Swift Observatory Space Simulation Testing

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The Swift Observatory is a Middle-Class Explorer (MIDEX) mission that is a rapidly re-pointing spacecraft with immediate data distribution capability to the astronomical community. Its primary objectives are to characterize and determine the origin of Gamma Ray Bursts (GRBs) and to use the collected data on GRB phenomena in order to probe the universe and gain insight into the physics of black hole formation and early universe. The main components of the spacecraft are the Burst Alert Telescope (BAT), Ultraviolet and Optical Telescope (UVOT), X-Ray Telescope (XRT), and Optical Bench (OB) instruments coupled with the Swift spacecraft (S/C) bus. The Swift Observatory will be tested at the Space Environment Simulation (SES) chamber at the Goddard Space Flight Center from May to June 2004 in order to characterize its thermal behavior in a vacuum environment.

In order to simulate the independent thermal zones required by the BAT, XRT, UVOT, and OB instruments, the spacecraft is mounted on a chariot structure capable of maintaining adiabatic interfaces and enclosed in a modified, four section MSX fixture in order to accommodate the strategic placement of seven cryopanels (on four circuits), four heater panels, and a radiation source burst simulator mechanism. There are additionally 55 heater circuits on the spacecraft. To mitigate possible migration of silicone contaminants from BAT to the XRT and UVOT instruments, a contamination enclosure is to be fabricated around the BAT at the uppermost section of the MSX fixture.

This paper discuses the test requirements and implemented thermal vacuum test configuration for the Swift Observatory.

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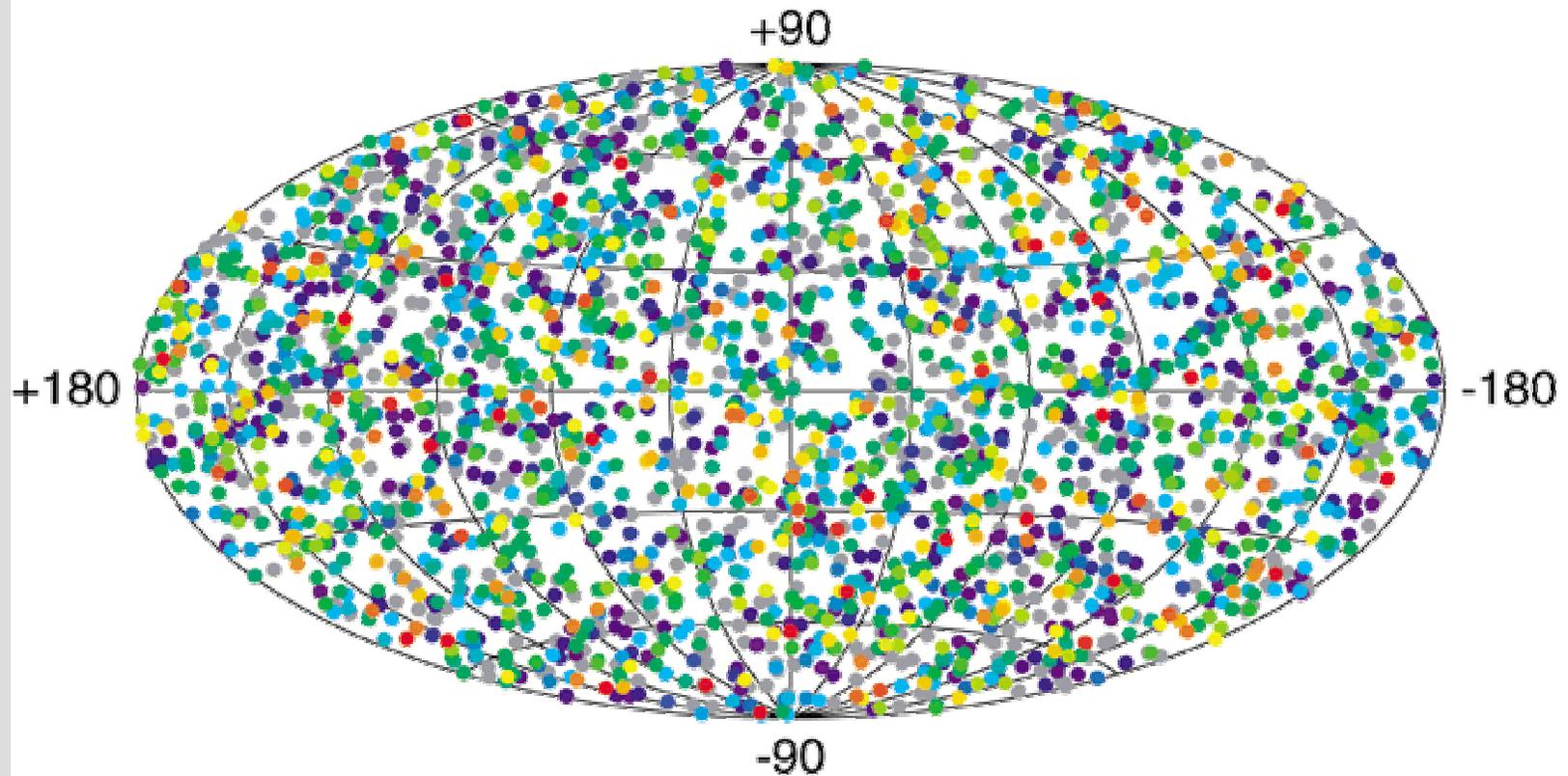**NASA-GSFC**

