



ZTF Data System: Phase-II Plans & Schedule

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November 19, 2020





ZTF Science Data System (ZSDS)

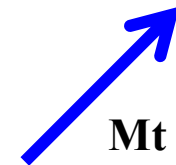


- The ZSDS is housed at IPAC, Caltech
- IPAC is a multi-mission science center (IRAS, 2MASS, *Spitzer*, WISE/NEOWISE, LSST, Euclid, WFIRST..)
- Responsibilities for ZTF:
 - data processing: from instrumental calibration to alert packets and lightcurves.
 - quality assurance; product archiving; user-interfaces to retrieve and analyze data.
 - management of data releases and user-support.
 - on-demand forced-photometry lightcurve service.

**Cahill Center
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IPAC



**Mt Palomar
~ 150 km**



ZTF Computing & Storage at IPAC



- We ingest ~ 300 GB of raw camera data *per night* to generate ~ 3.8 TB in products.
- Processing is in “real-time” and alert packets leave IPAC ~ 10 to 20 minutes since observation.
- Expect ~ 5.7 PB in data products at end of Phase-II.
- Compute cluster consists of 66 compute nodes (1192 processor cores @2.5GHz each).

Racks containing 66 compute nodes



Archive file servers/disk arrays





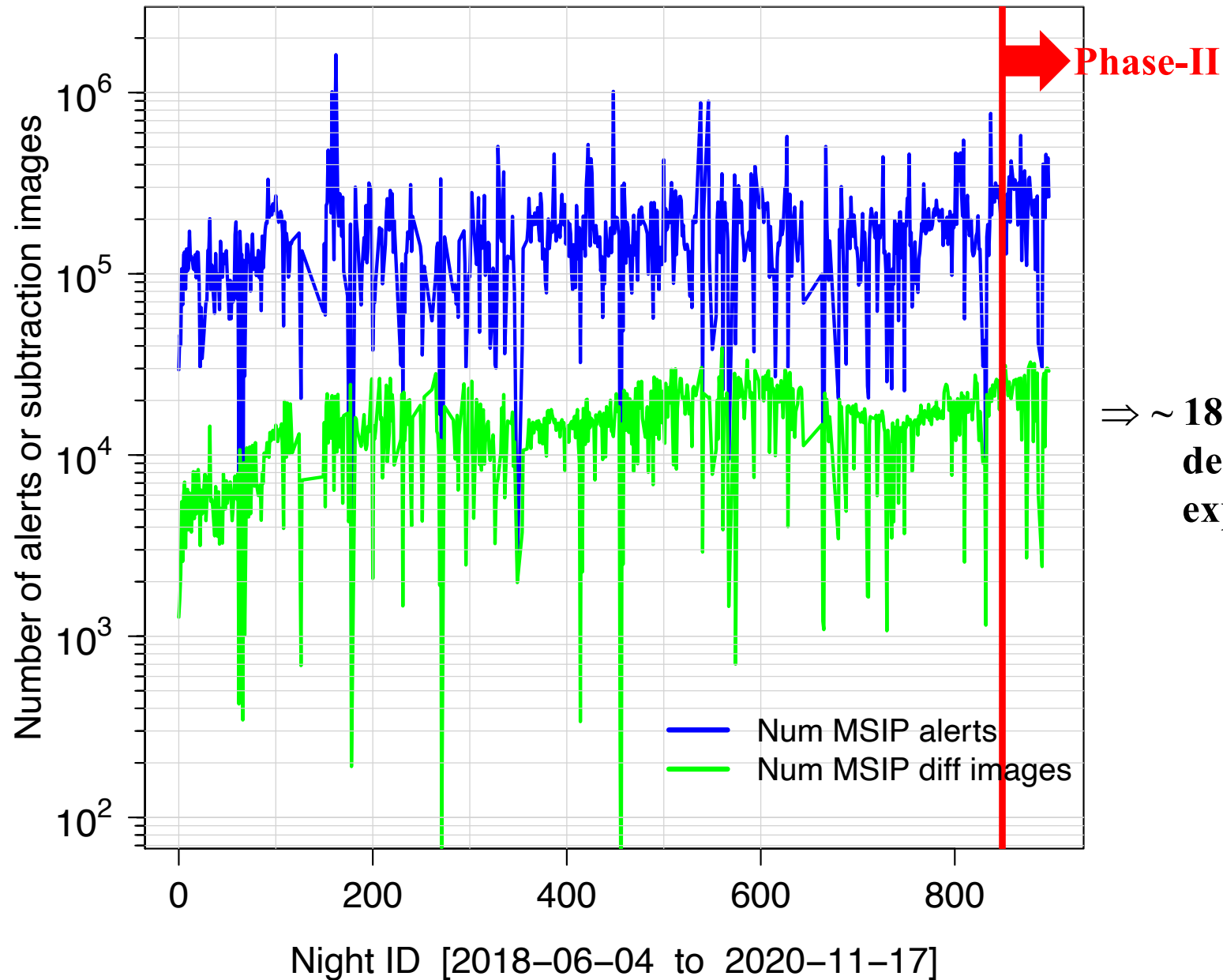
ZTF Public Release Data Products



- Like Phase-I, Phase-II public data releases will include:
 - Refinements to products and data quality flags in all previous releases (back to start of phase-I).
 - Products derived from additional observations:
 - Raw camera & calibration image data.
 - Calibrated single-epoch images, difference images, masks, PSFs, and source catalogs.
 - Lightcurves derived from positional re-matching across all epochs (back to start of Phase-I).
 - New reference images (co-adds), depth-of-coverage maps, and source catalogs.
 - Source database drawn from reference image catalogs to facilitate lightcurve retrieval.
- Public Alerts from the public surveys are not tied to any bulk data release
 - These continue to be distributed close to real-time for consumption by Alert Brokers.

