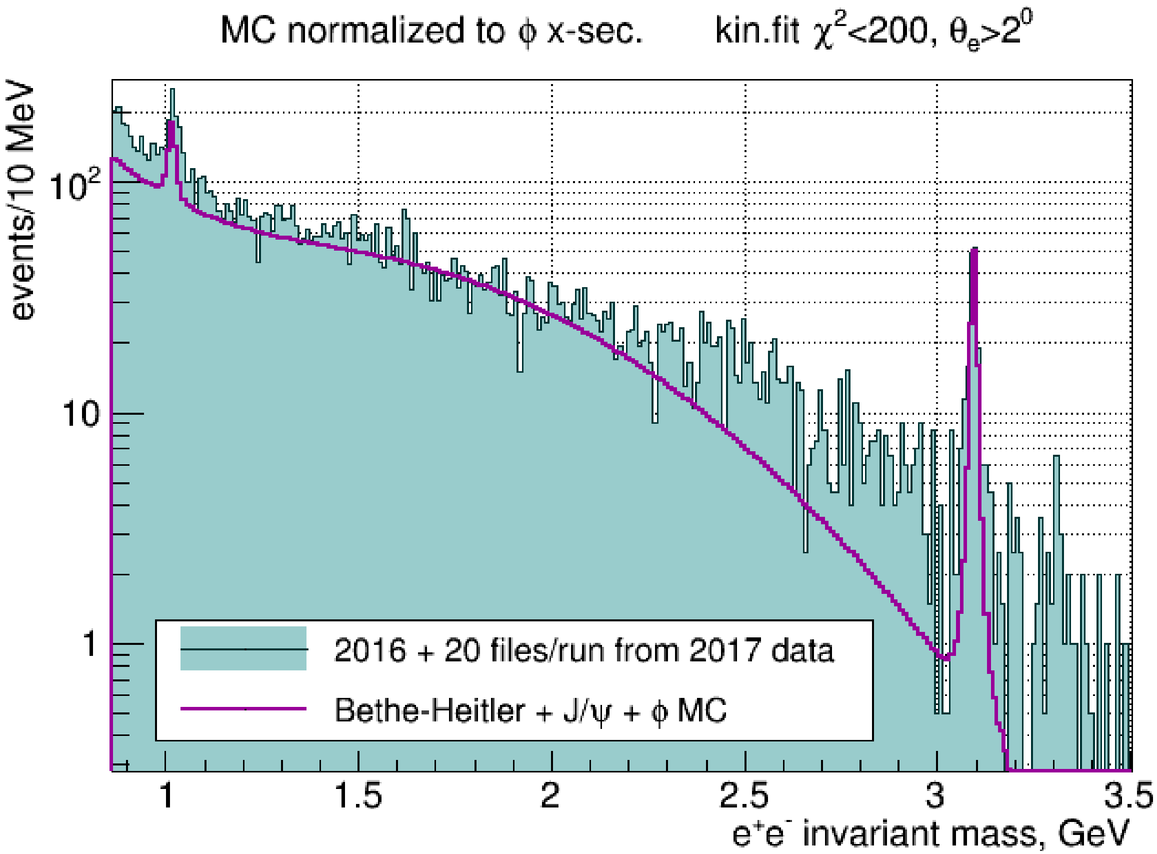
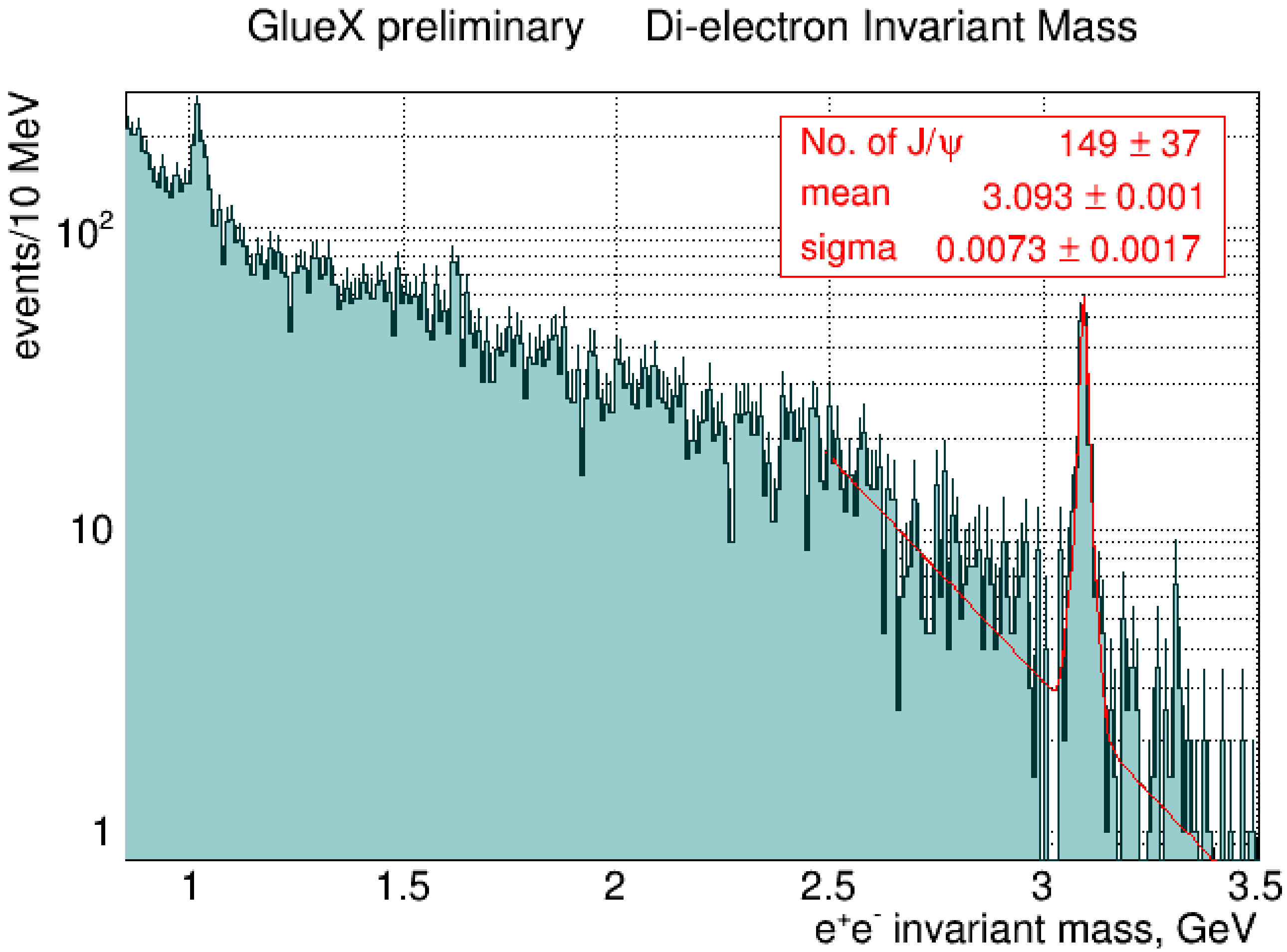
J/ψ update



