Near **E**arth **O**bject **Wide**-field **I**nfrared **S**urvey **E**xplorer (NEOWISE)

2015 Data Release

Scheduled for 26 March 2015

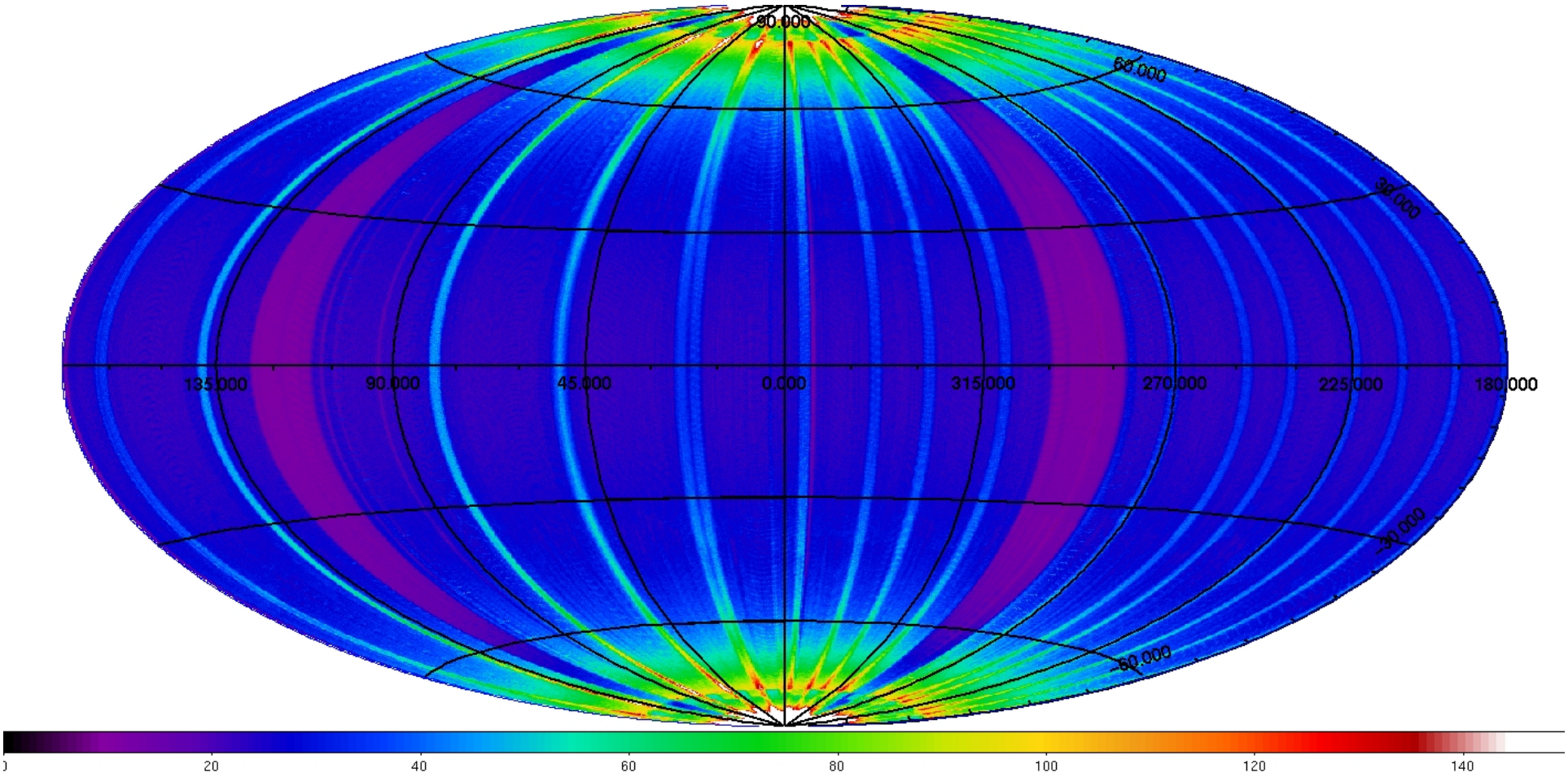
NEOWISE 2015 Release Overview

- **3.4 μm (W1) and 4.6 μm (W2)** images and extracted source information from the first year of the NEOWISE Reactivation mission
  - 13 Dec. 2013 through 13 Dec. 2014
- **Multiple, independent observations** of each point on the sky
- **Time-domain resource** to obtain positions and thermal infrared fluxes for solar system small bodies, as well as variability and motion studies of galactic and extragalactic sources
- Includes all Single-exposure images and source measurements, **regardless of quality**
  - Metadata provided to discriminate between good and poor data
- Data access via the **Infrared Science Archive (IRSA) and the IAU Minor Planet Center** using same tools available for the original WISE/NEOWISE mission data (*see IRSA demonstration by L. Rebull*)

NEOWISE 2015 Release Products

- **Single-exposure Image Sets**
  - **2,497,867** calibrated 1016x1016 pix FITS @ 2.75”/pix for each 7.7 sec exposure
  - W1 and W2 Intensity images, Uncertainty maps, Bit-masks
- **Single-exposure Source Database**
  - Position and W1/W2 flux information for **18,468,575,596** detections made on the individual Single-exposure images
- **Moving Object Tracklets**
  - **~16,860** sets of Single-exposure detection position/time pairs linked by the WISE Moving Object Pipeline System, and reported to the IAU Minor Planet Center. **~134,373** detections of **10,102** objects.
- **Known Solar-system object Possible Association List**
  - **14,383,217** instances of known solar system objects predicted to be in the NEOWISE FOV during the Single-exposures

NEOWISE Year 1 Depth-of-Coverage



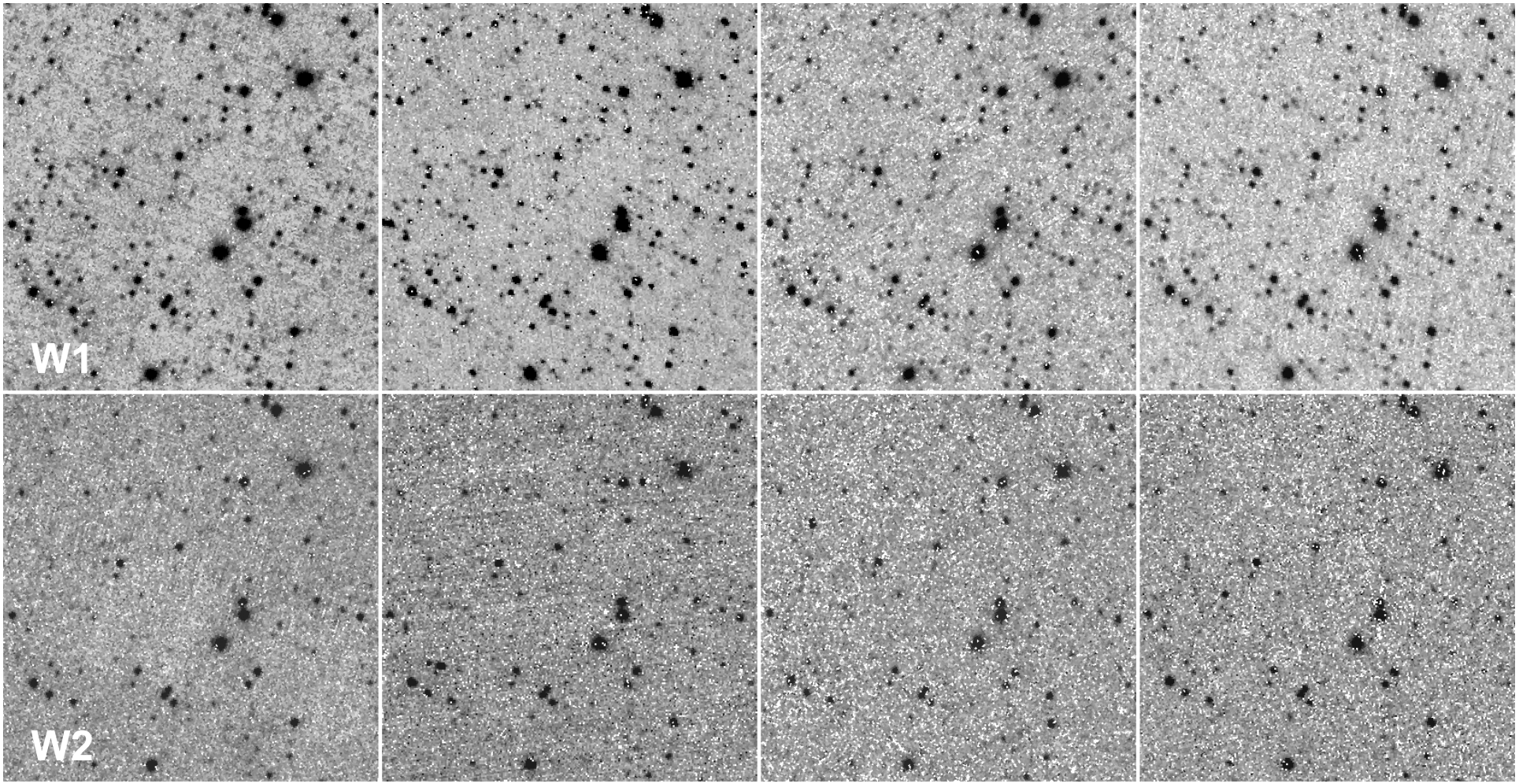
- Two inertial sky coverage epochs; six month baseline
- ~24 samples on the ecliptic plane; ~5300 at the ecliptic poles
- 8% of sky not surveyed in first epoch (April 4-23, 2014)

Data Processing Uses WISE System with Updates for NEOWISE

Updates include:

- **Instrumental calibrations**, adjusted over time to follow temperature variations
- Source extraction **PSF** templates derived from NEOWISE sky data
- **Photometric calibration** tied to AllWISE Source Catalog
- **Position reconstruction** with respect to 2MASS PSC sources adjusted for NEOWISE observation epoch using UCAC4.0 proper motions
- **Moving Object Pipeline System** parameters adjusted to optimize for W2 detections

