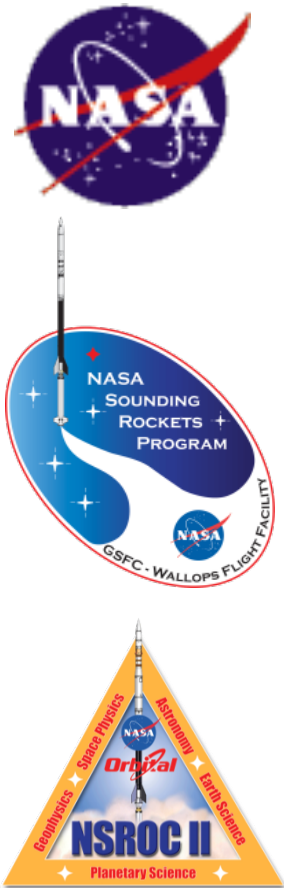


# Sounding Rocket Working Group

July 18, 2012

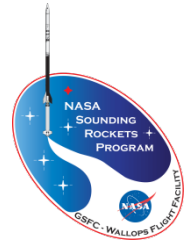


July 18, 2012

SRWG

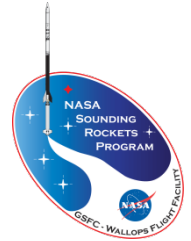
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# NSRP Briefing Outline



- Programmatics – Eberspecker/Schafer
  - SRPO
  - NSROC
  
- Motors & Vehicle Systems – Brodell / Hesh
  - Surplus
  - Brants
  - Orioles
  - FTS
  
- Educational Activities – Eberspecker
  
- Range Status – West
  - WSMR
  - Poker
  - Kwajalein
  - Woomera
  
- Technology Development – NSROC

# January SRWG Findings



## 1. Black Brant Motor Situation

- US Ammonium Perchlorate is being utilized in current production runs
- 3 flights have provided encouraging results
- Talos-Terrier-Oriole test flight is still planned to validate configuration as gap filler alternate for BBXII applications
- Brant status will be provided as part of the motor briefing

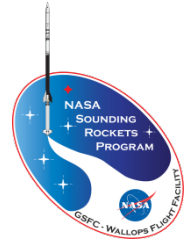
## 2. High-velocity Ejection Systems for Small Sub-payloads

- The SRPO has historically taken responsibility for developing subsystems to meet user community requirements
- If small sub-payloads are an emerging requirement, then the SRPO will develop the necessary support systems

## 3. Incorporate Larger Data Rates

- Work is progressing, but is lagging due to mission workload
- Details will be addressed as part of the technology development briefing

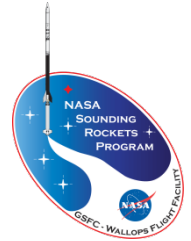
# January SRWG Findings



1. **White Sands Missile Range – Infrastructure**
  - Keeping integration area clean, lab flooring, clean tent status
  - Will be addressed as part of the range briefing
2. **Support for Infrastructure for Virtual Meetings**
  - Several Web-X accounts have been established
  - Video camera has been installed in conference room to support Web-X
  - Higher PolyCom system or similar tele-conference system is being ordered
3. **Dr. Mary Mellott**
  - The SRPO shares the SRWG's sentiments concerning Mary's contributions to the sounding rocket program



# Missions Flown Since Last SRWG



- **Core Science**

- 36.273 / Powell / tbd
  - Success
- 36.277 / Bock / tbd
  - Success
- 45.004 / Larsen / ATREX
  - Success
- 46.002 / Larsen / ATREX
  - Success
- 41.097 / Larsen / ATREX
  - Success
- 46.003 / Larsen / ATREX
  - Success
- 41.098 / Larsen / ATREX
  - Success
- 36.286 / Woods / EVEX
  - Success
- 36.272 / Cirtain / SUMI
  - Success
- 36.284 / Cirtain / Hi-C
  - Success

- **Technology**

- 12.074 / Hall / TBD
  - Success

- **Education**

- 41.101 / RockOn (Flt #5)
  - Success

- **Reimbursable**

- None

17 flights so far this FY. One TM failure and one experiment failure.

# FY12 Completed Missions

|    | Mission | Launch Date | Site   | PI          | Project                        | Comments  |
|----|---------|-------------|--------|-------------|--------------------------------|---|
| 1  | 36.225  | Oct 8       | WSMR   | Chakrabarti | PICTURE                        | Flown – Failure. TM RF cheater relay failed on up leg. No science data. |
| 2  | 41.093  | Oct 11      | Norway | Robertson   | CHAMPS                         | Flown – Success. No issue with Terrier spacer plate                     |
| 3  | 41.094  | Oct 13      | Norway | Robertson   | CHAMPS                         | Flown – Success. No issue with Terrier spacer plate                     |
| 4  | 36.264  | Nov 6       | WSMR   | McCammon    | XQC                            | Flown – Failure. Filter icing   |
| 5  | 36.274  | Dec 10      | WSMR   | Cash        | EXOS - CyGNESS #3              | Flown – Success   |
| 6  | 12.074  | Jan         | WFF    | Hall        | 2nd flight of Terrier-Malemute | FLOWN – Success. Slight roll/pitch coupling                             |
| 7  | 36.273  | Feb 13      | Poker  | Powell      | MICA                           | FLOWN – Success. Boom deployment anomaly                                |
| 8  | 36.277  | Feb 24      | WSMR   | Bock        |                                | FLOWN – Success. Brant combustion instability                           |
| 9  | 45.004  | March 15    | WFF    | Larsen      |                                | FLOWN – Success   |
| 10 | 46.002  | March 15    | WFF    | Larsen      |                                | FLOWN – Success   |
| 11 | 41.097  | March 15    | WFF    | Larsen      |                                | FLOWN – Success   |
| 12 | 41.098  | March 15    | WFF    | Larsen      |                                | FLOWN – Success   |
| 13 | 46.003  | March 15    | WFF    | Larsen      |                                | FLOWN – Success   |
| 14 | 41.101  | June 21     | WFF    | Koehler     | RockOn V                       | FLOWN – Success   |
| 15 | 36.286  | June 23     | WSMR   | Woods       | EVE #3                         | FLOWN – Success. 1st Flt of Wecco AP                                    |
| 16 | 36.272  | July 5      | WSMR   | Cirtain     | SUMI                           | FLOWN – Success. 2nd Flt of Wecco AP                                    |
| 17 | 36.284  | July 11     | WSMR   | Cirtain     | Hi-C                           | FLOWN – Success. 3rd Flt of Wecco AP                                    |

# CY12 Planning Manifest

|    | Mission  | Launch Date | Site | PI         | Project                          |
|----|----------|-------------|------|------------|----------------------------------|
| 1  | 39.011 R | July 21     | WFF  | Cheatwood  | IRVE III                         |
| 2  | 36.263   | July 24     | WSMR | Judge      |                                  |
| 3  | 12.076   | Aug 24      | WFF  | Brodell    | Talos-Terrier-Oriole Test Flight |
| 4  | 46.004   | Aug 16      | WFF  | Rosanova   | RockSat X                        |
| 5  | 36.269   | Aug 31      | WSMR | Rabin      | EUNIS                            |
| 6  | 46.001   | Sept        | Kwaj | Kudeki     | EVEX                             |
| 7  | 45.005   | Sept        | Kwaj | Kudeki     | EVEX                             |
| 8  | 41.100   | Sept        | Kwaj | Caton      |                                  |
| 9  | 41.100   | Sept        | Kwaj | Caton      |                                  |
| 10 | 36.268   | Oct 13      | WSMR | McCandliss | FORTISS #1                       |
| 11 | 36.271   | Oct 13      | WSMR | Beasley    |                                  |
| 12 | 36.239   | Oct 19      | WSMR | Korendyke  |                                  |
| 13 | 36.255   | Oct 31      | WSMR | Krucker    | FOXSI – Solar Physics Payload    |
| 14 | 36.XXX   | Oct         | WSMR | McCammon   | XQC #5                           |
| 15 | 36.253   | Nov 14      | WSMR | Hassler    | RAISE #2                         |
| 16 | 36.260   | Nov 14      | WSMR | Cook       | M101 Imager                      |
| 17 | 36.283   | Dec 4       | WSMR | Galeazzi   | DXL                              |
| 18 | 36.259   | Dec 14      | WSMR | Gendreau   | XACT #1                          |

End  
of  
FY

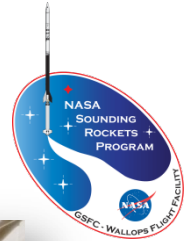
# CY13 Planning Manifest

|    | Mission | Launch Date | Site  | PI         | Project                  |
|----|---------|-------------|-------|------------|--------------------------|
| 1  | 36.XXX  | Jan         | WSMR  | McCandliss | FORTISS #2               |
| 2  | 36.245  | Jan 17      | WSMR  | Figueroa   | Micro-X                  |
| 3  | 36.235  | Jan 31      | WSMR  | Harris     | HYPE #1                  |
| 4  | 36.262  | Feb 1       | WSMR  | Kaiser     | ACCESS #1                |
| 5  | 40.027  | Feb 2       | PFRR  | Rowland    | VISIONS                  |
| 6  | 36.XXX  | Feb         | WSMR  | Kaiser     | ACCESS #2                |
| 7  | 36.282  | June        | WSMR  | Kankelborg | MOSES #2                 |
| 8  | 41.090  | June        | WFF   | Pfaff      |                          |
| 9  | 21.140  | June        | WFF   | Pfaff      |                          |
| 10 | 12.077  | June        | WFF   | Brodell    | Peregrine Test Flight #1 |
| 11 | 36.285  | July        | WSMR  | Beasley    | CHESS                    |
| 12 | 36.288  | July        | WSMR  | Vourlidas  | VAULT 2.0                |
| 13 | 36.XXX  | Oct         | WSMR  | Kaiser     | ACCESS #3                |
| 14 | 36.281  | Oct         | WSMR  | Bock       |                          |
| 15 | 36.XXX  | Oct         | WSMR  | Hassler    | RAISE #3                 |
| 16 | 12.078  | Oct         | WFF   | Brodell    | Peregrine Test Flight #2 |
| 17 | NA      | Nov         | Poker | Conde      |                          |

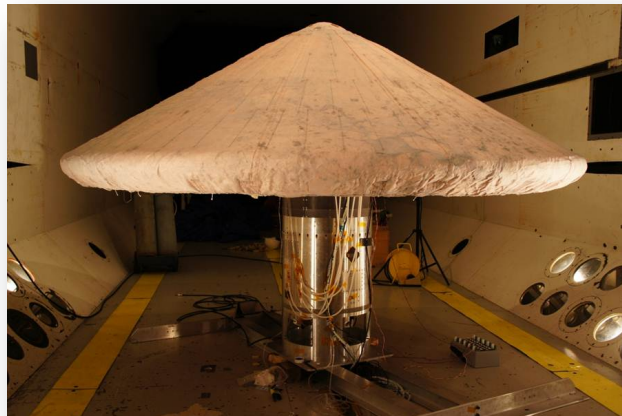
# CY13 Planning Manifest

|    | <b>Mission</b> | <b>Launch Date</b> | <b>Site</b> | <b>PI</b> | <b>Project</b> |
|----|----------------|--------------------|-------------|-----------|----------------|
| 18 | 40.029         | Nov                | Norway      | LaBelle   | CAPER          |
| 19 | 36.261         | Nov 2013           | WSMR        | Clarke    | VESPR          |
| 20 | 36.XXX         | Dec                | WSMR        | Gendreau  | XACT #2        |

# LaRC IRVE-3 Mission – On-the-Horizon



- Inflatable Re-Entry Vehicle (IRVE-3)
  - Third flight of the inflatable re-entry concept
  - Execute a flight-test that demonstrates inflation and survivability at a relevant dynamic pressure
  - Assess the performance of the vehicle from a thermal, and structural dynamics perspective
  - Validate the analysis and design techniques used in the development of the re-entry vehicle (RV)
  - All at higher heating loads than the previous IRVE missions.
  - Launching on a Black Brant XI
- Launching from Wallops Flight Facility
  - July 21 - 24, 2012



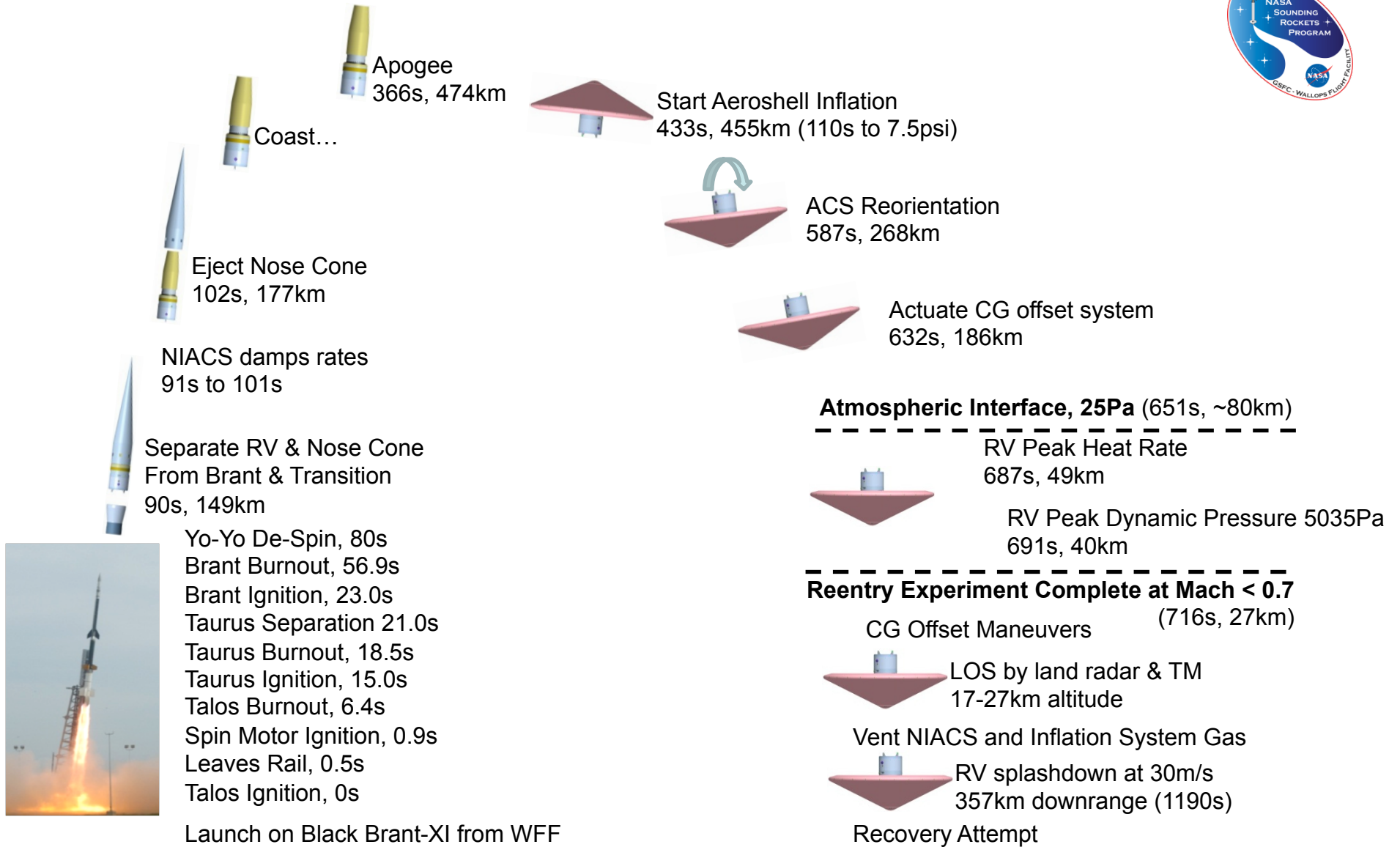
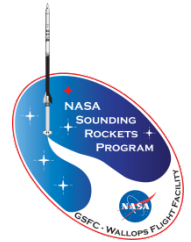
July 18, 2012

