

Briefing to Quality Leadership Forum

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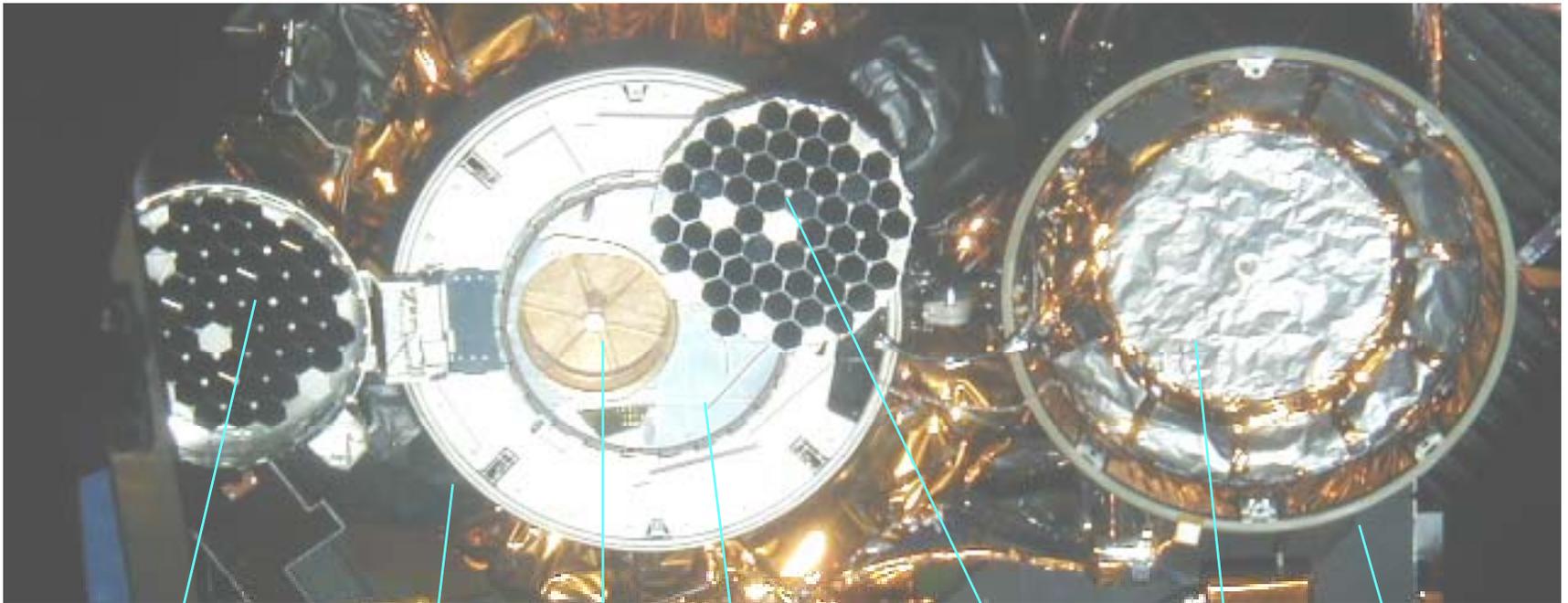
Mike Ryschkewitsch – NASA MIB

December 14, 2005

Topics

- What Happened
- Technical Findings
- Safety and Contingency Findings

Science Configuration (Thermal Vac)



