Inclusive cross sections with “real” electron ID

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ePIC joint physics/software meeting

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Cross section from simulation files

$$\frac{d\sigma}{dx_B\, dQ^2} = \frac{N}{C_{acc} \cdot C_{bin} \cdot L \cdot \Delta x_B \Delta Q^2}$$

$$\sigma_{red} = \left(\frac{d\sigma}{dx_B\, dQ^2}\right) \cdot \frac{Q^4 x_B}{2\pi\alpha^2 Y_+ \hbar^2 c^2}$$

$$Y_+ = 1 + (1-y)^2$$

- Acceptance and bin migration corrections from simulation

$$C_{acc} = \frac{N_{rec}(x_{gen}, Q^2_{gen})}{N_{gen}(x_{gen}, Q^2_{gen})} \qquad C_{bin} = \frac{N_{rec}(x_{rec}, Q^2_{rec})}{N_{rec}(x_{gen}, Q^2_{gen})}$$

- Scale counts to integrated luminosity of $L = 10$ fb^{-1} .
- Bin volumes $\Delta x_B \Delta Q^2$ from Monte Carlo (account for cuts)

- Using same simulated events for analysis and corrections... *by definition* will obtain the generated distributions
- Detector and reconstruction performance determines *size of the corrections*

Currently implemented electron ID

- Start with all reconstructed particles with negative charge
- Select particles with $0.9 < E/p < 1.2$
  - Reconstructed E and p
  - Truth track-cluster matching
- Take electron with largest $E - p_z$
  - Reconstructed E and p
  - Truth (hadron) PID

- Shortcomings:
  - Still using truth information
  - Calculated values of E/p and $E - p_z$ not saved in output

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- Evaluating performance
  - How often does reconstruction-based electron ID select the correct particle? Are most failures due to no identified particles, or mis-identified particles?
  - What is the impact of eID on corrections and bin stability/purity?

Details of the reconstruction and analysis

- Tag 24.06.0
- NC DIS events only!
- Electron track reconstruction only (focus on eID performance)
- Repeat analysis twice using reconstruction-based electron ID (eID) and truth-based electron ID (true ID).

- Kinematic cuts:
  - $Q^2 > 4$ GeV^2.
  - $W^2 > 10$ GeV^2.
  - $0.05 < y < 0.95$

eID success/failure rates

- Percentage of luminosity-weighted events (no kinematic cuts)
  - Success (eID identifies same reconstructed particle as true ID)
  - Fail, no ID (eID fails to identify reconstructed particle)
  - Fail, wrong ID (eID identifies different reconstructed particle than true ID)

	Success	**Fail, no ID**	**Fail, wrong ID**
5x41 GeV	87.3%	9.9%	2.8%
10x100 GeV	91.5%	6.5%	2.0%
18x275 GeV	80.7%	16.0%	3.3%

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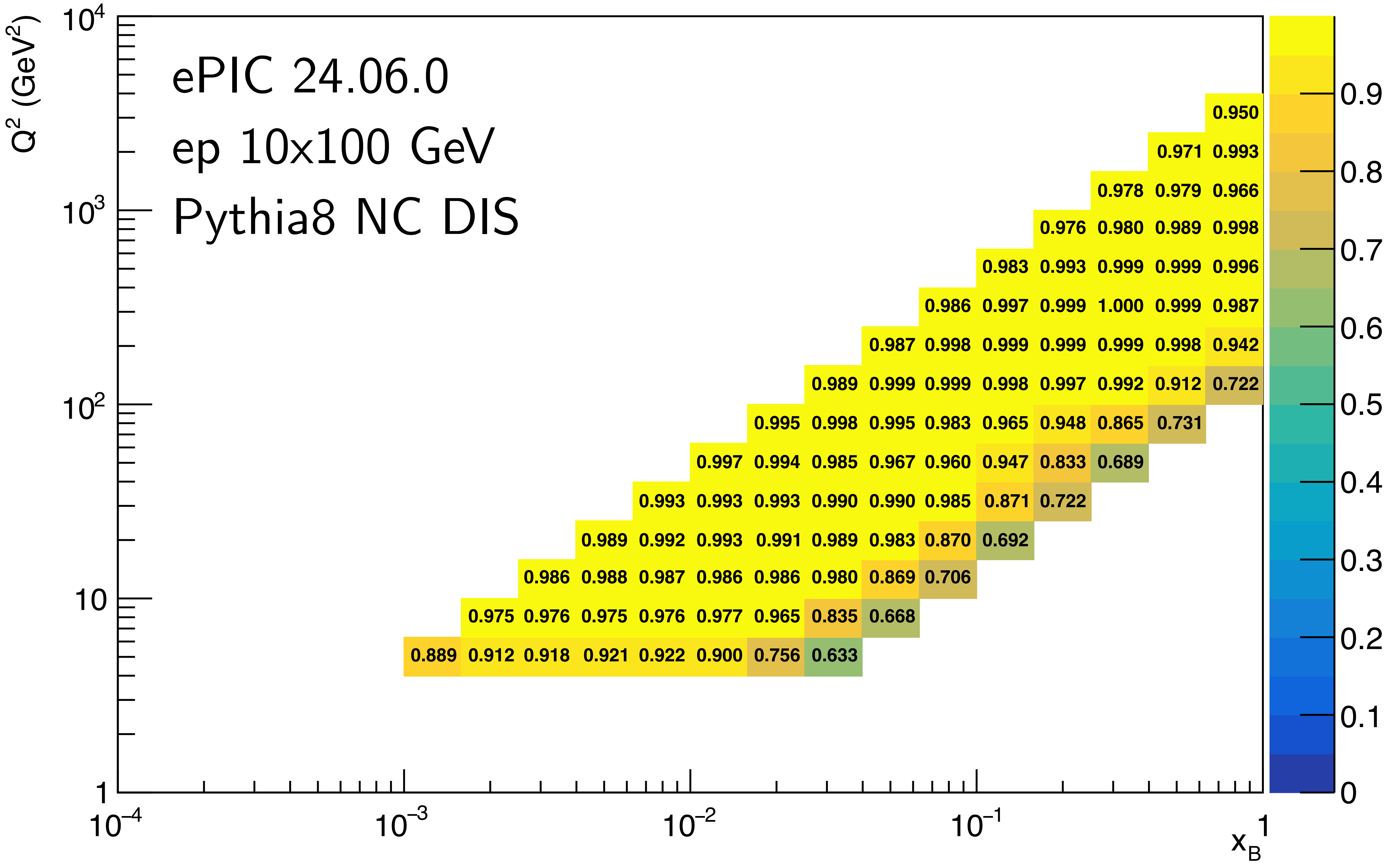
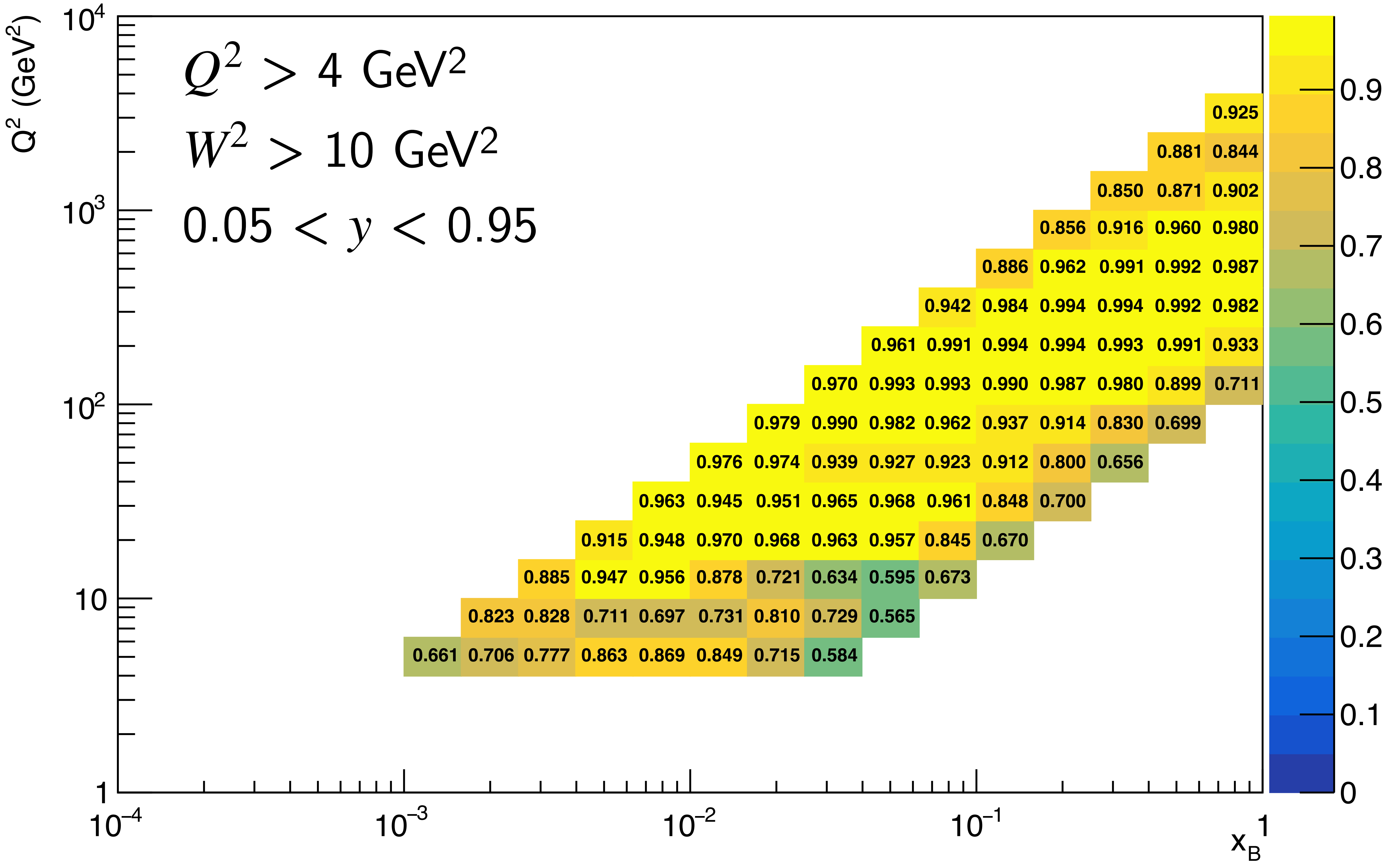
- Expect largest impact on acceptance
- To be done: examine dependence of success/failure rates on kinematic/electron variables

