

# $J/\psi$ and $\phi$ production from $^4\text{He}$

$J/\psi$  production:

Electron beam energy: 11 GeV

Luminosity:  $1.2 \times 10^{37}$  eN cm<sup>-2</sup> s<sup>-1</sup>

Target: 15-cm liquid  $^4\text{He}$  ( $\sim 2\%$  radiation length)

Acceptance:  $p > 300$  MeV,  $6^\circ < \theta < 29^\circ$ , full azimuthal

Electroproduction:

Scattered electron with  $p > 300$  MeV,  $6^\circ < \theta < 29^\circ$

Subthreshold cut:

$$E_{\gamma^*} < M_{J/\psi} + \frac{M_{J/\psi}^2 + Q^2}{2M_p}$$

Photoproduction:

Bremsstrahlung photon with target as the radiator

Subthreshold cut:  $E_\gamma < 8.2$  GeV

*Note:  $E_\gamma$  is known in simulation*

# J/ $\psi$ and $\phi$ production from $^4\text{He}$

$\phi$  production:

Electron beam energy: 2.2 GeV

Luminosity:  $1.2 \times 10^{37}$  eN cm<sup>-2</sup> s<sup>-1</sup>

Target: 15-cm liquid  $^4\text{He}$  ( $\sim 2\%$  radiation length)

Acceptance:

forward angle ( $\theta < 35^\circ$ ) use CLAS12 acceptance file from Zhiwen

central angle ( $35^\circ < \theta < 125^\circ$ ) assume acceptance for  $p > 300$  MeV

Electroproduction:

Scattered electron with  $p > 500$  MeV,  $2.5^\circ < \theta < 4.5^\circ$  (forward tagger)

Subthreshold cut:

$$E_{\gamma^*} < M_\phi + \frac{M_\phi^2 + Q^2}{2M_p}$$

Photoproduction:

Bremsstrahlung photon with target as the radiator

Subthreshold cut:  $E_\gamma < 1.57$  GeV

*Note:  $E_\gamma$  is known in simulation*

# $J/\psi$ and $\phi$ production from $^4\text{He}$

## Simulated cases

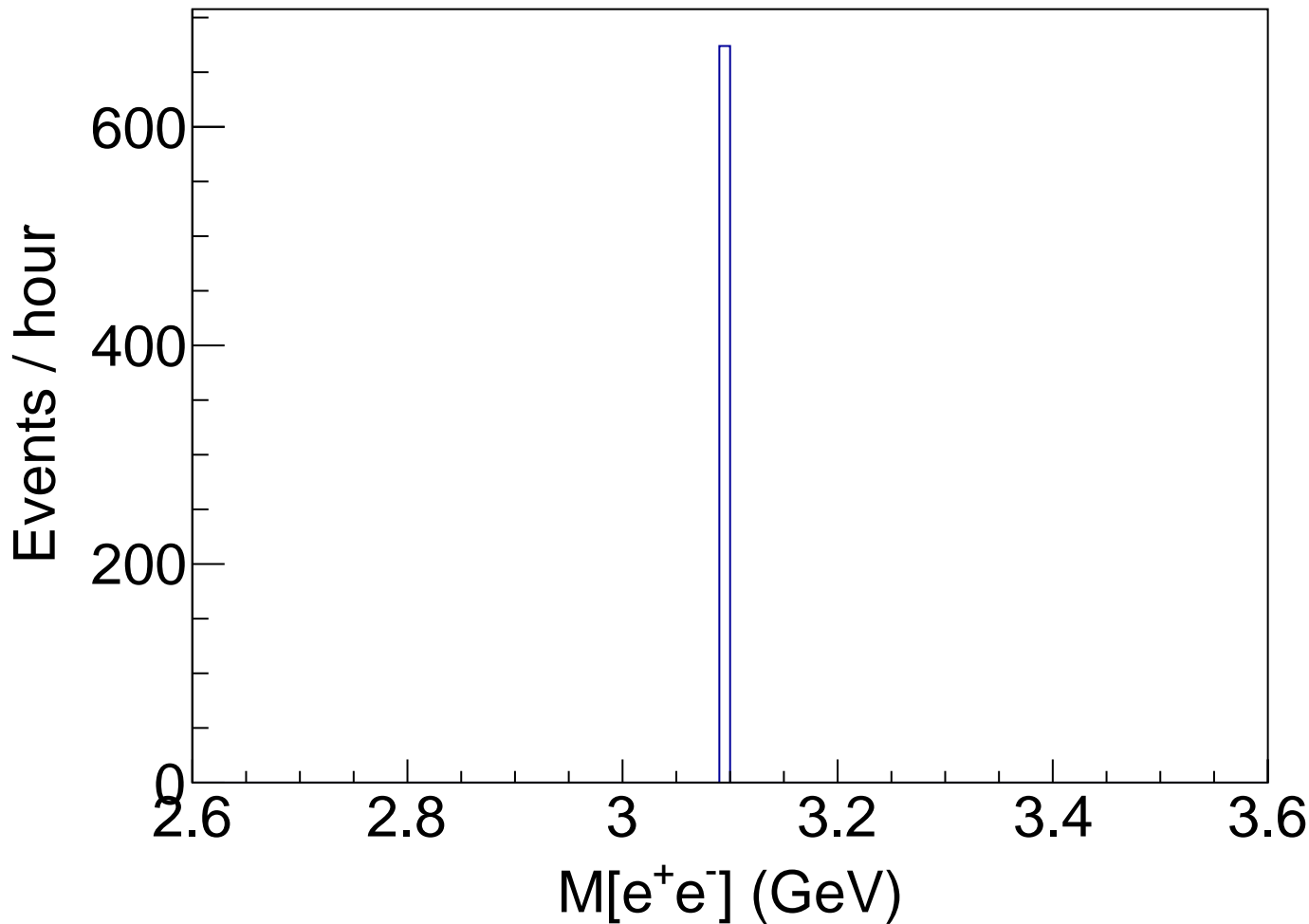
$J/\psi$ :

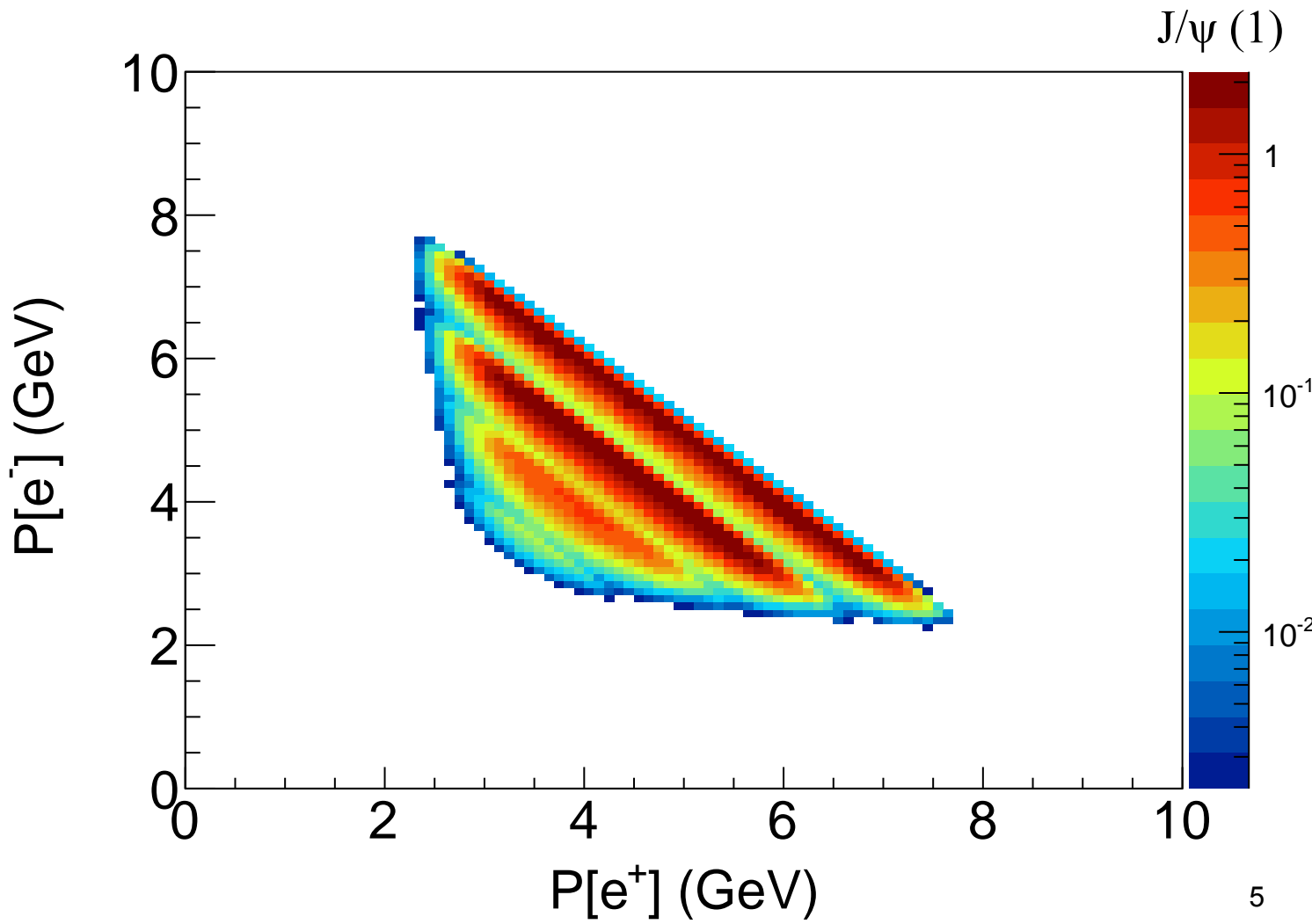
- (1) Electroproduction, without subthreshold cut
- (2) Electroproduction, with subthreshold cut
- (3) Photoproduction, without subthreshold cut
- (4) Photoproduction, with subthreshold cut

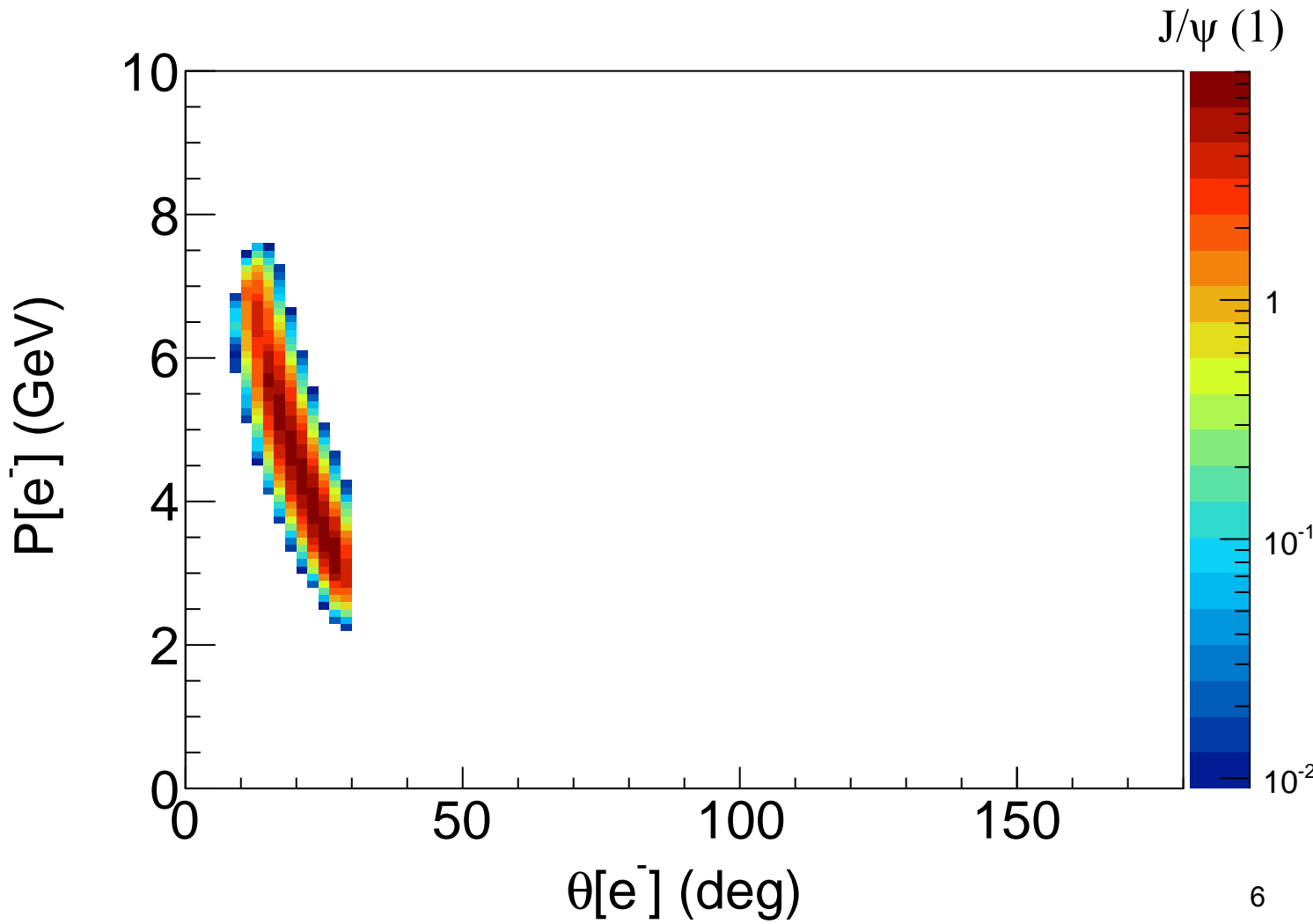
$\phi$ :

