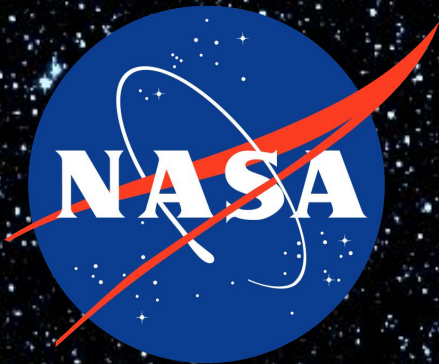




Transiting Exoplanet Survey Satellite

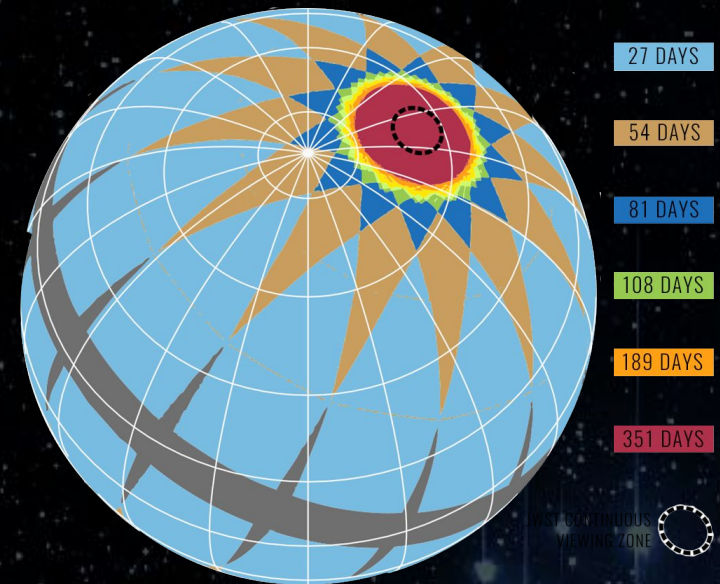
Kyle Hart
University of Hawaii



Introduction

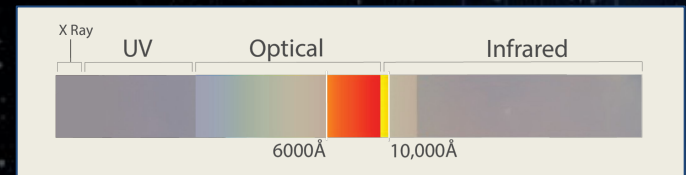
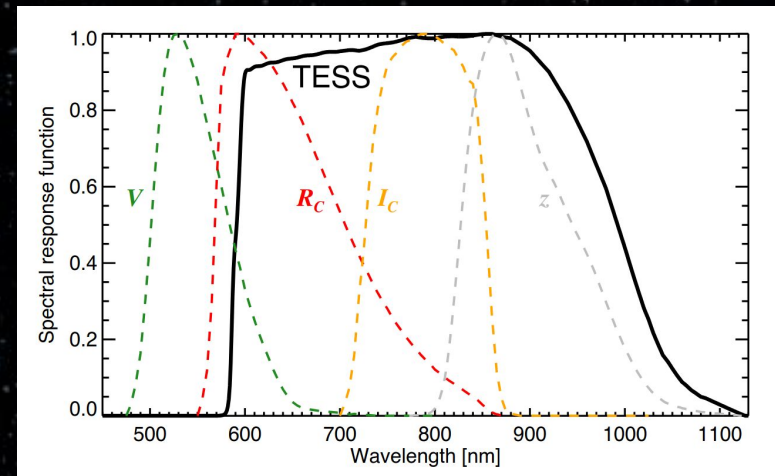


- Created as a follow-up for Kepler. Concentrates on exoplanet detection on near/bright stars.
- Targets should be candidates for **follow up spectroscopy** to measure planetary masses and atmospheric composition.
- High cadence “postage stamps” generated for special targets
- Searching for:
 - Earth-Neptune objects (super earths).
 - Broad range of orbital periods
 P_{\min} = several hours P_{\max} = 10-40 days.
 - Longer period ranges coincide with visibility of JWST (ecliptic poles)



Design

- CCD gives high linearity and dynamic range for bright stars
- Wide bandpass (600-1000 nm)
Centered on $I_C = 806$ nm Red limit of silicon CCD.
- Aperture size determined target exoplanets.
Simulations suggest 50cm^2 of collecting area, leads to diameter of 10cm.
- Time sampling dictated by transits (most in hours).
Partial transit phases for super-earths are in minutes.
 - Choosing 2 minute samples also allow asteroseismology.

