AME and component separation

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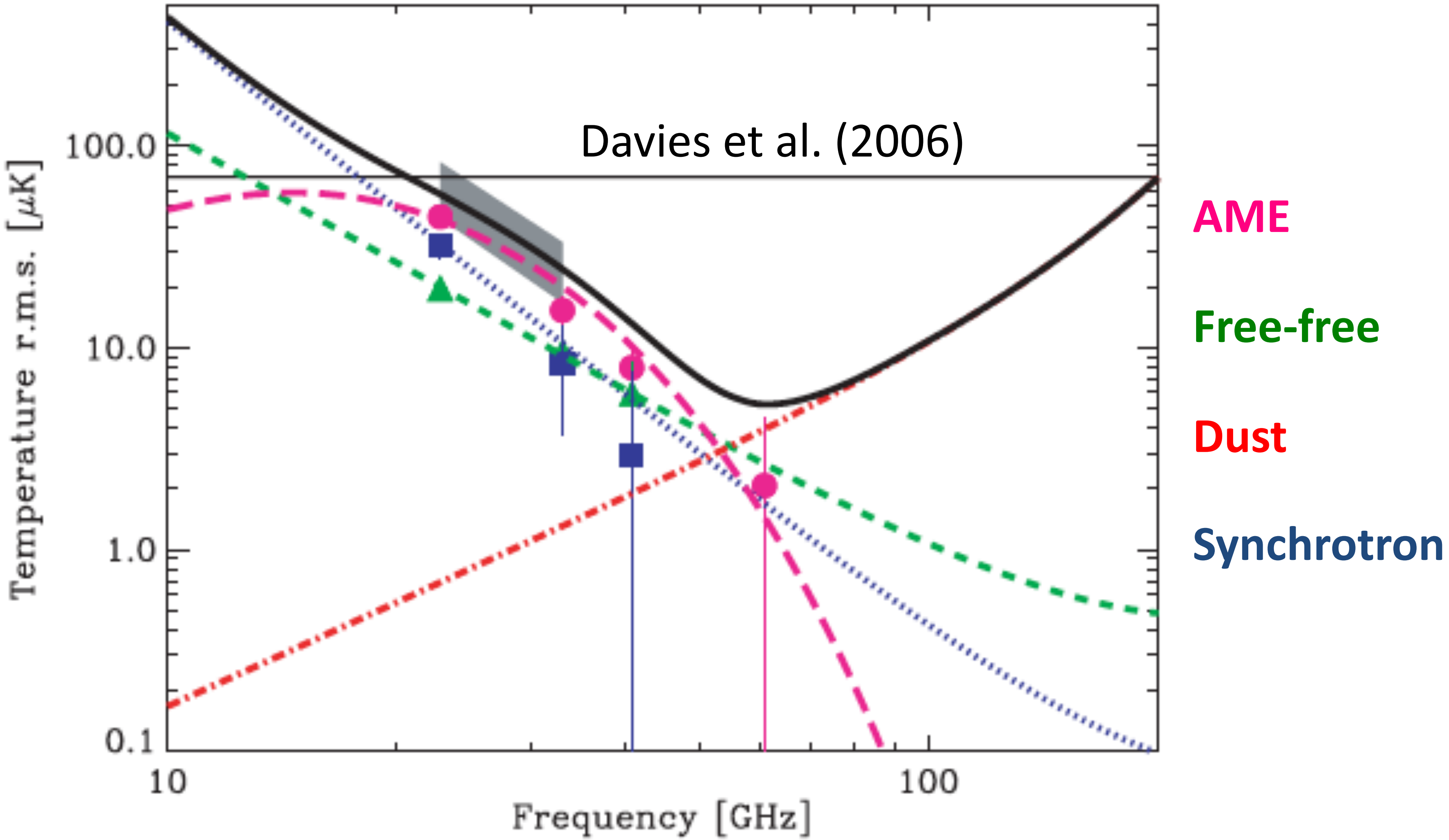
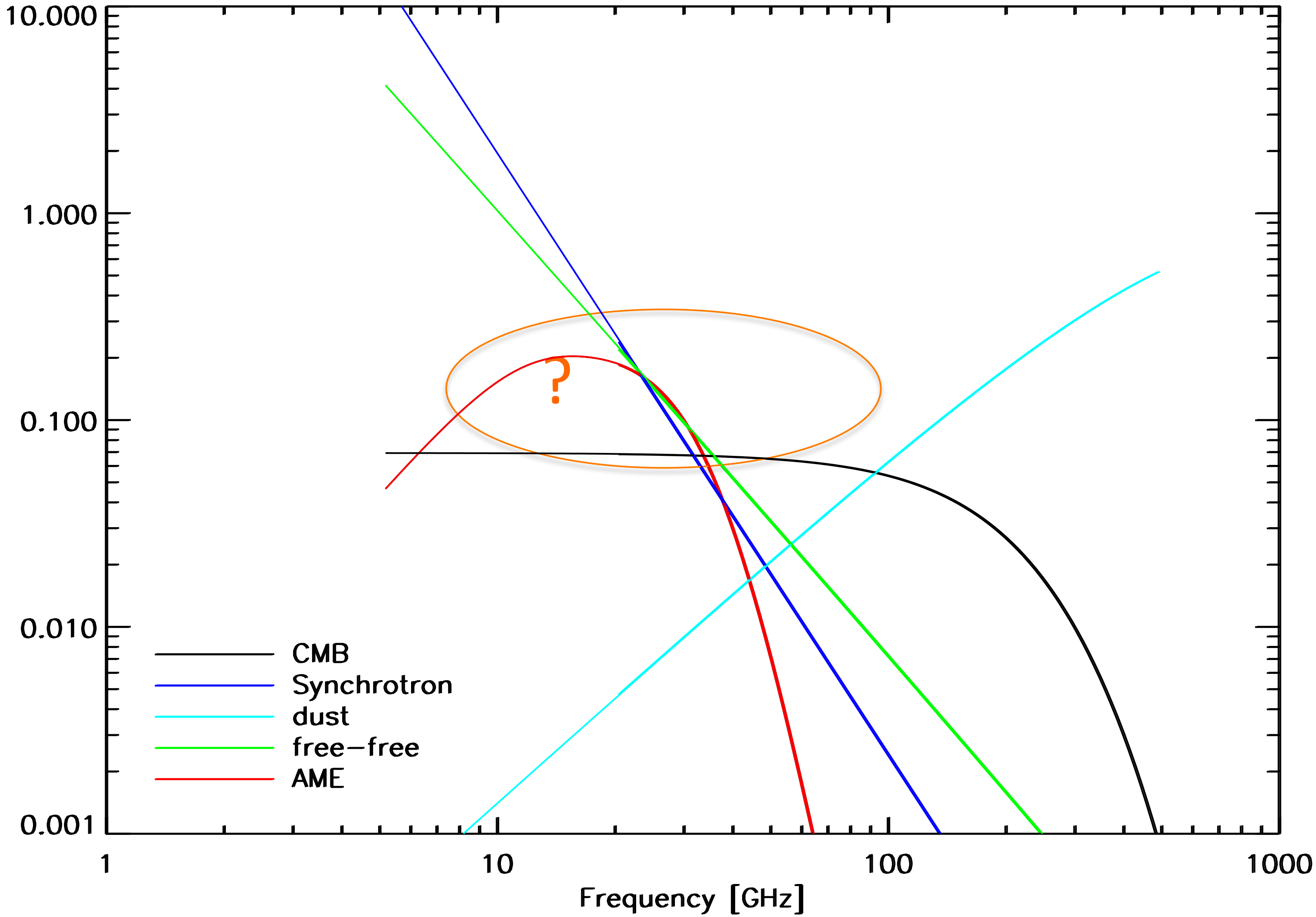
JBCA

