

# $J/\psi$ rate estimates

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Threshold energy  $E_\gamma = 8.2 \text{ GeV}$  (protons)

$m_c \approx 1.5 \text{ GeV}$

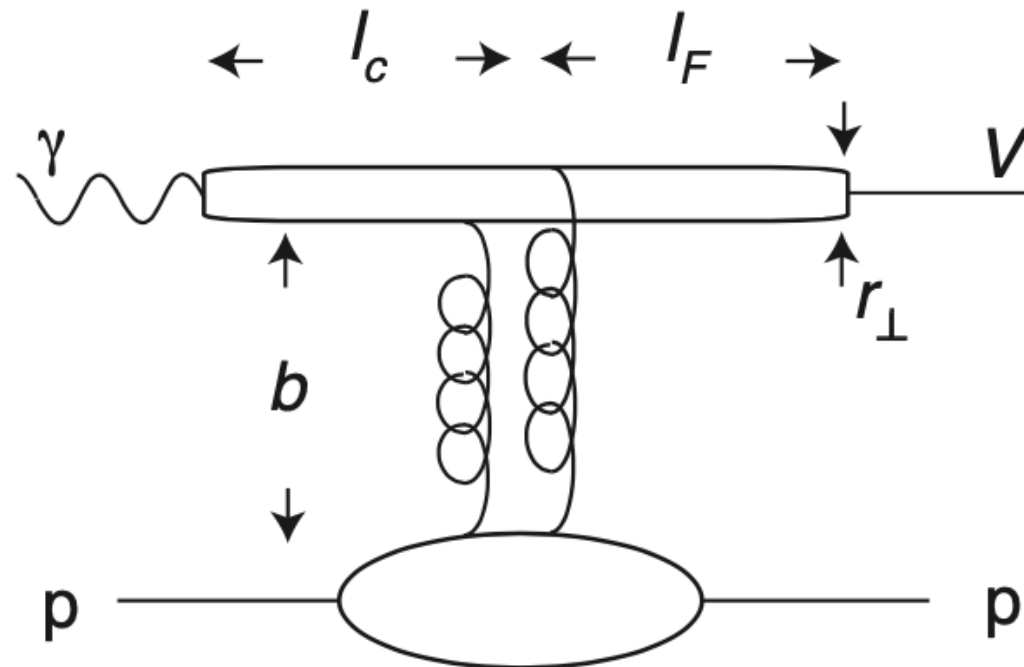
Photon travels:  $l_c = 2E_\gamma/4m_c^2 = 0.36 \text{ fm}$

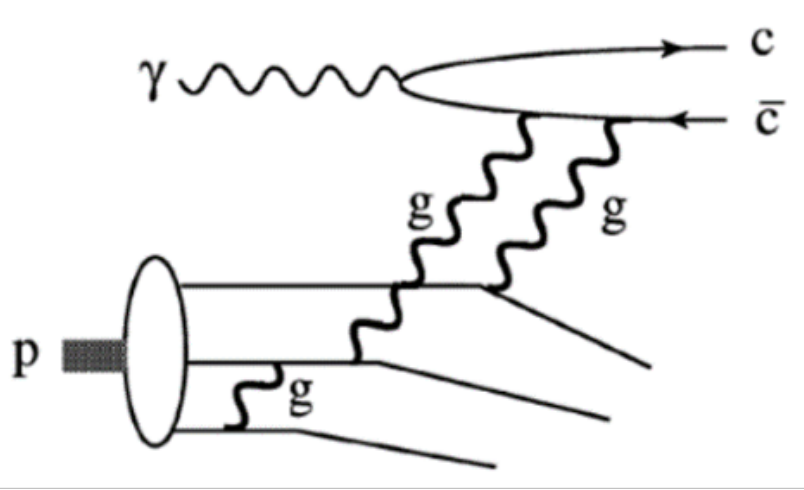
At threshold  $t_{min} \sim 1.7 \text{ GeV}^2$

