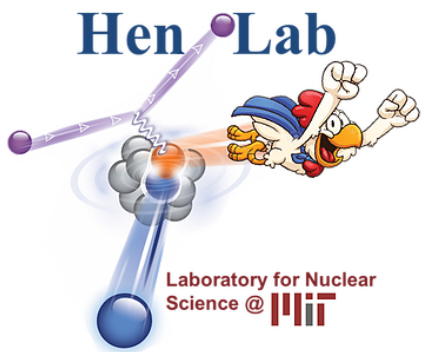
E2a: PID, Calibration, and Map Analysis Note

CLAS Nuclear Physics Working Group Meeting

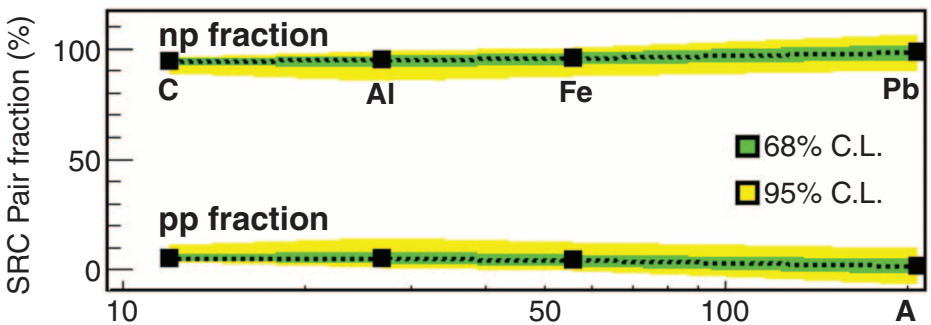
Axel Schmidt

MIT

November 15, 2018



Data mining has taught us a lot about short range correlations.



O. Hen et al., **Science** 346, p. 614 (2014)

- *pp* pairs are universally rare.

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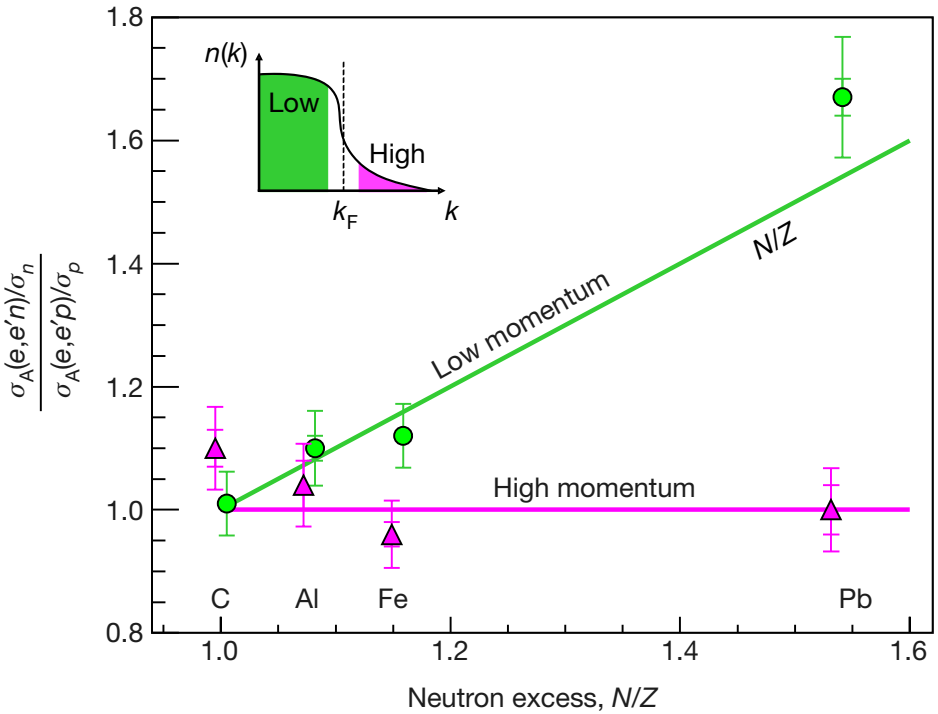

- *pp* pairs are universally rare.
- *np* dominance in asym. nuclei

M. Duer et al., **Nature** 560, p. 617 (2018)

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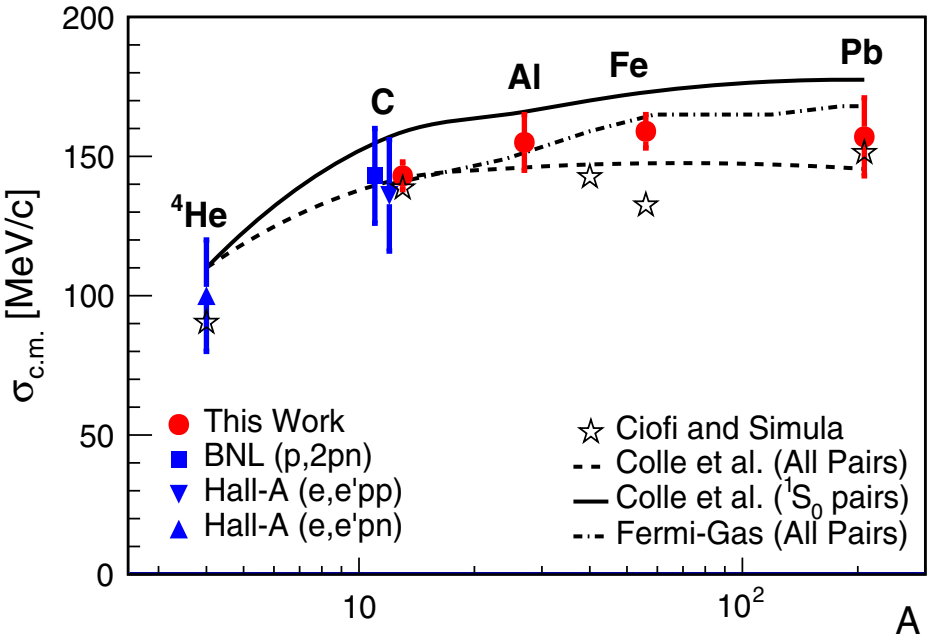

E. O. Cohen et al., **PRL** 121, 092501 (2018)

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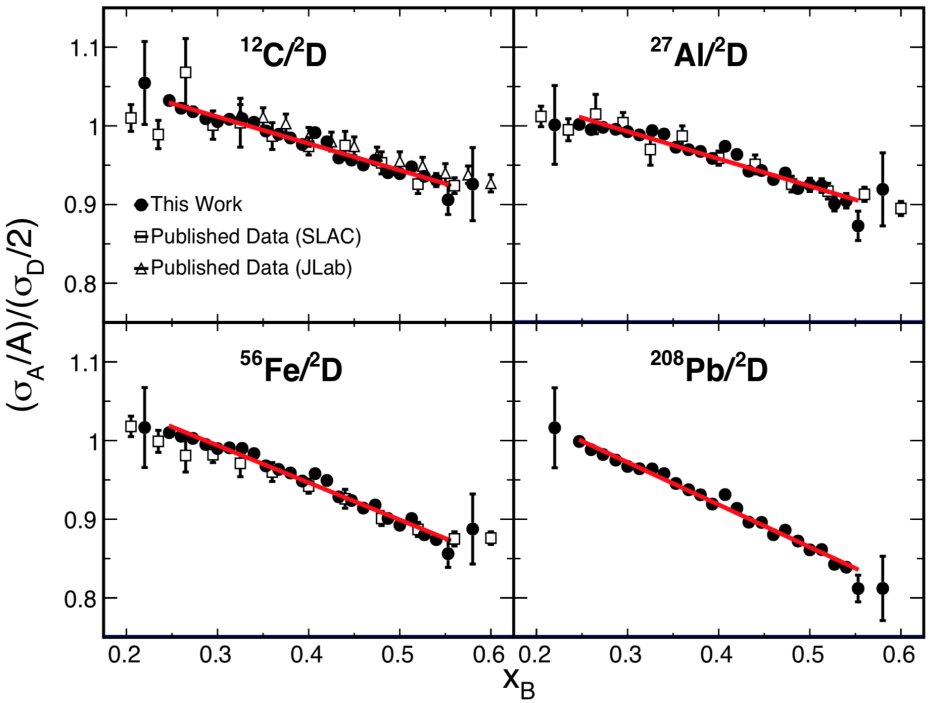

B. Schmookler et al., under peer review (2018)

- *pp* pairs are universally rare.
- *np* dominance in asym. nuclei
- Center of mass motion of pairs
- Connection to the EMC effect

All of these results have come from EG2.

- Beam energy: 5.014 GeV
- Targets: d, C, Al, Fe, Pb

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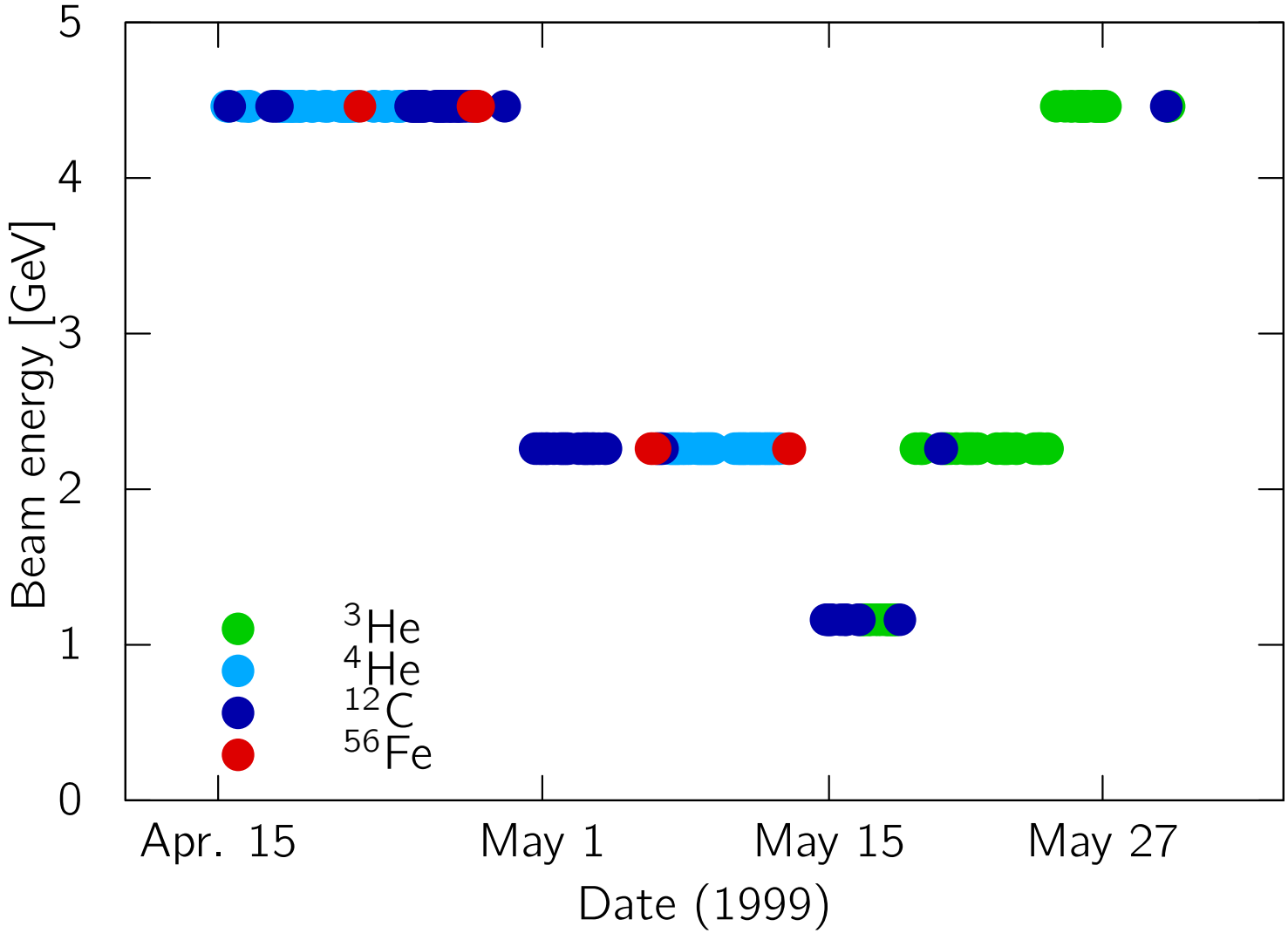
Limitations

1. One beam energy
2. No light nuclei
3. Size $\leftrightarrow$ Asymmetry

E2a offers new possibilities.



