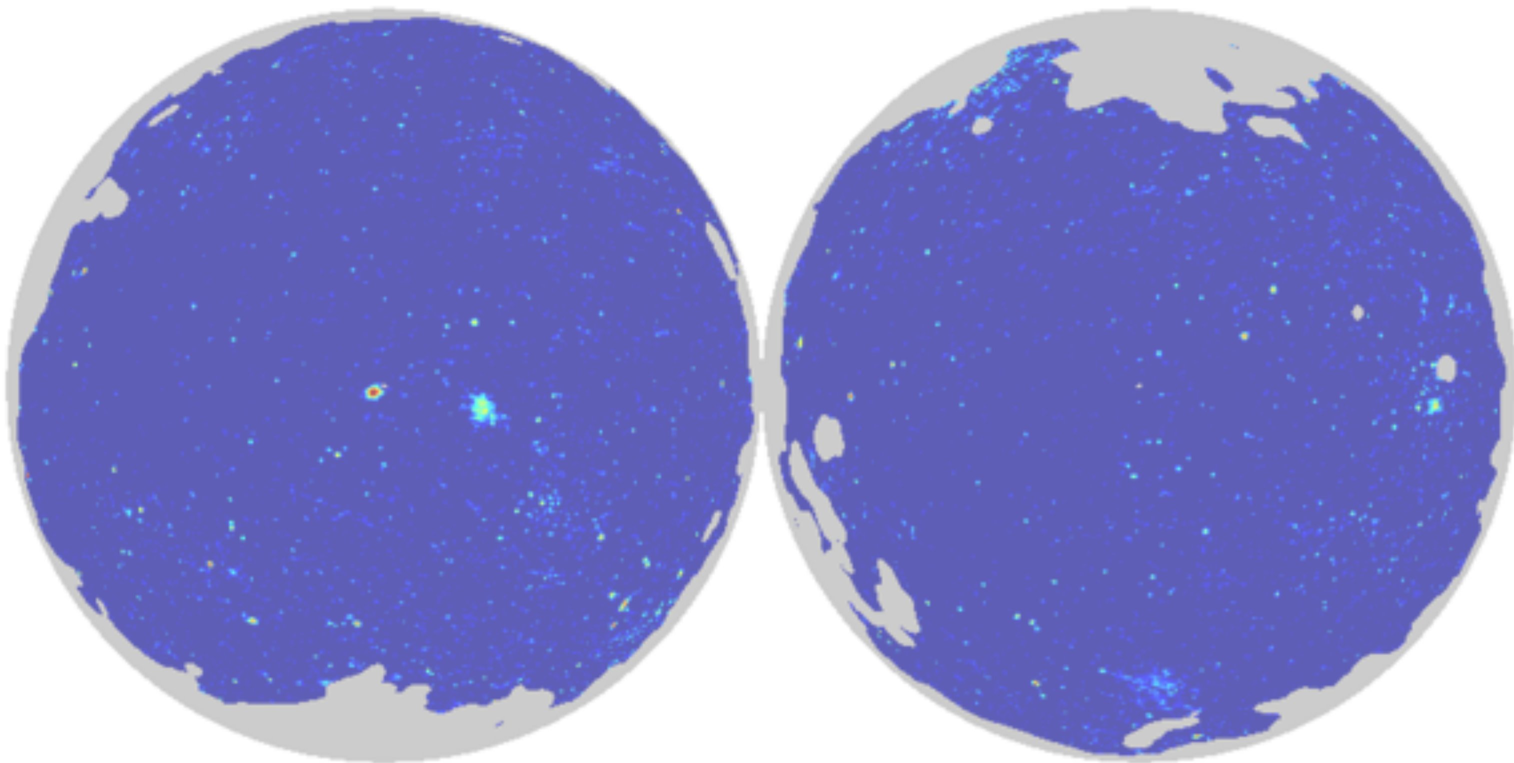
Planck 2014 results XXIV.
Planck all-sky Compton parameter map and characterization



B. Comis

Laboratoire de Physique Subatomique et Cosmologie (LPSC) - Grenoble

On behalf of the **Planck Collaboration**

The scientific results that we present today are a product of the Planck Collaboration, including individuals from more than 100 scientific institutes in Europe, the USA and Canada

Planck is a project of the European Space Agency, with instruments provided by two scientific Consortia funded by ESA member states (in particular the lead countries: France and Italy) with contributions from NASA (USA), and telescope reflectors provided in a collaboration between ESA and a scientific Consortium led and funded by Denmark.

Outline

Reconstruction methods: M**ILC**A & N**ILC**

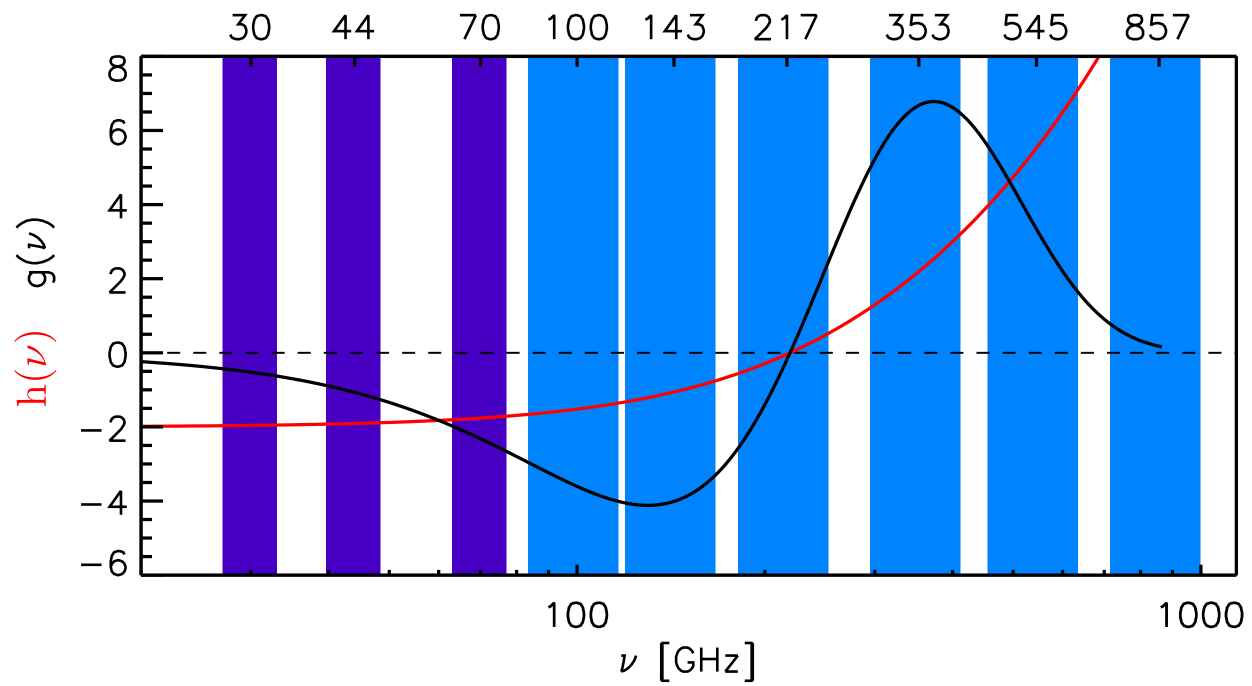
Map characterization
- signal (vs PSZ2)
- noise
- foregrounds

Residual contamination

(Cosmological) **use of the full-sky SZ map**

Conclusions

Reconstruction methods



$$\frac{\Delta T_{CMB}}{T_{CMB}} = h(\nu)y \qquad \frac{\Delta I_0}{I_0} = g(\nu)y$$

- constraints on electromagnetic spectra: preserve tSZ effect and remove CMB
- HFI channels at a common resolution of 10 arcmin
- 857 GHz used only for ell < 300

Adapted component separation algorithms:

- N**ILC** (Needlet Iindependent Linear Combination, *Remazeilles et al. 2011*)
- M**ILC**A (Modified Internal Linear Combination Algorithm, *Hurier et al. 2013*)

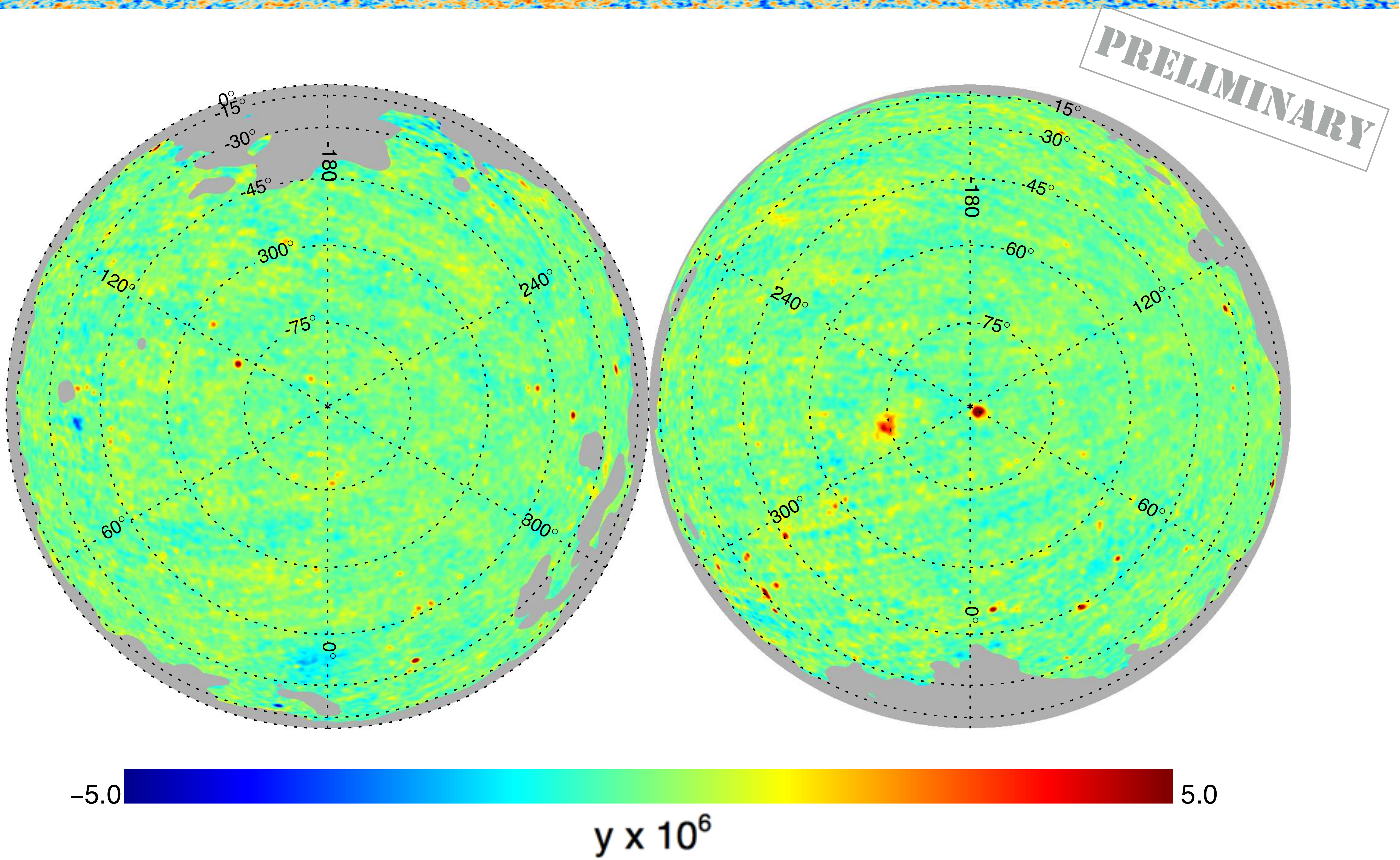
widely tested on simulations and data
[Planck 2013 Results XXI, PIP V, VI, VIII (2013)]

