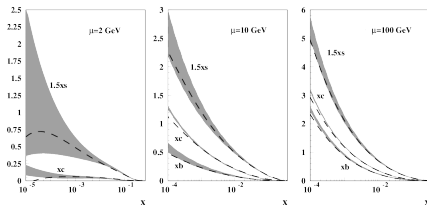
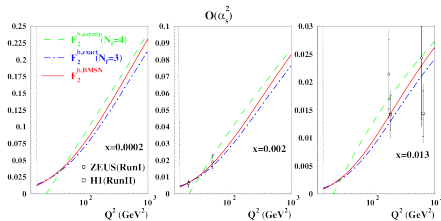


# ESR 10: Bottom-Quarks and Higgs Boson



Supervisor: J. Blümlein; Secondments at Zürich and Durham

- Improved understanding for heavy flavor PDFs for the LHC urgently needed
- Constraints from more data sets and more precise data
- VFNS at 3 Loops
- Phenomenological studies for various hard processes
- Improved prediction of the Higgs-boson production cross section



[ABKM09]

## VFNS to 3-Loops:

$$f_k(n_f + 1, \mu^2) + \bar{f}_k(n_f + 1, \mu^2) = A_{qq,Q}^{\text{NS}}\left(n_f, \frac{\mu^2}{m^2}\right) \otimes [f_k(n_f, \mu^2) + \bar{f}_k(n_f, \mu^2)] \\ + \bar{A}_{qq,Q}^{\text{PS}}\left(n_f, \frac{\mu^2}{m^2}\right) \otimes \Sigma(n_f, \mu^2) + \bar{A}_{qg,Q}^{\text{S}}\left(n_f, \frac{\mu^2}{m^2}\right) \otimes G(n_f, \mu^2)$$

$$f_{Q+\bar{Q}}(n_f + 1, \mu^2) = A_{Qq}^{\text{PS}}\left(n_f, \frac{\mu^2}{m^2}\right) \otimes \Sigma(n_f, \mu^2) + A_{Qg}^{\text{S}}\left(n_f, \frac{\mu^2}{m^2}\right) \otimes G(n_f, \mu^2).$$

$$G(n_f + 1, \mu^2) = A_{gq,Q}^{\text{S}}\left(n_f, \frac{\mu^2}{m^2}\right) \otimes \Sigma(n_f, \mu^2) + A_{gg,Q}^{\text{S}}\left(n_f, \frac{\mu^2}{m^2}\right) \otimes G(n_f, \mu^2).$$

$$\Sigma(n_f + 1, \mu^2) = \sum_{k=1}^{n_f+1} [f_k(n_f + 1, \mu^2) + \bar{f}_k(n_f + 1, \mu^2)] \\ = \left[ A_{qq,Q}^{\text{NS}}\left(n_f, \frac{\mu^2}{m^2}\right) + n_f \bar{A}_{qq,Q}^{\text{PS}}\left(n_f, \frac{\mu^2}{m^2}\right) + A_{Qq}^{\text{PS}}\left(n_f, \frac{\mu^2}{m^2}\right) \right] \\ \otimes \Sigma(n_f, \mu^2) \\ + \left[ n_f \bar{A}_{qg,Q}^{\text{S}}\left(n_f, \frac{\mu^2}{m^2}\right) + A_{Qg}^{\text{S}}\left(n_f, \frac{\mu^2}{m^2}\right) \right] \otimes G(n_f, \mu^2)$$

The choice of matching scales is **not free** and varies with the process in case of precision observables. Blümlein, van Neerven [hep-ph/9811351]

⇒ More involved for 2 masses: Blümlein, Wißbrock, 2014

## Status and Tasks:

- All logarithmic contributions to 3-loops are known [1403.6356, Higgstools 14-03], as well as several other complete OMEs
- Join in the calculation of yet missing massive OMEs  $A_{ij}^{(3)}$
- Combined *c&b*-quark decoupling to be worked out at 3 loops
- Design a code
- Apply the to various reactions at the LHC (including that of the **Higgs boson** (cooperating with exp. groups) performing phenomenological studies
- Improve **charm** and **bottom** quark densities and the other PDFs