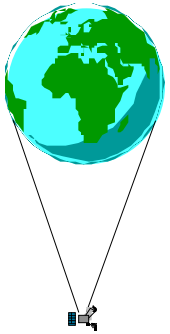

Objectives of Technology Study & Workshop

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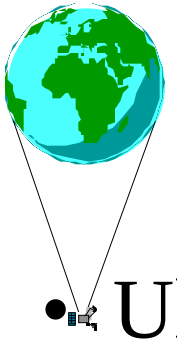
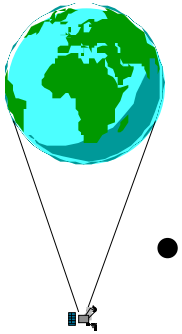


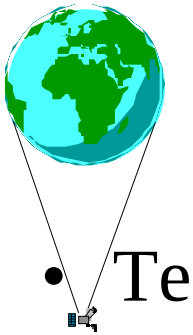
Introduction

- Ultra Long Duration Balloon Missions are a new era in scientific ballooning.
- Enables facility missions
  - Observatory on Top of the Atmosphere
    - Fly a large telescope for at least a 100 days in 2002. Recover, refit and refly.
    - Residual Atmosphere is 0.01% ($r_0 \approx 200$ m)
    - No need for high-speed adaptive optics
    - Long thermal time-scales--superior to low Earth orbit



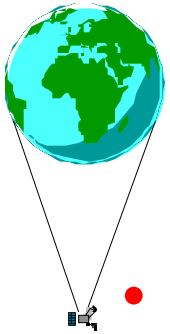
Advantages of ULDB

- Similar power, thermal and communication as spacecraft
- Payloads
  - ≥ 2000 lb. Science payload;large structures deployed at launch
  - Large structures fully deployed at launch
- Viewing Efficiency
  - Mid-latitude flights: 100 days with 12 hour cycles
  - Polar flights: 100 days full sun or full night
  - Comparison
    - LEO S/C: 33% efficiency(2900 on target hours per 1 year orbit)
    - 100-day Polar ULDB flight: 100% efficiency (2400 on target hours)



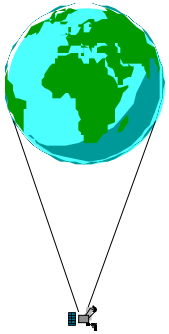
Technology Objectives for the New Era

- Technology objectives to be consistent with the cost-efficient nature of ballooning.
- Modest investment in technology would enable ambitious science missions far beyond the scope of the present balloon program.
- Some of this enabling technology is already under development at NASA and would require minor changes to meet ULDB needs.



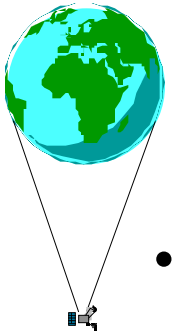
Workshop Objectives

- Identify technologies that would enable/enhance more ambitious science missions.
- Forge technology partnerships.
- Encourage small business, industry, government and educational institutions.
- Encourage space technologists to consider balloons (traditional,long duration or ULDB) for technology demonstration.
- Provide feedback to GSFC on the ULDB Technology Roadmap and technology study.



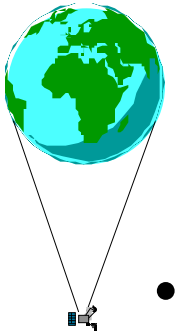
1998 ULDB Technology Study

- Joint GSFC/HQ Study
  - GSFC: Space Science Directorate(Code 600)/STAAC
  - HQ: Suborbital program
  - WFF
- Response to requests by Code 600 Visiting Committee and scientific community:
  - Improve technical capabilities of the current balloon program.
  - Provide a new and vastly improved capability with ULDB for ambitious Space Science.



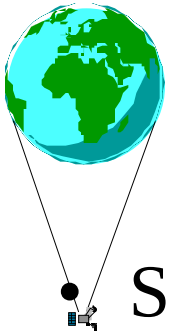
Objectives of ULDB Study

- Define technology needed to enable ambitious science.
  - Science would be funded by inclusion of ULDB in Explorer AOs. Long Duration (LDB) is now an option for UNEX.
- Demonstrate ULDB as a flight opportunity for NASA's major science themes.
- Identifying existing and developing technology which would support major science investigations on ULDB.
- Integrate ULDB technology goals in existing NASA technology programs.
- *As of 10/98 ULDB technology goals will be integrated into NASA's main technology thrusts.*
- Identify university, industrial and other government agencies as partners in technology development.