We reconstruct the tSZ* amplitude

$$y = \Sigma_i \Sigma_\alpha w_i^\alpha B^\alpha T_i$$

[for kSZ Planck results, check out Yin-Zhe Ma's poster]

y-map



PRELIMINARY
0°
-15°
-30°
-45°
-180
300°
120°
240°
-75°
60°
300°
0°
15°
30°
45°
180
60°
240°
120°
75°
300°
60°
0°
–5.0
5.0
y x 10^6

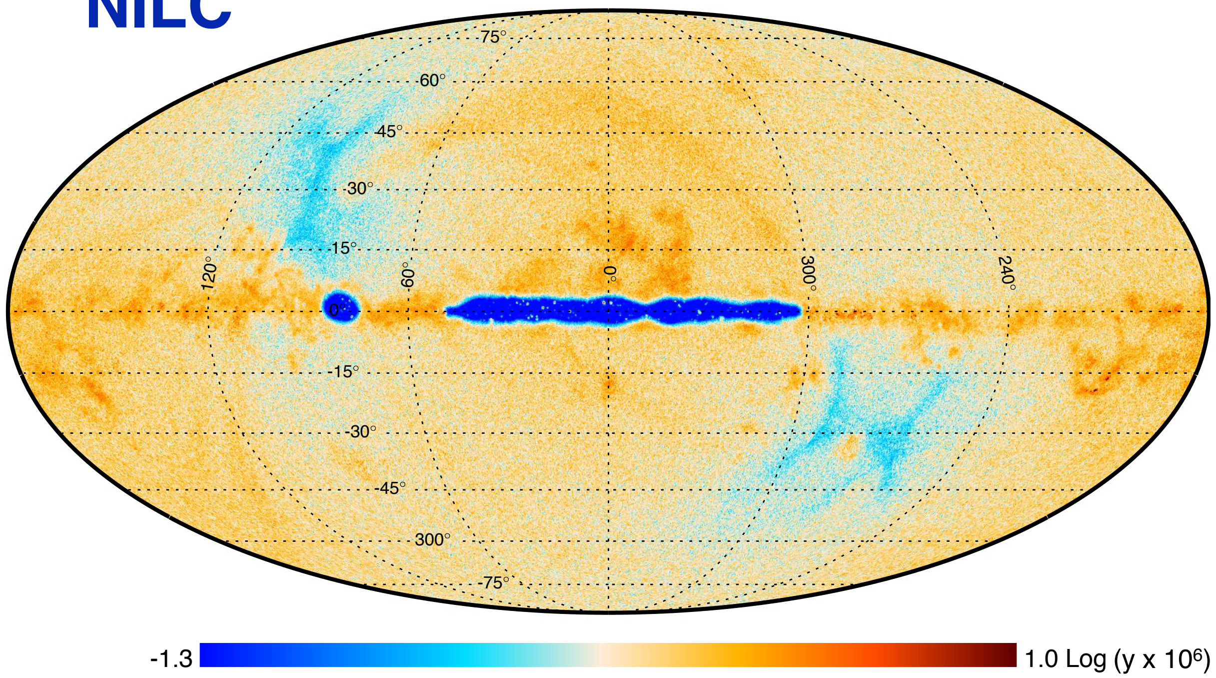
Noise

PRELIMINARY

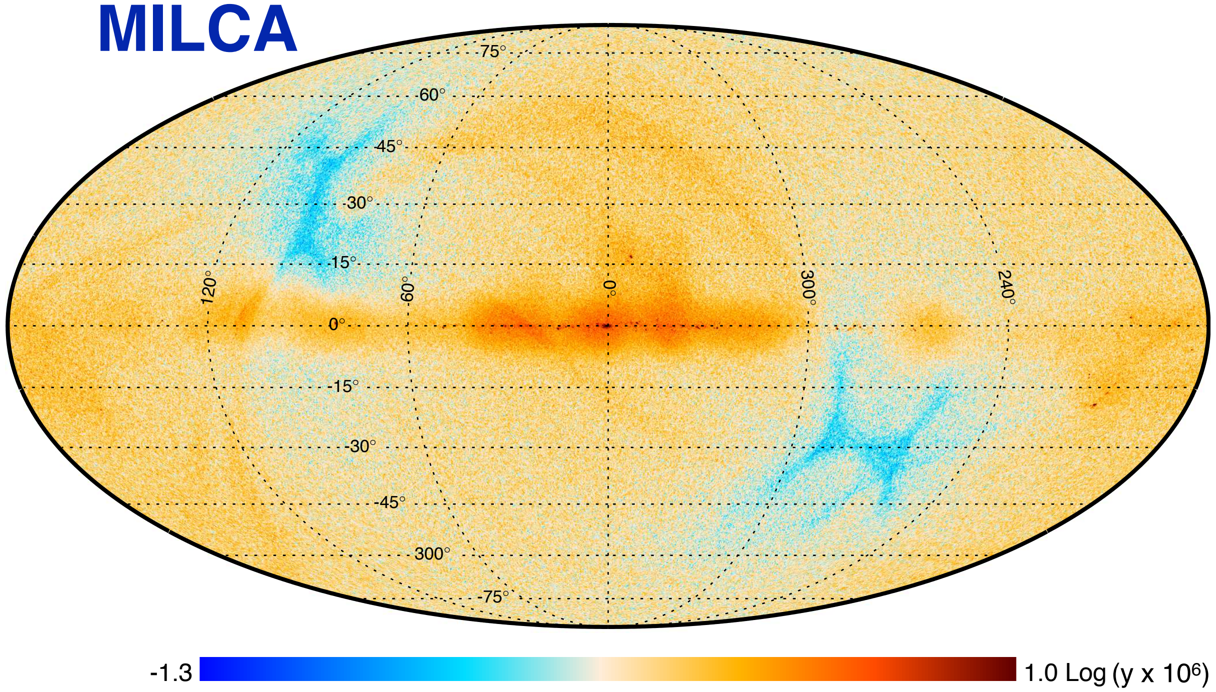
we use two subsets of data containing the same astrophysical signal

$$N = \frac{R_1 - R_2}{2} = \frac{(S + N_1) - (S + N_2)}{2}$$

NILC



MILCA



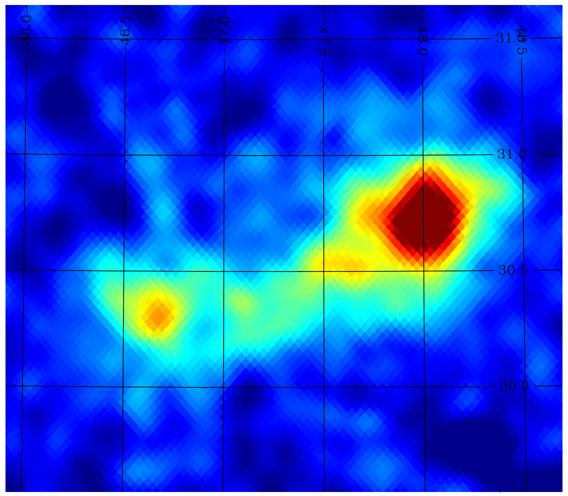
The y-map noise reflects **non-homogeneous** structure of the noise of Planck maps, mainly due to the **scanning strategy**:

