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Probing longitudinal distributions and correlations of net charges in the early-stage of heavy ion collisions

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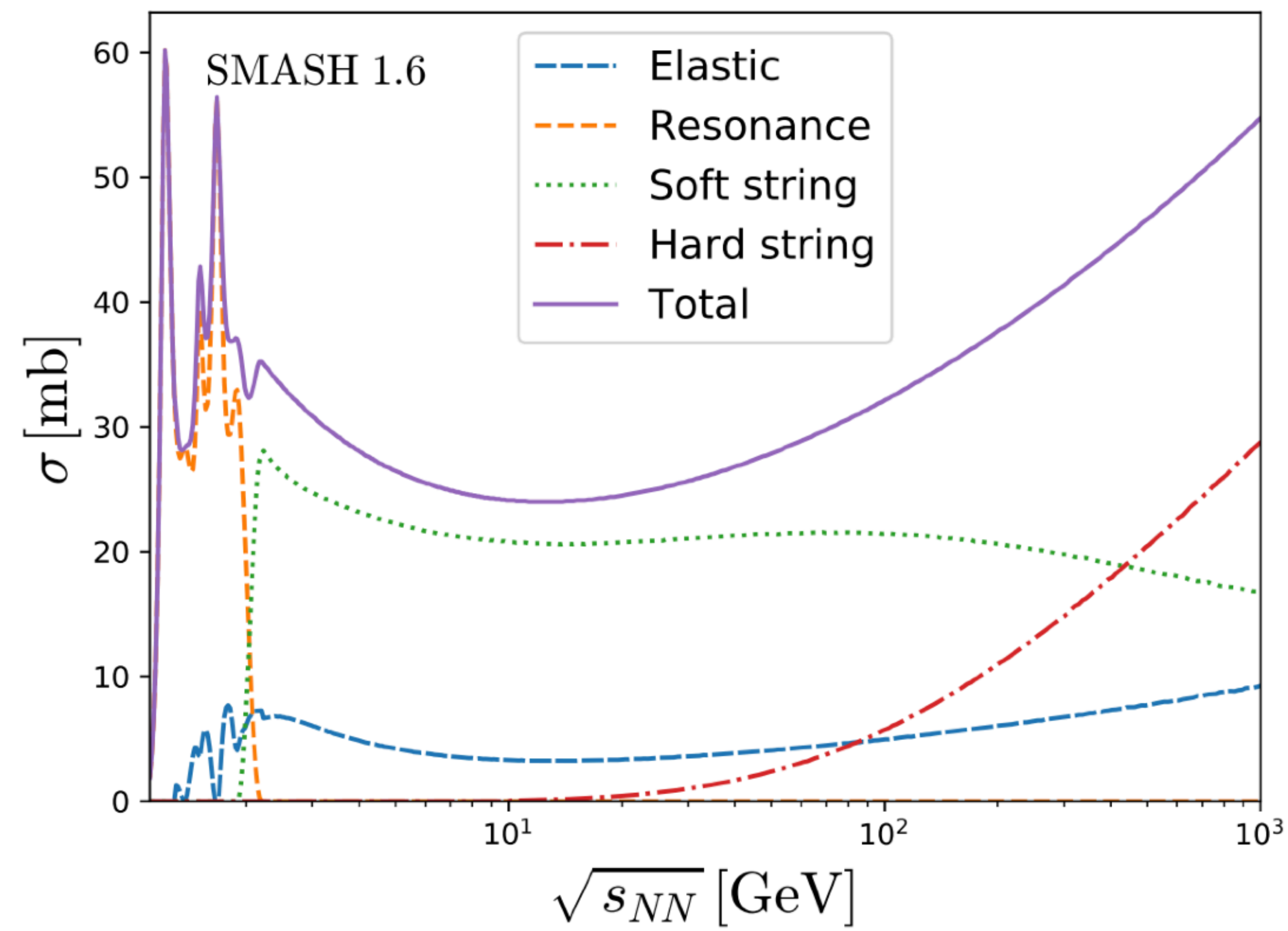
Introduction and motivation

- Conserved charges (net baryon, strangeness, etc.) have non-trivial longitudinal distributions in heavy-ion collisions at intermediate and low energies.
- We explore how those distributions evolve using the SMASH microscopic transport (for hadronic system). Weil J *et al.*, Phys. Rev. C94 054905 (2016)

Particle production mechanisms

- resonance excitations and decays for low collision energies
- string excitations and fragmentations for high collision energies
- (anisotropic) elastic collisions

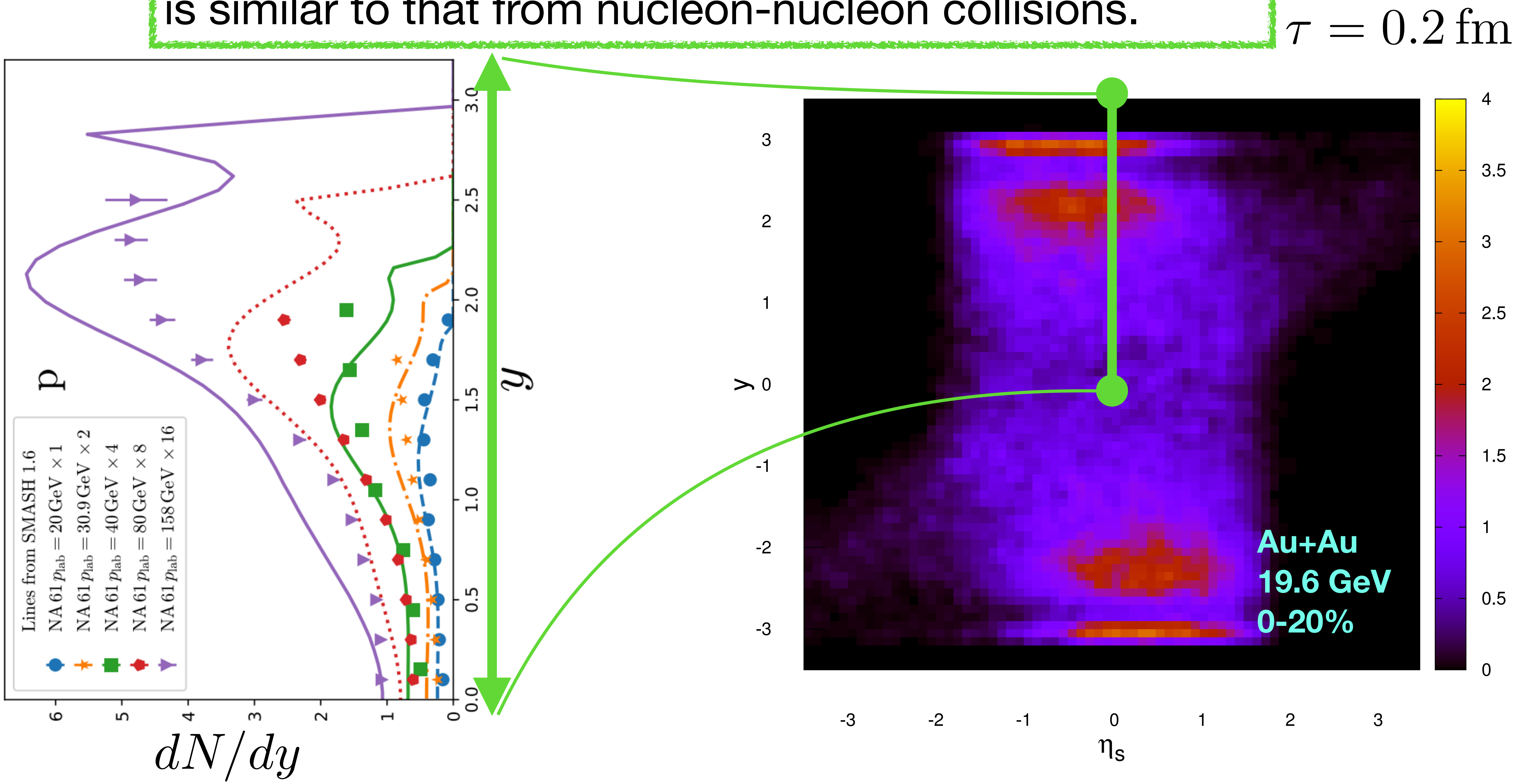


J. Mohs, S. Ryu and H. Elfner, J.Phys.G 47 (2020) 6, 065101

Results : net baryon transport in early stage

spacetime-momentum rapidity correlation

Early-time momentum-space distribution of net baryon is similar to that from nucleon-nucleon collisions.



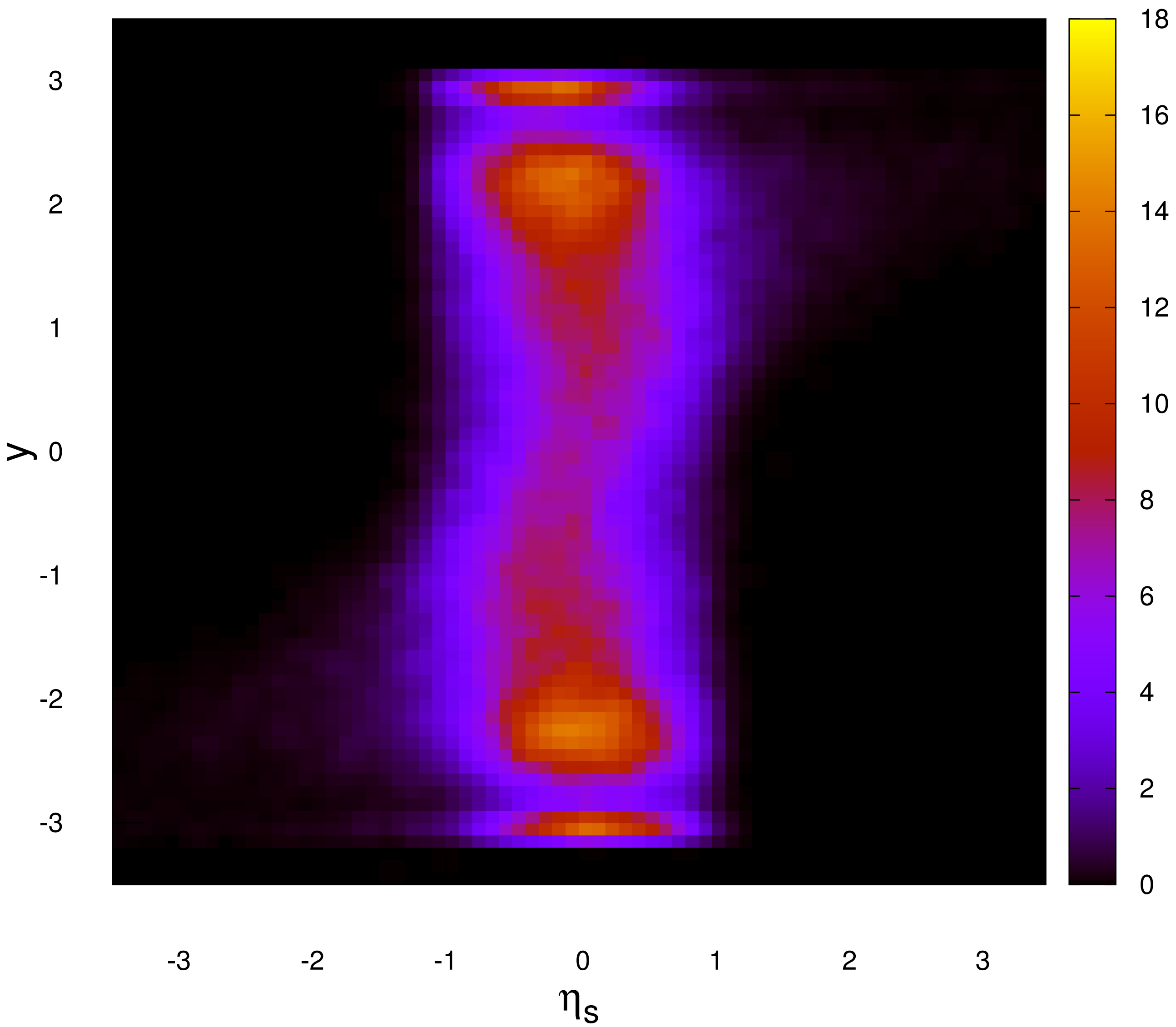
J. Mohs, S. Ryu and H. Elfner, J.Phys.G 47 (2020) 6, 065101