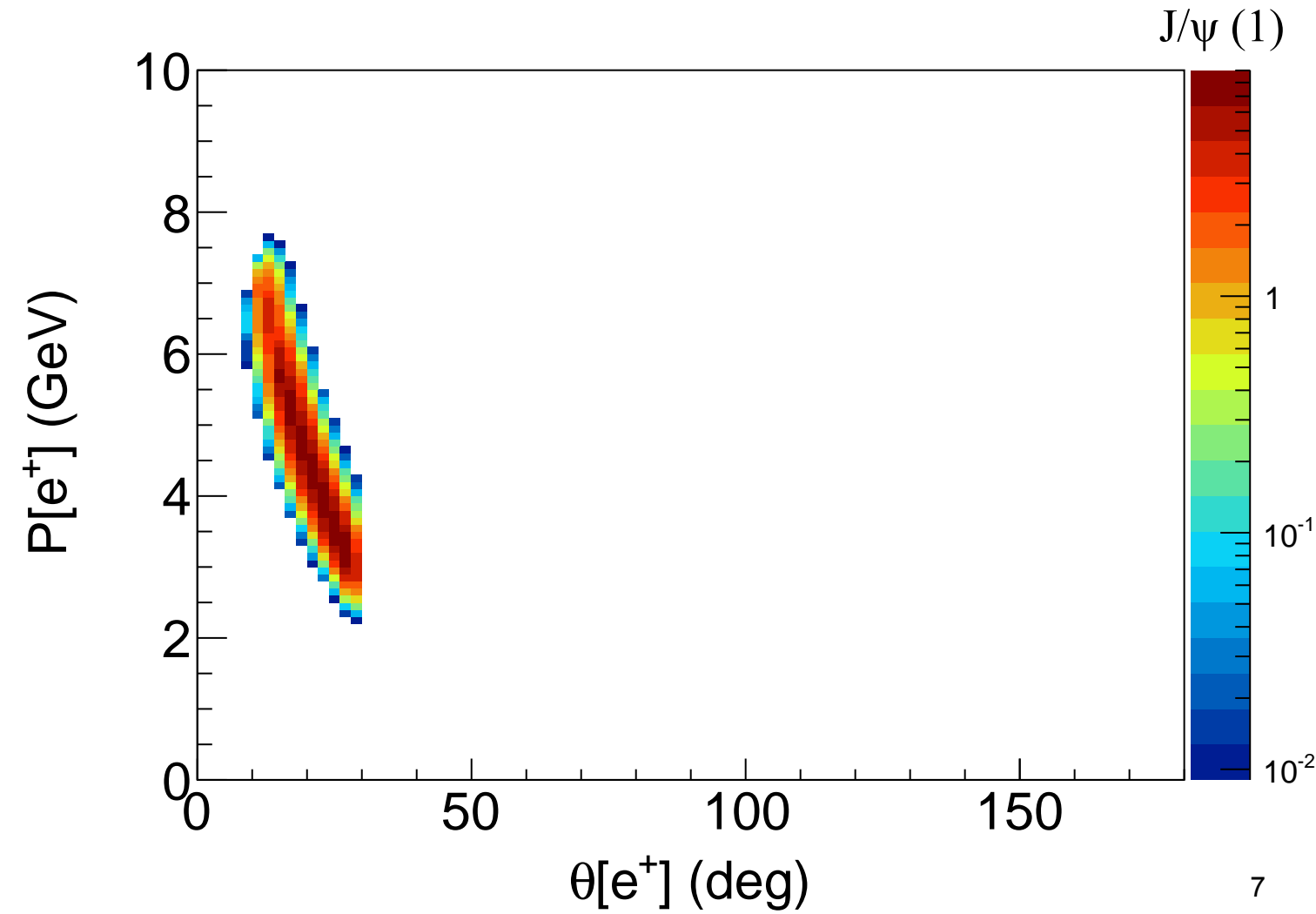
- (1) Electroproduction, without subthreshold cut
- (2) Electroproduction, with subthreshold cut
- (3) Photoproduction, without subthreshold cut
- (4) Photoproduction, with subthreshold cut

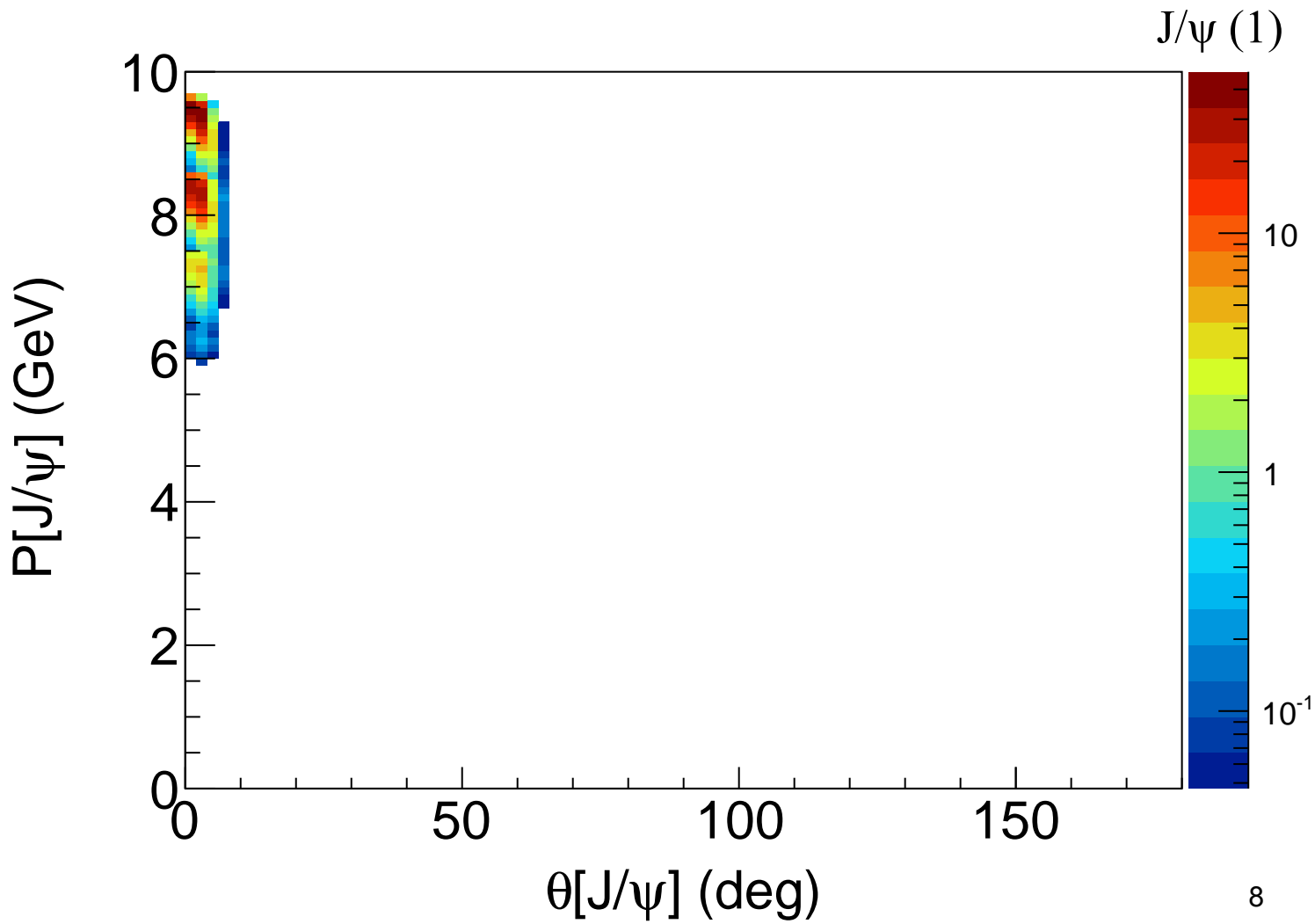
J/ψ (1)