E2a offers new possibilities.

- Multiple beam energies
  - Great for electrons-for-neutrinos
- ^{3}He, ^{4}He targets
  - In range of ab initio calculations
  - ^{3}He is extremely asymmetric
- Overlap with EG2
  - Cross checks with C, Fe

In my talk today:

1. Calibrations
2. Acceptance Maps
3. Applications and Future Work

E2a Calibrations

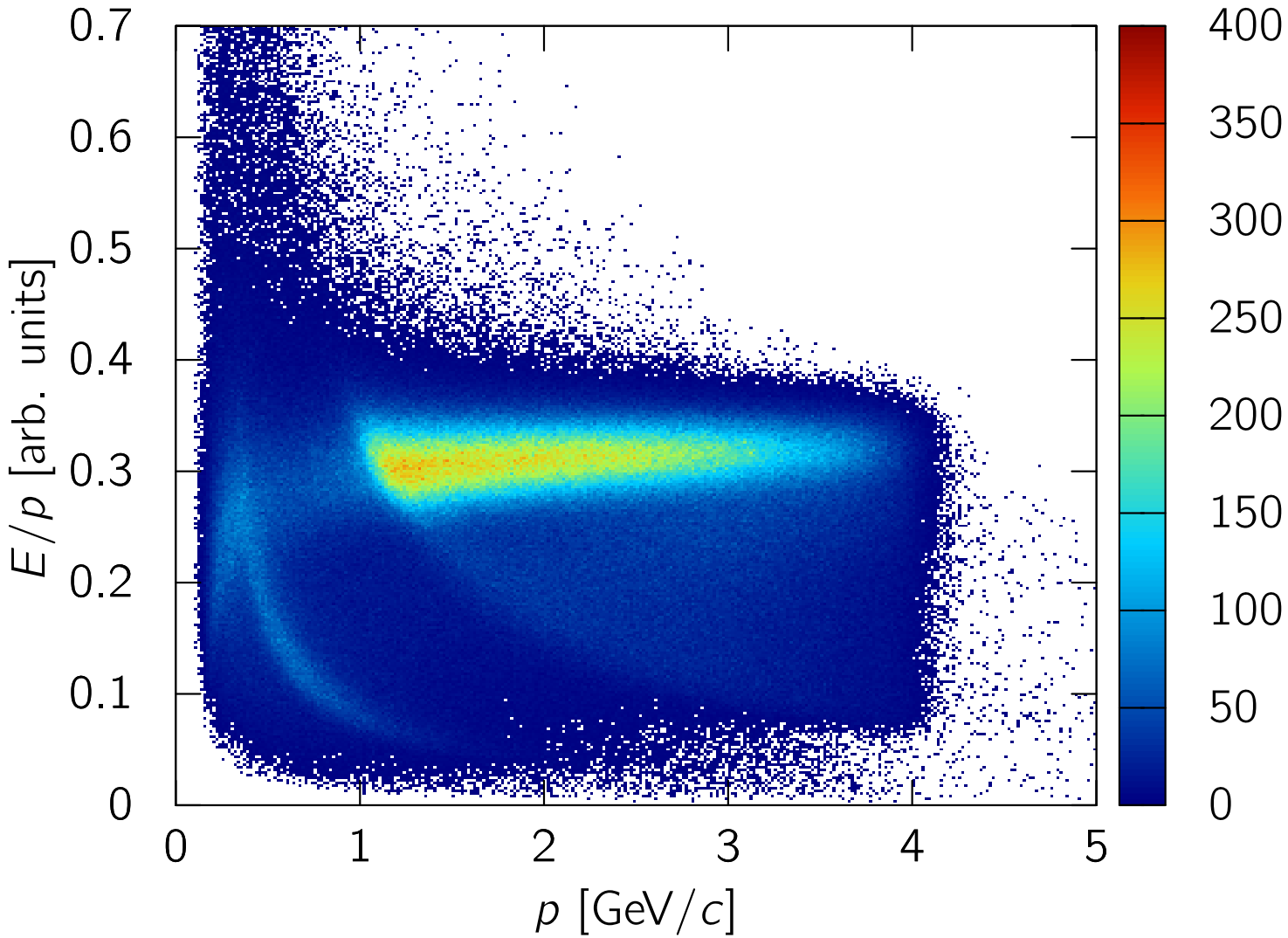
Curating the work by W. Ingram, S. McLauchlan, R. Niyazov, D. Protopopescu et al.

- Particle ID
- Momentum Corrections
- Vertex Corrections
- Fiducial Cuts

Described in Mariana Khachatryan's analysis note

PID: E/p for electrons

Δt vs. p for hadrons



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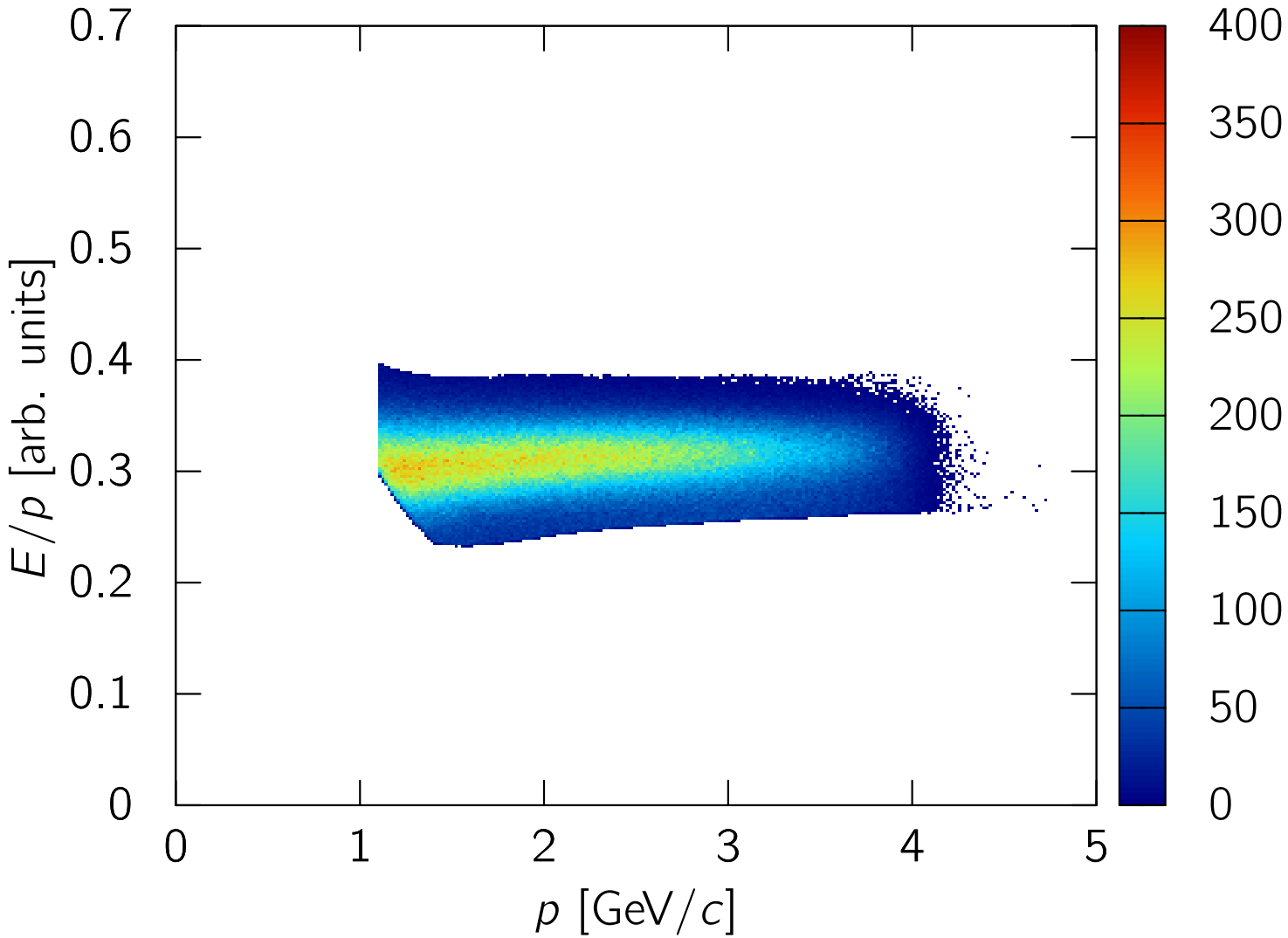

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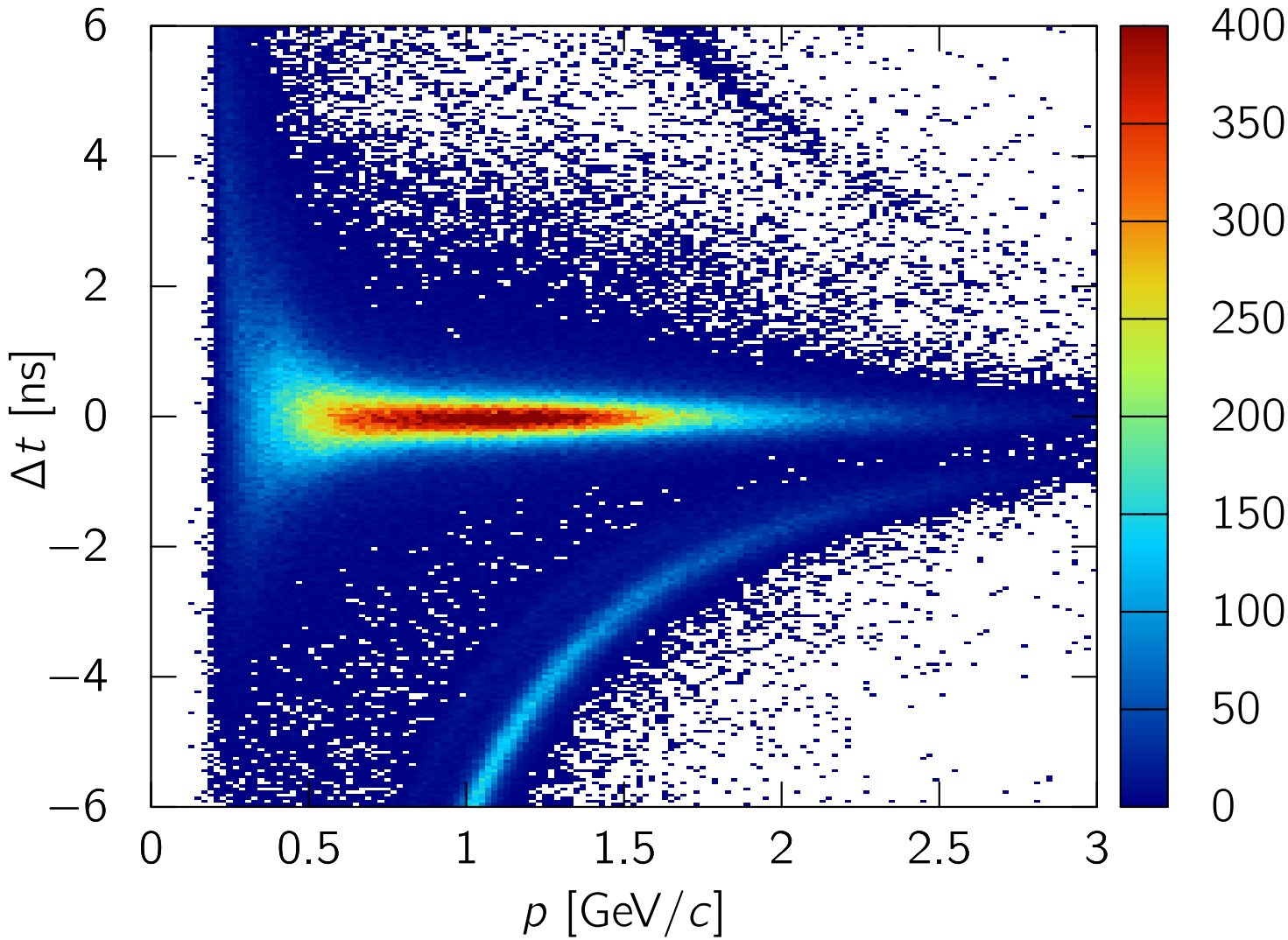

