SAMS-FF
TSH FOG & STAND ALONE SYSTEMS

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Introduction

- **The TSH and supporting equipment was developed as a flexible, modular system. The basic platform can be easily adapted for specific mission requirements without having to redesign the entire system.**

- **The TSH has been configured and operated for a variety of different missions, from ground-based platforms including drop towers and reduced gravity parabolic aircraft, to sounding rockets and the Space Shuttle, and ISS.**

- **This presentation describes the status, hardware configurations and mission results since the last MEIT.**

- **The TSH and supporting equipment was developed to be a more compact modular system. It does not require an ethernet connection like the RTS.**

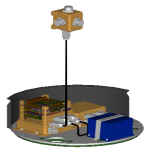
STATUS

- **Missions Supported: Terrier-Orion Sounding Rocket, SAL (Spread Across Liquid) Free Float on KC-135, Ground Testing, PARS (Parabolic Aircraft Rating System)-1**

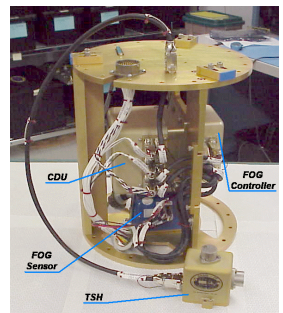
- **Present Missions: SAL-6 (2/7/01), STS-107 (NET 10/01), FCF (Fluids Combined Facility) ISS (International Space Station)**

- **Future Support: AMMS (Advanced Microgravity Measurement System), R2 (Research Module #2), R3 (Research Module #3), Permanent PARS**

SAMS-FF Progression

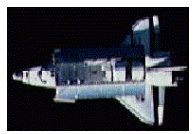


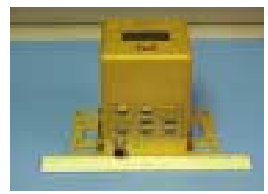
3
Terrier-Orion Mission
12/99
TSH, FOG, CDU
Telemetry



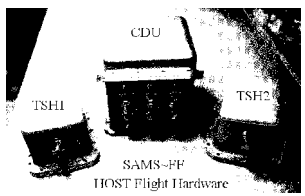
1
DARTFire Mission
9/97
TSH, FOG, CDU

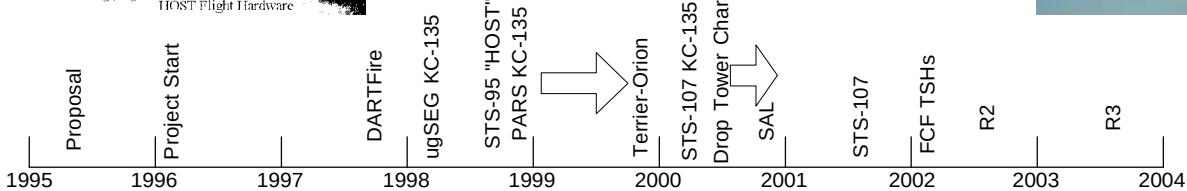
2
STS-95 "HOST" Mission
10/98
2 TSHs, CDU





4
STS-107 Mission
6/01
3 TSHs, FOG, CDU
Telemetry, Commanding





Triaxial Sensor Head

- **Measures general vibratory environment**
- **3 Orthogonal pendulous mass force-balance accelerometers in each TSH head**
- **Selectable bandwidth**
- **Small volume: 2.9”x2.9”x2.8”**
- **Low weight: ~1.1 lbs**
- **Low power draw: ~2 W**

Standalone TSH

The TSH can be used “stand-alone”

- **Power: +/- 15VDC, 1.65W**
- **Digital data output and control through standard RS-422 serial interface**

Most payloads have a control computer

- **Connect TSH, add power, and install software**
- **Easy to use where space is a premium**
- **Easy to synchronize data with other payload sensors**

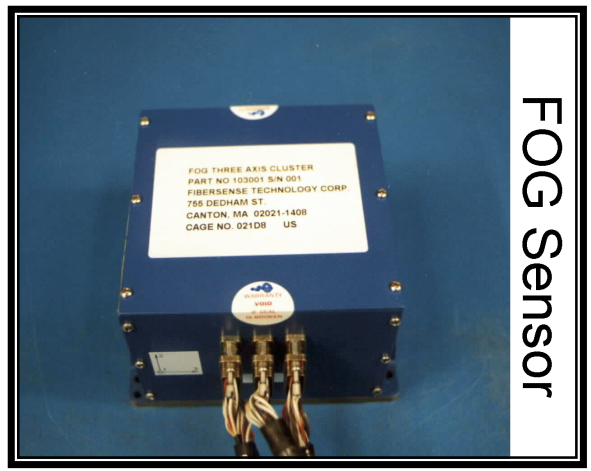
Missions Supported

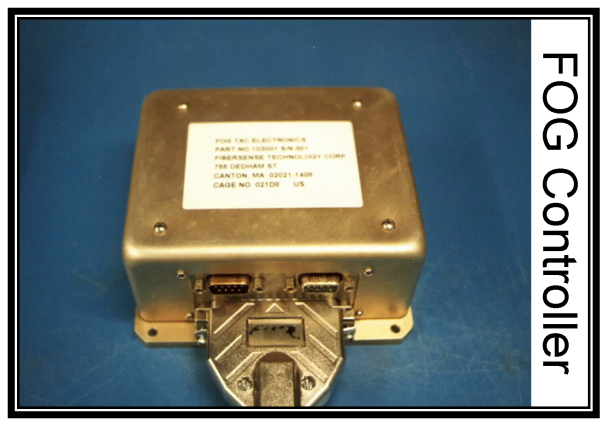
- **FCF**
- **ugSEG (KC-135 flight)**
- **SAL-6**
- **DARTFire**

11 SAMS TSHs are being built for integration in the GRC Fluids and Combustion Facility that is being designed and fabricated for flight on the International Space Station.

