# Scale Choices in Electroweak Higgs plus Jets Production

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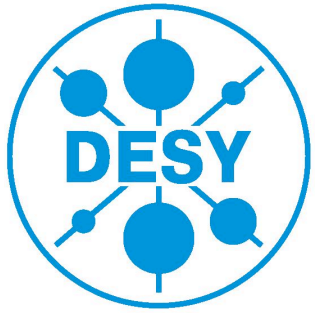
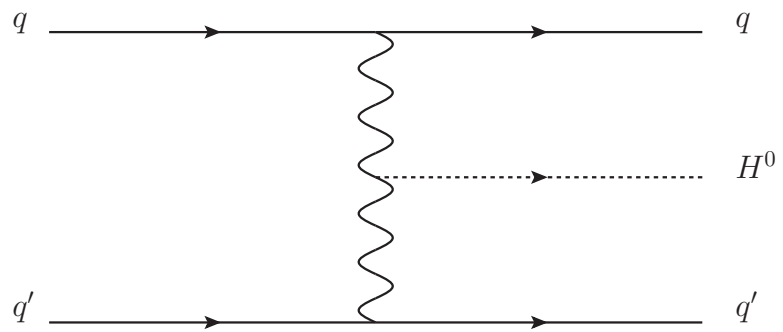



In collaboration with Simon Plätzer (DESY Theory)

# Introduction



- Herwig++ Monte Carlo generator
- Higgs production in VBF
- Important Higgs production channel
- a lot of involved scales $\longrightarrow$ huge dependencies

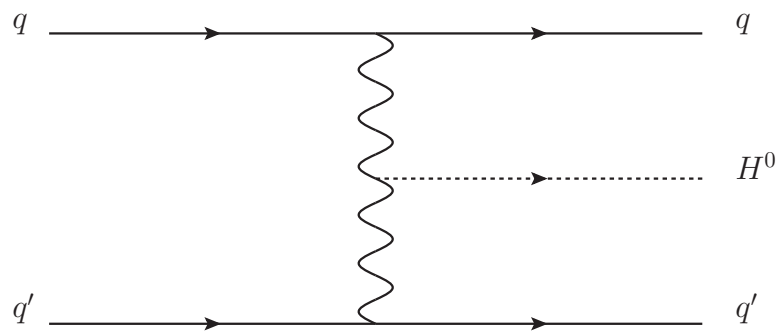


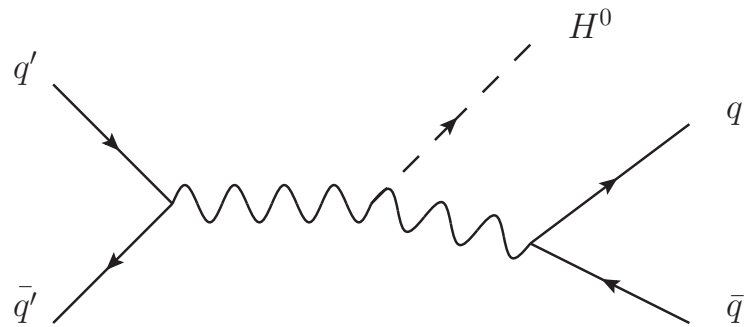
# Higgs plus jet production



- Full $O(\alpha^3)$ calculation includes VBF and Higgs-Strahlung
- and interference diagrams
- Vector boson fusion $\longrightarrow$ t-channel
- Interference-diagram: Higgs-Strahlung $\longrightarrow$ s-channel