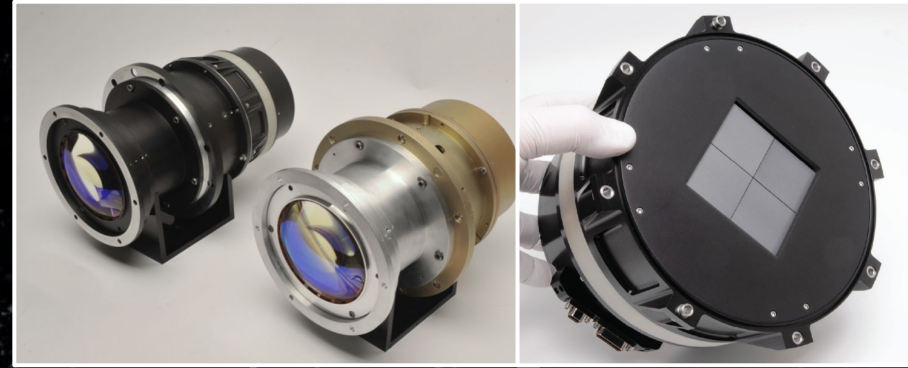




Specifications

- 4x mosaiced lens (with 2mm gap)
 - Focal ratio: $f / 1.4$
 - Diameter: 10.5 cm
 - FoV= 24 degree \times 24 degree
- MIT/Lincoln Lab CCID-80
 - Area: 2048 \times 2048 pixels
 - Pixel scale: 0.35 arcmin
 - Ensquared energy*: 50% one pixel
90% 4 \times 4 pixel
- Streaming 2 second exposure time, summed in buffer in groups of 60.

* Fraction of the total energy of the PSF that is within a square centered on the peak.



Survey	Mag limit	Cadence (hours)
TESS	19.1 - 18.5 - 17.9	0.5 - 0.16 - 0.06
ASAS-SN	18.5	20
ATLAS	19.5	48
ZTF	20.5	72
PanSTARRS	22.0	120
Rubin	24.0	72

Mission



Continuous sector observations for 27.4 days.

Highly elliptical orbit, inclined on the ecliptic plane.

13.7 day period. 2:1 resonance with Moon

Prime Mission: 2018-2020

Sectors 1-26. Cadence 1800 sec. (Cycles 1, 2)

Extended Mission 2020-2022

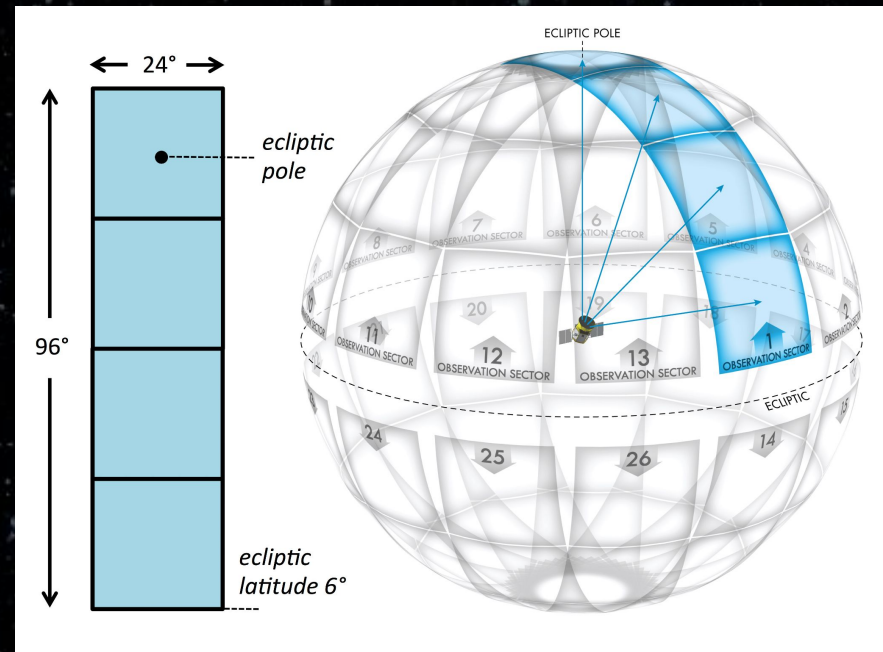
Sectors 27-35 Cadence 600 sec (Cycles 3, 4)

