# SRWG Agenda - NSROC

| Topic | Presenter | |
|---|---|---|
| **Agenda** | | **Cutler** |
| **Contract Status** | | |
| **Mission Successes** | | |
| **NSROC Report Card (Self Assessment)** | | **Krause** |
| **S19-D RTF Activities** | | |
| **Another Generation NSROC Vehicle** | | |
| **Mission Scheduling** | **Maddox** | |
|   Staffing | | |
| **GNC/ACS** | | **Costello** |
|   GLNMAC | | |
|   NIACS | | |
|   NMACS | | |
|   NSROC "a" | | |
|   Data Reduction | | |
| **Low Cost Telemetry System** | **Lankford** | |
| **Command Uplink** | | |
| **Solid Modeling** | | **Rosanova** |

# Contract Status



- Contract Has Been Novated to Northrop Grumman Information Technology (Technical Services – Aerospace Group)
  - Northrop Grumman Is Corporately Committed on NSROC (As Litton PRC Was)
  - The New Contract Ownership Will Be Transparent to the PI Community
- The Increased Launch Schedule Is Managed Within the Existing Budget (for Now)
- First Option Period (Feb ’03 – Jan ’06) Has Been Exercised

# Mission Success

NSROC

- **19 Comprehensive Mission Successes for GFY '02**
  - **Vehicle Types**
    - 3 – BBV
    - 8 – Orion
    - 2 – Nike/Orion
    - 3 – Taurus/Orion
    - 7 – BB IX
    - 2 – BB XII
    - 3 – Terrier/Orion
    - 2 – Terrier/Lynx
  - **Range**
    - WFF – 3
    - PFRR – 11
    - WSMR – 5
- **18 More on the Schedule for GFY '02**

# NSROC Report Card

- No Mission Failures to Report
  - Inflight Anomaly Noted on Christensen/21.128 – Questionable PFP Boom Data & Deployment
  - Hawkins/30.047 Student Mission – Parachute Deployed Early (Student Design)

- NSROC Has Maintained a Successful Launch Schedule While Incorporating Technical Innovation When Practical

- NSROC Staff Experience Base is Strengthening through Experience and Practice

# Launches Since Dec. 2001 SRWG

NSROC

| | | | |
|---|---|---|---|
| Kintner/40.014 | PFRR | 1/14/02 | Success |
| Kletzing/40.016 | PFRR | 2/06/02 | Success |
| Woods/36.192 | WSMR | 2/08/02 | Success |
| Christensen/21.128 | PFRR | 2/21/02 | Success |
| Larsen/33.069 | PFRR | 2/21/02 | Success |
| Larsen/33.070 | PFRR | 2/21/02 | Success |
| Lynch/30.049 | PFRR | 3/07/02 | Success |
| Lynch/30.050 | PFRR | 3/15/02 | Success |
| Lynch/30.051 | PFRR | 3/15/02 | Success |
| Lynch/30/052 | PFRR | 3/15/02 | Success |
| Hawkins/30.047 | PFRR | 3/18/02 | Success |
| Martinez/36.194 | WSMR | 4/30/02 | Success |
| Crosky/31.124 | WFF | 5/10/02 | Success |
| Crosky/31.125 | WFF | 5/16/02 | Success |
| Erdman/41.022 | WSMR | 6/05/02 | Success |
| Erdman/41.023 | WSMR | 6/05/02 | Success |
| Koehler/30.053 | WFF | 6/06/02 | Success |
| Martin/36.112 | WSMR | 6/11/02 | tbd |

# S19-D RTF Activities

- Digital S19-D Return-to-flight Progress
  - Changed the Name of DS-19 to the S19-D
  - Name Change Specifically to Eliminate Confusion About the Removal of the IIP Guidance Scheme (Full Guidance Through BB Burn, T + 44 Sec)
  - Result of the Vehicle's Capability to Fly off Range in the Event of a Hardware Failure Anytime After T+15 Sec
    - Range Requires a Full 3 Seconds Following Failure for Human Intervention Prior to Vehicle Leaving Range
    - A Hardware Failure After T + 15 Seconds Could Exit the Range Prior to a Destruct Command
  - Current Version Incorporated the New Digital Electronics With the Old Guidance Scheme ('Extended Rail' Control Loop)
  - Return-to-flight Mission Currently Slated for Judge/36.202 on 8/07/02

# Another Generation NSROC Vehicle



- The Terrier Mk.12 /Patriot Vehicle Shows Excellent Promise for Satisfying a Single Stage Black Brant VC Payload Requirements.
- Vehicle Configurations Not Limited to the Single Stage BBVC
- The Benefits of the Two Stage Terrier/Patriot Vehicle Configuration Include:
  - Broader Payload Carrying Capability
  - Less Wind Sensitivity
  - Smaller Impact Dispersions
  - $200k Per Mission Cost Savings

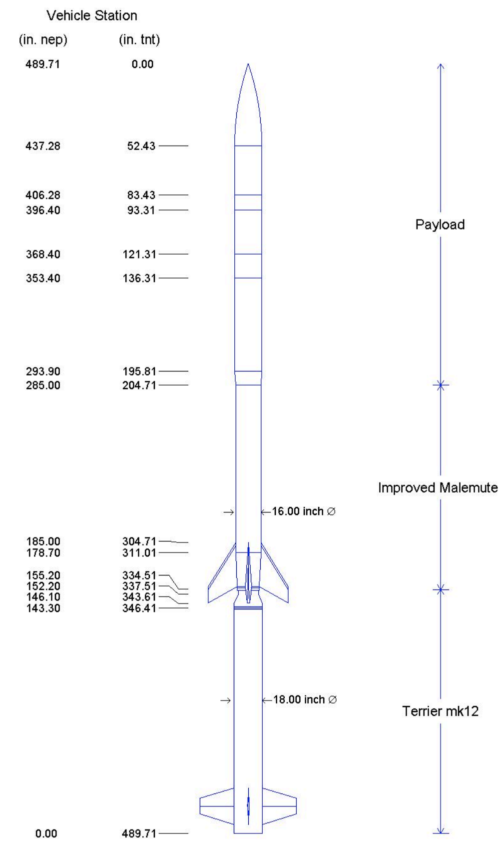



Figure 1. BBVB 21.130 Larsen, Vehicle Configuration

# Mission Scheduling

NSROC

Mission Manifest

| Fiscal Year | # of Missions |
|---|---|
| 99 | 23 (Several transition missions) |
| 00 | 16 |
| 01 | 12 |
| 02 | 37 (includes 11 FY01 PFRR Missions) |
| 03 | 30 |

FY 02 Missions That Have Slipped Launch by 1 Month or More 22/37 = 60%

Several WSMR Missions Have Multiple Launch Date Slips

- Results in Several Changes in Mission Team Assignments
- Risk Mitigated by Using Standardized Designs, Processes, and Procedures Whenever Possible

Critical PFRR Design Review slips

| | |
|---|---|
| Labelle | 36.200 |
| Larsen | 21.130 & 21.131 |
| Conde | 35.034 & 41.034 |

# Staffing

NSROC

Contract Staffing Level

| | | |
|---|---|---|
| Current | 153 | |
| Feb 1999 | 152 w/ 12 Vacant Positions | |
| Minimum/maximum | ~140/~160 | |
| Recent Hires | Past Month = 8 | Past Year = 18 |

Significant OT Currently Required to Meet Busy Launch Operation Schedules

Technical Staff Supporting Several Concurrent Missions

Technical Staff Recruitment

- Northrop Grumman and Orbital Recruitment Offices
- Summer Interns
- Student Launch Program Is Providing Talented “Fresh Out” Candidates
- Other PIs ????

# NSROC ACS Status – Jun 2002

- GLNMAC-200 Attitude Sensor
  - 2 On Hand
  - NASA Tasking Received 2/22/02
  - Work Stoppage Pending Receipt Of Sandia Data (Contractual Issues)
- ST-5000 Star tracker
  - Focus Anomaly Resolved (Mechanical Failure)
  - Pending Nordsieck Flight (Mar 2003)
- Inertial ACS (NIACS) – NASA Tasking Received 6/6/02
- Magnetic ACS (NMACS) – NASA Tasking Received 6/6/02
- NSROC(a) Significant Progress

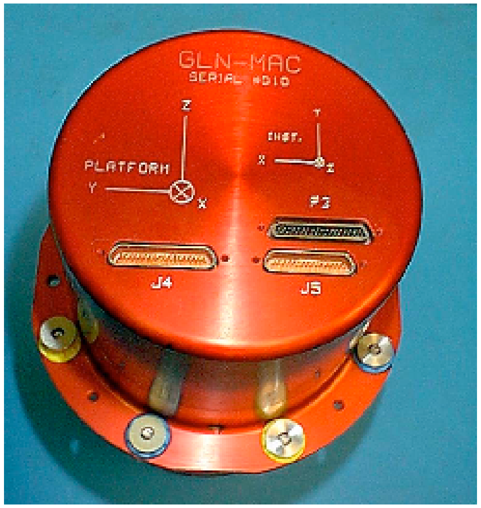
# ACS PROGRESS Dec 01- Jun 02

- Successful Flights
  - Harris 36.188 12/06/01 Aerojet Celestial
  - Kintner 40.014 01/14/02 SVC Inertial
  - Kletzing 40.016 02/06/02 SVC Magnetic
  - Woods 36.192 02/08/02 SPARCS VII Sun Pointing
  - Christensen 21.128 02/21/02 SVC TM Gyro
  - Martinez 36.194 04/30/02 SPARCS VII Sun Pointing
- GNC Data Reduction Capability Markedly Improved
- Surface-Mount In Use (NSROC(a), SPARCS-VII)
- ST-5000 Mk II Flight (Harris) Focus Anomaly Resolved
- Second GLNMAC-200 Received

# GLNMAC-200

NSROC

**GLN-MAC**




**NSROC P/N 1234567**


**FEATURES**

The GLN-MAC is a roll-stabilized inertial measurement unit for spinning vehicle applications. The GLN-MAC (**G**imbaled **LN**-200 w/ **M**iniature **A**irborne **C**omputer) contains a strapdown fiber optic gyro (FOG) and silicon accelerometers. The GLN-MAC was developed by Sandia National Laboratories in 1998. Roll- isolation is provided by the LN-200 mounted on a gimbal, thereby making it inertially stable from a spinning vehicle. The LN-200 is used without modification. The GLN-MAC isolates against spin rates up to 22 Hz. The LN-200 acceleration range is limited to 40 Gs acceleration, although roll-isolation is capable of more than 150 Gs. The GLN-MAC can be used as a guidance sensor on roll-stabilized sounding rockets, for reentry vehicle instrumentation, or as an inertial attitude control system sensor. The GLN-MAC mounts so the vehicle spin axis is parallel to the gimbal's rotational axis. Both raw gyro data and computed attitude solutions are available as data output for TM usage.

**AVAILABILITY / STATUS**

Lead time after December 2002 is anticipated at 4 months.

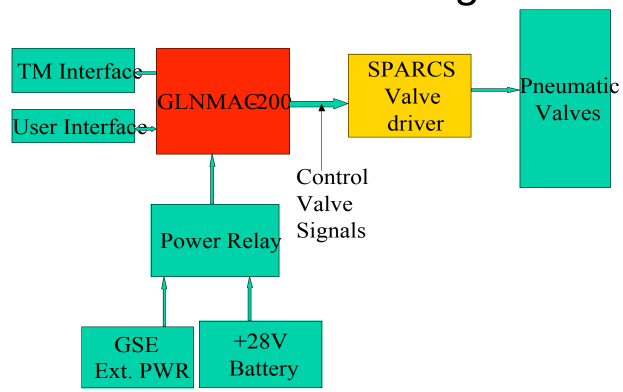
# NSROC Inertial ACS (NIACS)

**NSROC**

## NSROC Inertial ACS (NIACS)

**NSROC P/N xxxxxxxxx**

NIACS Block Diagram




**FEATURES**

The NSROC Inertial ACS (NIACS) is a cold-gas attitude control system for exoatmospheric applications. It contains a roll stabilized fiber-optic gyro/IMU with an embedded Motorola xxxxxx microprocessor. The attitude determination and control algorithms output commands to pneumatic valve drivers which control pointing in yaw, pitch, and roll. The pneumatic control system operates at two pressure levels. Available gasses include Nitrogen, Argon, and Freon-14. A differential pressure mode of operation provides very fine pointing control. An expansion module is available which doubles available maneuvering time by providing an additional pneumatic tank. Raw gyro data and computed attitude solutions are available for TM output. Future expansion plans include incorporation of Rate -Integrating Gyros and a Star Tracker for fine pointing on celestial targets, and full navigation capabilities provided by IMU and GPS.

