ULDB Demonstration Program:
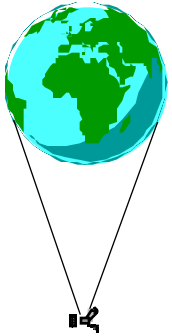## *Balloon Craft*

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Wallops Island, VA 23337

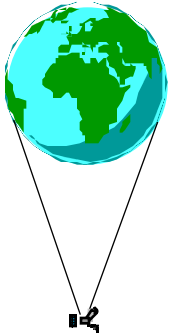david.stuchlik@gsfc.nasa.gov

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ULDB Ballooncraft
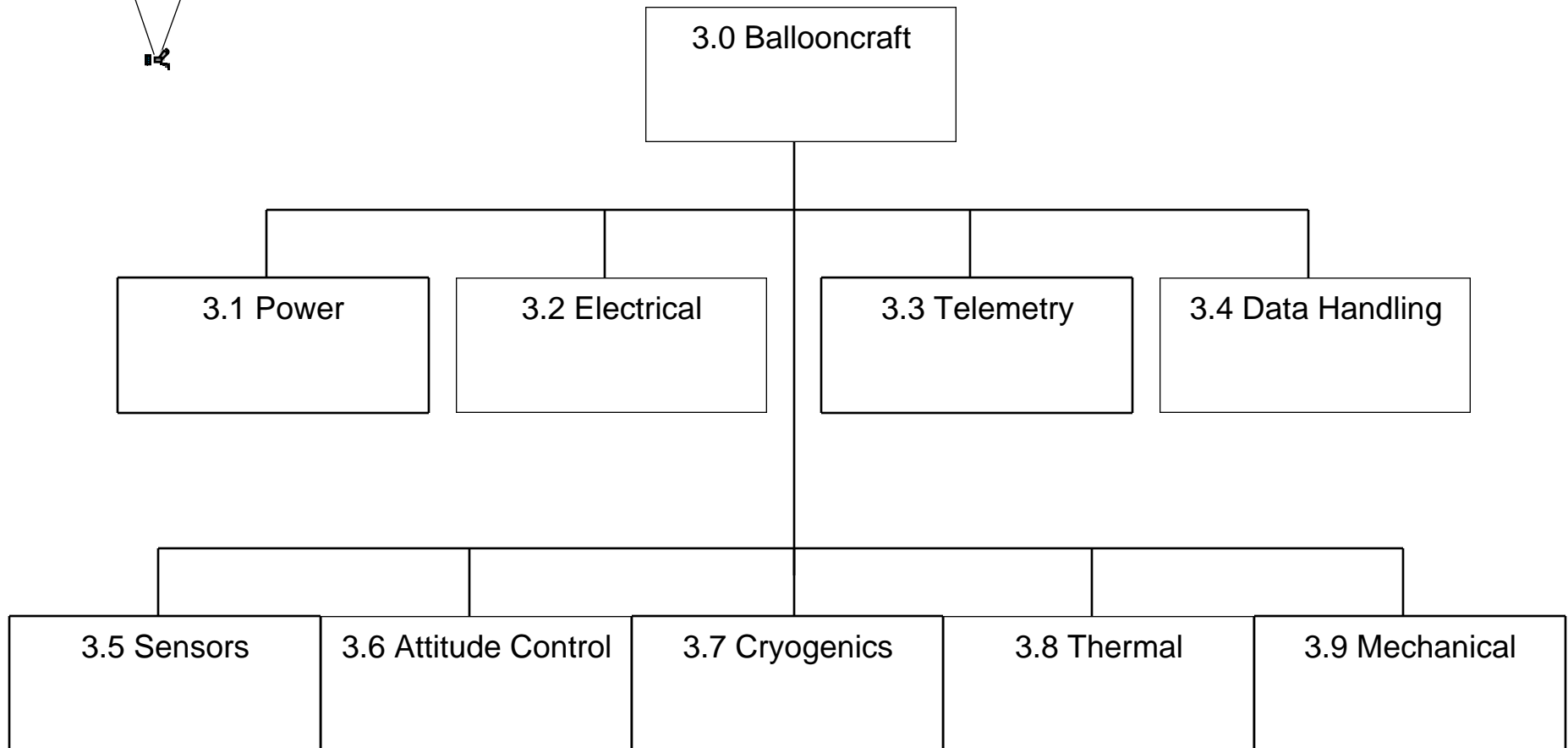
- # The Challenge
  - Provide comprehensive set of Flight and Ground Support Systems
    - Mission Operations Requirements
    - ULDB Science Requirements
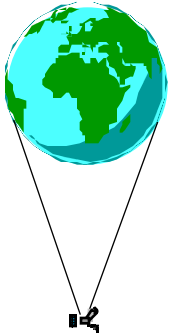   - TIGER Instrument Requirements

