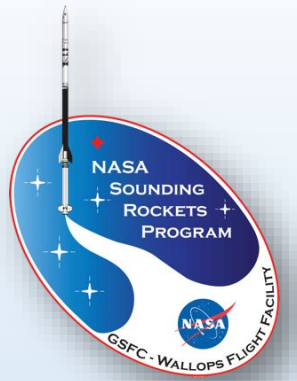


# NASA Sounding Rockets Program



Phil Eberspecker  
Chief, NASA Sounding Rockets Program Office



DATT Summit  
April 27, 2016



Sounding rocket  
emerging from  
its environmental  
cocoon





NASA Sounding Rockets Program



NASA Sounding Rockets Program

# Nature of the NASA Sounding Rockets Program

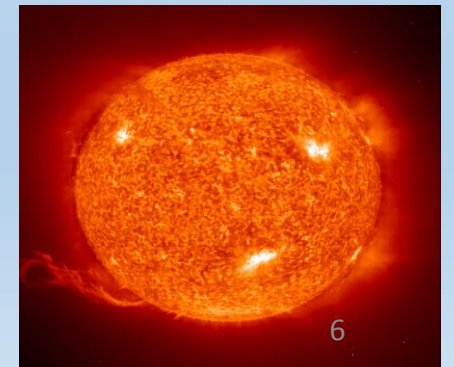
- Characteristics
  - Low cost
    - Part of the NASA Low Cost Access to Space (LCAS) program
  - Rely on surplus assets as much as possible to reduce cost
  - Acceptance of higher technical risk
    - Lower consequence
    - Higher probability of issues or failure
  - Quick turn around
  - Minimalistic project teams
  - Highly flexible and agile
  - Non Mil-Spec components
  - World-wide mobile operations
  - Implemented via the NASA Sounding Rocket Operations Contract (NSROC)
- Highly successful for NASA Science Mission Directorate
  - Cutting edge science is being conducted
  - Enables instrument development that ports into future orbital missions
  - Scientist development





# Types of Missions

- Geospace (Plasma Physics)
  - Solar Telescopes
  - Astronomical Telescopes
  - High Speed Aerodynamics and Propulsion
  - Reentry and Descent
  - Technology Development
  - Educational
- 
- Approx. 40 payloads/missions active at any given time
  - Approx. 18 flights/year





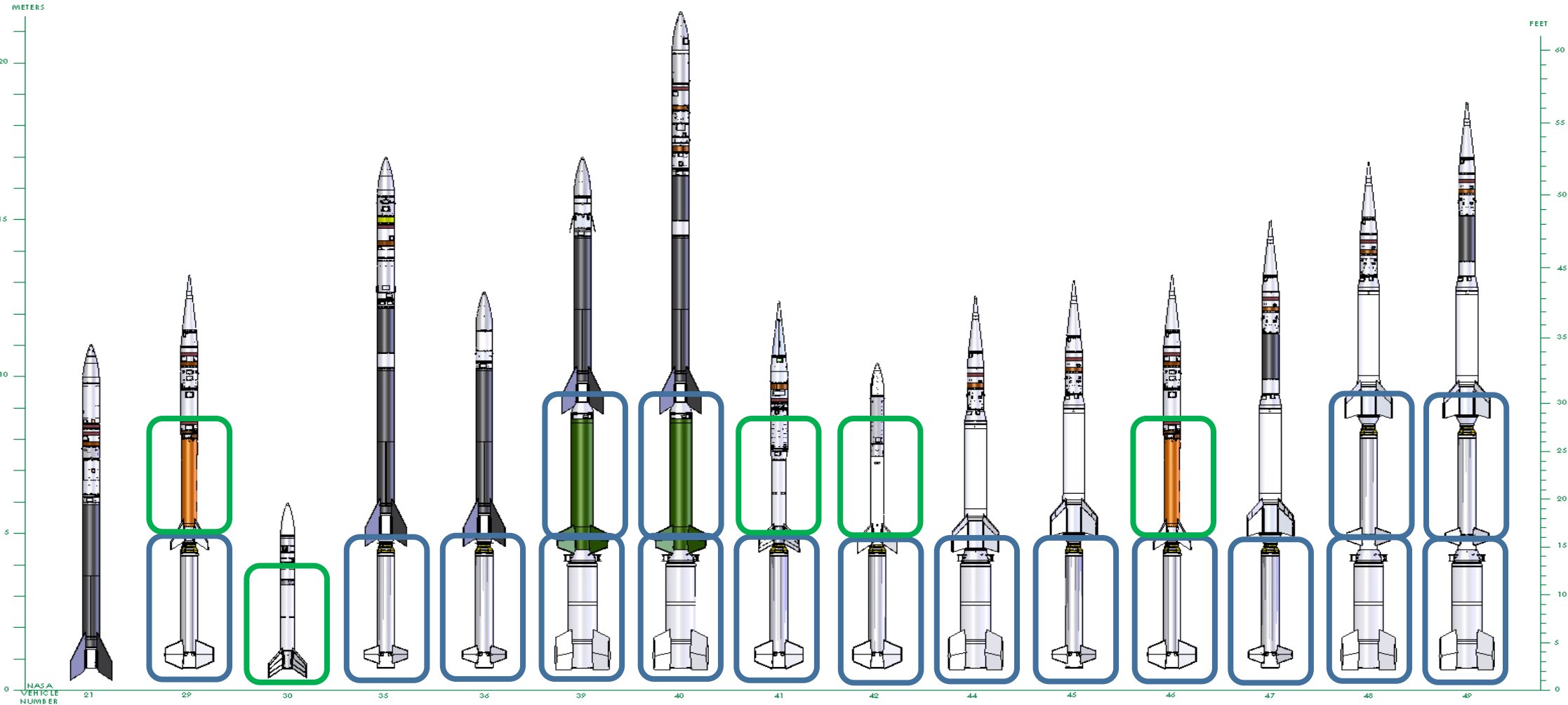
# Services Provided

- **Payload Development**
  - Attitude Control Systems
    - Magnetic, Inertial, Rate Control, Celestial, Solar
  - Telemetry Systems
    - 10 Mb/s standard, 20 Mb/s available
    - Command uplink & Video downlink
  - Payload 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**



