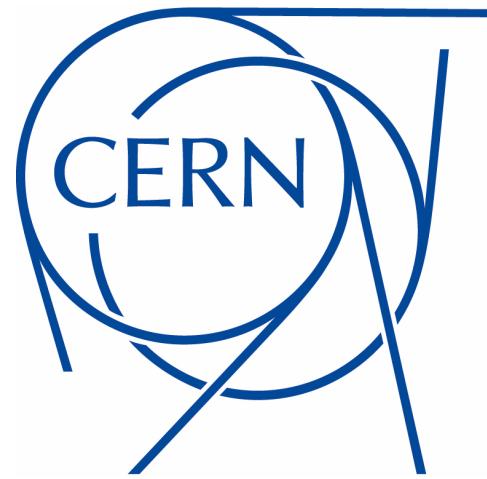


# Jet production and properties in pp and in the medium

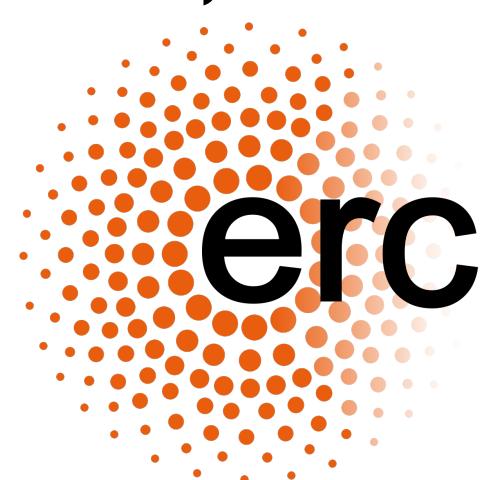


L. Cunqueiro, J. Holguin, D. Pablos, A. Soto-Ontoso, M. Spousta, A. Takacs, M. Verweij



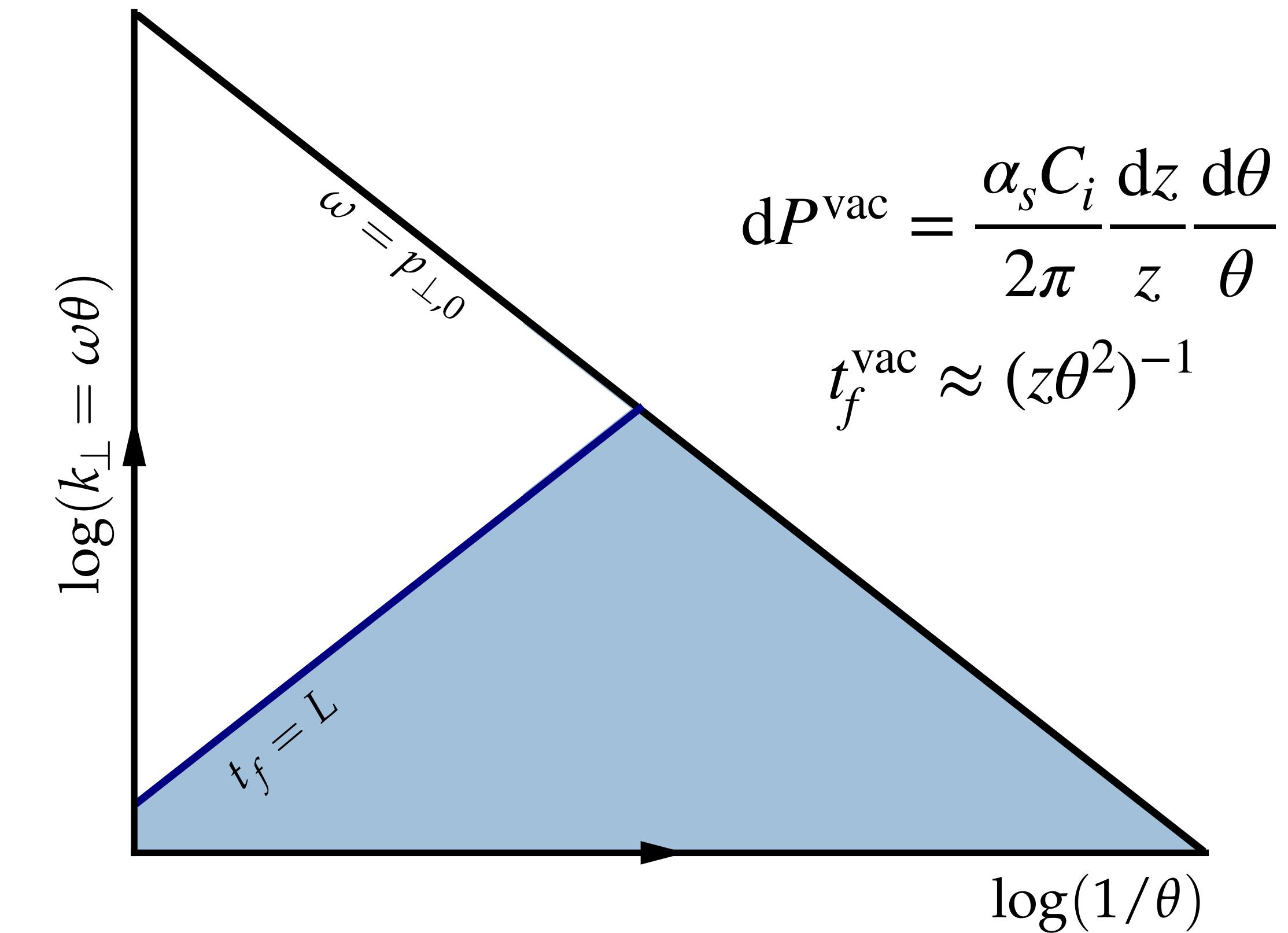
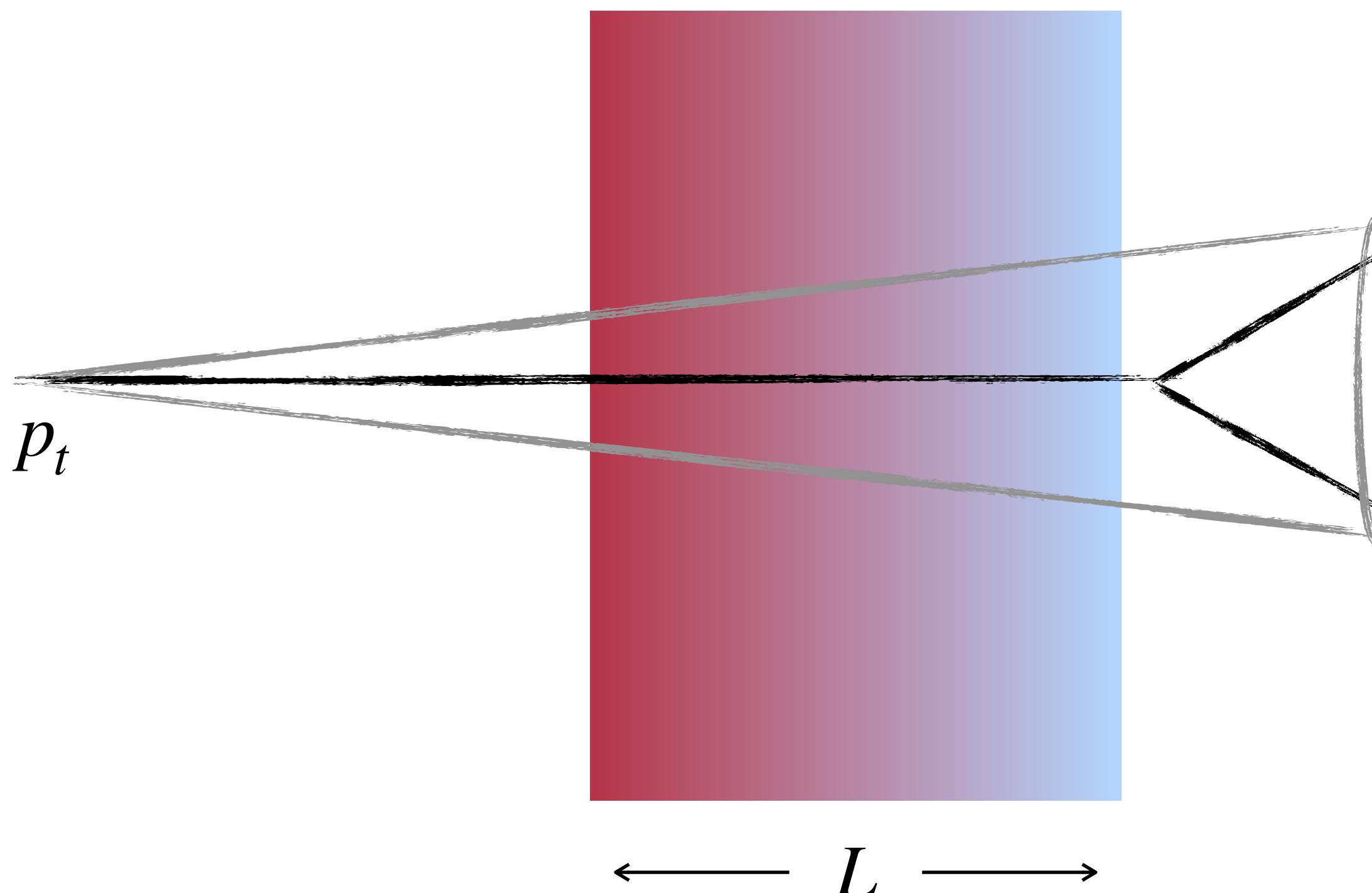
QCD Challenges from pp to AA collisions

Padova, 17th February, 2023



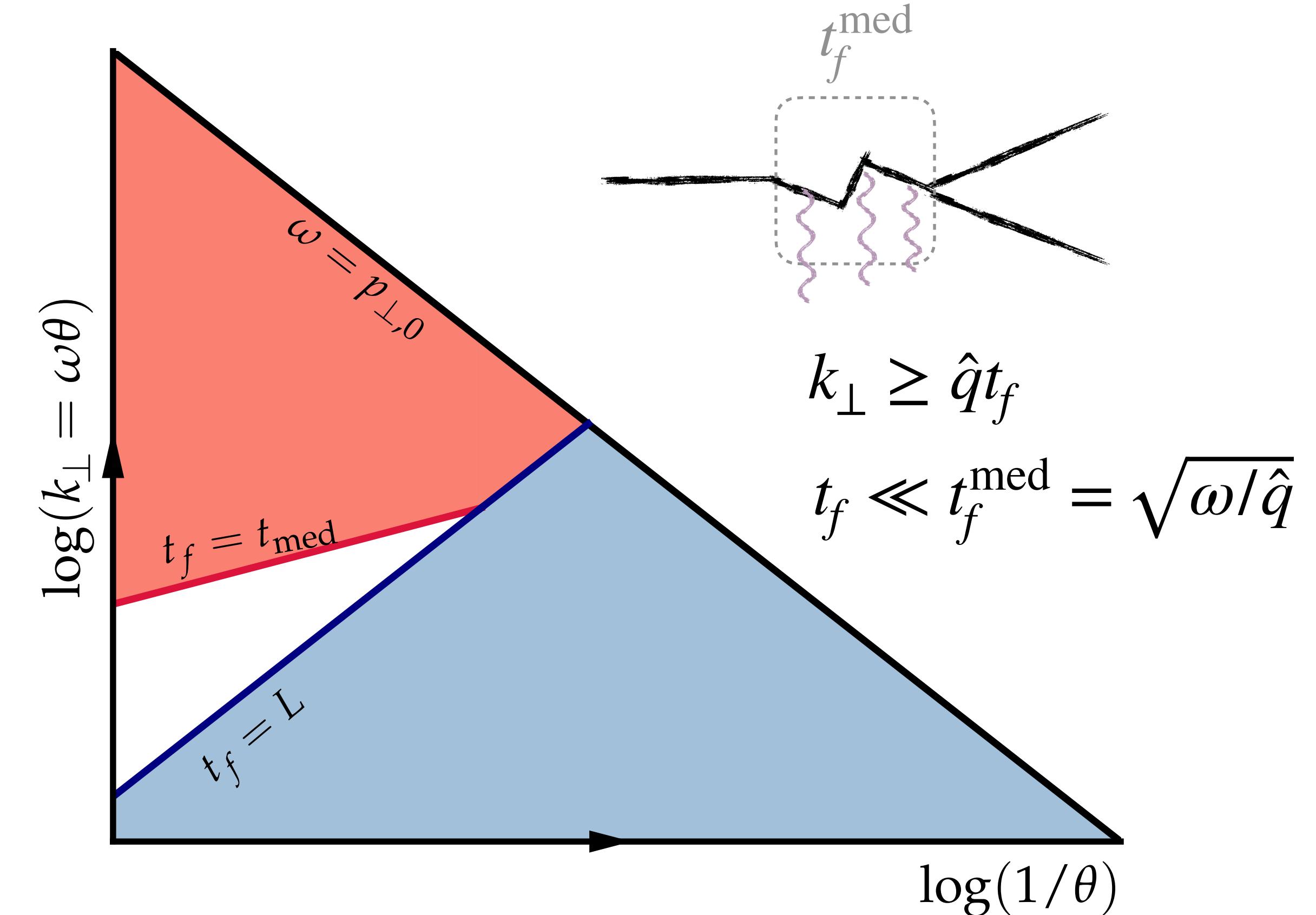
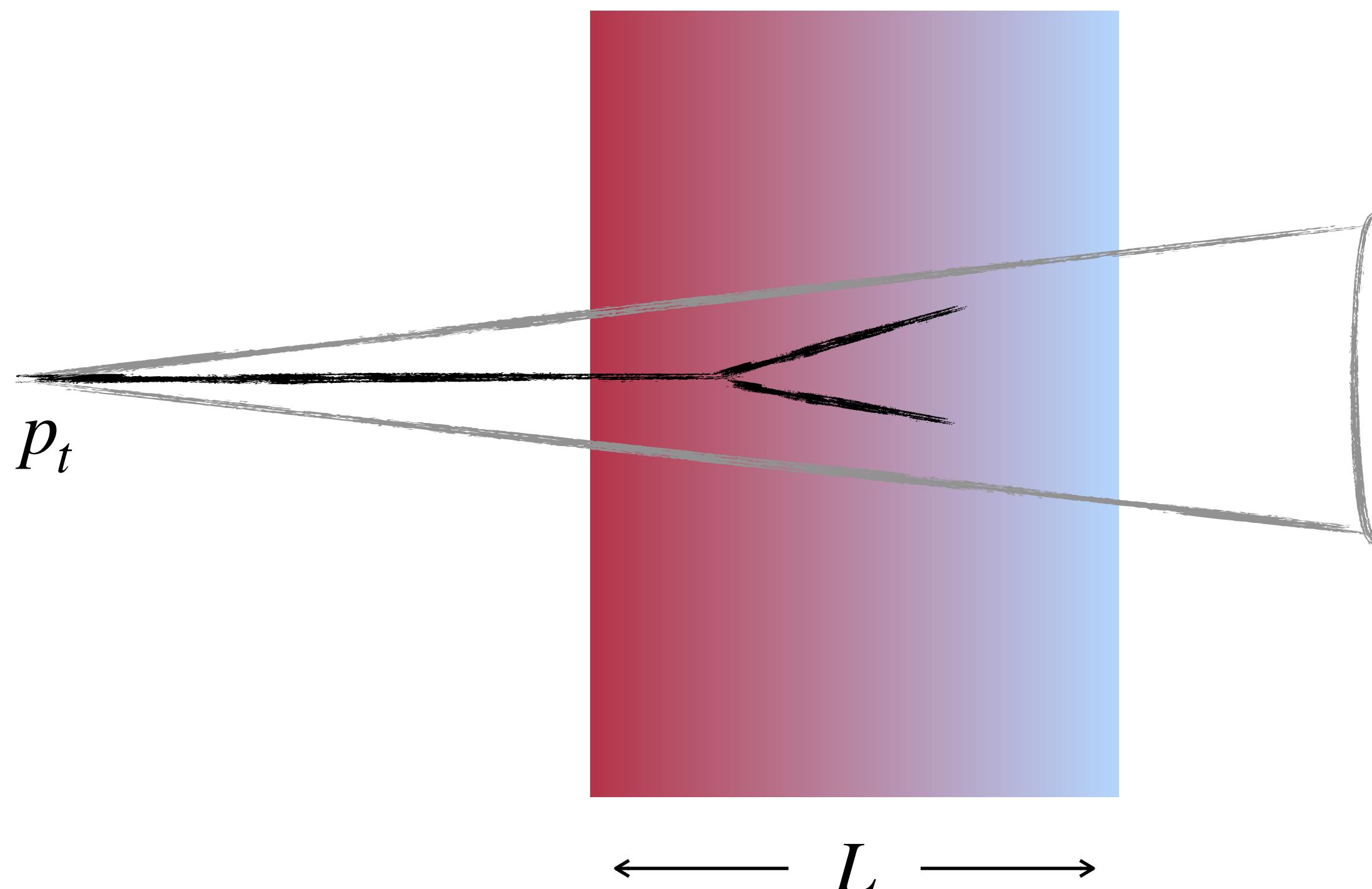
# Jet evolution in a nutshell: vacuum emissions outside QGP