**Fixed Collector Array
Inside Canister's Lid**

SRC Heat Shield

Concentrator

**Canister
Body**

**Stack of Four
Deployable
Collector Arrays**

**Fixed Foil Solar
Wind Collector**

SRC Back Shell

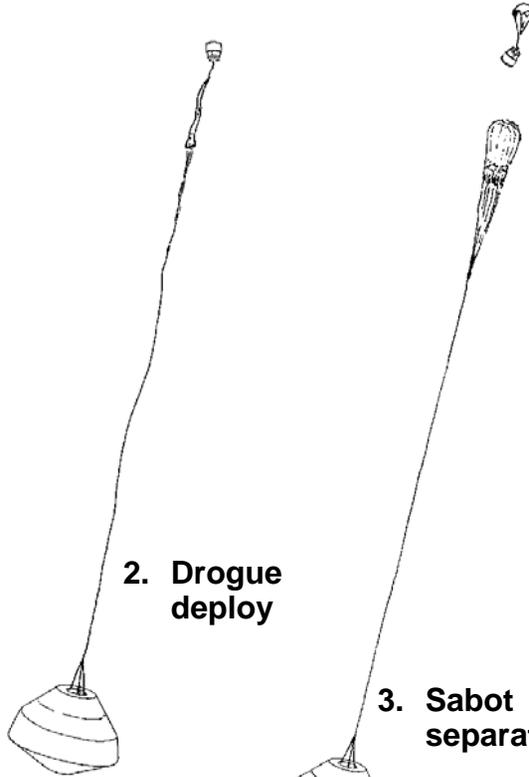
Drogue Sequence

Did
Not
Occur

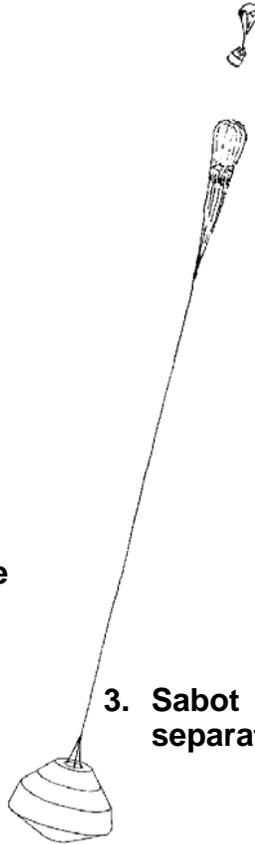
1. Mortar fire



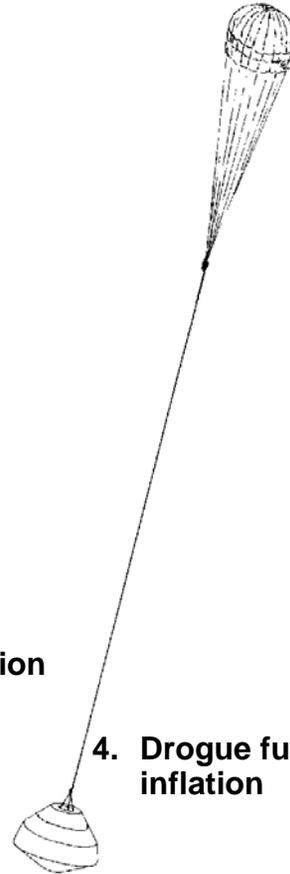
2. Drogue deploy



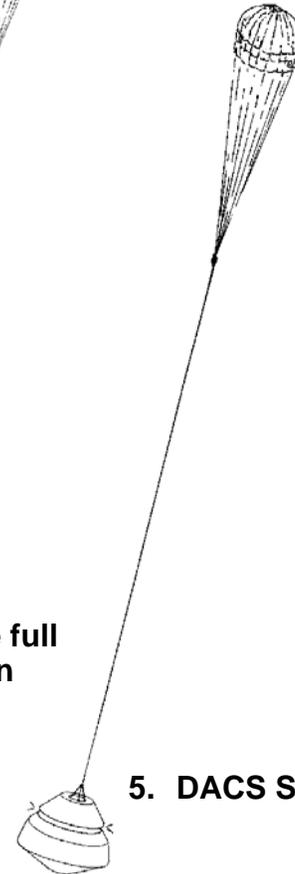
3. Sabot separation



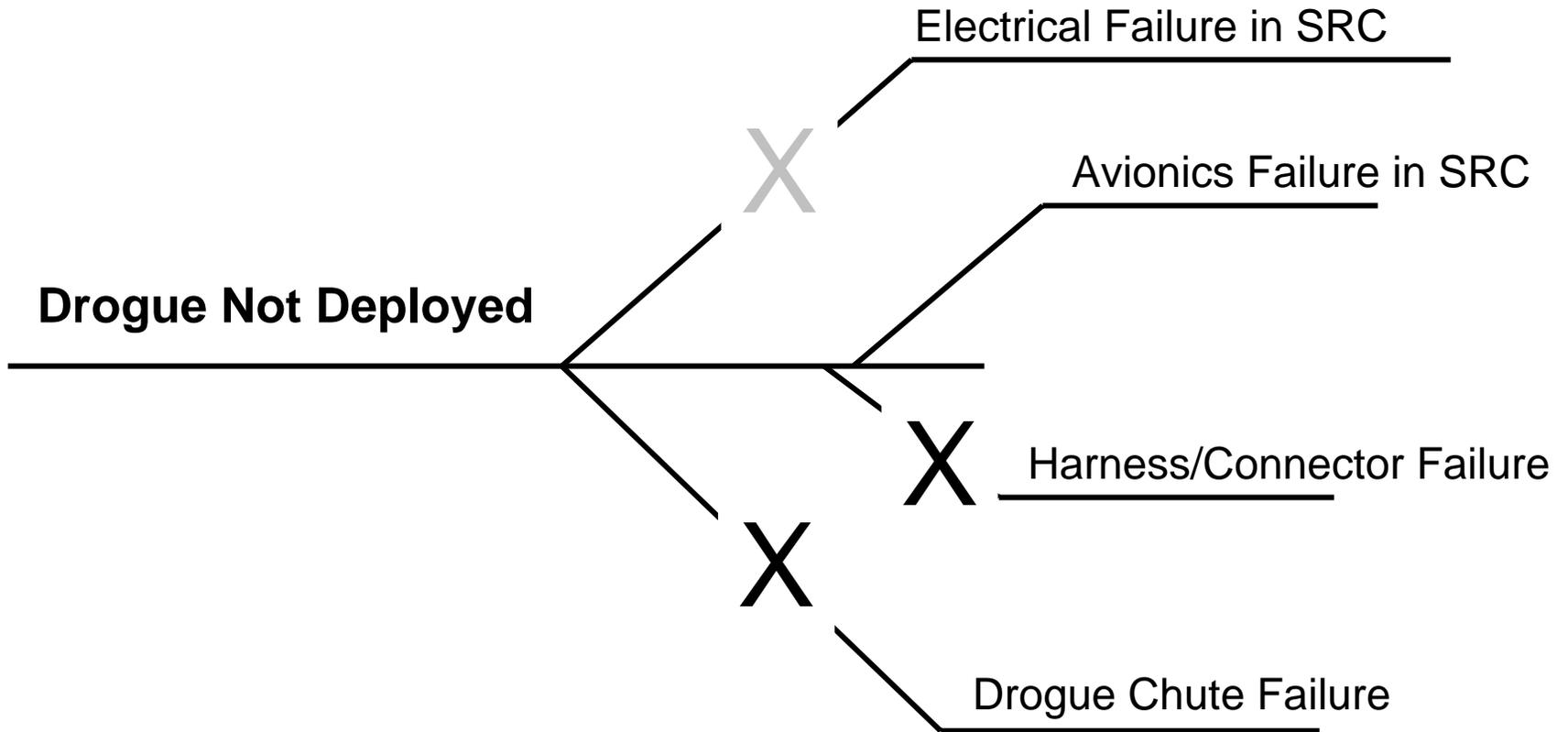
4. Drogue full inflation



5. DACS Separation



Fault Tree Status



Technical Findings

Overarching Findings

- Battery
 - Sufficient Energy Available
 - Met all predictions
- Thermal Protection System
 - Performed as required
- Navigation
 - Performed as required
 - Angle of Attack, Landing Ellipse as predicted

Technical Findings Topic Areas

- System Engineering
- Project Management
- Heritage
- Test as you Fly
- Red Team Reviews
 - Changes since last review
 - First Use Items

System Engineering

- **Ensure JPL is involved in all System Verification**
 - Audit of process/people
 - Audit of analysis into level 4 or 5 verification
 - System Team signature approval on subsystem test plans – to card level
 - Verification test walkthrough/reconstruction to Flight Readiness
 - **Insight/Oversight**
- **Assign Mission Mode Principle System Engineer**
 - Report on Success Tree for Mission Critical Events
- **Develop and Perform Incompressible Test List**
 - Phasing Tests
 - Including non AACS orientation or polarity sensitive hardware
 - How robust is safe-hold
 - What liens against safe hold operation
- **Use a Common Risk Management approach across Project**

Project Management

- Require JPL Project Managers to institute a formal process for systems engineering
 - Checks and Balances
 - Insight. Oversight
- Change the fee structure to reward cost and project management performance.

Red Team Reviews

- Hold a project Independent Readiness Review
 - Headed by Project Systems Engineering Team/Chief Engineer
- Considerations
 - Depth of Review
 - Continuity of Review Boards
 - Qualifications of Review Board Members and Chairs

Heritage Items

- Ensure that heritage hardware goes through the same strenuous verification and review process as new designs
 - List all heritage items
 - Show completion of verification by test
 - Demonstrate independent certification when verified by analysis/inspection

Test as you Fly Exceptions

- Develop a comprehensive Test As You Fly exception list and present it at each major review
 - List **ALL** Test as You Fly Exceptions
 - In depth review of Flight System Readiness
 - Demonstrate readiness of those items not tested in flight configuration

Recovery, Ground Safety and Communications Team

Focused on personnel safety,
contingency planning and
communication issues

Contingency and Safety Planning - Finding 1

- Inadequate resources to properly prepare for the event
 - Need to support large numbers of reviews and resulting actions stretched thin the limited workforce
 - Limited resources and associated late deliveries resulted in failure to ensure compliance between multiple contingency documents
 - Limited resources resulted in inadequate coordinated PPE Training
- Recommendations
 - The JPL Flight Project Practices (JPL Rules! Document ID 58032) document should be updated to identify adequate funding and schedule margin requirements late in the mission time frame necessary to ensure mission success for late mission critical activities. (This requirement is especially true of sample return and surface operations missions that are only now becoming a significant part of JPL mission work).

Contingency and Safety Planning - Finding 2

- Insufficient leadership attention to the details
 - Chain of Command for various contingencies was inadequately elaborated and explained.
 - Safety first was not an adequate part of the project leadership approach
- Recommendation
 - **Require Safety plans for sample return** (earth recovery) missions to be approved and signed-off by the cognizant “Directors for” , for both the Safety organization and for the doing project’s Directorate.
 - Further, project management chain of command during contingencies must be clearly identified in an appropriate Project level document.
 - Finally, all Category A risks (i.e., Project Flight Rules with severe mission success impact) must follow JPL’s Flight Project’ Practices document requiring Project Manager signature approval.