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Agenda

- Gamma Ray Burst (GRB) Science History

- Swift Mission

- Test Requirements, and Configuration

- Lessons Learned

Gamma Ray Burst Science History

- 1967: Military satellite detection

- 1991-2000: Compton Gamma Ray Observatory

  - Burst and Transient Source Experiment (BATSE)
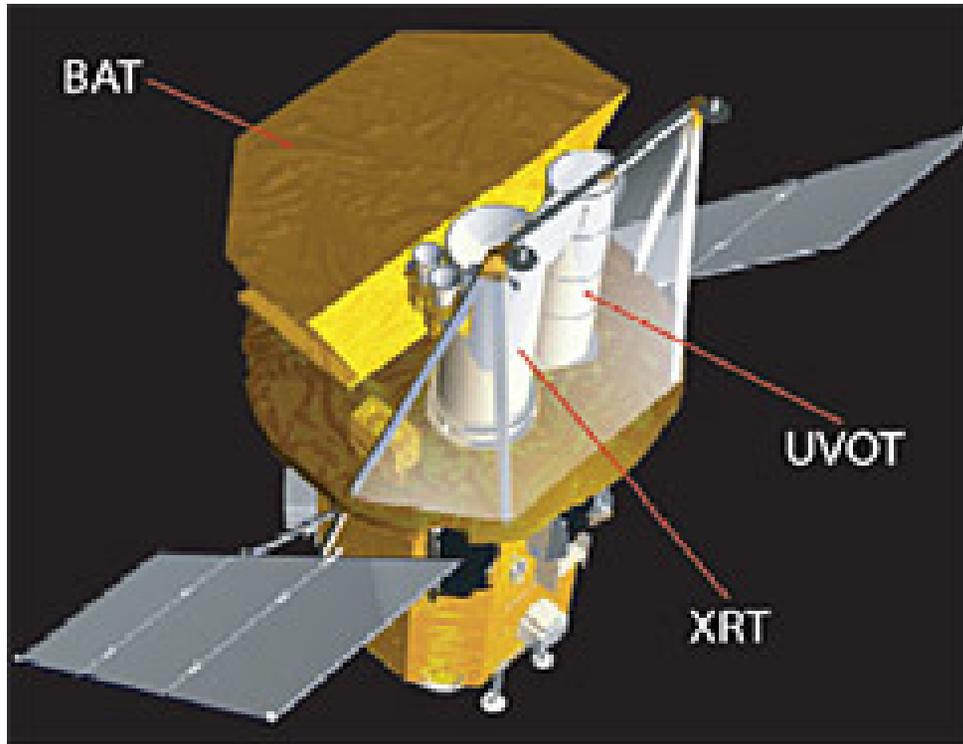
- 1997: BeppoSAX

BATSE GRB Detection Sites

2704 BATSE Gamma-Ray Bursts

Swift Mission - Overview

- Medium Class Explorer (MIDEX) mission

    - Burst Alert Telescope (BAT)

    - X-Ray Telescope (XRT)

