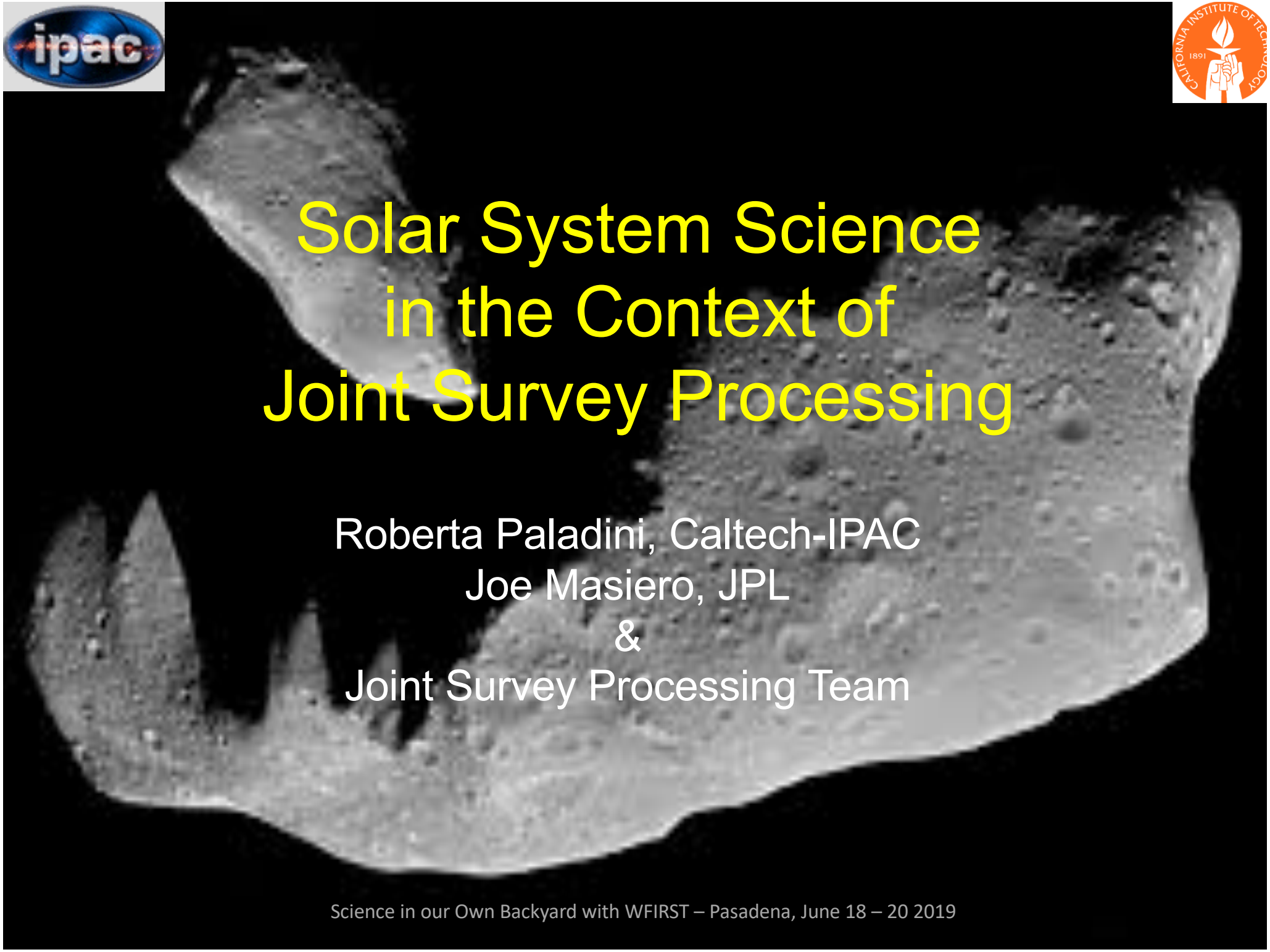
