SCET Improved SUSY Search

Xiaohui Liu

with S. Mantry and F. Petriello

Pheno 2012

Argonne National Laboratory

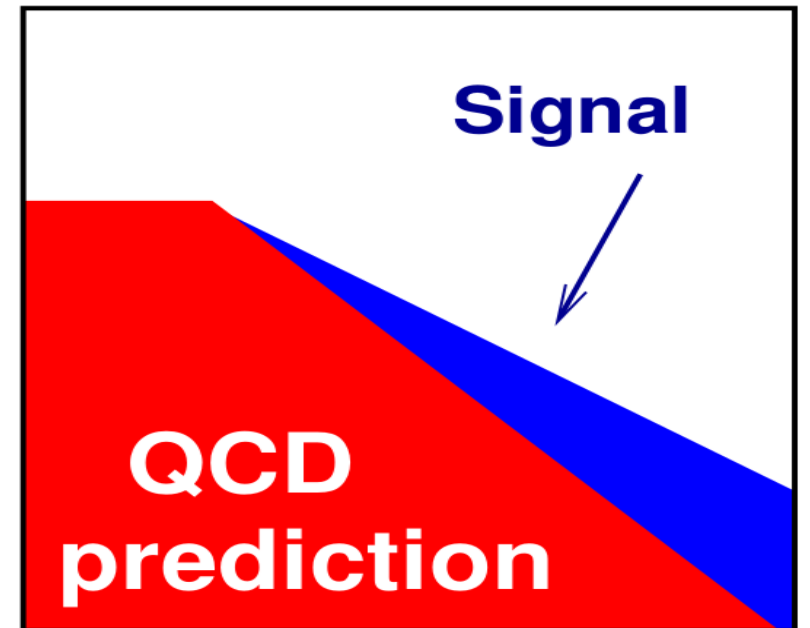Northwestern University

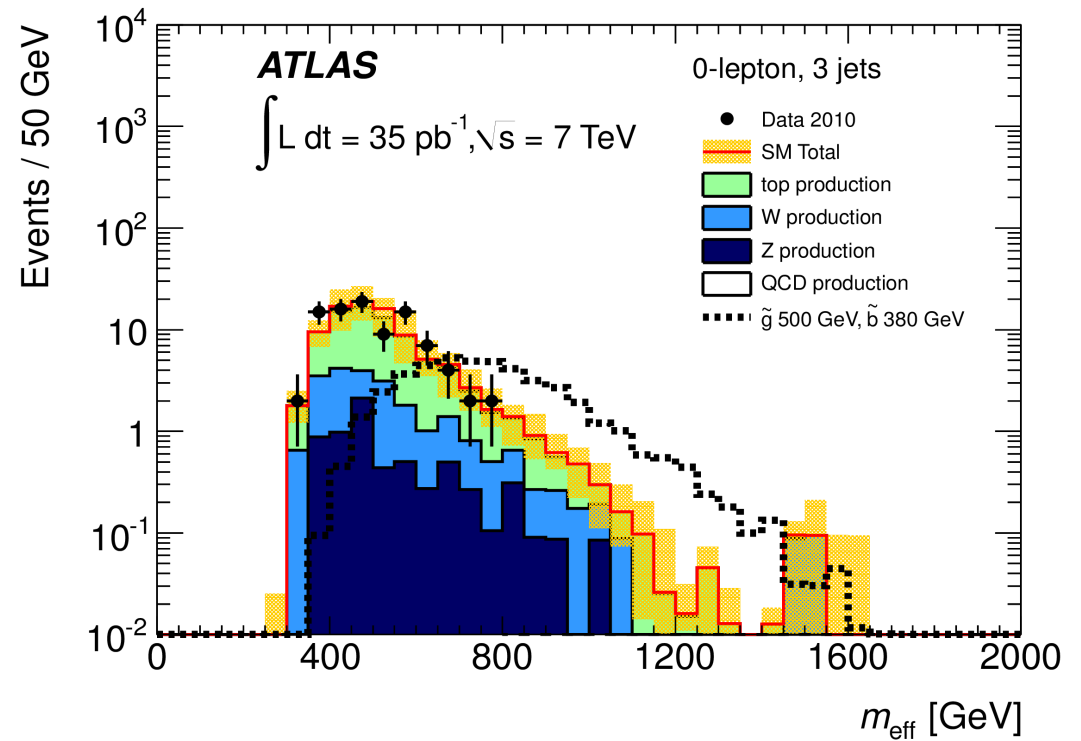# Outline

- Motivation

- Results

- Conclusion and Outlook

Motivation

- New physics as excesses to the data

(G.Salam, 11)
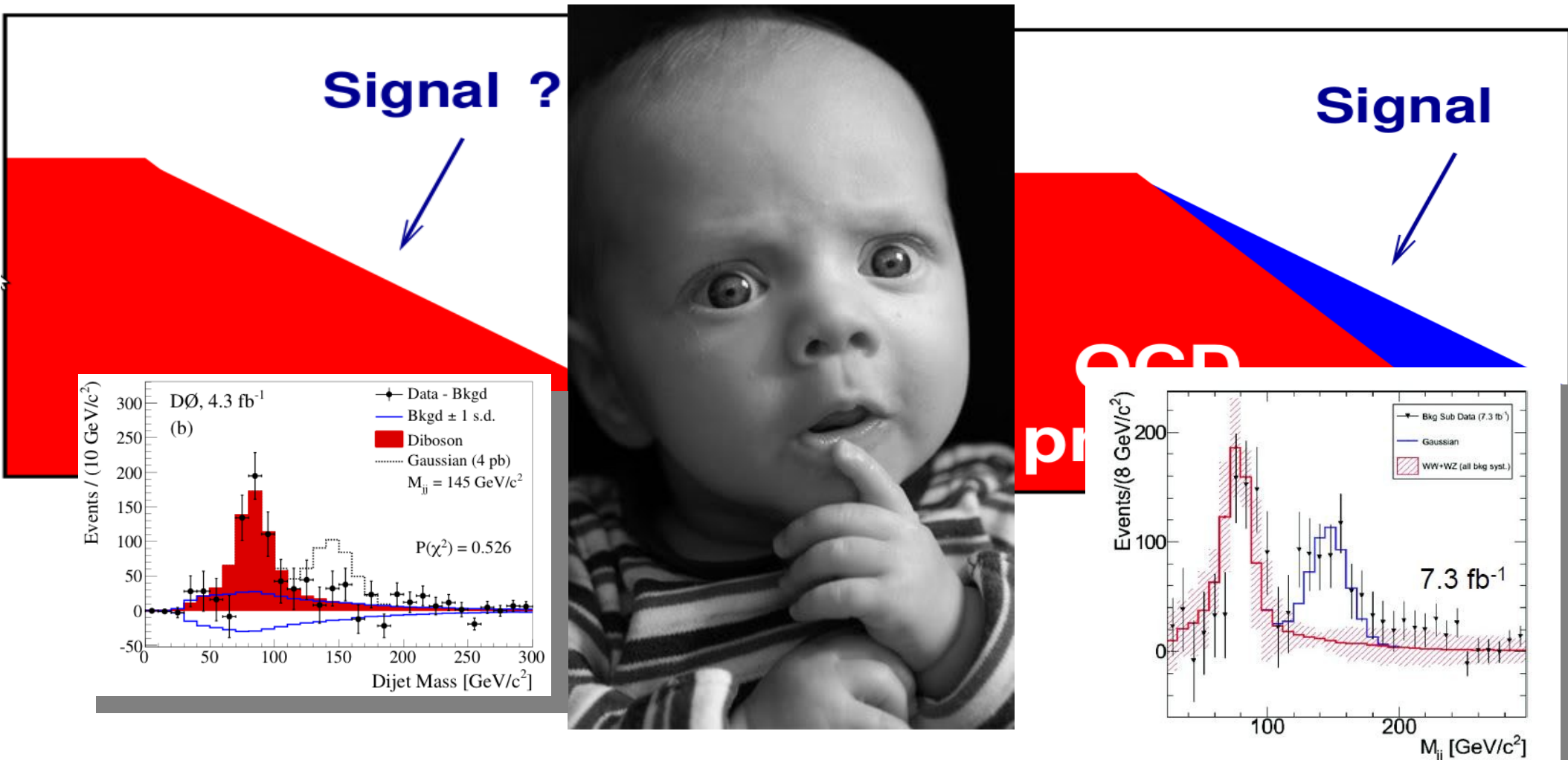
Motivation

- New physics as excesses to the data

Motivation

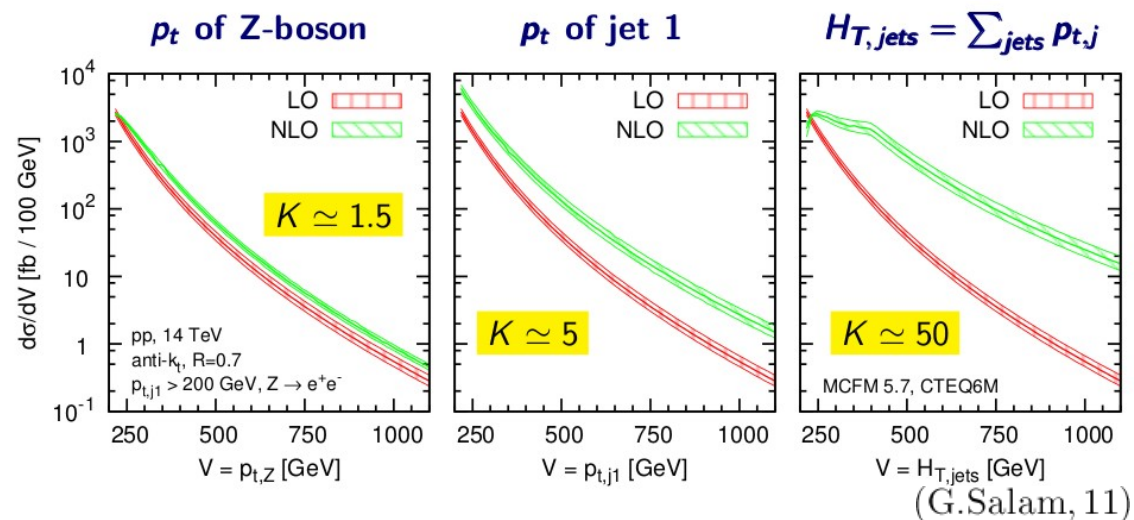- Knowledge of backgrounds is crucial

Motivation