**AVAILABILITY / STATUS**

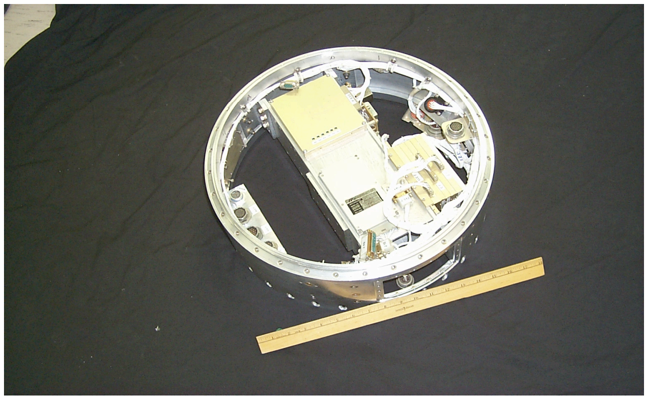
Mission lead time after January 2003 is expected to be 4 - 12 months (dependent on mission loading.)

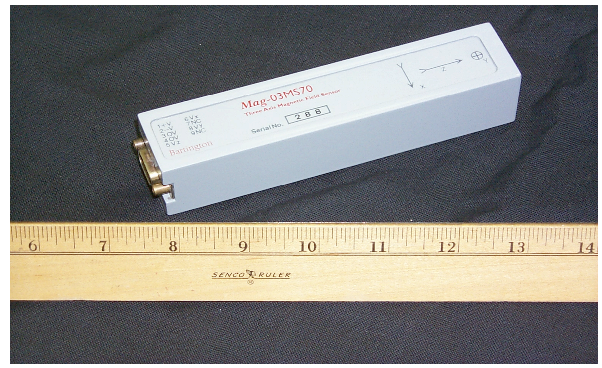
# Magnetic ACS (NMACS)

NSROC

## NSROC Magnetic ACS (NMACS)

**NSROC P/N** xxxxxxxxx






**FEATURES**

The NSROC Magnetic ACS) is a cold-gas attitude control system for exoatmospheric applications. It provides attitude control to align the payload longitudinal (roll) axis with the local earth magnetic field vector to an accuracy of 3 degrees or less. This control can be provided for either rolling or non-rolling payloads. The attitude determination and control algorithms output commands to pneumatic valve drivers which control pointing in yaw, pitch, and roll. The pneumatic control system operates at one pressure level. Available gasses include Nitrogen, Argon, and Freon-14 An expansion module is available which doubles available maneuvering time by providing an additional pneumatic tank. Additional attitude sensors including TM gyro, sun sensors, and horizon crossing sensors are available. Raw data and computed attitude solutions are available for TM output. The system may be customized for size as well as for attitude orientations other than nominal. Incorporation of additional sensors in the attitude determination and control algorithms will be accomplished when requirements demand and can enhance nominal accuracy to the 1 to 2 degree range.

**AVAILABILITY / STATUS**

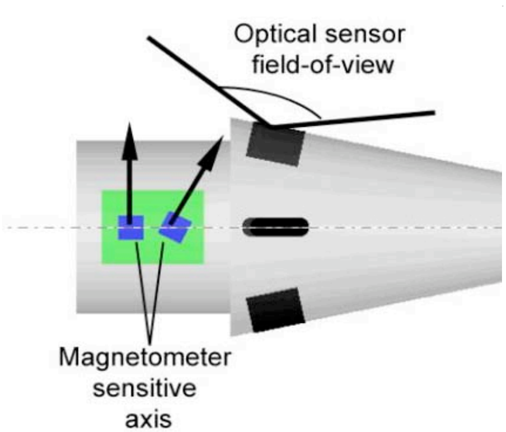
Mission lead time after January 2003 is expected to be 12 months.

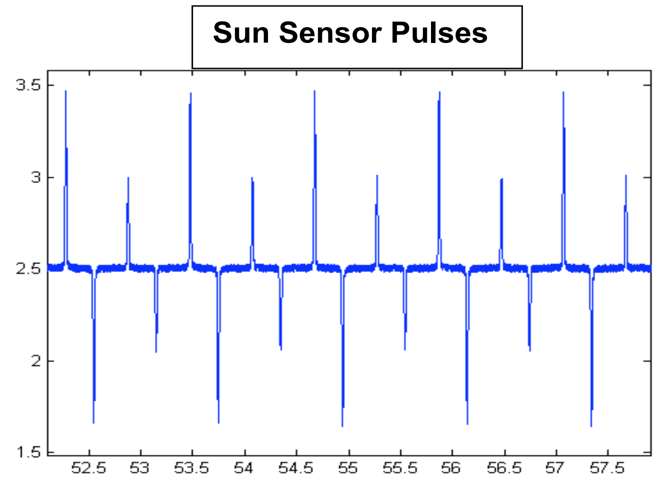
# NSROC(a)

NSROC

## NSROC(a)

NSROC P/N xxxxxxxxx




**FEATURES**

NSROC(a) is a minaturized attitude determination sensor system originally designed by Army Research Lab (ARL) for testing artillery shells. It has been adapted to sounding rockets with planned upgrades of additional sensors, on-board data processing and self -contained telemetry, and ultimately incorporation of full attitude control. Current capabilities include three-axis accelerometers, three axis magnetometer with additional redundant channel, roll rate sensor (implemeted with accelerometers), solid -state rate sensor, and sun vector sensor. An available infrared horizon-crossing sensor can be interfaced with NSROC(a).

**AVAILABILITY / STATUS**

Mission lead time after September 2002 is 6-12 months (depending on complexity).

# NSROC(a)

- 10 Missions Flown
  - Winstead 12.050 — Dec 2000 WFF
  - Laufer 30.046 — Apr 2001 WFF
  - Lynch 30.049, 050, 051, 052 — Mar, 2002 PFRR
  - Croskey 31.124, 125 — May, 2002 WSMR
  - Erdman 41.022, 023 — Jun, 2002 WSMR

- 14 Missions Scheduled
  - Winstead 42.002, 003 — Jul, 2002 PMRF
  - Goldberg 41.032, 033 — Jul, 2002 Norway
  - Erdman 41.024, 025 — Nov, 2002 WSMR
  - VALPE 41.039, 040 — Nov, 2002 WFF
  - Erdman 41.026, 027 — Jan, 2003 PFRR
  - Goldberg 41.030, 031 — Feb, 2003 Sweden
  - Lehmacher 41.041,042 — Mar, 2004 Peru

# NSROC(a) Status – Jun 2002

- NSROC(a) Miniaturized Attitude Determination
  - Is Going Flying!
  - Excellent Calibration Results From Sensors (Especially Sun Sensor)
  - Rate Gyro on Erdman Missions
  - TM Gyro on Goldberg Missions
  - Kalman Filter Attitude Determination Algorithm In Development
  - Will Replace TM Gyro On 41.041/042 Lehmacher (Peru, 2004)
- NSROC(a) Orders From PSL and ARL
- NSROC(a) Data Reduction Requirement
  - For Winstead 42.002/.003

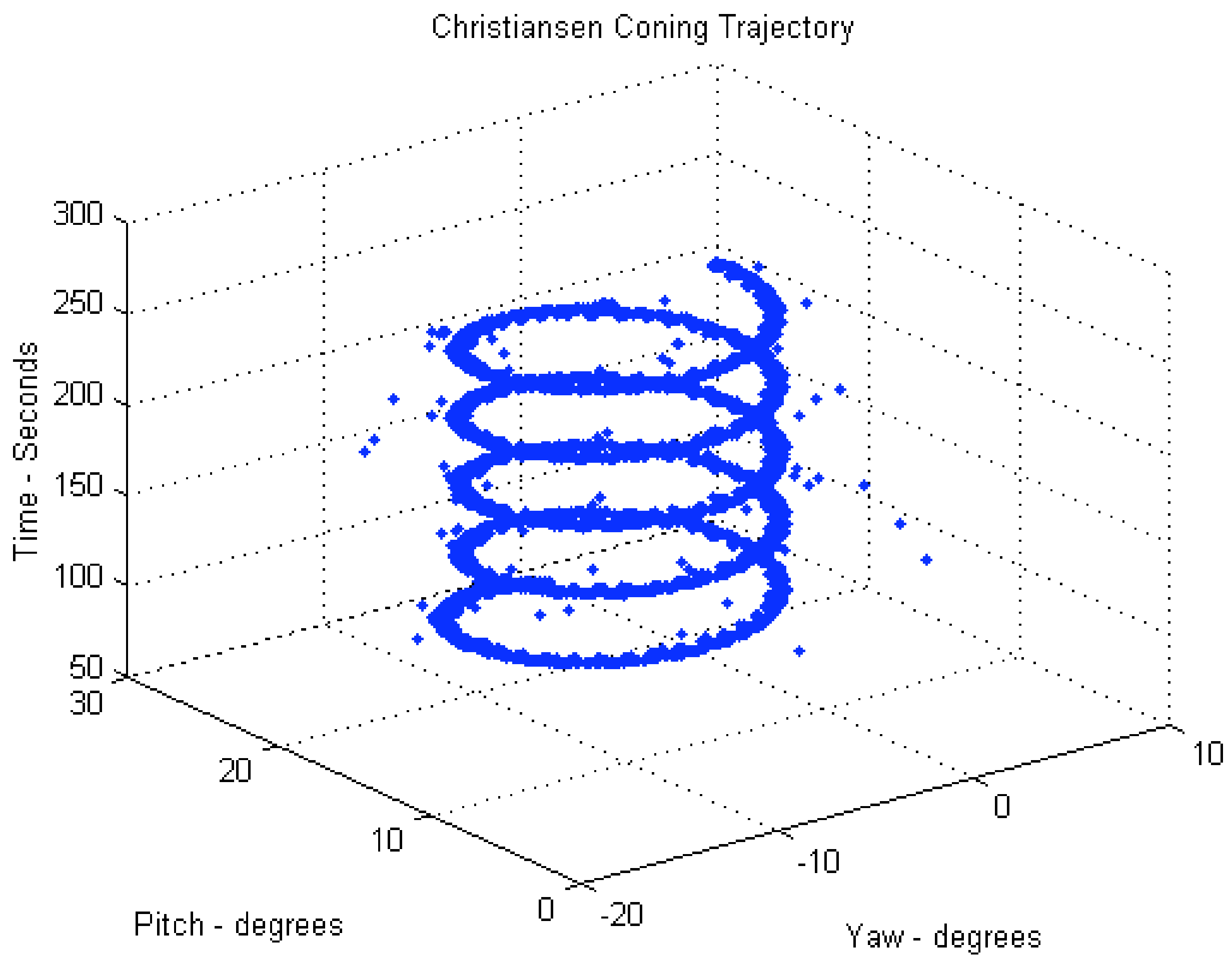
# Data Reduction



- Jeff Benton and Dennis Melvin
- 21.125 Pfaff
- 21.123 Pfaff
- 21.128 Christensen
- 40.014 Kintner
- 40.016 Kletzing
- NSROC(a)
  - Magnetic Calibration
  - Sun Sensor Calibration

