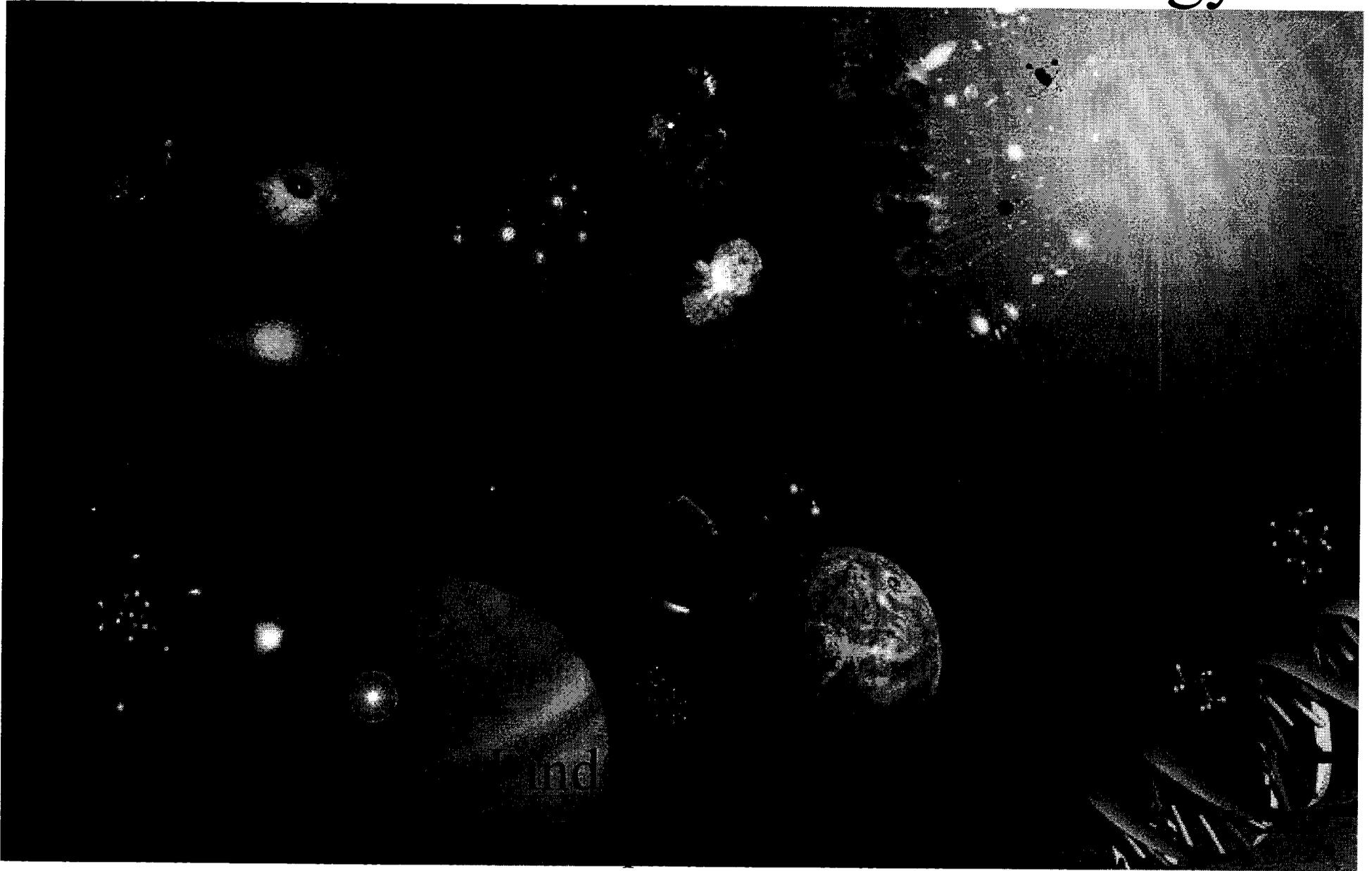


Terrestrial Planet Finder Technology



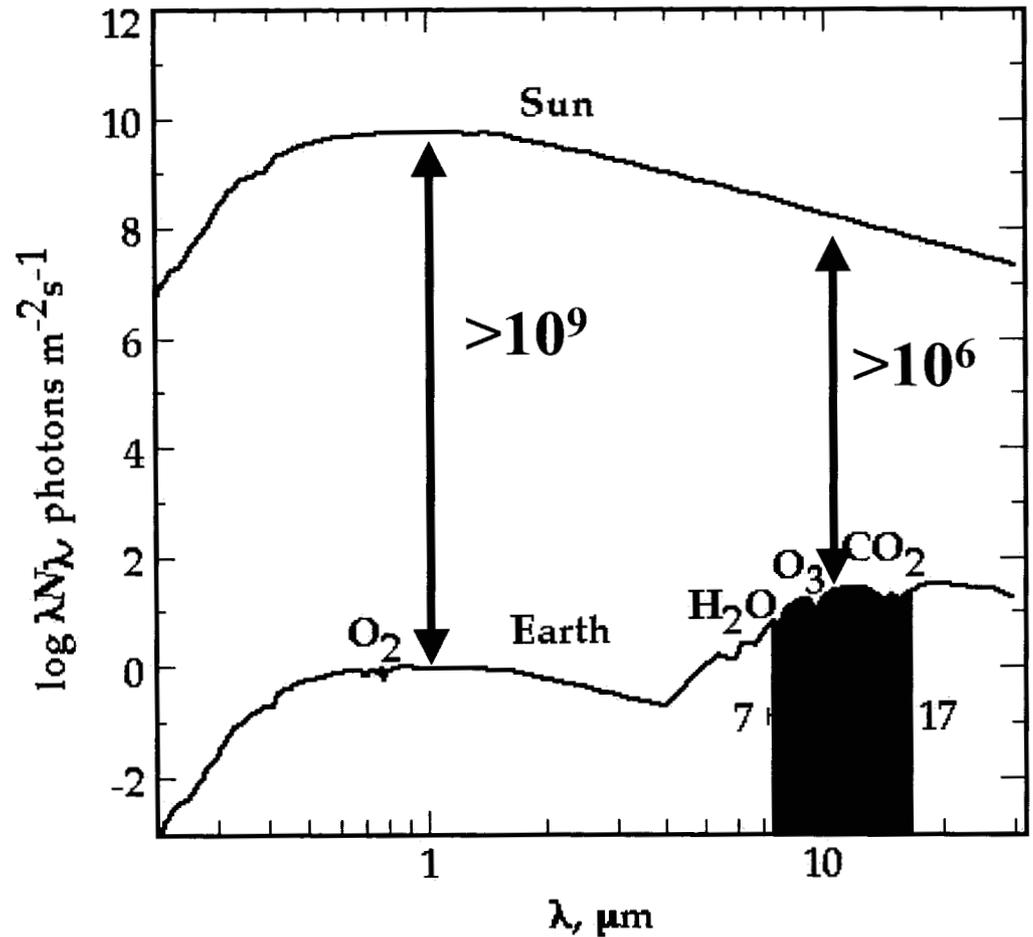
March 8-15, 2003

Goals for Terrestrial Planet Finder

- *Primary Goal:* Direct detection of *emitted* or *reflected* radiation from Earth-like planets located in the habitable zones of nearby solar type stars.
 - Determine orbital and physical properties
 - Characterize atmospheres and search for bio-markers
 - Search a statistically meaningful sample of stars (~150)
- *The Broader Scientific Context:* Comparative Planetology
 - Understand properties of all planetary system constituents, e.g. gas giant planets, terrestrial planets and debris disks.
- *Astrophysics:* An observatory with the power to detect an Earth orbiting a nearby star will be able to collect important new data on many targets of general astrophysical interest.

Terrestrial Planet Finder (TPF)

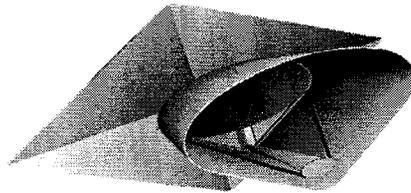
- Detecting light from planets beyond solar system is hard:
 - Planet signal is weak but detectable (few photons/sec/m²)
 - Star emits million to billion more than planet
 - Planet within 1 AU of star
 - Dust in target solar system ×300 brighter than planet
- Finding a firefly next to a searchlight on a foggy night



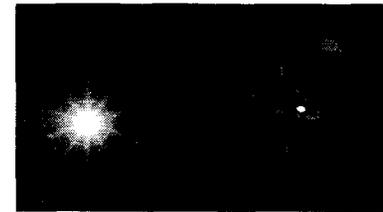
TPF Candidate Architectures

Four two-year studies by industrial/academic teams led to the selection of two classes of mission as candidates for TPF.

