An Update on Discoveries by NASA's Transiting Exoplanet Survey Satellite (TESS)

Richard Ignace

Department of Physics & Astronomy

East Tennessee State University

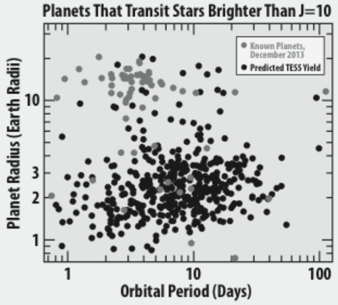
TESS SCIENCE OBJECTIVES

DISCOVER TRANSITING EXOPLANETS ORBITING NEARBY, BRIGHT STARS

The **NASA Kepler Mission** showed that planets are abundant throughout the Galaxy, but most of the Kepler planets orbit stars too distant for further study. The **NASA TESS Mission** will find exoplanets transiting nearby, bright stars: the best targets for followup characterization with large ground telescopes, the Hubble Space Telescope, and the James Webb Space Telescope.

TESS is designed to:
- Monitor 500,000 nearby stars for planets
- Focus on Earth and Super-Earth size planets
- Cover 400X larger sky area than Kepler
- Span stellar spectral types of F5 to M5

Planets That Transit Stars Brighter Than J=10



Transiting exoplanets allow us to observe:
- ***Fundamental properties:*** *mass, radius, orbit*
- ***Dynamics:*** *planet-planet interactions, mutual inclinations, moons, tides*
- ***Atmospheric composition + structure:*** *transmission spectrum, emission spectrum, albedo, phase function, clouds, winds*

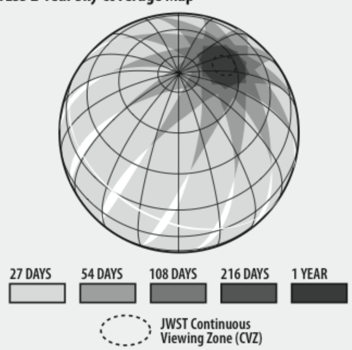
but only for those planets that transit stars that are bright and nearby.

TESS MISSION OVERVIEW

ALL-SKY, TWO YEAR PHOTOMETRIC EXOPLANET DISCOVERY MISSION

TESS will tile the sky with 30 observation sectors:
- At least 27 days staring at each 24° x 96° sector
- Brightest 200,000 stars at 1-minute cadence
- Full frame images with 30-minute cadence
- Map Southern hemisphere in first year
- Map Northern hemisphere in second year
- Sectors overlap at ecliptic poles for sensitivity to smaller and longer period planets in JWST Continuous Viewing Zone (CVZ)

TESS 2-Year Sky Coverage Map



TESS observes from unique High Earth Orbit (HEO):
- Unobstructed view for continuous light curves
- Two 13.7 day orbits per observation sector
- Stable 2:1 resonance with Moon's orbit
- Thermally stable and low-radiation

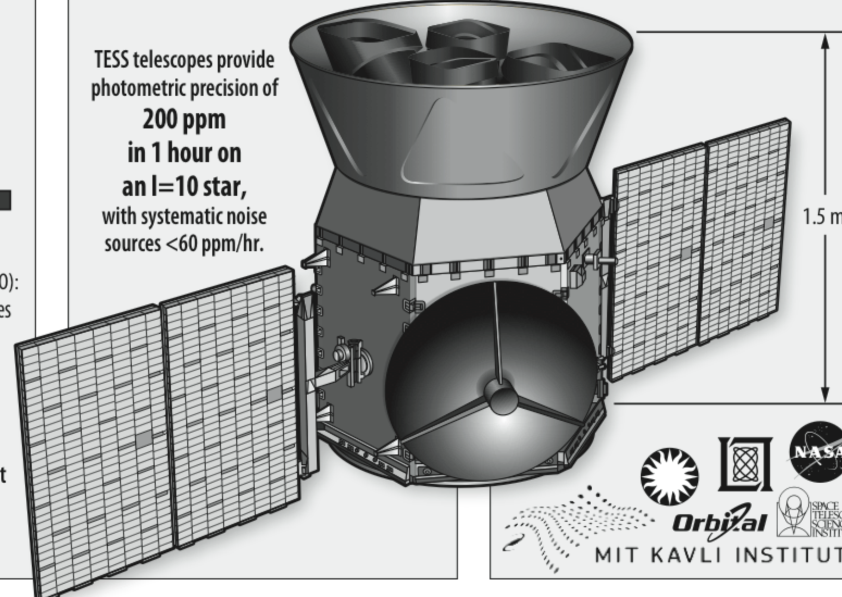
The TESS legacy:
a list of the closest transiting planet systems, which will forever be the best targets for followup studies.

