

Colour decoherence as a probe of medium effects in small systems

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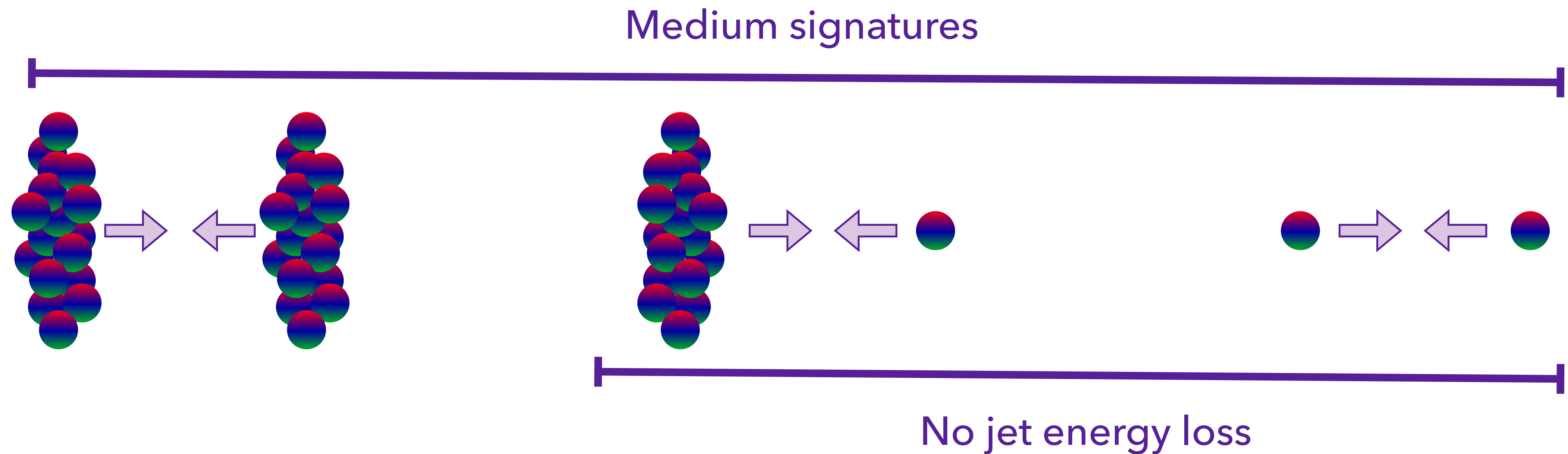
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Introduction

Introduction

Motivation

- ♥ Well established medium formation in large systems
- ♥ Medium signatures observed in small systems, but no energy loss
- ♥ Coherence effects could help probe jet-medium interaction



Coherence Effects in JEWEL

Introduction

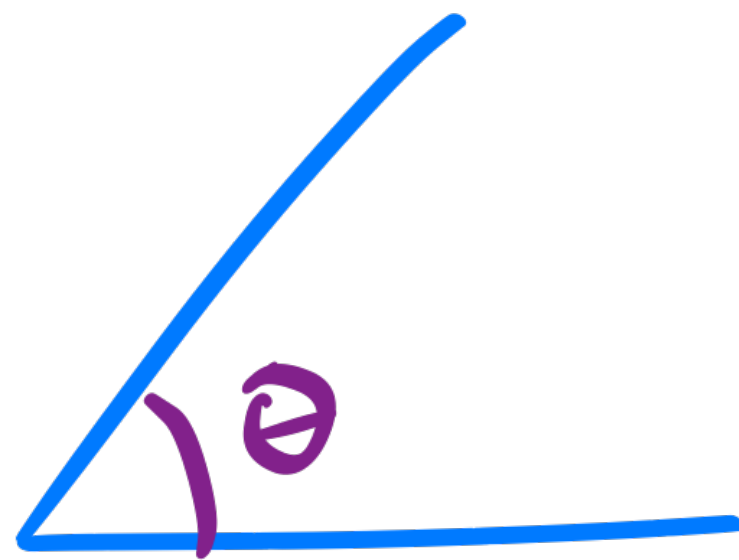
Coherence as angular ordering

- Subsequent emissions in a parton shower follow angular ordering

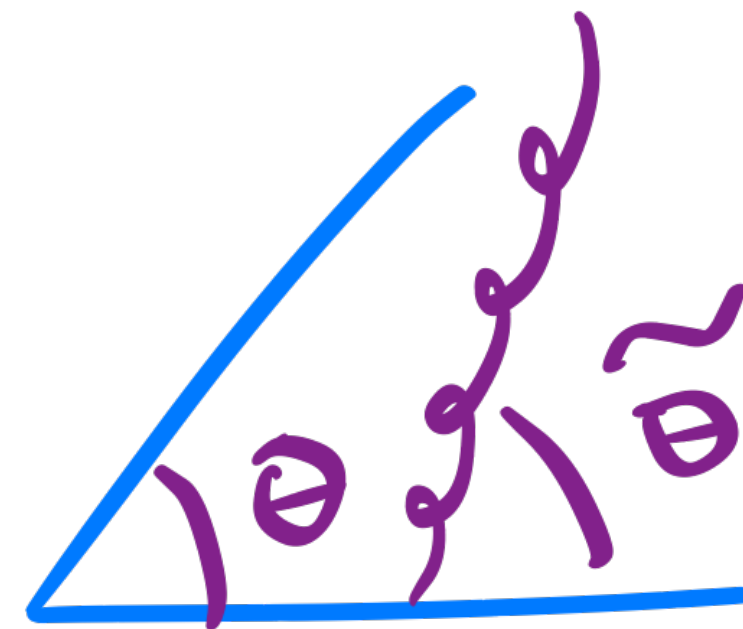
Introduction

Coherence as angular ordering

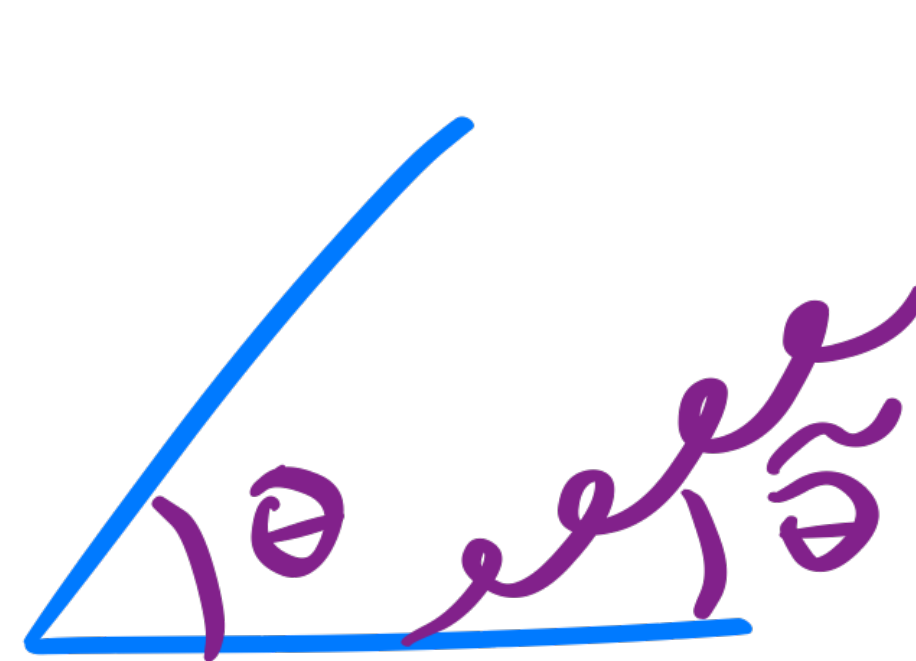
- ♥ Subsequent emissions in a parton shower follow angular ordering
- ♥ The angle of the first splitting is constrained by the angle of the initial dipole



Initial dipole



$$\tilde{\theta} > \theta$$



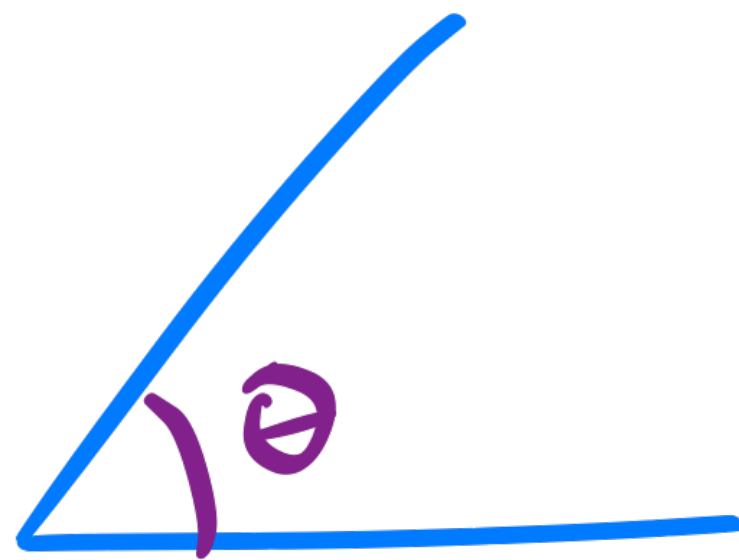
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1st splitting

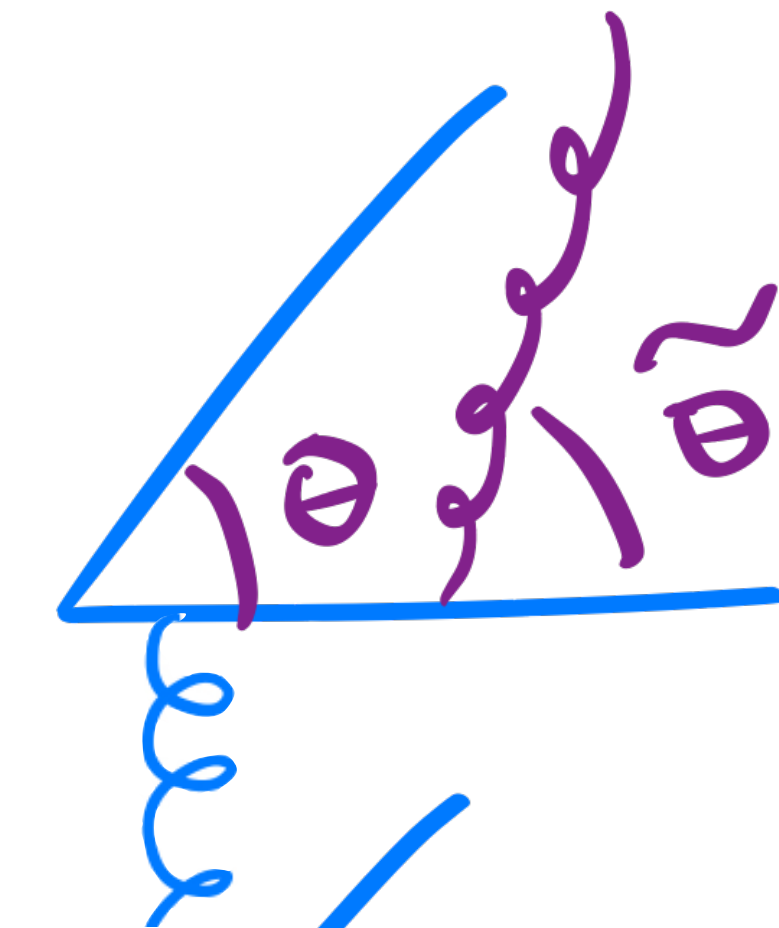
Introduction

Coherence as angular ordering

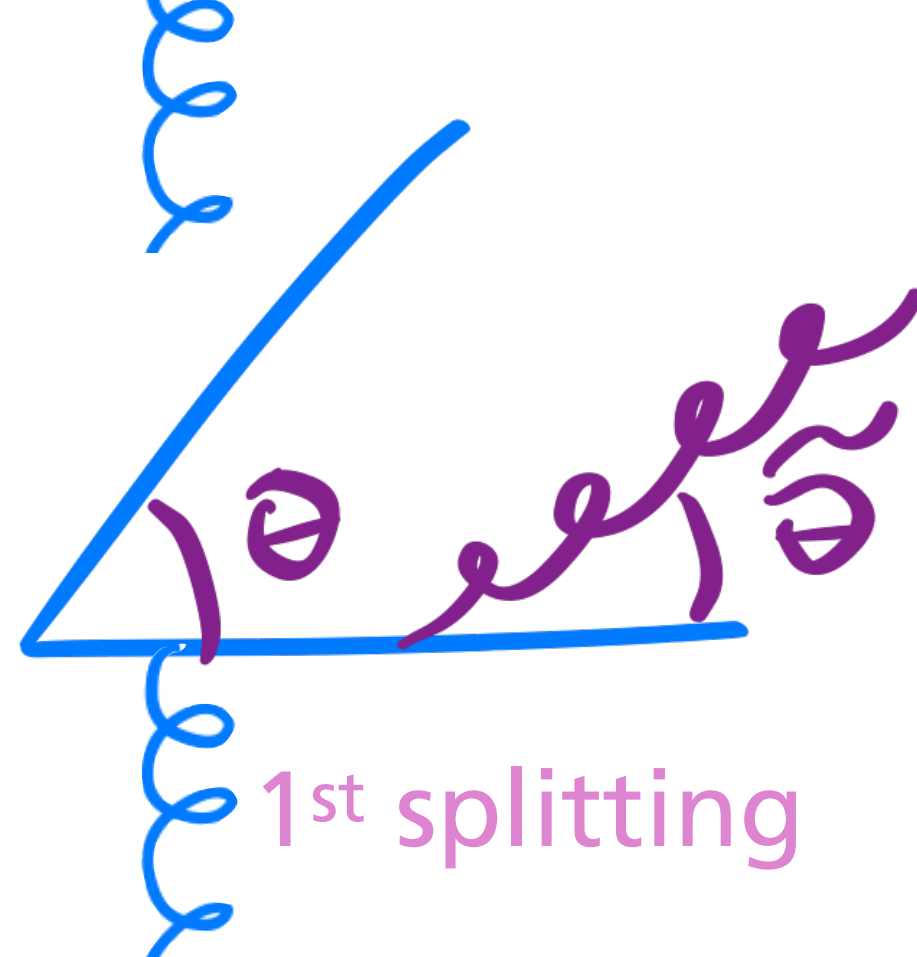
- ♥ Subsequent emissions in a parton shower follow angular ordering
- ♥ The angle of the first splitting is constrained by the angle of the initial dipole



Initial dipole



$$\tilde{\theta} > \theta$$



$$\tilde{\theta} < \theta$$

1st splitting

medium interaction
can break color
coherence and allow
 $\tilde{\theta} > \theta$

Introduction

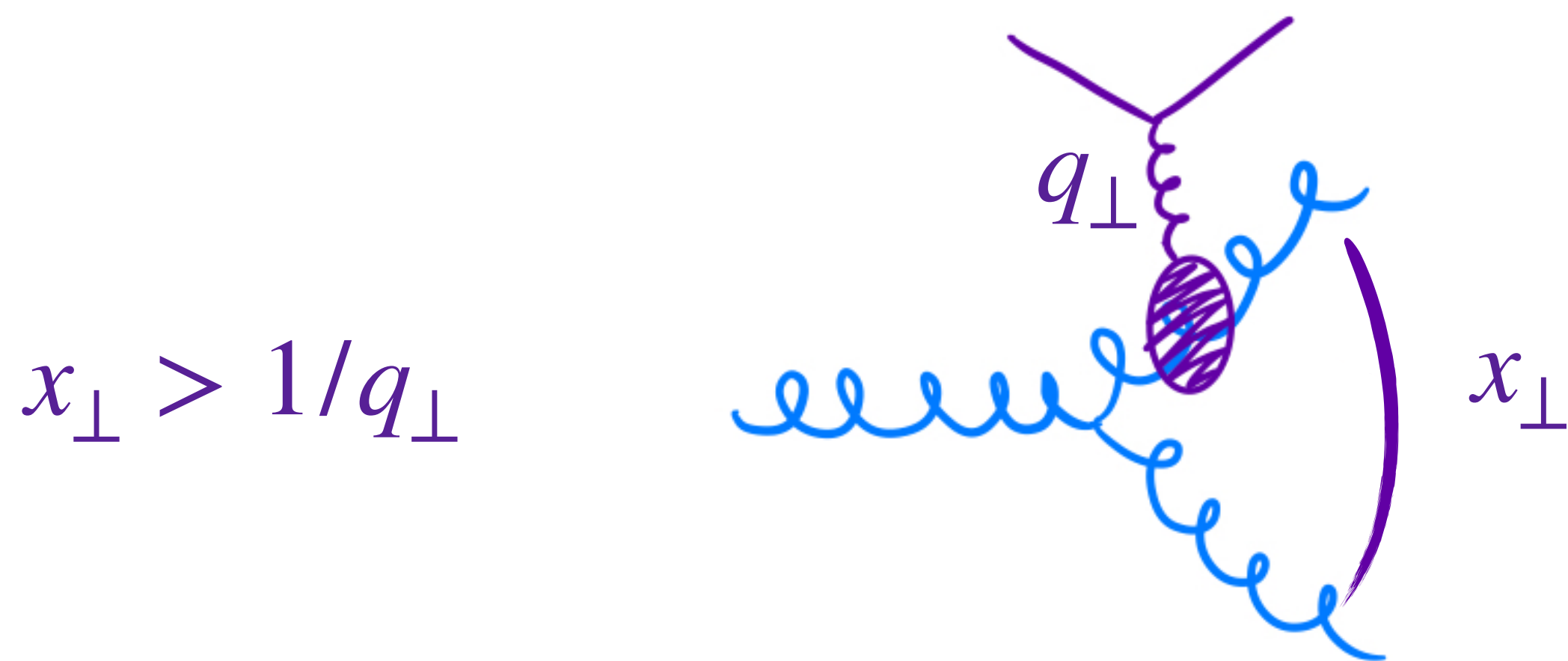
Coherence as scattering resolution

♥ Beyond AO: coherence also plays a role in the medium scatterings

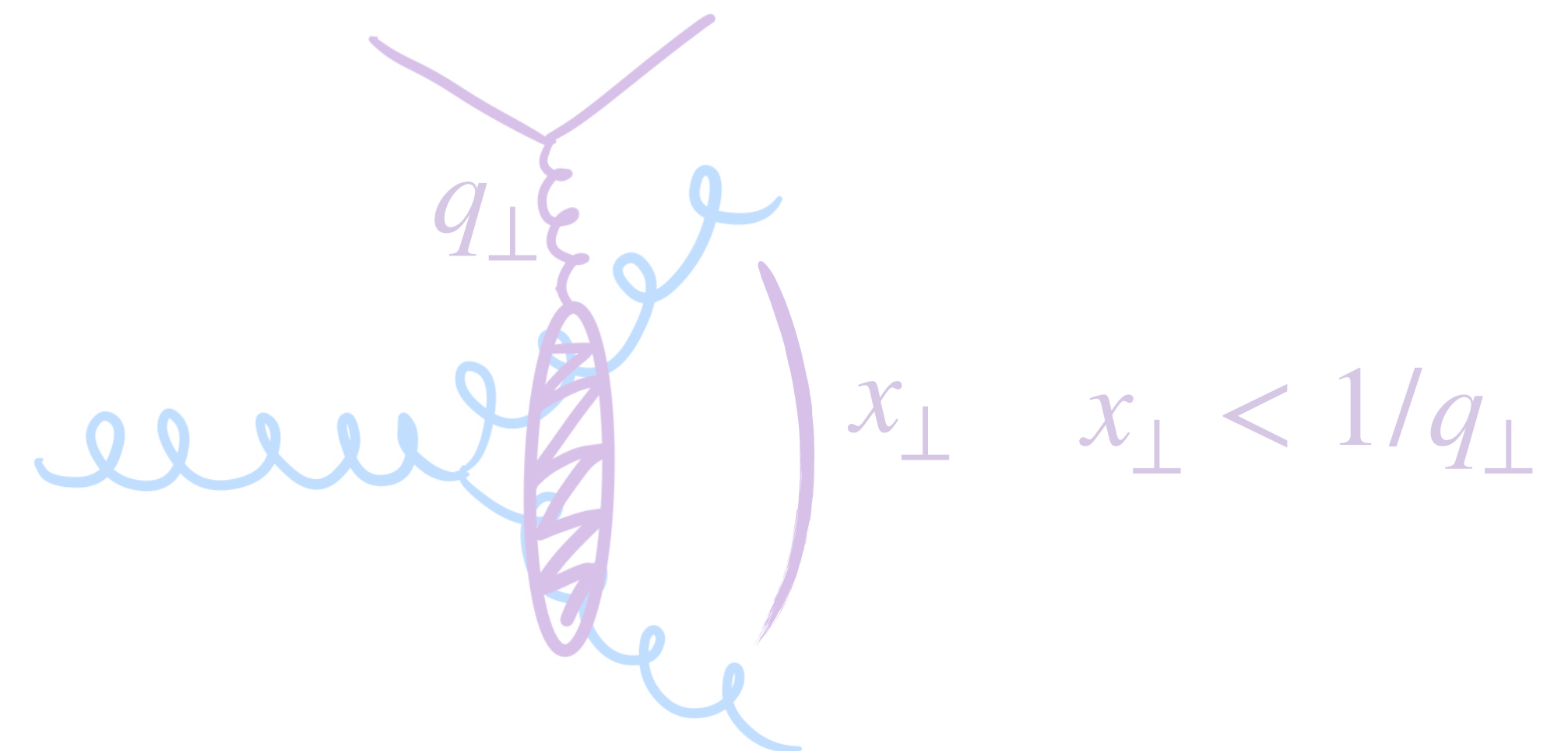
Introduction

Coherence as scattering resolution

- ♥ Beyond AO: coherence also plays a role in the medium scatterings
- ♥ Two possibilities:



