Identifying counterparts to sub-mm galaxies in Herschel-ATLAS:

Colour matters!

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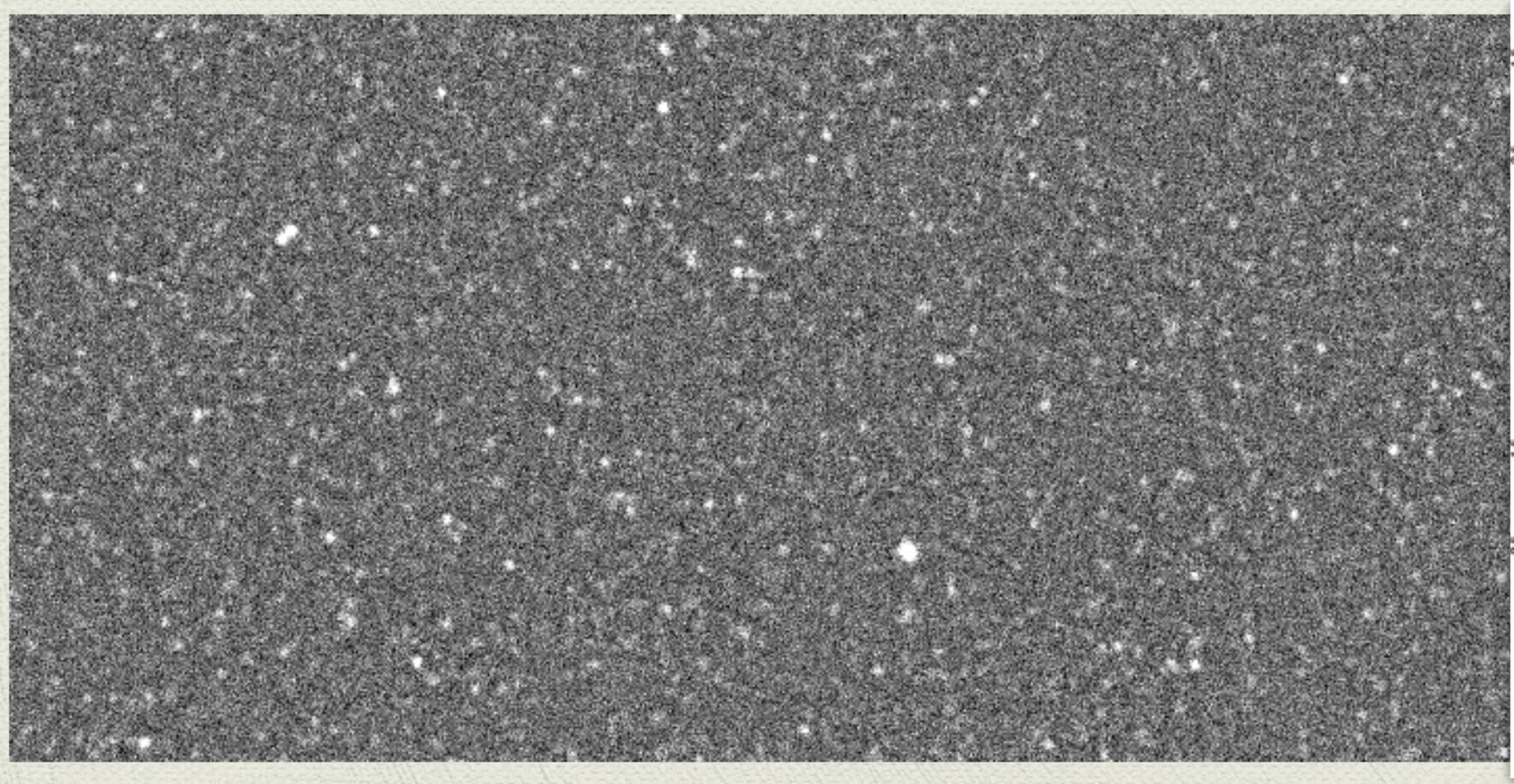
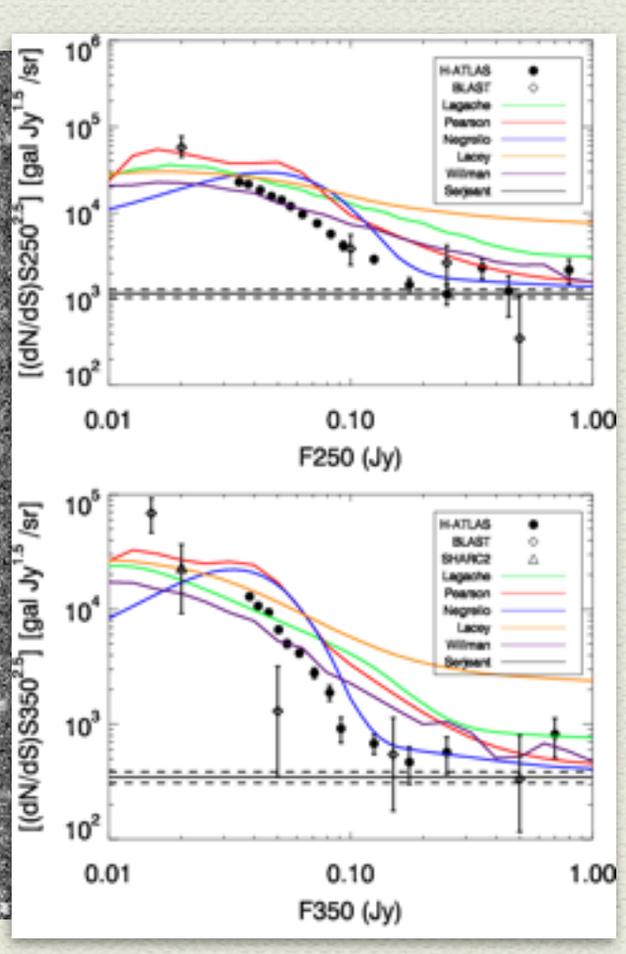
SMG IDs: a solved problem?

- A fundamental problem in sub-mm surveys: due to steep source counts and low resolution





SMG IDs: a solved problem?

