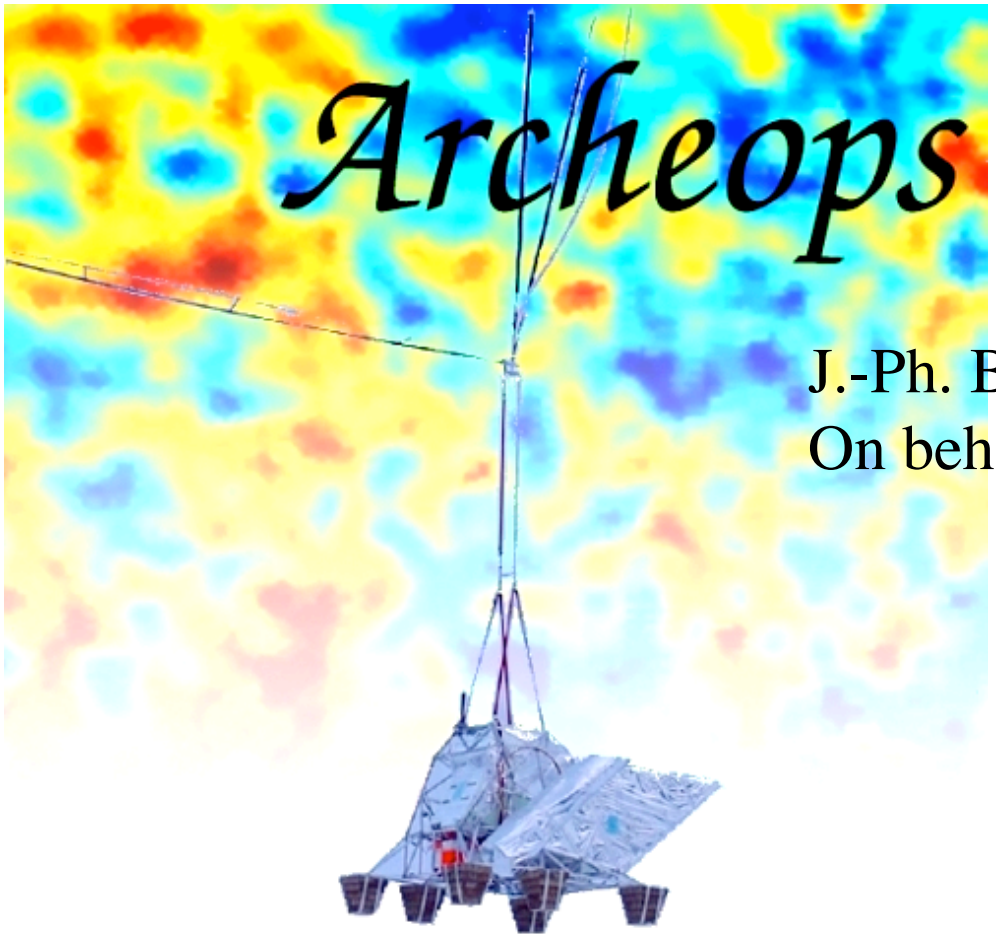


Archeops Results

J.-Ph. Bernard (CESR Toulouse)
On behalf of the Archeops collaboration

- CMB studies
- Polarization of dust emission
- Dust emission spectrum

Archeops characteristics

- Same concept as Planck HFI
  - Off-axis Gregorian telescope
  - Spider web bolometers at 100 mK

→ Testbed for Planck HFI

- Large sky coverage : 30%
  - Large circles on the sky during night-time
  - 19 hour flight during Arctic night

→ Constraints on low ℓ (>10)

- High angular resolution : 10-12 arcmin

→ Constraints on high ℓ (<700)

- Multiband photometer
  - 21 bolometers
  - 4 frequency bands : 143, 217, 353, 545 GHz

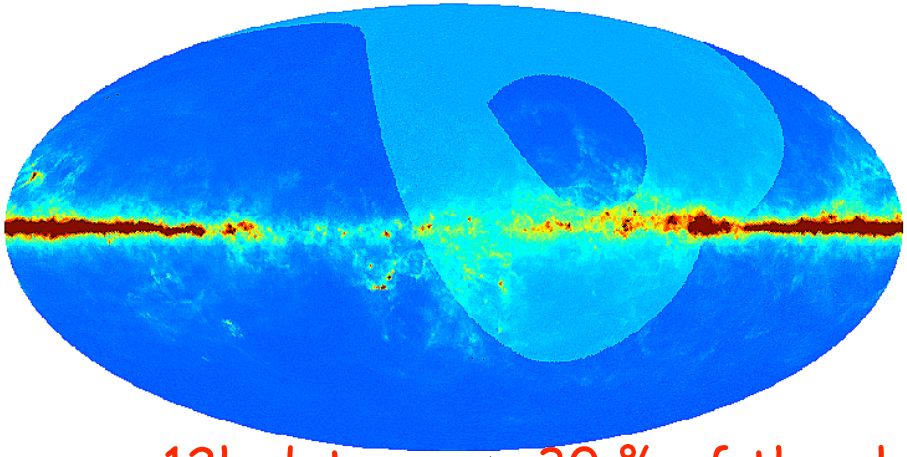
→ Good redundancy foreground sep.

- Polarized 353 GHz Channel

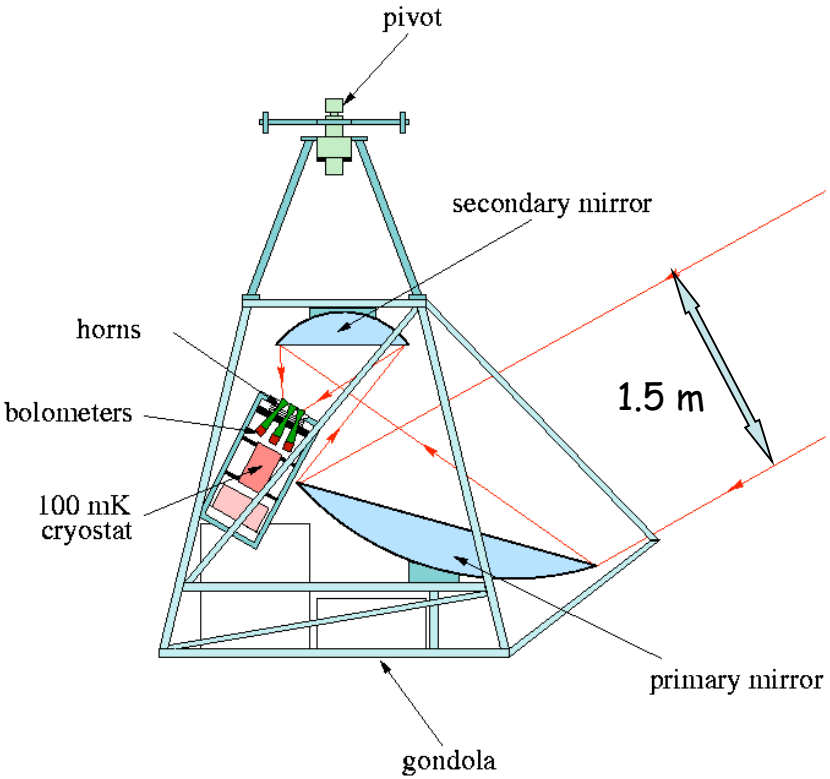
→ Polarized Foregrounds

Scanning Strategy

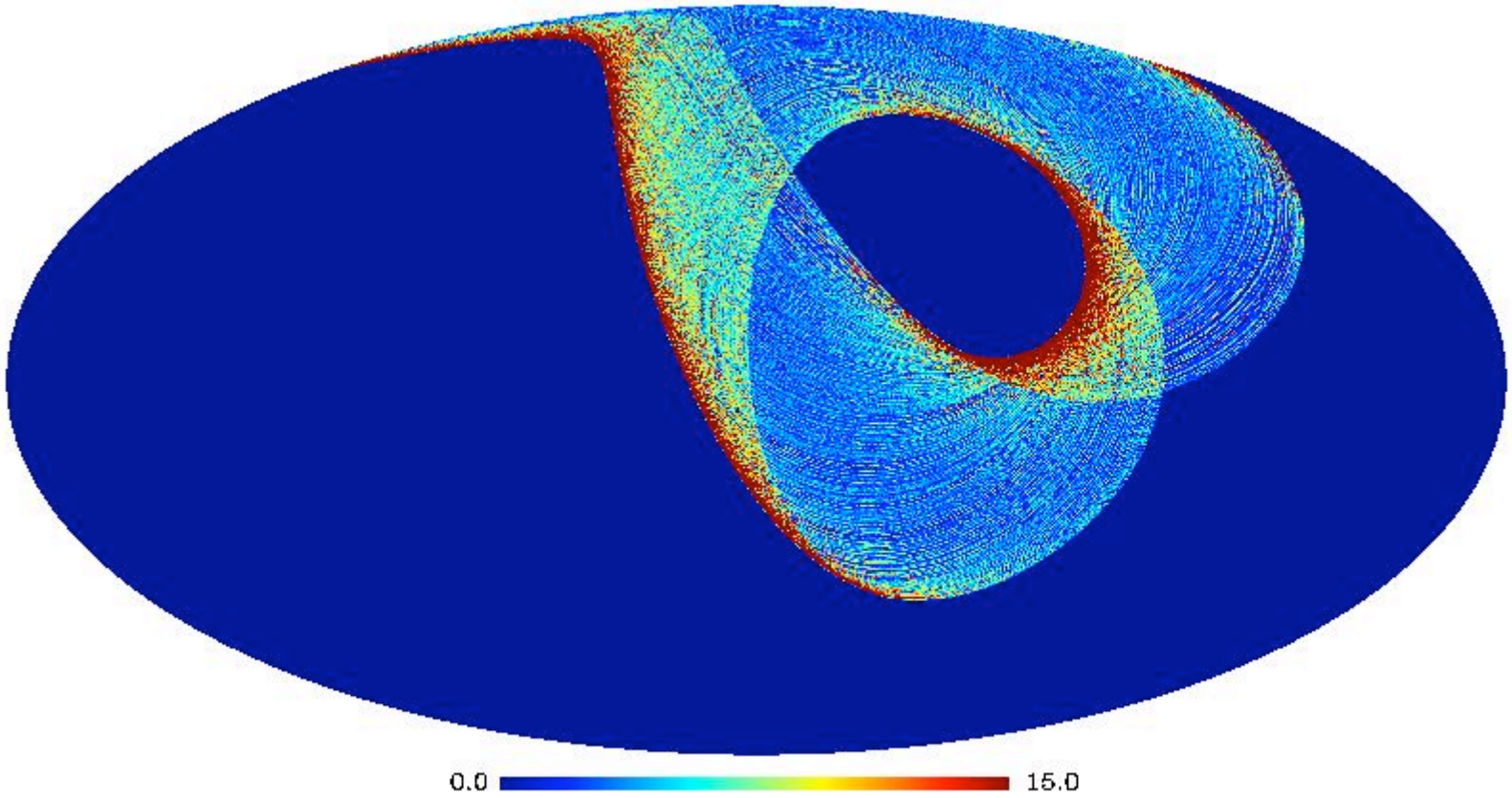
- altitude 35 km
- rotation speed: 2 rpm
- constant elevation : 41°
- flight during arctic night



