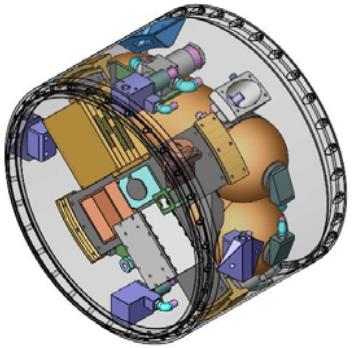
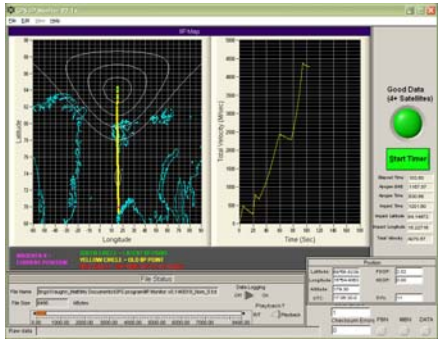


Sounding Rocket Working Group
December 10, 2008

NASA Sounding Rocket Operations Contract
(NSROC)



Wallops Flight Facility

SRWG Agenda - NSROC

NSROC State of Affairs	Rob Maddox
Operations	Jay Scott
Engineering Director	Ricky Stanfield
Chief Engineer	Dave Krause
Flight Performance	Mark Simko
Electrical Engineering	Shelby Elborn
Mechanical Engineering	Brian Creighton
Vehicle Engineering	Giovanni Rosanova
ACS/Sensors	Ron Kiefer
Conclusions	Rob Maddox

Program Manager

Rob Maddox

NSROC Programmatic

- Contract Status
  - Received contract extension until June 30, 2009
  - Preparing for NSROC II
  - Proposal activities will not disrupt operations
  - Received funding relief to increase staff and replenish inventories

- Financial Accounting Status
  - New Business Manager hired June 2008
  - Most issues are resolved concerning transition to One Source SAP
  - Developing new financial variance reporting tools
    - Labor Allocation Plans
    - Monthly Cost Summary Reports

- ITAR Status
  - Most TAA's are progressing well
  - Some provisos have restrictions on foreign national grad student interaction with Universities. This is being addressed between NASA HQ and Dept of State.

NSROC Programmatic

- Subcontract Status
- Significant hardware orders in place. Evergreen clause allows delivery of hardware up to one year beyond contract extension end date.
- Bristol – Completed 12 Black Brant motor buy, ~ 50% complete 18 Black Brant motor buy, beginning production for 15 Black Brants & 9 Nihka motors
- Saab – Recently acquired by RUAG Holdings, Switzerland
  - New name is RUAG Aerospace Sweden AB
  - TAA's being modified for new name
  - No disruption of support anticipated
  - S-19 Conversions are on track
- Univ of Wisconsin – On going support for ST 5000
- PSL – On going support for instrumentation and WSMR ground stations
- Anderson Metals – Significant orders for nosecones and ancillary hardware
- Troy 7 – Woman Owned Small Business from Huntsville. Provides post flight data analysis. Approx 2 FTE's per year

NSROC Programmatic

- Reimbursable Business
  - US Navy Aegis – Terrier Orion & Terrier Oriole from PMRF
  - ASAF Airborne Laser – 10 BBIX Missions from San Nic, CA
  - US Navy SCSC Fleet Training – 1 Terrier Orion, 1 Terrier Oriole from WFF
  - Max Launch Abort System (MLAS) – Significant fabrication and integration effort
  - MDA Next Generation Sensor Program (NGSP) – Another BBXI from WFF
- New business marketing has slowed due to end of contract. Most reimbursable work is now from returning customers.
- Several Technical Spinoffs from reimbursable customers.
- Hardware economies of scale being realized.

NSROC Programmatic

- Outreach
- Interns & Co-ops
  - Spring – 4 students
  - Summer – 12 Students
  - Fall – 5 students
- 10 former interns are now full time NSROC employees
- Supported Arcadia HS Robotics competition, Inspire the next generation day, Wor-Wic Community College and other high school presentations
- Significant, valuable, “real engineering work” being performed by students and reviewed by engineering mentors.

Operations

Jay Scott

TAA Statistics

- Any mission requiring interaction between NSROC personnel and non-US citizens requires Technical Assistance Agreement
- Average time from State Dept. submittal to execution: 16 weeks
  - Ranges from 10 to 45 weeks
  - Doesn't include internal corporate review
- Currently 13 missions on schedule that require TAA's
  - 7 executed
  - 1 waiting for State Dept. approval
  - 3 waiting for PI input
  - 2 in corporate review
- 39 total TAA's (3 companies X 13 TAA's)
- 59 total non-US citizens

TAA Provisos

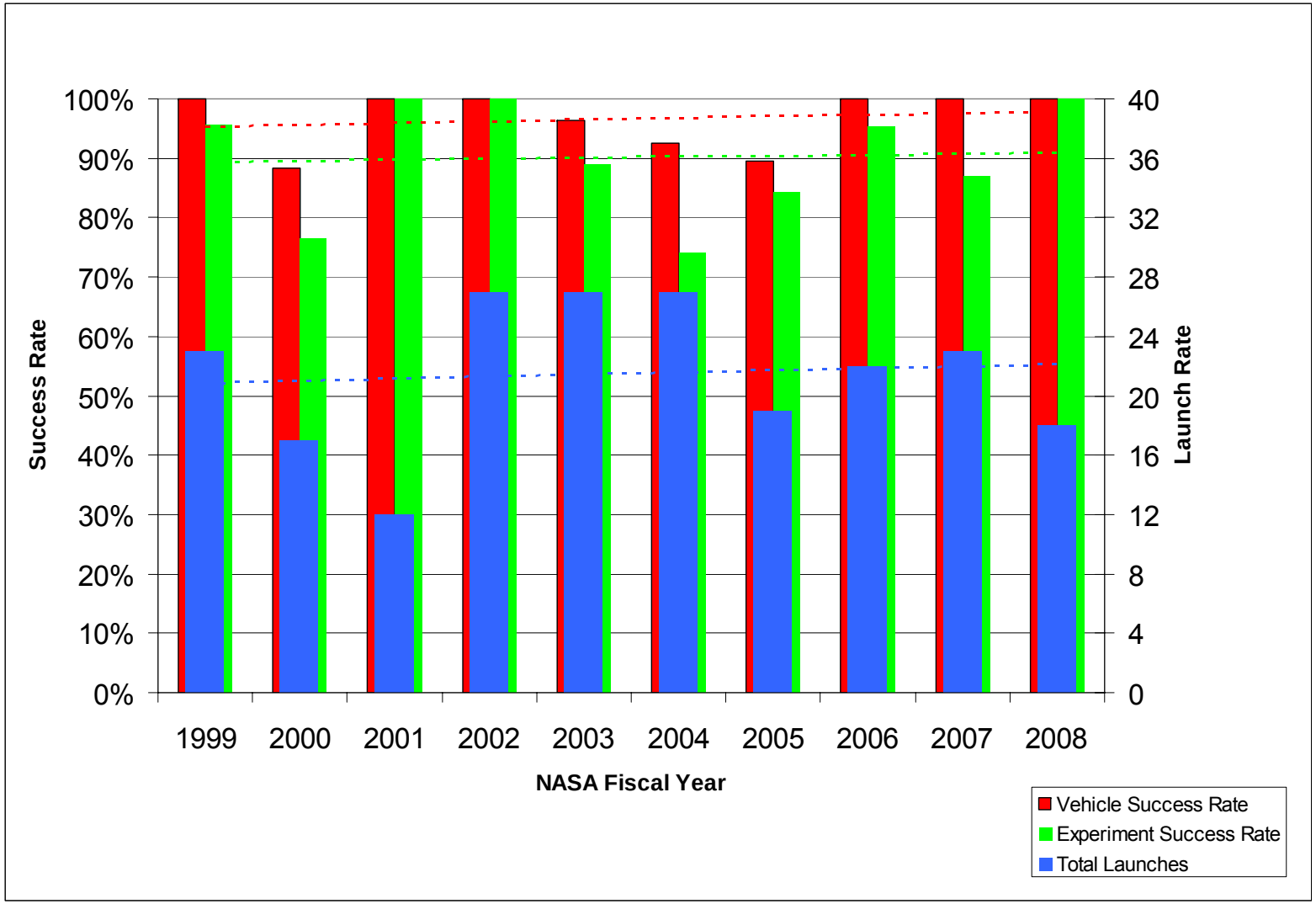
- 10 to 15 provisos per TAA
  - Most routine, but a few difficult to comply with
    - No collaborative failure analysis
    - No data exchange between PI and foreign exp. team members
    - No release of design methodology, engineering analysis, or manufacturing know-how
    - Must not augment or suggest changes that optimize, enhance, improve or increase foreign licensee's process and/or their capability for design, development, or manufacture

Staffing

- Bruce Scott retired in May of this year
- Replaced by Jim Deaton
  - Worked in SQA group since NSROC start
  - Extensive orbital vehicle experience
    - Scout
    - Conestoga
- Currently have one more opening

10 Year Mission History

(215 Total)



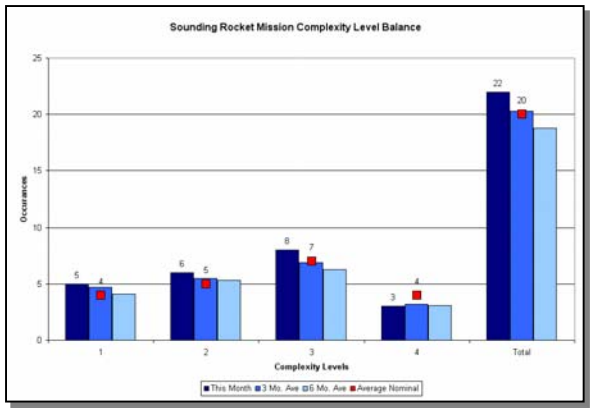
Engineering Director

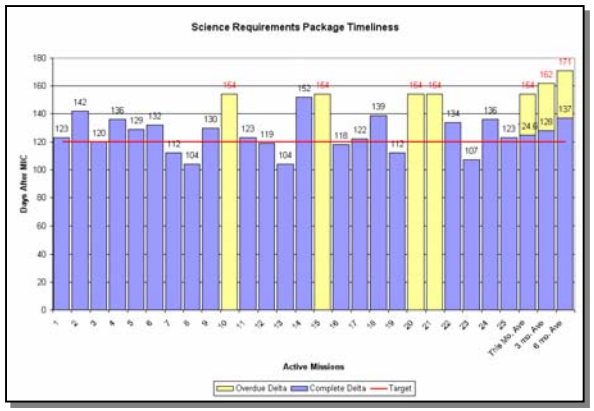
Ricky Stanfield

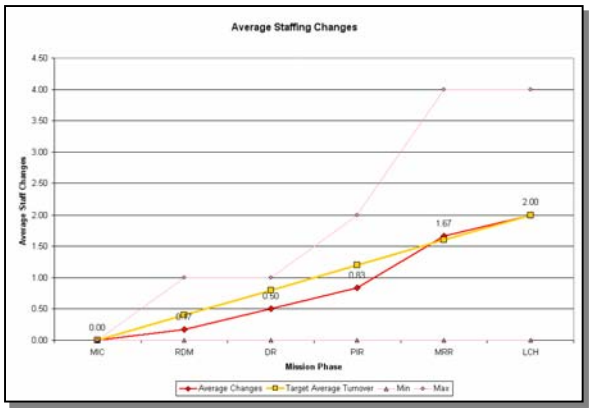
“Corporate Memory” and Engineering Robustness

