pp collisions and transverse momentum spectra

Guy Paic and Leonid Serkin

Departamento de Física de Altas Energías
Instituto de Ciencias Nucleares (ICN-UNAM), Mexico

The means will most probably not help us in the search of outliers

- The means are the result of many contributions – like the landau distribution for the energy loss – several effects contribute.
- The models can get the most prominent features but never all the details of the interactions
- IMHO they serve to compare models and measurements in a very crude manner.

A long history – tempting for theorists and experimentalists

Alexopoulos et alhttps://doi.org/10.1016/S0370-2693(02)01213-3,

CERN-Heidelberg-Lund Collaboration Charged Particle Spectra in ~ and ~p Collisions at the CERN ISR . W. Bell et al

Presently, it is widely believed that in pp collisions in the studied energy range a hot QCD matter is not produced in the typical inelastic minimum bias events due to small energy density. But in high multiplicity (HM) pp events the energy density may be comparable to that in AA collisions at RHIC and LHC energies. And if the thermalization time, τ0, is small enough, say τ0 ∼ < 0.5 fm, the mini-QGP with size of ∼ 2 − 3 fm should be formed quite likely to the large-size plasma in AA collisions

B.G Zakharov https://doi.org/10.48550/arXiv.1311.1159
Parton energy loss in the mini quark-gluon plasma and jet quenching in proton-proton collisions - We evaluate the medium suppression of light hadron spectra in pp collisions at RHIC and LHC energies in the scenario with formation of a mini quark-gluon plasma

P. Jacobs Search for jet quenching effects in high multiplicity pp collisions at $\sqrt{\mathrm{s}}$=13 Tev

arXiv:2001.09517 [nucl-ex]

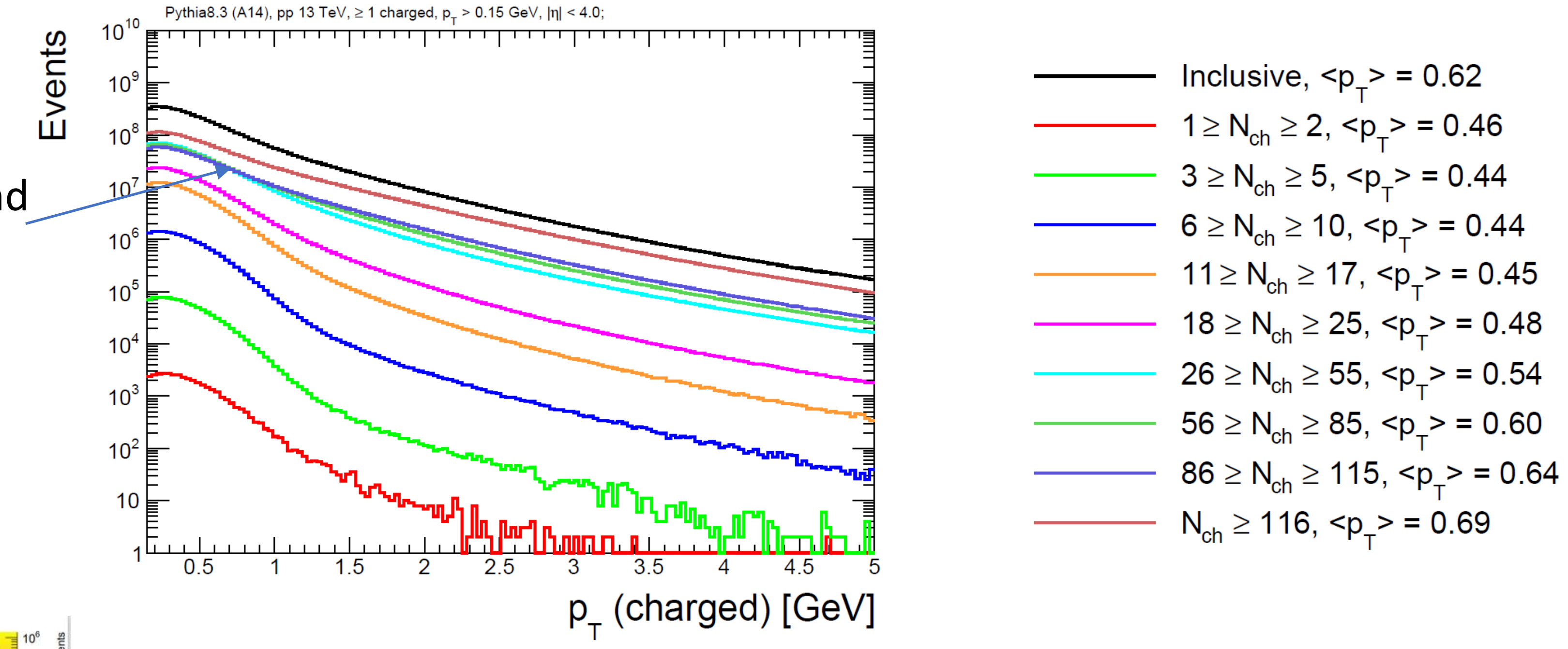
M. Mangano and B Nachman Observables for possible QGP signatures in central pp collisions
https://doi.org/10.48550/arXiv.1708.08369

