Simulations session.

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1. Alejandro Guirdo García.

   Electromagnetic fields in heavy ion collisions at MPD-NICA energies

2. Valeria Zelina Reyna Ortiz.

   Study of the Bi+Bi and p+p collisions for the MPD/NICA

3. Julio César Maldonado González.

   Particle Identification with MPD-TPC tracks

4. Dario Chaires.

   Au+Au collisions at NICA energies: UrQMD vs PHSD

5. José Jorge Medina Serna.

   Hadron production at RHIC energies towards polarization studies using Therminator

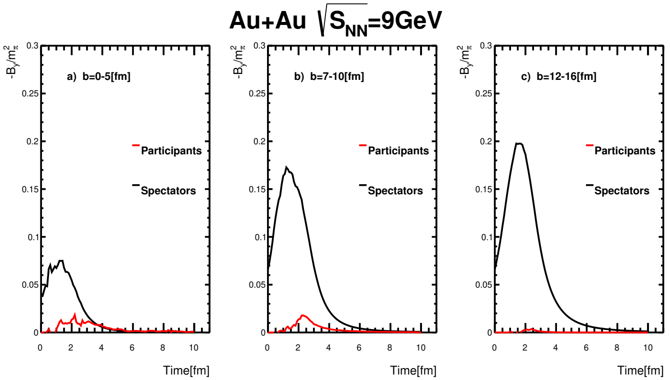
Electromagnetic fields in heavy ion collisions at MPD-NICA energies

1. The Lienard-Wiechert equations to calculate electromagnetic fields at any point in space and at any time.

   UrQMD: Au+Au and Bi+Bi $\sqrt{S_{NN}} = 4, 9, 11$ GeV

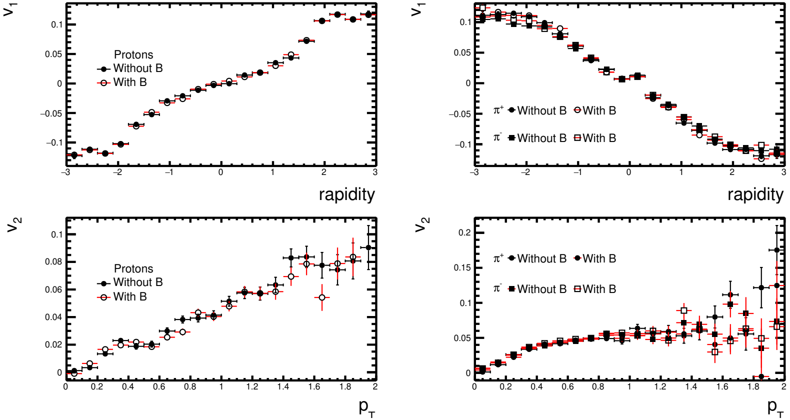
2. To simulate electromagnetic fields effect on UrQMD dynamic propagation we added the Lorentz force at the canonical equations

   Magnetic field effects on flows



Temporal evolution of electromagnetic fields produced by spectating and participating protons at $\mathbf{r} = 0$ in $Au + Au$ collisions with collision energy of 9 GeV in impact parameter ranges.

Magnetic field effects on flows



Direct and indirect flows of charged protons and pions adding the effects of magnetic fields to the dynamics of UrQMD. $Au + Au$ events at collision energy $(\sqrt{S_{NN}} = 11\ GeV)$ and $b = 7\ fm$.

Study of the Bi+Bi and p+p collisions for the MPD/NICA

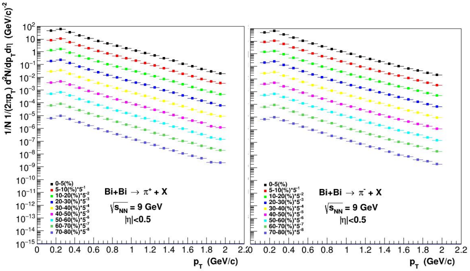
1. UrQMD+TPC: Bi+Bi collisions at energies of $\sqrt{s_{NN}} = 7$, 9, 9.46 and 11 GeV.

