NASA's Spitzer Space Telescope's Operational Mission Experience

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Spitzer's New Technologies

- **New Generation of Detector Arrays**

  (100 to 10,000 Gain in Capability over Previous Infrared Space Missions)
  - **IRAC:**
    - **256 x 256 pixel arrays operating at 3.6 μm, 4.5 μm , 5.8 μm , 8.0 μm**
  - **MIPS:**
    - **Photometer with 3 sets of arrays operating at 24 μm , 70 μm and 160 μm**
      - **128 x 128; 32 x 32 and 2 x 20 arrays**
    - **Spectrometer with 50-100 μm capabilities**
  - **IRS:**
    - **4 Array (128x128 pixel) Spectrograph, 4 - 40 μm**

- **Warm Launch Architecture**
  - **All other Infrared Missions launched with both the telescope and scientific instrument payload within the cryostat or Dewar**
  - **Passive cooling used to cool outer shell to ~40 K**
  - **Cryogenic Boil-off then cools telescope to required 5.5K**

- **Earth Trailing Heliocentric Orbit**
  - **Increased observing efficiency, simplification of observation planning, removes earth as heat source**

12 mly

M81: IRAC + MIPS

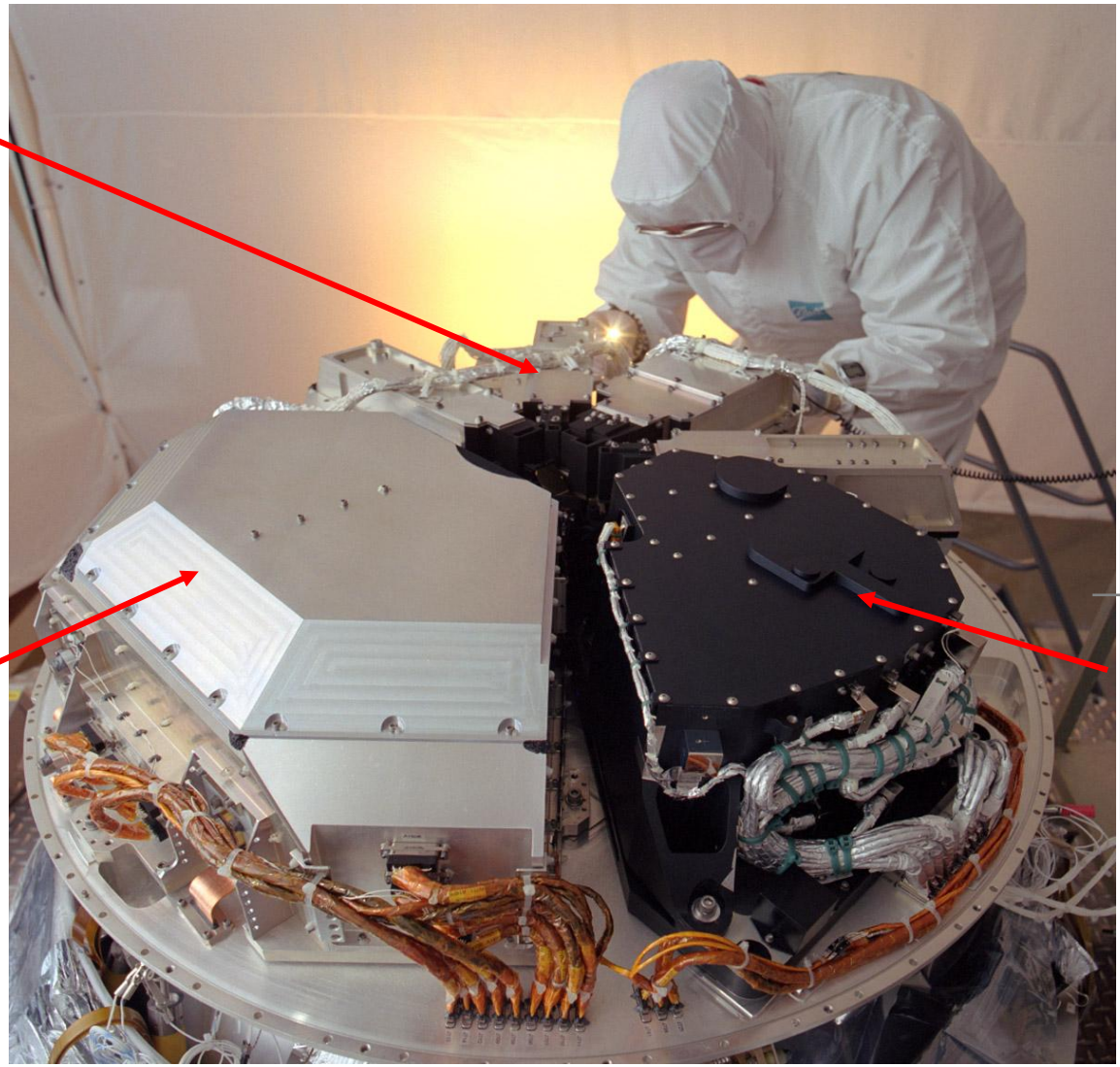
Spitzer Focal Plane Instruments

IRS
Spectrograph

J.Houck
Cornell

MIPS
Imaging
Spectroscopy

G.Rieke
U Arizona



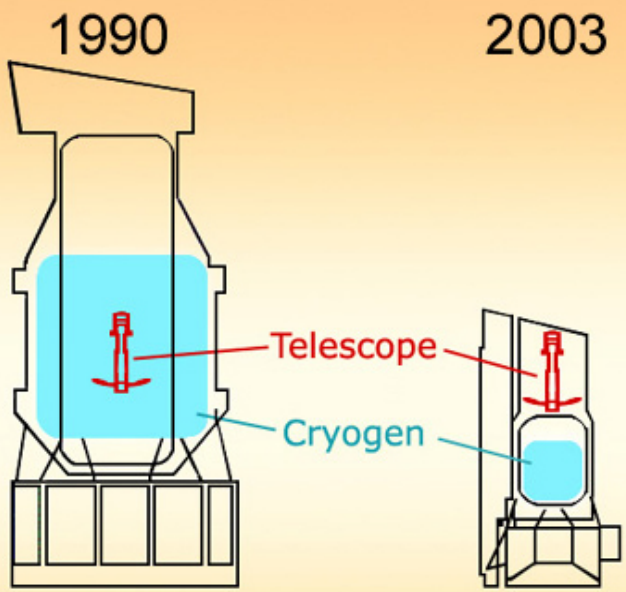
IRAC
Imaging

G.Fazio
Harvard/ GSFC

Spitzer Observatory Changes

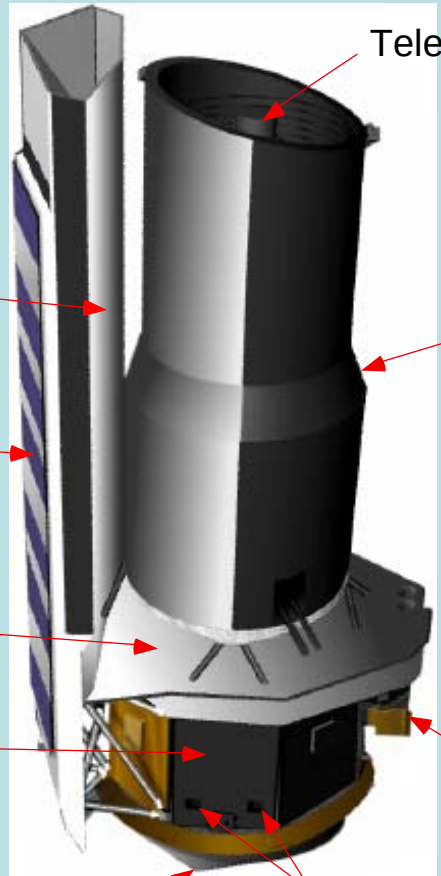
SPITZER SPACE TELESCOPE

DESIGN CHANGES

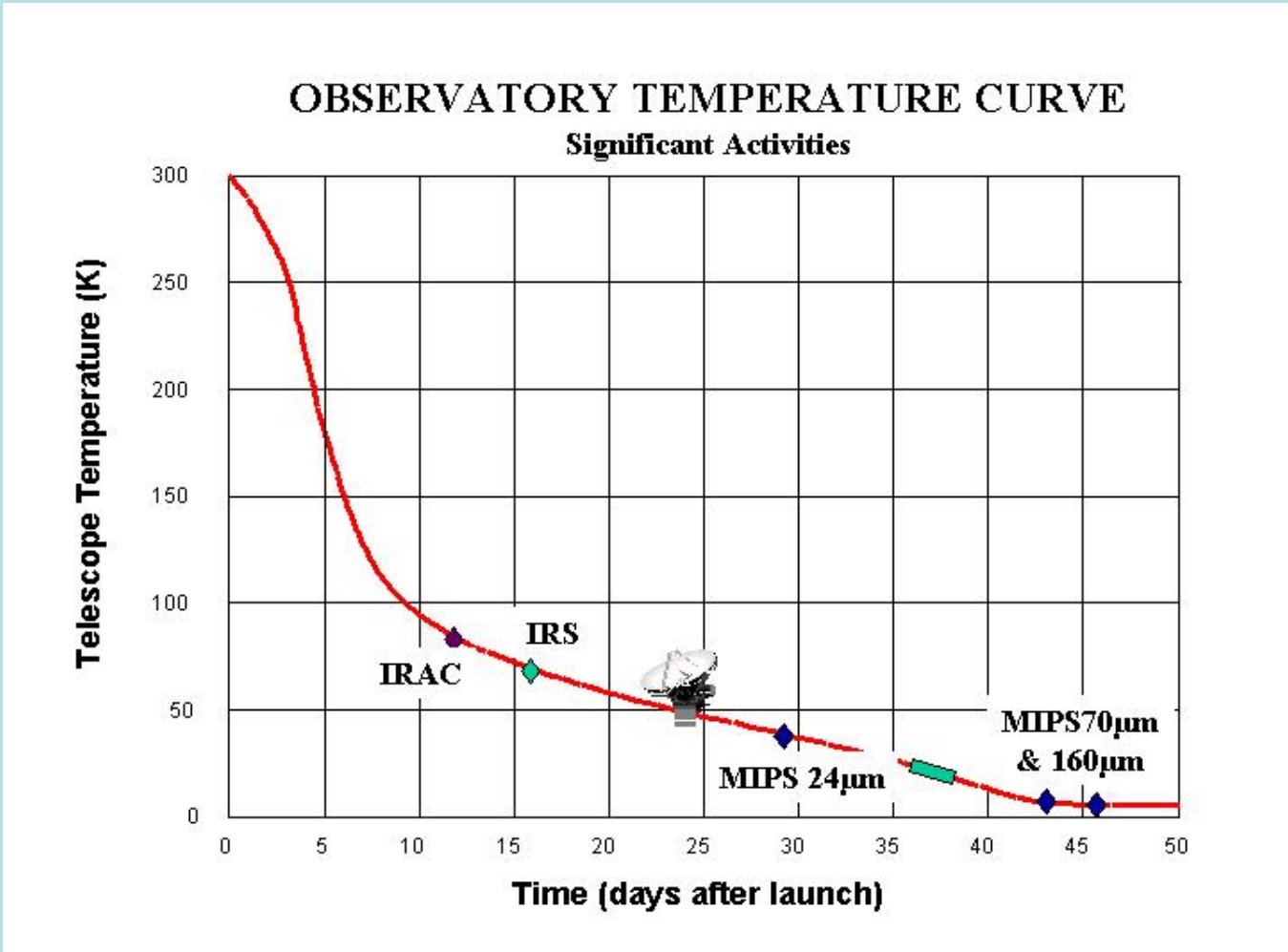


	COLD LAUNCH	WARM LAUNCH
Launch Mass	5700 kg	870 kg
Lifetime	5 years	5 years
Development Cost	~$2.2B	$0.67B
Launch Vehicle	Titan IV	Delta

