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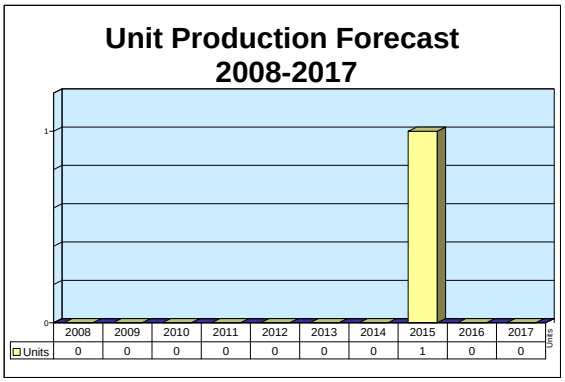
Terrestrial Planet Finder (TPF) - Archived 11/2009

Outlook

- TPF-C and TPF-I anticipated to launch around 2016 and 2019, respectively
- NASA and JPL Program Management Councils are in charge of program responsibility
- NASA expects a mission cost similar to that of the James Webb Space Telescope
- Actual funding has not materialized, and TPF remains without a firm launch date



Orientation

Description. The Terrestrial Planet Finder (TPF) is a set of two complementary space-based observatories that will search for Earth-like planets.

Sponsor. NASA's Jet Propulsion Laboratory, Pasadena, California, manages the mission and science operations. NASA and JPL Program Management Councils carry overall program responsibility.

Status. In development. TPF-C and TPF-I are anticipated to launch around 2016 and 2019, respectively.

Total Produced. None

Application. TPF's primary objectives are to search for and detect Earth-like planets around stars within approximately 60 light years, and to assess the atmospheres and habitability of these planets while searching for signs of life. TPF will also be used to carry out programs in comparative planetology and general astrophysics beyond what is currently possible. The latter applications are not currently design drivers for the mission, and should require little or no additional funding for the project.

Price Range. NASA expects a mission cost similar to that of the James Webb Space Telescope (JWST), which currently has an estimated program cost of $1.8 billion.

Terrestrial Planet Finder (TPF)

Contractors

Prime

Jet Propulsion Laboratory	http://www.jpl.nasa.gov, 4800 Oak Grove Dr, Pasadena, CA 91109 United States, Tel: + 1 (818) 354-4321, Prime
NOTE(S): No other contractors have been selected for the TPF program.	

Comprehensive information on Contractors can be found in Forecast International's "International Contractors" series. For a detailed description, go to www.forecastinternational.com (see Products & Samples/Governments & Industries) or call + 1 (203) 426-0800.

Contractors are invited to submit updated information to Editor, International Contractors, Forecast International, 22 Commerce Road, Newtown, CT 06470, USA; rich.pettibone@forecast1.com

Technical Data

Design Features. The TPF project consists of two complementary space observatories, the TPF-C and the TPF-I. The TPF-C is a visible-light coronagraph, and the TPF-I is a mid-infrared formation-flying interferometer. The combined system will allow TPF to observe over a wide wavelength range in its effort to observe extra-solar Earth-like planets. Both observatories will fly in an L2 (Lagrange point 2) orbit to allow easier viewing of distant stars and planets.

The TPF-C is currently planned to utilize a Cassegrain design, with an off-axis elliptical primary mirror measuring 8.0 by 3.5 meters along the major and minor axes, respectively. The separation between the primary and secondary mirrors is 12 meters. The secondary mirror is also off-axis with an elliptical profile, measuring 83 by 36.5 centimeters. The effective focal length of the system is 146 meters, with a field of view of 3.6 arcsec. A flat tertiary mirror directs light to an optical bench that lies beneath the primary mirror. The optical bench houses a wavefront-correction system, followed by a coronagraph.

The structure that supports the telescope includes separate thermal enclosures for the primary and secondary mirrors, as well as actuators to reposition the secondary mirror. The primary mirror will be adjusted with an actuated hexapod with dual-stage actuators, allowing for both coarse and fine adjustment.

There will be a six-beam laser metrology system to monitor the location of the primary mirror relative to the secondary mirror at all times. Everything is surrounded by a large six-vane v-groove radiator to provide thermal stability. The back of the primary mirror is also surrounded by a heated thermal enclosure that will maintain a steady controlled temperature. The primary mirror will be able to operate at close to room temperature, the temperature in which it was fabricated.

The TPF-I consists of two parts: four collector spacecraft and a single combiner spacecraft. Each collector carries a primary mirror, currently planned to be monolithic and between 3.5 and 4.0 meters in diameter. Each has a five-layer square sunshade measuring 15 meters on each side, which permits the optics to be passively cooled to about 40 kelvin. The collectors are configured with radio frequency (RF) systems for inter-spacecraft communication, limited spacecraft-to-Earth communication, and formation flying positioning.

