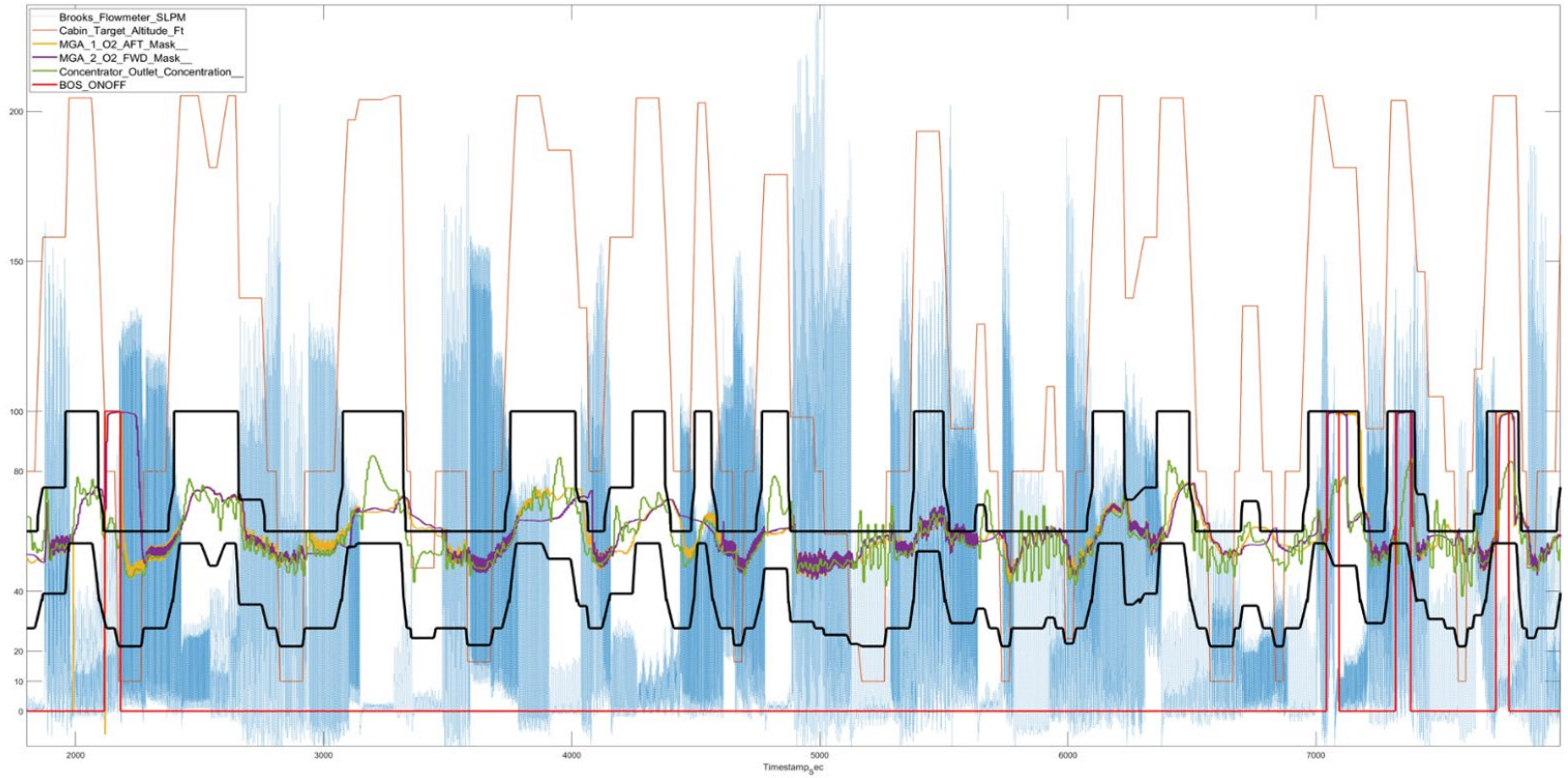
- **Seamless Dats Analysis Process**
  - **Customizable data analysis graphs using either JMP or MATLAB.**
  - **Statistical analysis to compare multiple test articles.**



