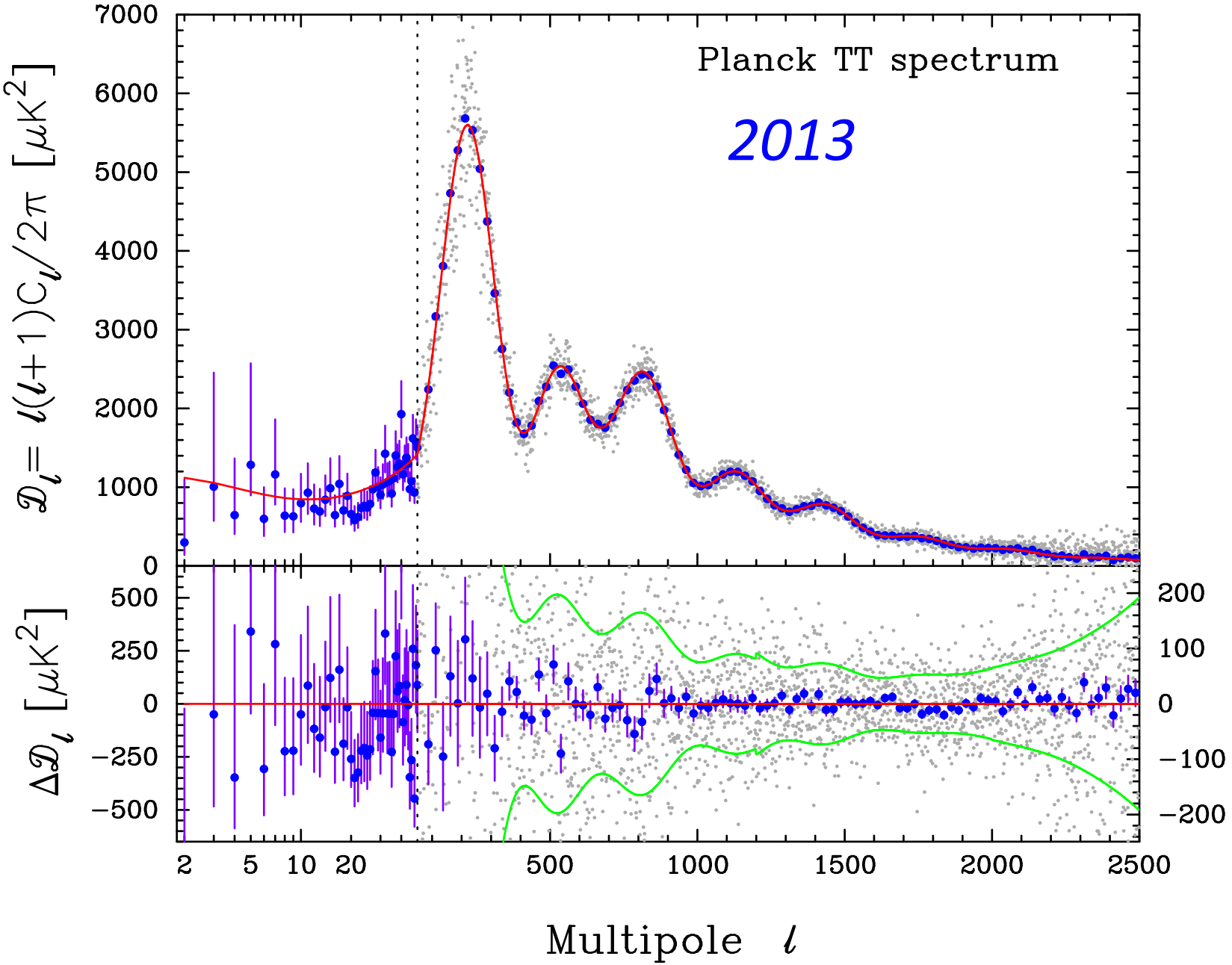
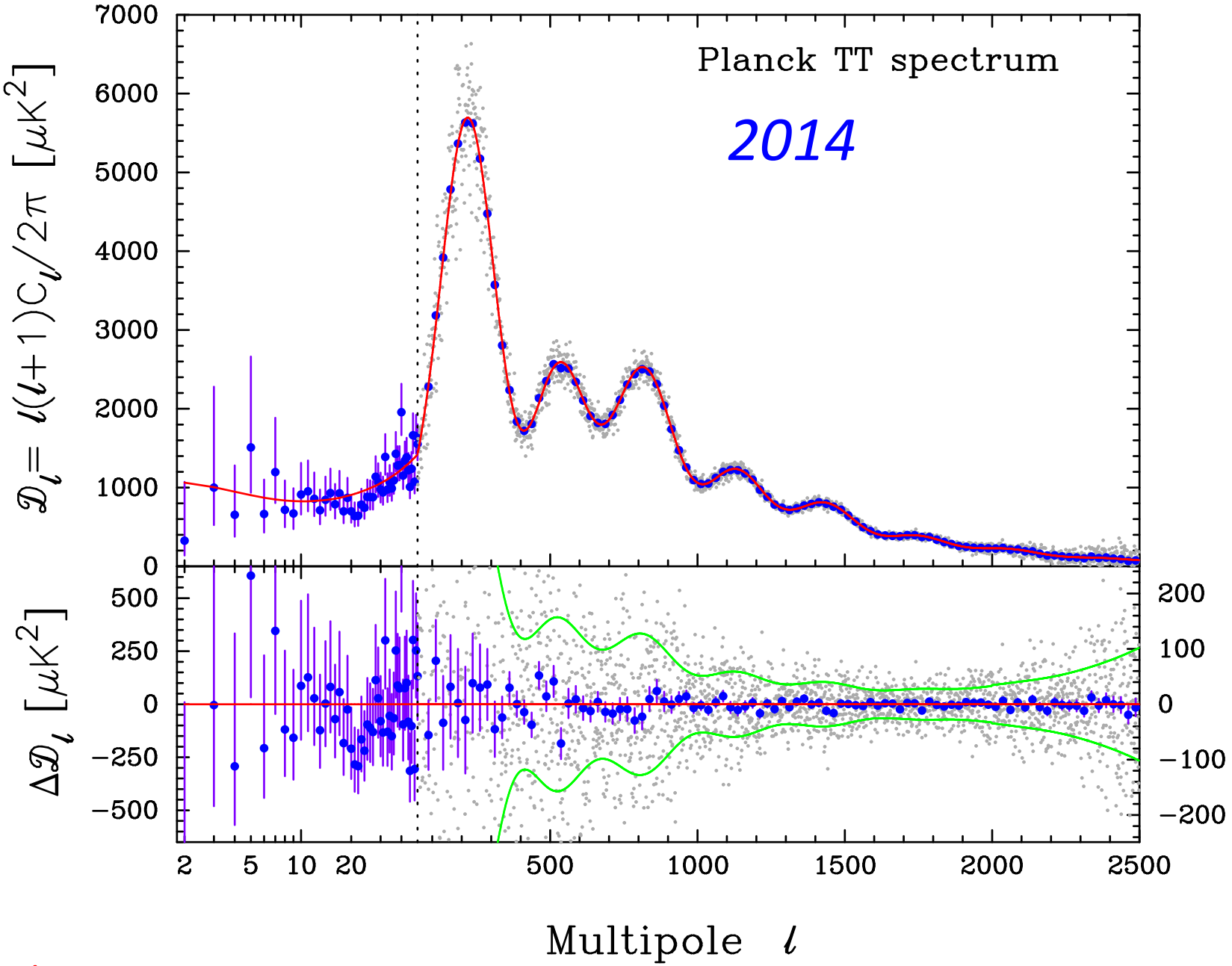
Planck 2015 results. XIII. Cosmological parameters

Jean-Baptiste Melin

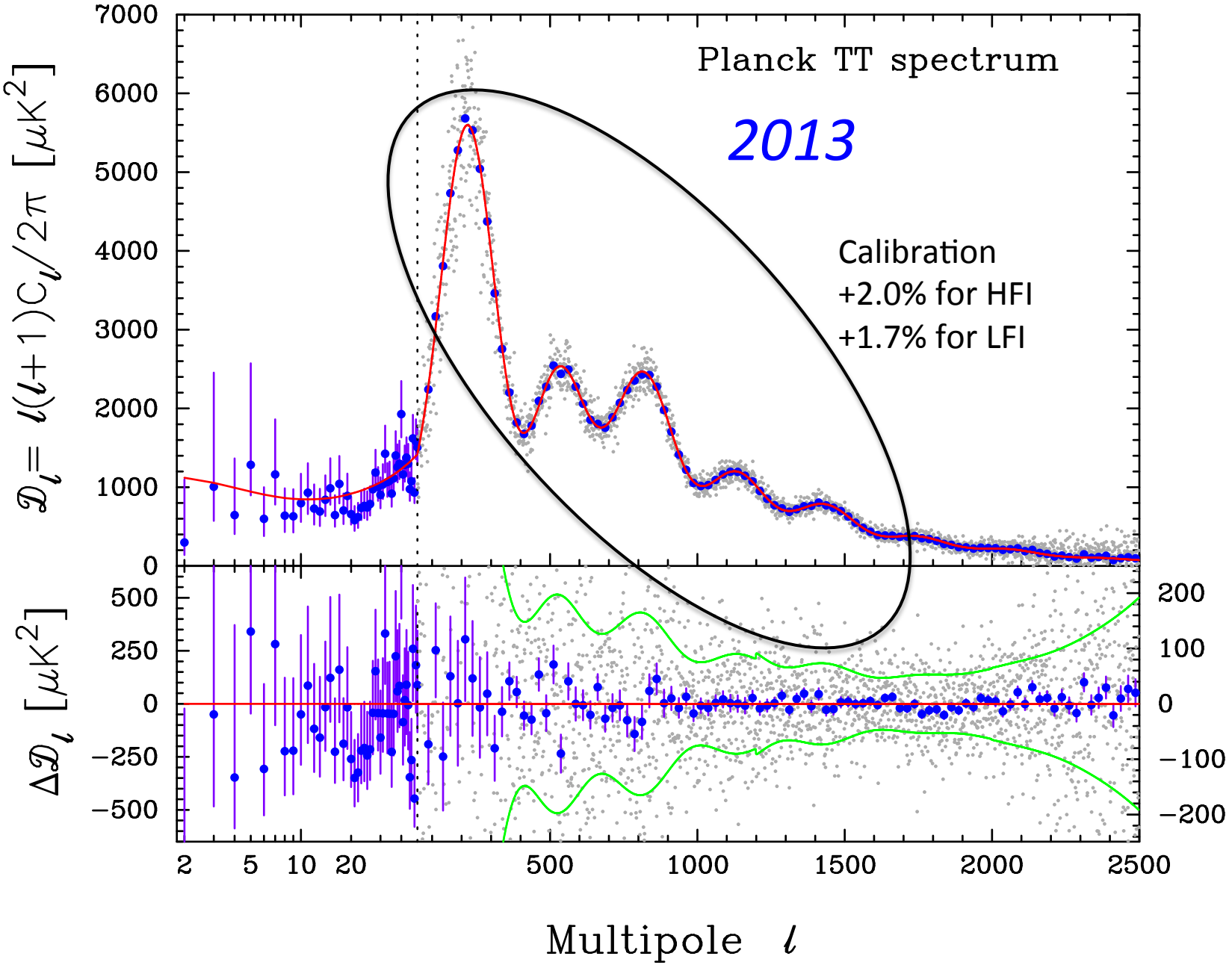
March 3, 2015


Planck TT spectrum
2013
$\mathcal{D}_l = l(l+1)C_l/2\pi\ [\mu K^2]$
$\Delta\mathcal{D}_l\ [\mu K^2]$
Multipole l
7000
6000
5000
4000
3000
2000
1000
0
500
250
0
−250
−500
200
100
0
−100
−200
2
5
10
20
500
1000
1500
2000
2500