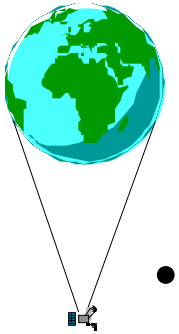
Planned Approach

- Identify Science Concepts
- Identify Technology Needs
- Develop Technology Roadmap
  - Attempts to predict technology needs in the near and long term
- Conduct Technology Workshops
  - Provide feedback to roadmap
  - Forge technology partnerships
- Sponsor scientific meeting presentations
  - Communicate the ULDB goal to support ambitious science
  - Interact and stimulate dialogue with potential scientific ULDB users



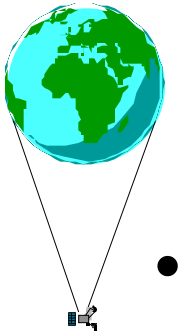
Process

- Survey to 1996 Balloon Technology workshop attendees(scientists and technologists) as well as others with keen interest in scientific ballooning.
  - letter+matrix of mission/technologies developed from 1996 workshop
- Ambitious science missions were identified from survey responses and input from the science community.
- Technologies in the roadmap were distilled from the requirements of proposed science missions.



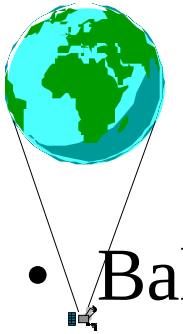
Mission Concepts

- A focusing telescope for energies above 20 keV. Energy range is 20-90 keV.
- 3-meter IR telescope.
- Large volume Ge gamma-ray spectrometer:10 to 20 liters of Ge.
- A 1.5 M telescope to resolve the fundamental magnetic field structures of the sun.
- Interferometer/planet finder.
- Coronagraph/planet finder.



Roadmap Organization

- Each Technology subject area identifies:
  - Enabled science:
    - What is needed
    - Today's state-of-the-art (SOTA)
    - Technical goals
      - » Technologies under consideration with TRLs (Technology Readiness Levels)
  - Cross cutting applications
  - Technology partners
- Roadmap is a living document.(Draft is available for review and comment. After initial release it will be revised at least once a year.)

