Jet Shape at LHC

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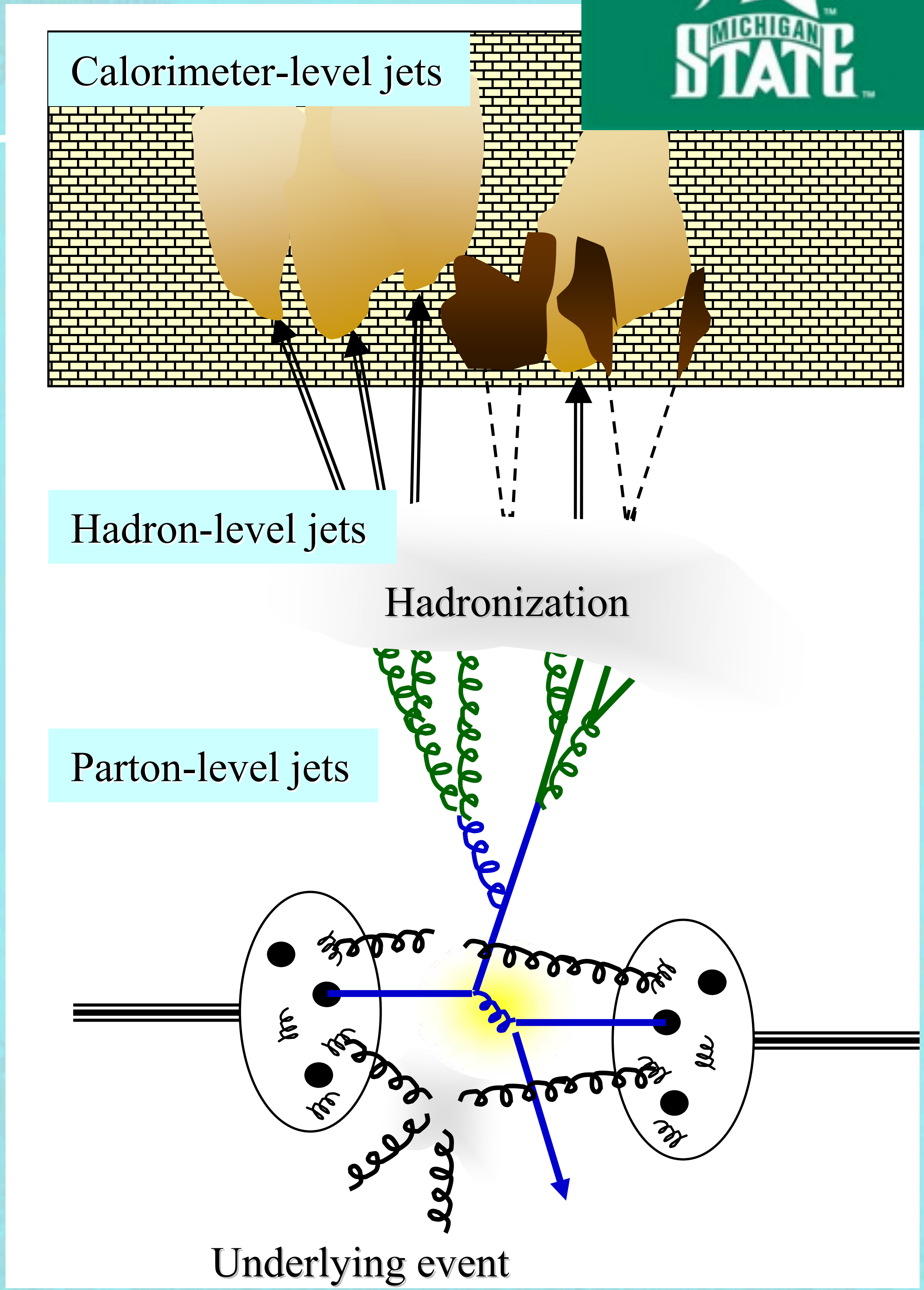
(in progress)

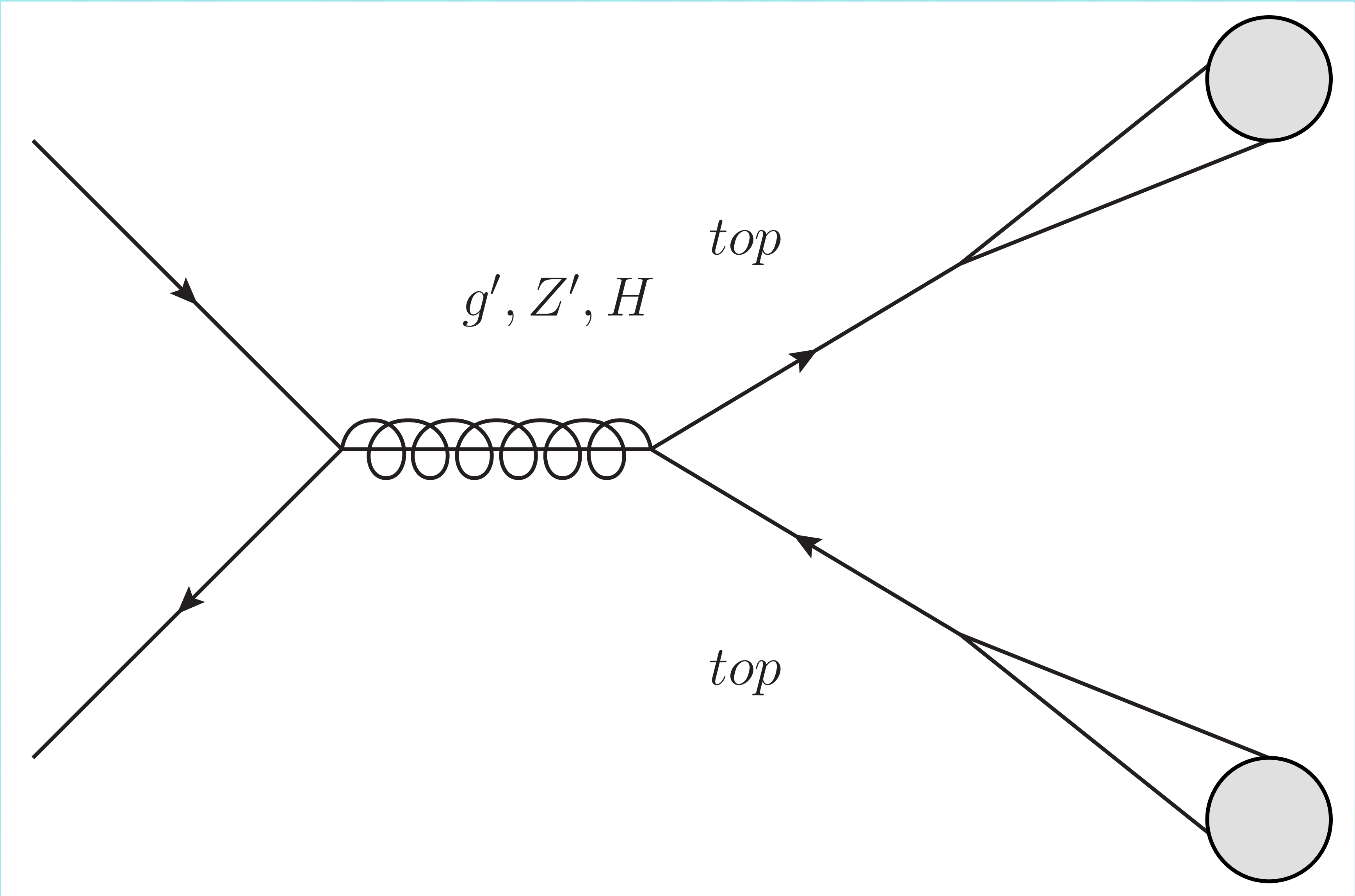
Jet at hadron colliders

- QCD strong interaction
- Parton Shower / Radiation
- Long distance correlation / Soft effect
- QCD confinement / Hadronization
- Collinear leptons