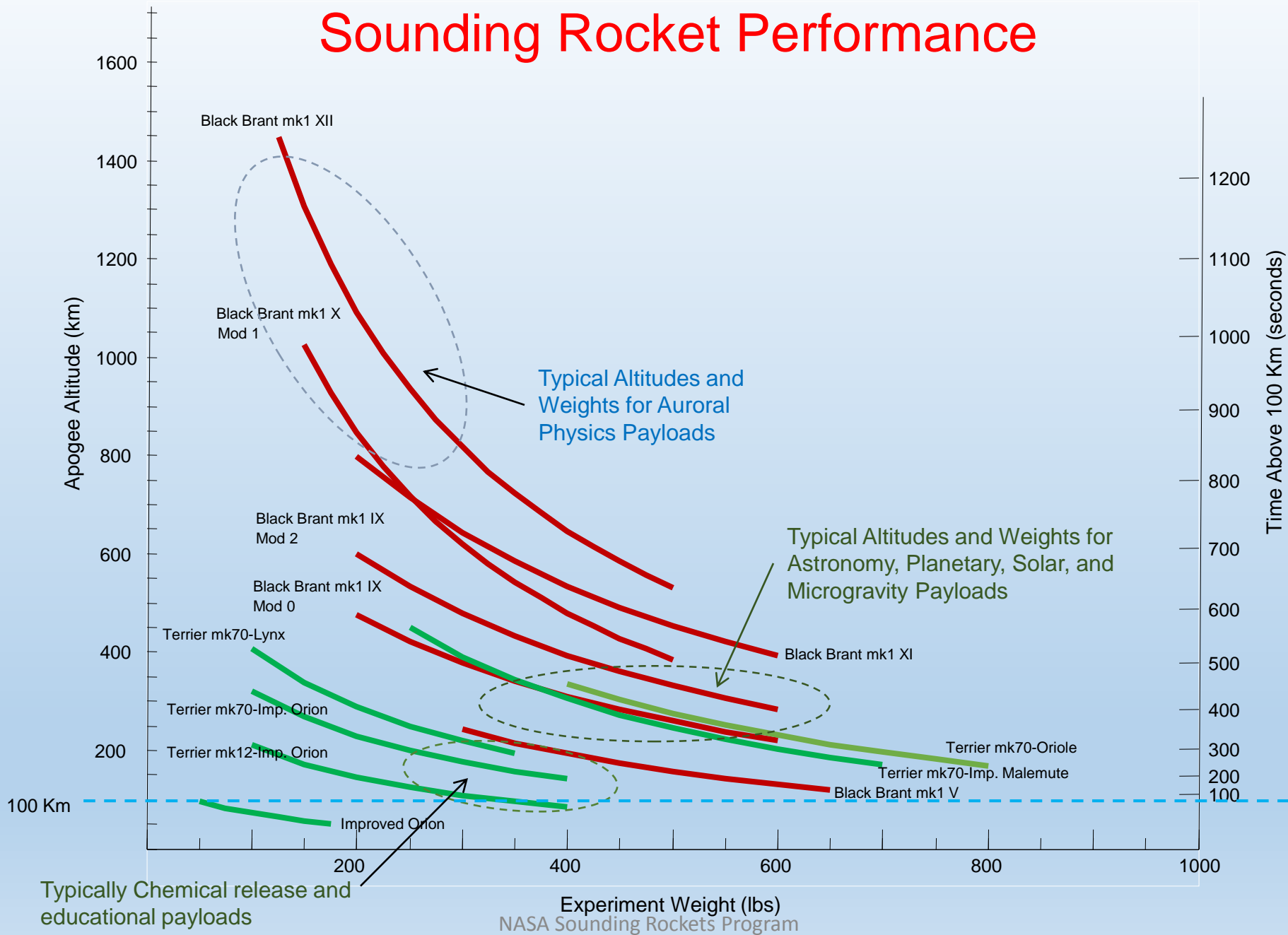


# Launch Vehicles





# Sounding Rocket Performance



# World-Wide Operations



Poker



Svalbard



Wallops



Andoya



White Sands



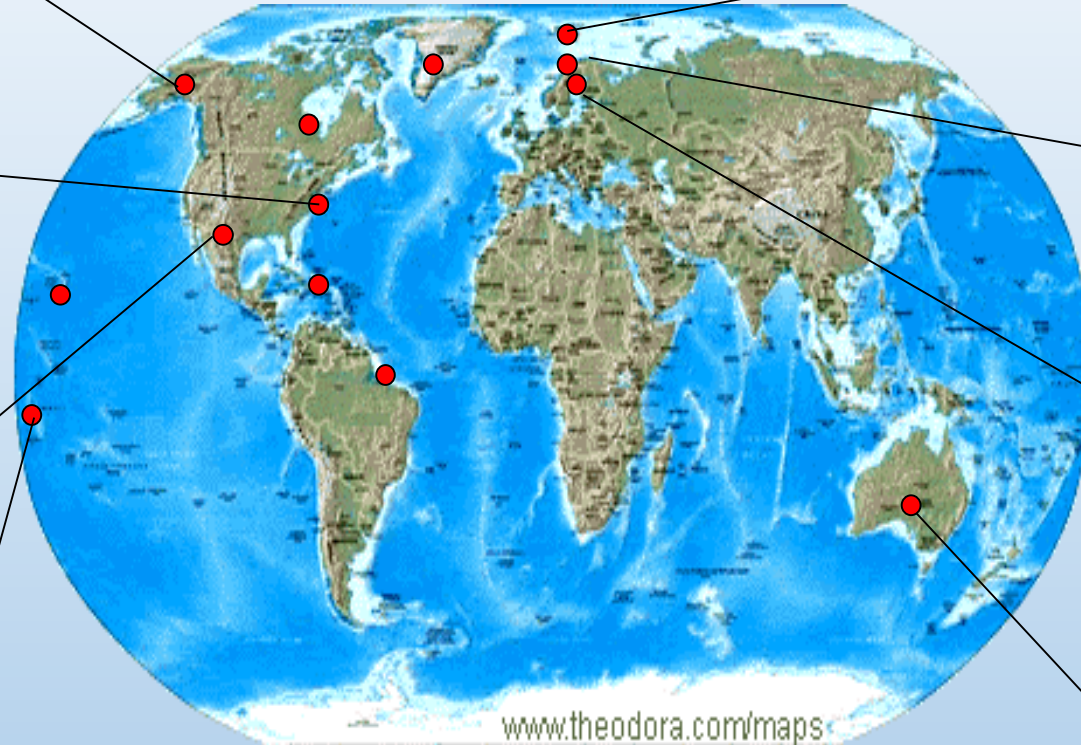
Esrange



Kwajalein



Woomera



The Sounding Rocket Program “goes to where the science is...”

**Test article  
deployment and  
ACS spin-up**

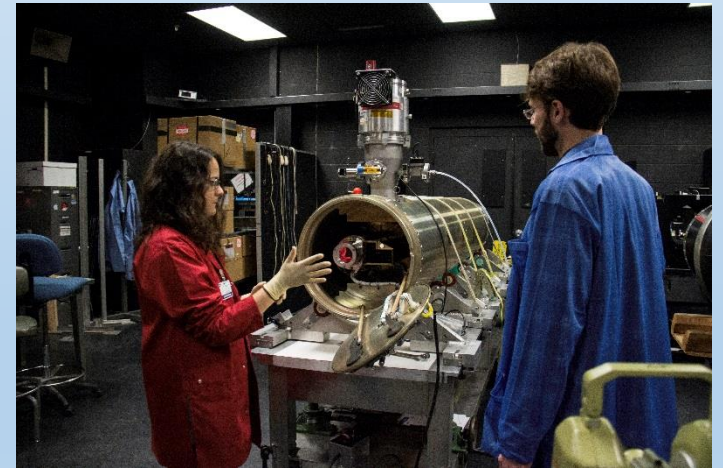
# Max Launch Abort System (MLAS)



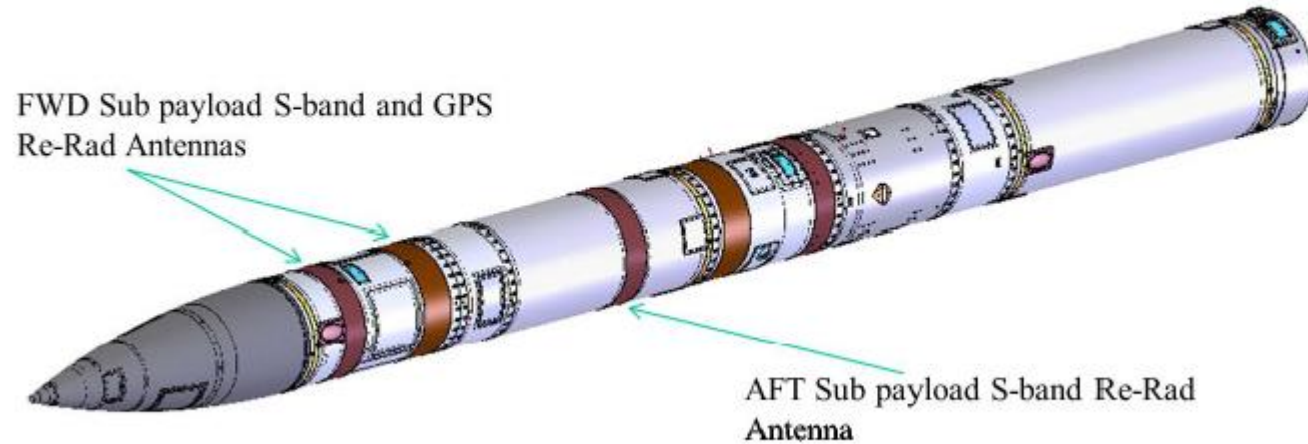