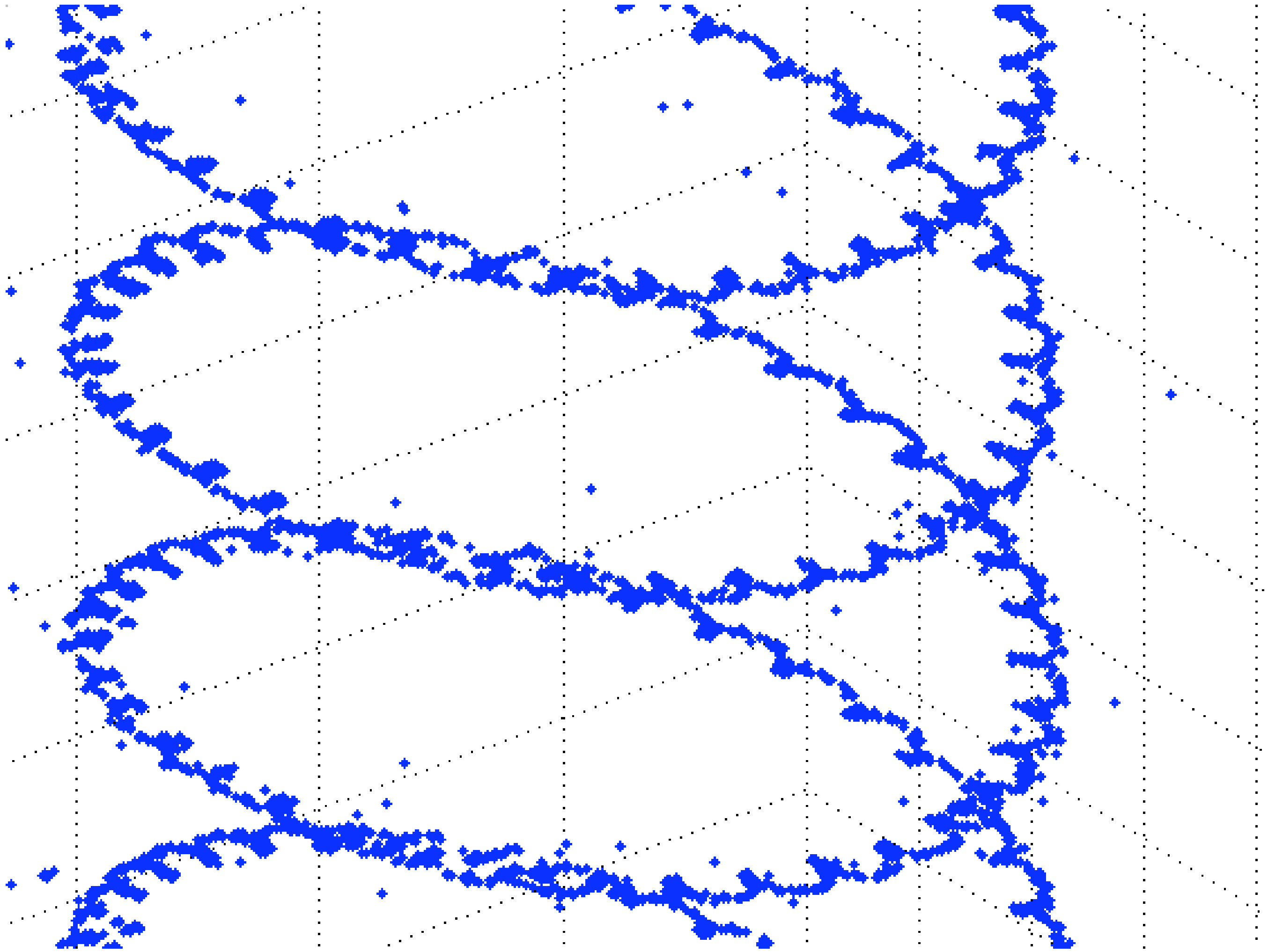
# 21.128 Christensen Pitch & Yaw

NSROC



# 21.128 Christensen Coning

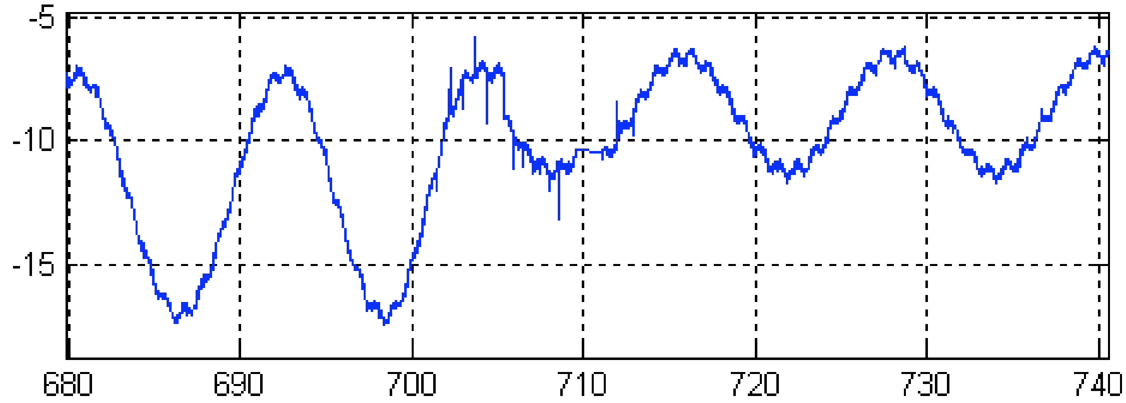
NSROC



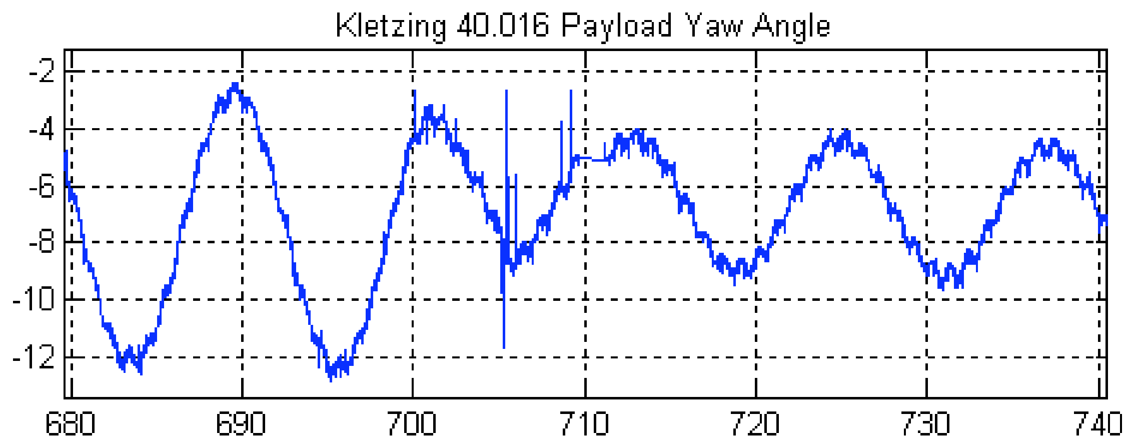
# 40.016 Kletzing Pitch & Yaw

NSROC

Pitch



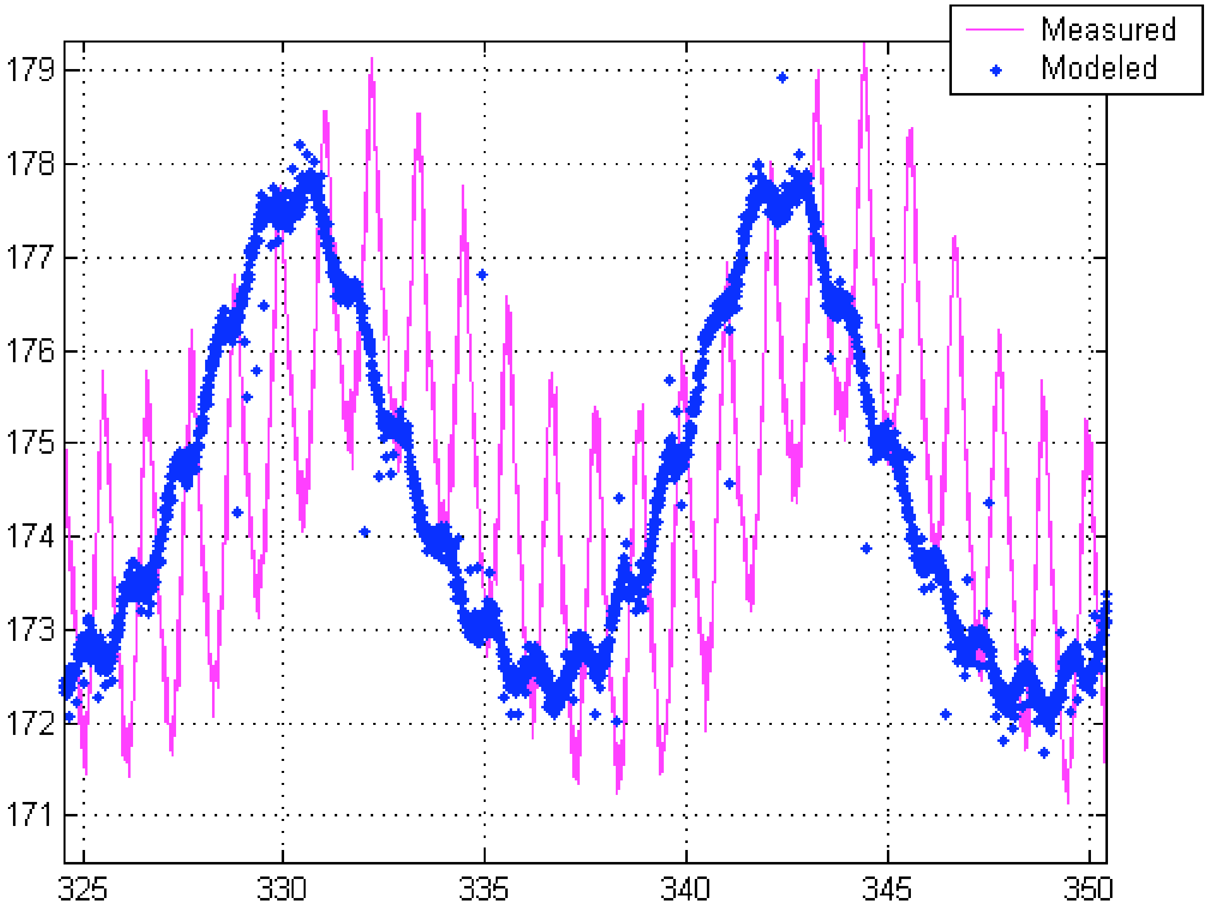