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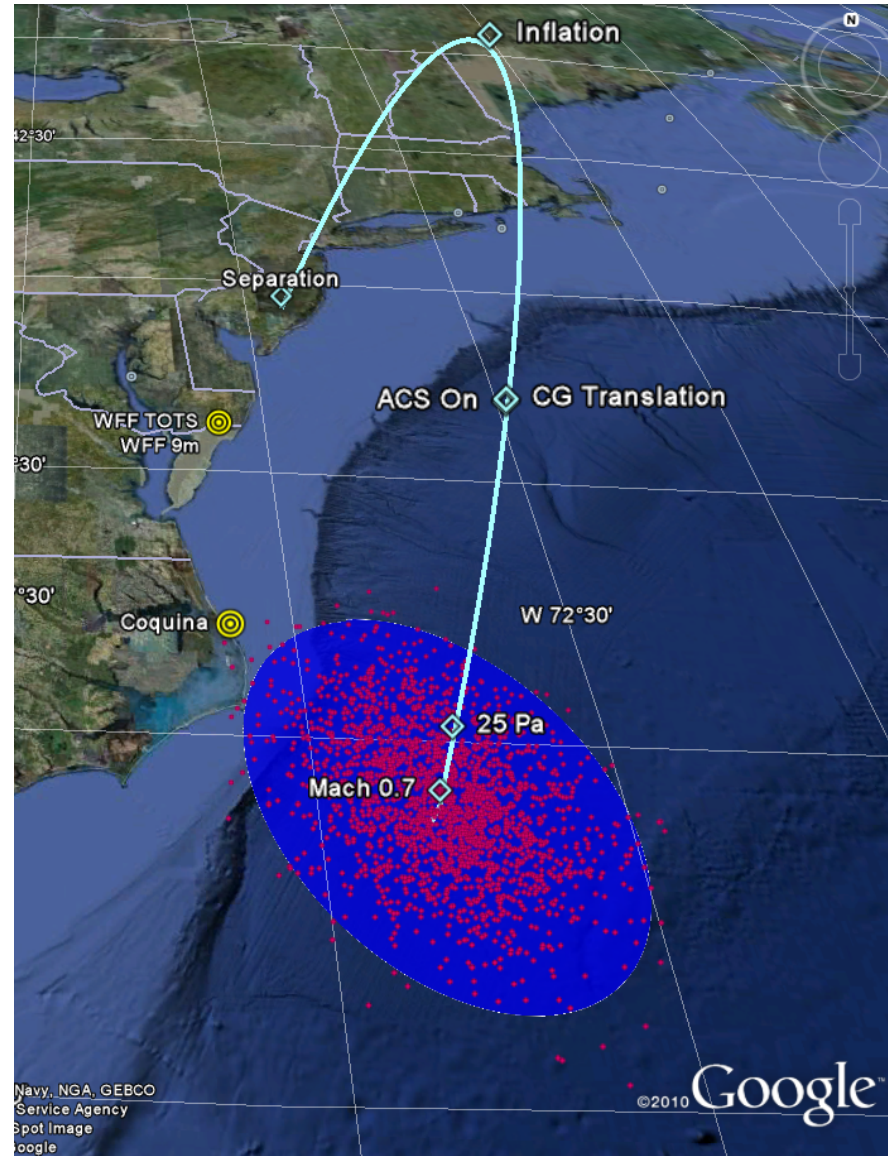
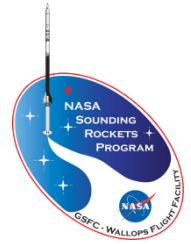
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# IRVE-3 Mission – On-the-Horizon

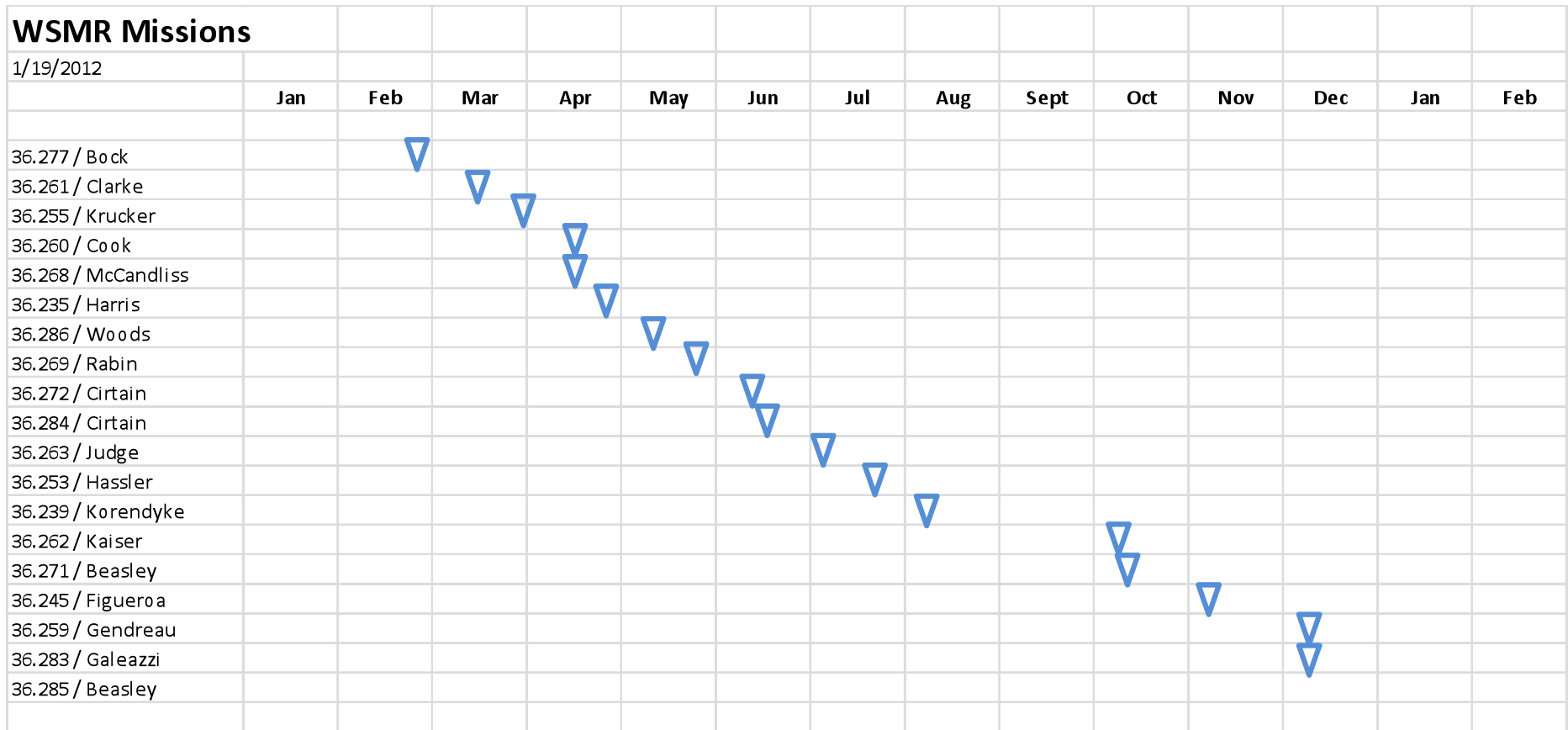


# IRVE-3 Mission – On-the-Horizon



July 18, 2012

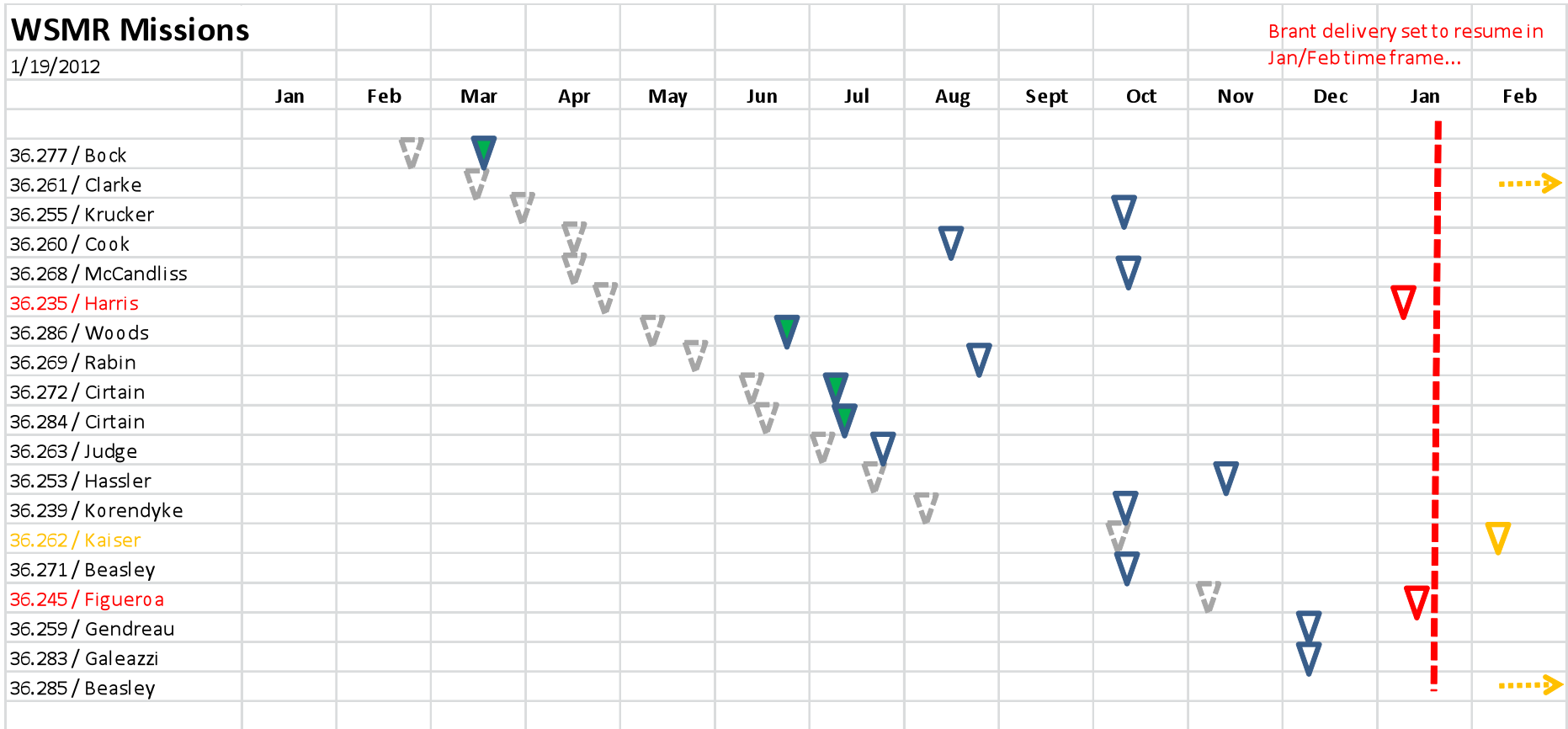
## WSMR Mission Scheduling Evolution



The attempt to clear the WSMR mission backlog failed...

The official Brant motor assignments have yet to be reestablished. Motors will be assigned on a first come, first served basis unless HQ establishes a priority list.

# WSMR Mission Scheduling Evolution



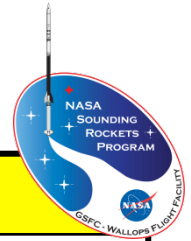
The attempt to clear the WSMR mission backlog failed...

The official Brant motor assignments have yet to be reestablished. Motors will be assigned on a first come, first served basis unless HQ establishes a priority list.

# New WSMR Scheduling Process

- T- 6 Months     Each range user will provide “windows” for their test and their range support requirements
- T - 60 Days     All requirements must be provided to range
- T – 14 Days     The range schedule will go into a “hard lock” at T-14 (previously 7 days), in order to provide final airspace training windows to the Air Force
- T – 7 Days     The Range will now “Code” missions (instead of T-3 days). All events will go to a “Ready to Conduct” stage at this point. After T-7 days, the Range may not be able to support any last minute changes.
- The most recent changes to the DoD Financial Management Regulation, 7000.14-R, allows test ranges to charge users for aborted or cancelled tests
- Beginning this October, if a test event or operation is cancelled and the scheduled time cannot be filled by another test event or operation, there will be some percentage of Unavoidable Cost charge (depending on when the event or operation is cancelled)
  - Details still being worked, but “Unavoidable Cost” charges most likely beginning at T-30 days and escalating forward to full projected cost as launch day approaches
  - Some percentage of the delta costs between the original cancelled mission and the substituted mission will be the Unavoidable Cost charge to the cancelled mission range user
    - ✓ Even if the time slot can be filled or substituted with another test event or operation, there may still be an Unavoidable Cost charge (still working the details)

# Failures and Anomalies



| Failure   | AIB lead | Status  |
|---|----------|---|
| - 40.026 Vehicle Dynamics and NC deployment anomaly | NASA     | AIB Report <u>complete</u> . Root causes: BB dynamics, non-heritage nosecone/experiment structure system design.                          |
| - 36.256 Uplink command camera performance anomaly  | NASA     | AIB Report <u>complete</u> . Root cause: Inadequate contamination control.  |
| - 36.257 Real-time Pointing Anomaly                 | NASA     | AIB Report <u>complete</u> . Root causes: Sub-optimal command console surroundings, inadequate understanding of expected command display. |
| - 36.257 Power Fluctuations                         | NASA     | AIB ongoing. Suspected cause: Faulty voltage regulator in experiment electronics.   |
| - 36.225 TM Loss                                    | NSROC    | AIB Report <u>complete</u> . Root cause: non-space-grade RF relay with history of contamination issues (on other programs).               |

| Anomalies                               | AIB Lead | Status  |
|---|----------|---|
| - 36.274 Star Tracker LIS determination | NSROC    | AIB Report <u>complete</u> . Root cause: Preflight analyses and understanding of ST5K algorithms inadequate for area of sky with high-density of very bright stars. |
| - 36.273 Boom Deployment                | NSROC    | AIB ongoing. Suspected cause: binding of deployment mechanism.  |