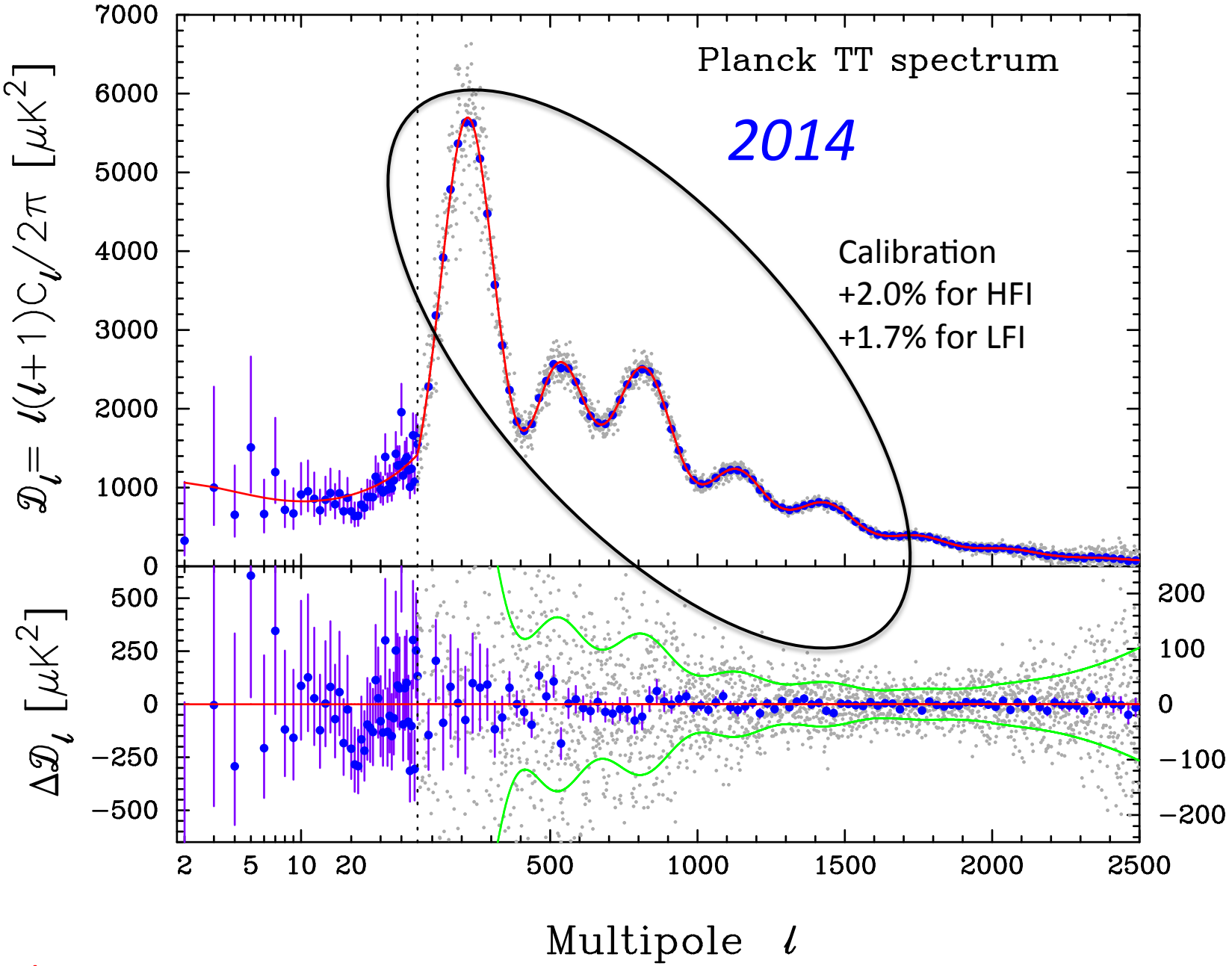


preliminary

Efstathiou @ Ferrara Dec 1, 2014



Efstathiou @ Ferrara Dec 1, 2014



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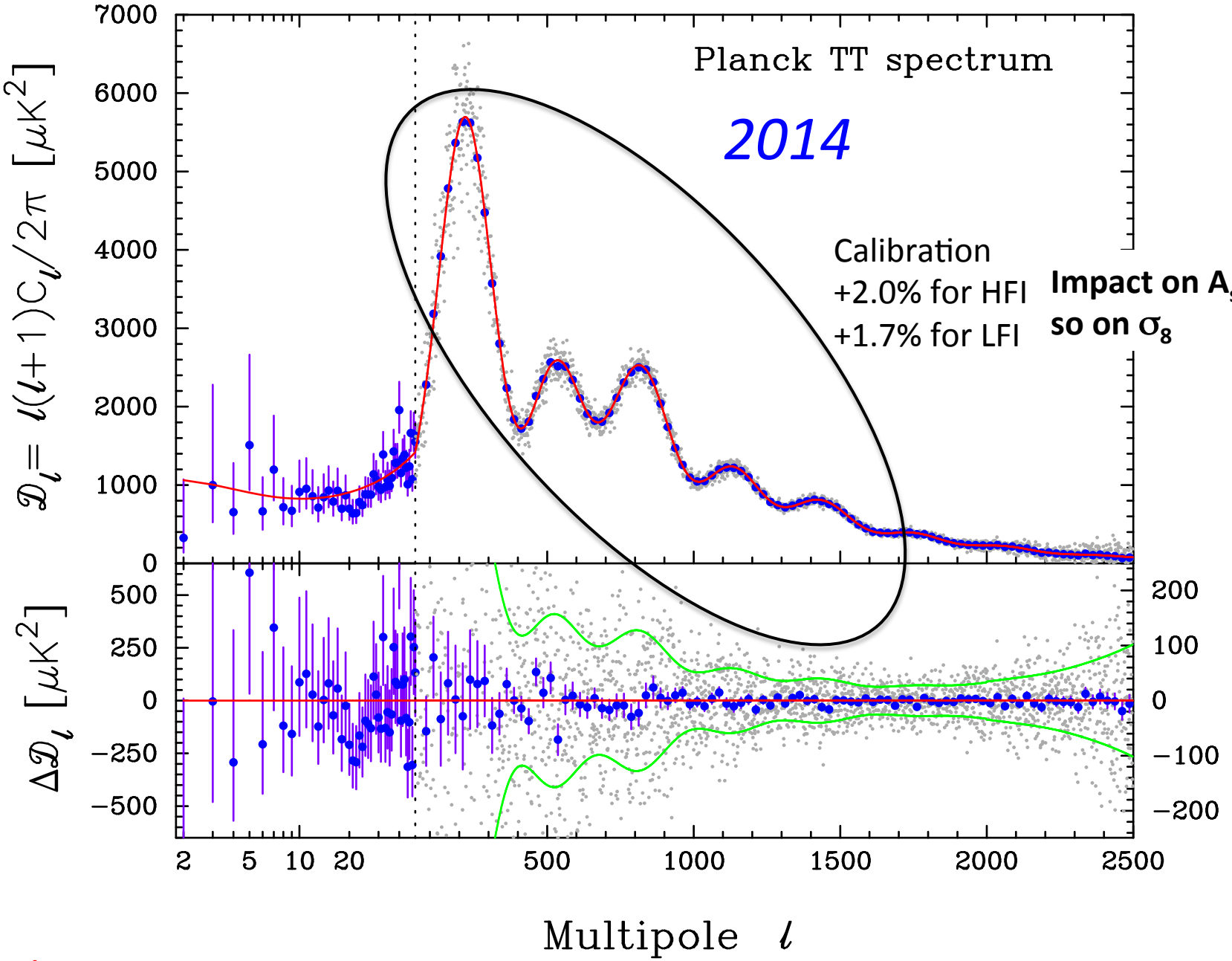
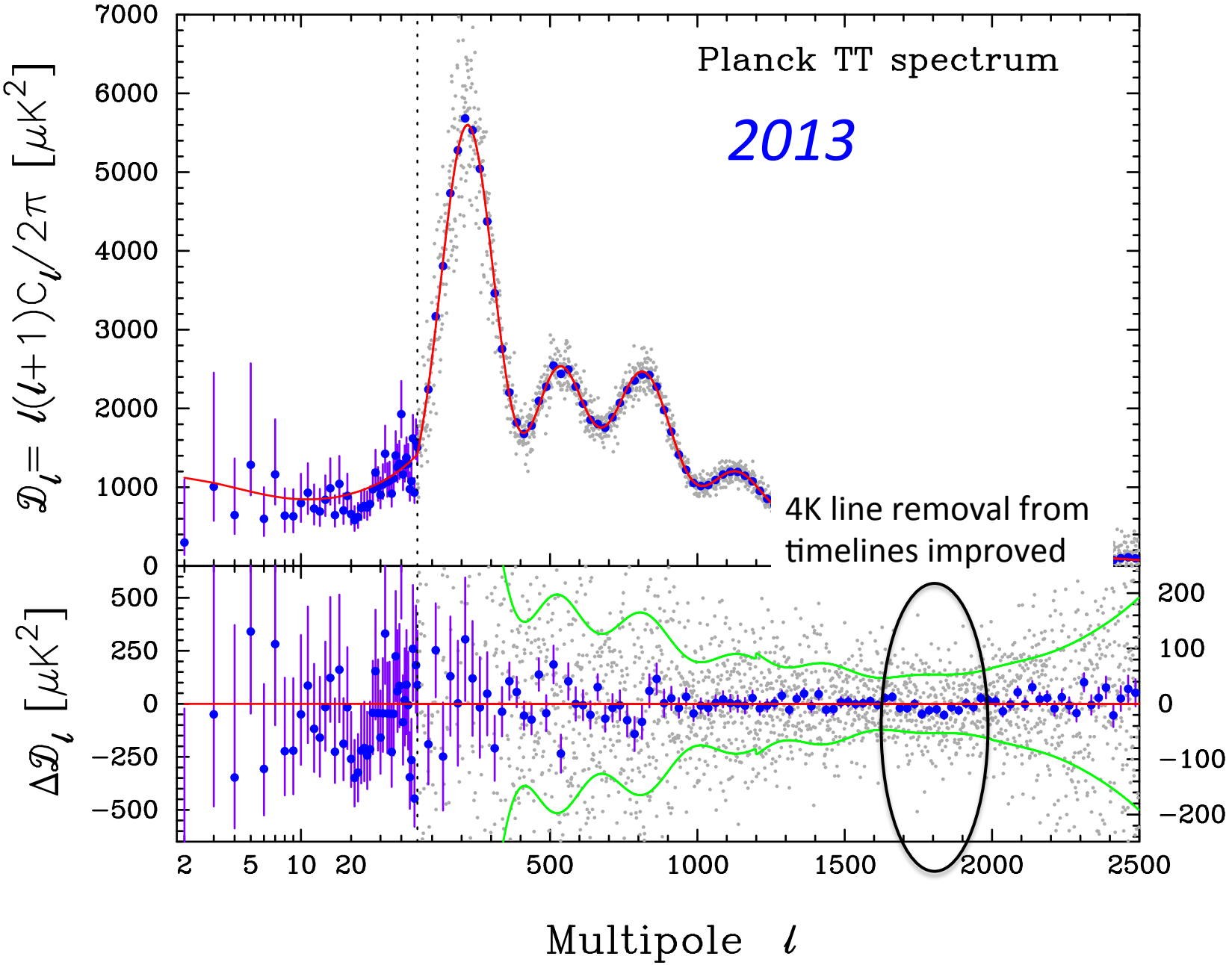
Efstathiou @ Ferrara Dec 1, 2014

