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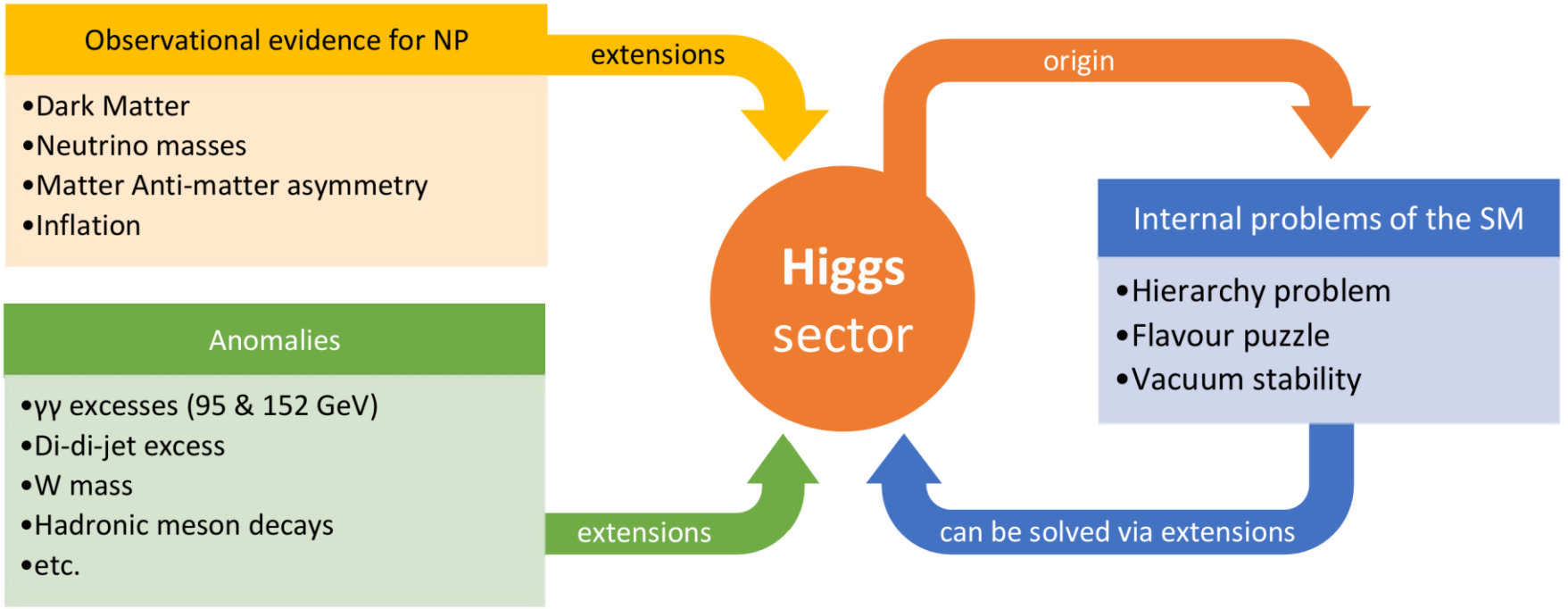
Discovery Prospects for the 95 GeV Higgs Candidate at CEPC

Guangzhou, 06.11.2025

Why new Higgses

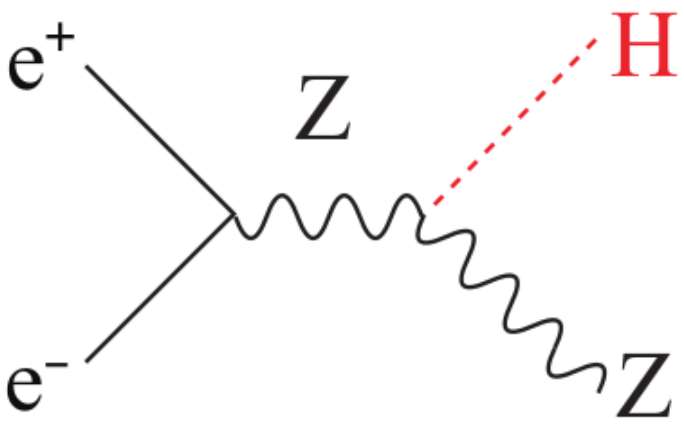
- No theoretical principle forbids new Higgses
- Nearly all top-down approached have new scalars



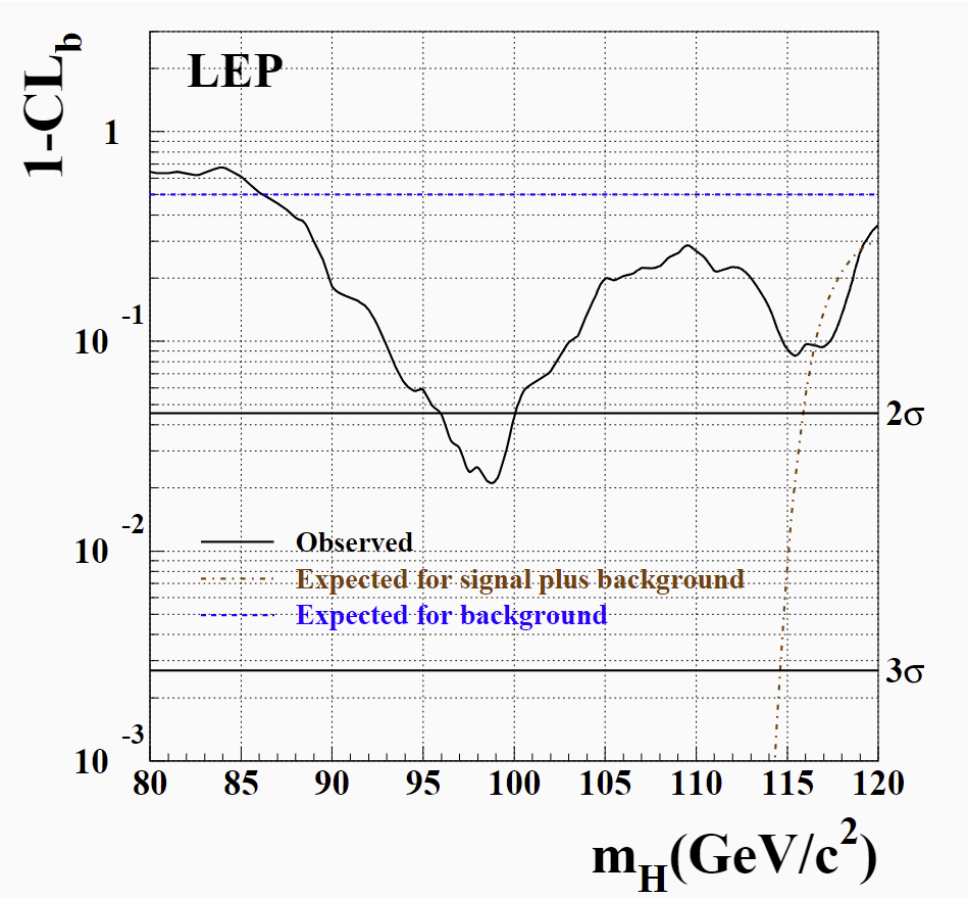
Higgs sector very promising place to expect NP