- # The Approach
  - GSFC Civil Servant Development Team
    - Requirements Definition
    - Trade Studies/Design Concepts
    - Design Reviews
    - Engineering Test Flight
    - Demo 2000 Flight with TIGER science instrument

ULDB Ballooncraft Development Team

3.0 Ballooncraft

- 3.1 Power
- 3.2 Electrical
- 3.3 Telemetry
- 3.4 Data Handling

- 3.5 Sensors
- 3.6 Attitude Control
- 3.7 Cryogenics
- 3.8 Thermal
- 3.9 Mechanical

ULDB Ballooncraft

- ## Power Subsystem

  - Requirement
    - Scalable, low weight power subsystem capable of supporting up to 1000 watts continuous power consumption
      - 12,000 watt-hours daytime, 12,000 watt-hours nighttime
    - Demo 2000 requirement
      - 4800 watt-hours daytime, 7200 watt-hours nighttime
  - Design
    - Deployed amorphous silicon flexible thin film PV panels
    - Solar tracking in azimuth
   - Nickel Metal Hydride (NiMH) battery power storage
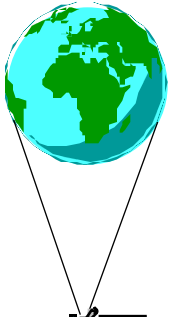
ULDB Ballooncraft

- **Telemetry Subsystem**
  - Requirement
    - Global downlink of science data at continuous rate > 9kbps
    - Redundant low rate global downlink of science and operations housekeeping data
   - Redundant low rate global uplink of science and operations commands
  - Design
    - TDRSS with High Gain Antenna (HGA)
      - New contract with Motorola for "balloon-class" transponder
        - » Lower cost version of 4th generation space qualified unit
      - Wallops in-house HGA
      - Bit rate capability >100 kbps MA, >300 kbps SSA
    - Low rate global communications
      - Inmarsat and ARGOS flight proven
   - Iridium and Orbcomm under development
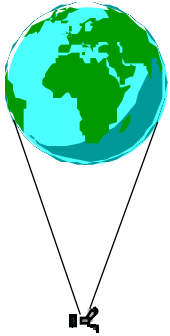
ULDB Ballooncraft

- ## Flight Data Processing and Data Storage
  - Requirement
    - Acquire, process and execute commands
    - Acquire, process, format data
    - On-board storage 10 GB required, 50 GB desired
  - Design
    - COTS PC-104 based 486-class flight processors
    - COTS real-time operating system
    - Multiple data interfaces
      - RS-232, Analog, Discrete Digital, MIL-STD-1553
    - Data storage using sealed hard disk drives
      - 18 GB per drive current density
   - 36 GB per drive in 1999
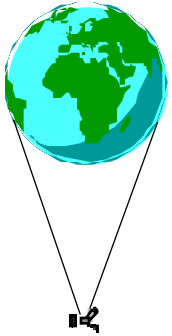
ULDB Ballooncraft

• Attitude and Position Determination

- Requirement
  - Determine location and altitude during flight
  - Determine absolute azimuth for TDRSS HGA and science data analysis
- Design
  - COTS Attitude Determination GPS unit
  - Provides time reference
  - Provides 3-D location with high accuracy
  - Provides azimuth determination
    - 4 antennas 1 meter apart
    - One degree accuracy
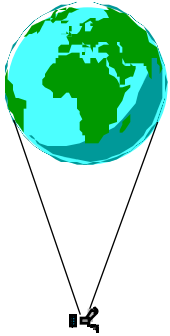
ULDB Ballooncraft

- ## Attitude Control
  - Requirement
    - Sun-tracking of solar panels
  - Design
    - WFF-developed azimuth positioner
    - Points entire gondola
      - < 5 watts
      - Better than 5 degree accuracy
   - Details in later presentation
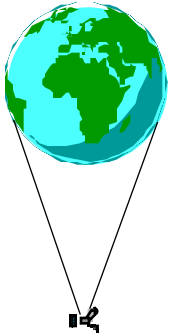
ULDB Ballooncraft