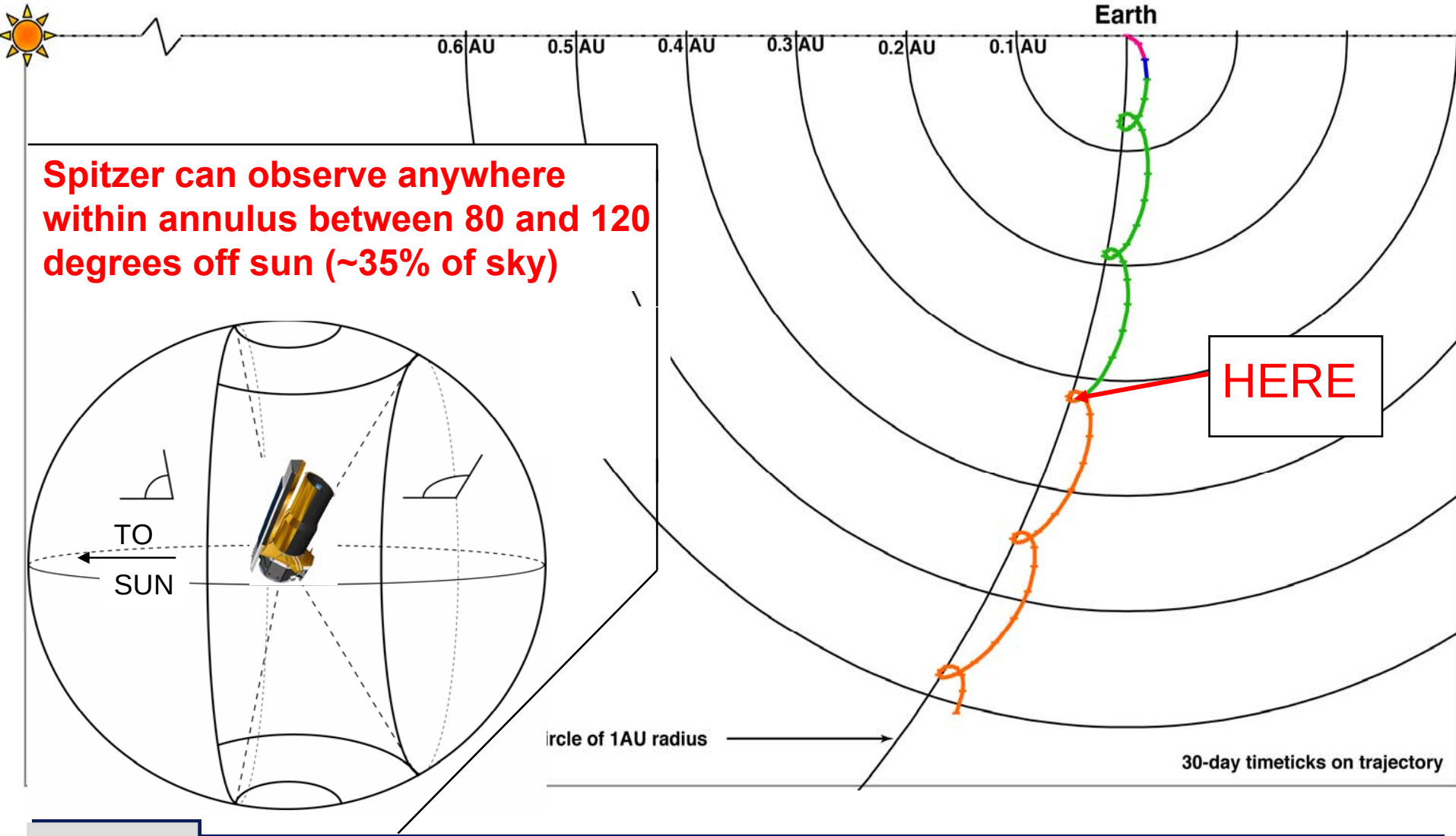
Spitzer Observatory



Spitzer Observatory Changes



Where's Spitzer Now?



Spitzer can observe anywhere within annulus between 80 and 120 degrees off sun (~35% of sky)

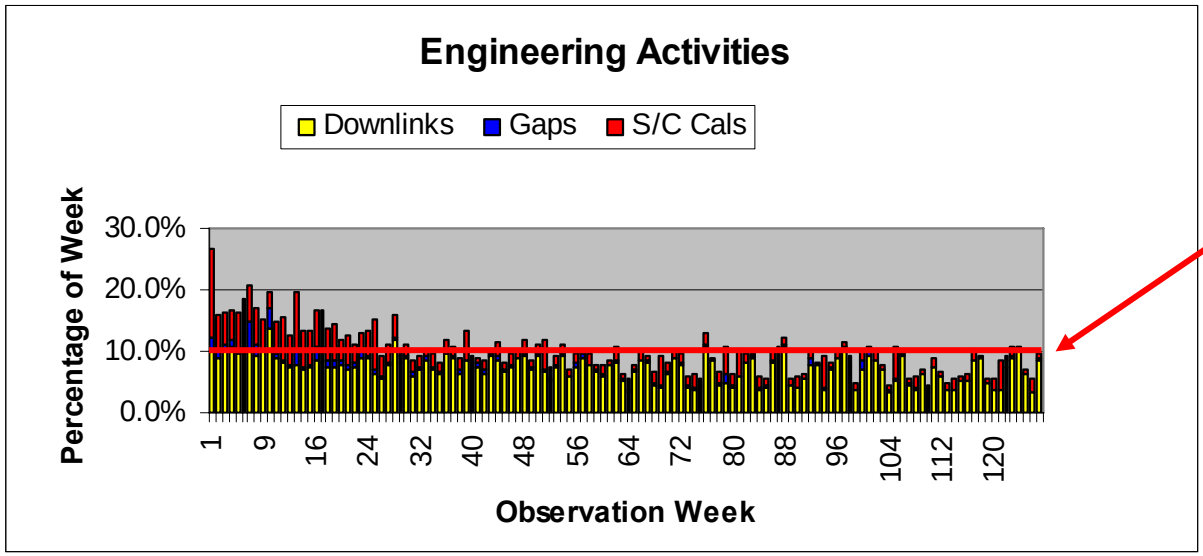
Operational Changes

- "Maximize Science Efficiency
  - Reduced "Non-Science" Activities
    - Reduction in Spacecraft Calibration Activities
    - Reduction in DSN Contacts
  - Optimize Science Planning
    - Improvements in Operational Procedures & Processes
    - Improvements in Operational Tools
  - Maximize DSN Downlink Data Rates
    - Move to 70m or 34m Arraying

