



Stony Brook University

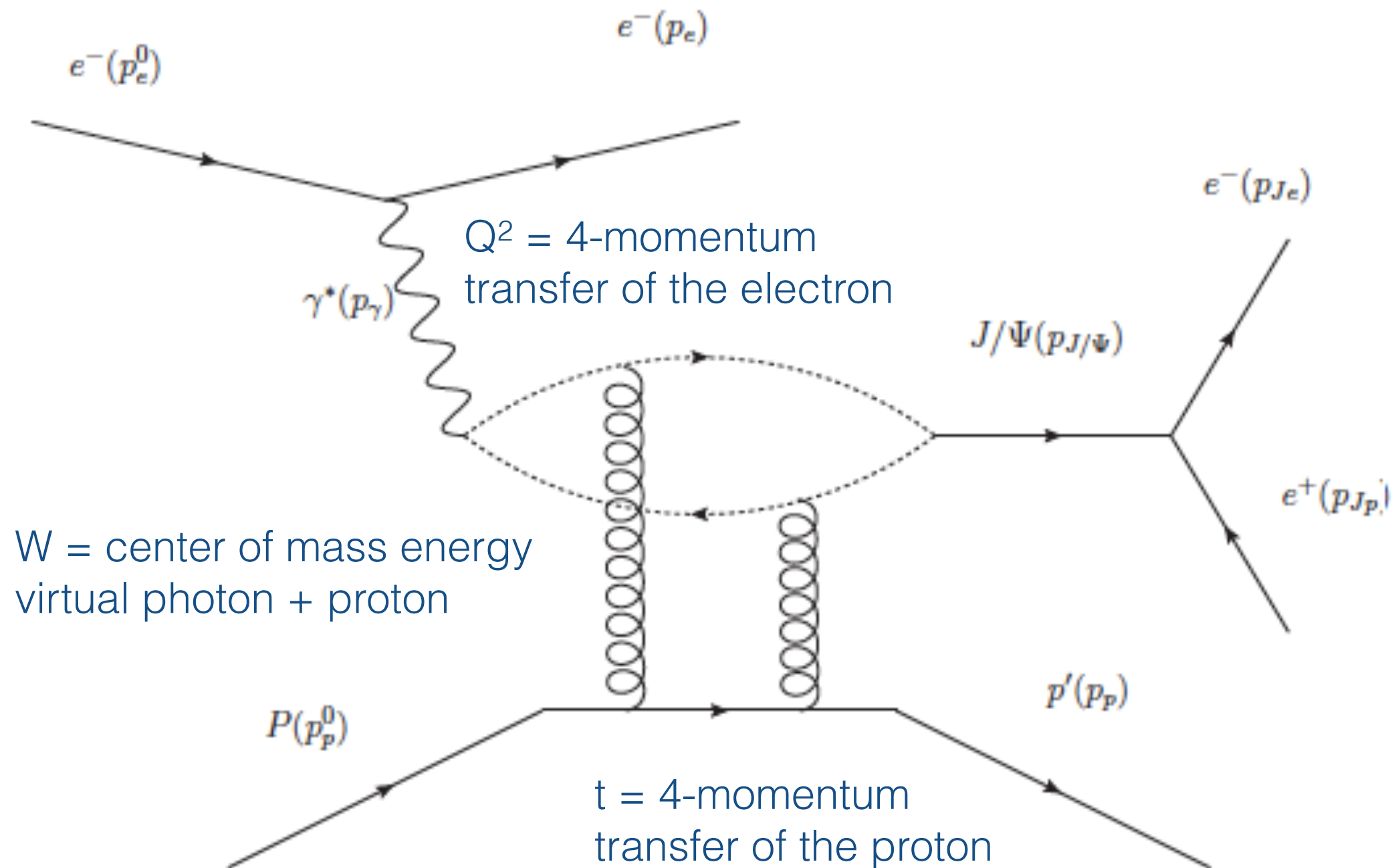
# J/Psi And Upsilon Production At Threshold At The EIC

(Work in progress)

