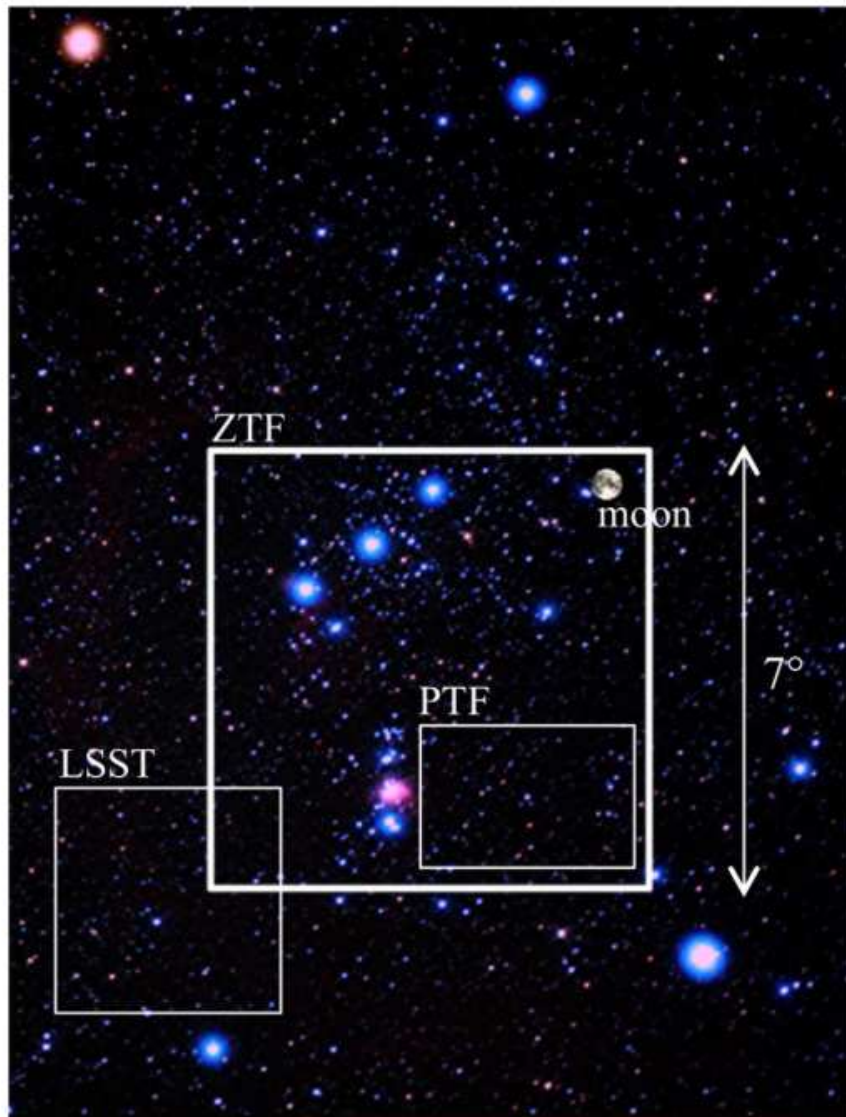


ABSTRACT

The Zwicky Transient Facility (ZTF) is a new time-domain survey based at Palomar Observatory that will commence in early 2018. ZTF will use a 47 square degree field with a 600 megapixel camera to scan the entire northern visible sky at rates of ~ 3760 square degrees/hour to depths of $R \sim 20.5$ mag. We review the data processing pipelines and the science-enabling products derived therefrom. These will support a broad range of research themes: from fast and young supernovae, variable stars, eclipsing binaries, counterparts to gravitational wave sources, to Solar System objects. We also describe the methods for data access and the data-release schedule for products derived from the public surveys.

