

Holmganga Jets Big Questions

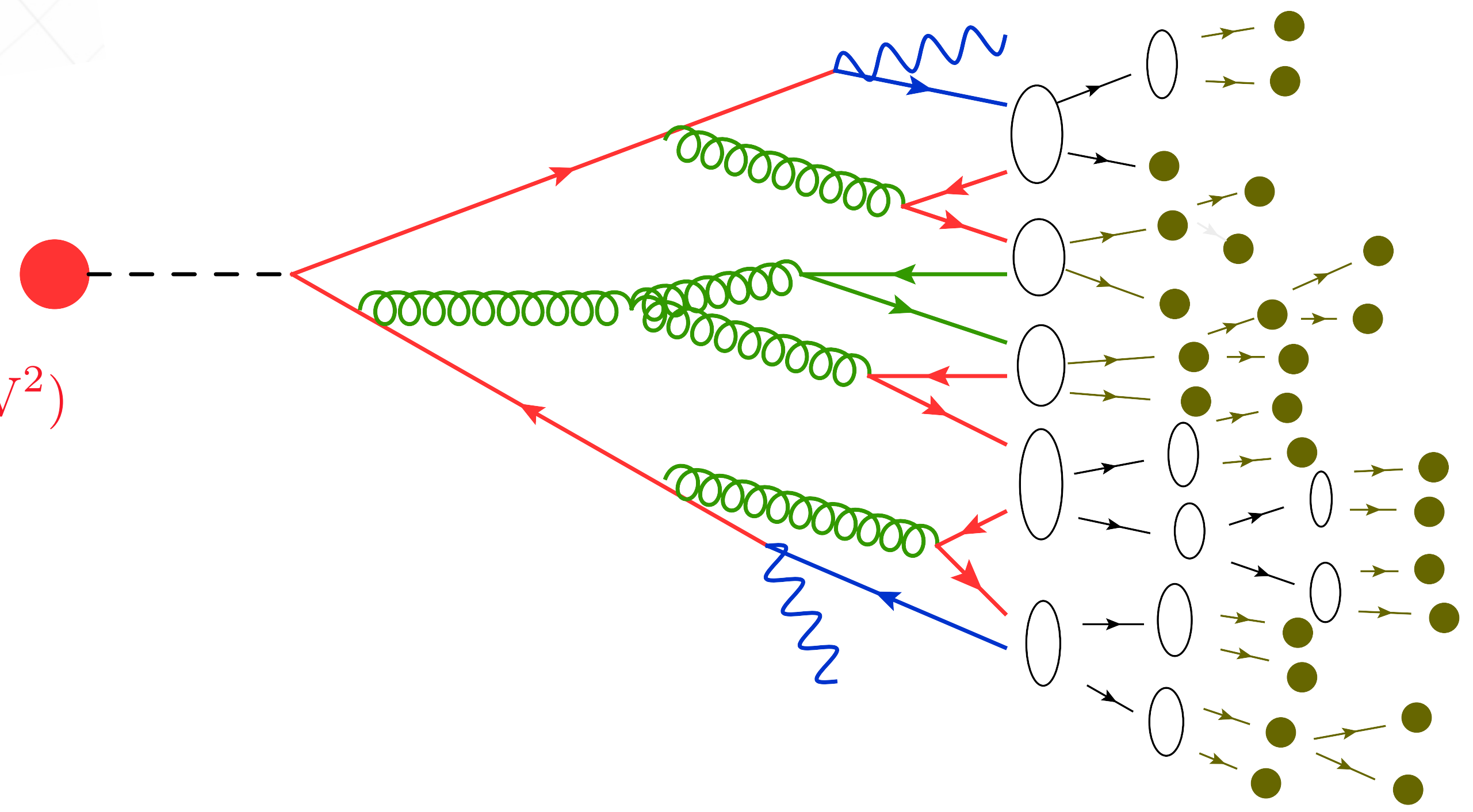
Jet observables: where to look for quenching effects

Jasmine, Korinna, Liliana, Isobel, Guilherme, Guy, Raghav

Scales of interest



$Q^2 \equiv \mathcal{O}(100^2 \text{GeV}^2 \sim 1 \text{TeV}^2)$

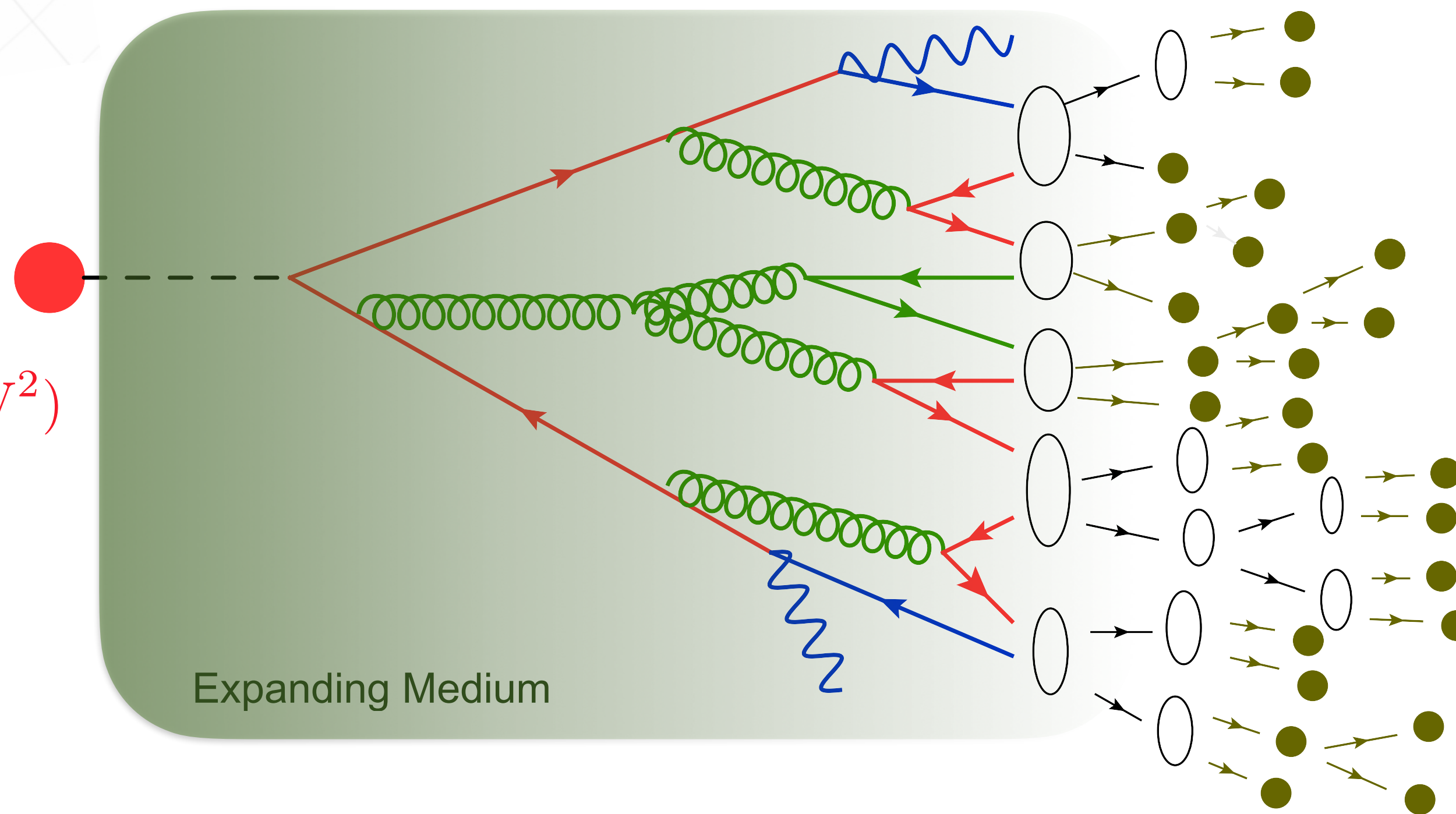


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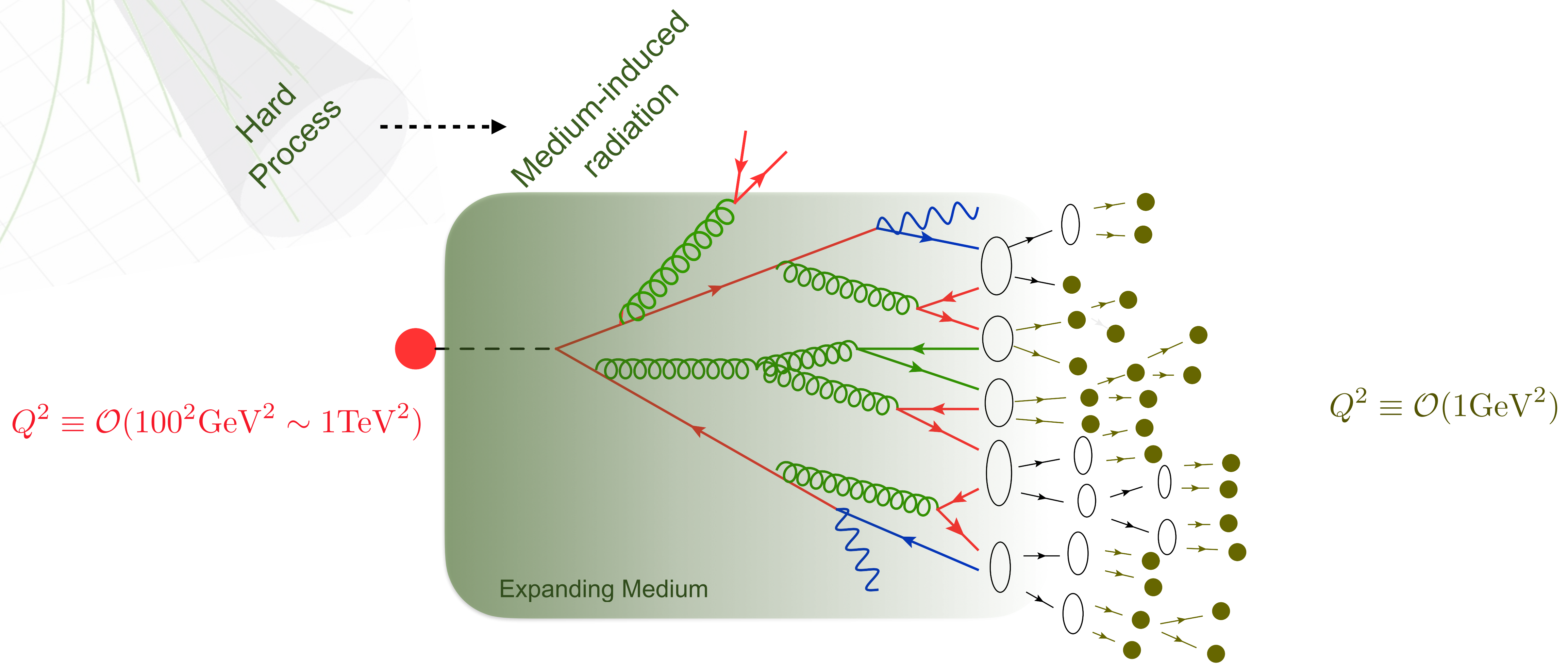
Hard Process

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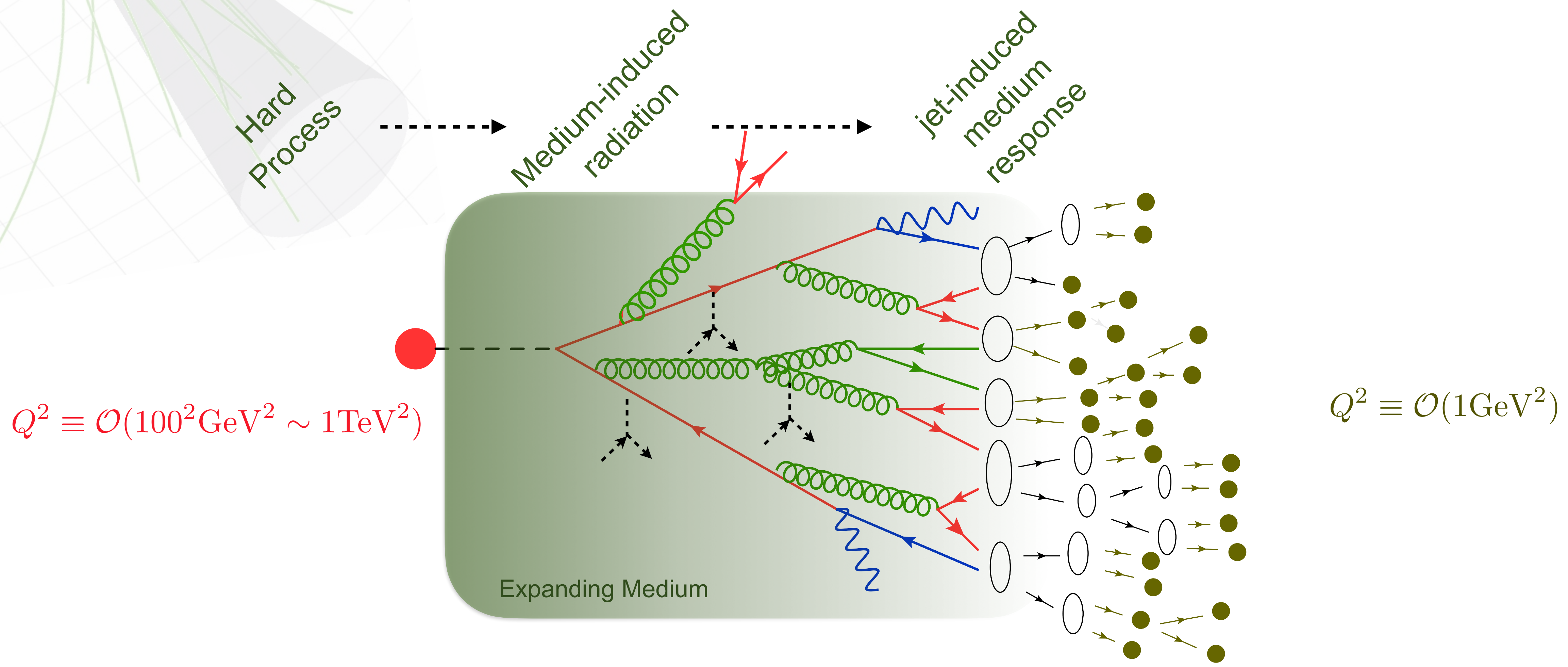
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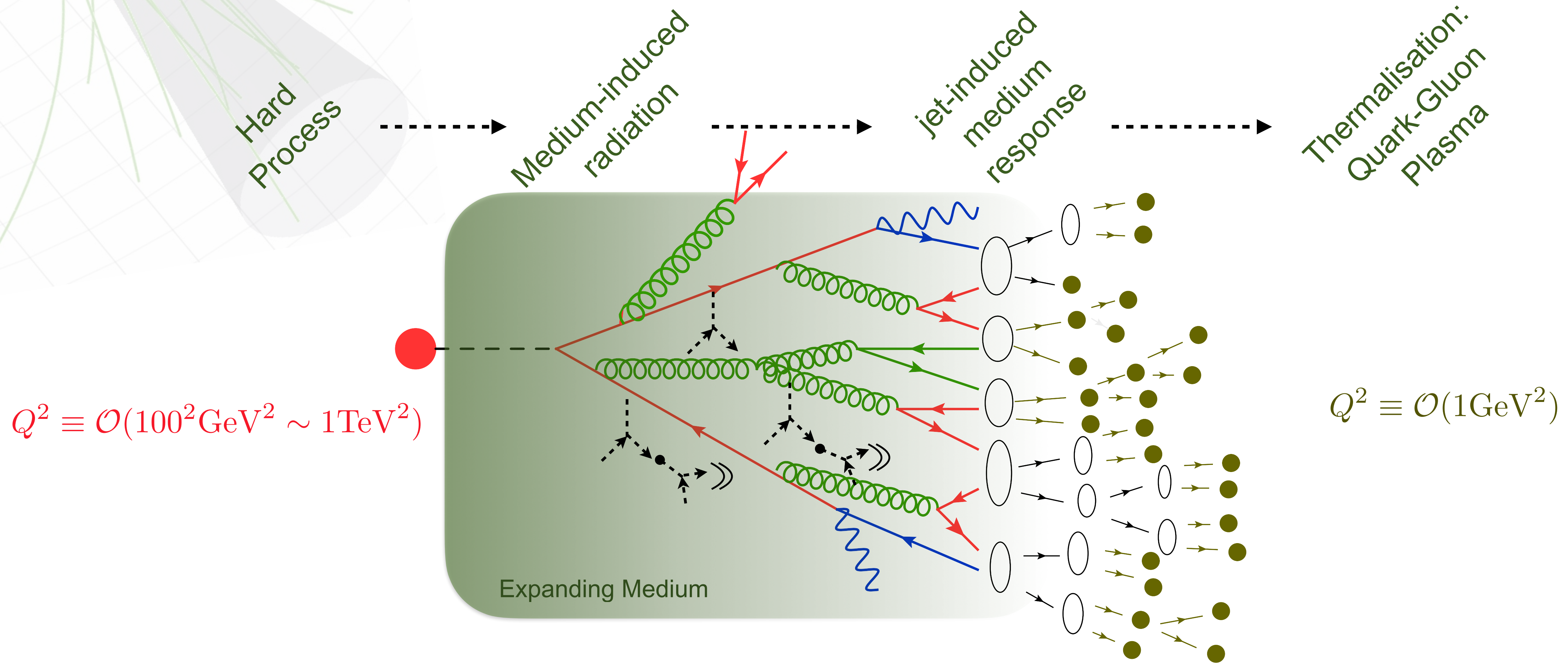
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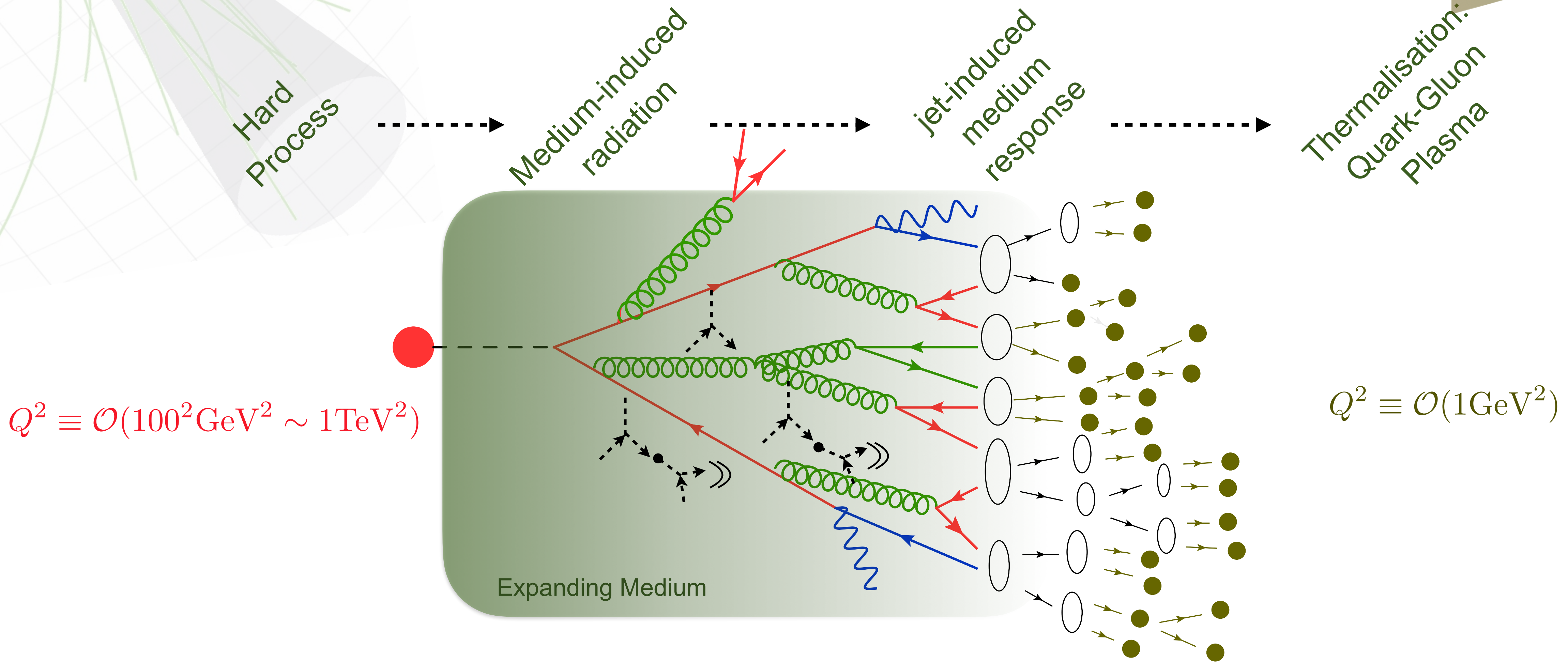


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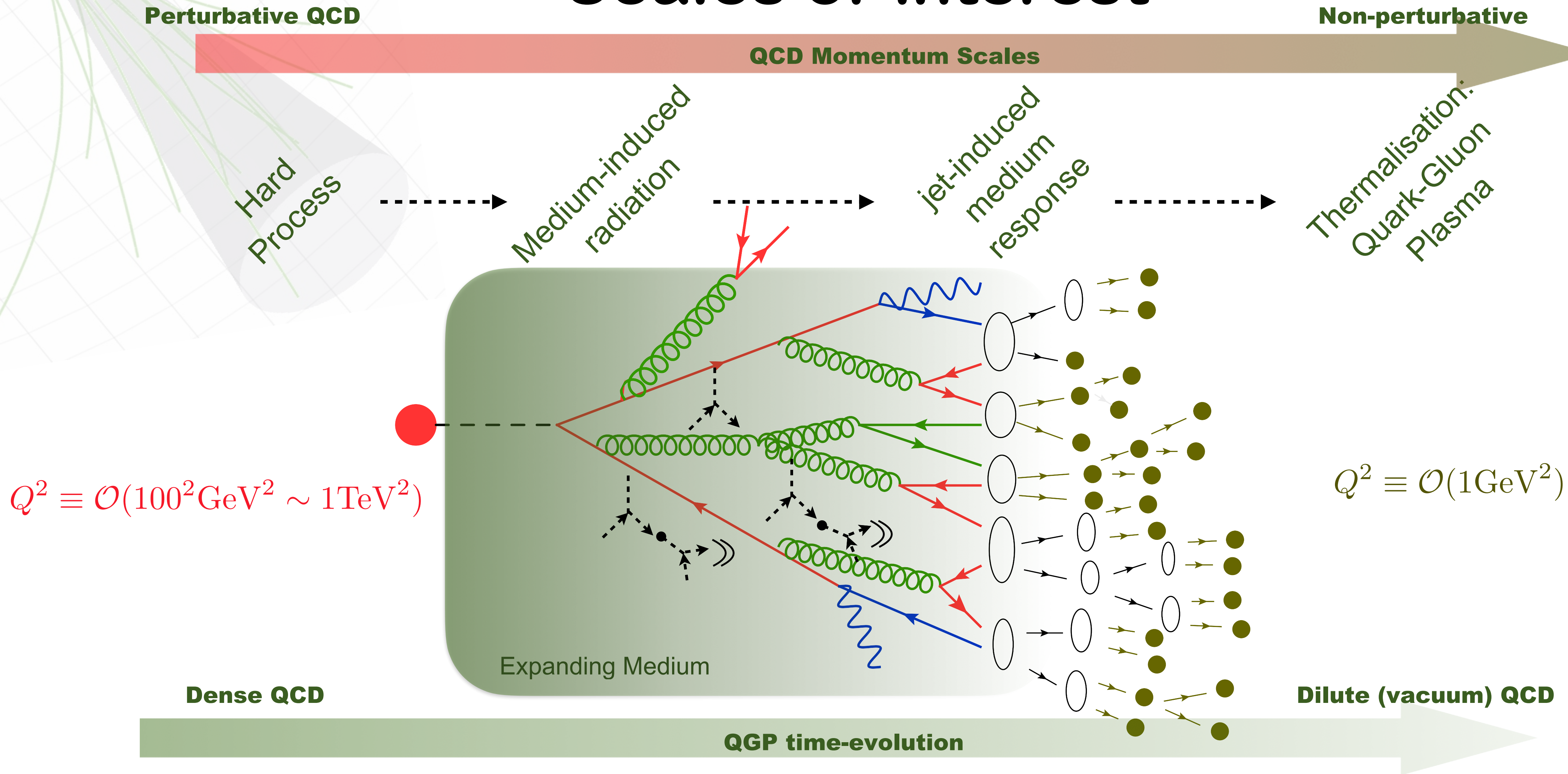
Perturbative QCD

