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Quark-mass effects in POWHEG and Hres results

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POWHEG formulation and the role of *hfact*

$$d\sigma^{\rm NLO+PS} = d\Phi_B \bar{B}^s(\Phi_B)\left[\Delta^s(p_\perp^{\rm min}) + d\Phi_{R|B}\frac{R^s(\Phi_R)}{B(\Phi_B)}\Delta^s(p_{\rm T}(\Phi))\right] + d\Phi_R R^f(\Phi_R) + d\Phi_R R_{reg}(\Phi_R)$$

$$\bar{B}^s = B(\Phi_B) + \left[V(\Phi_B) + \int d\Phi_{R|B} R^s(\Phi_{R|B})\right]$$

$R = R_{reg} + R_{div}$ is the sum of all the real emission squared matrix elements, with a regular (divergent) behaviour in the collinear limit

R^s enters in the Sudakov form factor $\Delta^s(p_T(\Phi))$

$$R^s = \frac{h^2}{h^2 + p_T^2} R_{div} \qquad R^f = \frac{p_T^2}{h^2 + p_T^2} R_{div}$$

at low ptH, the damping factor → 1, R_div tends to its collinear approximation,
at large ptH, the damping factor → 0 and suppresses R_div in the Sudakov and in the square bracket

the scale *h* fixes the upper limit for the Sudakov form factor to play a role,
effectively is the upper limit for the inclusion of multiple parton emissions

the total cross section does NOT depend on the value of *h*

A proposal to treat quark-mass effects with POWHEG

- In the following identity the square bracket is a correction to the first, only-top, term because of the yukawa suppression of the bottom coupling

$$|\mathcal{M}(t+b)|^2 = |\mathcal{M}(t)|^2 + \left[|\mathcal{M}(t+b)|^2 - |\mathcal{M}(t)|^2\right]$$

- The first term contains the full top-quark squared amplitude; the square bracket contains the top-bottom interference and the bottom squared amplitude

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- The total cross section is independent of the choice of *h*
  → the total cross section, including quark-mass effects, can be written as

$$\sigma(t+b) = \sigma(t, h = m_H/1.2) + [\sigma(t+b, h = m_b) - \sigma(t, h = m_b)]$$

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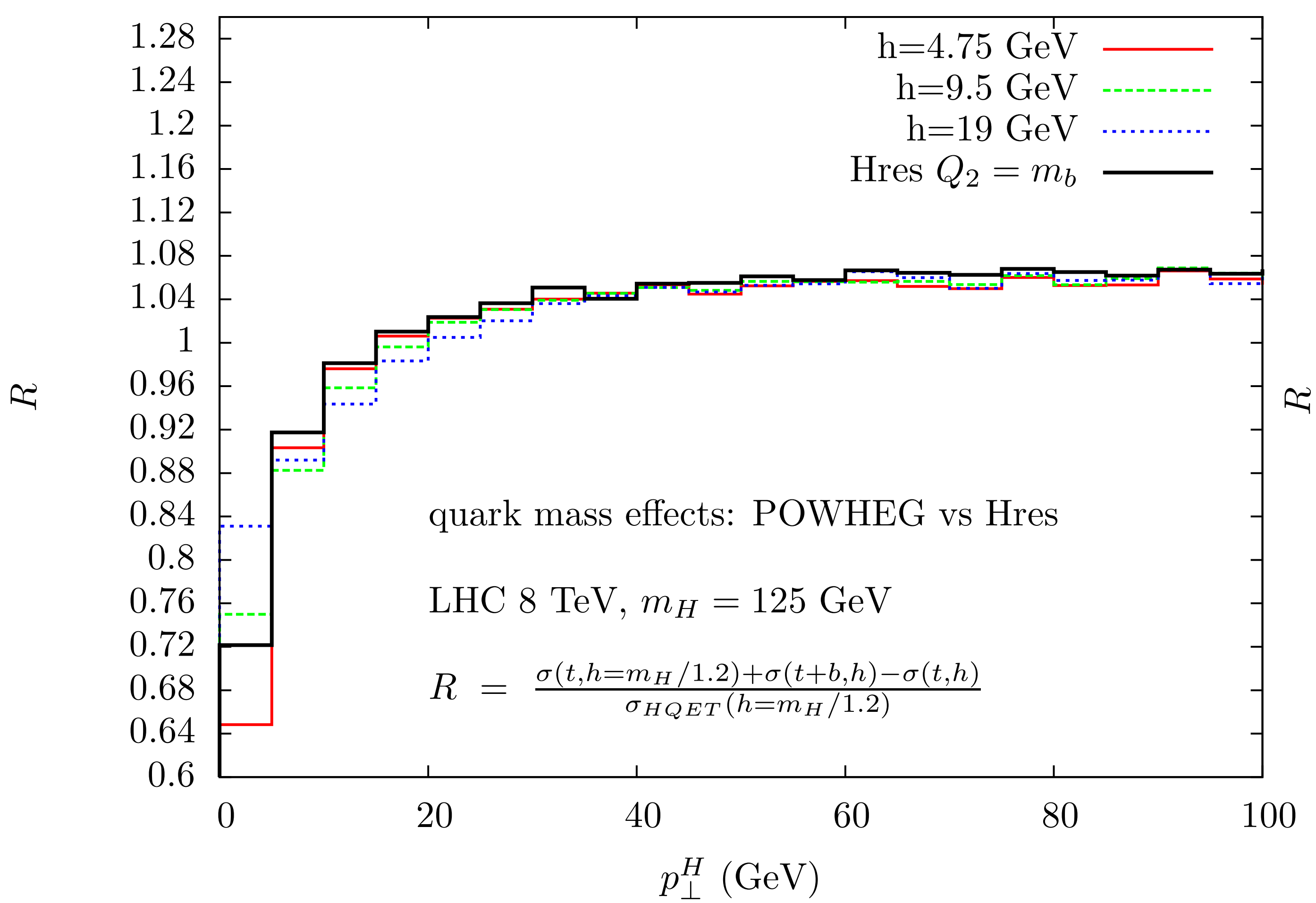
- Since the first term depends only on the top quark, a sensible choice is *h*=MH/1.2

