

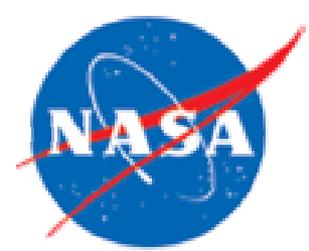
Space Environment Testbeds SET Experiment Options

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Goddard Space Flight Center

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Topics

- Introduction
- SET Concept
- Experiment Accommodations
- Investigation Processes
- Carrier Enhancements
- Summary

Introduction

Space Environment Testbeds (SET)

Goal

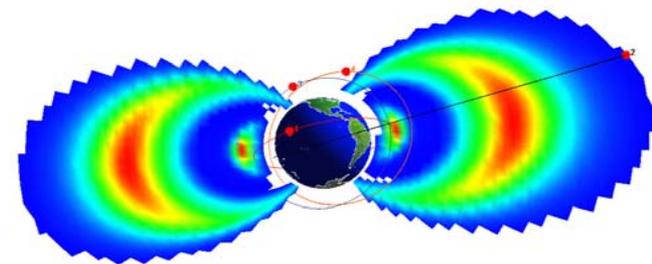
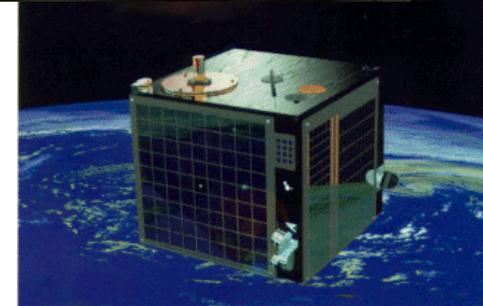
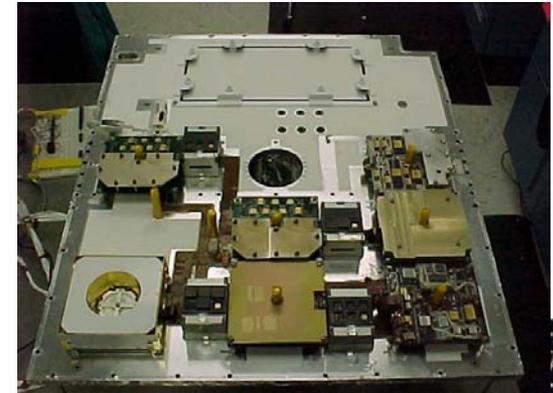
Improve the engineering approach to accommodate and/or mitigate the effects of solar variability on spacecraft design & operations

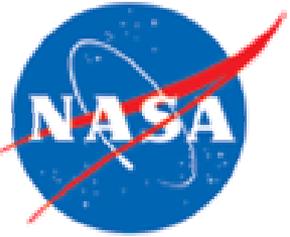
Approach

- Collect data in space to validate the physical mechanisms for performance degradation in the space environment
- Collect data in space to validate new & existing ground test protocols for the effects of solar variability on emerging technologies
- Develop & validate engineering environment models, tools, & databases for spacecraft design & operator

Scope

Spacecraft hardware & design /operations tools whose performance changes with solar variability

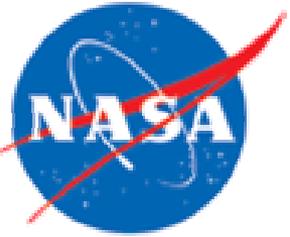




Definition of Terms

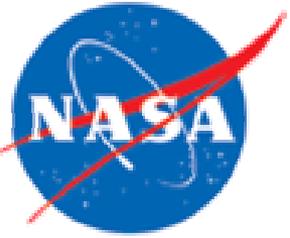
- **INVESTIGATION:** Proposal, resultant flight experiment, data and a deliverable product.
- **EXPERIMENT:** Card(s) or box flown to collect data
- **CARRIER:** Project-provided system that acts as the interface between experiments and a host spacecraft.
- **PAYLOAD:** A number of SET experiments integrated to a carrier, which is delivered to a host spacecraft for flight.
- **HOST:** A spacecraft that provides resources and the ride into space for a SET payload.
- **RESOURCES:** power, data TLM/CMD capability, bandwidth, up-mass, footprint, etc...

SET Concept Overview



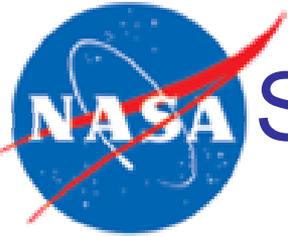
SET Investigation Approach

- **SET supports**
 - Investigations resulting in “data products”
 - Box & board level experiments
 - Environment investigations at different orbital attitudes
 - Investigations with partnership components
 - Government, commercial, other investigations
 - Hardware, data reduction, ground testing, facility usage
 - Investigations having acquired their own flight opportunity
- **SET does not support**
 - Ground test protocol
 - Instrument flight validation
 - Integration support to another host spacecraft other than the SET carrier



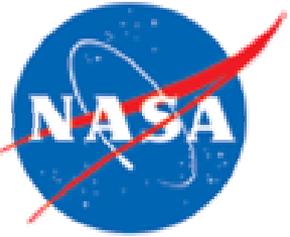
Partnering

- **Partnerships are required!**
- **Creative partnerships are encouraged**
 - Commercial organizations
 - Government organizations
 - Other investigation teams
- **Partnership support may include**
 - Hardware
 - Data reduction
 - Ground testing/analysis data
 - Facility usage
- **Partnership Example: You acquire the ride, we can support the investigation**