— : vacuum splittings



# Jet evolution in a nutshell: vacuum emissions inside QGP

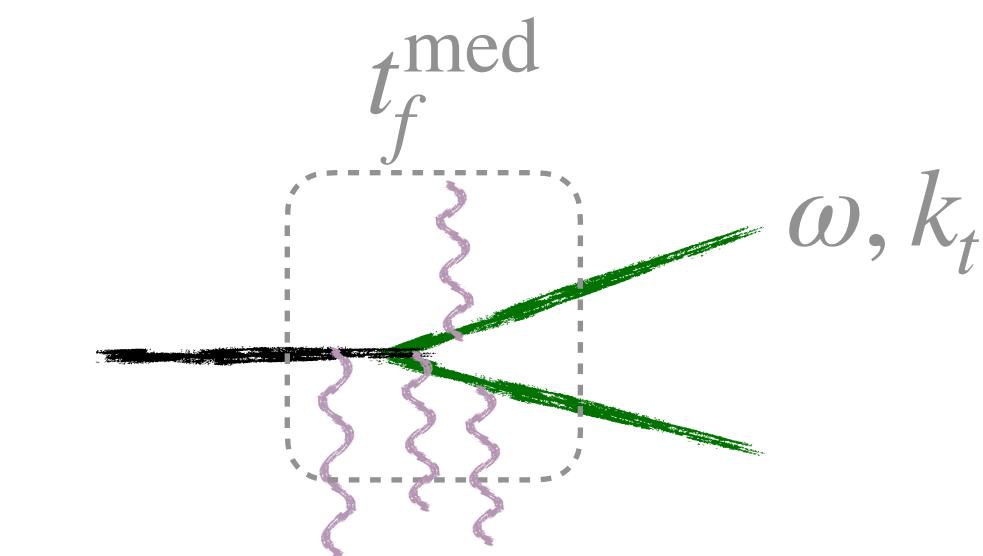
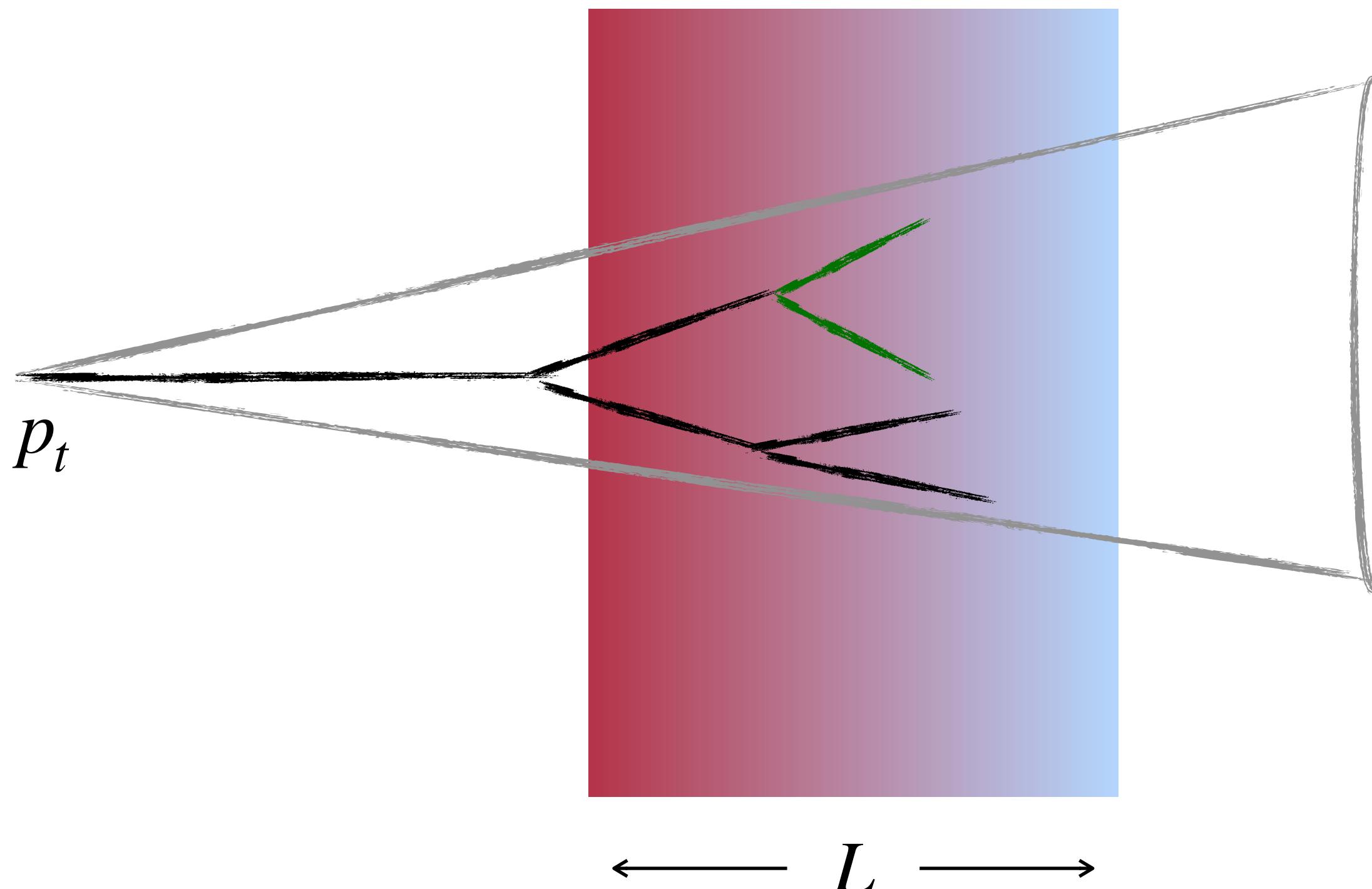
— : vacuum splittings



