Directed end elliptic flow of protons in Xe+CsI at 3.8A GeV

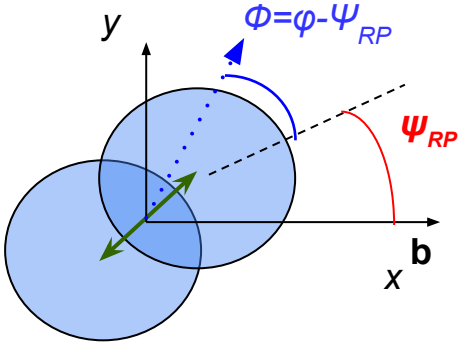
Mikhail Mamaev (JINR, INR RAS, MEPhI)
Arkady Taranenko (MEPhI, JINR)
Peter Parfenov (JINR, MEPhI)
Valerii Troshin(JINR, MEPhI)
Alexandr Demanov (MEPhI)

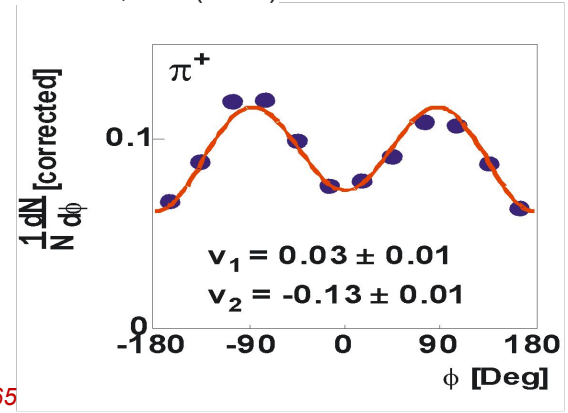
The work has been supported by the Ministry of Science and Higher Education of the Russian Federation, Project "Fundamental and applied research at the NICA (JINR) megascience experimental complex" № FSWU-2025-0014

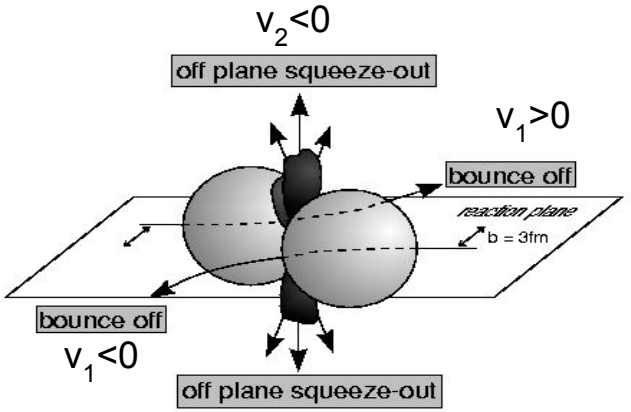
Analysis and Detector Meeting of the BM@N Experiment at NICA
25/02/2026

Azimuthal anisotropic flow 1989-2000

Diogene, M. Demoulins et al., Phys. Lett. B241, 476 (1990)
Plastic Ball, H.H. Gutbrod et al., Phys. Lett. B216, 267 (1989)







S Voloshin, Y. Zhang, Z. Phys. C70,(1996), 665

$$\frac{d^2N}{d\varphi d\Psi_{RP}} = \frac{N}{2\pi}(1 + 2\sum_{n=1}^{\infty} v_n \cos n(\phi - \Psi_{RP}))$$

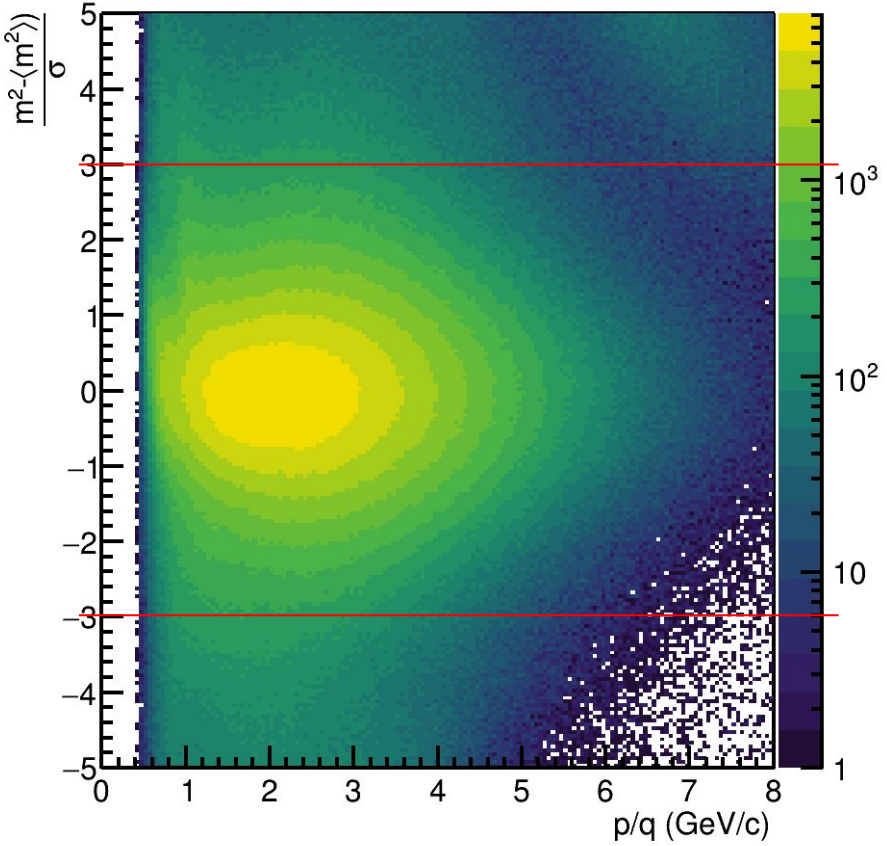
The anisotropy is quantified by decomposing the azimuthal distribution in a Fourier series

