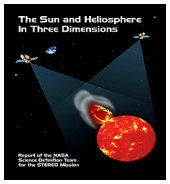
# STEREO MCRR

# Systems Review Office Report

**Richard Ho**

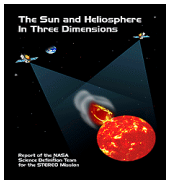
**March 2002**




# Technical Assessment Summary


**STEREO** **SRO**

- **Successfully Completed Instrument PDRs and Observatory PDR**
- **Level 1 and Minimum Mission Success Criteria Defined, Further Refinement and Flowdown in Progress**
- **Technical Baseline in Place; Spacecraft and Instrument System Designs at PDR Level Of maturity**
- **Substantial Subsystem And Component Design Heritage for Spacecraft and Instruments**
- **Issues and Risks Identified; No Significant Impact To Technical Baseline**
- **Challenges Ahead; Staffing and Processes In Place**




# Review Process Summary (1)

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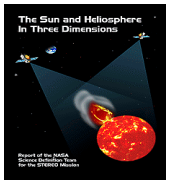
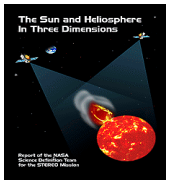
- **The STEREO Instrument PDRs Were Held:**
  - **IMPACT September 11-13, 2001 at APL**
  - **SWAVES September 14, 2001 at APL**
  - **PLASTIC September 25, 2001 at GSFC**
  - **SECCHI September 26-28, 2001 at NRL**
- **Instrument PDR Review Teams**
  - **Chaired by Richard Ho with GSFC AETD and Flight Projects team members**
  - **Supplemented with external members: Ken Sizemore (IRT member), Steve Battel, Michael Bay, Ed Devine, Casey DeKramer, John Mangus, Barry Mauk (APL), Rob Gold (APL)**
- **STEREO Observatory PDR Was Held on December 3-6, 2001 at APL**
- **STEREO Observatory PDR Review Team**
  - **Co-Chaired by Richard Ho (GSFC Code 301) and Bill Taylor (HQ IRT)**
  - **IRT Deputy Co-Chair Todd Denkins (HQ IPAO, LaRC)**
  - **GSFC AETD and Flight Projects team members**
  - **external independent team members, Aerospace and IPAO, LaRC**




# Review Process Summary (2)



- **STEREO Confirmation Assessment Review Was Held On December 7, 2001 at APL**
  - **Chaired by Bill Taylor, with HQ IRT**
  - **Participation By Richard Ho, GSFC Code 301**
- **GSFC Review Team to Provide Comprehensive Technical Assessment, System to Subsystem Level Disciplines**
- **HQ IRT to Provide System Level Technical Assessment, with Risk Areas Emphasis**
- **HQ IRT to Provide Project Management, Programmatics, Cost, and Schedule Assessment**
- **GSFC RAO To Provide Parametric Cost and Schedule Assessment**




# Instrument PDR Results Summary (1)

STEREO

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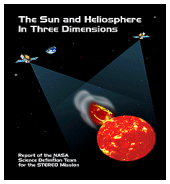
- **Instrument PDR Requests For Actions:**
  - **IMPACT 29 RFAs**
  - **SWAVES 8 RFAs**
  - **PLASTICS 17 RFAs**
  - **SECCHI 42 RFAs**
- **Instrument Components and Subsystems Have Substantial Heritage**
- **Instrument Designs are At PDR Level**
- **Instrument Teams Are Experienced and Knowledgeable**
- **Due To Instrument PDRs Before Observatory PDR, Lacking in Clear and Coherent Definition and Flow-down of Critical Mission Requirements To Instrument Level**
  - **Level 1 Science Requirement Flow-down (Resolved at Observatory PDR)**
  - **Minimum Science Requirement Flow-down (Resolved at Observatory PDR)**
  - **System Level Reliability Assessment Calculated To Subsystem level (Resolved at Observatory PDR)**
  - **EMI/EMC Requirements Flowdown (Resolved at Observatory PDR)**




