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 intermidiate objects which in the fusion process form central state X. Effectively central exclusive production of state X can be described as fusion process: $\gamma + \gamma \rightarrow X$, $\gamma +$ Pomeron $\rightarrow X$ or Pomeron + Pomeron $\rightarrow X$. Pomeron, 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 are absent and only $\gamma\gamma$ fusions are relevant. In ep collisions at HERA accelerator γPomeron (photoproduction) process also occurs. In pp collisions all three processes occur, 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.

Now in the era of large hadron collider, LHC, in proton-proton scattering with center of mass energy of 7 TeV, 8 TeV and achieved 13 TeV in 2015, 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 low-mass region $\approx 1 - 3$ GeV. In this region studies were 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. The aim of this project is to analyze data collected in 2015 in LHC in special low pile-up runs, with protons detected in ALFA detector in ATLAS experiment and to upgrade AFP detector allowing to collect data with much higher luminosity. Many exclusive channels and high statistics could lead to firm conclusions on the glueball sector.

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. Planned measurements can be used to tune phenomenological models of particle production in „forward" region. These models play important role not only in accelerator domain but also in the interpretation of experiments which measure cosmic ray interaction with Earth's atmosphere.