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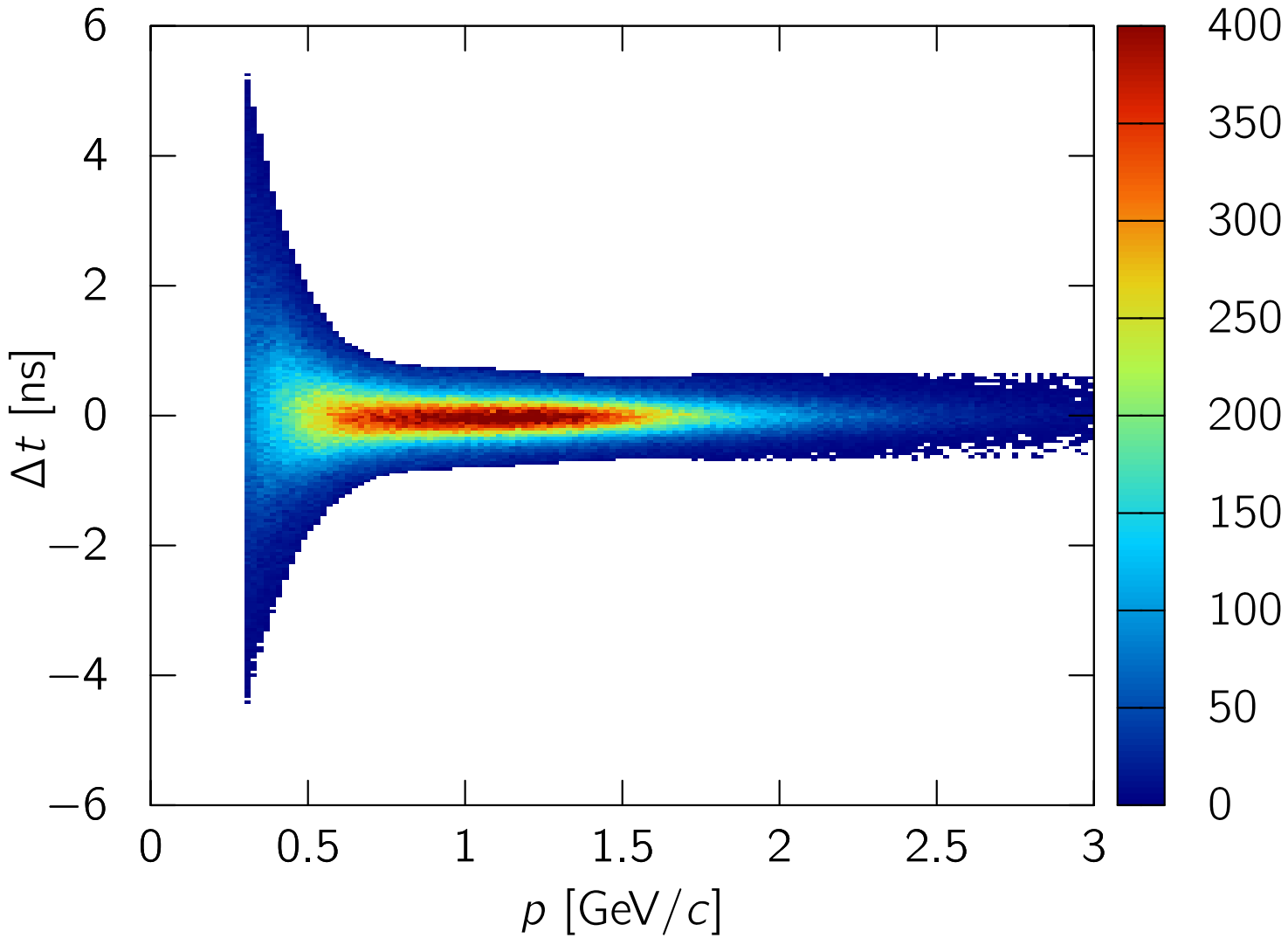
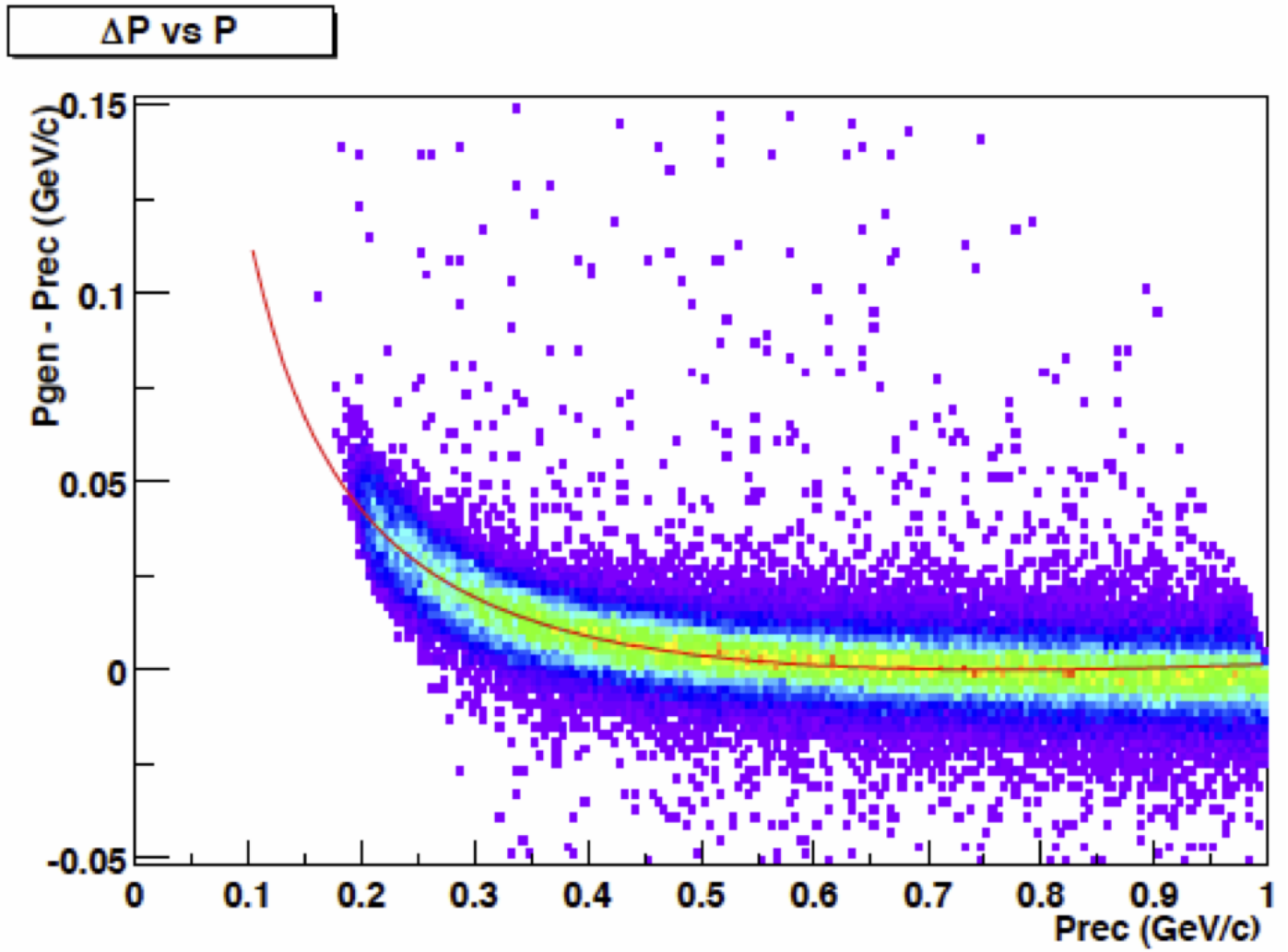
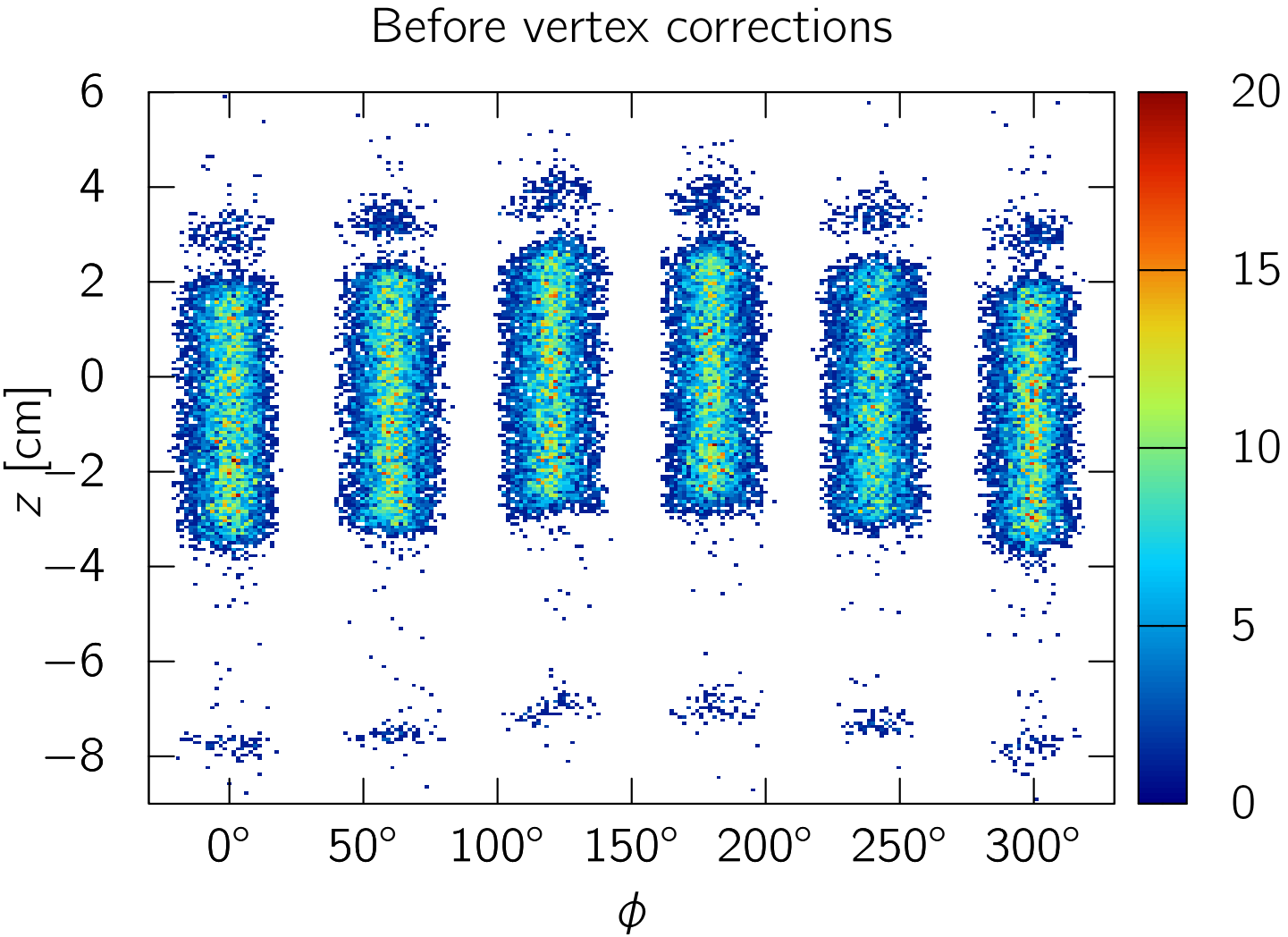


e^- mom. corrections determined from simulation



Vertex corrections are needed to correct for off-axis beam.