Higgs plus 2 jets

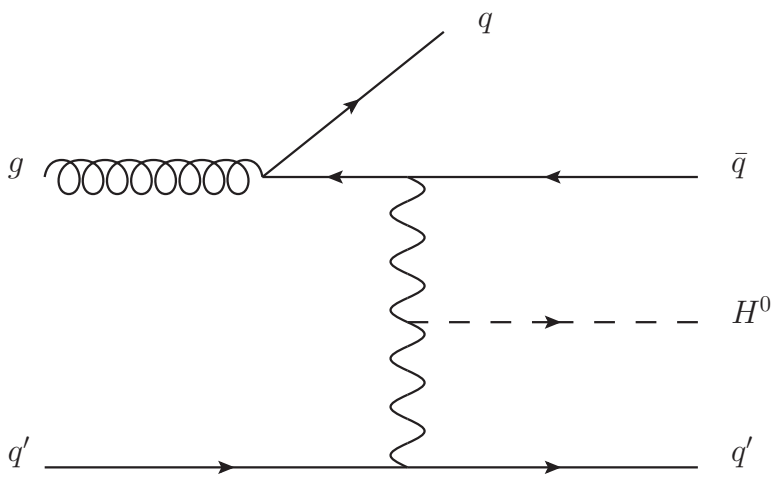


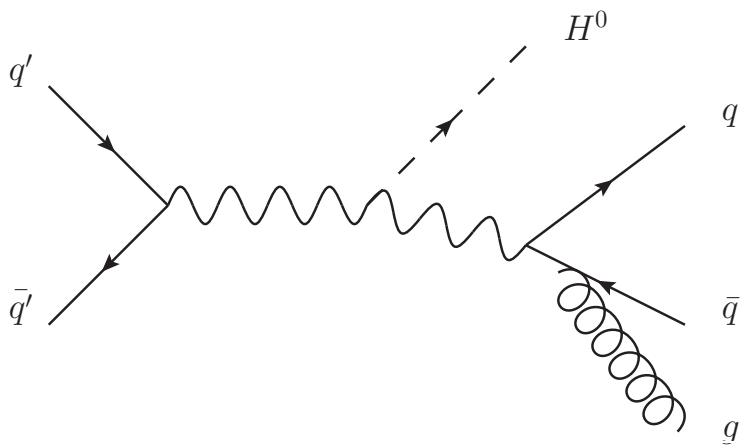



# Higher jet multiplicities

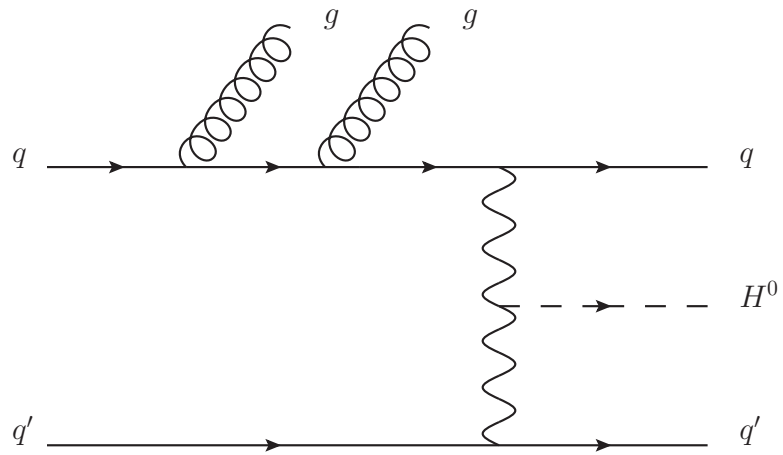


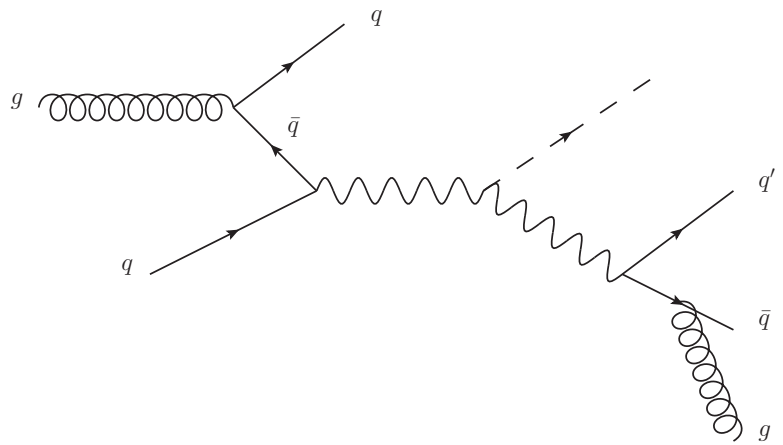
## Higgs plus 3 jets



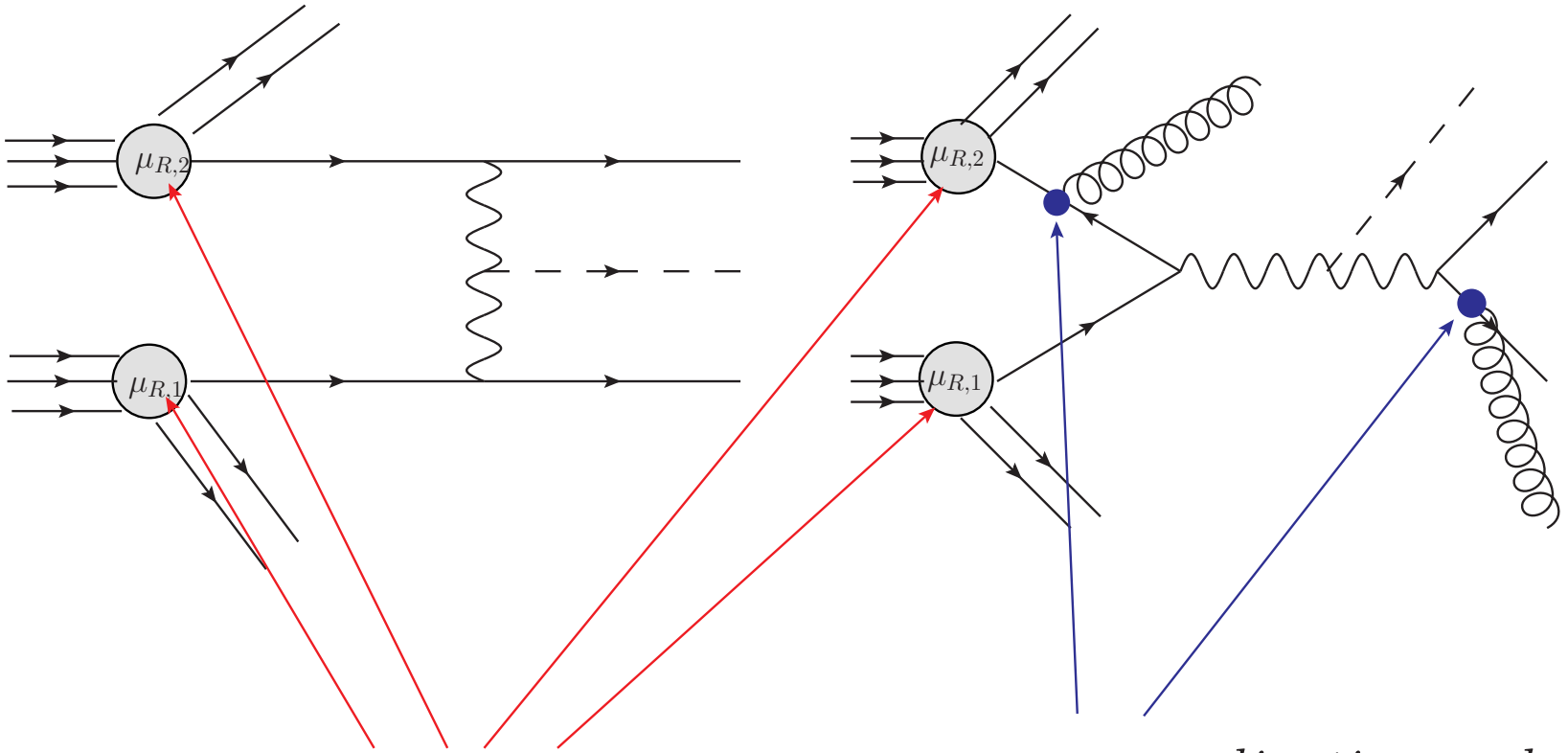

