MSSM HIGGS TRANSVERSE MOMENTUM

Michael Spira (PSI)

I Introduction

II Neutral Higgs Boson p_{TH}

I *INTRODUCTION*

MSSM/2HDM

• minimal extension: 2 Higgs doublets

ESB $\longrightarrow$ 5 Higgs bosons:

h, H	neutral, $\mathcal{CP}$ even
A	neutral, $\mathcal{CP}$ odd
$H^{\pm}$	charged

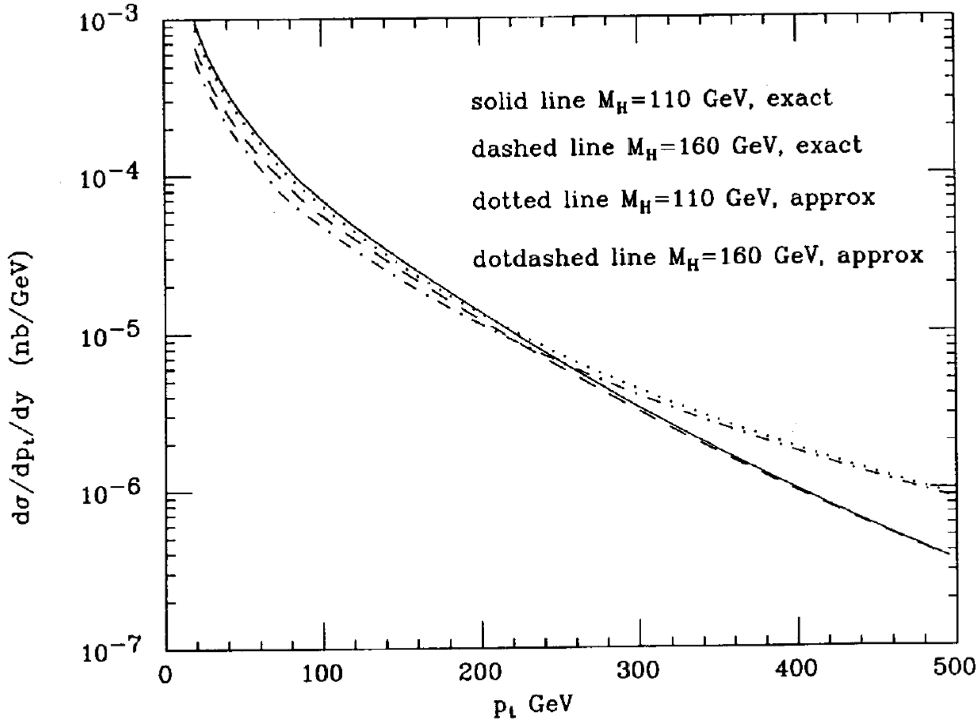
• modified couplings:
2HDM type II [I]
MSSM

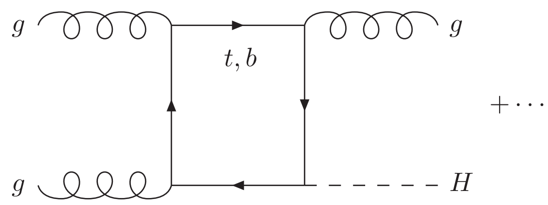
tg$\beta \uparrow \longrightarrow g_t \downarrow, g_b \uparrow$

ϕ	g_u^{ϕ}	g_d^{ϕ}	g_V^{ϕ}
h	c_α/s_β	$-s_\alpha/c_\beta$ [c_α/s_β]	$s_{\beta-\alpha}$
H	s_α/s_β	c_α/c_β [s_α/s_β]	$c_{\beta-\alpha}$
A	ctgβ	tgβ [$-$ctgβ]	0

II NEUTRAL HIGGS BOSON p_T

Higgs p_T spectrum: $gg \to Hg$





$m_t = 160$ GeV

Ellis, Hinchliffe, Soldate, van der Bij

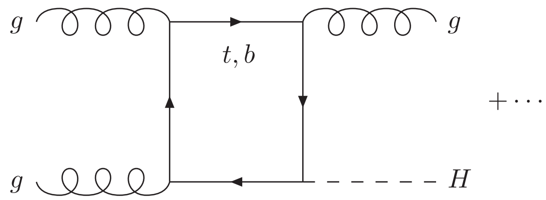
- mass effects important @ large p_T
- NLO corrections: $M_H^2 \ll m_t^2, p_T^2$