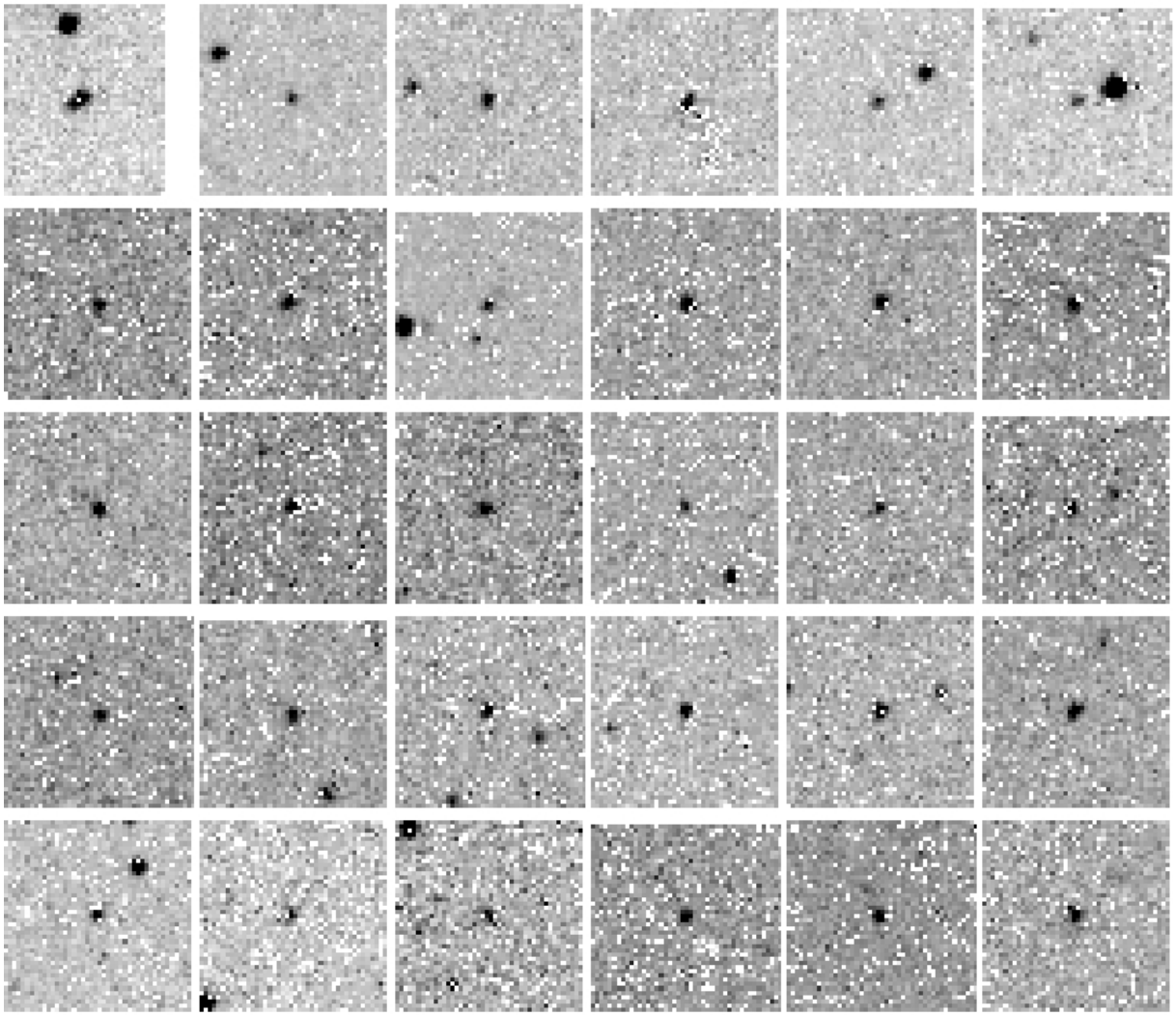
NEOWISE Data Quality Comparable to Original WISE Survey



3/1/2010	12/30/2010	4/25/2014	12/9/2014
Cryo	Post-Cryo	NEOWISE epoch 1	NEOWISE epoch 2

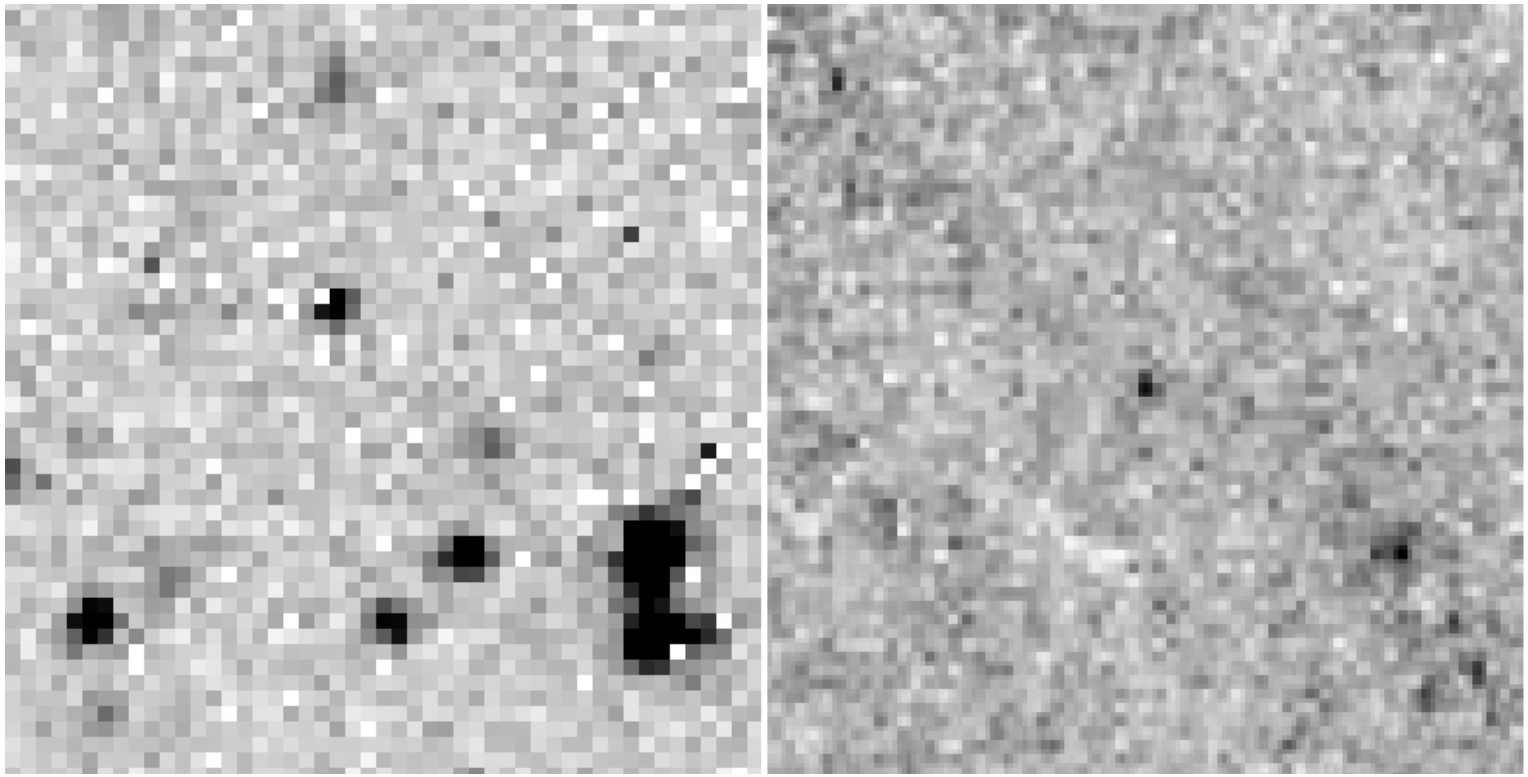
Single-exposure images showing 12’x12’ region near the north ecliptic pole

Solar System Object Images for Recovery, Pre-covery and Analysis



- W2 Single-exposure images of 2005 UP156 (2'x2' sections)
- 30 separate observations during 4-7 July 2014 encounter

Image Stacking to Detect Faint Objects

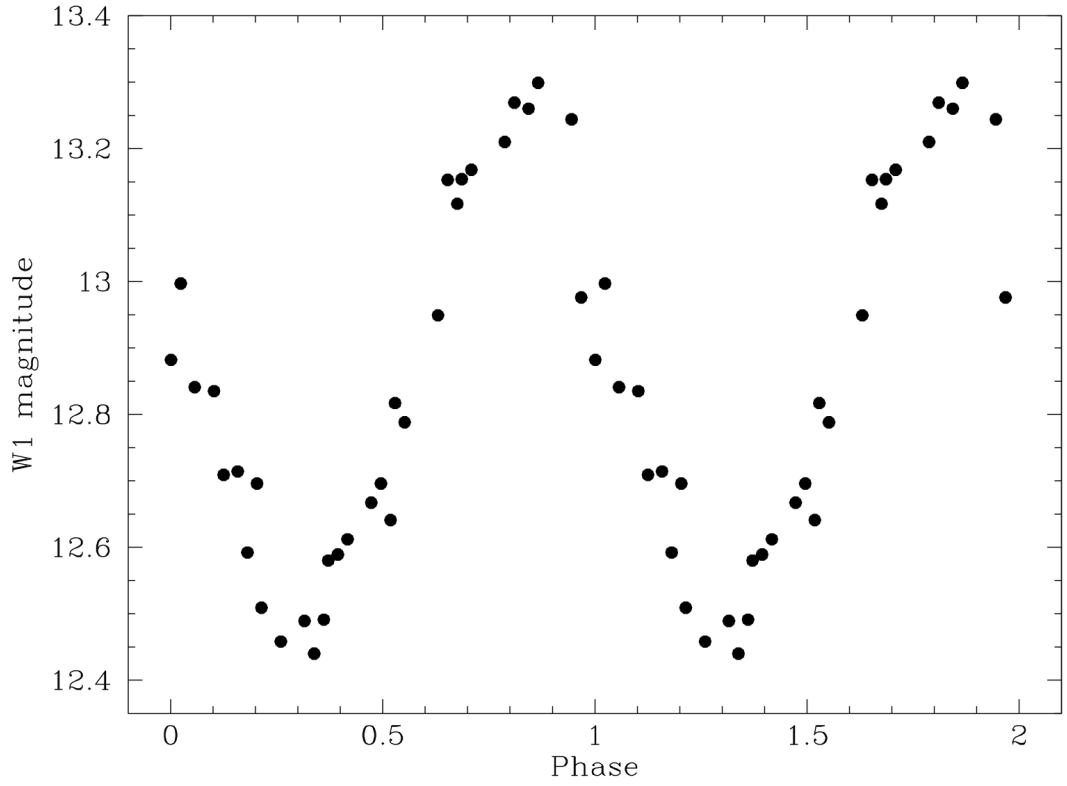


W1 Single-exposure – no detection at expected asteroid position

W1 “Moving” coadd of 15 Single-exposure objects. Positions from KSSOPAL – clear W1 detection