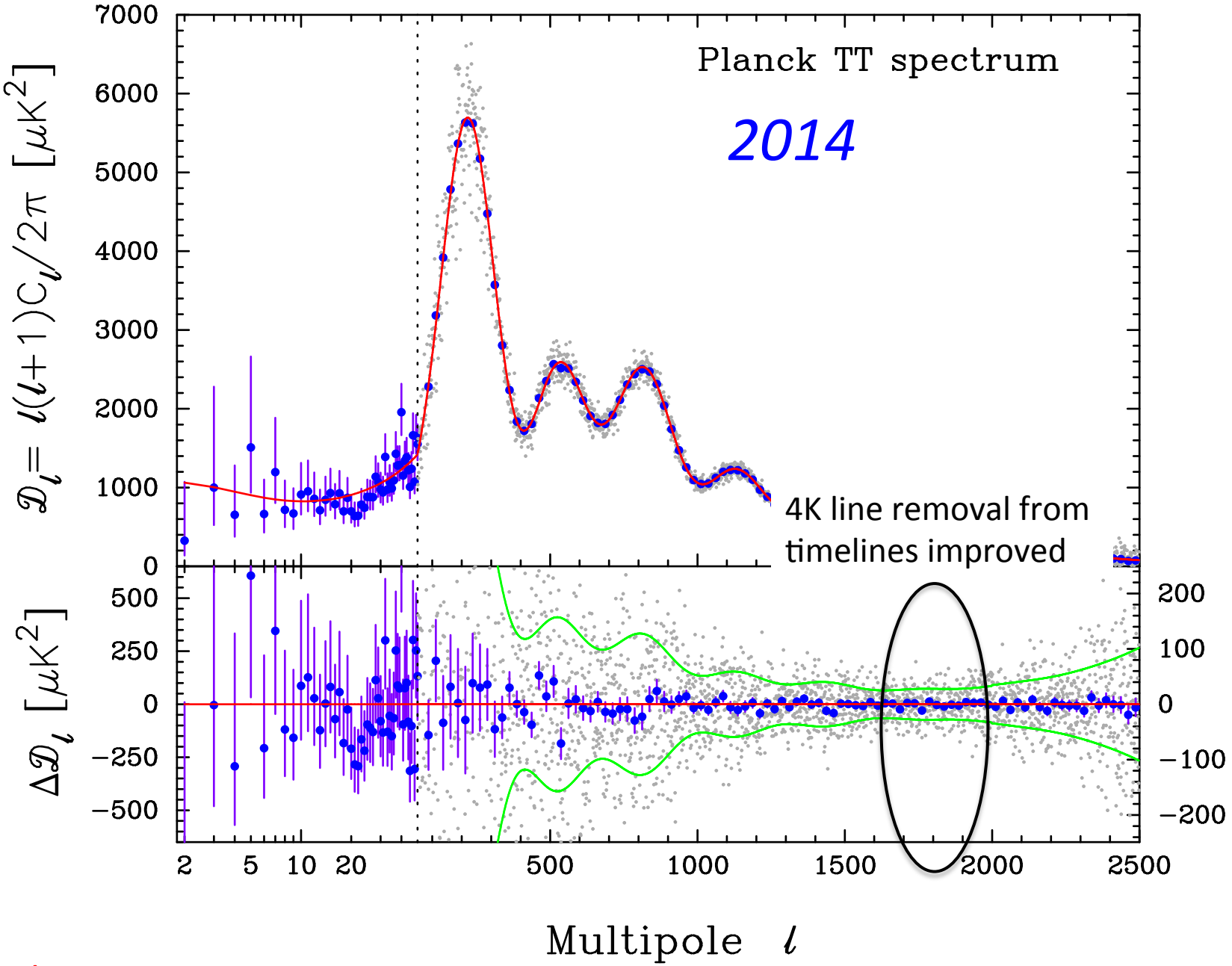


preliminary

Efstathiou @ Ferrara Dec 1, 2014

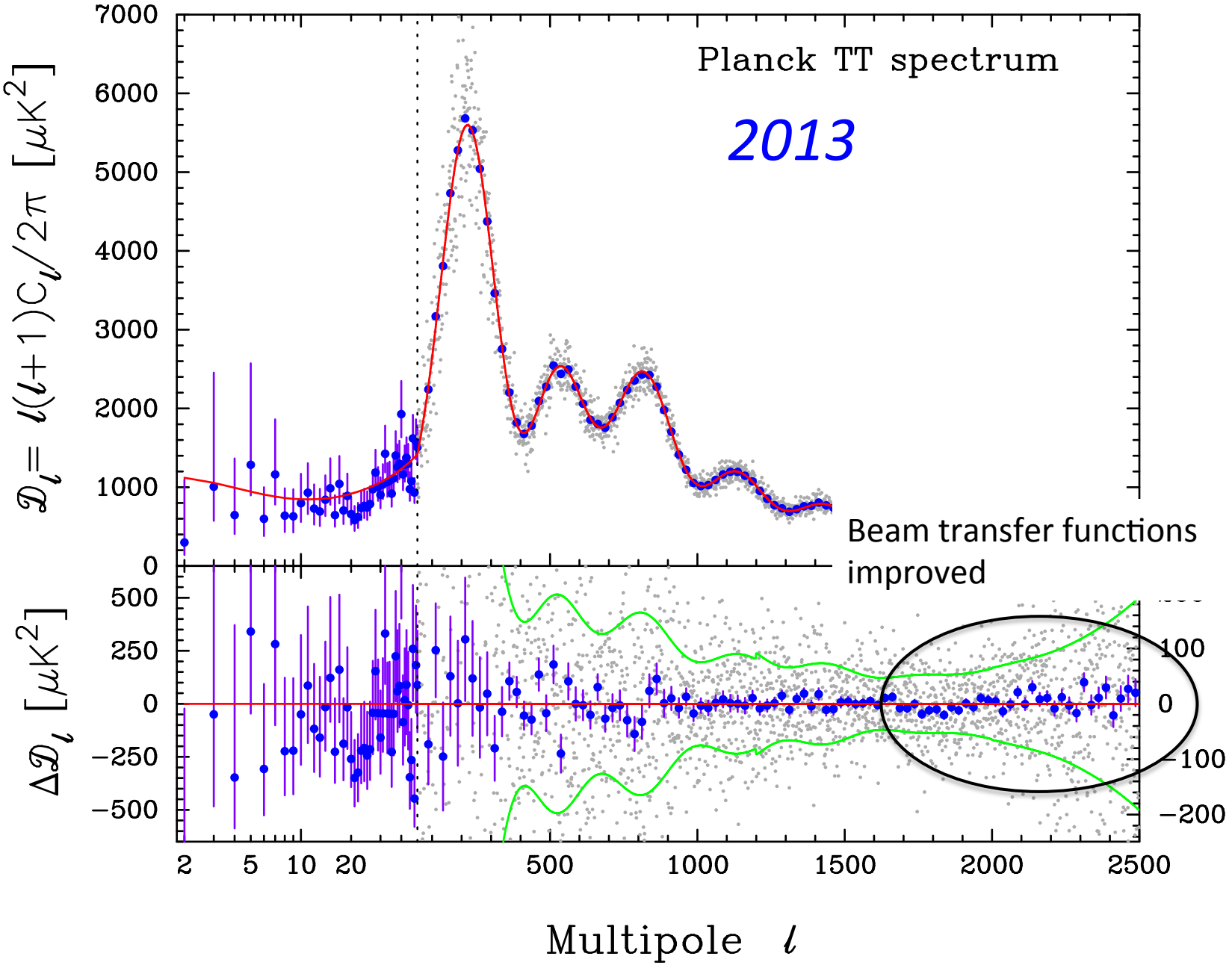


Efstathiou @ Ferrara Dec 1, 2014

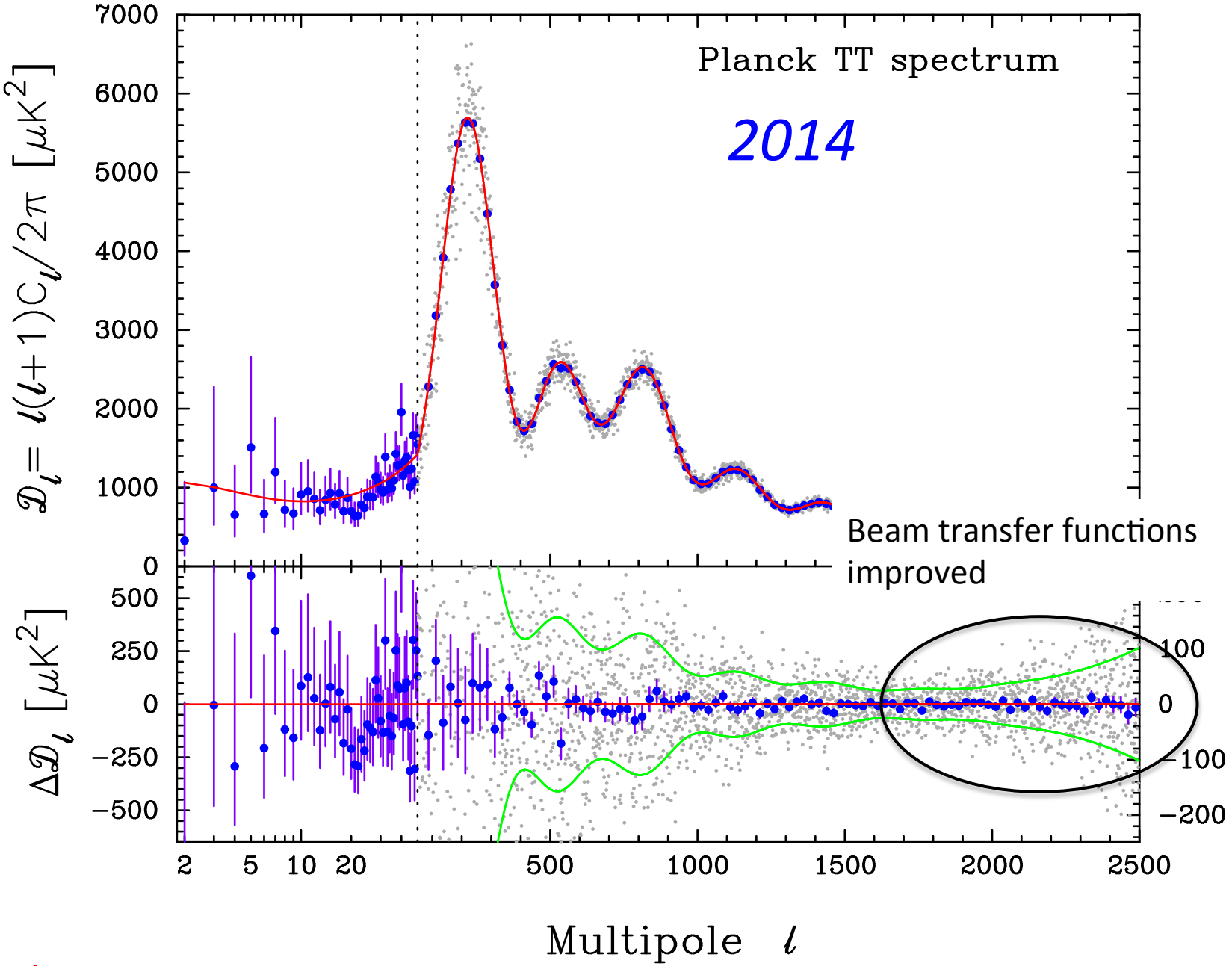


preliminary

Efstathiou @ Ferrara Dec 1, 2014

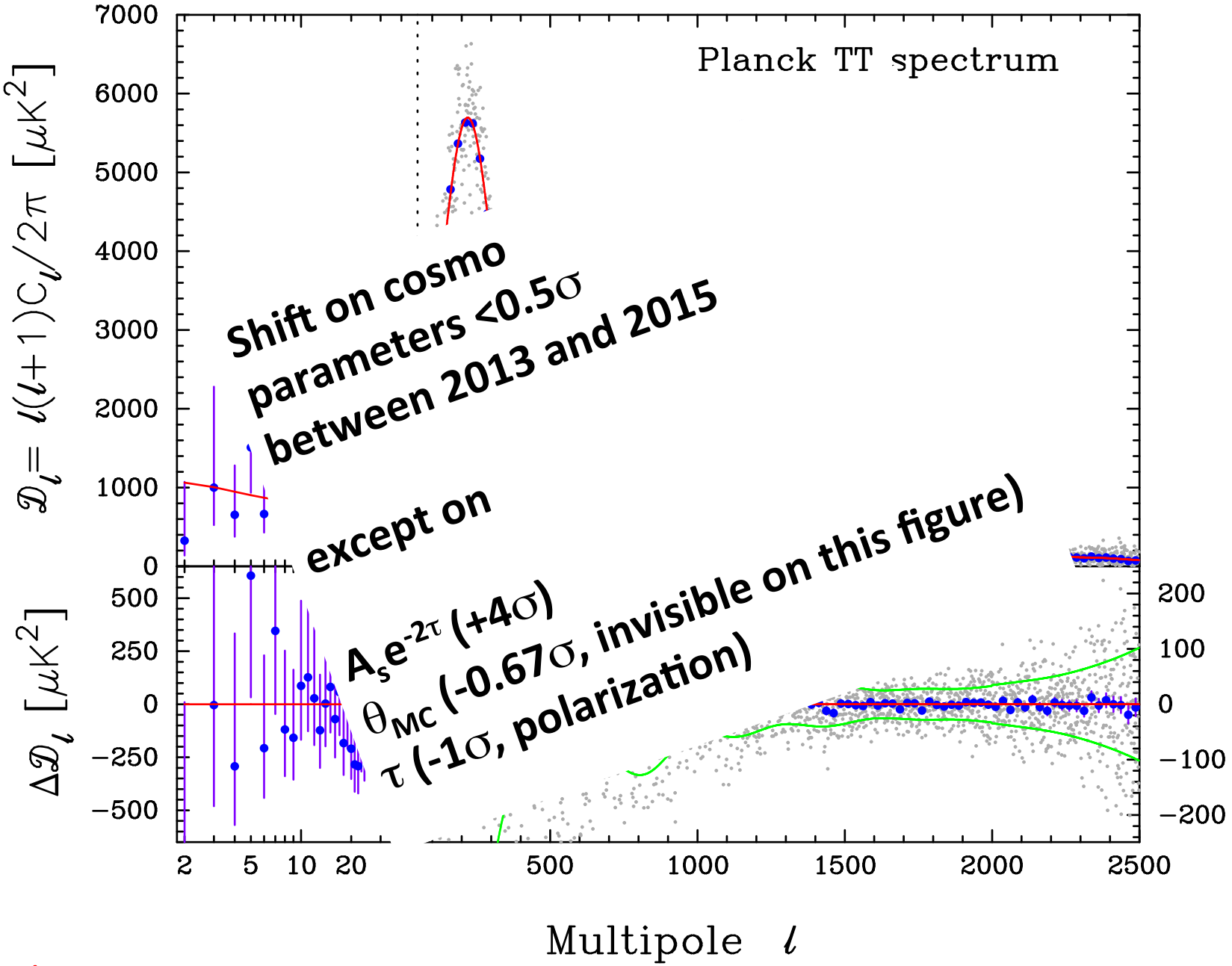


Efstathiou @ Ferrara Dec 1, 2014



preliminary

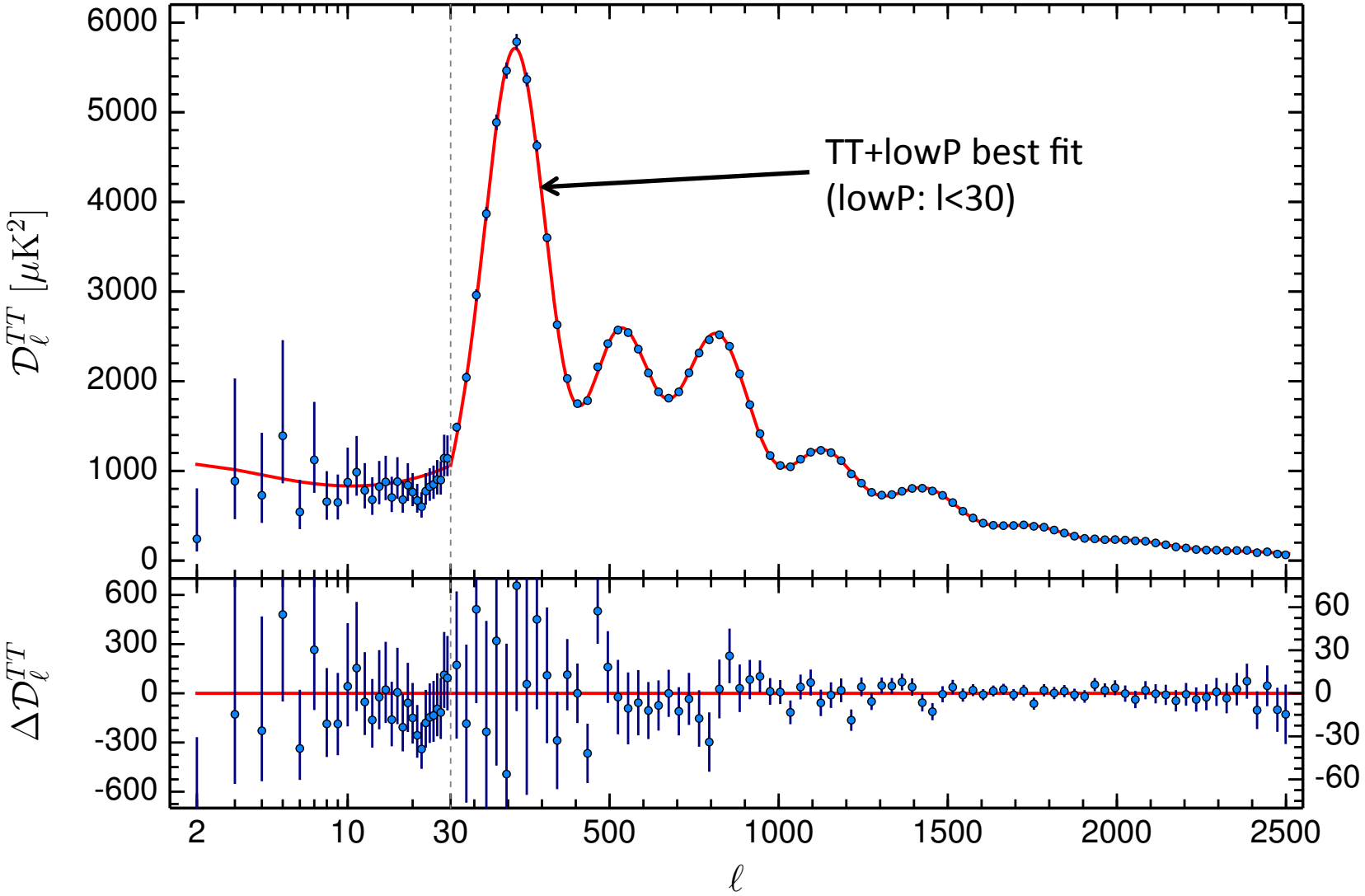
Efstathiou @ Ferrara Dec 1, 2014



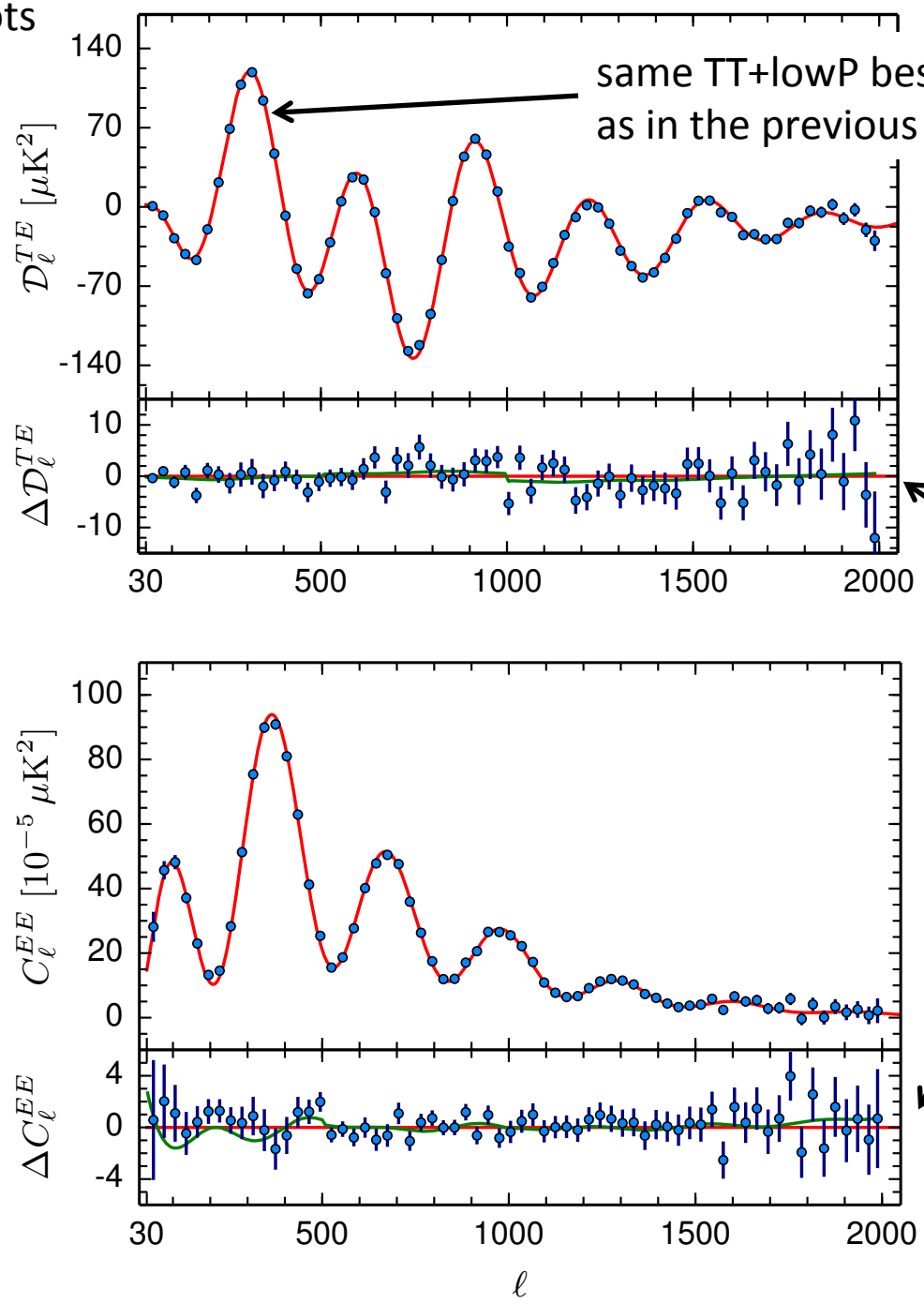
preliminary

Efstathiou @ Ferrara Dec 1, 2014

Now, the official 2015 TT plot from the paper



and the polarization plots



Residuals dominated
by the T-P leakage

Power spectra and likelihoods