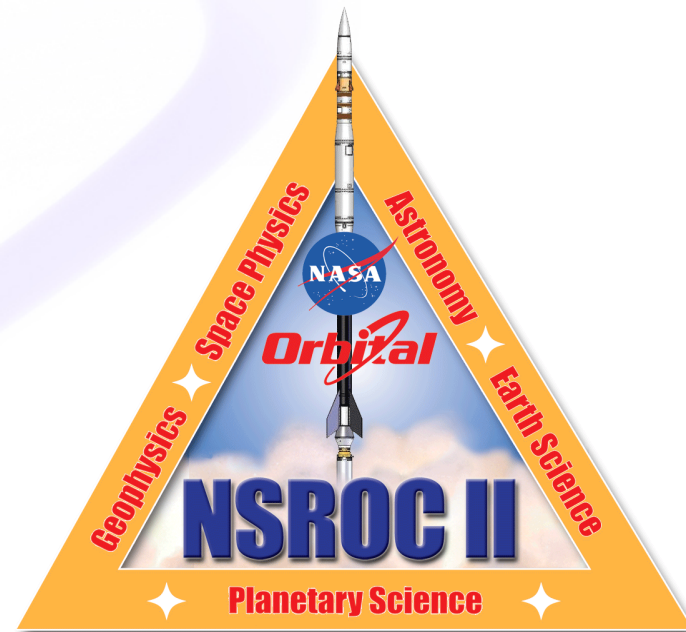




# NASA Sounding Rocket Operations Contract II

## Sounding Rocket Working Group

18 July 2012



*Innovation You Can Count On™*  
July 18, 2012



## Programmatic Overview



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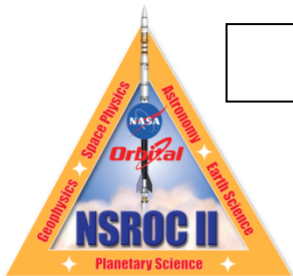
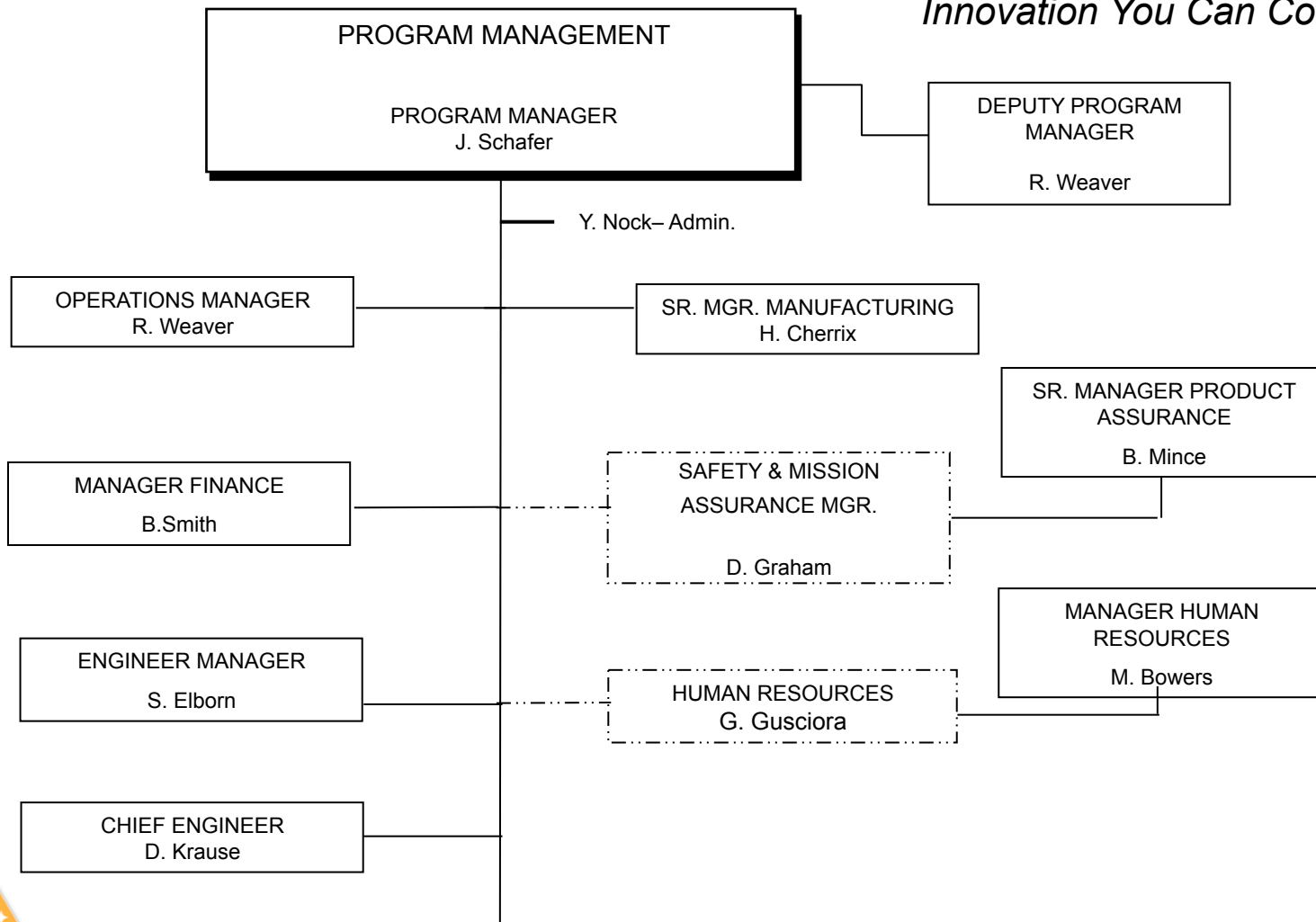
- Launch vehicle and payload success:
  - Annual rolling wave: 17/19 missions (89%)
  - Since commencing Launch Readiness Memo: 23/25 (92%)
- Supporting PI schedules
- Financial constraints complicating hardware availability and limiting developments:
  - Ordnance (FTS and payload actuation): significant cost escalation and late deliveries
  - Limits staff levels and Orbital 'reach back' to overcome setbacks (FTS batteries,) obsolescence issues (LEOS, batteries) and pre-planned upgrades (high capacity data storage)



# NSROC II – Program Management



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# NSROC Staffing



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- Stable employment with low attrition since NSROC II commenced
- Effective processes reducing quality escapes without measurable degradation in cost or schedule performance

### NSROC II Employment Metrics

| 7/16/2012    |              | Full Time Employees [1] | Full Time Equivalent [2] | Change Log Since Last SRPO Review |
|--------------|--------------|-------------------------|--------------------------|-----------------------------------|
| Orbital-TSD  | WFF          | 89.8                    | 97.2                     | Add: Elec Eng.                    |
|              | WSMR         | 11.0                    | 9.3                      |                                   |
|              | Greenbelt    | 1.0                     | 2.9                      |                                   |
|              | BAF          | 0.0                     | 1.8                      |                                   |
|              | Intern/coops | 7.0                     | 2.0                      |                                   |
| Orbital-SSG  |              | 0.0                     | 0.2                      |                                   |
| Orbital LSG  |              | 0.0                     | 1.9                      |                                   |
| LJT          |              | 60.0                    | 59.1                     | Less: Elec. Tech                  |
| Hawk         |              | 7.0                     | 5.5                      | Add: Mech Eng. Less: Mech Eng.    |
| Hammers      |              | 2.0                     | 2.1                      | Add: Mech Eng.                    |
| PSL          |              | 0.0                     | 3.6                      |                                   |
| <b>Total</b> |              | <b>170.8</b>            | <b>183.5</b>             |                                   |

[1] Assigned full time to the NSROC Program

[2] The accumulation of hours charged, divided by the number of billable hours in a week, includes off-site FTEs



## Principal Investigator Coordination



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- NSROC has worked hard to eliminate mission degradation due to process escapes
  - Increased emphasis on ‘Test Like You Fly’ and ‘Test Like You Test’
- Export Compliance
  - Complete and accurate Foreign National (FN) paperwork required four months prior to FN involvement
    - Where possible, Orbital writing TAAs for companies instead of individuals to permit personnel substitutions
    - Where possible, Orbital writing discipline TAAs to permit individuals access across missions
  - Flight data is not ITAR controlled
  - The definition of ‘payload’ and application of Cosmic Infrared Background Experiment (CIBER) disposition as ‘not subject to the licensing jurisdiction of the Department of State’ requires additional analysis for ongoing program applicability





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- Propulsion
  - Black Brant demonstrating significantly improved performance with the latest propellant configuration
  - Oriole inventory predominantly used for three and four stage configurations
  - Assessing two and three stage all-GFE configurations
- Plan to transition from Orbital-LSG to NSROC Flight Termination System electronics delayed to 2013 while the NSROC Launch Vehicle staff works higher priority hardware availability issues





# Surplus Motors

Chuck Brodell

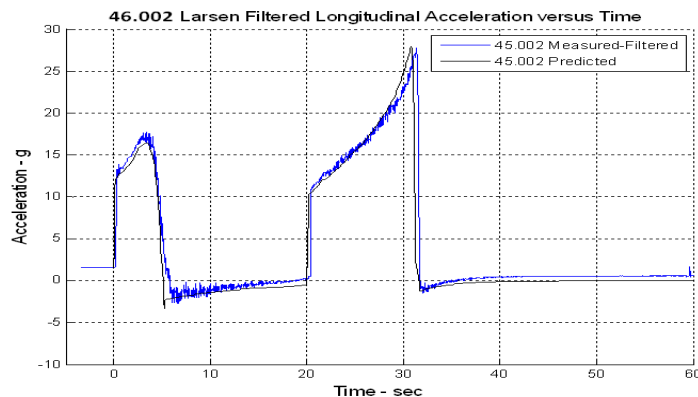
# Surplus Motor Inventory

- Surplus DOD booster inventory is healthy
  - Talos
    - Indian Head tooled up and conducting refurbishment
    - Recent trade with with China Lake for an additional 24 units located at Hawthorn
  - Terrier MK70
    - Significant inventory stored at Hawthorn
  - Terrier MK12
    - Grain spacer plate developed to cope with shrinking/aging cartridge grains
      - Migrating from steel to linen phenolic spacer on future launches
  - Improved Malemute
    - Improved lap/radax joint qualified 1/11/12
    - Transferred 35 propulsion units with 45 exit cones from MDA to NASA
      - Planning receipt of hardware in September 2012
  - In discussion with Navy for surplus Lynx (MK104) motors
- Procured 12 new Talos shipping containers and 24 Nike transportation pallets



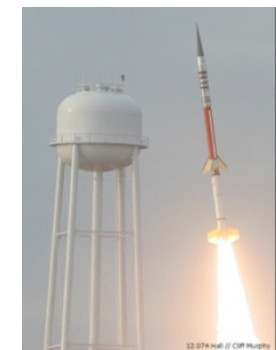
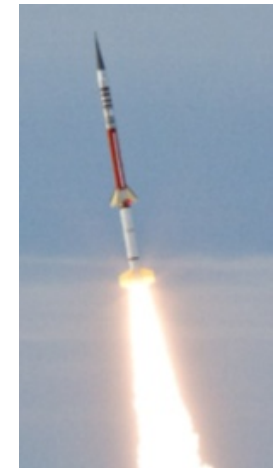
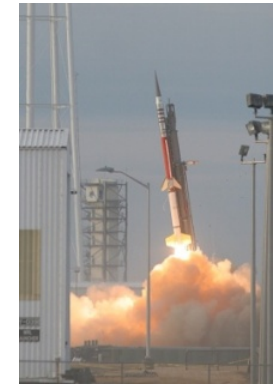
# Terrier/Improved Malemute

- Successful second test flight 1/10/12
  - Verified integrity of new head cap radax/lap joint
- Vehicle successfully utilized on two Larsen science missions in March, 46.002 & 46.003
- Good overall stability, flight dynamics, and performance
  - Vehicle slightly underperforming compared to predictions
    - More flight data samples needed to refine models
- Motor pressure is consistent flight to flight with no detrimental burn characteristics due to spin environment
- Performance is ~20% better than BBV and is less wind sensitive
- ~40% performance improvement over a Terrier/Orion
- Some limitations on payload size/weight
- Vehicle currently manifested for additional science missions
  - 46.005/Rosenova August 2012 at WFF
  - 46.004/Kudeki September 2012 at Kwajalein



## Performance Comparison 750 lb payload

|            |        |
|------------|--------|
| MK70/IM    | 250 KM |
| MK70/Orion | 150 KM |
| MK1 BBV    | 200 KM |



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SRWG

25

FWD Interface Ring

# Black Brant Status

Chuck Brodell

Cathy Hesh

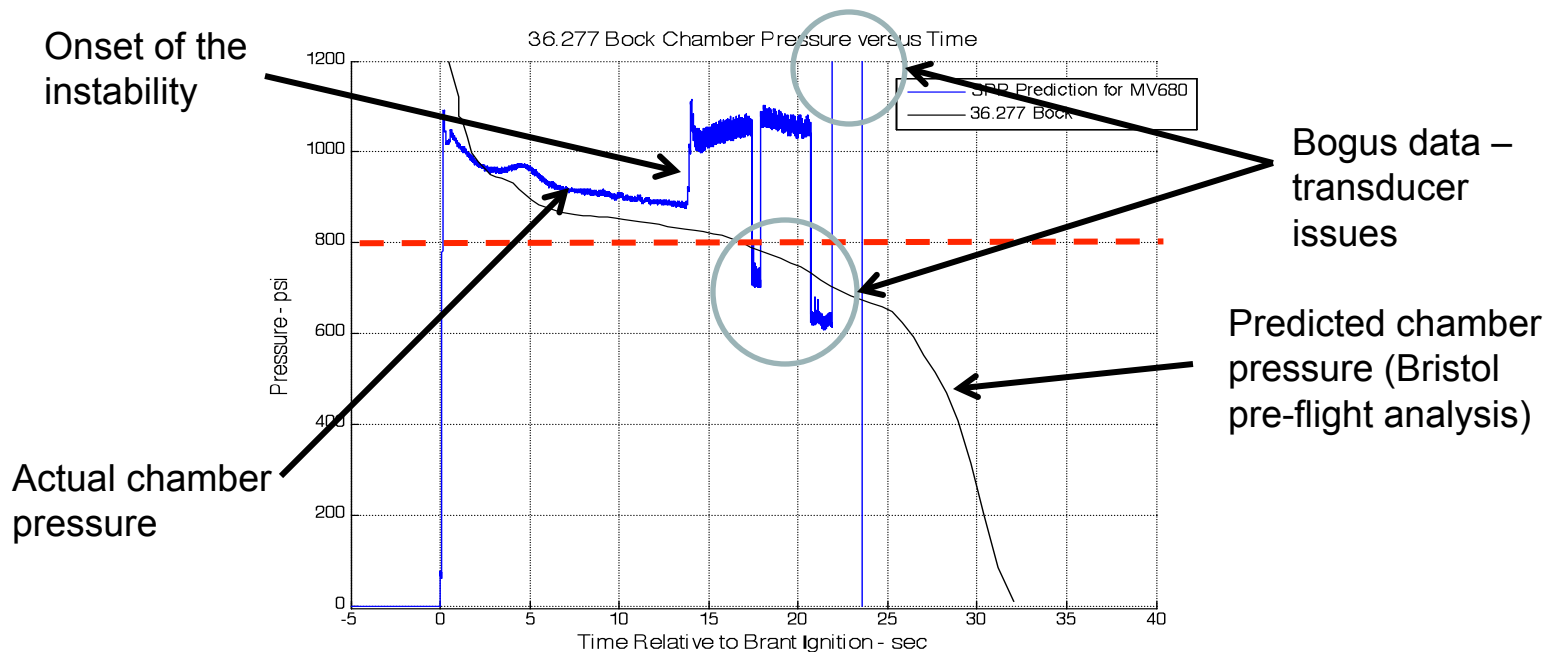
# Brant Flight Status

- **BBIX** (Terrier-Brant)
  - WSMR Flights have resumed
  - Motors are utilizing larger throat diameter of 4.308” after 36.227 combustion instability
  - Use of US AP incorporated in design
  - Moratorium History
    - May 2010, 36.270 combustion instability WSMR
    - December 2010, 40.026 thrust misalignment Norway
    - March 2012, 36.277 combustion instability WSMR
- **BBX** (Terrier-Brant-Nihka)
  - Moratorium (no spin up seen on BBIXs, similar burnout altitude)
  - Potential Nihka impact dispersion due to Brant coning
  - Recent BBIX recovered hardware is showing favorable erosion with utilization of US AP
- **BBXI** (Talos-Taurus-Brant)
  - Moratorium is lifted for 39.011 on schedule at WFF July 2012
    - Not a safety issue, but dynamics could cause mission failure
- **BBXII** (Talos-Taurus-Brant-Nihka)
  - Moratorium
  - Potential Nihka impact dispersion due to Brant Coning
  - FTS required until confidence is gained with the high altitude BB flights
  - Improved erosion characteristics with US AP is helping confidence

