PDC2025
Stellenbosch, Cape Town, South Africa

Please submit your abstract at https://iaaspace.org/pdc.

(please select the topic that best fits your abstract from the list below)
(you may also add a general comment - see end of this document)

☐ **Ongoing and Upcoming Mission Highlights**
☐ **Apophis: T-4 Years**
☐ **Hypothetical Asteroid Threat Exercise**
☐ **Key International and Policy Developments**
☑ **Near-Earth Object (NEO) Discovery**
☐ **NEO Characterization**
☐ **Deflection / Disruption Modeling & Testing**
☐ **Space Mission & Campaign Design**
☐ **Earth Impact Effects & Consequences**
☐ **Disaster Management & Impact Response**
☐ **Public Education and Communication**
☐ **The Decision to Act: Political, Legal, Social, and Economic Aspects**

Rapid Pre-discovery of Near-Earth Objects

Tam Nguyen [1]
[1] University of Maryland, 3170 Glenn Martin Hall, College Park, MD 20742, USA, 301-405-7350, tamz@umd.edu

Keywords: *pre-discovery, search, detection, follow-up*

The Vera Rubin Observatory Legacy Survey of Space and Time (LSST) will provide an unprecedented number of potential Near-Earth Object (NEO) discoveries. Many of these new NEO detections will require additional detections for confirmation and orbit refinement. While follow-up strategies have been actively developed, it is expected to take a significant dedicated amount of time and resources to follow up on all potential LSST detections. An alternative approach to provide additional detections of potential new NEOs is to search for these objects in archival image data from past and current surveys; such methods are often referred to as pre-discovery. The challenges with NEO pre-discovery include the large search space needed due to high trajectory uncertainty and the limited sensitivity of sensor systems from past surveys in comparison to LSST. To address these challenges, we have developed a new efficient synthetic tracking pipeline to search for and detect NEOs beyond the single-frame limit over a large search space. The pipeline utilizes divide-and-conquer techniques to rapidly search a large trajectory hypothesis space and combine the signal across frames over time to aggregate sufficient signal-to-noise ratio for detection. This technique has been previously demonstrated to provide significant speedup in comparison to traditional search approach to provide detections of solar system

objects up to 3 visual magnitudes fainter than the single-frame detection limit with limited a priori state knowledge. We present results from our proof-of-concept demonstration of NEO pre-discoveries with image data from the Transiting Exoplanet Survey Satellite (TESS) mission, showing that it is possible to find NEOs fainter than the instrument's single-frame sensitivity limit and without precise ephemeris knowledge. This pipeline can be adapted to perform NEO pre-discovery as well as follow-up search with data from several existing surveys to complement follow-up efforts to rapidly confirm new NEOs in the age of LSST.