Second Extended Mission 2022-2025

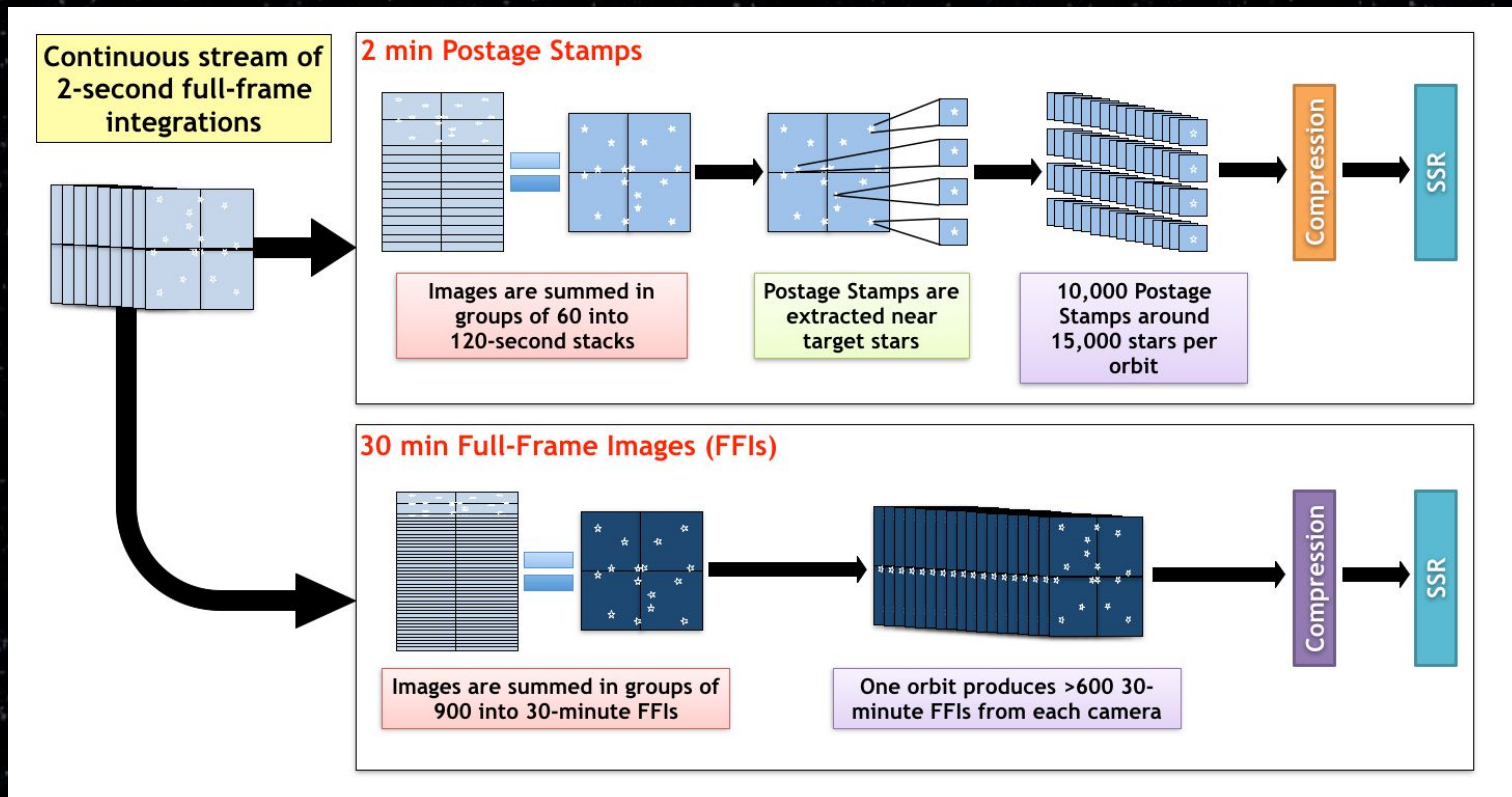
Sectors: 56-83 Cadence 200 sec (Cycles 5, 6, 7)

Currently finishing Cycle 6 (Sector 83)

