1) Run16 Author List and Shifts

2) BES-I, BES-II and BES-III

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Poniatowska[50], **J. Porter[23]**, M. Posik[42], **A.M. Poskanzer[23]**, N.K. Pruthi[31], J. Putschke[51], **H. Qiu[23]**, A. Quintero[19], S. Ramachandran[20], S. Raniwala[36], R. Raniwala[36], R.L. Ray[44], **H.G. Ritter[23]**, J.B. Roberts[37], O.V. Rogachevskiy[18], J.L. Romero[5], A. Roy[49], L. Ruan[3], J. Rusnak[11], O. Rusnakova[10], N.R. Sahoo[43], P.K. Sahu[13], ~~**I. Sakrejda[23]**~~, **S. Salur[23]**, J. Sandweiss[53], A. Sarkar[14], J. Schambach[44], R.P. Scharenberg[34], **A.M. Schmah[23]**, W.B. Schmidke[3], N. Schmitz[24], J. Seger[9], P. Seyboth[24], N. Shah[40], E. Shahaliev[18], P.V. Shanmuganathan[19], M. Shao[38], M.K. Sharma[17], B. Sharma[31], W.Q. Shen[40], **Z. Shi[23]**, S.S. Shi[7], Q.Y. Shou[40], **E.P. Sichtermann[23]**, R. Sikora[1], M. Simko[11], S. Singha[19], M.J. Skoby[15], D. Smirnov[3], N. Smirnov[53], W. Solyst[15], L. Song[45], P. Sorensen[3], H.M. Spinka[2], B. Srivastava[34], T.D.S. Stanislaus[48], M. Stepanov[34], R. Stock[12], M. 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RNC STAR Authors

#	Name	Run16 function	# of week	#	Name	Run16 function	# of week
1	G. Contin	shift	1	11	J. Thaeder	PC	3
2	X. Dong	shift	1	12	N. Xu	shift	1
3	M.K. Mustafa	PC	3	13	A. Manion	left rnc	0
4	G. Odyniec	shift	1	14	I. Sakrejda	left rnc	0
5	J. Porter	shift	1	15	L. Greiner	Exp.	
6	H. Qiu	shift	1	16	J.H. Thomas	Exp.	
7	S. Salur	online shift	1	17	A. Poskanzer	Honoree author	
8	A. Schmah	shift	1	18	H.G. Ritter	Honoree author	
9	Z. Shi	trainee	1	19	H. Wieman	Honoree author	
10	E. Sichtermann	shift	1		S. Mizuno	trainee	2
	Total # of authors:		18 - 19				
	Total # of assigned shift weeks:		(13-14)*1.5 = 19.5 - 20 weeks				
	Total # of shift weeks:		18				

1) Run16 Author List and Shifts

2) **BES-I, BES-II, BES-III (?)**

Fluctuations in Strongly Interacting Hot and Dense Matter: Theory and Experiment

EMMI Workshop
@
GSI

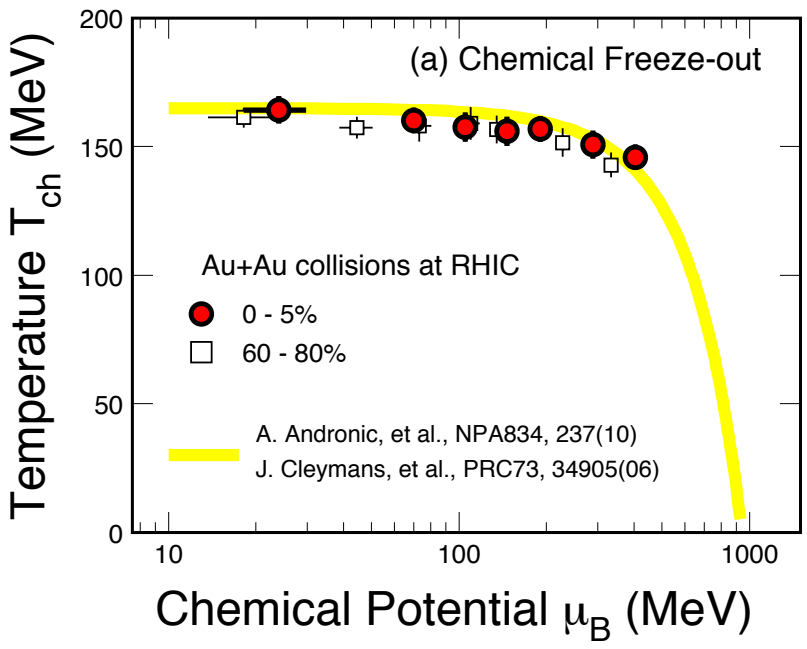
November 2-6, 2015

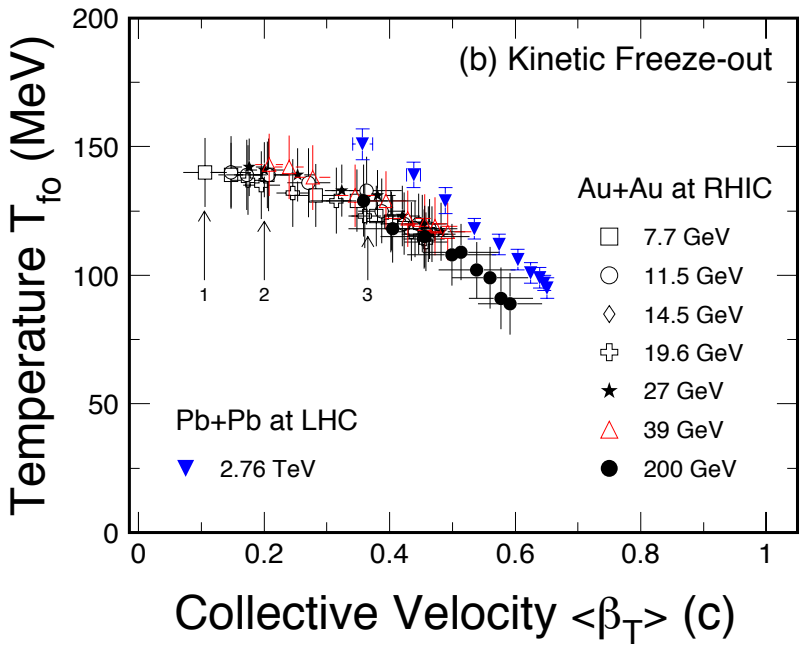
1) BES-I data analysis completed and reported at QM2015 in October 2015

2) What do they mean, what should be the focus in BES-II?

3) Do we need BES-III: the next generation fixed-target experiments?