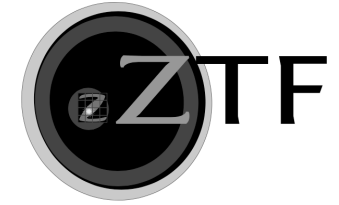


Public Alert Statistics

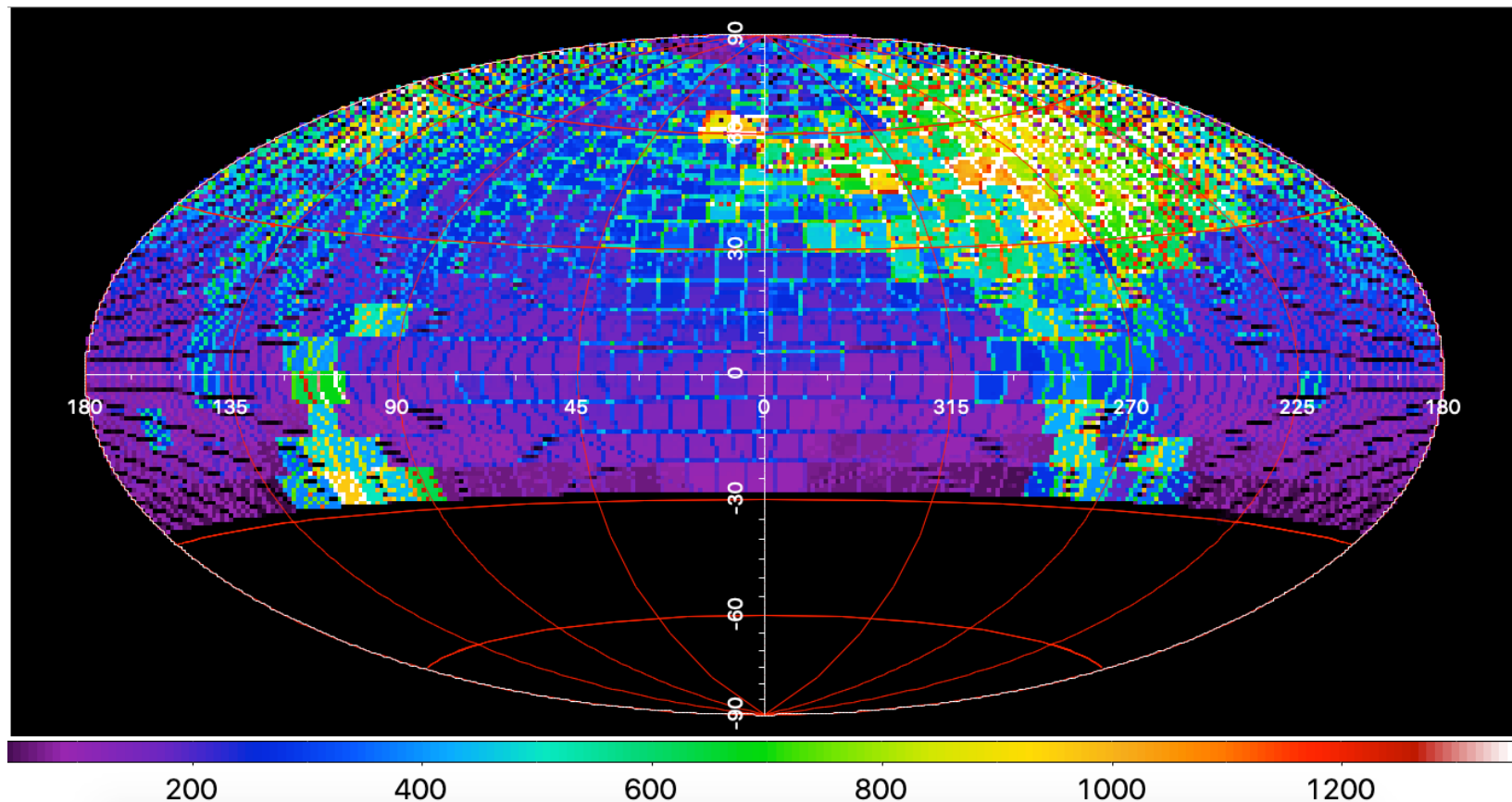




Data Release 4 coming soon (Dec 9, 2020)



- Observation span included: **March 17, 2018 – June 30, 2020 (all from Phase-I)**
~ 27 months of public survey and ~ first 15 months of private (partnership) survey data.
- Phase-I public survey had 3-night cadence with 1-night cadence in Galactic plane $|b| < \sim 7^\circ$
- Private surveys had a mixed cadence down to $< \sim 1$ minute.
- ~ 18.5 million “usable” single-epoch calibrated images; ~ 2 billion lightcurves with ≥ 10 epochs each





Phase-II Public Data Release plan



- Move from a 6-month to 2-month release cycle for all data.
- **For public survey data:** move from a 6-month to 2-month proprietary period following DR4.
- **For private data** (partnership/Caltech science programs): continue with 18-month embargoing.

| Release | Release Date | Public survey observation span | Private surveys observation span |
|---------|--------------|--------------------------------|----------------------------------|
| DR4 | 12/09/20 | 03/17/18 – 06/30/20 | 03/17/18 – 06/30/19 |
| DR5 | 03/31/21 | 03/17/18 – 01/31/21 | 03/17/18 – 09/30/19 |
| DR6* | 06/30/21 | 03/17/18 – 04/30/21 | 03/17/18 – 12/31/19 |
| DR7* | 08/31/21 | 03/17/18 – 06/30/21 | 03/17/18 – 02/29/20 |
| DR8* | 11/03/21 | 03/17/18 – 08/31/21 | 03/17/18 – 04/30/20 |
| DR9* | 01/05/22 | 03/17/18 – 10/31/21 | 03/17/18 – 06/30/20 |
| ... | ... | | |

* Bimonthly release cycle



Data Access and Visualization Tools

<https://irsa.ipac.caltech.edu/Missions/ztf.html>



- Access is through IRSA at IPAC.
- Can search for images and source catalog files by position or object name (including SSOs), sources extracted from co-adds & their lightcurves; overlays, time series viewer w/ interactive manipulation.
- Accompanying APIs (command-line driven retrieval) are available for all services.

