



Polarized point sources in the QUIJOTE Wide Survey

RADIO
FOREGROUNDS


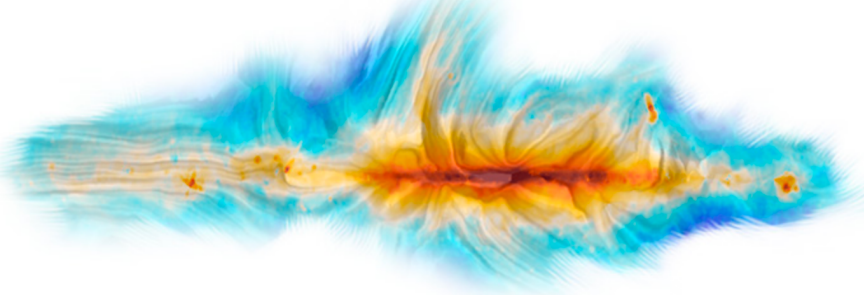
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Instituto de Física de Cantabria (UC-CSIC)
CMB foregrounds for B-mode studies
Wednesday, October 17th, 2018

Overview

- Method
- Sample
- The RADIOFOREGROUNDS point source catalogue, v1.0
 - Consistency checks
 - Validation
 - Statistical properties
- Conclusions

Method: Filtered Fusion (FF)

A Python 3 version of IFCAPOL

SOFTWARE

Detection of polarised radio sources: IFCAPOL

We provide IFCAPOL, a FORTRAN90 package that implements the Filtered Fusion technique for the detection/estimation of the polarized emission from compact sources in microwave sky maps.

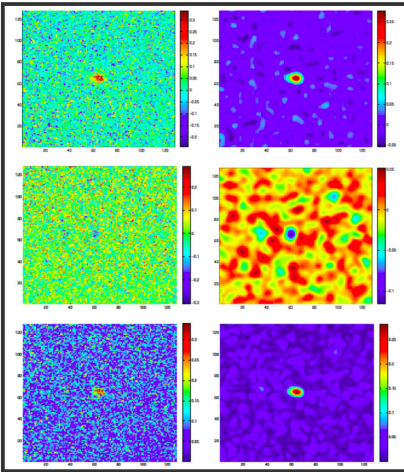
Download

The open source code is publicly available [here](#).

Installation and dependencies.

The codes are written in FORTRAN90. The code is provided as gzipped tar file containing eight f90 module files plus a Makefile for installation. The code needs also a C++ compiler and it also depends on a number of FORTRAN90 libraries:

- cfitsio for FITS files input/output
- healpix for manipulation of HEALPix [6] spherical sky maps
- Daniel Mortlock's general and sphere libraries [7] for fast projection of HEALPix maps into planar patches



Navigation:

- Presentation
- Work plan
- Team
- Jobs
- Publications
- Presentations
- Software
- Visu3D-GMF
- MF-reconstruction
- tSourceDetection
- Outreach

1. F. Argüeso, J. L. Sanz, D. Herranz, M. Lopez-Caniego, and J. González-Nuevo, "Detection/estimation of the modulus of a vector. Application to point-source detection in polarization data," *MNRAS*, vol. 395, no. 2, pp. 649–656, 2009.
2. M. López-Caniego, M. Massardi, J. González-Nuevo, L. F. Lanz, D. Herranz, G. de Zotti, J. L. Sanz, and F. Argüeso, "Polarization of the WMAP Point Sources," *ApJ*, vol. 705, no. 1, pp. 868–876, Nov. 2009

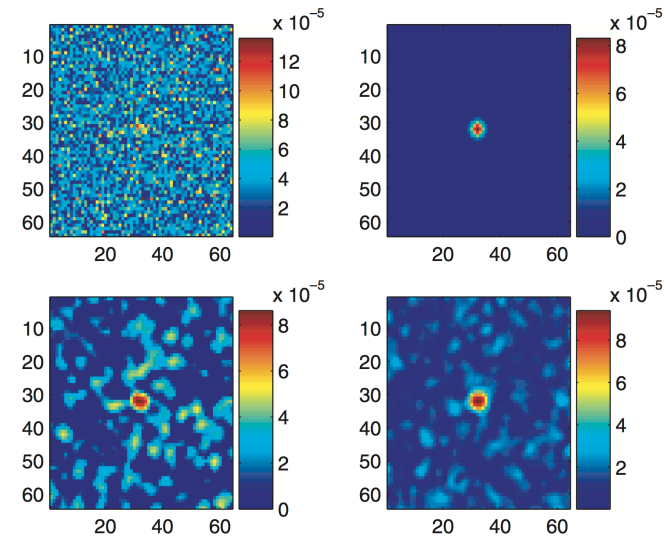
Method: Filtered Fusion (FF)

- Small flat patches
- **Matched filter** for Q and U maps

$$Q_{MF}, U_{MF} = \psi_{Q,U} \otimes Q, U$$

$$\psi_{Q,U}(k) \propto \frac{\tau_b(k)}{P_{Q,U}(k)}$$

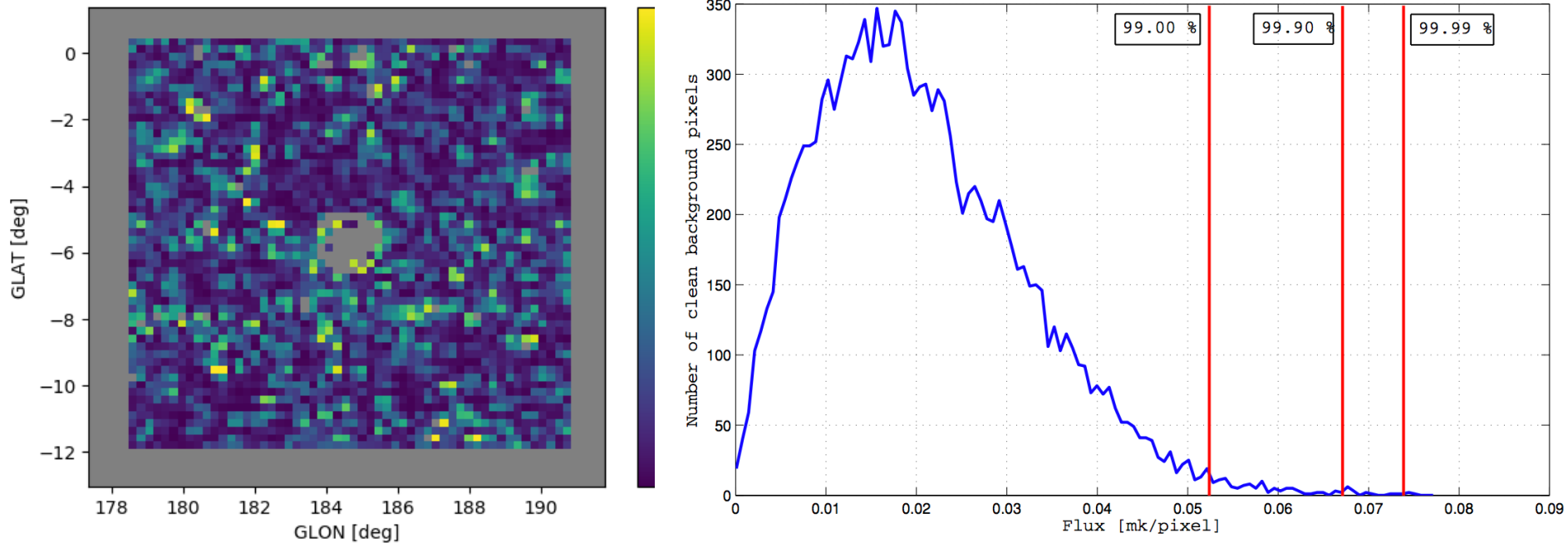
- Unbiased
- Maximum efficiency
- Optimal for Gaussian color noise



- $P = (Q_{MF}^2 + U_{MF}^2)^{1/2} \rightarrow$ non-Gaussian residual noise!
 - Detection significance instead of SNR (although SNR is still useful)

