Implementation of popcorn mechanisms in HIJING code

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Contents

HIJING code

HIJING: Heavy Ion Jet Interaction Generator

Miklos Gyulassy and Xin-Nian Wang, Comput. Phys. Comm. 83, 307(1994)

- A microscopic transport model
- Build to work at RHIC and LHC energy
- A two component model

- **Jet Production ($p_T > p_0$)** (Main source of hadrons at LHC energies)

  Jet cross section (σ_{jet})

- **String interactions ($p_T < p_0$) (FTF/DPM)**

  soft parton cross section (σ_{soft})

HIJING uses

- Eikonal formalism to determine the number of wounded nucleons+ number of hard collisions.
- PYTHIA 5.3 to generate kinetic variables for each hard scattering (high p_T).
- JETSET 7.2 for jet fragmentation.

The main improvements

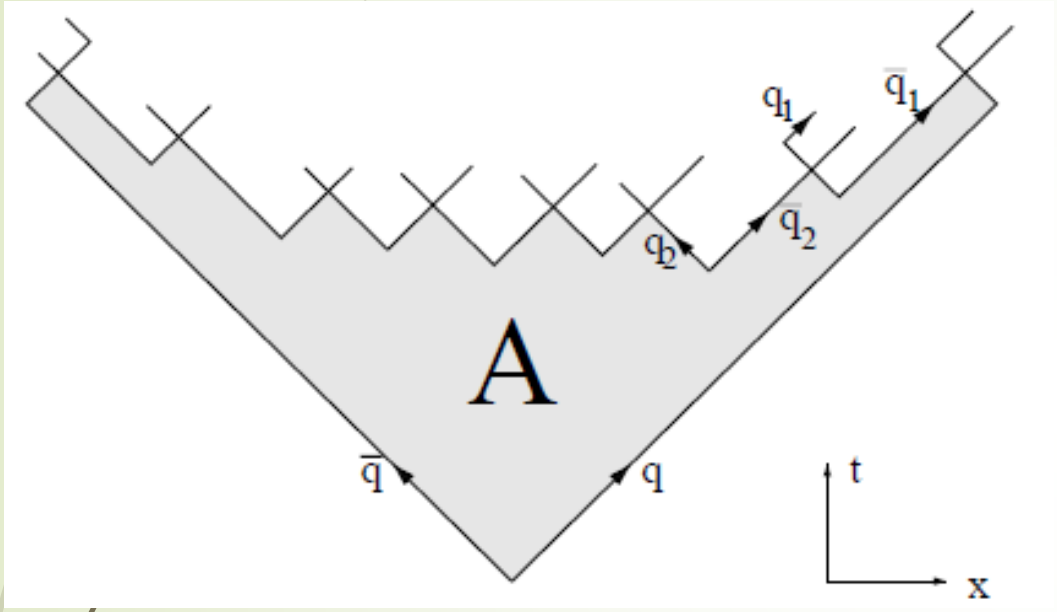
HIJING 1.383

- PYTHIA 5.3 to generate kinetic variables for each hard scattering (high p_T).
- JETSET 7.2 for jet fragmentation.

Improved HIJING

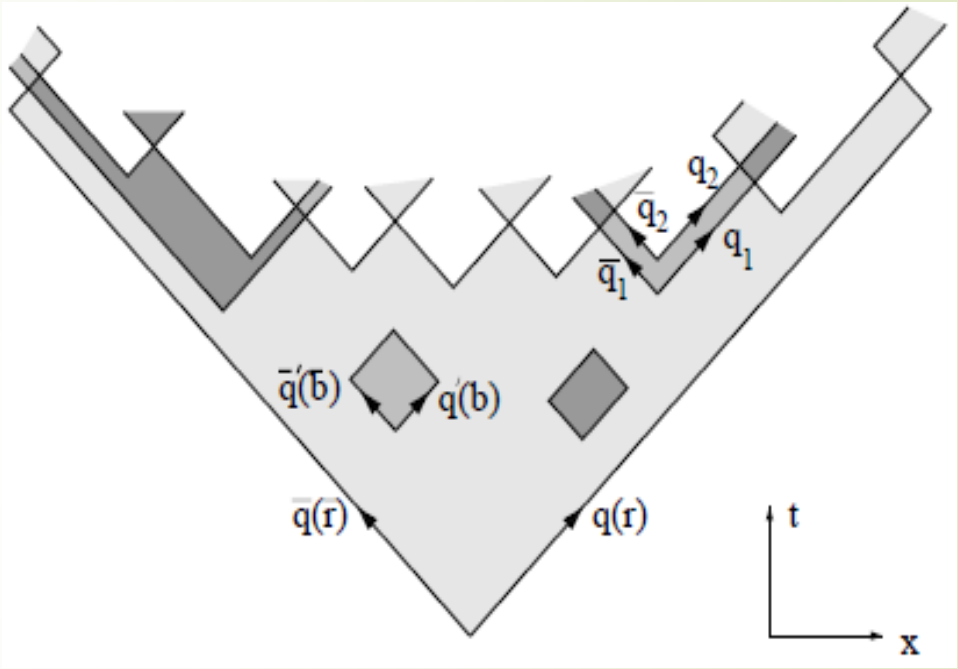
- PYTHIA 6.4 is now implemented

Popcorn models



Di-quark model

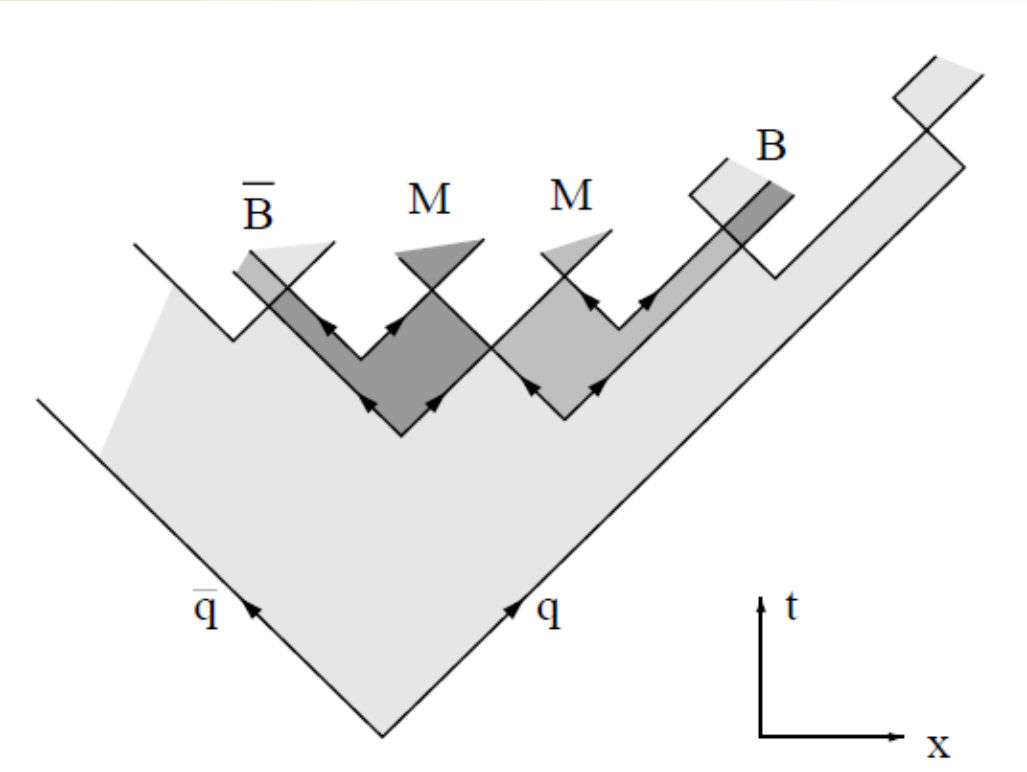
($B\bar{B}$ channel)