Hints for a 95 GeV Higgs

- LEP: $e^+e^- \rightarrow Z^* \rightarrow Z(H \rightarrow bb)$



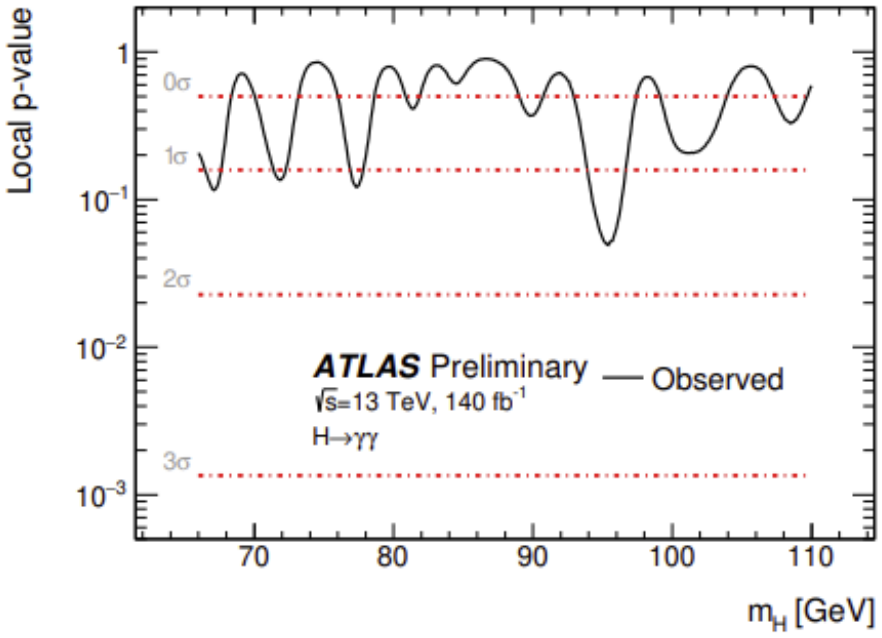
- Used the lower the search range

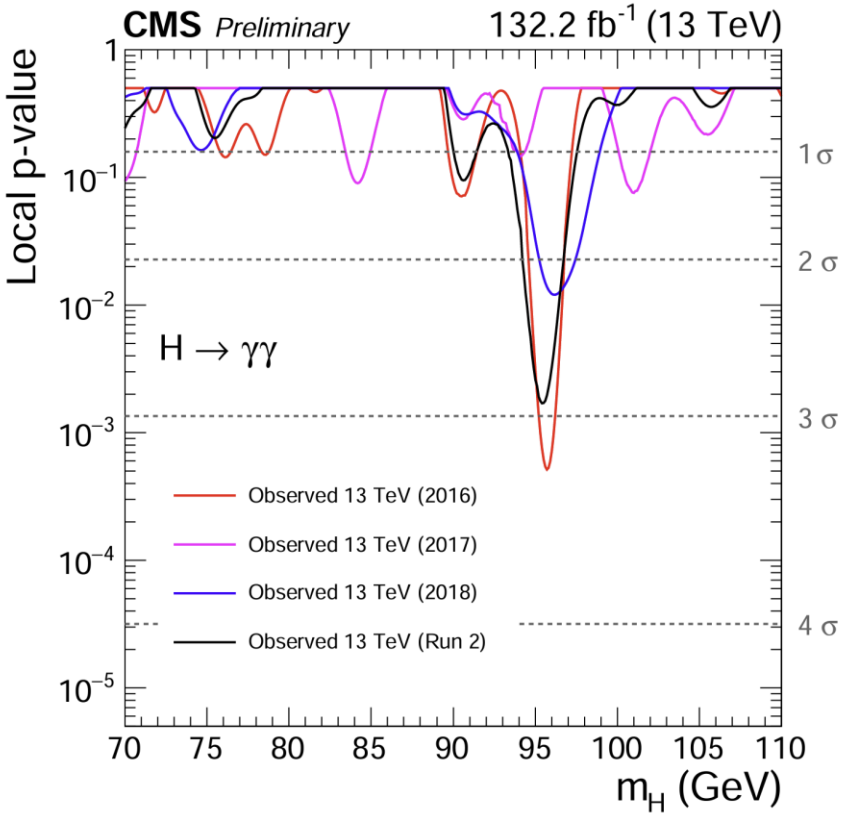


LEP excess compatible with 95 GeV

Hints for a 95 GeV Higgs

- ATLAS & CMS: γγ

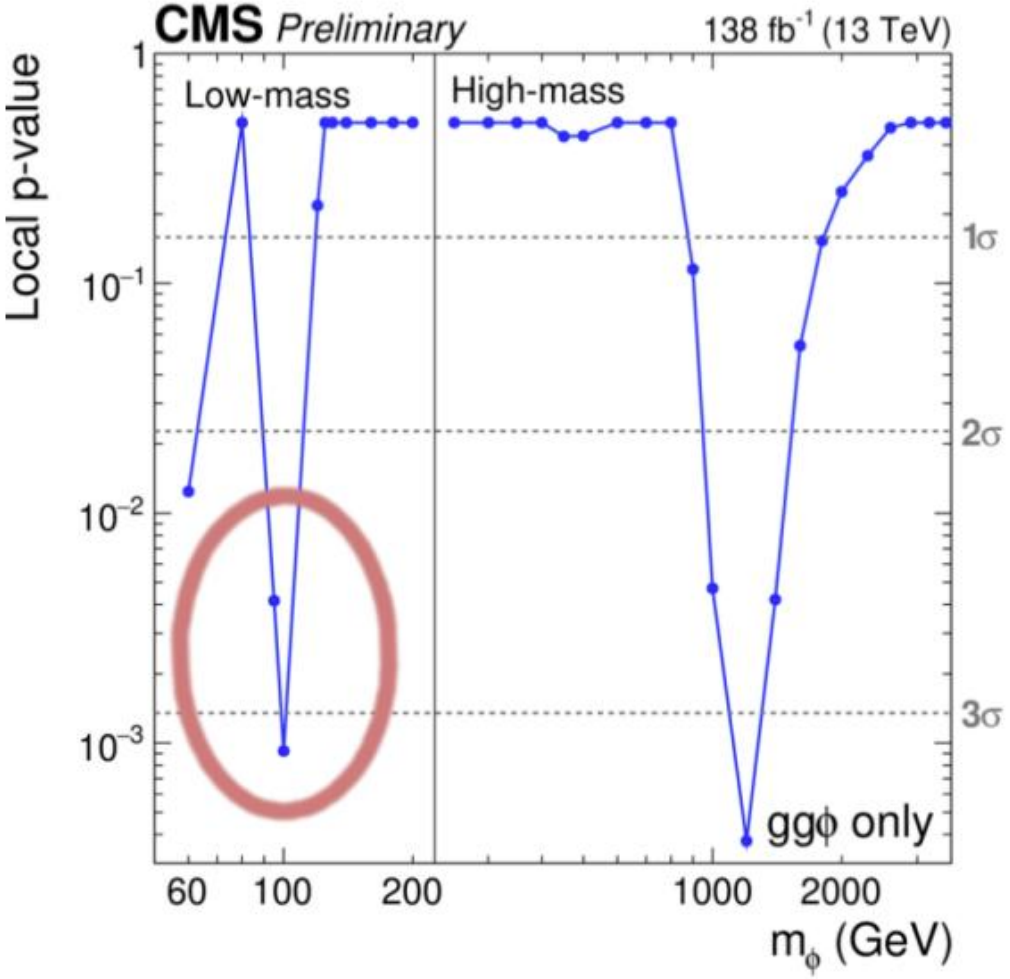




Nice agreement at 95 GeV

Hints for a 95 GeV Higgs

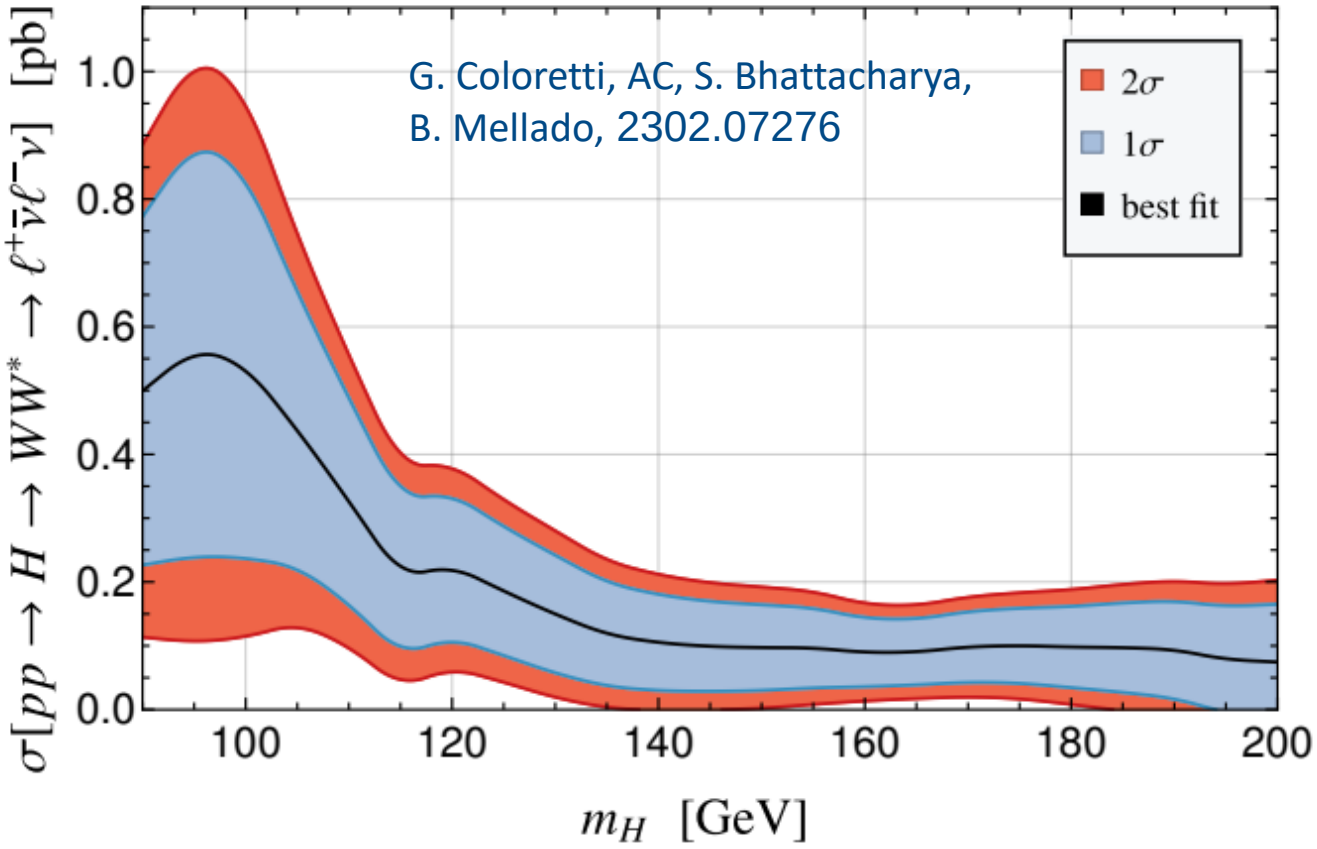
- CMS: ττ
- No dedicated ATLAS search
- No excess in the side-bands of the SM analysis