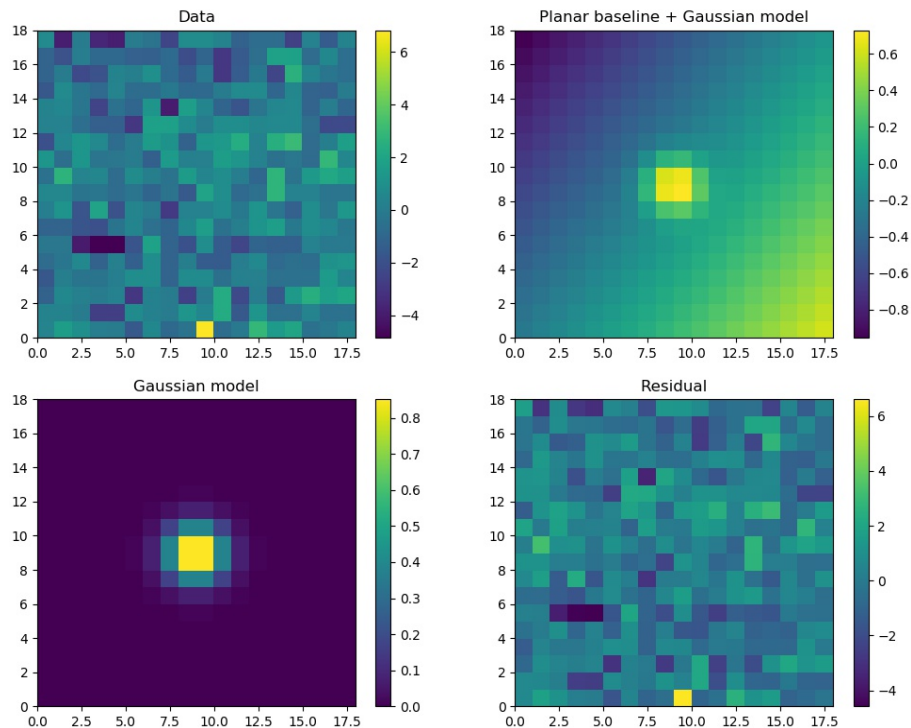
Method: Filtered Fusion (FF)

- Significance of the detections
 - Mask borders and source (5% brightest pixels)



Additional method: Q, U Gaussian fitting

- Fit to a Gaussian profile + planar baseline
- For white noise, equivalent to FF

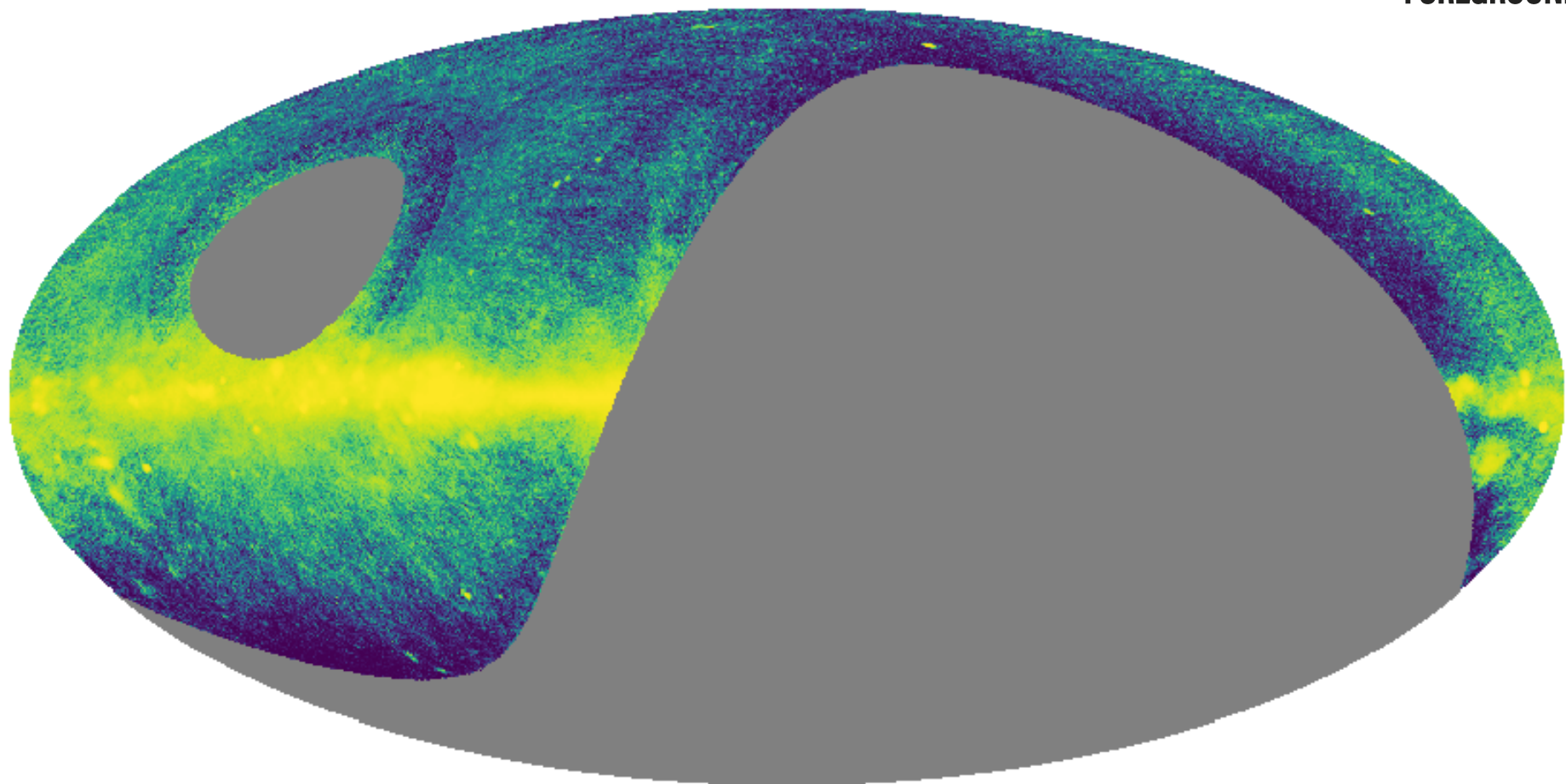


- Extra consistency check
- Particular sources

The sample: Planck PCCS2 polarized sample at 30 GHz

- Non blind search
- P. Collaboration, “*Planck 2015 results. XXVI. The Second Planck Catalogue of Compact Sources,*” *Astronomy & Astrophysics*, 594, A26, 2016.
- 114 sources detected with significance >99.99% or, at least, as 99% upper limits
- Providing I , P , ϕ values at 30 GHz as reference
- 41 sources in the Wide Survey area
 - Most of them in the Galactic Plane
 - A few near the mask border

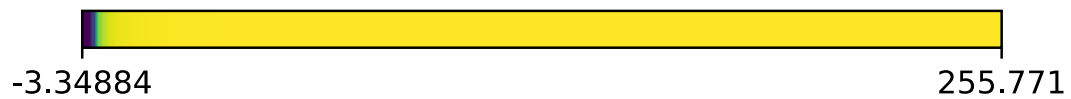
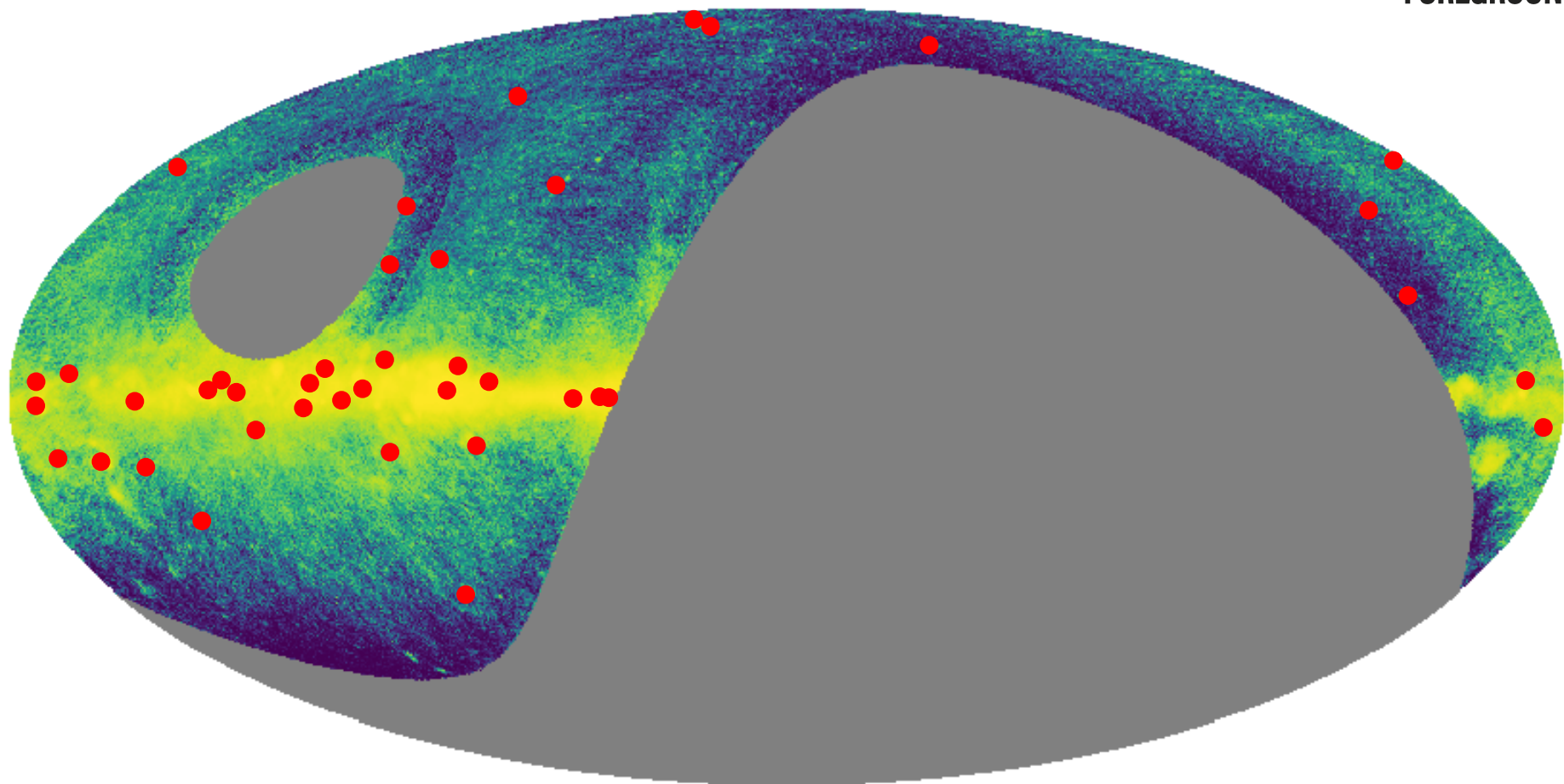
MFI 13GHz temperature [mK]