TESS SCIENCE INSTRUMENT

FOUR WIDE FIELD-OF-VIEW CCD CAMERAS

Each of the four cameras has:
- 24° x 24° Field-of-View
- 100 mm effective pupil diameter
- Lens assembly with 7 optical elements
- Athermal design
- 600nm - 1000nm bandpass
- 16.8 Megapixel, low-noise, low-power, MIT Lincoln Lab CCID-80 detector

TESS telescopes provide photometric precision of 200 ppm in 1 hour on an I=10 star, with systematic noise sources <60 ppm/hr.



TESS SPACECRAFT

DESIGNED FOR PHOTOMETRIC STABILITY

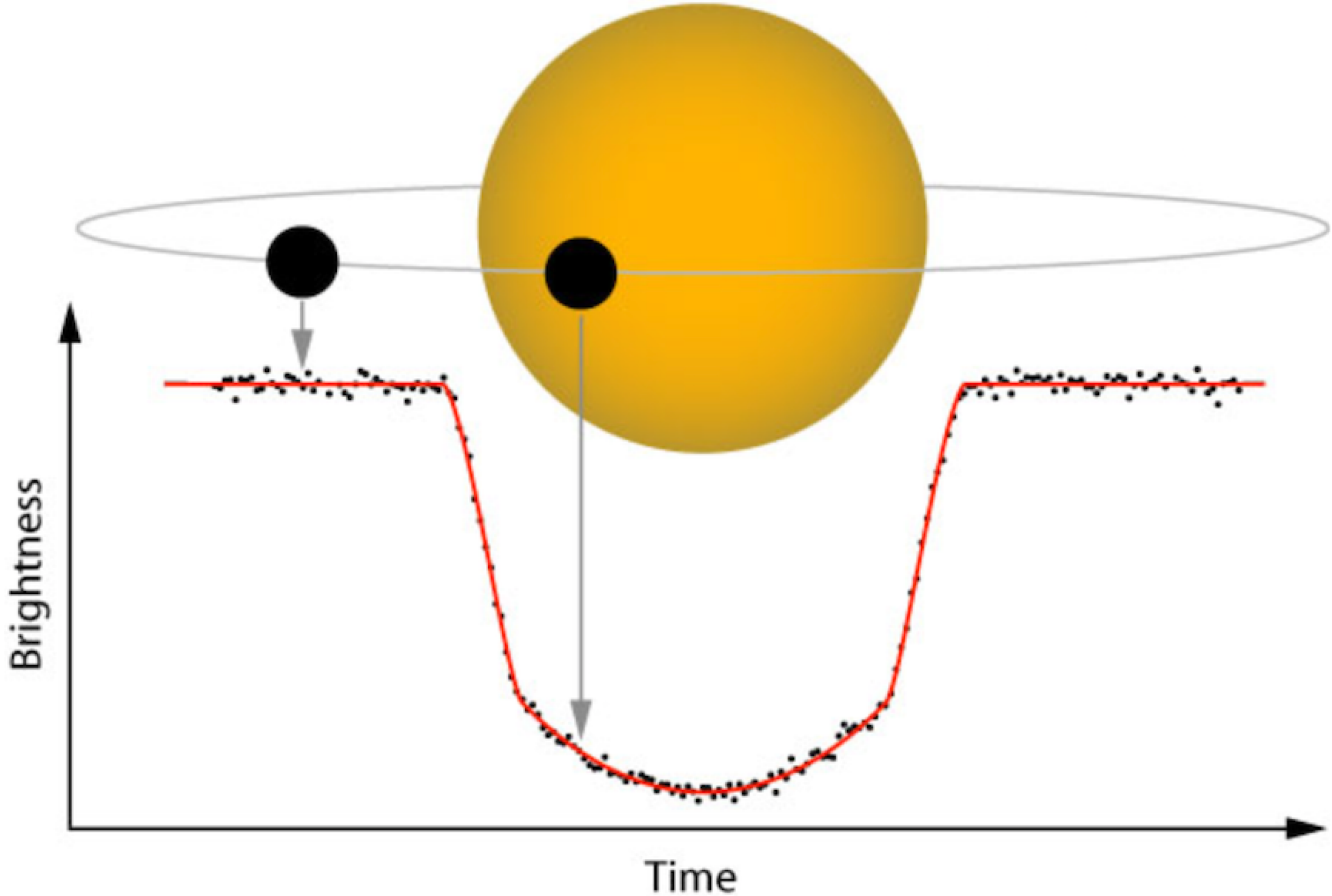
Heritage Orbital LEOStar-2 spacecraft bus:
- 3-axis stabilized pointing, with ≤3 arc-sec performance
- Two-headed star tracker; 4 wheel zero-momentum system
- 400W single-axis articulating solar array
- Passive thermal control
- Mono-propellant propulsion system
- Ka-band 100 Mbps science downlink