## Higgs plus 4 jets



# Factorization and Renormalization scale



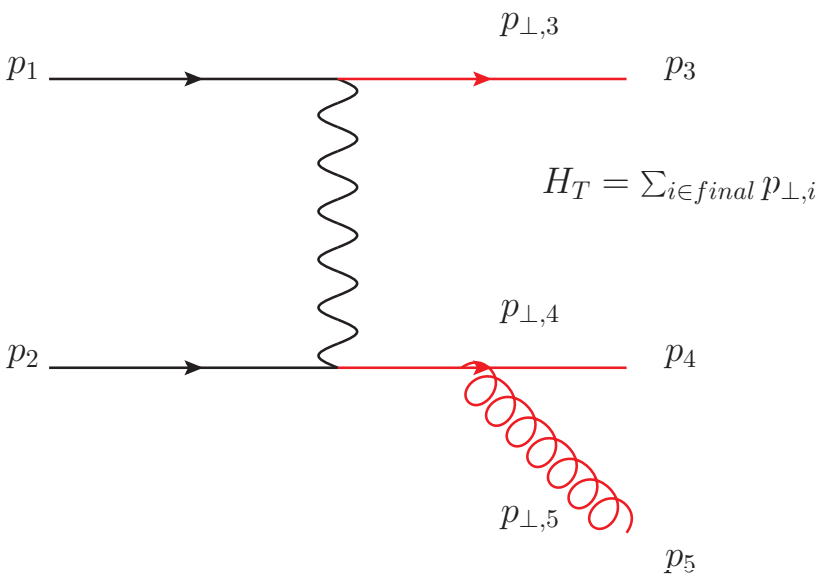


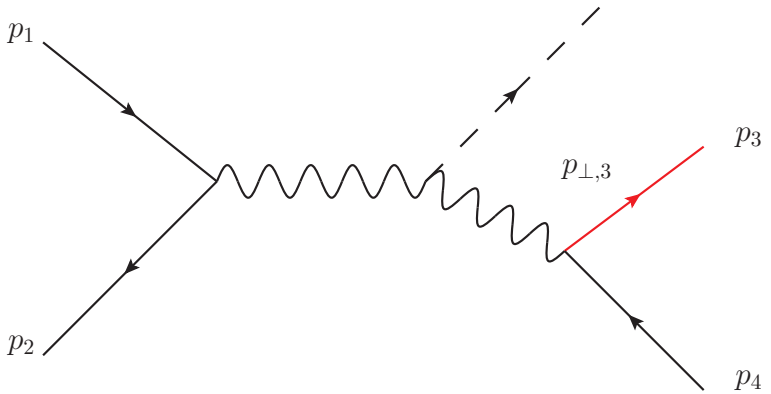

$PDF : factorization\ scale$ $\alpha_S : renormalization\ scale$

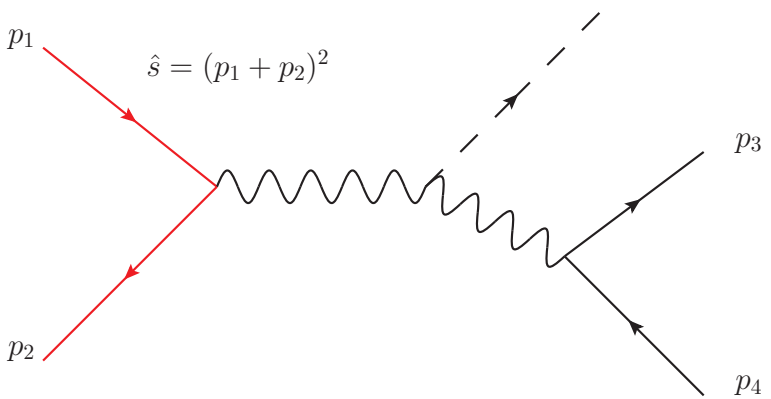
