

Mono-Higgs heavy scalar models

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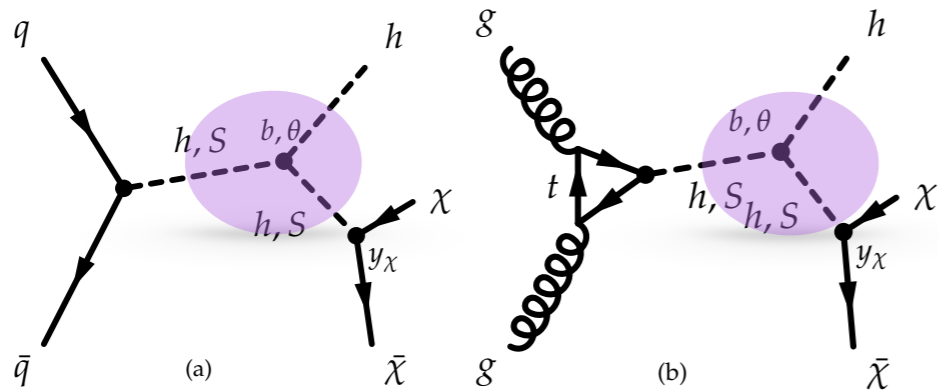
LPNHE, Institute Lagrange de Paris
On behalf of the ATLAS Mono-Higgs Group

LHC Dark Matter WG public meeting

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Mono-Higgs from a scalar mediator



