



MPD/NICA PWG1

Global Observables

TOPICS OF INTEREST and near plans

23/07/2019

The 1st meeting of PWG1

17:00 Moscow time (9:00 Mexican time)

To be discussed today

- Introduction: MPD/NICA at JINR and Global Observables
- Some flashes from SQM-2019
- Physics motivation(s) for further studies and our near steps: MC simulation requests
- Other

Introduction

MPD/NICA at JINR and Global
Observables

Abstract of the report at QM-2019 (4-9 November 2019)
by Adam Kisiel (for the MPD Collaboration)

The physics performance of the MPD Detector at JINR

The Multi-Purpose Detector is under construction at the Joint Institute for Nuclear Research, as part of the NICA Accelerator Complex. It aims to study the phase diagram of QCD matter at maximum baryonic density, determine the nature of the phase transition between the deconfined and hadronic matter and search for the critical point.

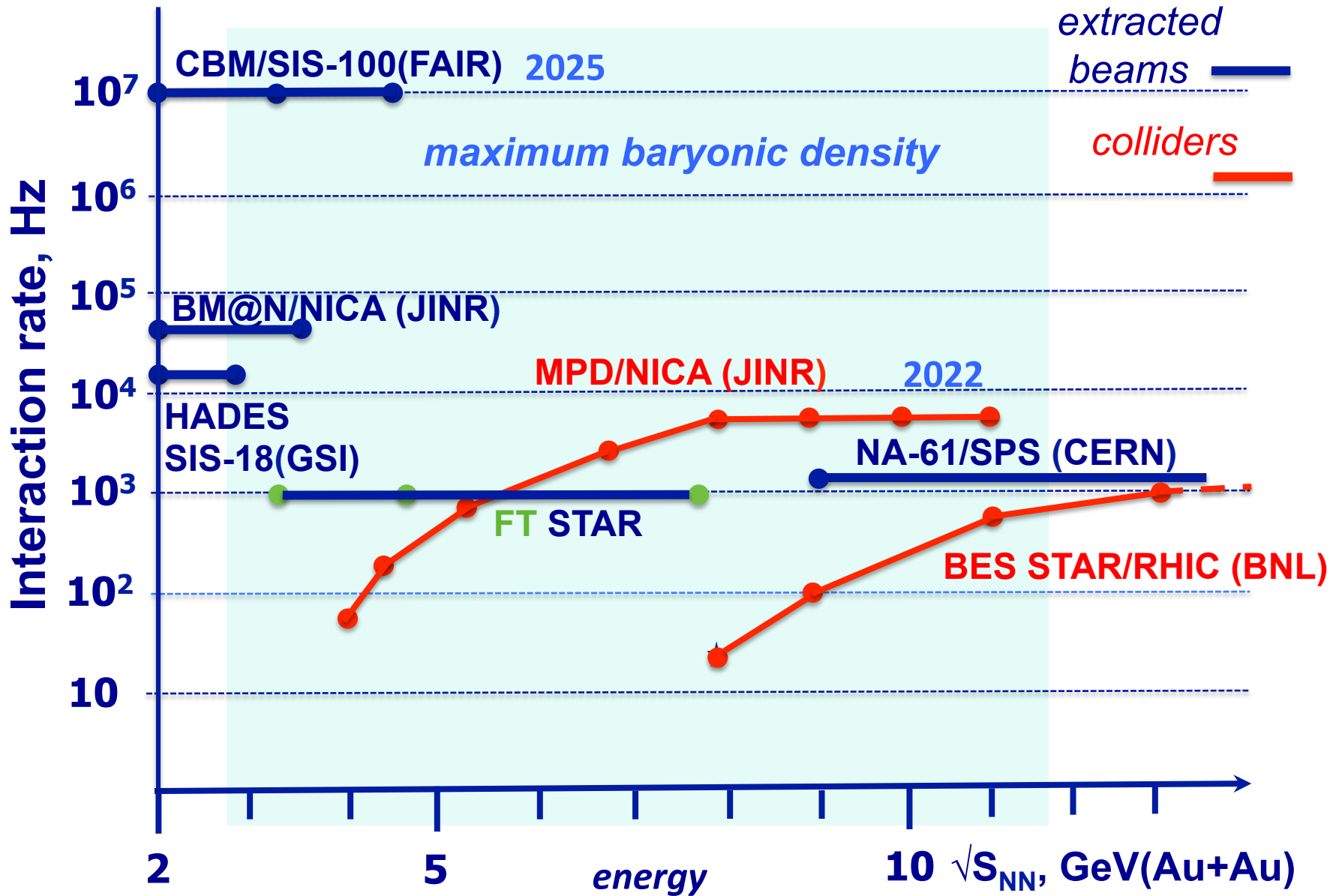
The designed physics performance of the detector components will be discussed. Spectra of identified hadrons, including hyperons and hypernuclei will be presented, with emphasis on differential measurement and total yield extraction. The quality of directed and elliptic flow determination will be discussed, with comparison to model expectations. The sensitivity of event-by-event fluctuations and femtoscopic measurements to the nature of the phase transition and the presence of a critical point will be given. Performance of the electromagnetic calorimeter working in conjunction with the tracking system for the di-lepton measurements and the potential for identification of charmed mesons will be described. In summary, all the main components of the physics programme of the MPD Collaboration will be presented.

Comments (GF):

- Our task is to provide before November 2019 the possible input to the slides of this report (Physics and MC simulations).
- Physics tasks and MC simulations – what types of the MC Event generators should be considered ?

Set-ups: *in operation*

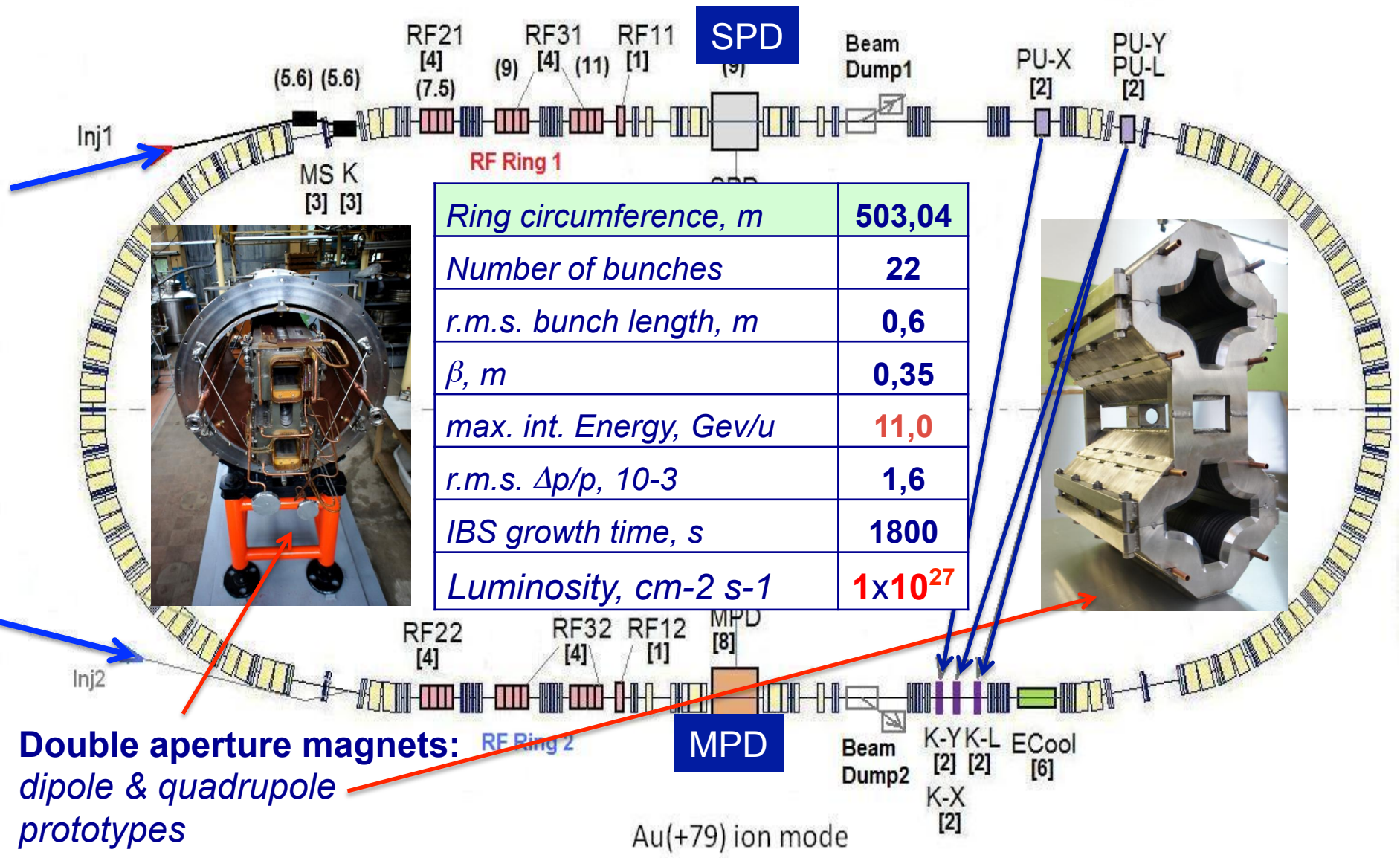
In construction



Comments (GF):

