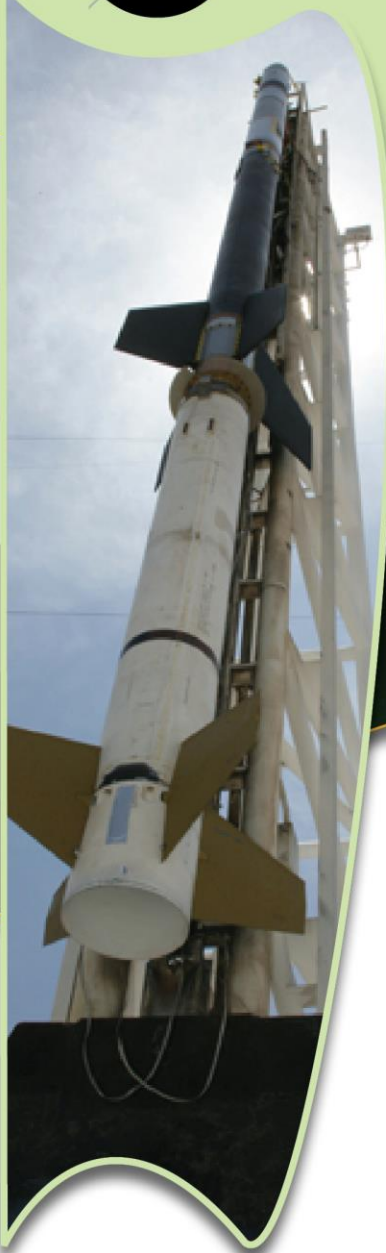
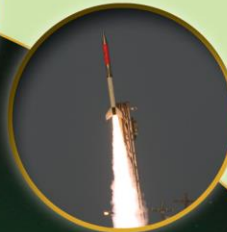