Contingency and Safety Planning – Finding 3

- Inconsistent contingency planning and preparation
 - Late Contingency Reviews and subsequent Plan Development/Rework resulted in Multiple Contingency Plans with No Singular Source
 - Recommendation
 - Provide project management training to ensure necessary attention is given Contingency Plans. A section on safety and contingency planning at the Project Manager's Workshop is recommended.
 - A single overarching Contingency Plan (or binder) at the project level should be required for all missions. This document should define the requirements for all other project sub-elements. These contingency requirements should include the identification of required tests and training activities, ORTs, etc

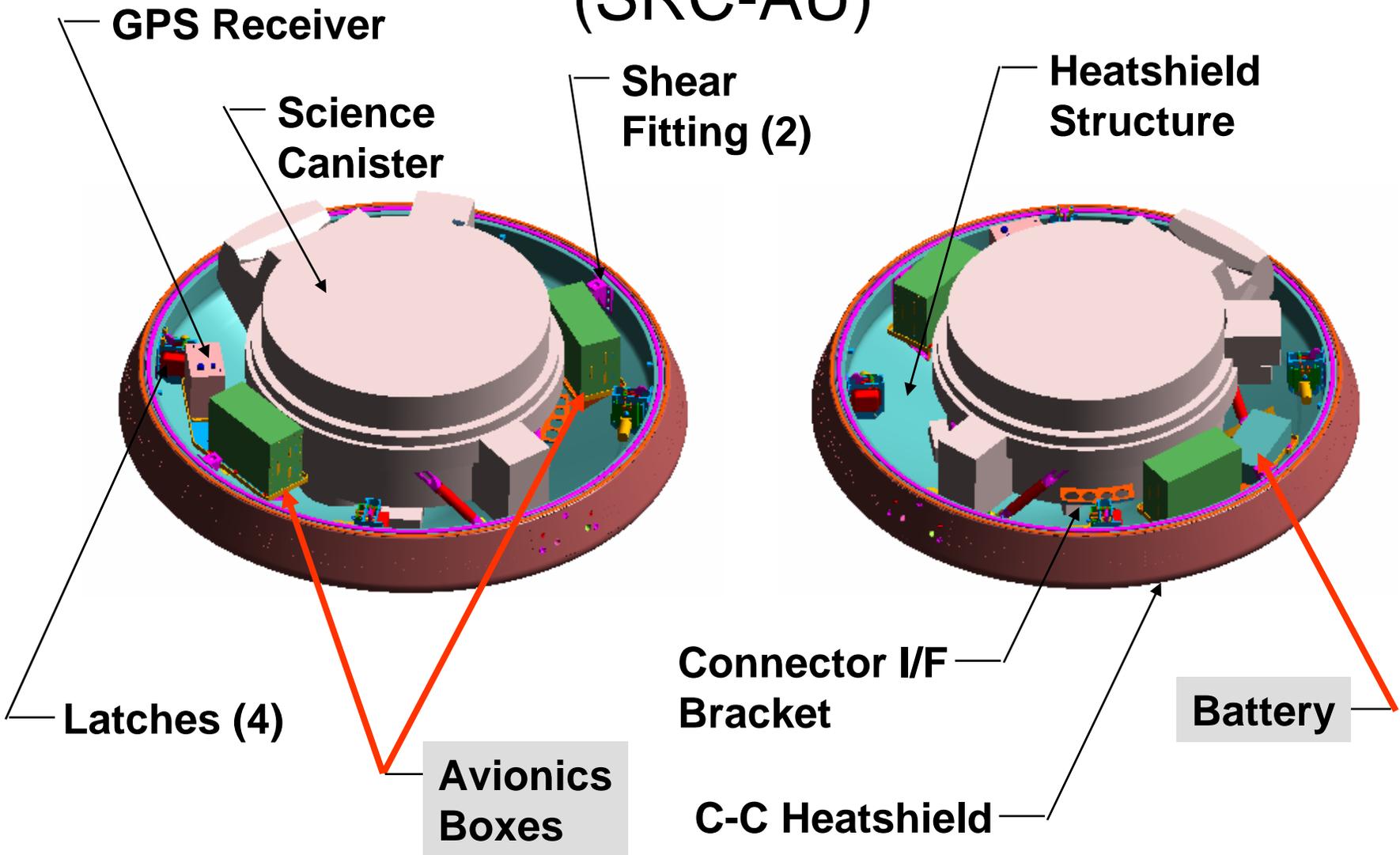
Contingency and Safety Planning - Finding 4

- Poor On-Site communications
 - Personnel on the scene were not equipped with proper communications capabilities; consequently intentions were confused and conflicting
 - Recommendations
 - Clearly identify requirements for recovery type missions to ensue effective communicators between the Project Manager and the onsite personal as well as among on-site

Backup

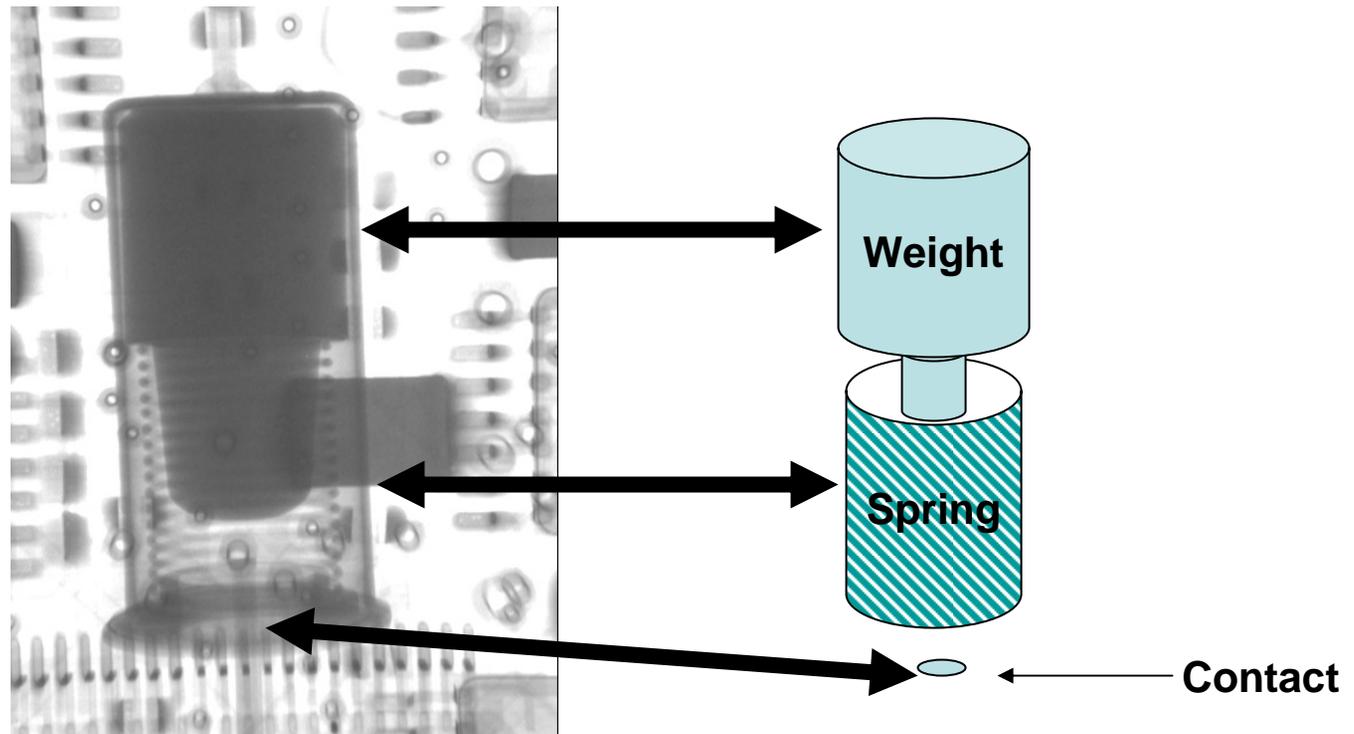
Details of Mishap

Sample Return Capsule – Avionics Unit (SRC-AU)