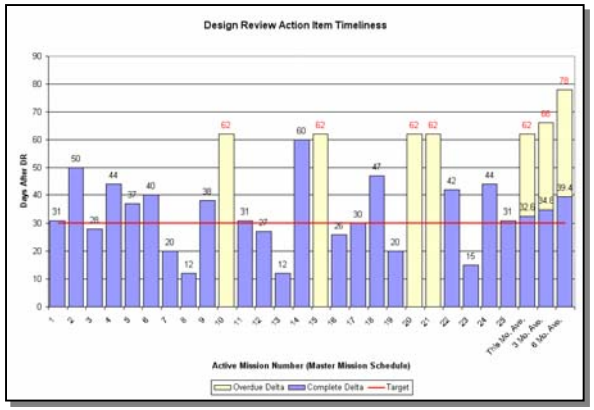
- The NSROC Team, SRPO, and the Scientists remain dedicated to successful missions and payloads
  - Complete and timely understanding of requirements
  - Recruitment and Retention of experienced engineers, technicians, and machinist
  - Effective design and analysis tools, and solid experience driven design practices
  - Good use of configuration management, knowledge base, and lessons learned
  - Effective communication within NSROC and with the Science community
- The NSROC Contractor Team is continuing to work towards these objectives
  - Implementation of tracking metrics as leading indicators of quality
  - Continuing to implement our Risk Tracking Summary and Lessons Learned processes to anticipate and mitigate errors, and prevent repeated mistakes
  - Effective configuration management of standard systems and of unique designs
  - Recruiting, training, and retention of engineers and technicians
  - Timely and continuous interaction with the Science Team, with an open invitation to be of assistance with design or implementation challenges
  - Effective use of Requirements Matrices to define expectations and track approaches

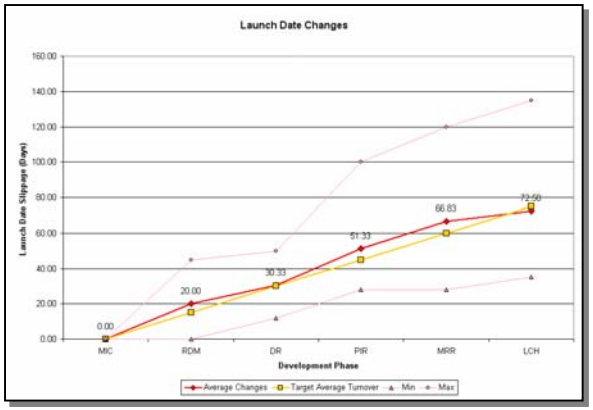
Engineering Leading Indicators







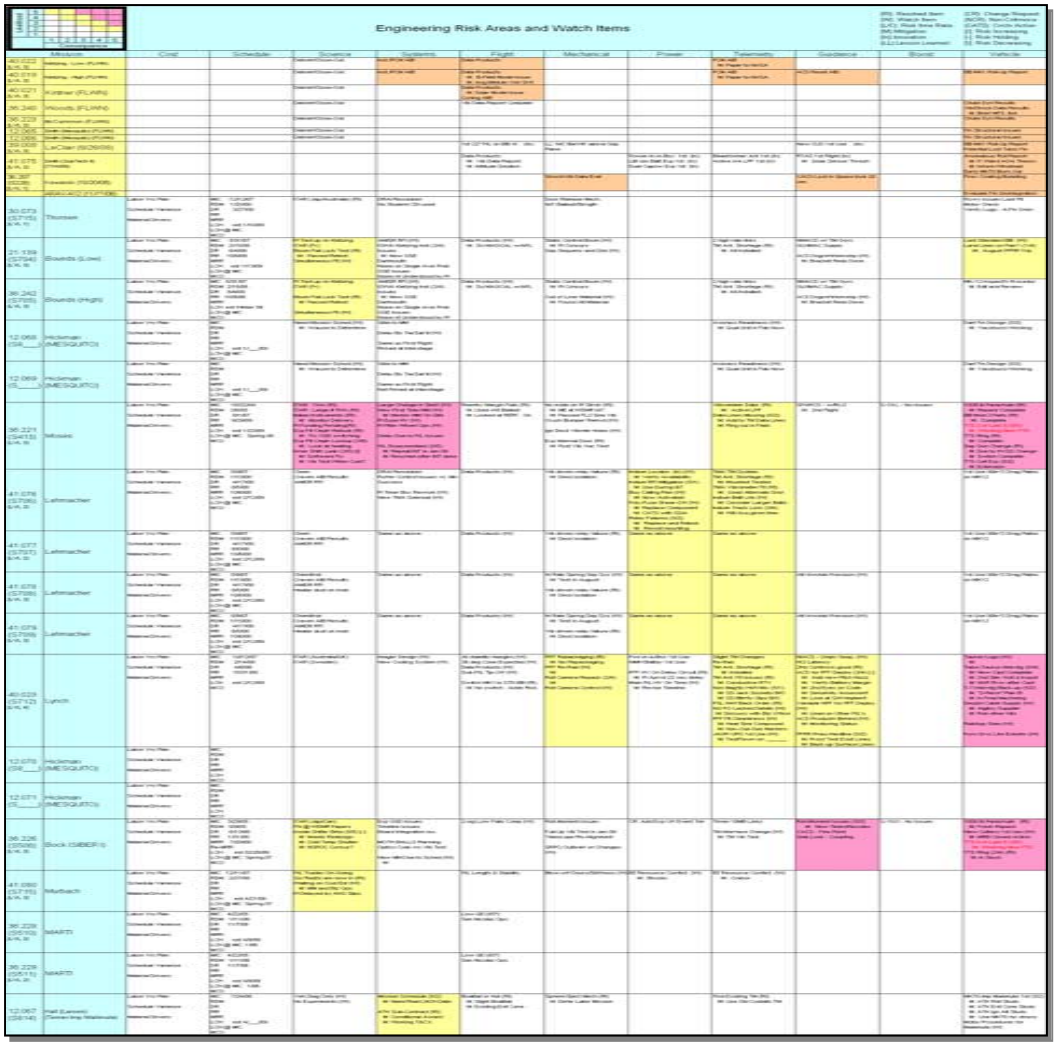




- NSROC has studied the contributing factors to mission success from an engineering process point of view
- We've modeled a monitoring process after the NGTS Leading Indicators example
- Engineering has defined six leading indicators that we will monitor
- The data above is fictitious and will be replaced with live data in 2009
- These Indicators will help us balance responsiveness (flexibility) with quality (reliability) and with cost

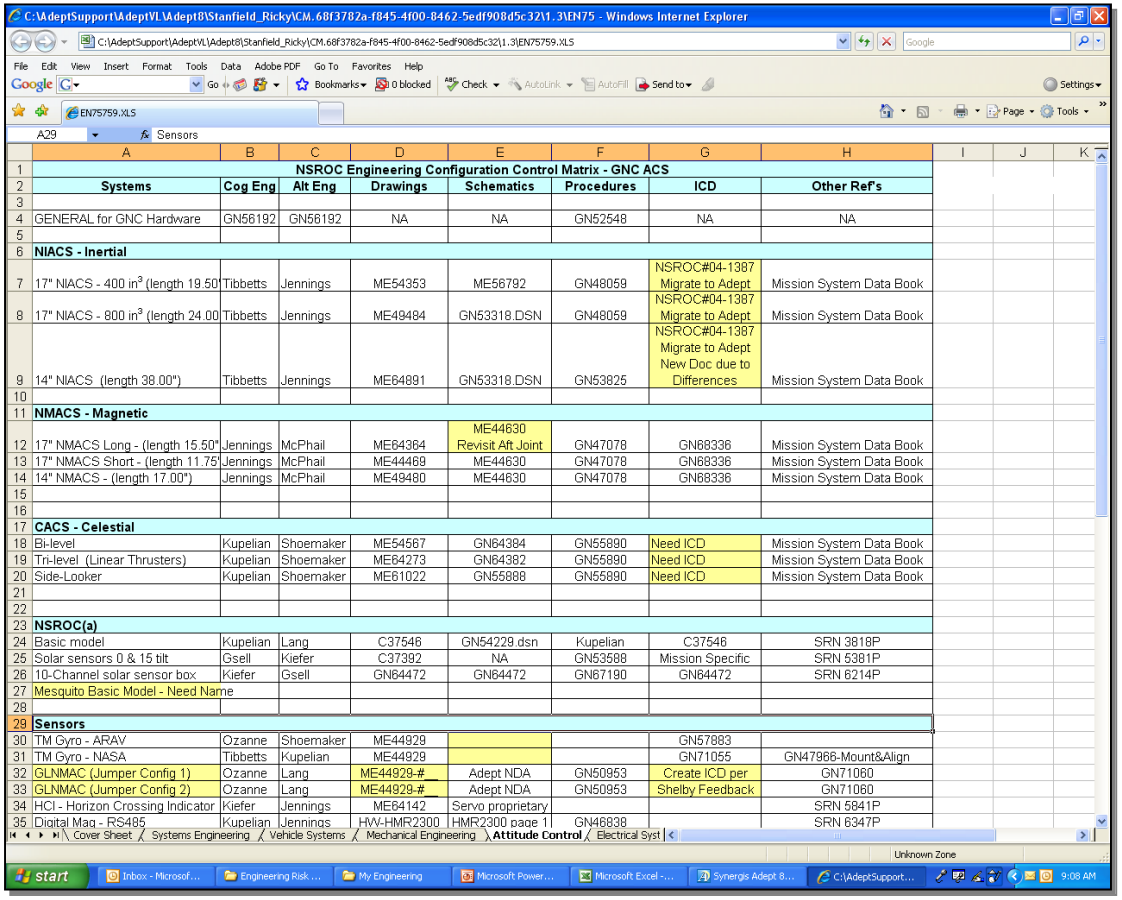
Risk Identification and Tracking

- The Engineering Risk Summary continues to be our main risk identification and tracking tool
  - Identifies risks by mission and engineering discipline
  - Tracks issues to closure with severity and mitigation notes
  - Tracks trends by department across all missions
- Matrix is updated each week
  - Reviewed with engineering leads monthly
  - Provided to SRPO as reference
  - Need to review more frequently with Mission Managers
- Implemented Improvements
  - Revised color code to reflect NASA Risk Management Guidelines
  - Expanded legend of symbols
  - Defined in new ISO Process
- Future plans include a migration to a MS Access version



Configuration Control Matrix

- NSROC continues to populate the Configuration Control Matrix
  - Applies to all NSROC standard systems, processes, and assets
  - Now includes Systems Engineering processes
  - Captures top level defining documents and cognizant engineer
  - Top level documents reference subordinate documents
  - CCB Panel meets once each month to update one engineering discipline
  - Shared with SRPO as a reference
- CCB serves as a forum for focused systems engineering discussion of every standard system
- CCB Matrix is now Adept controlled itself as EN75759



	A	B	C	D	E	F	G	H
1	NSROC Engineering Configuration Control Matrix - GNC ACS							
2	Systems	Cog Eng	Alt Eng	Drawings	Schematics	Procedures	ICD	Other Ref's
3								
4	GENERAL for GNC Hardware	GN56192	GN56192	NA	NA	GN52548	NA	NA
5								
6	NIACS - Inertial							
7	17" NIACS - 400 in^3 (length 19.50'	Tibbetts	Jennings	ME54353	ME56792	GN48059	NSROC#04-1387 Migrate to Adept	Mission System Data Book
8	17" NIACS - 800 in^3 (length 24.00	Tibbetts	Jennings	ME49484	GN53318.DSN	GN48059	NSROC#04-1387 Migrate to Adept	Mission System Data Book
9	14" NIACS (length 38.00")	Tibbetts	Jennings	ME64891	GN53318.DSN	GN53825	NSROC#04-1387 Migrate to Adept New Doc due to Differences	Mission System Data Book
10								
11	NMACS - Magnetic							
12	17" NMACS Long - (length 15.50"	Jennings	McPhail	ME64364	ME44630 Revisit Aft Joint	GN47078	GN68336	Mission System Data Book
13	17" NMACS Short - (length 11.75'	Jennings	McPhail	ME44469	ME44630	GN47078	GN68336	Mission System Data Book
14	14" NMACS - (length 17.00")	Jennings	McPhail	ME49480	ME44630	GN47078	GN68336	Mission System Data Book
15								
16								
17	CACS - Celestial							
18	Bi-level	Kupelian	Shoemaker	ME54567	GN64384	GN55890	Need ICD	Mission System Data Book
19	Tri-level (Linear Thrusters)	Kupelian	Shoemaker	ME64273	GN64382	GN55890	Need ICD	Mission System Data Book
20	Side-Looker	Kupelian	Shoemaker	ME61022	GN55888	GN55890	Need ICD	Mission System Data Book
21								
22								
23	NSROC(a)							
24	Basic model	Kupelian	Lang	C37546	GN54229.dsn	Kupelian	C37546	SRN 3818P
25	Solar sensors 0 & 15 tilt	Gsell	Kiefer	C37392	NA	GN53588	Mission Specific	SRN 5381P
26	10-Channel solar sensor box	Kiefer	Gsell	GN64472	GN64472	GN67190	GN64472	SRN 6214P
27	Mesquito Basic Model - Need Name							
28								
29	Sensors							
30	TM Gyro - ARAV	Ozanne	Shoemaker	ME44929			GN57883	
31	TM Gyro - NASA	Tibbetts	Kupelian	ME44929			GN71055	GN47966-Mount&Align
32	GLNMAC (Jumper Config 1)	Ozanne	Lang	ME44929-#__	Adept NDA	GN50953	Create ICD per	GN71060
33	GLNMAC (Jumper Config 2)	Ozanne	Lang	ME44929-#__	Adept NDA	GN50953	Shelby Feedback	GN71060
34	HCI - Horizon Crossing Indicator	Kiefer	Jennings	ME64142	Servo proprietary			SRN 5841P
35	Digital Mag - RS485	Kupelian	Jennings	HW-HMR2300	HMR2300 page 1	GN46838		SRN 6347P