The NASA Sounding Rocket Program

IEEE International Conference for
Wireless for Space and Extreme
Environments



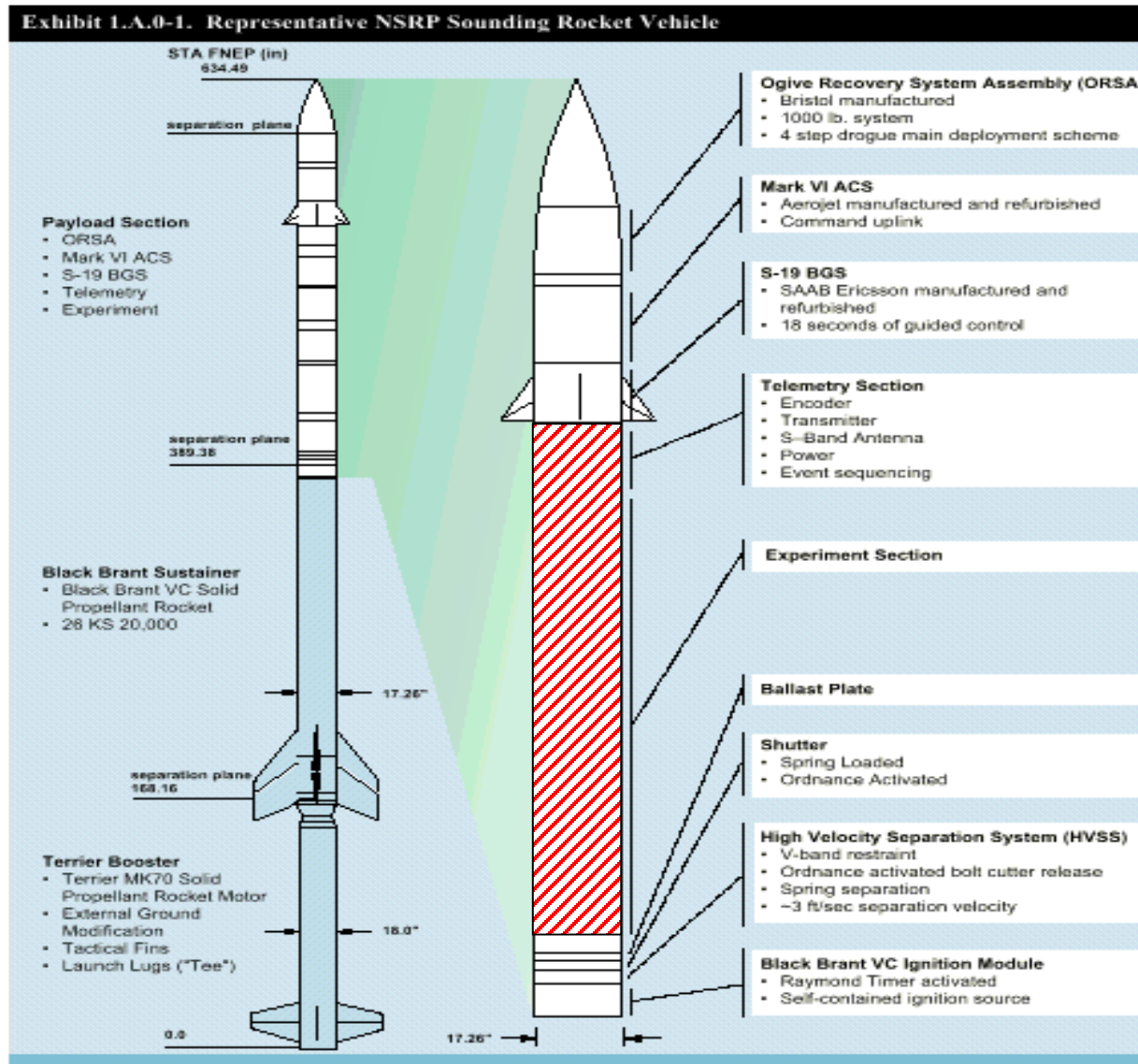
Brian Hall

Technology Manager

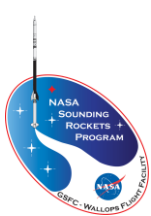
NASA Sounding Rockets Program Office

December 16, 2015

The “Sounding Rocket”

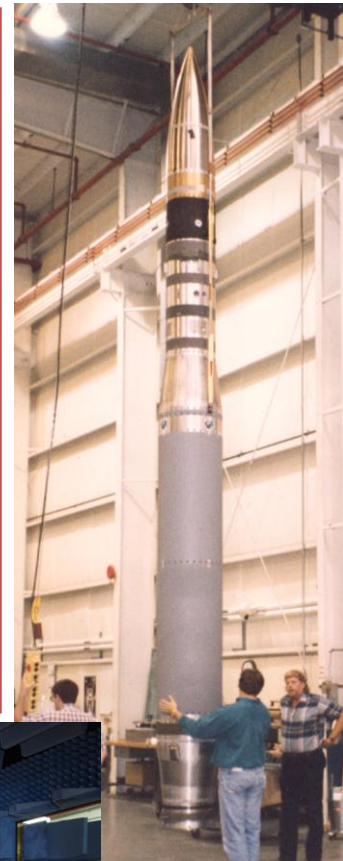


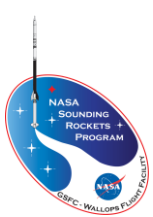
The Black Brant IX MOD 1 (Terrier MK70 – Black Brant VC) is the reference vehicle used for discussion purpose.



Why Sounding Rockets?

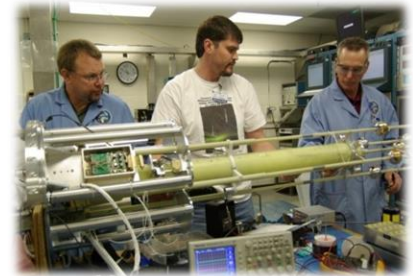
- Low cost access to space
 - Short flight duration, but enables space-based experiments that might otherwise not get done
- Project lifetimes are short (typically 3 years)
- Can accept higher technical risk since consequences of failure are lower
 - Program success not based on any single flight
 - Safety risk is never compromised
- Allows for in situ measurements
 - Balloons fly too low for some applications
 - Satellites fly too high and/or too fast
- Relatively low velocities while the instruments pass through the scientific events
- Reuse of payloads possible in many instances
- Ideal for technology development
 - New instruments/detectors
 - Atmospheric entry vehicles
- Education and Training



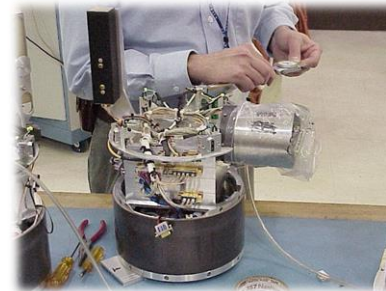


Sounding Rocket Mission Categories

- Science Missions
 - Science investigations
 - Geospace
 - High Energy Astrophysics
 - Solar Physics
 - Planetary Atmospherics
 - Instrument Development
- Technology Development and Demonstration Missions
 - Sounding Rocket Technologies
 - Entry, Descent, and Landing Technologies
 - Hypersonic Propulsion Technologies
- Educational Flight Missions
 - High school
 - University Undergraduate
- NASA Training Missions
- Reimbursable Missions