# Third Occurrence of Combustion Instability

- **36.277/Bock**
  - Pre-blended Norchem (Chinese) AP
    - Propellant had high burn rate formulation, older lot
  - Launched March 22, 2012
  - 4.208" Throat Diameter (enlarged to reduce  $P_c$ )
  - Instability began 13 sec. after Brant ignition (out of family)
  - High vibrations experienced
    - **Major FTS concern**
  - Mission was successful – no indications of any system anomalies

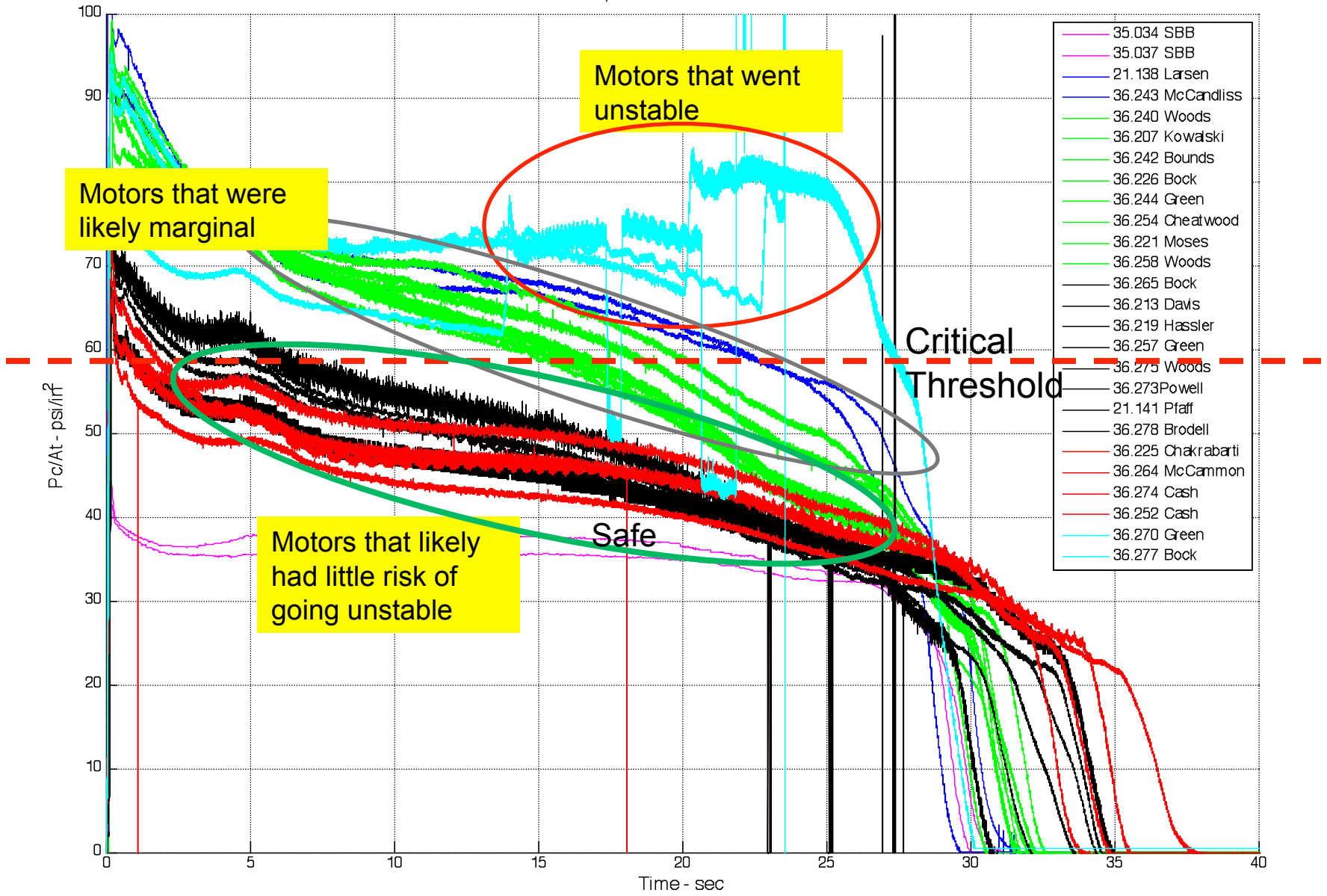
15 successful Brant flights between Green and Bock occurrences...





# Pressure/Throat Area Ratios

Pressure/Throat Area, Black Brant Versions with Standard BB



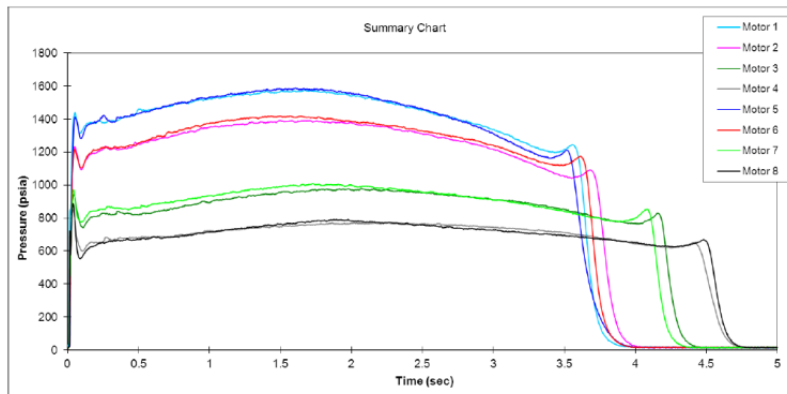
## Path Forward After 36.277 Combustion Instability

- Preventative actions implemented:
  - Instrumented FTS deck following 3 flights
  - Nozzle throat diameter was opened by an additional 0.1 in.
    - Mitigates risk of flight chamber pressure being higher than pre-flight prediction
    - Reduces chamber pressure and increases burn time
      - Increased burn time could lead to more throat erosion
  - Real-time monitoring of motor strip chart data in the blockhouse during flight
    - SRPO, NSROC, and WSMR Missile Flight Safety will observe the pressure, acceleration, and vibration data real-time
    - If motor enters a combustion instability, FTS qualification environments will be exceeded, and WSMR Missile Flight Safety has the option of destructing the vehicle
  - Conservative wind weighting criteria
  - Motor hardware recovery and examination
    - Hardware showing reduction in erosion
- Evaluate P and P/A ratios for all flights
- Continue to closely monitor performance and recover/inspect flight hardware

# New WECCO Ammonium Perchlorate (AP)

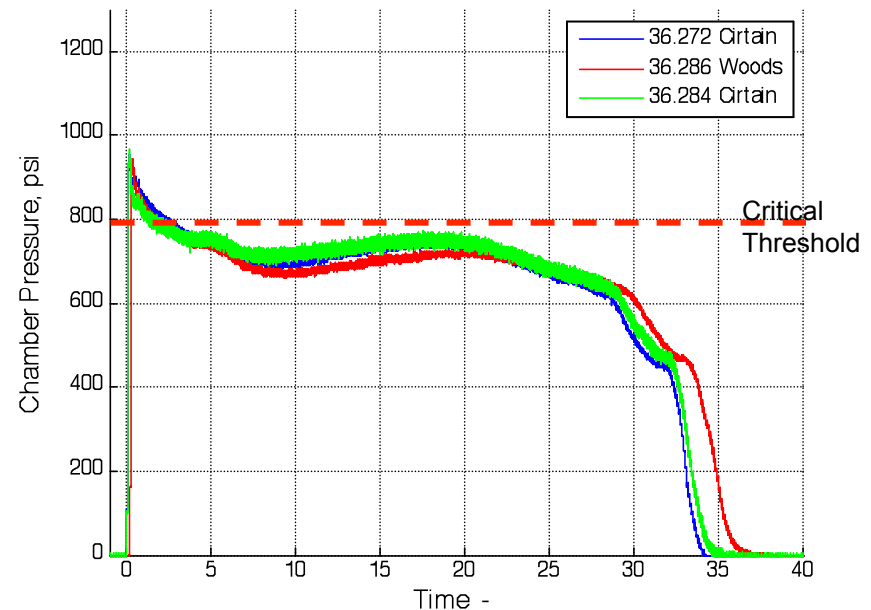
- Bristol has completed qualification program to utilize WECCO Type II Ammonium Perchlorate (AP)
  - WECCO is a US supplier of AP
  - Type II AP is residual
- Previous three flights have used WECCO AP with good results
  - Less regressive pressure curves
  - Improved erosion
  - Less erosion, higher pressure may increase chance of instability

Figure A-2. Burn Rate Traces for the 8 2x4 motors tested for 11B021



Burn rate results from WECCO full-scale 2x4 test motors

Pressure Vs. Time



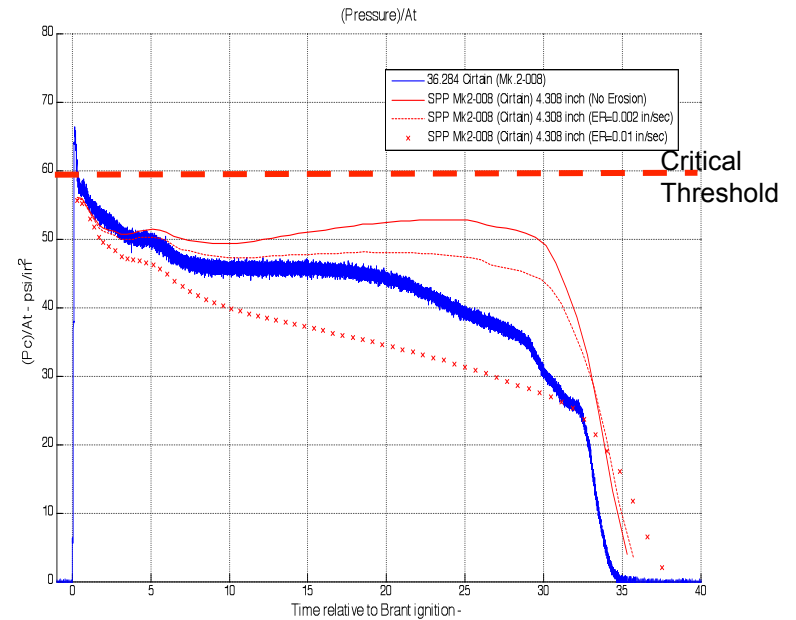
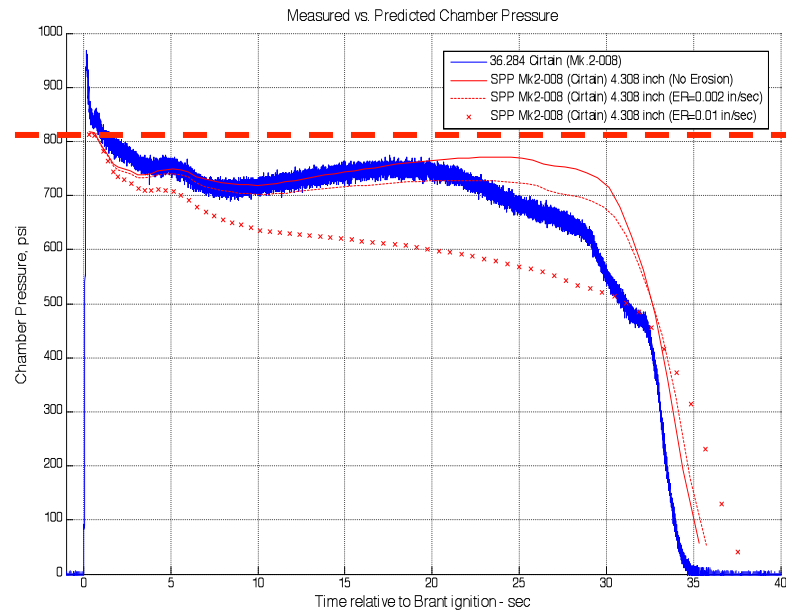
July 18, 2012

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# Threshold Criteria

- Predicted motor pressure below 800 psi during middle of burn
- P/A ratio of below 60
- 36.284 provides indication of non linear erosion throughout burn



# Recovered Hardware

- Improved erosion on flights with unblended US AP
- Aft insulators remaining intact
- Good insulation margin remaining
- Continue to recover/examine all flight hardware



36.286  
Woods



Previous flights show erosion through graphite at throat entrance, only small amount of silicon insulation remaining inside of aft closure case