Staffing and Retention

NSROC Engineering Staffing Plan

Engineering Staff		
Stanfield	NG	Director
Krause	OSC	Chief Eng.
Blake	NG	Admin

Manager	Administrative
Vacant/Planned	Part Time
Retiring	Unapproved Plan
Leave/Disability	~~Resigning~~

Location	Guidance				Flight Performance				Vehicle Systems				Systems Engineering				Electrical				Mechanical				Environmental				Information Technology			
Wallops Flight Facility	**Kiefer**	**OSC**			**Simko**	**OSC**	**Eng**		**Rosanova**	**OSC**	**Eng**		Vacant	Not Posted			**Elborn**	**OSC**	**Eng**		**Creighton**	**OSC**	**Eng**		**Maxfield**	**NG**	**Eng**		**Donovan**	**NG**		**Mgr**
	Crippen	RSS		Ad	Onions	NG		Ad	Weidner	RSS		Ad	------	------			Nock	OSC		Ad	------	------			-------	------			-----	-----		
	Jennings	ARC	Eng		Disbrow	OSC	Eng		Burkhead	NG	Eng		Vacant	Not Posted			Lankford	OSC	Eng		Mandigo	NG	Eng		Hudson	NG		Tek	Holmer	NG		Tek
	Kupelian	NG	Eng		Edwards	NG	Eng		Hesh	NG	Eng		Vacant	Not Posted			Diehl	NG	Eng		Yacobucci	NG	Eng		Marshall	NG		Tek	Watkinson	NG		Tek
	Ozanne	NG	Eng		Kilcoyne	NG	Eng		Owens	NG	Eng		Vacant	Not Posted			Cranor	ARC	Eng		Thompson	OSC	Eng		Sharpe	NG		Tek				
	Tibbetts	OSC	Eng		Power	NG	Mth		Wroblewski	NG	Eng		Vacant	Not Posted			Hesh	NG	Eng		Widmyer	OSC	Eng		Russell	NG		Tek				
	Shoemaker	OSC	Eng		Melvin P/T	NG	Eng		Serabian	NG	Eng						Vaughn	NG	Eng		Reese	NG	Eng									
	Benton	OCS	Eng		Vacancy 1	Not Posted			Scott P/T	NG	Eng						Gsell	OSC	Eng		Foster	NG	Eng									
	Gsell P/T	OSC	Eng						Contingent 1	Not Posted							Murray	OSC	Eng		Fleming	NG	Eng									
	McPhail	NG		Tek					Contingent 2	Not Posted							Brooks	OSC	Eng		Hylbert	NG		Drft								
	Lang	NG		Tek													Malaby	OSC	Eng		Walthall	OSC		Drft								
	Doyon	OSC		Tek													Bradley	NG	Eng		Paschak	ARC		Drft								
	Scott, Mike	NG		Tek													Johnson	OSC	Eng		Daughton	ARC		Drft								
	Corson	NG		Tek													Banks	NG	Eng		Vacancy 1	NG VurV										
	Snyder P/T	NG		Tek													Bowden	NG	Eng		Vacancy 2	Not Posted										
	Miller P/T	NG		Tek													Amey	NG	Eng		Vacancy 3	Not Posted										
	Vacancy 1	NG VurV															Blake P/T	NG	Eng		Vacancy 4	Not Posted										
	Contingent 1	Not Posted															Vacancy 1	Offered														
	Contingent 2	Not Posted															Contingent 1	Not Posted														
WSMR	**Martinez, C**	**OSC**	**Eng**						Evans	OSC		Tek					Starr	OSC		Tek	Christensen	OSC	Eng									
	Grzelachows	NG		Ad					Evavold	OSC		Tek					Bower	ARC		Tek												
	Martinez, J.	OSC	Eng														Hoxworth	OSC	Eng													
	Harmon	OSC		Tek																												
	Maldonado	NG		Tek																												
Totals	**Engineers**		9				6				7				0				17				9				1				0	
	Non-Engineers			11				1				3				0				3				4				4				3

- NSROC continues to recruit for engineers and turn-over continues to be light
  - Lost 1 ME and hired 1 ME, 1 VSE, and 2 EE since June 2008
  - Several recruits have very specialized skill sets we were looking for (Serabian and Gabbard)
  - Transitioned Giovanni Rosanova to lead VSE and brought up Brian Creighton to lead ME
- Average years of experience holding steady, with new employees pulling averages down slightly
  - ACS: 9 (+0) FP: 15 (-0) EE: 11 (-2) VSE: 6 (-1) ME: 2 (-1)
- NSROC is continuing to encourage engineers to take on more project engineering responsibility
  - Improves Systems Engineering Skills and Project Execution
  - Grooms Future Leaders and Mission Managers
- NSROC continues to develop its approach for staffing Systems Engineer for the program

Engineering Resources

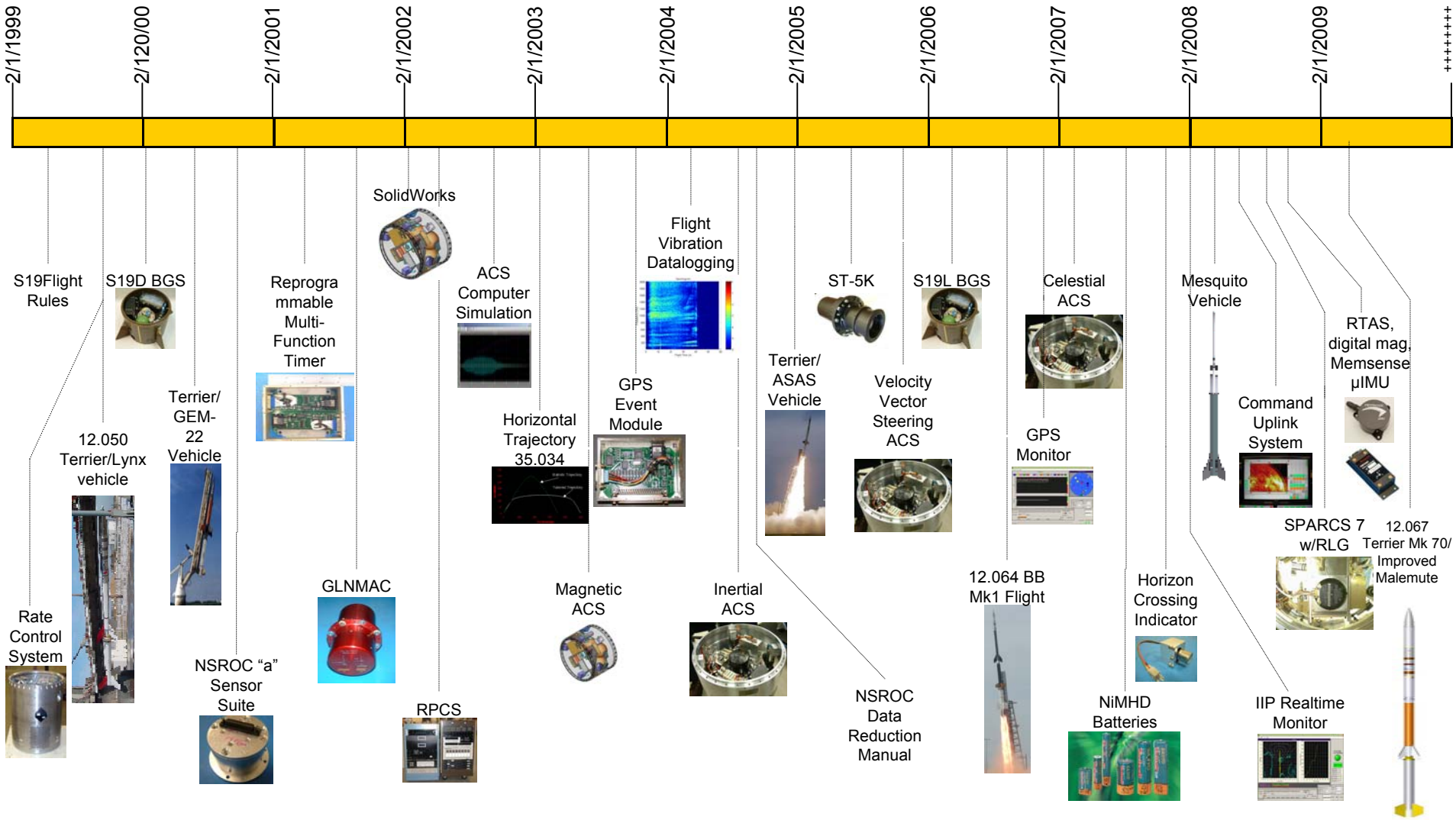
- Engineering Leading Indicators
  - Quantifying mission complexity balance and requirements stability
  - Optimizes work force to match pressures of overall mission set
- Engineering Risk Summary
  - Keeps attention on all risks
  - Identifies emerging risks early when they can be resolved with least impact
  - Maintains open awareness and dialog on risks and challenges
- Configuration Control Board process
  - Focusing on standardized systems, their specifications, and ownership
  - Minimizes effort needed to use these systems on all missions
- Staffing and Recruiting
  - Focused and persistent recruiting is filling our strategic engineering needs
  - Building a staff base to meet engineering and mission management needs

NSROC Engineering has a good tool set for monitoring workload and the work force to fully support the projected mission manifest

NSROC Engineering

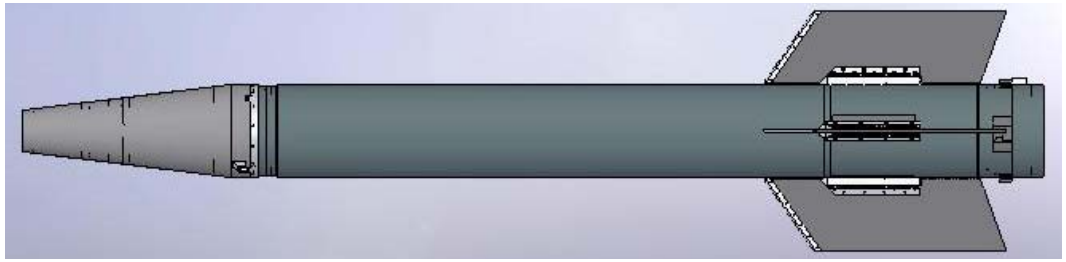
Dave Krause

NSROC Technology Enhancements



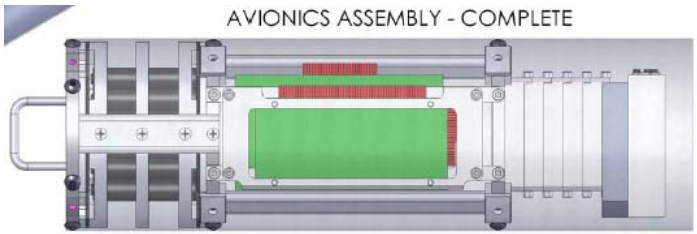
Mesquito Vehicle

- 2 Flight Tests on May 6 & 7
  - Flights included inert dart assembly
  - High speed optics showed clean rail travel
  - No WFF radar track
  - Navy Aegis showed small portion of trajectory reconstruction
  - Dart separation did occur, unverifiable separation time and apogee
  - Booster fin assembly at ~8 seconds when radar boresight locked
- Design Changes for Next Flights
  - Inclusion of Avionics Suite
    - Allow TM tracking from mainland (lower slew rates)
    - Capture environmental data through boost phase
    - Capture attitude data
  - Booster Fin Assembly
    - Reduce operational complexities
    - Structurally more robust



