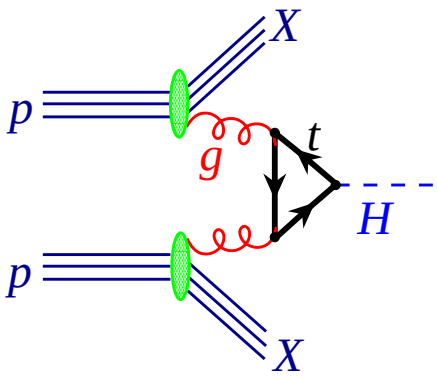
Higgs production in bottom quark fusion

Robert Harlander (CERN)

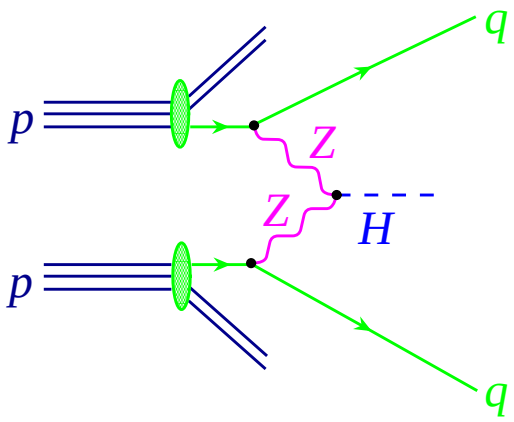
EPS 2003, Aachen

- SM Higgs production at the LHC
- higher order predictions
- Supersymmetric Higgs: bottom quark fusion
- Conclusions