Singles Measurements





1) Chemical Freeze-out:

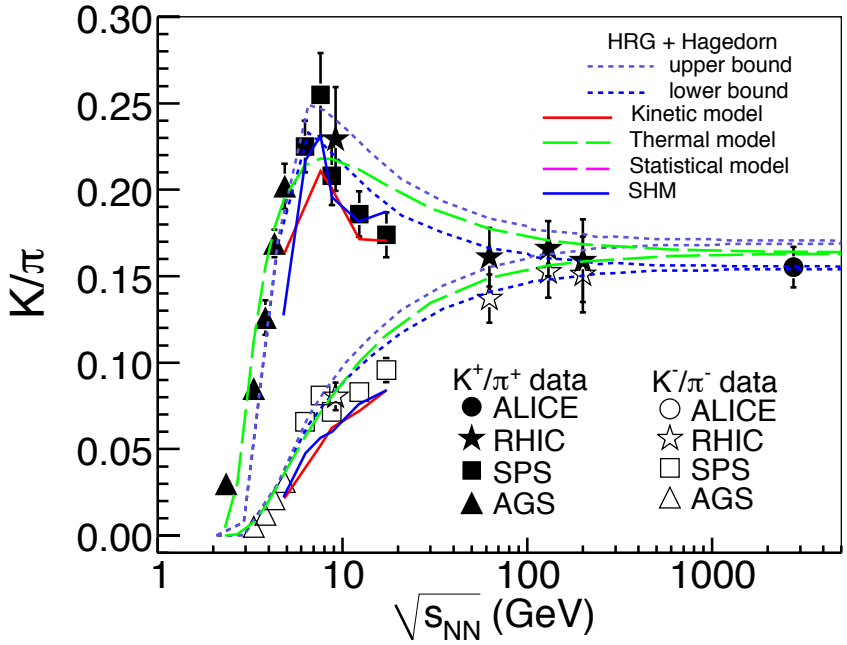
- Collider Experiments cover: T_{CH} ~ 150 MeV, $0 < \mu_B < 450$ MeV
- Fixed-target experiments cover: $350 < \mu_B < 750$ MeV

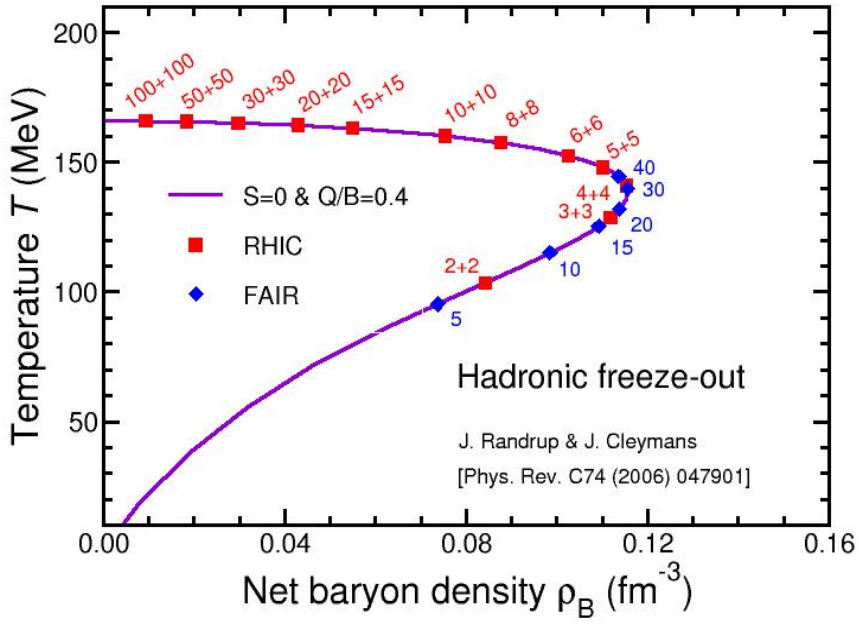
  More dramatic temperature changes in large μ_B region.

2) Thermal Freeze-out:

- The higher the collision energy, the stronger the collectivity
- The more central the collision, the stronger the collectivity and lower the thermal freeze-out temperature ➔ similar local freeze-out condition

K^+/π Ratios and Baryon Density

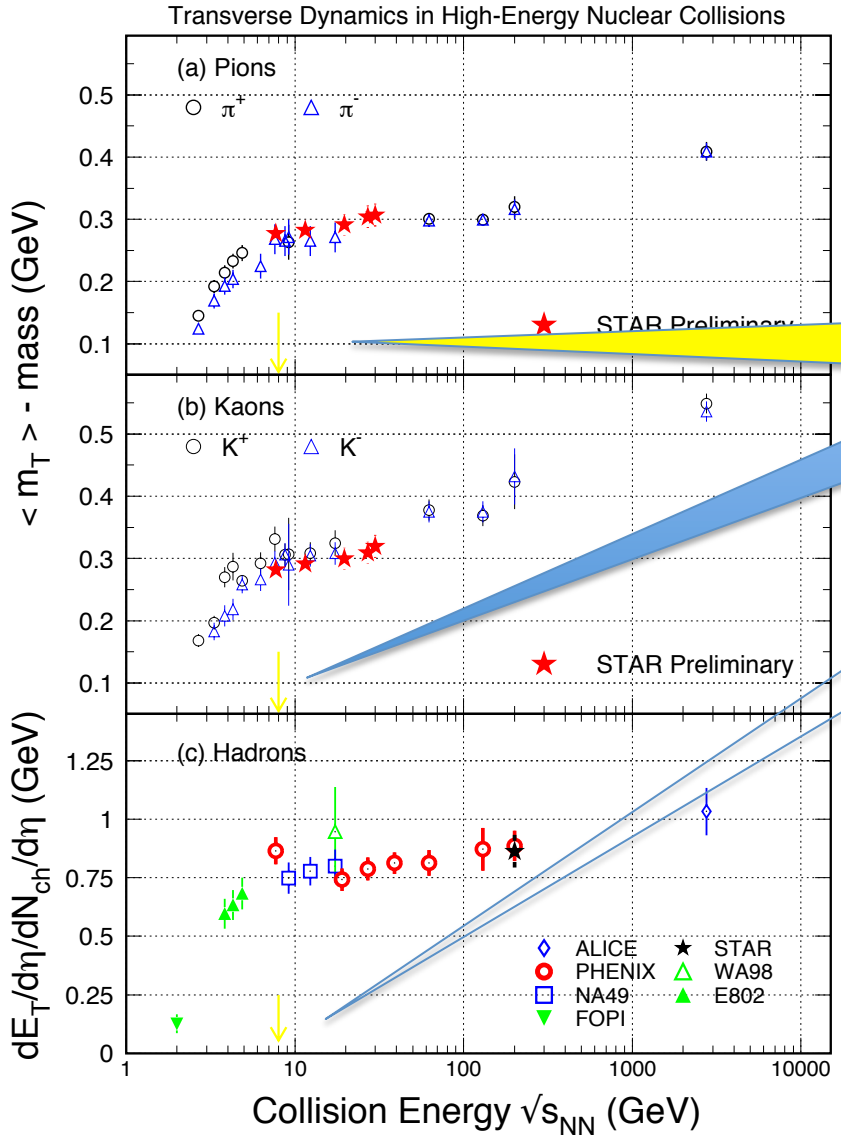




1) In heavy ion collisions K^+/π ratio peaks at $\sqrt{s_{NN}}$ ~ 8 GeV, K^-/π ratio is a smooth and merges with K^+/π at higher collision energy
2) Model: Baryon density reaches a maximum at $\sqrt{s_{NN}}$ ~ 8 GeV

