Charter of the TESS Follow-up Observing Program Working Group

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Goal

The primary goal of the TESS Follow-up Observing Program (TFOP) Working Group (WG) is to provide follow-up observations that will facilitate achievement of the Level One Science Requirement to measure masses for 50 transiting planets smaller than 4 Earth radii.

A secondary goal of the TFOP WG is to foster communication and coordination both within the TESS Science Team and with the community at large in order to minimize wasteful duplication of observations and analysis. We operate under the guiding principle that efficient use of limited resources and increased opportunity for collaboration should improve the quality *and* quantity of scientific output. Although the primary focus of the TFOP WG is to achieve the Level One Science Requirements, any science coming out of TESS can also be served.

Scientific Context

The TESS Science Office (TSO) is responsible for producing lists of TESS Objects of Interest (TOIs), based on the light curves, data validation reports, and vetting forms delivered by the Science Processing Operations Center (SPOC) and on other available information such as the TESS Input Catalog.

After lists of TOIs have been produced by the TSO, the next steps are to identify those TOIs that are astrophysical false positives and to validate surviving TOIs as transiting planets at a high level of confidence so that they can be considered as candidates for additional follow-up observations, such as precise radial velocity work aimed at deriving orbits and planetary masses in order to meet the TESS Level One Science Requirement.

In many cases follow-up observations will also be needed to improve the knowledge of the mass and radius of the host stars, if the uncertainties in those parameters limit the accuracy of the mass and radius of the orbiting planet(s). Follow-up observations may also be needed to improve the knowledge of the contamination of the TESS photometry by nearby objects in the photometric aperture, so that the uncertainty in the contamination does not limit the accuracy of the planetary radius. Although this work will often support follow-up spectroscopy of exoplanetary atmospheres, that effort is the responsibility of the Atmospheric Characterization WG.

TFOP WG Functionalities and Sub Groups

Much of the work of the TFOP WG falls into five general areas of functionality, each of which will have its own Sub Group;

1. Seeing-limited Photometry to identify false positives due to variable stars such as eclipsing binaries that contaminate the TESS image of a candidate transiting planet. The usual procedure will be to schedule observations in and out of predicted transit events to see if nearby objects show eclipses that are responsible for the transit-like events in the target light curves due to contamination. In some cases seeing-limited photometry may contribute to the validation of a candidate by providing a better inventory and better photometry of the objects in the nearby scene to a candidate than is provided by the TESS Input Catalog. For some planet candidates that show deeper transits, ground-based seeing-limited photometry may be able to confirm and/or improve the photometric ephemerides provided by TESS, or even provide improved transit event light curves or transit time variation measurements.
2. Recon Spectroscopy to identify astrophysical false positives and to contribute to improved stellar parameters for the host star in those cases where the uncertainty in the planetary mass and radius is limited by the uncertainties in the mass and radius of the host star. Recon spectroscopy can identify eclipsing binaries that masquerade as transiting planets by revealing large velocity variations due to an orbiting stellar companion consistent with the photometric ephemeris from TESS. Blends of a target star with a nearby (usually fainter) eclipsing binary that is not spatially resolved can show composite spectra where the orbit of the contaminating eclipsing binary is consistent with the photometric ephemeris from TESS. These are but two examples of the false positives revealed by Recon Spectroscopy. Spectroscopic determinations of effective temperature, surface gravity, and metallicity can often contribute to improved estimates of the mass and radius of the host star, when analyzed with the help of stellar models or empirical relations.
3. High-resolution Imaging with adaptive optics, speckle imaging, and/or lucky imaging to detect nearby objects that are not resolved in the TESS Input Catalog or by Seeing-limited Photometry. This can be important for improving the validation of planets before they are sent on for Precise Radial Velocity observations, or when there is significant light from a very close companion that is contaminating the planetary radius determination.
4. Precise Radial Velocity Work with the goal of deriving orbits for the planet(s) orbiting the host star for the determination of planetary mass(es) relative to the host star. Recon spectroscopy can play a significant role in the selection of the best transiting planet candidates for mass determinations by providing measurements of the line broadening and of activity indicators such as emission in the Ca II and Halpha lines.
5. Space-based Photometry with facilities such as HST, Spitzer, MOST, CHEOPS, and JWST, primarily to confirm and/or improve the photometric ephemerides provided by TESS, but also to provide improved light curves for transit events or even transit time variations in some cases.