- A fundamental problem in sub-mm surveys: due to steep source counts and low resolution

- *P*-statistics $p = 1 - \exp(-\mu_r).$

Hughes 98, Barger 99, Smail 00, Ivison 02, Chapman 03, etc

- Likelihood ratio (LR)

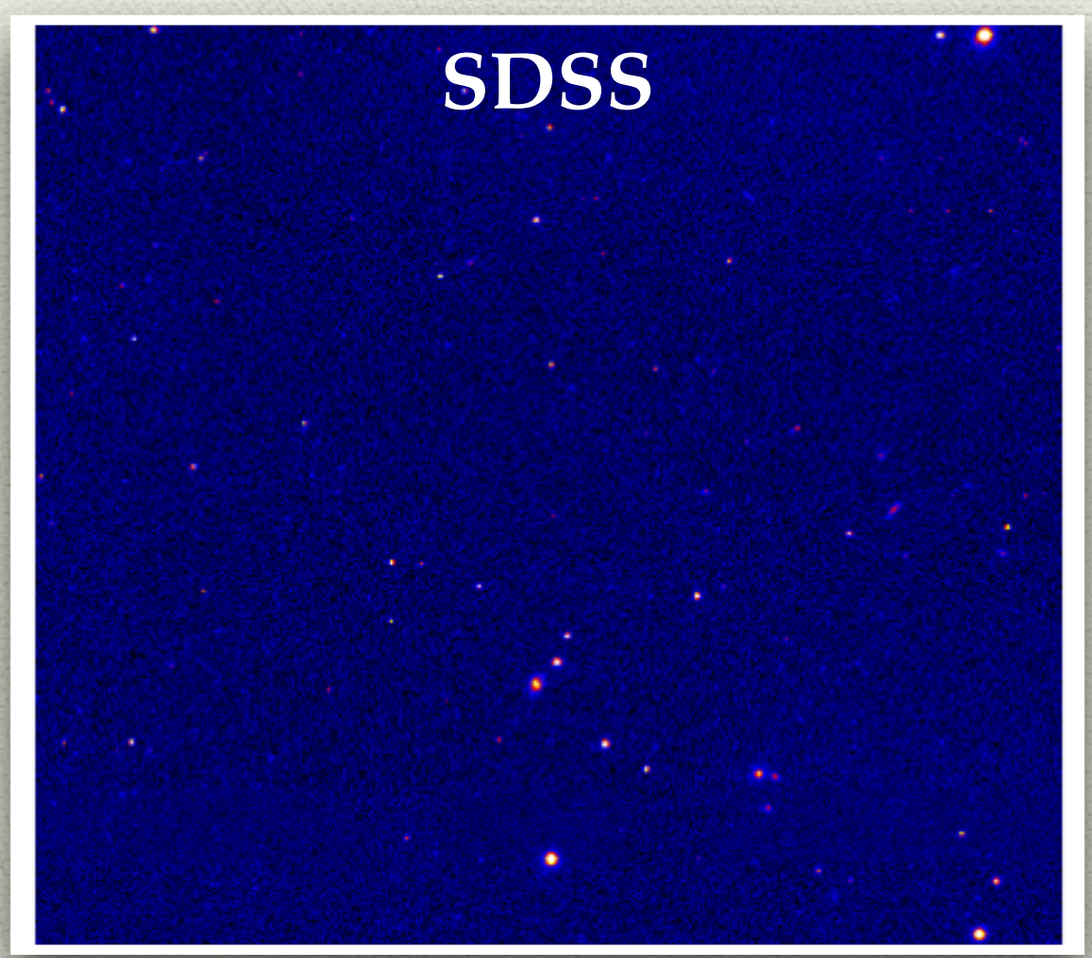
$$L = \frac{P(m, c, x, y, \mathrm{id})}{P(m, c, x, y, \mathrm{chance})} = \frac{q(m, c) f(x, y)}{n(m, c)}.$$

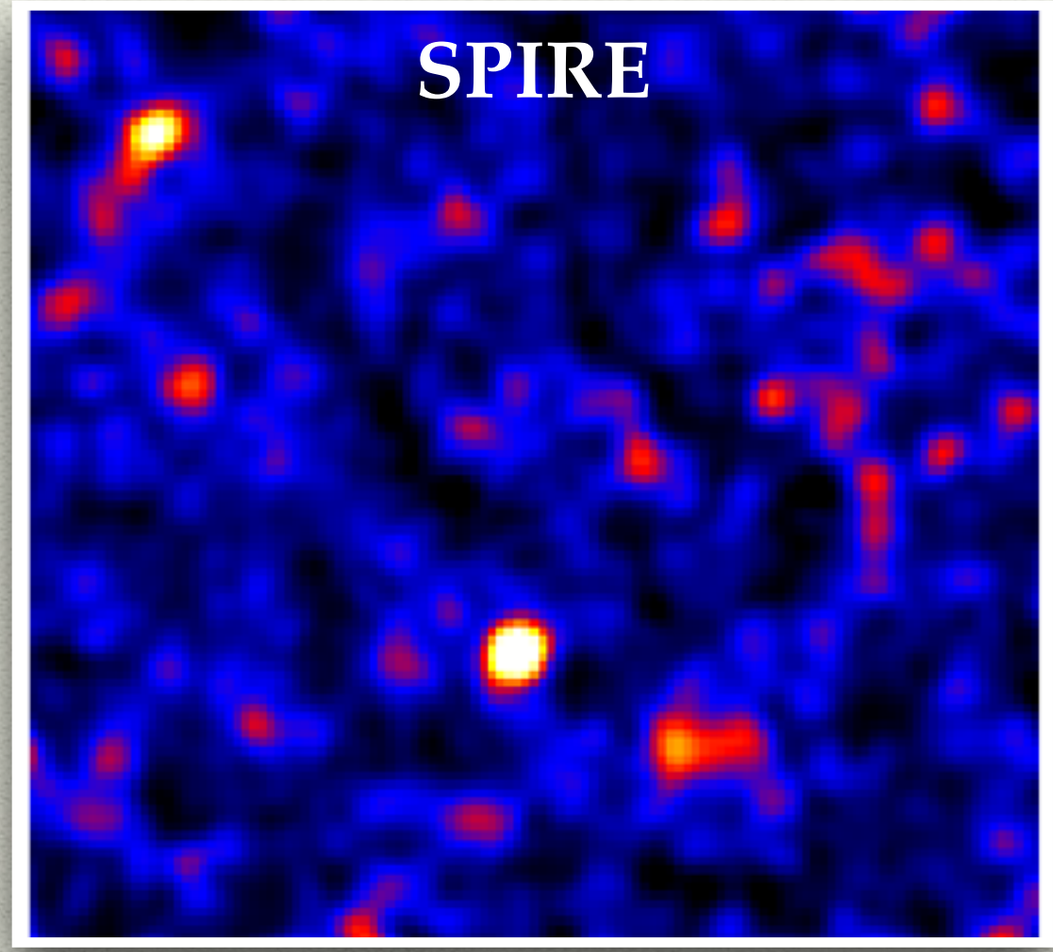
Sutherland & Saunders 92, Chapin+11, Smith+11, Fleuren+12, Roseboom+13