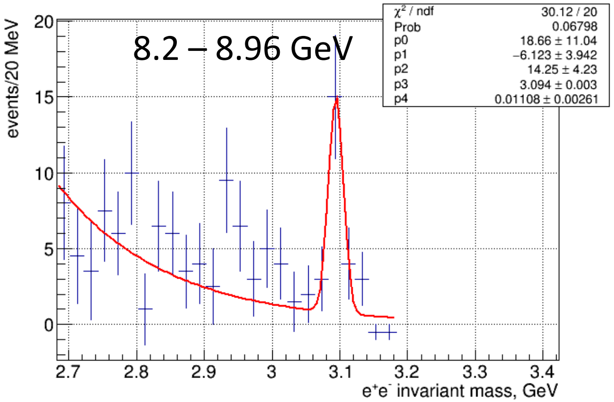
- Using full 2016 statistics and 20 files per run from 2017
- 2017 data about 20% of data set presented here
- 10% (high intensity runs) – not well calibrated (S.Dobbs)
- Require kin.fit converges with χ^2<200, and $\theta_e > 2^0$
- Using 2016 flux, corrected for the different endpoint for 2017 data
- Absolute flux not used, instead normalization to ϕ x-section

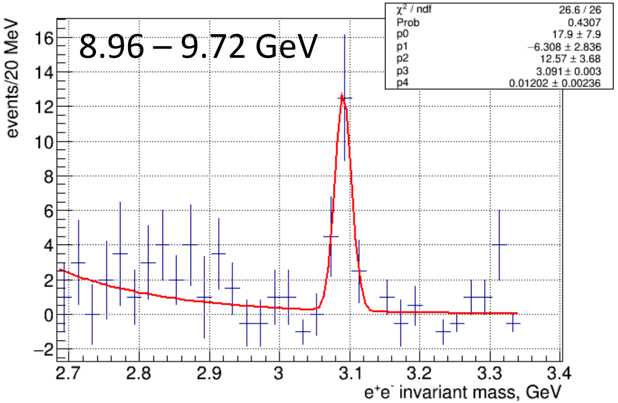
2016 + 20 files per run from 2017 data

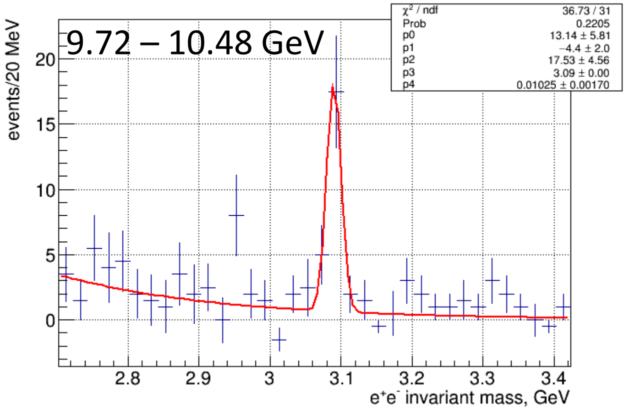


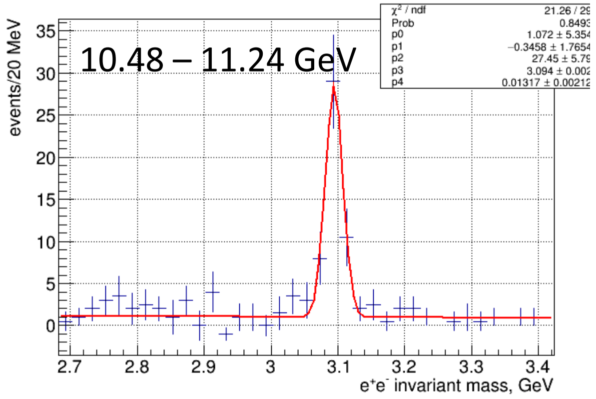
- Combined statistics allowed for mass peak fitting in bins of energy and t