At  $E_\gamma = 10 \text{ GeV}$   $t_{min} \sim 1. \text{ GeV}^2$

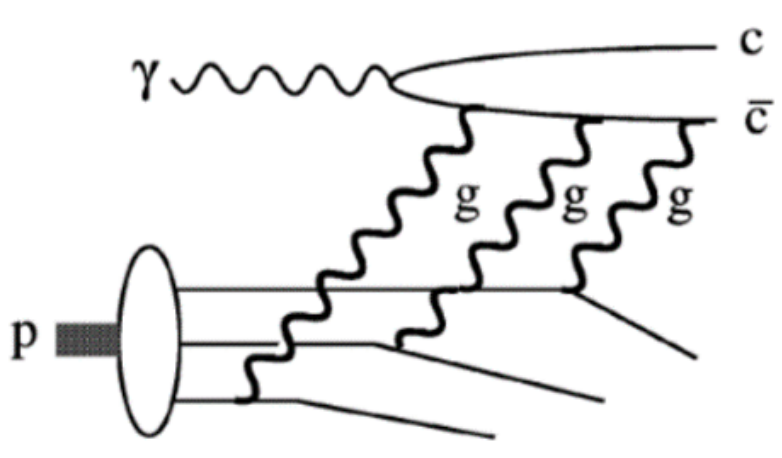
Transverse size:  $r_\perp \sim 1/(\alpha_s m_c) = 0.3 \text{ fm}$