medium resolves
individual partons



medium does not resolve:
scattering is rejected

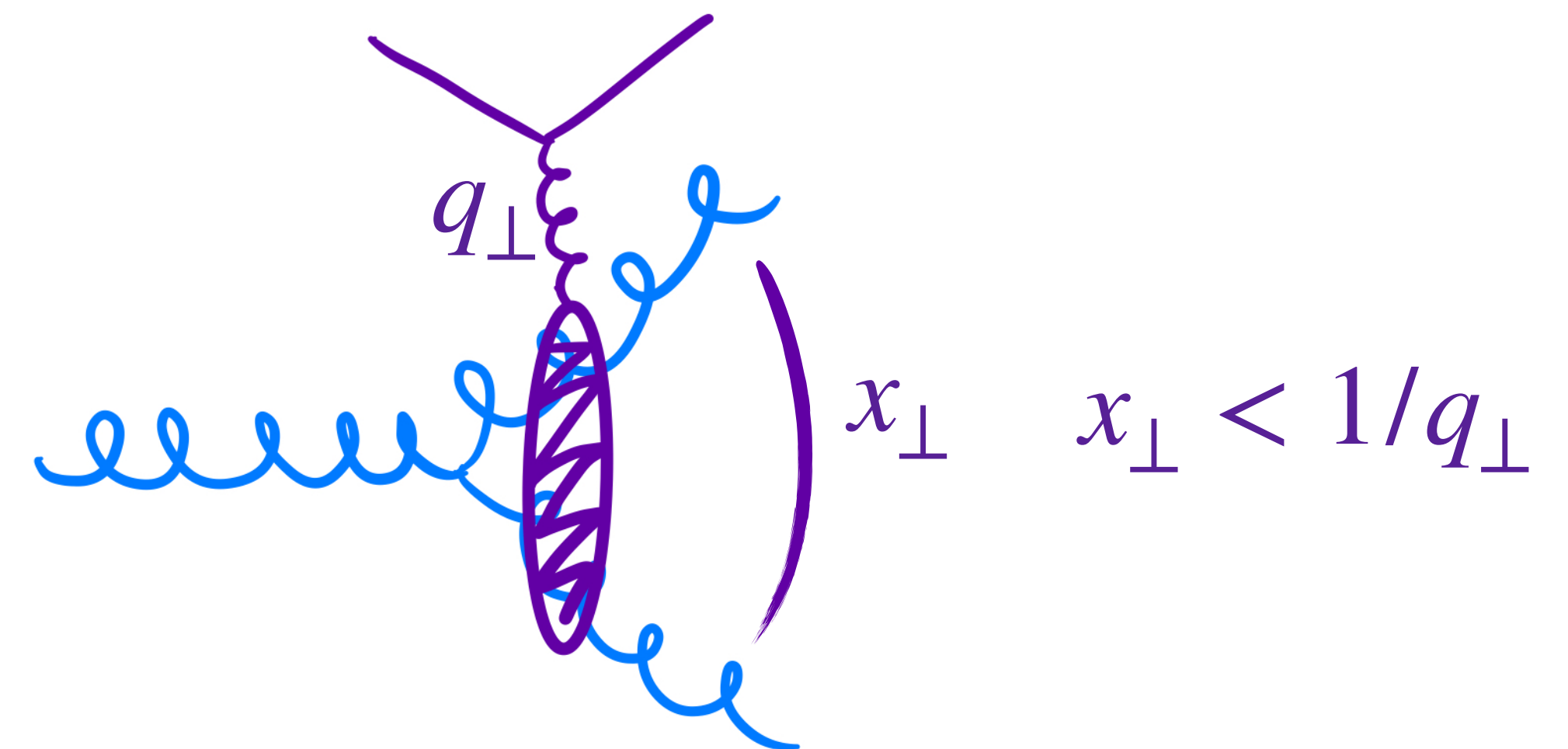
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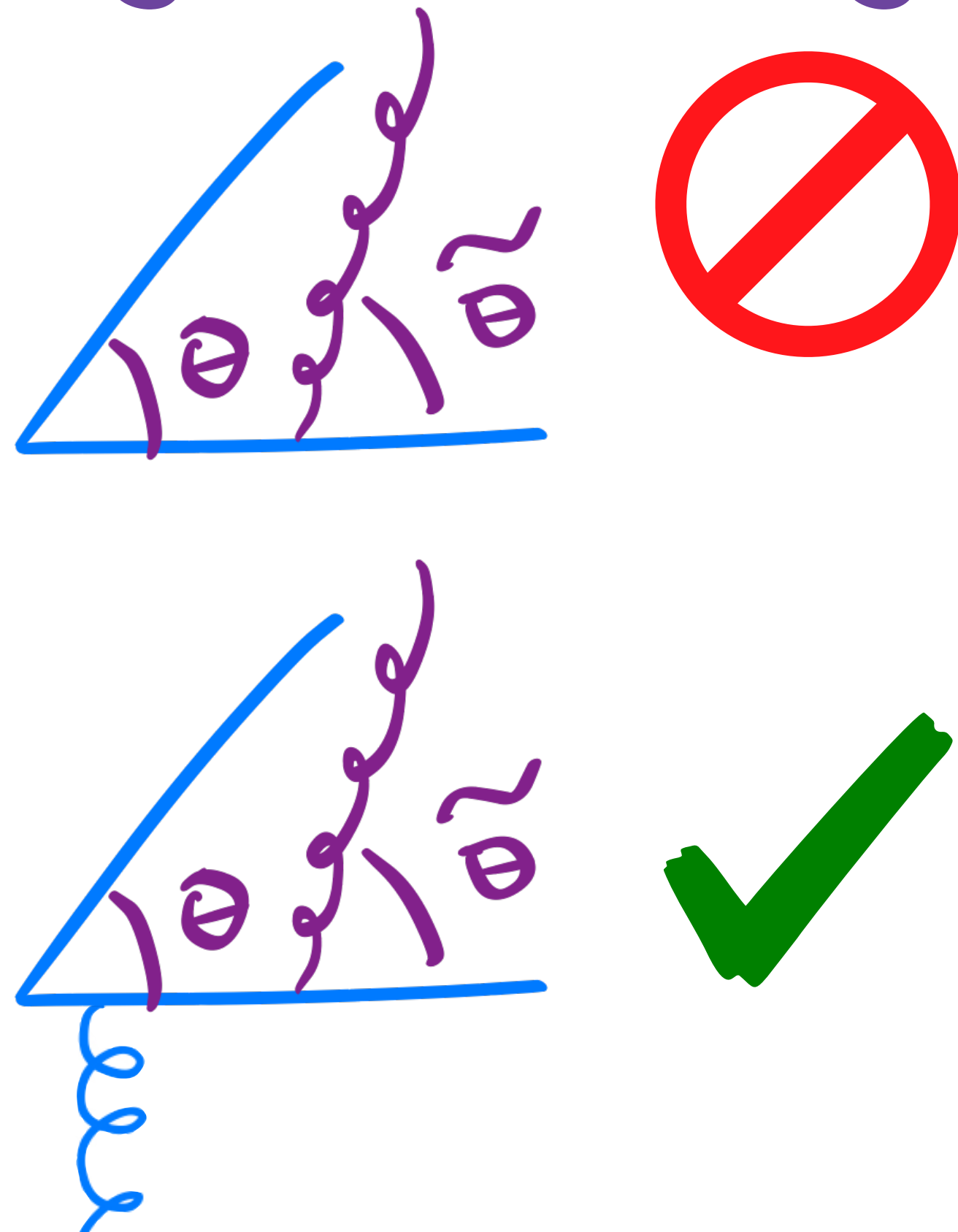
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Coherence as scattering resolution

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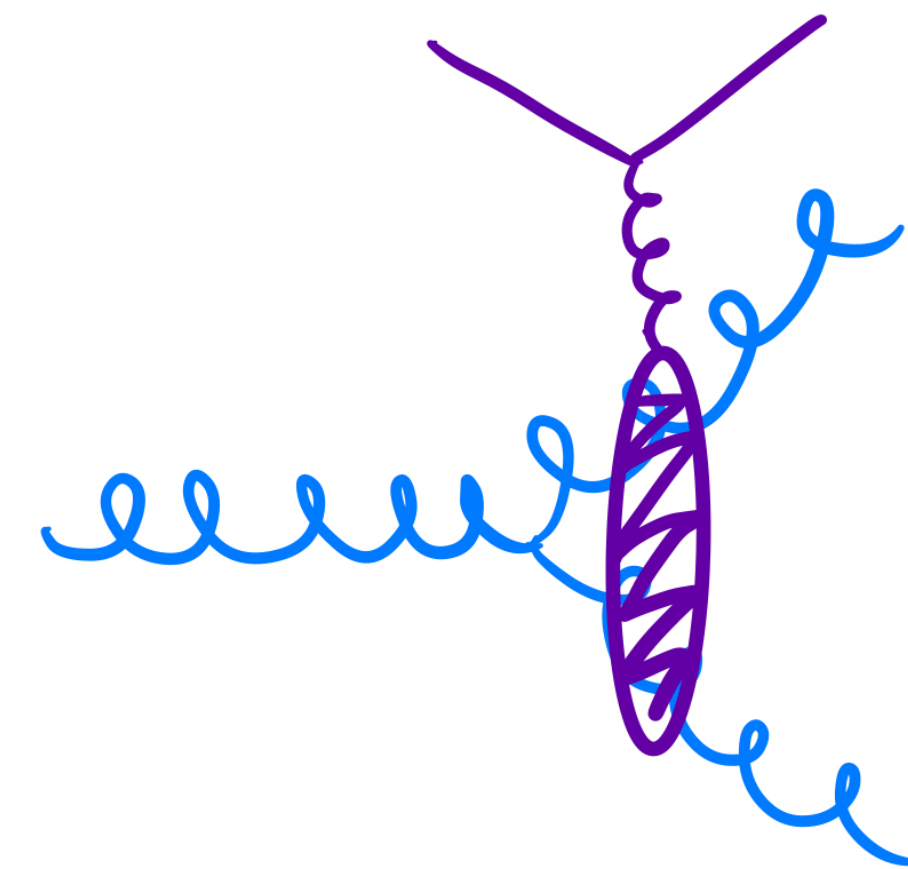


Angular ordering



Relevant dipole: initiating parton
+ color partner (large angle)

Scattering resolution



$$x_{\perp} < 1/q_{\perp}$$

unresolved partons
cannot scatter

Relevant dipole: shower dipoles
(increase during the evolution)

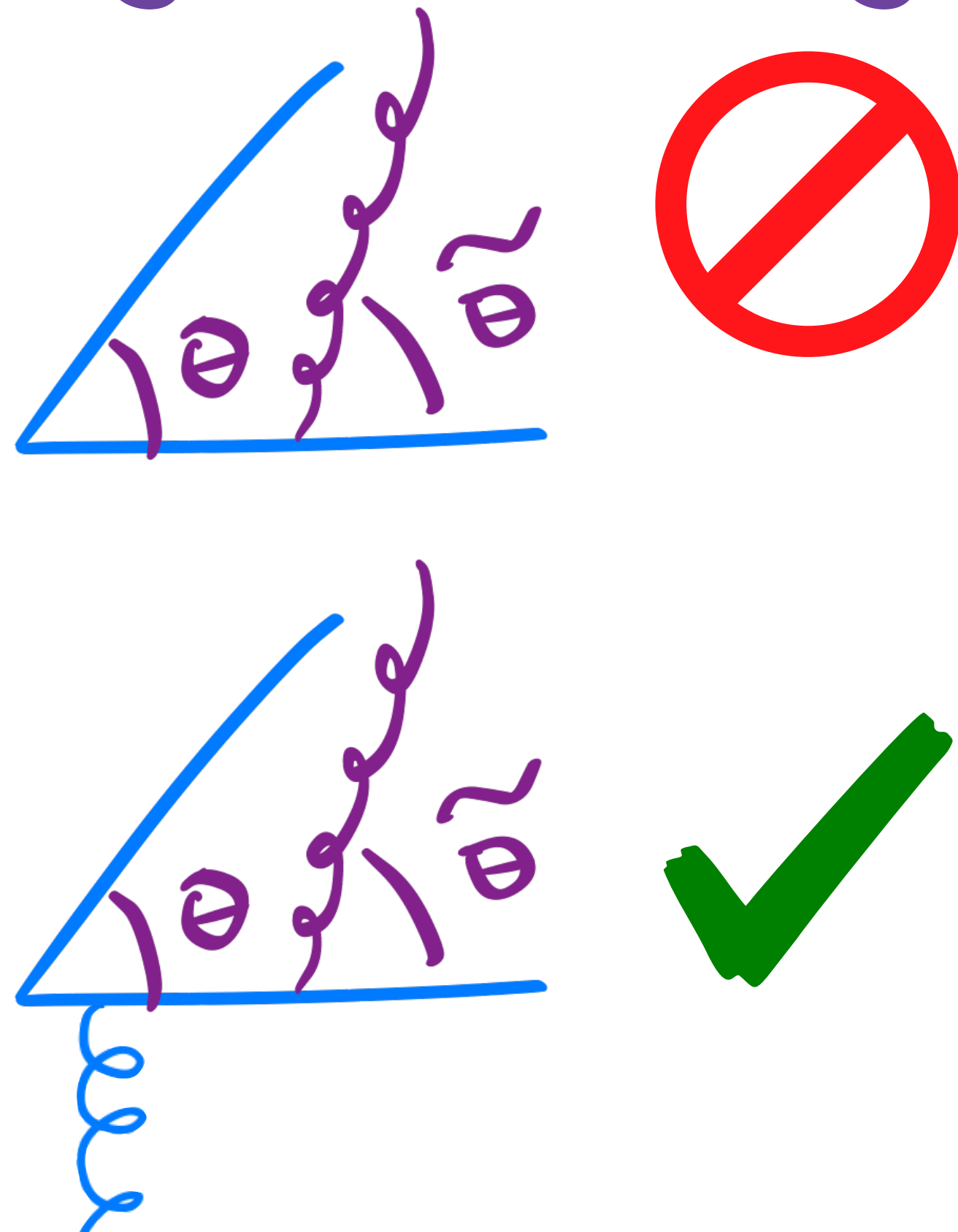
Jet Quenching without Energy Loss

arXiv:2510.11914



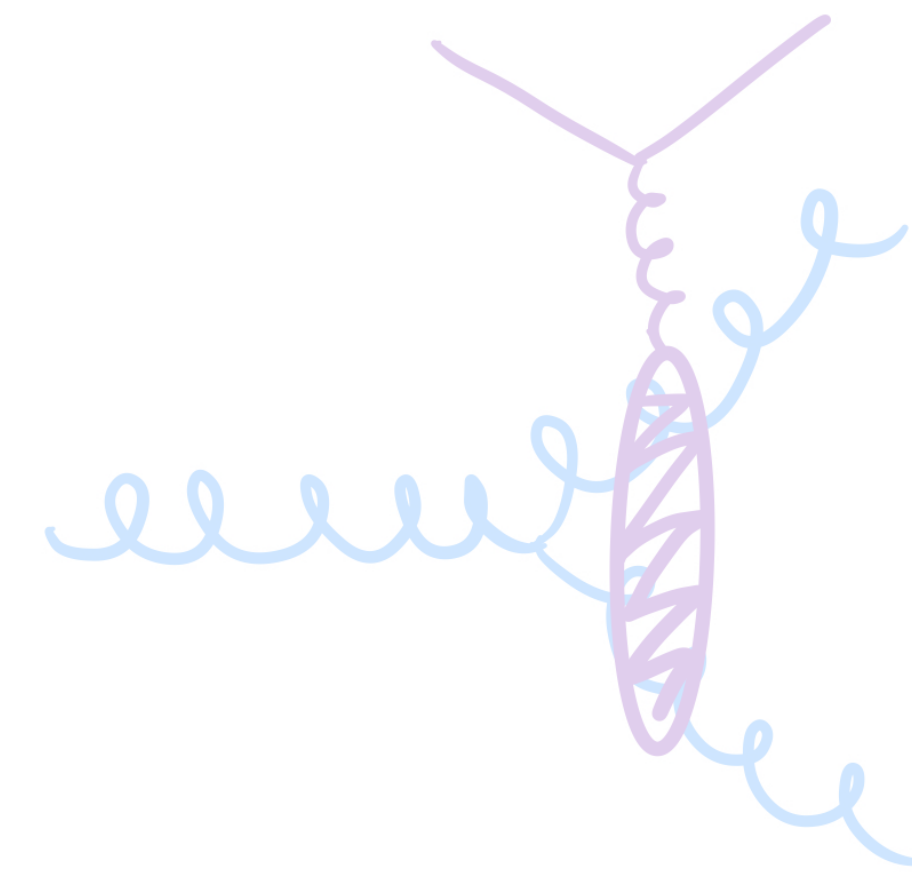
(updated version soon)