- ## Cryocooling

  - Requirement

    - Balloon flight-qualify Sunpower Model M77 stirling cycle cryocooler for future ULDB instrument use for detector cooling
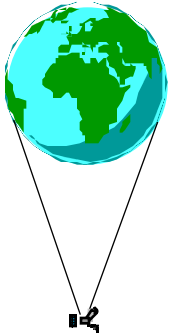
  - Design

    - Sunpower Cryocooler test flight June 1998 on LDB flight from Alaska
    - WFF in-house housing, thermal control system, vibration monitoring system
    - GSFC/Greenbelt 552 has tested this unit and developed vibration compensation circuitry
   - Test flight demonstrated successful operation at balloon float altitudes
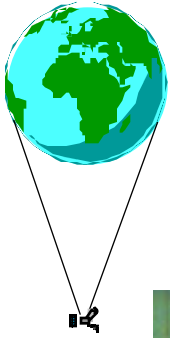
ULDB Cryocooler Test Flight
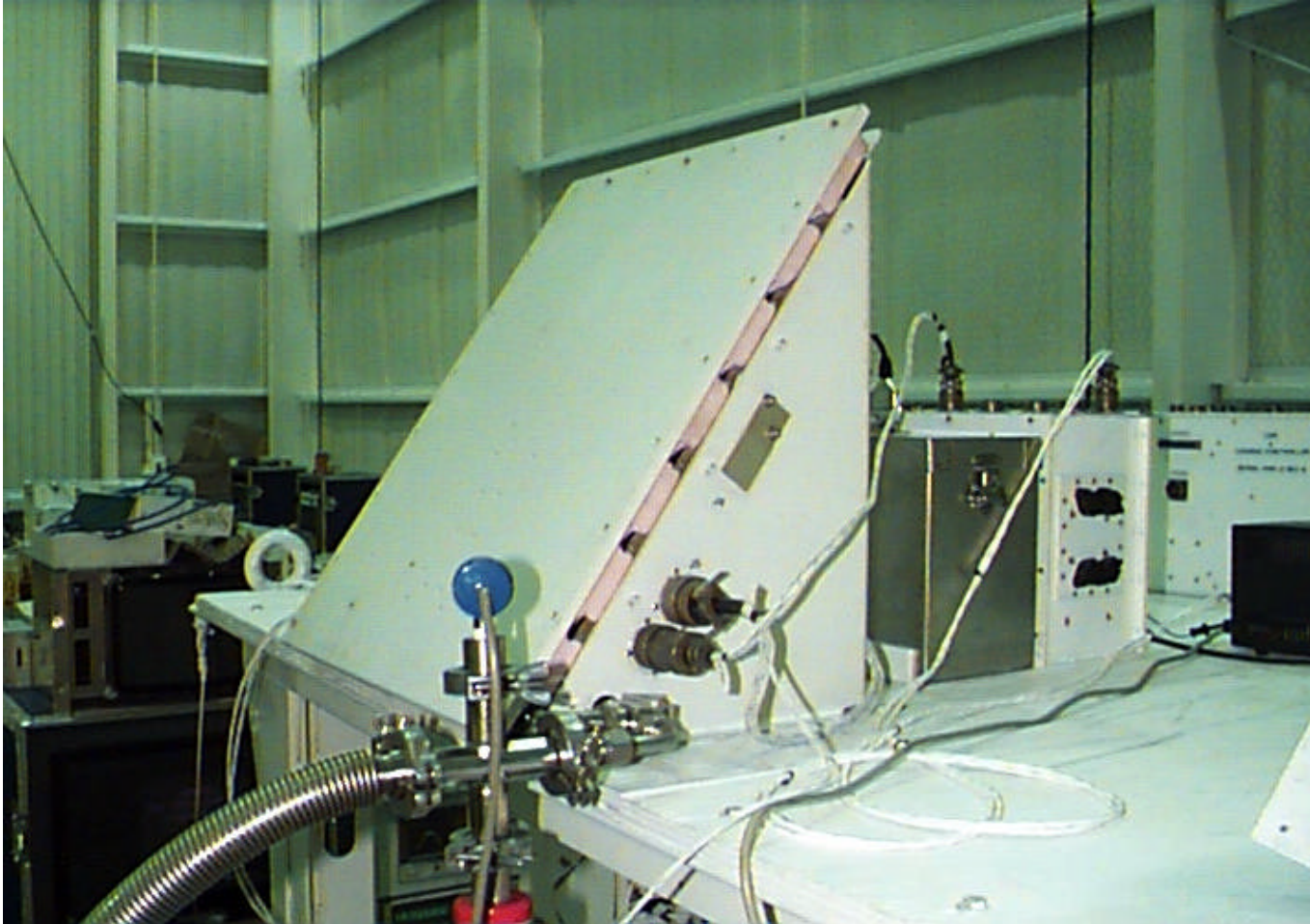
ULDB Ballooncraft

