Higgs production with High Energy Jets

Helen Brooks Jeppe Andersen

IPPP, Durham University

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Outline

1. Overview of High Energy Jets
   - Introduction
   - Formulation of the matrix element
2. Higgs plus jets
   - Effective field theory
   - Finite quark mass corrections
3. Summary

Introduction

What is HEJ?

HEJ is a framework for calculating the cross sections of **multi-jet processes**, which by making an **approximation** to the matrix element, allows for an **all-order resummation** of the **large logarithms** associated with **hard, well-separated** emissions.

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- The logarithms are most relevant in the *Multi-Regge Kinematic* (MRK) limit, where the rapidities and momenta satisfy $y_1 \gg y_2 \gg \ldots \gg y_n$ and $p_{i\perp} \simeq p_{j\perp}$ and where $\hat{s} \gg \hat{s}_{ij} \gg p_{i\perp}^2$

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- To formulate an approximate matrix element which facilitates resummation, need to consider which contributions are large in the MRK limit

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Factorization

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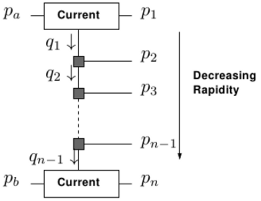

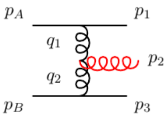

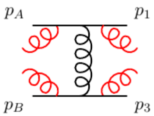

Formulation of the matrix element

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- For example, the colour and helicity summed/averaged matrix element for a $qQ \to n$ parton process is given by:

$$\overline{|\mathcal{M}^t_{qQ\to qg\ldots gQ}|}^2 = \frac{1}{4(N_c^2-1)} \|S_{qQ\to qQ}\|^2 \cdot \left(g_s^2 C_F \frac{1}{\hat{t}_1}\right) \cdot \left(g_s^2 C_F \frac{1}{\hat{t}_{n-1}}\right) \cdot \prod_{i=1}^{n-2} \left(\frac{-g_s^2 C_A}{\hat{t}_i \hat{t}_{i+1}} V^\mu(q_i, q_{i+1}) V_\mu(q_i, q_{i+1})\right)$$

where $S_{qQ\to qQ}^{h_a h_b \to h_1 h_2} = \langle 1_{h_1}|\mu|a_{h_a}\rangle g^{\mu\nu} \langle 2_{h_2}|\nu|b_{h_b}\rangle$

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- The inclusive m-jet cross section is found by performing the phase space integral of an explicit sum of real, radiative corrections.

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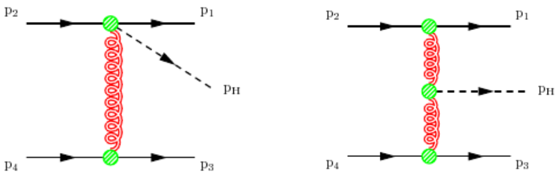
Effective field theory

Two cases: Higgs outside (in rapidity) jets, and in-between jets



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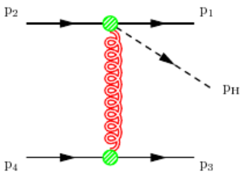

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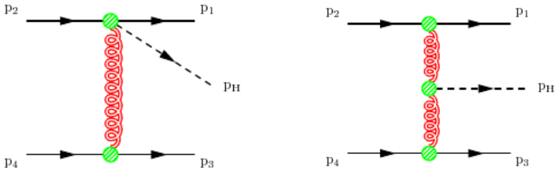

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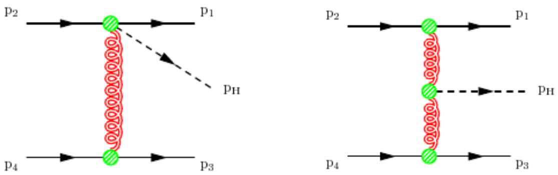

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- For Higgs between jets describe Higgs coupling to gluons via an effective vertex obtained in the infinite top mass limit
- Absorb vertex into spinor string:

$$S^{h_a h_b \to h_1 h_2}_{qQ\to qHQ}(q_1, q_2) = \langle 1_{h_1}|\mu|a_{h_a}\rangle g^{\mu\sigma_1} V^H_{\sigma_1\sigma_2}(q_1, q_1)\langle 2_{h_2}|\sigma_2|b_{h_b}\rangle$$

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- For the rapidity ordered process $qQ \to qHgQ$ we have:

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Finite quark mass corrections

- The effective field theory works well where there is only one scale involved (m_H) - but in our formulation there are scales which are **not always small** compared to the top mass $\Rightarrow$ finite top effects become important

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- Can even include bottom mass (interference) effects in this way

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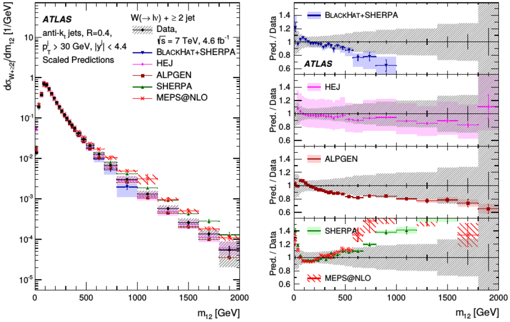
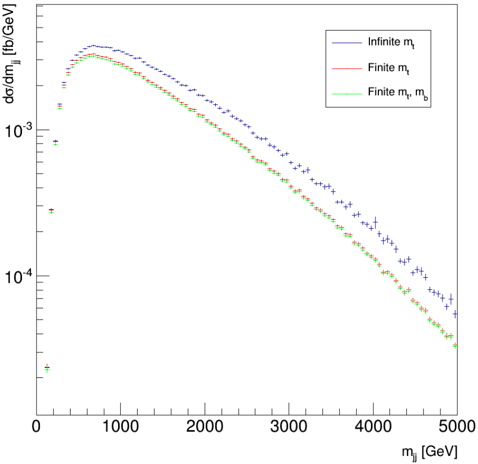
Atlas results for $W+ \geq 2j$ (arXiv:1409.8639)



Finite quark mass corrections

- Preliminary results for $ud \rightarrow uHd$ - large corrections for large invariant dijet mass



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- These building blocks can be adapted for difference processes, such as Higgs plus jets
- We are currently incorporating finite quark mass corrections

References

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