- Does not account for correlations, multiple counterparts, lenses

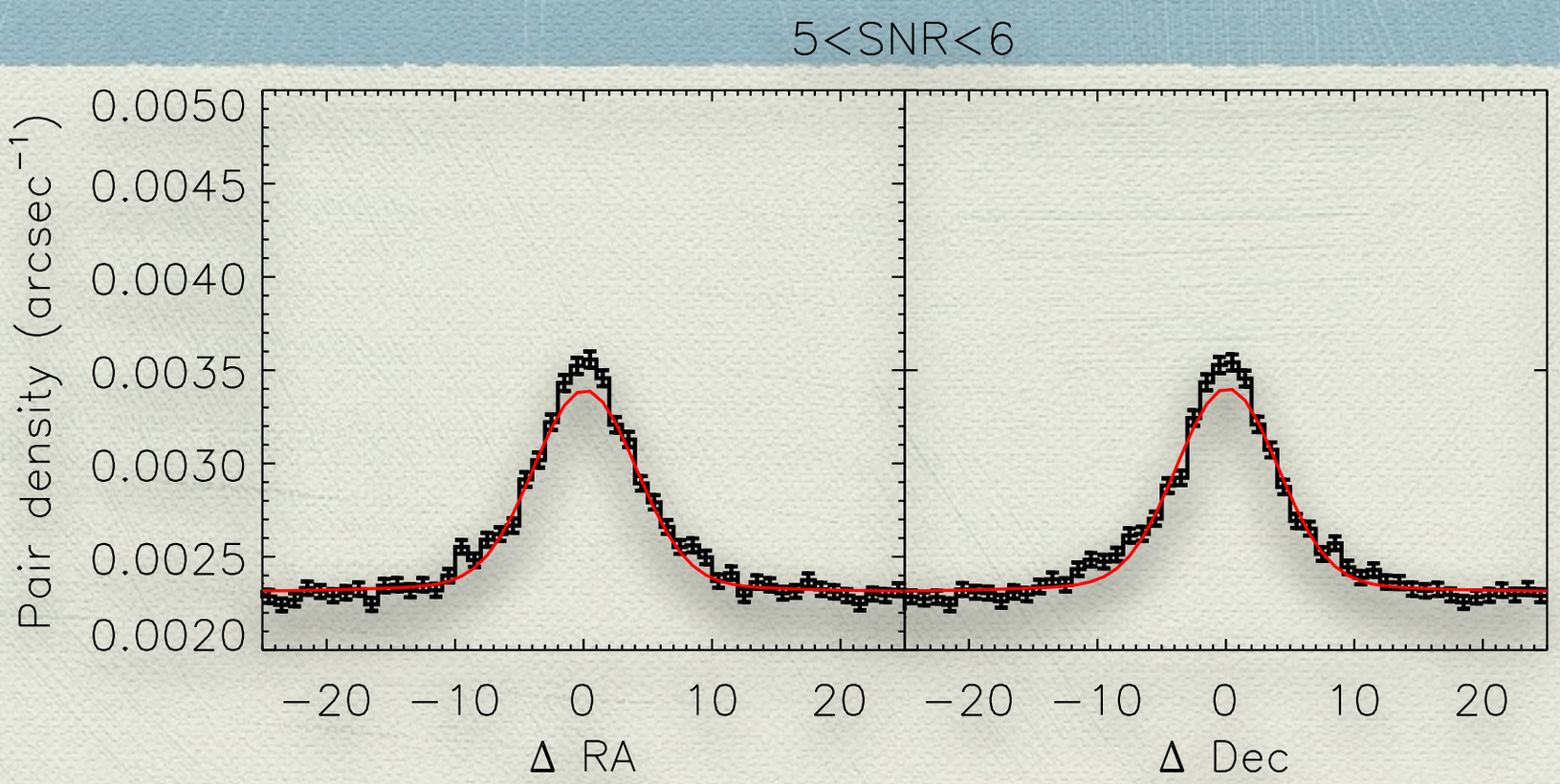
IDs for Herschel-ATLAS

- ~150 deg^2, 5sigma~30 mJy, probing low and high redshifts
- Matching catalogue from SDSS

