Abstract (draft)

This proposal is aimed to extend the experimental program *"A Search for Excited Nucleons and Hybrid Baryons at Masses $M \geq 1.8$ GeV with CLAS12 in Hall B"* [1] to the measurement of the exclusive $\pi^+ n$, $\pi^0 p$, ηp, $K^+\Lambda$, $K^+\Sigma^0$, and $\pi^+\pi^- p$ electroproduction channels off the proton with electron beam of energies E_{beam} = 6.6 GeV and E_{beam} = 8.8 GeV in a range of photon virtualities Q^2 from 0.05 GeV^2 to 2.0 GeV^2 and at invariant masses of the final hadron system W from thresholds up to 3.0 GeV utilizing the CLAS12 detector system and the Forward Tagger in Hall B. This extension will provide access to the electrocouplings of nucleon resonances excited in the virtual photon/proton s-channel at the still almost unexplored photon virtualities from 0.05 GeV^2 to 0.2 GeV^2. In the Q^2-range from 0.2 GeV^2 to 1.0 GeV^2 we will overlap with the 11-GeV beam energy data and rely on them above 1.0 GeV^2. This proposal substantially enhances our capabilities to:

- search for new baryon states with the glue as a constituent component, the so-called hybrid baryons, by extending the measurements towards small photon virtualities where the expected magnitudes of the hybrid-baryon electroexcitation amplitudes are maximal;

- search for three-quark "missing" resonances at low photon virtualities in the electroproduction of different final hadron states with the highest fluxes of virtual photons ever achieved in exclusive meson electroproduction experiments;

- study the structure of prominent nucleon resonances in the mass range up to 3 GeV in the regime of large meson-baryon cloud contributions and explore the N^* longitudinal electroexcitation approaching the photon point.

The πN and ηp final states will be measured in topologies where the scattered electron and one of the two final state hadrons are detected, while the four-momentum of the second hadron will be reconstructed employing energy-momentum conservation. In the KY channels the electroproduced K^+ and the p from the hyperon decay will be measured. For the $\pi^+\pi^- p$ channel the observables will be obtained from the combination of all possible event topologies where the scattered electron and all final hadrons are detected, as well as when only two of three final state hadrons are detected, with the four-momentum of the third

hadron reconstructed from energy-momentum conservation. The unpolarized differential cross sections will be obtained for the aforementioned exclusive channels and complemented by measurement of the differential transverse-transverse and transverse-longitudinal interference cross sections. In the KY channels, the angular dependencies of the differential cross sections will be augmented by data on the induced and transferred polarizations for the recoiling hyperons, while for $\pi^+\pi^-p$ exclusive electroproduction, nine independent one-fold differential cross sections will extracted in each bin of W and Q^2.

From these data the $\gamma_v pN^*$ electrocouplings will be determined employing the analysis tools described in Refs. [1, 2], which will be further developed to reproduce the observables from CLAS12 for $Q^2 < 0.2$ GeV^2. The results at different values of Q^2 from the different exclusive channels will substantially enhance our capability for the discovery of new baryon states. Consistent results on resonance masses, $\gamma_v pN^*$ electrocouplings for all exclusive decay channels under study, and Q^2-independent partial hadronic decay widths, over the full covered Q^2-range, will offer convincing evidence for the existence of new states. The hybrid baryons will be identified as additional states in the N^*-spectrum beyond the regular three-quark states as was predicted in recent LQCD studies of the baryon spectrum [3] that demonstrated the emergence of hybrid baryons from the QCD-Lagrangian. Since spin-parities of hybrid baryons are expected to be the same as those for regular three-quark states, information on the $\gamma_v pN^*$ electrocoupling evolution with Q^2 becomes critical in the search for hybrid baryons. The distinctively different Q^2-evolution of the hybrid-baryon electrocouplings is expected considering the different color-multiplet assignments for the quark-core in a regular versus a hybrid baryon, i.e. a color singlet and octet, respectively. Low photon virtualities offer a preferential regime for the studies of hybrid-baryon electrocouplings. Moreover, this kinematic range corresponds to the biggest contributions from the meson-baryon cloud, allowing us to considerably improve the knowledge on this component, which is relevant for the structure of all N^* states studied so far [2], as well as to explore the longitudinal N^* electroexcitation as the photon virtuality goes to zero.

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[1] A. D'Angelo *et al.*, *"A Search for Excited Nucleons and Hybrid Baryons at Masses $M >$ 1.8 GeV with CLAS12 in Hall B"*. A Proposal to the CLAS collaboration for review as part of the Run

Group A Science Program at E_{beam}=11 GeV.

[2] I.G. Aznauryan *et al.*, Int. J. Mod. Phys. E**22**, 1330015 (2013).

[3] J. J. Dudek and R. G. Edwards, Phys. Rev. D**85**, 054016 (2012).