- For component separation we mean:
  1. Estimate of the frequency spectrum
  2. Reconstruction of the amplitudes
  – Focus on diffuse emission
- Why it is important
  – Understand the origin and physics of the AME
  – Good cleaning of the CMB signal
  – Good recovery of the other Galactic components
- Why it is difficult
  – Many components in the same frequency range
  – Similar frequency spectrum (in 20-60 GHz range)

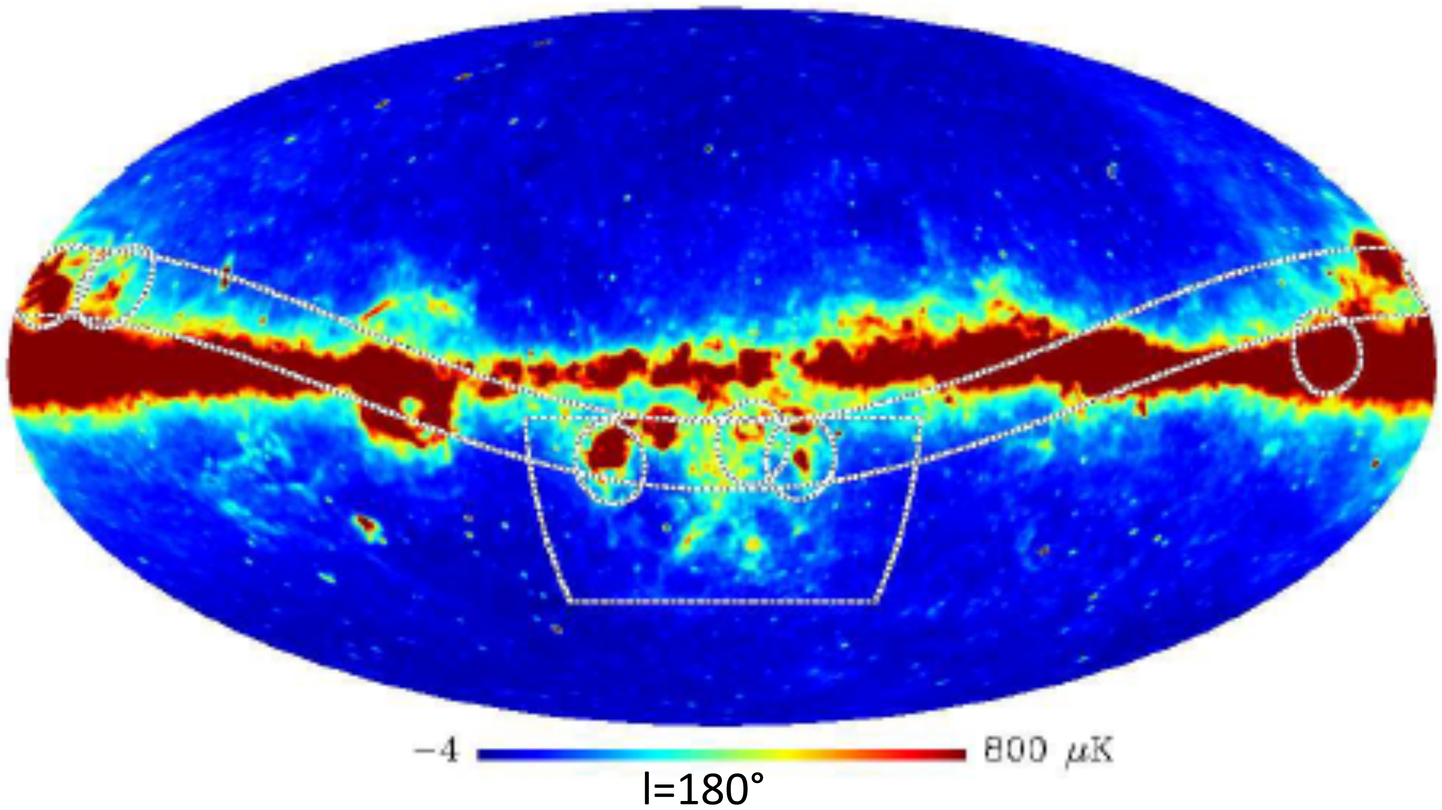

Davies et al. (2006)
100.0
10.0
1.0
0.1
Temperature r.m.s. [μK]
10
100
Frequency [GHz]
AME
Free-free
Dust
Synchrotron


10.000
1.000
0.100
0.010
0.001
1
10
100
1000
Frequency [GHz]
CMB
Synchrotron
dust
free−free
AME
?

Planck intermediate results (in prep.)