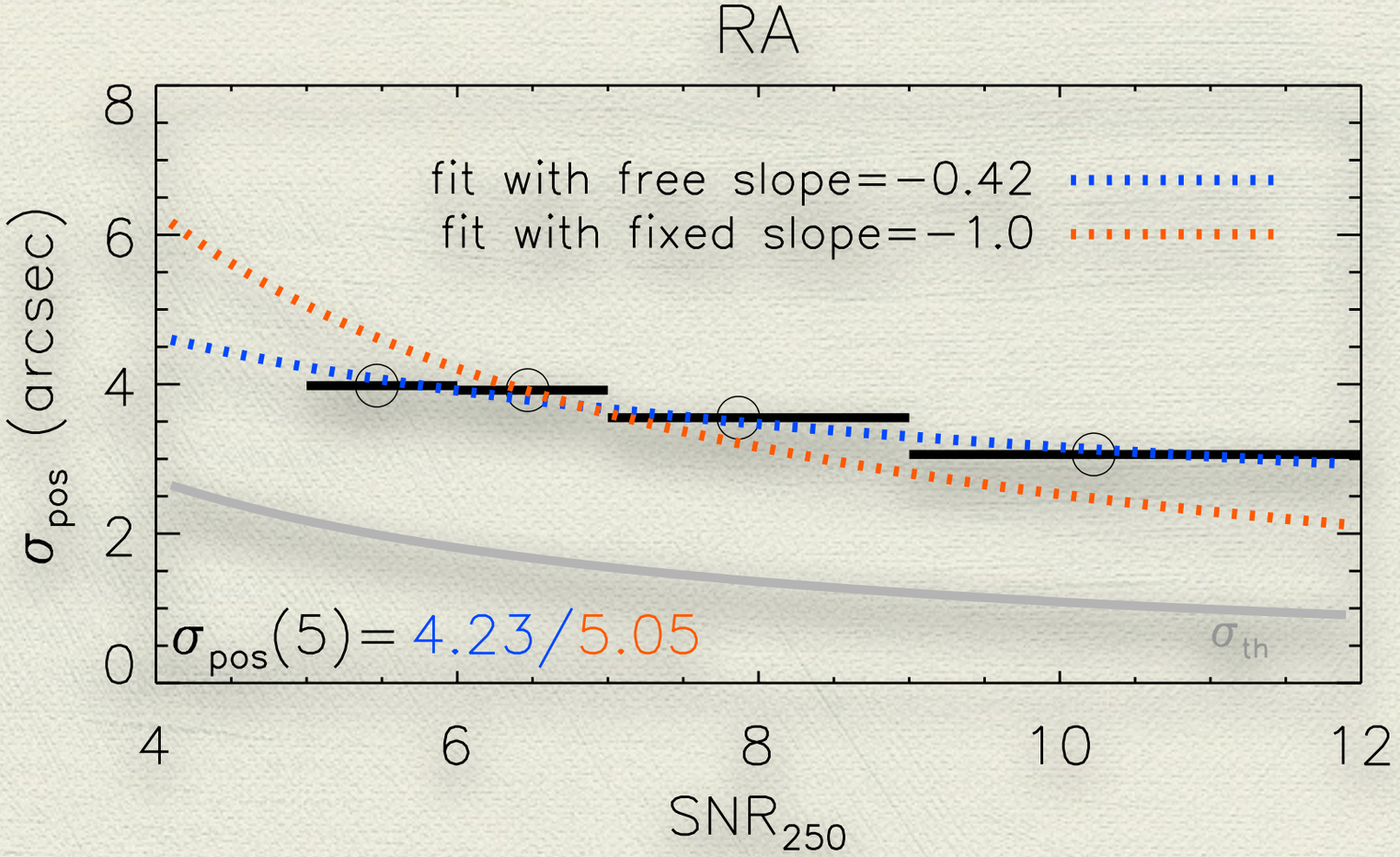




SPIRE-SDSS positional offsets

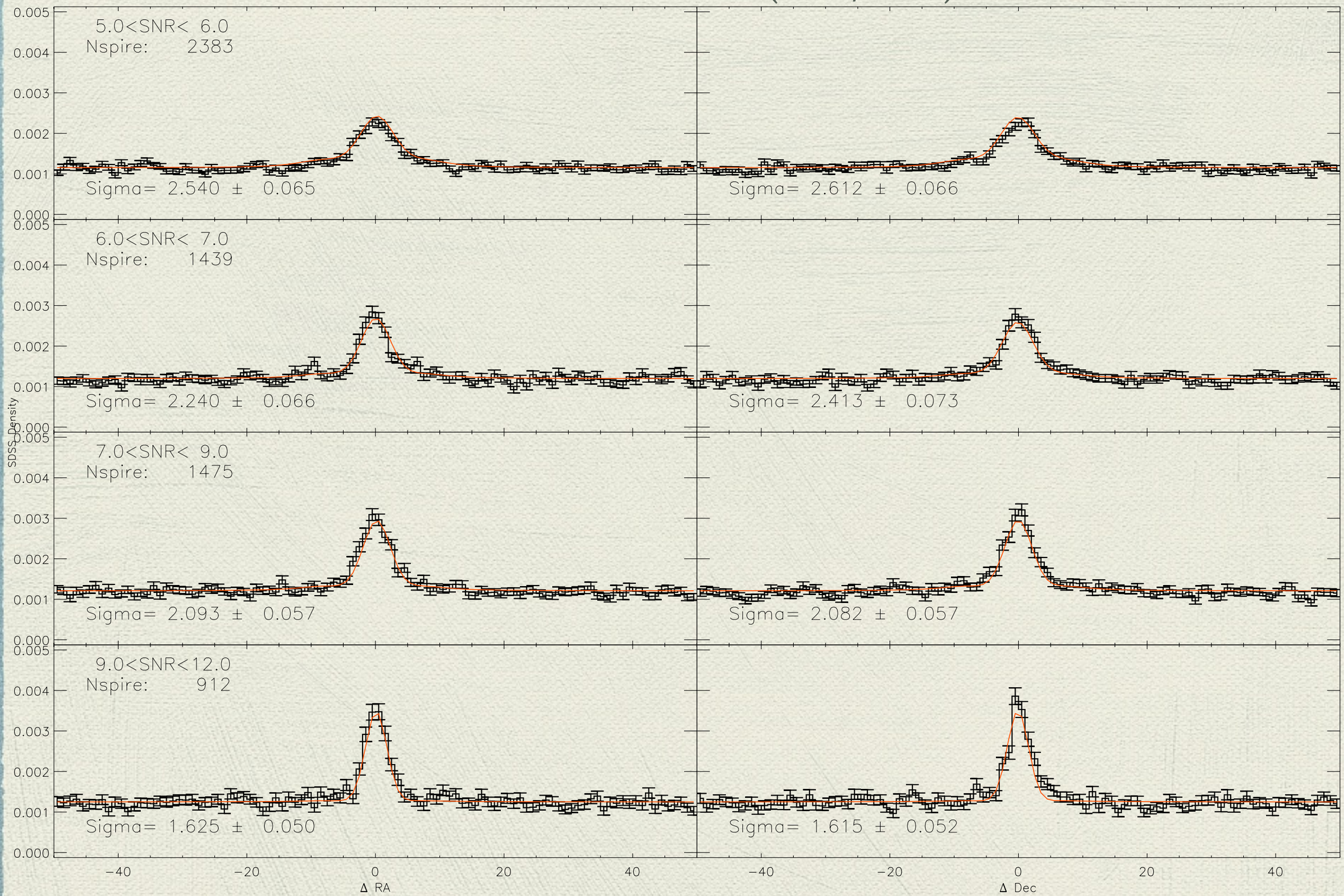


- Offsets to all objects around a SPIRE source:
  - positional errors of true counterparts
  - correlated objects: clustered objects at the same redshift
  - lensing objects in the line of sight