Au+Au central collisions at $\sqrt{s_{NN}}$ ~ 8 GeV ➔ **μ_B ~ 380 MeV**

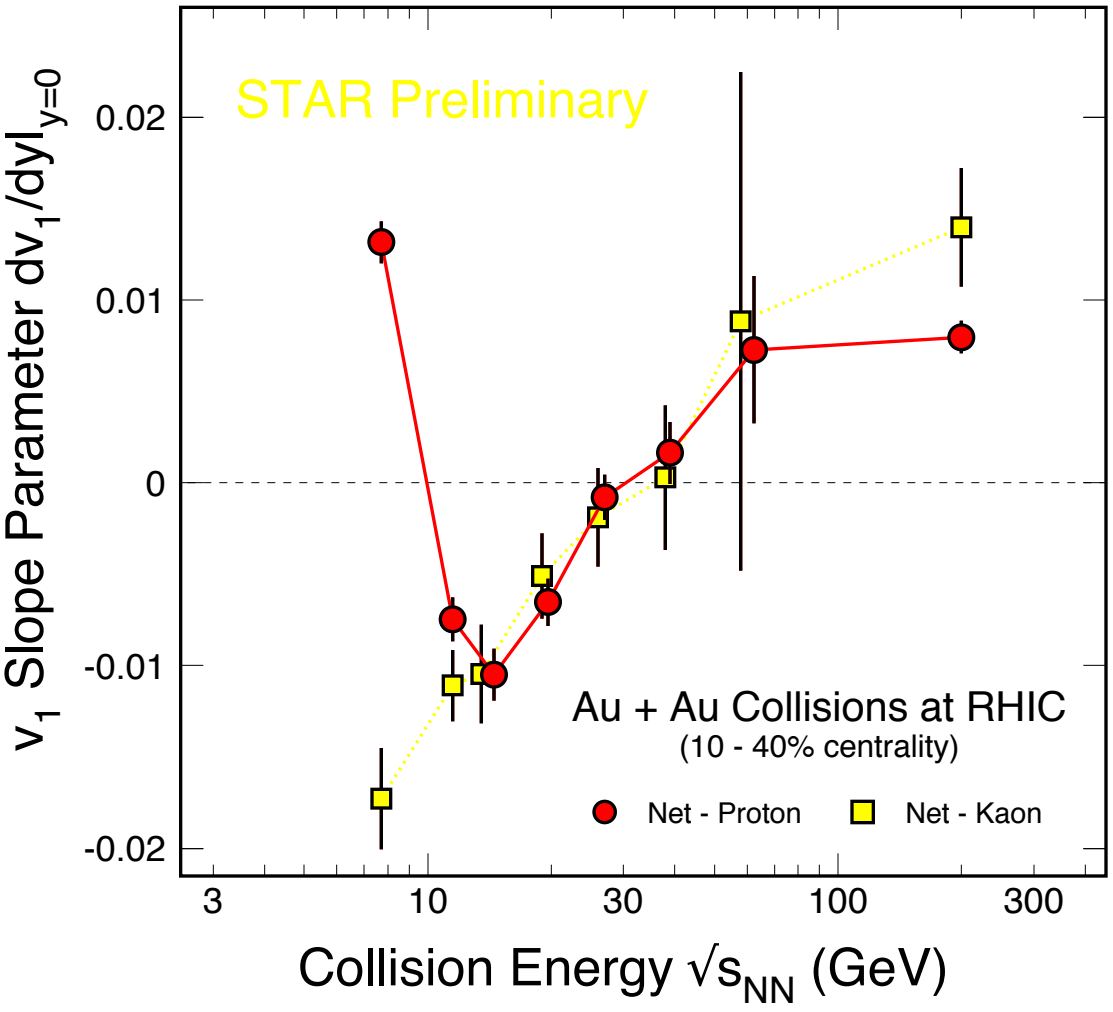
Collectivity



$\sqrt{s_{NN}}$ ~ 10 GeV

Above 10 GeV, collectivity is saturated and particle production becomes more dominant!

