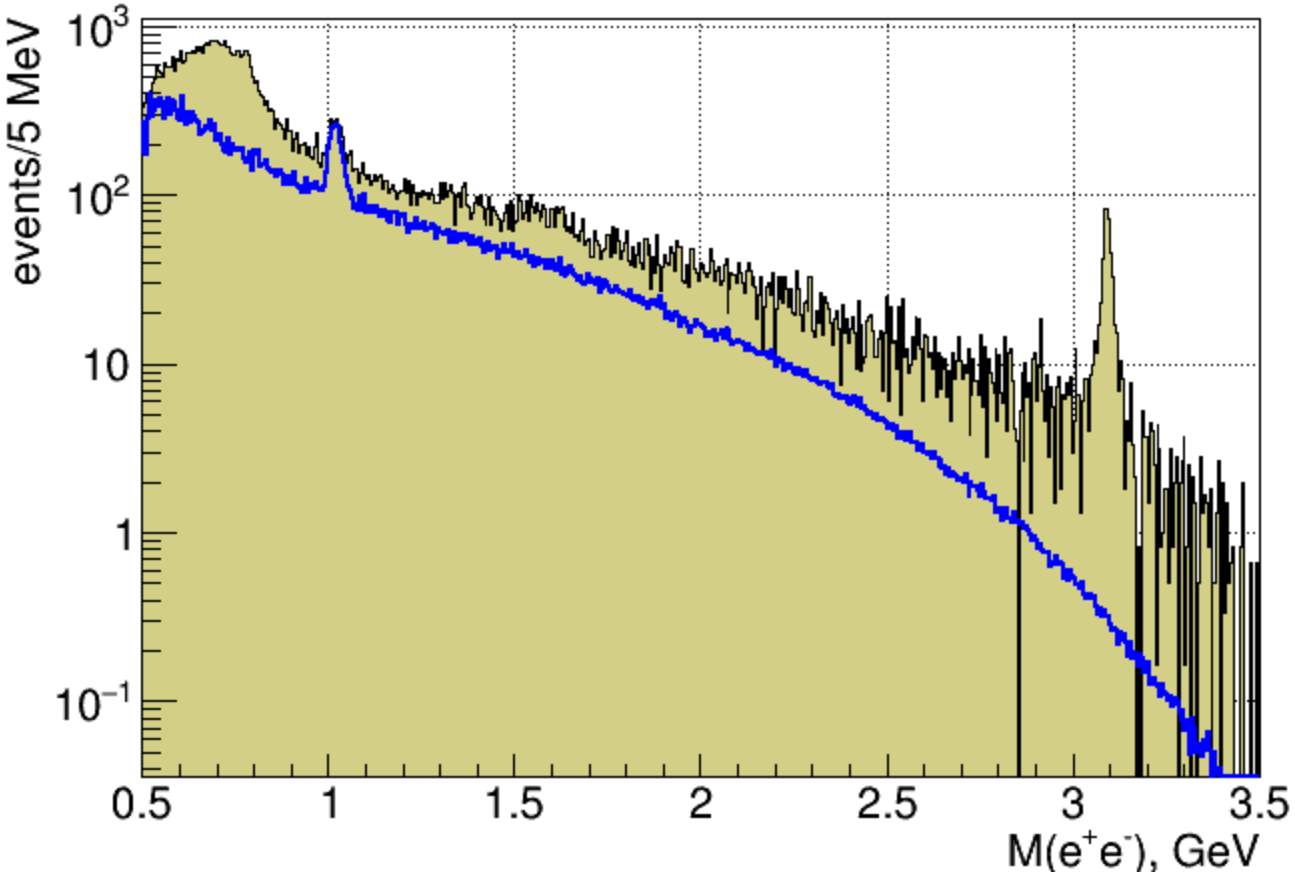
Update on J/ψ cross-section

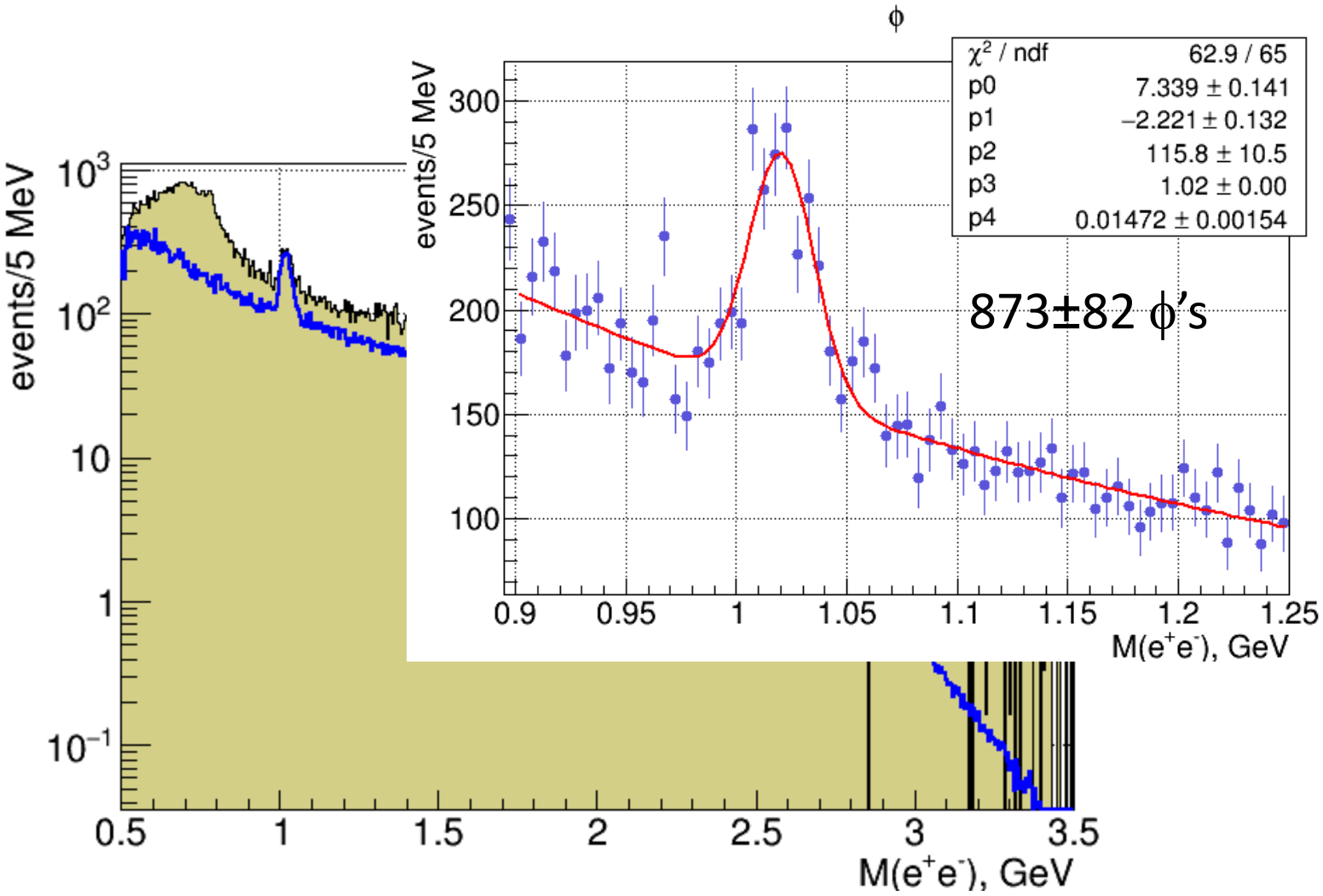
- Using latest reconstruction/analysis of all the data 2016,2017 – number of J/ψ's increased by a factor of ~2.5
- Cross-section normalization to Bethe-Heitler (BH) continuum in 2-2.5 GeV invariant mass (before 1.5-2.5)
- 10 points (before 6) in the energy range 8.2-11.8 GeV
- Higher statistics – better understanding of the systematics
- t-dependence - critical for comparison with SLAC measurements and theories
- New ideas about theoretical interpretation of the cross-section near threshold