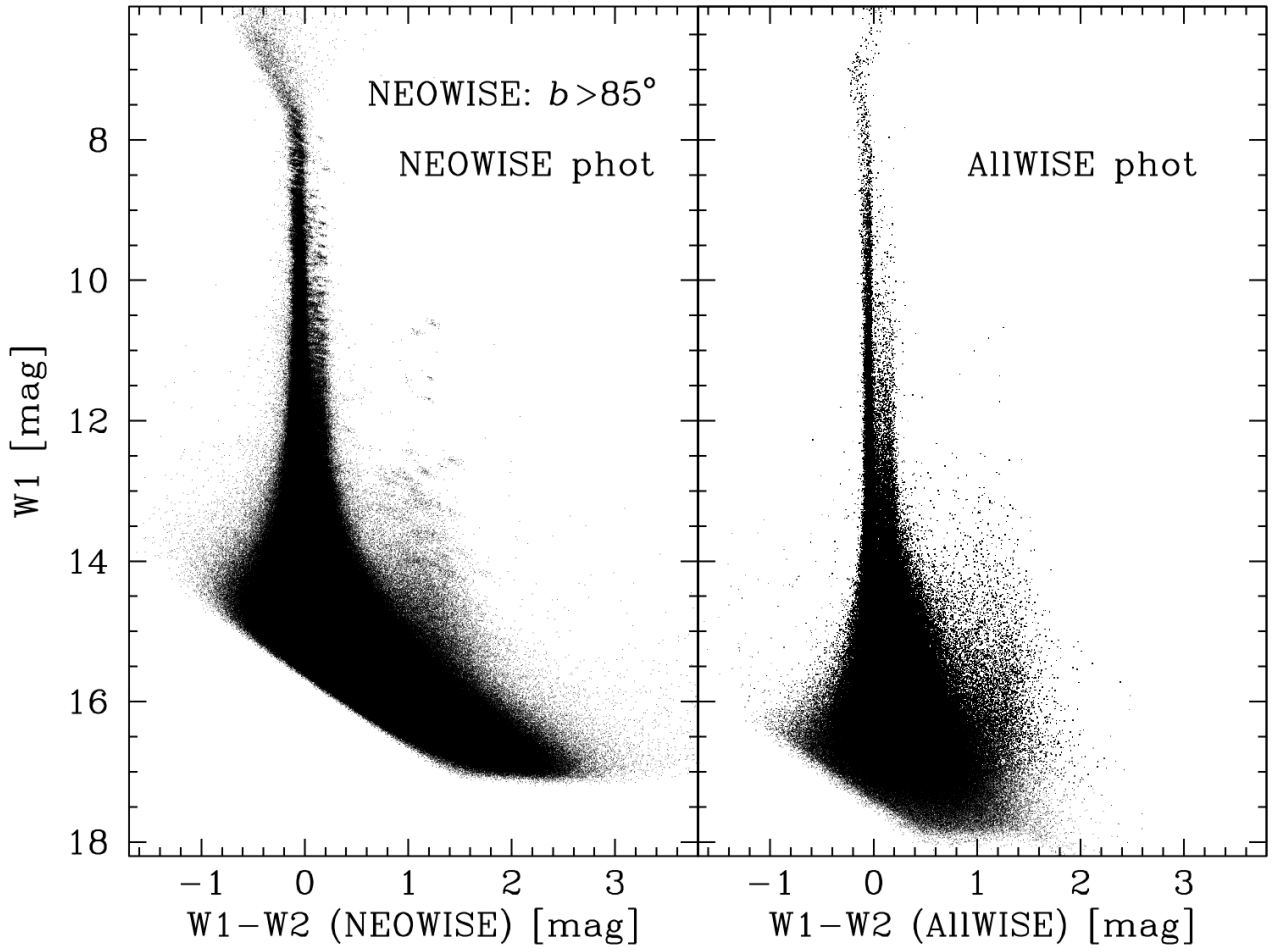
2’x2’ images of centaur 2008 YB3 (Bauer et al. 2013)

Single-exposure DB is a Resources for Solar System Object Measurements and Time-Domain Analyses



- NEOWISE phase-folded W2 light curve of asteroid 2005 UP156 using Single-exposure DB photometry (P=0.8362 days)
- (*also talks by S. Sonnett, F. Masci, and poster by J. Rich et al. for more on flux variability*)

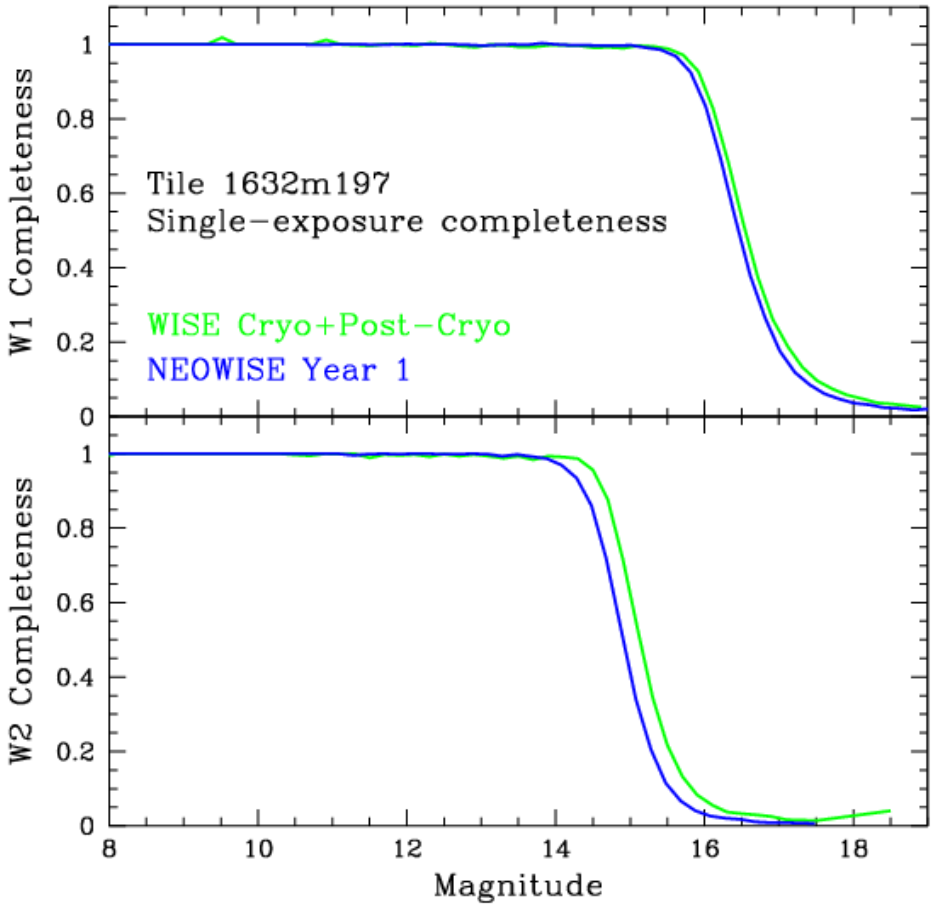
Most Single-exposure DB Detections are Inertial Background Sources



AllWISE Catalog associations provided for each Single-exposure DB entry (W1/W2/W3/W4)

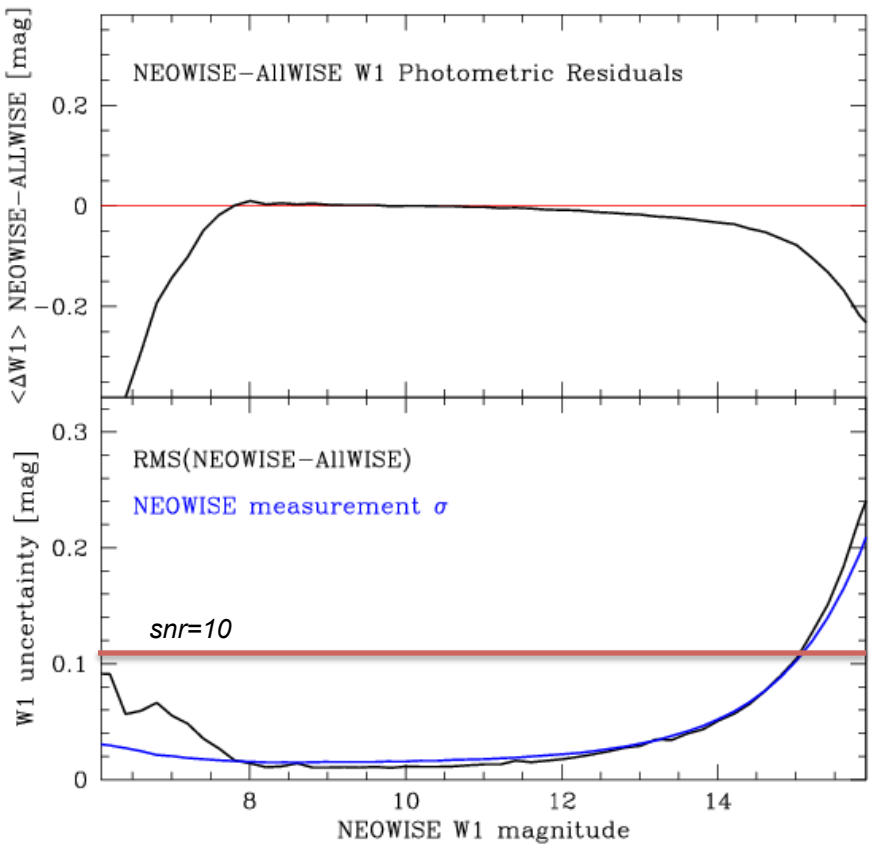
CMD for NEOWISE DB entries at NGP. (left) NEOWISE DB photometry. (right) AllWISE photometry for same sources.