- Our general task is to make the analysis of the existing experimental landscape (BES-1 and BES-II programmes , NA61/SHINE results) and to developed a detailed experimental program for the MPD

45 T*m, 4.5 GeV/u for Au⁷⁹⁺



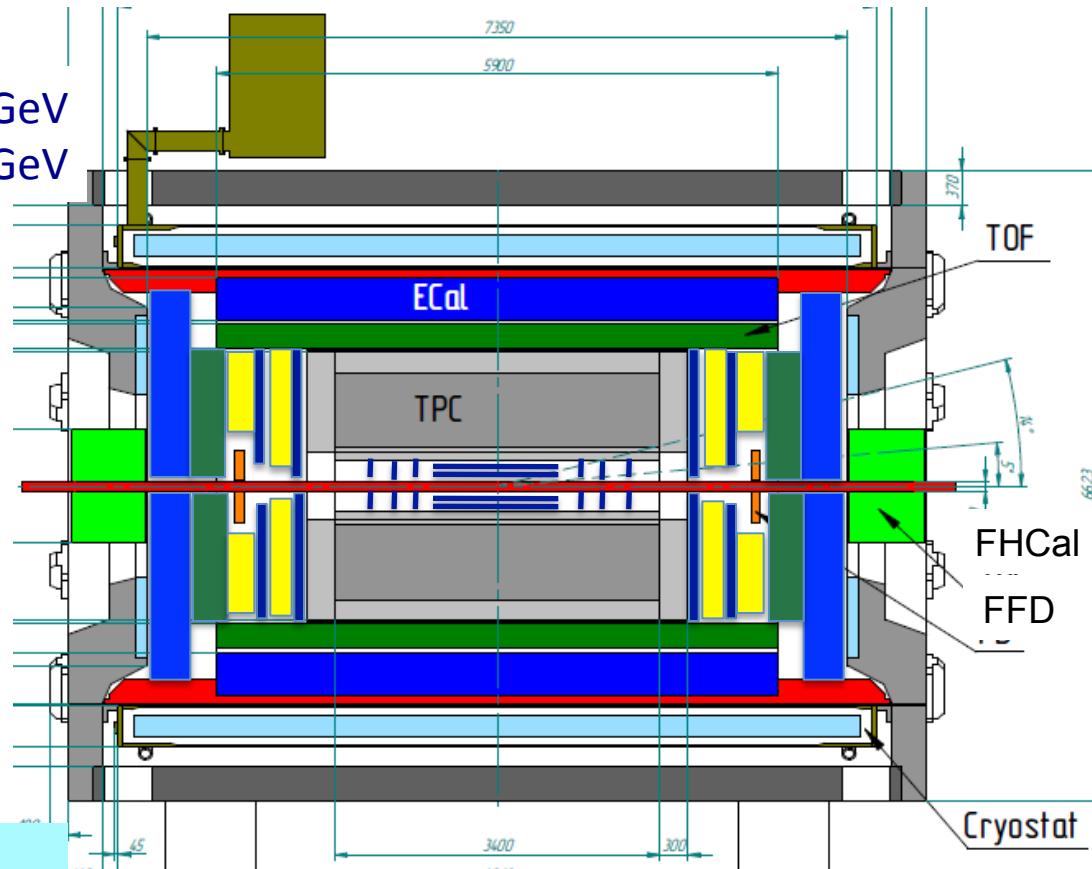
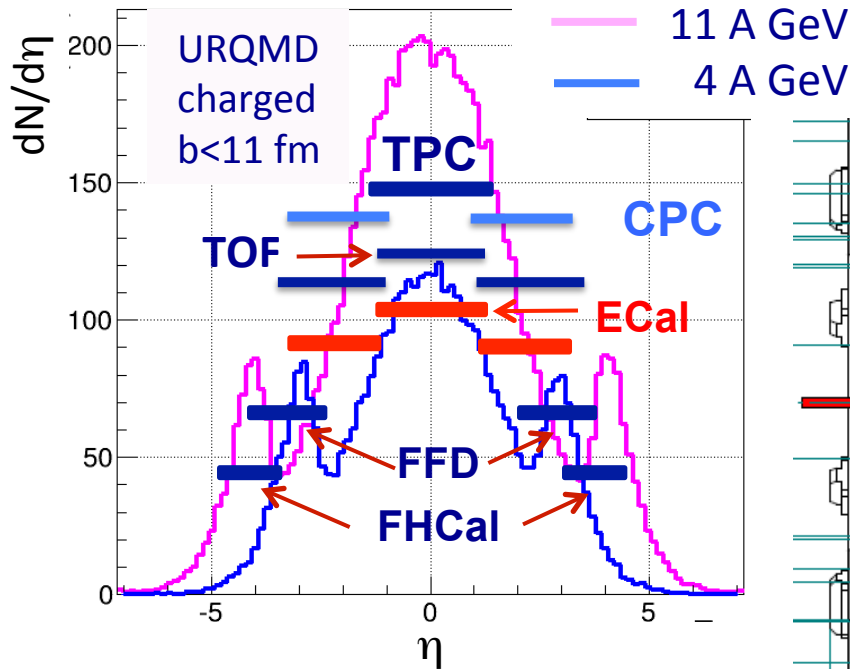
Double aperture magnets:
dipole & quadrupole
prototypes

Multi-Purpose Detector (MPD)

stage I: TPC, TOF, ECAL, FHCAL, FFD

stage II (2023): + ITS + EndCap (CPC, Straw, TOF, ECAL)

stage II acceptance

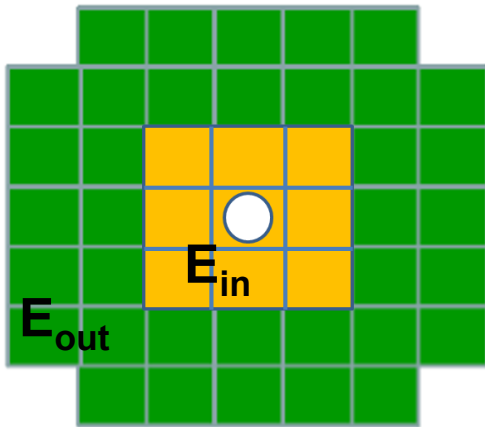


stage I: put in operation in 2022

FHCAL: for determination of reaction plane and centrality

responsibility of INR RAS

- 2-arm (left/right) calorimeter (at ~ 3.2 m from the IP)
- arm consists of 45 modules - 15×15 cm² each
- module - 42 lead/scintillator layers

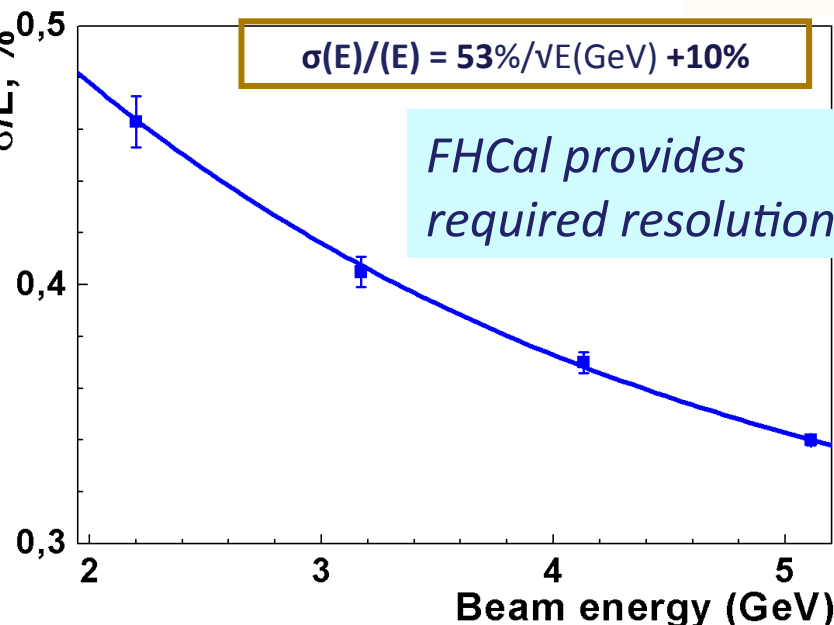


FHCAL coverage: $2.2 < |\eta| < 4.8$

Transverse granularity allows to measure:

- *the reaction plane with the accuracy $\sim 20^0$ - 30^0*
- *the centrality with accuracy below **10%**.*

modules production – in progress



One of the new developments

Alexander Ivashkin:

"The novel method of spectator nucleons energy reconstruction, based on the transverse gradient measurements of the energy deposition in the FHCAL, is showing its capabilities to resolve the ambiguity in the energy deposition for central/peripheral A-A collisions."