- Temperature spectra TT (l>=30) → likelihood
  - 100x100, 143x143, 217x217, 143x217
  - 80%, 70%, 60% of the sky for 100, 143, 217GHz
- Temperature likelihood (l<30)
  - Low resolution pixel-based CMB maps

Planck TT

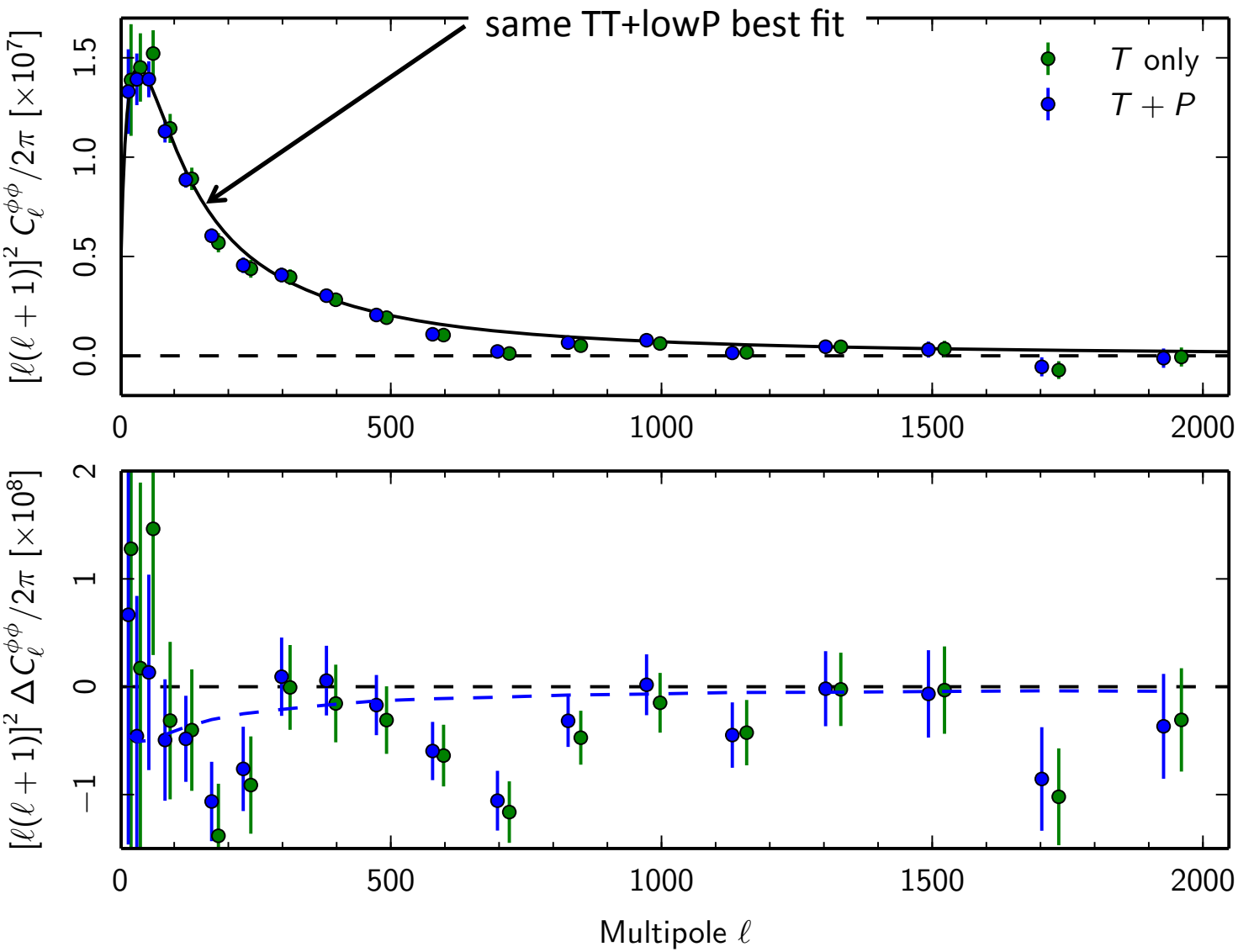
- Polarization spectra TE, EE (l>=30) → likelihood
  - All frequency combination with 100, 143 and 217GHz
  - 70%, 50%, 41% of the sky for 100, 143, 217GHz

Planck TE
Planck EE

- Polarization likelihood (l<30)
  - Low resolution Q and U LFI 70GHz map cleaned by the LFI 30GHz and HFI 353GHz maps

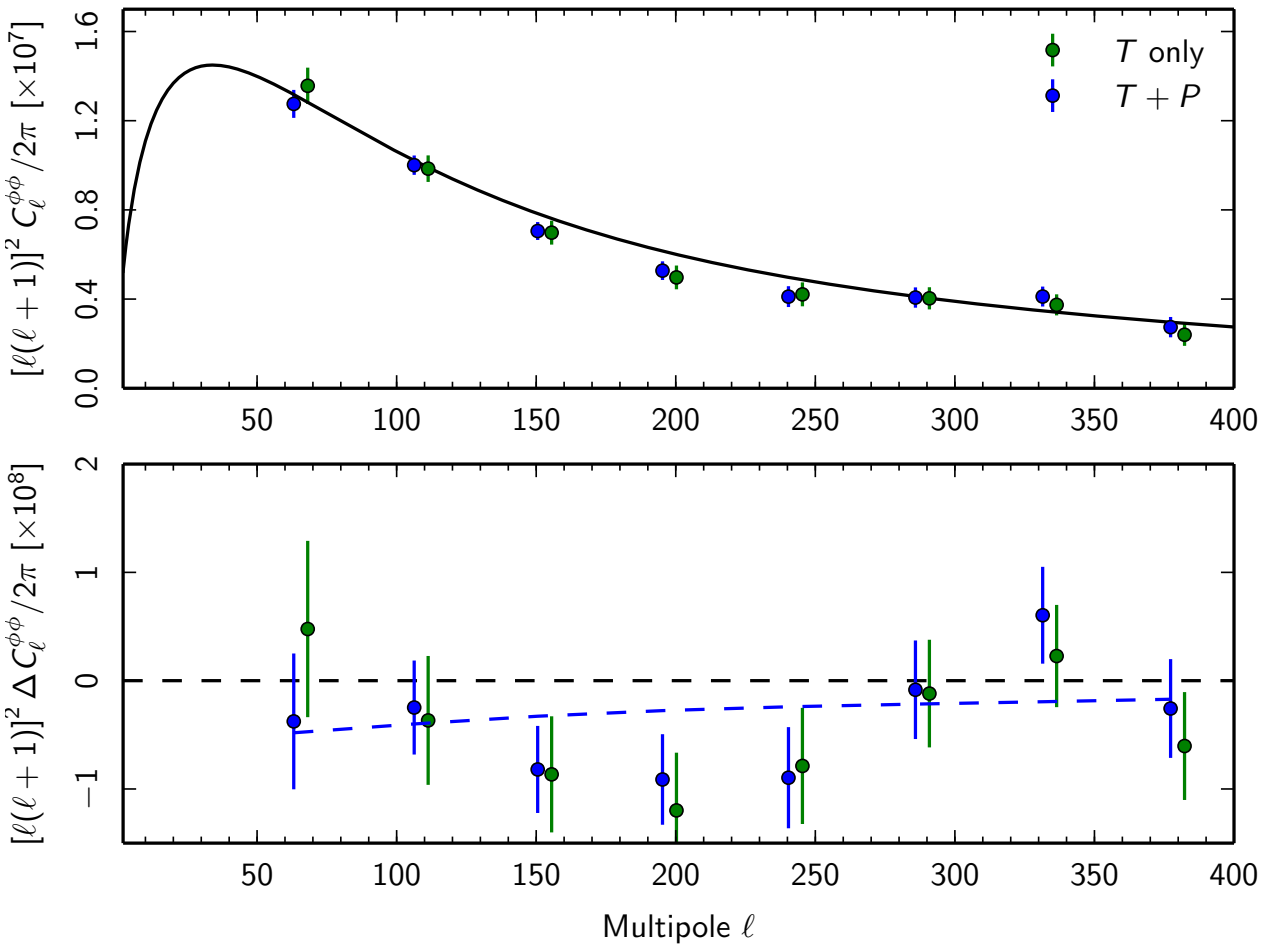
LowP
instead of WP (WMAP polarisation) in 2013