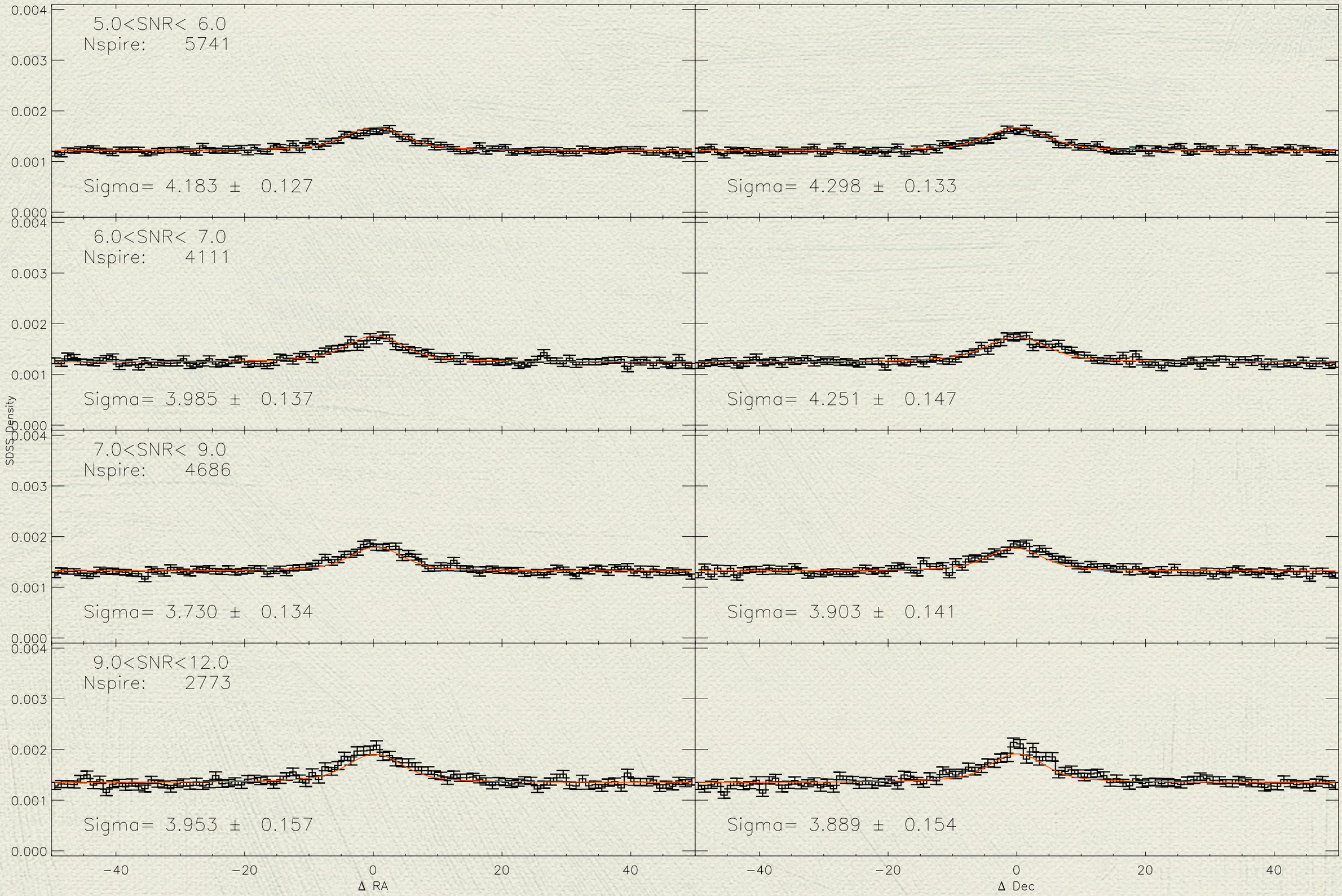


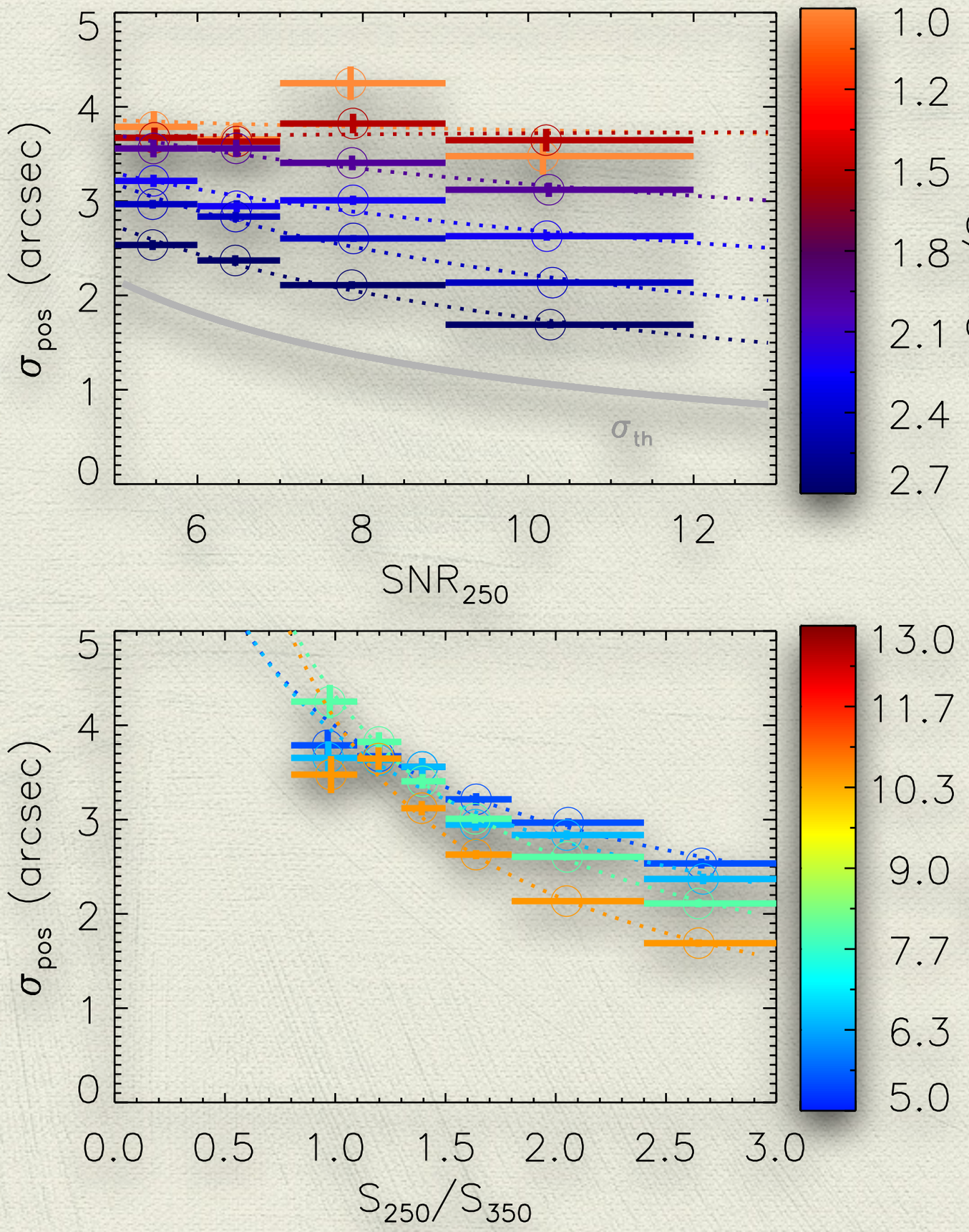
- In theory: $\sigma_{\rm pos}({\rm SNR}) = 0.6\frac{\rm FWHM}{\rm SNR}$
