

Transiting Exoplanet Survey Satellite



TESS Observations in Year 2

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The Story So Far...Year 1 Observations



https://tess.mit.edu/science/ddt/

5,400

1,000

Exoplanet

DDT

Guest Investigator

1500

1500

34,700

5,700



Pointing Performance in Year 1

• Spacecraft Stability has improved dramatically since the beginning of Year 1





Momentum dump frequency has decreased

- From every 2.5 days to every 3.375 days (~3 per orbit)
- MIT, NGIS, and GSFC are working together to reduce the number further
- They won't go away anytime soon



But Let's Talk About Scattered Light

Low-level, patchy, diffuse light seen in all cameras



Very high light levels, seen primarily in Camera 1



TESS Science Conference I, 29 July 2019



Patchy Scattered Light Visible When Earth is "Up"





Patches Follow the Earth/Moon





- Scattered light from Earth/Moon starts becoming a problem when the angle to the boresight of a camera is <35°
 - A major problem <25°
 - Affects a few sectors in Year 1





During certain sectors in Year 2, at the nominal pointing, the Earth will be close enough to cameras 1 and 2 to render large fractions of sectors not useful for transit detection





Why is Scattered Light Such a Problem Now?

Scattered Light Has Seasons



- Impact of scattered light is highest when the Earth is near antisolar near orbit apogee
- TESS primary mission: May-September



• Because orbit apogee is in the southern ecliptic hemisphere, the Earth is more likely to be in the FOV when pointing north







Sectors 14-16 Could All Benefit From a Shift

S14



1685

1690

1695

TJD

1700

1705

1710



S15

S16









ТJD

Sectors 24-26 Are Also Affected

S24 S25 S26 Earth/Moon angles for Sector 24 (O55 + O56), Ecl. Dec. = +54 Earth/Moon angles for Sector 25 (057 + 058), Ed. Dec. = +54 Earth/Moon angles for Sector 26 (O59 + O60), Ed. Dec. = +54 2020-04-15 23:55:00 to 2020-05-13 08:35:00 UTC 2020-06-08 22:23:00 to 2020-07-04 22:45:00 UTC 2020-05-13 08:35:00 to 2020-06-08 22:23:00 UTC FFI Cadence Number FFI Cadence Number FFI Cadence Number 35000 35200 35400 35600 35800 36000 36200 36400 36600 36800 37000 37200 37400 37600 37800 38000 38200 38400 180 180 180 Σ Σ Camera 1 to Earth Camera 2 to Earth Camera 3 to Earth Camera 4 to Earth Camera 1 to Moon Camera 2 to Moon Camera 3 to Moon Camera 4 to Moon Camera 1 to Earth Camera 2 to Earth Camera 3 to Earth Camera 4 to Earth Camera 1 to Moon Camera 1 to Moon Camera 3 to Moon Camera 4 to Moon Camera 1 Camera 2 Camera 3 Camera 4 Camera 1 Camera 2 Camera 3 Camera 4 to Earth to Earth to Earth to Earth to Moon to Moon Σ 2 0 160 Le 160 ight 140 140 Italia sight 140 <u>a</u> 120 <u>a</u> 120 ĝ 120 ίΩ ß +54° came Ë 100 100 100 ar een een eeu 80 80 80 betw offset betw offset betv 60 60 60 offset 40 40 40 Degrees Degrees 20 20 20 egr Õ 1955 1960 1965 1970 1975 1980 1990 1995 2000 2005 2010 2010 2015 2020 2025 1985 ТJD TJD TJD Earth/Moon angles for Sector 24 (055 + 056), Ecl. Dec. = +85 Earth/Moon angles for Sector 25 (O57 + O58), Ed. Dec. = +85 Earth/Moon angles for Sector 26 (059 + 060), Ecl. Dec. = +85 2020-04-15 23:55:00 to 2020-05-13 08:35:00 UTC 2020-05-13 08:35:00 to 2020-06-08 22:23:00 UTC 2020-06-08 22:23:00 to 2020-07-04 22:45:00 UTC FFI Cadence Number FFI Cadence Number FFI Cadence Number 35200 35400 35600 35800 36000 36200 38000 35000 36400 36600 36800 37000 37200 37400 37600 37800 38200 38400 180 180 180 Camera 1 to Earth Camera 2 to Earth Camera 3 to Earth Camera 4 to Earth Camera 1 to Moon Camera 2 to Moon Camera 3 to Moon Camera 4 to Moon Σ Camera 1 to Earth Camera 2 to Earth Camera 3 to Earth Camera 4 to Earth Camera 1 to Moon Camera 3 to Moon Camera 4 to Moon Camera Camera Camera Camera Camera Camera Camera to Earth to Earth to Earth to Moon to Moon to Moon to Moon Σ Σ 2 160 Le 160 <u>분</u> <u></u>140 뚬 5 140 ight 140 لم 120 å 120 8 120 (T ത +85° 100 100 100 an een een 80 80 80 offset betw offset betw betw 60 60 60 offset 40 40 40 Degrees Degrees Degrees 20 20 20 0 0 1965 1970 1975 1980 2010 2015 2020 2025 1955 1960 1985 1990 1995 2000 2005 2010

2035

12

2030

ТJD

38600

2030

38600

2035

ТJD



Plan: Shift Sectors 14-15 North, Then Review 16, 24-26

- Upsides:
 - Camera 1 and 2 are nearly completely free of interruptions to transit searches
 - Fields on "the other side of the pole", onto which camera 4 would shift, are observed twice
 - No impact to Level 1 requirements
 - No risk to spacecraft health and safety
- Downsides:
 - Certain fields near the ecliptic will not be observed in the prime mission
 - Any data would have been strongly contaminated by Earthand moonlight
 - But: will be available during a second extended mission
 - Small fraction of selected Cycle 2 GI proposals affected





CVZ* is still CV'd, Kepler field still observed in Northern Shift



* Continuous Viewing Zone