Visible Coronagraphs

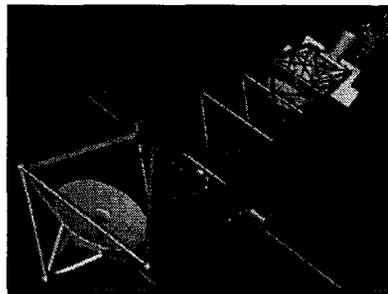


Variable Pupil Visible
Coronagraph

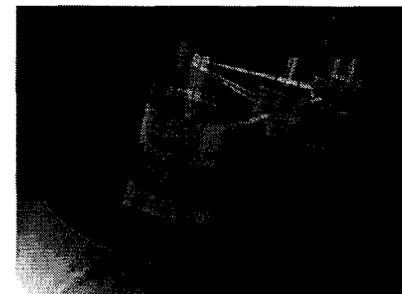


Apodized Square Aperture

IR Interferometers



Structurally Connected IR
Interferometer

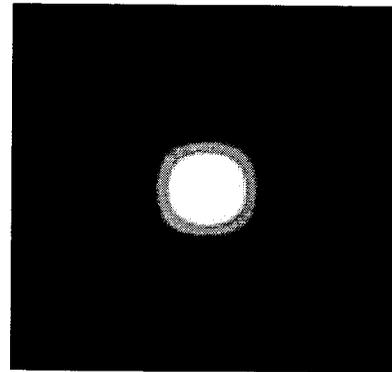
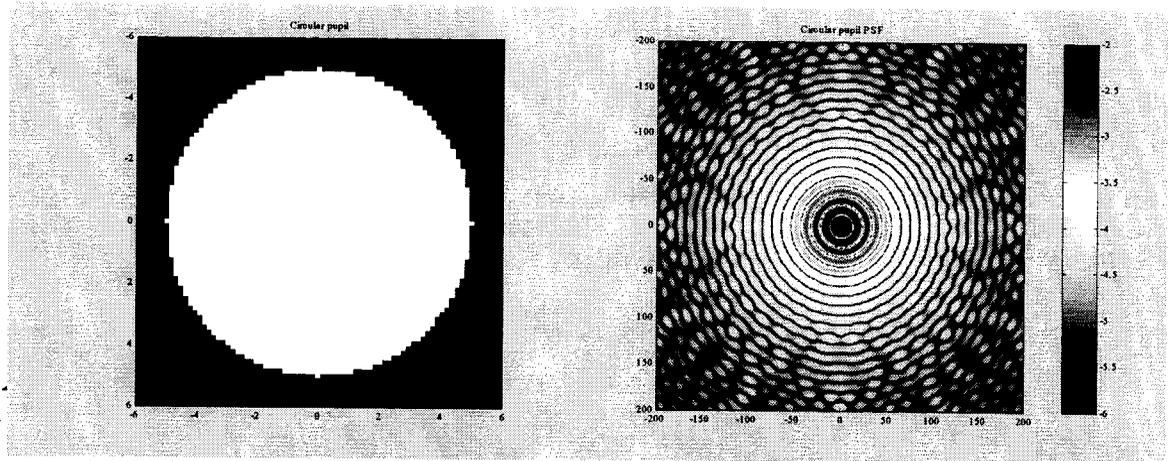


Separated Spacecraft IR
Interferometer

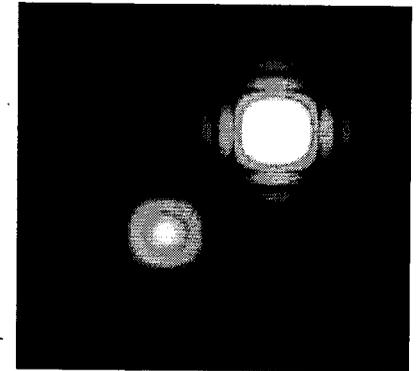
TPF will carry both classes forward for technology development and further studies, leading to selection of a single design by 2006.

Control of Star Light

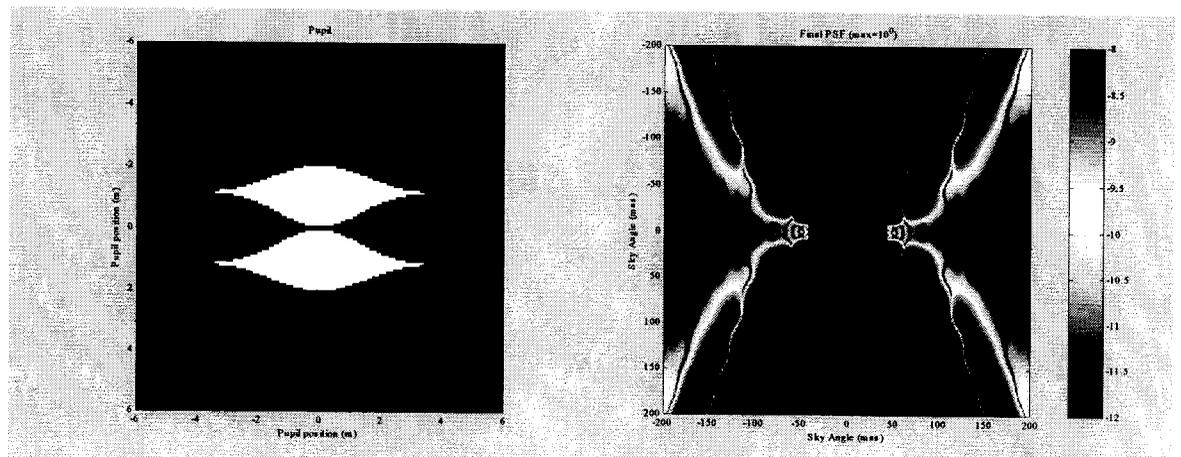
- Control *diffracted* light with various apodizing pupil and/or coronagraph
 - Square masks
 - Graded aperture
 - Multiple Gaussian masks
- Control scattered light
 - Deformable mirror with 10,000 actuators for final $\lambda/3000$ wavefront ($<1 \text{ \AA}$)



