Multiplicity Dependence of Hadron Spectra @ LHC

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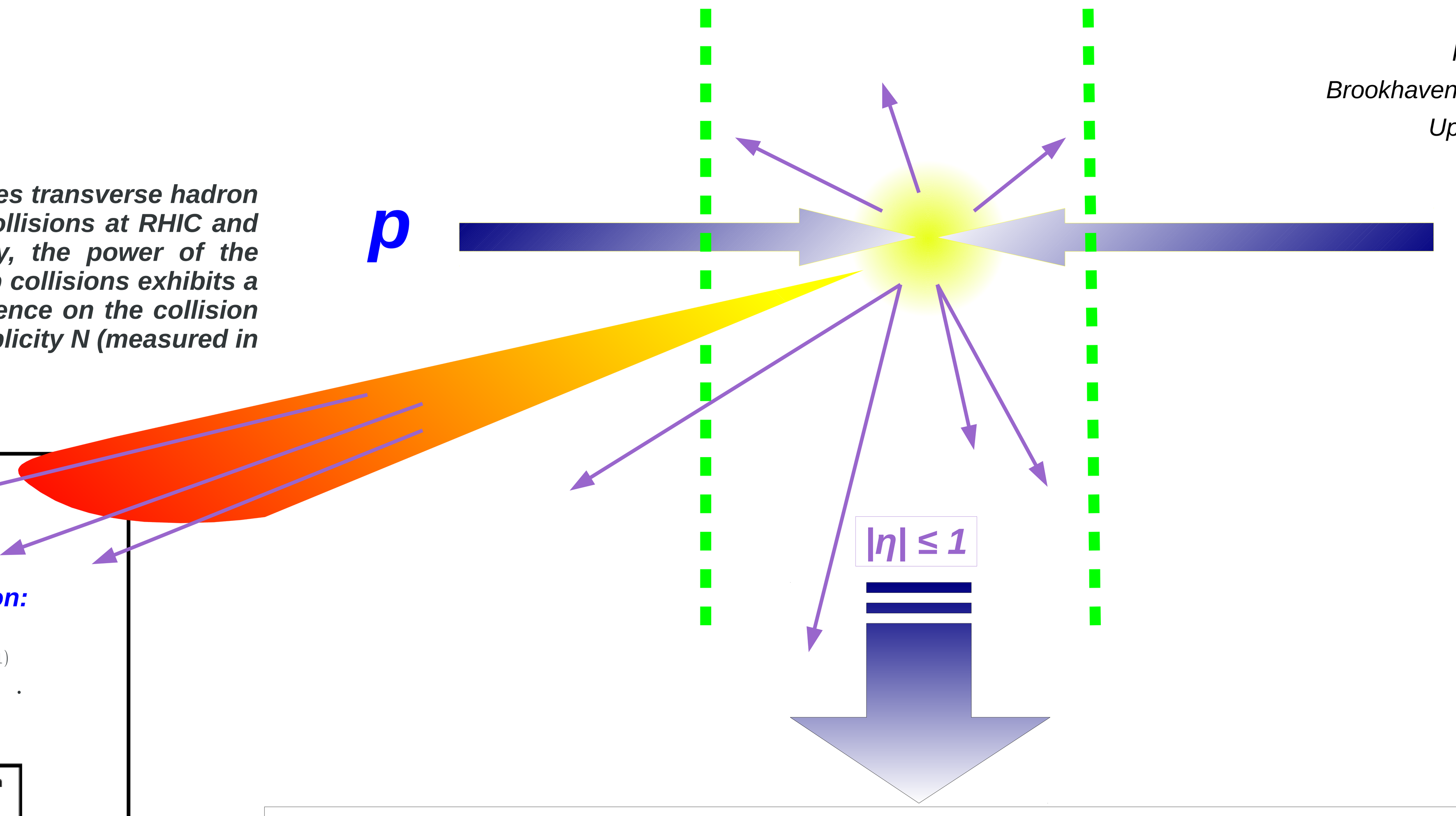
Abstract

Fragmentation functions measured in e^+e^- and pp collisions are well reproduced via a fragmentation model based on microcanonical statistics and superimposed Euler--Gamma-type multiplicity fluctuations [1,2]. The power of the obtained analytic fragmentation function developes a double-logarithmic dependence on the QCD scale Q^2 [3].