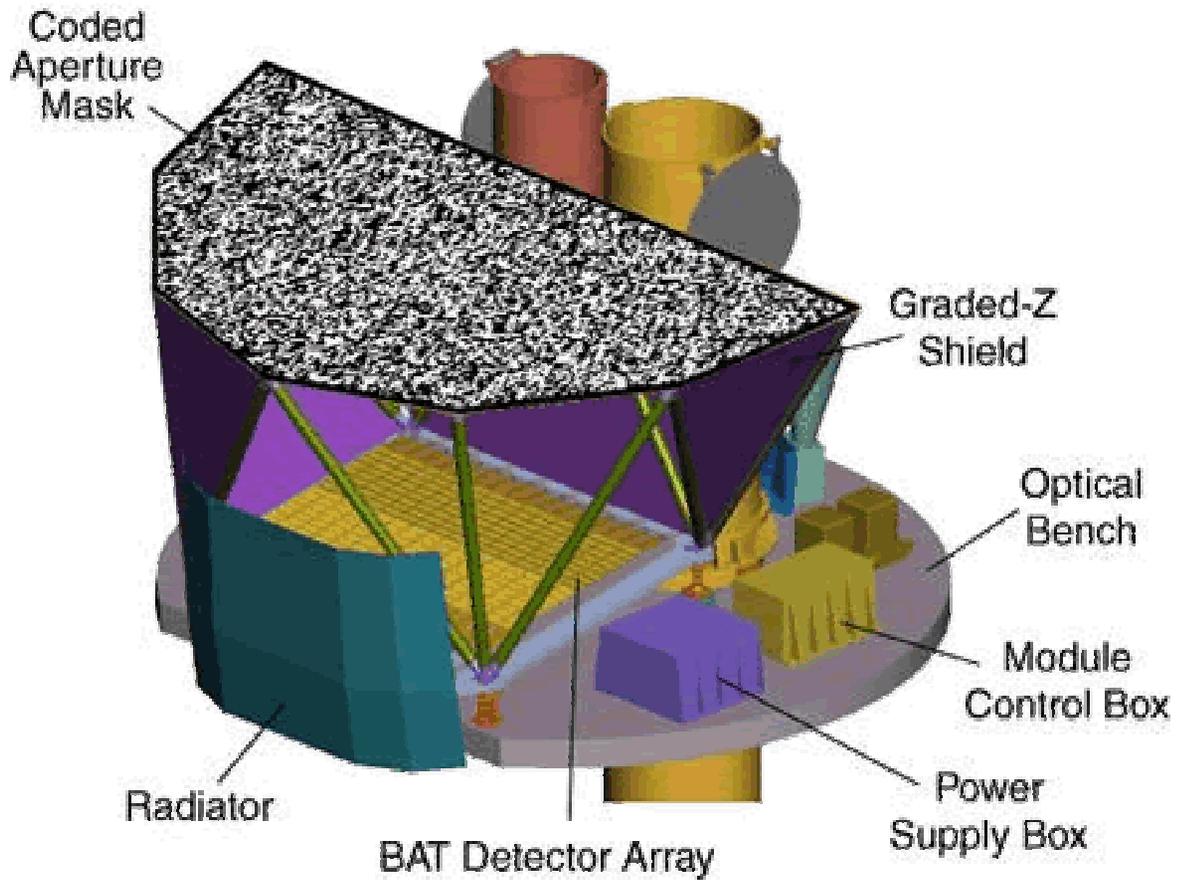   - Ultraviolet Optical Telescope (UVOT)