Roll Rate Sensor

- **Fiber Optics Gyroscope-No moving parts**
- **Measures vehicle roll rate by light wave phase shift in opposing fiber coils**
- **Resolution = 0.1 arc-secs**
- **Small volume: 3.8”x4.4”x3.0” (sensors)**
  4.8”x5.0”x2.2” (controller)
- **Low weight: < 4 lbs**
- **Low power: ~10 W**





Control & Data Acquisition Unit (CDU)

- Conditions and distributes power to attached sensors
- PC/104 industrial grade embedded system with real-time control software for data and command
  - CPU board i486 processor
  - 6 GB rotational hard drive for data storage
  - Serial I/O board
  - Analog/Digital I/O board
  - Ethernet board interface to SH EDSMU
- LCD display for status and checkout
- Designed to be easily modified and upgraded
- Small volume: 5.3”x5.3”x5.0”

SAMS-FF Front Control and Display

SAMS-FF CDU: system status displayed on LCD

STS-107 nominal operations of μg data recording require no crew interaction

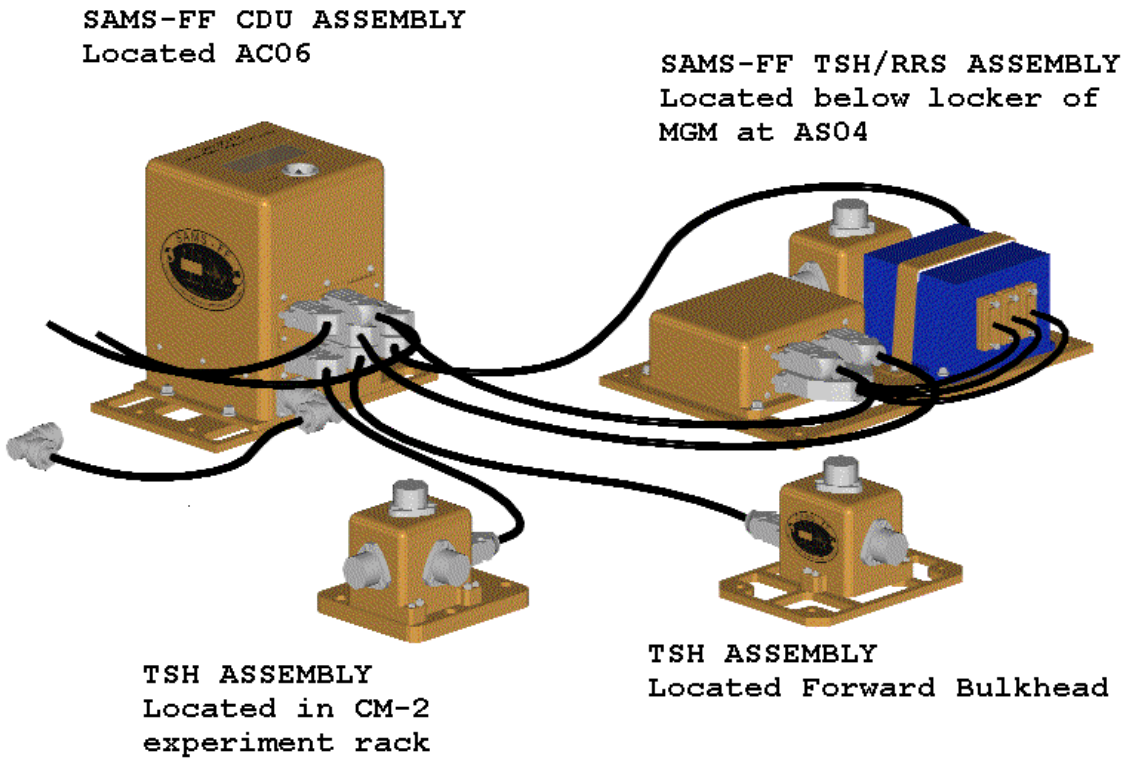
No touch temperature hazards

<u>Features to note</u>:

LCD display (center)

System power switch (SW1 at bottom)

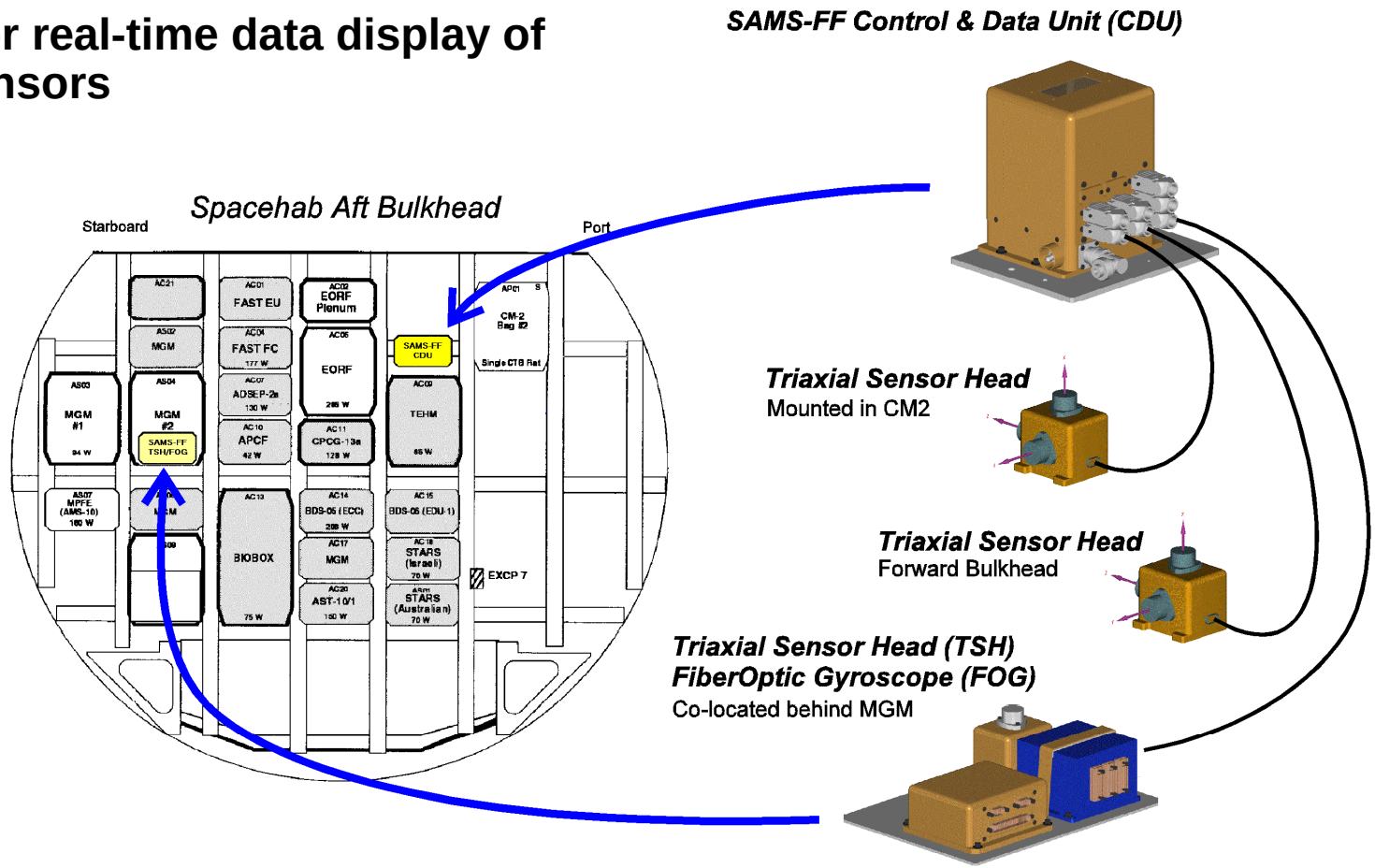
General Description: System Configuration for STS-107