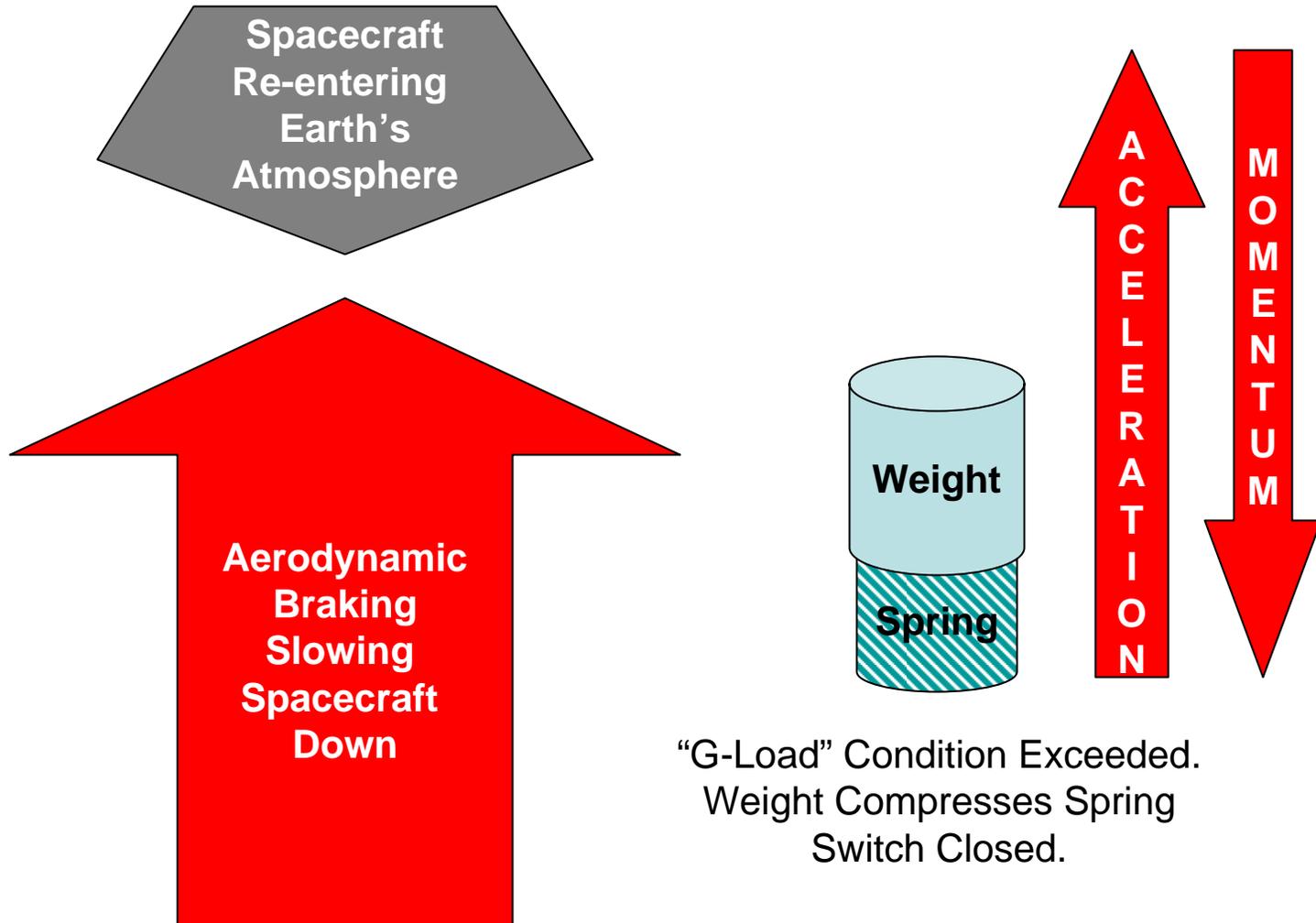


How Does the G-Switch Work?

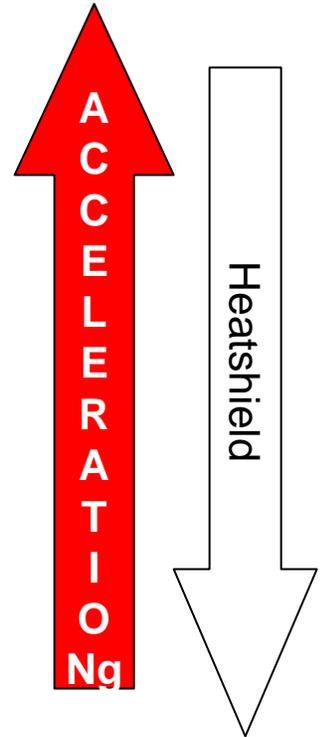
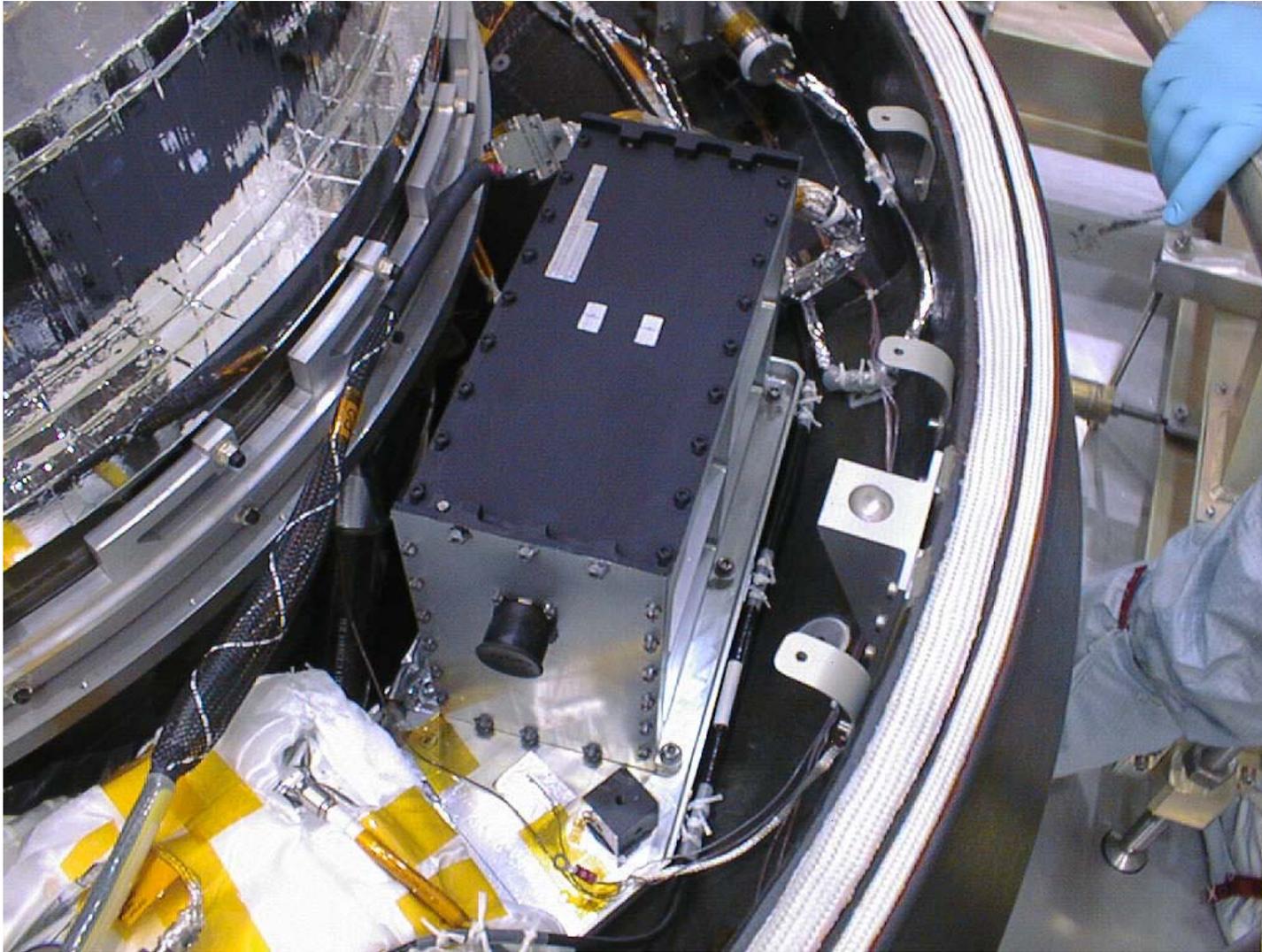
Exploded view of inside of G-Switch