12h data → 30 % of the sky



Sky coverage



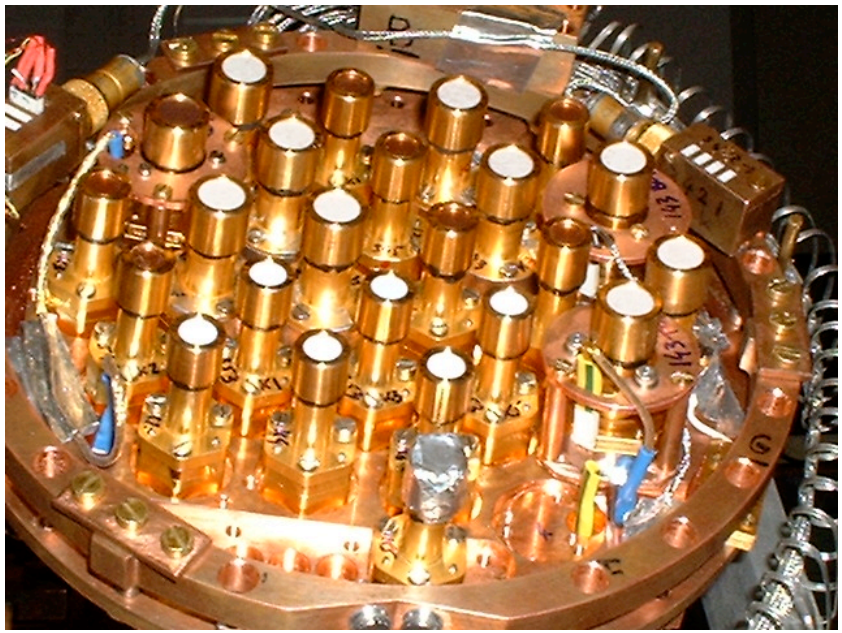
very inhomogeneous coverage

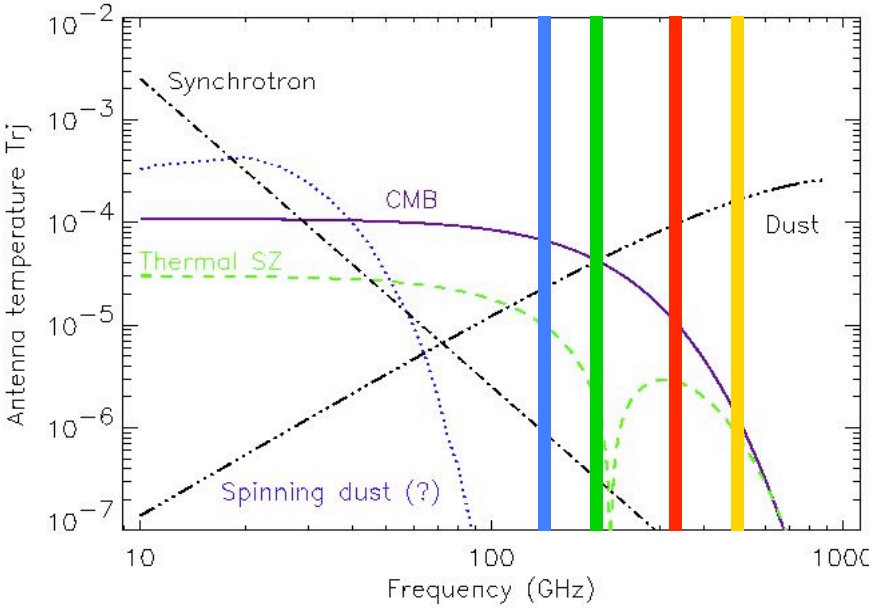
Focal Plane

Cryostat $^3He/^4He$ dilution

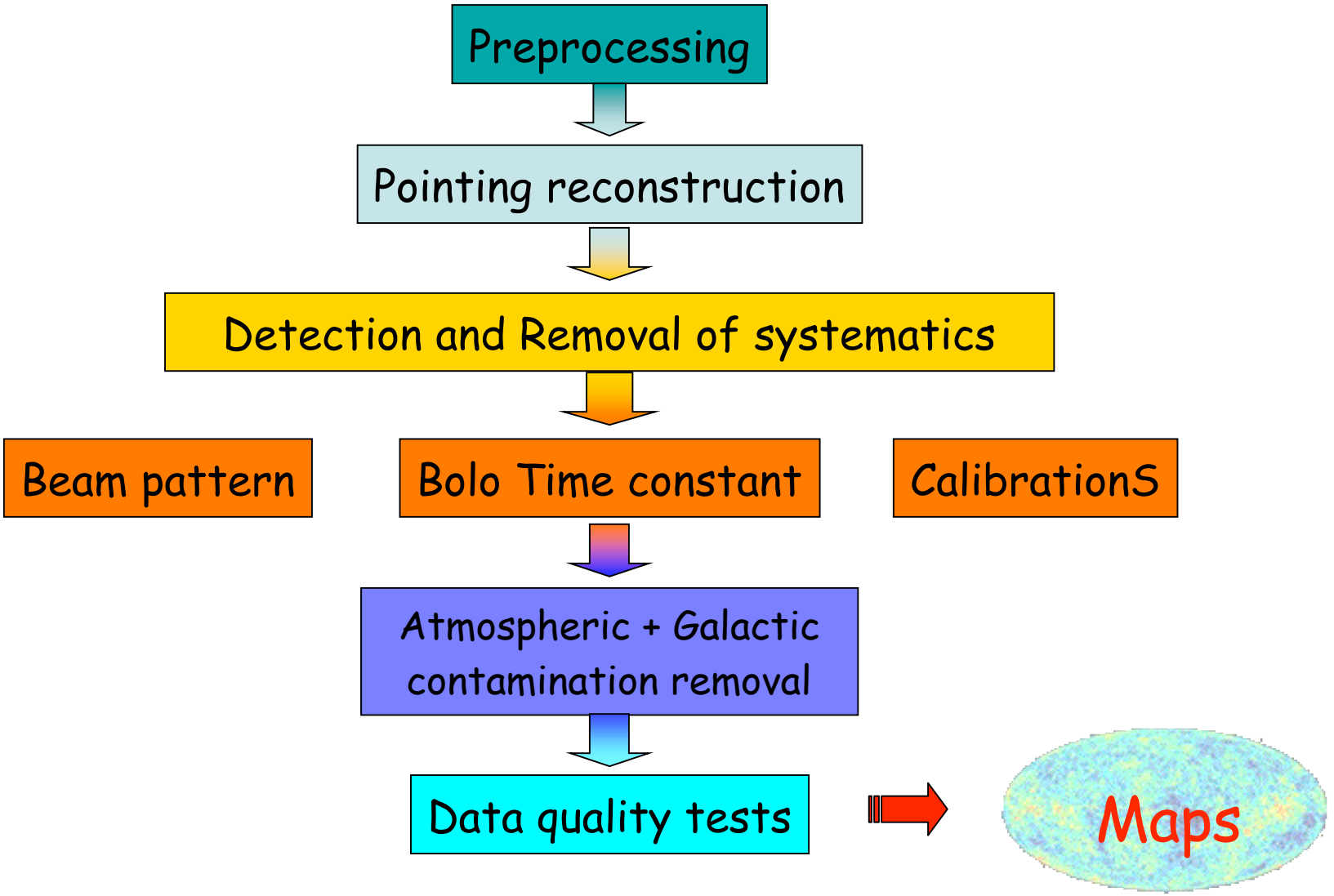
Spider web bolometers at 100 mK

6 at 143 GHz
8 at 217 GHz
6 at 353 GHz (polarized)
2 at 545 GHZ

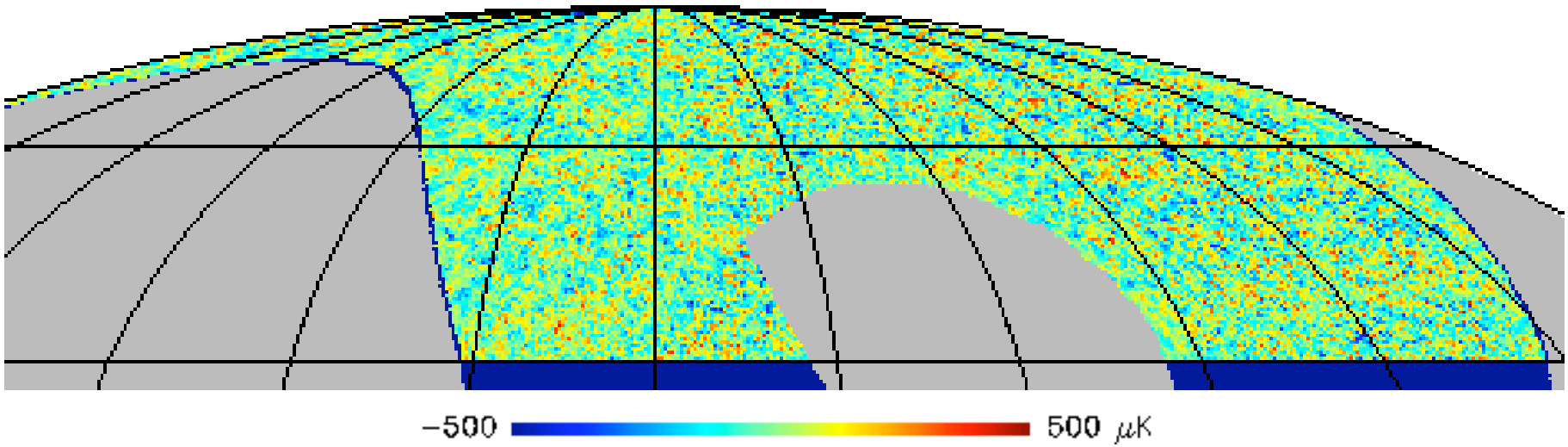




Data Processing



CMB map



