Karlsruhe Institute of Technology

Status update: NLO reweighting for MSSM samples

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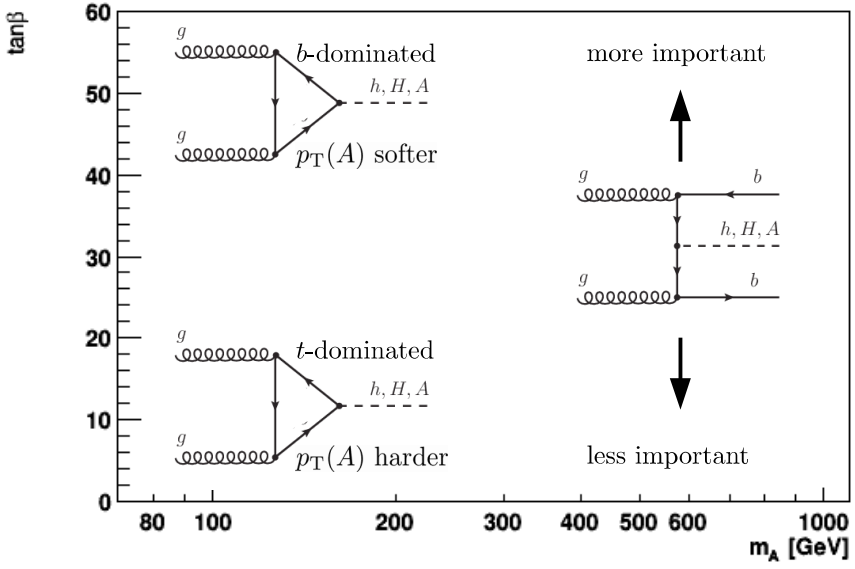
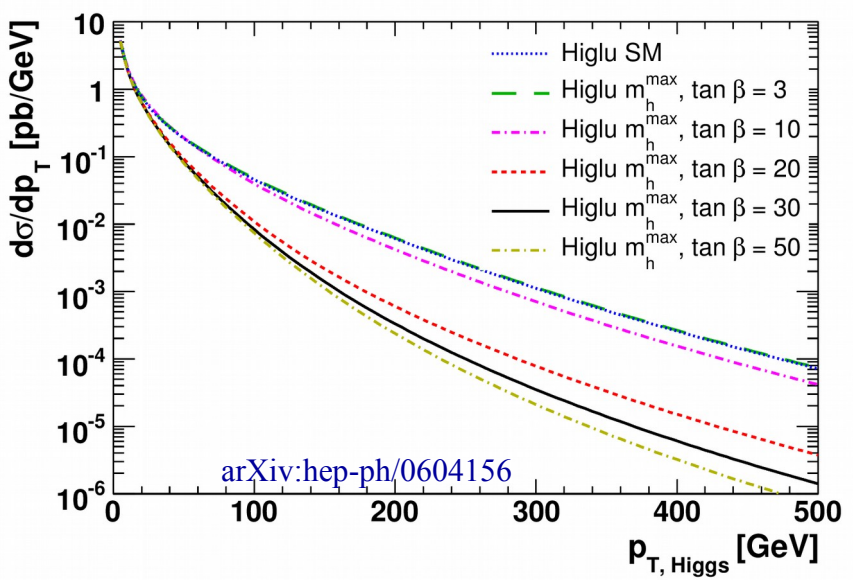
MSSM $H \to \tau\tau$

- In the MSSM the coupling to down-type quarks and fermions is enhanced by $\tan\beta$
- With increasing $\tan\beta$ $bb \to \phi$ dominates over $gg \to \phi$
- Also b dominates over t in the $gg \to \phi$ loop
  - Affects the $p_{\mathrm{T}}(\mathrm{A})$ distribution





Reweighting by Higgs p_{T}

- Produce t+b interference term using POWHEG MSSM NLO at given reference point in m_{A} and $\tan\beta$

$$\left(\frac{Y'_{\mathrm{t,MSSM}}}{Y'_{\mathrm{t,SM}}}\right)^2 \sigma^t_{\mathrm{SM}}(Q_t) + \left(\frac{Y'_{\mathrm{b,MSSM}}}{Y'_{\mathrm{b,SM}}}\right)^2 \sigma^b_{\mathrm{SM}}(Q_b) + \frac{Y'_{\mathrm{t,MSSM}}}{Y_{\mathrm{t,MSSM}}}\frac{Y'_{\mathrm{b,MSSM}}}{Y_{\mathrm{b,MSSM}}} \left(\sigma^{t+b}_{\mathrm{MSSM}}(Q_{tb}) - \left(\frac{Y_{\mathrm{t,MSSM}}}{Y_{\mathrm{t,SM}}}\right)^2 \sigma^t_{\mathrm{SM}}(Q_{tb}) - \left(\frac{Y_{\mathrm{b,MSSM}}}{Y_{\mathrm{b,SM}}}\right)^2 \sigma^b_{\mathrm{SM}}(Q_{tb})\right)$$

