Exclusive phi meson electro-production with CLAS12

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Outline

- Physics Motivation
- Particle ID
- Current Status
- Future work

Physics Motivation

The $s\bar{s}$ production of the ϕ meson allows for a unique probe of the nucleon's gluonic GPD as the flavor composition prevents coupling to the valence or light sea quarks of the nucleon. Thus the exclusive ϕ primarily interacts with the gluonic field, ultimately allowing for the measurement of the spatial image of the gluons in the nucleon.

Particles of Interest

Specifically interested in measuring the fully exclusive reaction comprised of:

- scattered electron
- recoiled proton
- ϕ meson decay pair K^+ and K^-

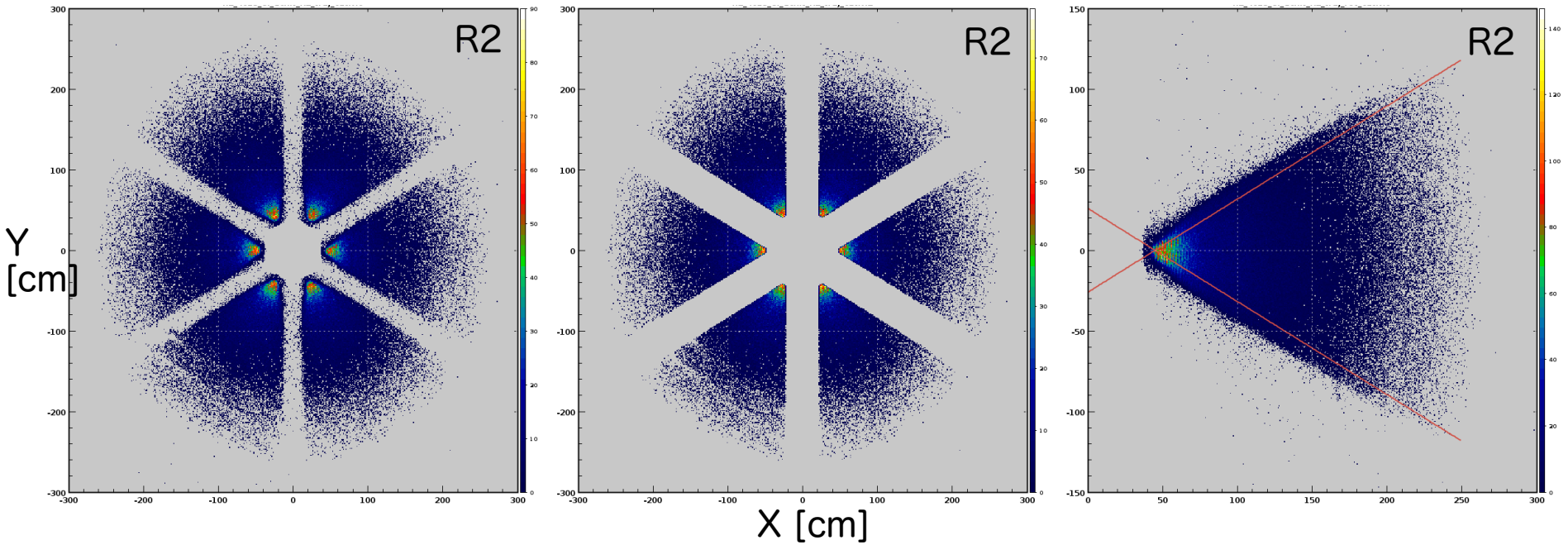
Applied Electron Candidate Cuts

Below is a table of cuts applied to all negative tracks from a personalized electron cuts as opposed to those in EventBuilder.

PIP Cuts	EventBuilder Cuts
Cut Name	**Cut Name**
Negative Charge	Negative Charge Cut
DC Region 1 Fiducial Cut	Sampling Fraction Cut
DC Region 2 Fiducial Cut	HTCC Nphe Cut
DC Region 3 Fiducial Cut	FTOF Hit Response
PCAL Fiducial Cut	PCAL Energy Deposited Cut
FTOF Hit Response	
Sampling Fraction Cut	
HTCC Nphe Cut	
Minimum Momentum Cut	
PCAL Energy Deposited Cut	
Vertex Cut	

DC Fiducial Region 2

Fiducial Cuts were applied to the DC R2 by finding the hit position for negative particles integrated over all sectors, and applying a nominal cut using the sector dimensions.