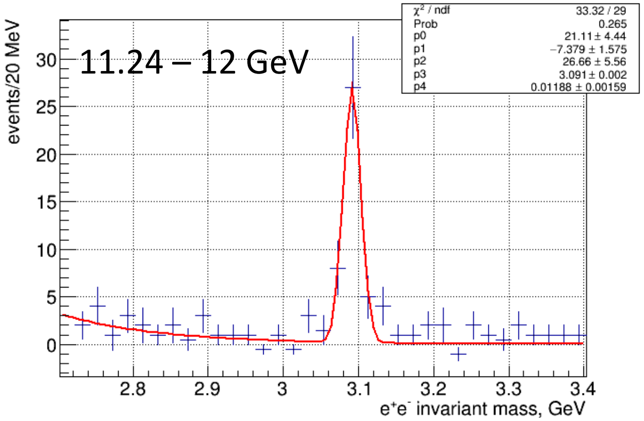
J/ψ mass fits in bins of energy



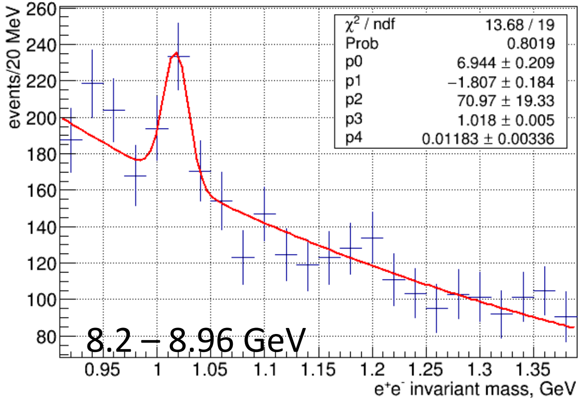


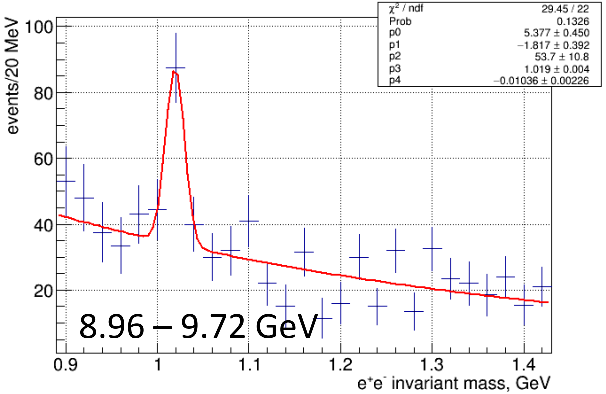


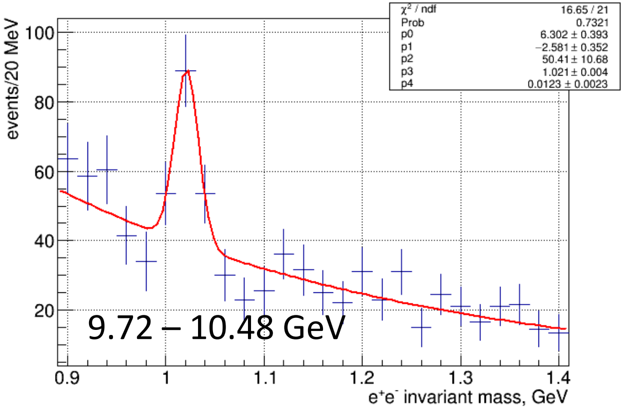


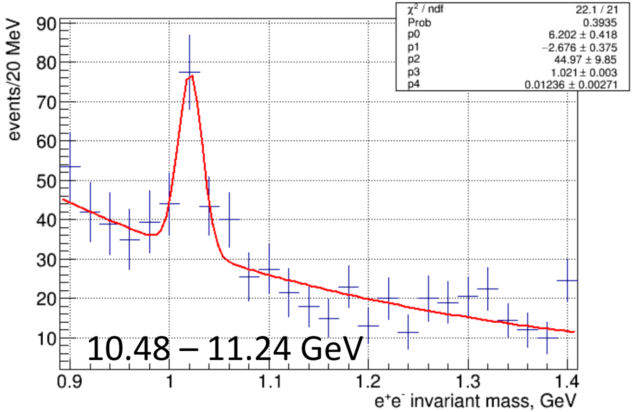


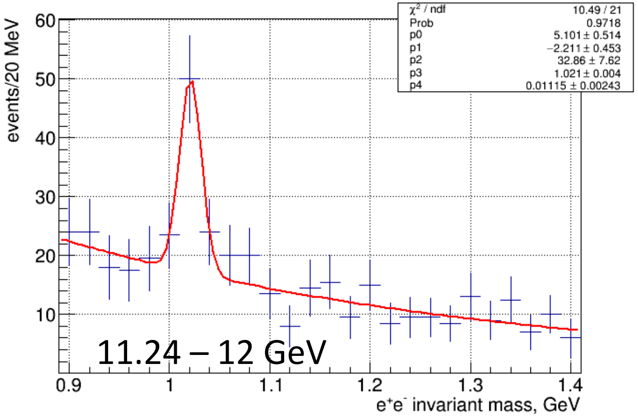
ϕ mass fits in bins of energy



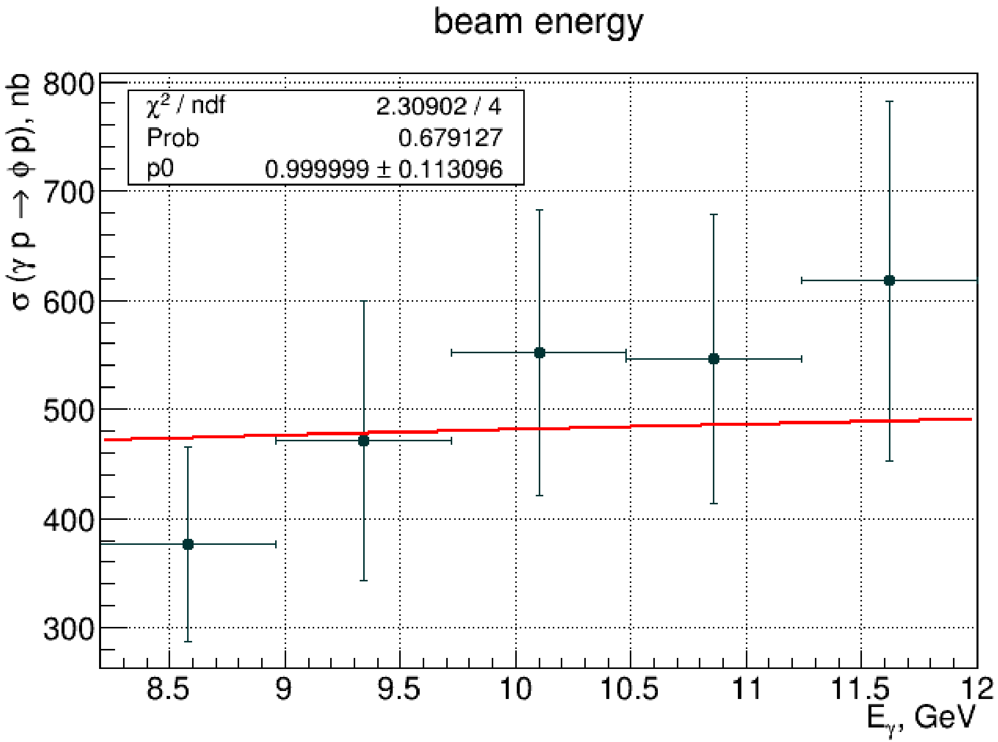






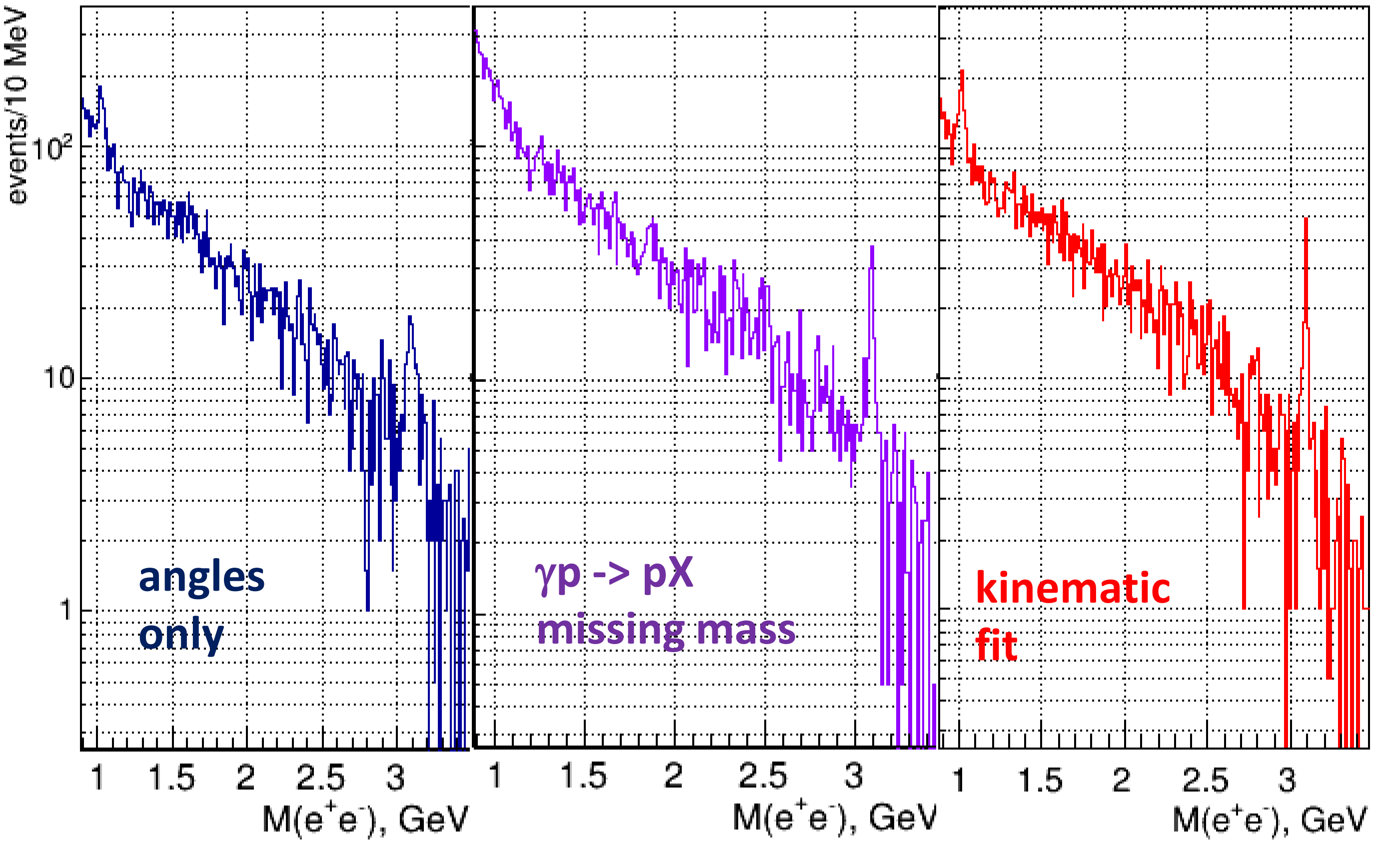


ϕ x-sec. vs beam energy

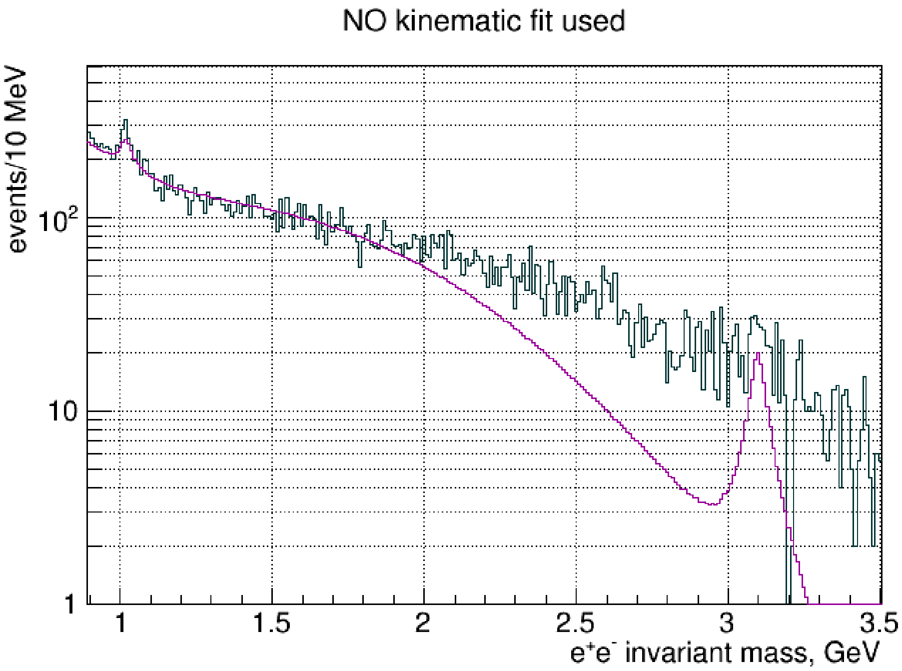


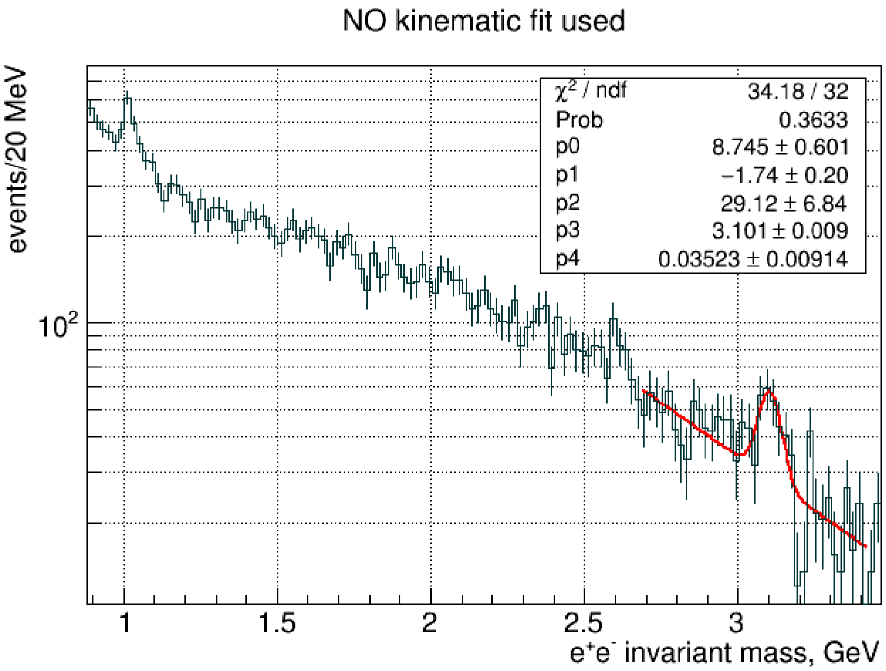