Yaw




Time - Seconds

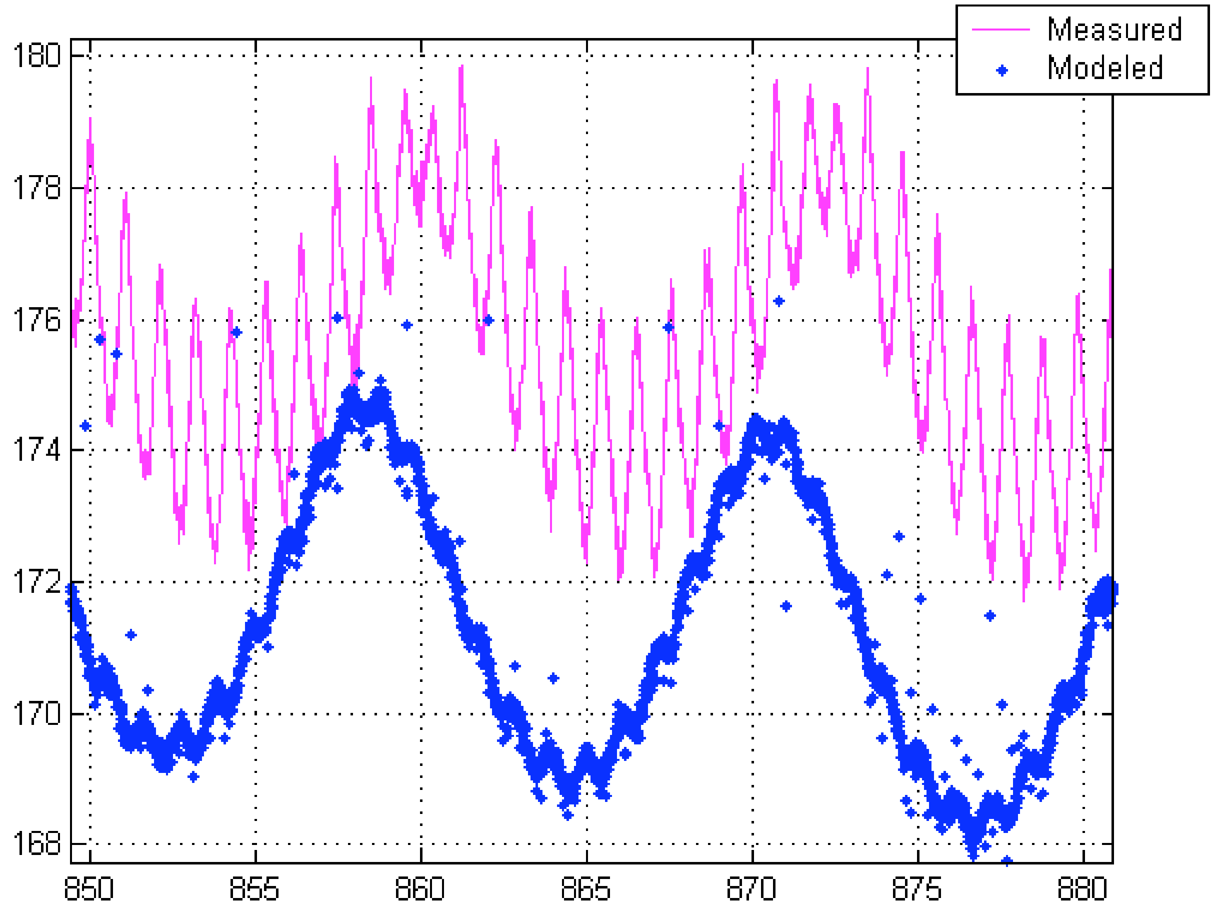
# 40.016 Kletzing
# Magnetic Aspect Angle





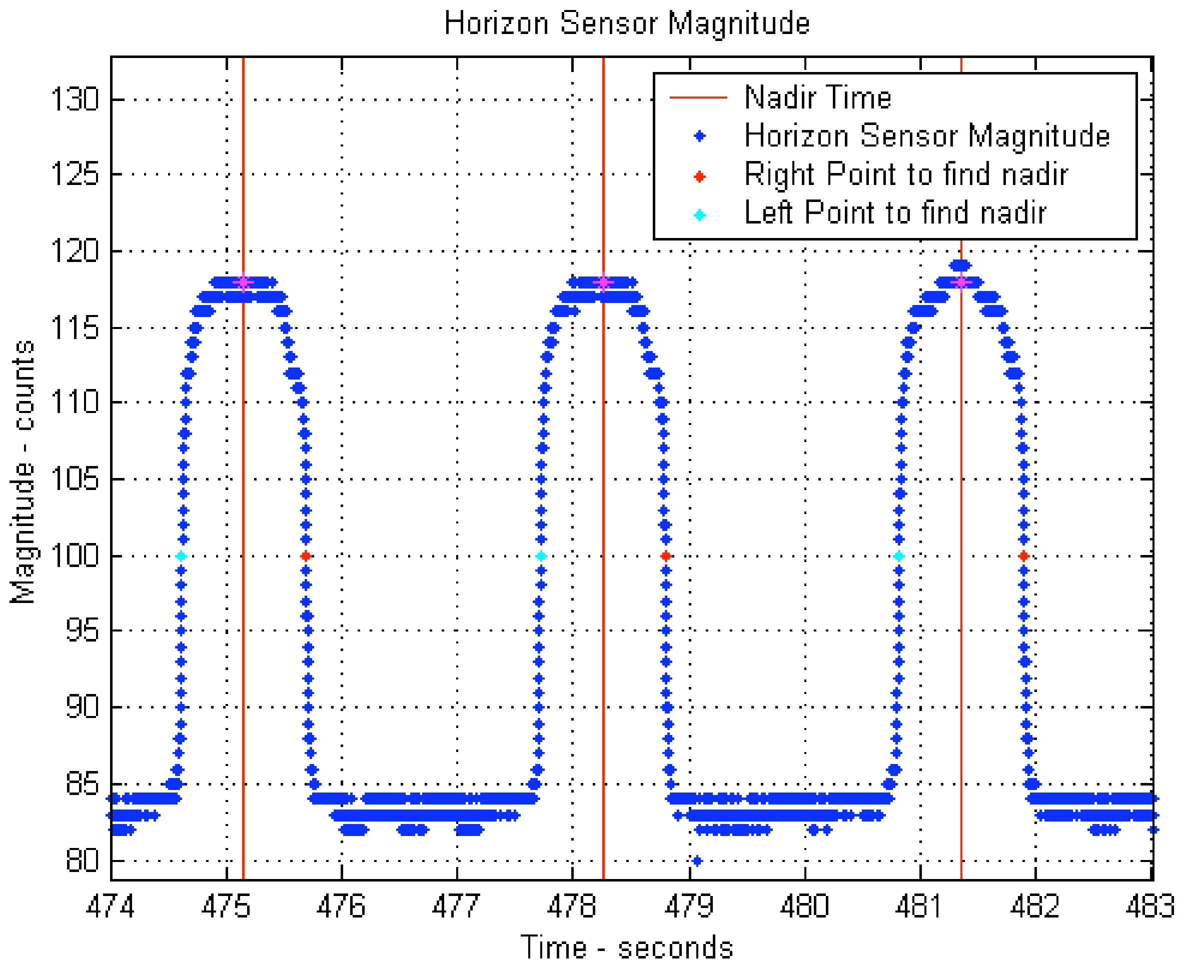
# 40.016 Kletzing
# Magnetic Aspect Angle

NSROC



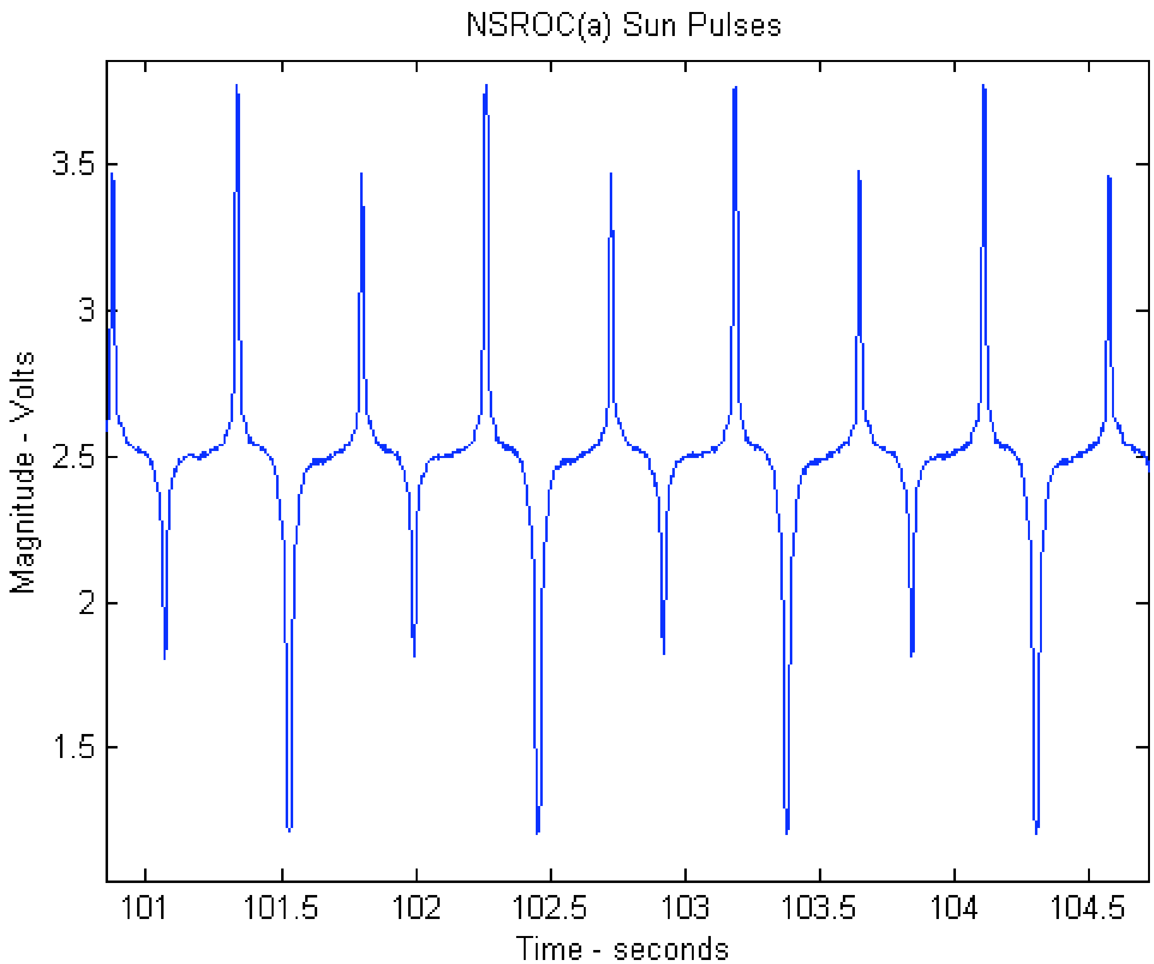
# 40.014 Kintner
# Horizon Crossing Indicator