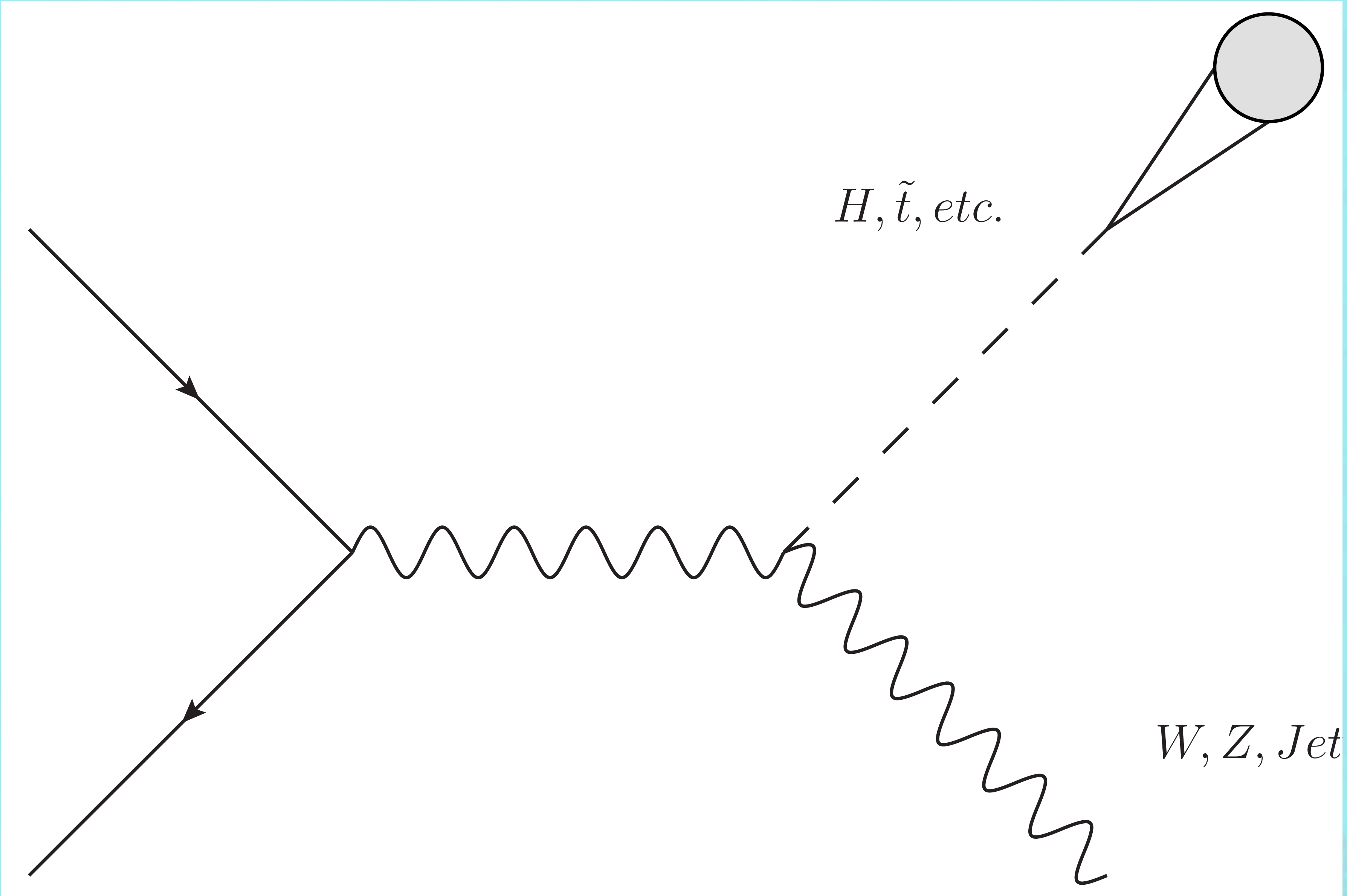


Impact at the LHC

LHC will produce more than 10^5 top with pT>1TeV



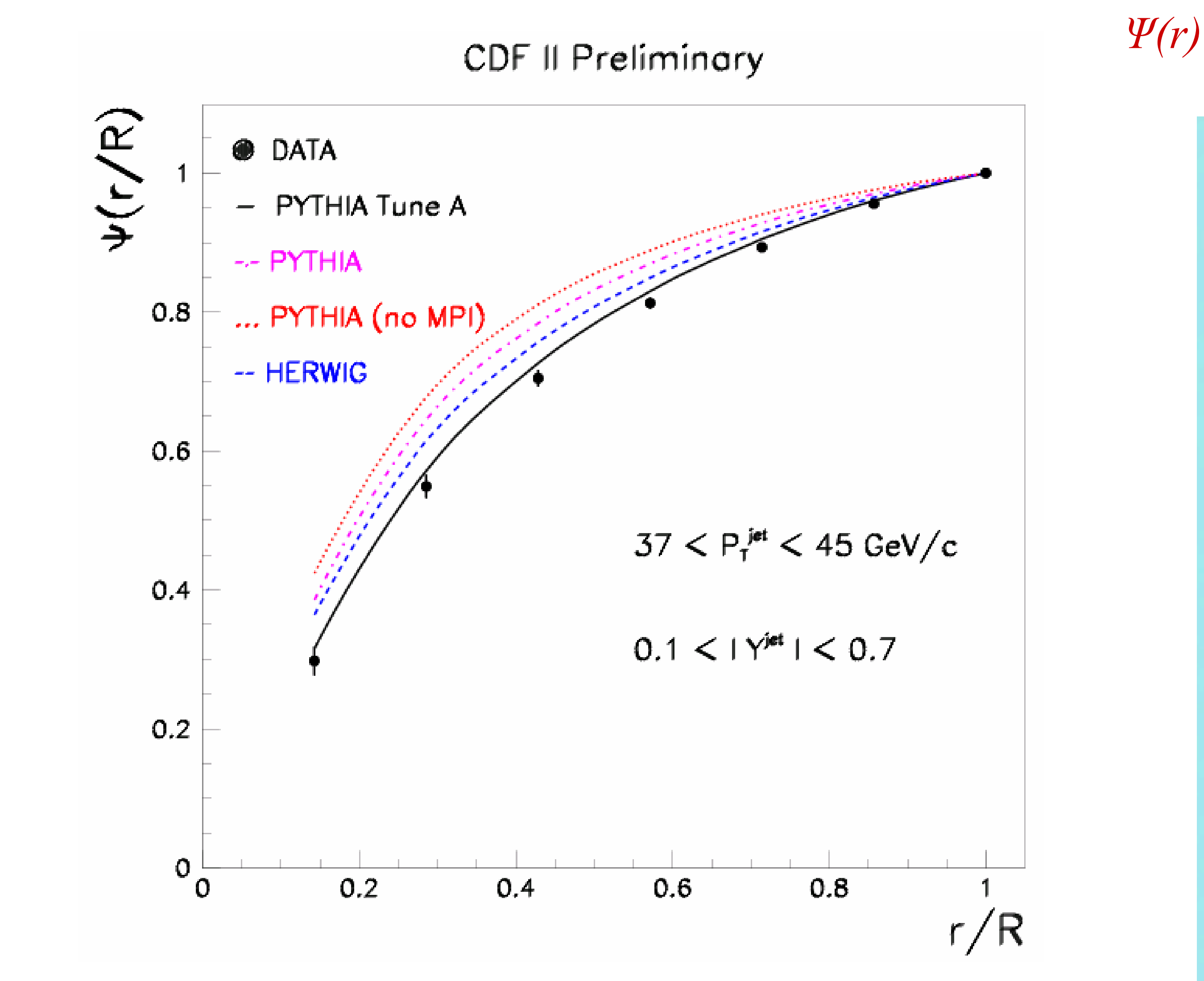
Impact at the LHC



What we found

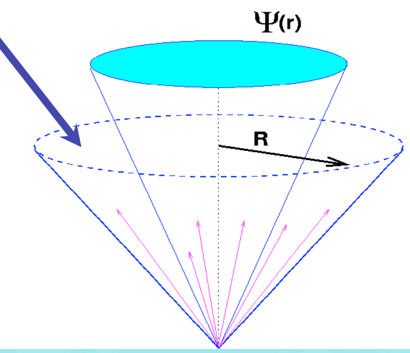
- For the jet mass region around top quark or Higgs, NLO jet function underestimates the rate of QCD jet background.
- Resummation effect changes shapes of QCD jet background.
- Resummation gives correct behavior in small jet mass region.