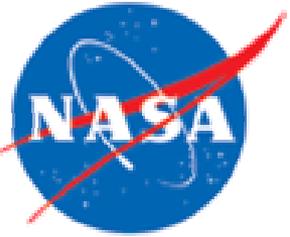
SET Investigation Requirements

- **Space Environment Exposure**
 - **Expose each investigation to the relevant space environment**
 - **Maximize exposure to the space environment**
- **Data collection**
 - **Collect data at sufficient rate to correlate to *in situ* environment**
 - **Provide event driven data acquisition mode**
 - **Acquire sufficient data to obtain statistical distributions of performance**
 - **1 year design life with 2 year goal**



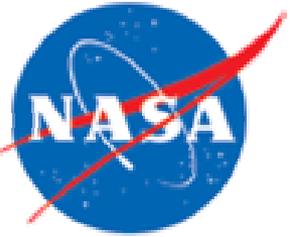
Implementation Concept

- Collect a number of flight-ready experiments designed to support pertinent science investigations
 - **NRA**
 - **Partnerships**
 - **Previously peer reviewed experiments**
- Design a system (carrier) to act as an intermediary between experiments and a TBD host spacecraft. The carrier provides:
 - **standardized interface to flight experiments**
 - **adaptable interface to host spacecraft**
- Acquire a launch and limited services from a spacecraft which offers excess capability (a 'ride')
 - **Currently soliciting launch opportunities on host spacecraft**



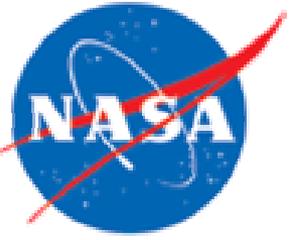
Implementation Concept (cont)

- Manifest flight experiments compatible with available rides
- **Integration:**
 - Experiments to carrier, common interface
 - Carrier to host spacecraft, unique interface
- **Flight and data acquisition/distribution to P.I.s**
 - Via a centralized SET system
 - Command & TLM. Non-real time data/cmd. On the order of 1/wk.
 - Network-based distribution
- **Post-flight data products delivery to SET**
 - Archive in accordance to LWS Program Plan (non-ITAR controlled data)



SET Carrier Design Concept

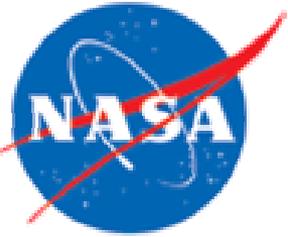
- **Standardized**
 - Defined interface to experiments irrespective of mission to be flown
- **Flexible**
 - adaptable to TBD Host spacecraft
 - Distributed architecture and physical layout
- **Low-risk**
 - Heritage Parts
 - Fail-safe between SET Carrier and Host spacecraft
- **Carrier must-work: environment hardened**
- **Experiments will operate to “failure” (which is required to characterize performance)**



Carrier Design Concept (cont)

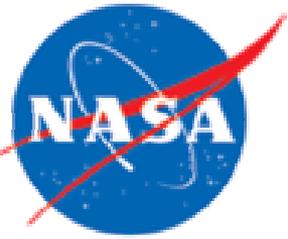
- **Correlative Environment Monitor (CEM)**
 - **Provided by SET**
 - **Can be combined with an investigation to characterize the space environment**
 - **Complement experiment's science on a particular ride**
 - **Data provided to investigators & also available to be used as an event trigger for limited experiment functions**

Experiment Accommodations Overview



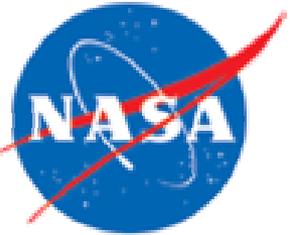
Experiment Accommodation Options

- **Card experiment**
 - **Can be housed in a carrier-provided box**
 - **Single 3 U board (100mm x 160mm)**
 - **Double-wide 6 U board (223mm x 160mm)**
 - **Single card experiment**
- **Box experiment**
 - **Experiment provided box**
 - **Multi-card or single card**
 - **Sized cards other than 3U or 6U**
- **Interface/connect to other cards, boxes, experiments**
- **Shielding options/box lid configuration, baseline thickness of .010 in Al**