Swift Observatory

BAT Capabilities

- Large FOV instrument

- Burst detection through coded aperture mask

- Modes: Burst and Survey

  - Determine critical GRB triggers

  - Relay 1-4 arcmin. position within 15 sec.
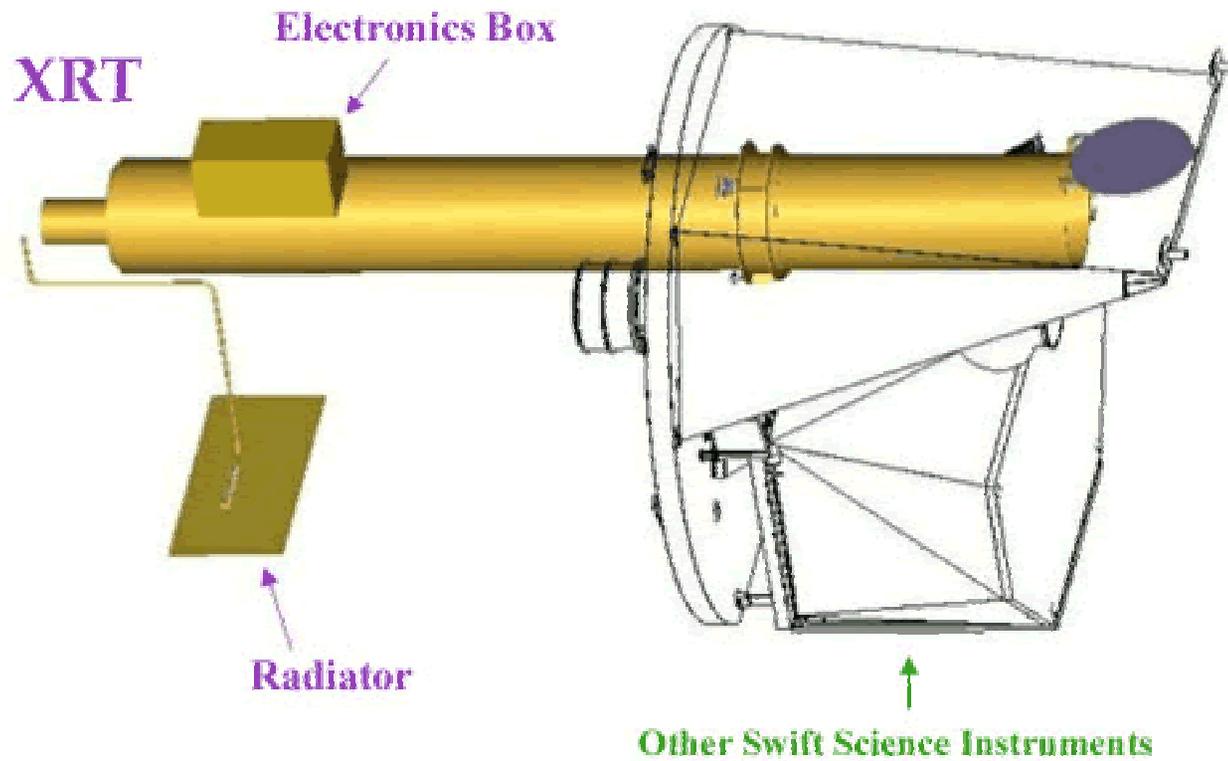
  - Hard X-ray survey

BAT Instrument

Coded Aperture Mask
Graded-Z Shield
Optical Bench
Module Control Box
Radiator
BAT Detector Array
Power Supply Box
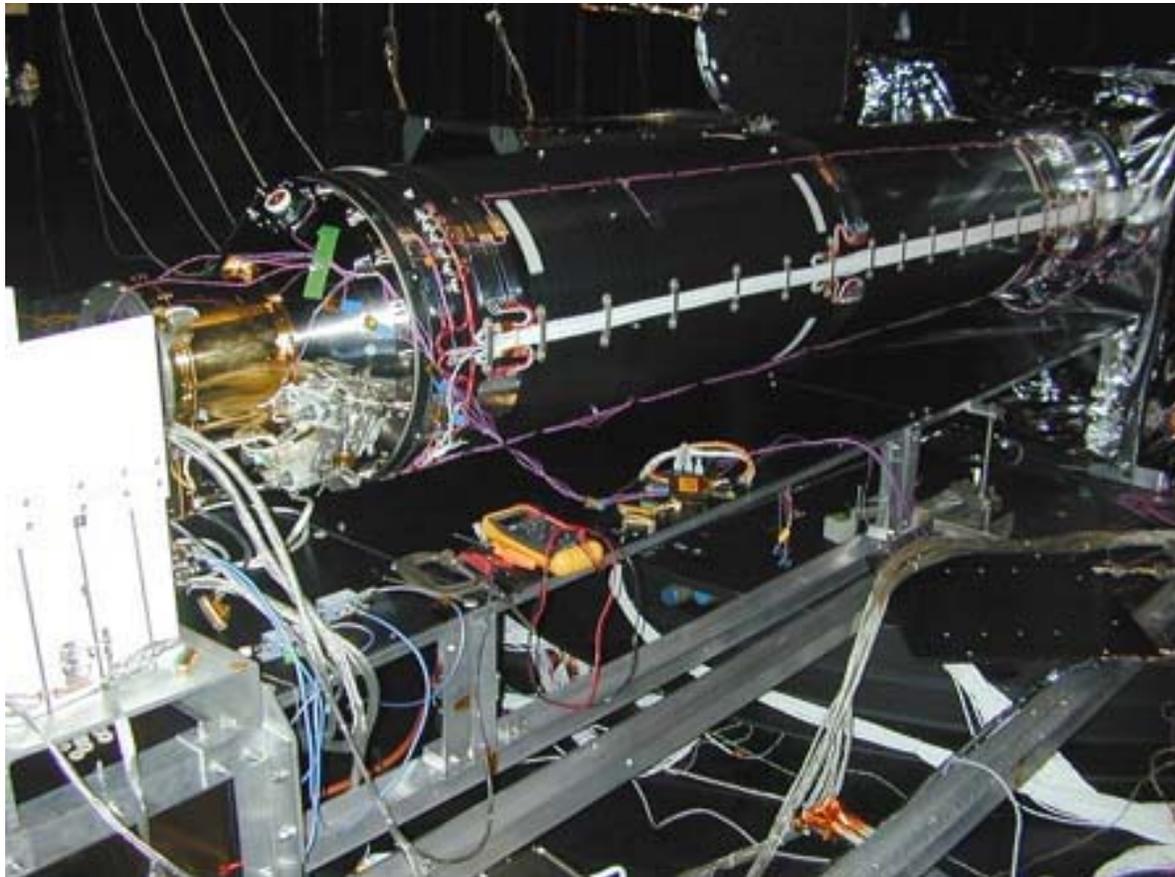
BAT (on Observatory)