Transverse momentum broadening sets the scale for medium dynamics

# Jet evolution in a nutshell: medium-induced emissions

— : vacuum splittings    — : medium induced splittings



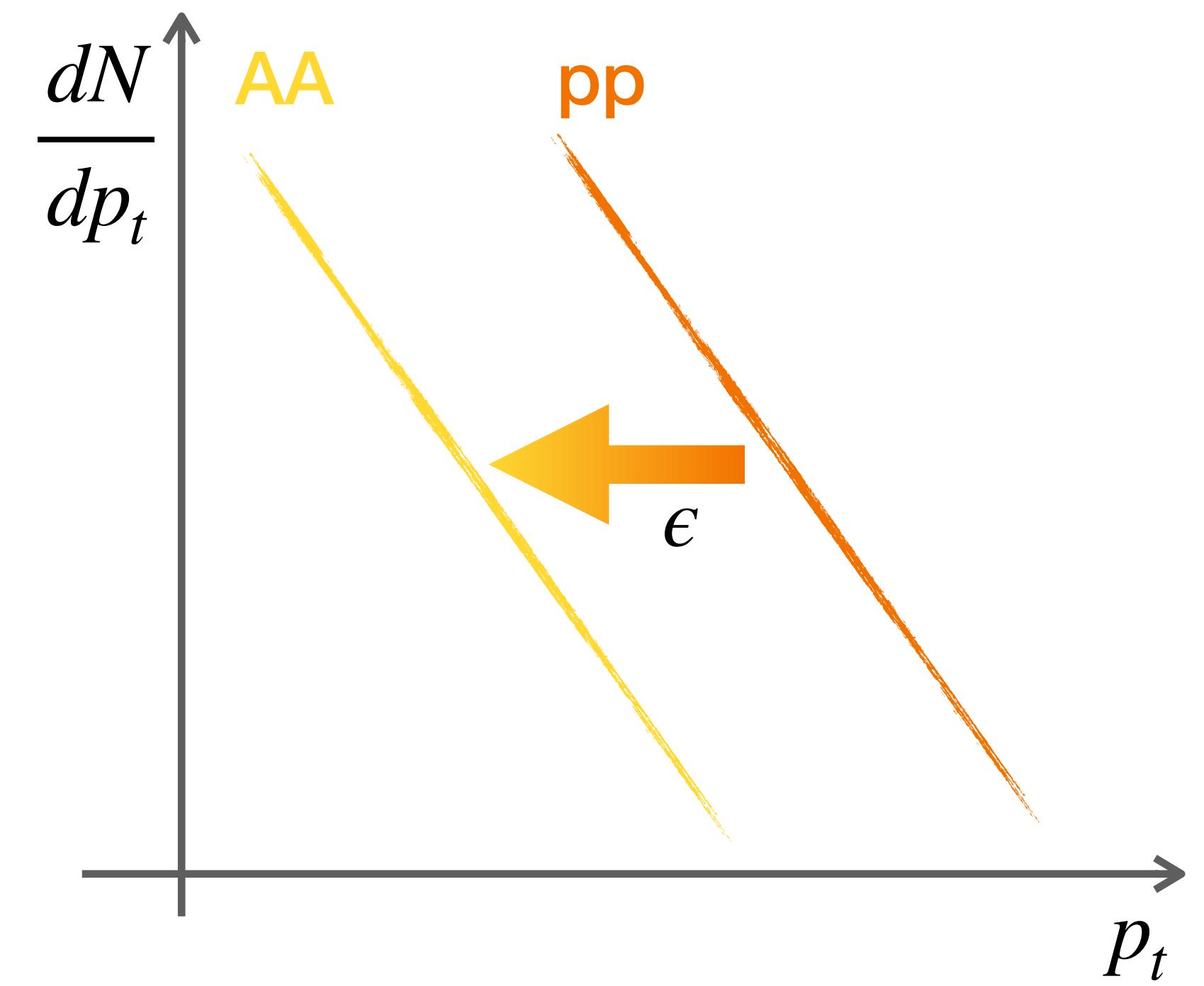
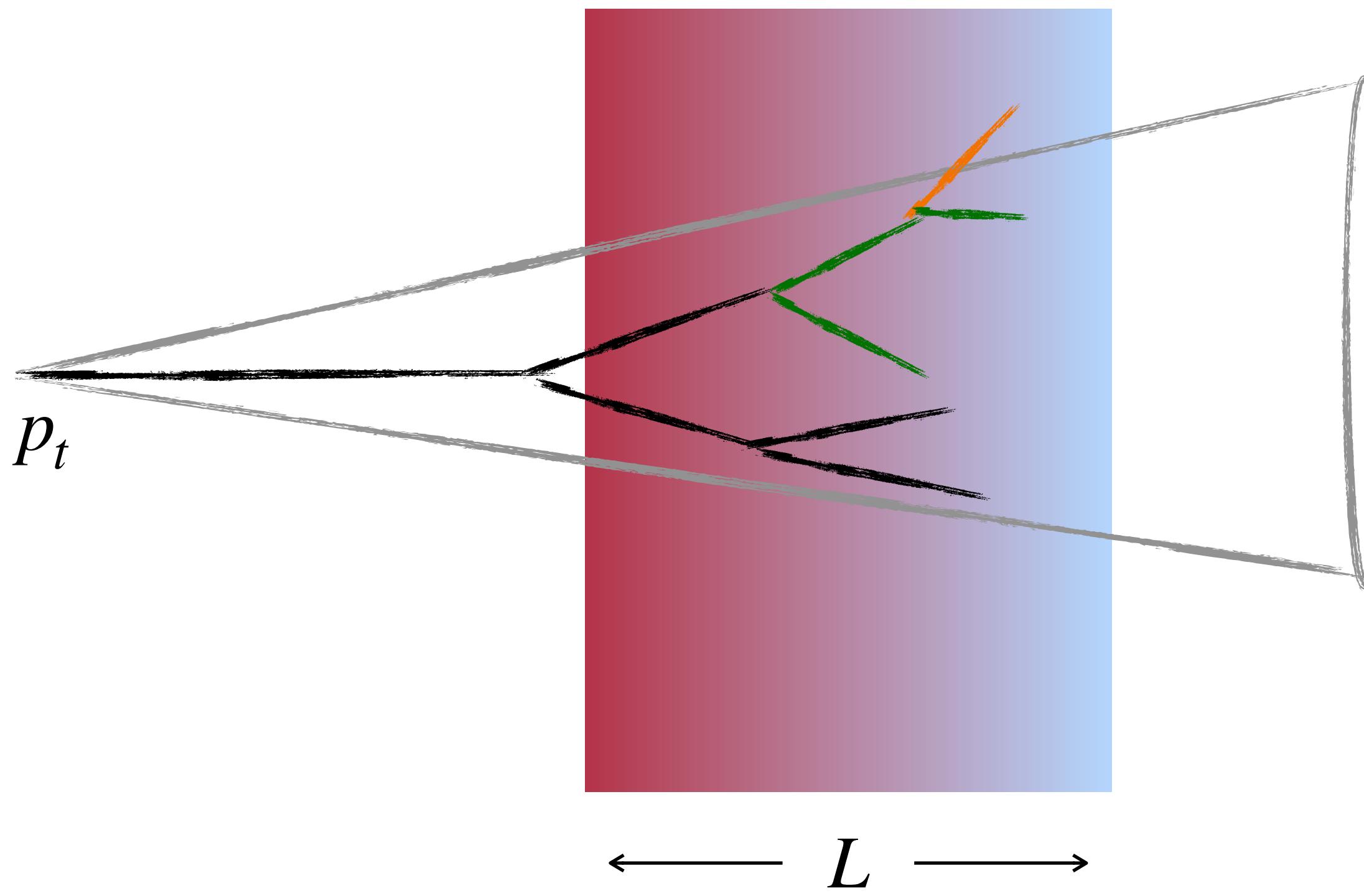
$$dP^{\text{mie}} = \frac{\alpha_s^{\text{med}} C_i}{2\pi} \frac{dI}{d\omega d^2 k_t}$$

[See C. Andres talk]

Medium-induced emissions are typically soft, wide angle emissions

# Jet evolution in a nutshell: medium-induced emissions

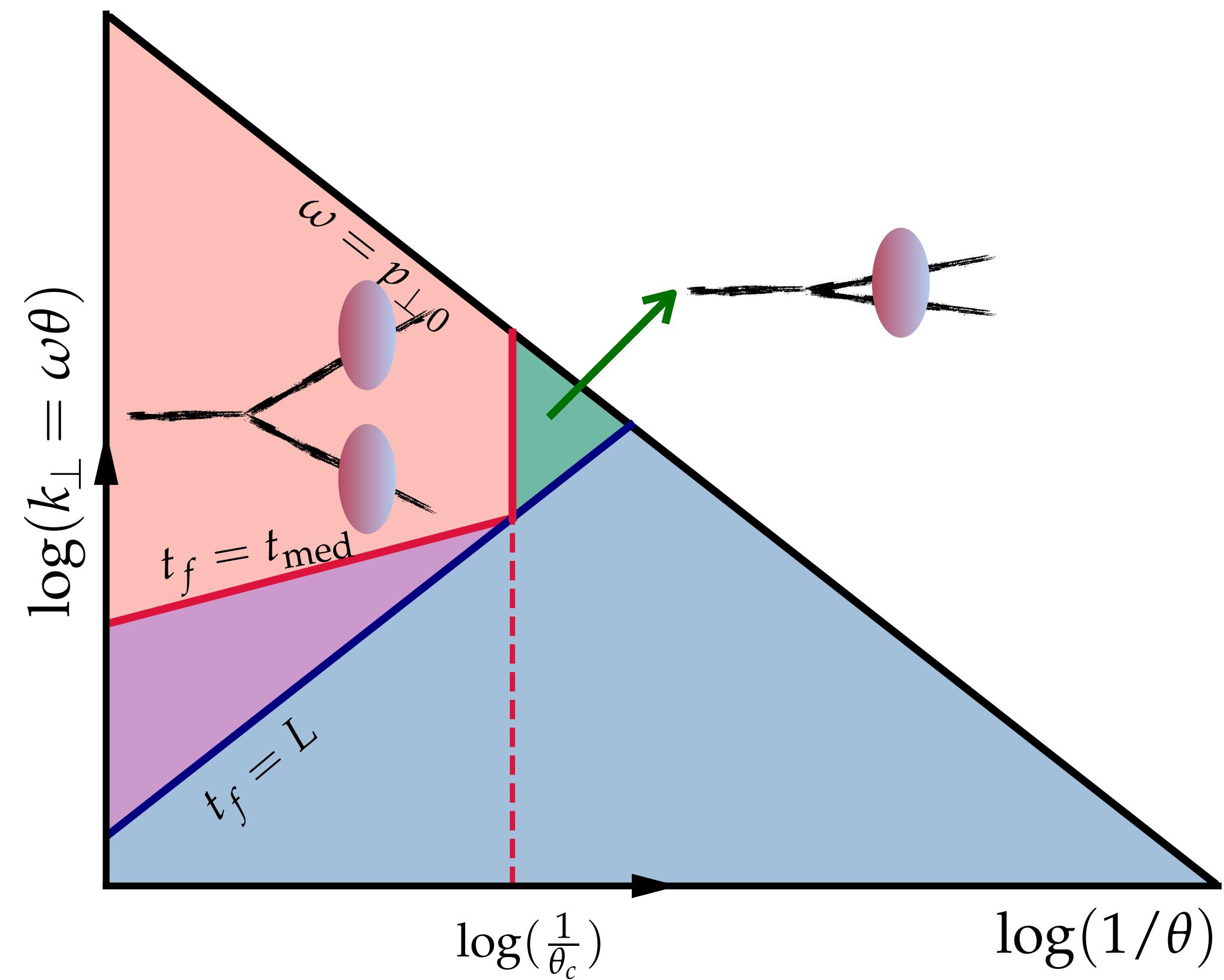
— : vacuum splittings    — : medium induced splittings    — : energy loss



$$\text{Quenching: } \frac{d\sigma_{\text{med}}}{dp_t} = \int_0^\infty P_>(\epsilon) \frac{d\sigma_{\text{vac}}}{d(p_t + \epsilon)} d\epsilon$$

# Jet evolution in a nutshell: color coherence

— : vacuum splittings    — : medium induced splittings    — : energy loss

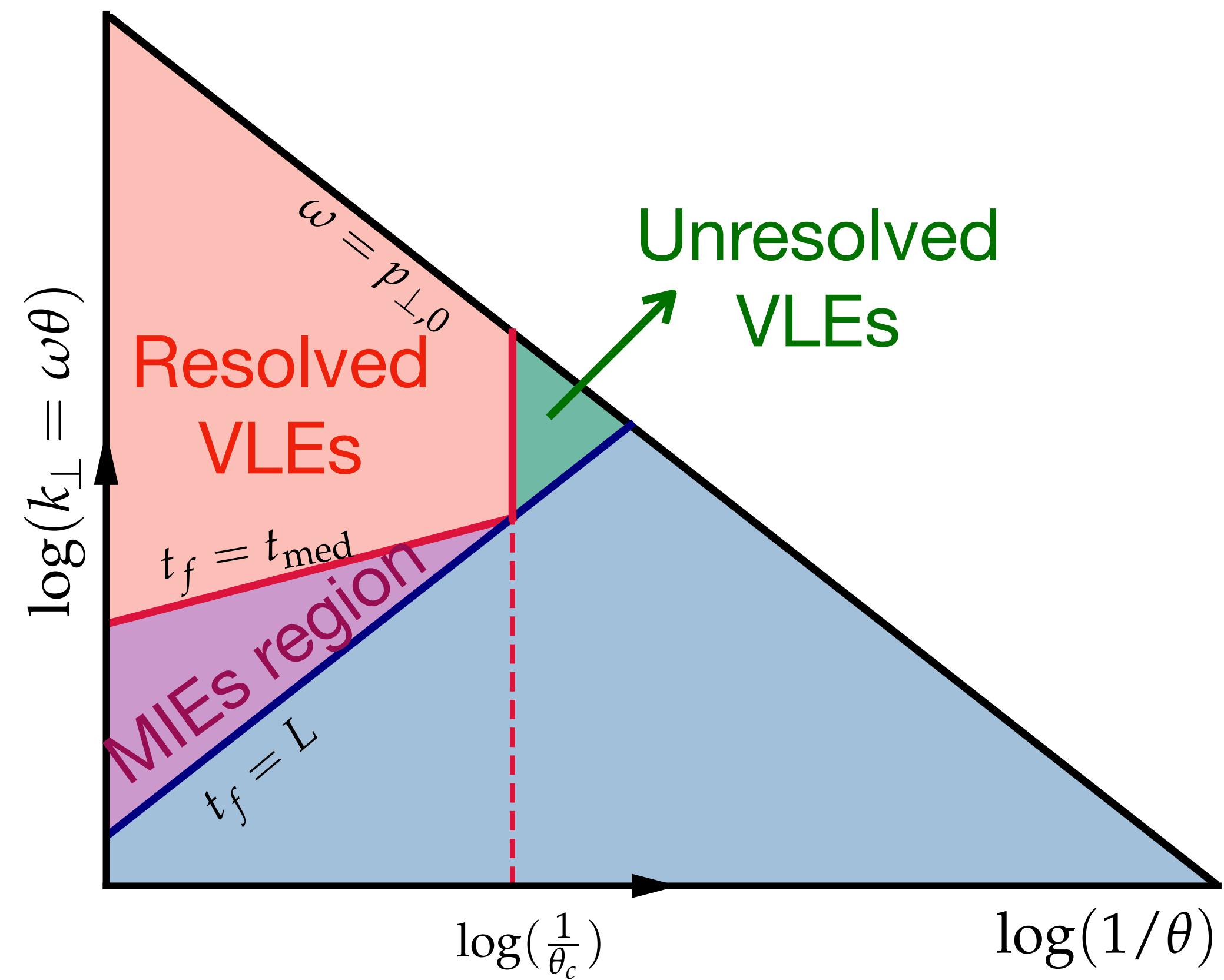


$$\theta_c = \frac{2}{\sqrt{\hat{q}L^3}}$$

$\theta_c$  characterises the resolution power of the medium to propagating color probes

# Jet evolution in a nutshell: medium-induced emissions

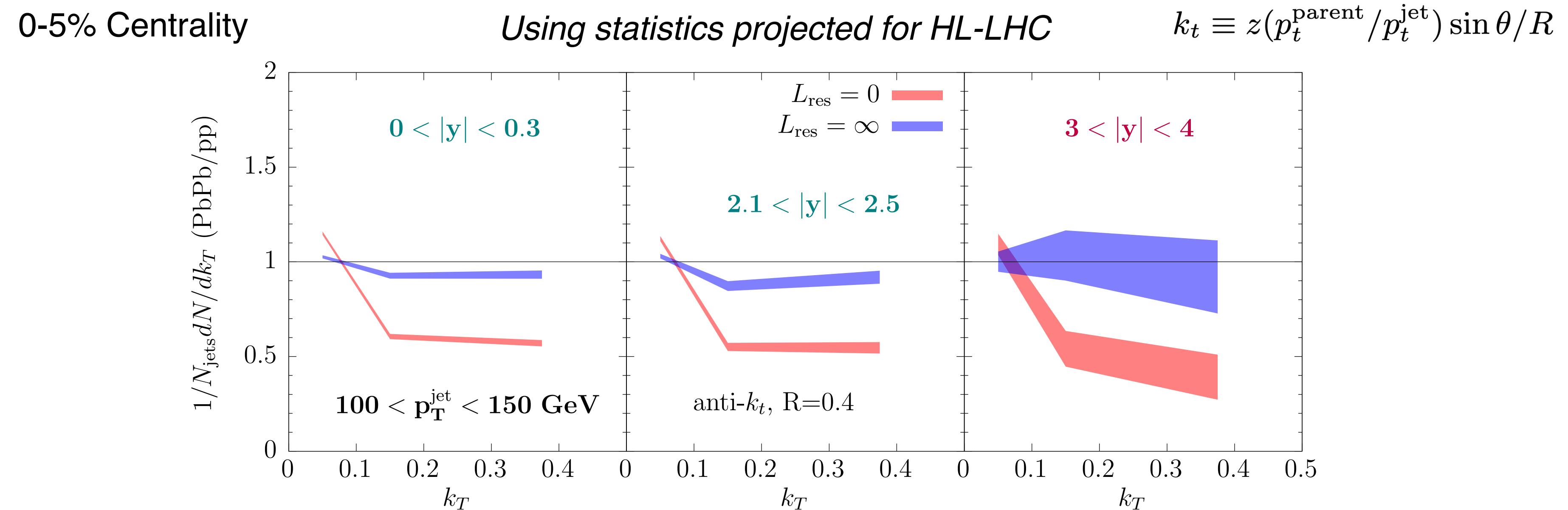
— : vacuum splittings    — : medium induced splittings    — : energy loss



How can we test this description of the in-medium jet evolution?