- But we see a weaker SNR dependence and apparently much larger positional errors

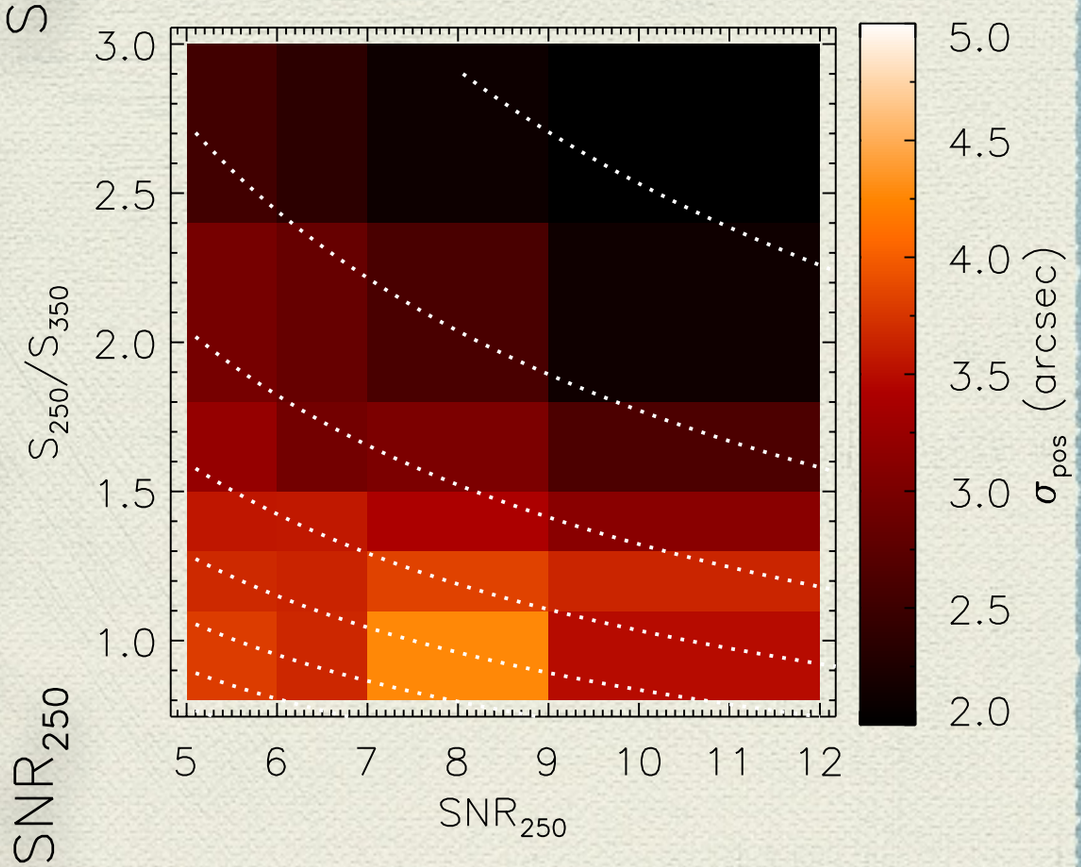
Blue (250/350)


