C-BASS
The C-Band All Sky Survey

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Jodrell Bank Centre for Astrophysics

AME workshop, Manchester, 2-4 July

C-BASS COLLABORATION

Caltech/JPL

Dayton Jones, Russ Keeney, Oliver King, Charles Lawrence, Erik Leitch, Stephen Muchovej, Tim Pearson, Matthew Stevenson and Tony Readhead.

HartRAO

Roy Booth and Justin Jonas.

KACST

Yaser Hafez.

Manchester

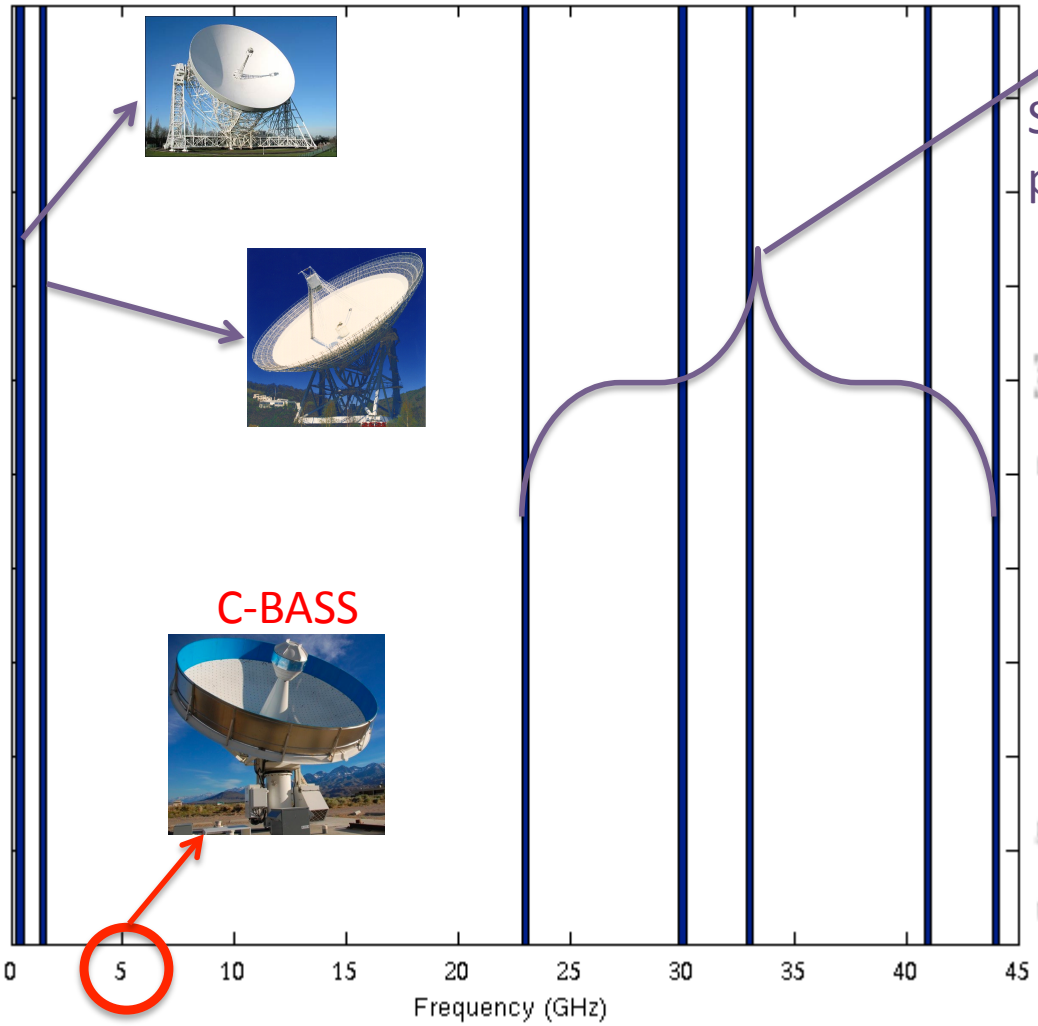
Richard Davis, Clive Dickinson, Melis Irfan, Patrick Leahy.

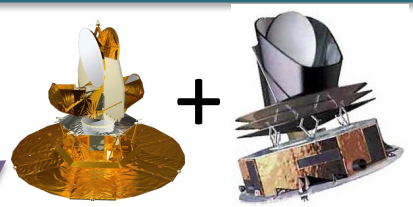
Oxford

Charles Copley, Christian Holler, Jaya John John, Mike Jones, Jamie Leech, Angela Taylor and Joe Zuntz.

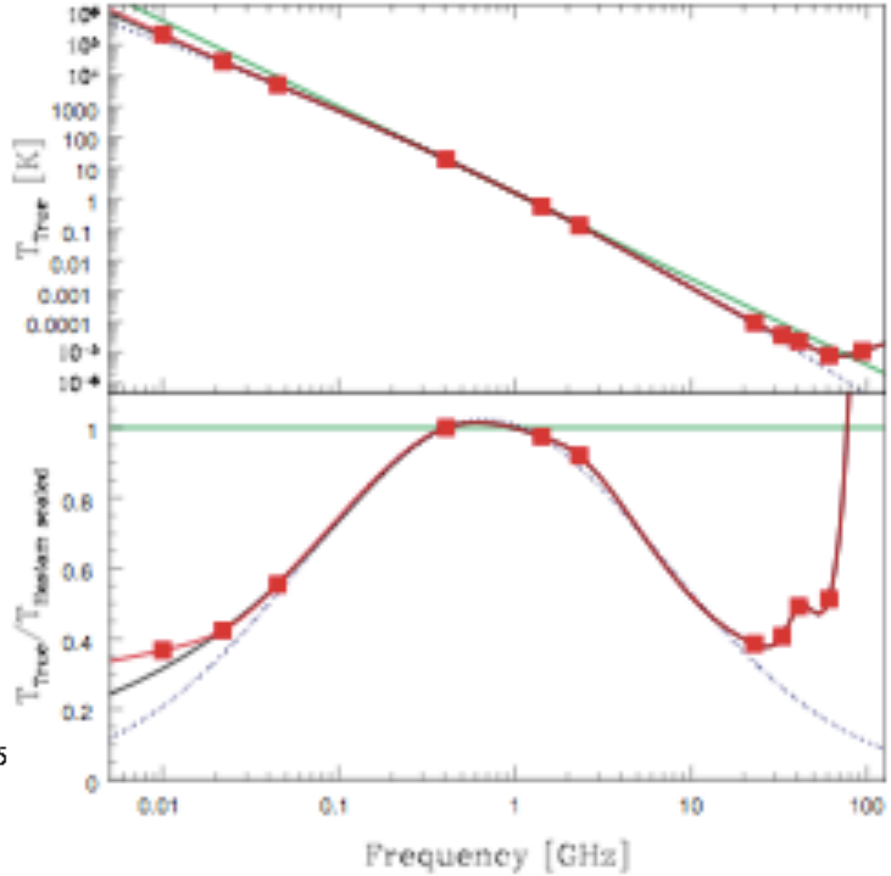
WHY 5 GHZ ?

