Contribution ID: **24** Type: **not specified**

Studies of Two-Pion Production and Time-like Electromagnetic Structure of Baryons in Pion-Induced Reactions

Wednesday, 19 October 2022 14:30 (30 minutes)

The High Acceptance Di-Electron Spectrometer (HADES) [1], installed at GSI Helmholtzzentrum in Darmstadt, was designed for spectroscopy of positron-electron pairs with excellent purity and mass resolution. The experimental program of HADES focuses on two main goals: (I) measurements of dielectron emission of a compressed baryonic matter formed in 1-2 AGeV heavy-ion collisions and investigate in-medium hadron properties, and (ii) studies of dielectrons production in elementary proton–proton (pp) and pion–proton (pp) collisions. The latter one provides a crucial baseline to understand in-medium effects in hot and dense baryonic matter.

The elementary collisions, especially those with pion beams, offer a great opportunity to study baryon resonance Dalitz decays (R $\rightarrow$ Ne+e−) and role of the vector mesons $\rho/\omega/\varphi$ in the corresponding time-like electromagnetic transition form factors (eTFF). In order to separate contributions 0f various resonances a systematic energy scan and high precision data are needed.

In 2014 a large dataset of π^--p scattering have been obtained at the four pion beam momenta 0.656, 0.69, 0.748 and 0.8 GeV/c [2]. For the first time, combined analysis of hadronic and dielectron final states have been performed, using polyethylene and carbon targets. Two-pion channels have been included into the multichannel Partial Wave Analysis (PWA) developed by the Bonn-Gatchina group [3]. As a result cross sections for $\Delta\pi$, Nσ, Nρ isobar contributions have been obtained. Very crucial for the dilepton studies was the extraction of resonance Dalitz decay followed by investigation of spin density matrix elements (the helicity structure of baryon eTFF).

In this talk, a set of differential cross-section distributions of the two-pion final states ($\pi^+\pi^-$ and $\pi^-\pi^0$) in a function of invariant masses, di-pion emission angle, helicity and Gottfried-Jackson angles will be presented and compared to the PWA solutions [2]. The special attention will be paid to the role of ρ-N coupling for N*(1520) and N*(1535) and extraction of the mass dependence of the effective time-like eTFF. The eTFF will be compared to various versions of the Vector Dominance Model [4] and to quark-constituent model calculations [5].

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Session Classification: Parallel 1

Track Classification: Baryon resonances in experiments with hadron beams and in the e+e- collisions