Results : net baryon transport in early stage

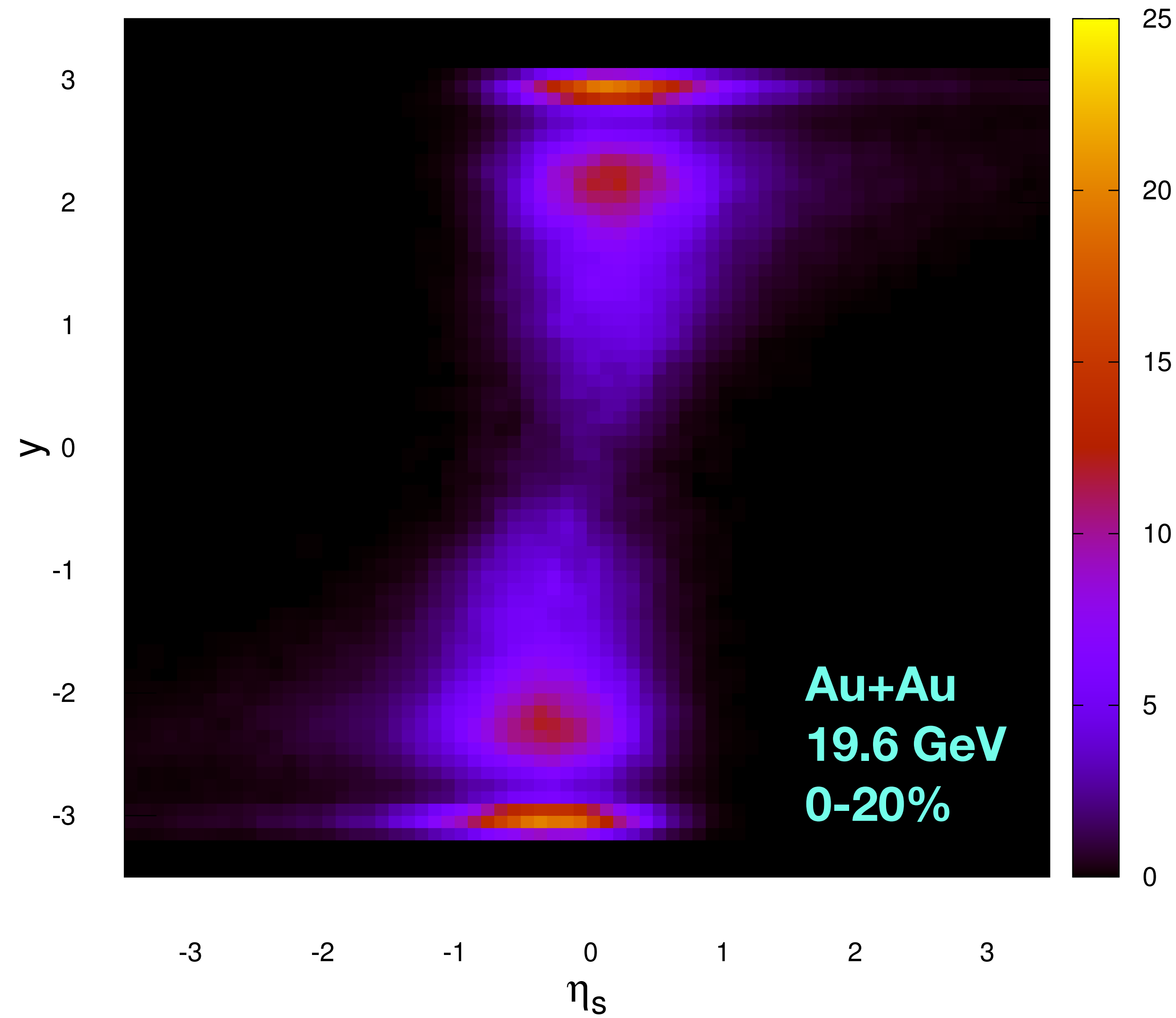
spacetime-momentum rapidity correlation

Rapid baryon transport toward mid-rapidity occurs by secondary collisions in the first fm/c.

$\tau = 0.4\,\mathrm{fm}$



w/ secondary collisions



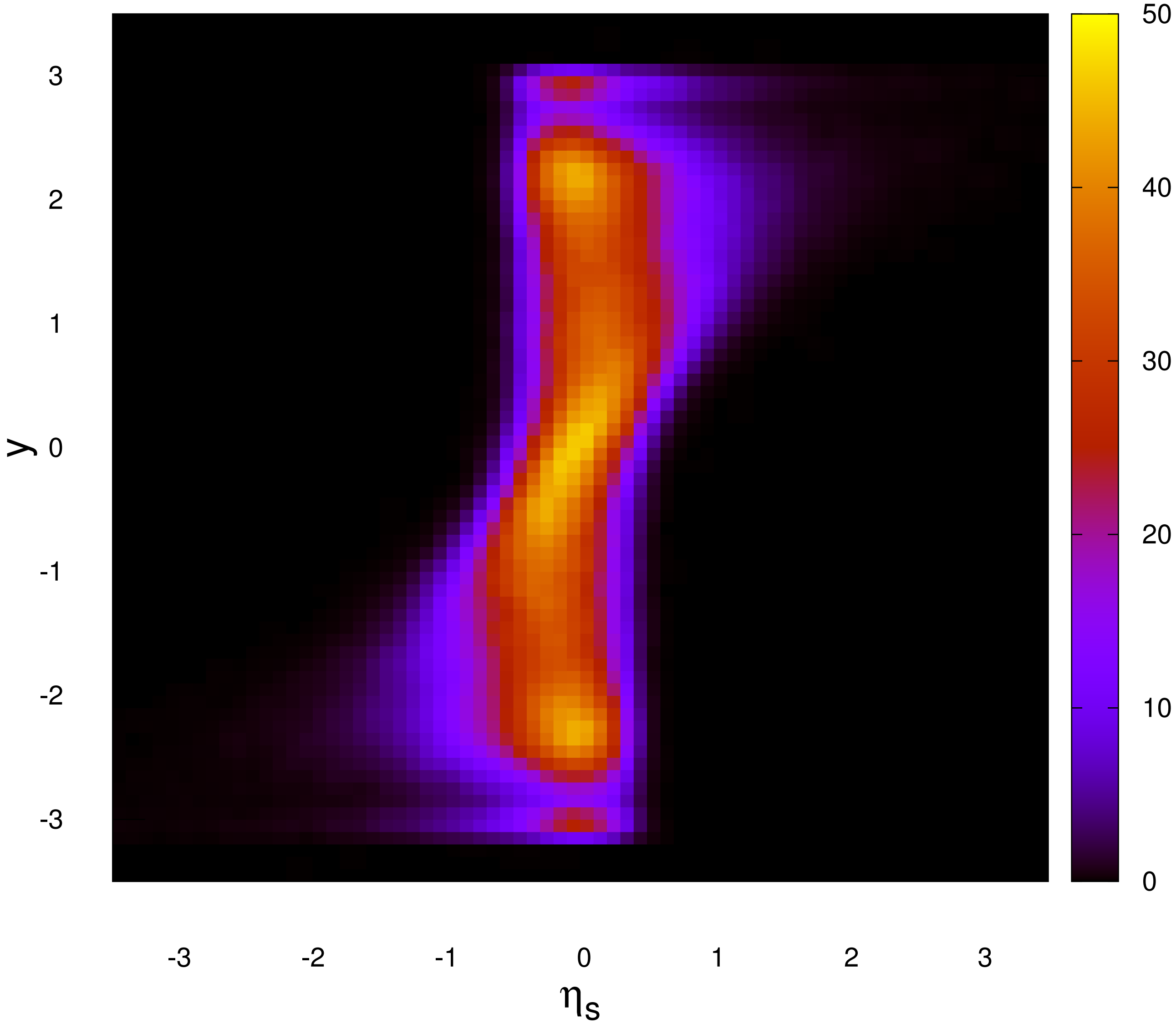
w/o secondary collisions

Results : net baryon transport in early stage

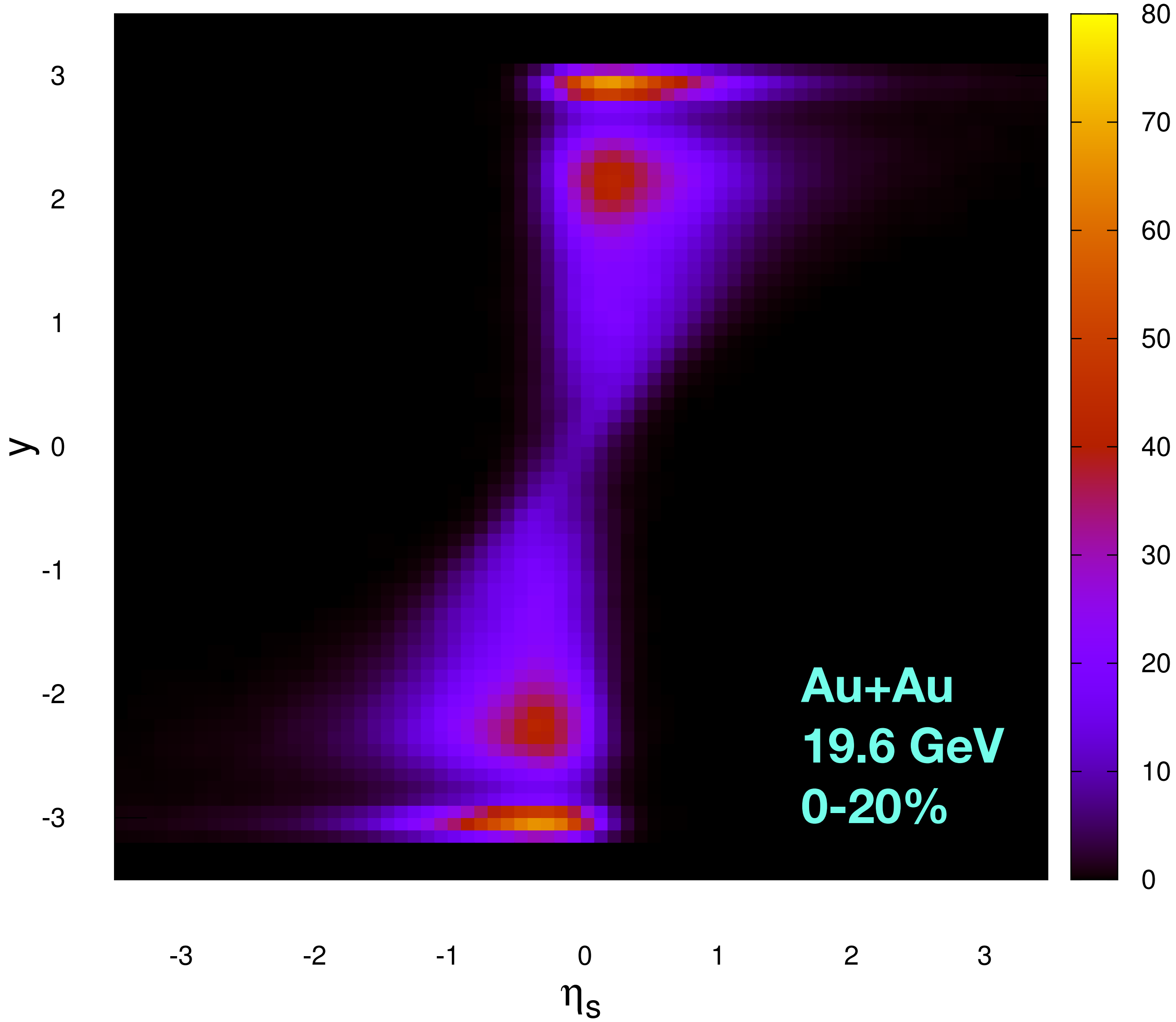
spacetime-momentum rapidity correlation

Rapid baryon transport toward mid-rapidity occurs by secondary collisions in the first fm/c.

