National Aeronautics and Space Administration

TPF Terrestrial Planet Finder

TPF-C Instrument Concept Studies
Pre-Proposal Workshop

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Agenda

- Mission (PIP 3.1)
- Orbit (PIP 3.2)
- Launch Vehicle (PIP 3.3)
- Spacecraft (PIP 3.4)
- Payload Pointing (PIP 3.5.1.4)

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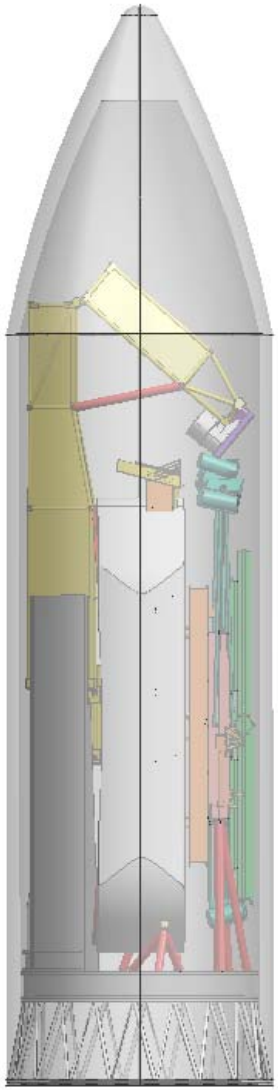
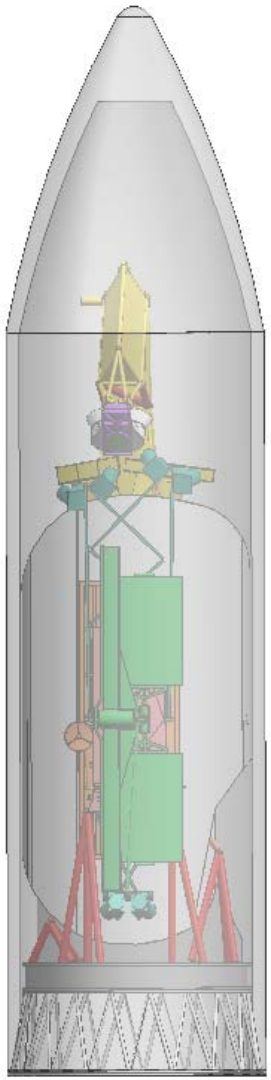
Mission, Orbit and Launch Vehicle

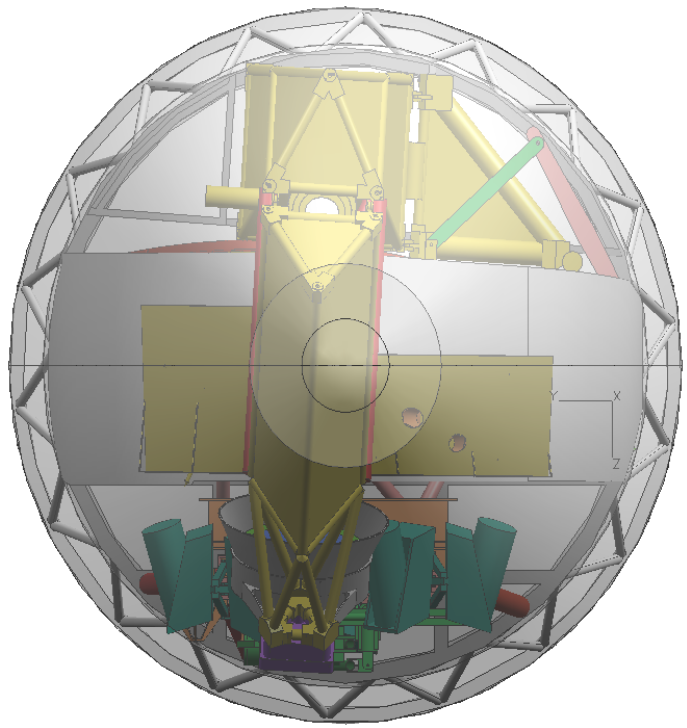
- Mission duration is 5 years with a goal of 10 years
  - Consumables provided for 10 years, including propellant
- Baseline orbit is a L2 Lissajous orbit with direct trajectory
  - Same as JWST baseline
  - Launch $C_3 = -0.69\ km^2/s^2$
  - Time to reach operating orbit is about 109 days
- Field of Regard is anti-sun hemisphere less 5° guard-band
  - A cone with 85° half-angle centered on the anti-sun vector
- Launch vehicle is EELV with existing 5m fairing
  - Telescope short axis limited to ~ 3.5m
  - Drawings of the launch configuration follow
- Launch mass capability is ~ 9,200 kg
  - A mass breakdown table follows