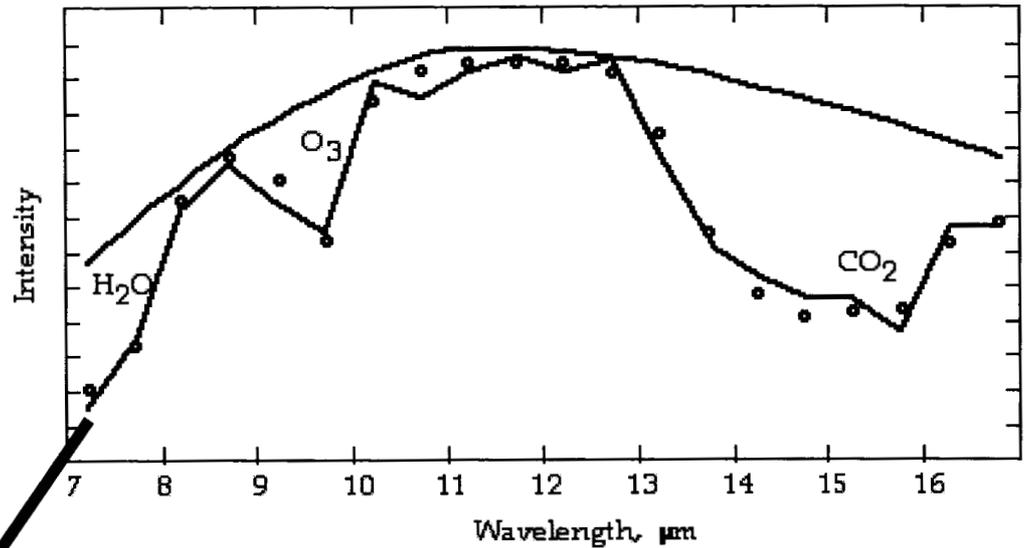
Apodized Square Aperture



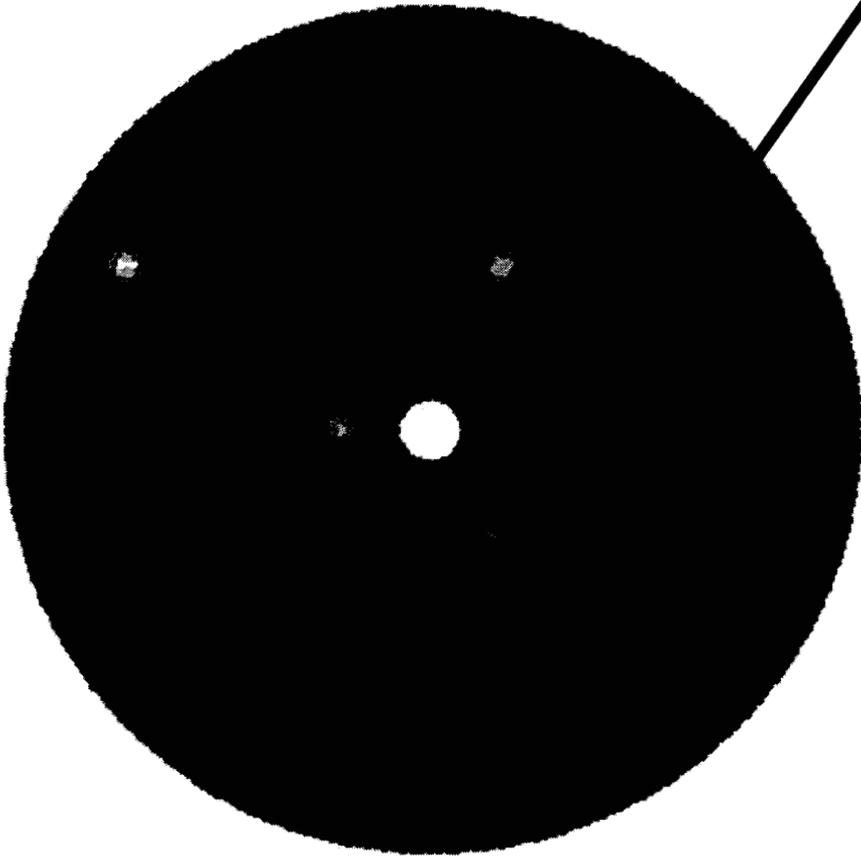
100:1 Star to Planet Ratio Apodization



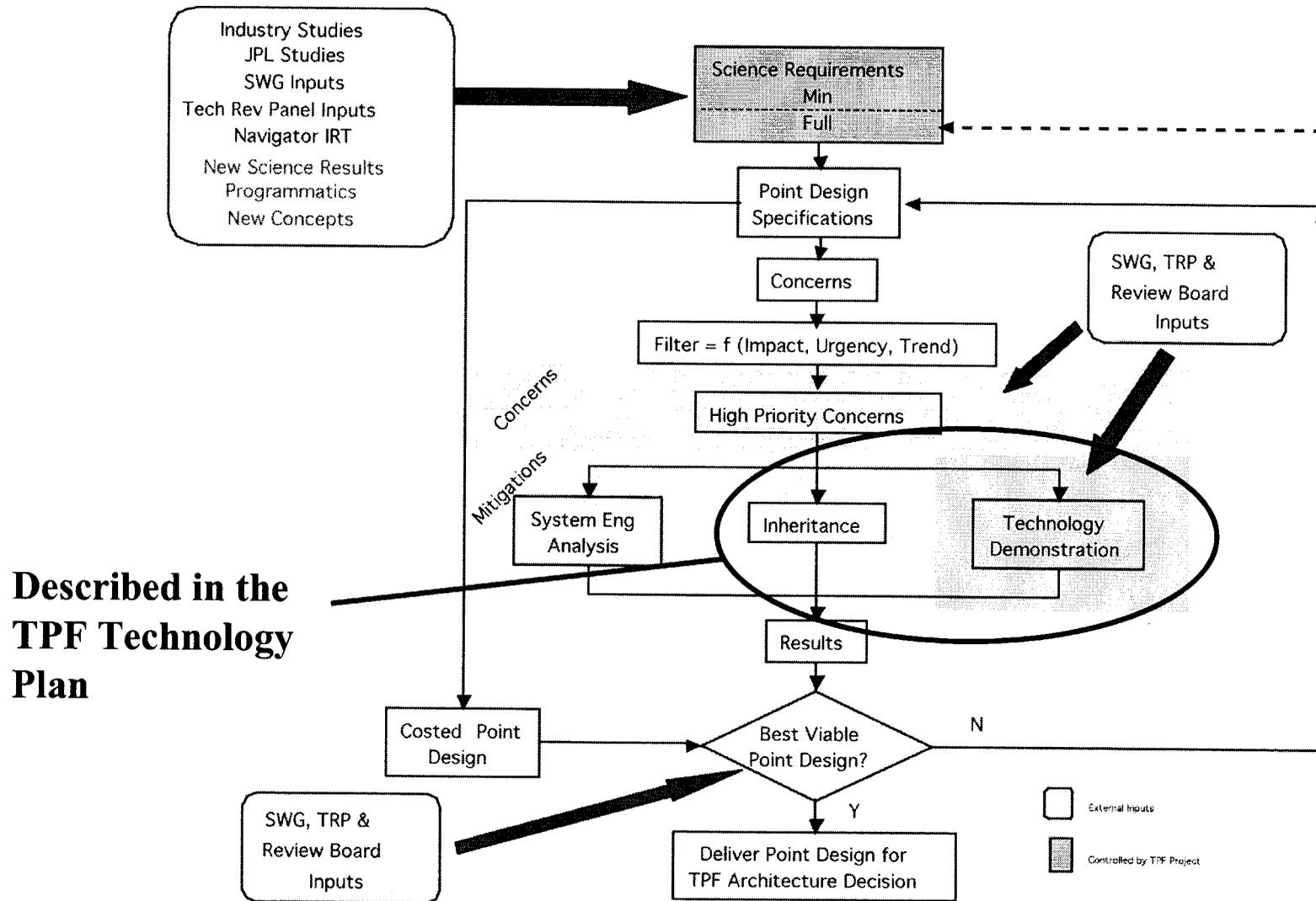
Interferometer Detects and Characterizes Planetary Systems



- TPF produces image of planetary system
 - Orbital location
 - Temperature and radius
- TPF produces spectrum to search for biomarkers
- 1-2 m telescopes to find Jupiters, nearest Earths
- 3-4 m telescopes for full TPF goals