The single combiner receives the light from all of the collectors and combines it to produce interferometric fringes that reveal a planet's light. The combiner therefore houses the principal science detectors, which are cooled to about 6 kelvin by an onboard cryocooler. Like the collectors, the combiner carries a five-layer sunshade, deployable cryo-radiators, stray light baffles, and other traditional spacecraft electronics.

Since it is the center of communications within the formation, the combiner is equipped with a more extensive RF system that includes a gimbaled high-gain antenna for communication with Earth. The current mission plan dictates that the spacecraft have a minimum separation of 5 meters from edge to edge, with a maximum separation of 35 meters. These figures imply a minimum total array size of 40 meters, with a maximum size of 150 meters, depending upon the formation architecture of the spacecraft.

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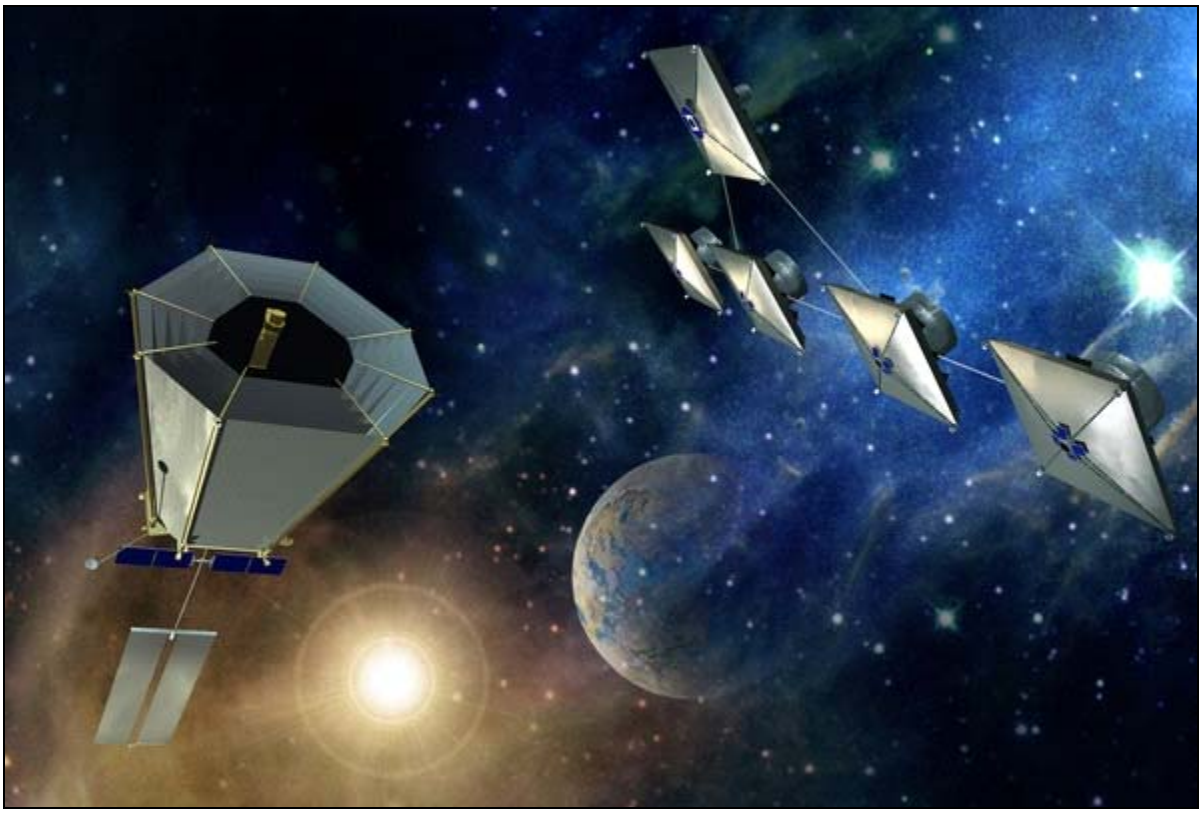
	Metric	U.S.
Dimensions		
TPF-C primary mirror size	8.0 m x 3.5 m	26.25 ft x 11.48 ft
TPF-I primary mirror diameter	3.5 m	11.48 ft
TPF-I array size	40 m - 150 m	131.23 ft - 492.13
Weights		
TPF-C	6,200 kg	13,669 lb
TPF-I collector (x4)	1,431 kg (total 5,724 kg)	3,154.8 lb (total 12,619 lb)
TPF-I combiner	1,413 kg	3,115.1 lb
Performance		
TPF-C power	3 kW	
TPF-I collector power	862 W	
TPF-I combiner power	1,445 W	
TPF-I angular resolution	50 - 75 milli-arcsec	
TPF orbit	L2 (1.5 million km)	
TPF design life	5 years (goal 10 years)	



Artist's Impression of the TPF-C (left) and TPF-I (right) Spacecraft

Source: NASA

Program Review

Background. In 1999, JPL published the Terrestrial Planet Finder book, which presented the scientific case for the mission. In 2001, the National Research Council prepared its decadal review of astronomy and astrophysics, "Astronomy and Astrophysics in the New Millennium." The decadal committee recommended that NASA proceed with the TPF project, noting its extreme scientific importance.