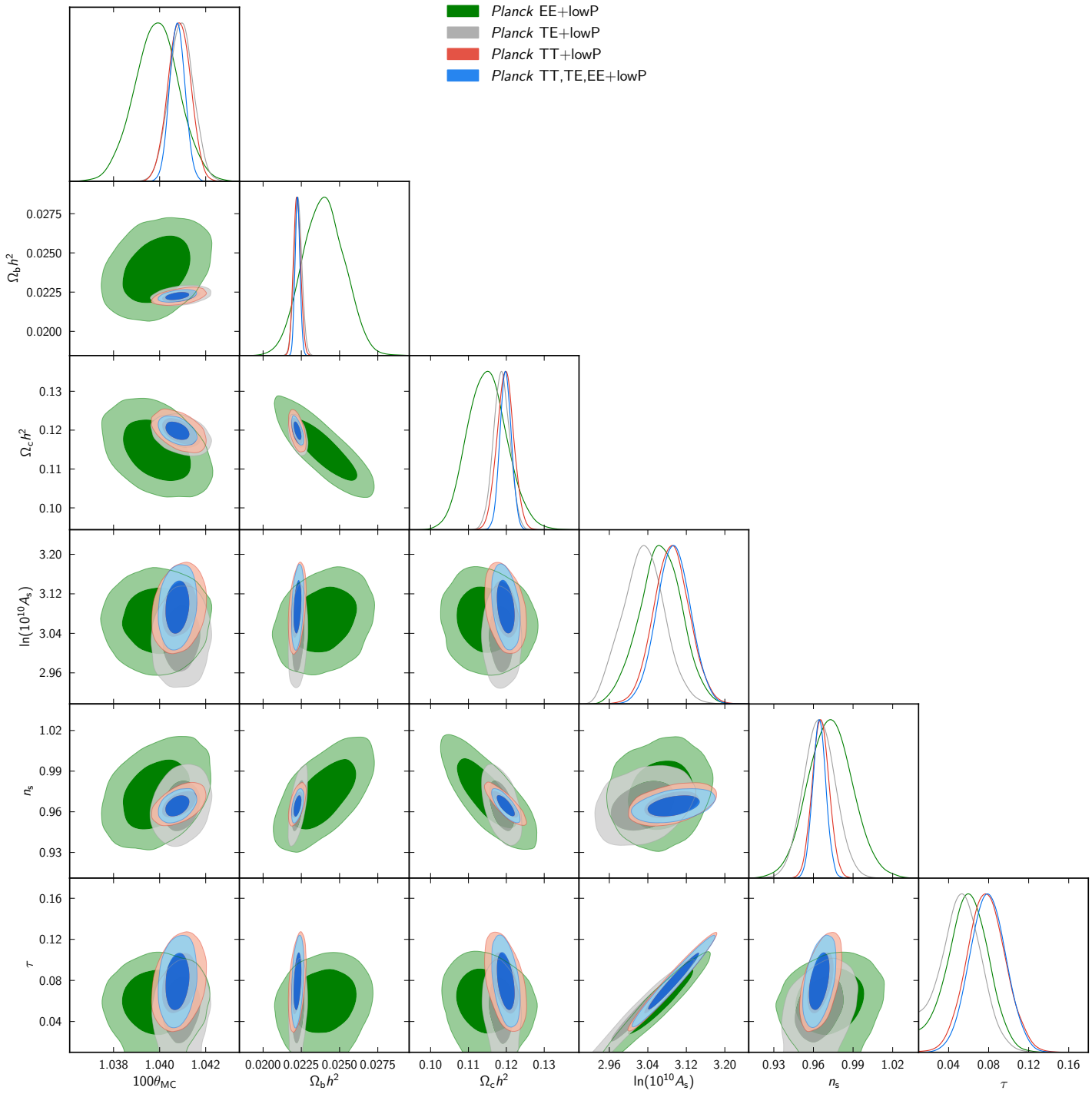
Power spectra and likelihoods



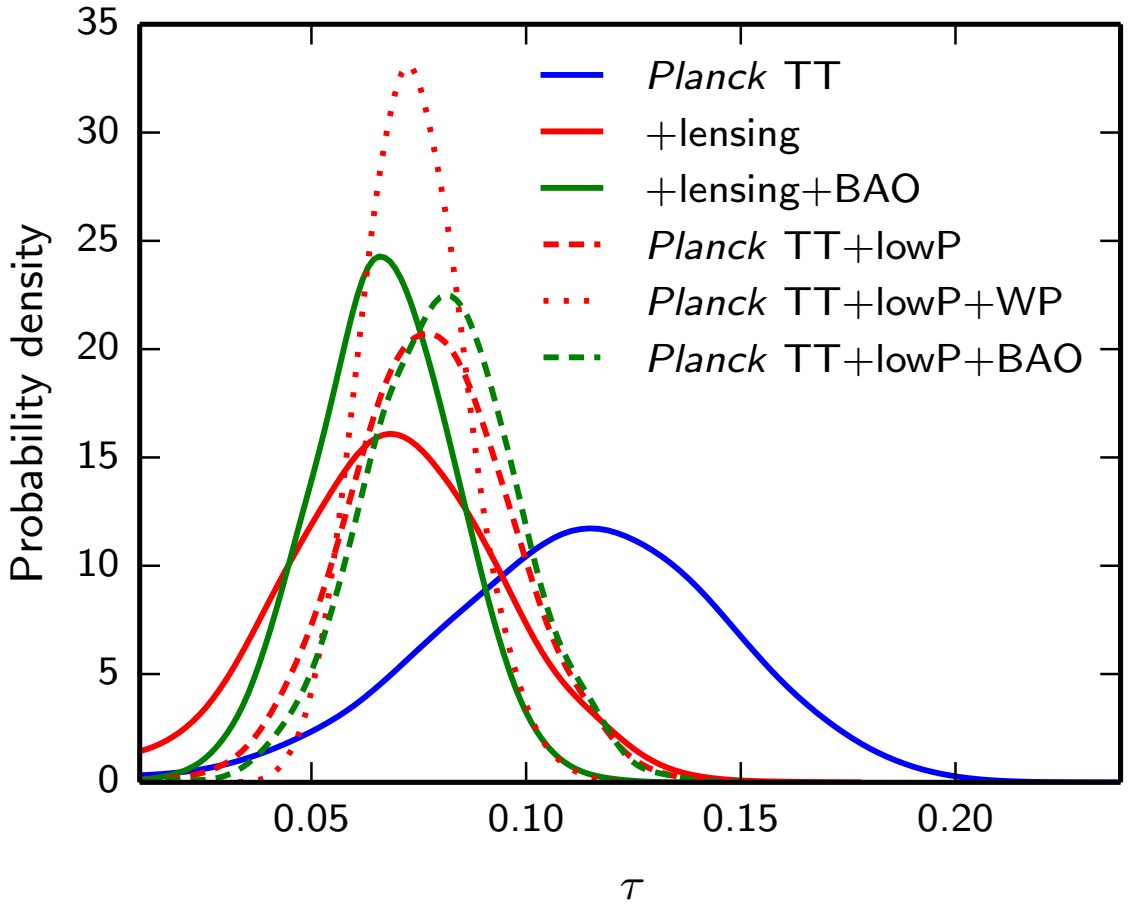
Power spectra and likelihoods

+ lensing likelihood

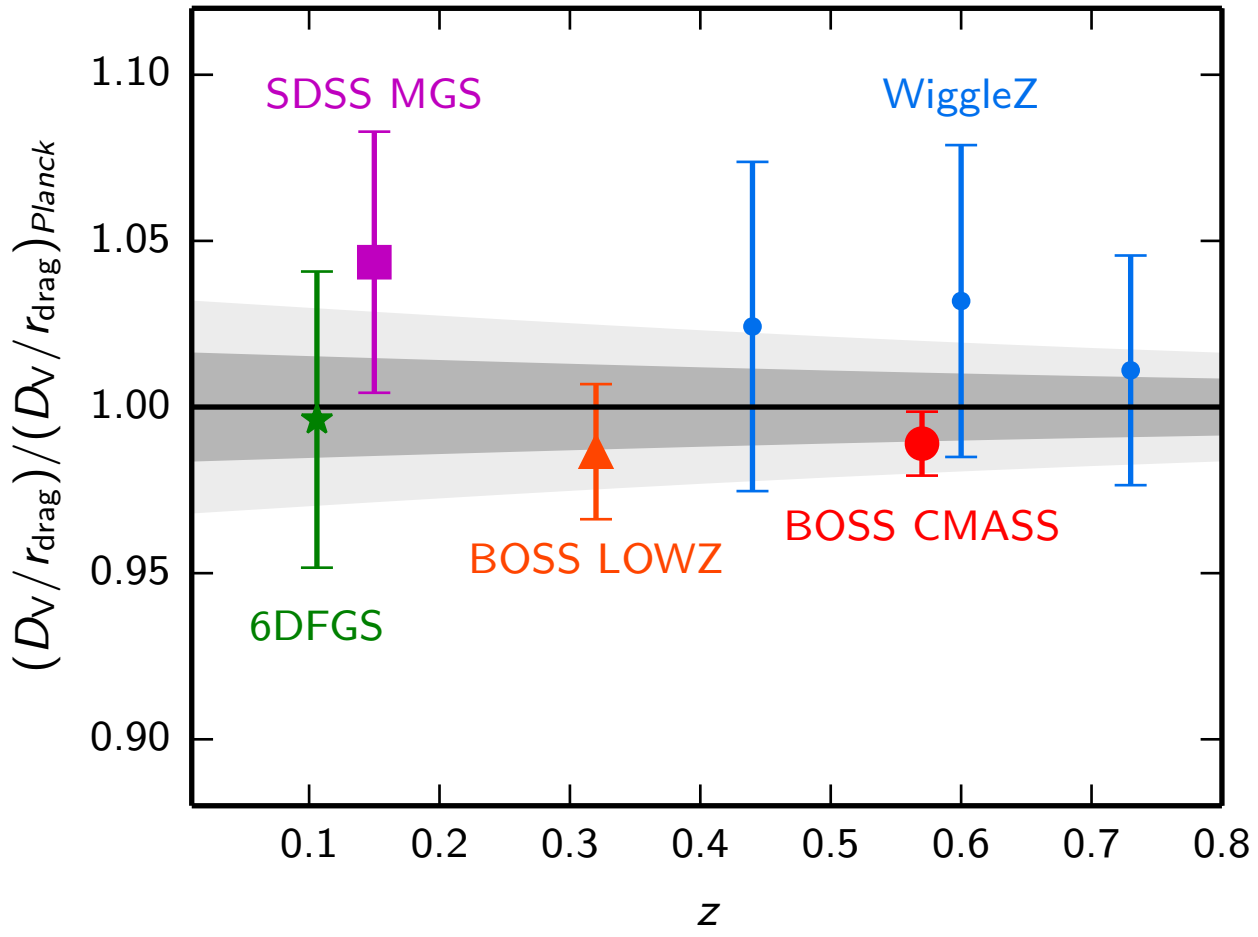



Planck EE+lowP
Planck TE+lowP
Planck TT+lowP
Planck TT,TE,EE+lowP
$100\theta_{MC}$
$\Omega_b h^2$
$\Omega_c h^2$
$\ln(10^{10}A_s)$
n_s
τ
1.038
1.040
1.042
0.0200
0.0225
0.0250
0.0275
0.10
0.11
0.12
0.13
2.96
3.04
3.12
3.20
0.93
0.96
0.99
1.02
0.04
0.08
0.12
0.16