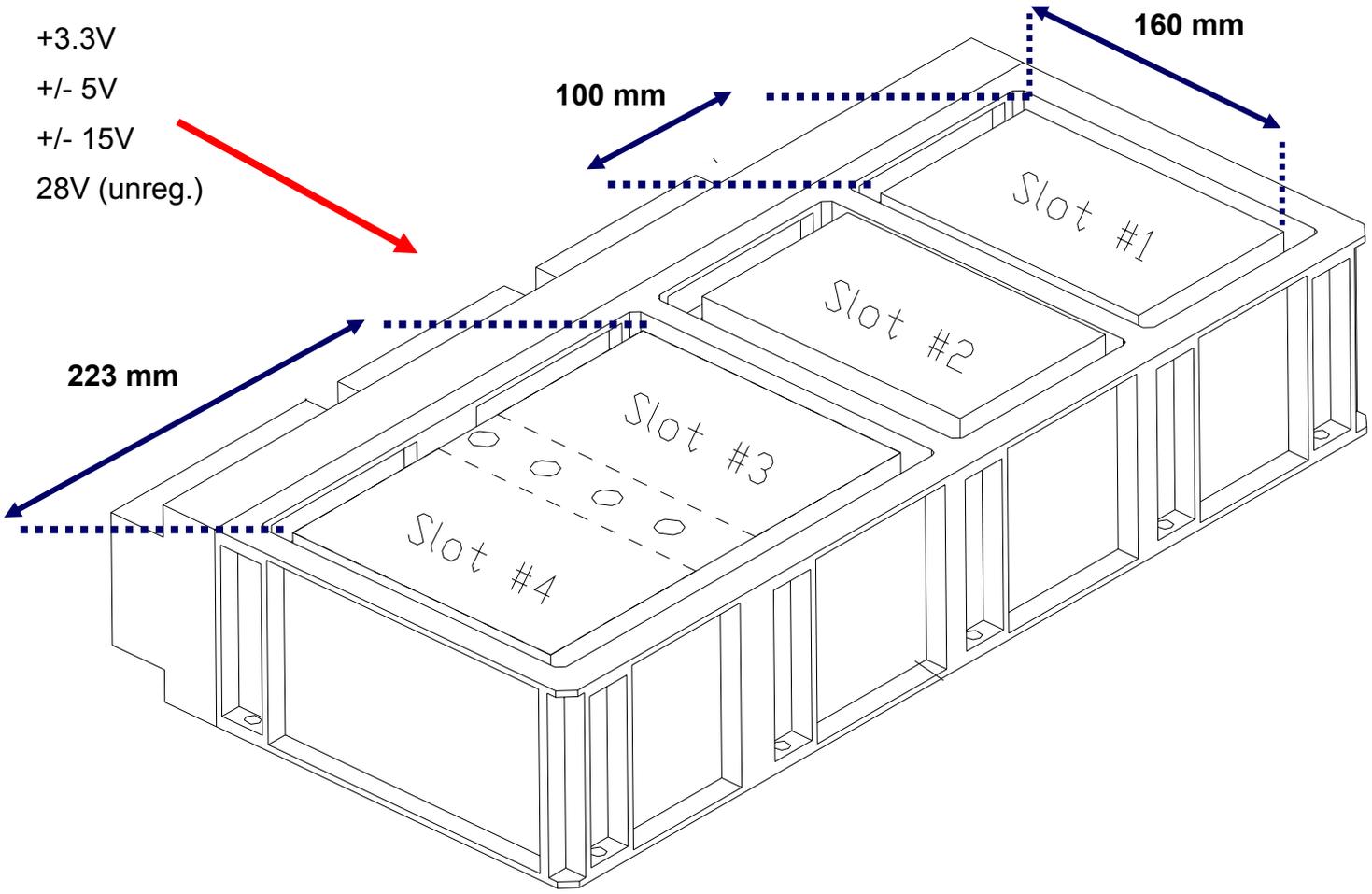


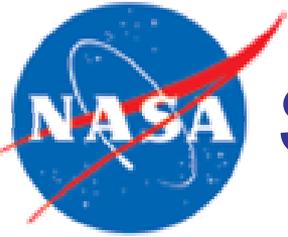
Experiment Accommodation Options (cont)

- **Standard 80 pin interface connector**
- **Max power of 4.0 W per 3 U board, 7.0 W for 6 U board and TBD W per box.**
- **Max standby power 110 mW**
- **Available power**
 - **+3.3V**
 - **+/- 5V**
 - **+/- 15V**
 - **Unregulated 28V**
- **RS-422 data command interface**
- **4 analog data channels**
- **Commanding**
- **Dosimeters**
- **Temperature sensor**

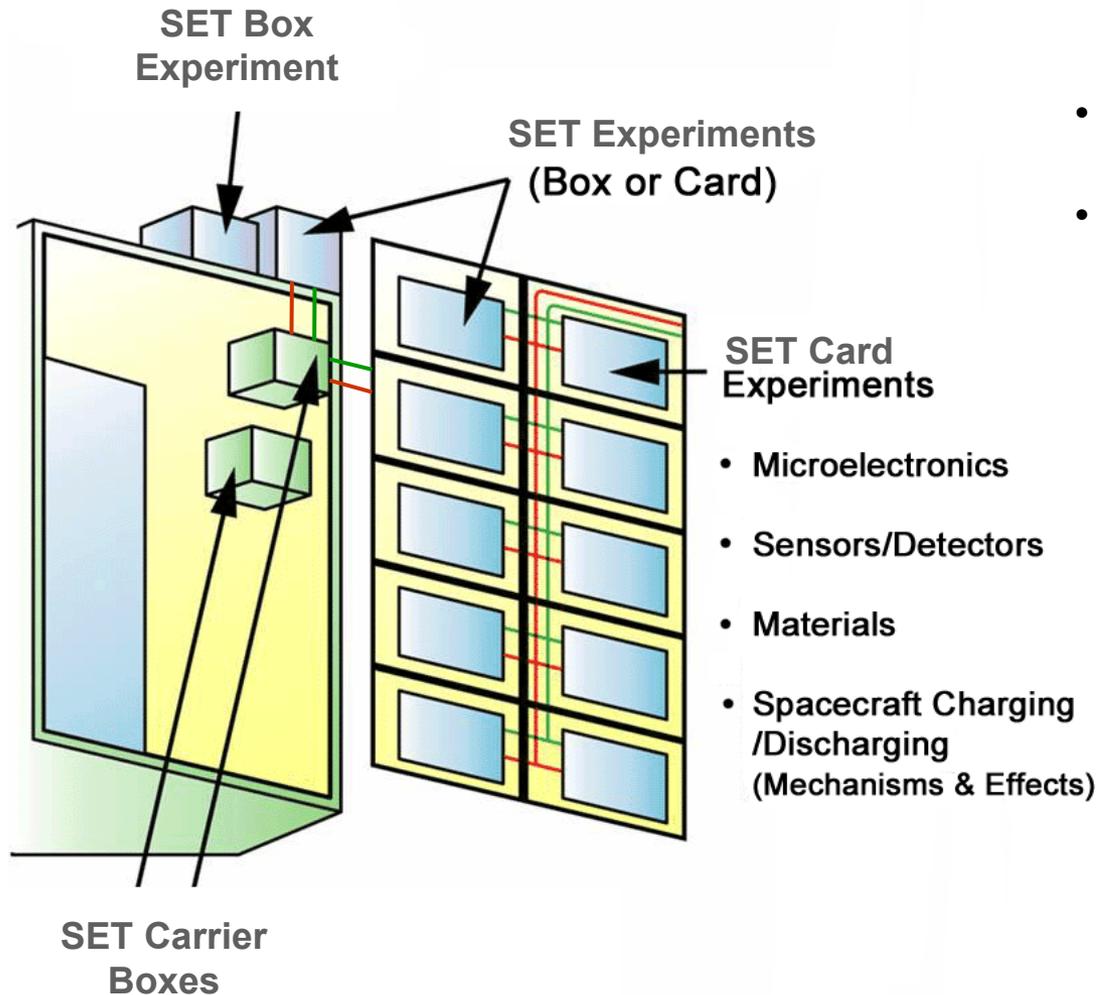


Carrier-provided Box (typical)