Acceptance correction (10x100 GeV)

True ID



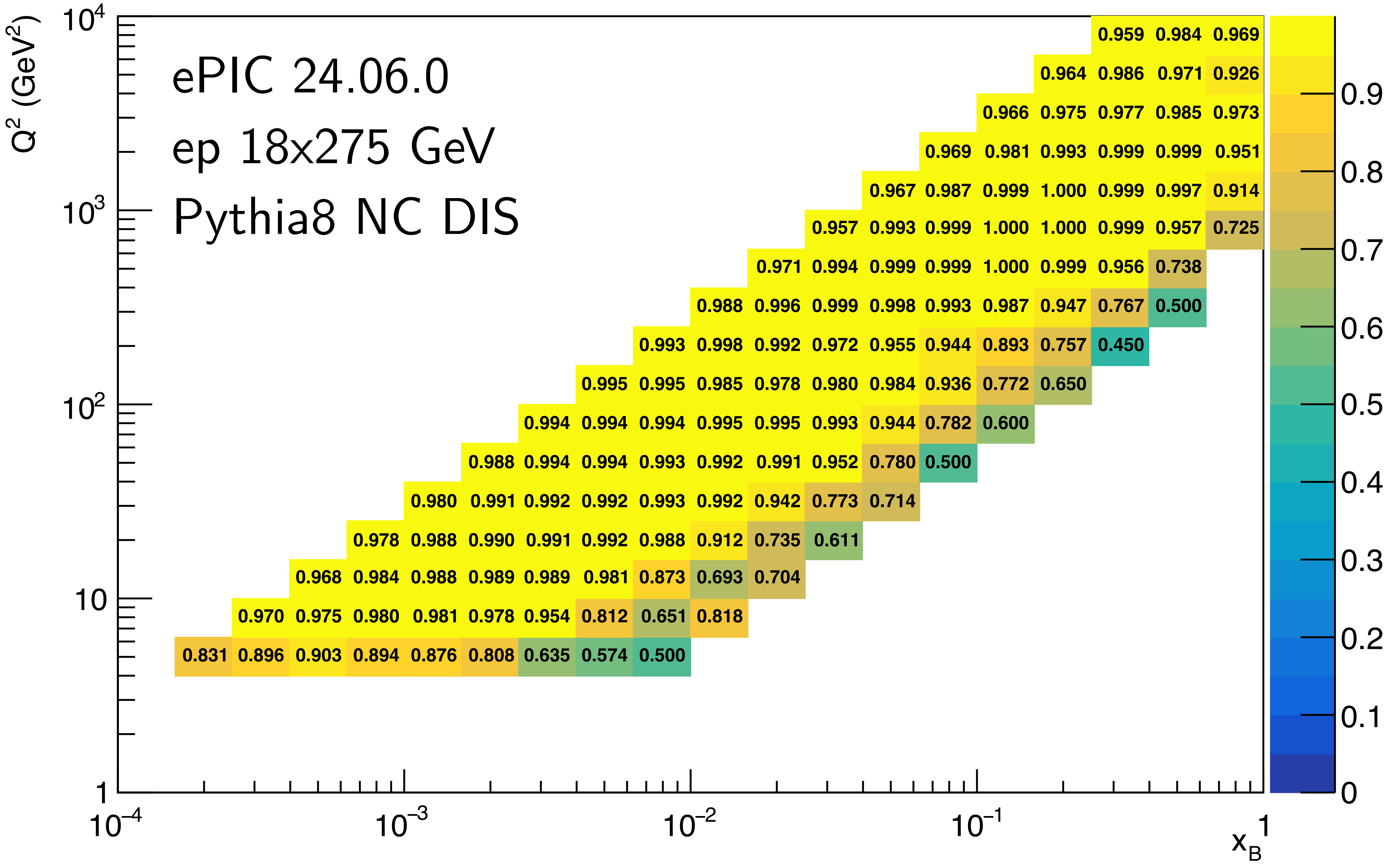
eID



$$C_{acc} = \frac{N_{rec}(x_{gen}, Q^2_{gen})}{N_{gen}(x_{gen}, Q^2_{gen})}$$

Acceptance correction (18x275 GeV)

True ID



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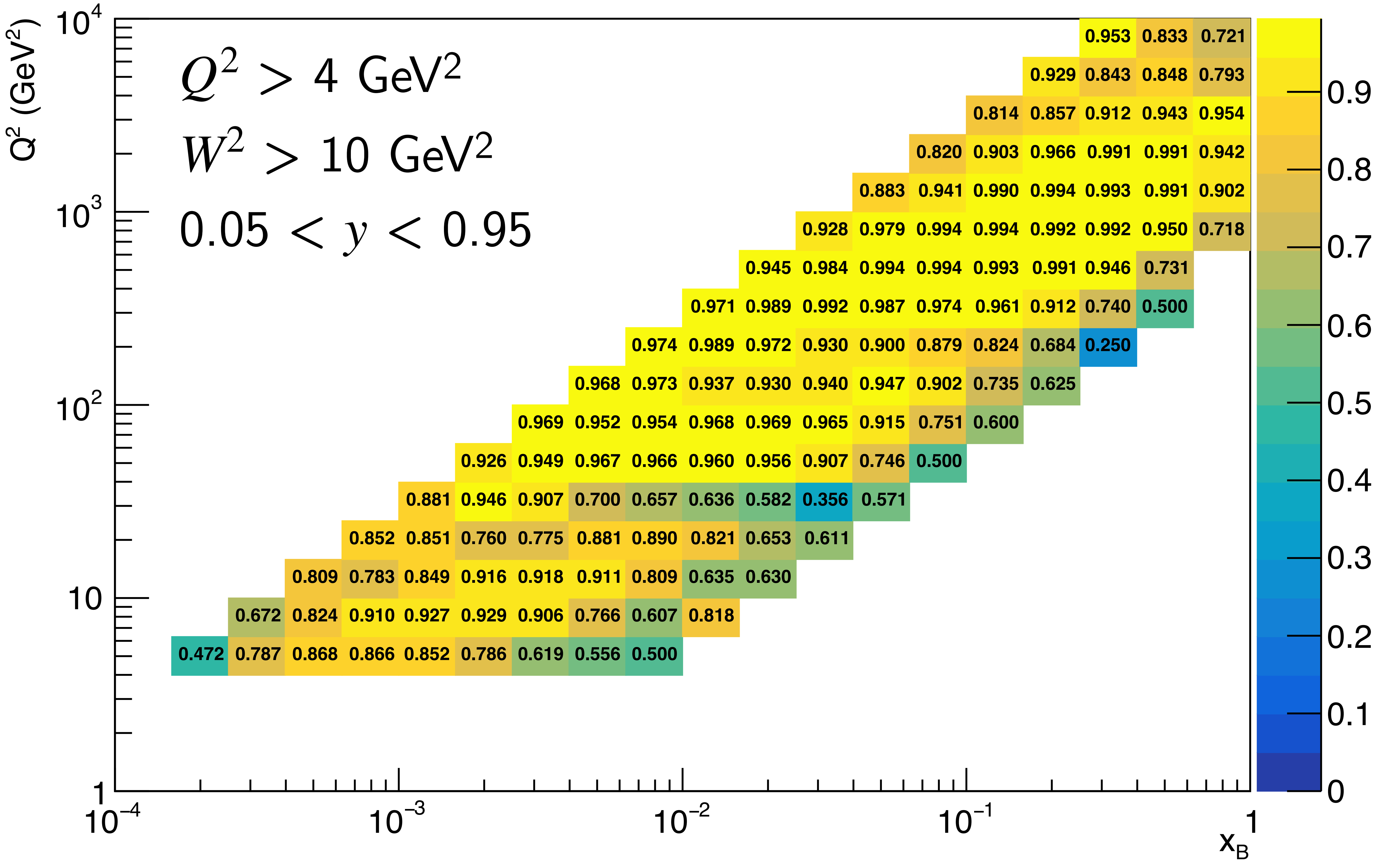