ZTF at a Glance



- Using the 48-inch Samuel Oschin Telescope at Palomar Observatory
- A fast, wide-area time-domain survey:
 - fast, young, and rare flux transients
 - counterparts to gravitational wave sources
 - low-z Type Ia SNe for cosmology
 - variable stars & eclipsing binaries
 - Solar System objects
- Active detector area: $\sim 47 \text{ deg}^2$
- Areal survey rate: $3760 \text{ deg}^2 / \text{hour}$
- Single exposure depth (5σ): $r \sim 20.5 \text{ mag.}$
- Median image quality (r): $\sim 2.2''$ (FWHM)
- Nominal survey duration: 3 years
- Number of filters: 3 (g, r, i)
- Survey entire Northern visible sky to $\delta \sim -28^\circ$
- Survey start date: \sim February 2018

Data Volumes and Statistics

Estimates per night, based on an average on-sky duration of ~ 8hr 40min

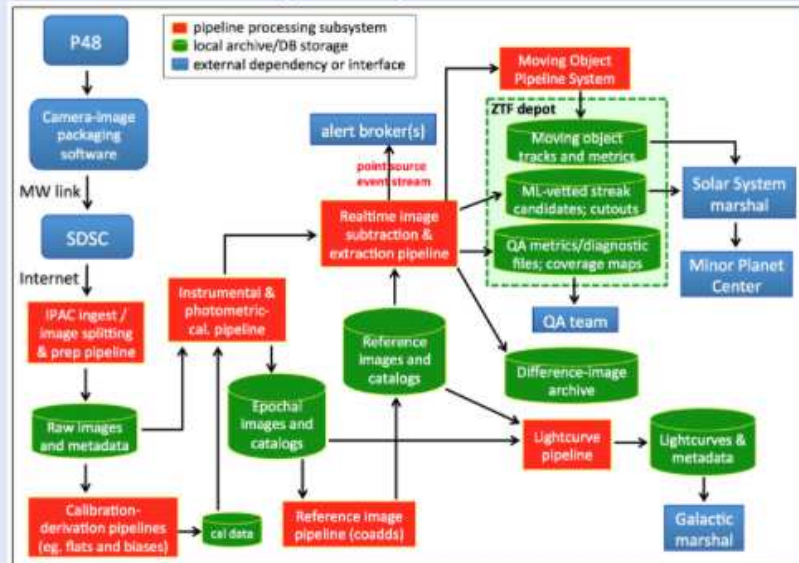
- Number of on-sky camera exposures per night: ~ 700; calibration exposures: ~ 100
- Raw image data volume: ~ 1 TB (no compression)
- Raw incoming data rate: ~ 230 mega bits per second (no compression)
- Data product volume: ~ 3.8 TB per night (real-time products only)
- Number of point source transient events (flux and motion-induced): ~ 1 million (0.1x – 5x)
following machine-learned vetting of $> 5\sigma$ events; sky-location dependent
- Number of streaks (candidates for “fast-moving” objects following ML vetting): ~ 10 to 50
- Number of single exposure extractions: ~ 1 billion (PSF-fit based); ~ 300 million (aperture-based)
sky-location dependent
- Number of single readout-quadrant image products (science, difference, mask, catalogs): ~ 230,000

For nominal three-year survey (number of observing nights / year: ~ 260):

- Volume of data products: ~ 3 PB
- Number of single-exposure extractions: ~ 800 billion (PSF-fit based); ~ 230 billion (aperture)
- Number of reference images (co-adds in static library for image subtraction): ~ 282,000 (~ 55 TB)

Processing Overview & Data Flow

- The Data System is housed at IPAC. This consists of all processing and calibration pipelines, archive, alert-distribution infrastructure, and user-tools to support data access and exploration.
- Raw exposures are relayed via microwave link to IPAC
- Each quadrant of the 16 CCDs is processed separately
- The automated real-time pipeline produces science data in < ~10 minutes following data ingestion at IPAC

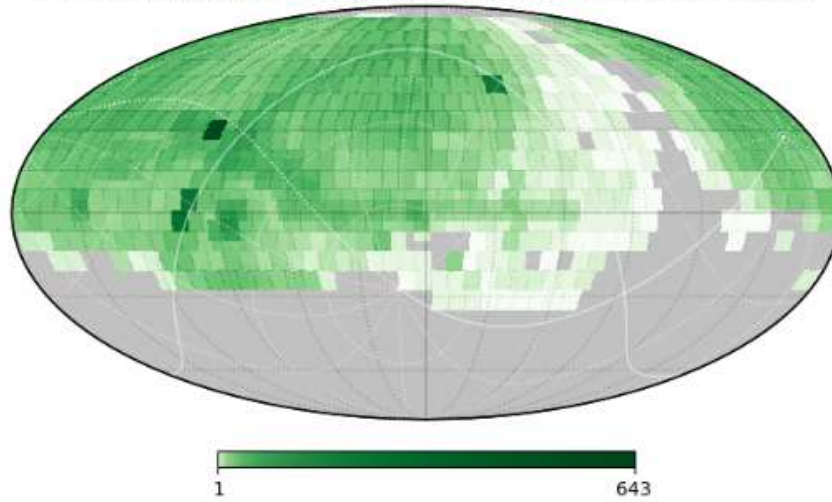


- Green components indicate storage in the form of an archive and/or database residing at IPAC to serve either the public, science marshals (via ZTF-depot) or the collaboration.
- Red components represent the core pipelines.
- Blue components indicate external interfaces or dependencies.