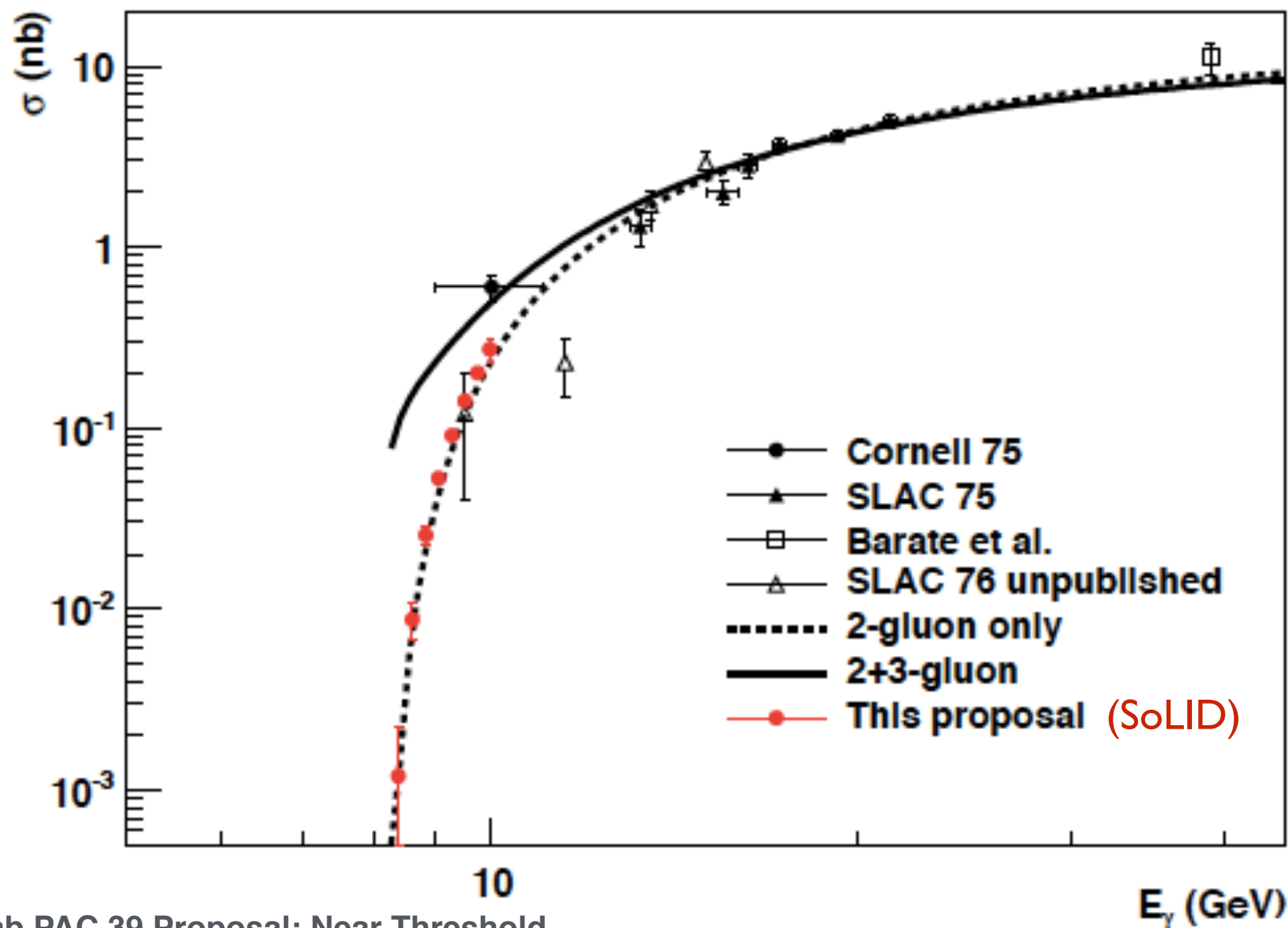
Abhay Deshpande, Nils Feege

The Proton Mass: At the Heart of Most Visible Matter  
April 6, 2017

# J/ $\Psi$ electroproduction in electron-proton collisions

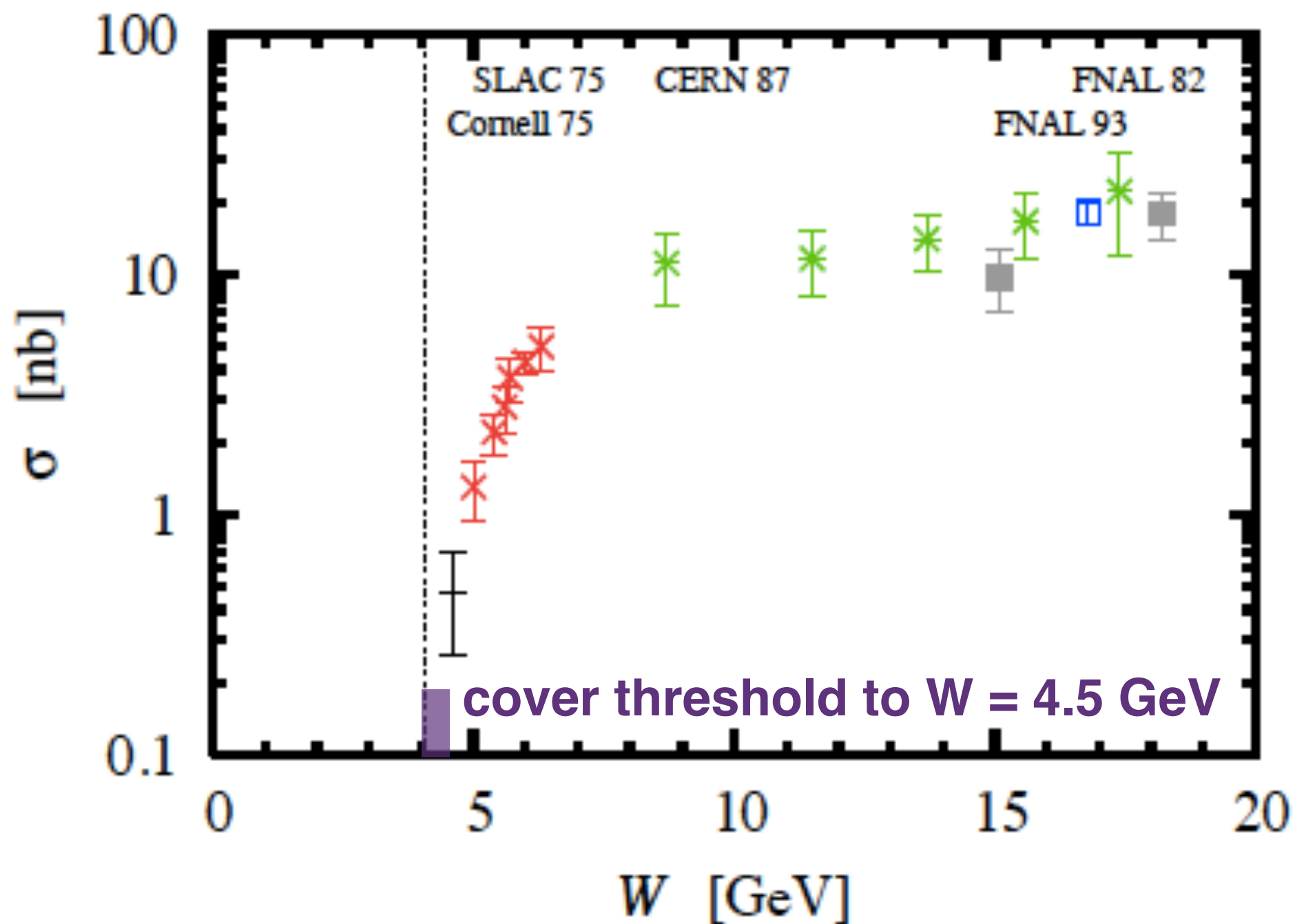


# Total $J/\psi$ photoproduction cross section at SoLID

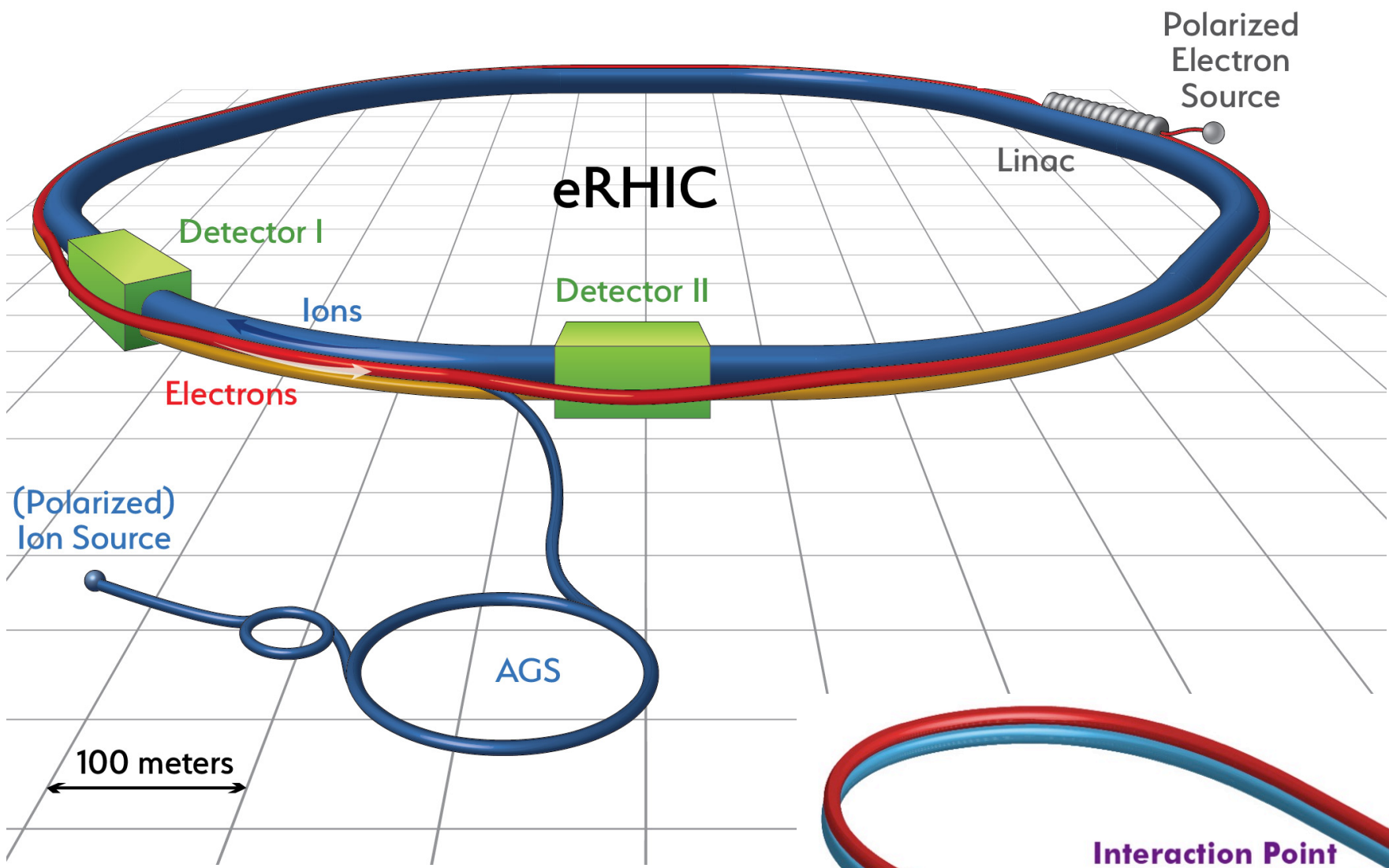


$E_e = 11$  GeV  
 $E_p = 0$  GeV  
 $\sqrt{s} = 4.8$  GeV

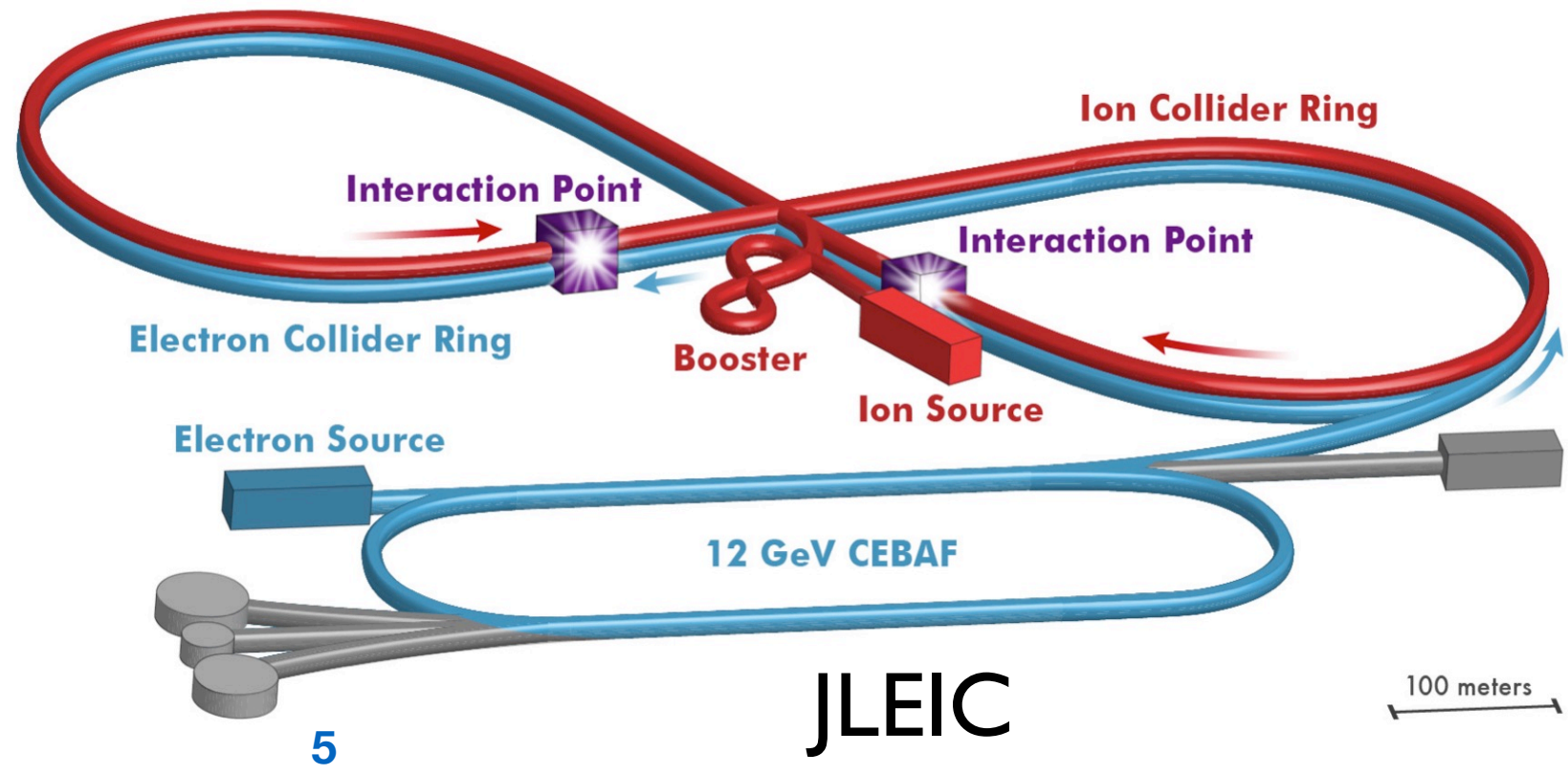
# Total $J/\psi$ photoproduction cross section at CLAS12



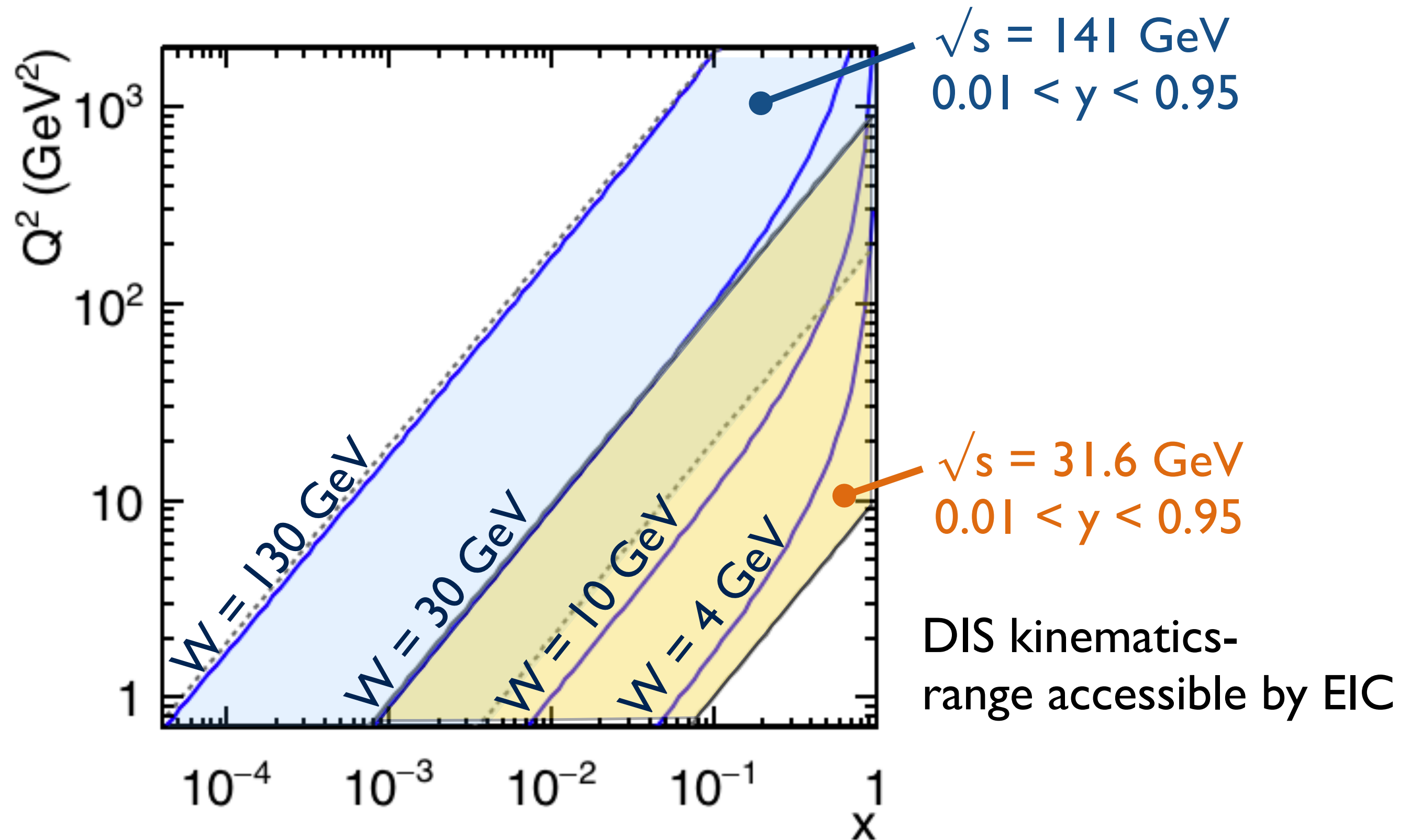
# The Electron Ion Collider



Ee (GeV)	Ep (GeV)	$\sqrt{s}$ (GeV)
5	50	31.6
10	100	63.2
20	250	141

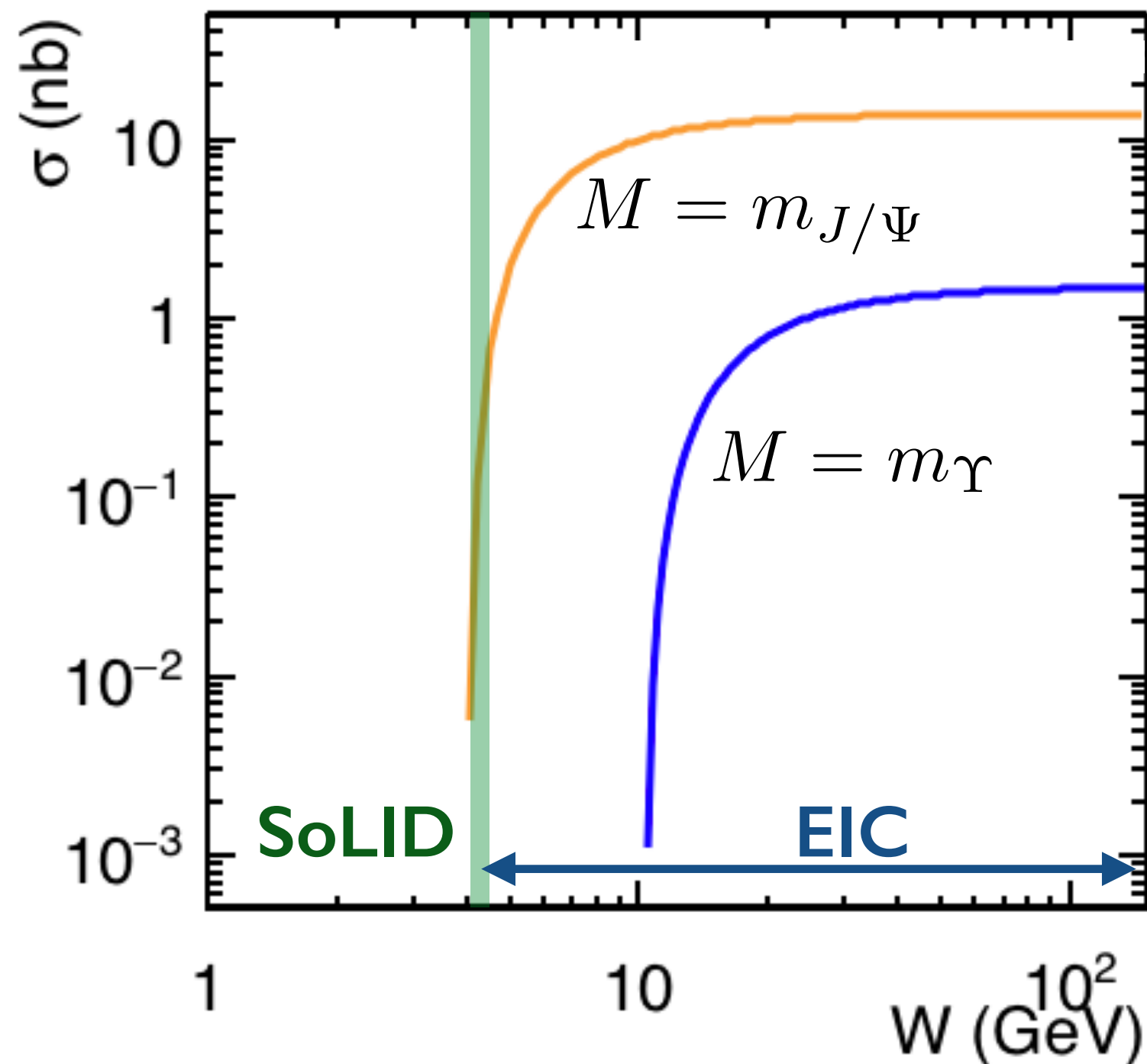


# What can an EIC contribute?





# J/ψ and Upsilon production near threshold at the EIC?



$$\frac{d\sigma}{dt} = N_{2g} v \frac{(1-x)^2}{R^2 M^2} e^{1.13t}$$

$$x = \frac{(2m_p M + M^2)}{(W^2 - m_p^2)}$$

$$v = \frac{1}{16\pi}$$

$$N_{2g} = 7.5671 \cdot 10^3$$

S. J. Brodsky et al,  
*Phys. Lett.*, B498:23, 2001

# J/ $\Psi$ and Upsilon production near threshold at the EIC?



Use SoLID event generator for J/ $\Psi$  production near threshold.

Thanks Zhiwen Zhao and Xin Qian!

Reproduce SoLID plots ( $E_e = 11$  GeV).

Adapt for EIC: Use  $m_{J/\Psi}$  or  $m_\Upsilon$ , simulate as 'fixed target' and boost final state particles.

Run simulations for EIC luminosity and detector acceptances.