SAMS-FF on STS-107
Shuttle Mission (10/01)

Highlights:

- **Acceleration and Roll-Rate measurements**
- **Downlink for real-time data display of selected sensors**



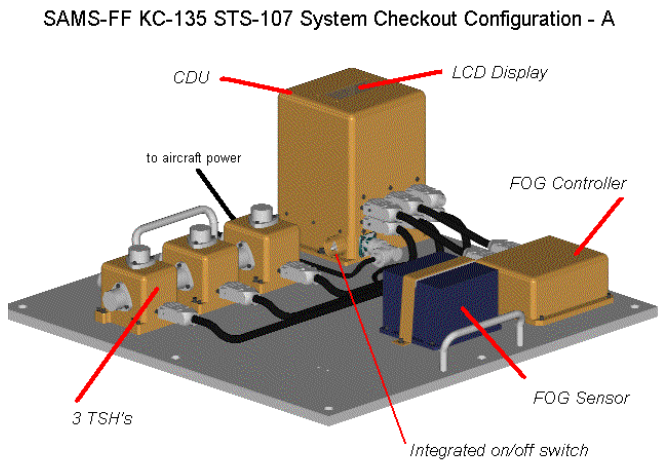
SAMS-FF STS-107
Checkout Flight on the KC-135

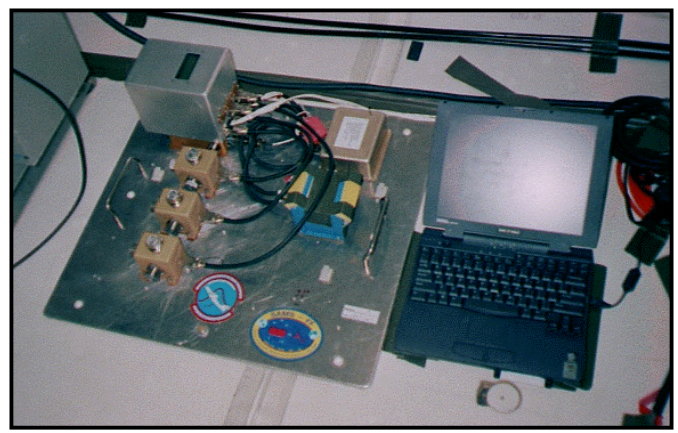
Flew system on the KC-135 parabolic aircraft to:

- Verify operation in low-g setting
- Exercise system from hardware integration and operation through data processing

Flew all components of the STS-107 mission:

- CDU
- 3 TSHs
- FOG





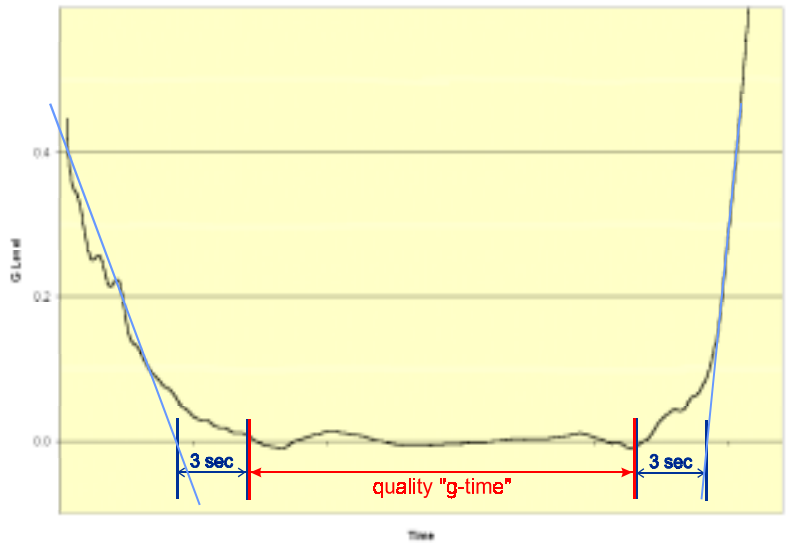
SAMS-FF STS-107 System Mounted in KC-135

PARS:
Parabolic Aircraft Rating System

- Need:
  - A concise and timely way of informing both experimenters and crew of the “quality” of parabolas flown
- SAMS-FF Configuration
  - 1 TSH
  - 1 CDU (laptop PC)
  - Battery Box (power to TSH)
  - 50 Hz sampling rate *(BW (-3dB)=13.1 Hz)*
  - Intelligent data gathering
    - only records data below 0.7g
    - makes parabola identification easy
    - focuses on conditions of most interest

