Jets at high multiplicity

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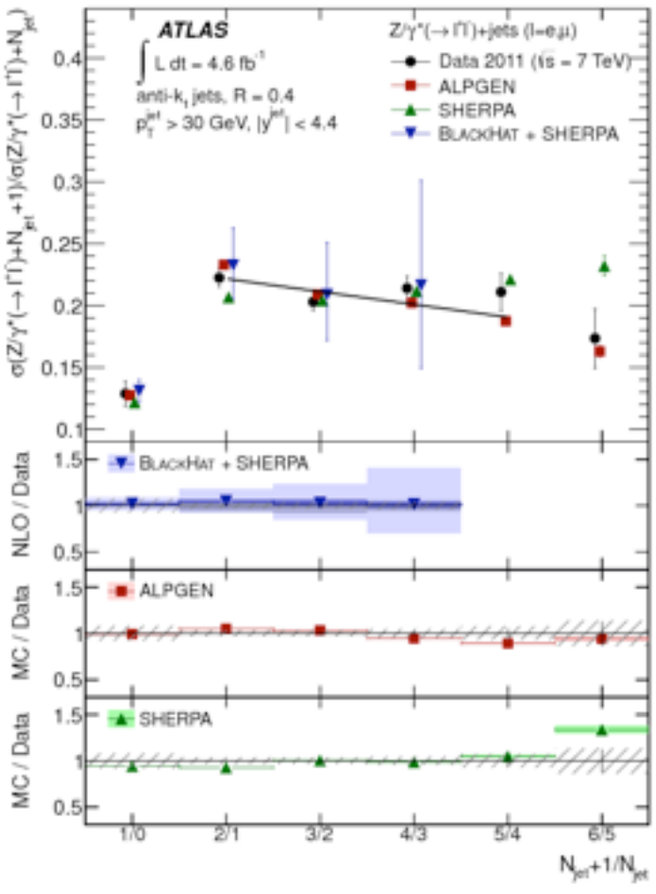
@ Pheno 2015

with: Englert, Gerwick, Plehn, Schumann

Scaling patterns

staircase scaling

[Steve Ellis,Kleis,Stirling(1985); Berends(1989)]



constant ratios

$$R_{\frac{n+1}{n}} = \frac{\sigma_{n+1}}{\sigma_n} = R_0$$

same for exclusive and inclusive

[Englert,Plehn,PS,Schumann (2011)]

observed at: UA1, Tevatron

confirmed at LHC [1304.7098]

→ staircase small tilt

→ Poisson flattens out

needs high p_T jet → phase space

QED:

resolvable

n independet emissions

$$P(n) = \frac{\bar{n}^n e^{-\bar{n}}}{n!}$$

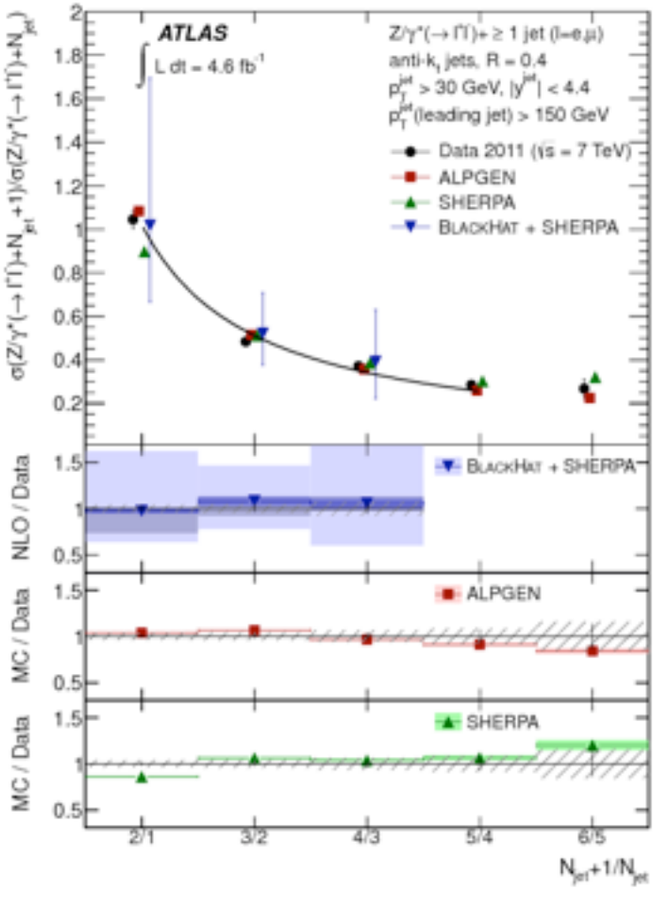
normalization

bosonic phase space

unresolvable
resummed

Poisson scaling

[Peskin & Schroeder; Rainwater, Zeppenfeld(1997)]