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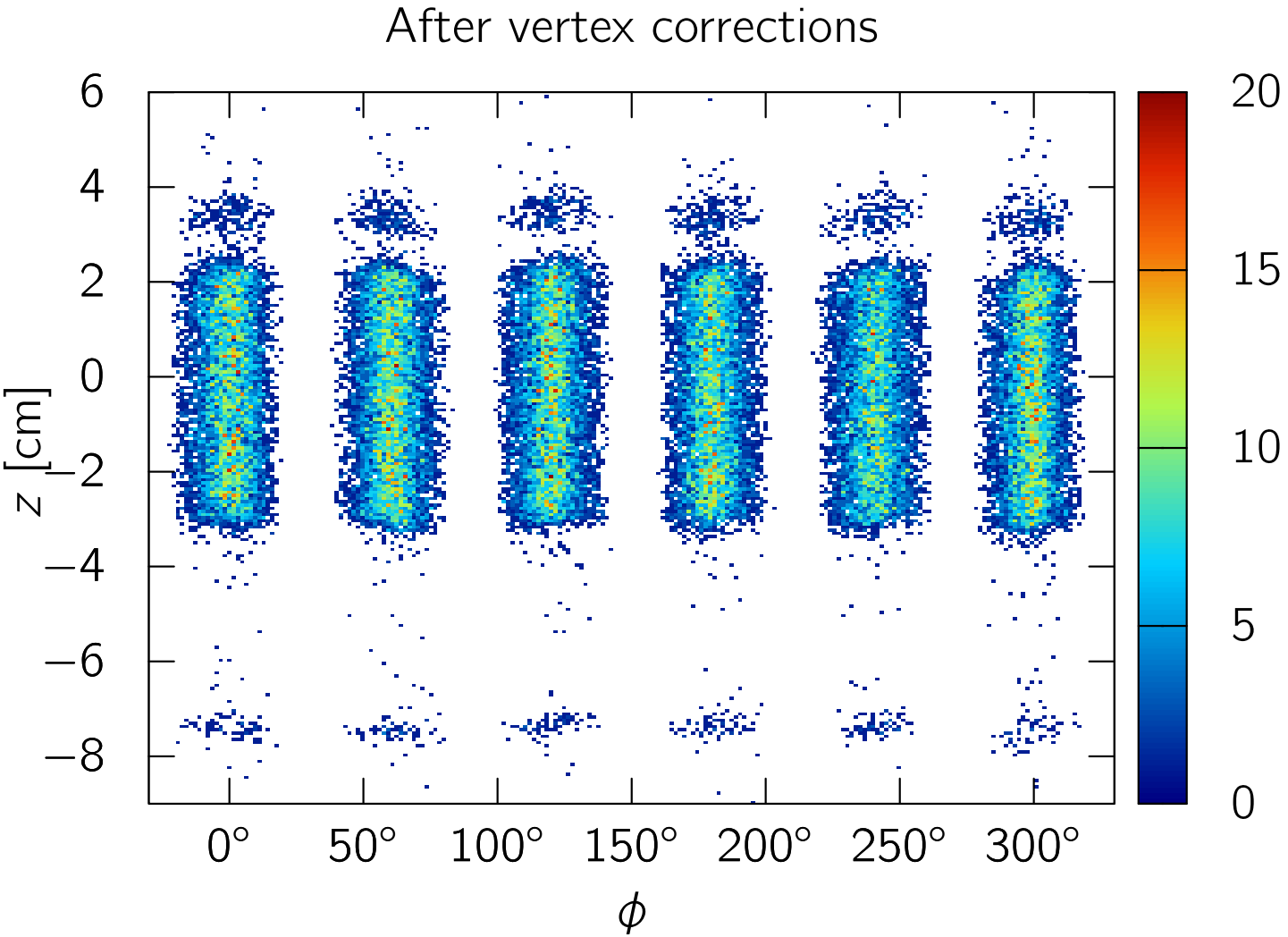
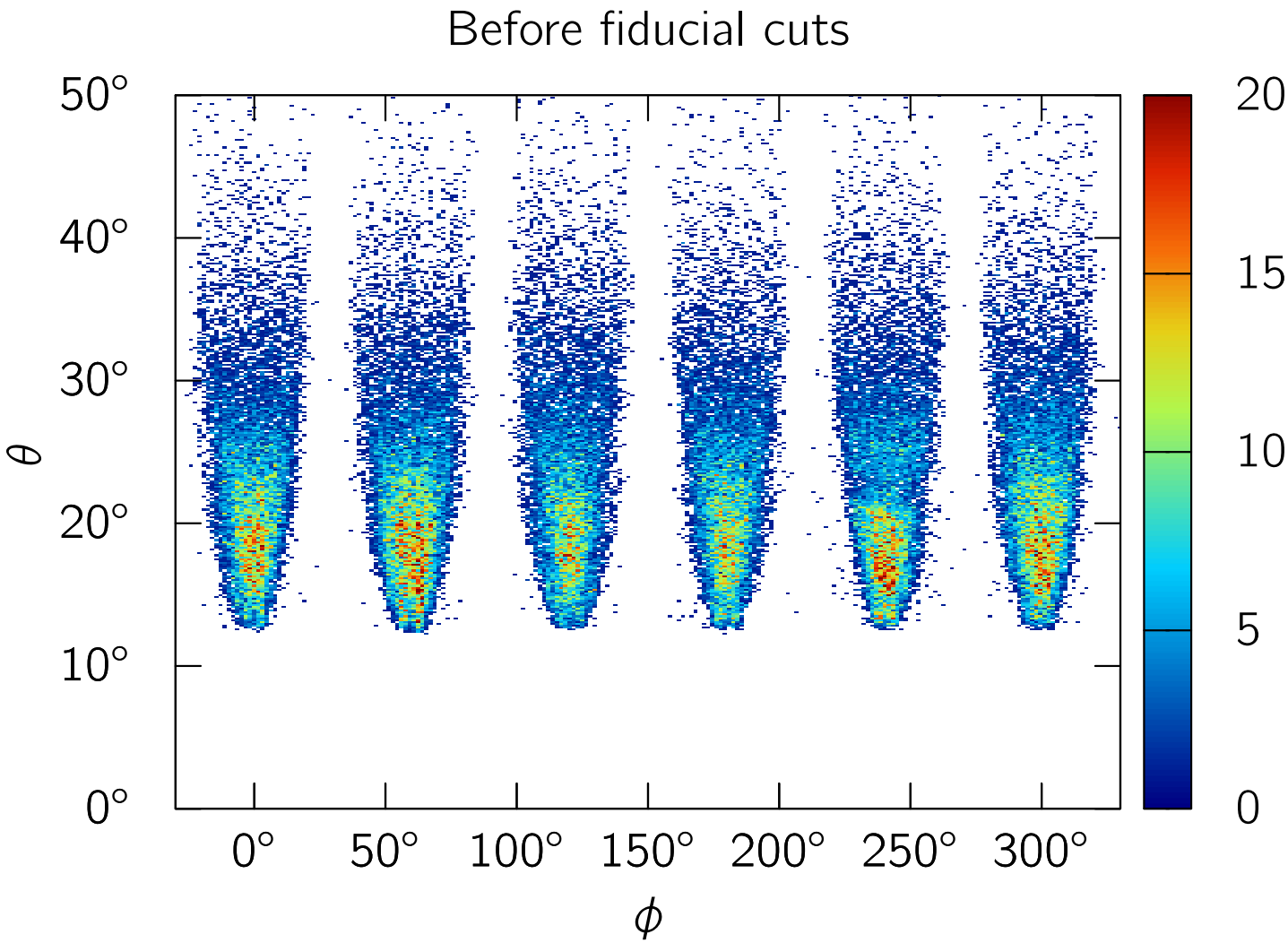


Fiducial cuts: remove acceptance edges



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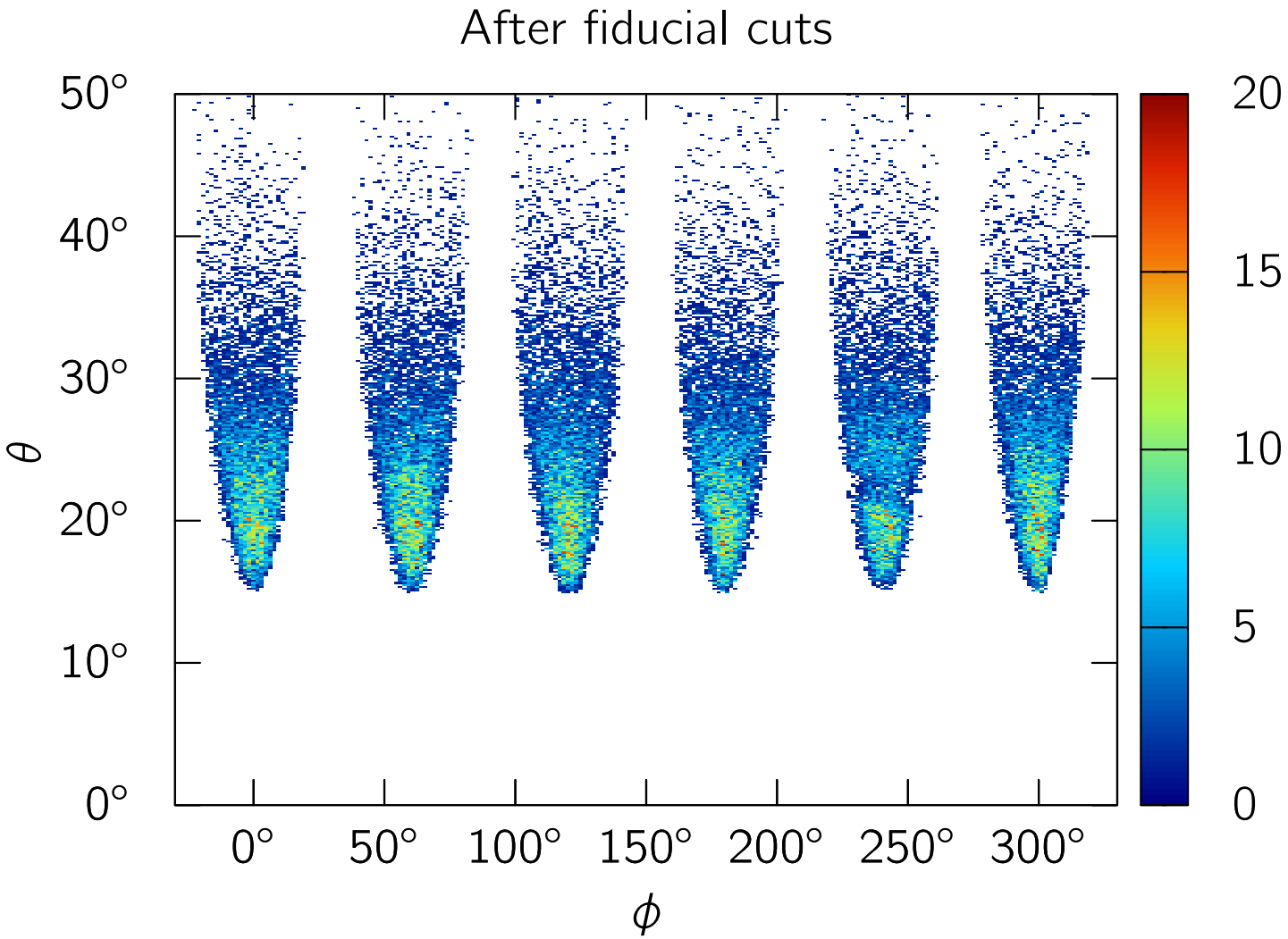