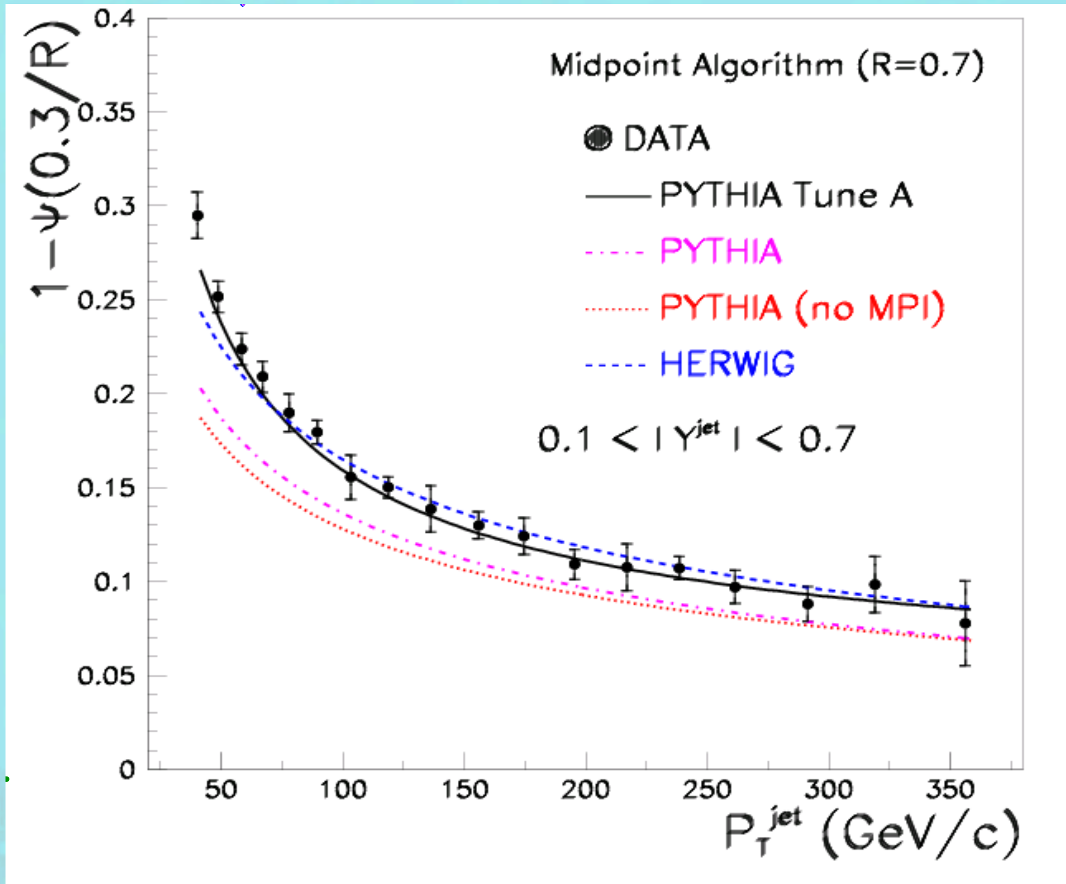
Drawback of Monte Carlo



$$\Psi(r) = \frac{1}{N_{jets}} \Sigma_{jets} \frac{p_T(0,r)}{p_T^{jet}(0,R)}$$

$1 - \Psi(r)$





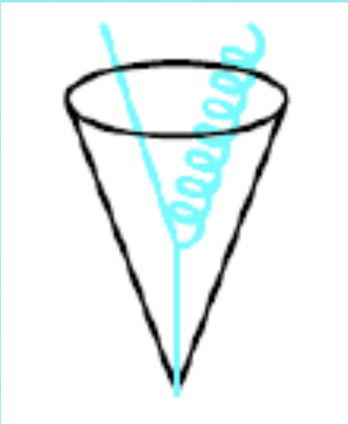
We know how to model the jet fragmentation reasonably well !!

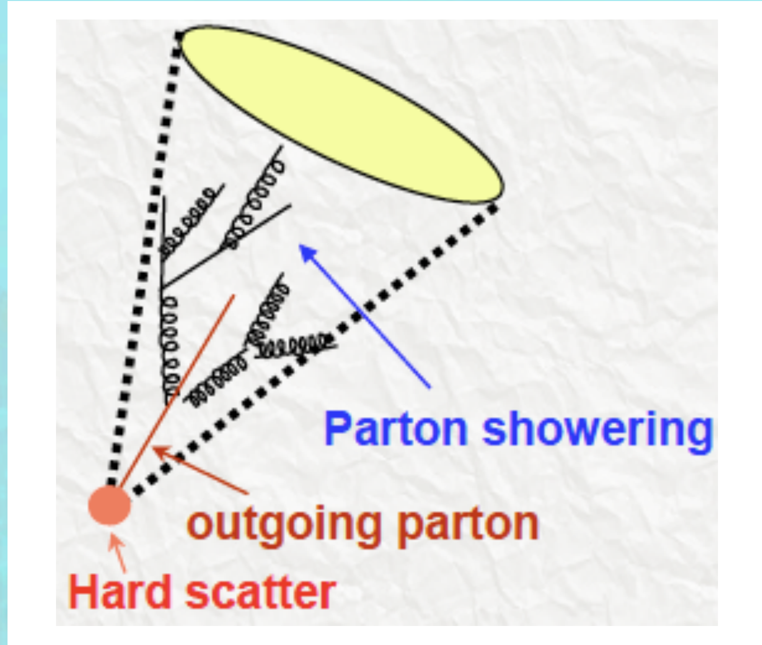
Jet function

$$\frac{d\sigma}{dP_T} = \int dM_J^2 \frac{d\sigma(P_T, M_J^2)}{dP_T} J(M_J^2)$$

Jet function is based on first principle calculation of QCD.

- Monte Carlo: leading log radiation, hadronization, underlying events, etc.
- NLO jet function: one soft / collinear radiation
- Resumed jet function: multiple soft / collinear (double log) radiations





Jet function

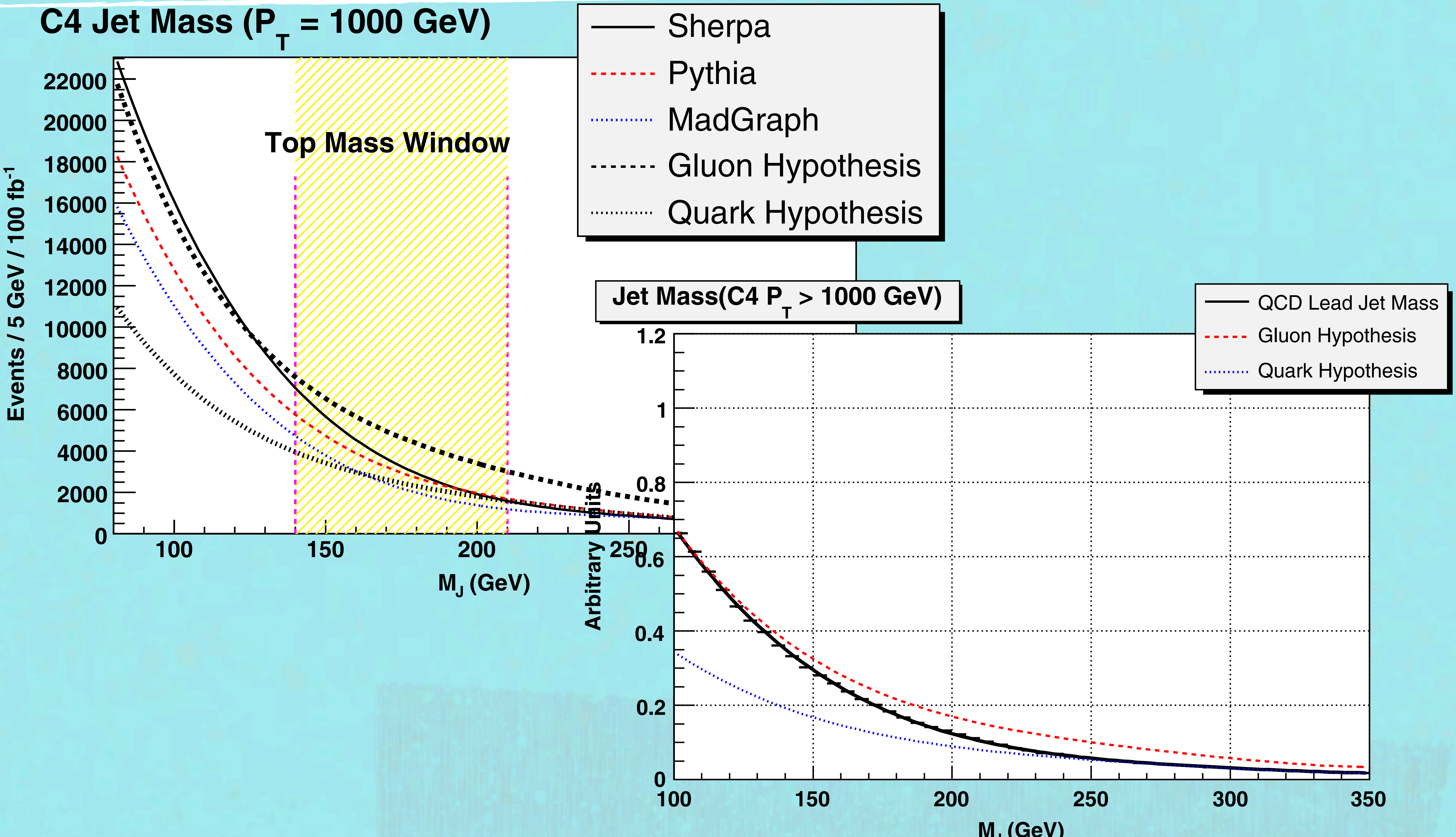
$$J_i^{(0)}(m_{J_i}^2, p_{0,J_i}, R) = \delta(m_{J_i}^2).$$