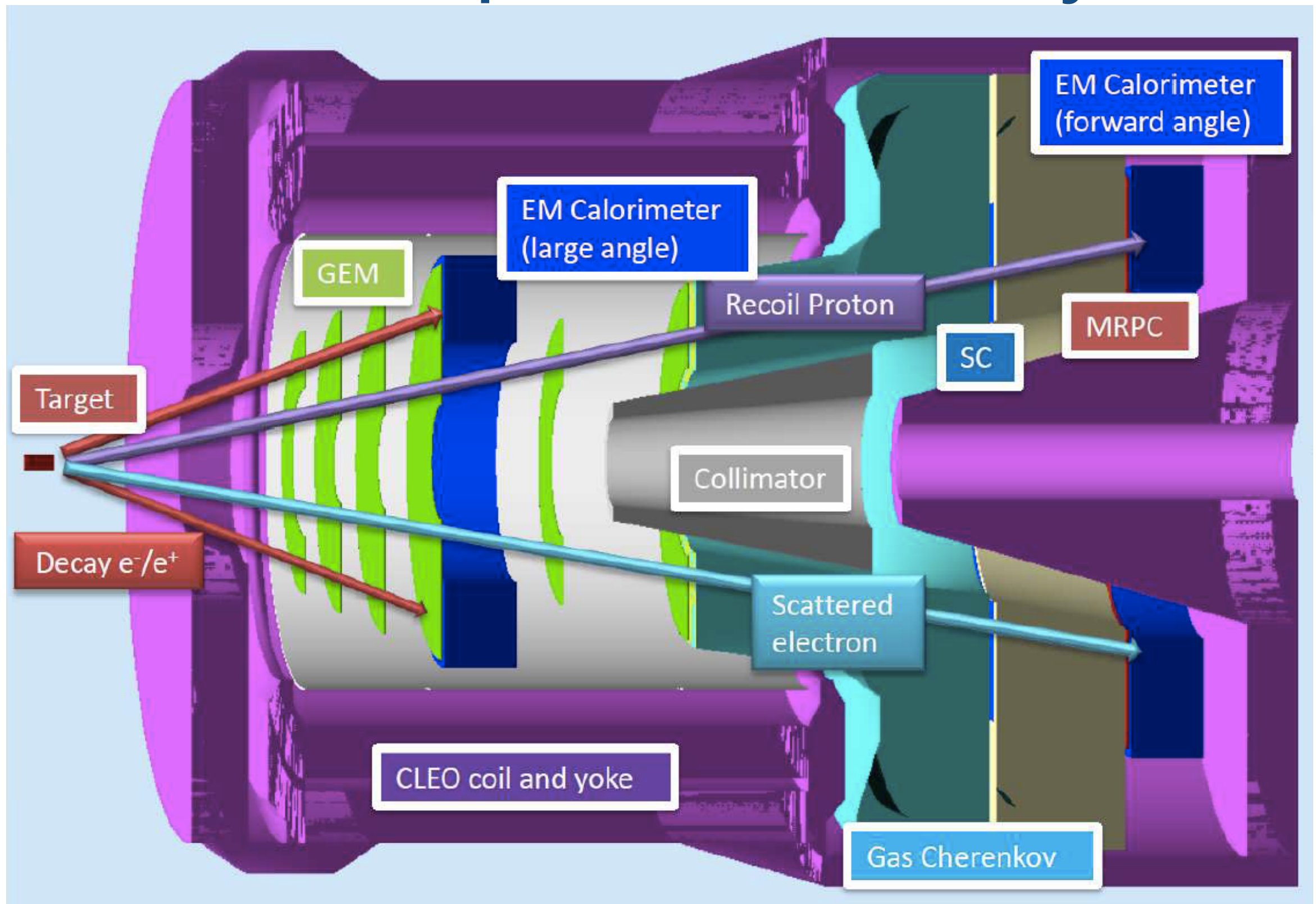


# SoLID event generator

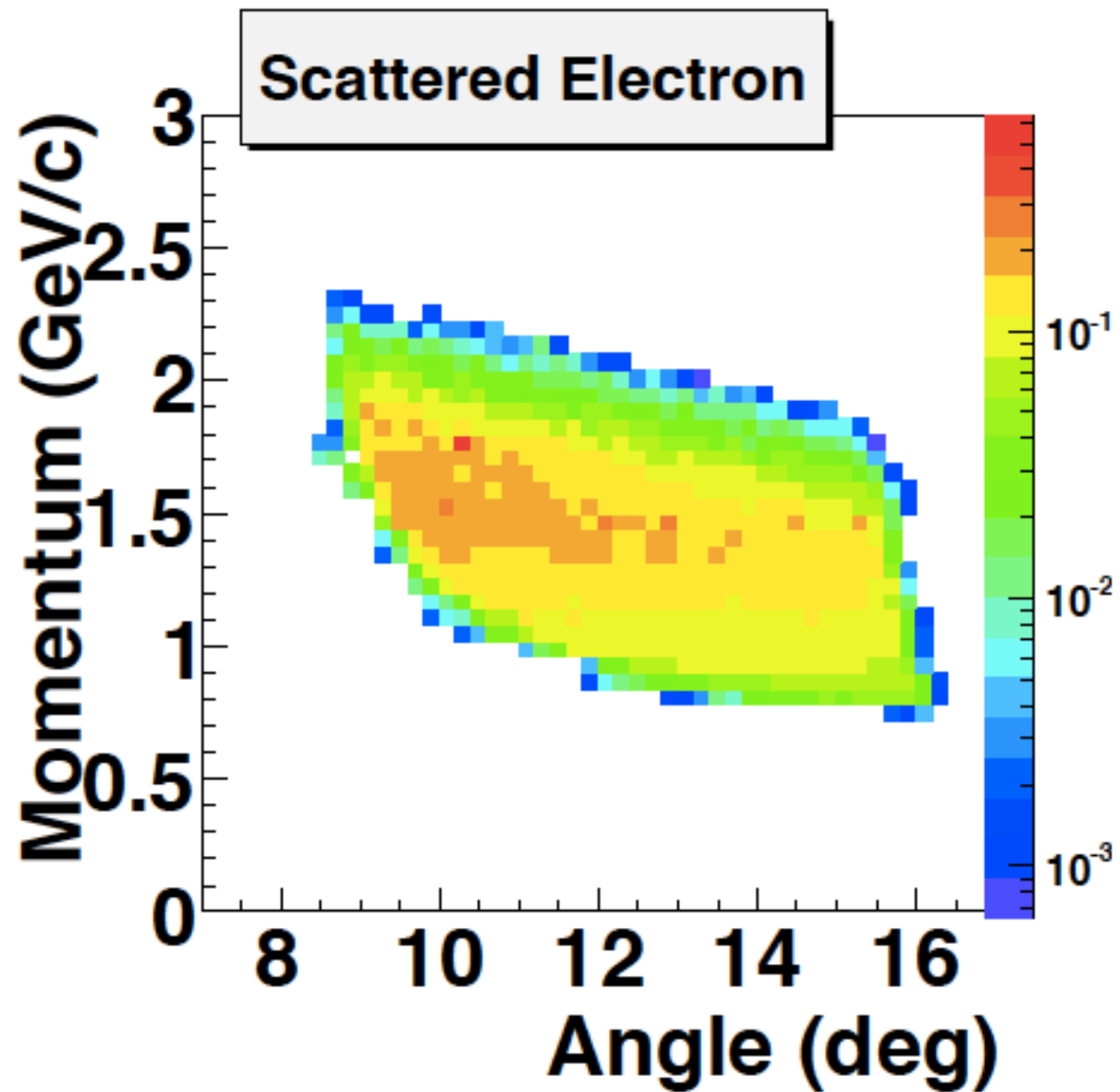
## Simulation Procedure

- Uniformly generate scattered e's angles and momentum
  - Determine if the invariant mass of the rest system is good for a  $J/\psi$  and a proton.
- Uniform sample recoil proton's angles
  - Calculate the momentum of the recoil proton. (2 solutions normally)
- Calculate cross section and decay probability
  - Apply acceptance.

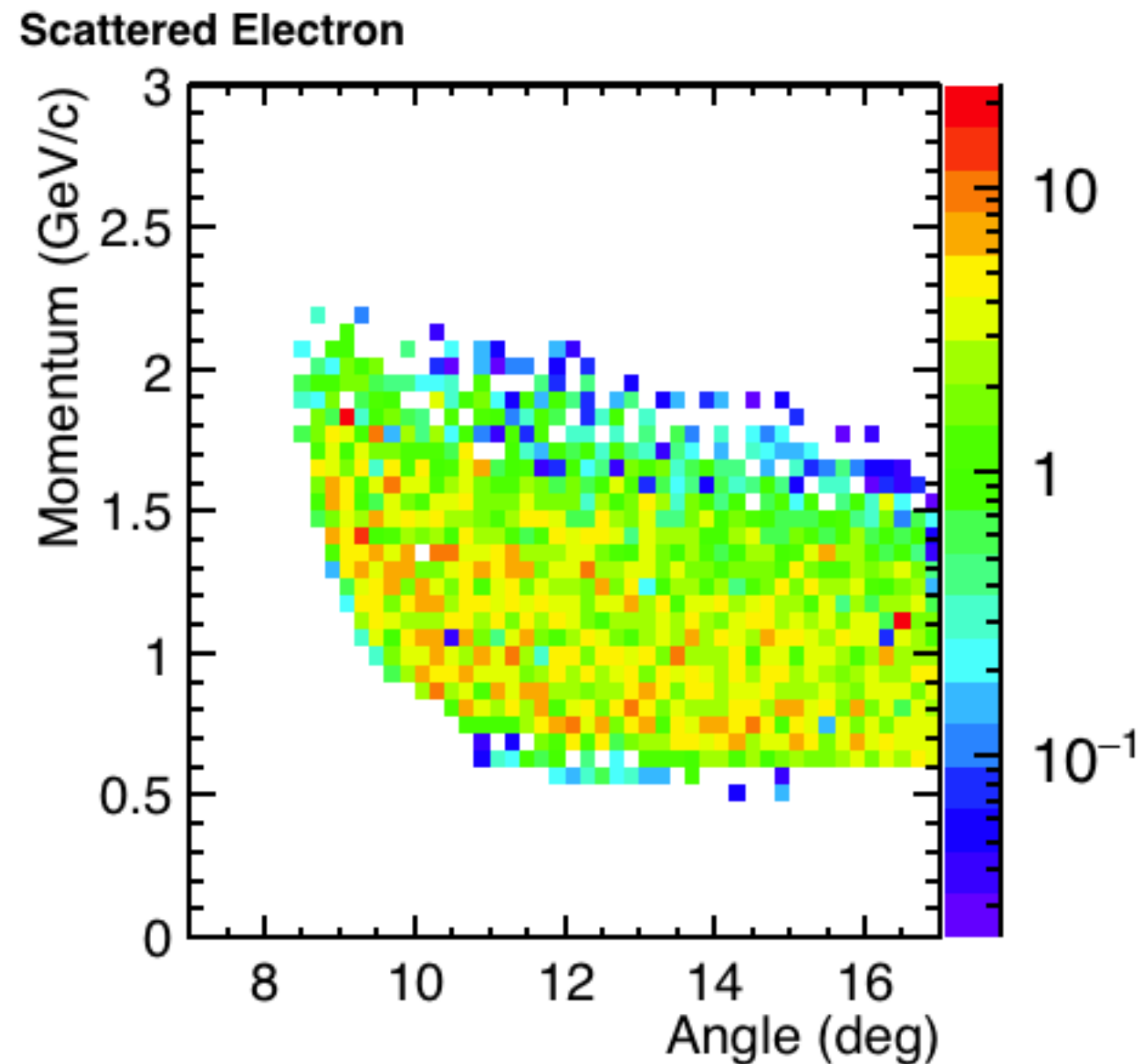
# SoLID Experimental Layout



# Reproducing SoLID plots

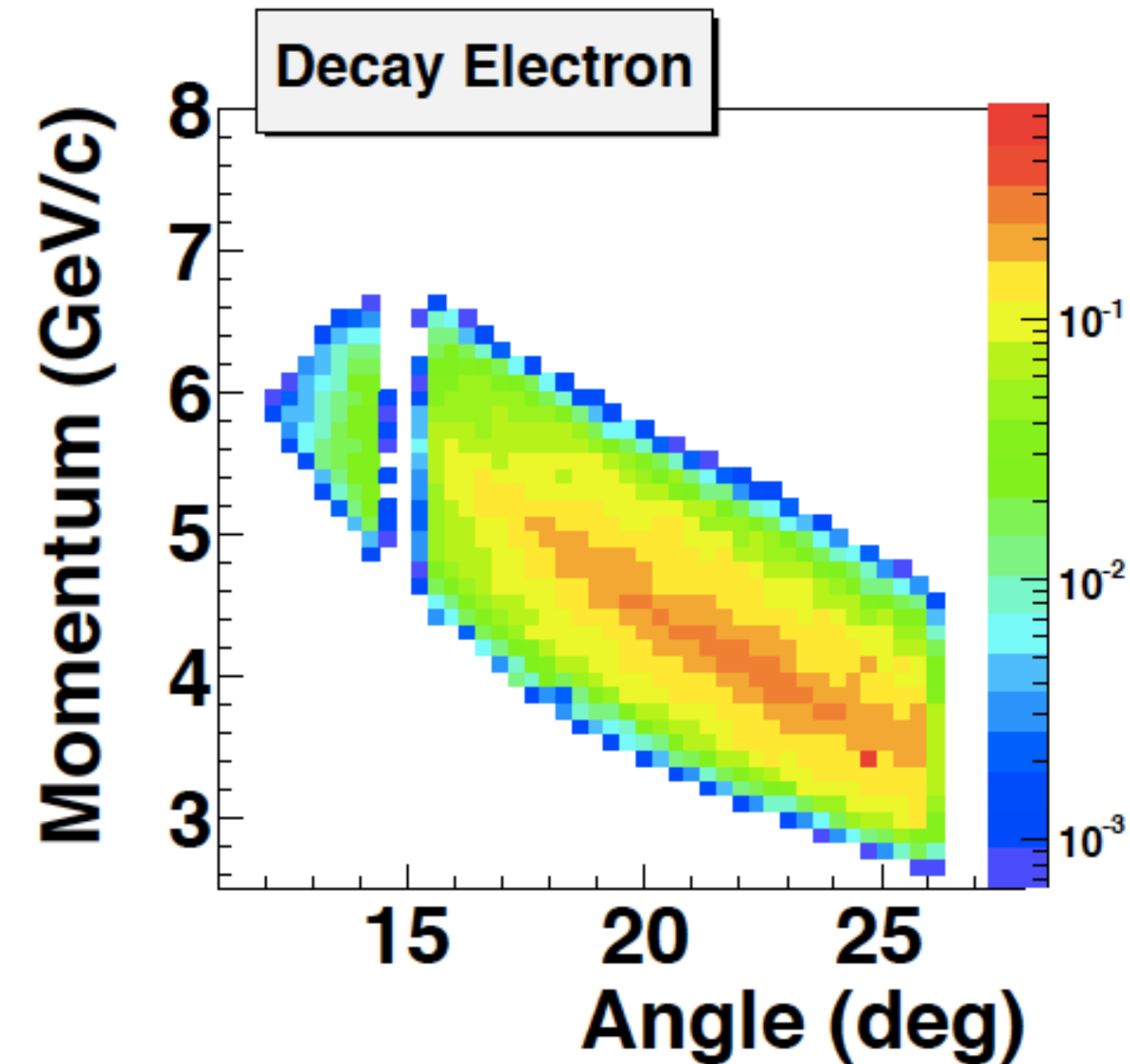


JLab PAC 39 Proposal: Near Threshold  
Electroproduction of J/Psi at 11 GeV (SoLID)

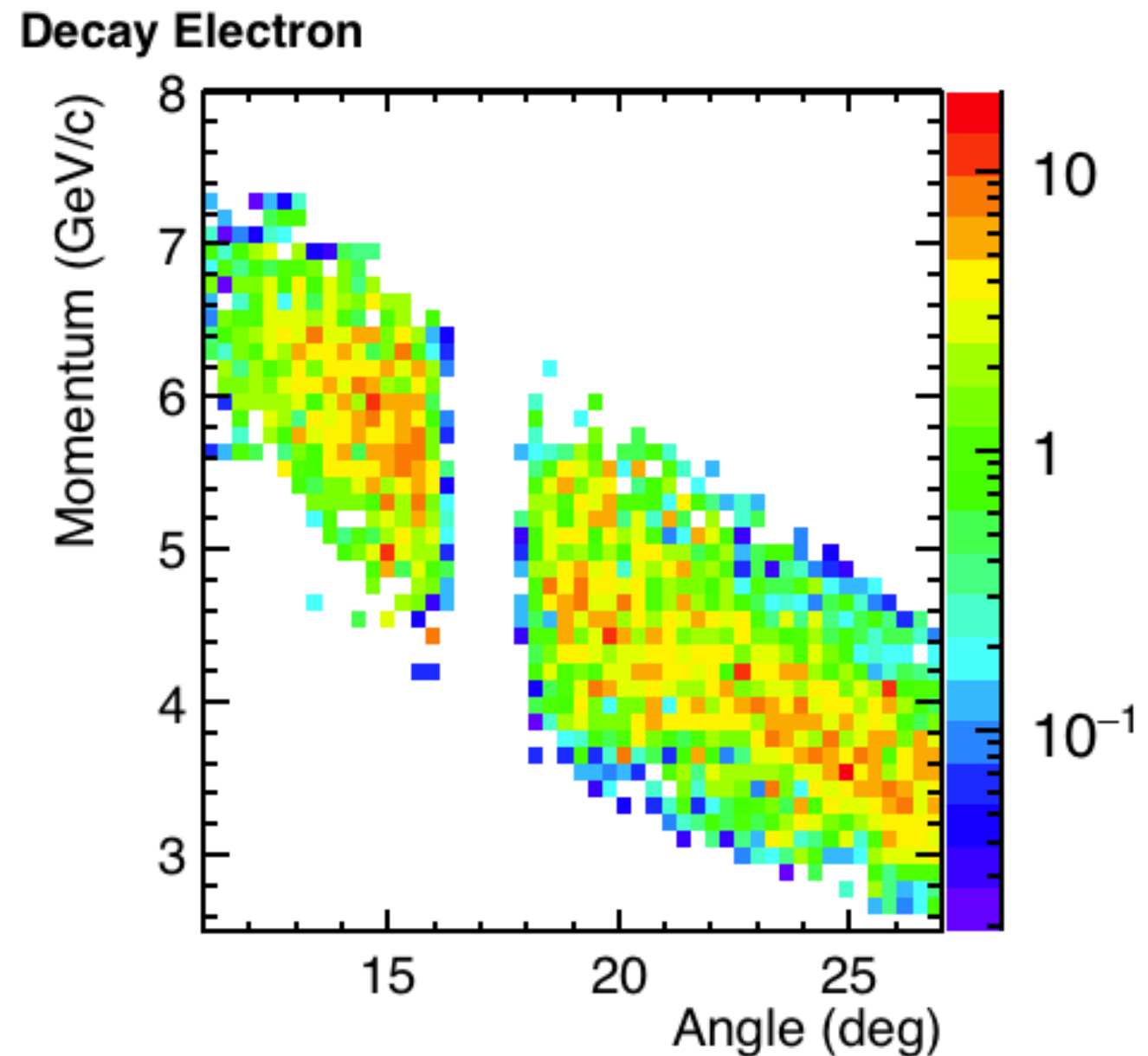


electro-production, 11 GeV

# Reproducing SoLID plots



JLab PAC 39 Proposal: Near Threshold  
Electroproduction of J/Psi at 11 GeV (SoLID)