Mesquito Vehicle – Current Flight Plan

Mesquito Go Forward Plan					
	Configuration				
Flight	Dart	Interstage	Booster	Instrumentation	Goal
12.068 FT2a: control	- baseline, dart attached to booster - tail assembly modified for umbilicals & lanyard	baseline	baseline	YES	- verify structural integrity through burn - investigation of 12.065, .066 anomaly - verify aero properties (thrusting and coasting)
12.069 FT3: Rev A control	- baseline, dart attached to booster - tail assembly modified for umbilicals & lanyard	baseline	modified booster fin assembly (REV A)	YES	- verify structural integrity through burn - verify aero properties (thrusting and coasting)(primarily drag) - verify structural integrity of modded fin assembly
12.070 FT4:	baseline 4" diameter, separating, clamshell nosecone	baseline	REV A	YES	- verify separation - verify dart performance - gather flight environment data
12.071 FT5:	baseline 4" diameter, separating, clamshell nosecone	baseline	REV A	YES	- verify separation - verify dart performance - gather flight environment data
baseline = same as 12.065, .066					



AVIONICS ASSEMBLY - CURRENT FLIGHT ARTICLE

Terrier Mk 70/Improved Malemute Vehicle

12.067 Mission

- Goals
  - New vehicle for Sounding Rocket stable
  - Expand capability of Sounding Rocket program
  - Reduce cost per mission
- Benefits
  - Cost savings over single stage Brant (~$400k)
- Performance
  - Demo flight shows 750 lbm to ~320 km
  - Parametric studies in process
- Vehicle Diagnostics
  - Vibrometers
  - Accelerometers
  - Thermistors
  - Video camera
- Remaining Questions
  - Spin sensitivity
  - Adequate ignitor output for at altitude ignition (~25k ft)
  - Acceleration levels
- Tentative Launch Date
  - Spring 2009

Payload Assembly

-17.26" diameter, 11 degree taper nosecone

-TM from ACS developmental missions, 7 flights

-No recovery planned

-Ignition module is CDI based

Improved Malemute

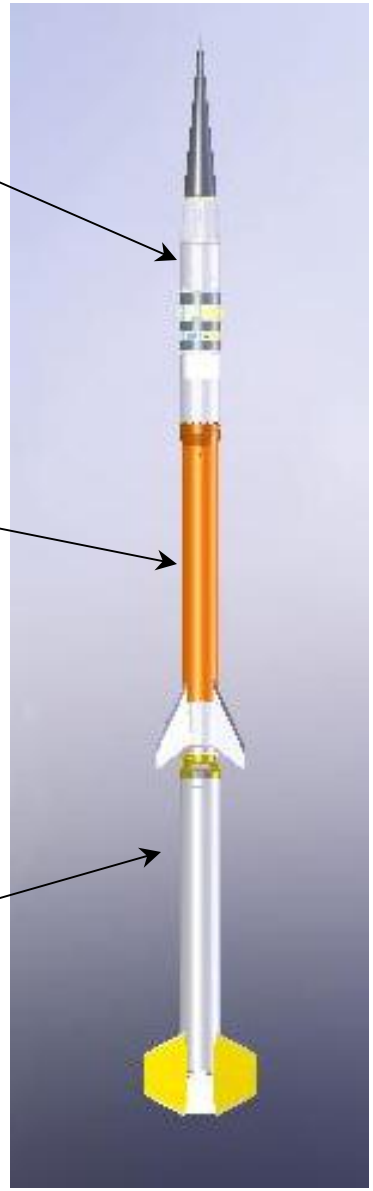
- Military surplus
- 1.9 ft^2 fins from Malemute heritage
  - single wedge
  - swept back
- High thrust, 12 sec burn solid propellant
- 16" diameter

Terrier Mk 70

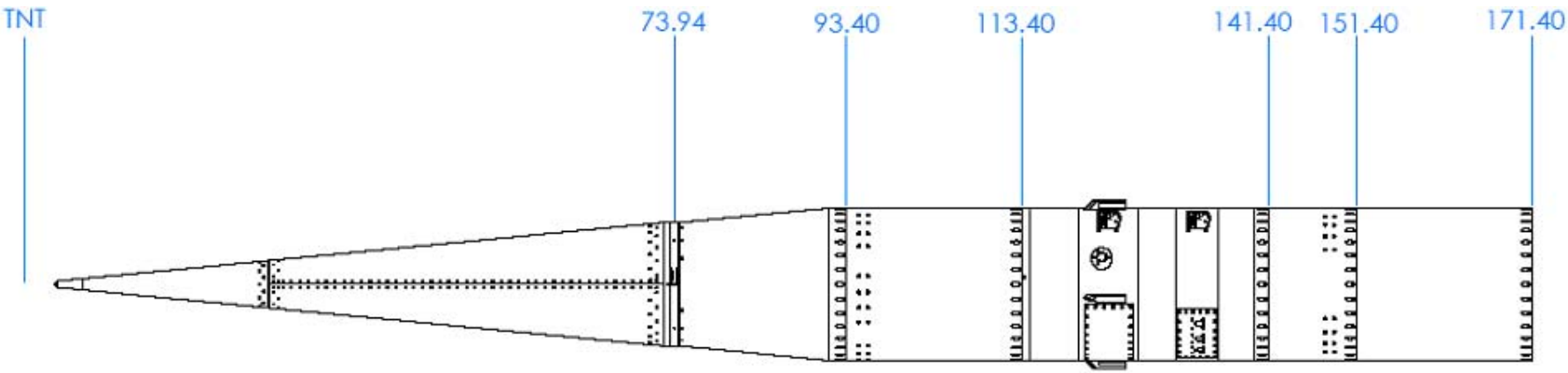
-Solid propellant

-4.8 ft^2 fins

-Adequate reserves for 10 years



12.067 Payload & Vehicle Configuration



Nosecone
- 11 deg stainless steel NC
  - stock item
- Non-deployable
- Mast
  - Magnetometers
  - µIMU - Memsense

Transition
- 11 deg taper
  - new build
- Aluminum
- Ballast mount

Ballast Module
- In-stock Item
- Aluminum structure
- Solar sensors

Telemetry Module
- Reflight hardware
  - 12.052, 12.053, 12.056, 12.058, 12.059, 12.061
- 2 (3 w/ GPS) RF antennas
  - S-band OPCM data
  - S-band analog video
  - GPS (?)
- C-band Transponder
- Diagnostics interface
  - Accelerometers
  - Vibrometers
  - Thermistors

EXP Module
- Previous EXP Module
- Aluminum structure
- Idiot ring adaptor

Transition
- 11 deg taper
  - new build
- Aluminum structure
- Ballast mount

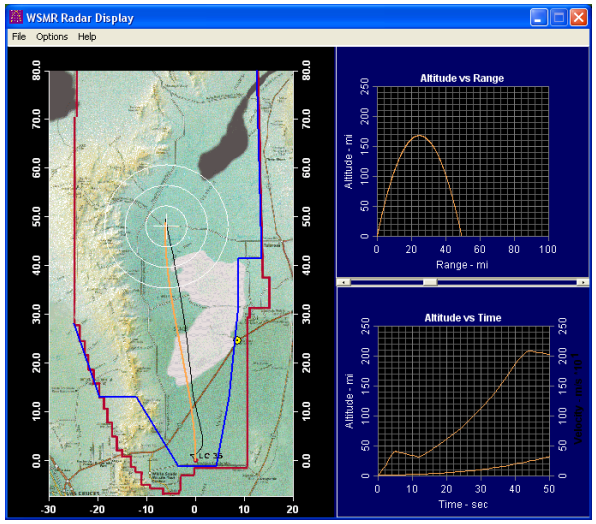
Other Ongoing Investigation

- Black Brant Mk 1
  - Chuck Brodell, AIB Chairman
  - Panel includes Brodell, Ward, Krause, Hesh, Kotsifakis, Geisler, Ray, Bowden
  - Investigating 2 anomalous aspects
    - Spin-up at pressure tail-off (up to 2.2 Hz) on high altitude flights (39.008)
    - Low performance (BBIX w/ Mk 1 expected increase ~10%, now ~3%)
  - Both items appear related to Ammonium Perchlorate quantity and size
    - Bristol switched AP manufacturer from US to Chinese
    - Affects the agglomeration of liquid alumina and aluminum oxide internal of motor
      - Impulse lost due to lack of phase change, gaseous Al not contributing in plume
      - Liquid dump at pressure decay provides momentum transfer to increase spin rate (does not completely explain spin up)
    - Similar issue to STAR motor loss (during GPS satellite deployment)

Flight Performance

Mark Simko

Wind Weighting & FP Programs



- Wind Weighting
  - All FP Engineers fully trained in WW operations
  - WW conducted remotely or on site as required
  - Performed Wind Weighting on 99 missions launched @ WSMR & PMRF
  - Established written procedures and guidelines following BBIX cut down
- FP Programs
  - Finished converting all relevant FP programs from VAX to PC
  - Mix of FORTRAN, C++, MATLAB programs
  - GUI's created to increase efficiency and reduce input errors
  - FORTRAN and C++ programs are Configuration Controlled, working on MATLAB programs
  - Manuals and procedures established for Preflight, Postflight, Wind Weighting
  - Converted many pre existing paper documentation to PDF
  - Archive of missions/analysis on server

Vehicle Development & Internal FP Meetings

- Vehicle Development
  - Replaced Black Brant with Black Brant mk1 in vehicle stacks
  - Terrier mk70-Lynx
  - Terrier mk70-Improved Orion
  - Eliminated Taurus-Orion, Nike, and standard Orion
  - Flew “horizontal” BBX trajectory
  - Developing Mesquito
  - Single Stage Terrier
  - Terrier mk70-ASAS
  - Terrier mk70-Oriole
- Internal FP Meetings
  - ~Weekly FP meeting
    - Review of new/modified production code
    - Share analytical techniques
  - ~Quarterly interdisciplinary meeting between FP-ME-VS

FP Improvements

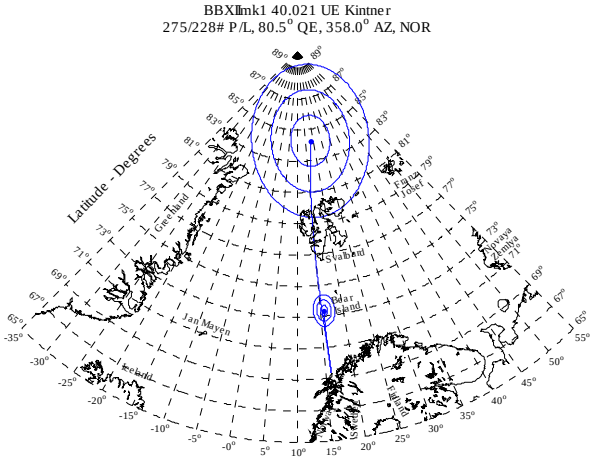


Figure 3.5-1. Impact Dispersion Map

- FP Improvements
  - 100% electronic reports
  - Many “how to” manuals on many analysis topics
  - Faster more powerful computers
    - Quicker turn around time on analysis
    - More Monte Carlo dispersion analysis
    - Visual NASTRAN simulations
  - All analysis available on intranet and available for review
    - Inputs, outputs, results
    - Compare similar payloads
  - More comprehensive MRR and DR documentation
  - Updated Sounding Rocket Database
  - Archived old TM and RADAR tapes from pre NSROC to DVD’s

Attitude Determination

- Attitude Determination
  - Part of Flight Performance
  - Updating attitude reduction manual
    - Comprehensive reference and training tool
    - Reference for science community
    - Revision due in 2009
  - Updating attitude reduction programs
  - Developed new techniques to remove attitude sensor error/drift
  - Troy 7 Subcontract developing new techniques for attitude reconstruction from sparse sensor data
    - Successfully implemented on 40.021/Kintner
    - To be evaluated further with 40.022/Kletzing and 41.075/Smith

Personnel

- Personnel
  - 4–Flight Performance Engineers
    - 50+ man years experience
  - 2-Attitude Determination Engineers
    - 40+ man years experience
  - 1-Documentation Specialist