GlueX data normalized to world data fit (red line) - gives estimate of the luminosity, that is used for the x-section calculation

Reconstructing p, e^+, e^- momenta from angles (2016 data)



Reconstructing p, e⁺, e⁻ momenta from angles

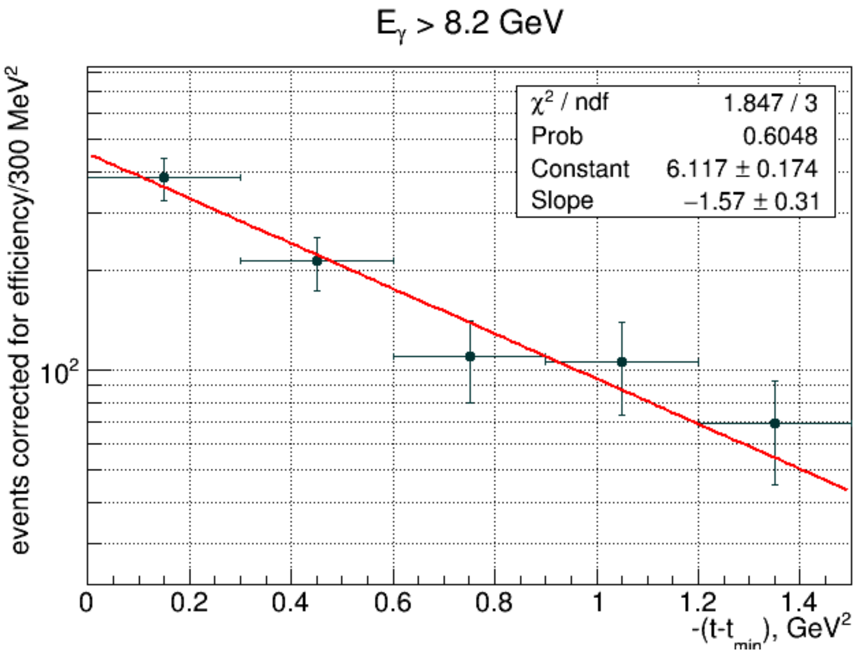




Momenta calculated from angles

Require energy conservation to +/- 200 MeV and Δr(vertex) < 4 cm

J/ψ analysis in bins of t



t-slope of Cornell data 1.25 +/- 0.2 GeV^{-2} at E_γ = 11 GeV

GlueX result (total): 1.57 +/- 0.31 GeV^{-2}

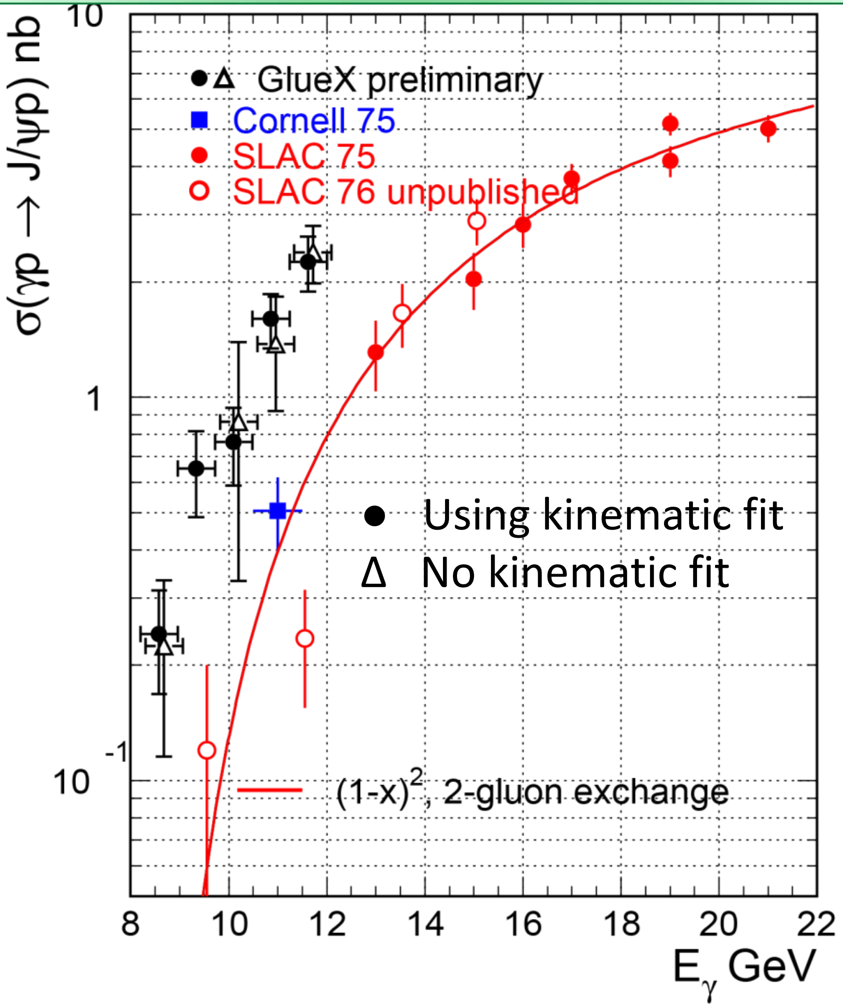
GlueX result for E_γ > 9.7 GeV: 1.73 +/- 0.30 GeV^{-2}