Comments (GF):

- This is a very important development
- FHCAL is needed for the proper and robust selection of events in order to define the initial conditions
- We hope to discuss it later in details at one of the following meetings
- MC simulations – what type of the MC Event generator to use?

PWG1: Global Observables

TOPICS OF INTEREST

- Rapidity distribution of charged particles
 - particle ratios
- Total event multiplicity
- Total event energy
 - event transverse energy
 - event mean transverse pT
 - charged particles density at midrapidity
 - particle ratios
- Centrality determination and different estimators
 - spectator nucleons (N_s) and number of nucleon-participants (N_{part})
 - multiplicity classes: pros and cons
 - different estimators and impact parameter b
 - event-by-event spectator measurement
- Total cross-section measurement
- Event primary vertex determination
- Event plane measurement at all rapidities

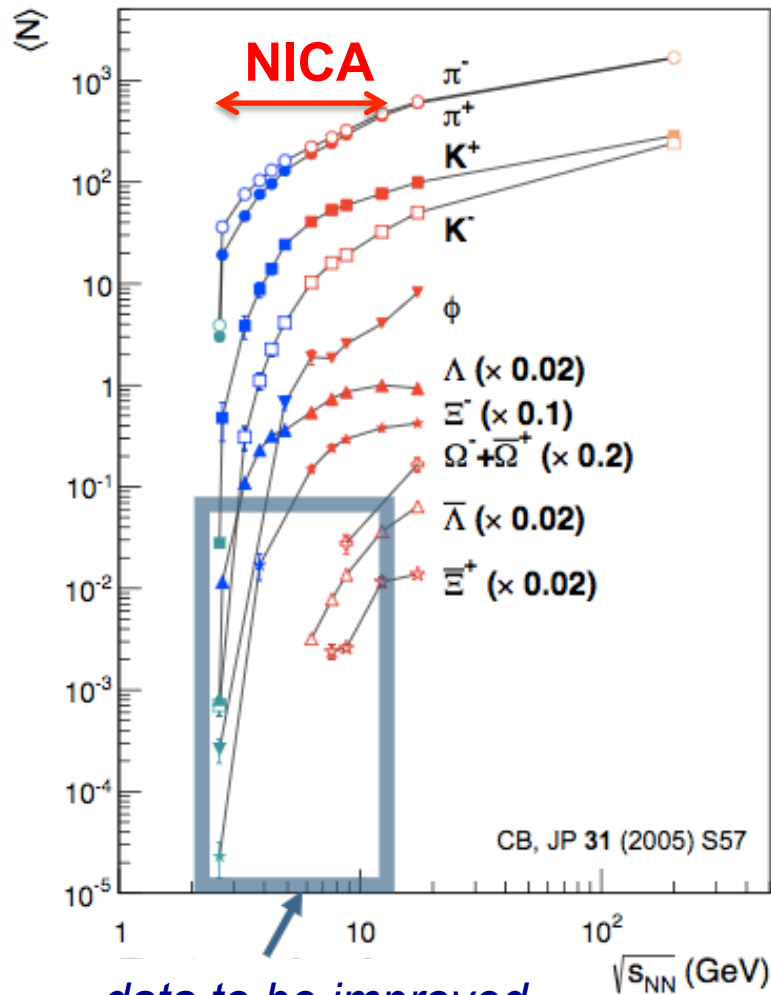
To be discussed today

- Some flash from the SQM-2019 conference in Bari



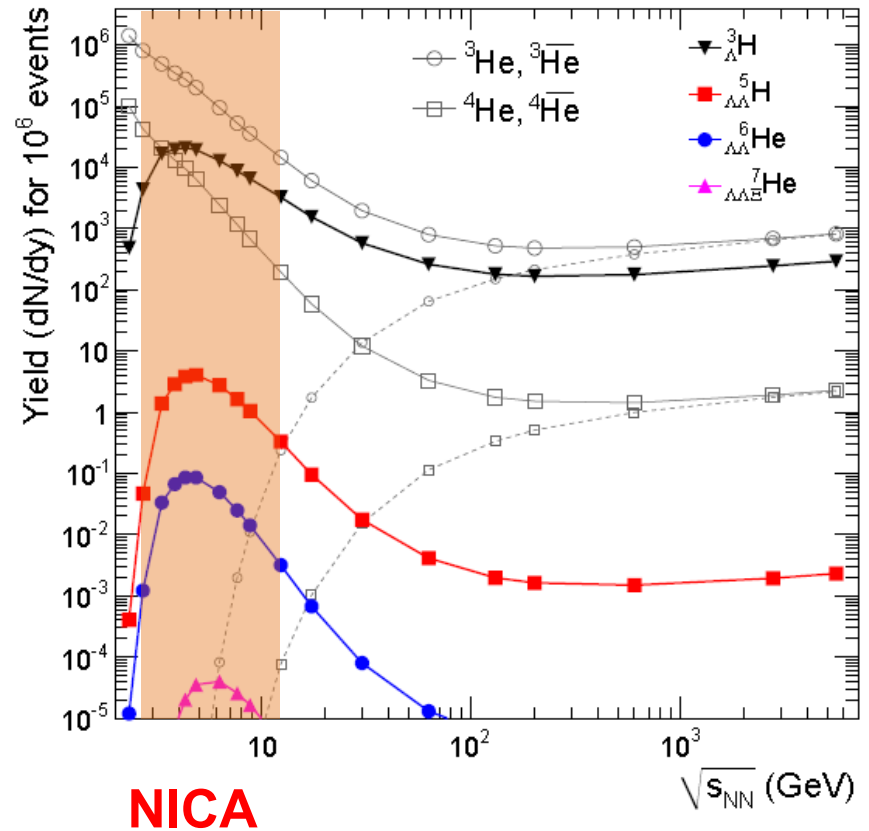
The 18th International Conference on
Strangeness in Quark Matter (SQM 2019)
10-15 June 2019, Bari (Italy)

From the report by V.Kekelidze at the SQM-2019:
Energy Dependence of Total Yields



data to be improved
C. Blume, SQM-2017

Hypernuclei production enhanced at high baryon densities (NICA)