variance map + angular power spectrum of homogenous noise

y-map examples

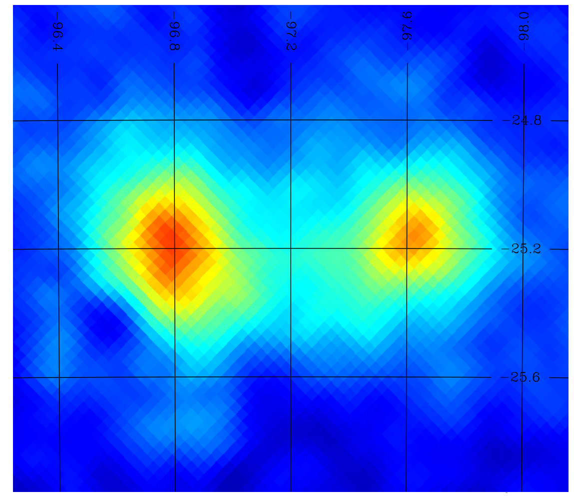
PRELIMINARY

NILC



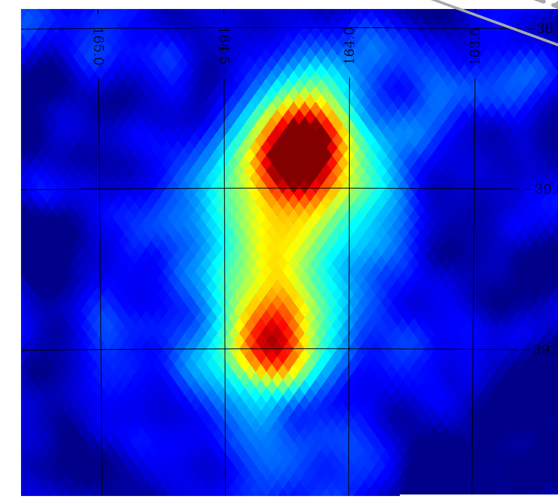
-2.0 (312.7, 30.6) Galactic 25.0

y x 10^6



-2.0 (262.8, −25.2) Galactic 25.0

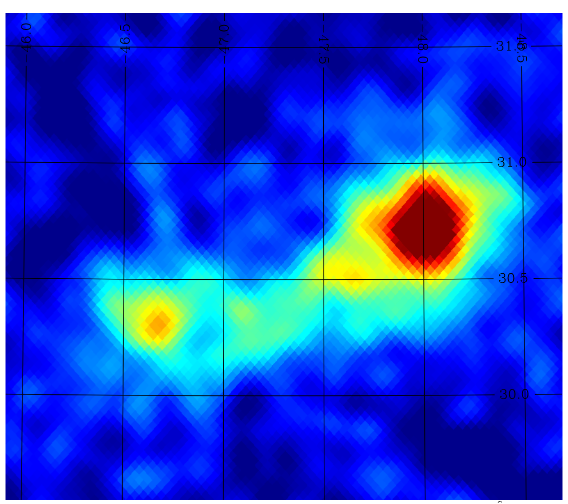
y x 10^6



-2.0 (164.2, −39.2) Galactic 35.0

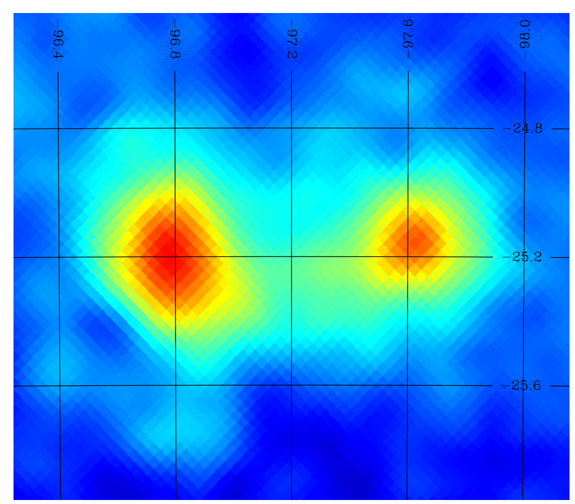
y x 10^6

MILCA



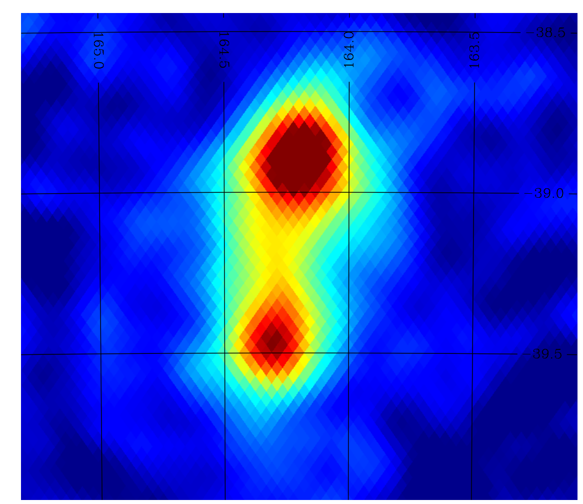
-2.0 (312.7, 30.6) Galactic 25.0

y x 10^6



-2.0 (262.8, −25.2) Galactic 25.0

y x 10^6



-2.0 (164.2, −39.2) Galactic 35.0

y x 10^6

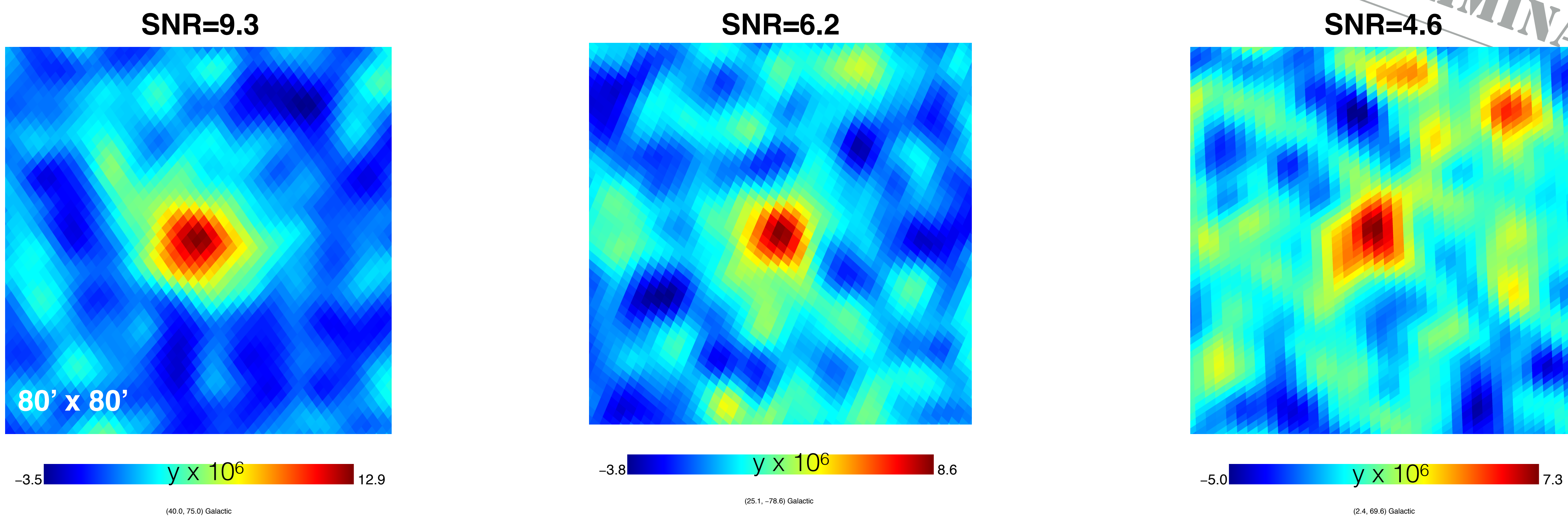
Systems analysed in PIP VIII (2012)