Organization

The Steering Committee for the TFOP WG shall consist of the chairs for the above five Sub Groups plus the TESS Director of Science and Deputy Director of Science, and a representative for ExoFOP-TESS at NExScI. Initially the subgroup chairs shall be Karen A. Collins for Seeing-limited Imaging, Samuel N. Quinn for Recon Spectroscopy, David Ciardi for High-resolution Imaging, David W. Latham for Precise Radial Velocity Work, and Diana Dragomir for Space-based Photometry. The current Director and Deputy Director of Science are David W. Latham and Sara Seager. Jessie Christiansen is the current representative for ExoFOP-TESS at NExScI.

The Sub Group chairs are responsible for organizing the activities of their Sub Groups and recruiting the initial members. People who wish to become a member of the TFOP WG should approach the chair of the Sub Group in which he or she is most interested. Sub Groups can choose to operate under this general charter, or they may choose to develop their own charter that governs the organization of their Sub Group. Individuals may be members of more than one Sub Group.

Conduct and Working Group Policies

Joining the TFOP WG is considered a statement of intention to abide by the conduct and policies set forth herein, and to contribute to the tasks outlined above.

Collaboration and coordination – both within the TESS Science Team and with the greater community – will be paramount to the success of the TFOP and the TESS mission. TFOP WG members will therefore make good faith efforts to coordinate the planning of observations and to share TOI-related data and results by uploading to ExoFOP-TESS in a timely manner. Members further agree to protect all intellectual property shared at meetings (in person, or via phone/video) or on the web and through email.

In some cases the data and results obtained by TFOP WG members may have restrictions that prevent uploading to a website available to the open public. One example might be products from collaborations or institutions where there are prior agreements that constrain open public release until certain conditions (such as publication) are met. Another example might be preliminary results from Precise Radial Velocity Work, where data need to be accumulated until a definitive orbit can be derived. Negotiations are underway with NExScI for the option for TFOP WG members to password-protect data and derived products for some proprietary period. These data and products would then only be viewable by other authorized members of the TFOP WG until the expiration of the proprietary period. Use of this option should be governed by guidelines in the charters for Sub Groups.

To facilitate collaboration and scientific output, TFOP WG members should propose to lead projects that make use of TFOP data. These proposed projects will be listed securely on the membership pages of the TESS wiki, and should be interpreted as signaled intent to lead a project (rather than proprietary ownership of it). These proposals will enable the solicitation of additional data and will foster connections with other group members who

have the interest and expertise to contribute. They will also reduce the number of duplicative efforts (and the rush to publish, which often lowers quality), and they will provide the originators of data the opportunity to be asked to join collaborations on projects that rely upon their data.

If observations submitted to EXOFOP-TESS are useful in improving the confirmation and characterization of planets, then the person who provided the observations should be granted the right of co-authorship on the first paper that reports and utilizes these observations. TFOP WG members who want to utilize data obtained by others should contact the originator of the data so that the involved parties can decide whether authorship is warranted or instead an acknowledgement is sufficient. In this way, TFOP WG members who provide valuable reconnaissance observations that might not always lead to their own publications can get appropriate recognition for their contributions. For further details, consult the TFOP WG Publication Policy document.

Concerns about collaboration and data usage can be brought to the TFOP WG Steering Committee, who can mediate any disputes if necessary.

Communications and Membership

TFOP WG communications utilize mailing lists for the full Working Group and the Sub Groups as appropriate. All emails to the mailing lists should be treated as confidential and should never be forwarded or copied to non-members. Regular meetings, held electronically via WebEx, will occur to discuss the planning, status, and analysis of observations. Additional suggested topics of discussion or concerns should be directed to the appropriate Sub Group chairs and will be reviewed by the Steering Committee as needed. Individuals with the desire and ability to contribute to the TFOP WG can apply to become a TFOP WG member. Applications should be sent to the chair(s) of the appropriate Sub Group(s) and will be reviewed by the Steering Committee. Applications must contain:

- A statement that the applicant agrees to abide by the TFOP WG charter.
- A summary of the applicant's scientific background, research interest and expertise, and expected/planned contribution to the TFOP WG,
- The facilities available to the applicant for follow-up work, and the Sub Group(s) of interest.

Members of any subgroup may participate in meetings and communications of any other subgroup, but without voting privileges.

An approved member of the TFOP WG may include more junior scientists as part of his/her research group without the junior scientists having to apply to be members. In this scenario, the approved member is responsible for the conduct and behavior of the junior members with whom he/she is associated, and the junior members are bound by the same conduct and behavior rules as the approved member. A junior member may apply to be a member of the TFOPWG on his/her own; such an application is subject to the same approval process as any other application.