J/ψ x-sec. vs beam energy

SLAC results calculated from $d\sigma/dt(t=t_{min})$ using t-slope

t-slope of SLAC data 2.9 GeV^{-2} (measured at 19 GeV)

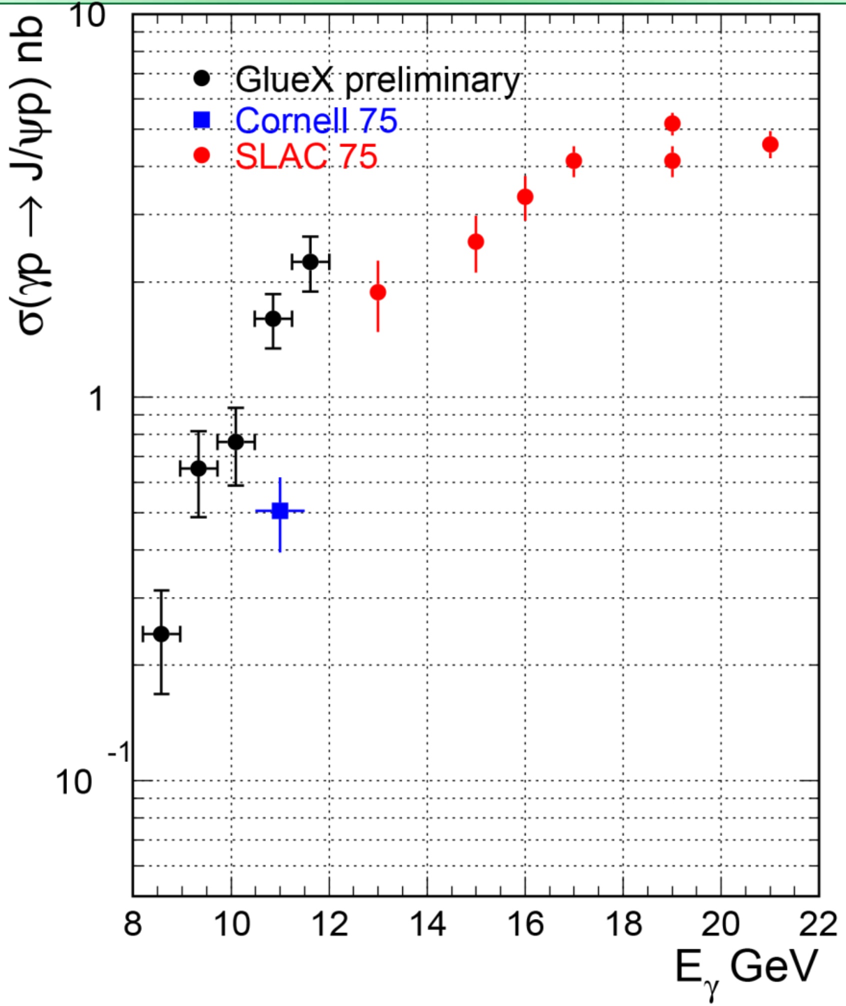
t-slope of Cornell data 1.25 GeV^{-2}



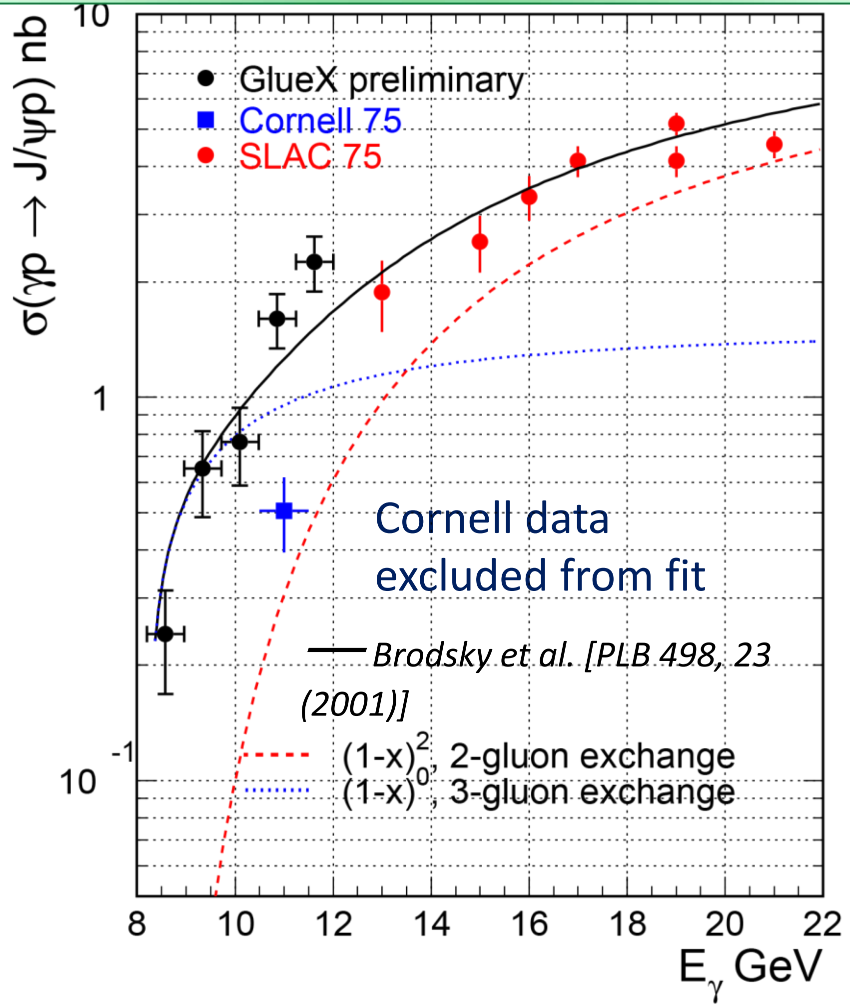
J/ψ x-sec. vs beam energy

t-slope of SLAC data 1.73 - 2.9 GeV^{-2} (11-19 GeV)

t-slope of Cornell data 1.25 GeV^{-2}



J/ψ x-sec. vs beam energy



t-slope of SLAC data 1.73 - 2.9 GeV^{-2} (11-21 GeV)