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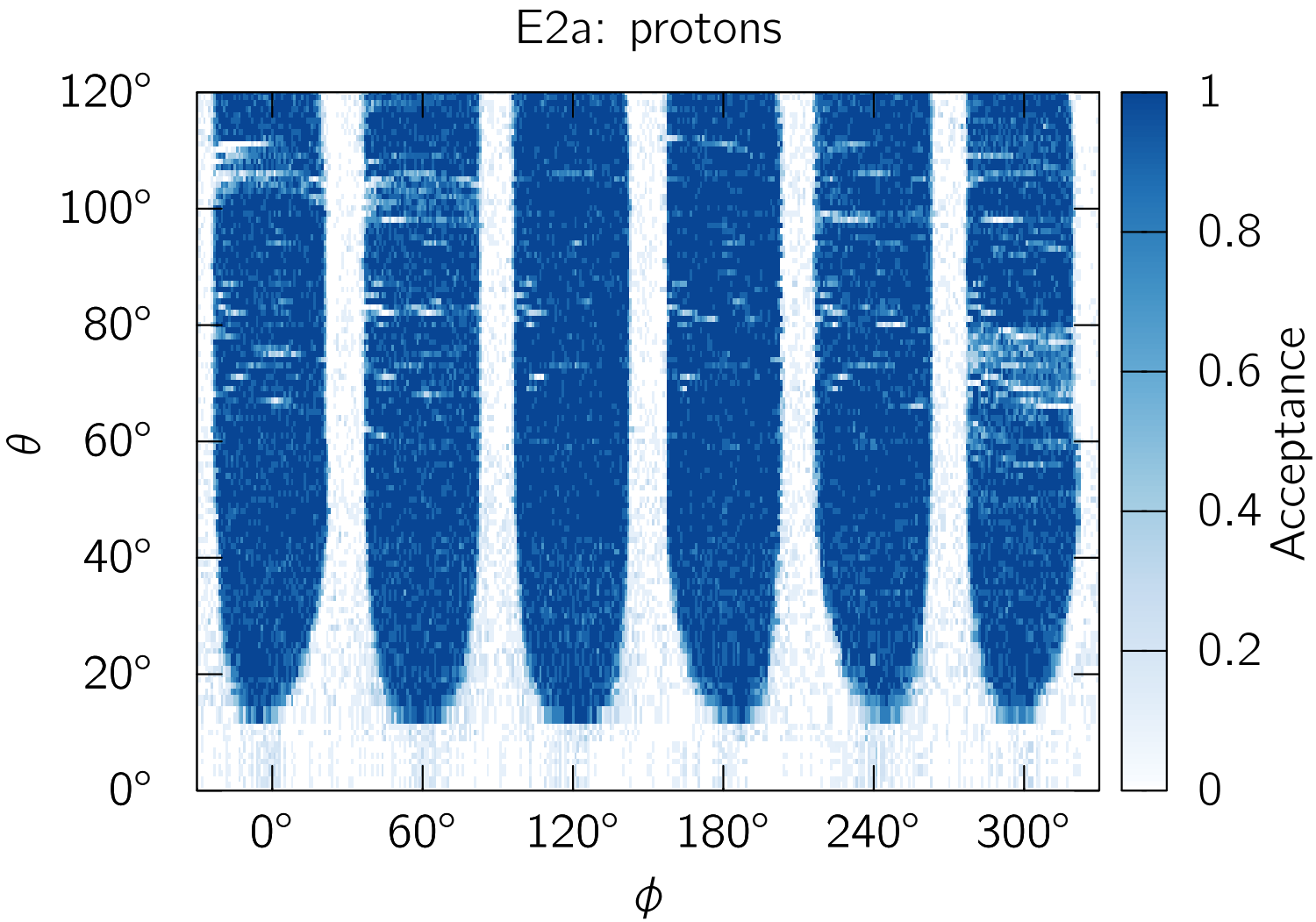
2. **Acceptance Maps**
3. Applications and Future Work

Detector acceptance by "Map"



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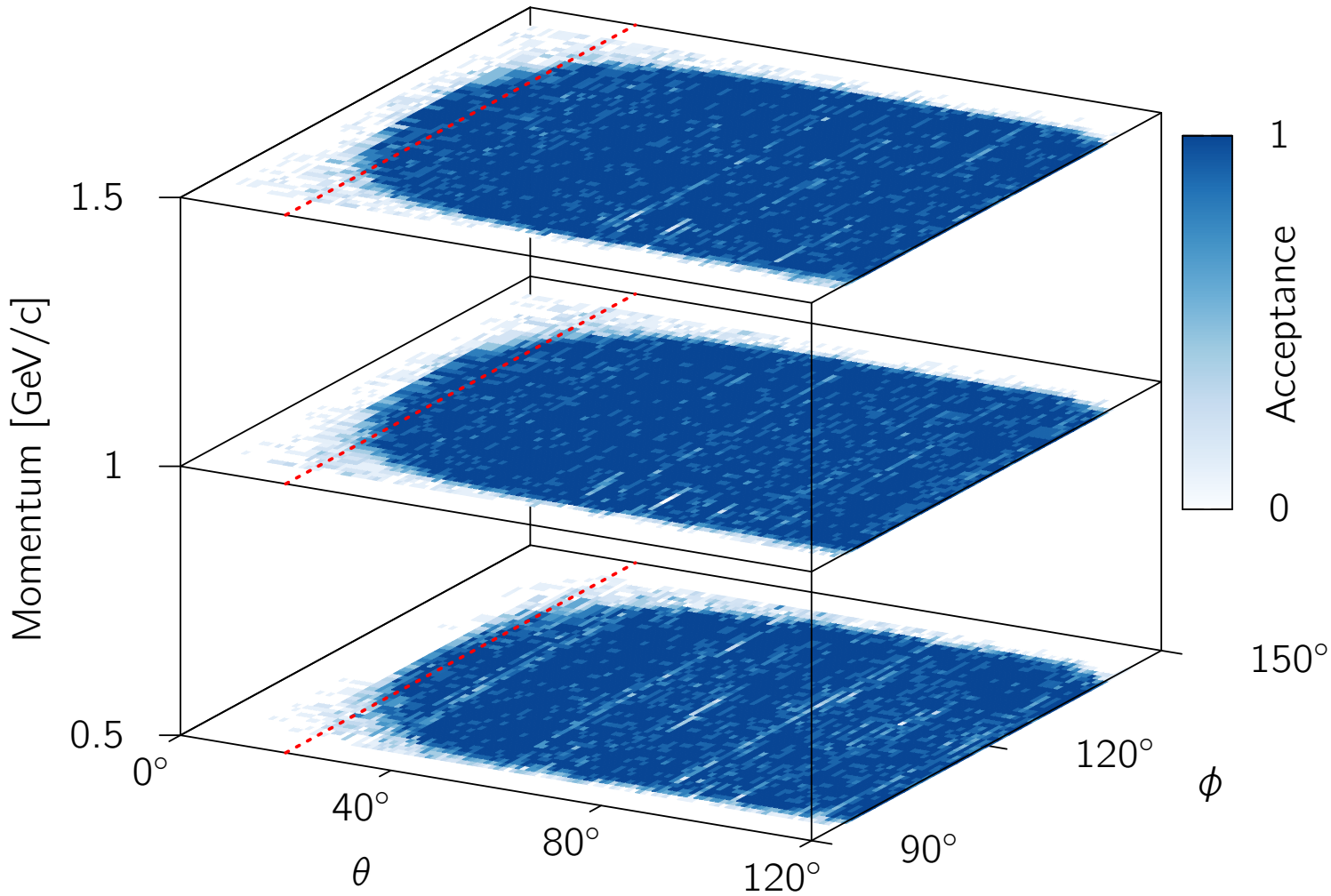


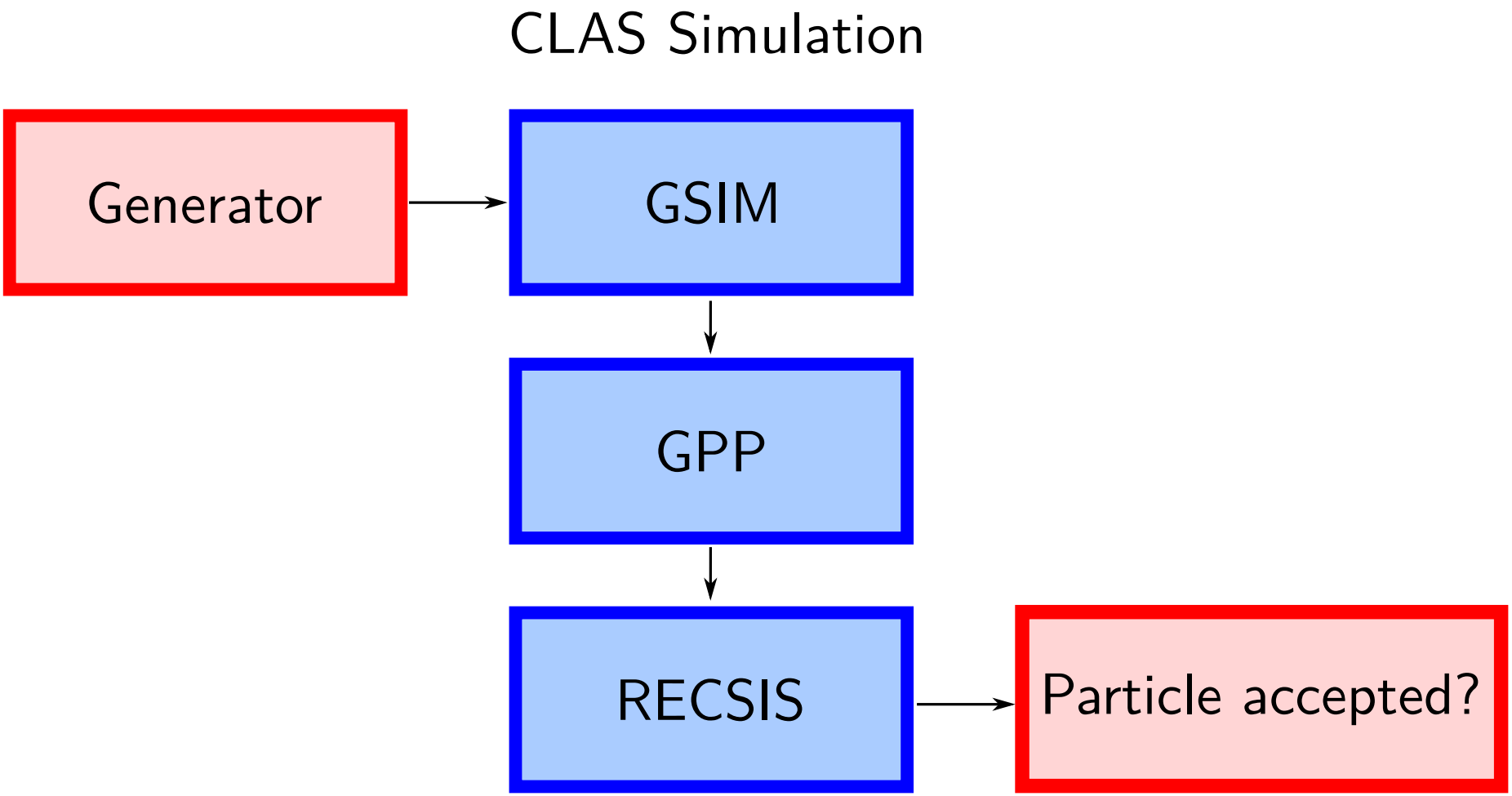
Detector acceptance by "Map"

- Two 3D histograms in p, $\cos\theta$, ϕ space
  - Simulated events generated per bin
  - Simulated events accepted per bin
- Acceptance $\equiv N_{acc.}/N_{gen.}$
- User can propagate errors if desired

Maps have advantages.

