The TESS Science Data Archive

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Abstract

The Transiting Exoplanet Survey Satellite (TESS) is an all-sky survey mission designed to discover exoplanets around the nearest and brightest stars. The Mikulski Archive for Space Telescopes (MAST) at the Space Telescope Science Institute will serve as the archive for TESS science data. The services provided by MAST for the TESS mission are to store science data and provide an Archive User Interface for data documentation, search, and retrieval. The TESS mission takes advantage of MAST multi-mission architecture to provide a cost-effective archive that allows integration of TESS data with data from other missions.

1. Introduction

The Transiting Exoplanet Survey Satellite (TESS) is a NASA Astrophysics Explorer mission designed to discover exoplanets around the nearest and brightest stars.[1] TESS was launched on April 18, 2018 on a SpaceX Falcon 9 rocket and began science observations in July 2018. The Mikulski Archive for Space Telescopes (MAST) at the Space Telescope Science Institute serves as the archive for TESS science data.[2]

2. Science Objectives

TESS will search for transiting planets by conducting large area surveys of bright stars and known M dwarfs within ~60 parsecs. Planetary host stars discovered by TESS will require follow-up observations with ground and space-based observatories, such as JWST, in order to further characterize the exoplanets.

The TESS mission will generate valuable science data products for exoplanet and other astronomical studies. Target pixels and associated light curves are sampled every two minutes for approximately 15,000 stars per sector. Full frame images (FFI) contain 24° x 96°areas of the sky sampled every 30 minutes.

3. Observatory Operations Concept

The TESS observatory includes four cameras. Each camera consists of f/1.4 lens with an effective aperture of 10.5 cm and a 24x24 degree field of view. Each camera field of view is imaged onto four CCDs, for a total of 16 CCDs in the focal planes. The individual pixel size is 21 arc-seconds on the sky.

Target stars are selected from the TESS Input Catalog (TIC)[3]. At present, the TIC contains approximately half a billion persistent luminous objects over the entire sky that are potential two-minute targets or are needed to document nearby fainter stars that contaminate the target photometry.

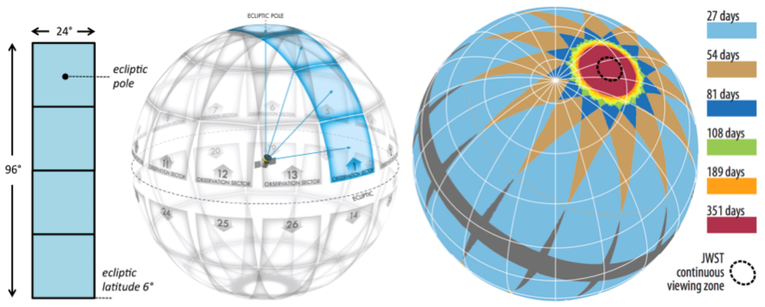

Figure 1 – TESS camera field-of-view and sector mapping[1]. The four TESS cameras cover a field-of-view of 24° x 96°, raised by about 6° from the ecliptic. Thirteen sectors are needed to cover one hemisphere. As declination increases, there is an increasing amount of overlap with the field-of-view. Near the ecliptic poles sources can be observed continuously.

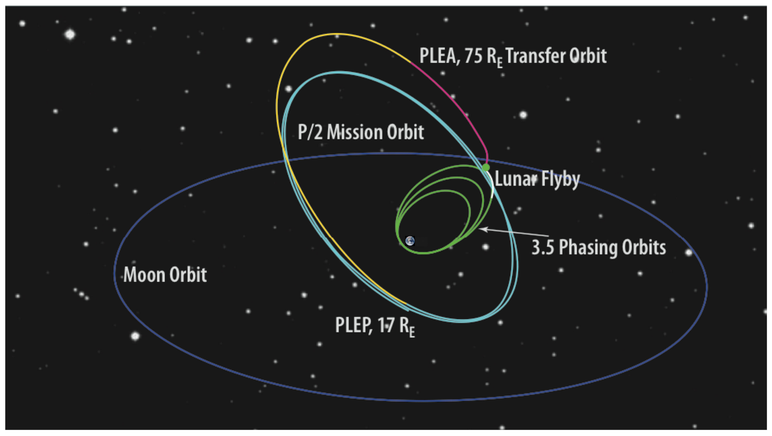

Figure 2 – TESS Earth-centered orbit[1]. The TESS orbit is designed for continuous periods of science observation, yet a perigee sufficiently close to Earth to allow the downlink of an entire orbit's data over Ka-band. The orbit, named P/2, is a 13.7-day Earth-centered orbit in 2:1 resonance with the Moon. The P/2 mission orbit has an apogee of 59 Earth radii and a perigee of 17 Earth radii. There are two TESS orbits per sector.