- Knowledge of backgrounds is crucial
  - Difficulties and potential problems
    - Large K factor

p_t of Z-boson — p_t of jet 1 — $H_{T,jets} = \sum_{jets} p_{t,j}$; LO, NLO; $K \simeq 1.5$, $K \simeq 5$, $K \simeq 50$; pp, 14 TeV, anti-k_t, R=0.7, $p_{t,j1} > 200$ GeV, $Z \to e^+ e^-$; MCFM 5.7, CTEQ6M; (G. Salam, 11)

Motivation

- Knowledge of backgrounds is crucial
  - Difficulties and potential problems
    - Large K factor
    - Sudakov Logs $\alpha_s^n \log^{2n-m}(Q^2/q^2)$
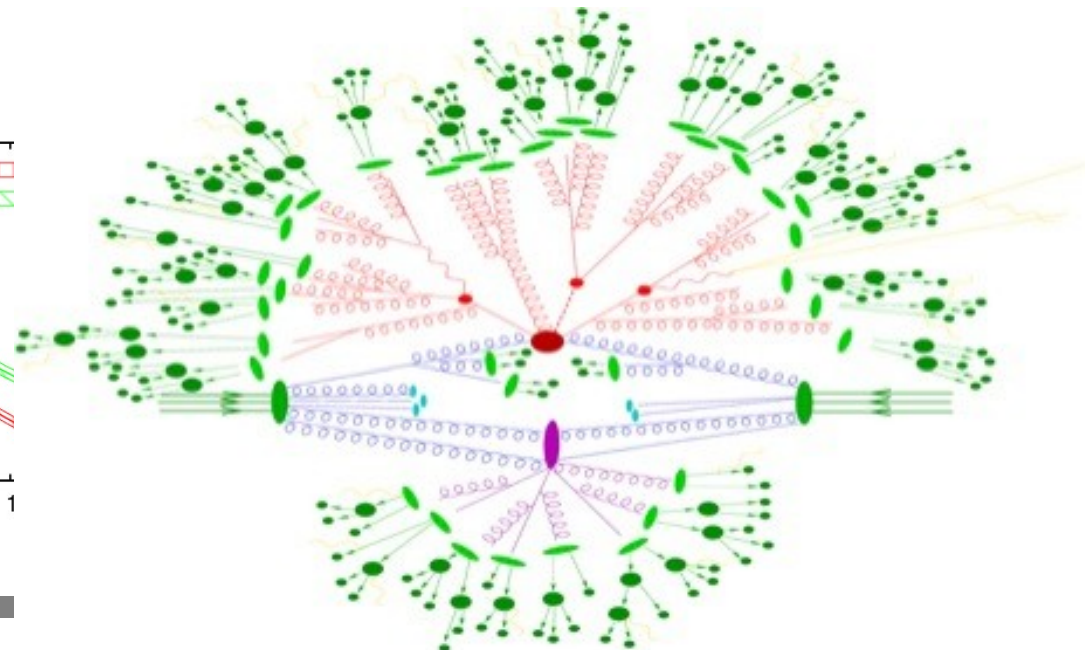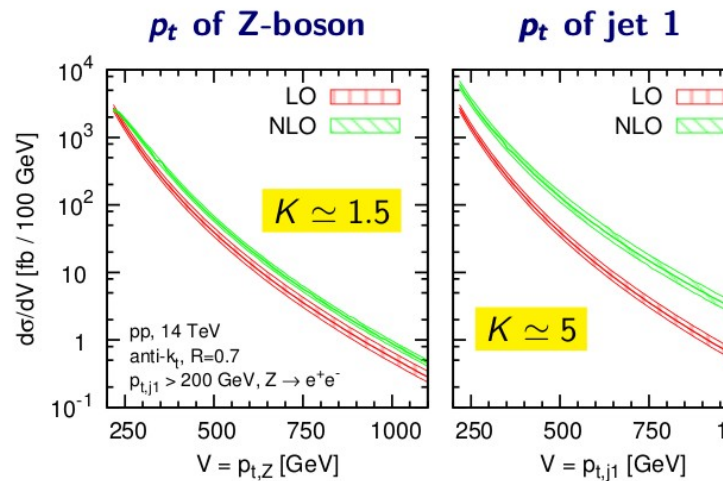