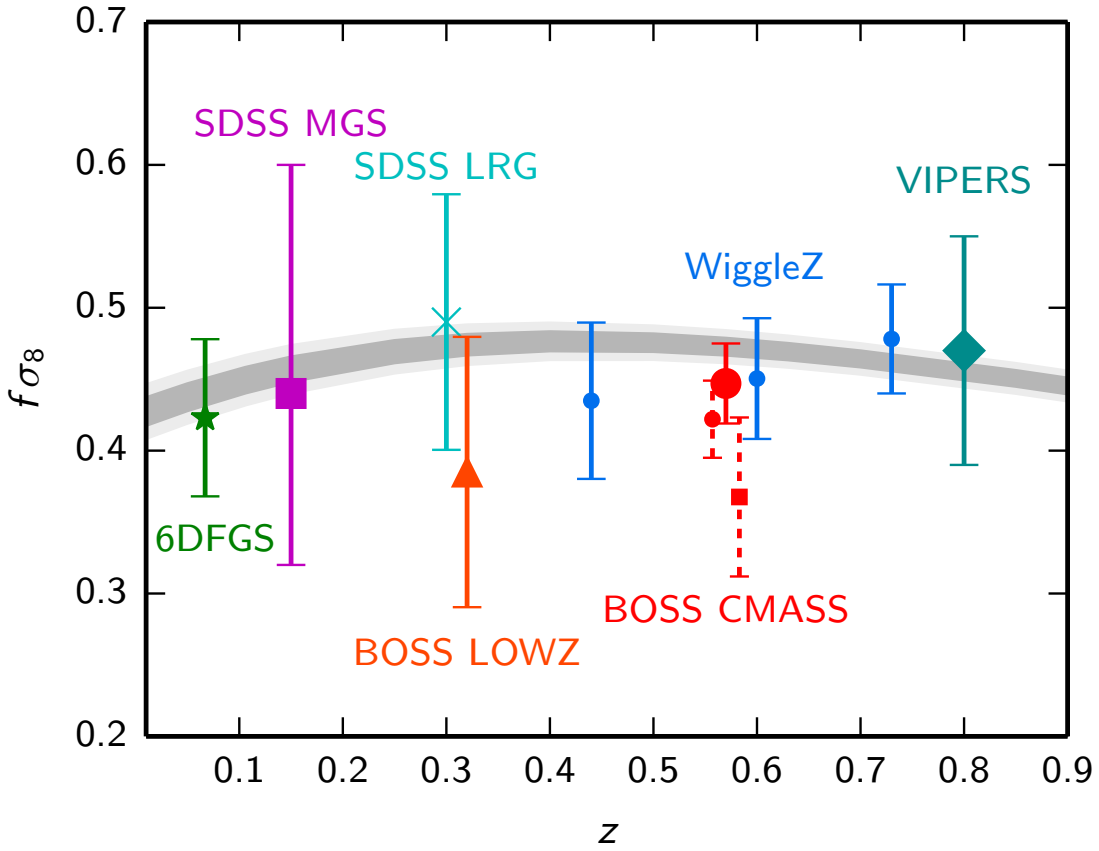
Reionization optical depth τ



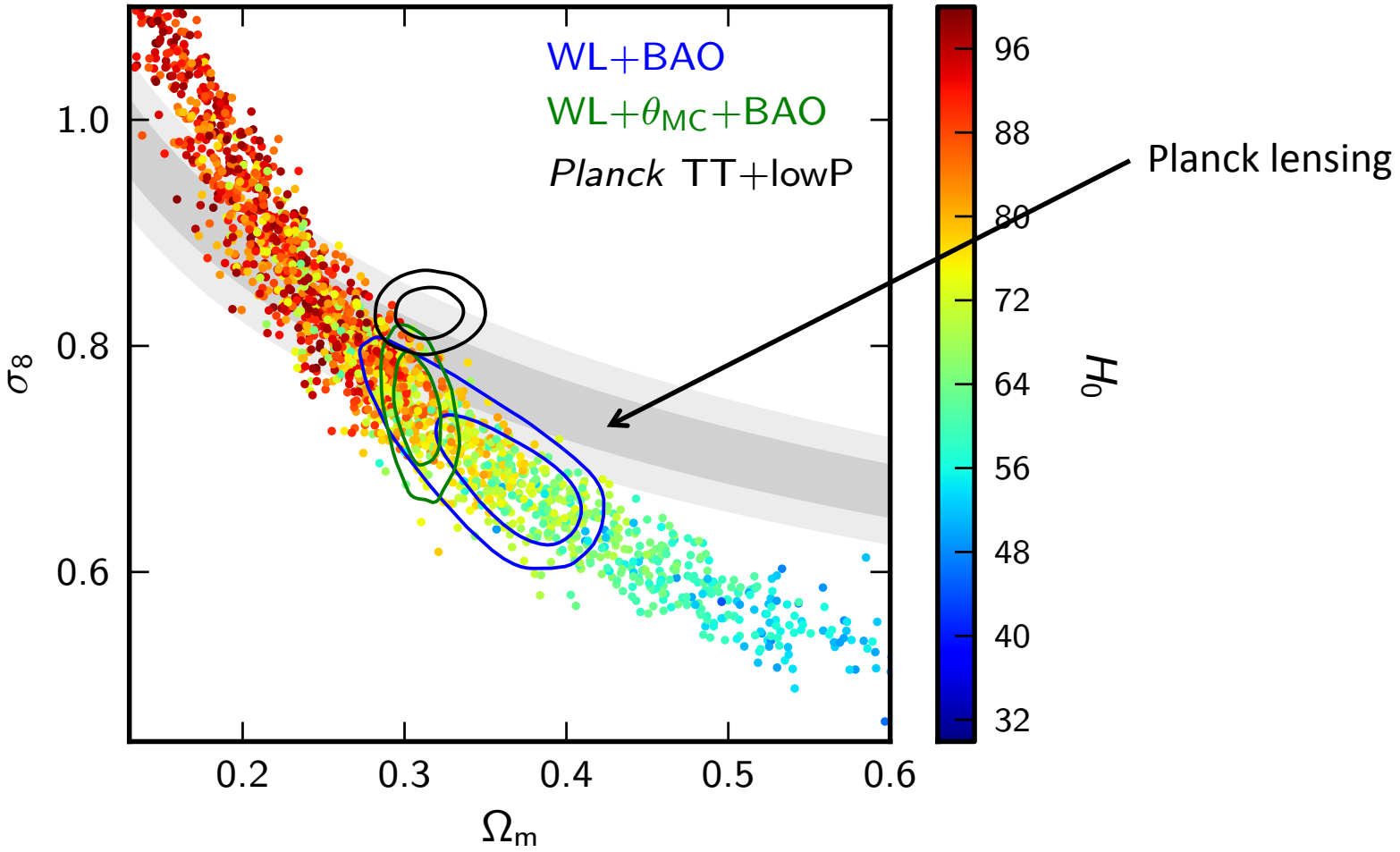
Planck & BAO


SDSS MGS
WiggleZ
6DFGS
BOSS LOWZ
BOSS CMASS
1.10
1.05
1.00
0.95
0.90
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
z
$(D_V/r_{drag})/(D_V/r_{drag})_{Planck}$

Planck & RSD

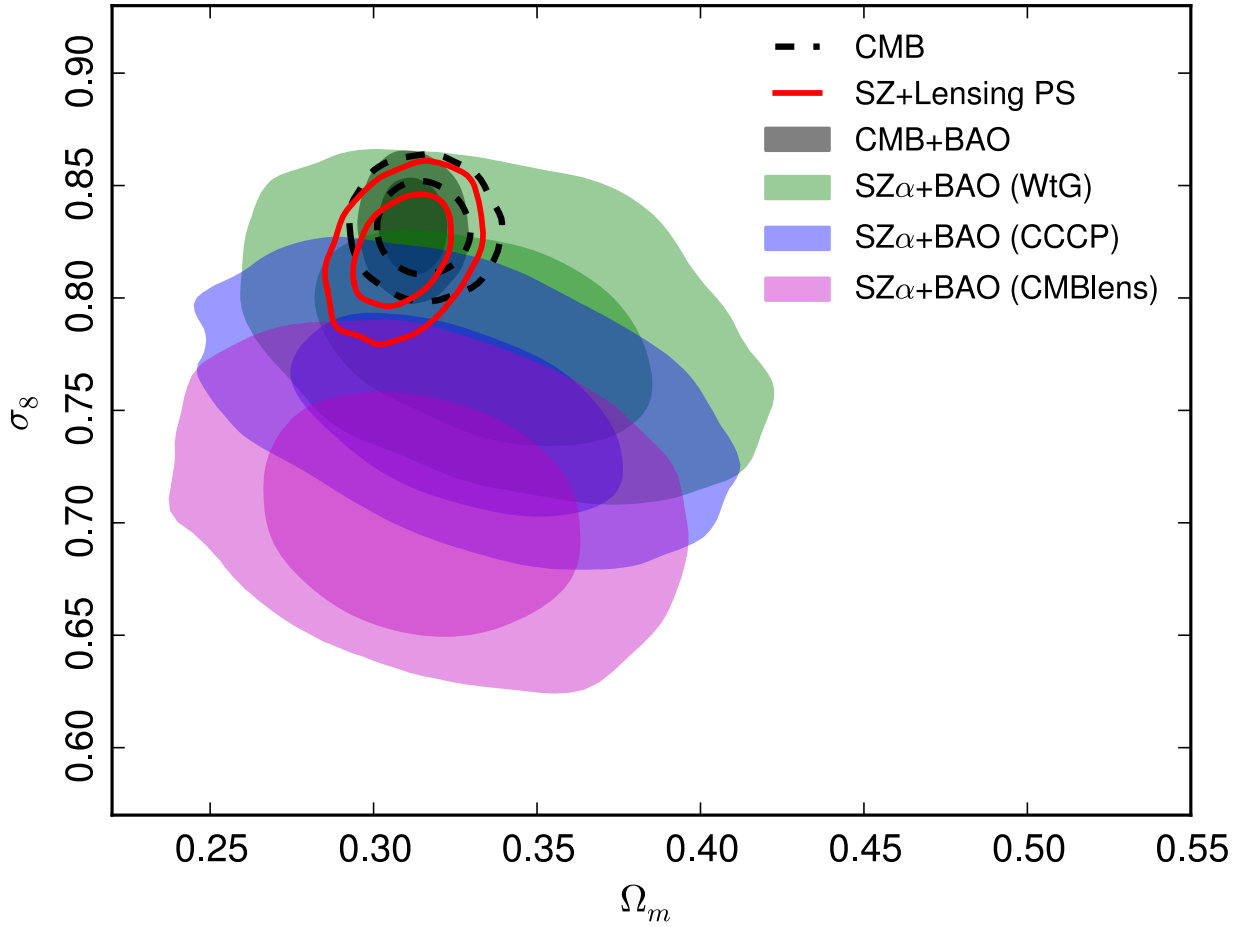

0.7
0.6
0.5
0.4
0.3
0.2
$f\sigma_8$
SDSS MGS
SDSS LRG
VIPERS
WiggleZ
6DFGS
BOSS LOWZ
BOSS CMASS
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
z