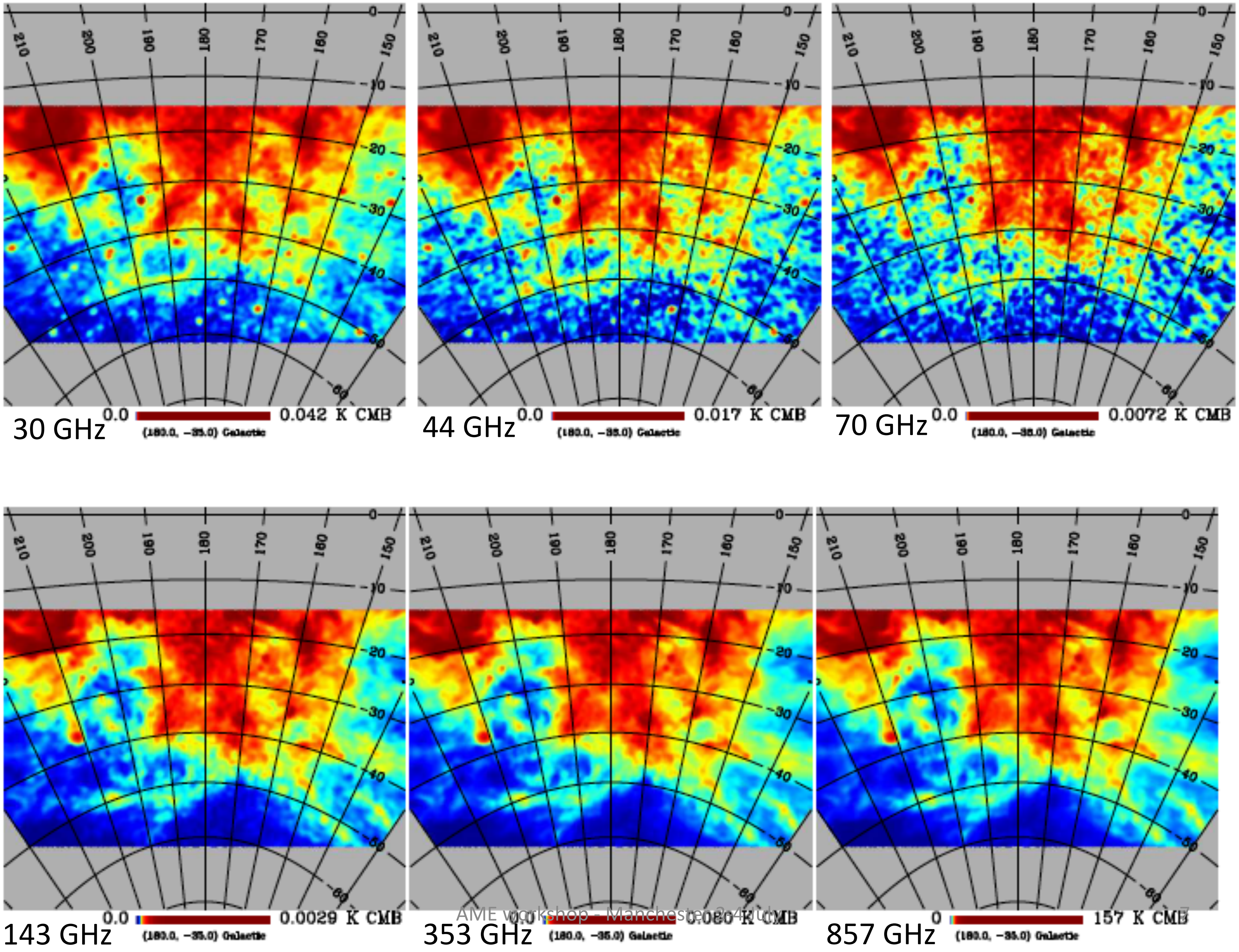
Planck Collaboration et al. , “Component separation in the Gould Belt system”

- Separation of diffuse AME with Planck data + external data
- Gould Belt: bright foregrounds, large extent in the sky, not in the Galactic Plane



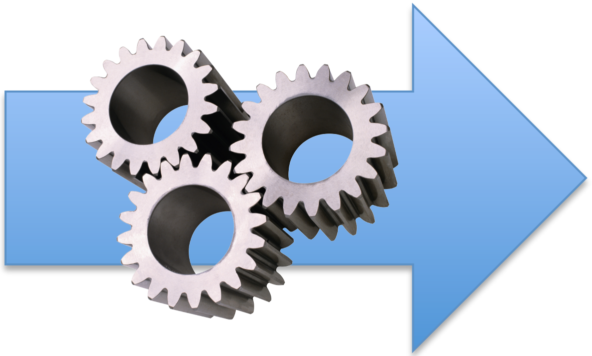
We consider the Gould Belt South, l=130°-230°, b=-10°-50°

Fainter Galactic Plane -> cleaner view of the Gould Belt


30 GHz
0.0
0.042 K CMB
(180.0, −35.0) Galactic
44 GHz
0.0
0.017 K CMB
(180.0, −35.0) Galactic
70 GHz
0.0
0.0072 K CMB
(180.0, −35.0) Galactic
143 GHz
0.0
0.0029 K CMB
(180.0, −35.0) Galactic
353 GHz
0.0
0.080 K CMB
(180.0, −35.0) Galactic
857 GHz
0
157 K CMB
(180.0, −35.0) Galactic

Component separation

- Planck
  - 30 GHz
  - 44 GHz
  - 70 GHz
  - 143 GHz
  - 353 GHz
- WMAP K band (23 GHz)
- Haslam 408 MHz map
- 23 GHz free-free template