PCAL Fiducial Cut

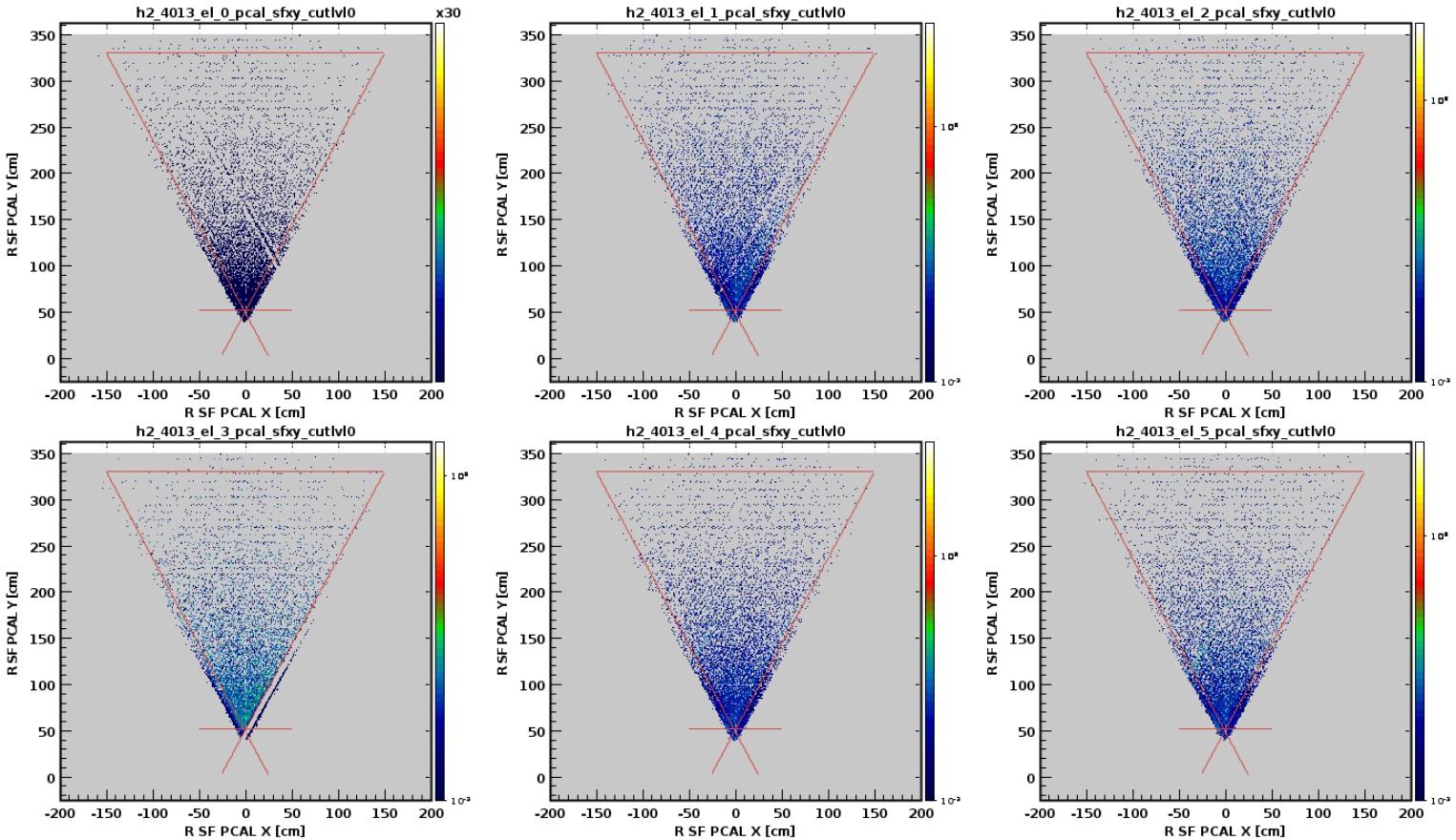


Figure: Mapping of sampling fraction across surface of the PCAL. Achieved by taking the ratio of hit position weighted with SF to hit position for all negative tracks.

PIP Sampling Fraction Cut

Sector dependent sampling fraction cut.