Besides, this function also describes transverse hadron spectra measured in pp and AA collisions at RHIC and LHC energies [4,5,6]. Interestingly, the power of the spectra of pions stemming from pp collisions exhibits a similar double-logarithmic dependence on the collision energy $\sqrt{s}$ and on the hadron multiplicity N (measured in the $|\eta|<1$ region) [6].



Statistical Jet Fragmentation?

Hadron distribution in a ***microcanonical*** jet of **N hadrons** (in 1 dimension) [1,2]:

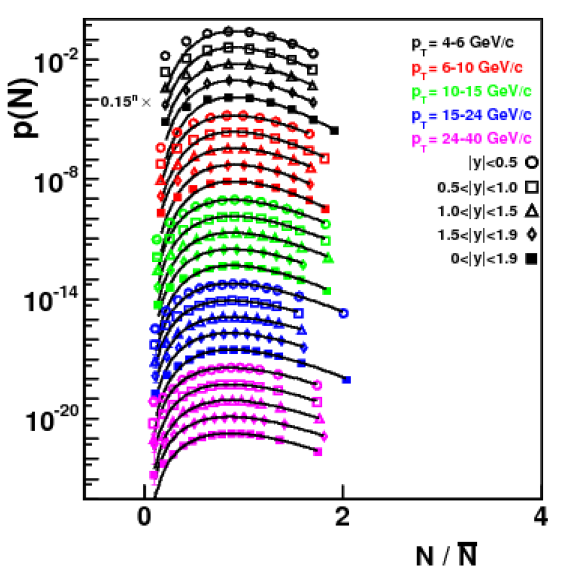
$$\frac{dN^{1JET}}{dz} \propto (1-z)^{N-2} ,$$

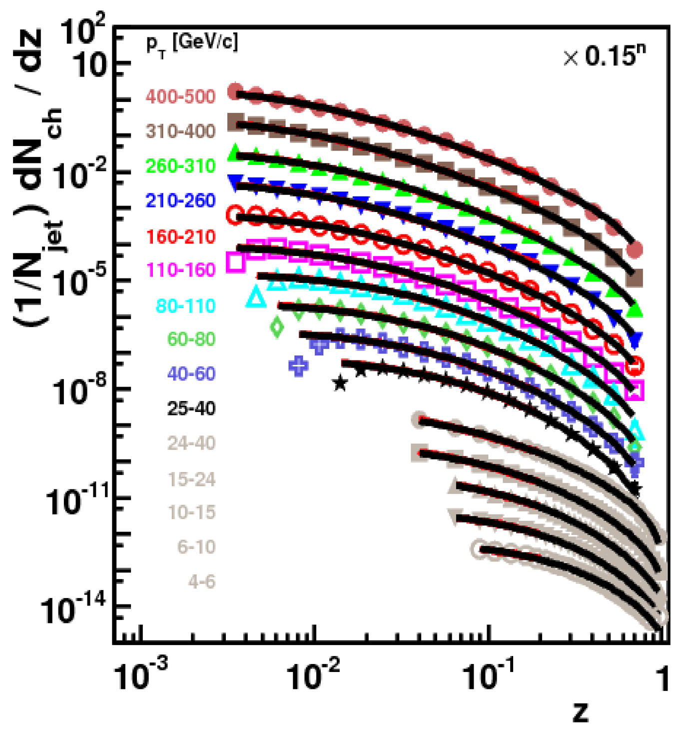
Multiplicity fluctuation in jets:

$$p(N) \propto \left(\frac{N}{\bar N}\right)^{\alpha-1} \exp\left[-\alpha \frac{N}{\bar N}\right] .$$