01 Oct 2024



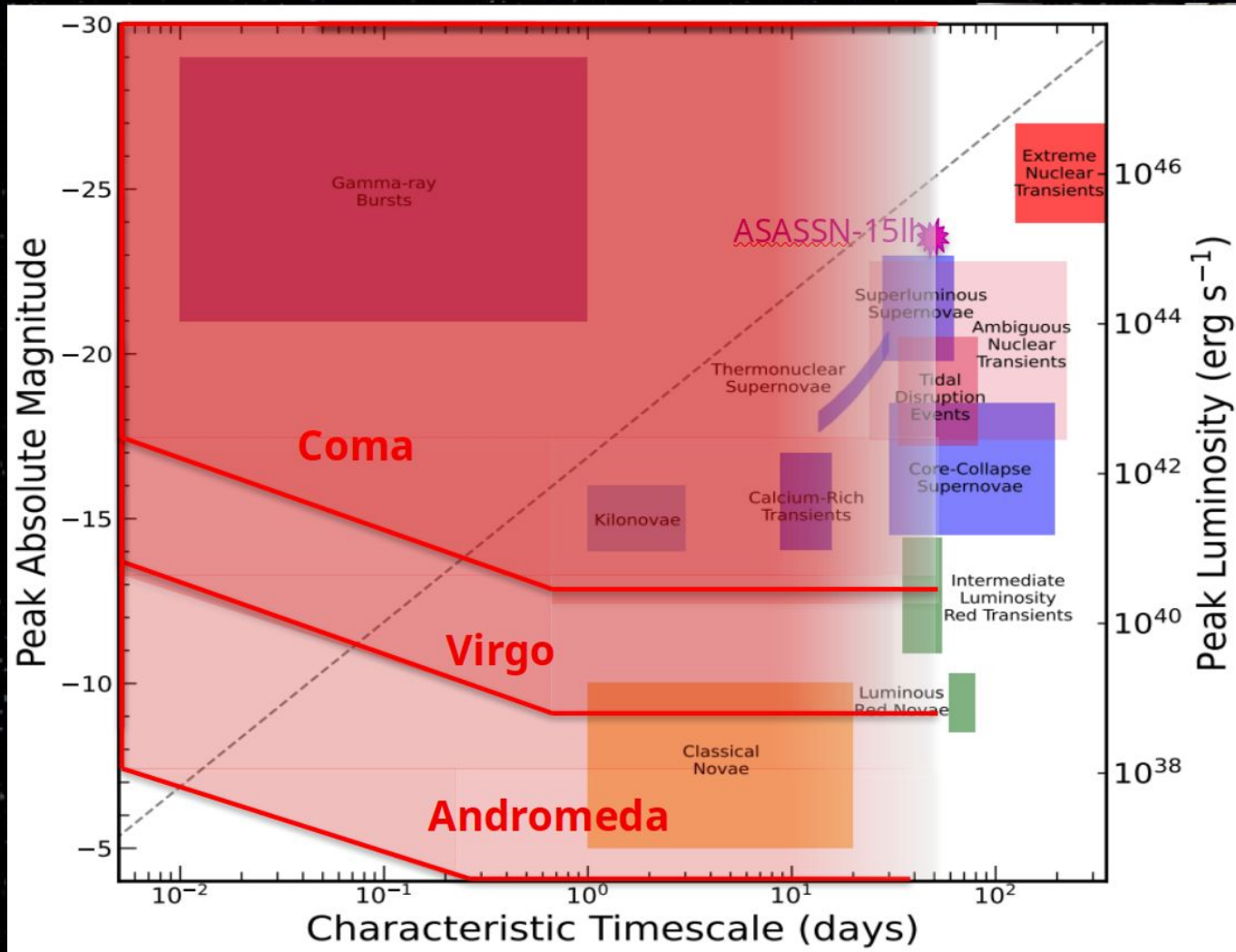
Data Products



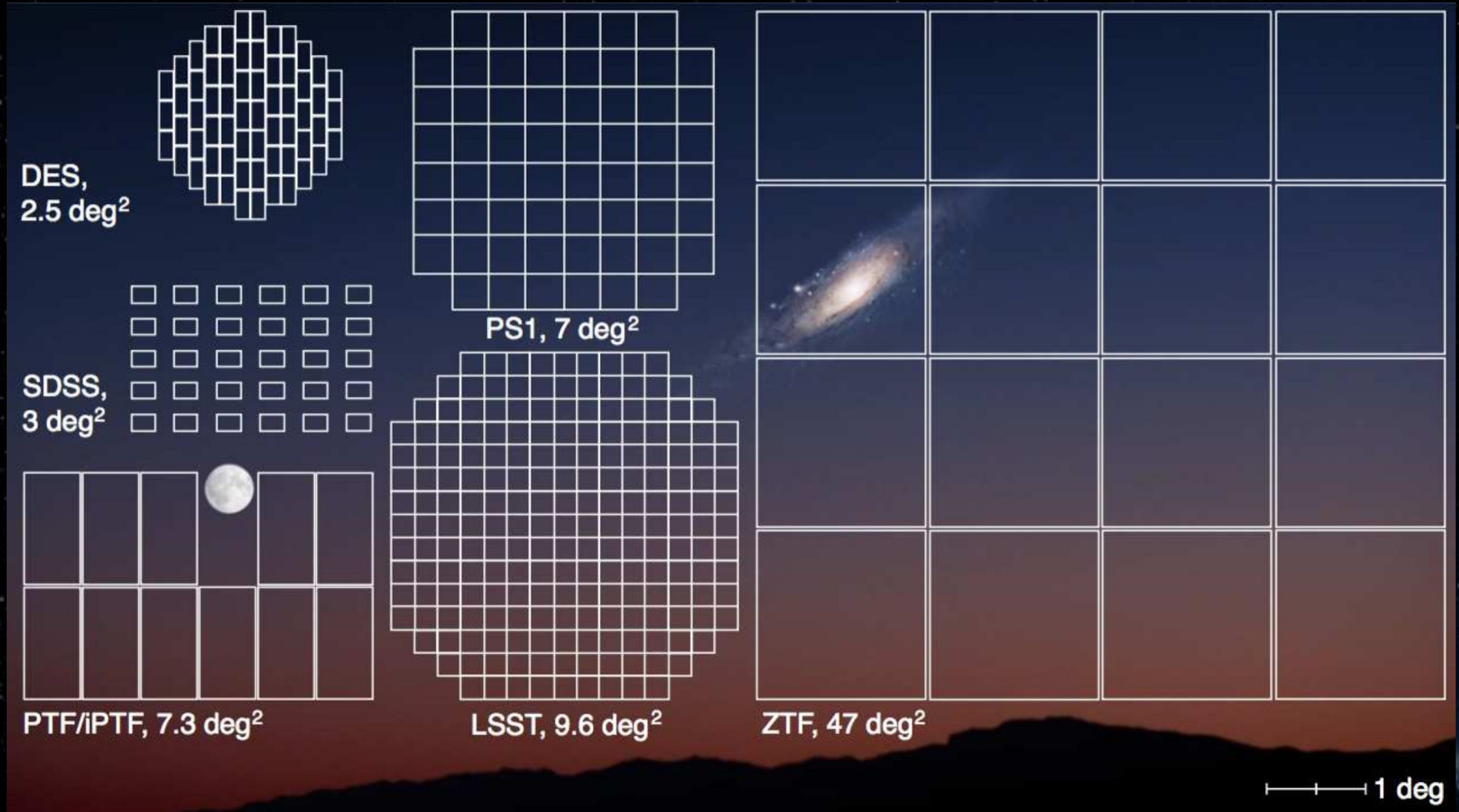
Target Pixel Files (TPFs) and Full-Frame Images* (FFIs) available through MAST