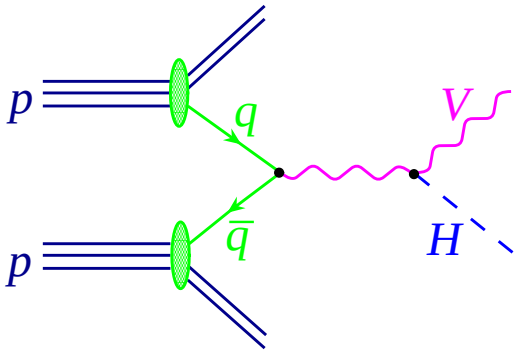
Production Modes



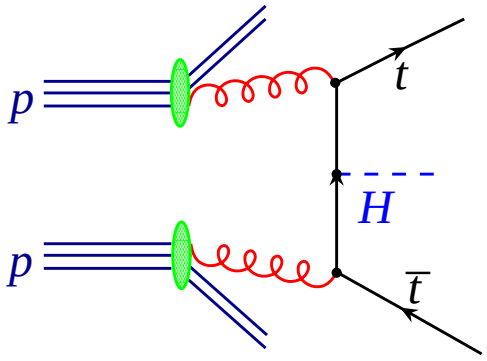
Gluon fusion



Weak Boson Fusion

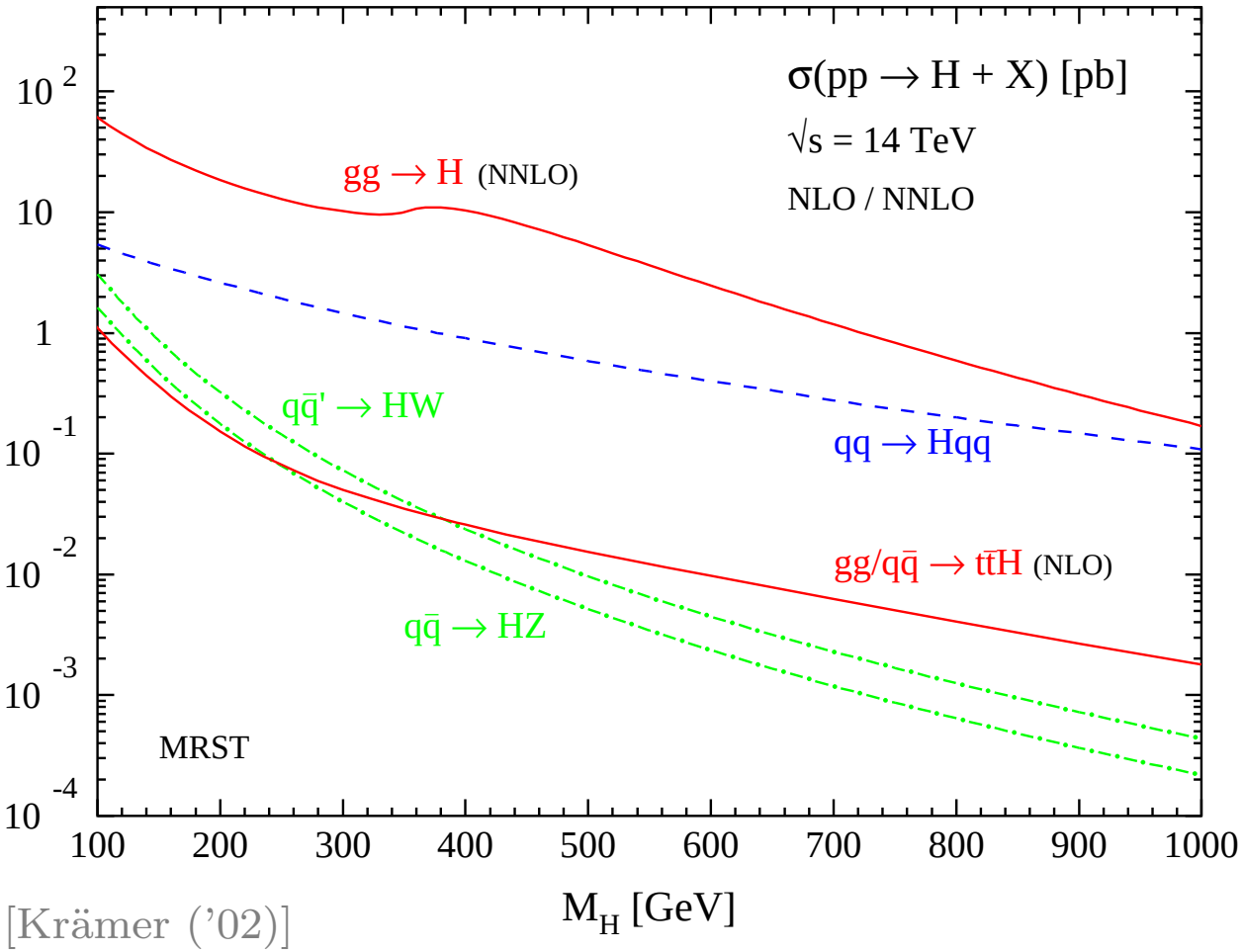


Higgs Strahlung

