



A New Search for Optically Faint GEO Debris

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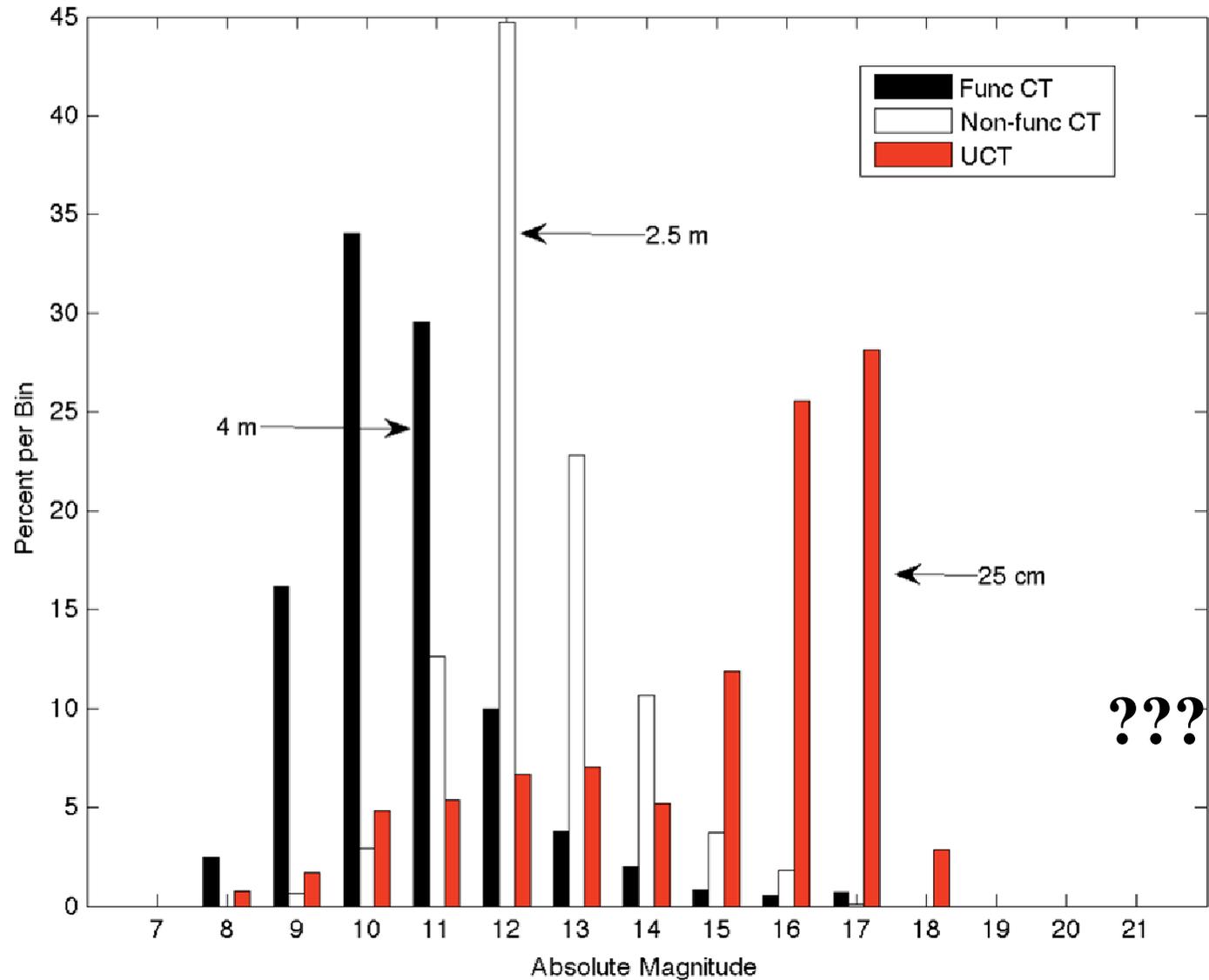
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Heather Cowardin (ESCG), Kira Abercromby (CalPoly),
Jiri Silha (Comenius University)

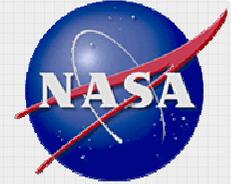
Presented at 29th IADC Berlin: 11-14 April 2011.

*Work supported by NASA's Orbital Debris Program Office,
Johnson Space Center, Houston, Texas.*



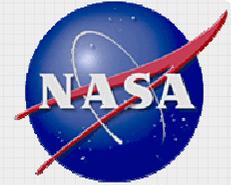
0.6-m MODEST 2007-2009 Detections





What is the distribution of faint debris?