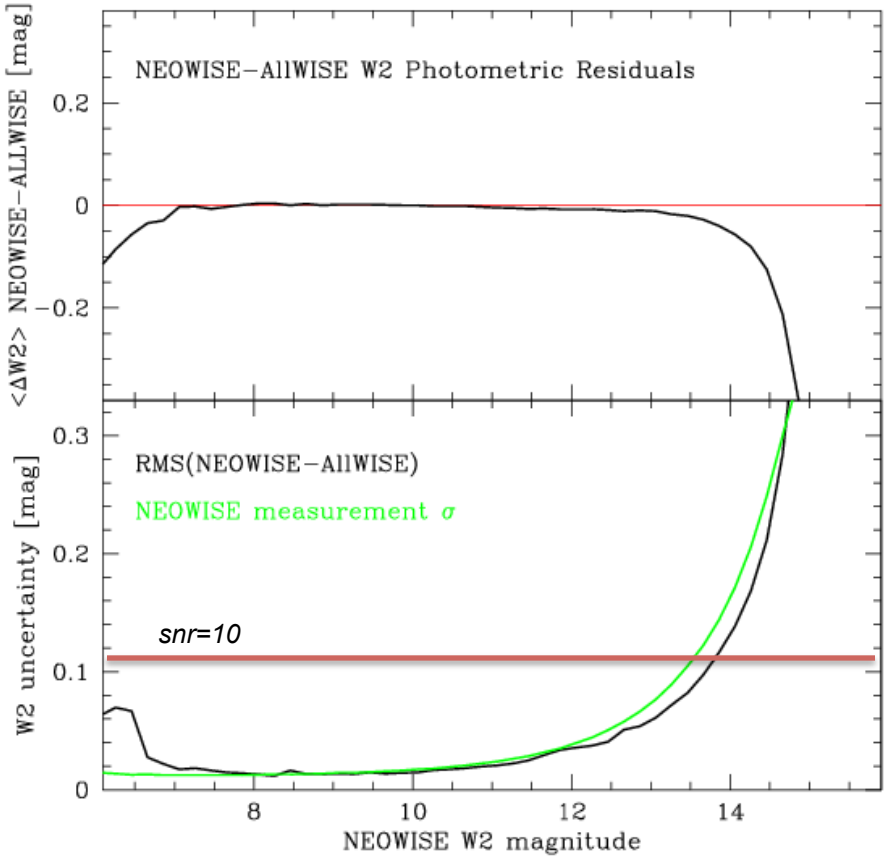
Single-exposure Detection Completeness: 90% @ W1 < 15.8, W2<14.4 mag



- Within 0.1 and 0.3 mag (W1, W2) of the completeness during the original WISE survey
- Internal, differential completeness measured using repeated observations of the same objects (Ndet/Nobs)

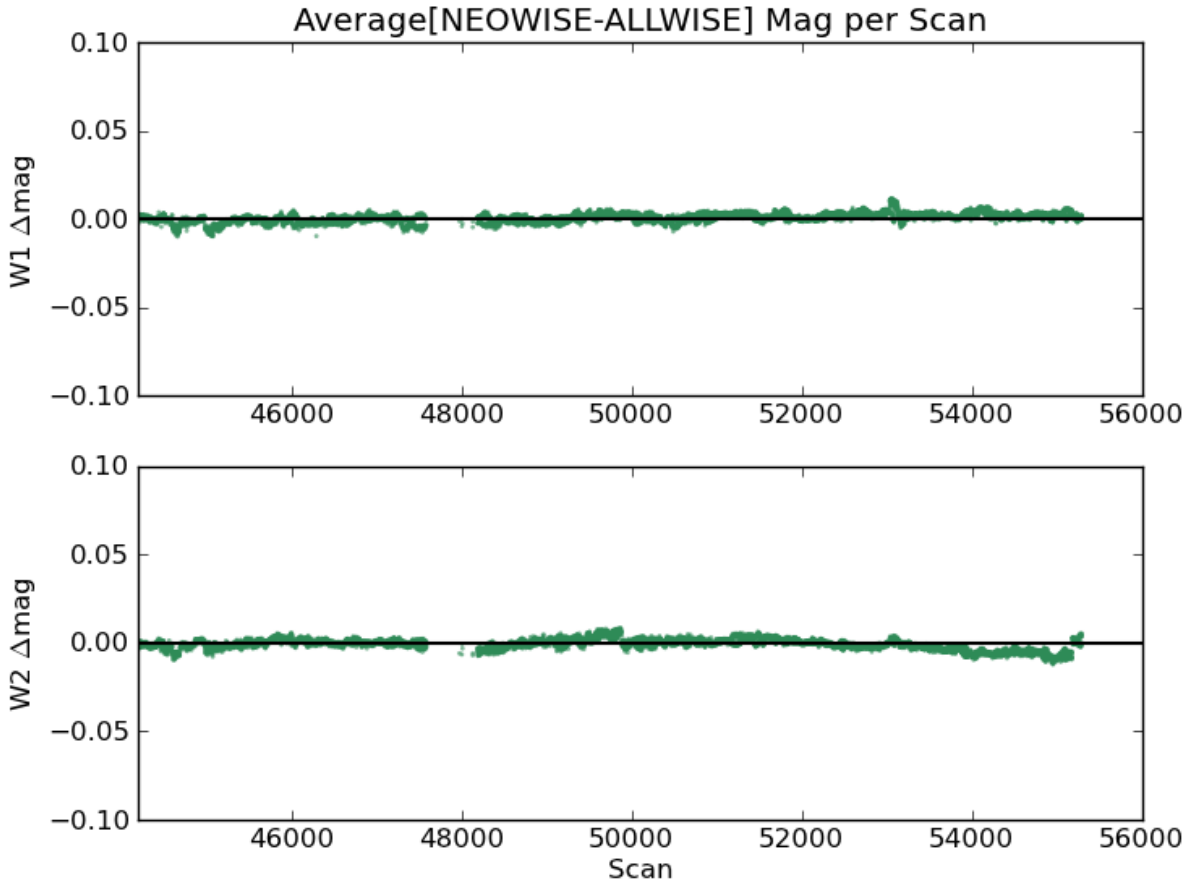
Single-exposure Sensitivity: SNR=10 @ W1=15.0, W2=13.7 mag





- (top) Mean NEOWISE DB – AllWISE Catalog photometric residuals for sources with b>85^{o}
- (bottom) Black lines: RMS of NEOWISE-AllWISE residuals. Blue/green lines: mean NEOWISE measurement uncertainties

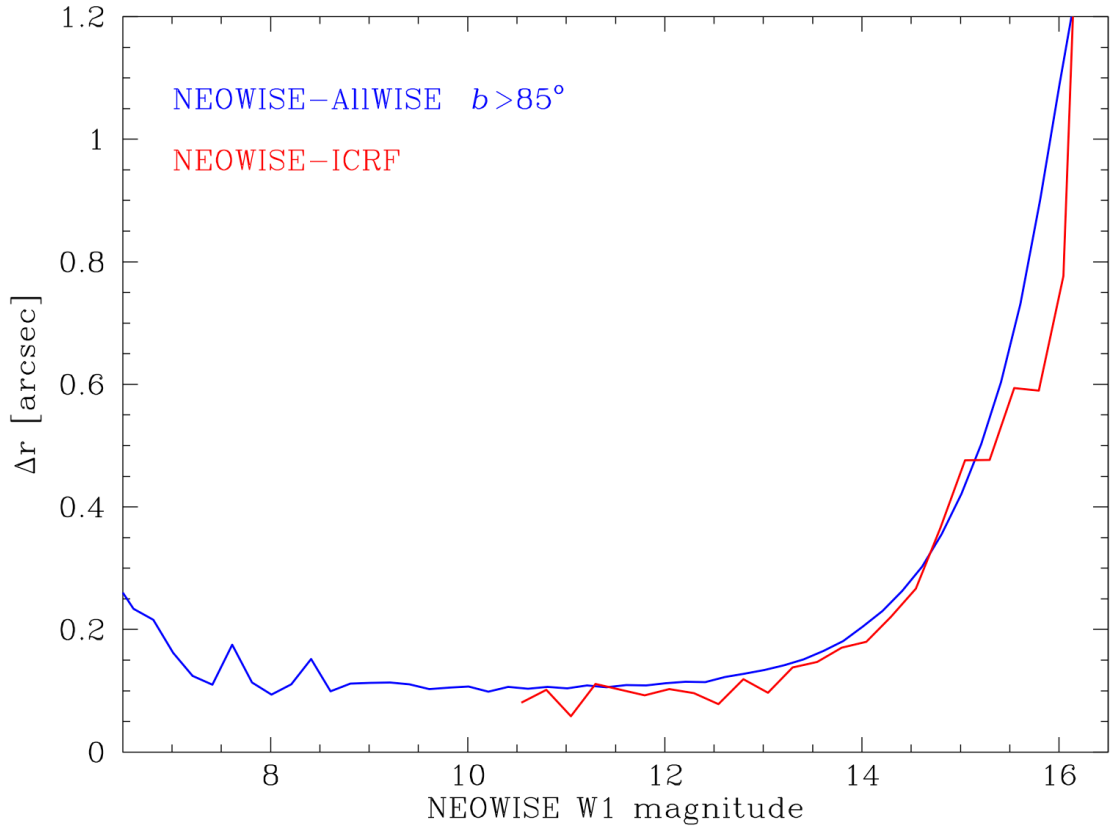
Photometric Zero Point Stable to <1%



- NEOWISE photometry calibrated to AllWISE Source Catalog
- Residuals <0.01 mags
- Small variations and features related to detector temperature variations and flight system events

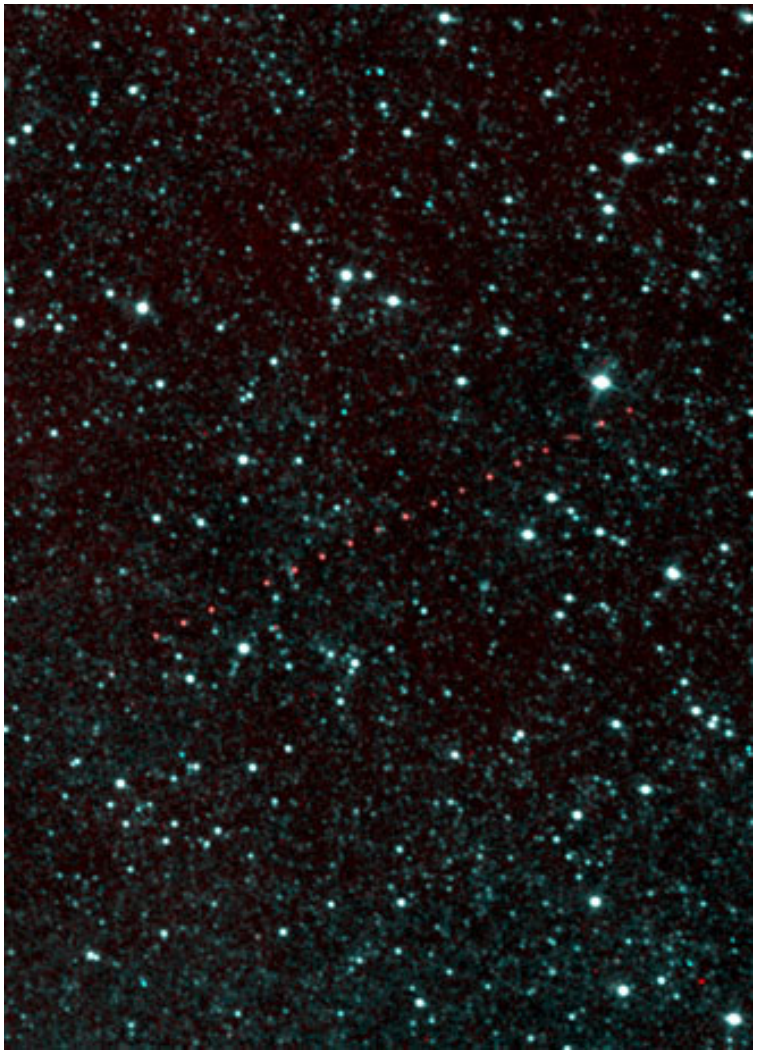
Average difference between NEOWISE Single-exposure and AllWISE Source Catalog photometry as a function of scan number (time). Each point computed using thousands of high SNR measurements.