Invariant mass spectrum

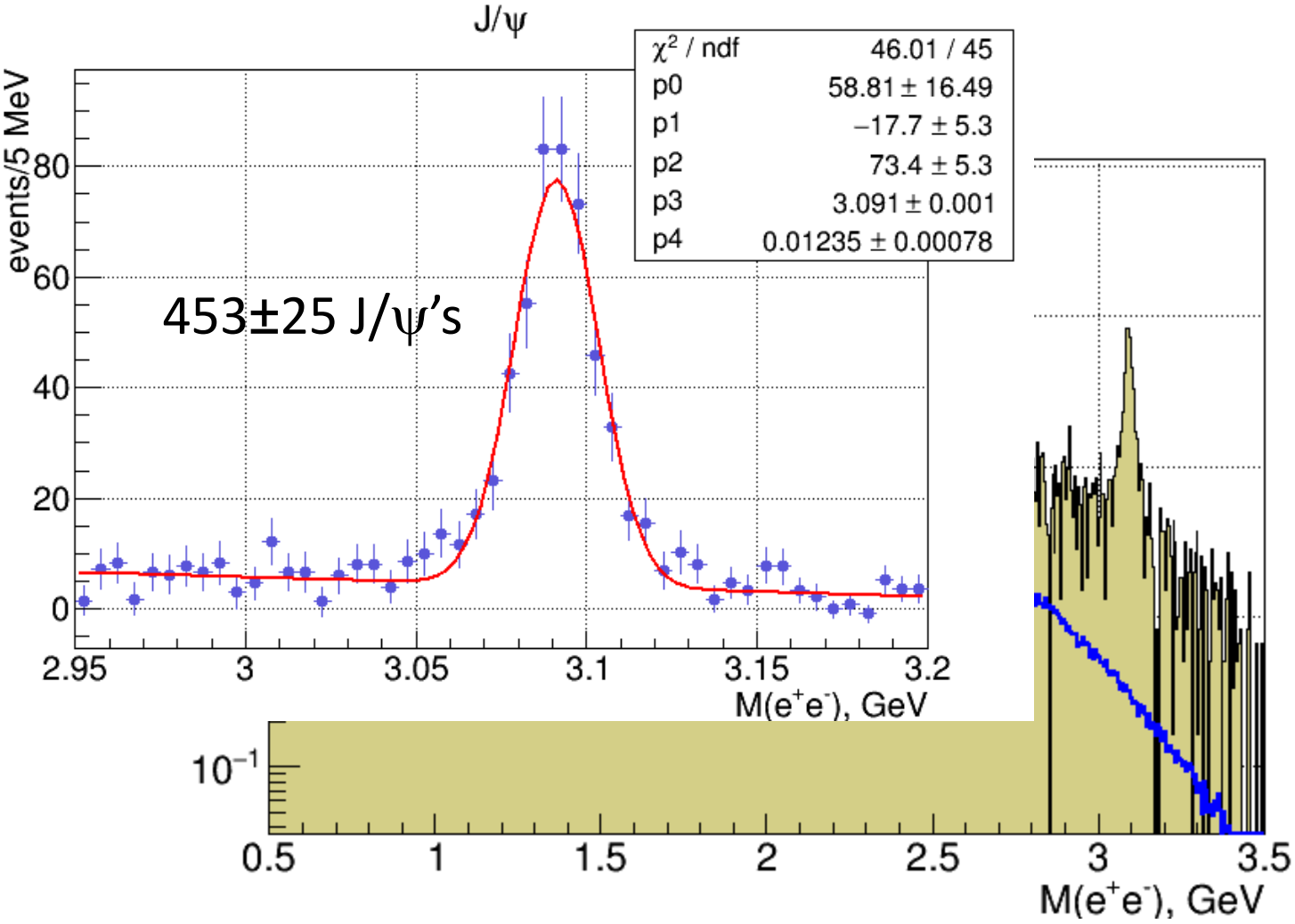


- Continuum higher than MC simulation - π contamination of 50-60% explains this (before we had 30-35% contamination)