Launch Configuration





- Existing 5m dia. fairings limit the telescope short axis to about 3.5m
- Fairing height is not currently a limit



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Mass Estimate Breakdown

Component	Mass Estimate (kg)	% of Total Launch Mass
Payload	3553	
Telescope	2412	40.6
Payload Support Subsystem	446	7.5
Starlight Suppression Subsystem	515	8.7
Planet Detection Camera	10	0.17
Planet Characterization Instrument	20	0.3
General Astrophysics Instrument	150	2.5
Spacecraft	2382	40.1
Total Launch Mass	5934	
Launch Vehicle Capability	9200	
Launch Margin	**3316**	
Launch Margin*	**35.8**	

*Defined as (LV Capability-Total Estimate)/Launch Capability

- Estimates for placeholder instruments included for reference only and DO NOT represent limiting allocations
- Guideline for > 30% margin is satisfied
- Allowable estimate growth is 56%

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Spacecraft-Power

	Power Estimate (W)	% of Total Power
Payload	800	44.4
Telescope including thermal control	375	20.8
Payload System Electronics and thermal control	125	6.9
Starlight Suppression Subsystem	100	5.6
Planet Detection Camera	20	1.1
Planet Characterization Instrument	30	1.7
General Astrophysics Instrument	150	8.3
Spacecraft	1000	55.6
Total Power	1800	
Available EOL Power	3000	
Power Margin (W)	**1200**	
Power Margin (%)*	**40**	

*Defined as (Available Power-Total Estimate)/Available Power

- Power is provided by a 3kW (EOL) solar array
- Estimates for placeholder instruments included for reference only and DO NOT represent limiting allocations
- Guideline for > 30% margin is satisfied
- Allowable estimate growth is 67%

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Spacecraft- Downlink Data Rate

- Science downlink provides 64Mbps capability
  - Max capability in anticipation of GAI requirements
  - Ka-Band downlink to 34m DSN stations
  - Downlink average duration is 2.5 hours per day
- Additional X-Band downlinks for engineering functions
- Uplink is X-Band only

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Spacecraft and Payload Pointing

- A Fine Steering Mirror (FSM) in the SSS is used to align the beam onto the occulting mask based upon input from a Fine Guidance Sensor at the occulting mask, or Lyot stop
- The spacecraft provides bore-sight pointing control
  - Coarse pointing with conventional star trackers
  - Intermediate pointing with precision star cameras mounted on the payload
  - Fine pointing with an active vibration isolation system using FSM position data
- A new occulting mask baseline requires significantly better pointing
- The secondary mirror (SM) is now pointed in 2 axes to relax the bore-sight pointing requirement
  - Uses existing hexapod actuator but new control loop fed by the FSM position
  - SM off-pointing limited to 4 mas per an aberration allocation
- Pointing capabilities defined in paragraph 3.5.1.4 and Table 6 of the PIP are now obsolete
- The following table summarizes the current specifications

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Pointing Summary

Pointing Mode	Function	Pointing Accuracy *	Principle Sensor	Principle Actuator
Coarse Bore-sight Pointing	Initial Slew to Star	10 arc-sec	SC mounted star-trackers	SC reaction wheels
Intermediate Bore-sight Pointing	Intermediate handoff to FSM	0.4 arc-sec	Payload mounted acquisition camera	SC reaction wheels
Fine Bore-sight Pointing	Intermediate handoff to SM	4 mas	FSM Position	Active vibration isolation system
SM Beam Steering	Limit Beam-walk on optics before FSM	0.4 mas	FSM Position	SM hexapod in 2 axes
FSM Beam Steering	Center beam on occulting mask	0.3 mas bias & 0.3 mas stability	FGS	FSM

SC = spacecraft
SM = Secondary Mirror
FGS = Fine Guidance Sensor
FSM = Fine Steering Mirror
* Total bias & stability, unless otherwise noted

- FGS/FSM requires a suitably bright star in the center of the field
- GAI pointing without a central bright star is not yet addressed

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