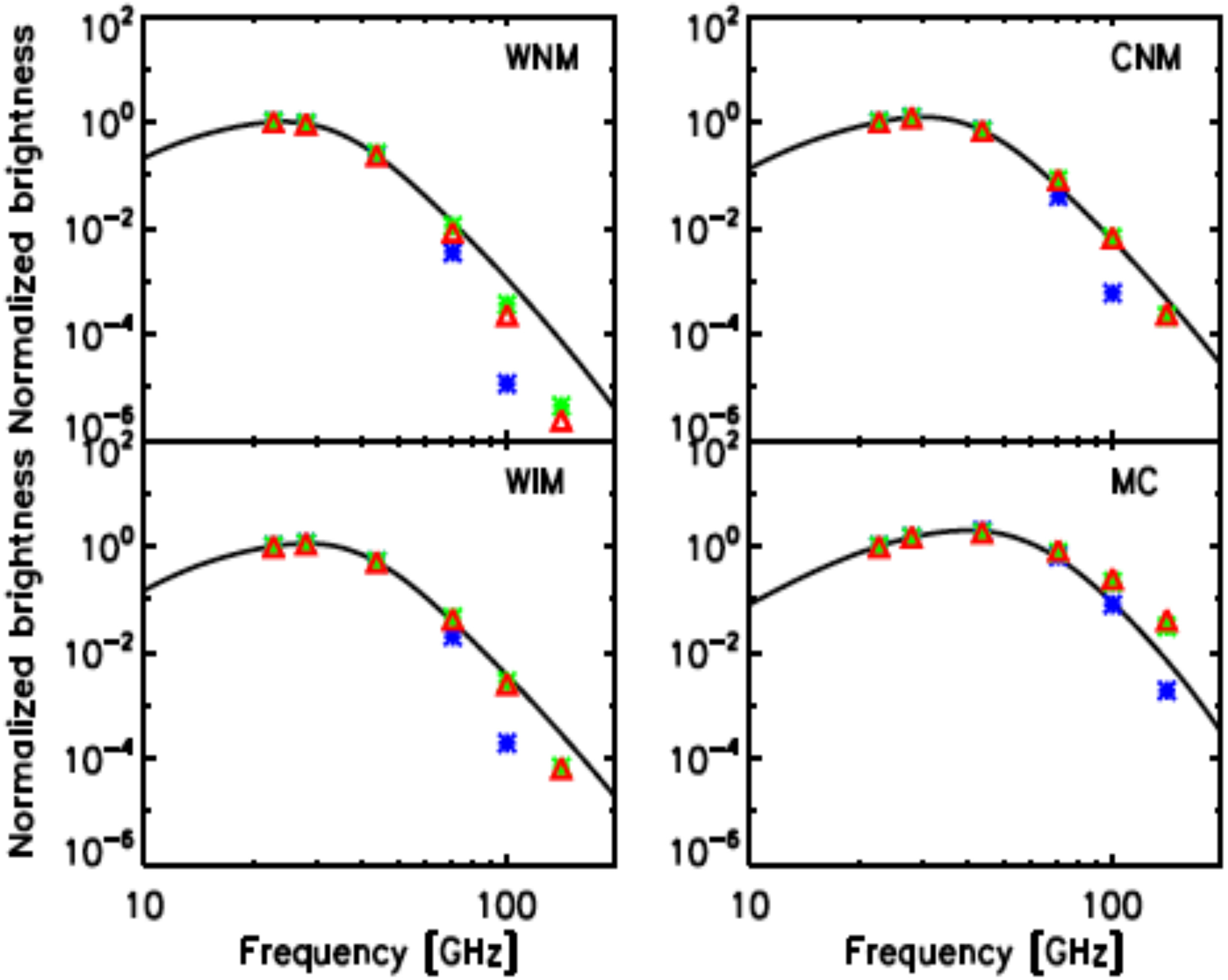


- CMB
- Synchrotron
- Free-free
- Thermal dust
- AME

1) AME frequency spectrum

- Method: Correlated Component Analysis (CCA)
  Bonaldi et al. (2006), Ricciardi et al. (2010)
- Use 2nd order statistics of data (morphology)
- Use parametric models for the frequency scalings
- Works on square sky patches (20°X20°) with Fourier transforms
- The information on the morphology is powerful, allows good constraints

Fit complex spectra with a simple parametric relation



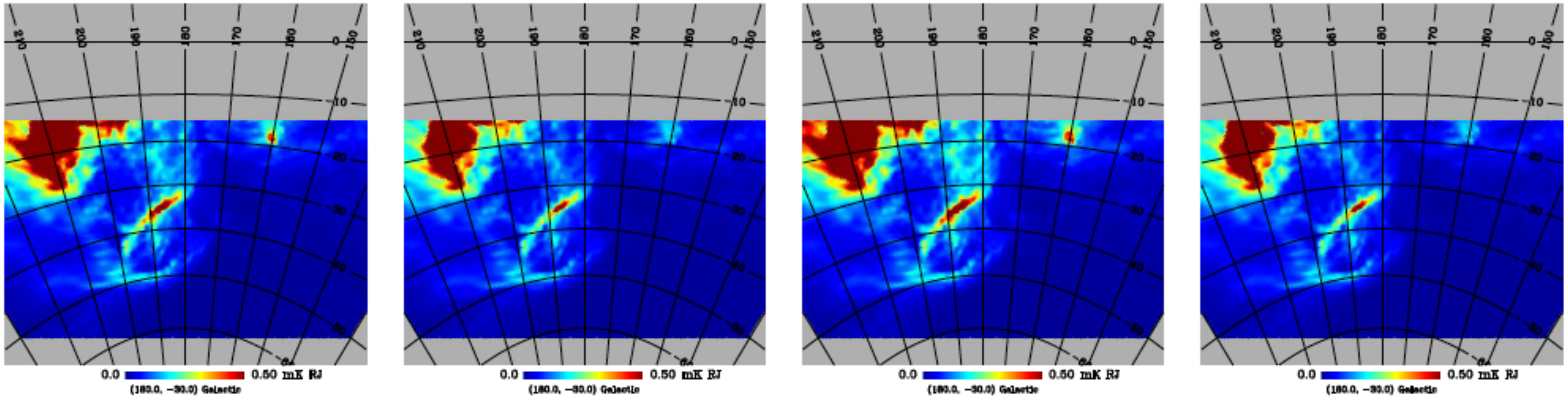
Parabolic (CCA, Bonaldi et al. 2007)

Gaussian (Commander)

Grey-body (Tegmark et al. 2000)