All-Sky Surveys under 50 GHz





Synchrotron dominant in polarisation and off-plane intensity, investigate power law model:



de Oliveira-Costa et al 2008

SCIENCE MOTIVATION

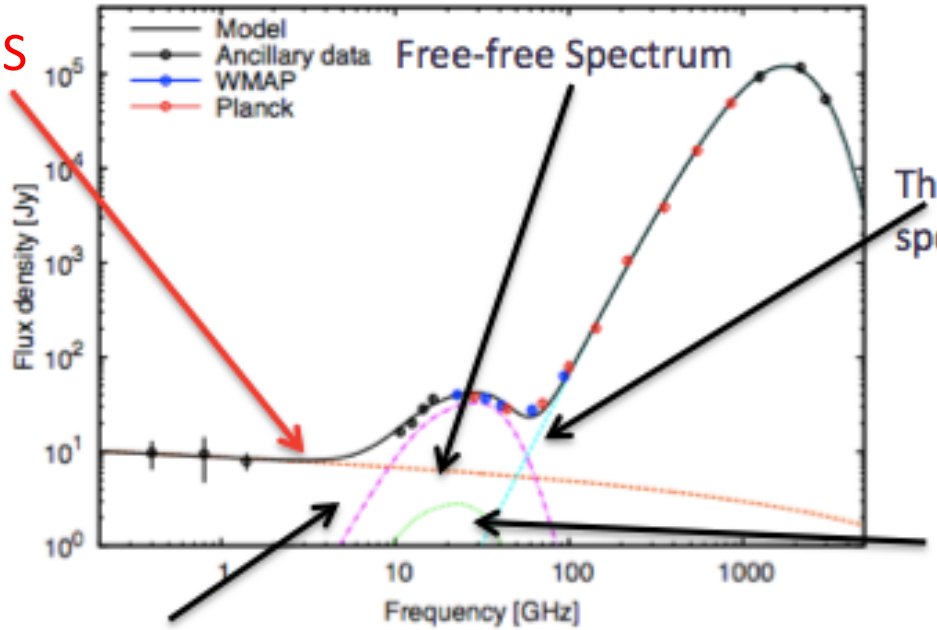
Polarised emission measurement for CMB foreground removal

However …

Wide range of galactic science possible including anomalous emission research:

- Placing lower limit constraints on anomalous emission frequency range.

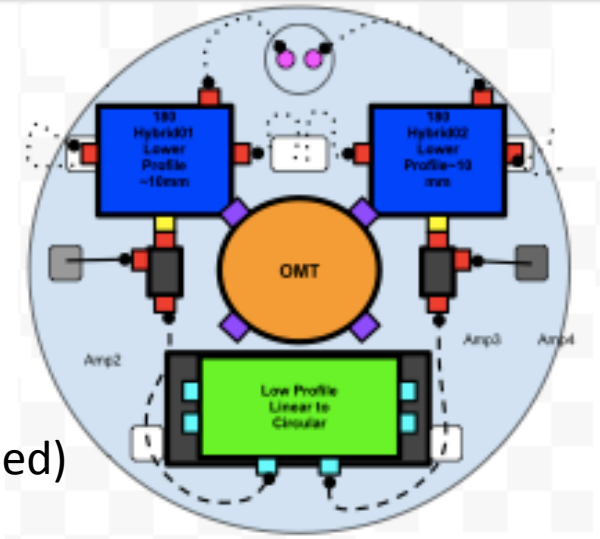
C-BASS

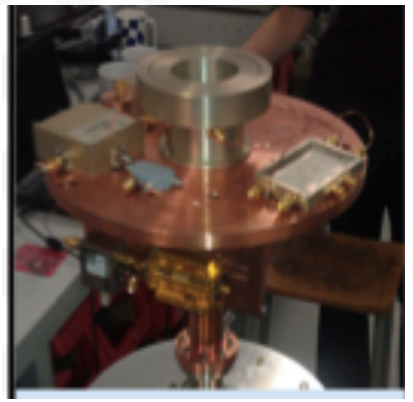


Planck Early Results XX – C. Dickinson

C-BASS

- ✧ 5 GHz (6 cm) all-sky survey
- ✧ Intensity and Linear Polarisation
- ✧ Northern 6.1 m dish, OVRO, California (taking survey data)
- ✧ Southern 7.6 m dish South Africa (soon to have receiver attached)
- ✧ FWHM resolution 44 arcmin
- ✧ Target Sensitivity 0.1 mK /beam rms
- ✧ Target System temp ~ 25 K