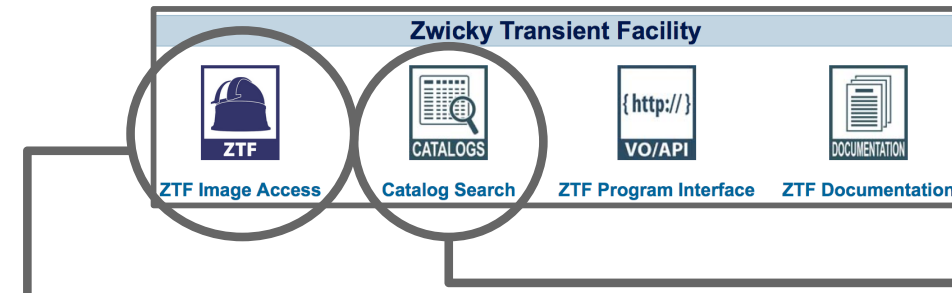


Image viewer and product retrieval

The screenshot shows the IRSA ZTF interface. At the top, there are tabs for "IRSA", "DATA SETS", "SEARCH", "TOOLS", and "HELP". Below the tabs is a search bar with "Search by Position" selected. A table of search results is displayed with columns for "ra", "dec", "field", "ccid", "qid", "fid", "filtercode", and "obsdate". An "Image Preview" window shows a grayscale image of a galaxy.

| ra | dec | field | ccid | qid | fid | filtercode | obsdate |
|--------------------|-------------------|-------|------|-----|-----|------------|-----------------------------|
| 202.71695070000000 | 47.22087448000000 | 757 | 7 | 2 | 1 | zg | 2018-03-25 08:23:05+00 |
| 202.73263794000000 | 47.21753299000000 | 757 | 7 | 2 | 1 | zg | 2018-03-28 07:12:59+00 |
| 202.73615898000000 | 47.22155018000000 | 757 | 7 | 2 | 1 | zg | 2018-03-28 08:22:39+00 |
| 202.71972336000000 | 47.21063876000000 | 757 | 7 | 2 | 1 | zg | 2018-03-31 06:21:19+00 |
| 202.72316125000000 | 47.21021096000000 | 757 | 7 | 2 | 1 | zg | 2018-03-31 09:25:07+00 |
| 202.72104319000000 | 47.21017058000000 | 757 | 7 | 2 | 1 | zg | 2018-04-03 08:09:47+00 |
| 202.71400458000000 | 47.21577604000000 | 757 | 7 | 2 | 1 | zg | 2018-04-06 06:38:38+00 |
| 202.71568606000000 | 47.21889729000000 | 757 | 7 | 2 | 2 | zr | 2018-04-06 07:41:22+00 |
| 202.71762416000000 | 47.23116792000000 | 757 | 7 | 2 | 2 | zr | 2018-04-09 07:52:17+00 |
| 202.71832977000000 | 47.23047786000000 | 757 | 7 | 2 | 2 | zr | 2018-04-09 08:06:27+00 |
| 202.71621500000000 | 47.22770816000000 | 757 | 7 | 2 | 2 | zr | 2018-04-14 06:52:32+00 |
| 202.71808145000000 | 47.22717503000000 | 757 | 7 | 2 | 2 | zr | 2018-04-14 07:05:24+00 |
| 202.71791762000000 | 47.22829482000000 | 757 | 7 | 2 | 2 | zr | 2018-04-18 06:53:52+00 |
| 202.72073673000000 | 47.22868590000000 | 757 | 7 | 2 | 2 | zr | 2018-04-18 07:53:57+00 |
| 202.71818401000000 | 47.23849410000000 | 757 | 7 | 2 | 1 | zg | 2018-04-21 07:21:56.583+00 |
| 202.71565131000000 | 47.22622389000000 | 757 | 7 | 2 | 2 | zr | 2018-04-24 05:38:06.4444+00 |
| 202.71074760000000 | 47.22845716000000 | 757 | 7 | 2 | 1 | zg | 2018-04-24 06:10:19.168+00 |
| 202.72166779000000 | 47.21821107000000 | 757 | 7 | 2 | 1 | zg | 2018-04-27 08:07:18.6+00 |
| 202.71388932000000 | 47.22022804000000 | 757 | 7 | 2 | 1 | zg | 2018-04-30 04:37:31.698+00 |
| 202.71407927000000 | 47.28600865000000 | 757 | 7 | 2 | 1 | zg | 2018-05-04 05:18:33.215+00 |
| 202.72238357000000 | 47.21735115500000 | 757 | 7 | 2 | 1 | zg | 2018-05-07 06:50:04.127+00 |
| 202.72556200000000 | 47.21730320000000 | 757 | 7 | 2 | 2 | zr | 2018-05-07 08:18:41.18+00 |