# Standard methods of scale choice I



- Fixed Scale
- MaxPt scale
- sHat scale
- HT scale



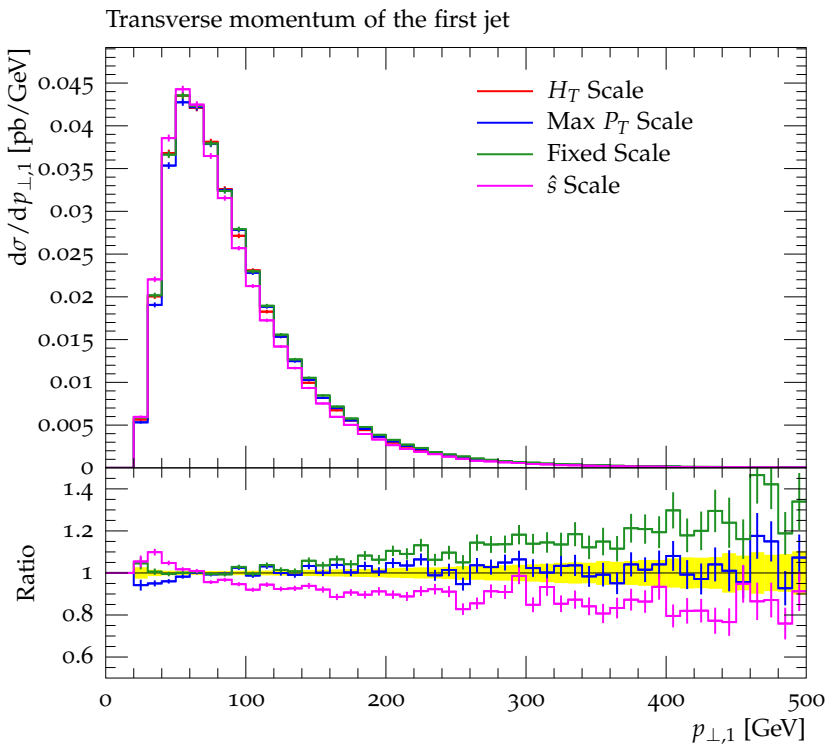
# Standard methods of scale choice II



Example: $p_\perp$ of the leading jet

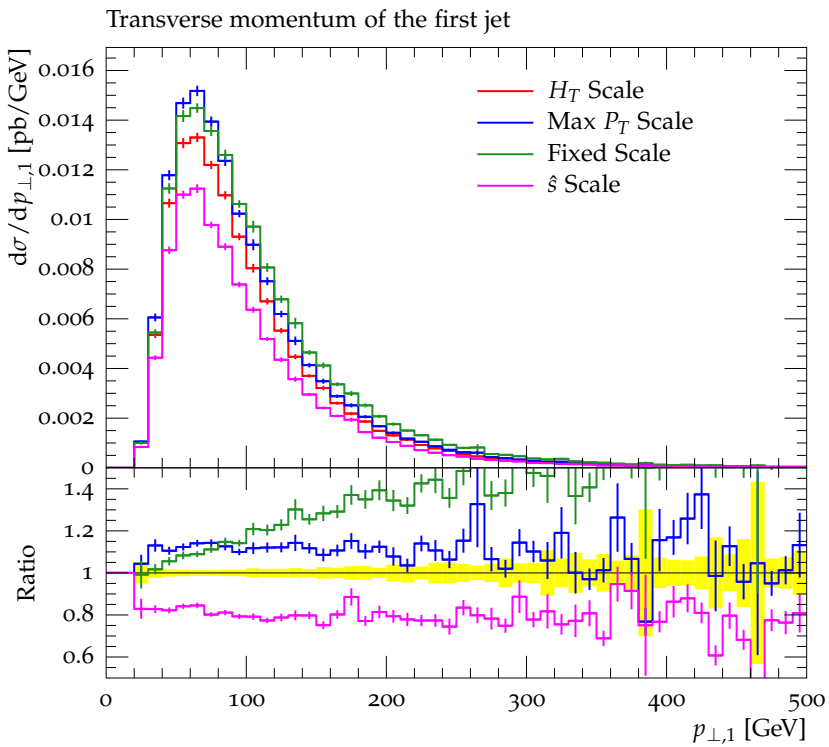