Non-perturbative

QCD Momentum Scales

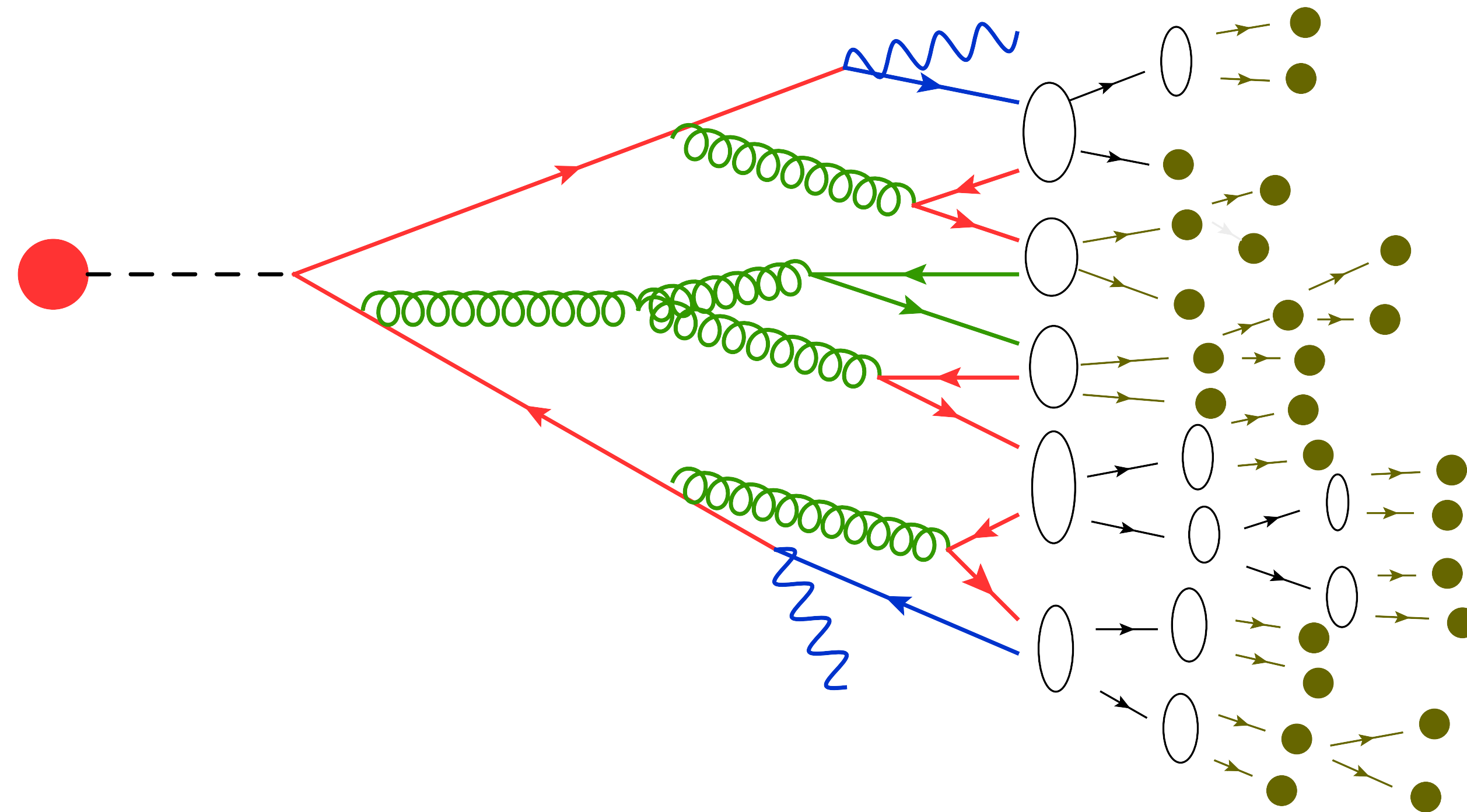


Scales of interest



Jet observables (I)

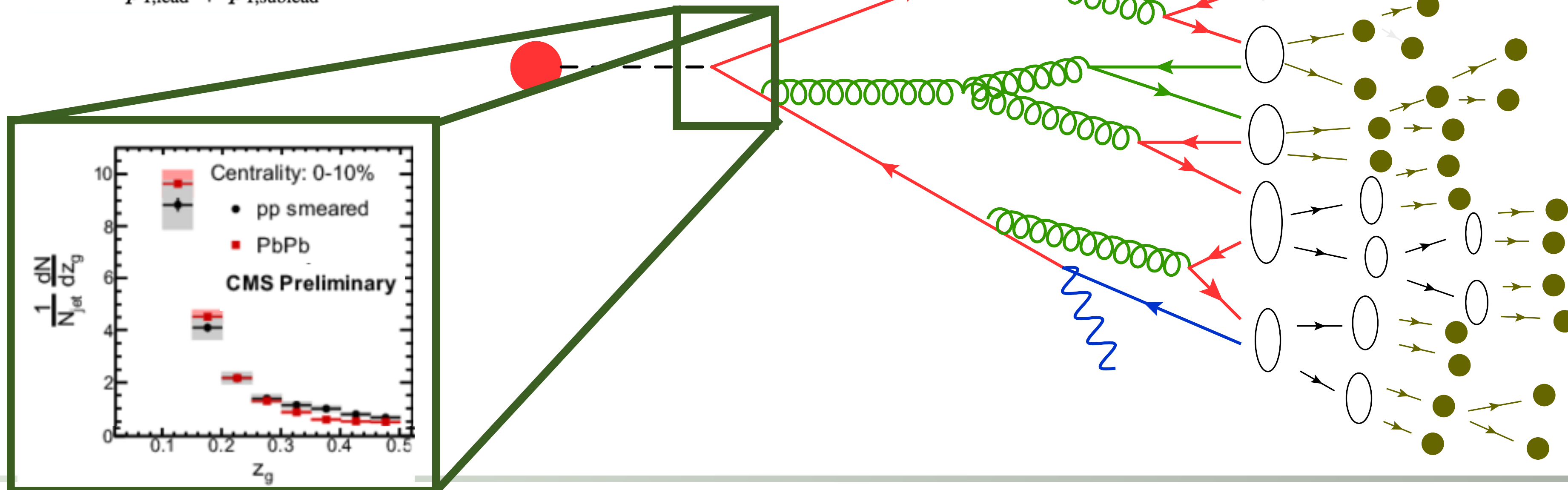
- ◆ Where to look for QGP information?
- ◆ Which momentum and which timescales scales are accessible in which observables?



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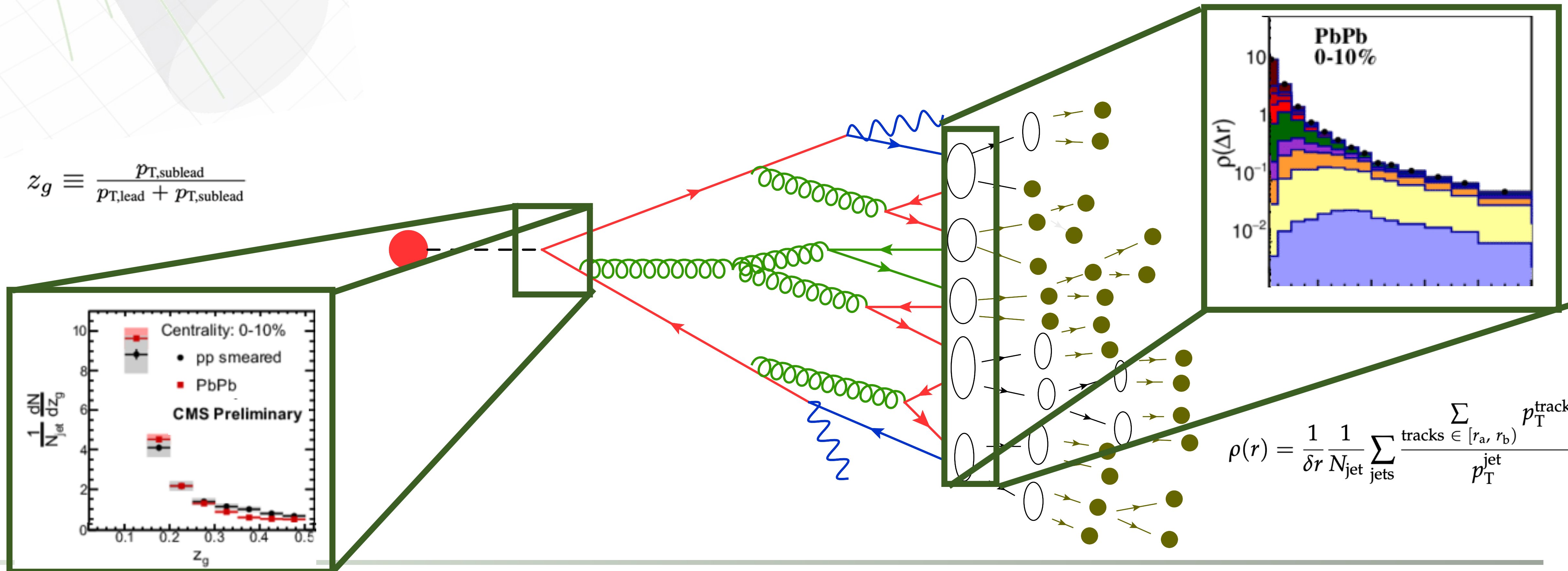
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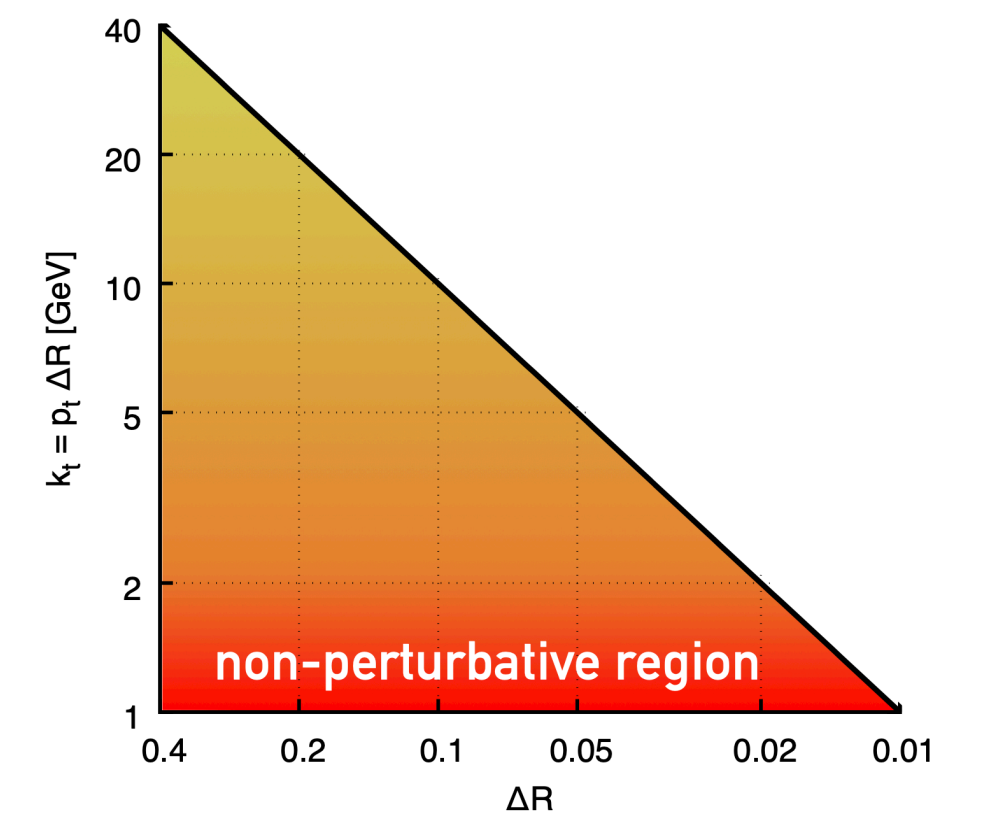
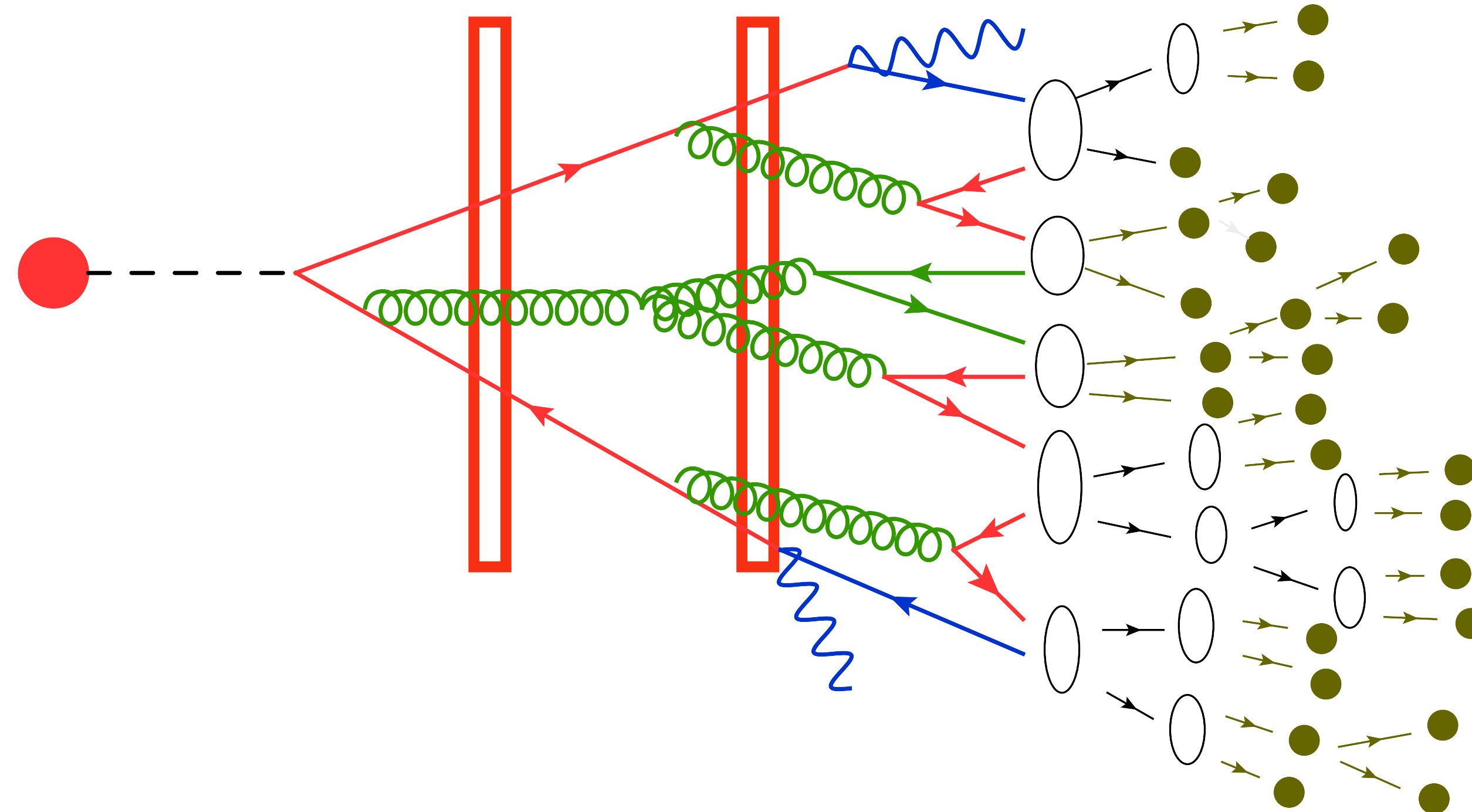
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$$\rho(r) = \frac{1}{\delta r} \frac{1}{N_{\text{jet}}} \sum_{\text{jets}} \frac{\sum_{\text{tracks} \in [r_a, r_b)} p_T^{\text{track}}}{p_T^{\text{jet}}}$$

Jet observables (II)

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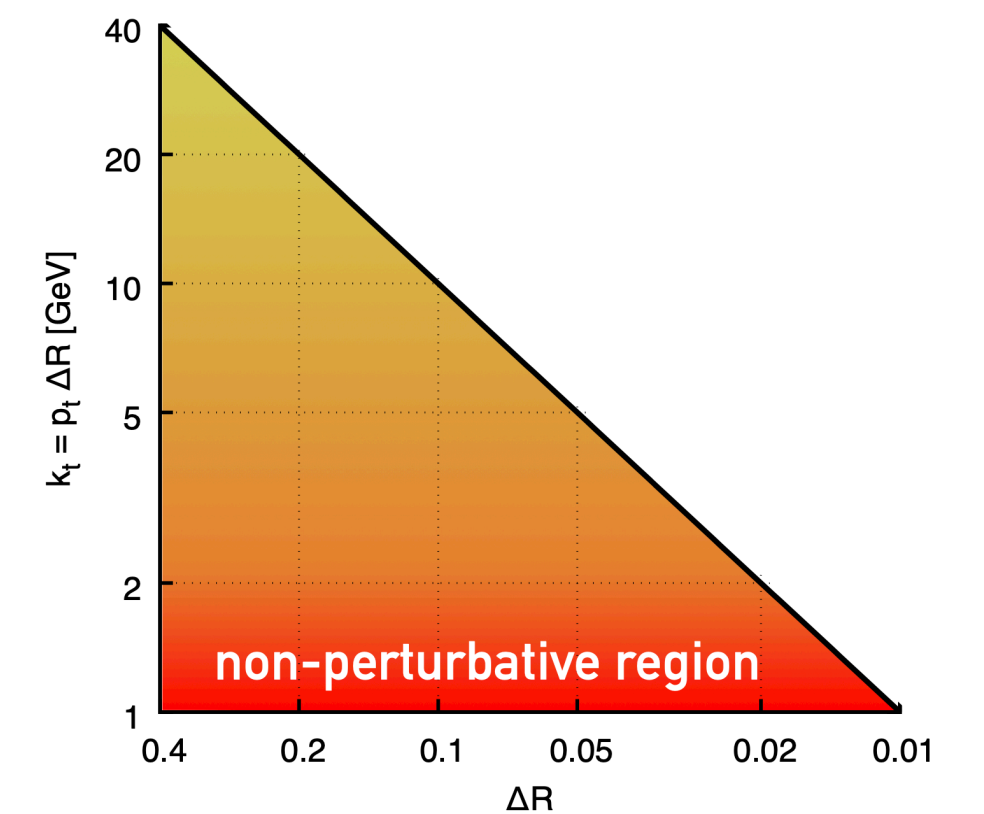
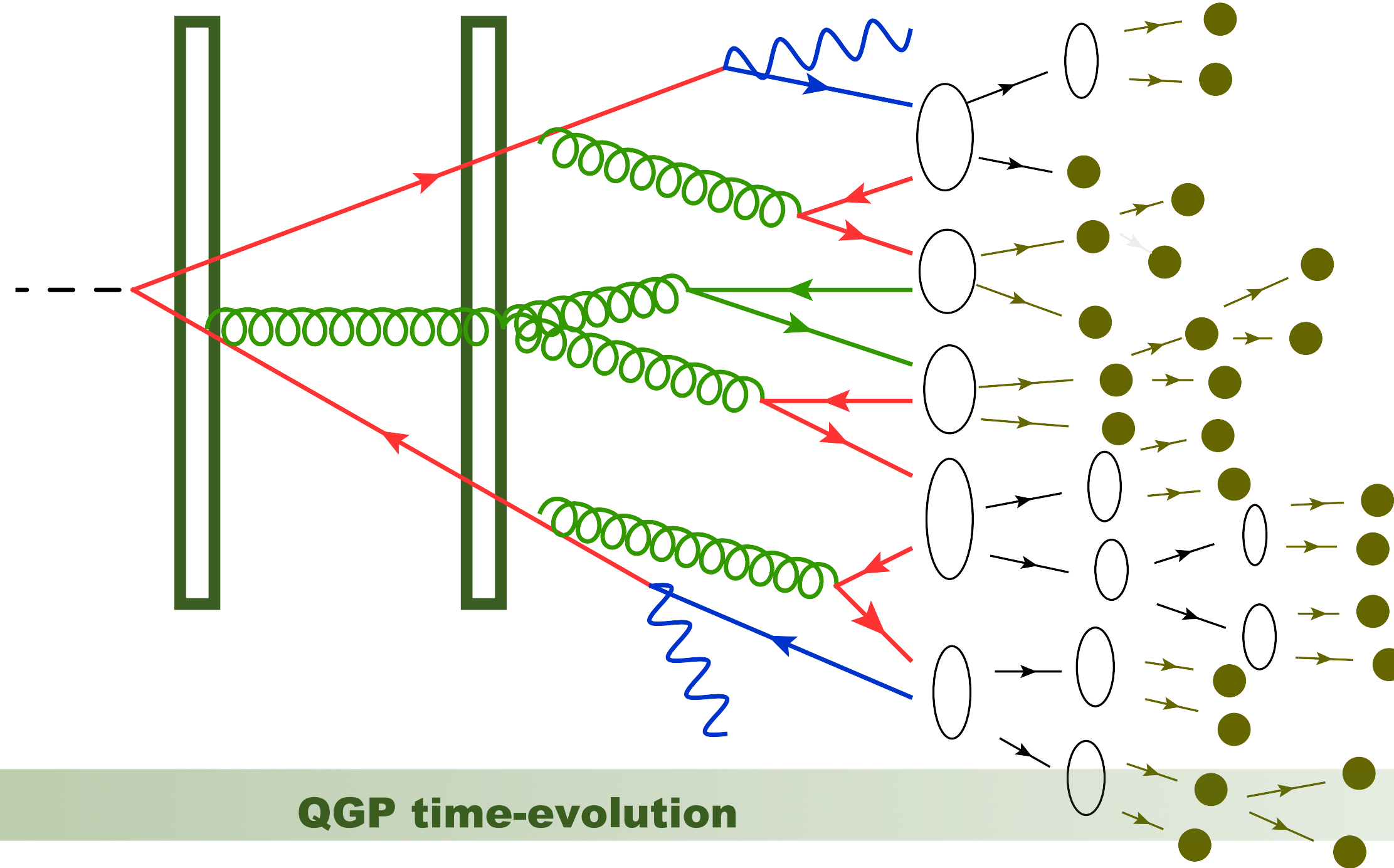
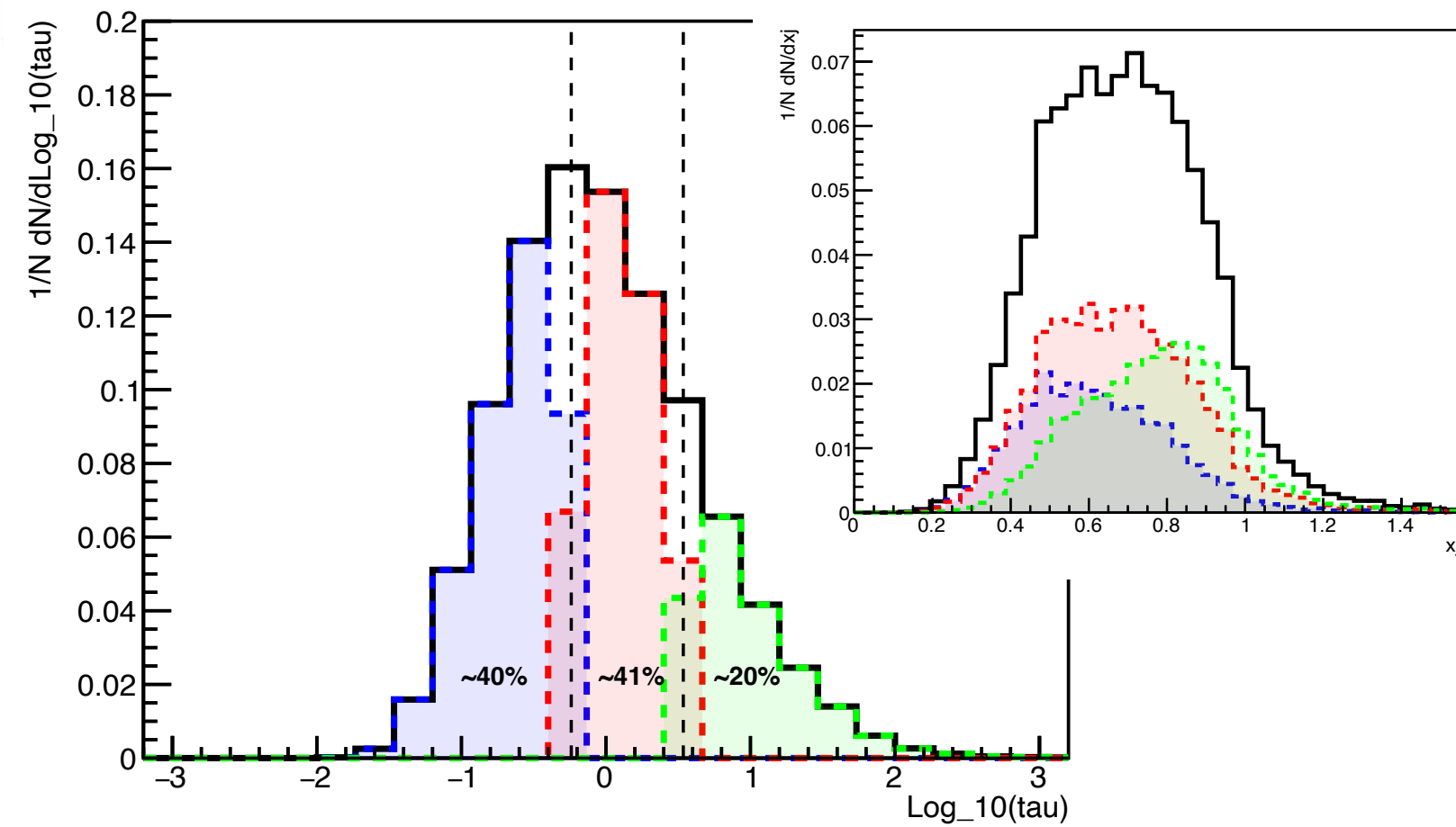