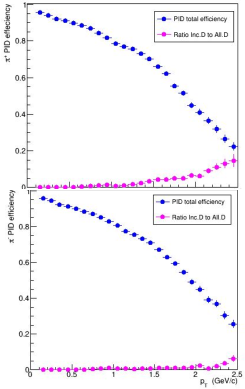
   Plots of the transverse momentum for the identified hadrons: kaons, pions, protons

2. UrQMD+TPC: p+p collisions at $\sqrt{s_{NN}} = 10$ GeV.

   Transverse momentum vs pseudorapidity

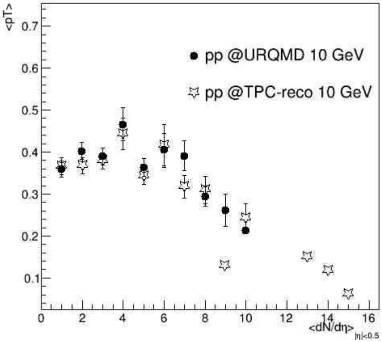
Yields π for different centrality classes and efficiency





The graph on the left shows the outputs of π for different centrality classes.
The graph on the right shows the pid total efficiency (blue), the ratio of incorrectly defined particles to all defined ones (magenta).

<pT> vs <Nch> Rec



Comparing with UrQMD 10GeV 1000 Events (same urqmd production before reconstruction)

- Descending pT tendency for particles & tracks
- Reco-Tree has some events with 0 tracks
- Similar points, error bars justify some of the differences,
- Reconstruction finds more points (why?)

Particle Identification with MPD-TPC tracks

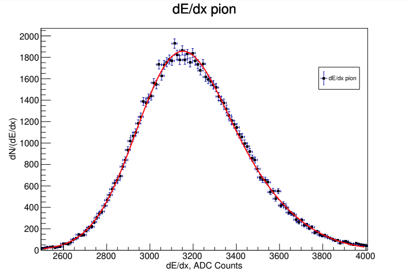
1. PID: Bayesian approach vs machine learning techniques (GLM)

   Preliminary results for UrQMD+TPC, Bi+Bi at $\sqrt{s_{NN}} = 11$ GeV.

Fit and probability density function

Using a Gaussian probability density function to fit data,

$$r(s|\pi) = A\exp\left(-\frac{(s-\mu)^2}{2\sigma^2}\right)$$



Obtaining the result:

- $FCN = 68.3756$
- Constant
  $A = 1.84022e+03$,
  $ERROR = 1.17648e+01$
- Mean
  $\mu = 3.13593e+03$,
  $ERROR = 3.19178e+00$
- Sigma
  $\sigma = 2.00574e+02$,
  $ERROR = 1.67078e+00$

Probabilities a priori C_i

The probabilities C_i can be estimated with Time-of-Flight measurements,

$$m = \frac{p}{\beta\gamma} = p\sqrt{\frac{c^2t^2}{l^2} - 1}$$

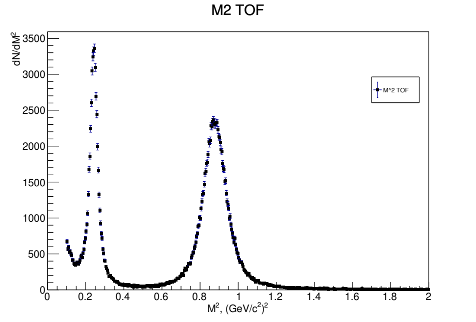


Figure 3: M^2 TOF for 10k events for primary particles.

Generalized Linear Model (GLM)

Coefficients:

	Estimate	Std. Error
(Intercept)	-7.51945	12.06997
dEdx	0.00377	0.00365
P	8.06809	9.61674

The discriminant function can be write as follow,

$$y = -7.51954 + (0.00377)dEdx + (8.06809)P$$

A test data element is defined as followed, obtaining a probability from 0 to 1 for both classes (protons (0) and pions(1)),

```
newdata = data.frame(P = 0.377411, dEdx = 2782.666)
predict(model, newdata, type="response")
```

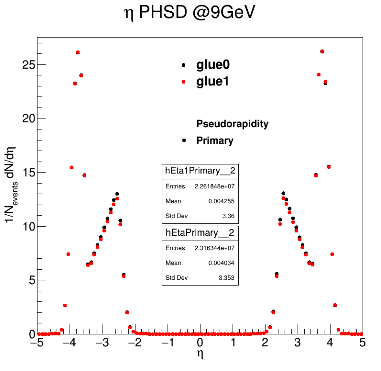
Au+Au collisions at NICA energies: UrQMD vs PHSD

1. Study for pay geometry for the BeBe with PHSD generator.

   Au+Au at $\sqrt{s_{NN}} = 9$ and 11 GeV with both glue1 and glue0. This was made with the purpose of checking the implications of turning off the partonic phase.