## Higgs with 2 Jets

- only factorization scale
- small scale dependence




## Higgs with 3 Jets

- additional renormalization
- huge scale dependence



# Scale variations I

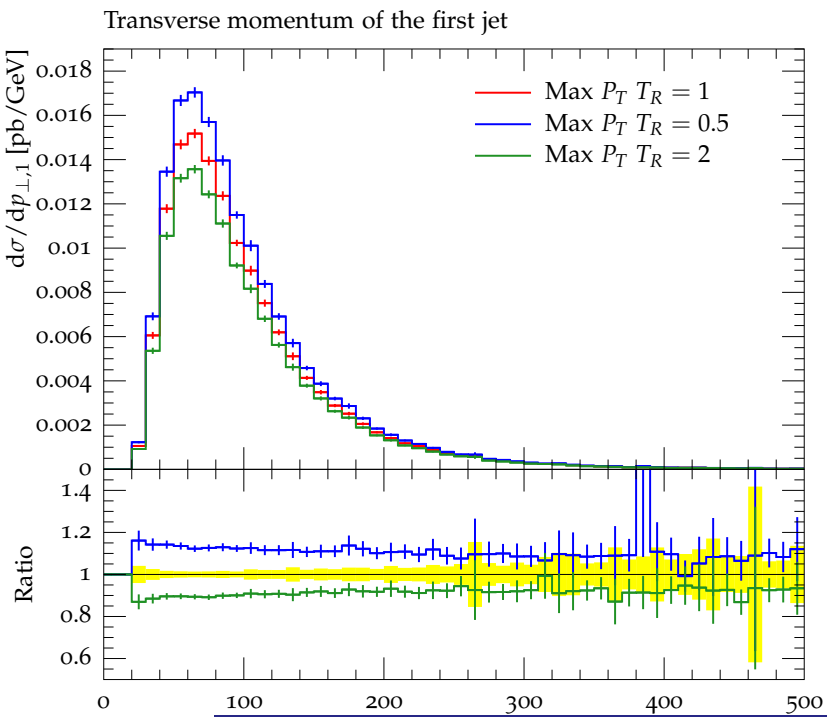


Example: Renormalization scale variation with MaxPt scale choice