Electrical Engineering

Shelby Elborn

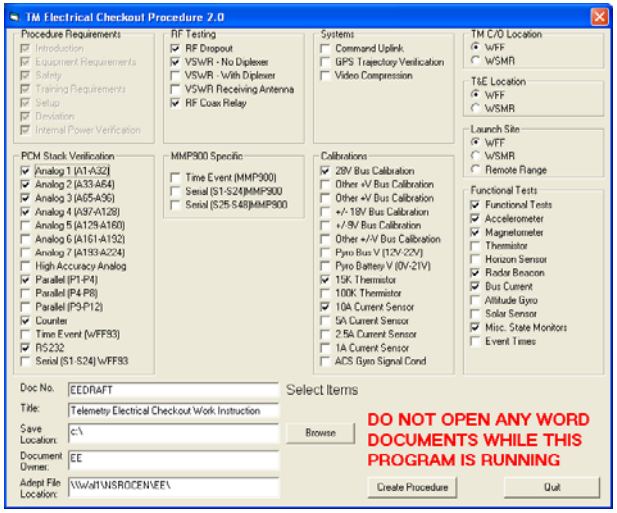
Electrical Engineering Plan

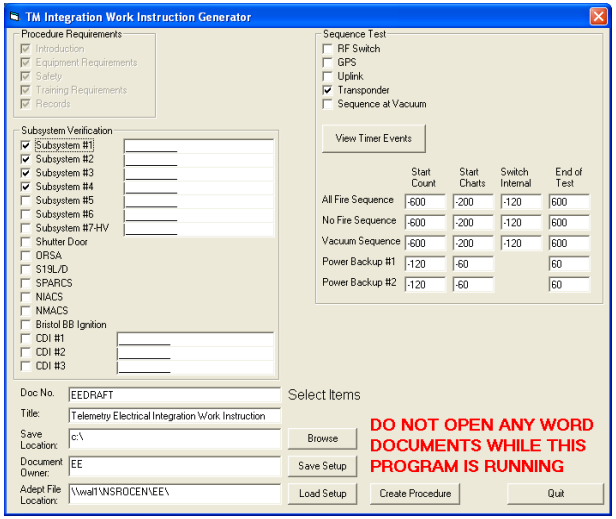
- Efficient Use of Engineering Hours
  - Reduce Design Time
  - Reduce Electrical Checkout Time
    - Automate Component Testing
  - Reduce Date Reduction Time
- Improved Capabilities
  - Flight Hardware
    - NSROC Developed Hardware
    - Purchased Flight Hardware
  - Ground Support Systems
  - High Data Rate Telemetry

Payload Design

- Standardization
  - Standardized Electrical Power Systems
  - Standardized WSMR Instrumentation Systems
  - Standardized CDI systems

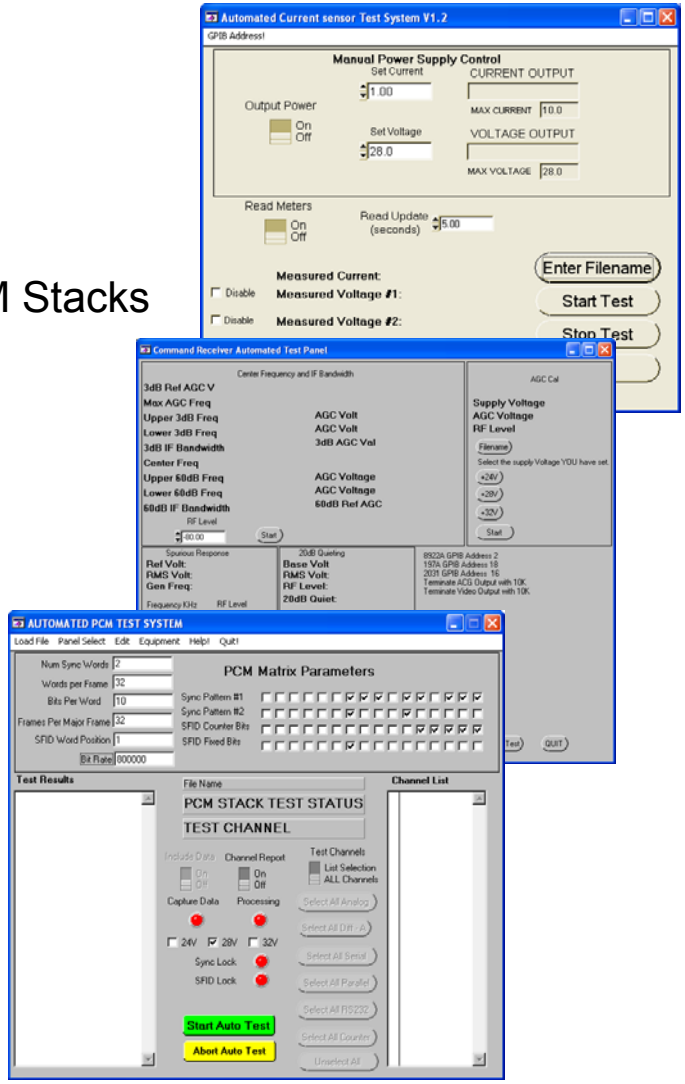
- Software Developed to Reduce Design Time
  - Wire-list Program
  - TM Checkout Work Instruction Generator
  - TM Integration Work Instruction Generator
  - PCM Order Form





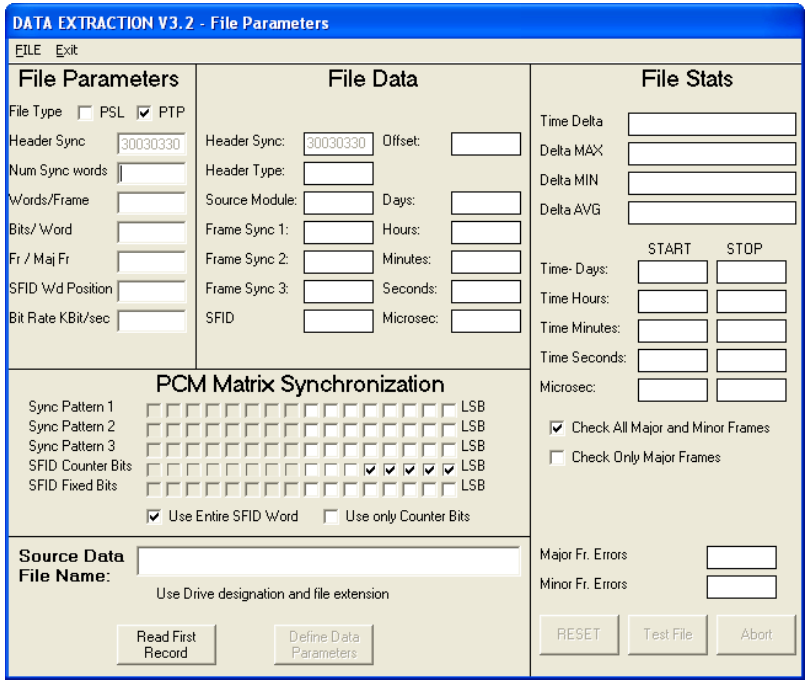
Electrical Testing

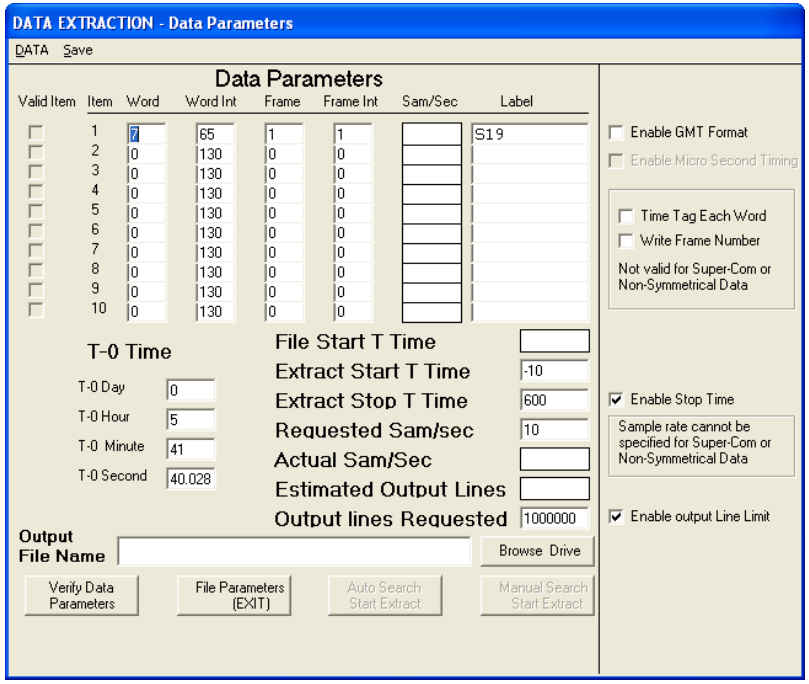
- Automated Test Systems
  - Automated PCM Stack/Payload Test System
    - Assigned Engineers to build and test PCM Stacks
  - Automated Transmitter Test System
  - Automated Command Receiver Test System
  - Automated Command System Test
  - Automated Current Sensor Test System
  - Automated RMFT Test System
  - Automated Battery Test & Cycle Test System



Data Reduction

- NSROC Developed Software
  - Data Extract Program
  - Software to Extract GPS Parameters



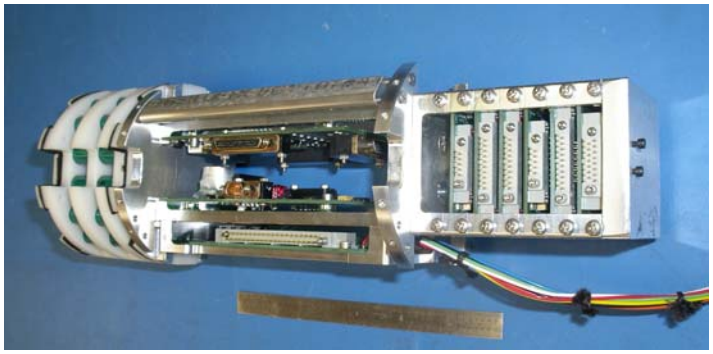


Flight Hardware

- NSROC Developed Flight Hardware
  - RMFT
  - Dual RMFT
  - Power Control and Distribution System
  - Three Axis accelerometer in one 3x4x1 box
  - Surface mount monitor box
  - Low Cost TM Encoder (LCTE)
  - Opto Isolated monitor box
  - GPS Event Module(GEM)
  - 8 channel fixed format PCM encoder for test rockets
  - Dual Capow Pack

Flight Hardware

- NSROC Developed Flight Hardware – cont.
  - Mesquito Development
    - Mesquito PCM 1.75” x 1.75” PCM System
    - Solid State Power Switching/monitoring
    - Nose Cone Pyro System
    - Miniature Accelerometer, Magnetometer, Solar Aspect package
  - GPS – Newest Version is Javad JNS-100
  - Anti-Aliasing Vibrometer Filter

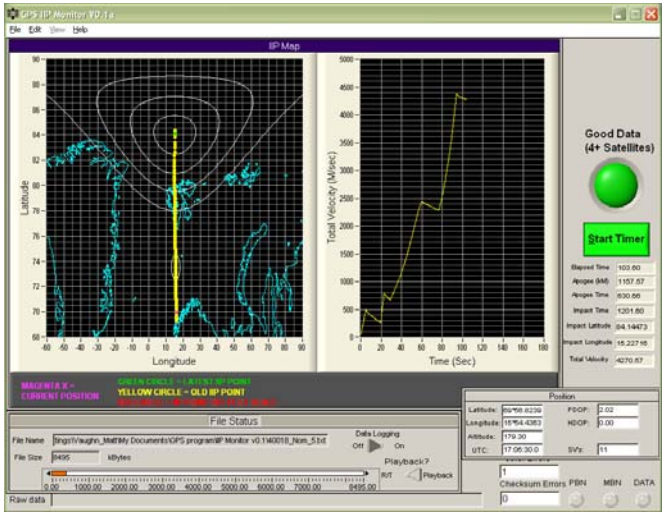


Flight Hardware

- Purchased/Qualified Flight Hardware
  - High Efficiency Transmitters
  - Nickel Metal Hydride Batteries
  - Airborne Bit Sync/Decom
  - WFF93 Command Receiver
  - Antennas
    - 22” GPS/S-Band
    - 17.25” Upper S-Band
    - 17.25” GPS/S-Band (PSL and Haigh-Farr)
    - 14” S-Band
    - 9” GPS/S-Band
    - 4” GPS/S-Band
    - 2.75” S-Band