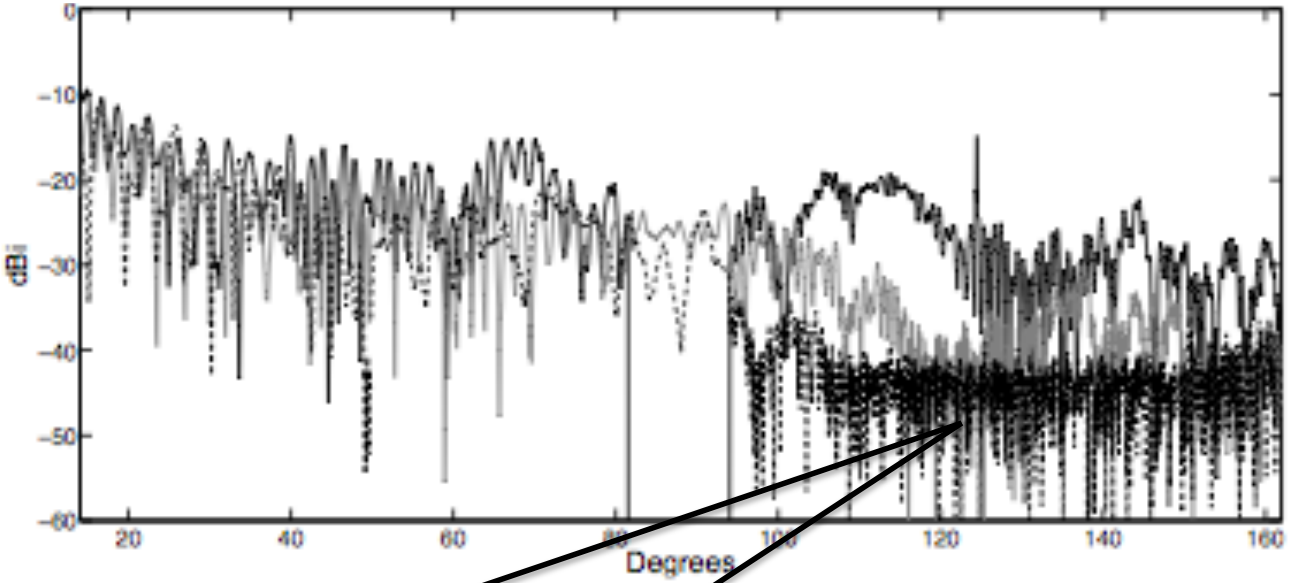


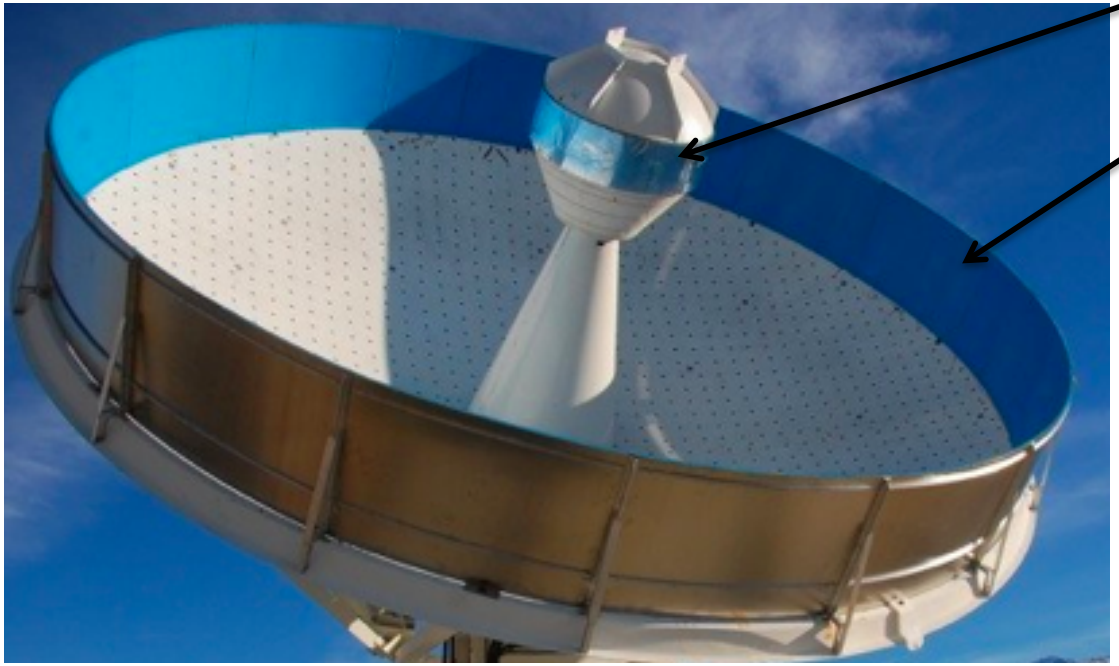


Above: Southern C-BASS receiver

Right: Northern C-BASS

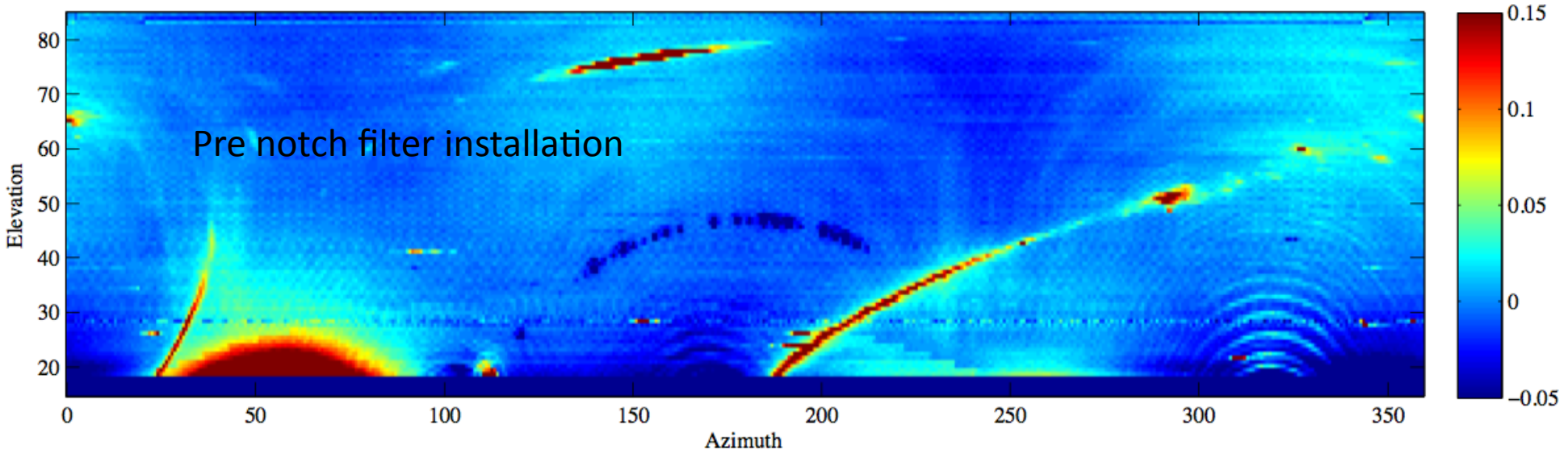
NORTHERN OPTICS

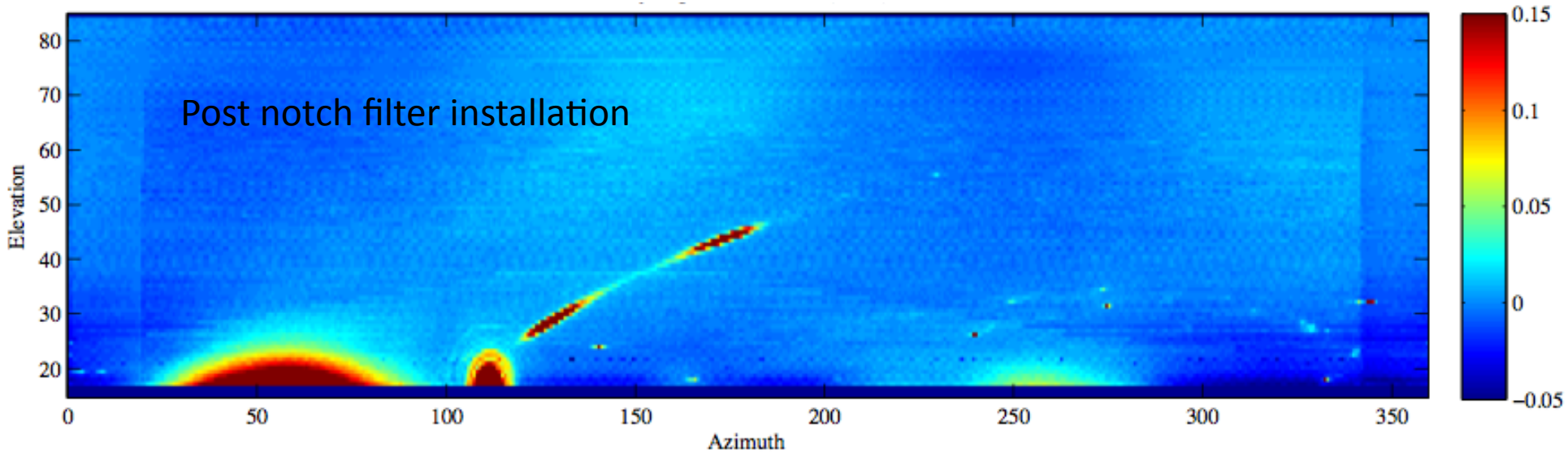




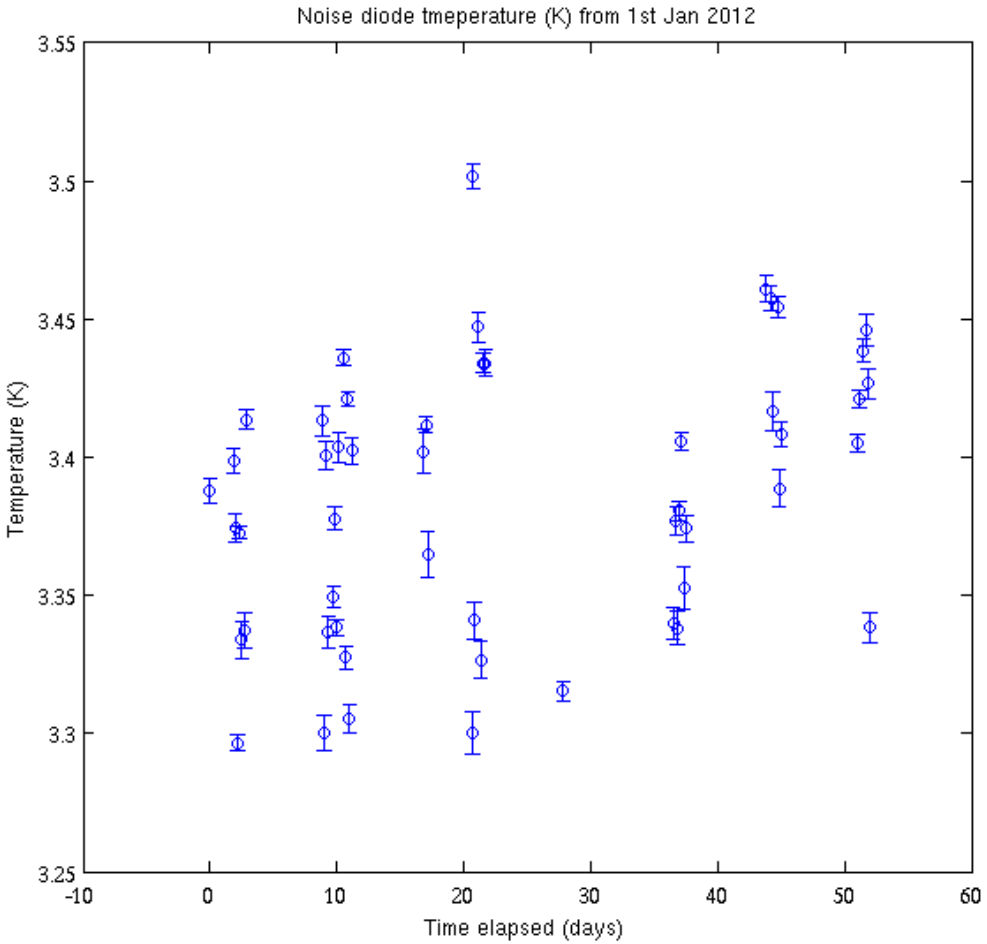
arXiv:1111.2702v1 Holler et al, 2011

NORTHERN RFI





NORTHERN CALIBRATION



Absolute calibration not required for spectral index (TT-plots):