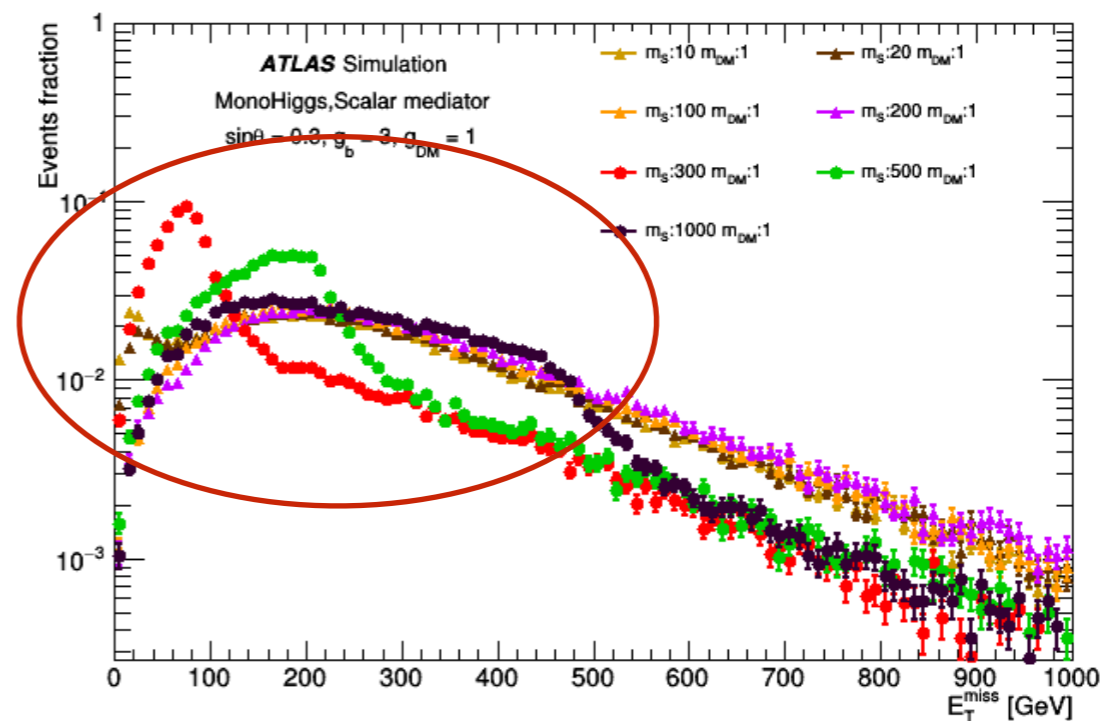
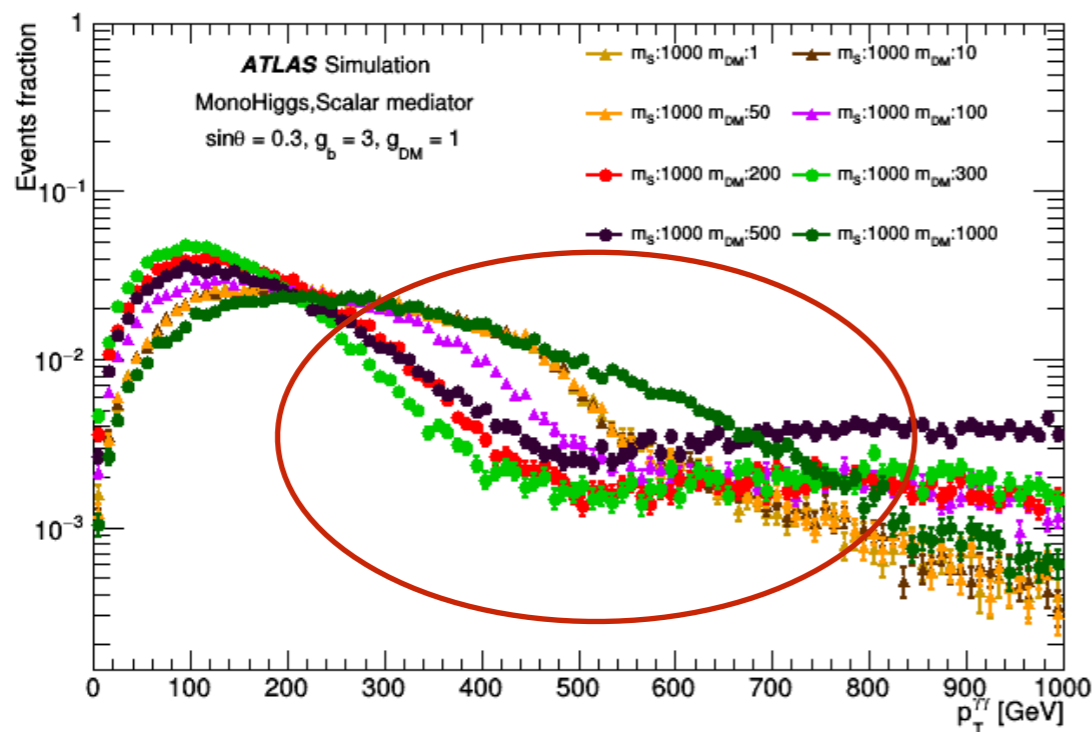
$$\mathcal{L} \supset -y_\chi \bar{\chi} \chi (\cos \theta S - \sin \theta h) - \frac{m_q}{v} \bar{q} q (\cos \theta h + \sin \theta S)$$

$$\frac{\sin \theta}{v} (2m_h^2 + m_S^2) h^2 S + b v h S^2 + \dots$$

- From DM report (1507.00966)
- a benchmark for this mono-higgs scalar model:
 - $b=3$: coupling between new scalar and SM Higgs
 - Yukawa-like coupling of new scalar to DM: $y_\chi=1$,
 - mixing angle of new scalar S and Higgs: $\sin\theta=0.3$