$$J_i^q(m_J^2, p_{0,J_i}, R) = \frac{(2\pi)^3}{2\sqrt{2}\,(p_{0,J_i})^2}\frac{\xi_\mu}{N_c}\sum_{N_{J_i}} \mathrm{Tr}\left\{\gamma^\mu \langle 0|q(0)\Phi_\xi^{(\bar{q})\dagger}(\infty,0)|N_{J_i}\rangle\langle N_{J_i}|\Phi_\xi^{(\bar{q})}(\infty,0)\bar{q}(0)|0\rangle\right\}$$
$$\times\delta\left(m_J^2 - \tilde{m}_J^2(N_{J_i},R)\right)\delta^{(2)}(\hat{n}-\tilde{n}(N_{J_i}))\delta(p_{0,J_i}-\omega(N_{J_c})), \qquad \text{(A.3)}$$

$$J_i^g(m_J^2, p_{0,J_i}, R) = \frac{(2\pi)^3}{2(p_{0,J_i})^3}\sum_{N_{J_i}} \langle 0|\xi_\sigma F^{\sigma\nu}(0)\Phi_\xi^{(g)\dagger}(0,\infty)|N_{J_i}\rangle\langle N_{J_i}|\Phi_\xi^{(g)}(0,\infty)F_\nu{}^\rho(0)\xi_\rho|0\rangle$$
$$\times\delta\left(m_J^2 - \tilde{m}_J^2(N_{J_i},R)\right)\delta^{(2)}(\hat{n}-\tilde{n}(N_{J_i}))\delta(p_{0,J_i}-\omega(N_{J_c})). \qquad \text{(A.4)}$$

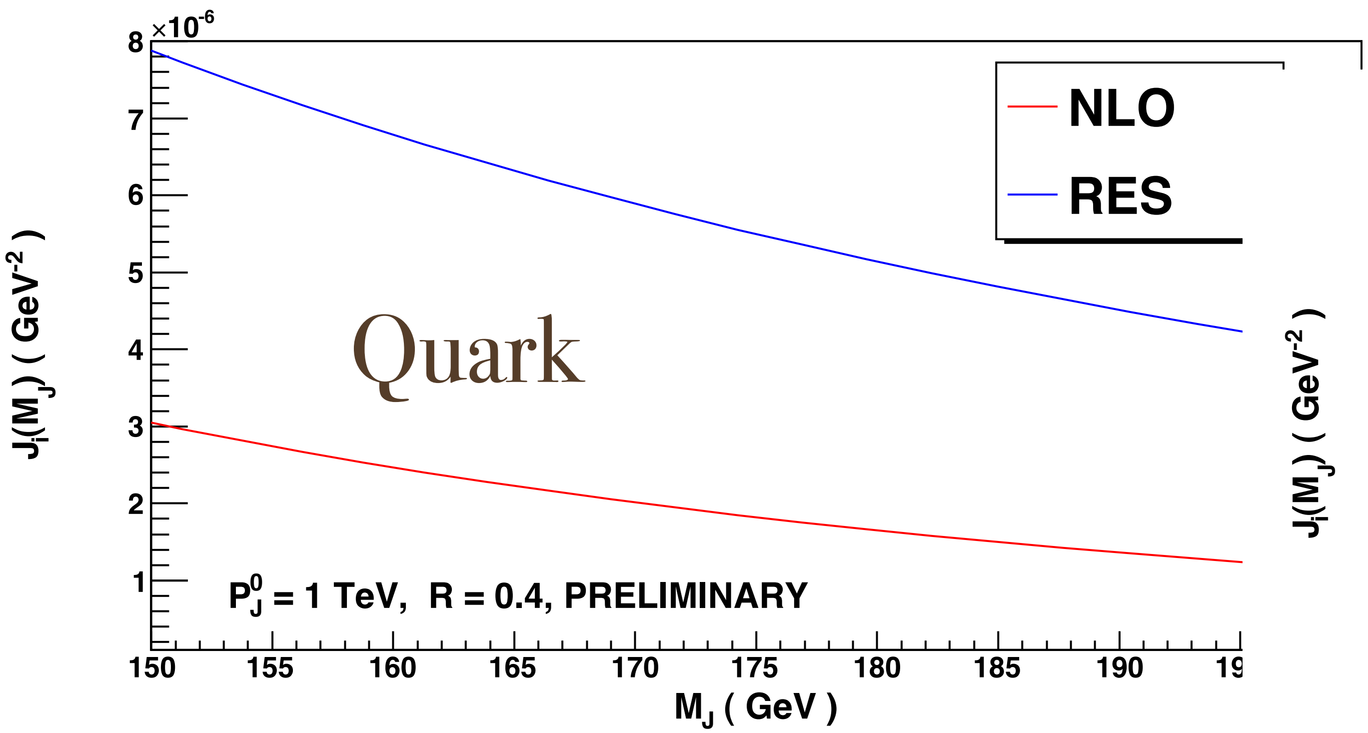
C.F. Berger, T. Kucs, and G. Sterman, Phys. Rev. D 68, 014012(2003)