$\tau = 0.8\,\mathrm{fm}$



w/ secondary collisions



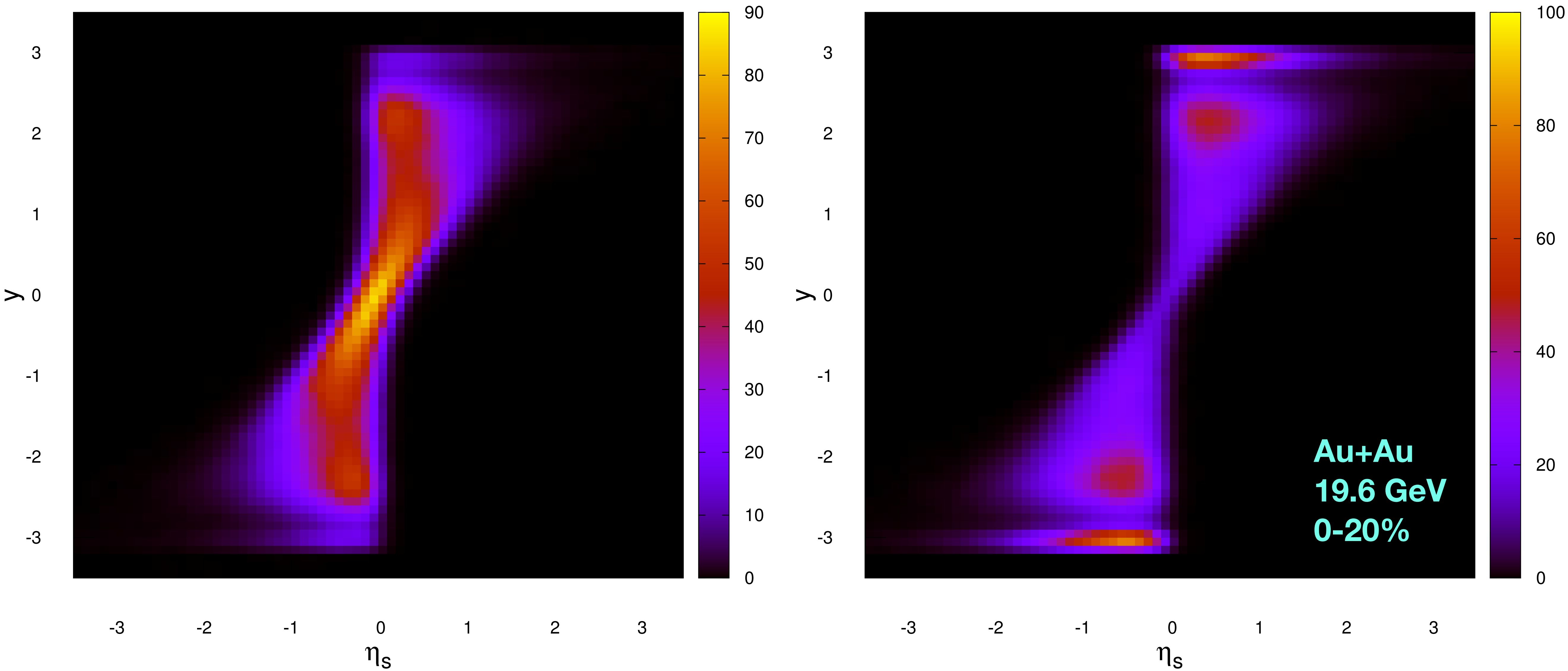
w/o secondary collisions

Results : net baryon transport in early stage

spacetime-momentum rapidity correlation

Rapid baryon transport toward mid-rapidity occurs by secondary collisions in the first fm/c.

$\tau = 1.2\,\mathrm{fm}$



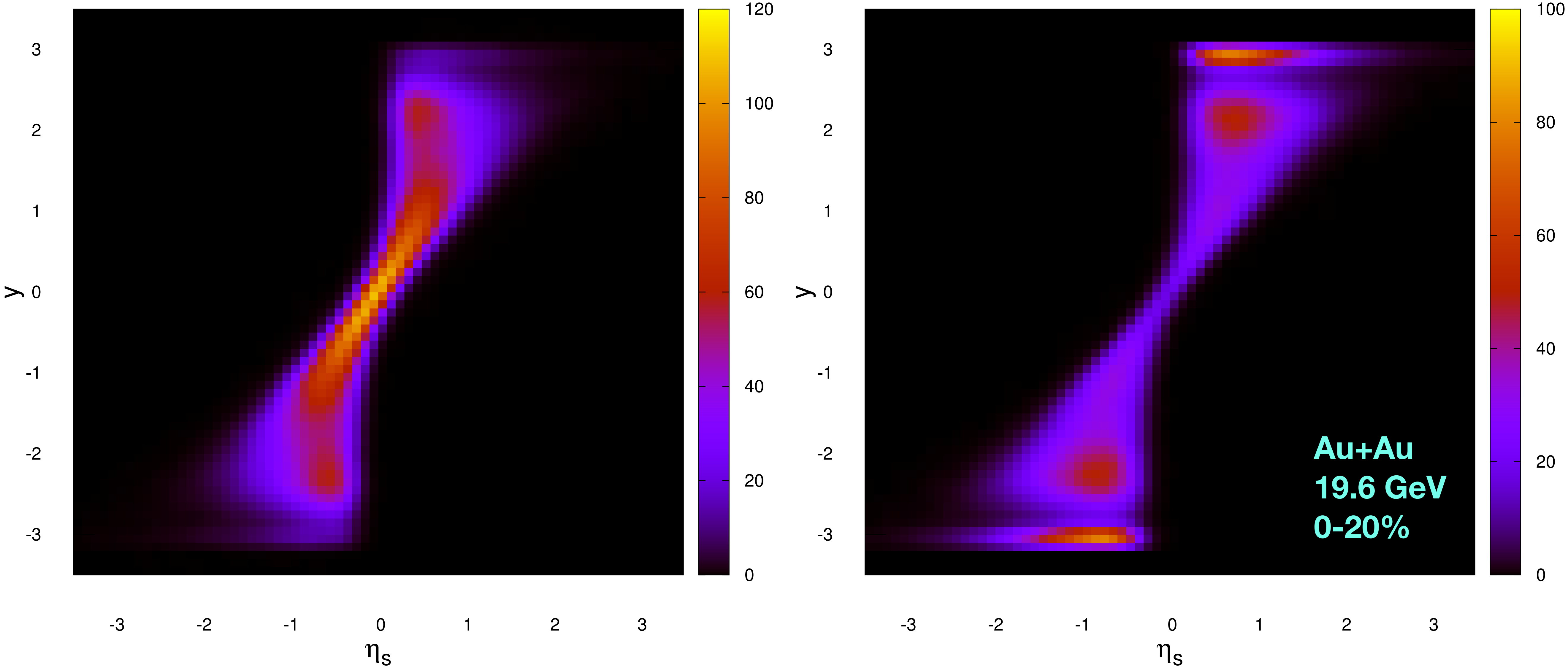
w/ secondary collisions **w/o secondary collisions**

Results : net baryon transport in early stage

spacetime-momentum rapidity correlation

Rapid baryon transport toward mid-rapidity occurs by secondary collisions in the first fm/c.

$\tau = 1.6\,\mathrm{fm}$



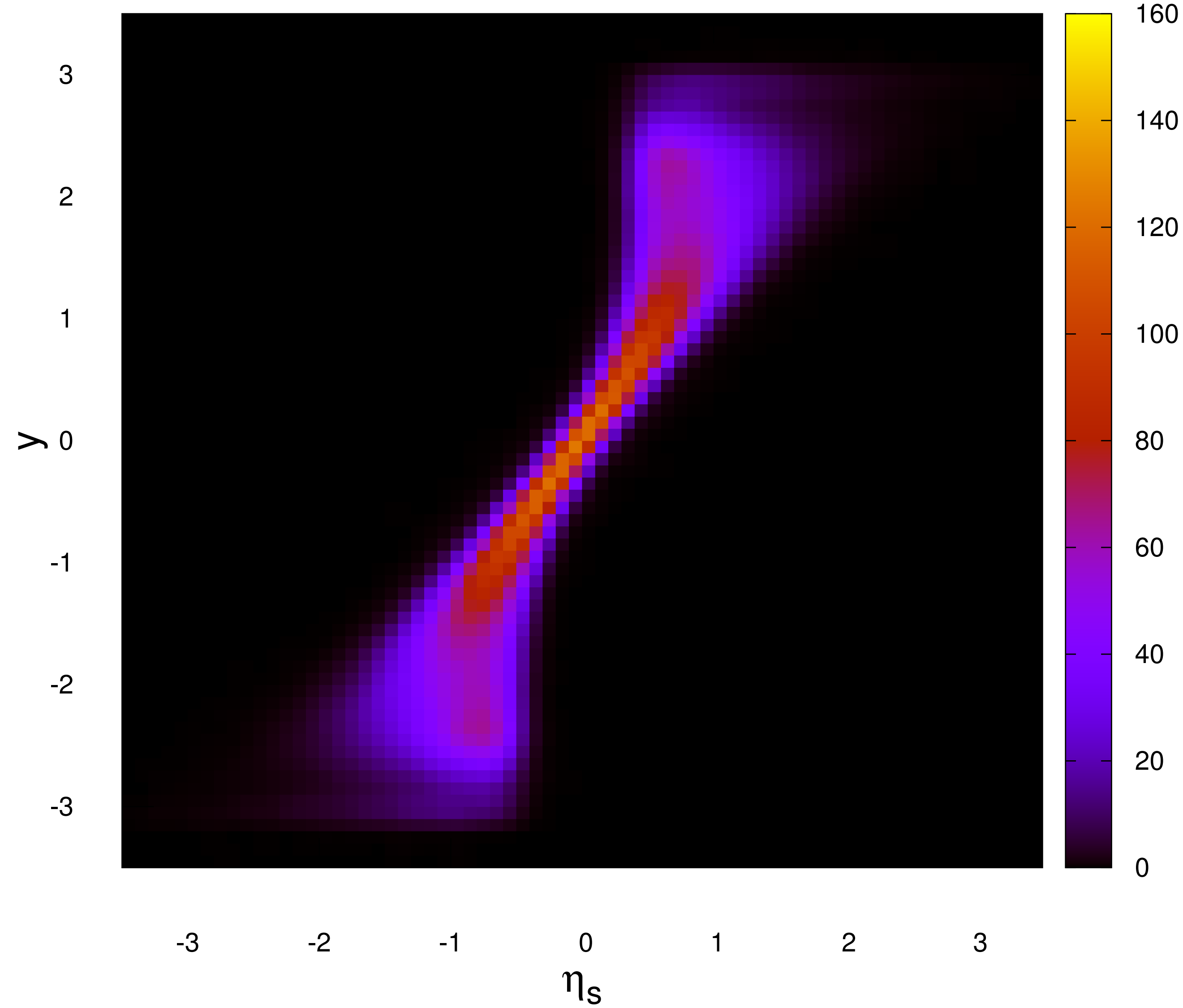
w/ secondary collisions **w/o secondary collisions**

Results : net baryon transport in early stage

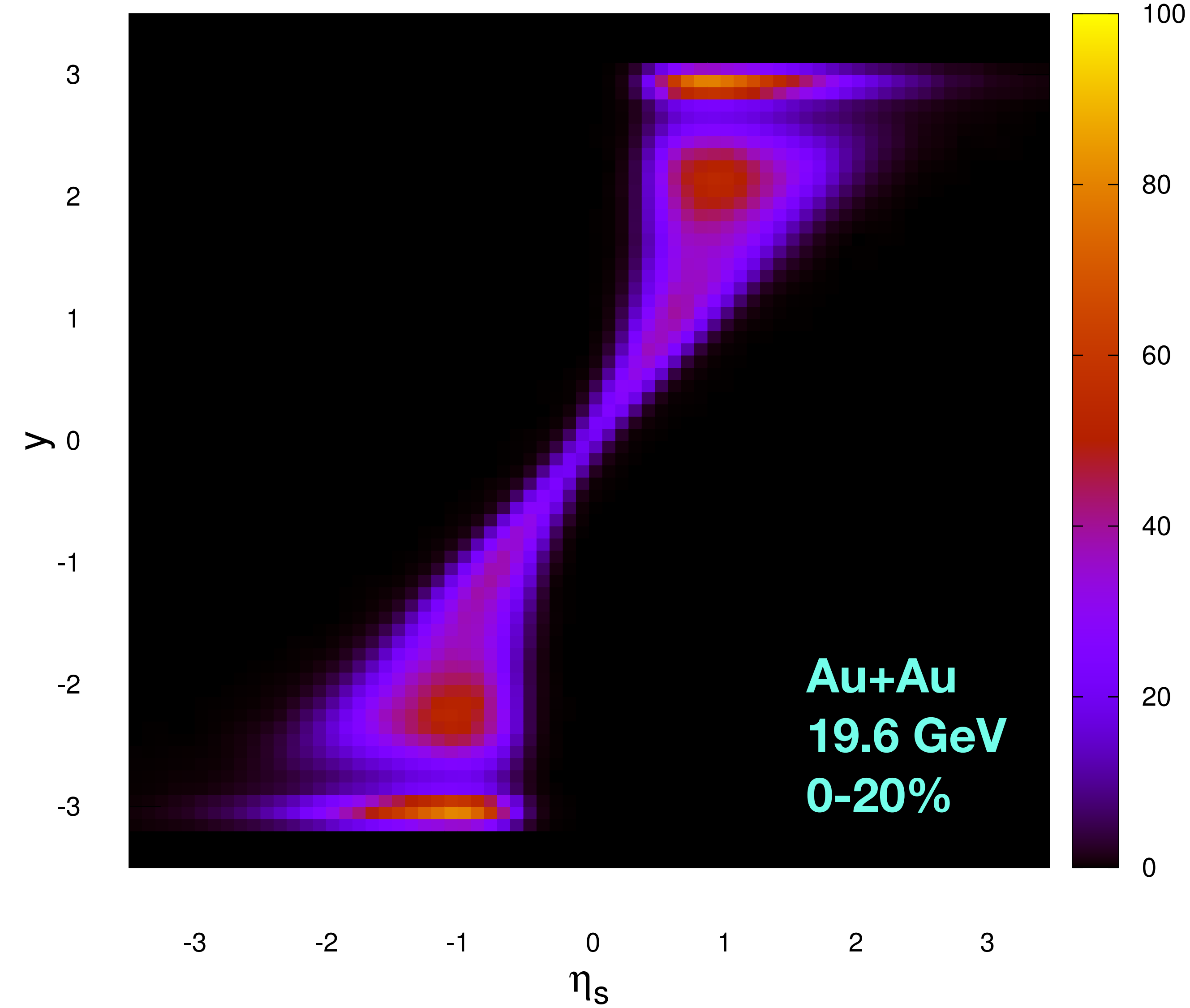
spacetime-momentum rapidity correlation

Rapid baryon transport toward mid-rapidity occurs by secondary collisions in the first fm/c.