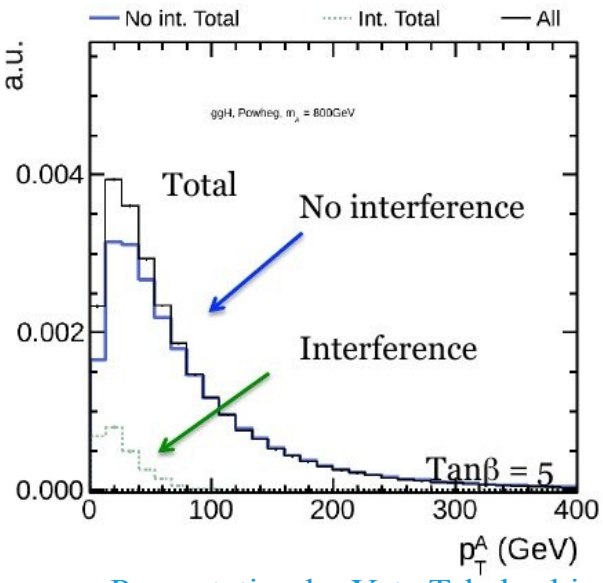
Yukawa Coupling Coefficient

Interference Term

Function of tanβ

Function of m_A

- Avoids large cancellations in the interference term
- Validate that the dependence of the interference term on $\tan\beta$ is small



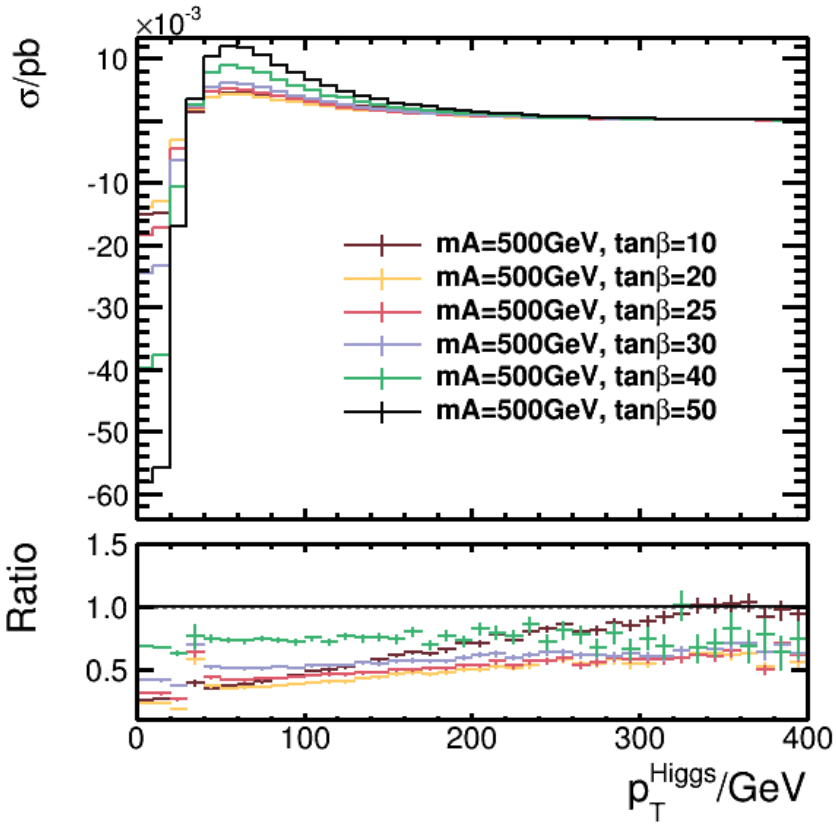
Presentation by Yuta Takahashi

Changes with respect to last time

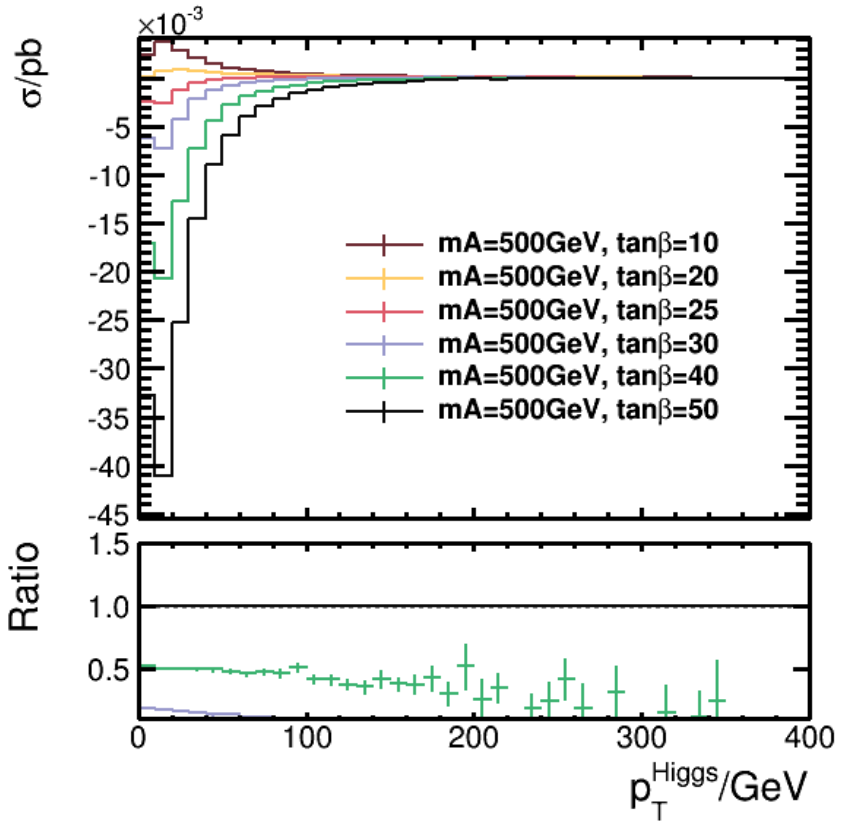
- Found a bug in the used POWHEG configuration files used for the SM samples
  - The Higgs-mass parameter was not substituted correctly for each mass-point
- After discussion with Emanuele and Stefan
  - For the interference term switch from evaluating in the MSSM to evaluating in the 2HDM model (samples and coupling coefficients)