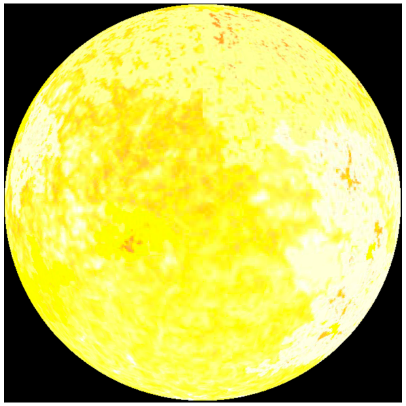
TESS will launch in 2018, in time to find planets for JWST to observe.

Orbital
SPACE TELESCOPE SCIENCE INSTITUTE
MIT KAVLI INSTITUTE

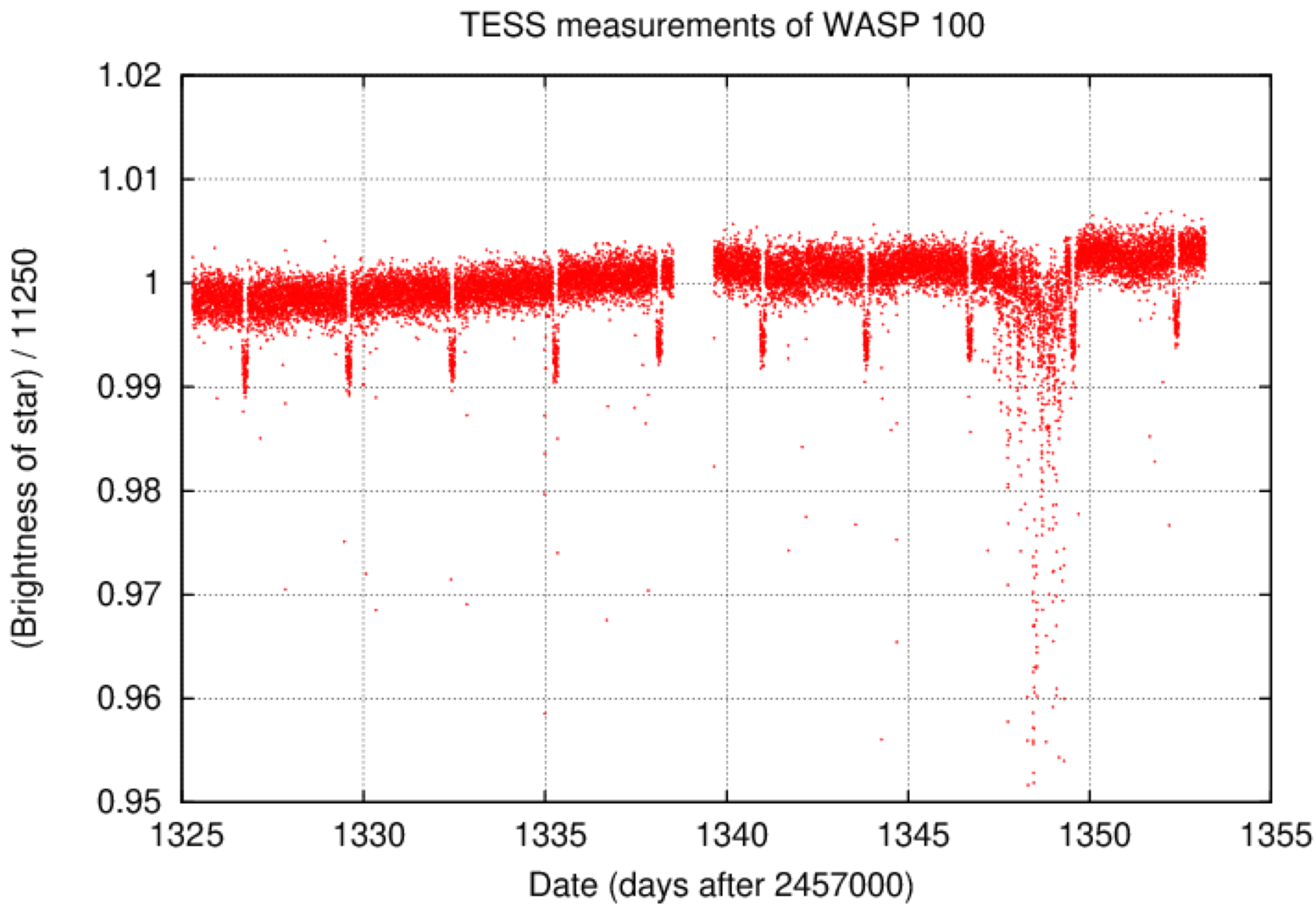
Principal Investigator: Dr. George R. Ricker, MIT