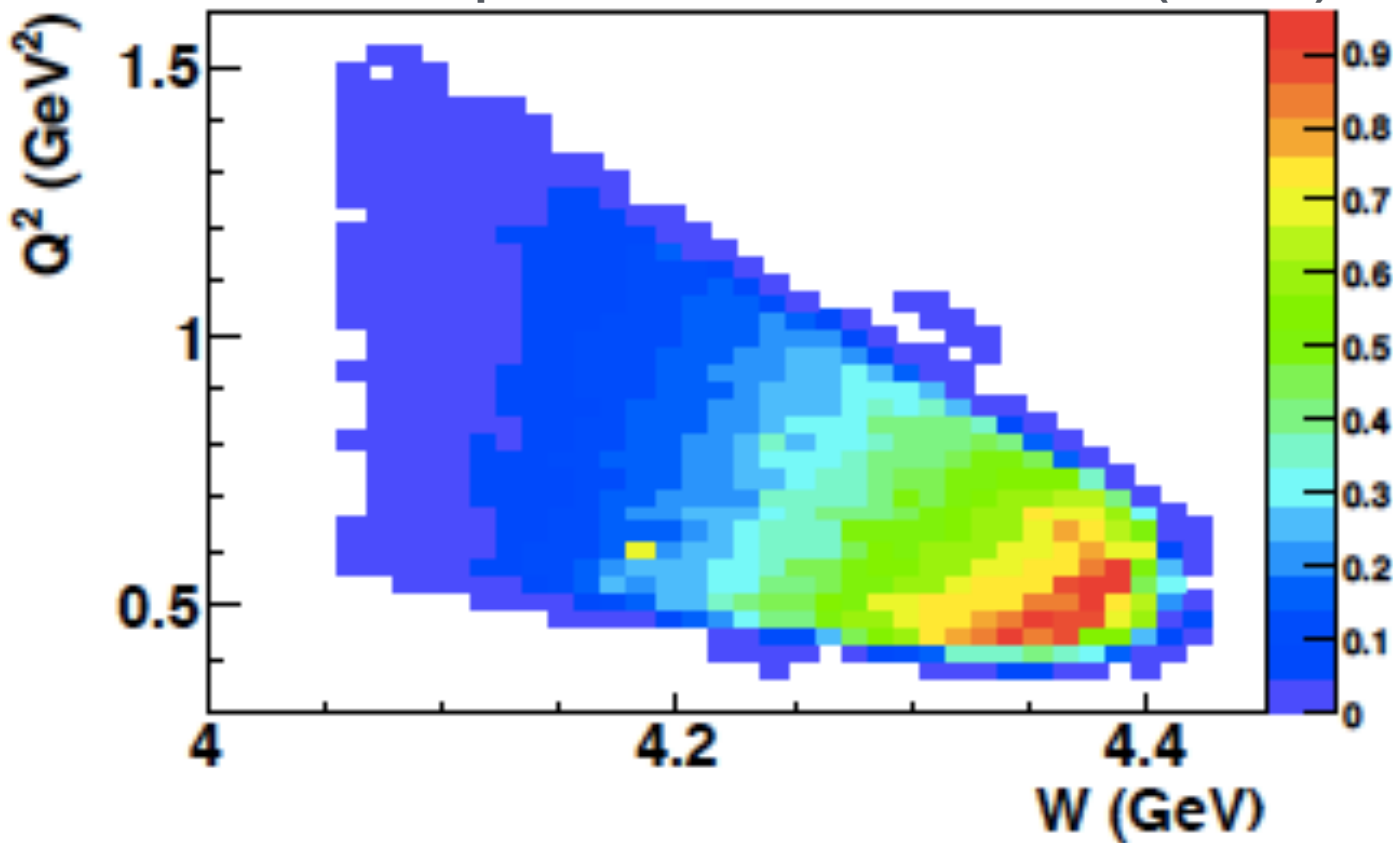


electro-production, 11 GeV

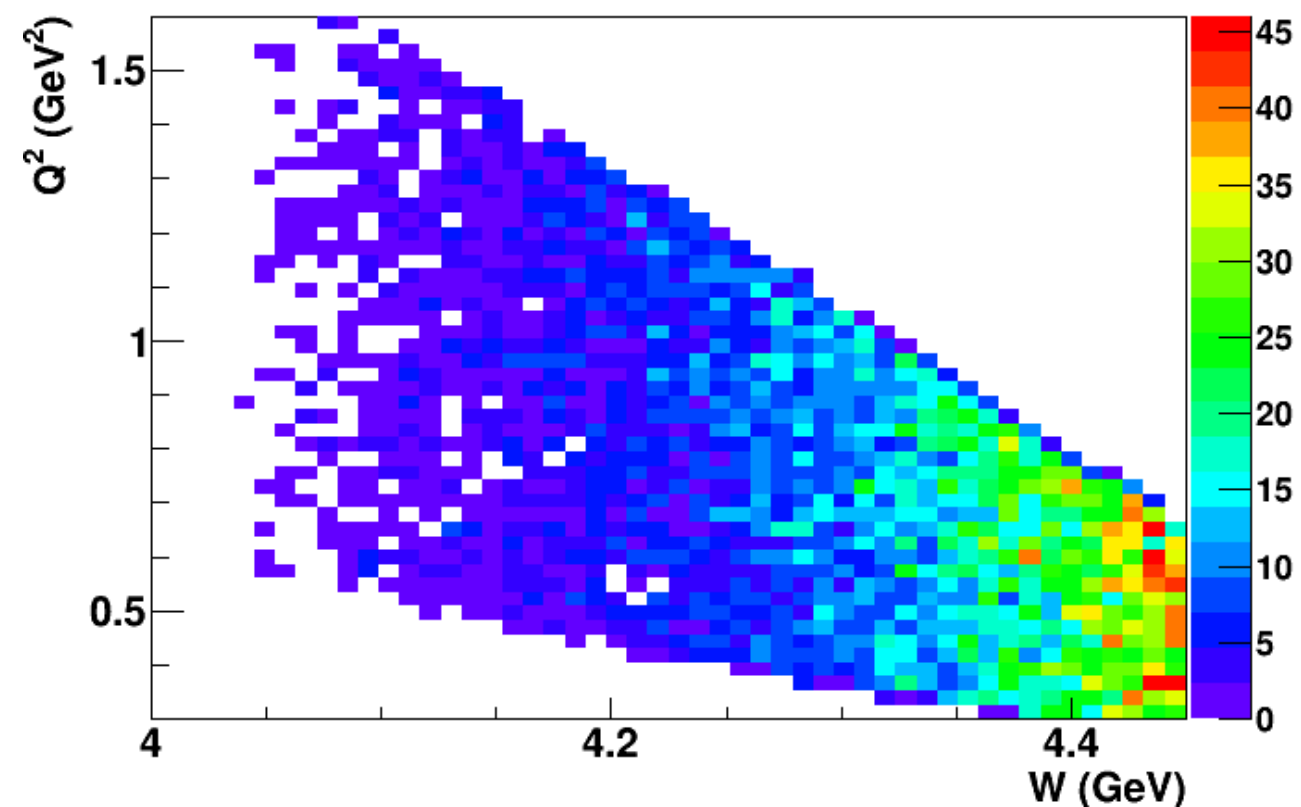


# Reproducing SoLID plots

JLab PAC 39 Proposal: Near Threshold  
Electroproduction of J/Psi at 11 GeV (SOLID)



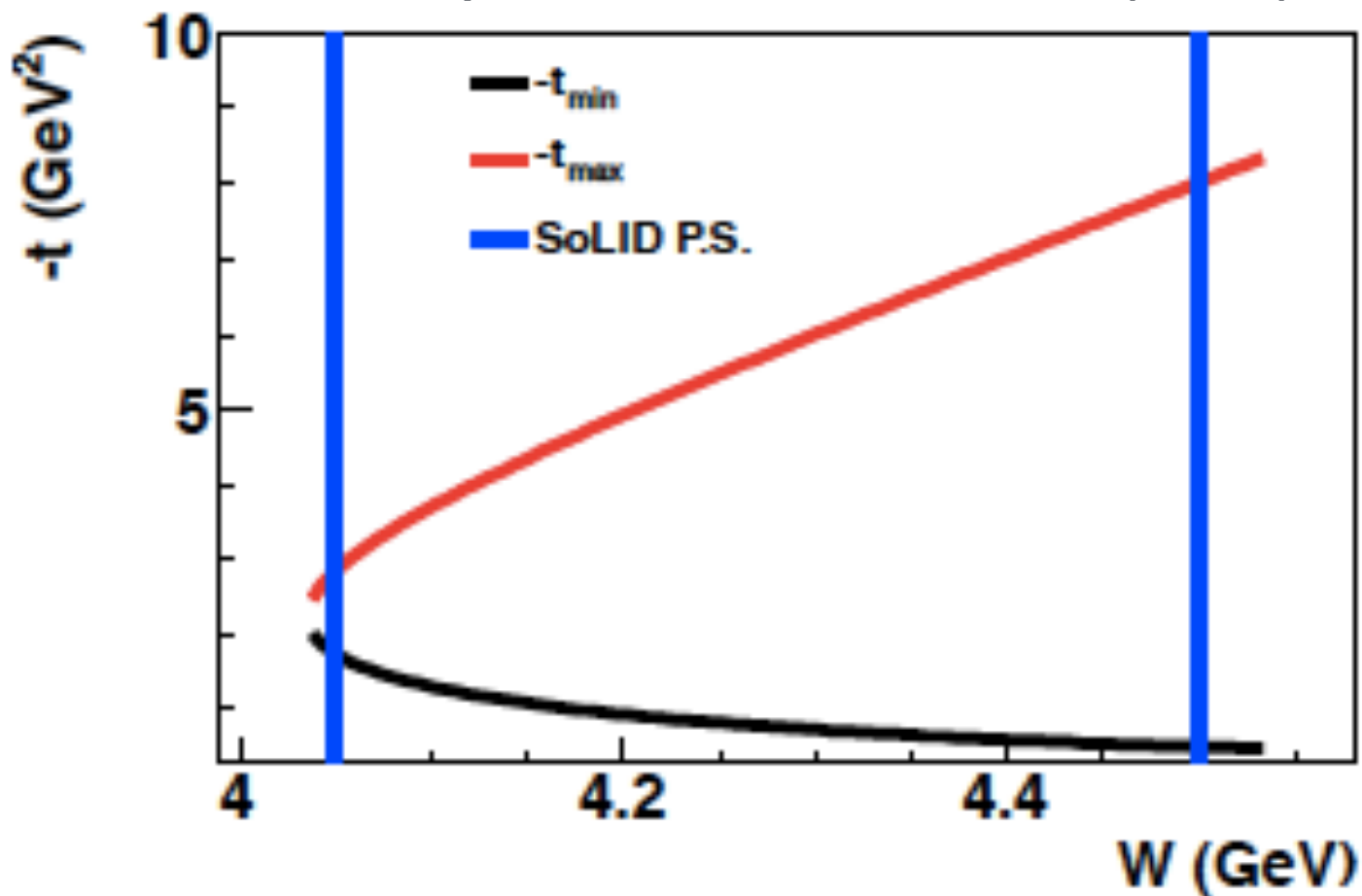
electro-production, 11 GeV



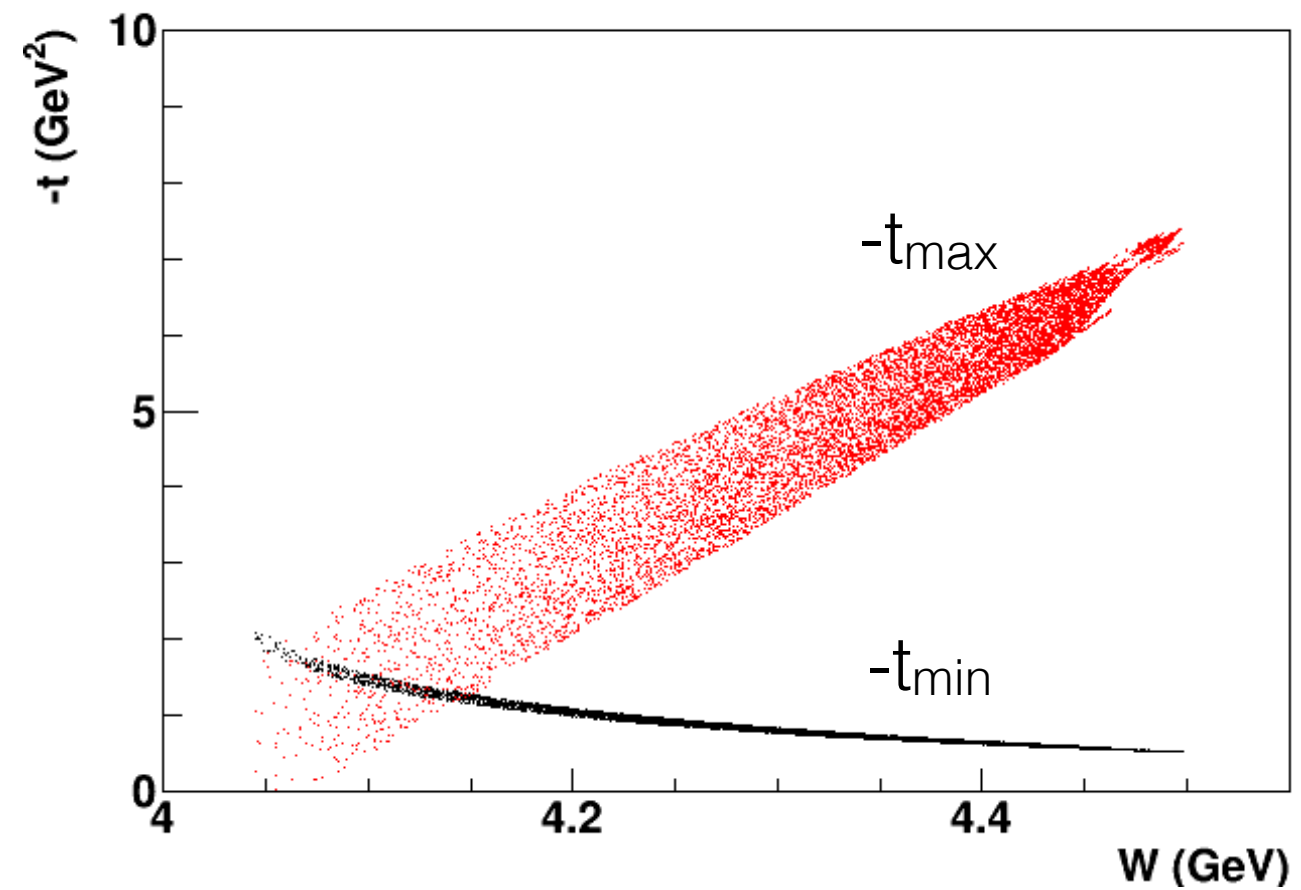


# Reproducing SoLID plots

JLab PAC 39 Proposal: Near Threshold  
Electroproduction of J/Psi at 11 GeV (SOLID)