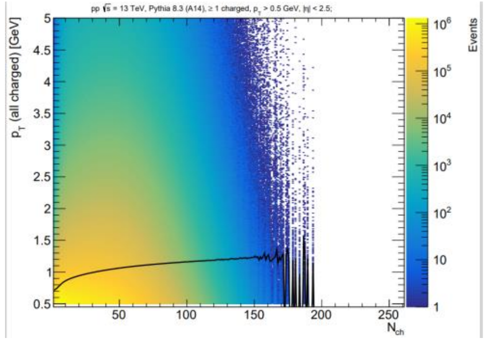
We consider observables such as jet energy loss and jet shapes, which could point to the possible existence of an underlying quark-gluon plasma, or other new dynamical effects related to the presence of large hadronic densities. Eur. Phys. J. C 78 (2018) 343

Pythia8.3, pT > 0.15 GeV, |η| < 4.0

Instead of plotting the mean pt in function of multiplicity we compare the pt spectra for each multiplicity bin! The simulation shows interesting behavior

Note the evolution in shape of the spectra and the crossing at ~ 1.5 GeV/c





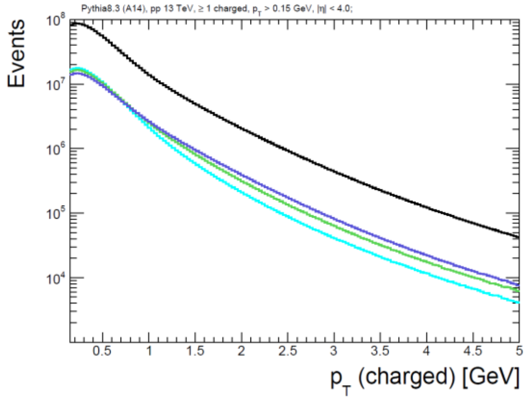
The 3D plot of pythia pt vs multiplicity

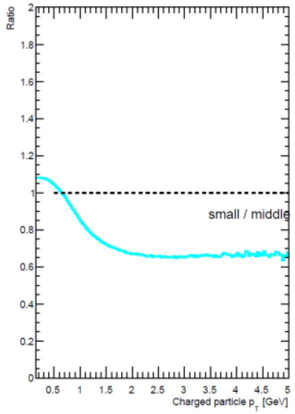
The mean reflects only a small part of the real situation – outliers are out hiding there?

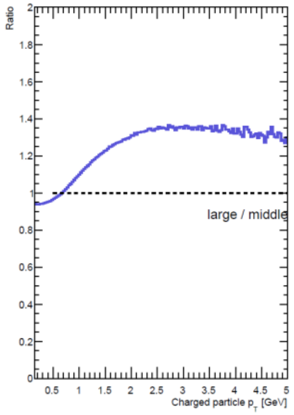
The model comparison much more sensitive with the “total” approach!