Astrometry Accurate to 100 mas for High SNR Sources



Mean radial offsets between NEOWISE Source DB positions and (red) ICRF reference source position, and (blue) AllWISE Source Catalog positions, as a function of NEOWISE W1 magnitude.

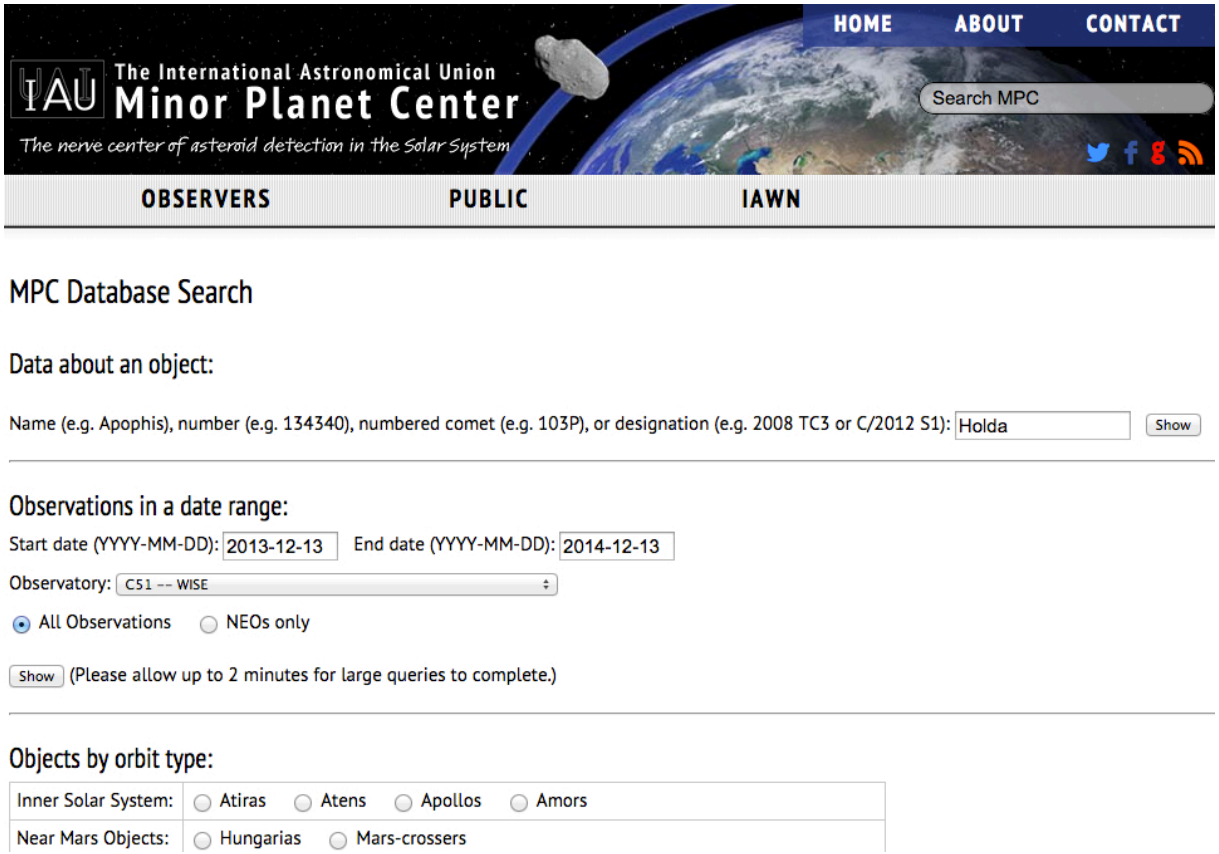
Moving Object Tracklets Are Vetted NEOWISE Solar System Object Detections



(872) Holda tracklet observed on first day of NEOWISE Reactivation survey

- Sets of Single-exposure detection position/time pairs linked by WISE Moving Object Pipeline System, reported to the IAU Minor Planet Center (MPC)
- MPC vets candidate tracklets by linking to existing and new observations
- **16,860 tracklets** reported to the MPC between mid-December 2013 and 13 December 2014.
- **Confirmed 134,373 detections of 10,102 objects**

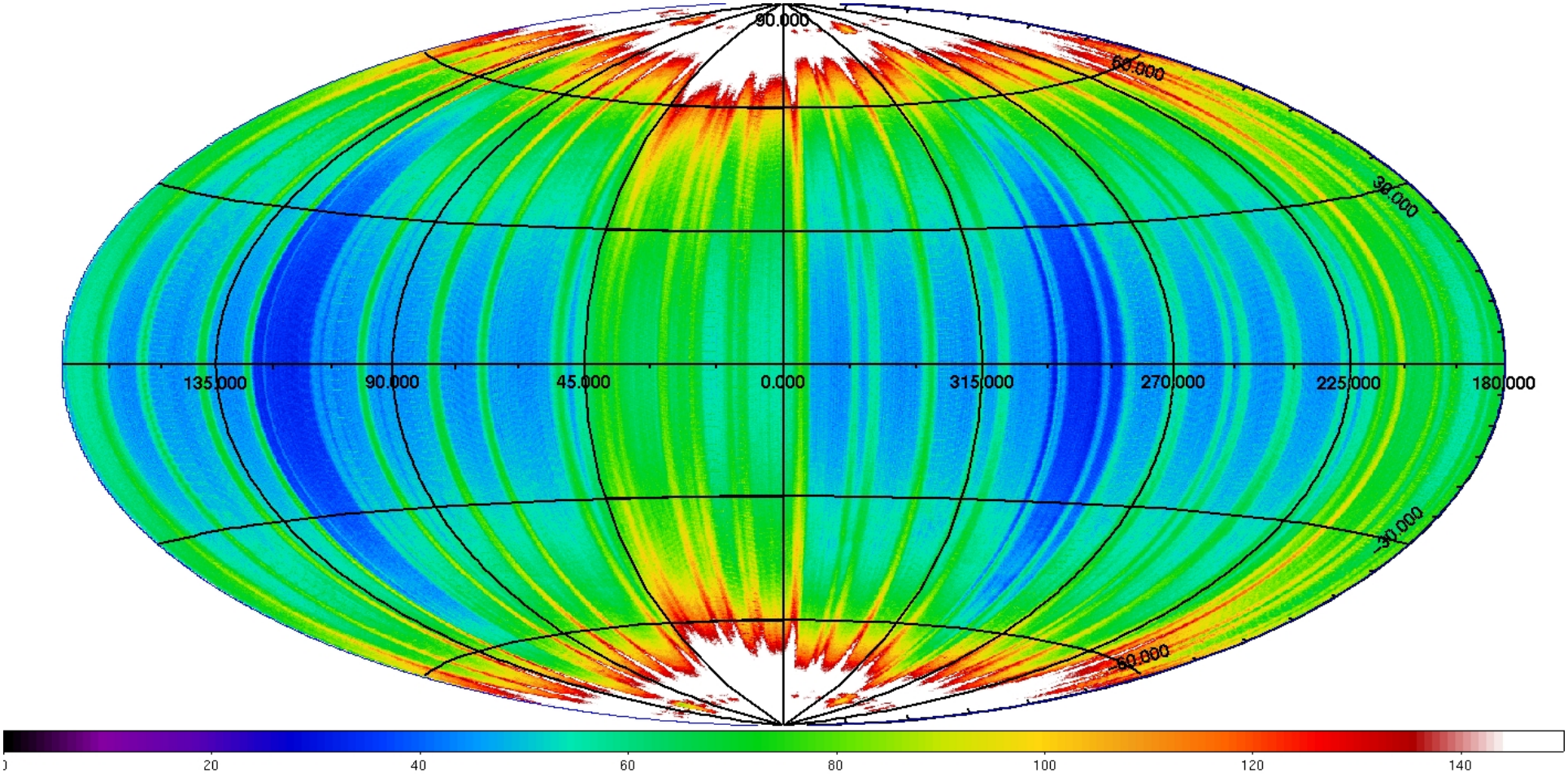
Retrieve Moving Object Tracklets Using the MPC Observation Database



- Search by object name,
- Date range: 2013-12-13 to 2014-12-14
- Identify NEOWISE observations using Observatory code: C51 (WISE)