Geospace Payload undergoing integration



Ejectable Subpayload



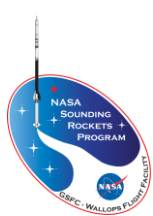
Rock-On Experiment Assembly



Hypersonic Propulsion



Reentry Aeroshell

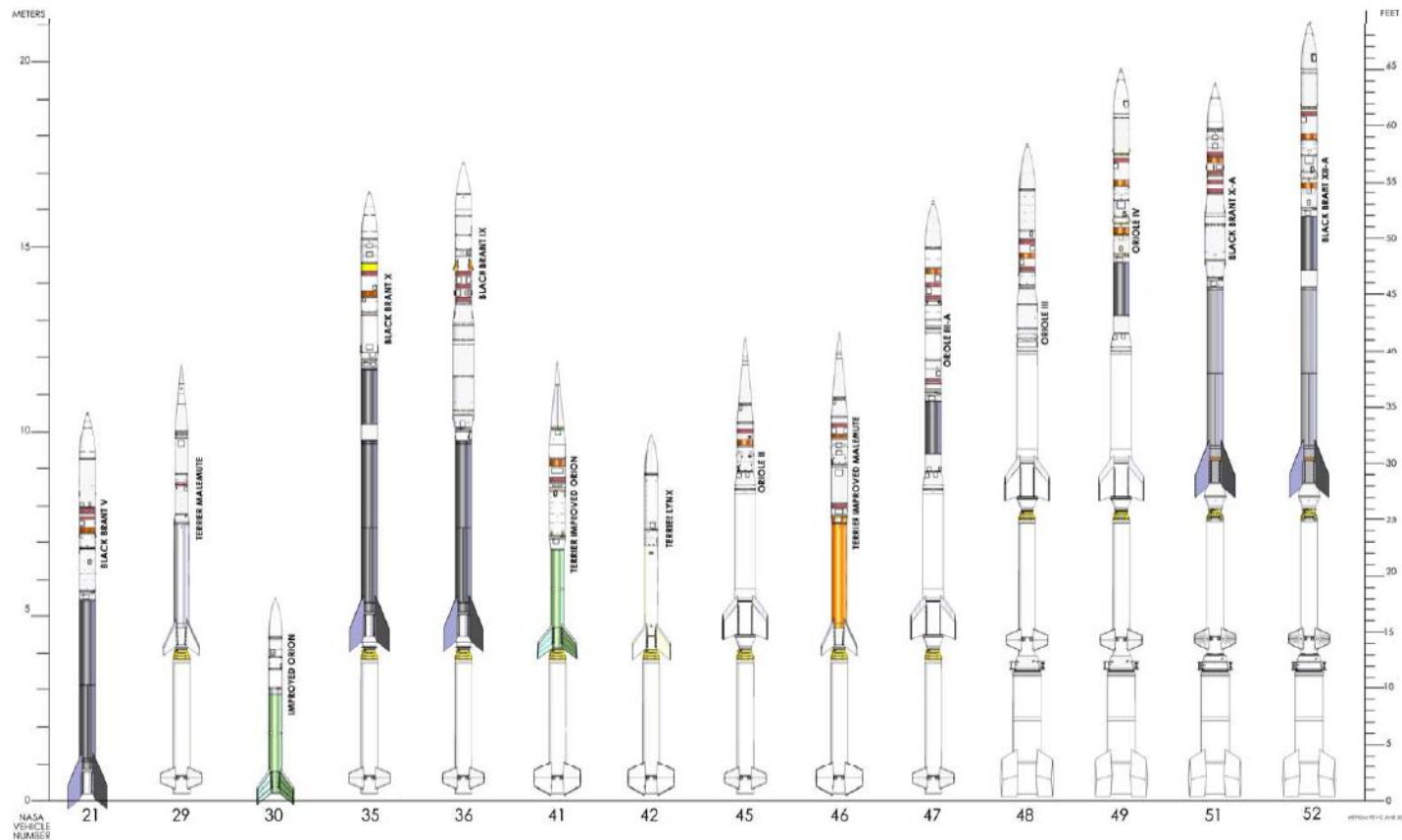


Project Support Services

- Payload Development
 - Attitude Control Systems
 - Magnetic
 - Inertial (coarse pointing and velocity vector tracking)
 - Celestial (sub arcsec pointing)
 - Telemetry Systems
 - Multiple links
 - 10 Mb/s data rates
 - Command uplink
 - Video down link
 - Recovery Systems
 - Boost Guidance Systems
 - Aerodynamic control for early portion of powered flight
 - Experiment Structures
 - Deployment Systems
- Mission Analysis
 - Flight performance
 - Ground and Flight Safety
- Launch Vehicles
- Operations Support
 - Mobile range development
 - Launcher servicing and erection
 - Field operations
- Technology Development