falling ratios

$$R_{\frac{n+1}{n}} = \frac{\sigma_{n+1}}{\sigma_n} = \frac{\bar{n}}{n+1}$$

Bremsstrahlung in QCD

[Konishi te al. (1979); Ellis, Stirling, Webber (1996); Gerwick, Gripaios, Schumann, Webber (2012)]

generating functional formalism

$$\Phi_i(t) = u \exp\left[\int_{t_0}^{t} dt' \sum_{jl} \Gamma_{i\to jl}\left(\frac{\Phi_j(t')\Phi_l(t')}{\Phi_i(t')} - 1\right)\right]$$

democratic limit

→ staircase scaling

$t \to t_0$ high multiplicities

$$\Phi_g \sim \frac{1}{1 + \frac{1-u}{u\Delta_g} - \mathcal{R}(u)}$$

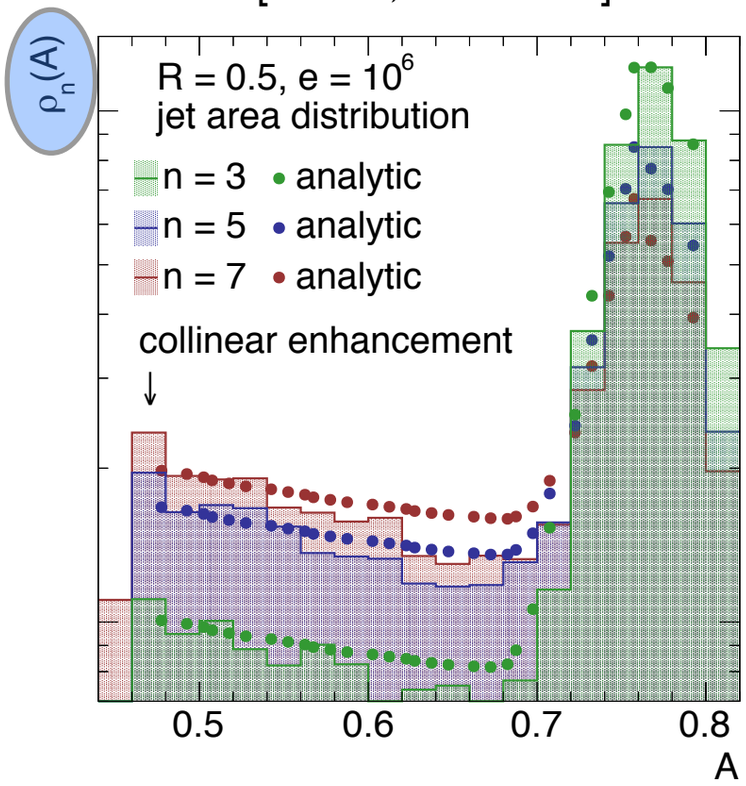
large log limit:

→ Poisson scaling

$t \gg t_0$ low multiplicities

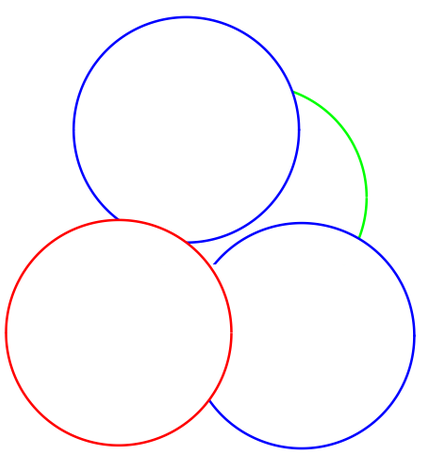
$$\Phi_i(t) = \frac{u\Delta_i(t)}{\Delta_i(t)^u}$$

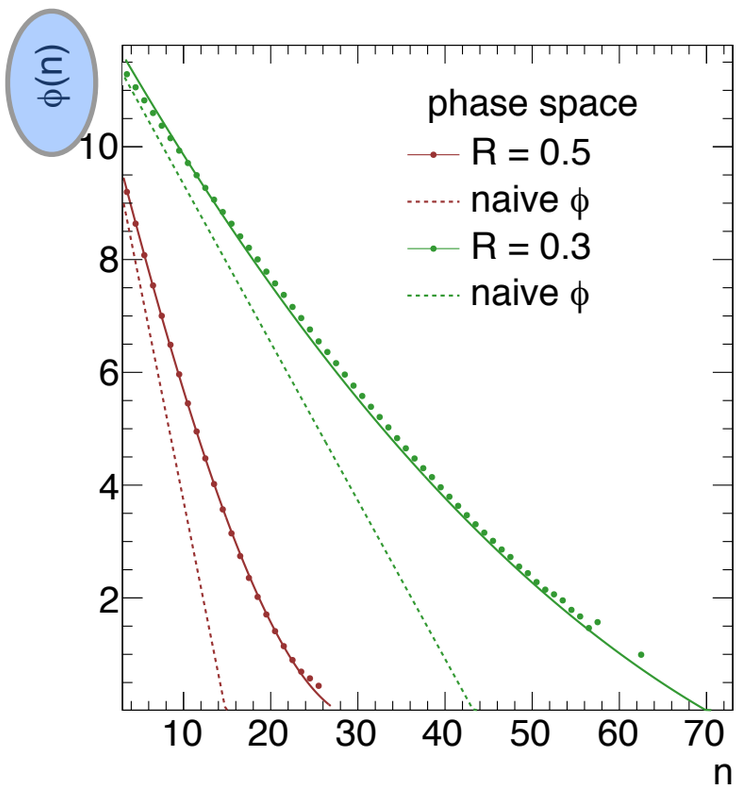
[Gerwick, PS: 1412.1806]