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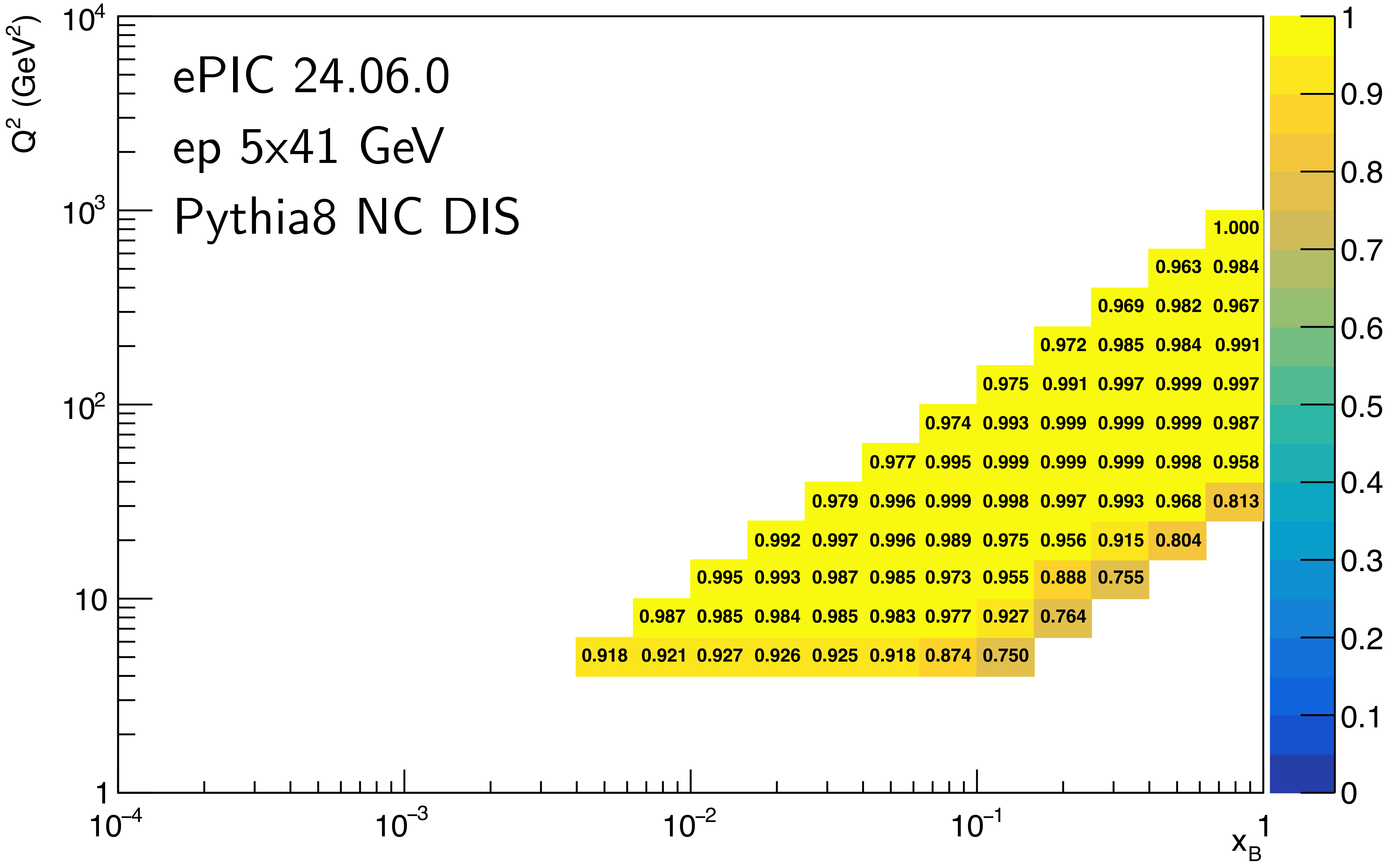

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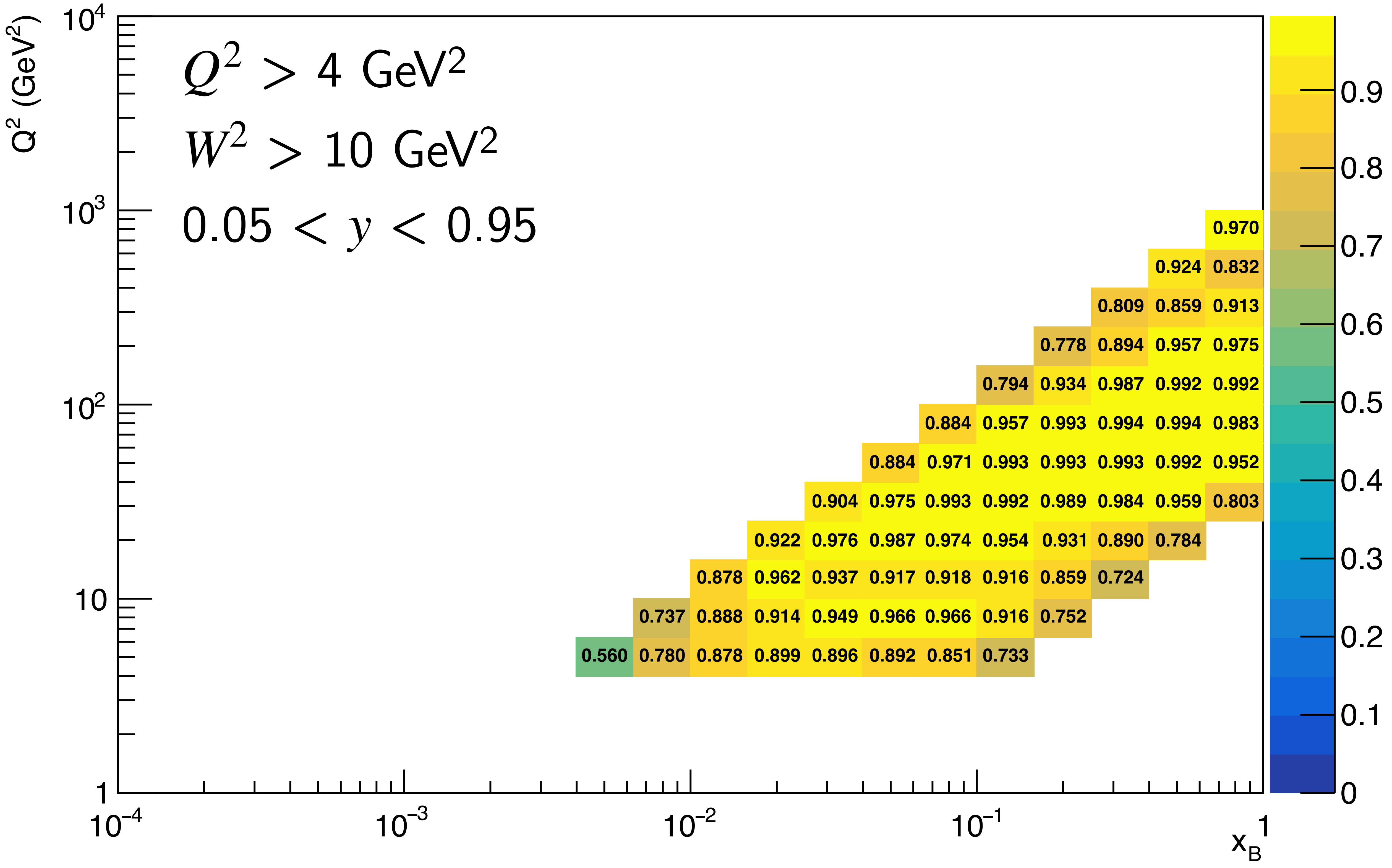

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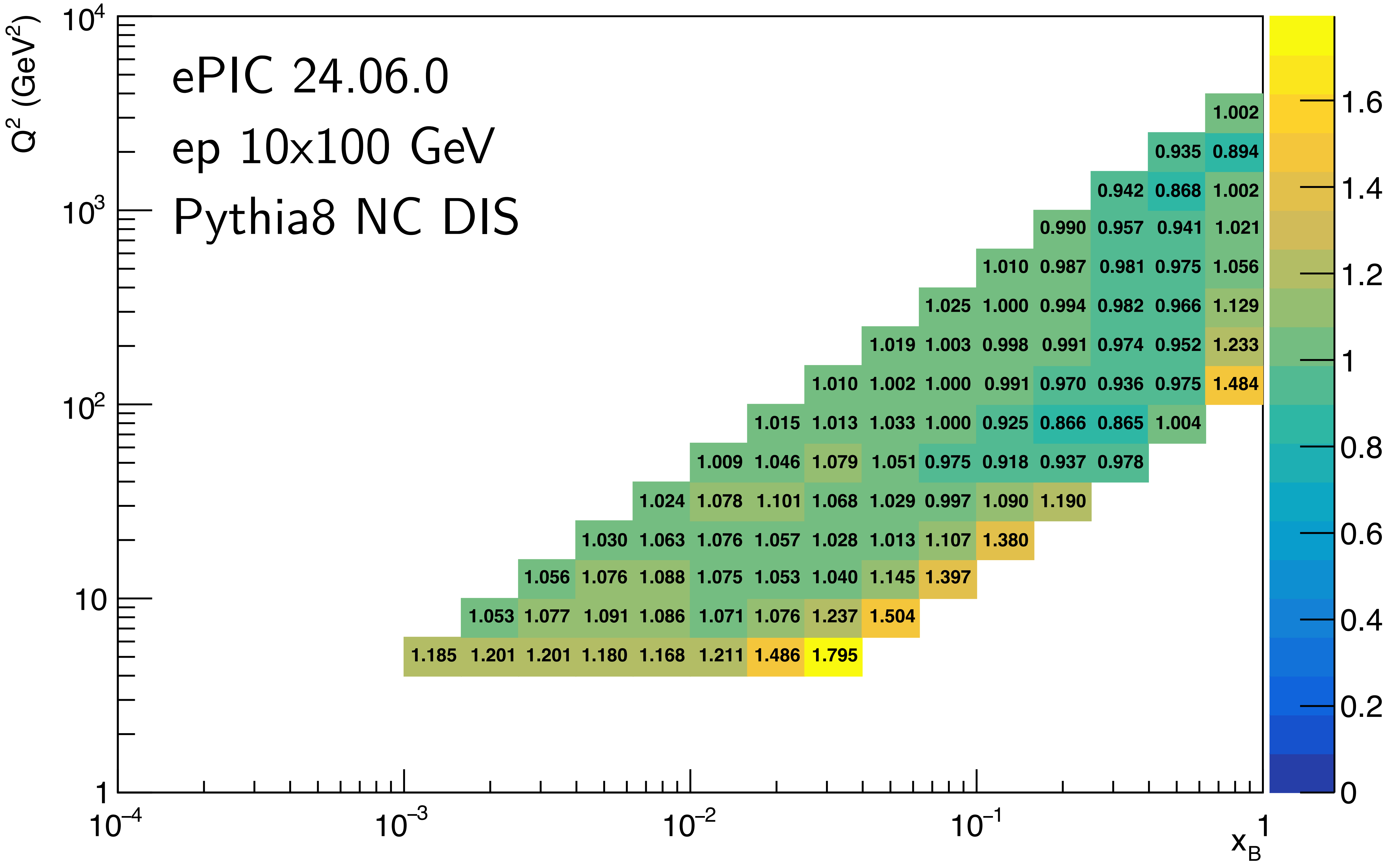
Bin migration correction (10x100 GeV)