NICA
*A. Andronic, P. Braun-Munzinger,
 J. Stachel, H. Stoecker*

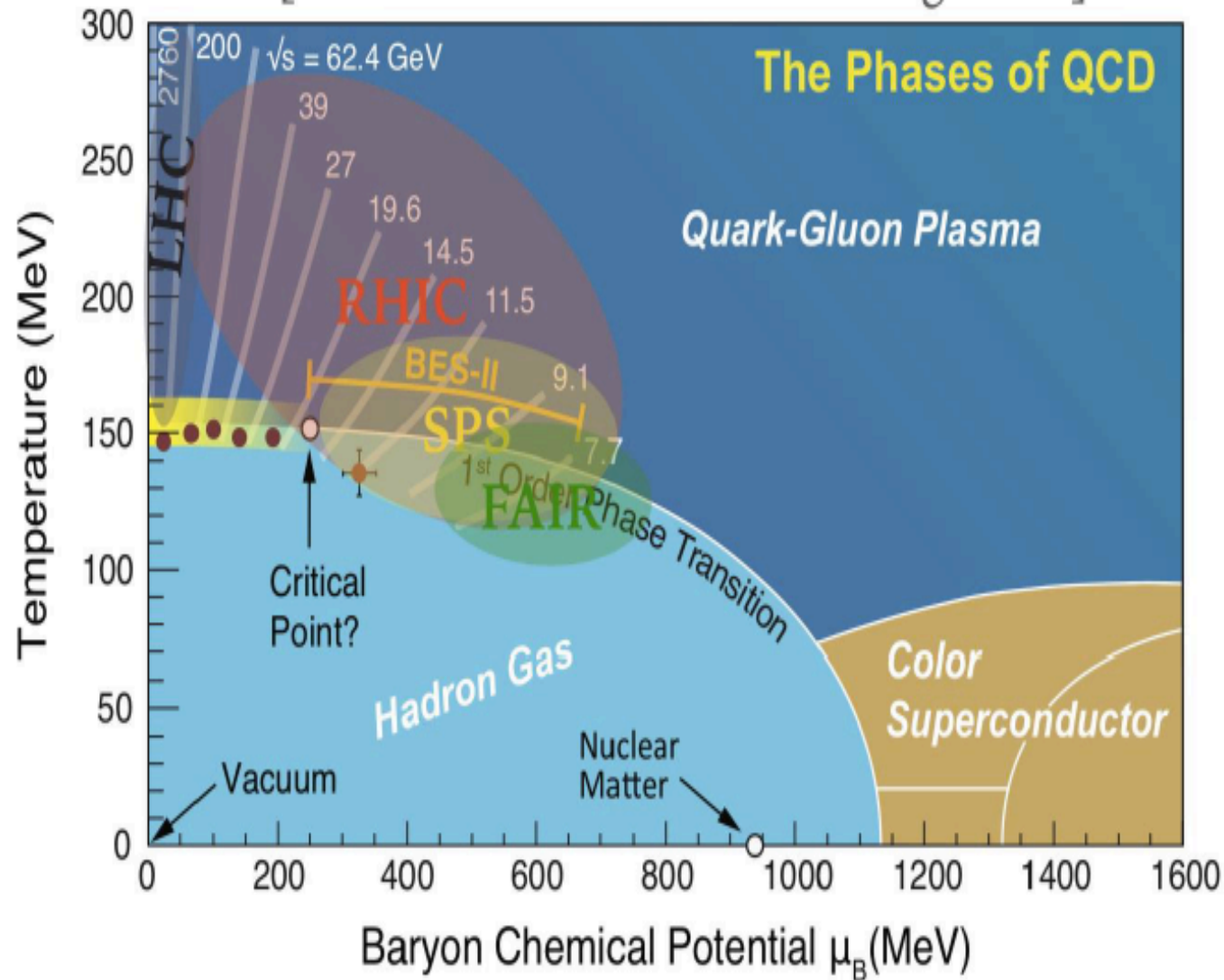
Several slides from RHIC Beam Energy Scan report
by Xianglei Zhu at SQM-2019



The 18th International Conference on
Strangeness in Quark Matter (SQM 2019)
10-15 June 2019, Bari (Italy)

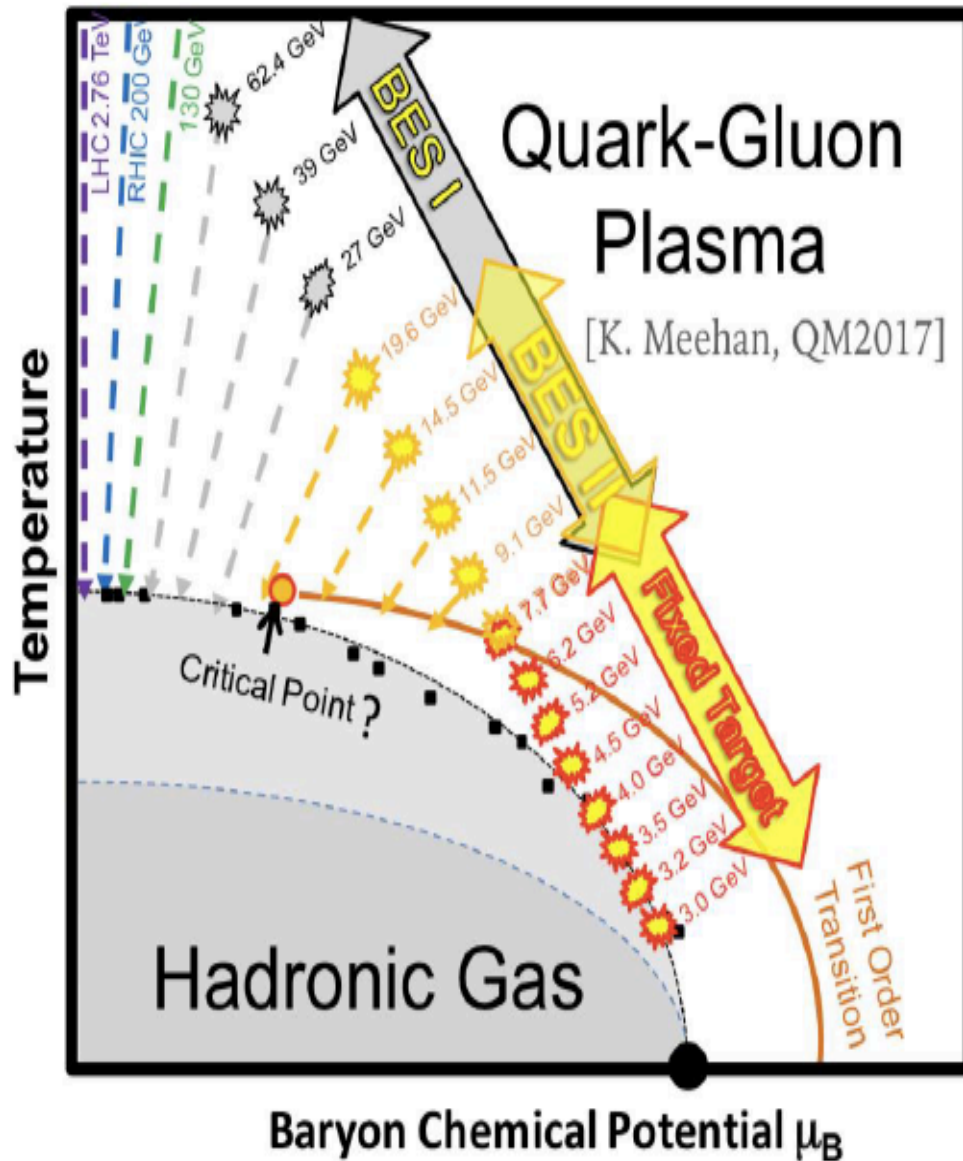
Strangeness and LF at intermediate
baryon density (RHIC BES +SPS)

by Xianglei Zhu



- **RHIC BES & SPS**

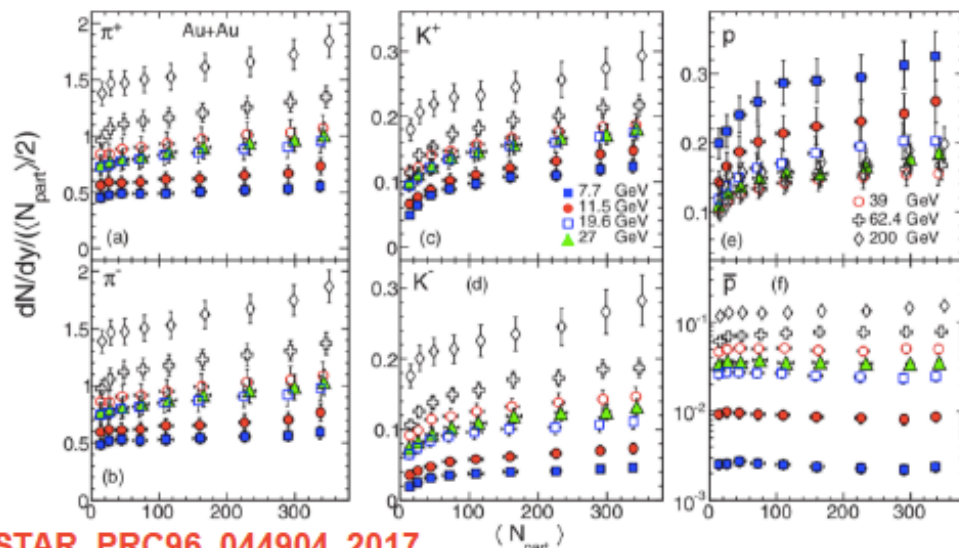
Cover the intermediate baryon density region