- **Does debris distribution continue to increase with fainter optical brightness?**
- **In particular, what is distribution fainter than $R = 20$ (roughly 10 cm in diameter).**
- **Requires large telescope and excellent image quality.**
- **Goal: reach the faintest limiting magnitude possible from the ground.**

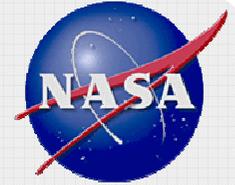


6.5-m Magellan Telescopes

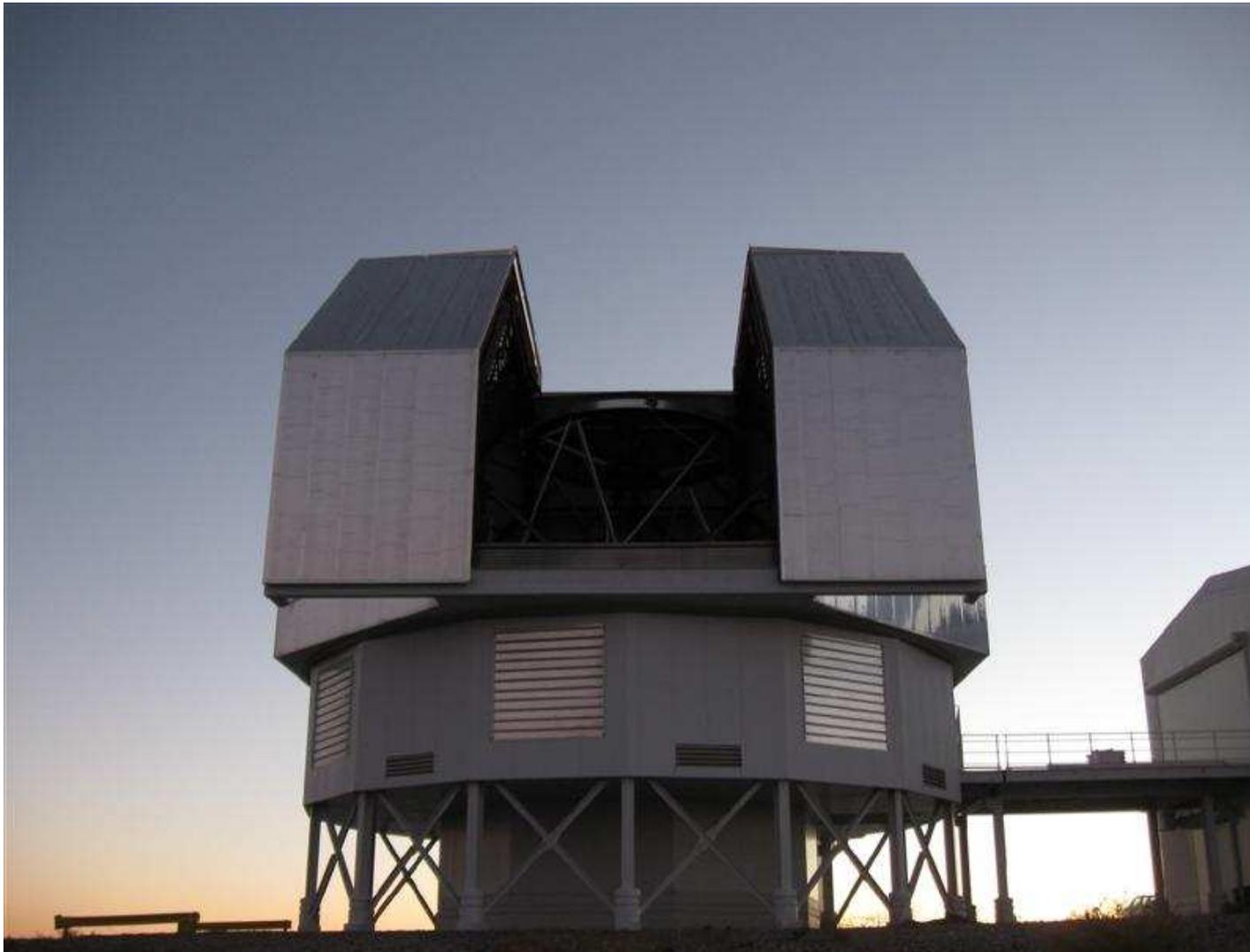
Las Campanas Observatory, Chile



Collaboration of Carnegie Institution, University of Arizona, Harvard University, University of Michigan, and Massachusetts Institute of Technology.