Tension with large scale structures



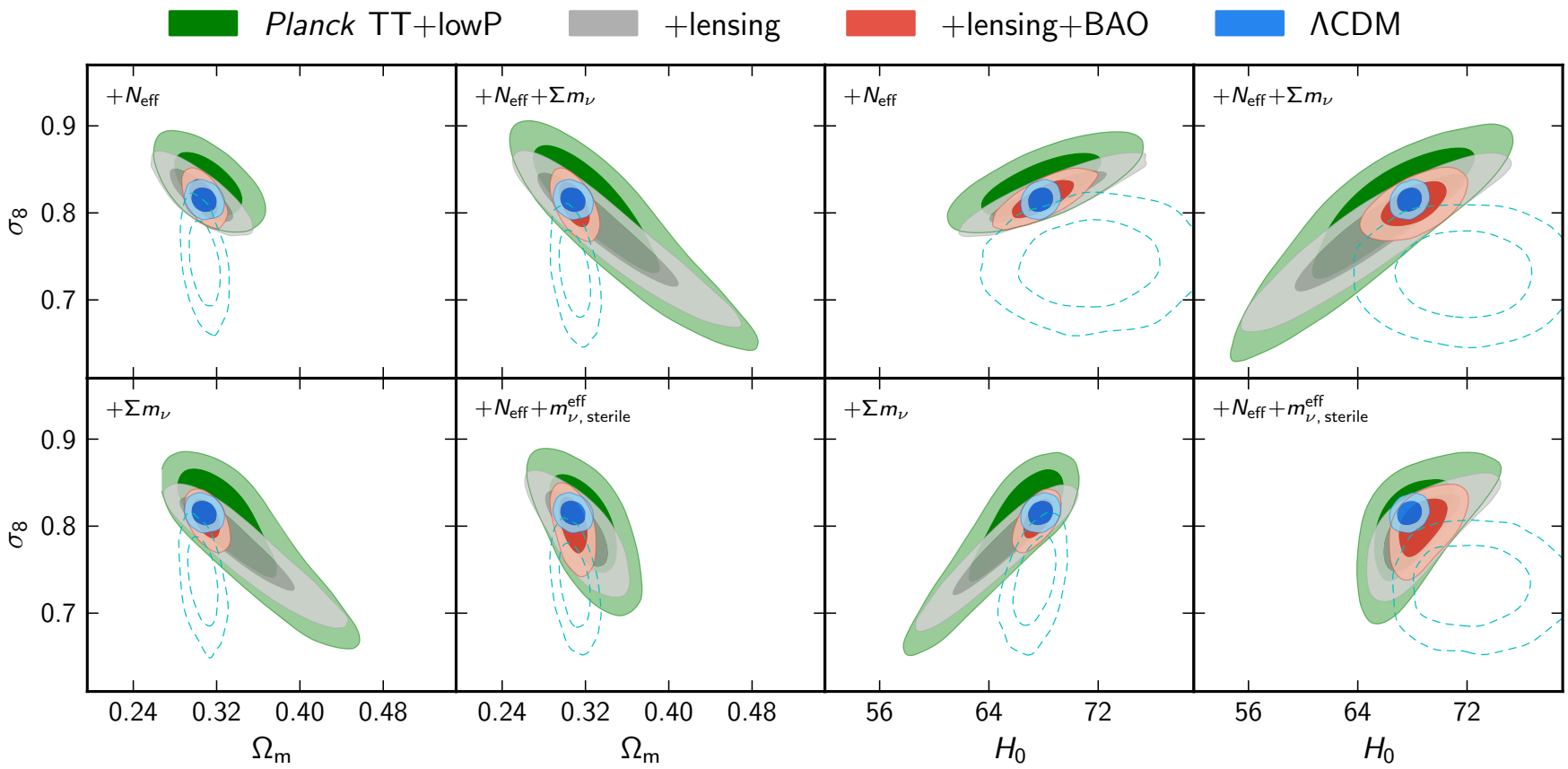
Tension with large scale structures

Planck clusters

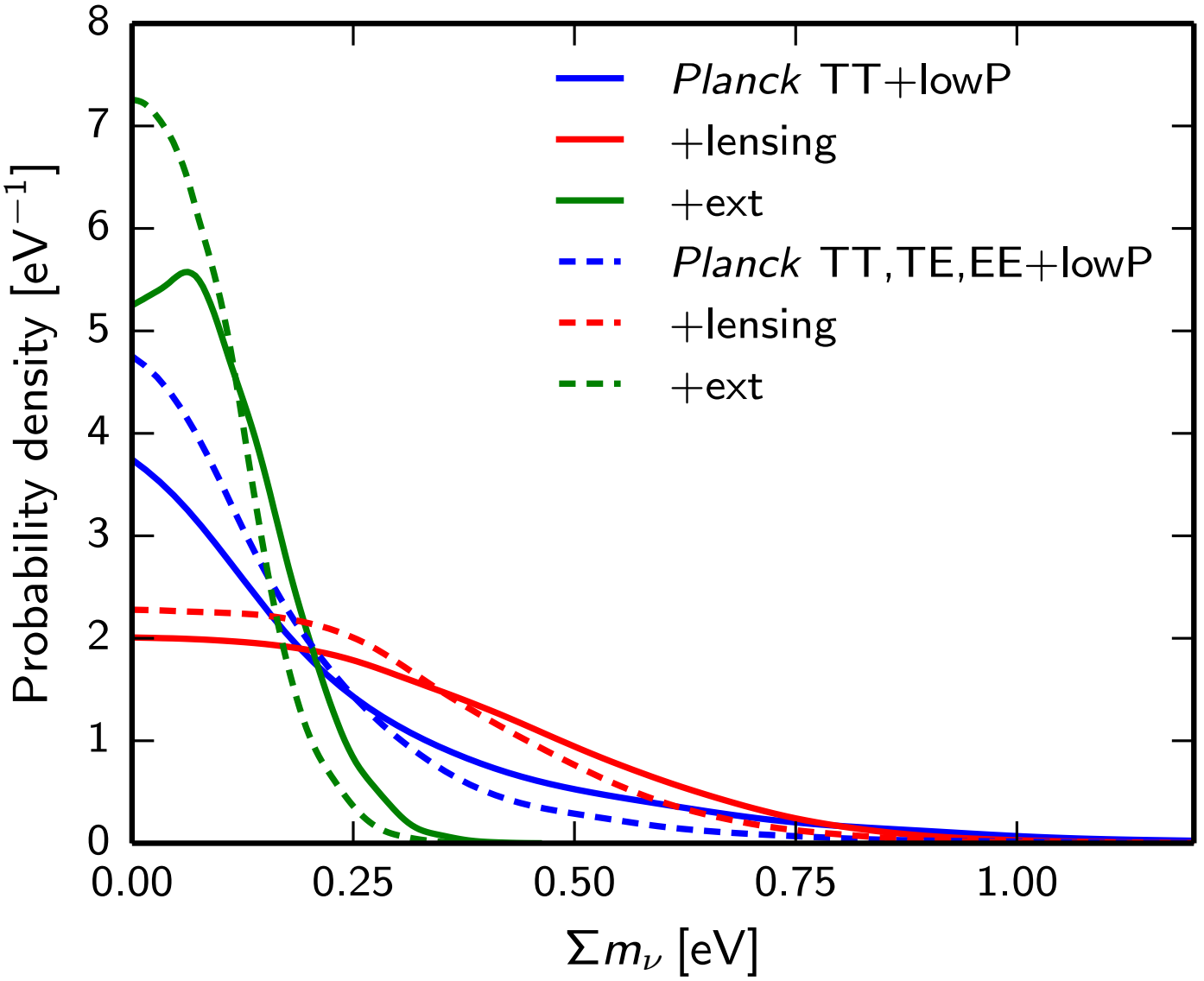


Planck 2015 results. XXIV.
Cosmology from SZ cluster counts

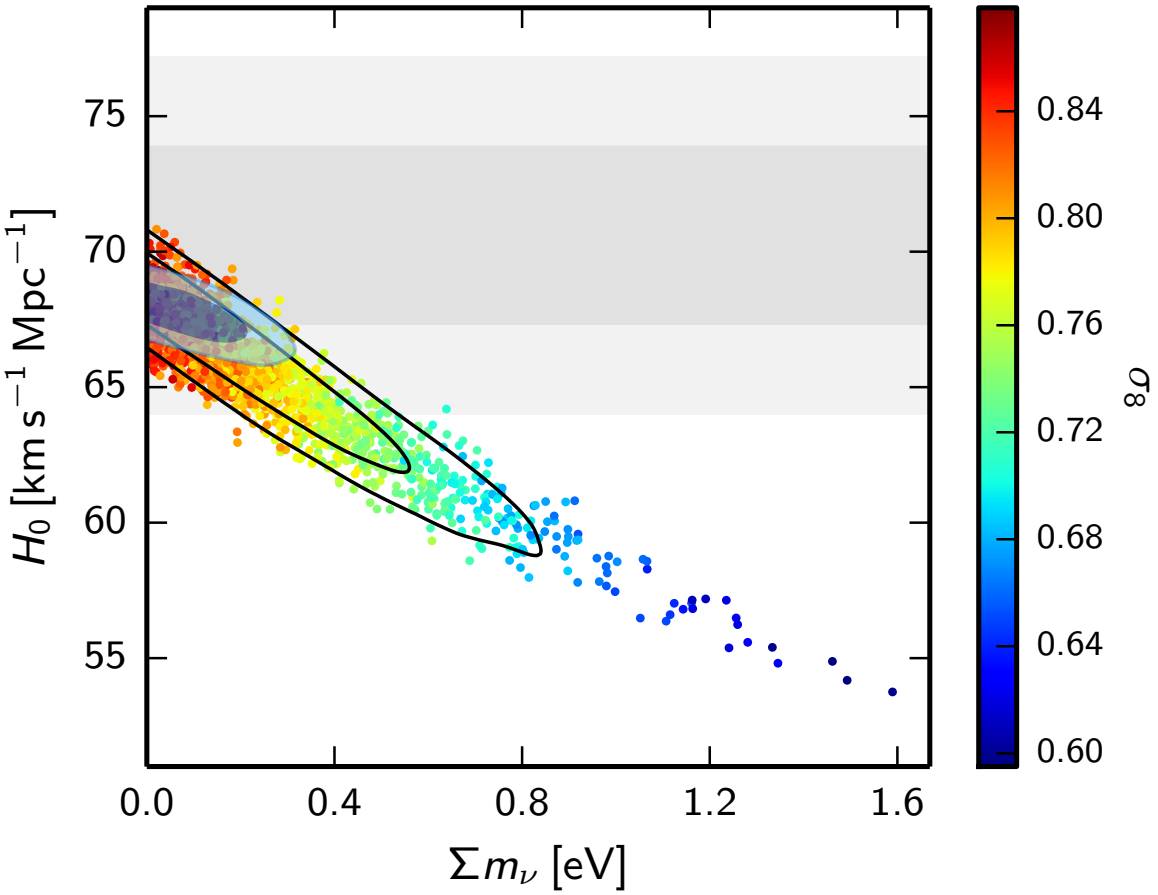
Neutrinos help
but cannot be the unique answer