# Instrument PDR Results Summary (2)

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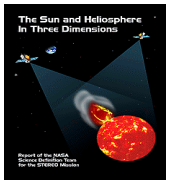
- **Instrument Issues & Risks**
  - **Single String Architecture**
  - **SECCHI Low Mass and Negative Power Reserves (resolved)**
  - **ASIC Development Efforts Have Limited Schedule Reserves (resolved)**
  - **Multi-Organizational Support Required For Flight Software Development Efforts For IMPACT, PLASTIC, and SECCHI**
  - **SWAVES Has Stringent EMI/EMC Requirements (Staff and processes in place to meet this challenge)**
  - **SECCHI Has Very Stringent Contamination Requirements (Staff and processes in place to meet this challenge)**
  - **Engineering Test Unit Development and Testing Need Better Definition (resolved)**
  - **Challenges Of the Management, Coordination and Responsibility Flow For This Multi-National and Multi-Organizational Mission Effort (Staff and process in place to meet this challenge)**




# Observatory PDR Results Summary (1)

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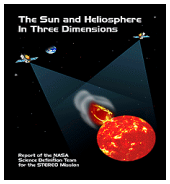
- 62 Requests For Actions Were Generated
- APL Has Established a Solid Technical Baseline For The Observatory
- Observatory Design Has Reached Preliminary Design Level Of Maturity
- Substantial Technical Progress Toward Addressing Issues That Were Raised at Instrument PDRs
  - SECCHI Mass & Power Problems Resolved
  - Full Science and Minimum Science Requirements Established
  - Credible System Level Probabilistic Assessment Has Been Performed For Full and Minimum Science
  - Demonstrated system level flowdown of EMI/EMC requirements
  - Demonstrated system level flowdown of Contamination Control requirements




# PDR Results Summary (2)

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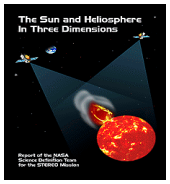
- **Observatory Issues & Risks**
  - **Spacecraft Reliability**
  - **Operational Design Robustness**
  - **System Level Deployment Of Mechanisms Not Yet Defined**
  - **Flight Software behind in design maturity**
  - **Selection & Procurement Of Critical Spacecraft Mechanisms (A/B separation) and Propulsion Tanks not yet finalized**
  - **Various Aspects Of Contamination Design & Control Considerations**
  - **Spacecraft charge buildup**
  - **Three months of schedule contingency appears very limited**




# Issues/Recommendations (1)

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1. **Spacecraft Reliability**

**Issue: Spacecraft has selected redundancy. Reliability in certain critical functions should be further evaluated.**

**Recommendations:**

**a) Further flowdown of reliability analysis, FMEA, fault tree analysis, to evaluate weak design links.**

**b) Evaluate recommended redundancies and improvements:**

- **Redundancy for A/B spacecraft separation**
- **Redundancy for C&DH and ACS processors**
- **Redundancy for integrated electronics module power supplies**

**c) Conduct peer review**

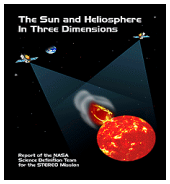
2. **Single String Instrument Design Architectures**

**Issues: Centrally distributed data and power sources susceptible to single point failures and failure propagation, which may render entire instrument suites useless.**

**Recommendation:**

**a) Further Flowdown of reliability analysis, FMEA, fault tree analysis, to evaluate weak design links.**

**b) Evaluate and incorporate selected redundancies and failure isolation designs.**

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# Issues/Recommendations (2)

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3. **Operational Design Robustness**

**Issue: Operational design subject to undesirable consequences in case of failure: thruster firing in the blind; lack of communications during LV/observatory separation, deployment and spacecraft separation sequences, instrument turn off in safemode regardless of power condition.**

**Recommendations:**

**a) Avoid thruster firings in the blind**

**b) Acquire communication for launch and early separation and deployment sequences**

**c) Turn off instruments only in power critical situations**

**d) Conduct operational design peer review**

4. **Mechanisms Deployment**

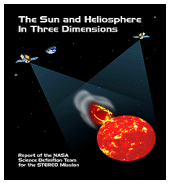
**Issue: Numerous spacecraft and instrument mechanisms must be successfully deployed to meet mission objectives: A/B spacecraft separation, solar array, IMPACT boom, SWAVES antennas**