RHIC

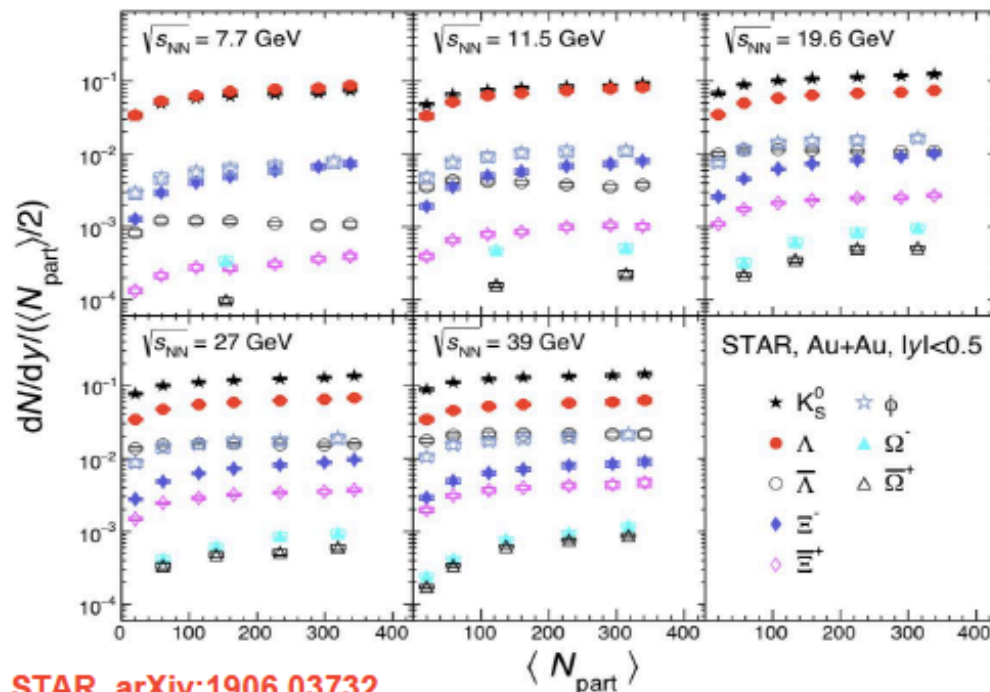
- full azimuthal coverage at mid-rapidity
- BES-I (completed)
 $Au+Au \sqrt{s_{NN}} = 62.4 - 7.7$ GeV
- BES-II (on-going)
 $Au+Au \sqrt{s_{NN}} = 19.6 - 7.7$ GeV
- Fixed-target (on-going)
 $Au+Au \sqrt{s_{NN}} = 7.7 - 3.0$ GeV

Particle yields (STAR BES-I)



STAR, PRC96, 044904, 2017

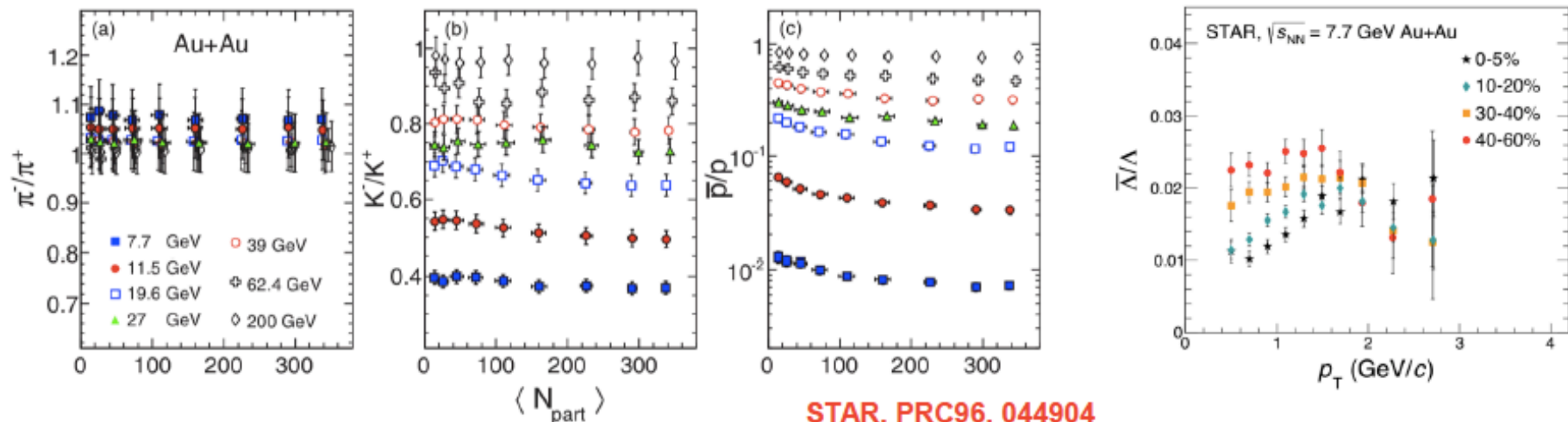
- dN/dy at mid- y for all species vs centrality and energy
- Yield per participating pair increases towards central and higher energies in general



STAR, arXiv:1906.03732

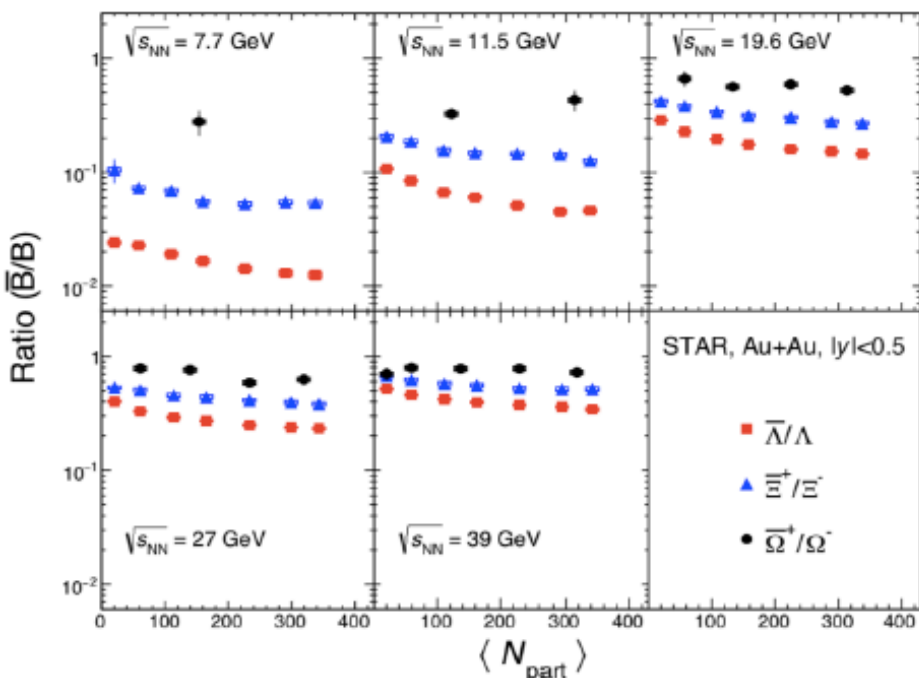
- Exceptions:
 - p and Λ yields decrease towards higher energy
 - \bar{p} and $\bar{\Lambda}$ has weak centrality dependence

Anti-hadron to hadron ratio (STAR BES-I)



STAR, PRC96, 044904

STAR, arXiv:1906.03732

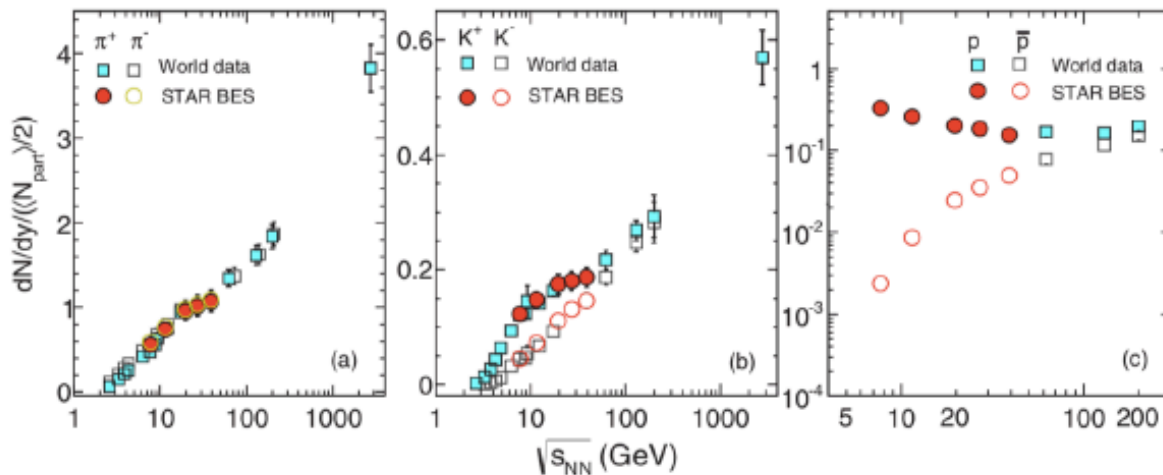


- Centrality dependence of \bar{B}/B ratios: **peripheral > central**
- This effect is more prominent at lower energies. **baryon stopping and/or anti-baryon absorption**
- **Loss of low p_T $\bar{\Lambda}$ in central collisions**