30% of the sky covered

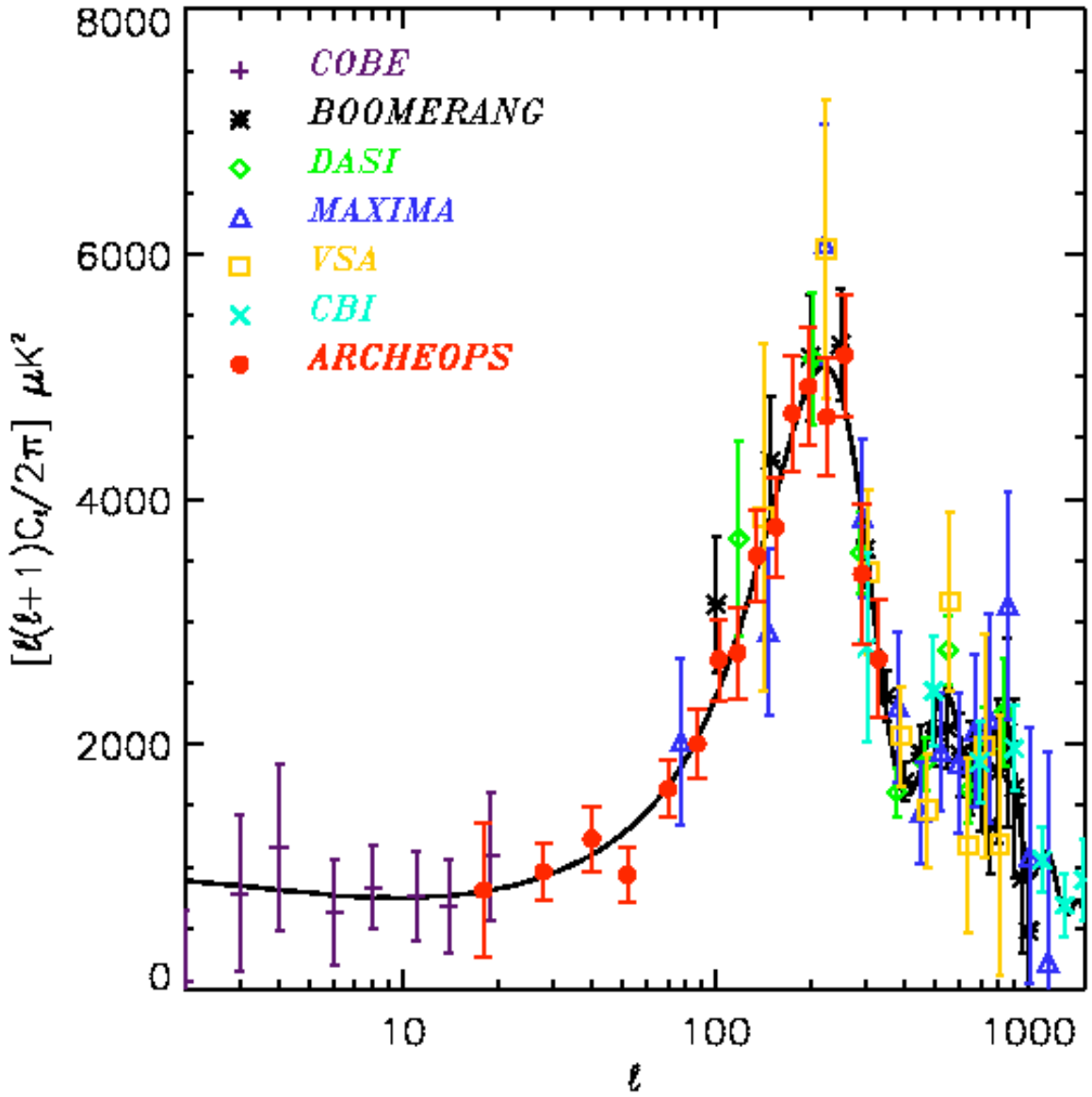
12.6% used for CMB (b>40°)

2 bolometers (143+217 GHz) (so far…)

8 millions of data points,

Sensitivity : ~ 90 μK.sec$^{1/2}$

CMB power spectrum



Oct 2002 :

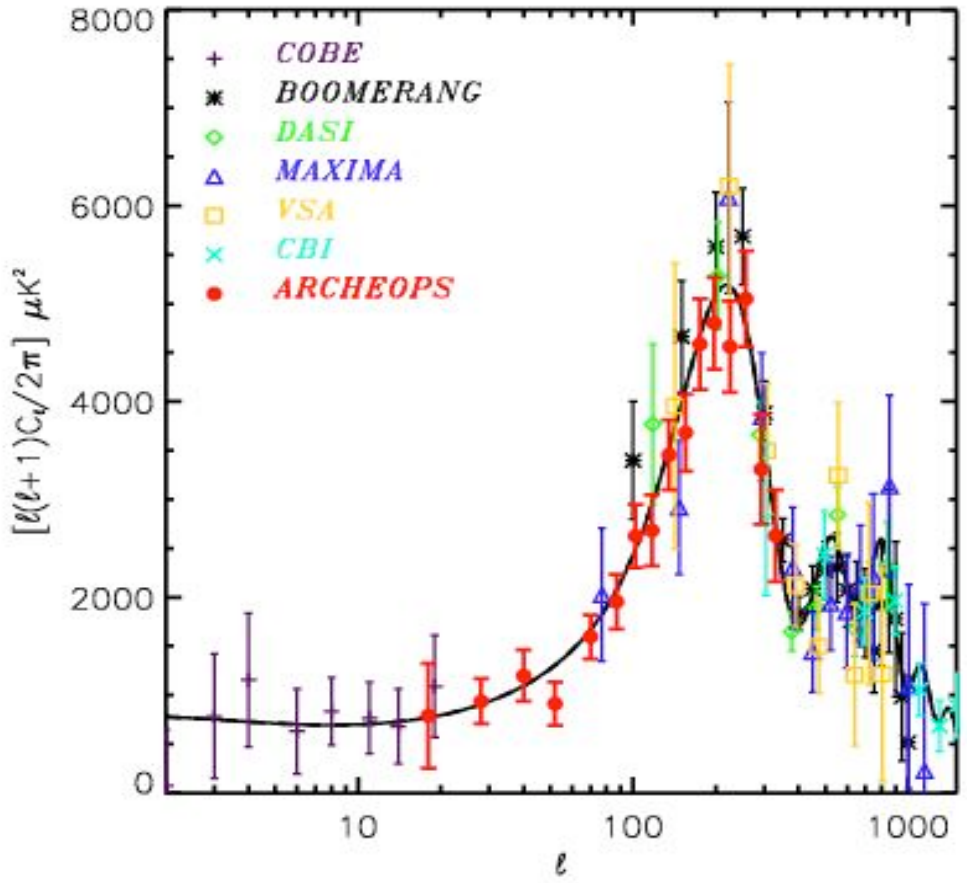
Benoit *et al* 2003, A&A, 399, L19

Before WMAP :

- *First link from COBE to the first peack*
- *Best sampling and smallest error bars on the 1st peak*