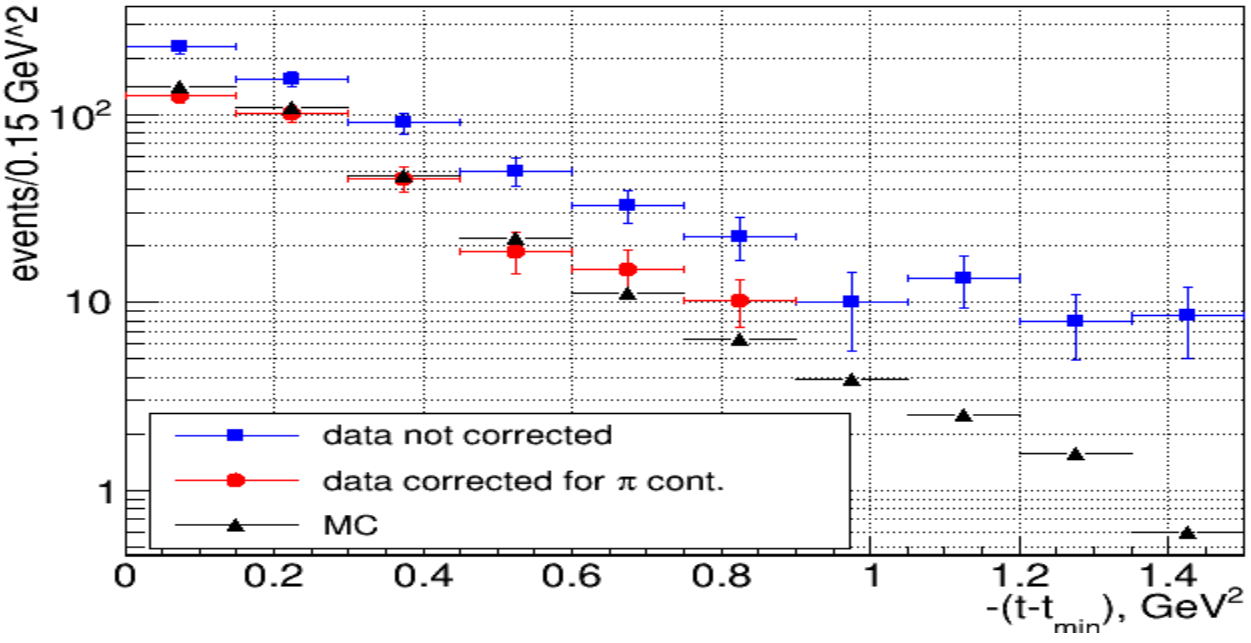
Invariant mass spectrum

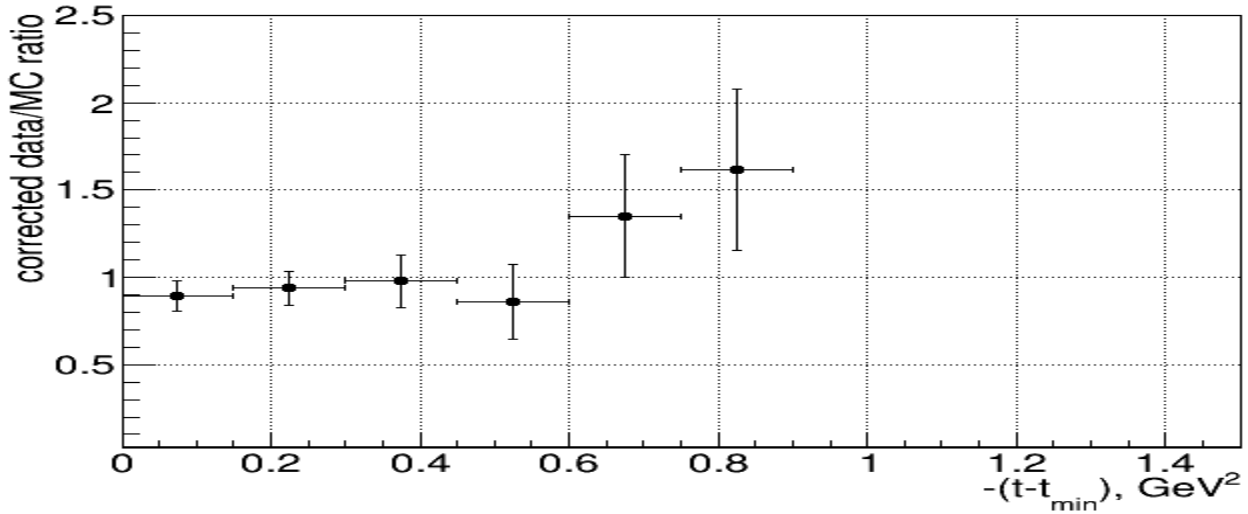


Invariant mass spectrum

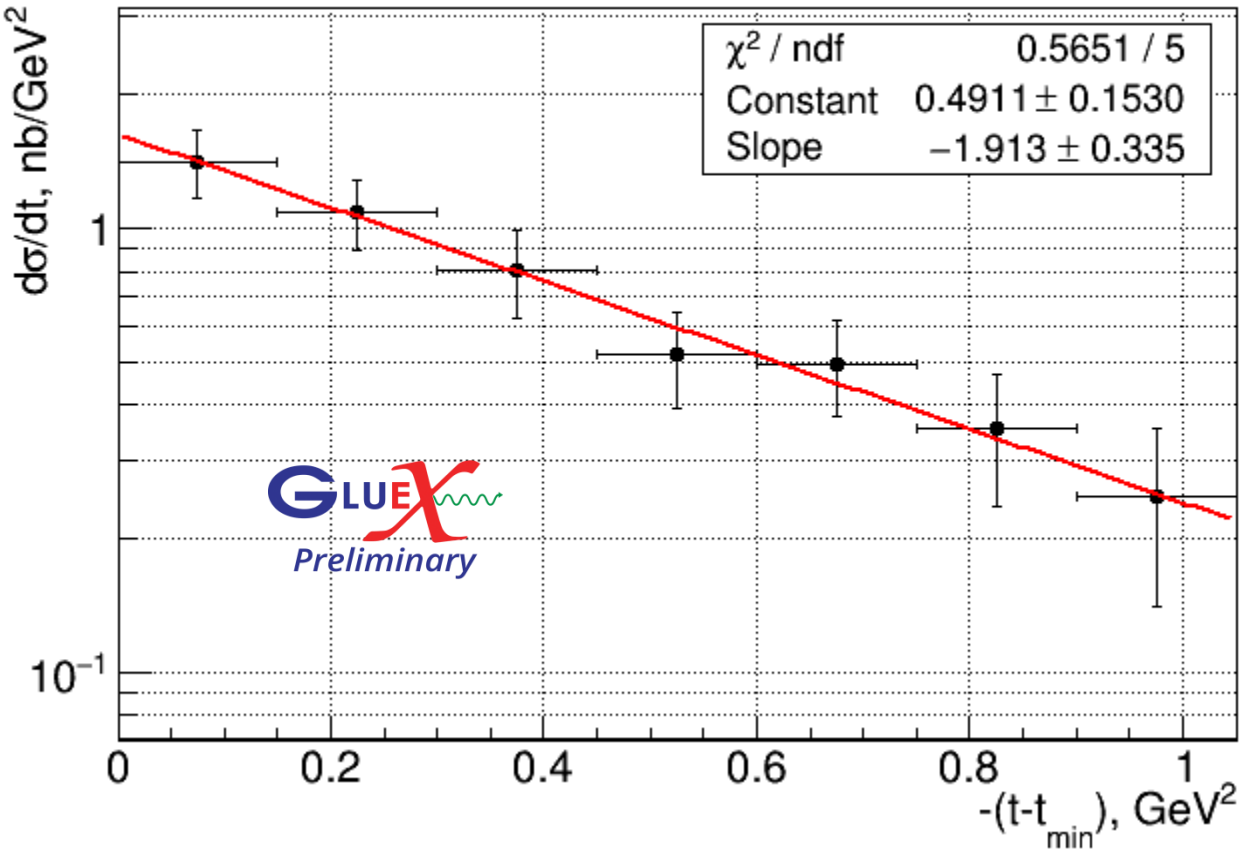


BH (2-2.5 GeV) t-distribution E>10 GeV