Comments (GF):

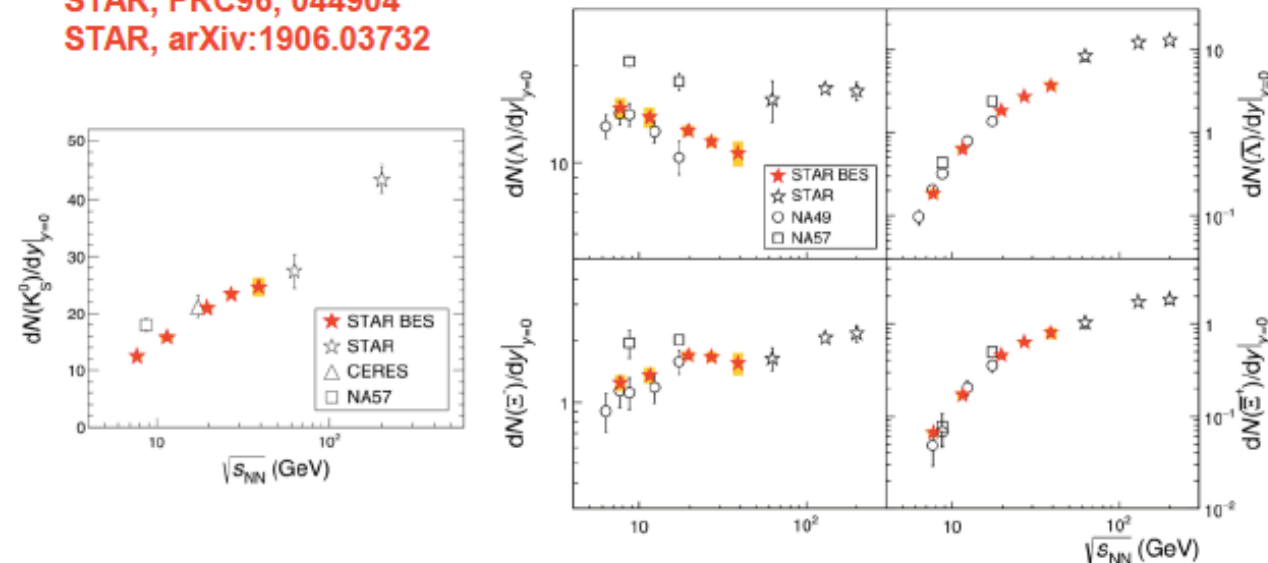
- Scaling with N_{part} (and some deviations) – baryon stopping?
- Particle ratios in this energy domain?
- What types of the MC Event generators should be considered ?
- URQMD?
- Modified Glauber?
-other?

Particle yields in central collisions (STAR BES-I)

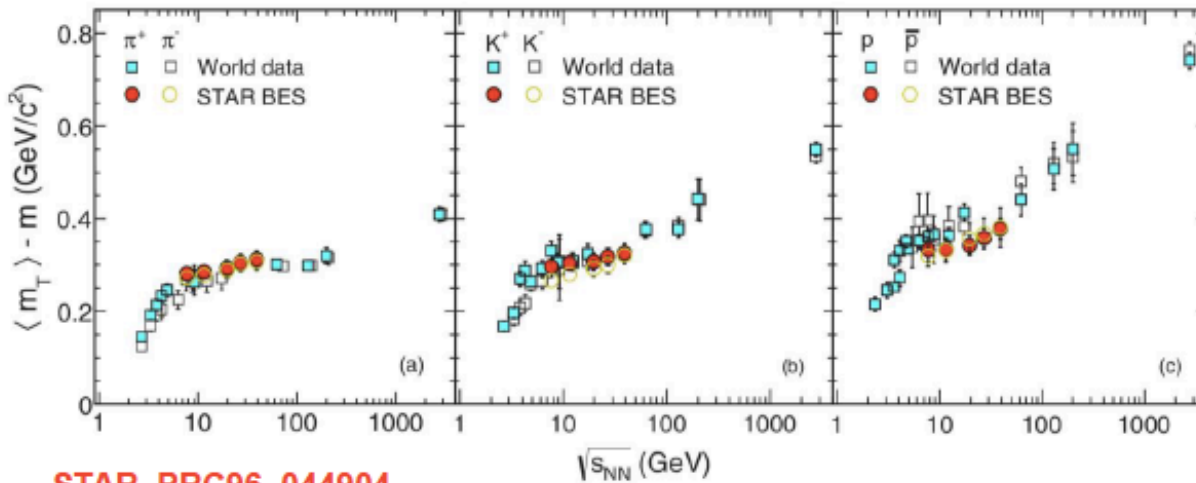


STAR, PRC96, 044904
 STAR, arXiv:1906.03732

- STAR BES-I data consistent with published data in general
- Rich structure in these excitation functions
- p and Λ yields reach minimum at 39 GeV: interplay of baryon transport and pair production

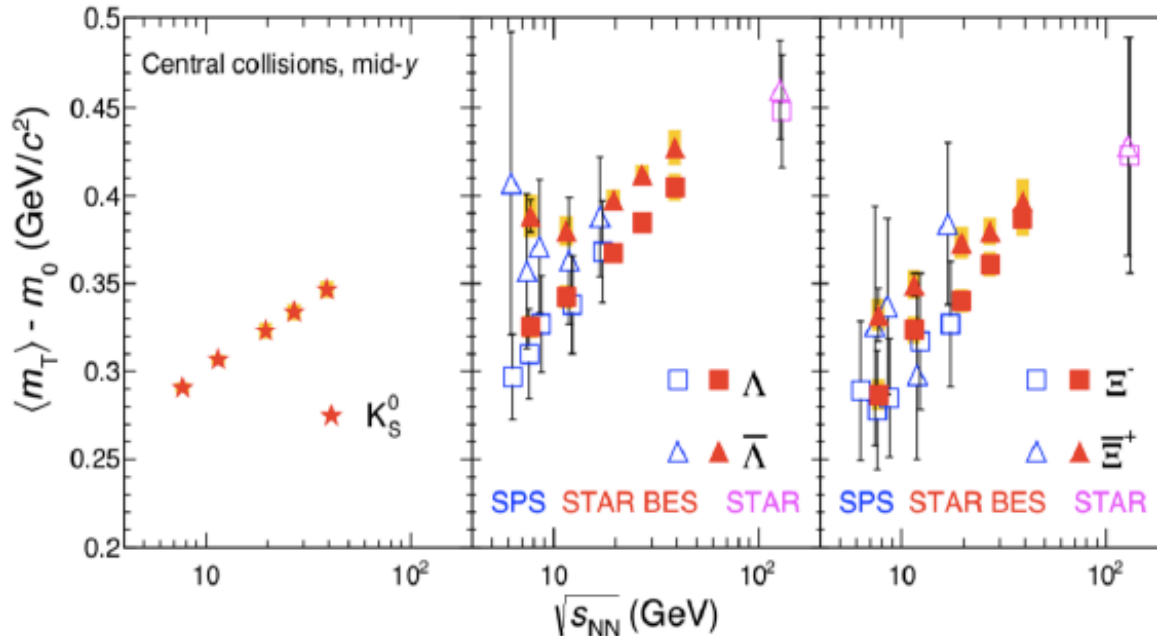


Average transverse mass (STAR BES-I)