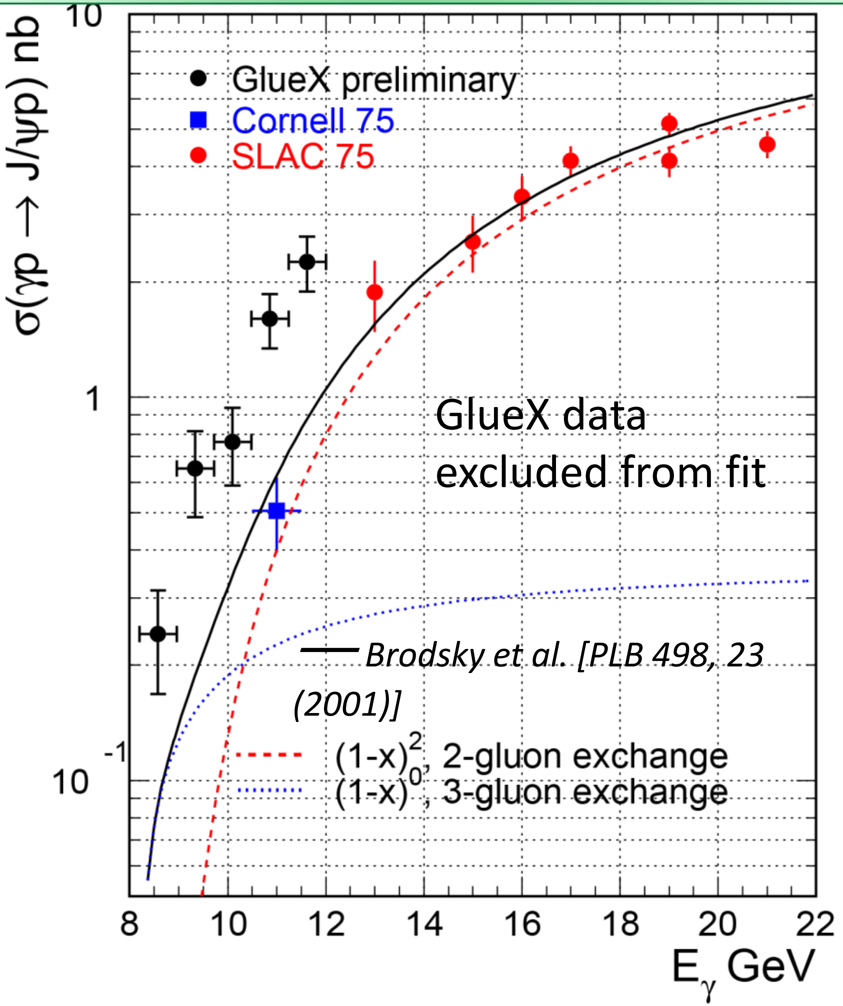
t-slope of Cornell data 1.25 GeV^{-2}

- Three-gluon exchange dominates

J/ψ x-sec. vs beam energy

t-slope of SLAC data 1.73 - 2.9 GeV^{-2} (11-21 GeV)

t-slope of Cornell data 1.25 GeV^{-2}

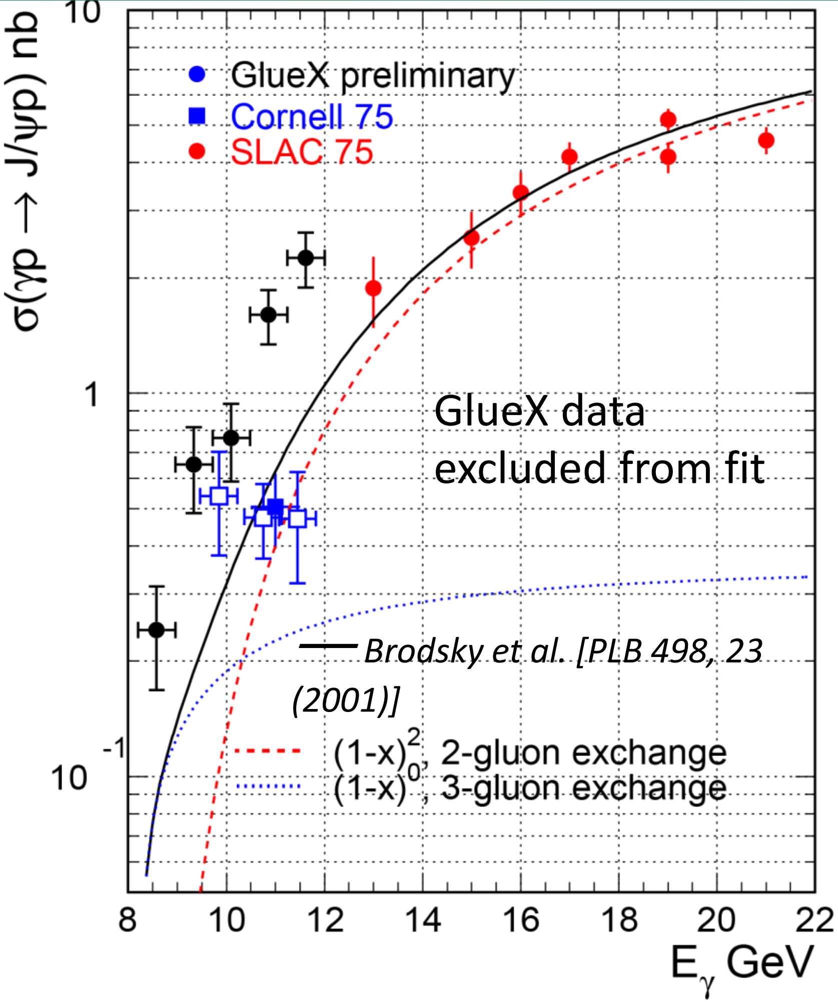


- Two-gluon exchange dominates

Cornell results

t-slope of SLAC data 1.73 - 2.9 GeV^{-2} (11-21 GeV)

t-slope of Cornell data 1.25 GeV^{-2}



- γ Be -> e^+e^- X
- Bad mass resolution (~100 MeV)
- Beam energy calculated from e^+e^- assuming elastic reaction – can explain the no-energy-dependence of the cross-section?

Cornell results

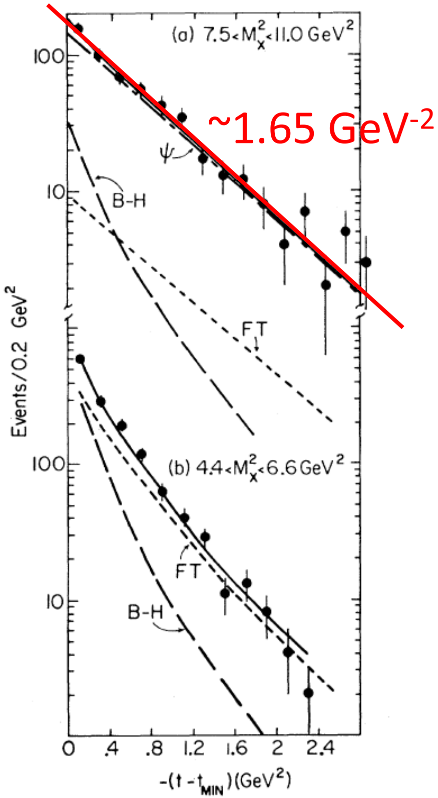


FIG. 2. $t - t_{min}$ distributions for c–c events in two mass regions. The solid curves represent the sum of the contributions from Bethe-Heitler pairs (B-H), n–n and n–c feedthrough (FT), and for (a) the fit to the ψ cross section described in the text.