Correlations: v_1

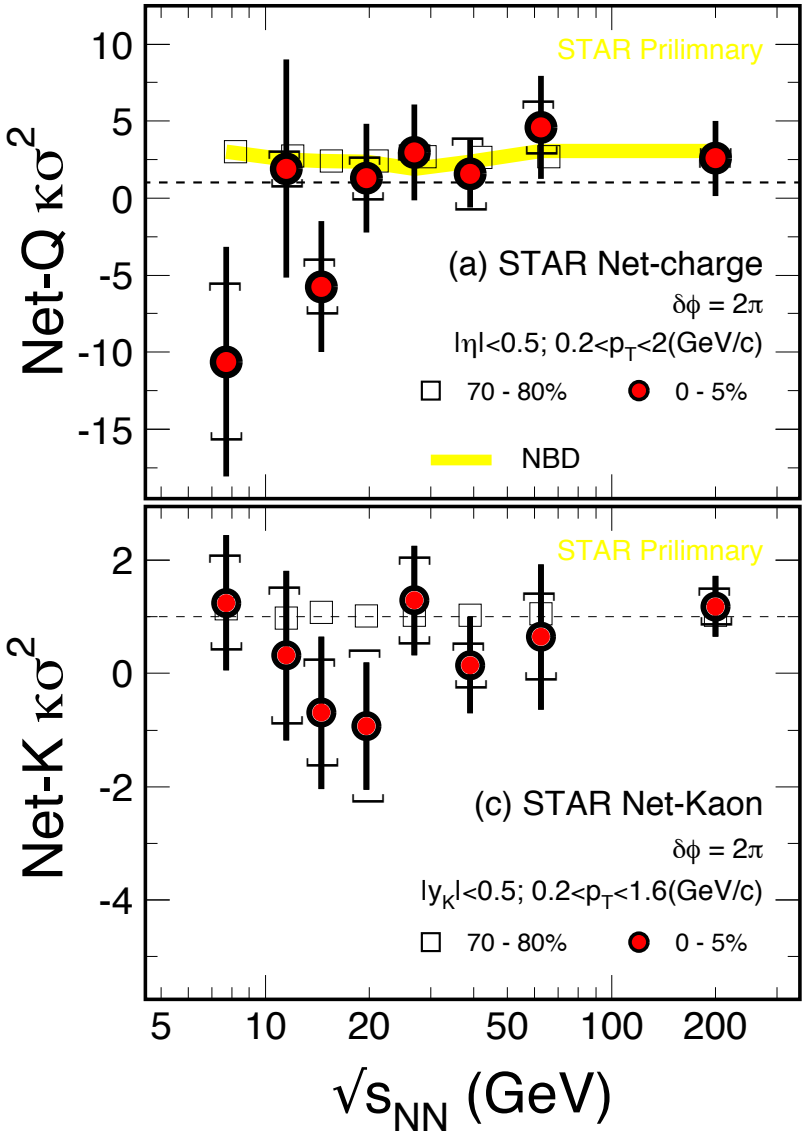


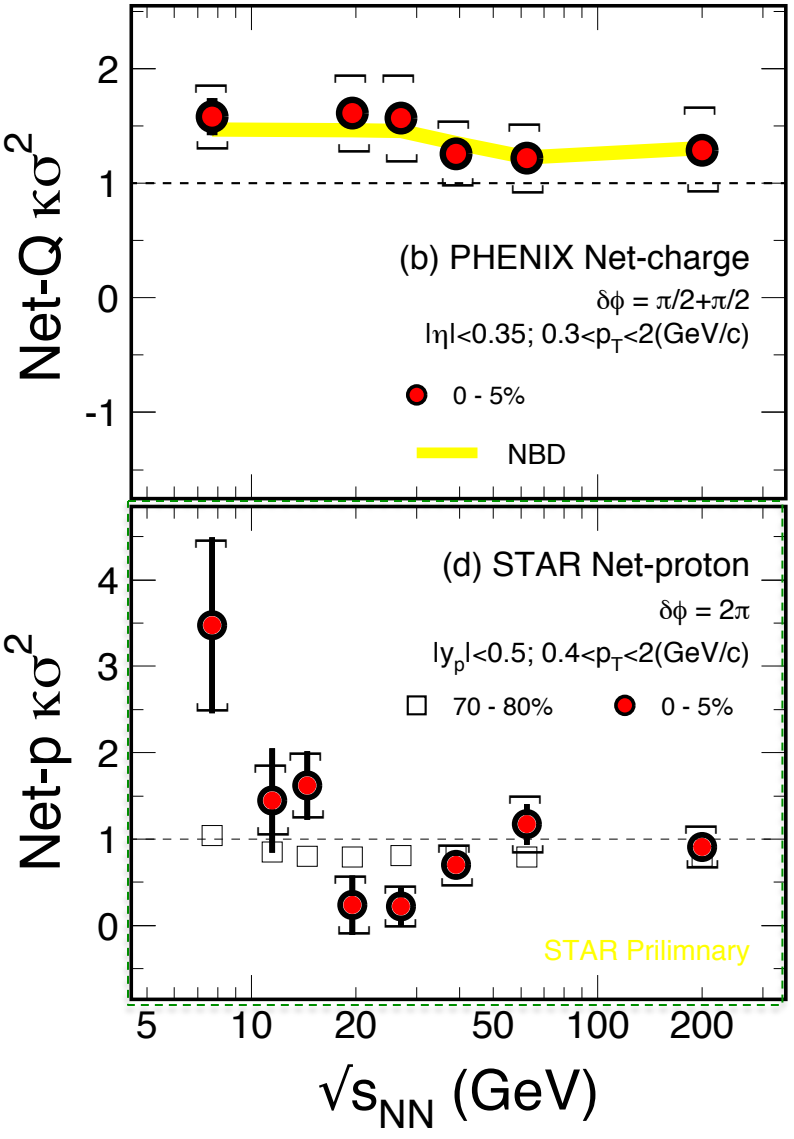
1) Net-Kaon and Net-p behavior similarly at high energy region and show a split below 14.5 GeV Au+Au collisions

2) At low energy, *i.e.,* high net-baryon density region, repulsive force becomes dominant, see A. Onishi *et al*. (05) and R. Rougemont *et al.* (15)

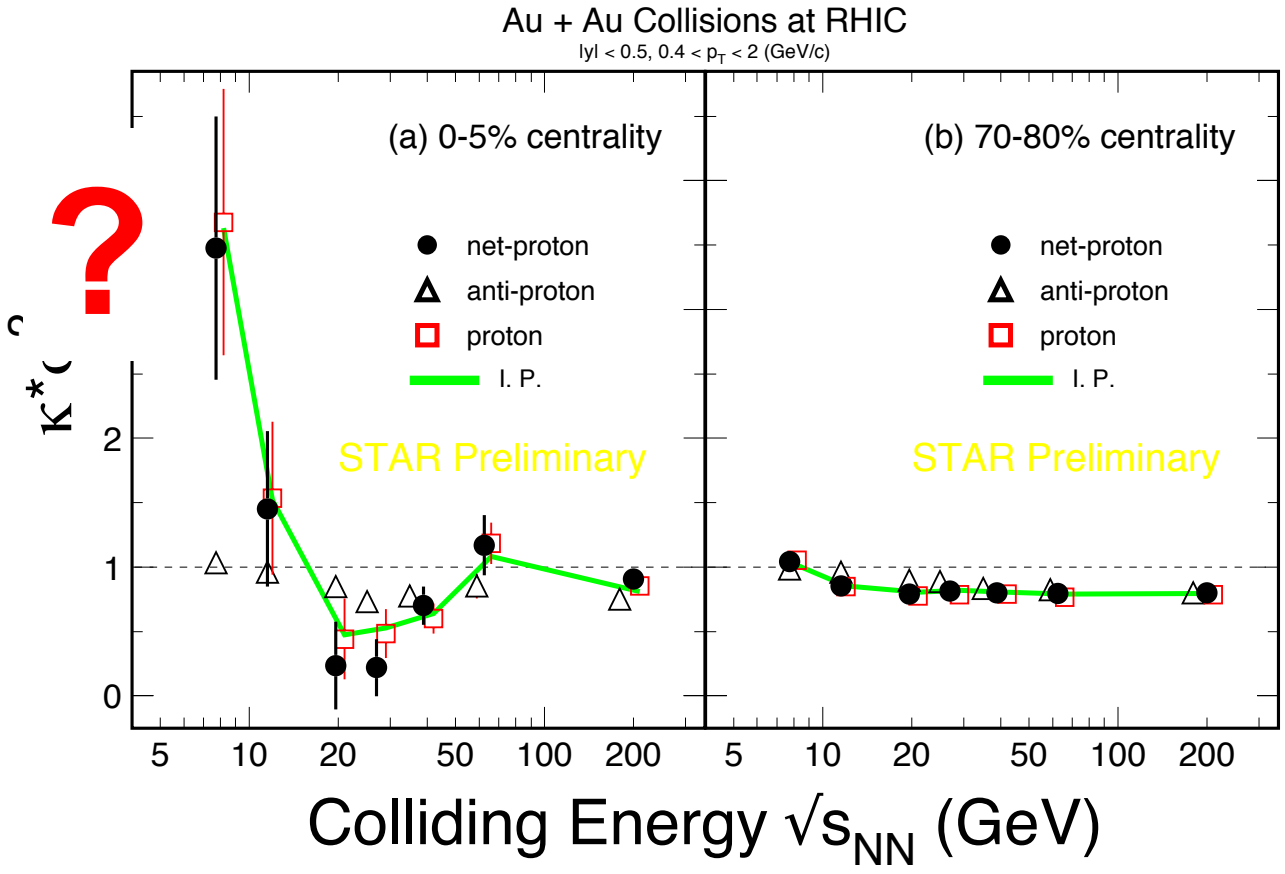
Au+Au central collisions at $\sqrt{s_{NN}}$ ~ 14.5 GeV ➔ **μ_B ~ 265 MeV**

Higher Moment Results





Net-proton Higher Moment



Indication of Critical Region (CR)?