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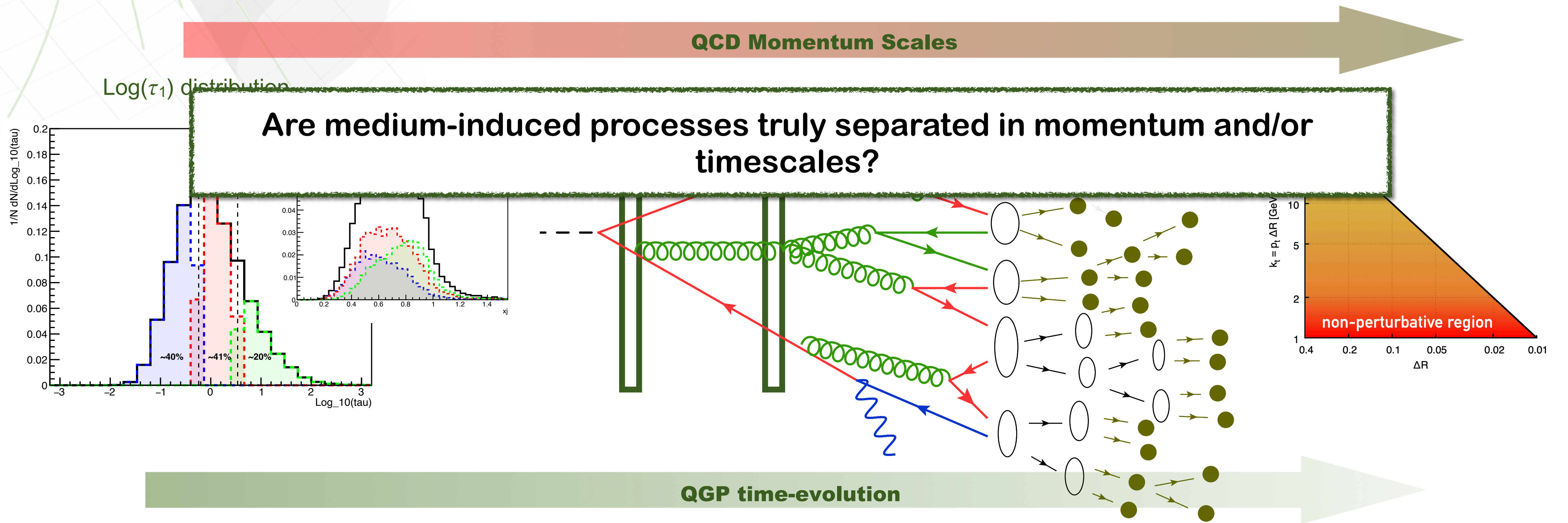


Log(τ_1) distribution



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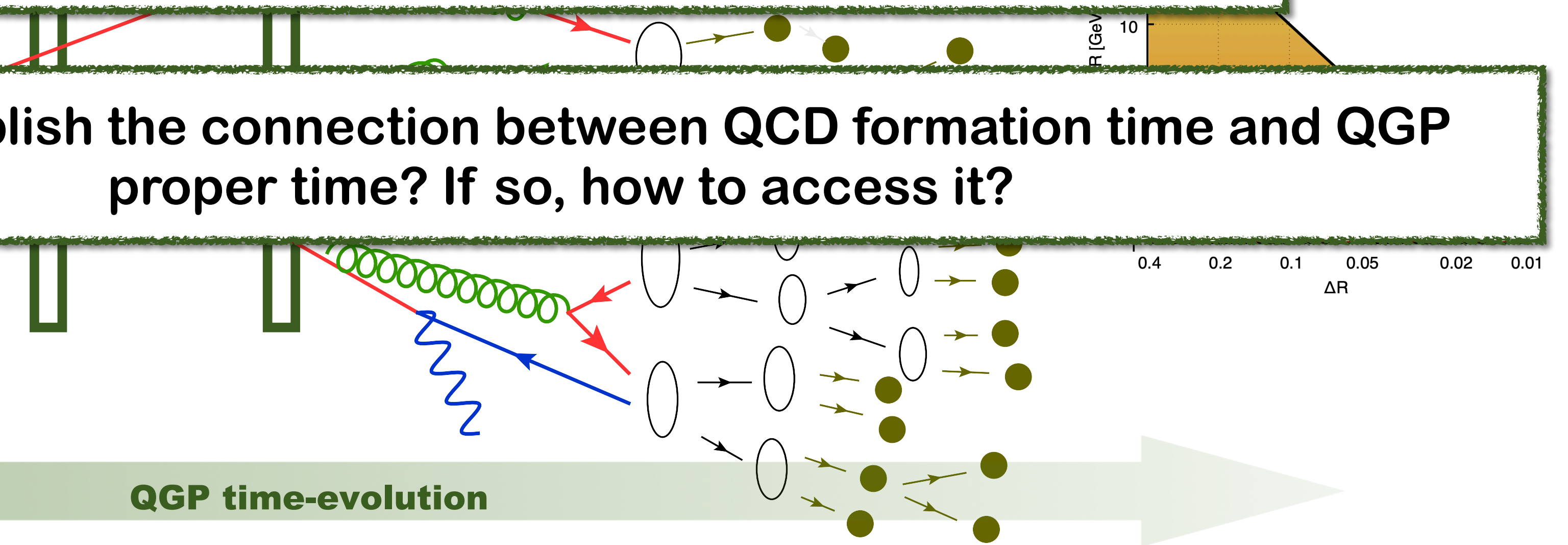
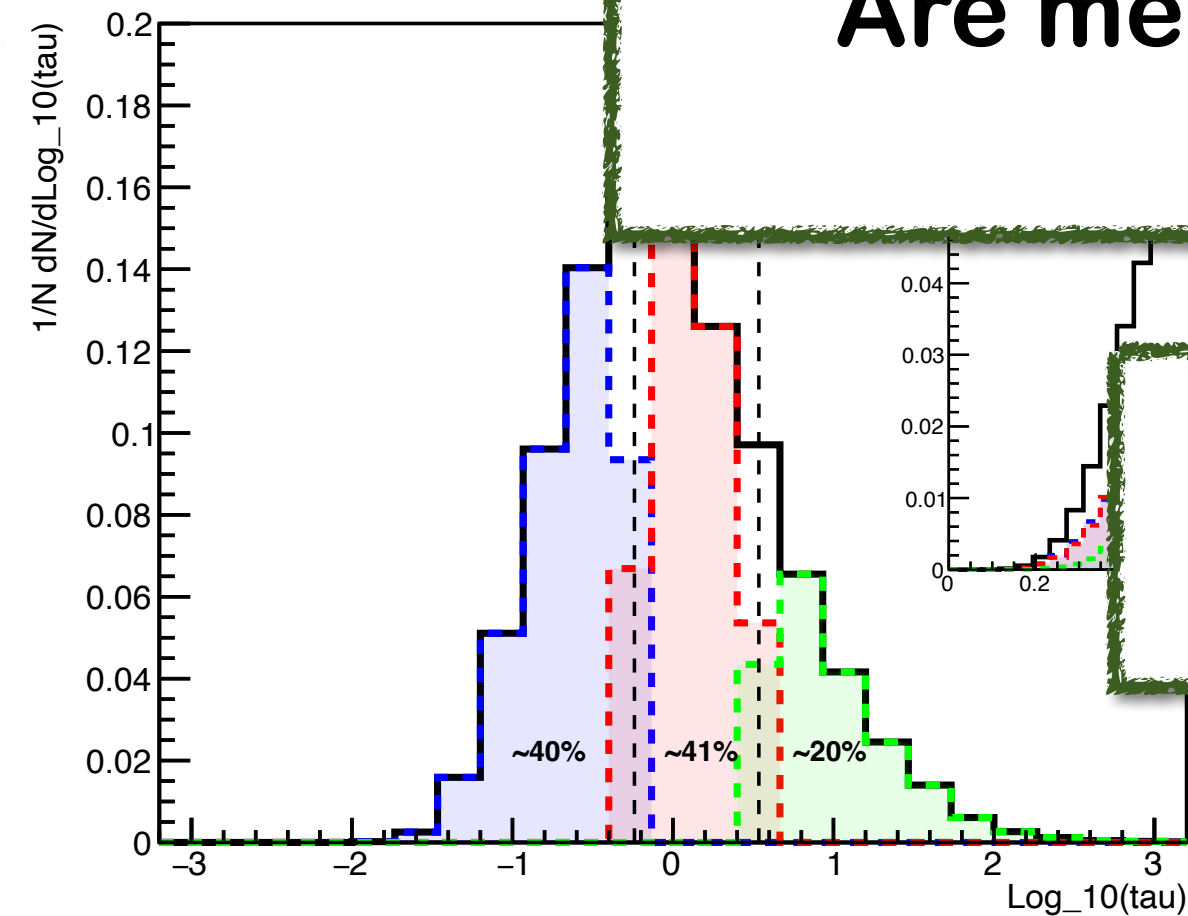
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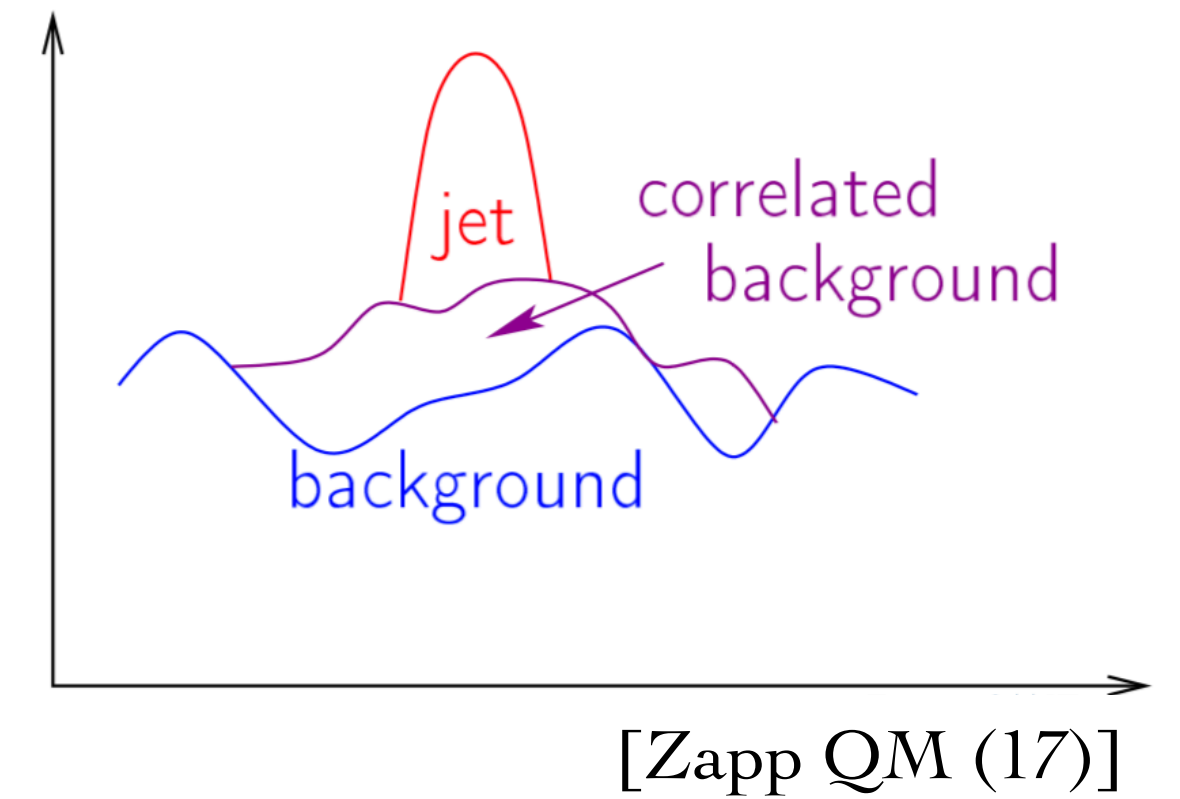
Are medium-induced processes truly separated in momentum and/or timescales?

Can we establish the connection between QCD formation time and QGP proper time? If so, how to access it?



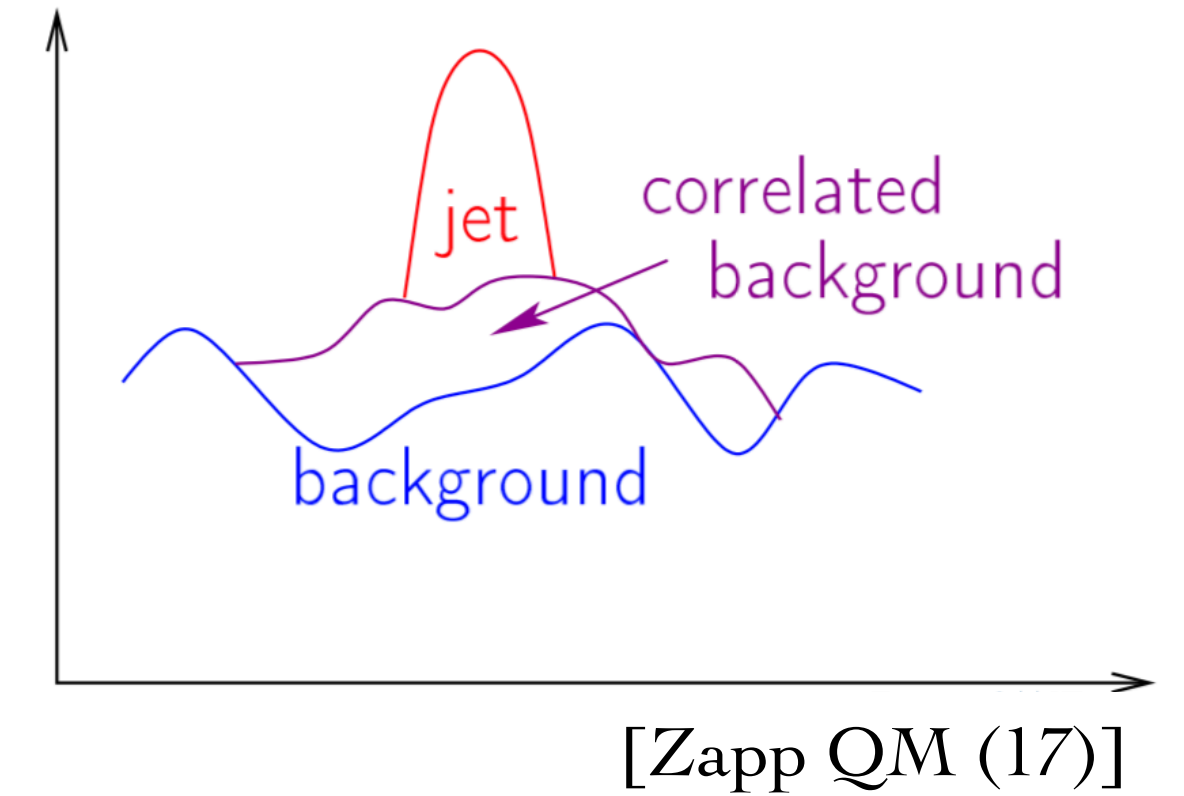
Grooming, bkg subtraction and jet pt selection

- ◆ A heavy-ion jet object: are we sure we are defining the same object across different models and experimental results?

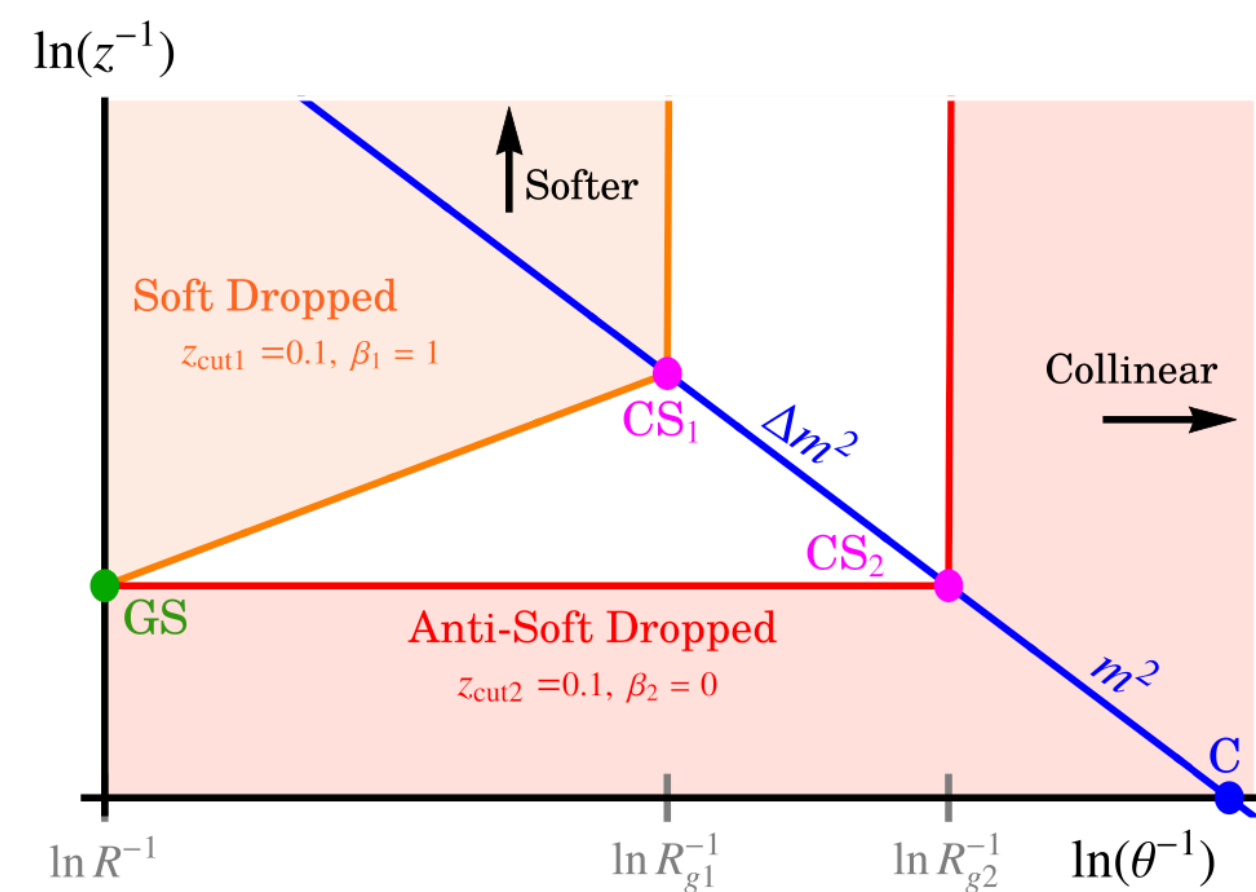
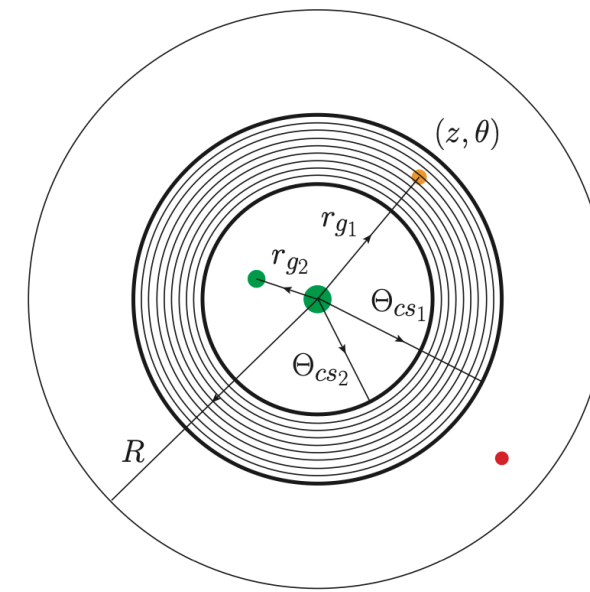
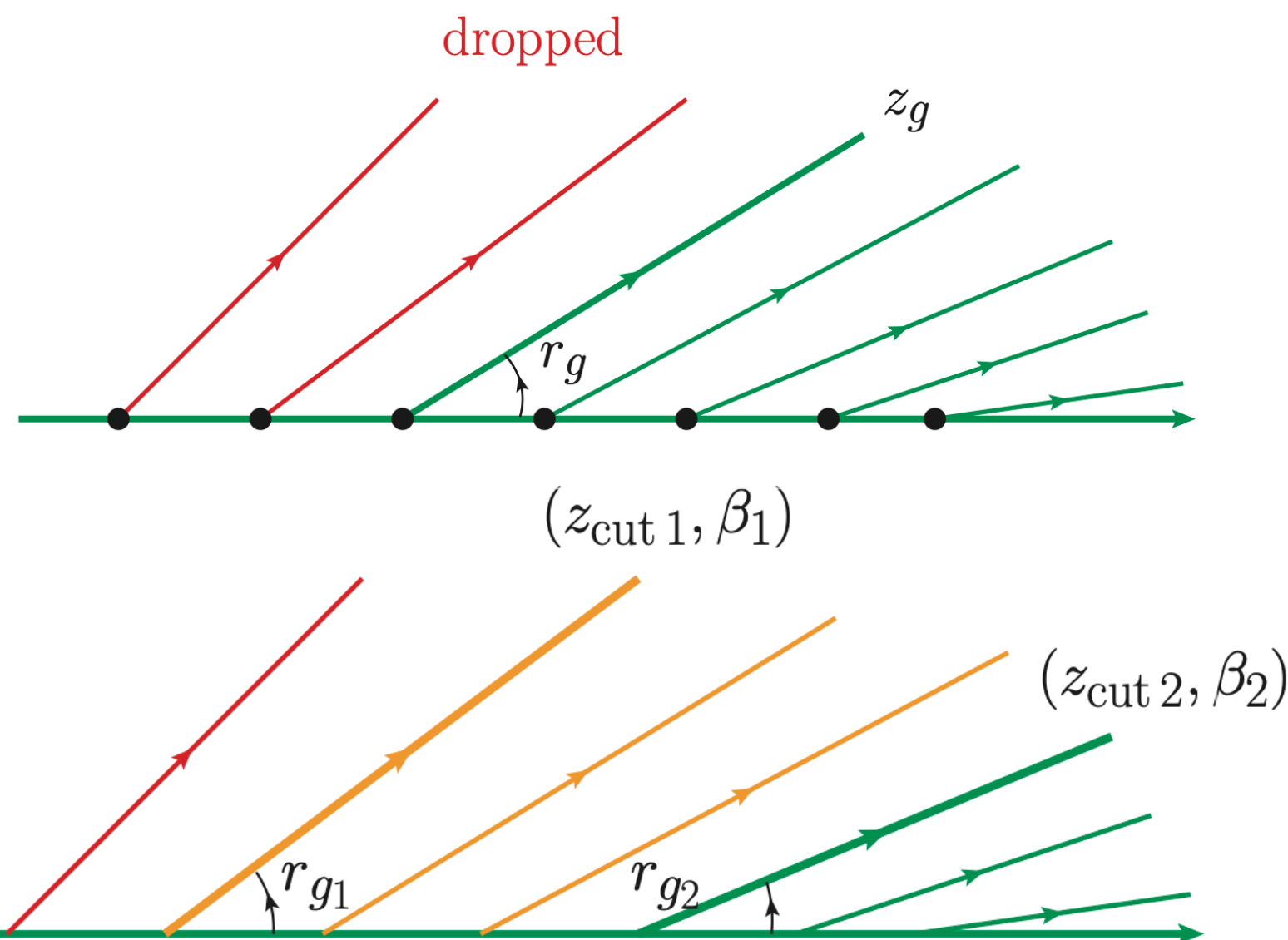


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- ◆ Several grooming choices. Which ones will provide a better sensitivity?