Impact distance:  $b \sim 1/m_c \sim 0.13 \text{ fm}$





2-gluon J/ψ photoproduction

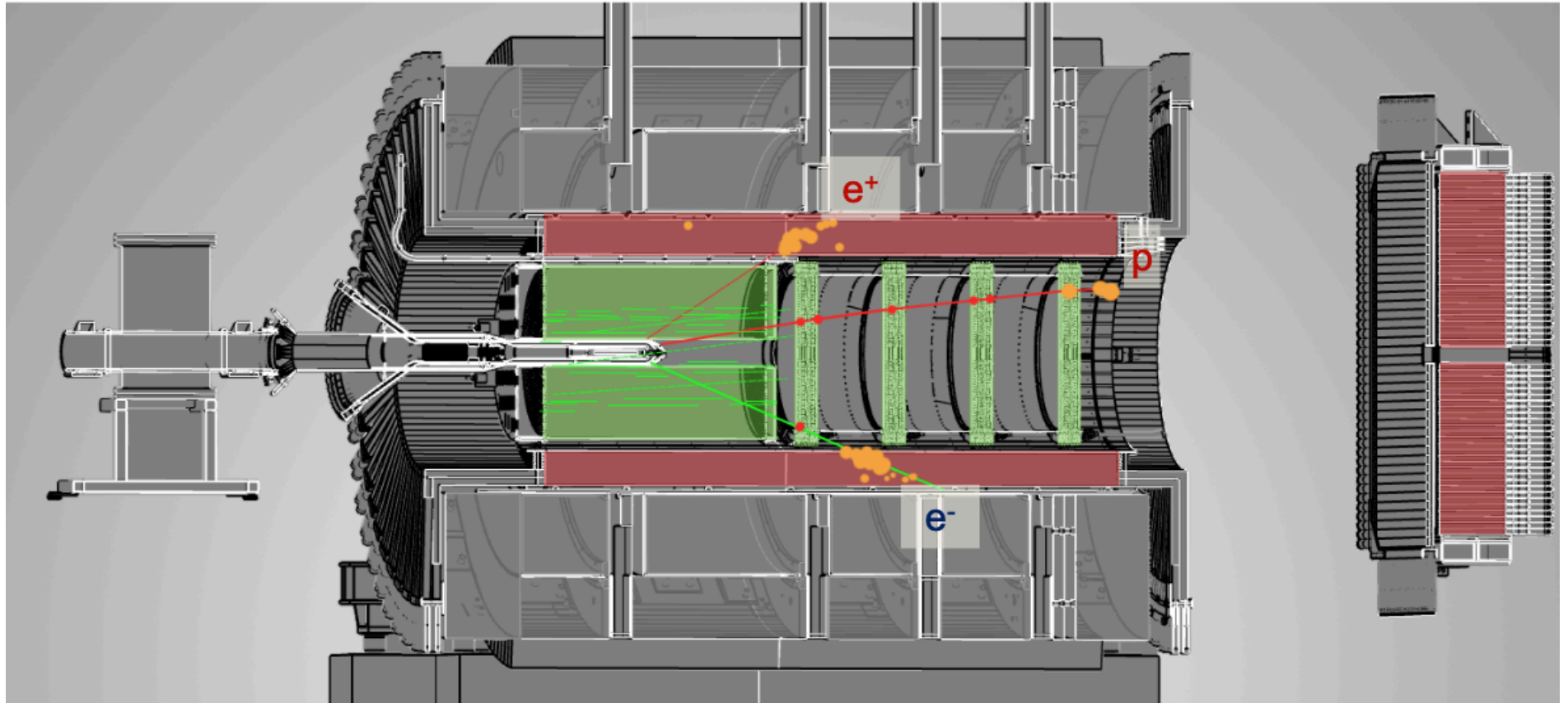