500 000 events of Au+Au $\sqrt{s_{NN}} = 9$ GeV

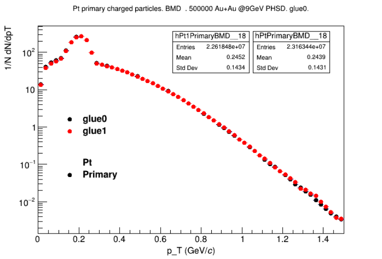
Pseudorapidity distributions



- BeBe pay, PHSD @9 GeV
- Primary particles that hit the BeBe
- glue0 (black dots)
- glue1 (red dots)
- Overall glue0 seems to surpass glue1 slightly
- The difference can only be perceived at pseudorapidity ranges between ± 4 and ± 2.

500 000 events of Au+Au $\sqrt{s_{NN}} = 9$ GeV

Transverse momentum distributions

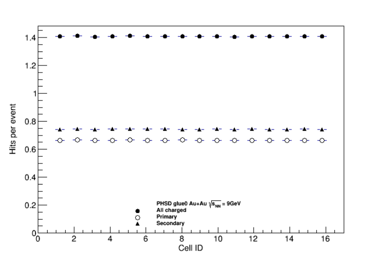


- Same configuration as before
- On this distribution a difference is almost not perceptible
- Lumpiness for great values of P_T

First ring of BeBe Pay at $\sqrt{s_{NN}} = 9$ GeV

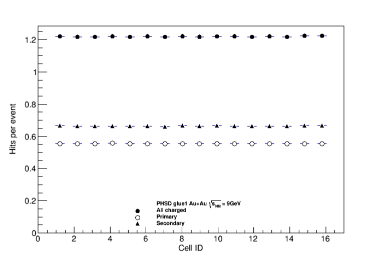
To go further in this analysis, over the following sections, I'm showing the results coming from the distributions of hits per event using PHSD and the Pay geometry

glue0



All: around 1.4
Primary: around 0.65
Secondary: around 0.75

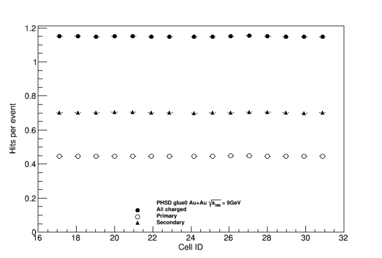
glue1



All: around 1.2
Primary: around 0.55
Secondary: around 0.65

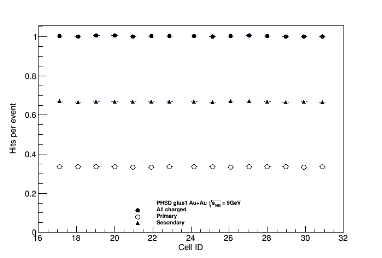
Second ring of BeBe Pay at $\sqrt{s_{NN}} = 9$ GeV

glue0



All: around 1.2
Primary: around 0.45
Secondary: around 0.7

glue1



All: around 1
Primary: around 0.35
Secondary: around 0.65

Synthesized tables for the three innermost rings

$\sqrt{s_{NN}} = 9$ GeV

Ring	Gen. Setting	All	1ary	2ary
1	glue0	~ 1.4	~ 0.65	~ 0.75
	glue1	~ 1.2	~ 0.55	~ 0.65
2	glue0	~ 1.2	~ 0.45	~ 0.7
	glue1	~ 1	~ 0.35	> 0.65
3	glue0	> 0.7	> 0.25	> 0.45
	glue1	< 0.75	< 0.3	~ 0.45

$\sqrt{s_{NN}} = 11$ GeV

Ring	Gen. Setting	All	1ary	2ary
1	glue0	~ 1.6	~ 0.7	~ 0.9
	glue1	~ 1.25	~ 0.5	< 0.8
2	glue0	~ 0.88	~ 0.26	> 0.6
	glue1	~ 0.9	~ 0.26	~ 0.62
3	glue0	~ 0.82	> 0.3	~ 0.5
	glue1	> 0.82	~ 0.3	~ 0.5

Hadron production at RHIC energies towards polarization studies using Therminator

