GLIMPSE-I versus WISE All-Sky Catalog

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Summary

- Obtained 719,531 matches between the GLIMPSE-I "reliable" catalog and WISE All-Sky (cryo mission) catalog in galactic plane ($|b| < 2.5°$, $295° < l < 65°$).
- Due to shear size, a random subset of the GLIMPSE-I catalog (2 million sources) was used.
- Constraints on WISE Catalog sources:
  - no upper limits on band 1 and 2 fluxes
  - avoid spurious detections in bands 1 and 2 from instrumental artifacts
  - avoid any instance of saturation in cores of band 1 and 2 sources
  - **note selection effect from** 5σ flux cut in either WISE band 1 or 2 - implicit in catalog
- We compared GLIMPSE IRAC bands: I1, I2 ~ 3.6, 4.5um to WISE bands: W1, W2 ~ 3.4, 4.6um
- WISE beam FWHM (W1 & W2) ~ 6 arcsec; I1 ~ 1.66 arcsec; I2 ~ 1.72 arcsec.
- All photometry (GLIMPSE & WISE) is from PSF-fitting – crucial for deblending!
- **NOTE**: All-Sky WISE Catalog spans ~ 10 – 25 frames deep (median ~ 15) across this l, b range.
  - but unlikely to get significant sqrt(*N*) improvement in S/N in galactic plane since we're confusion limited.

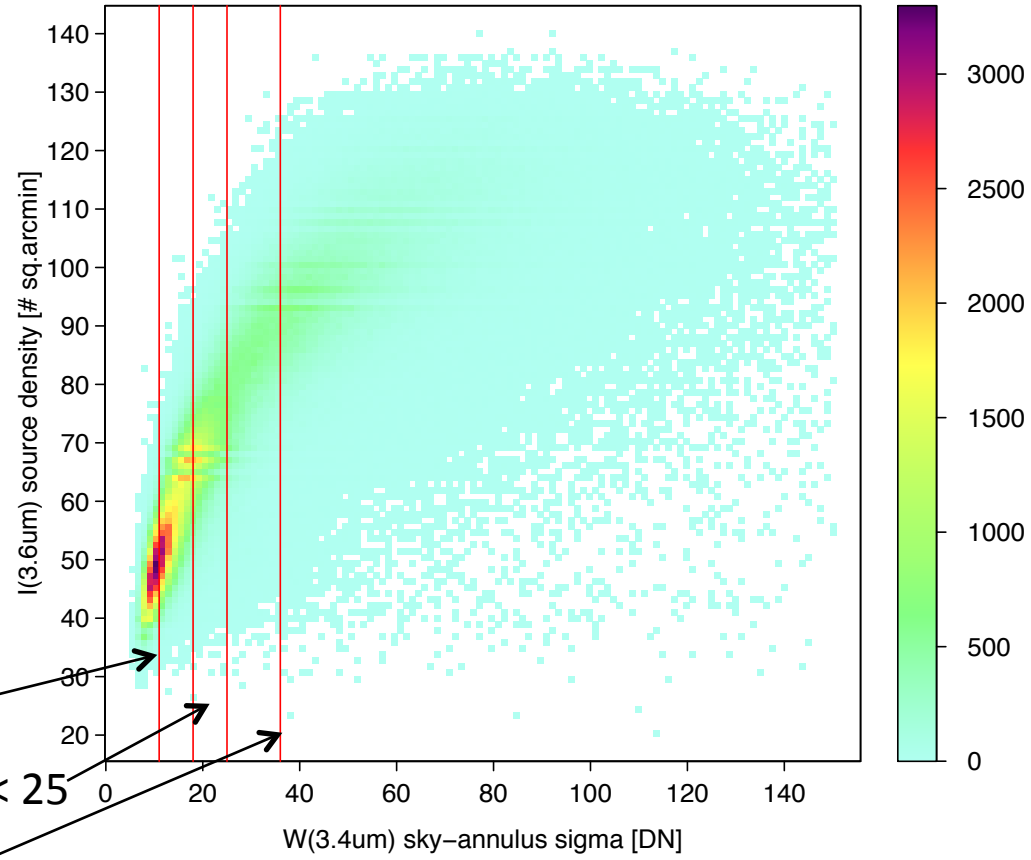
- **Conclusions:**
  - in highest source-density regions, GLIMPSE photometry can get us ~ 1.2/1.5 mag deeper at W1/W2 wavelengths for fixed S/N => equivalent to reduction in uncertainties by factors of 3 to 4!