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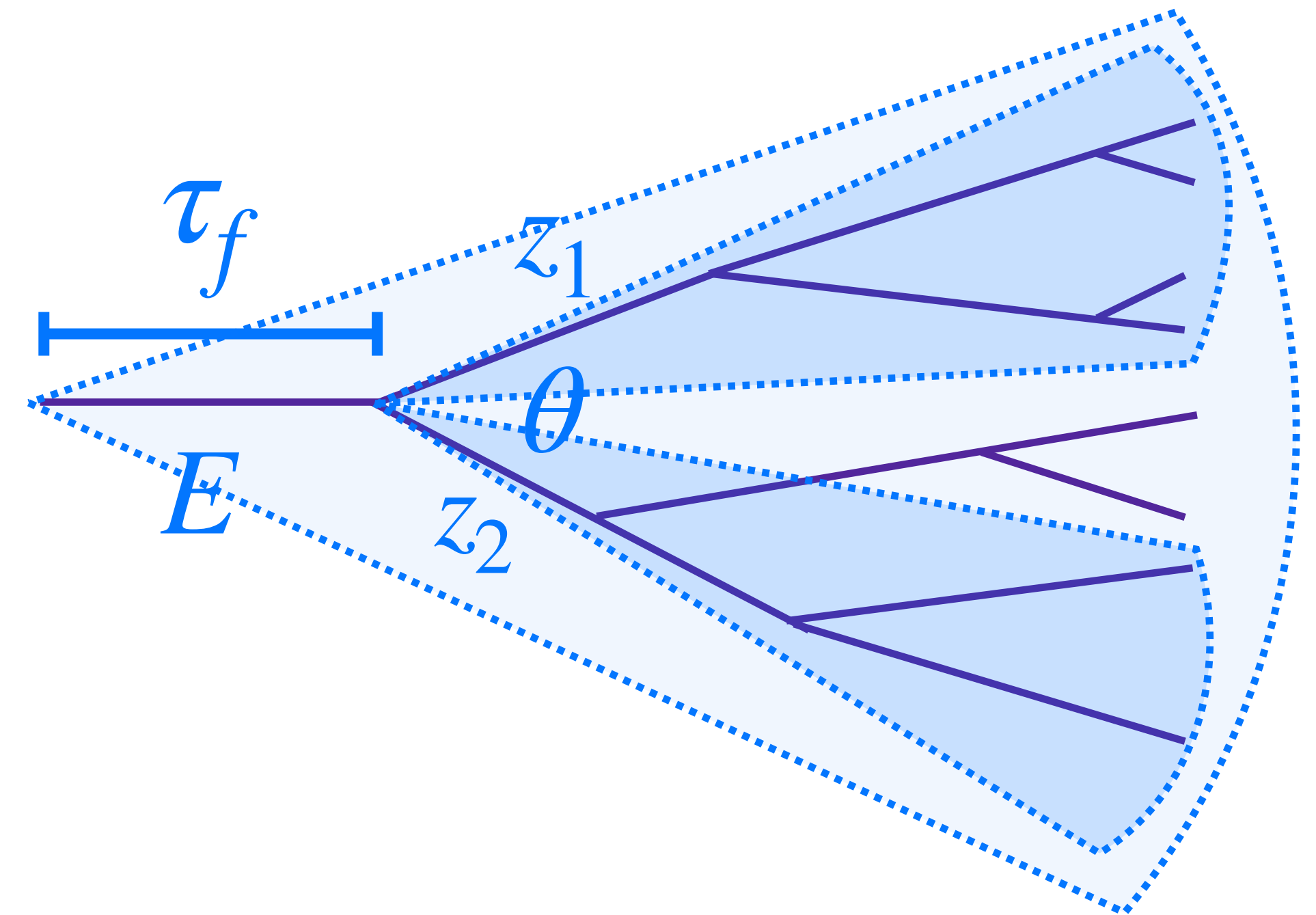
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Jet Quenching without Energy Loss

Formation time

- ♥ Jet formation time
- ♥ Reconstructed with τ -reclustering algorithm

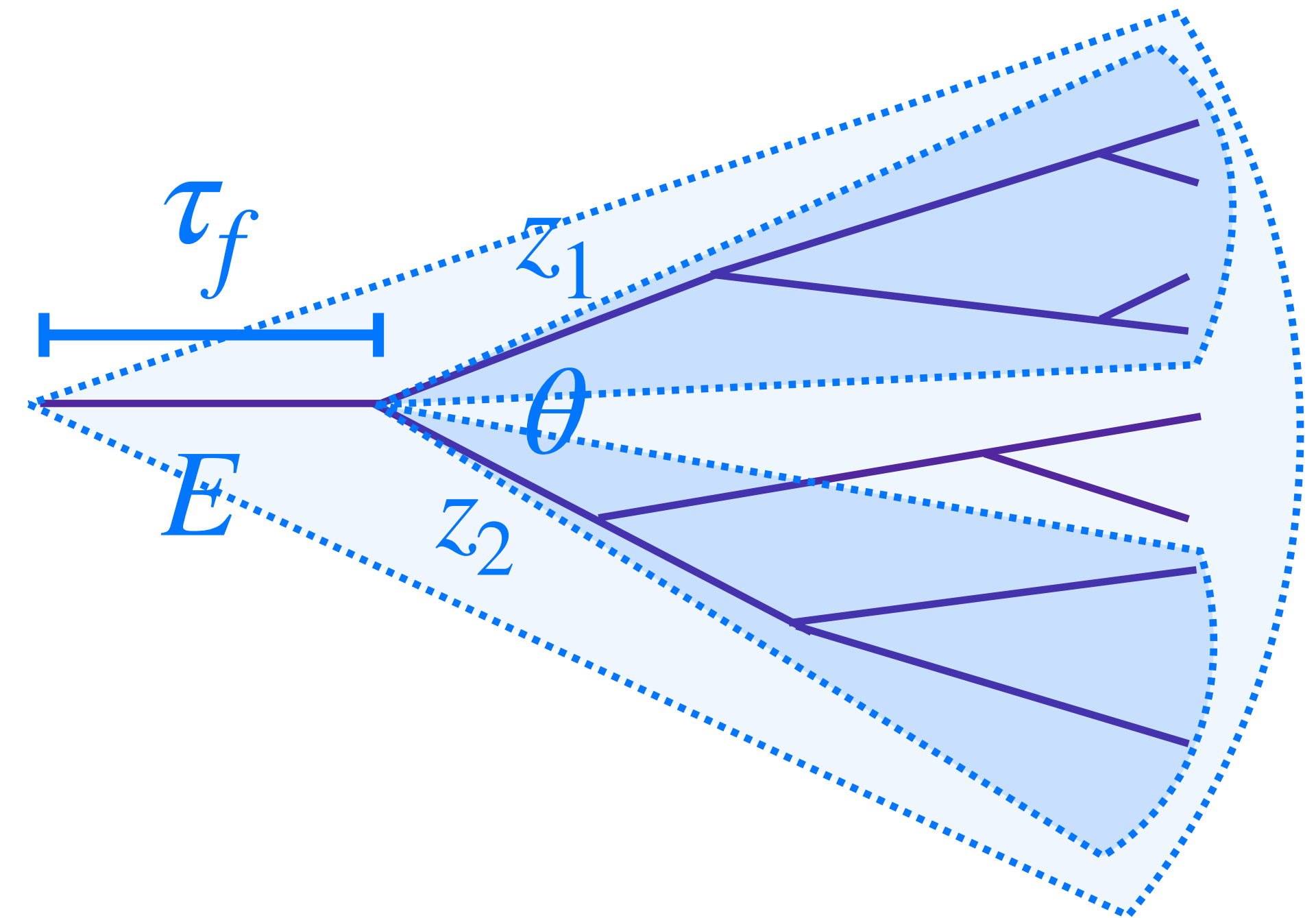
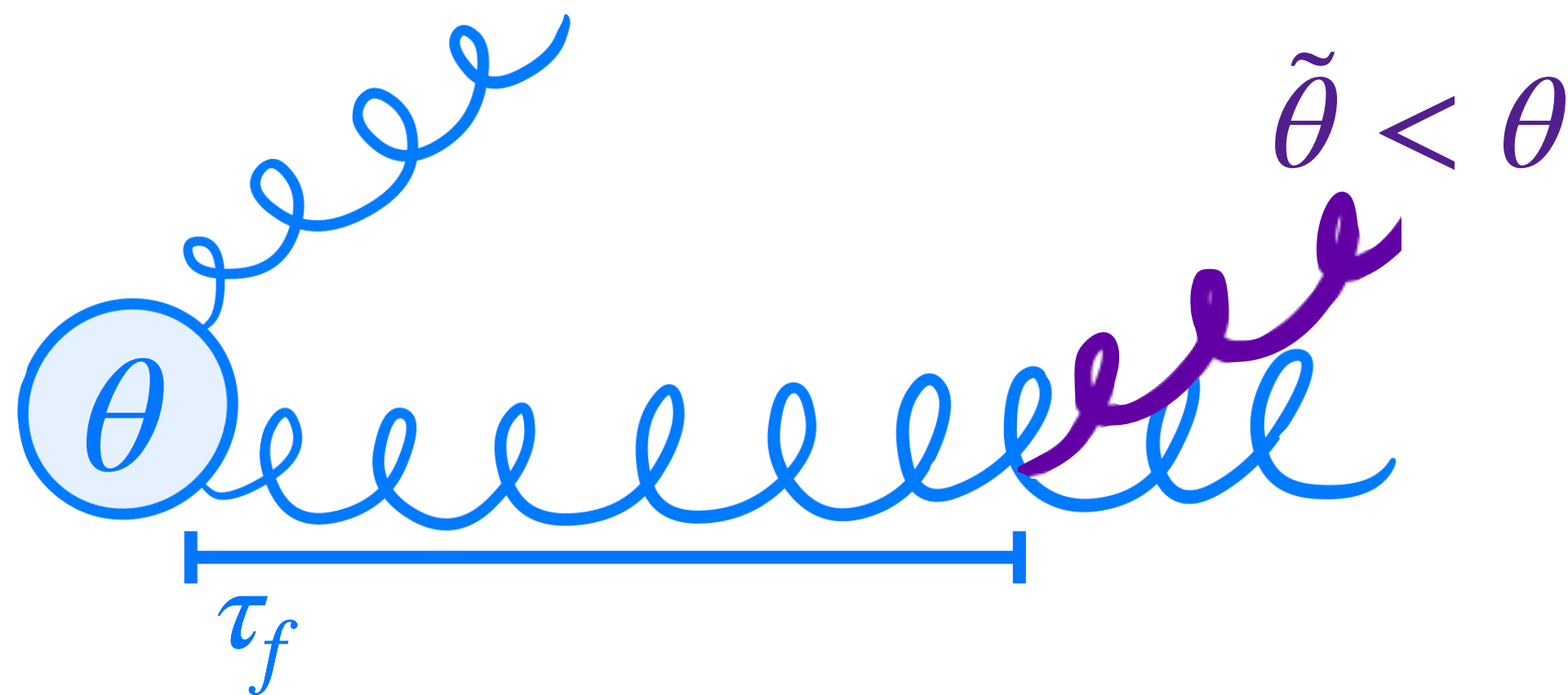


$$\tau_f \sim \frac{1}{2Ez_1z_2(1 - \cos \theta)}$$

Jet Quenching without Energy Loss

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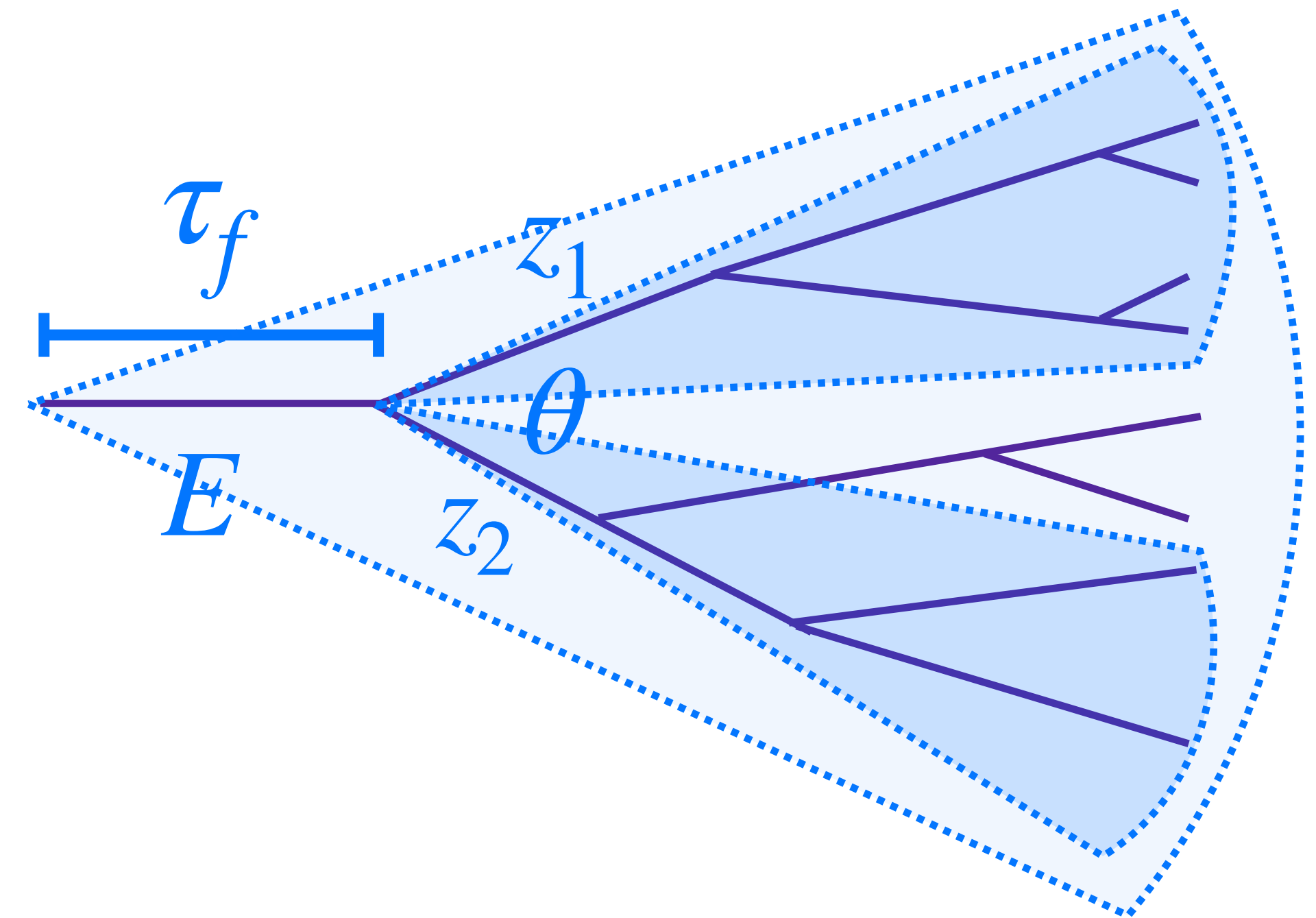
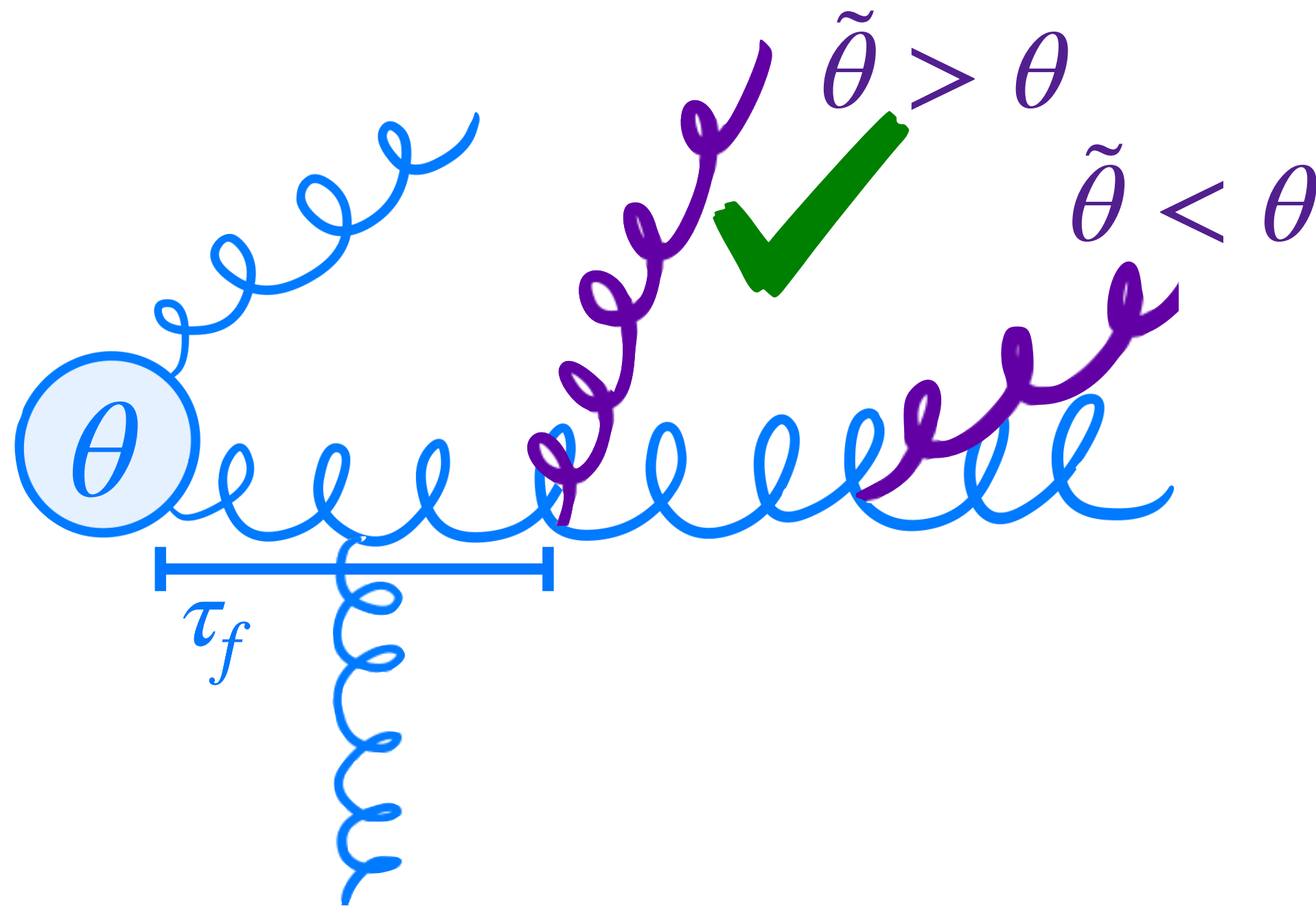