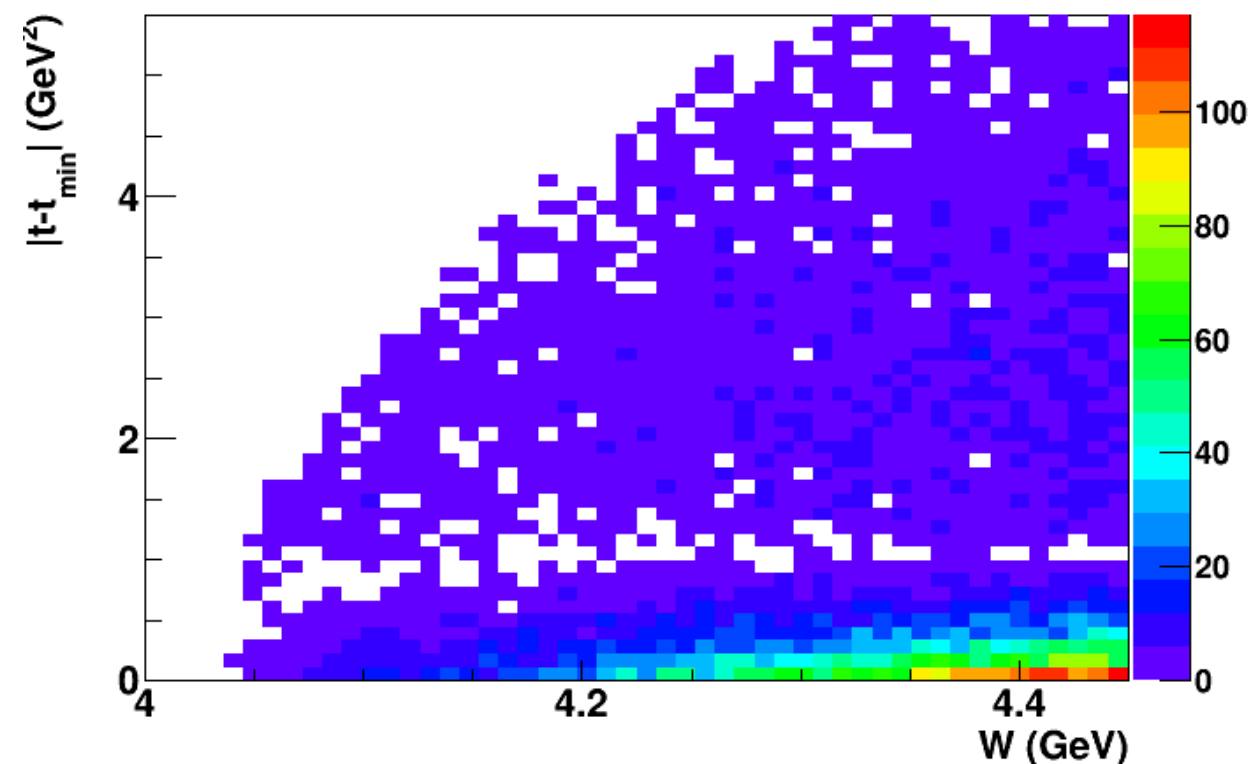
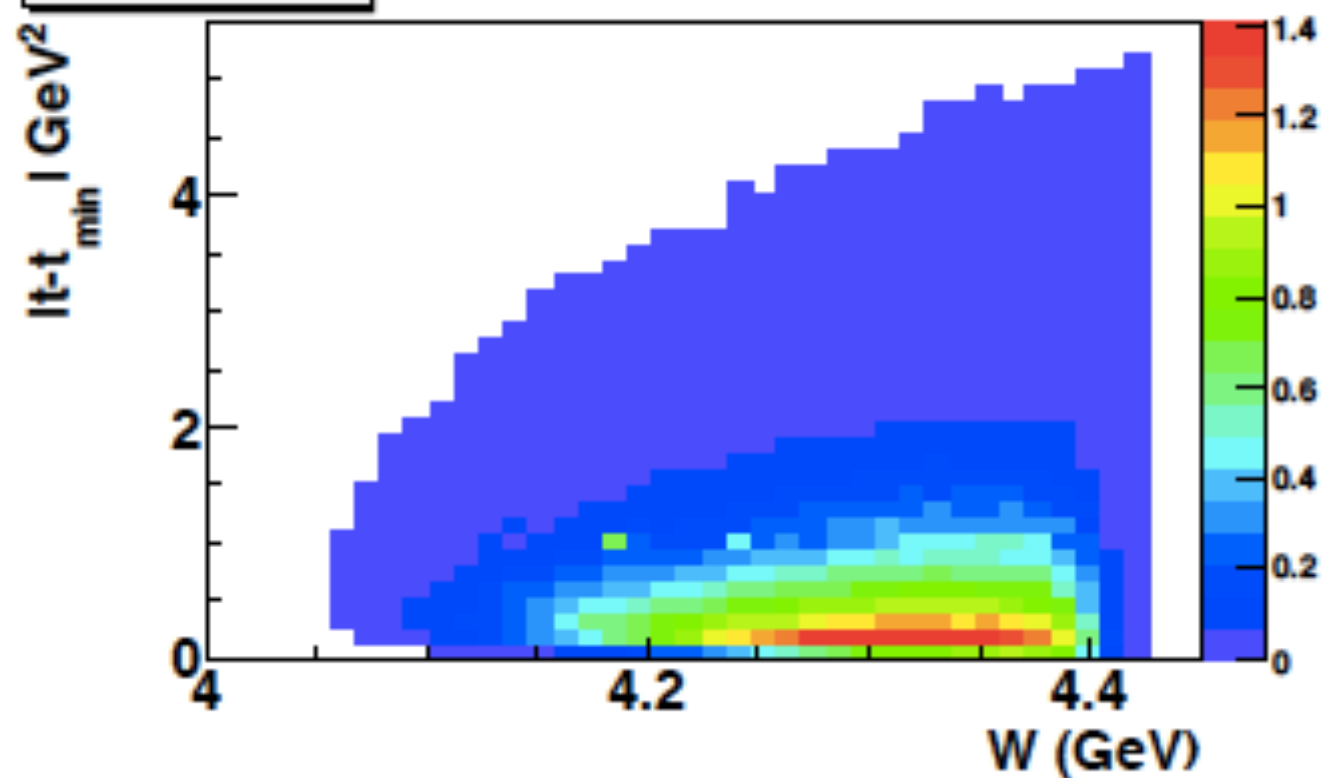


electro-production, 11 GeV

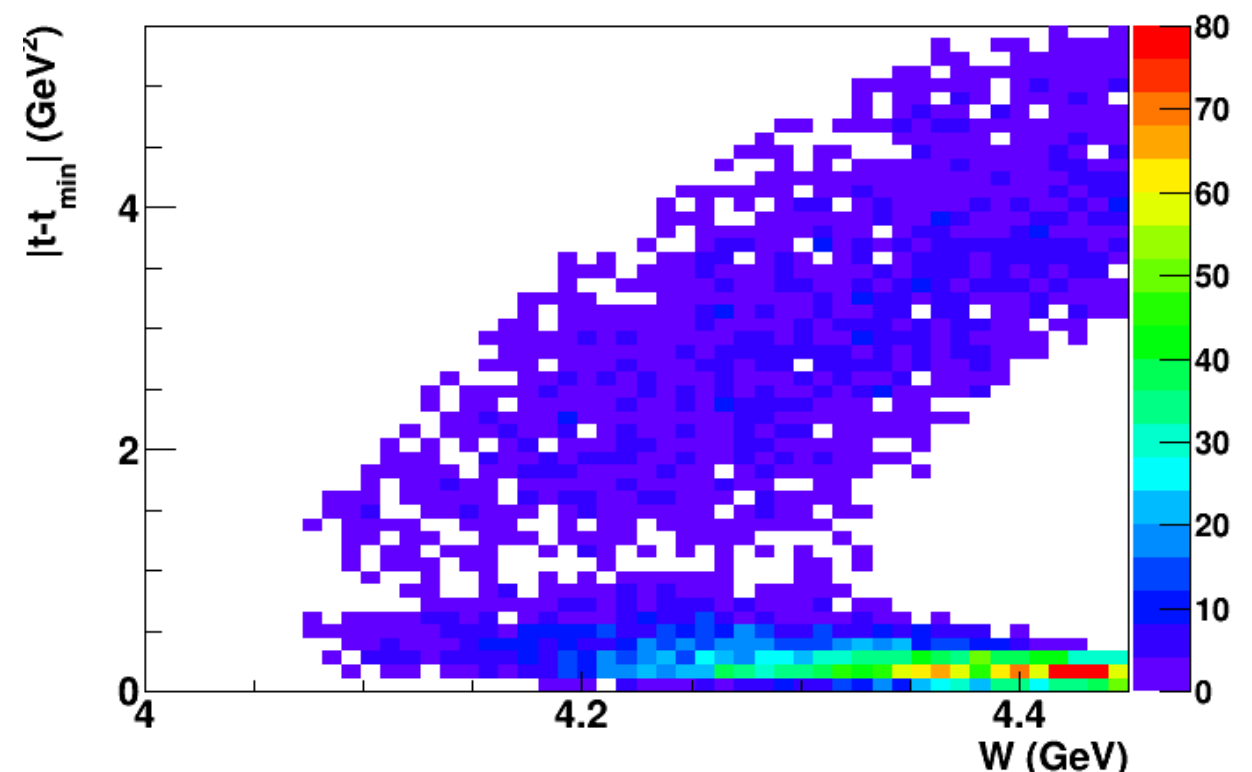
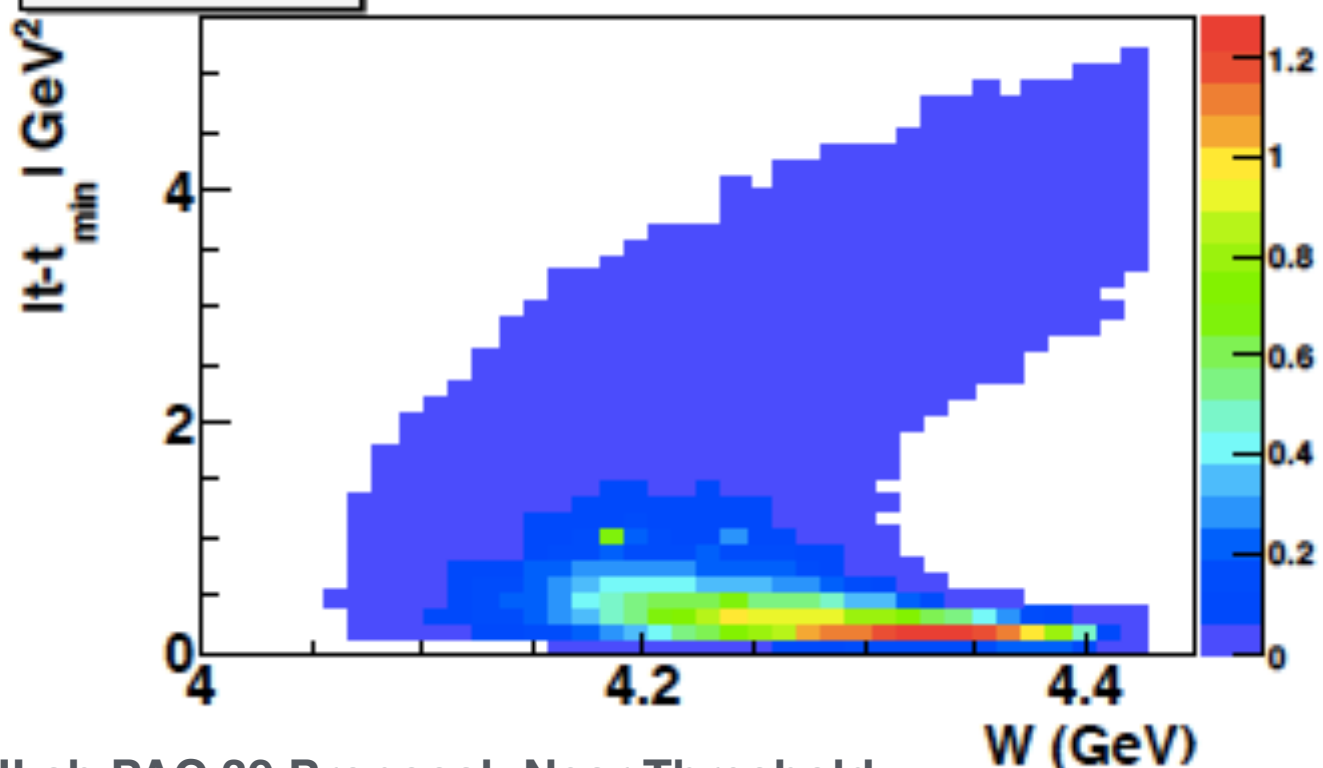