Lab Capabilities [7/8]

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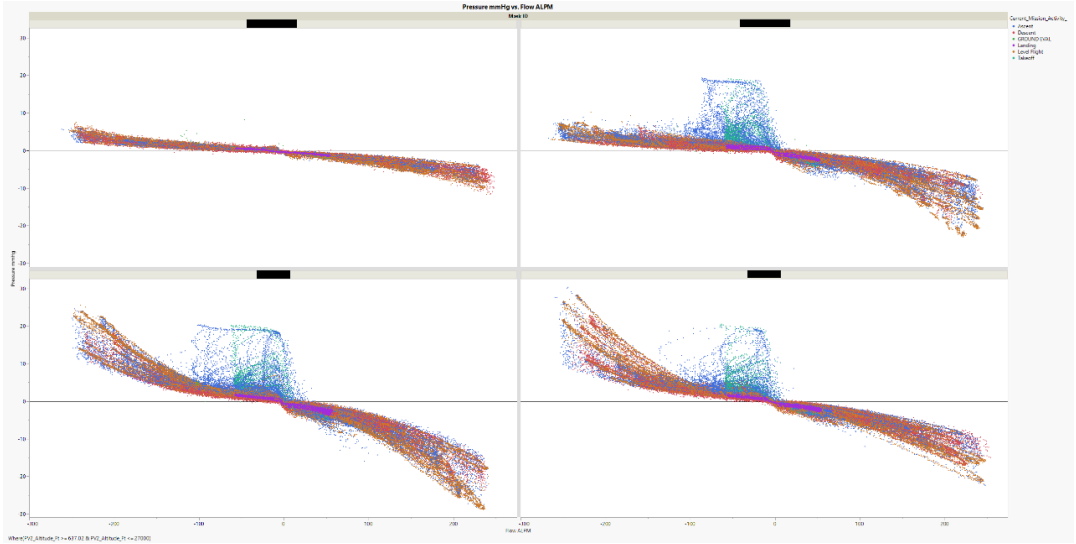

- **Test Planning and Reporting**
  - **Experienced team to assist in designing a test plan to meet MIL-STD-3050A, MIL-STD-810H, or equipment specific requirements**
  - **Test plan templates to expedite test planning process**
  - **Test reports that provide informative graphs of data and detailed analysis customizable parameters**
  - **Follow-up support for questions about testing results and the test report**

Lab Capabilities [8/8]

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- **Testing Capabilities**
  - **Air Worthiness Testing Support**
    - Replicate aircraft system (orientation, plumbing length, connectors) as found in the aircraft
  - **Baseline testing**
    - Create a functional baseline to compare to potential incident equipment
    - Compare baseline data to potential system updates or modifications
    - Functional baseline data allows for rapid turn-around in the event of equipment failure or UPE
  - **Incident Investigation**

Past Testing Successes [1/7]

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- **C-17 Incident Testing Support**
  - **Conducted Altitude Testing on CRU-73A Regulator, CRU-60 Regulator, Mask, Helmet, and Associated Hoses**
    - **2-week turnaround**
  - **Able to compare collected data to spec sheets, altitude performance schedule, and relevant MIL Standards**
  - **Analyzed data allowed program officers to evaluate LSS equipment performance at time of incident**

Pressure Altitude (x1,000 ft)	Ratio of oxygen added with diluter lever in the normal oxygen position (%)			
	1 to 14 LPM	15 to 50 LPM	51 to 85 LPM	86 to 135 LPM
0	0 to 100	0 to 30	0 to 30	-
5	1 to 100	1 to 33	1 to 33	-
10	6 to 100	6 to 35	6 to 27	6 to 35
15	14 to 100	14 to 42	14 to 30	14 to 45
20	24 to 100	24 to 55	24 to 55	24 to 55
25	40 to 100	40 to 80	40 to 80	40 to 90
28	60 to 100	60 to 100	60 to 100	60 to 100
32	98 to 100	98 to 100	98 to 100	98 to 100
	Ratio of oxygen added with diluter lever in 100% oxygen position (%)			
All altitudes	98 to 100	98 to 100	98 to 100	98 to 100

