The main theme of this project is study of central exclusive particle production in proton-proton collisions, $p + p \rightarrow p + X + p$. *Central production* means that state X is well separated from protons scattered under very small angles, which define „forward" region. *Exclusive production* means that in the experiment all particles forming state X are detected. Elastic scattering $p + p \rightarrow p + p$ can be described by the exchange of the object which mediate interaction. It can be photon in case of electromagnetic interaction or object called Pomeron in case of strong force. Strong force is short-range interaction therefore Pomeron can not be interpreted as single mass-less gluon. In the simplest form it can be gluon pair. Production of additional particles in the central region can be described as a process where both protons independently emit intermediate objects which in the fusion process form central state X. Effectively central exclusive production of state X can be described as fusion process: $\gamma+\gamma \rightarrow X$, γ+Pomeron $\rightarrow X$ or Pomeron+Pomeron $\rightarrow X$. Proton may also emits intermediate meson π and dissociates into leading baryon (neutron or Δ) significantly increasing possible combinations of primary interacting objects. Pomeron and pion, being strongly interacting, dominates in proton-proton scattering except processes with very low four-momentum transfer between primary and scattered protons where γ-exchange dominates.

In e^+e^- colliders, e.g. LEP, Pomerons(pions) are absent and only $\gamma\gamma$ fusions are relevant. In *ep* collisions at HERA accelerator γPomeron(pion) process also occurs. In *pp* collisions all three types of processes occur supplemented by possible change of the Pomeron by pion, but PomeronPomeron fusion dominates except where it is forbidden. Thus exclusive lepton-pair productions requires $\gamma\gamma$ fusion, and while it was a large part of the program at e^+e^- colliders it was only observed in *pp* colliders for the first time in 2007($X = e^+e^-$) and 2009($X = \mu^+\mu^-$). Exclusive vector meson production ($X = \rho, \omega, \phi, J/\Psi, \Upsilon$) is forbidden in $\gamma\gamma$ and PomeronPomeron, and was a large part of the HERA program, but was only seen in *pp* collisions in 2009. Processes with leading neutron were observed in lepton-hadron and hadron-hadron colliders but only in inclusive mode.

Now in the era of large hadron collider, LHC, in proton-proton scattering with center of mass energy of 13 TeV, central exclusive reactions enter a whole new regime of high central masses, in addition to low mass states to be studied with greater precision. The reach $\gamma\gamma$ collisions extends to W^+W^-, γPomeron to Z-bosons, and PomeronPomeron to high transverse momenta jets (a narrow cone of hadrons) and eventually Higgs bosons ($p + p \rightarrow p + H + p$ with no other particle produced).

This project focuses on two distinct processes: Pomeron-Pomeron fusion into low-mass state (mainly light meson pairs or resonanses) and photon-photon fusion into intermediate bosons $WW/ZZ/WZ$. Common for both processes is measurement of forward proton in the dedicated detectors located very close to the LHC beam. Measurement of scattered protons allows full reconstruction of the event. In Pomeron-Pomeron fusion region studies are directed to search for exotic resonances as glueballs, bound states of gluons with no constituent quarks. An existence proof and characterization of these compound objects offer unique insight into the strong interaction since the mass-less gluon self-interaction is exclusively responsible for the mass of glueballs. Study of exclusive production of low mass states will deliver important information which will help to understand exclusive production of massive or more complicated states as jets, W/Z or Higgs bosons. In photon-photon fusion studies are directed to search for exclusive intermediate bosons pair production. This process is a golden channel to test Standard Model and search fot new physics beyond Standard Model.