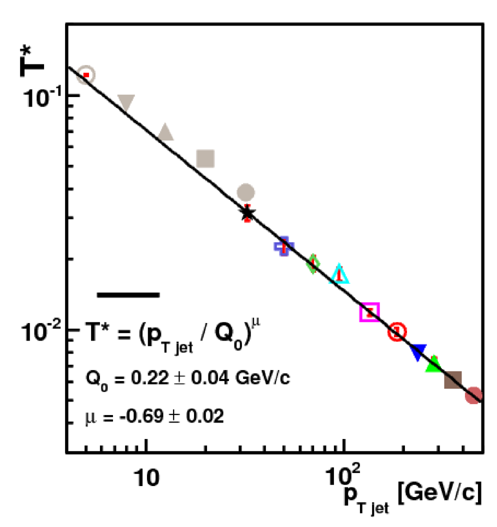
The multiplicity-averaged distribution:

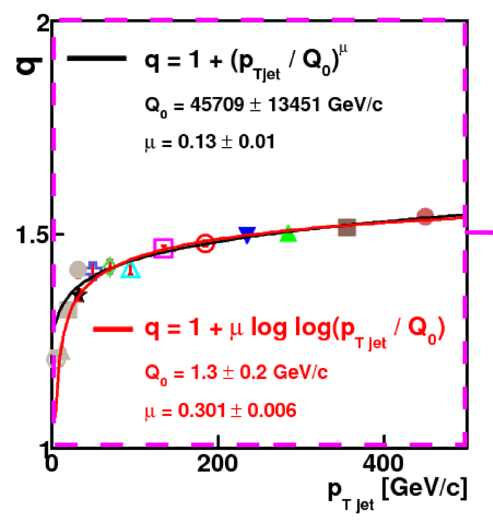
$$\left\langle \frac{dN^{1JET}}{dz} \right\rangle_N \propto \left[1 - \frac{q-1}{T^*}\ln(1-x)\right]^{-1/(q-1)} .$$





Dependence of the fitted parameters on $P_{T\,jet}$:





K. Urmossy etal, *Phys. Lett. B*, **718** (2012) 125-129, arXiv:1204.1508
K. Urmossy etal, *Phys. Lett. B*, **701** (2011) 111-116, arXiv:1101.3023

Tranverse Spectra in pp

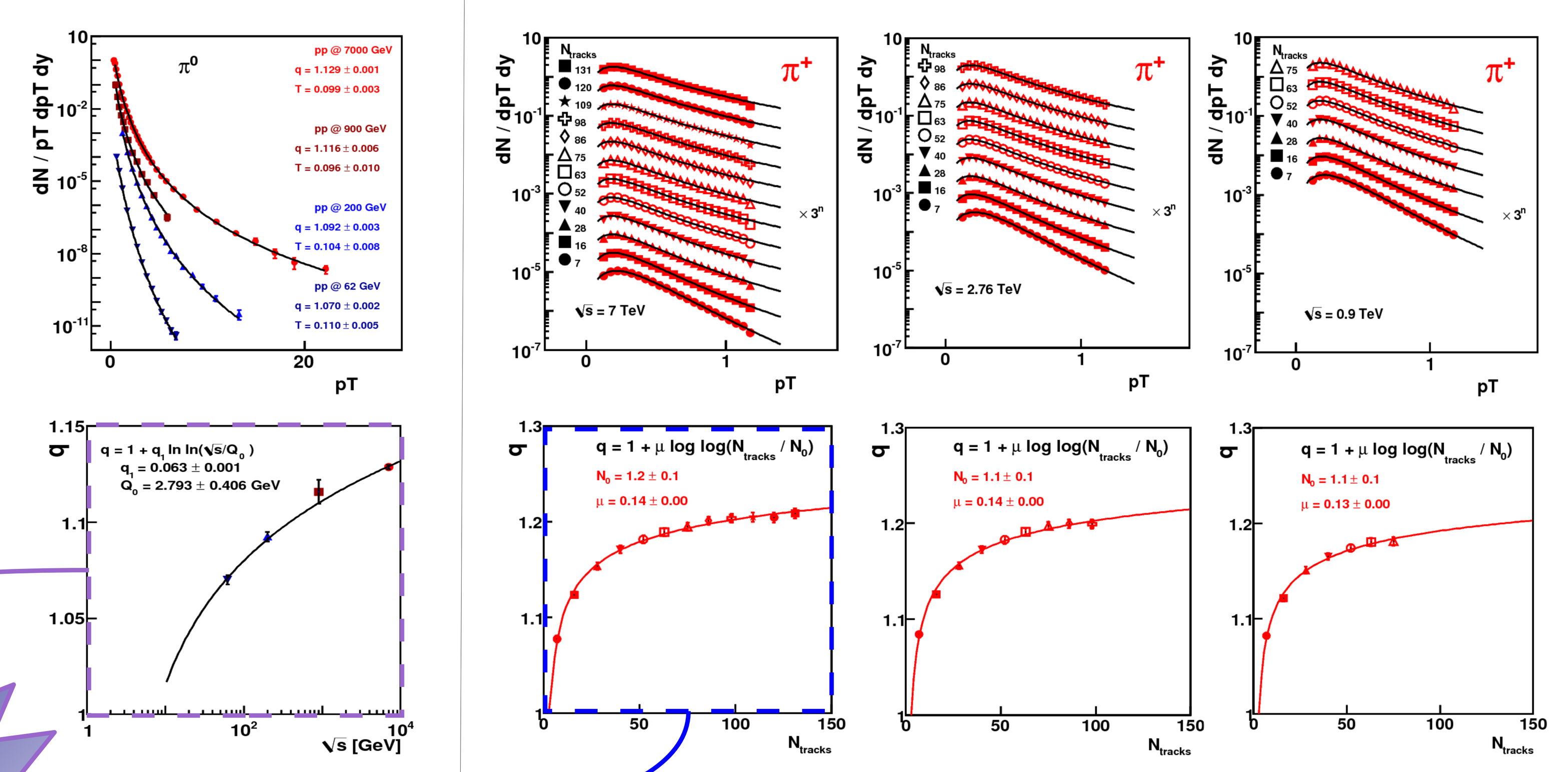
Hadron **spectra** in ***pp*** collisions can be described by the ***Tsallis distribution*** [5,6]:

$$\frac{dN}{d^3p} \propto \left[1 + \frac{q-1}{T}(m_T - m)\right]^{-1/(q-1)} .$$

Interestingly, transverse ***π* spectra** in ***pp*** collisions depends ***similarly on √s*** and on the multiplicity ***N*** in $|\eta| \le 1$ range [6]:

$$q(s) = 1 + q_1 \ln\ln(\sqrt{s}/Q_0) ,$$
$$q(N) = 1 + \mu \ln\ln(N/N_0) .$$

√s = fix **N = fix**



K. Urmossy, arXiv:1212.0260

q depends similarly on √s, Q and N

Application in parton a model calculation

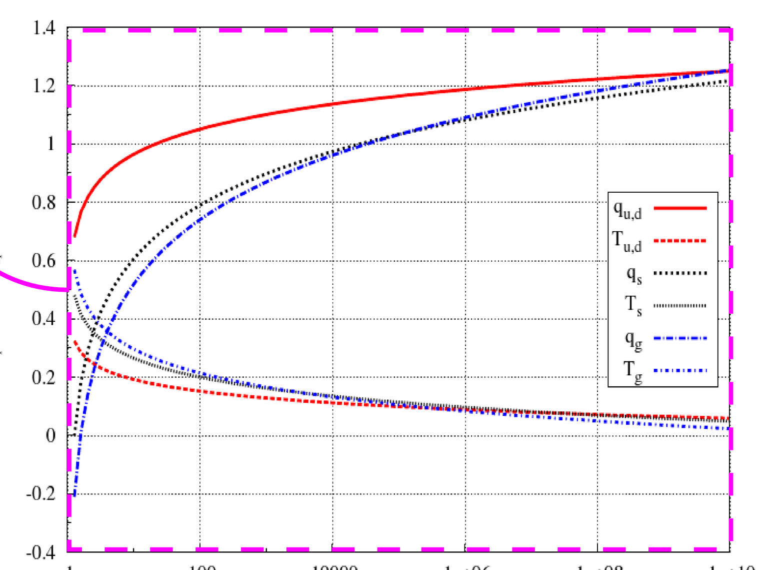
At low energies, ***z << 1***, the above formula approaches the ***Tsallis distribution*** [3]