(G.Salam, 11)
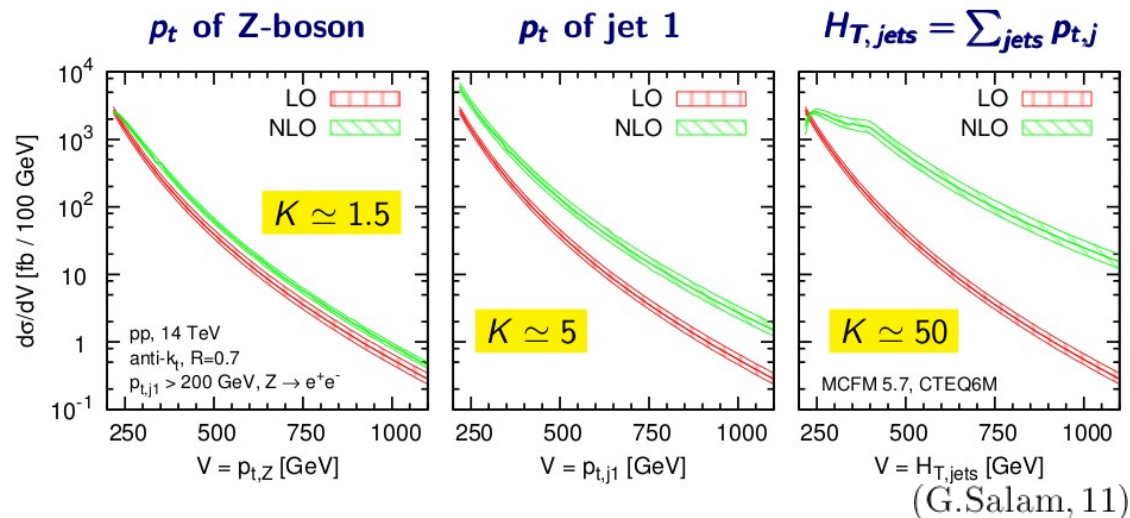
Motivation

- ## Knowledge of backgrounds is crucial

  - ### Difficulties and potential problems

    - Large K factor
    - Sudakov Logs $\alpha_s^n \log^{2n-m}(Q^2/q^2)$
    - Multi-scales

Motivation

- Knowledge of backgrounds is crucial
  - Threshold logs and dynamical enhancement
    - $\alpha_s^n \left(\dfrac{\log^m(1-z)}{1-z} \right)_+$
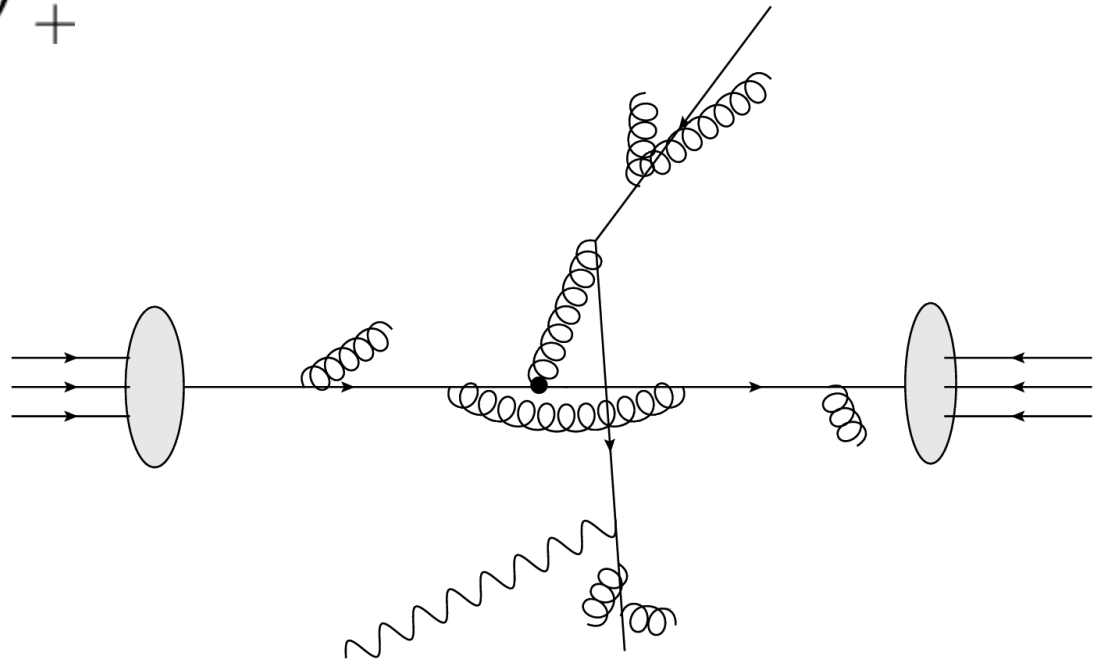
Motivation

- Knowledge of backgrounds is crucial
  - Threshold logs and dynamical enhancement

- $$\alpha_s^n \left(\frac{\log^m(1-z)}{1-z} \right)_+$$

- Important for $x \gtrsim 0.3$

(C.Bauer, 10, T.Becher, 07)

CTEQ6L1: gg

Parton Luminosity [nb]

$\sqrt{\hat{s}}$ [TeV]

- 0.9 TeV
- 2 TeV
- 4 TeV
- 6 TeV
- 7 TeV
- 10 TeV
- 14 TeV

(C.Quigg, 09)

Motivation

- Knowledge of backgrounds is crucial
  - Threshold logs and dynamical enhancement
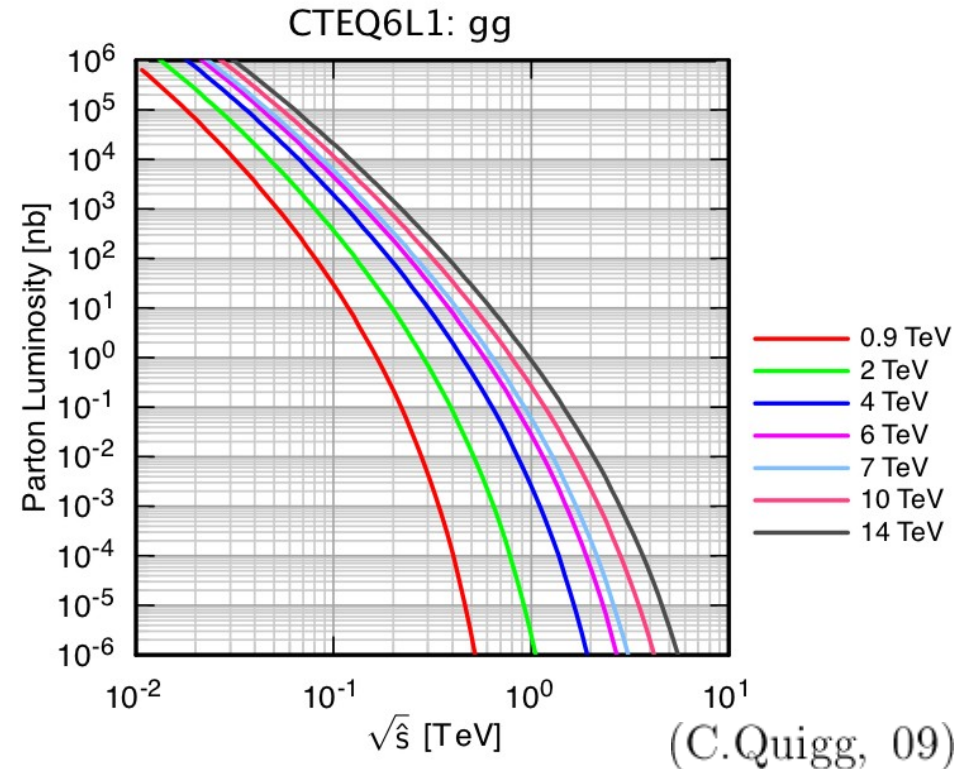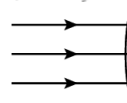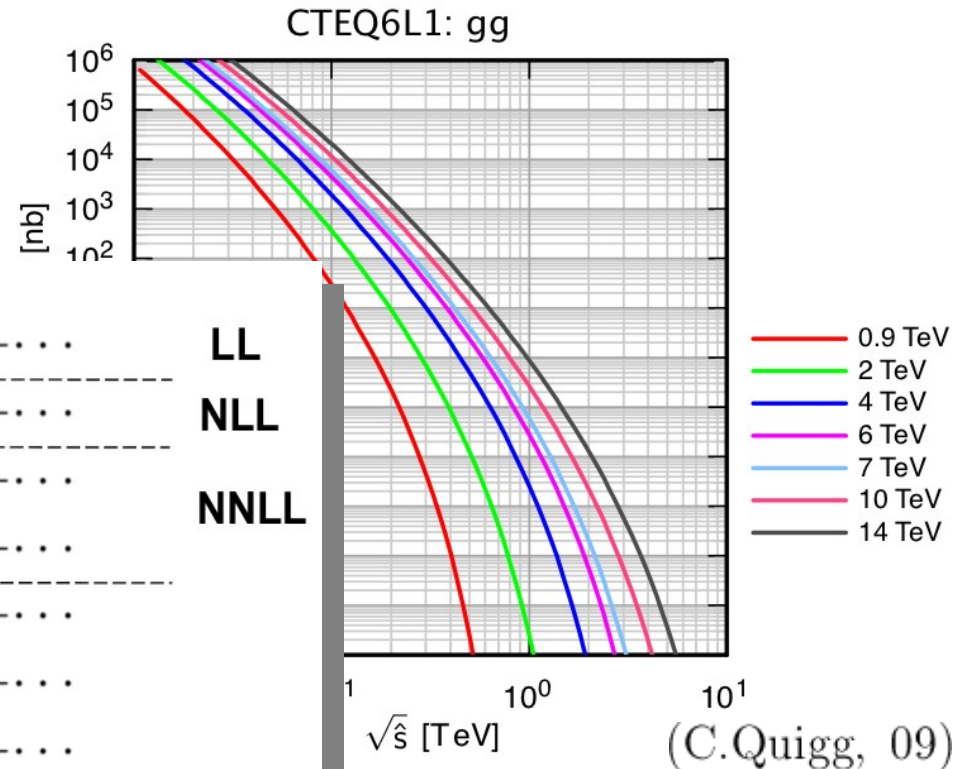
- $\alpha_s^n \left(\dfrac{\log^m(1-z)}{1-z} \right)_+$