Lightcurve retrieval / Time Series Tool

The screenshot shows the "Lightcurve retrieval / Time Series Tool" interface. It includes a "Column Selection" panel with a table of columns, a "Period Finder" section, and a "Lightcurve" plot showing magnitude (mag) versus Modified Julian Date (mjd). Below the plot are several image thumbnails.

| magerr | psfflux | psffluxerr | psfmag | psfmagerr | catflag |
|--------------|------------|------------|------------|--------------|---------|
| 0.0325878002 | 44952.2773 | 1337.30322 | 14.6323109 | 0.0320000015 | 0 |
| 0.037760957 | 44213.0938 | 1490.41650 | 14.6610432 | 0.0370000005 | 0 |
| 0.0295599000 | 42692.2578 | 1120.64917 | 14.6845760 | 0.0289999992 | 0 |
| 0.0319281705 | 42889.3398 | 1240.37988 | 14.6808405 | 0.0309999995 | 0 |
| 0.0337643623 | 41299.7500 | 1262.87744 | 14.6791391 | 0.0329999998 | 0 |

Period finding

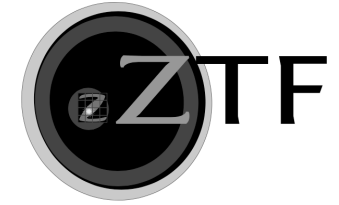
The screenshot shows the "Period finding" interface. It includes a "Periodogram" plot showing power versus period (d) and a "Recalculate Periodogram" section with a table of results.

| Period | Power |
|------------|---------------|
| 0.29994613 | 3.8787380074 |
| 0.29104259 | 3.7076500616 |
| 0.29895426 | 3.6011330519 |
| 0.30048138 | 2.2154002609 |
| 0.30020479 | 3.2279113994 |
| 0.30058169 | 5.9786702386 |
| 0.30051979 | 1.7981762003 |
| 0.30674911 | 0.4188084772 |
| 0.30057171 | 1.3490328033 |
| 0.30996206 | 1.1575026296 |
| 0.31162423 | 0.6026407564 |
| 0.31328989 | 1.3764313276 |
| 0.31096132 | 78.9267920987 |



Moving Object Search Tool (MOST)

asteroids pre-covered by ZTF imaging



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MOST - Moving Object Search Tool

The Moving Object Search Tool (MOST) can determine the orbit for a given solar system object then find images of object's predicted positions in select image datasets housed at IRSA (see [Instructions](#)). It can serve as a "precovery" if newly discovered objects were previously observed.

Image Dataset ztf

For ZTF: Time Range = 2017-10-15 to present
 For complete range, leave limits blank (but this may take a long time)
 Example: Antonia 2017-11-01 to 2017-12-31

| | |
|--|--|
| Observation Begin (UTC) <input type="text" value="2018-03-17"/> | Observation End (UTC) <input type="text" value="2020-10-22"/> |
| Ephemeris Step Size (day) <input type="text" value="1"/> | Output Mode Regular |