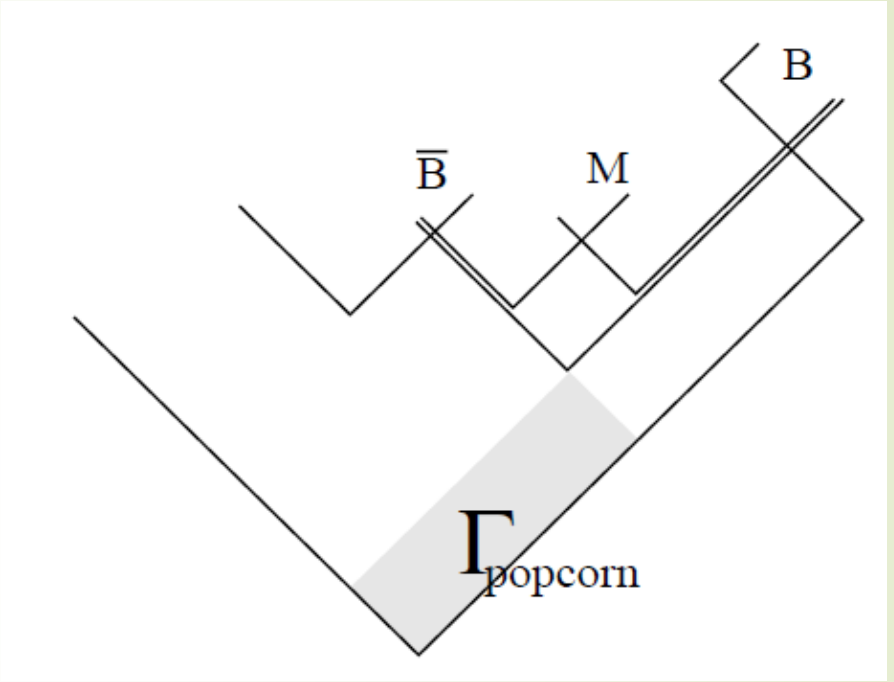
Simple popcorn model

($B\bar{B}$ and $BM\bar{B}$ channels)

Advanced popcorn model



($B\bar{B}$ and ($B..MMM\ ...\bar{B}$) channels)



Suppression by the proper time of the break-up points

Results of the improved HIJING code in p+p collisions

Parameters of popcorn mechanisms in p+p collisions

Table 1. Parameter sets of HIJING/SP(AP) for p + p collisions.

HIJING/SP

Set	$\gamma_{q'q'}$	γ_s	γ_{qs}	γ_{10}	γ_M	α	b GeV^{-2}
1	0.1	0.3	0.4	0.05	0.5	0.5	0.9
2	0.07	0.22	0.4	0.05	0.5	0.5	0.9

HIJING/AP

Set	$\gamma_{q'q'}$	γ_s	β_u GeV^{-1}	$\Delta\beta$ GeV^{-1}	δa	ρ GeV^{-2}	α_a	α_b	b GeV^{-2}
1	0.2	0.3	0.6	1.2	0.6	0.7	0.5	0.5	0.9
2	0.15	0.22	1.0	1.2	0.6	0.7	0.5	0.5	0.9
3	0.15	0.22	1.0	1.2	1.0	0.7	0.5	0.95	0.9
4	0.15	0.22	1.0	1.2	1.0	0.13–0.7	0.5	0.95	0.9

Parameters in PYTHIA 6.4

Simple popcorn	Parameter
Suppression of di-quark pair P(qq/q)	$\gamma_{q'q'=}$Parj(1)=0.1
Suppression of s-quark pair P(s/u)	$\gamma_{s=}$Parj(2)=0.3
Suppression of strange diquark production P(us/ud % s/d)	$\gamma_{qs=}$Parj(3)=0.4
Suppression of spin 1 diquark 1/3 P(ud_1/ud_0)	$\gamma_{10=}$Parj(4)=0.05
Relative production by $BM\bar{B}$ and $B\bar{B}$	$\gamma_{M=}$Parj(5)=0.5

Advanced popcorn	Parameter
Suppression of di-quark pair P(qq/q)	$\gamma_{q'q'=}$Parj(1)=**0.2**
Suppression of s-quark pair P(s/u)	$\gamma_{s=}$Parj(2)=0.3
Suppression of popcorn mesons	β_u=Parj(8)=0.6
Suppression of popcorn systems surrounded by an $s\bar{s}$ pair	$\Delta\beta$ =Parj(9)=1.2
Large Γ – suppression of diquark vertices	δa =Parj(10)=0.5
Small Γ – suppression	ρ =**Par(192)=0.5**

Momentum Distribution of hadrons

$$f_{\alpha\beta}(z)\alpha\ \frac{1}{z}\ z^{a_\alpha}\left(\frac{1-z}{z}\right)^{a_\beta}\ e^{-b\,m_\perp^2/z}$$