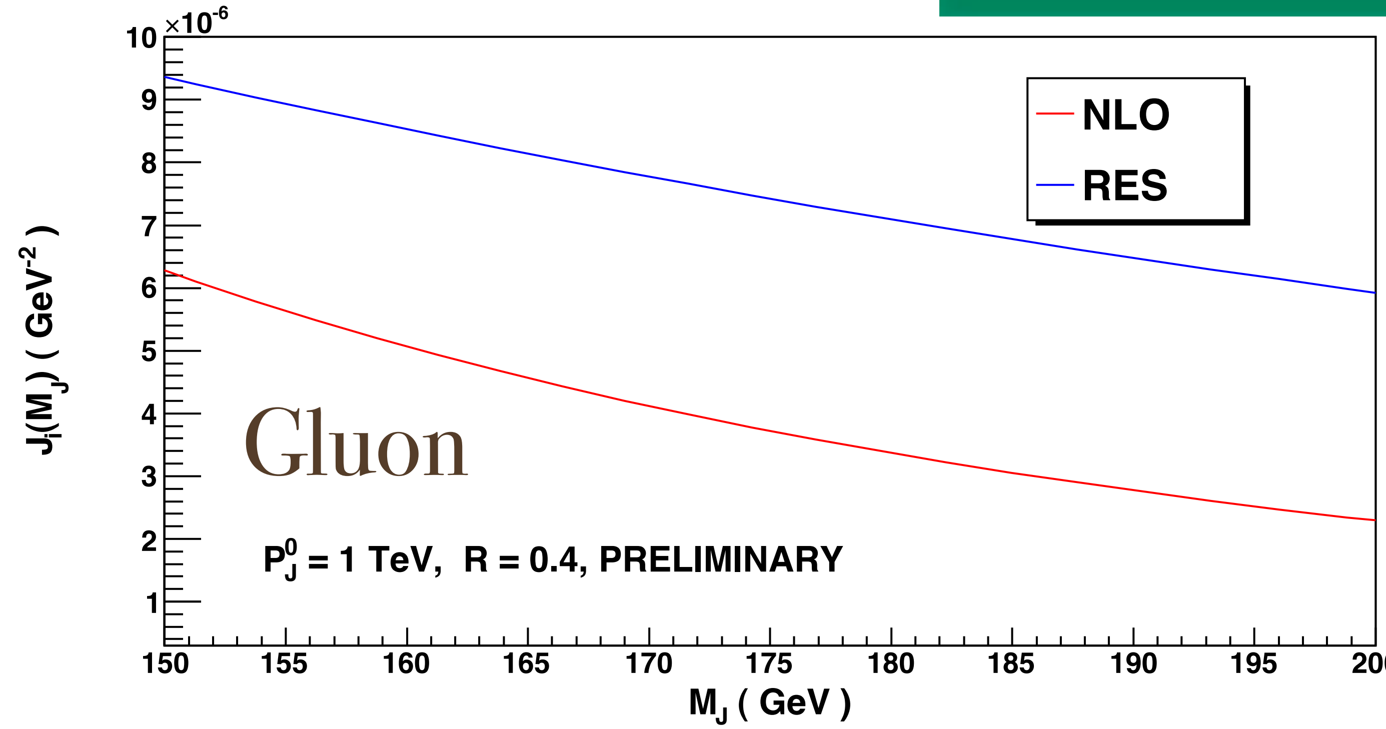
MC with NLO jet function

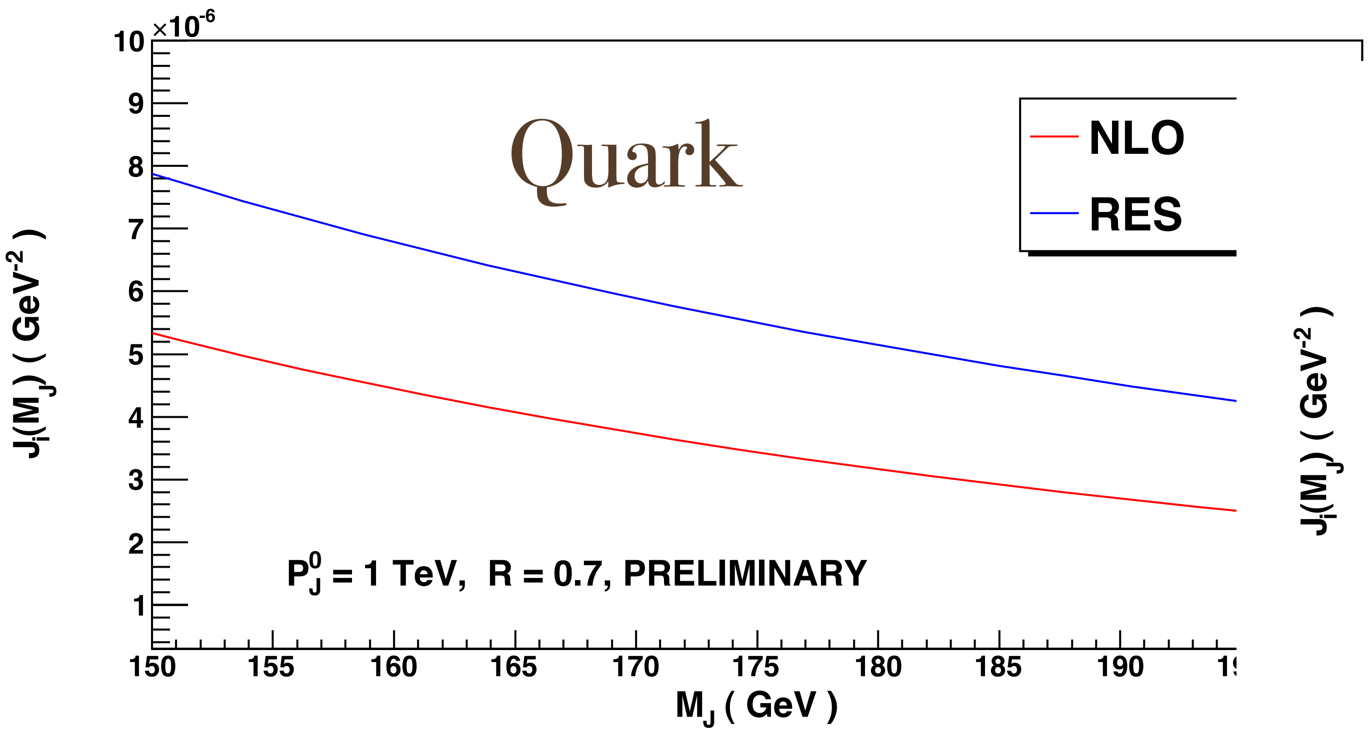


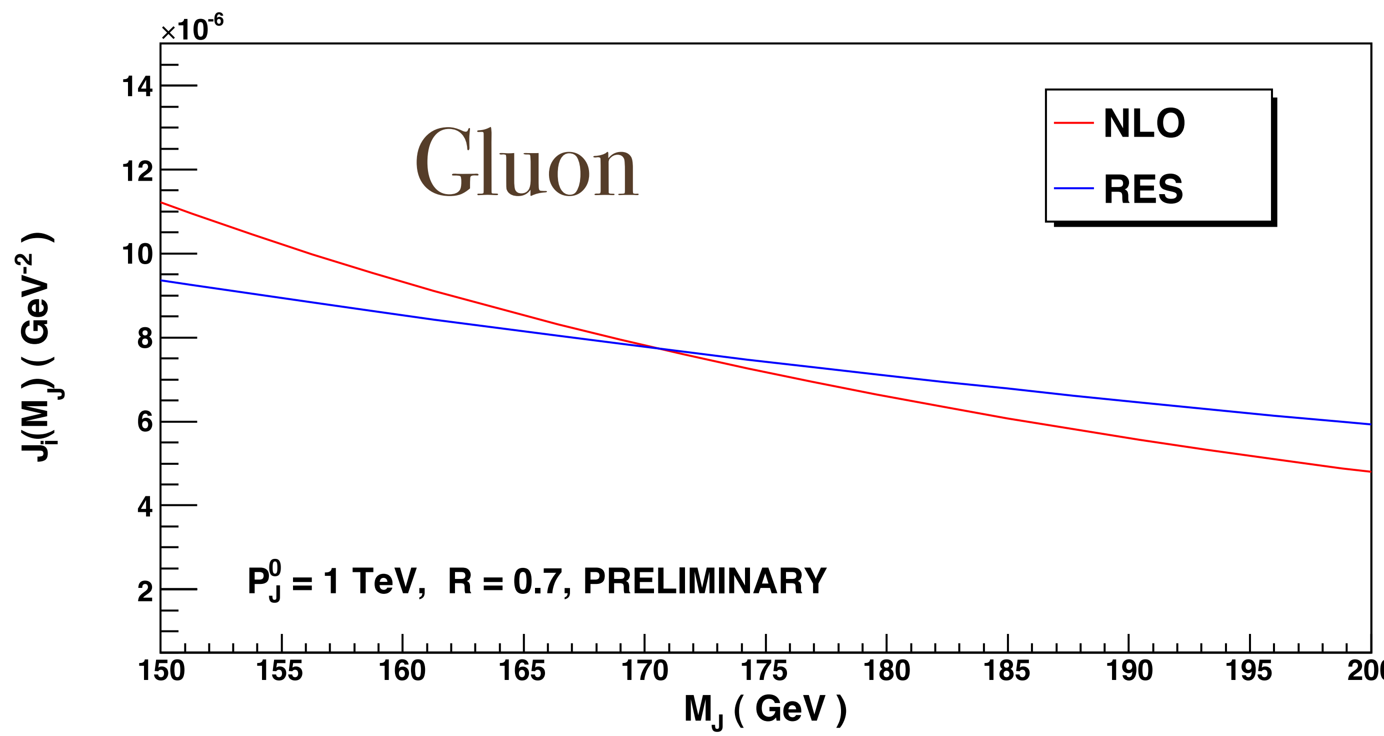
L.G. Almeida, et al., Phys.Rev.D79:074012,2009.

NLO vs Resummed jet function (Top mass range)