- Simulation is pre-computed
- Maps are simple and fast to query
- Prevents risk of users running CLAS simulations ‘wrong’

How to make a map



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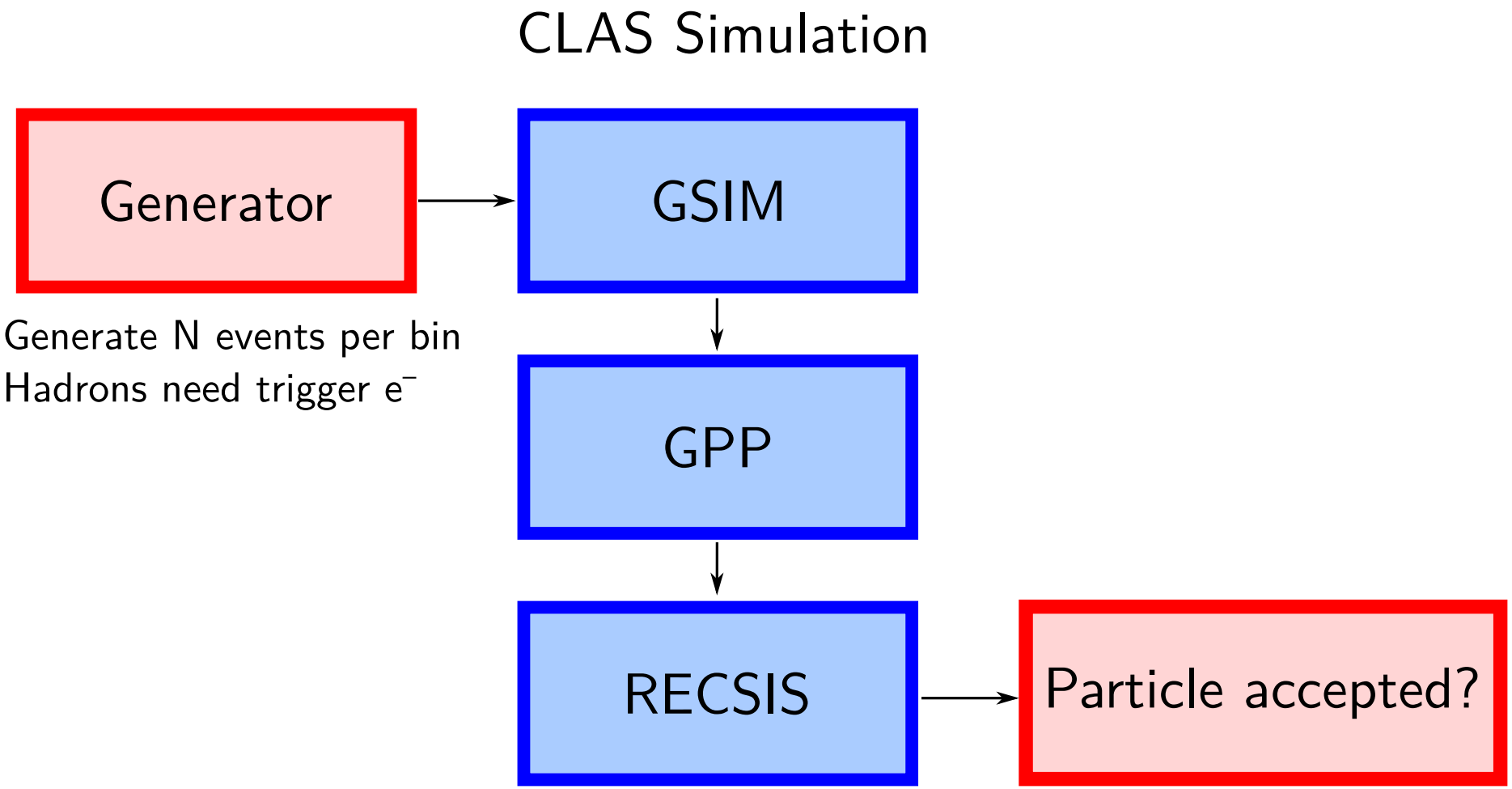

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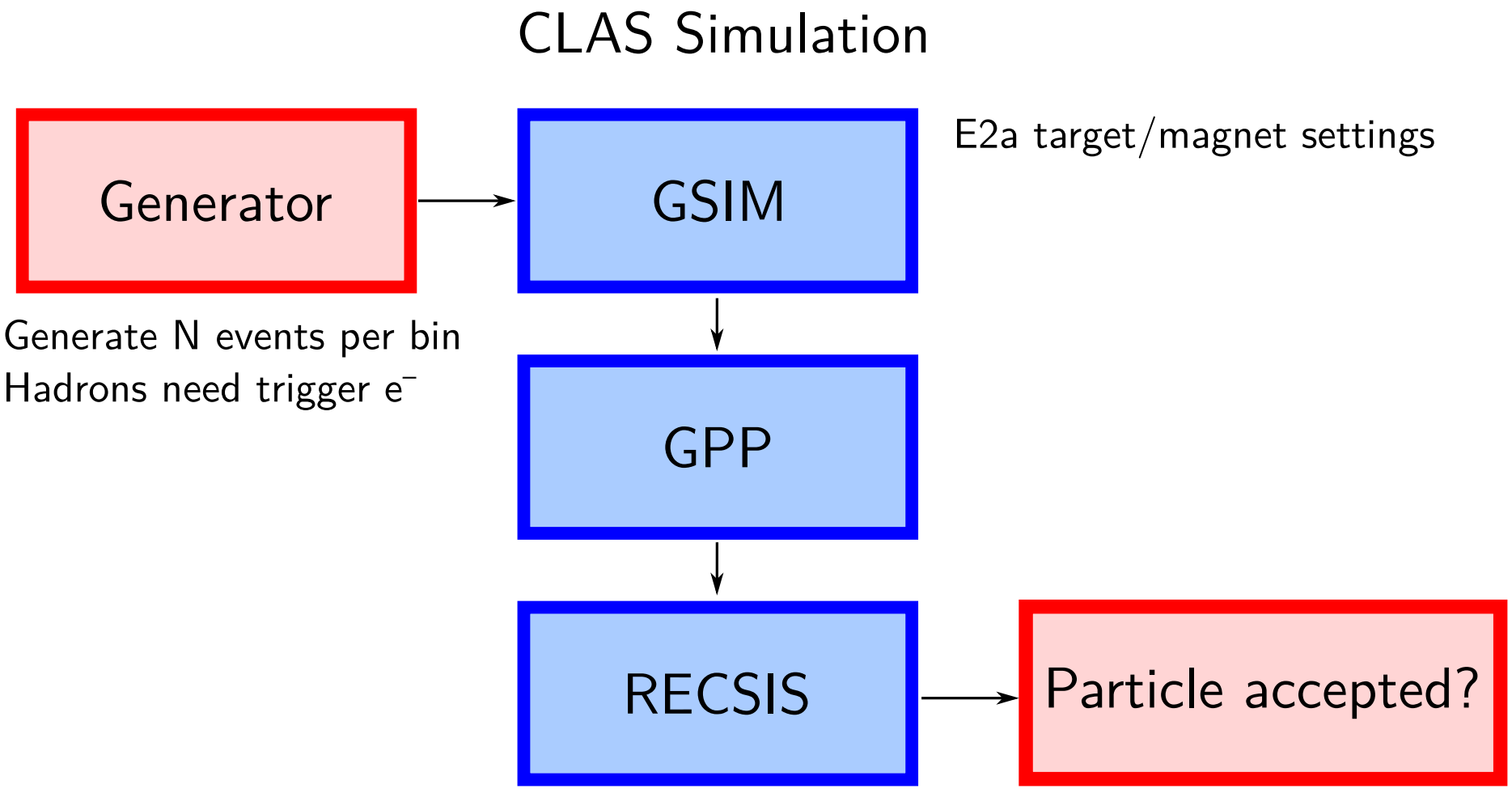

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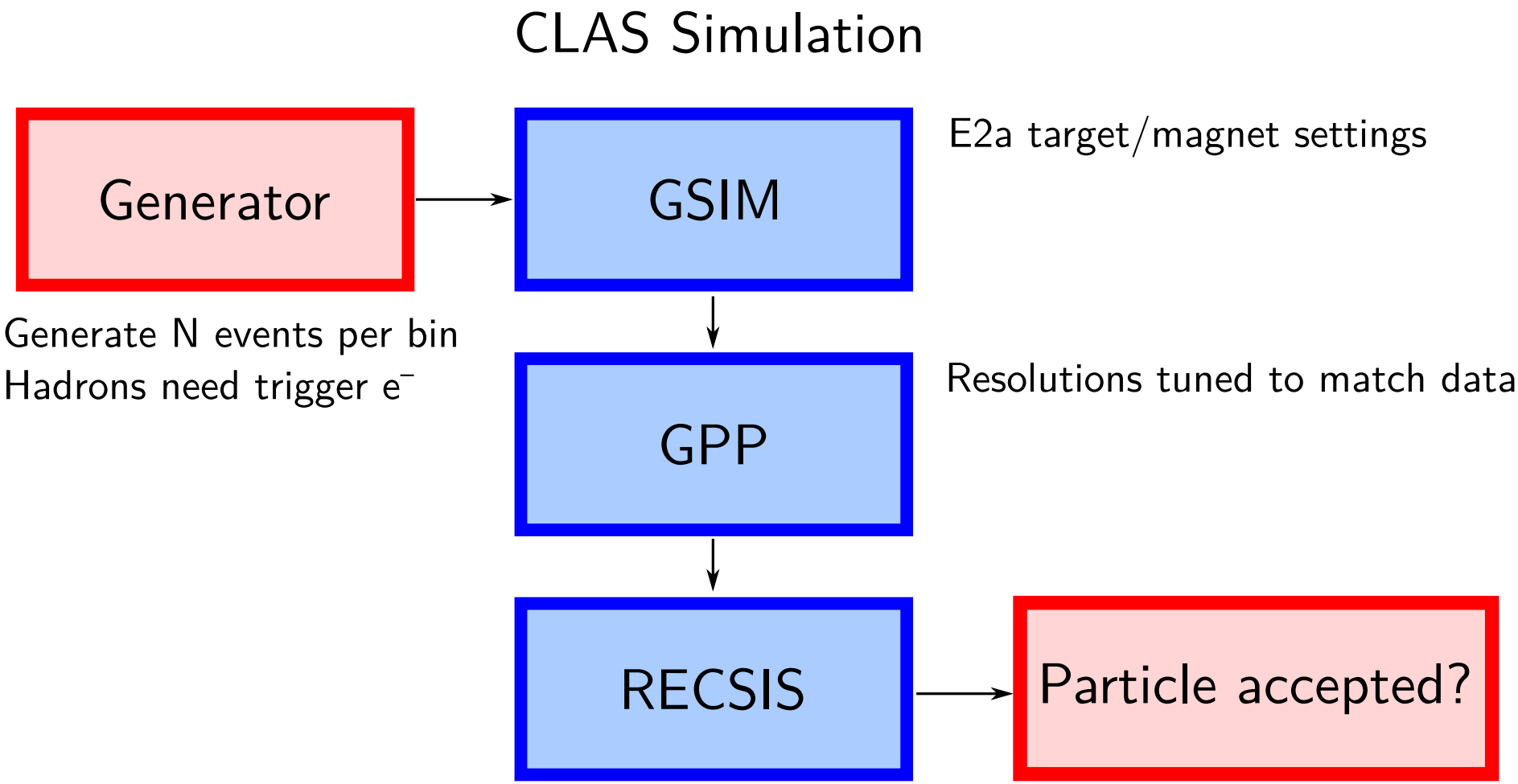