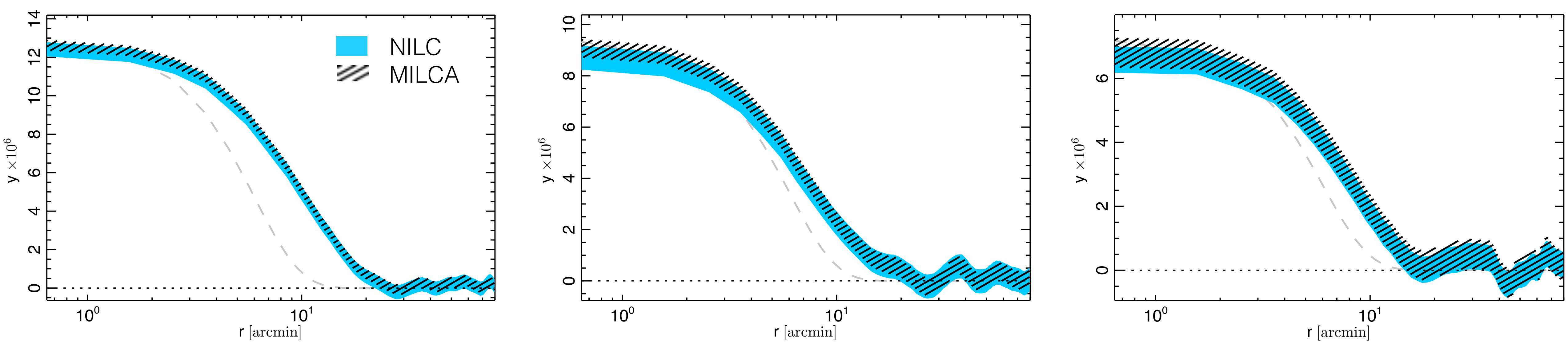
y-map examples

Complementary tool with respect to the cluster catalog

PRELIMINARY

NILC





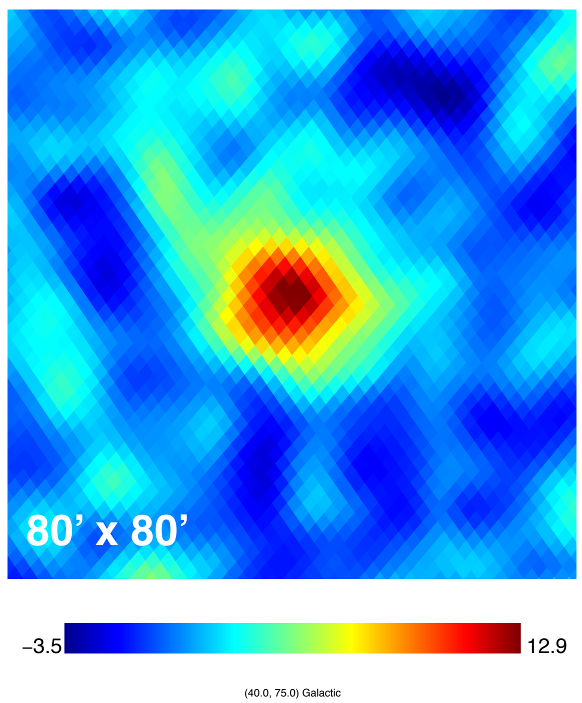
y-map examples

Complementary tool with respect to the cluster catalog

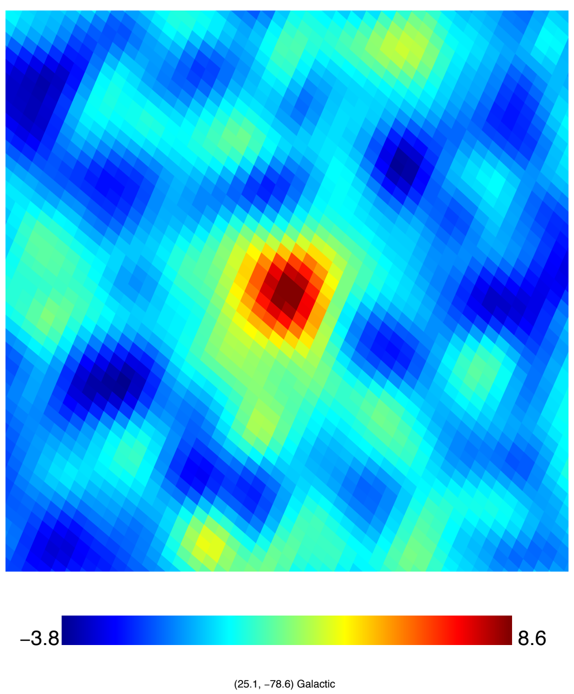
PRELIMINARY

MILCA

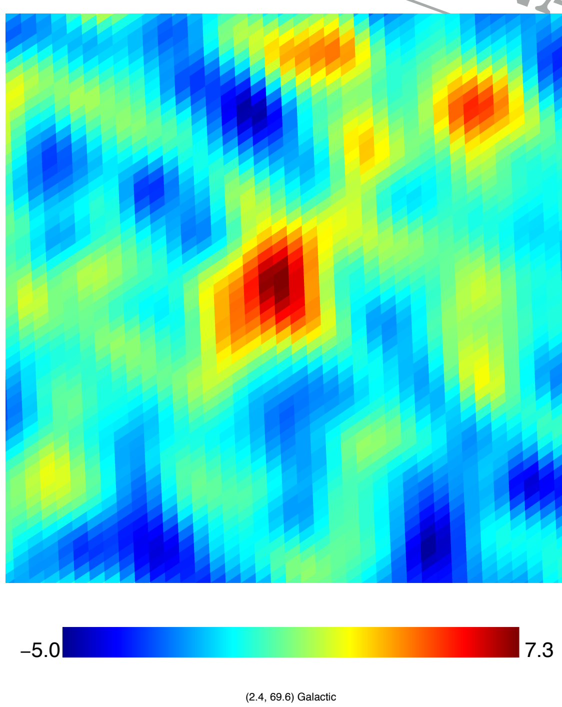
SNR=9.3

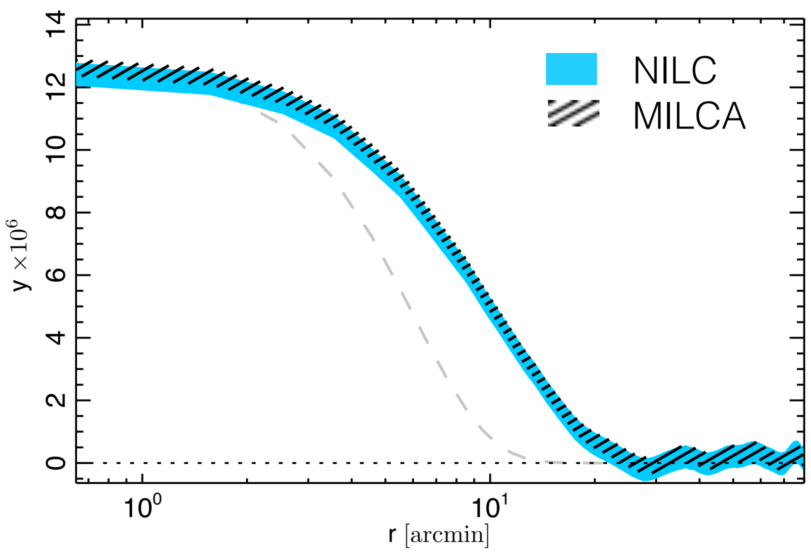


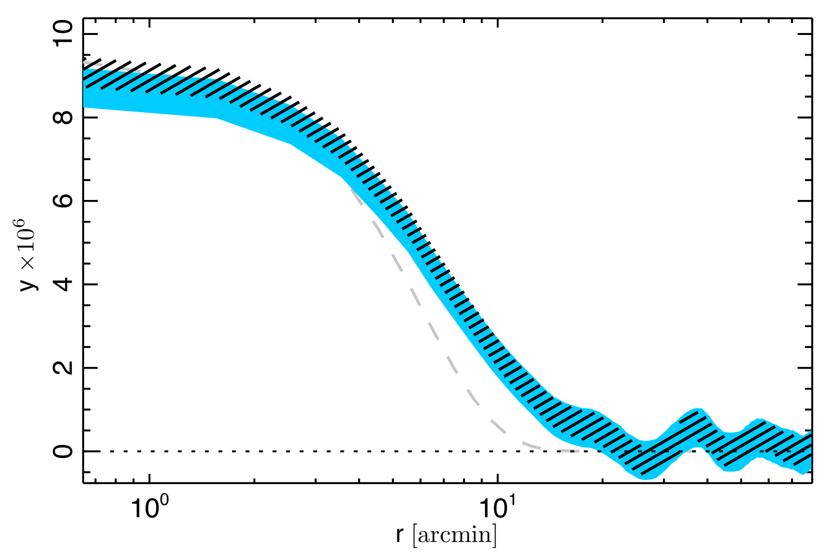
SNR=6.2

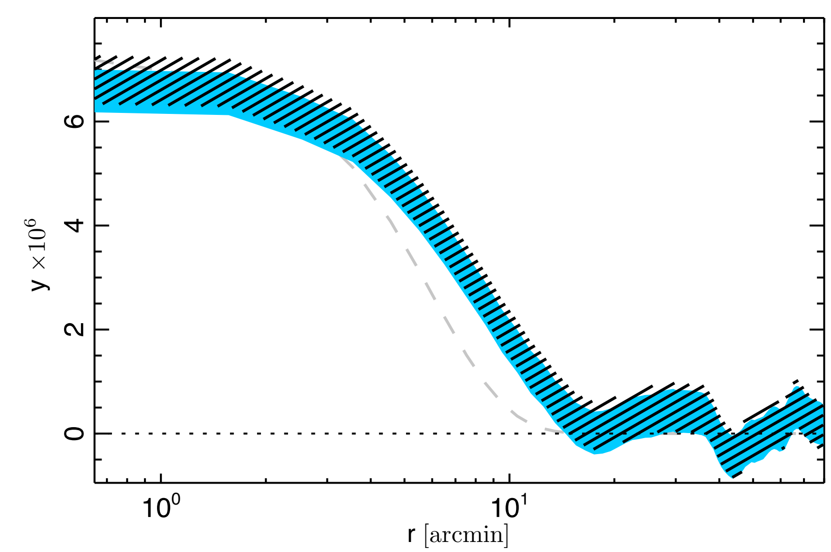


SNR=4.6



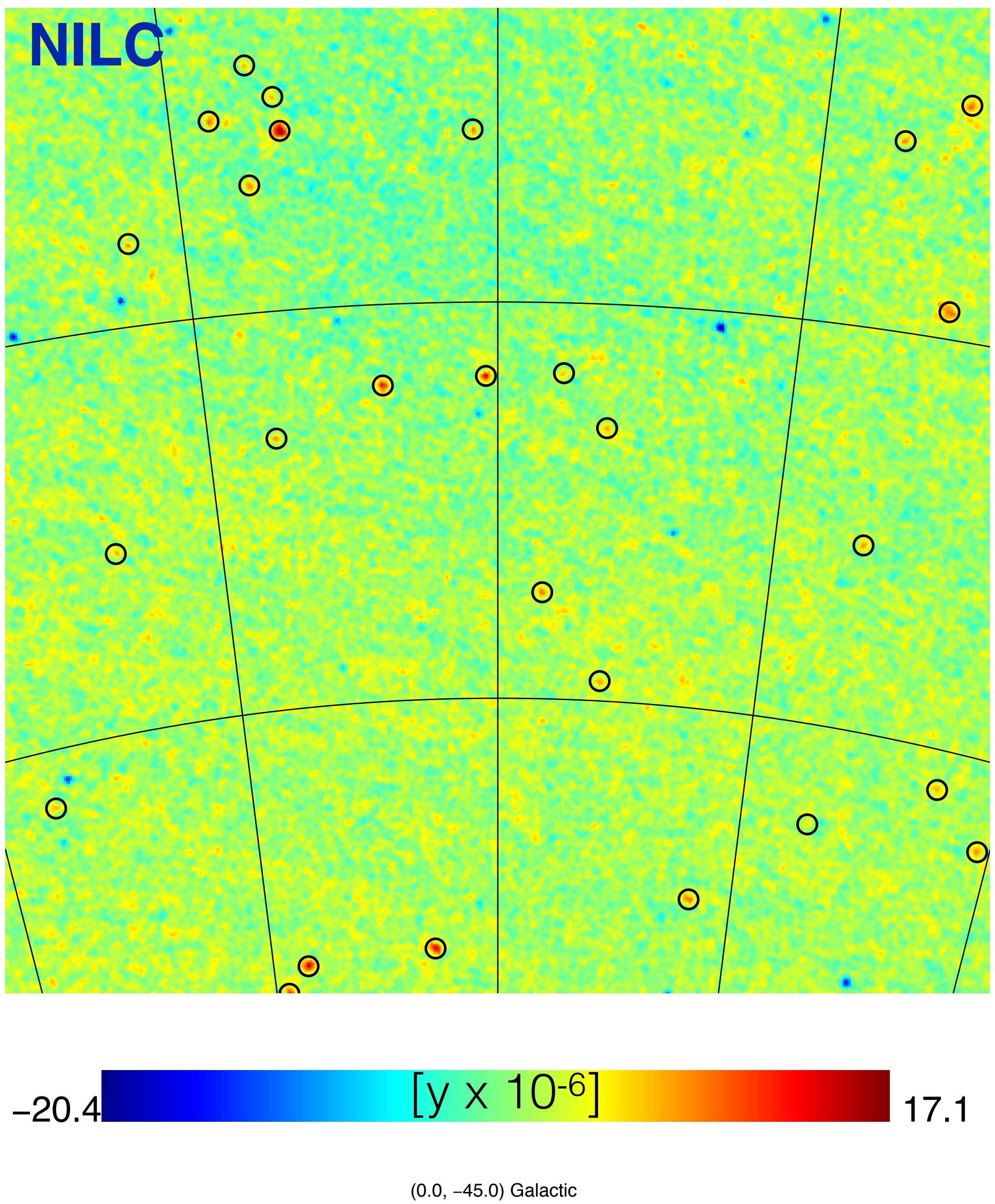


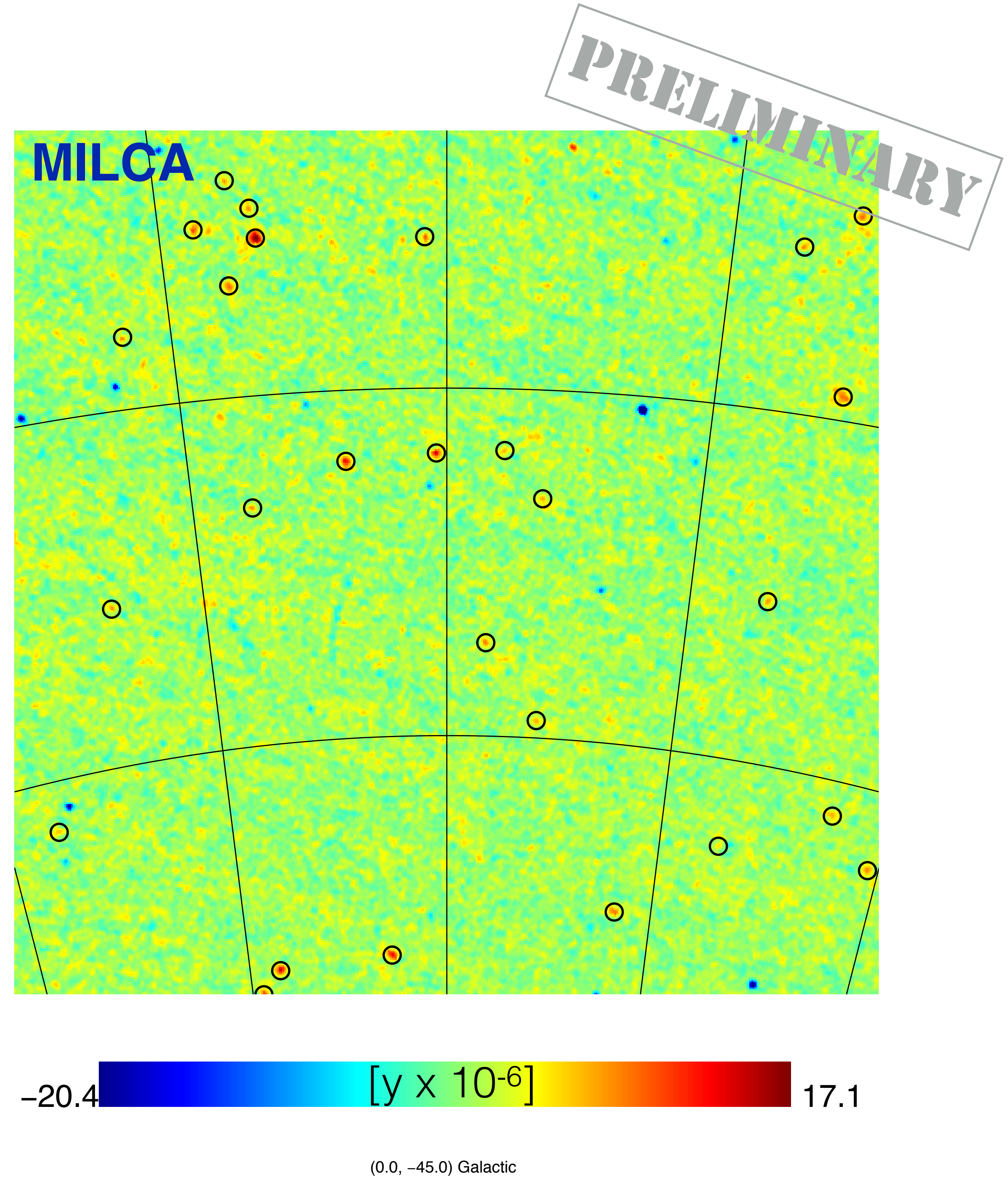




y-map

◯ **PSZ2 candidates**

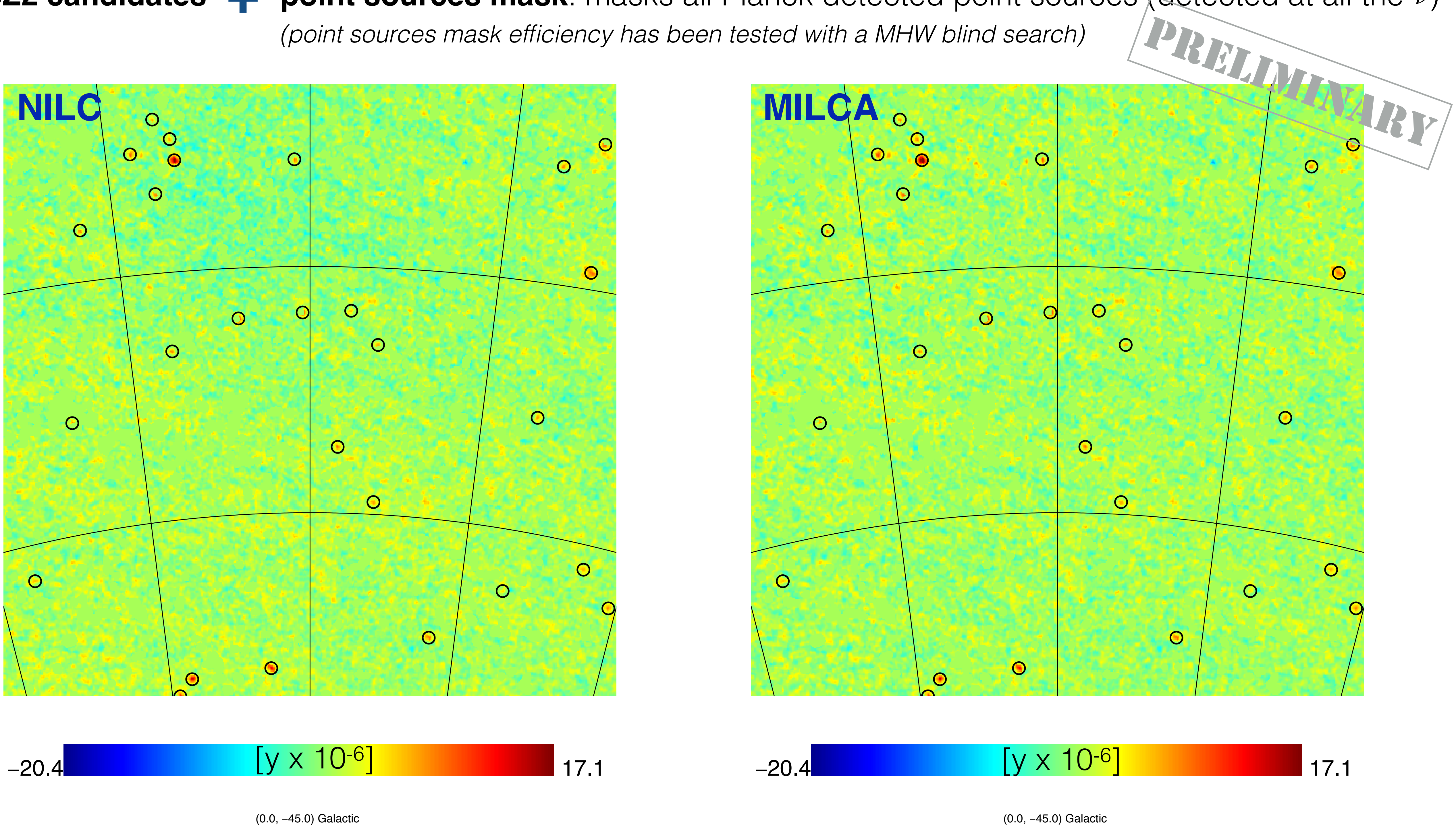




y-map

◯ **PSZ2 candidates** **+** **point sources mask**: masks all Planck detected point sources (detected at all the ν)