$$v_n = \langle \cos n(\phi - \Psi_{RP}) \rangle$$

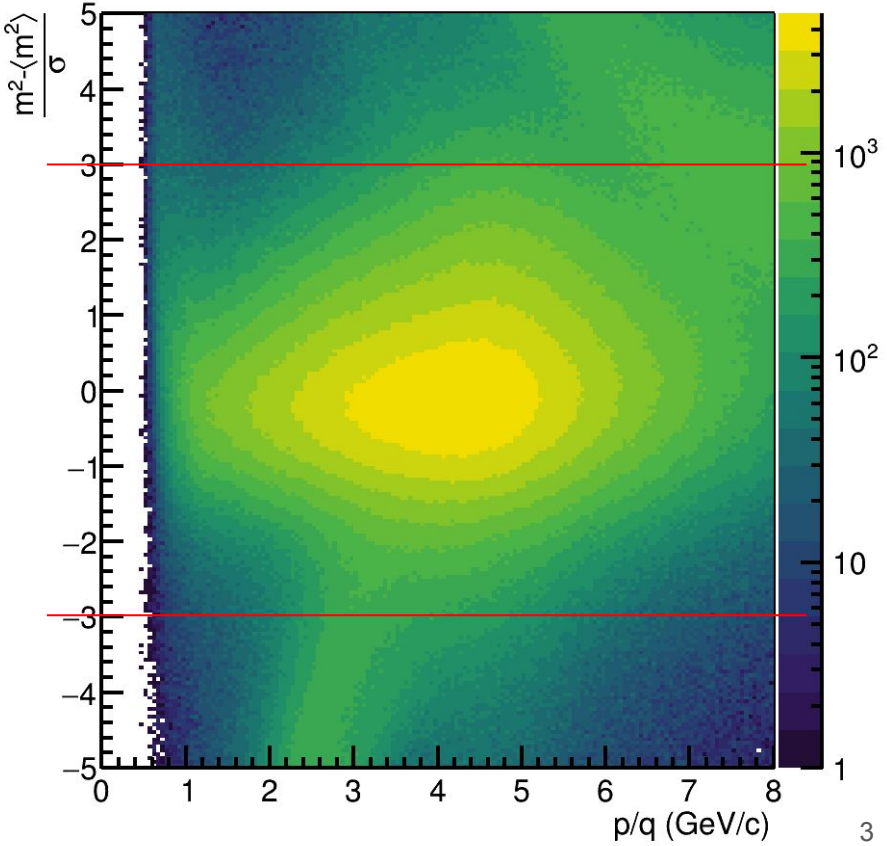
v_1 is directed flow, v_2 — elliptics and v_3 — triangular