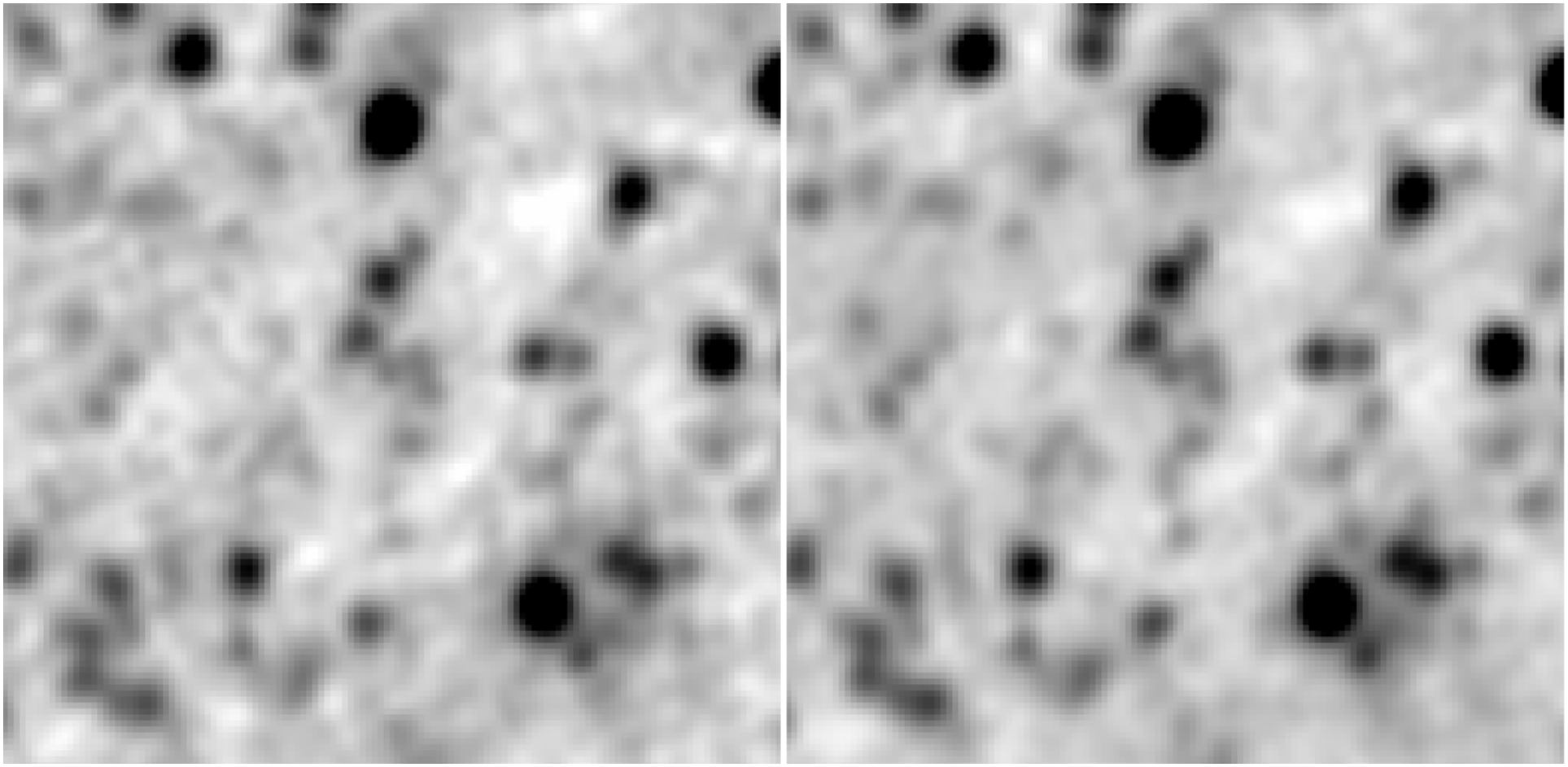
- Use returned positions and times of NEOWISE (C51) observations to search Single-exposure Source DB via IRSA to retrieve flux and measurement quality information

Single-exposure Depth-of-Coverage
WISE + NEOWISE Year 1



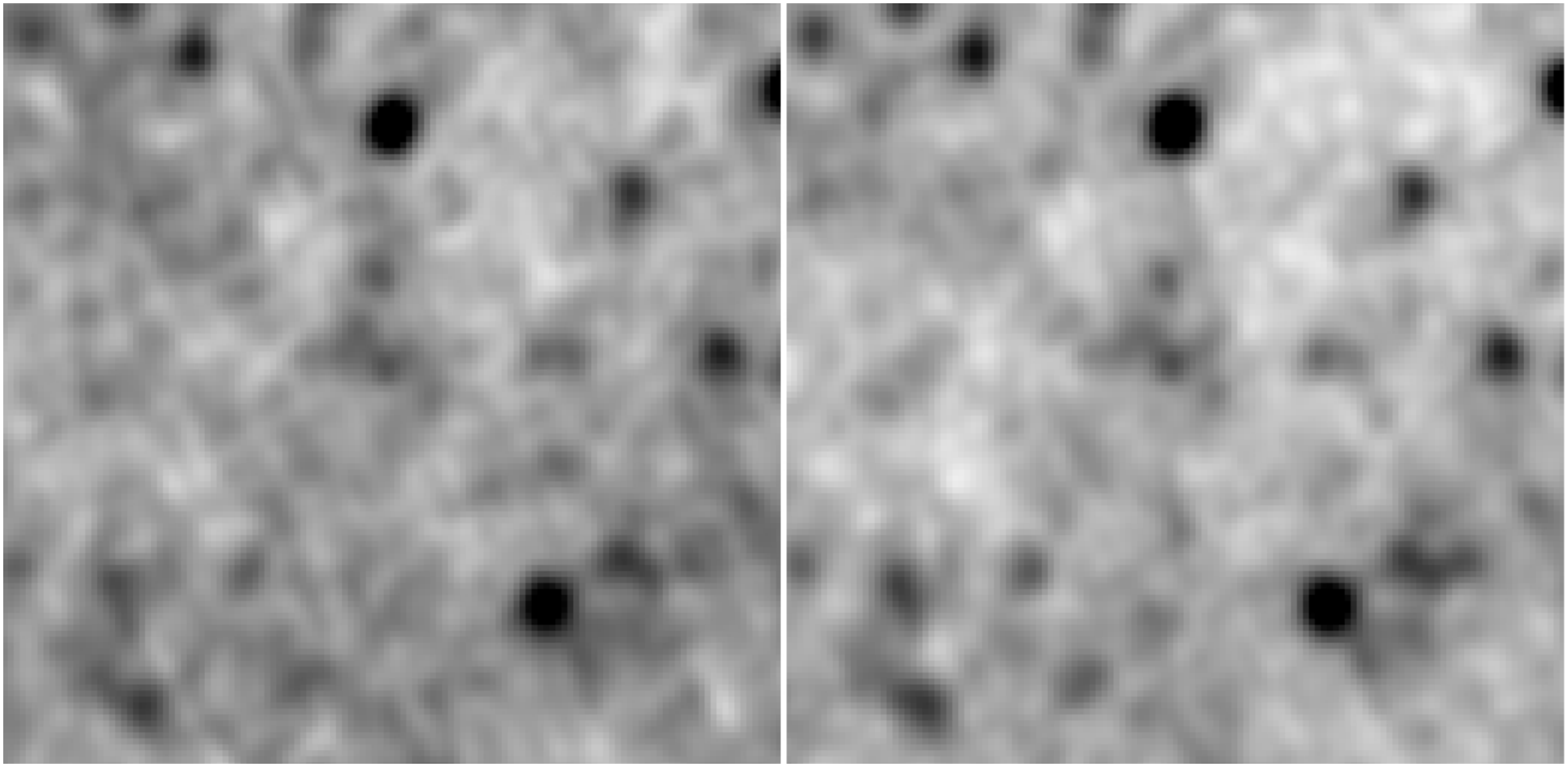
- Four epochs; four year baseline
- ~48 samples on the ecliptic plane; ~11,000 at the ecliptic poles

Increase Photometric Sensitivity By Combining WISE/NEOWISE Data



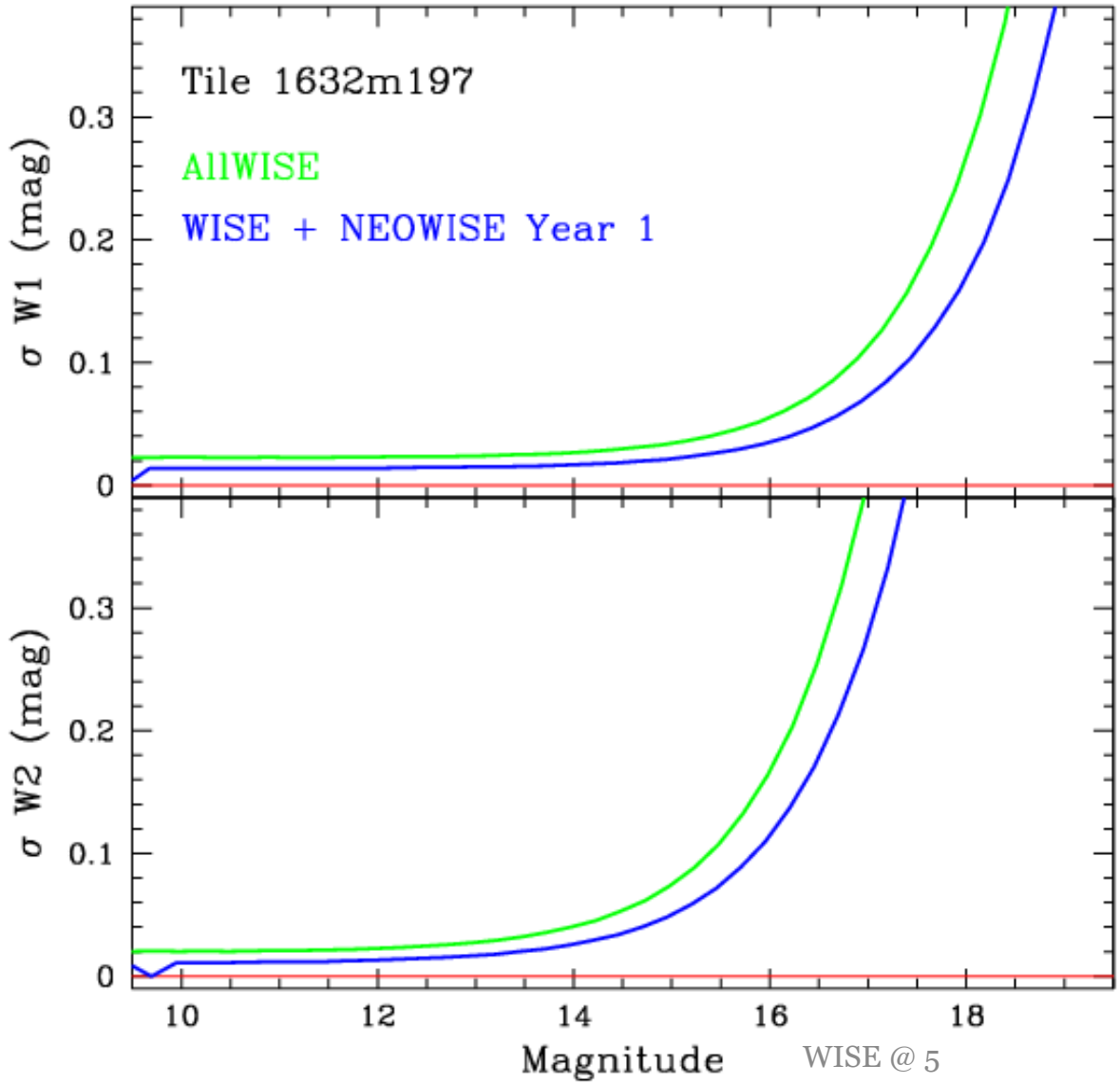
Coadded W1 images: (left) AllWISE; (right) AllWISE+NEOWISE Year 1