Comparison with cosmological Models

Oct 2002 : Benoit *et al* 2003, A&A, 399, L25

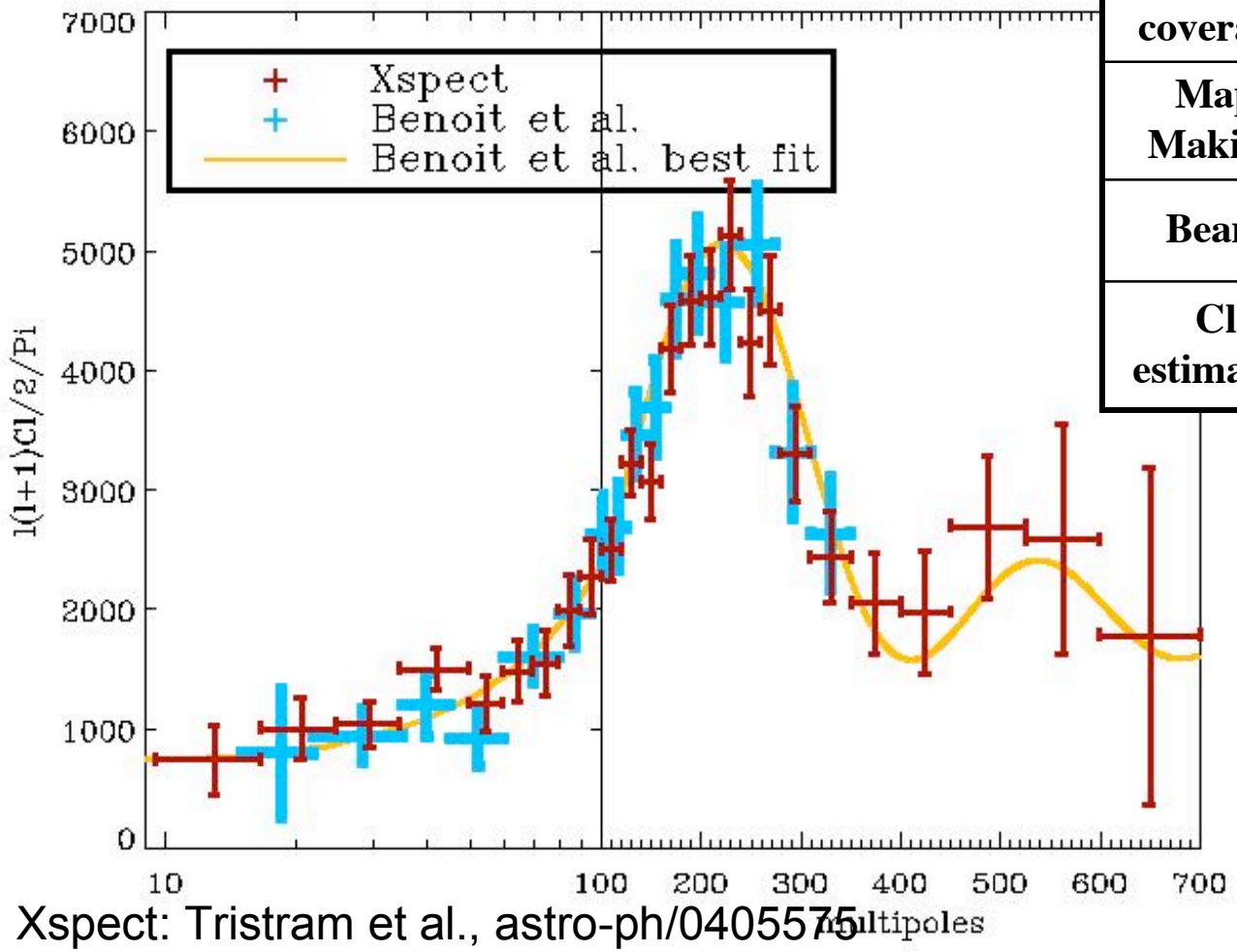


typical Λ-CDM

- $\Omega_{tot} = 1.00$
- $\Omega_{\Lambda} = 0.70$
- $\Omega_b h^2 = 0.020$
- $H_0 = 100h = 70$ km/s/Mpc
- $n = 1.00$
- $Q = 18\ \mu K$
- $\tau = 0$

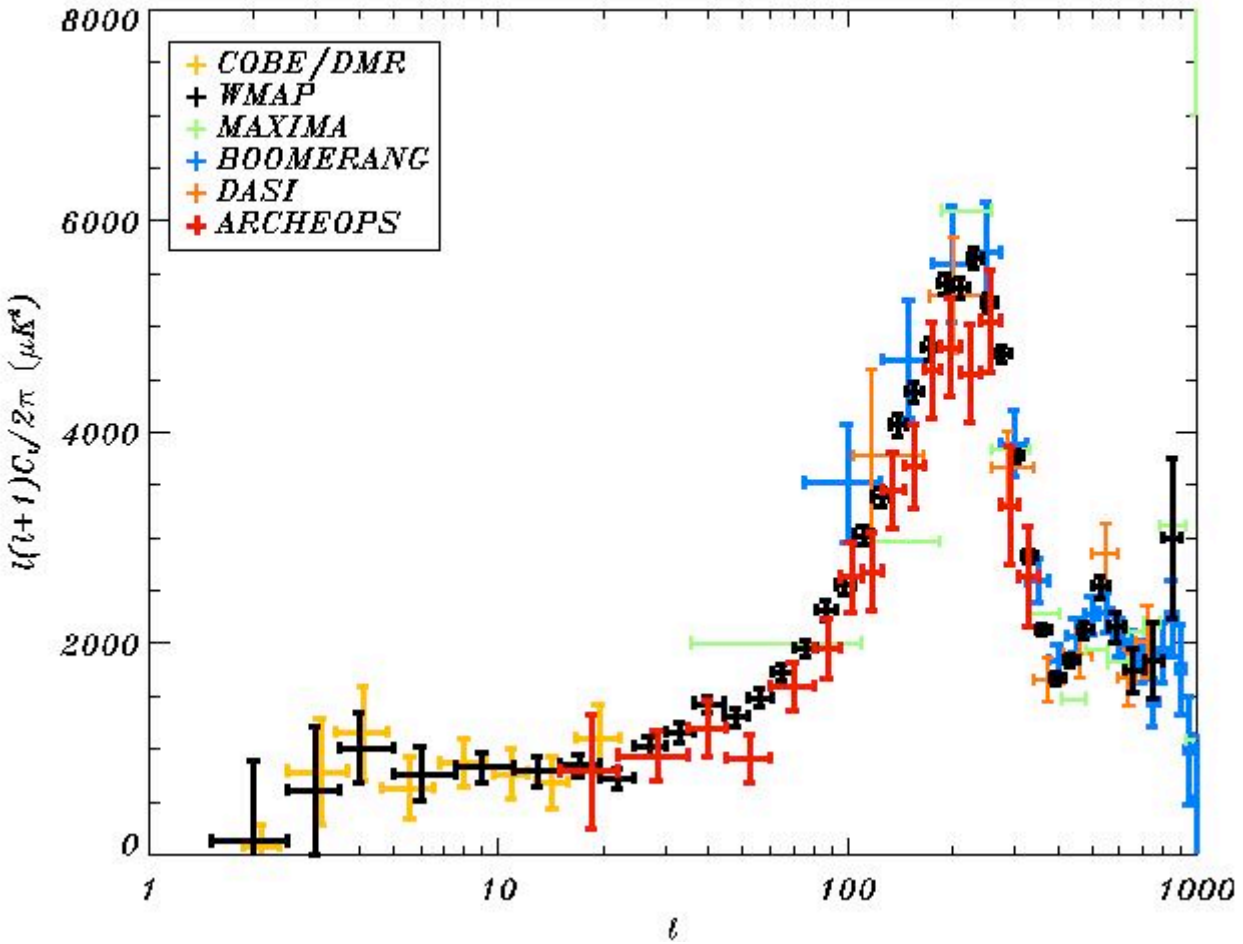
Using More bolometers and different methods

nb of bolo	2	6
sky coverage	12.6%	19.9%
Map Making	simple	MIRAGE
Beam	ellipticity	Asymfast
Cl estimator	MASTER	Xspect SMICA



Xspect: Tristram et al., astro-ph/0405575
SMICA: Patanchon et al., astro-ph/0311305

Archeops vs WMAP

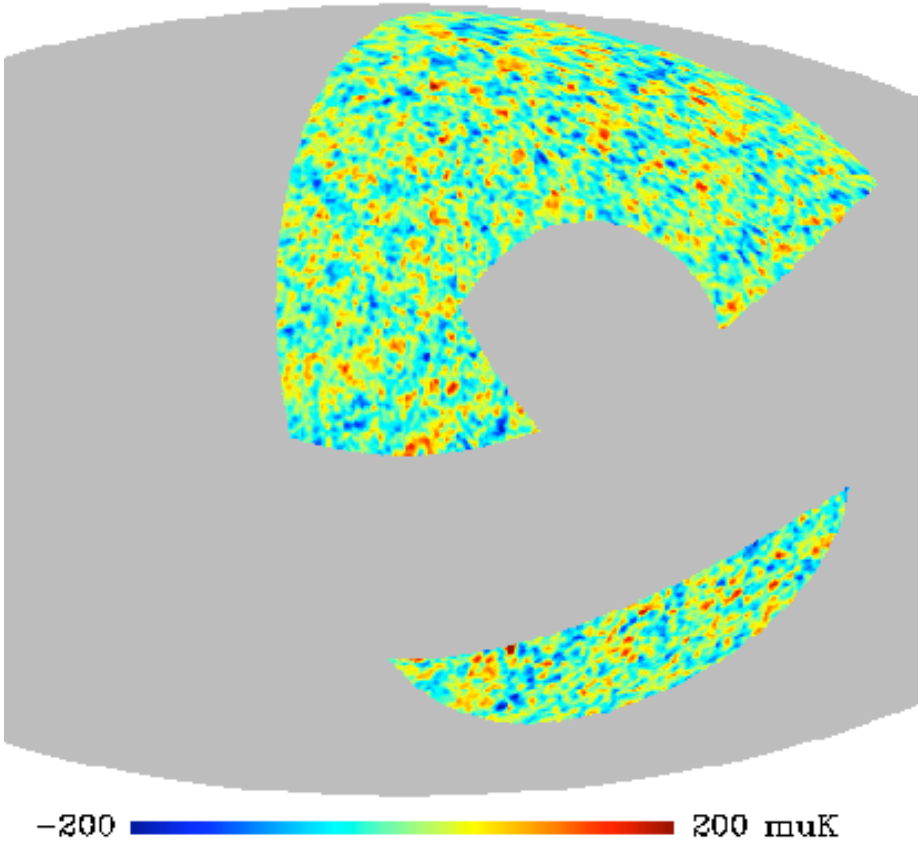


Similar C_l

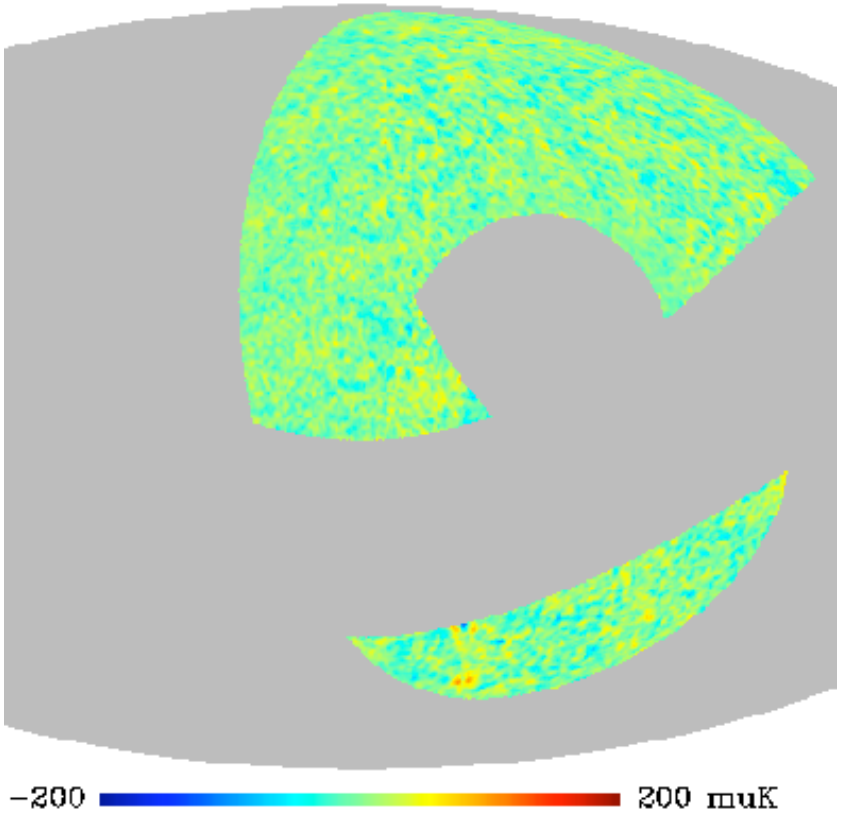
(but some absolute calibration uncertainty remains)