$\tau = 2.0\,\mathrm{fm}$



w/ secondary collisions



w/o secondary collisions

Results : net baryon transport in early stage

spacetime-momentum rapidity correlation

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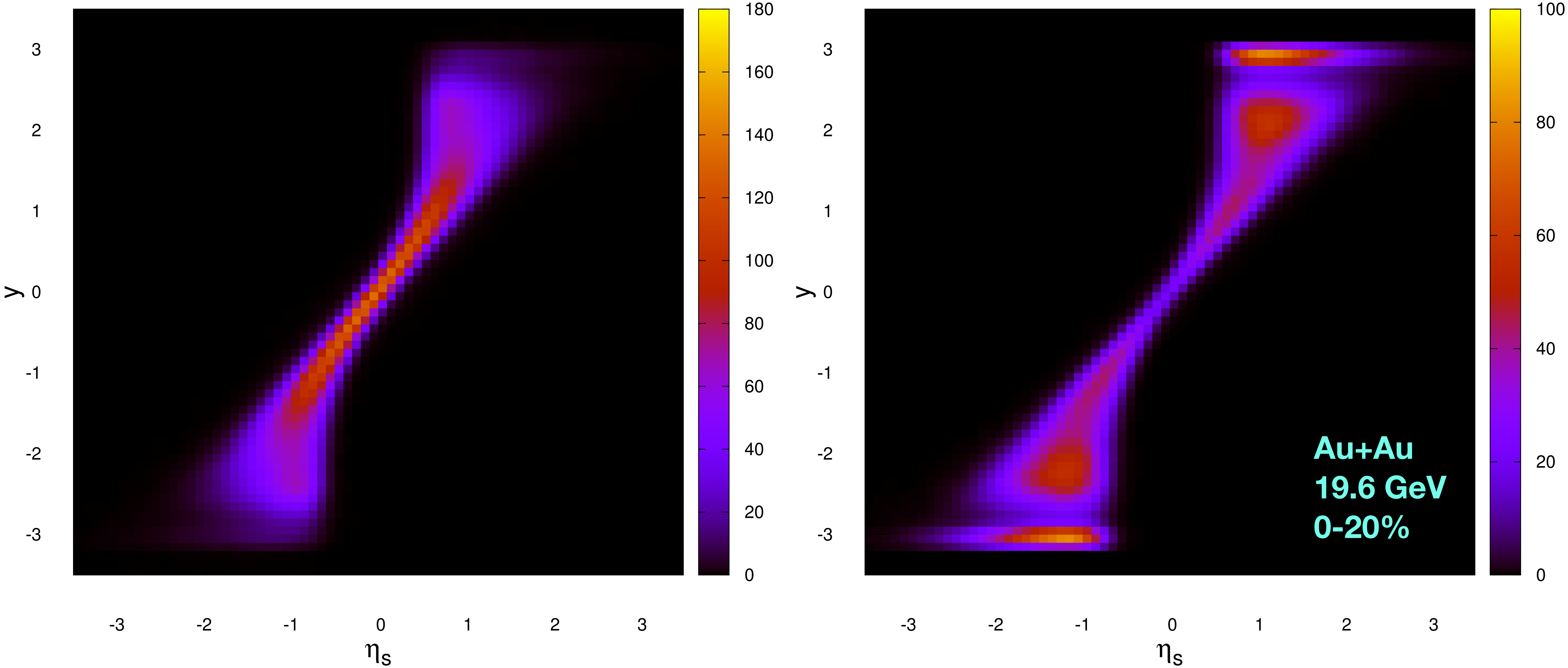

w/ secondary collisions **w/o secondary collisions**

Results : net baryon transport in early stage

spacetime-momentum rapidity correlation

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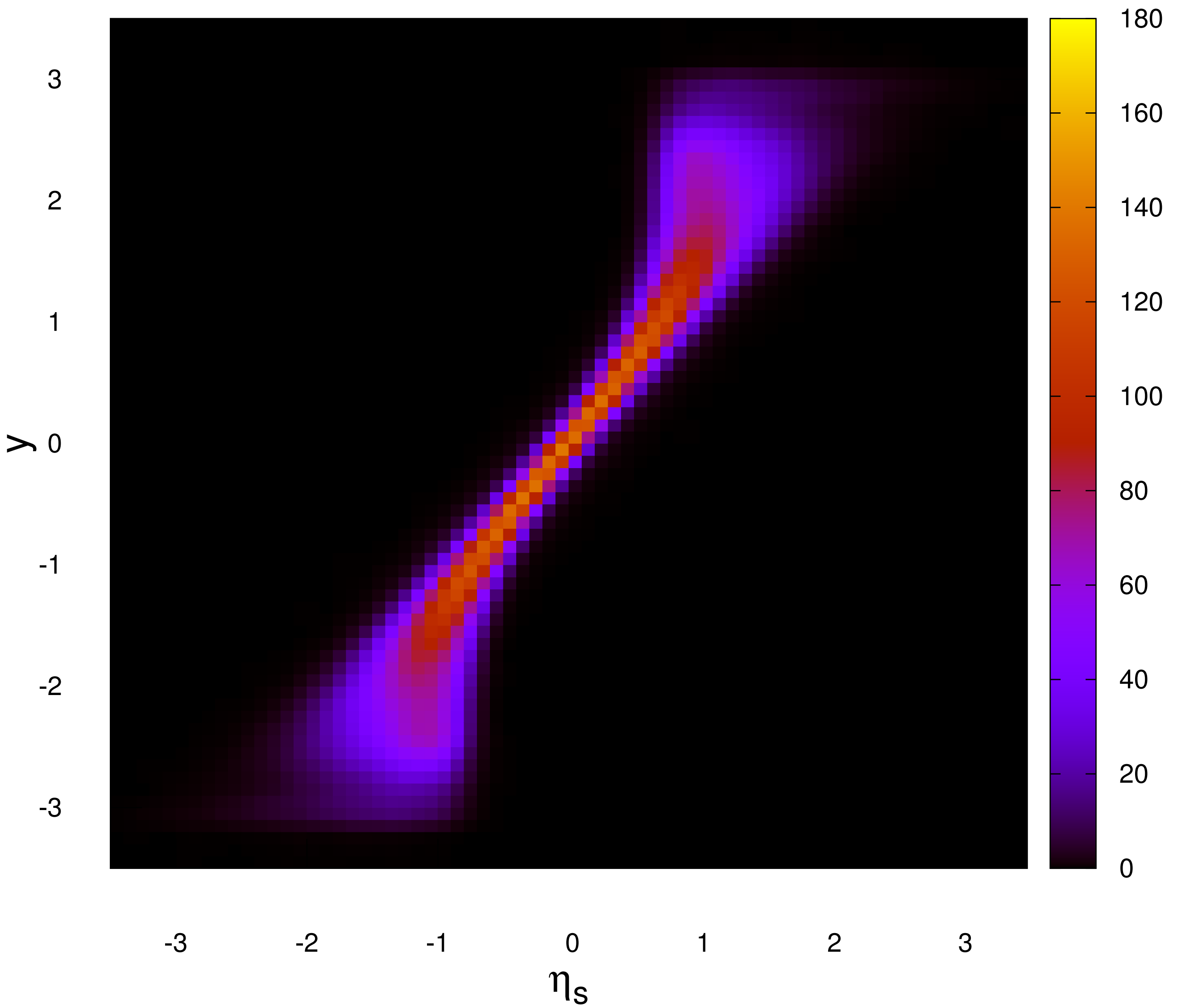
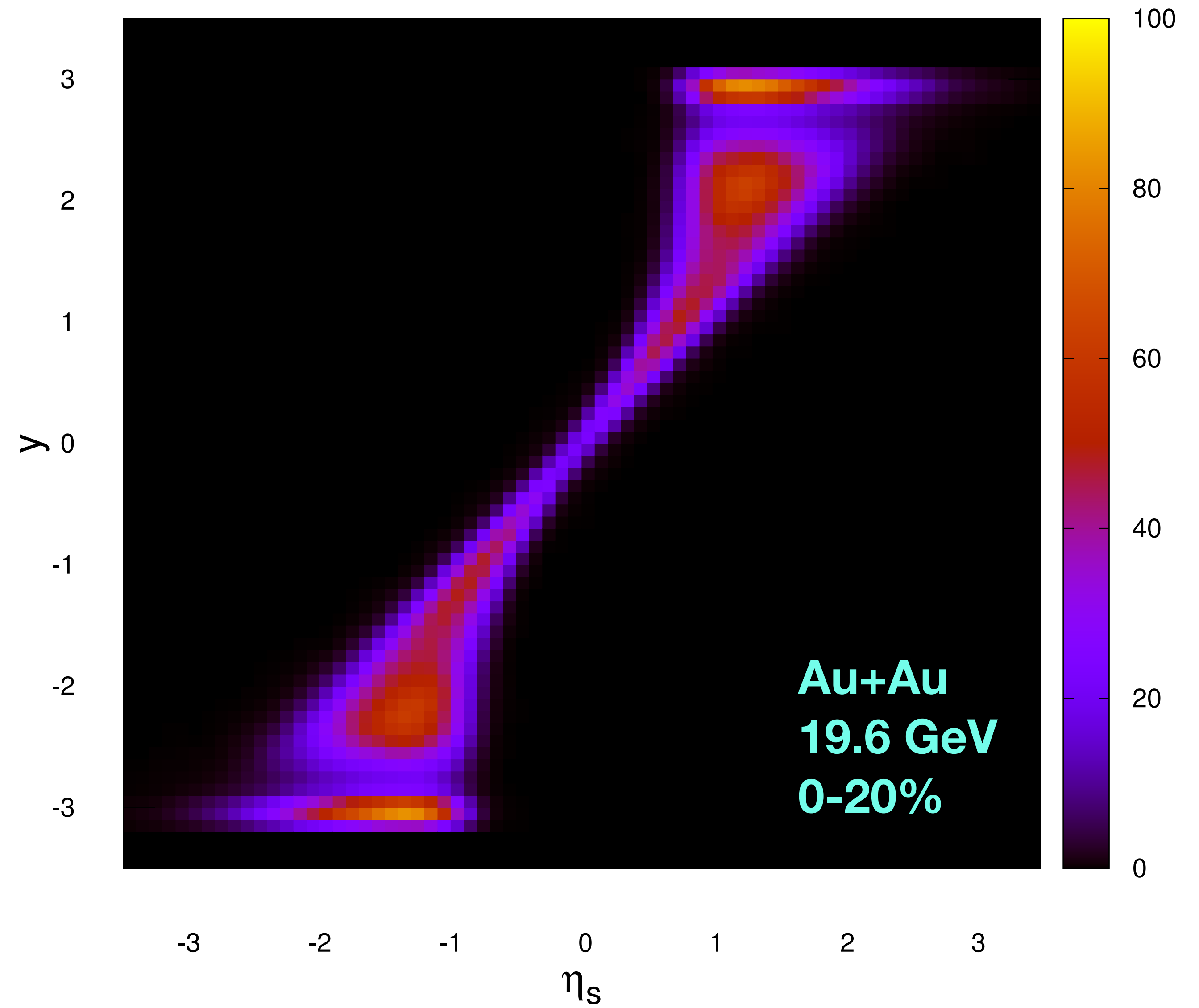
$\tau = 2.8\,\mathrm{fm}$