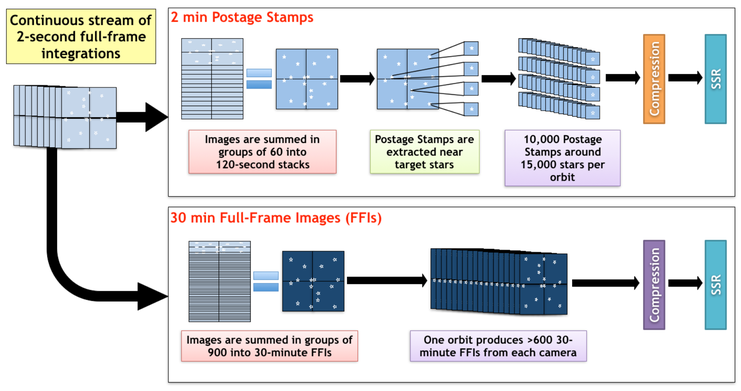

Figure 3 – Instrument science data flow.[4] CCD detector 2-second integrations are summed into 2-minute postage stamps around approximately 15,000 target stars per sector and 30-minute full frame images.

Table 1– Science data products that are significant components of the data volume

Data Type	Data Volume (GB/sector)	Data Volume (GB/year)	Notes
DSN IDRs	300	3900	S/c SFDU data for safe keeping, compressed
Uncalibrated FFI	380	5000	16 files per 30 minute cadence
Calibrated FFI	770	10000	16 files per 30-minute cadence
Target pixel files	760	9800	15000 targets/month, 100 pixels/target, 2 minute cadence
Light curves	30	410	One per target per sector
Collateral pixel files	890	11500	Leading virtual column, trailing virtual column, smear row, and virtual row
Total	**3100**	**40600**	

4. Archive User Interface

Archive users will access TESS data files and catalogs through the MAST web-based Archive User Interface (AUI). The home page for the MAST archive is at http://archive.stsci.edu. The AUI allows users to search, query, preview, and retrieve data. The TESS archive user experience is integrated into the MAST user interface along with data from other missions such as Kepler, HST, and JWST.

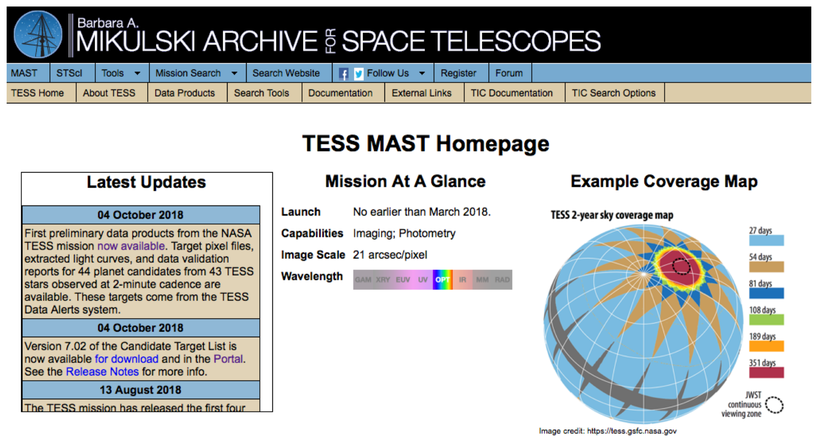

Figure 4 – The MAST AUI provides a TESS mission specific home page at http://archive.stsci.edu/tess/. The TESS specific page provides access to TESS mission data and documentation. The page also provides links to MAST tools that can be applied to TESS data.

References

[1] Ricker, G.R. et al., "Transiting Exoplanet Survey Satellite," Journal of Astronomical Telescopes, Instruments, and Systems 1(1), 014003 (2015).

[2] Swade, Daryl et al., "The TESS Science Data Archive," Proc. SPIE 10704 (2018).

[3] Stassun et al ., "The TESS Input Catalog and Candidate Target List description," AJ, 156: 102 (2018)

[4] Schlieder, J., "TESS Observatory Guide," https://heasarc.gsfc.nasa.gov/docs/tess/docs/TESS_observatory_guide_v1.1.pdf, Version 1.1 (June 30, 2017).