Archeops vs WMAP

(Archeops + WMAP)/2



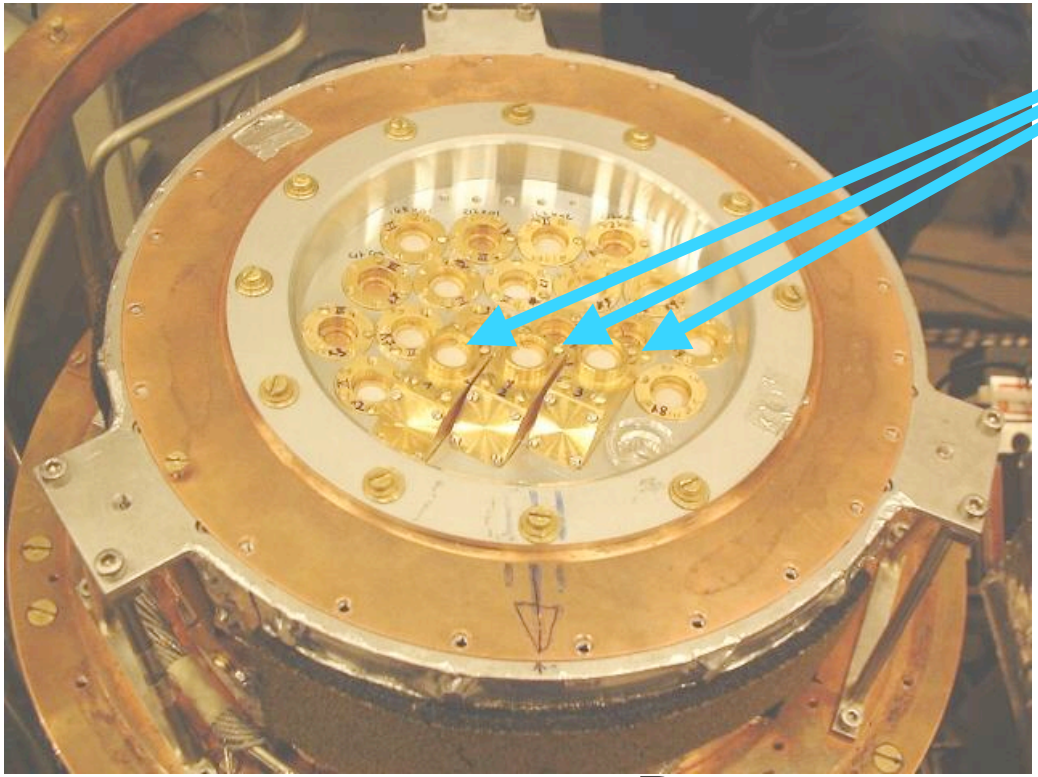
(Archeops - WMAP)/2

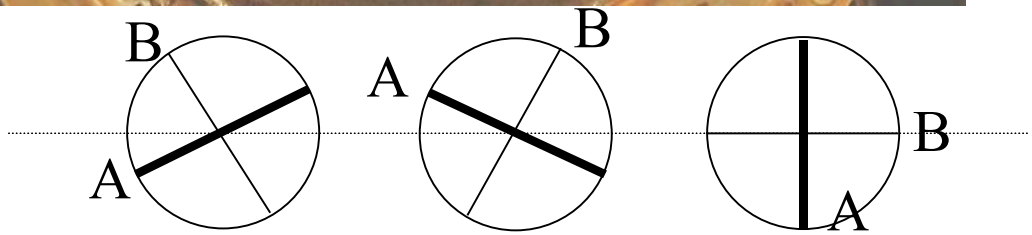


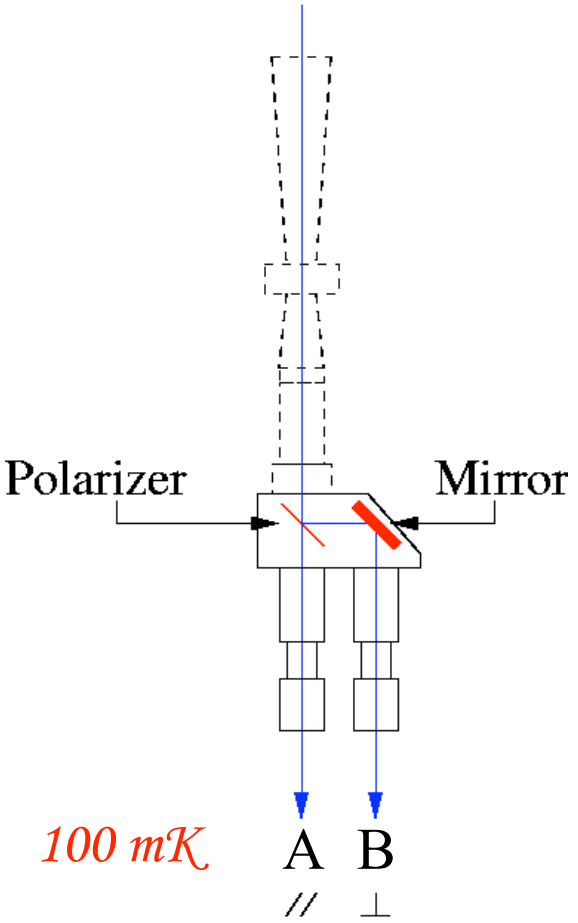
Same Sky !

Polarization

353 GHz (6 = 3 OMT pairs)







I,Q,U determination

Time Ordered Measurements : $\mathbf{M}$

Sky Stokes parameters : $\mathbf{S} = (I, Q, U)$

Pointing matrix (pixel + polarizers angles) : $\mathcal{A}$

Noise covariance matrix : $\mathcal{N}$

$$\mathbf{M} = \mathcal{A}\mathbf{S} + \mathbf{N}$$

Minimum χ^2 solution :

$$\mathbf{S} = (\mathcal{A}^T \mathcal{N}^{-1} \mathcal{A})^{-1} \mathcal{A}^T \mathcal{N}^{-1} \mathbf{M}$$

(3, 3) Matrix *(3) Vector*

Noise is white on a few degree scale.

Each pixel is solved for I, Q, U individually

Polarization of individual MCs

	$\mathcal{P}$ (%)	θ (deg)
1	12.1 ± 1.8	59 ± 4.6
2	22.3 ± 3.3	78 ± 3.7
3	7.5 ± 0.9	46 ± 3.5
4	23.3 ± 6.5	175 ± 7.4
5	12.3 ± 2.9	87 ± 6.6
6	16.3 ± 1.8	89 ± 3.2