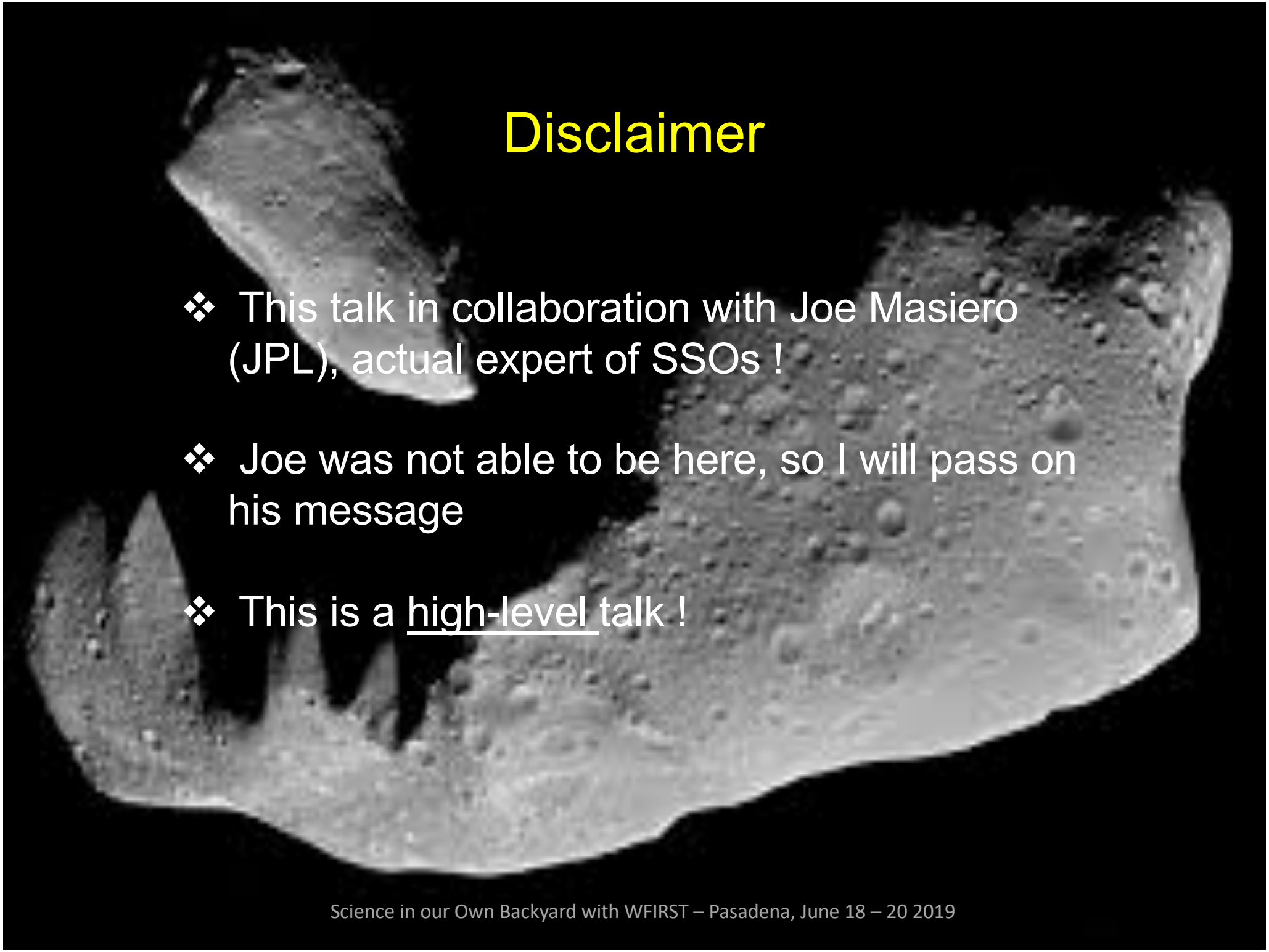