# Reproducing SoLID plots

3-Fold Channel

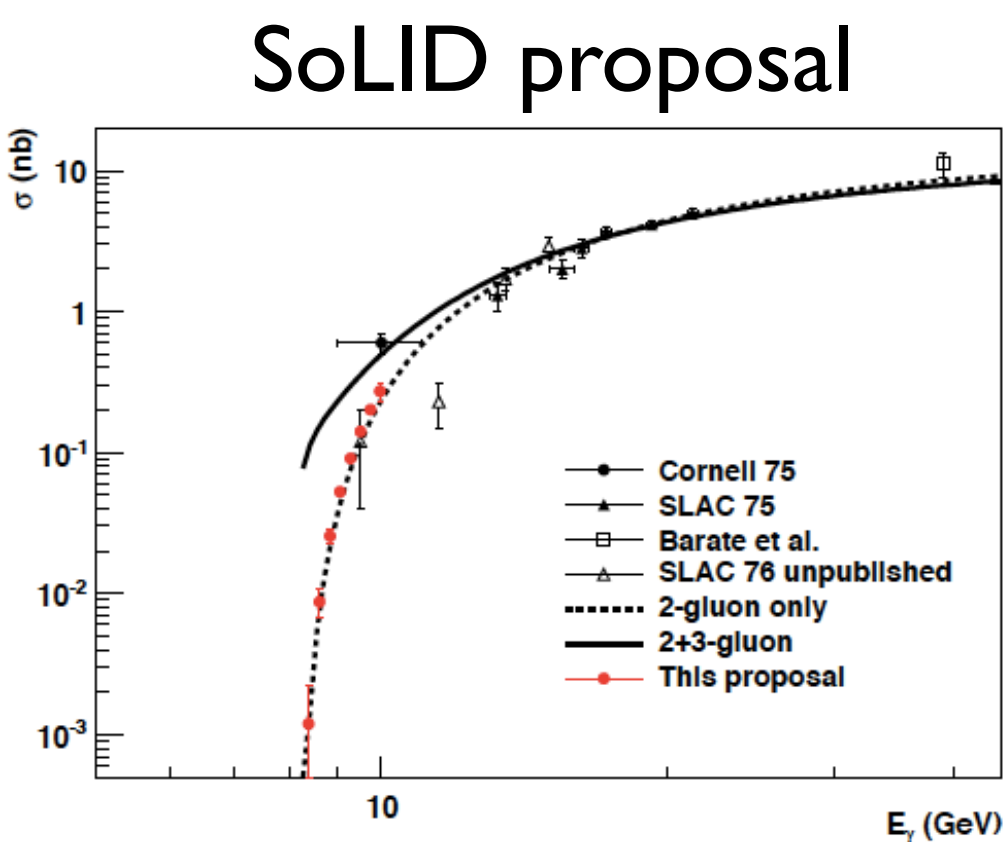


4-Fold Channel

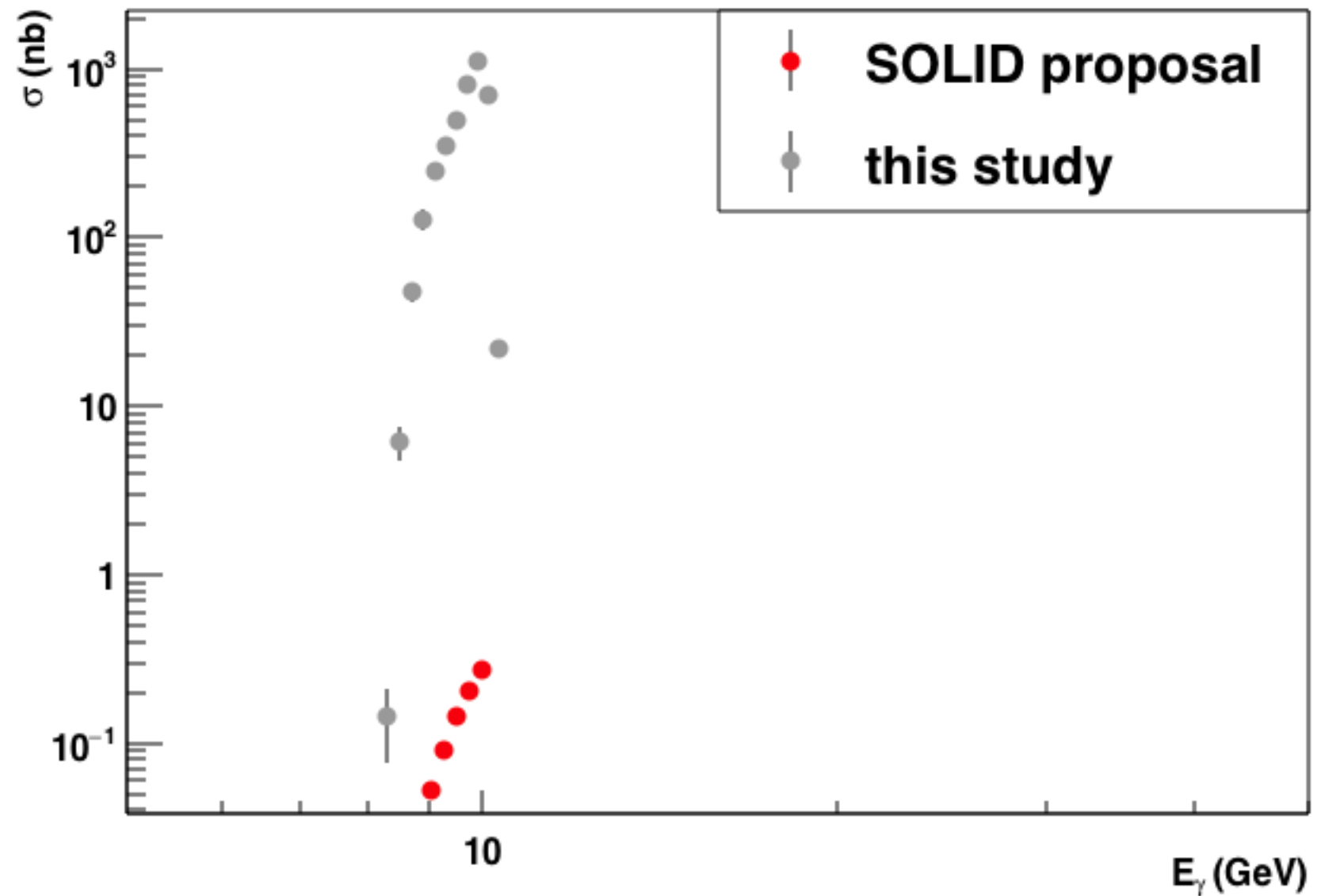


# Reproducing SoLID plots

## SoLID proposal

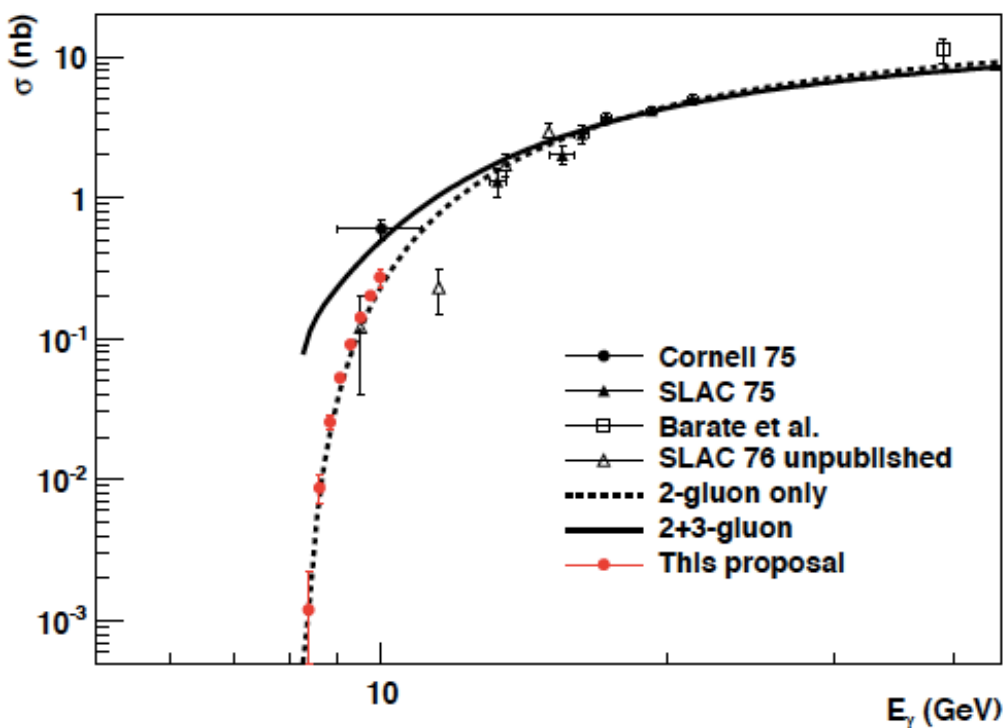


JLab PAC 39 Proposal: Near Threshold  
Electroproduction of J/Psi at 11 GeV (SOLID)

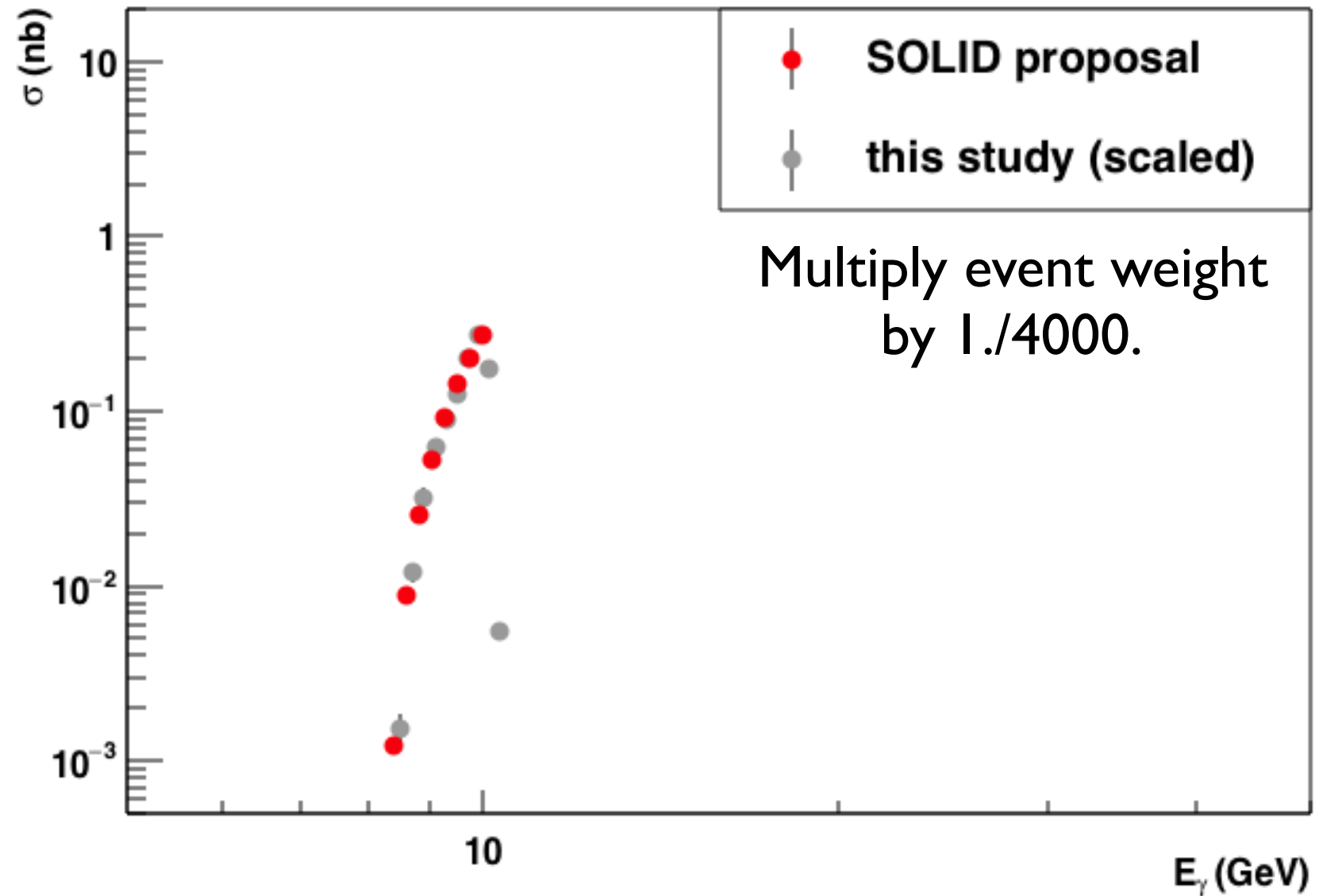


# Reproducing SoLID plots

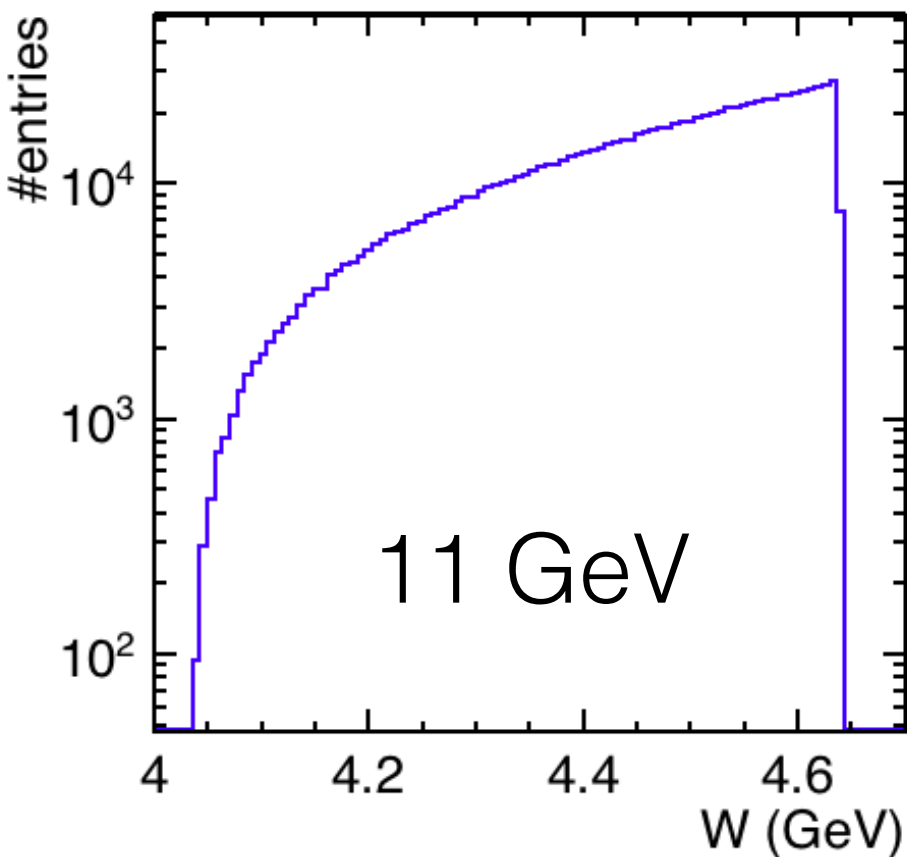
## SoLID proposal



JLab PAC 39 Proposal: Near Threshold  
Electroproduction of J/Psi at 11 GeV (SOLID)