Proton N-sigma distributions

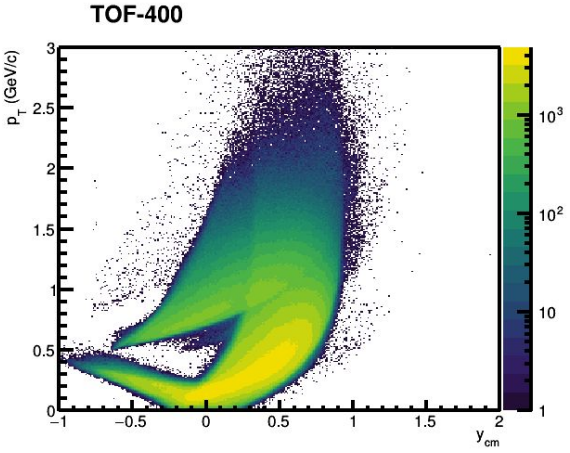
TOF-400

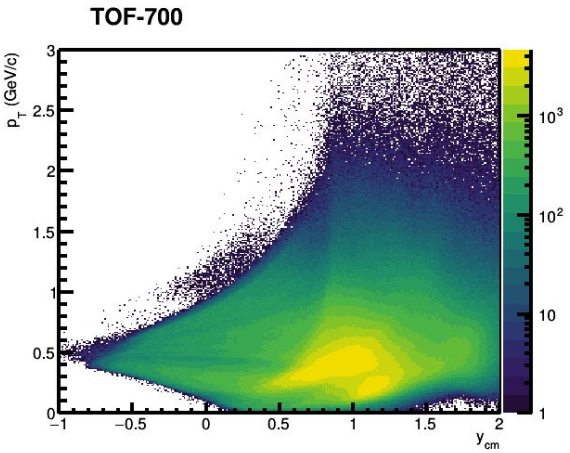


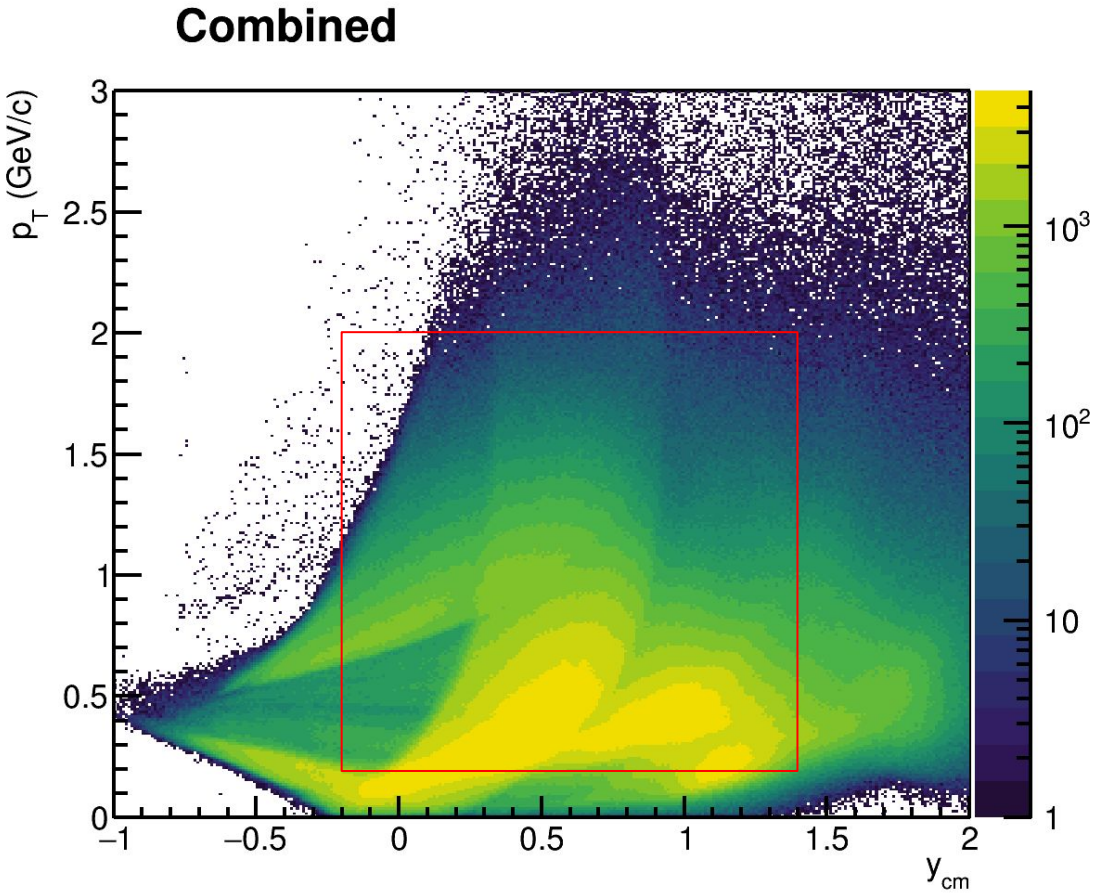
TOF-700



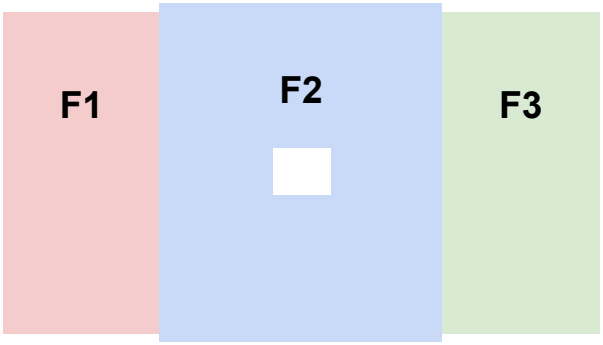
Proton p_T-y acceptance







Elliptic flow observables



$$v_2 = \frac{\langle u_2 Q_1^a Q_1^b \rangle}{R_1^a R_1^b}$$

$$\langle x_2 X_1^a X_1^b \rangle \quad \langle y_2 X_1^a Y_1^b \rangle$$
$$\langle x_2 Y_1^a Y_1^b \rangle \quad \langle y_2 Y_1^a X_1^b \rangle$$

In the case of azimuthal isotropy of detector acceptance and no magnetic field:

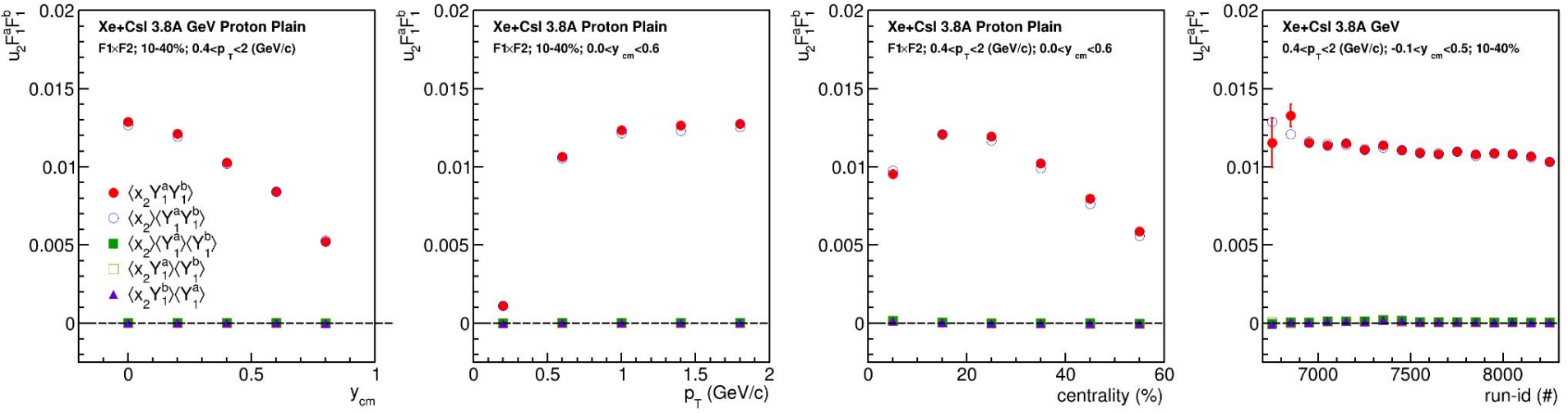
$$\langle x_2 \rangle = 0 \quad \langle Y_1 \rangle = 0$$

$$v_2 = 2\frac{\langle x_2 Y_1^a Y_1^b \rangle}{\langle Y_1^a Y_1^b \rangle}$$

v_2 is the resolution-corrected cumulant of u_2 and two Q_1-vectors

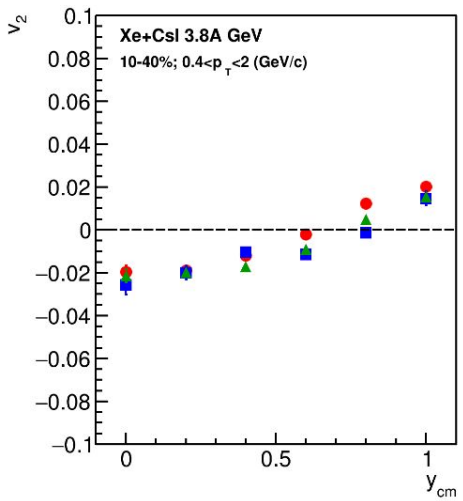
$$v_2 = 2\frac{\langle x_2 Y_1^a Y_1^b \rangle - \langle x_2 \rangle \langle Y_1^a Y_1^b \rangle}{\langle Y_1^a Y_1^b \rangle}$$

