Questions from the preproposal conference (Eric Smith and Susan Keddie)

GENERAL QUESTIONS

1. Q: Will the spacecraft provide data storage? How much?
   Yes. Assume the spacecraft will provide 1 or 2 days of data storage.

2. Will instruments be required to store their own data?
   Some buffering within the instruments will be needed but bulk data storage will be provided by the spacecraft. The spacecraft will provide at least one full day of science data storage, and perhaps two days, depending upon the volume of data.

3. Q: How firm are the packaging constraints on the GAI?
   The height constraint is caused by the volume available between the spacecraft and the primary mirror in the launch configuration. The primary mirror must be located relative to the centerline of the launch shroud. The spacecraft must fit within the curve of the shroud. The primary mirror stands vertically in the launch shroud and the diameter of the shroud limits the spacing between the spacecraft and OTA. In the plane "parallel" to the mirror surface, the limiting factor is both the fairing diameter and fitting into the v-groove sunshade (which limits us to keep all the instruments, structure, etc., roughly within a rounded corner rectangle of 8x3.5m size of the primary. Otherwise, the configuration can be changed to accommodate the GAI.

4. Q: what is the static wavefront error capture range?
   We don't know yet what the ground to flight wavefront error will be. We are planning to provide a coarse DM with an actuator stroke of 5 microns to compensate the errors, and are continuing to analyze the predicted ground to flight effect.

5. Do all requirements apply to the ½ earth problem?
   Yes they do

6. Why 50% throughput requirements on 3 bands and 50% with R~70 on the spectrograph?
   There are no "50% throughput" requirements. There are requirements that read as follows: .. the ratio of color-characterized planets to all detected planets around the core stars have an expectation value of at least 50%, and …the ratio of spectrally characterized planets to all detected planets around the core stars have an expectation value of at least 50%. The rationale for these requirements is that the difficulty of performing these characterizations varies significantly with the star characteristics and where in the HZ the planets are found. We expect to detect more planets than are possible to characterize.
   The distinction between three spectral bands to confirm detection of a planet and a resolution of 70 on the spectrograph is that three bands are believed to be enough to discriminate the color of the light received to tell if it is a planet orbiting a star or an

object in the distance. Thus three bands are desired for planet detection. The R~70 resolution is desired for characterization to determine elements in the atmosphere.

7. Is mission lifetime a free parameter?

The instruments should be designed to fit their observing within the 5 year design lifetime (10 year goal). Thus, they should complete their planned science within 5 years, within constraints related to other science requirements. Assumptions should be stated.

8. **Q (p94)**: How big is the dither and over what time span?

The dither angle is 30 degrees and the rate of roll is nominally 1 deg per minute. The period in between dither maneuvers varies with the star dependent integration time and the yet to be determined stability capabilities.

POINTING

9. Can you specify the bandwidth figures on the pointing requirements?

We are using preliminary estimates of:

Jitter Rejection Bandwidths	
Coarse Bore-sight pointing:	1/60 Hz
Intermediate Bore-sight Pointing:	TBD
Fine Bore-sight Pointing:	10-200 Hz
SM Beam Steering:	TBD
FSM Beam Steering:	50 Hz

Partitioning between the Fine Bore-sight pointing and the SM Beam Steering is not resolved, but in combination must achieve 0.4 mas pointing capability over all disturbance frequencies. The fine guidance sensor sensing capability is greater than 500Hz. The values in this table are referenced to a magnitude 7 star. The FGS sensing rate is proportional to star flux. However, the active isolation senses inertial errors in pointing of the payload and provides compensation at higher rates independent of star flux and uses feedback from the FSM to compensate for bias drift. The star magnitude required is somewhat dependent on the accuracy required. Details can be developed further during the concept studies.

10. Why do you need a whole other set of optics to go from 0.4 to 0.3 marcsec?

The 0.4marcsec performance level applies to steering of the Secondary Mirror and is needed to control beam-walk on the optics before the Fine Steering Mirror. The 0.3 marcsec (0.3mas accuracy and 0.3mas stability) performance level applies to the FSM and is needed to align the beam onto the occulter. The control bandwidth needed for the FSM, which is not currently specified, will be higher than the control bandwidth for the SM.

11. **Q (p94)**: A question regarding pointing. Will the instrument be rotating slowly, or the whole telescope will be rotating slowly?