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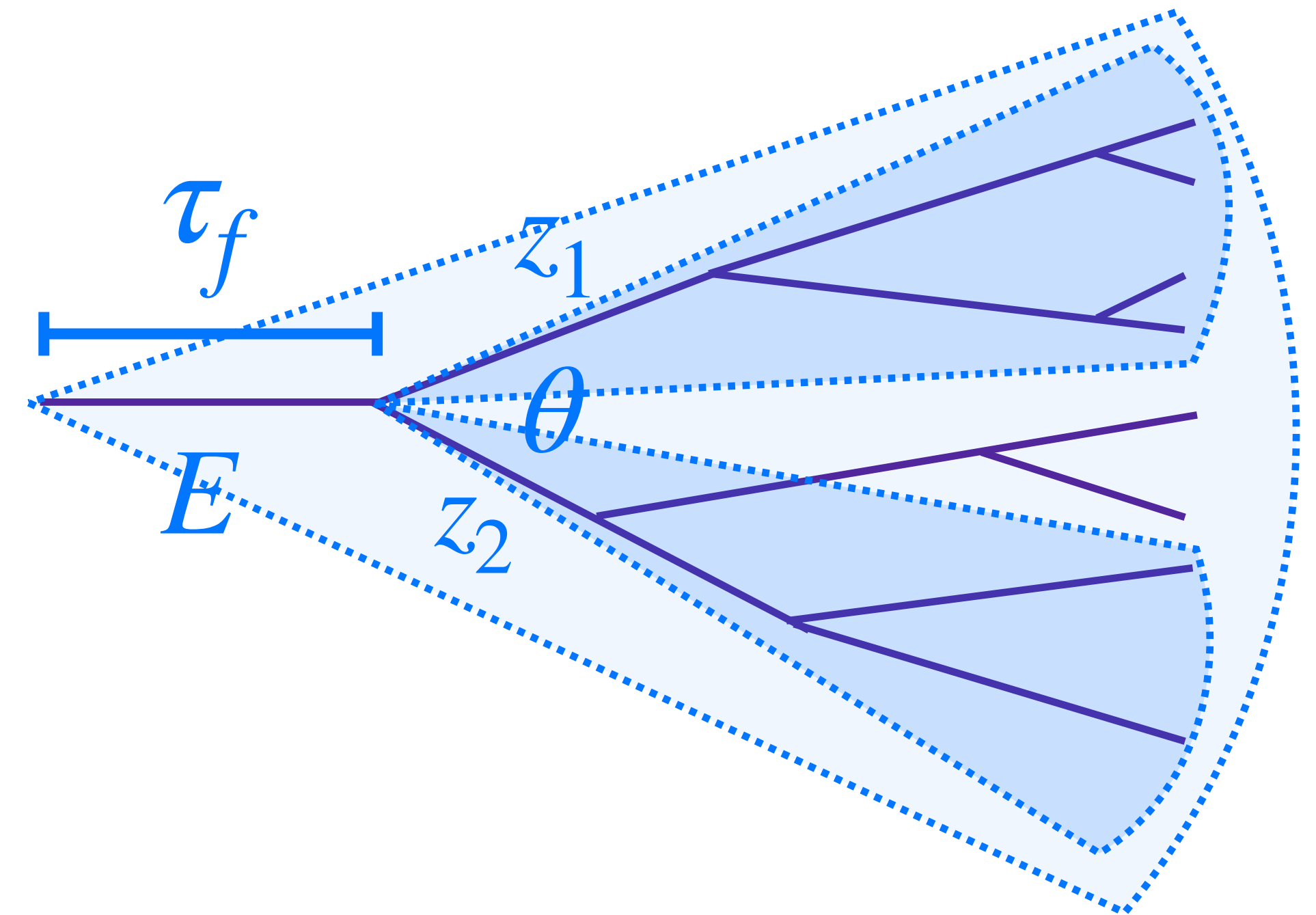
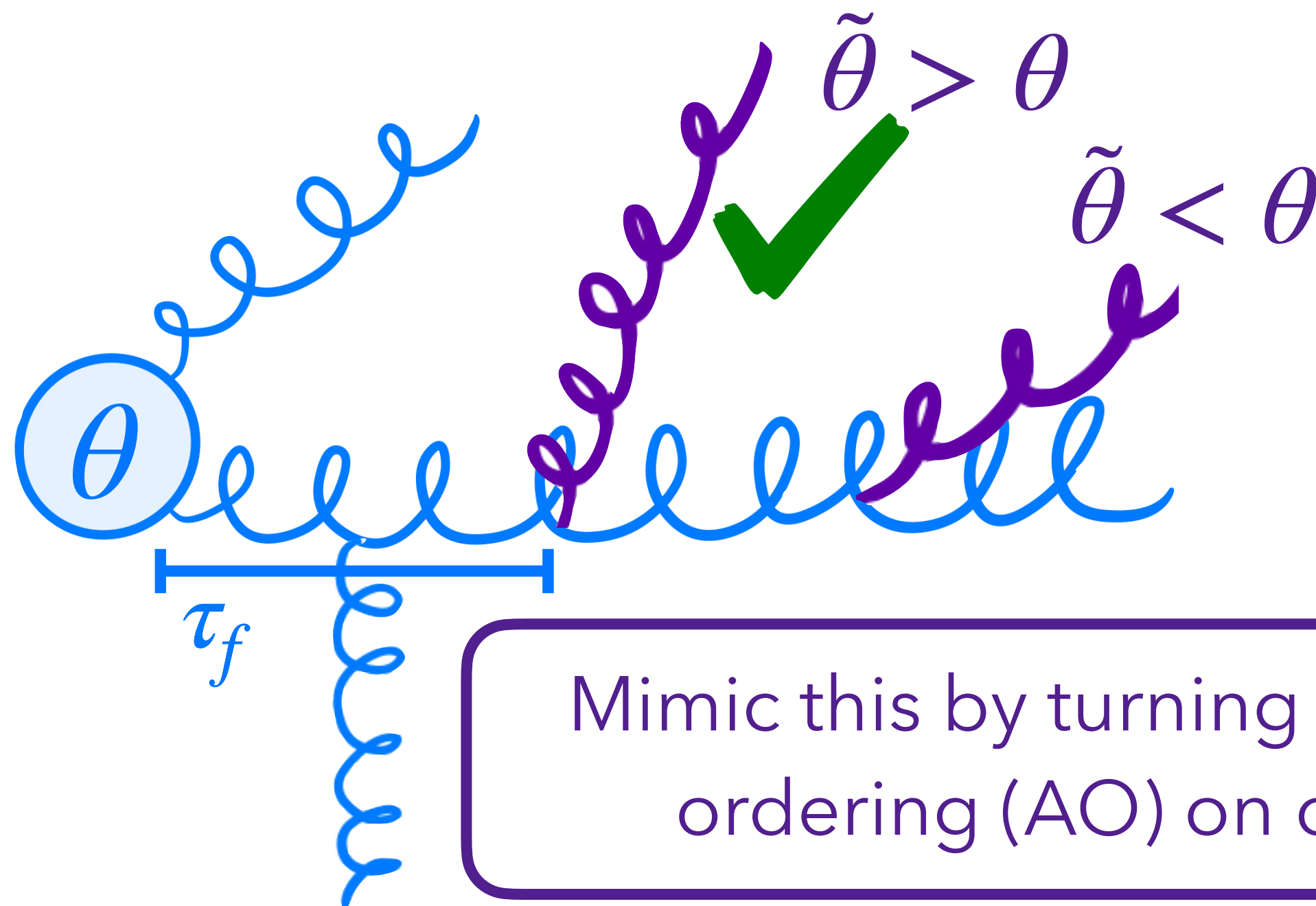


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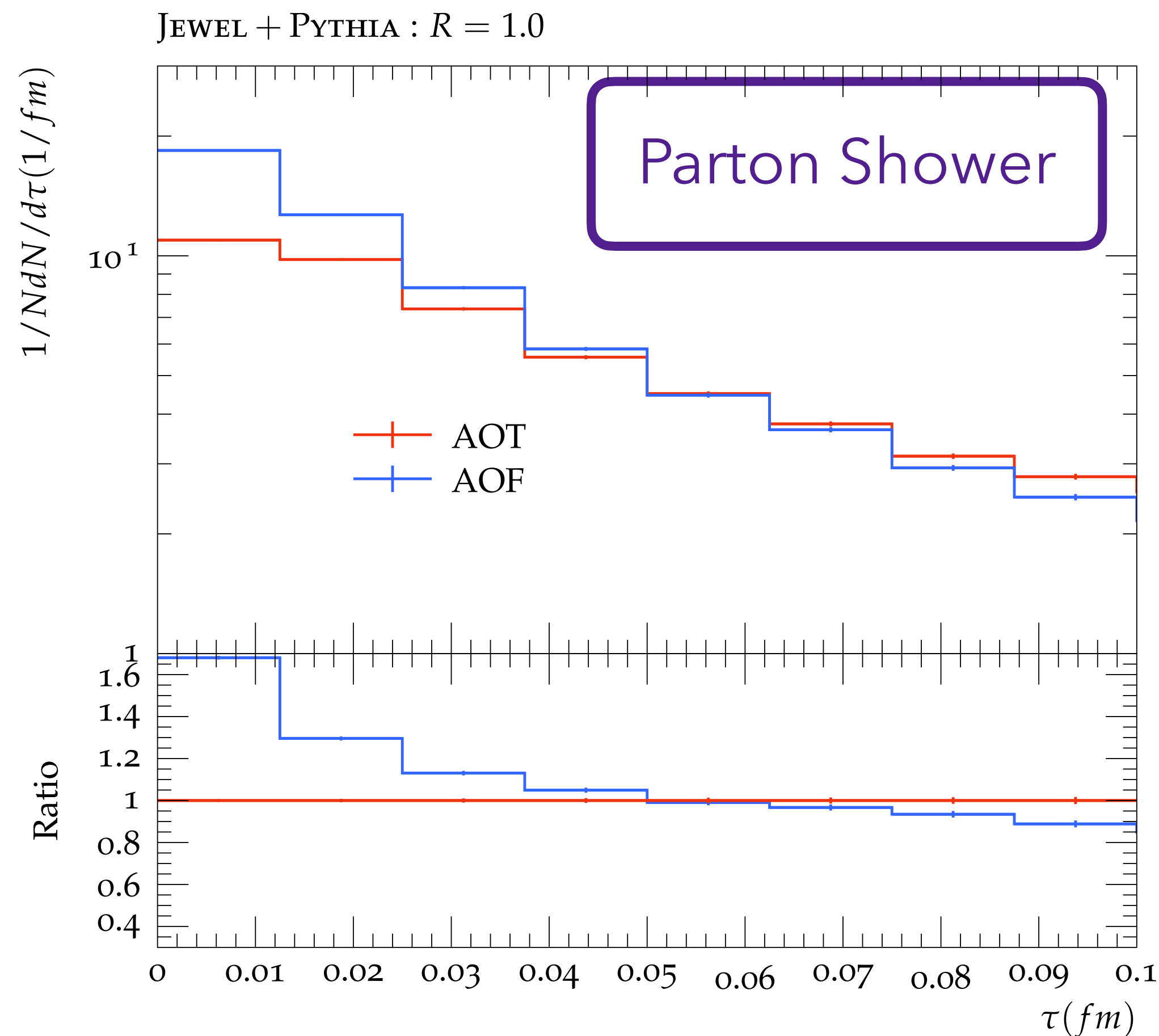
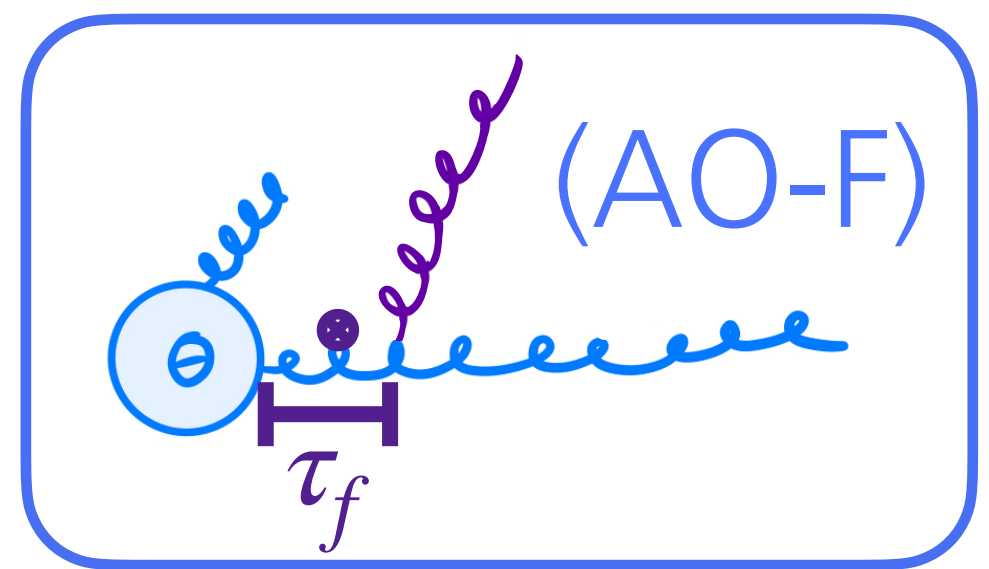
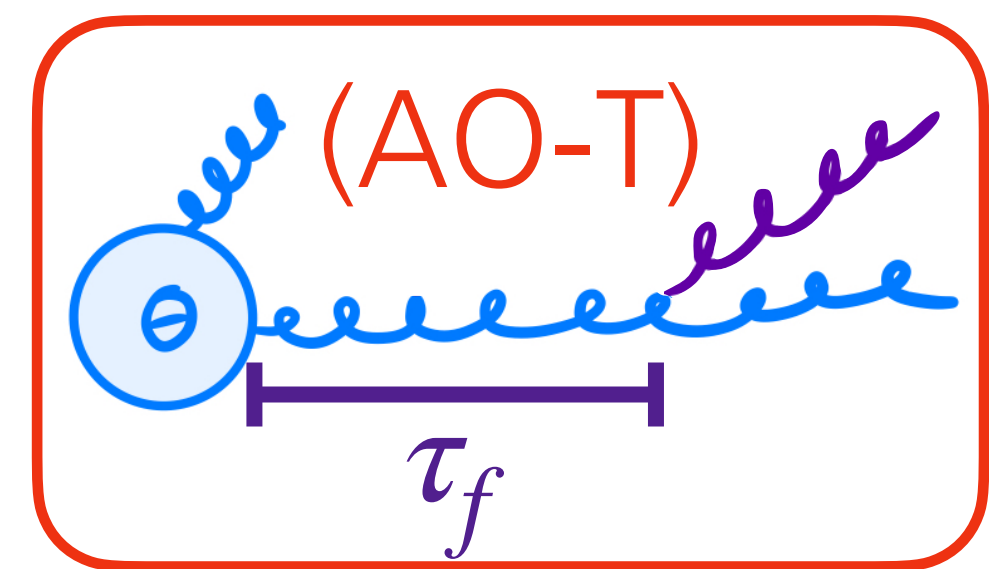


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Jet Quenching without Energy Loss

Effect of coherence breaking

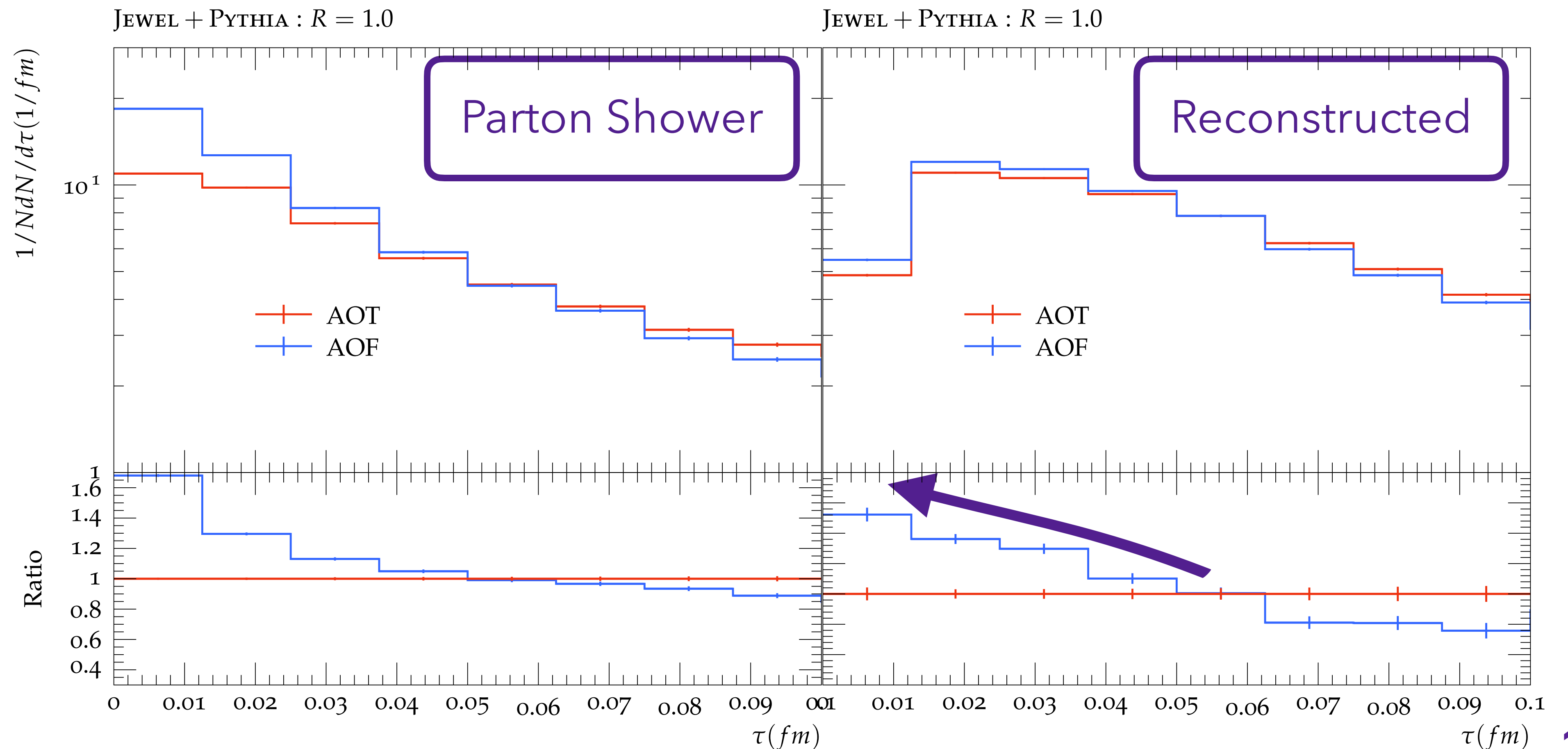
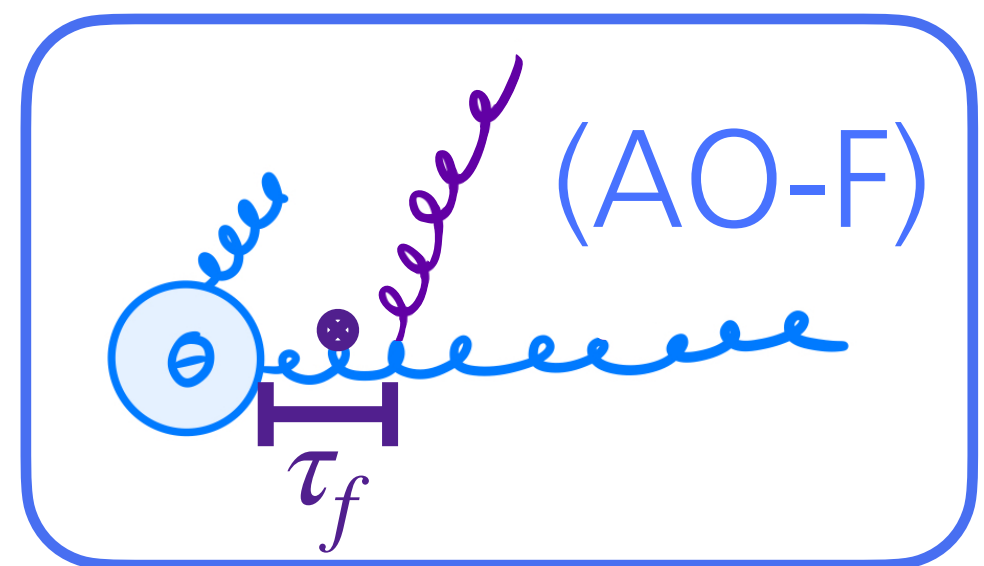
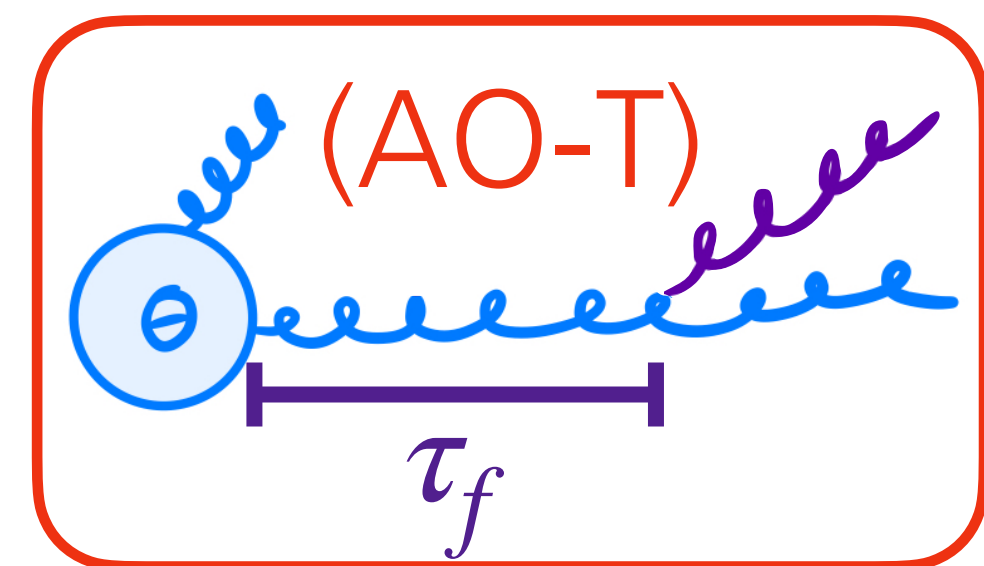
♥ Formation time distribution