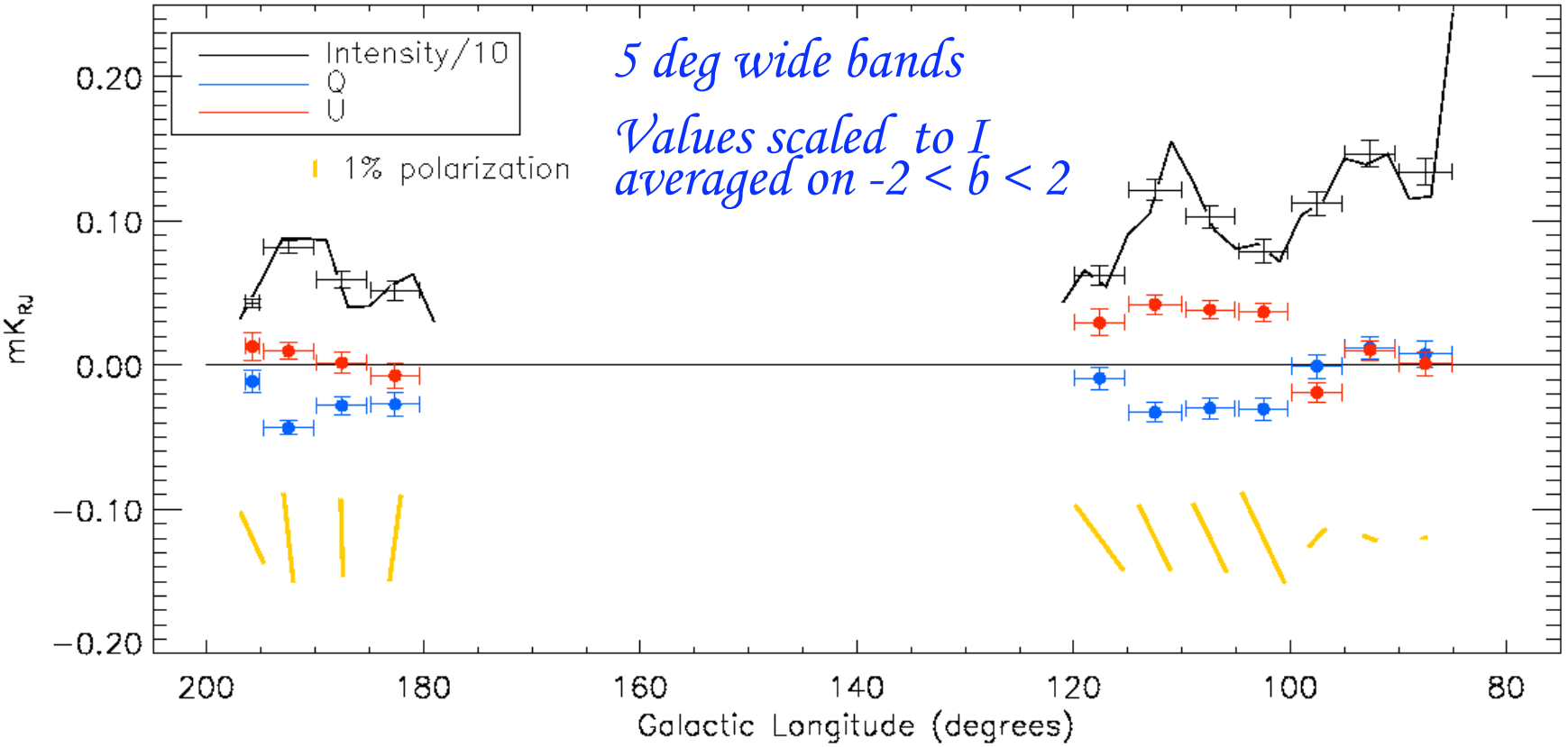
Benoît *et al*, astro-ph/0306222

7	11.0 ± 1.1	87 ± 3.2

Taurus complex

8	5.2 ± 3.2	101± 13.8
9	7.3 ± 2.7	133 ± 11.7
10	< 2.4	23 ± 14.5

Polarization of diffuse emission



Orientation mainly orthogonal to the Galactic plane

P about 3-5% in average

No polarization in Cygnus

Interpretation

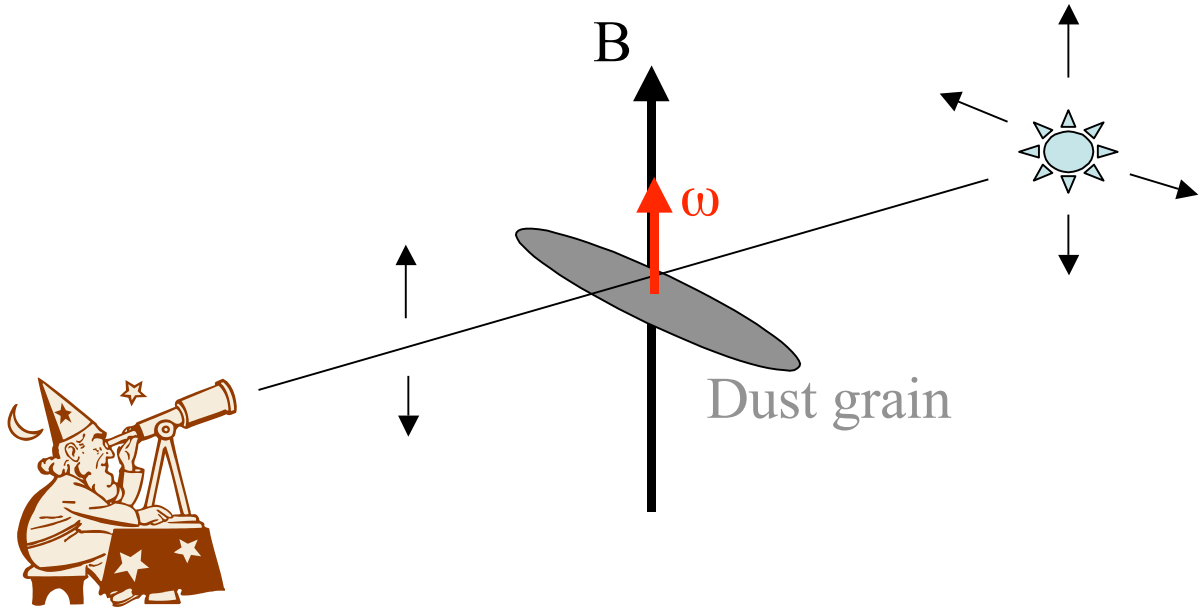
1. Dust grains are elongated

They absorb optical light better along their long axis

They emit in the direction of their long axis

2. They are aligned by the Galactic magnetic field

Optical starlight polarization is orthogonal to the grains' major axis



Interpretation

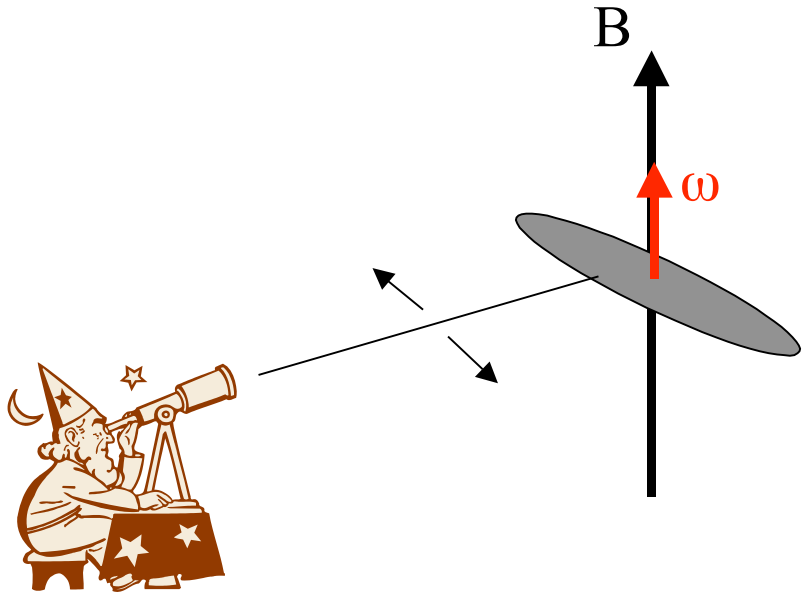
1. Dust grains are elongated

They absorb optical light better along their long axis

They emit in the direction of their long axis

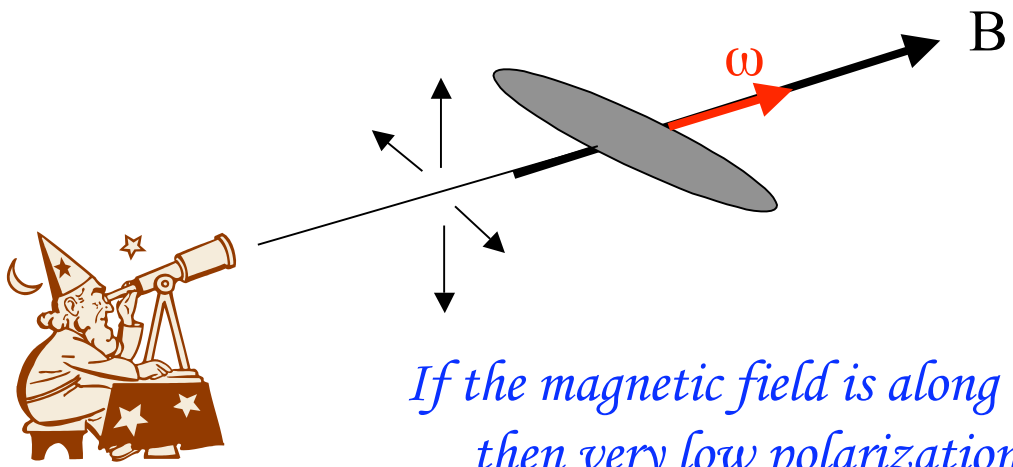
2. They are aligned by the Galactic magnetic field