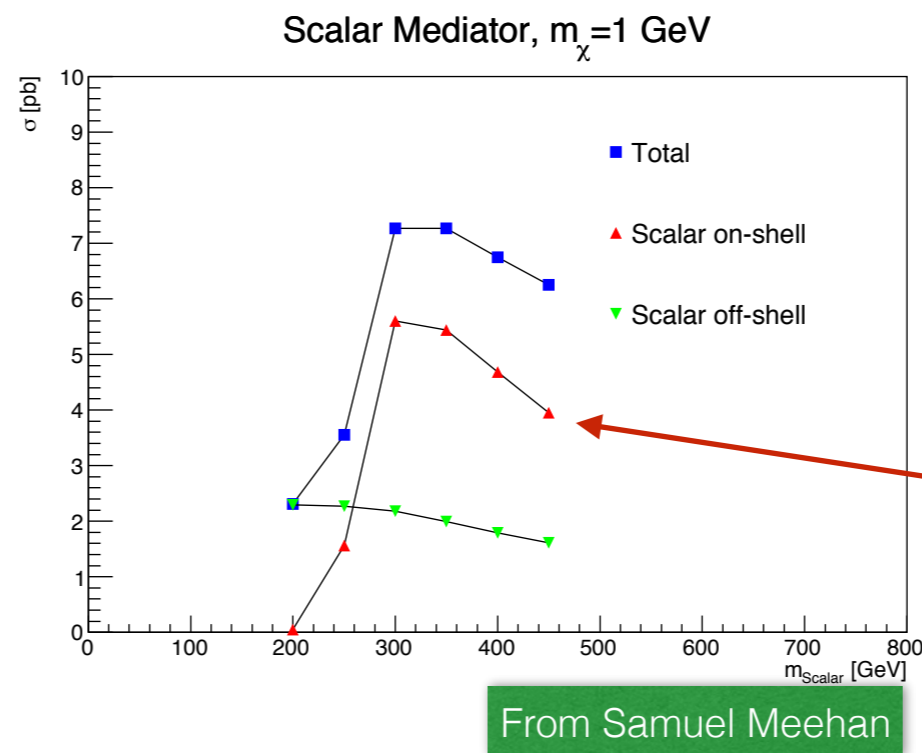
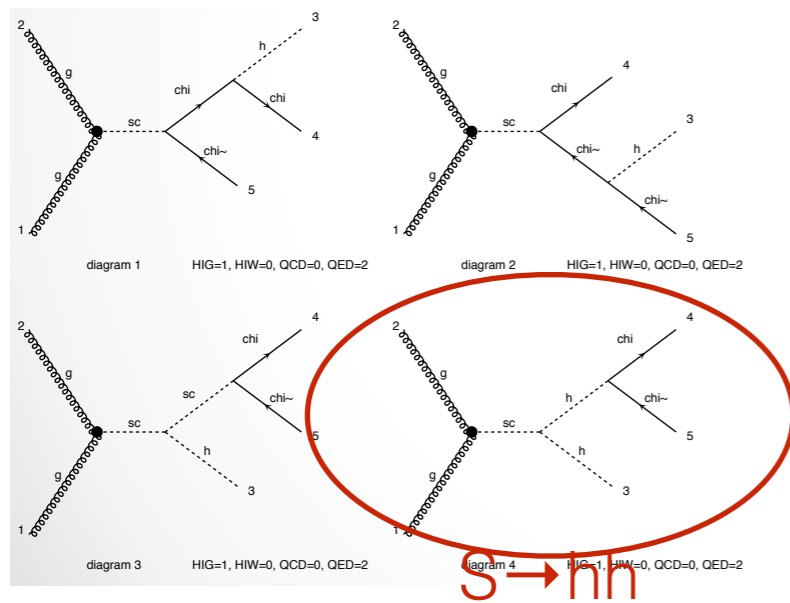
Mono-Higgs from a scalar mediator

- However
 - ◉ With the recommended parameter setting (in 1507.00966), we see a strange shape at yy p_T and E_T^{miss} when $m_S \sim 2m_\chi + m_h$
 - ◉ We think the recommended mixing angle $\sin\theta=0.3$ was **overestimated**



Overestimated mixing angle

- The mixing angle $\sin\theta$ was recommended to be 0.3:
 - come from Run 1 Higgs data: $\sin\theta \leq 0.4$