What will happen at even lower energy?

Observed So Far

1) Single particle spectra: compression and the baryon density, at freeze-out, peaks at $\sqrt{s_{NN}}$ ~ 8 GeV
   ➔ **μ_B ~ 380 MeV**

2) Correlation: dv_1/dy peaks at $\sqrt{s_{NN}}$ ~ 14.5 GeV
   ➔ **μ_B ~ 270 MeV**

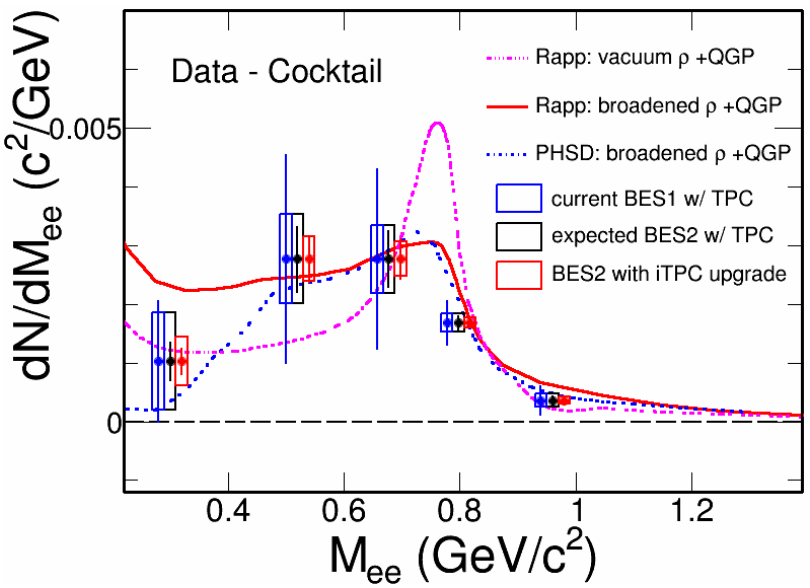
3) Higher moment ratios: $\kappa\sigma^2$ dip at $\sqrt{s_{NN}}$ ~ 20 GeV
   ➔ **μ_B ~ 200 MeV** and sharp increase at low energies

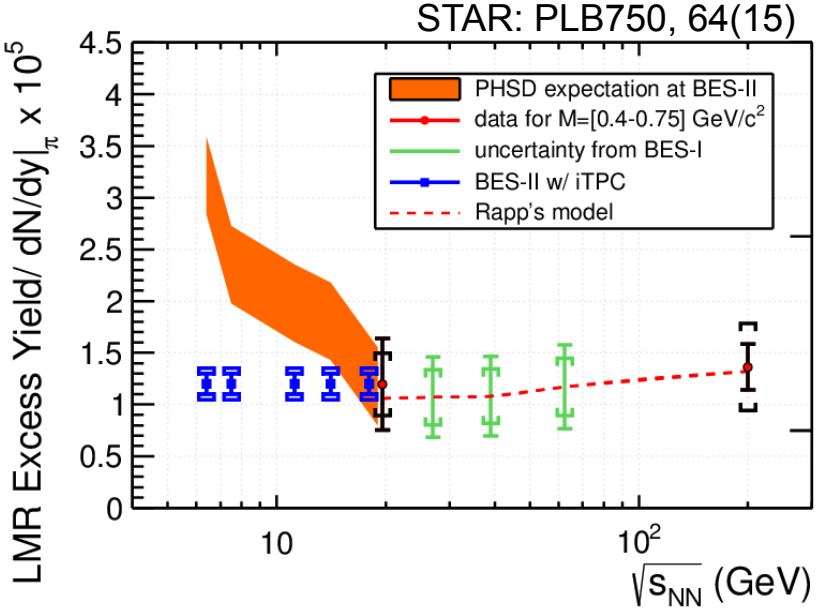
Event Statistics for BES II at RHIC

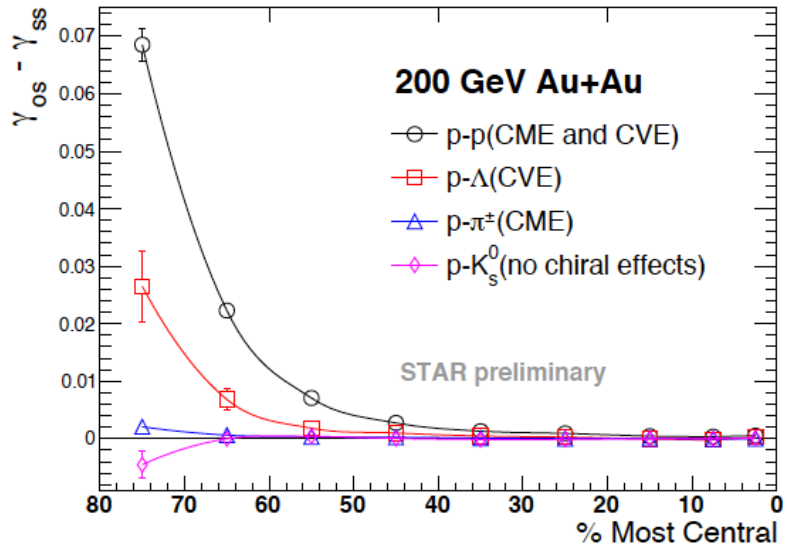
$\sqrt{s_{NN}}$ (GeV)	Events (10^6)	BES II / BES I	Weeks	μ_B (MeV)	T_{CH} (MeV)
200	350	2010		25	166
62.4	67	2010		73	165
39	39	2010		112	164
27	70	2011		156	162
19.6	**400** / 36	**2019-20** / 2011	**3**	206	160
14.5	**300** / 20	**2019-20** / 2014	**2.5**	264	156
11.5	**230** / 12	**2019-20** / 2010	**5**	315	152
9.2	**160** / 0.03	**2019-20** / 2008	**9.5**	355	140
7.7	**100** / 4	**2019-20** / 2010	**14**	420	140