1. The main goal of this work is to implement a polarization mechanism in therminator.

   Therminator simulation: Au+Au at $\sqrt{s_{NN}} = 200$ GeV

   Freeze-out models: Siemens-Rassmusen and Schnedermann-Sollfrank-Heinz

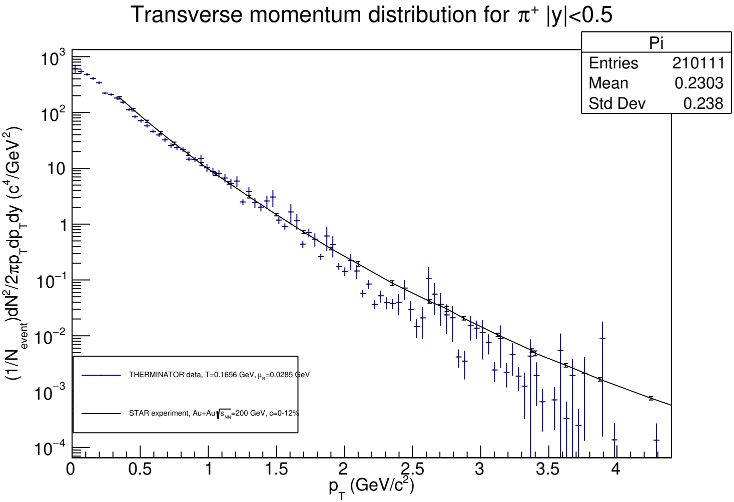


Figure: Comparison of the transverse momentum distribution at $|y| < 0.5$ for the π^+ obtained in Therminator with parameters showed in 1 for the Cracow single freeze-out model with 1000 events with the data reported (Phys. Rev. Lett. 97, 152301).

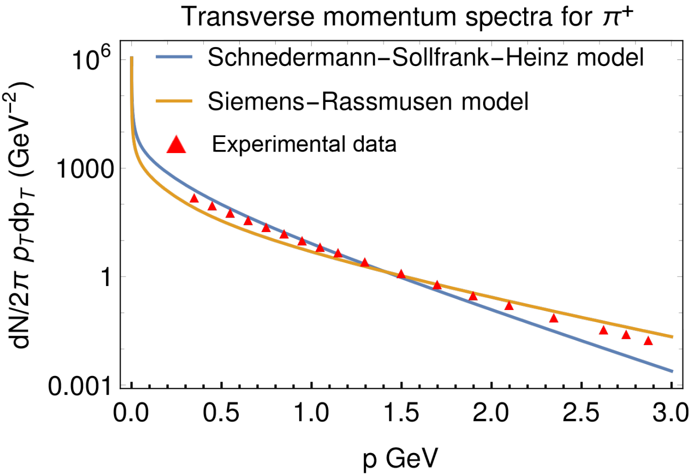


Figure: Comparison of the transverse momentum spectra for π^+ between Siemens-Rassmusen spherical model and Schnedermann-Sollfrank-Heinz cylindrical model using the parameters showed in table 1 with STAR data (Phys. Rev. Lett. 97, 152301).

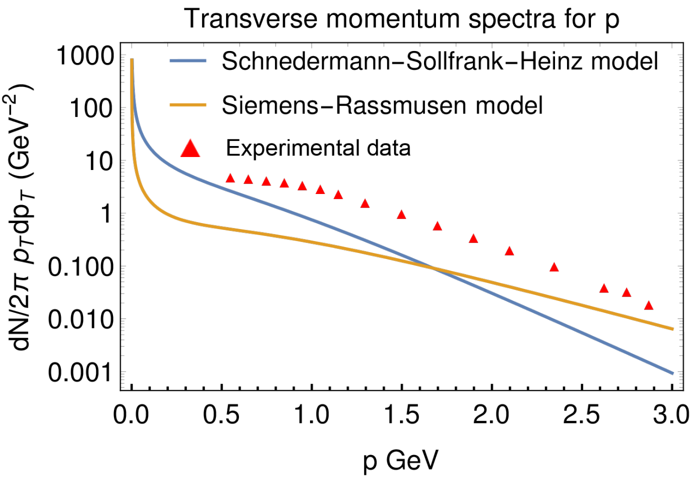


Figure: Comparison of the transverse momentum spectra for p between Siemens-Rassmusen spherical model and Schnedermann-Sollfrank-Heinz cylindrical model using the parameters showed in table 1 with STAR data (Phys. Rev. Lett. 97, 152301).

To Do

- **Electromagnetic fields in heavy ion collisions at MPD-NICA energies**
    1. Test EM added in UrQMD .
    2. Observables for studies with and without potentials.
- **Study of the Bi+Bi and p+p collisions for the MPD/NICA**
    1. Studies of PID and reconstruction tracks with TPC
- **Particle Identification with MPD-TPC tracks**
    1. Implement $r(s|i)$ probability density functions and C_i obtain from histograms to calculate bayesian conditional probability $\omega(i|s)$.
    2. Compare with GLM model results implementing in R for a binomial class data set.

To Do

- **Au+Au collisions at NICA energies: UrQMD vs PHSD**
  1. Check p_T and η distribution for BeBe pay geomety
  2. LAQGSM
- **Hadron production at RHIC energies towards polarization studies using Therminator**
  1. Improve Therminator studies
  2. Studying polarization mechanism in heavy-ion collisions
  3. Include a polarization term in the freeze-out models and Therminator