Past Testing Successes [2/7]

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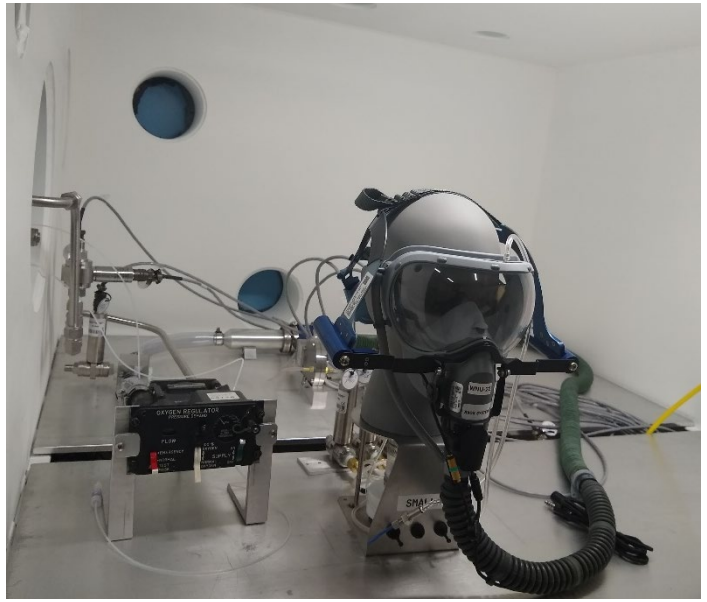
- **Quick Don Mask**
  - **Testing of the Quick Don Mask (QDM) started**
  - **Tested from 0-35K ft simulated altitude**
  - **Quantified difference in oxygen consumption between mask variants**



  - **Established testing and equipment swap out procedures**
  - **Marked the completion of IOC lab capabilities**

Past Testing Successes [3/7]

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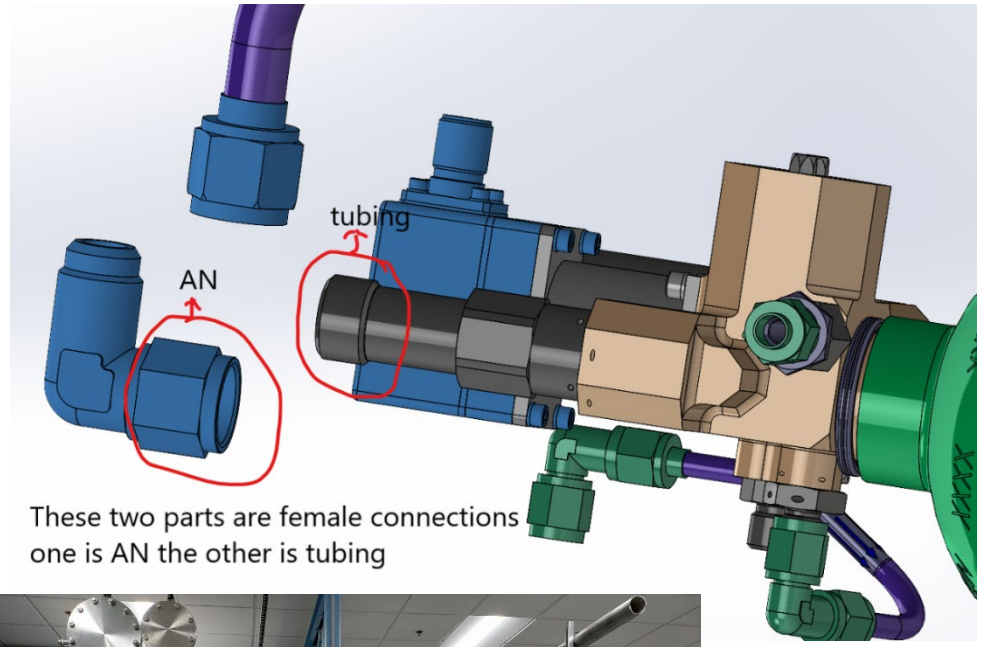
- **T-7A OBOGS Phase 1 Qualification**
  - **Conducted over 1200 individual tests for this effort**
  - **Qualified T-7 OBOGS**
  - **Assisted in the verification of over 100 T-7 operational requirements**
  - **Used 3-D modeling software to model system install**