$$C = \alpha_s L^2 + \alpha_s^2 L^4 + \alpha_s^3 L^6 + \alpha_s^4 L^8 + \cdots \quad \text{LL}$$
$$\alpha_s L^1 + \alpha_s^2 L^3 + \alpha_s^3 L^5 + \alpha_s^4 L^7 + \cdots \quad \text{NLL}$$
$$+ \alpha_s^2 L^2 + \alpha_s^3 L^4 + \alpha_s^4 L^6 + \cdots \quad \text{NNLL}$$
$$+ \alpha_s^2 L^1 + \alpha_s^3 L^3 + \alpha_s^4 L^5 + \cdots$$
$$+ \alpha_s^3 L^2 + \alpha_s^4 L^4 + \cdots$$
$$+ \alpha_s^3 L^1 + \alpha_s^4 L^3 + \cdots$$
$$+ \alpha_s^4 L^2 + \cdots$$
$$+ \alpha_s^4 L^1 + \cdots$$
$$+ \cdots$$

CTEQ6L1: gg

[nb], $\sqrt{\hat{s}}$ [TeV]
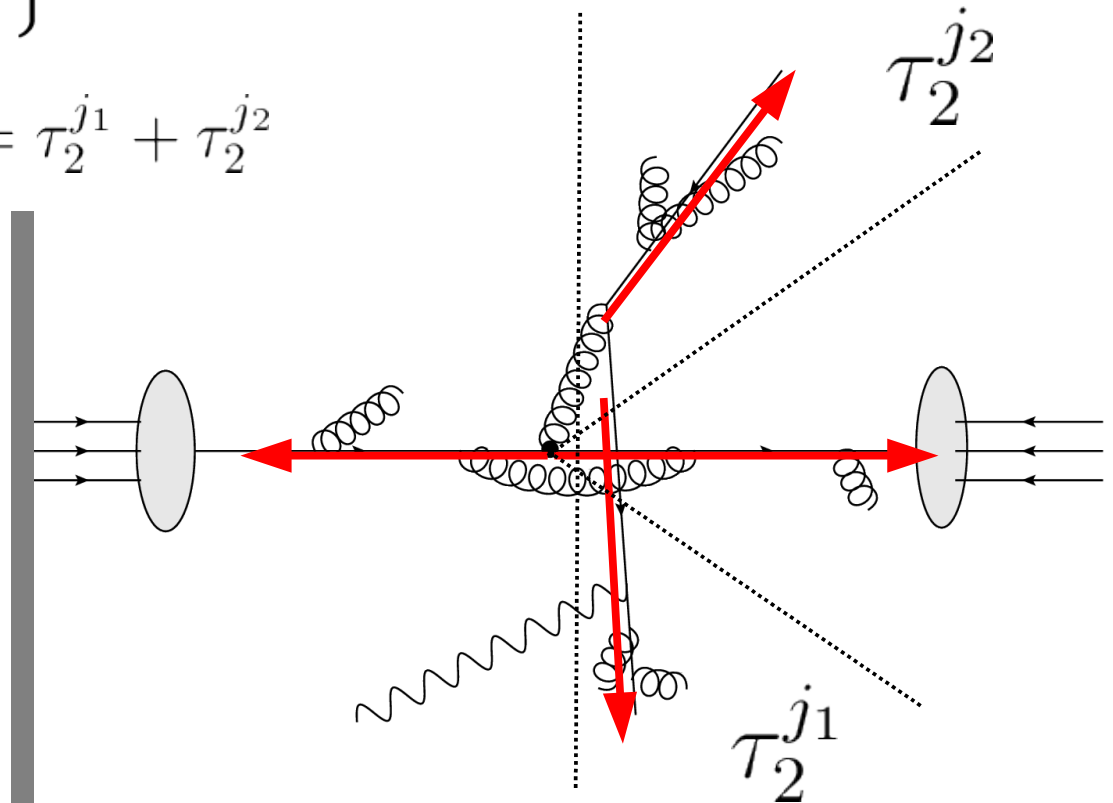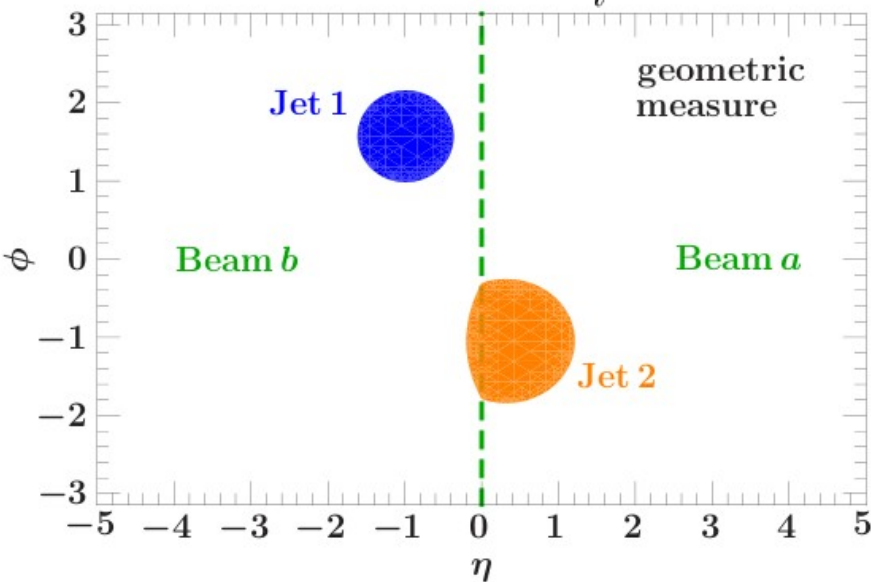
0.9 TeV
2 TeV
4 TeV
6 TeV
7 TeV
10 TeV
14 TeV