J/ψ t-distribution for E=10-11.8 GeV

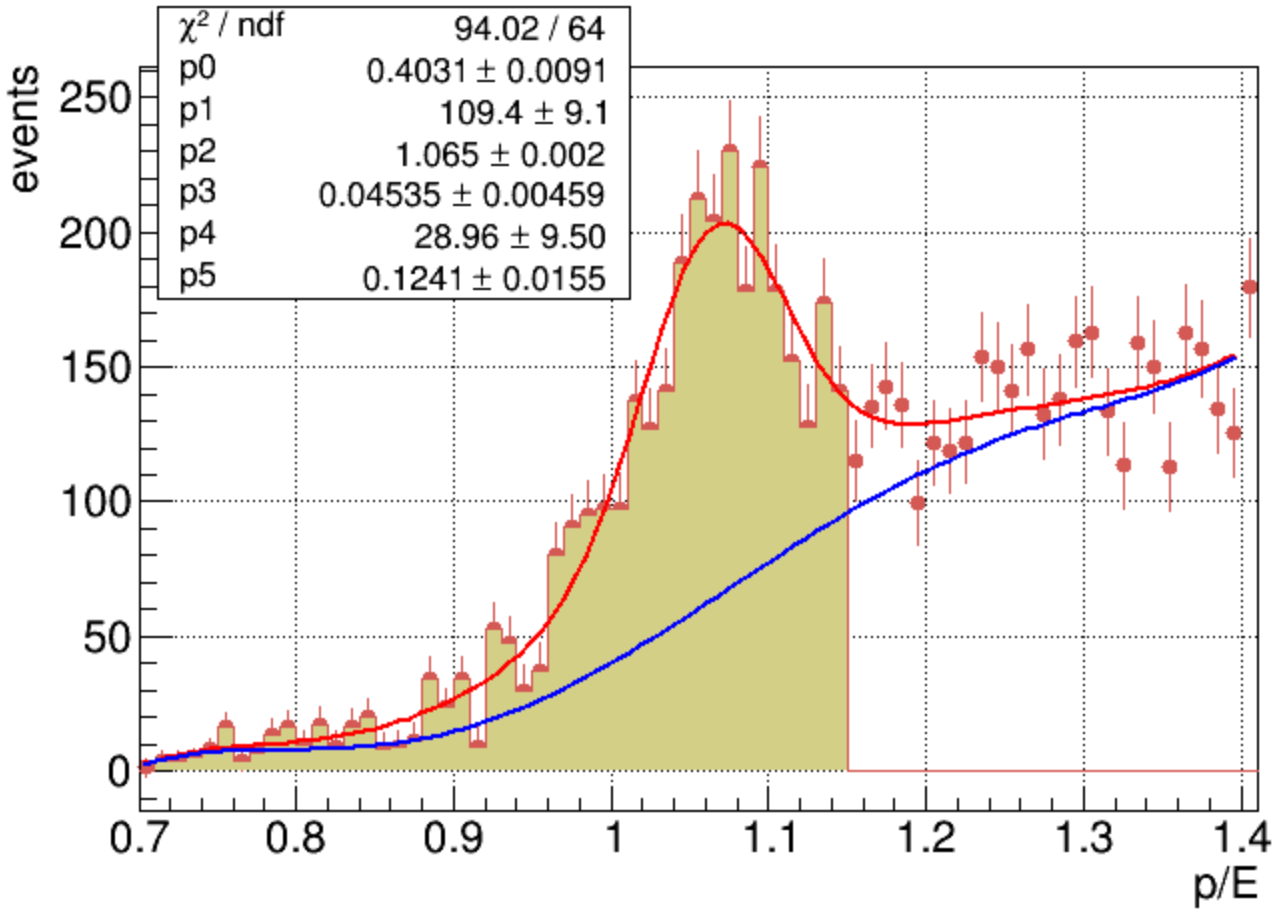


Assuming - BH normalization not needed

SLAC t-slope 2.9±0.3 GeV^{-2} at 19 GeV

Cornell t-slope 1.25±0.2 GeV^{-2} at 11 GeV

BH(2-2.5 GeV) p/E distribution t<0.6 GeV^2

