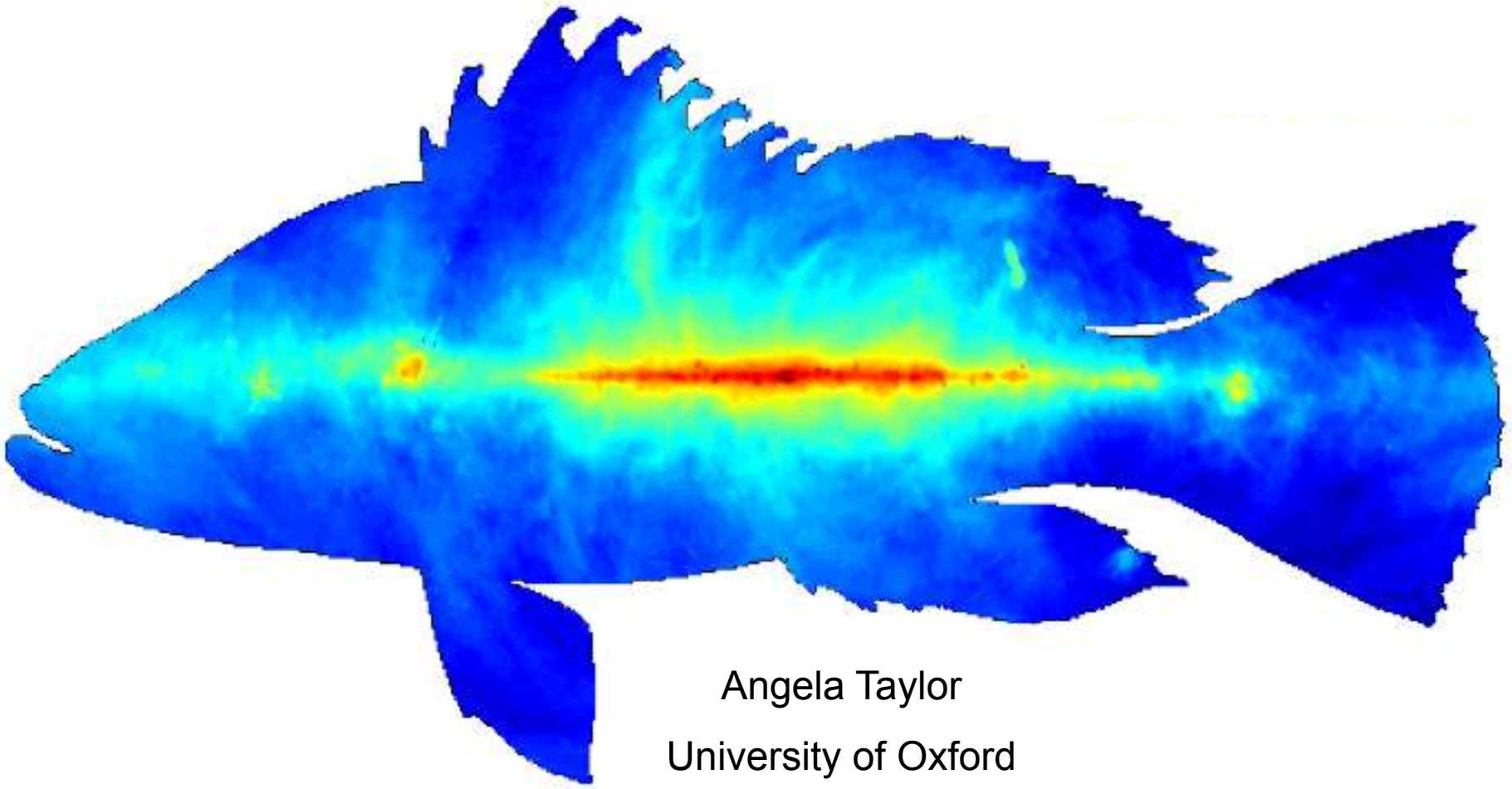
C-Band All-Sky Survey (C-BASS)



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C-Band All-Sky Survey (C-BASS)

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Tim Pearson, Stephen Muchovej, Tony Readhead,

South Africa

Justin Jonas (Rhodes/SKASA), Charles Copley (SKASA), Cynthia Chiang, Heiko Heligendorff, Moumita Aitch (UKZN)

KACST, Saudi Arabia

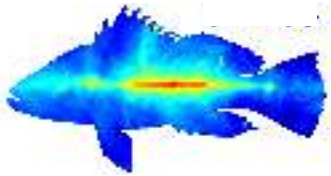
Yasser Hafez

Moved on…

Oliver King, Matthew Stevenson, Melis Irfan

C-BASS - Overview

Sky-coverage	All-sky
Angular resolution	0.73 deg (43.8 arcmin)
Sensitivity	< 0.1mK r.m.s (confusion limited in I)
Stokes coverage	I, Q, U, (V)
Frequency	1 (0.7) GHz bandwidth, centered at 5 GHz
Northern site 	OVRO, California Latitude, 37.2 deg
Southern site 	MeerKAT site, Karoo, South Africa Latitude -30.7 deg



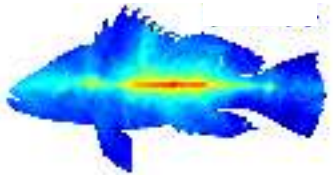
C-BASS - Science Goals

Primary aims:

- To allow more accurate subtraction of the polarized Galactic synchrotron emission from e.g. WMAP, Planck and future B-mode experiments.
- To improve the modeling of Galactic total intensity emission and hence allow CMB experiments to access the currently inaccessible region close to the Galactic plane.
- To provide all-sky maps in I, Q and U at 5 GHz for the community.