Reduced significance of <2σ

Low mass WW resonances searches

- ATLAS and CMS combination



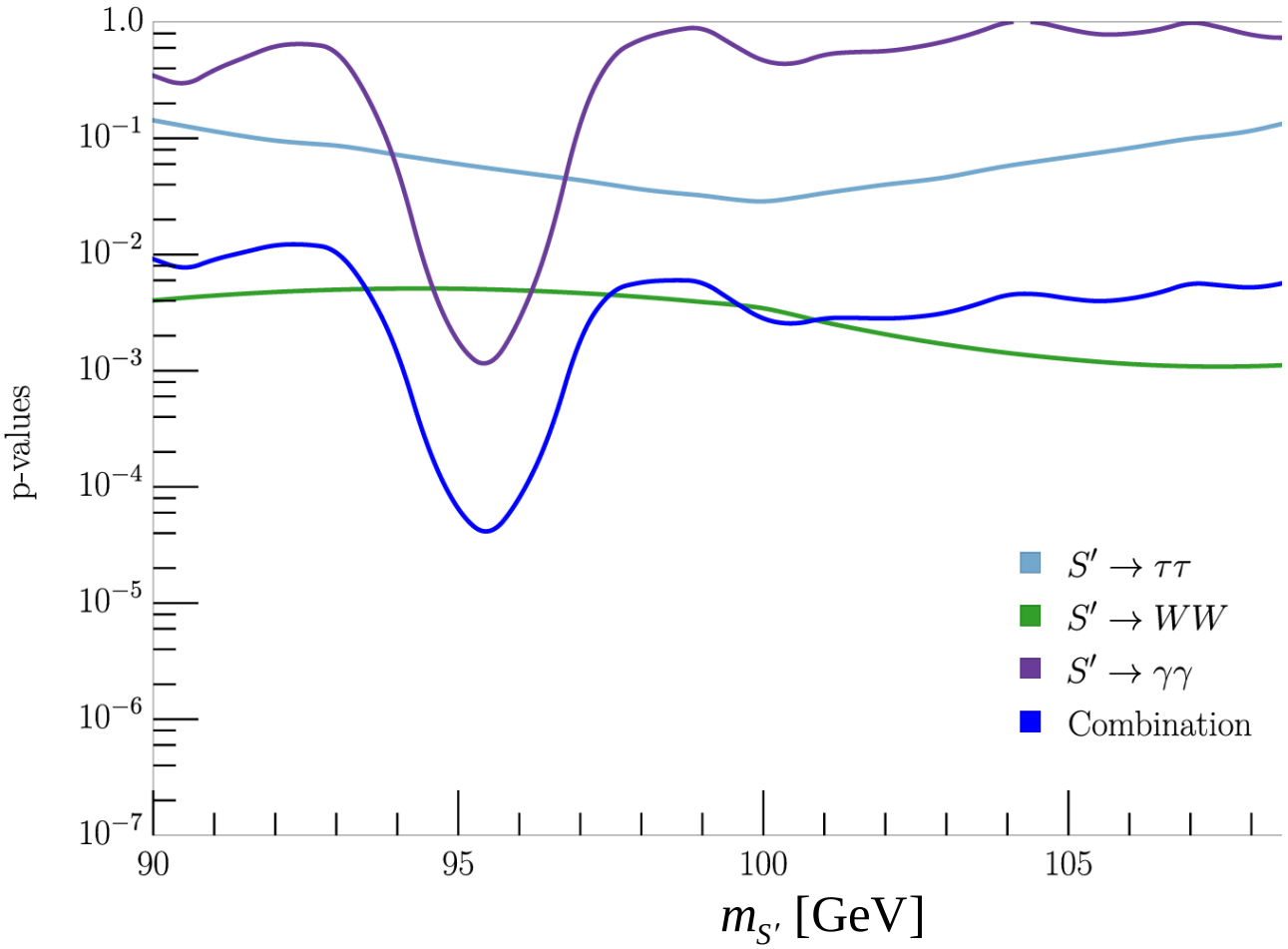
Transverse mass sensitive to additional missing energy from associated production