# Observables for testing color decoherence

## Hybrid Model - Jet Quenching MC



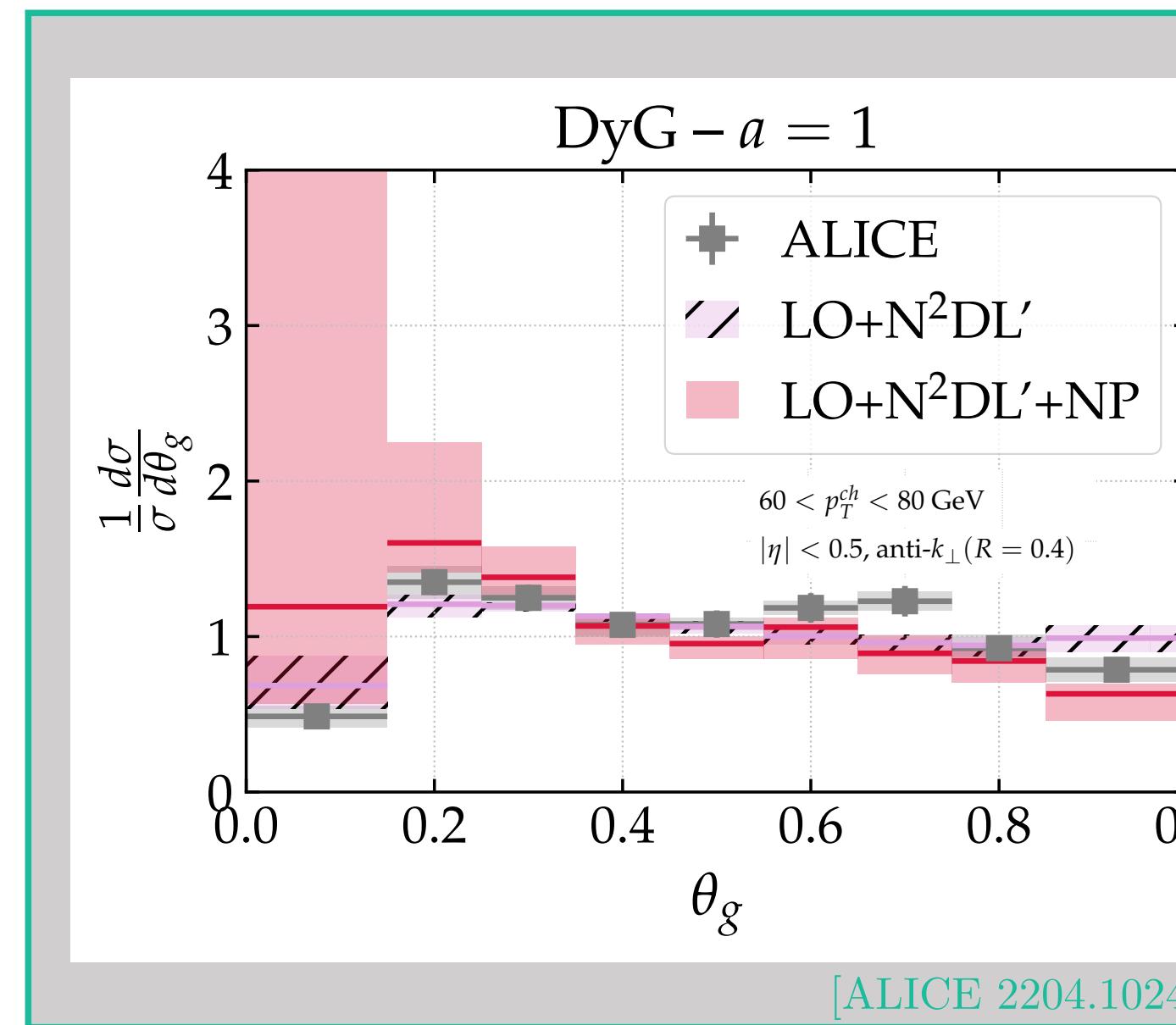
- Small effect from total charge quenching ( $L_{\text{res}} = \infty$ ) at mid-rapidity.
- Narrowing persists at forward rapidities if jet substructure resolved ( $L_{\text{res}}=0$ ).

# Observables for testing color decoherence

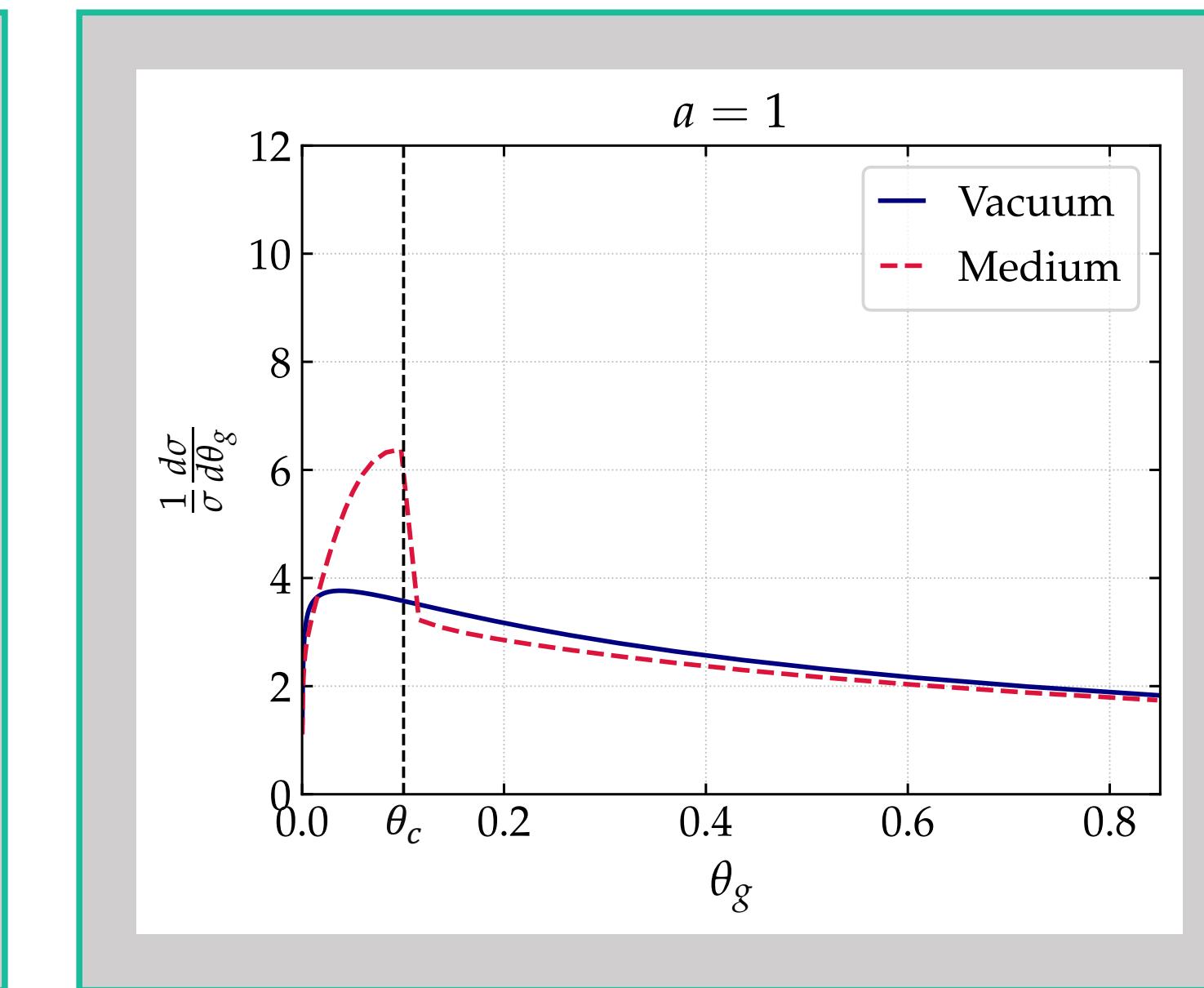
Angle of the hardest branching

[Caucal,Soto-Ontoso,Takacs]

Precise pQCD calculation in pp  
[arXiv:2103.06566]



Changes in AA  
[arXiv:2111.14768]



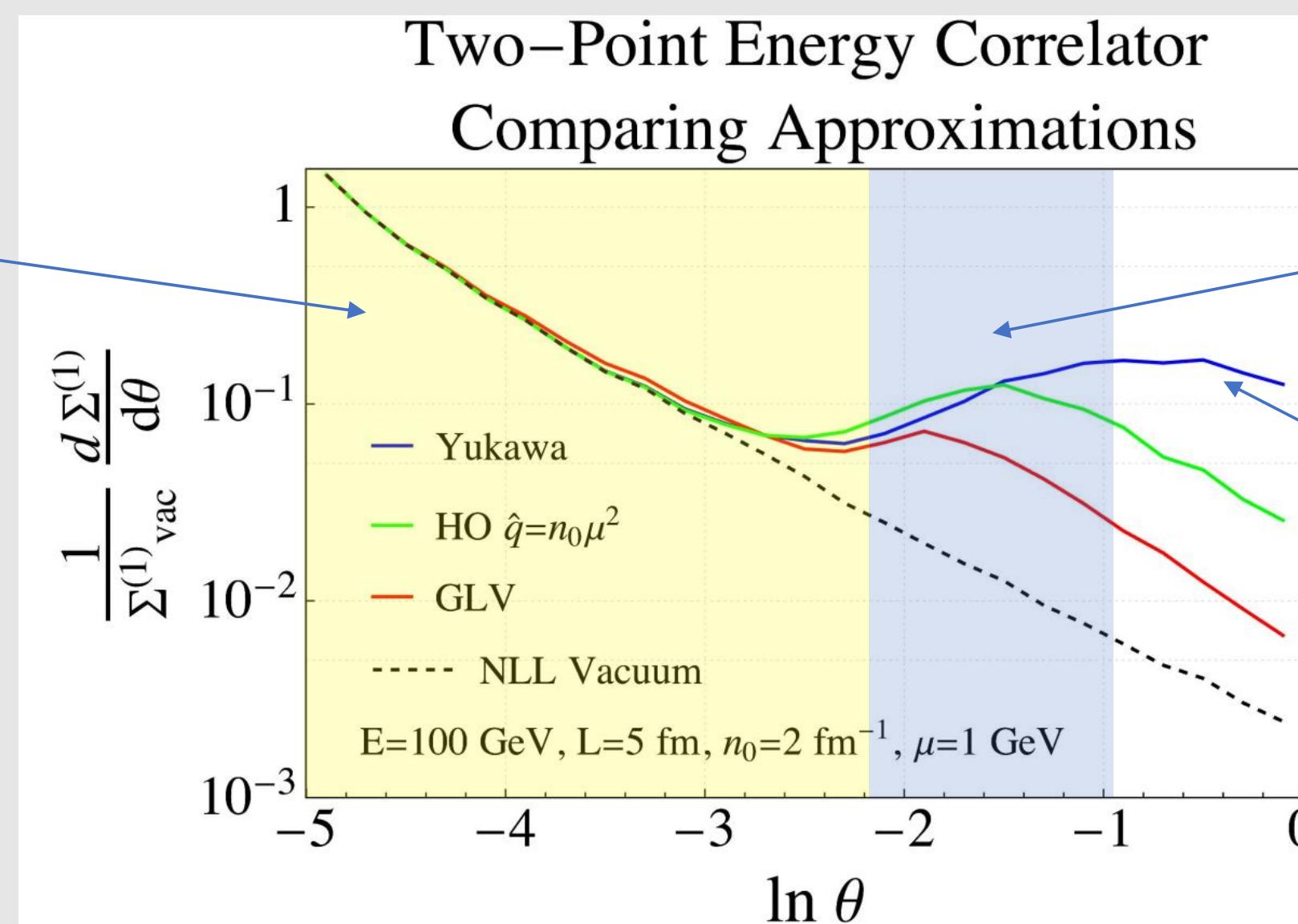
huge enhancement around  $\vartheta_c$ !