3-gluon J/ψ photoproduction

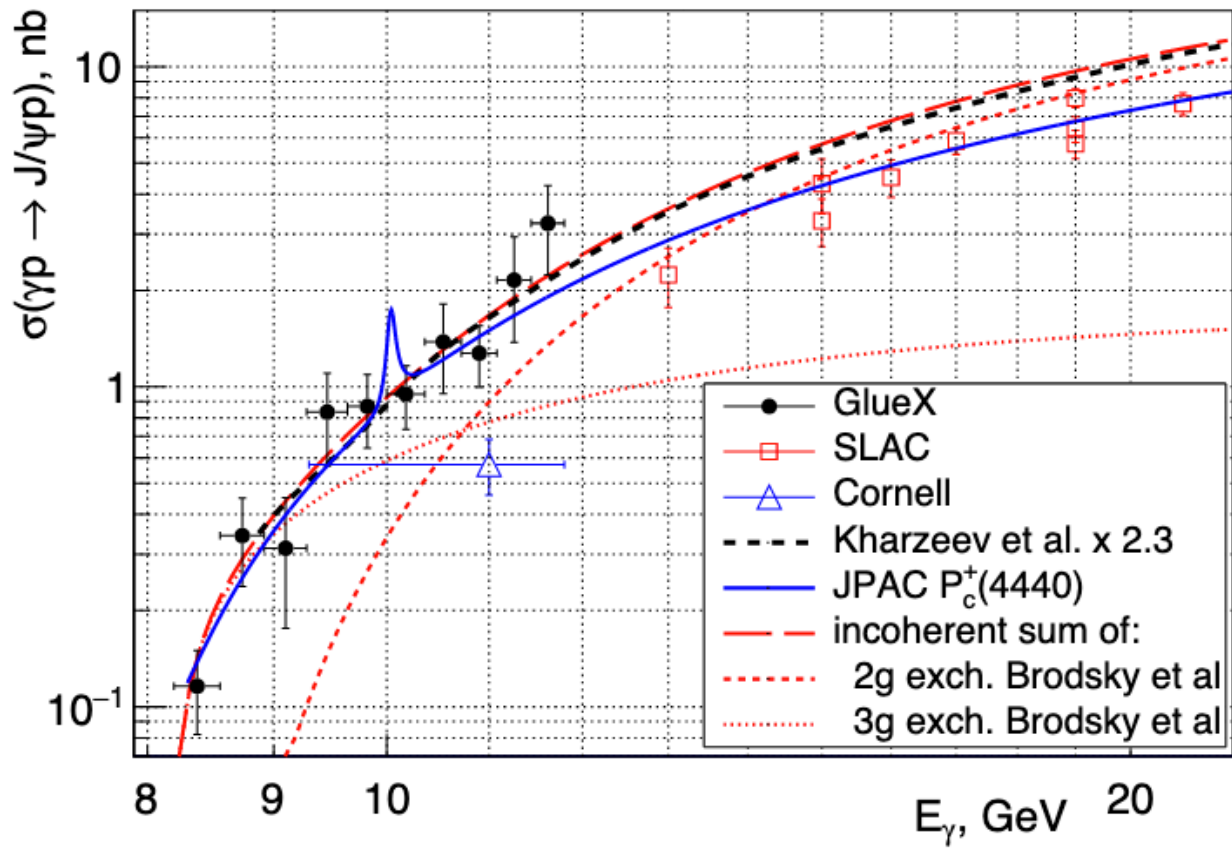
Brodsky et al., Phys. Lett. B 498, 23 (2001)]