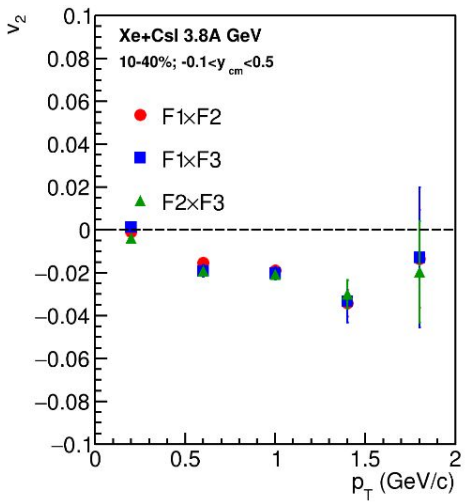
Correlation of proton u_2 with FHCal Q_1

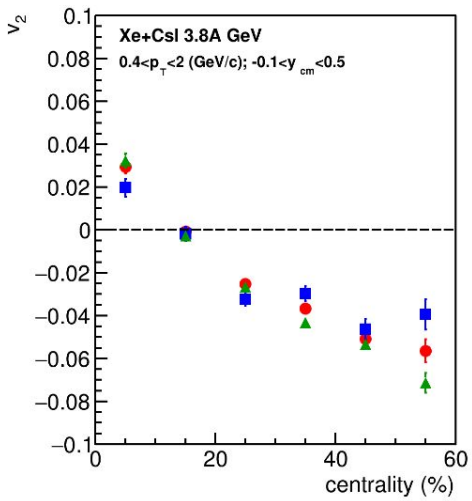


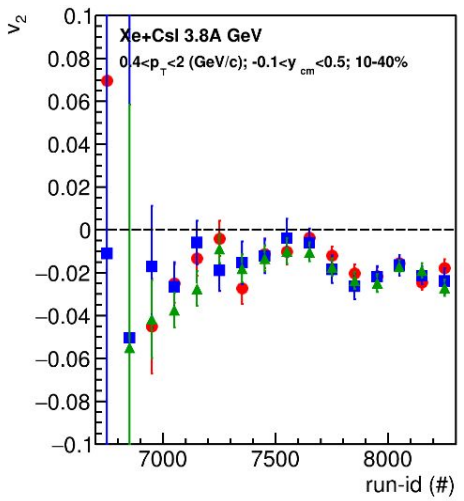
We observe high contribution from detector azimuthal non-uniformity: ellipticity of the acceptance with major axis along x-axis