- ## Thermal and Mechanical
  - Requirement
    - Perform Thermal Analysis and develop thermal control systems to maintain ballooncraft within operating limits
    - Design and provide ballooncraft structure, enclosures and mechanisms
  - Design
    - In-house thermal analysis and control
      - Application of passive control techniques first priority
    - In-house mechanical design of gondola structure, PV panel structure and deployment mechanism, Command and Data Module, etc.
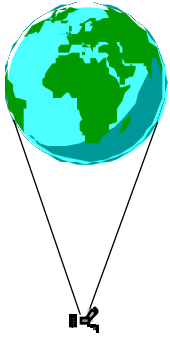
ULDB Ballooncraft
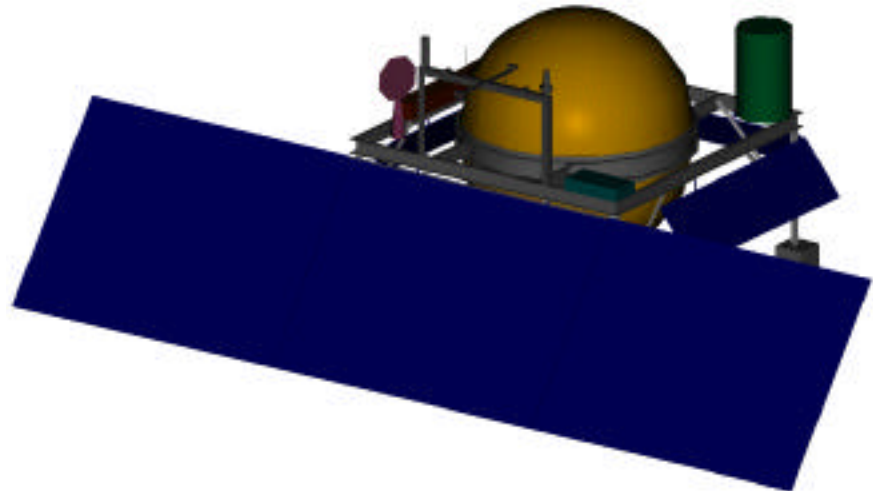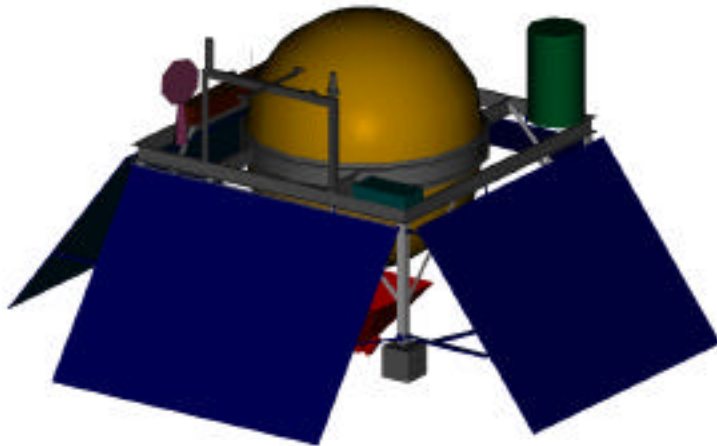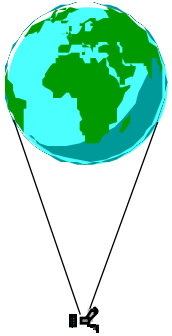
ULDB Ballooncraft

- ## Operations Control Center
  - Requirement
    - Support flight operations via line of sight and global communications
    - Support off-site instrument data delivery and command receipt
  - Design
    - Combination of GOTS and COTS on workstations
      - GOTS Integrated Test & Operations System (ITOS)
        - » Used on SMEX, SMEX Lite, SPARTAN
        - » ITOS to be enhanced to support remote data monitoring and control
      - COTS products for enhanced operations displays