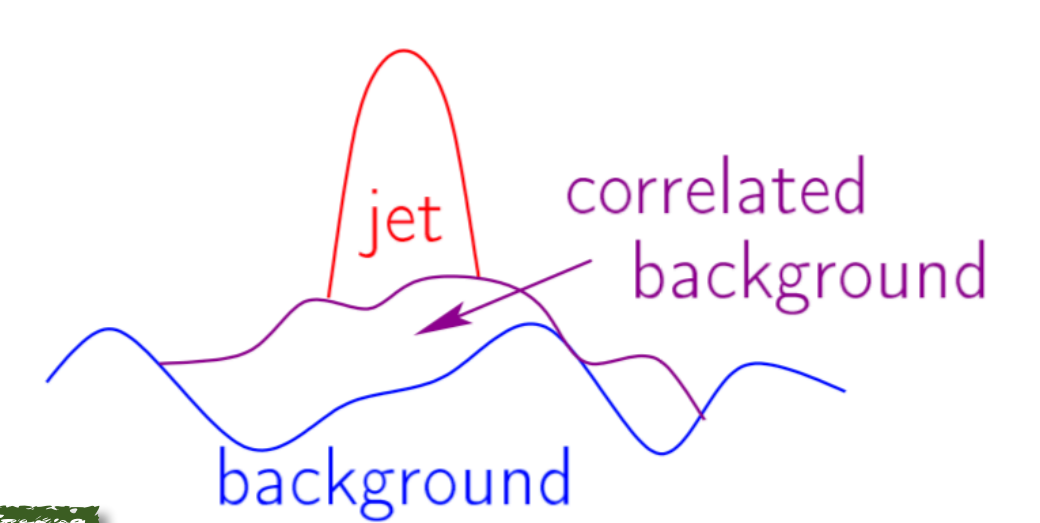


[Chien, PPP13, NTNU (19)]



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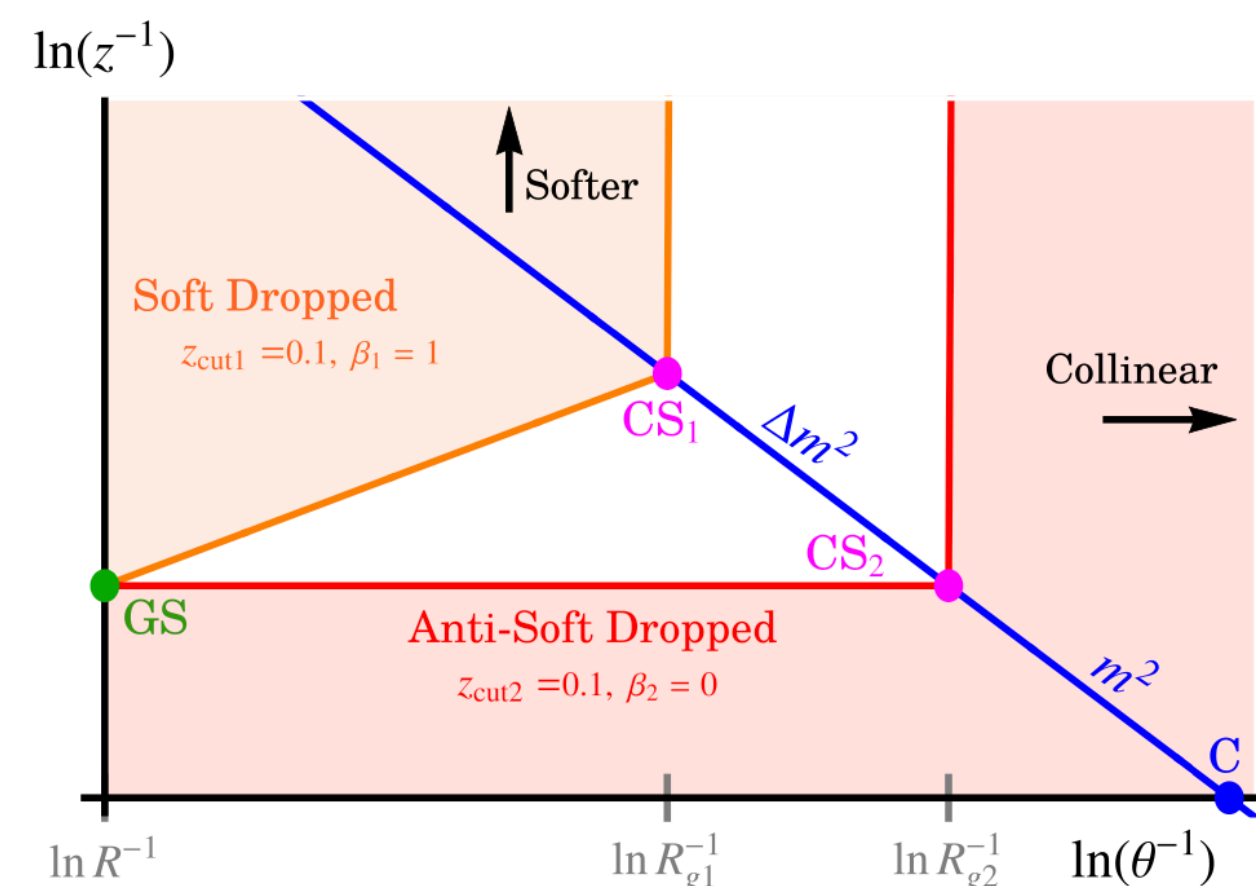
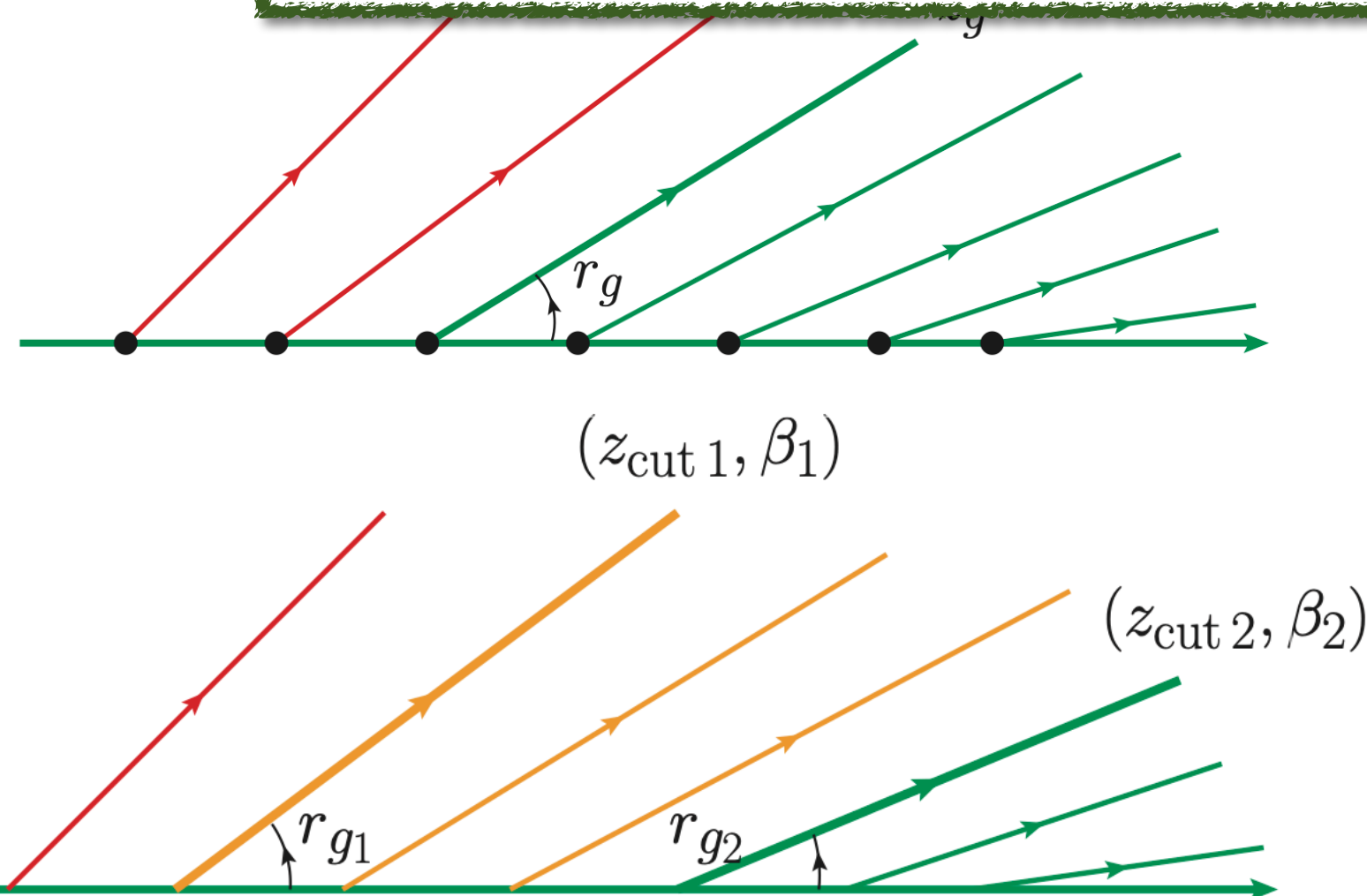
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Do we understand what are we removing when applying different groomings?

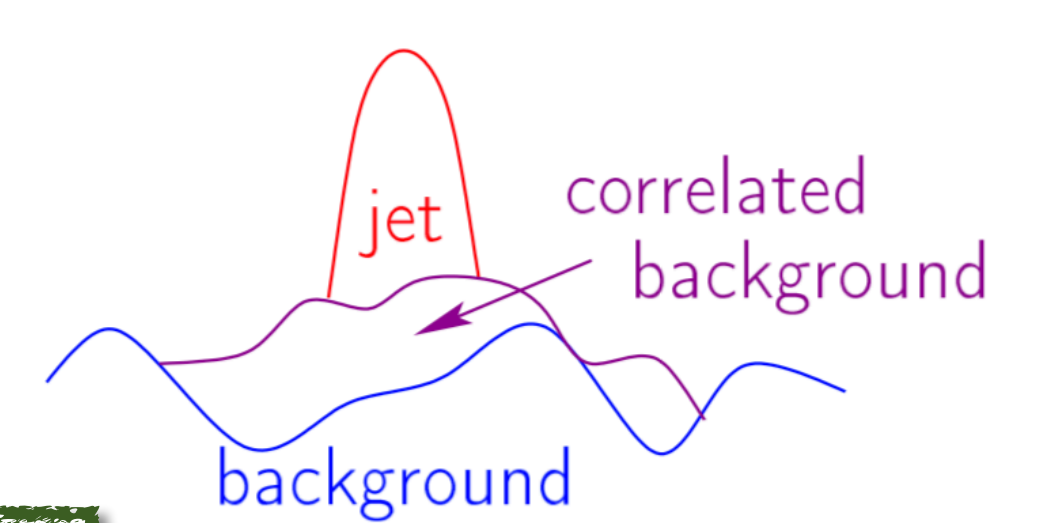
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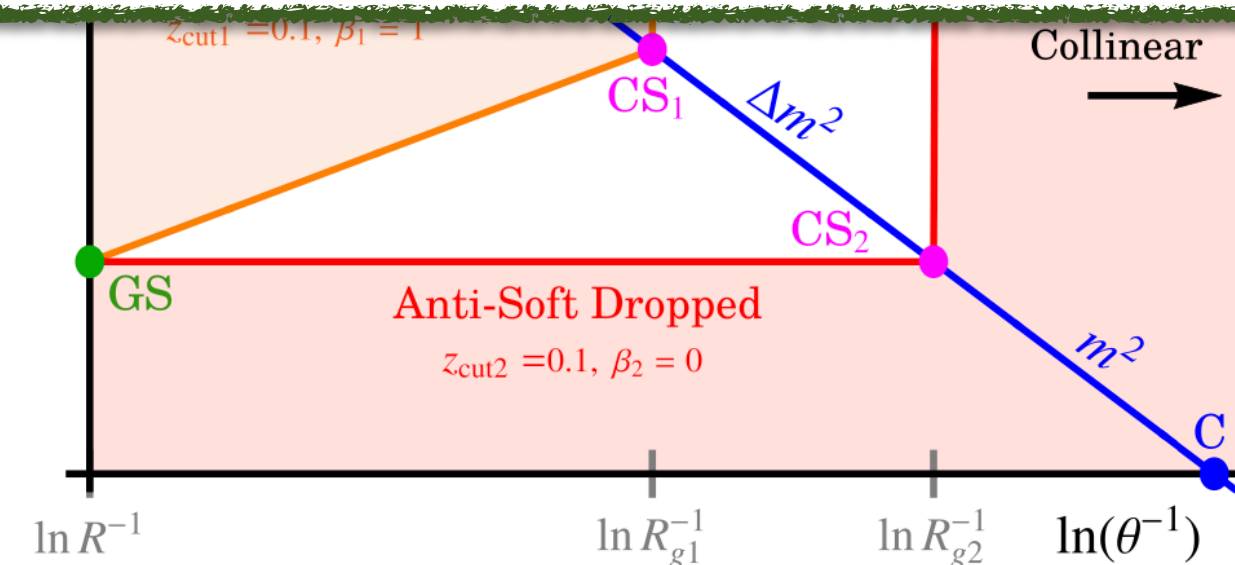
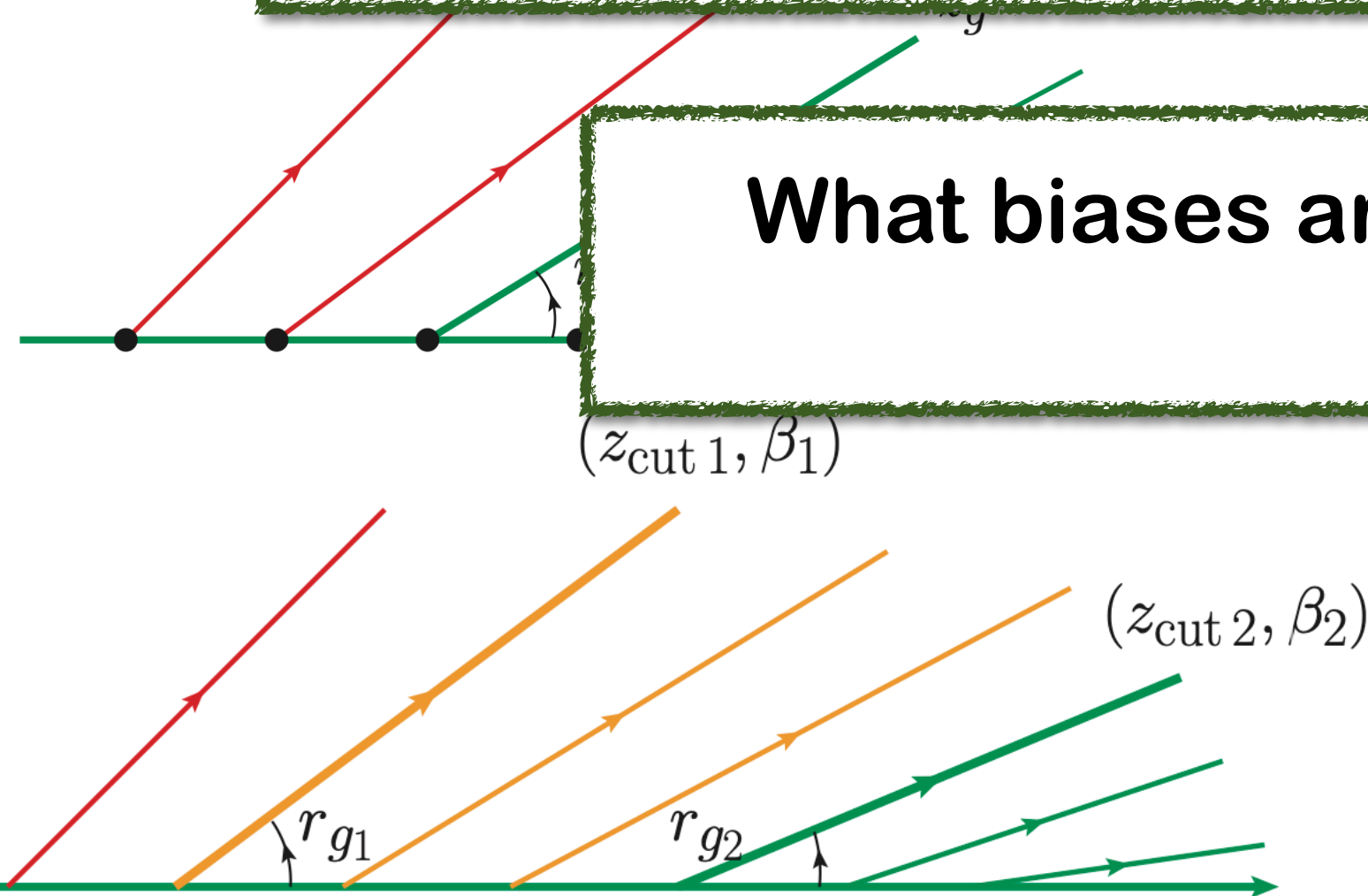


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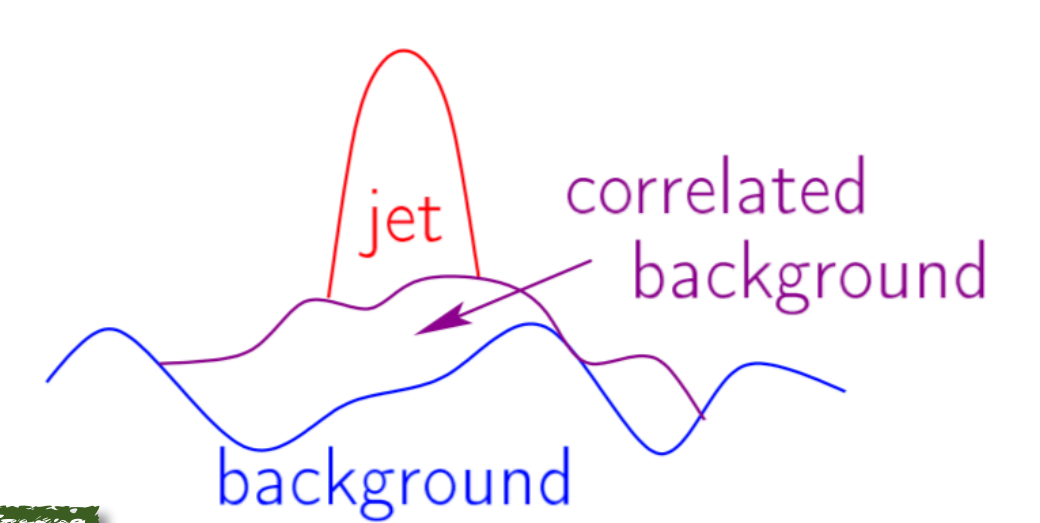
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What biases are we inducing when looking for background-subtracted/groomed observables?



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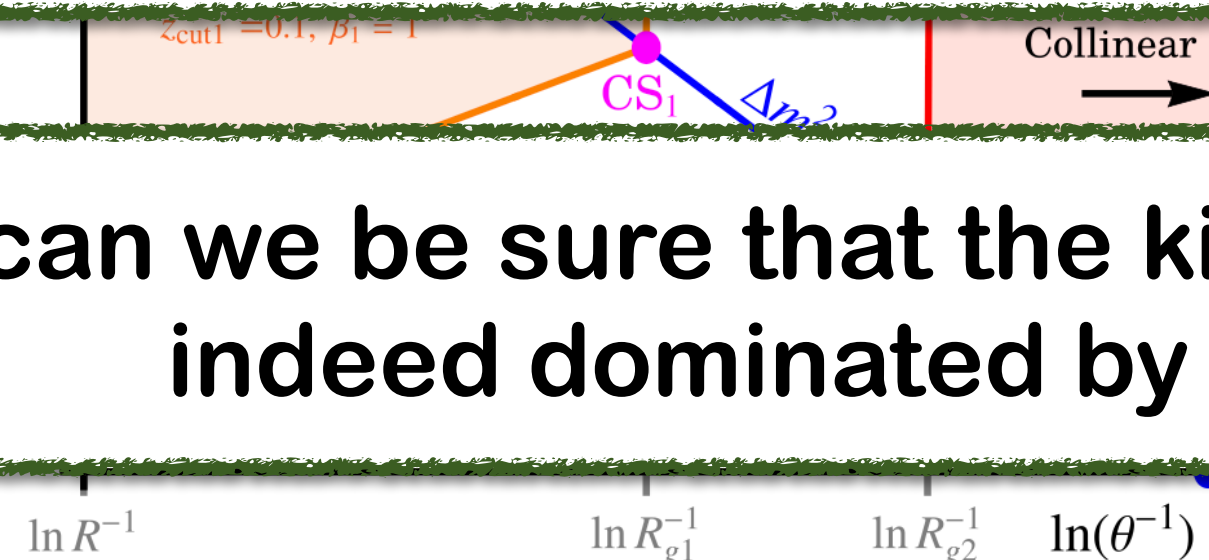
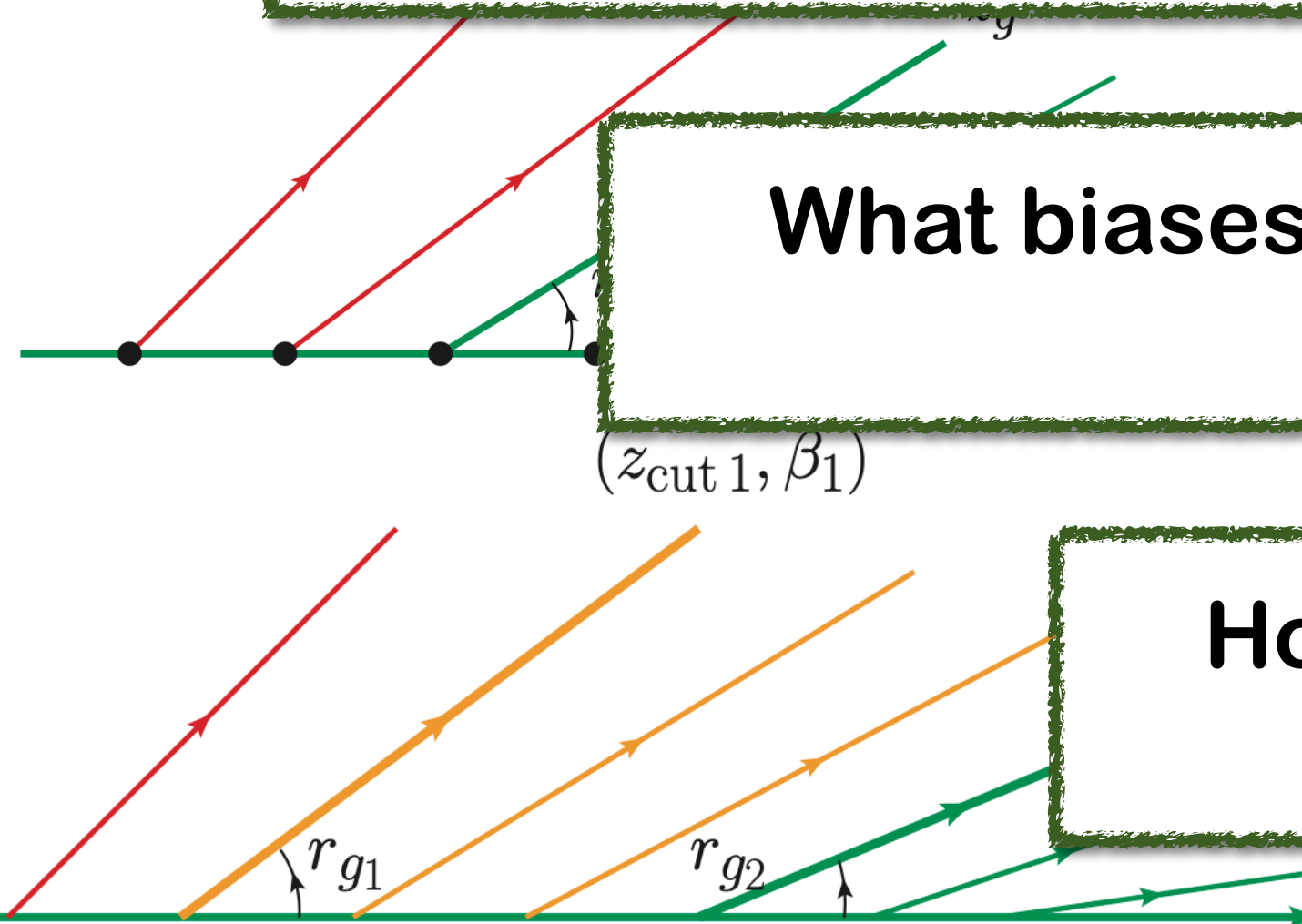
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Do we understand what are we removing when applying different groomings?

