The SCUBA-2 Cluster Snapshot Survey and Submillimetre-Bright Central Galaxies

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JCMT User Meeting - Seoul - Jan/Feb 2018

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S2CSS

- Background/Motivation
- Selection
- Analysis
- Results

Cosmic Eyelash

- Observation of MACSJ2135-010217 z =0.324
- serendipitous discovery of S_870 ~ 100mJy
- CO (1-0) detection , z = 2.3
- Lens model - Magnification ~ 32x
- Follow up - insight into the properties of the cold and dense interstellar medium (Danielson et al. 2011, 2013
- Resolved kpc molecular gas clouds - grip on SFR

Lensed Galaxies

- Lensed galaxies can provide an opportunity to gain an insight into the astrophysics at z>1 and observe below limits

- Gravitational lenses are rare - require chance alignment, even rarer are those which are magnified many times over

- Takes advantage of neg-K correction.

- Typically in blind survey: N(S>20mJy) ~ 1 deg^-2.

- Not a huge number of these are known - aim to increase this.

- This is the largest dedicated survey aimed at detecting bright lensed systems

Target Selection

- Target the most massive clusters to hunt for brightest eyelash like sources

- Clusters selected based off of their X-Ray luminosity - chose brightest L_X>10^44 erg s^-1

- Selected from BCS, eBCS, REFLEX and MACS

- Typical redshift of clusters ~ 0.2-0.3

- Targeted 202 clusters covering 0.33 deg^2 with a 1σ depth of 12 mJy beam^-1

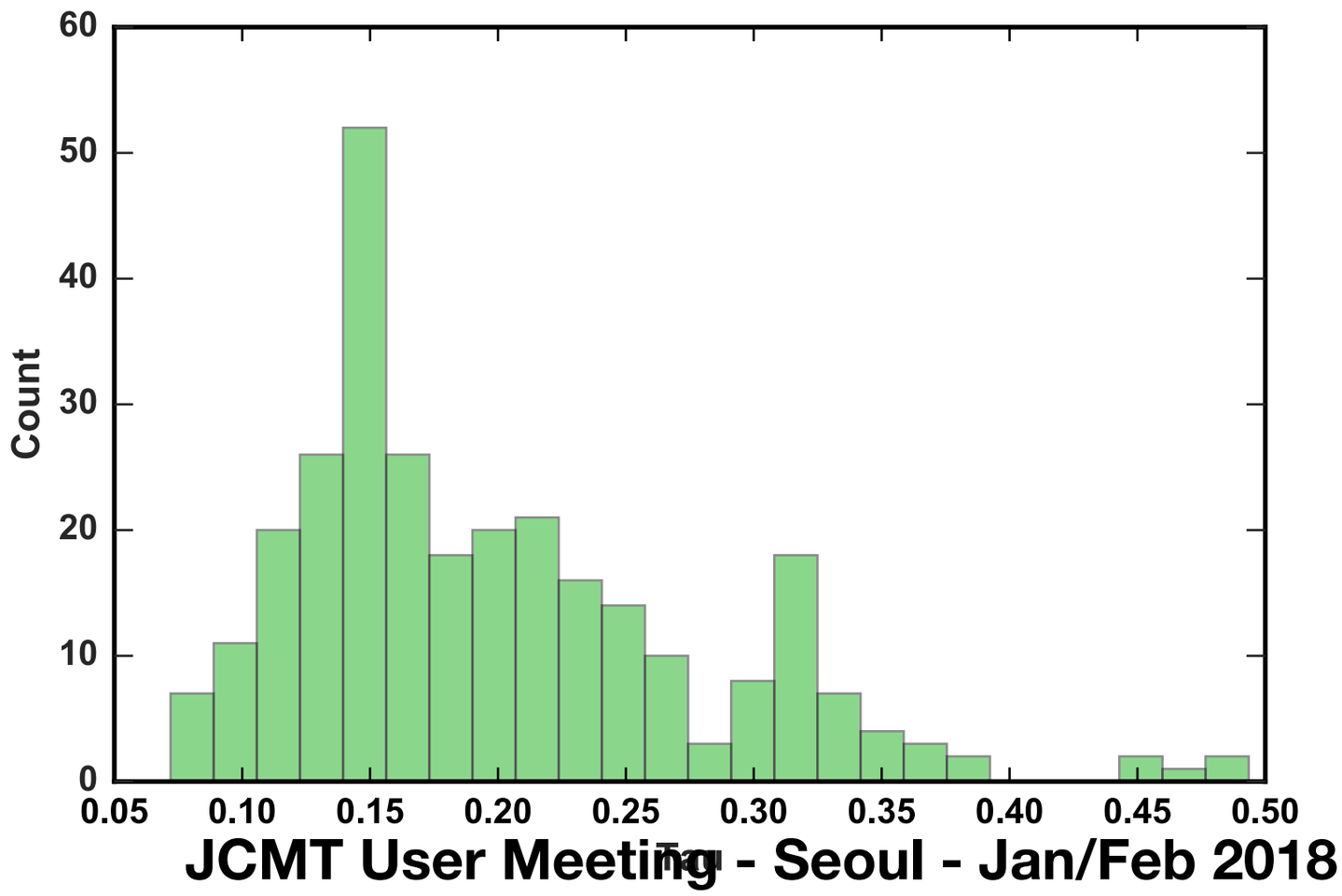
Target Selection

- Poor weather programme JCMT weather band 4-5 typical <τ> = 0.19±0.08

- 30min 850um CV Daisy maps exposures August 2012 - July 2013

- R = 5’

- FCF = 556 Jy beam^-1 p



Detection

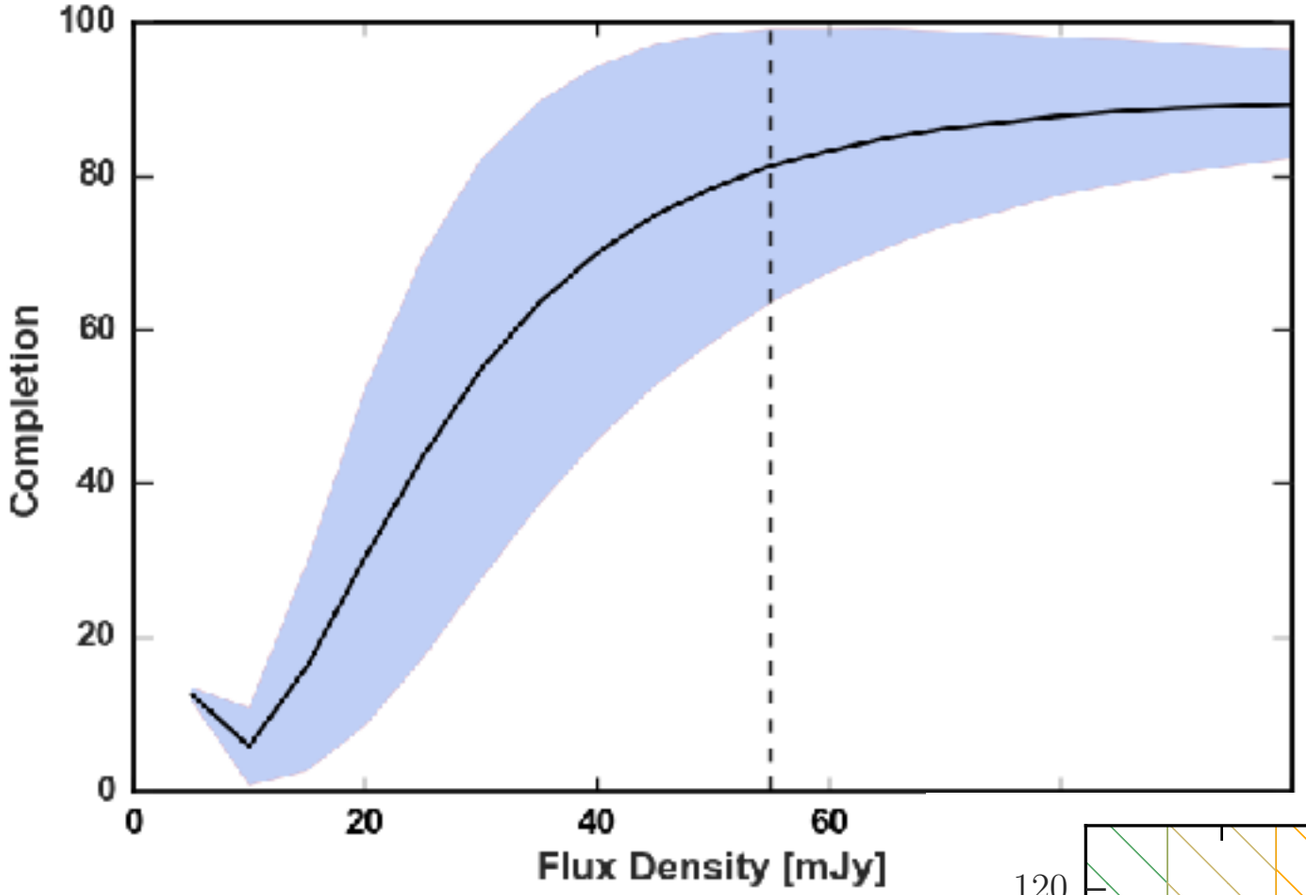
- Simple peak/centre finder algorithm
- Find >1300 >3.5σ sources
- 1016 3.5<σ<4, 312 4<σ<5, 39>5
- Unrealistic that there are 1300 SMG detections from 202 clusters - would mean 6 bright per cluster!

