

PHENIX measurements of identified charged hadron production in p+Al, p+Au, and Cu+Au collisions $\sqrt{s_{NN}}$ =200 GeV

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Physics motivation

- Particle production from quark-gluon plasma (QGP) ullet
- π, Κ, ρ, ...
- Fragmentation and recombination are two main processes

PHENIX central arm

Charged particle tracking & momentum measurement - Drift-Chambers (DC) and first layer of pad chamber (PC1)

Particle identification Time-of-flight (TOF) with start signal from the BBC detectors







Detailed studies on the processes can be done with various particle species in different sizes of collision systems

- **Evolution from small to large systems** \bullet
 - Comparison between 0–20% d+Au (N_{part}~15.3) and 60–92% Au+Au (N_{part}~14.7) \rightarrow Consistent p/π ratio
 - \rightarrow Universal scaling of the ratio of p_T spectra for pion, kaon, and proton









	Centra	Centrality determination with the BB		
		Centrality	$\langle N_{ m coll} angle$	$\langle N_{ m part} angle$
		p+Al	2.1 ± 0.2	2.1 ± 0.1
		0-12/0	2.1 ± 0.2 2.4 ± 0.2	3.1 ± 0.1
		$0-207_{0}$	0.4 ± 0.0	4.4 ± 0.3 2 2 ± 0.1
		40-72%	2.3 ± 0.2 1.7 ± 0.1	3.3 ± 0.1 1.6 ± 0.2
		⁻³ He+Au		
		0-88%	$10.4{\pm}0.7$	$11.3 {\pm} 0.5$
		020%	$22.3{\pm}1.7$	$21.1{\pm}1.3$
	³ He Au	20- $40%$	14.8 ± 1.1	$15.4 {\pm} 0.9$
		40- $60%$	$8.4{\pm}0.6$	$9.5 {\pm} 0.6$
		0-88%	$3.4{\pm}0.3$	$4.8 {\pm} 0.3$
		Cu+Au		
		0-80%	$123.8{\pm}12.0$	$70.4 {\pm} 3.0$
		020%	$313.8 {\pm} 28.4$	$154.8 {\pm} 4.1$
	Au Au	20- $40%$	129.3 ± 12.4	80.4 ± 3.3
		40- $60%$	41.8 ± 5.3	$34.9 {\pm} 2.9$
		60-80%	$10.1{\pm}2.0$	11.5 ± 1.8
1 1.5 2 2.5 3 3.5 4 4.5	5	U+U		
р _т (Ge	eV/c)	020%	$935{\pm}98$	330 ± 6
I		20- $40%$	335 ± 33	$259{\pm}7$
		40- $60%$	81 ± 13	65 ± 6
		60-80%	17 ± 4	18 ± 3

Results

Nuclear modification factors of identified hadrons



Small systems

p+Al collisions

 \rightarrow Similar nuclear modification factors for all particles

charge

-1.5

-20

- \rightarrow Weak centrality dependence
- ³He+Au collisions
- \rightarrow Stronger p_T broadening than p+Al collisions \rightarrow Possibility due to larger multiple scattering and radial flow effects

 \rightarrow Baryon enhancement in central collisions

Cu+Au collisions

 \rightarrow Strangeness enhancement

Similar modification in ϕ and proton in mid-peripheral, $\frac{1}{28}$ whereas a larger R_{AB} of proton in central collisions

U+U collisions

 \rightarrow Difference between ϕ and proton even in 40–60%



K/π ratio from small to large systems



 \rightarrow Consistent p/π ratio between p+Al and p+p collisions \rightarrow Modest centrality dependence

 \rightarrow Stronger centrality dependence \rightarrow Possibly due to recombination