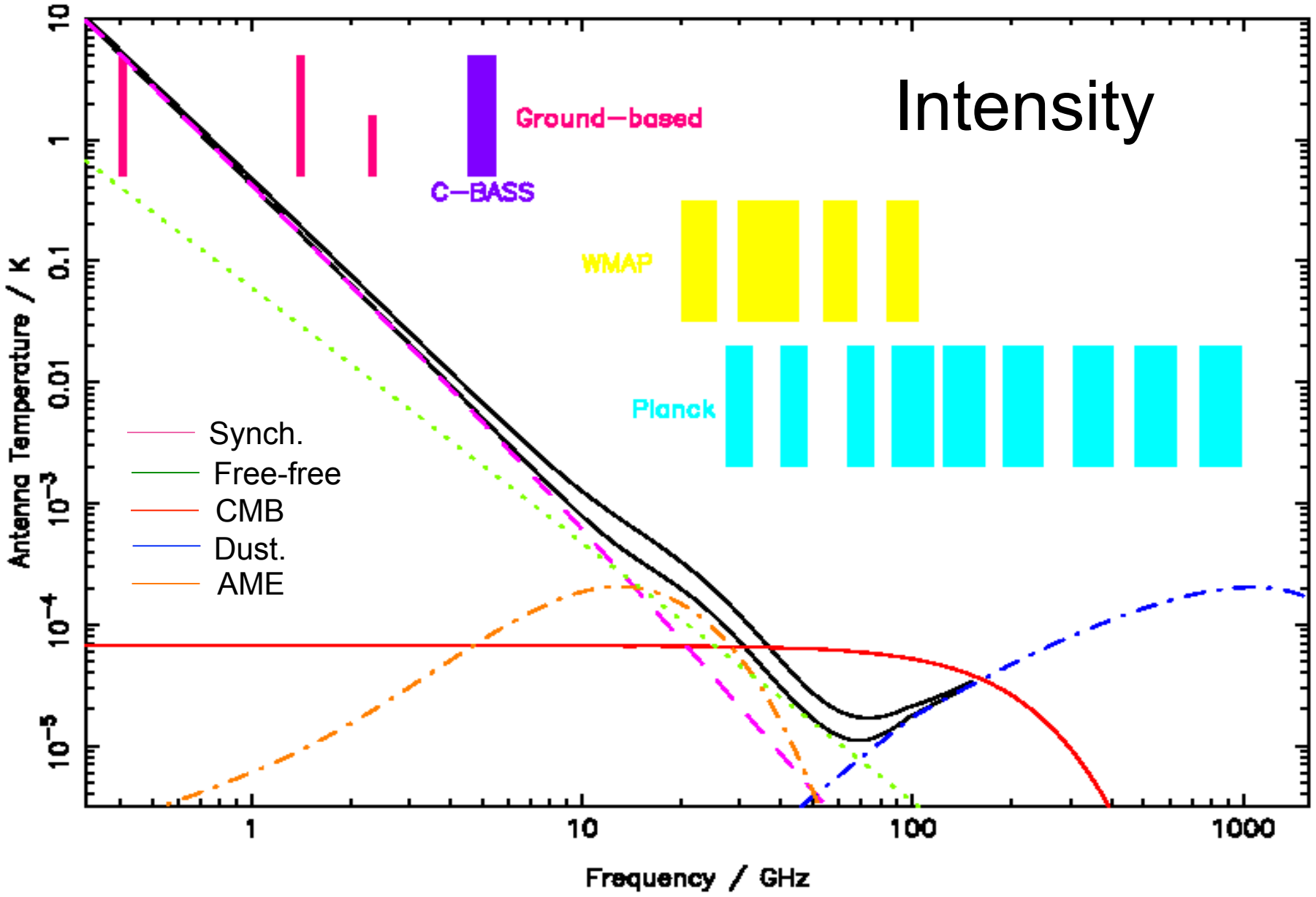
Secondary aims:

- To map the local Galactic magnetic field and improve our understanding of the the propagation of cosmic rays through it.
- To further study anomalous dust.
- Help our understanding of / belief in the Galactic Haze….
- To study radio loops