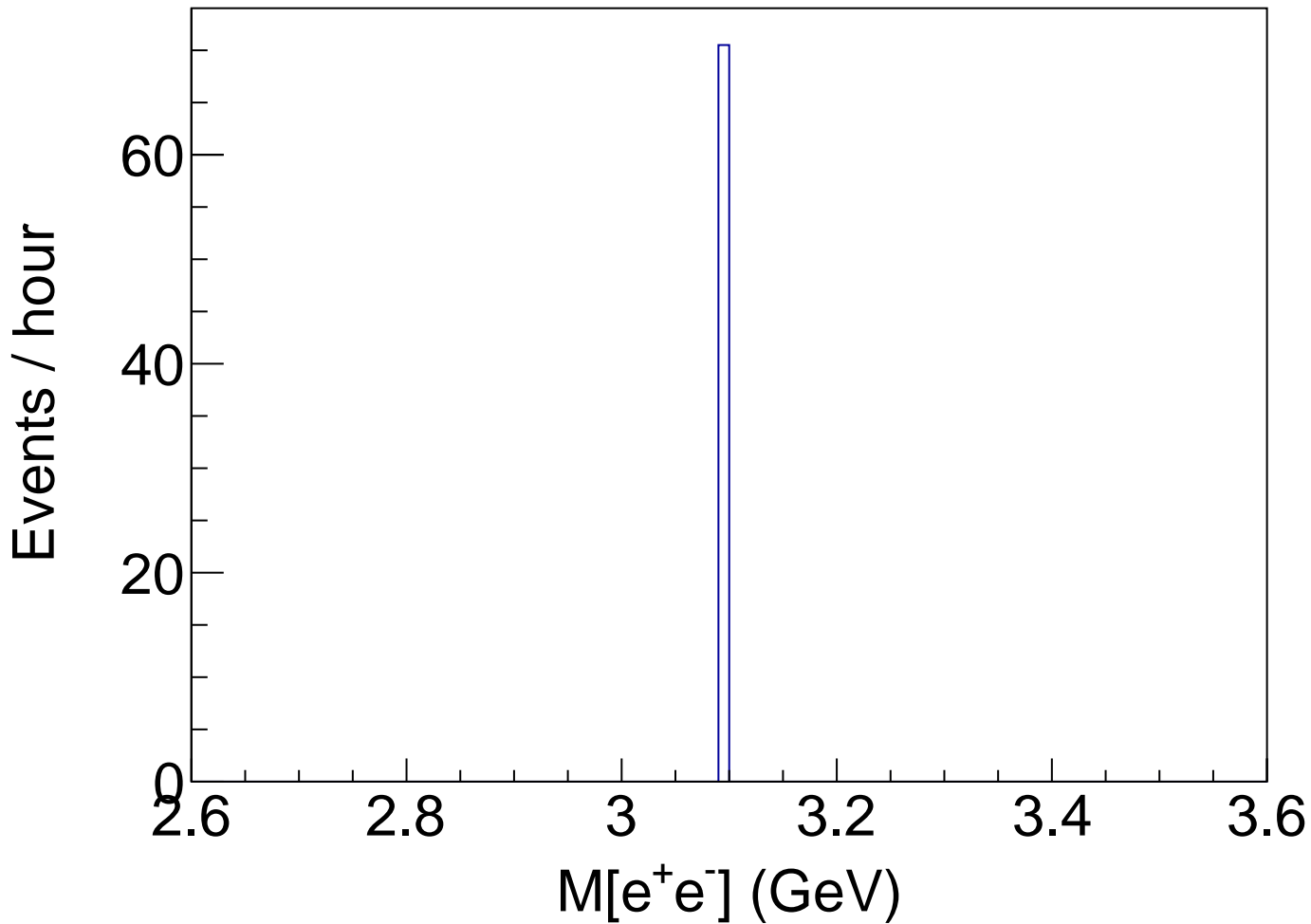


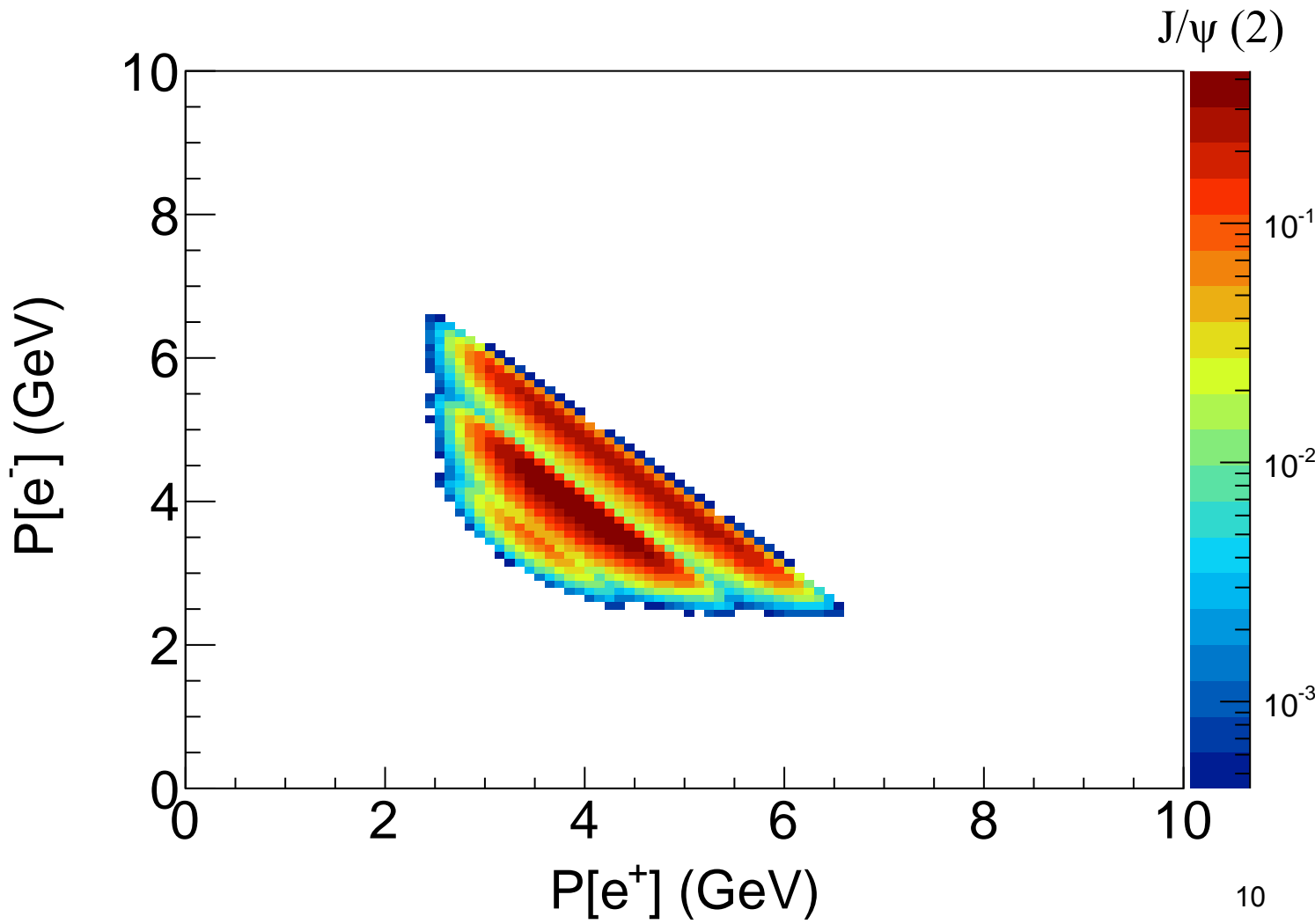


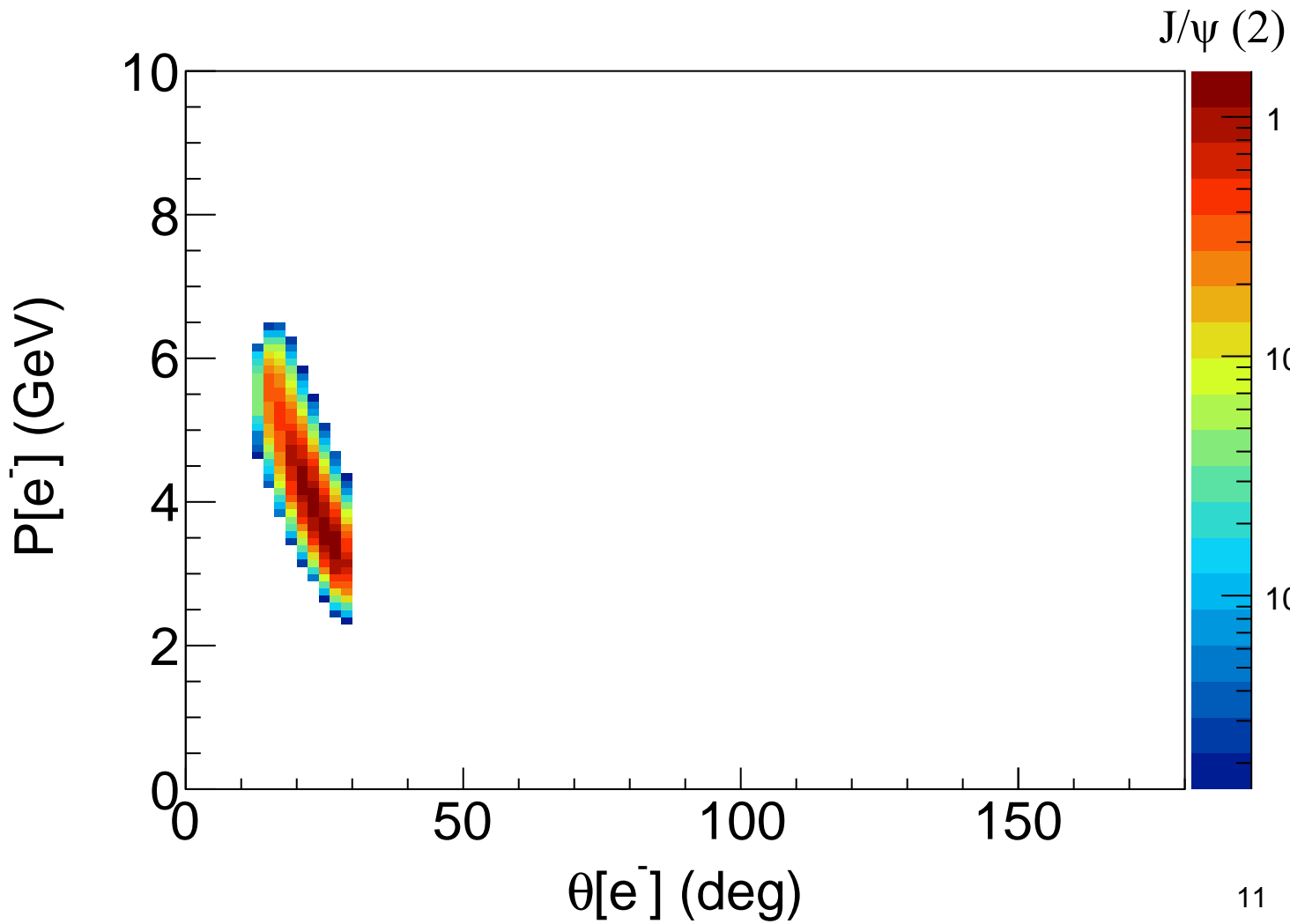


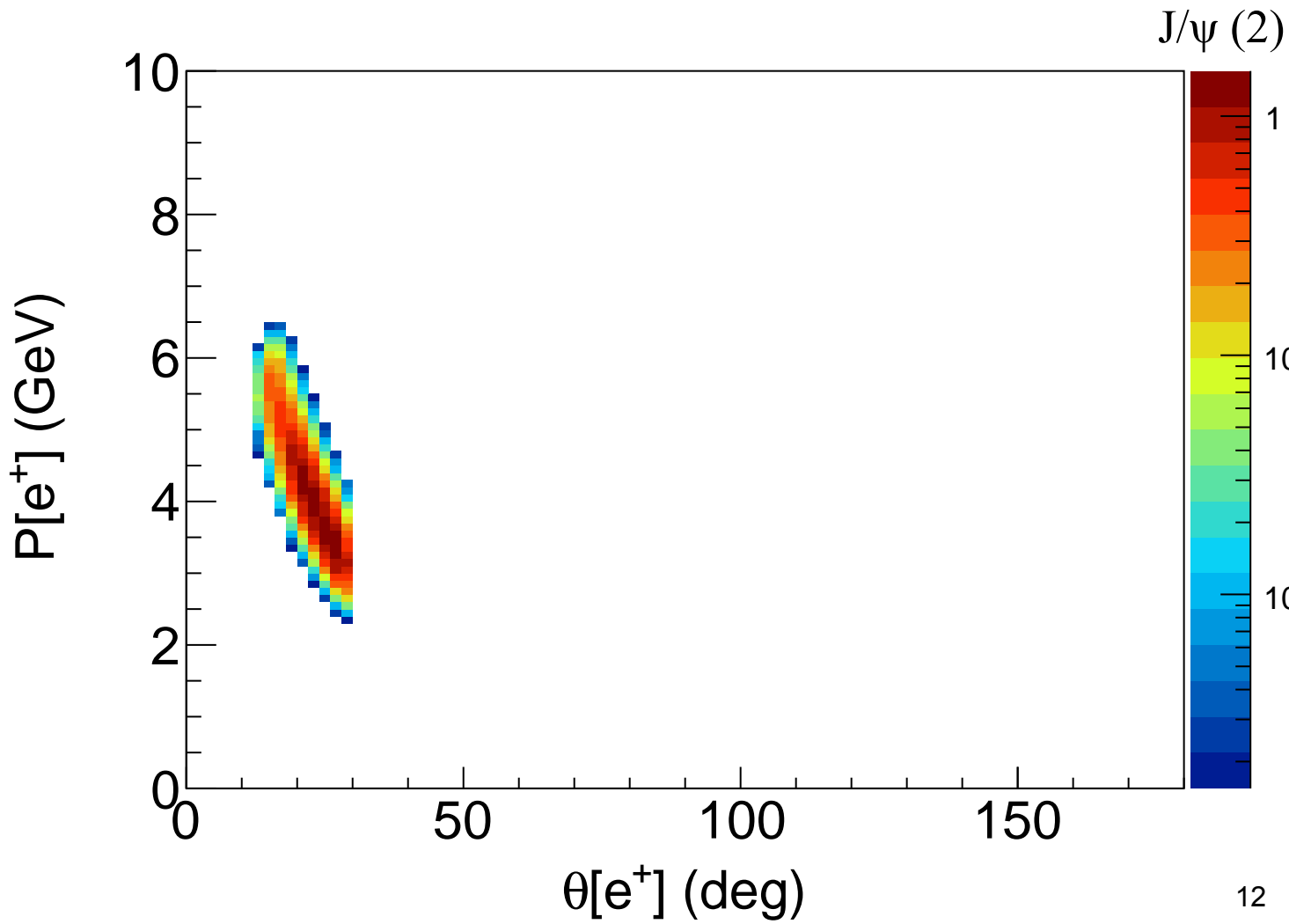


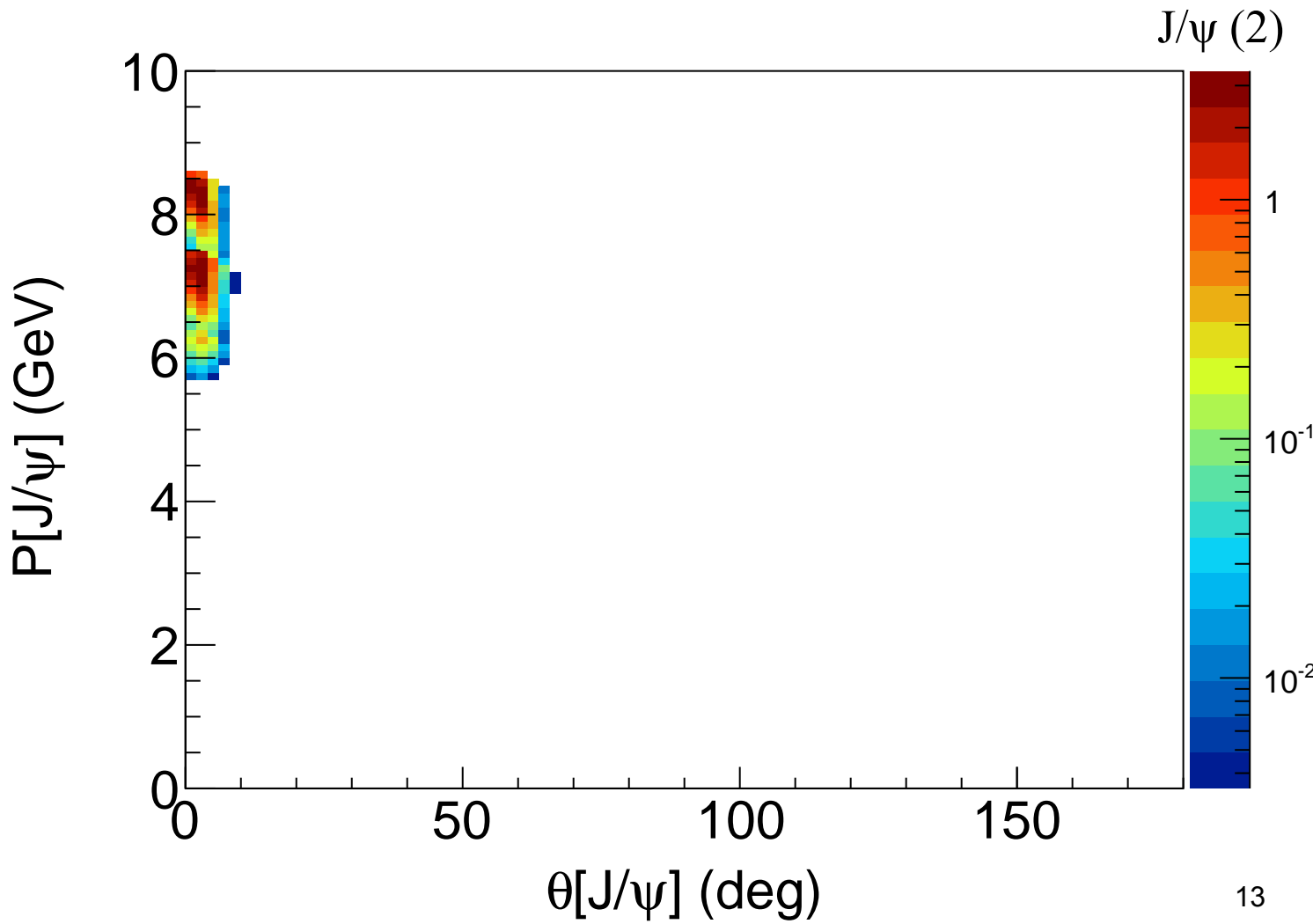