# Technology Development Thrusts

- Higher flying suborbital vehicles
  - New stacks of existing rocket motors assets
- Payload-to-payload RF communications
- Higher Telemetry Data Rates
  - Currently maximum is 20 Mb/s
  - Seeking 300+ Mb/s
  - X-band desirable, but may be required to use C-band instead
- Reduced reliance on ground assets
- Compact/miniaturized components

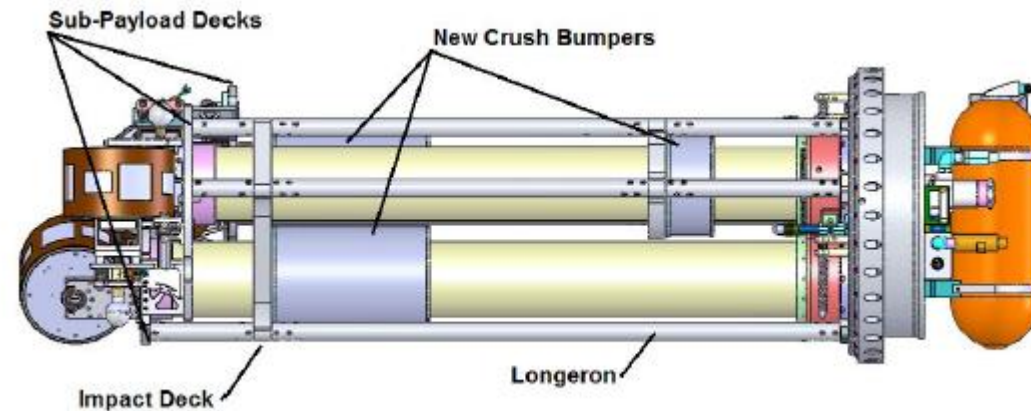
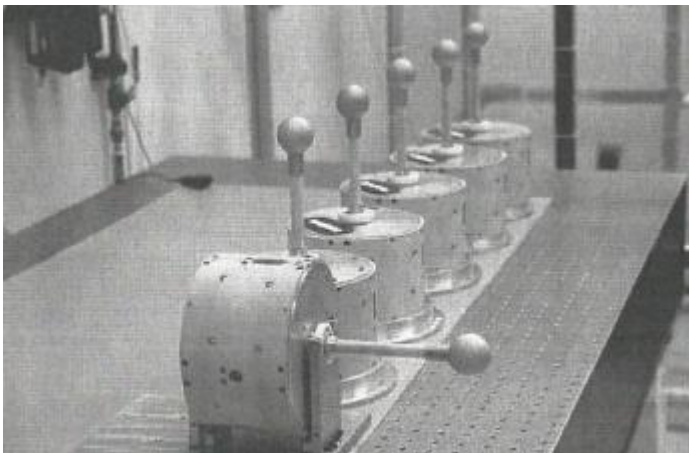