Solar System Science in the Context of Joint Survey Processing

Roberta Paladini, Caltech-IPAC
Joe Masiero, JPL
&
Joint Survey Processing Team

Science in our Own Backyard with WFIRST – Pasadena, June 18 – 20 2019



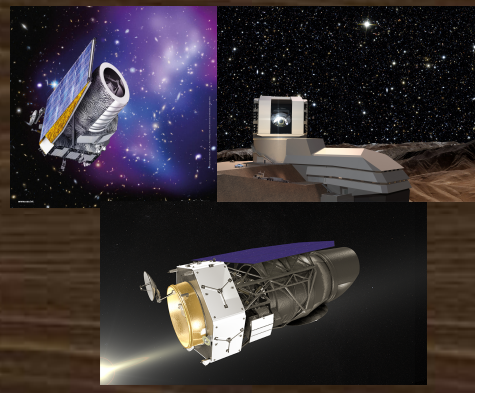
Disclaimer

- This talk in collaboration with Joe Masiero (JPL), actual expert of SSOs !
- Joe was not able to be here, so I will pass on his message
- This is a high-level talk !

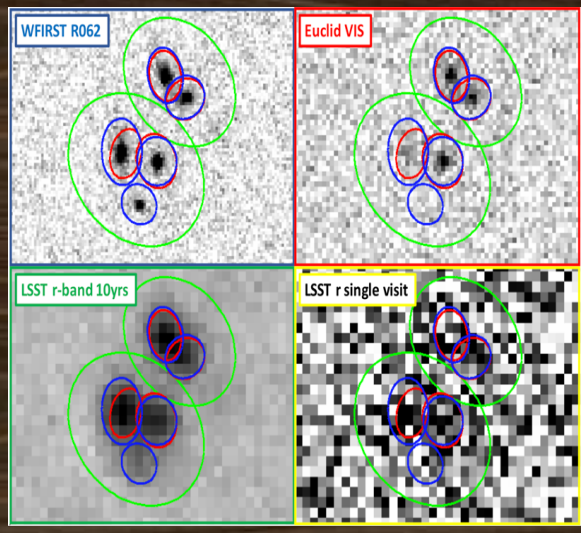
Slide courtesy of Ranga Ram Chary

Joint Survey Processing: Whole >> ∑parts

- A tri-agency (NSF, DoE, NASA) initiative to optimally combine LSST, Euclid and WFIRST data sets at the pixel level.
  IPAC-led (Chary & Helou), with participation from STScI, Princeton and the Astronomical community at large.



- Combination of space-resolution (~0.1-0.2”) near-infrared data and ground-resolution (>0.7”) optical data enables precision cosmology and a range of new astrophysics, including in the time-domain.



- Large data volume (~100 PB) requires utilization of distributed software container technology and high speed networking. ~1Billion CPU hours needed.

- FY19 prototype start with Subaru+Hubble data. 1% of project cost.

LSST, Euclid and WFIRST Sky Coverage

- LSST will provide multi-epoch imaging of the Southern sky
- Euclid will not image the Galactic/Ecliptic Plane until end of primary mission (2028-), however the high-latitude survey will generate an important date set that can be searched for near-Earth and Mars-crossing asteroids
- WFIRST may undertake dedicated surveys of both the Galactic Plane and the Ecliptic Plane

The benefit(s) of Joint Survey Processing to SSO Science

The main merits of combining these data sets are:

1. Reducing confusion noise in the images, by fitting for and subtracting known sources in the field, providing better sensitivity to moving objects

2. Providing a long time baseline (> 10 yrs) over which to measure the position of SSOs, improving orbital solutions

Pre-covery and Recovery (Main science driver)

Pre-covery: process of finding the image of an object in some data for the purpose of calculating a more accurate orbit

Recovery: while “pre-covery” refers to”pre-discovery” image, “recovery” refers to imaging of a body which was lost to our view (as behind the Sun) but it now visible again

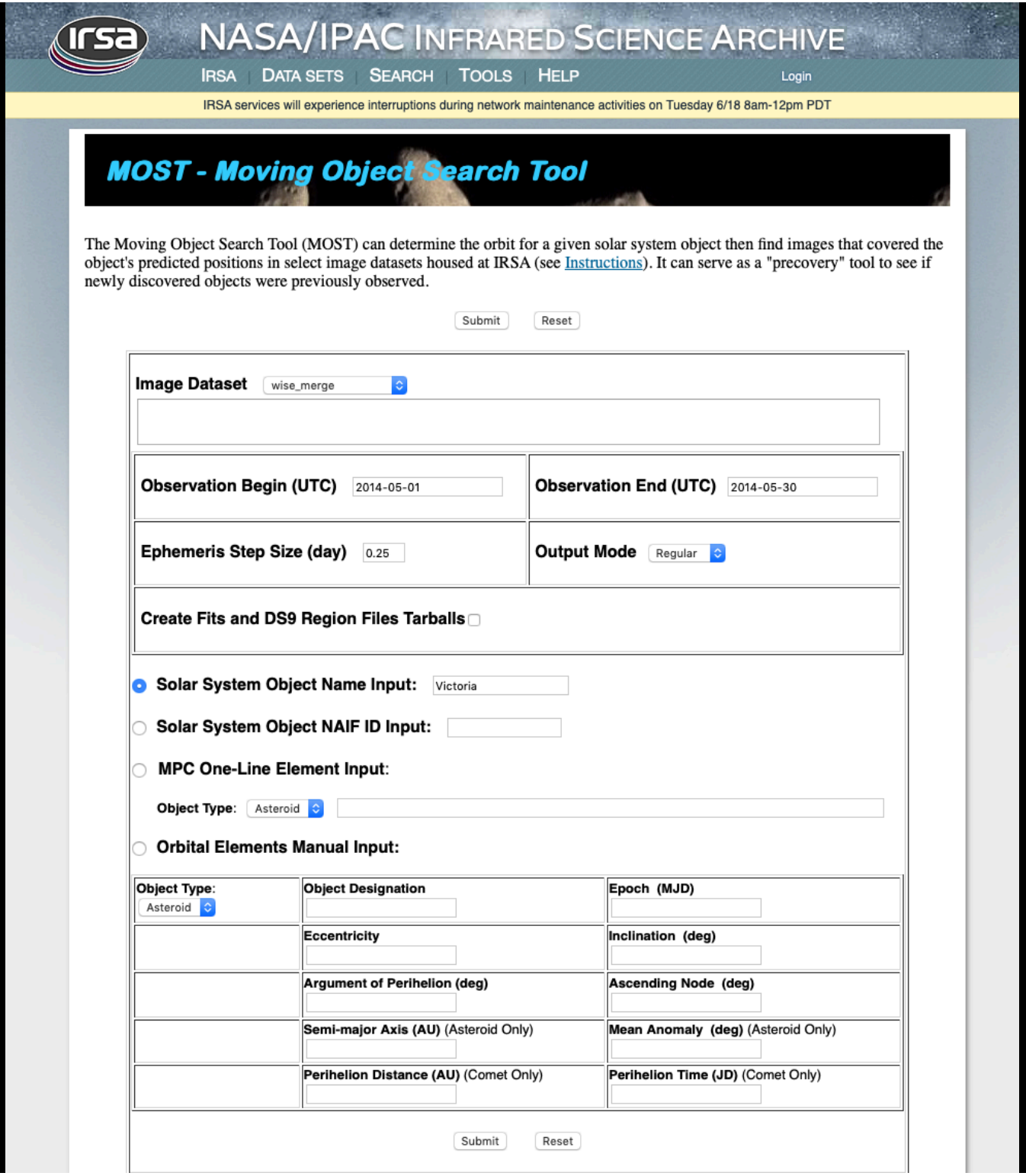
Pre-covery and Recovery (Main science driver)

