High-energy resummation in inclusive hadroproduction of Higgs plus jet

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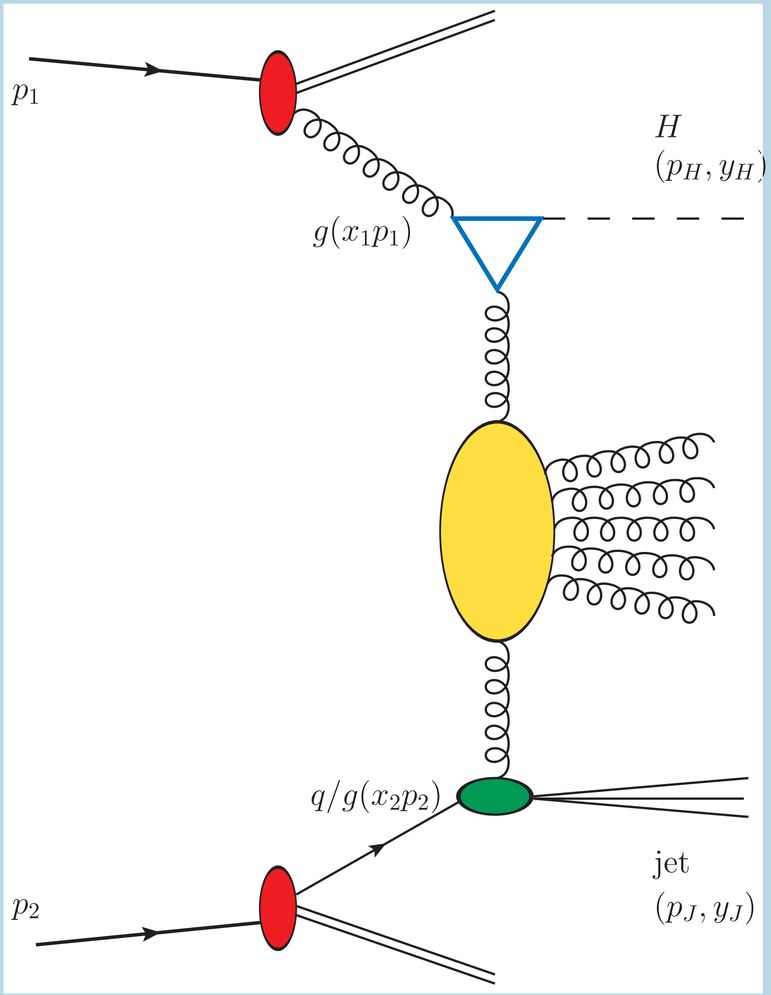
Main Process

Adopting a kinematic which strictly respects the semi-hard regime, with the hard-scale set by the Higgs and top-quark masses, we introduce and study with NLA BFKL accuracy the inclusive production of a Higgs boson and a jet as a novel semi-hard reaction for the manifestation of the BFKL dynamics.



Motivation

The motivation for this work is twofold:
(1) *Phenomenologically*, we want to calculate the cross section and to study the angular distributions of our process at LHC energies.
(2) *Theoretically*, we consider just high-energy effects, in the kinematical range where they only matter.

Phenomenology

Firstly: we study the φ-averaged cross section, C_0, the azimuthal-correlation moments, $R_{n0} = C_n/C_0 \equiv \langle \cos n\varphi \rangle$, and their ratios, $R_{nm} = C_n/C_m$as functions of the Higgs-jet rapidity distance, ΔY.

(1) An appropriate region for the search for pure BFKL signal, the (**symmetric**) configuration: 20 GeV $< |\vec{p}_{H,J}| <$ 60 GeV;

(2) The realistic LHC cuts, where 10 GeV $< |\vec{p}_H| < 2M_t$, and the jet 20 GeV $< |\vec{p}_{H,J}| <$ 60 GeV inside CMS configuration, (**asymmetric**)

