CMB-M5 mission Workshop, CERN, Geneva, 16-20 May 2016

Hunting down the right inflation model ! LiteBird vs. LiteCORE vs. CORE+

Sébastien Clesse

in collab with:
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delensing products provided by:
J. Errard (Inst. Lagrange, Paris)
S. Feeney (Imp. College, London)

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What are the initial conditions of the LCDM model?

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Amplitude + scalar spectral index

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Shape of the potential: concave, convex, slope, multi-field
Slow-roll (Hubble-flow) parameters: $\epsilon_1, \epsilon_2, \epsilon_3$

Models confronted to data: Bayes factor + $\texttt{ASPIC}$ **Library**

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Martin, Ringeval, Vennin, 1312.3529

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What's next?

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What's next?

LiteBird, LiteCORE, CORE

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What is the right model?

LiteBird, LiteCORE, CORE

Reheating?

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1. **MCMC Bayesian analysis:** `MontePython` **&** `COSMOMC`

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2. Experimental specifications: LiteBird, LiteCORE120, LiteCORE150, CORE, optimal-CORE

Channel [GHz]	FWMH [arcmin]	ΔT [μK arcmin]	ΔP [μK arcmin]
LiteBird, $l_{\rm max} = 1350$, $f_{\rm sky} = 0.7$			
80	55	12.5	17.7
90	49	10.0	14.1
100	43	12.0	17.0
120	36	9.5	13.4
140	31	7.5	10.6
166	26	7.0	9.9
195	22	5.0	7.1
LiteCORE-120, $l_{\rm max} = 3000$, $f_{\rm sky} = 0.7$			
80	13.5	8.8	12.5
90	11.9	7.1	10.0
100	10.5	8.5	12.0
120	8.8	6.7	9.5
140	7.4	5.3	7.5
166	6.3	5.0	7.0
195	5.4	3.6	5.0

LiteCORE-150, $l_{\rm max} = 3000$, $f_{\rm sky} = 0.7$			
80	10.8	8.8	12.5
90	9.5	7.1	10.0
100	8.4	8.5	12.0
120	7.0	6.7	9.5
140	5.9	5.3	7.5
166	5.0	5.0	7.0
195	4.3	3.6	5.0
*(opt-)*CORE, $l_{\rm max} = 3000$, $f_{\rm sky} = 0.7$			
100	8.4	6.0 (4.2)	8.5 (6.0)
115	7.3	5.0 (3.5)	7.0 (5.0)
130	6.5	4.2 (3.0)	5.9 (4.2)
145	5.8	3.6 (2.5)	5.0 (3.6)
160	5.3	3.8 (2.7)	5.4 (3.8)
175	4.8	3.8 (2.7)	5.3 (3.8)
195	4.3	3.8 (2.7)	5.3 (3.8)
220	3.8	5.8 (4.1)	8.1 (5.8)

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3. **Fiducial models: Higgs inflation (HI) & Mutated Hybrid Inflation (MHI)**

Most favored after Planck
zero-parameter model

~ no tensors,
~ in the middle of Planck
confidence region for n_s

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   Delensed spectrum used as a noise for C_l^{BB}

5. **Model comparison: Bayes factor for ~200 models in** `ASPIC` **library**

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Bayes Factor: $B^i_{\mathrm{Ref}} \equiv \dfrac{\mathcal{E}(\mathcal{M}_{\mathrm{Ref}}|D)}{\mathcal{E}(\mathcal{M}_i|D)} = \dfrac{p(\mathcal{M}_i|D)}{p(\mathcal{M}_{\mathrm{Ref}}|D)}$

$$p(\mathcal{M}_i|D) = \frac{\pi(\mathcal{M}_i)\mathcal{E}(D|\mathcal{M}_i)}{\sum_i \pi(\mathcal{M}_i)\mathcal{E}(D|\mathcal{M}_i)} \qquad \mathcal{E}(D|M_i) = \int \mathrm{d}\theta_{ij}\mathcal{L}(\theta_{ij})\pi(\theta_{ij}|\mathcal{M}_i)$$

Jeffrey's scale: ln B < -5 < -2.5 < -1 0

Strong Moderate Weak Inconclusive

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~ between 10^5 and 10^6 CPU hours
> 2000 model comparisons