**Recommendations:**

**a) Perform FMEA, fault tree analysis**

**b) System level deployment testing**

**c) Conduct mechanisms peer review**




# Issues/Recommendations (3)

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5. **Flight Software**

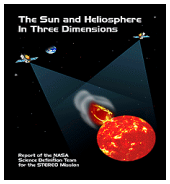
**Issues: a) Flight software design not at PDR level (except SWAVES); b) Multi-organizational involvement for IMPACT, PLASTIC, and SECCHI flight software efforts.**

**Recommendations:**

**a) Conduct flight software PDR/peer review when ready**

**b) Clear definition of requirements, ICDs and responsibility flow**

**c) Develop robust test beds for risk mitigation.**

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# Conclusions (1)

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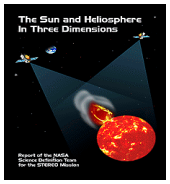
- **Full and Minimum Mission Success Criteria Defined, Further Refinement and Flowdown in Progress**
- **Technical Baseline in Place; Spacecraft and Instrument System Designs at PDR Level Of maturity**
- **Substantial Subsystem And Component Design Heritage for Spacecraft and Instruments; Technical Challenges Ahead; Low to Medium Risks**
- **Established Integrated Independent Review Plan; Review Teams Defined; Established Systems Review, Instrument Review, Peer Review Schedule**
- **Experienced Project, Mission Integrator and Instrument Teams**
- **Project, Mission Integrator,and Instrument Team Roles and Responsibilities Appear to Be Well Defined**
- **Data and Configuration Management Process Appears Adequate**
- **Requirement Management Process Appears Adequate**
- **Risk Management Process Appears Adequate**
- **Flight Software IV&V Assessment In Progress; Adequate Funding Allotted**

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# Conclusions (2)

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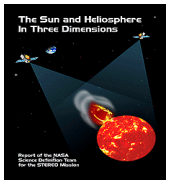
- **ISO Audit Completed; NO Significant Negative Finding (Need To check)**
- **IRT and RAO Schedule Assessment Completed**
- **IRT and RAO Cost Assessment Completed**
- **Project Ready For Implementation**

# BACK-UPS

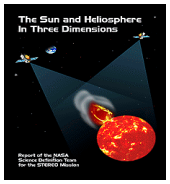



# Instrument Review Team Members

STEREO

SRO

- Richard Ho GSFC/301
- Tom Venator GSFC/470
- Mitchell Davis GSFC/565
- Bill Mocarsky GSFC/566
- Jack Shue GSFC/563
- Amri Hernandez-Pellerano /563
- Art Ruitberg GSFC/563
- Dennis Hewitt GSFC/545
- Rob Chalmers GSFC/545
- Daniel Nguyen GSFC/545
- Peter Shu GSFC/553
- Harry Shaw GSFC/562
- Larry Ryan GSFC/663
- Raymond Whitley GSFC/582
- Stan Hunter GSFC/661
- Roger Thomas GSFC/682
- Ed Wollack GSFC/685
- Barry Mauk APL
- Rob Gold APL
- Ken Sizemore Independent
- Steve Battel Battel Eng'g
- Michael Bay J&T
- Ed Devine Swales
- Casey DeKramer Swales
- Victor Sank QSS
- John Mangus Bart & Asso



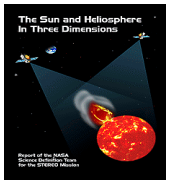

# Observatory Review Team Members

STEREO

- Richard Ho GSFC/301
- Mike Femiano GSFC/571
- Tom Venator GSFC/470
- Bill Mocarsky GSFC/566
- Vickie Moran GSFC/428
- Darrell Zimbelman GSFC/530
- Dennis Hewitt GSFC/545
- Scott Glubke GSFC/574
- Paul Ondrus GSFC/428
- Robert Gold APL
- Michael Bay J&T
- Victor Sank QSS

SRO

- Bill Taylor Independent
- Bill Bangs Swales
- Jean Olivier Independent
- Ken Sizemore Independent
- Richard Briet Aerospace
- Dave Glackin Aerospace
- Jim Clemmons Aerospace
- Todd Denkins LaRC
- Yvonne Dellapenta LaRC
- Ted Hammer LaRC
- Chris Chromik LaRC