$$\sigma^{t+b}_{\mathrm{MSSM}}(Q_{tb}) - \left(\frac{Y_{\mathrm{t,MSSM}}}{Y_{\mathrm{t,SM}}}\right)^2 \sigma^{t}_{\mathrm{SM}}(Q_{tb}) - \left(\frac{Y_{\mathrm{b,MSSM}}}{Y_{\mathrm{b,SM}}}\right)^2 \sigma^{b}_{\mathrm{SM}}(Q_{tb}) \Rightarrow \sigma^{t+b}_{\mathrm{2HDM}}(Q_{tb}) - \left(\frac{Y_{\mathrm{t,2HDM}}}{Y_{\mathrm{t,SM}}}\right)^2 \sigma^{t}_{\mathrm{SM}}(Q_{tb}) - \left(\frac{Y_{\mathrm{b,2HDM}}}{Y_{\mathrm{b,SM}}}\right)^2 \sigma^{b}_{\mathrm{SM}}(Q_{tb})$$

Checking the effect on the interference



Evaluated using MSSM samples and coupling coefficients



Evaluated using 2HDM samples and coupling coefficients

BACKUP

Reweighting by Higgs p_{T} (I)

- The factor to reweight the events can be derived from SM samples

$$\left(\frac{Y_{\mathrm{t,MSSM}}}{Y_{\mathrm{t,SM}}}\right)^2 \sigma^t_{\mathrm{SM}}(Q_t) + \left(\frac{Y_{\mathrm{b,MSSM}}}{Y_{\mathrm{b,SM}}}\right)^2 \sigma^b_{\mathrm{SM}}(Q_b) + \left(\frac{Y_{\mathrm{t,MSSM}}}{Y_{\mathrm{t,SM}}}\frac{Y_{\mathrm{b,MSSM}}}{Y_{\mathrm{b,SM}}}\right)\{\sigma^{t+b}_{\mathrm{SM}}(Q_{tb}) - \sigma^t_{\mathrm{SM}}(Q_{tb}) - \sigma^b_{\mathrm{SM}}(Q_{tb})\}$$

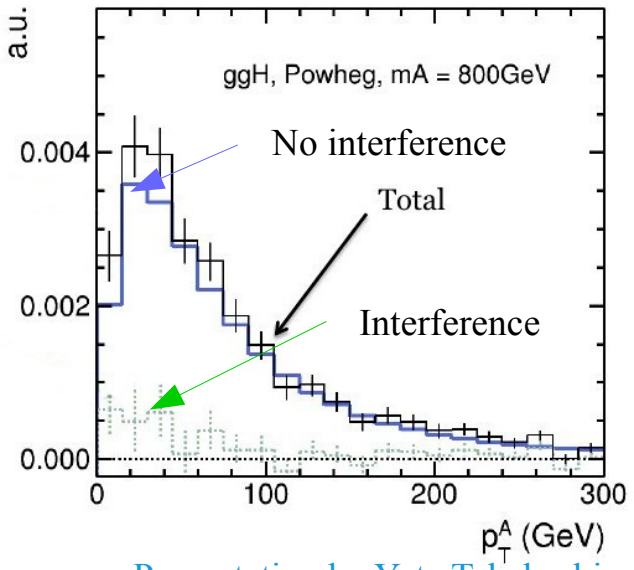
Yukawa Coupling Coefficient

Interference Term

Function of tanβ

Function of m_A

- Advantage
  - Producing 5 GEN-level SM samples @NLO per $m_{\mathrm{A/H}}$ point is sufficient to reweight to any $m_{\mathrm{A}} - \tan\beta$ point
- Disadvantage
  - Bottom-quark contribution is very small in the SM
  - Interference term has a big cancellation
    - Spiky distribution even for large MC statistic



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