A: During planet detection, the entire telescope will be stationary to within the described pointing regime for one scene collection. The telescope will then rotate ~30 degrees for the next scene collection. These two scenes will be subtracted to extract light from potential planets that lie in the zone along the high-resolution, long axis of the telescope. We have called the collection of these two scenes a dither. The telescope will then rotate another 30 degrees and repeat collection of the two scenes described above to discover planets along the next high-resolution axis of the telescope. Finally, the telescope will perform the final 30 degree rotation and two scene collection. This scenario has been chosen to maximize both speckle removal from the scene and completeness of planet searching around the target star.

12. Table 6 of 3.5.1.4 is now obsolete. This must be updated.

The updated pointing requirements were presented at the pre-proposal conference.

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

These are valid for the long axis direction and scales by 8/3.5 for the short axis direction. The SSS requires ~1arcsec accuracy on the roll axis. The roll axis accuracy for the GAI is estimated to be ~ 0.2 arcsec.

13. What is the best estimate for the power spectrum of angular disturbances/errors/rates when a bright star is not being tracked by the SSS? A number of 1 kHz control frequency was discussed at the meeting, but this is a demanding rate if there is no 6th magnitude star to guide off of. On the other hand the SSS guiding spec is likely to be much tighter than that of the GAI. So the question is if we track/control at frequencies less than 1 KHz, how fast does the 0.4 mas degrade?

The control frequency of 1 KHz is not correct. Refer to question 9 for the estimated control frequencies that have been assumed.

14. Q: Do you have detailed requirements for the FSM?

Details are not completely worked out. The only requirement is the angular resolution of the FSM which is on the order of 3 milliarcsec.

15. Q: Are the quoted pointing capabilities 1-sigma numbers and what is the bandwidth on them?
    The pointing capabilities presented in question 12 are 1-sigma numbers. The bandwidths are not fully specified. The control bandwidths are given in question 9.

16. Q: How do you define a "bright star" for the purposes of the establishing the pointing accuracy of the system when the SSS is not in use?
    Refer to question 9.

17. Q: Is it allowable for the GAI to drive the secondary in a control loop?
    If this question applies to dedicated GAI operations, the answer is yes. If it applies to an engineering pointing relationship, then the proposal would be evaluated carefully.

ENVIRONMENT

18. Can the project provide an estimate of the radiation and particle environment at L2?

A report of the radiation and particle environment at L2 that was written for JWST is attached to the website: http://planetquest/TPF/tpc_nra_pip.cfm

19. **Q (p77)**: How stable the temperature of the primary mirror is at L2?
    A: Analysis of an earlier design (the minimum mission concept) predicted primary mirror temperature stability on the order of milli Kelvin. The analysis was based on a fully integrated model exercised through varying sun angles, through expected worst-case maneuvers, with temperature and perturbations resulting. An updated design is being modeled and will be analyzed and results will be presented in the June-July timeframe.

20. Q: What is the temperature of the FSM?
    The fine steering mirror is located in the starlight suppression system where it is maintained in the temperature range stated in the PIP as 290-305K.

TELECOM

21. Will an upgrade of the DSN impact TPF-C?
    The baseline high rate science down-link is consistent with the plans for JWST, which is scheduled to launch prior to TPF-C. No DSN upgrades beyond what is needed for JWST are currently assumed.

22. Can you schedule the 2.5 hours of downlink/day?
    Yes, as negotiated with the DSN schedulers.

23. Q: Is the 64 Mbit rate during the 2.5 hour downlink or a daily average?
    The 64 Mbps rate applies during the 2.5 hour downlink.

24. Q: Does the 2.5 hour window apply to X-band also?
    Yes

THROUGHPUT

25. What are the permitted reflectivity variations on the primary, secondary and fold mirrors?
    Our preliminary assessment of the allowable coating variation is between .1 to .01 percent.

26. Is the 10 arcsecond hole in the Pick-Off Mirror a radius or diameter measure?
    It is a diameter (remember, this is for placeholder instruments and is not a firm value). The size of this hole is driven by the SSS required margin beyond its field of view.

27. What is the performance of the SSS?
    Please use the performance described in the PIP for the purposes of this proposal.

28. **Q (p89)**: Is the most critical factor the reflectivity?
    The most critical element in terms of throughput is the occulting mask currently estimated at 59% at the IWA and about 68% averaged between the IWA and OWA.

29. **Q (p87)**: What is the transmission number of the Michelson beam-splitter?
    The Michelson beam-splitter throughput is currently estimated at 90% for a 500 to 800 nm bandpass, based on a preliminary coating design. The total throughput to the instruments after the SSS is 8% at the IWA and about 11% averaged between the IWA (0.0618 arc-sec) and the OWA (1.13 arc-sec).