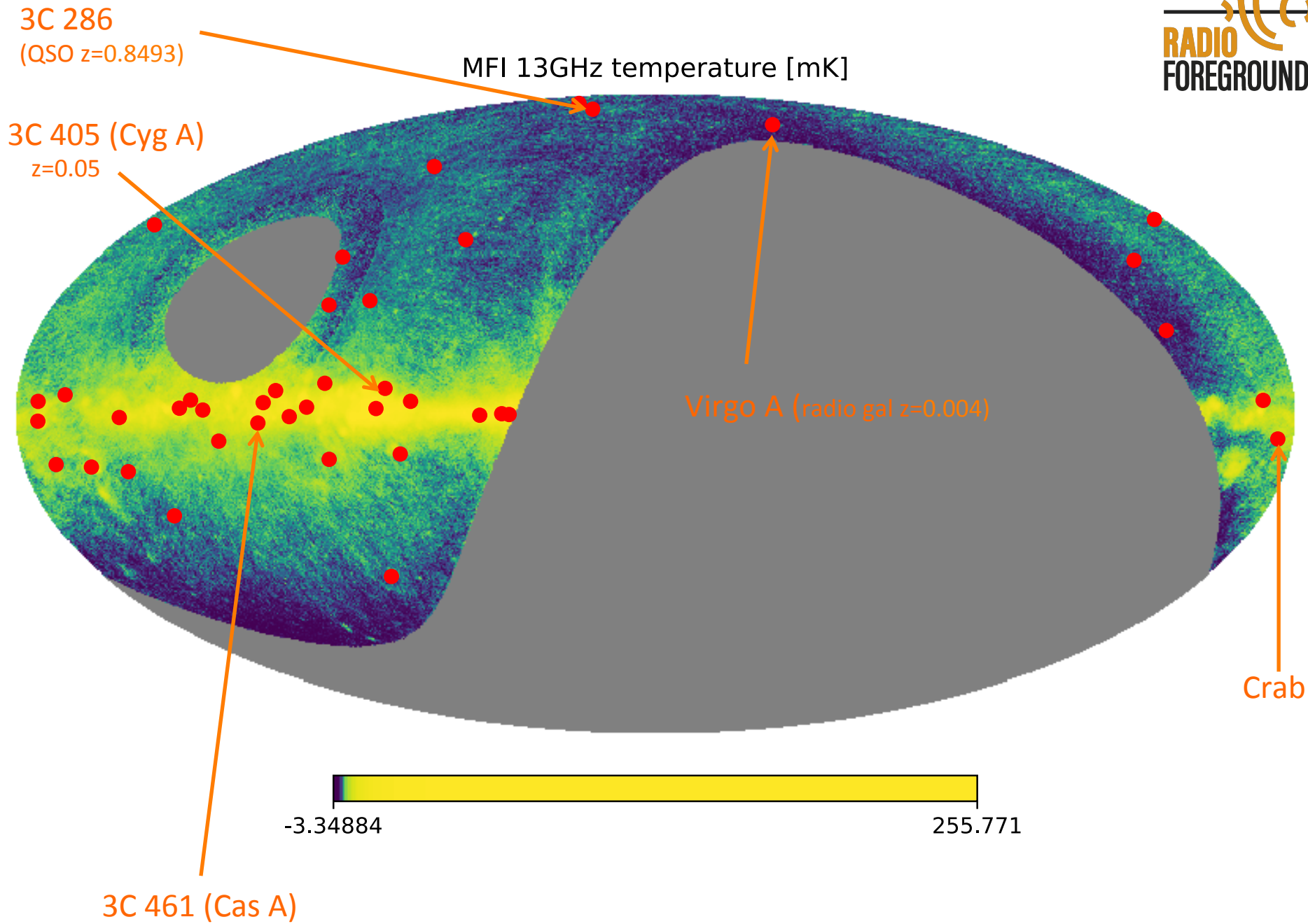
-3.34884

255.771

MFI 13GHz temperature [mK]