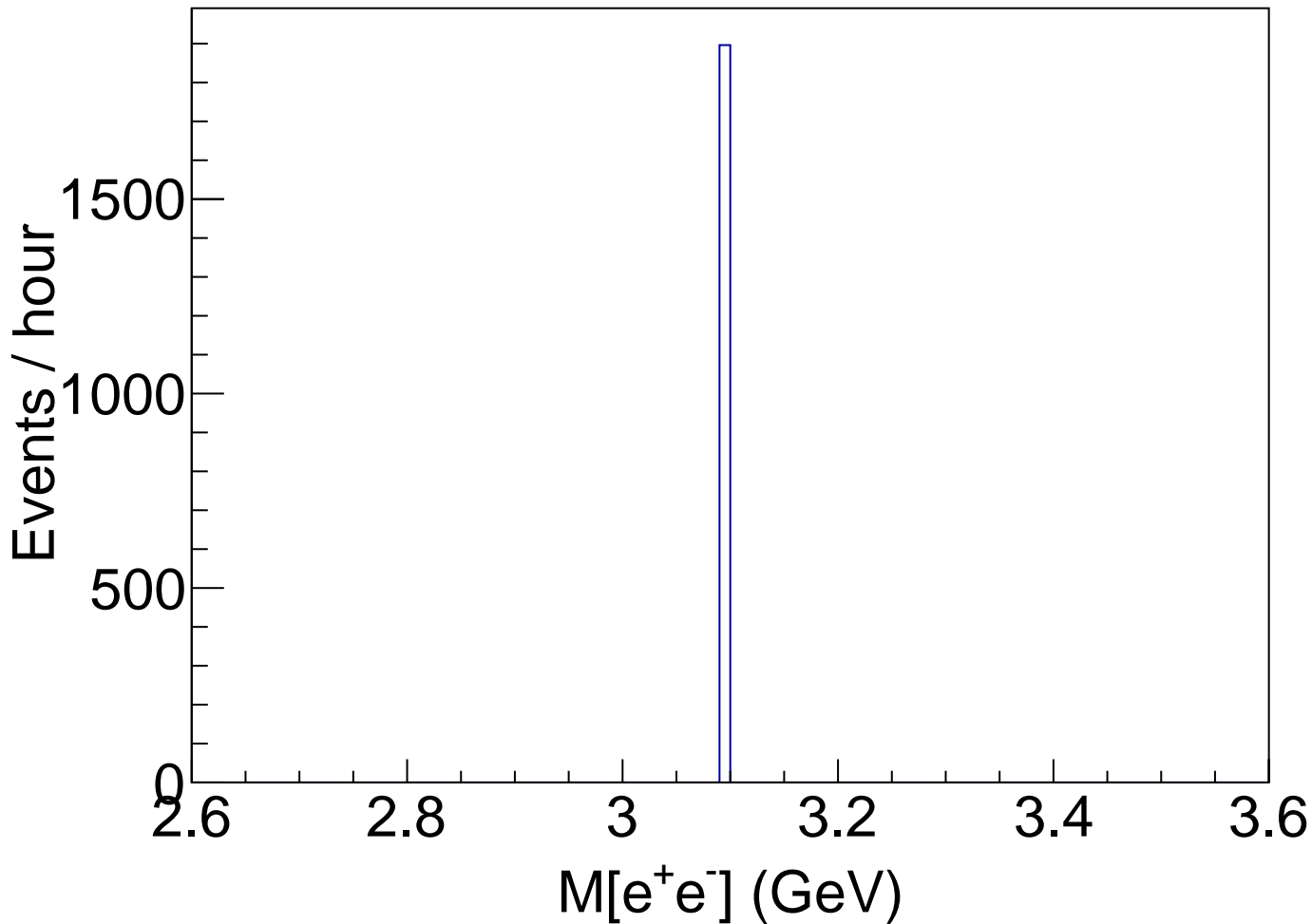




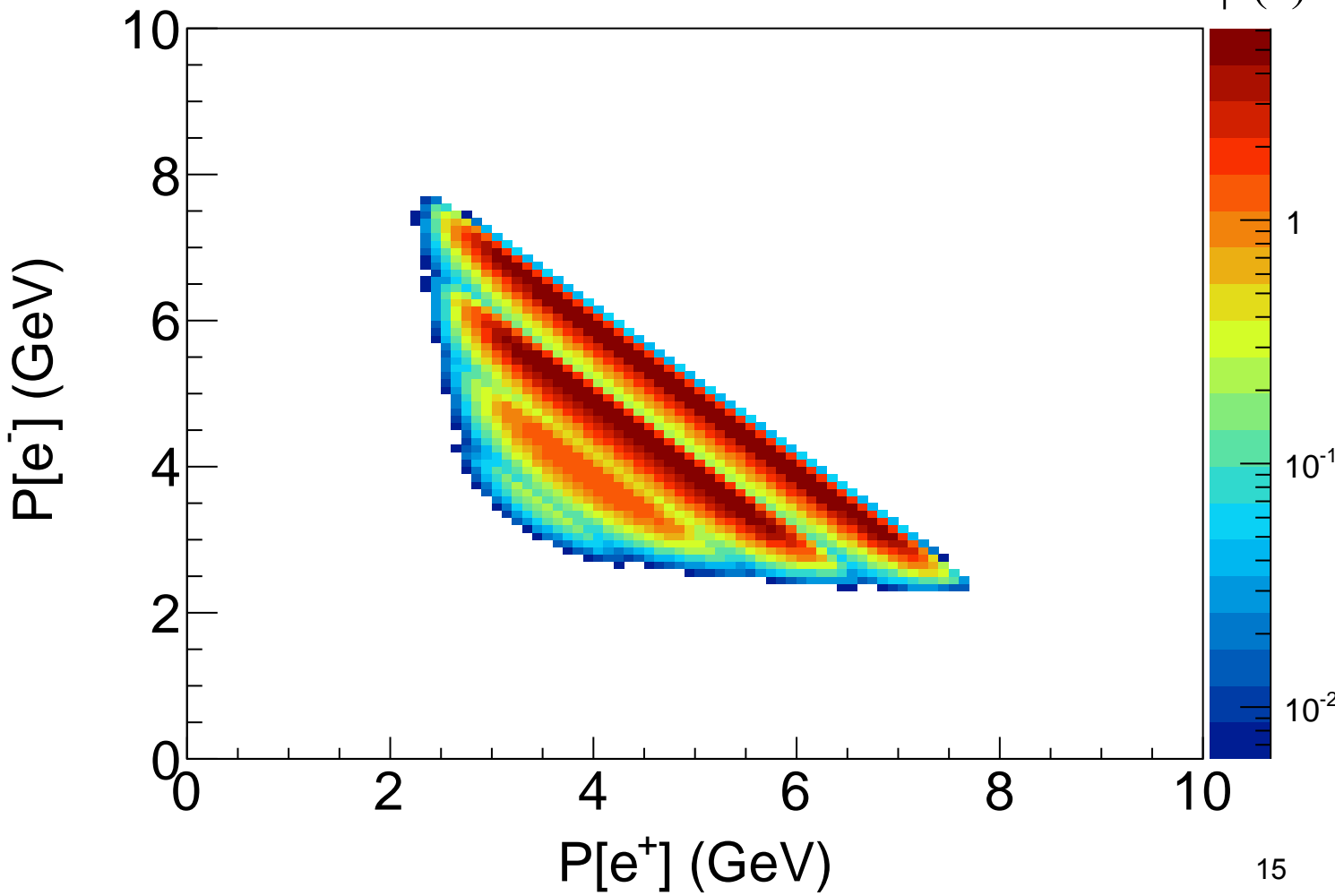


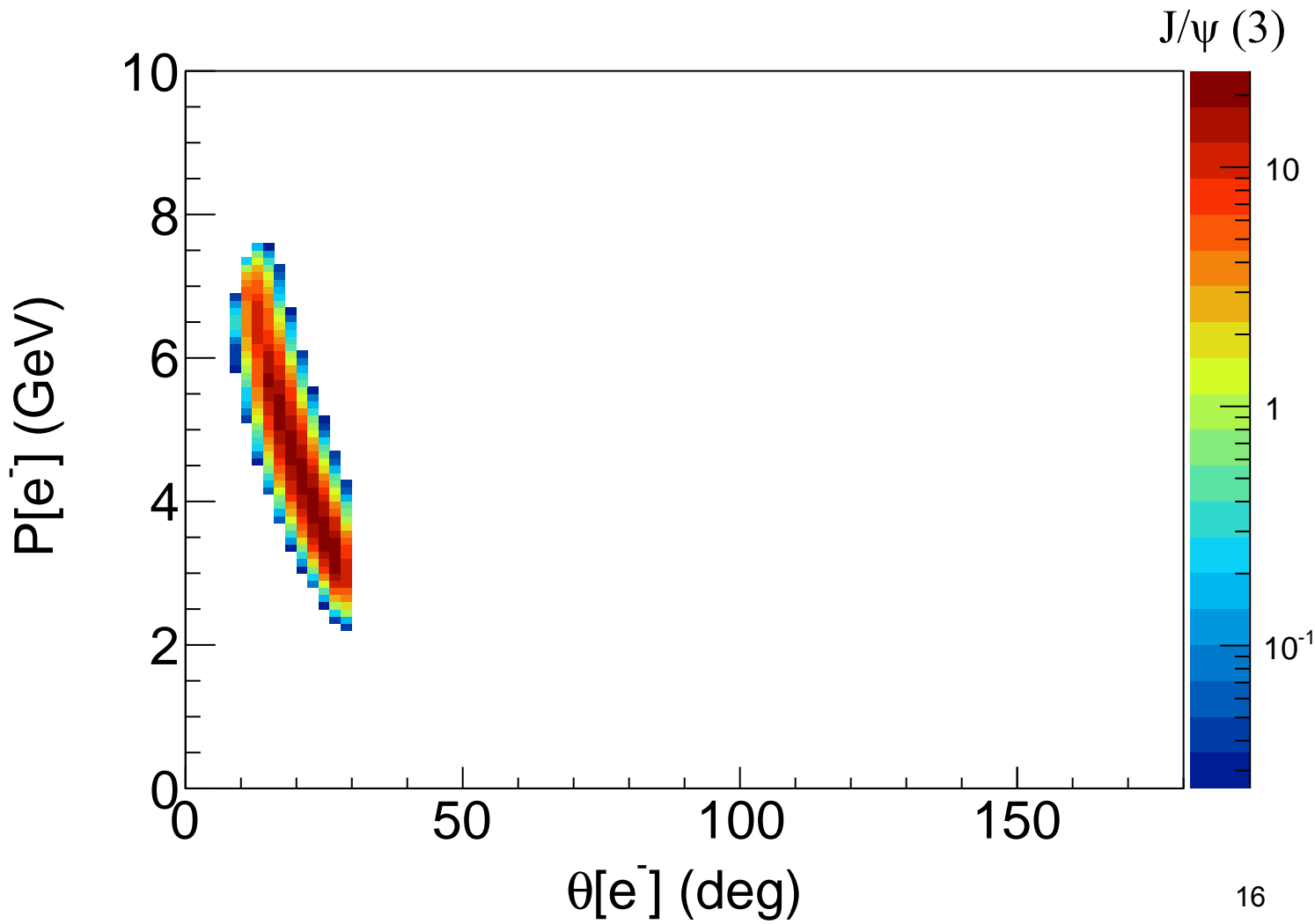






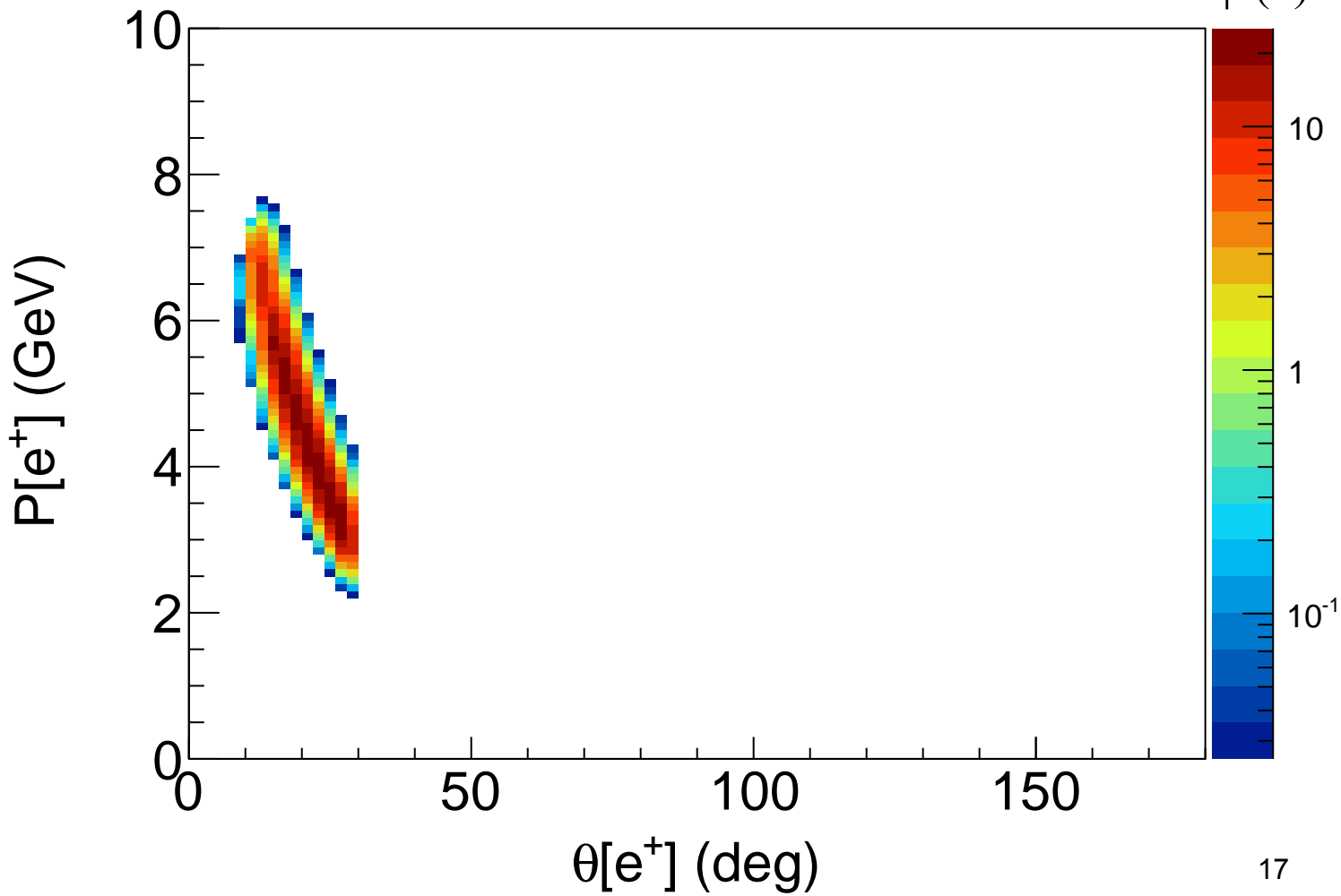