- Minimize Helium Usage
  - Eliminate Mass Gauge Measurement
    - Pulse Mode Helium Usage Measurement
  - Maintain Science Observation Cycling
    - IRAC to IRS to MIPS
    - Extend Observation Campaign Lengths
  - Warm MIPS Campaigns
    - Segregate MIPS into Warm (8.5 K) and Cold (5.6 K) Campaigns beginning in Cycle 3

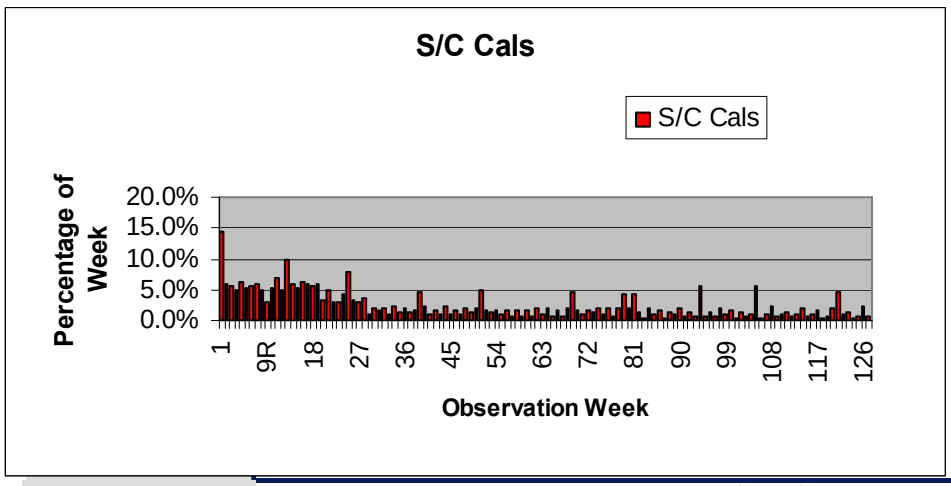
Eta Carinae Nebula

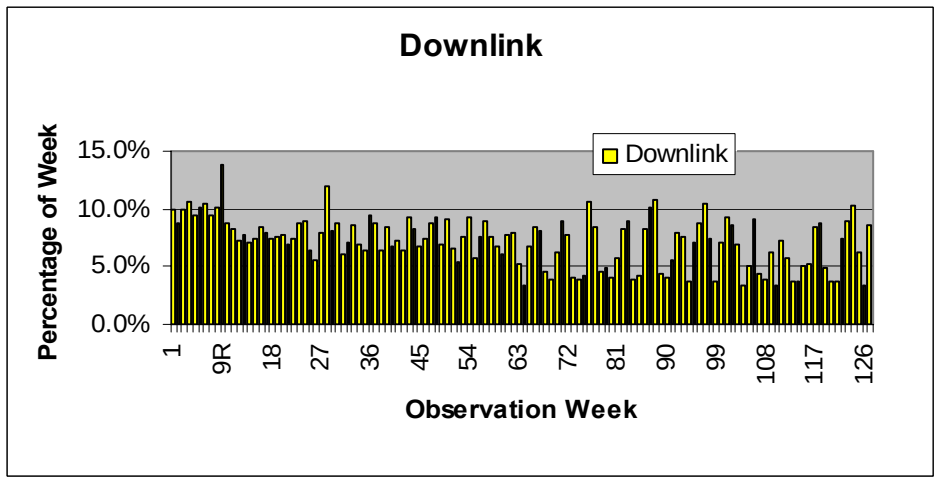