Jet Quenching without Energy Loss

Effect of coherence breaking

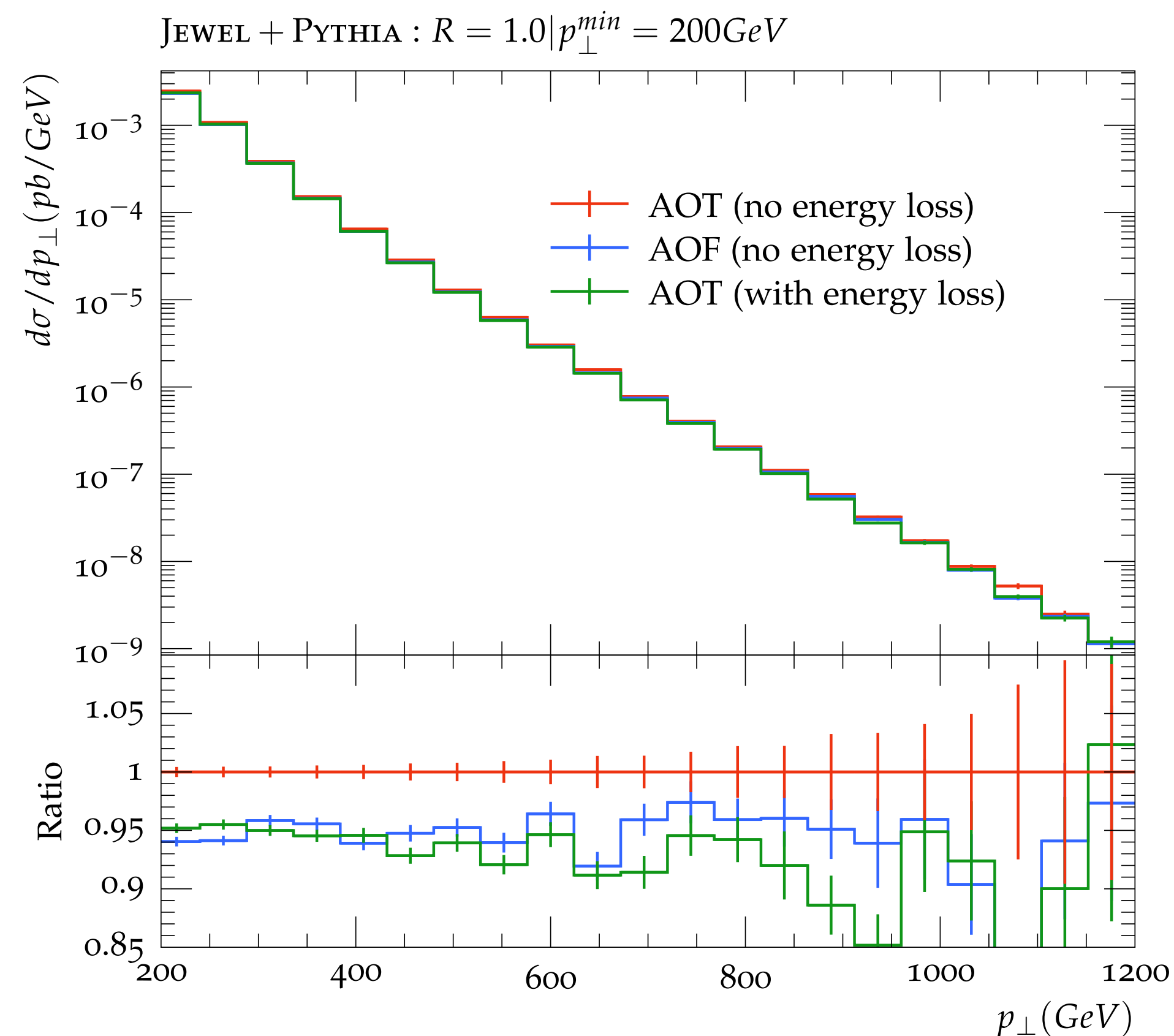
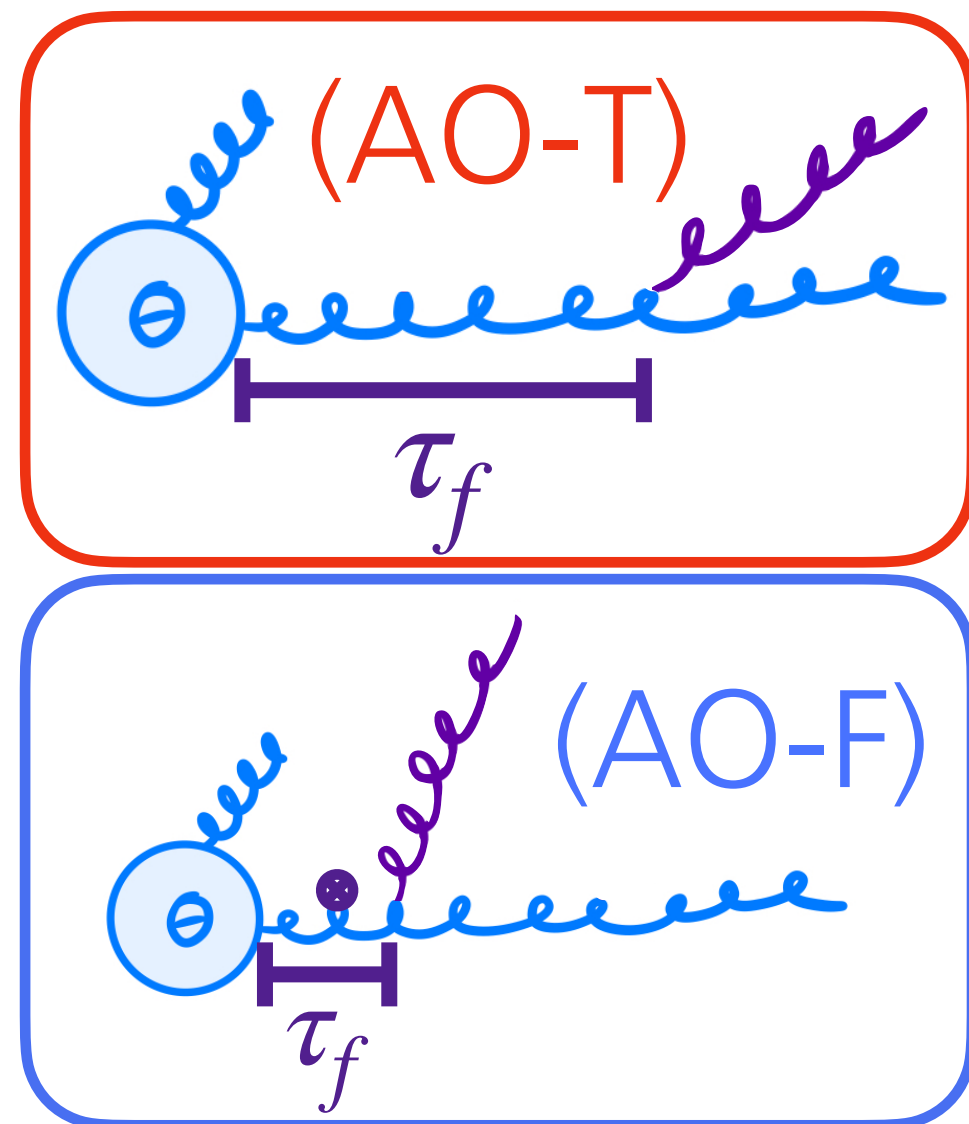
♥ Formation time distribution



Jet Quenching without Energy Loss

Suppression

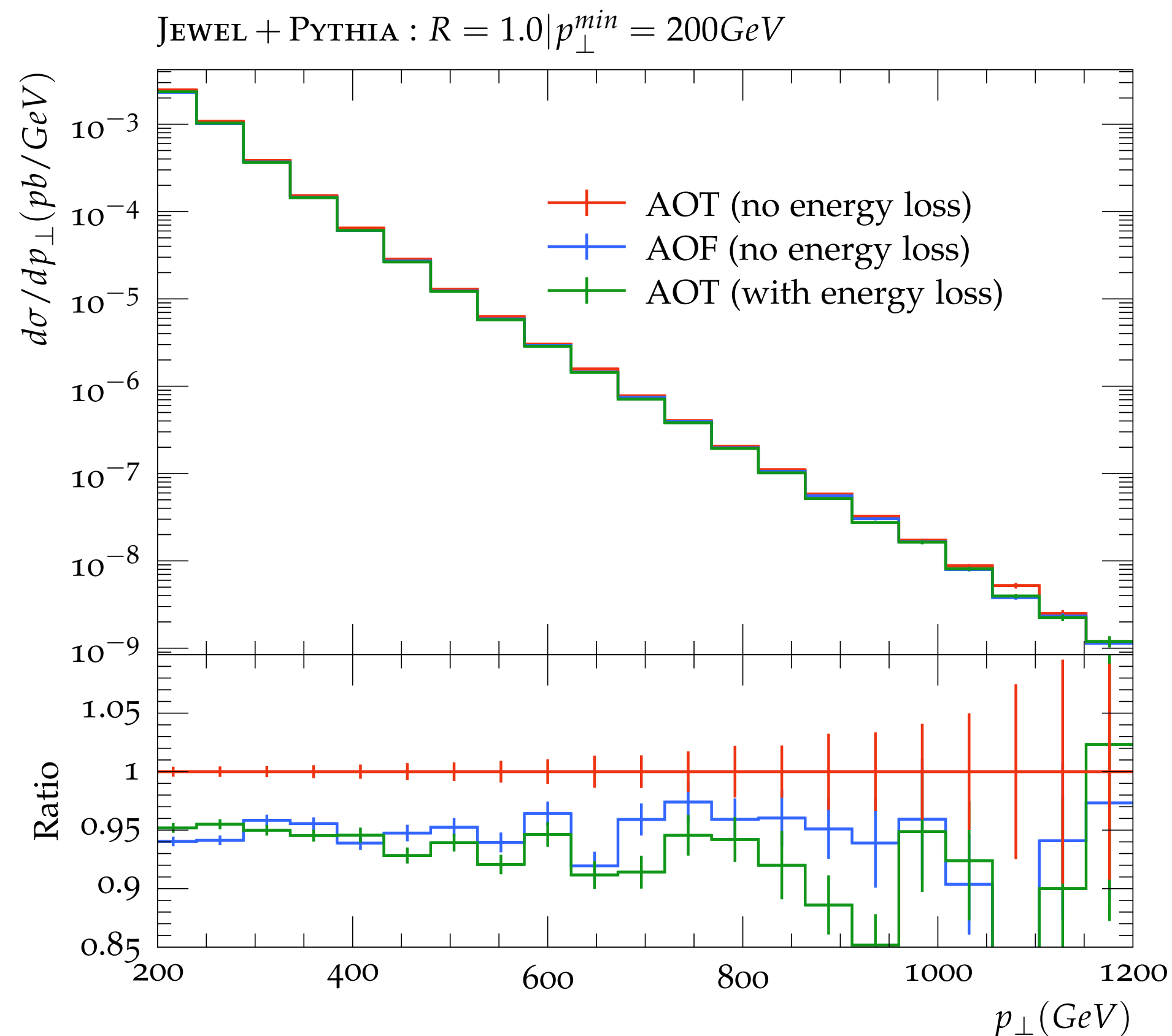
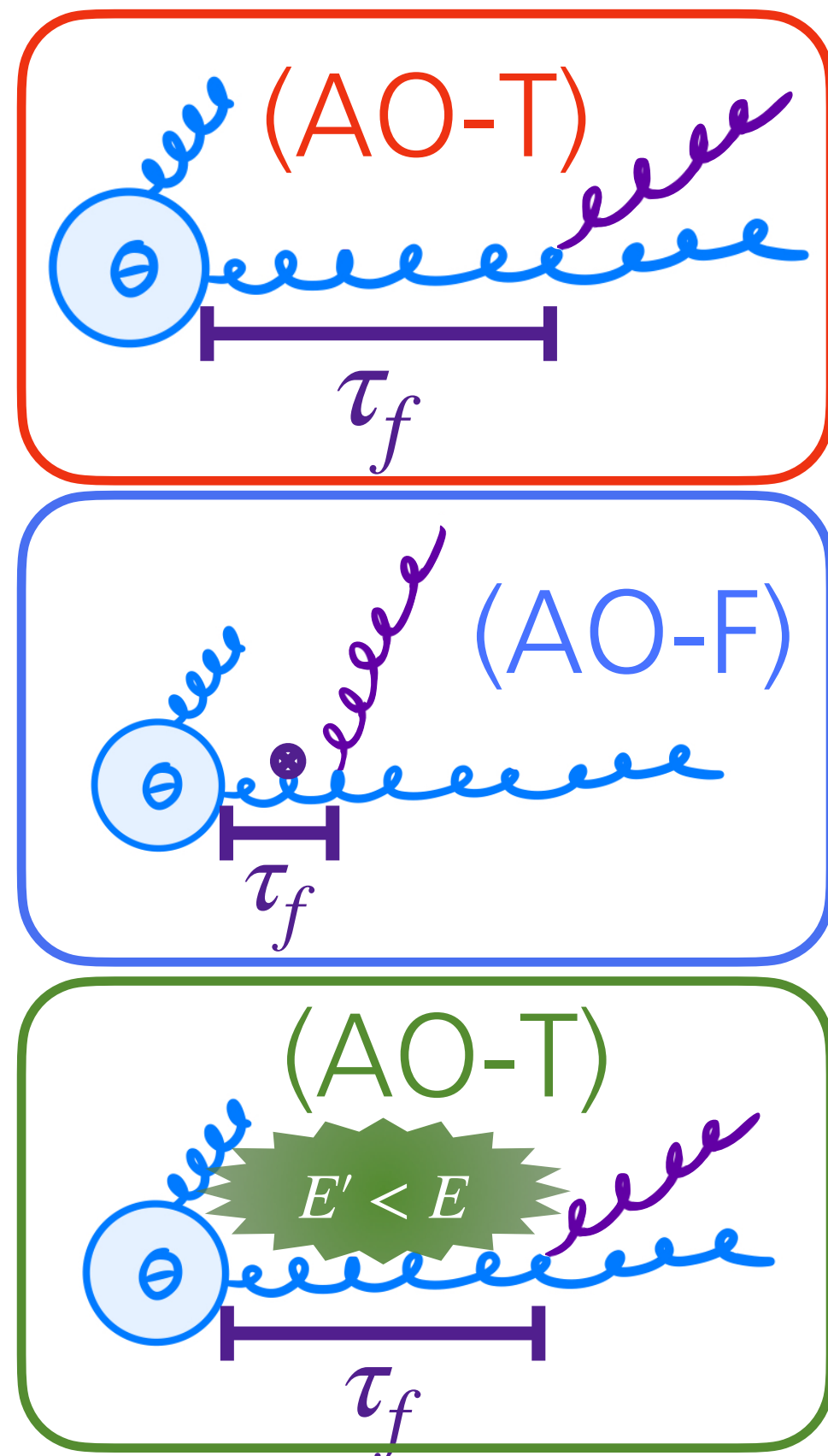
♥ Color decoherence also appears as a suppression in the jet spectrum