OPTICAL

30. **Q (p87):** Will there be any filters after the beam-splitter that isolate the spectral region that will be corrected for a given exposure?
    A: Currently the width of the corrected spectral region is being studied as part of the starlight suppression system technology effort. Required filters to limit this can be incorporated in the starlight suppression system as they are better understood. Progress on this effort will be communicated to the winning instrument study concept teams to keep them informed throughout the process of the studies.

31. **Q (p88)**: So, the filters would be part of the instrument?
    A: At this time the filters can be part of the instrument or can be proposed to be inserted in designated locations in the starlight suppression system.

32. **Q (p124)**: What spectral region will be corrected for wave front errors?

A: The entire required waveband, 500-800 nm will be corrected for wave front errors in the starlight suppression system. This is required in order to suppress the starlight to meet the contrast requirements that enable planet detection and characterization. This band-pass will not be corrected instantaneously, but will likely be corrected in smaller waveband segments – the preliminary corrected waveband is only an estimate and is being analyzed by the project with experiments being done to understand what can be achieved. For the purposes of this proposal, 100nm bandwidth can be used.

33. **Q (p126)**: So, within the 500 to 800 nm band-pass, will any single exposure span 100 nanometers?

A: 100 nm can be used in performance analyses. Please state what value you have used, and how it affects the performance, so that we can understand your assumptions.

34. **Q (p127)**: Could you clarify how do we need to treat the wavefront corrected band-pass?

A: The starlight suppression system will provide the required contrast within a narrow bandwidth range – roughly 100nm. Several contrast data sets at bandwidths that span the required 500-800nm band pass will be provided.

35. **Q (p88):** Regarding the starlight suppression, will there be some guidance on the amount of (residual) starlight going into the instrument? For example, it said that the contrast overall would be 1.5 times 10^{-11}, is that overall in the .5 to .8 micron region?

This holds over an estimated bandwidth of 100nm.

36. **Q (p89-90)**: How good (well corrected) each of the individual optics in the beam train has to be? Lambda over a couple hundred?

There is an error budget that has been developed for the system that was presented in the PIP. The table below describes the wavefront error allocation that has been used to define stability requirements – both thermal and jitter – between dither observations.

	Primary	Secondary	Fold	OAP	Deformable
zernike mode	rms amplitude(Å)	rms amplitude(Å)	rms amplitude(Å)	rms amplitude(Å)	rms amplitude(Å)
z2	0	0	0	0	0
z3	0	0	0	0	0
z4	4	1	0.5	0.5	0.5
z5	4	1	0.5	0.5	0.5
z6	4	1	0.5	0.5	0.5
z7	2	0.5	0.25	0.25	0.25
z8	4	1	0.5	0.5	0.5
z9	3	0.75	0.375	0.375	0.375
z10	4	1	0.5	0.5	0.5
z11	0.05	0.0125	0.00625	0.00625	0.00625
z12	0.05	0.0125	0.00625	0.00625	0.00625
z13	0.05	0.0125	0.00625	0.00625	0.00625
z14	0.05	0.0125	0.00625	0.00625	0.00625
z15	0.05	0.0125	0.00625	0.00625	0.00625

Initial static error allocation studies indicate that the small optics (after the secondary) will require <1 nm r.m.s. surfaces if we observe over a 100 nm bandpass.

37. **Q (p90)**: What is the steady polarization of each of the two paths, and how steady it is? How steady are they?

A: The effect of varying polarization has not yet been addressed. Currently the High Contrast Imaging Testbed laser source has varying polarization with time, and has experienced no contrast degradation from this effect down to a contrast level of 10e-9. We are preparing to analyze the effect of polarization changes because they may affect the ability to reach lower levels of contrast – down to 10e-10.

38. **Q (p90-91)**: What is the polarizer's extinction?

Present calculation using a sample design indicates a level below 1E-4 through the 500-800 nm range. Coating design and actual performance are still under consideration.

39. **Q (p91)**: Is there circular polarization at this position?

The residual level of circular polarization is a matter of detailed design and modeling. No requirement specific to circular polarization has been established.

40. **Q (p92)**: Are the two (polarization) beams combined at the end?

A: No, the two beams are used to feed two collection systems – placeholders selected were two detection camera detectors and two characterization instrument detectors

Comment (p92): Please be prepare that there will be (could be) requirements for the instruments to provide information back to the Observatory. For example, it is almost certain that the starlight suppression system will use the data from the planet detection camera for its wave front correction. Other examples might be the use of the general astrophysics instrument for initial alignment of the system.

SCIENCE

41. **Q (p98)**: Could you clarify the "relevance to NASA objectives" requirement?