PARS:
Parabolic Aircraft Rating System

- A 1 to10 scale rating based on statistical analysis by KC-135 personnel of historical g-data.
- SAMS-FF constantly monitors the g-environment.
  - Records each parabola in separate data files
  - Computes rating immediately following each parabola
  - Rating displayed on screen and recorded in file for later printing
  - Individual parabola data can be provided post flight upon request for further evaluation



PARS Algorithm

1.) find 0.4 and 0.2 crossing points

2.) determine 0-intercept points of these lines

3.) offset by 3 seconds to avoid entry/exit noise

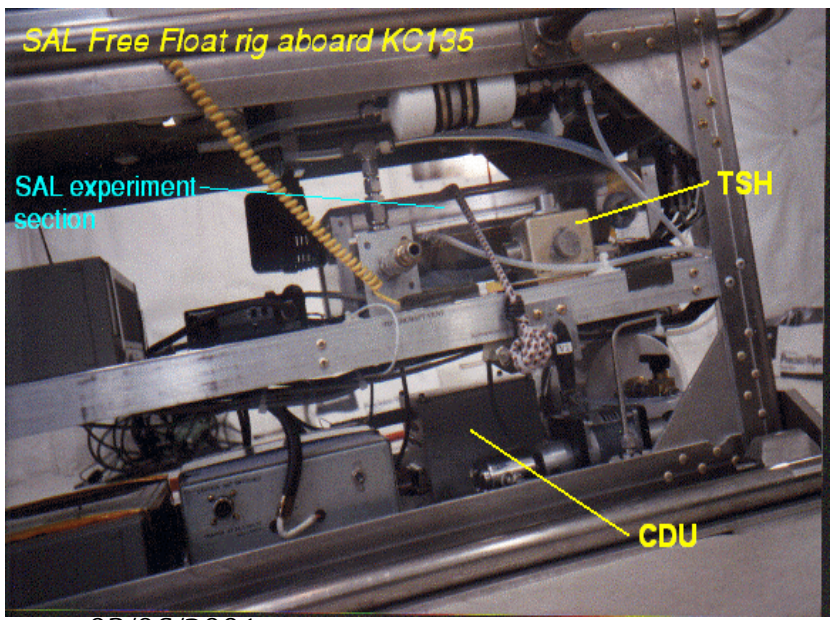
4.) determine rating based on g RMS over the quality period.

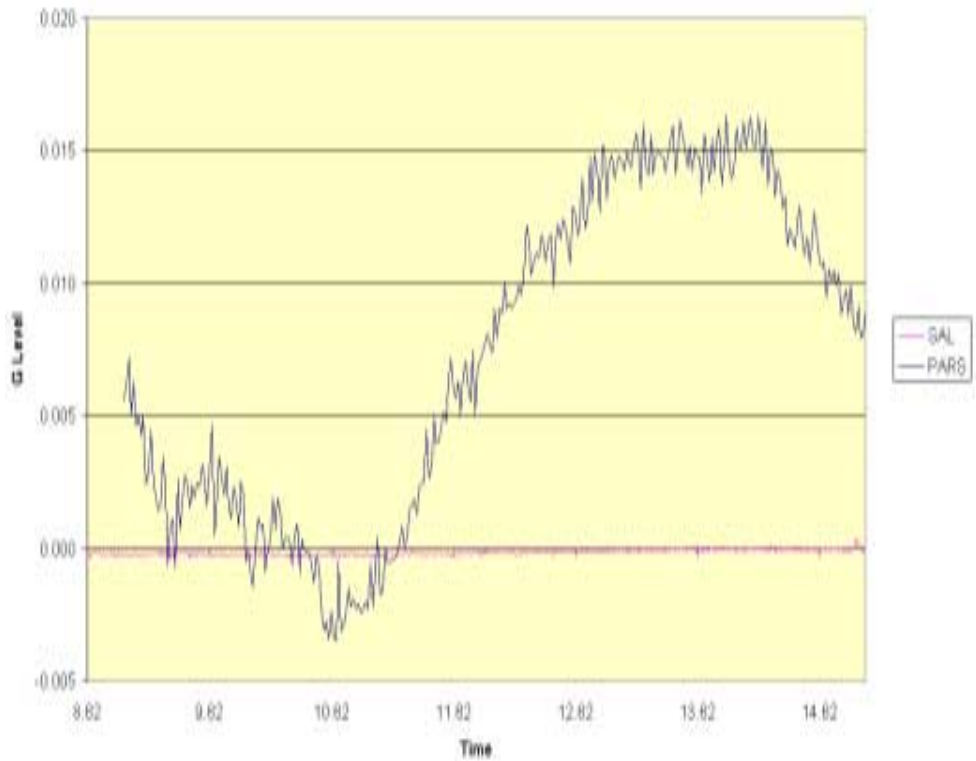
Supporting the Spread Across Liquids (SAL) Experiment

KC-135 Flights:

4/26-30/99 & 6/14-18/99

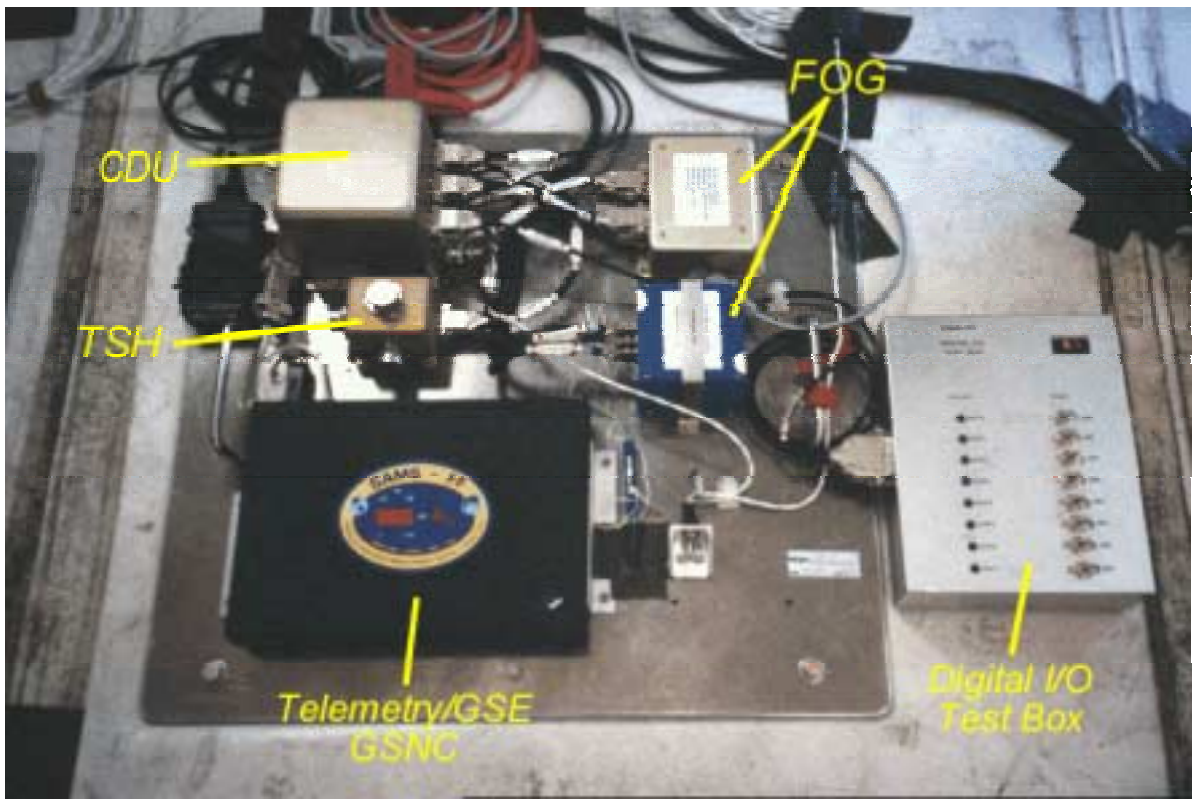
A free-float rig with one TSH and a CDU





SAL freefloat vs. PARS boltdown quality low-g time Parabola #1 4/30/99

Reflight of hardware used on 41.020



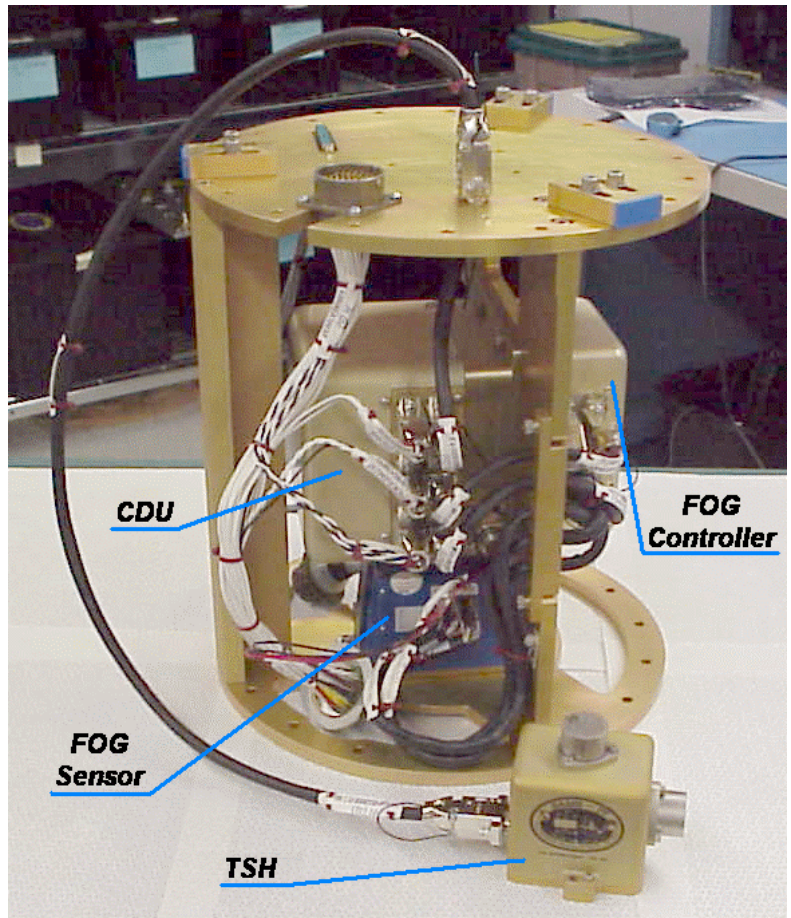
Terrier-Orion
Sounding Rocket (Flight 41.020)

First flight of a new class of sounding rocket

- 14” diameter
- Payload weight including SAMS-FF and Microscale heaters was approx 469 lbs
- µg time (180-220 seconds)
- Flown at WFF (water recovery)

SAMS mission goals

- Characterize acceleration environment of vehicle during µg period
- Support Microscale heaters experiment
- Implement downlink for real-time data display
- Payload available to support reflights with minor expense