NSROC



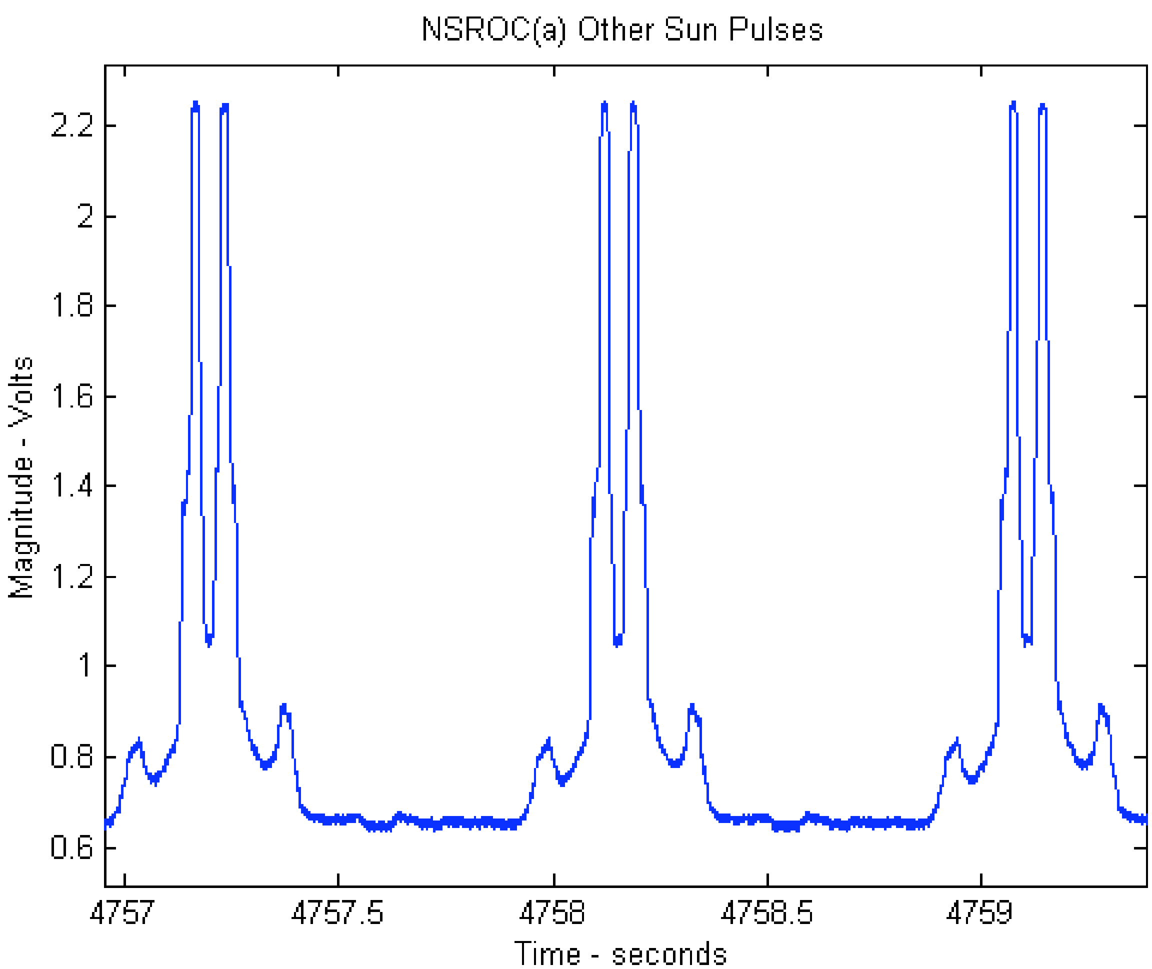
# 41.022 Erdman
# NSROC(a) Sun Pulses

NSROC



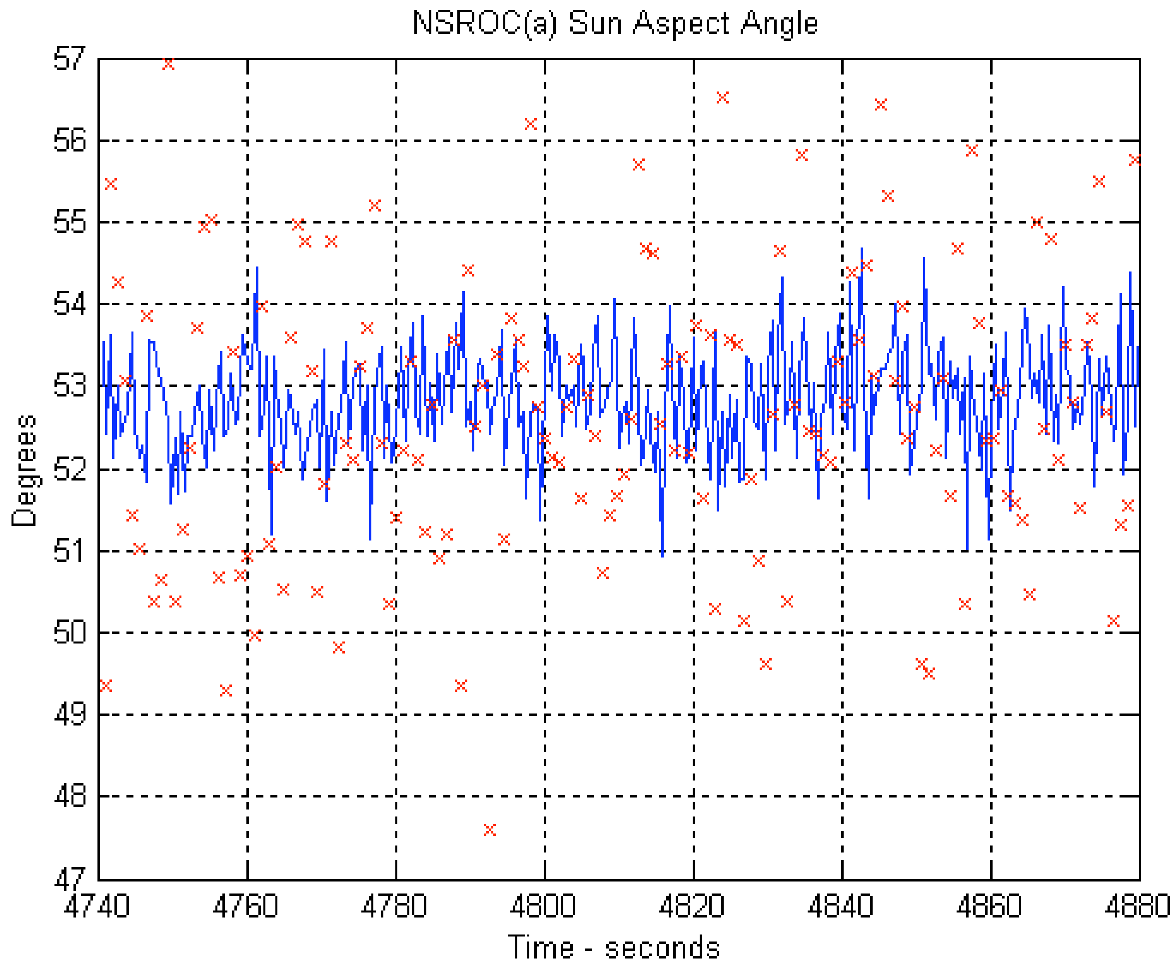
# 41.022 Erdman
# Bayshore Sun Sensor

NSROC



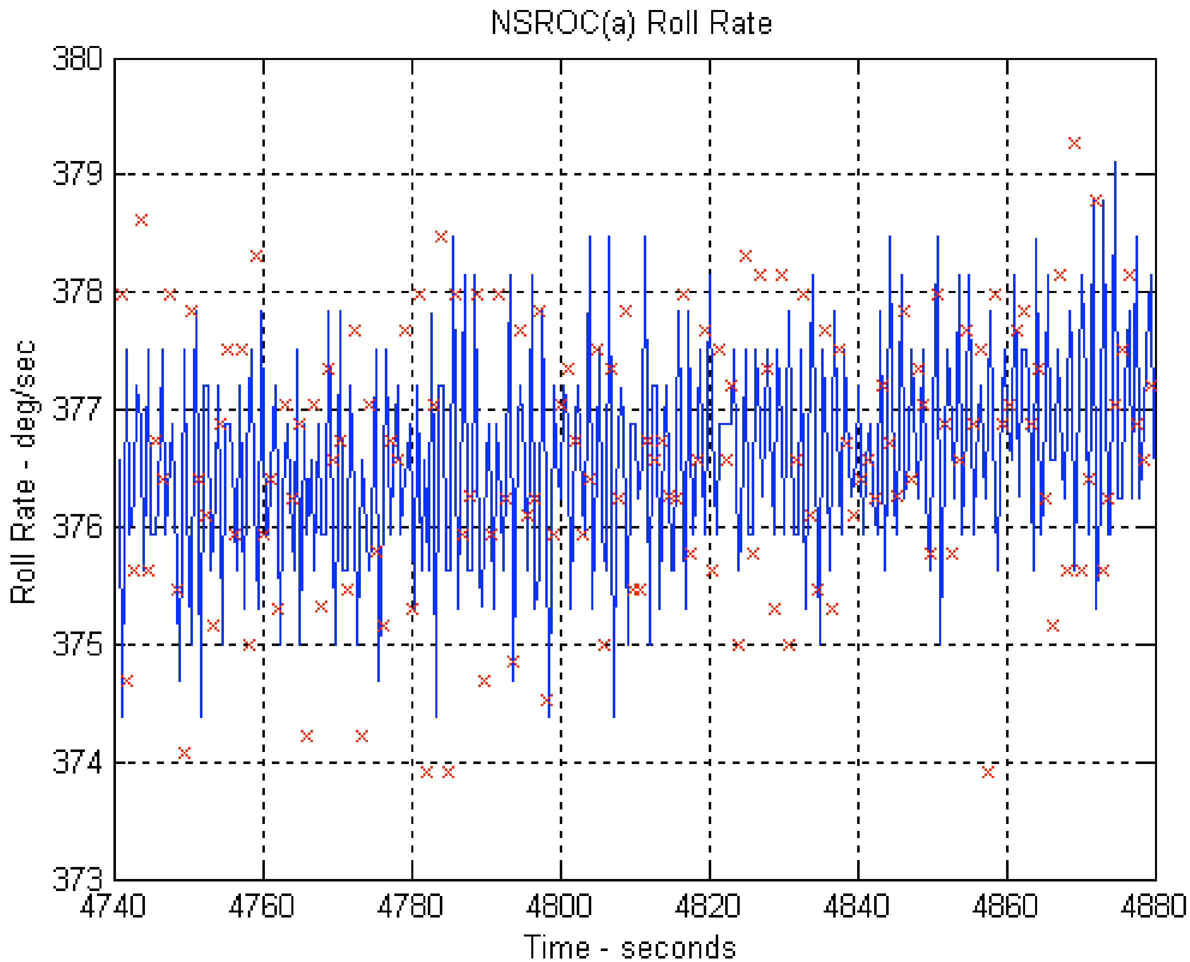
# 41.022 Erdman Sun Sensors NSROC(a) vs Bayshore

NSROC



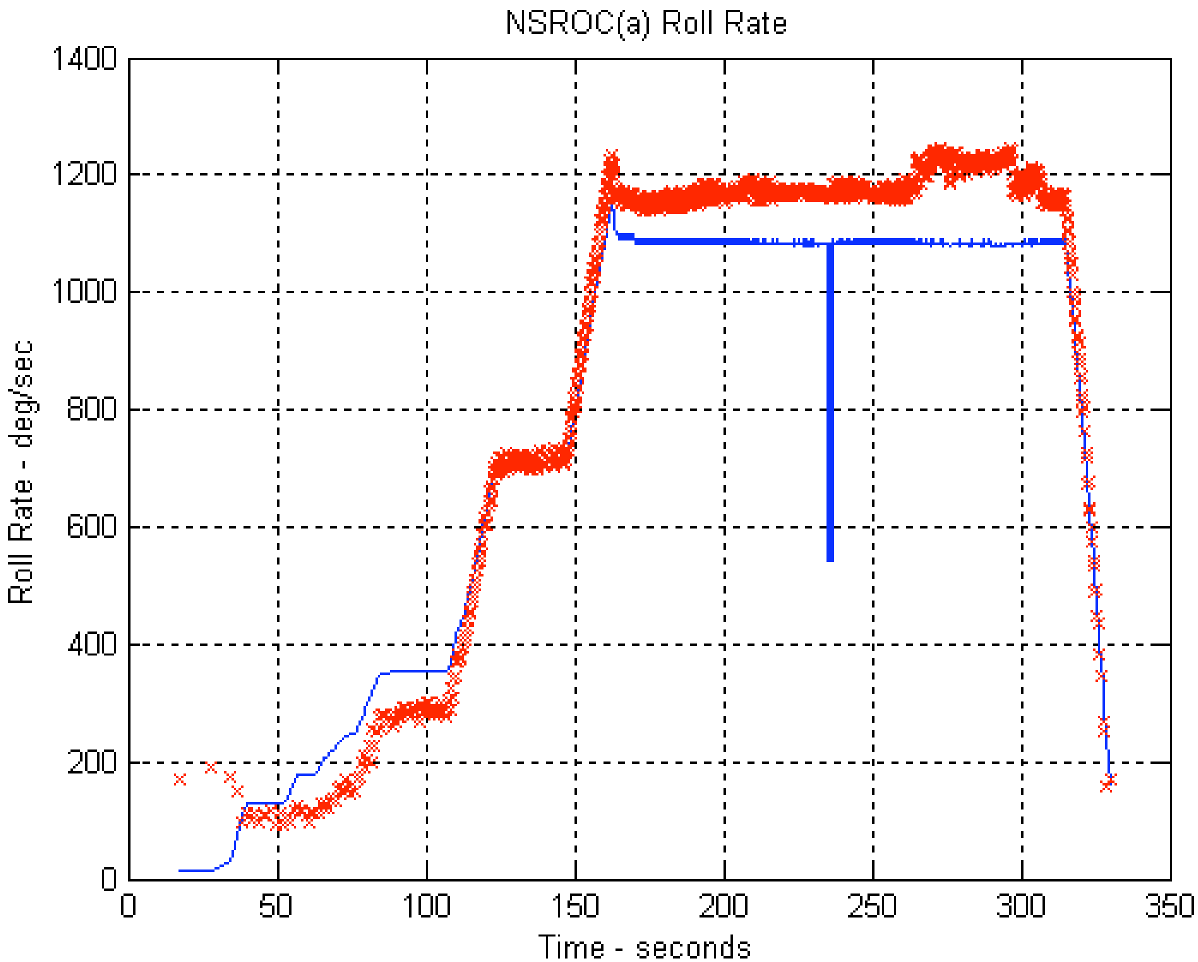
# 41.022 Erdman Roll Rate NSROC(a) vs Bayshore