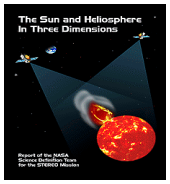

# IMPACT RFA List

**STEREO**

| | |
|---|---|
| 1 | C&T EGSE Software |
| 2 | Software Development Plan |
| 3 | FSW Review Schedule |
| 4 | Boom Un-locked |
| 5 | Minimum Science Requirements |
| 6 | Boom Cold Survival Test |
| 7 | Thermal Analysis on Magnetometer |
| 8 | IDPU Thermal Analysis |
| 9 | Stacer Deployment Mechanism |
| 10 | Boom Testing |
| 11 | VLSI Delivery |
| 12 | SIT Grounding |
| 13 | SEPT Magnetic Emissions |
| 14 | Level 1 Requirements Flowdown |
| 15 | Limiting Resistor For Boom Actuator |
| 16 | LVPS Short |
| 17 | Secondary power grounding |
| 18 | Boom Analysis & Test Plan |
| 19 | SIT Foil Breakage |
| 20 | L1 Detectors |

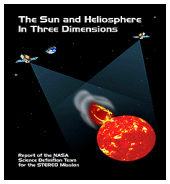
**SRO**

| | |
|---|---|
| 21 | PHA ASIC |
| 22 | SEP Software Resources |
| 23 | SEP Instrument Test Environment |
| 24 | SEP System FMEA |
| 25 | SEP Power Supply |
| 26 | Processor Margins |
| 27 | Time Tagging |
| 28 | SEP Survival Heaters |
| 29 | Glint onto SEPT Detectors |




# SWAVES RFA List

| STEREO | | SRO |
|---|---|---|
| 1 | EMI/EMC Requirements | |
| 2 | Switching Transient Measurements | |
| 3 | EMI/EMC Requirements Traceability | |
| 4 | Radiated Emissions Data | |
| 5 | SA3300 Qualification | |
| 6 | Clock Speed De-rating | |
| 7 | RAM Availability | |
| 8 | Limiting Resistor For Antenna Release Actuators | |




# PLASTIC RFA List

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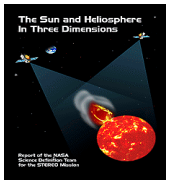
1 Qual Model Schedule
2 Parallel Channel Fault Isolation
3 HVPS Specification
4 HV Supply Issues
5 Low Voltage Converter
6 MCP Count rate
7 Solid State Detectors
8 Full Solar Wind Exposure
9 Timing Requirements
10 Strength Verification
11 Operating Temperatures of Two SC
12 ITO-Coated Silver Teflon
13 Survival Heaters
14 Improve Thermal Model Fidelity
15 HVPS Qualification Plan
16 ASIC Fabrication Cycles
17 GSE Presentation



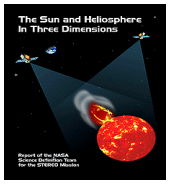

# SECCHI RFA List

**STEREO**

| | |
|---|---|
| 1 | Mass/Power Margins |
| 2 | Component Environmental Testing |
| 3 | Interface Definitions |
| 4 | Image Scheduling & time Tagging |
| 5 | HI Optics Radiation Resistant |
| 6 | Scattered Light Rejection |
| 7 | Contamination Control Managm't |
| 8 | Z306 Black paint |
| 9 | Glass/Ti Interface Stress |
| 10 | MPA Door Qualification |
| 11 | Vitron O-Ring |
| 12 | SCIP KM Qualification |
| 13 | Marconi CCD |
| 14 | CCD Meet Radiation Requirement |
| 15 | Heater Noise To CCD |
| 16 | 70 MIPS RAD 750 Processor |
| 17 | RAL ASIC |
| 18 | ASIC testing With CEB |
| 19 | SEB Thermal Accommodation |
| 20 | SEB Thermal Cycling Boundaries |
| 21 | Non- Redundant Heater |