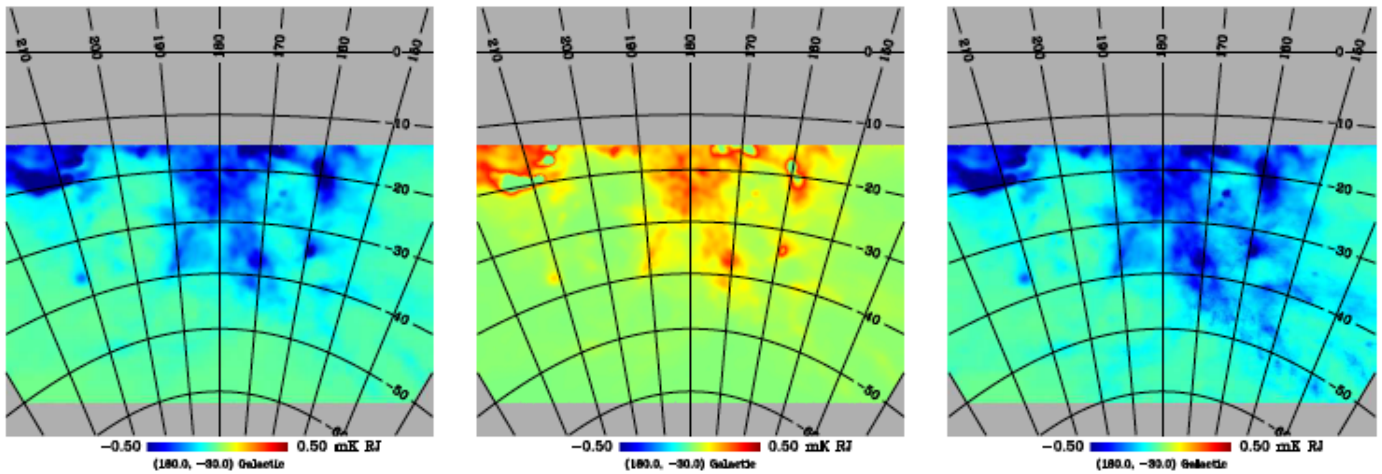
Free-free templates

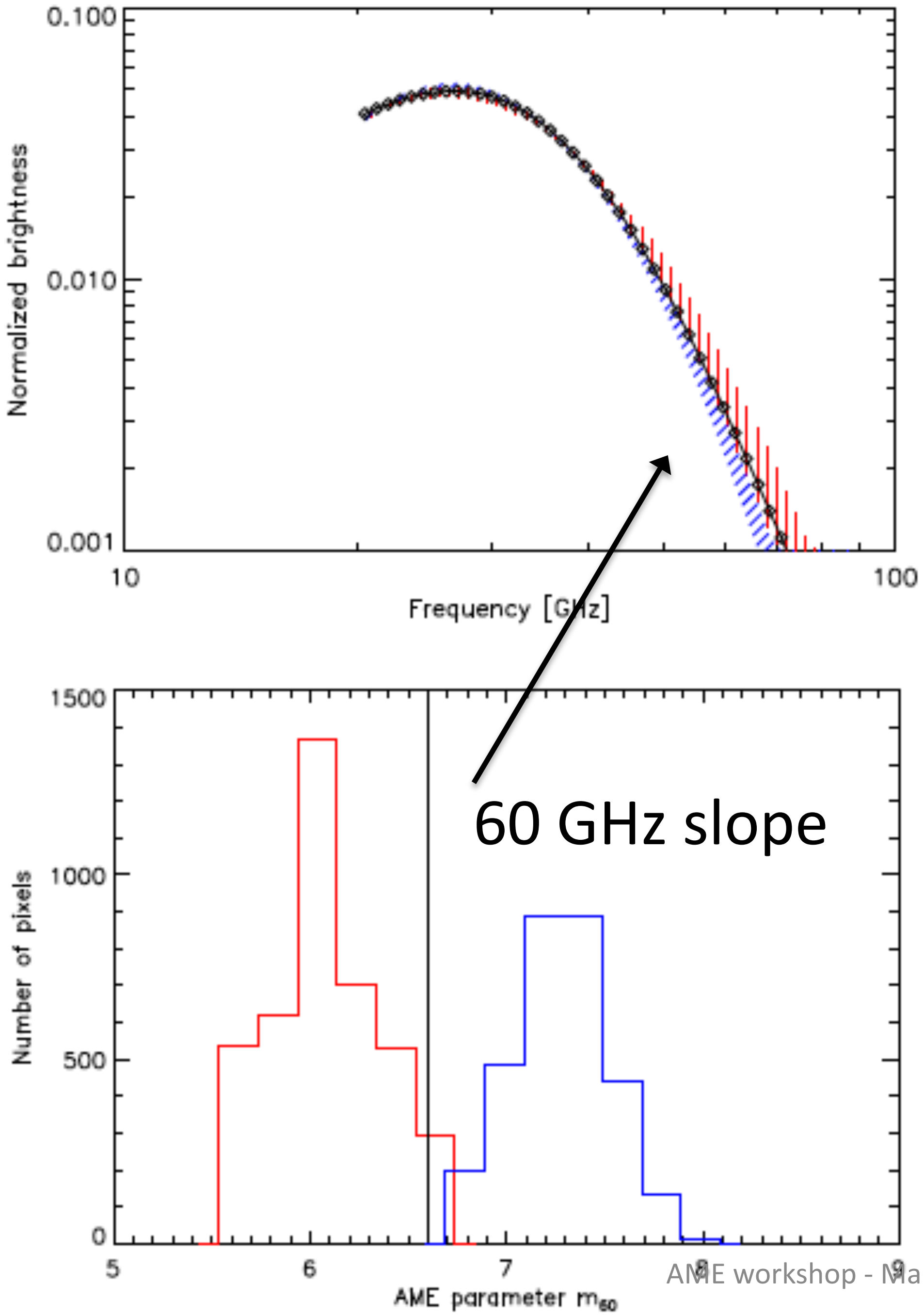
Reference FF1 FF2 FF3



(FF#-Ref)/Ref

up to 60%, dust-correlated



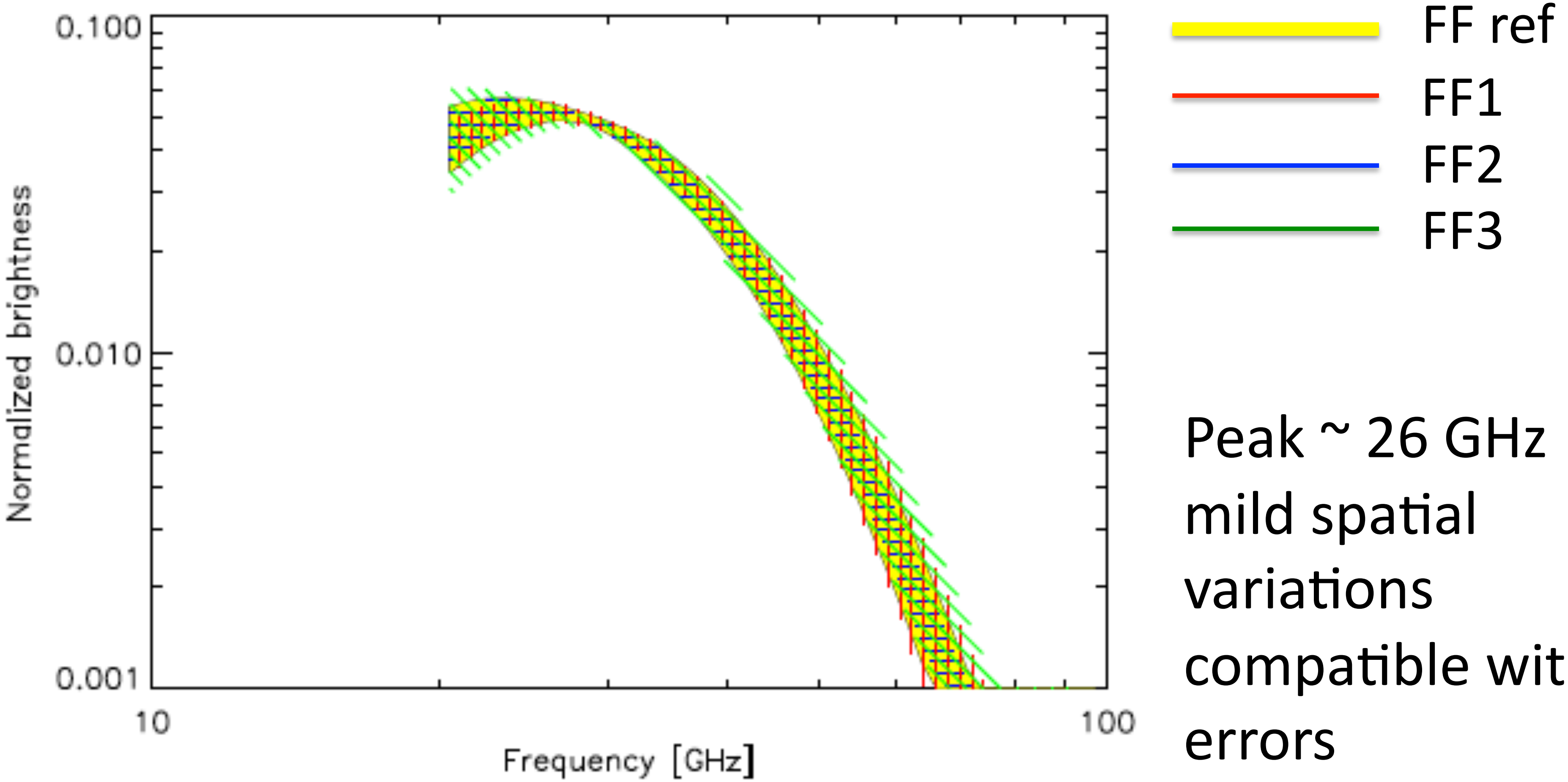


SIMULATIONS

"True" free-free= Ref
use for the estimation:
FF1 (red) FF2 (blue)

- CCA does a good job!
- AME peak frequency recovered with few GHz errors
- Possible biases on AME high-frequency slope