True ID



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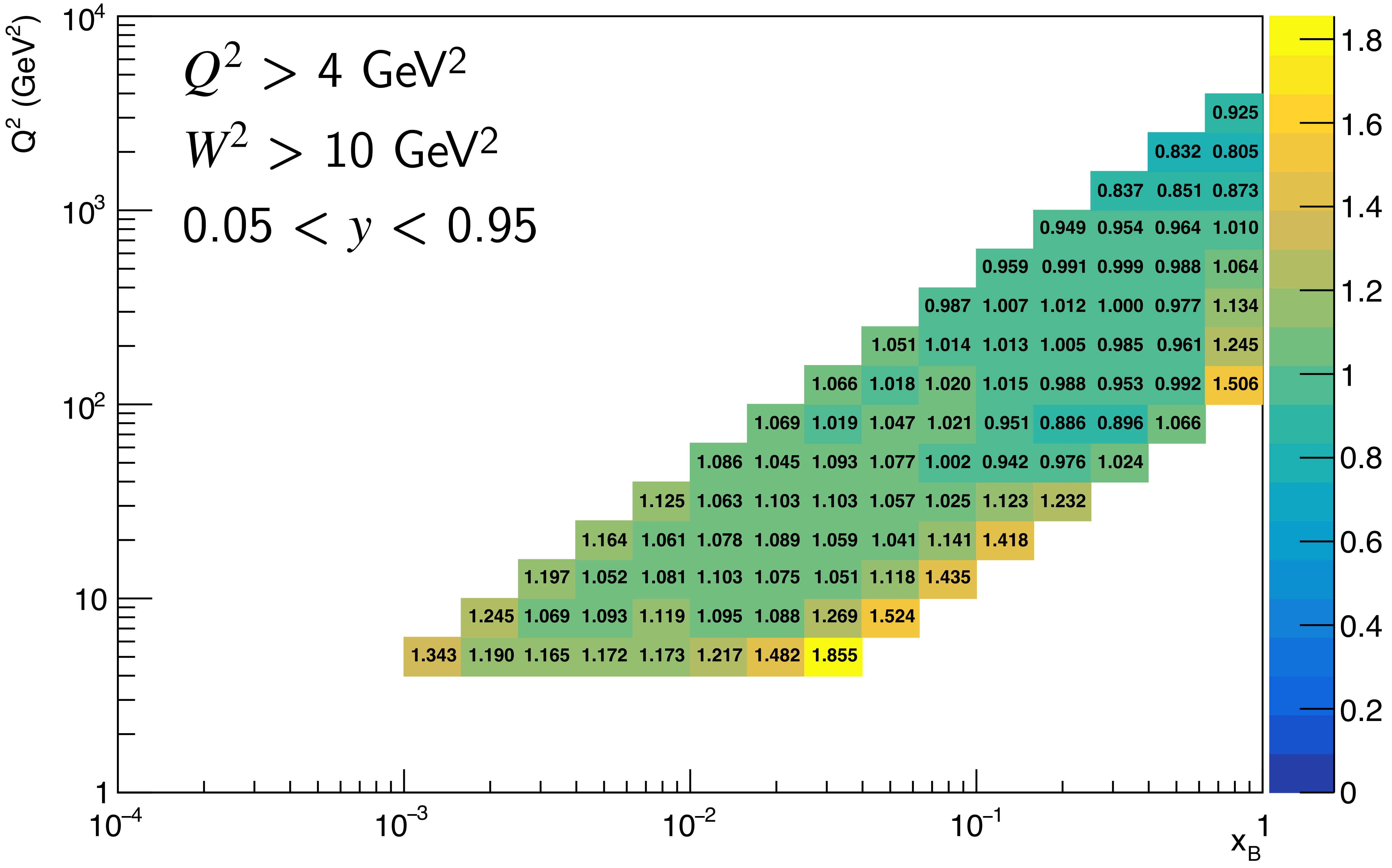

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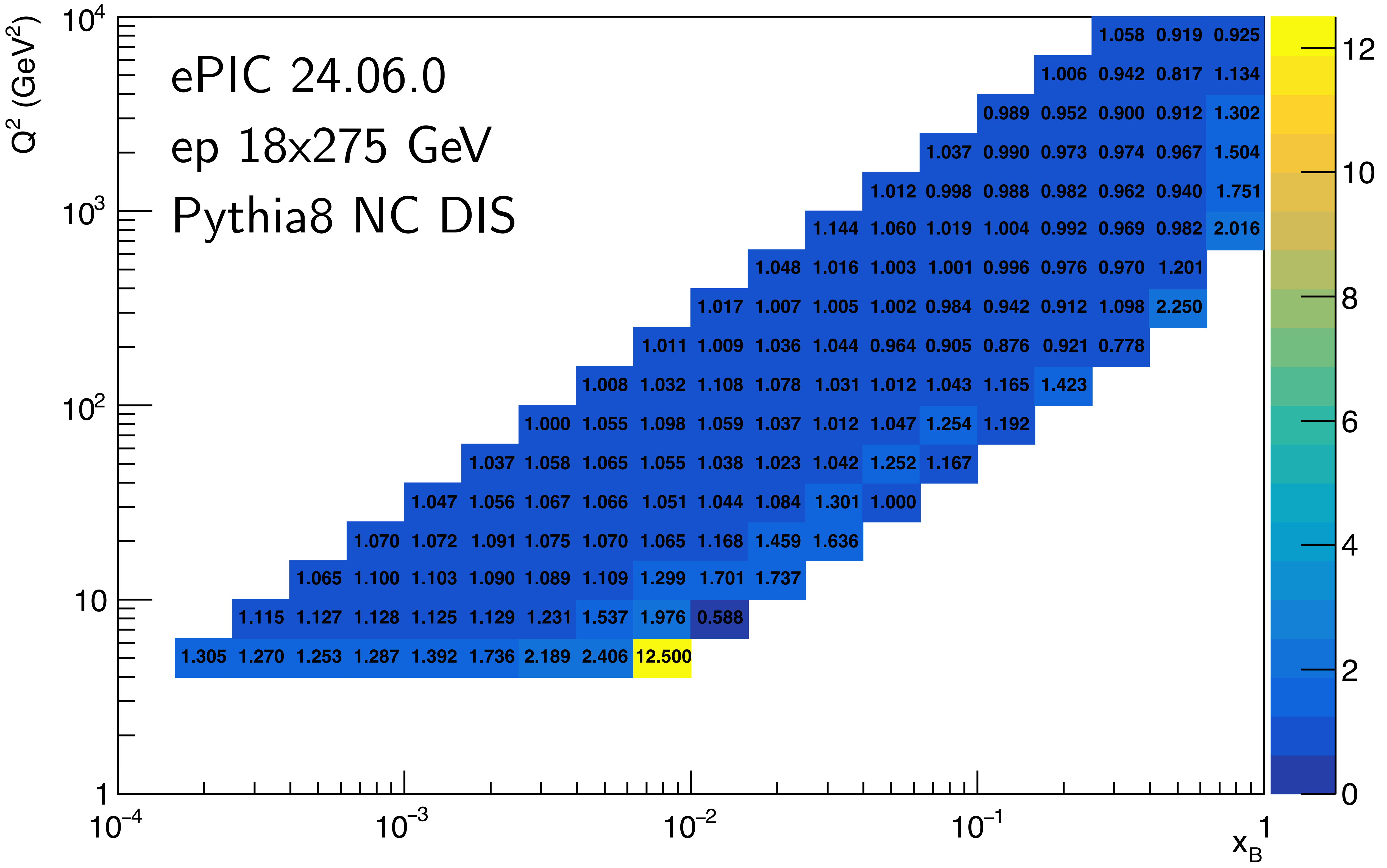
Bin migration correction (18x275 GeV)

True ID



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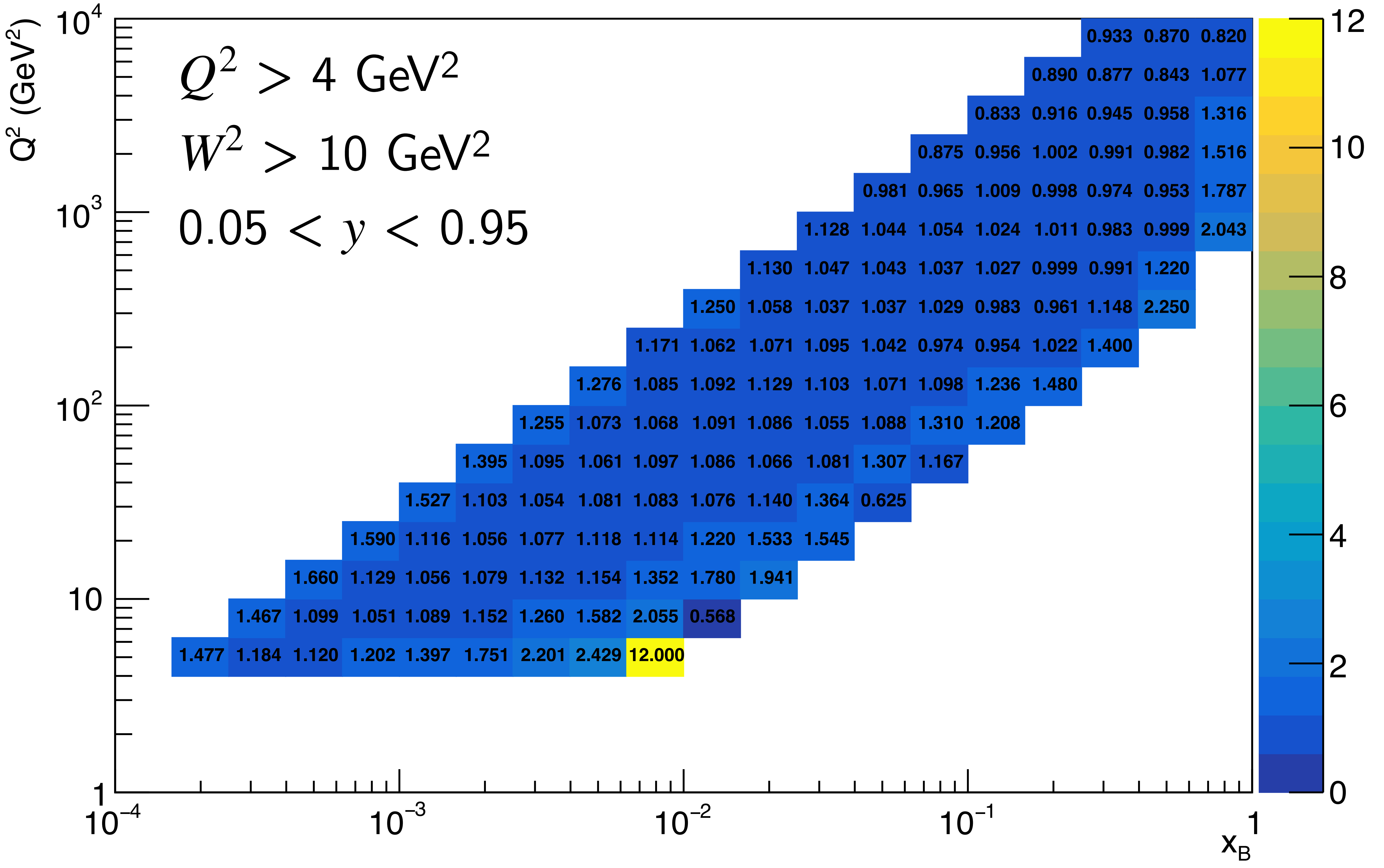