# J/ $\psi$ event

Exclusive reaction  $\gamma p \rightarrow J/\psi p \rightarrow e^+ e^- p$

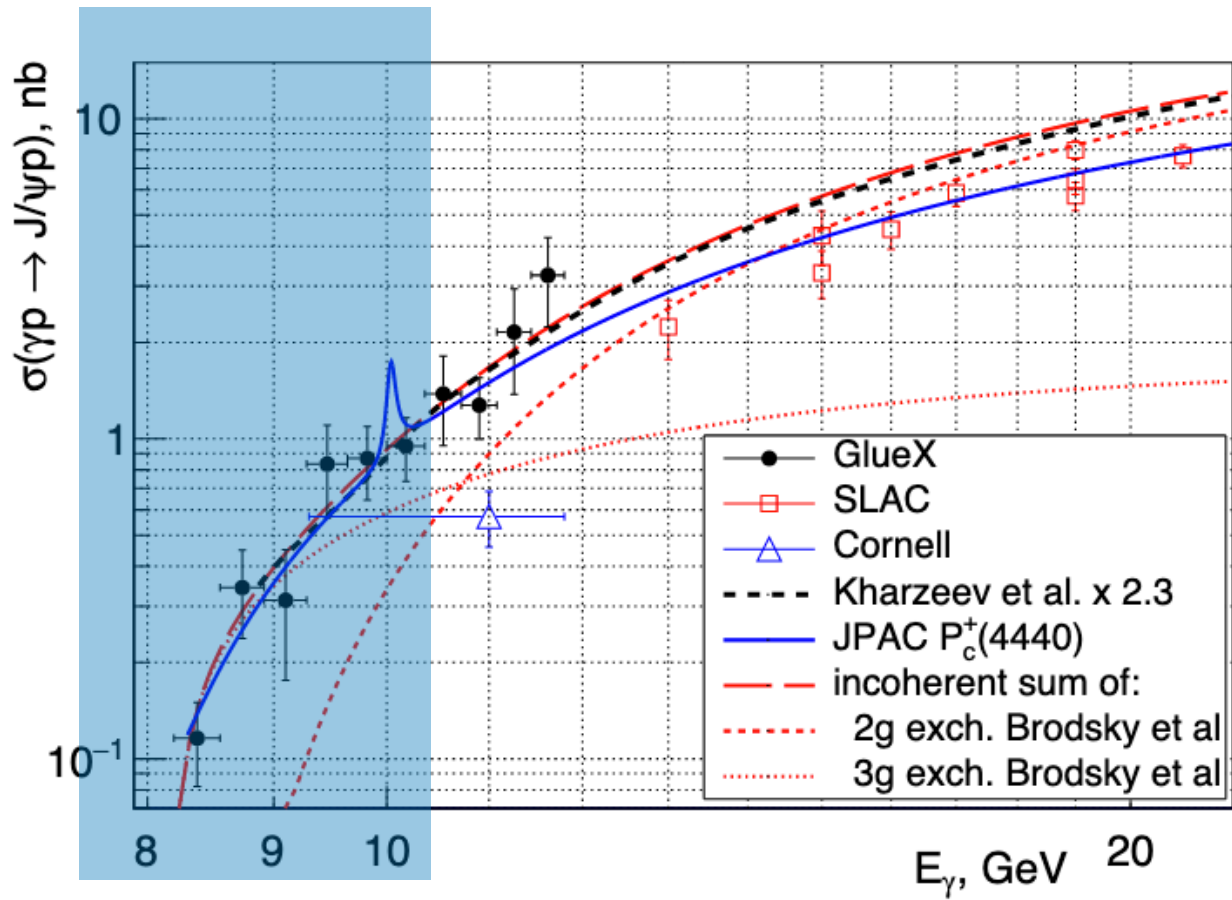


Taken from Gluex Collaboration



near-threshold  $J/\psi$  photoproduction at GlueX

Phys. Rev. Lett. 123, 7 (2019)



SRC-CT Experiment

near-threshold  $J/\psi$  photoproduction at GlueX

Phys. Rev. Lett. 123, 7 (2019)

## Summary of $J/\psi$ production with nuclear targets

| date | reference         | experiment | beam     | energy        | target          | state           |
|------|-------------------|------------|----------|---------------|-----------------|-----------------|
| 1975 | Knapp [13]        | FNAL       | $\gamma$ | 50–200 GeV    | Be              | $J/\psi$        |
| 1975 | Gittelman [12]    | Cornell    | $\gamma$ | 11 GeV        | Be              | $J/\psi$        |
| 1975 | Camerini [1]      | SLAC       | $\gamma$ | 13–21 GeV     | p, d            | $J/\psi, \psi'$ |
| 1976 | Nash [14]         | FNAL       | $\gamma$ | 31–80 GeV     | d               | $J/\psi$        |
| 1976 | Andersen [15]     | SLAC       | $\gamma$ | 9.5–15 GeV    | Be, Ta          | $J/\psi$        |
| 1982 | Binkley [16]      | FNAL       | $\gamma$ | 60–300 GeV    | p, d            | $J/\psi$        |
| 1984 | Denby [17]        | FNAL       | $\gamma$ | 105 GeV       | p               | $J/\psi$        |
| 1986 | Sokoloff [18]     | FNAL E691  | $\gamma$ | 120 GeV       | p, Be, Fe, Pb   | $J/\psi$        |
| 1987 | Barate [19]       | CERN NA14  | $\gamma$ | 90 GeV        | ${}^6\text{Li}$ | $J/\psi, \psi'$ |
| 1993 | Frabetti [20]     | FNAL E687  | $\gamma$ | 100–375 GeV   | Be              | $J/\psi$        |
| 1997 | Breitweg [21, 22] | HERA ZEUS  | $e$      | 850–32400 GeV | p               | $J/\psi$        |
| 2000 | Aldoff [23, 24]   | HERA H1    | $e$      | 360–43300 GeV | p               | $J/\psi, \psi'$ |

Talken form PR-07-106

$$N_{Total} = \frac{Z}{A} \cdot \mathcal{L} \cdot \sigma_{AV} \cdot Br \cdot \epsilon$$

$$\sigma_{\gamma A} = A \cdot \sigma_{\gamma N}.$$

Assuming

$$\sigma_{AV} = 0.5 \text{ nb}$$

$$Br = 0.06 (J/\psi \rightarrow e^- e^+)$$

$\epsilon = 0.25$  (taken from previous  $J/\psi$  at Gluex)

| <b>A</b>  | <b>Z</b> | <b>Total Lumi (1/nb)</b> | <b>Total Counts</b> |
|-----------|----------|--------------------------|---------------------|
| <b>2</b>  | 1        | 17100                    | 64                  |
| <b>4</b>  | 2        | 16100                    | 60                  |
| <b>12</b> | 6        | 9900                     | 37                  |

Note: The luminosity was estimated for  $E_\gamma > 7 \text{ GeV}$

The total counts is overestimated for above the threshold