$$p_T\ kick\ of\ Gaussian\ Wdith$$
$$\sigma_{q'q'} = \sigma_{qq} \times f$$

$$f = 1\ \ for\ \ p + p$$
$$f = 2\ \ for\ \ A + B$$

$$\kappa\ \propto \frac{(a_\alpha - a_\beta + 1)}{b(a_\alpha + 2)}$$

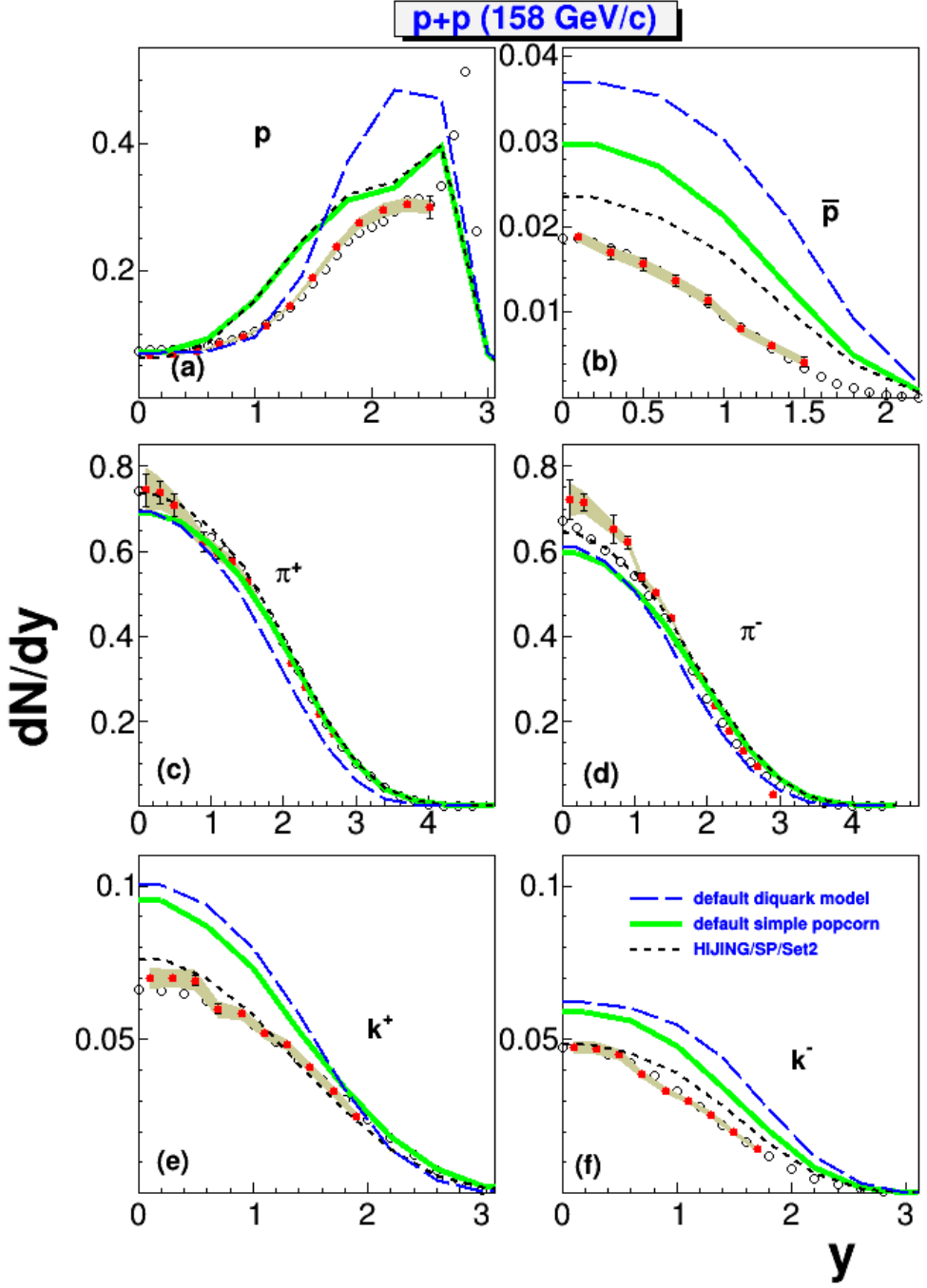
String Tension

a_α for the previously produced $q\bar{q}$ pair	Parj(41)=0.5
b	Parj(42)=0.9
a_β for the new $q\bar{q}$ pair	Parj(45)=0.5
σ_{qq}	Parj(21)=0.36 GeV/c

Rapidity distributions

Simple popcorn(SP)