How Does the G-Switch Work?



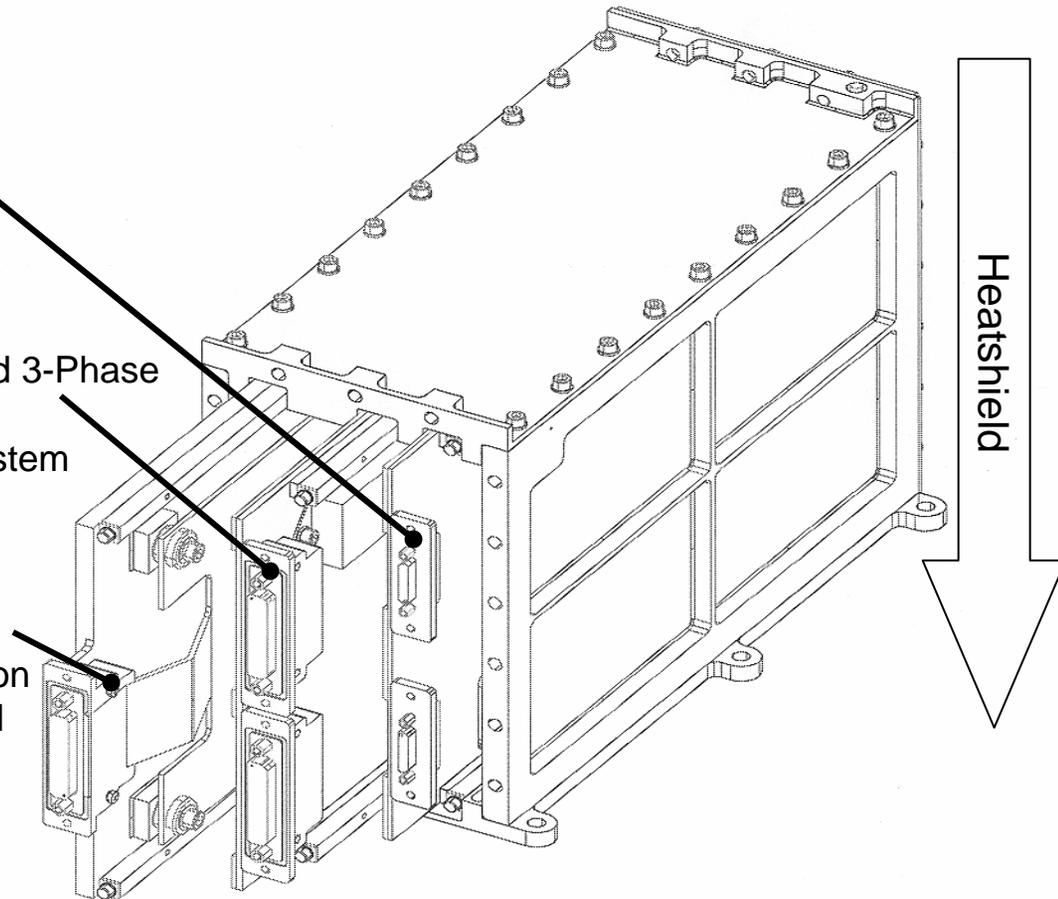
Genesis AU Installed in SRC



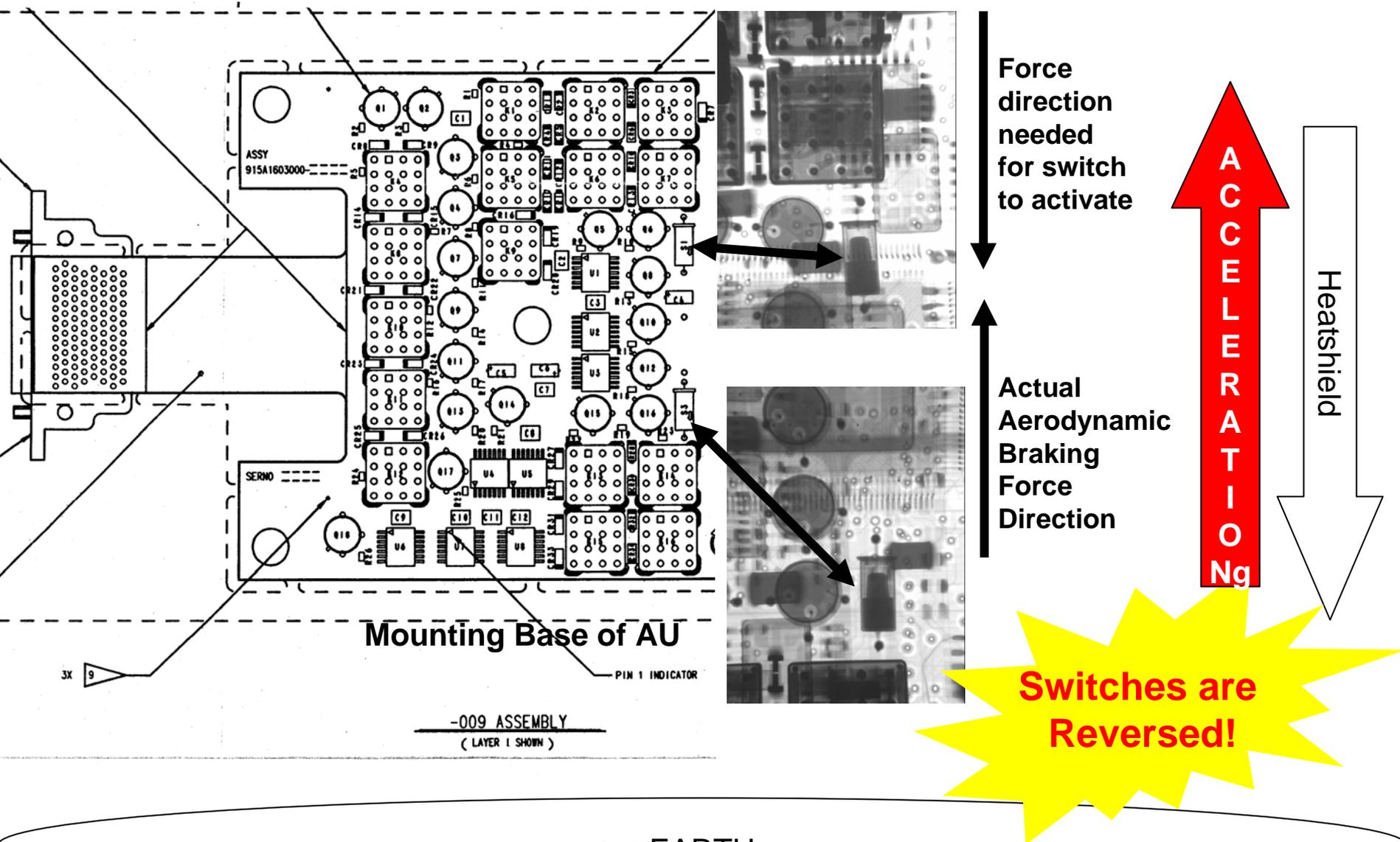
Genesis Avionics Unit

Major Components

- Event Sequence Timer (EST)
 - Provides timing for SRC reentry
 - Provides NSI firing commands
- Motor Drive Electronics (MDE)
