Performance of Elliptic Flow Studies at NICA/MPD

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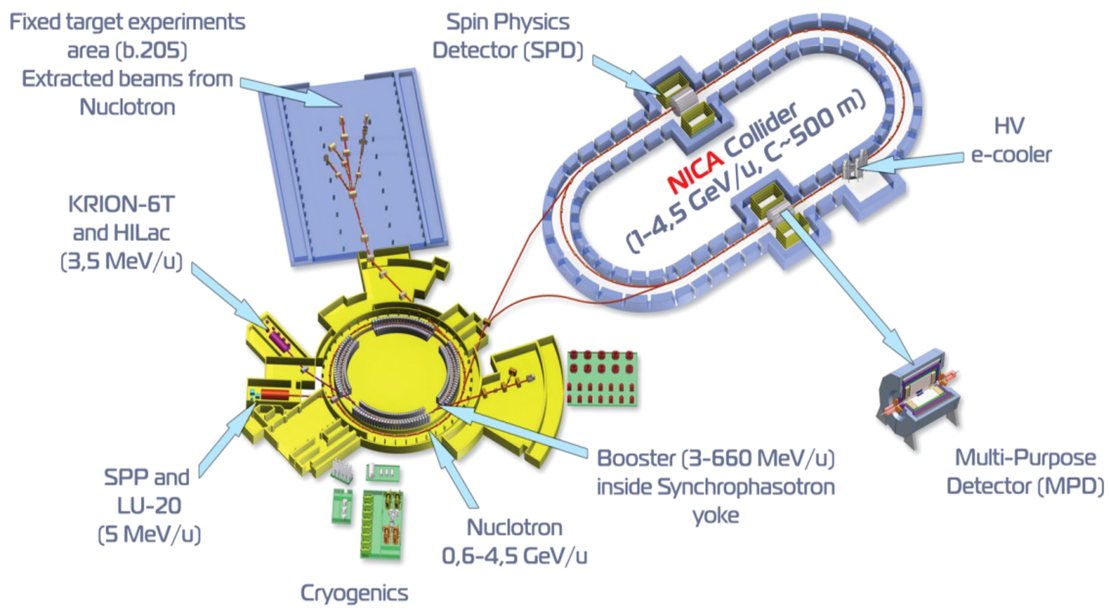
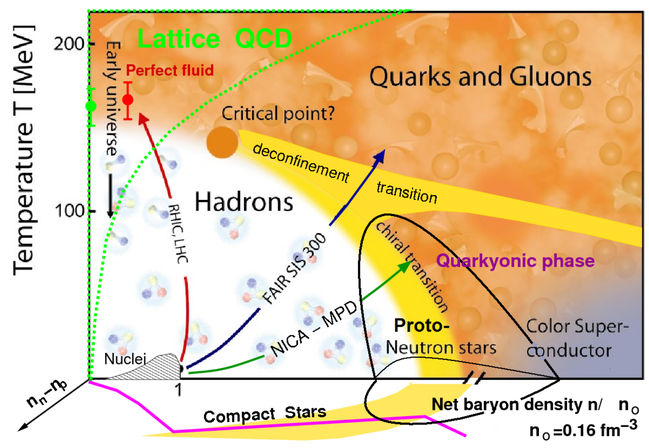
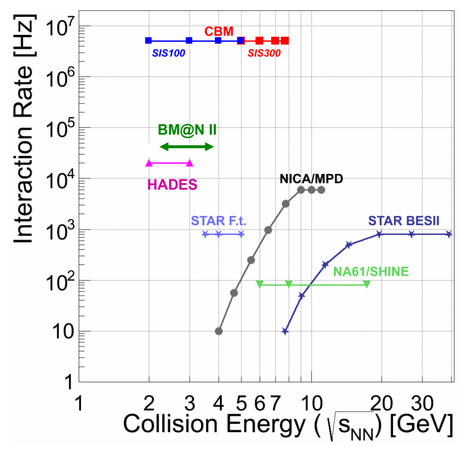
Anisotropic flow presents a unique insight into heavy ion collision physics.
The presented poster reveals the prospects of studying elliptic flow at the NICA/MPD facility through the UrQMD model.
Presented are results on elliptic flow for simulated and reconstructed hadrons at the planned NICA energy range.