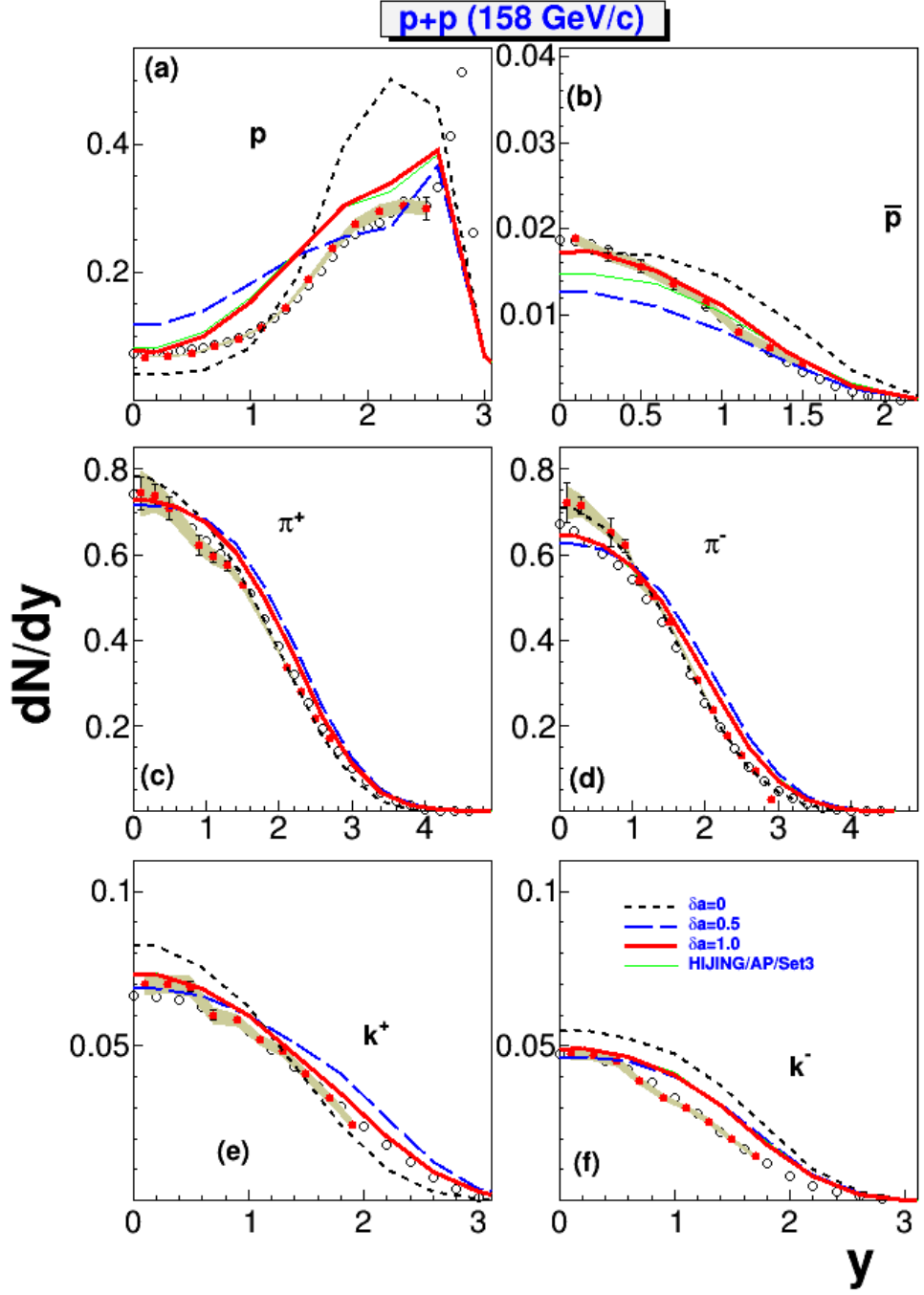
calculations



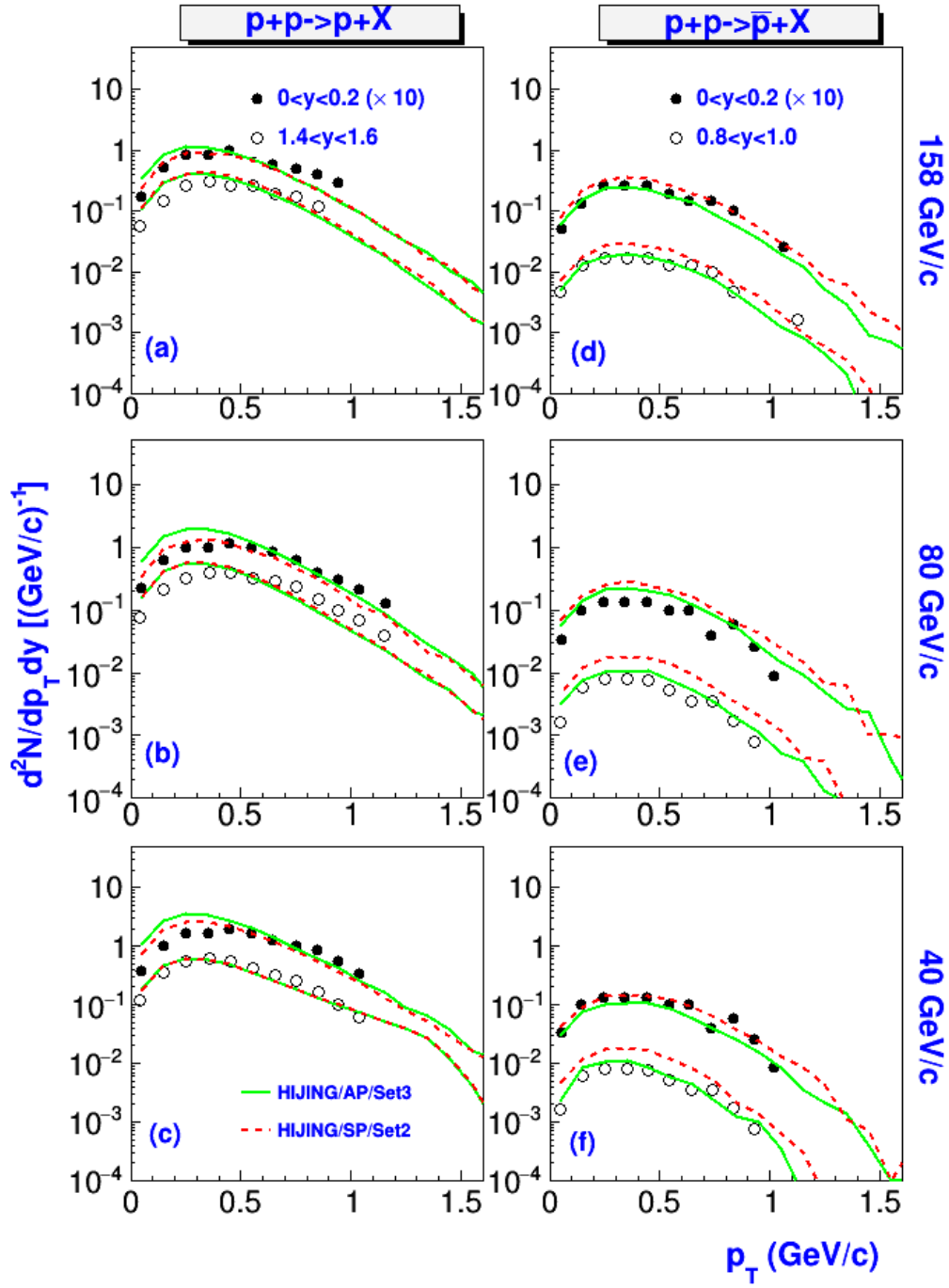
Rapidity distributions

Advanced popcorn(AP)