w/ secondary collisions

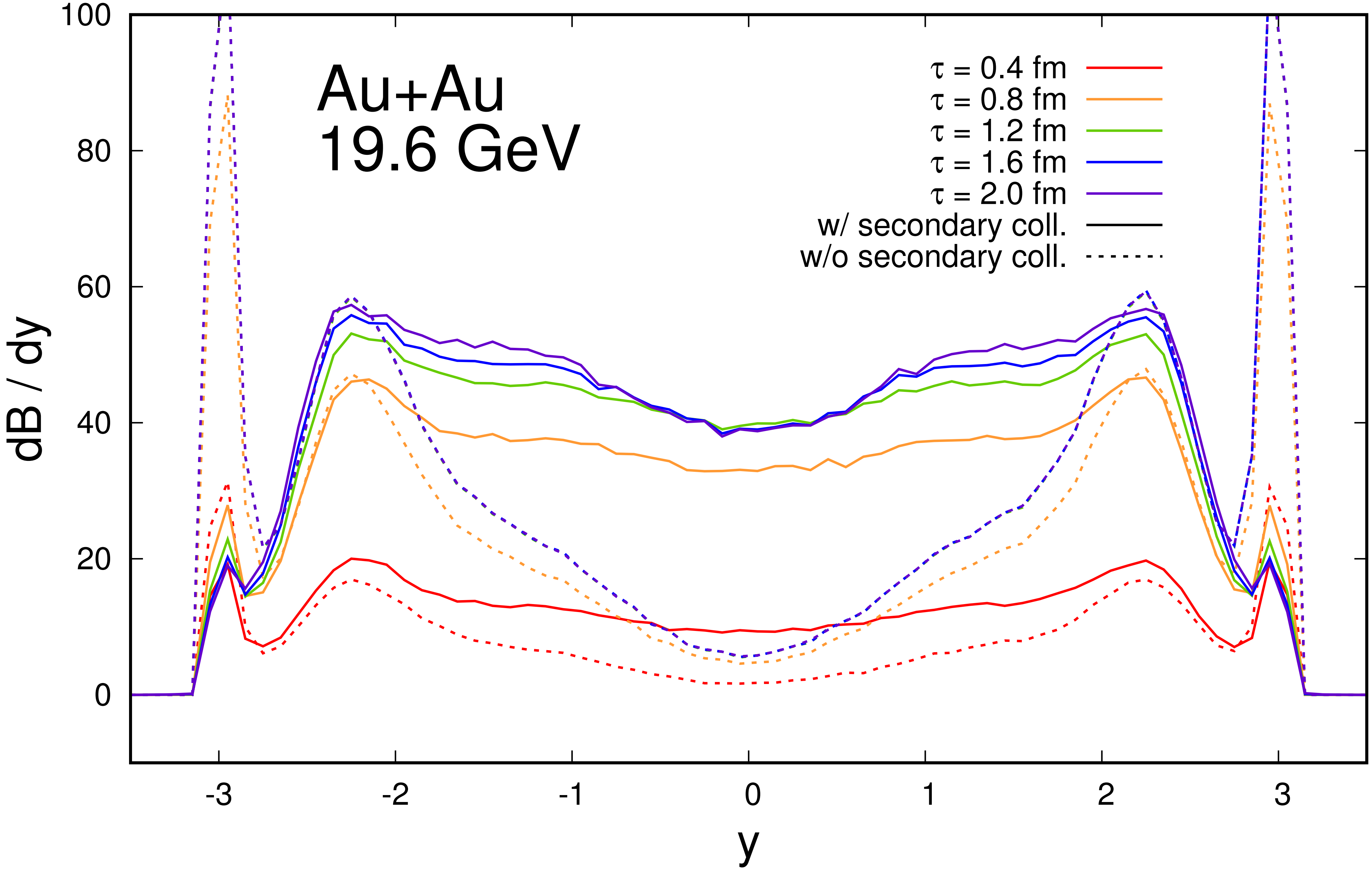


w/o secondary collisions

Results : net baryon transport in early stage

momentum rapidity distribution

Rapid baryon transport toward mid-rapidity occurs by secondary collisions in the first fm/c.



Conclusions

- We study early-time longitudinal dynamics of net baryon number with the microscopic transport SMASH, in which particles are produced through resonance excitations and string fragmentations.

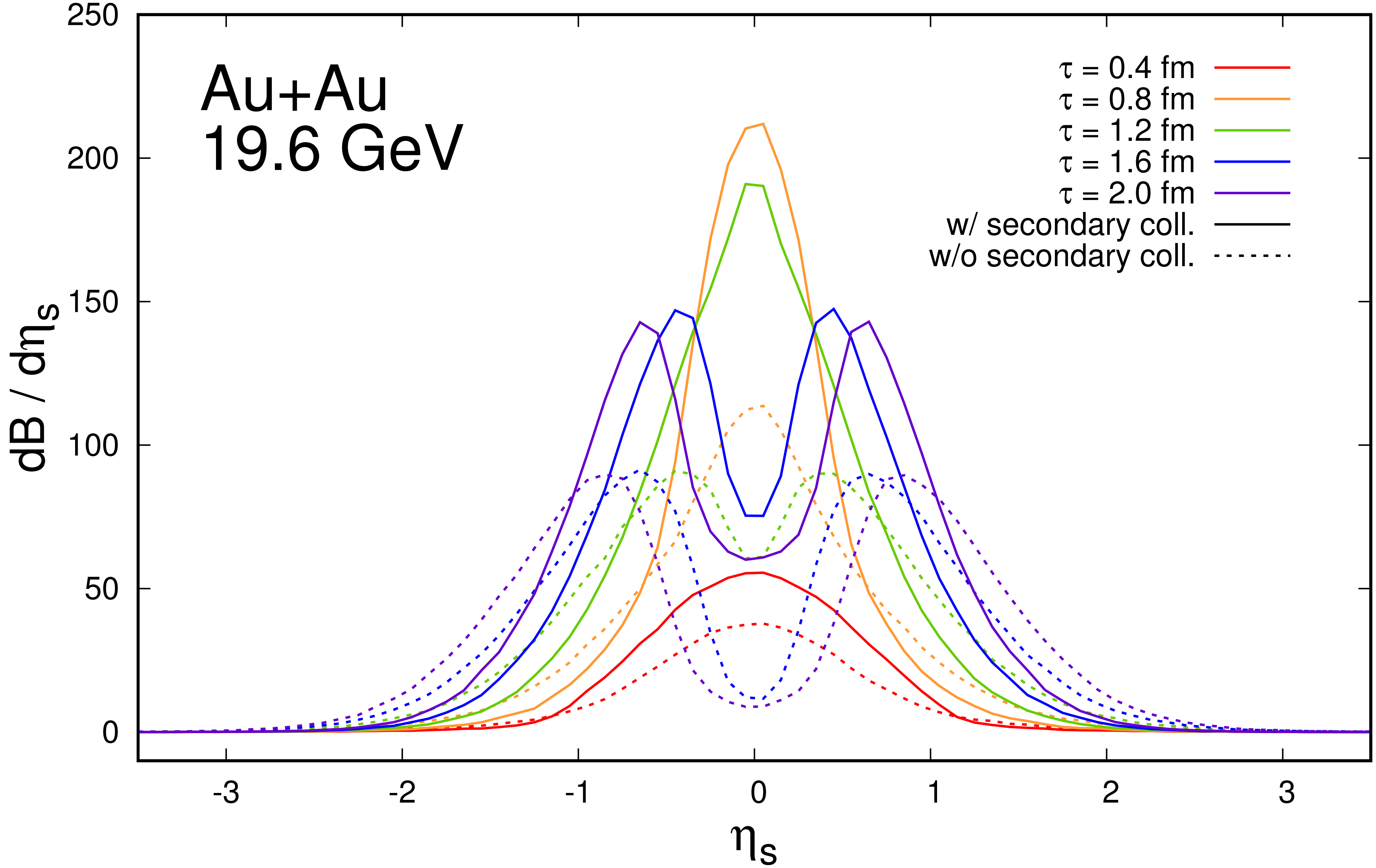
- Secondary collisions play crucial roles to efficiently transport net baryon number from forward to mid-rapidity in the first fm/c.

Even more story

Results : net baryon transport in early stage

spacetime rapidity distribution

Rapid baryon transport toward mid-rapidity occurs by secondary collisions in the first fm/c.

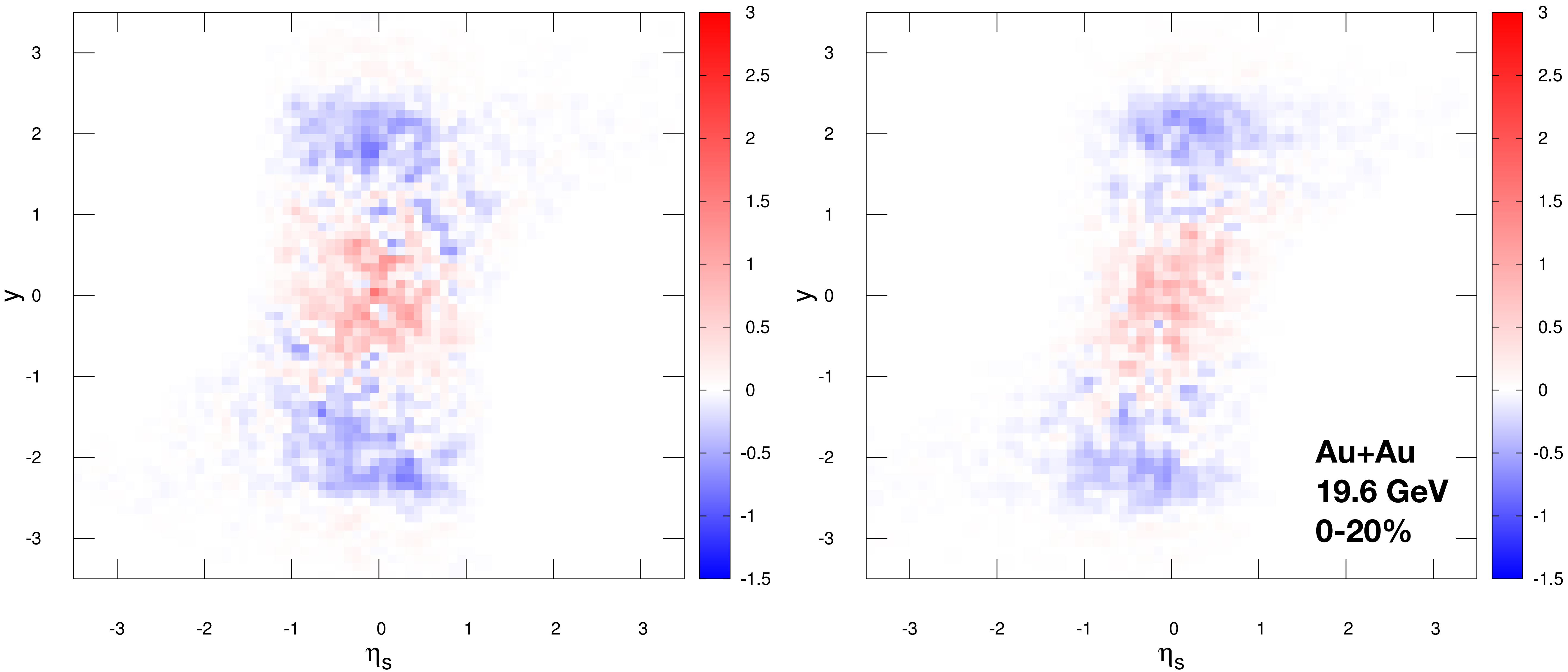


Results : net strangeness in early stage

spacetime-momentum rapidity correlation

Secondary collisions does not make as big difference as net baryon.