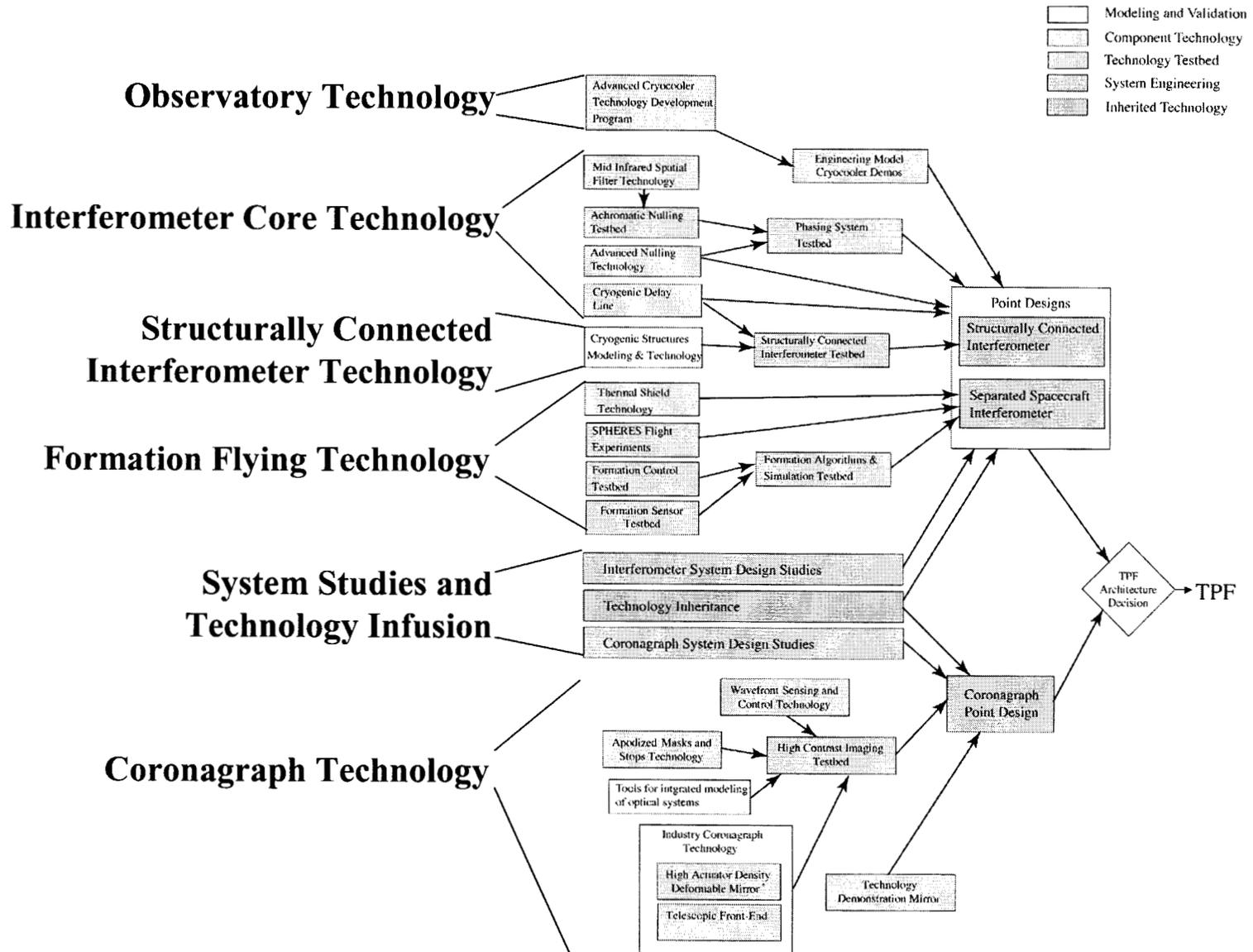


TPF Technology Requirements



**Described in the
TPF Technology
Plan**

TPF Technology Roadmap



Observatory Technology

Advanced Cryocooler Technology Development Program (ACTDP):

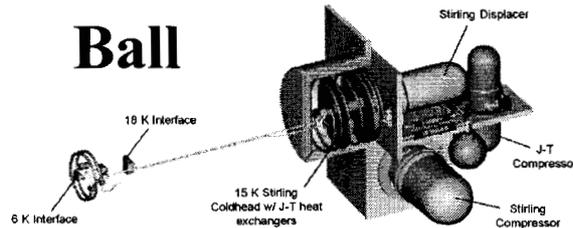
- TPF is developing cryocoolers with 18K/6K cooling stages

- ACTDP will produce two engineering model coolers (with options for electronics) by 2005

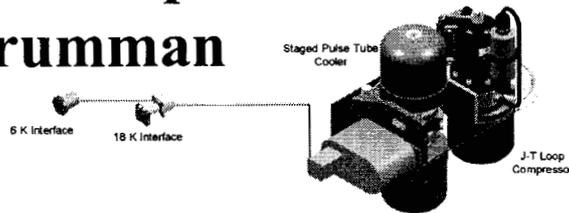
- Requirements derived from TPF, JWST, and Constellation-X

- Three coolers selected for further development: Ball, Lockheed Martin, and Northrop Grumman