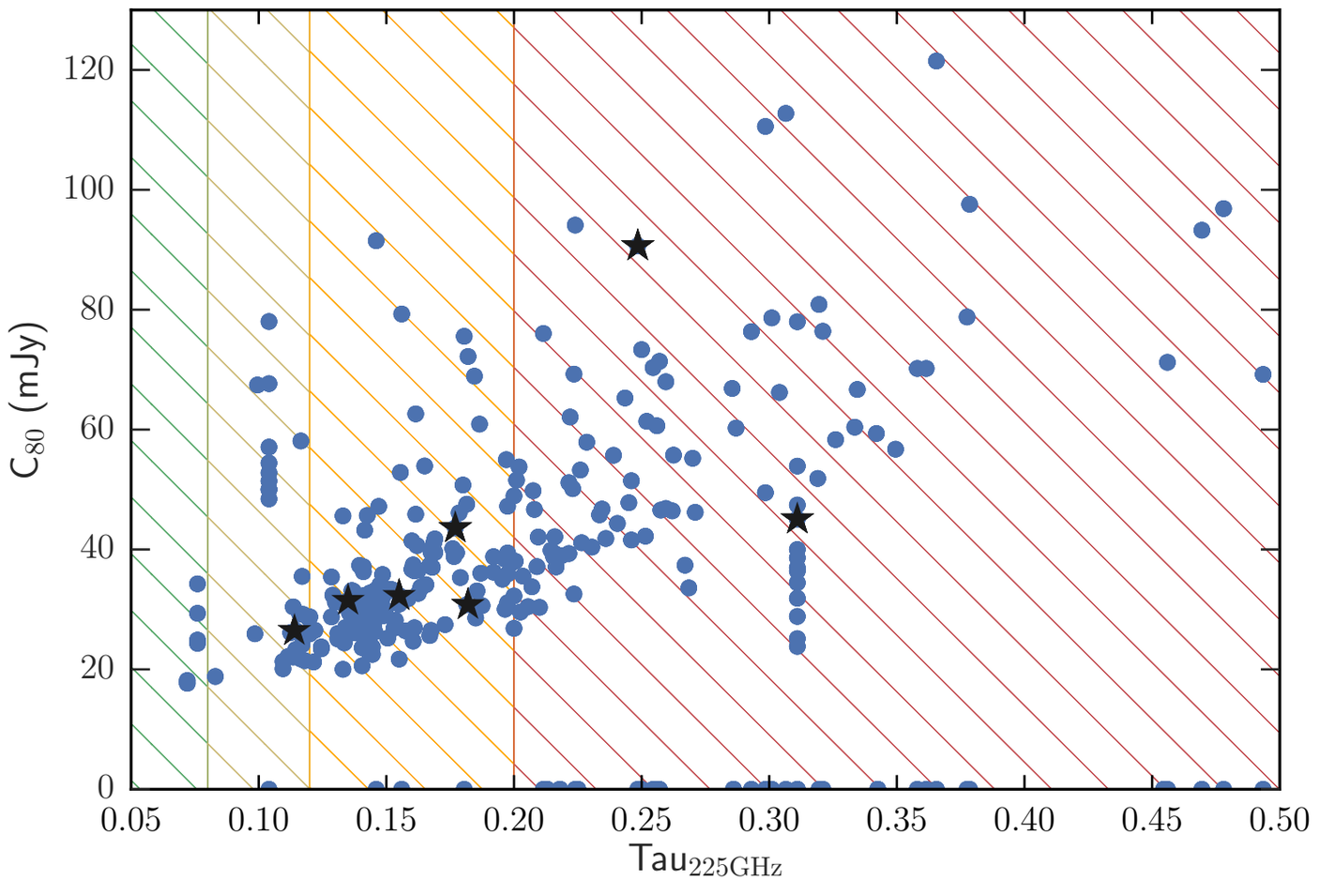
Selection

- Need to select based off of map properties not just sigma (but do believe >5sig)

- Use completeness simulation to determine those sources 4-5sig, c_80 