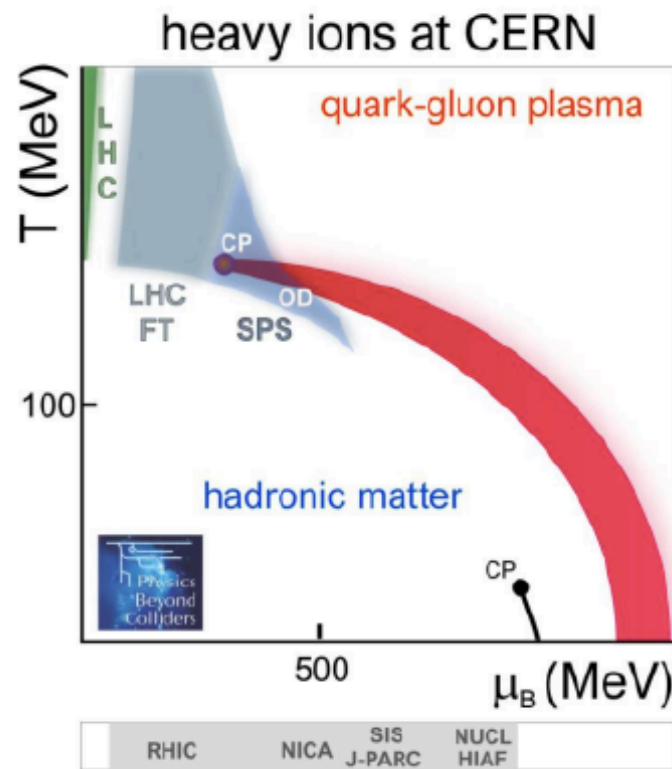
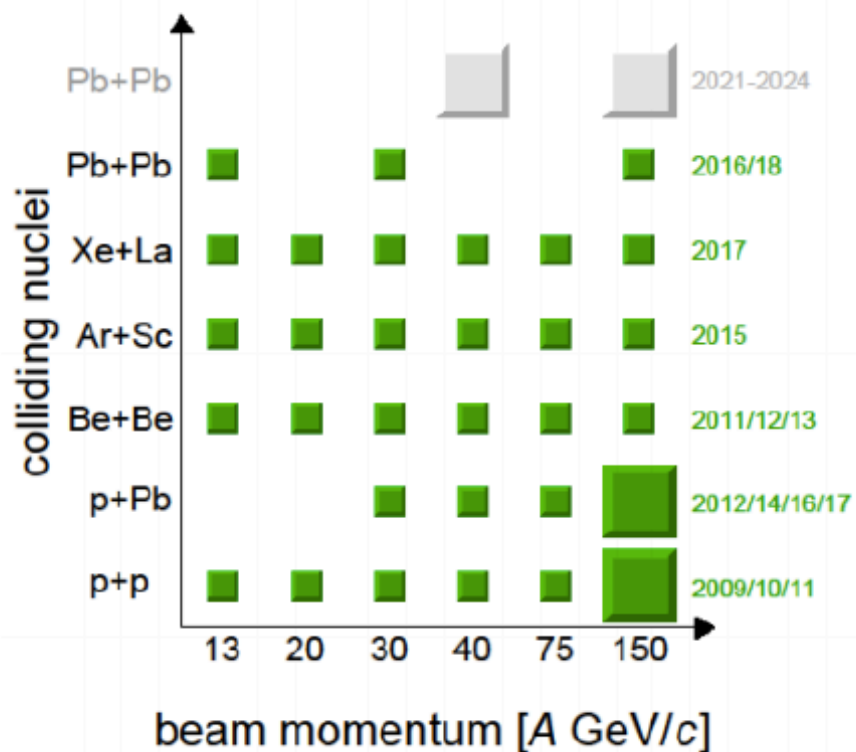


STAR, PRC96, 044904
 STAR, arXiv:1906.03732

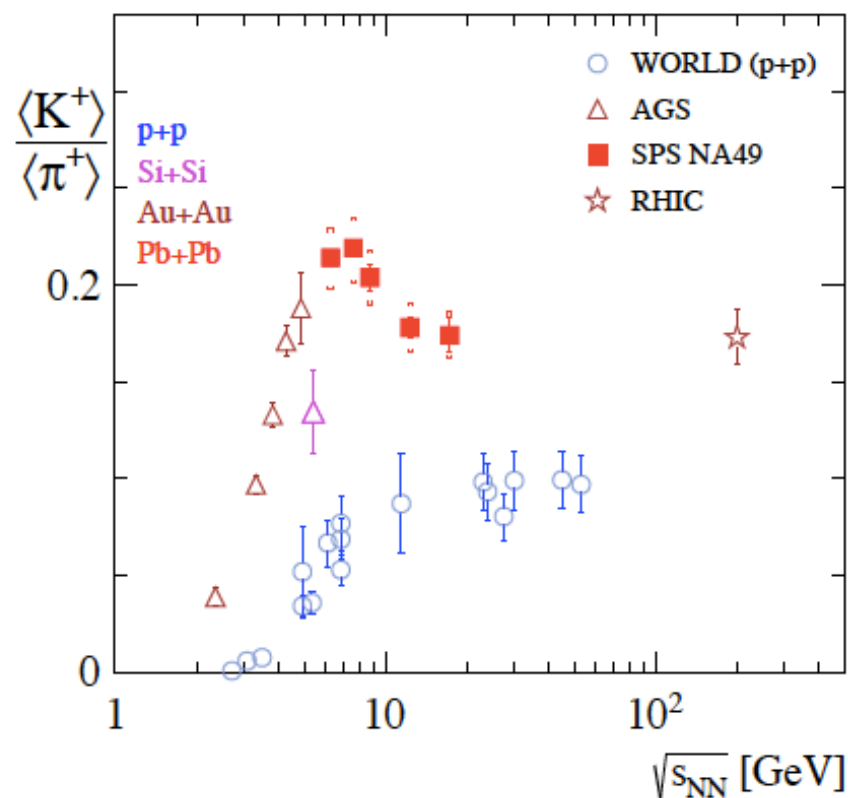
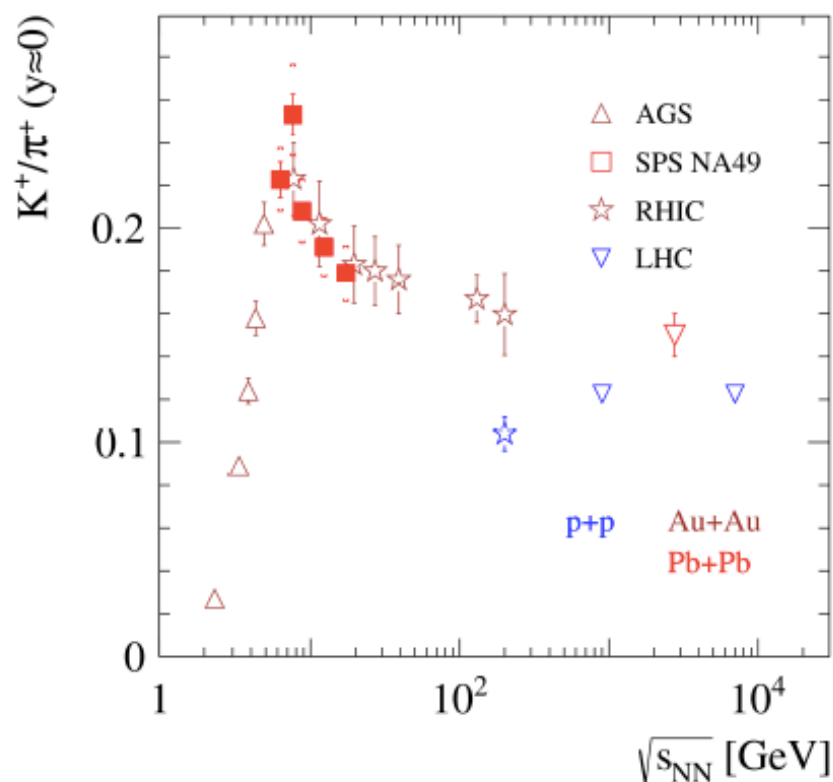
- A step-like structure can be seen in the energy dependence first-order phase transition?
- Λ and $\bar{\Lambda}$ show split at lower energies might be due to baryon-antibaryon annihilations at high baryon density



- NA61/SHINE performed unique, two-dimensional scan in collision energy and nuclear mass number of colliding nuclei
- Data cover unique range in the phase diagram of strongly interacting matter