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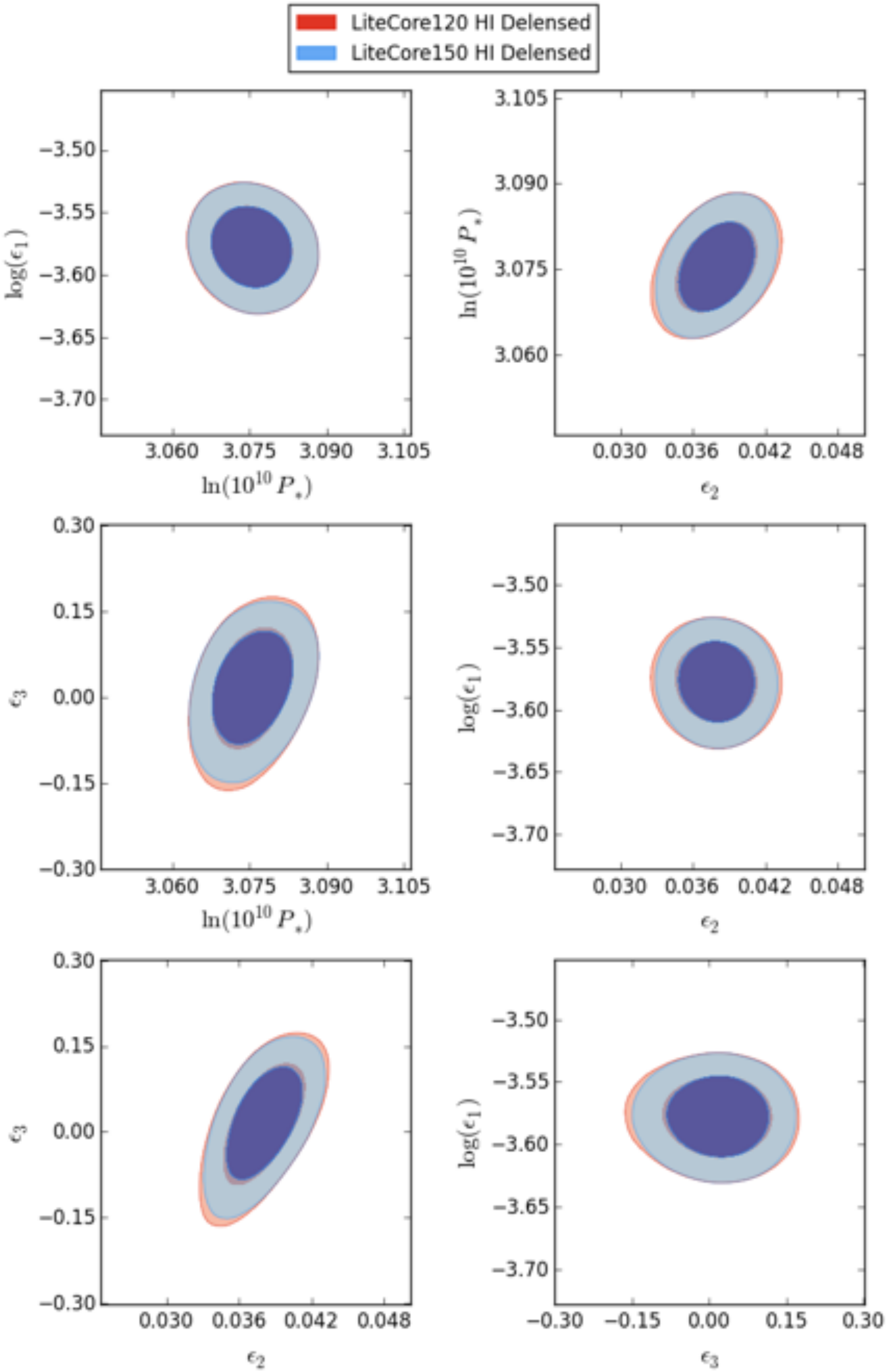
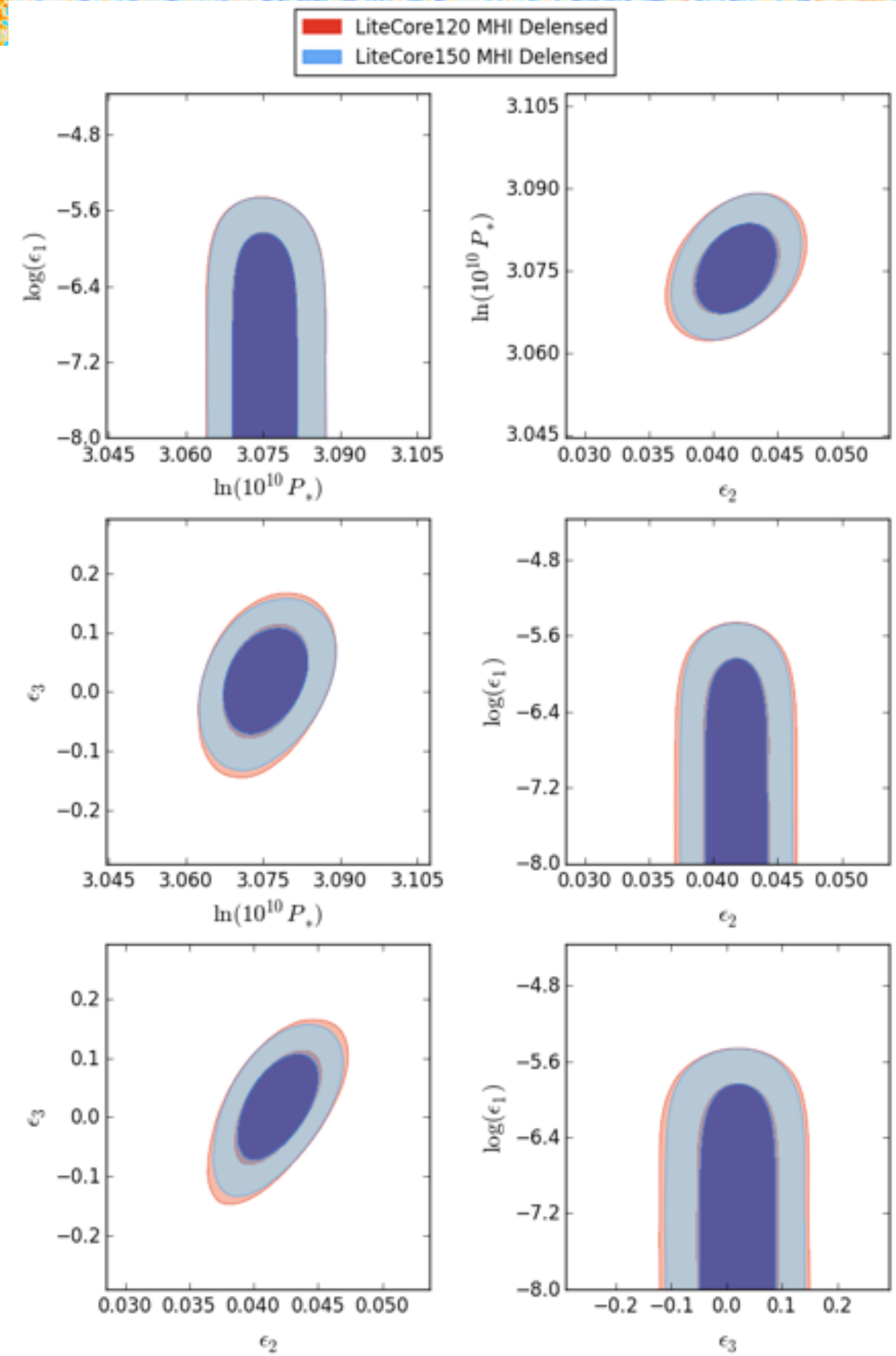
3. ...to compute forecasts on $\epsilon_1, \epsilon_2, \epsilon_3$