proxy for 5sig e.g Saha 1995

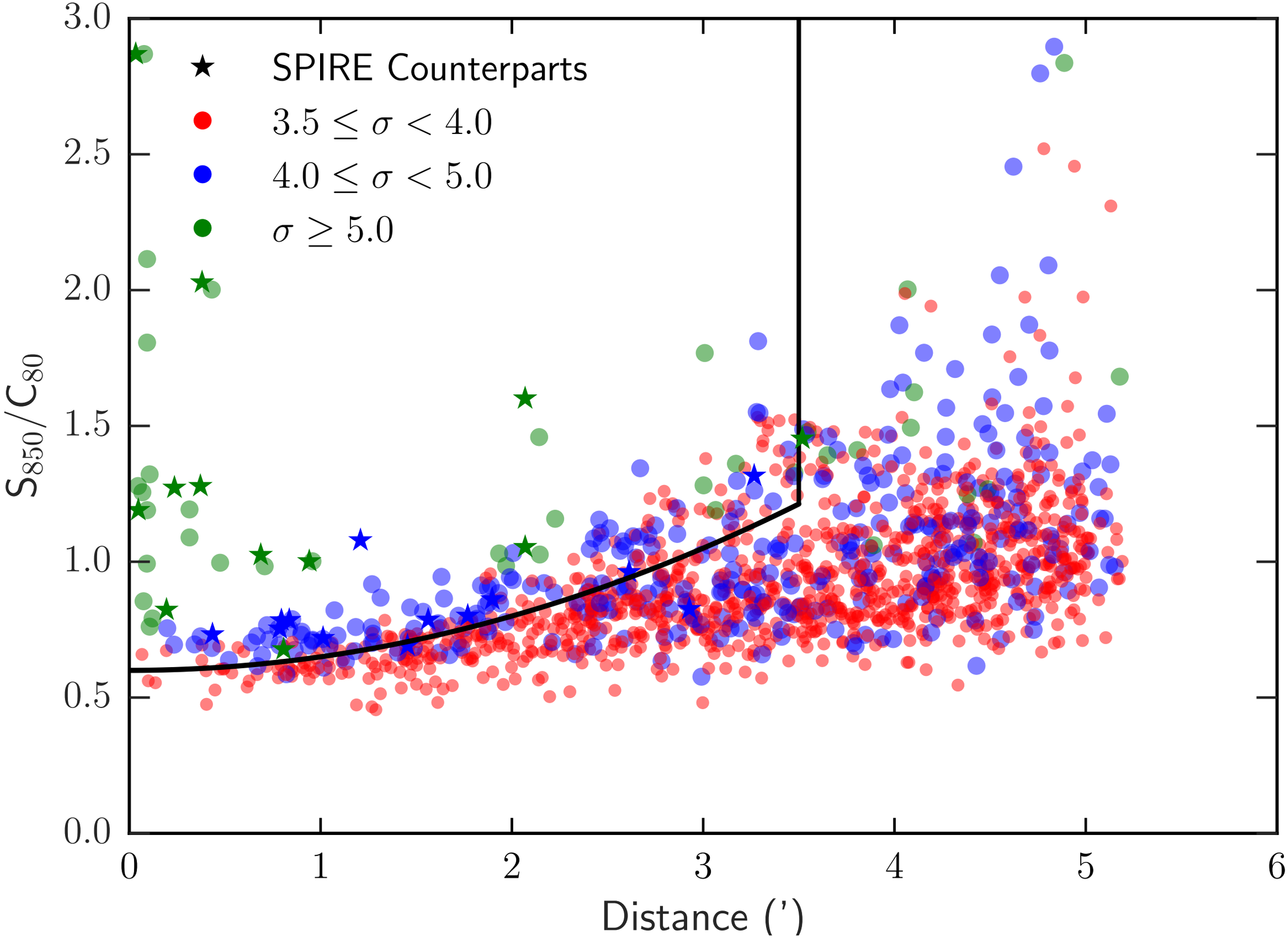
- C_80 determined by injecting PSF in random positions, attempt to extract and repeat for various flux levels multiple times