# Multi-point measurements



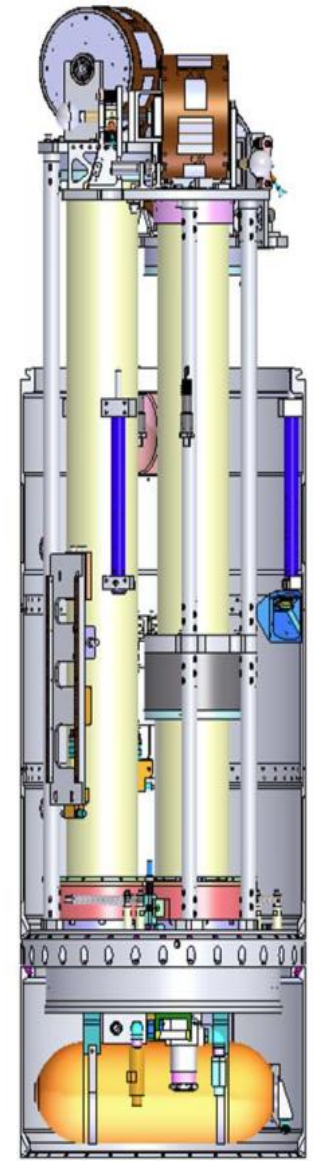
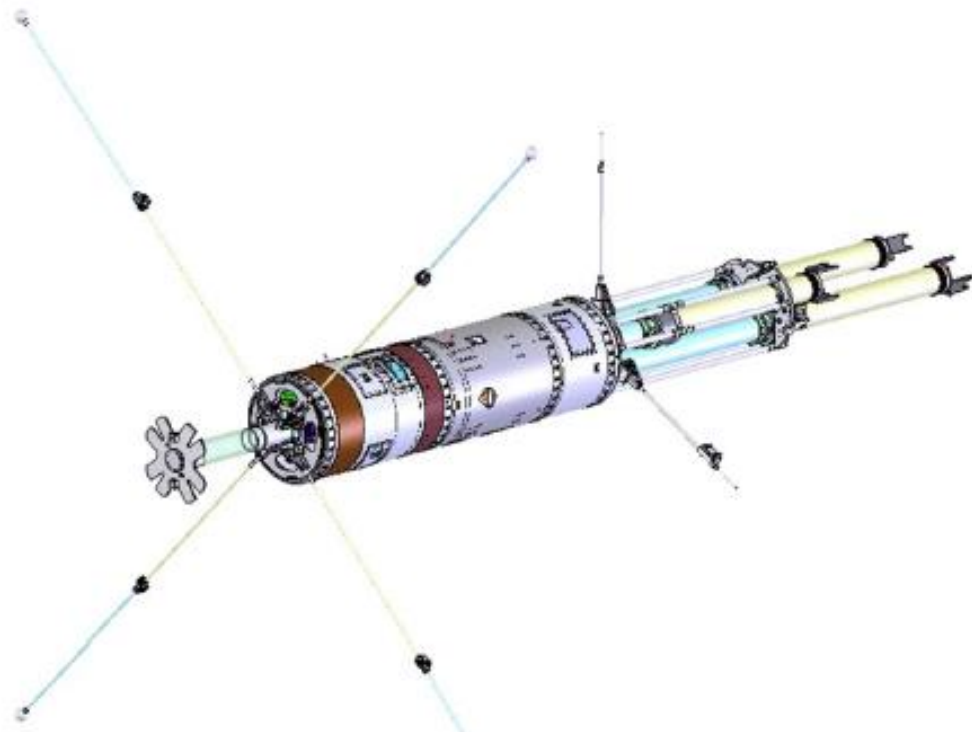
## Frequencies:

- Sub Payloads (200 Kb/s, PCM/FM)
  - 2215.5 MHz (2 Watt)
  - 2217.5 MHz (2 Watt)
  - 2219.5 MHz (2 Watt)
  - 2221.5 MHz (2 Watt)
  - 2223.5 MHz (2 Watt)
  - 2225.5 MHz (2 Watt)
- Main Payload (4.8 Mb/s, PCM/FM)
  - 2279.5 MHz (10 Watt)





Poker Launch – 6 telemetry antenna were required to track the 7 separate payload bodies







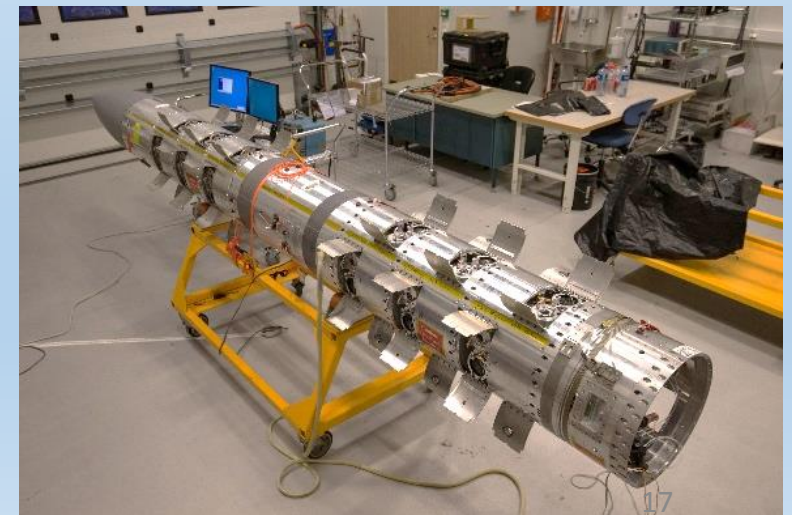
## Lift-Off...