NSROC Developed GSE

- Remote Payload Control System (RPCS)
- RPCS+ for controlling hazardous systems
- Portable GPS Ground Stations
- Digital Display Universal Suitcase
- Remote Temperature System (ROMOTEMP)
- GPS IIP
- Multi-Timer Display



High Data Rate Telemetry

- High Data Rate Efforts Completed to Date
  - 39.008 LeClair/MDA June 26th, 2008, 200 MBPS at Ku-Band

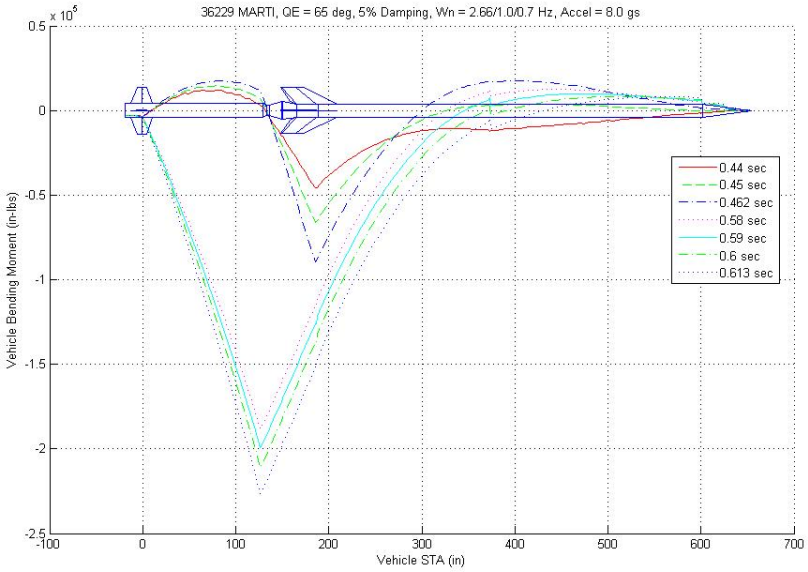
- High Data Rate Efforts in Progress/Planning
  - 36.245 Figueroa/GSFC, new PSL “MV” PCM encoders @ 20 MBPS
  - 40.025 LaBelle/Dartmouth
    - NSROC is evaluating digitization of the Dartmouth Baseband signal at ~12.5 MSPS with 16 bit resolution = 200 MBPS
    - NENS can develop LCT2 to accept 200 MBPS, add synchronization and convert to convolutionally encoded rate ½ QPSK modulated 30 Watt RF output at X-Band
    - NSROC has located a vendor and will procure a 17.25” diameter X-Band wraparound antenna for data transmission

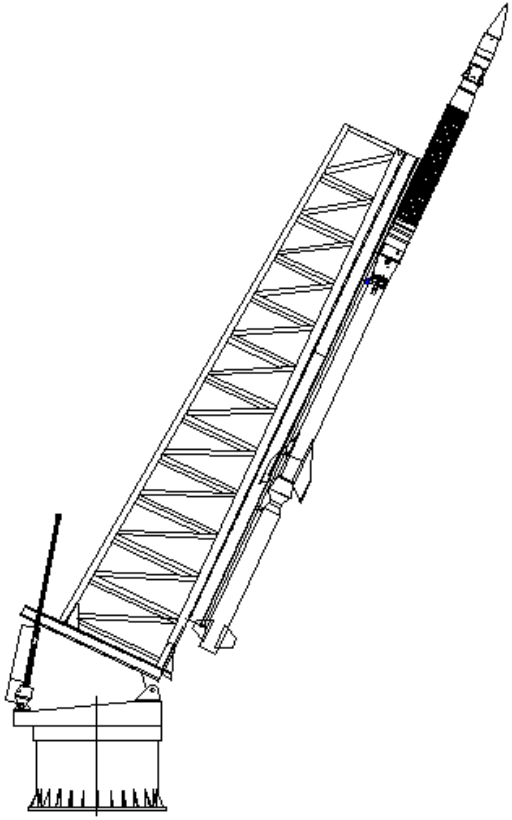
Mechanical Engineering

Brian Creighton

Mechanical Engineering

- **Launcher Egress Analysis**
  - Program written to calculate vehicle loads during rail travel.
  - Analysis performed on a few different payloads (MARTI, Lehmacher, and Bounds).
  - Works well on single and two stage vehicles.
  - Needs the following improvements:
    - Better modeling of three and four stage vehicles
    - Model launcher dynamics (i.e. boom flexing)



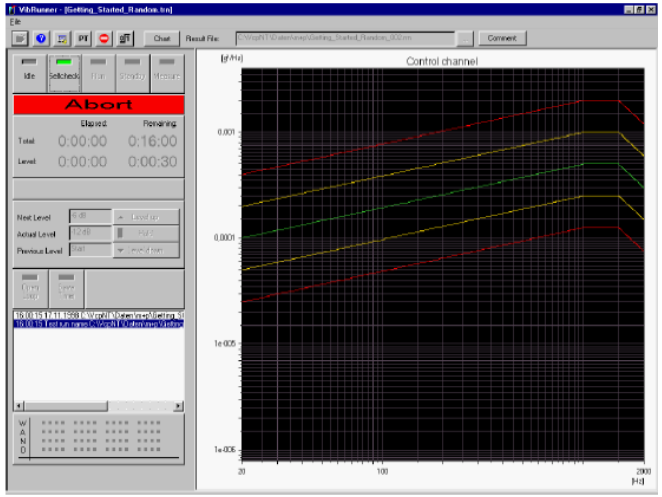


T&E Lab

- **MOI-to-POI Table Upgrade**
  - The hardware and software modifications have been completed.
  - Continue to gather data on different test articles so the output can be compared with the Gisholt spin balance machine output.
  - Some issues need to be worked out to measure the POI of test articles with long flexible booms deployed (i.e. E-Field Booms on Bounds Payloads).

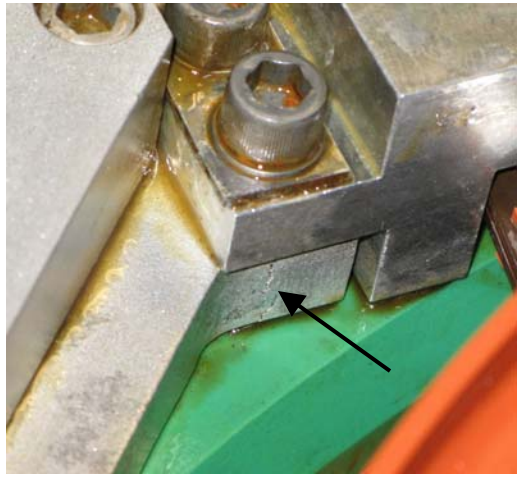
T&E Lab

- **Vibration Controller Upgrade**
  - Upgraded the controller software to the M+P VibControl package.
  - Advantages include:
    - Force gauge input and control
    - Modal testing support
    - Hardware abort capability
    - Windows based software (more user friendly and easier to repair / replace)



T&E Lab

- **Vibration Shaker Failure (late October)**
  - Flexure mounting ring inside the lateral shaker table cracked.
  - Replaced the lateral shaker table with one acquired from GSFC earlier this year.
  - Completed this with minimal impact to the workflow in the lab.



Machine Shop

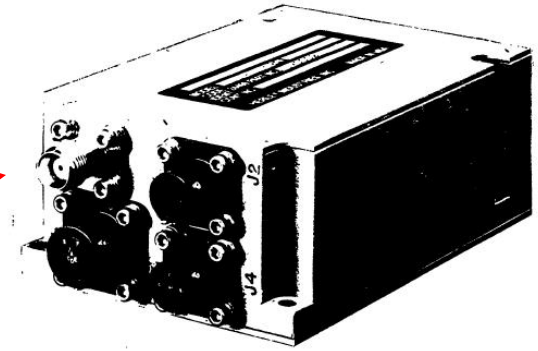
- **New equipment over last 10 years**
  - Leadwell V30 3-axis milling center
  - Leadwell V40 3-axis milling center w/ rotary indexer
  - Fryer MC40 3-axis milling center
  - KomoButler 4-axis milling center
  - WaterJet
  - American Turn Master 2-axis turning center
  - Haas VF2 3-axis milling center w/ 4th axis plug-n-play

Vehicle Engineering

Giovanni Rosanova

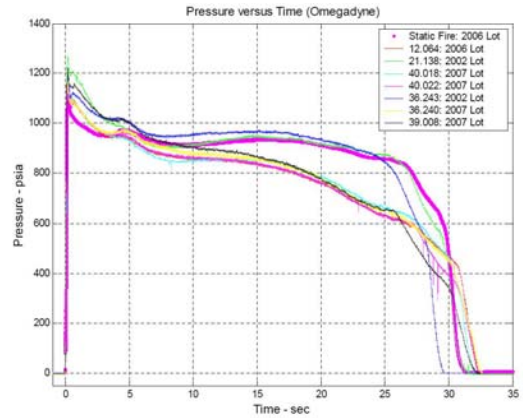
Vehicle Engineering

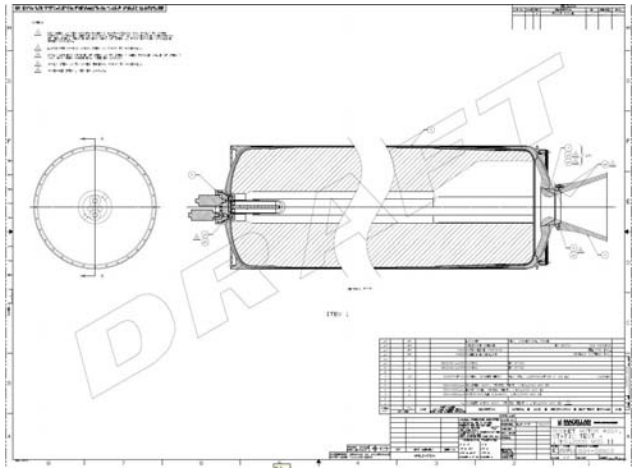
- Flight Termination System
  - Interim Hybrid System
    - Heritage system is single string, in Bristol Igniter housing (TTS)
    - Lowest quantity component is heritage receiver (Herley HFTR100)
    - WSMR MFS suggested replacing receiver with newer model until all heritage system components are used up.
    - Substitute receiver (Herley HFTR60) also prime candidate for follow-on new FTS.
    - Design Review for Interim Hybrid System January 14, 2009 at WFF.
    - First flight expected Spring 2009
  - New System
    - Design complete, components selected, test plan in development
    - Target first flight Fall 2009



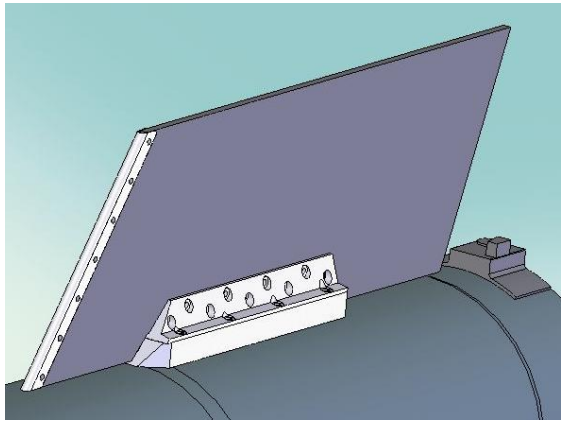
Vehicle Engineering

- Black Brant Mk1 Performance Investigation
  - NSROC, NASA, Bristol, and a SME in weekly telecons
  - Propellant chemistry and aluminum slag build-up are primary focus
  - Solutions: Accept as-is? Change propellant recipe?
- New Nihka
  - NSROC, NASA, Bristol, and a SME held design review, action items in work
  - Static fire planned in Spring 2009 at Bristol
  - Deliveries begin in Fall 2009
- Terrier Mk70 – Improved Malemute Development
  - Coordinating with ATK on IM roll rate and altitude ignition studies
  - Design of IM tail can and payload adapter





Vehicle Engineering



- Mesquito Development
  - Fin interface redesign and subsequent testing
- Terrier Mk12 Issues
  - High percentage failing pressure test during inspection
    - Currently only two good units at WFF
  - Indian Head also discovered some with shrunken grain
  - Not clear if issues are related
  - Planning static firing at Wallops Spring 2009
- New ORSA Electronics
  - Heritage System
    - Mechanical timer inventory diminishing and recent reliability problems
    - New mechanical timers cost prohibitive
    - Bristol refurbishments expensive and take months
  - New System
    - Introducing electronic timer, new g-switch, and circuit consistent with other NSROC systems
    - Test flight of deck Spring 2009, target first operational flight Fall 2009