(point sources mask efficiency has been tested with a MHW blind search)



blind source detection

to test the consistency with the PSZ2

PRELIMINARY

→ *IFCAMEX algorithm (MHW2, [Gonzalez-Nuevo et al. (2006), López-Caniego et al. (2006)])*

→ *single frequency matched filter [Melin et al. (2006)]*

positive point sources SNR > 4

MHW **@MILCA: 457**/1522 are PSZ2 objects

MHW **@NILC: 500**/1018 are PSZ2 objects

MF **@MILCA: 1107**/1472 are PSZ2 objects
(**867** are **confirmed clusters)**

MF **@NILC: 1096**/1502 are PSZ2 objects
(**835** are **confirmed clusters)**

blind source detection

to test the consistency with the PSZ2

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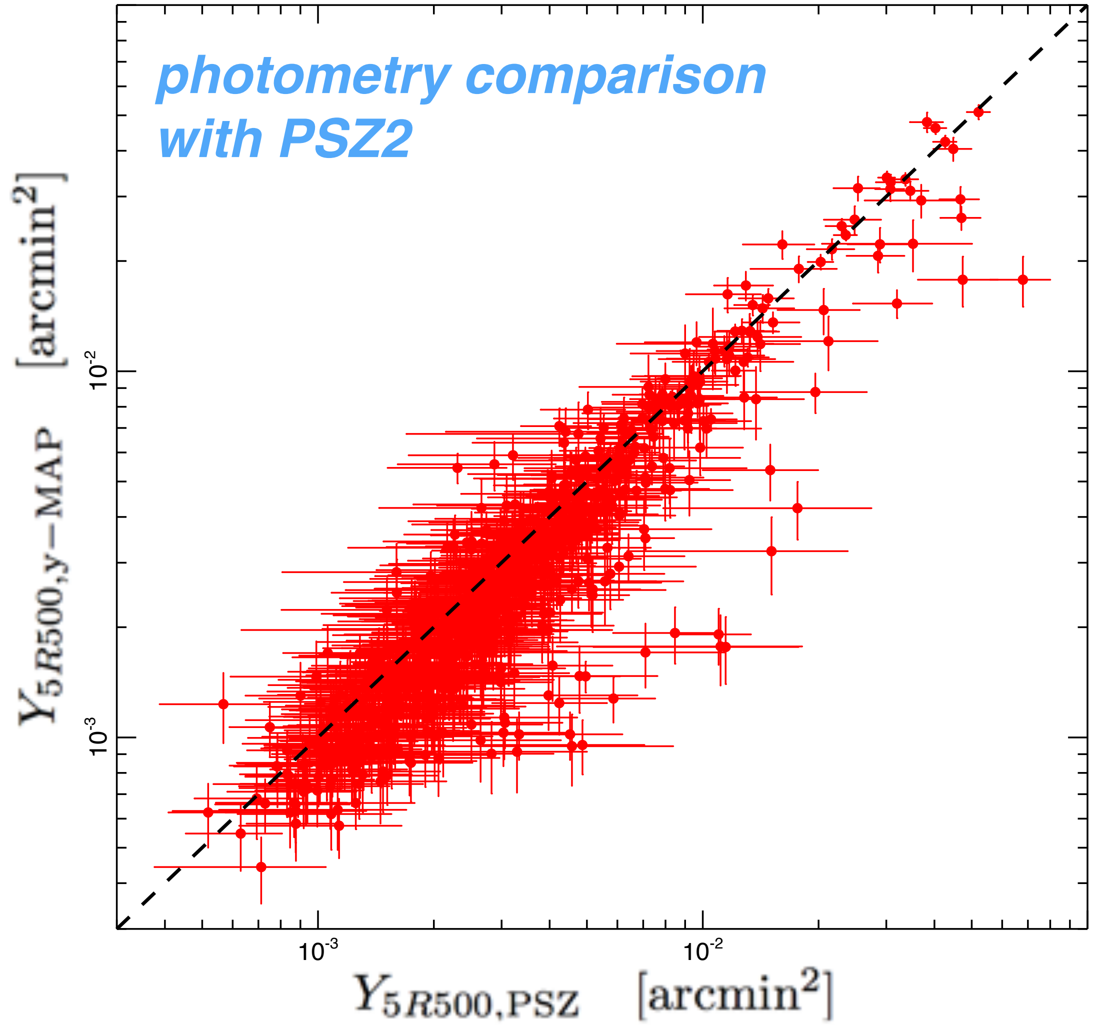