Jet Quenching without Energy Loss

Suppression

♥ Color decoherence also appears as a suppression in the jet spectrum

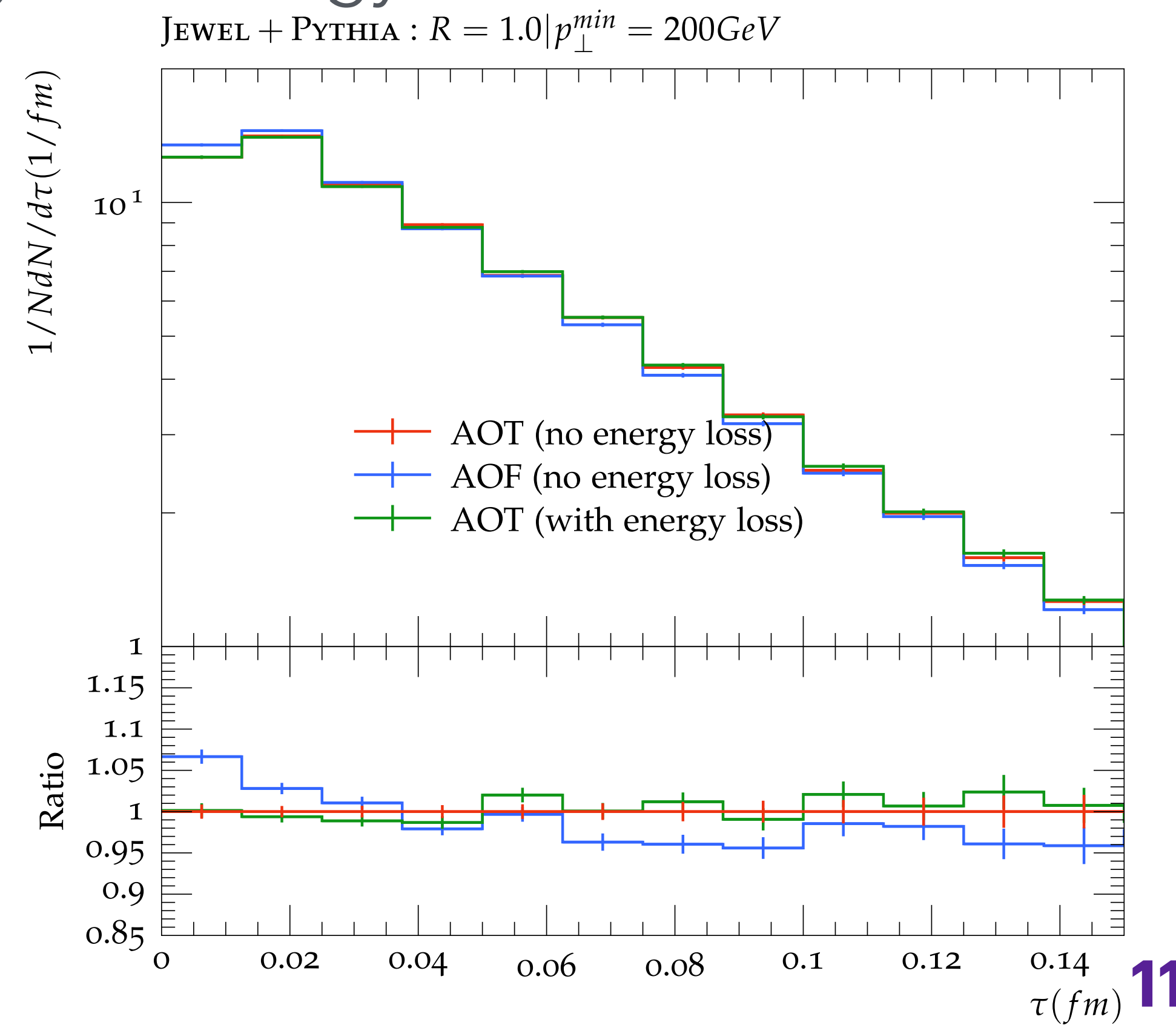
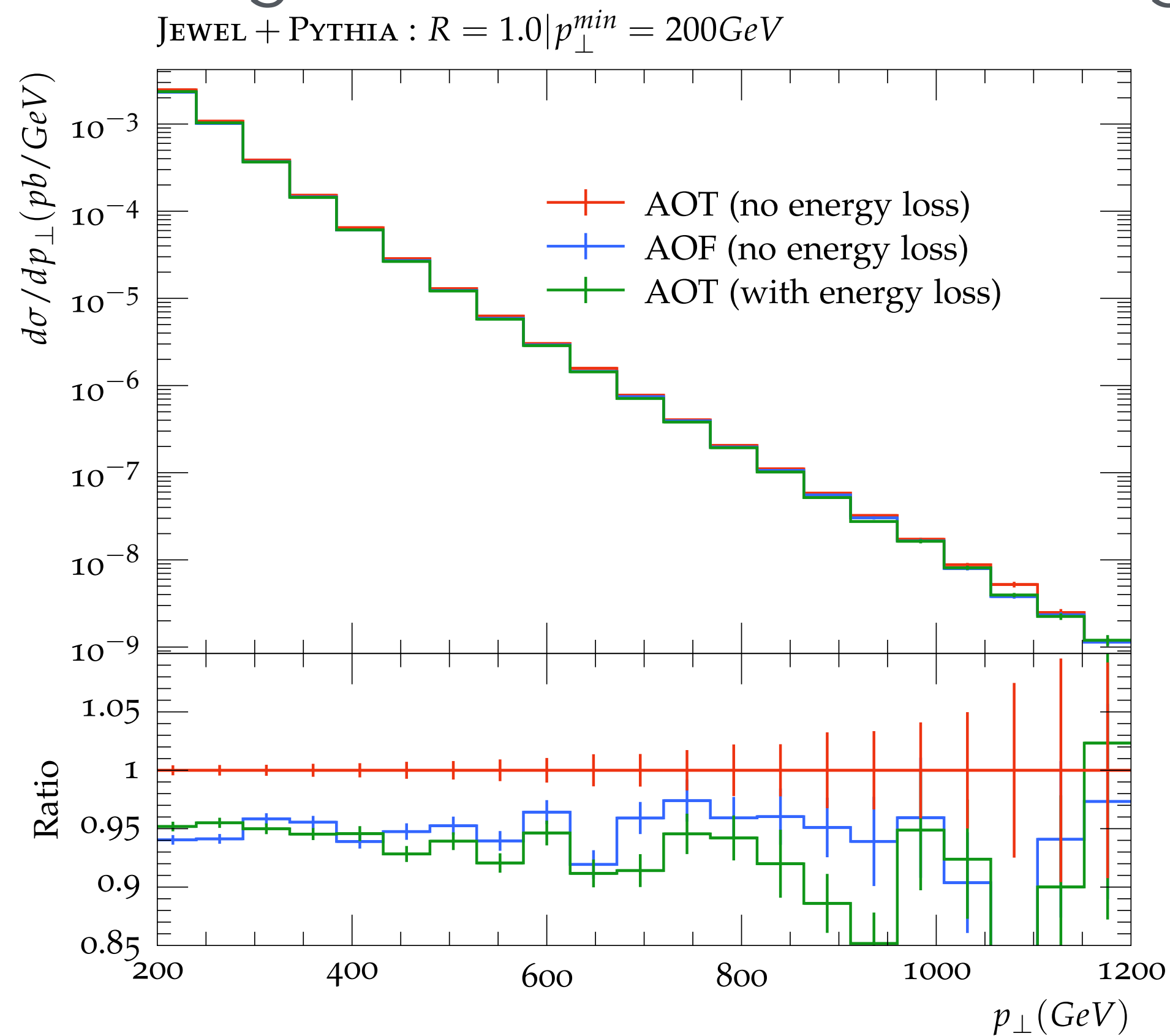
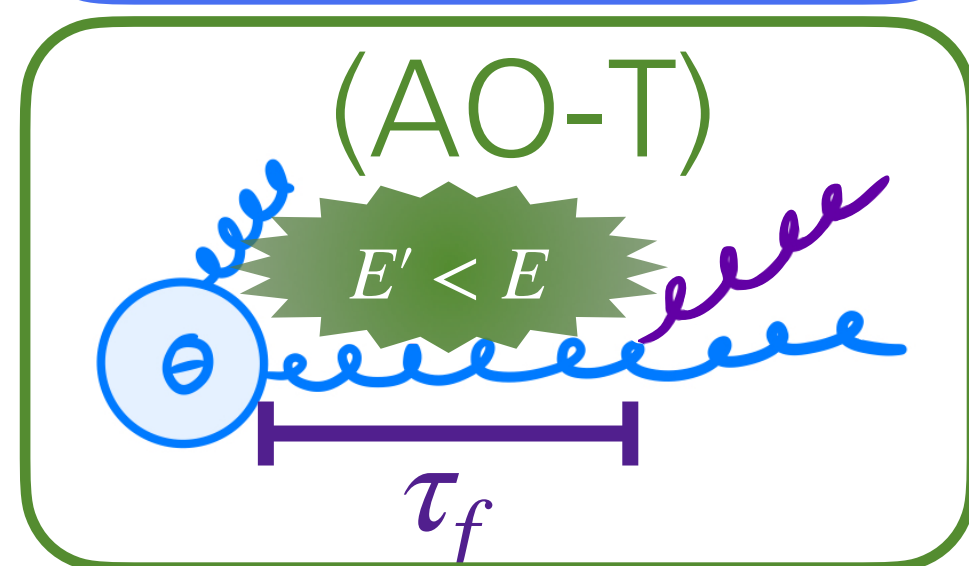
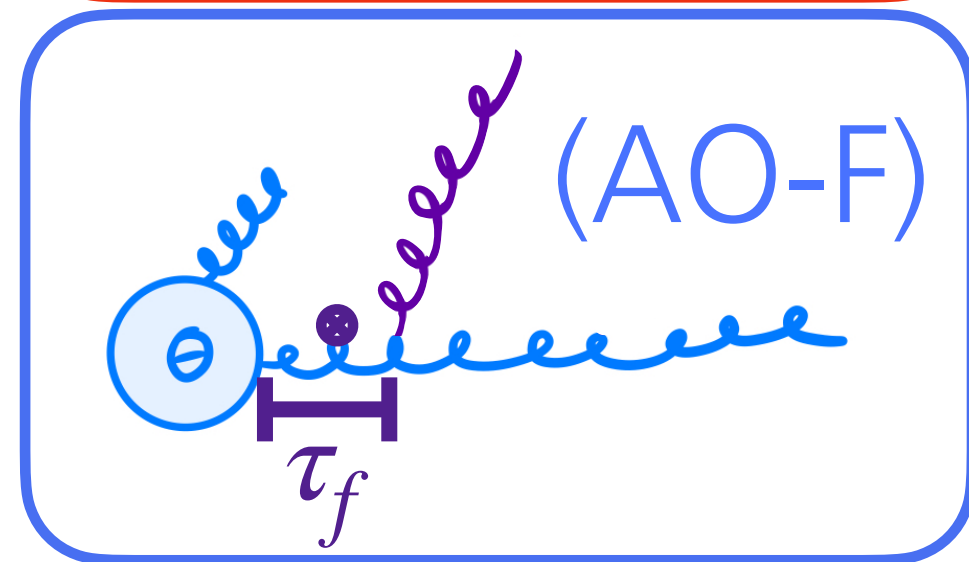
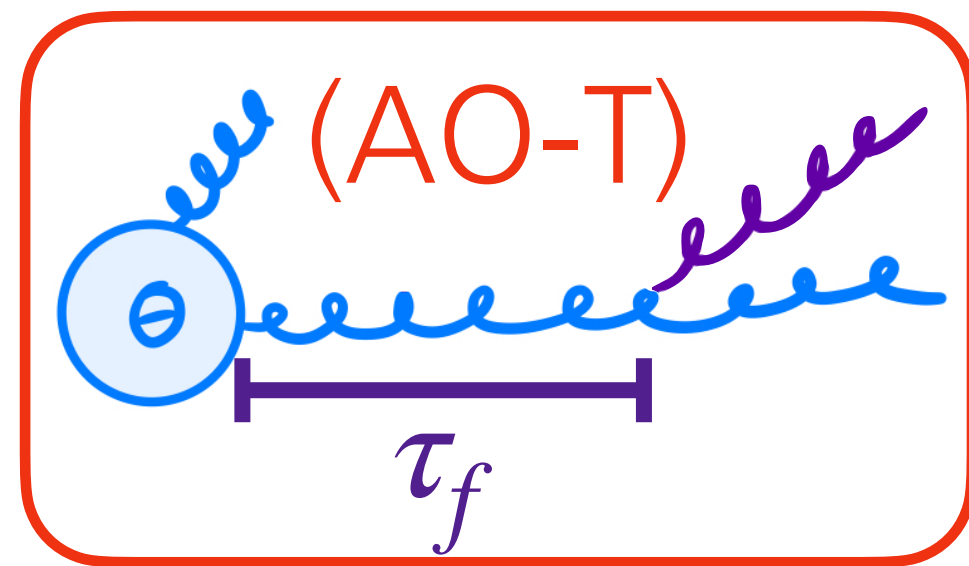


Jet Quenching without Energy Loss

Suppression

♥ Color decoherence also appears as a suppression in the jet spectrum

♥ Formation time distinguishes coherence breaking and energy loss



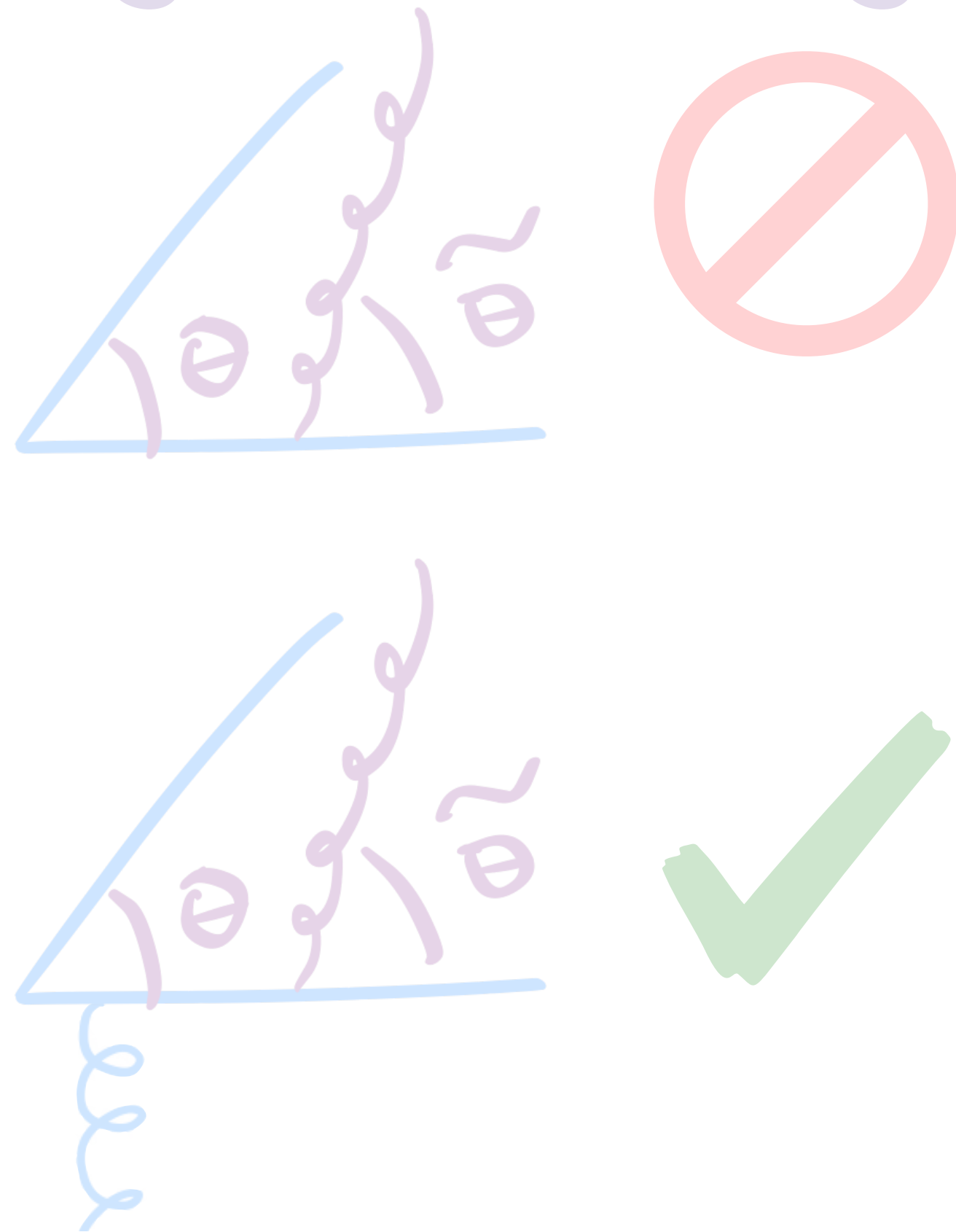
Colour coherence in small systems

arXiv:2510.17570



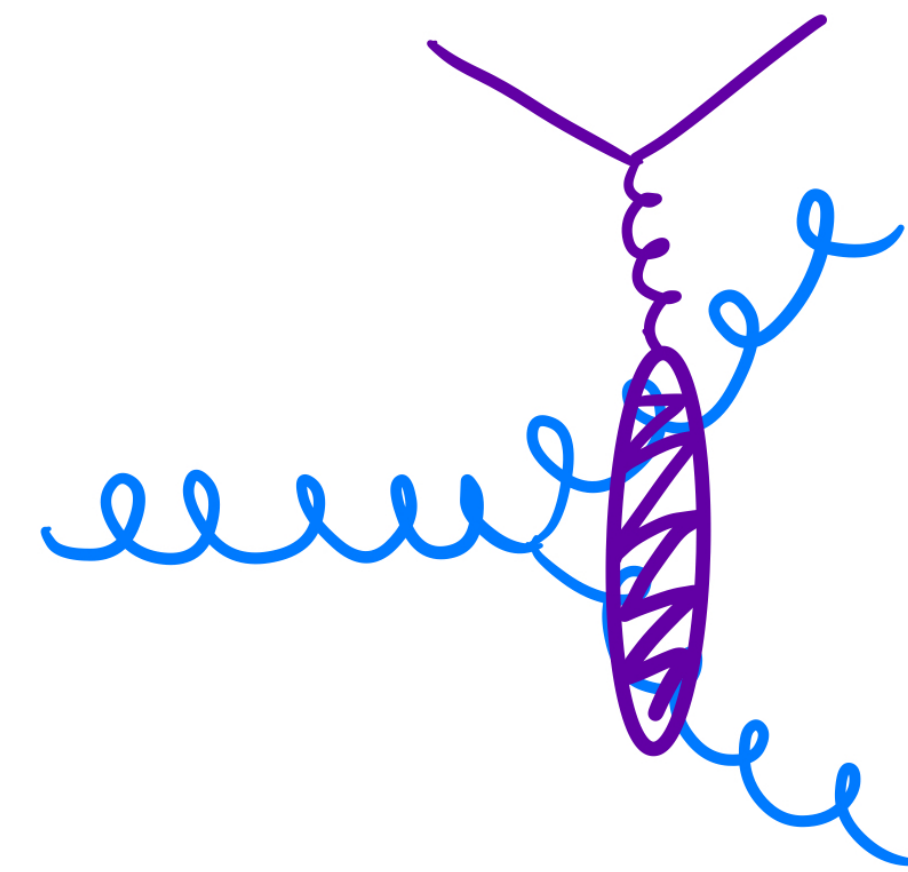
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Angular ordering



Relevant dipole: initiating parton
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Scattering resolution