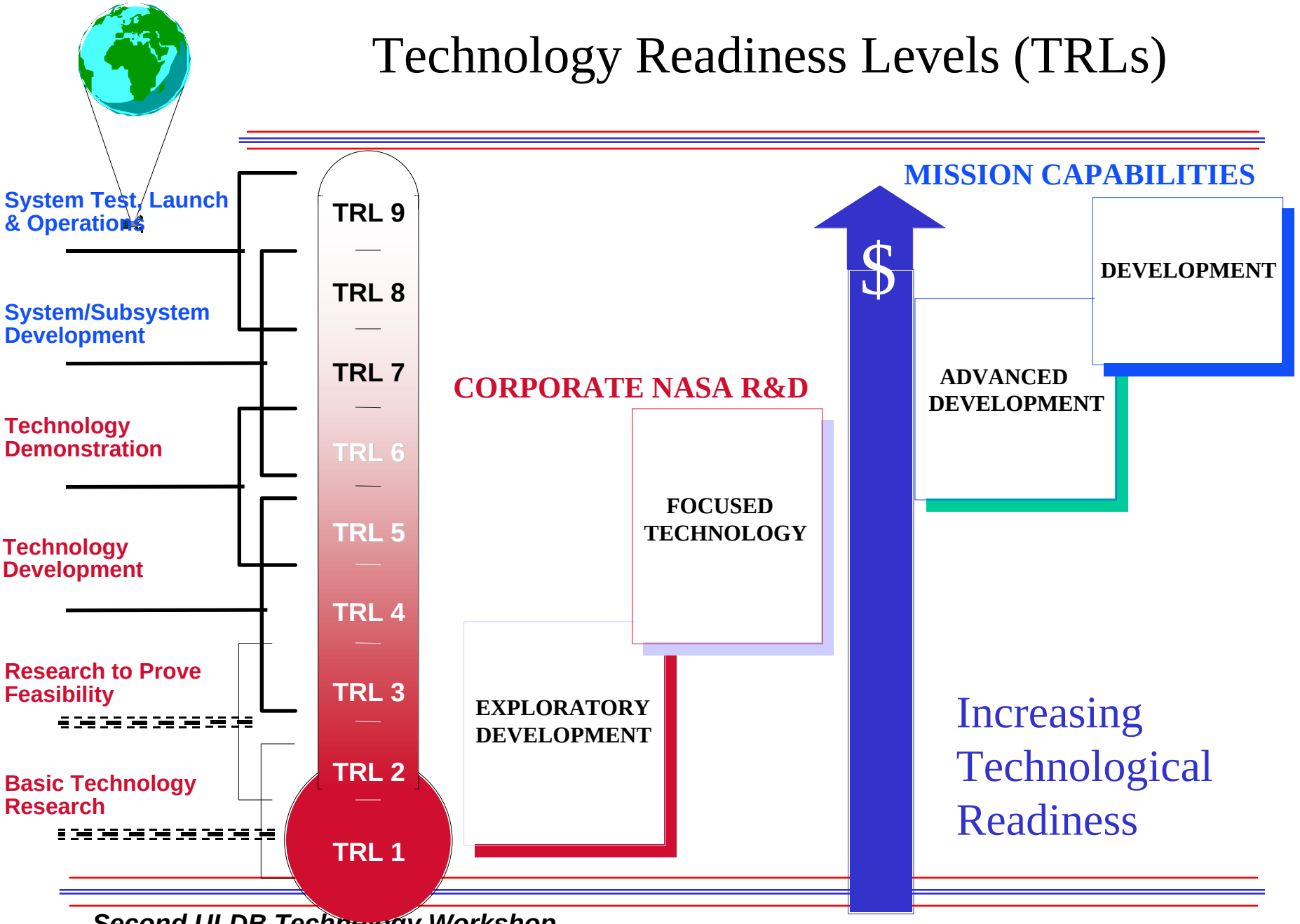


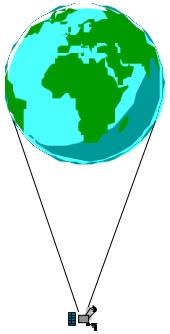
Technology Areas
Based on Mission & Science Requirements

- Balloon Technologies
- Trajectory Prediction & Control
  - Latitude & Altitude Control
  - Weather Prediction
- Power Systems
  - Generation
  - Storage
  - Management & Distribution
- Communications *
  - Data collection
  - Data return
  - Command & control Thermal
- Pointing Systems
- Termination & Recovery Systems
- Launch Systems *
- Operations Autonomy *

* Covered in the Roadmap but not presented in Workshop

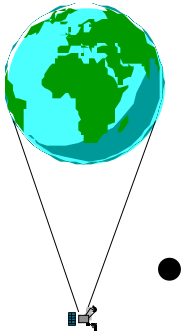
Technology Readiness Levels (TRLs)





Technology Readiness Levels

Basic Technology Research	**LEVEL 1**	BASIC PRINCIPLES OBSERVED AND REPORTED
Research To Prove Feasibility	**LEVEL 2**	TECHNOLOGY CONCEPT AND/OR APPLICATION FORMULATED
	LEVEL 3	ANALYTICAL & EXPERIMENTAL CRITICAL FUNCTION AND/OR CHARACTERISTIC PROOF-OF-CONCEPT
Technology Development	**LEVEL 4**	COMPONENT AND/OR BREADBOARD VALIDATION IN LABORATORY ENVIRONMENT
Technology Demonstration	**LEVEL 5**	COMPONENT AND/OR BREADBOARD VALIDATION IN RELEVANT ENVIRONMENT
	LEVEL 6	SYSTEM/SUBSYSTEM MODEL OR PROTOTYPE DEMONSTRATION IN A RELEVANT ENVIRONMENT (Ground or Space)
System/Subsystem Development	**LEVEL 7**	SYSTEM PROTOTYPE DEMONSTRATION IN A SPACE ENVIRONMENT
System Test, Launch and Operations	**LEVEL 8**	ACTUAL SYSTEM COMPLETED AND "FLIGHT QUALIFIED" THROUGH TEST AND DEMONSTRATION (Ground or Space)
	LEVEL 9	ACTUAL SYSTEM "FLIGHT PROVEN" THROUGH SUCCESSFUL MISSION OPERATIONS



Future Goals

- Define visionary goals with an implementation plan.
  - 2005: ≥ 200 day flight
  - 2010: ≥ 500 day flight with a much greater weight capability
  - 2015: ≥ 1000 day flight :

    The Observatory on Top of the Atmosphere.