100
80
60
40
20
0
Completion
0
20
40
60
Flux Density [mJy]

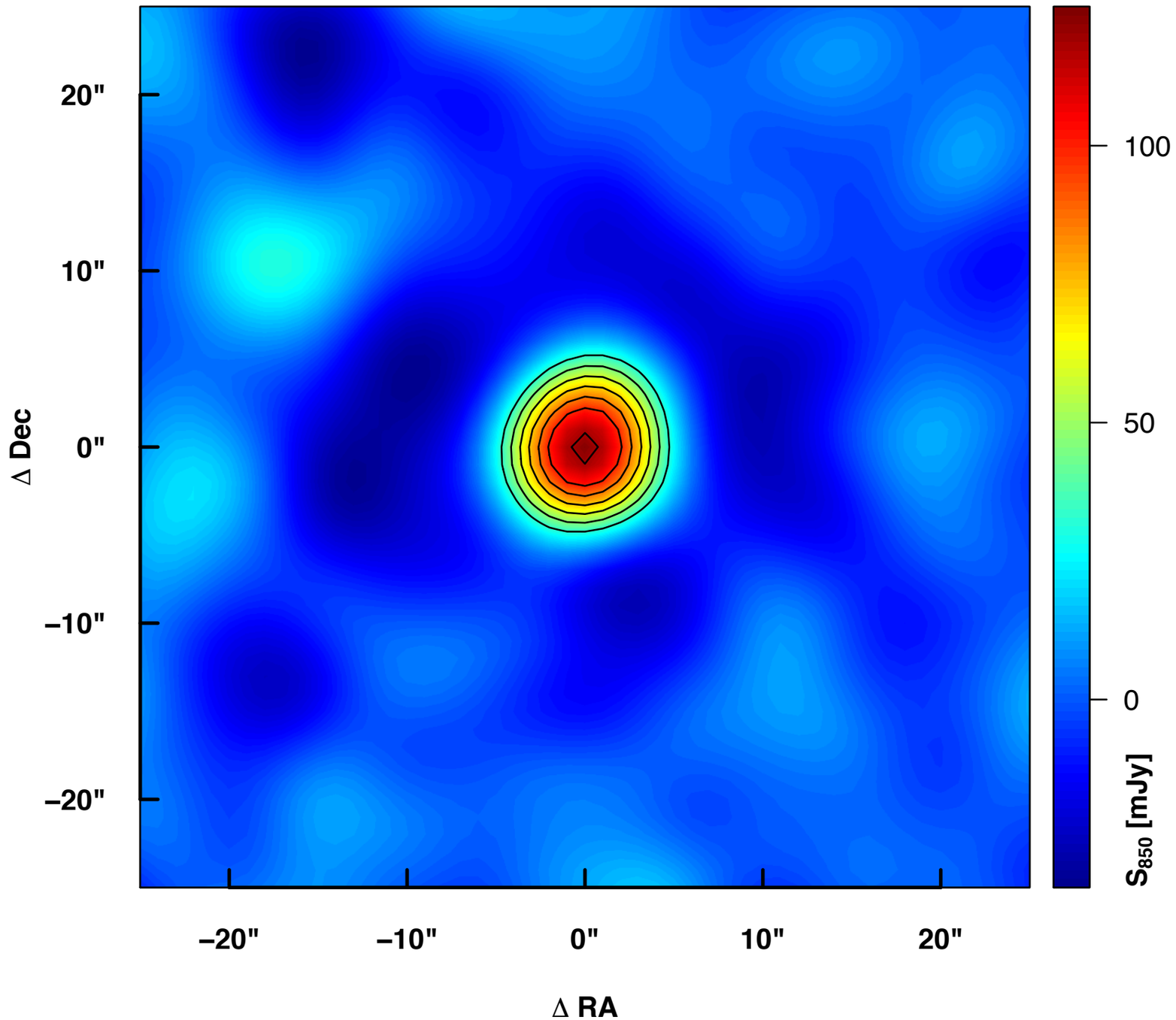

120
100
80
60
40
20
0
C_{80} (mJy)
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
Tau_{225GHz}