(C.Quigg, 09)

Results

- $pp \to \gamma + 2j$

  - SCET and Jettiness (I. Stewart, F. Tackmann, W. Waalewijn, 10)

$$\tau_2 = \sum_k \min_i \left\{ \frac{2q_i \cdot p_k}{Q_i} \right\}$$

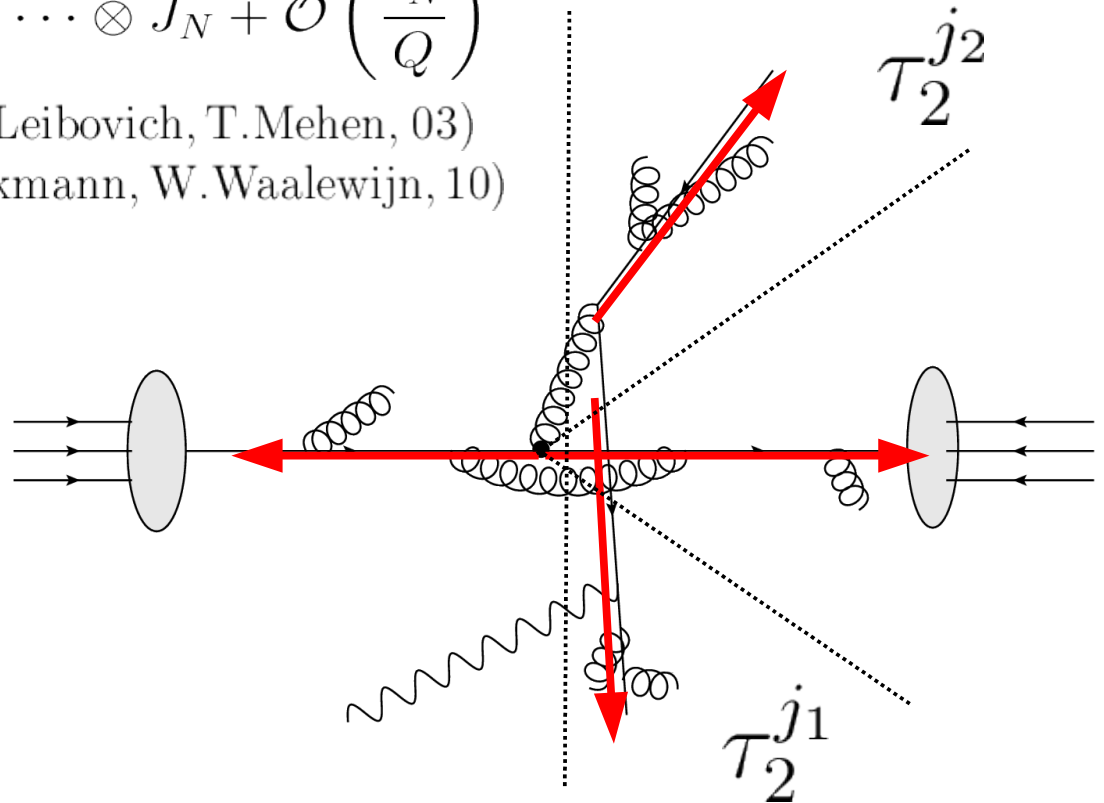$$\tau_2 = \sum_i \tau_2^i \to \hat{\tau}_2 = \tau_2^{j_1} + \tau_2^{j_2}$$

Results

- $pp \rightarrow \gamma + 2j$

  - SCET and Jettiness

  - Factorization and resummation

$$\mathrm{d}\sigma \sim F \cdot H \cdot S \otimes B_a \otimes B_b \otimes J_1 \otimes \cdots \otimes J_N + \mathcal{O}\left(\frac{\tau_N}{Q}\right)$$
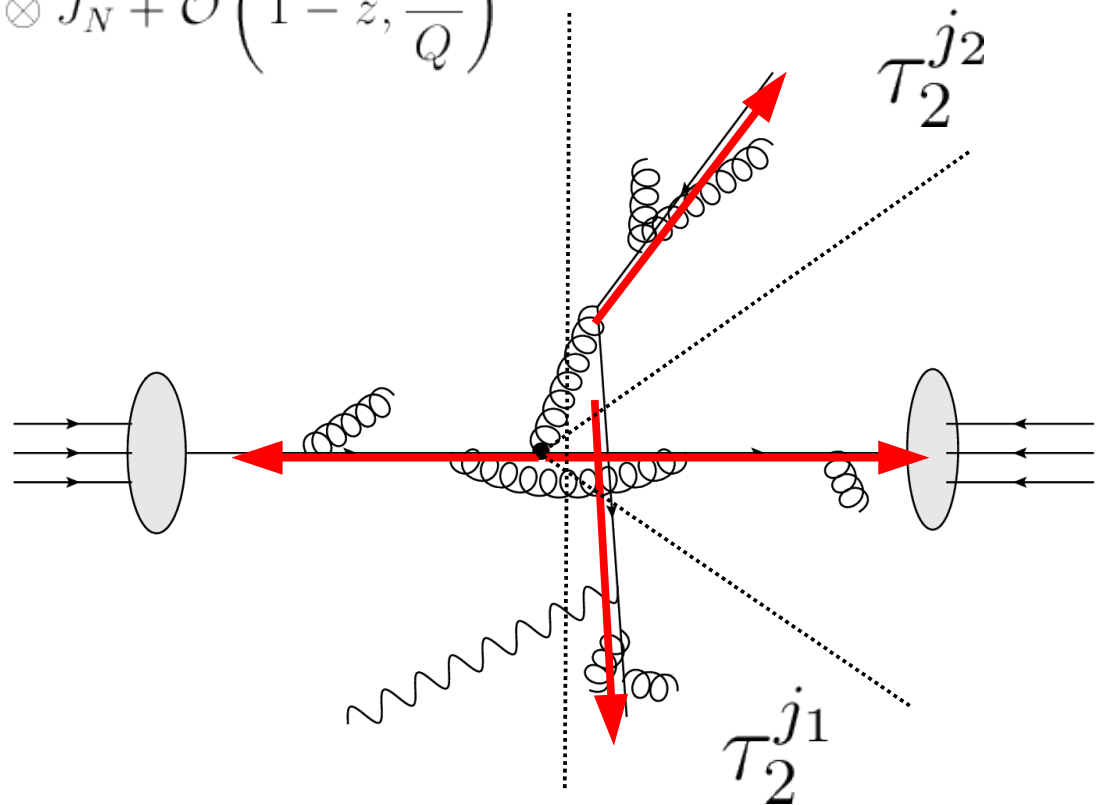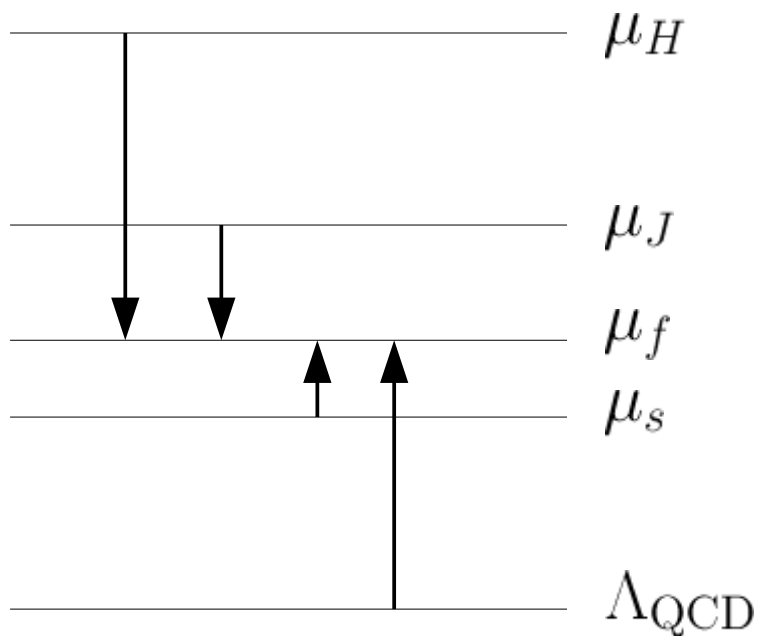
(S.Fleming, A.K.Leibovich, T.Mehen, 03)
(I.Stewart, F.Tackmann, W.Waalewijn, 10)