    => translates to effectively I1 < 13.6, I2 < 13.4 for S/N > 10, where confusion-noise is included in S/N estimate.
  - In lower source-density regions (but still confusion limited), GLIMPSE can get us ~ 0.2 mag deeper at these wavelengths

    => translates to effectively I1 < 14.6, I2 < 14.4 for S/N > 10, where confusion-noise is included in S/N estimate.
  - in general, GLIMPSE appears to give us more accurate photometry across all source-densities in the galactic plane.
- For comparison, in unconfused regions (densities <≈ 10 sources arcmin^{-2}), we typically find S/N > 10 for W1 < 15 mag and W2 < 14.1 mag **on single exposures.** In these regions, sensitivity can be assumed to scale approximately as sqrt(*N*).

WISE source density indicator?

- Suitable source-density indicator on local scales not available in WISE Catalog
- Found that the RMS fluctuation in the sky (background) annulus around each WISE source to be a good proxy for local WISE source density
- Correlates with IRAC-1 source density reported in GLIMPSE catalog on ~2.5’ scales.
- We assume **three source-density regimes** for our photometric comparisons (labeled below).



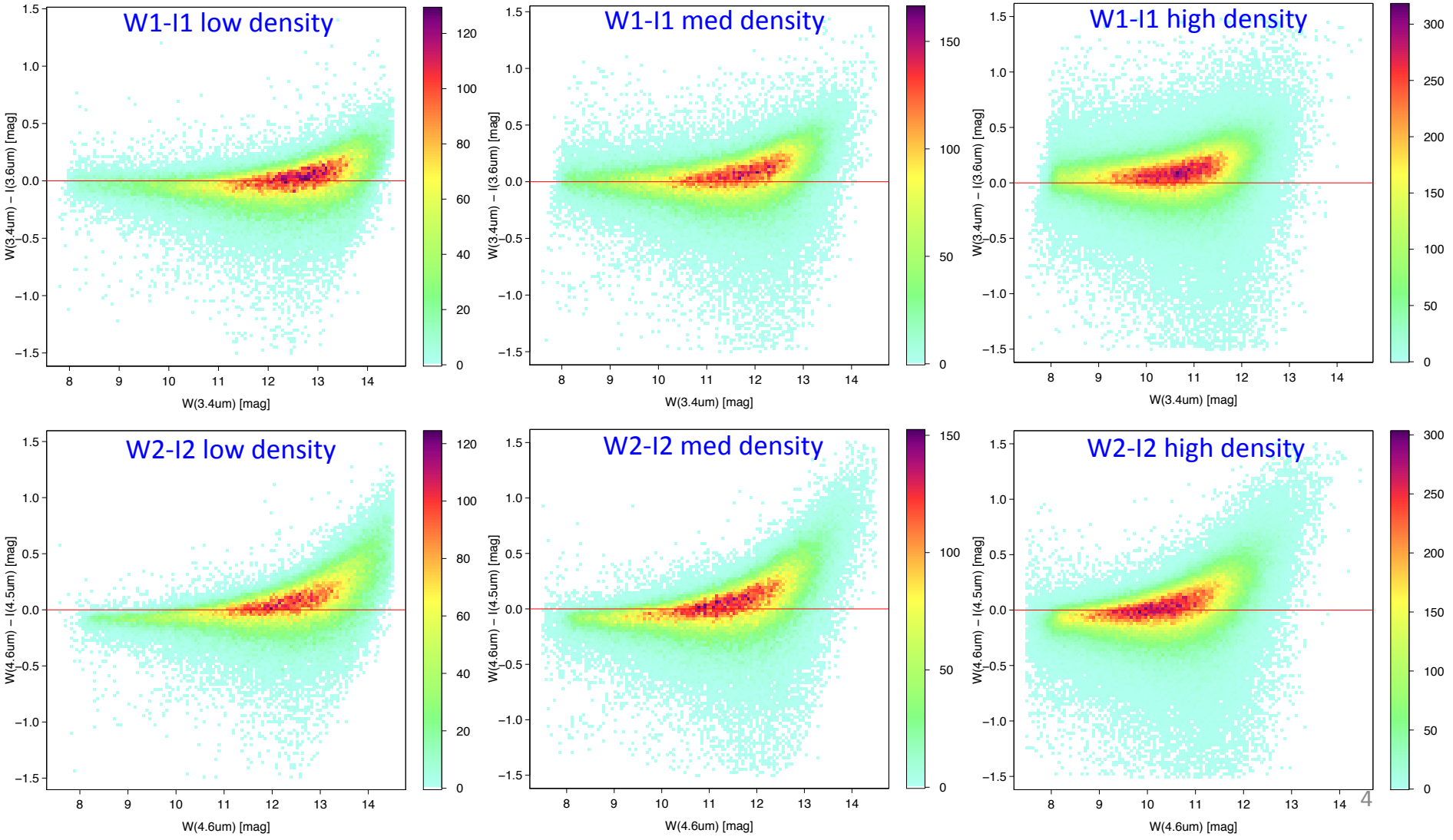
(1) low: σ < 11

(2) med: 18 < σ < 25

(3) high: σ > 36

“W1 – I1 versus W1” & “W2 – I2 versus W2”

- Scatter in magnitude differences increase towards higher source densities => WISE beam more “confused”
- Upturn in W? – I? towards faint magnitudes => known flux underestimation bias in WISE all-sky photometry(?)
- Photometry gets brighter towards higher source densities => fixed 5σ cut in WISE where σ includes confusion



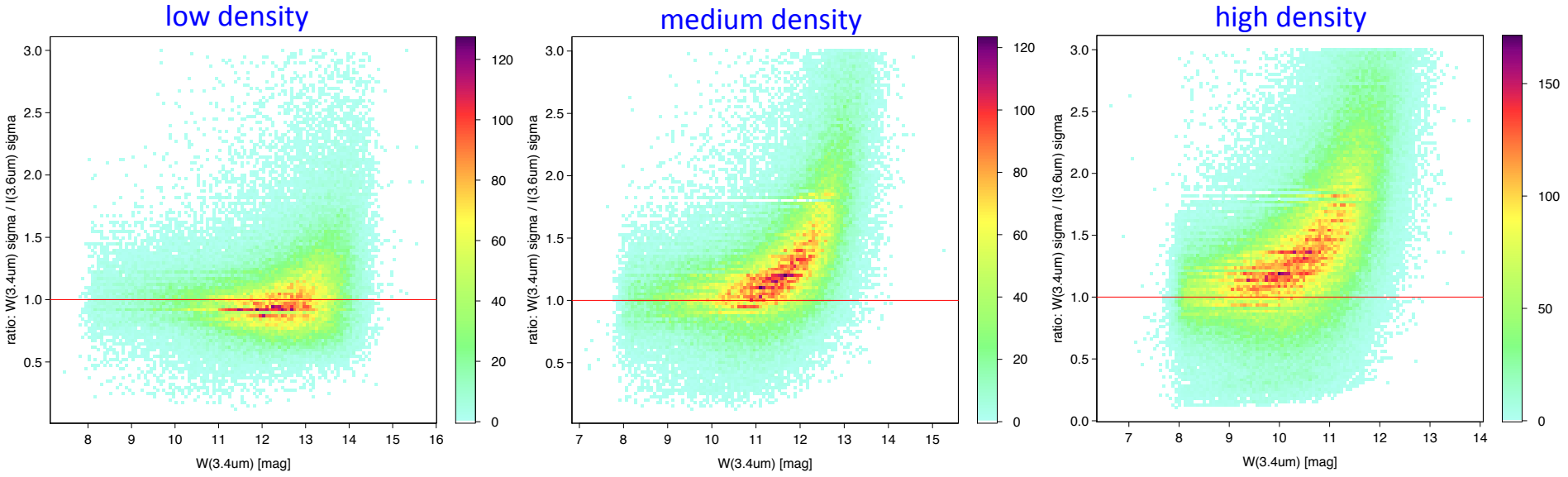
sigma ratio: σ[W1]/σ[I1] versus W1

- IRAC-1 mag uncertainties from GLIMPSE were first rescaled by x0.55 to conform with W1 at bright magnitudes
  - Otherwise, why would the IRAC fluxes be more uncertain than WISE in a highly confused region?
  - WISE uncertainties account for confusion noise. Not sure about IRAC uncertainties!
- Nonetheless, what matters is the dependence of this ratio versus magnitude => onset of confusion noise in W1
- WISE fluxes become relatively more uncertain than IRAC fluxes towards:

  (i) fainter fluxes;