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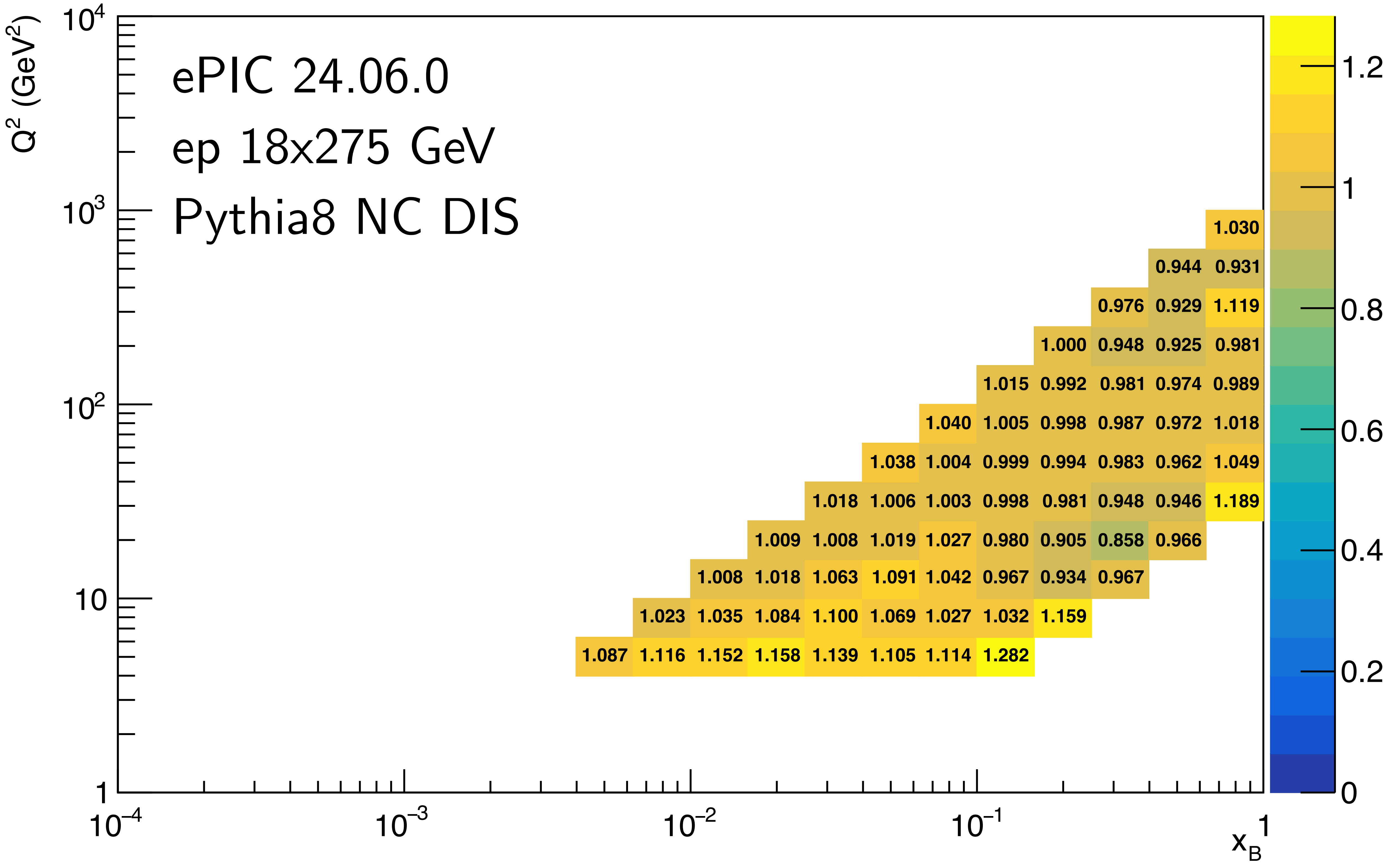

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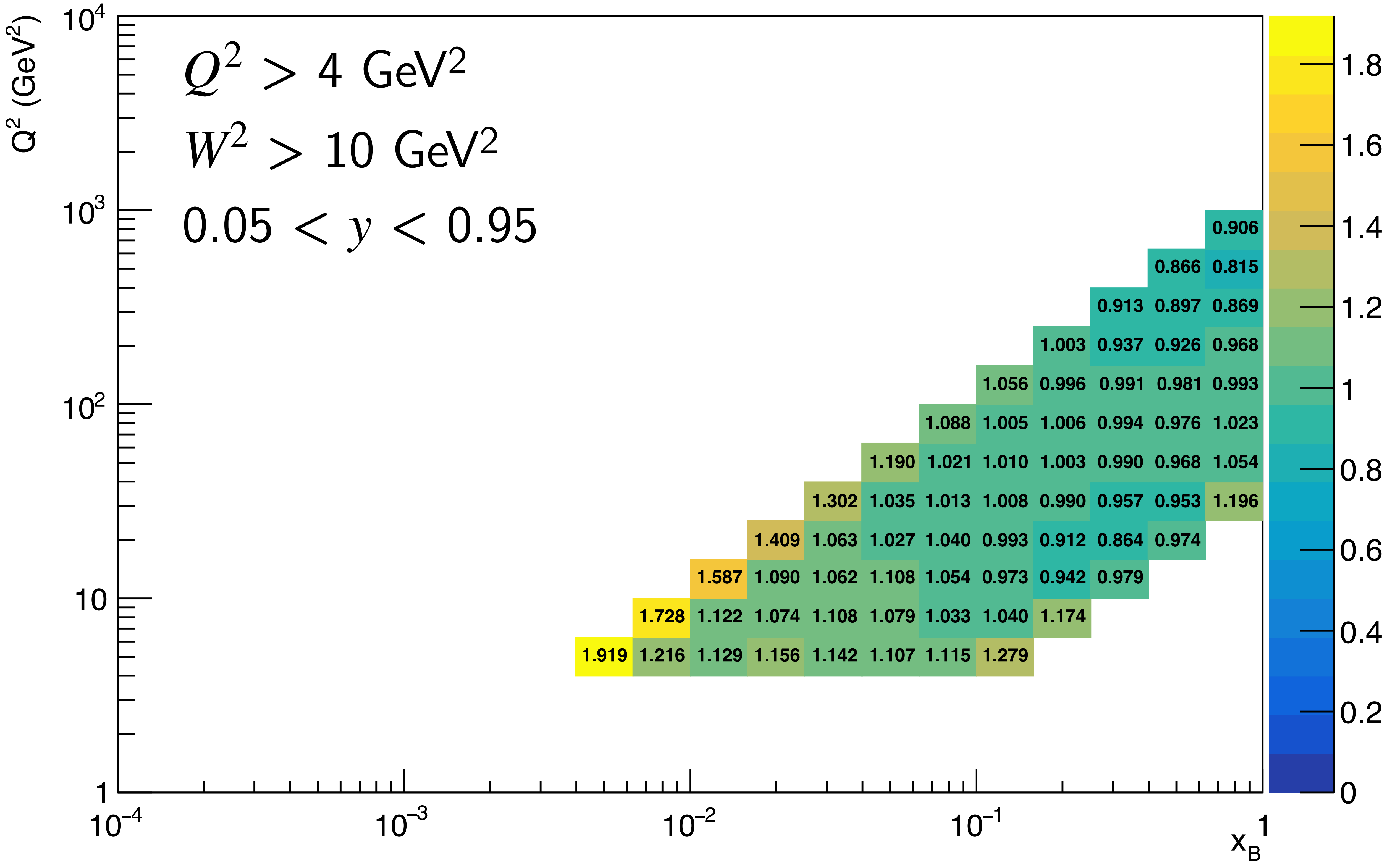