Forward looking aft



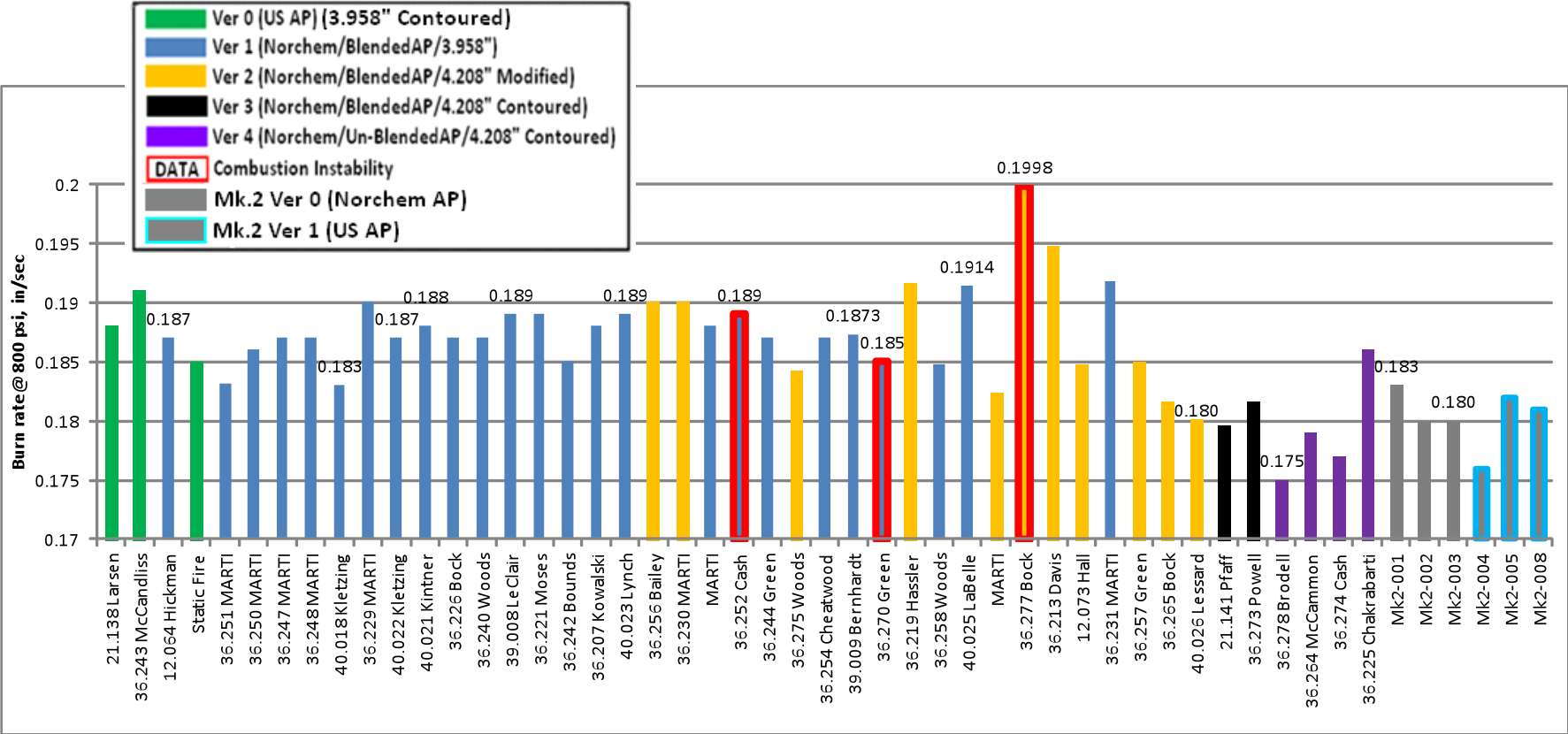
Aft looking forward

36.284  
Cirtain

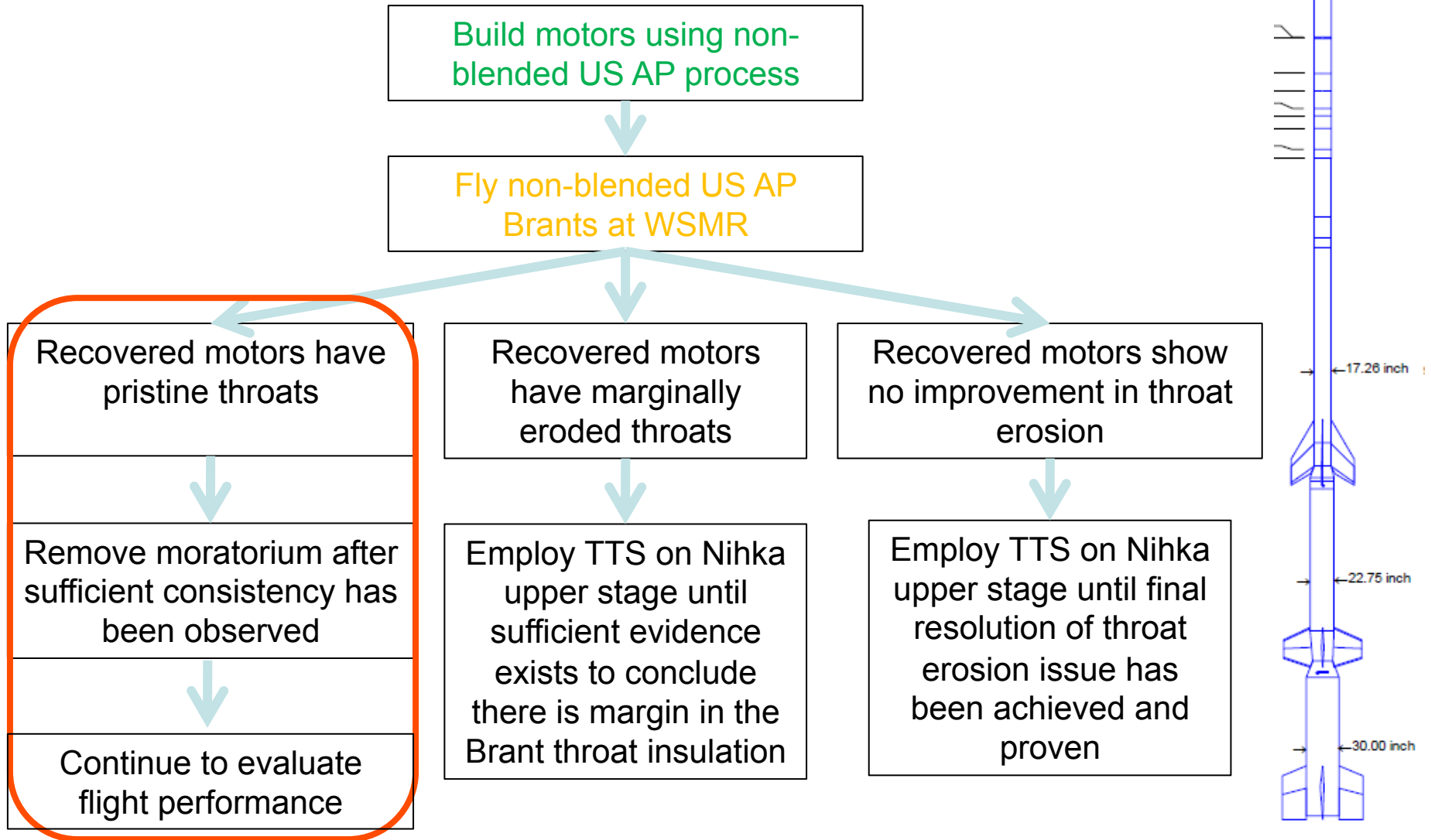
# Continued Testing and Analysis

- Combustion Instability study with MSFC/WFF is underway
  - NESC supported
  - Anticipate completion within three months
- T-Burner tests to be conducted
  - Testing Mk1 (Norchem, unstable motor), Mk2 (Weco AP), and possibly STD Brant propellant
  - Quench bomb tests will also be conducted on samples
- MSFC is running simulations using the Standard Stability Prediction (SSP) code
  - Models are being built using best information available
  - Qualitative assessment did show linearly stable motor design
  - 1-D and 3-D SSP runs with T-burner data
  - Time accurate CFD runs looking at vortex shedding Desired analysis/testing outcomes
  - Sean Fischbach supporting research (MSFC expert in solid rocket combustion instability)
  - Identify cause of instability
- Better define a stability criteria for motor
- Continue to collect and analyze flight data

# Burn Rate of Brant Motors



# BBXII Return to Flight Plan



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# Black Brant Evolution Definitions

| Version          | Definition   | Flt Count | # In Inventory                               |
|------------------|--|-----------|--|
| Mk1<br>Version 0 | Baseline BB Mk1 design with US oxidizer (AP)   | 3         | 0  |
| Mk1<br>Version 1 | Switch from US oxidizer to Chinese oxidizer  | 26        | 0  |
| Mk1<br>Version 2 | Nozzle throat size increase, cylindrically bored out post motor assembly   | 11        | 3  |
| Mk1<br>Version 3 | Nozzle throat size increase, contoured pre motor assembly  | 1         | 2  |
| Mk1<br>Version 4 | Chinese oxidizer not pre-blended, larger nozzle throat size contoured pre motor assembly.  | 4         | 1  |
| Mk2<br>Version 0 | Motor case material change from 4335 to hybrid 4335 rings/4140 sheet steel, Chinese oxidizer not pre-blended, larger nozzle throat size, contoured pre motor assembly. | 0         | 2  |
| Mk2<br>Version 1 | Switch from Chinese oxidizer to US oxidizer. Second nozzle throat size increase, cylindrically bored out post motor assembly   | 3         | 4  |
| Mk3              | Motor case material change to 4140 with closed die forging end rings, nozzle throat size TBD, contoured pre motor assembly   | 0         | Under development.<br>Delivery in late 2012. |

# Black Brant Inventory

- Total of 12 Black Brant motors in inventory (6 BB Mk1, 6 BB Mk2)
  - 3 are quarantined from WSMR use
- Black Brant Mk1 Motors in Inventory:
  - Qty. 1, BB Mk1 V3 (Chinese AP, Pre-blended, Low Burn Rate)
    - Allocated to 21.140 Pfaff, quarantined from WSMR due to low burn rate
  - Qty. 1, BB Mk1 V3 (Chinese AP, Pre-blended, High Burn Rate)
    - Quarantined due to high burn rate
  - Qty. 1, BB Mk1 V4 (Chinese AP, Unblended, Thin Wall Motor Case)
    - Available for WSMR 2012 use
- Black Brant Mk1 Motors – Surplus from ABL Program:
  - Qty. 1, BB Mk1 V1 (Chinese AP, Pre-blended)
    - Needs throat modification to 4.308"
    - Available for WSMR 2012 use
  - Qty. 1, BB Mk1 V2 (Chinese AP, Pre-blended)
    - Available for WSMR 2012 use
  - Qty. 1, BB Mk1 V1 (Chinese AP, Pre-blended)
    - Needs throat modification, has extended exit cone installed, has higher burn rate
    - Quarantined from WSMR due to high burn rate
- Black Brant Mk2 Motors in Inventory:
  - Qty. 2, BB Mk2 V0 (Chinese AP, Unblended, Hybrid Motor Case)
    - 1 allocated for 39.011 Cheatwood, 1 available for WSMR 2012 use
  - Qty. 4, BB Mk2 V1 (US AP, Unblended, Hybrid Motor Case)
    - All allocated for WSMR 2012 use

# Black Brant Contracts and Delivery Schedule

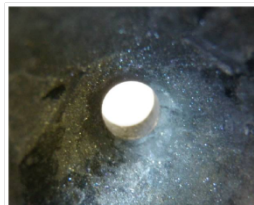
- Bristol in a production hold until the Black Brant Mk3 motor case has been qualified
  - Deliveries will resume in November 2012 and will continue at a rate of 1 motor every 3 weeks through September 2013
- 3 open Black Brant motor contracts:
  - Contract for 12 motors (base contract)
    - 2 motor deliveries remaining
      - Black Brant Mk3 motors will be delivered in November and December 2012
  - Contract for 12 motors (option year 2 contract)
    - 12 motor deliveries remaining
      - Black Brant Mk3 motors will be delivered in FY13, between January and September 2013
  - Contract for 12 motors (option year 3 contract)
    - Long lead contract in place
    - Production contract will be issued in early FY13 to assemble and cast the motors
      - Black Brant Mk3 motors will be delivered in FY14

# Bristol Technical Updates

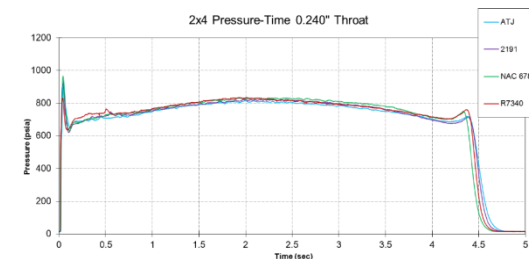
- **Black Brant Mk3 Motor Case (All 4140 Steel)**
  - Decision for long-term Black Brant Mk3 motor case is to use 4140 sheet steel for tubes and 4140 closed die forgings for end rings
  - Order of 4140 closed die forgings (procured from US steel mill) for end rings arrived at Bristol in June, currently being machined
  - Qualification of 4140 motor case via burst test will occur in October 2012
  - First production motor delivery holding at November 2012
  - Bristol has changed the heat treat process to get better material ductility since 4140 steel tends to be more brittle
    - Slightly reduces ultimate strength and burst pressure
- **New Graphite Throat Insert**
  - Heritage graphite material, ATJ graphite, has been discontinued
  - Bristol has tested 4 new candidate graphite materials and 3 have been selected as acceptable alternates.
  - Testing included firing 32 small-scale test motors and 4 small-scale long burn test motors
  - Erosion rate and pattern were consistent between the 3 candidate materials and pressure curves in test motors were consistent
  - Final material selection will be based on availability and cost and will be complete in July 2012



5.5" Motor Static Fire



5.5" Motor Nozzle Inlet Post Fire



2x4 Test Motor Firing w/ New Graphite Materials

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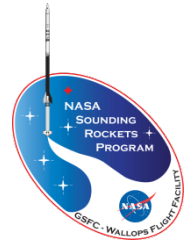
40

# Bristol Technical Updates

- Black Brant Propellant Development Plan
  - Bristol is evaluating options for improving the Black Brant motor
  - Primary goal is to get back to the reliability of the standard Black Brant motor
  - Bristol is considering 3 options:
    - Option #1: Propellant development only
    - Option #2: Propellant and nozzle development
    - Option #3: Complete motor re-development
- Long Lead Procurement Activities
  - To ensure reliability of the Black Brant motor and production schedule, Bristol is working to procure larger lots of critical components
    - WECCO Type II Ammonium Perchlorate
      - Bristol working with the vendor to secure enough material to manufacture 36 Black Brant motors
      - Procuring oxidizer from the same lot will help consistency of propellant burn rate and performance between Black Brant motors
    - 4140 Steel
      - Current inventory of sheet steel can manufacture up to 15 additional motors
      - Current inventory of forgings can manufacture up to 24 additional motors
      - Bristol working with vendors to procure additional steel to ensure steady production on future motor contracts

# Black Brant Summary

- The third Brant combustion instability occurred March 2012
  - Drove decision to migrate to new nominal throat diameter of 4.308”
  - Establish P/A criteria to help define risk
- Migrated to US Ammonium Perchlorate
  - More consistent pressure curves with the first three flights
  - Reduced erosion observed on recovered hardware
  - Reduce concern of high altitude tail off anomalies
- Hybrid motor case is performing adequately
- 4140 motor cases on schedule to be in production prior to the end of the year
- Researching additional improvements
  - Propellant formulation (solids particle size distribution) similar to Standard Brant
  - Aft closure re-design to allow larger throat diameter
  - New grain geometry configuration and propellant formulation
- Motor inventory and near-term delivery schedule does not support the current mission manifest

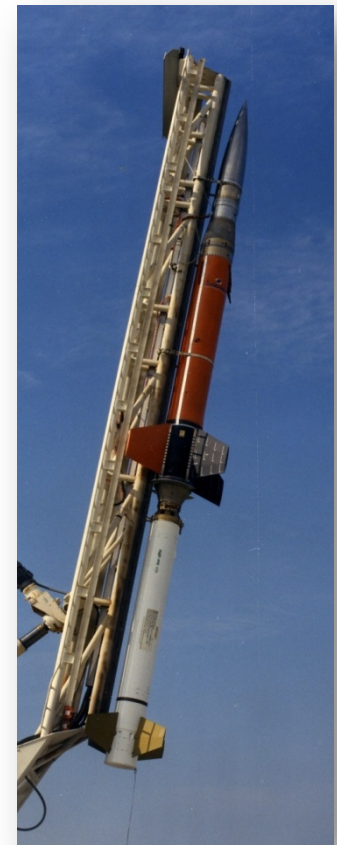


# Oriole

Chuck Brodell

# Oriole Utilization

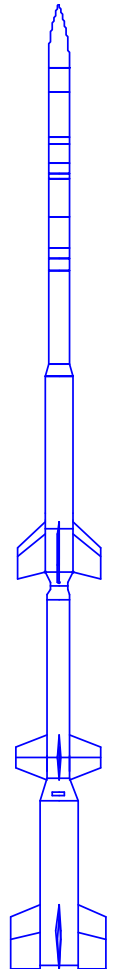
- Oriole motors have been procured to augment supply of sustainer motors
- Six Oriole motors are being purchased to support program needs
  - First four motors received
  - Delivery of last two motors expected later this year
- Planned usage on several ranges
  - 45.004/Larsen March 2012 at WFF
  - 12.075/Brodell August 2012 at WFF
  - 45.005/Kudeki September 2012 at Kwajalein
  - \*TBD.027/Rowland Winter 2013 at PFRR
  - \*TBD.029/LaBelle Dec 2013
  - \*TBD.028/Swenson at PFRR
- Two fin designs to be utilized for two stage and high altitude third stage configurations
- Higher mission cost with this motor
- Residual post burn Oriole thrust causing some mission implementation concerns
- Cannot support all missions due to stability criteria concern