DATA

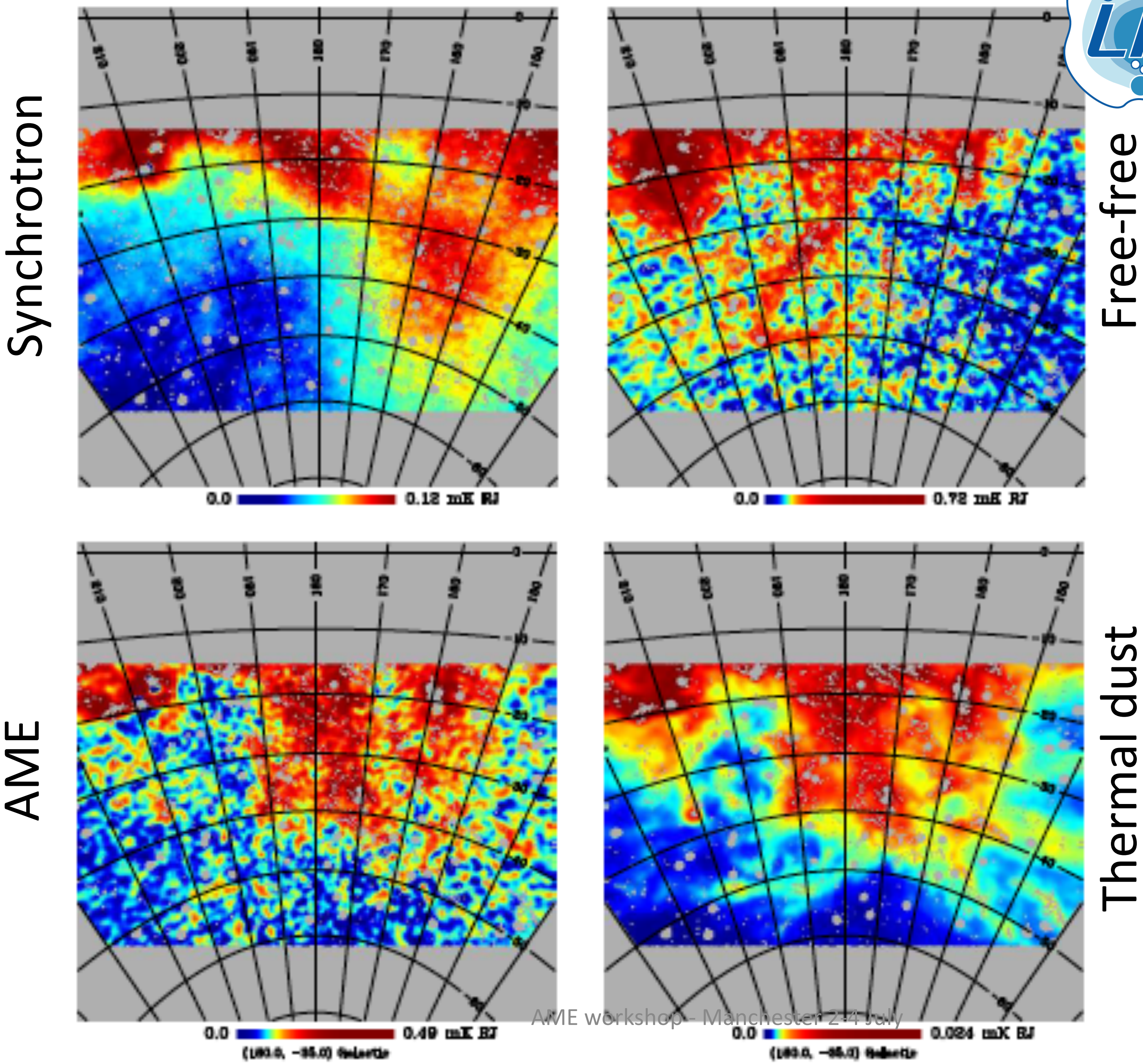


Peak ~ 26 GHz
mild spatial variations compatible with errors

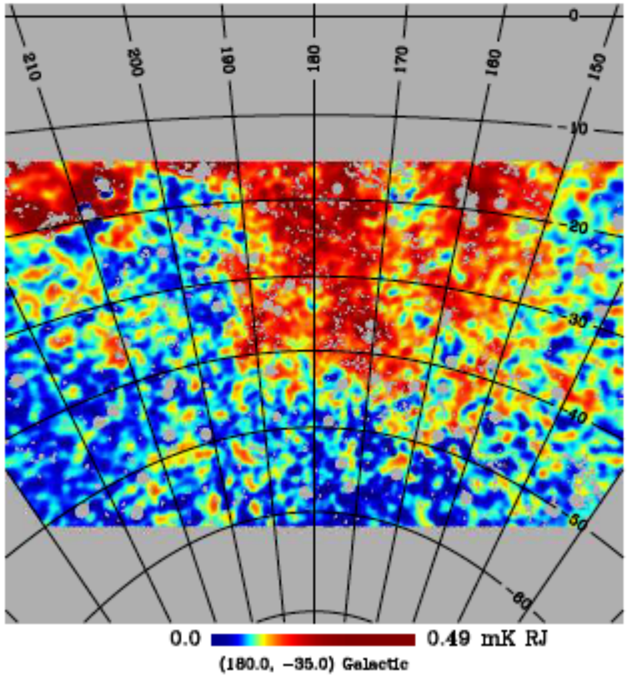
2) Reconstruction of amplitudes

- Generalised Least Square (GLS) solution: linear combination of data depending on noise and component spectra
- We combine equalized-resolution (1deg) data
  - WMAP K band (23 GHz)
  - Planck 30, 44 70, 143, 353 GHz
  - Haslam 408 MHz map

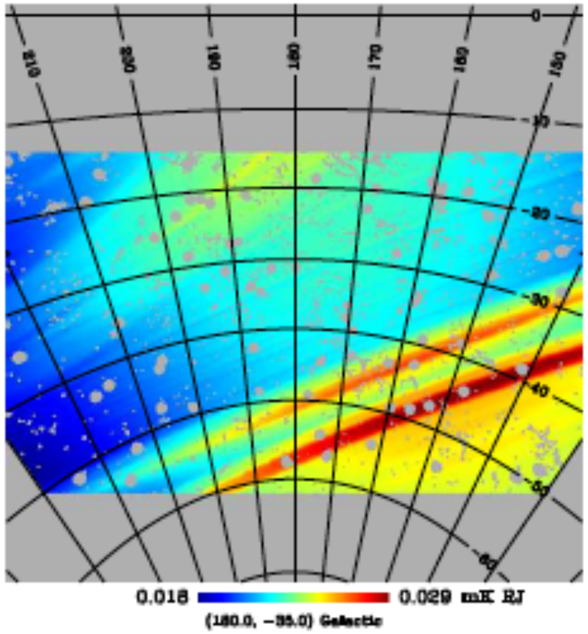
DATA



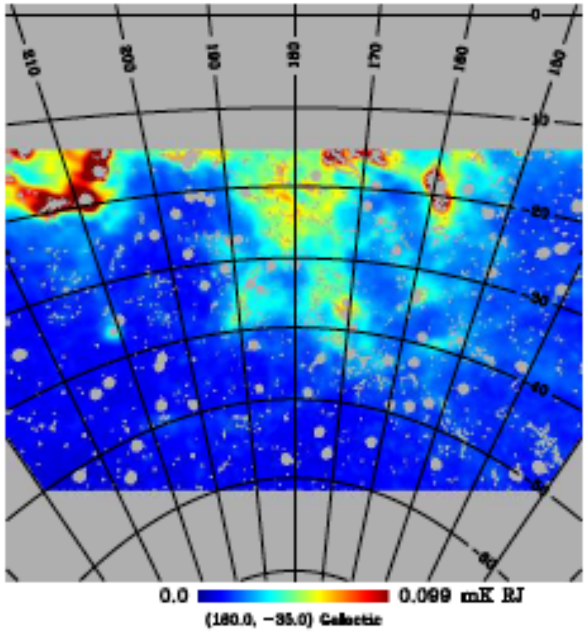
Synchrotron
Free-free
AME
Thermal dust
0.0
0.12 mK RJ
0.0
0.72 mK RJ
0.0
0.49 mK RJ
0.0
0.024 mK RJ