  (ii) progressively higher source densities

  => consistent with confusion effects



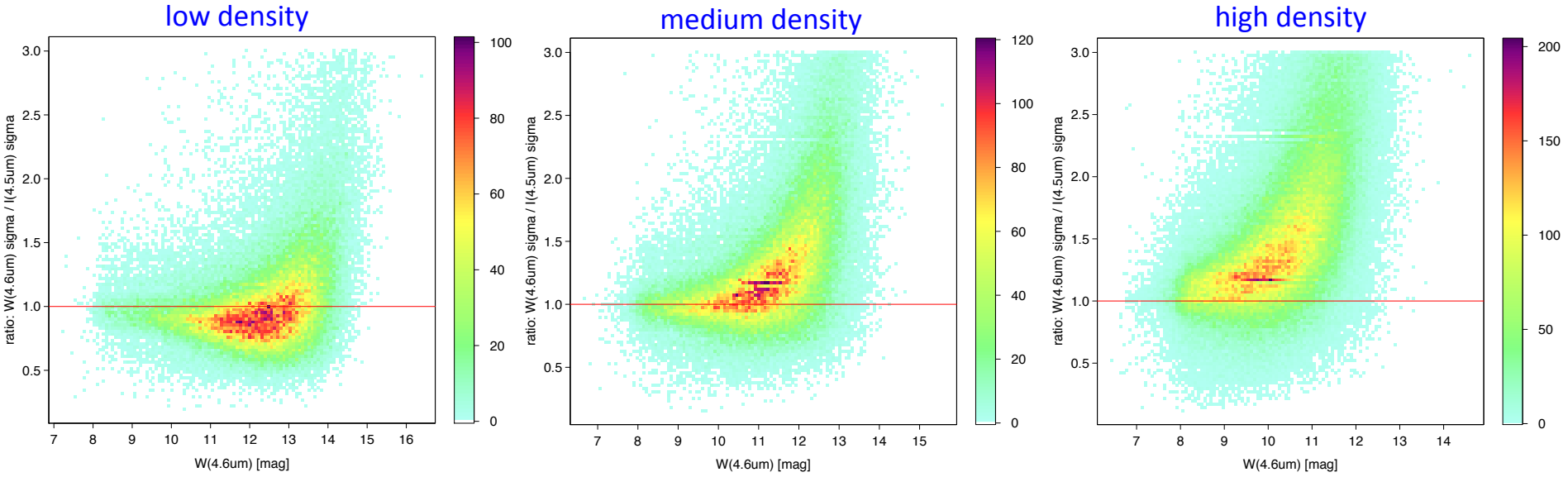
sigma ratio: σ[W2]/σ[I2] versus W2

- IRAC-2 mag uncertainties from GLIMPSE were first rescaled by x0.43 to conform with W2 at bright magnitudes
  - Otherwise, why would the IRAC fluxes be more uncertain than WISE in a highly confused region?
  - WISE uncertainties account for confusion noise. Not sure about IRAC uncertainties!
- Nonetheless, what matters is the dependence of this ratio versus magnitude => onset of confusion noise in W2
- WISE fluxes become relatively more uncertain than IRAC fluxes towards:

  (i) fainter fluxes;

