

Space-dynamic correlations in quasi-two-particles $\pi+Xe \rightarrow \pi+n$ interactions at GeV energy region

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We report the results of investigation of correlation between the rapidity, transverse momentum and impact parameter (IP) of pions, η^0 -mesons and protons produced in quasi-two-particles $\pi+Xe$ interactions at 2.34. The aim of this investigation is to clear up whether and to what extend one can determine this way an interval of IP where the reaction have taken place. The work has been performed by means of the JAM code.

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1. INTRODUCTION

It is commonly known that the impact parameter (IP) is a very important quality determining the initial interaction geometry of hadron-nucleus interactions. Of special interest is also to study this way the possibility of localization of available nontrivial intranuclear ingredients. But directly measured are momenta and energies of identified secondary particles only. So, the question arises whether and to what extent one can estimate the interval of IPs at which a specific reaction channel occurred. In the first place important are quasi-two-particles interactions which can be regarded as simplest probes for such investigations (for example, [1, 2]). To clear up this problem it is appropriate to analyze the correlation between some constructions of the measured features and IP using reliably established modeling codes.

Earlier [3] we investigated the correlation between multiplicity, rapidity and IP of charged pions, protons and neutrons produced in π +Xe interactions at intermediate energies by means of JAM modeling code and found that there exists some meaningful correlation between IP and both the average multiplicity and average rapidity of produced particles and it is possible in principle to infer more than simply qualitatively about the initial interaction geometry on the basis of available observables.

In the present work we study the correlation between the rapidity, transverse momentum and impact parameter of pions, η^0 -mesons and protons produced in quasi-two-particles π +Xe interactions at 2.34 GeV in order to clarify the possibility of plausible estimation of IP interval where these reactions occur. The work has been performed using the JAM simulation code.

2. RESULTS

Below we describe the results of simulation by using of JAM code of rapidity (η), transverse momentum (\mathbf{p}_T) and impact parameter (\mathbf{b}) distributions of pions, η^0 -mesons and protons emitted in quasi-two-particles channels of π +Xe interactions at 2.34 GeV/c. Nevertheless, as any real detector has an energy threshold of particle's registration we have taken into account that among the investigated produced particles may also appear other not registered particles: protons with energy less than 21 MeV, charged pions of energy less than 5 MeV and neutrons. Such a background is marked in brackets.

2.1. REACTION $\pi^+ + \text{Xe} \rightarrow \pi^0 + p + (n/p/\pi^\pm) + A$ at 2.34 GeV/c

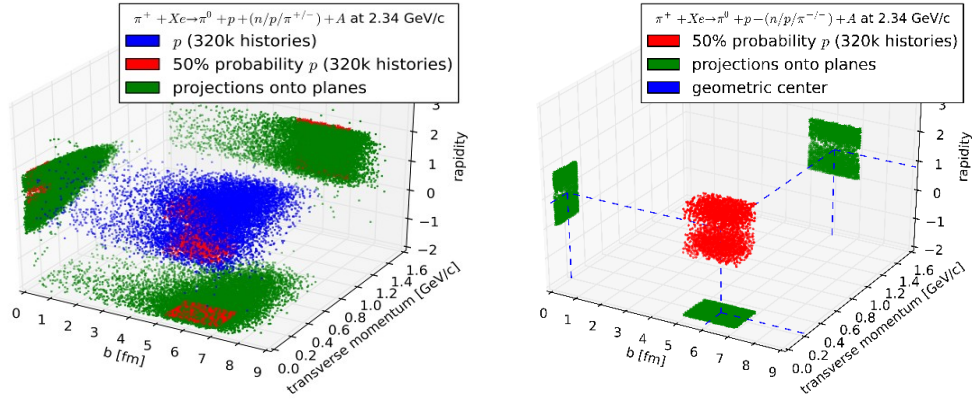


Fig.1 (left) shows the 3D (η - p_T - b) distribution of all protons above 21 MeV emitted in the reaction. But if one single out 50% of protons symmetrically concentrated around the maximum value of their p_T distribution and similarly around a maximum value of their η distribution only then the 3D (η - p_T - b) distribution for these protons appear as in Fig.1 (right). Therefore, one can simply notice then one half of the most probable protons emerging from the $\pi^+ + \text{Xe} \rightarrow \pi^0 + p + (n/p/\pi^\pm) + A$ at 2.34 GeV/c reaction under investigation were emitted from a cylinder like nuclear volume with axis at $b \approx 6$ fm and radius equal to ~ 1 fm.

The results of analogues as above analysis but with regard to neutral pions from the reaction $\pi^+ + \text{Xe} \rightarrow \pi^0 + p + (n/p/\pi^\pm) + A$ at 2.34 GeV/c are showed in Fig.2. It is worth to notice that the location of a source of these pions and its dimension coincide satisfactorily with the source of accompanying protons.