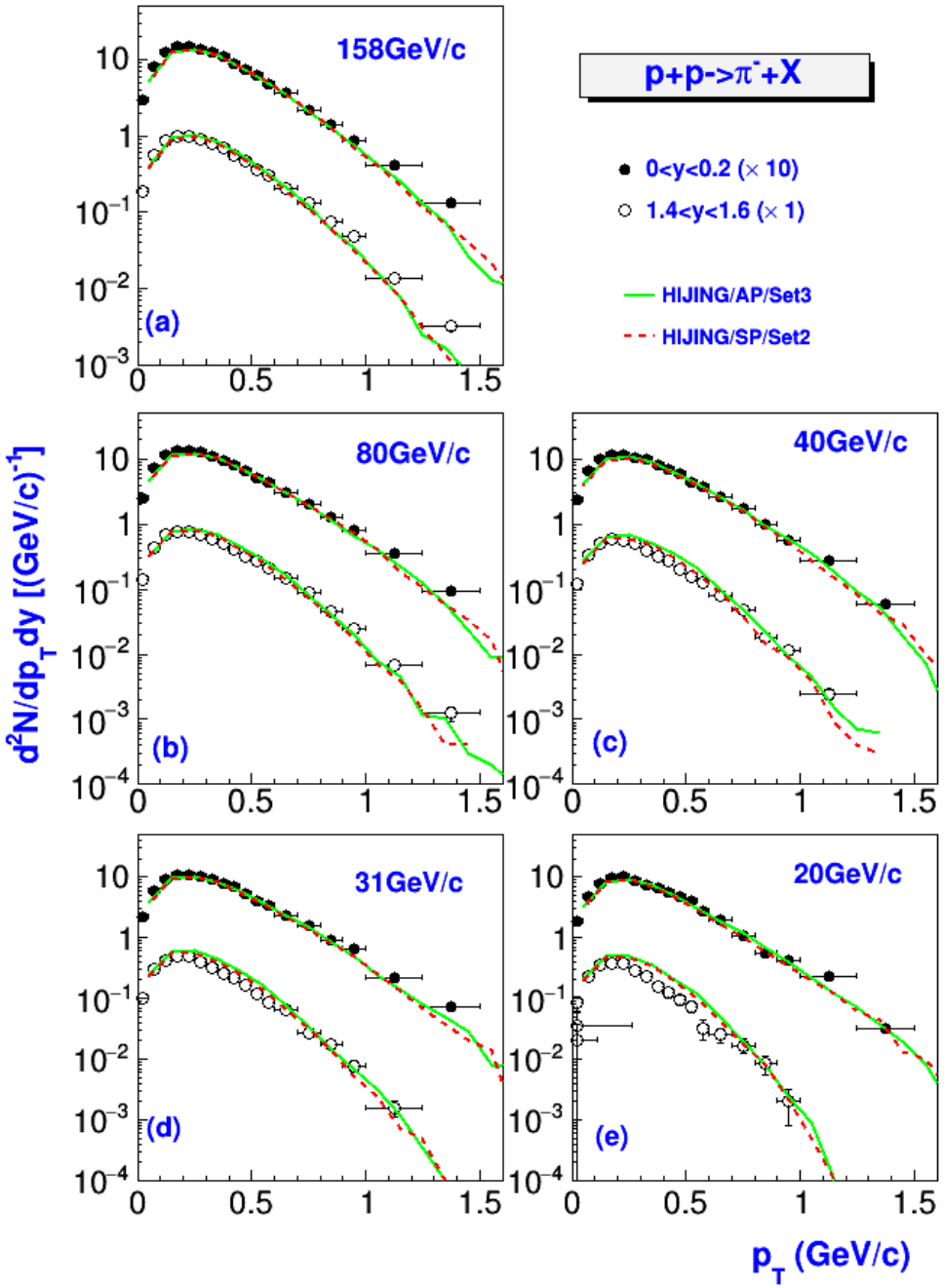
calculations



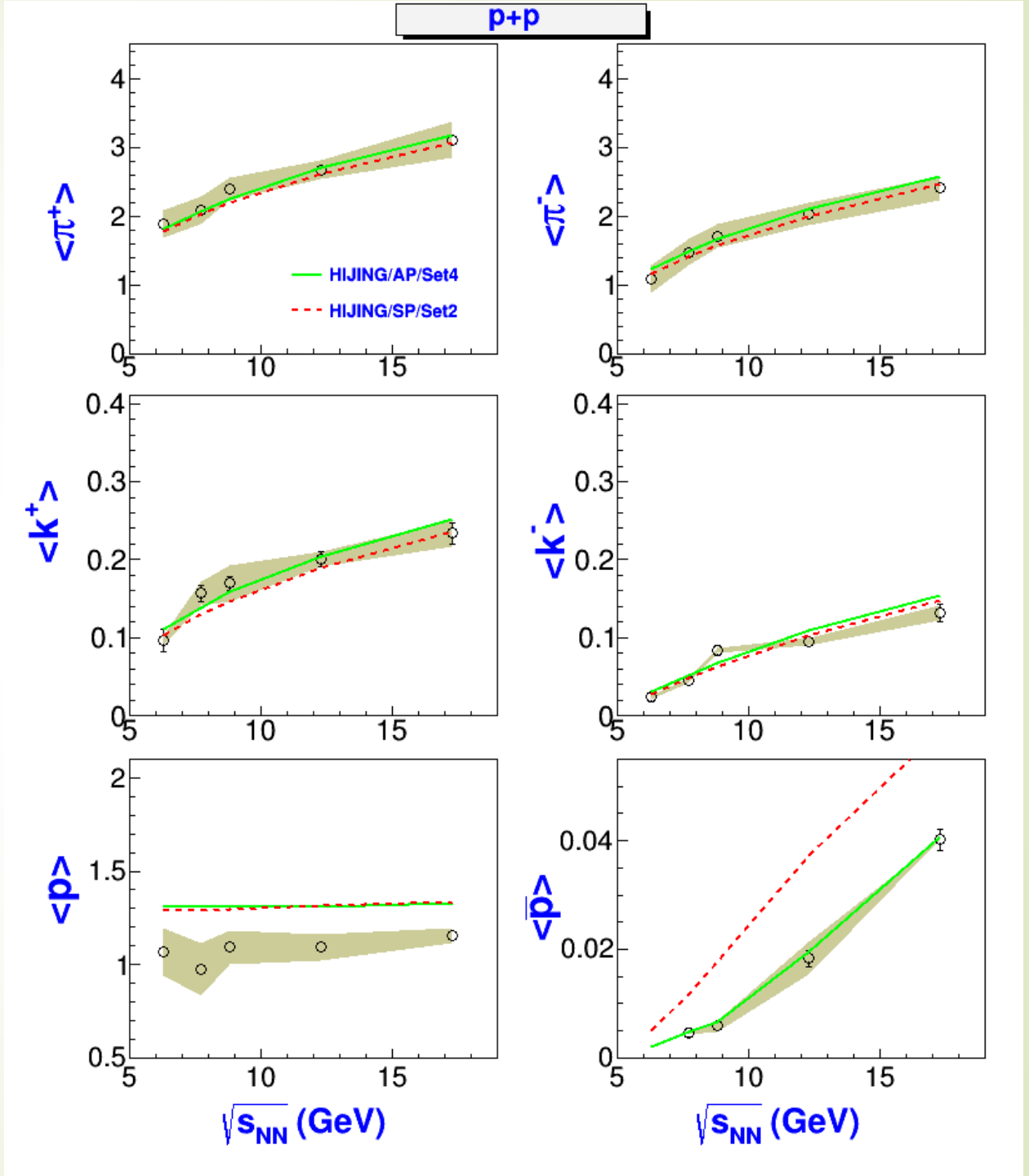
Transverse Momentum distributions



Transverse momentum distribution



Energy dependence



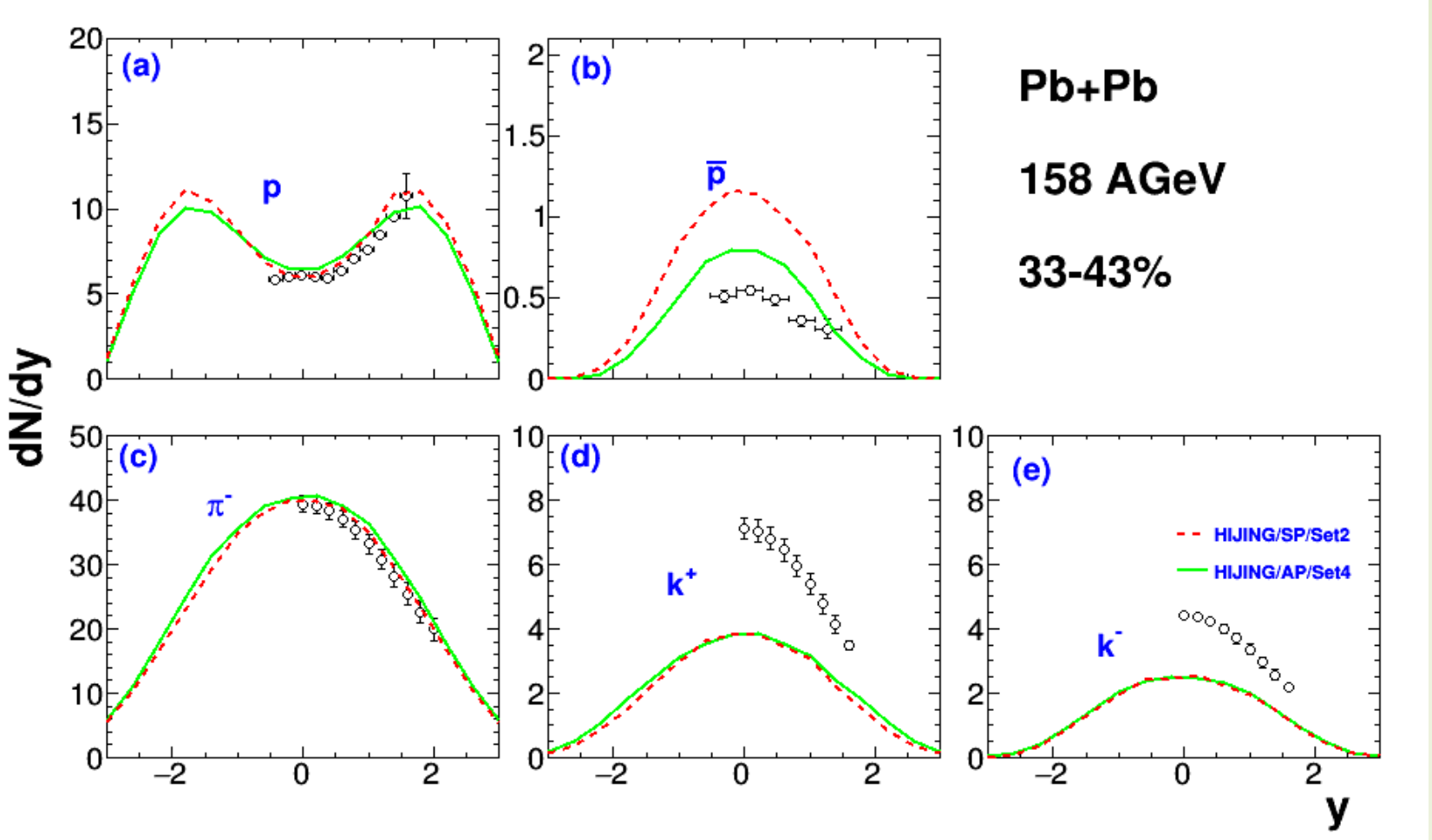
Results of the improved HIJING code in Pb+Pb collisions