A: All proposals submitted should describe the investigation's relevance to NASA objectives (see question 42). This is an important evaluation criterion.

42. **Q (p101-102)**: How well/detailed does the science need to be featured in the proposal?

A: The science investigation must be of sufficient depth that a peer review panel can evaluate its intrinsic merit and its relevance to NASA objectives.

43. PROGRAMMATIC

44. **Q (p98)**: Where can we find the documents describing NASA strategic goals?

A: NASA and Science Mission Directorate Universe Division strategic goals may be found at:
http://www.nasa.gov/pdf/55583main_vision_space_exploration2.pdf

and
http://origins.jpl.nasa.gov/library/roadmap03
and
http://universe.nasa.gov/be/preface.html

45. **Q (p99)**: Can you clarify how will be proposals evaluated on cost realism?
    A: Proposal costs should match the proposed work effort.

46. **Q (p103)**: Is there a key schedule is against which one is proposing? In other words, is there a schedule that shows on what date will the funding start?
    A: NASA intends to initiate funding in August 2005

47. **Q (p104)**: On the study schedule, it asks for an interim report in November. Are there guidelines for how far the study should be at that point? What will be done with the information at that point that -- that that won't need to be done until February or so?
    A: Successful proposers will work with the STDT throughout the funded period to refine instrument concepts for TPF-C. The November interim report is a mid-course brief-out opportunity. Successful proposers will be made ex-officio members of the STDT.

48. How will selected PIs work with the Project?
    Selected PIs become members of our Science and Technology Definition Team and will attend quarterly 2-day meetings and participate in weekly 1 hour telecoms. They will be informed as the design progresses and as technology achievements occur. They can engage freely in discussions and make suggestions on architecture development.

49. Q: Should successful proposers expect to work through the STDT or directly with the project?
    The successful PIs will become part of the STDT and the STDT works directly with the project.

50. **Q (p105)**: Are individual technology demonstrations out of the scope of this NRA?
    A: The funding for this study is not intended to support technology demonstrations. If related technology demonstration is occurring through other funding sources, it may be used to support the technical maturity description of the proposed concepts.

51. **Q (p110)**: Are the results of the concept studies made public?
    A: The concept study reports become government property and can be made public. There is a planned conference in February 2006 for potential proposers to the flight instrument AO at which summary information from these final reports may be used.

52. **Q (p110)**: How would you characterize the weighting between existing technology and technology that needs to be developed or somewhat developed?

A: Proposals must justify their proposed hardware regardless of its development status. Proposals that require technology maturation of hardware must justify the new hardware and include a plan for its development consistent with the TPF-C schedule. It is NASA's intent that technology must be at TRL 5 to enter phase B and TRL 6 to enter phase C (implementation).

53. **Q (p111)**: Is there a schedule for technology readiness?
A: Plans for technology readiness must show that any proposed developments are at Technology readiness level 6 by instrument NAR.

54. **52.Q (p111)**: What is NAR and when does it happen?
A: NAR stands for nonadvocate review. It is one of the gates a project must pass through on the road to confirmation-to-proceed with hardware development. For TPF-C this mission milestone occurs in approximately mid FY11 (pending availability of funding and technology maturation).

55. **Q (p112)**: Is there any consideration given for a public outreach claim in these proposals?
A: Proposals do not need to have a public outreach aspect. No extra credit will be given for including such a component to the concept study.

56. **Q (p112-113)**: What is the official targeted launch date?
A: TPF-C is scheduled for launch in 2015.

57. **Q (p114)**: Is it the same thing to transfer technology to the government and, therefore, make it public? Are those two different things or are they one and the same?
A: There are no requirements for the proposal or the final concept study report for transfer of technology to the government. Only the instrument concept is transferred to the government.

58. **Q (p115)**: What about the model deliverables? These deliveries are outside the study report. Is that a true statement, or are they part of the study report?
A: The models would not be a part of the study report. We would like to receive them so we can use features in developing the design concept, but their delivery is optional.

59. **Q (p115)**: It's only the study report that will become public, not these outside deliveries?
A: The models would be retained by the team and used only by the TPF-C team as appropriate. They will not be made public.

60. **Q (p116)**: If we have independent partners in our study, are we required -- and they pay for their own work, are we required to report the details of their work? They may have proprietary information that they don't want to have made public.

A: Proprietary information should not be included in the concept study report. Details of non-NASA funded work included in the concept study report are required only to the extent they contribute to the comprehensibility and clarity of the report.