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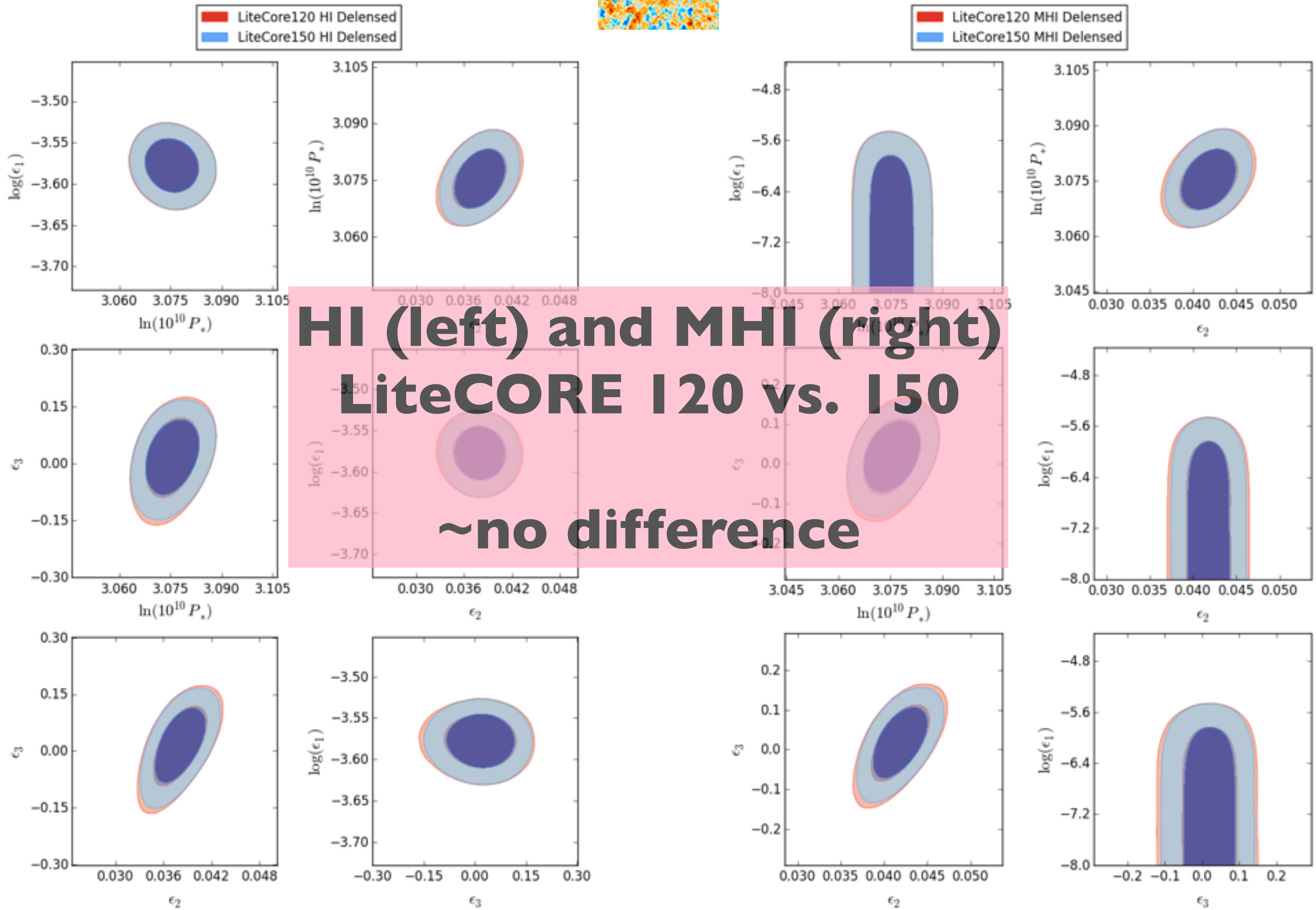