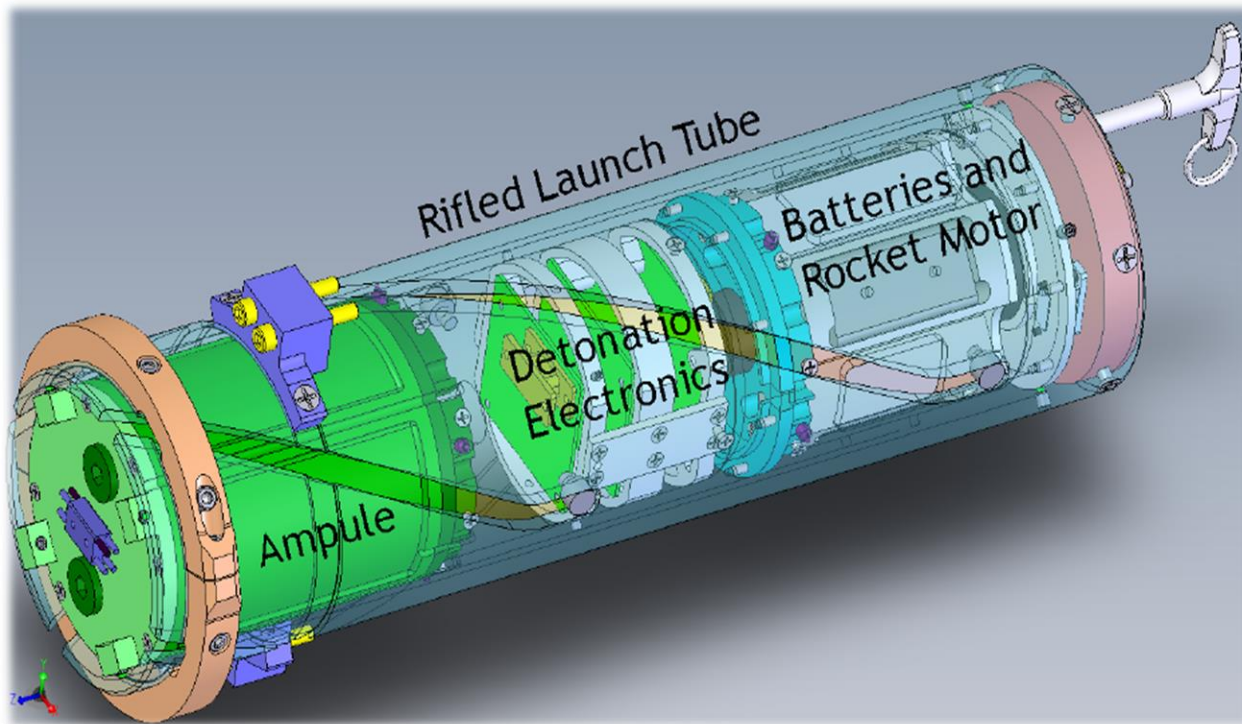
## Releases...



- Rocket propelled micro-payloads
- 20 or more on a given flight
- Potentially large separation distanced (10's of kilometers)
- Too many objects to be tracked using ground assets



# Small Rocket Propelled Subpayloads



Early version of the ampoules have been chemical deployment devices which did not include telemetry.

Work is underway to enable payload-to-payload communications.

- DNT-900 Radio Link
- Low data rates
- Striving for higher data rates



Conde 52.001

Ampule Doors Deploy  
(using flight timer)

