Higgs production with High Energy Jets

Helen Brooks Jeppe Andersen

IPPP, Durham University

YTF

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Outline

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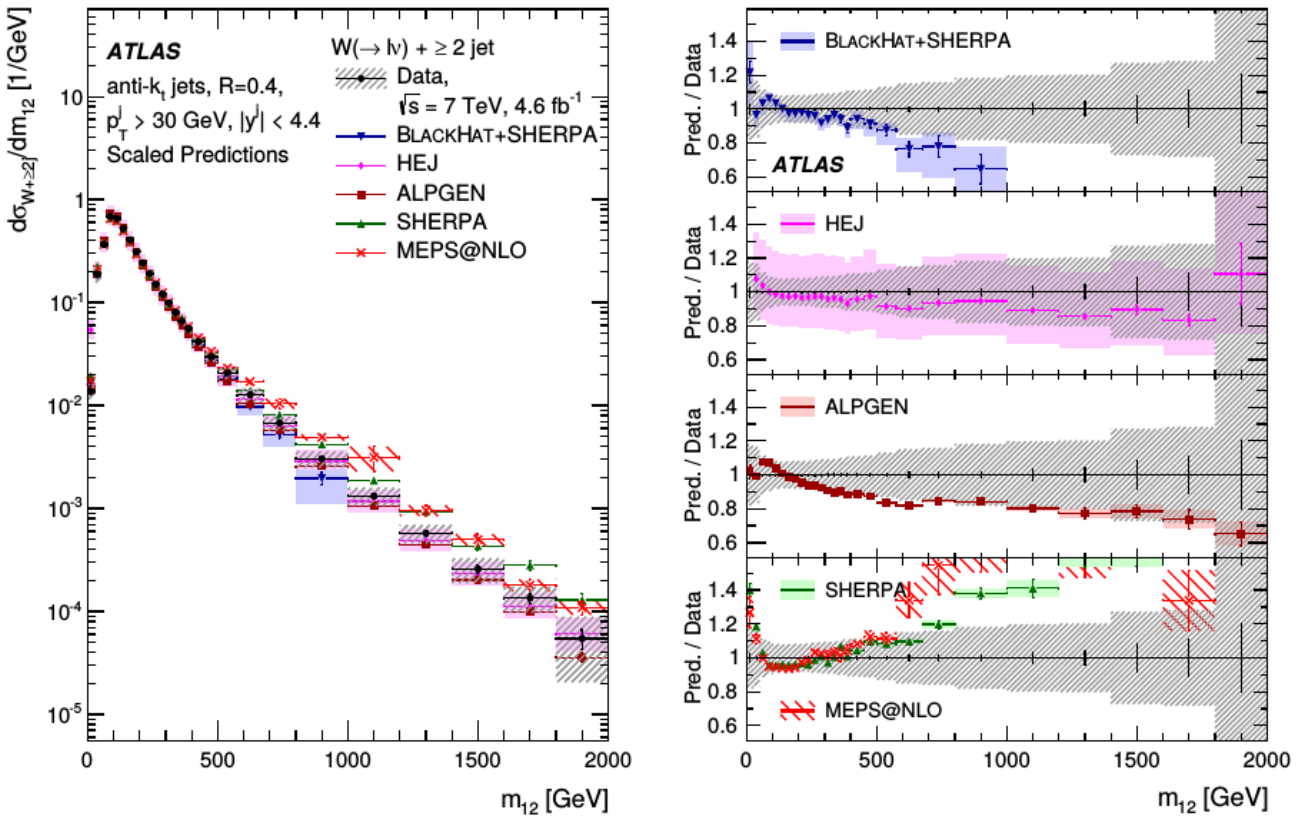
- HEJ provides a good description in precisely this part of phase space

Motivation
W+jets

As the radiation pattern at large m_{jj} will be relatively process-independent we can test our description using another process.