HI (left) and MHI (right)
LiteCORE 120 vs. 150

~no difference

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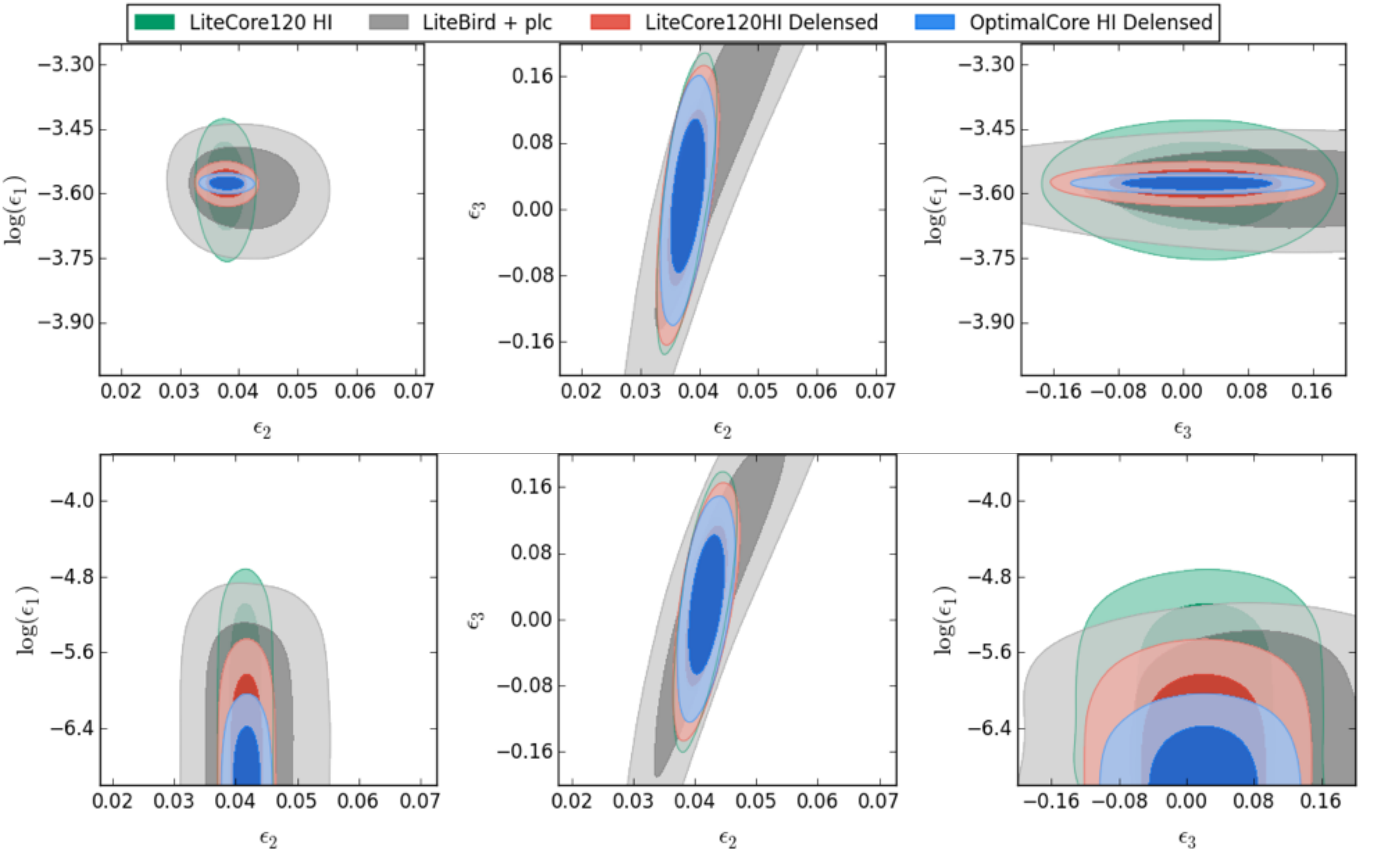
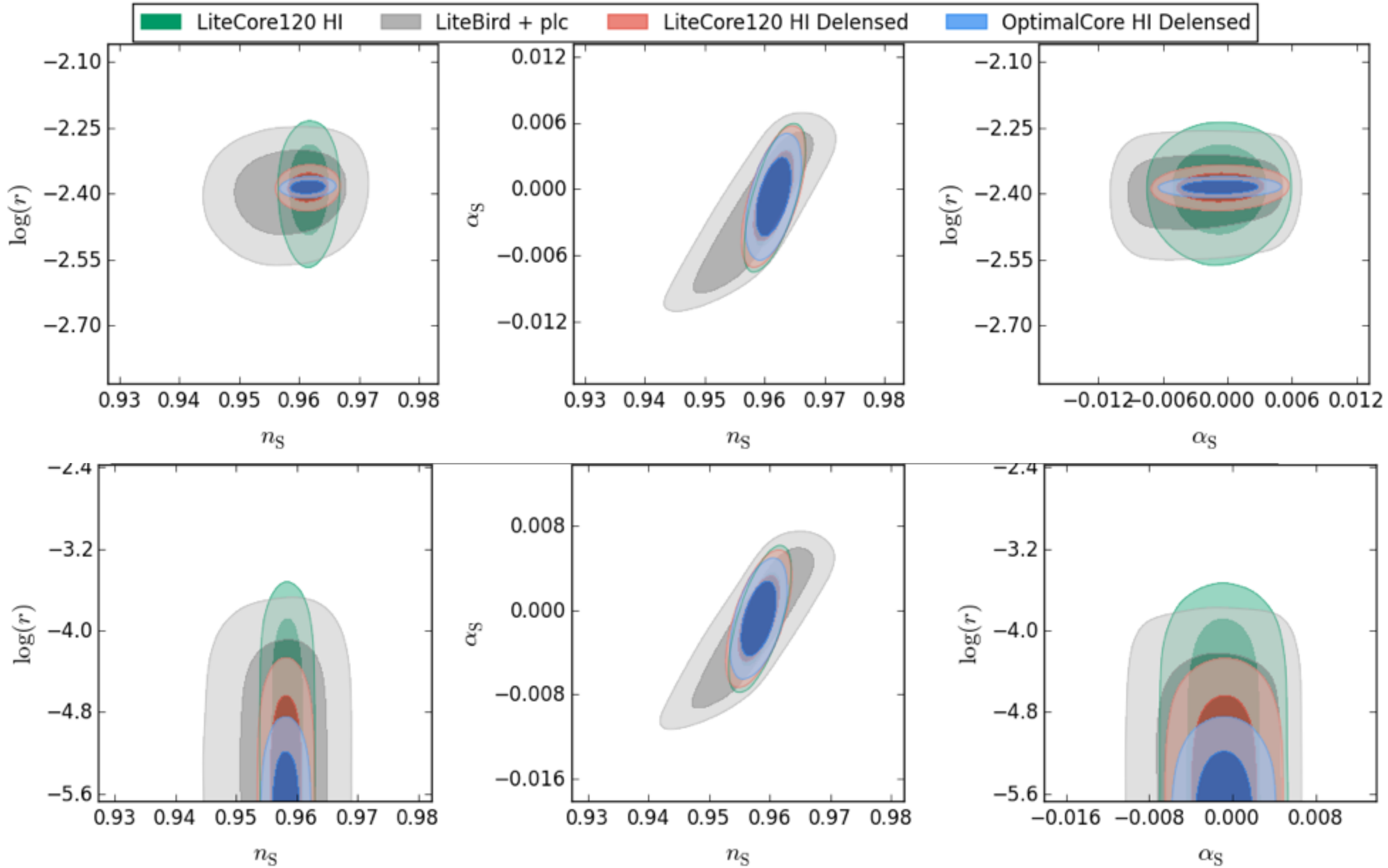
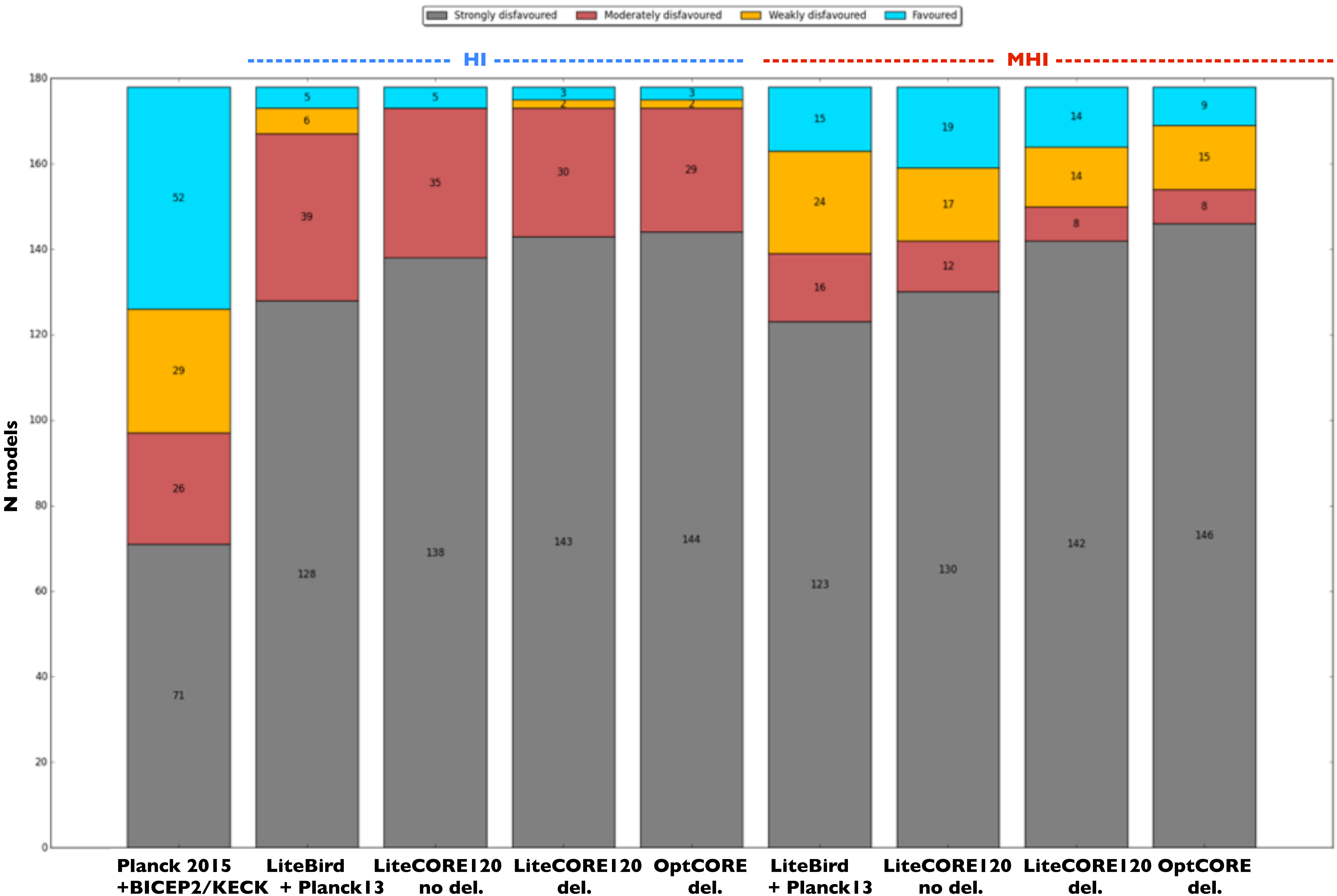