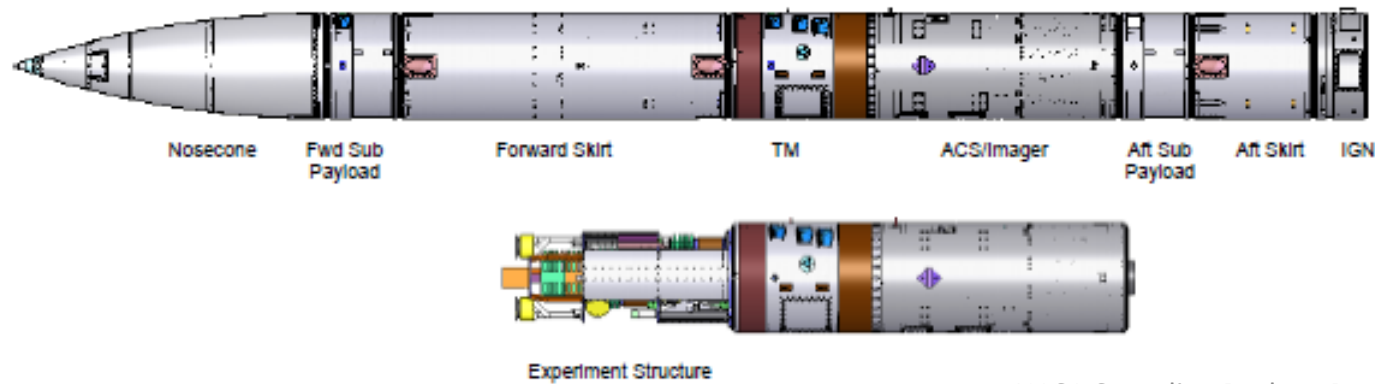
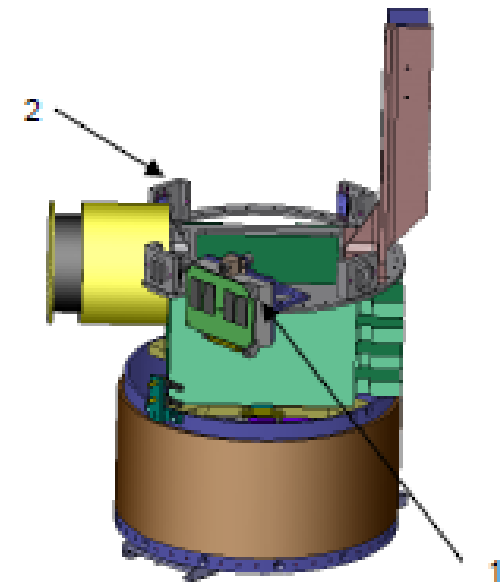
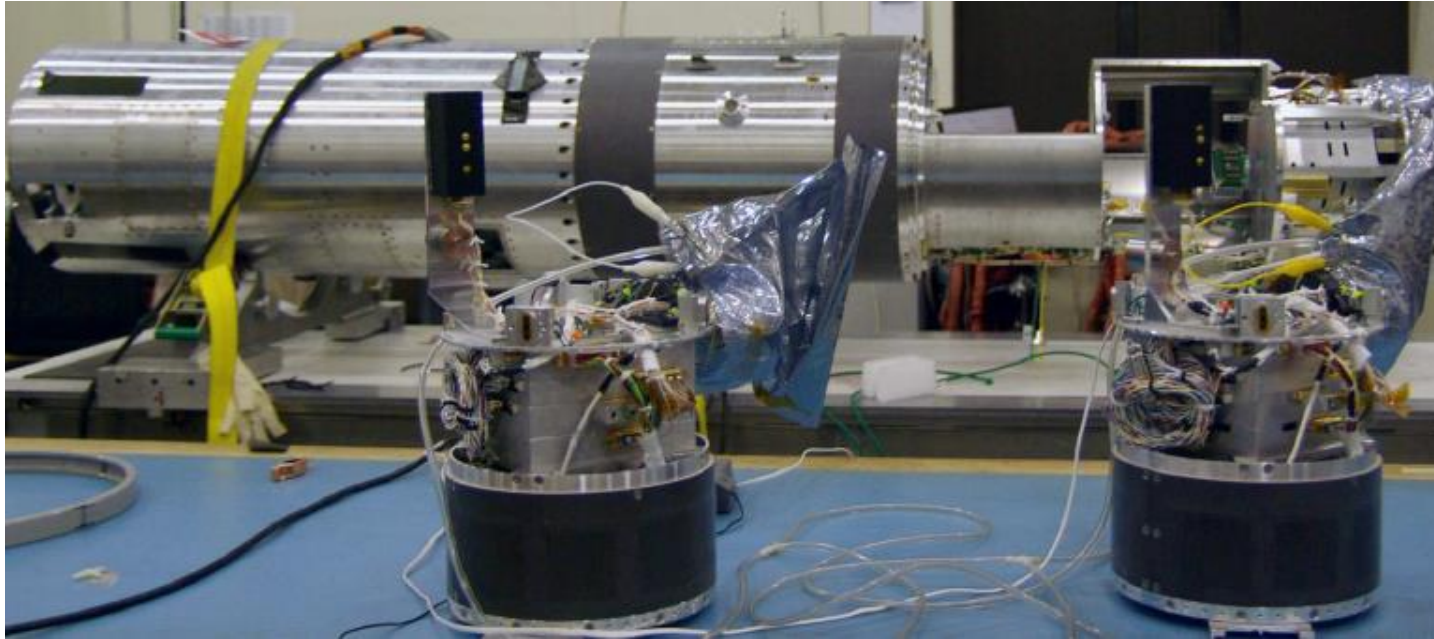
27 September 2014







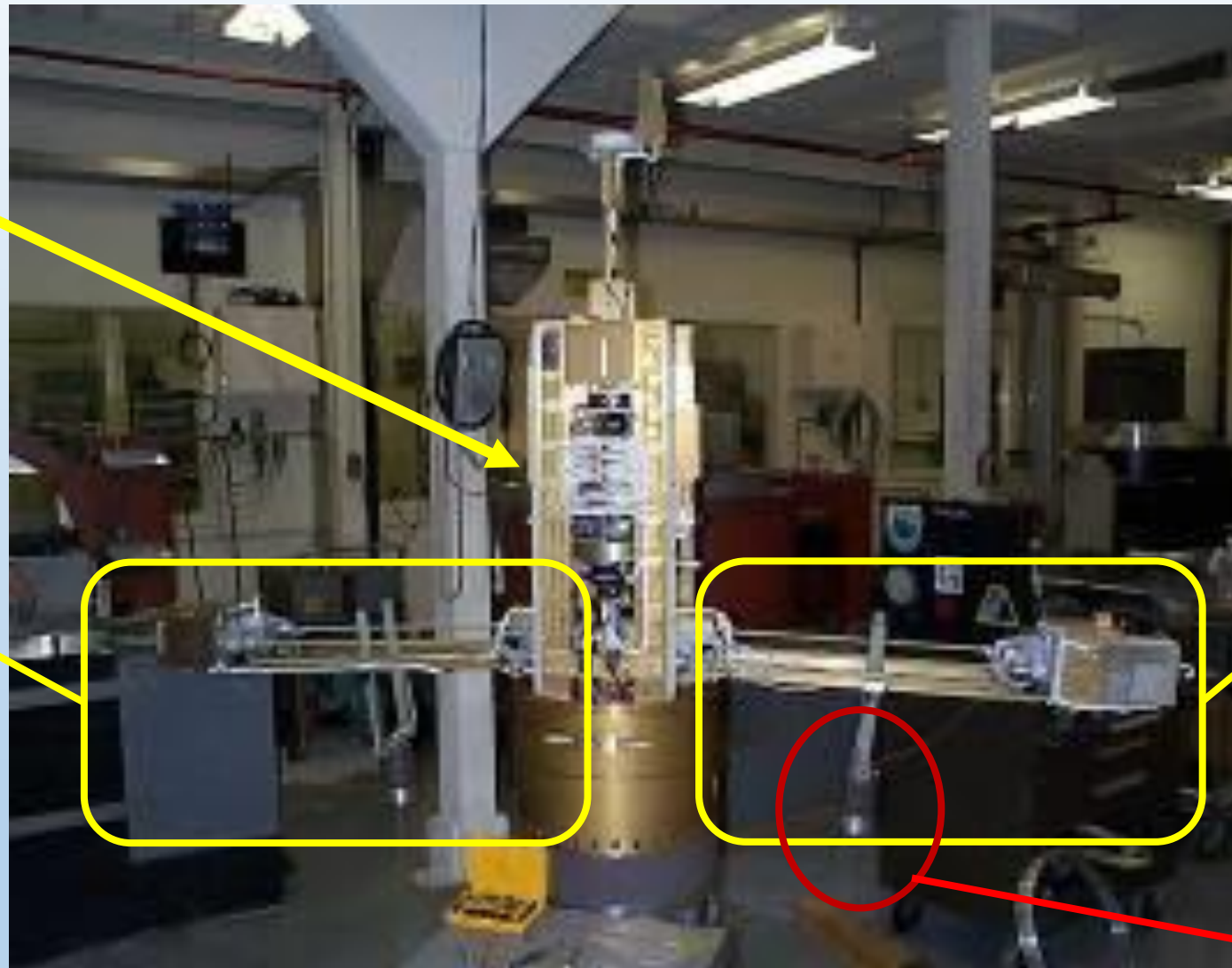
# More sub-payloads, different requirements...