$\tau = 0.4\,\mathrm{fm}$



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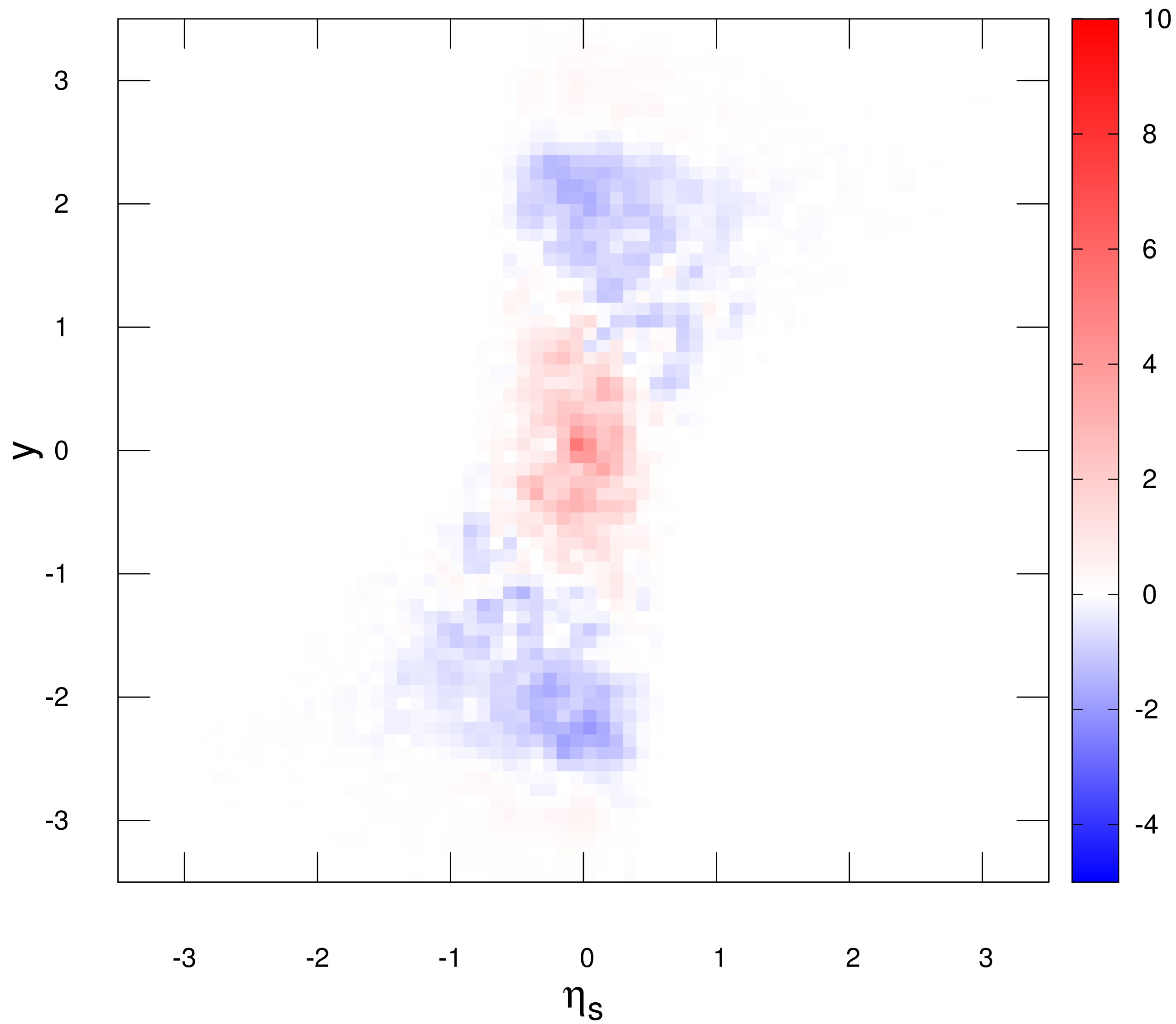
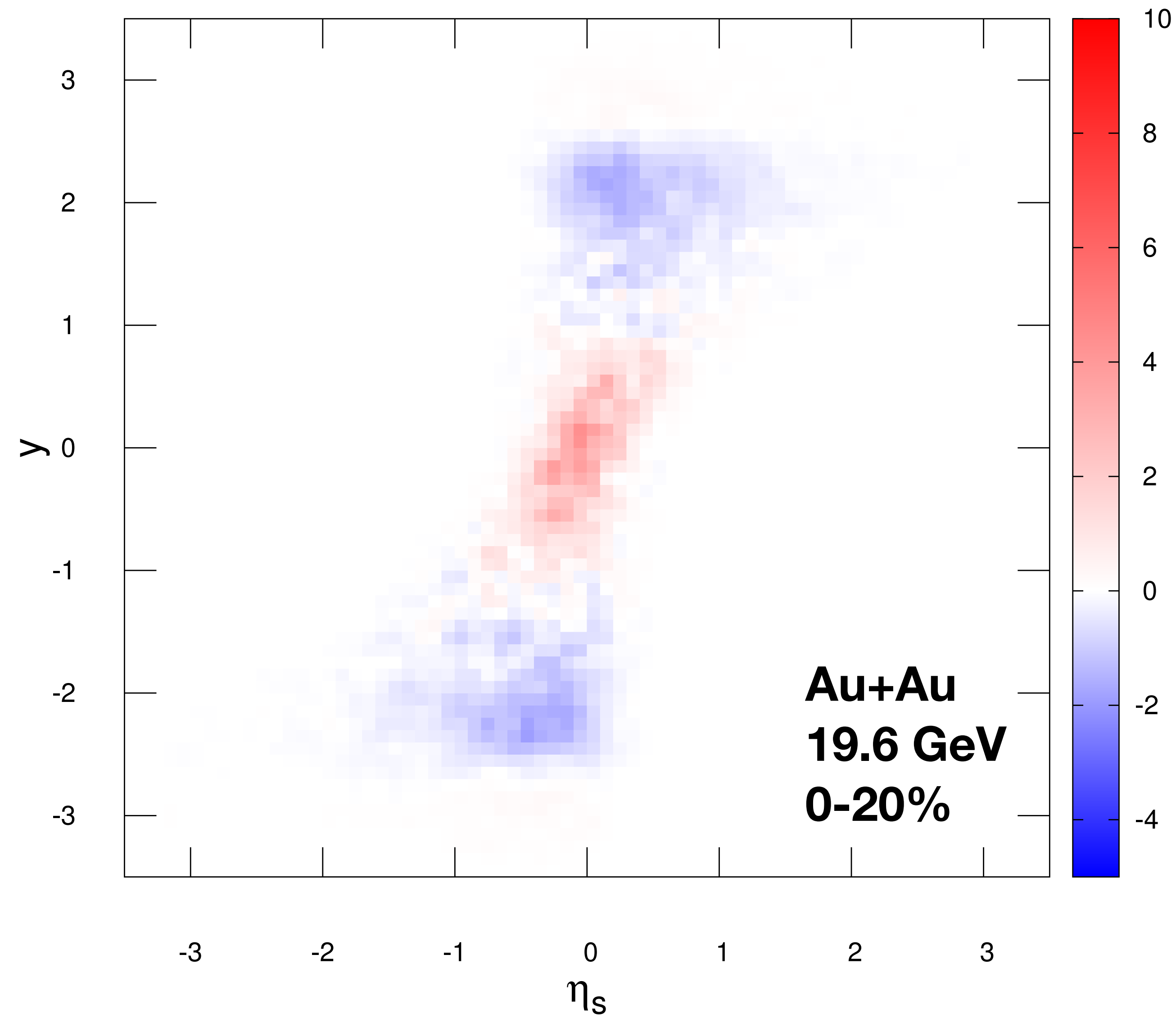