NSROC



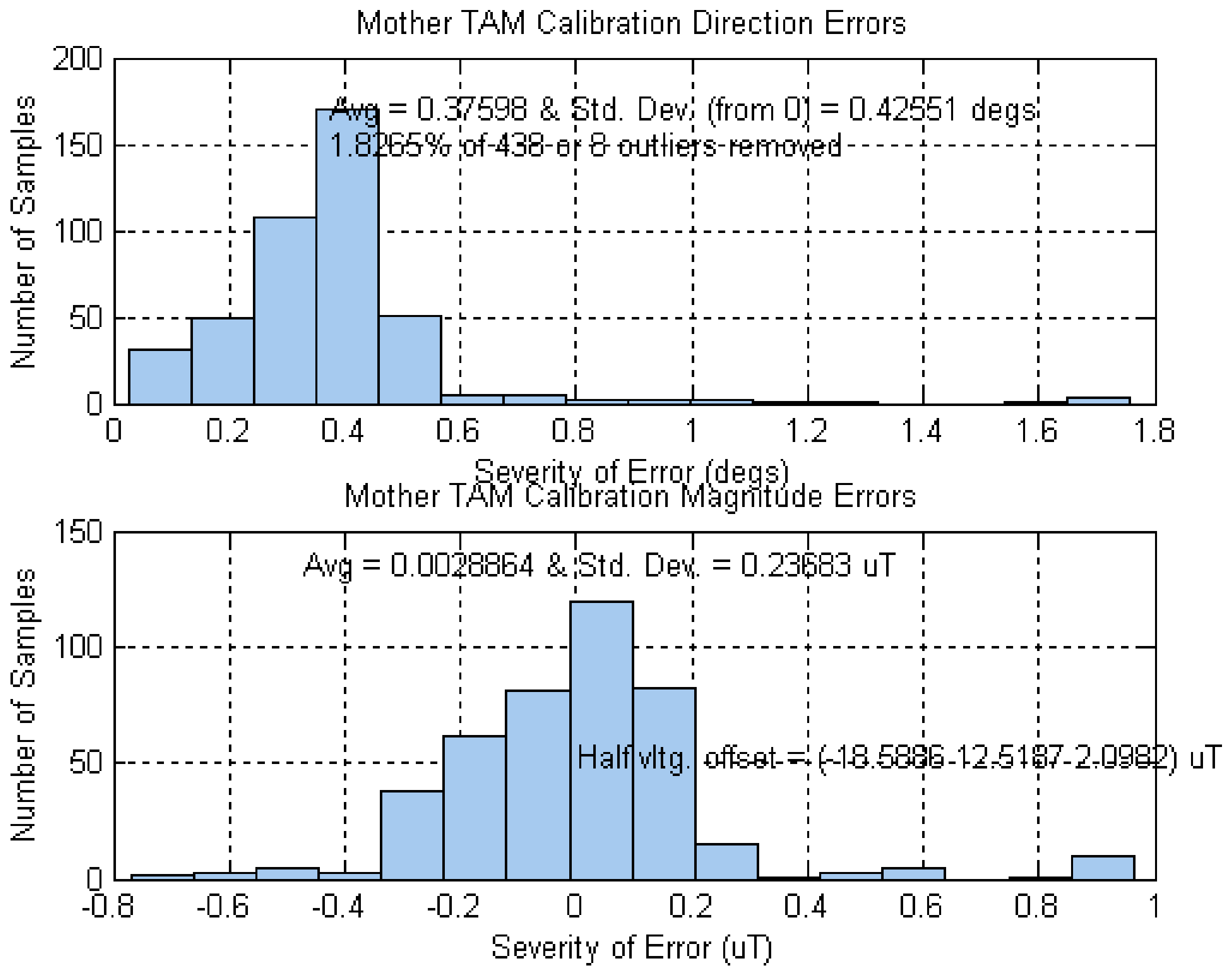
# NSROC(a) Roll Rate
# AO Ring Vs Sun Sensor

NSROC



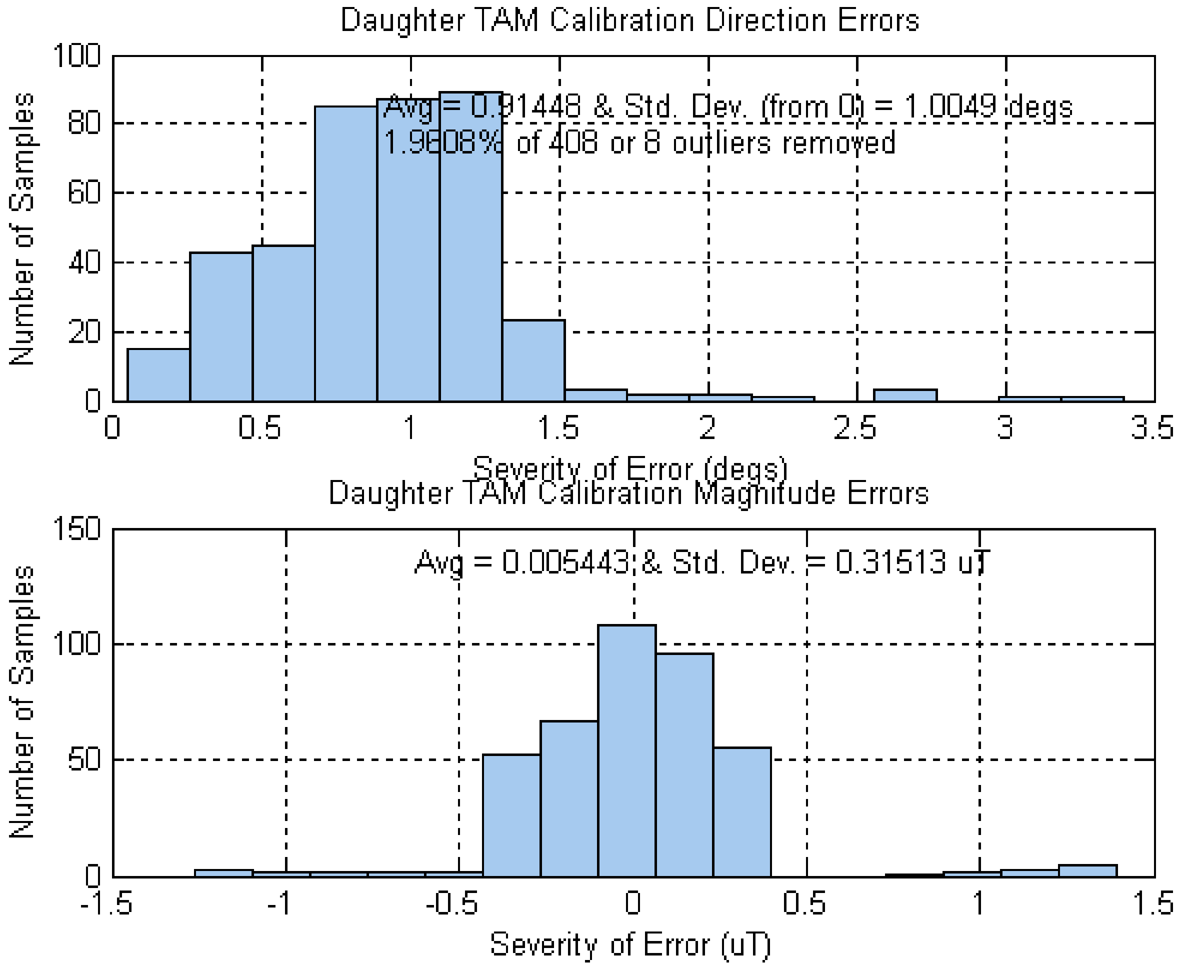
# 42.003 Winstead MagCal TM TAM

NSROC



# 42.003 Winstead MagCal NSROC(a) TAM

NSROC



# ACS Summary



- NIACS and NMACS Task Received From NASA 6/6/02
  - NIACS & NMACS 8 Month Schedule
  - NIACS/NMACS Test/Demo Flight Jun 2003
  - GLNMAC-200 To Replace MIDAS After Test/Demo Flight
- NSROC Can Bring All Systems In-House Eventually
  - Currently No Urgency For DS-19 w/DMARS
  - Aerojet Would Require Eventual MARI Replacement (DMARS Or GLNMAC-200)
- NSROC(a) Provides Cheap Capability Extension
  - To Replace TM Gyro On Day Missions
  - Looking For Horizon Sensor For Night Missions

# Low Cost Telemetry System

## Approach

- NSROC (a) package $960-$1300 without and with Solar Aspect
- Custom built PCM system $1000
- 1 Watt S-Band Transmitter $1600
- WFF Low Profile S-Band Antenna $1500

## Targeted Missions

- Chemical Release Payloads
- Low Budget Student Payloads
- Terrier-Lynx Target Missions

# Low Cost Telemetry System

## Status

NSROC (a) package
- In-production

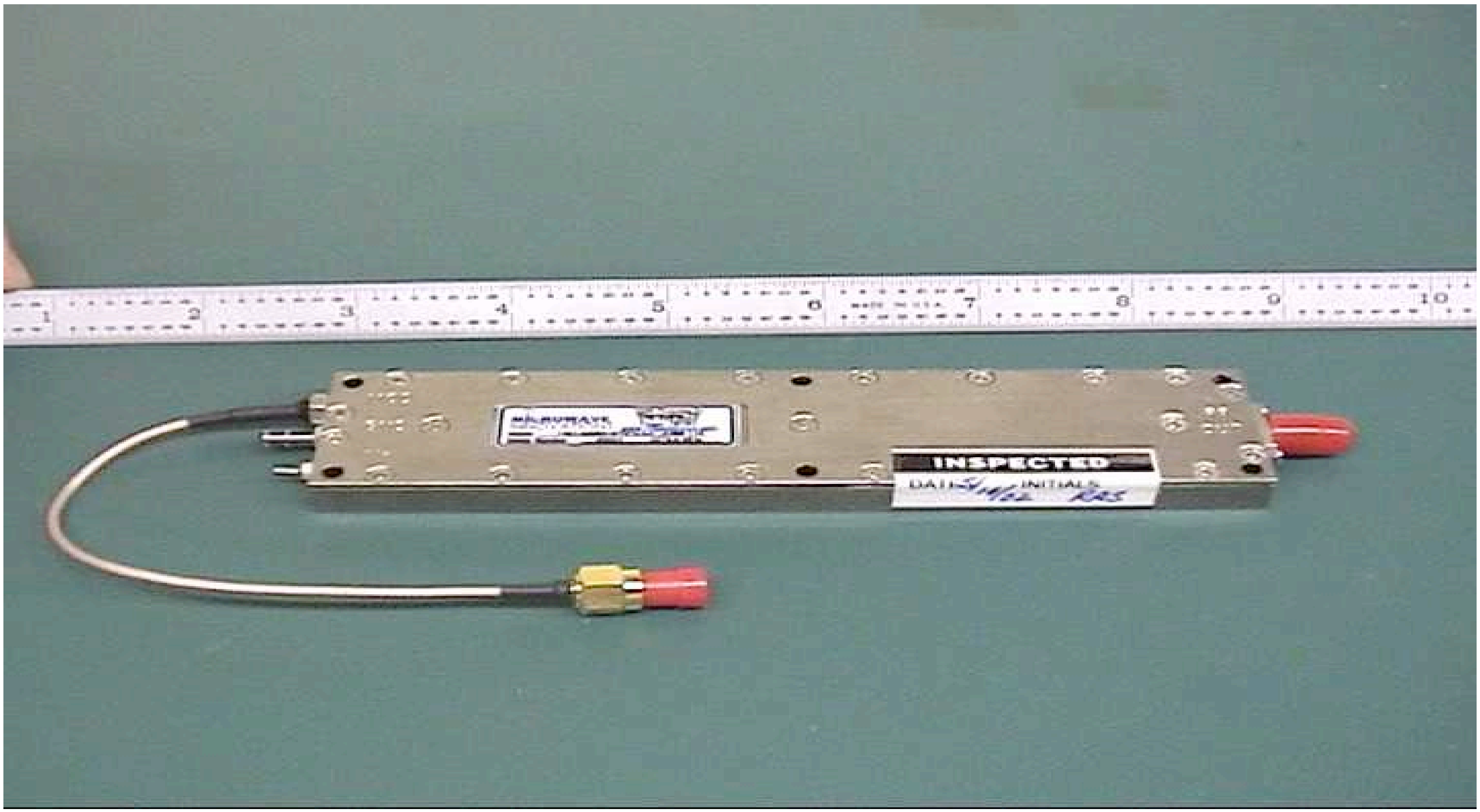
Custom built PCM system
- NSROC approved for procurement of design and development by USU
- System design set for 32 analog channels standard, RS232/422 channel, 32 digital inputs, 14 bits/word, re-programmable, up to 2 M BPS