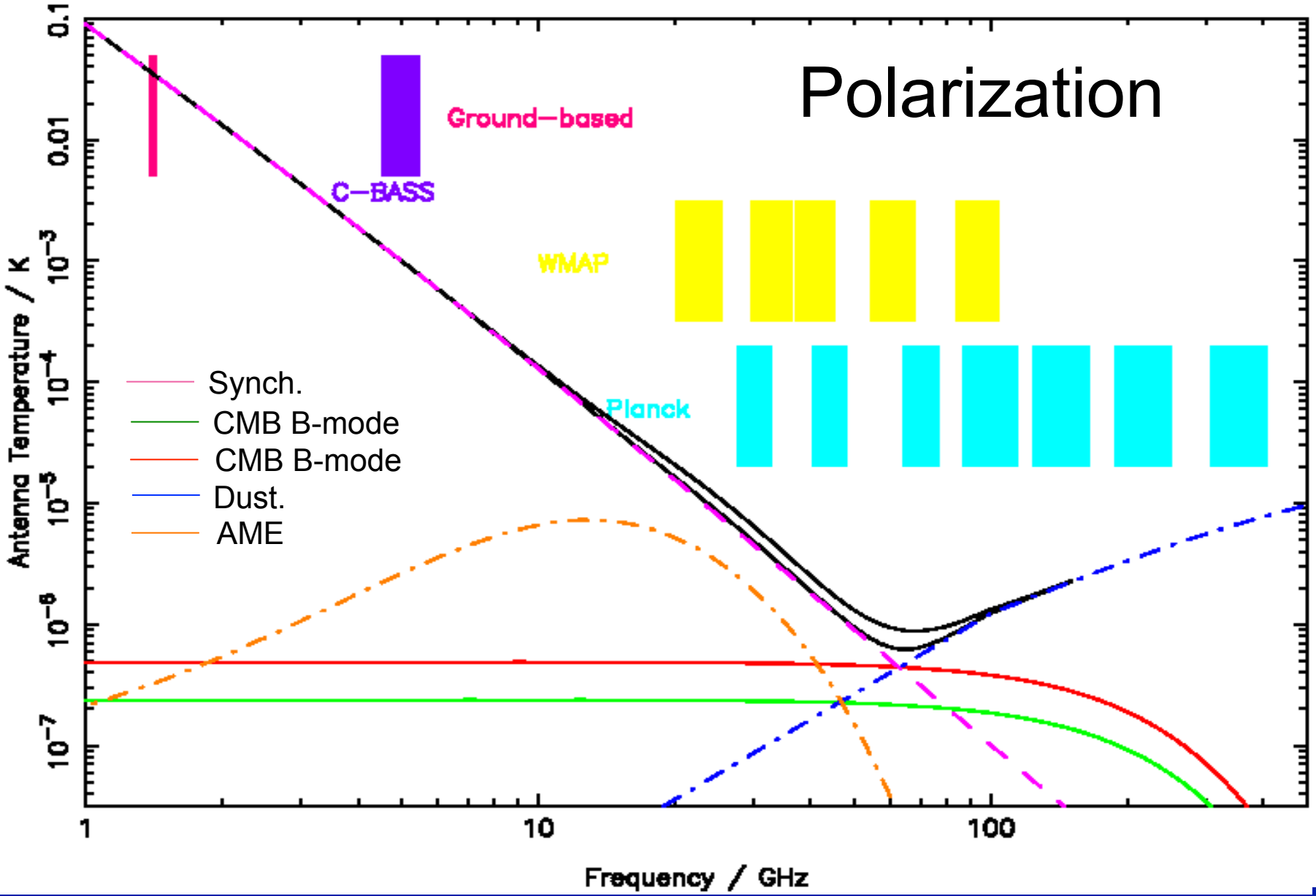


….to name but a few ….

Why a 5 GHz survey?



Why a 5 GHz survey?



Impact on Planck results (1)

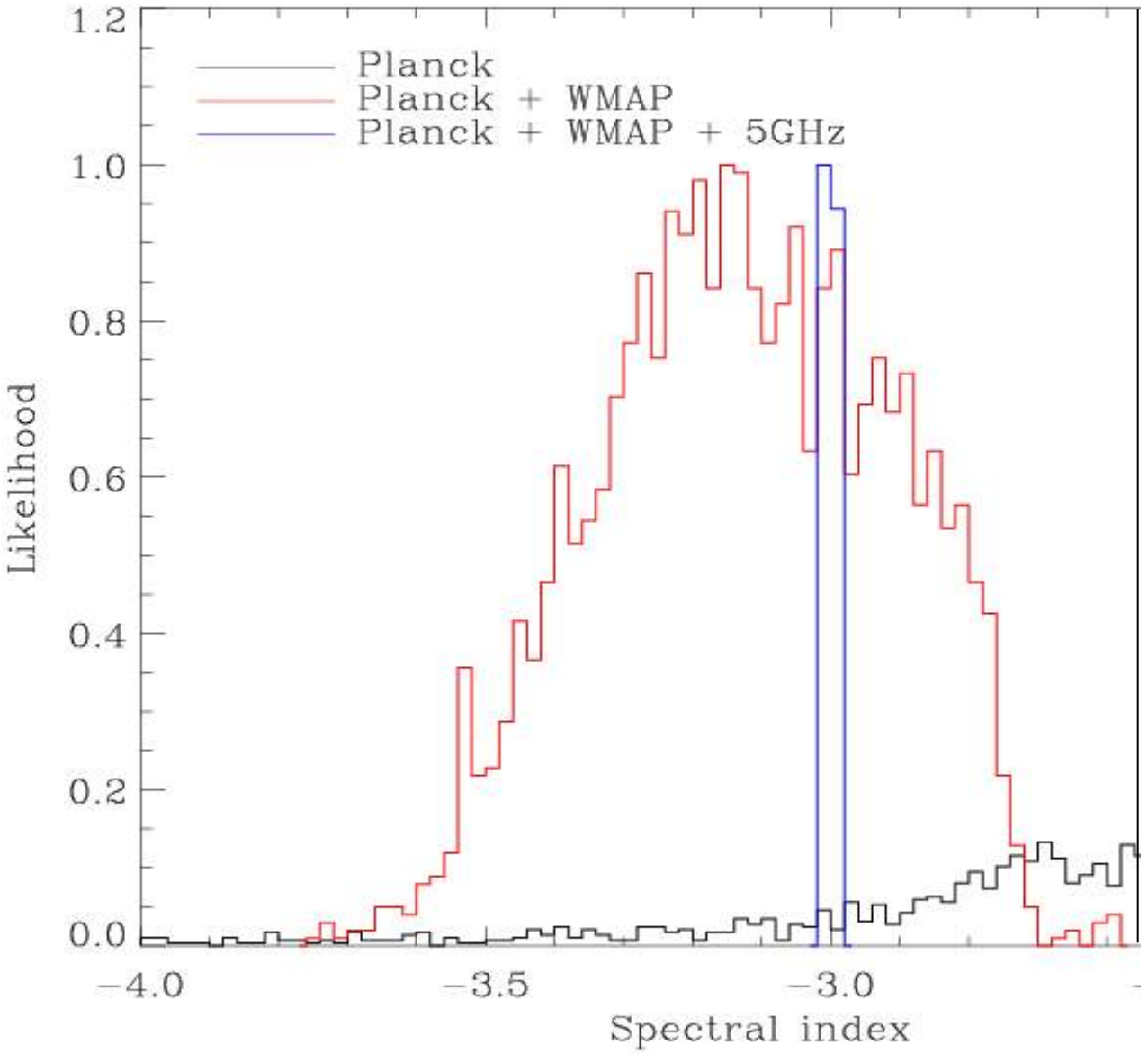
	Planck	Planck+CBASS
Stokes I		
CMB mean error (μK)	5.4	4.0
Synch amp error (μK)	1.4	0.44
Synch index error	0.29	0.03
Dust amp error (μK)	3.4	2.8
Dusts index error	0.26	0.29
Stokes Q,U		
CMB mean error (μK)	3.6	2.7
Synch amp error (μK)	0.67	0.17
Synch index error	0.29	0.03
Dust amp error (μK)	1.3	0.97
Dust index error	0.26	0.29