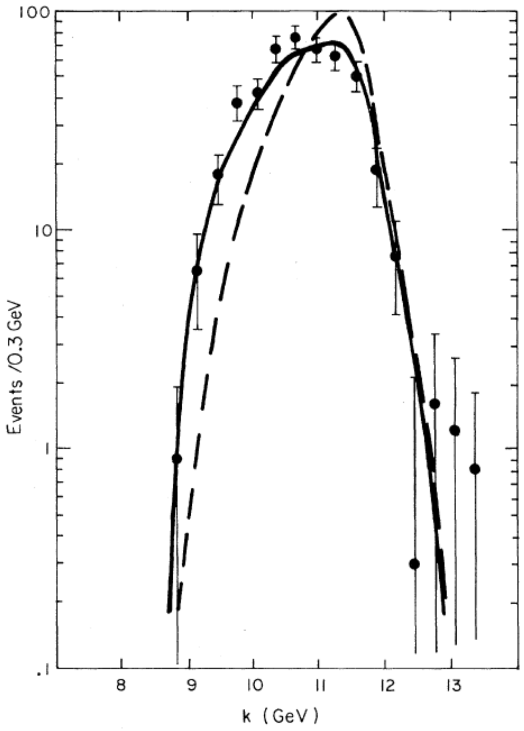


FIG. 3. The reconstructed photon energy distribution for the ψ events with Bethe-Heitler pairs and feed-throughs subtracted. The solid line is the expected distribution for a cross section $d\sigma/dt = 0.9\,\exp(1.2t)$. The dashed line is for $d\sigma/dt = 0.144(k - 8.2)^2 \exp(1.2t)$ nb/GeV^2.

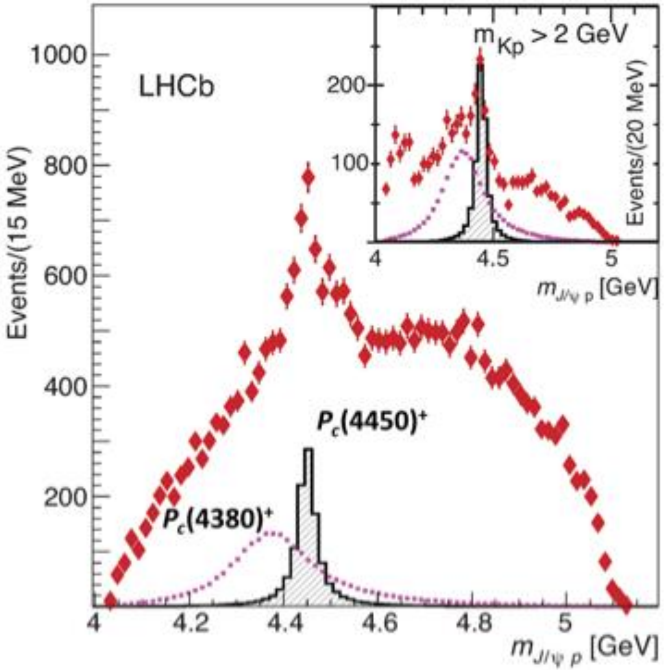
- Steep acceptance with the beam energy
- t-slope from the plot (~1.65) contradicts the value in the paper (1.25 GeV^{-2})

LHCb Pentaquarks

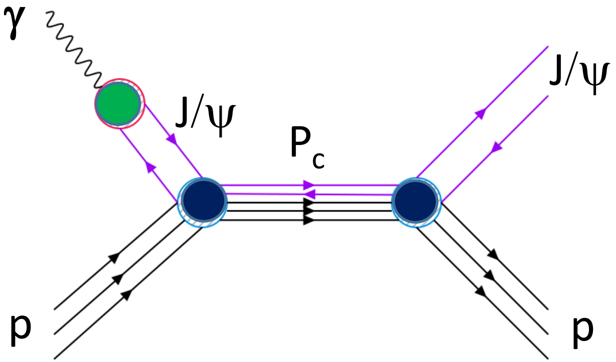
$\Lambda_b \rightarrow K^-(J/\psi\ p)$

Pc(4380): Γ=205 MeV $J^P=3/2^{+(-)}$
Pc(4450): Γ=39 MeV $J^P=5/2^{-(+)}$

Interpretations:
- (charmed baryon) – (anti-charmed meson) molecule ($\bar{D}^*\Sigma_c$)
- Resonance in terms of quark degrees of freedom
- Kinematic effects: threshold effect (χ_{c1} p) , ATS



Phtotoproduction of LHCb Pentaquarks



$\sigma \sim BW(\Gamma_{Pc},M_{Pc})*BR(P_c\text{->}\gamma p)*BR(P_c\text{->}J/\psi p)$

$BR(Pc\text{->}\gamma p) \sim \Gamma(J/\psi \text{ -> } \ell^+\ell^-)*BR(P_c\text{->}J/\psi p)$ (VMD)

$\sigma \sim BR^2(P_c\text{->}J/\psi p)$

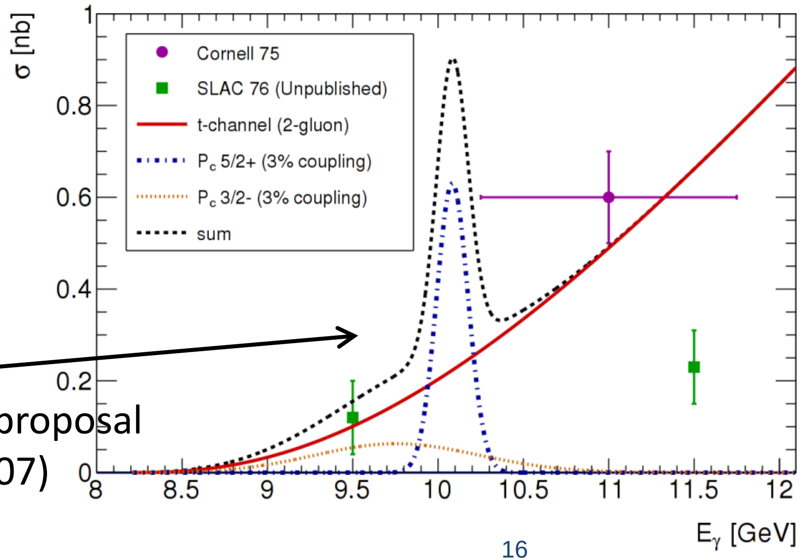
1)V.Kubarovsky and M.B.Voloshin, arXiv: 1508.00888.
2)M.Karliner and J.Rosner, arXiv: 1508.01496.
3)A.Blin, C.Fernandez-Ramirez, A.Jackura, V.Mathieu, V.Mokeev, A.Pilloni, and A.Szczepaniak,arXiv: 1606.08912