 - Provides motor commands for EC and 3-Phase motors
 - Provides Telemetry from SRC Subsystem
- Relay Module
 - Provides Multiplexing to motor drives
 - Provides for SRC Battery Depassivation
 - **G-Switches Mounted On This Board**



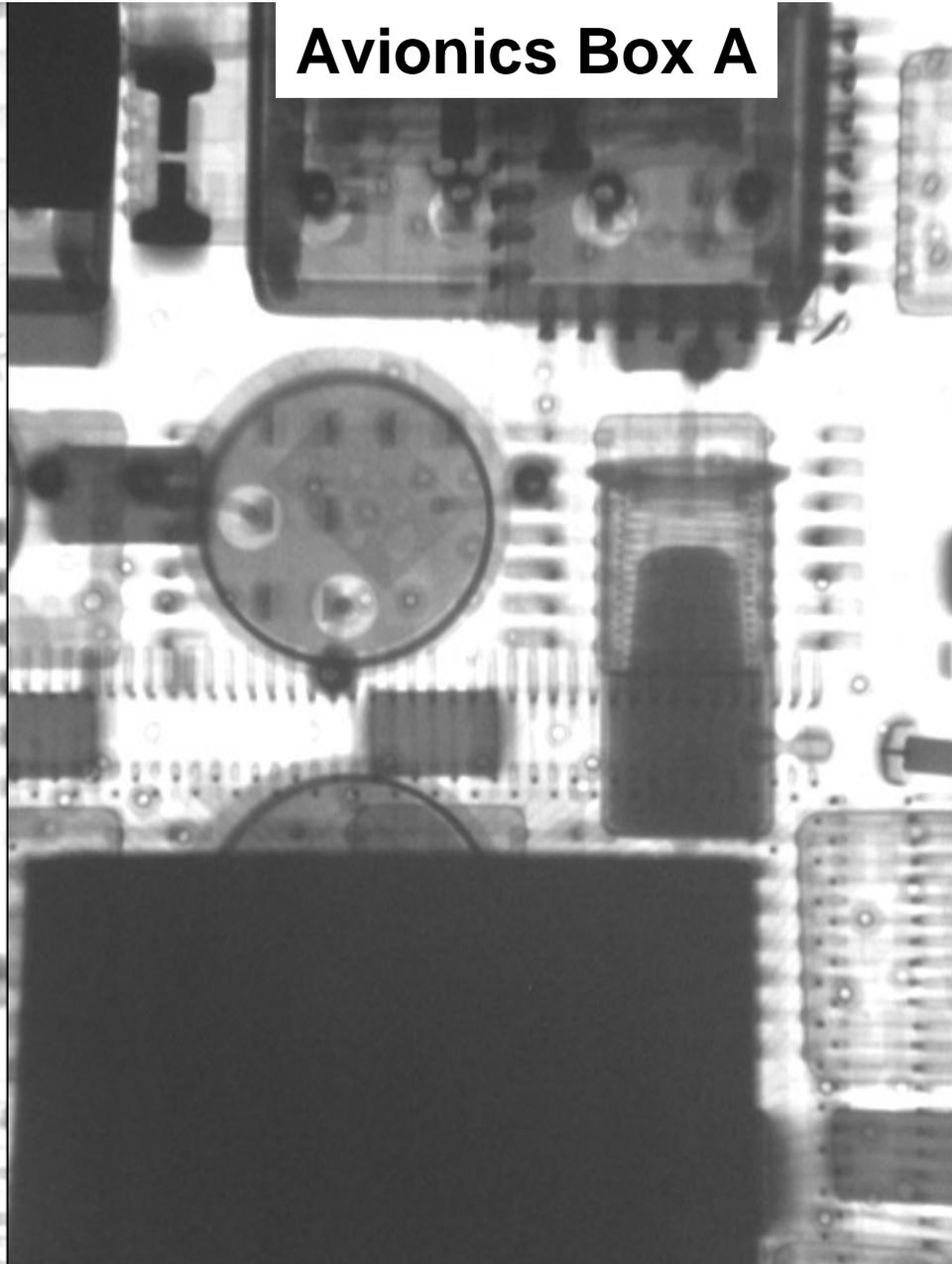
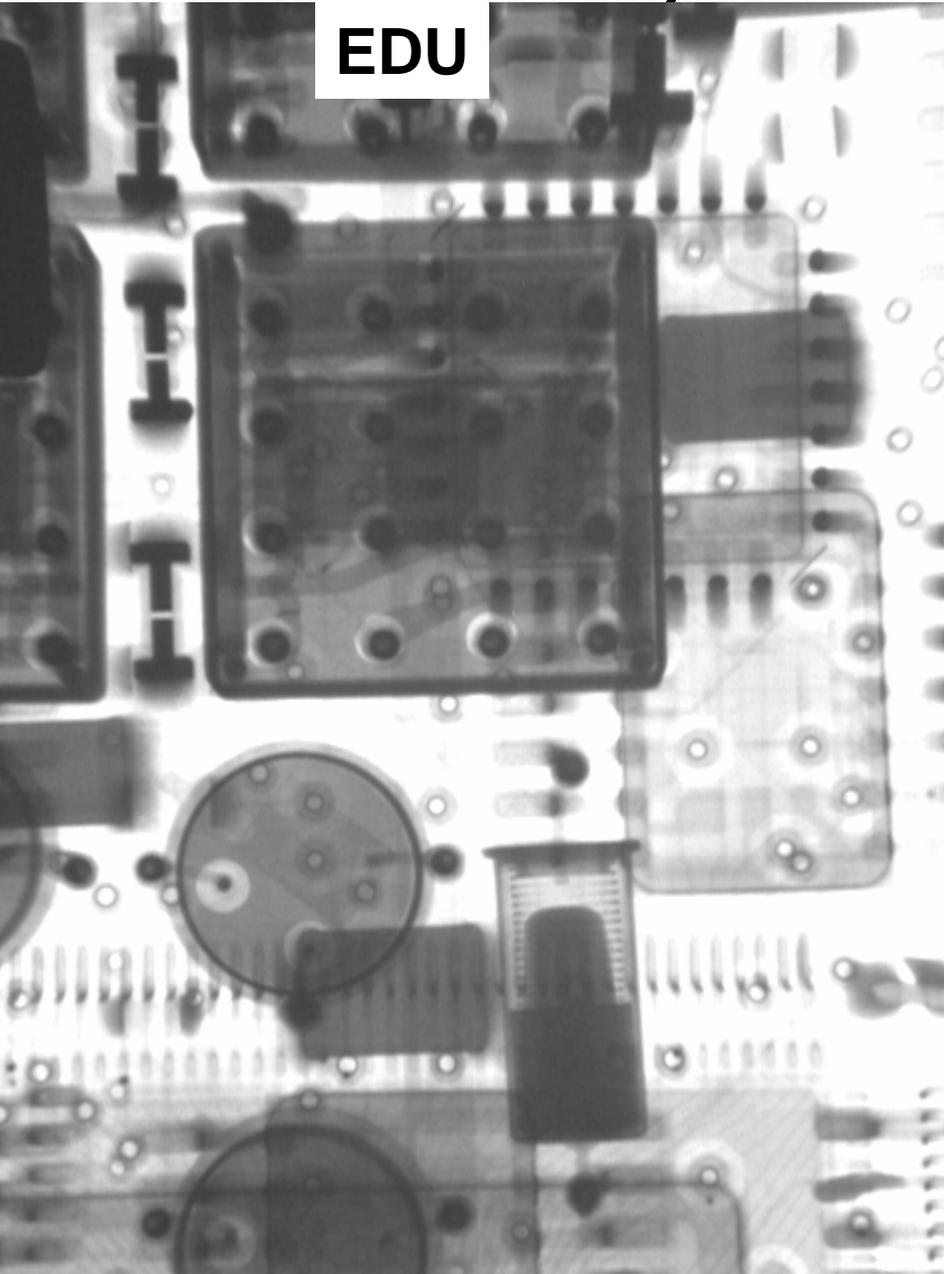
G-Switch Orientation