Low Cost S-Band Transmitter
- Undergoing acceptance testing at WFF

Low Profile 14” S-Band Antenna
- Flown successfully on 6 missions

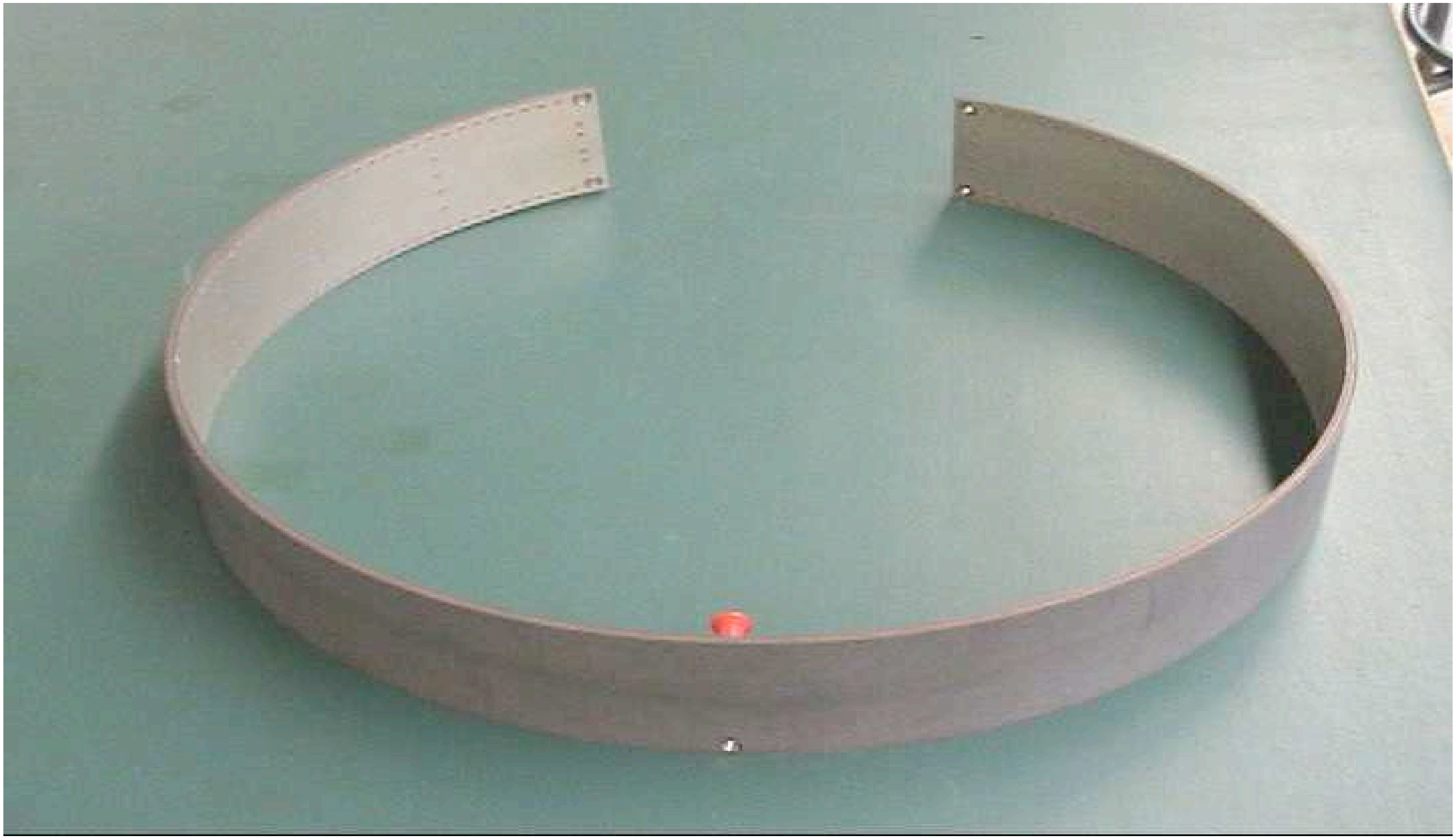
NSROC

# Low Cost S-Band Transmitter



# New 14” S-Band Antenna

NSROC



# Program Enhancements

## Remote Control Payload Control System

- To be used for testing and launch of 36.202 Judge on August 8, 2002
- Unit is currently at WSMR undergoing final system checkout

# Planned Program Enhancements



**Increasing PCM bit rate to 16 MBPS**

- PSL working on increasing for Parallel Digital Data Inputs

**Development of GEM (GPS Event Module)**

- In-Flight Event control of altitude critical events using GPS receiver
- Multi-Function Timer used as back-up event control
- 1 Kilometer event control accuracy

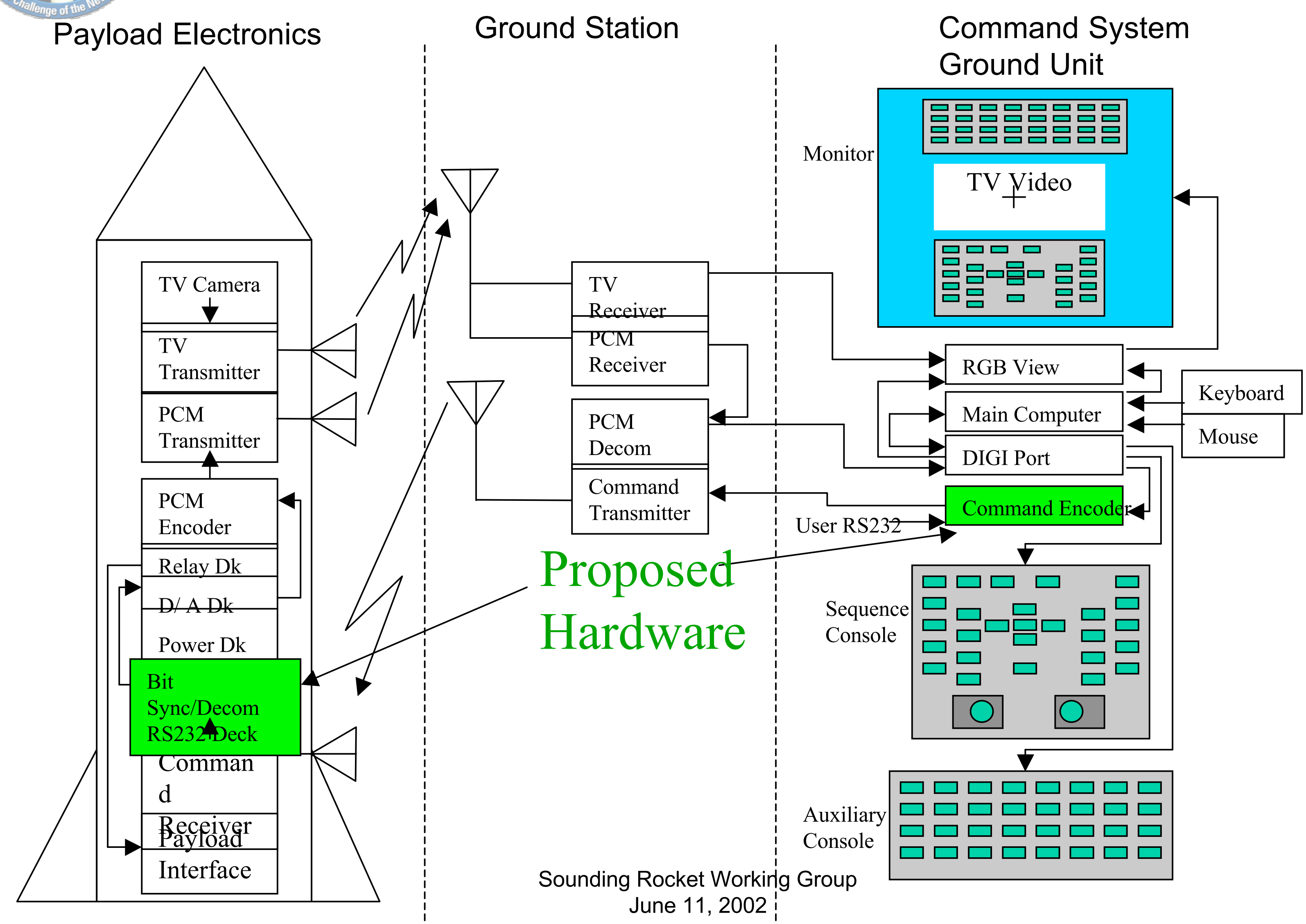
# Planned Program Enhancements

**Command Uplink Data Rate Increase and Channel Expansion**

- Current uplink system provides for 2-1200 Baud data streams with one for pointing and relay control and one for Experimenter
- Proposed upgrade capable of 4 RS232 or 422 outputs with programmable Baud rates.
- Preliminary test results indicate operation with existing command receivers good to at least 200K BPS which allows 4 outputs to operate at 38.6K baud
- System upgrade will be required for GLNMAC ACS control
- Cost for upgrade <$16K per system for flight proven hardware

