The observation of neutrino oscillations has given a new insight into the properties of these fundamental particles and, according to many theorists, opens the door on physics beyond the Standard Model. This phenomenon is also connected to many fundamental open problems such as matter-antimatter asymmetry in the universe (CP violating phase in neutrino oscillations). Studies of neutrino oscillations have entered the era of precise measurements, so they require better understanding of systematic effects among which one the most significant ones are neutrino cross sections uncertainties.

The goal of this project is to study pion production in several channels of the neutrino interactions in T2K - the world's leading accelerator neutrino experiment. The reactions which will be studied constitute significant backgrounds to neutrino oscillation measurements and will give an insight into important problems in understanding neutrino scattering. The following research tasks will be completed within this project:
1. Developing event selections for charged current (CC) neutrino interactions on lead.
2. Improving the event selection for the neutrino induced charged current neutral pion (π^0) production on carbon.
3. Development of the event selection for neutral current (NC) neutrino reactions on carbon with π^0 production.
4. Testing event selections and improving the reconstruction algorithms based on the results of the evaluation.
5. Estimating systematic errors of event selections.

The T2K's near detector (ND280) aims at investigating neutrino cross sections to reduce systematic errors in neutrino oscillation analyses. The ND280 detector consists of the several components and gives the unique opportunity to measure cross sections on various nuclear targets.
The main goal of the project is to develop cuts for selecting the samples of neutrino induced charged current and neutral current pion production (CC1π and NC1π) on lead and carbon. The samples will be used in the cross sections calculations. In the process of selection of neutrino events the multivariate analyses will be used.

The results of this project will provide more information on the nature of pion production in neutrino interactions and will significantly contribute to understanding of the systematic errors in T2K. This will ultimately lead to more precise estimate of the CP violating phase.
Project will also provide a set of algorithms, applications and scripts that will be incorporated into the T2K experiment's software and might be incorporated into multi-experiment tools.