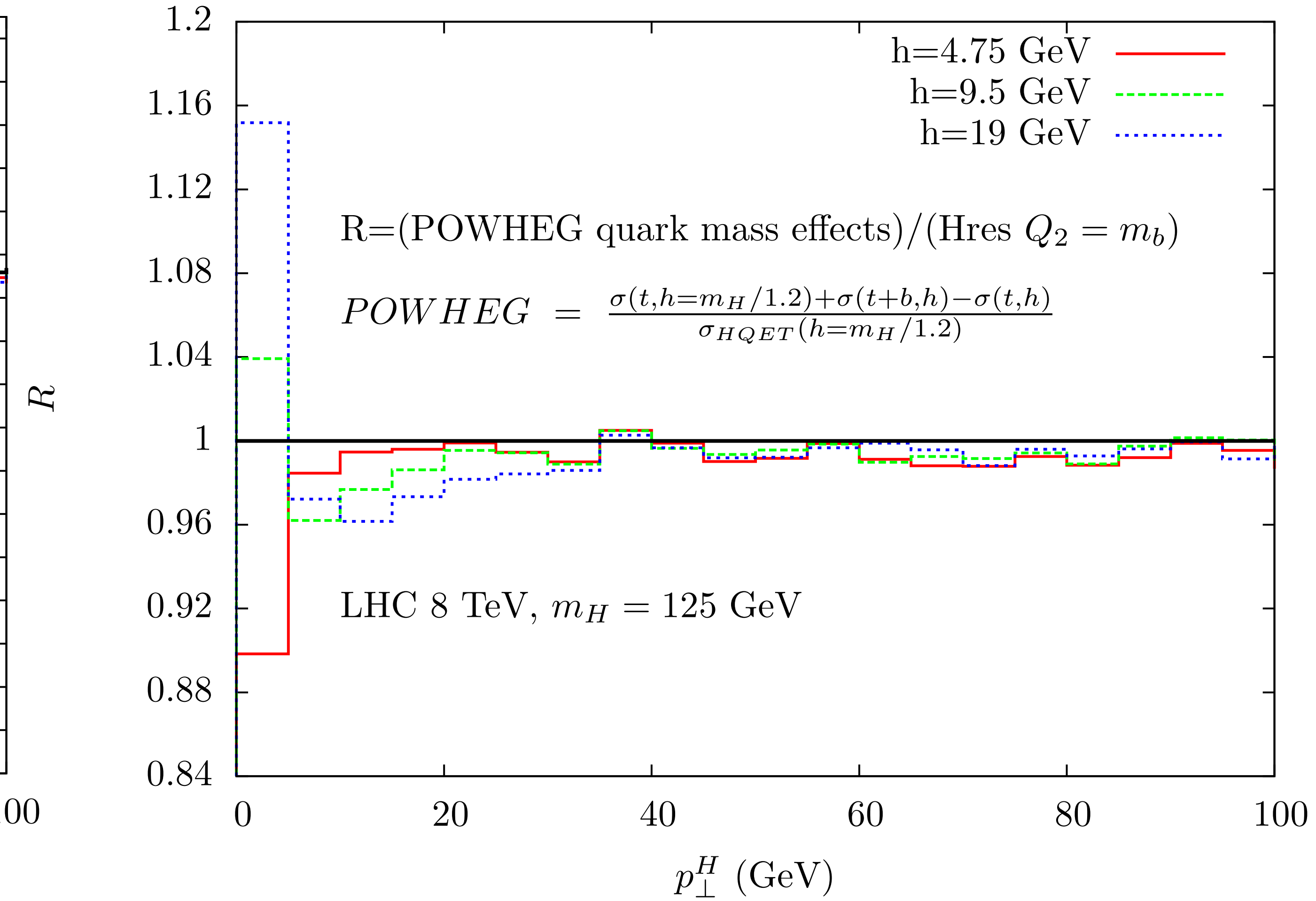
- Since the square bracket contains the top-bottom interference and the bottom squared amplitude, but no pure top-quark contribution, a sensible choice is *h*=mb