Magellan 1 telescope – Walter Baade





First Observing Run

- **9 hours of time spread over 3 nights – 25-26-27 March 2011 UT.**
- **Last two nights photometric – seeing at start of observation sequence usually 0.6-0.7 arc-seconds FWHM.**
- **Software modifications required to enable tracking at GEO debris rates.**
- **MODEST observed simultaneously on same fields from Cerro Tololo 100 km to south.**



Instrument: IMACS f/2 camera

- **IMACS: Inamori-Magellan Areal Camera & Spectrograph**
- **IMACS f/2 camera used in imaging mode – 8 CCD mosaic**
 - 0.4 arc-second pixels in binned 2x2 mode.
 - 24 arc-minute diameter unvignetted field of view (FOV) – widest FOV on Magellan.
 - Sloan R filter.
 - 35 second cadence for 5 second exposures.
- **Small field of view, but very deep probe. Limiting magnitude in 5 seconds estimated to be fainter than 22nd R magnitude.**
- **Telescope and instrument best suited for specialized debris studies.**



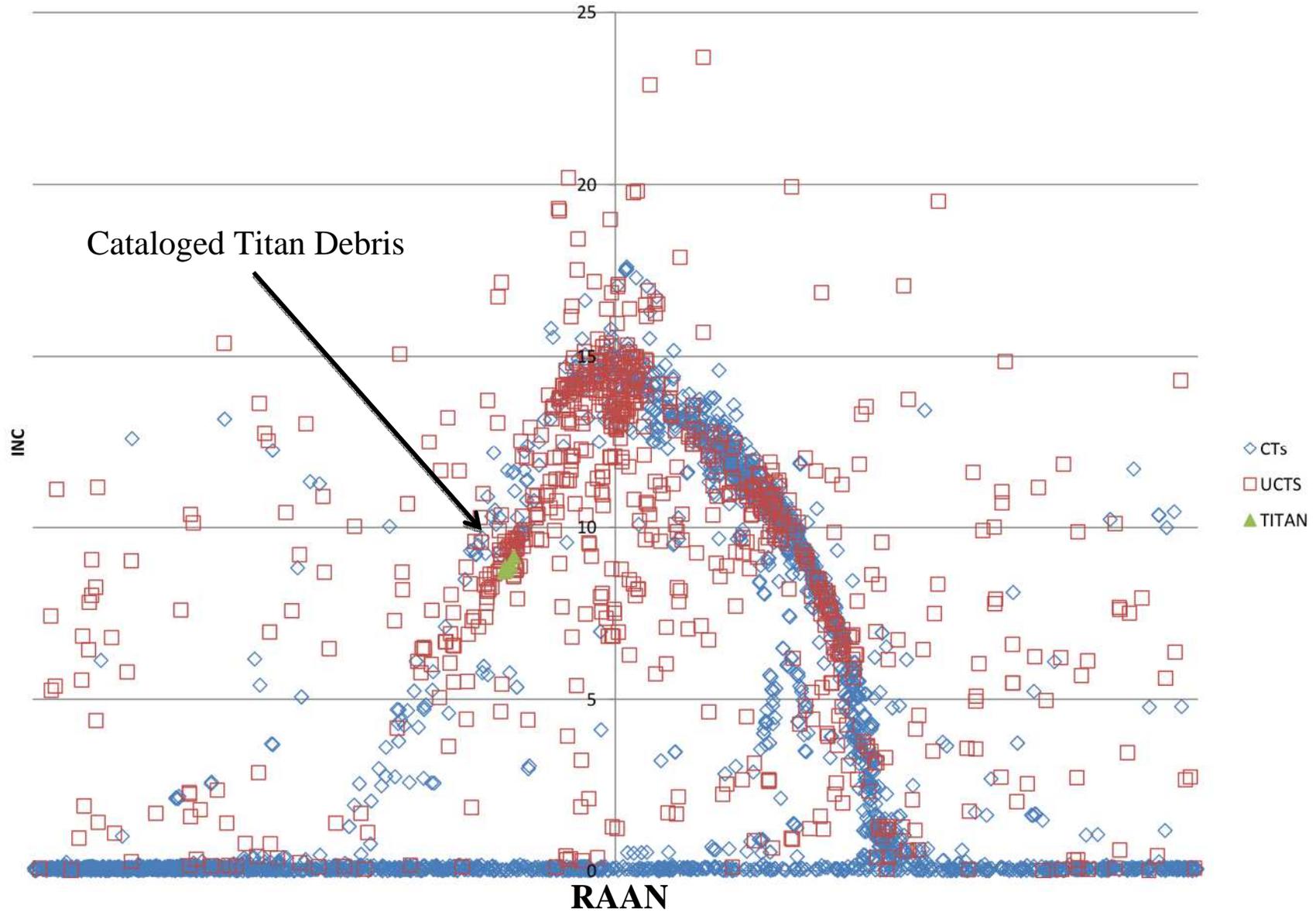
Magellan Target: Titan debris 1968-081

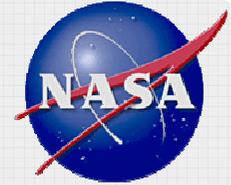
- **Fragmentation of Titan 3C Transtage at GEO – occurred 21 Feb 1992.**
 - *NASA History of On-Orbit Satellite Fragmentations (14th Edition, 2008)*
- **8 debris objects plus Titan 3C Transtage in catalog.**
- **All clustered in RAAN-INC space.**
- **Objective of this run – is there optically faint debris on circular orbits associated with this fragmentation?**
- **Observed two Titan debris fragments: 25001 and 33513.**
- **Observed ‘pseudo objects’ with same orbit as 25001 and 33513, but different mean anomalies – typical offset step 15 degrees.**
 - 30 x 5 second exposures while tracking at pseudo object rate.
 - 30 x 5 second exposures with telescope tracking off.



