The STAR detector upgrades for the BES II and beyond physics program

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The Beam Energy Scan program (BES) at the Relativistic Heavy Ion Collider (RHIC) is dedicated to exploring the Quantum Chromodynamics (QCD) phase diagram and search for the critical point of the QCD phase transition. The results from the BES phase I program show hints of a first-order phase transition in the QCD phase diagram and the turn-off of the characteristic signatures of the quark gluon plasma at low collision energies, $\sqrt{s_{NN}} < 20$ GeV. Three upgrades of the STAR detector, the Event Plane Detector, the inner Time Projection Chamber, and the endcap Time Of Flight, provide an unique opportunity to further investigate the nature of the QCD phase diagram during the BES phase II program (BES II), which covers the $\sqrt{s_{NN}}$ from 7.7 to 19.6 GeV in collider mode and from 3 to 7.7 GeV in fixed-target mode.

Beyond the BES II, the STAR Collaboration plans to design, construct, and install a suite of new detectors in the forward rapidity region ($2.5 < \eta < 4$) over the next two years, enabling a program of novel measurements in pp, pA and AA collisions. This extension of STAR's kinematic reach will allow detailed study of cold QCD physics at both very high and very low partonic momentum fraction. The new subdetectors to be installed comprise a Forward Calorimeter System, with electromagnetic and hadronic calorimetry. As well as a Forward Tracking System, which consists of 3 layers of silicon mini-strip detectors and 4 layers of small-strip Thin Gap Chambers.

In this presentation, the detailed description on the detector upgrades of the STAR detector for the BES II and beyond, their performance, as well as the future physics opportunities, will be given.