$J/\psi(3)$

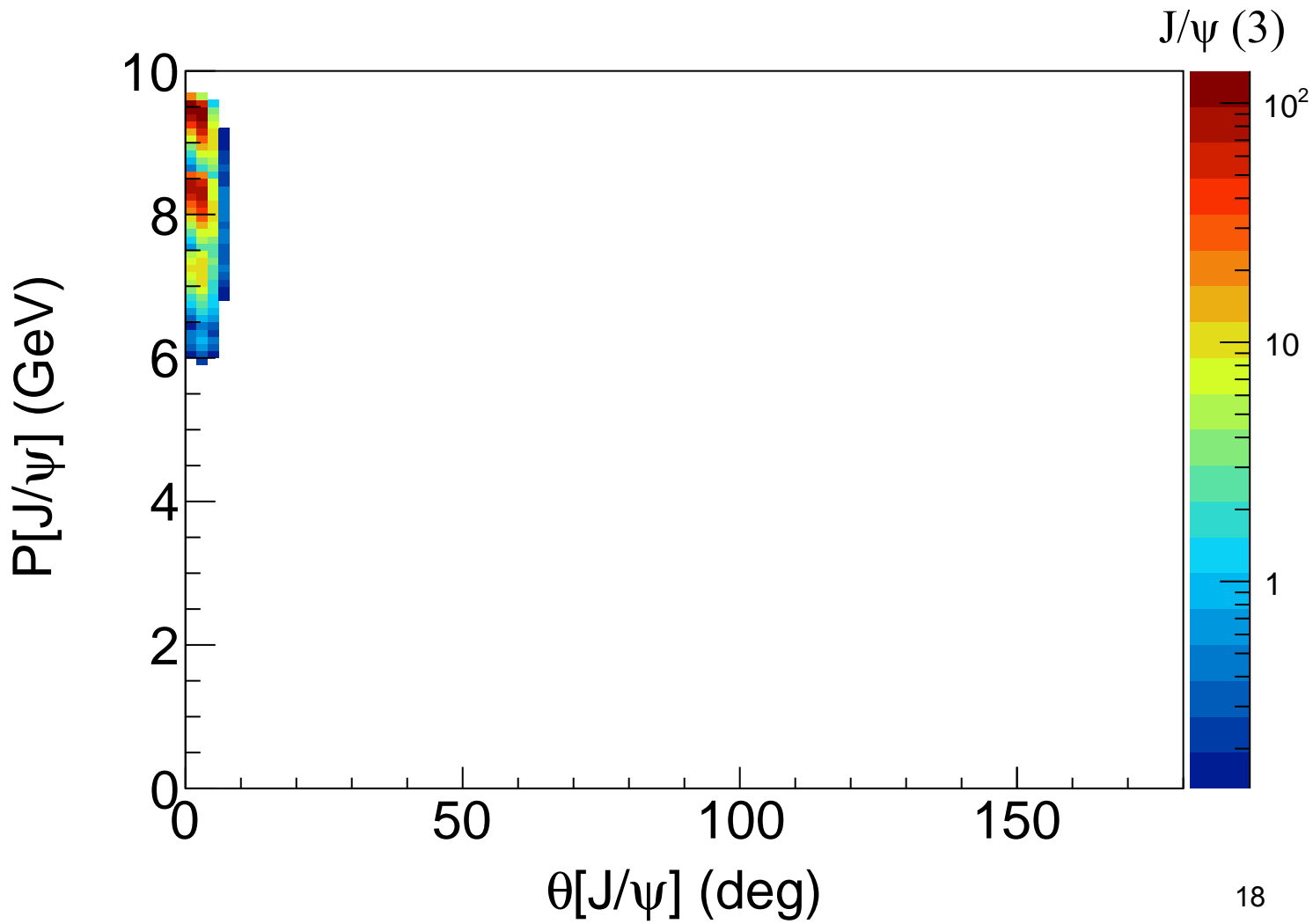


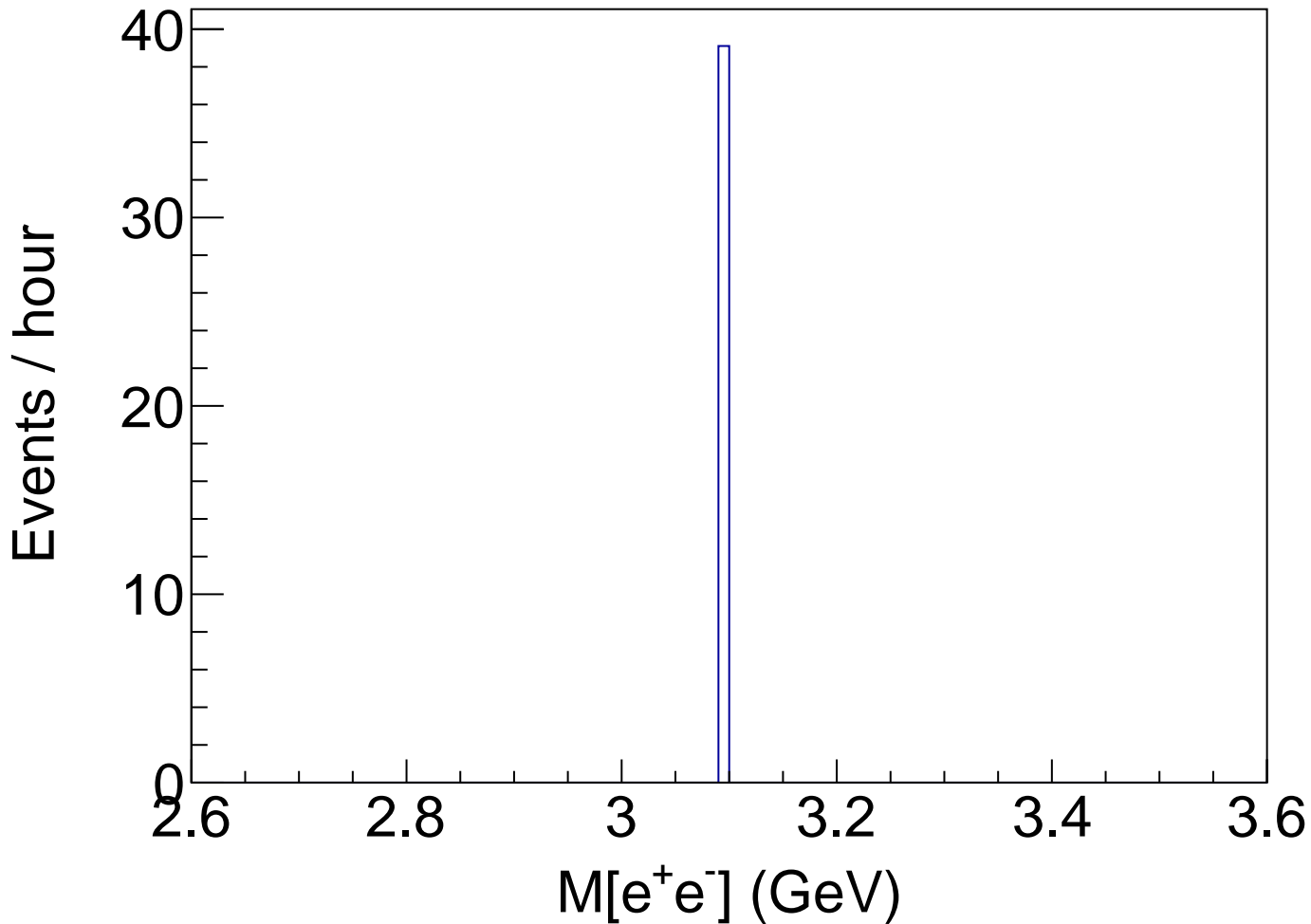


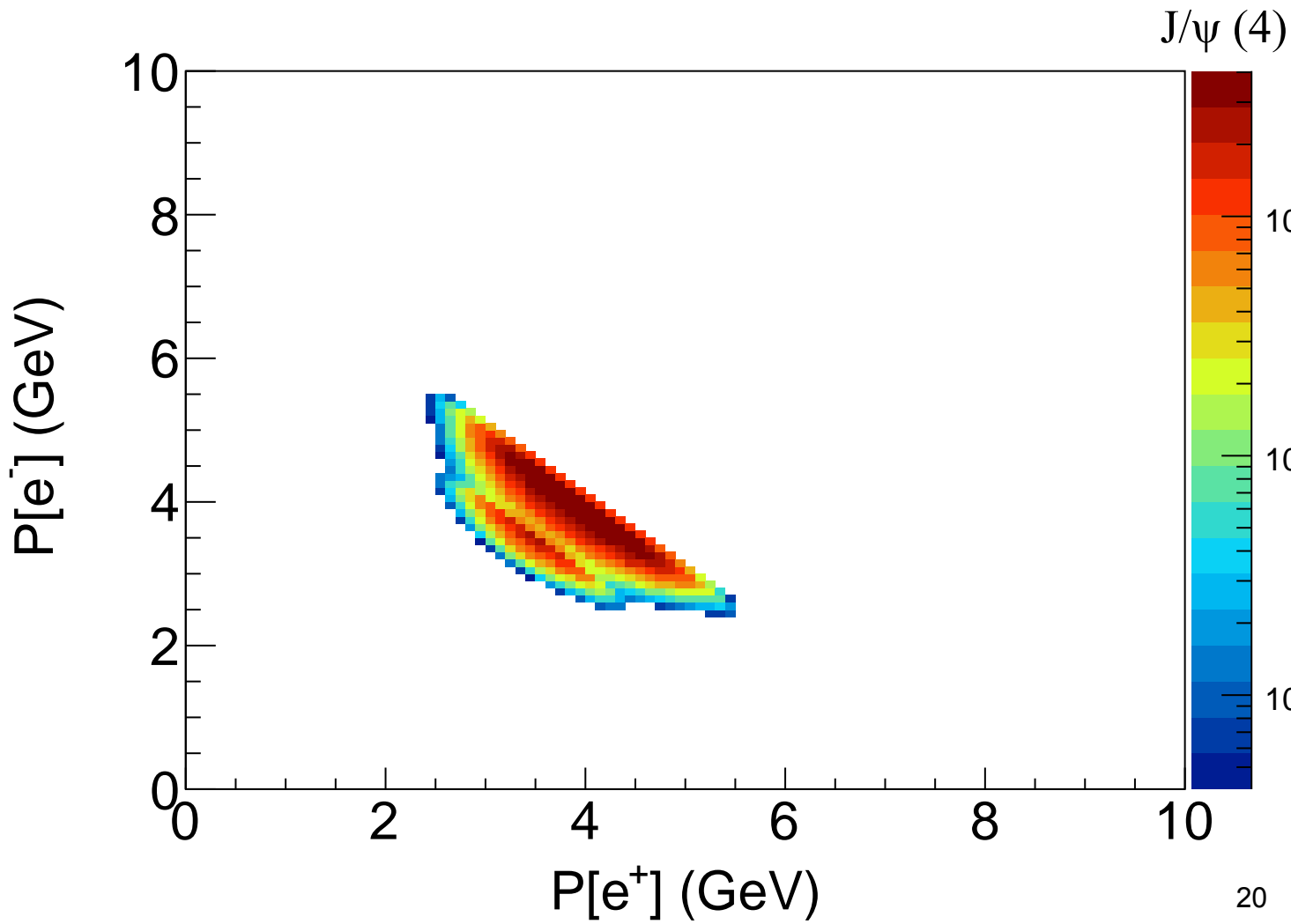


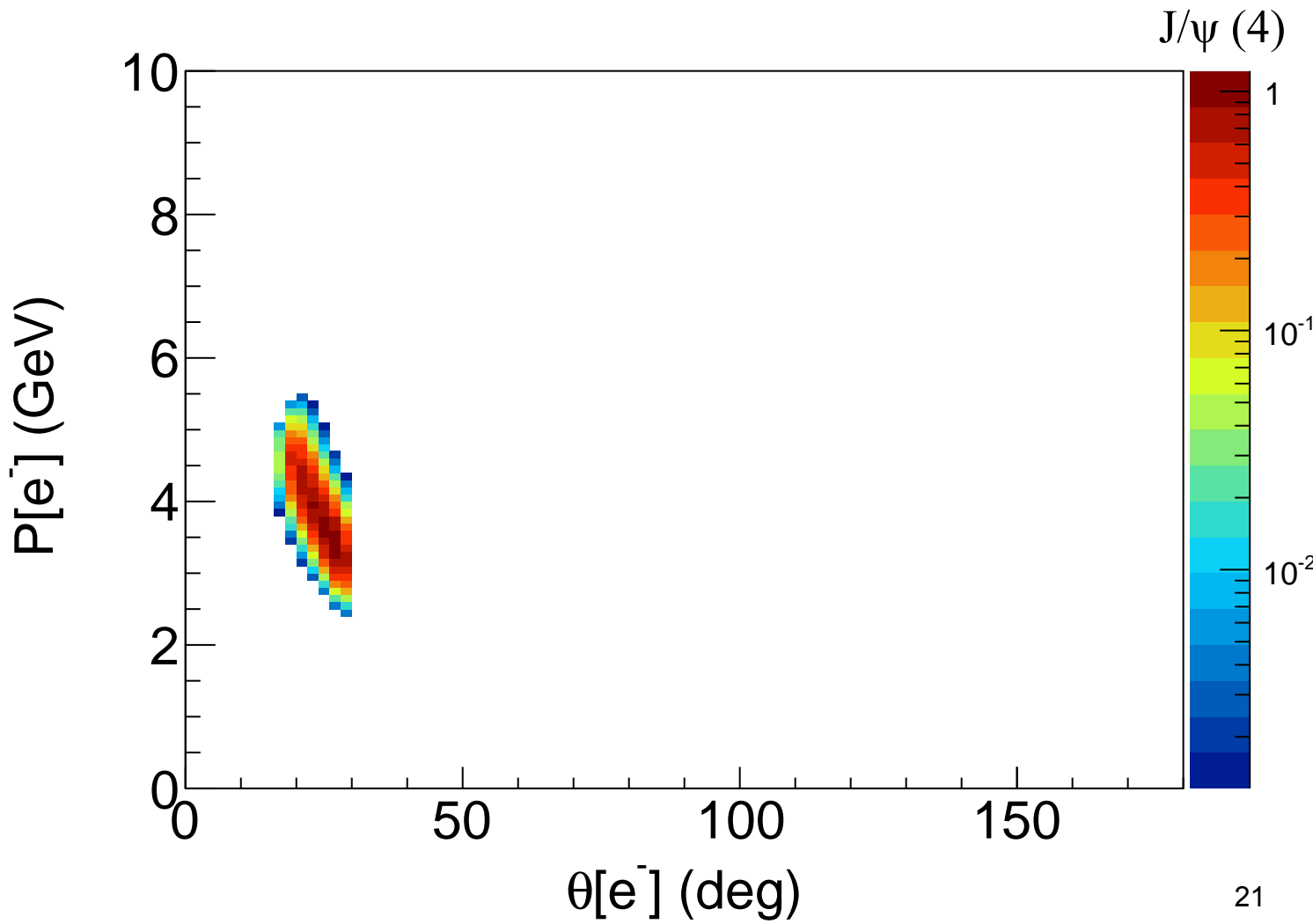
$J/\psi(3)$