61. **Q (p118)**: There's also supposed to be a general management plan of what you're going to provide and how you're going to provide it. So how much of this is considered motherhood in the sense that it's been stated and we don't need to reiterate it?
    A: You will need to describe your plan for conducting the proposed study. Nothing that is not included in the proposal can be assumed.

62. **Q (p120)**: Will there be a web site where today's presentations and Q&A will be posted and when?
    A: Yes. See http://planetquest.jpl.nasa.gov/TPF/tpc_nra_pip.cfm or visit the NSPIRES website pages for the ROSES 2005 solicitation and its section for this opportunity.

63. **Q (p123)**: Foreign PI and CoI participation?
    A: Foreign PI's are ineligible for NASA funding. Foreign PI proposals will be considered nonresponsive. Foreign CoI's are permissible, but are not eligible for NASA funding.

64. **Q (p128)**: Because of the Guidebook for Proposers issue, is there any possibility for having the due date for proposals extended?
    A: No

65. **Q (p129)**: Because of the additional information requested, is there any possibility of increasing the page limit?
    A: No

66. **Q (p132)**: What is the extent to which modifying the SSS is seen as responsive to the NRA?
    A: Proposers are free to include augmentations/variations to the SSS or to propose their own independent SSS.

67. Can wavefront processing be proposed or is it being done onboard?
    Wavefront processing can be proposed. Also, the starlight suppression system is developing wavefront sensing and control, with wavefront processing being done onboard.

68. **Q (p133-134)**: Comments from participants (Bob Brown?) about including GenAstro in Level 1 to basically protect it. Q: Will the GenAstro instrument going to be protected under Level 1 requirements?

A: It is premature at this time to define level 1 requirements for the mission. It is currently the intent of NASA to include general a general astrophysics instrument and associated time allocation on TPF-C.

Comments (p134-137): Extensive discussion about the treatment of GenAstro and including it in Level 1 requirements.

69. **Q (p138)**: Is there any kind of allocation to the number of the six awards that might be going to the different instruments?
    A: No

70. **Q (p139)**: What kind of people would be reviewing the proposals and will those people be identified before the proposal deadline to avoid having them on red teams?
    A: Review panels may be composed of conflict-free scientific and engineering community members.

71. **Q (p141)**: Is six awards mentioned in the NRA a solid number and do you have hard funding?
    A: There is a limit to the total funds available for this opportunity. There is no preset level of funding per proposal.

72. **Q (p141)**:Is it expected that there will be further definition of the telescope that study has to fit to during the next six weeks?
    A: No. Instrument concept studies will be evaluated against the telescope outlined in the PIP.

73. Can proposals impose some changes on some things in the PIP?
    Proposals need to address the mission described in the PIP. We are anticipating that the studies will change and influence the architecture of the mission. In order to be accepted, suggested changes will need to bring advantages to the mission. Any performance advantage will have to be presented with the justification analysis, the assumptions, and any foreseen impact on the system.

74. Will there be further refinement of the telescope models during the time we are writing our proposals?
    Yes. The architecture will continue to develop without slowing down. The proposals are expected to address the design presented in the PIP.

75. **Q (p76)**: (Regarding various trade studies currently under study): Should we (the proposers) be prepared to accommodate these in our studies?
    A: What we are hoping to learn from the studies is how the instruments might influence the design of the mission. We will be studying many engineering trades, and are hoping to capture resources for accommodation of the instruments as the studies progress. It would be helpful to us if you would provide insight on how your instrument would be affected by some of our choices. We would not expect you to alter your

instrument concept to address a moving target – unless it is a simple matter for you to change some values in your analysis. For all your analyses, we expect to receive your assumptions. In the proposal, please address the design presented in the PIP.

76. **Q (p142)**: At this point would it be best to put only the science team (PI, CoIs) on the proposal and not worry about engineers and managers?
    A: Proposals should only include those people who will substantively contribute to the science investigation and instrument plan.

77. **Q (p143)**: Regarding technology readiness, because of the six months time scale the most you can get is a plan to mature the technology. Is that enough?
    A: This NRA only calls for a plan for technology maturation.

78. **Q (p144)**: Will there be an identification of future TPF-C related opportunities for bidding over the next several years?
    A: Yes. There will be a future competition for the flight instruments and science working group.

79. **Q (p145)**: Is there a schedule for the competition for TPF-C?
    A: Yes. The current intent is to release an Announcement of Opportunity for Flight Instruments in May 2006 with a selection in November 2006.

80. Will there be future opportunities to propose for TPF involvement?
    Yes: AO for flight instruments, test beds, flight hardware

81. Is an E/PO plan required in the proposal?
    No E/PO plan is required for this concept study.