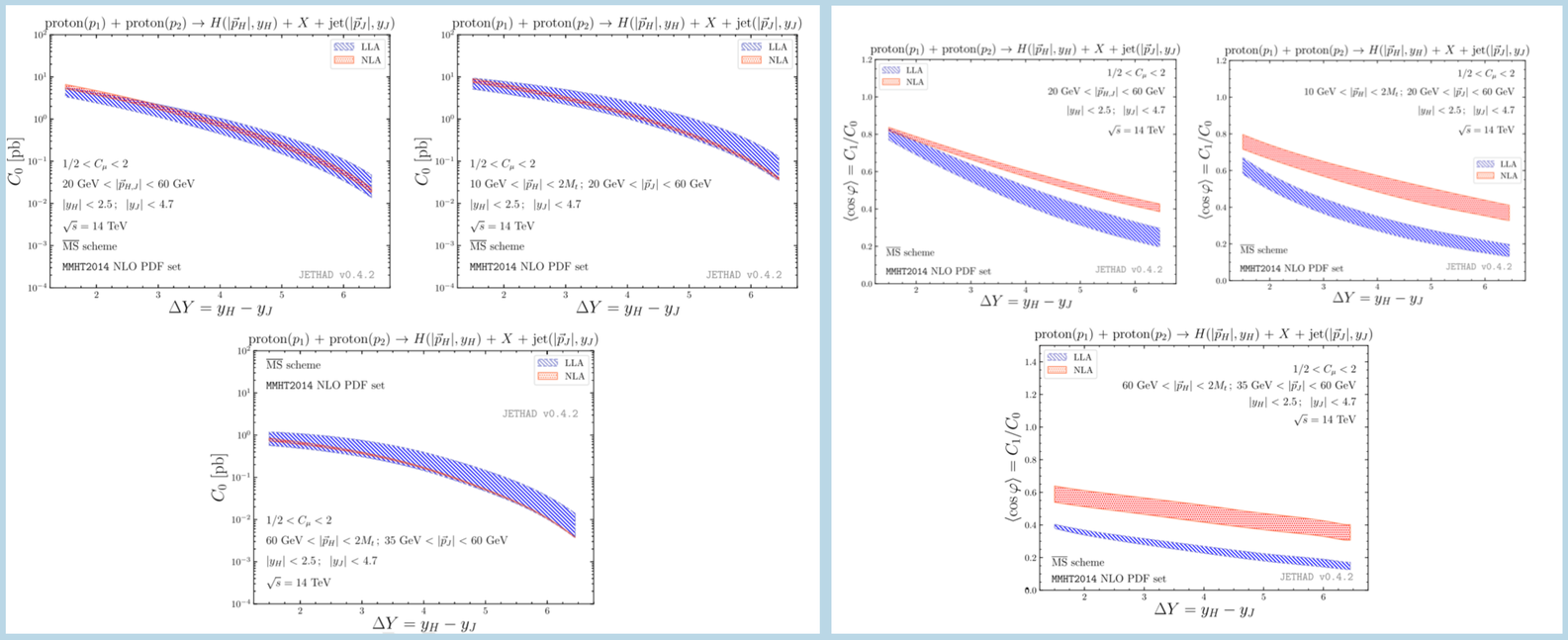
(3)**disjoint windows**, which allows for the maximum exclusiveness in the final state: 35 GeV $< |\vec{p}_J| <$ 60 GeV and 60 GeV $< |\vec{p}_H| < 2M_t$.

Secondly: we present the p_H-distribution for a given value of ΔY, where 35 GeV $< |\vec{p}_J| <$ 60 GeV, and $|y_H| < 2.5, |y_J| < 4.7$ inside the CMS rapidity acceptances.

The $(\mu_{R,F})$-scales set depending on the subprocess to which they are belong, and varying in the range from 1/2 to two.

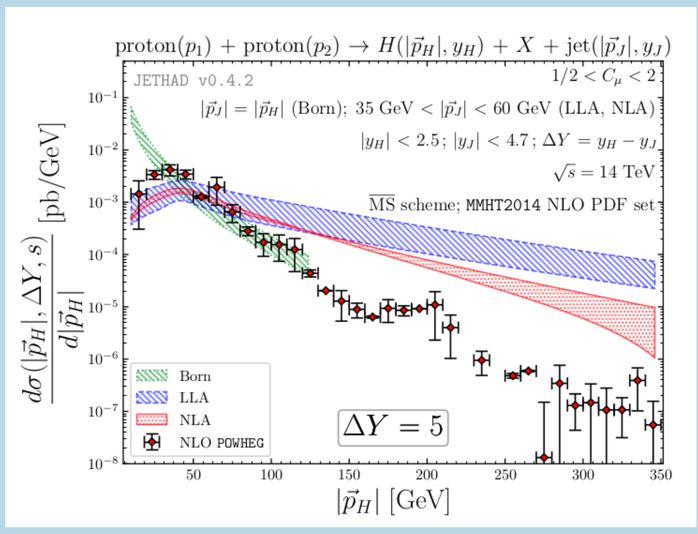
ΔY-distribution and azimuthal correlations