# Observables for testing color decoherence

## Numerical evaluation of $F_{\text{med}}$

Controlled by  $\theta_L$



Controlled by  $(\theta_c - \theta_L)$

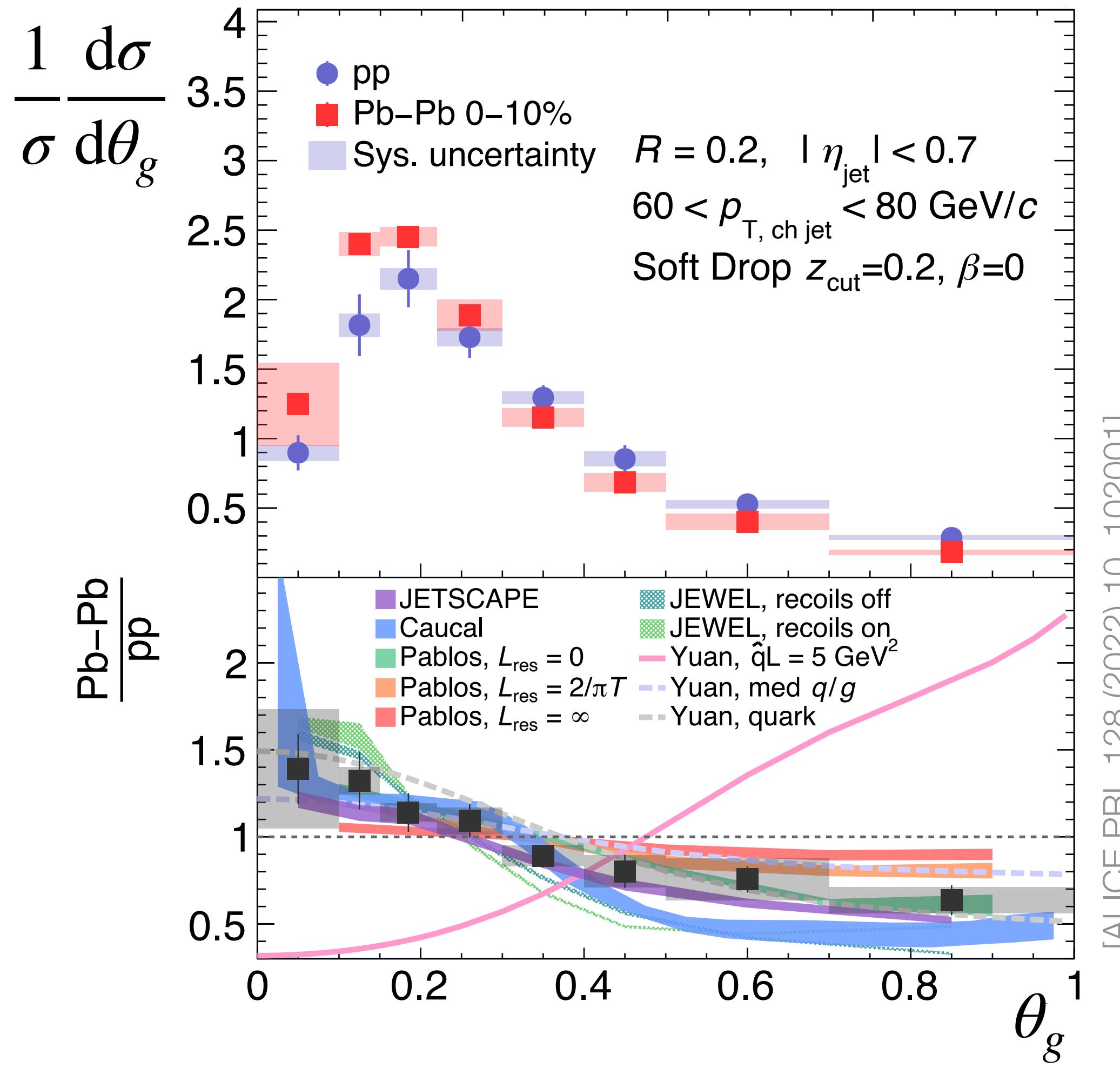
Controlled by number of  
large scatters limit.  
Behaves as if medium is  
infinitely long and so  
always decoherent.

Provided  $E \gg E_c \sim \hat{q}L^2$

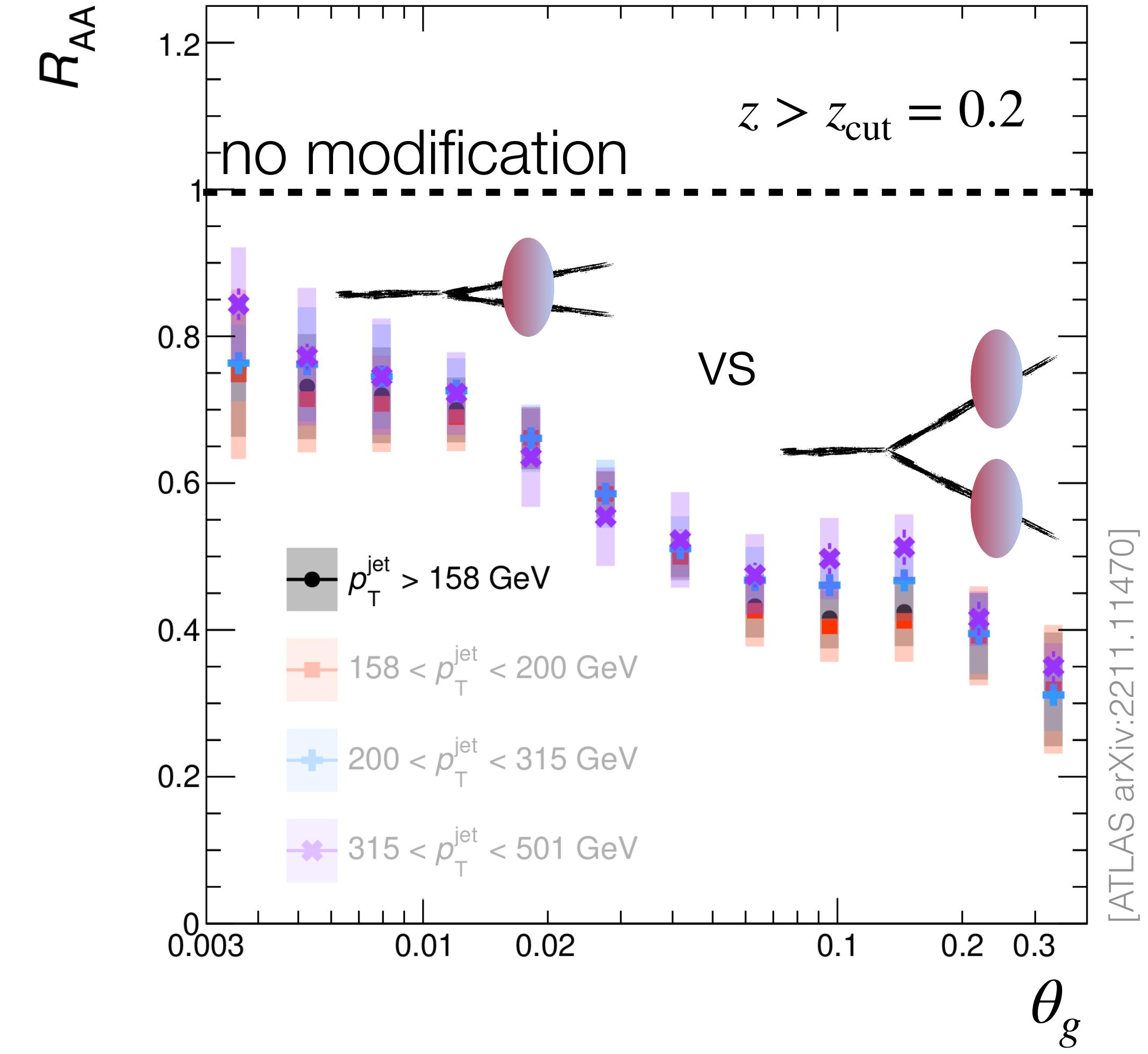
13/02/2023

[Jack Holguin's talk]

# Experimental indications of color decoherence



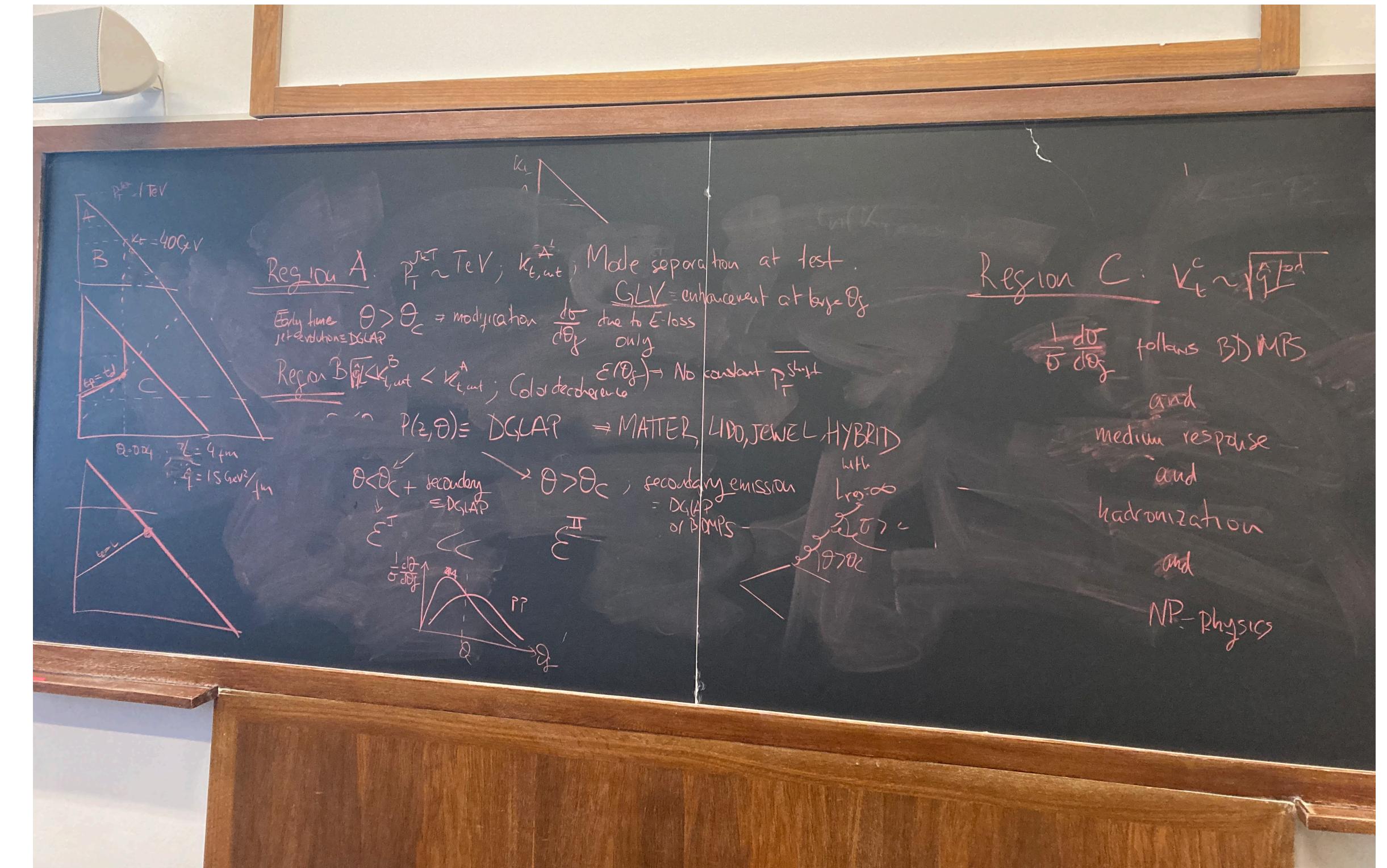
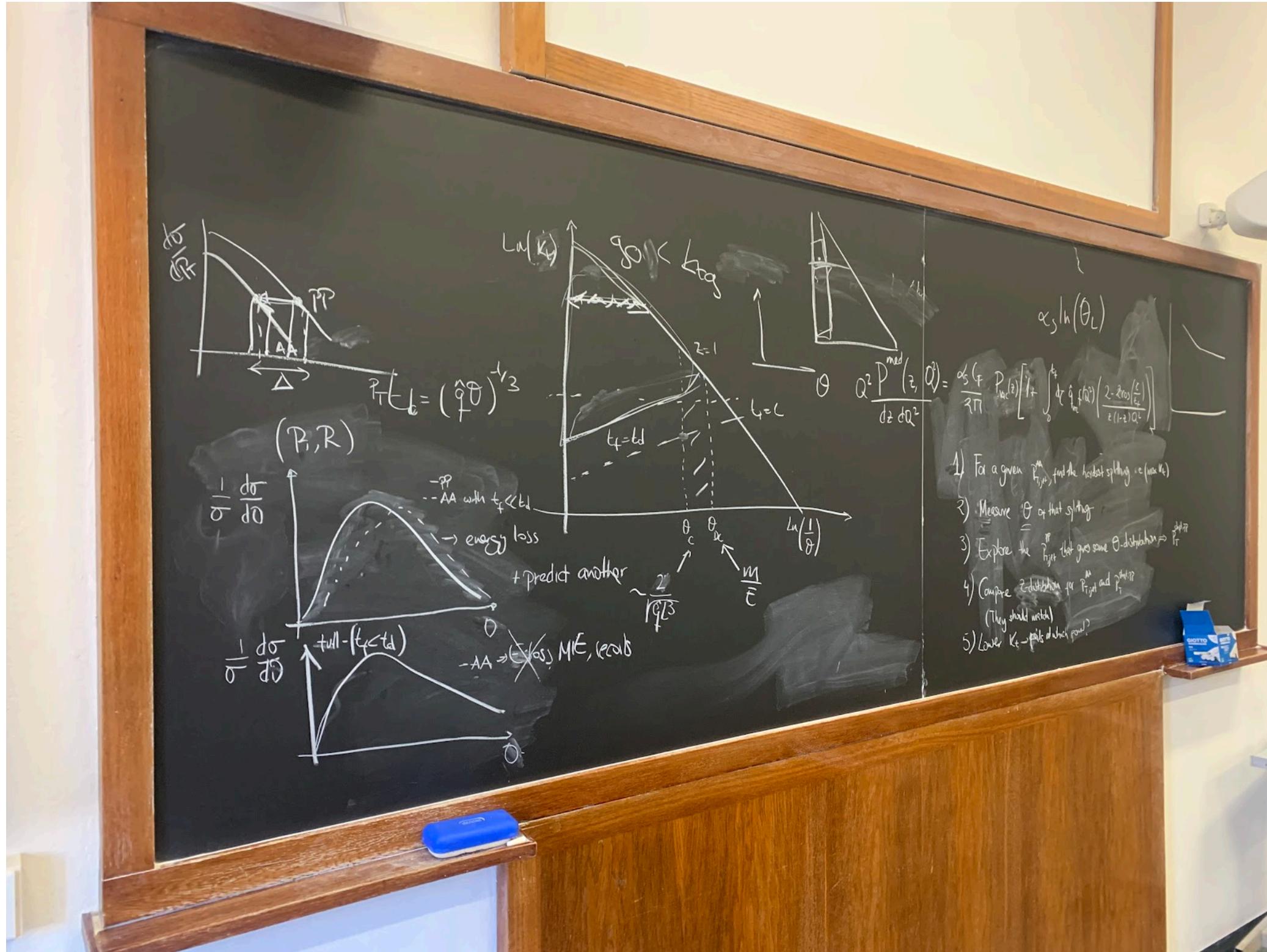
[ALICE PRL 128 (2022) 10, 102001]