$$T(\nu) = A\,\nu^{-\beta}$$

$$T(\nu_1) = \left(\frac{\nu_1}{\nu_2}\right)^{-\beta} T(\nu_2) + \text{temperature offsets}$$

Noise Diode calibration done using Cas A antenna temp (T_A) to convert units into K:

$$\text{Flux Density (Jy)} = \frac{2\,T_A\,k_B \times 10^{26}}{\eta\,\pi\,(\text{dish radius})^2}$$

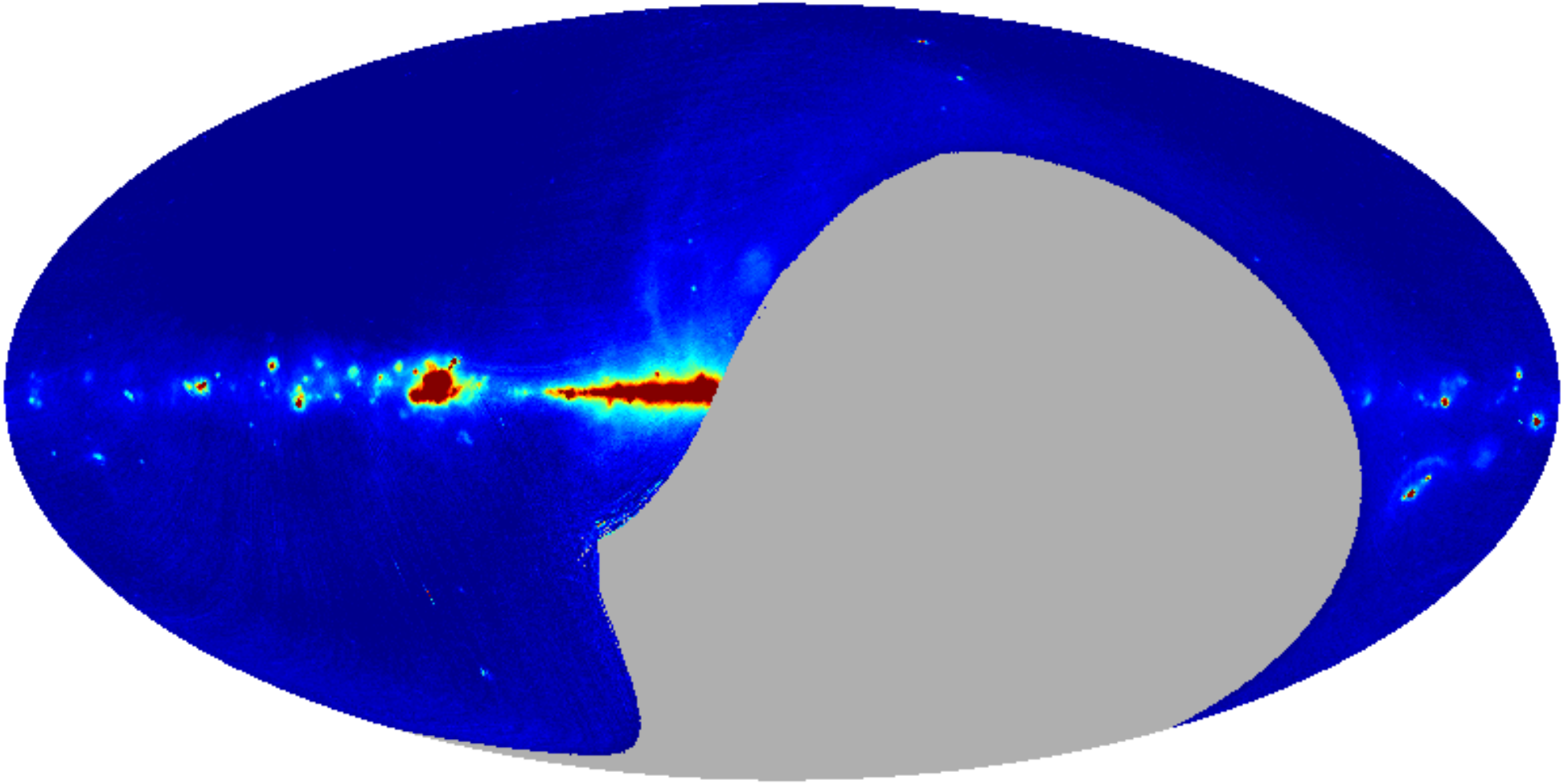
Noise Diode temperature = 3.38 ± (0.048 + 0.292) K

