## II. WORKING GROUP 1: MULTIQUARK STATES

### A. Physics Motivation

(1/2pg)

### B. Processes accessible at EIC

(1 pg)
Processes (with order of magnitude estimates for cross sections?):

- Virtual photon, real photon, polarization measurements to have more probes to the internal structure and quantum numbers of exotic candidates

- Processes for hidden-flavor pentaquarks: $\gamma p \to P_c \to J/\psi p, \Lambda_c \bar{D}$, $\gamma p \to P_b \to \Upsilon p, \Lambda_b \bar{B}$

- Processes for the $XYZ$ states: $\gamma p \to (X, Y, Z)N \to NJ/\psi$+pions. It should be better to study the $\gamma p \to Z_c + N$ process with high $W$ values rather than in the near-threshold region.

  The leading order NRQCD estimate for the inclusive production of the $X(3872)$ at $\sqrt{s} = 100$ GeV: $\mathcal{B}(X(3872) \to J/\psi\pi^+\pi^-)\,\sigma(X(3872), Q^2 > 1\text{ GeV}) \approx 2.6$ pb, which amounts to $\mathcal{O}(2000)$ events per day with a luminosity of $10^{34}\text{cm}^{-2}s^{-1}$.

  The COMPASS $\tilde{X}(3860)$ with quantum numbers $1^{+-}$ decaying into the $J/\psi\pi^+\pi^-$. If the quantum numbers are correct, then it should be closely related to all the puzzling $X$ states around 3.9 GeV, and can also decay into $J/\psi\eta$ in an $S$-wave.

  $XYZ$ above 3.9 GeV and bottomonium analogues of the $XYZ$ states.

- As a factory of heavy baryons: $\gamma p \to \mathcal{B}_c \bar{D}$, $\gamma p \to \mathcal{B}_b \bar{B}$, where $\mathcal{B}_Q$ is used to denote a heavy baryon.

- Production of the doubly-heavy hadrons. Theoretical estimates of the production rate of doubly heavy baryons exist: $\mathcal{O}(10^7)$ events/year for $\Xi_{cc}$ and $\mathcal{O}(10^5)$ events/year for $\Xi_{bc}$ with a luminosity of $10^{34}\text{cm}^{-2}s^{-1}$.

### C. Connections and complementarity with other experiments

(1/2 pg)
Comparisons with GlueX, COMPASS, and HERA:

- kinematics – photon energy and $q^2$ ranges
- luminosities
- comparison of rates for $J/\psi$ production (as a benchmark)

Comparison with LHCb:

- Source of $XYZ$ states at LHCb are mainly from $B$ decays, which limits the mass range up to around $m_B - m_K \approx 4.8$ GeV.
- Different kinematics, useful to disentangle triangle singularities from resonances.

### D. Requirements and implication for the experimental setup

(beam, detector, ...) (1/2 pg)
General requirements:

- $4\pi$ coverage detector for angular analyses
- ability to reconstruct lower-momentum tracks (e.g. for $\psi(2S) \to \pi^+\pi^- J/\psi$)
- photon energy resolution (e.g. for $\chi_{cJ} \to \gamma J/\psi$)
- reconstruction of many-particle final states (e.g. for $\eta_c \to 6\pi$, etc.)

Define a list of benchmark reactions for efficiency, resolution, and particle-ID studies:

- $\gamma p \to (J/\psi, \psi(2S), \chi_{cJ}, \eta_c) + (n\pi, nK) + p$