**SRO**

| | |
|---|---|
| 22 | Component Thermal Requirements |
| 23 | Off Nominal Thermal Analysis |
| 24 | Increase Number Of T/V Cycles |
| 25 | COR1 Maturity |
| 26 | Distortion Measurement |
| 27 | Flight Software Management |
| 28 | FSW Processing Timeline |
| 29 | SCIP EMI/EMC Testing |
| 30 | Alignment Following Environment |
| 31 | HI Co-Alignment Requirements |
| 32 | COR1 Temperature Predictions |
| 33 | EUVI Contamination |
| 34 | ITO Silver Teflon |
| 35 | Single String Reliability |
| 36 | EMI/EMC TIM |
| 37 | Possible EUVI Filter Damage |
| 38 | Hollow Core Motor Qual Test |
| 39 | EUVI Filter Wheel Heritage |
| 40 | SCIP Mass Properties |
| 41 | Shutter/Door Off Nominal Operations |
| 42 | CCD Heater EMI |

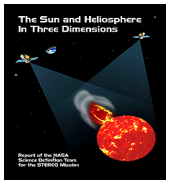



# Observatory RFA List (1)

**STEREO**

**SRO**

| | |
|---|---|
| 1 | Risk Management |
| 2 | Instrument Risks |
| 3 | Systems Engineering Management |
| 4 | Requiremts Flowdown/Compliance |
| 5 | Mission Success Criteria Flowdown |
| 6 | Software Reviews |
| 7 | Use Of lessons Learned |
| 8 | Control Of Interfaces |
| 9 | System Level Appendage Deploymt |
| 10 | “Relaxed” Contamination Control |
| 11 | SECCHI-HI Contamination |
| 12 | SECCHI On-Pad/Orbit Contaminatn |
| 13 | Electrostatic Discharge Contaminatn |
| 14 | Spacecraft Charging |
| 15 | SECCHI-HI Stray Light |
| 16 | PLASTIC FOV Accommodation |
| 17 | Mate/Demate With “Hot” Battery |
| 18 | Deployment with Ground Contact |
| 19 | Spacecraft A/B Separation |
| 20 | Safing Modes |
| 21 | Frequency Domain Analysis |
| 22 | Flexible Appendage Jitter |
| 23 | Tracker/IMU not Co-Located |
| 24 | Structural Alignment |
| 25 | Spacecraft Spin Rate |
| 26 | Modal Test |
| 27 | Single Thruster Firing |
| 28 | Thruster Failure Isolation |
| 29 | DSS To Decoder A/B |
| 30 | DSAD as Backup To Tracker |
| 31 | Revisit 5 lb Thruster |
| 32 | Inverted Tank |
| 33 | Propulsion System Electronics |
| 34 | Mechanisms not Selected |
| 35 | Power/Thermal Book Keeping |
| 36 | Power Margin with BOL Heater #s |
| 37 | Flight Software PDR |
| 38 | IEM Power Supply |
| 39 | Chassis Shunt |
| 40 | SA Cell Side Out |




# Observatory RFA List (2)

**STEREO**

| | |
|---|---|
| **41** | **Instrument C&T backup at MOC** |
| **42** | **Science Data Products** |
| **43** | **Higher Downlink Rates** |
| **44** | **Phasing Plan** |
| **45** | **Distances From the Sun For Analyss** |
| **46** | **Antenna Switch** |
| **47** | **SWAVES Boom Induced Contamint** |
| **48** | **Frame Error Rate** |
| **49** | **Command Anomaly Tracking** |
| **50** | **Hydorcarbon Contamination** |
| **51** | **Water Test for Propulsion System** |
| **52** | **Battery Heater Sizing** |
| **53** | **Clamp band on B Spacecraft** |
| **54** | **MLI Installation Techniques** |
| **55** | **Glint Into Star Tracker** |
| **56** | **Redundant Thermostats** |
| **57** | **Flight/I&T Battery** |
| **58** | **Mission Operations Peer Review** |
| **59** | **Data Downlink Requirements Consistency** |
| **60** | **HI-1 backup For Star Tracker** |

**SRO**

| | |
|---|---|
| **61** | **Mission Operations Staffing** |
| **62** | **Thermal Design Rationales** |