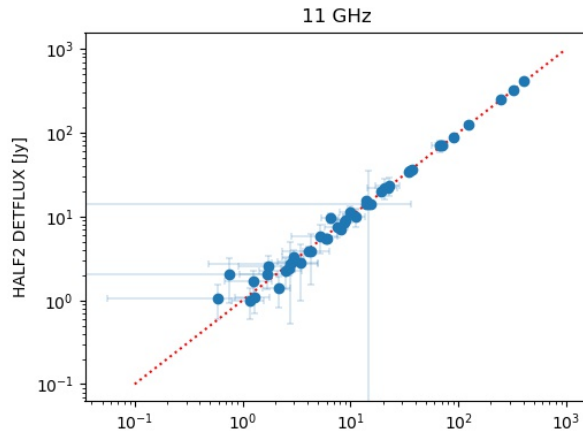
41 sources



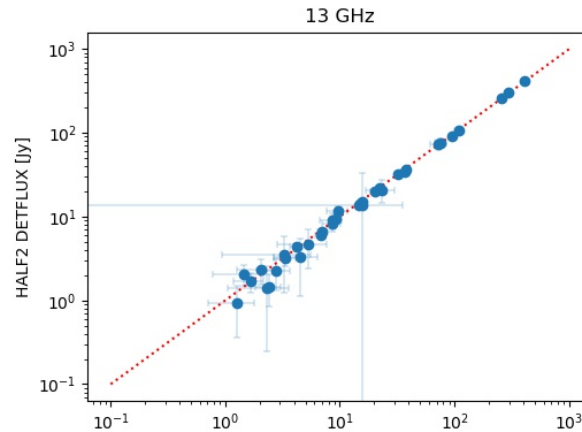
Results: consistency checks

- Half survey vs. half survey: intensity

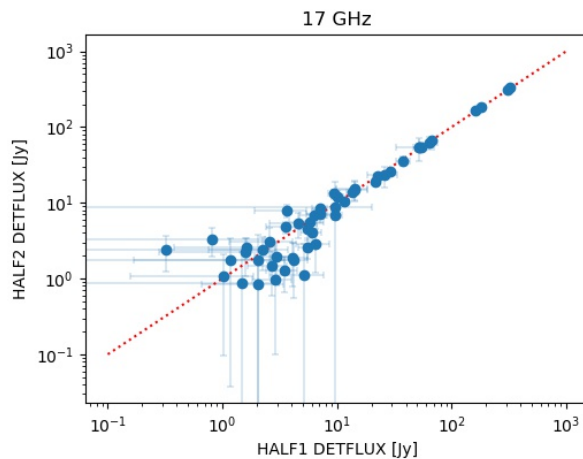
$$y = 1.002x - 0.066$$



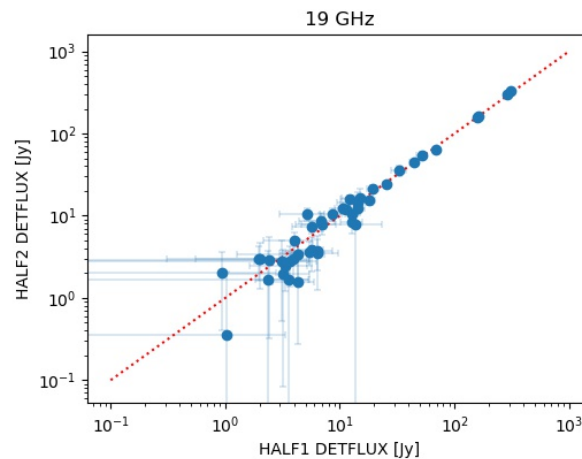
$$y = 1.001x - 0.32$$



$$y = 1.024x - 0.723$$



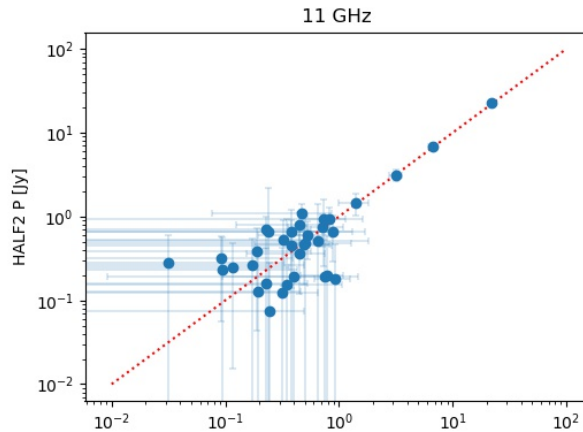