* Calibrated via Science Processing Operations Center (SPOC) - Prime Mission
MIT's TESS Image Calibrator (TICA) - Extended Missions

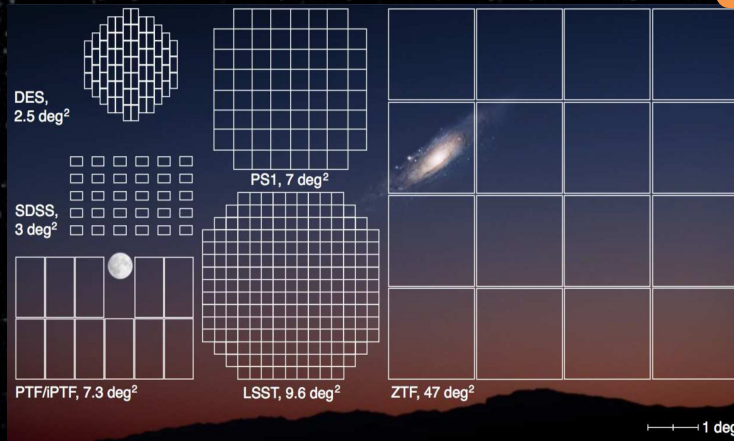
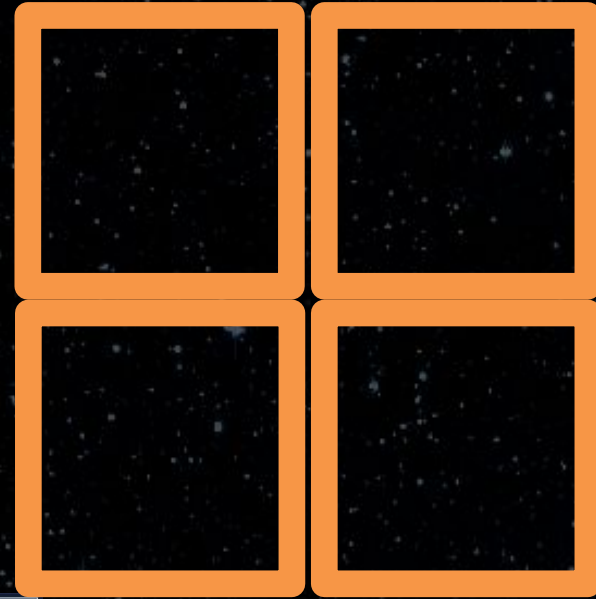
Coverage Depth