# Talos-Terrier-Oriole Vehicle Development

- 12.075 GT Test flight on schedule for August 2012
- Inert Nihka will be included to verify dynamics prior to 4<sup>th</sup> stage ignition
- Alternatives to high altitude vehicle configurations
  - Suitable for three or four stage configurations
  - Augment Sounding Rockets stable of vehicles
  - Mitigate risk associated with current vehicles
- Confirm acceptable vehicle stability
- Verify high altitude Oriole ignition
- Validate Oriole performance models
- Flight qualify new high altitude Oriole fin
- Gain flight experience to enable support of the winter 2013 science mission(s)
- Integrate the MK70 into a stack as a 2<sup>nd</sup> stage
  - Requires use of a new load bearing tailcan
  - Potential to replace Taurus motor
    - Eliminate logistical challenges of the 1.1 rating
    - Removes risk of reliance on aging hardware
- Current performance predictions indicate potential of 30% apogee increase over BBXII in some configurations

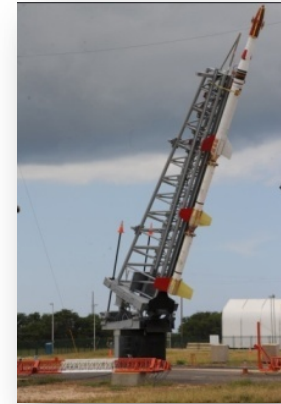
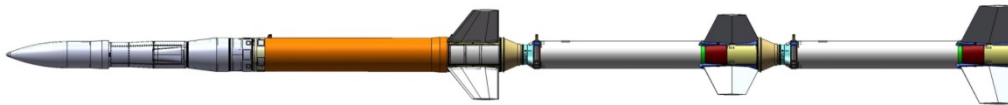


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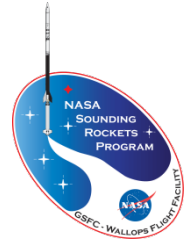
# Other Oriole High Altitude Alternative, TTO

- Terrier-Terrier-Oriole Vehicle developed by the Navy
  - Performance is predicted to be somewhere between BBXI and BBXII
- Successfully launched 5/1/12 at PMRF!
  - A key to the configuration is the Kratos developed load bearing tailcan
  - This mission grows heritage of flying the Terrier Mk70 as a second stage
  - Provided flight qualification of the split load bearing tailcan design
  - This vehicle will demonstrate design of large fins on the Terrier first stage
  - This flight and a successful flight of 12.075 may allow us to fly at PFRR without FTS this coming winter
- Opens up potential for multiple new vehicle configurations



# Upcoming High Performance Flights

- Rowland
  - Jan/Feb 2013
  - Talos-Terrier-Oriole-Nihka
  - Predictions indicate 30% improved performance over the BBXII
  - Assuming successful WFF 12.075 test flight this summer in conjunction with successful Navy TTO launch (May 1, 2012)
  - BBXII performance not adequate to meet success requirements
  - Current version of Brant has not flown at high altitude
  - FTS situation (may be dropped if test flight is successful)
- LaBelle
  - December 2013
  - Talos-Terrier-Oriole-Nihka?
- Swenson
  - Jan/Feb 2014
  - Talos-Terrier-Oriole-Nihka
  - May consider shifting back to a BBXII



# Peregrine

Chuck Brodell

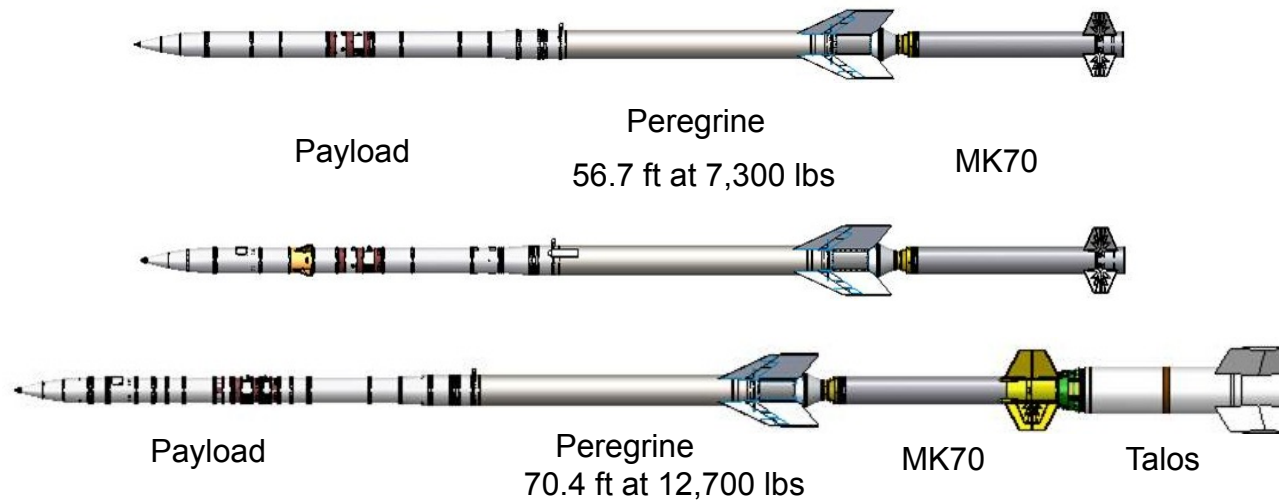
# Scope of Peregrine Project

- Heritage sustainer motor used by the Sounding Rocket Program has had technical issues and inconsistent performance for the past several years
  - Peregrine is a risk mitigation effort
- Peregrine motor is intended to be an alternative sustainer motor suitable for use in multiple vehicle configurations
- Peregrine goal is to develop low cost reliable propulsion unit that provides current or improved performance capability
  - Utilize simple well characterized designs
  - MSFC develops the propulsion unit and WFF develops the vehicles
  - NASA owned design
  - Commercially manufactured
- NESC/MSFC/WFF conducted a feasibility study of a NASA designed replacement in 2011
- Testing program consists of case proof test, static firing, and three flight tests
- Test Flights will include a Space Technology Program (STP) experiment section
- Success oriented schedule



# Test Flight Vehicle Configurations

- There are both a two and three stage vehicle configuration to be utilized in the flight test program
- The two stage configurations will be identical (1,100 lbs) with the exception of Flight Termination System (FTS) hardware and S-19 at WSMR
- The two stage configuration will have a Terrier MK70 first stage booster
- The three stage configuration will consist of a Talos first stage and Terrier MK70 second stage
  - Will have an inert 4<sup>th</sup> stage below the payload

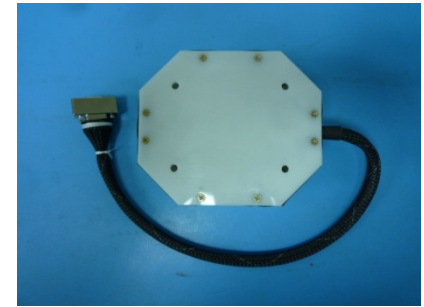


# Flight Termination Status

Cathy Hesh

# FTS Progress Since Last SRWG

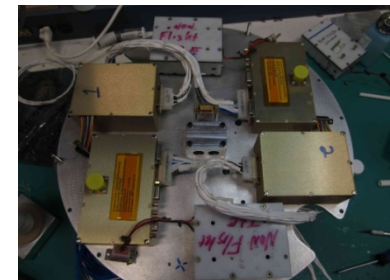
- Successfully launched 4 missions from WSMR
  - 36.277 Bock
  - 36.286 Woods
  - 36.284 Cirtain
  - 36.272 Cirtain
- New FTS battery configuration designed for new lot of cells
  - Planned qualification completion in October 2012
- NSROC FTS controller (FTSC)
  - Final board revision completed and tested, planned qualification in early 2013
- Competitive procurement for new ordnance kits
  - New order placed for ordnance kits (paddles)
- Building inventory of FTS components
  - Received new orders of receivers, antennas, and batteries
  - New orders placed with LSG for additional conical shape charges and FCDCs
  - Planned procurement for safe/arm devices
- Supported integration of WSMR 3-Event CDI for final test flight in August 2012
  - Final test flight will be 46.004 Rosanova, will initiate all flight critical events (ignition, de-spin, separation)
  - Environmental qualification testing to be performed in fall 2012 with first operational flight in mid 2013



25 Cell A Pack Prototype FTS Battery



FTS Controller Test Unit

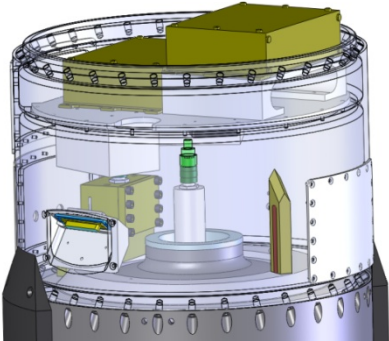


46.004 Rosanova Flight CDI Deck



# FTS System Availability

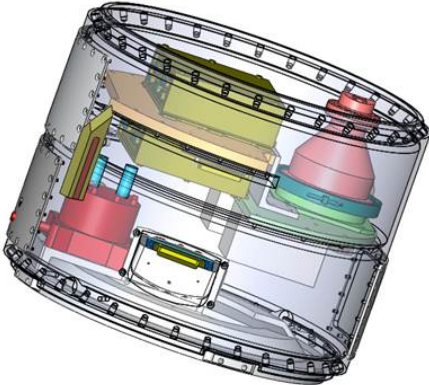
July 2012 – March 2013



“Single Deck”  
with FTLU and  
Paddles

7 systems  
available

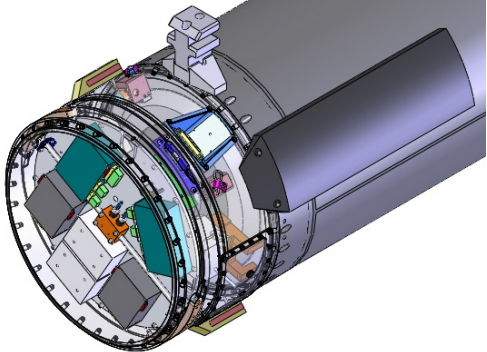
March – November 2013



“Split Deck”  
with FTLU,  
CSC, and new  
Safe/Arm

8 systems  
available

Late 2013

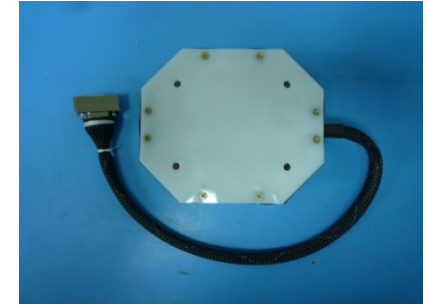


NSROC FTS  
with FTSC,  
WSMR 3-Event  
CDI, and new  
ordnance kit

Ignition and  
FTS integrated  
in one module

# FTS Inventory and Order Status

- **Antennas**
  - Adequate inventory to support mission manifest
- **Receivers**
  - Adequate inventory to support mission manifest
- **Batteries**
  - Current inventory of NiCad cells (Sanyo) can support 3 flights
  - New NiCad cell lot delivered, evaluated, and qualification packs are built
  - Acceptance and qualification testing to be performed in July-September 2012
  - Expected first use to be in October 2012
  - Inventory level may affect 2012 WSMR launch manifest if cells do not pass qualification testing
  - Completed evaluation testing on C cell battery pack which could be utilized in the event of a qualification failure
- **Electronics Box**
  - **FTLU**
    - Current orders of FTLUs can support 13 flights, delivery rate of at least 1-2 flights per month, will meet mission requirements
  - **FTSC**
    - Final board revision completed and tested
    - Prototype board build at Wallops with NSROC procedures
    - Kitting parts and qualification build expected late summer or early fall 2012



25 Cell A Pack Prototype FTS Battery



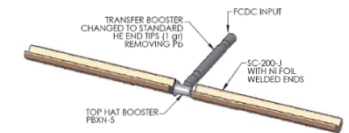
FTS Controller Test Unit

# FTS Inventory and Order Status

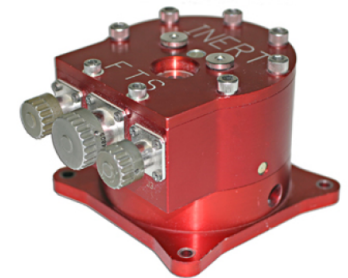
- Ordnance
  - 7 existing Goodrich kits with expected shelf life through March 2013
  - Competitive procurement resulted in award to legacy vendor of ordnance kits
    - Configuration will be paddles and FCDCs
    - 30 ordnance kits ordered
    - Delivery expected in late November 2013
    - Technical Risks:
      - 150% margin testing
        - » Vendor has determined LSC has minimal margin, testing planned in early August to determine actual margin
        - » Vendor has identified optional LSC explosive to increase margin, but is more temperature sensitive and requires TPS
      - Booster to LSC interface design change
        - » New design that should increase reliability, but differs from heritage design
  - Big Red Safe/Arm Device
    - Electro/mechanical device that is remotely controlled
    - Implementation will begin on missions in late 2012
    - 7 on order through Orbital LSG, expected procurement for additional units to be in place by end of FY12
  - Orbital conical shape charges and FCDCs
    - 5 conical shape charges and 5 sets of FCDCs in inventory
    - 3 additional conical shape charges ordered, expected delivery in March 2013
    - NSROC working with LSG to identify additional CSC and FCDC that may be available to fulfill mission requirements in mid to late 2013
  - Ordnance inventory level could affect mid to late 2013 WSMR launch manifest



Heritage FTS Paddle Design



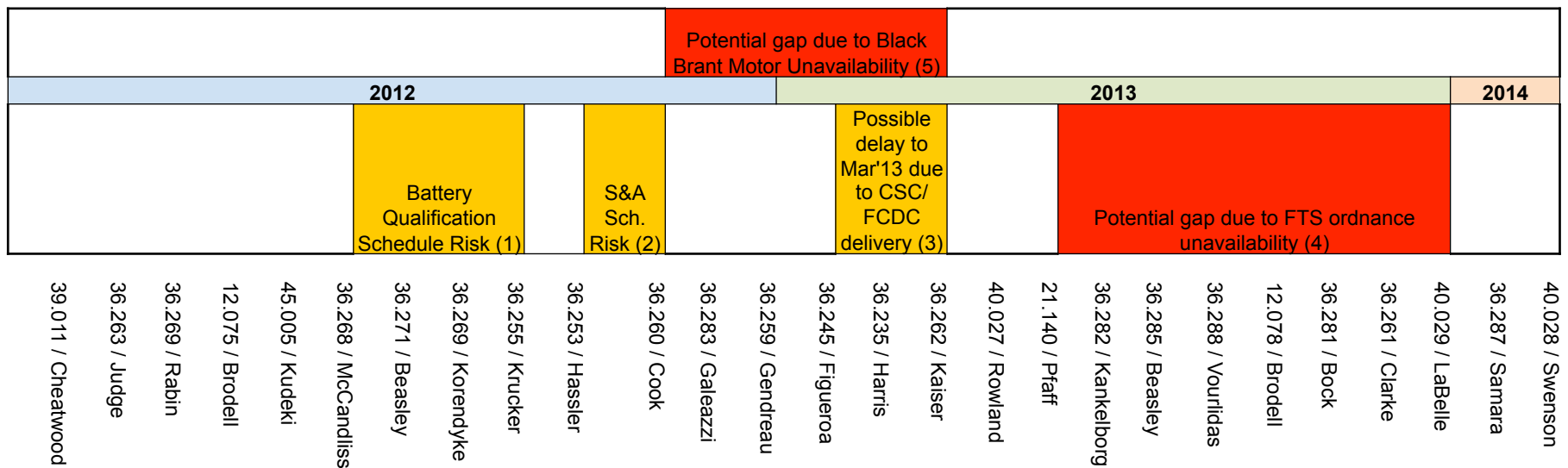
Redesigned Paddle Booster to LSC Interface