Create Fits and DS9 Region Files Tarballs

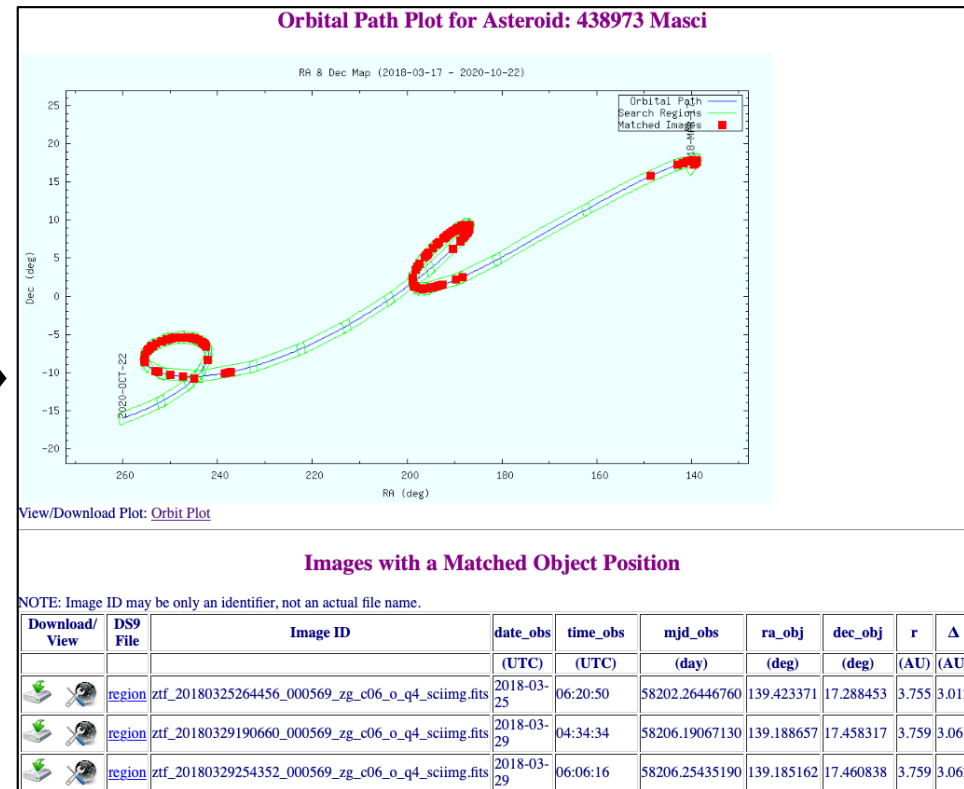
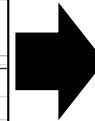
Solar System Object Name Input:

Solar System Object NAIF ID Input:

MPC One-Line Element Input:

Object Type: Asteroid

Orbital Elements Manual Input:





Phase-II: major data-system upgrades



| Capability / functionality | Release date |
|--|---------------------------|
| Public forced photometry service | 2020-12-01 (beta testing) |
| Forced photometry histories in alert packets (T – 30 days) | 2021-02 (TBD) |
| Database, system, & infrastructure upgrades to support +3yr | 2021-04-01 |
| Bimonthly public release of file-based data products | 2021-06-30 (commence DR6) |
| New lightcurve datastore format and database | 2021-10-01 |
| More frequent release of lightcurves (tied to new datastore) | 2021-11-01 (commence DR8) |
| P60 archive & data access service | 2021-10-01 |



Phase-II: other improvements



- Update astrometric calibration framework to use *Gaia Early DR3*.
- Update automated PSF-estimation software to further improve photometric accuracy: goal is $<\sim 1\%$ *absolute* precision (relative to PanSTARRS1), consistently on photometric nights.
- Propagate additional nearest *Gaia*-source metrics into alert packets, including proper motions.
- Include data in alert packets from the *PS1 Source Types & Redshifts with ML (PS1-STRM)* catalog.
- Refine Star/Galaxy classification scores of nearest PS1 sources in alert packets using latest ML.
- Reprocess subsets of improperly calibrated Phase-I data following upgrades.



Data Access & Documentation



- **Public Data Release: recipes for retrieving any ZTF data:**
<https://www.ztf.caltech.edu/page/dr3>
- **Access to Images, Catalogs, lightcurves, and analysis tools:**
<https://irsa.ipac.caltech.edu/Missions/ztf.html>
- **Growing archive of raw public alert packets and usage:**
<https://ztf.uw.edu/alerts/public/>