all three papers $\sigma^{max} \sim 10\ \mu b$ for $P_c(5/2+)$ 100% BR

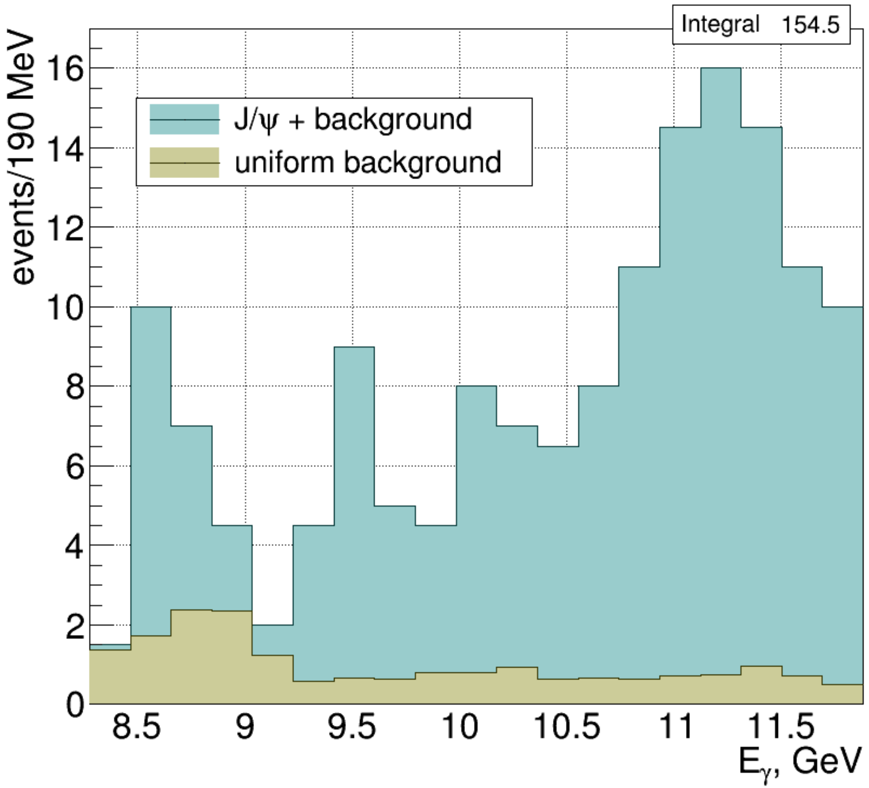
1)Q.Wang, X.Liu, and Q.Zhao,arXiv: 1508.00339

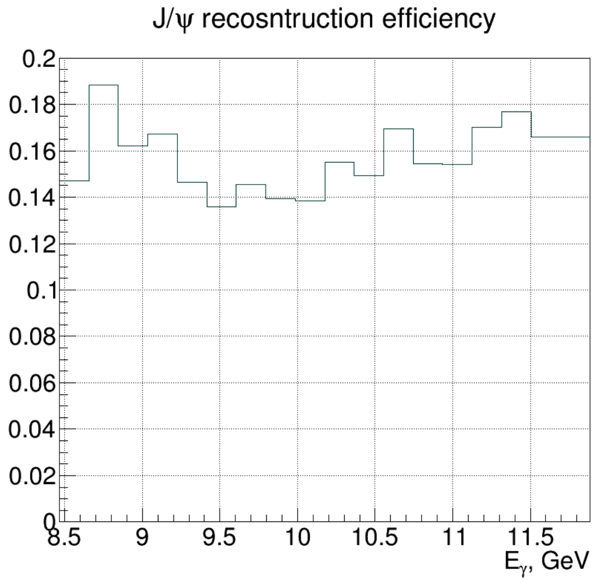
$\sigma^{max} \sim 0.7\ \mu b$ for $P_c(5/2+)$ 100% BR

Hall C 5q-proposal
(E12-16-007)



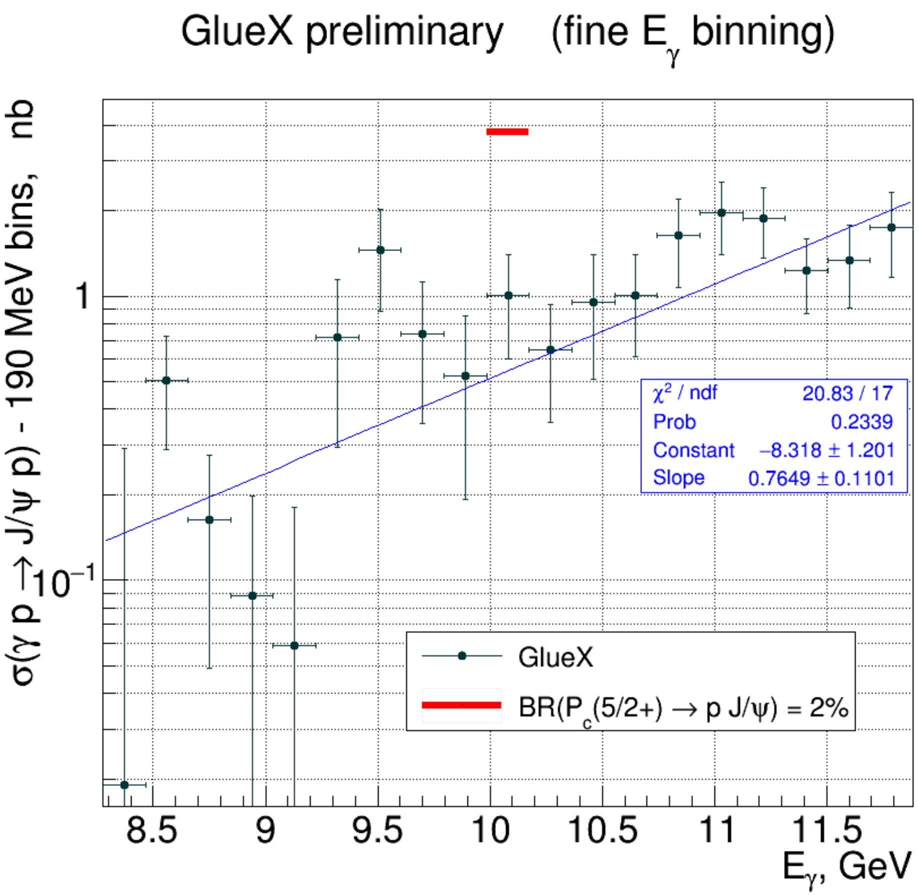
J/ψ x-section in finer bins of beam energy





- Fine bins in E_γ: 190 MeV corresponds to 39 MeV in W, the P_c(4450) width
- Background subtracted assuming uniform (with energy) distribution normalized to the total background events

Upper limit for BR($P_c \to p\, J/\psi$)



- If preliminary results hold (~ factor of 2) we can put upper limit of BR(P_c->J/ψp) < 2% or less

- What about lower limit?

LHCb has measured:

BR(Λ_b -> K^-J/ψ p) = 3.2 10^{-4}

BR(Λ_b -> K^-P_c)*BR(P_c->J/ψ p) = 1.3 10^{-5}

If BR(P_c->J/ψ p) too small then

BR(Λ_b -> K^- + J/ψ p) << BR(Λ_b -> K^- +!(J/ψ p))

(M.Karliner and J.Rosner, PRL 115 122001)

Conclusions

- Despite analyses are preliminary, using ~35-40% of the total statistics, very unlikely these conclusions will change: the effects we observe are much bigger than the expected systematics:

1. GlueX cross-section is much higher than old data/fits with theoretical curve
2. GlueX and Cornell results can't be reconcile and they result in different predictions for the reaction mechanism near threshold
3. We can set upper limit for the pentaquark BR(P_c(4450)->p J/ψ) at level of 1-2%

Plans for analysis/publication by the end of the year

Due to the expected high impact of the results:

Requirements:

- Need total flux and agreement with $\phi \to K^+K^-$ and $\phi \to \pi^+\pi^-\pi^0$
- Need agreement with Bethe-Heitler (two MC models simulated by Sean)
- Need some confidence in efficiency simulations (like comparing MC vs data with different cuts, studying electron/proton tracking efficiencies, etc.)
- Need to improve FCAL and BCAL resolution at high electron energies
- Need to analyze both the whole spring 2016 and spring 2017 data with the same reconstruction software version before final analyses
- Writing analysis paper (simultaneously)

Organization:

- Forming two independent groups using different analysis codes (above some level)?
- Blind data in the energy range around pentaquark? (Mark D.)