4. ...and on n_s, r, α_s



4. then hunt down the right model!



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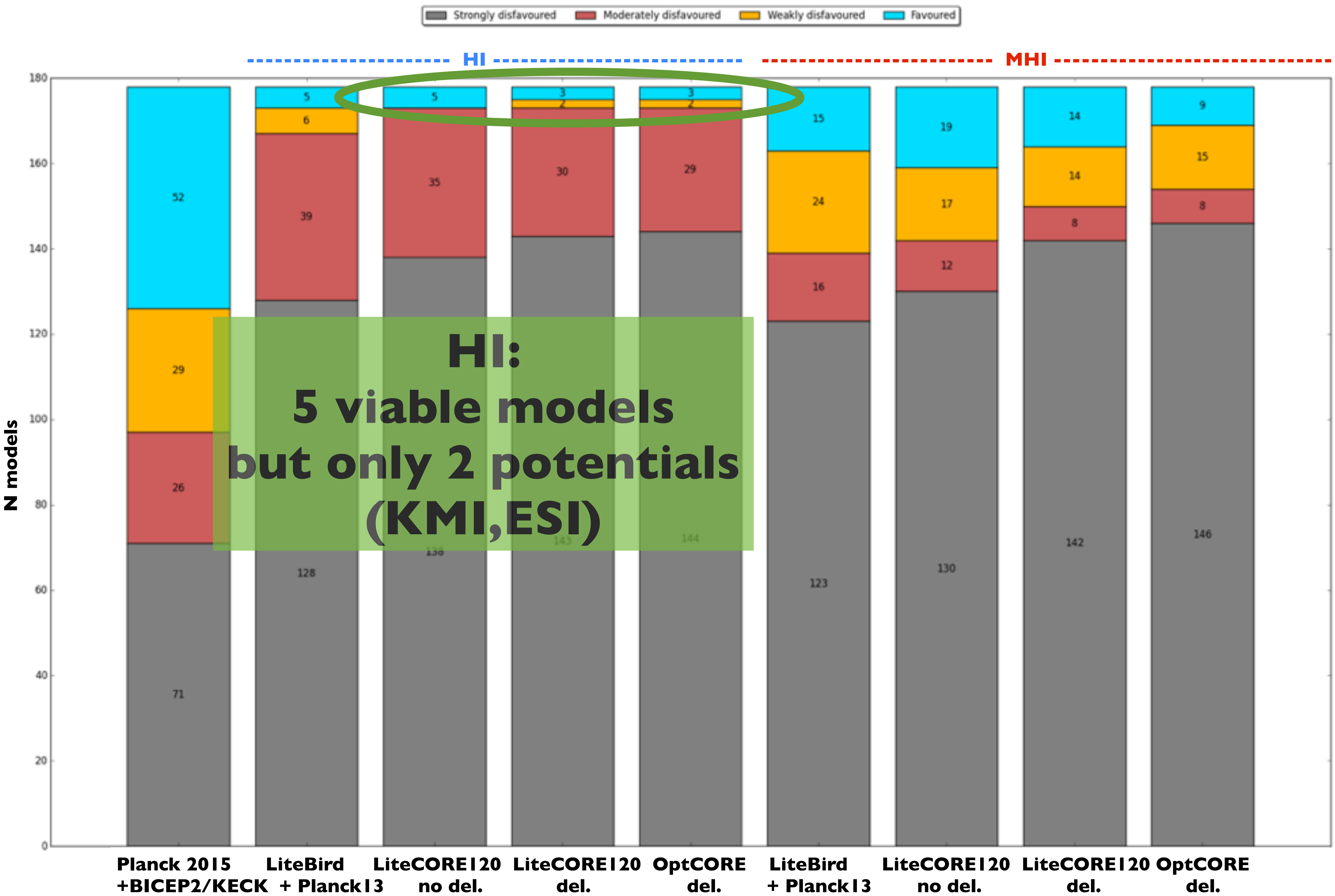