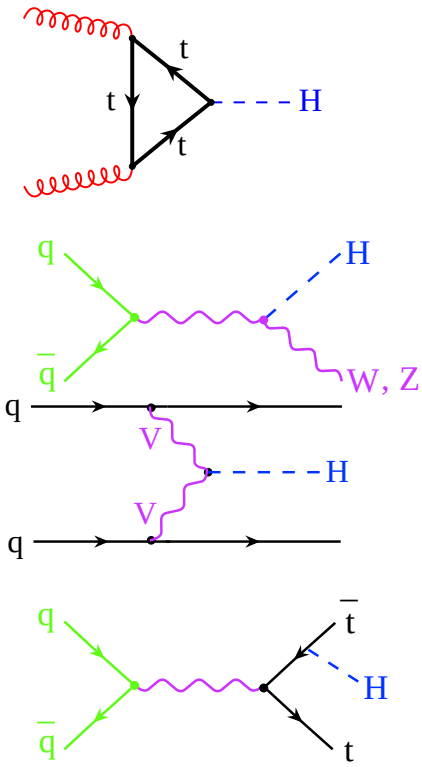


$t\bar{t}H$

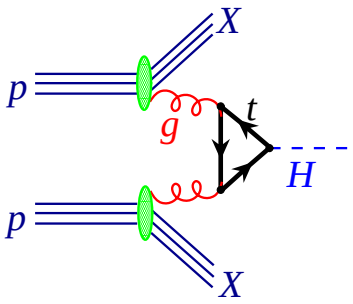
SM Higgs production at the LHC

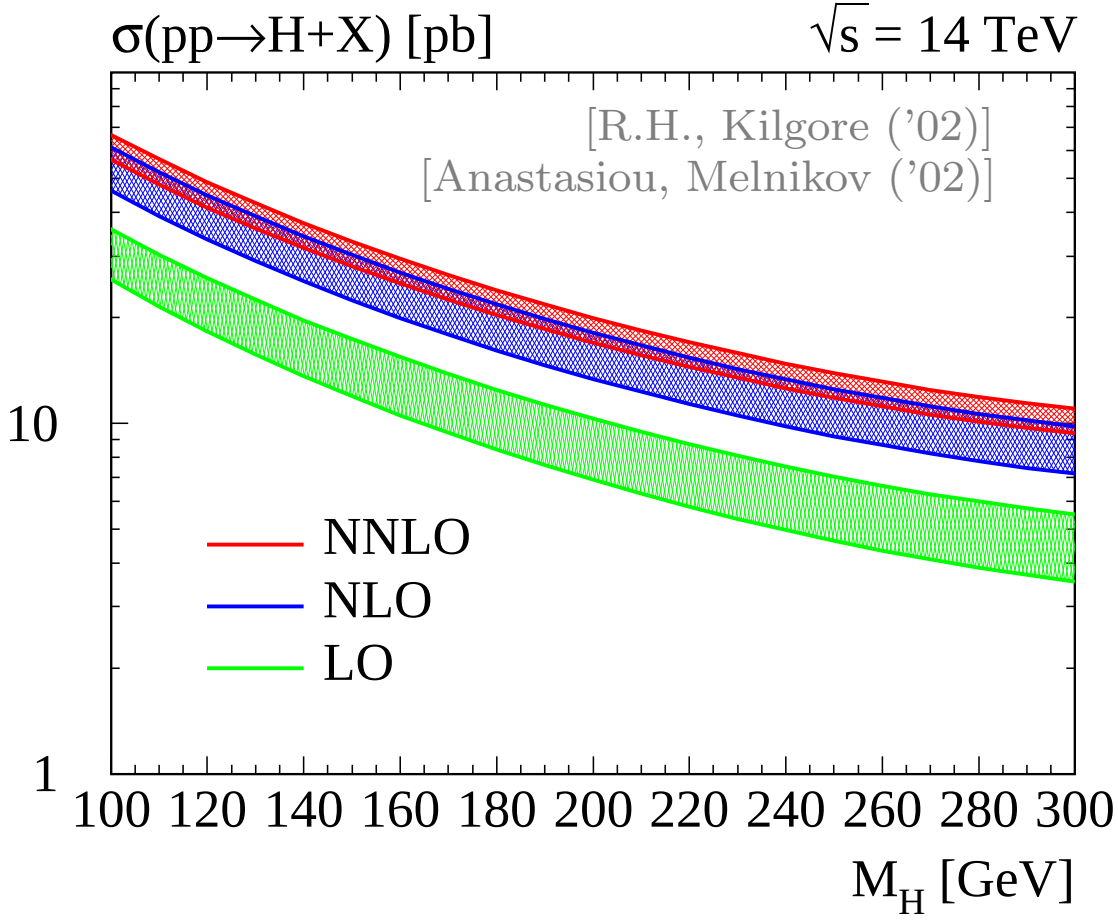


[Krämer ('02)]