Results

- $pp \rightarrow \gamma + 2j$

  - SCET and Jettiness
  - Factorization and resummation

$$\mathrm{d}\sigma \sim F \cdot H \cdot S \otimes f_a \otimes f_b \otimes J_1 \otimes \cdots \otimes J_N + \mathcal{O}\left(1 - z, \frac{\hat{\tau}_N}{Q}\right)$$

Results

- $pp \to \gamma + 2j$

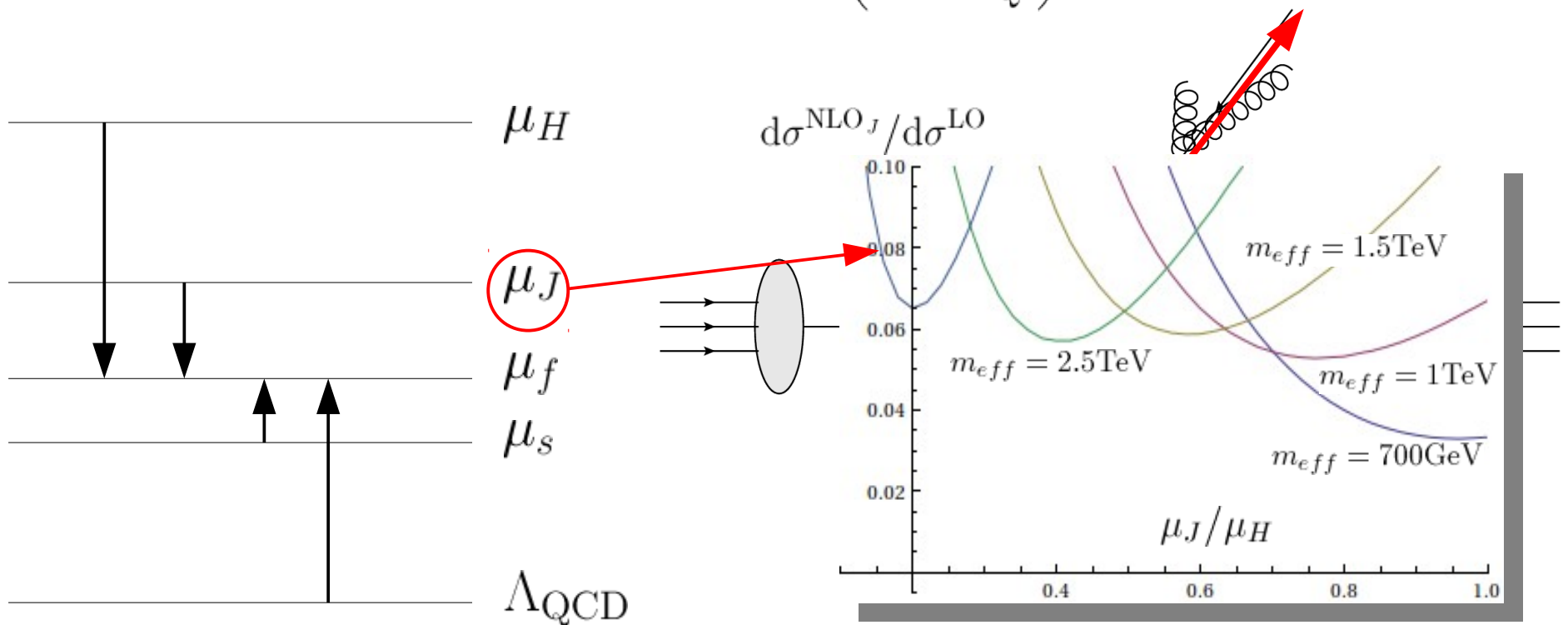 - SCET and Jettiness
  - Factorization and resummation

$$\mathrm{d}\sigma \sim F \cdot H \cdot S \otimes f_a \otimes f_b \otimes J_1 \otimes \cdots \otimes J_N + \mathcal{O}\left(1 - z, \frac{\hat{\tau}_N}{Q}\right)$$