Typical high latitude 1 deg pixel
Mean synch amplitude 80 uK@ 23 GHz
MCMC reconstruction

25% improvement
× 3 improvement
× 10 improvement

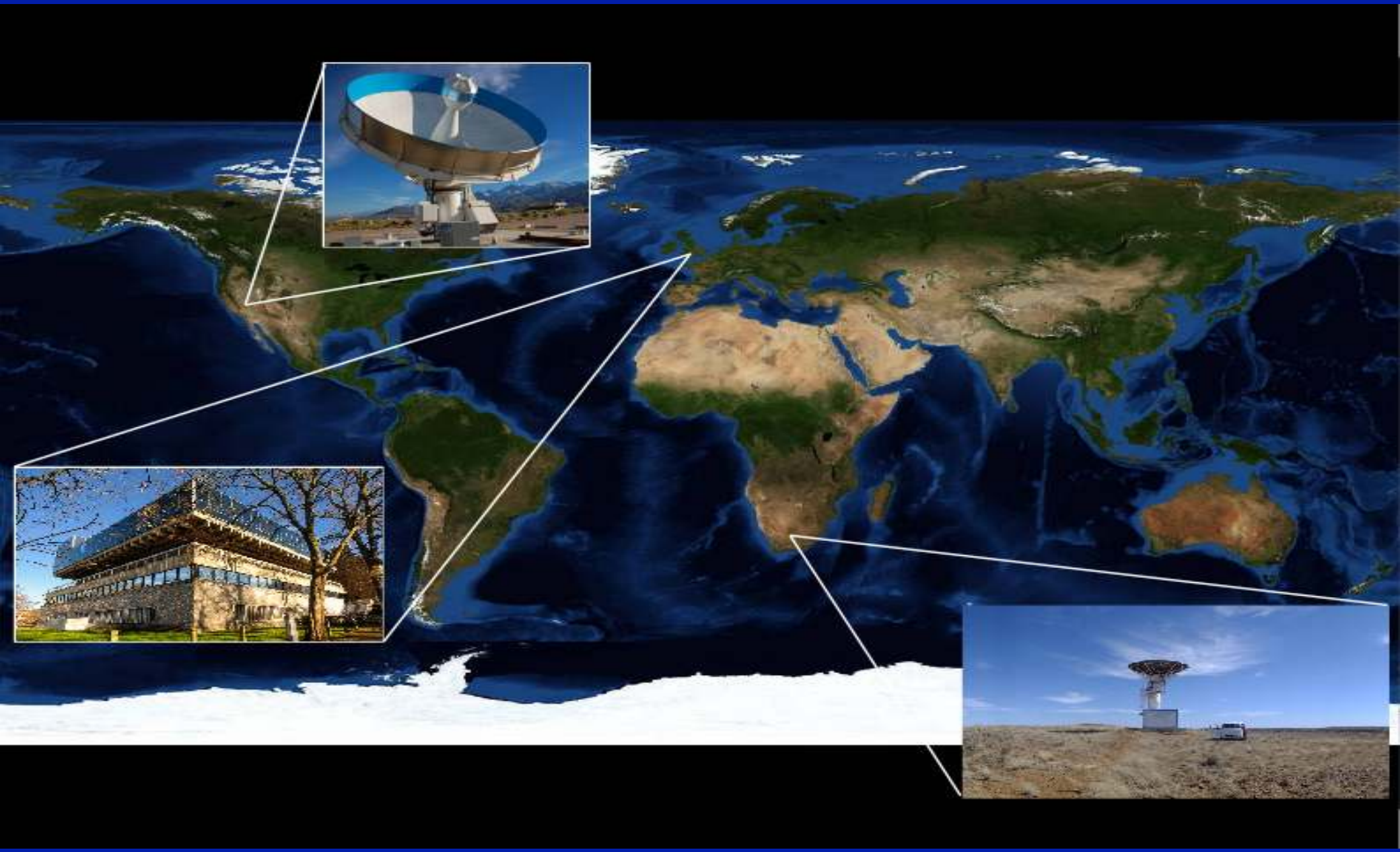
25% improvement
× 4 improvement
× 10 improvement

Impact on Planck results (2)



Constraining the synchrotron spectral index…

The C-BASS Survey



C-BASS North Telescope

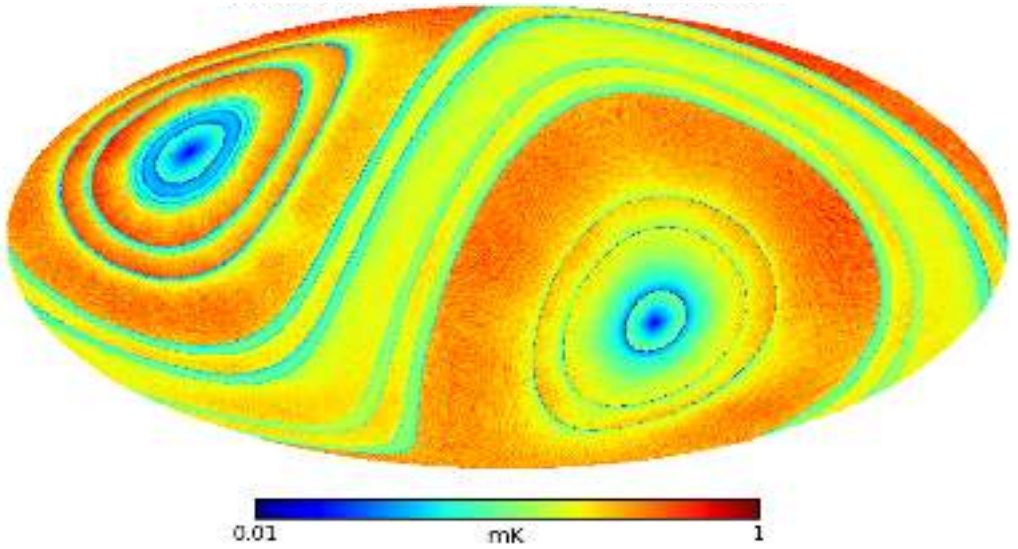
- 6.1-m dish, with Gregorian optics
- Secondary supported on foam cone
- Receiver sat forward of the dish
- Very clean, circularly-symmetric optics
- Absorbing baffles to minimize spillover