-115

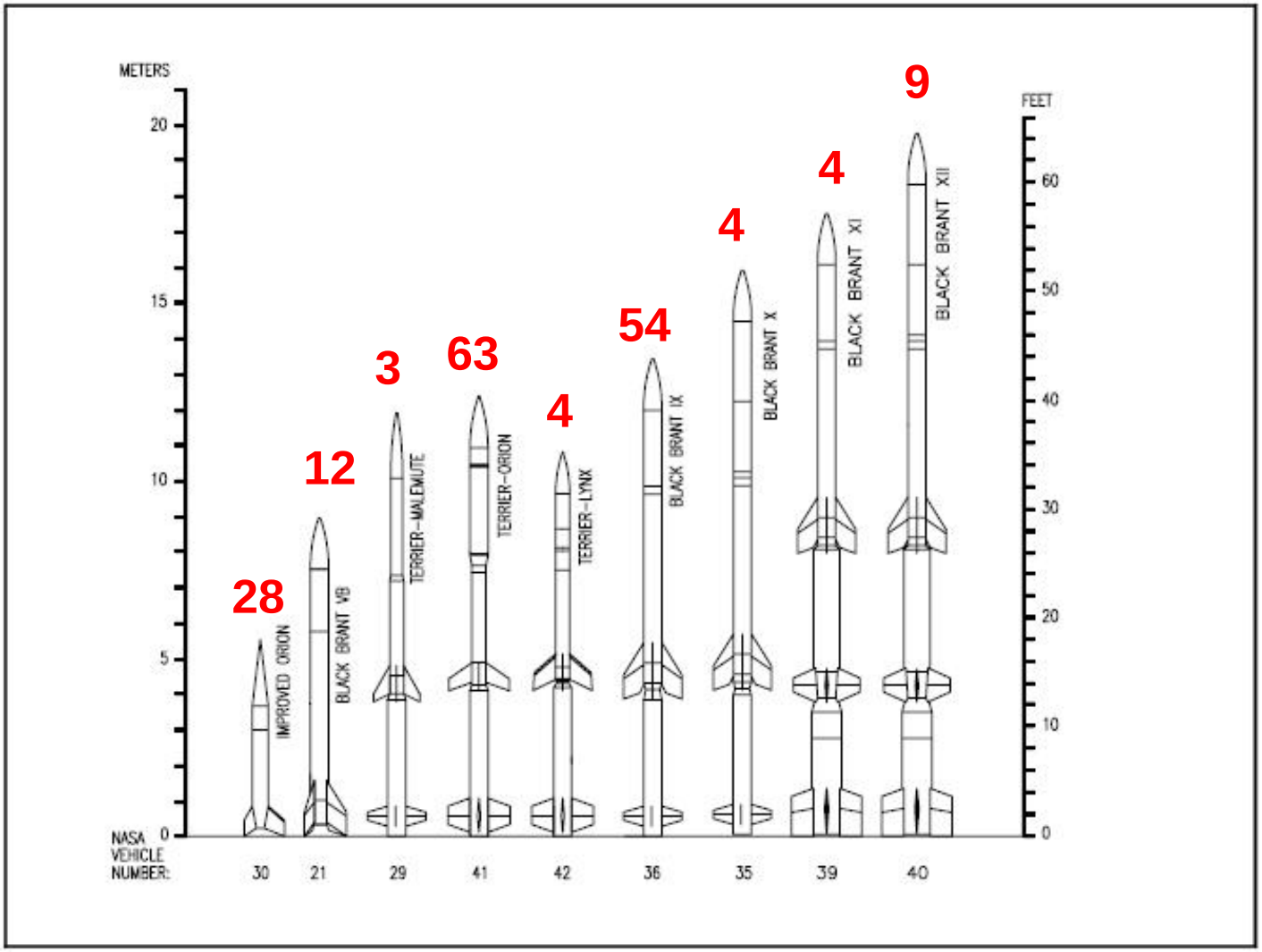
Inertia Switch Inc.
Model 6UO-115
G-Switch

Vehicle Engineering

- Water Recovery of Telescopes (SRWG Findings)
  - BB9 or larger will have downrange impact >50 miles
  - Recommend developing steerable recovery to bring payloads closer to land
  - Payload need to have sealed ACS, TM, experiment electronics
    - There is heritage sealing these types of sections
- Staffing
  - Recovery Systems Engineer, Belinda Serabian
    - Mechanical Engineering degree
    - FAA certified rigger for personnel parachutes
    - Previous employment developing heavy drop military cargo parachutes
  - Recovery Systems Engineering Mentor, Bruce Scott
    - Part-time-on-call

Vehicle Engineering

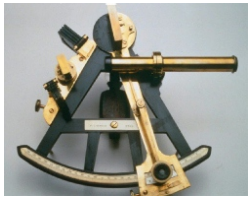
Ten Year Summary
Vehicles Launched



ACS/Sensors

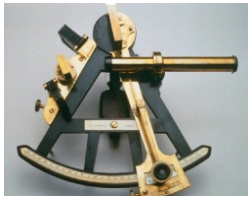
Ron Kiefer

Sensor Hardware - Standard



- GLNMAC
  - S/N 057 is being built (WFF)
- Solar Sensors
  - SLIT (set contains 4 sensors)
  - Coarse Solar Sensor
  - MASS
  - LISS
- Magnetometers
  - TM Bartington (0-5V)
  - NMACS Bartington (± 10V)
- Star Tracker
  - ST5000 (University of Wisconsin)
- Rate Sensor
  - Gyro chip sensor
- Horizon Crossing Indicator
  - HCI by Servo Corporation of America

Sensor Hardware - New

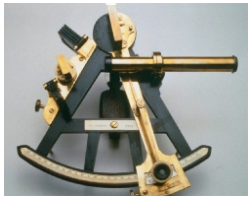


- Micro-IMU
  - Size of a “Hockey puck”
  - Robust – by MEMSense
- Digital Magnetometer
  - Honeywell HRM2300
  - Better performance
- Ring Laser Gyro - SPARCS
  - 1 lb unit by Honeywell
  - Improvement over RIG control
- ST5000 repackaged (Mark III)
  - Smaller, lighter, more robust

GSE

- Command Uplink System
  - Latest state-of-the-art technology
  - Touch screen control

Sensor Hardware - New

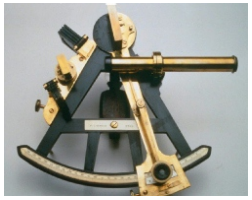


MEMSense Micro-IMU

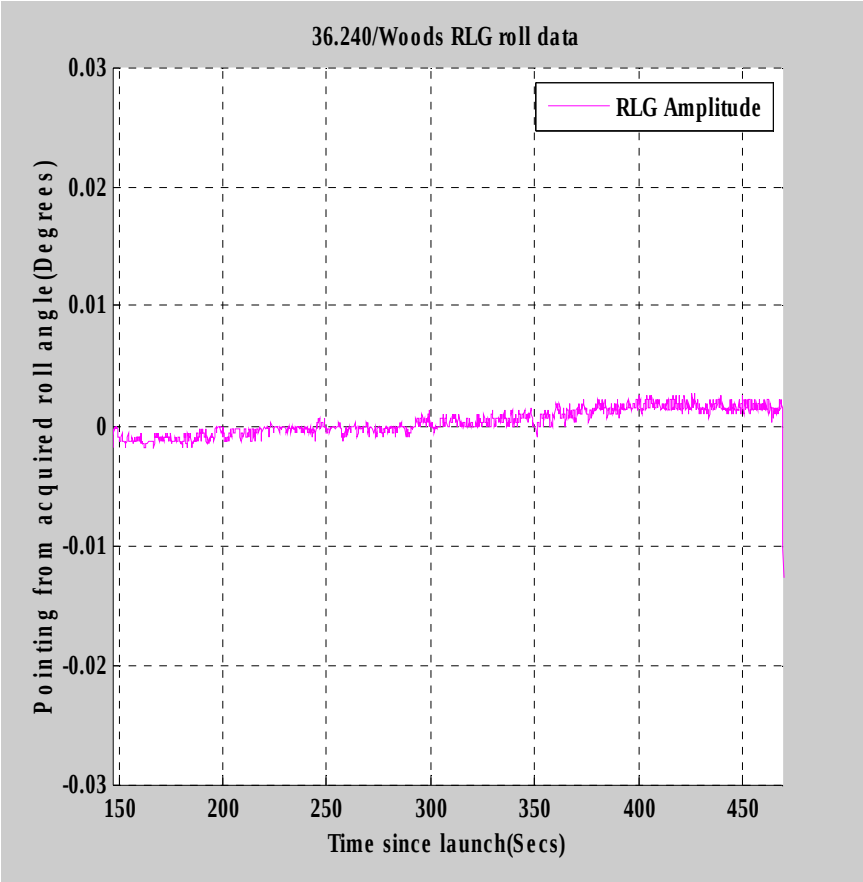
Digital Magnetometer

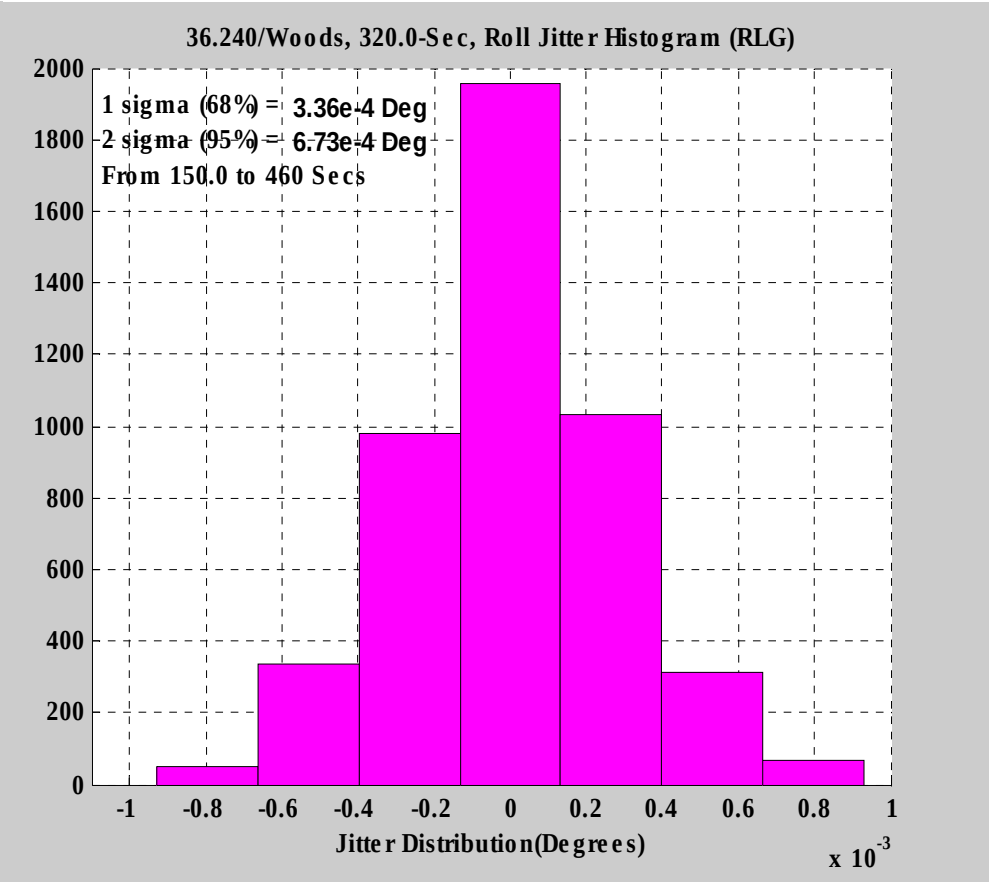
SPARCS 7 Performance

with Ring Laser Gyro (RLG)

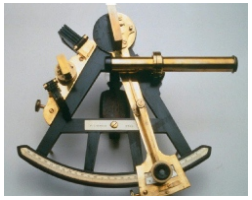


- 36.240/Woods roll drift was 0.038 deg/hr and roll jitter was below 0.0007 degrees for 95% of time (2σ).
- These numbers represent an improvement over the RIG of about 8 and 4.5 times respectively in the roll axis.