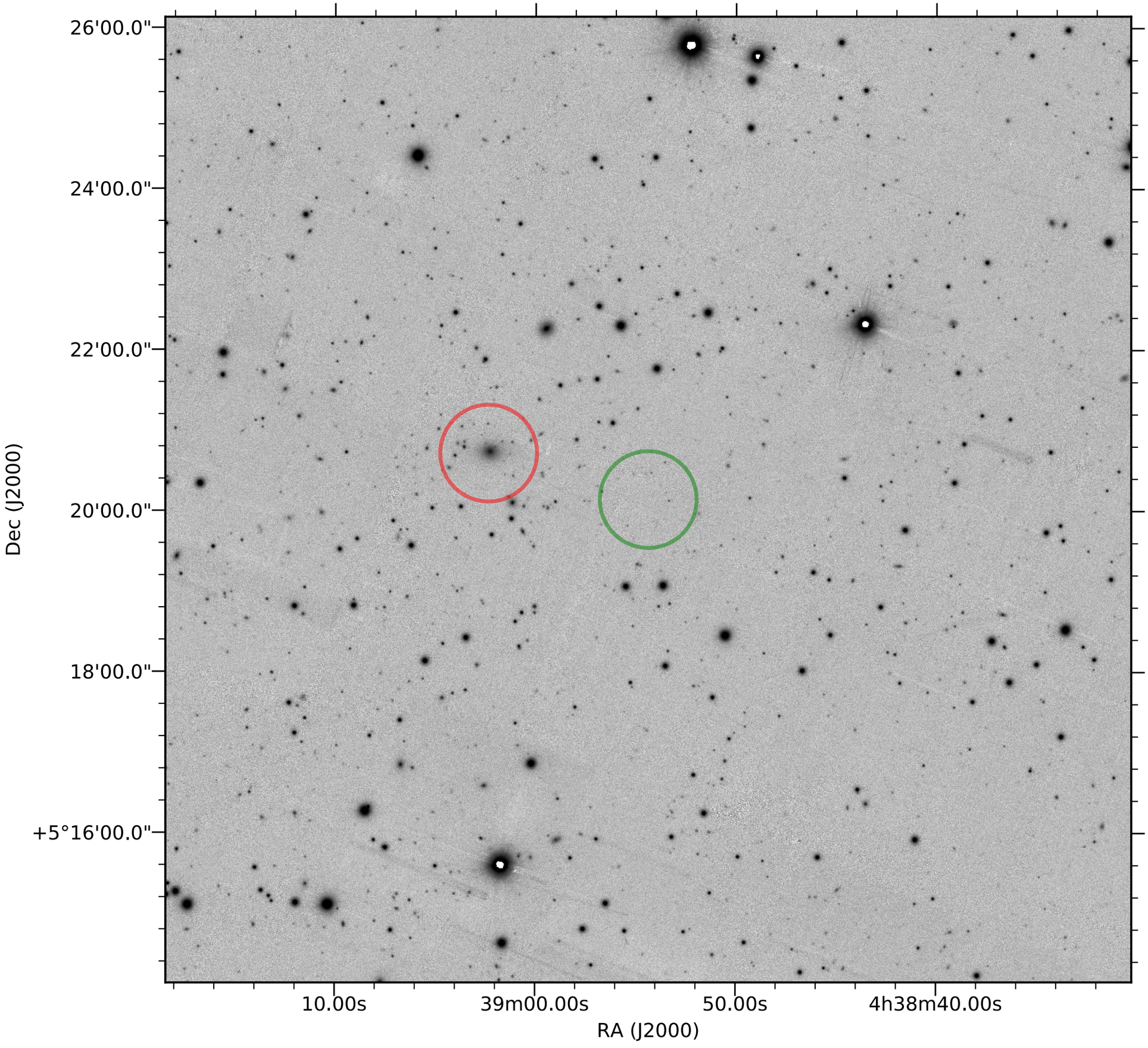
Selection

- Hard radius cut off of 3.5’ - Deep region of SCUBA-2 map
- Threshold follows:
- Determined S850/C80 > 0.7 + 0.05*R^2 provided adequate sample size


SPIRE Counterparts
$3.5 \leq \sigma < 4.0$
$4.0 \leq \sigma < 5.0$
$\sigma \geq 5.0$
S_{850}/C_{80}
Distance (')
0.0
0.5
1.0
1.5
2.0
2.5
3.0
0
1
2
3
4
5
6

- Using structure find ~110 candidate sources
- <S_850> ~ 40mJy
- N(S>20mJy) -> 101
- Cluster <z> ~ 0.26
- <R> ~ 1.7’