1) Event statistics driven by QCD CP search and di-electron measurements

BES-II: Chiral Properties





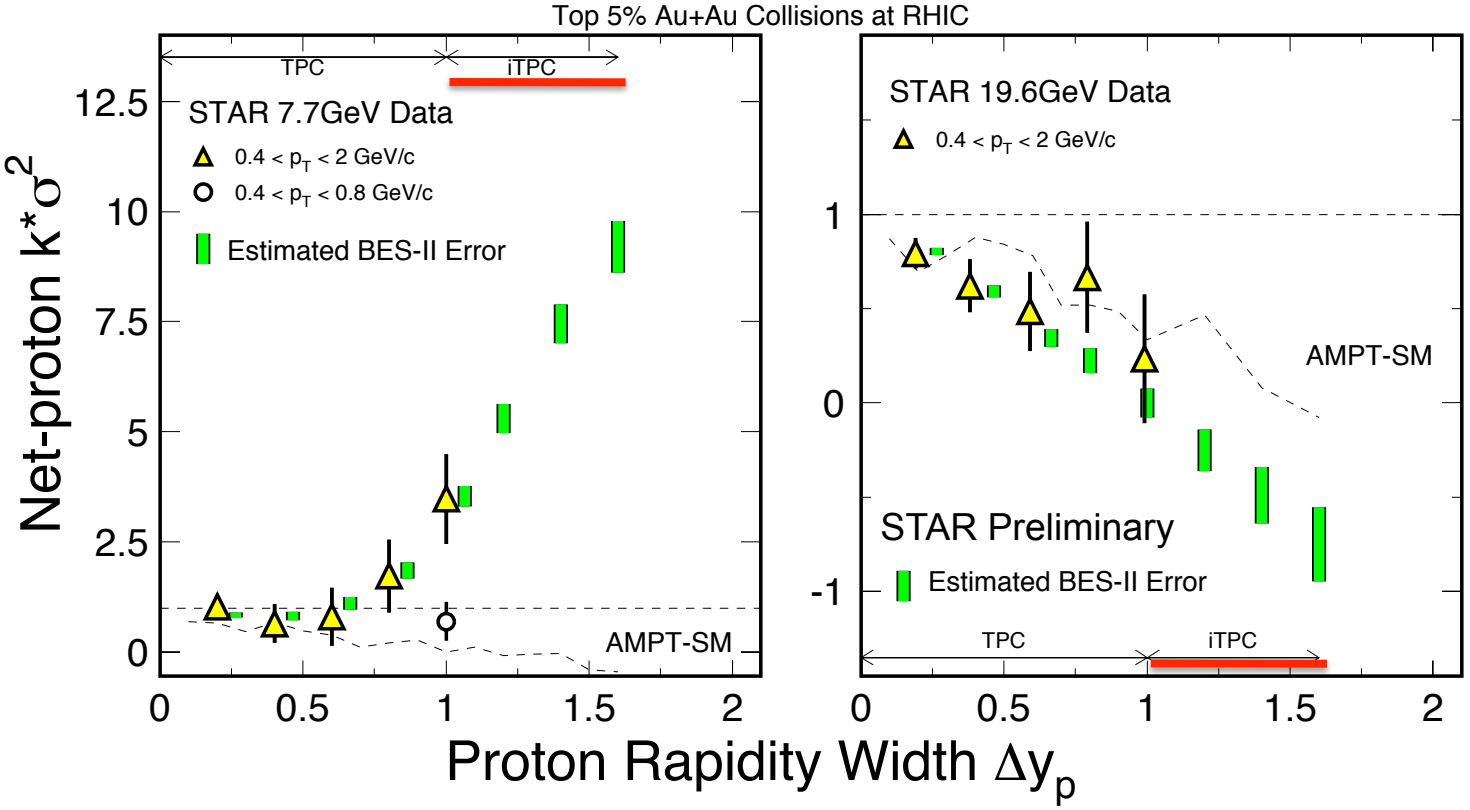


High net-baryon region:

1) Precision measurements on di-electron distributions

2) Global Chiral properties with identified hadrons

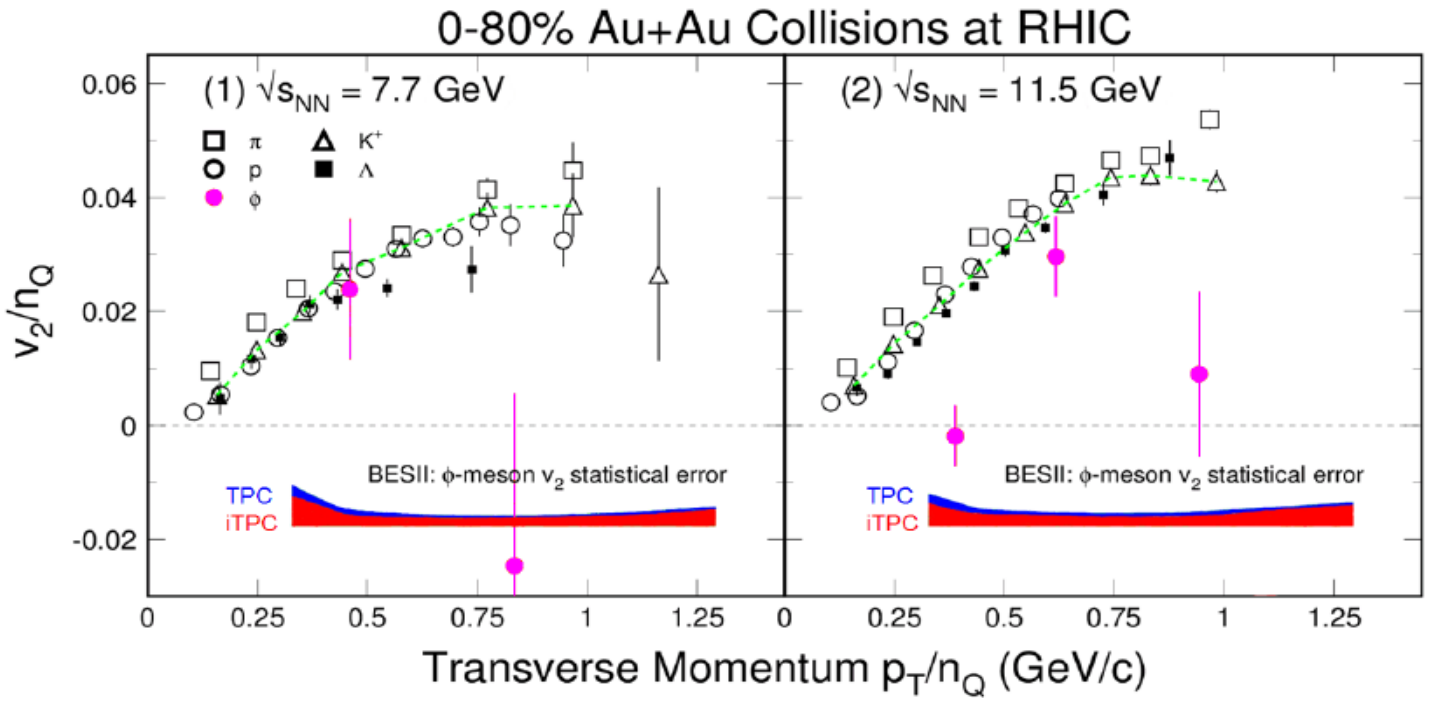
BES-II: Critical Point



1) iTPC extend the rapidity coverage to Δy = 1.6, allowing to studying kinematic acceptance for the CP (CR) search