X-Rays of G-Switches

EDU

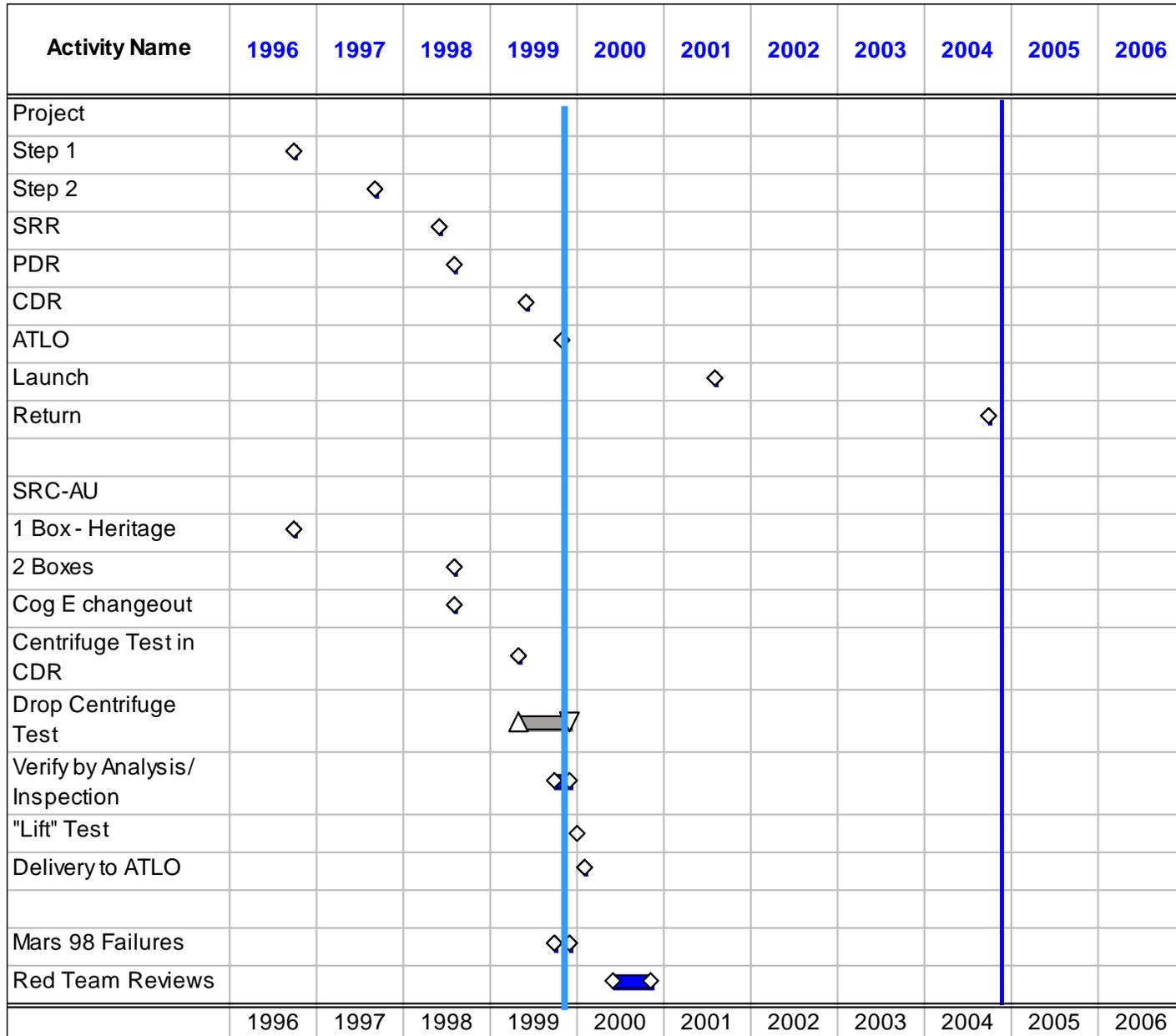
Avionics Box A



How was this not caught?

