Feasibility study for πN TDAs with PANDA in the reaction $\bar{p}p \to J/\psi\pi^0$

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Transition Distribution Amplitudes (TDAs) are parametrizations of the hadronic matrix elements that occur in the perturbative Quantum Chromodynamics calculations of a certain family of reactions within framework of collinear factorization. This framework has had significant success in the analysis of Deeply Virtual Compton Scatterings where Generalized Parton Distributions are the relevant confinement related hadronic matrix elements. There has been interest within the theoretical community to replicate the success to other families of reactions, in particular backward Virtual Compton Scattering, backward meson electroproduction, and more recently, forward and backward meson production with an associated e^+e^- or J/ψ in $\bar{p}p$ annihilation. The universality of the TDAs for these reactions and the validity of the factorization approach have not been proven yet, but constitute a promising avenue for current and future experiments to extend our understanding of the reaction mechanisms. The measurement of a variety of reactions with as wide a kinematic coverage as possible is a crucial ingredient for the validation of the approach in these reactions.

The PANDA experiment under construction at the future FAIR facility will be ideally suited to access these observables, in particular the pion-to-nucleon TDAs (πN TDAs) which can be used to learn about the pion cloud contribution in the nucleon wave function. The wide kinematic coverage of the PANDA detector will be crucial in testing the predictions of the momentum transfer dependence of the cross section. It is in this context that we propose a complete feasibility study of the measurement of one of the reactions covered by the TDA models $\bar{p}p \to J/\psi\pi^0$, with the J/ψ decaying in the e^+e^- channel. We report the results from full simulation of all the relevant background contributions, including $\bar{p}p$ annihilation into $\pi^+\pi^-\pi^0$, $\pi^+\pi^-\pi^0\pi^0$, $\pi^+\pi^-\pi^+\pi^-\pi^0$, $J/\psi\pi^0\pi^0$, and show that other potential background sources have negligible contributions. We use a combination of existing data and established hadronic generators to fix the cross section and angular distributions. We demonstrate that this reaction is readily measurable by PANDA and provide estimates for the counting rates and signal to background. In addition, we give expected uncertainties on differential cross section measurements and the extraction of the angular distribution of the J/ψ decay electrons, which can both be used to test the validity and universality of TDAs.