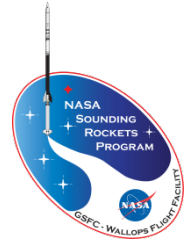
"Big Red" Safe/Arm Device

# Motor and FTS Hardware Availability Projection

- Funding availability and long lead times with vendors have led to a “just in time” delivery problem on motors and FTS hardware which causes problems meeting the mission manifest
- NSROC and NASA are anticipating hardware availability issues in late 2012 and mid to late 2013



- Risk Mitigation:
  - “C” cell batteries are available in “A” cells don’t pass qualification, ~3-4 month schedule delay
  - Range meeting on 8/1 to work out details of transition
  - Shipping hardware to the field pre ELAT to speed up schedule
  - Working to obtain additional FCDC/CSC to minimize possible launch gap
  - Utilizing Oriole motors where possible to conserve Black Brant motors for WSMR



# Educational Activities

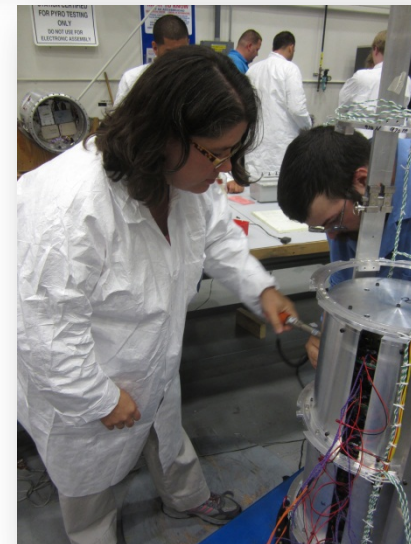
## Eberspeaker

# Educational Activities

- RockOn (5<sup>th</sup> Flight)
  - Payload included kits experiments and custom RockSat-C experiments
  - Approximately 80 participants
  - Launched June 21, 2012
  - HQ was not able to provide funding

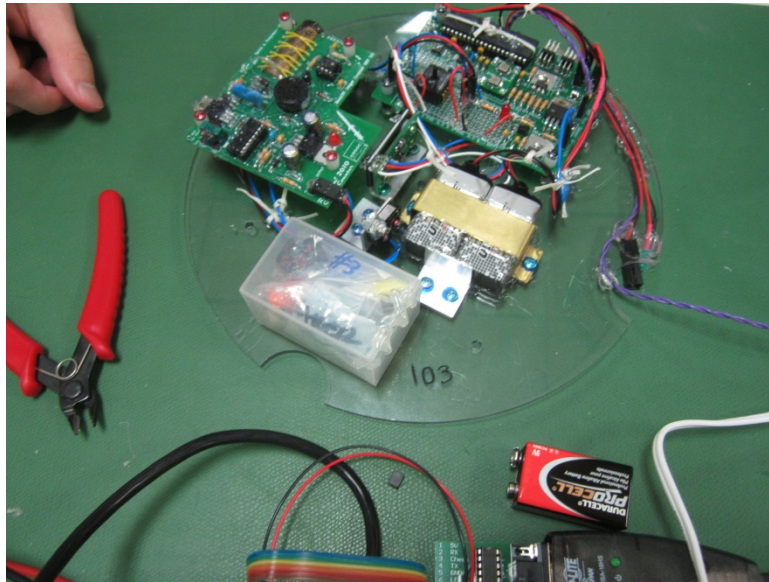


RockOn Lift-off

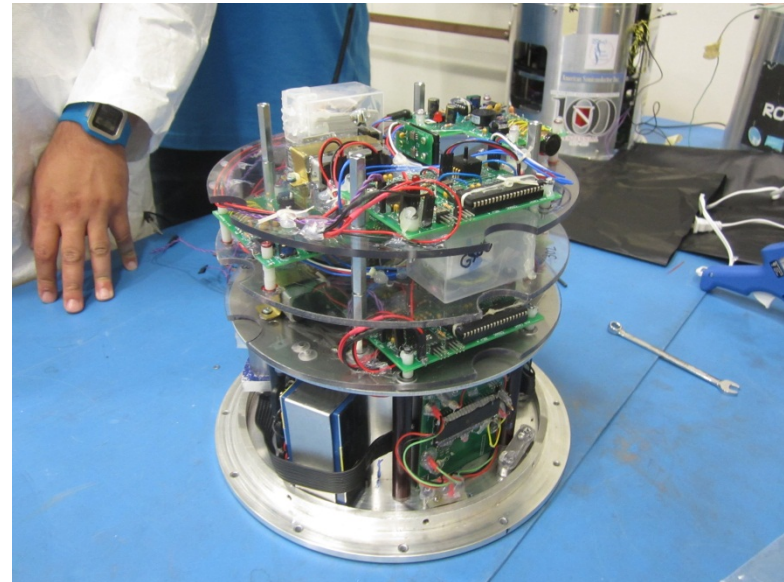




# Educational Activities



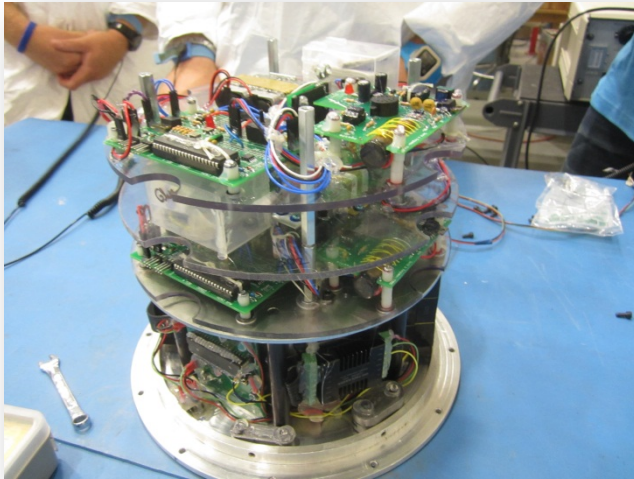
RockOn Kit Experiment



RockSat-C Experiment with a Stack of Kit Experiments

# Educational Activities

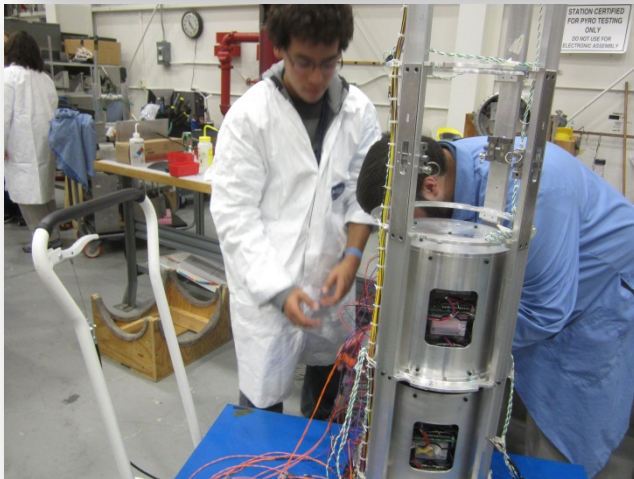
Experiment Stack



Containment Can



Can Stack



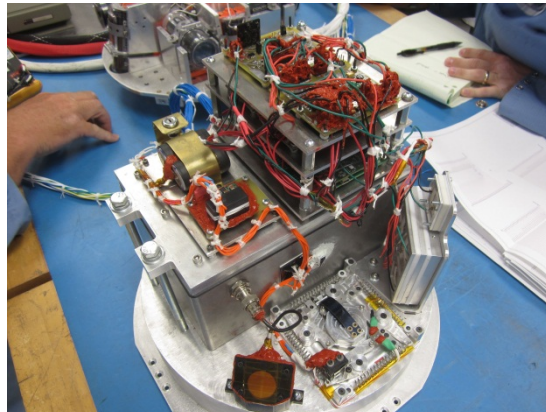
Experiment Skin w/ View Port





# Educational Activities

- RockSat X
  - More advanced experiments with full exposure to space environment
  - 6 university teams participating
  - Will use digital magnetic ACS
    - Test flight for new system
  - August 2012 Launch
  - HQ was not able to provide funding



# Educational Activities

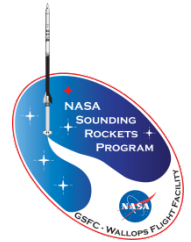
- WRATS Week (Year 2)
  - 21 HS teachers from around the country
  - Week long session held during RockOn launch week
  - Teachers learned about rocket physics, built rockets and electronic payloads
  - HQ was not able to provide funding





# Launch Ranges

John Hickman  
SRPO Operations Manager

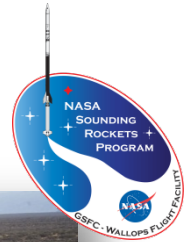


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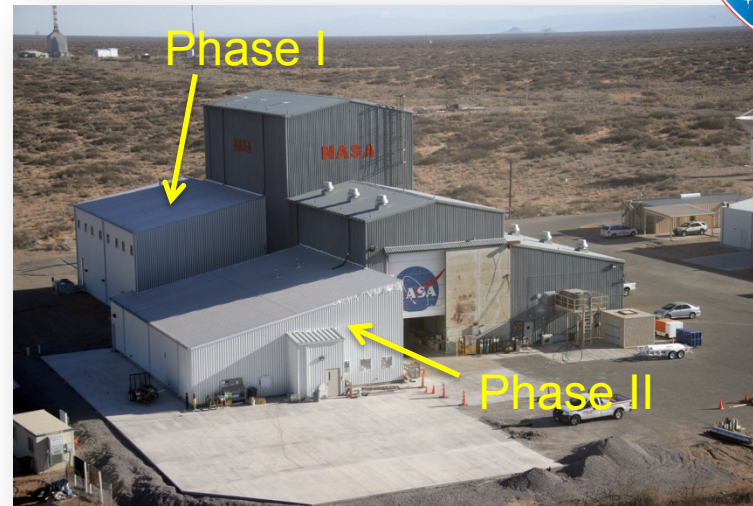
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# Launch Range Updates - WSMR



- 3 Phase LC-35/36 consolidation to be complete this fall
- Phase 1 - New integration lab is up and running
- Two new Clean Tents installed in the integration lab
  - One was certified to <10K
  - Other had a filter leak and required some work
- Offices and conference room are up and running
- “Clean Room” practices are just started to be implemented
  - Difficult to do with all the construction
  - Space is a premium in the interim
  - Plans for “clean” operation in work
- Other SRWG findings
  - Floor was repaired
  - Portable hoist delivered for lab



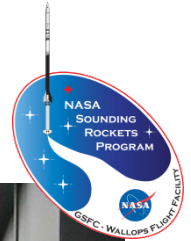
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# Launch Range Updates - WSMR

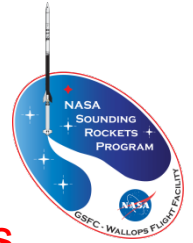


## Phase II - Solar Lab, Air Bearing, Tech Lab's at the 95% completion

- Solar port installed – removed from N-200
- Tech labs are essentially complete
  - Electronic lab, pneumatics lab, HILTS lab, Celestial lab
- NASA recently conducted walk thru
  - 55 item punch list created
  - Contractor at work making repairs on Heliostat, air bearing, and optics lab
- NASA will take occupancy in mid/late August
  - Transition of equipment will be based on mission schedules
  - Fluid nature of schedules have made planning the exact date of transition a challenge
  - Likely completion Jan/Feb with current schedules



# Launch Range Updates - WSMR



## Phase III – Ground Station/Rest Room Rehab is 50% complete

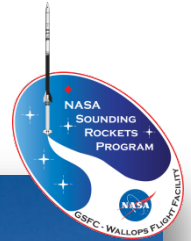
- TM ground station consolidation
- Raised (conditioned) floor for TM racks
- New ADA compliant rest rooms (long over due!!)
- Reception and Safety Offices
- Vestibule for Main Entrance
- PSL Offices
- Mag Cal installation in high bay
- Epoxy coat the low and high bay floors
  - Final step in total rehab of VAB
- Will make facility much more “clean” friendly

## Recycled (Refurbed) Cable trays



## Conditioned Raised Floor for TM Racks

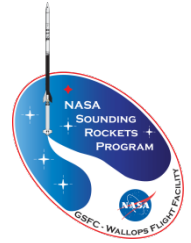
# Launch Range Updates - Wallops



- Executed 5 Launch/5 minute Sounding Rocket Series
  - ATREX – Anomalous Transport Experiment - Dr. Larsen/Clemson
  - Major infrastructure enhancement preparing 5 launchers including 3 mobile – Kudos to NSROC
  - Very challenging range planning and coordination effort – not easy!!!
    - Failure mode planning & Countdown
    - Safety, Wind Weighting, Range Clearance
  - Outstanding team effort
- Launcher maintenance now under NSROC purview
  - ARC and 50K were under code 840
- ARC upgrades implemented to support IRVE 3 mission next week



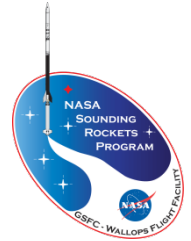
# Launch Range Updates - Poker



- Environmental Impact Statement on track for public release this fall
  - Expect to be at HQ for review mid-July
  - Public meetings will be held in Fairbanks and Anchorage this fall
  - Great cooperation with USFWS, BLM
  - Wilderness designation – Even if this goes through we will be “grandfathered” in under historical use
    - Early coordination and building relationship with USFWS personnel paid off
- Recovery of Hardware (Rockets and Payloads) is a major reason we have been successful with EIS and our partners
  - Major emphasis on search and removal and record keeping
  - Annual budget allocation targeted for recovery operations
  - This is the right thing to do.....no question

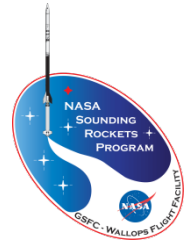


# Launch Range Updates - Poker



- Poker Staff Reorganization is Pending
  - Greg Walker, current Range Manager is taking a faculty position
  - He will remain with PFRR <25% of his time.....mainly during launch season
  - Looking to promote from within and backfill vacancies
  - No official proposal received from GI but expecting it any time
- New “Redstone” being installed on TM Hill
  - Came from Dugway and is being installed by Code 840
  - Great “Cold Weather” antenna
  - Foundation design and construction this summer – Installation likely in the Spring
- Range ready to support 40.027 Rowland this winter (February)
  - Return of Black Brant XII to flight status
  - Oriole based “BB XII” possibly utilizing Flight Termination
  - Issue being worked with Safety support and fielding a command uplink system – both being worked by SRPO and 840

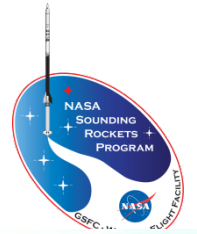
# Launch Range Updates - Kwajalein



- Site survey completed late May/early June
  - 3 remote atolls surveyed for camera site and transmitter/receive stations
  - Remote atoll access is challenging
  - Good progress made on Safety on other technical issues
- Team is there now installing MRL launcher and servicing the 20K
  - Preparing for cable installation
  - Completed installation of explosive storage shelters
- Final Cost Estimate is promising for this and future campaigns
  - ~\$1M for 4 launches in 1 full moon down period; range buildup; Altair
  - 20% contingency for unknowns