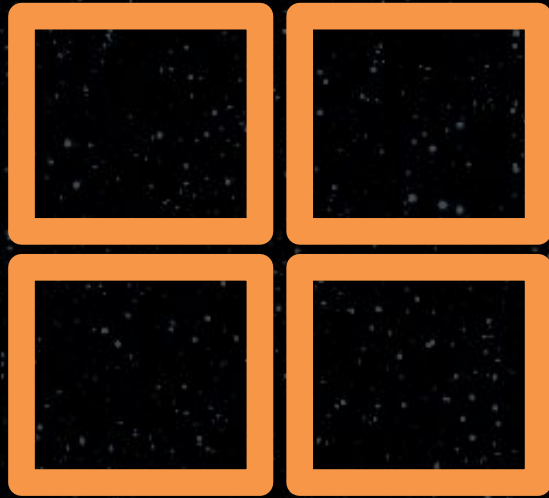
Coverage Area



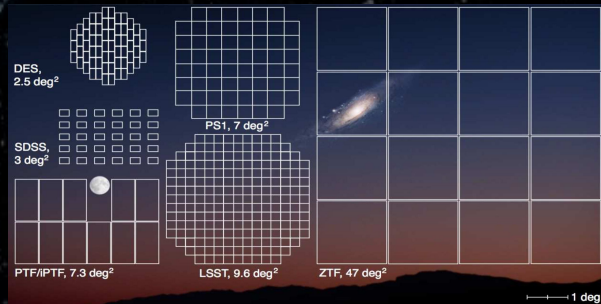
Coverage Area



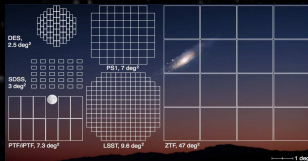
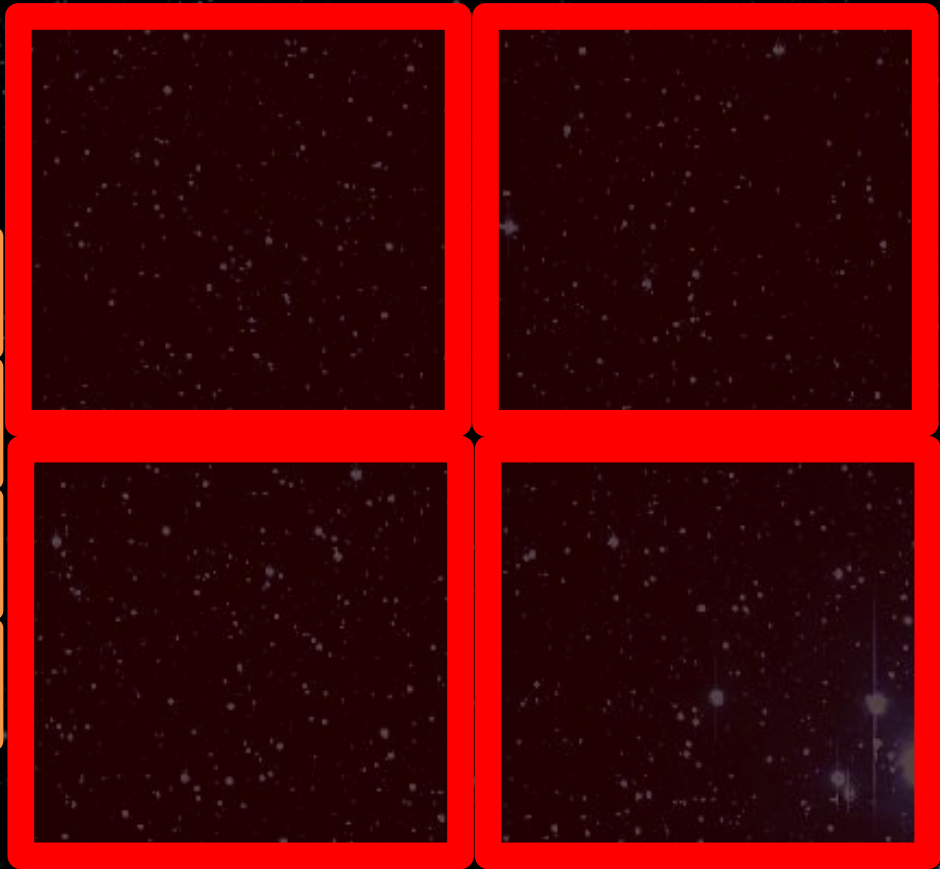
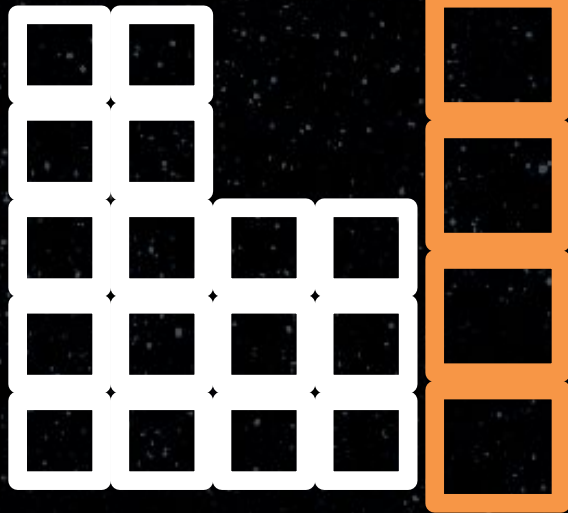
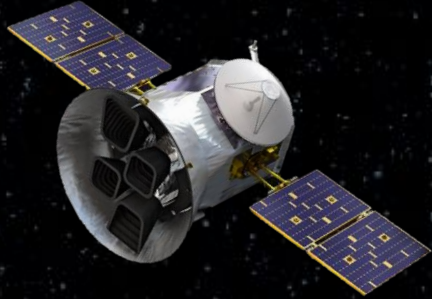
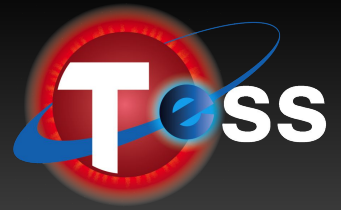
Coverage Area