New physics effect preferred

95 GeV Combination

S. Bhattacharya, G. Coloretti, A. Crivellin, et al. arXiv:2306.17209

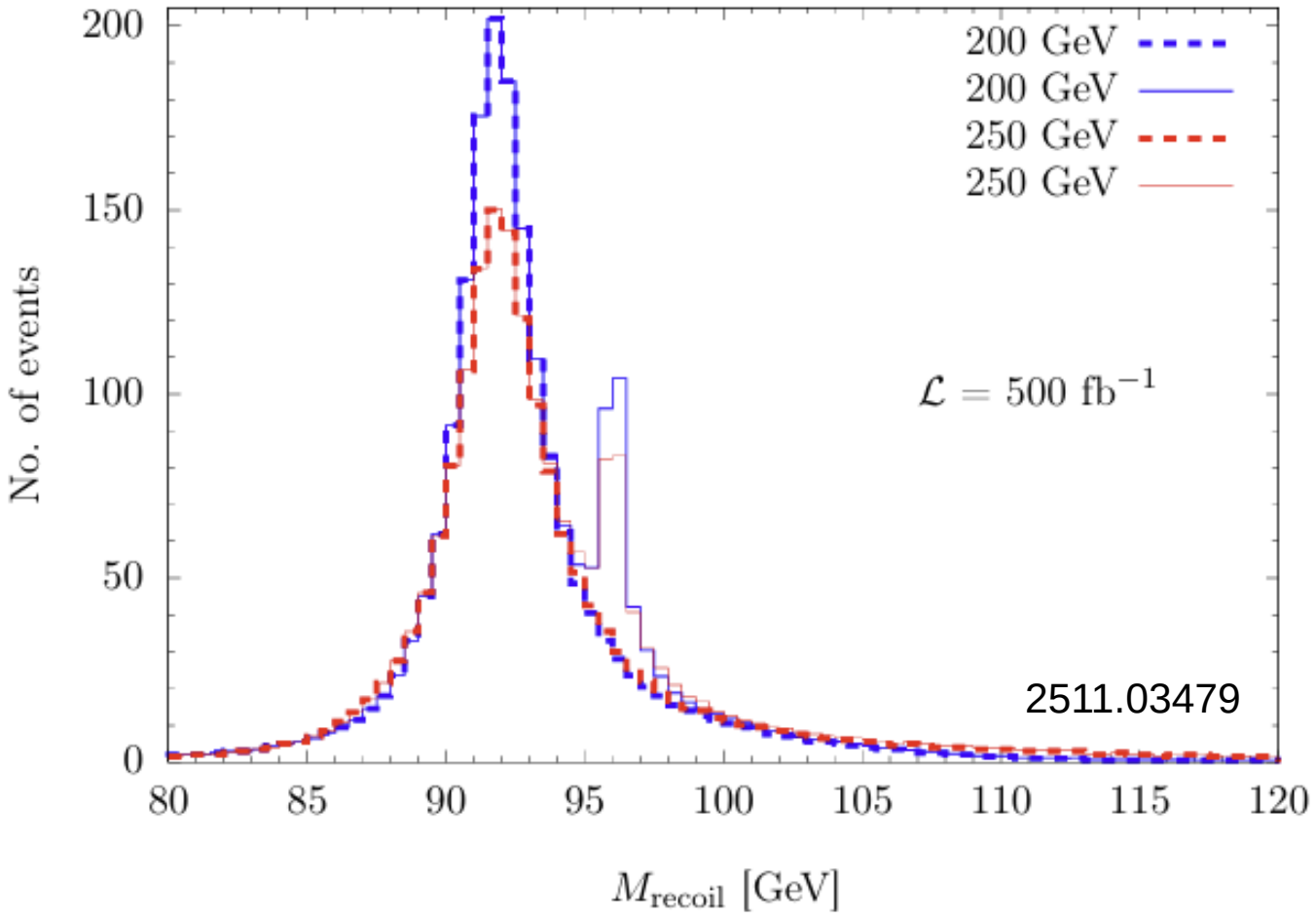
- LEP used to reduce the LLE



3.4σ global significance

Recoil Method

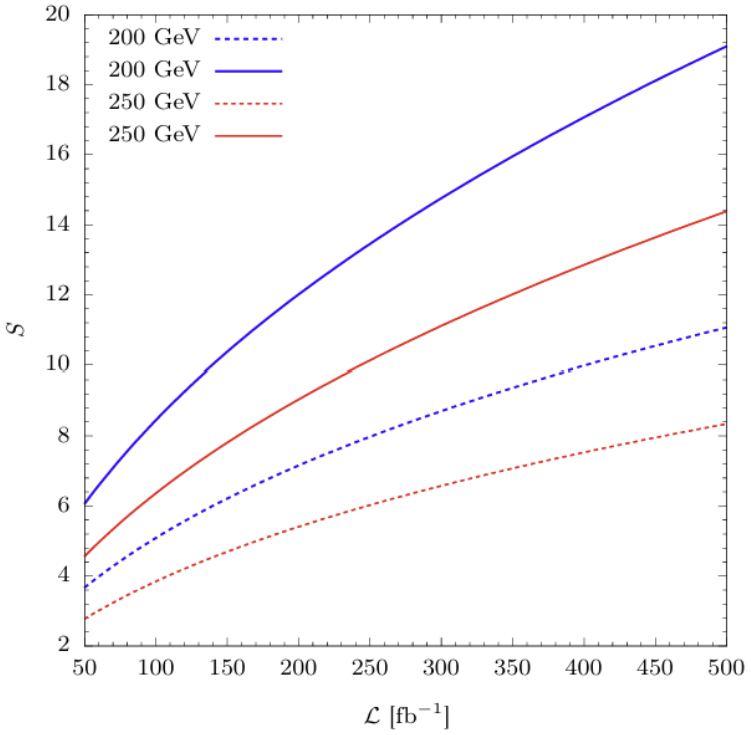
2407.16806



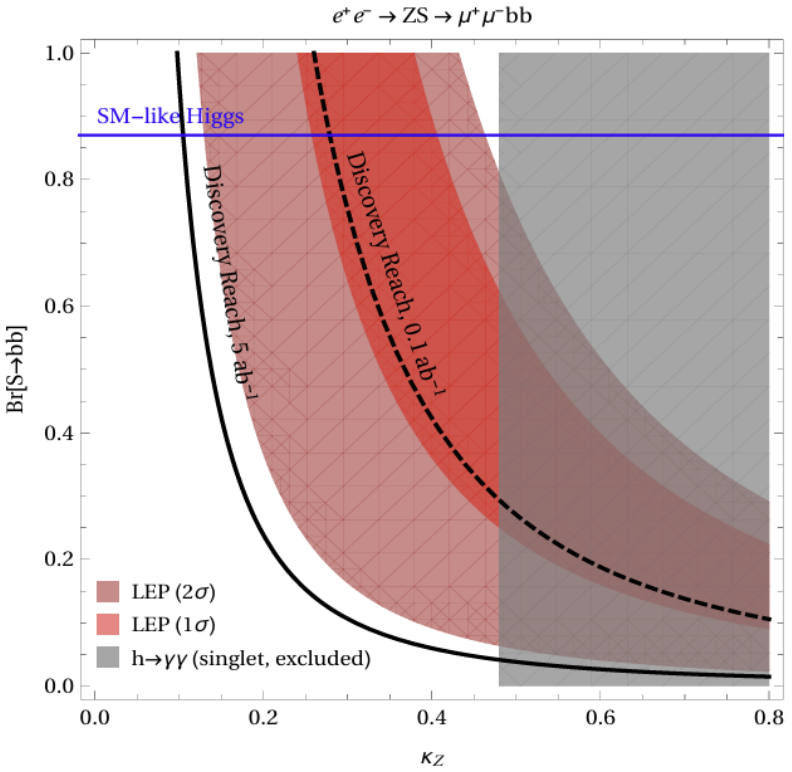
Enhances discovery prospects with DNN