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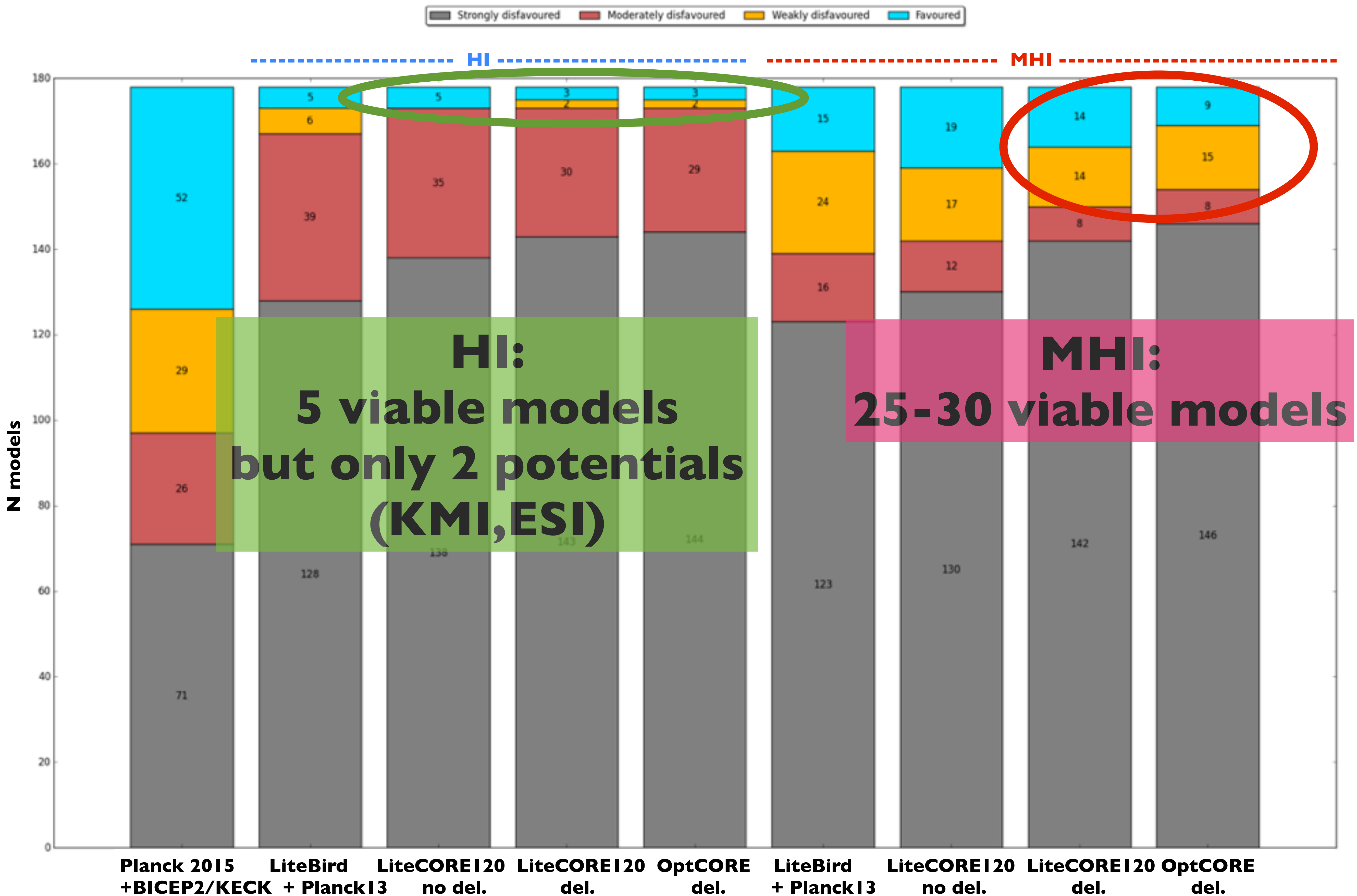
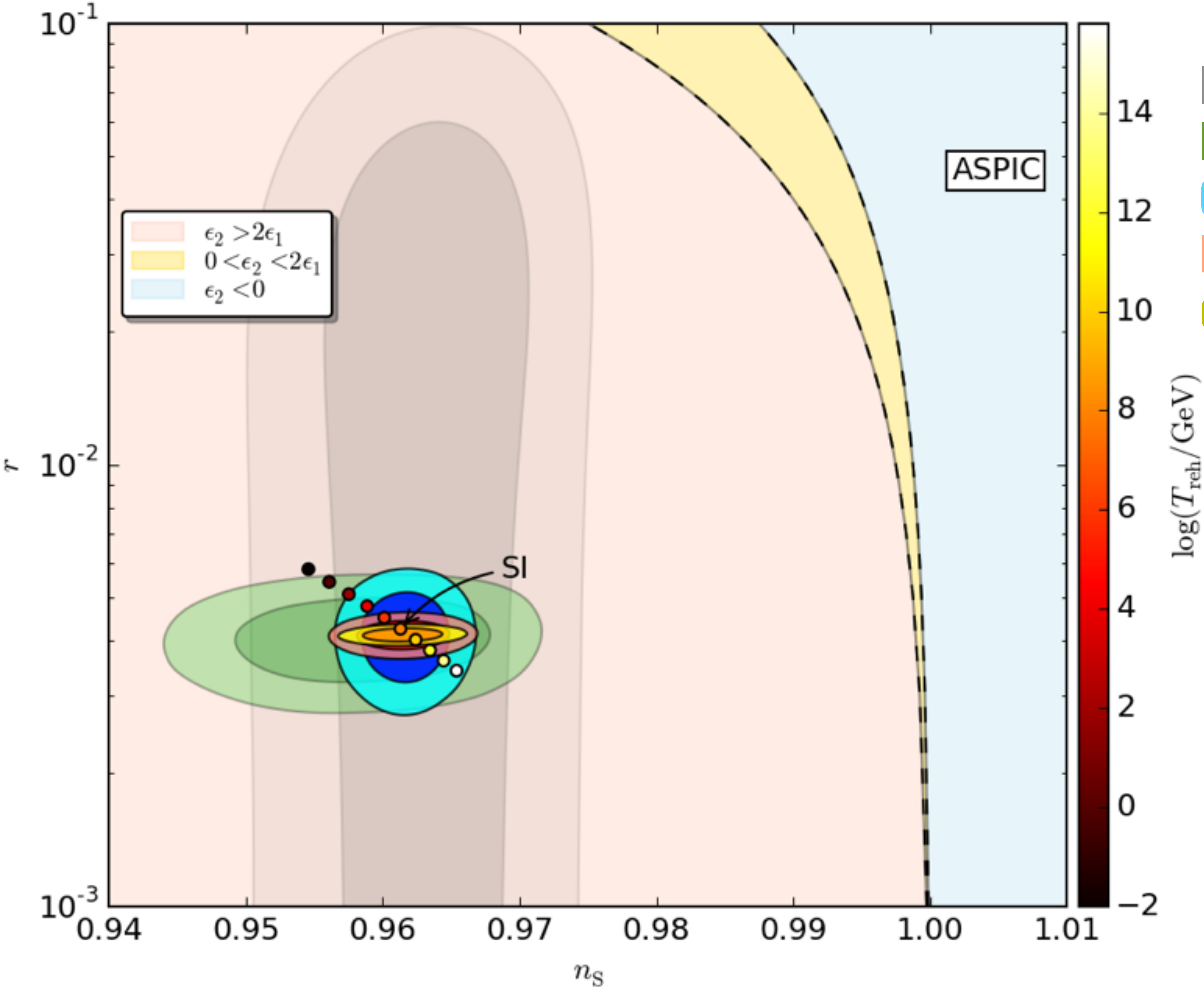