blind source detection

to test the consistency with the PSZ2

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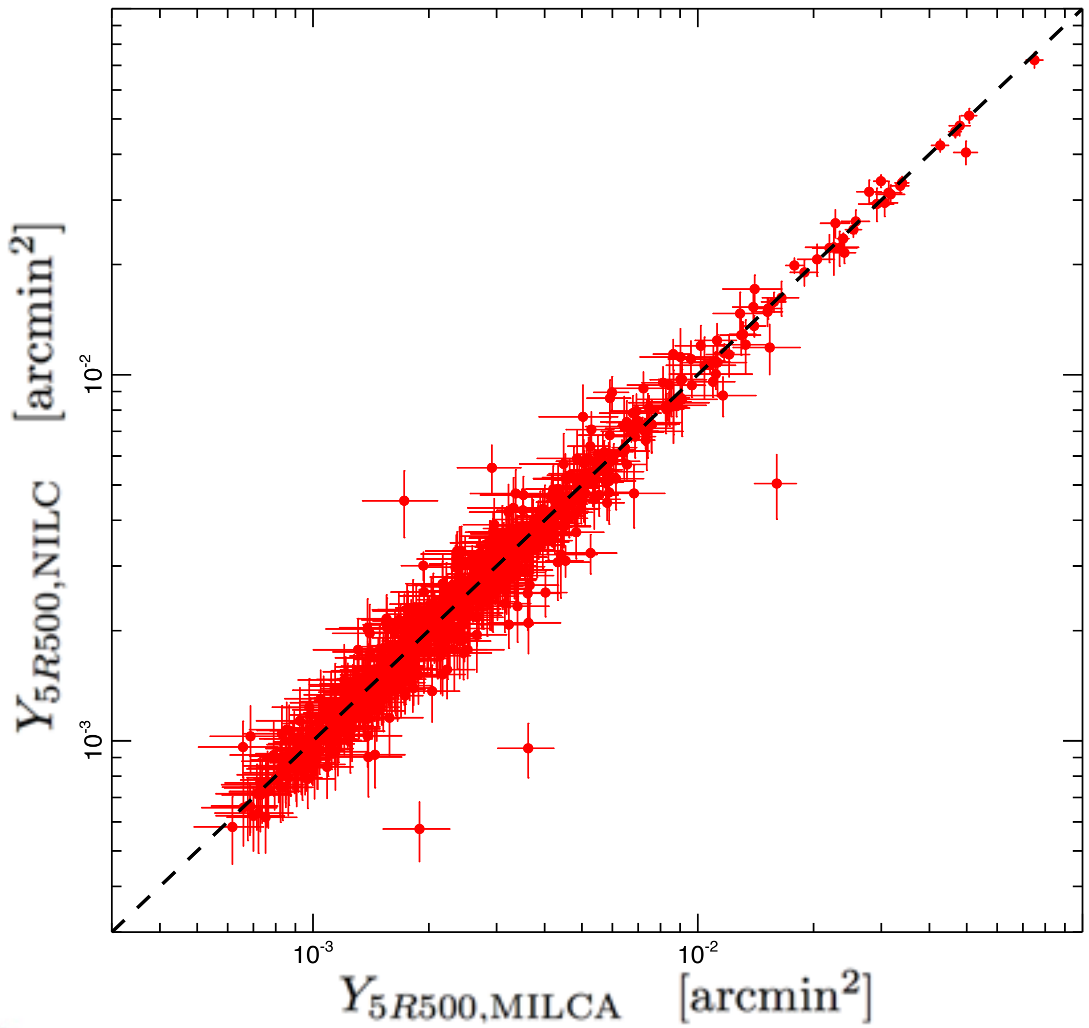
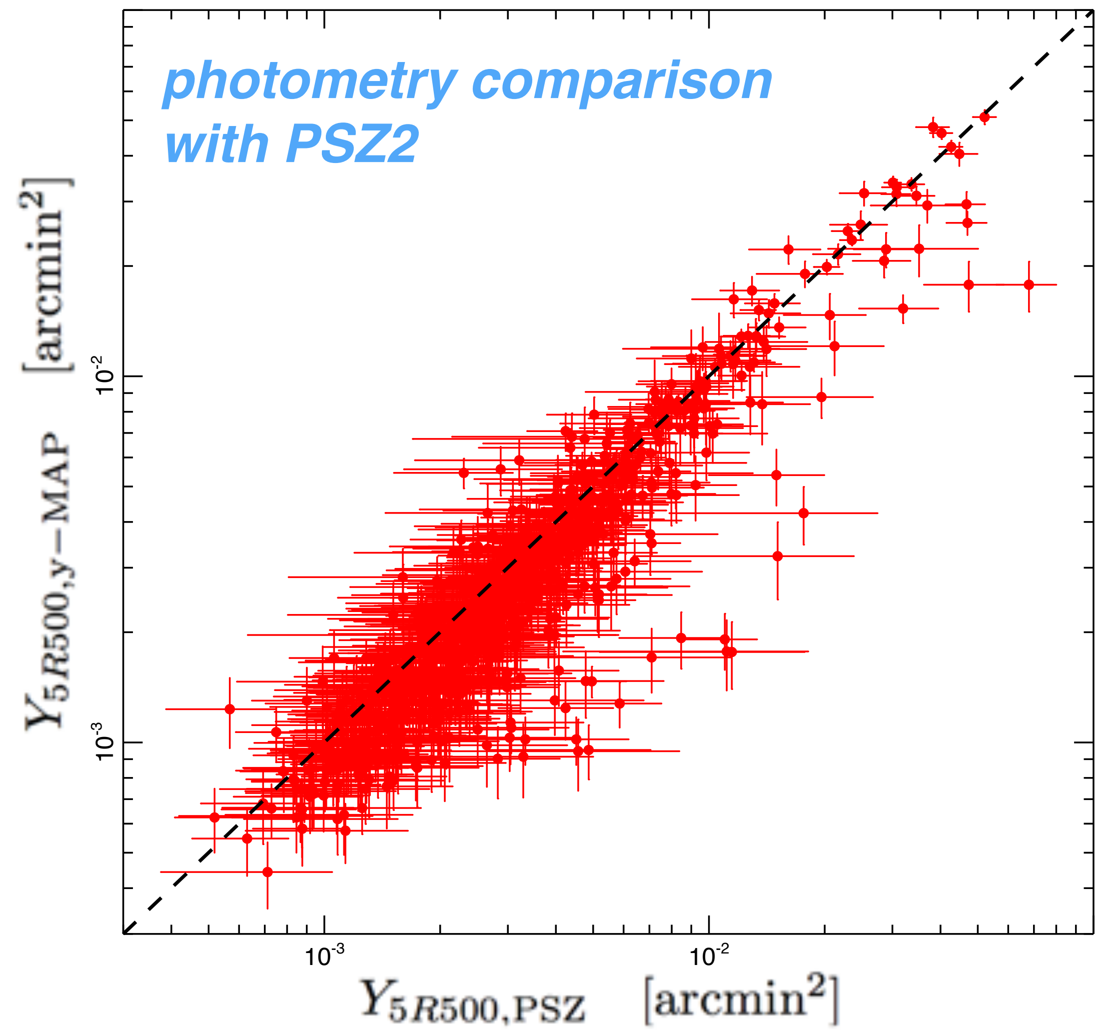
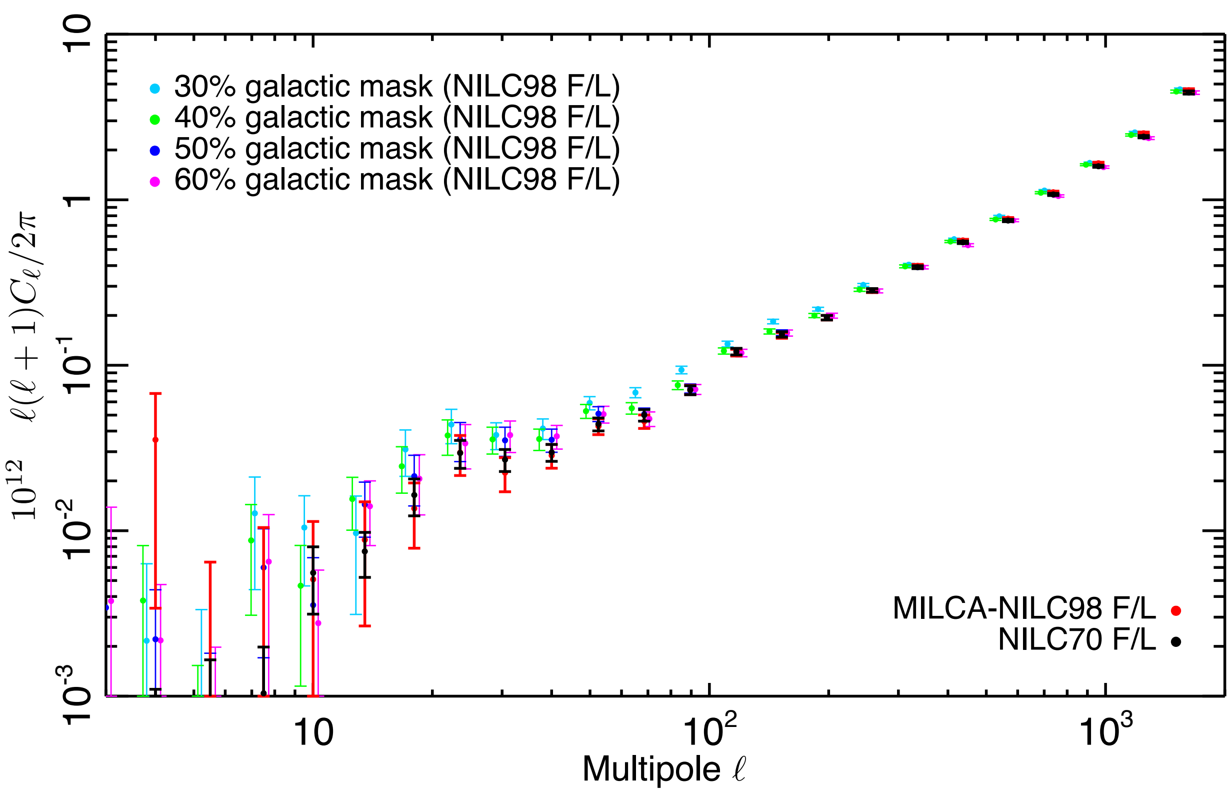


