

1 Prospects of exploring nucleon and nucleus structures in
2 hadronic collisions with the STAR experiment in 2022
3 and beyond

4 STAR Collaboration

5 The exploration of the fundamental structures of nucleon and nucleus has always thrived
6 on the complementarity of lepton scattering and purely hadronic probes. With the Electron
7 Ion Collider (EIC) on the horizon, it becomes more urgent than ever to complete key mea-
8 surements in this regard with high precision in hadronic $p+p$ and $p+Au$ collisions during the
9 final years of RHIC running. When combined with future data from the EIC, these measure-
10 ments will be essential to establish the validity and limits of factorization and universality.

11 To carry out these measurements, the STAR collaboration is planning to collect data from
12 transversely polarized $p+p$ collisions at $\sqrt{s} = 510$ GeV in 2022 and transversely polarized
13 $p+p$ and $p+Au$ collisions at $\sqrt{s_{NN}} = 200$ GeV in 2024. A full suite of forward detectors will be
14 installed at STAR prior to the $p+p$ run in 2022, providing excellent charged-particle tracking
15 at high pseudorapidity ($2.5 < \eta < 4$) for the first time, coupled with both electromagnetic
16 and hadronic calorimetry. In addition, detector upgrades realized for the Beam Energy
17 Scan II program further extend and improve STAR's tracking and particle identification
18 capabilities beyond those existed for previous $p+p$ and $p+Au$ runs. By exploiting these
19 new capabilities, STAR will determine fundamental proton properties such as the Sivers and
20 transversity distributions over nearly the entire range of $0.005 < x < 0.5$. We will also probe
21 fundamental properties of heavy nuclei including non-linear low- x gluon dynamics, nuclear
22 PDFs, nuclear fragmentation functions, and spin-dependent hadronization.

23 In this talk, we will outline prospects for key measurements envisioned to be carried out
24 in 2022 and 2024, as well as briefly reporting on the progress of the STAR forward upgrade
25 preparations.