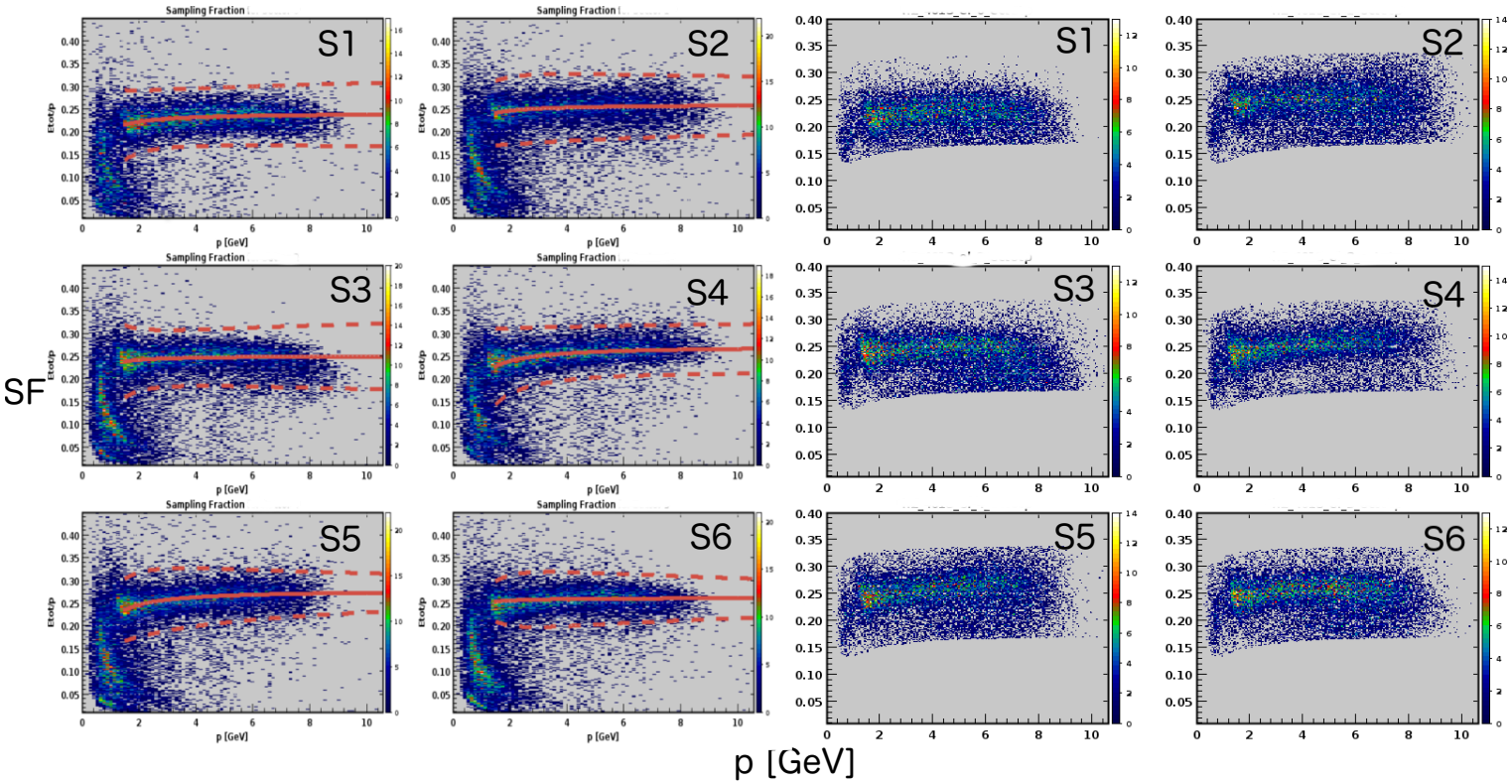


Figure: Sampling fraction cut limits per sector.

Electron Vertex Cut

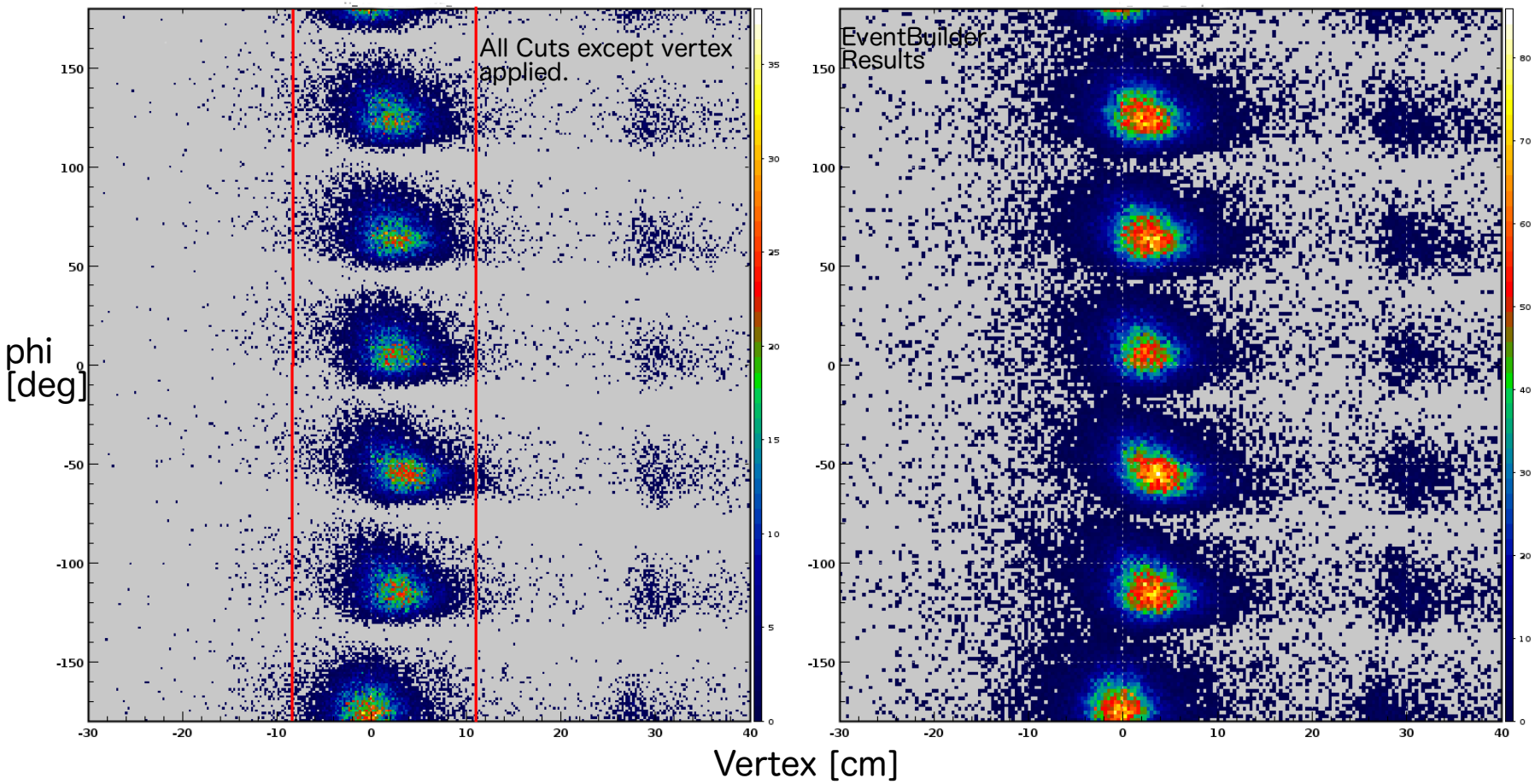


Figure: Z-vertex cut at -8 and 11 cm from CLAS12 target center.