Terrestrial Planet Finder (TPF)

In May 2002, NASA chose two separate TPF mission architectures for further development and review. The platforms, one a visible-light coronagraph and the other a mid-infrared formation-flying interferometer, would use different means to achieve the same goal. In May 2004, NASA approved both concepts and decided to move forward with TPF as a combination of two platforms, the TPF-C (coronagraph) and the TPF-I (interferometer).

In its initial "Summary Report on Architecture Studies" for the TPF, NASA planned for the project to begin its formulation phase sometime in 2007. Both TPF missions are in the pre-formulation phase and are undertaking technology risk reduction activities. TPF-C is currently in pre-Phase A, and could start the Mission Concept Review in 2008. TPF-I is also currently in pre-Phase A, and is expected to enter into Phase A sometime in 2010. It is possible that these dates will be pushed back, as NASA's FY07 budget request announced a deferral of the TPF indefinitely and the project plans in the FY08 request are still under scrutiny.

NASA currently hopes the TPF-C will be launched sometime around 2016, and the TPF-I before 2020. Launch delays are possible, depending on how the aforementioned budget changes affect technology development.

House Restores FY07 TPF Funds

The House Appropriations Committee recommended a total of $16.7 billion for the NASA FY07 budget, which is $83.2 million below what was requested and an increase of $462.4 million over the FY06 level, not including emergency supplemental funding. The Committee recommended $10 million to be allocated to Terrestrial Planet Finder for continued technology development.

Funding

Funding for the TPF project resides in a new "Exoplanet Exploration Technology" line that is part of "Other Missions and Data Analysis," and can be found under the theme, Astrophysics. The following data are derived from NASA's FY09 budget request. Note that funds for the Space Interferometer (SIM) are also located in this line and have been subtracted from funds shown in FY09-FY13. Funding indicated is not exclusively for the TPF as these funds have not been broken out separately by NASA.

US FUNDING

	FY07 AMT	FY08 AMT	FY09 AMT	FY10 AMT	FY11 AMT	FY12 AMT	FY13 AMT
Other Missions and Data Analysis	32.5	29.6	16.3	11.2	10.5	11.7	9.9

All $ are in millions.

Timetable

Month	Year	Major Development
May	2004	TPF-C and TPF-I architectures approved by NASA
	2016	Possible launch of TPF-C on EELV with 5 x 19 meter fairing
	2019	Possible launch of TPF-I on Delta 4050H

Forecast Rationale

The long list of space telescopes in NASA's plans indicates that clear priorities need to be set, and some researchers are beginning to worry that programs designed to detect life will be favored over fundamental investigations into the inanimate, physical sciences. The president's vision, delivered in 2004, explicitly calls for NASA to "conduct advanced telescope searches for Earth-like planets and habitable environments around other stars," and categorizes future NASA missions, such as the Space Interferometry Mission and the Terrestrial Planet Finder, as high priority and life-oriented.

Finding an exact analogue of our planetary system is highly unlikely given the chaotic processes involved in

planet formation, yet scientists have no reason to believe that planetary systems, at least similar to our own, are not commonplace. The 160 known extrasolar planetary systems in our system were nearly all discovered by methods that strongly favor the detection of gas-giant planets with short-period orbits. Such planets are indeed likely to hinder the formation of habitable, Earth-like planets, but the recent discovery of more than a half-dozen super-Earths, planets in the range of 5 to 15 Earth masses, implies that Earth-mass planets are commonplace.

The indefinite deferment handed down with the release of the FY07 budget was a jolt to program management, but the restoration of funding by the House Appropriations Committee is a positive sign for the TPF. Forecast International expects both spacecraft will be produced; however, only the TPF-C is represented in the **Ten-Year Outlook** chart below, as production of the TPF-I will fall outside the forecast period.

Ten-Year Outlook

ESTIMATED CALENDAR YEAR UNIT PRODUCTION												
Designation or Program		**High Confidence**				**Good Confidence**			**Speculative**			
	Thru 2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**Total**
Jet Propulsion Laboratory												
Terrestrial Planet Finder												
	0	0	0	0	0	0	0	0	1	0	0	1
Total	0	0	0	0	0	0	0	0	1	0	0	1