Motivation for NA61/SHINE measurements



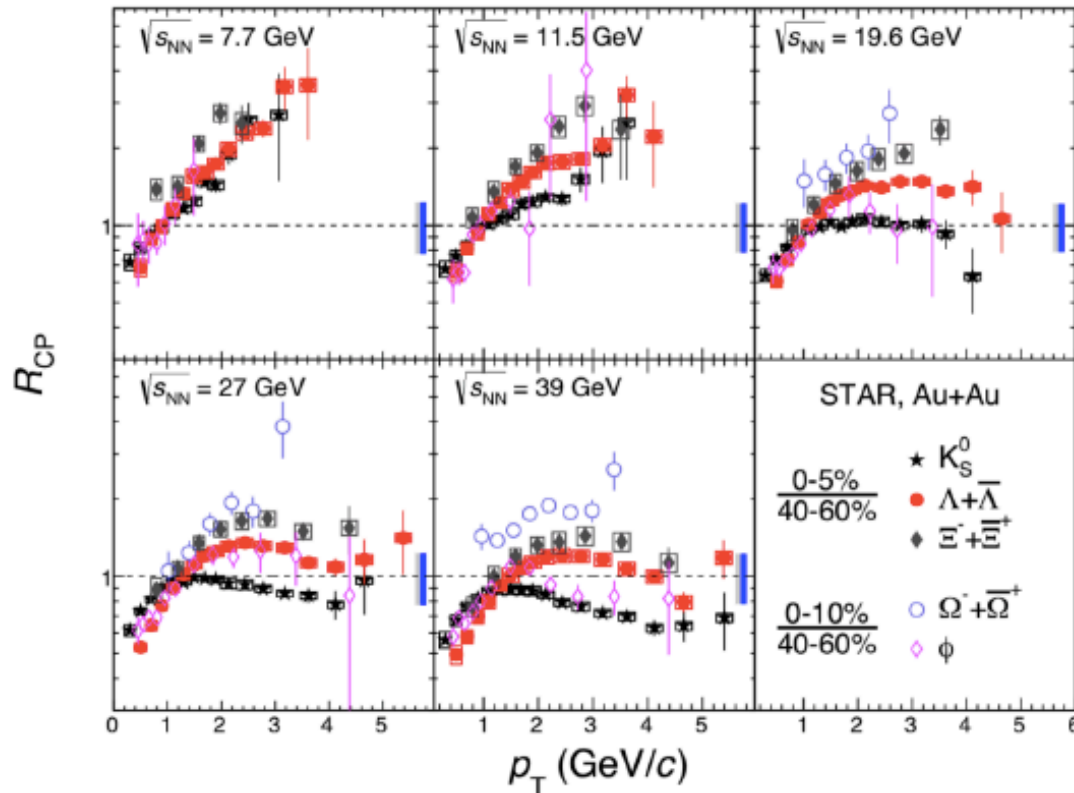
- Rapid change in the K^+/π^+ ratio - HORN - was observed in Pb+Pb collisions (NA49). Predicted as a signature of the onset of deconfinement
- Before NA61/SHINE no precise data on system size dependence of particle production at SPS energies

NA49, *PRC* 66, (2002), NA49, *PRC* 77, (2008); M. Gaździcki, M.I. Gorenstein, *A. Phys. Pol.* B30, 2705 (1999)

Comments (GF):

- Can we measure “Horn” and some “tails” with better accuracy at the MPD/NICA?

Nuclear modification factors R_{CP}



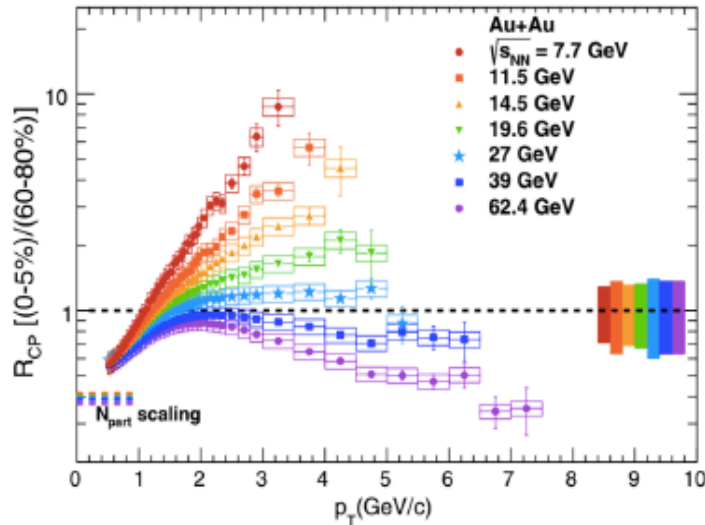
$$R_{CP}(p_T) = \frac{[d^2\sigma/(N_{bin}p_T dp_T dy)]_{central}}{[d^2\sigma/(N_{bin}p_T dp_T dy)]_{peripheral}}$$

STAR, arXiv:1906.03732

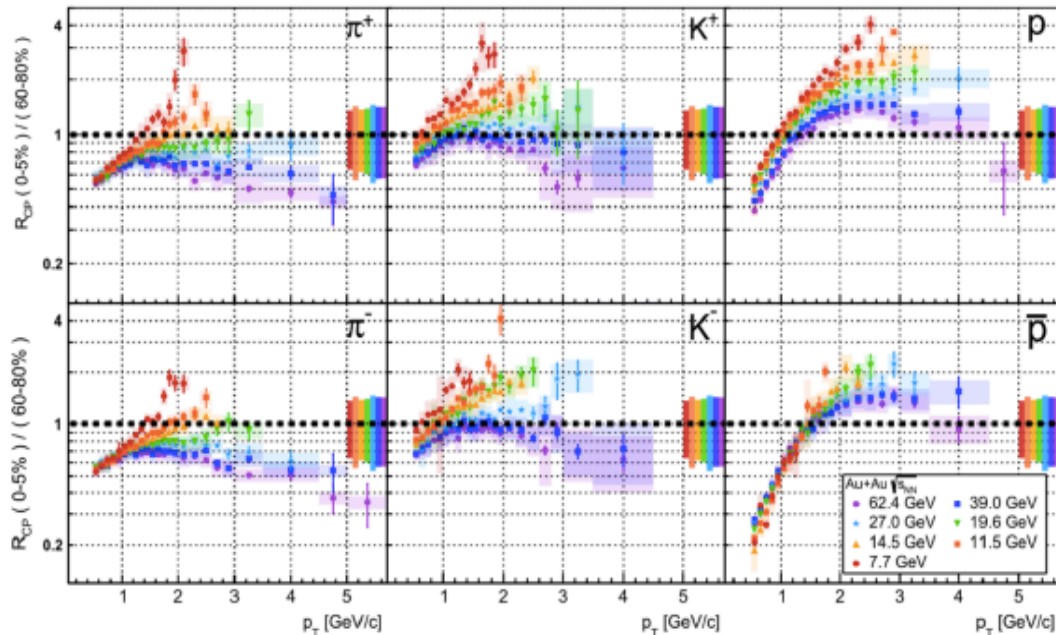
- No K_S^0 suppression in Au+Au 7.7 and 11.5 GeV
- Cronin effect and other effects (radial flow) compete with partonic energy loss
- Intermediate p_T , particle R_{CP} difference becomes smaller @ 7.7 and 11.5 GeV

by Xianglei Zhu

Nuclear modification factors R_{CP}



- No suppression for lower energies
- Cronin effect and other effects (radial flow) compete with partonic energy loss



STAR, PRL121, 032301, 2018

Comments (GF):

- RHIC experimental data include Glauber based estimates of N_{bin} collisions – this defines the values of R_{AA} and R_{CP} --???
- Can we provide the measurements of $N_{\text{spectators}}$ and N_{part} at the MPD/NICA?
- Can we provide the different approach at the MPD/NICA for N_{bin} collisions ?

To be discussed today

- Physics motivation(s) for further studies
and our near steps: MC simulation requests

Example -- the first MC request

A short physics motivation for the request

1 A Monte-Carlo model to use--vHLLX+UrQMD model

hybrid model with viscosity, allowing to choose equation of state:

-crossover equation of state (EoS)

- first order EoS

created by Yurii Karpenko describing well bulk observables of RHIC BES .

2 we need of 2 sets of simulations with 1PT and crossover PT:

2 The requested combination of collision system (e.g. Au+Au)

Au-Au

collision energy (eg. 11 AGeV)

7.7, 11.5

requested centrality or centralities

0-5%, 5-10%, 10-20%, 20-50%

number of events at each combination of system+energy+centrality

7.7 AuAu , 0-5% centrality, 1PT EoS 1 mln events

7.7 AuAu , 0-5% centrality, crossover (XPT) EoS 1 mln events

.....

11.5 AuAu , 10-20% centrality, 1PT EoS 2 mln events

11.5 AuAu , 20-50% centrality, XPT EoS 3 mln events

4 The version of reconstruction software and MPD geometry to use

- We have not information about current status of the reconstruction software. Therefore we can't
- specify the version.

5 Any other special requests for the production

To be discussed today

Other things

---further meetings:

- Time: 17:00 Moscow time (9:00 Mexican time)
- Day: twice a month? Tuesday?
- Vidyo Connect should be used
- INDICO setup will be provided

Meeting of the MPD PWG convenors on Wednesday, July 24th

10:00 AM Dubna time, 9:00 AM CET

The agenda:

- the status of the MC requests from the PWGs and further MC requests
- report on the possible MC production at LHEP cluster
- discussion of the proposed MicroDST structure and tests
- organization of the first PWG meetings
- attracting collaboration members to participate in PWG activities