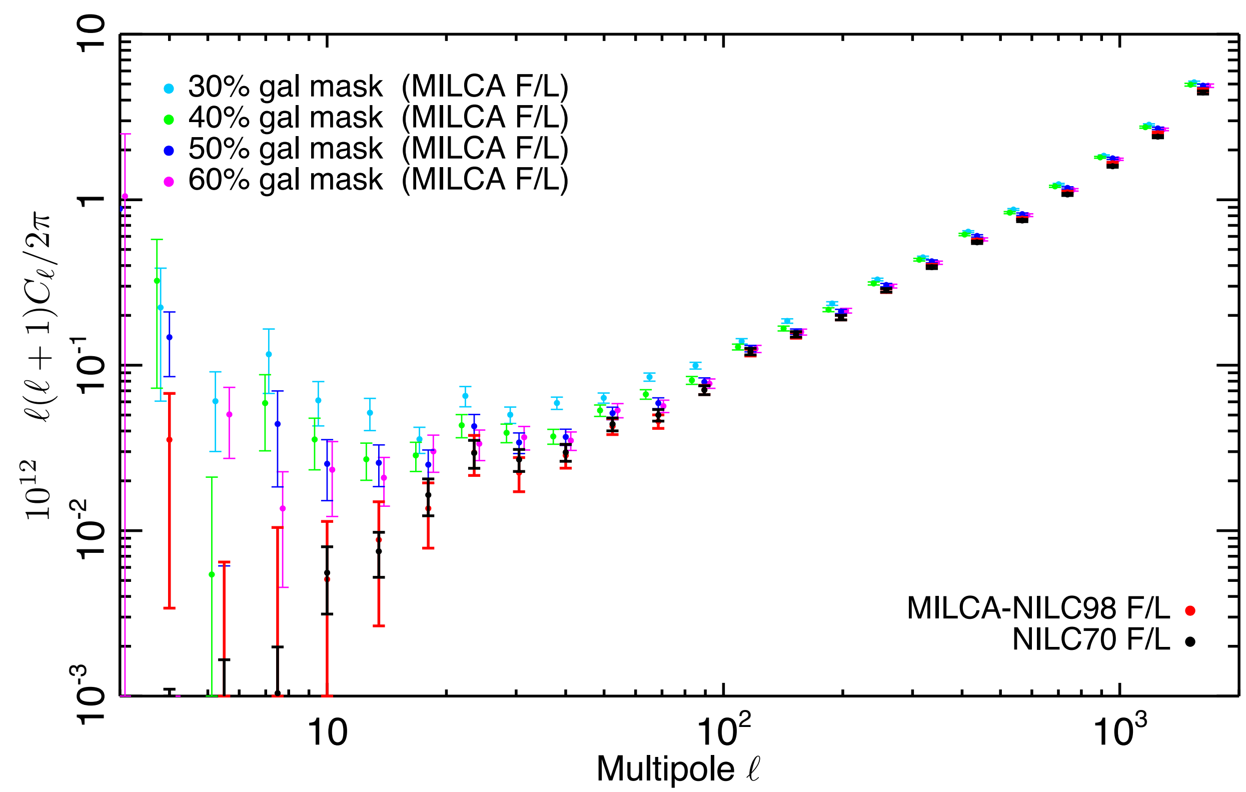


Galactic contamination

PRELIMINARY

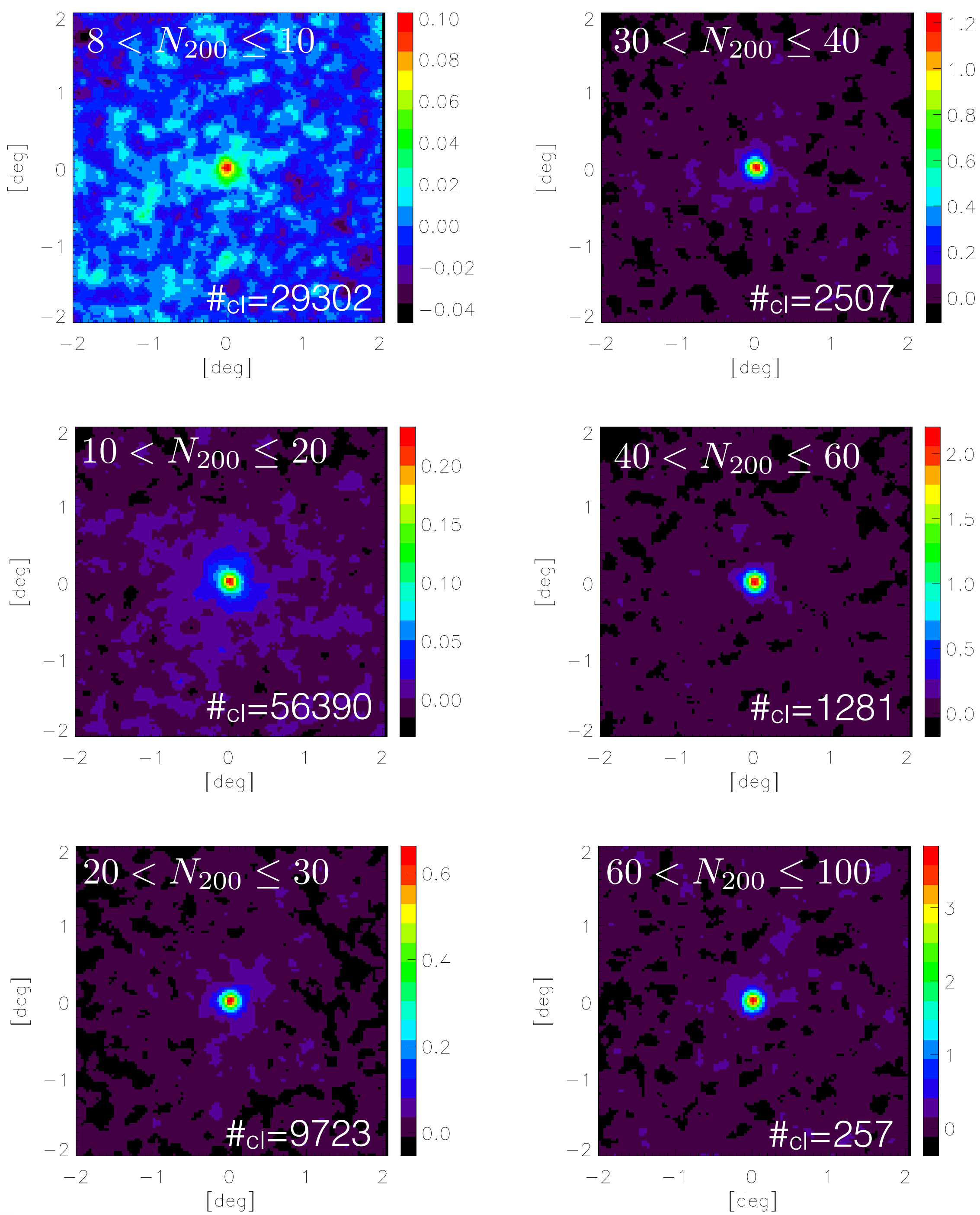
galactic dust emission is the dominant foreground at large angular scales



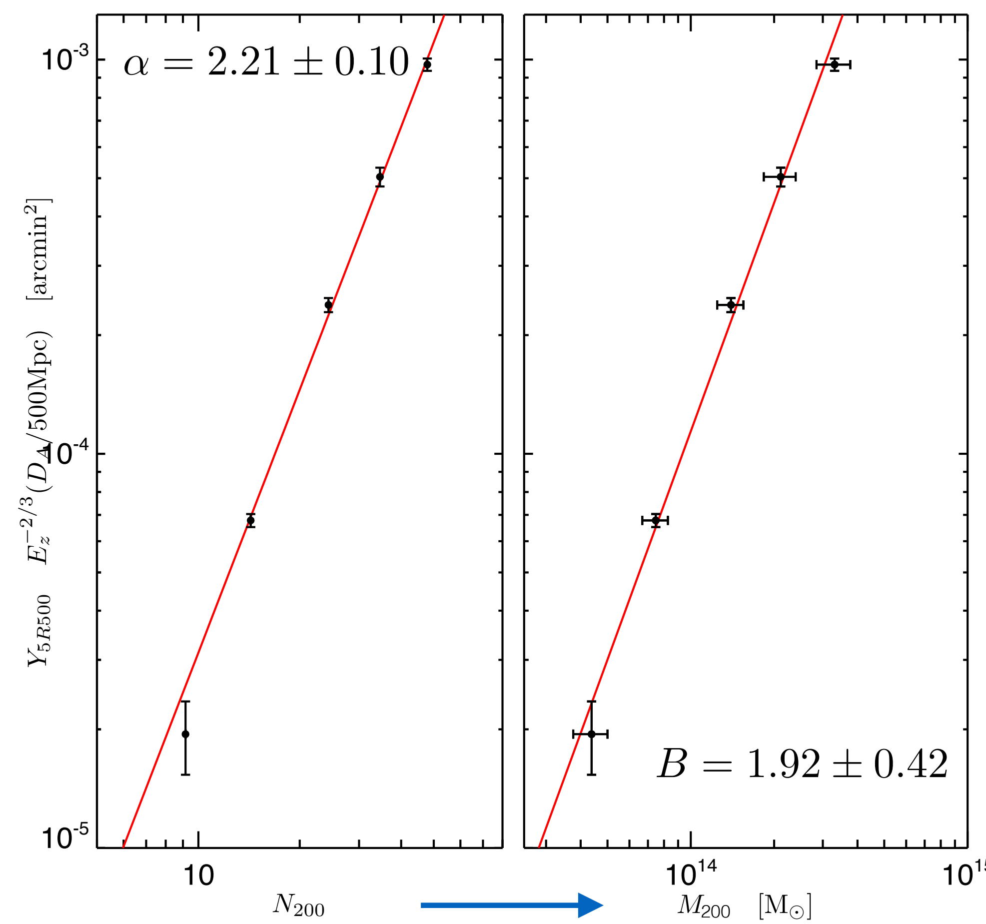


SZ signal within the noise

132,684 clusters of galaxies (SDSSIII *[Wen et al. 2012]*)



$$Y_{5r500} E_z^{-2/3} \left(\frac{D_A(z)}{500Mpc}\right)^2 \propto N_{200}^{\alpha} \qquad Y_{5r500} E_z^{-2/3} \left(\frac{D_A(z)}{500Mpc}\right)^2 \propto M_{200}^{B}$$