Increase Photometric Sensitivity By Combining WISE/NEOWISE Data



Coadded W2 images: (left) AllWISE; (right) AllWISE+NEOWISE Year 1

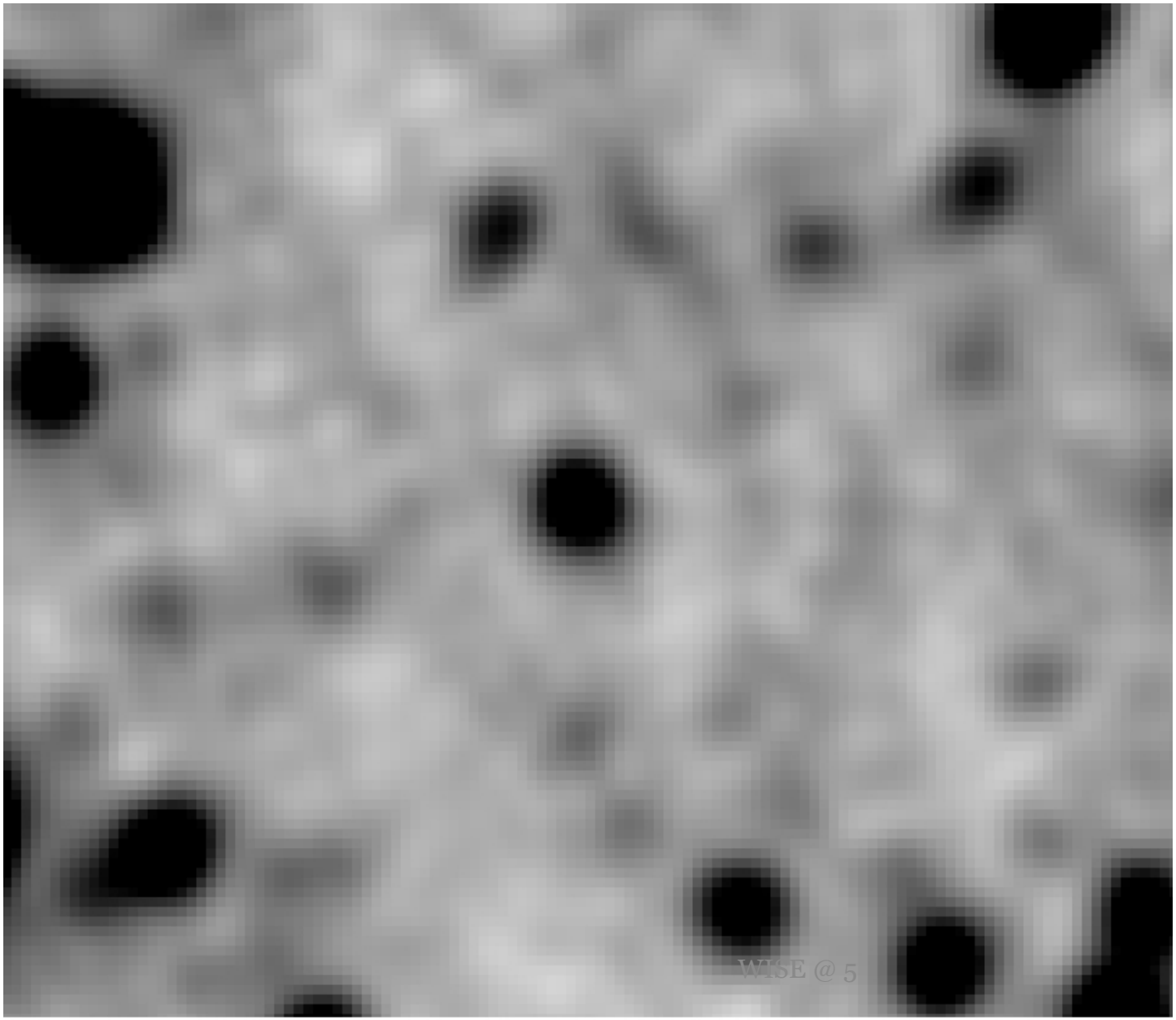
Increased Photometric Sensitivity with 2x epochs



Average photometric measurement uncertainty as a function of magnitude from coadded images

See MaxWISE poster by P. Eisenhardt

Additional Observation Epochs Enable Small Motion Detection



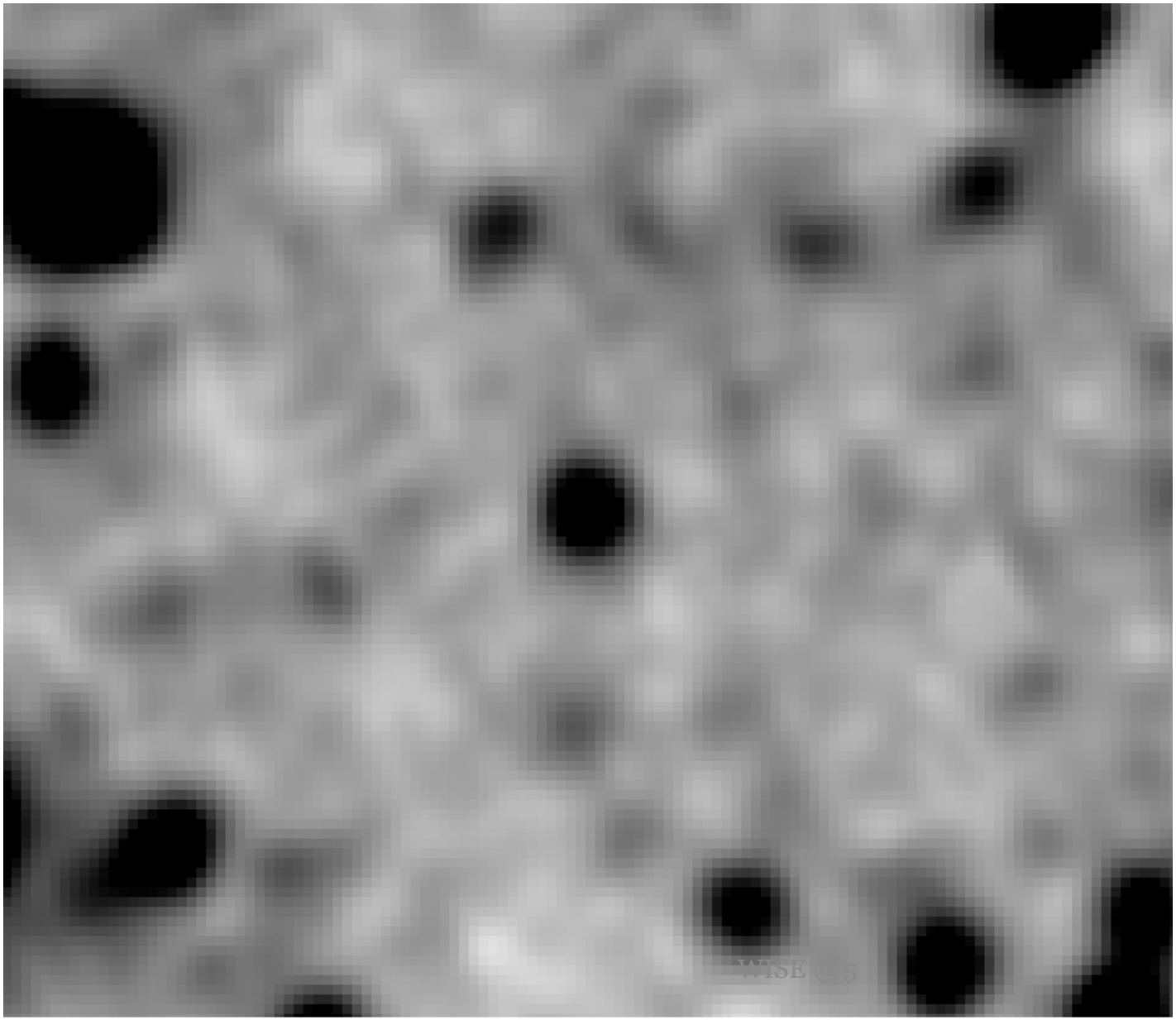
AllWISE coadded W2 Atlas Image of nearby brown dwarf (talk by A. Schneider)

2 epochs, 6 month baseline motion fit (AllWISE):