[Zapp QM (17)]

What biases are we inducing when looking for background-subtracted/groomed observables?

How can we be sure that the kinematic region we are looking at is indeed dominated by the effect we are looking?



New observables

- ◆ Theory designed and QCD inspired

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“Top-down”

Theory



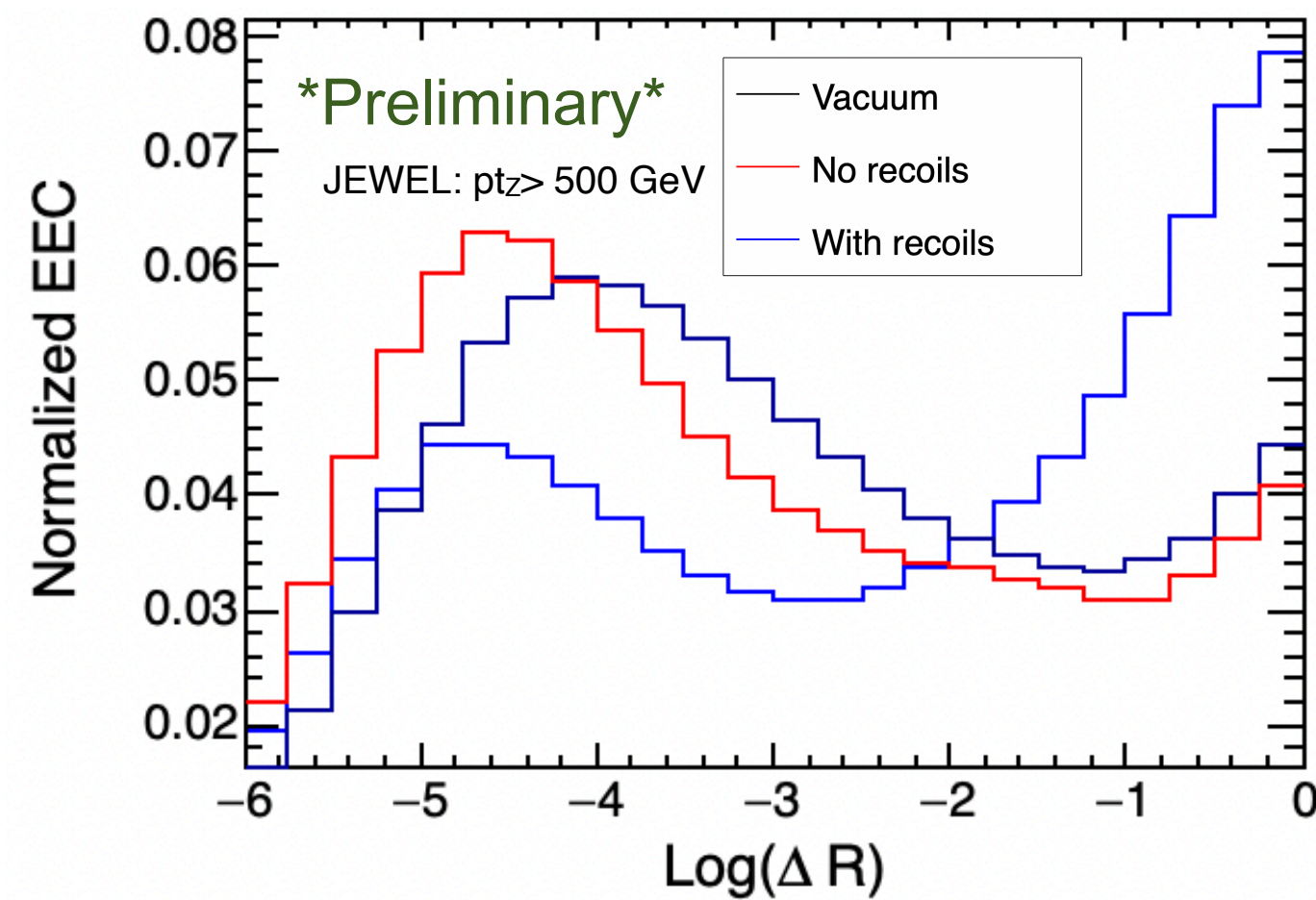
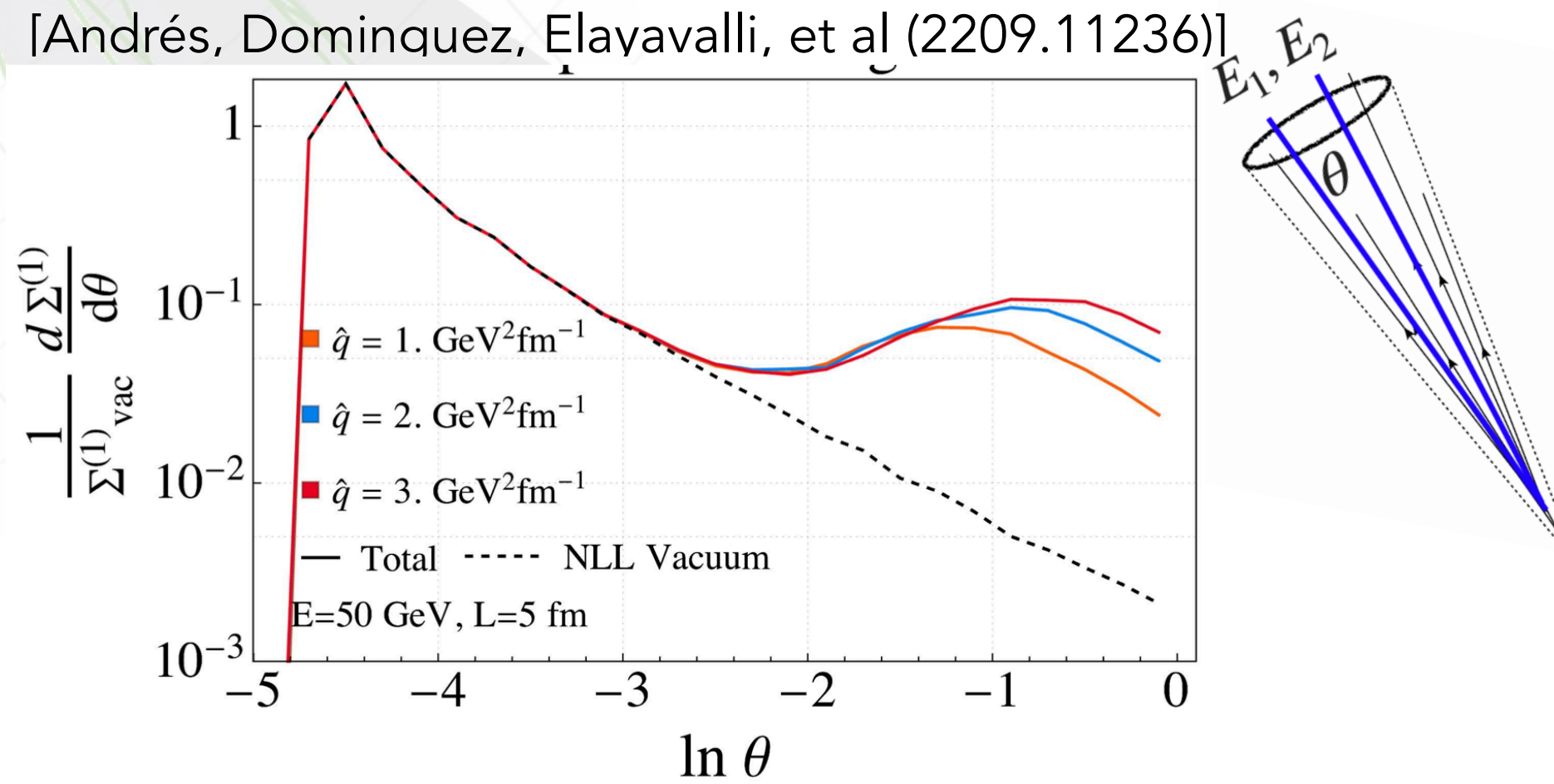
Experiment

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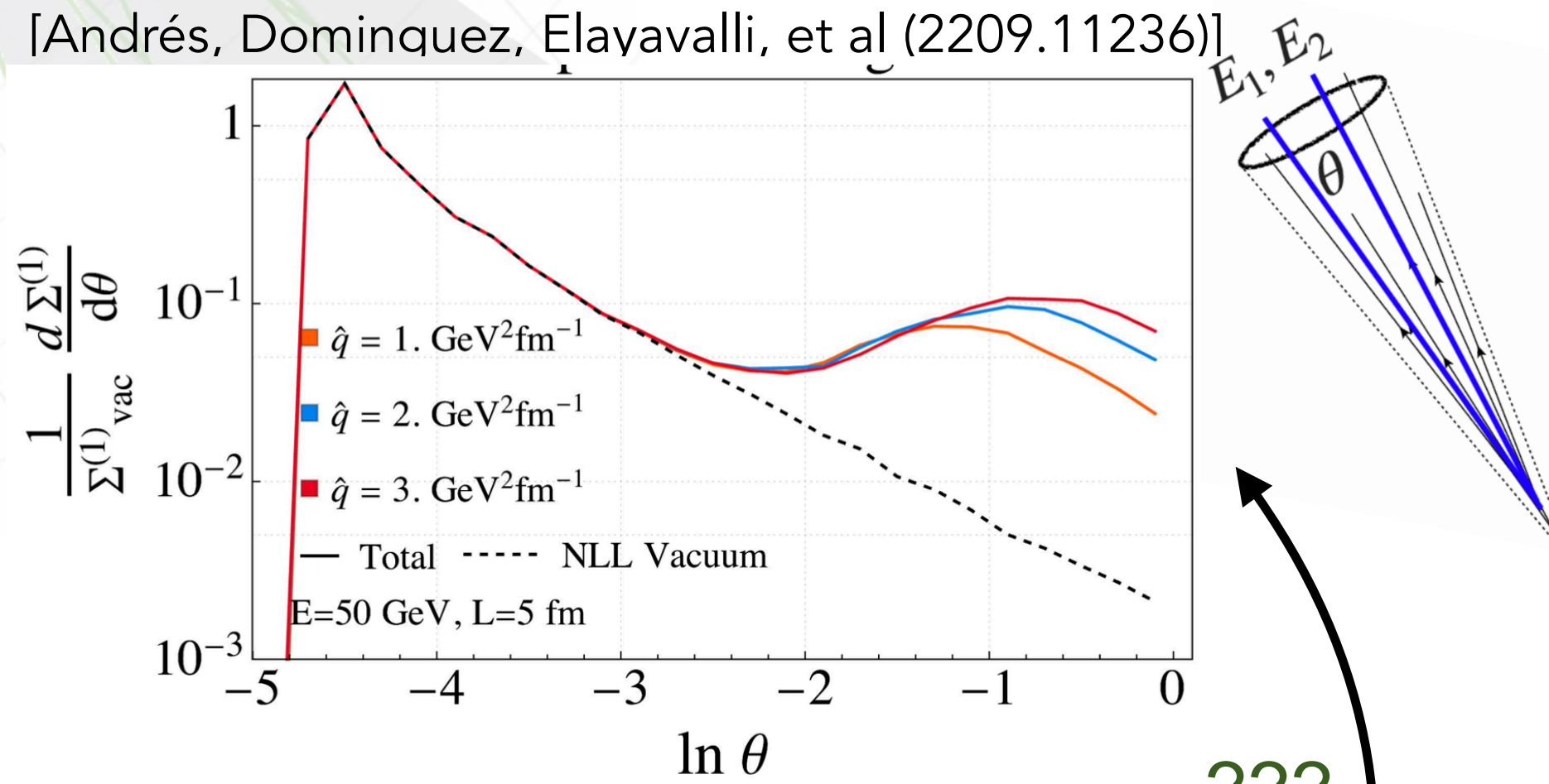
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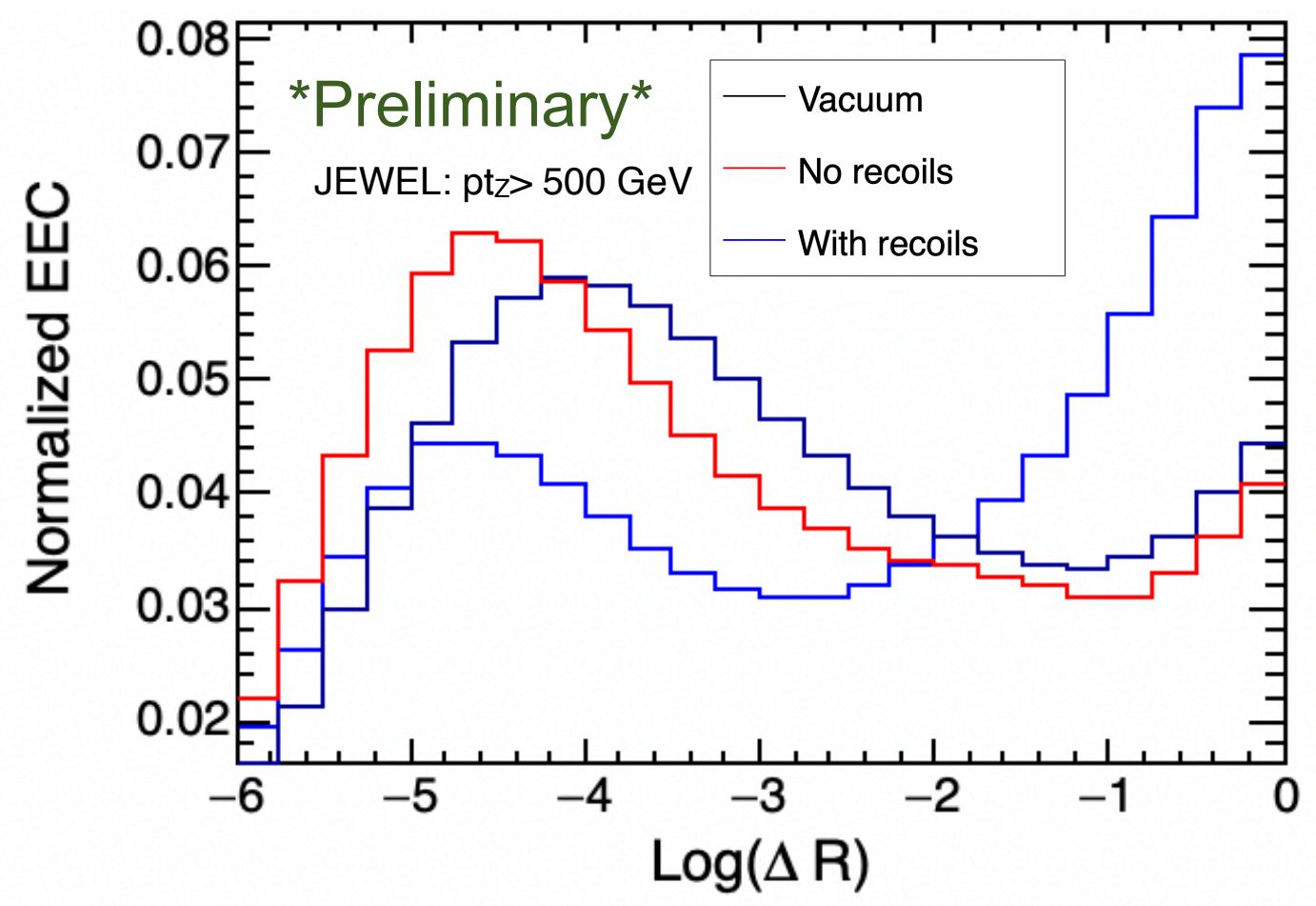
[Andrés, Dominquez, Elayavalli, et al] (2209.11236)

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Theory



???



Experiment

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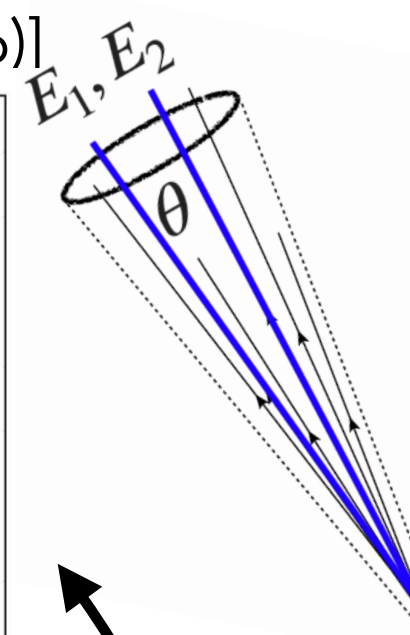
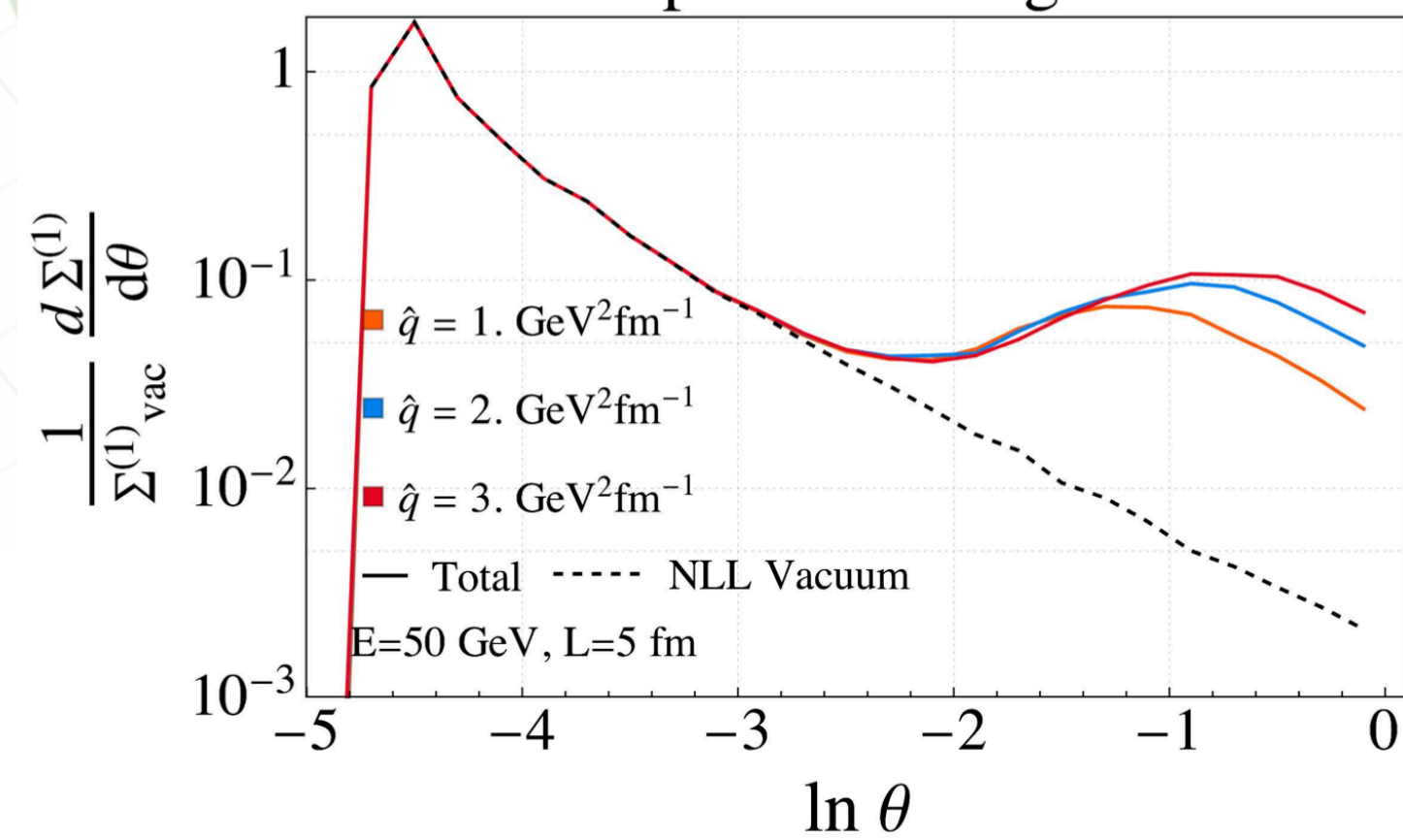
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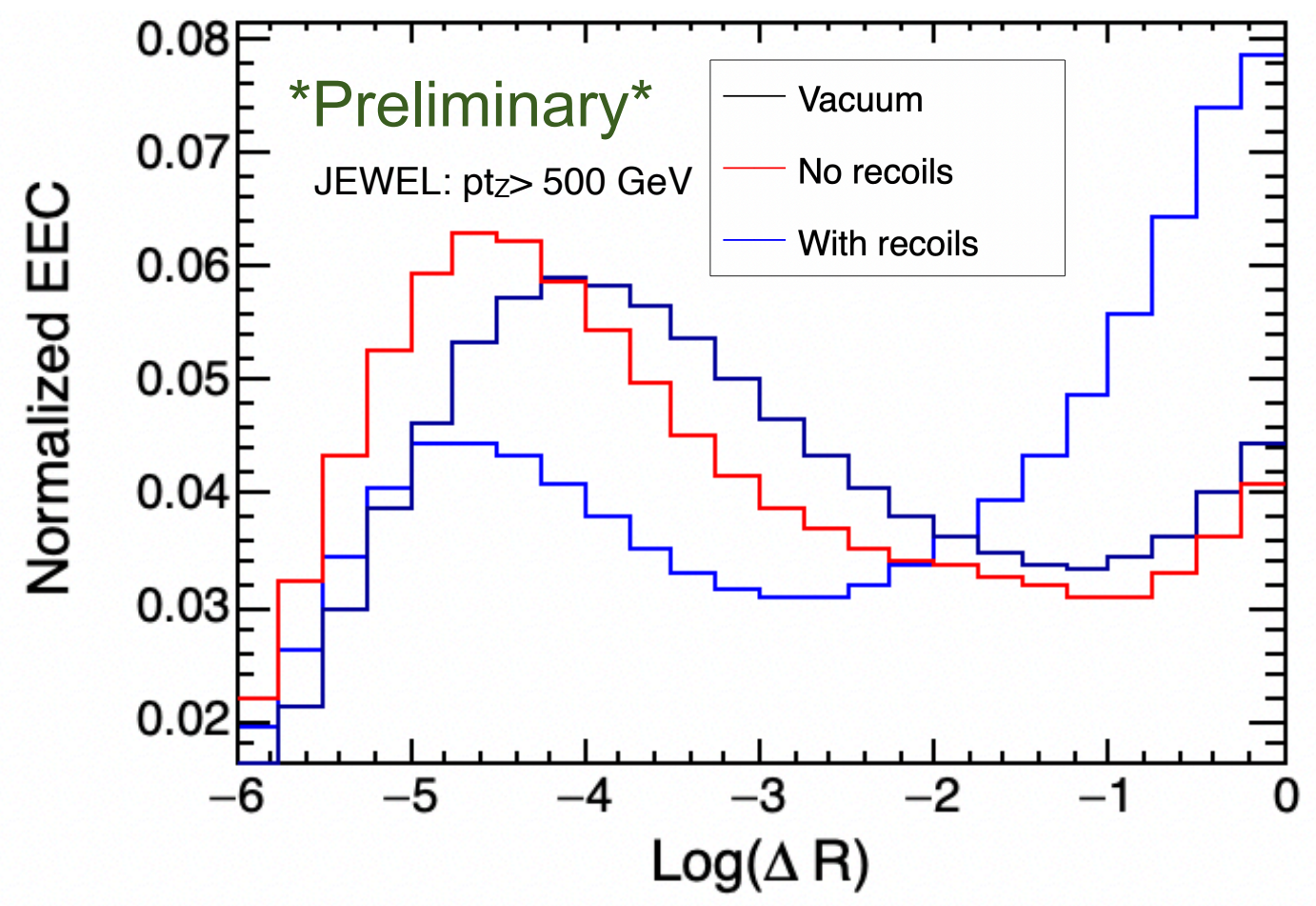
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“Bottom-up”

Experiment

Experiment



???