Known to around 1 and 10 % respectively

Noise Diode Uncertainties

Astronomical Uncertainties

PRELIMINARY INTENSITY



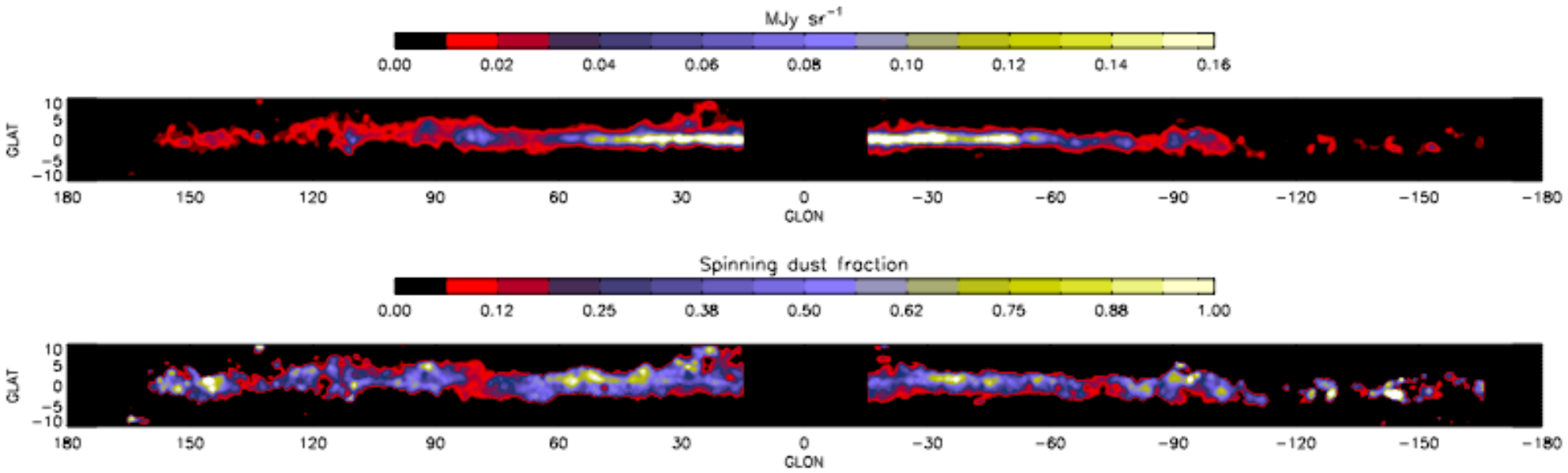
EARLY SCIENCE

We have the SN ratio within the galactic plane in intensity to begin looking at AME areas of interest such as:

Cygnus – LDN 944 and LDN 1103: possible anomalous emission detection in the Cygnus rift

Mon. Not. R. Astron. Soc. 400, 1394-1412(2009), Scaife + AMI collaboration

The Galactic Plane - Planck Early Results XXI, A&A 536 2011 Marshall & Planck collaboration



BARNARD'S LOOP

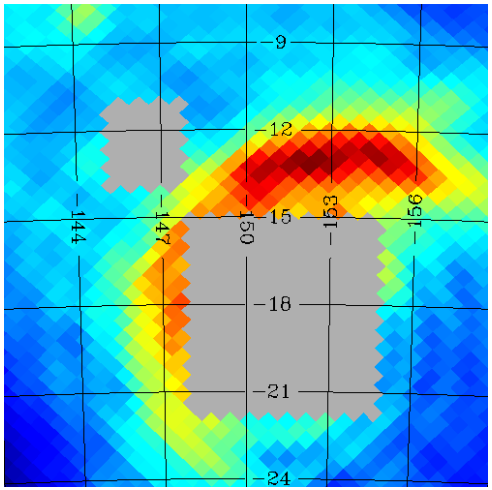
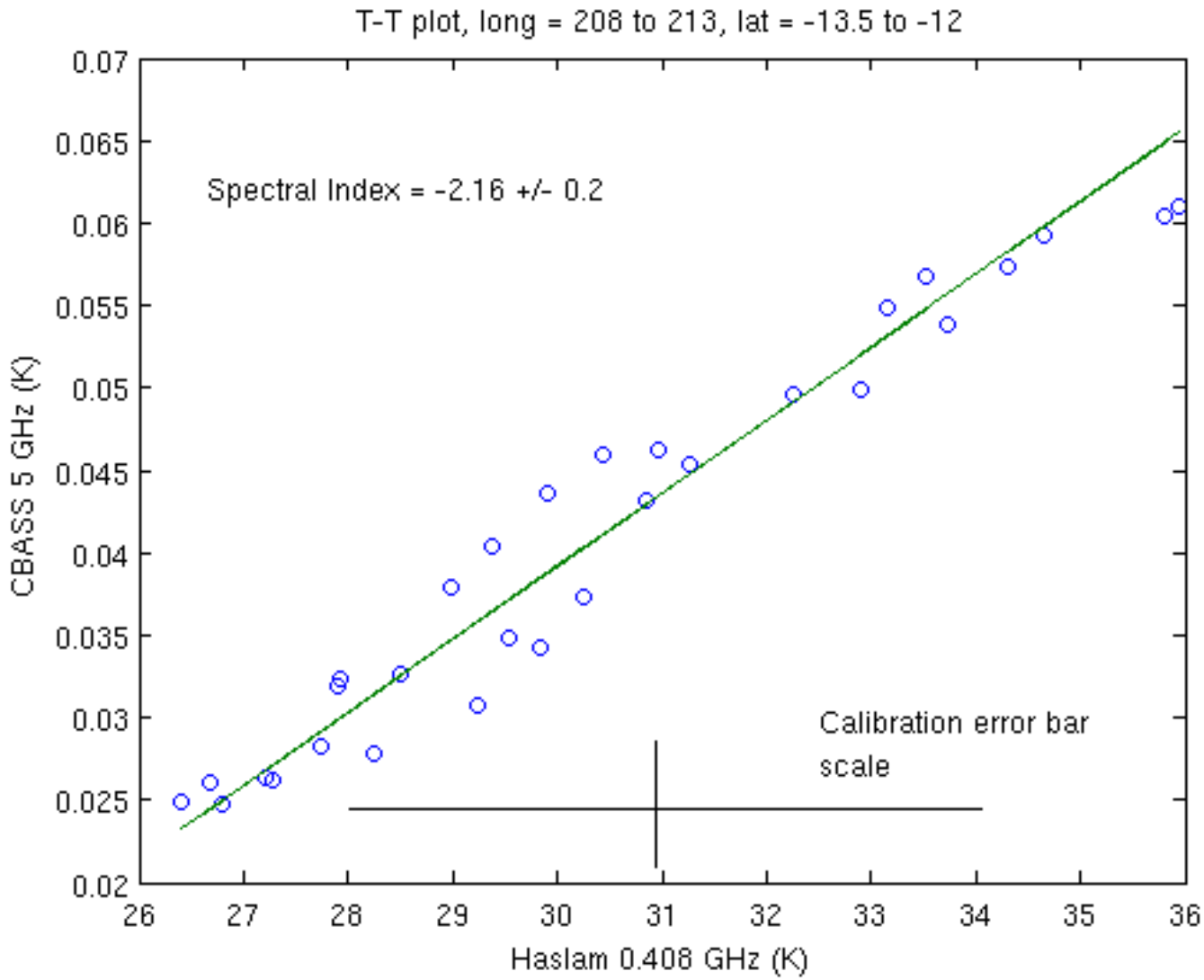