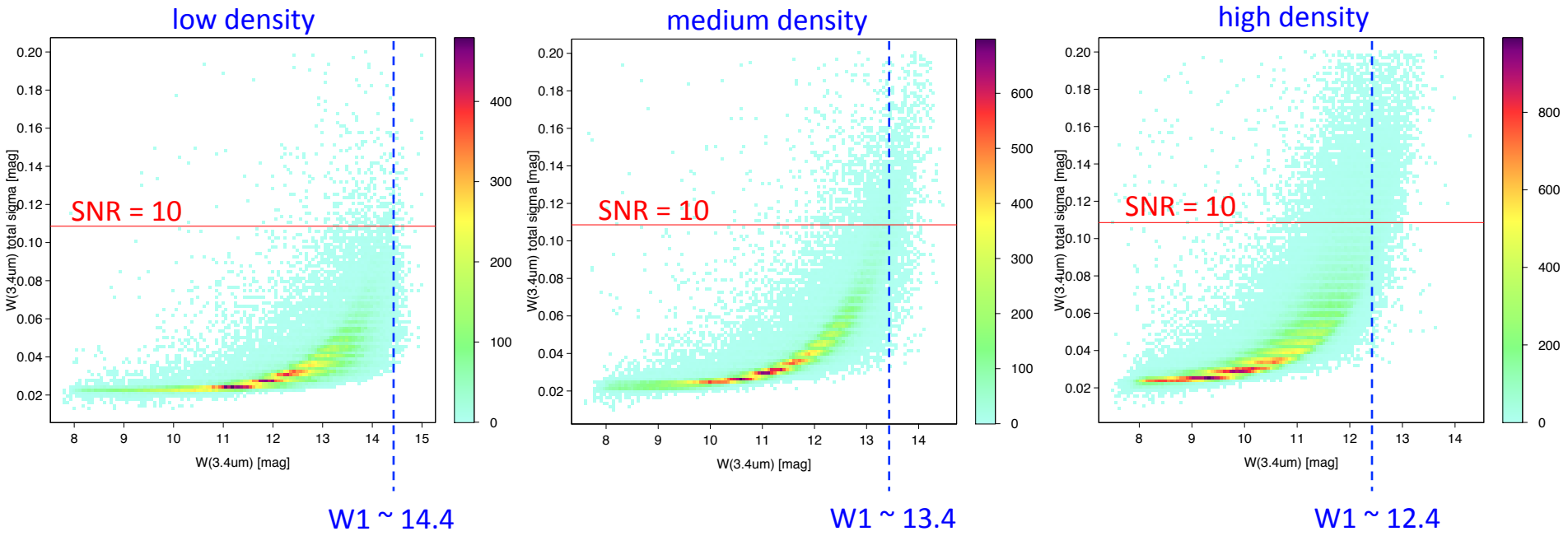
  (ii) progressively higher source densities

  => consistent with confusion



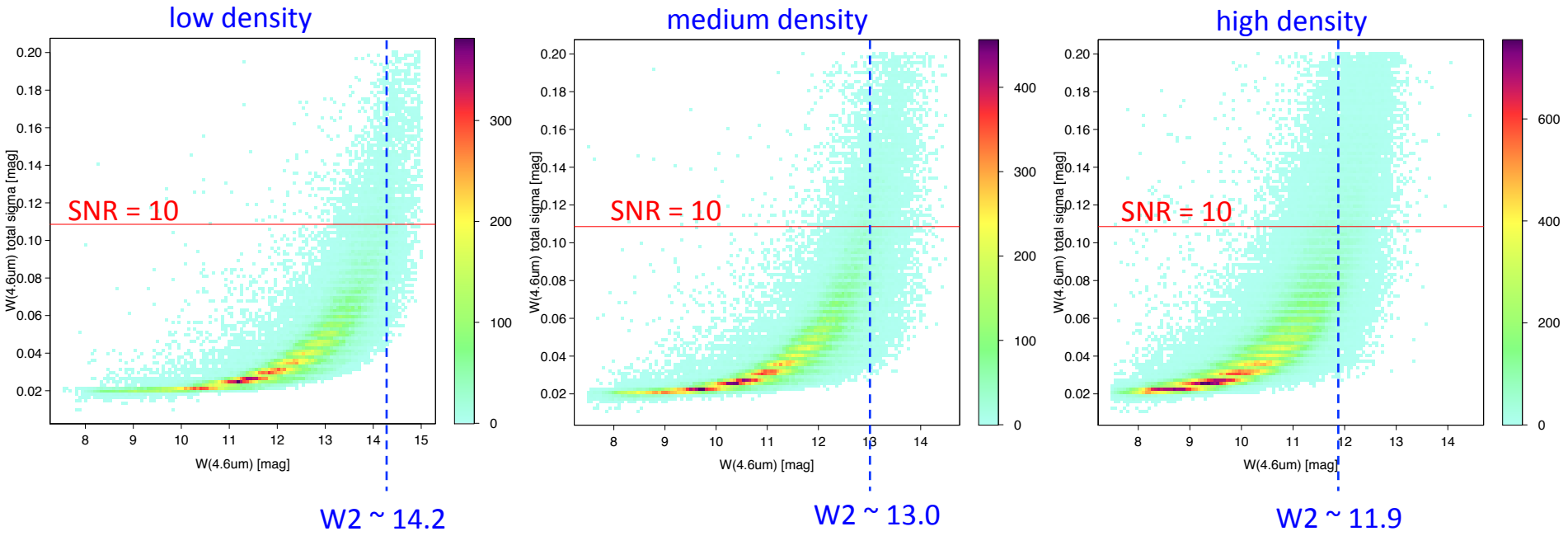
σ[WISE1] versus WISE1 mag

- Approximate limiting W1 magnitudes for SNR = 10 are indicated below where sigma includes confusion-noise.
- Compared to GLIMPSE IRAC1 photometry [slide 9], W1 limiting magnitudes are shallower by approx. -0.2, -0.8, and -1.2 mag at low, medium, and high source densities respectively.