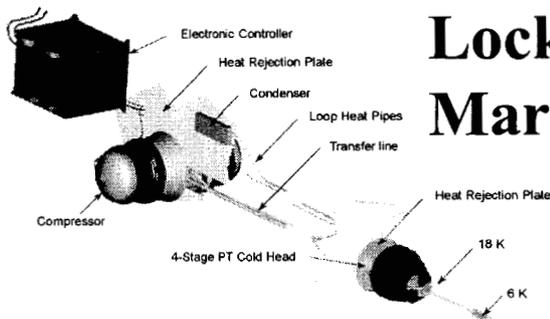
Ball



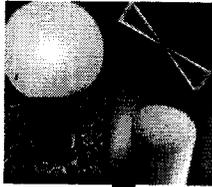
Northrop Grumman



Lockheed Martin

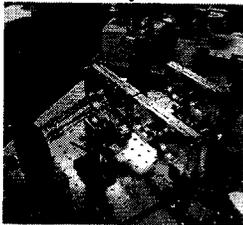


Interferometer Technology

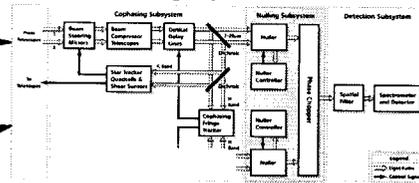


**Mid-Infrared
Spatial Filter
Technology**

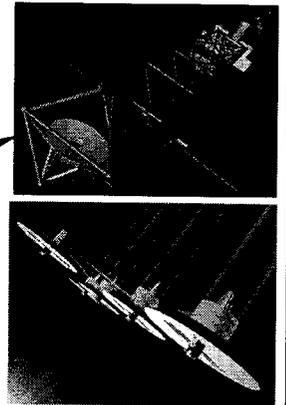
**Achromatic
Nulling
Testbed**



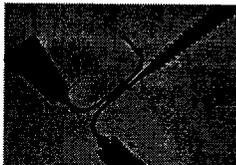
Phasing System Testbed



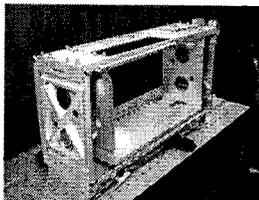
**Interferometer
Point Designs**



**Advanced
Nulling
Technology**



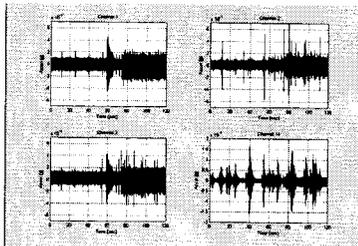
**Cryogenic
Delay Line**



**Structurally Connected
Interferometer Testbed**



**Cryogenic
Structures and
Modeling
Technology**

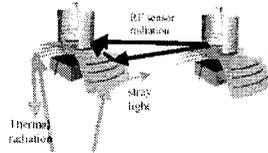


Formation Flying Technology

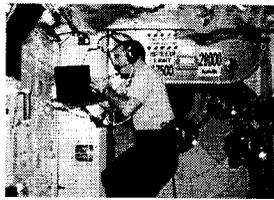
Inherited Formation Flying Technologies



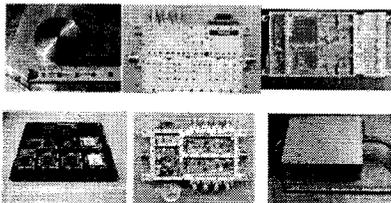
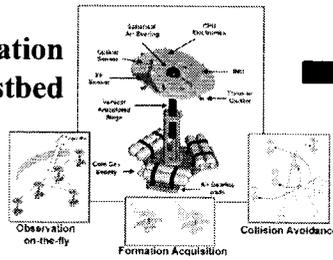
Thermal Shield Technology