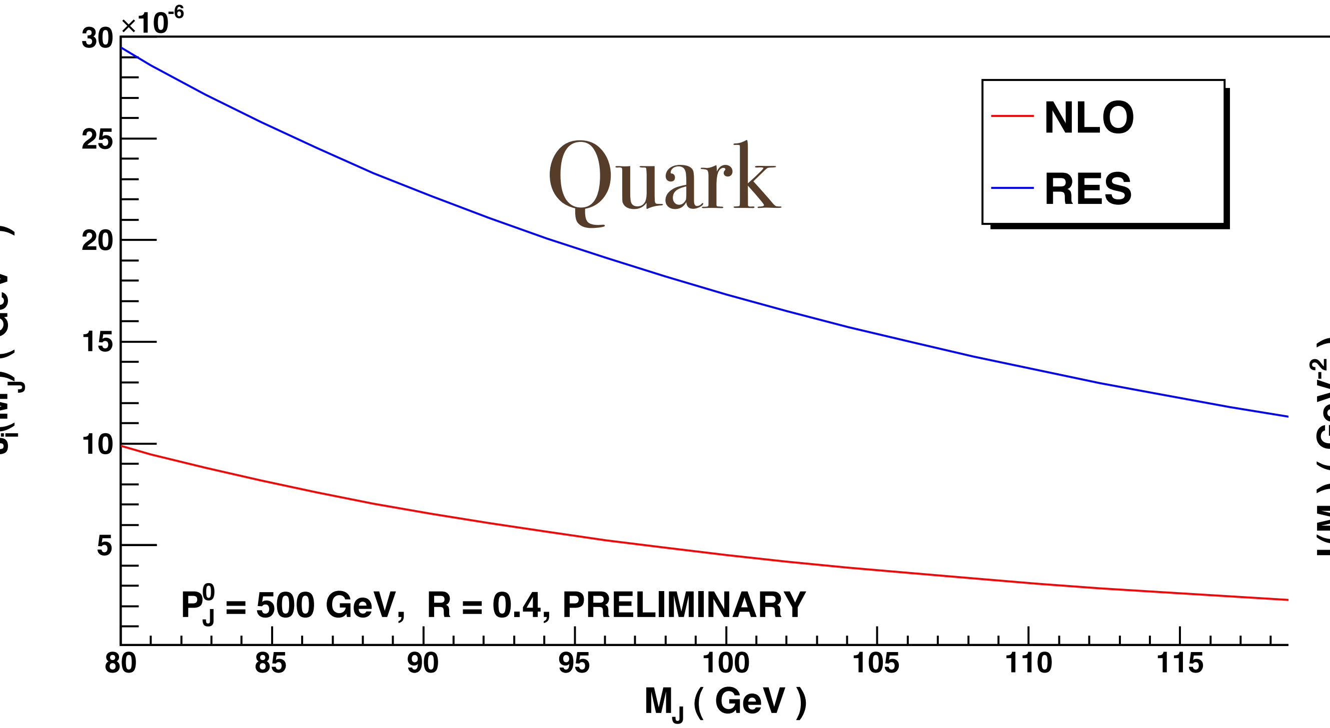


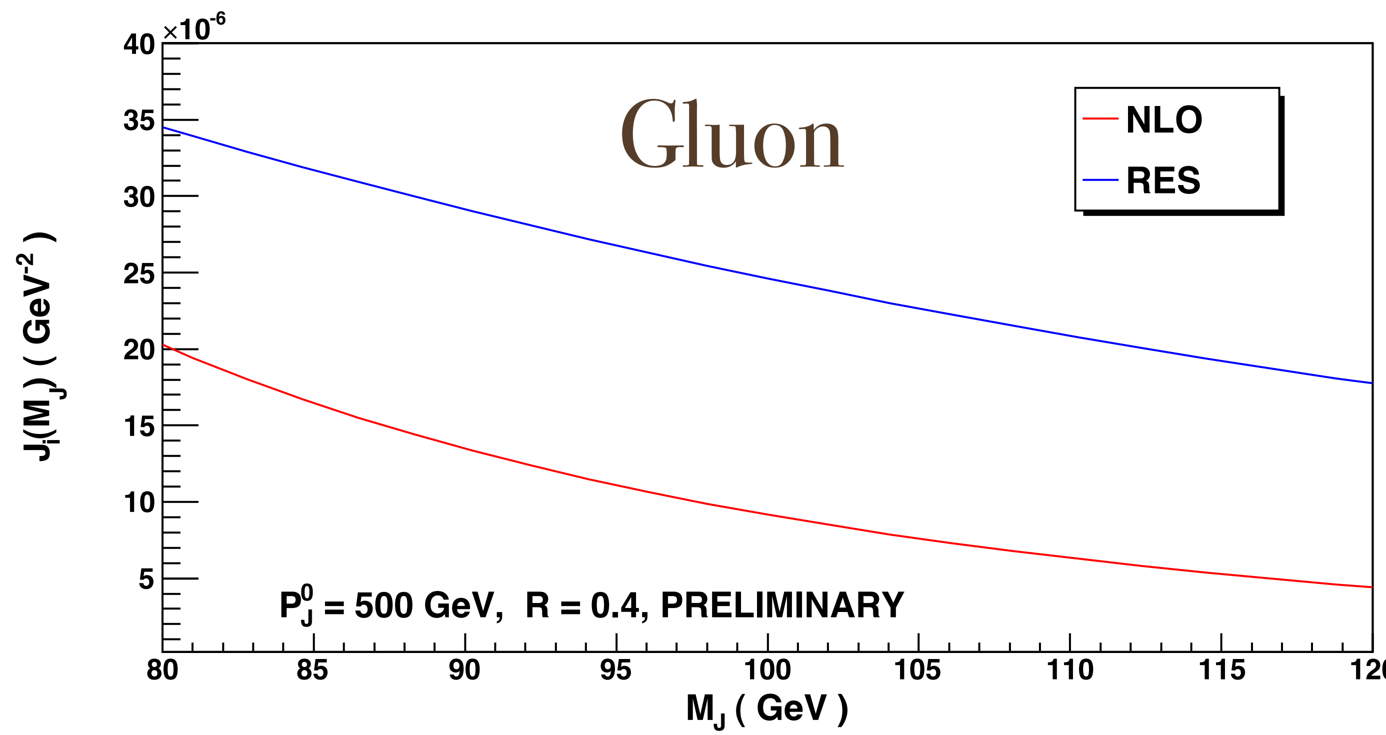


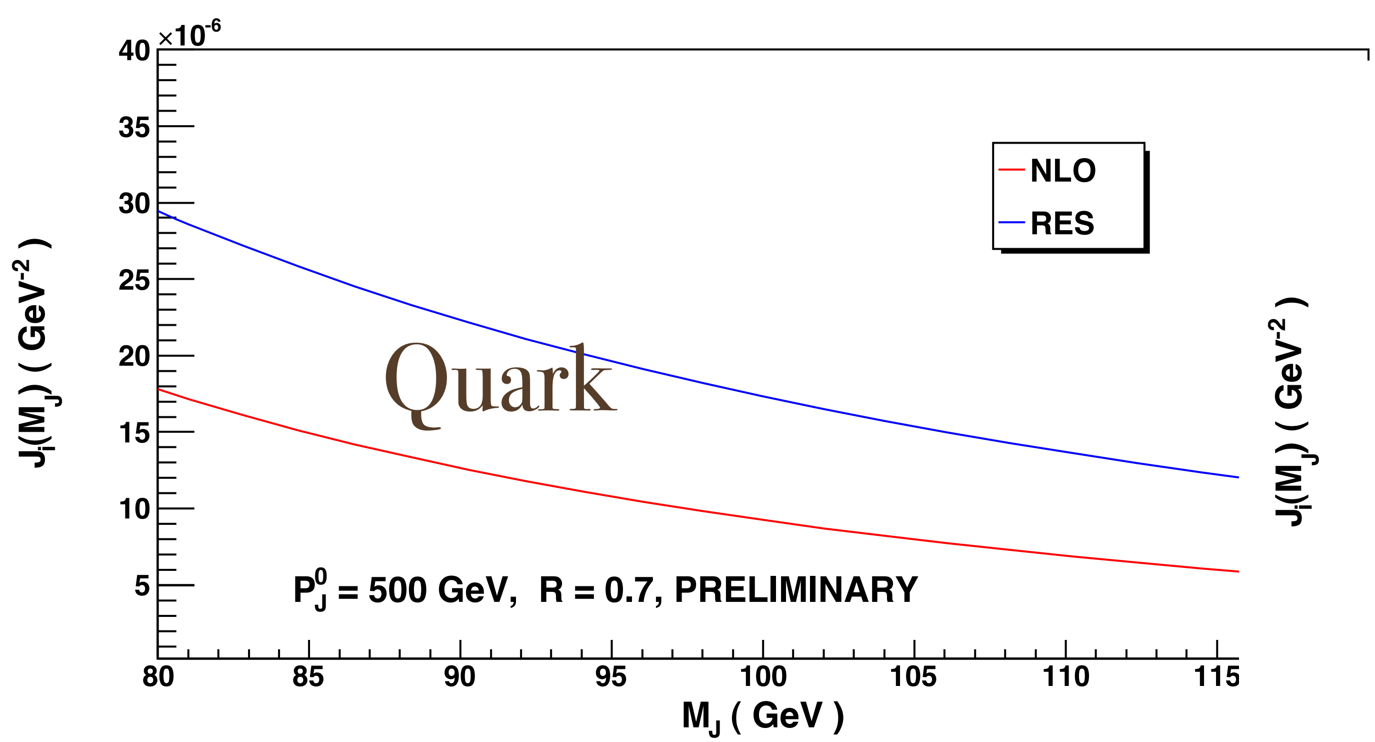


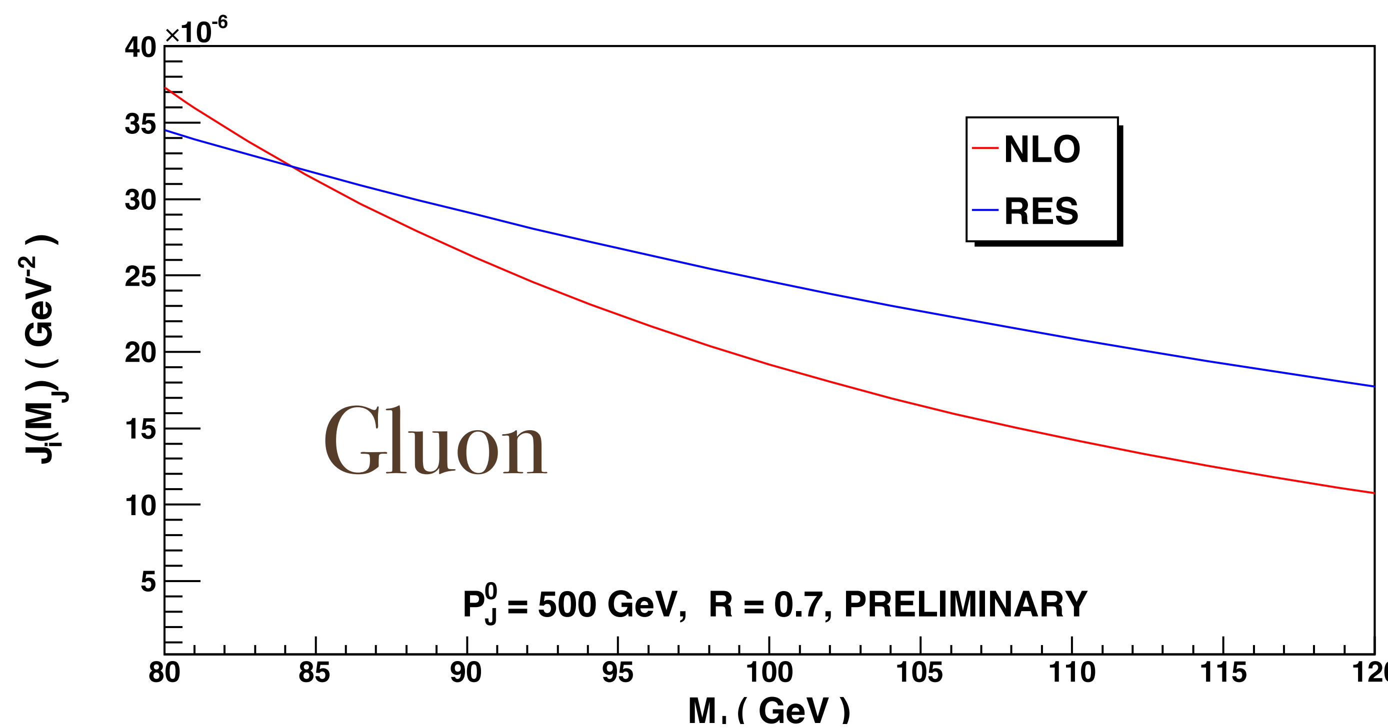


NLO vs Resummed jet function (Higgs mass range)