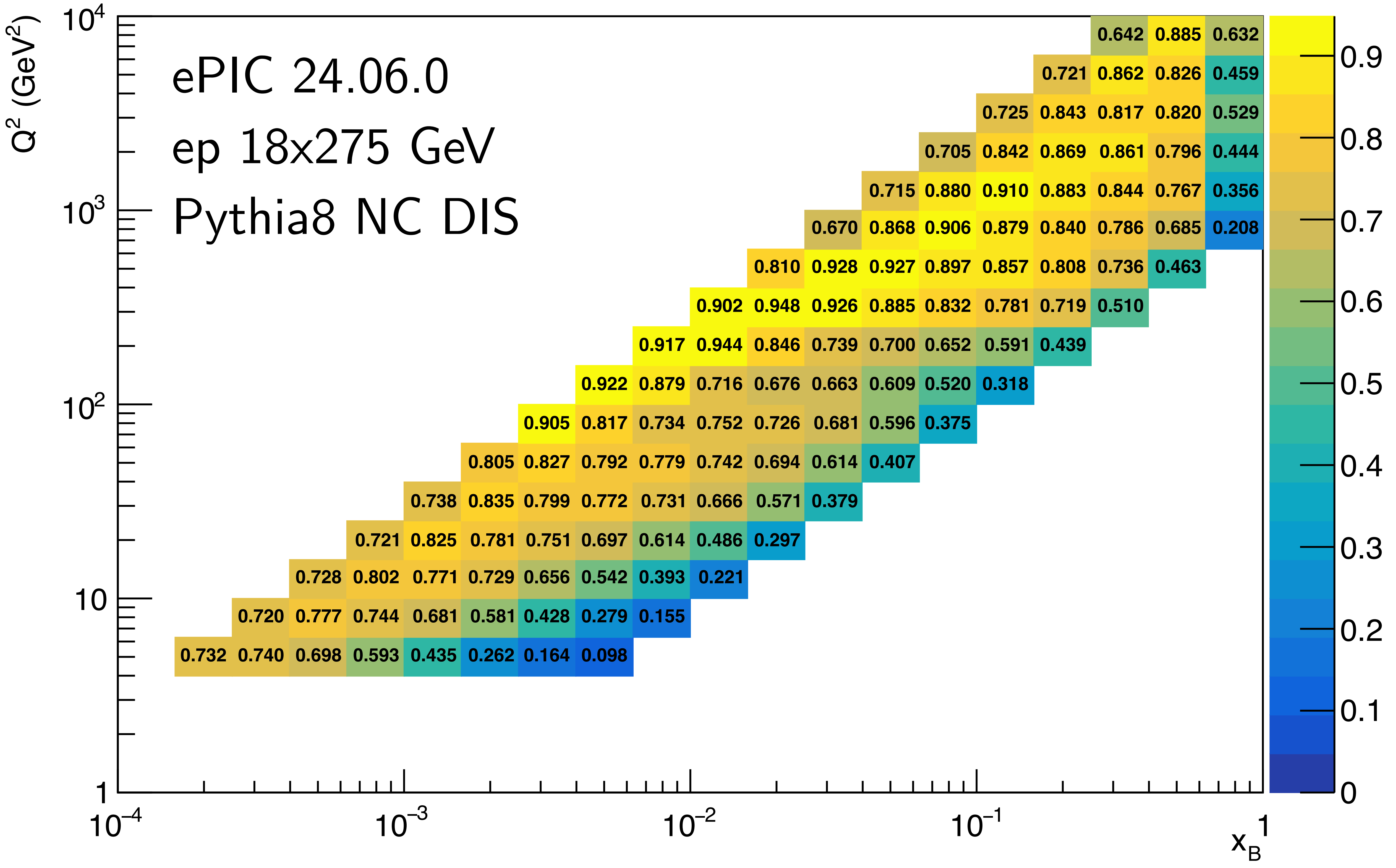
$$C_{bin} = \frac{N_{rec}(x_{rec}, Q^2_{rec})}{N_{rec}(x_{gen}, Q^2_{gen})}$$

Bin purity (10x100 GeV)

$$P = \frac{N_{gen+rec}}{N_{rec}}$$

Bin purity (18x275 GeV)

True ID



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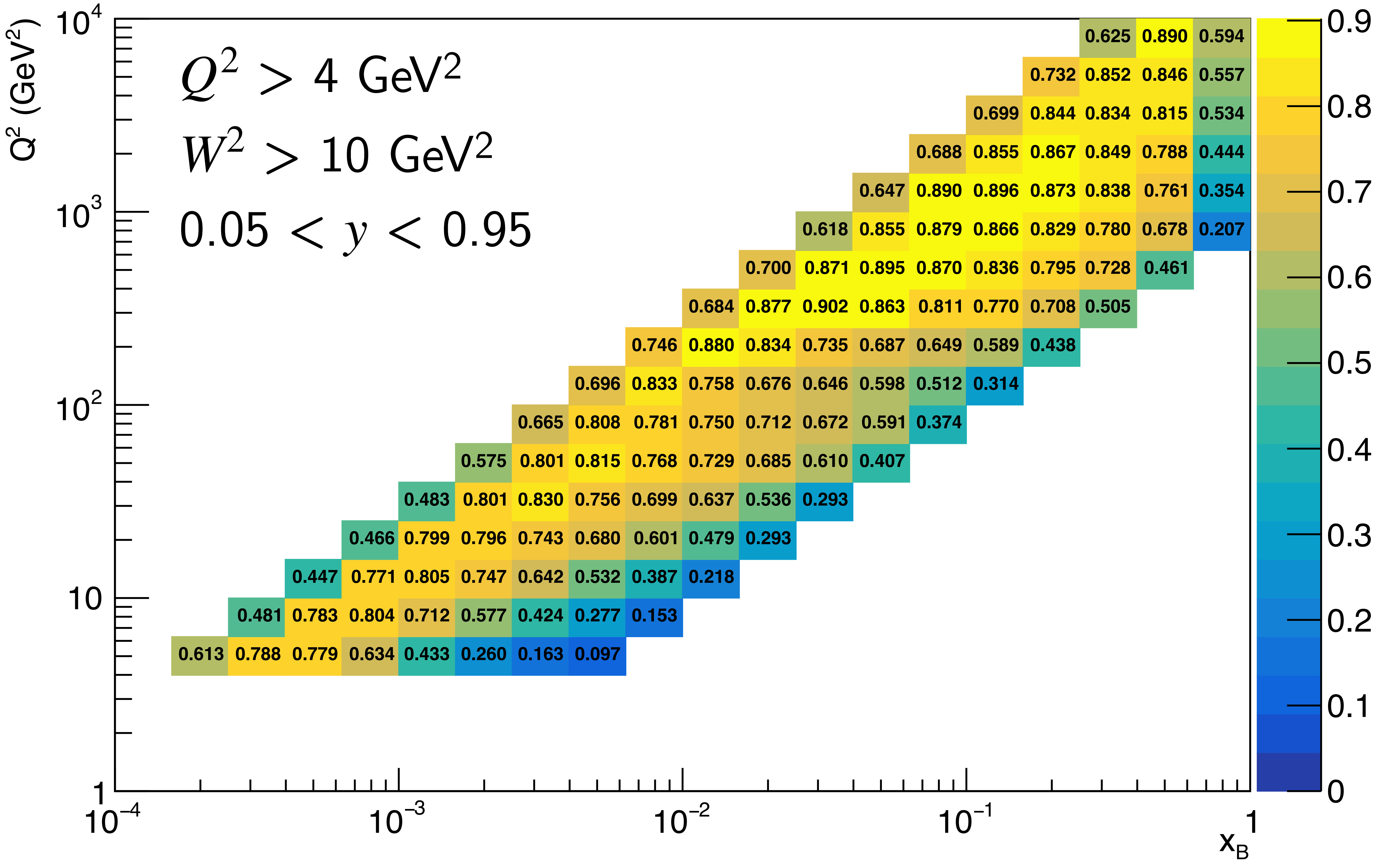

$$P = \frac{N_{gen+rec}}{N_{rec}}$$

Bin purity (5x41 GeV)