XRT

- Focusing X-Ray telescope

- Three readout modes: Imaging, Timing, and Photon-counting

- 5 arcsec. accuracy within 10 sec.
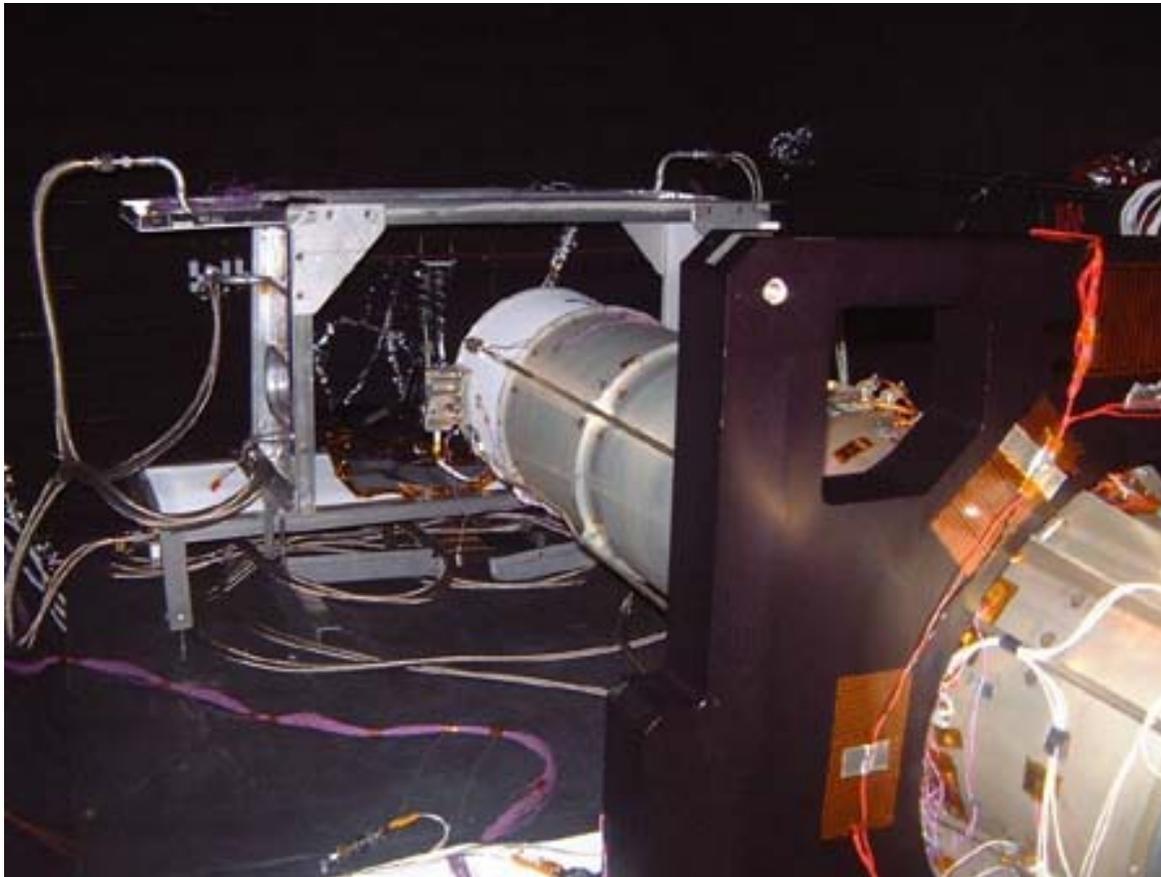
XRT Instrument