- We propose to use the above formula also for the differential distributions

Numerical comparison with Hres

- Hres results (arXiv:1306.4581) kindly provided by M. Grazzini



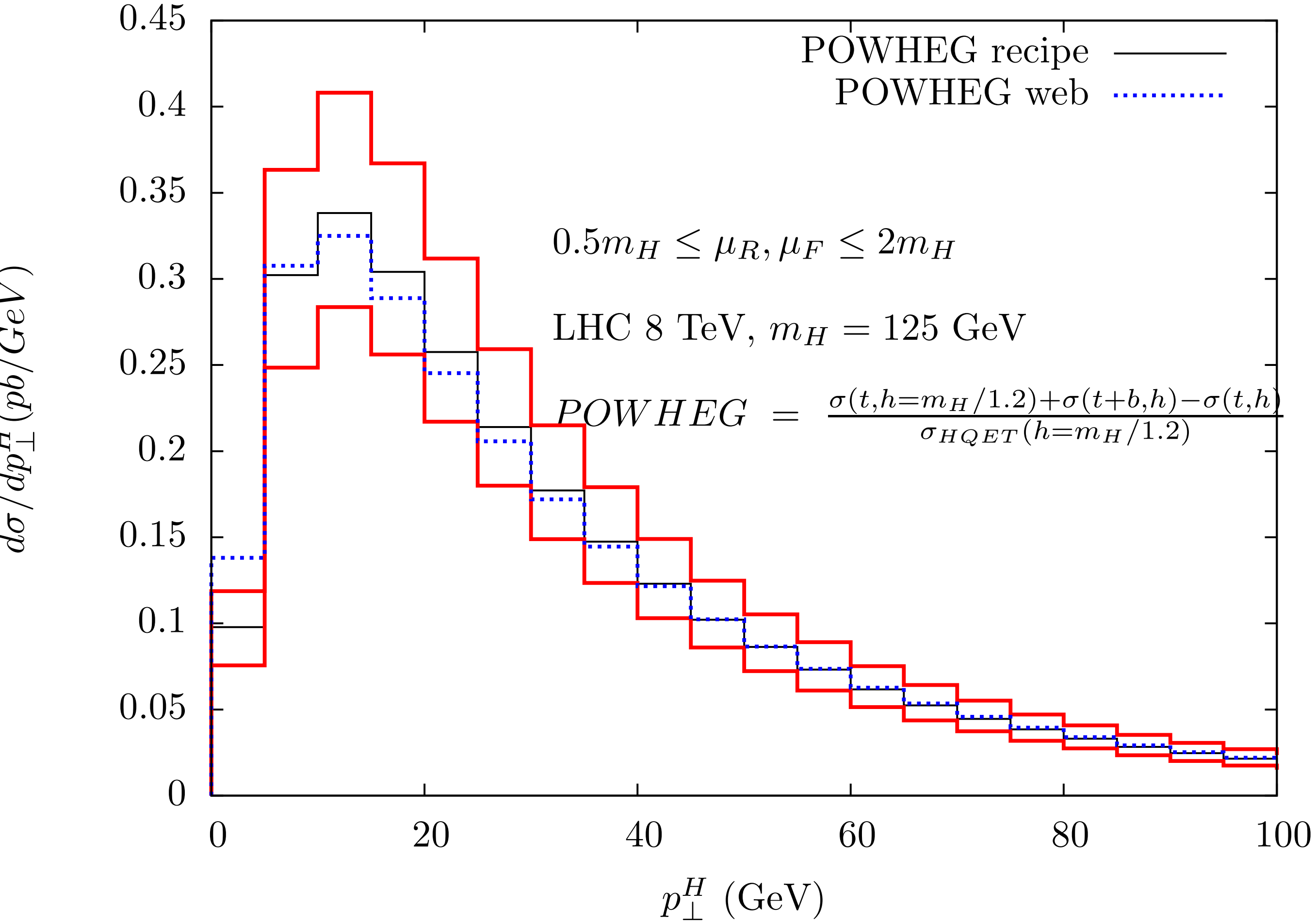


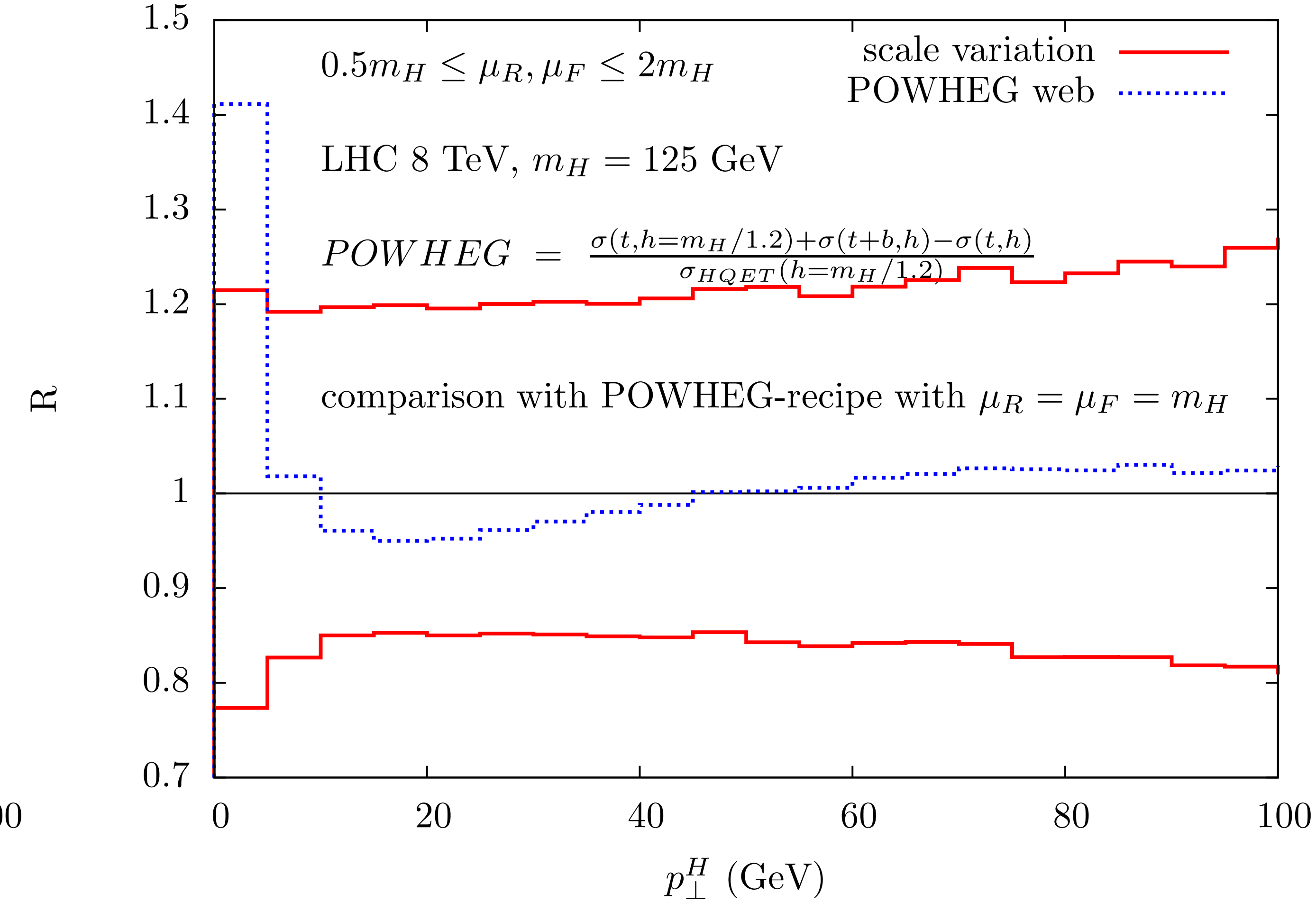
- Significant suppression due to bottom mass effects in the first two bins, rather flat and positive corrections above 30 GeV

- Agreement with Hres, choosing h=4.75 GeV, better than 2% level, with the exception of the first bin

- The statistical accuracy and the bin size can still be improved

Scale variation (preliminary)





- Canonical renormalization and factorization scale variation (red) computed with the new recipe
- Comparison with the present quark-mass-effect POWHEG version in the POWHEG-box (blue)

Conclusions

- The use of *hfact* to control the range where multiple parton emissions plays a role allows to treat in a different way top and bottom parts of the amplitude

- A simple combination of 3 POWHEG runs reproduces quite accurately the LO+NLL Hres calculation

- under discussion: merging the 3 contributions in one single code