Submm emission is along the grains' major axis



Polarized emission should be orthogonal to polarized absorption

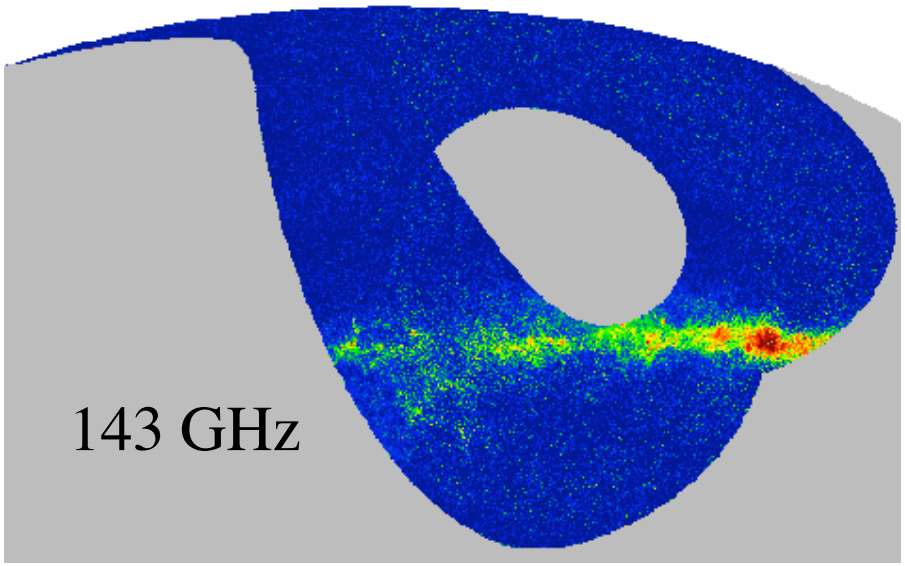
Interpretation

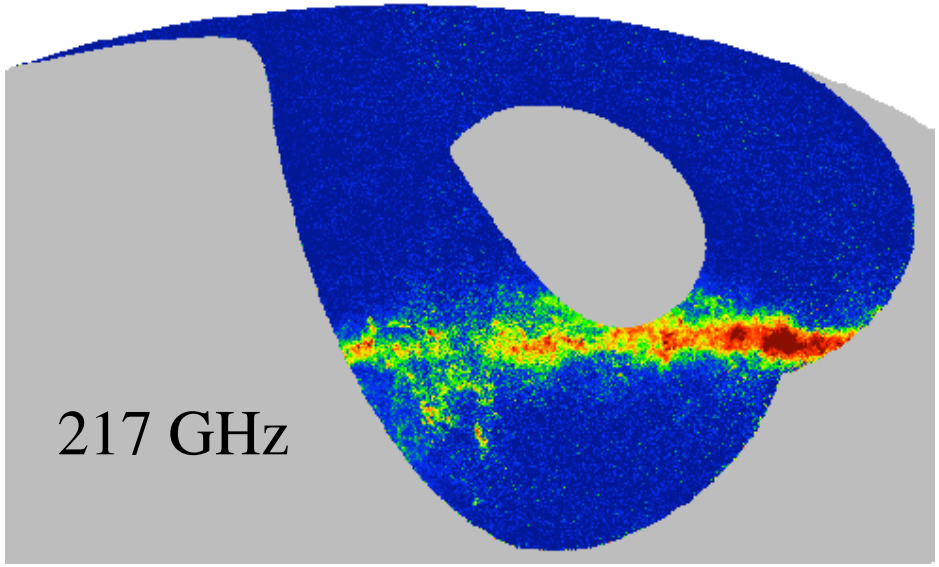


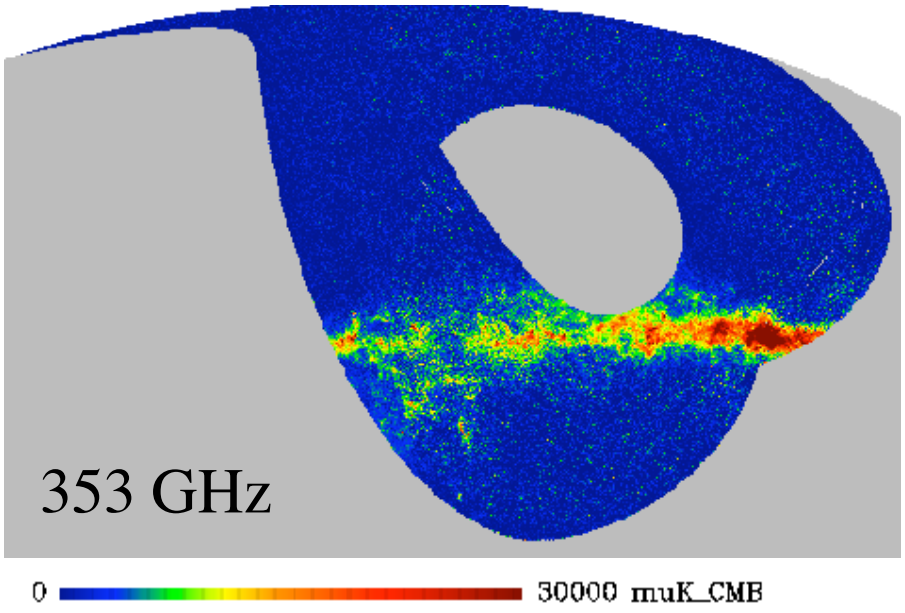
If the magnetic field is along the line of sight, then very low polarization is expected .

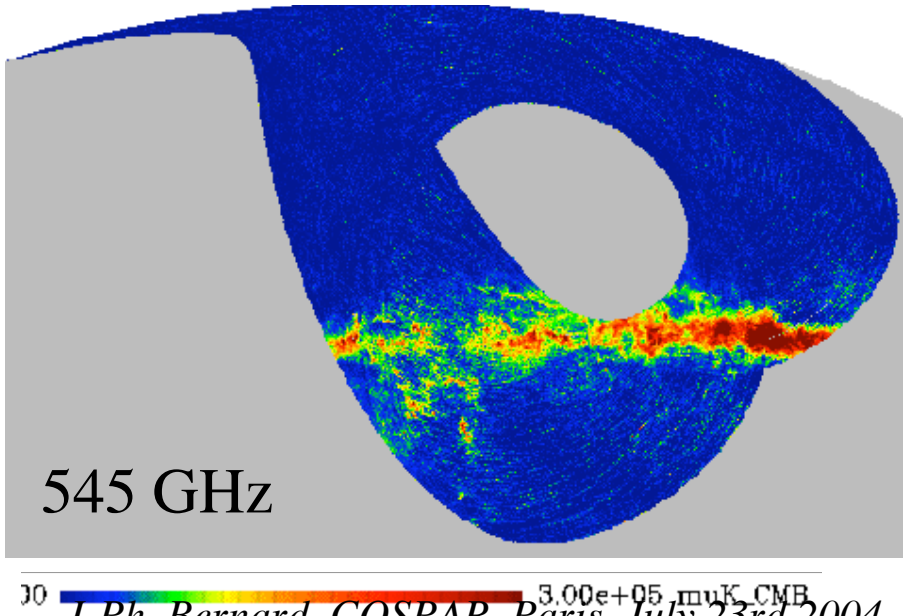
The Galactic magnetic field is locally along the line of sight when we look at Cygnus !