Video

Main  
Payload

Deployable  
Sub-Payload



Deployable  
Sub-Payload

Deployable  
Soda Can  
Antenna

# Solar Telescope – Shutter Door

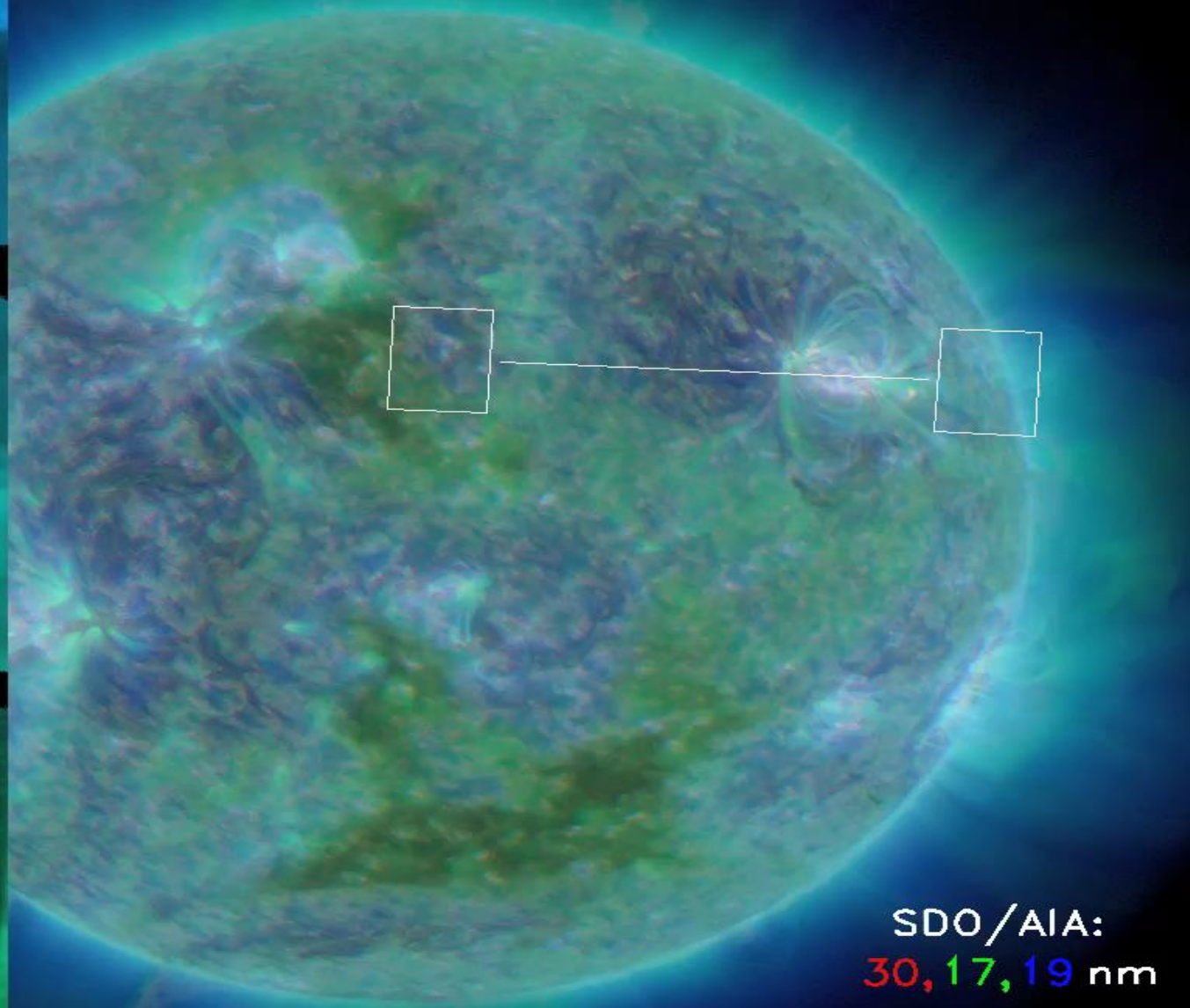


30 – 37 nm

EUNIS: 23 Apr 2013, T=17:30 UT

T + 132 s

52 – 63 nm



SDO/AIA:  
30, 17, 19 nm

# LaRC Inflatable Reentry Vehicle Experiment

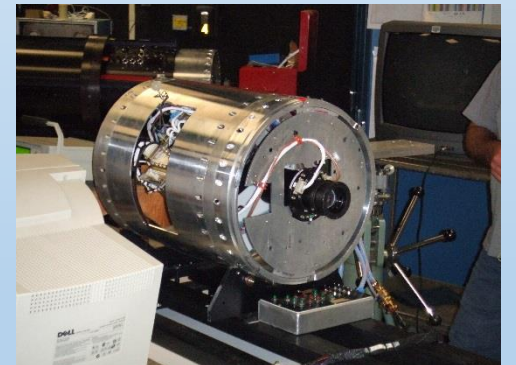
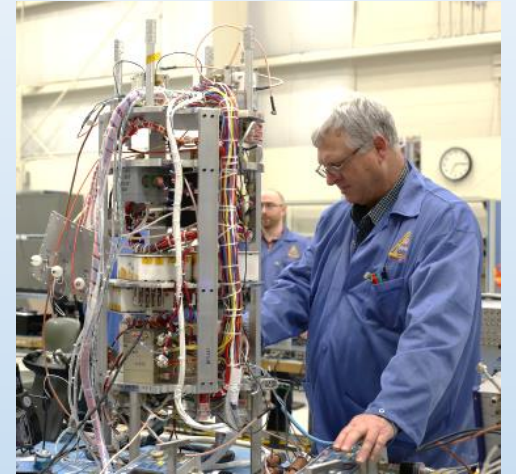




# General Telemetry Characteristics

- Data Rates
  - Current
    - 10 Mb/s (standard)
    - 20 Mb/s (emerging)
    - Up to 3 links can be flown simultaneously (at high data rate)
  - Future
    - 300 Mb/s – 400 Mb/s
- Transmitters
  - S-Band
    - 2 to 20 Watts