Electron Kinematic Region

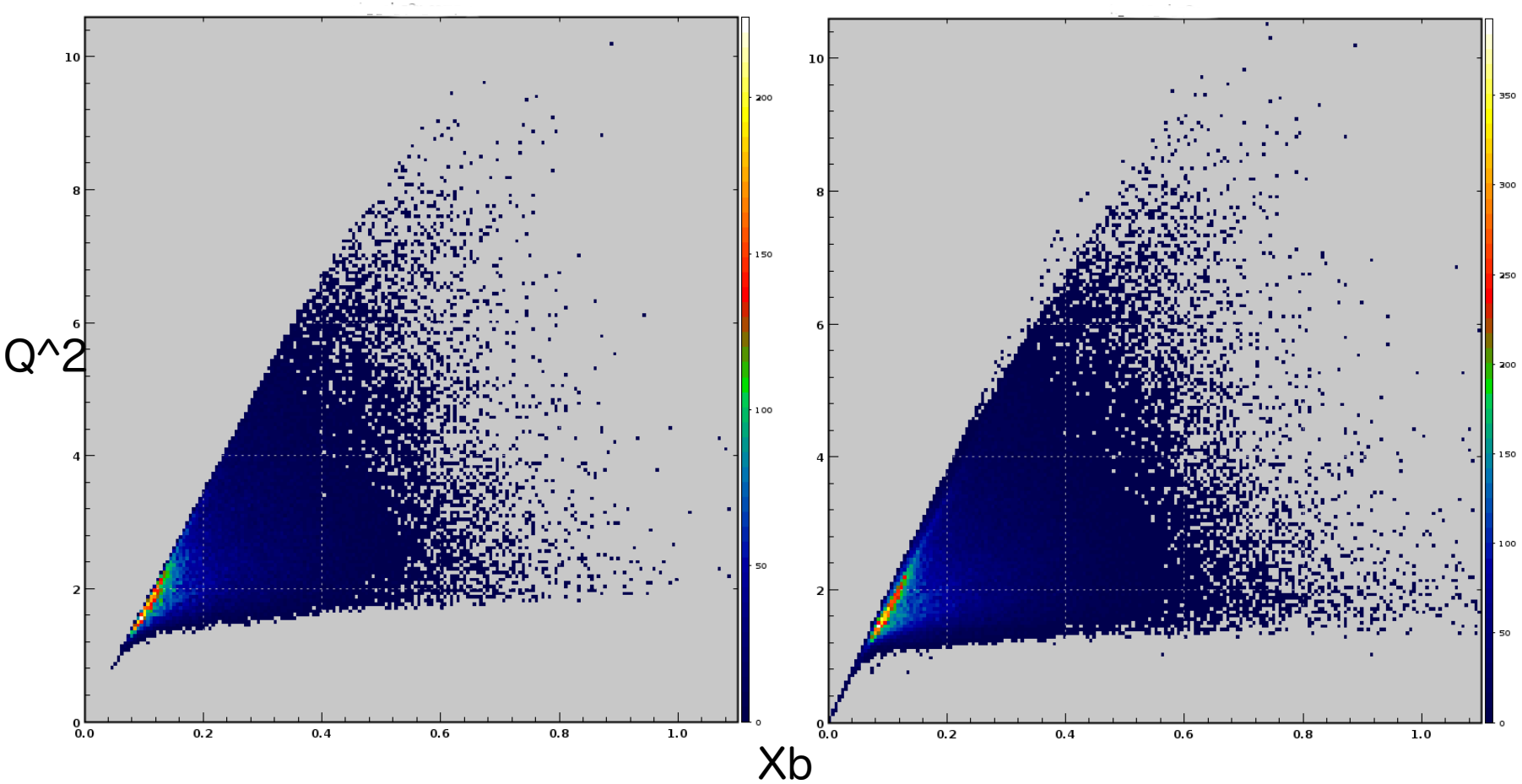


Figure: Kinematic space of Q^2 vs Xb for final electron sample

Cut Results