5.0<SNR< 6.0
Nspire: 2383
Sigma= 2.540 ± 0.065
Sigma= 2.612 ± 0.066
6.0<SNR< 7.0
Nspire: 1439
Sigma= 2.240 ± 0.066
Sigma= 2.413 ± 0.073
7.0<SNR< 9.0
Nspire: 1475
Sigma= 2.093 ± 0.057
Sigma= 2.082 ± 0.057
9.0<SNR<12.0
Nspire: 912
Sigma= 1.625 ± 0.050
Sigma= 1.615 ± 0.052
SDSS Density
0.000
0.001
0.002
0.003
0.004
0.005
−40
−20
0
20
40
Δ RA
Δ Dec

Red (250/350)


5.0<SNR< 6.0
Nspire: 5741
Sigma= 4.183 ± 0.127
Sigma= 4.298 ± 0.133
6.0<SNR< 7.0
Nspire: 4111
Sigma= 3.985 ± 0.137
Sigma= 4.251 ± 0.147
7.0<SNR< 9.0
Nspire: 4686
Sigma= 3.730 ± 0.134
Sigma= 3.903 ± 0.141
9.0<SNR<12.0
Nspire: 2773
Sigma= 3.953 ± 0.157
Sigma= 3.889 ± 0.154
SDSS Density
0.000
0.001
0.002
0.003
0.004
−40
−20
0
20
40
Δ RA
Δ Dec


σ_{pos} (arcsec)
σ_{th}
SNR_{250}
S_{250}/S_{350}


S_{250}/S_{350}
SNR_{250}
σ_{pos} (arcsec)

Brighter, redder SPIRE sources have more SDSS associations at large radii

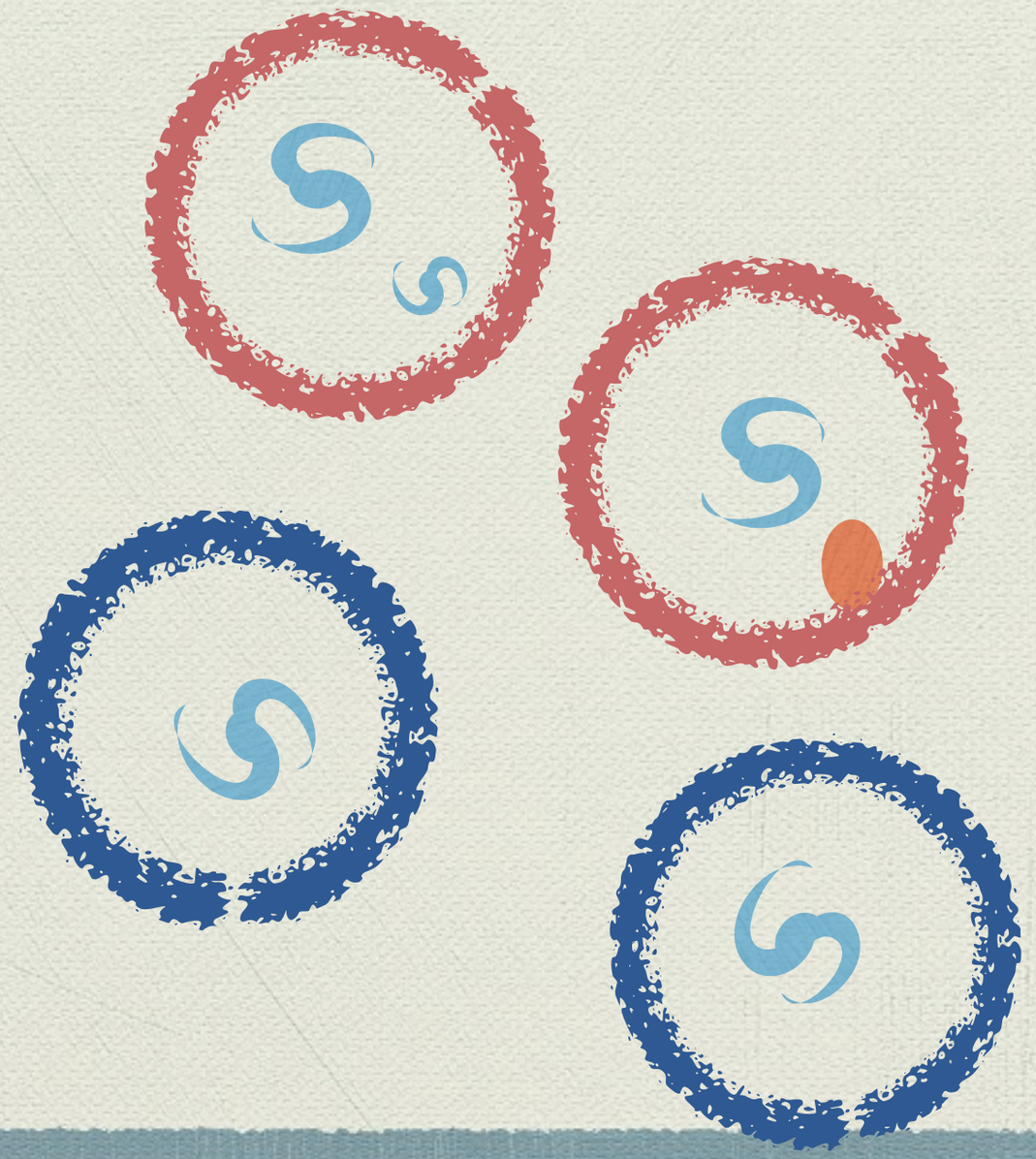
Why?

1. Clustered galaxies around the SPIRE source?

- Perhaps we have not properly accounted for the correlation function

- Is this worse for red sources because they are more likely to be blends?