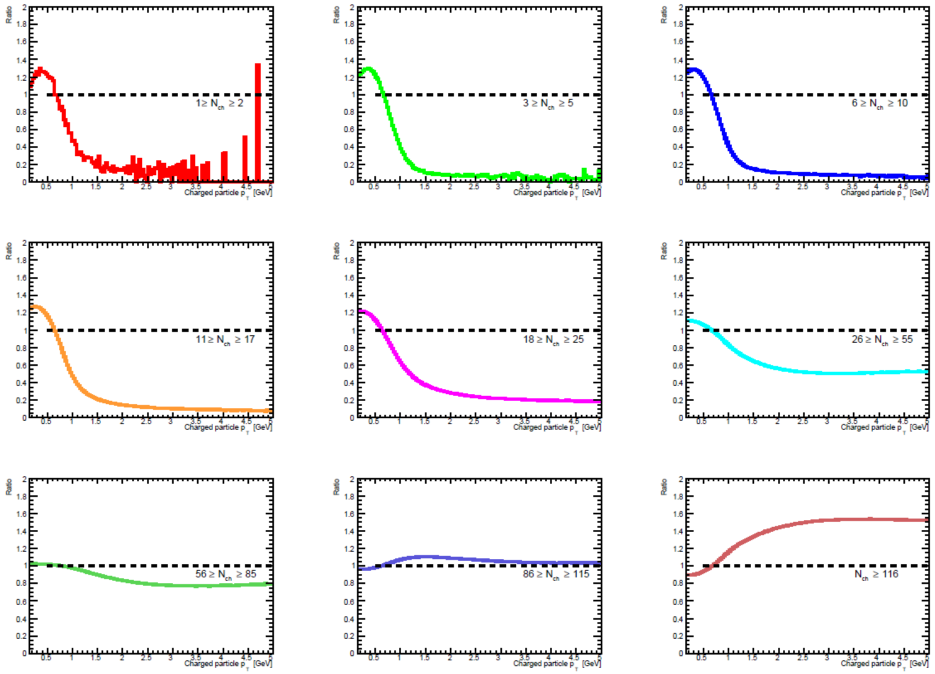
Pythia8.3, pT > 0.15 GeV, |η| < 4.0

Ratio to inclusive in 9 bins of Nch – rapid changes and zoom on the crossing spercra