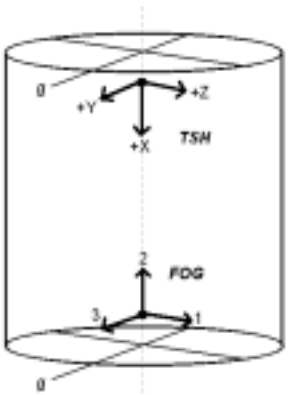


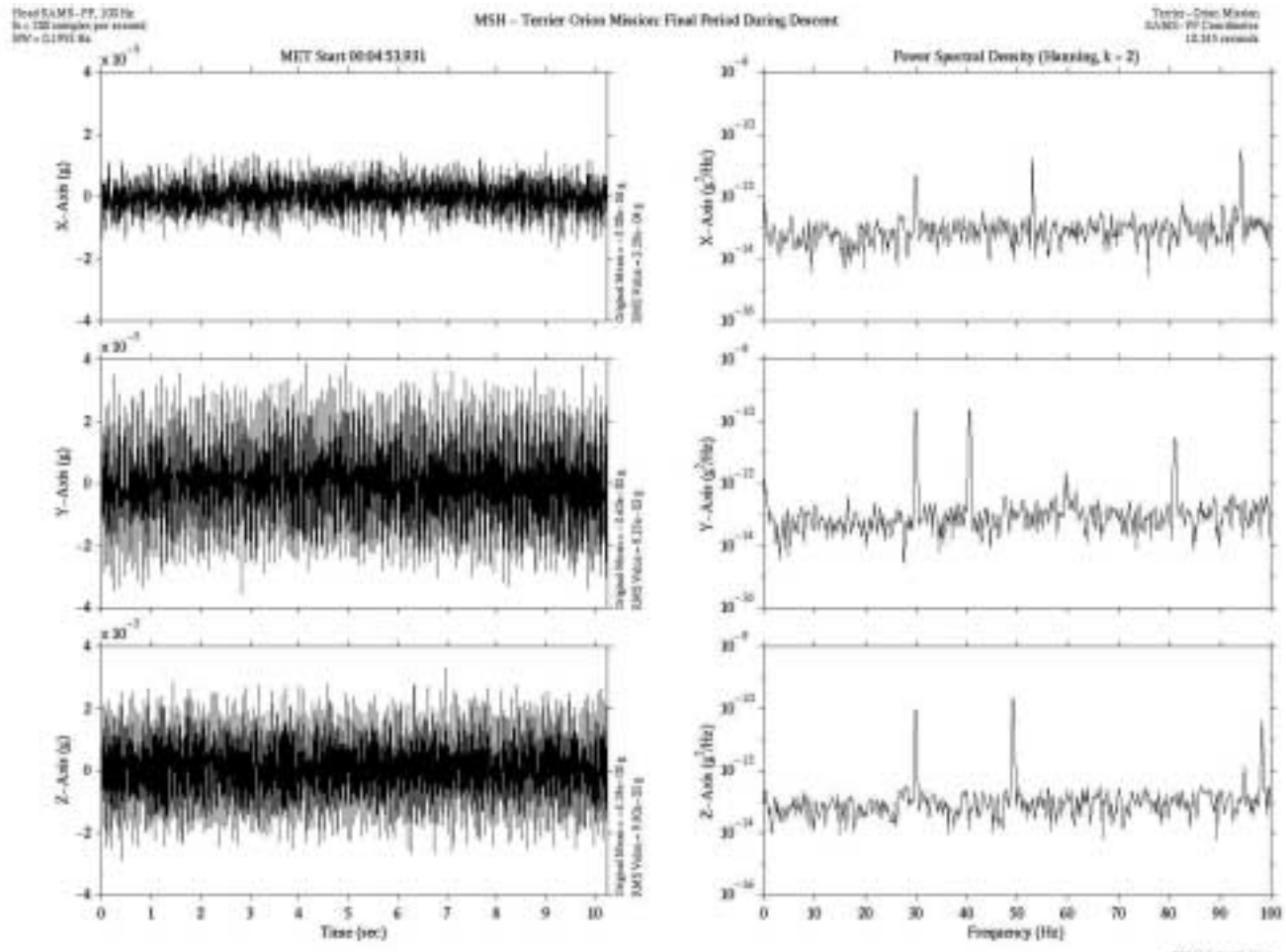
SAMS System Flown on Terrier-Orion Sounding Rocket Flight 41.020 on December 17, 1999.

Terrier-Orion Sounding Rocket Mission Results-TSH

General: ***The SAMS sensors consisted of a TSH and a FOG. Total time for TSH acceleration measurements was 277seconds.***

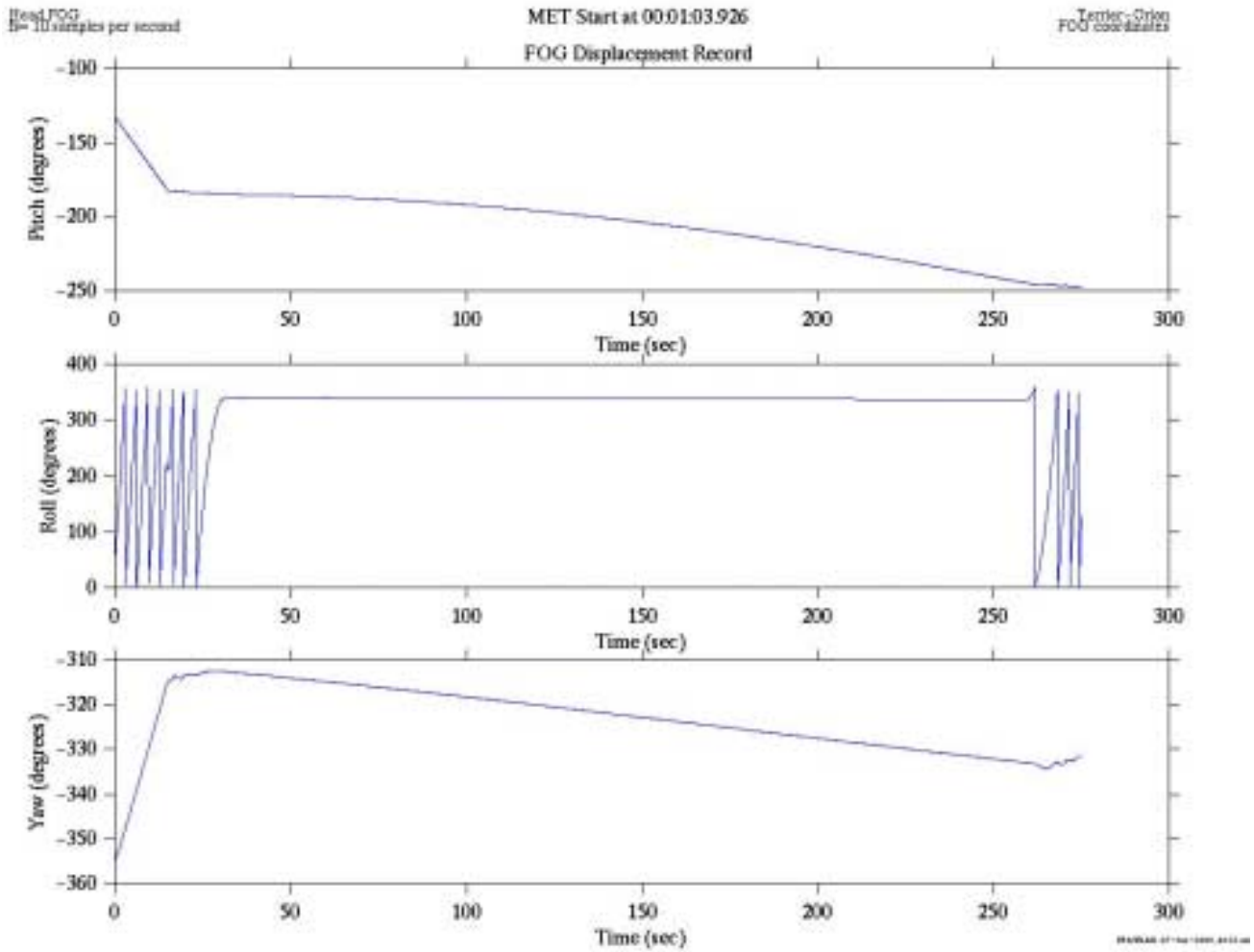
TSH Data: ***Data has appearance of noise floor data, with maximum amplitude of 2.7 ug . PSD has no significant peaks, and noise floor is near 10^{-14} g2/Hz.***