v_2 as a function of y_{cm}, p_T, centrality and run-id



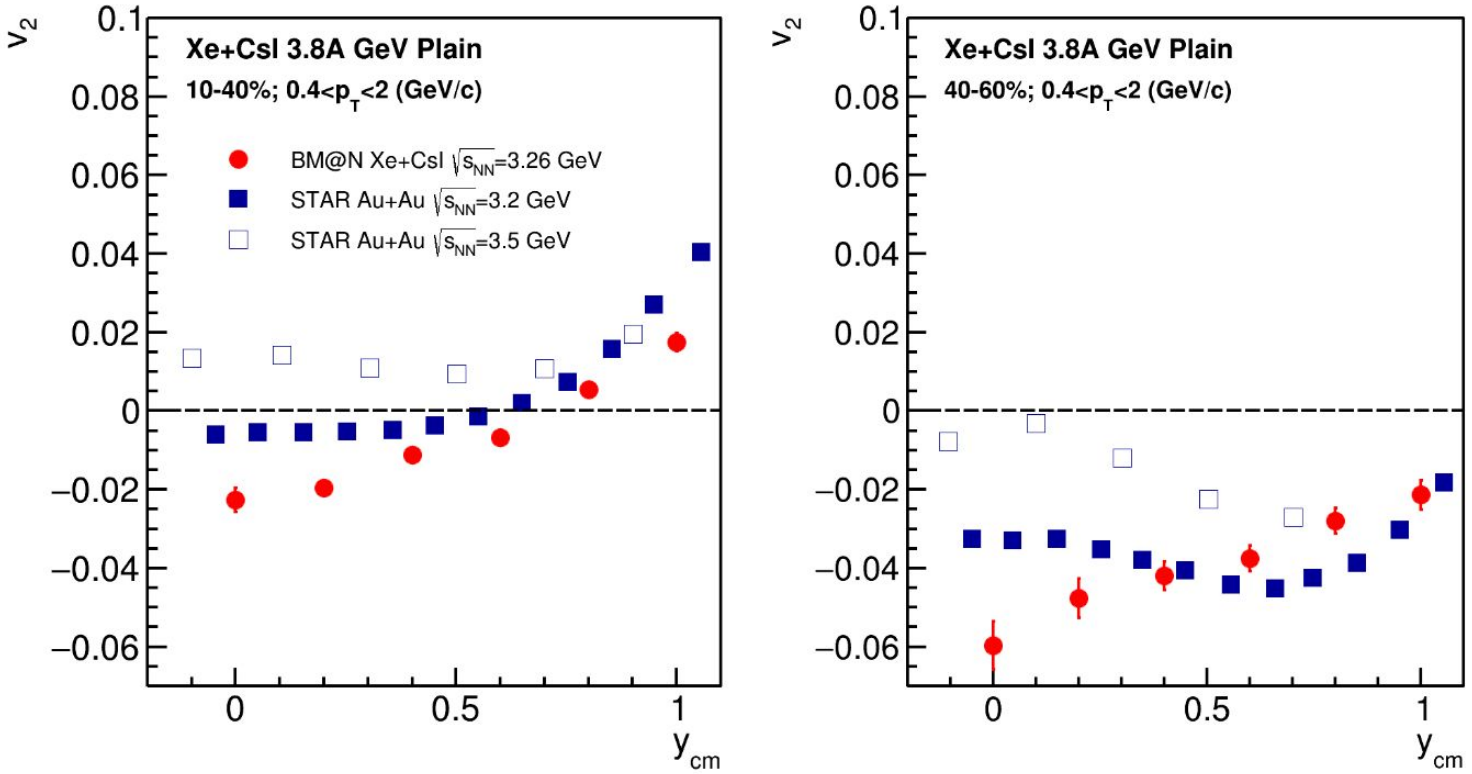






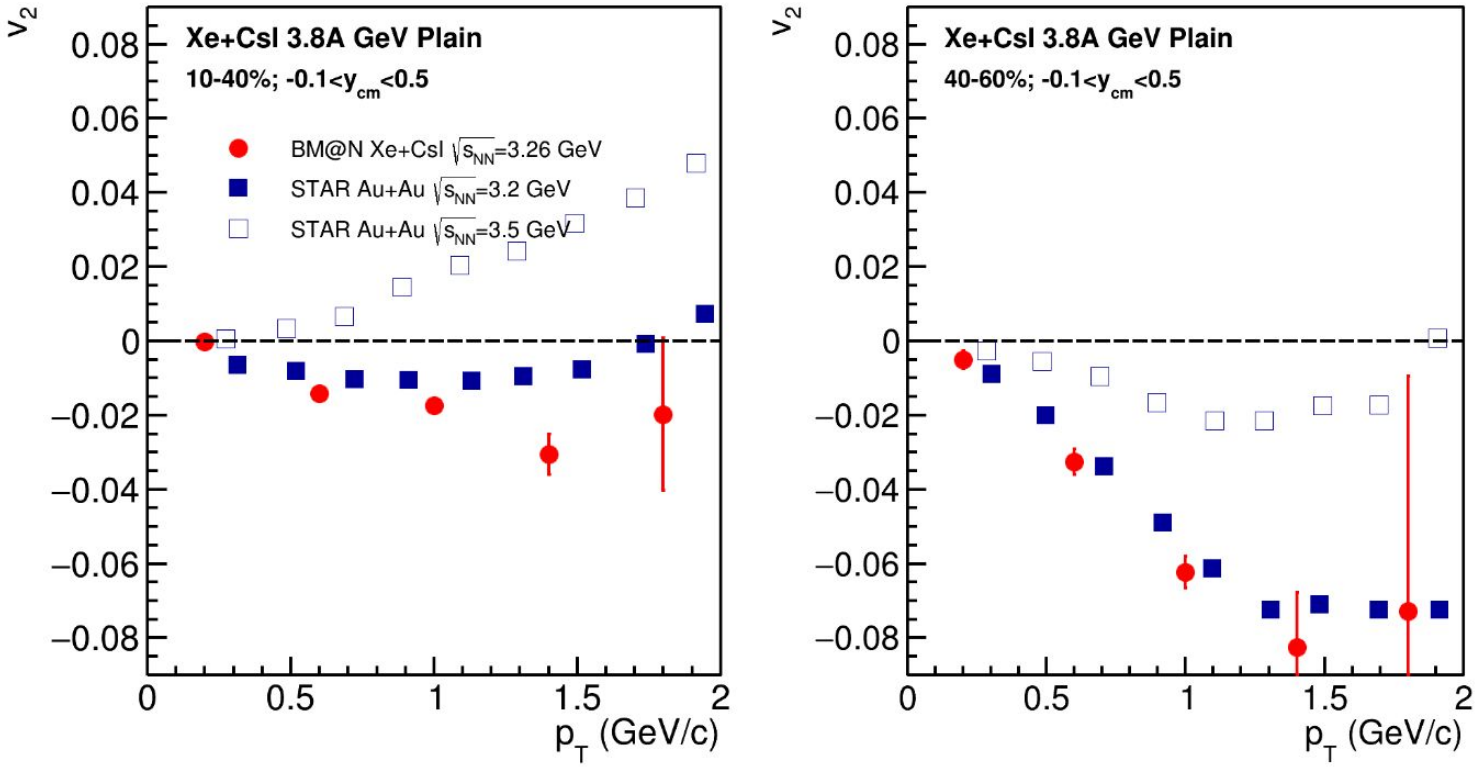
After extracting v_2 we see its dependence on run-id, additional investigations are needed

Comparison with STAR-FXT data: y-dependence



Roughly in agreement with STAR, although additional improvements to the measurement procedure are required

Comparison with STAR-FXT data: p_T-dependence



Roughly in agreement with STAR, although additional improvements to the measurement procedure are required

Preliminary results for proton v_1

Analysis Note

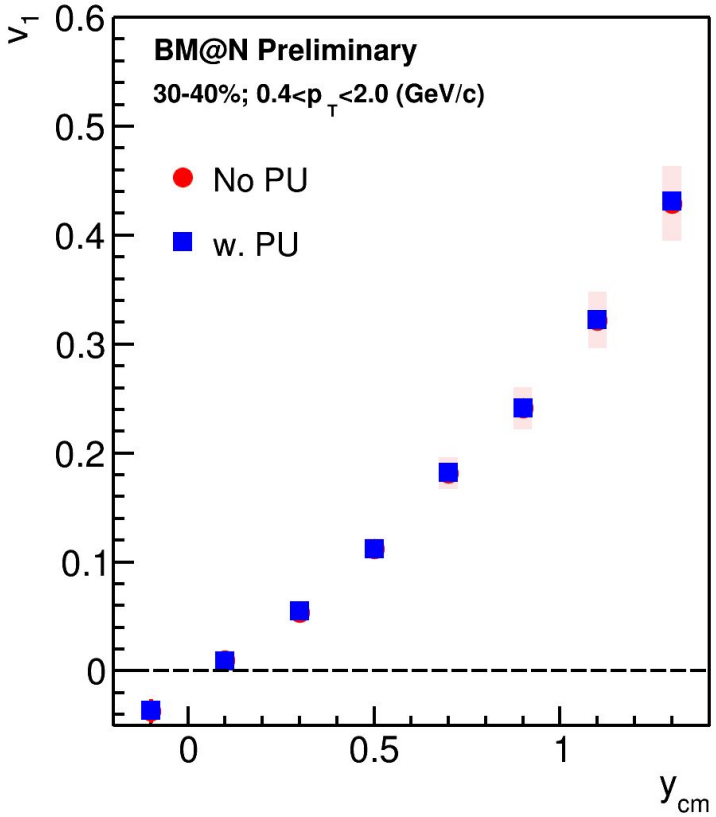
Directed flow v_1 of protons in the Xe+Cs(I) collisions at 3.8 AGeV (BM@N run8)