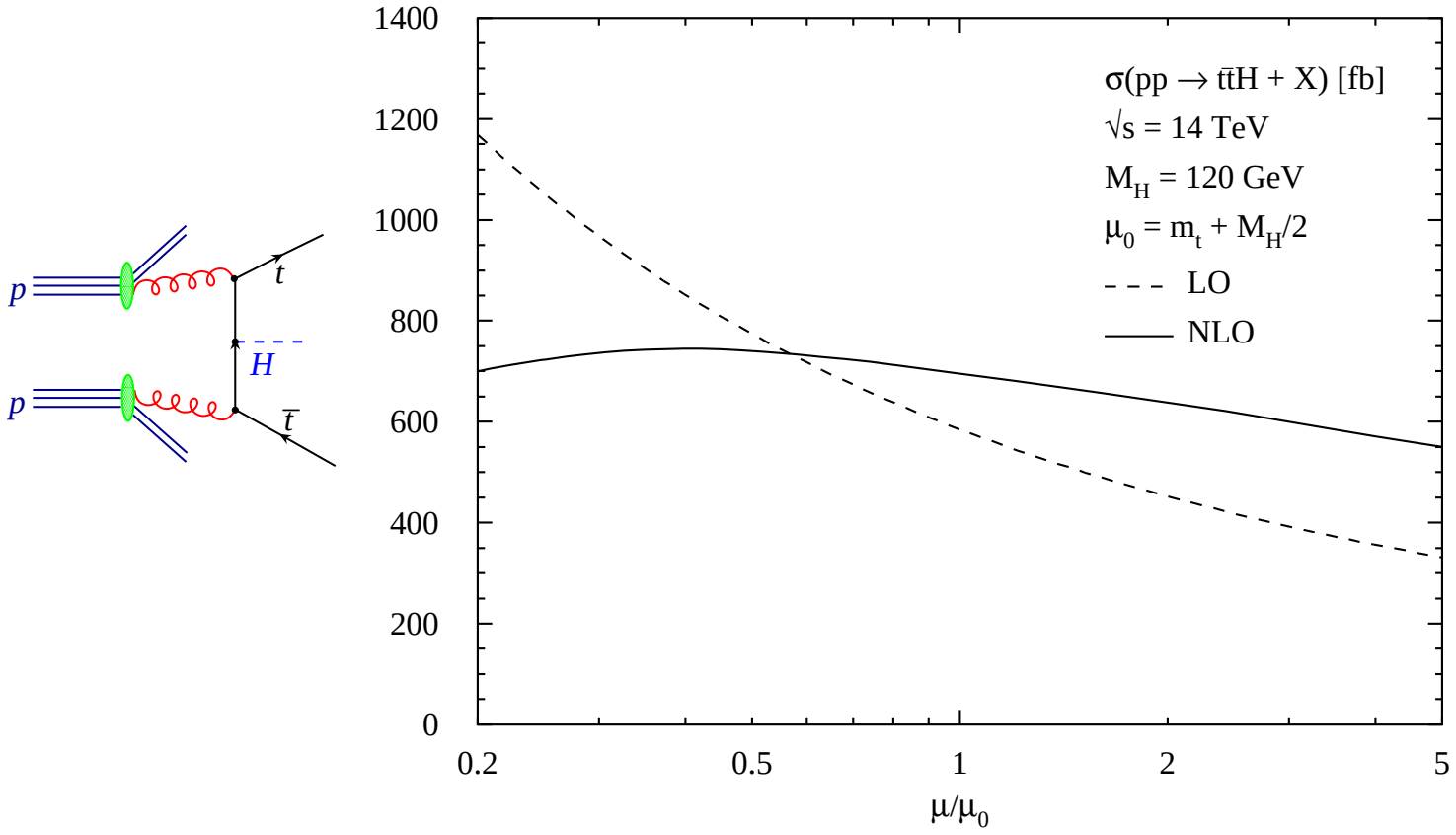
$gg \to H$ at NNLO





(see also [Ravindran, Smith, v.Neerven ('03)])

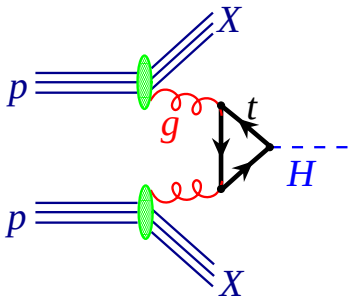
$t\bar{t}H$ at NLO



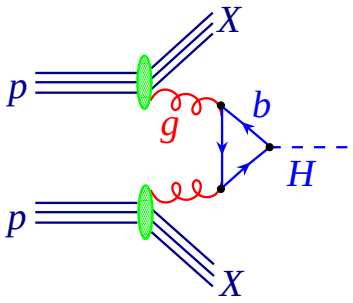
[Beenakker, Dittmaier, Krämer, Plümper, Spira, Zerwas ('01)]
[Dawson, Reina, Wackeroth, Orr, Jackson ('03)]