- Improved constraints on the orbits of the targets → Improve predictions of their future positions
- For objects that come close to the Earth, these further constraints can be used to rule out Earth-impacting solutions
- For spacecraft mission targets, accurate orbits allow for simpler mission planning

Pre-covery and Recovery (Main science driver)

- Pre-covery and recovery can be achieved by stacking of all available single-epoch frames from LSST, Euclid and WFIRST along the path of motion of the object;

- Alternatively, a source identification tool, such as MOST (Moving Object Search Tool) available at IRSA, applied to the single-frame images can be used.


NASA/IPAC INFRARED SCIENCE ARCHIVE
IRSA | DATA SETS | SEARCH | TOOLS | HELP
Login
IRSA services will experience interruptions during network maintenance activities on Tuesday 6/18 8am-12pm PDT
MOST - Moving Object Search Tool
The Moving Object Search Tool (MOST) can determine the orbit for a given solar system object then find images that covered the object's predicted positions in select image datasets housed at IRSA (see Instructions). It can serve as a "precovery" tool to see if newly discovered objects were previously observed.
Submit
Reset
Image Dataset wise_merge
Observation Begin (UTC) 2014-05-01
Observation End (UTC) 2014-05-30
Ephemeris Step Size (day) 0.25
Output Mode Regular
Create Fits and DS9 Region Files Tarballs
Solar System Object Name Input: Victoria
Solar System Object NAIF ID Input:
MPC One-Line Element Input:
Object Type: Asteroid
Orbital Elements Manual Input:
Object Type: Asteroid
Object Designation
Epoch (MJD)
Eccentricity
Inclination (deg)
Argument of Perihelion (deg)
Ascending Node (deg)
Semi-major Axis (AU) (Asteroid Only)
Mean Anomaly (deg) (Asteroid Only)
Perihelion Distance (AU) (Comet Only)
Perihelion Time (JD) (Comet Only)
Submit
Reset

Chemical Composition

- The combined LSST, Euclid and WFIRST photometric data points also allow to set broad constraints on the object chemical composition, using colors or albedos (if a diameter is available from another source). These parameters are a function of the object's composition.

- Photometric colors have been successfully used to provide broad taxonomic classification of asteroids in the optical (Carvano et al. 2010) and NIR (Popescu et al. 2018), which could be expanded upon by JSP

Object Shape

- With sufficiently long baselines, it is possible to reconstruct the shape of small SSOs using sparsely sampled light curve photometry
- This is achieved by using light curve inversion techniques (see Durech et al. 2010, DAMIT: Database of Asteroids Models from Inversion Techniques)

SSO Requirements on Joint Survey Processing

- Single-epoch frames, both with and without source subtraction with non-sidereal stacking capability;
- Absolute astrometric precision of 0.1 arcsec, to be achieved after taking into account the proper motions of stars between the different epochs of LSST, Euclid and WFIRST
- absolute photometric precision at 1 sigma of 0.05 mag to allow for quantification of the phase and rotation curves of the objects observed