Clustering



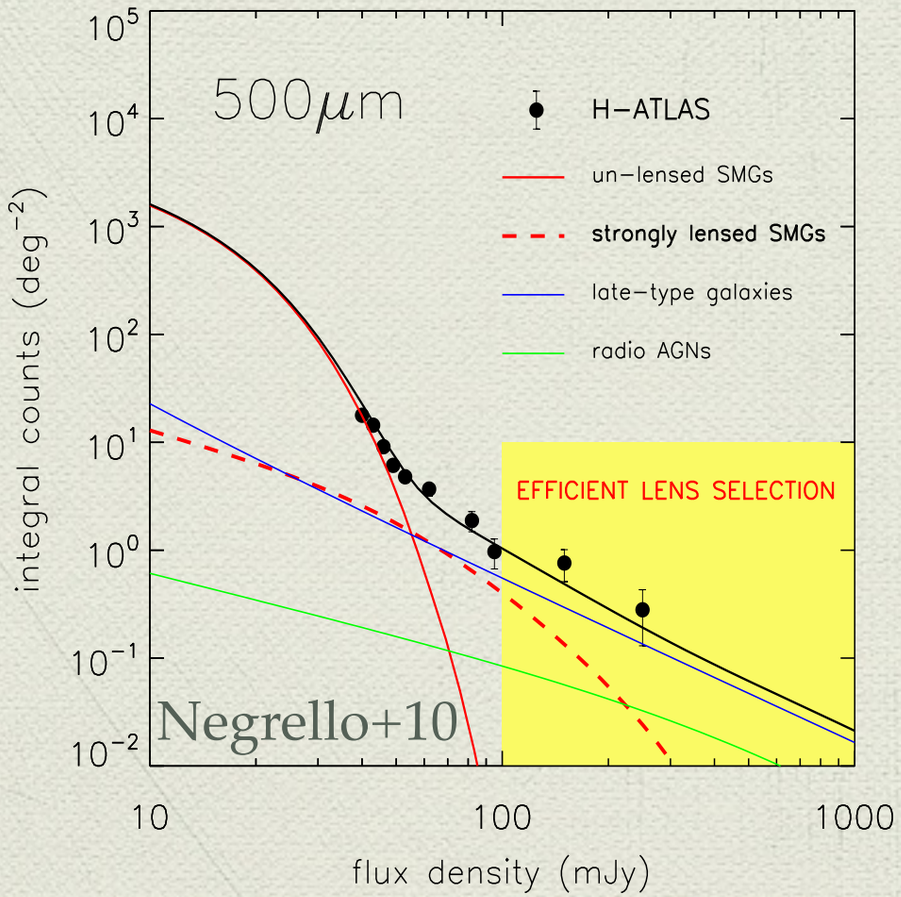
Brighter, redder SPIRE sources have more SDSS associations at large radii

Why?

2. Many red SPIRE sources are lensed?

- We know that the brightest red submm galaxies are likely to be lenses
- Could the offsets between the lenses and the submm images be affecting the measured positional errors?

Lensing



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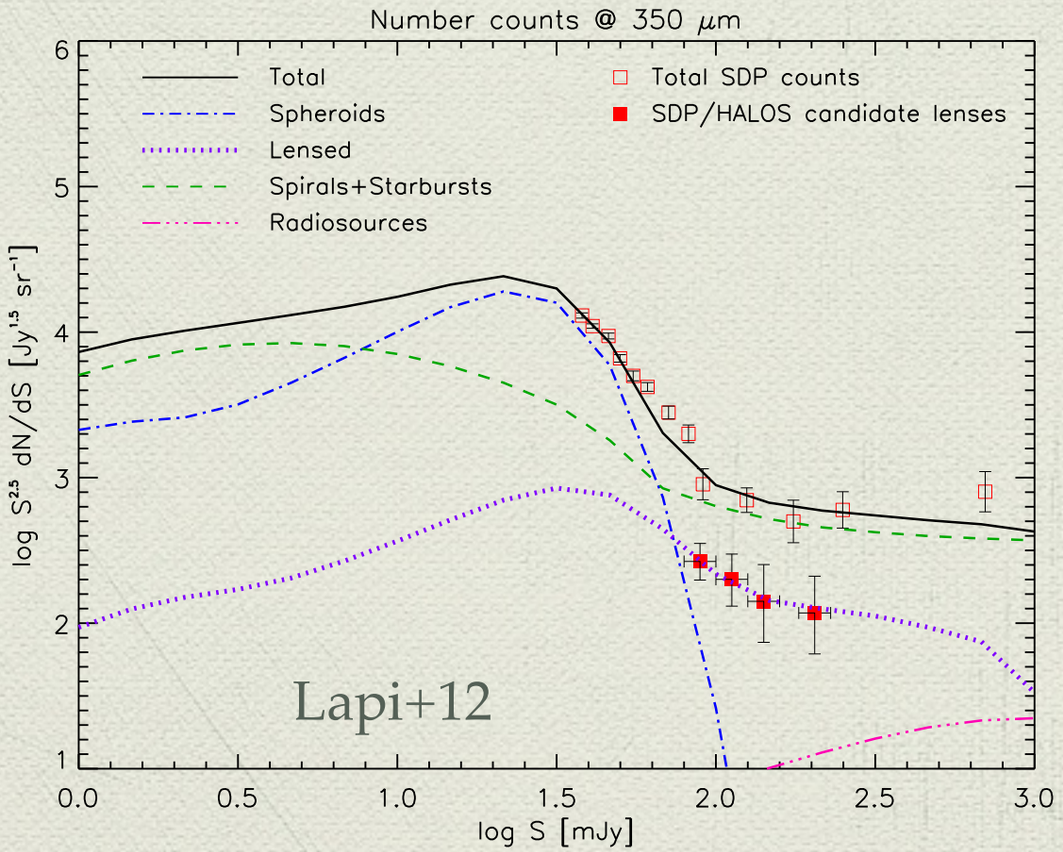
Lensing



Blue

Faint → Bright

5<SNR<6 | 6<SNR<7 | 7<SNR<9 | 9<SNR<12

Red

Average excess per SPIRE source

1.000
0.100
0.010
0.001

0 5 10 15 20

Separation, arcsec

$0.8 < \frac{250}{350} < 1.3$

$1.3 < \frac{250}{350} < 1.8$

$1.8 < \frac{250}{350} < 3.0$

Lens modelling : Gonzalez-Nuevo+ in prep.

How common is (weak) lensing among SMGs?

- This depends on evolution of the LF at high redshifts

- If strong, then most SMGs are unlensed, but are strongly clustered such that their positional errors are increased

- If it weakens, then lensing is more common, and there is a much greater chance of identifying the lens as the counterpart to a red SMG.