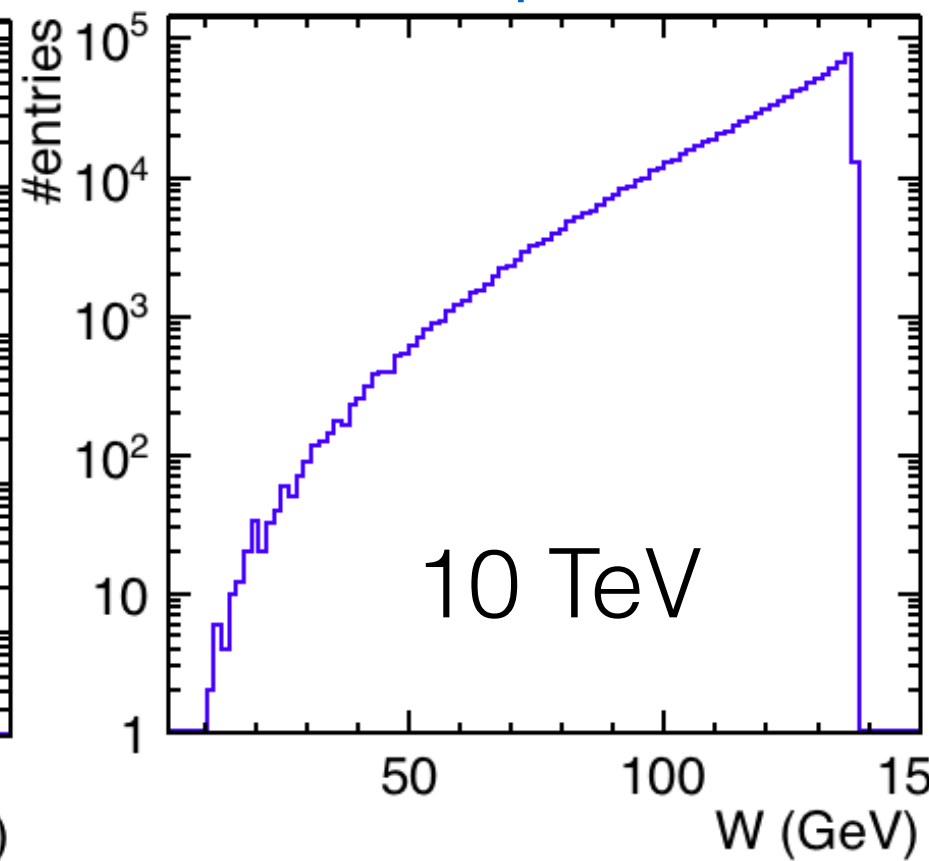
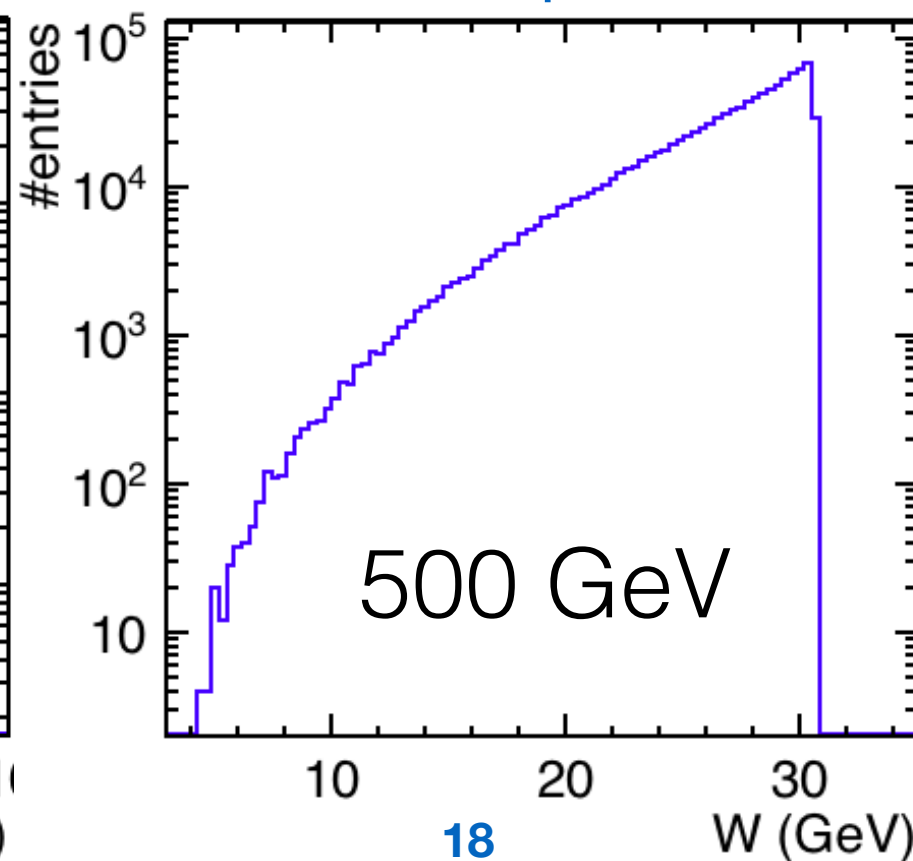
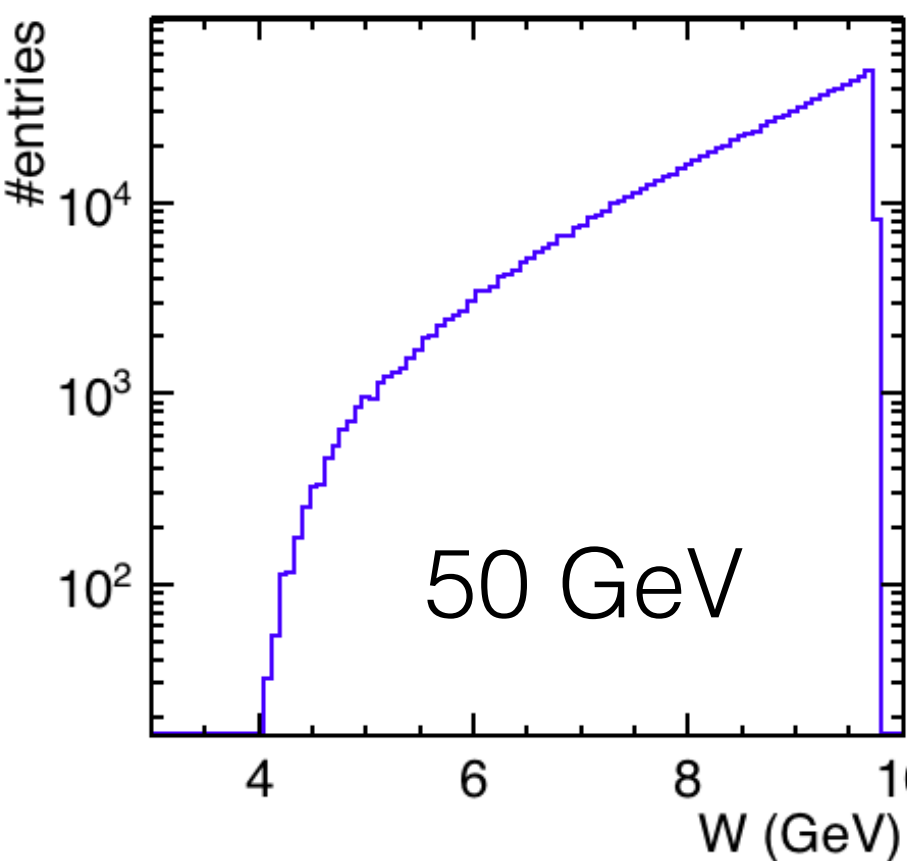


# Using SoLID event generator at EIC $\sqrt{s}$



corresponding  $\sqrt{s}$   
'e5xp50'

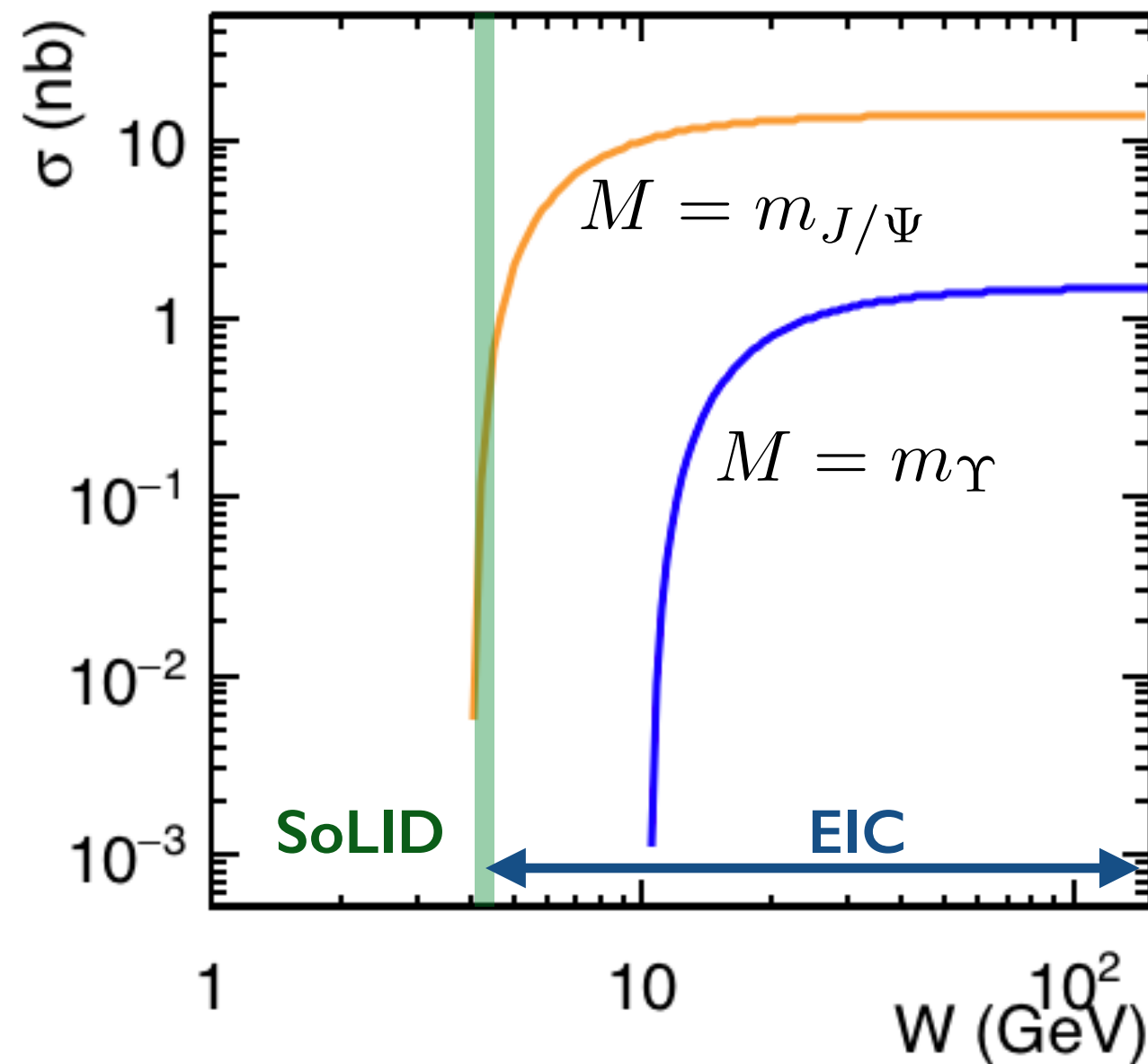
corresponding  $\sqrt{s}$   
'e20xp250'





Using SoLID event generator for EIC is work in progress:

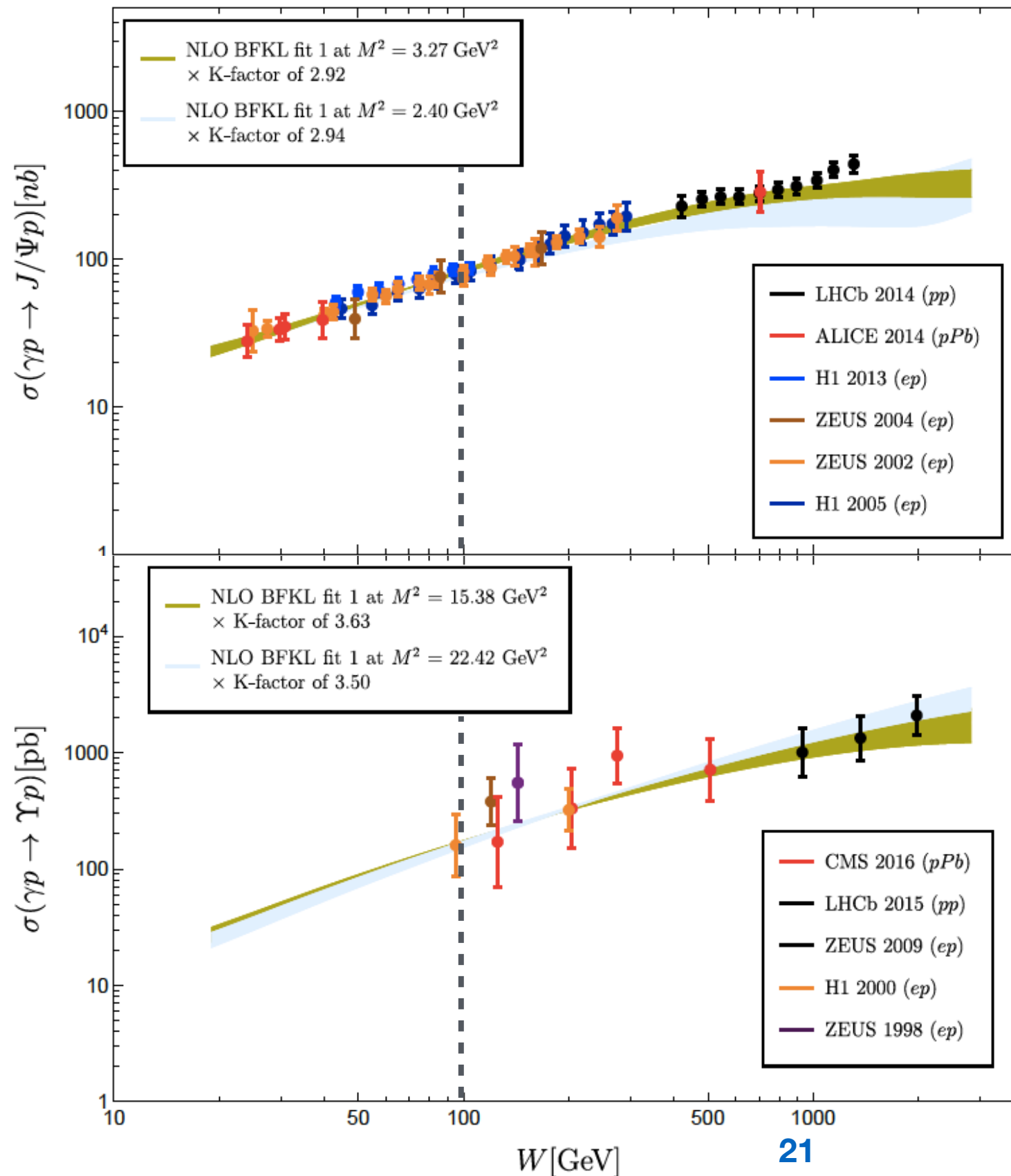
- ➡ SoLID acceptance looks mostly good (need to understand remaining discrepancies).
- ➡ Need correct event weights (cross section).
- ➡ Need to implement boost of final state particles for EIC.



Measuring Upsilon (and J/Psi) production near threshold at the EIC seems like an exciting opportunity- kinematics coverage looks promising!