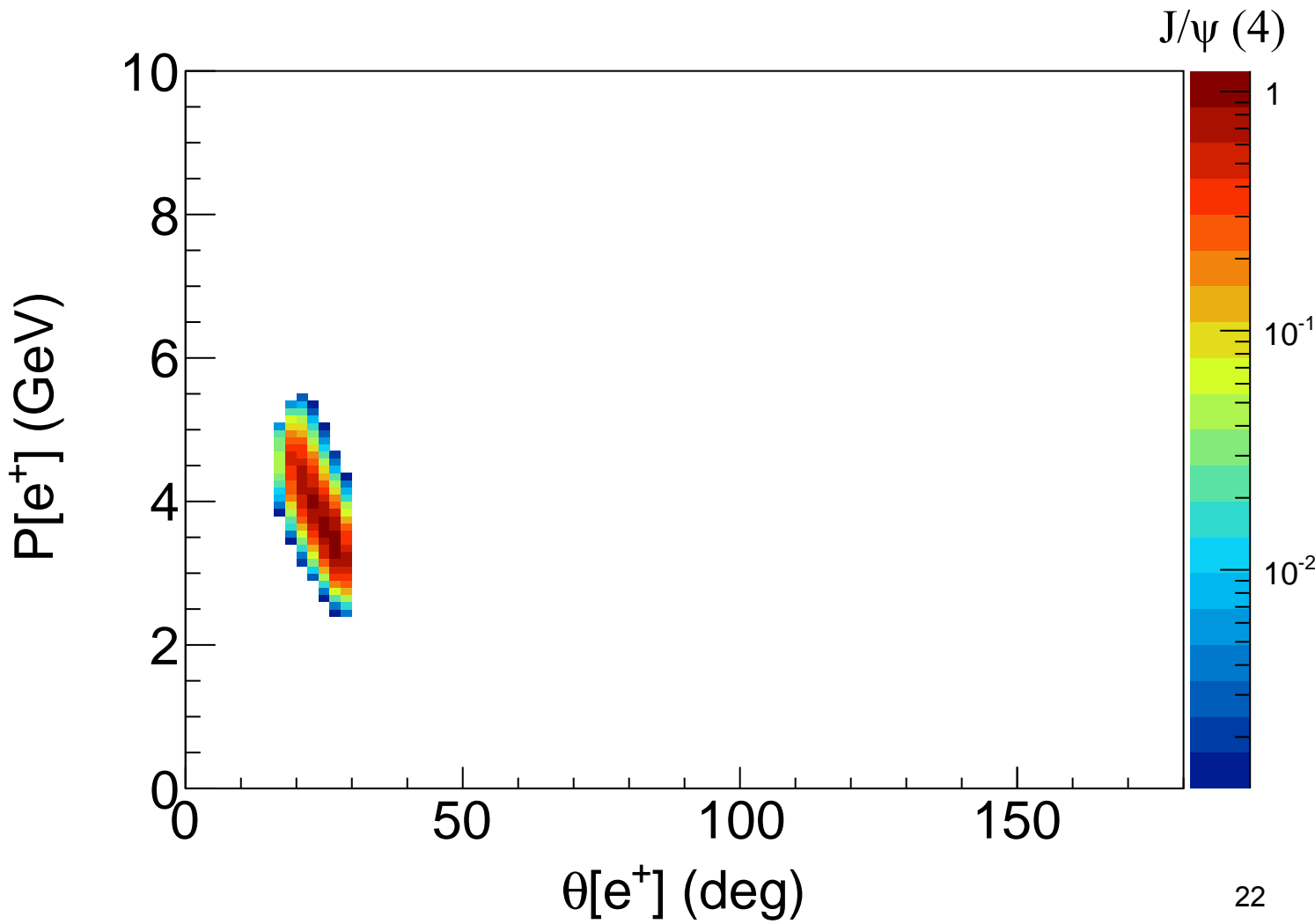


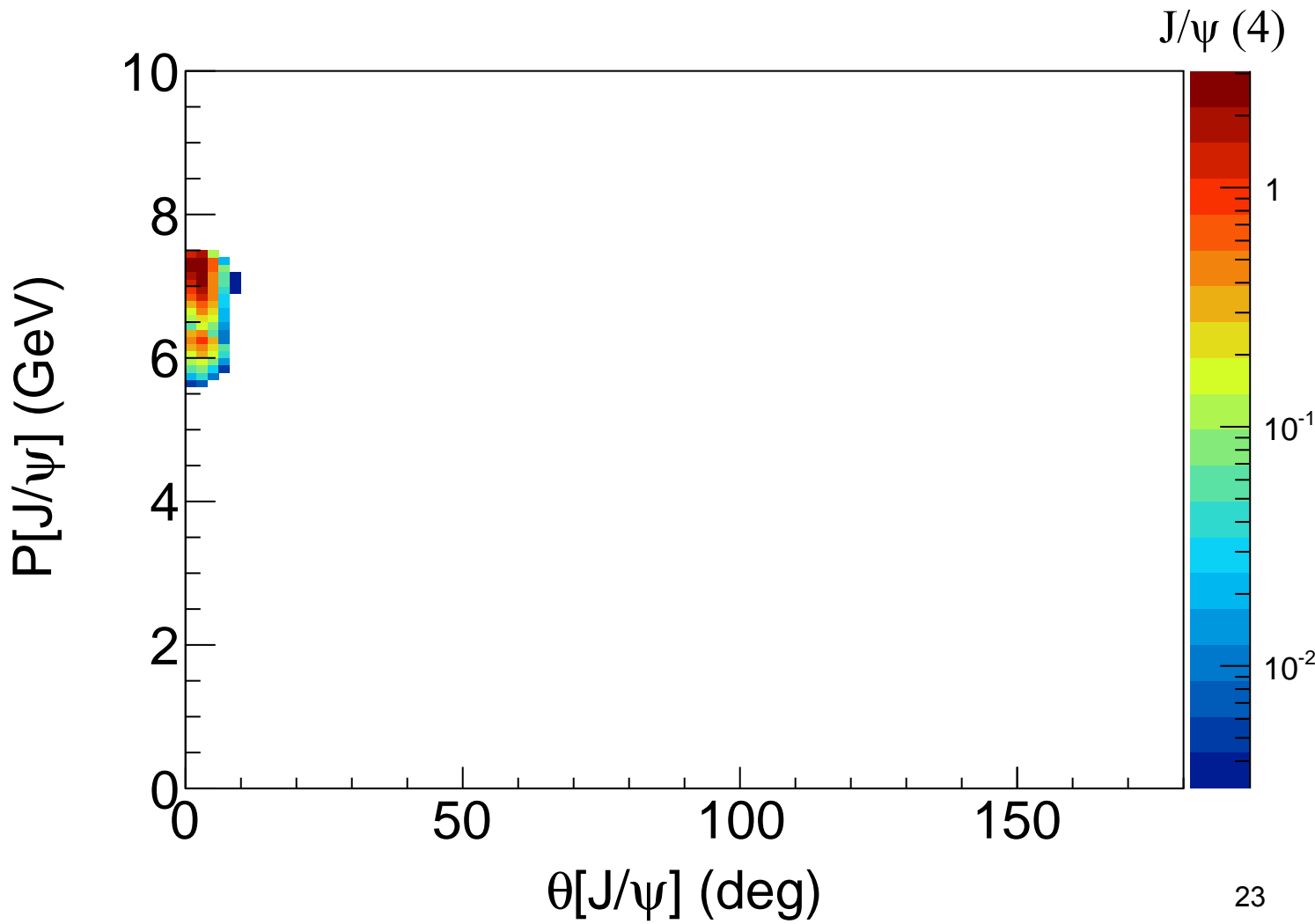


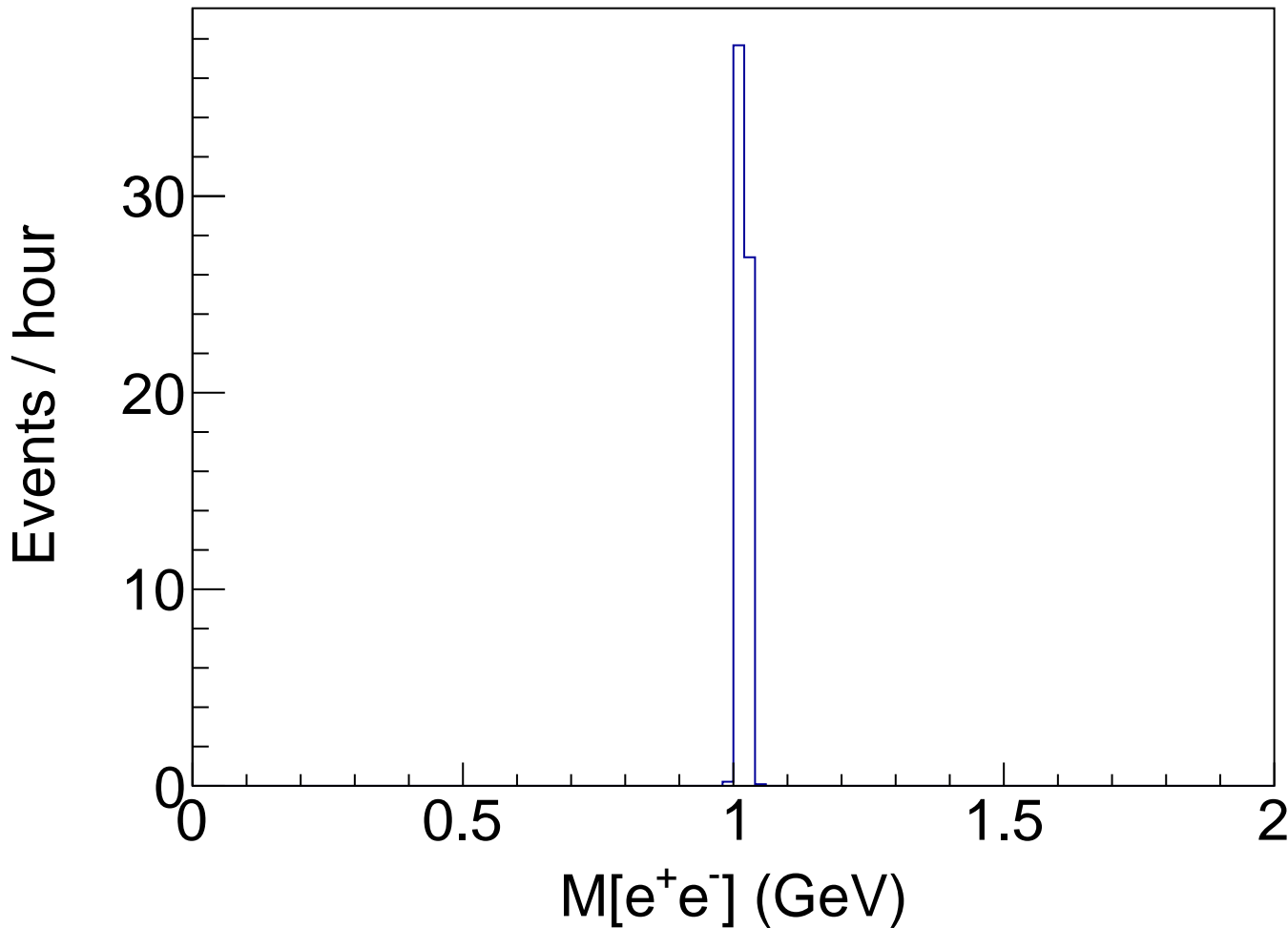




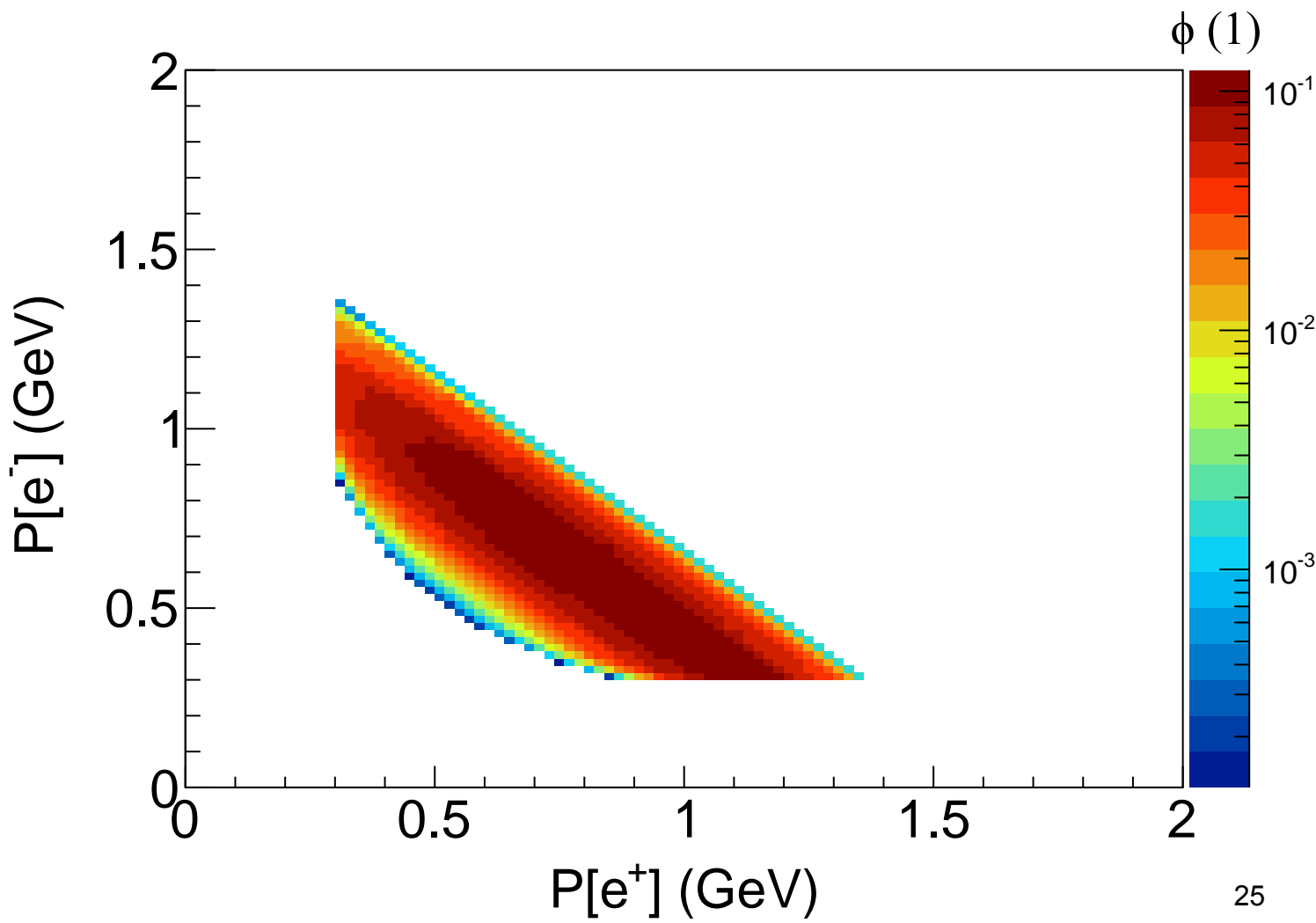


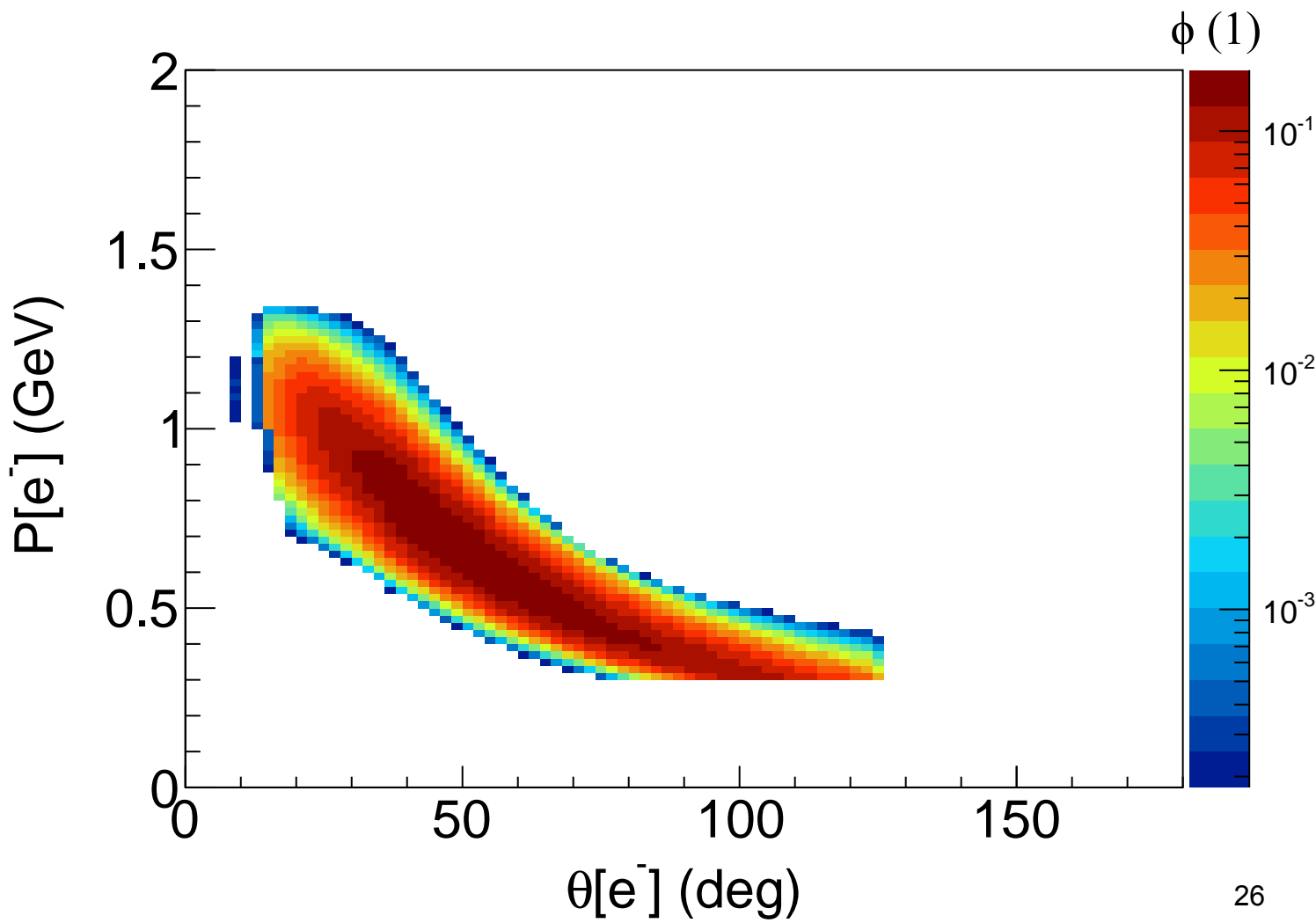


