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New Instrumentation for Future High Precision Proton and Deuteron Radius Experiments

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Recent results of from high precision measurements of deuteron rms charge radius using spectroscopy of muonic deuterium show ~7σ discrepancy with the previously world-average CODATA values and ~3.5σ smaller than with ordinary deuterium spectroscopy, adding a new "*deuteron charge radius puzzle*" to the extensively discussed "*proton charge radius puzzle*" in the nuclear physics community. We propose to conduct two high precision electron scattering cross section experiments on windowless hydrogen (PRad-II) and deuterium (DRad) targets to extract proton and deuteron charge radius at very low scattering angles. Both experiments will use an upgraded version of the experimental setup of the previous proton charge radius experiment (PRad) successfully conducted at JLab in 2016. In the present talk, after a brief introduction to the physics motivation of DRad and PRad-II experiments, we will present the PRad-II and DRad experimental setup with a focus on the new instrumentation. We will discuss the addition of a second tracking layer, based on the state-of-the-art Micro Pattern Gaseous Detector (MPGD) technologies in addition to the existing PRad GEM layer in order to improve vertex reconstruction of the scattered electrons. We will also introduce the new idea of silicon-based cylindrical proton recoil detector inside the target cell for the control of the inelastic electro-disintegration background process in the DRad experiment and for tagging the recoil proton to cleanly identify very forward angle ep events in the PRad-II case. Finally, we will describe the small angle calorimeter installed downstream to the main setup to achieve the very low Q^2 values required by the two experiments.