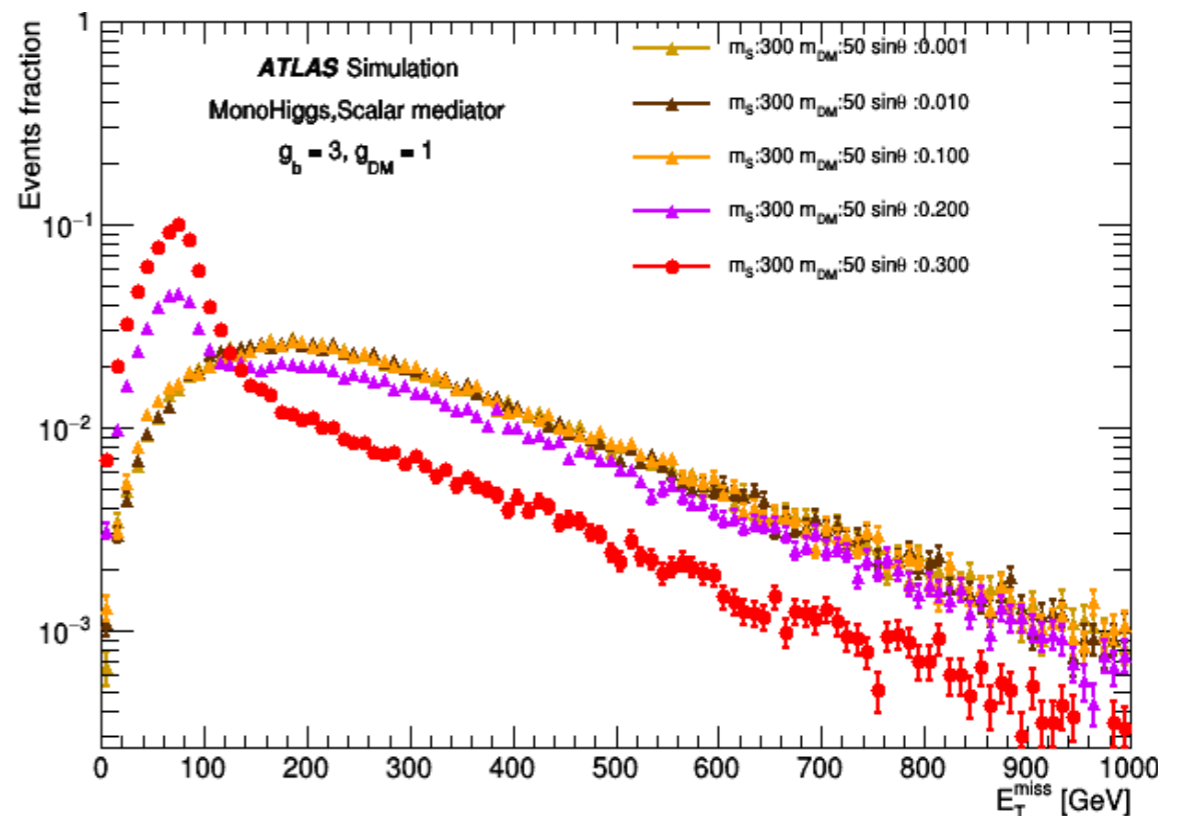
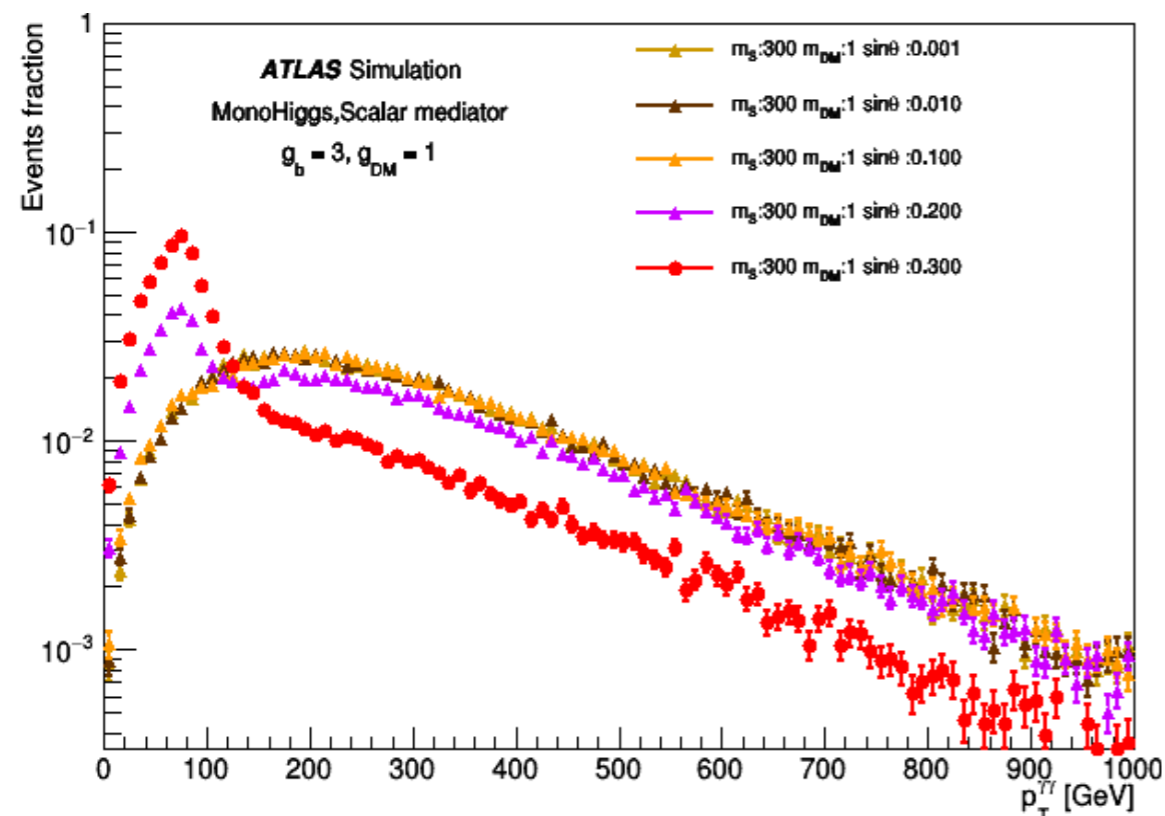
$$V_{\text{cubic}} \approx \frac{\sin\theta}{v} (2m_h^2 + m_S^2) h^2 S + b v h S^2 + \dots$$