Superconducting accelerator complex (Nuclotron based Ion Collider fAcility)







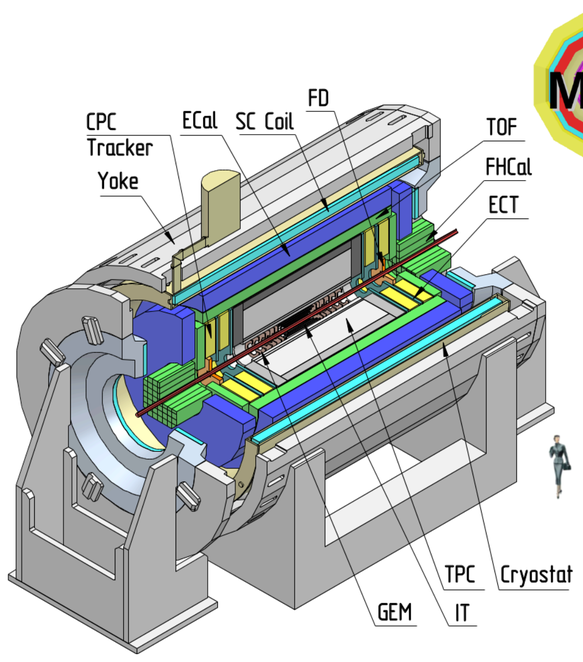
Motivation for NICA/MPD

* Study Hot and Dense Barionic Matter
* Region of Highest Net Barion Density
* Equation of State, Phase Transition
* Multiplicity, Ratios, Critical phenomena, HBT, EM probes, **Collective Flow**, etc...

* pp, pA, AA, AB
* polarized beams
* HIC physics
* Med & Industry

* $\sqrt{s_{AuAu}}$=11 GeV
* $L_{AuAu}=10^{27}\,cm^{-2}s^{-1}$
* $\sqrt{s_{pp}}$=27 GeV
* $L_{AuAu}=10^{32}\,cm^{-2}s^{-1}$

Multi-Purpose Detector



* 1st stage: **TPC**, **TOF**, ECAL, **FHCal**, FFD
* Requirements:
  - up to 7·10³ ev/s with mult. up to 1400
  - large acceptance
  - low material budget
  - precise tracking and identification

Data Set, Simulation & *Analysis*

** Event Generator:*

- UrQMD 3.4 (non-hydro), $Au^{79+}Au^{79+}$, $\sqrt{s_{NN}}$=11 GeV, 8..12 fm, 500k events

** Realistic MPD Simulation*

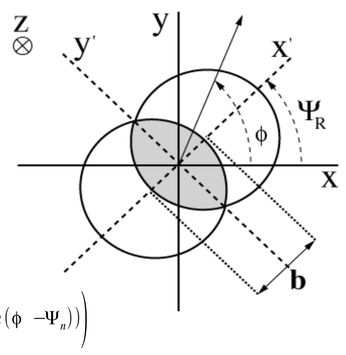
- Geant4 transport,
- Realistic **TPC** Cluster Simulation and Response
- **FHCal** Energy Deposition by channels

** Analysis*

- Track selection TPC_{hits}>30, $|\eta|$<1.5, p_T<2.0 GeV/c
- Realistic Particle Identification by **TPC** and **TOF**
- Realistic Λ Reconstruction
- Realistic Elliptic flow

Anisotropic Flow

* Non-zero impact parameter
* Spatial anisotropy
* Pressure gradient
* Momentum anisotropy