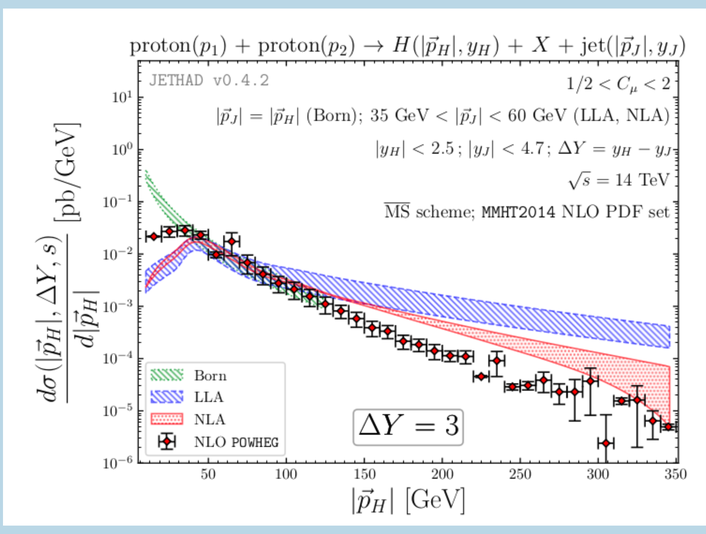
In the figure below we present results for the ΔY-distribution, C_0 and the azimuthal-correlation moment, C_1/C_0, in our three distinct kinematic configurations under investigation. Here, the onset of the BFKL dynamics comes easily out. The growth with energy of the pure partonic cross sections is suppressed by the convolution with PDFs, this leading to a lowering with ΔY of hadronic distributions. Notable, NLA predictions (red) show a milder discrepancy with respect to pure LLA (blue) ones. This represents a novel feature in the context of semi-hard reactions, thus demonstrate the underlying assumption that the large energy scales provided by the emission of a Higgs boson stabilize the BFKL series.



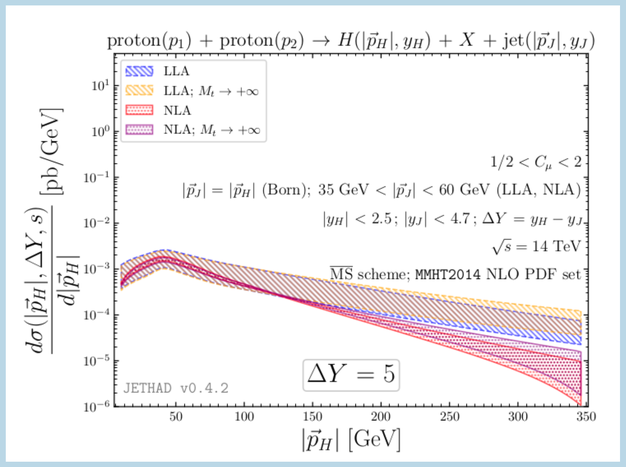
p_H-distribution: $d\sigma/d\Delta Y\, dp_H$

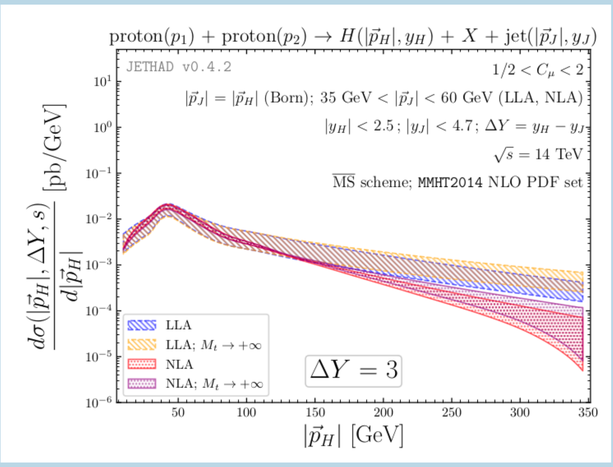
we present also the p_H-distributions at $\Delta Y = 3$ and 5, as obtained by a fixed-order NLO calculation through the POWHEG method, by suitably adapting the subroutines dedicated to the inclusive Higgs plus jet final state. It is interesting to observe that, both in both cases at $\Delta Y = 3, 5$, the NLO fixed-order prediction is systematically lower than the LLA-and NLA-BFKL ones and this is more evident at the larger ΔY, where the effect of resummation is expected to be more important. This observation provides with an interesting window for discrimination between fixed-order and high-energy-resummed approaches.





We compared the distributions presented above with the corresponding ones obtained in the large top-mass limit, $M_t \to +\infty$, We noted that, within this limit, cross sections become at most $5 \div 7\,\%$ larger, whereas the effect on azimuthal correlations is very small or negligible. The impact on the p_H-distribution is also quite small in the $|\vec{p}_H| \sim |\vec{p}_J|$ range, while it become more manifest at larger values of $|\vec{p}_H|$.





Conclusions

- Higgs + jet exhibit quite a *fair stability* under higher-order corrections.
- A high-energy treatment is *valid* and can be afforded in the region where $\vec{p_H} \sim \vec{p_J}$.
- p_H-distributions would rely on a *unified formalism* where *distinct resummations* are concurrently embodied.