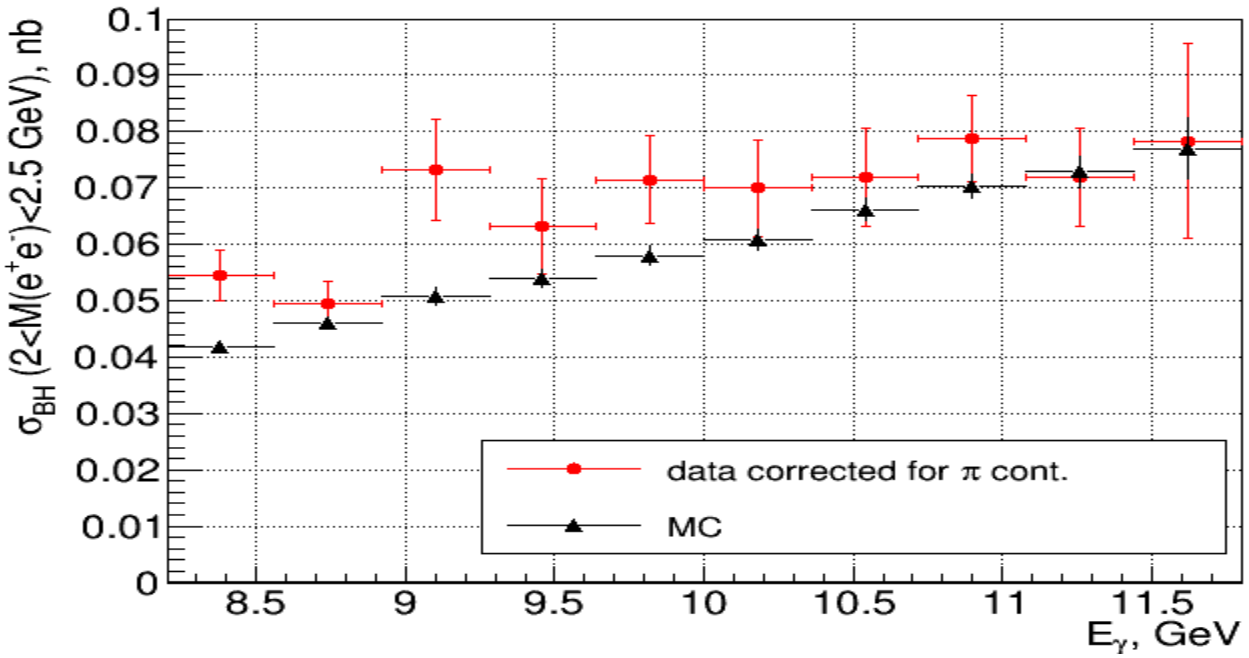


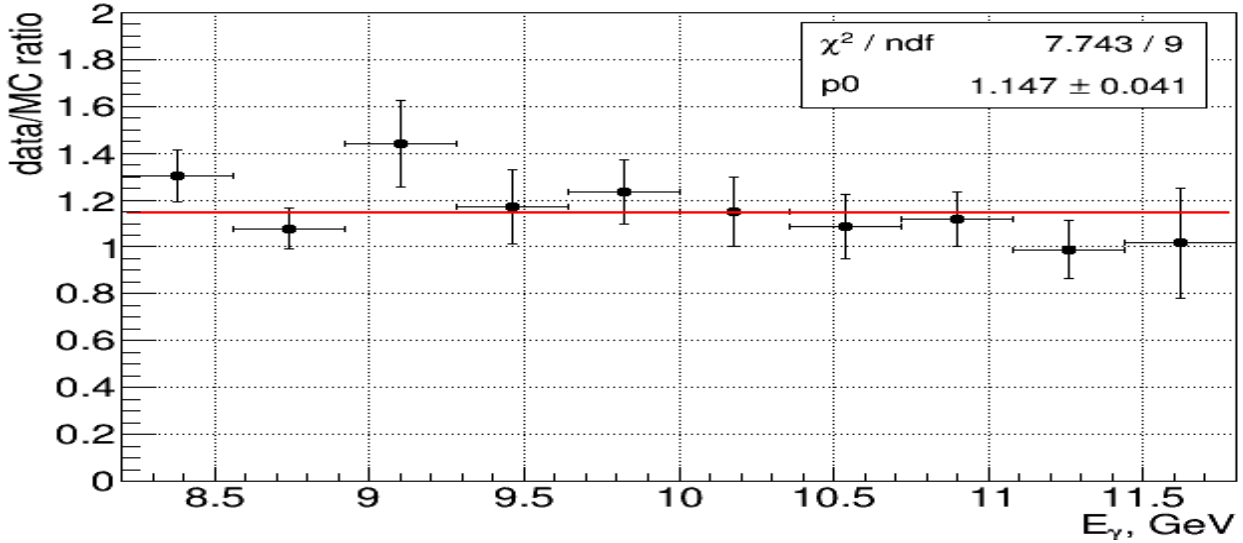
45.4±1.5% π contamination (t<0.6)

no stat. significant E-dependence

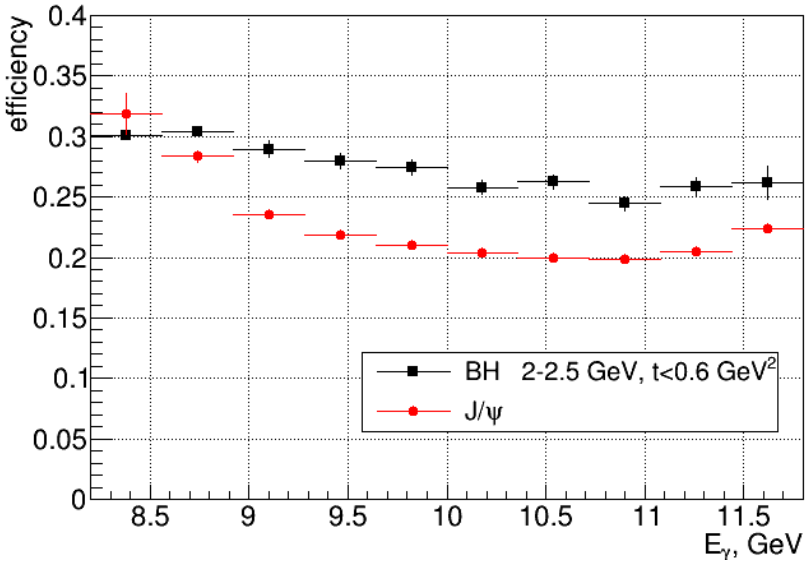
57% for ver3 (all t), 35% ver2 (all t)