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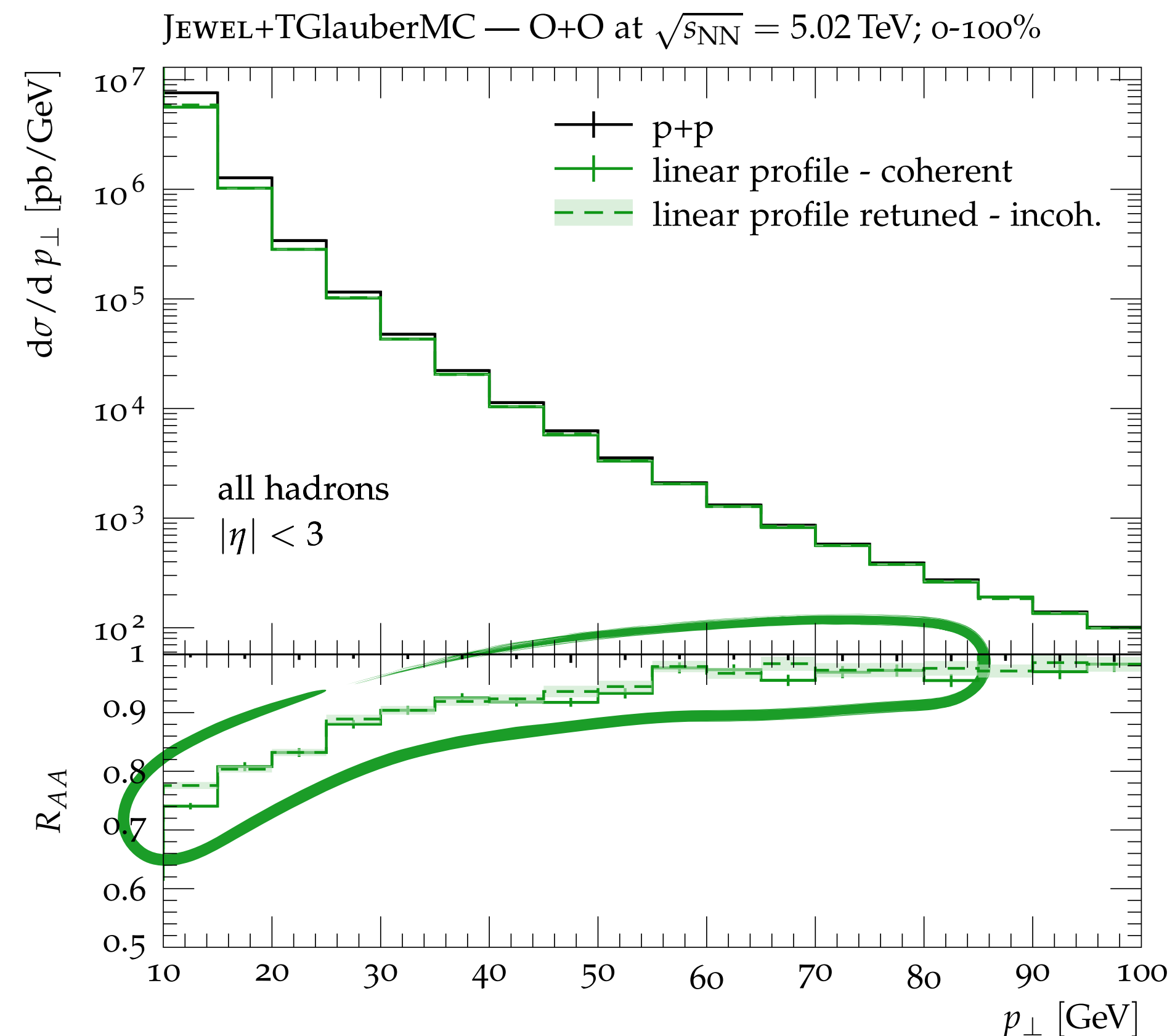
unresolved partons
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Relevant dipole: shower dipoles
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Color coherence in small collision systems

Coherence effect on v_2

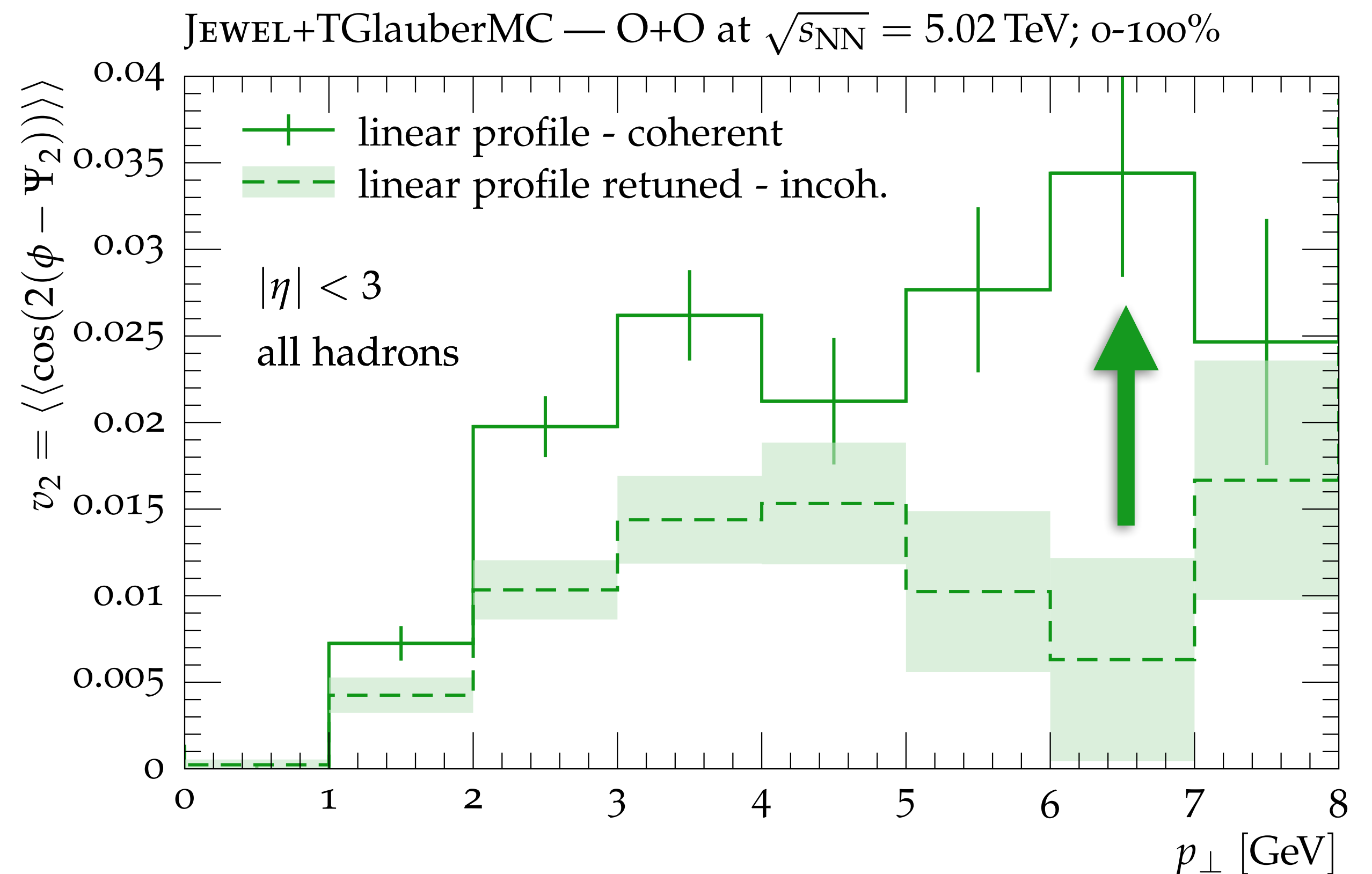
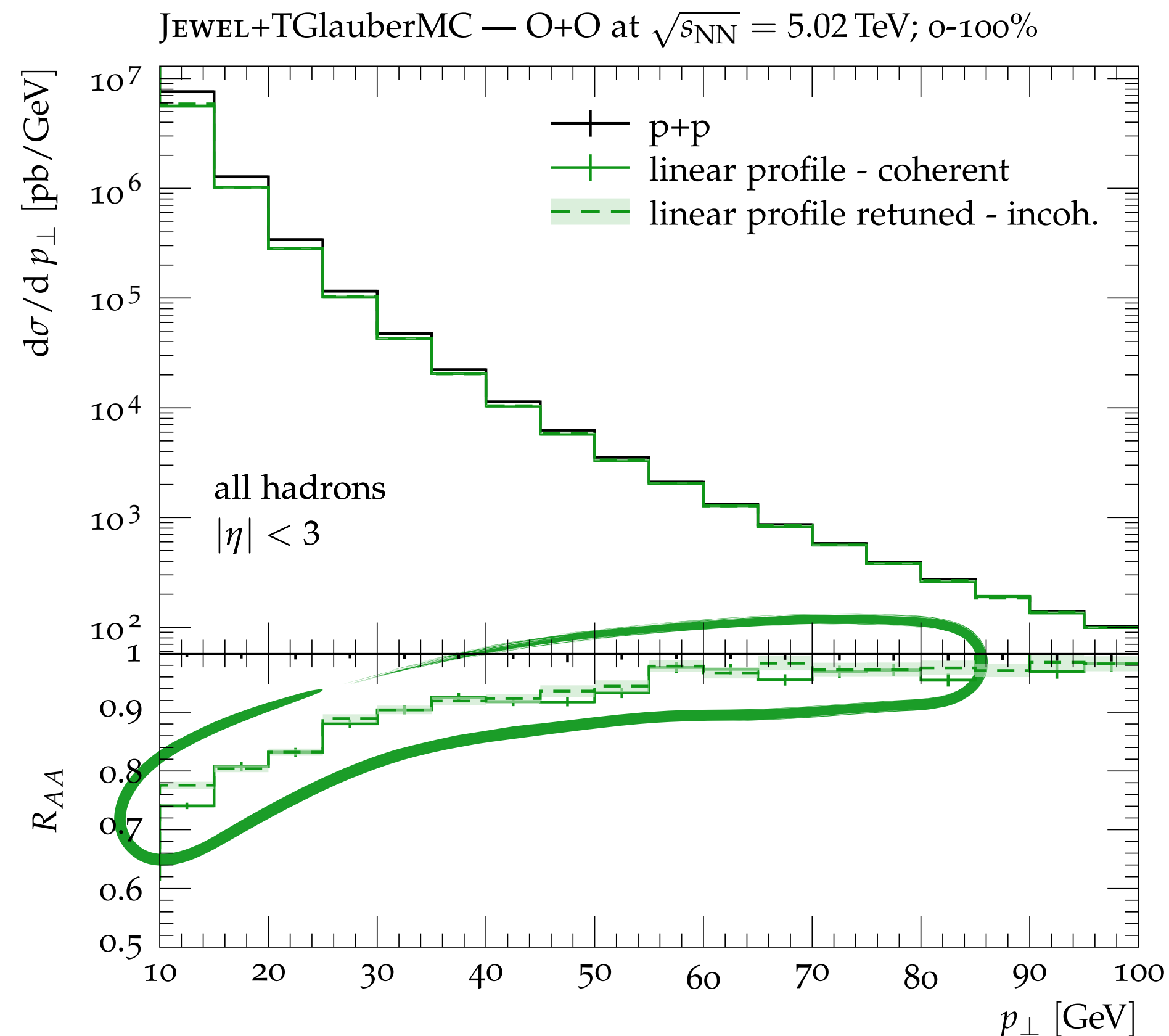
♥ T_i tuned such that coherent and incoherent have the same R_{AA}



Color coherence in small collision systems

Coherence effect on v_2

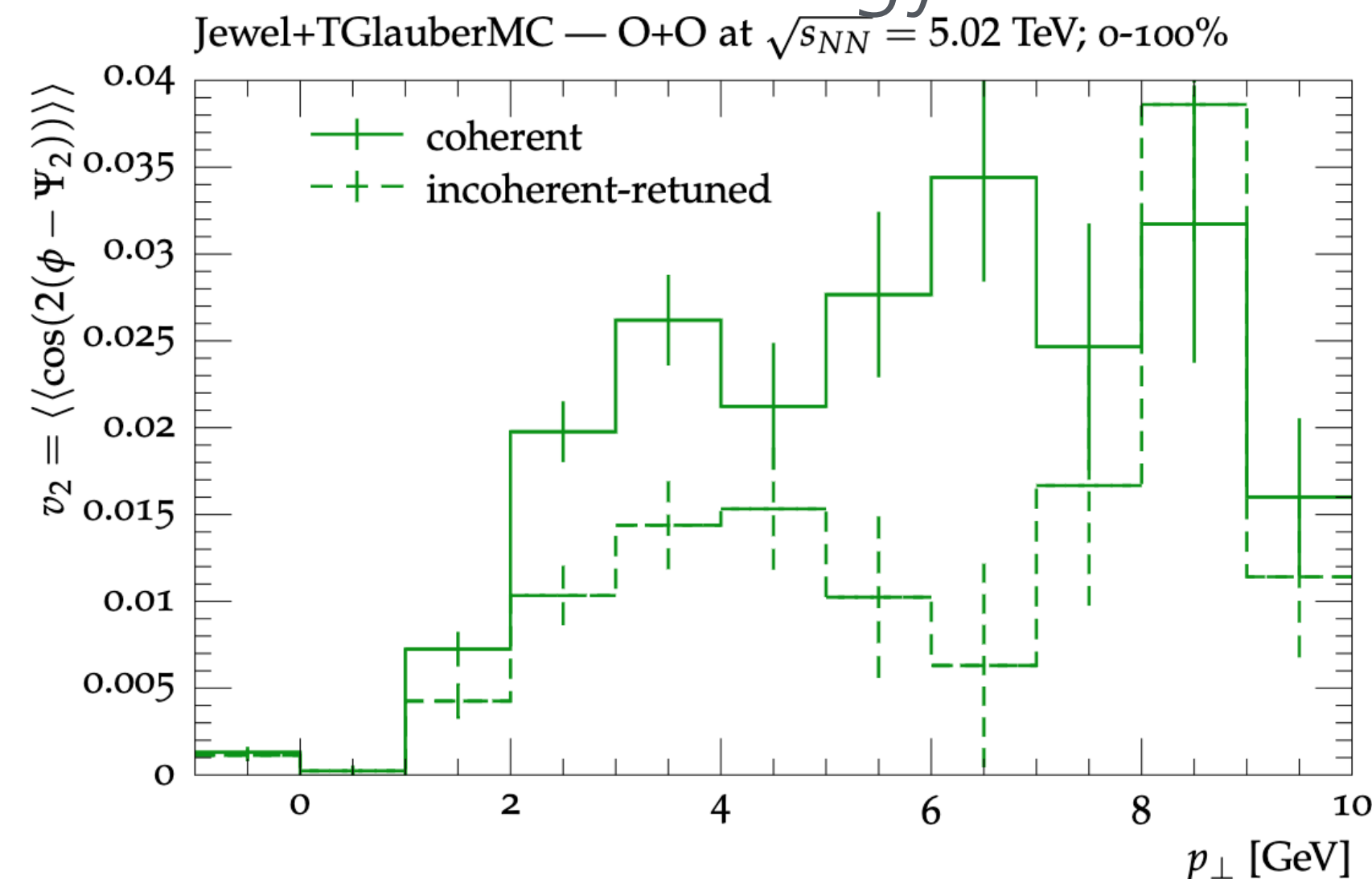
- T_i tuned such that coherent and incoherent have the same R_{AA}
- Coherence increases v_2 : rejected early scatterings are compensated at later times



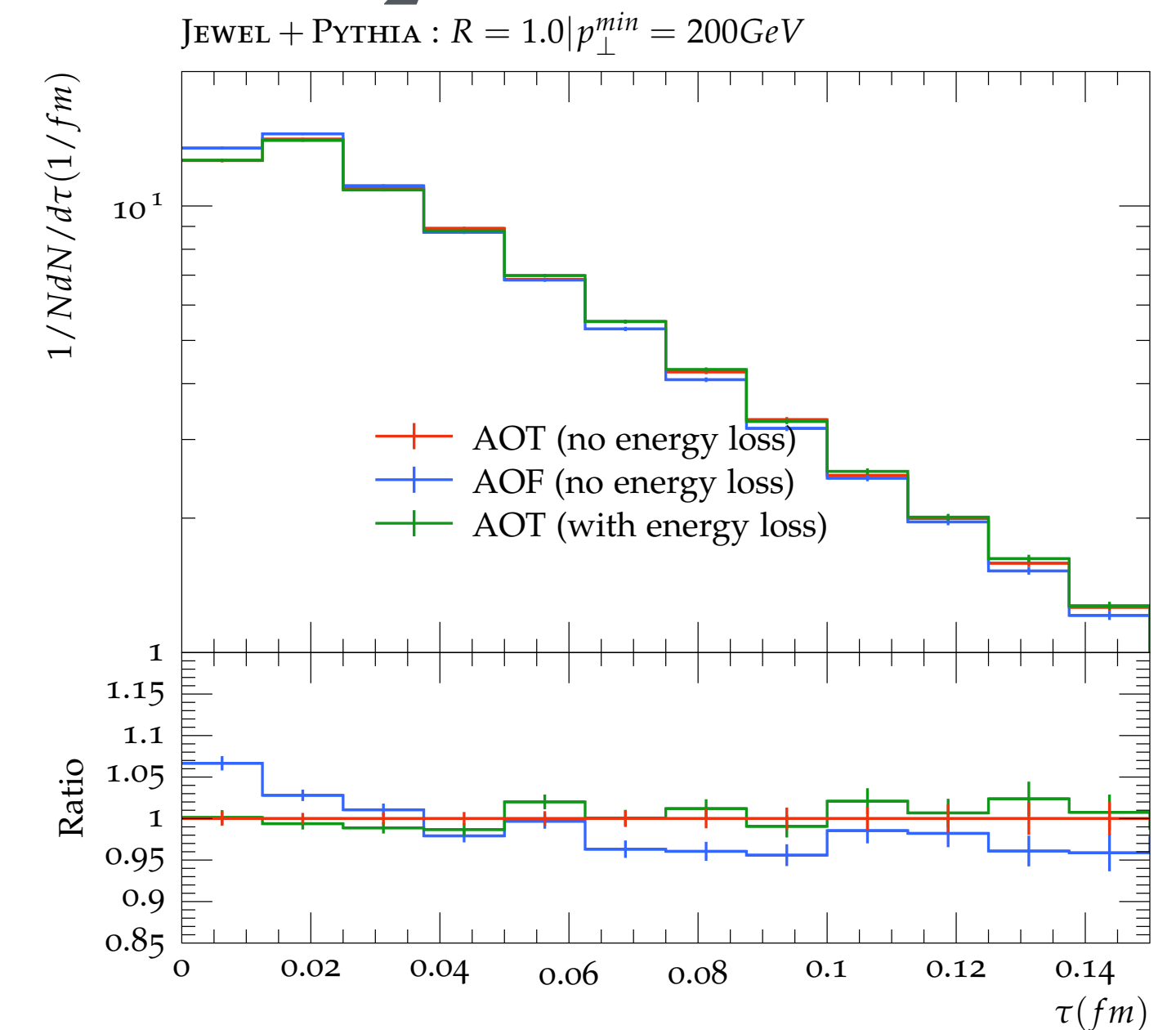
Conclusions

Conclusions

- Early soft rescatterings may break angular ordering which will shift the formation time distribution and suppress the $p_{\perp}$ distribution of jets
- Formation time distribution can distinguish between energy loss and the breaking of AO and is potentially measurable
- In larger systems, coherence effects may also lead to an increase in v_2 even if the same amount of energy loss is observed