Spitzer Observatory Efficiency



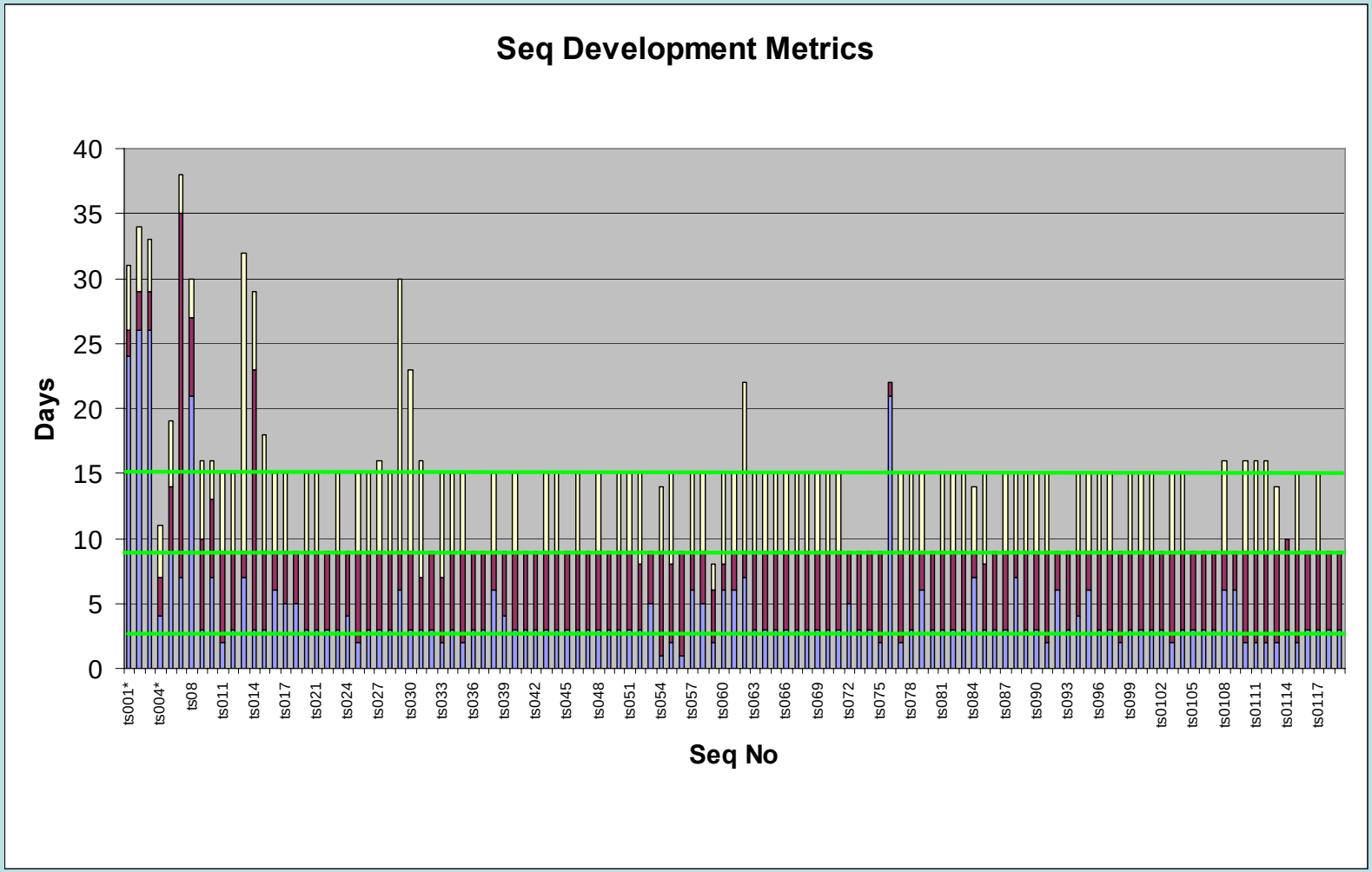
Science Efficiency Goal 90%

Average Science Efficiency 89.72%

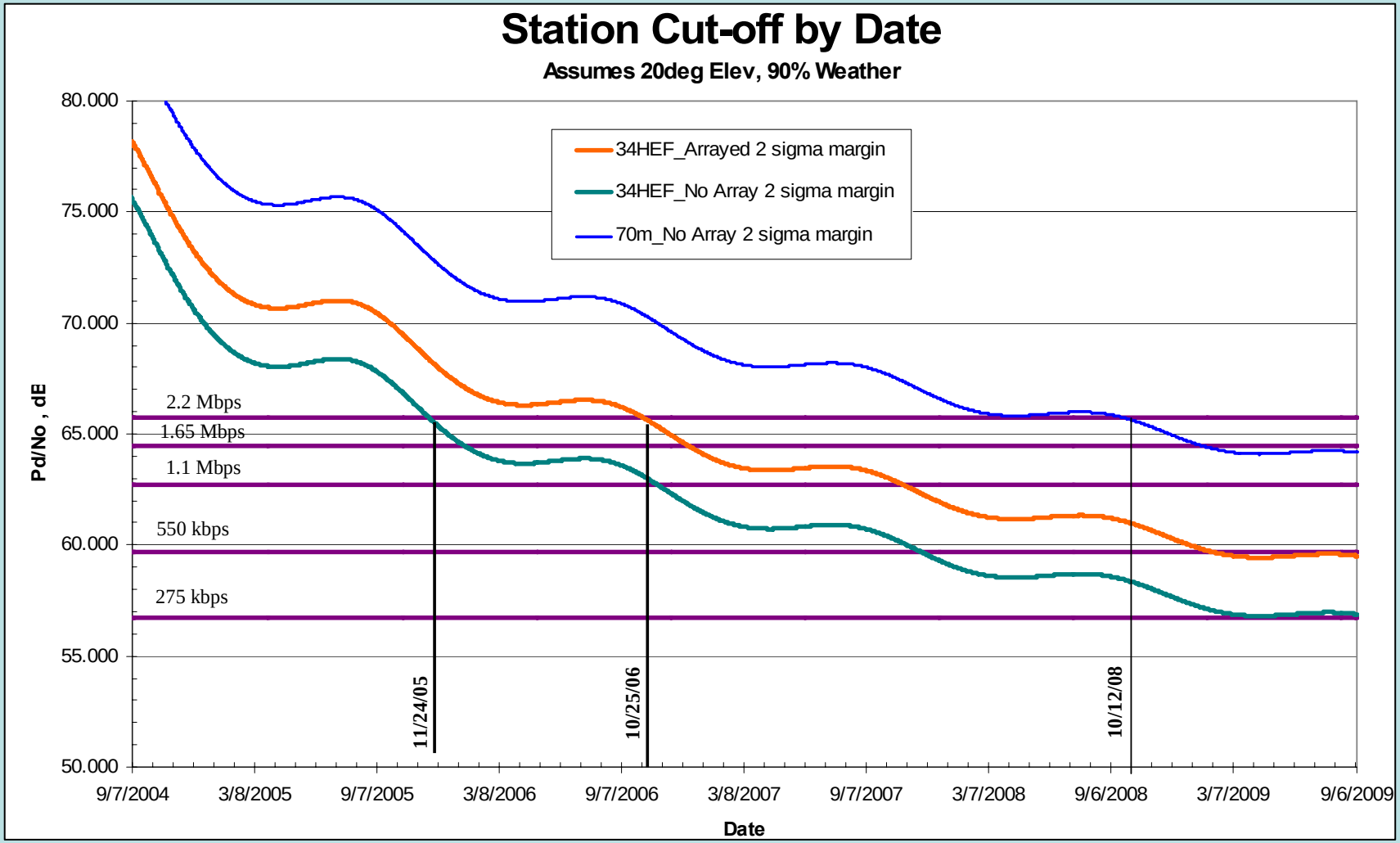




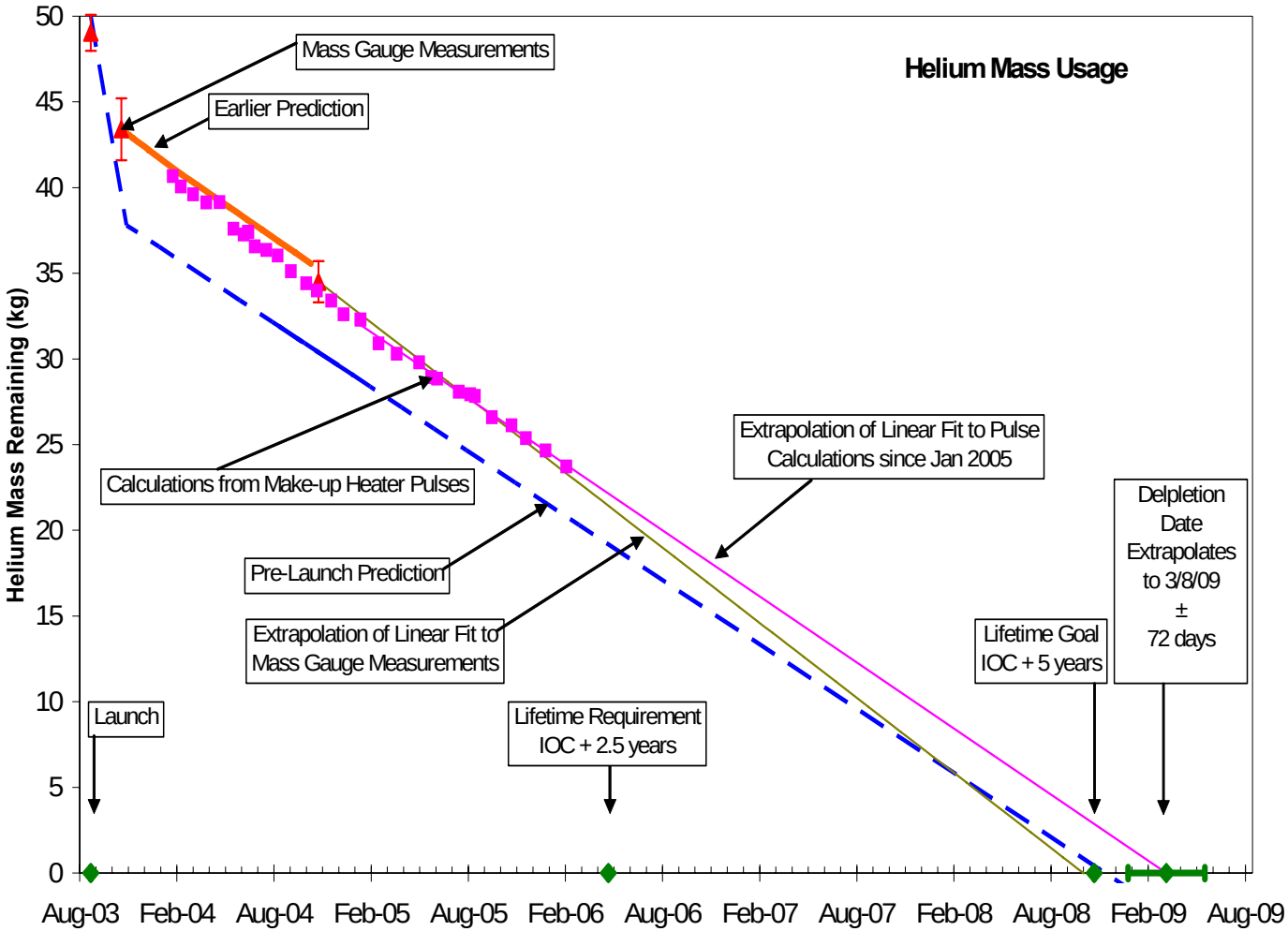
Spitzer Development Cycle



DSN-Spitzer Link Performance



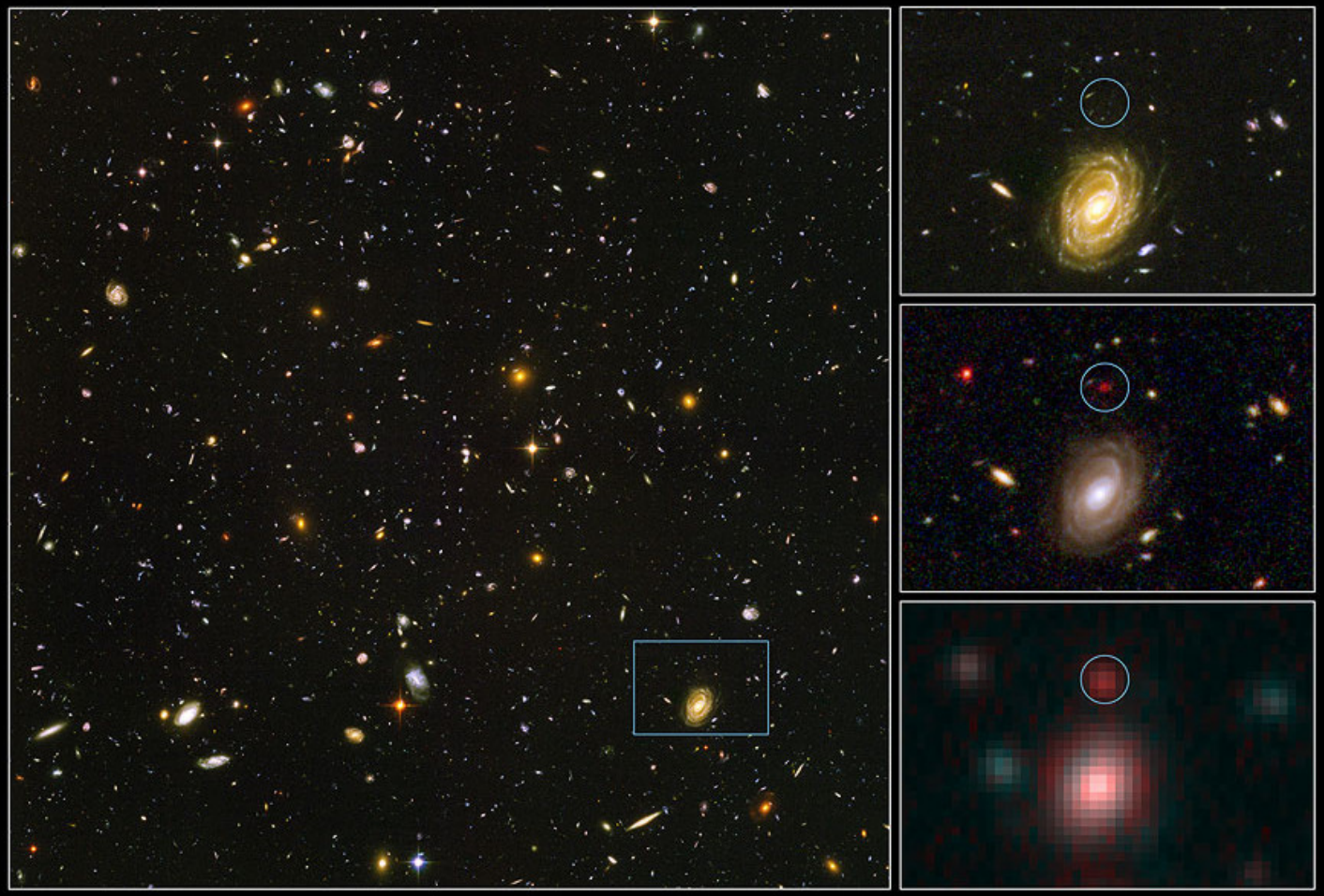
Spitzer Super Fluid Helium Consumable



Driving Science Objectives

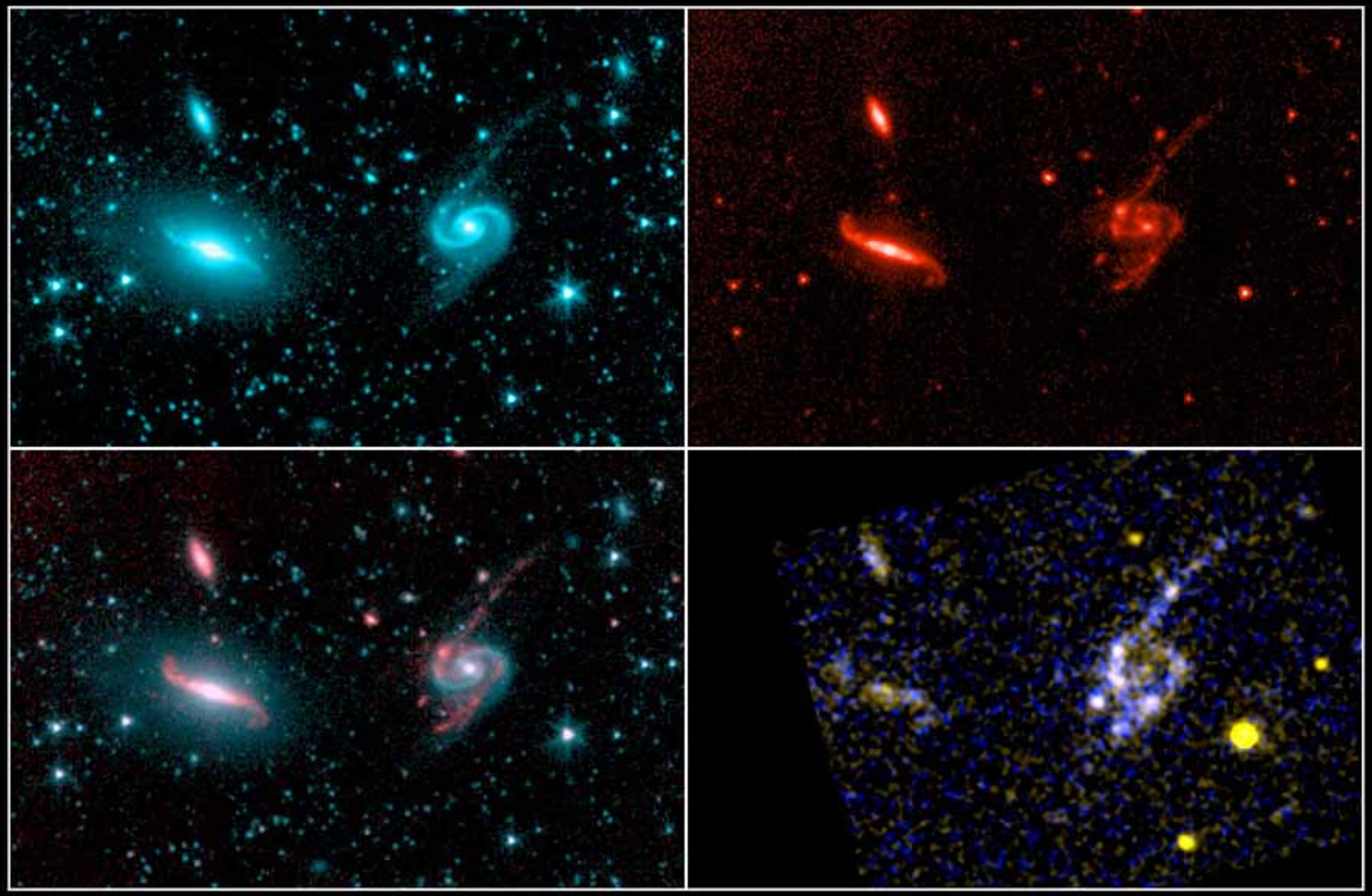
- **Proto-planetary and Planetary Debris Disks**
  - **Study of material around nearby stars which is indicative either of a planetary system in formation or of a more mature planetary system which replenishes the circum-stellar matter**
- **Brown Dwarfs and Super Planets**
  - **Understanding the formation, composition, and structure of objectives with masses between 0.001 and 0.1 times that of the sun**
- **Ultra-luminous Galaxies and Active Galactic Nuclei**
  - **Study of the most luminous objects in the nearby and distant Universe, objects which may radiate predominantly in the IR and have thousands of times the power output of our own Milky Way Galaxy.**
- **The Early Universe**
  - **Study of the formation and evolution of galaxies, looking back to an epoch when the Universe was no more than one-fifth of its current size and age**