XRT (Instrument TV Configuration)

UVOT

- Based on X-ray MM-Newton Optical Monitor

- Simultaneous UV and optical measurement

- Photon counting detectors

UVOT (Instrument TV Configuration)

UVOT (on Observatory)

Test Requirements

- Deep space environment

- Ability to simulate gamma ray burst

- Light-tightness during UVOT testing

- Maintain 0.1 degree orientation tilt on BAT

- Maintain cleanliness level of instruments

Test Objectives (1/3)

- Mission Simulations

- Optical Bench (OB) Cycling

- Instrument

    - UVOT Door Module (DM)-Cold Survival

    - UVOT Detector Electronics Modules (DEMs) - TV Cycling, Hot/Cold Operational TB

    - UVOT High Voltage Test

Test Objectives (2/3)

- ## Instrument (cont.)

  - BAT Image Processors (IPs) - TV Cycles, Hot/Cold TB

  - BAT Power Control Box (PCB) - TV Cycles

  - BAT Detector Array - TV Cycles

Test Objectives (3/3)

- **Instrument (cont.)**

  - XRT Telescope Door-Cold Survival Balance

  - XRT Power-up and Venting

  - XRT Heater-Induced Deflection Test

  - XRT Heat Rejection System (HRS) Testing

  - XRT Light Leak Test

  - XRT FPCA Camera Door Opening Test

  - XRT Hot Pixel Measurement
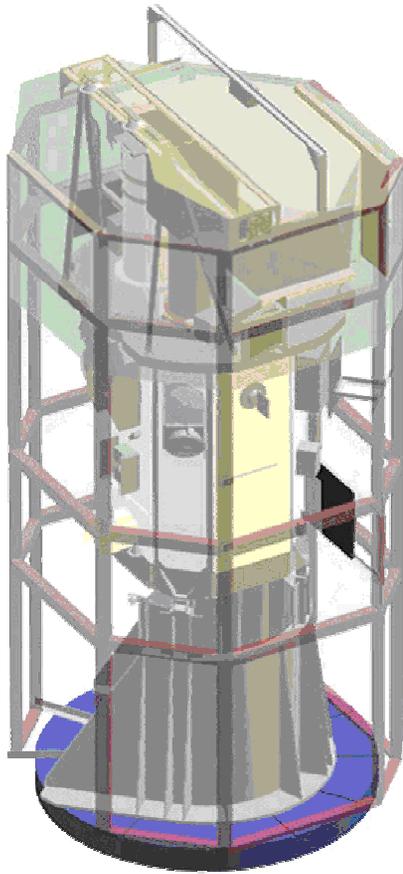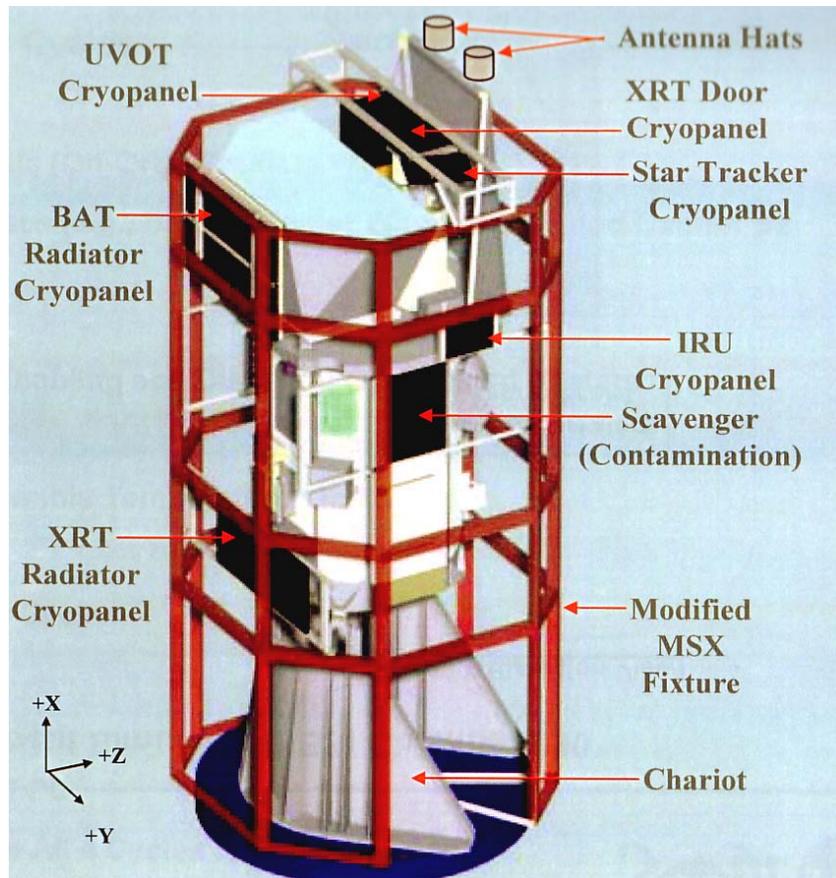
  - XEP Cycling