$$y = 1.024x - 0.501$$



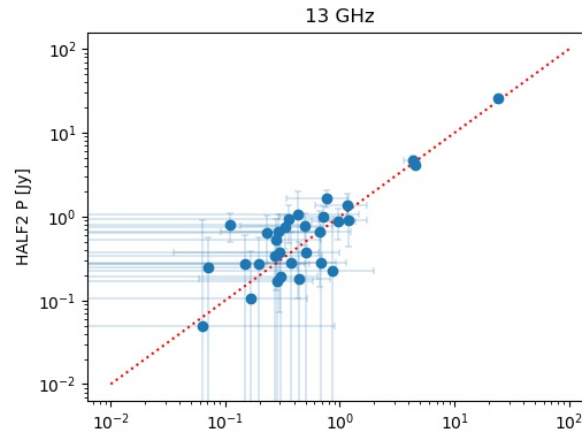
Results: consistency checks

- Half survey vs. half survey: polarization

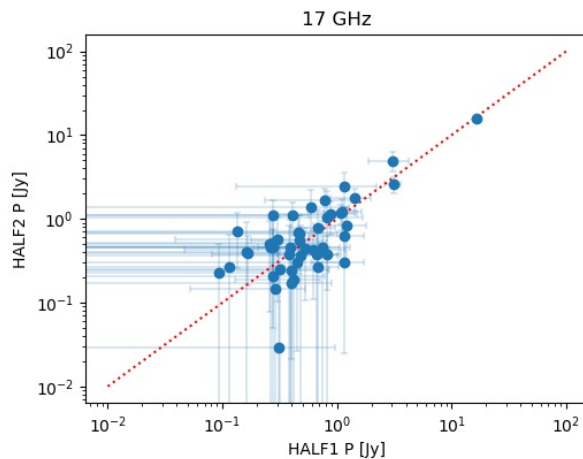
$$y = 1.039x - 0.016$$



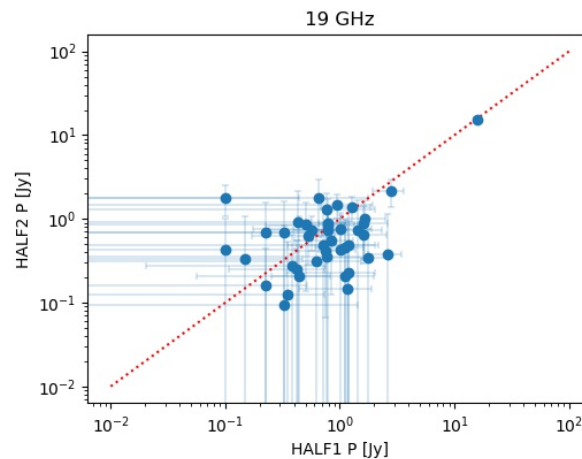
$$y = 1.062x + 0.860$$



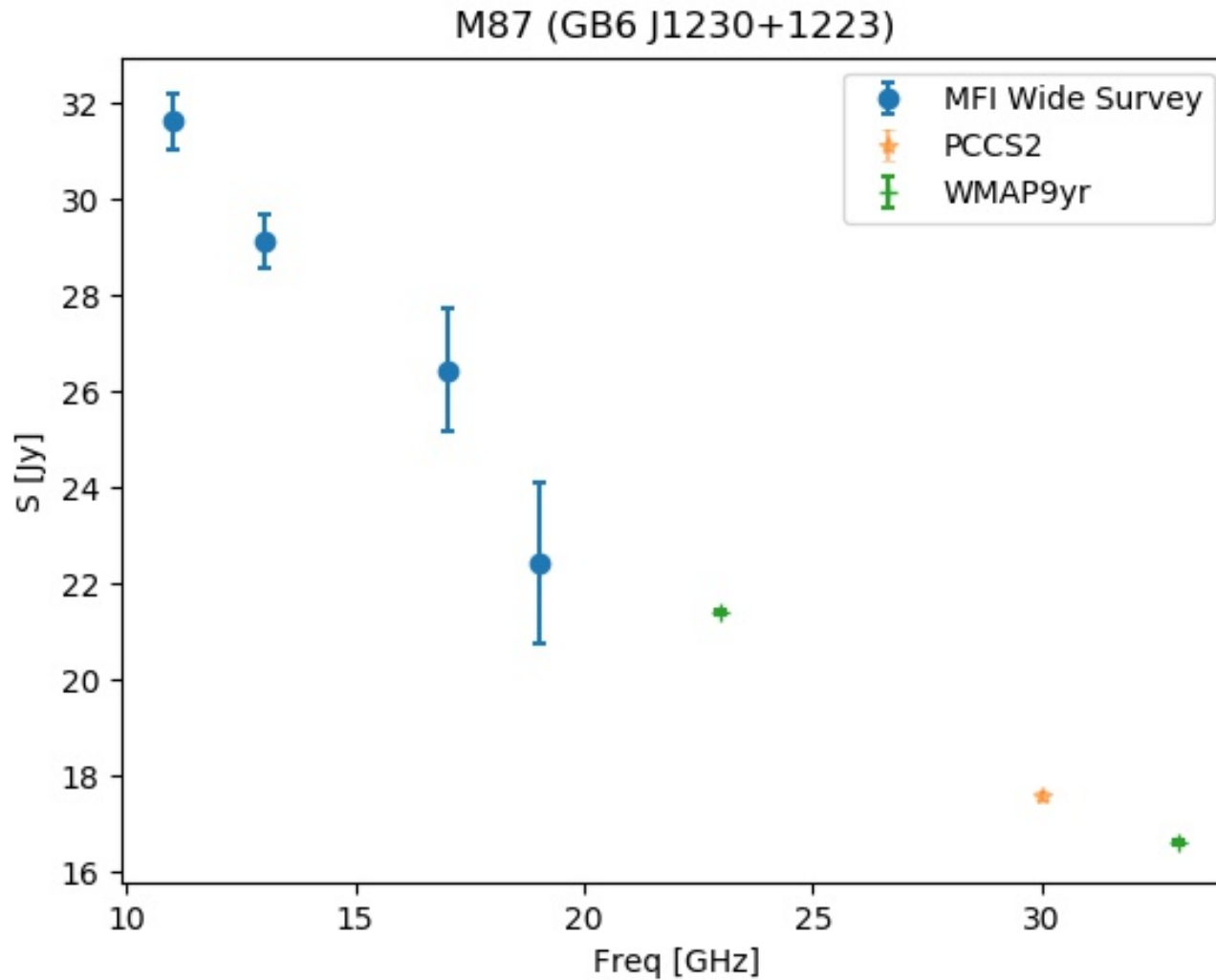
$$y = 0.045x + 0.040$$



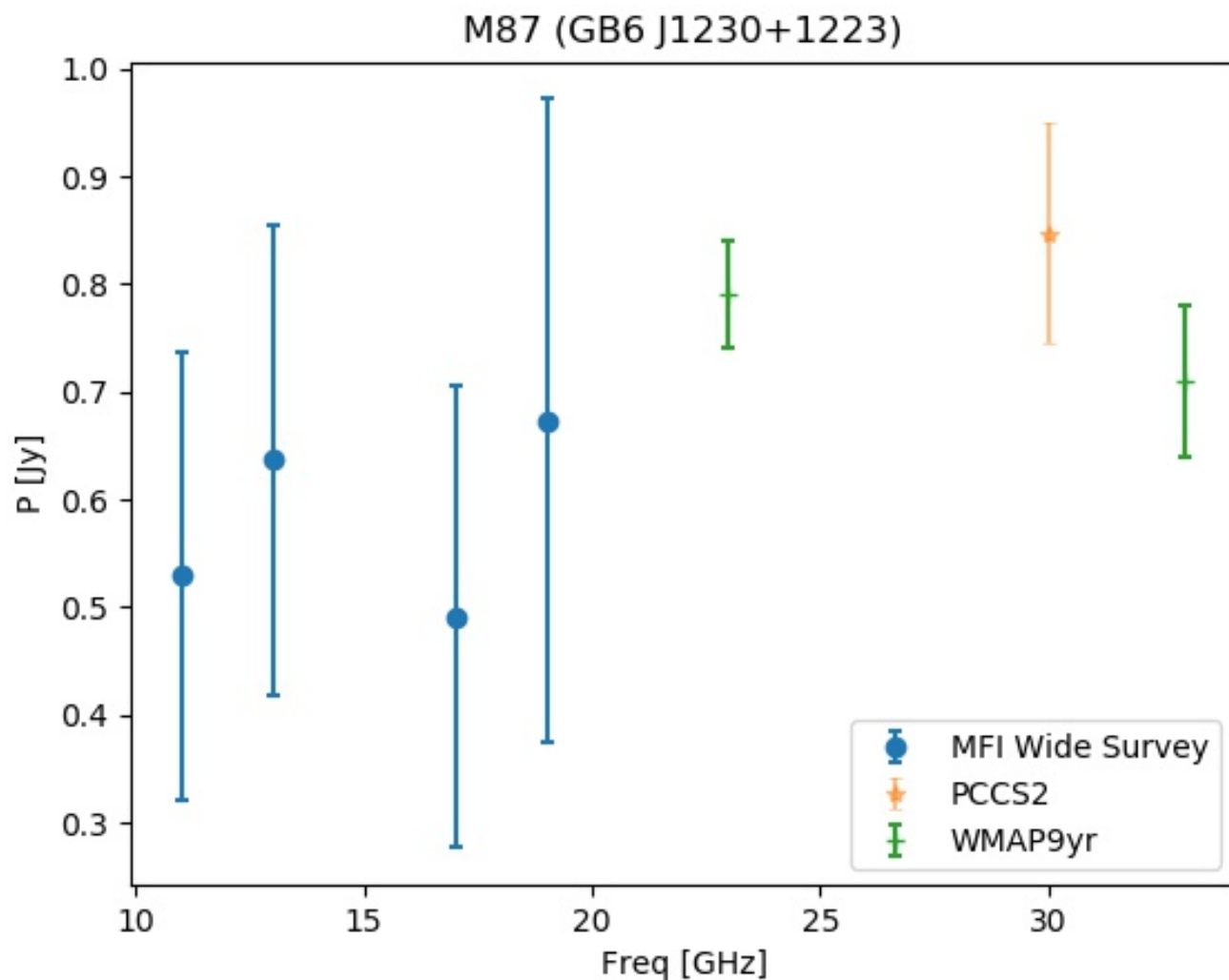