Discovery potential

- 10% SM Higgs signal strength



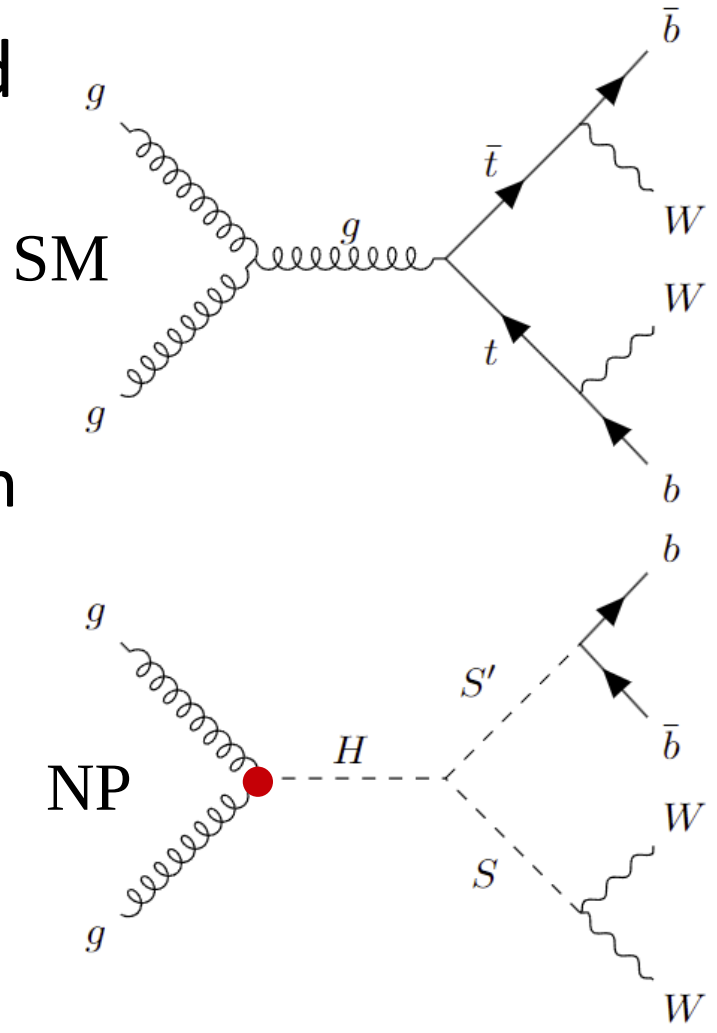
- Singlet case



Whole region preferred by LEP can be covered

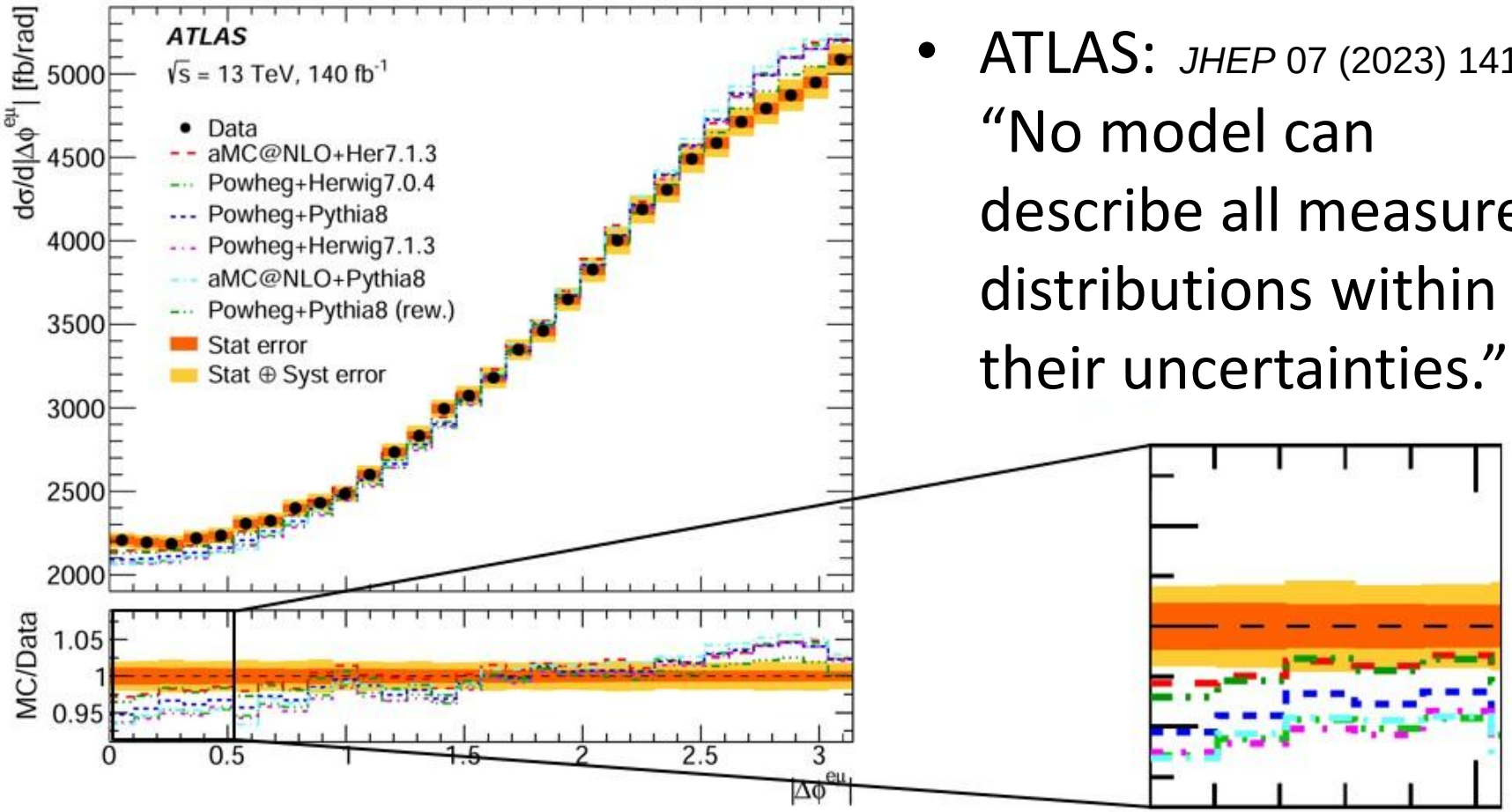
New Physics in Top-Quark Distributions

- ATLAS analysis normalized to the total cross section
  - only sensitive to the shape of NP
  - NP at small angels can explain deficit at large angles