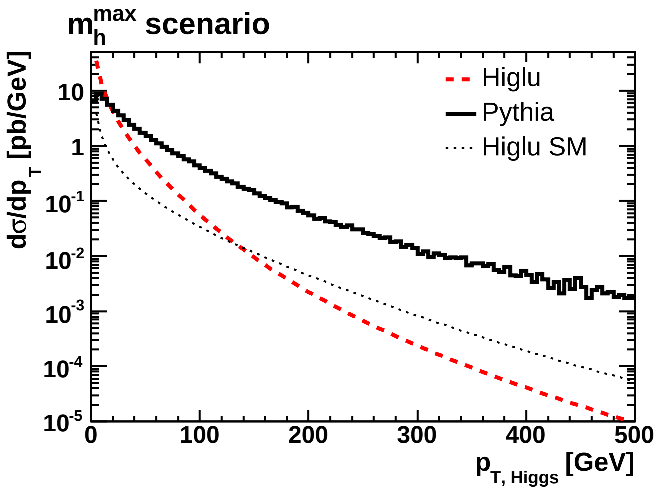
Schmidt
De Florian eal
Ravindran eal
Boughezal eal

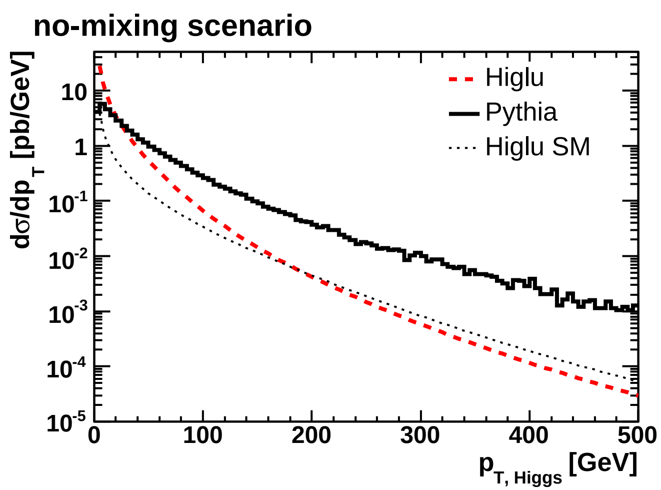
- NLO top mass effects small up to $p_T \sim 300$ GeV