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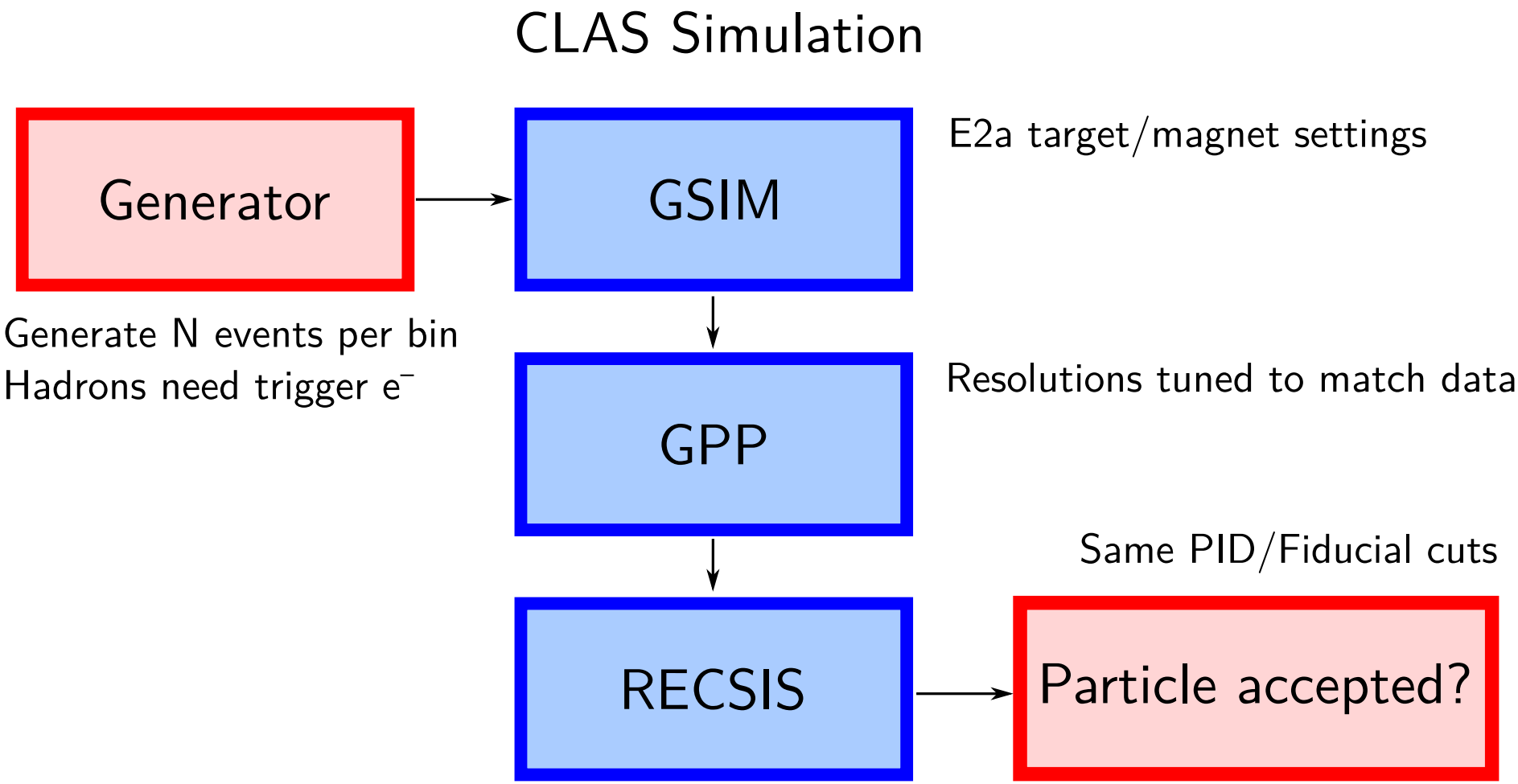

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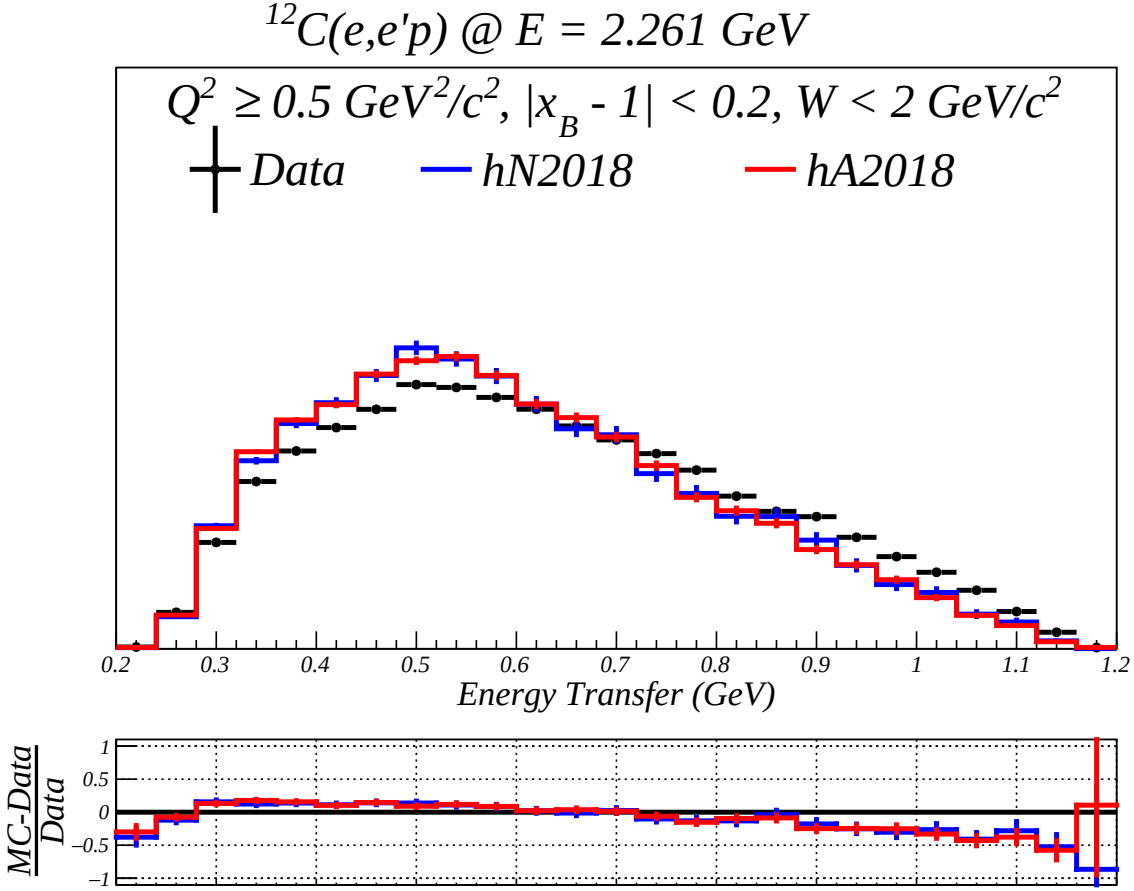
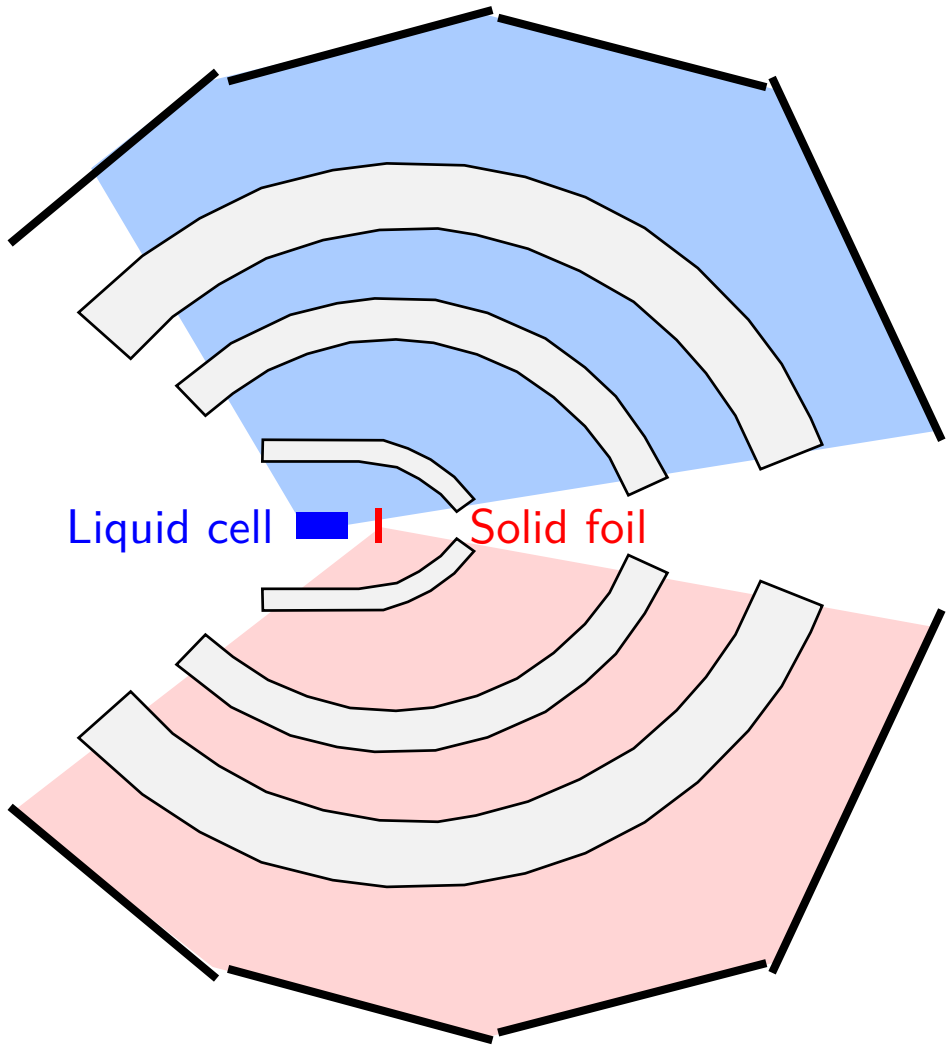
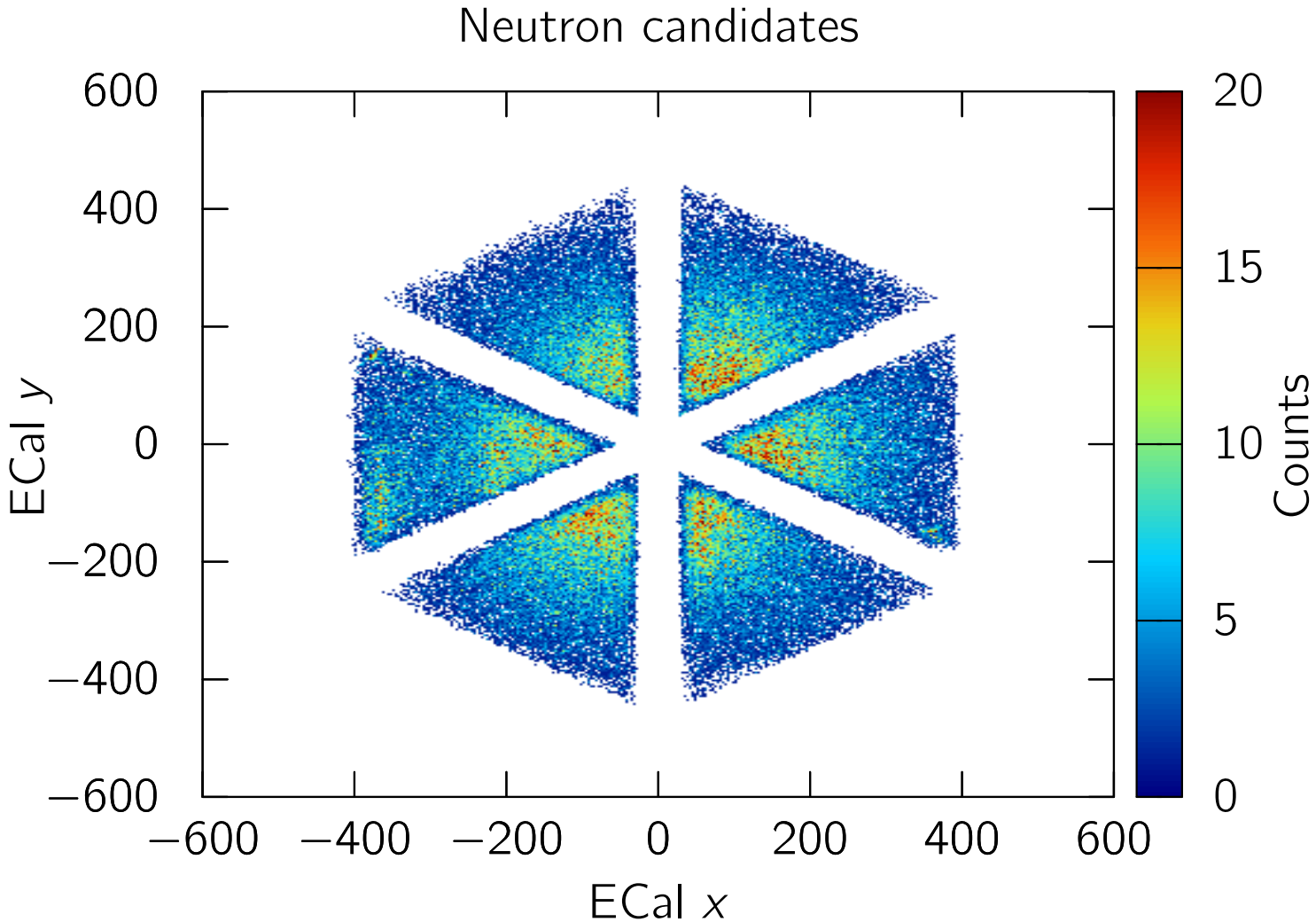