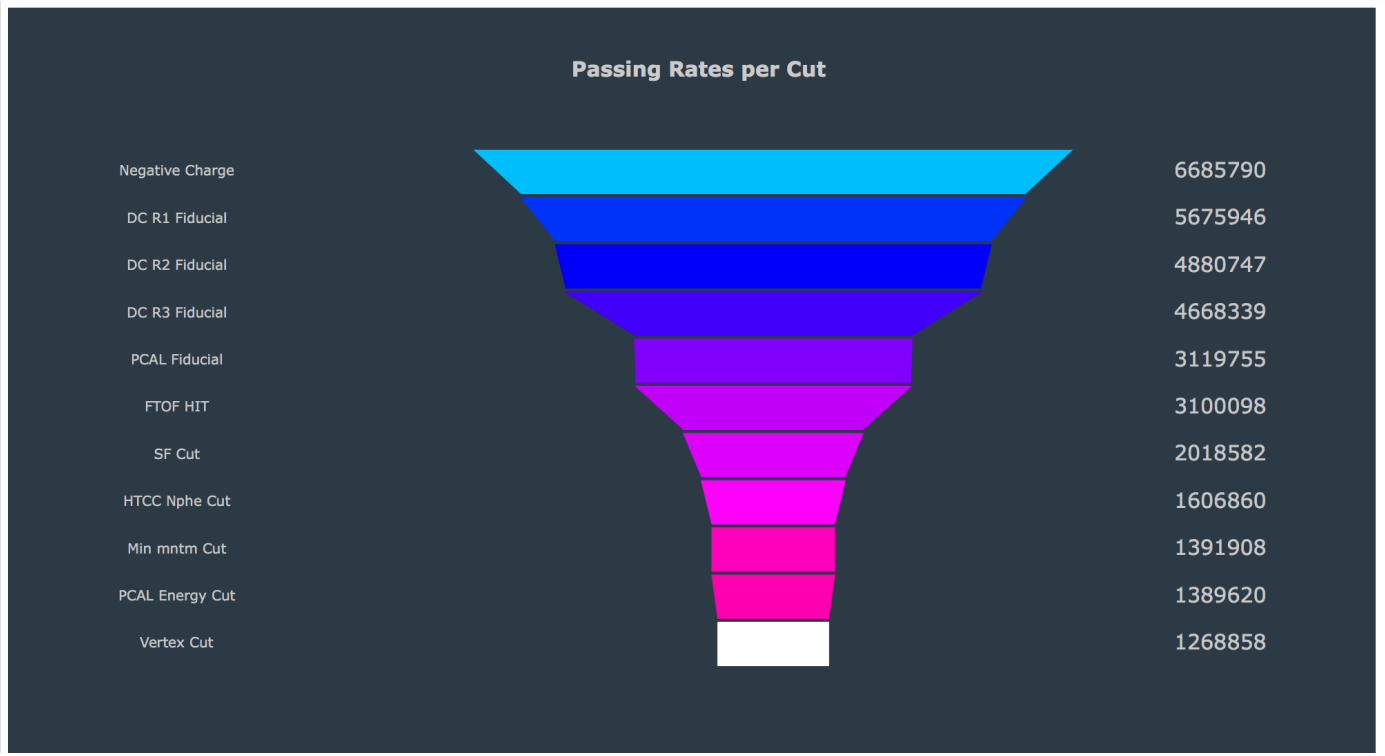
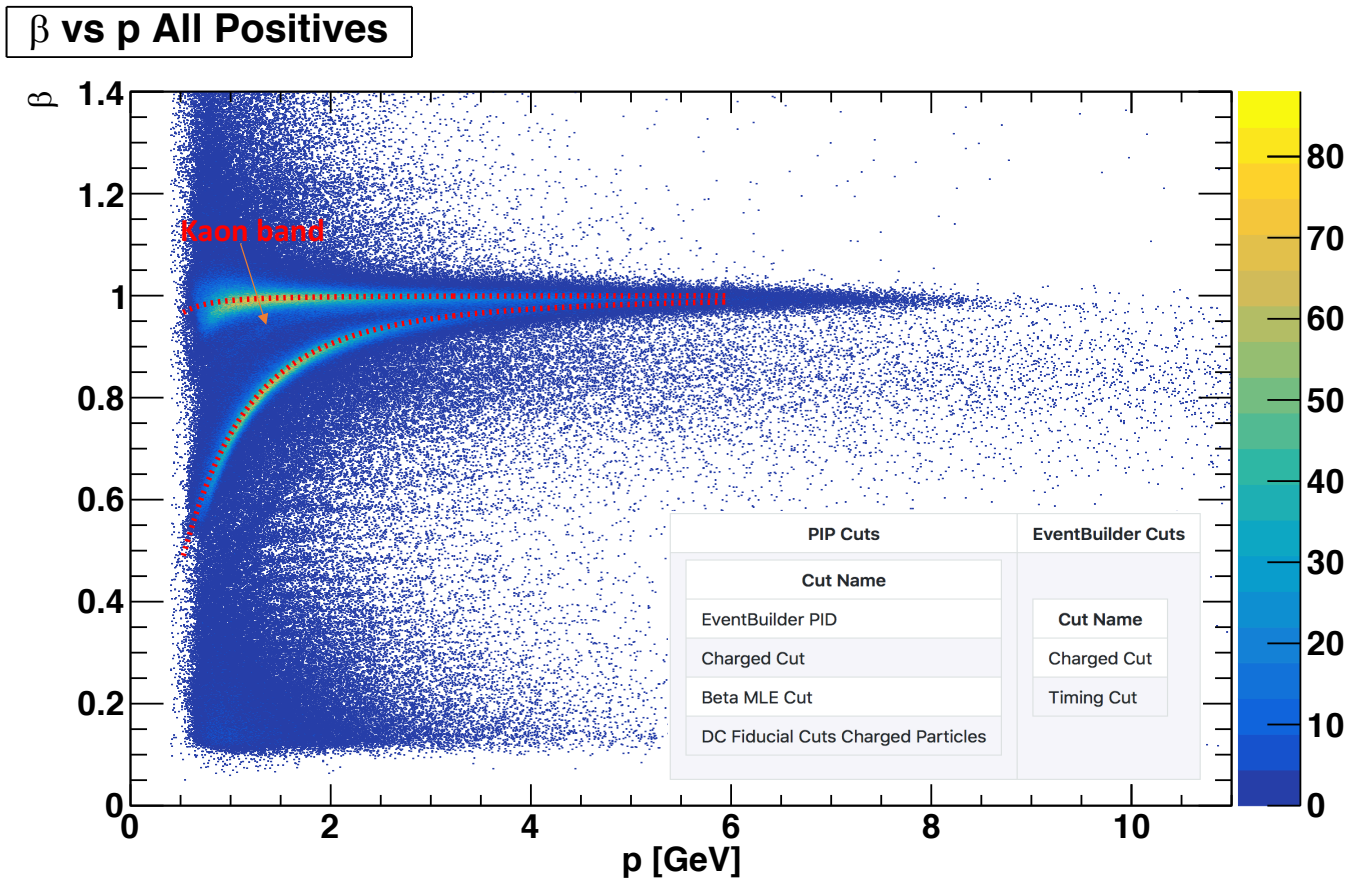


Figure: Each layers represents how many negative tracks have passed all previous layers.