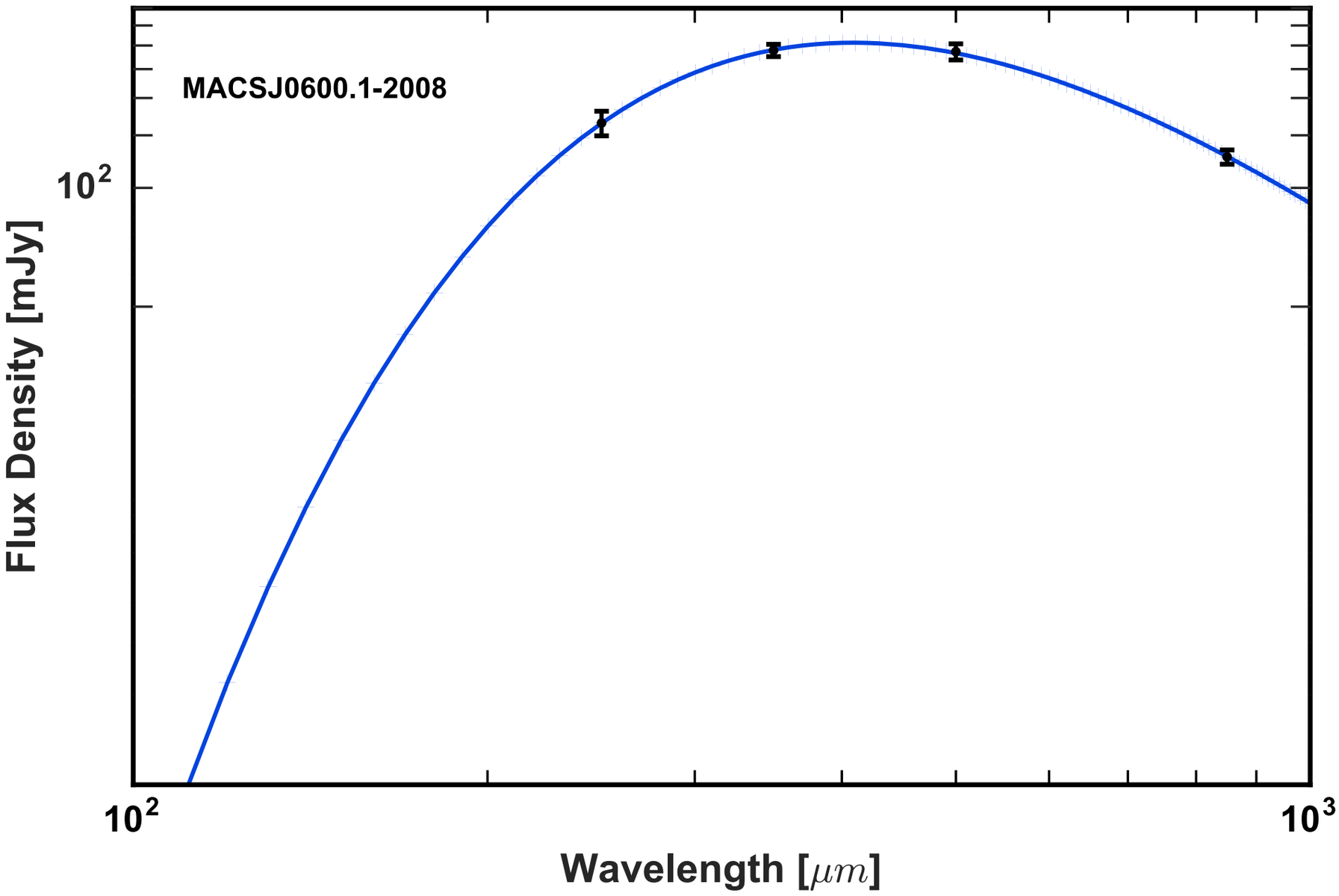

26'00.0"
24'00.0"
22'00.0"
20'00.0"
18'00.0"
+5°16'00.0"
Dec (J2000)
10.00s
39m00.00s
50.00s
4h38m40.00s
RA (J2000)

HERSCHEL Lensing Survey

- HLS targeted subset of the same clusters Egami et al. 2010

- SPIRE - 250, 350, 500um observations

- Joint SCUBA-2/SPIRE detections provide more confidence of the reality of detections and allow us to roughly estimate redshifts through far-infrared colours.



MBB fit with Redshift as free param, T=40k Shown

Spectroscopic comparison

- Previous work CO : MACSJ0455.2+0657,MACSJ1731.6+2252 and MACSJ2043.2-2144

- MACSJ0455, MACSJ1731 and MACSJ2043,z = 2.927, 2.712 and a blended source of z = 2.04, 3.25, 4.68 respectively. Zavala 2015

- In comparison we find photometric redshifts for MACSJ0455 z = 1.3 – 2.3, MACSJ1731 z = 1.9 – 3.2 and MACSJ2043 z = 1.8–3.1.

Spectroscopic Comparison

- Private comms with ALMA spectroscopic follow ups of some sources as well

- Find most in good agreement, likely the rest also follow. z = 2.6 typical spectroscopic SMG redshift

Brightest Cluster Galaxies

- Targeted at the BCG of each cluster
- Find 7 likely associated with the BCG R < 0.1’
- Some sources confirm with previous Hogan 2015
- Also find examples which disagree with H15 and lay >0.1’ from BCG

Summary

- Initial detections found 1100 >3.5 sig sources reduced to 112, <S_850> = 40mJy, <R_S2CSS> = 1.7’
- Photometric Redshifts typical Z~ 2.4 Spectro redshift typical Z ~ 2.6 - good agreement!
- Largest number of unknown lensed cluster sources
- 7 bright submm BCG observations
- Thermal SEDs built for ~ 25 sources