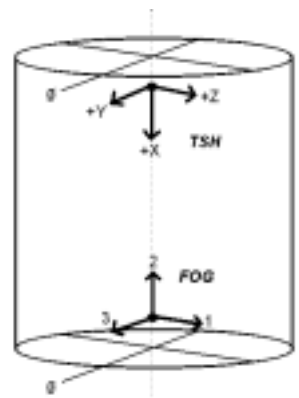




Terrier-Orion Sounding
Rocket Mission Results-FOG

Pitch, Yaw and Roll during science portion of Terrier-Orion





2.2 Second Drop Tower Characterization

Drop Tower Release Mechanism

Closeup of Hardware

View Down the Drop Tower

Performed an initial characterization of the acceleration environment of the NASA GRC 2.2 Second Drop Tower

System consisted of a CDU (RTD) and TSH

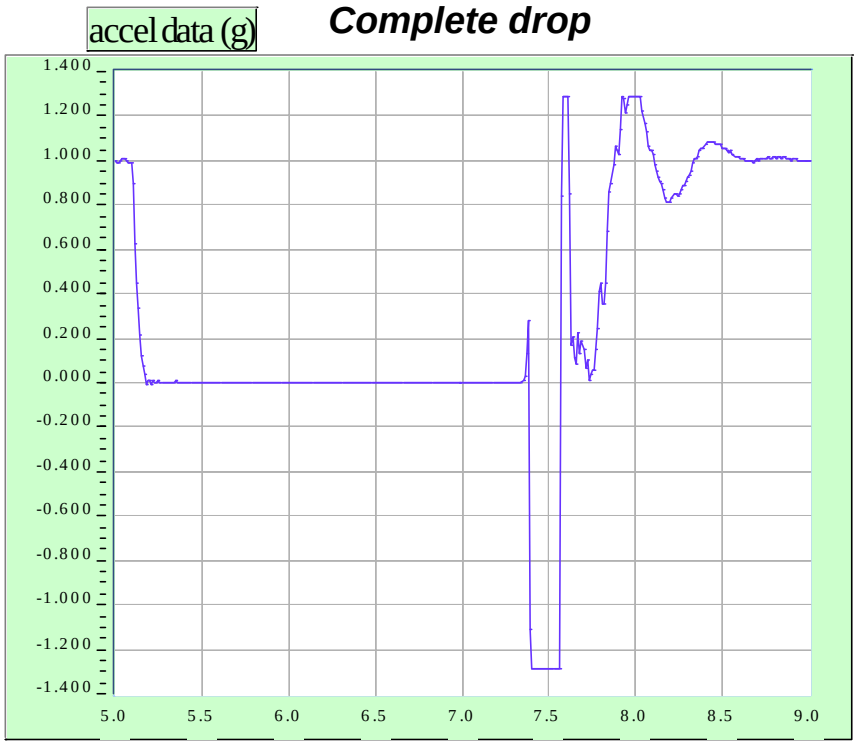
Support week of drops

- **Check acceleration levels**
- **Confirm system operation**
- **See if any accel bias shift**

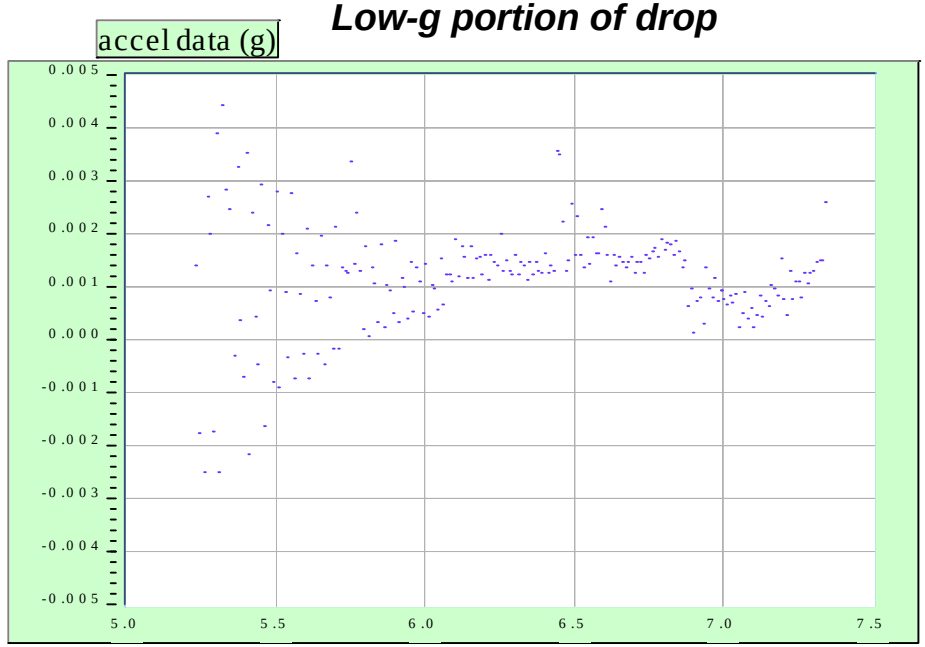
Permanent system will be configured based on the results of the testing