5. ...and constraints on reheating



Planck
LiteBird
CORE (no del.)
LiteCORE120 (del.)
optCORE (del.)

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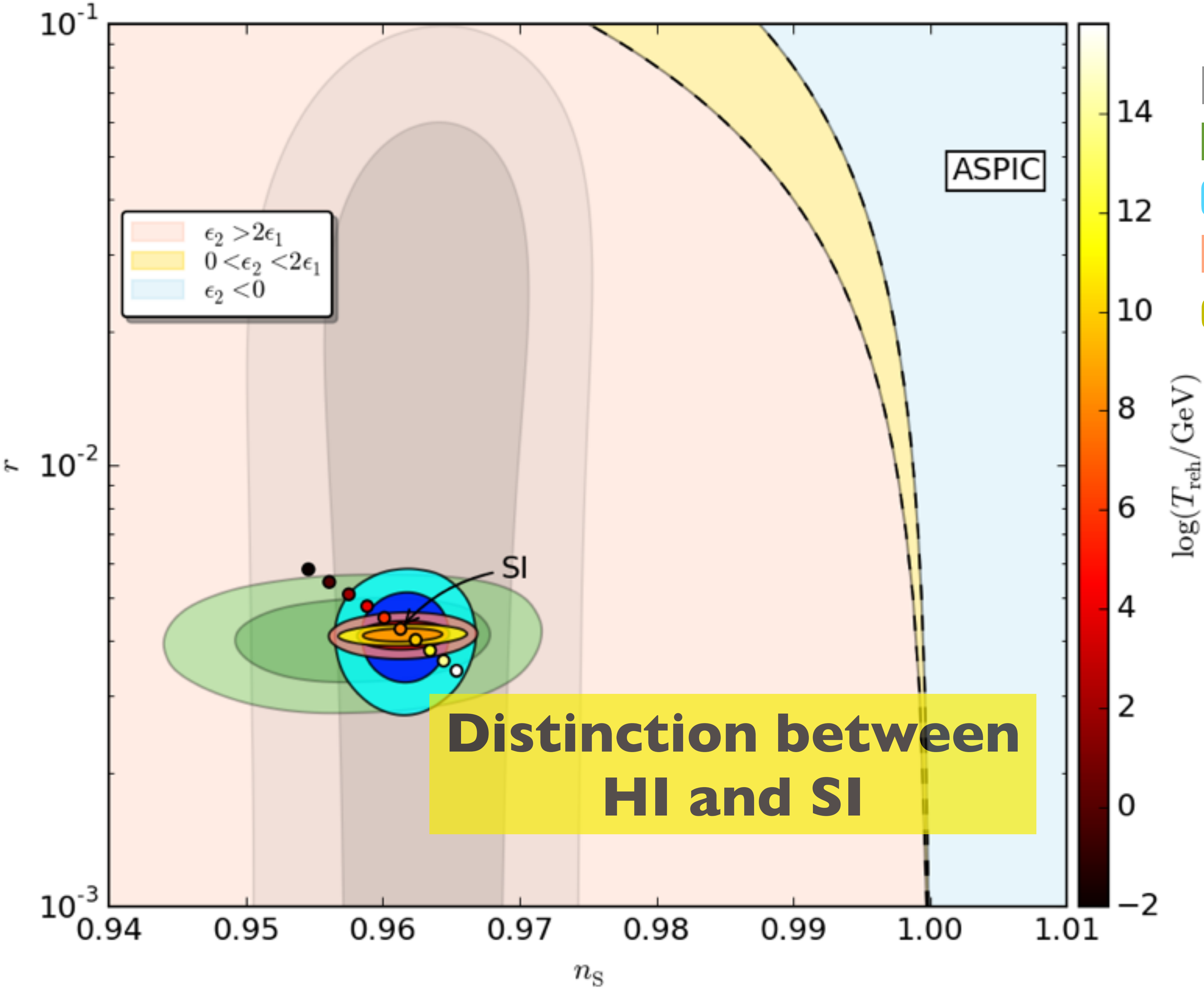

Planck
LiteBird
CORE (no del.)
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optCORE (del.)

Distinction between HI and SI

Conclusion

1. Size does not matter, sensitivity does!
2. If tensors, isolating a few models is possible...
3. ...and reheating temperature can be measured
4. If no tensors: ~25-30 viable models

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My preferred experiment:
LiteCORE120, 2x longer mission