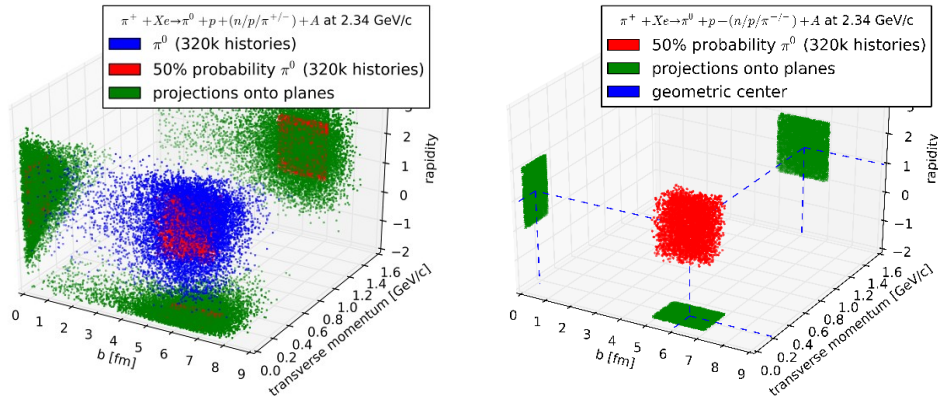


Fig.2. Same as Fig.1. but for neutral pions.

2.2. REACTION $\pi^+ + \text{Xe} \rightarrow \eta^0 + p + (n/p/\pi^\pm) + A$ at 2.34 GeV/c

Similar investigation as in the case of $\pi^+ + \text{Xe} \rightarrow \pi^0 + p + (n/p/\pi^\pm) + A$ at 2.34 GeV/c has been performed with respect to the reaction $\pi^+ + \text{Xe}$ where instead of neutral pions observed are η^0 mesons. The results are demonstrated in Figs. 3 and 4.

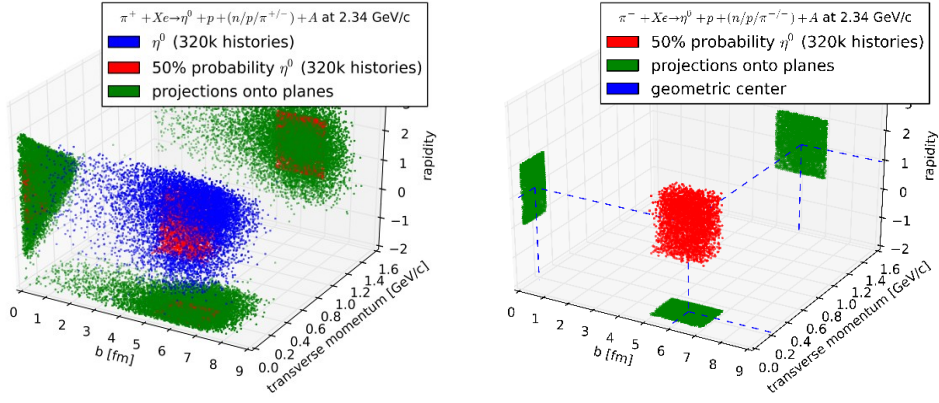


Fig.3. Same as Fig.1 but for η^0 mesons from $\pi^+ + \text{Xe} \rightarrow \eta^0 + p + (n/p/\pi^{\pm}) + A$ at 2.34 GeV/c reaction.

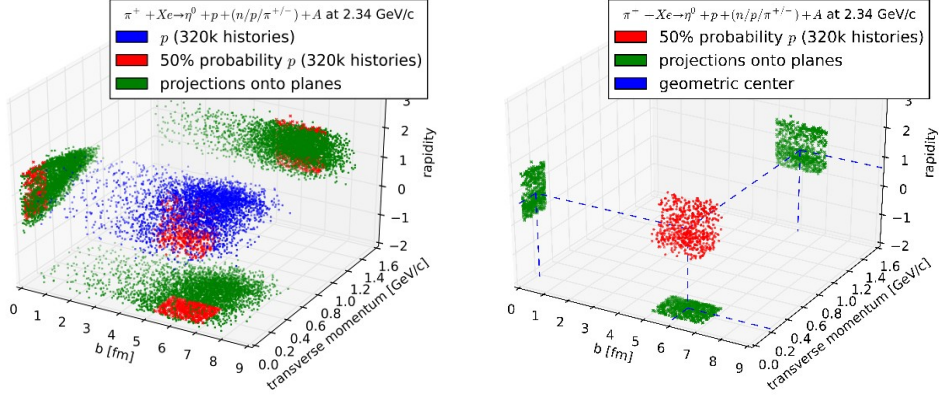


Fig.4. Same as Fig.3 but for protons.

The calculated energy spectra of neutrons produced in different experimental channels both by electrons of 200 MeV, 600 MeV and 1000 MeV and protons of 200 MeV, 600 MeV and 1000 MeV energy are depicted in Fig.2.

3. SUMMARY AND CONCLUSION

We have investigated the correlation between the rapidity (η), transverse momentum (\mathbf{p}_T) and impact parameter (\mathbf{b}) of pions, η^0 -mesons and protons produced in quasi-two-particles $\pi^+ + \text{Xe}$ interactions at 2.34 in order to clear up whether and to what extend one can determine this way an interval of impact parameters where the reaction have taken place when measured are momenta and energies of these particles only. The work has been performed by means of modeling with the help of the JAM code.

One can conclude that it is possible to estimate an intranuclear location of these quasi-two-particles channels of the investigated reactions at least for $\sim 50\%$ of emitted particles concentrated symmetrically around their \mathbf{p}_T and η distributions. Then the obtained result for the relevant impact parameters is $\mathbf{b} \approx 6 \pm 1$ fm. Moreover, similar investigation has as well been done with respect to the two-particle channels of the $\pi^+ + \text{Xe}$ interactions at 3.5 GeV/c leading to

quite coinciding conclusions. Our results may also be useful for the investigation of nontrivial intranuclear ingredients searching by means of quasi-two-particles channels as a probe.

References

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