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The TESS science processing operations center

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500 word abstract

The Transiting Exoplanet Survey Satellite (TESS) was selected by NASA's Explorer Program to conduct a search for Earth's closest cousins starting in late 2017. Tess will conduct an all-sky transit survey of F, G and K dwarf stars between 4 and 12 magnitudes and M dwarf stars within 200 light years. TESS is expected to discover ~1,000 small planets less than twice the size of Earth, and to measure the masses of at least 50 of these small worlds. Because these stars are typically 10X closer and 100X brighter than the *Kepler's*, they are much more amenable to follow-up observations and characterization. Indeed, the James Webb Space Telescope should be able to characterize the atmospheres of many of the TESS discoveries.

The TESS science pipeline is being developed by the Science Processing Operations Center (SPOC) at NASA Ames Research Center based on the highly successful *Kepler* pipeline. Like the *Kepler* pipeline, the TESS pipeline will provide calibrated pixels, simple and systematic error-corrected aperture photometry, and centroid locations for all 200,000+ target stars, observed over the 2-year mission, along with associated uncertainties. The science data will be processed on the NAS Pleiades Supercomputer for efficiency. The pixel and light curve products are modeled on the *Kepler* archive products and will be archived to the Mikulski Archive for Space Telescopes (MAST). In addition to the nominal science data, the 30-minute Full Frame Images (FFIs) simultaneously collected by TESS will also be calibrated by the SPOC and archived at MAST.

Each 27.4-day period, TESS will observe a 24° by 96° swath of sky extending from ~6° above ecliptic equator to the ecliptic pole in the anti-Sun direction. TESS rotates by 27.7° after each observing "sector" in order to cover one hemisphere during the first year of observations. The spacecraft then flips over to cover the other hemisphere during the second year. While most of the stars are only observed for 27.4 days, the "pole" camera is centered on the celestial pole, allowing a ~450 square degree area in each hemisphere to be observed continuously for a year.

The TESS pipeline will search through all light curves for evidence of transits that occur when a planet crosses the disk of its host star. The Data Validation pipeline will generate a suite of diagnostic metrics for each transit-like signature discovered, and extract planetary parameters by fitting a limb-darkened transit model to each potential planetary signature. The results of the transit search will be modeled on the *Kepler* transit search products (tabulated numerical results, time series products, and pdf reports) all of which will be archived to MAST.

This paper provides an overview of the TESS science pipeline and describes the development of the SPOC remaining before launch in August 2017. The data rate for TESS is 10X that of *Kepler*, presenting challenges for keeping up with the 27-day cadence of observations for a mission with 26 distinct fields of view. We describe innovations allowing us to scale the *Kepler* design to meet TESS's demanding requirements.

100 word summary

The Transiting Exoplanet Survey Satellite (TESS) will conduct a search for Earth's closest cousins starting in late 2017. TESS will discover ~1,000 small planets and measure the masses of at least 50 of these small worlds. The Science Processing Operations Center (SPOC) is being developed based on the *Kepler* science pipeline and will generate calibrated pixels and light curves on the NAS Pleiades supercomputer. The SPOC will search for periodic transit events and generate validation products for the transit-like features in the light curves. All TESS SPOC data products will be archived to the Mikulski Archive for Space Telescopes.

Speaker biography

Jon Jenkins is a research scientist in the Engineering Division at NASA Ames Research Center. He has worked for over 22 years on developing science pipelines for transit surveys and related technology test beds for projects such as the *Kepler* Mission and the Vulcan Project. He led the design and development of the *Kepler* Mission's science pipeline and is now leading the design and development of the TESS Mission's science pipeline. He received a PhD in electrical engineering from the Georgia Institute of Technology.