BH (2-2.5 GeV) E-distribution for t<0.6 GeV^2

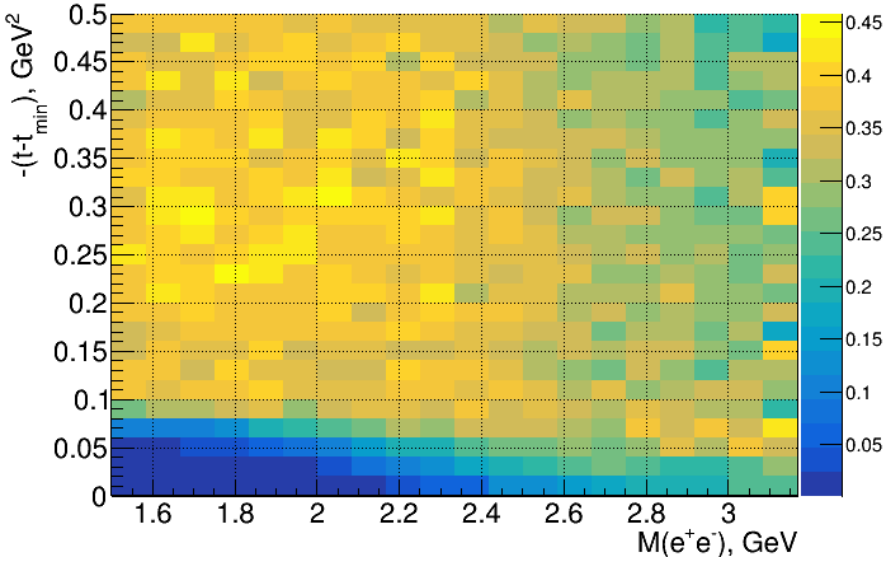


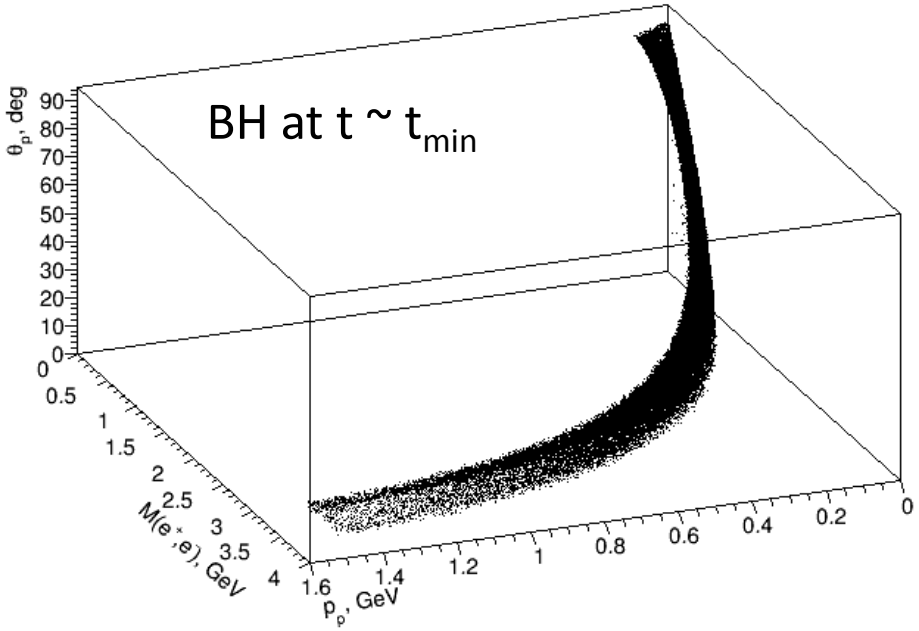


Efficiency comparison BH vs J/ψ

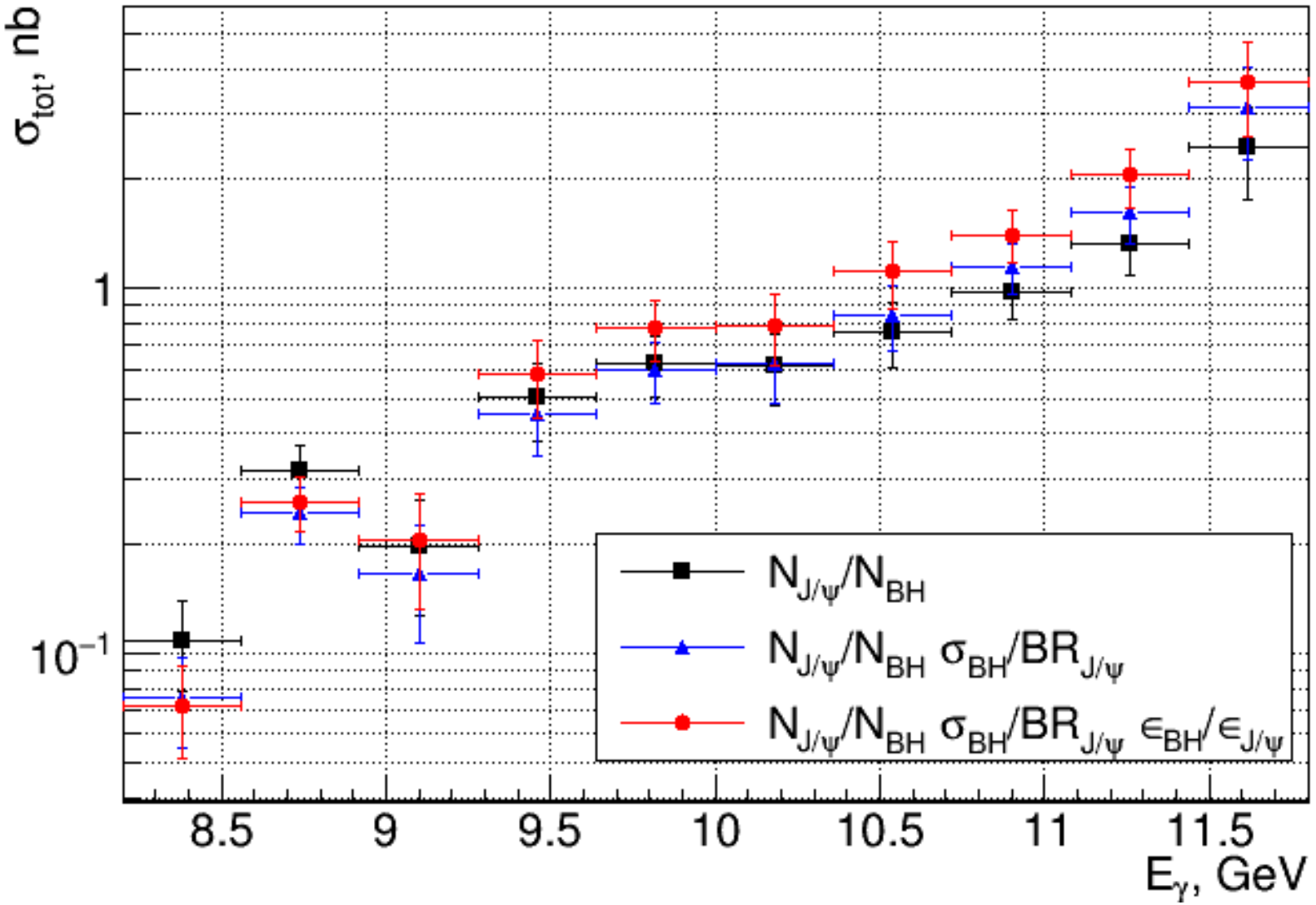


BH efficiency

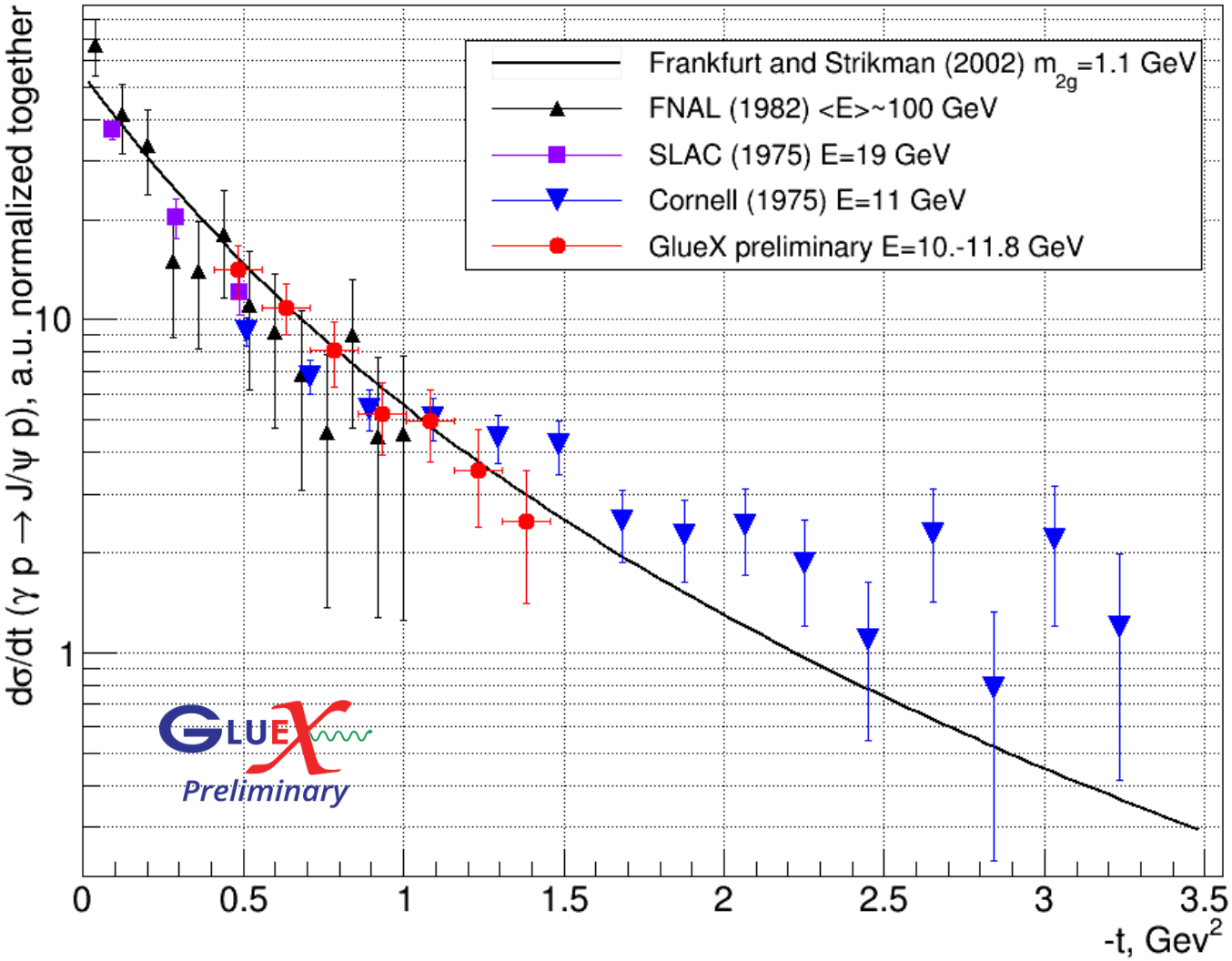




J/ψ cross-section calculations