$$y = 0.958x - 0.112$$



Results: validation

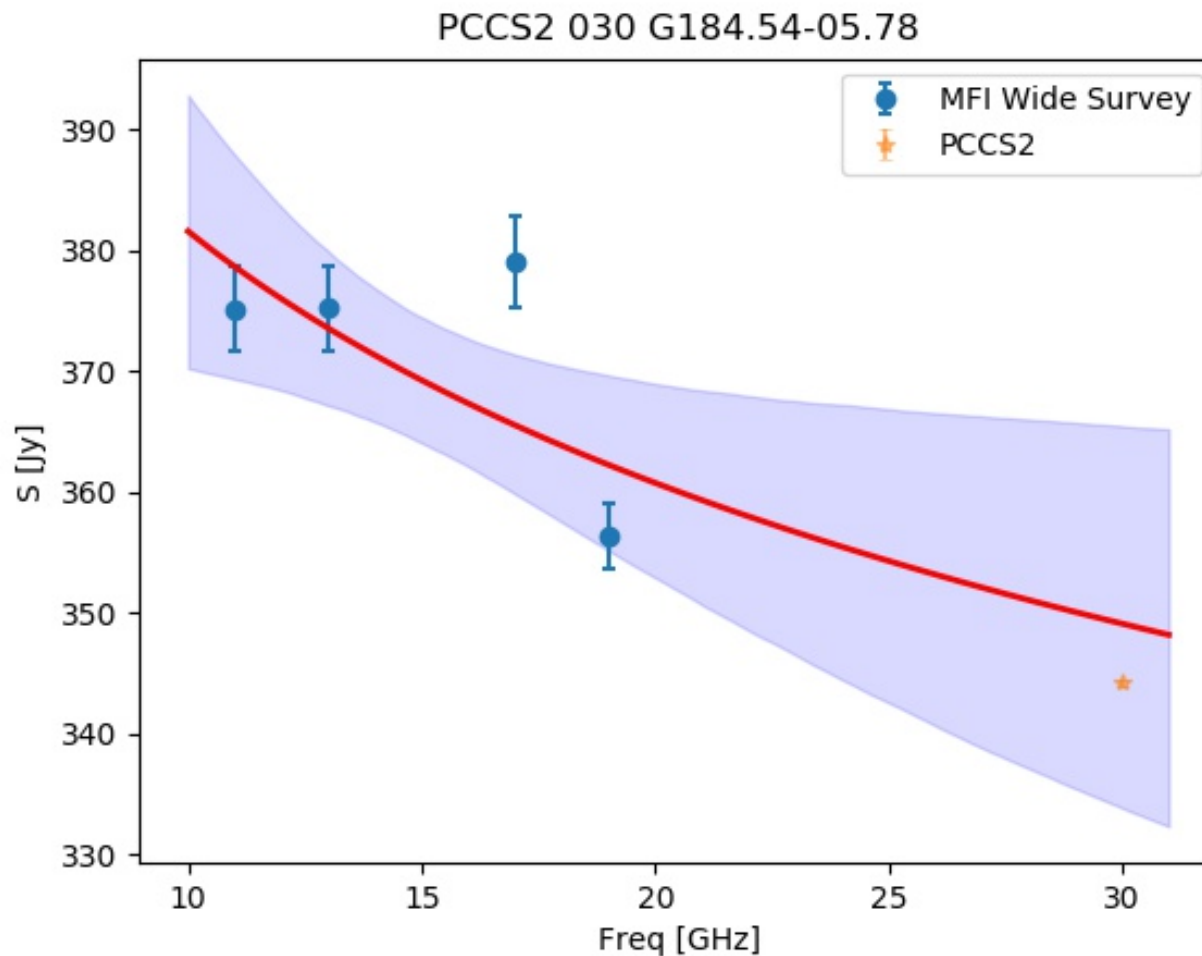


Results: validation

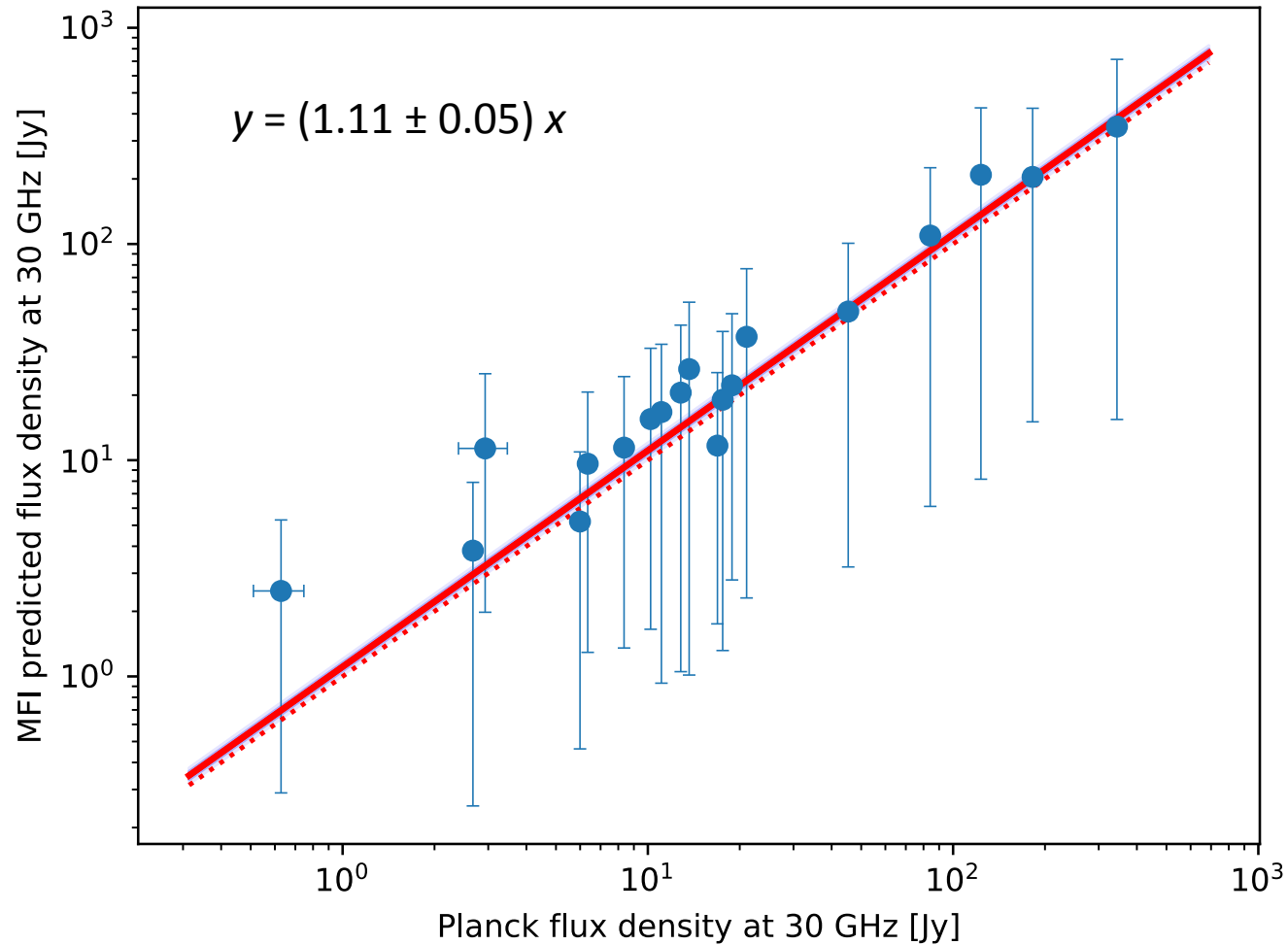


Results: validation (*Planck*)

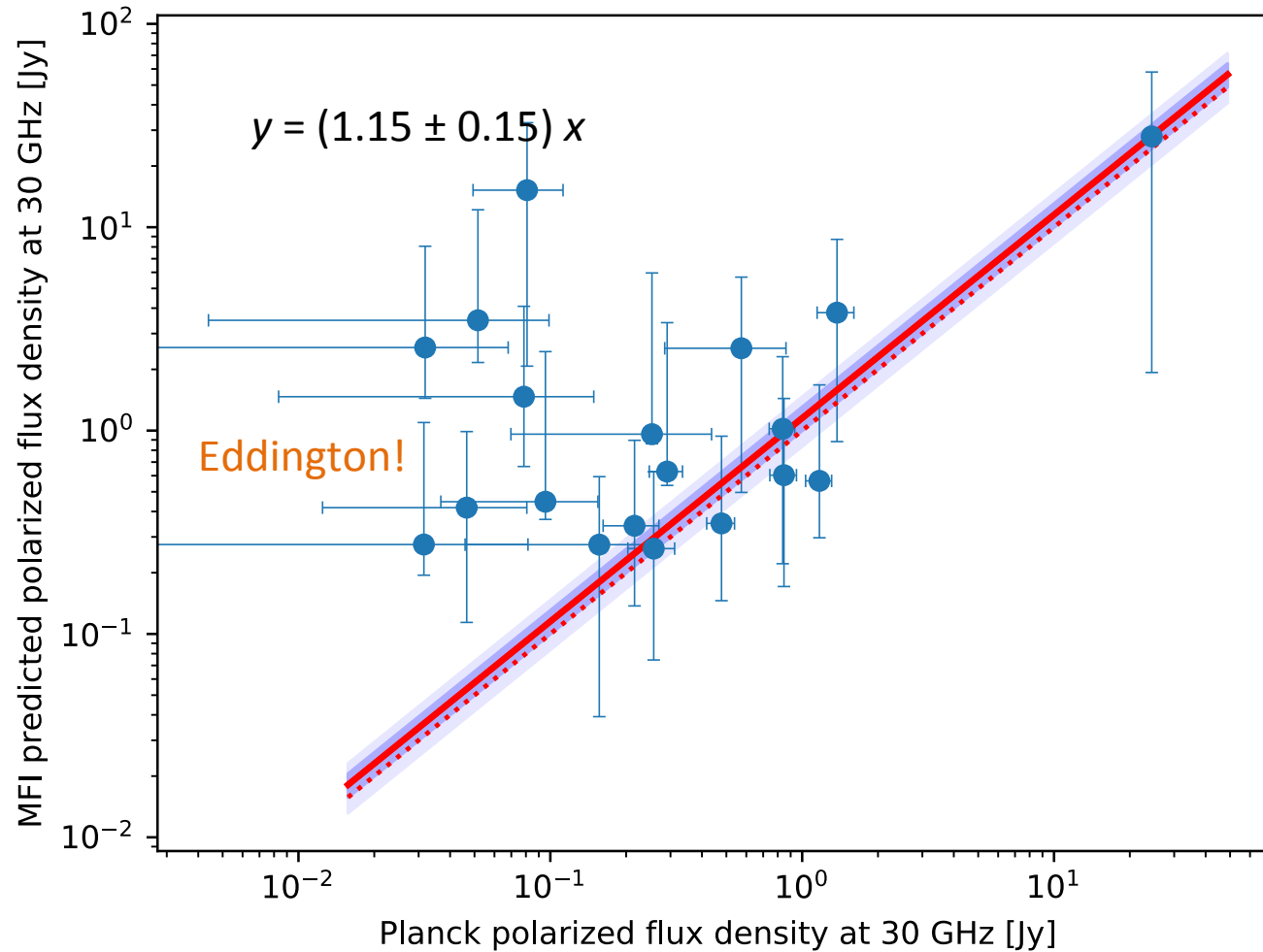
Fit a spectral index to QUIJOTE data and extrapolate to 30 GHz



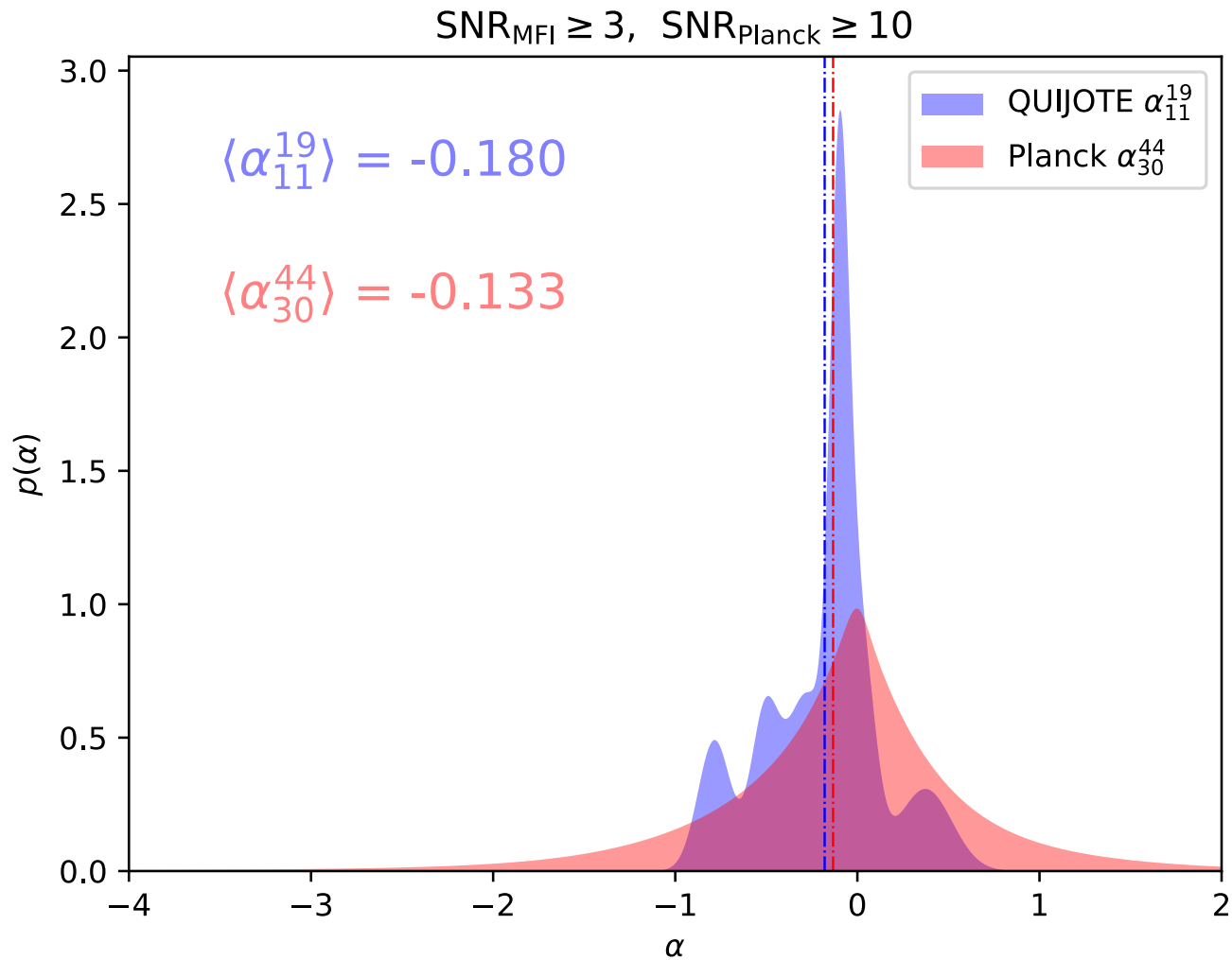
Results: validation (Planck)