- Associated production of new scalars decaying to WW and bb has a top-like signature



Related to the 95 GeV and 152 GeV hints?

Differential Top-Quark Distributions

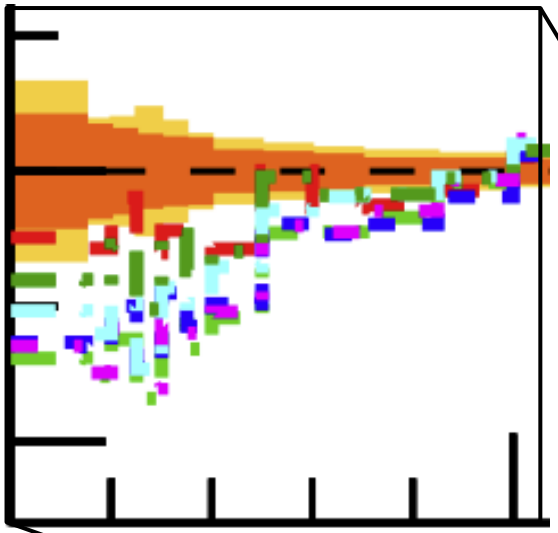


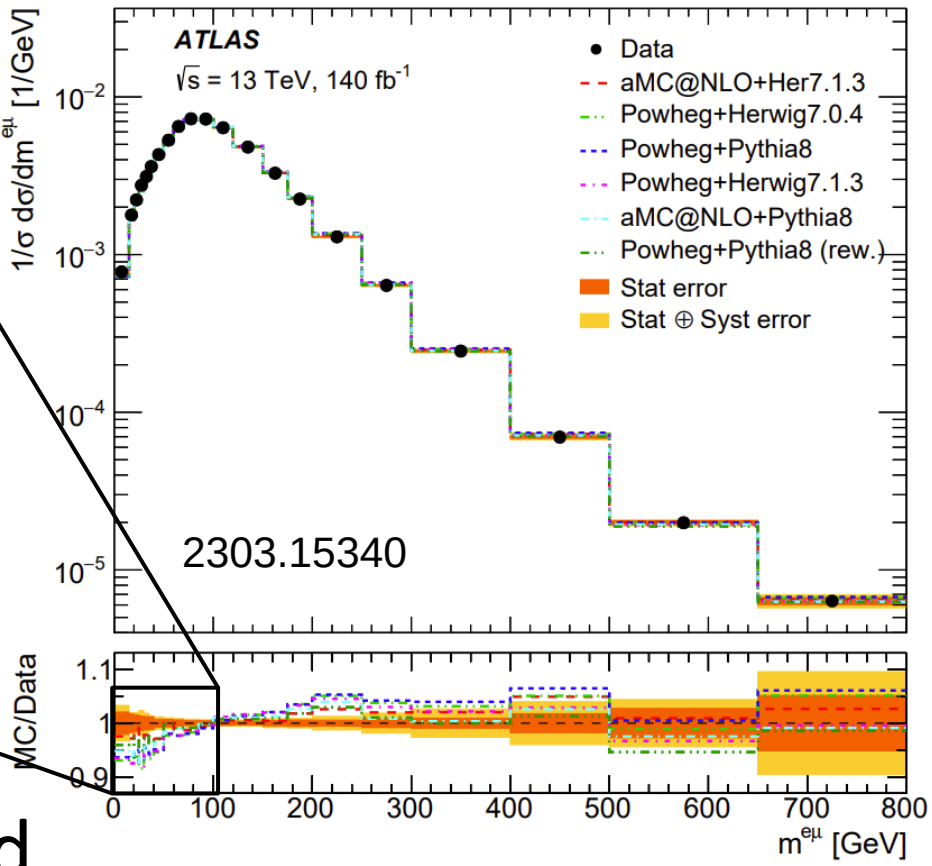
- ATLAS: *JHEP* 07 (2023) 141 "No model can describe all measured distributions within their uncertainties."