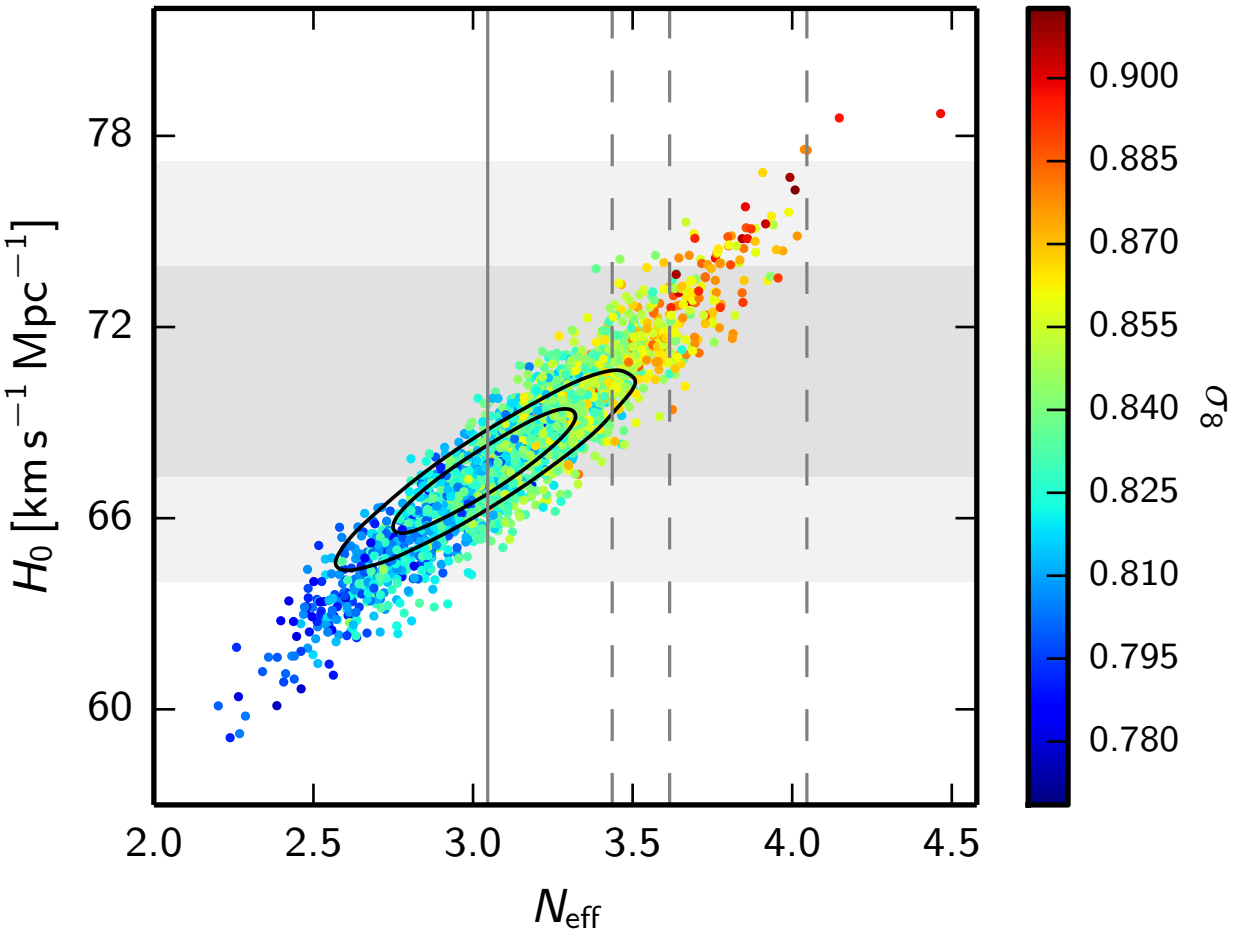
Neutrino mass



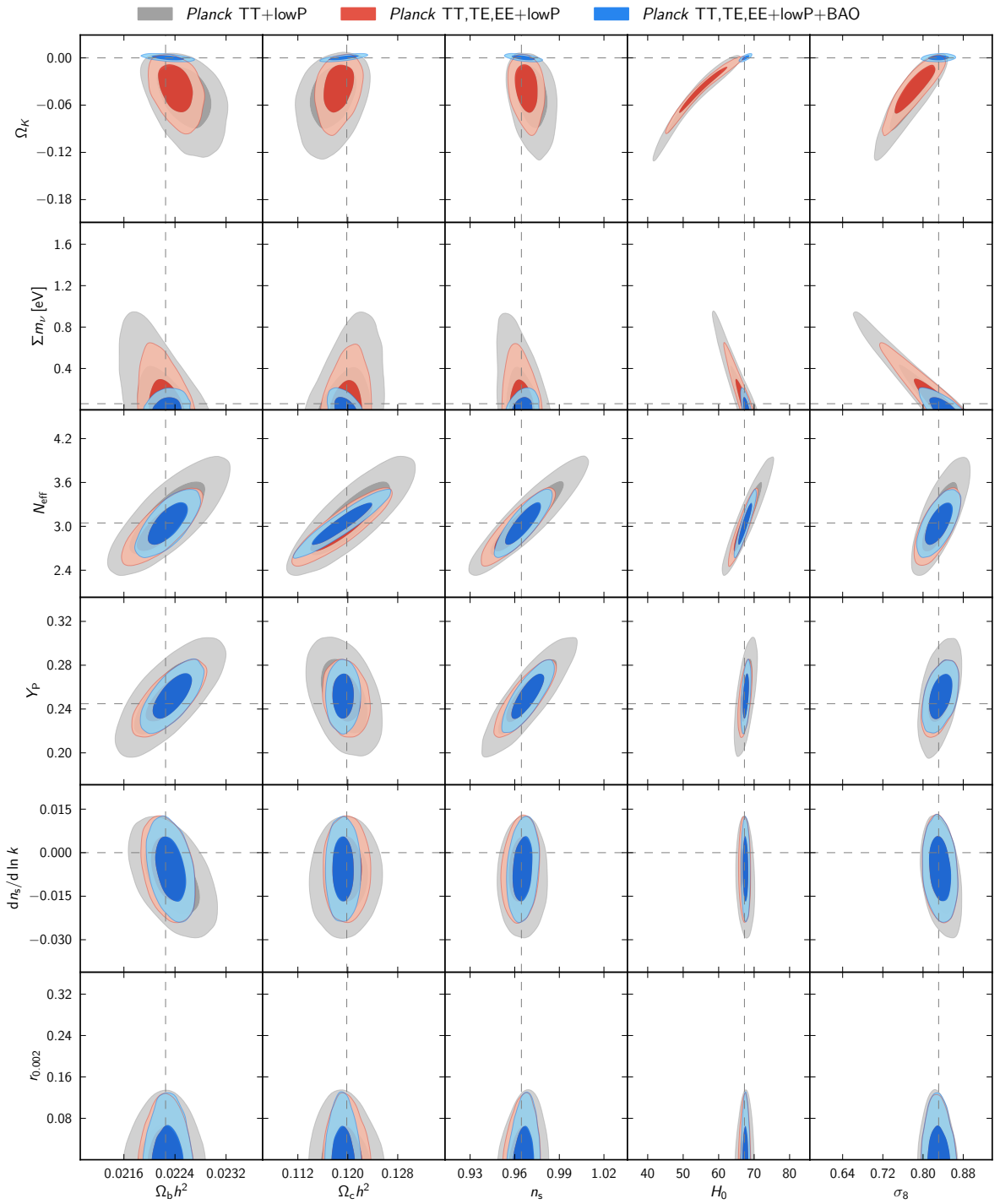
Neutrino mass



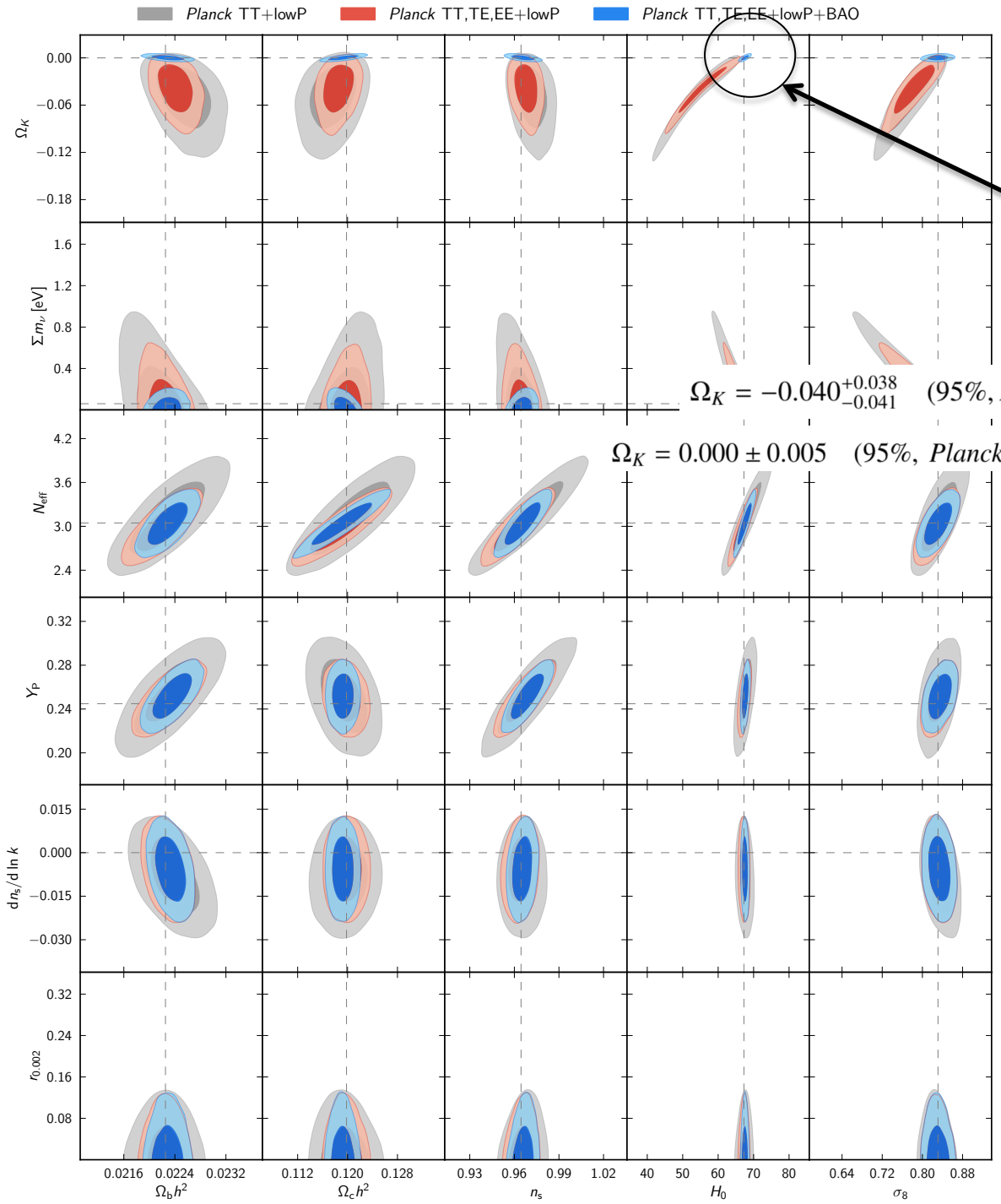
Number of neutrinos



Other extensions of the base ΛCDM model



Other extensions of the base ΛCDM model

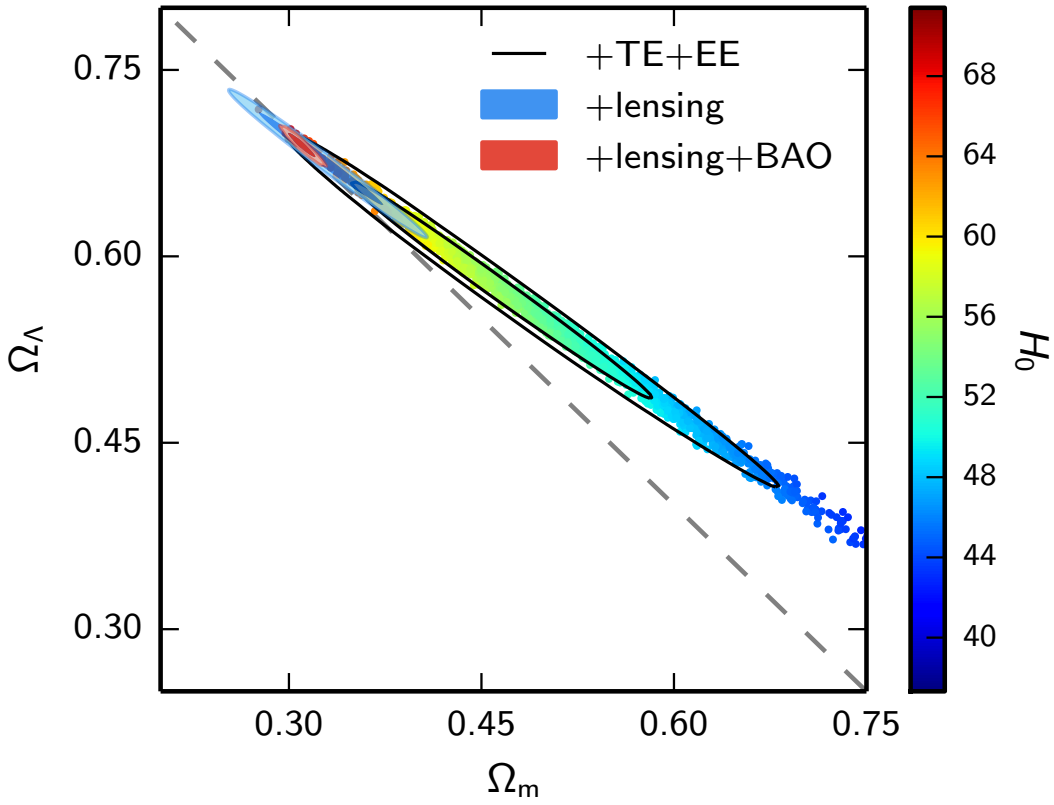


Curvature ?

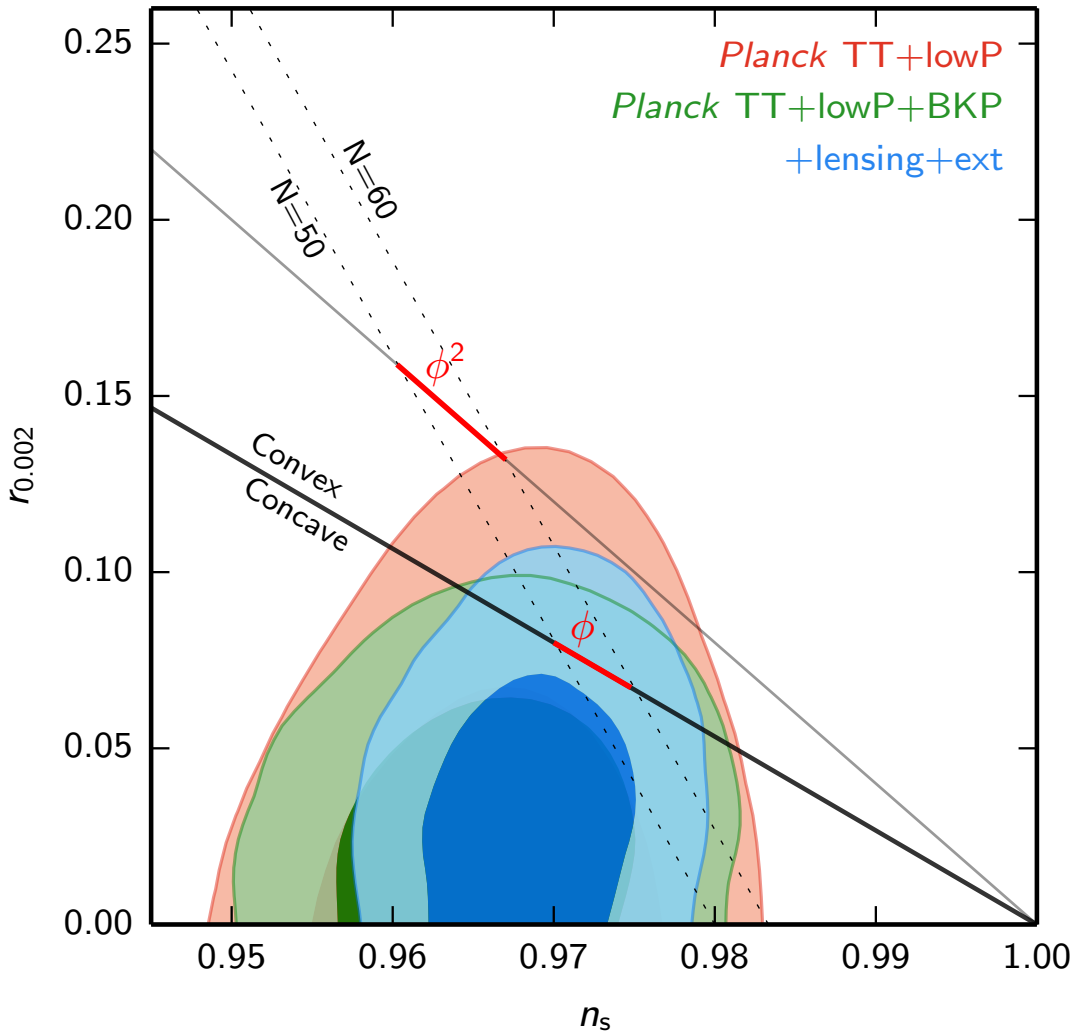
$\Omega_K = -0.040^{+0.038}_{-0.041}$ (95%, *Planck* TT,TE,EE+lowP),

$\Omega_K = 0.000 \pm 0.005$ (95%, *Planck* TT+lowP+lensing+BAO).

Curvature


+TE+EE
+lensing
+lensing+BAO
0.75
0.60
0.45
0.30
Ω_Λ
0.30
0.45
0.60
0.75
Ω_m
68
64
60
56
52
48
44
40
H_0

Constraints on r



r<0.09
(95%CL *Planck* TT+lowP+lensing+ext+BKP)

Conclusions

- 2015: data from the full mission + polarization spectra (TE, EE)
- Cosmo parameters shift only by ~<0.5σ between 2013 and 2015 except θ_{MC} (+0.7σ), $A_s e^{-2\tau}$ (+4σ) and τ (-1σ)
- Neff=3.04 ± 0.18 (TT+TE+EE+lowP+BAO)
- Σm_ν<0.23 eV (95%CL, TT+TE+EE+lowP+lensing)
  [Σm_ν<0.17 eV (95%CL, TT+TE+EE+lowP+BAO)]
- r<0.09 (95%CL, TT+lowP+lensing+ext+BKP)
- Still a very good agreement between Planck and BAO
- No more tension with SNIa (Betoule et al. 2014), H_0 (if error from previous studies revised)
- Tension with structures on σ_8 still present

(Planck, BAO, structure seem incompatible)