    - 1.5 MHz to 40 MHz frequency response
  - Need to migrate to X-band or C-band

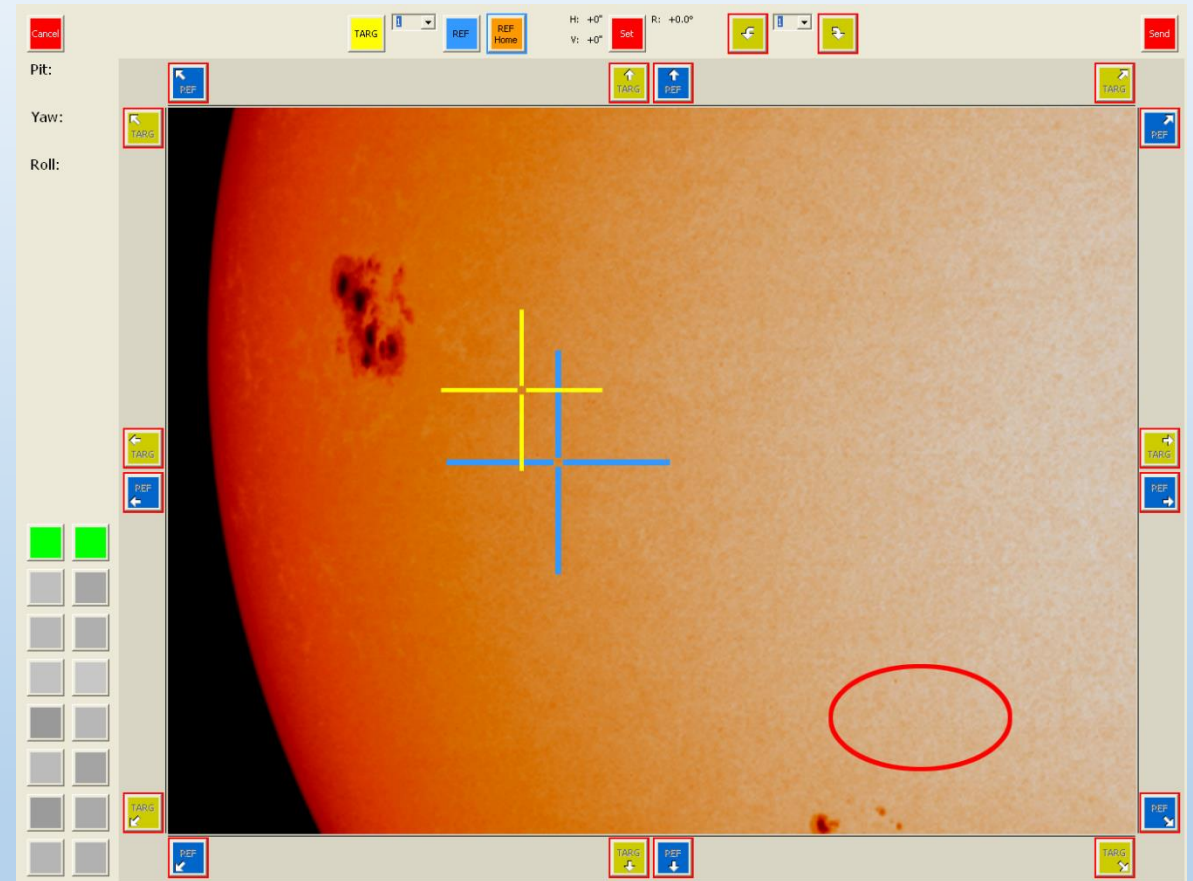
- Encoders
  - WFF 93 Encoder
    - Bi-Phase L
    - NRZL
    - RNRZL
    - Conv NRZM
    - Conv NRZL
  - MV Encoder
    - Bi-Phase L
    - NRZL
    - RNRZL
    - Conv NRZM
    - Conv NRZL





# Command Uplink

- Flight Termination
  - 421 MHz, 425 MHz, 428 MHz
  - Tone System
- Payload / ACS Control
  - 437.5 MHz
  - Tone System



Touch screen SPARCS uplink command control panel

# Contacts

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- Brian Hall
  - Technology Manager
  - 757-824-1477
  - brian.a.hall@nasa.gov

# Questions?