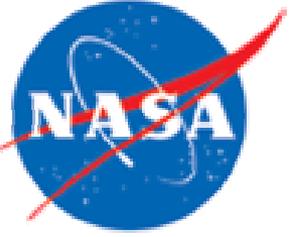




SET Services to Experimenters

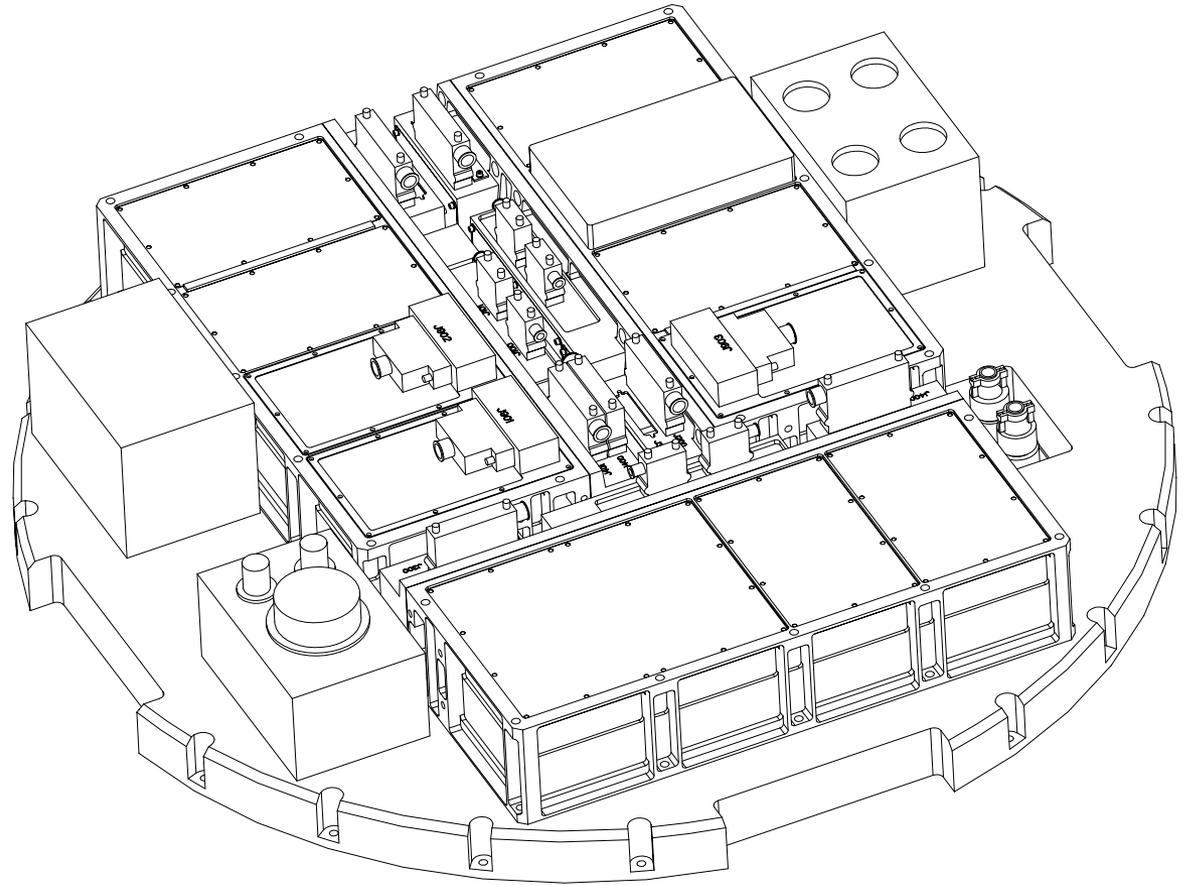


- **A carrier will provide in-flight services to experiments.**
- **Features**
 - **Attached to a host spacecraft**
 - **Modular design**
 - **Experiments integrate to carrier through a standard interface**
 - **Experiments manifested into most appropriate orbit**
 - **Correlative Environment Monitor (CEM) appropriate for experiments**
 - **Command and telemetry services**
 - **Non-retrievable**

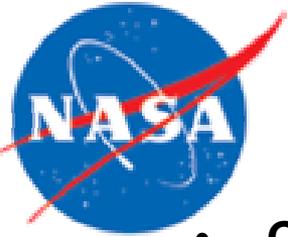


SET Payload Representative Configuration

- **Interface hardware to Host spacecraft**
- **CEMs**
- **SET Carrier Equipment**
- **Boxes housing SET Experiments**
- **SET Box Experiments**

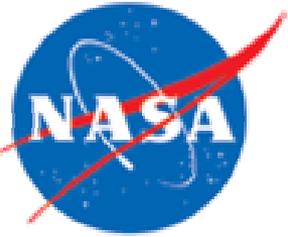


SET Processes for Investigations



SET Investigation Stages

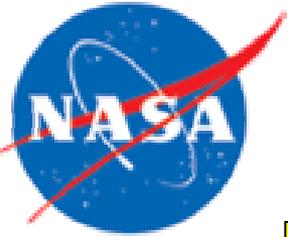
- **Concept Definition**
 - NRA proposal preparation and submittal
 - NRA proposal selection
 - Phase A
 - Six month contract period
 - Detailed project concept development
 - Phase A study report due at end of contract phase
- **Concept/Hardware Development**
 - Down selected from Phase A
 - Contract extended for hardware development phase
 - Develop flight & ground hardware, support mission opportunity
- **Flight support**
 - Mission support, one year nominal, two year goal
 - Data analysis/evaluation
 - Commanding opportunity
- **Post flight**
 - Data analysis
 - Delivery of final data product, end of mission + six months