Thermal Profile
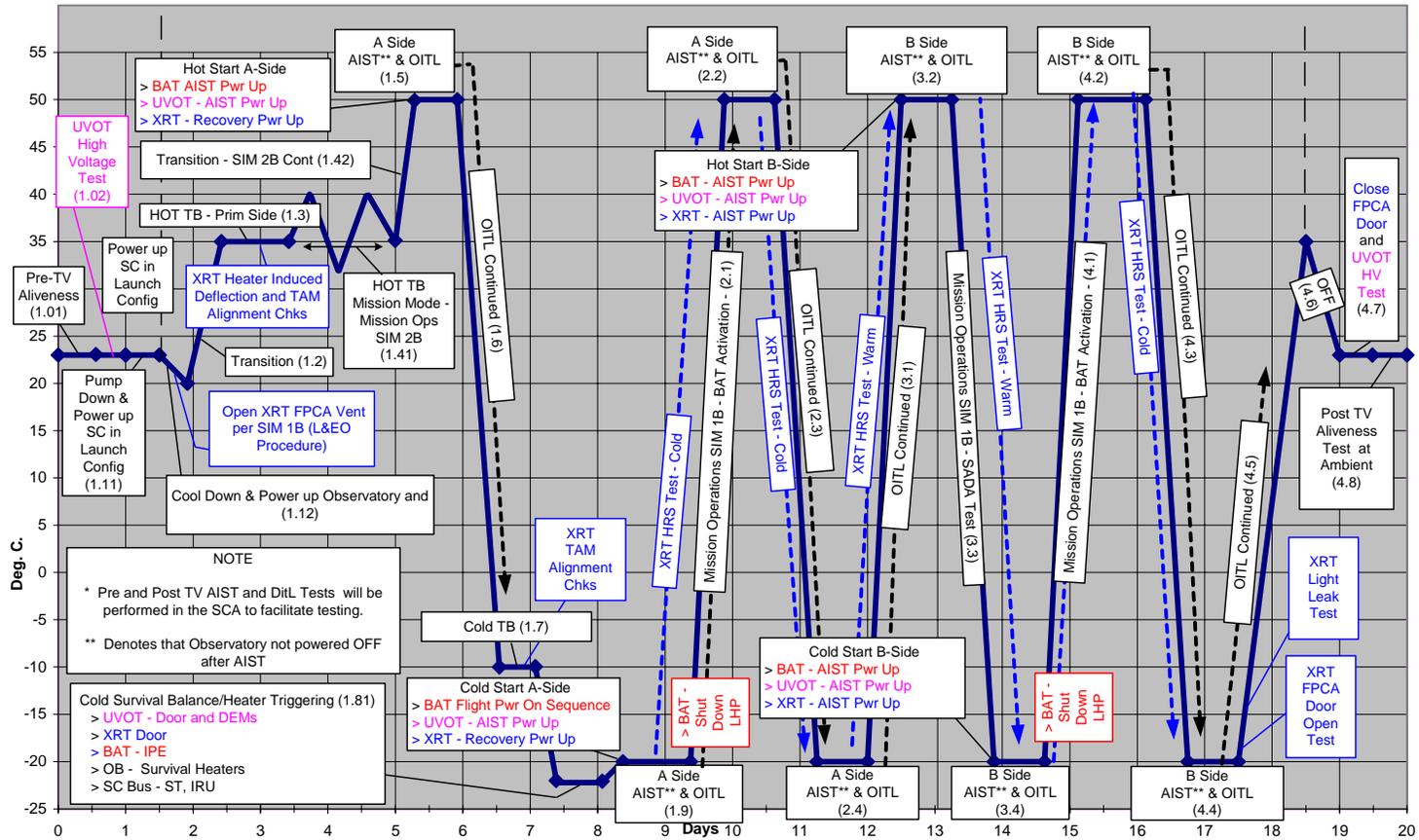
Test Setup

- 384 T/Cs and 57 Silicone Diode channels

- 68 Heater ckts (7 ZQ channels)