Past Testing Successes [4/7]

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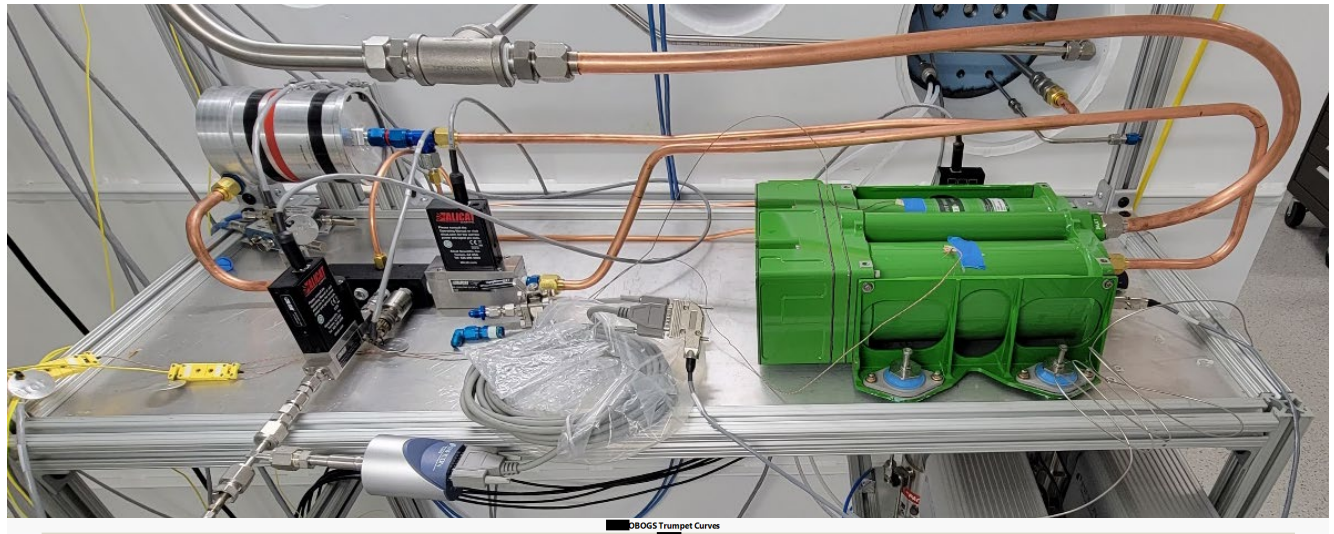
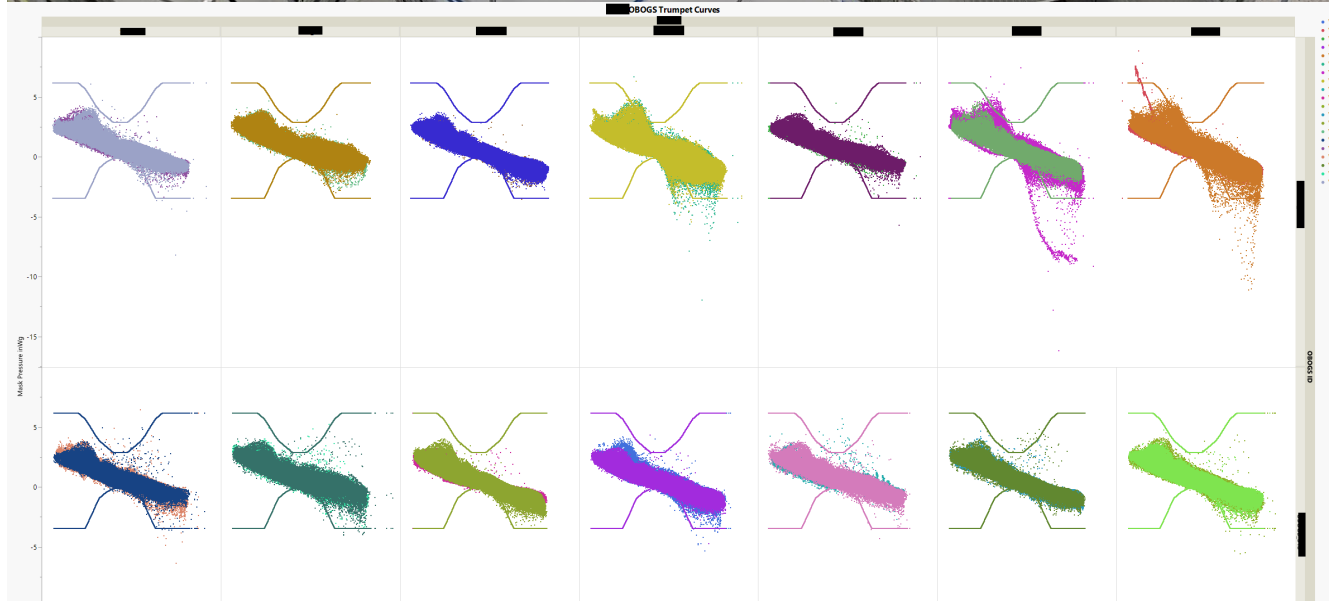
- **F-35**
  - Comparison testing of the F-35
    - Tested performance of various F-35 concentrator and regulator combinations
  - Tested variants of peripheral sensors to determine system performance characteristics
  - Established F-35 OBOGS and SPA baseline