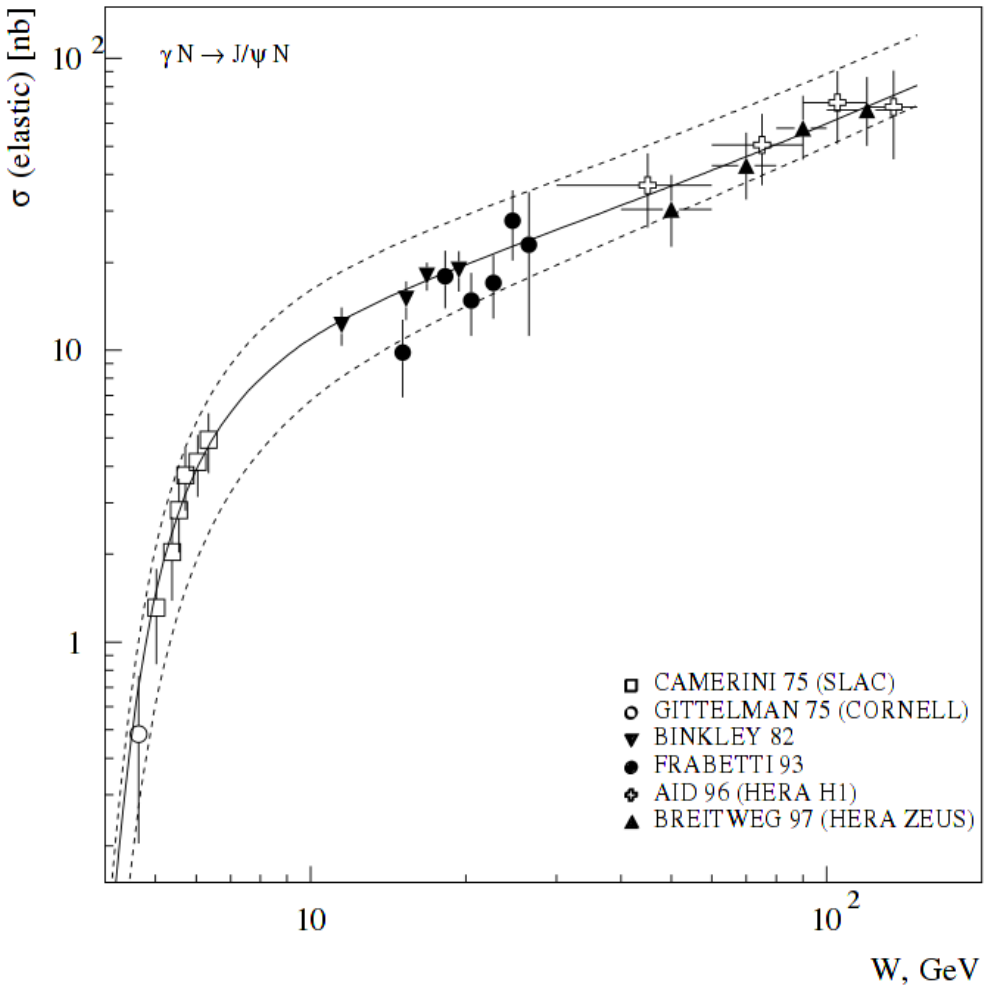
Proton Gluonic Form Factor



$ds/dt \sim 1/(1-t/m_{2g}^2)^4$

i.e. gluonic form-factor in dipole form (Frankfurt and Strikman PRL D66 2002)

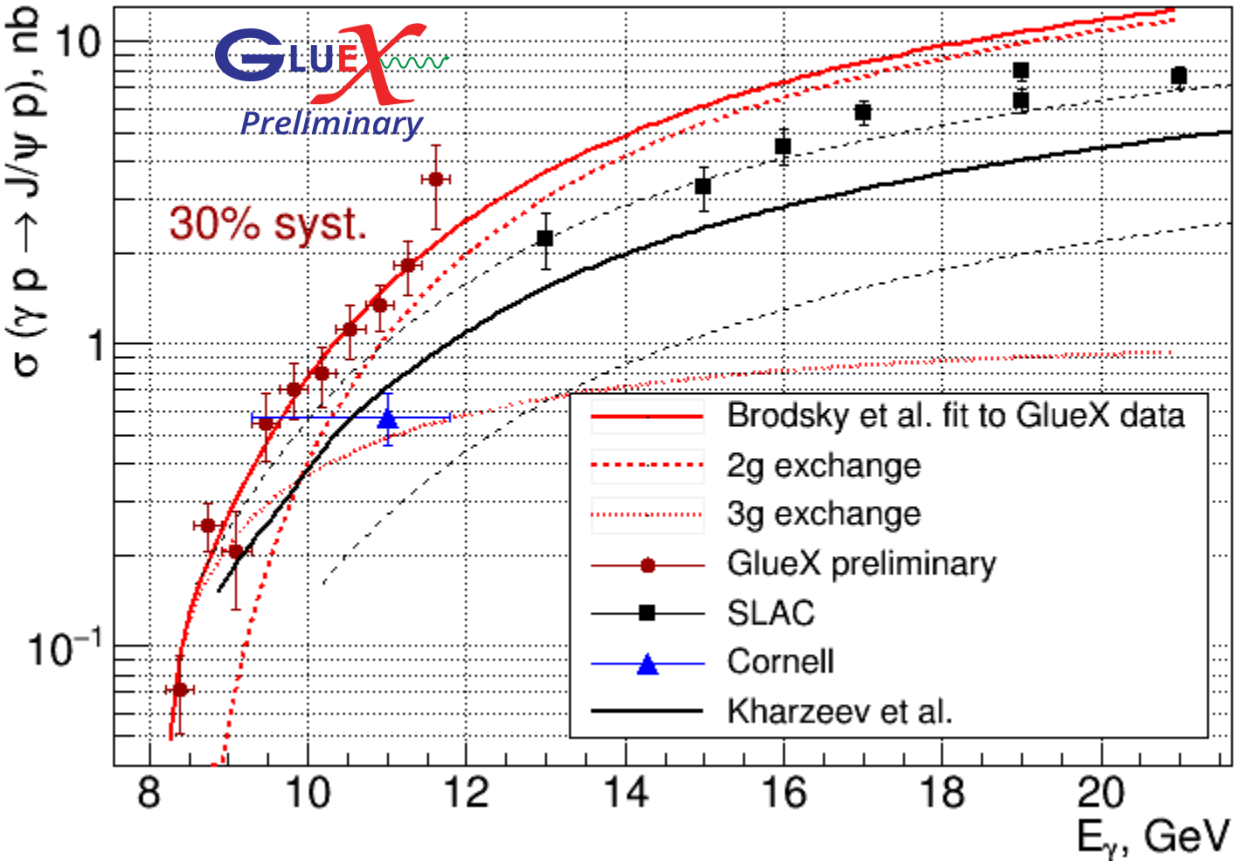
J/ψ threshold photoproduction and the mass of the proton