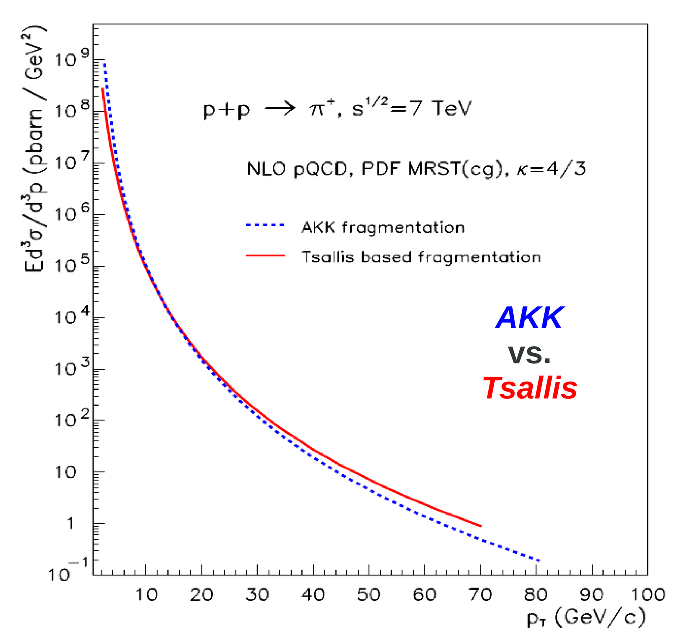
$$\left\langle \frac{dN^{1JET}}{dz} \right\rangle_N \propto \left[1 + \frac{q-1}{T} z\right]^{-1/(q-1)} .$$

AKK *u, d, s, g* fragmentation functions can be fitted by the ***Tsallis***-type one using [3]:

$$q(Q^2) = q_0 + q_1 \ln\ln Q^2 ,$$
$$T^*(Q^2) = T_0 + T_1 \ln\ln Q^2 .$$

Application in ***pQCD calculation***





G. G. Barnafoldi etal, *Gribov 80 Conference*: **C10-05-26.1**, p.357-363

Disentangling Soft & Hard Yields in Heavy-ion Collisions [see preliminary on arXiv]

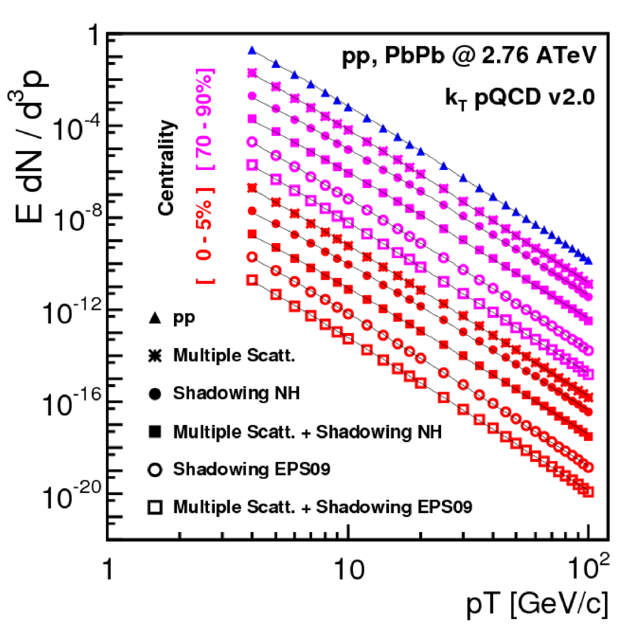
The ***hard + soft*** model:

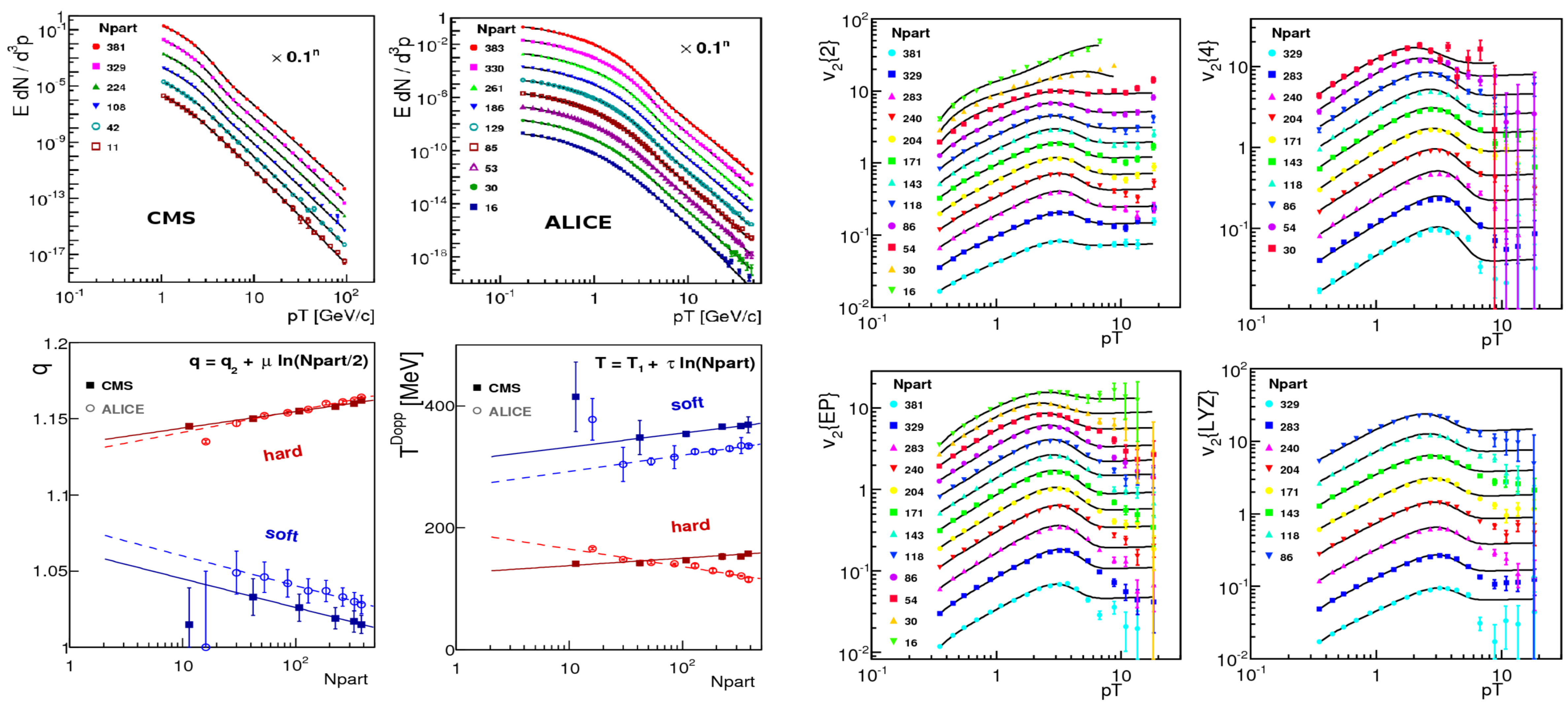
$$E\frac{dN}{d^3p} = E\frac{dN^{hard}}{d^3p} + E\frac{dN^{soft}}{d^3p}$$

Both types of yields are Tsallis distributions:

$$E\frac{dN^{soft/hard}}{d^3p} = A\left[1 + \frac{q-1}{T}\left[\gamma(m_T - v\,p_T) - m\right]\right]^{-1/(q-1)}$$

The hard yield is Tsallis, because it fits pQCD spectra in PbPb @ 7 TeV.
The remaining soft yield can be described by another Tsallis too [4].





References

[1] K. Urmossy etal, *Phys. Lett. B*, **718** (2012) 125-129, arXiv:1204.1508
[2] K. Urmossy etal, *Phys. Lett. B*, **701** (2011) 111-116, arXiv:1101.3023
[3] G. G. Barnafoldi etal, *Gribov 80 Conference*: **C10-05-26.1**, p.357-363
[4] K. Urmossy etal, *Phys. Lett. B*, **689** (2010) 14-17, arXiv:0911.1411
[5] G. G. Barnafoldi etal, 'Hot Quarks 2010', *J. Phys. Conf. Ser.* **270** (2011) 012008
[6] K. Urmossy, arXiv:1212.0260

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