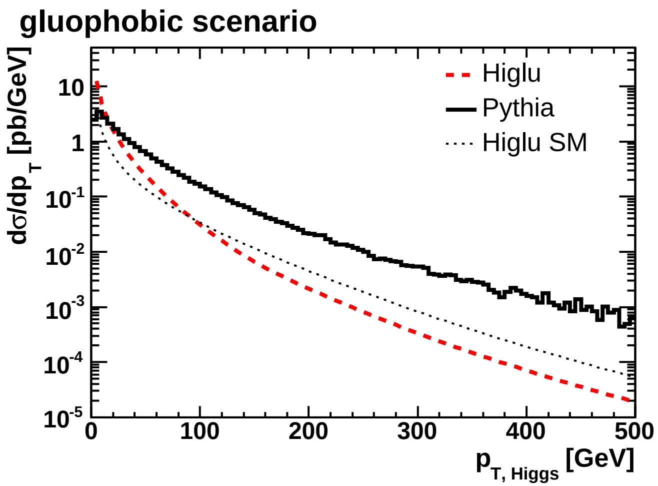
Harlander eal

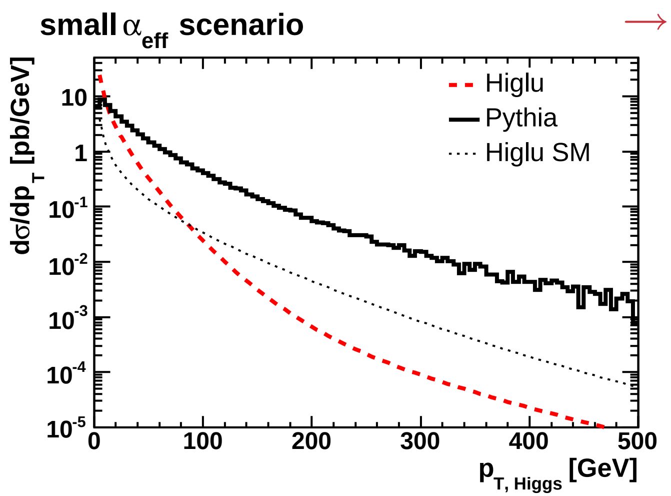
Higgs p_T spectrum: $gg \to Hg$







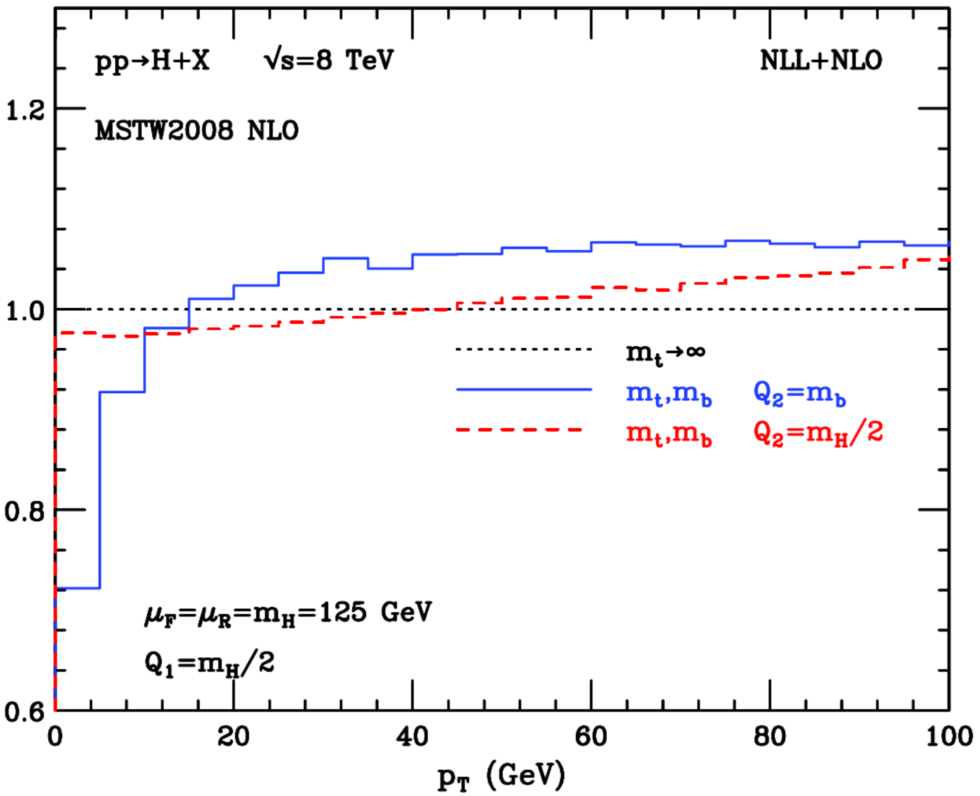




$\to$LO @ large $p_T/M_\phi/g_b^\phi$!

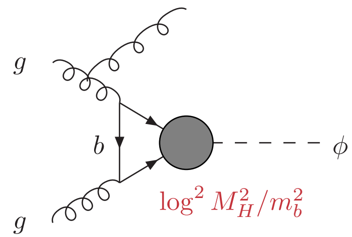
Langenegger, S.,
Starodunov, Trüb

• factorization: $p_T \ll 2m_b \to Q \sim m_b$ [← HRes, POWHEG, MC@NLO]

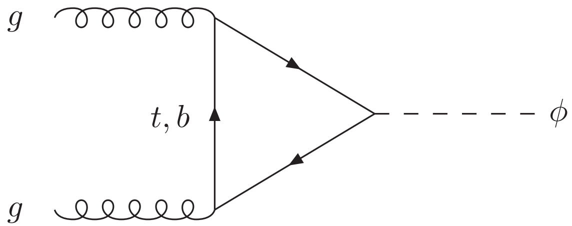


Grazzini, Sargsyan

• Sudakov form factor → unresummed logs



$gg \to \phi$



Georgi,. . .

