GlueX DIRC Calibration (I)

DIRC calibrations

Analysis of GlueX Data

- Identify clean reaction channels for GlueX DIRC
- Estimate statistics in bins of P, Θ for each sample in ~ 1 month of production running

Analysis of Simulation

- Use identified reactions to generate ~ 1 month of simulated event with DIRC
- Calculate Θ_c, photon yield, single photon resolution, separation power, etc.
- Intentionally alter mirror angles, bar box alignment in simulated geometry

DIRC calibrations

Analysis of GlueX Data

- Identify clean reaction channels for GlueX DIRC
- Estimate statistics in bins of P, Θ for each sample in ~ 1 month of production running

Analysis of Simulation

- Use identified reactions to generate ~ 1 month of simulated event with DIRC
- Calculate Θ_c, photon yield, single photon resolution, separation power, etc.
- Intentionally alter mirror angles, bar box alignment in simulated geometry

Identify Clean Reaction Channels

Physics Analysis Motivation:

- Excellent particle identification is crucial to the success of GlueX physics program. The identification of kaons in the final state is mandatory to separate the signal events from the huge pionic background.

- Since $\phi \rightarrow K^+ K^-$ is a clean channel with 48.9 % branching fraction , such a benchmark physics channel is a good candidate to evaluate the GlueX DIRC detector performance.

- The study includes $K_s \rightarrow \pi^+ \pi^-$ and $\Lambda \rightarrow P \pi^-$ clean channels with 48.9 %, 69.2 and 63.9 % branching fraction as well.

Identify Clean Reaction Channels

Analying decay (1):

- $\gamma, P \rightarrow \phi\ P$
  - $\phi \rightarrow K^+ K^-$
- RunPeriod-2017-01/analysis/ver08

Analyzing decay (2):

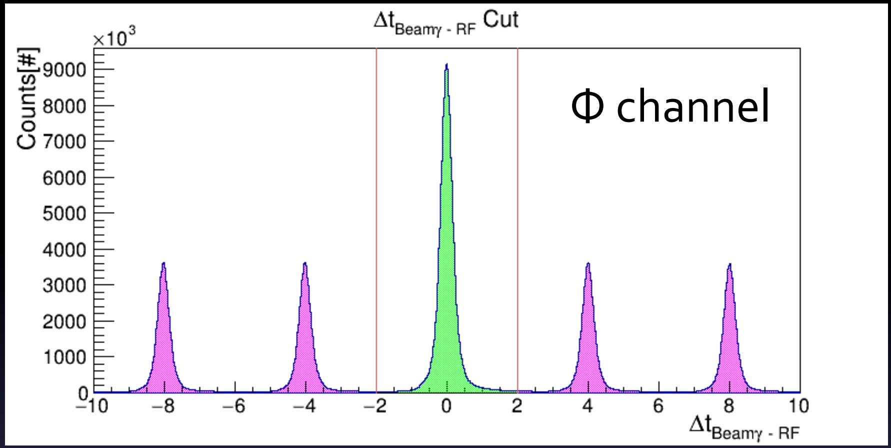
- $\gamma, P \rightarrow K_s\ K^+ \pi^-\ P$
  - $K_s \rightarrow \pi^+ \pi^-$
- RunPeriod-2017-01/analysis/ver08

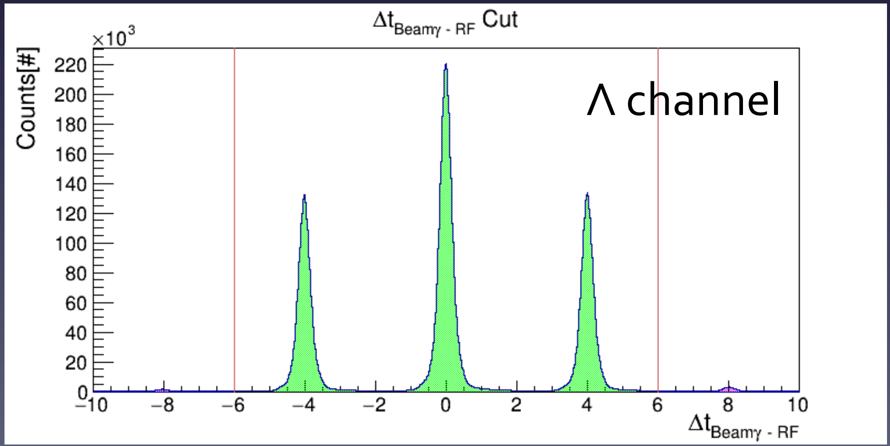
Analyzing decay (3):