Recap of Factorization

- The colour and helicity summed/averaged matrix element for a $qQ \to n$ partonic process was 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 $S^{h_a h_b \to h_1 h_2}_{qQ\to qQ} = \langle 1_{h_1}|\mu|a_{h_a}\rangle g^{\mu\nu} \langle 2_{h_2}|\nu|b_{h_b}\rangle$

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- It was the simplicity of the factorized structure that made it possible to perform the summation of emissions to all orders in α_s
- Need to adapt this to include emission of a Higgs boson

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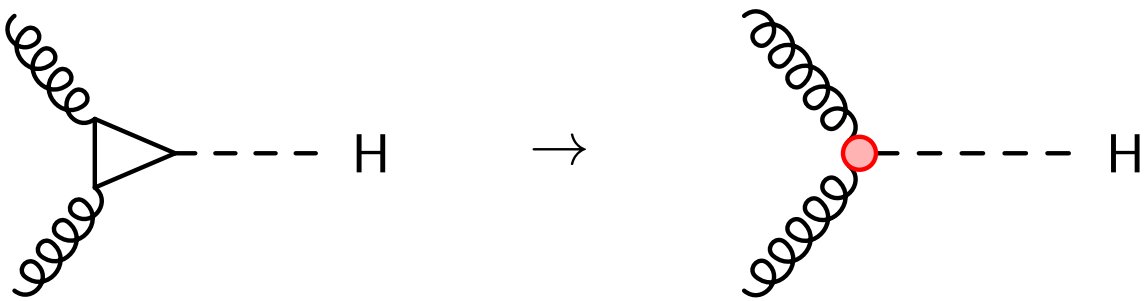
- The standard simplification made is to integrate out the top mass, effectively sending the top mass to infinity



Constructing the matrix element

- As in the pure jets case, we want to accurately describe the Multi-Regge Kinematic limit, in which the momenta and rapidity of the jets 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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- We shall consider these cases separately

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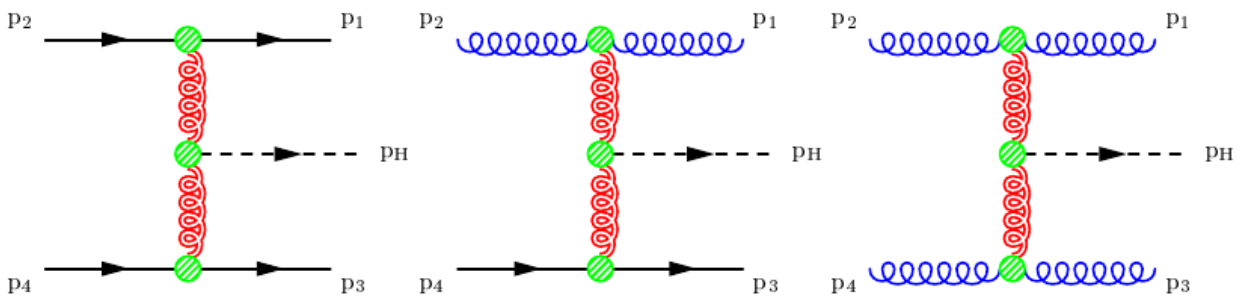
- The effective Higgs vertex can then be absorbed into the spinor string:

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



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- Then, for example, the rapidity ordered process $qQ \to qHgQ$ we have:

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Higgs outside jets

- For Higgs outside jets, we define *impact factors* for Higgs+jet and the quark/gluon jet, e.g. for $qQ \to HqQ$ we have:

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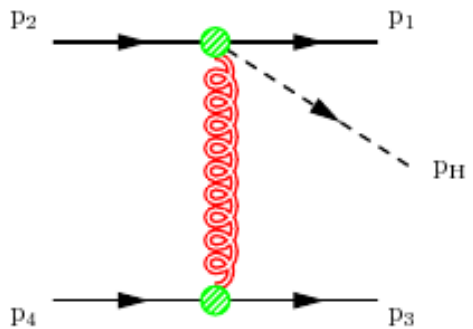

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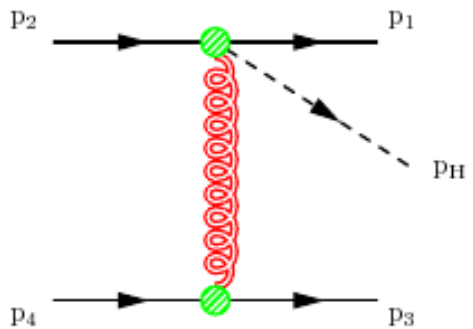