2) Precision measurement of net-proton higher moments at high net-baryon region

BES-II: Collectivity



1) Precision measurement for φ-meson v_2

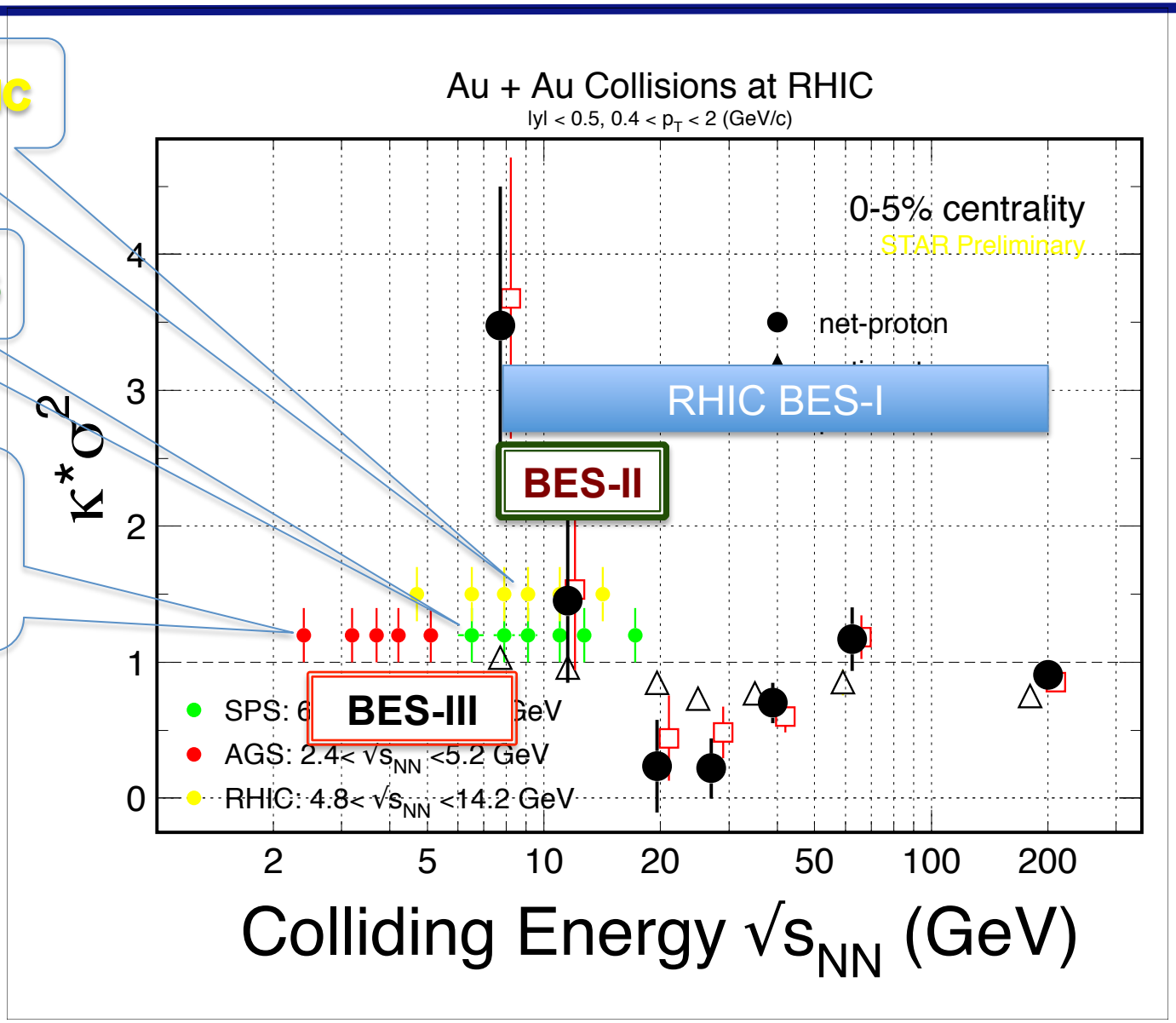
2) Study the partonic vs. hadronic interactions in the high net-baron region

BES-III: Pin Down the Location of CP?

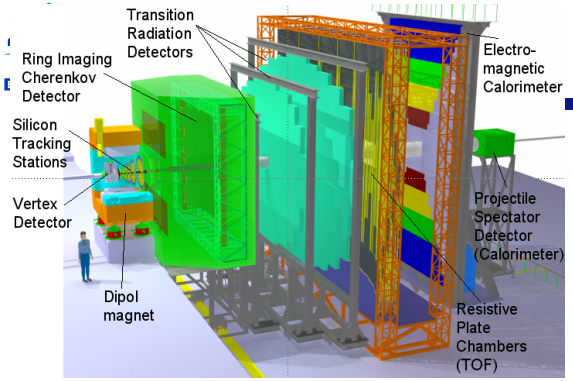
CBM@RHIC

CBM@SPS

CBM or CBM@AGS



CBM@BNL

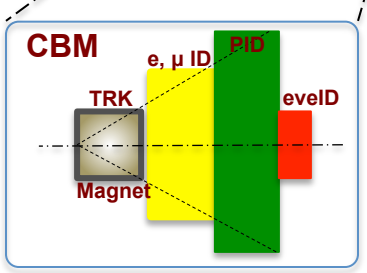


1) **Study QCD phase structure**
2) **Maintain heavy ion community**
3) **CBM@eRHIC is an add on cost**