ASAS SN

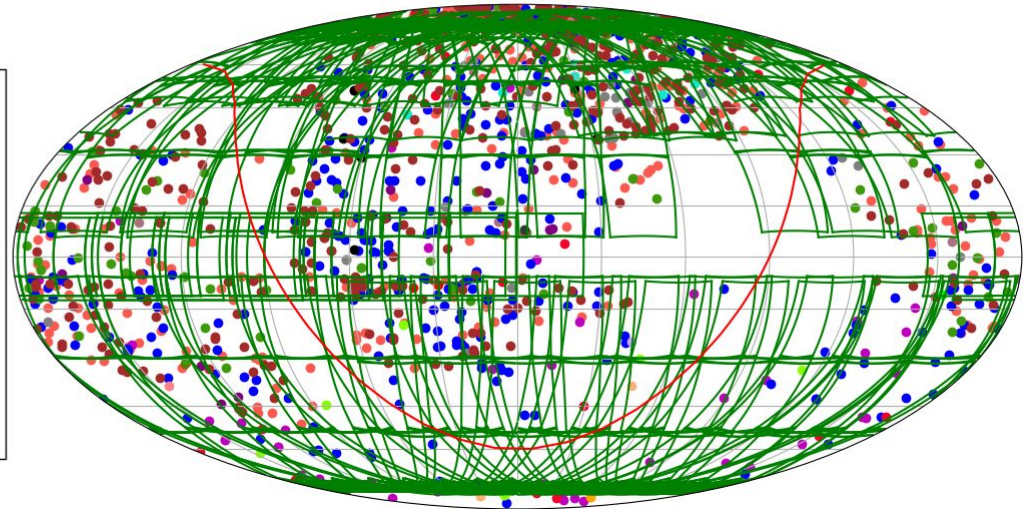


Coverage Area



Supernovae Sectors 1-80
N=1478

- | | |
|--------------|--------------------|
| ● ALeRCE | ● PTSS |
| ● AMPEL | ● Pan-STARRS |
| ● ANTARES | ● Pan-STARRS1 |
| ● ASAS-SN | ● SGLF |
| ● ATLAS | ● SNHunt |
| ● BOSS | ● STSP |
| ● DLT40 | ● TAROT |
| ● Fink | ● Tomo-e_Gozen |
| ● GOTO | ● ULL-ASTRO-MASTER |
| ● GaiaAlerts | ● XOSS |
| ● ISSP | ● YSE |
| ● LOSS | ● ZTF |
| ● MASTER | ● ePESSTO+ |
| ● OGLE | |



Cataclysmic variables & Novae
Young Stellar Objects (YSOs)
Stellar flares
Gravitational Wave counterparts
Supernovae

Gamma-Ray Bursts
AGN/Blazar/Quasars
Tidal Disruption Events
Fast Radio Bursts

GRB Optical Counterpart



07 Mar 2023, the Fermi Gamma-ray Burst Monitor (GBM) triggered

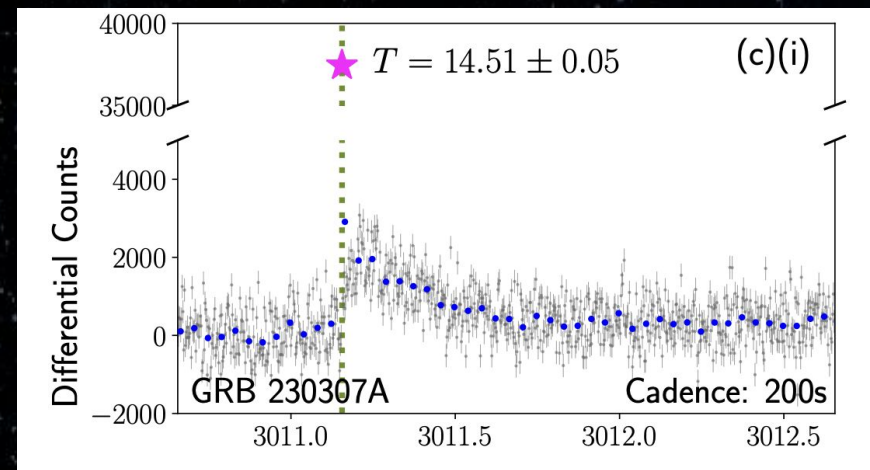
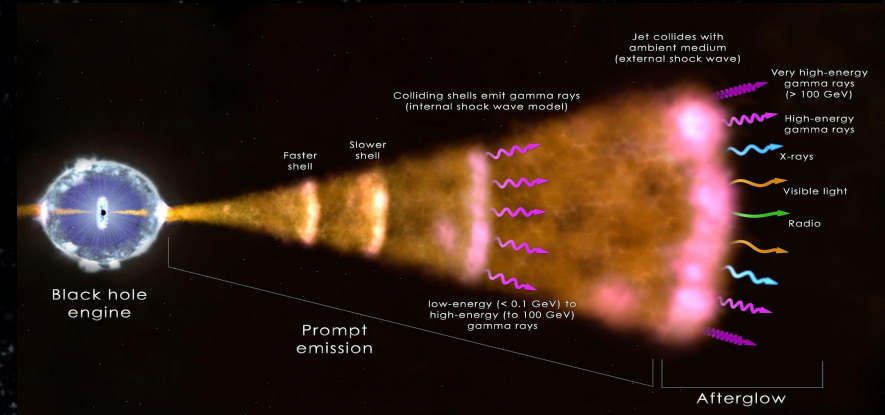
09 Mar 2023, optical afterglow detected by ULTRACAM on Gemini South