## ***Additional Slides***

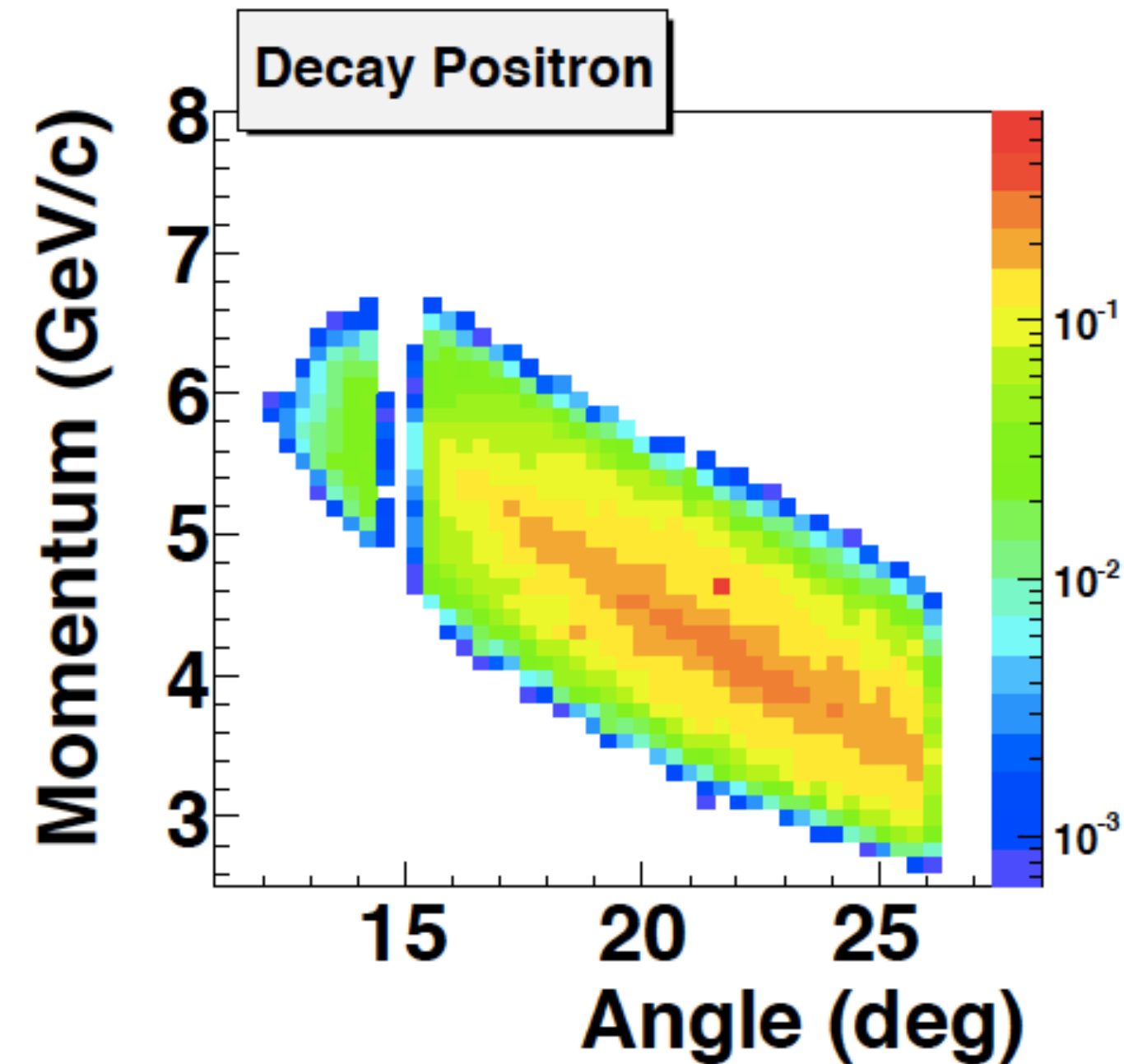
# J/ψ and Υ at other experiments



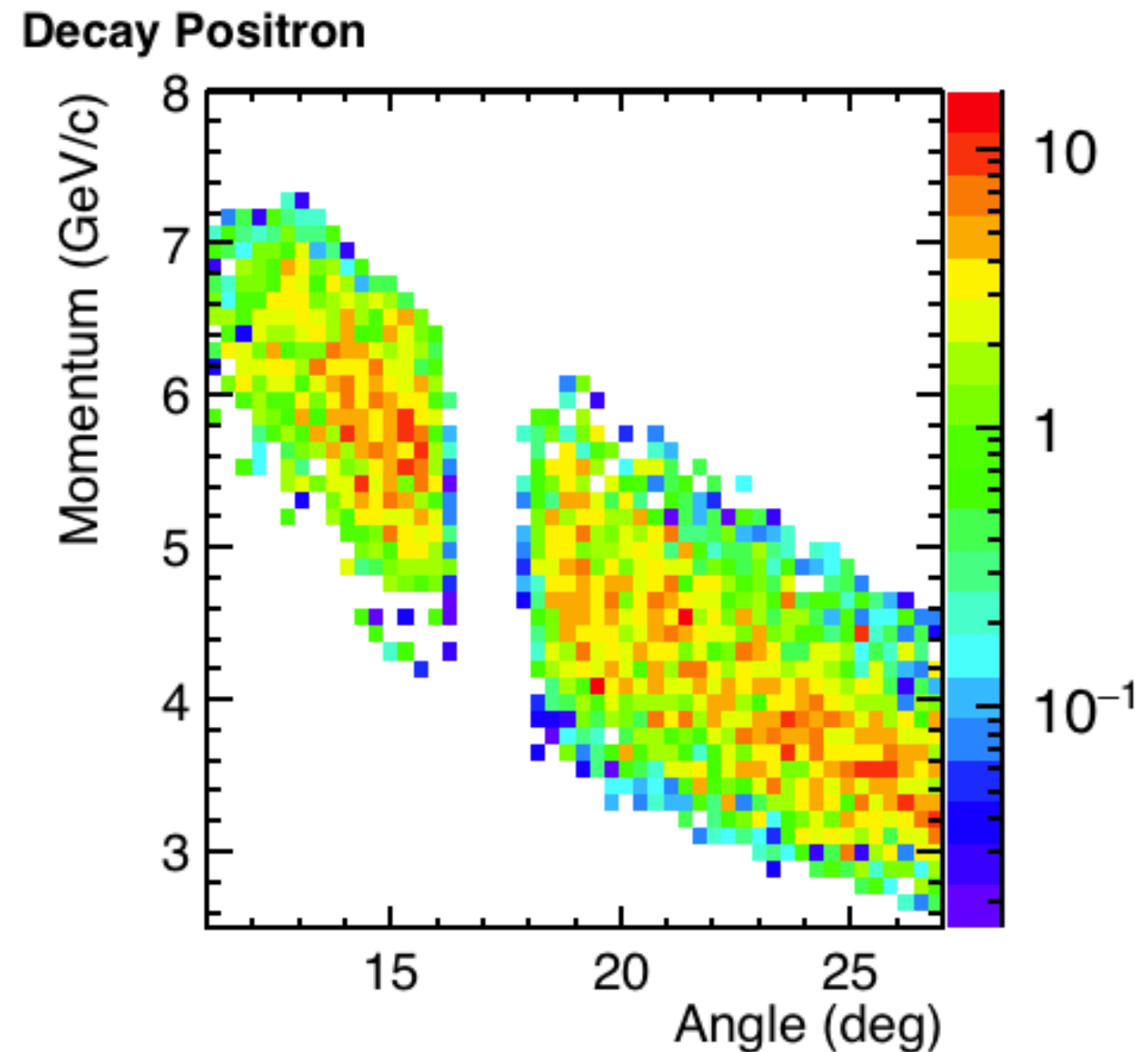
ratio  $\sim 0.0015$   
at  $W = 100 \text{ GeV}$

M. Hentschinski,  
arXiv:1611.06165v1

# Reproducing SoLID plots

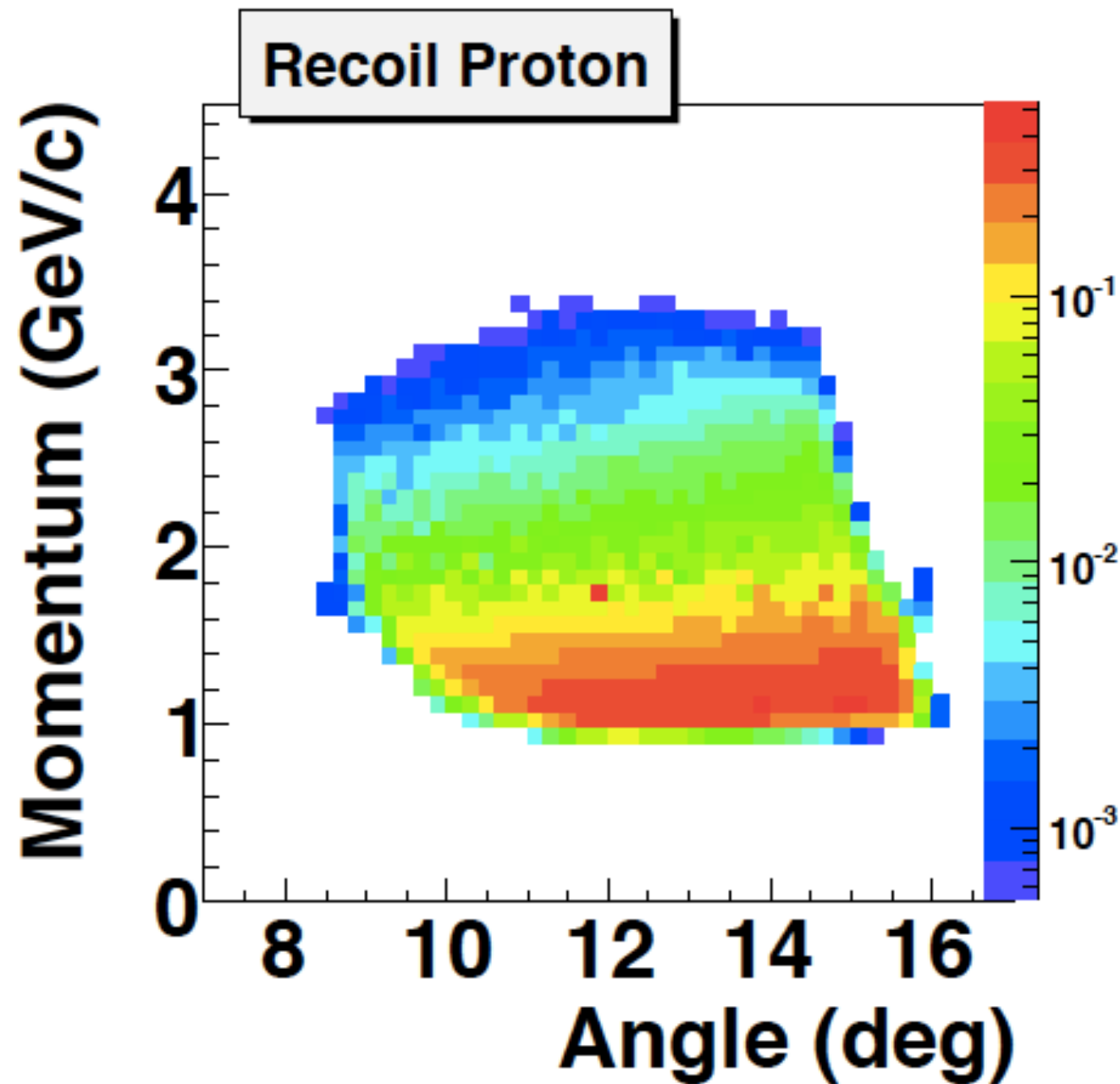


JLab PAC 39 Proposal: Near Threshold  
Electroproduction of J/Psi at 11 GeV (SoLID)

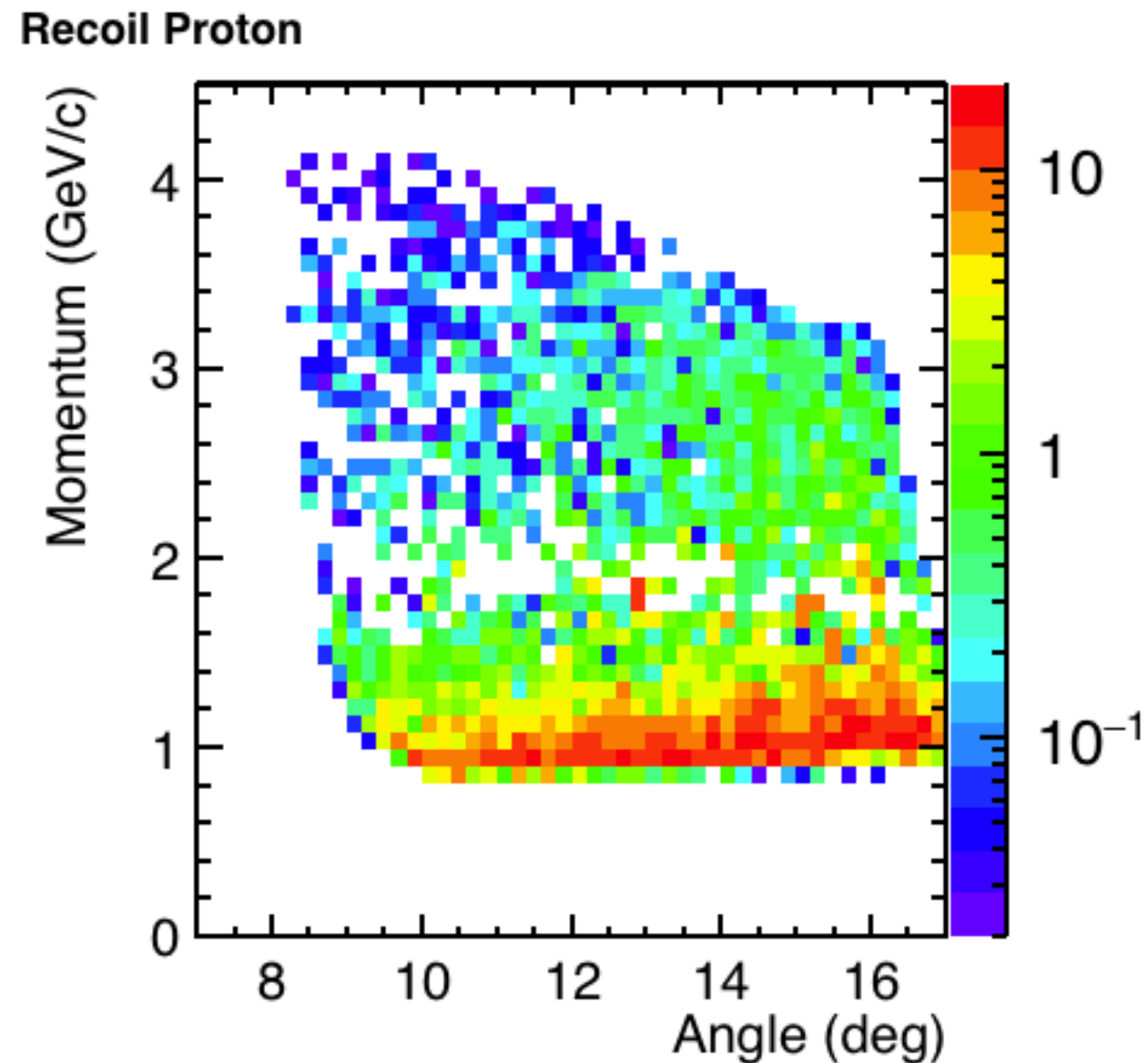


electro-production, 11 GeV

# Reproducing SoLID plots



JLab PAC 39 Proposal: Near Threshold  
Electroproduction of J/Psi at 11 GeV (SoLID)



electro-production, 11 GeV