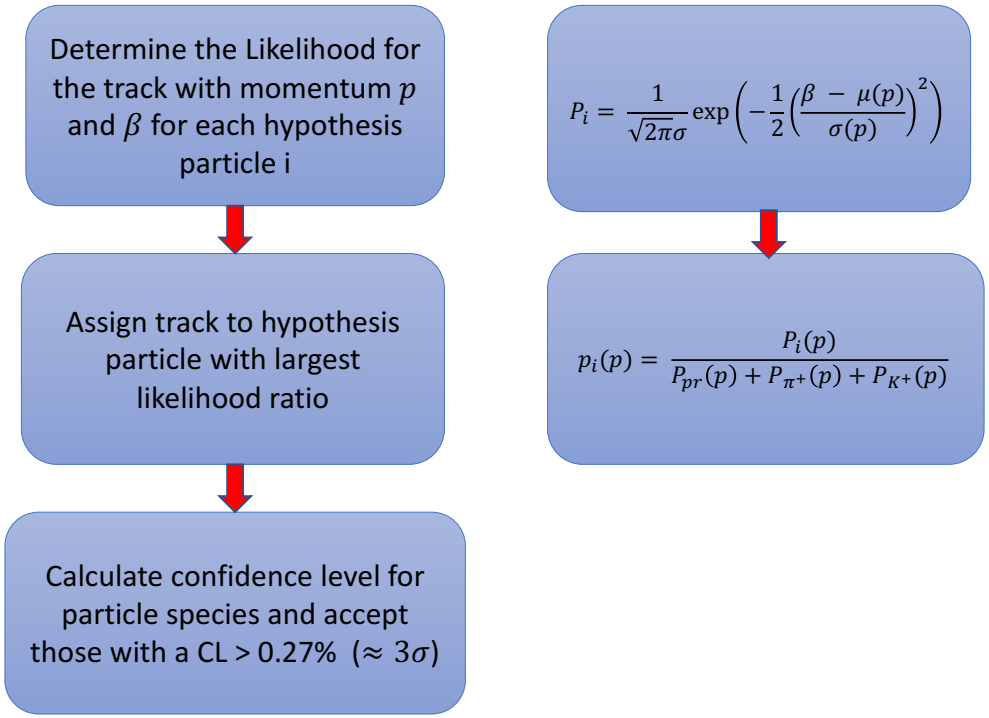
Hadron ID using TOF Information

After finding an electron candidate, on which the event start time is based, hadrons are identified using the cuts from the table below.



Hadron ID using Maximum Likelihood Estimator

- Maximum likelihood estimator provides a tool to meaningfully assign a charged track with a given momentum and β to a particle label which avoids double assignment.