$$T_R = 0.5, 1, 2$$

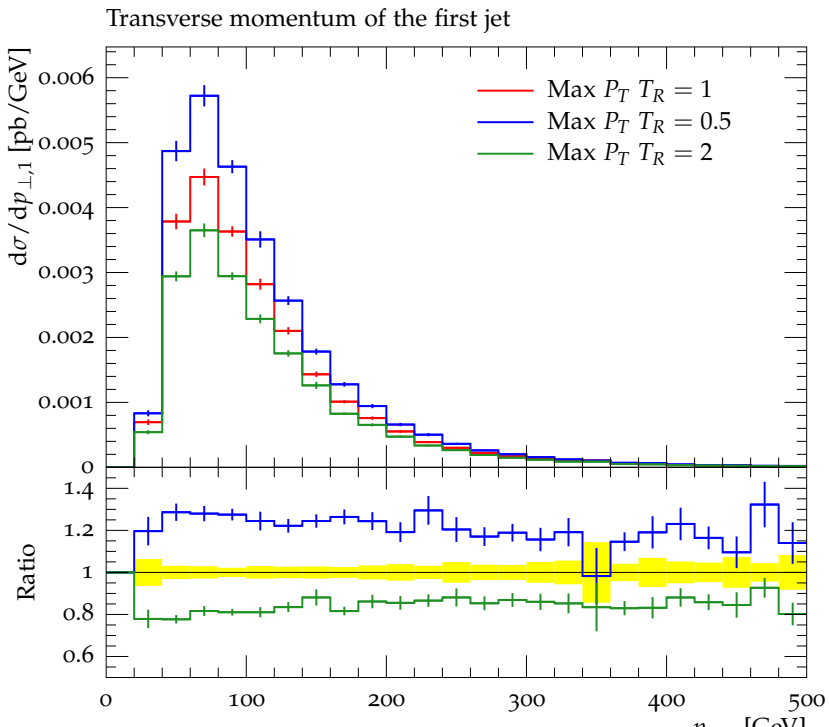
## Higgs with 3 Jets

- order in $\alpha_S = 1$
- running of $\alpha_S \rightarrow$ Off-set




## Higgs with 4 Jets

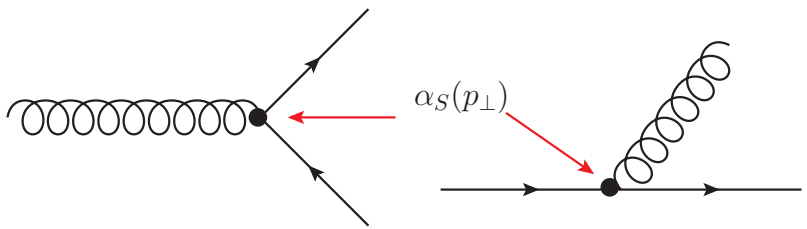
- order in $\alpha_S = 2$
- small shape deviations