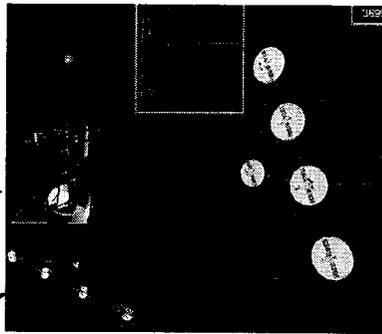
SPHERES Flight Experiments



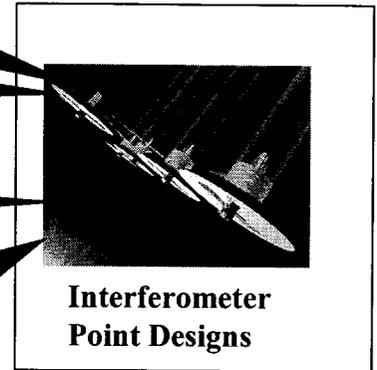
Formation Control Testbed



Formation Sensor Technology

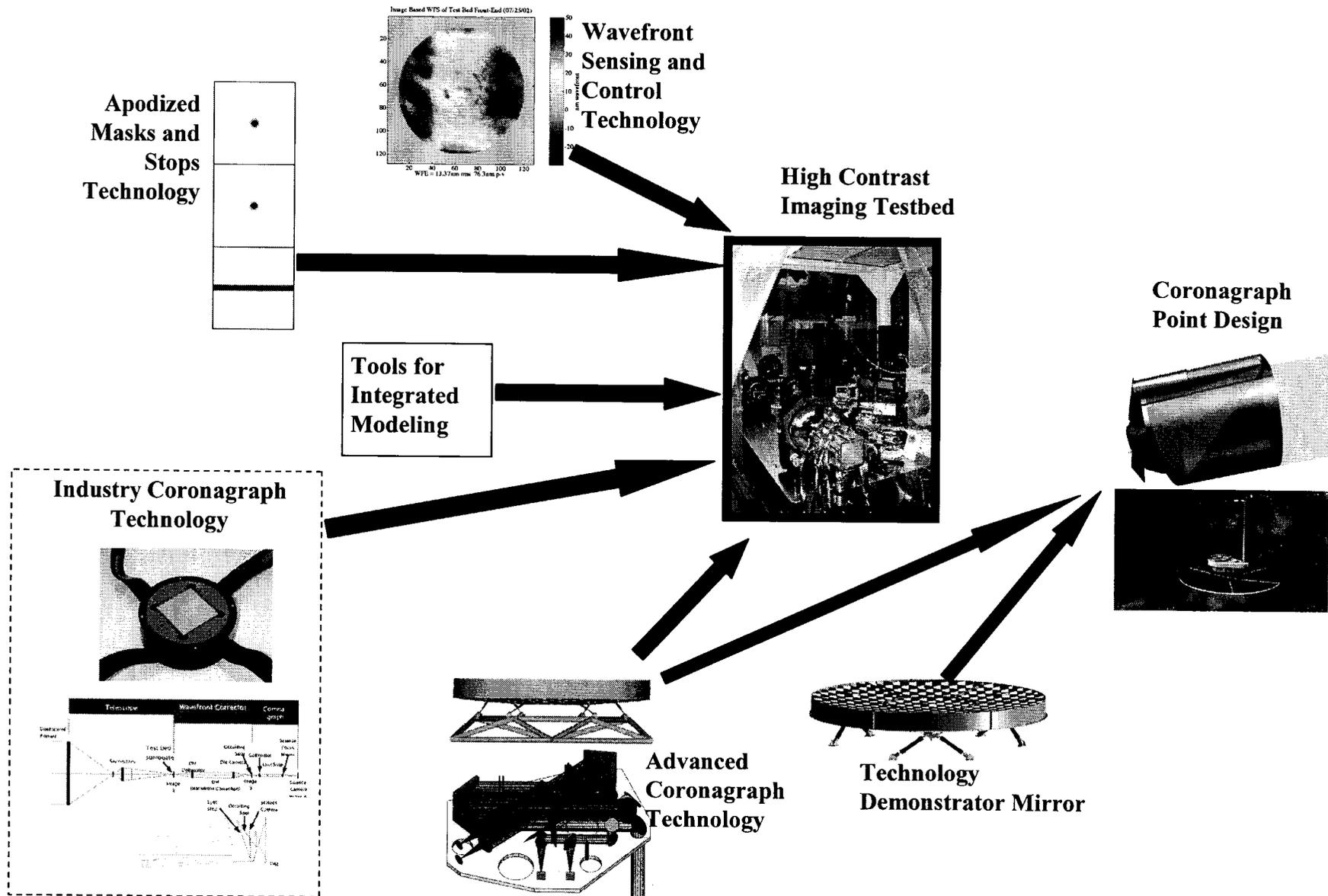


Formation Algorithms and Simulation Testbed



Interferometer Point Designs

Coronagraph Technology



The complete TPF Technology Plan will be posted at: <http://TPF.jpl.nasa.gov>

The image shows a screenshot of the Terrestrial Planet Finder (TPF) website. At the top, there is a navigation bar with links for JPL HOME, EARTH, SOLAR SYSTEM, STARS & GALAXIES, and TECHNOLOGY. Below this is the NASA logo and the title "Terrestrial Planet Finder" in a stylized font. To the right of the title is a spectral plot showing absorption lines for H₂O, CO₂, and O₃. Further right, it says "Jet Propulsion Laboratory California Institute of Technology".

Below the title bar is a secondary navigation bar with links for PLANET QUEST, NEWS, ENGINEERS & SCIENTISTS, LINKS, ORIGINS, and SEARCH.

On the left side, there is a vertical menu with icons and text for: HOME, WHAT IS TPF?, SCIENCE GOALS, TECHNOLOGY GOALS, PROJECT STATUS, QUICK FACTS, TEAM, and MULTIMEDIA GALLERY. At the bottom of this menu is a circular logo for "The Planet Finder Club".

The main content area features a large image of a star with a protoplanetary disk. Overlaid on the image is the text "Origins of Stars, Planets..." at the top and "...and Life" at the bottom right. Below the image, it says "a key element in NASA's Origins Program".

At the bottom of the page, there is a dark bar with three links: LIBRARY, FELLOWSHIPS, and EDUCATOR RESOURCES. The word "LIBRARY" is circled in red.