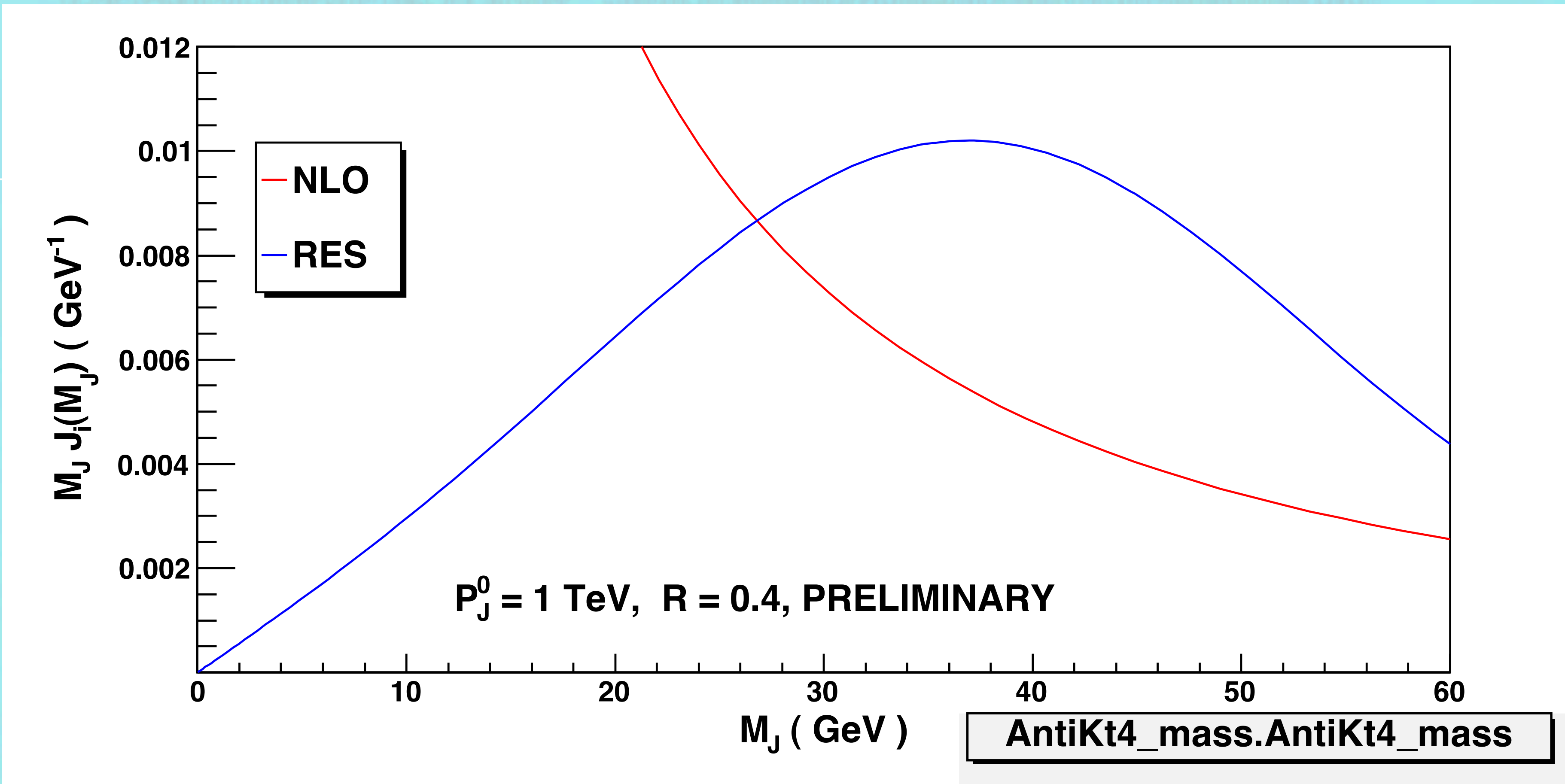


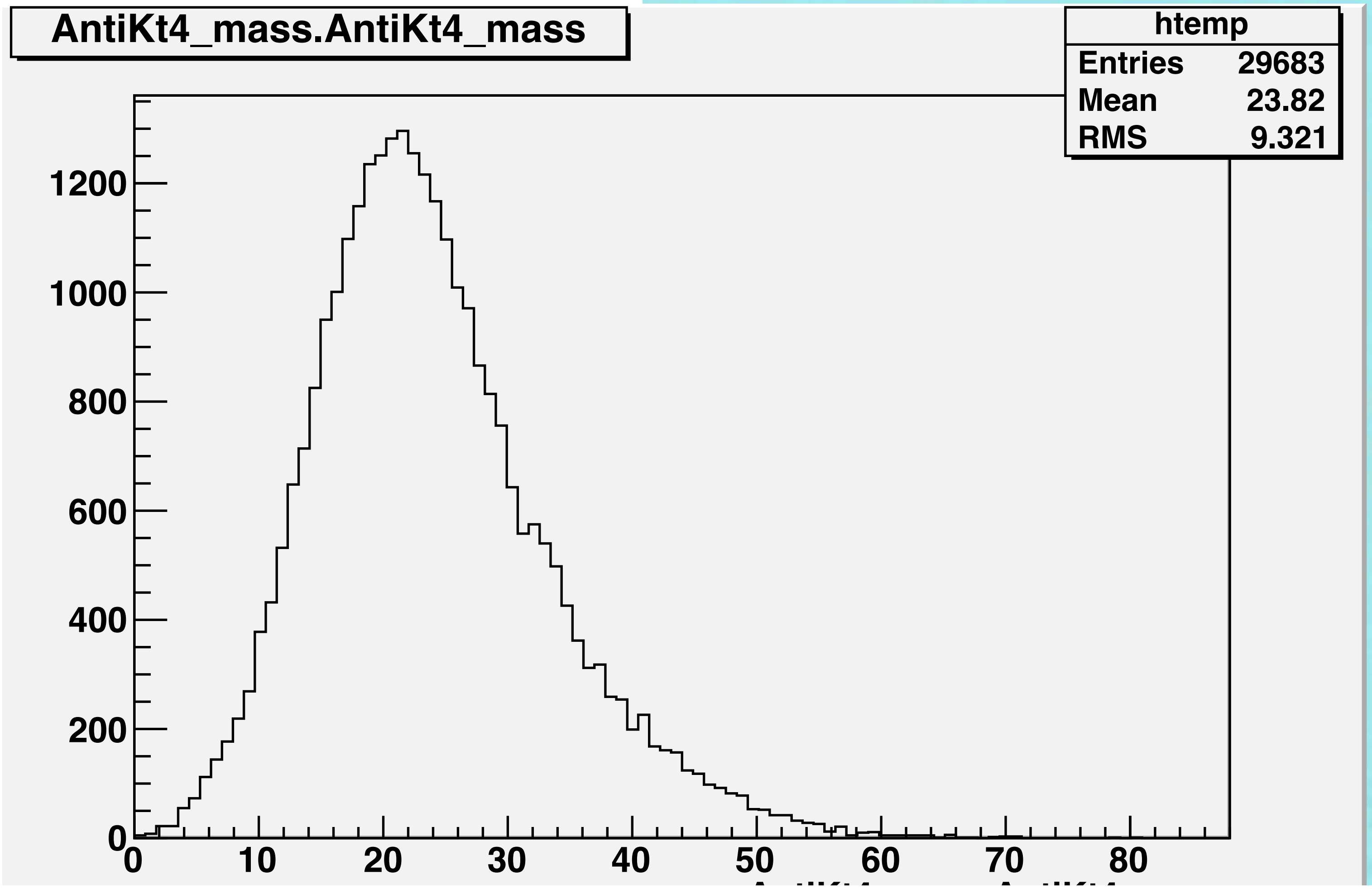






NLO vs Resummed jet function (Low mass range)





Conclusion & Prospect

- Resummation effect is important for describing QCD jet.
- Resummation calculation can improve prediction on jet shapes, as compared to Event Generators or NLO calculations.
- Further investigation on energy profile is in progress.