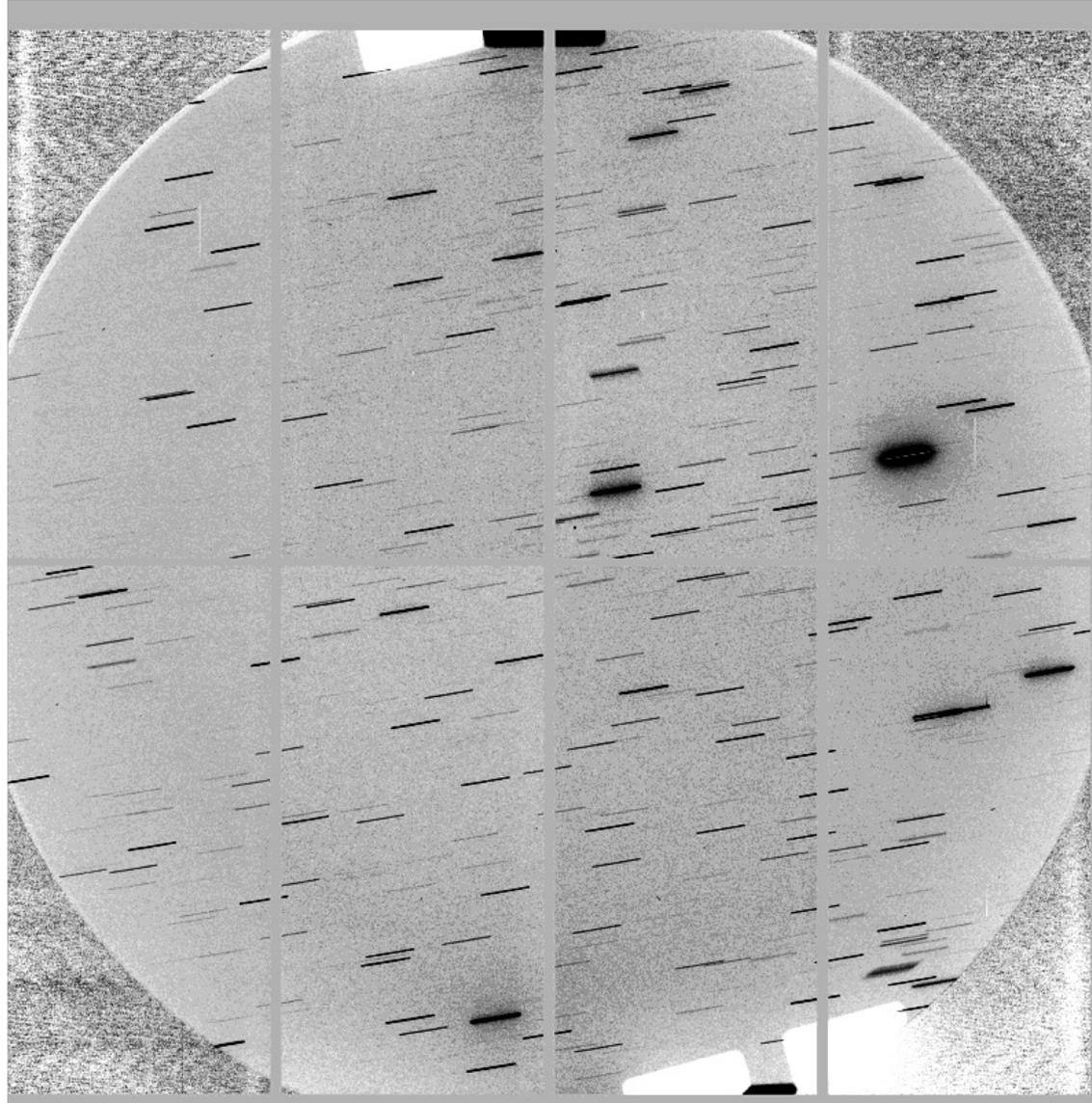
MODEST 2007-2009: RAAN vs Inc

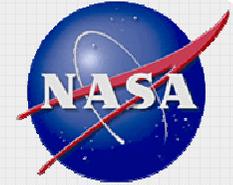
assuming circular orbits



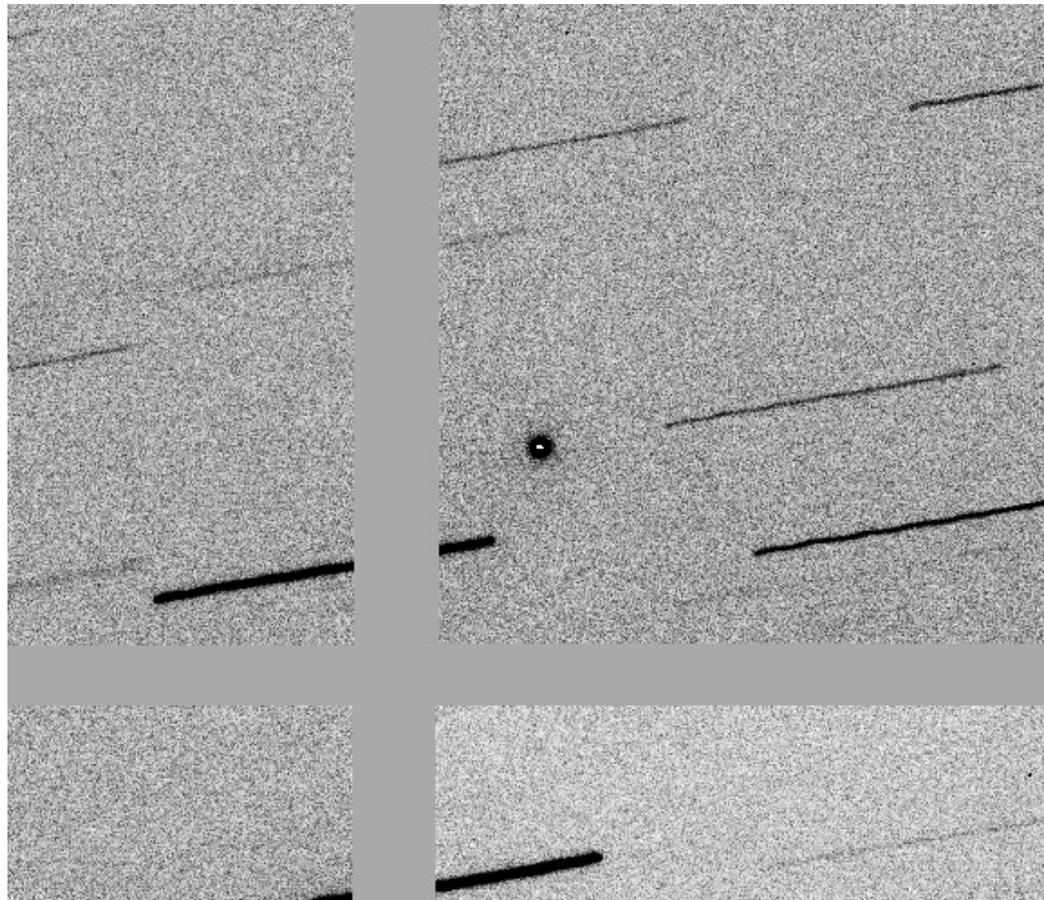


Magellan data example: SSN 33513



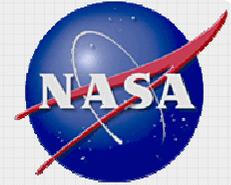


Titan Debris: SSN 25001



Detector saturated in 5 second exposure!





Future

- **Full reduction and analysis of both Magellan and MODEST data obtained 25-27 March 2011.**
- **Photometric calibration – what is faintest magnitude reached?**
- **‘Shift and add’ reduction to reach faintest levels.**
- **Apply for more time – perhaps 1-2 nights every 6 months. Not guaranteed.**