Past Testing Successes [5/7]

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- **Incident Investigations**
  - **Worked with several AF Labs to conduct investigations on failure instances**
  - **Completed testing and data analysis within 2 weeks**

Reference 5, 6, 7

Past Testing Successes [6/7]

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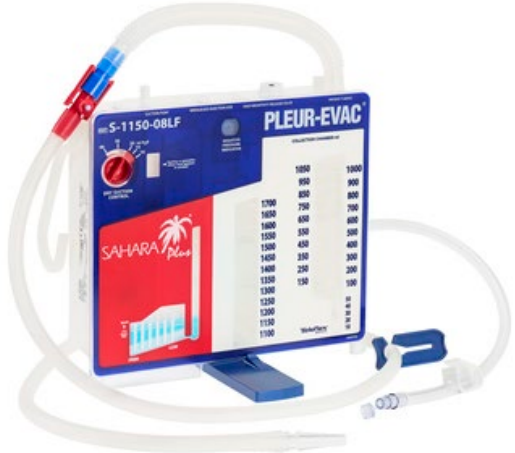
- **Not all testing is directly related to OBOGS or breathing systems**
- **Collaborated with the Aeromedical Test Lab (ATL) to collect equipment data for preliminary airworthiness investigations**
  - **ATL/Medical Equipment**
  - **Kosmos, Quinflow, APRU, Ultrasound, Versaflo, Chest Drain System**
- **Collaborated with NAMRU**
- **In addition to O2 systems have tested medical equipment such as stretchers and Quinflow units**



Reference 3, 4

Past Testing Successes [7/7]

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- **Additional Projects**
  - **T-6 SureSteam OBOGS**
  - **Mask/Hose Investigations**
    - **High Performance Mask (HPM)**
    - **Engineering Change Proposal (ECP) Comparison**
    - **Phantom Oxygen Mask (POM) Harness Comparison**

Future Aims [1/1]

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- **Investigate LSS equipment associated with physiological events**
  - **Be a resource for incident testing needs before and after they occur**
    - **Preventative *and* investigative**
  - **Simulate incident profiles and conditions following the event**
- **Obtain representative LSS and AFE for each DoD aircraft, both for OBOGS assisted platforms and other LSS equipment**
  - **F-15E, F-16, F-22, A-10, etc.**
    - **Have tested F-35, T-7A, and T-6 SureStream to date**
  - **Concentrators, regulators, plumbing, BOS bottles, helmets, masks, chest-mounted regulators, etc.**
- **Collaborate and test with all branches of the military**
- **Expand airworthiness/safe-to-fly testing capabilities**
- **Install cameras in each PV**

Questions/Discussion [1/1]

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- Lab Phone #: 937-713-9341

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