[ATLAS arXiv:2211.11470]

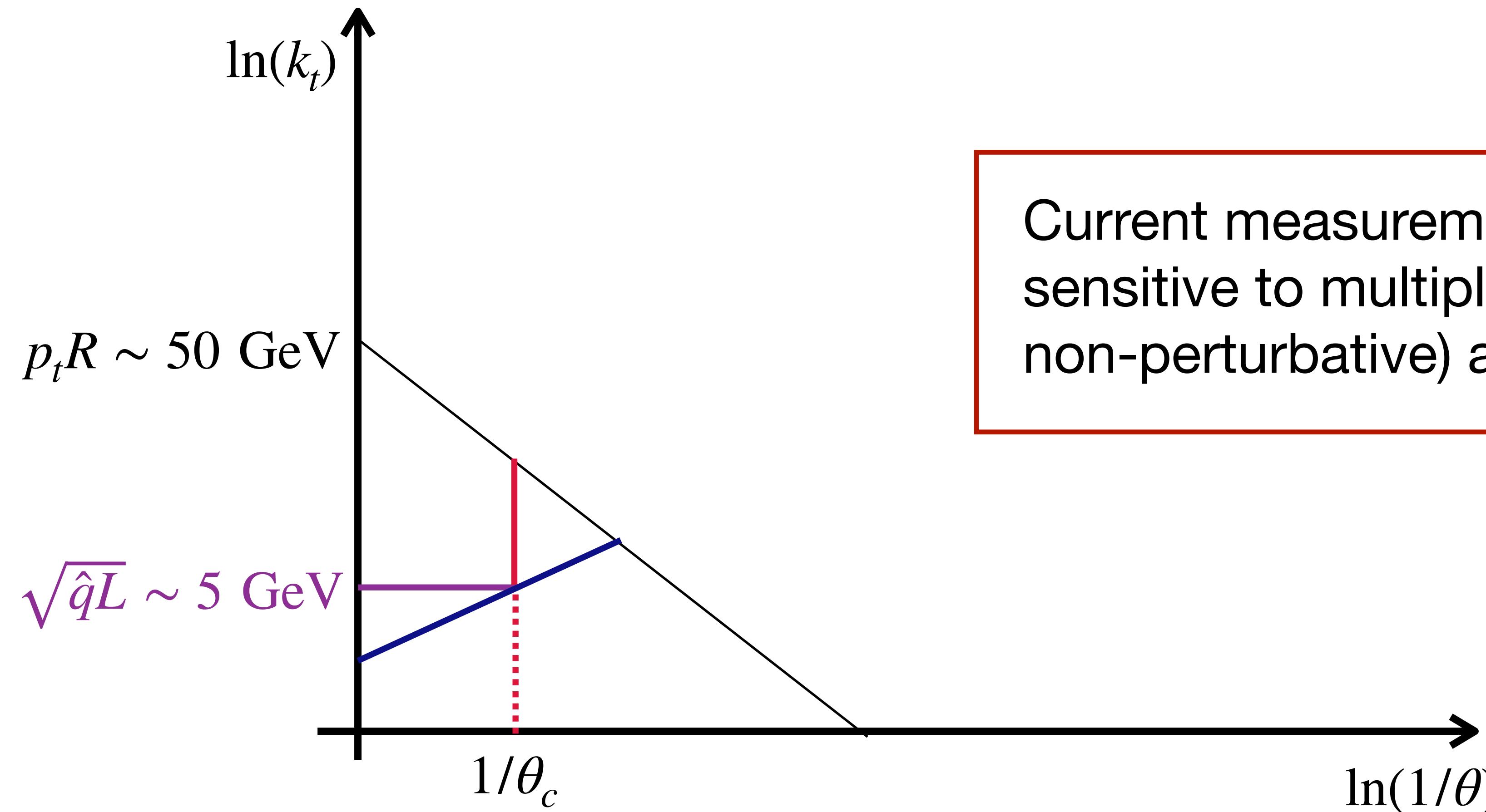
No conclusive evidence of critical angle in current data

# Brainstorming in Padova



# New idea: scanning the Lund plane with substructure

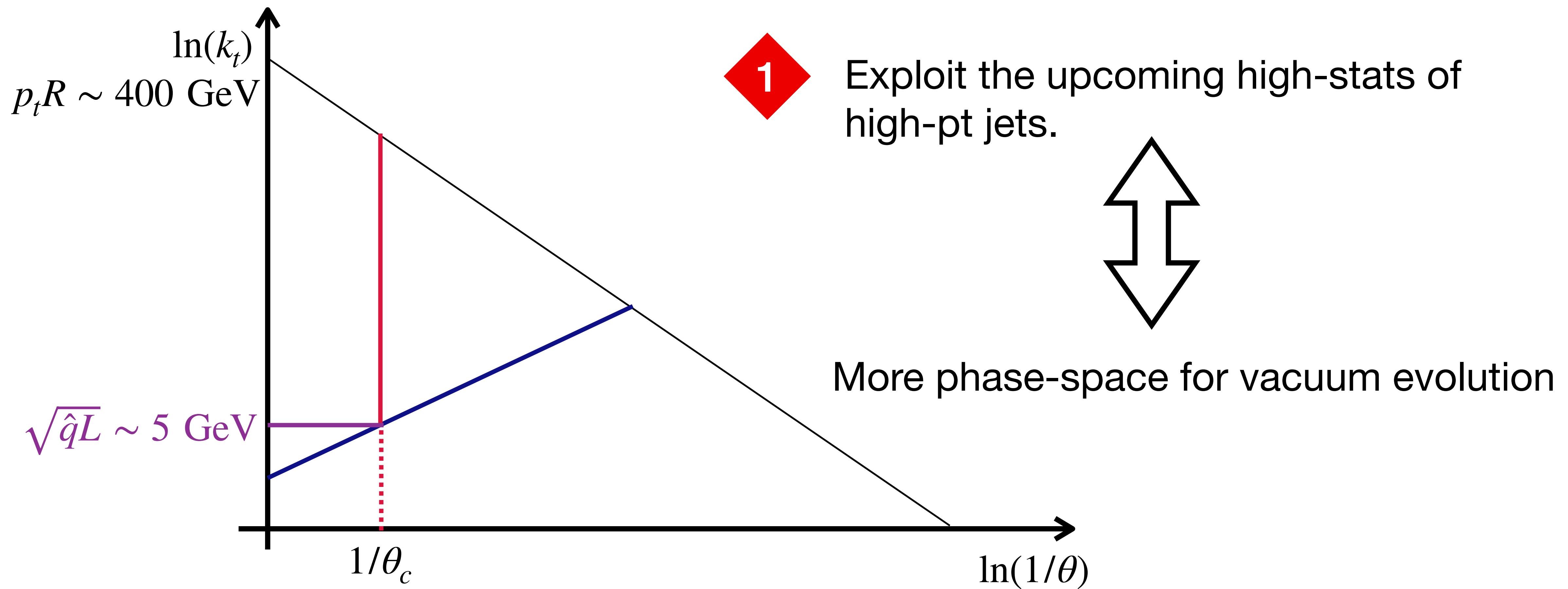
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Current measurements (low-pt jets) are sensitive to multiple effects (pQCD vs non-perturbative) at once

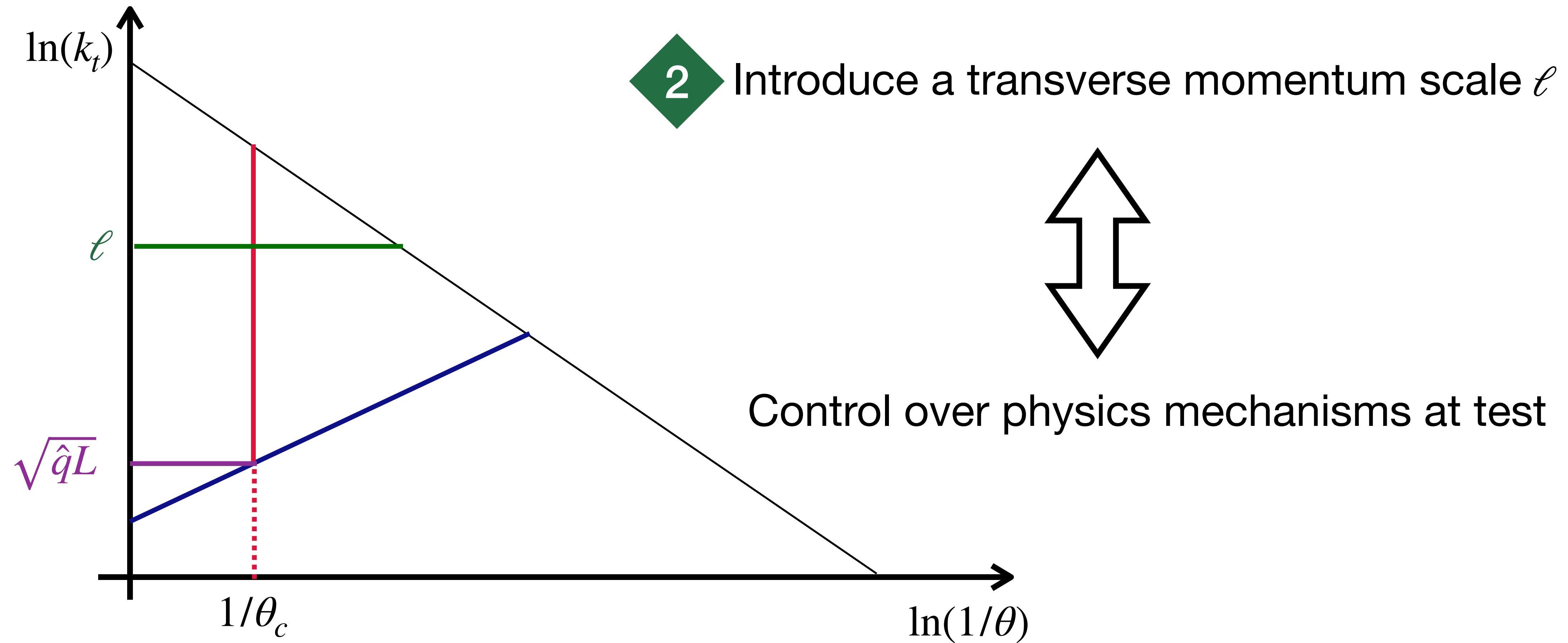
# New idea: scanning the Lund plane with substructure