C-BASS South Telescope

- CBASS South in the Karoo desert, South Africa
- 7.6m ex-telecoms dish
- Cassegrain
- Similar receiver to north – but frequency resolution (128 channels)

Survey Parameters

- 360° scans at constant elevation.
- Deep NCP scans for check of systematics.
- Survey data at several elevations
  - Through NCP
  - Through NCP + 10, 30,40 °
- Scan at 5 different speeds between
- 3.8 and 4.2 deg/s → scan in 90s
  - Need fknee < 10 mHz
- Pointing and opacity and flux calibration every 2 hours.
- Continuous gain monitoring via noise diode injection.

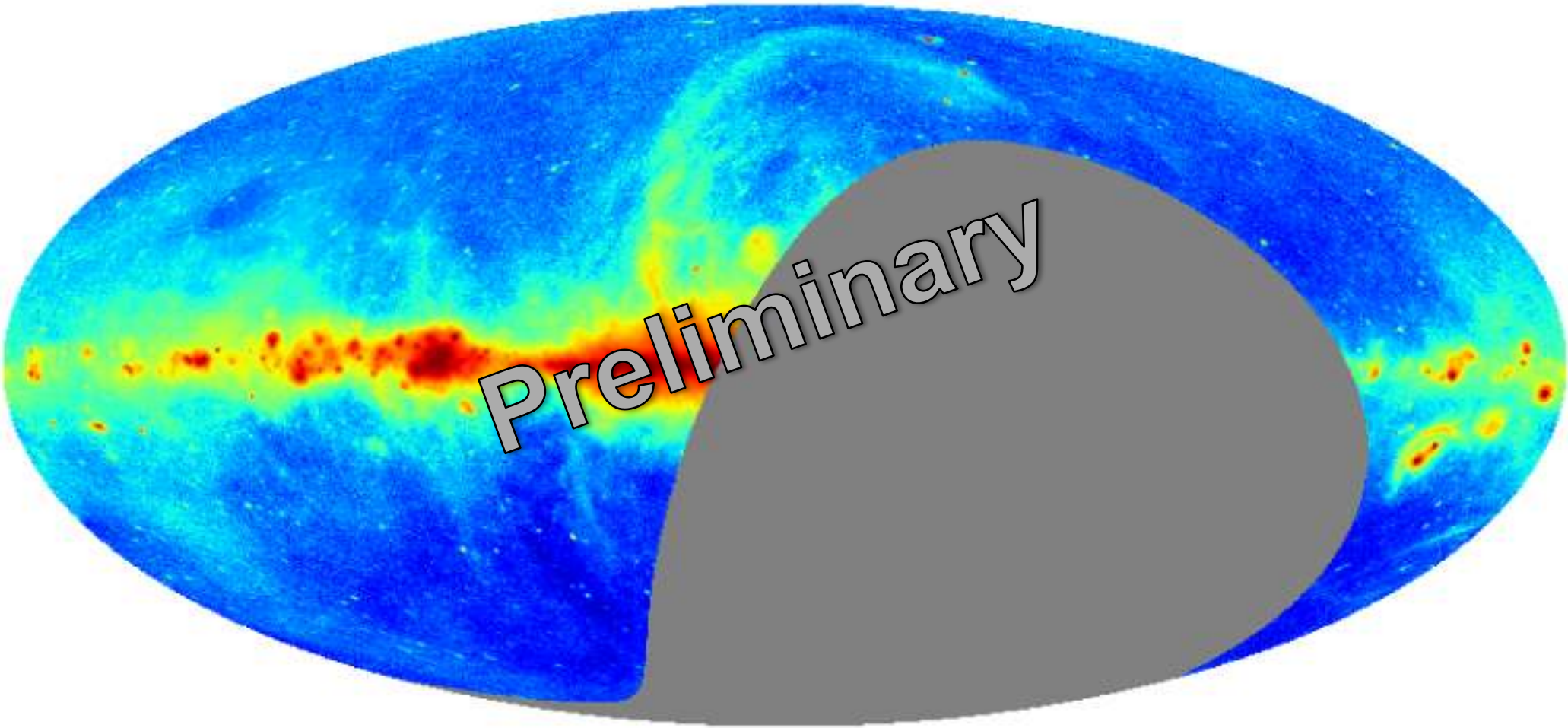


Simulation of elevation scans in North and South (mk/512 pixel)

- Daytime only for 24 months.
- Random drop-outs added.
- Very good coverage at poles and overlap region.