Table 2. Parameter sets of HIJING/SP(AP) for Pb + Pb collisions.

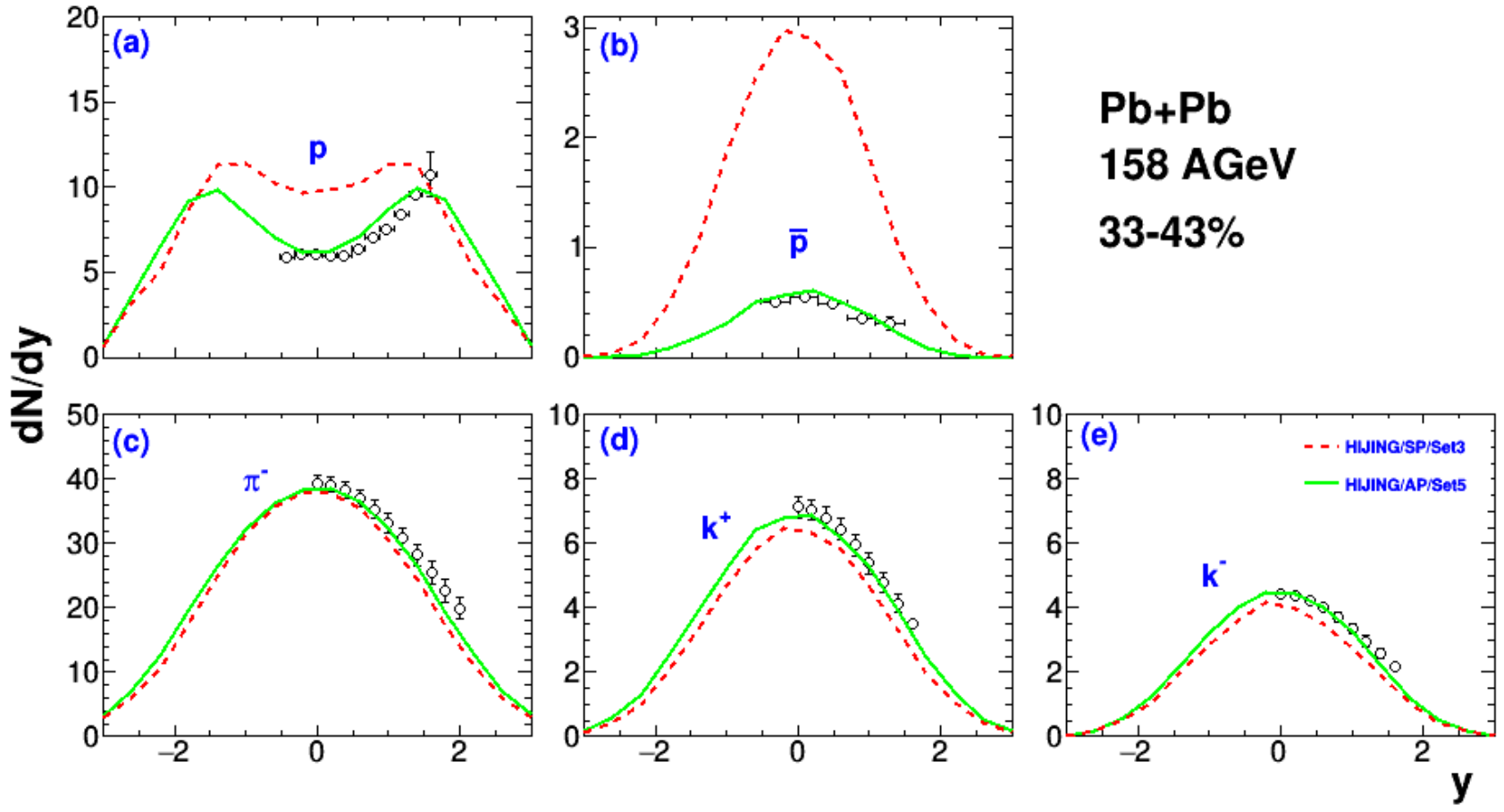
	α	b GeV^{-2}	$\gamma'_{q\bar{q}}$	γ'_s	$\sigma'_{q\bar{q}}$ GeV/c
HIJING/SP/set3	2.2	0.325	0.19	0.39	0.792

	α_a	α_b	b GeV^{-2}	$\gamma'_{q\bar{q}}$	γ'_s	$\sigma'_{q\bar{q}}$ GeV/c
HIJING/AP/set5	1.11	0.95	0.44	0.2	0.39	0.792