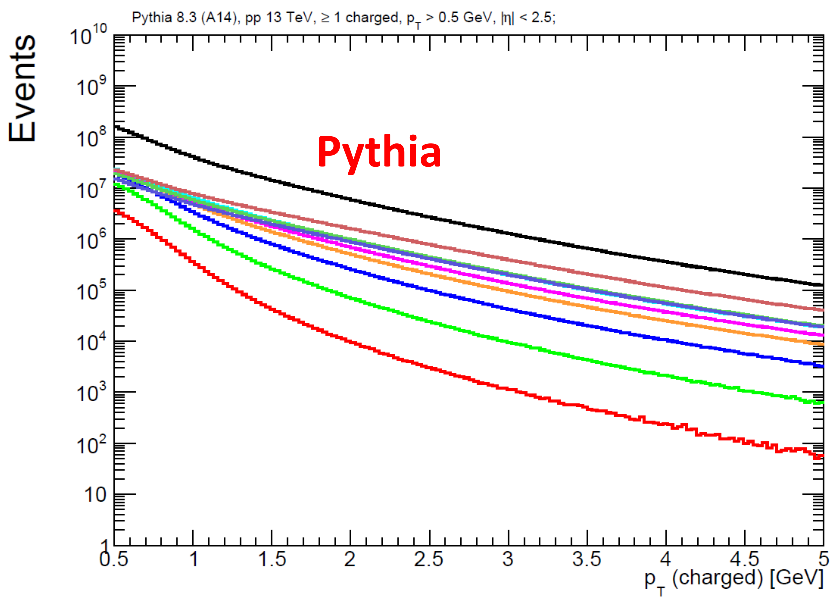


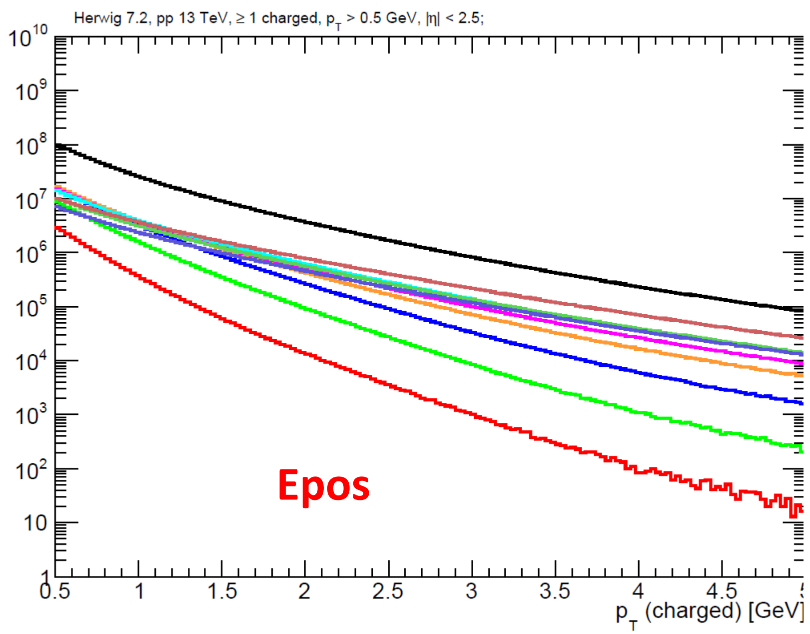


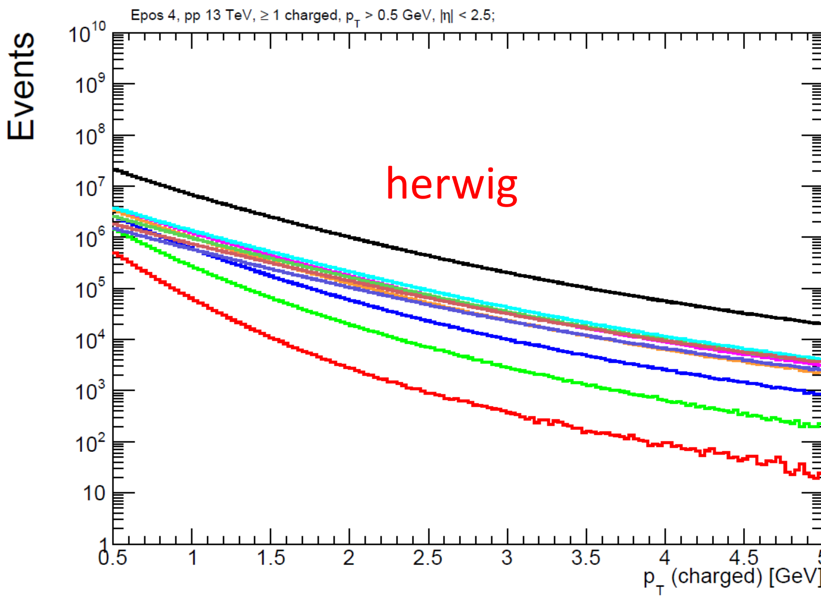


Within a small multiplicity range important change of shape!

Pythia vs Herwig vs Epos in the pT distribution







Small differences in the mean pt's but important differences in the spectra!

Pythia	Herwig	Epos
Inclusive, $\langle p_T \rangle = 0.98$	Inclusive, $\langle p_T \rangle = 0.99$	Inclusive, $\langle p_T \rangle = 1.02$
$1 \geq N_{ch} \geq 2$, $\langle p_T \rangle = 0.72$	$1 \geq N_{ch} \geq 2$, $\langle p_T \rangle = 0.76$	$1 \geq N_{ch} \geq 2$, $\langle p_T \rangle = 0.77$
$3 \geq N_{ch} \geq 5$, $\langle p_T \rangle = 0.77$	$3 \geq N_{ch} \geq 5$, $\langle p_T \rangle = 0.82$	$3 \geq N_{ch} \geq 5$, $\langle p_T \rangle = 0.85$
$6 \geq N_{ch} \geq 10$, $\langle p_T \rangle = 0.84$	$6 \geq N_{ch} \geq 10$, $\langle p_T \rangle = 0.87$	$6 \geq N_{ch} \geq 10$, $\langle p_T \rangle = 0.91$
$11 \geq N_{ch} \geq 17$, $\langle p_T \rangle = 0.90$	$11 \geq N_{ch} \geq 17$, $\langle p_T \rangle = 0.92$	$11 \geq N_{ch} \geq 17$, $\langle p_T \rangle = 0.98$
$18 \geq N_{ch} \geq 25$, $\langle p_T \rangle = 0.95$	$18 \geq N_{ch} \geq 25$, $\langle p_T \rangle = 0.97$	$18 \geq N_{ch} \geq 25$, $\langle p_T \rangle = 1.01$
$26 \geq N_{ch} \geq 35$, $\langle p_T \rangle = 1.00$	$26 \geq N_{ch} \geq 35$, $\langle p_T \rangle = 1.02$	$26 \geq N_{ch} \geq 35$, $\langle p_T \rangle = 1.05$
$36 \geq N_{ch} \geq 45$, $\langle p_T \rangle = 1.03$	$36 \geq N_{ch} \geq 45$, $\langle p_T \rangle = 1.06$	$36 \geq N_{ch} \geq 45$, $\langle p_T \rangle = 1.07$
$46 \geq N_{ch} \geq 55$, $\langle p_T \rangle = 1.07$	$46 \geq N_{ch} \geq 55$, $\langle p_T \rangle = 1.10$	$46 \geq N_{ch} \geq 55$, $\langle p_T \rangle = 1.09$
$N_{ch} \geq 56$, $\langle p_T \rangle = 1.11$	$N_{ch} \geq 56$, $\langle p_T \rangle = 1.15$	$N_{ch} \geq 56$, $\langle p_T \rangle = 1.11$