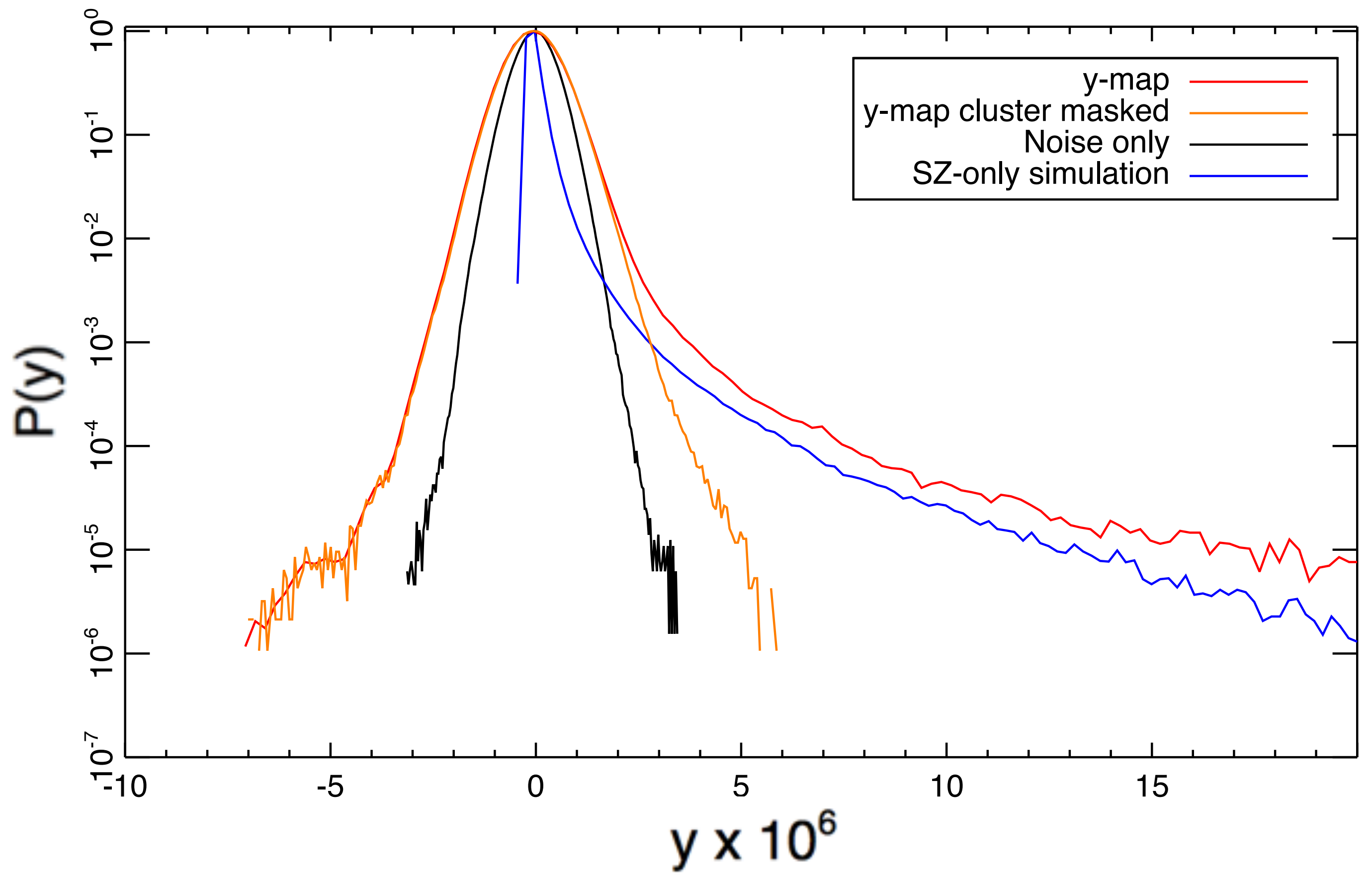
We can consider the reconstruction sufficiently robust even where SZ is not the dominant signal

Science with the y-map

- extract patches around single clusters: flux / profile comparison (not model-dependent) *[e.g. PIP V (2013)]*
- stacking *[e.g. PIP V (2013), Hurier et al. (2014)]*
- cross-correlation studies *[e.g. Hurier et al. (2014), Hill & Spergel (2014), Van Waerbeke e al. (2014)]*
- cosmological constraints → **P(y)**
  power spectrum
  bi-spectrum

P(y) - 1D PDF

PRELIMINARY



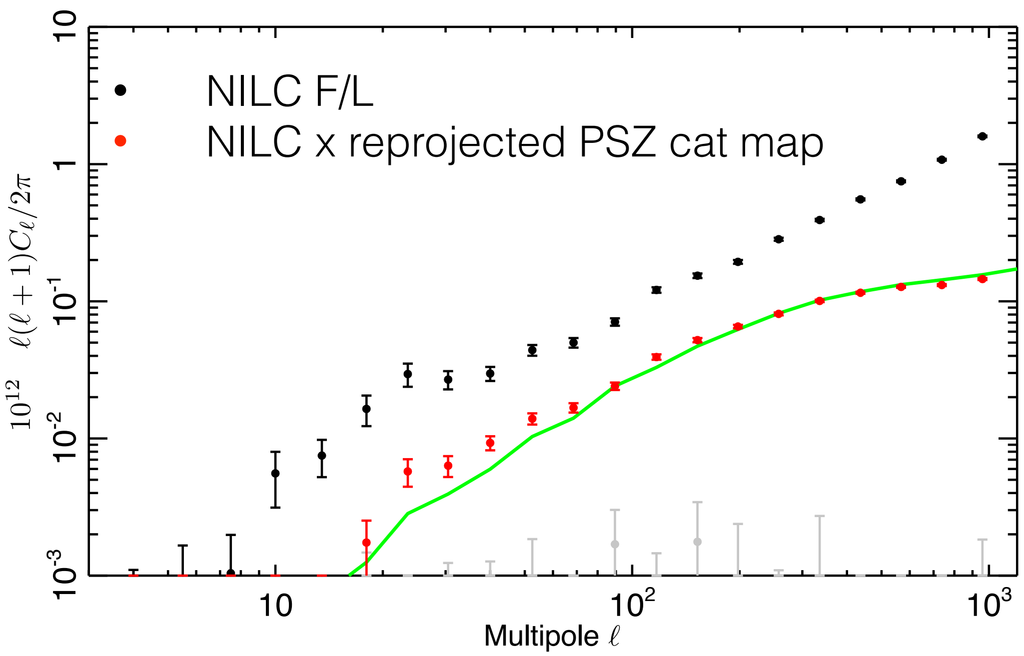
the positive tail provides information about the population of galaxy clusters *[Rubiño-Martín & Sunyaev 2003]*

[Hill et al. 2014 (arXiv:1411.8004)]

Science with the y-map

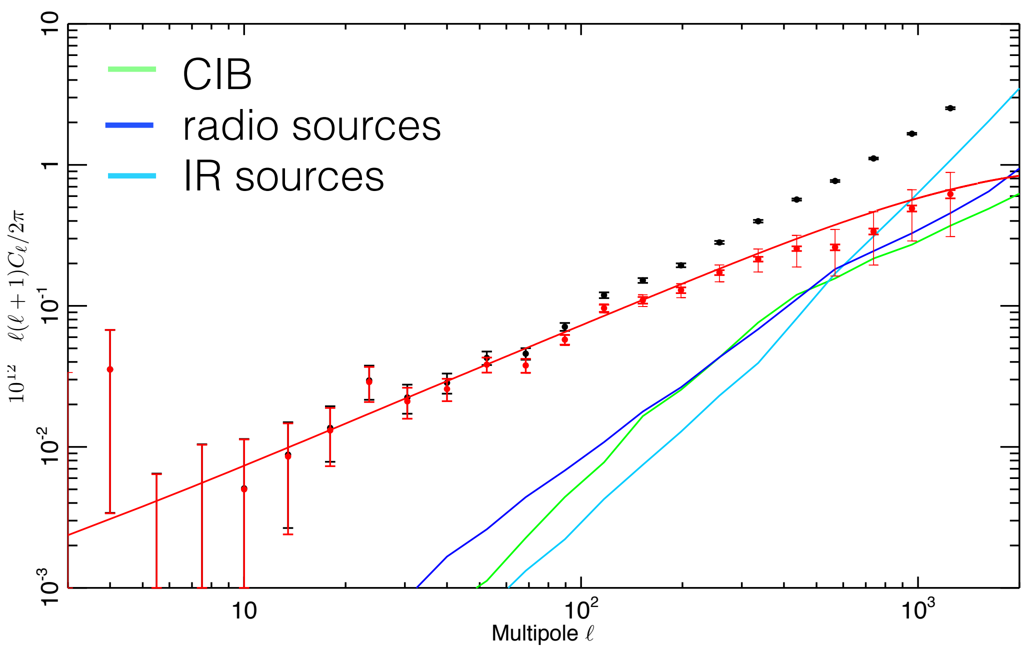
PRELIMINARY

SZ power spectrum:



a significant fraction of the signal in the reconstructed Planck Compton parameter maps is due to the tSZ effect of detected and confirmed clusters of galaxies

$$C_\ell = C_\ell^{tSZ}(\Omega_m, \sigma_8) + A_{CIB} C_\ell^{CIB} + A_{PS}(C_\ell^{IR} + C_\ell^{Rad})$$



- **tSZ:** halo model (1-halo and 2-halo term),Tinker et al. (2008) mass function + Arnaud et al. (2010) universal pressure profile ($0 \leq z \leq 3$, $10^{13} M_\odot \leq M_{tot} \leq 5 \times 10^{15}$)

residual foreground contamination at high-multipoles

- **CIB & point sources:**
  - models of the power spectrum for each observation channel + cross correlations between channels [CIB & CIBxSZ = ***Planck Collaboration A29 (2014)***, IR & radio sources = ***Planck Collaboration XXI (2014)***]
  - the **ILC weights** are applied to Gaussian realizations of the foreground contribution for channel

Conclusions

Working with the Planck frequency channel maps from 30 to 857 GHz **we have reconstructed the tSZ signal over the full sky using tailored component separation methods**.

We have proceed to an **extensive testing and validation** of the Planck y-map and we have characterized it in terms of :

- **signal** very nice agreement with PSZ2
  maps are dominated by SZ at $100 \lesssim \ell \lesssim 800$
- **noise** (inhomogeneous, can be characterized by pixel dependent variance and a homogeneous gaussian noise)
- **foreground contamination** (dust emission is important at large angular scales, for radio and IR point sources a mask is provided, residual contamination from CIB can be further treated at the spectra level)

After a thorough validation process, we find this map to be of high-enough quality to allow further very interesting analyses!

We will deliver:	y-maps noise maps ILC weights	+	*point sources mask*

The scientific results that we present today are a product of the Planck Collaboration, including individuals from more than 100 scientific institutes in Europe, the USA and Canada

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Thank you!