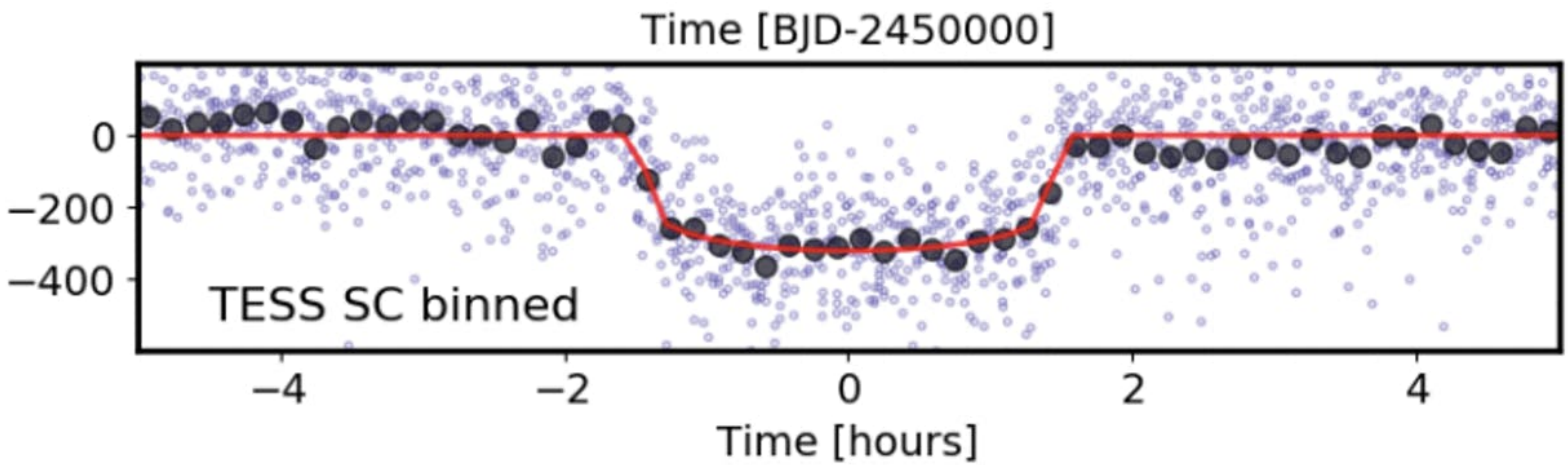
For more information, visit http://tess.gsfc.nasa.gov