- $\Delta\phi^{e\mu}$ angle between the leptons from the W decays

New Physics pollution of this SM measurement?

Differential Top-Quark Distributions



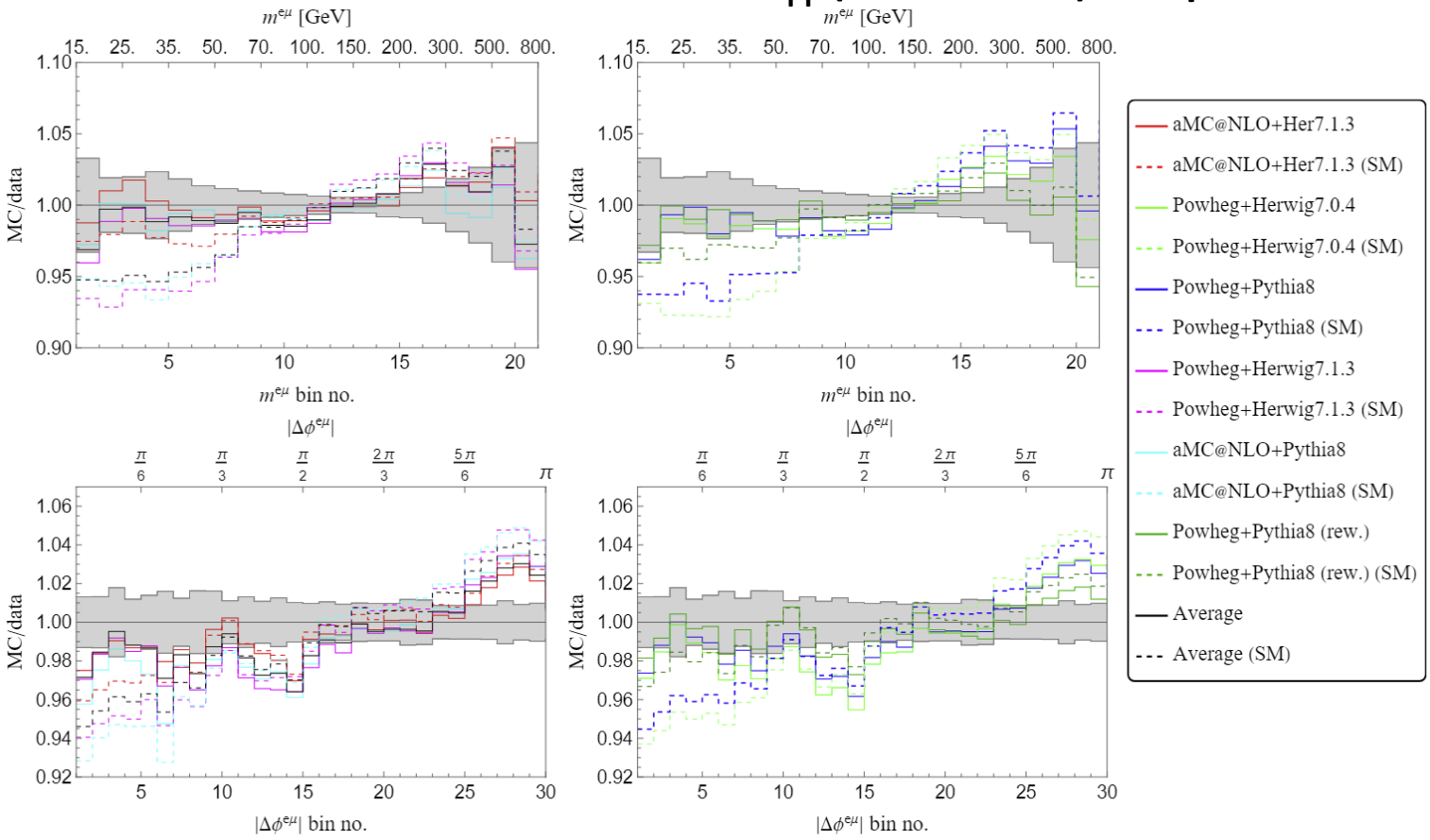


- ATLAS:
  "No model can describe all measured distributions within their uncertainties."

New Physics pollution of this SM measurement?

Simplified Model: H→SS'→WWbb 2308.07953

- Fix m_S=151.5GeV and $m_{S'}$=95GeV by the hints for narrow resonances. Weak m_H (270GeV) dependence.