Gamberini,. . .

$$\sigma(pp \to \phi^0) = \sigma_0^\phi \tau_\phi \frac{d\mathcal{L}^{gg}}{d\tau_\phi}$$

$$\sigma_0^{h/H} = \frac{G_F \alpha_s^2}{288\sqrt{2}\pi} \left| \sum_Q g_Q^{h/H} A_Q^{h/H}(\tau_Q) \right|^2 \qquad \sigma_0^A = \frac{G_F \alpha_s^2}{128\sqrt{2}\pi} \left| \sum_Q g_Q^A A_Q^A(\tau_Q) \right|^2$$

$$A_Q^{h/H}(\tau_Q) = \frac{3}{2}\tau_Q \left[1 + (1 - \tau_Q) f(\tau_Q)\right] \qquad A_Q^A(\tau_Q) = \tau_Q f(\tau_Q)$$

$$f(\tau) = \begin{cases} \arcsin^2 \dfrac{1}{\sqrt{\tau}} & \tau \geq 1 \\ -\dfrac{1}{4}\left[\log \dfrac{1+\sqrt{1-\tau}}{1-\sqrt{1-\tau}} - i\pi\right]^2 & \tau < 1 \end{cases} \qquad \tau_Q = 4\frac{m_Q^2}{M_\phi^2} \qquad \tau_\phi = \frac{M_\phi^2}{s}$$

$$f(\tau) \to -\frac{1}{4}\log^2\left(\frac{M_H^2}{mb^2}\right)$$

- QCD corrections:

$$\sigma(pp \to H+X) = \sigma_0 \left[1 + C\frac{\alpha_s}{\pi}\right] \tau_H \frac{d\mathcal{L}^{gg}}{d\tau_H} + \Delta\sigma_{gg} + \Delta\sigma_{gq} + \Delta\sigma_{q\bar{q}}$$

$$C(\tau_Q) = \pi^2 + c(\tau_Q) + \frac{33-2N_F}{6} \log \frac{\mu^2}{m_H^2}$$

$$\begin{aligned}
\Delta\sigma_{gg} &= \int_{\tau_H}^1 d\tau \frac{d\mathcal{L}^{gg}}{d\tau} \times \frac{\alpha_s}{\pi}\sigma_0 \left\{ -\hat{\tau} P_{gg}(\hat{\tau}) \log\frac{M^2}{\hat{s}} + d_{gg}(\hat{\tau}, \tau_Q) \right. \\
&\qquad \left. +12 \left[\left(\frac{\log(1-\hat{\tau})}{1-\hat{\tau}} \right)_+ - \hat{\tau}[2 - \hat{\tau}(1-\hat{\tau})] \log(1-\hat{\tau}) \right] \right\} \\
\Delta\sigma_{gq} &= \int_{\tau_H}^1 d\tau \sum_{q,\bar{q}} \frac{d\mathcal{L}^{gq}}{d\tau} \times \frac{\alpha_s}{\pi}\sigma_0 \left\{ \hat{\tau} P_{gq}(\hat{\tau}) \left[-\frac{1}{2}\log\frac{M^2}{\hat{s}} + \log(1-\hat{\tau}) \right] + d_{gq}(\hat{\tau}, \tau_Q) \right\} \\
\Delta\sigma_{q\bar{q}} &= \int_{\tau_H}^1 d\tau \sum_{q} \frac{d\mathcal{L}^{q\bar{q}}}{d\tau} \times \frac{\alpha_s}{\pi}\sigma_0 \; d_{q\bar{q}}(\hat{\tau}, \tau_Q)
\end{aligned} \tag{40}$$

$$\begin{aligned}
c(\tau_Q) &\to \frac{5}{36}\log^2(-4\tau_Q - i\epsilon) - \frac{4}{3}\log(-4\tau_Q - i\epsilon) \\
d_{gg}(\hat{\tau}, \tau_Q) &\to -\frac{2}{5}\log(4\tau_Q)\left\{7 - 7\hat{\tau} + 5\hat{\tau}^2\right\} - 6\log(1-\hat{\tau})\left\{1 - \hat{\tau} + \hat{\tau}^2\right\} \\
&\qquad +2\frac{\log\hat{\tau}}{1-\hat{\tau}}\left\{3 - 6\hat{\tau} - 2\hat{\tau}^2 + 5\hat{\tau}^3 - 6\hat{\tau}^4\right\} \\
d_{gq}(\hat{\tau}, \tau_Q) &\to \frac{2}{3}\left\{\hat{\tau}^2 - \left[1 + (1-\hat{\tau})^2\right]\left[\frac{7}{15}\log(4\tau_Q) + \log\left(\frac{1-\hat{\tau}}{\hat{\tau}}\right)\right]\right\} \\
d_{q\bar{q}}(\hat{\tau}, \tau_Q) &\to 0
\end{aligned}$$