(actual coverage in North)

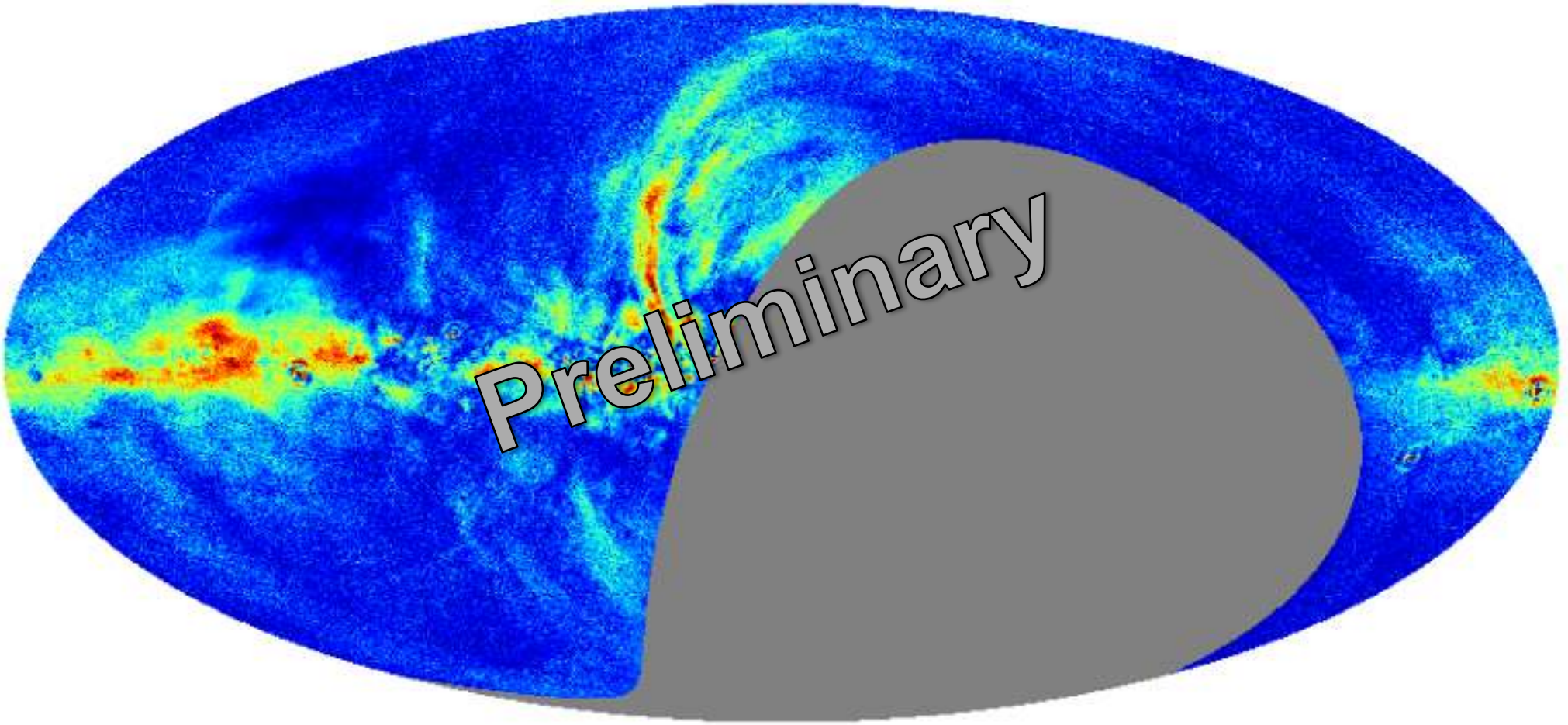
CBASS-N: Intensity



- Destriped map – Descart (Sutton et al MNRAS 2010, 407, 1387)
- Highly non-linear colour scale to show features at all brightness levels
- Ratio of brightest pixel to thermal noise level in the map is over 10,000:1.
- Thermal noise = 0.1mK/ 0.85deg pixel

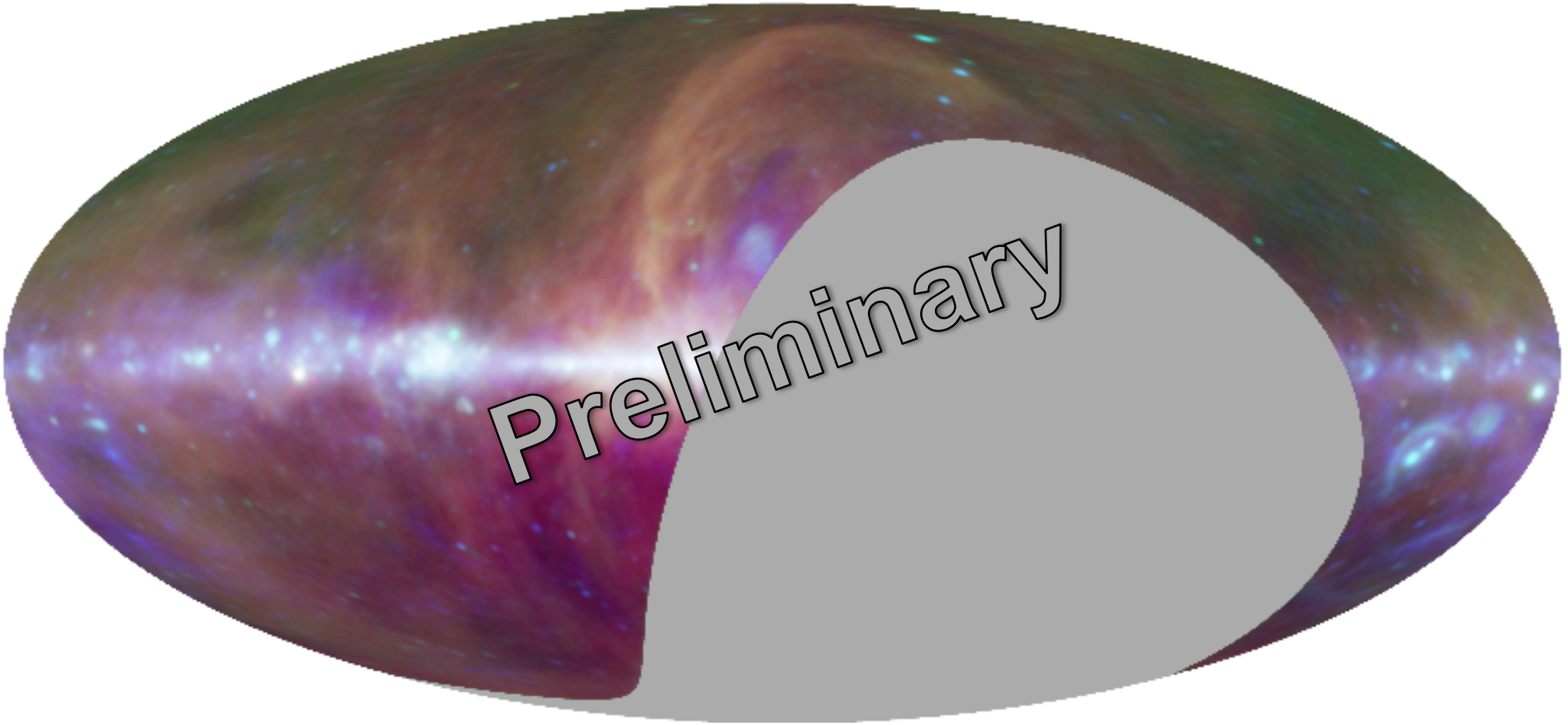
  → 30nK @ 100 GHz with β=-2.7 or 12μK @ 11 GHz