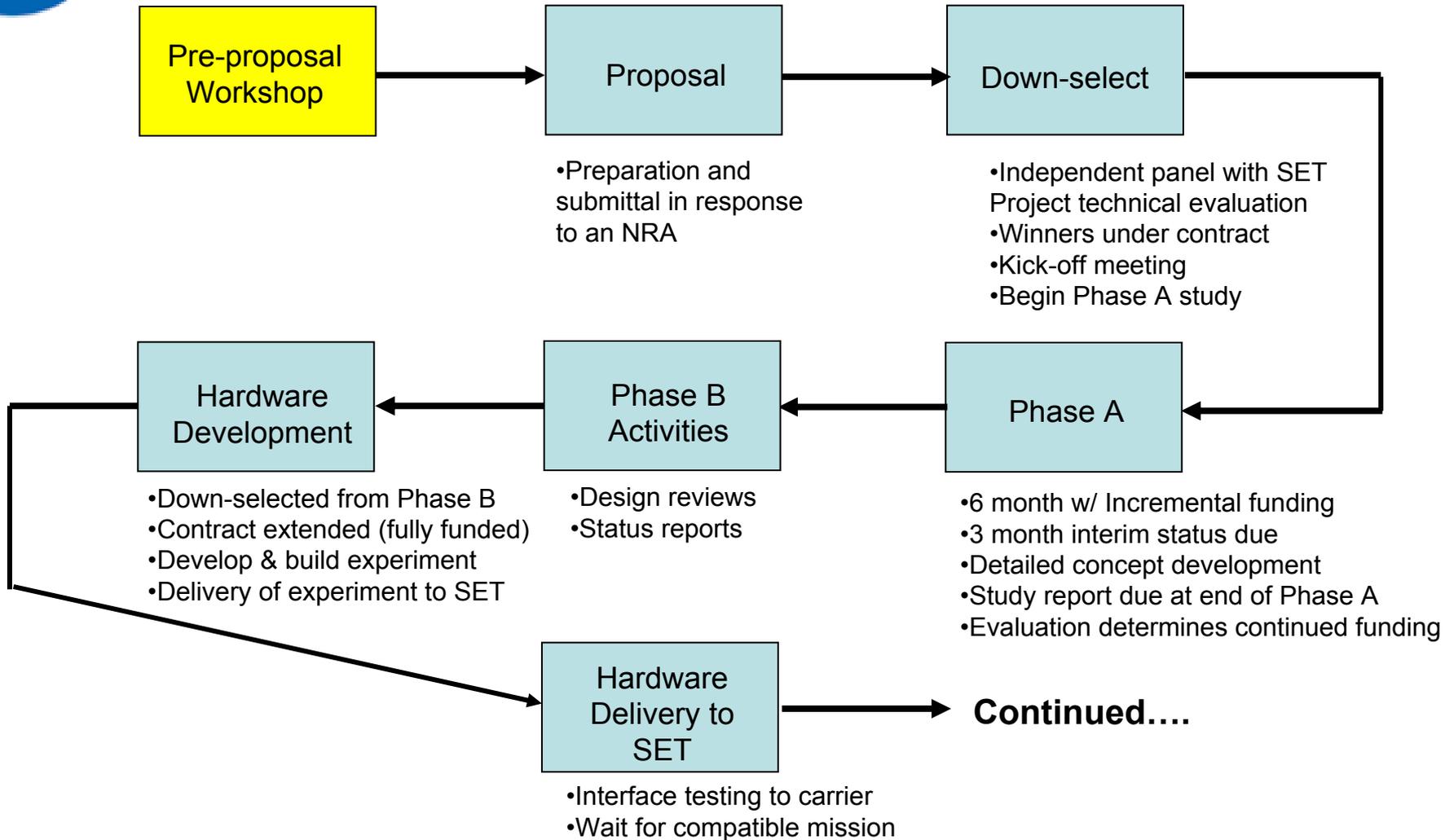
SET Schedule Template

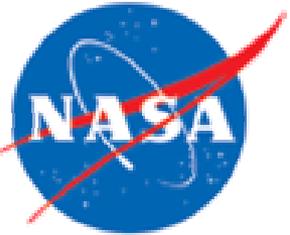
(for reference only)

- NRA release 0 (months)
- Phase A proposals due 3
- Phase A proposal selection 8
- Phase A initiation 9.5
 - Contract initiation
 - Project kickoff
- Phase A completion, 6 month reports due 15.5
- Down select, enter hardware development phase 17.5
- Design Review 22.5
- Pre-environmental review 28
- Pre-ship review 29.5
- Delivery to SET 30
- I&T with carrier
- Launch TBD = L
- Baseline 2 year operational support L+24
- Provide results to LWS program L+30