10 Mar 2023, Deep Space Network (DSN) begins downlink with TESS

11 Mar 2023, Payload Operations Center (POC) calibrates and delivers to MAST

12 Mar 2023, MAST makes data public

MIT Quick Look Pipeline confirms location, with prompt emission and afterglow



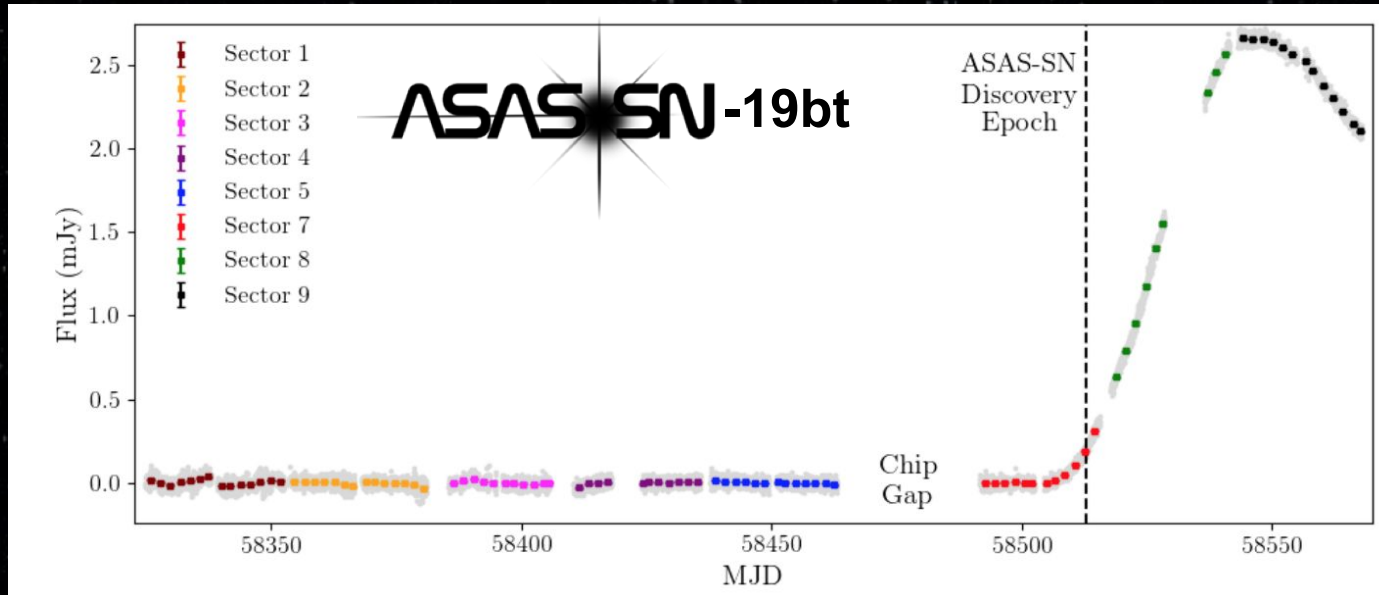
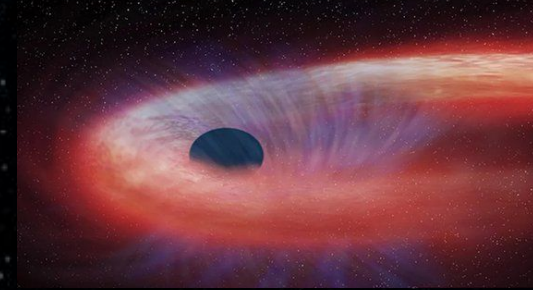
Tidal Disruption Events

29 Jan 2019: transient detected by ASAS-SN

31 Jan 2019: spectroscopic follow-ups by Magellan Clay 6.5m

Target-of-Opportunity (TOO) follow-up observations by
Swift UVOT and XRT

Luckily, event was located in TESS continuous viewing zone (CVZ)



TESS Patrol



Forced Photometry Service

- Based on ASAS-SN SkyPatrol.
- Hosted and operated by U. of Hawaii.
- Account based system (similar to ATLAS).

Spec:

- Field-wise reference subtraction pipeline via ISIS.
- Photometry performed via coordinates or SIMBAD lookup.
- Query via website, API, or Python client.

Open beta available in 1-2 months.

The screenshot shows the TESS Sky Patrol web interface. At the top, there are logos for the University of Hawaii, the TESS mission, and the Institute for Astronomy. Below the logos, there is a section titled 'Using in Publications' with a citation: 'When using please cite: Hart et al. (2024) and Shorrock et al. (2024)'. A paragraph below states: 'Development of the TESS Sky Patrol Infasture was funded through TESS GI Program G05110 and the development of the TESS Image Subtraction Pipeline was developed partially through TESS GI Programs G022244, G04174, and G06140.' The main content area is divided into two panels. The left panel, titled 'Job 869', shows job details: RA Dec: 264.73664614 74.83014502, MJD: [213939,293493, 2093463,1282839], Job Status: Queued, and Queued at: 4/25/2024, 7:21:45PM. The right panel, titled 'New Task Request', has input fields for RA, Dec, and MJD. A 'Data' button is visible at the bottom left of the job details panel.

The screenshot shows a data table and a light curve plot. The table has columns for RA (deg), Dec (deg), RA (hms), Dec (hms), First Observation, Last Observation, Mean, Median, RMS, Min, and Max. Below the table is a table with columns for MJD, CTS per Second, E CTS per Second, Mag, and Mag Error. The light curve plot, titled 'Mag to Julian Date', shows a scatter plot of magnitude versus Julian Date, with a clear upward trend in magnitude over time. The plot has a y-axis labeled 'Mag' ranging from 14.7 to 15.2 and an x-axis labeled 'Julian Date' ranging from 59,855k to 59,885k. A zoomed-in view of the data points is shown in the bottom right corner.



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