$e4\nu$: work by A. Papadopoulou, M. Khachatryan, A. Ashkenazi

Maps allow corrections for different target positions.



Maps allow comparing proton and neutron acceptances.



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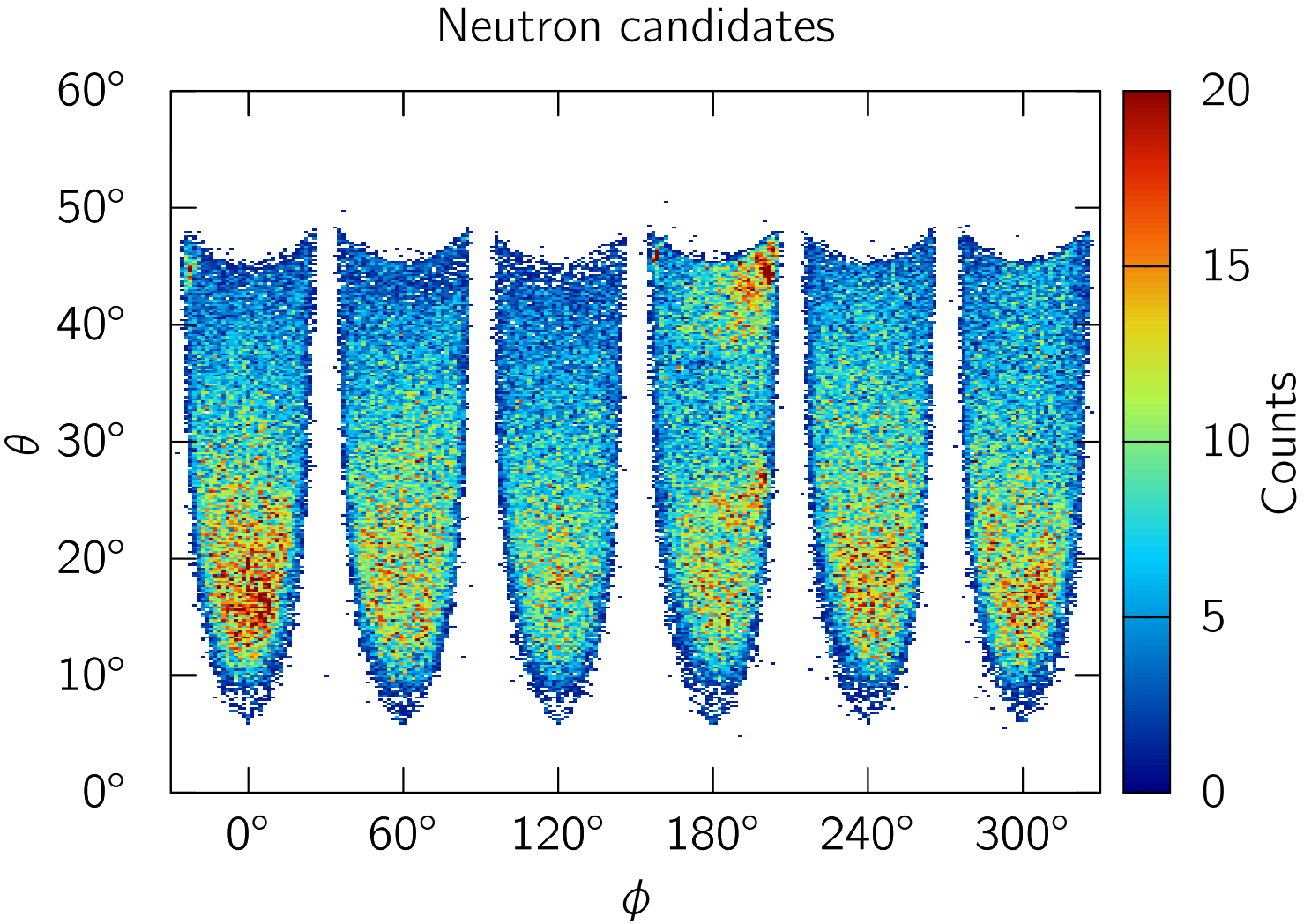
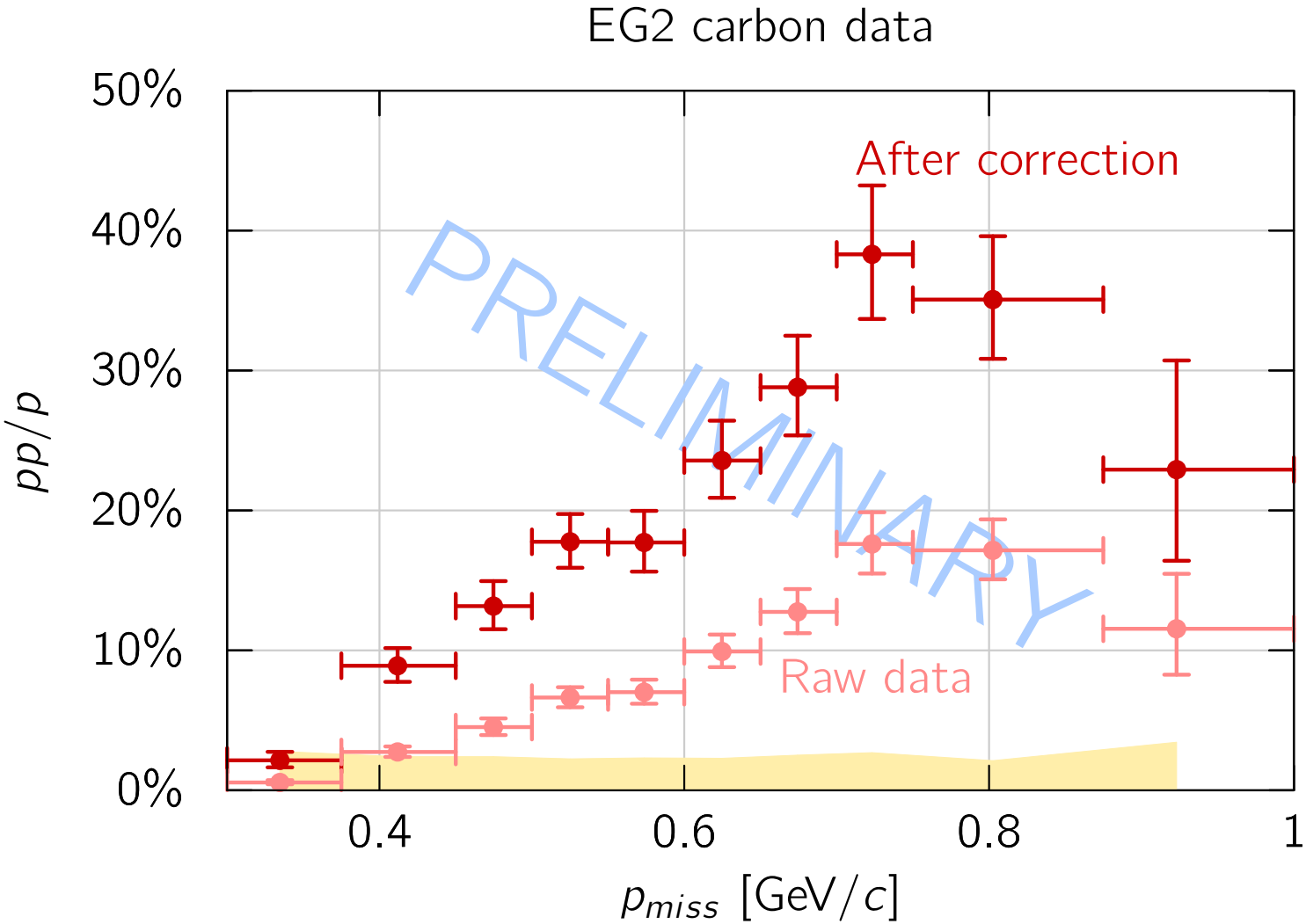


Maps allow estimating how many recoil protons escape detection.



Conclusions

1. New E2a data mining program
2. Produced E2a acceptance maps
3. Additional chapter in E2a technical note