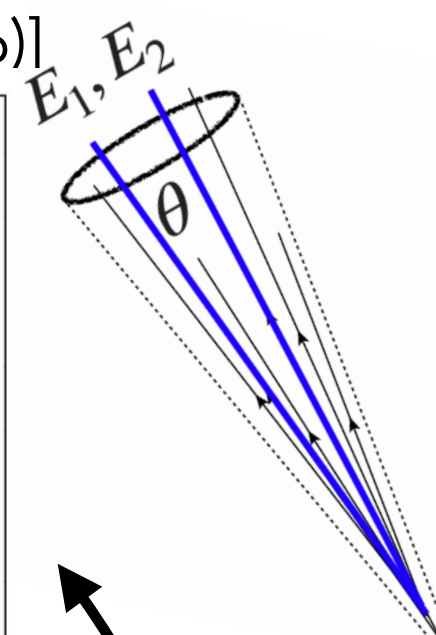
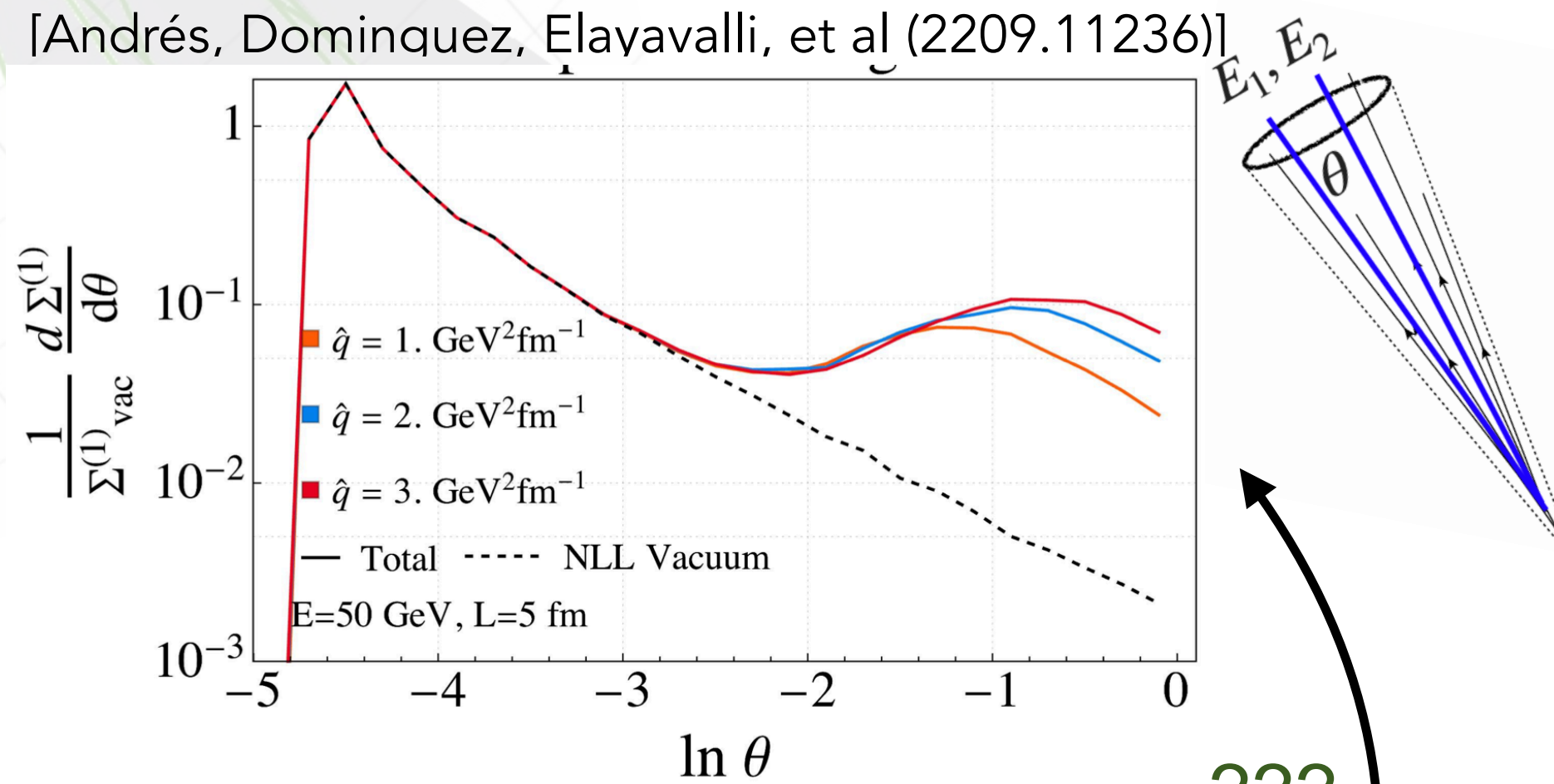
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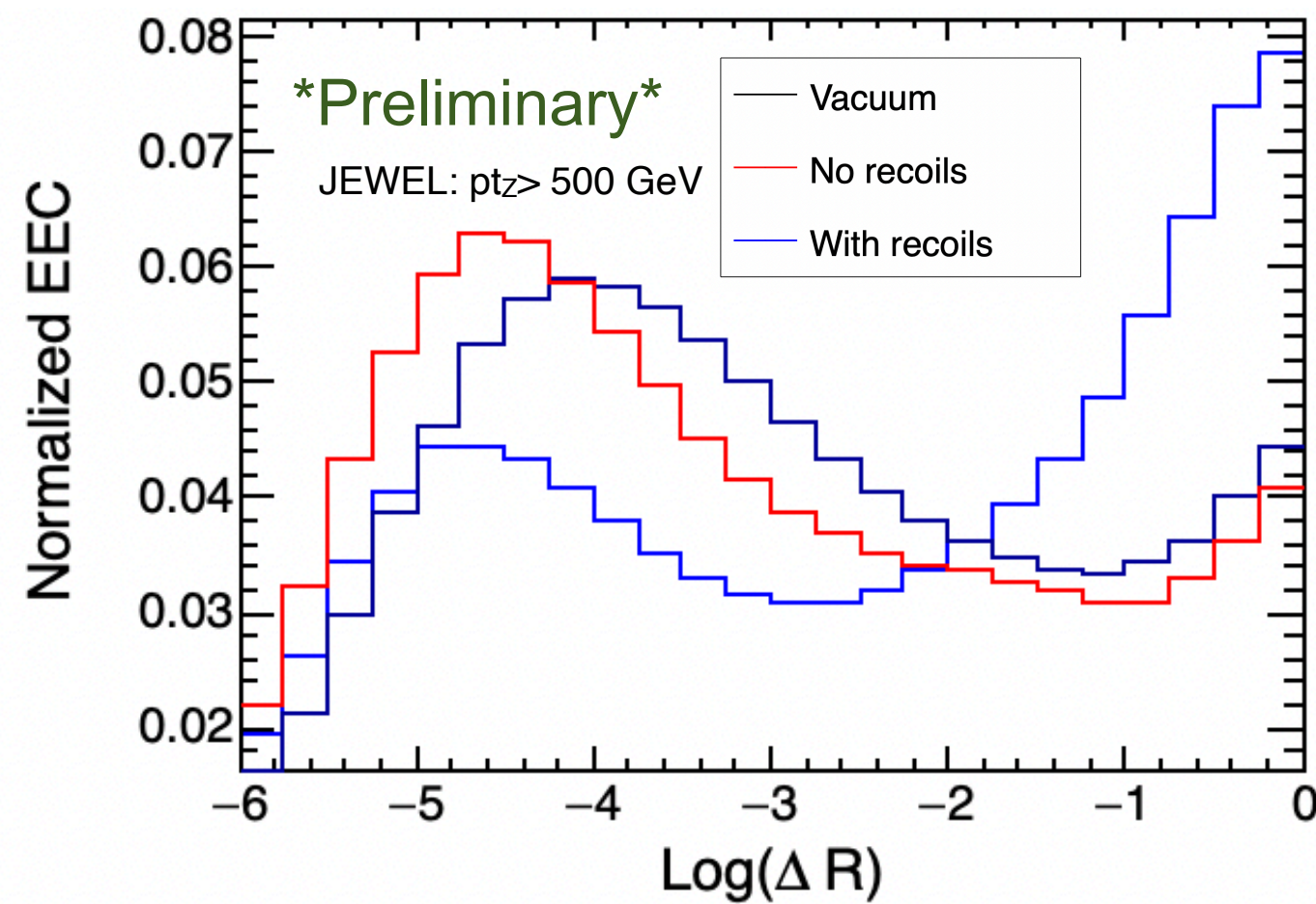
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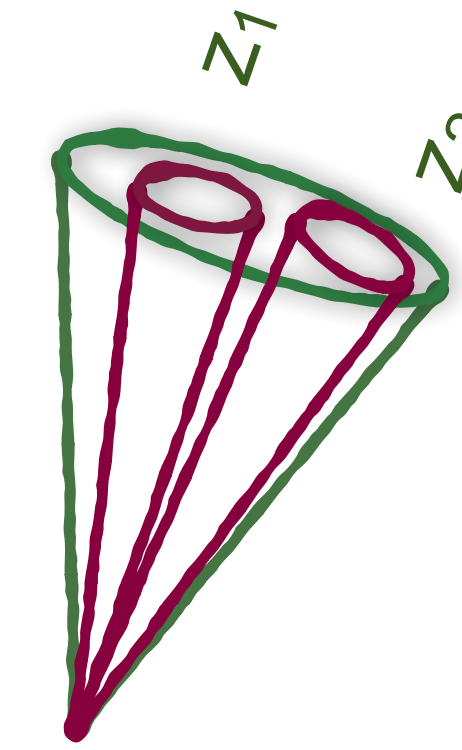
Experiment



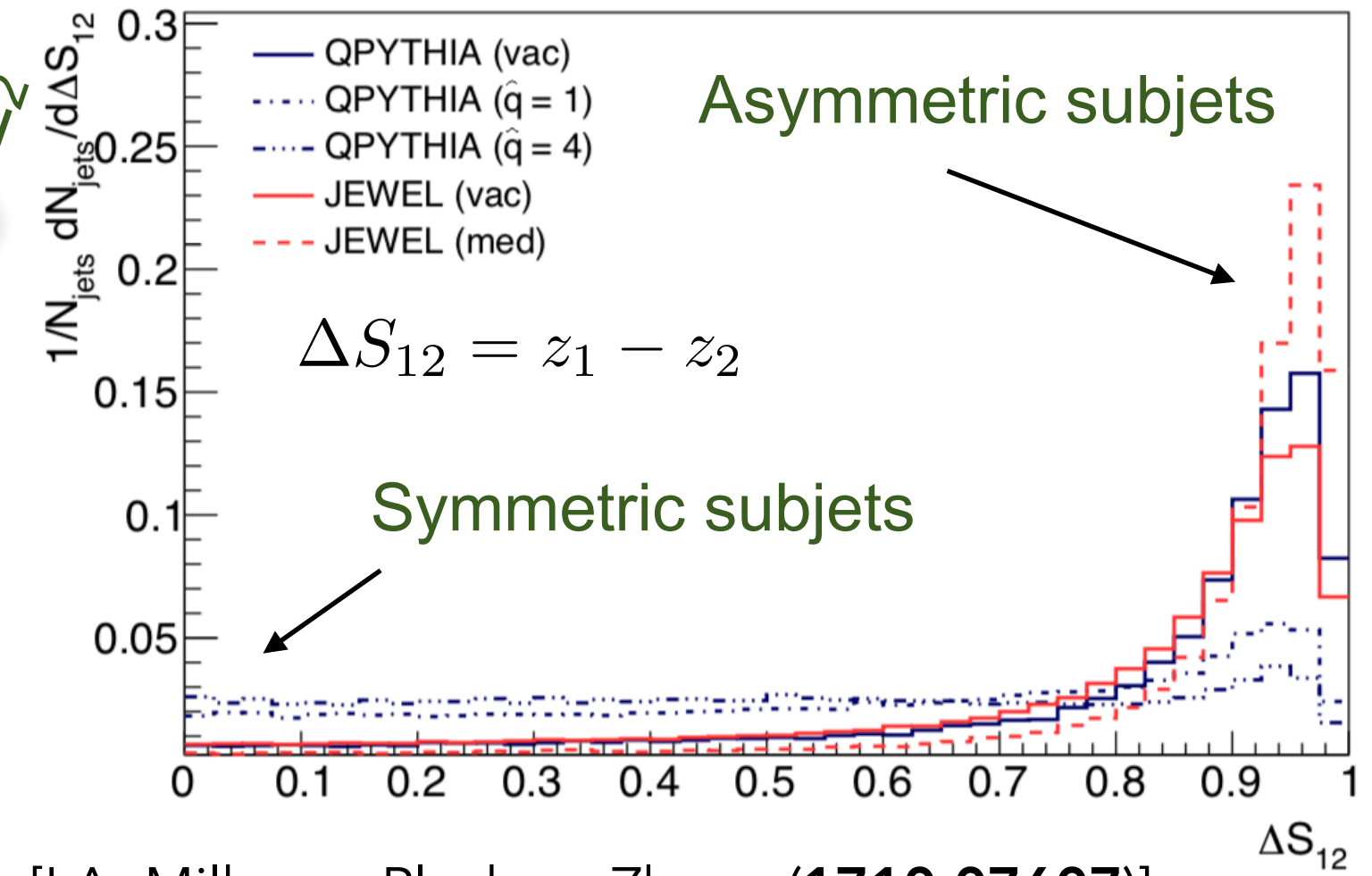
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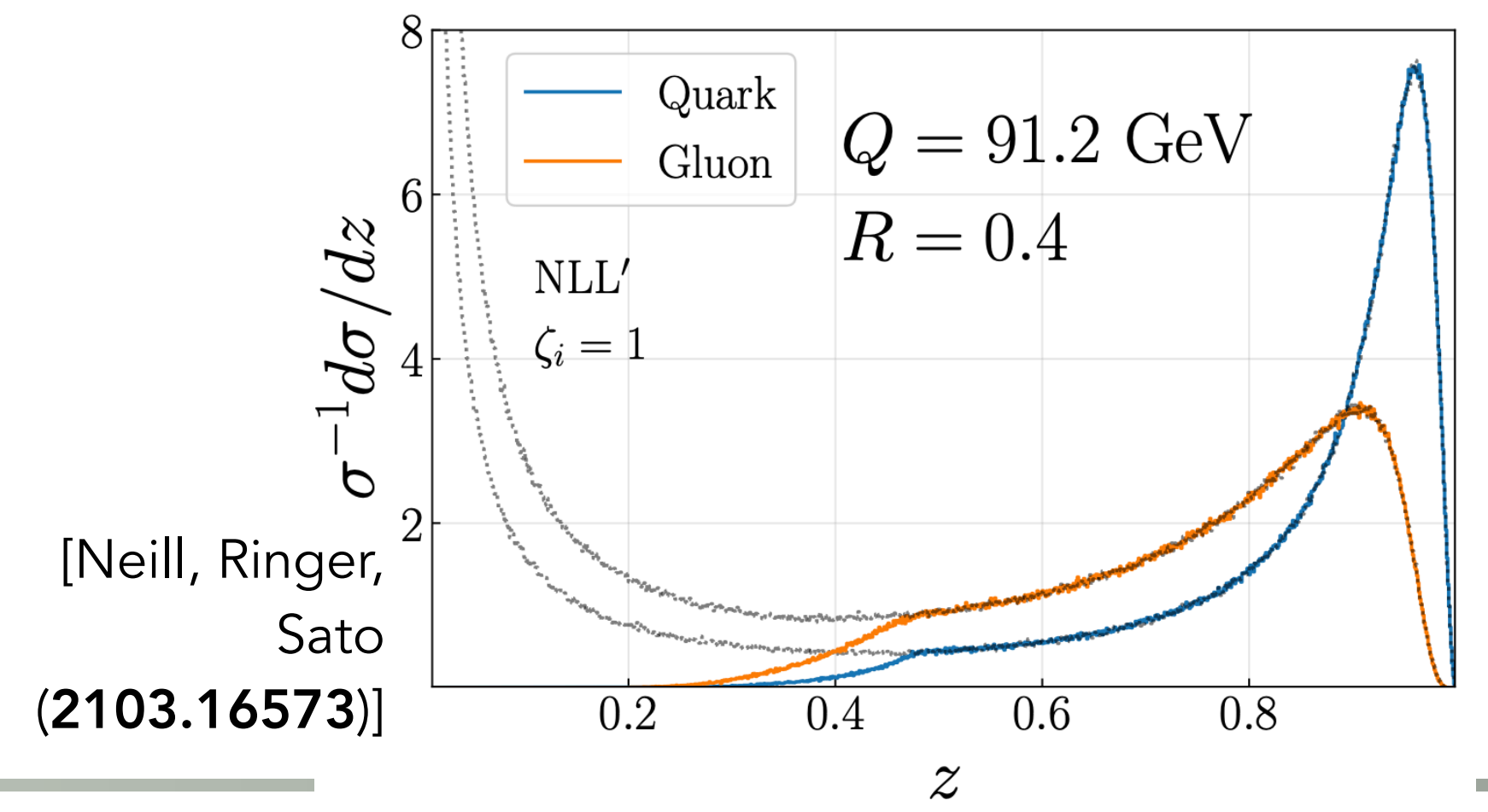
Experiment



Theory



[LA, Milhano, Ploskon, Zhang (1710.07607)]

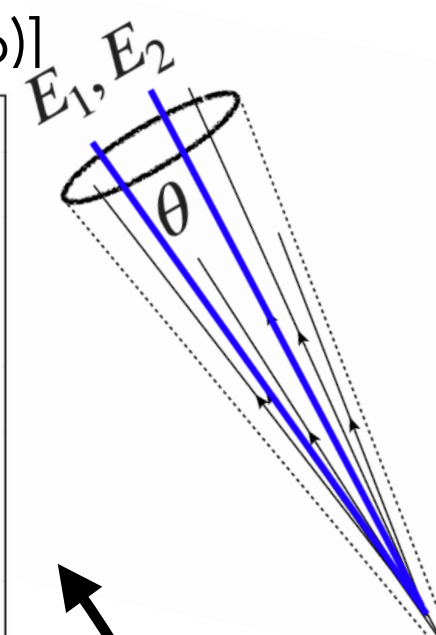
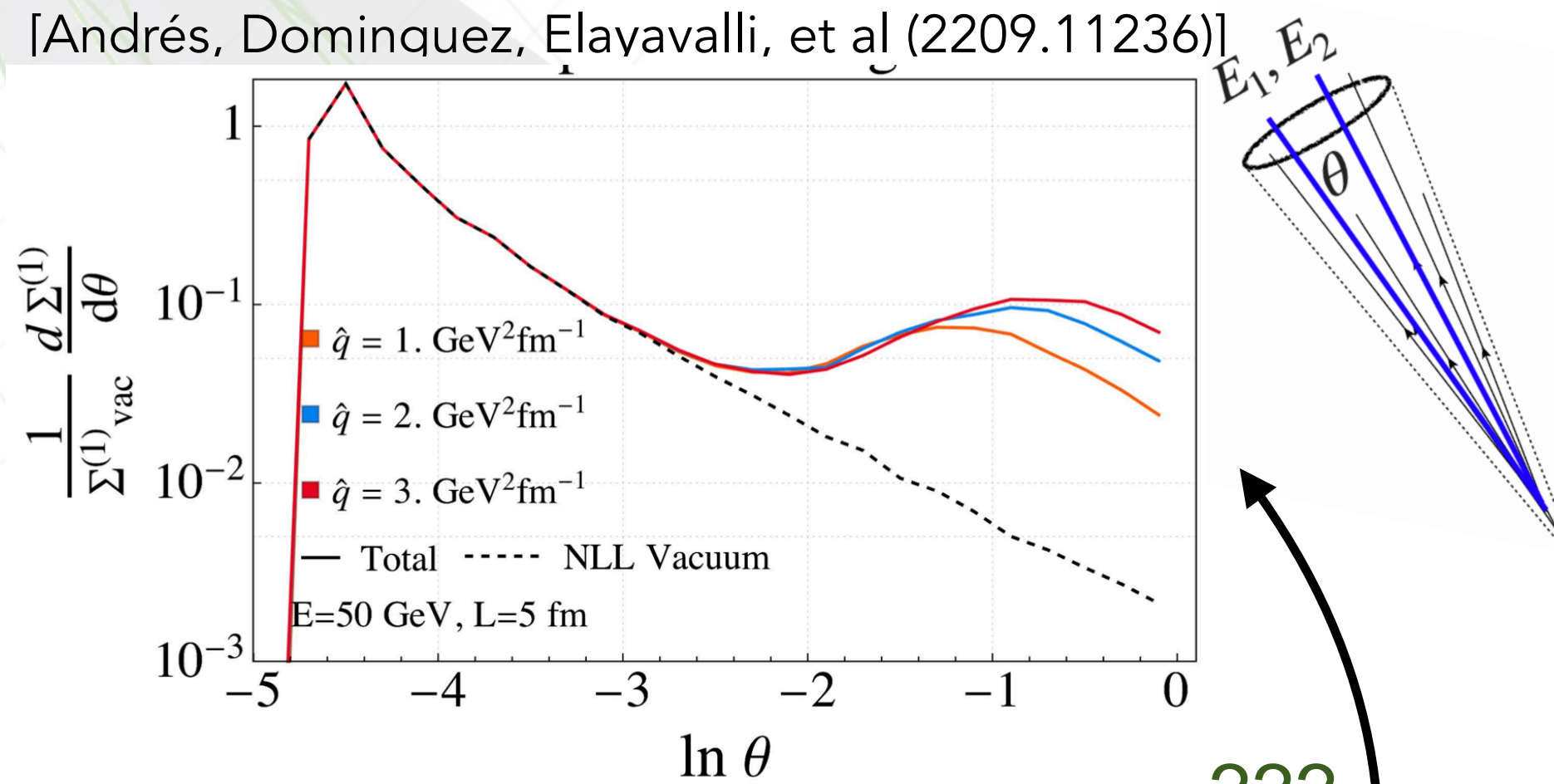