Data from the vertical axis (X) in 2nd drop.

Complete drop



Low-g portion of drop

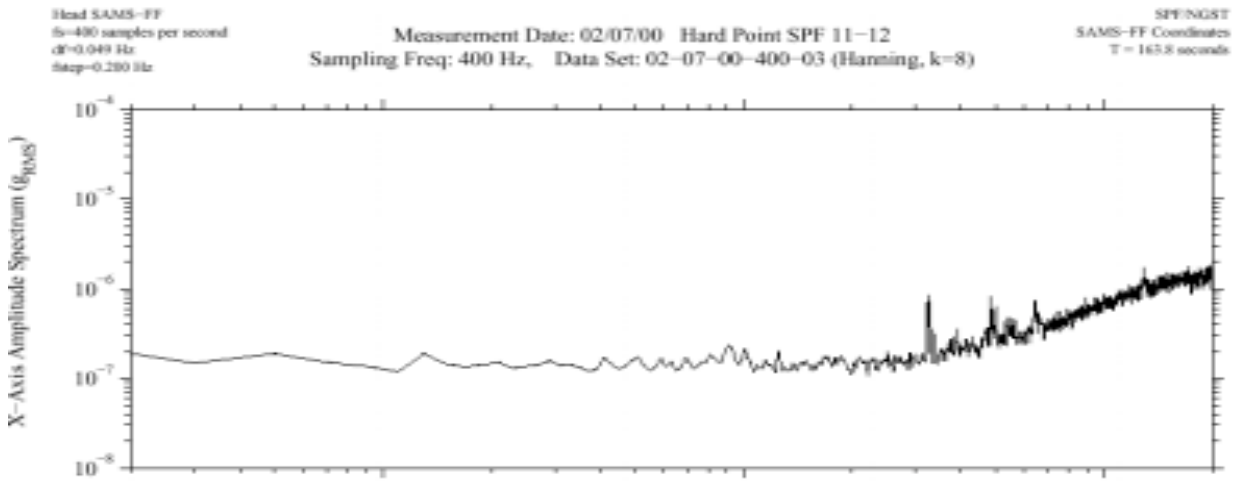


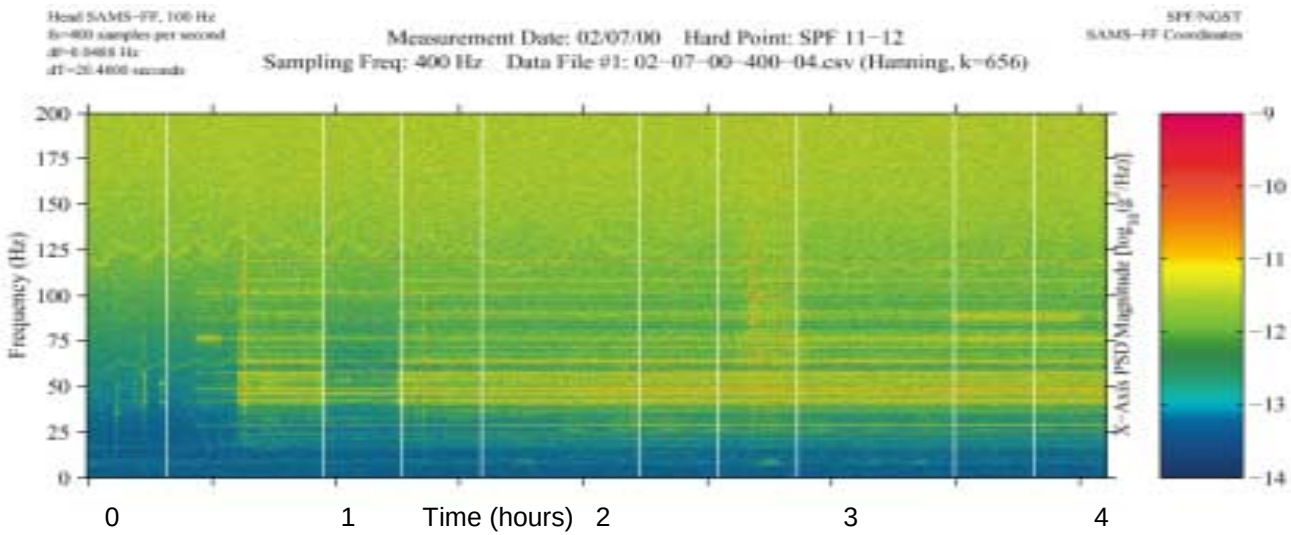
No appreciable bias or scale factor shift measured on the accelerometers due to the shock of the landing.

Ground Testing
Plum Brook Station

- Requested to characterize accelerations at the Space Power Facility (SPF) at Plum Brook Station
- TSH was used in a standalone mode connected to a SPF computer with SAMS-FF data acquisition software
- Quietest ground environment measured to date
- (< 0.2µg for 2Hz BW)
- It is possible to measure uG experiment on the ground.

Ground Testing – SPF data





Conclusion

TSH and FOG sensors are available to support payloads on a variety of different platforms

System is easily configured to support mission requirements

Complete service package including hardware and data analysis

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