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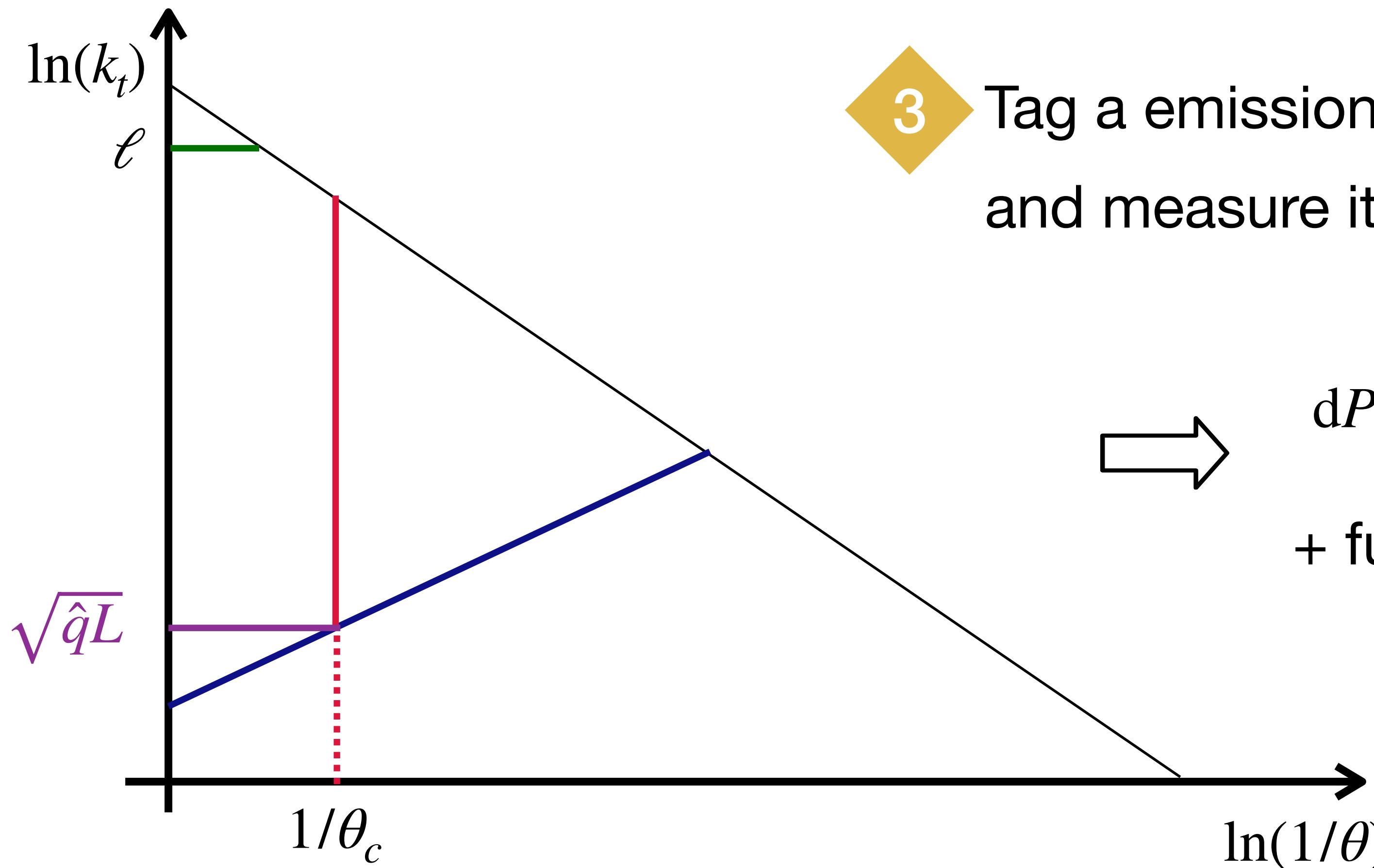


# New idea: scanning the Lund plane with substructure

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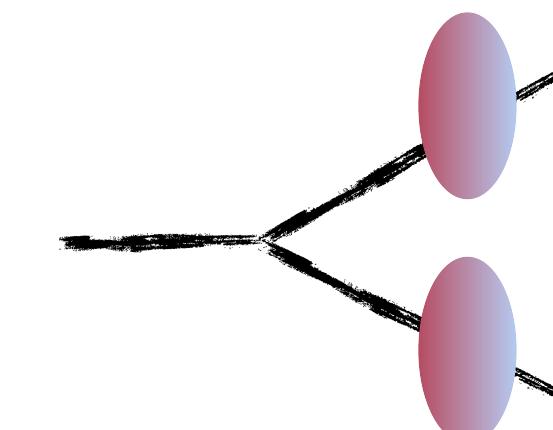


# New idea: scanning the Lund plane with substructure

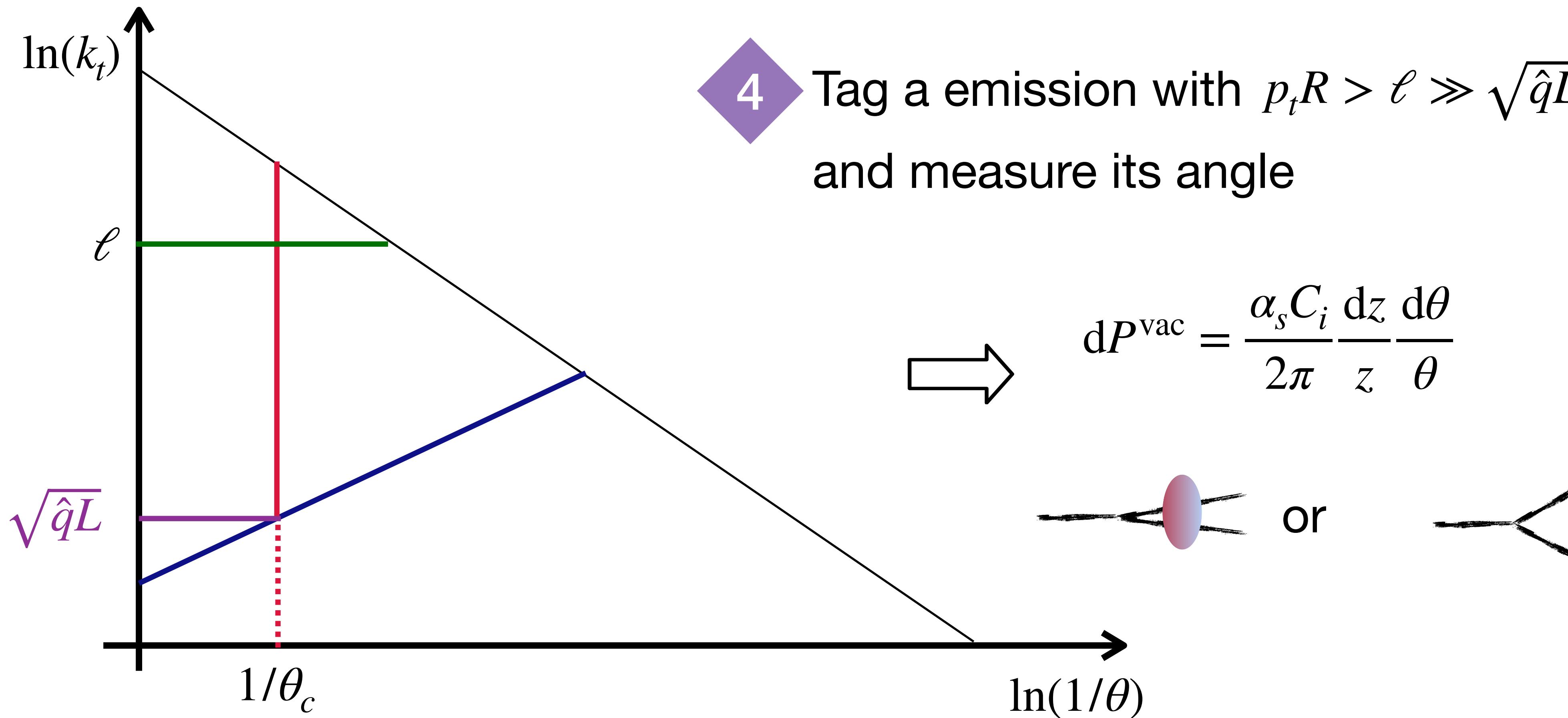


3 Tag a emission with  $\ell \sim p_t R \gg \sqrt{\hat{q}L}$   
and measure its angle

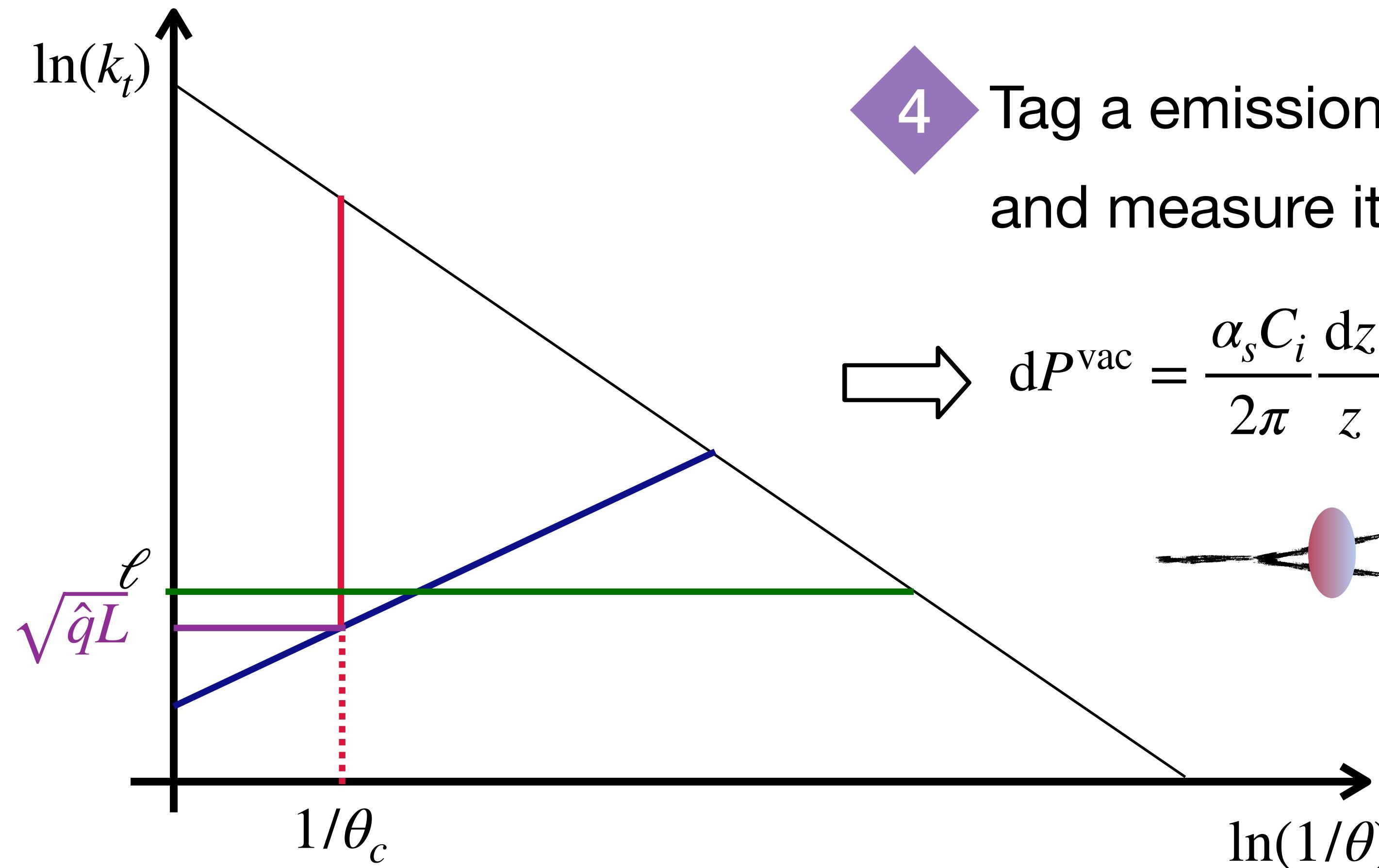
→  $dP^{\text{vac}} = \frac{\alpha_s C_i}{2\pi} \frac{dz}{z} \frac{d\theta}{\theta}$   
+ fully incoherent energy loss



# New idea: scanning the Lund plane with substructure



# New idea: scanning the Lund plane with substructure



4 Tag a emission with  $\ell \sim \sqrt{\hat{q}L}$   
and measure its angle

$$dP^{\text{vac}} = \frac{\alpha_s C_i}{2\pi} \frac{dz}{z} \frac{d\theta}{\theta} \quad \text{or} \quad dP^{\text{mie}} = \frac{\alpha_s^{\text{med}} C_i}{2\pi} \frac{dI}{d\omega d^2 k_t}$$

or  
  
hadronization, medium  
response...