- the large $\sin\theta$ will give huge weight on the resonant $S \rightarrow hh$ diagram

- Scans on DM report unfortunately didn't see this dependence of kinematics on mixing angle because of the mass is chosen to plot

Suggestions From ATLAS Mono-Higgs

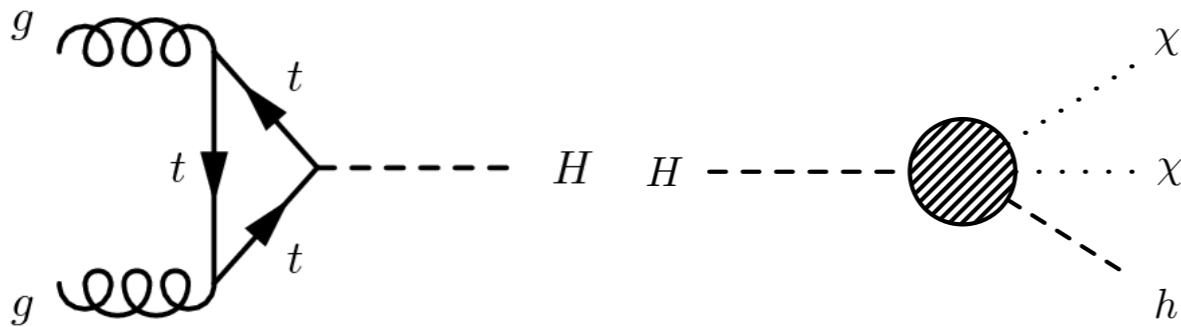
- Is the recommended (1507.00966) mixing angle $\sin\theta = 0.3$ overestimated?



- We suggest to use $\sin\theta = 0.1$ as a revised benchmark for both experiments

EFT heavy scalar model

- Besides the recommended mono-Higgs models, in ATLAS mono-H(yy) searches, we had taken on a search for a heavy scalar which can decay to a SM Higgs in association with ETmiss
- This scalar, **H**, is assumed to be produced through gluon fusion
- H is being searched for in the range of $2m_h < m_H < 2m_t$ (1506.00612)
- H is chosen to decay to $h\chi\chi$ through an effective vertex



$$\mathcal{L}_Q = \boxed{-\frac{1}{2}\lambda_{Hh\chi\chi} Hh\chi\chi} - \frac{1}{4}\lambda_{HHhh} HHhh - \frac{1}{4}\lambda_{hh\chi\chi} hh\chi\chi - \frac{1}{4}\lambda_{HH\chi\chi} HH\chi\chi,$$