Minimal SUSY SM

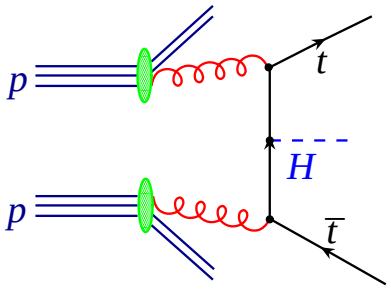
$$\frac{\lambda_b}{\lambda_t} = \frac{m_b}{m_t} \cdot \frac{v_u}{v_d} = \frac{m_b}{m_t} \cdot \tan\beta$$



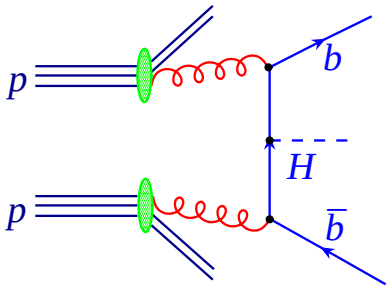
NNLO



NLO

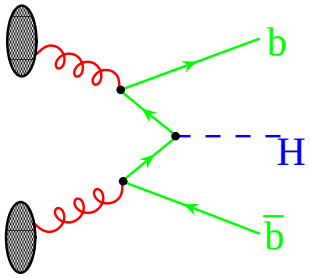


NLO



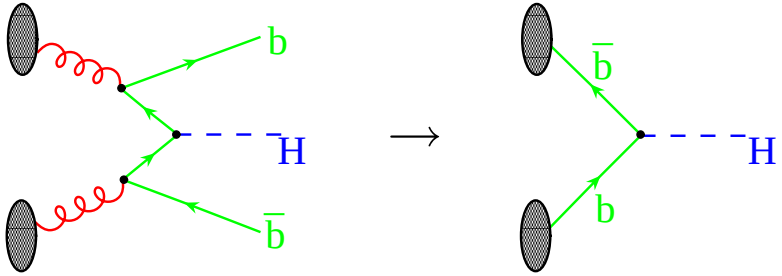
LO

$pp \to Hb\bar{b}$



$\to$ collinear logs $\sim \ln \frac{m_b^2}{M_H^2}$

resum:

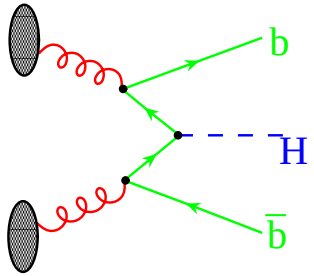


bottom PDFs

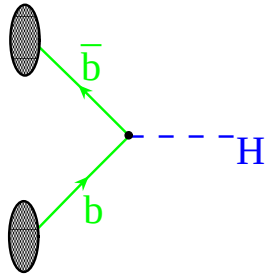
[ACOT, Willenbrock, Kunszt, ...]

$pp \to Hb\bar{b}$ at NLO

[Dicus, Stelzer, Sullivan, Willenbrock ('99)]
[Maltoni, Sullivan, Willenbrock ('03)]

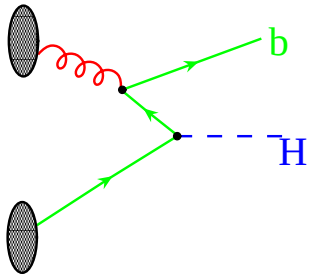


$\to$



$\sim (\alpha_s l_b)^2 \to \alpha_s^n l_b^n$

$\left\{ \begin{array}{l} \alpha_s(\alpha_s l_b) \\ \to \alpha_s^n l_b^{n-1} \end{array} \right\} \sim$