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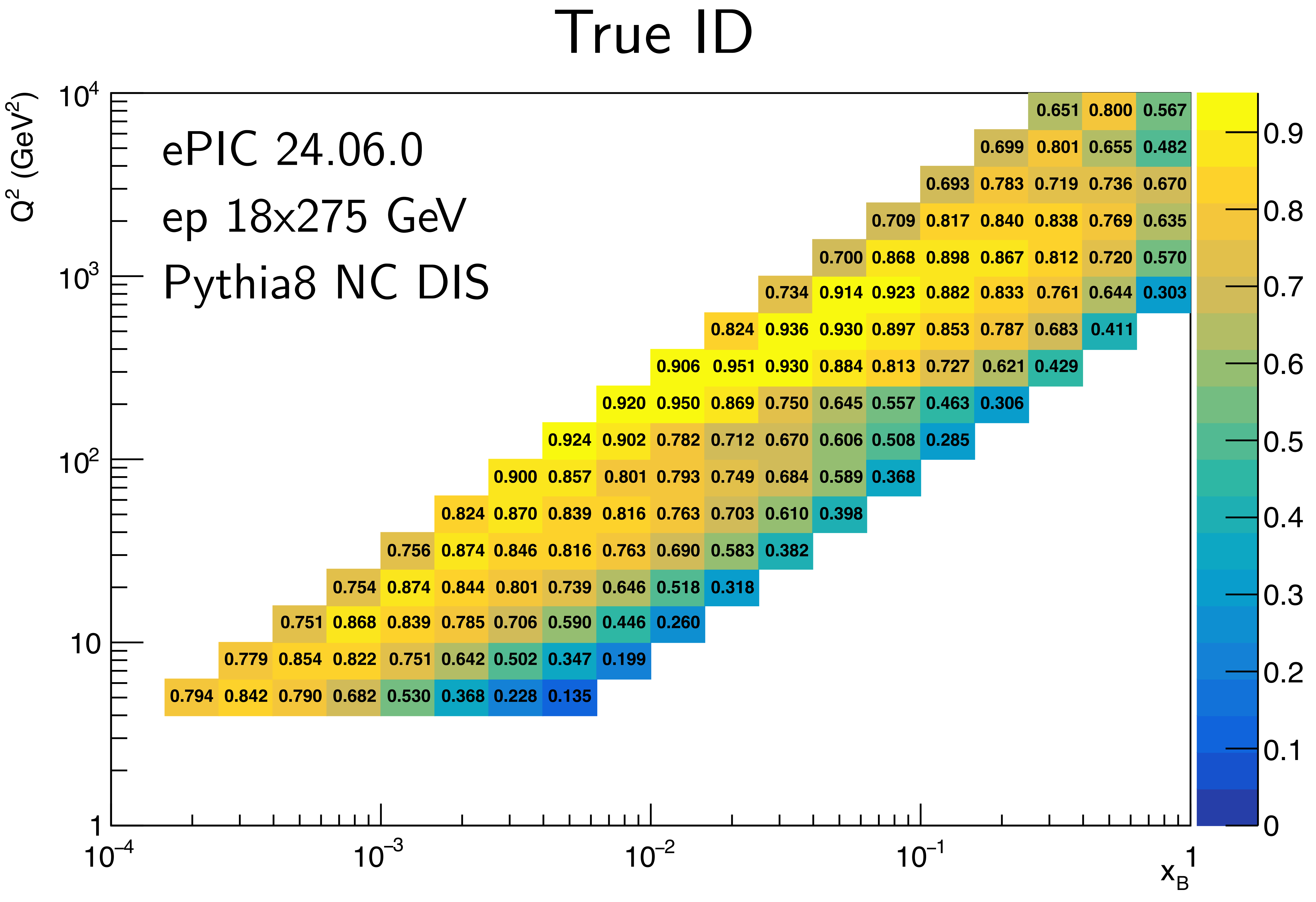
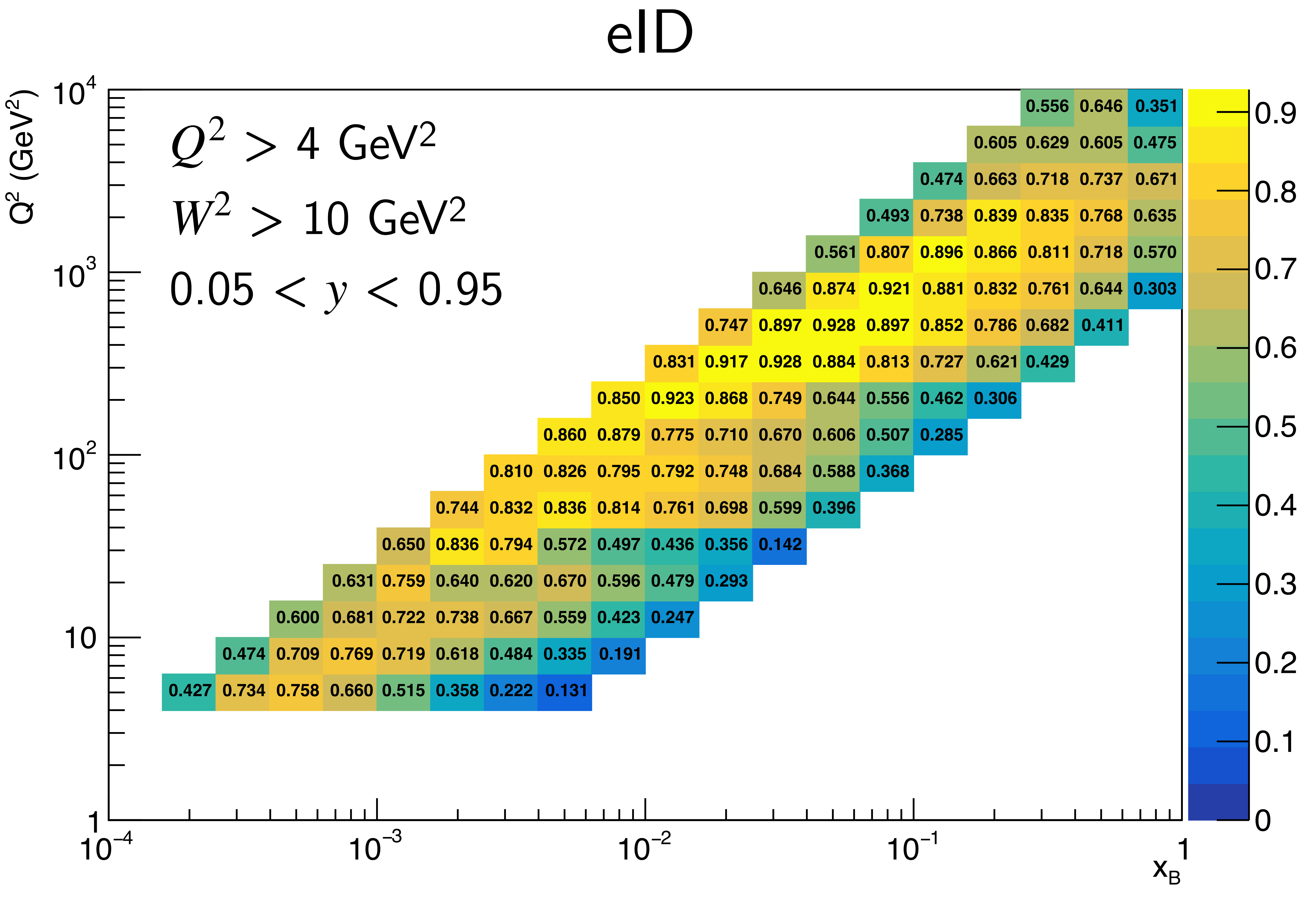
Bin stability (10x100 GeV)

$$S = \frac{N_{gen+rec}}{N_{gen}}$$

Bin stability (18x275 GeV)





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Bin stability (5x41 GeV)

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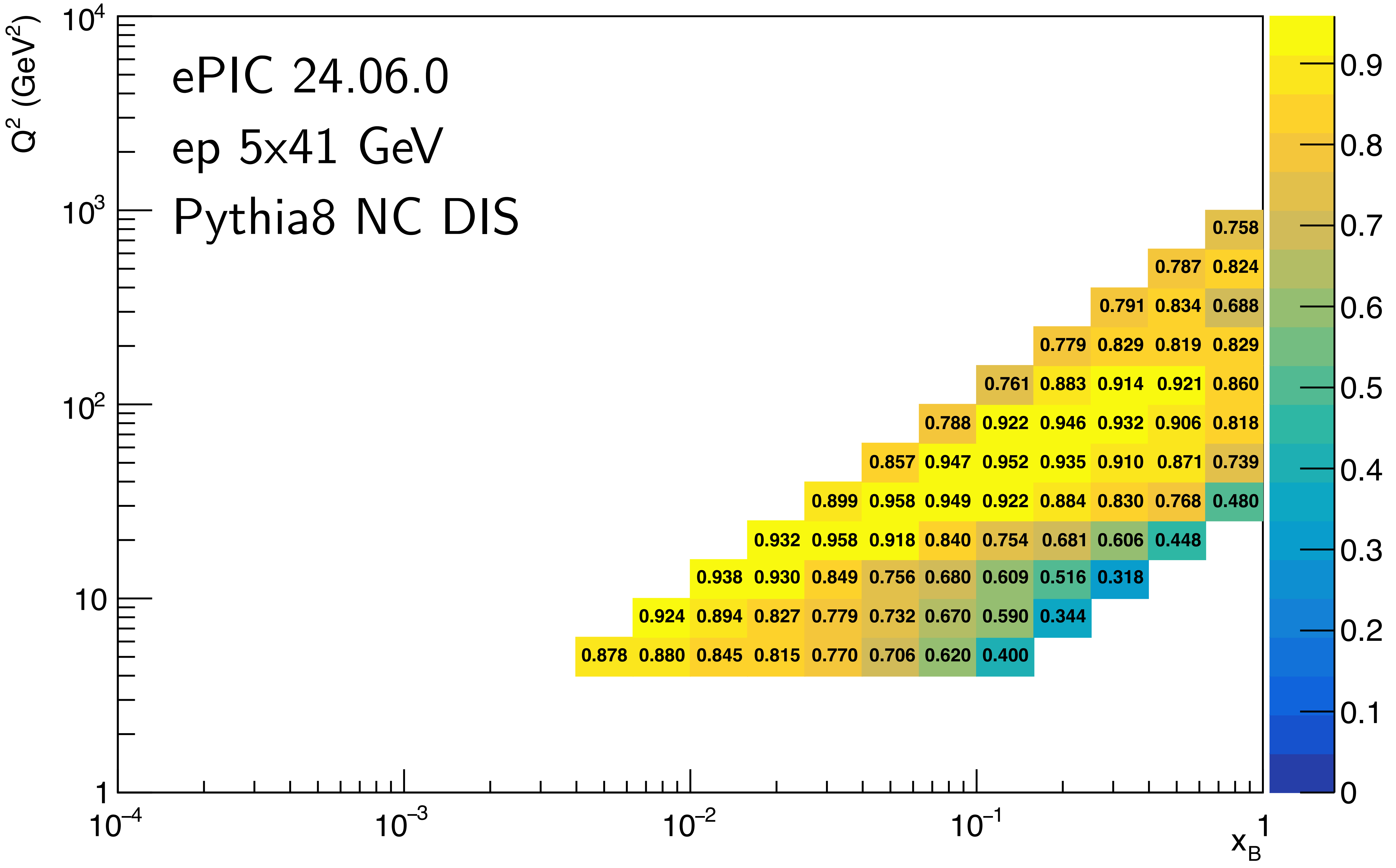