CBASS-N: Pol. Intensity



- Polarized intensity (Stokes $(Q^2 + U^2)^{1/2}$) and is on a linear intensity scale.
- Thermal noise ~ 0.1mK/ 0.85deg pixel (possibly ~20% better in final map)
  → 30nK @ 100 GHz with β=-2.7 or 12μK @ 11 GHz

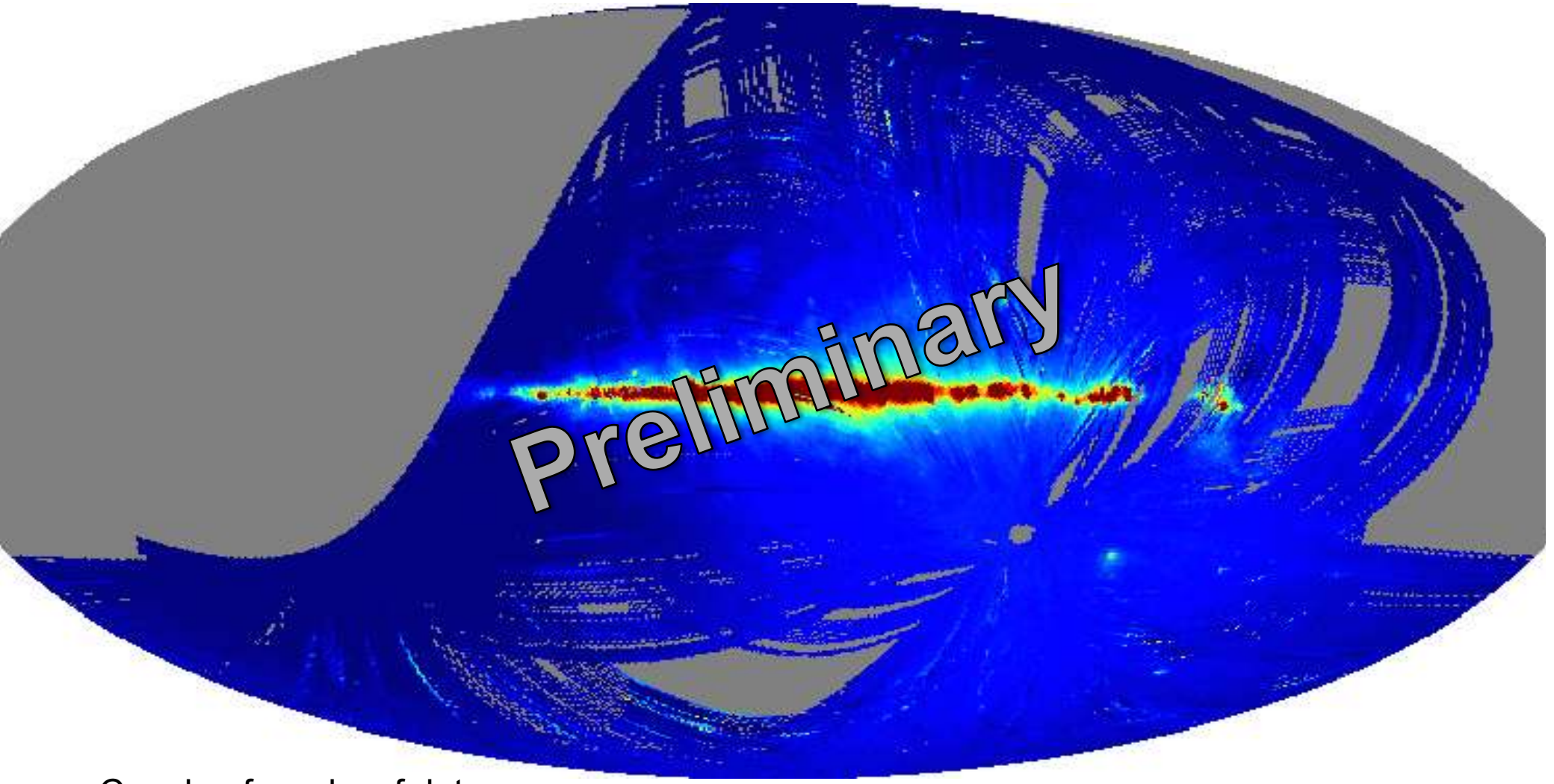
408 MHz - 5 GHz – 23 GHz



This map is a three-colour image

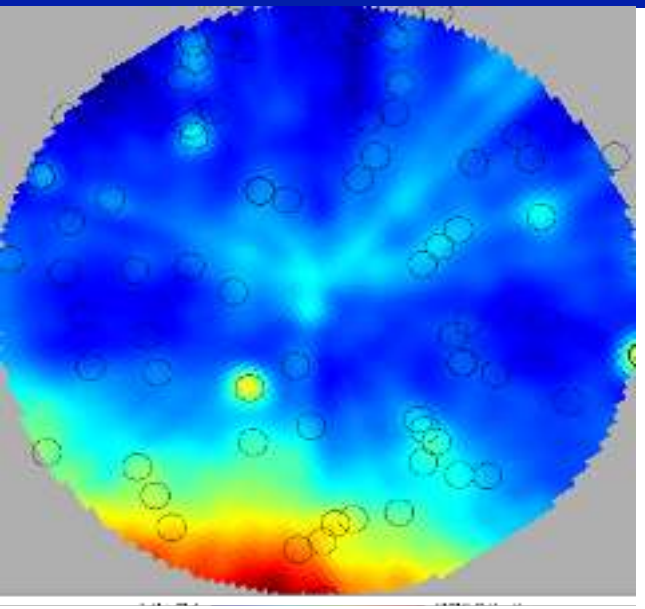
- RED: Haslam et al 408 MHz map
- GREEN: C-BASS I map
- BLUE: WMAP (K-V) band ~ high-ν diffuse emission with the CMB removed.
- Colours balanced such that temperature spectrum of index −2.7 would appear white.

CBASS-S: I (very early data!)