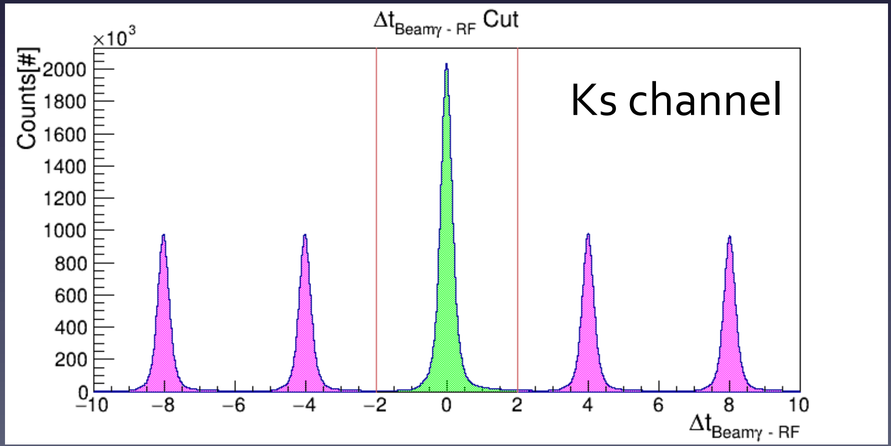
- $\gamma, P \rightarrow \Lambda\ K^+$
  - $\Lambda \rightarrow P\ \pi^-$
- RunPeriod-2017-01/analysis/ver09

RF cuts

The high resolution RF time (signal from the accelerator, siganl every ~4 ns) can be used as a reference for selecting the beam photon that matches each event, and for timing PID as well.







PID Δt Cuts

Φ channel PID Δt (BCAL/FCAL/TOF) [ns]

proton: ±0.4, ±1.5, ±10.2
K^+ : ±0.75, ±2.0, ±0.25
K^- : ±0.75, ±2.0, ±0.25

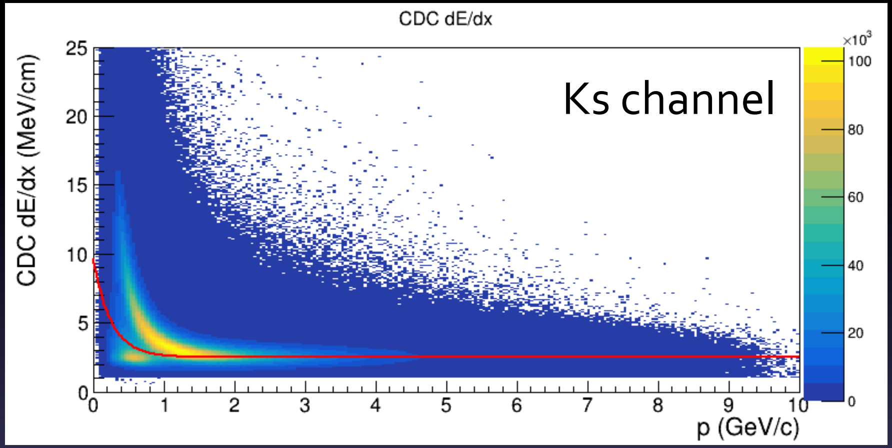
Ks channel PID Δt (BCAL/FCAL/TOF) [ns]

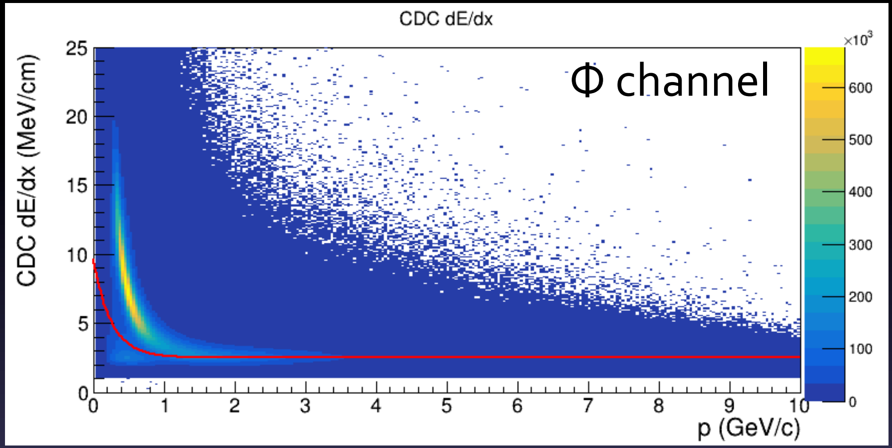
proton:±0.4, ±1.5, ± 0.2
π^+ : ±0.5, ±1.0, ±0.25
π^- : ±0.5, ±1.0, ±0.25
K^+ : ± 0.75,±2.0, ±0.25