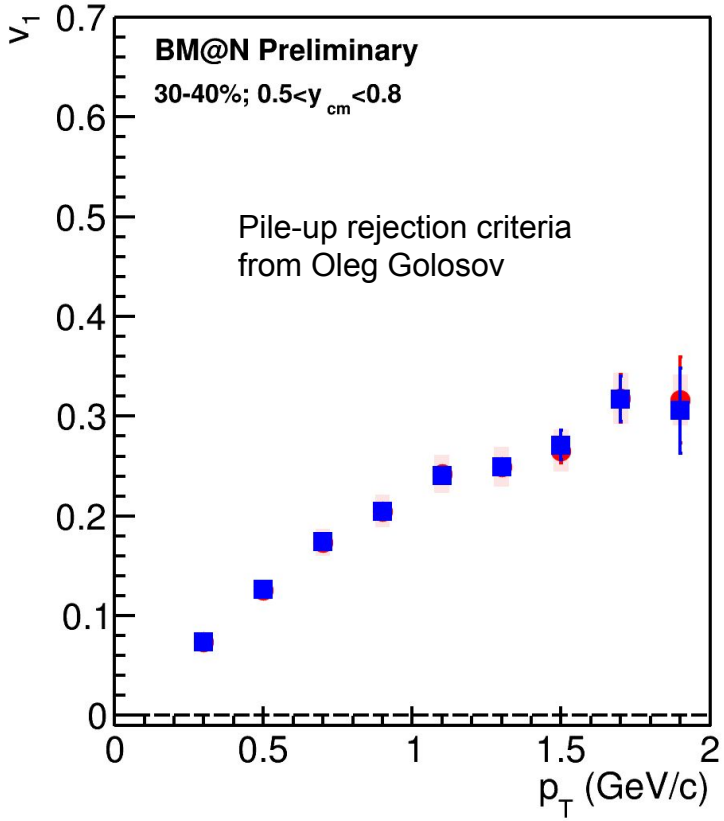
Mikhail Mamamev[1], Arkadiy Taranenko[2], Alexander Demanov, Petr Parfenov, Valery Troshin.
National Research Nuclear University MEPhI, Moscow, Russia
Joint Institute for Nuclear Research, Dubna, Russia
Institute for Nuclear Research of the Russian Academy of Sciences, Moscow, Russia

In this note, we present the directed flow v_1 measurements of protons from Xe+Cs(I) collisions at 3.8 AGeV (BM@N run8). We show the datasets, event and track selection cuts, centrality definition, event plane reconstruction and resolution. The v_1 results are presented as function of transverse momentum (p_T) and rapidity (y_{cm}) for 10-30% central Xe+Cs(I) collisions. The systematic uncertainty study will also be presented and discussed. The v_1 measurements are compared with results of JAM transport model calculations and published data from other experiments.

Analysis note: https://indico.jinr.ru/event/4750/attachments/19780/34163/ANoteFlowRun8.pdf

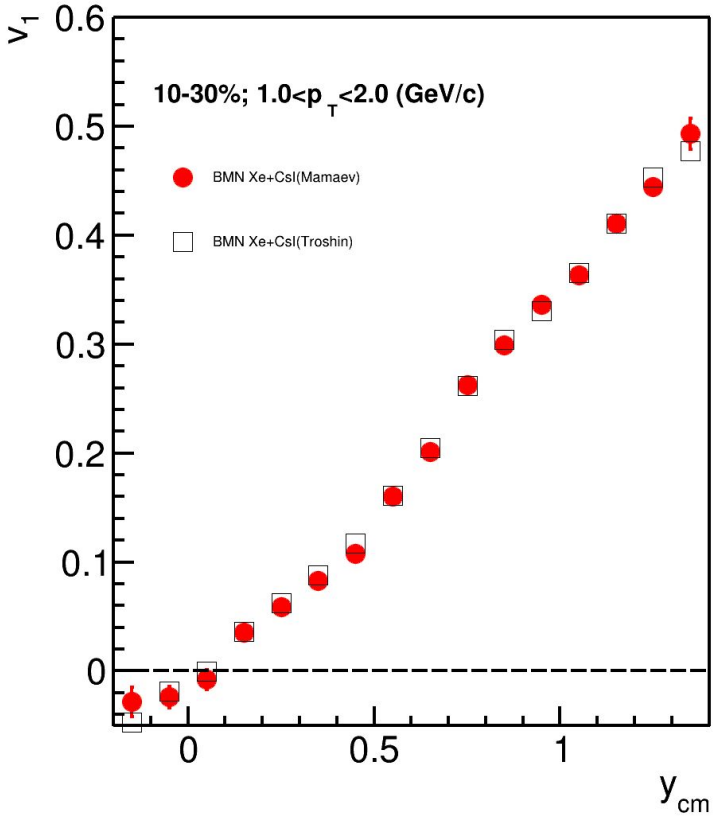
Contribution of the pile-up events to v_1 of protons