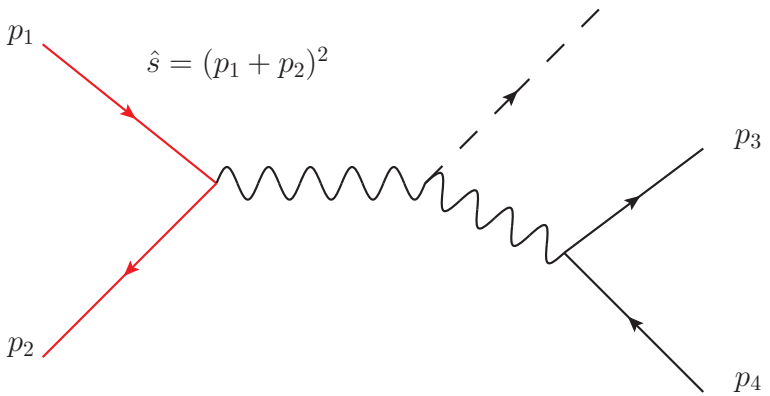


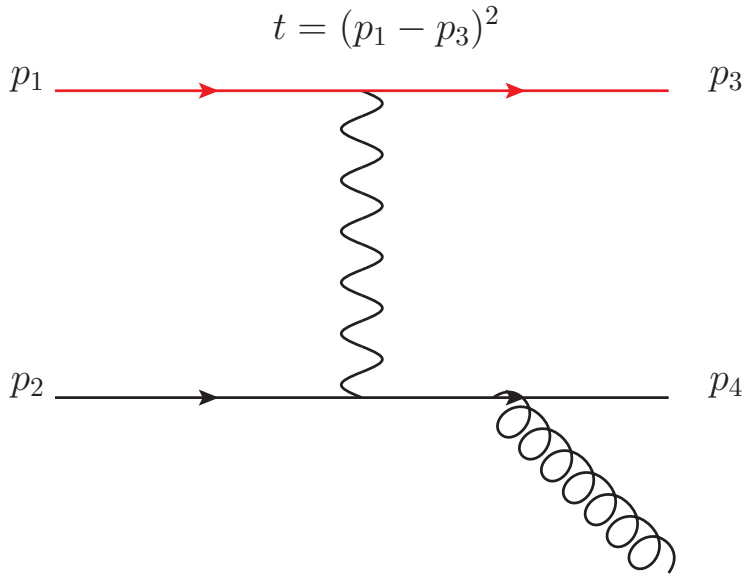
# Issue of scale choice



- Gluon-splitting and -radiation $\longrightarrow \mu_R \sim p_\perp$
- t-channel diagrams $\longrightarrow \mu_F \sim t$
- s-channel diagrams $\longrightarrow \mu_F \sim s$
- Initial state radiation $\longrightarrow$ $\mu_F \sim p_\perp$



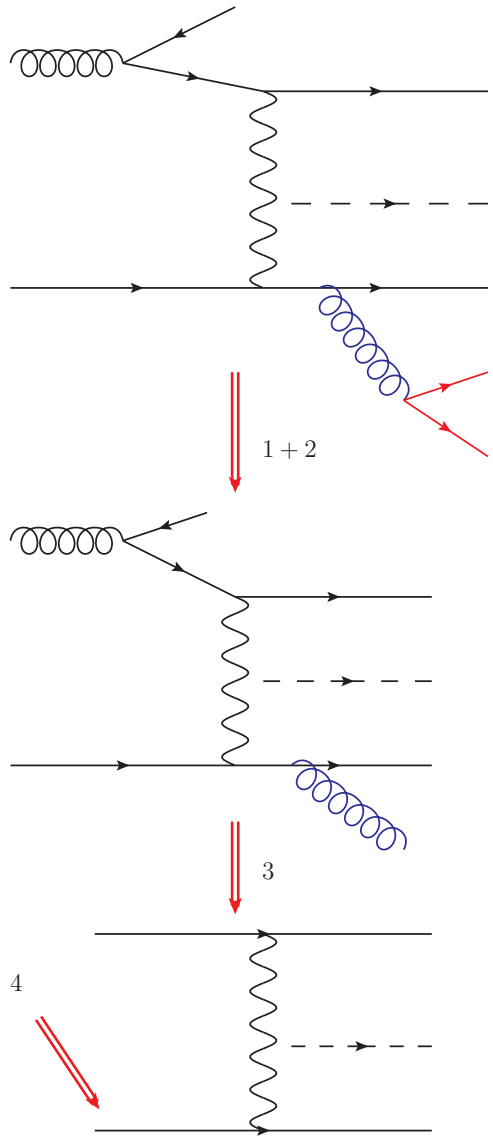



# MINLO I



1. search for pair of partons with minimal $d_{ij} = \min(p_{\perp,i}^2, p_{\perp,j}^2)\frac{\Delta R_{ij}}{R}$
2. cluster to one particle and set $\mu_R = \sqrt{d_{ij}}$ , if initial state radiation set also $\mu_F = \sqrt{d_{ij}}$
3. repeat onetime per order in $\alpha_S$
4. choose remaining $\mu_R$ as mentioned before