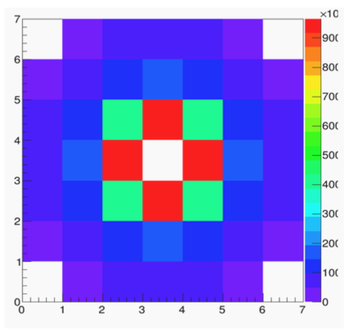


$$E\frac{d^3N}{d^3\boldsymbol{p}}=\frac{dN}{2\pi\, p_T dp_T dy}\left(1+2\sum_{n=1}^{\infty}v_n(p_T,y)\cos(n(\phi-\Psi_n))\right)$$

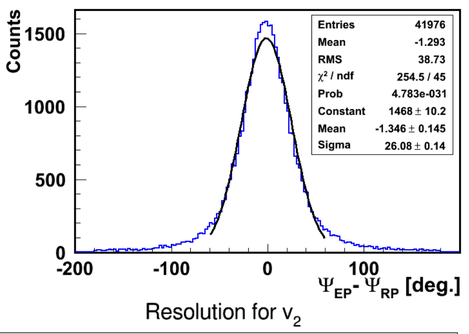
Event-Plane Angle & Resolution

To determine the Differential elliptic flow, the Event-Plane method based on the Forward Hadron Calorimeters were used.
Forward(L) & Backward(R) 2<|η|< 5

Energy deposition in FHCal



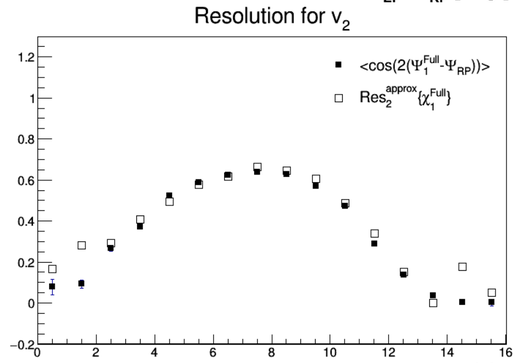
The Difference between True Reaction Plane and Reconstructed Event Plane is less than 30°.



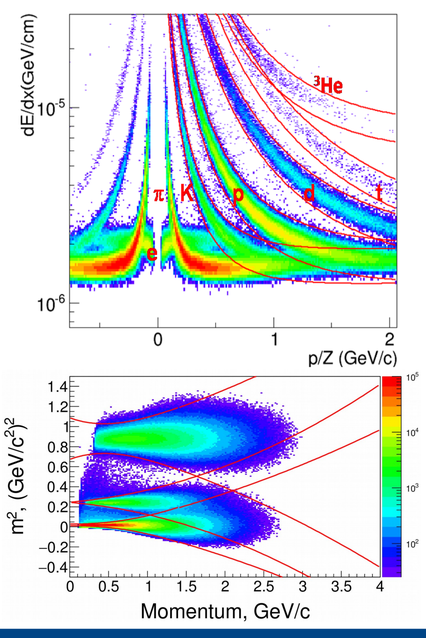
$$Q_x^m=\frac{\sum E_i\cos(m\phi_i)}{\sum E_i}$$
$$Q_y^n=\frac{\sum E_i\sin(m\phi_i)}{\sum E_i}$$
$$\Psi_m^{EP}=\frac{1}{m}Atan2(Q_y^m,Q_x^m)$$

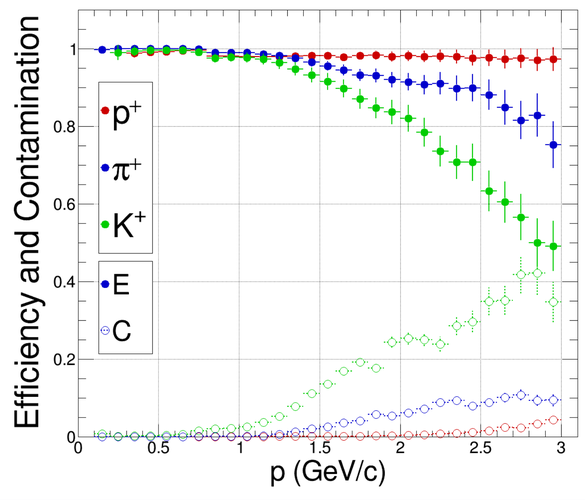
$$Res^2\{\Psi_n^{EP,L},\Psi_n^{EP,R}\}=\langle\cos(n(\Psi_n^{EP,L}-\Psi_n^{EP,R}))\rangle$$
$$v_n=\frac{\langle\cos(n(\varphi-\Psi_n^{EP}))\rangle}{Res\{\Psi_n^{EP}\}}$$