Hadron ID Results

Results of using maximum likelihood estimator approach for hadron pid

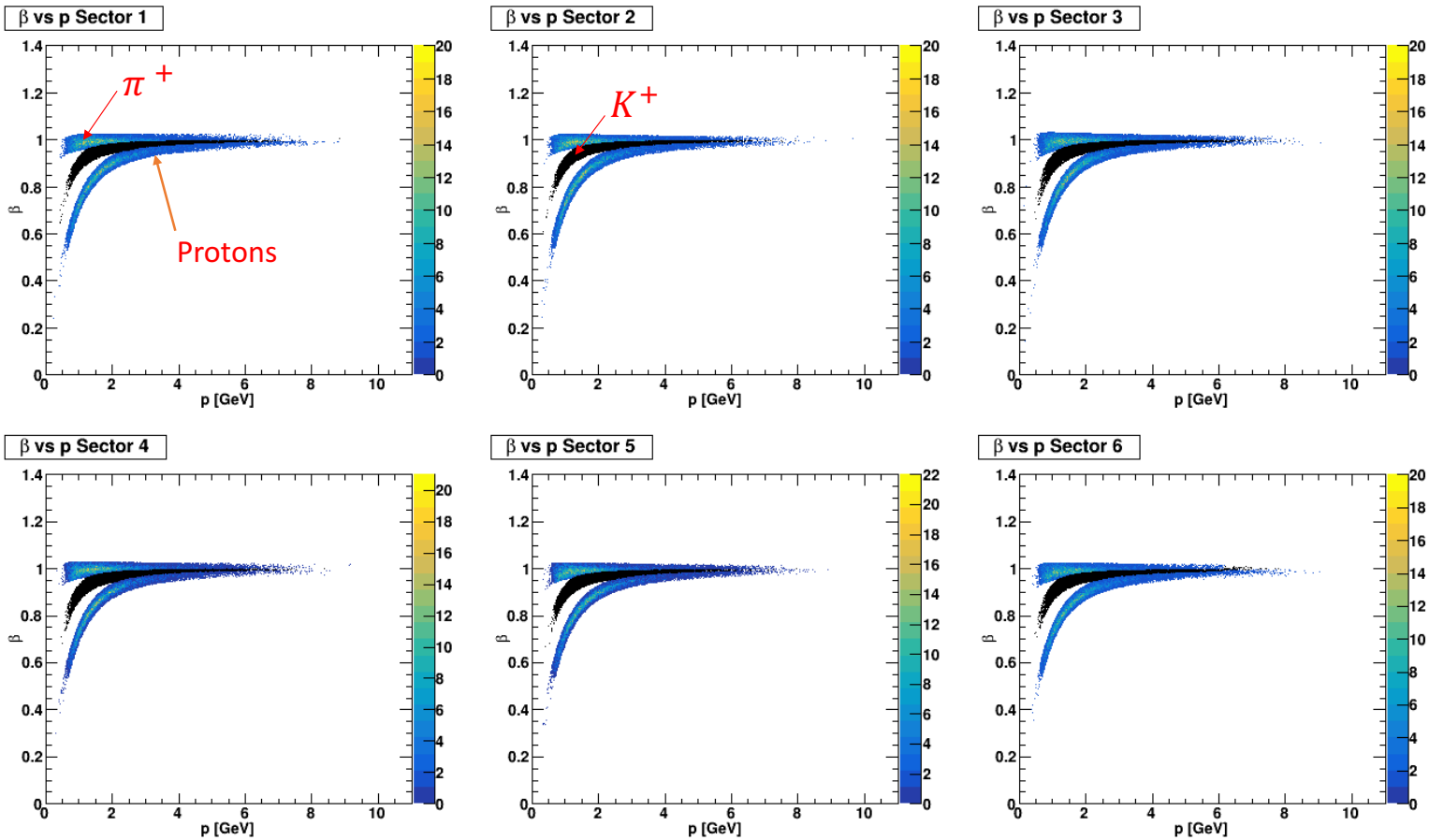
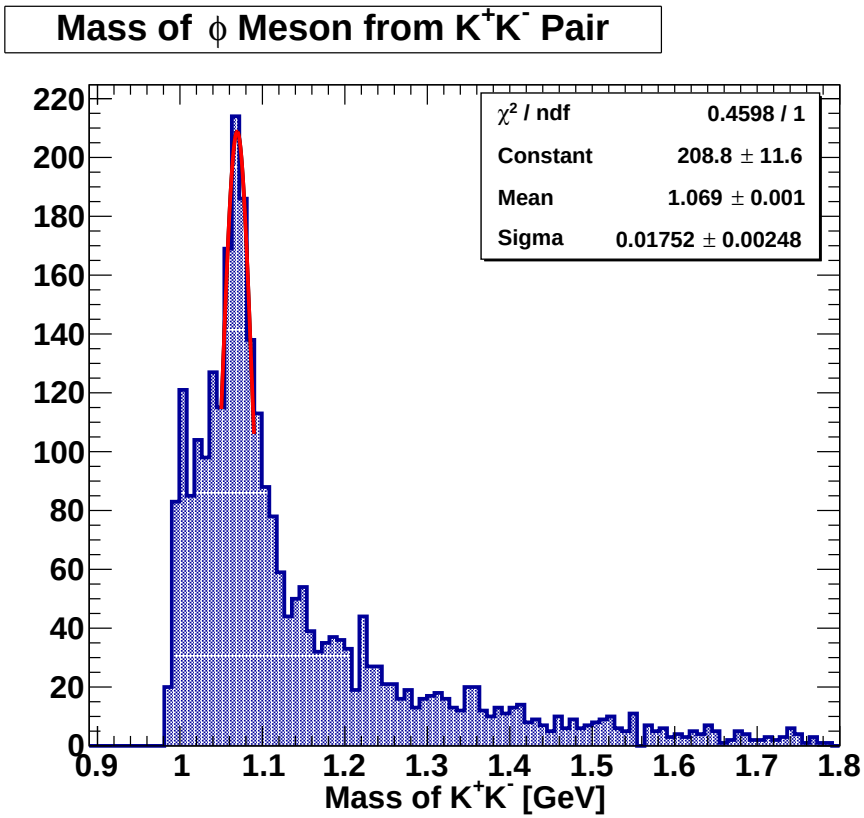


Figure: Sector dependent β vs p results for π^+, K^+, and proton.

Final State Selection

This study is interested is the decay mode of the $\phi \rightarrow K^+K^-$ such that the final state consists of epK^+K^-.