# Command Uplink Rate Increase

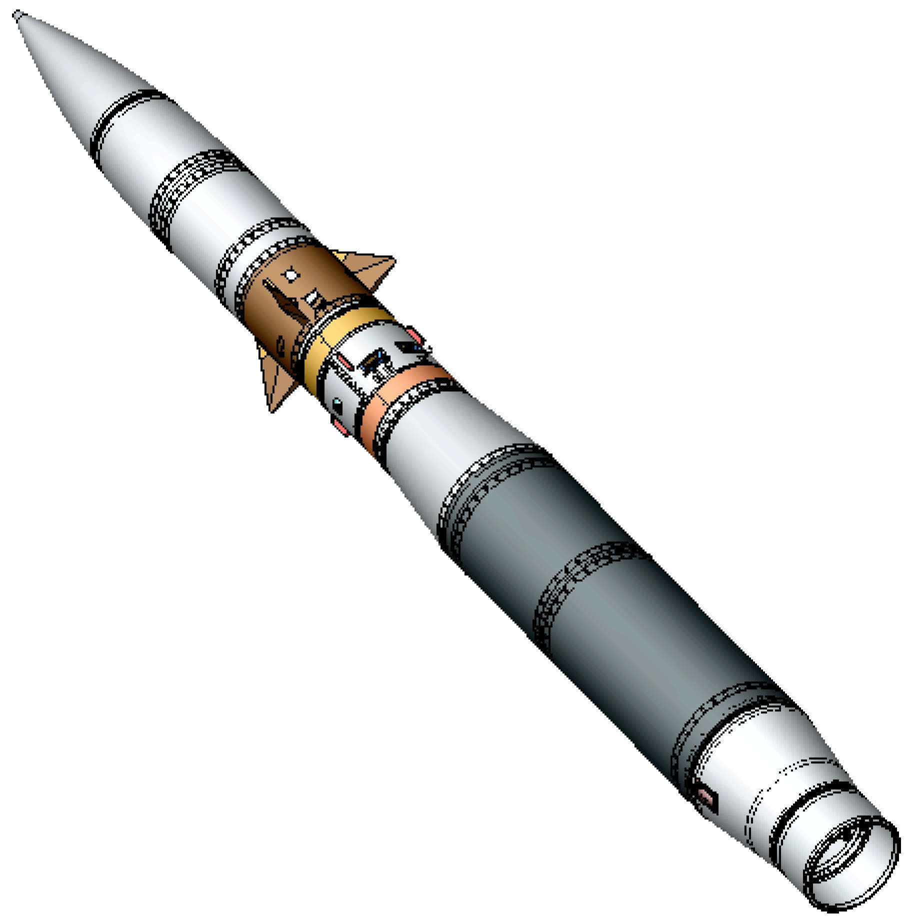
NSROC



# Solid Modeling

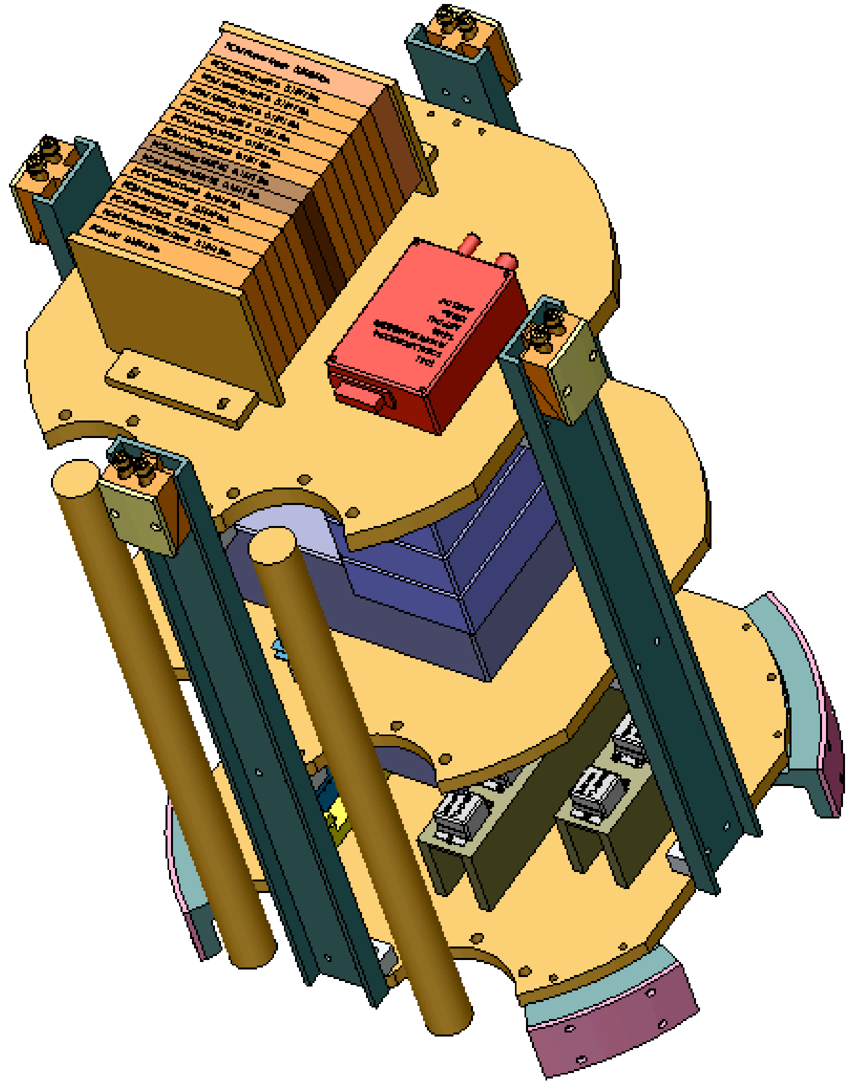
- **SolidWorks** ® 3D solid modeling software is now the primary design tool used by NSROC Mechanical Engineering

- AutoCAD still in use, but will eventually be phased out



# Solid Modeling

NSROC



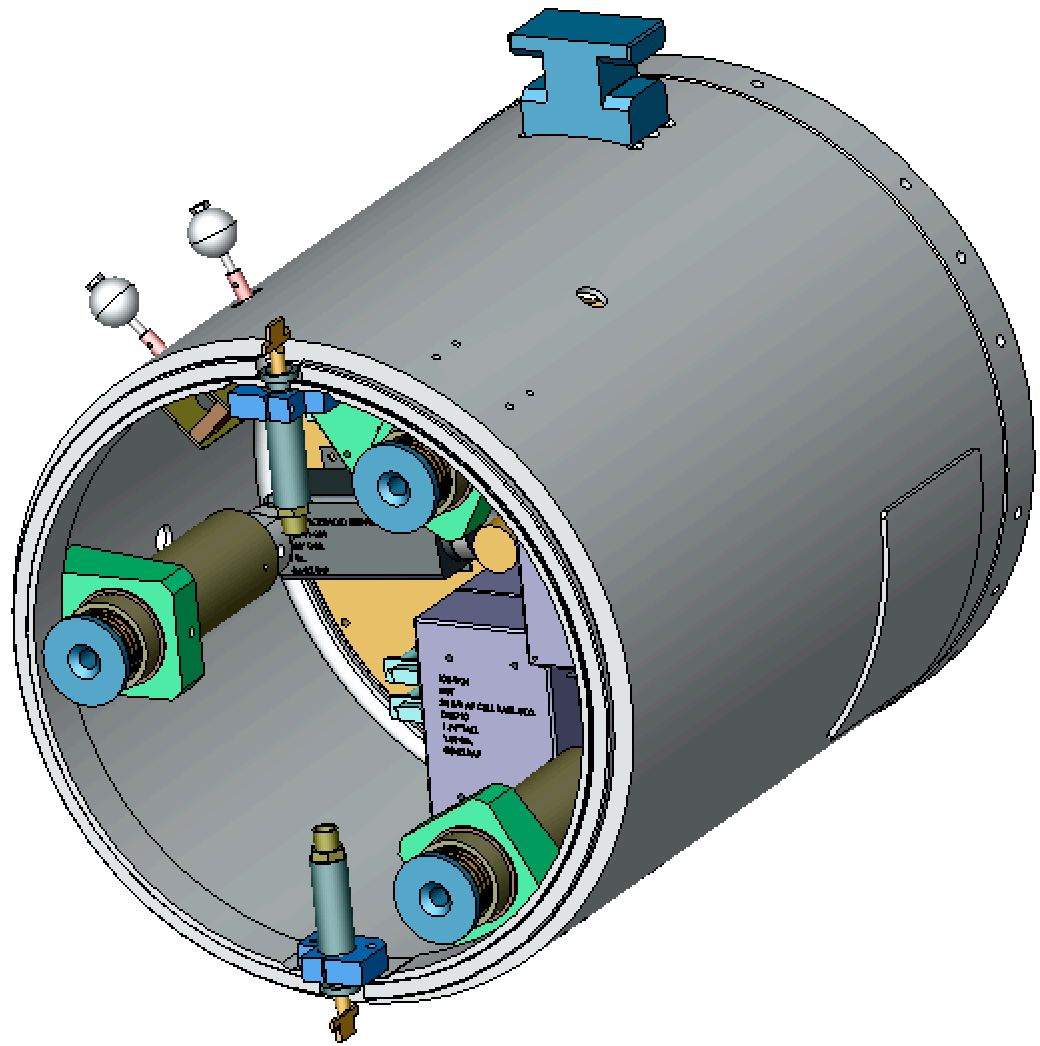
•Reduces design time

•Reduces design iterations when design is interactive among disciplines

# Solid Modeling

•Mass properties estimates and weight/stiffness distribution information automatically

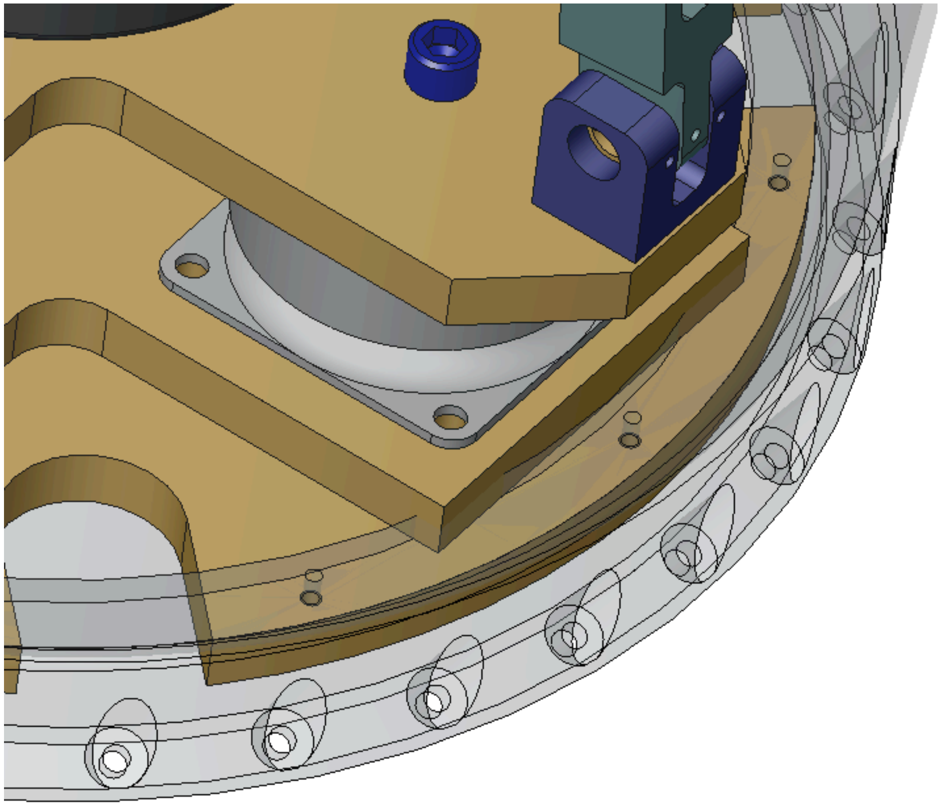
•Currently building solid model library of standard components and skin features



# Solid Modeling

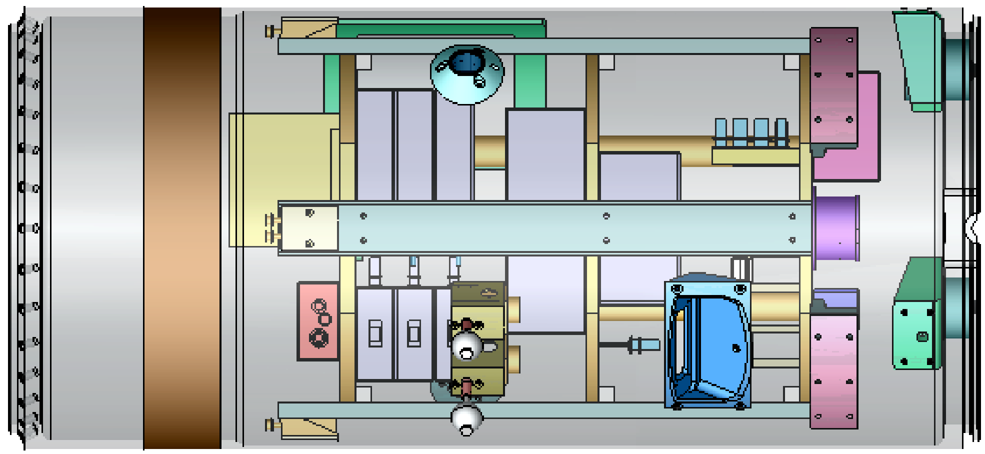
•Better virtual fit-checks if Experimenter's parts are solid models.

•Success so far with SolidWorks and Pro-E modeled parts



# Solid Modeling

- Enhanced presentation quality
- More detail readily available for design reviews and payload team design meetings



# Conclusions

- NSROC Is Committed to Continuing the Successes We Currently Enjoy
- Satisfying the Code S PI Mission Requirements Is Still NSROC's Primary Goal
- NSROC Is Committed in Expanding the Technical Innovations While
  - Maintaining a Cost Effective Environment
  - Meeting the Success Requirements of the PIs
  - Making Effective Use of the In-House Talent and Experience
- NSROC's Receipt of the SRWG Findings Is Important for Future Growth Planning