Results

- $pp \to \gamma + 2j$

  - SCET and Jettiness
  - Factorization and resummation

$$\mathrm{d}\sigma \sim F \cdot H \cdot S \otimes f_a \otimes f_b \otimes J_1 \otimes \cdots \otimes J_N + \mathcal{O}\left(1 - z, \frac{\hat{\tau}_N}{Q}\right)$$
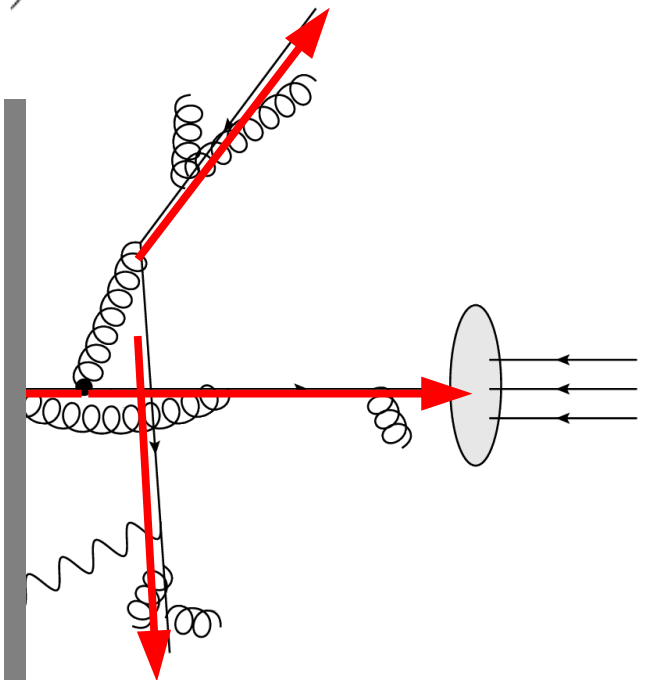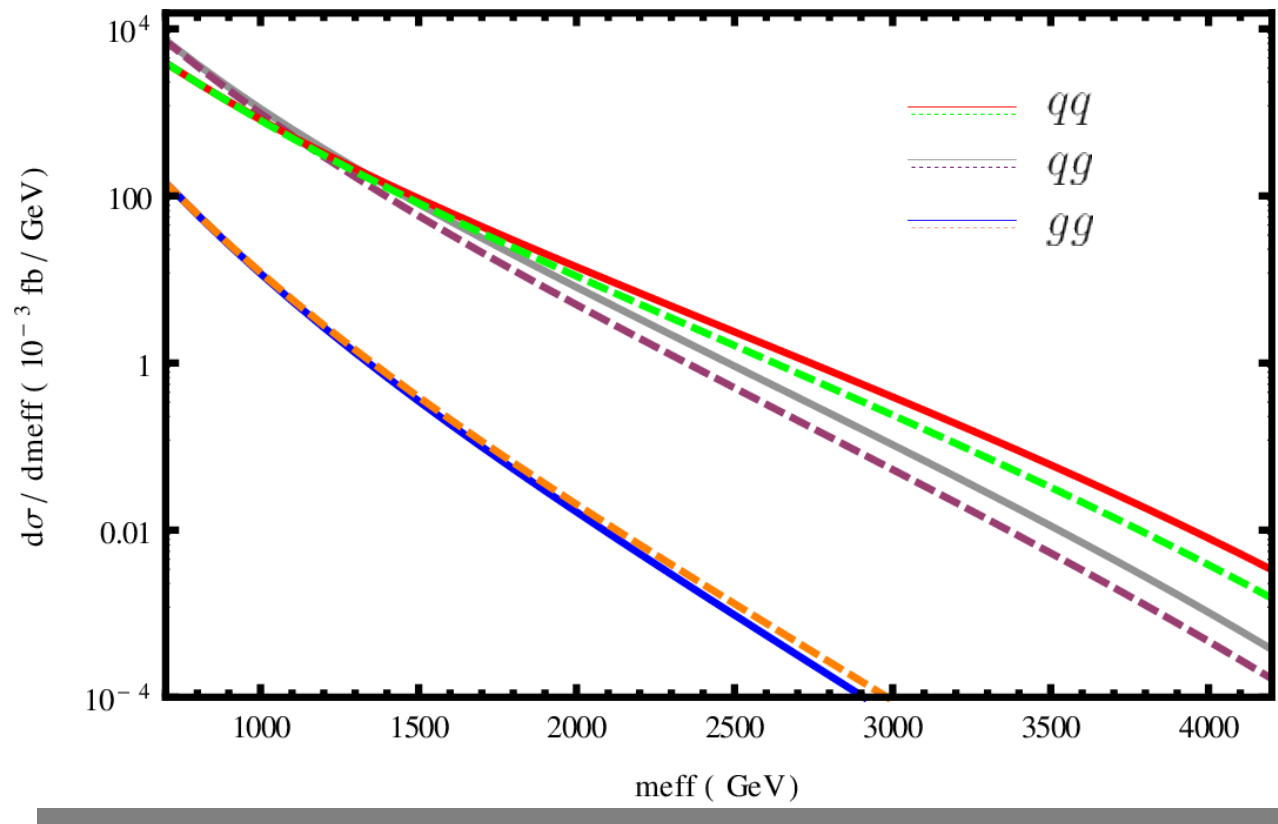
$$
\begin{aligned}
C = \; & \alpha_s L^2 \; + \; \alpha_s^2 L^4 \; + \; \alpha_s^3 L^6 \; + \; \alpha_s^4 L^8 \; + \cdots \qquad \text{LL} \\
& \alpha_s L^1 \; + \; \alpha_s^2 L^3 \; + \; \alpha_s^3 L^5 \; + \; \alpha_s^4 L^7 \; + \cdots \qquad \text{NLL} \\
& + \; \alpha_s^2 L^2 \; + \; \alpha_s^3 L^4 \; + \; \alpha_s^4 L^6 \; + \cdots \qquad \text{NNLL} \\
& + \; \alpha_s^2 L^1 \; + \; \alpha_s^3 L^3 \; + \; \alpha_s^4 L^5 \; + \cdots \\
& + \; \alpha_s^3 L^2 \; + \; \alpha_s^4 L^4 \; + \cdots \\
& + \; \alpha_s^3 L^1 \; + \; \alpha_s^4 L^3 \; + \cdots \\
& + \; \alpha_s^4 L^2 \; + \cdots \\
& + \; \alpha_s^4 L^1 \; + \cdots \\
& + \cdots
\end{aligned}
$$

Results
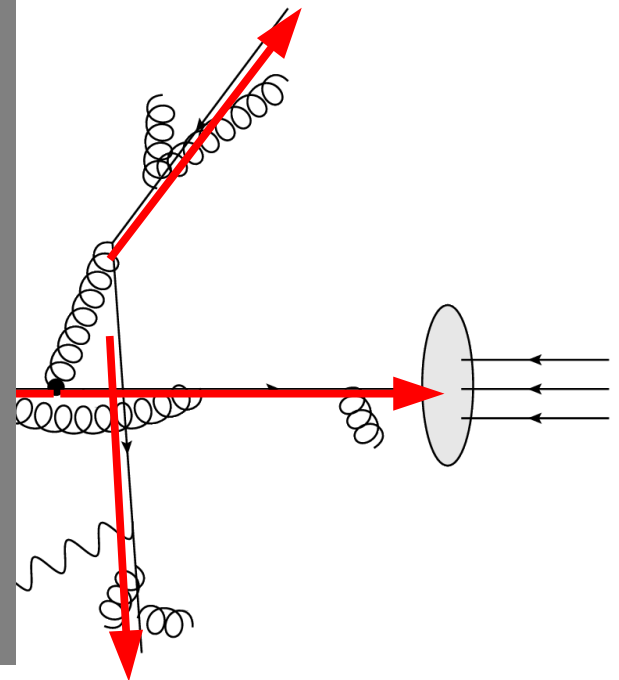
- $pp \rightarrow \gamma + 2j$
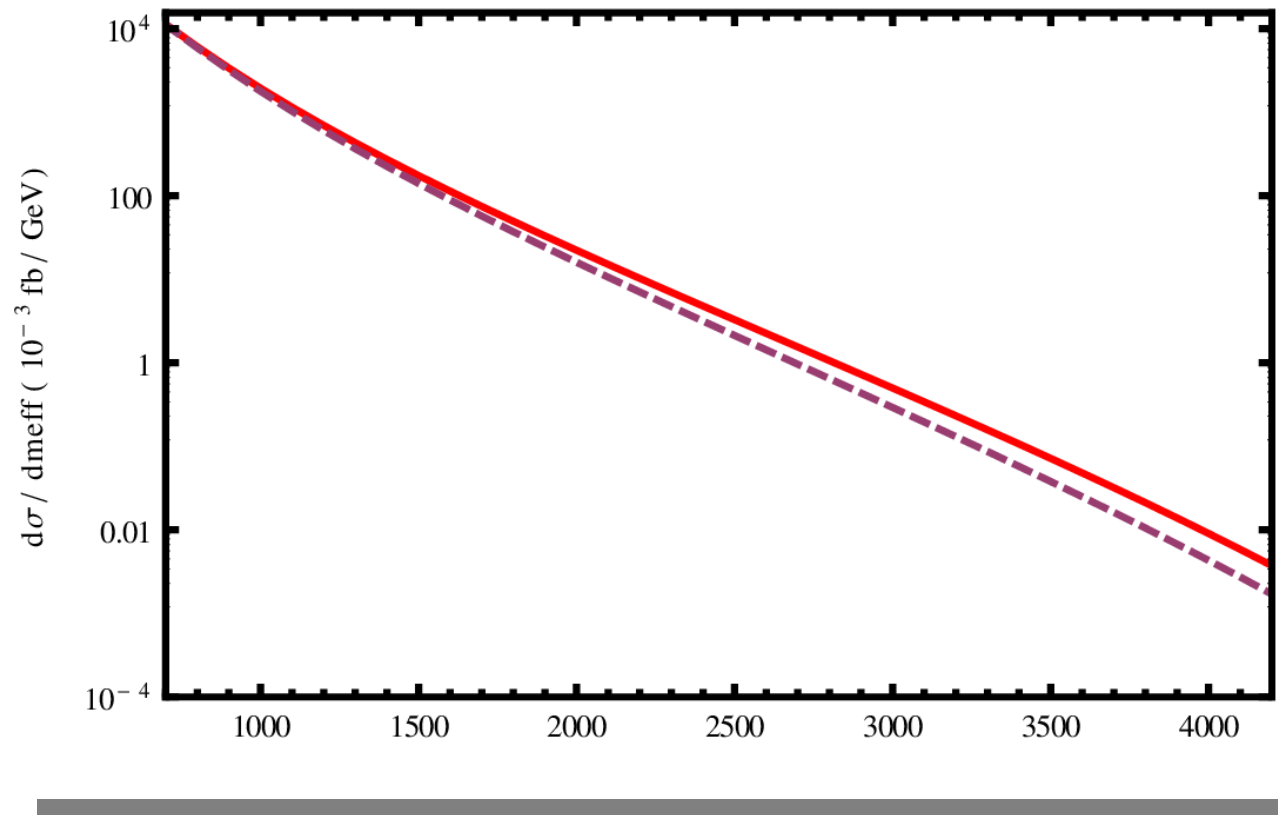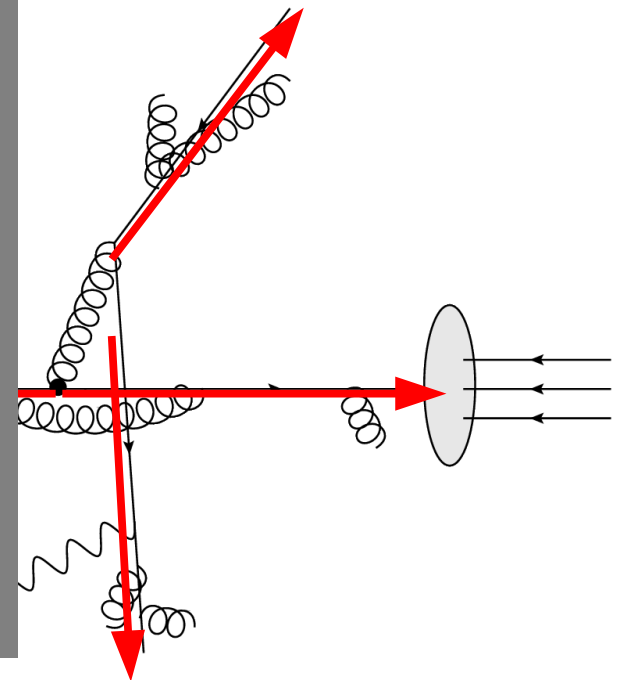
  - Numerical results