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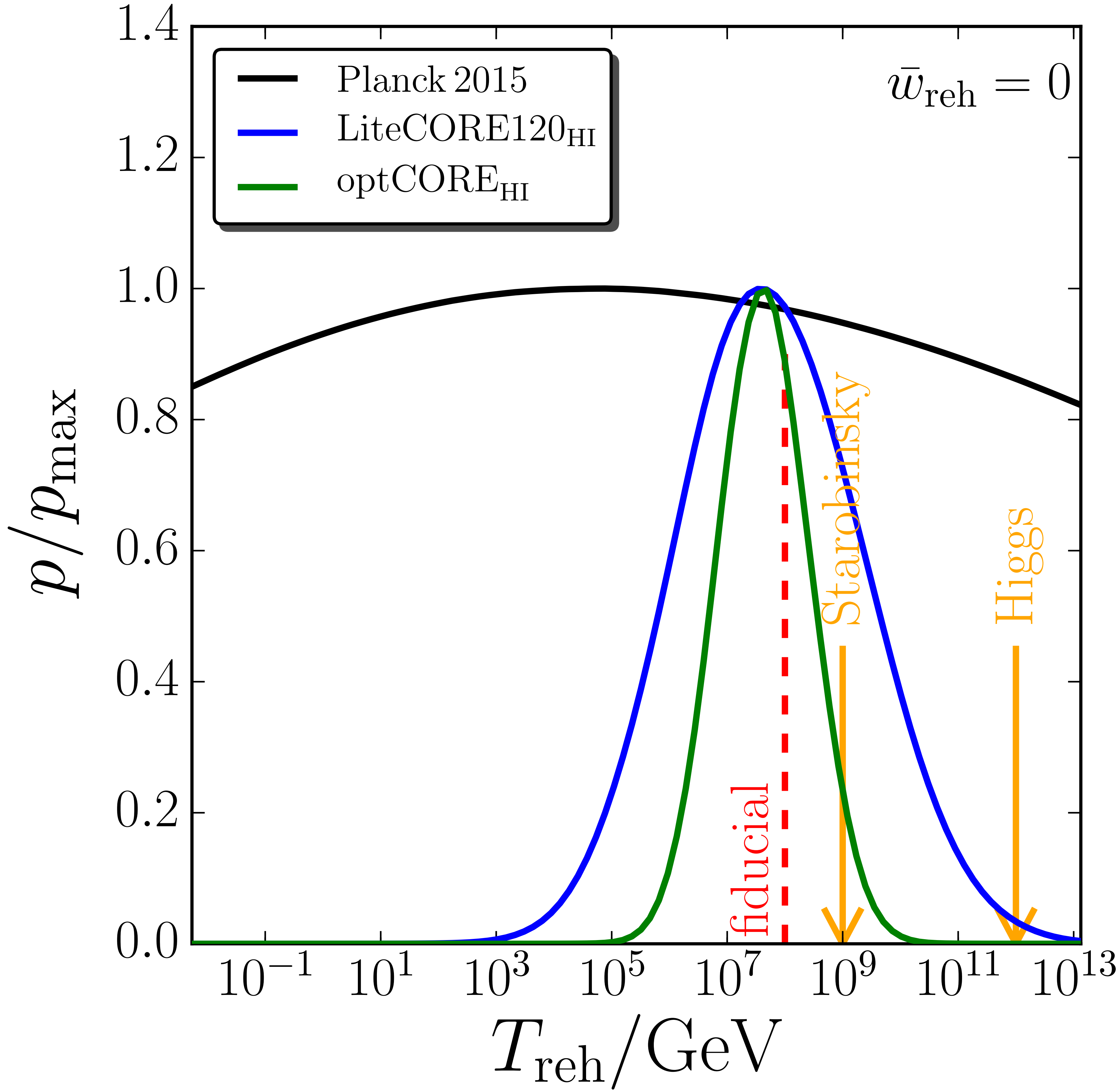
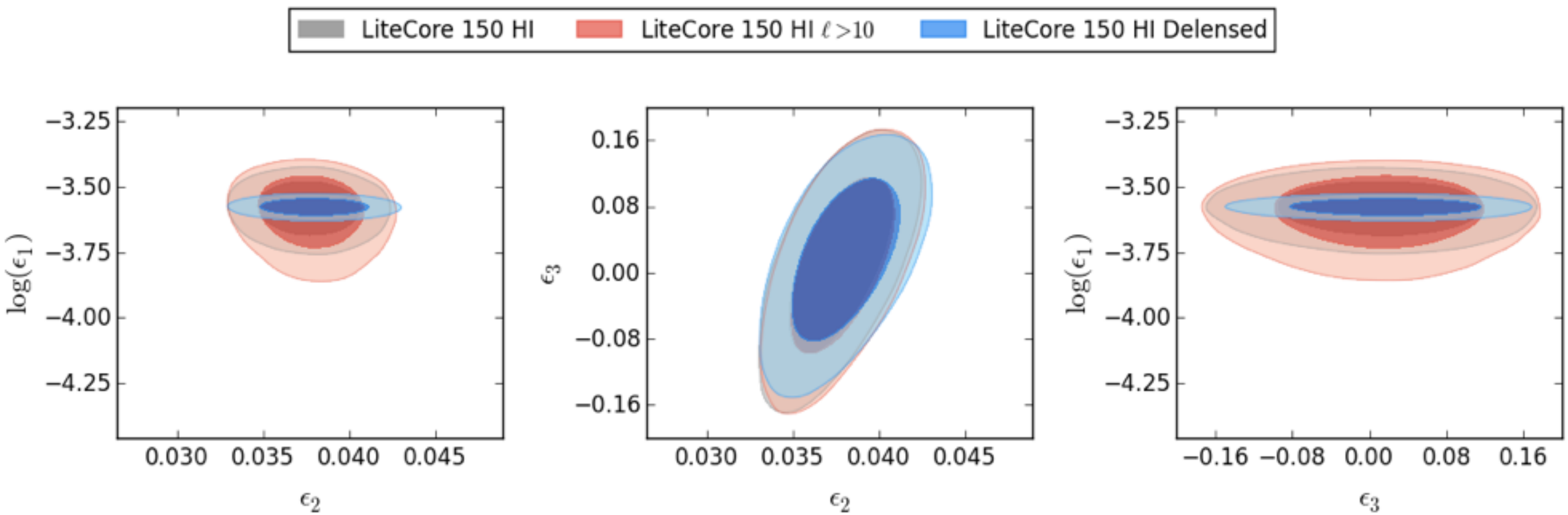
Conclusion

Thank you!



1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
$p/p_{\rm max}$
Planck 2015
LiteCORE120$_{\rm HI}$
optCORE$_{\rm HI}$
$\bar{w}_{\rm reh} = 0$
fiducial
Starobinsky
Higgs
10^{-1}
10^{1}
10^{3}
10^{5}
10^{7}
10^{9}
10^{11}
10^{13}
$T_{\rm reh}/{\rm GeV}$


LiteCore 150 HI
LiteCore 150 HI $\ell > 10$
LiteCore 150 HI Delensed
$\log(\epsilon_1)$
ϵ_2
ϵ_3
−3.25
−3.50
−3.75
−4.00
−4.25
0.030
0.035
0.040
0.045
0.16
0.08
0.00
−0.08
−0.16