μ_α= 889±419mas

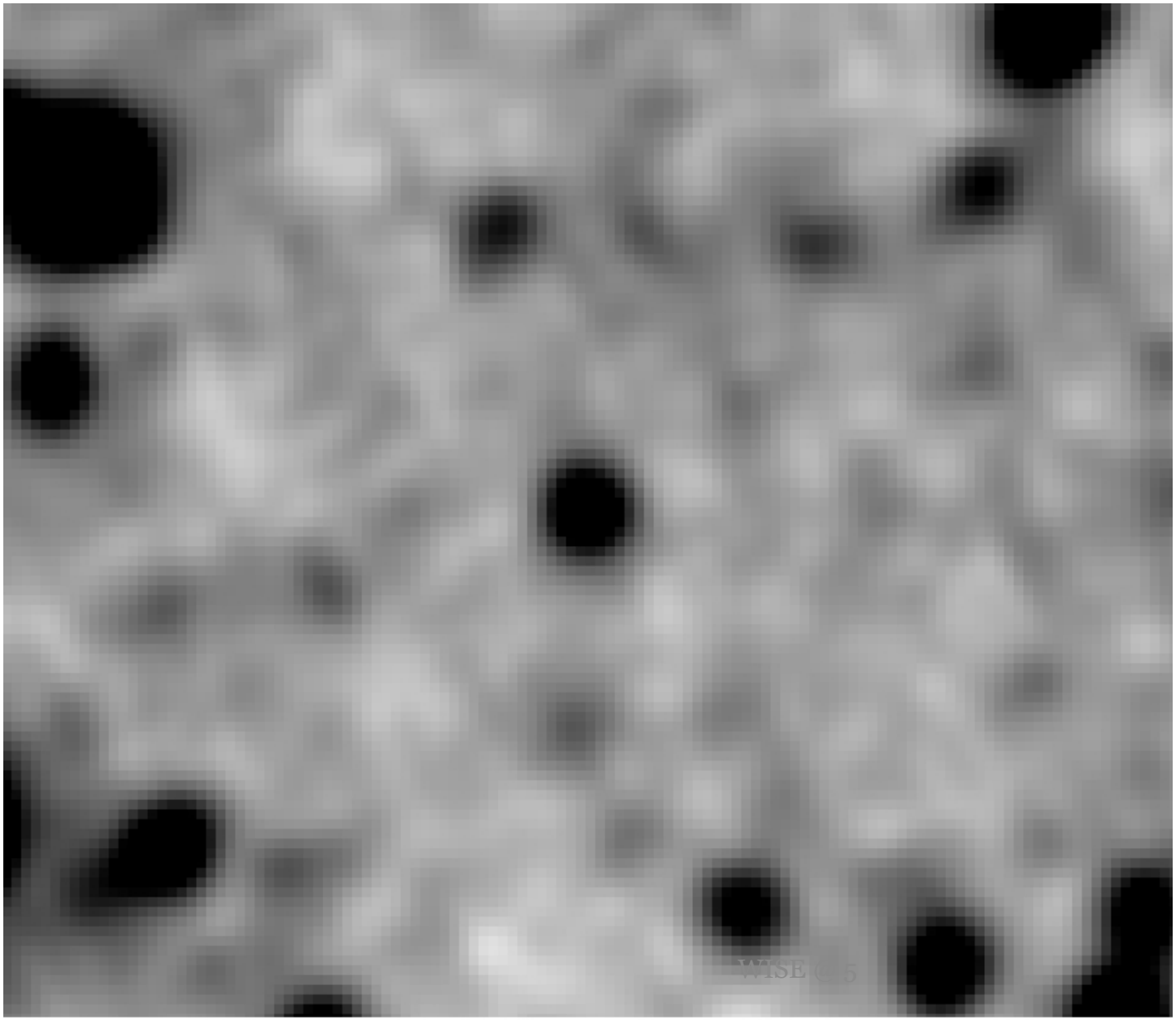
μ_δ=-222±454 mas

Additional Observation Epochs Enable Small Motion Detection



NEOWISE Year 1 coadded W2 Image of nearby brown dwarf

Additional Observation Epochs Enable Small Motion Detection



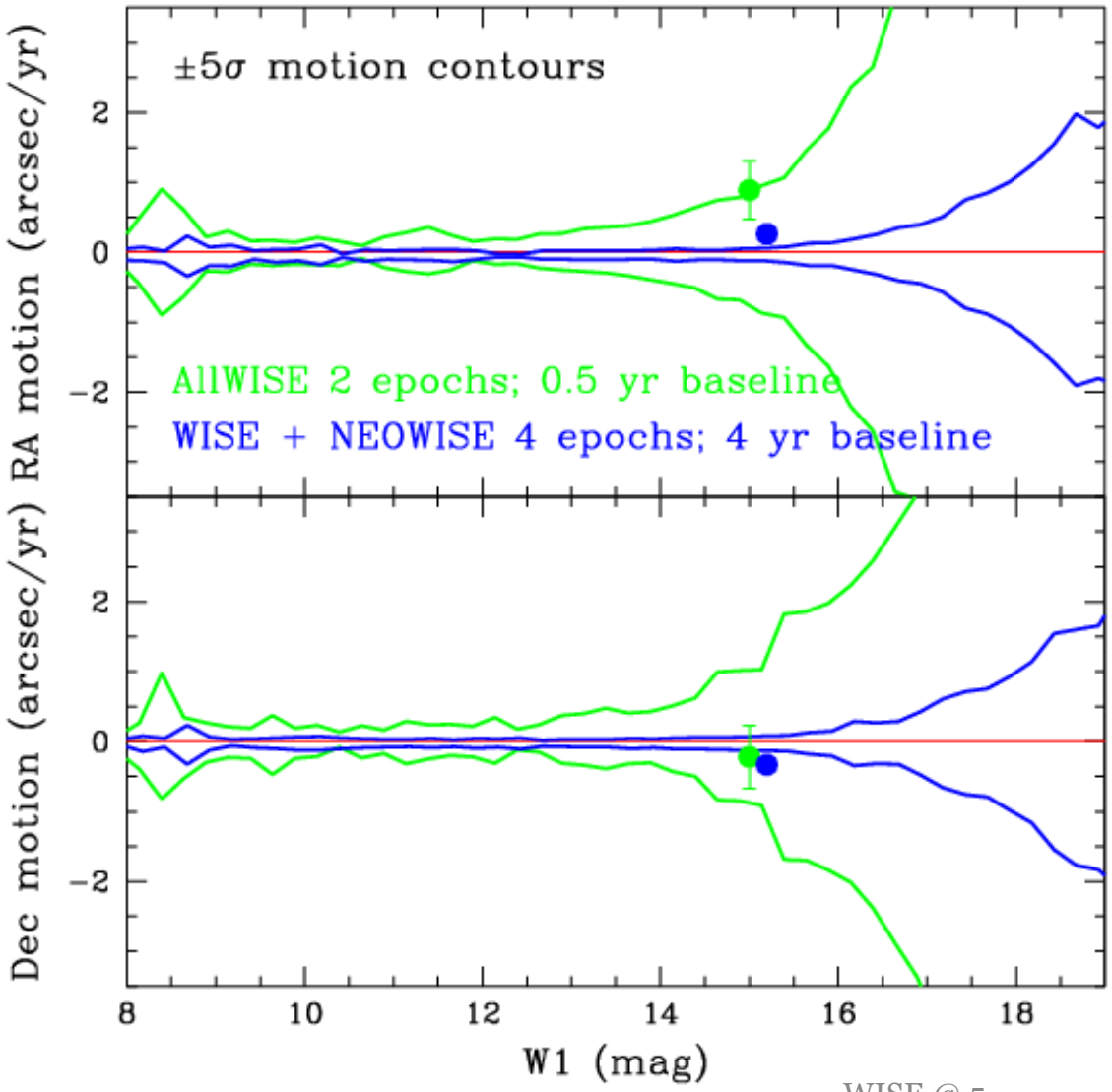
NEOWISE Year 1 coadded W2 Image of nearby brown dwarf

4 epochs, 4 year baseline motion fit (WISE+NEOWISE):

μ_α= 262±43 mas

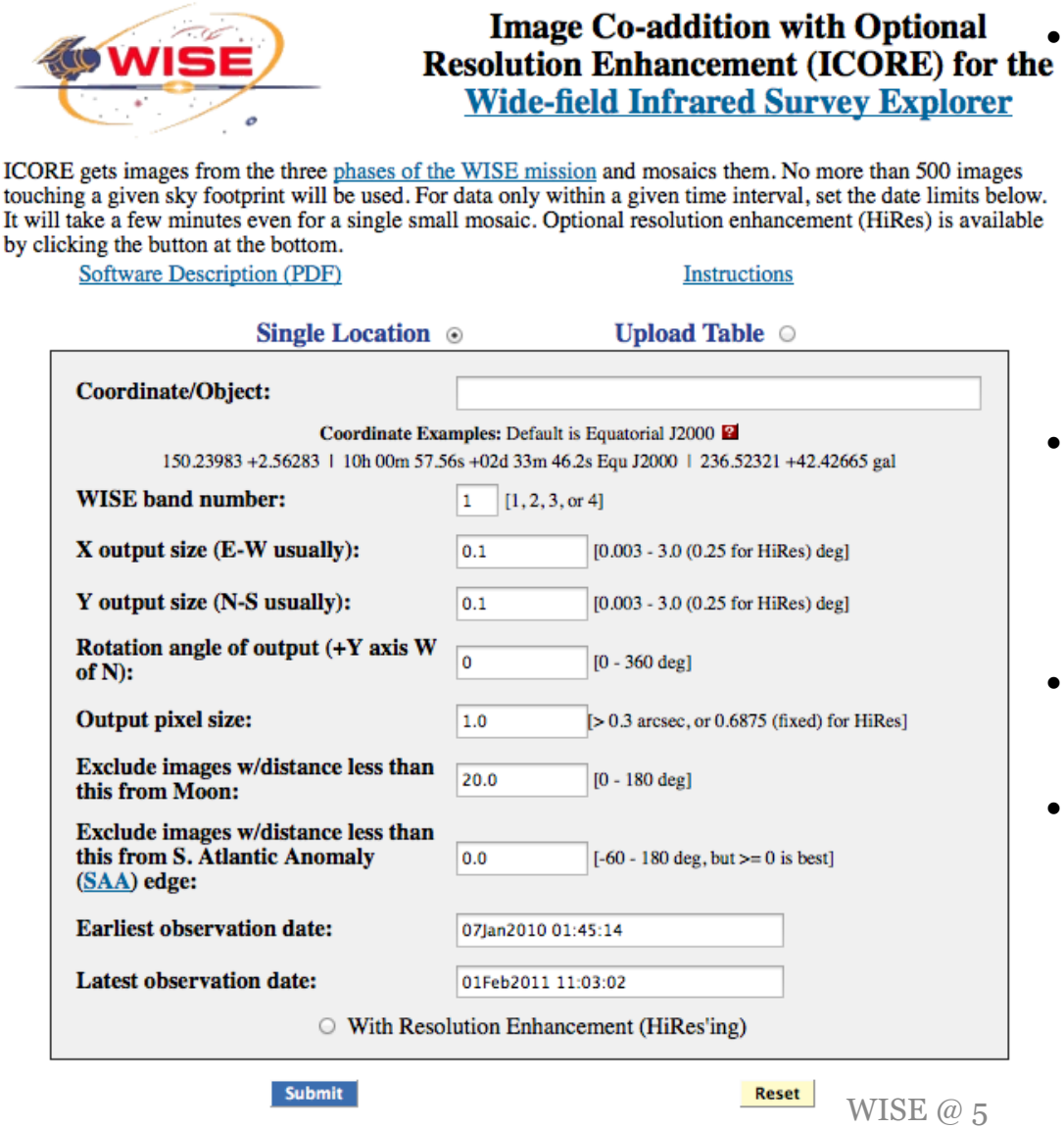
μ_δ=-334±47 mas

Improved motion measurement accuracy from 4-year baseline and 2x more samples



5-sigma motion measurement derived for source that had <2-sigma motion in AllWISE catalog

IRSA's Custom WISE/NEOWISE Image Coaddition Tool



- Create custom coadded images by combining Single-exposures from original WISE and NEOWISE Year 1 surveys
  - Specify footprint, projection, scale
  - Specify subset of images to combine by observation time
- Utilizes coaddition routine that is the same as used for WISE Atlas Image generation
  - ICORE (F. Masci)
- Option to include Resolution Enhancement
- Initial release enables static position coadds. Future versions will enable "moving" coadds.