Kharzeev et al. Eur. Phys. C9 (1999) – Absolute (factor 2-3 uncertainty) perturbative calculations using gluon PDFs

"… at low energies the photoproduction amplitude is proportional to the matrix element of the gluon part of the trace of the QCD energy-momentum tensor evaluated over the nucleon state; this quantity arises from the scale anomaly of QCD. The resulting contribution to the photoproduction amplitude is real …The low-energy J/ψ photoproduction data can thus be used to extract the fraction of the nucleon's mass arising from gluons…"

J/ψ cross-section – preliminary results

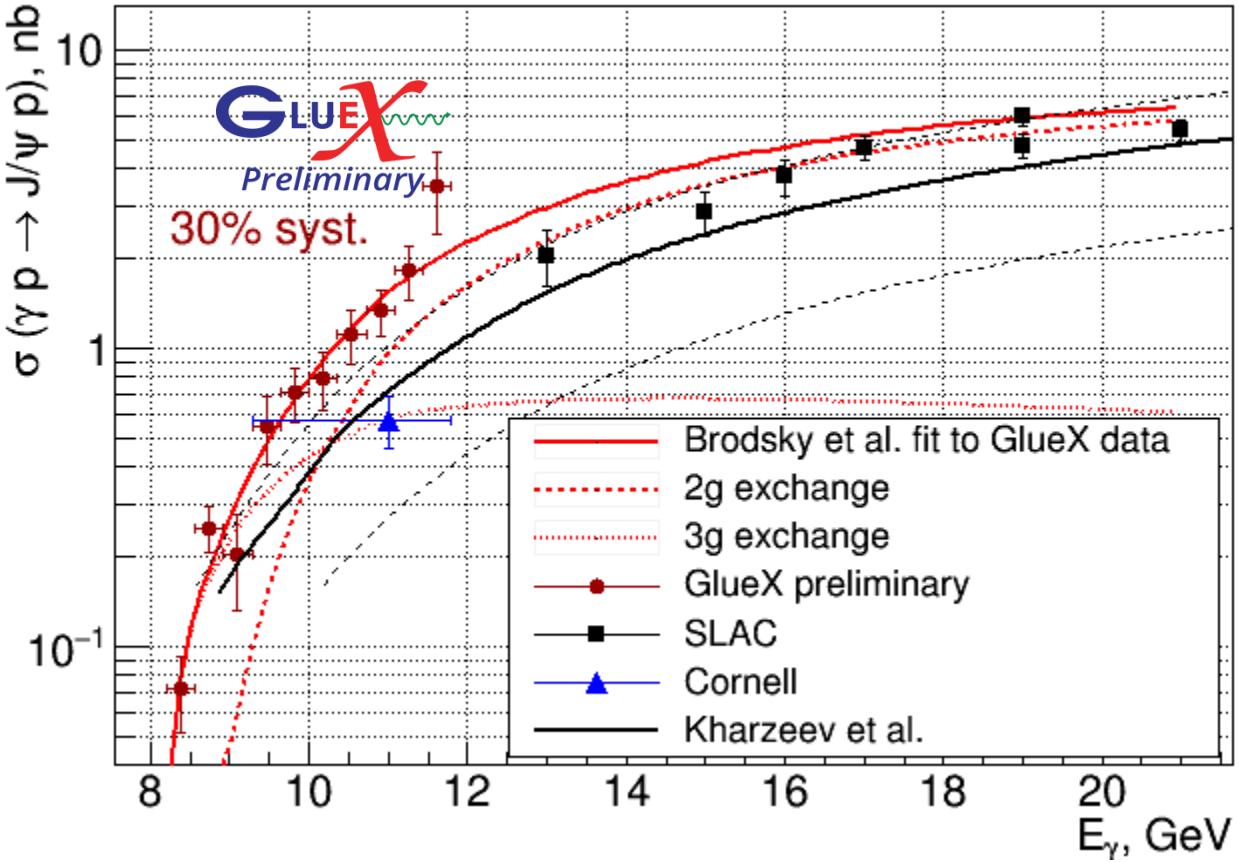


SLAC results calculated from $d\sigma/dt(t=t_{min})$ assuming $\sim 1/(1-t/1.1^2)^4$

Cornell data: horizontal errors represent acceptance

Kharzeev et al. 1999 – gluonic contribution to the mass of the proton – 80% if calculations are verified

J/ψ cross-section – preliminary results



SLAC results calculated from $d\sigma/dt(t=t_{min})$ using t-slope that changes linearly between 19 and 11 GeV: 2.9 to 1.8 GeV^{-2}

Cornell data: horizontal errors represent acceptance

Kharzeev et al. 1999 – gluonic contribution to the mass of the proton – 80% if calculations are verified

Remaining to be done (from my June report)

- REST production and analysis of 2016 (first) and 2017 data, using latest sim-recon
- Generate MC sets of data for each period for BH and J/ψ (and ϕ?) with the latest sim-recon.:
  - For J/ψ with two different t-slopes 1.25 GeV^{-2} (Cornell) and 4 GeV^{-2} (close to BH t-slope)
  - Including Richard's generator for BH
- Repeating the whole J/ψ analysis
- Further work on systematics based on the new results
- Setting limit on pentaquark BR (Sean, Alex A.)
  - Procedure with bins
  - Unbinned analysis:
    - so far JPAC model implemented (Alex A.), need to add flux and efficiency to the pdf
    - how to take into account background (accidental, physics etc.)?
  - effect of the t-channel model (JPAC) might be significant – need other models, but how to take into account s/t-channel interference
- Writing the analysis notes (in parallel)
- Writing the paper (in parallel)

Timeline (from my June report)

- Finishing REST production and analysis launch by the end of August (fall 2018 run starts at that time!)
- Results ready by end of September
- Analysis notes and paper ready by end of October and submitted to the review committee
- Paper submitted for publication by the end of the year

J/ψ threshold photoproduction and the mass of the proton

Kharzeev's statement:

"The J/psi photoproduction is a clean probe of the gluon structure of the nucleon. While at high energies the J/psi photoproduction is adequately described by the Pomeron exchange as well as perturbative QCD models, at low energies the photoproduction amplitude is proportional to the matrix element of the gluon part of the trace of the QCD energy-momentum tensor evaluated over the nucleon state; this quantity arises from the scale anomaly of QCD. The resulting contribution to the photoproduction amplitude is real; its energy dependence has been reconstructed using the (subtracted) dispersion relation.. The low-energy J/psi photoproduction data can thus be used to extract the fraction of the nucleon's mass arising from gluons, and the corresponding spatial distribution."