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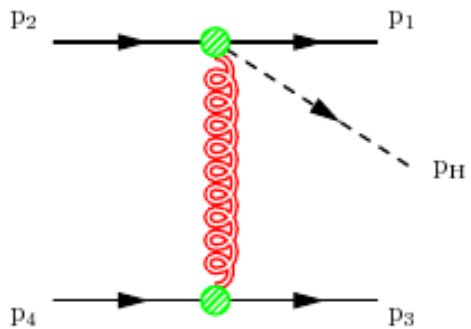

- This now has a similar structure to our $2 \to 2$ partonic amplitudes
- Can just continue as before by adding in effective (Lipatov) vertices for each additional gluon emission

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- Accuracy can be improved further by including digrams that have a b quark circulating in the loop - this has an effect via interefence with the top loop.
- Accounting for the b does not add any complexity to the problem - it is a simple matter of summing over the flavours once the top corrections have been implemented.

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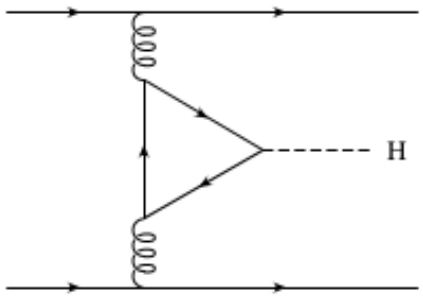

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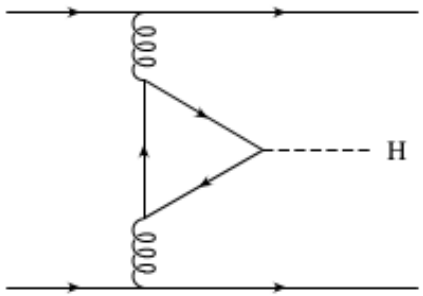
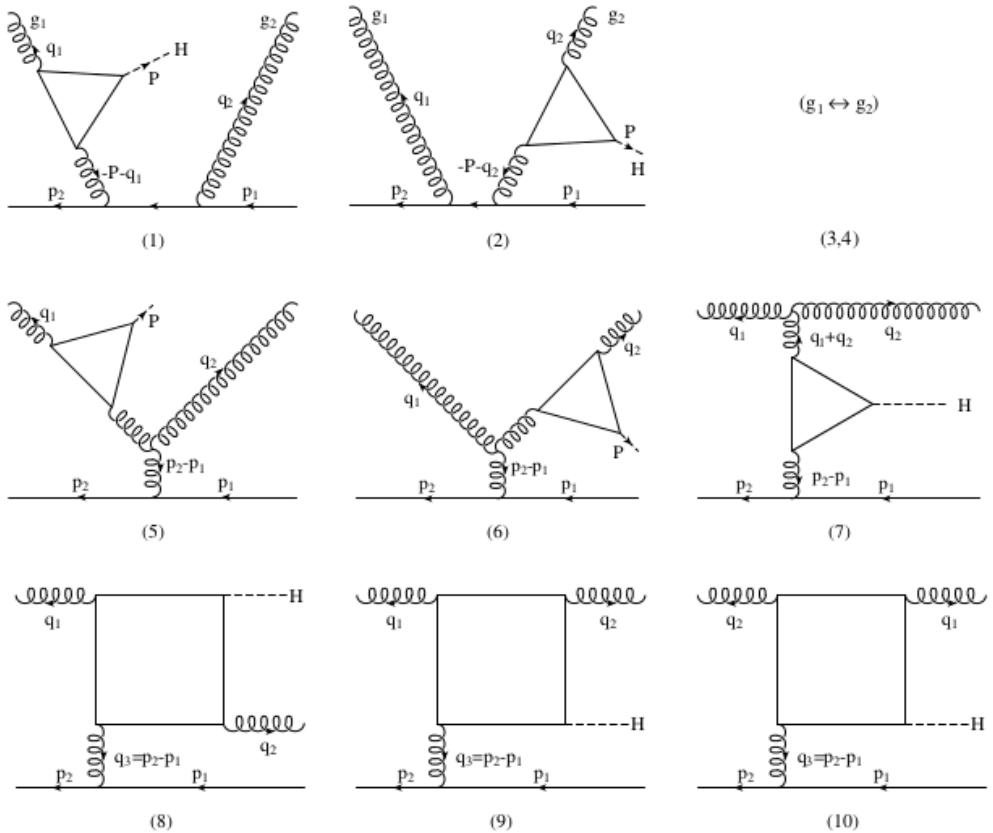


- For Higgs outside jets, need to adjust the q-H impact factor.