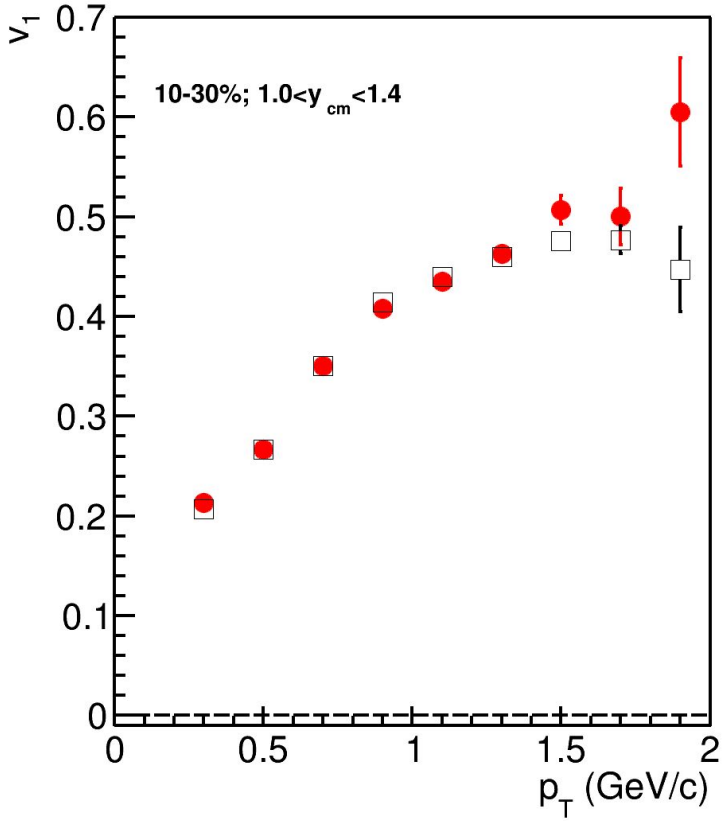




No significant contribution from pile-up was observed

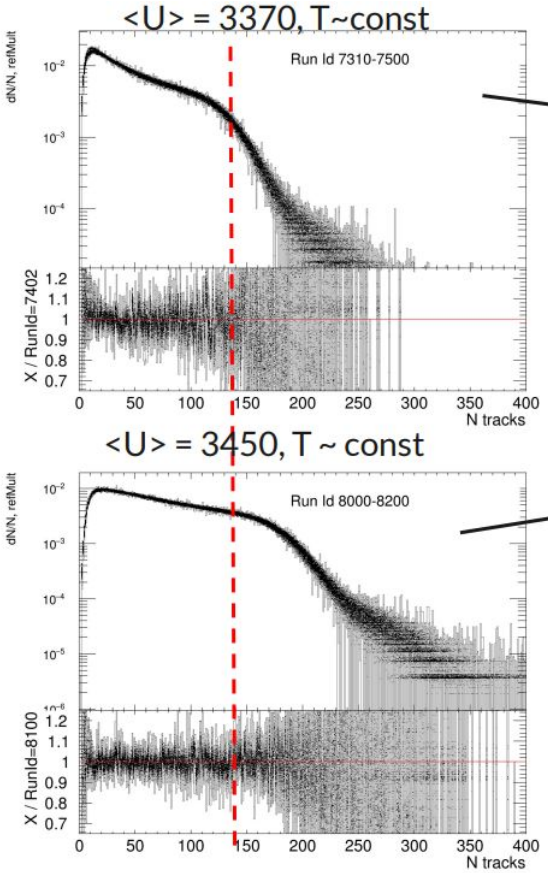
Updates on v_1 of protons



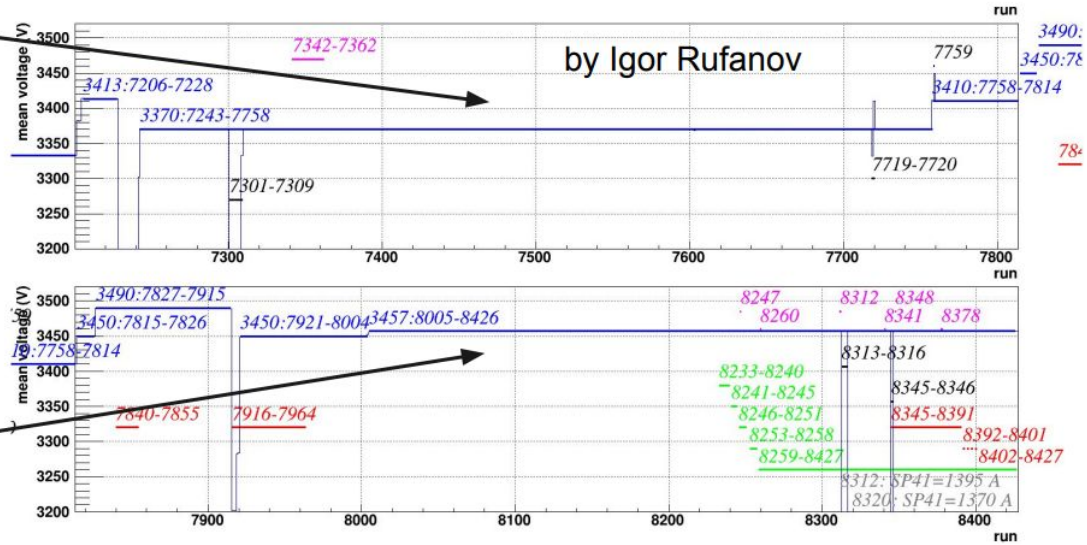


Valery Troshin independently reproduced the preliminary result

Run-ID-dependence of centrality estimation



By A.Demanov



Strong dependence of multiplicity on voltage.
Run-by-run corrections are required!

Run-by-run multiplicity calibration

By A.Demanov

RunId$_{ref}$: 8120-8170

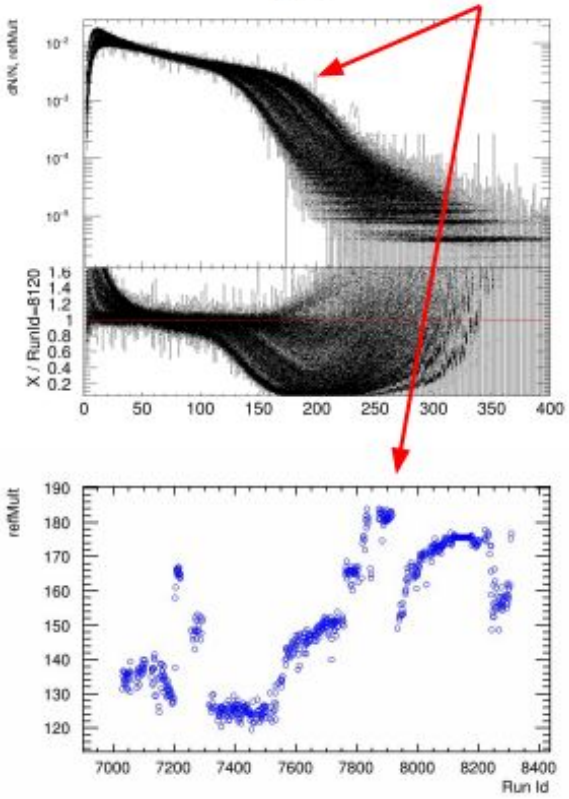
Extract the high-end point of refMult distribution in each RunId via fitting the refMult tail by the function:

f(refMult) = A*Erf(-σ*(refMult-h)) + A

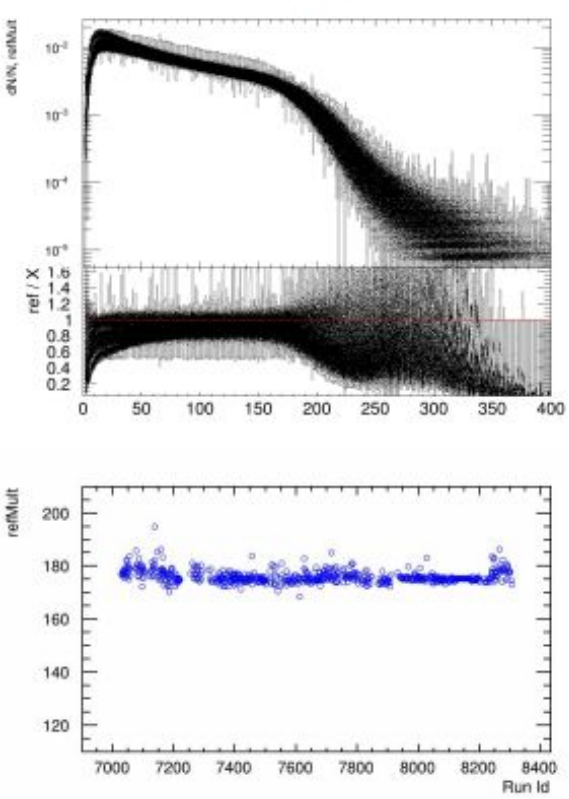
refMult can then be corrected by:

refMultCorr = refMult * h$_{ref}$ / h(RunId)

Def

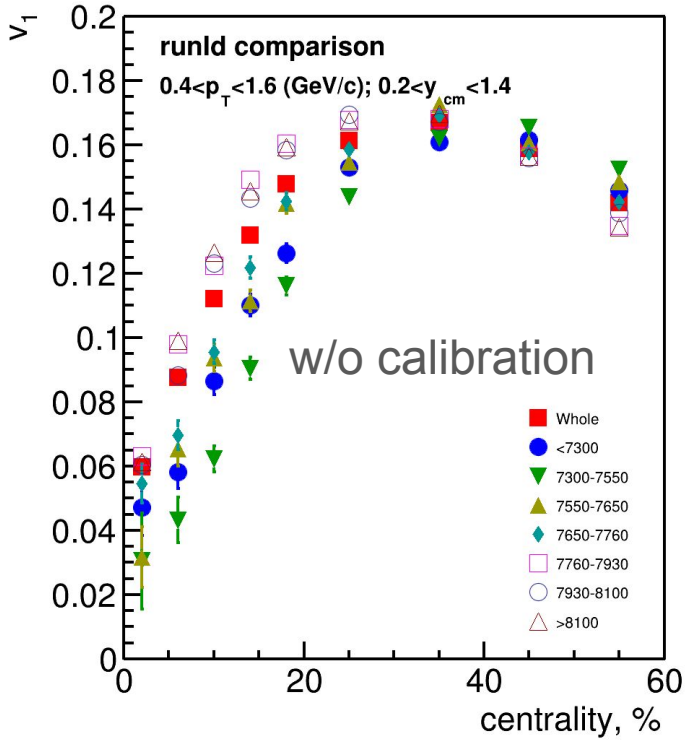


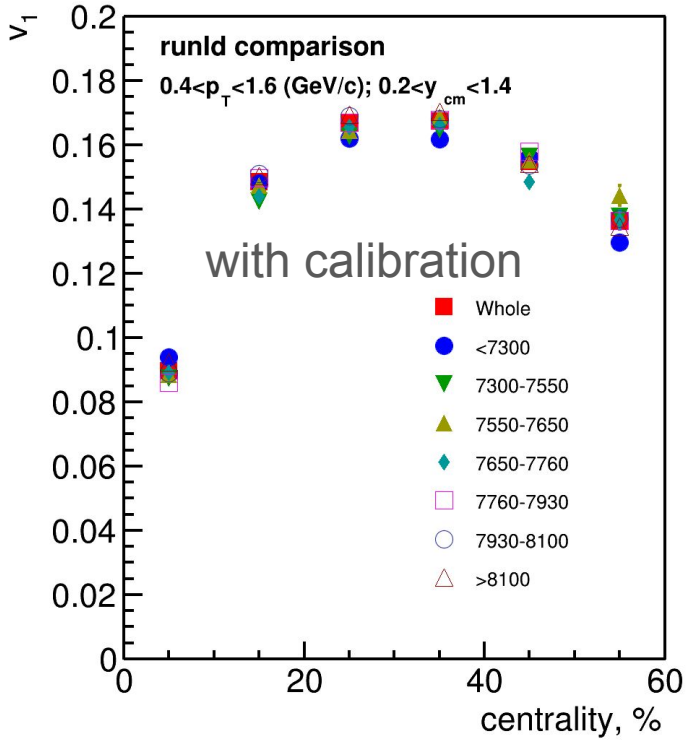
After shift



v_1 vs centrality for different RunId groups: 5 bins

A.Demanov
V.Troshin





Large run-by-run variation of multiplicity leads to different ranges for the same centrality -> different v_1

Outlook and summary

- Elliptic flow is measured in Xe+CsI collisions at 3.8A GeV
- Run-id dependence is observed, additional investigation is needed
- Rough agreement with STAR-FXT data
- No significant difference between preliminary results and new pile-up rejection is observed
- Preliminary result for v_1 of protons is independently reproduced by V.Troshin
- Centrality estimation procedure is being refined.

Backup

Proton v_2 vs deuteron v_2