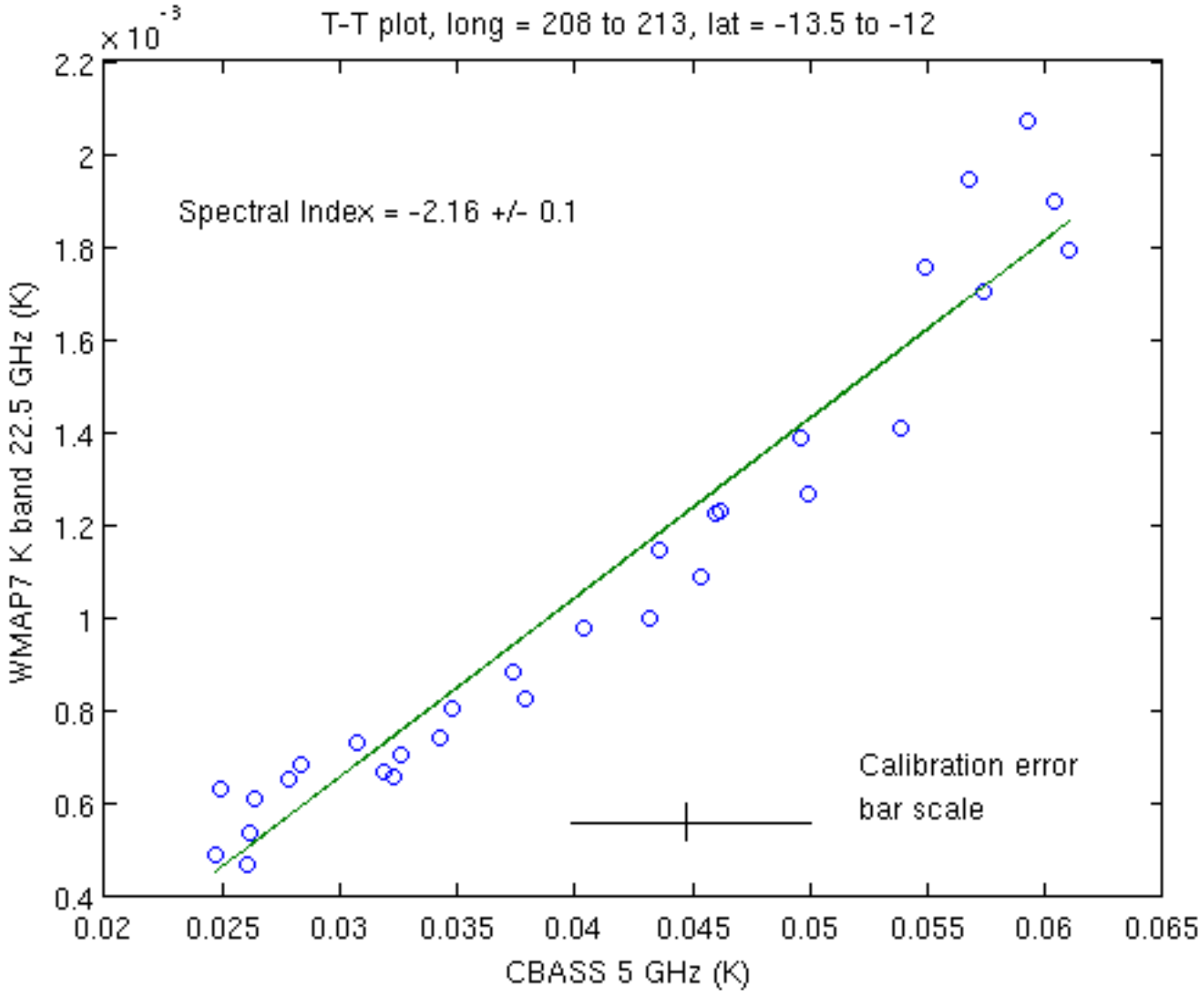
Figure above: Loop region at 5 GHz with point sources removed

Haslam & C-BASS



BARNARD'S LOOP

WMAP7 & C-BASS



CYGNUS X

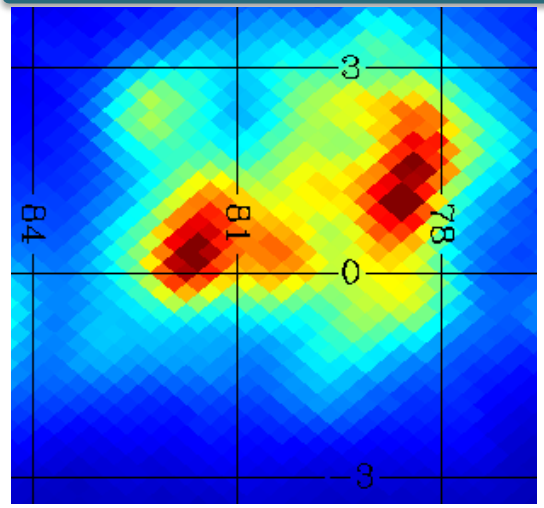
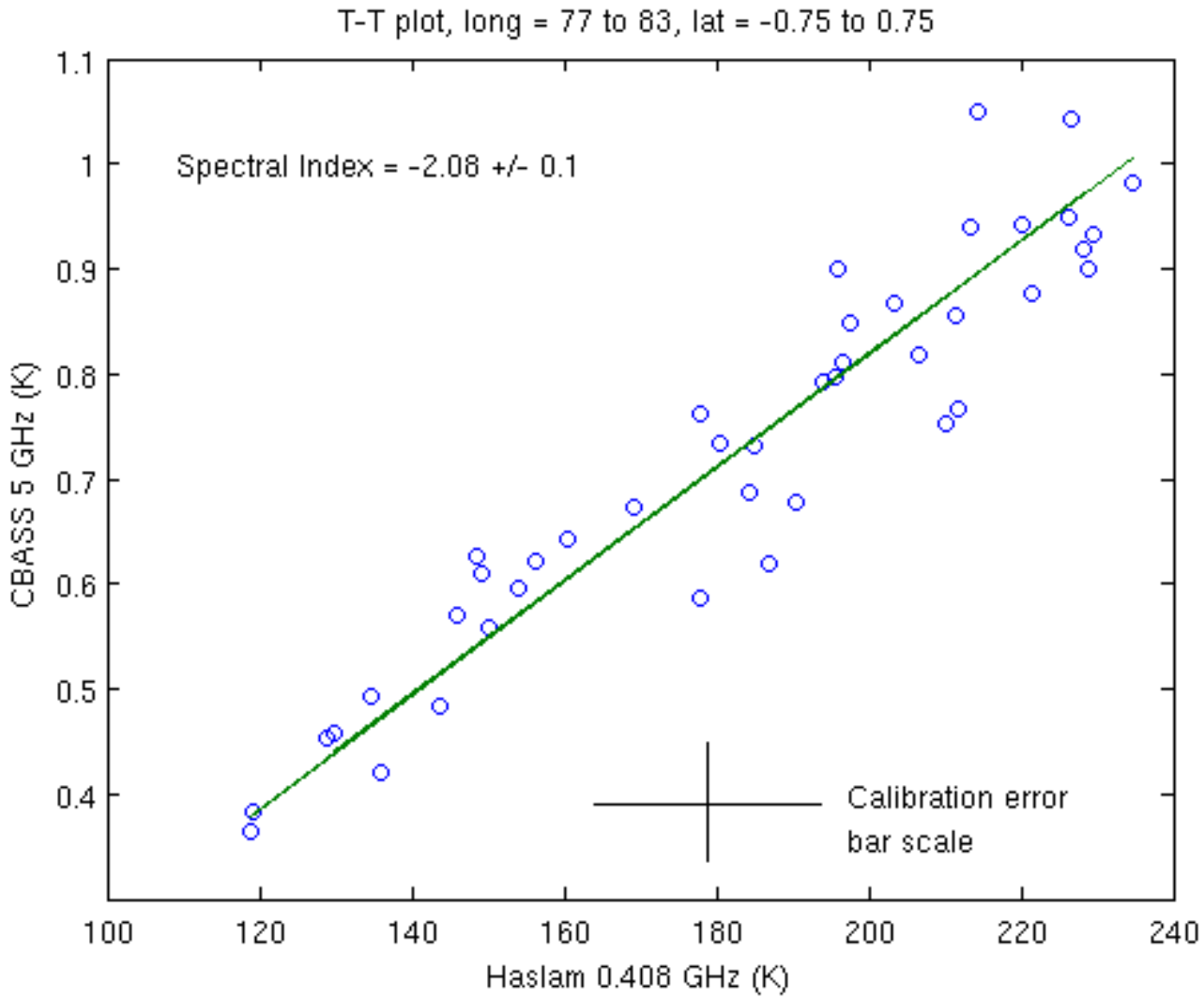