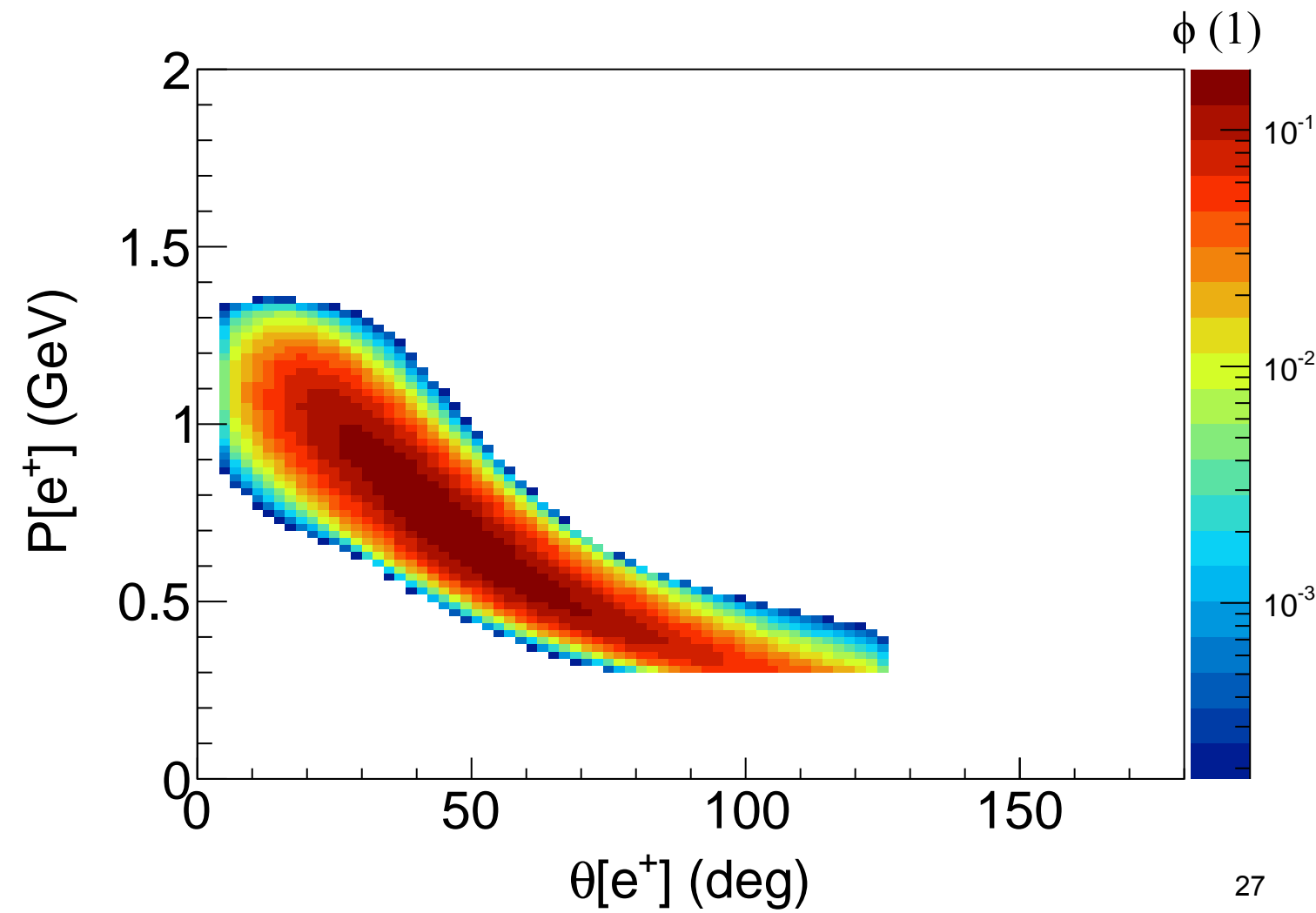


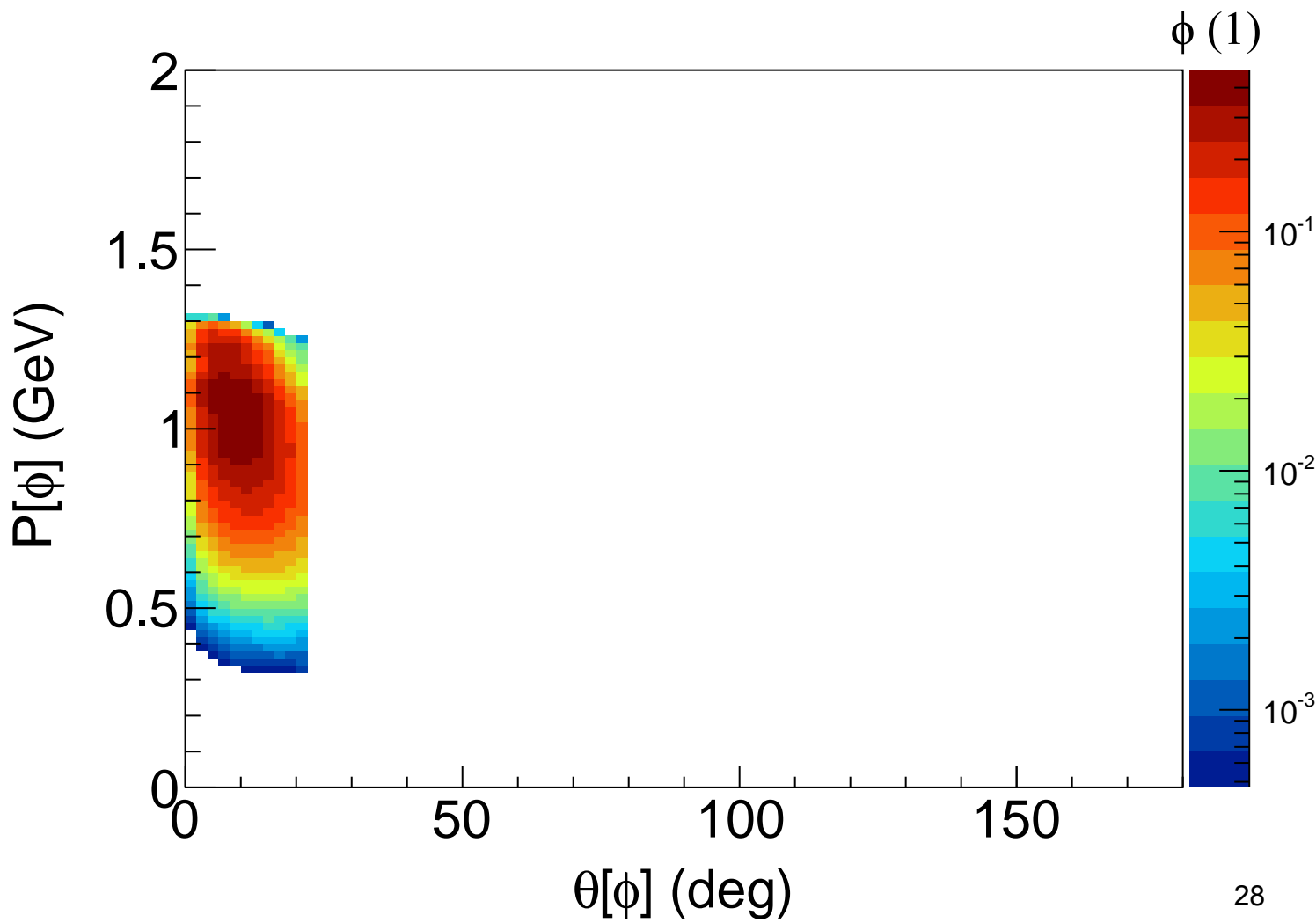
$\phi(1)$ 





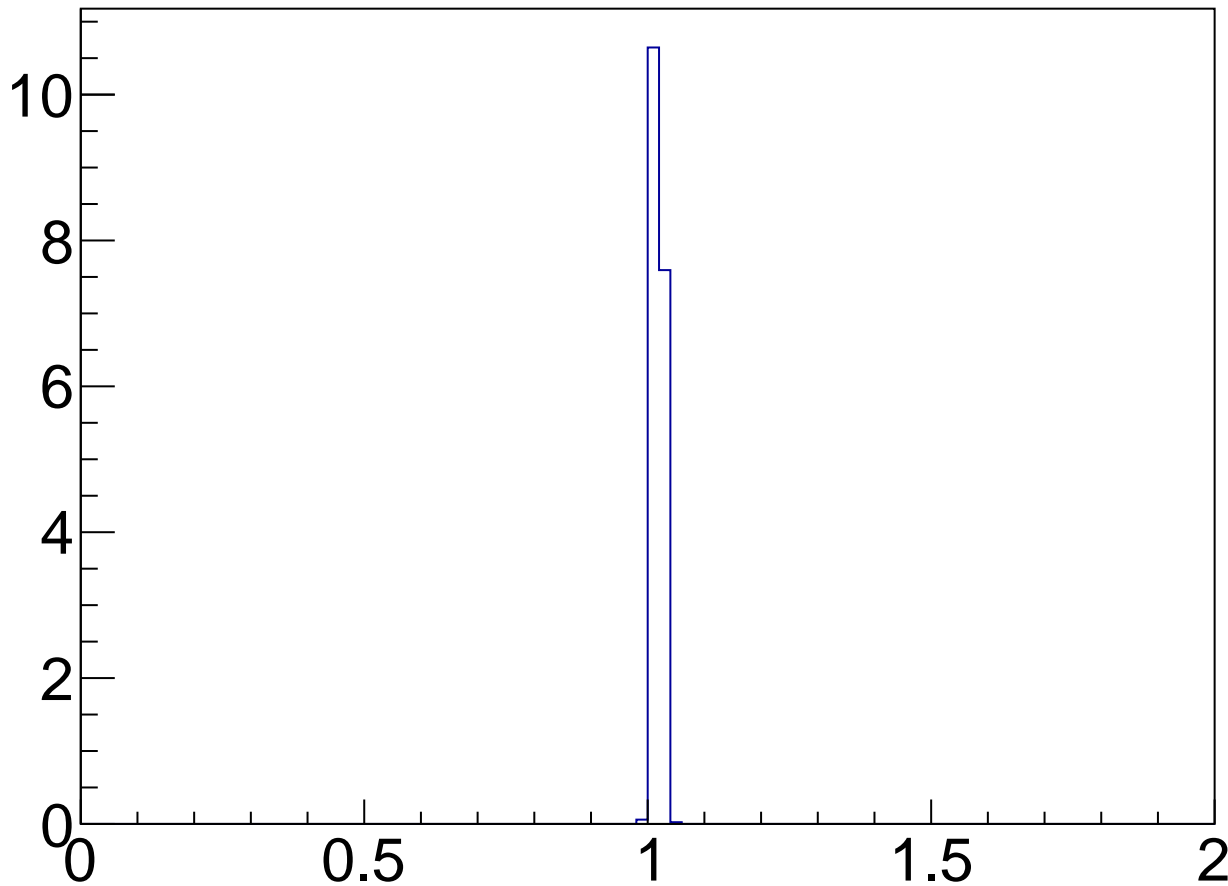




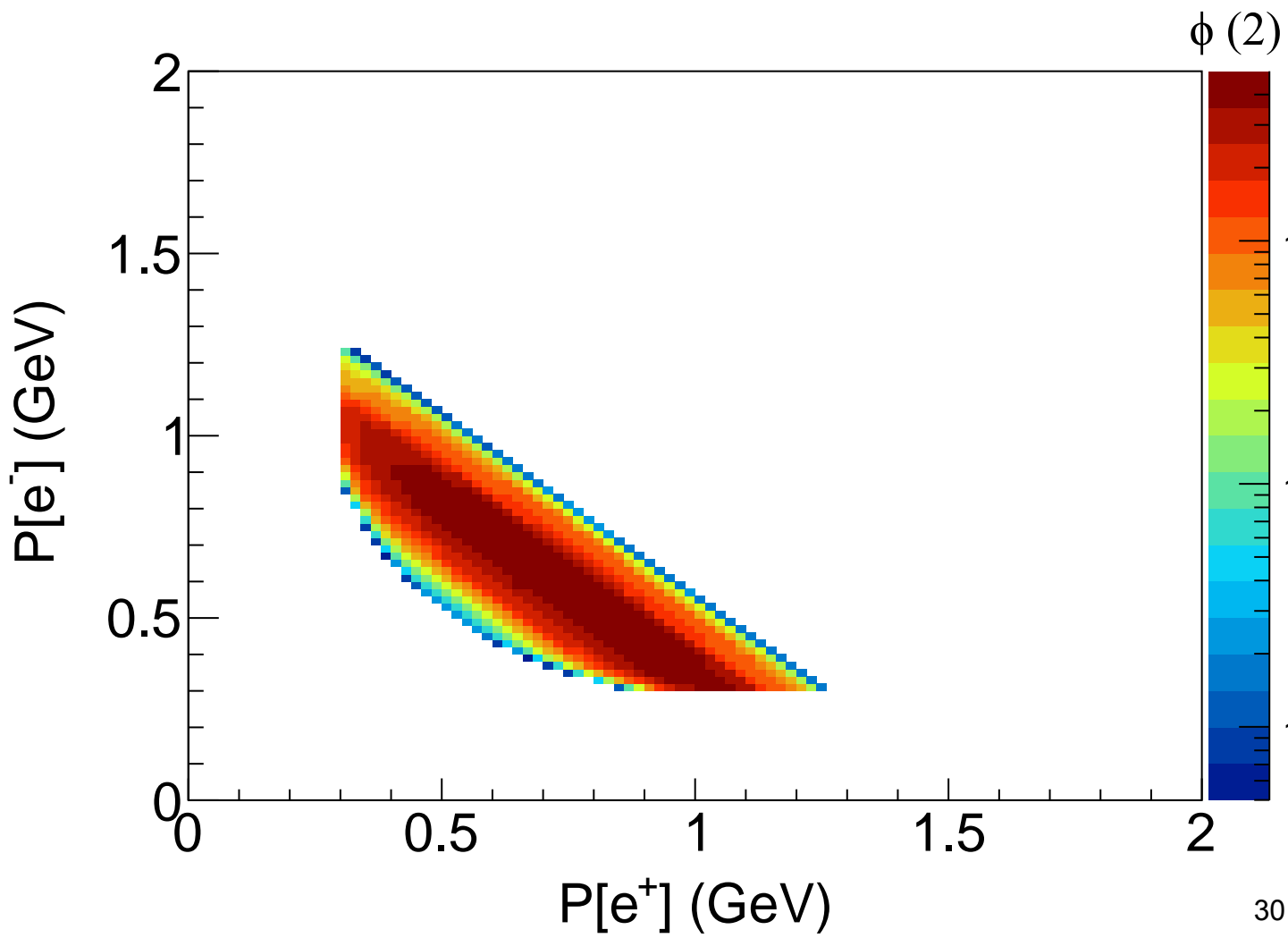