- 7 Cryopanels on 4 TCUs

- 3 Cryopanels on LN2 ckts (w/heaters or bucking plates)

- 5 TQCMs

- 4 Scavenger Plates
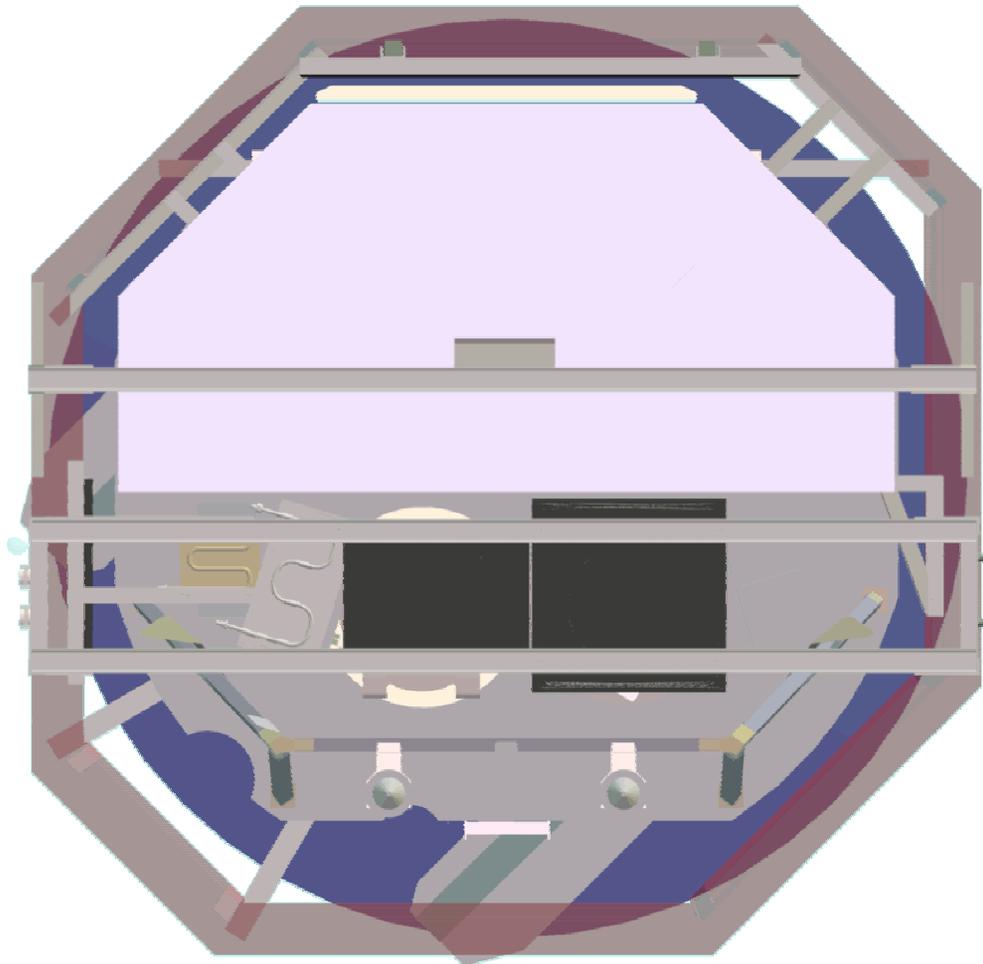
- Contamination Enclosure

Test Configuration (1/2)

Test Configuration (2/2)

Test Configuration - Plan View

Lessons Learned

- Design allowance >6 in.

- Design for increased heat load in vacuum (90W.➜Δ80°C).

- Negligible difference in thermal loss between applied heaters and bucking plates on cryopanels.

- LN2 line losses of 10-30°C.

- Zero-Q method on pre-existing chariot titanium block interface not commutable to Swift setup.

Swift Observatory Status