# Launch Range Updates - Kwajalein

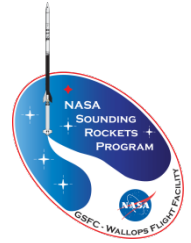


- Range conflict with large DoD program is looking more likely
  - High priority FTI mission for MDA
  - Launch window is Sept 27 – Oct 15
  - While outside our launch window, their site prep and large staff will prevent us for executing our mission
  - Technically they were on the schedule first but were anticipated to move to the right
    - October not viable due to same issues
    - EVEX could not be ready in time for Aug window
  - July 23 is the final decision point
    - Scheduled FTI technical review
    - Last Day TMA can be shipped to meet schedule
- Options for EVEX/MOSC are being evaluated by science teams
  - April and Sept are the likely choices



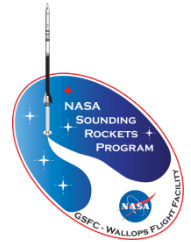
NASA Launchers (150 feet beyond the photo)

# Launch Range Updates - Woomera



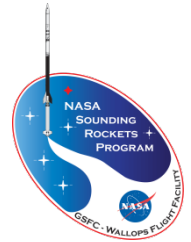
- Making progress getting “approval” to launch in Australia
  - Working through HQ and Australian agency CSIRO, *Commonwealth Scientific and Industrial Research Organisation* to get an exemption from the commercial licensing requirements
  - CSIRO believes as our sponsor they can get this approval but progress is slow
- Asbestos “import” issues recently came to our attention
  - Appears Navy has been working to get a waiver solution
  - Rumors indicate approval is immanent
- Navy seems to be less interested in using Australia – but still pursuing
  - Bureaucracy/paperwork and cost issues
  - Recently flew one mission from Norway and looking at WSMR for other options
- Options for Southern Hemisphere Missions
  - Due to workload and schedule, may need to delay Woomera campaign to 2015
  - Consider Kwajalein and water or no-recovery
    - Could launch high performance configuration
    - Infrastructure, cost, and logistics well established

# Launch Range Updates – On-the-Horizon



- Wake Island Launcher Recently Activated
  - 50 K launcher to support the FTI project
  - Navy Research Rockets (partner with the SRPO) is the provider
  - 19 degrees North latitude
  - Permanent infrastructure unknown but just watching development
- Potential missions from off range into WSMR
  - Navy has approached FAA about long range missions into WSMR
  - Launch site at Ft. Wingate has been used in recent history and it about 250 miles from WMSR
  - Launch site at Green River, Utah has not been used in several years but appears viable based on discussions with FAA
  - Range to WSMR from Green River is ~435 miles
  - Need active and accurate guidance to take advantage of this

# Remote Ops Cost Reduction



- Range costs are becoming excessive
  - Andoya = \$36K per day (as an example)...
- Need to investigate ways to reduce costs
  - Collaboration on campaigns allows for cost sharing
    - Kwaj and Woomera
  - Apply Ship & Shoot in select instances
    - Andoya



# Technology Development

## NSROC Engineering

July 18, 2012

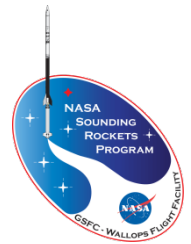
SRWG

75





# Mission Driven Development Efforts



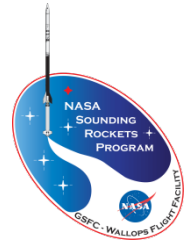
## Agenda

1. Telemetry Systems
2. Guidance, Navigation, & Control
3. Mechanical Systems
4. Vehicle Systems
5. Recovery Systems
6. Ground Support Equipment
7. Technology Flights

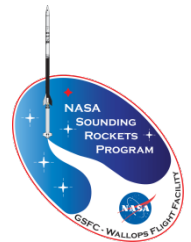




# Telemetry Initiatives



- Larger Data Rates – Currently limited to 20 MBit
  - 20 MBit PSL MV PCM Encoder – Required for Figueroa
    - Developing capability to automate testing
    - Unit will go through qualification testing
    - PSL needs to implement the external clock input (required for Figueroa)
  - On-board Recording for PCM data – Required for Figueroa
    - Teletronics Technology Corp
    - MSSR-2010-SA/MSSR-110C
    - Record rate to 48 MBps
    - AETD is working on the qualification test plan
  - Ground Stations can support 20 MBit data rates
- RF
  - Transmitters currently limited to NRZ-L modulation
  - Ground station receivers limited to NRZ-L
  - RF Spectrum Limited to S-Band and Upper S-Band

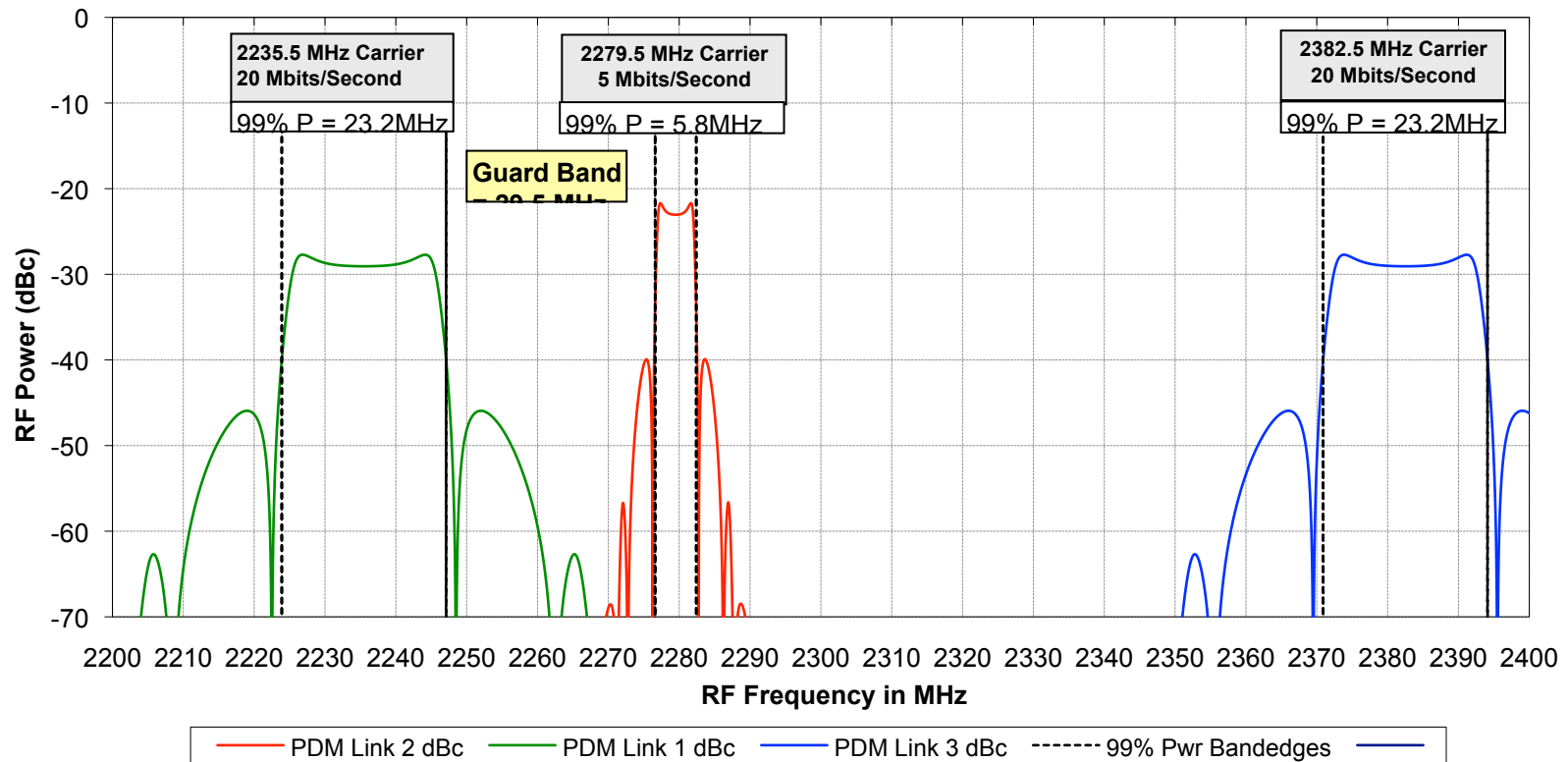


# Telemetry Initiatives

## Calculated RF Spectrum for Missions 36.245

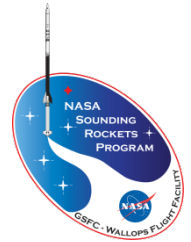
(Using 10 MHz Resolution Bandwidth and Analog)

(Assumes RNRZ-L PCM/FM; 4 pole CD pre-mod filter @ 0.7 X Bit Rate; Peak Carrier Deviation = 0.35 X Bit Rate)





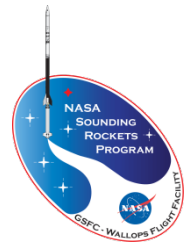
# Telemetry Initiatives



- Qualified 10 Watt High Efficiency Transmitter
- Evaluating a New Strain Gauge Monitor
  - Same strain gauge
  - New Conditioning board
  - Contains an auto zero – old design used a pot
    - Microcontroller adjusts the bridge circuit – digital pot
    - Board is built
    - Qualification – after Rosanova flight opportunity



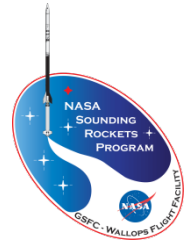
# GN&C Initiatives



- Developed Digital NMACS
  - Successfully flown on airbearing.
- Worked with AETD and U Wisconsin to develop a method for analyzing celestial target with potential issues for ST5000.
  - Figueroa identified as a potential issue and solution being worked.
- Continued enhancements to GLN-MAC / GPS integration:
  - Altitude-based maneuver advance – flown on Larsen and to be flown Cheatwood.
  - Full navigation solution. Tested on ground with 1<sup>st</sup> flight on Brodell
- Qualification of QRS-116 rate sensors (NMACS) – improved shock survivability and potential performance benefits. Replaces QRS 11.
- Upgrade of electronics for LISS (SPARCS)
- ST5K – working on conformal coat process for new units



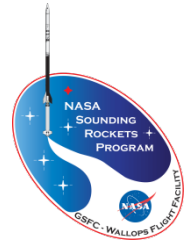
# Mechanical Systems Initiatives



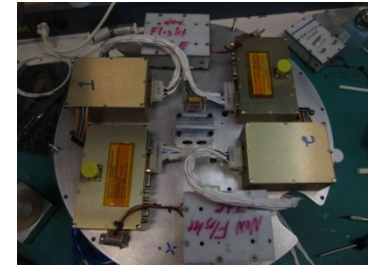
- Development
  - 36.283/Galeazzi motorized side looking doors
  - 40.028/Swenson air spring sub-payload deployment
  - 46.004/Rosanova ACS control magnetometer mast on the heatshield
  - Vacuum Monitor System in Qualification
    - MKS 972,  $1 \times 10^{-8}$  Torr to atmosphere
  - Redesign of deployable/slammer door
    - Successfully tested and flown on 36.277/Bock
- Launcher
  - Talos-Terrier-Oriole modification at WFF and PFRR
- Launcher Egress
  - Analysis complete for low QE Larsen missions and 12.075/Brodell



# Vehicle Systems Initiatives



- **New Subsystems**
  - 3-Event CDI (WSMR BBIX)
    - Fourth test flight in Aug. 2012, will perform flight critical events
  - NSROC LEOS
    - Development and qualification effort planned for late 2012 – mid 2013
- **New FTS Development**
  - Electro/Mechanical Safe/Arm Device (late 2012)
  - NSROC FTS Controller (early to mid 2013)
  - New Ordnance Kits (late 2013)
  - Qualifying new 25 cell NiCad battery
- **New Vehicle Stacks**
  - Talos-Terrier-Oriole-Nihka
    - First use of Terrier as 2<sup>nd</sup> stage and Oriole as 3<sup>rd</sup> stage
    - CDI packaged in the Terrier Head Cap
    - Terrier Load Bearing Tailcan
    - Talos- Terrier Interstage



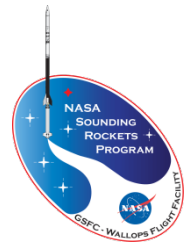
3-Event WSMR BBIX CDI Deck



Talos-Terrier-Oriole Vehicle Stack



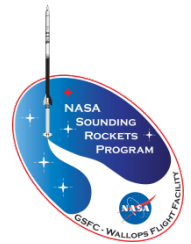
# Vehicle Systems Initiatives



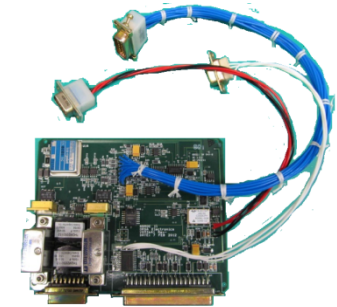
- Motor Development
  - Terrier Mk12 Spacer Ring
    - Linen phenolic spacer ring designed to alleviate shrinking grain issues
  - Improved Malemute
    - Motor Adapter
    - New fin build with updated materials and thermal protection system
    - High altitude igniter in early stages of development.
  - Black Brant
    - Flying new hybrid motor case, new propellant blending technique, and new oxidizer vendor.
    - All new 4140 motor case qualification burst test scheduled for October 2012



# Recovery Systems Initiatives



- NSROC ORSA Electronics
  - New circuit with electronic timers
  - First test flight planned for late 2012



Prototype ORSA Controller Board



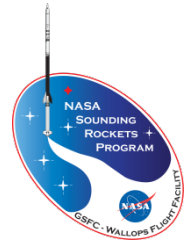


# Ground Station Upgrades

- Master Controller and Software
  - Initial Phase - complete
    - Master Controller computer installed in Ground Station #1
    - Drivers for RF control equipment implemented
  - Final Phase – next fiscal year
    - Implement Master Controller in other 2 stations
    - Complete data flow drivers
  - WSMR Ground Station – will be based on WFF system
- Developing virtual charts



# Planned Flight Demonstrations

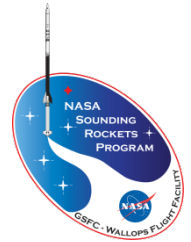


## Test Flight Opportunities

- 12.075 Brodell
  - MV encoder
  - WSMR 3 event CDI
- 46.004 Rosanova
  - Digital NMACS
  - QRS 116 Rate Sensor
  - Test of new strain gauge design
- Galeazzi
  - ORSA circuit



# New NSROC Mission Tasks



- FTS Tasks
  - CSC /FTLU, Paddle/FTLU, Paddle/FTSC
  - 25 Cell FTS Battery Pack Qualification
  - Goodrich Ordnance
  - FTSC Fabrication
  - FTS Skin Fabrication
- Black Brant Issues
  - AP, nozzle, steel
- CDI at WSMR (not using Bristol Systems) on all BB IX
  - Fabrication
- Rigor
  - Lessons Learned
  - Walk Down Procedures
  - FRR
  - Data Reviews
- Launcher work
  - Five launches at WFF (launcher capability)
  - Upgrades for PFRR and WFF