Deficit at large $\Delta\phi^{e\mu}$ & $m^{e\mu}$ explained as well

Simplified Model: H→SS'→WWbb 2308.07953

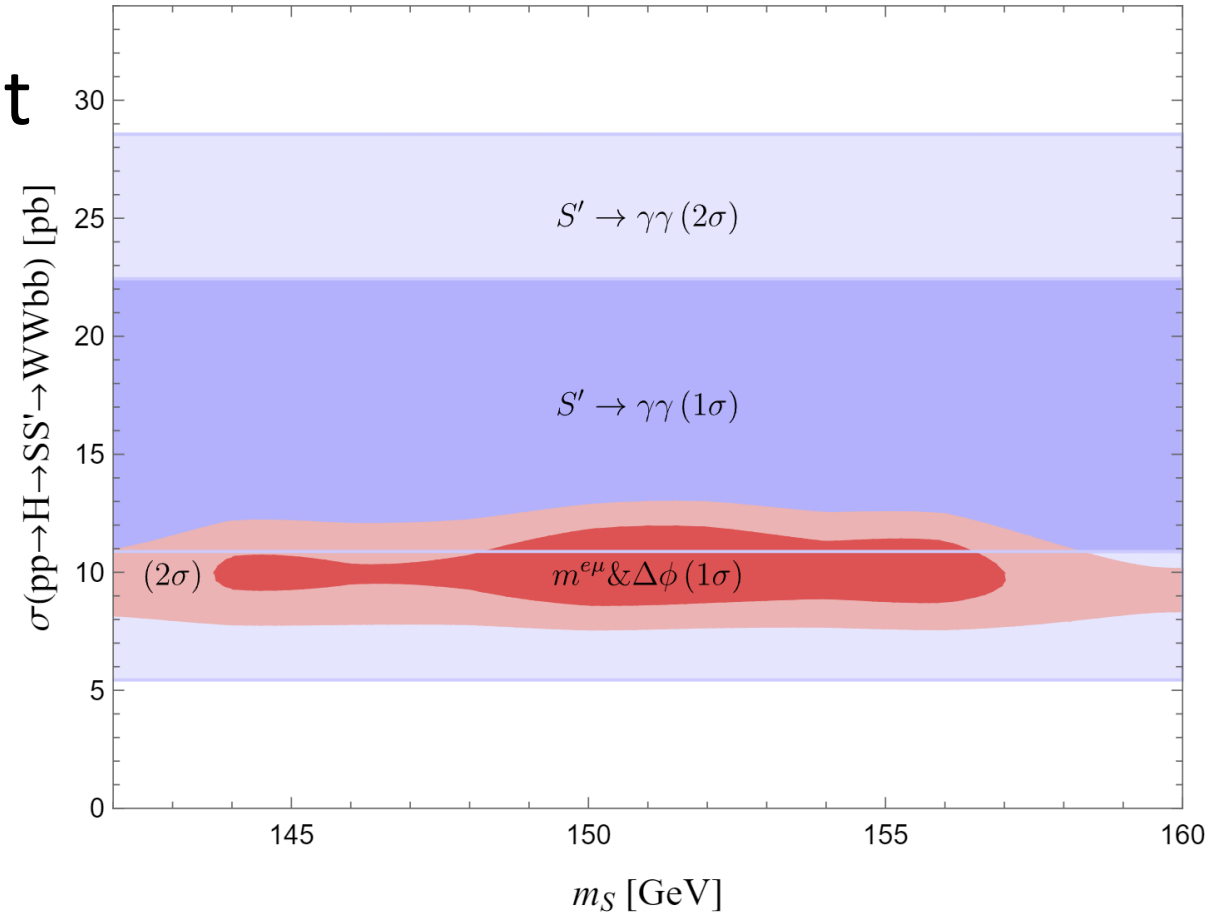
Monte Carlo	$\chi^2_{\rm SM}$	$\chi^2_{\rm NP}$	$\sigma_{\rm NP}$	Sig.	m_S[GeV]
Powheg+Pyhtia8	213	102	9pb	10.5σ	$143-156$
aMC@NLO+Herwig7.1.3	102	68	5pb	5.8σ	$--$
aMC@NLO+Pythia8	291	163	10pb	11.3σ	148-157
Powheg+Herwig7.1.3	261	126	10pb	11.6σ	149-156
Powheg+Pythia8 (rew)	69	35	5pb	5.8σ	$--$
Powheg+Herwig7.0.4	294	126	12pb	13.0σ	149-156
Average	182	88	9pb	9.6σ	143-157

- Improvement of SM prediction imperative!

Agreement with data significantly improved (>5σ)

Is 95 GeV a singlet? Relation to 151.5 GeV?

- S'(95): Singlet decays dominantly to bb
- S(152): decays dominantly to WW



Consistent with 95 GeV γγ signal strength & a mass of S of 152 GeV

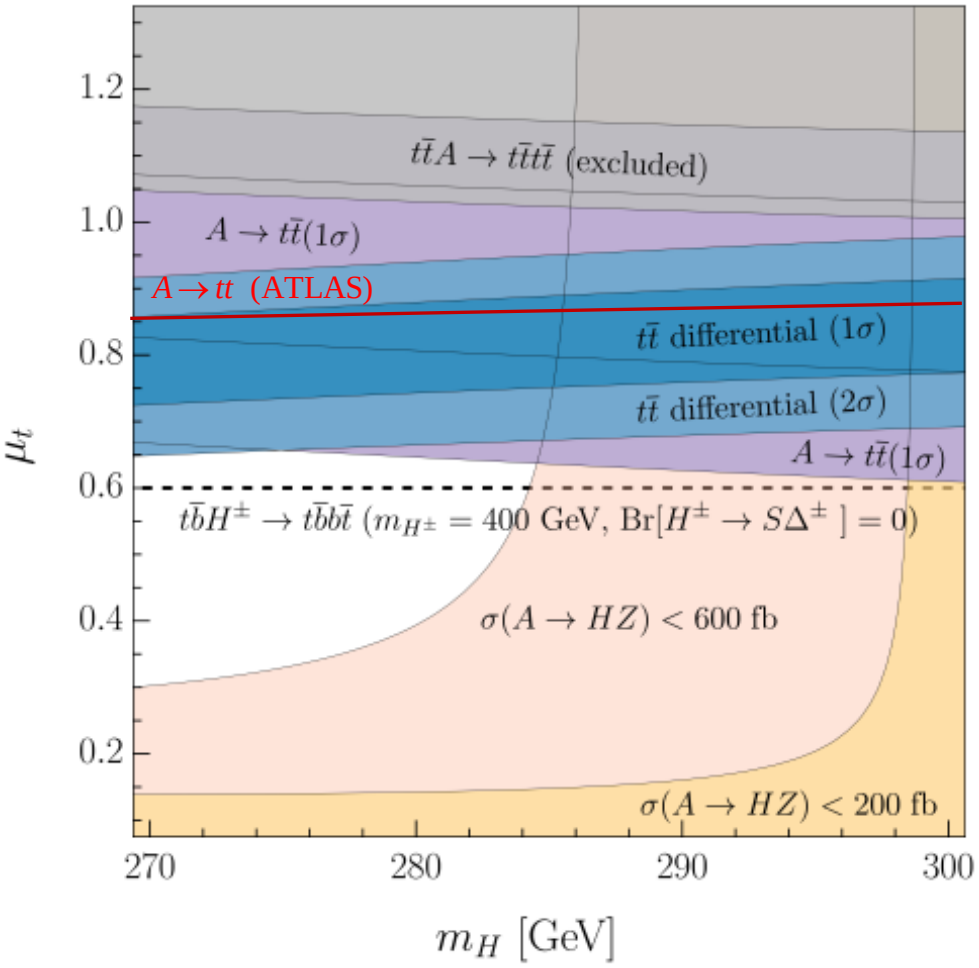
Δ2HDMS and top-quark production

Field	$SU(2)_L$	$U(1)_Y$
ϕ_s	1	0
ϕ_2	2	1/2
ϕ_1	2	1/2
Δ	3	0

Explains:

- Top-quark differential distributions
- Di-photon excesses
- Resonant top-quark production Elevated 4-top cross section

G. Coloretti, A.C. and B. Mellado, 2312.17314



Combined explanation possible

Conclusions

- Hints for narrow resonances at 95 GeV in:
  - Di-photons
  - WW
  - Di-tau
  - Z+bb
- CEPC can cover whole region preferred by LEP
- Interesting correlations with the excesses at 152 GeV and differential top-quark distributions