- Top (Higgs, W, Z, etc.) jet can also be described by similar jet function. This study is particularly important for the LHC.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Thank you


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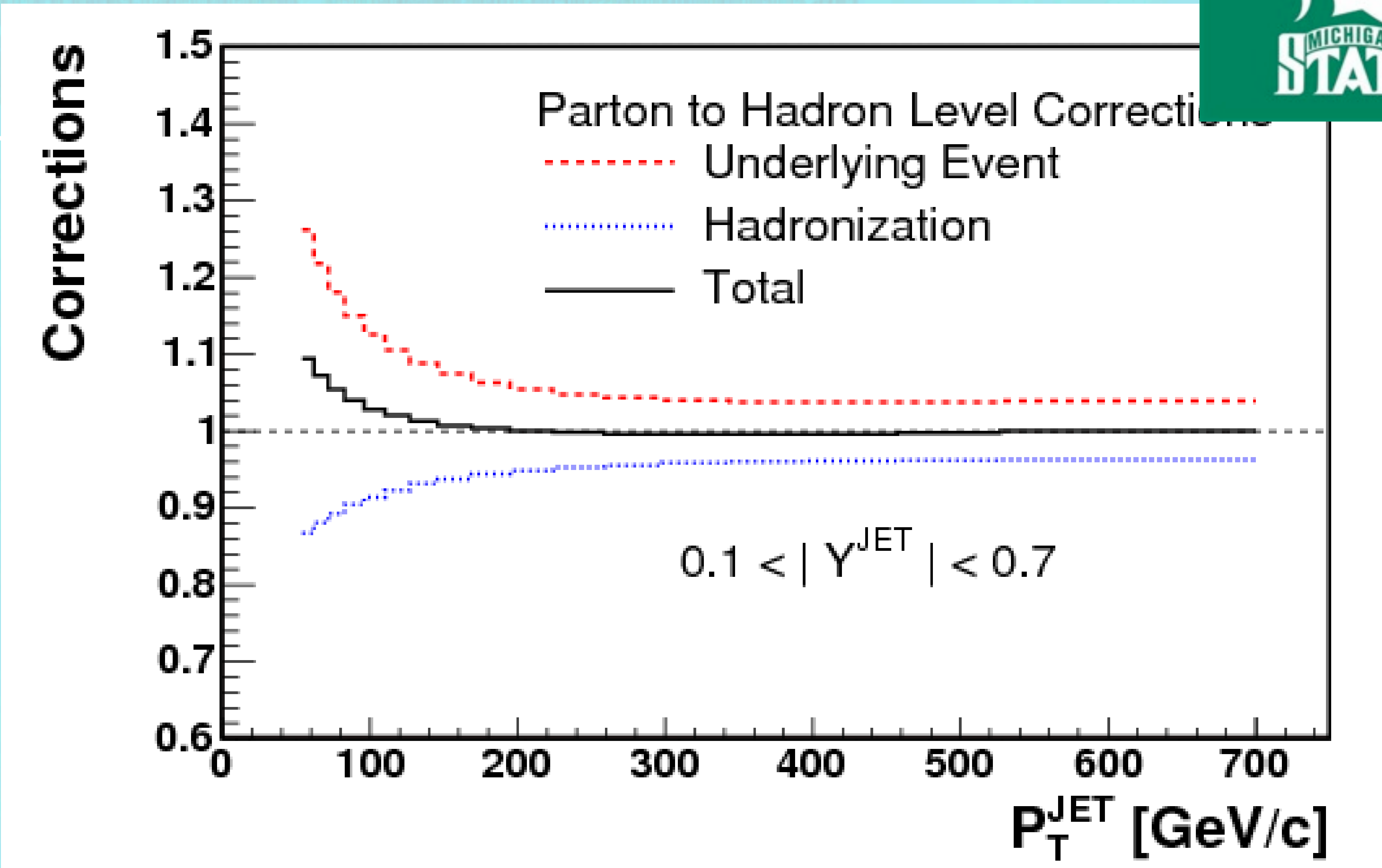

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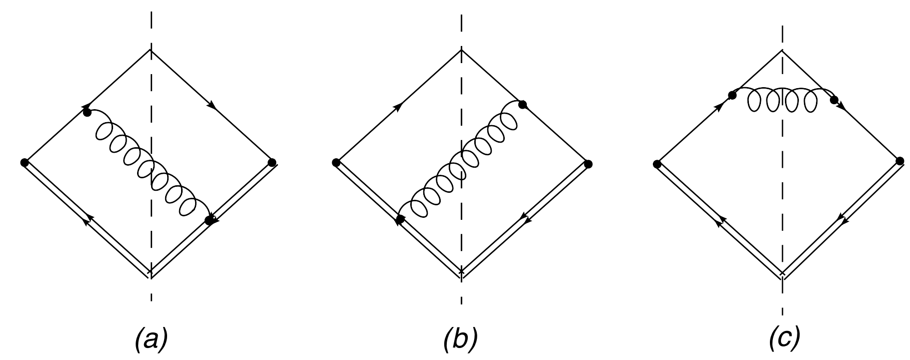

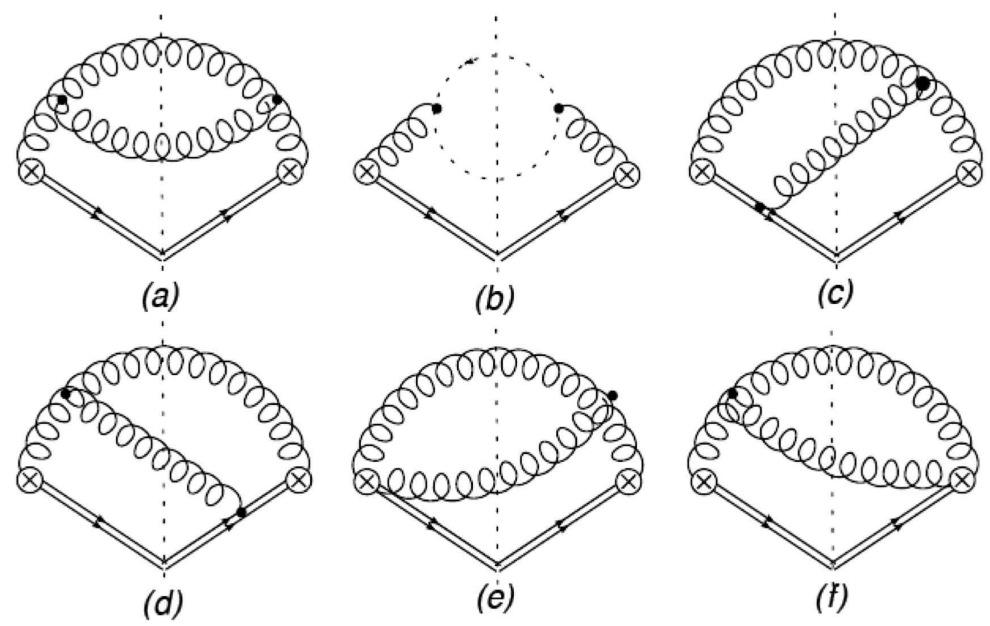

L.G. Almeida, et al., Phys.Rev.D79:074012,2009.

Resummed Jet function