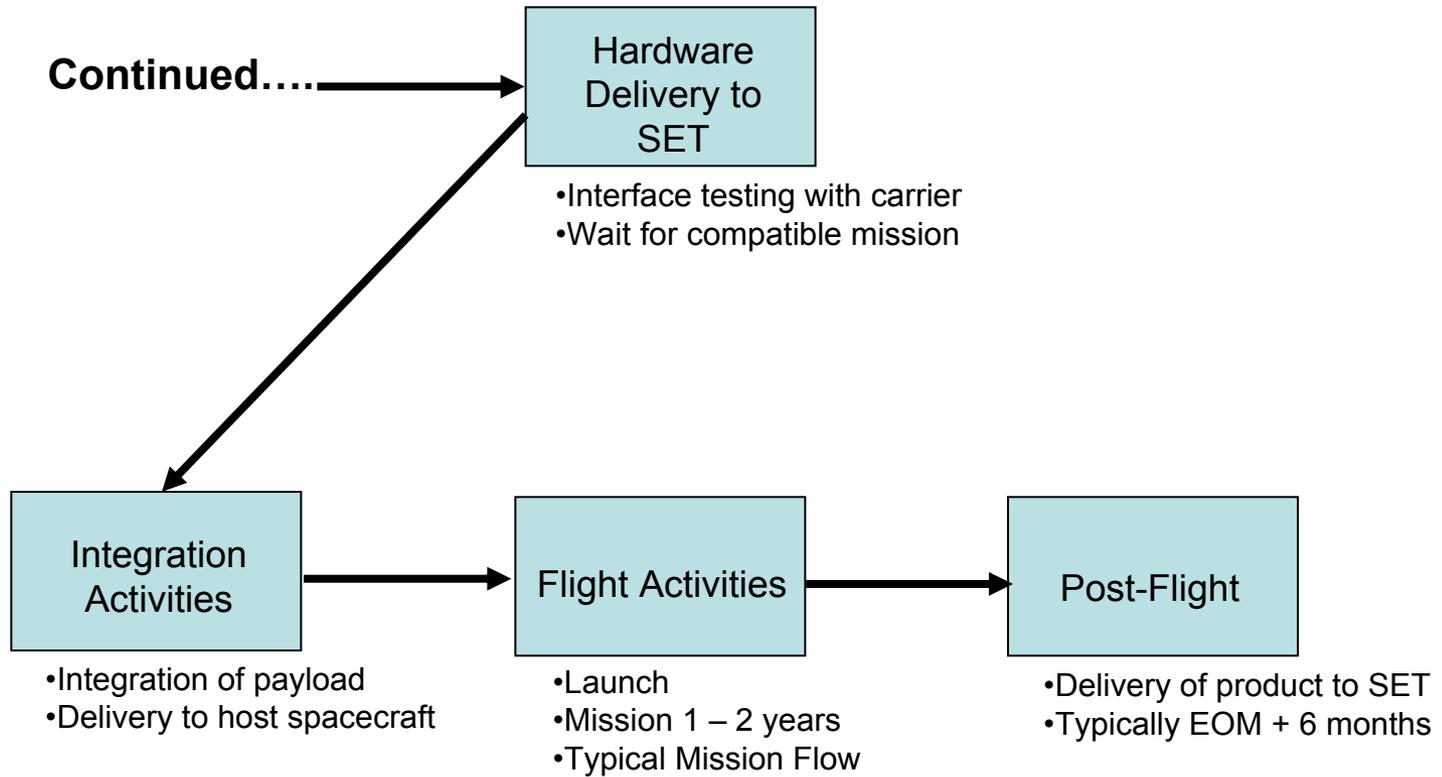


SET Investigation Stages

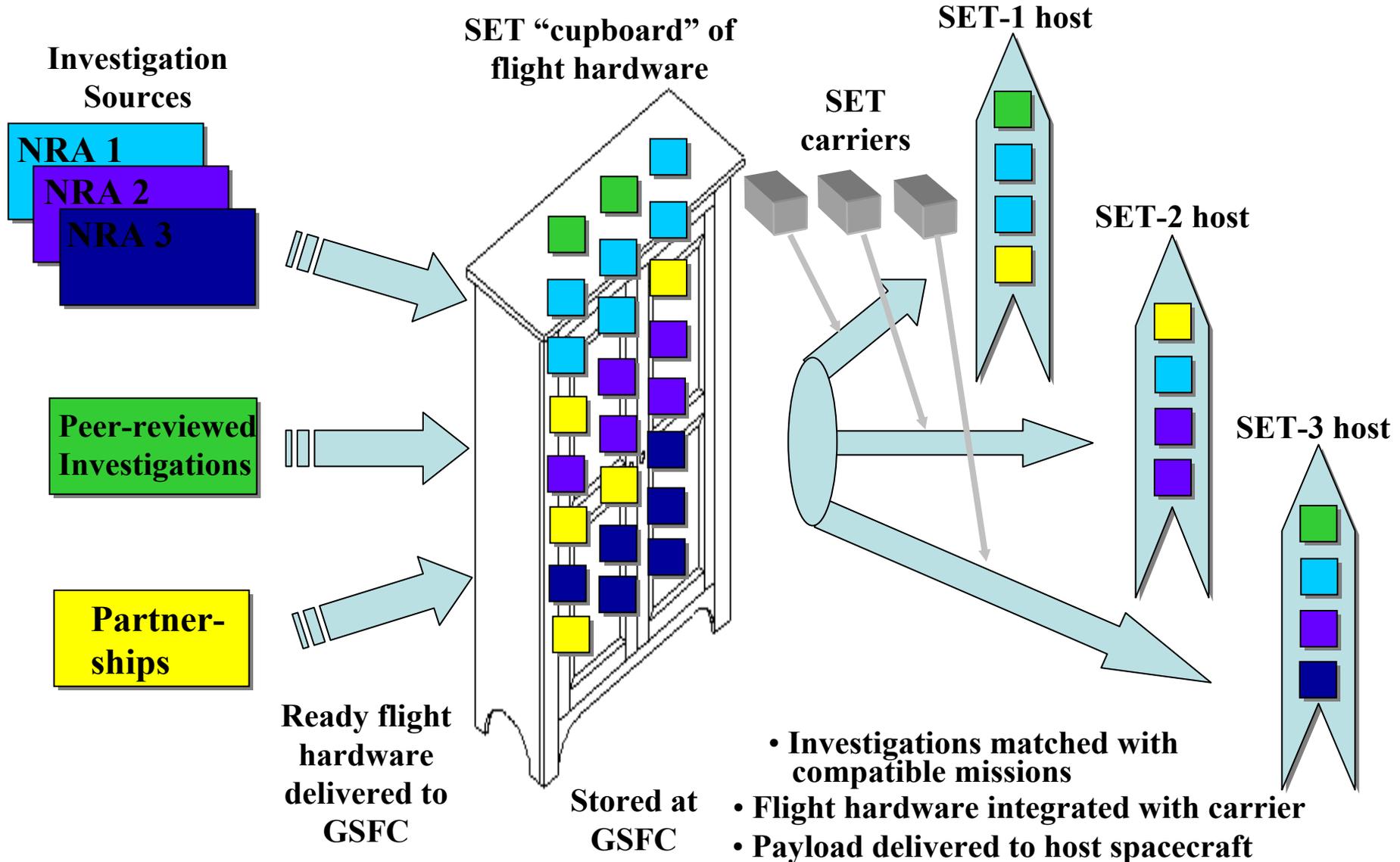


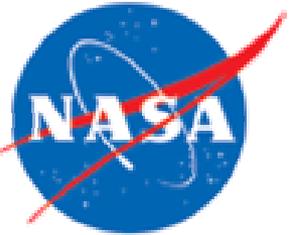


SET Investigation Stages

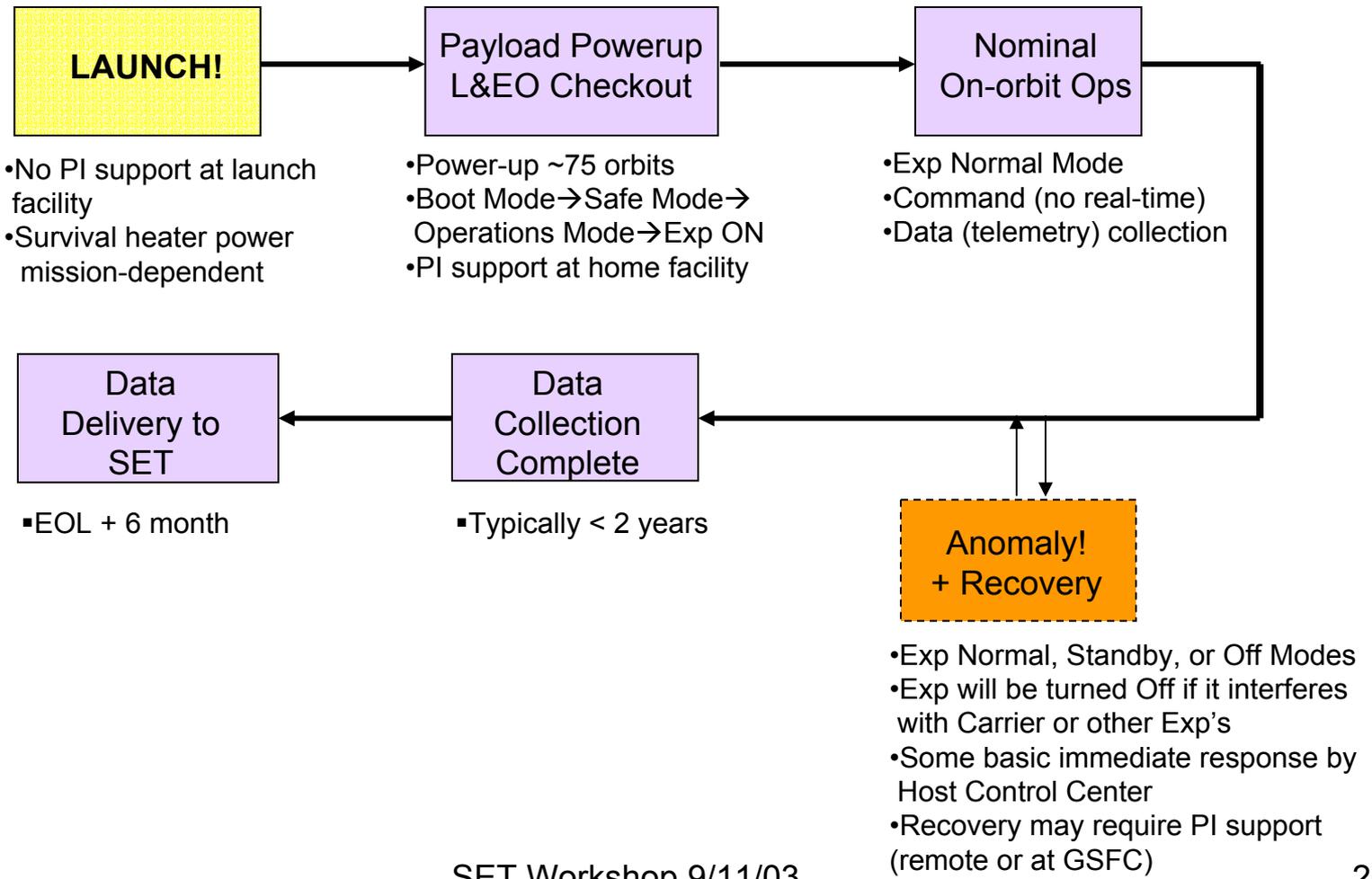


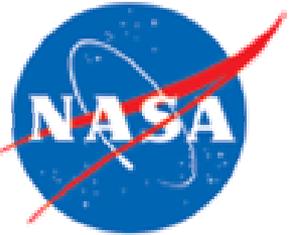
Manifesting Concept



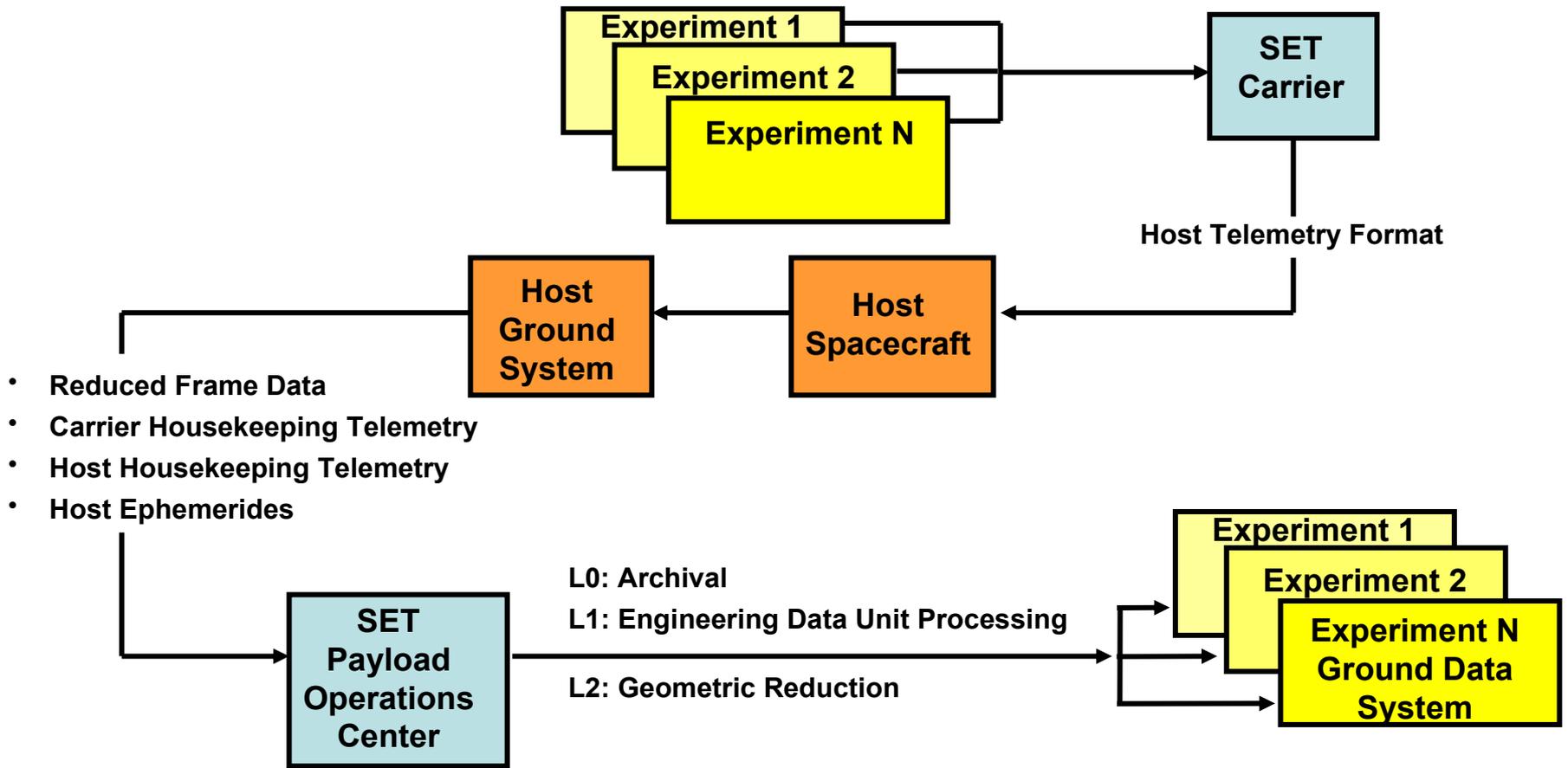


Typical Mission Flow



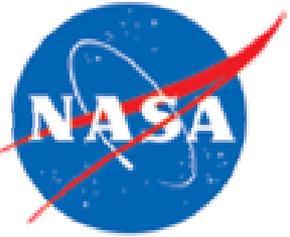


SET Mission Typical Data Processing Flow



“In the works”...

Carrier Capability Enhancements



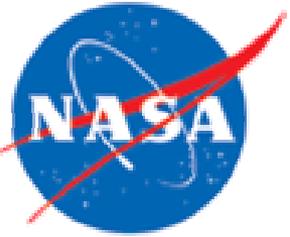
Carrier Plus

“Front-end” processor capability added to baseline carrier