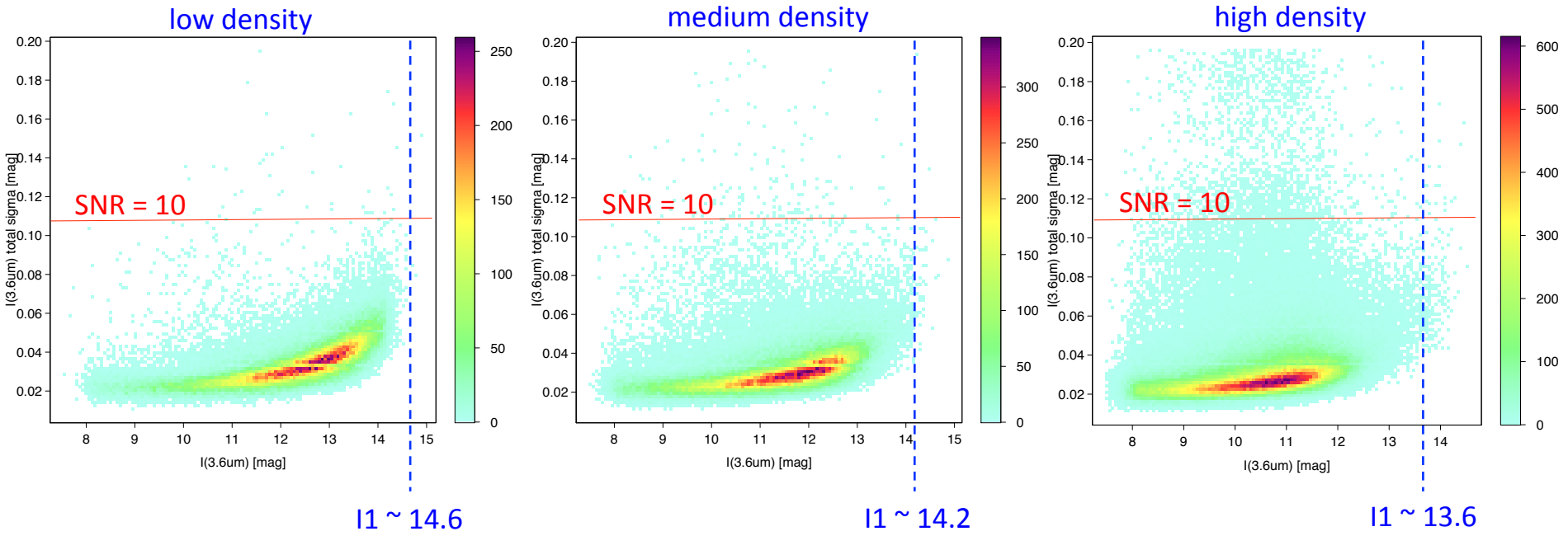
σ[WISE2] versus WISE2 mag

- Approximate limiting W2 magnitudes for SNR = 10 are indicated below where sigma includes confusion-noise.
- Compared to GLIMPSE IRAC2 photometry [slide 10], W2 limiting magnitudes are shallower by approx. -0.2, -0.8, and -1.5 mag at low, medium, and high source densities respectively.



σ[IRAC1] versus IRAC1 mag

- NOTE: only IRAC sources matched to **SNR > 5** WISE Catalog sources are shown.
  => explains paucity of IRAC sources at faint magnitudes where WISE counterparts would be at SNR <= 5?
- Approximate limiting IRAC1 magnitudes for SNR > 10 are approx. +0.2, +0.8, and +1.2 mag deeper than W1 at low, medium, and high source densities respectively [cf. slide 7].



σ[IRAC2] versus IRAC2 mag

- NOTE: only IRAC sources matched to **SNR > 5** WISE Catalog sources are shown.
  => explains paucity of IRAC sources at faint magnitudes where WISE counterparts would be at SNR <= 5?
- Approximate limiting IRAC2 magnitudes for SNR > 10 are approx. +0.2, +0.8, and +1.5 mag deeper than W2 at low, medium, and high source densities respectively [cf. slide 8].