Parameters of popcorn mechanisms in A+A collisions

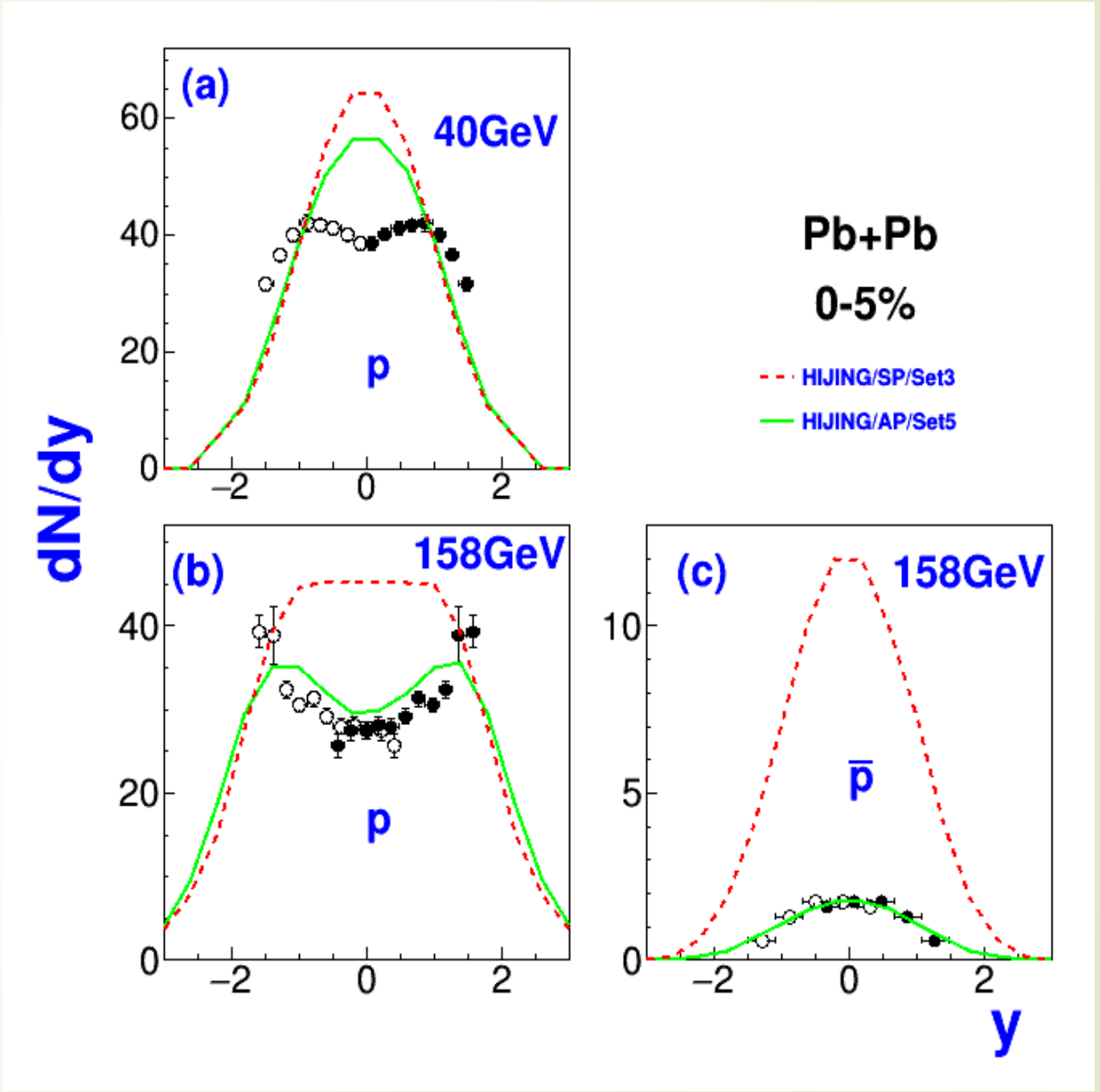


Peripheral interactions

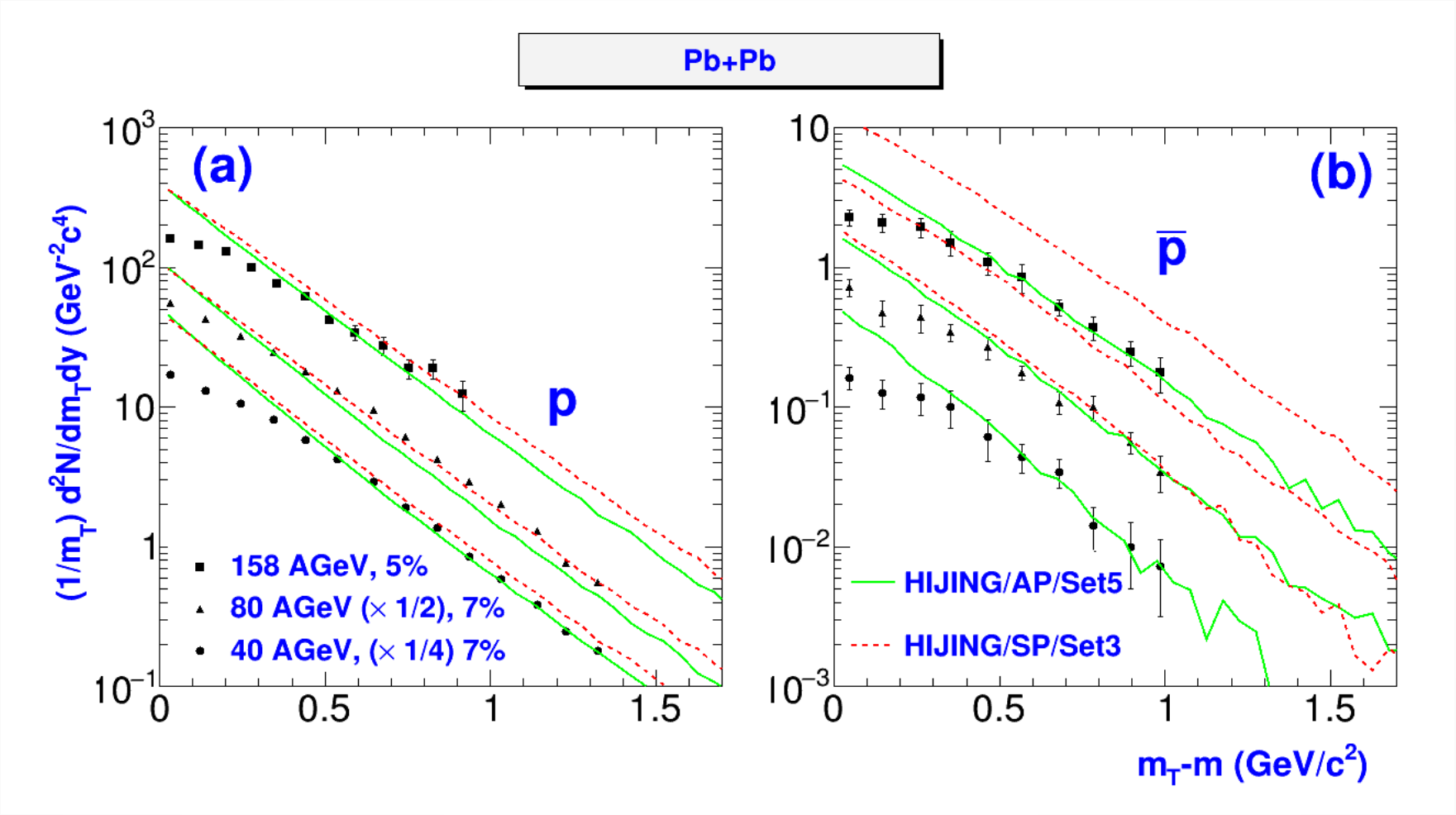


Peripheral interactions

Central Pb+Pb collisions



Transverse mass spectra

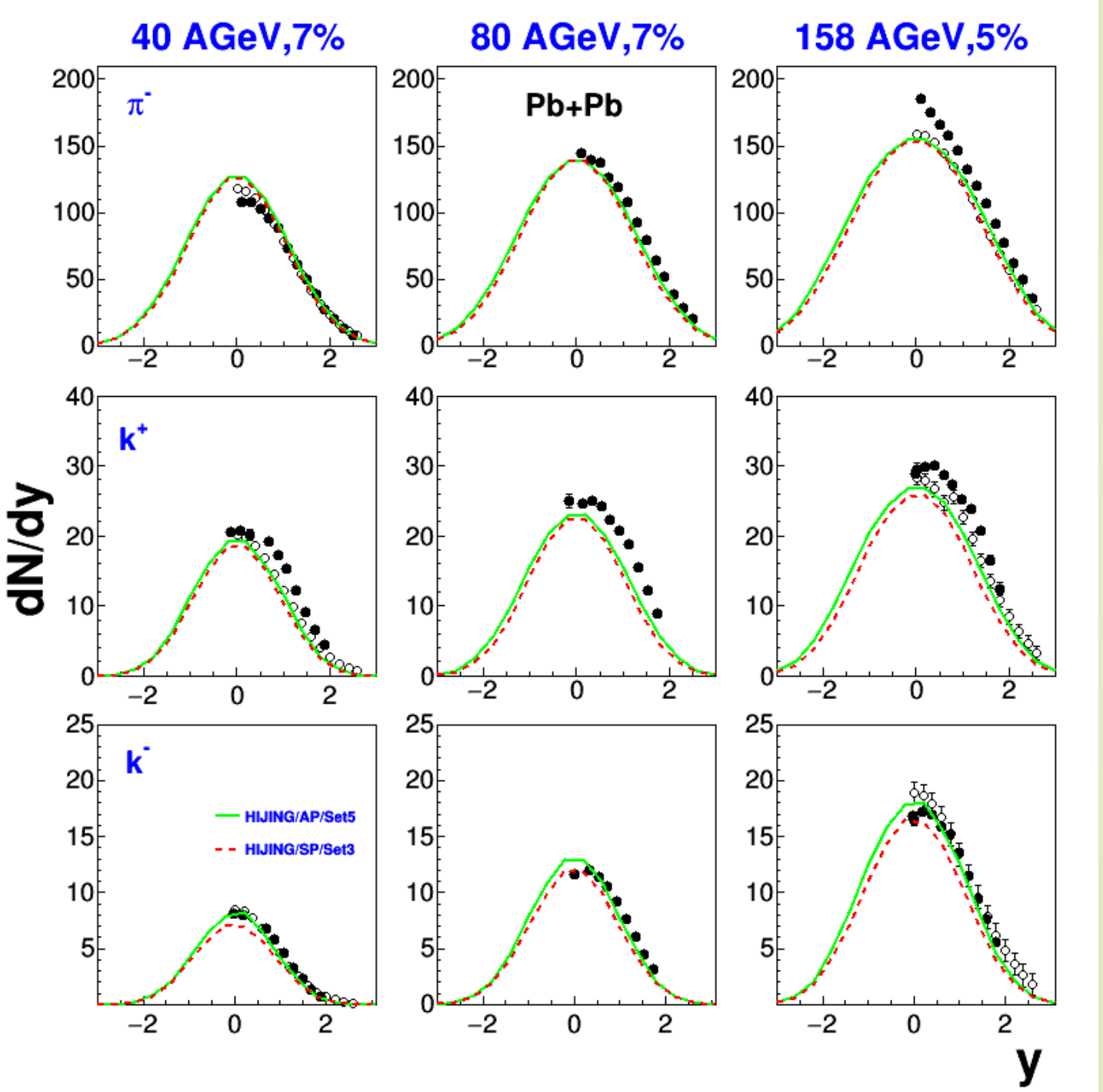


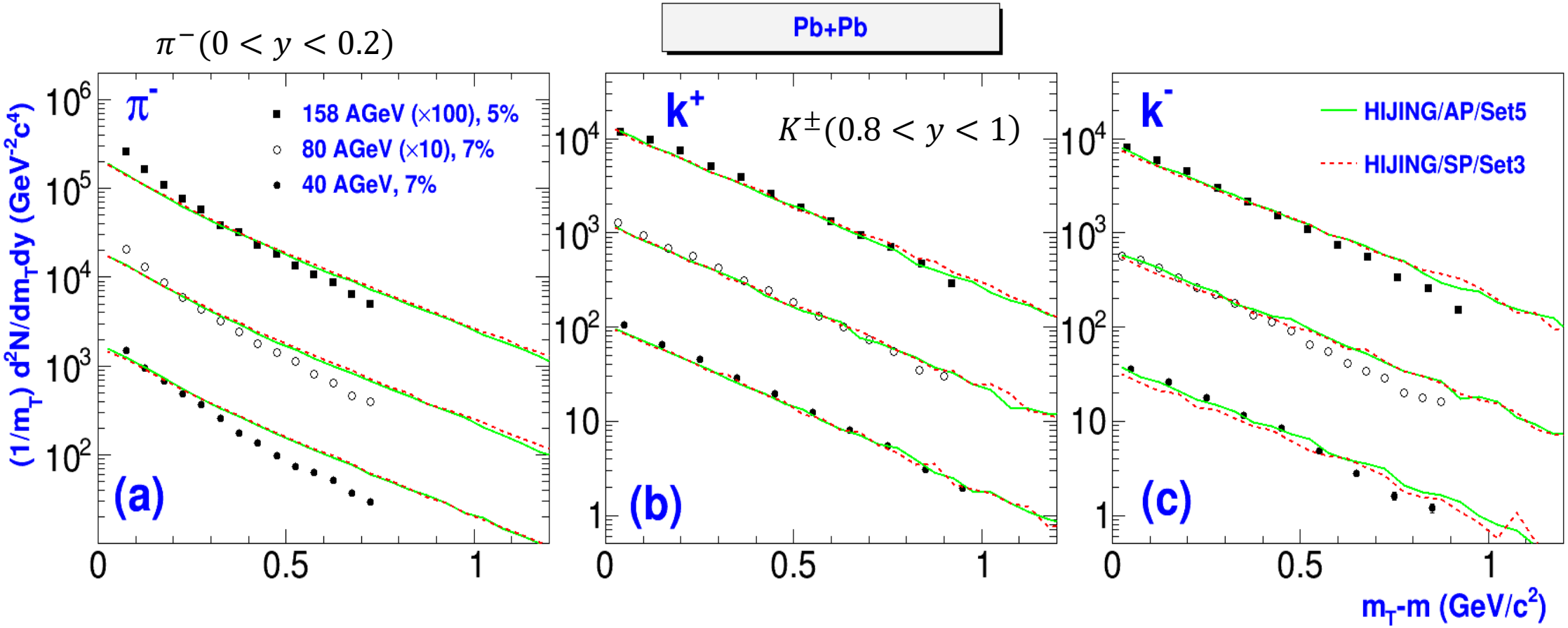
$1.9 < y < 2.3$ for 40 AGeV

$2.2 < y < 2.6$ for 80 AGeV

$2.4 < y < 2.8$ for 158 AGeV

Rapidity distributions





Transverse mass Spectra

Conclusions

- ✓ **Main Improvement of HIJING code is**
  - **PYTHIA 6.4 is now included**
- ✓ **Rapidity density of $p, \bar{p}, \pi^{\pm}$ and $k^{\pm}$ are well reproduced for**
  - ✓ $p + p$ collisions at 40, 80, and 158 GeV
- ✓ **Central and forward rapidity results for the Transverse mass spectra of π^{-}, p and $\bar{p}$ are well reproduced at CERN SPS energies.**
- ✓ **Rapidity and Transverse mass spectra of $p, \bar{p}, \pi^{\pm}$ and $k^{\pm}$ yield are described for**
  - ✓ Pb+Pb collisions at $40, 80\ and\ 158\ A\mathrm{GeV}$.
- ✓ **Final State interactions should be taken into account.**

Thanks