$|\eta| > 2.5$

$\Delta R_{ij} > 0.4$

$p_T > 100 \text{GeV}$

Results

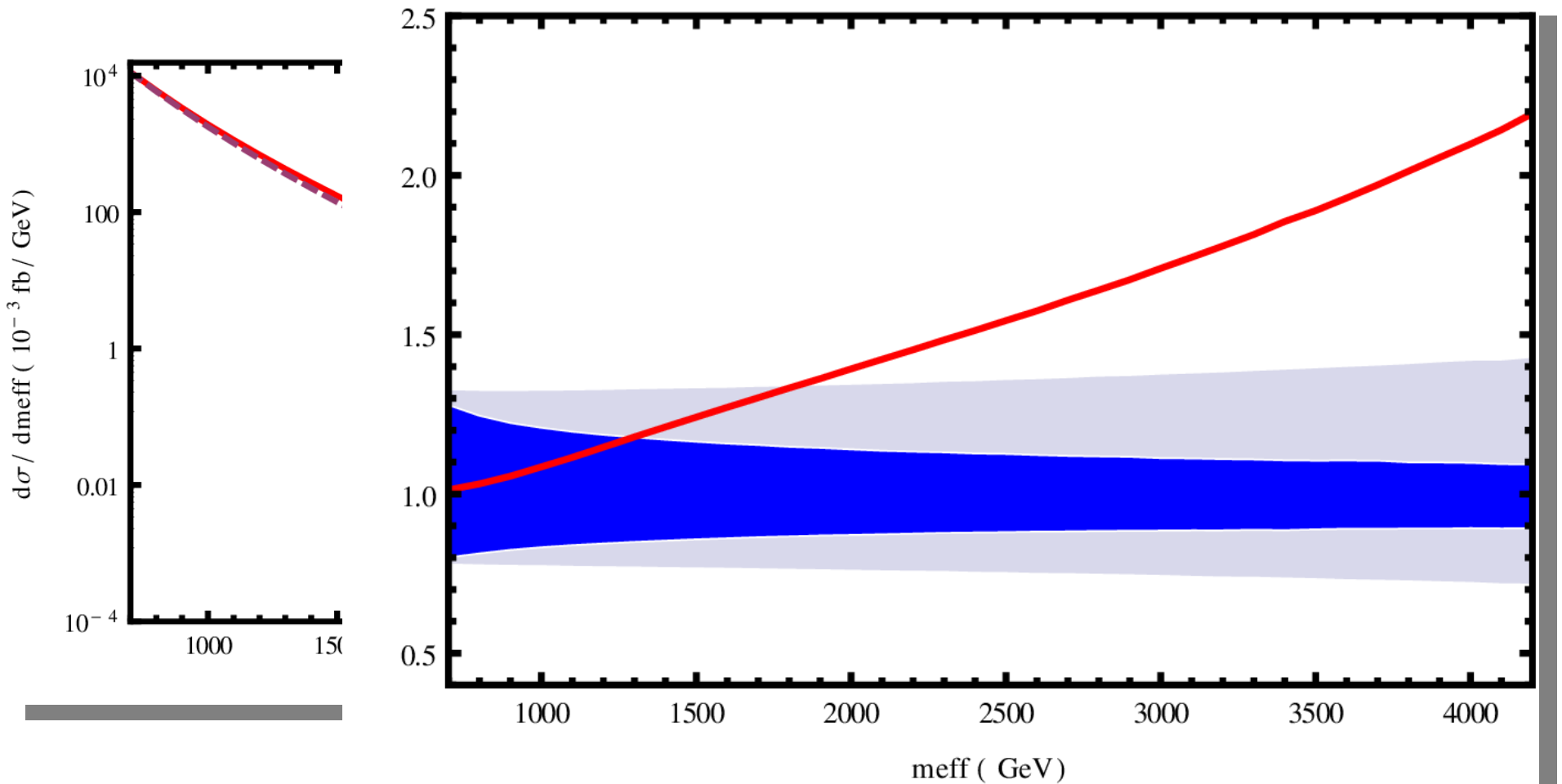- $pp \rightarrow \gamma + 2j$

  - Numerical results

$|\eta| > 2.5$

$\Delta R_{ij} > 0.4$

$p_T > 100 \text{GeV}$

Results

- $pp \to \gamma + 2j$

  - Numerical results

Conclusion and Outlook

- Better understanding of backgrounds

- Higher accuracy

- Other processes

Thanks

Backup