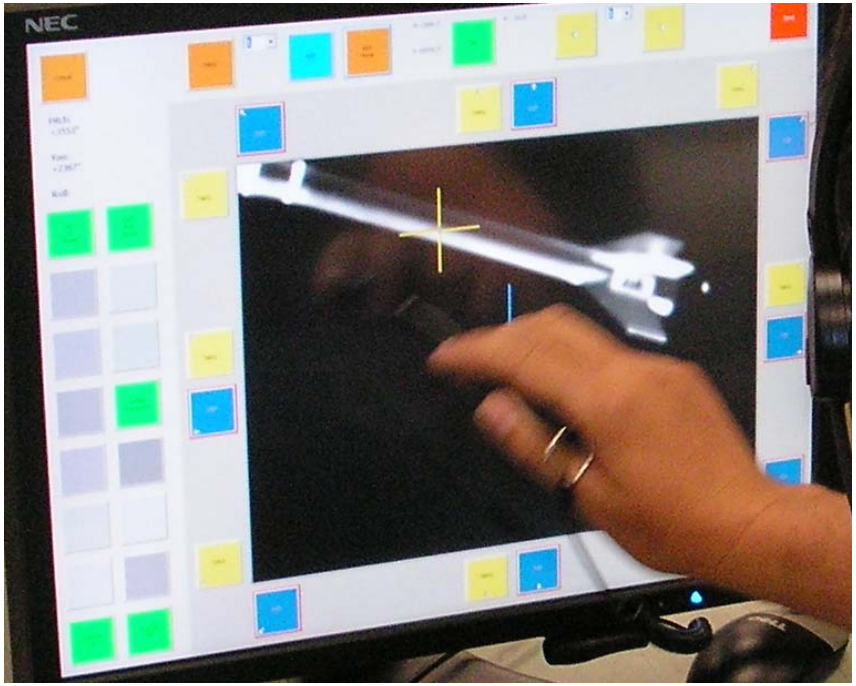


Sensor Hardware – New GSE

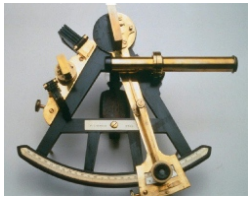


Command Uplink System

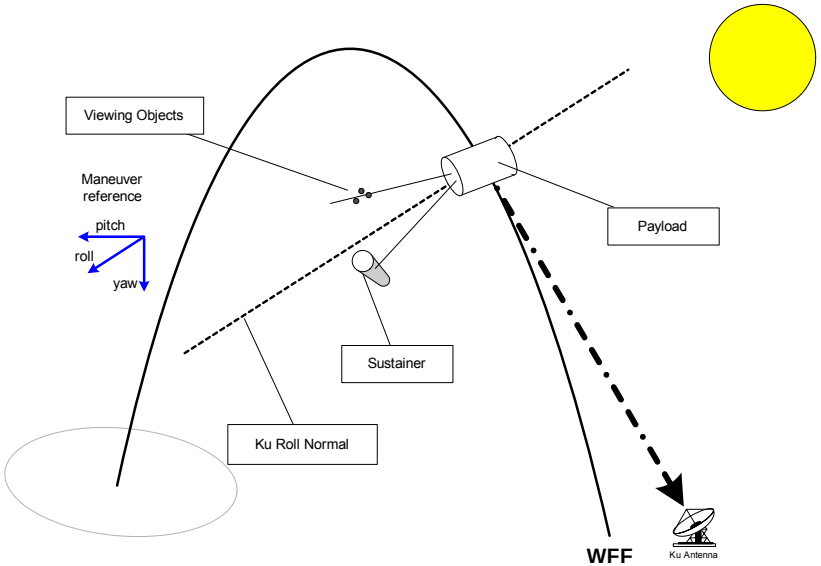
- Touch Screen Control - LeClair MDA payload June 26, 2008



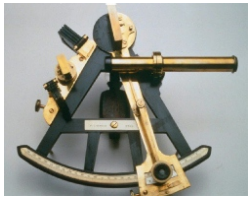
ACS Hardware – LeClair 39.008



- 3 axis pointing control of payload based on 2 requirements
  - Ku band transmitter horn
  - Mission pointing requirements
- Roll payload to best fit secondary target.
- Flight results:
  - ~0.03° pointing
  - Ku lock maintained
  - 12.5° Ku link half angle.

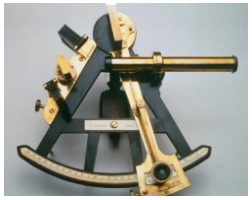


ACS Hardware - New

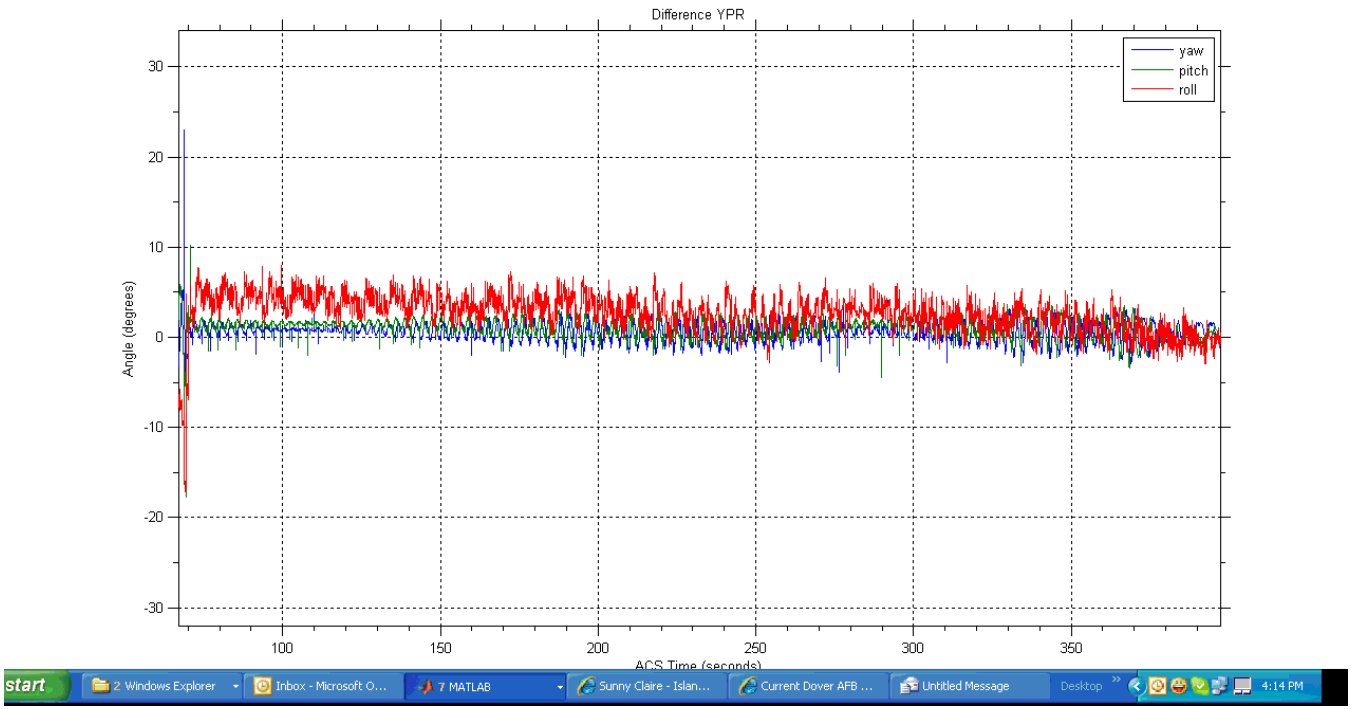


- RTAS
  - Provides payload attitude real-time
  - Uses the micro-IMU and GumStix computer
  - Also uses solar sensors, HCI and digital magnetometer
  - Maiden flight was Smith 41.075 on July 14, 2008

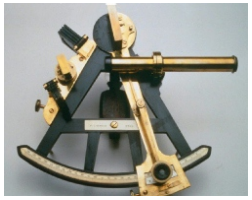
RTAS Flight Attitude on Smith



- ~ 3 degree accuracy over complete flight
- 1 Hz roll rate



ACS Hardware - Standard



Flight Proven Attitude Control Systems

- NIACS
  - Accuracy of 1 deg
  - Inertial or spinning to 2 Hz
- NMACS
  - Accuracy of 3 deg, sensor dependent
  - Magnetic spinners to 5 Hz
- CACS
  - Fine pointing <0.5 arcsec.
  - ST5000 tracker (no guide stars required)
- SPARCS
  - Fine Pointing <0.2 arcsec
  - 4 units available for solar missions

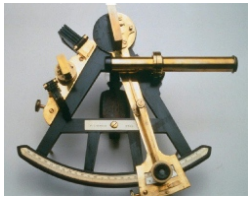
Sensor Suite

- NSROC(A)
  - Miniature unit used with SLIT solar sensors

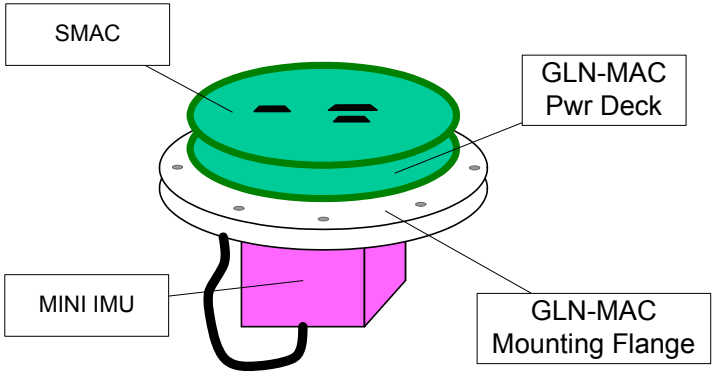
Boost Guidance Systems

- S19 BGS
  - 3 units of S19D with DMARS
  - 4 units of S19L with LN200
  - 4 more S19L units on order

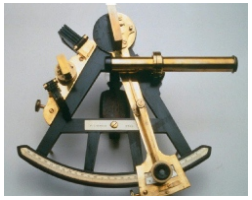
ACS Hardware - Innovation



- Candidate for TM Gyro application
  - New development
  - Intended as GLNMAC Replacement for attitude data
  - Lighter and cheaper than GLNMAC
  - Expect to be available in 2010
  - Maiden flight on Bull 41.082 – Spring
  - Mini-IMU flew on LeClair 39.008



NSROC ACS Missions



Recent Past

- Smith 41.075

  Launched July 14, 2008
  - RTAS
  - GLNMAC (Beamformer)

- Kowalski 36.207

  Launched October 20, 2008
  - Celestial ACS
  - S19D
  - CUS

Present

Poker Campaign 2009

- Bounds 36.242 and 21.139
  - NMACS
  - TM GLNMAC
- Lehmacher 41.078/41.079
  - Sensors Only
    - TM Magnetometer
    - Horizon Crossing Indicator (HCI)
- Lynch 40.023
  - NIACS
    - Dual thrust pneumatics for PFF deploy
  - Solar Sensors (5 sets), HCI (3)

WSMR

- Moses 36.221 (Jan 2009)
  - SPARCS (w/CUS)
  - S19L
- Bock 36.226 (Feb 2009)
  - CACS
  - S19D
- Davis 36.213 (April 2009)
  - SPARCS (w/CUS)
  - S19D

Near Future

- Hassler 36.219
  - SPARCS - RLG
  - S19L
- Green 36.244
  - CACS
  - S19D
- Cash 36.252
  - CACS
  - S19D
- Korendyke 36.239
  - SPARCS - RLG
  - S19L
- Green 36.257
  - CACS
  - S19D
- Nordsieck 36.173
  - CACS
  - S19L
- Harris 36.235

  October 2009
  - CACS
  - S19D

Conclusions

- NSROC is committed to continuing the SRPO mission and program successes. 2008 has been a good year for Sounding Rockets.

- NSROC's Primary Goal is unchanged:
  - to satisfy the NASA PI mission requirements.

- NSROC is committed in expanding the technical innovations while
  - Meeting the requirements of the PIs
  - Maintaining a cost effective environment
  - Making effective use of the in-house talent, experience and hardware.

- NSROC's early receipt of the SRWG findings is important for future growth planning.
  - Thank you to the SRWG for providing these important findings