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QCD with LHC p-p and e-p Collisions

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Recent results of quantum chromodynamics (QCD) studies using proton-proton collision data at the CERN Large Hadron Collider (LHC), as well as future prospects with a proton-electron collider project, the Large Hadron Electron Collider (LHeC), are presented. After the discovery of the Higgs boson, main physics subjects of the LHC are detailed studies of the Higgs properties and extensive exploration of new physics beyond the Standard Model at the energy frontier. The LHC is now in a shutdown period for the upgrade and will restart in 2015 first with the center-of-mass energy of 13TeV and the energy will reach 14TeV later on. The luminosity will also significantly increase with time. At a hadron collider, strong interaction takes critical roles. Therefore, comprehensive studies on QCD with theoretical and experimental aspects are essential in order to suppress the systematic uncertainties on the signal and background processes and improve the sensitivities to the new physics at the LHC. Measurements of the cross-sections and kinematics provide important tests of QCD predictions and modeling including higher order perturbative QCD calculations, proton structure encapsulated in parton distribution functions (PDFs) and parton shower and fragmentation processes. Various event topologies, such as productions of jets, electroweak bosons, heavy quarks and combination of these, have been investigated at the LHC to widely test the validity of QCD application. Among them, as an example, W production in association with charm quarks is sensitive to the PDF of strange quarks. In addition, the LHeC project proposes another approach to the QCD studies by a proton-electron collider, i.e. high resolution microscope, with a factor 4 higher center-of-mass energy with respect to the HERA collider, using a 7TeV proton beam at the LHC with a new 60GeV electron beam. Varieties of subjects are expected with the LHeC such as precise measurements of the PDF, distribution of partons at low-x and strong coupling constant. These measurements will enhance physics capability at the LHC and therefore they are highly complementary. Capability of electroweak measurements and forward physics at the LHeC will be also presented.