Resolution for v_2

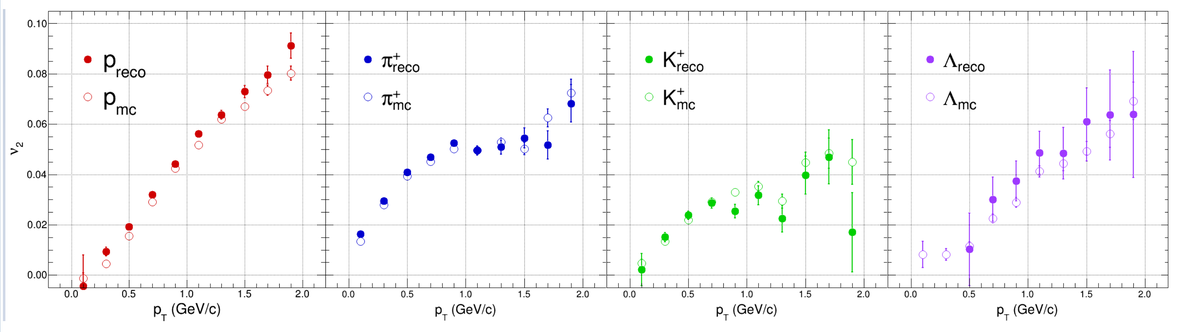


Particle Identification

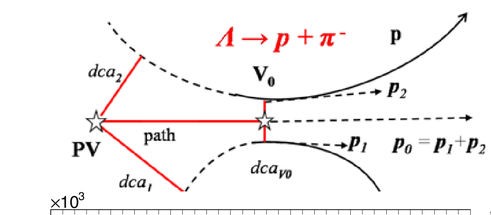




Differential Elliptic Flow

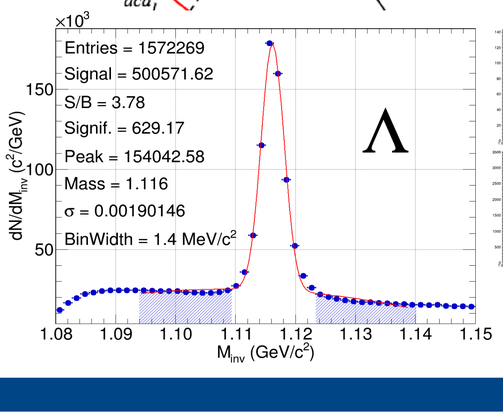


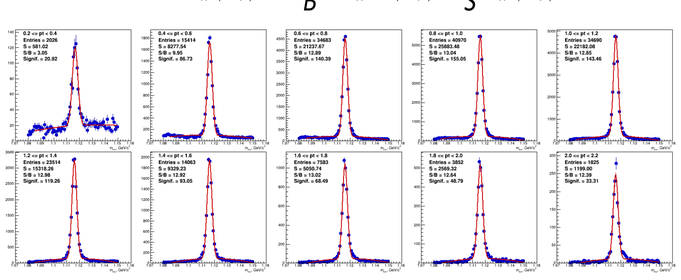
Λ Reconstruction



* Flow in peak and background region
* Background flow subtraction:

$$v_n^S(p_T)=\frac{S+B}{B}v_n^{S+B}(p_T)-\frac{B}{S}v_n^B(p_T)$$





Reconstructed Lambda mass in bins of transverse momentum

Conclusion:

Elliptic flow studies may provide a better understanding of the initial fireball conditions. To assess NICA/MPD capabilities in this regard simulated events were reconstructed and several hadrons were analyzed. Even though the data set is limited, the results are promising and merit further investigation.