Component



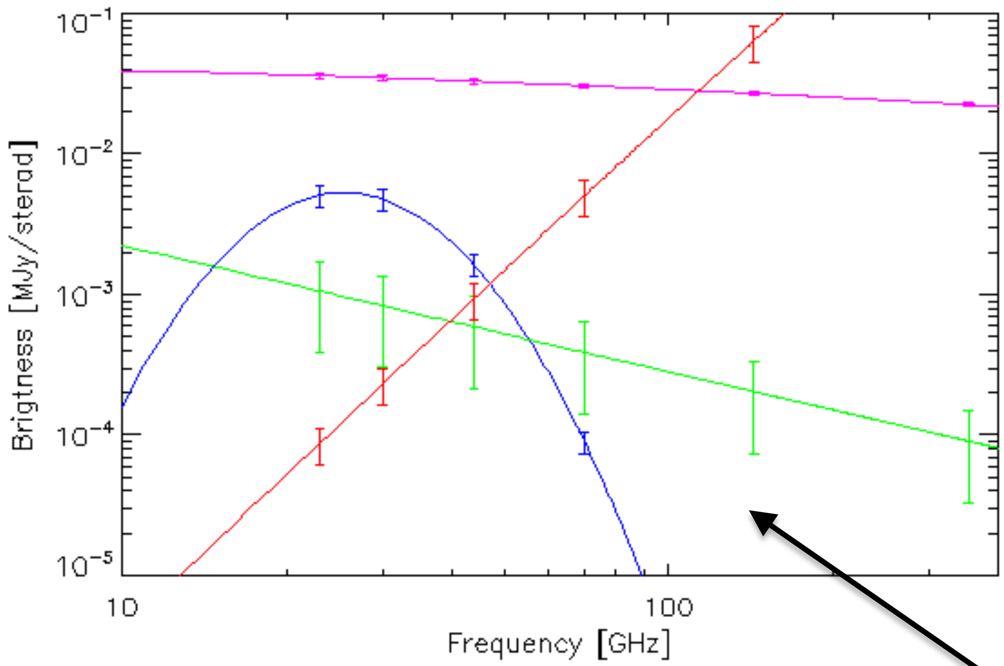
Noise RMS

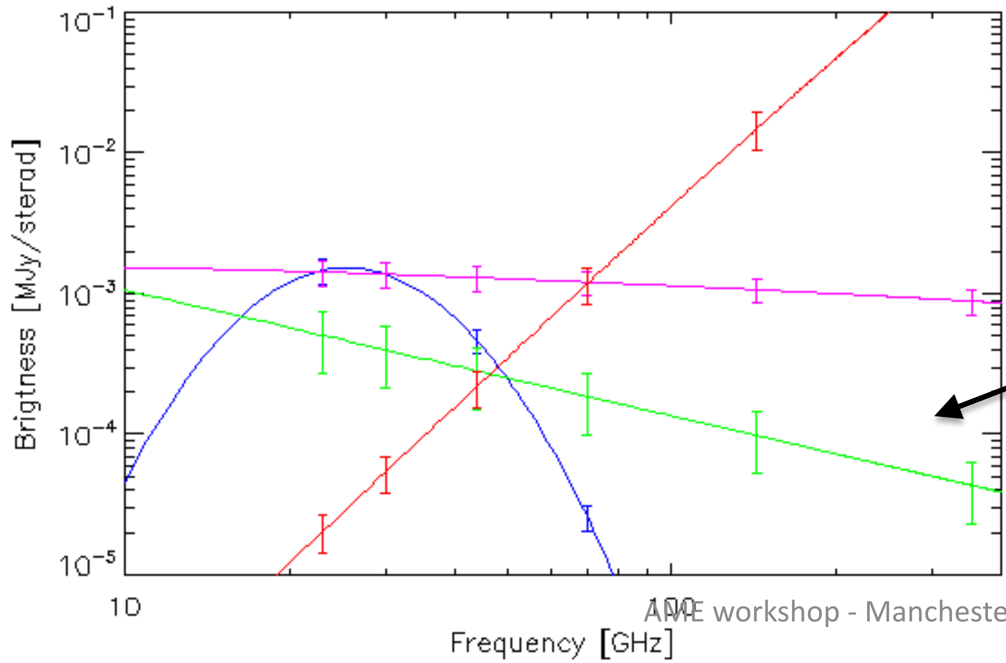


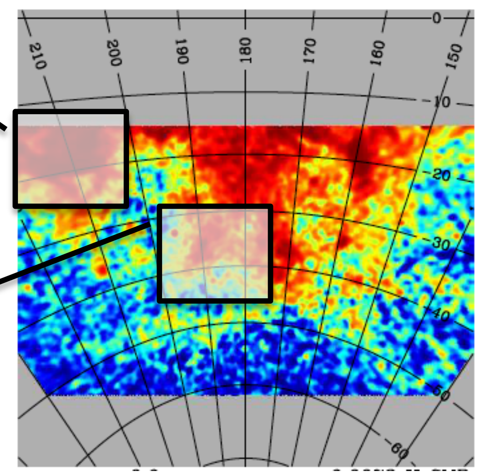
Separation RMS

Spectral models

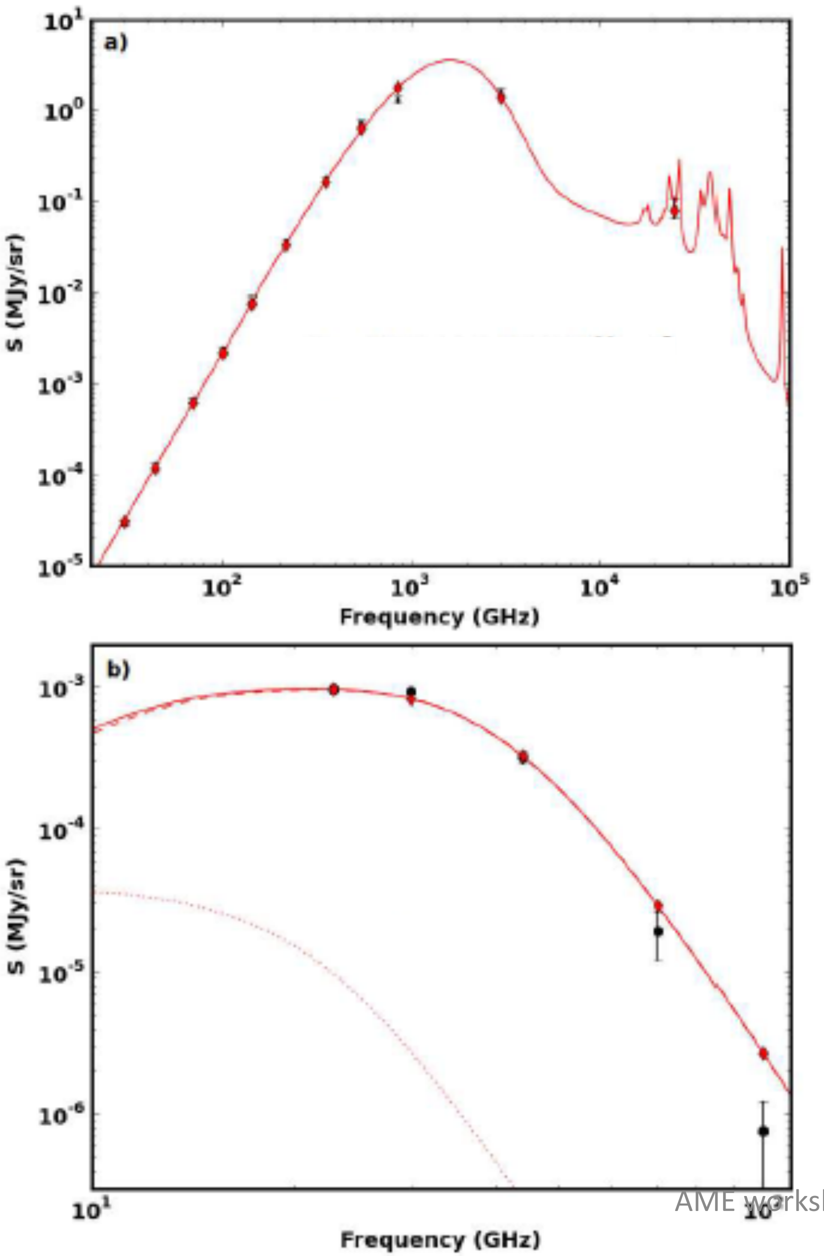
AME **synch** **dust** **free-free**







Can it be spinning dust?



- Ysard et al. (2011): Spdust + dustEM
- IR (Planck + IRIS) -> G_0, N_H
- Low freq (WMAP, Planck) + G_0, N_H -> n_H hydrogen density
- Results for different regions in the Gould Belt

The scientific results that we present today are the product of the Planck Collaboration, including individuals from more than 50 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.

Paper almost ready!