w/ secondary collisions



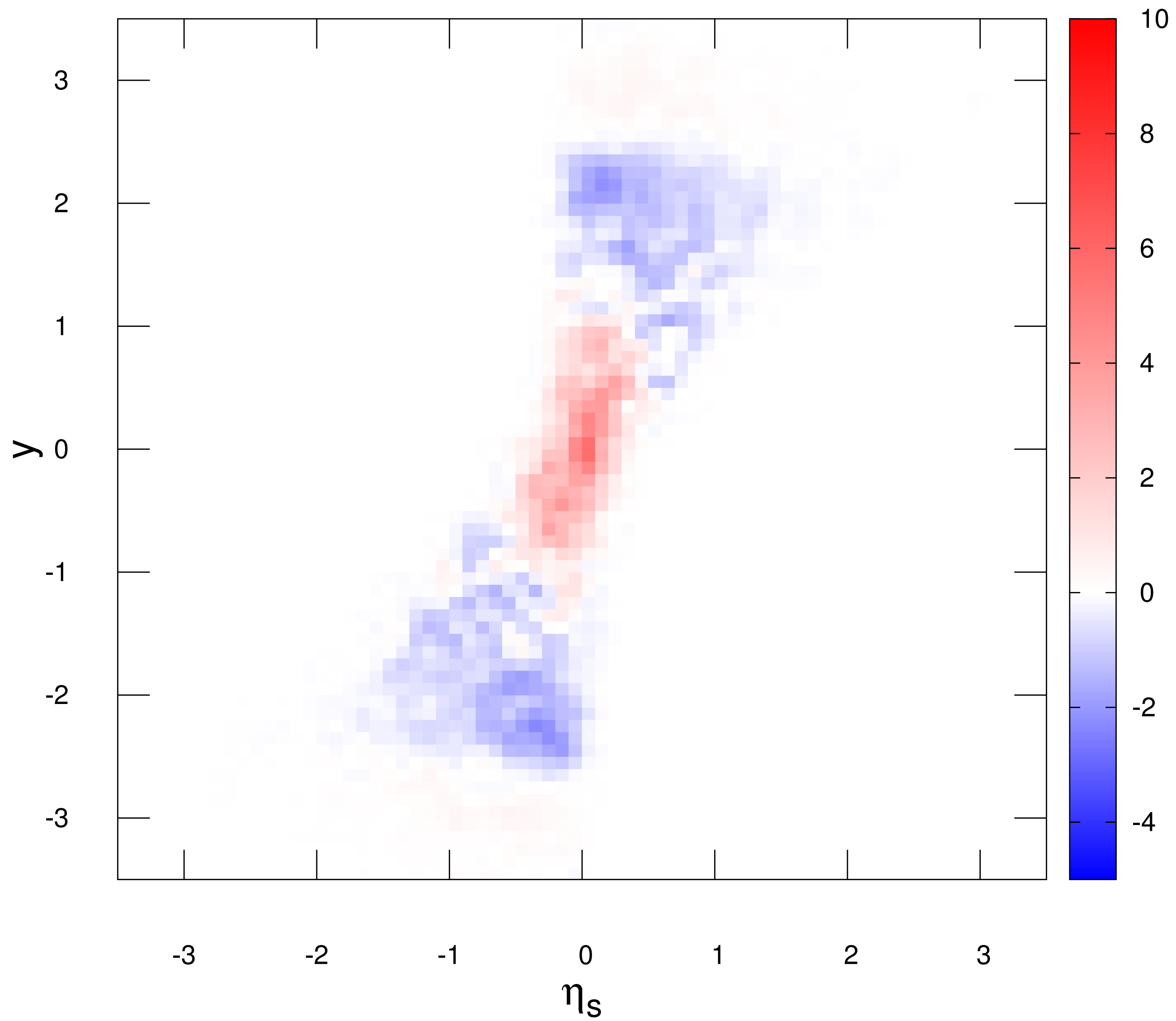
w/o secondary collisions

Results : net strangeness in early stage

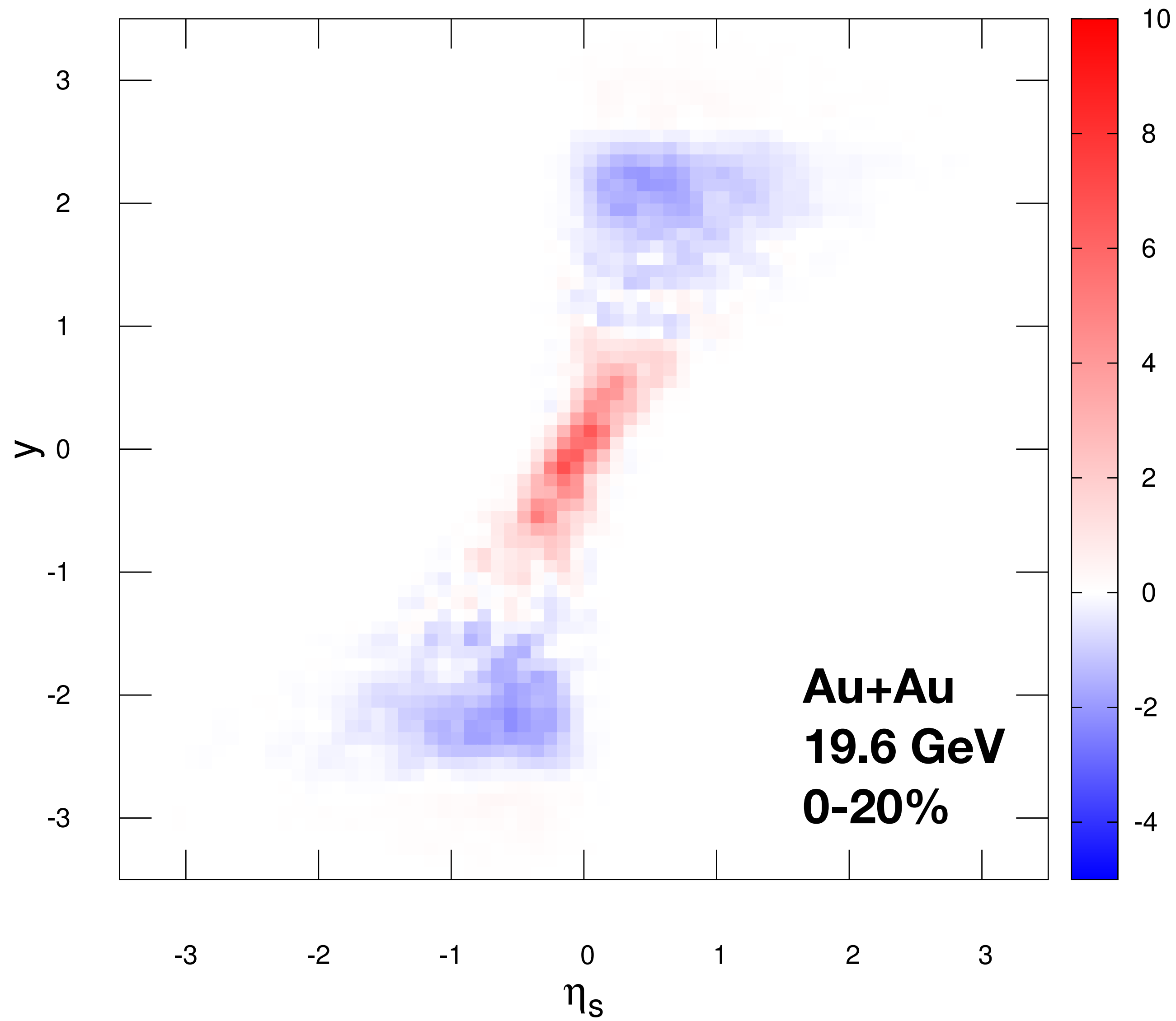
spacetime-momentum rapidity correlation

Secondary collisions does not make as big difference as net baryon.

$\tau = 1.2\,\mathrm{fm}$



w/ secondary collisions



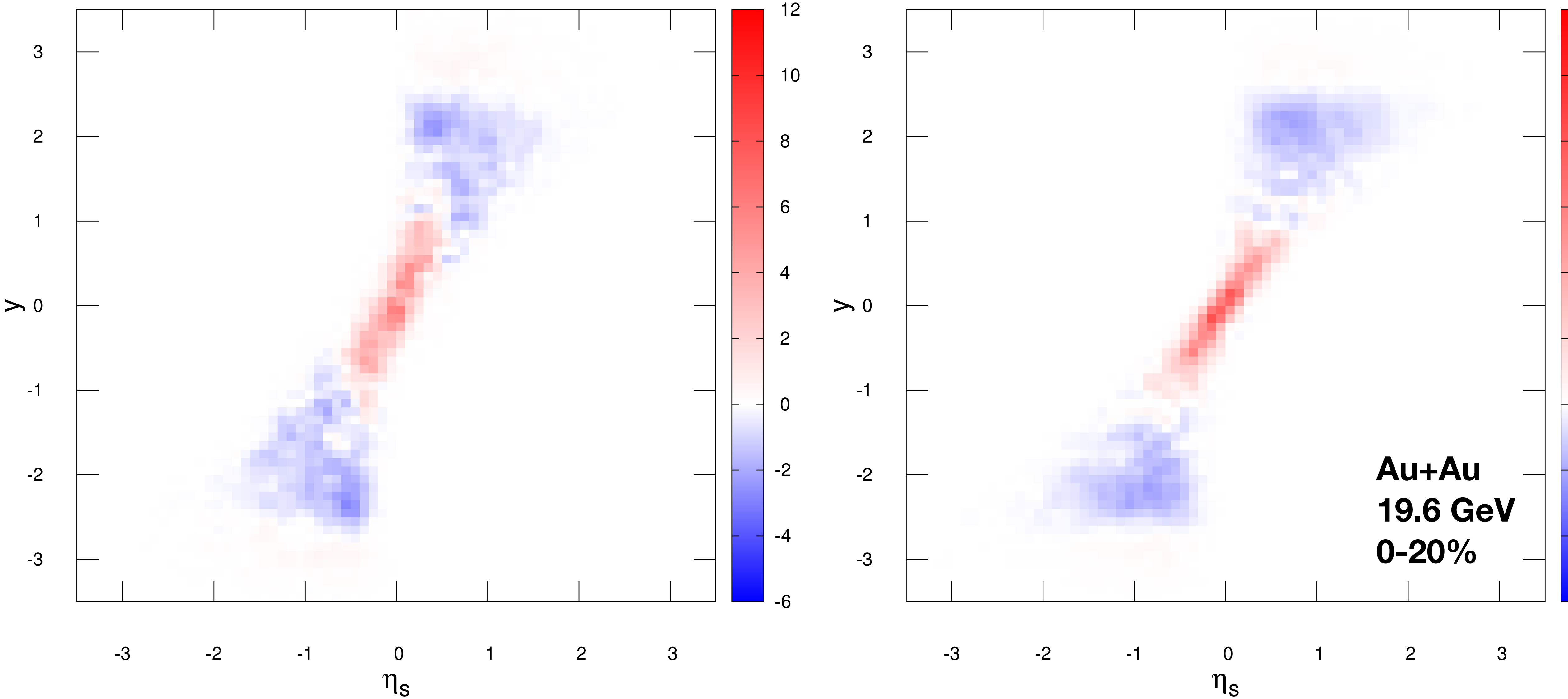
w/o secondary collisions

Results : net strangeness in early stage

spacetime-momentum rapidity correlation

Secondary collisions does not make as big difference as net baryon.

$\tau = 1.6\,\mathrm{fm}$



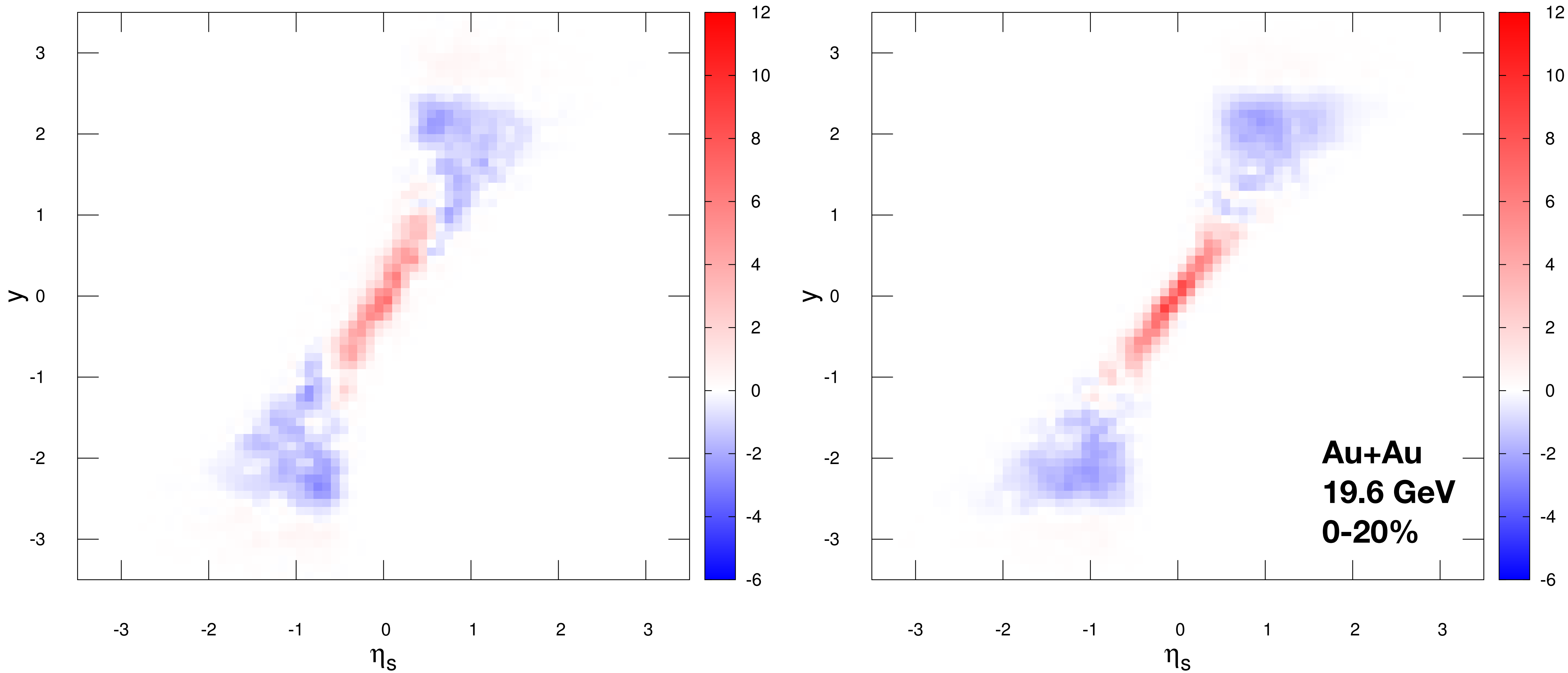
w/ secondary collisions **w/o secondary collisions**

Results : net strangeness in early stage

spacetime-momentum rapidity correlation

Secondary collisions does not make as big difference as net baryon.

$\tau = 2.0\,\mathrm{fm}$



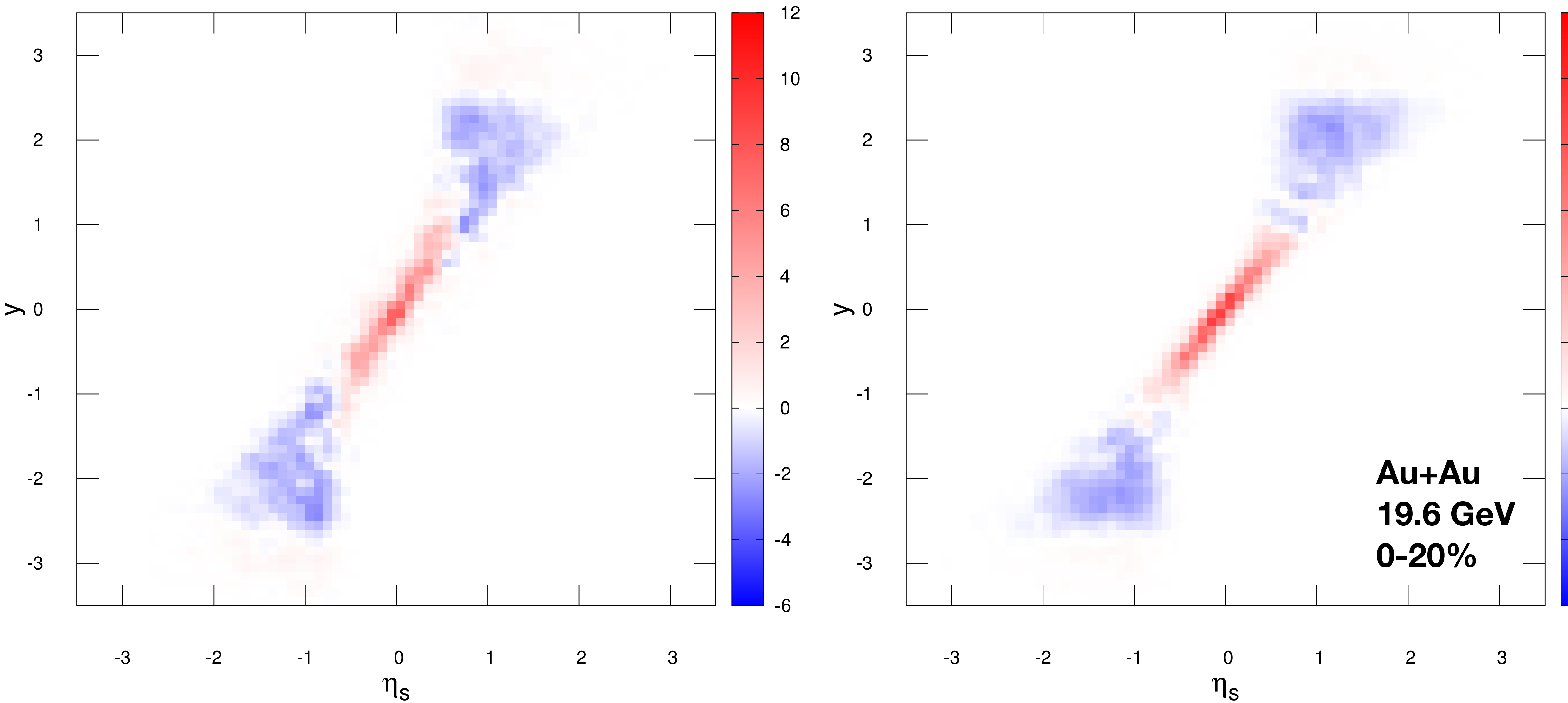
w/ secondary collisions **w/o secondary collisions**

Results : net strangeness in early stage

spacetime-momentum rapidity correlation

Secondary collisions does not make as big difference as net baryon.