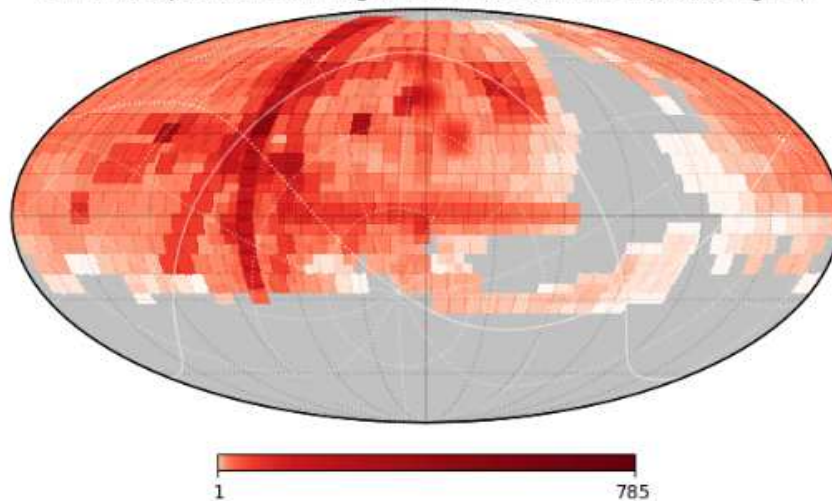
Survey Coverage

ZTF is currently in commissioning. The pipeline produces cumulative coverage maps. Shown here are coverage maps for commissioning observations (green for the g filter, red for the r filter)

ZTF : G : Equatorial : All Programs : Thru 2018-01-03 (23/69 Nights)



ZTF : R : Equatorial : All Programs : Thru 2018-01-03 (36/69 Nights)



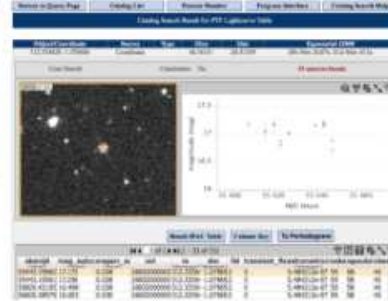
Data Access

- The archive can be accessed using either GUIs or APIs (examples below).
- These allow for searches based on position, time-windows, known object name (including Solar System objects), and filtering on observing parameters.
- The GUIs include the ability to overlay catalogs, visualize lightcurves, and compute periodograms.

Image viewer and file-product retrieval



Lightcurve viewer/analyzer and retrieval



Moving Object Search Tool (MOST)

Image Dataset:

Observation Range (J2000):

Observation End (J2000):

Observation Step Size (deg): Output Mode:

Create File and FITS Region Files: Create Custom Images Page or Target:

Enter System Object Name Input:

Data Products & Release Schedule

- Instrumentally calibrated, readout-quadrant based epochal image products: images, masks, PSF-fit and aperture photometry catalogs, difference images.
- Alert (point-source event) stream from real-time image-differencing pipeline: packetized with historical metadata and upper limits.
- Raw science and accompanying calibration image data used in pipelines.
- Reference images (co-adds): includes coverage and uncertainty maps, PSF-fit and aperture photometry catalogs.
- Lightcurves from matched epochal PSF-fit photometry.
- Cutouts and metadata on streaking transients, i.e., from fast moving NEOs; detected and vetted from difference images.
- Moving-object tracks generated from linking point-source transients detected from difference images for both known and new Solar System objects.

Public Release Schedule

- Alerts (point source transient events) from the public portion of the survey are planned to commence at Survey Start + 4 months.
- The first public data release of image and catalog products from the public survey is planned for Survey Start + 12 months.
- Information on potentially new NEOs and Solar System Objects will be periodically submitted to the IAU's Minor Planet Center and can be accessed using the services offered by the MPC.