ϕ Mass Spectrum



Final Kinematic Phase Space

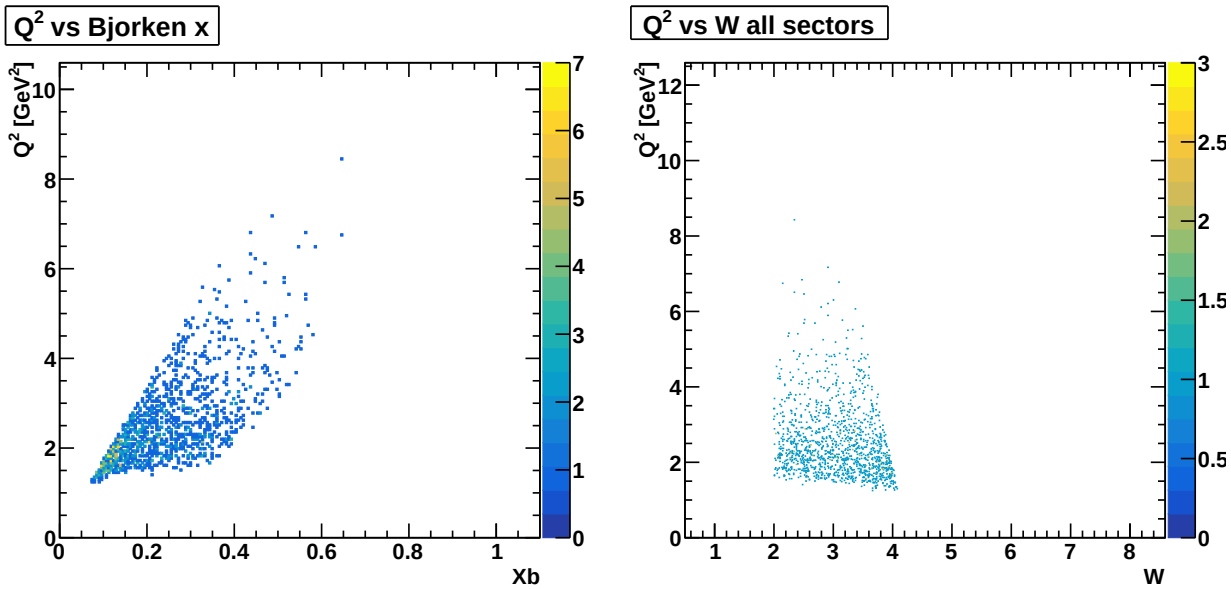


Figure: Final kinematics phase space after 3σ cut on phi mass

Final Kinematics of Final State Particles

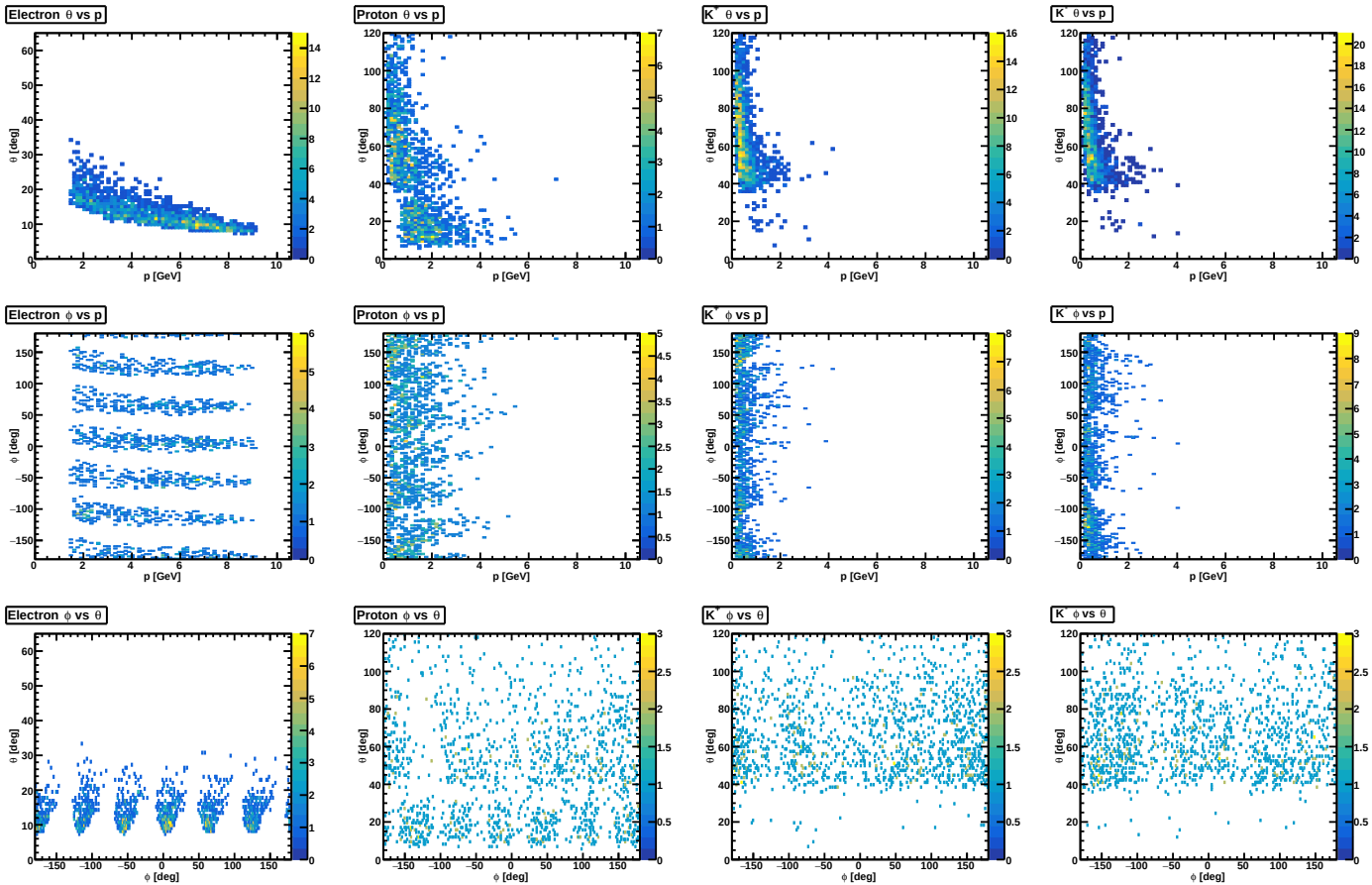


Figure: Final kinematics of the electron, protons, and Kaon pair after applying 3σ cut on phi mass

Conclusion and Future Work

- Improve particle ID for electron, proton, and Kaon.
- Improve exclusivity cuts
- Implement kinematic fitter
- Use GEMC using realistic event generator to study acceptances.
- Study radiative correction