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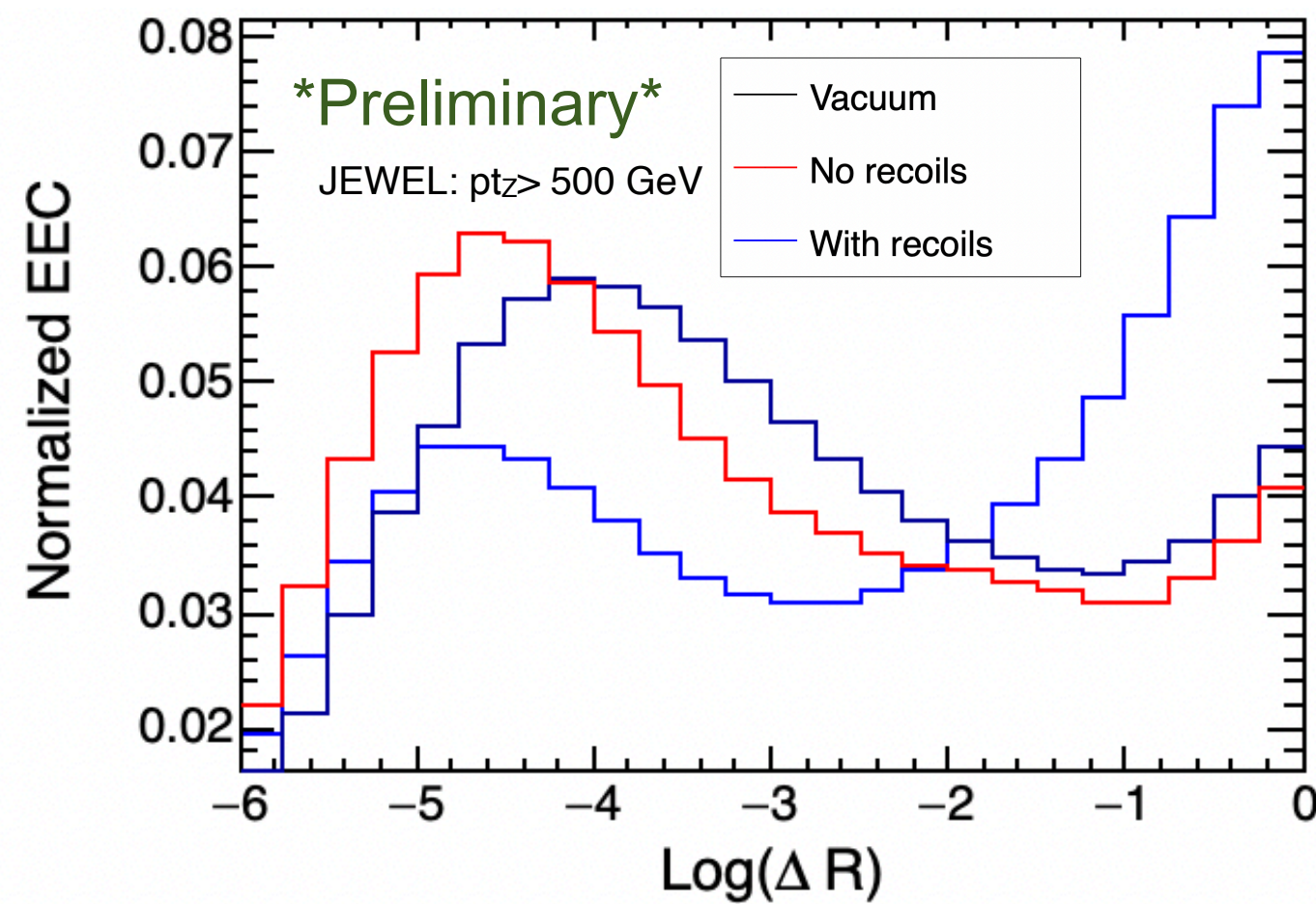
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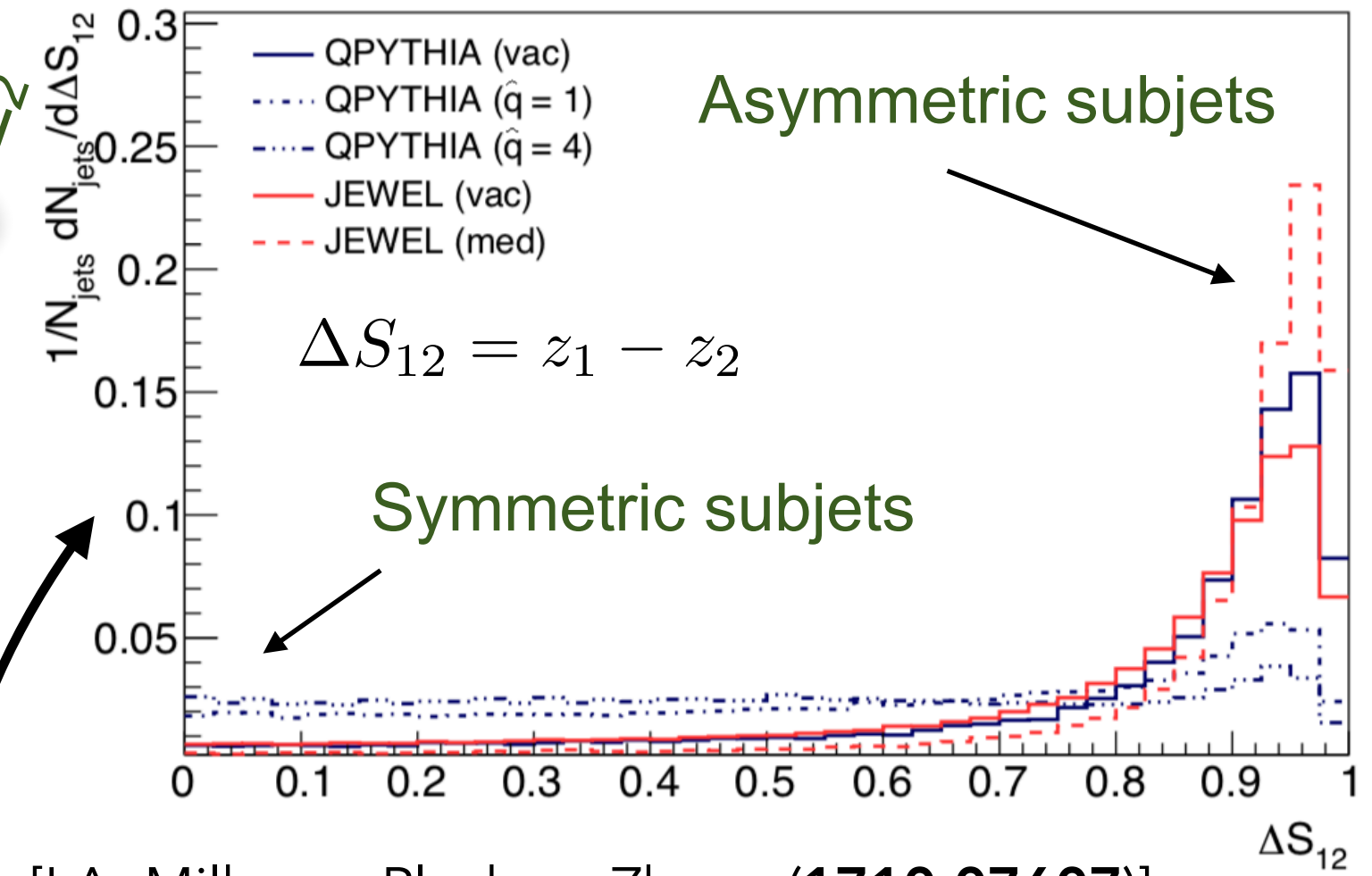
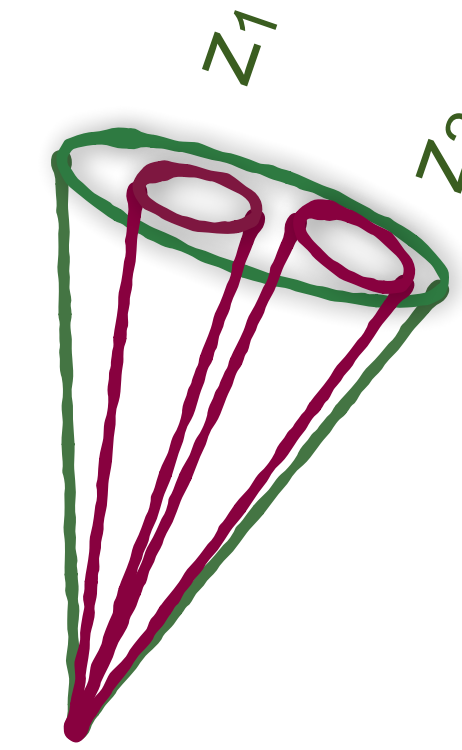
Experiment



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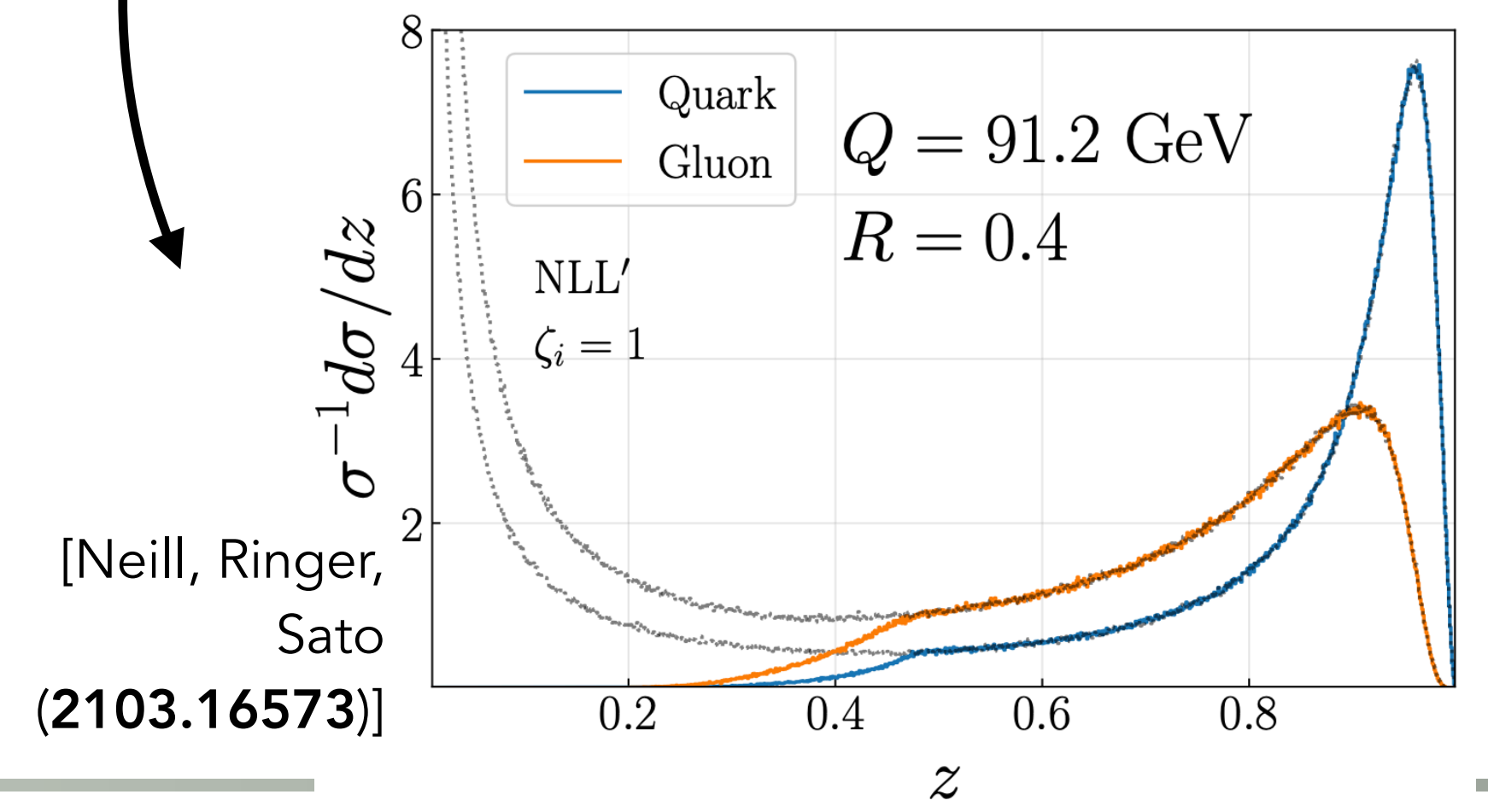
“Bottom-up”

Experiment



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Theory



[Neill, Ringer, Sato (2103.16573)]

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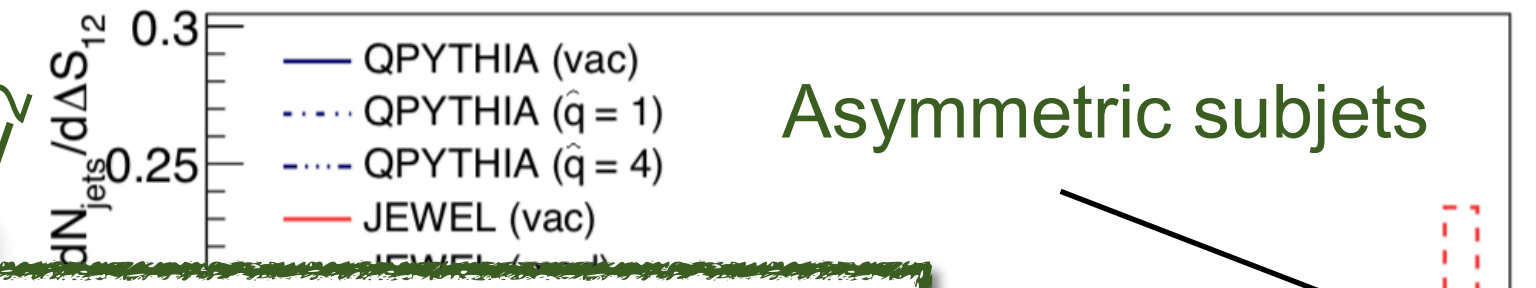
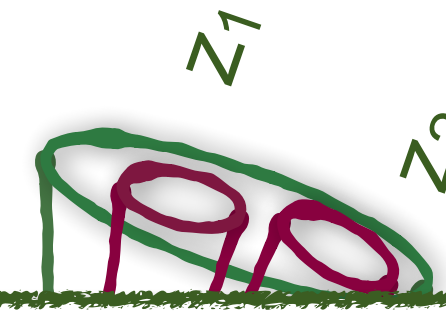
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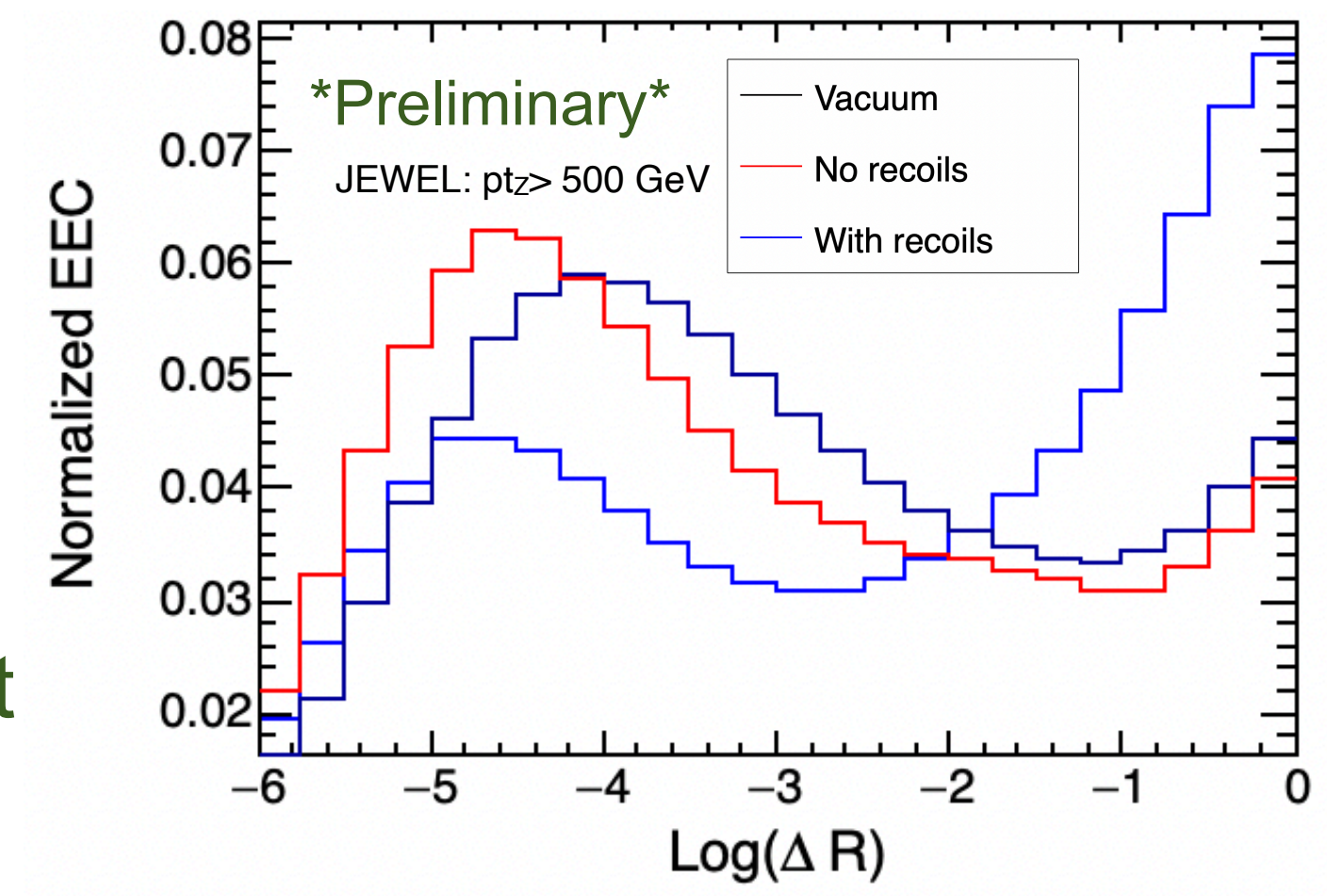
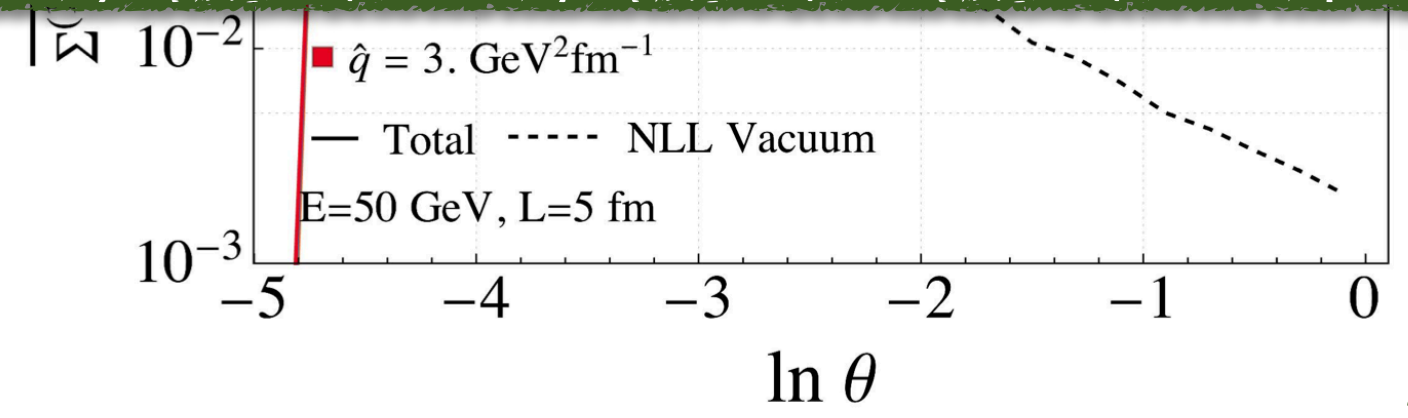
“Bottom-up”

Experiment



Asymmetric subjects

Is there a unique(better) choice on how to design QGP-oriented observables?