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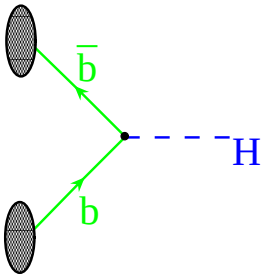
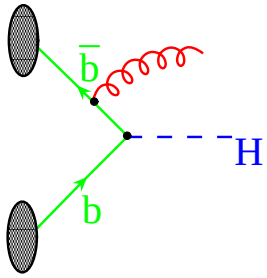
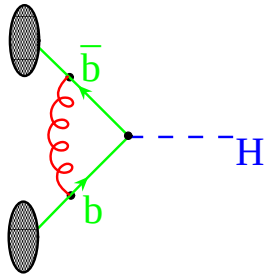


$\left\{ \begin{array}{l} \alpha_s(\alpha_s l_b)^2 \\ \to \alpha_s^n l_b^{n-1} \end{array} \right\} \sim$



$+$

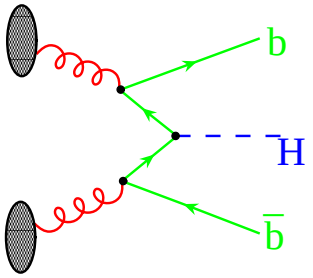


$+ \cdots$

$pp \to Hb\bar{b}$ at NNLO

[R.H., Kilgore ('03)]

NNLO: $\left\{ \begin{array}{l} \alpha_s^2(\alpha_s l_b)^0 \\ \to \alpha_s^n l_b^{n-2} \end{array} \right\} \sim$



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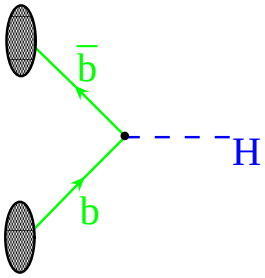


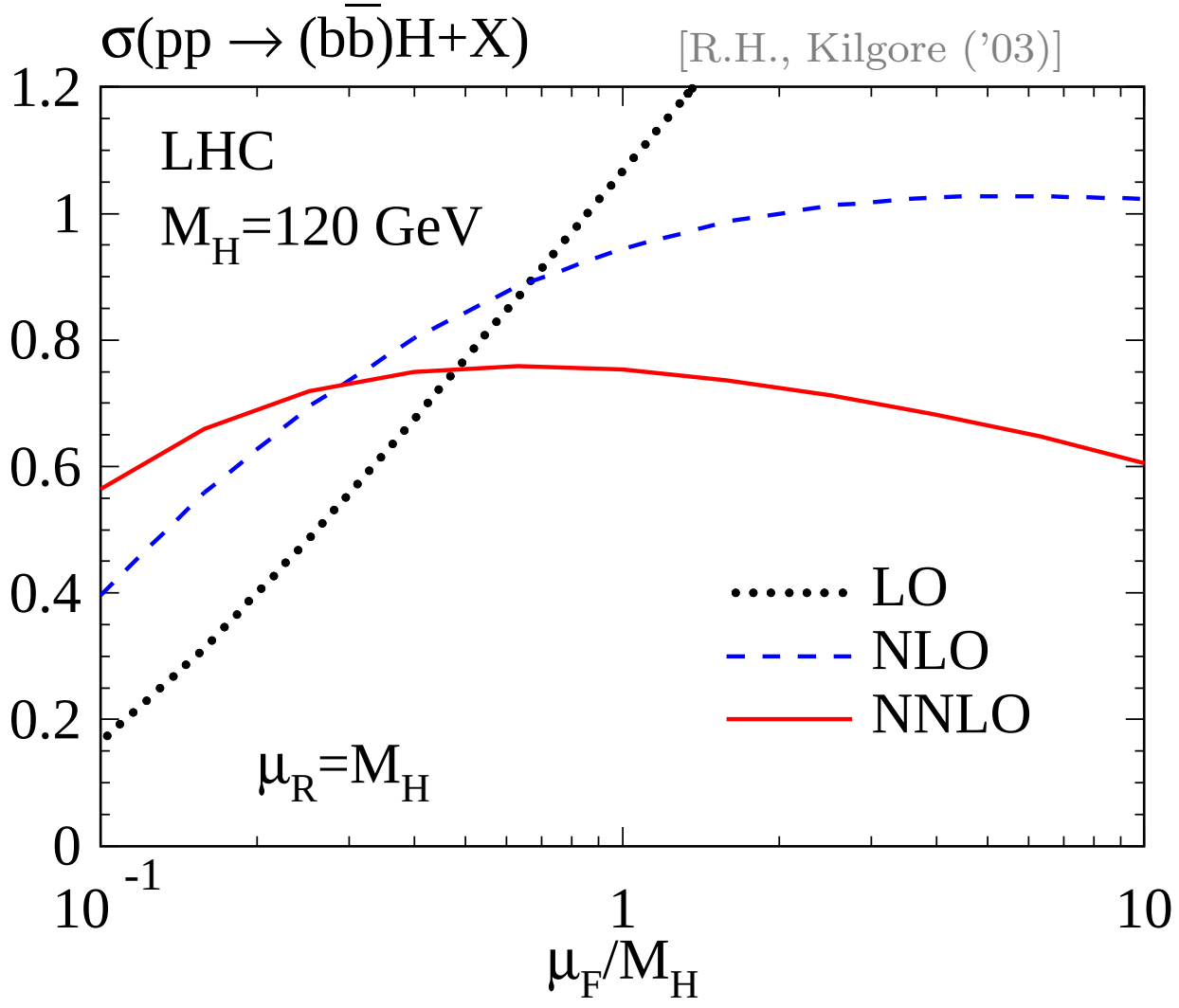
$$\sigma(b\bar{b} \to H) = \sum_n (\alpha_s l_b)^n \Big\{ \quad \alpha_s^2 \, [\quad c_{n0} \, l_b^2 \quad + \; c_{n1} \, l_b \; + \; c_{n2} \quad]$$