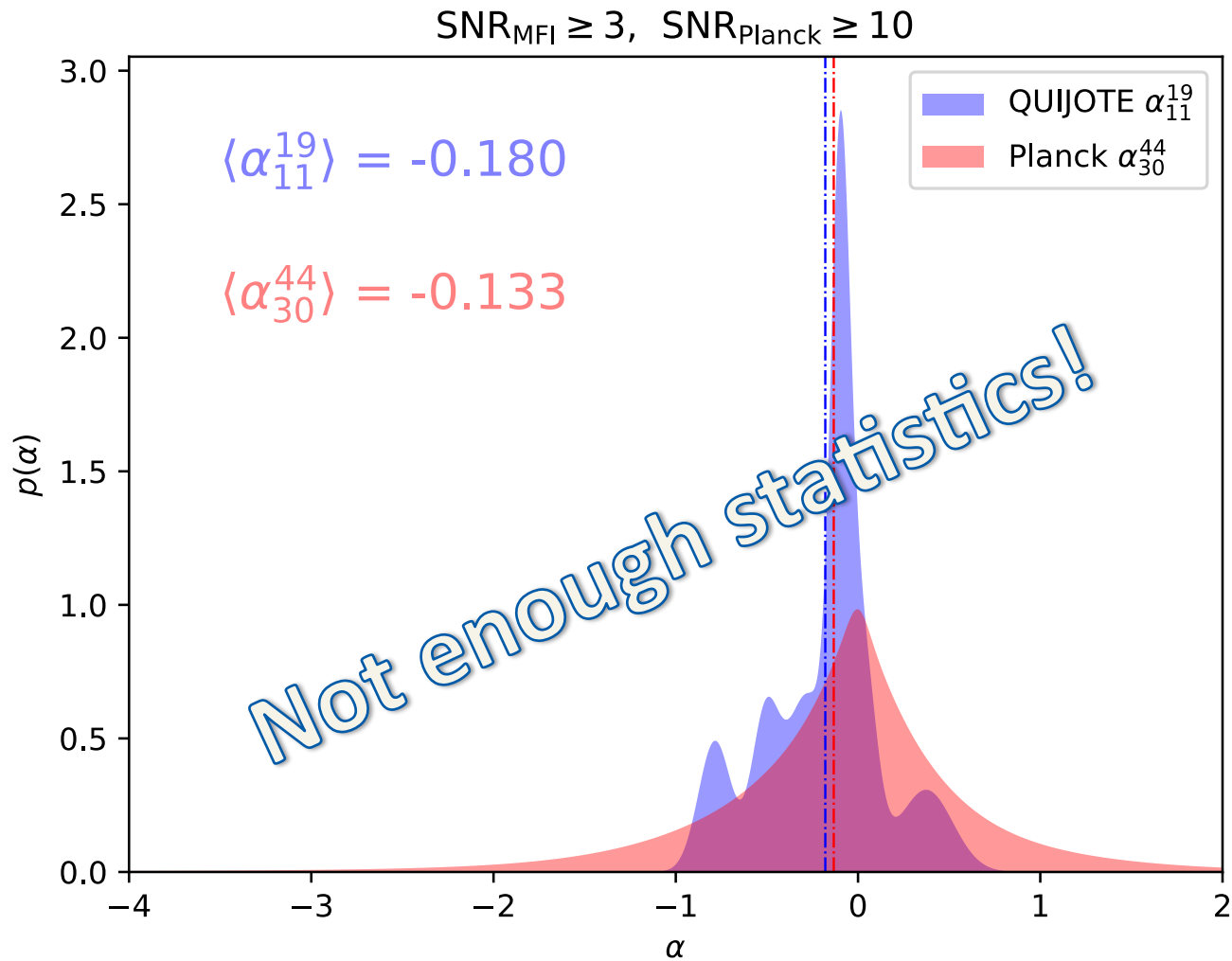
Results: validation (Planck)



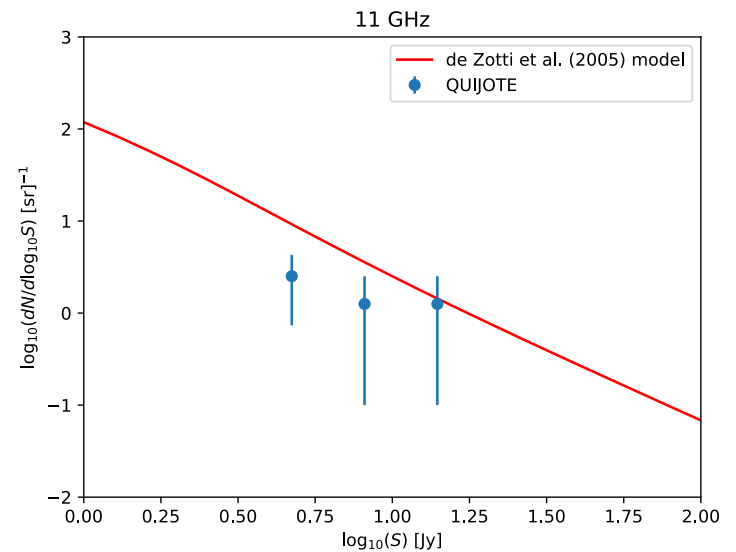
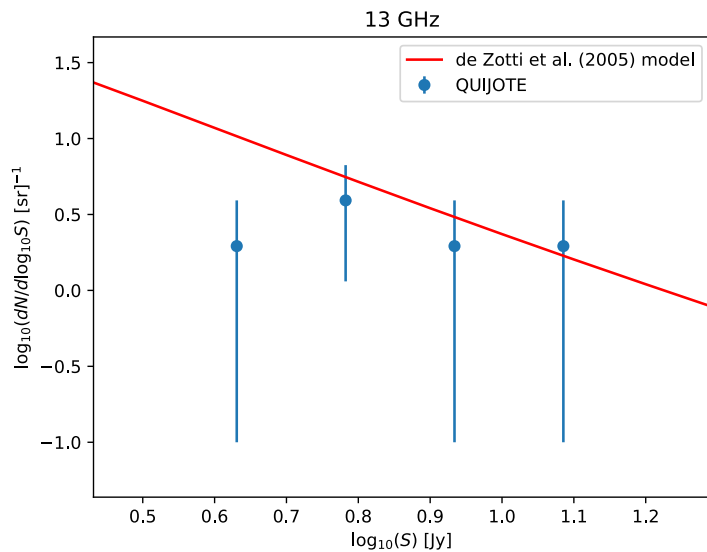
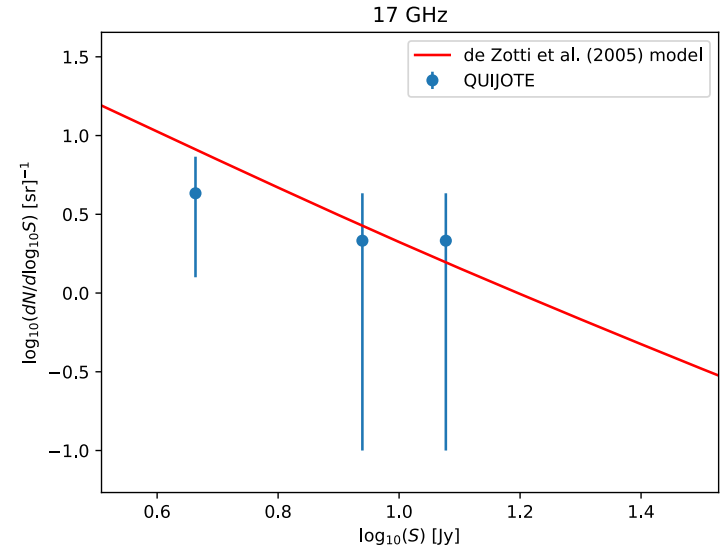
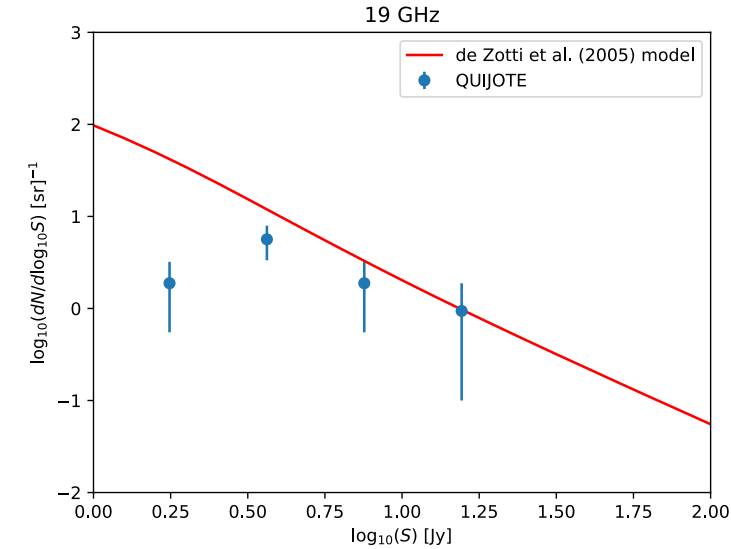
Results: statistical analysis