Archeops Galactic maps

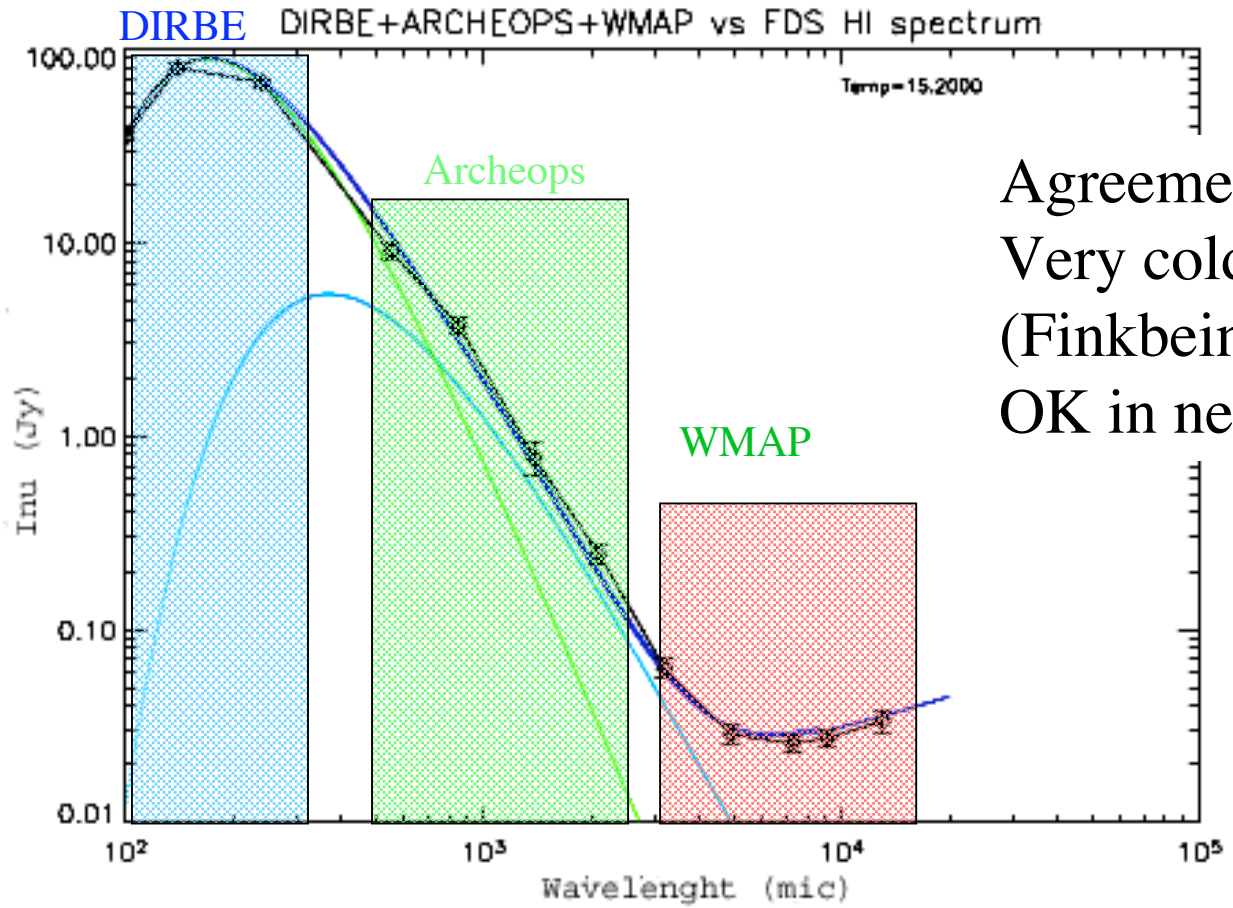






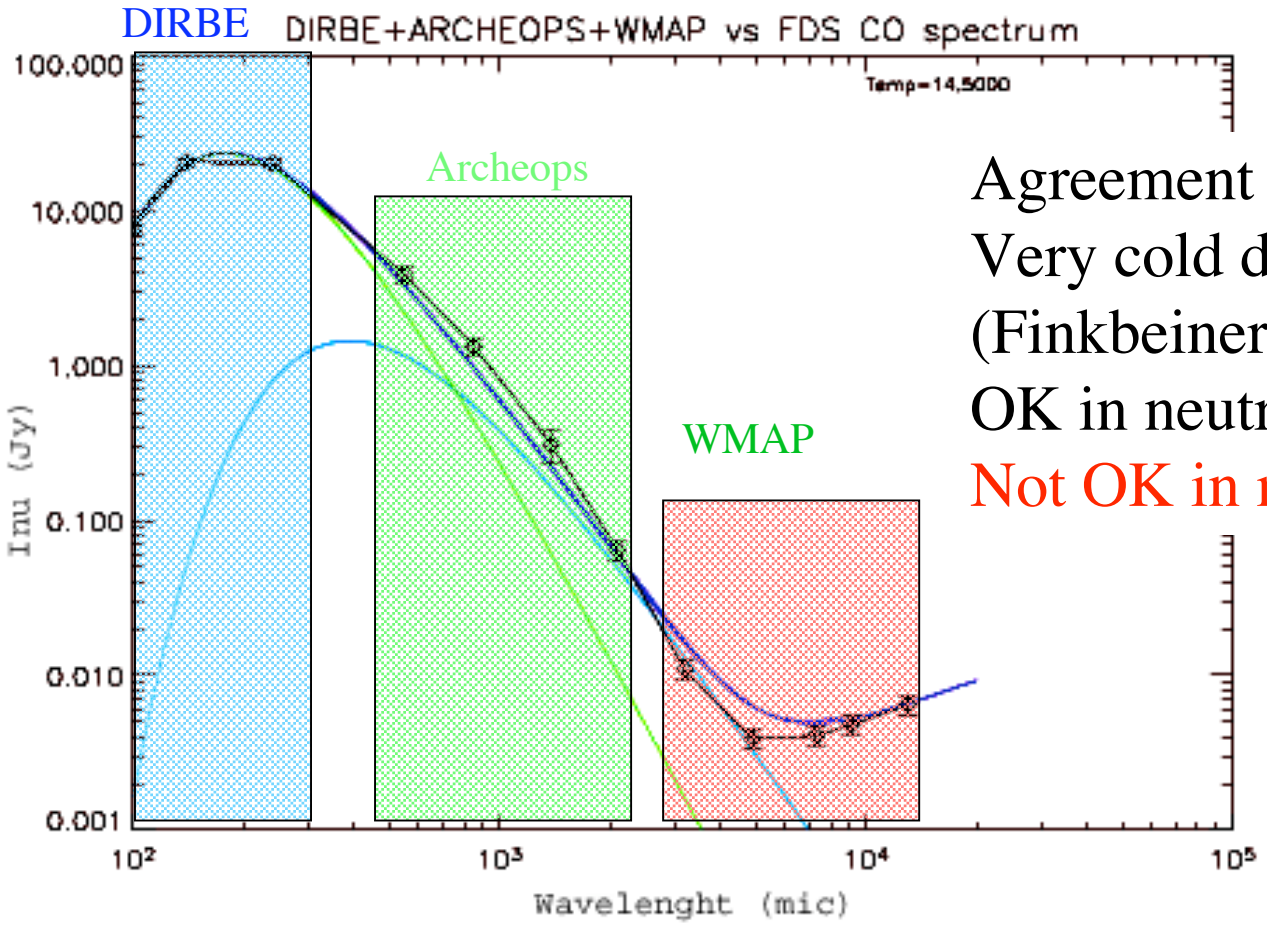


Dust spectrum in Neutral ISM



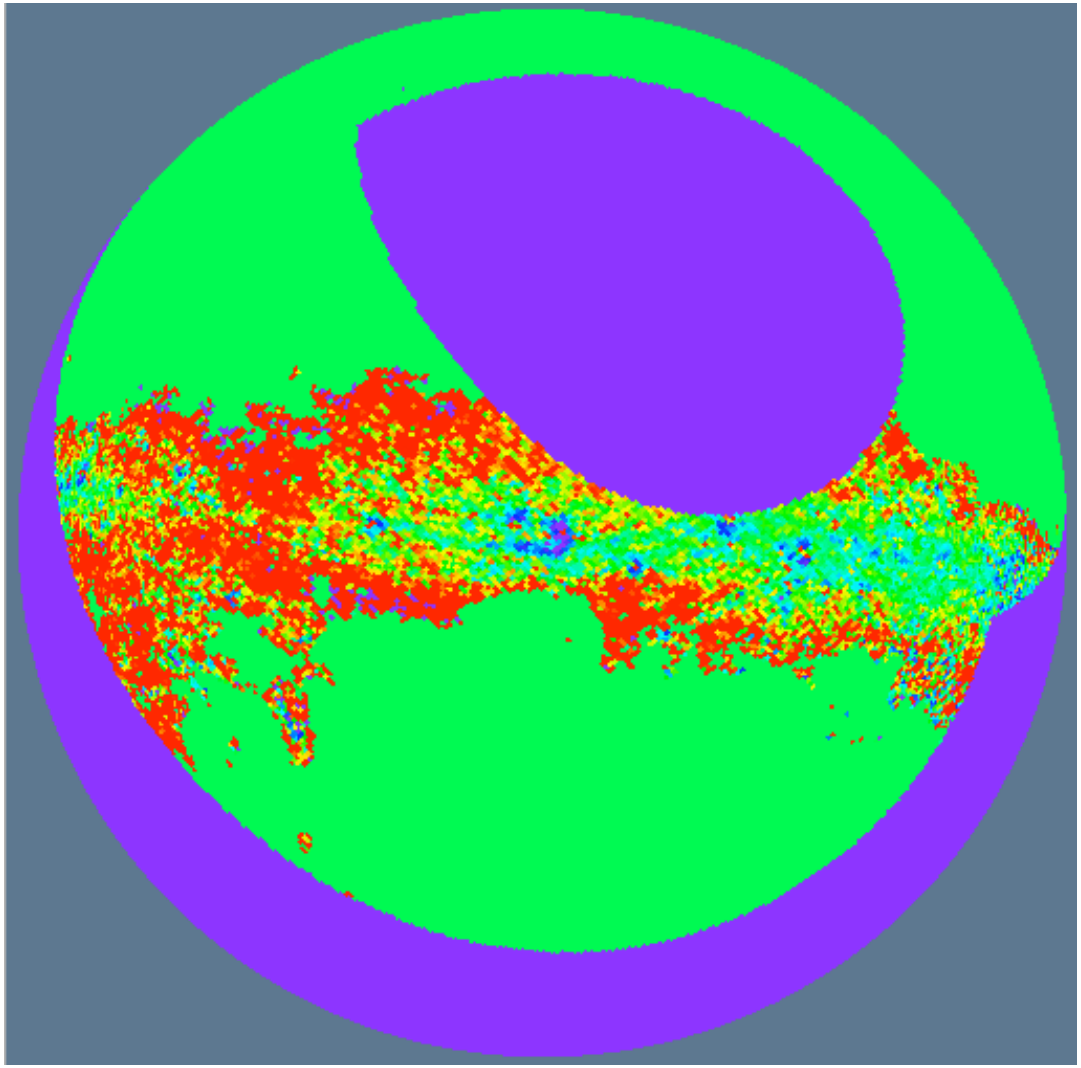
Agreement with Warm +
Very cold dust models
(Finkbeiner, Schlegel, Davies 99)
OK in neutral ISM

Dust spectrum in Molecular ISM



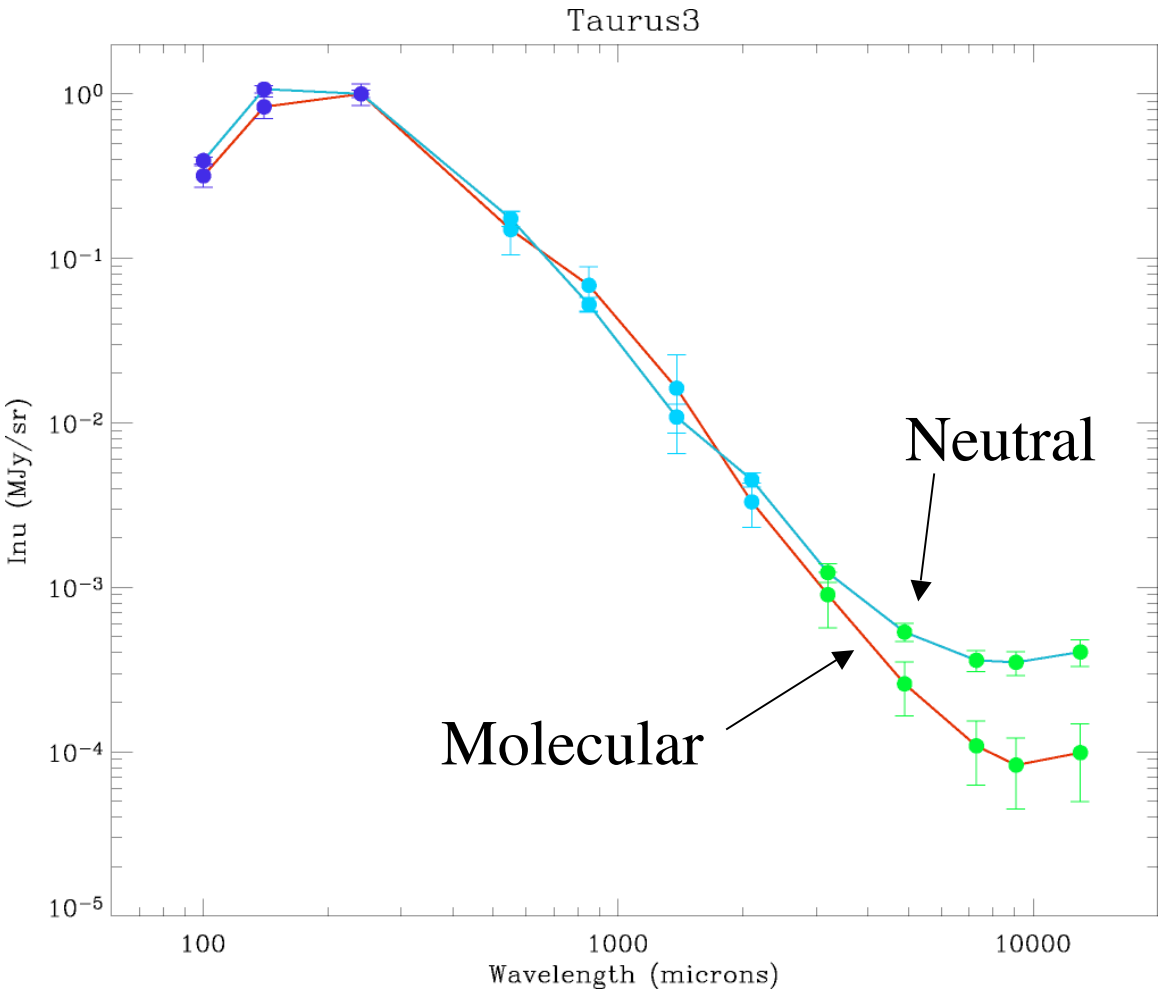
Agreement with Warm +
Very cold dust models
(Finkbeiner, Schlegel, Davies 99)
OK in neutral ISM
Not OK in molecular ISM

Dust spectrum in Molecular ISM



217 GHz excess map with respect to FSD Model

Dust spectrum in Molecular ISM



Dust emission can be evidenced up to λ=7mm in some molecular clouds.

Conclusions

- Archeops has allowed to map a large fraction of the sky (30%) in the submm-mm at 10'-12' resolution.
- Archeops has allowed the most precise pre-WMAP determination of CMB fluctuations in the range $20 < \ell < 300$
- Archeops has allowed the first large scale measurement of dust emission polarization along the Galactic Plane. Polarization results are consistent with the known magnetic structure of our Galaxy
- Unexpectedly high polarization levels are found in several isolated MCs Diffuse polarisation levels indicate intrinsic levels well above 5%
- Analysis of the submm-mm dust emission is now possible towards the different phases of the ISM
- Archeops has provided a representative preview of Planck observations

The End