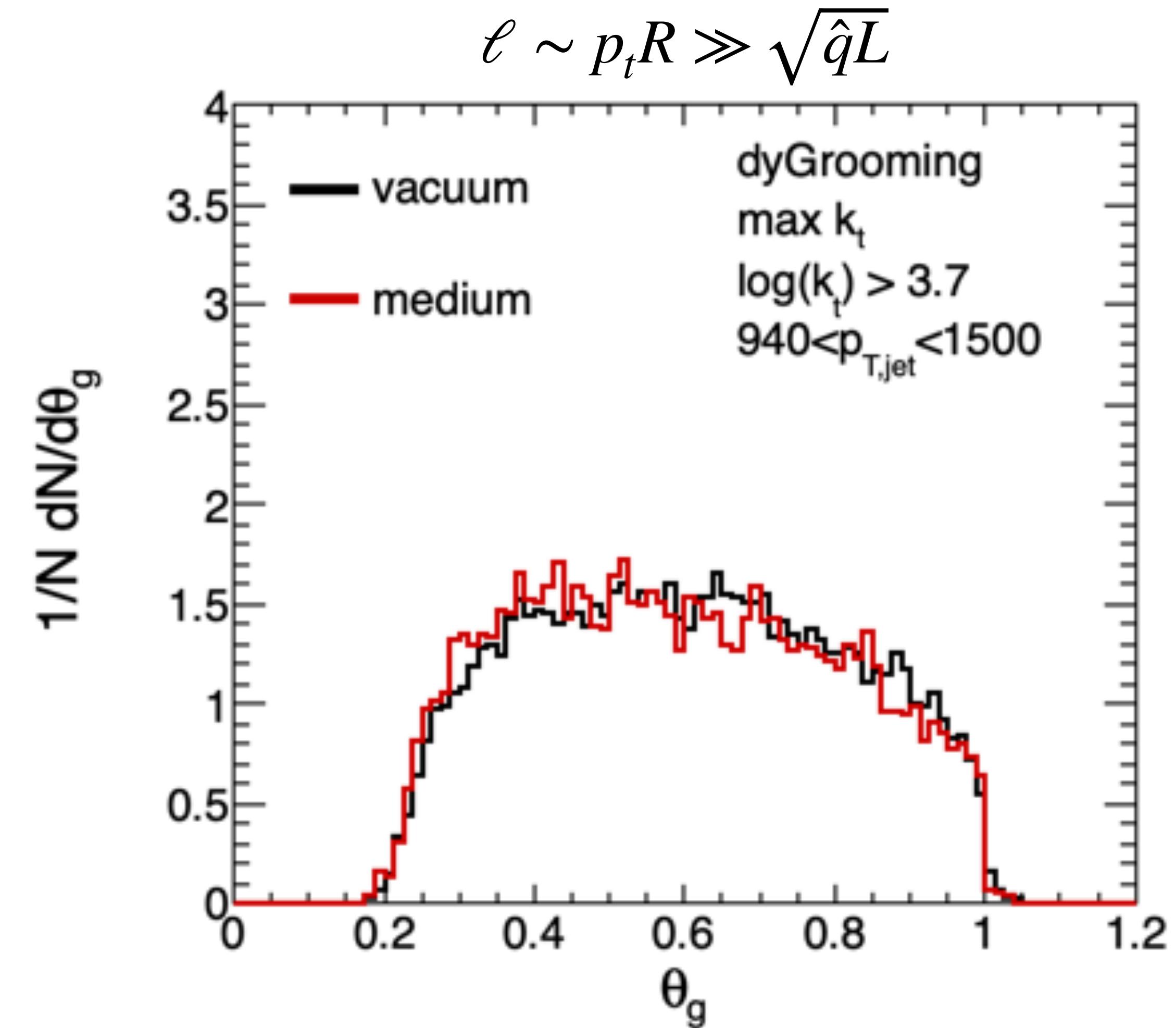
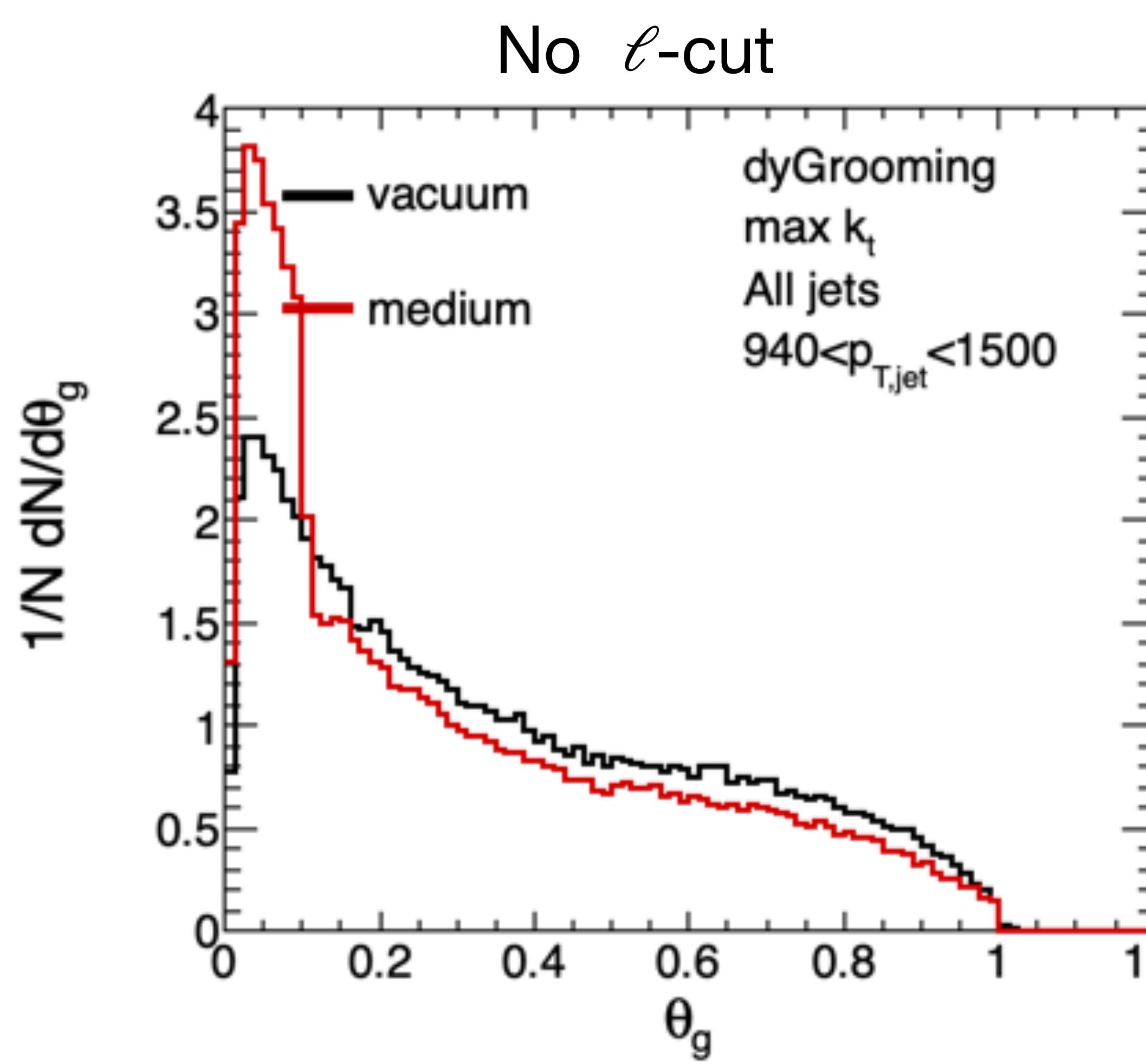
# Preliminary results

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# Preliminary results with JetMed

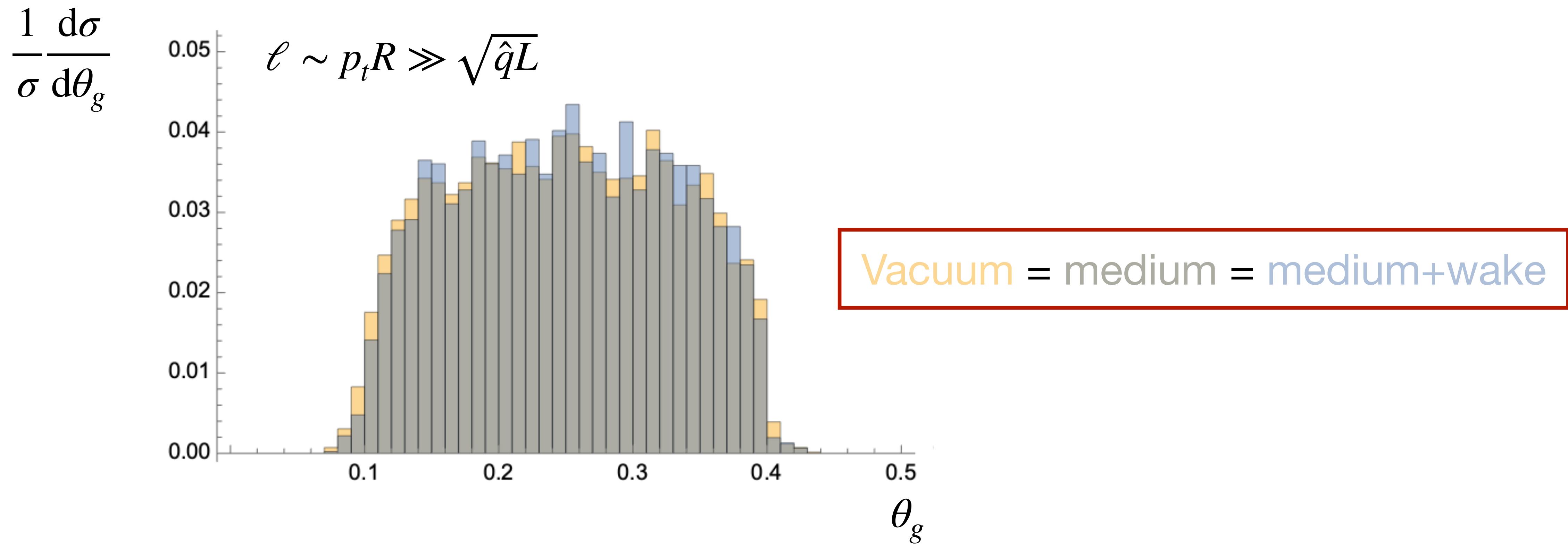
[Caucal et al. PRL 120 (2018) 232001]



Very small impact of energy loss after imposing  $k_t > \ell$

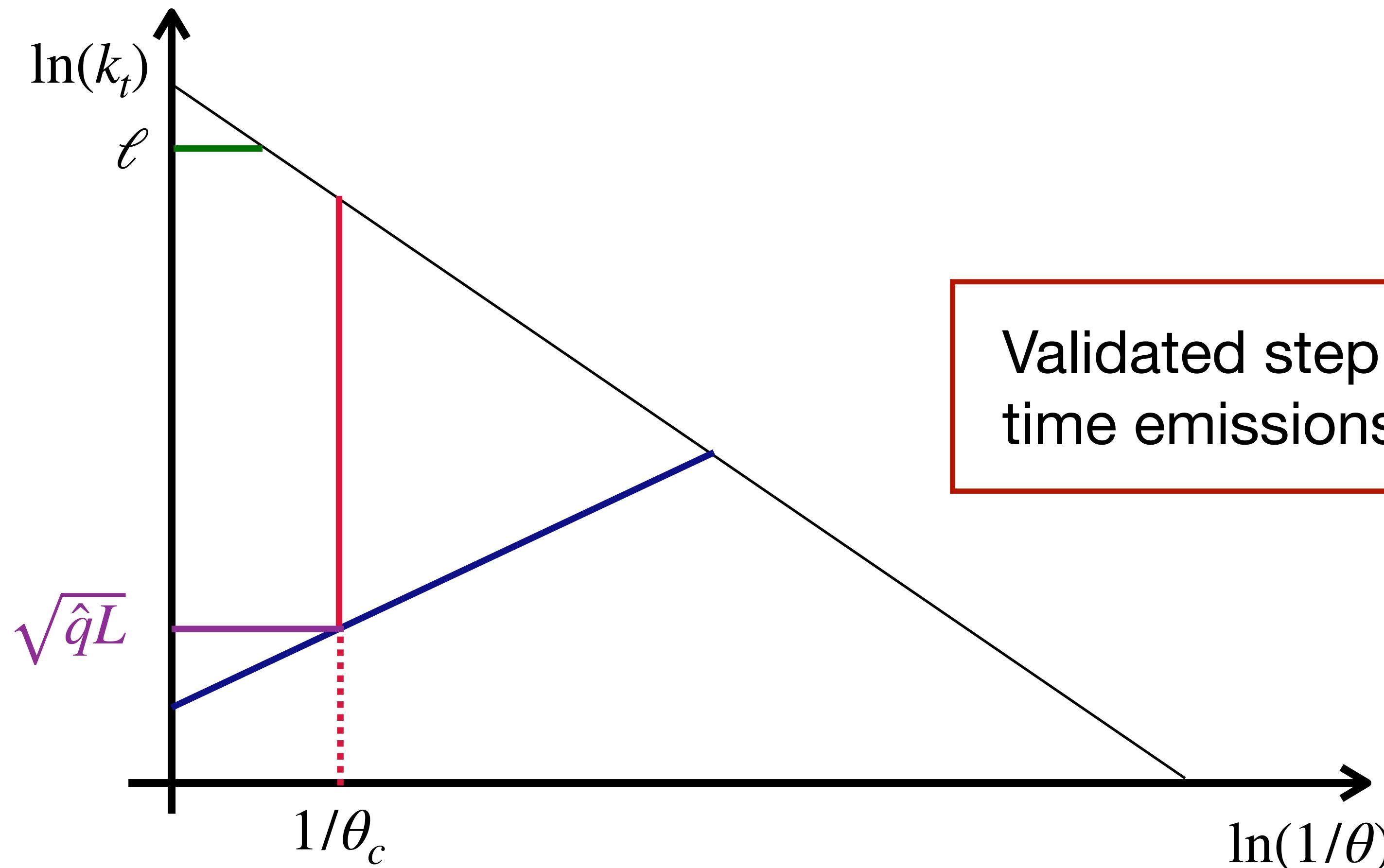
# Preliminary results with Hybrid $L_{res} = 0$

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# Preliminary results

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# To be continued!

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