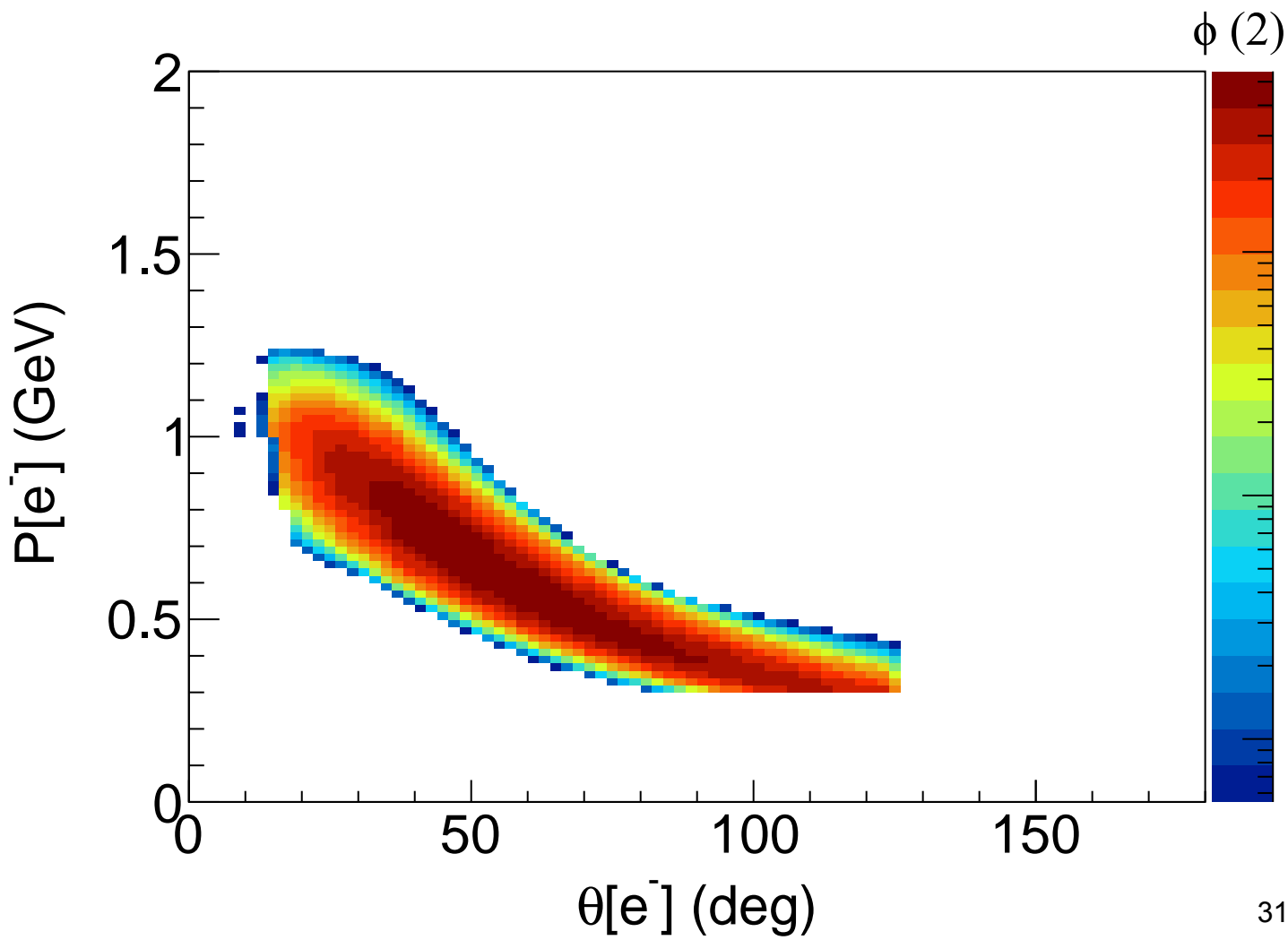
Events / hour

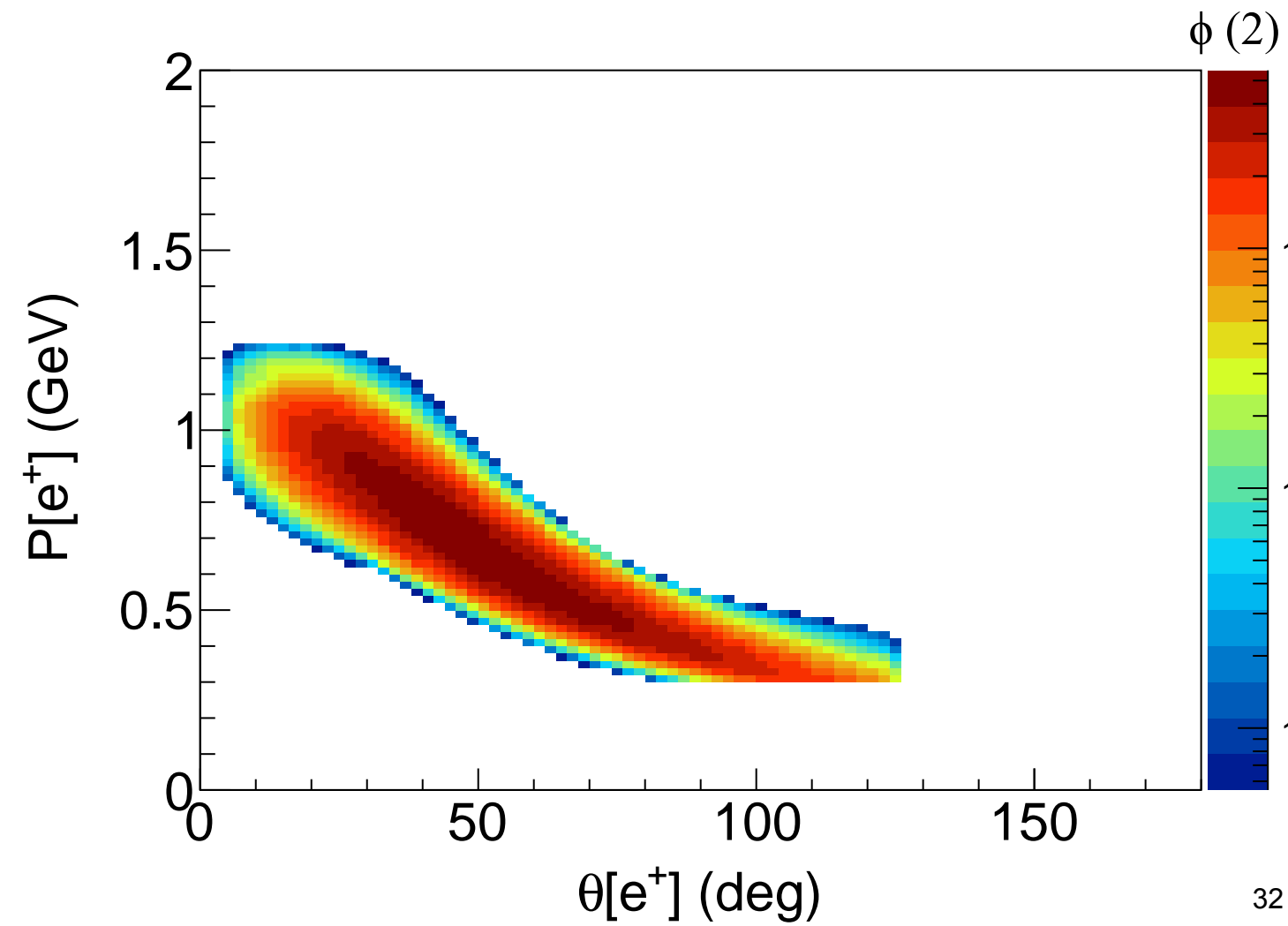
$\phi(2)$



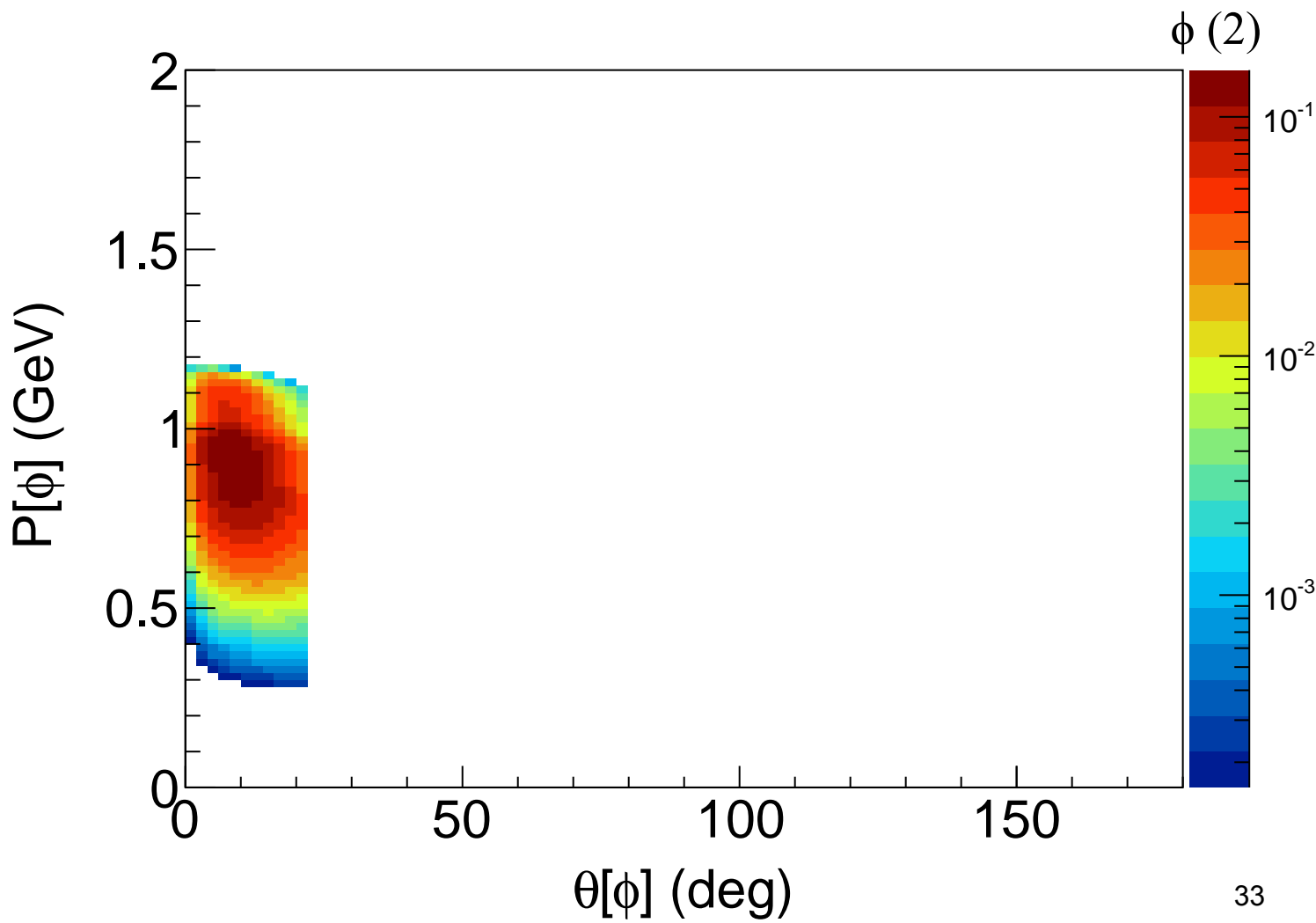
$M[e^+e^-]$  (GeV)











$\phi(3)$ 