$\tau = 2.4\,\mathrm{fm}$



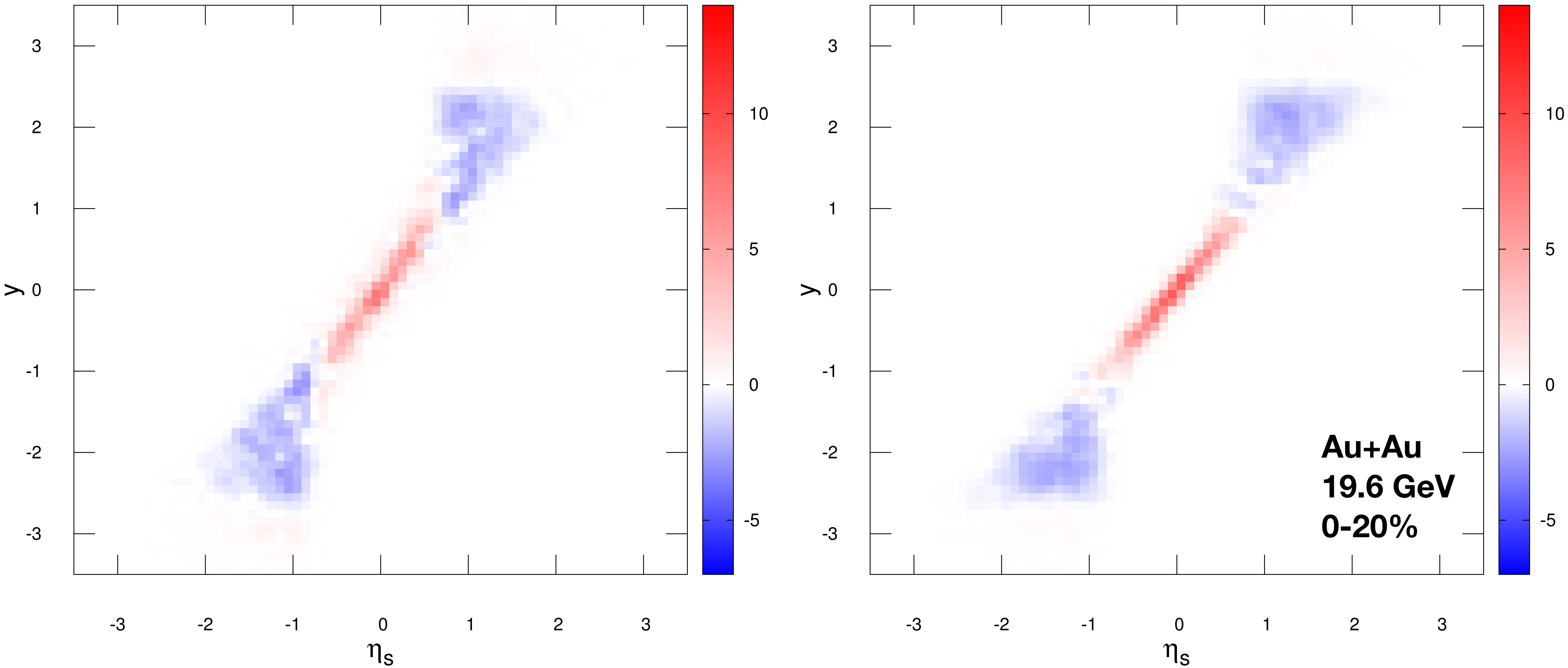
w/ secondary collisions **w/o secondary collisions**

Results : net strangeness in early stage

spacetime-momentum rapidity correlation

Secondary collisions does not make as big difference as net baryon.

$\tau = 2.8\,\mathrm{fm}$



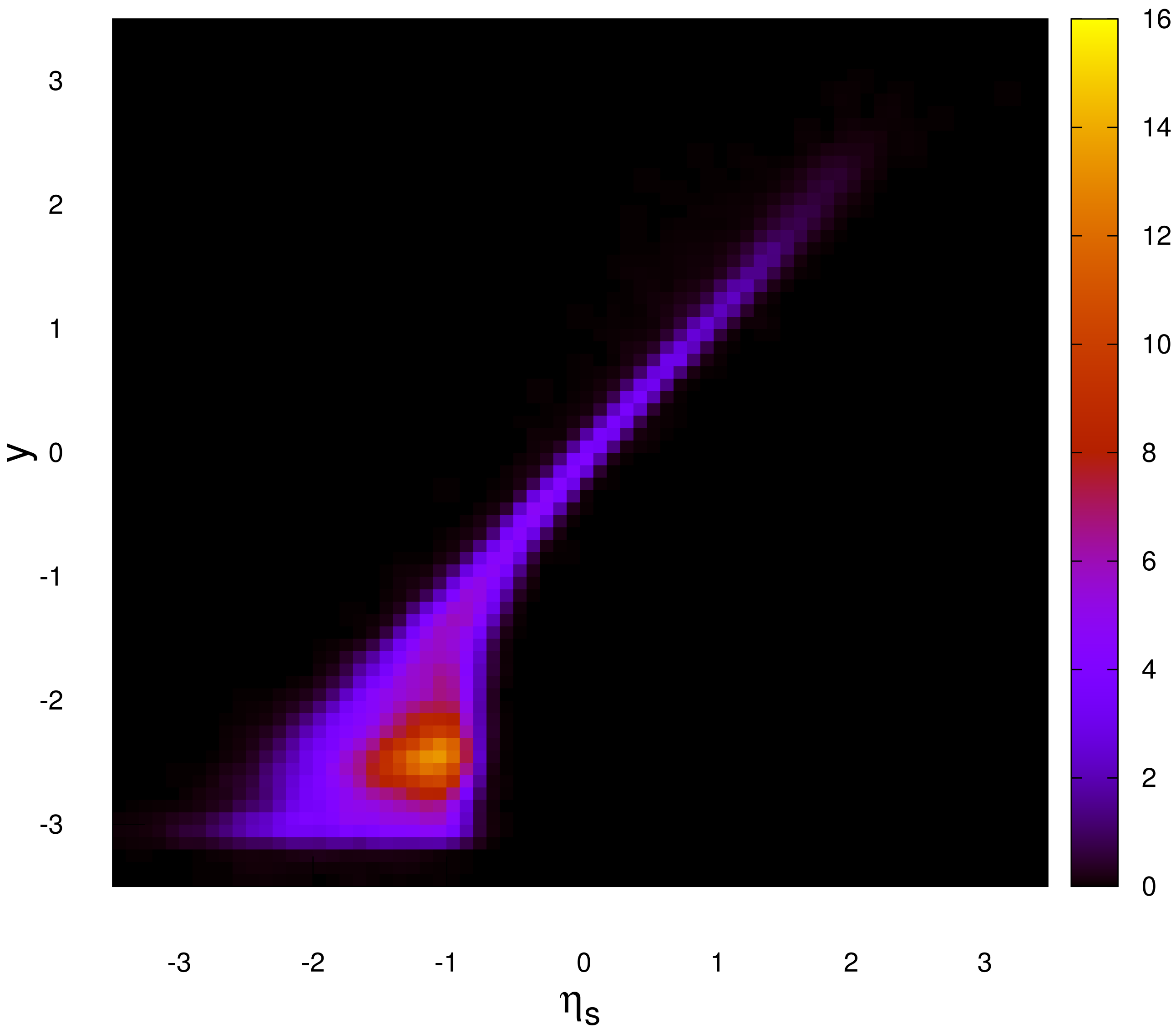
w/ secondary collisions **w/o secondary collisions**

Results : system size dependence of net baryon

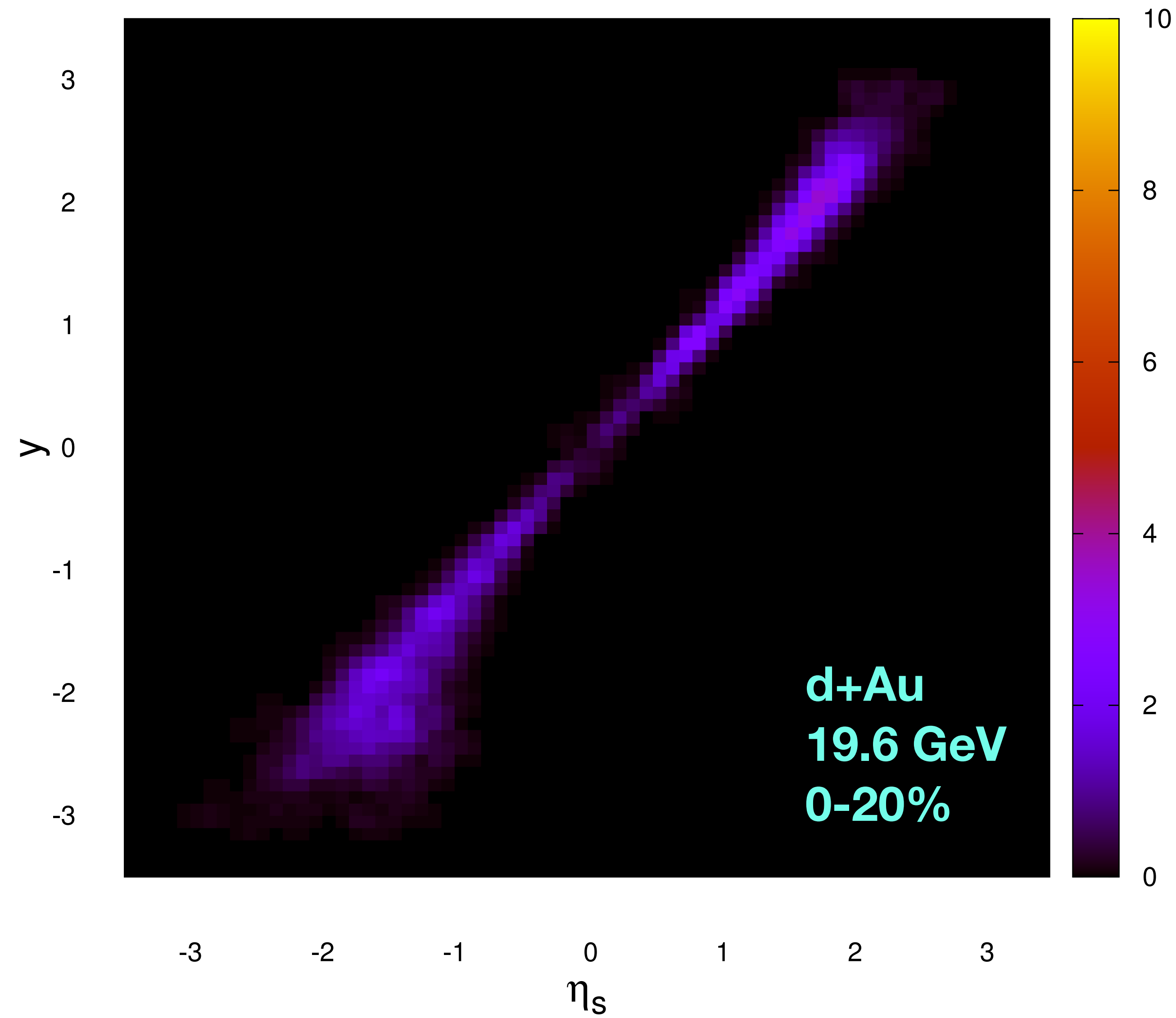
spacetime-momentum rapidity correlation

Secondary collisions are crucial in net baryon transport.

$\tau = 2.8\,\mathrm{fm}$



w/ secondary collisions



w/o secondary collisions