The Early Universe--Theme



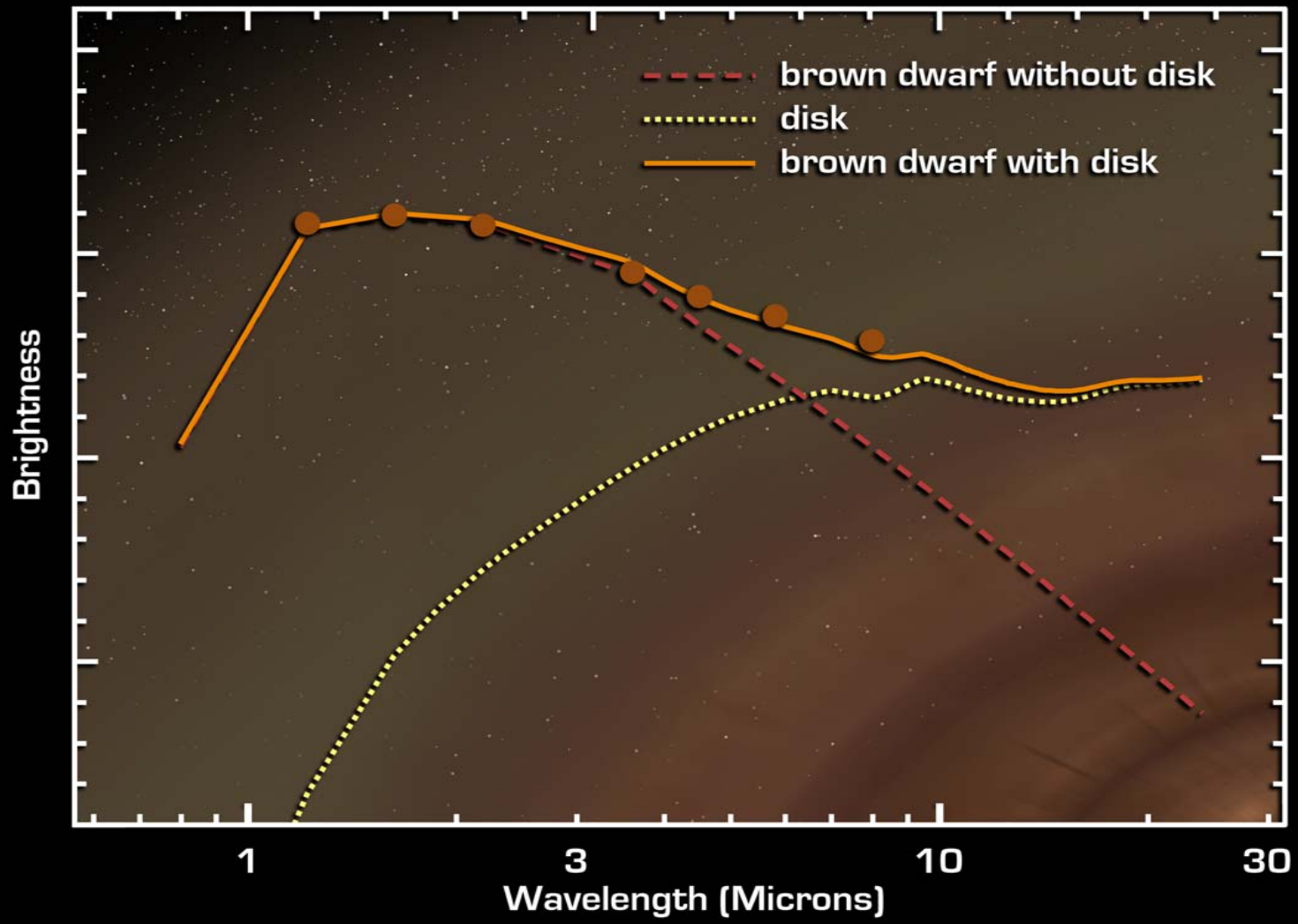
Spitzer & Hubble Team up to Find ‘Big Baby’ Galaxies in the Newborn Universe

Ultra-luminous Galaxies and Active Galactic Nuclei



Images of Interacting Galaxy Pair Arp 65
(A possible precursor to an Ultra-luminous IR Galaxy)

Brown Dwarfs and Super Planets



Spectrum finds Planetary Building Blocks in Surprising Place (About Brown Dwarfs)

Proto-Planetary and Planetary Debris Disks

Glimpse Legacy Team Image of RCW 48
Each Circled Star (in Right Image) shows a Circum-stellar Disk

SPITZER

Successfully Completed 2.5 yr Cryogen Mission Requirement

Congratulations!

3 Yrs Cryo to GO!

What Limits Spitzer Operations?

- **Projected Spitzer Extended Mission Lifetime constrained by:**
  - **Modest Additional Funding with 60% to Science Community**
  - **Adequacy of Consumables**
    - **Cryogen Depletion anticipated to be March 8, 2009 ±72 Days**
    - **No Other Consumable Issues**
  - **Telecom performance degradation anticipated to occur in December 2014**
    - **~Launch + 11.3 years represents natural end of Spitzer operational phase**
      - **Recovery of 40 bps (Safe Mode Rate) Over Low Gain Antenna No Longer Possible after December 2014**

Observatory capable of providing a credible extended mission for 5 years past expected cryogen exhaustion date

Extended Mission Study

All science, technical and programmatic elements are conducive to a robust post-cryogen Spitzer mission, consisting of the following three elements:

I - Capturing the legacy of Spitzer through a permanent archive

- **Applying the full knowledge and understanding of Spitzer by Spitzer experts**

II – Pursuing a vigorous Spitzer archival research program

- **Spitzer contribution to science is impacting all major areas of astrophysics and will continue beyond end of cryogenic mission**
- **Spitzer archival research & observations will continue strong synergy with Hubble, Chandra, theory, lab astro, other facilities**

III - Utilizing the resource of the post-cryo observatory until its natural end

- **Provide superb science that is unmatched at 3.6 and 4.5 µm until JWST**

Detailed planning continues:

- Plan greatly enhances utilization of all the Spitzer resources:

- Data, Expertise, Operating post-cryo observatory to fulfill the promi

Spitzer Posters & Papers

- **The Spitzer Space Telescope's Performance: Getting the most out of a Great Observatory [6720-2]**
- **Quality Interaction between Mission Assurance and Project Team Members [6720-3]**
- **Planning and scheduling the Spitzer Space Telescope [6270-40]**
- **Spitzer Pre-launch Mission Operations System: The Road to Launch [6270-41]**
- **The Spitzer Science Center: system description and lessons learned due to two years of operation [6270-42]**
- **Spitzer Observatory Operations: Increasing Efficiency in Mission Operations [6270-49]**
- **Spitzer Telescope Archive Interface [6270-72]**
- **Data quality and analysis at the Spitzer Science Center [6270-73]**
- **Spitzer Space Telescope Proposal Process [6270-83]**
- **For More Information, See:**
  - **http://www.spitzer.caltech.edu**