Acts as an intermediary between baseline carrier and experiments with higher data rates (ex. Sensors).

Provides data handling, buffering and compression to allow experiments with higher data rates to interface with baseline carrier

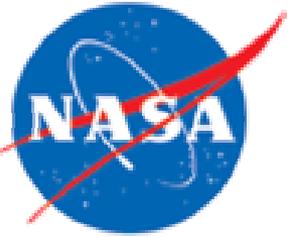
Why Carrier Plus??? - Provides a tool to validate models used to predict displacement damage effects for devices such as sensors, by comparison with on-orbit performance. Radiation design margins (RDM) may be reduced.



Carrier Plus Concept Status

- **Defined**
 - Top level architecture
 - Sensor head architecture
 - Initial FPA devices (CCD & APS)
 - Thermal support requirements
 - Electrical support requirements
 - Data flow estimates
- **In process**
 - Processing & storage requirements
 - Optical support requirements
 - Carrier interface details
 - Concept of operation

Summary



Summary

- **GOAL: Improve the engineering approach to accommodate and/or mitigate the effects of solar variability on spacecraft design & operations**
- **Provide a standard, well-defined interface to experiments with the flexibility to adapt to available host spacecraft flight opportunities**
- **Develop and improve capabilities**
- **Get science!**

For more information see

<http://lws-set.gsfc.nasa.gov>