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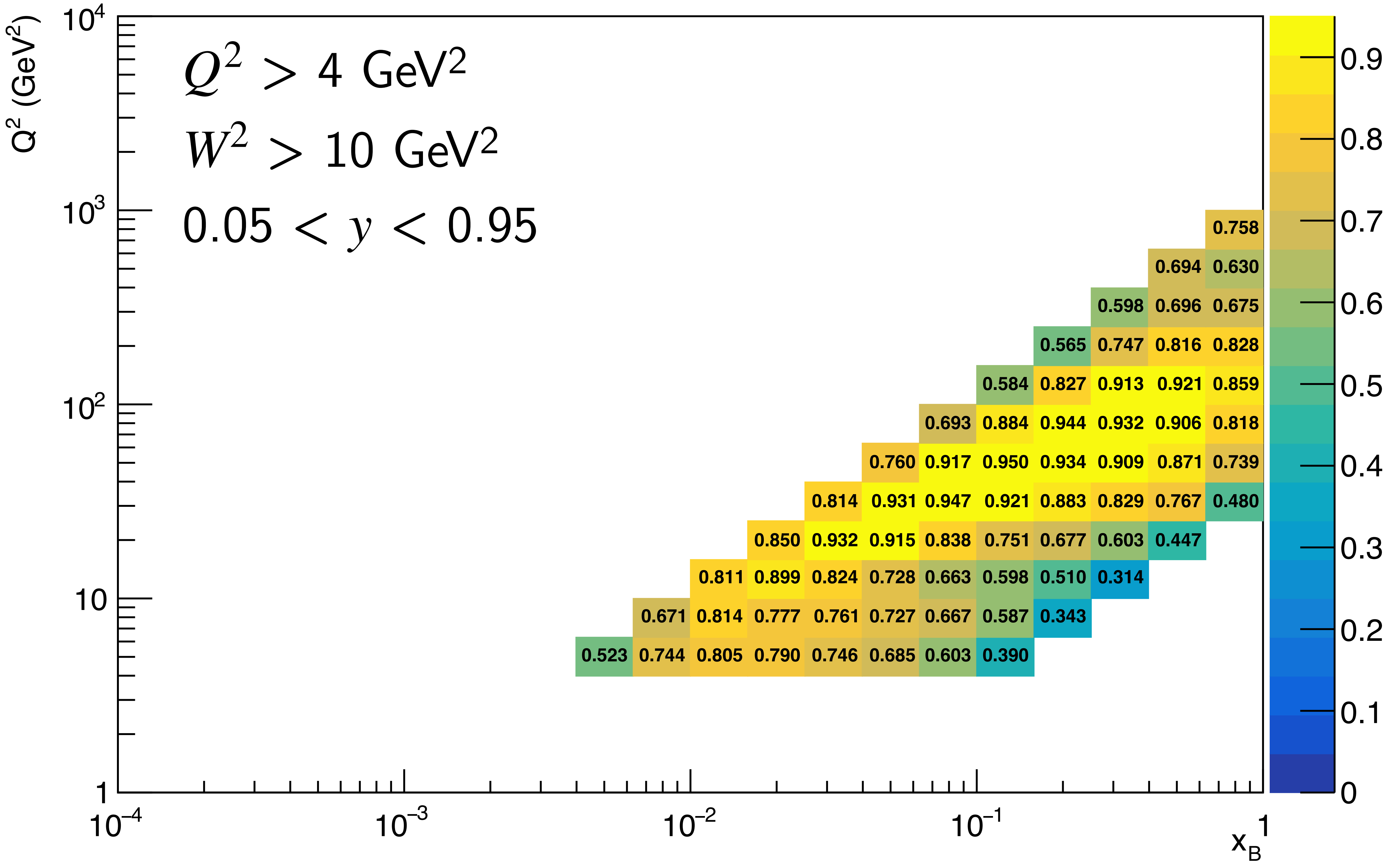

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Reduced cross section (10x100 GeV)

$$\sigma_{red} = \left(\frac{d\sigma}{dx_B\, dQ^2}\right) \cdot \frac{Q^4 x_B}{2\pi\alpha^2 Y_+ \hbar^2 c^2} \qquad Y_+ = 1 + (1-y)^2$$

ePIC 24.06.0
ep 10x100 GeV, 10 fb^{-1}
Pythia8 NC DIS

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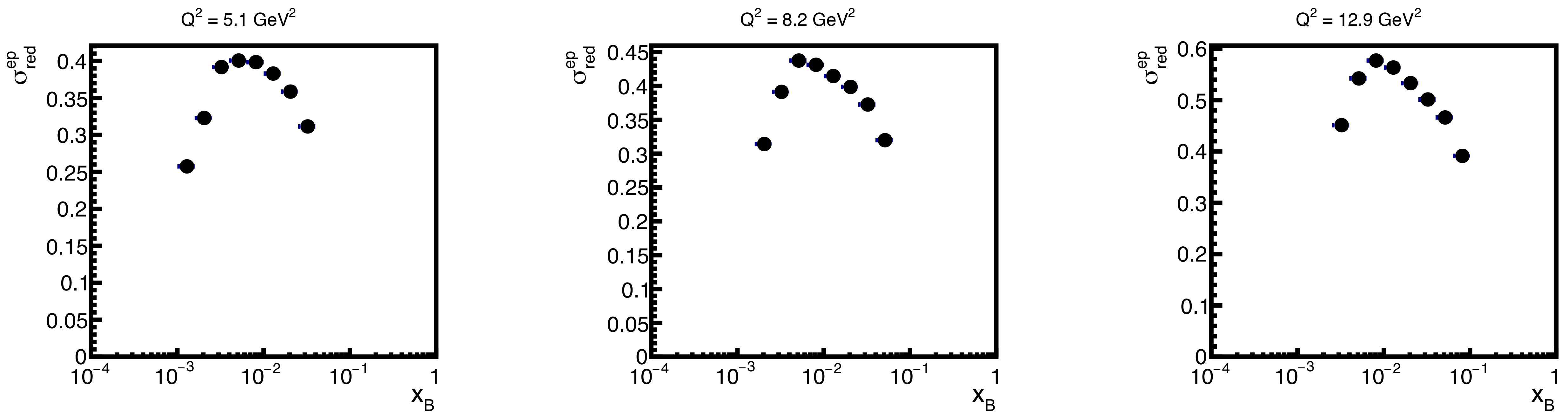

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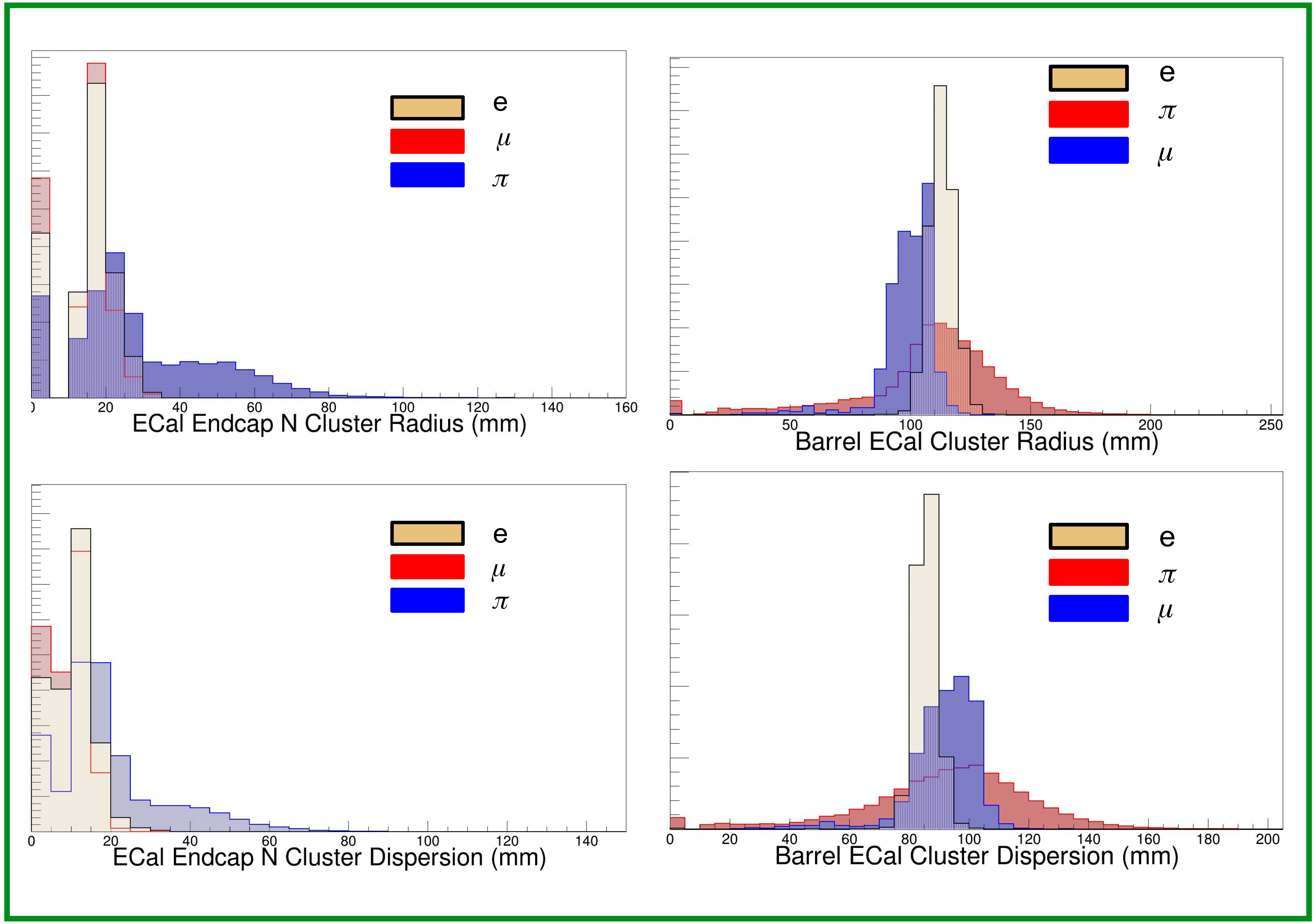
- Still working towards completely reconstruction-based electron ID
  - Track-cluster matching (Aliaa Rafaat, AUC)
  - Hadron PID
- Optimize existing eID cuts on E/p and $E - p_z$
- Develop further eID cuts on calorimeter shower shape (Andrew Hurley, UMass Amherst)



Future/ongoing physics work

- Systematic studies
  - Kinematic resolutions
  - Energy calibration
  - Pion contamination
- Double-spin asymmetries (Win Lin, SBU)
- Need eA events (not possible with Pythia8...?)