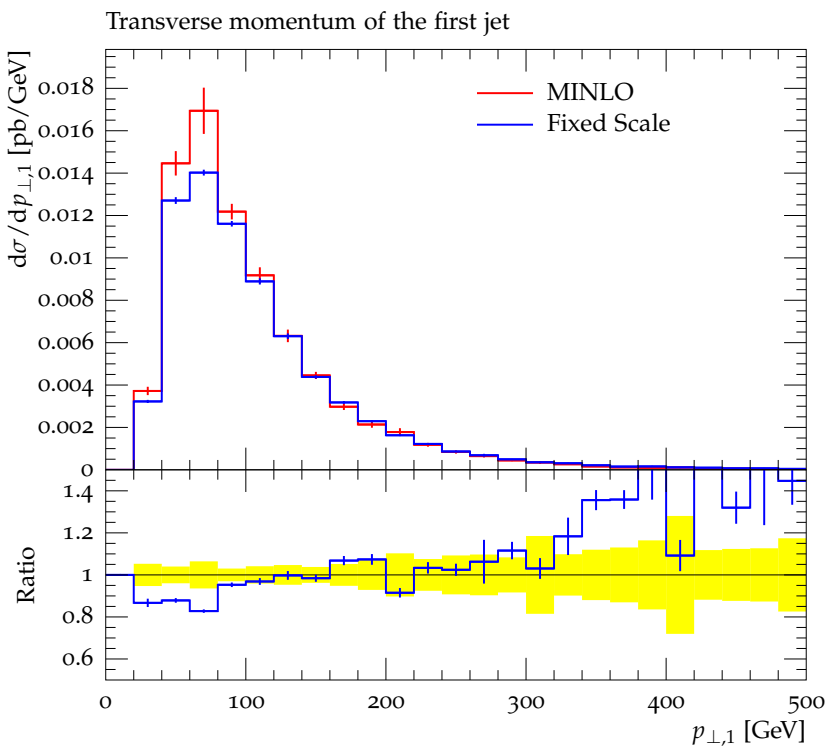


# Some results

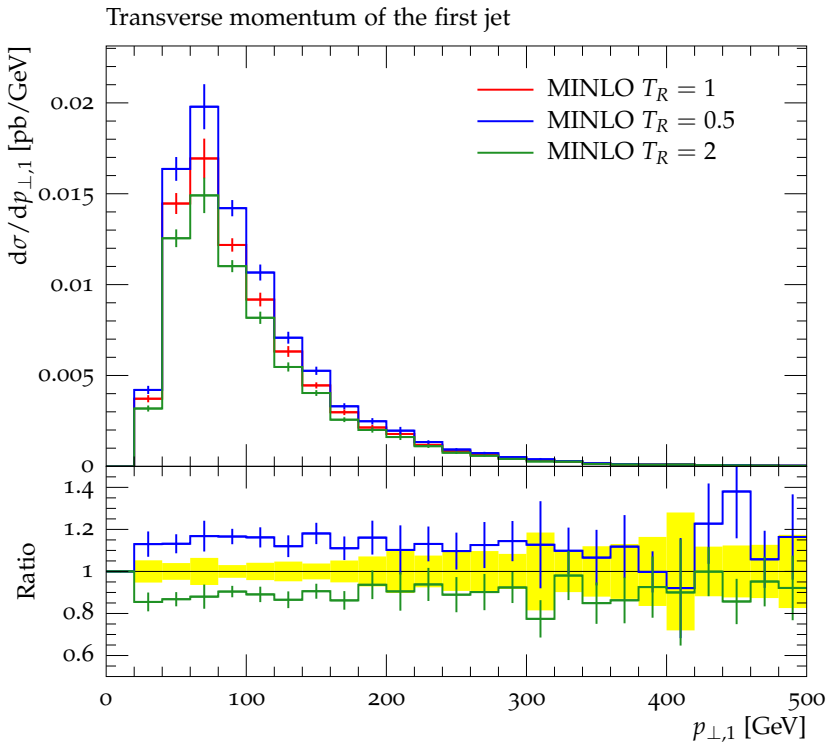


Results of the MINLO algorithm for Higgs plus 3 jets

- $p_\perp$ of leading jet
- Compared with the Fixed scale choice




- scale variation



# Summary



- Huge scale dependencies in higgs production in VBF
- Issue of choosing the right factorization and renormalization scale
- One possible Solution $\Rightarrow$ MINLO alogrithm

Outlook:

- Implementation of the full MINLO algorithm (including Sudakov-formfactors)
- Getting full NLO matrix-elements for VBF

Thank you for your attention.
Questions?