$$\downarrow \qquad\qquad \downarrow \qquad\qquad \downarrow \qquad \downarrow$$

PDFs LO NLO NNLO

$$+ \alpha_s^3 d_{n3} + \alpha_s^4 d_{n4} + \ldots \Big\} \to \text{higher orders}$$

$b\bar{b} \to H$ at NNLO



Conclusions

- SM Higgs production cross section available up to NNLO
  $\rightarrow$ theoretical $\sim$ experimental accuracy

- important new and general techniques for
  multi-loop and phase space evaluations

- supersymmetric Higgs production:
  - on the way to NNLO
  - test of new concepts

Expansion + Resummation

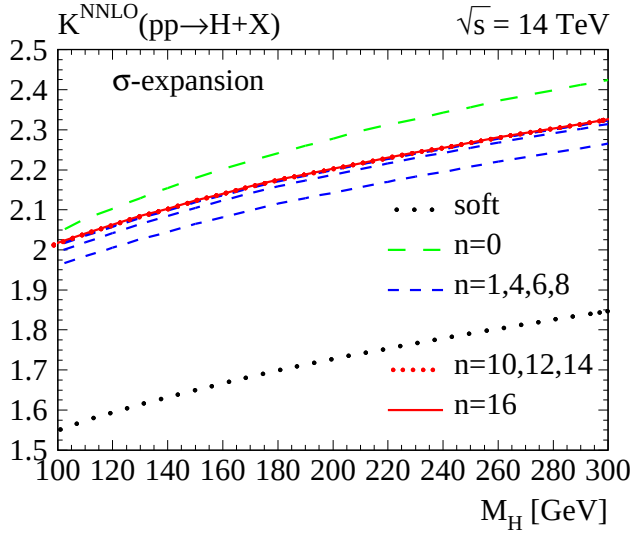
[R.H., Kilgore '02]

- write $\hat{\sigma}(x)$ as series in $(1-x)$

$\Rightarrow$ approximate result

$$\sigma_{pp}(z) = \int_z^1 \mathrm{d}\tau\, \mathcal{L}_{ij}(\tau)\, \hat{\sigma}_{ij}\left(\frac{z}{\tau}\right)$$

$$x = M_H^2/\hat{s}\,, \quad z = M_H^2/s$$



- match coefficients of basis functions [Kilgore '02]

$\mathrm{Li}_2(x),\ \mathrm{Li}_2(1-x),\ \mathrm{Li}_2(1-x^2),\ \mathrm{Li}_3(x),\ \ldots$

$\Rightarrow$ exact result