Constructing the matrix element

$qg \to qgH$

Replacing a quark by a gluon means we have to insert a triangle loop on every gluon line in the 3 diagrams for $qg \to qg$, and box diagram in the 3-gluon vertex in 3 different ways:



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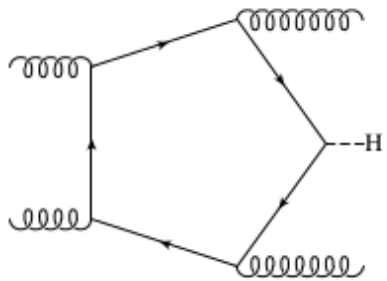
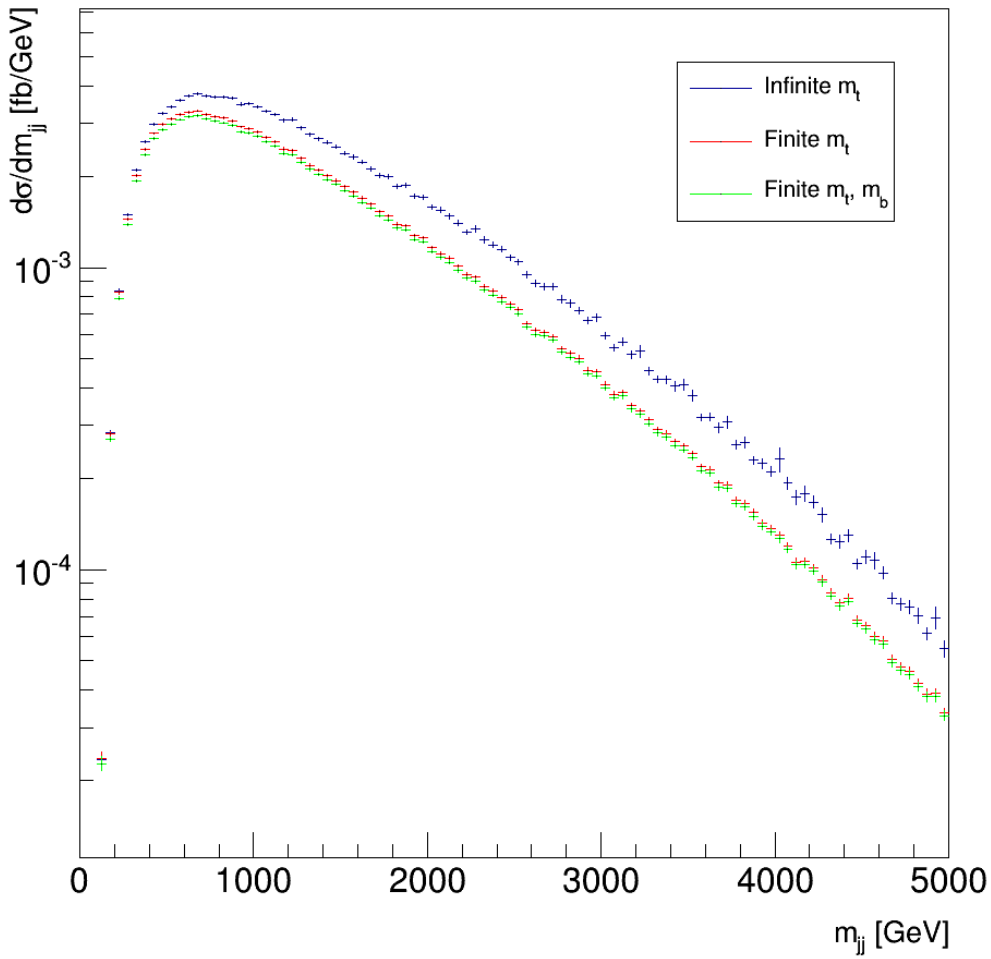
- The case will be similar for $gg \to ggH$, but even more diagrams - need to include pentagon loops:



Results
Dijet Invariant Mass Spectrum

Preliminary results for $ud \to uHd$



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- To get the most accurate description it is important to include finite quark mass corrections.
- We have promising results for $qQ \to qQH$.
- We are currently working on incorporating finite quark mass corrections for other channels.