eRHIC

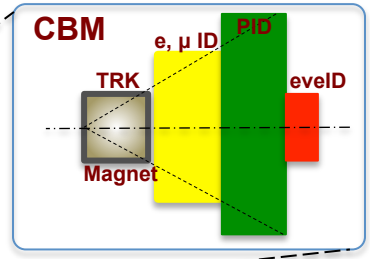
RHIC Ring

AGS



2025 - …
CBM@eRHIC
$\sqrt{s_{NN}} \leq 14$ GeV

2020 - 2025
CBM@AGS
$\sqrt{s_{NN}} \leq 5.4$ GeV

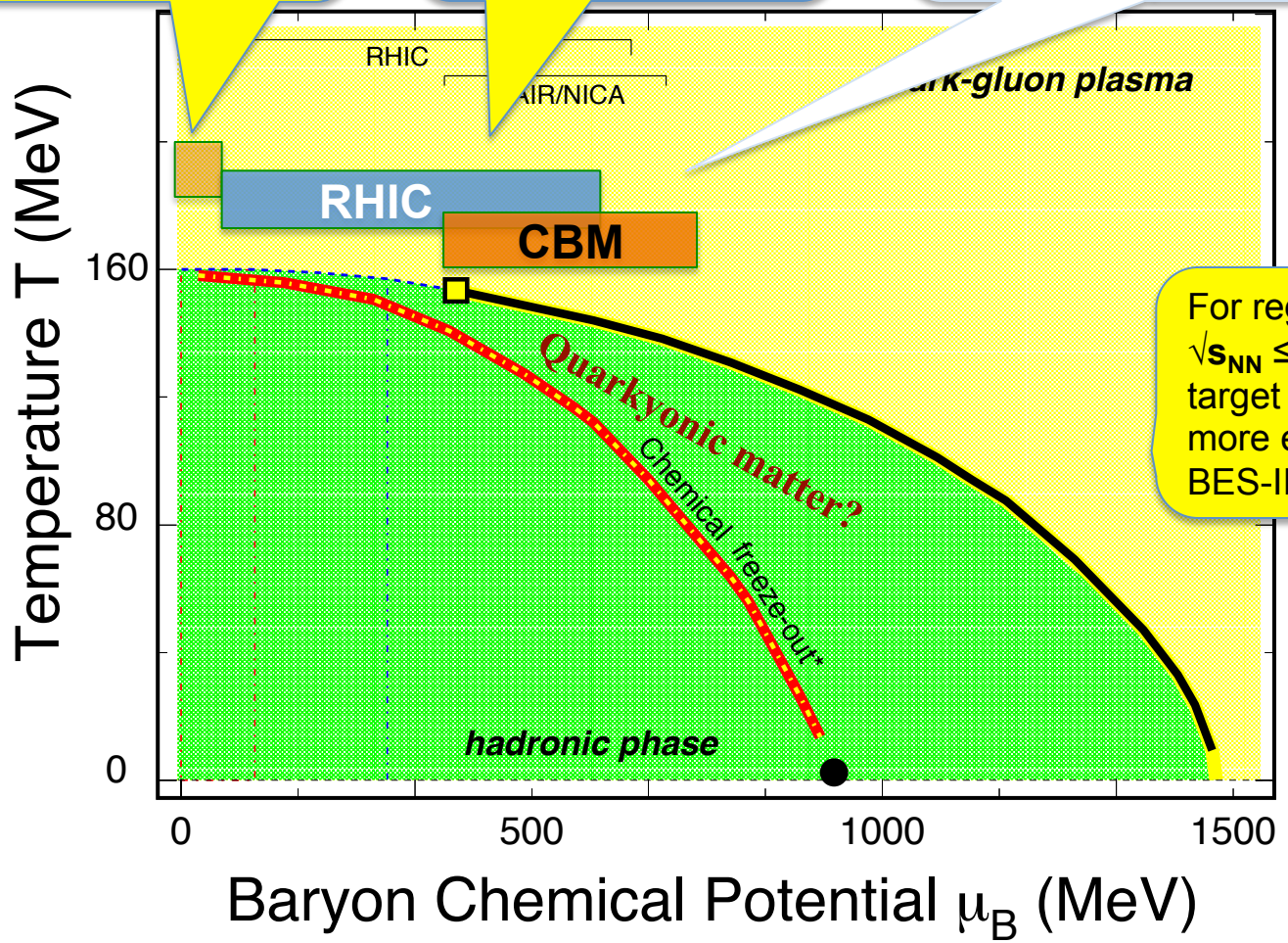


Exploring QCD Phase Structure

LHC+RHIC
Property of sQGP
$0.2 \le \sqrt{s_{NN}} \le 5.4$ TeV

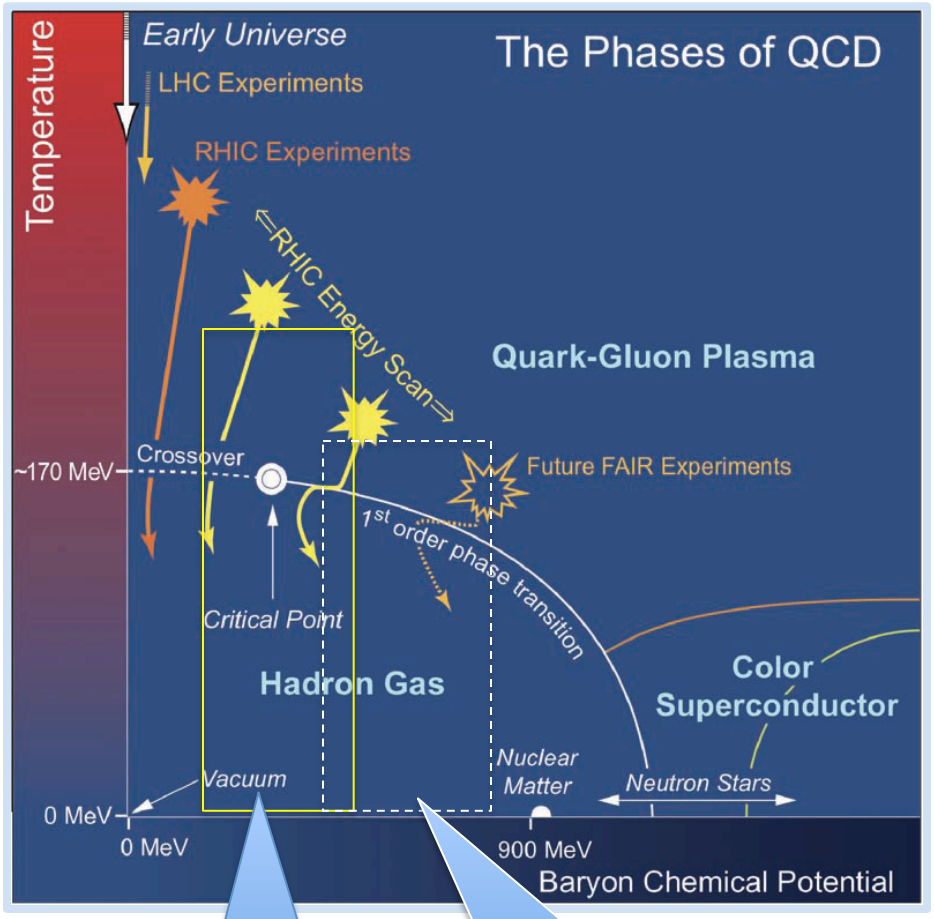
RHIC BES-II
Critical Point
$7.7 \le \sqrt{s_{NN}} \le 20$ GeV

RHIC + FAiR
CP, 1st phase boundary, Quarkyonic Matter
$\sqrt{s_{NN}} \le 8$ GeV



For region $\mu_B > 500$ MeV, $\sqrt{s_{NN}} \le 5$ GeV, fixed-target experiments are more efficient BES-III?

Summary



RHIC BES-II collider mode
200 < μ_B < 420 MeV

Future Experiments BES-III
300 < μ_B < 750 MeV

2019-2020: RHIC e-cooling and iTPC upgrades bring BES-II: a **new era** for studying the QCD phase structure at high net-baryon region (200 < μ_B < 420 MeV) with unprecedented precision and coverage. Possible new discovers are:

1) The QCD critical point (region) and phase boundary
2) Properties with Chiral symmetry

2020 and beyond: fixed-target experiments at large net-baryon density: 300 < μ_B < 750 MeV
(12 < $\sqrt{s_{NN}}$ < 3 GeV)