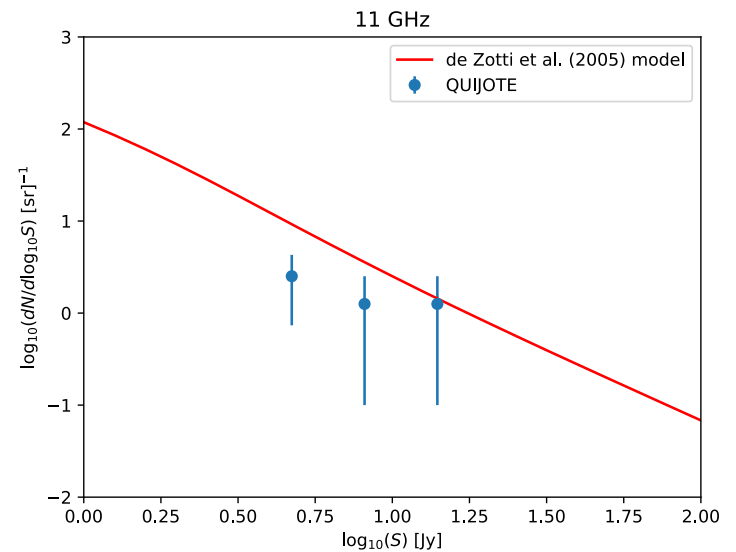
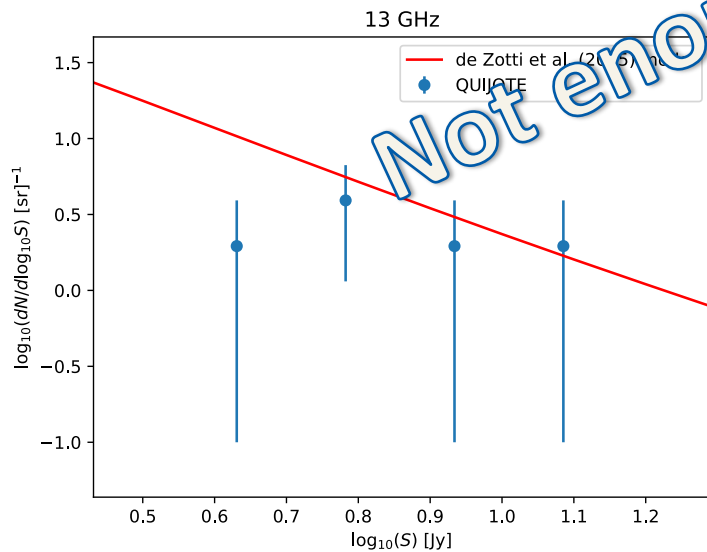
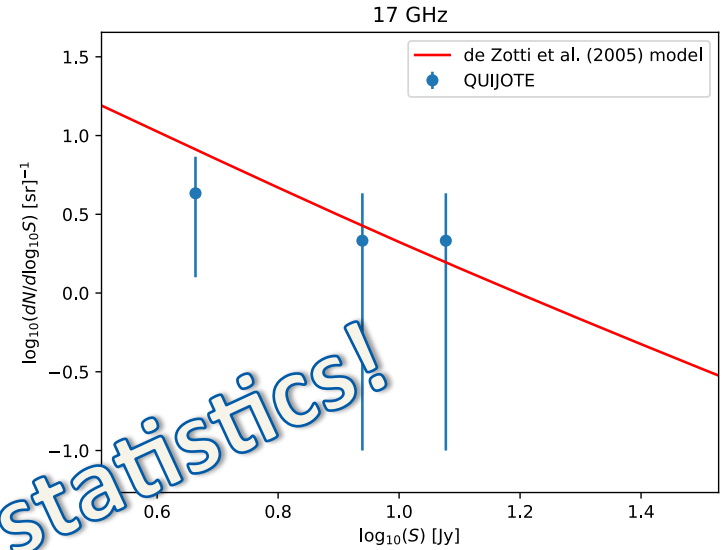
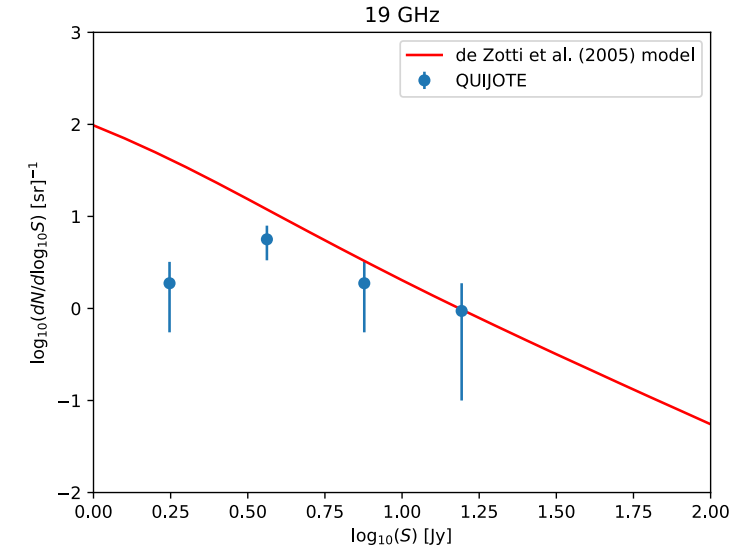
Results: statistical analysis



Results: statistical analysis



Results: statistical analysis



Not enough statistics!

Results: statistical analysis

Freq [GHz]	$\langle \Pi \rangle$ [%]	Π_{median} [%]	Nsamp [SNR Π >3]
11	2.82	2.34	5
13	2.94	2.59	4
17	2.39	1.57	4
19	2.86	1.78	4

Results: statistical analysis

Freq [GHz]	$\langle \Pi \rangle$ [%]	Π_{median} [%]	Nsamp [SNR Π >3]
11	2.82	2.34	5
13	2.91	2.59	4
17	2.39	1.57	4
19	2.86	1.78	4

Not enough statistics!

Summary

- First version of the QUIJOTE compact source catalogue
- NON BLIND: 41 targets with known polarization signal from *Planck*
- Preliminary work:
 - High noise levels
 - Early map version
 - Low number of objects / low SNR
 - **Main purpose:** additional QUIJOTE map validation/consistency check
- Future version(s) (ongoing work):
 - Widen the non-blind search to all the PCNT catalogue
 - Non-blind search
 - Multifrequency detection