NASA Suborbital Launch Vehicles

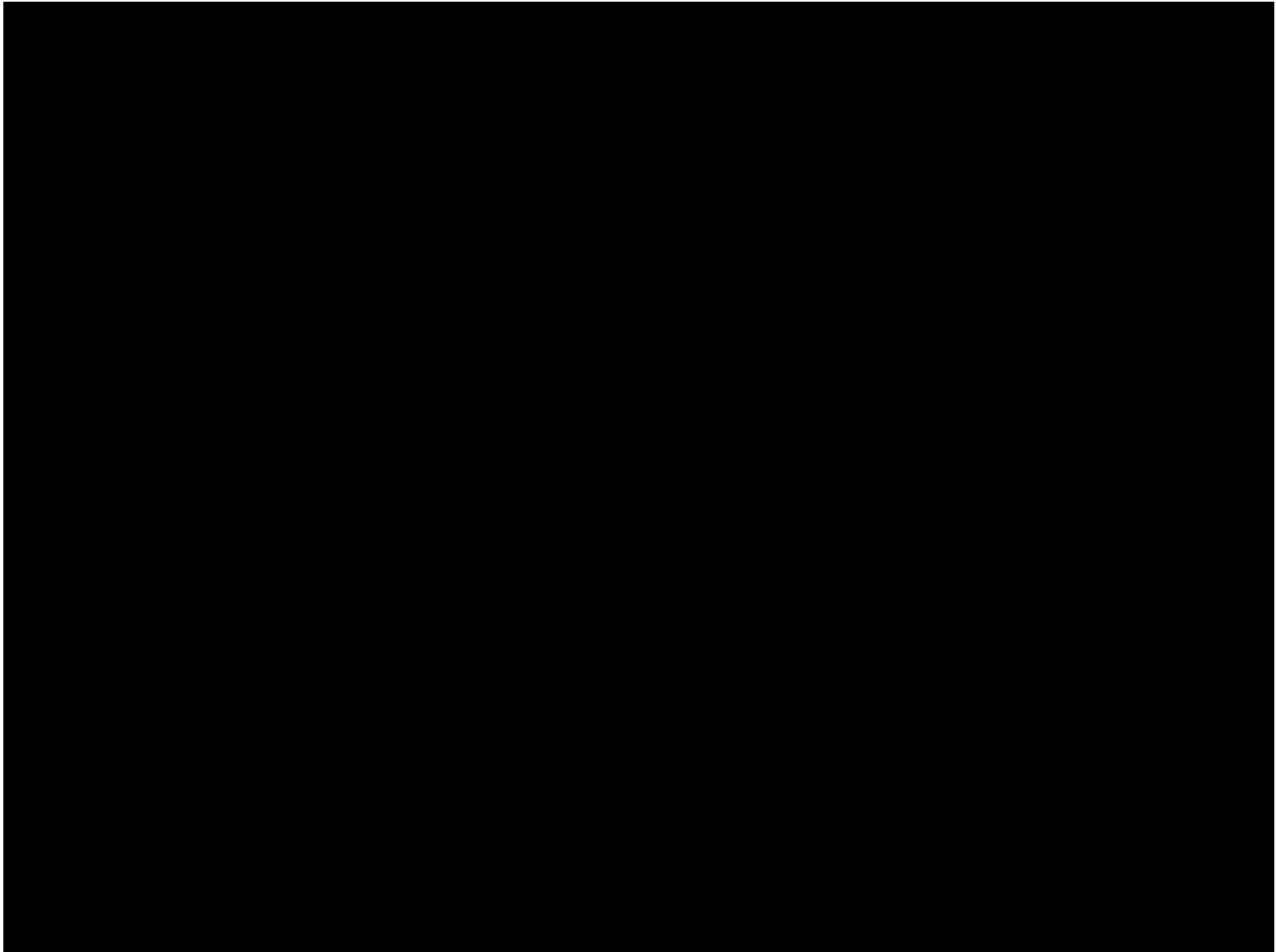


- Variety of launch vehicles covering max altitudes from 100 -1500km, using various motor combinations (Terrier, Black Brant, etc)
- Sounding rocket vehicles are composed of military surplus and commercially available rocket motors
- Vehicle selection is based on payload weight and scientific requirements

Sounding Rocket Launch Video



Sounding Rocket Mission Video



Key Technology Needs

- Telemetry Enhancements
 - Increasing data rates beyond standard 10 Mbps systems
 - High data rate on-board recording
- Deployable sub-payloads
 - Deployment systems
 - Miniature electronics
 - Constellation communications
- Remote sensors/monitoring
 - Design for harsh environments (temp, acceleration,...)
 - Locations not conducive to wiring harnesses (rocket motor nozzles, fins, interstage hardware)

Flights of Opportunity

- RockOn, RockSat-C, RockSat-X Educational Flight Project
 - NASA, Colorado Space Grant, and Virginia Space Grant collaboration
 - Annual Educational Flight Opportunity
- Reimbursible Flight Opportunities
 - RideShare opportunities on annual/semi-annual technology demonstration missions
 - Reimbursible mission opportunities