non-trivial geometry

anti-k_T algorithm





overlay effects → area depletion
collinear & circular → exact area model
study very high multiplicities in MC
iterativly good for moderate jet numbers

Summary

[Gerwick, PS: 1412.1806]

$$R_{\frac{n+1}{n}} = \left(R_0 \left[1 + \frac{1}{B + (n+1)} \right] + \frac{dR_0}{dn}(n+1) \right) \times \frac{\phi(n+1)}{\phi(n)}$$

small & vanishing as $R \to 0$

jet spectra follow simple scaling patterns

staircase scaling is a firm QCD prediction (& observed)

@ LHC: low multiplicities due to PDF effects

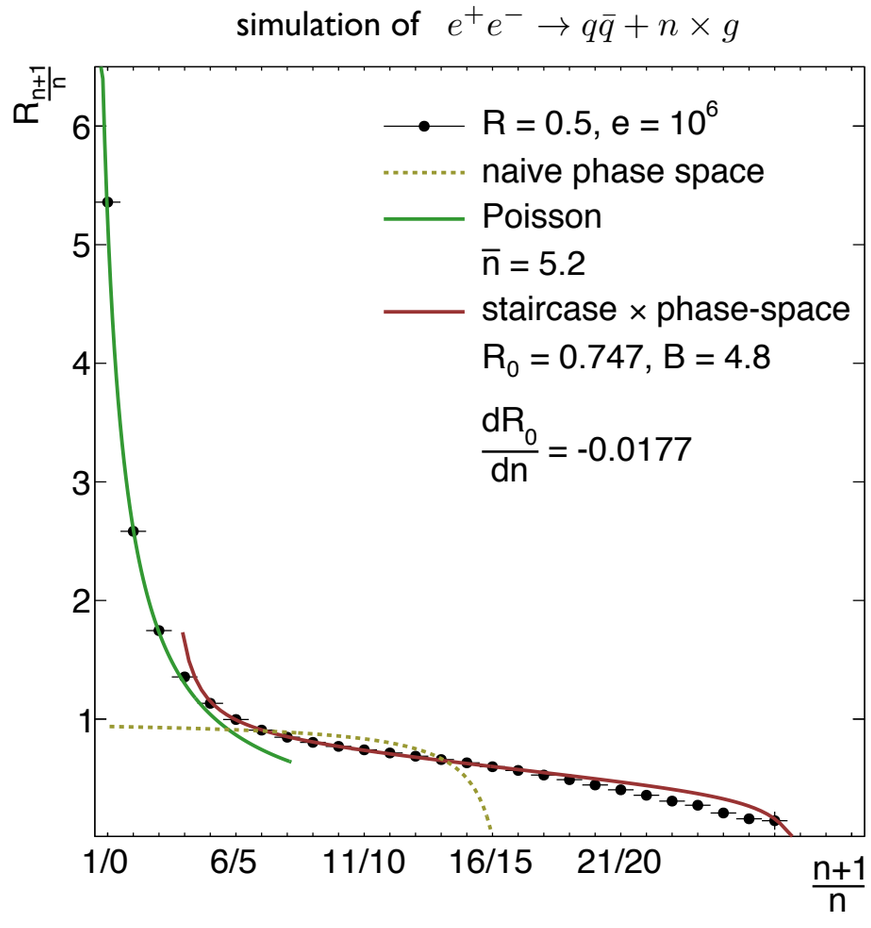
three sources for deviations

→ breaking terms ✔

→ phase space ✔

→ finite jet radius ✘

QCD high multiplicity predictions possible [difficult with NLO]



Experiment: [Ellis,Kleis,Stirling(1985), Alioli et al, JHEP (2011) 095, Aad et al. Phys. Rev. D **85** 092002 (2012) and 1304.7098]

Generating functional: [Konishi te al. (1979); Ellis, Stirling, Webber (1996); Gerwick, Gripaios, Schumann, Webber (2012)]

Scaling patterns: [Englert,Plehn,PS,Schumann PRD 83 (2011) and JHEP 030 (2012), Gerwick,Plehn,Schumann PRL 108 (2012), Gerwick, Plehn, PS, Schumann JHEP 162 (2012), Gerwick, PS arxiv: 1412.1806]