Thank you

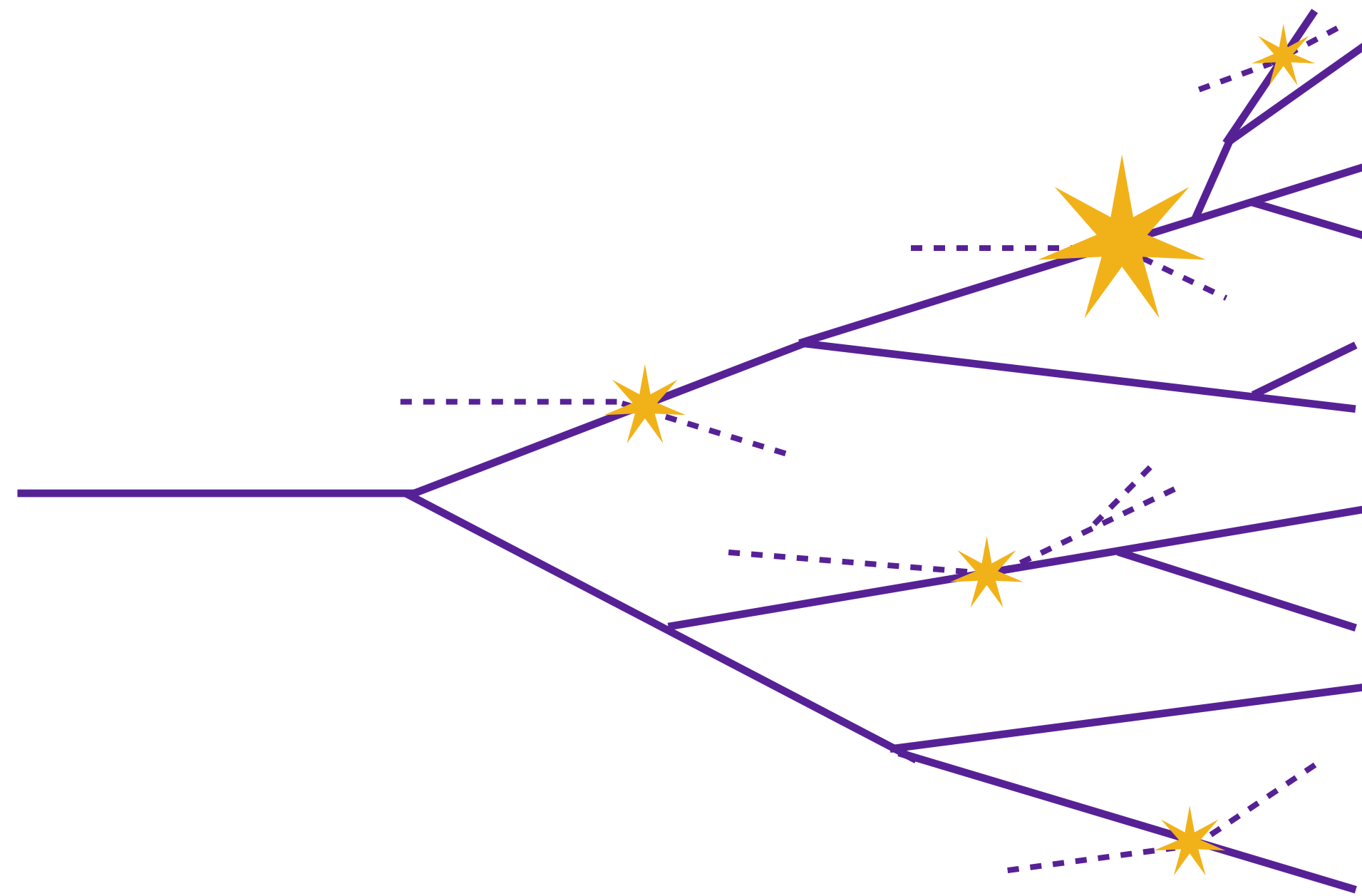


Back up

Introduction

JEWEL

- ♥ J_{EWE}L uses Pythia-6.4 structure but with its own virtuality ordered final state parton shower
- ♥ Partons are allowed to scatter off medium particles via pQCD cross section

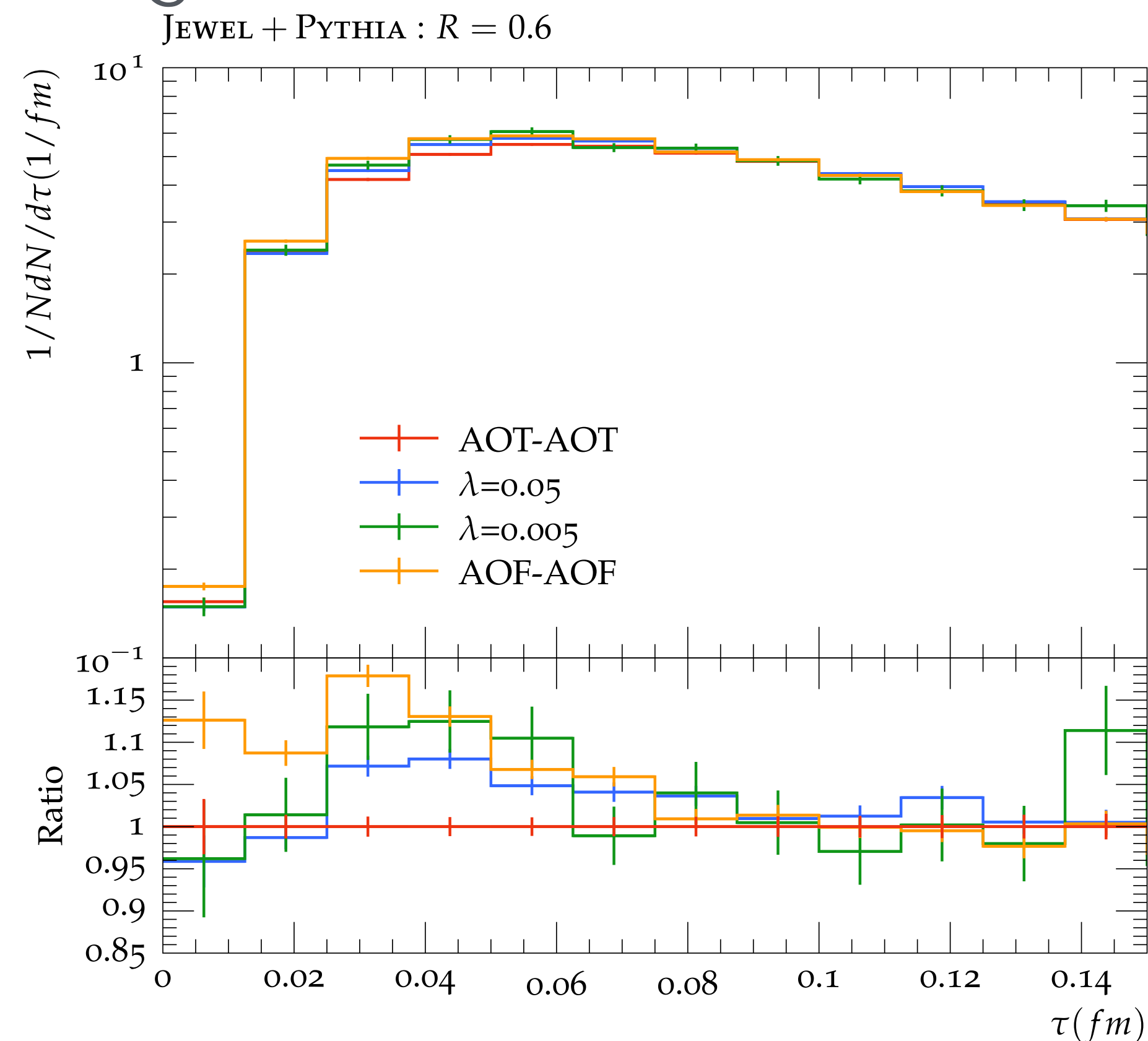
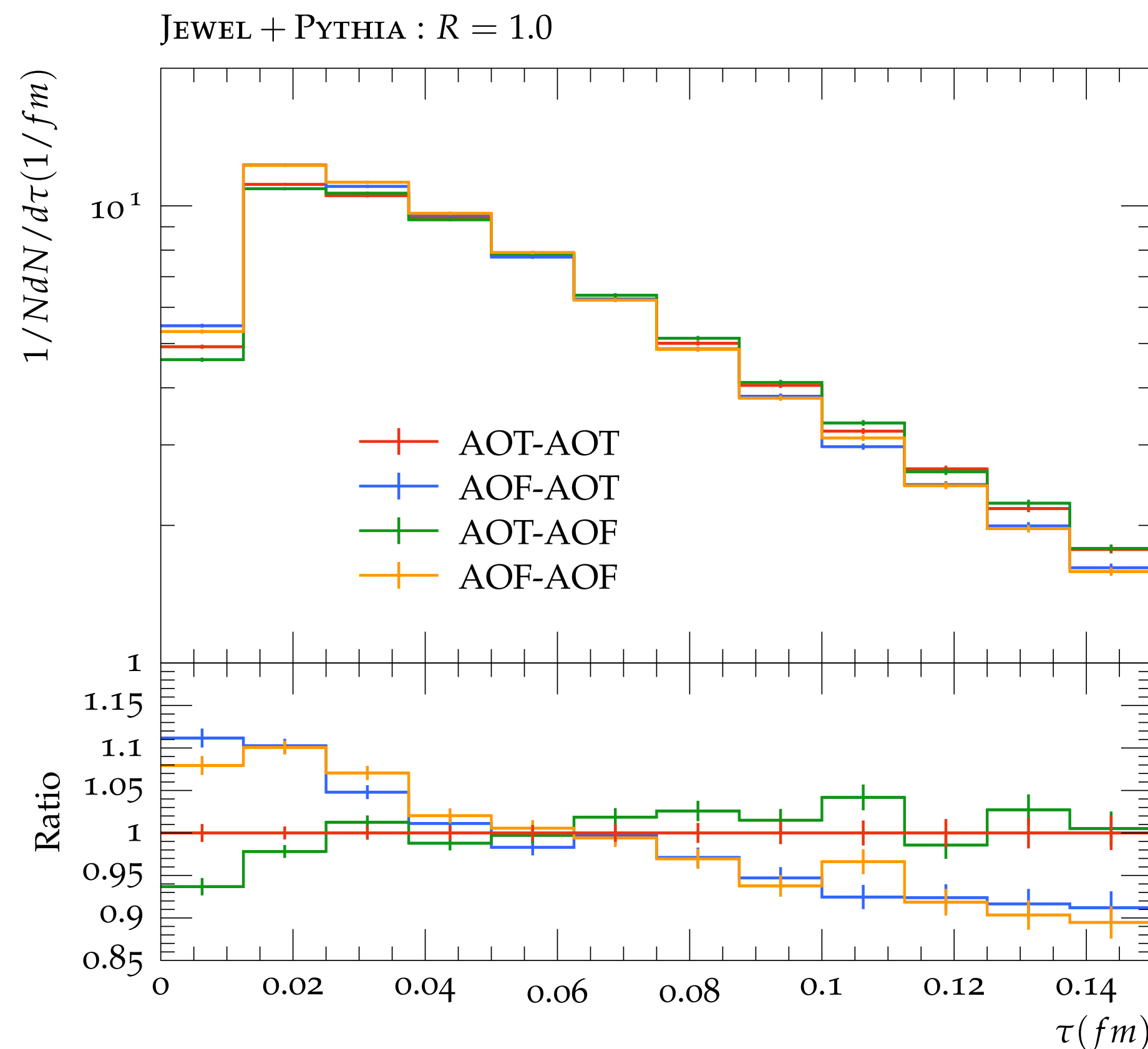


$$\frac{d\sigma}{dt} \propto \frac{\alpha_s^2}{(t + \mu_D^2)^2}$$

Jet Quenching without Energy Loss

Relaxing the assumptions

- τ distribution is not sensitive to coherence breaking in the second splitting
- With the effect also in the second splitting, we can move to smaller radii

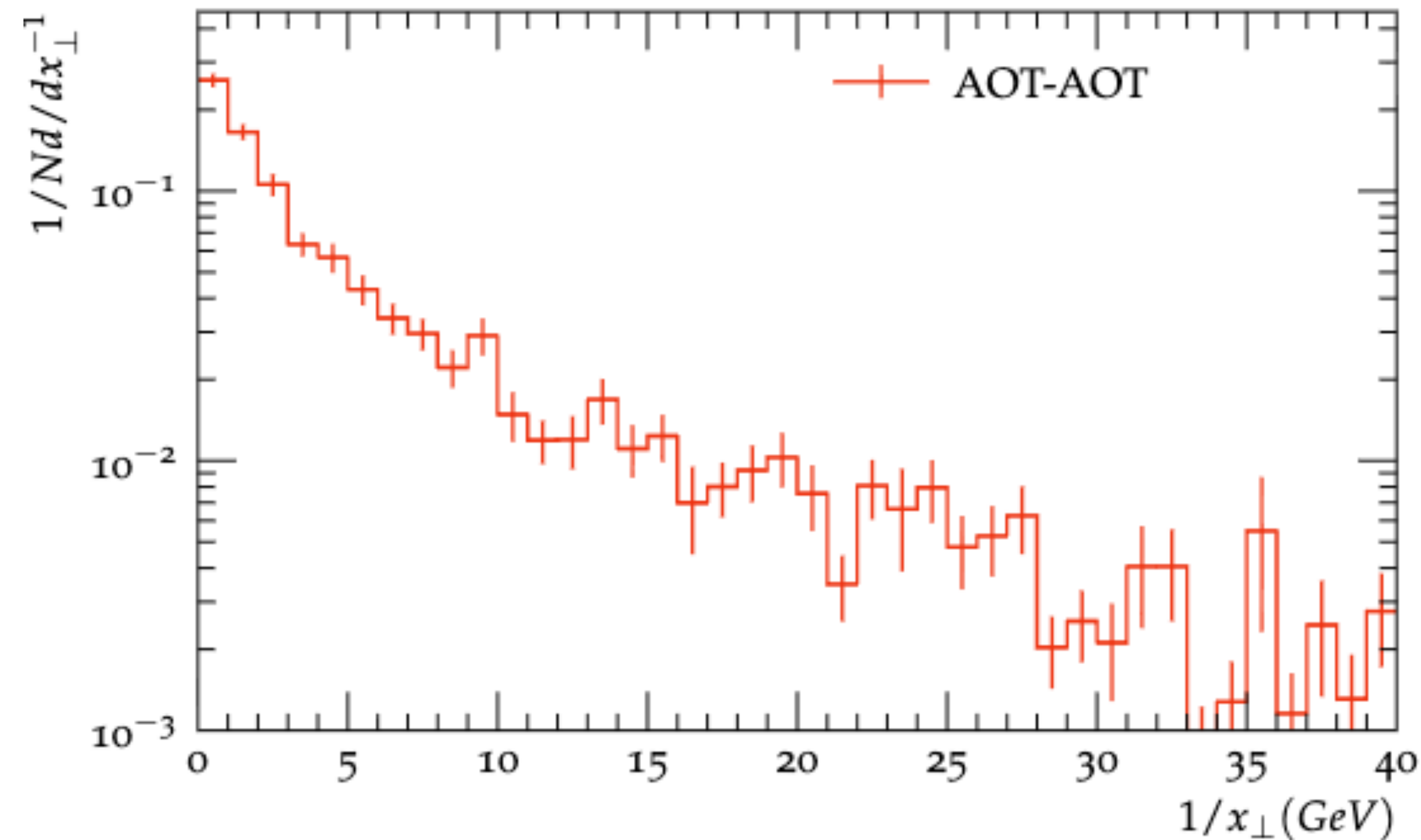


Scattering
probability:
 $1 - e^{-\tau/\lambda}$

Jet Quenching without Energy Loss

Resolving the initial dipole

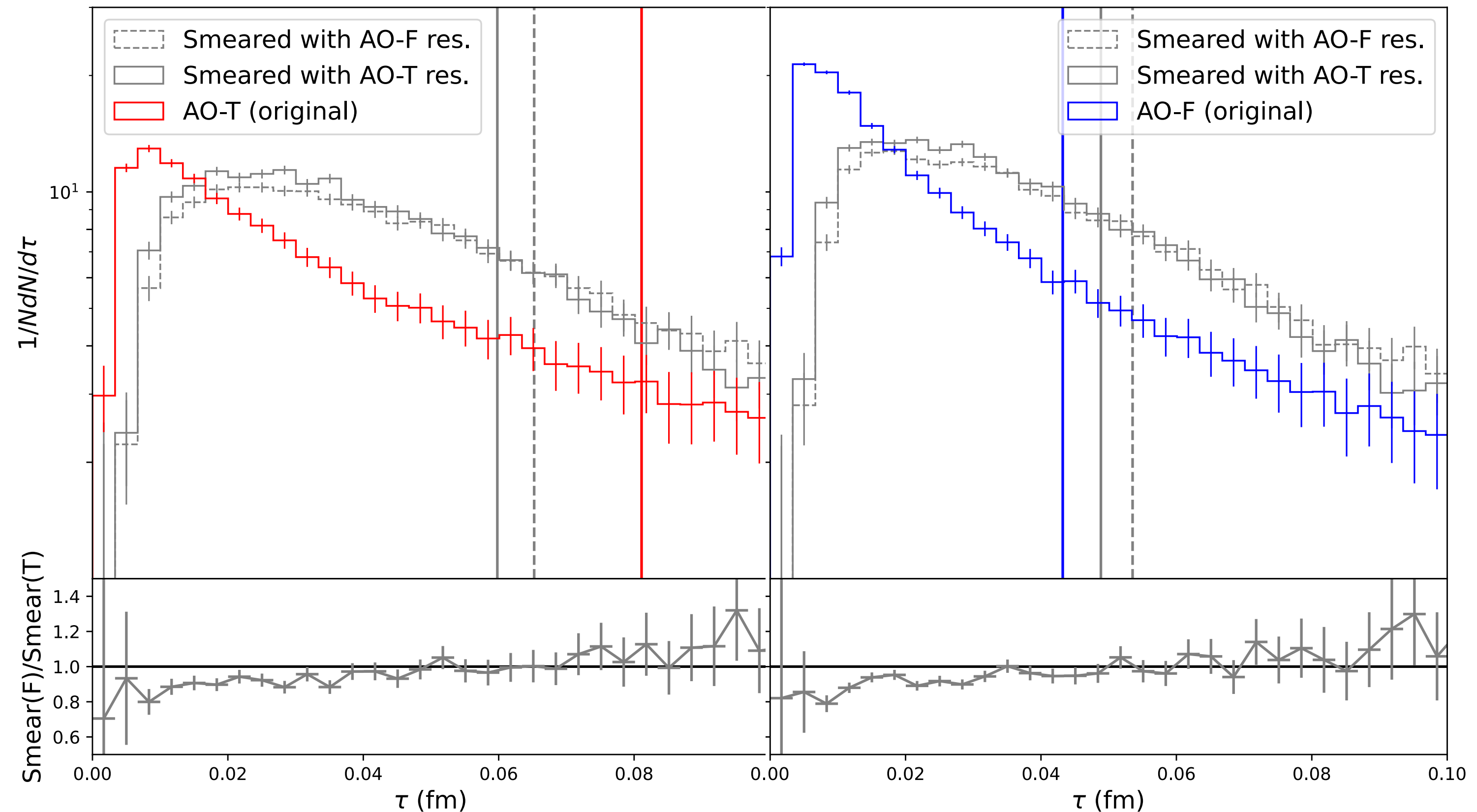
- ♥ Transverse resolution scale for the first emission is typically a few GeV.



Jet Quenching without Energy Loss

Smearing

- Smearing is mainly due to misconstruction effects
- AO-F smearing skews towards larger τ compared to the AO-T smearing
- The reconstructed AO-F still has smaller τ due to the remainder of the *underlying distribution*



Jet Quenching without Energy Loss

Soft drop grooming

♥ Soft drop attenuates the signal but it remains visible