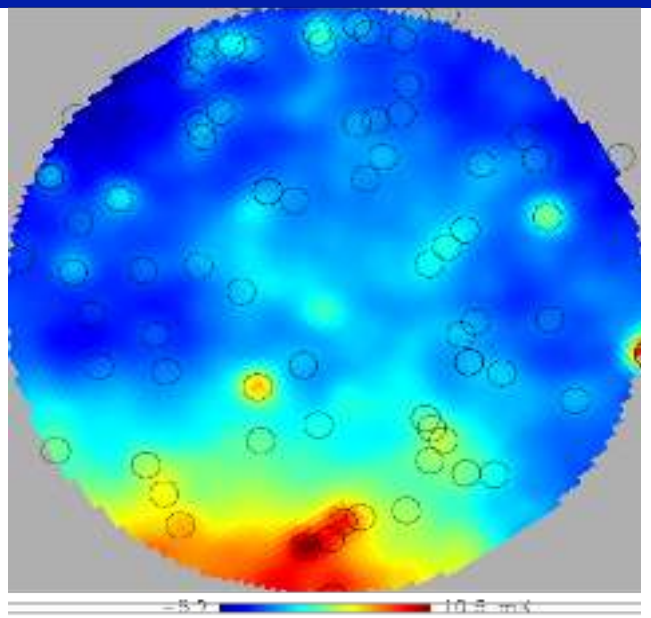


- Couple of weeks of data
- Almost completely raw – very little editing
- Non-linear colour scale

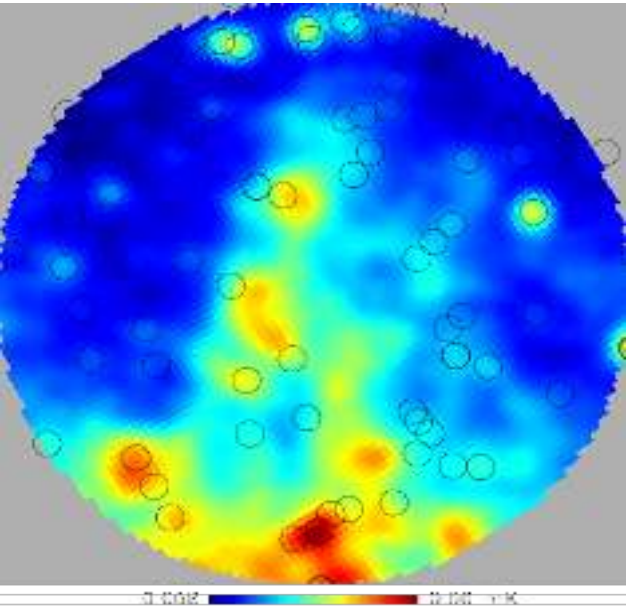
NCP - components



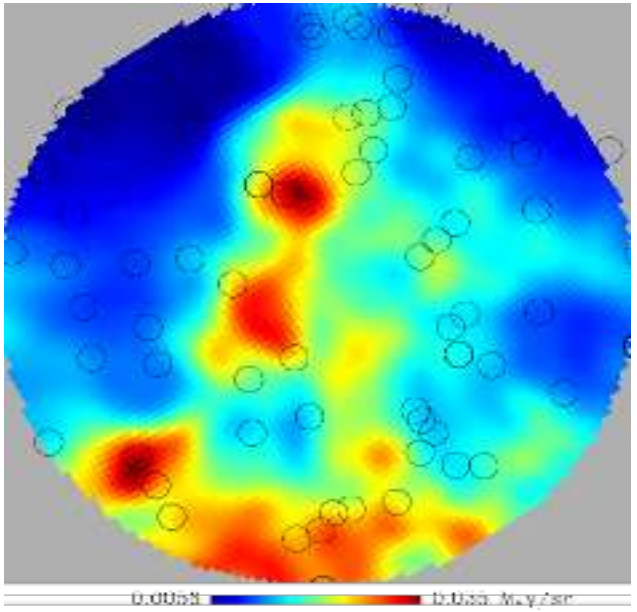
408 MHz – synchrotron?



CBASS 5 GHz - synchrotron



WMAP 23 GHz – synchrotron + AME



IRIS 100 μm – thermal dust

CBASS Status

- Northern survey now complete
- Reducing Northern data + preliminary science
- Staged publications -> data release

- Southern survey started now.
- 2 yrs data taking expected in south
- Full data release once surveys completed and combined…

Look out for upcoming papers…..