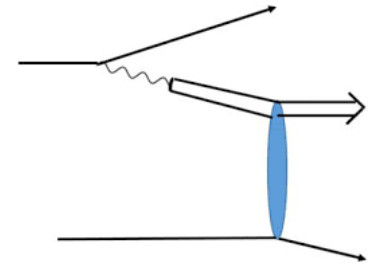# Exclusive and Tagging Group:
# Golden Channels

## Daria, Sal and Spencer

ATHENA Bi-weekly meeting
July 8th, 2021

- Golden Channels
- Monte Carlo Comparisons

# Golden channels – goals & questions

- A mixture of reactions to challenge different parts of the detector
- Many of our channels factorize into 'central' & far-forward parts
  - The latter are mostly from nuclear breakup
  - Backward/u-channel production is the exception
- Spectroscopy (e. g. XYZ states) is included in our charge
- Far-forward detector design and resolution at low t will be largely similar between the detector proposals, so we should focus on channels which challenge the central detector.
  - Coherent light ions are mostly limited by far-forward detectors. Should this be a key (partial) channel for the ATHENA proposal?
- We need channels for which MC generators exist
  - For many channels, we have multiple MC generator, but we do not know how well they agree with each other?
- Should all golden channels be at the top beam energy?
  - Backward production is probably better at lower energies

# Golden Channel List

- Incoherent DVCS on deuteron + $\pi^0$ + BH (central $\gamma$ or $\gamma\gamma$ + p + n)
- TCS (central $e^+e^-$)
  - more challenging than J/$\psi$ photoproduction channel
- $\Phi$ in ep (central $K^+K^-$ + intact/dissociated ion)
- $\Upsilon$ in eA ($e^+e^-$ or $\mu^+\mu^-$)
  - Show that we can see first (or 2nd or 3rd) minimum
    - 2nd or 3rd minimum is needed to avoid windowing artifacts in the Fourier transform to F(b)
    - Could do this with other mesons instead (or also)
  - Need decent mass resolution to separate 3 $\Upsilon$ states
- Other possible channels
  - Backward/u-channel production of $\omega$ -> $\pi^0\gamma$
    - A challenge for forward calorimetry
  - $Z_c^+$->J/$\psi$ $\pi^+$
    - $\sigma$ largest at threshold -> forward focused. Or look at X->J/$\psi$ $\pi^+\pi^-$

# Some key plots

- Acceptance in rapidity for $e^+e^-$ pairs
  - This maps into Bjorken-x

- $\Phi$->$K^+K^-$ acceptance vs. $p_T/Q^2$ and rapidity/Bjorken x

- $d\sigma/dt$ for coherent production, showing our ability to resolve the 2$^{nd}$ and 3$^{rd}$ diffractive minima

- Plot (TBD) showing low $Q^2$ tagging capability

- Acceptance vs. photon energy and Mandelstaam-u for backward production

- Acceptance vs. photon energy for spectroscopy channel

# Generators

- 4 vector meson generators with partially overlapping final states
  - SARTRE, BEAGLE and eSTARlight, lager
- Do they agree with each other?  Do they agree with HERA data?
  - Proposal: pick a set of channels.   Have each MC proponent (or ??) generate a set of events (in HEPMC format or ?),
  - An independent party will compare the cross-sections, & distributions of rapidity, $Q^2$,M, t and decay product angles
    - In multiple $Q^2$ ranges since the cross-section drops so quickly with $Q^2$?
    - Other variables to compare (outgoing electron or proton/ion?)
  - Looking for an independent volunteer to lead this
    - Within the EIC software group?
- Possible channels for comparison:
  - ep-> ep$\rho$ + direct $\pi^+\pi^- ->$ ep$\pi^+\pi^-$ at HERA energies
  - ep-> ep $\Upsilon$(1S) ->eAuee at HERA energies
  - eAu-> eAu $\Upsilon$(1S) ->eAuee 18 GeV e$^-$ on 110 GeV/n  Au
  - eAu -> eX $\phi$ -> eXK$^+$K$^-$ 18 GeV e$^-$ on 110 GeV/n  Au