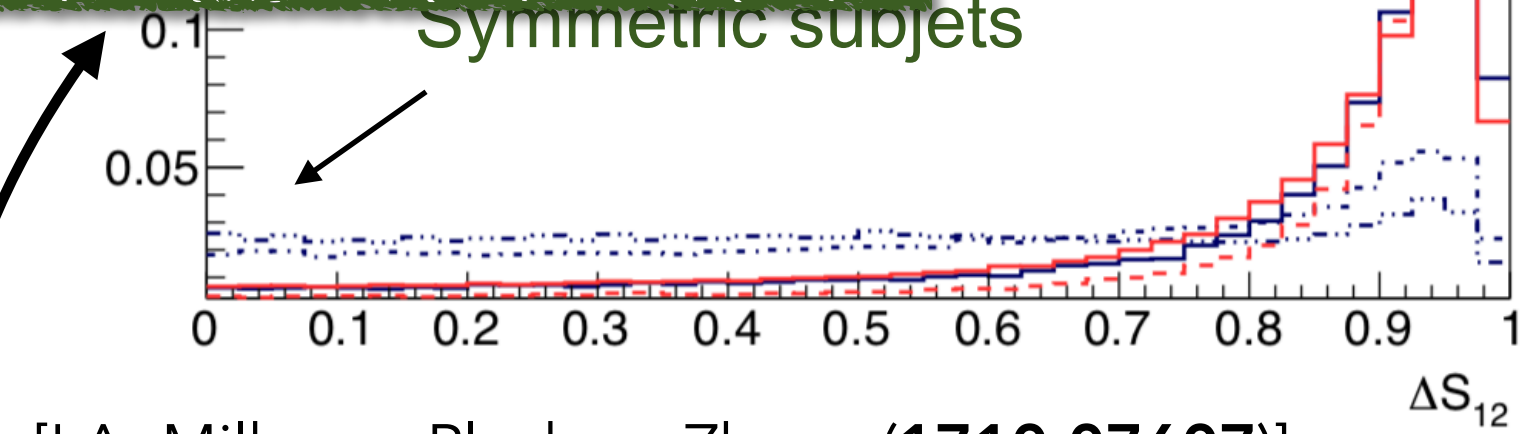


Experiment

Theory

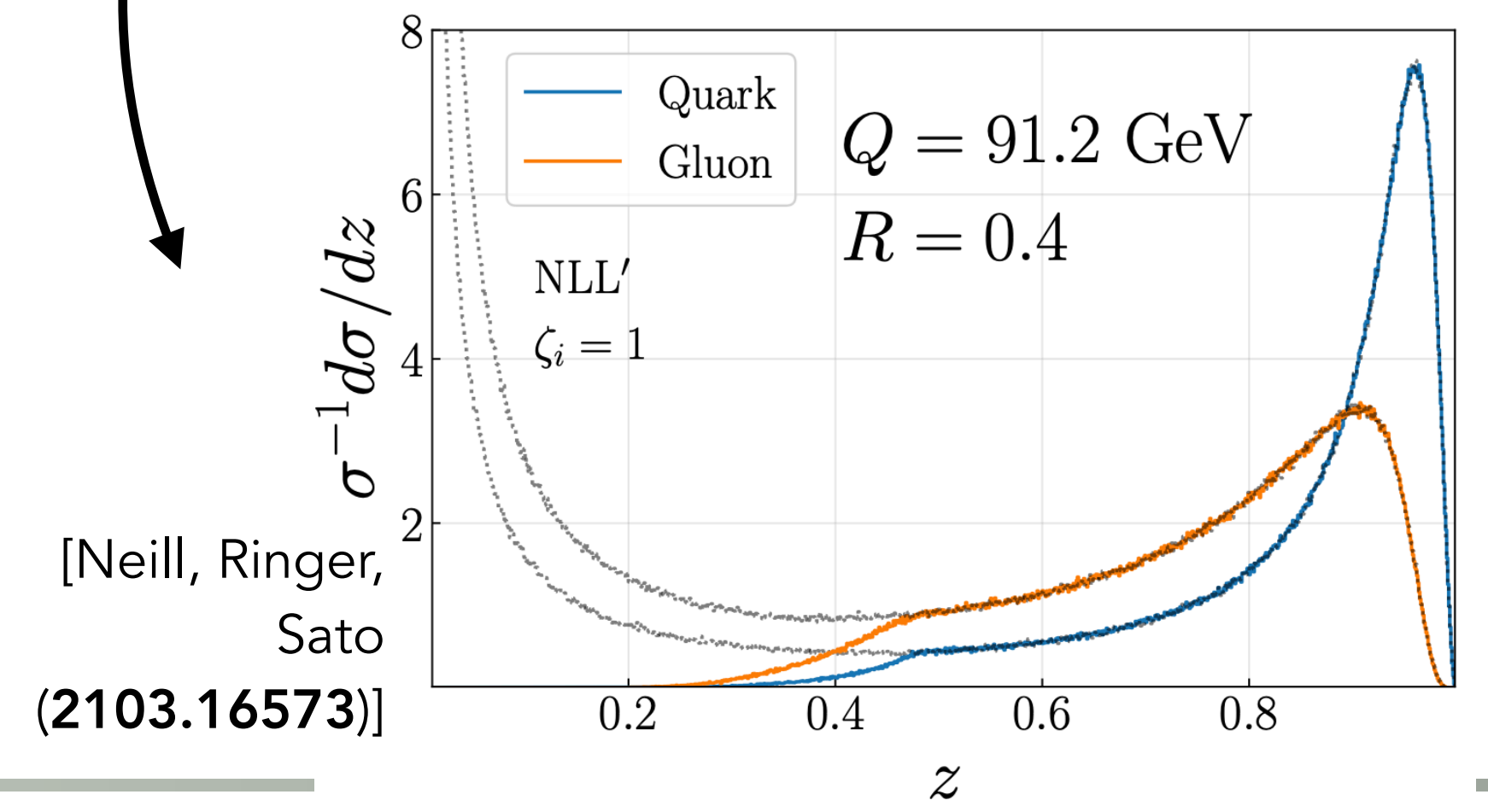
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Symmetric subjects

[LA, Milhano, Ploskon, Zhang (1710.07607)]



[Neill, Ringer, Sato (2103.16573)]

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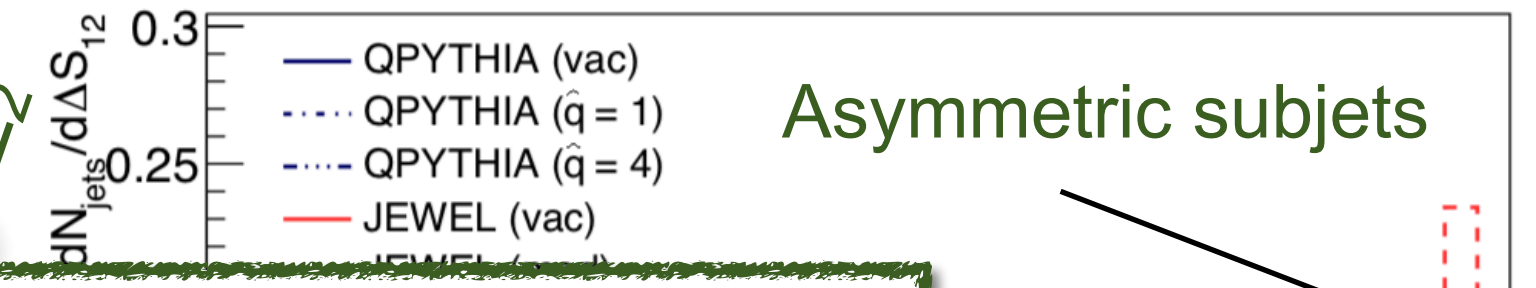
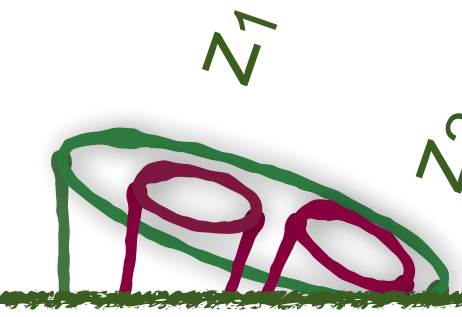
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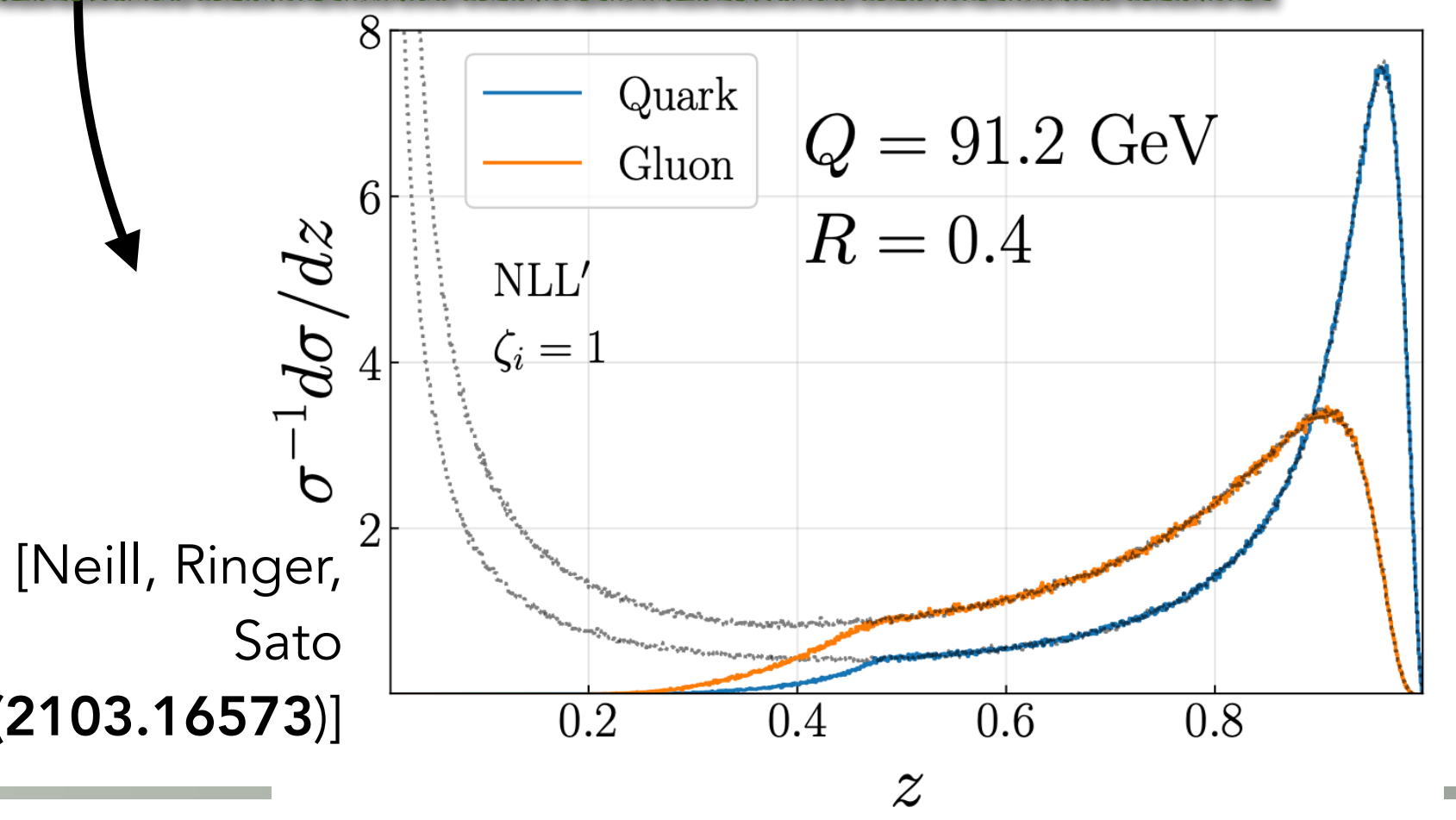
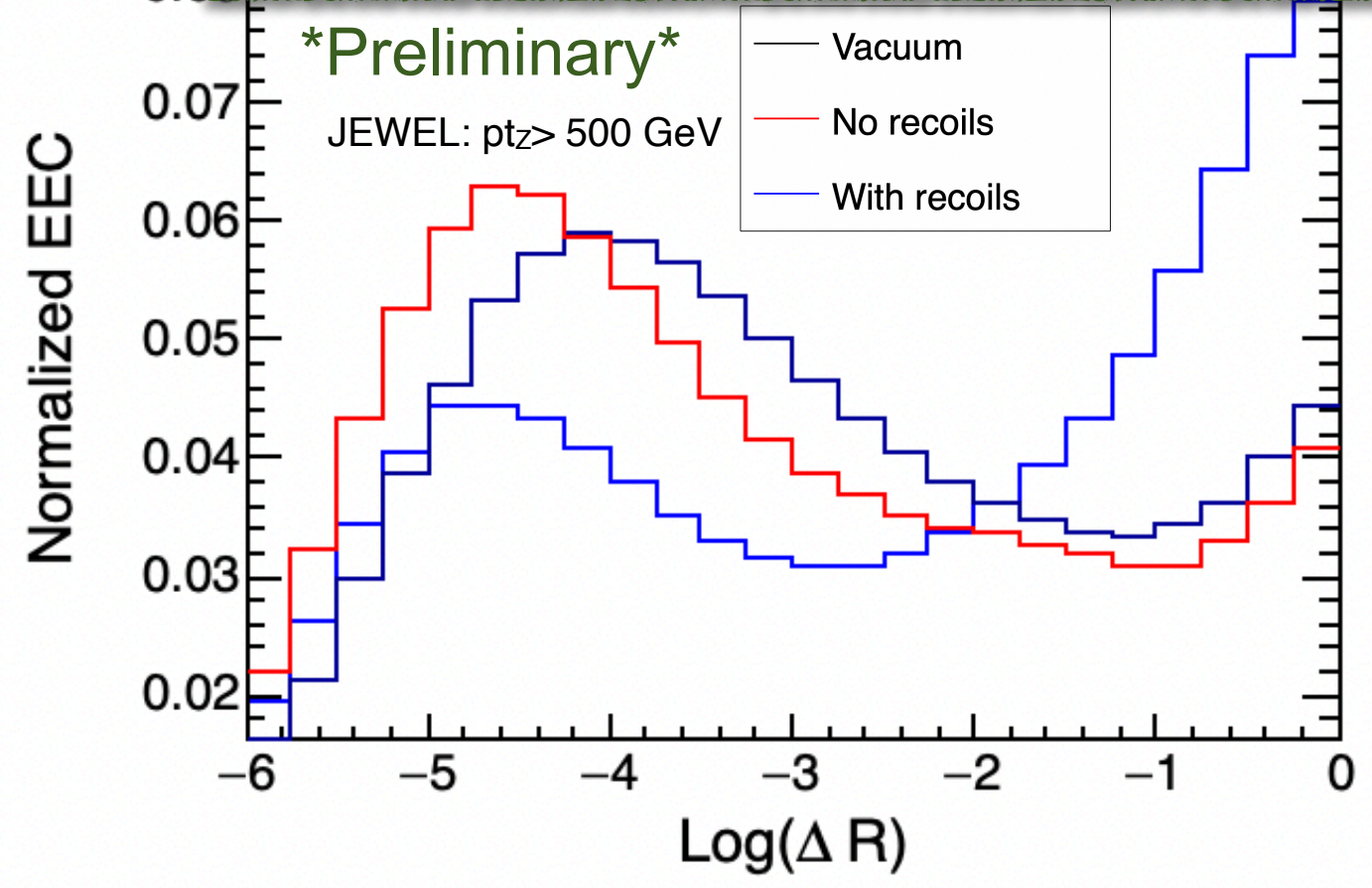
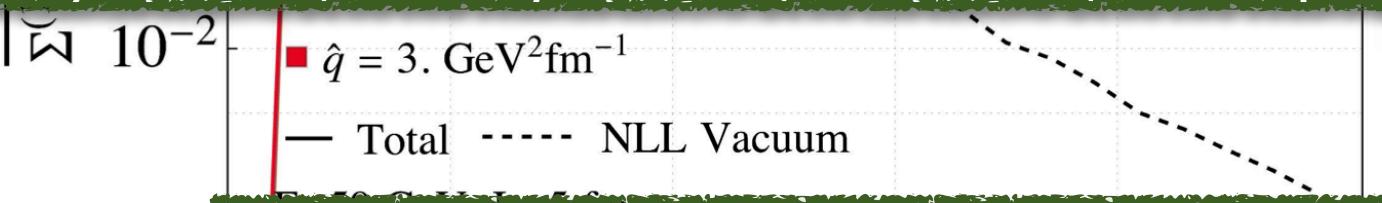


“Bottom-up”



Is there a unique(better) choice on how to design QGP-oriented observables?

How dependent are we from a theoretical assumption or a given Monte-Carlo model?



Theory
Experiment

Experiment
Theory

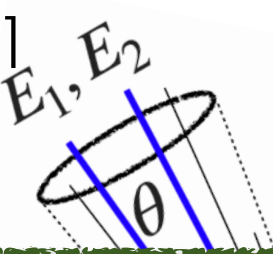
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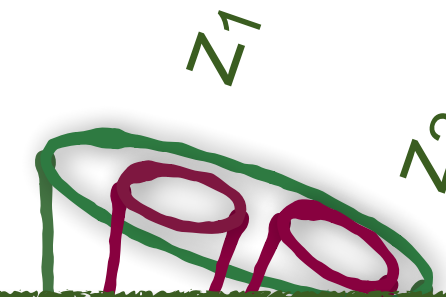
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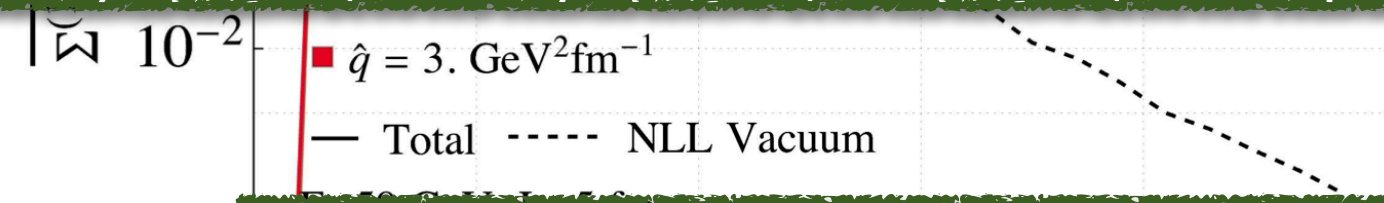
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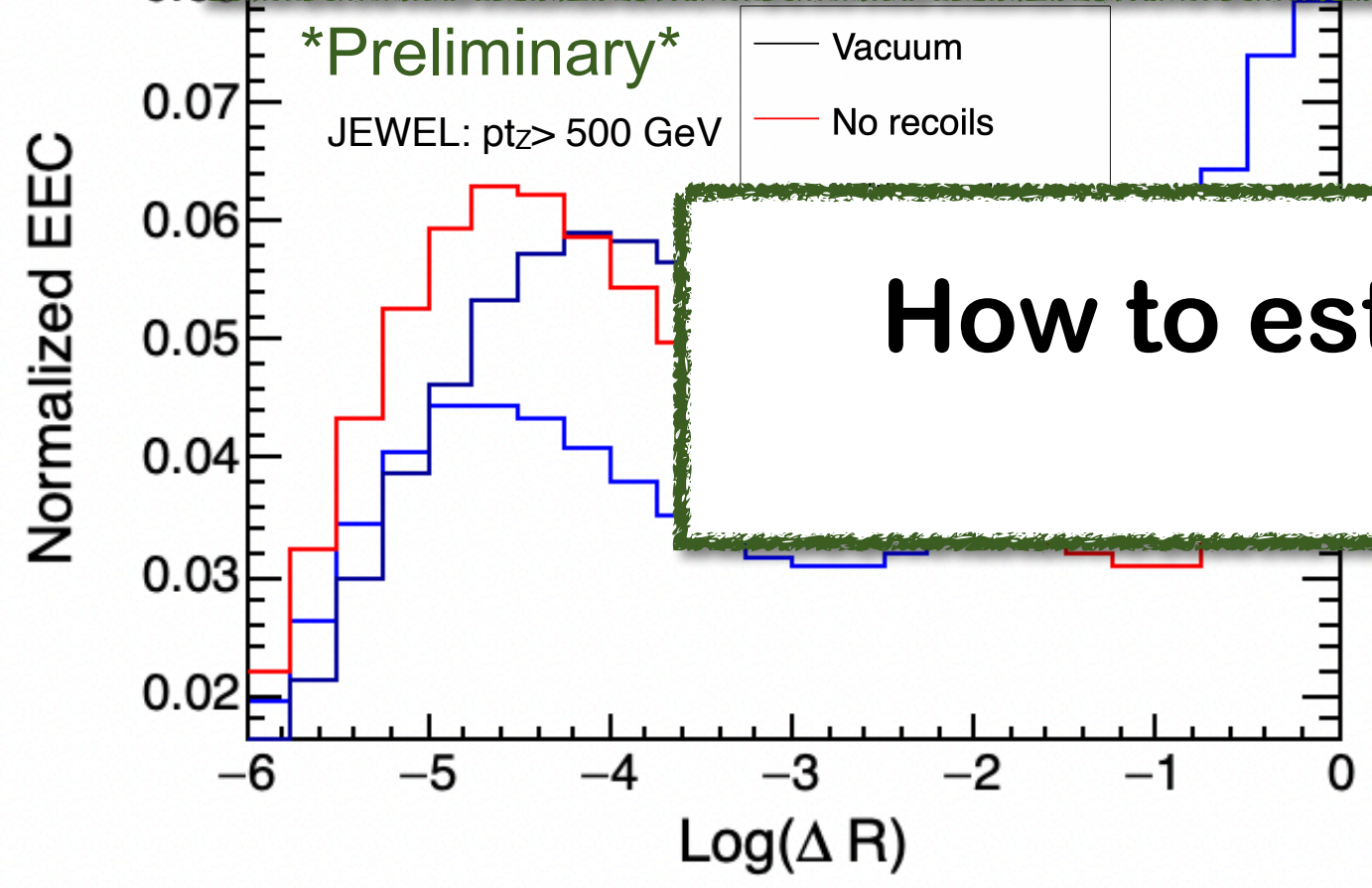
Theory

Experiment

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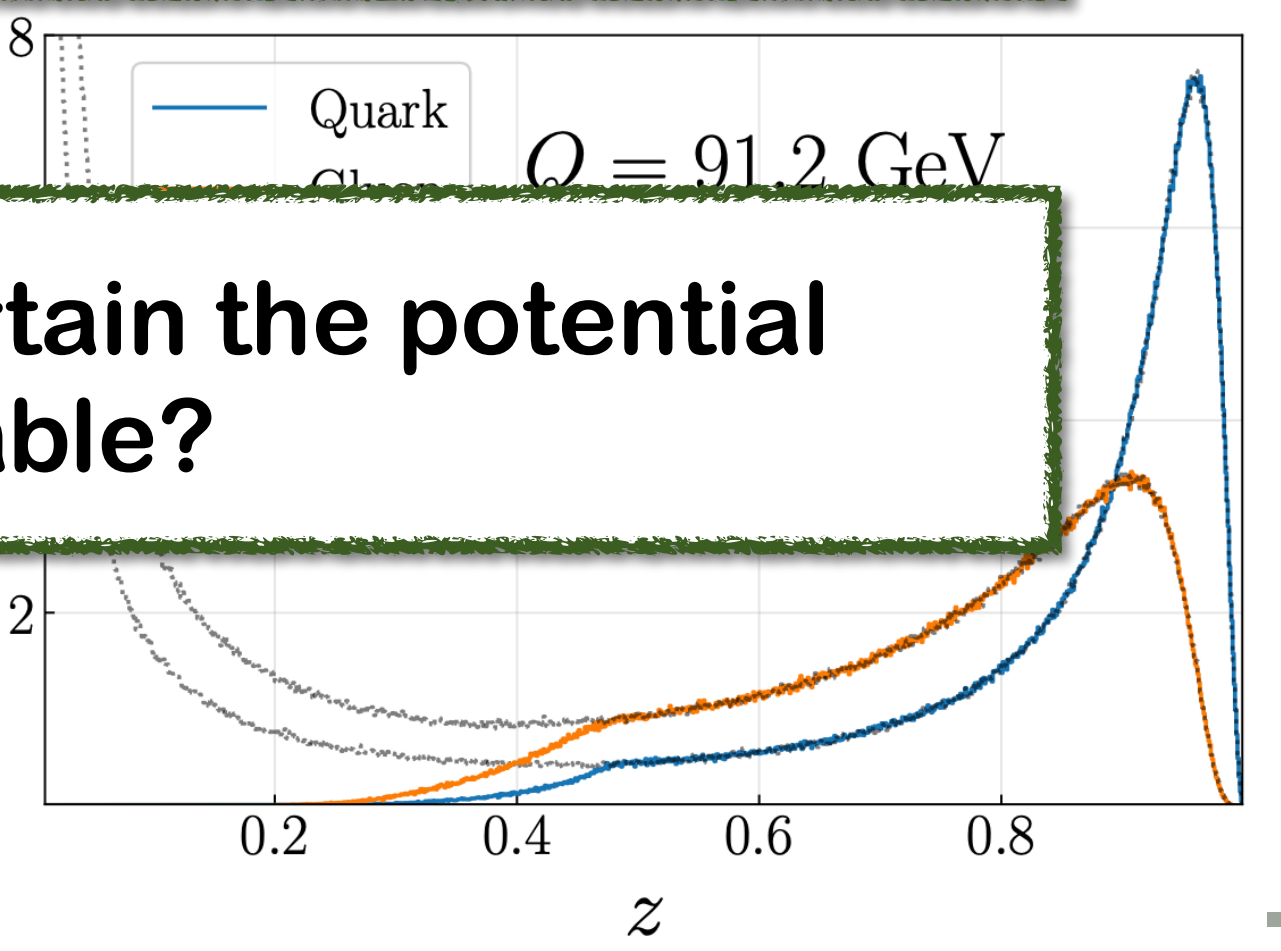
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How to estimate theory uncertainties to ascertain the potential discrimination of a given observable?

Theory

[Neill, Ringer, Sato] (2103.16573)



Experiment

The background features a light gray grid pattern. Overlaid on this are several purple lines of varying thickness and style, including solid lines, dotted lines, and thick, semi-transparent bands. Some lines are curved, while others are straight. In the bottom-left corner, there are several overlapping, semi-transparent geometric shapes in shades of yellow, green, and gray, resembling a stylized architectural or abstract design.

Backup Slides

Some Open Questions

- ◆ Jets in heavy-ions are a truly multi-scale problem:
 - ◆ **Are jet-medium processes truly separated in momentum and/or timescales?**
 - ◆ Where to look for jet quenching phenomena?
- ◆ Jet substructure:
 - ◆ 1D vs 2D observables: complementarity? Are they useful to learn about QCD phenomena?
 - ◆ **What is the smoking gun for medium-induced radiation vs jet-induced response? Where to look for?**
 - ◆ **Which observables can access different QGP timescales using jets at current accelerators?**
- ◆ Jet Grooming and/or background subtraction:
 - ◆ **Do we understand what are we removing when applying different groomings?**
 - ◆ **Is background subtraction really removing jet quenching signal from jets?**
- ◆ Designing new observables:
 - ◆ **Is the best strategy for heavy-ions the same for pp (top-down)? How suitable are bottom-up approaches for QGP-related studies?**
 - ◆ **How dependent are we from a theoretical assumption or a given Monte-Carlo model?**
 - ◆ How close to non-perturbative physics we need to aim?