Brightness
Time



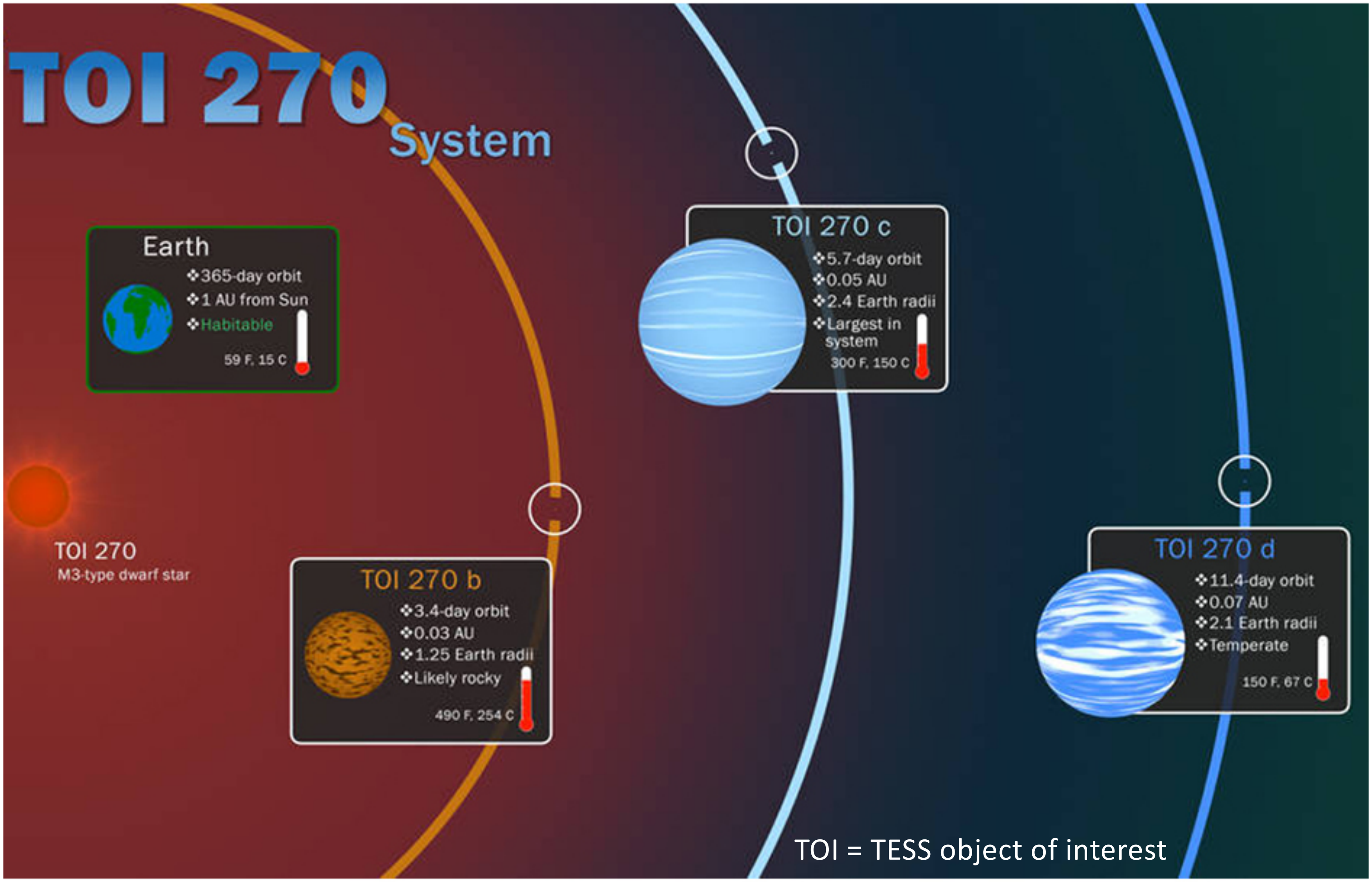
How the star could look





How many transits are ”folded”, or averaged, to produce a superior detection

Easier to find small planets around small stars



Detection gives orbit and planet size; combining with star info gives temperature

Recent Highlights ala Video

- Earth Planet in a Habitable Zone
- Planet Orbiting Two Stars