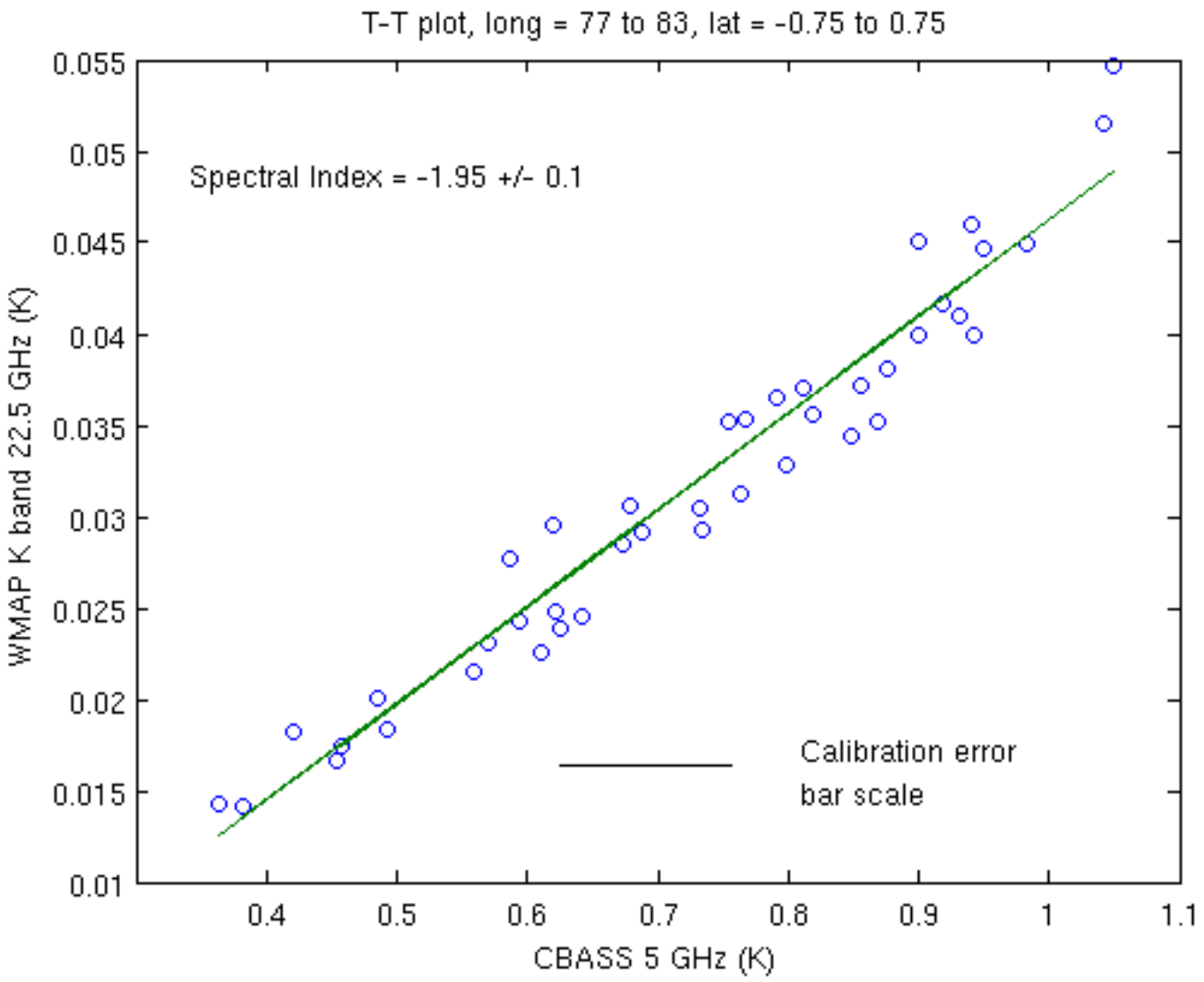
Figure above: Cygnus region at 5 GHz

Haslam & C-BASS



CYGNUS X

WMAP7 & C-BASS



THE GALACTIC PLANE

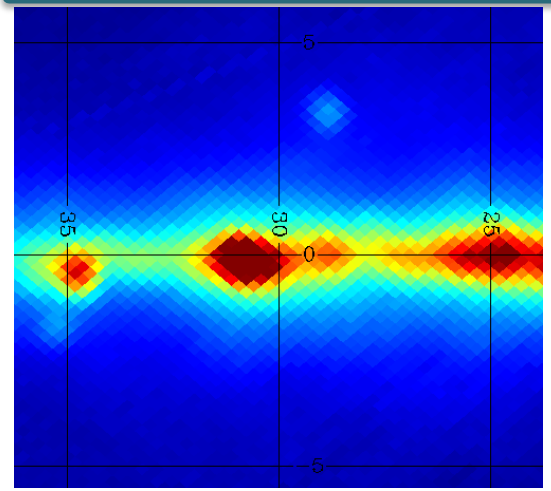
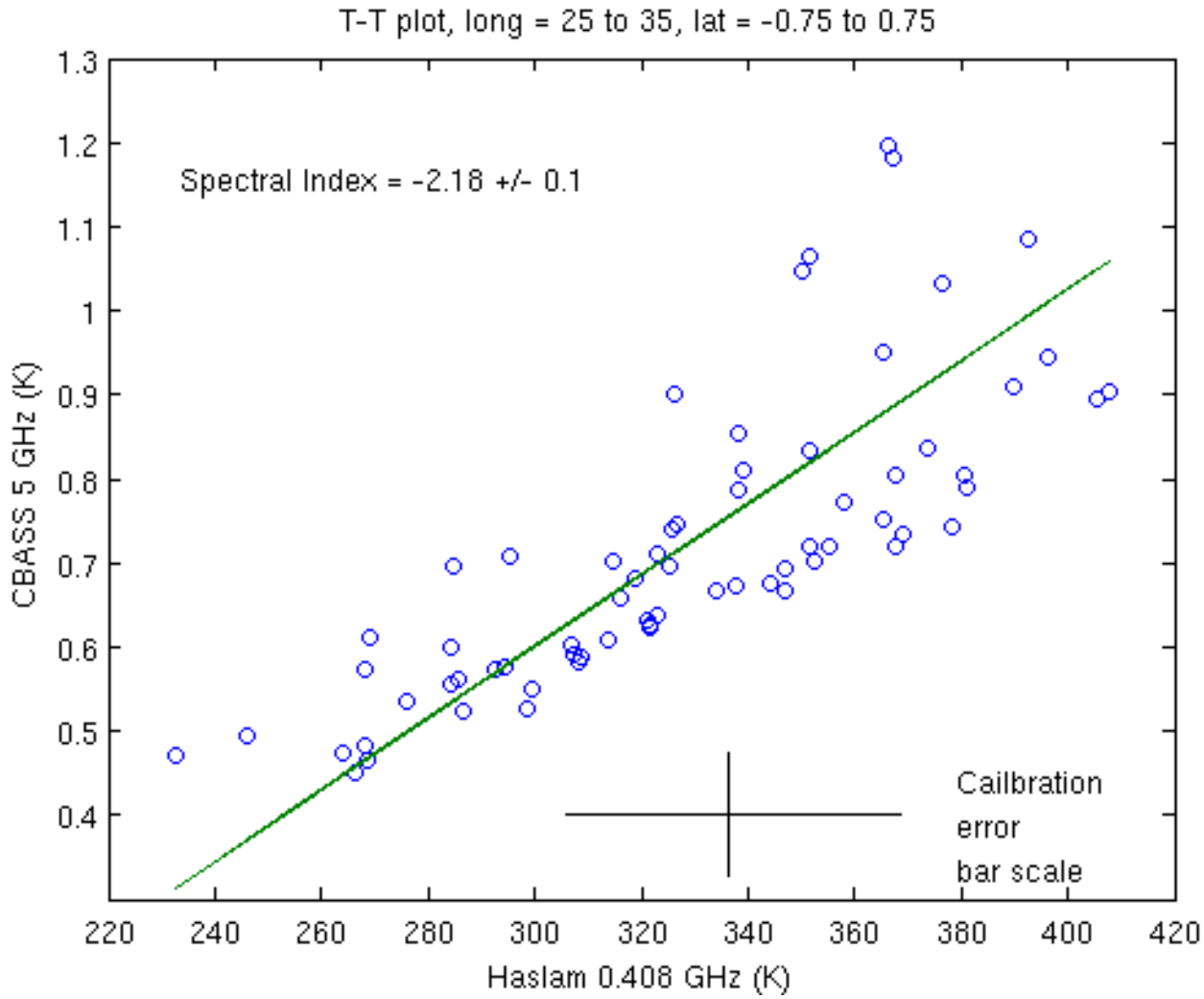


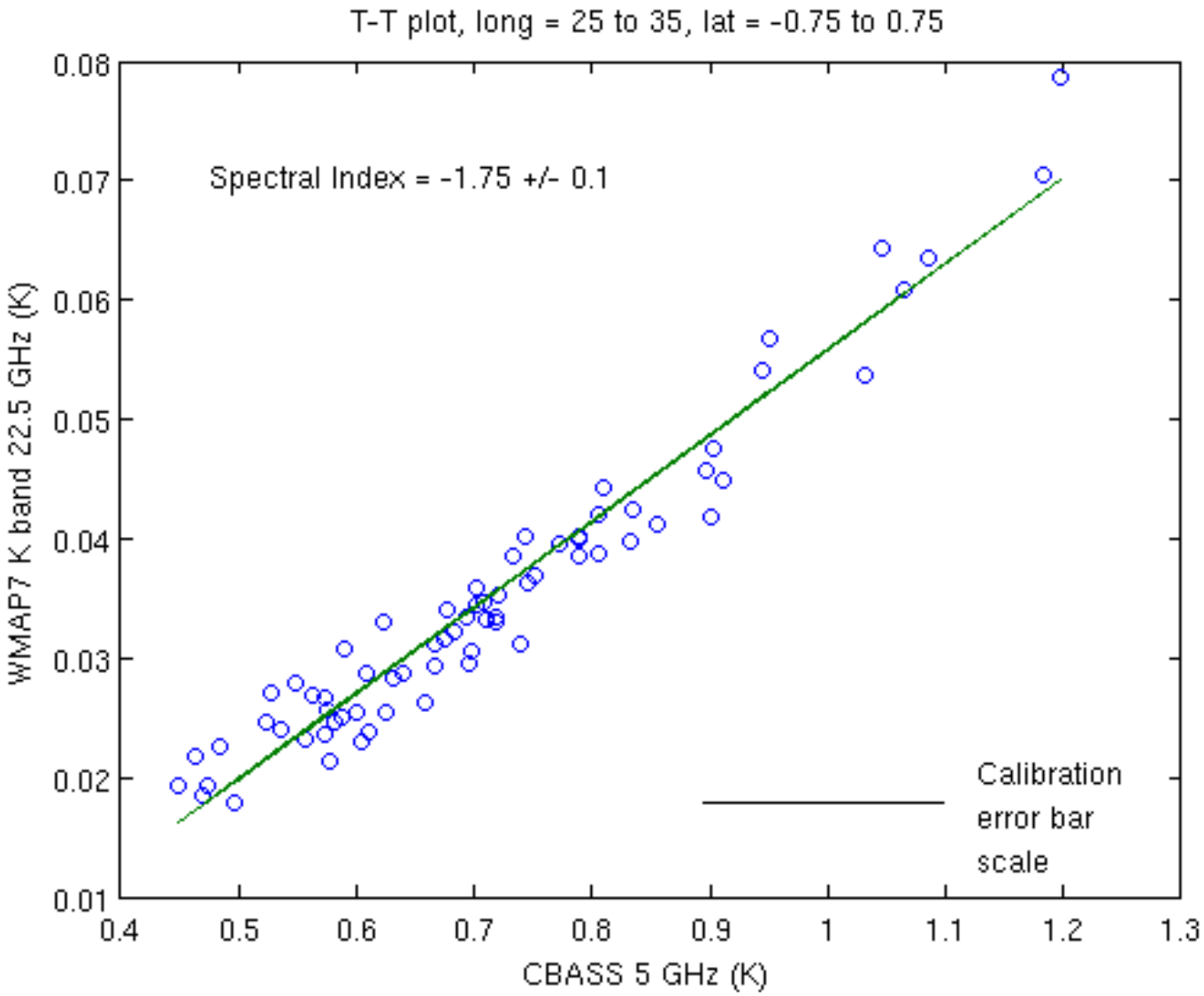
Figure above: Galactic plane between 25 and 35 ° longitude.

Haslam & C-BASS



THE GALACTIC PLANE

WMAP7 & C-BASS



CONCLUSIONS

• C-BASS has already produced intensity maps of the galactic plane from the Northern hemisphere with a high enough SN ratio to begin AME investigations.

• Haslam 0.408 GHz comparison: spectral indices consistent with free-free emission ($\beta \approx -2.1$) for the Galactic Plane, Cygnus X and Bernard's Arc regions.

• Comparison with WMAP7 K-band (22.5 GHz) present indications of anomalous emission ($\beta \approx -1.7$) within the Galactic Plane. Assuming no synchrotron emission, AME = 70 ± 25 % of plane.

	Haslam Comparison	WMAP7 K-band comparison
Bernard's Arc	-2.16 ± 0.2	-2.16 ± 0.1
Cygnus X	-2.08 ± 0.1	-1.95 ± 0.1
Galactic Plane	-2.18 ± 0.1	-1.75 ± 0.1

• Work for the imminent future: a more vigorous error analysis as well as astronomical calibration improvements.