- Very limited System Engineering Team
- Critical SRC-AU functionality impacting level 1 requirements was key focus during development
- Cog E change out at critical time
- SRC-AU delivery late
- Decision to verify by analysis/ inspection
 - Delete centrifuge test
 - Perceived to be expensive, time-consuming test
- Continuity Test Performed
- Delivered to ATLO
- No system level test to verify switch orientation

Genesis Timeline



Other Items

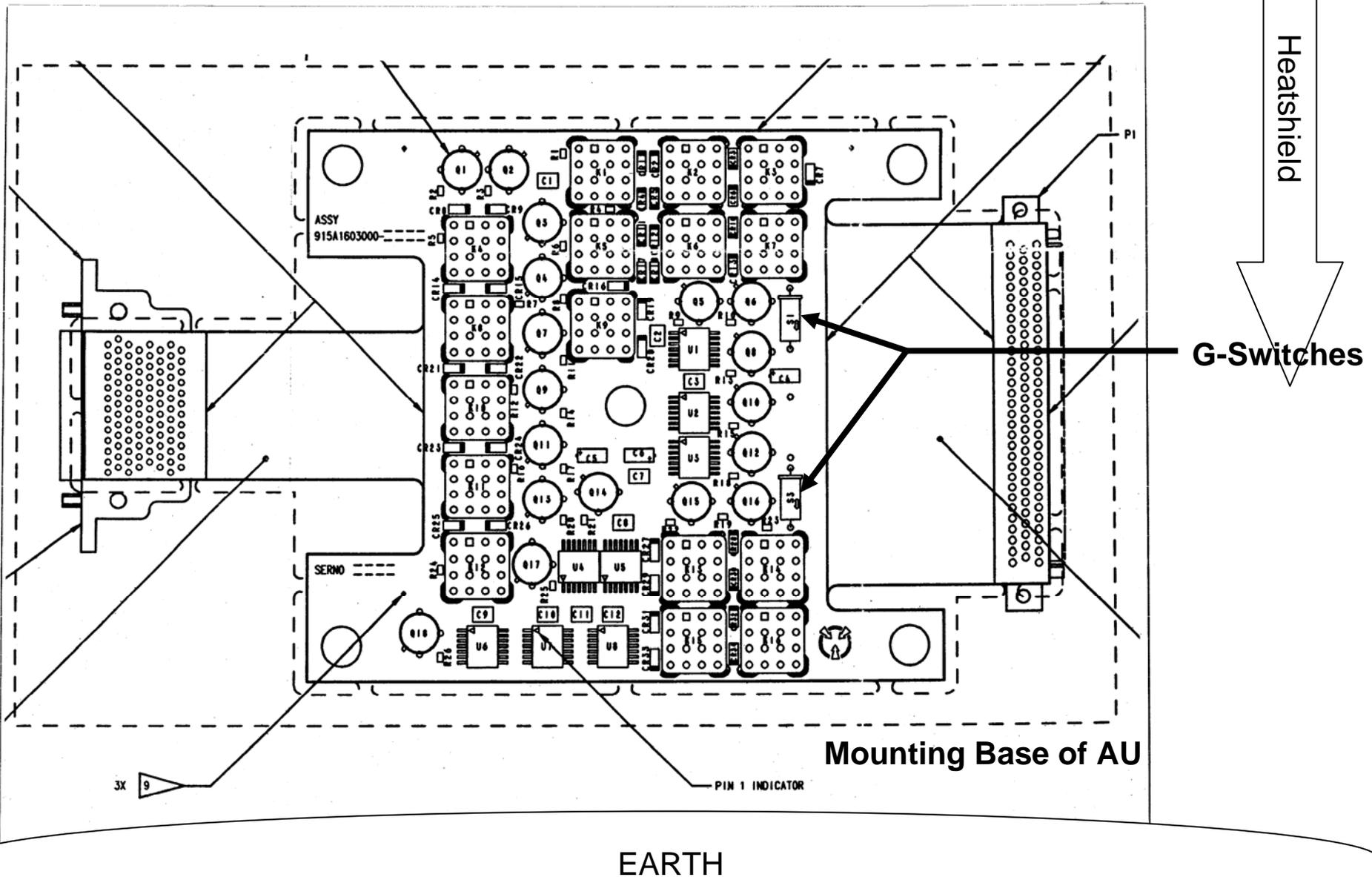
Changes since last review

- Clearly state changes since last review
- Verification of change completion
- Liens against change completion

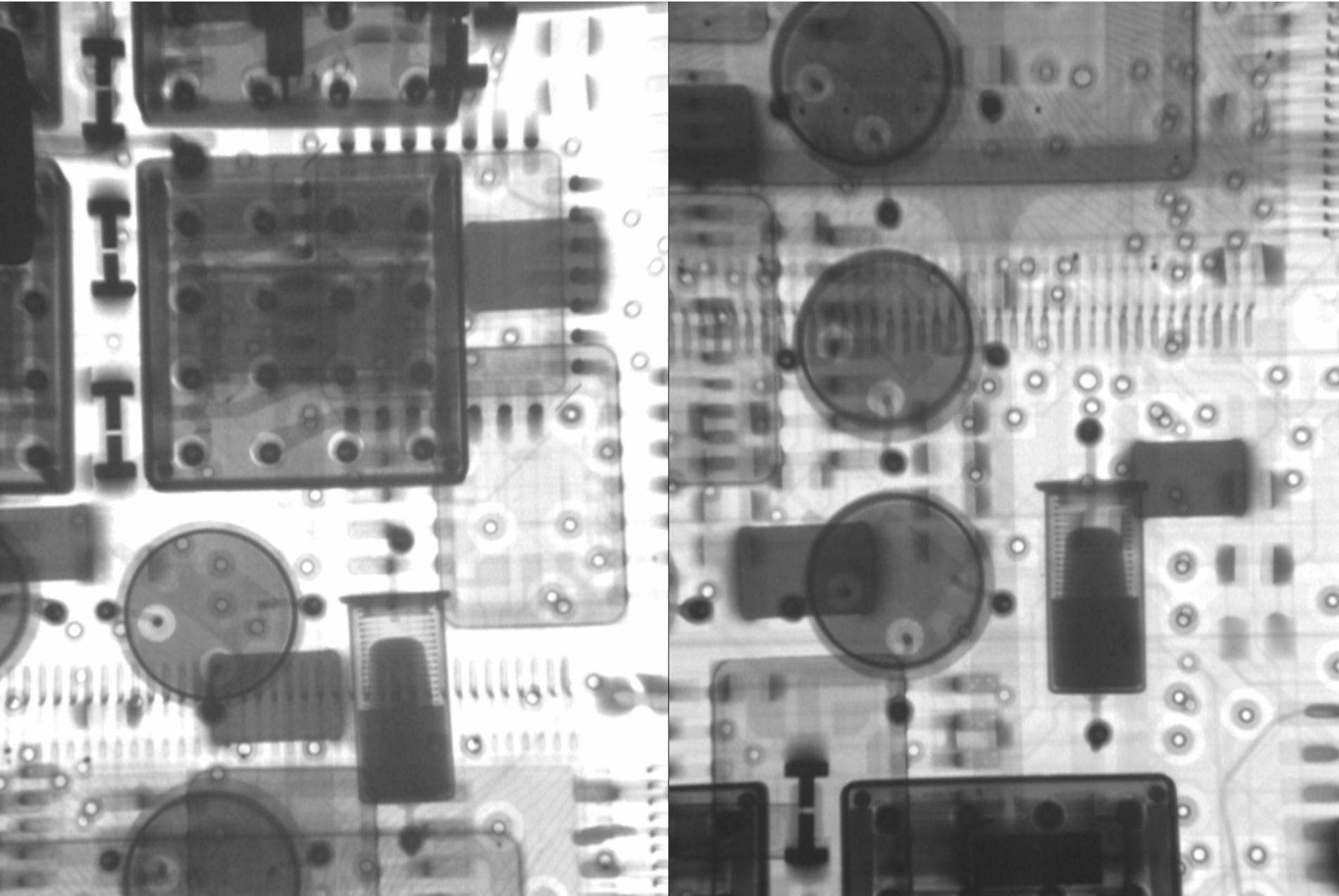
First Use Items

- State all first use items

Genesis SRC AU Relay Card with G-Switches



EDU AU X-Rays of G-Switches



Three Generations of FBC have refined FBC S/C