Λ channel PID Δt (BCAL/FCAL/TOF) [ns]

proton: ±0.6, ±1.5, ± 0.5
π^- : ±0.5, ±2.5, ±2.0
K^+ : ±1.0 ,±2.25, ±0.5

CDC dE/dx Cuts

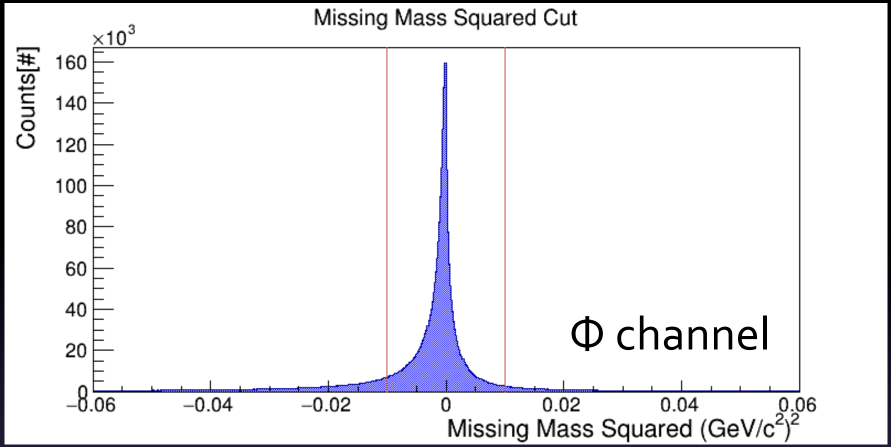


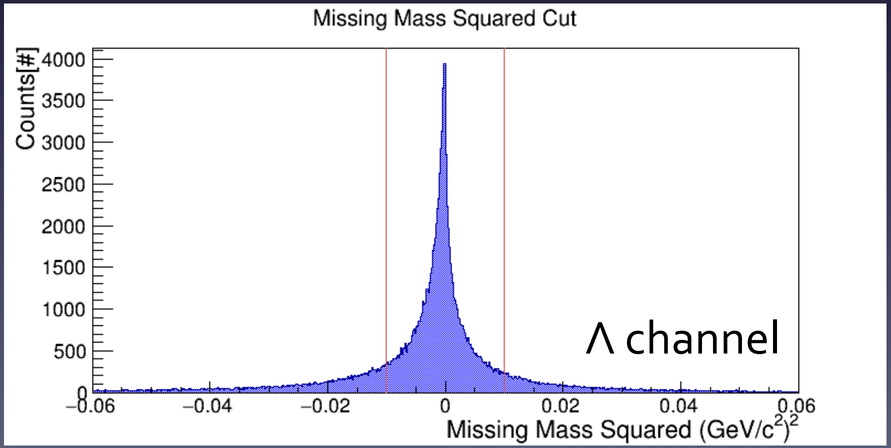


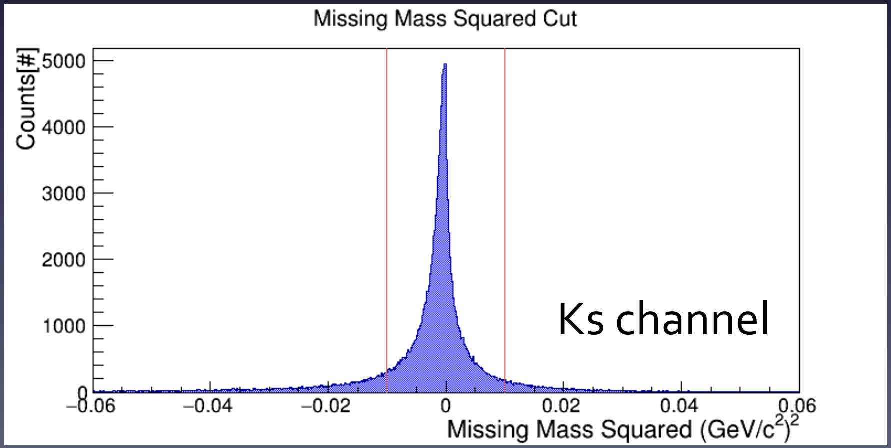
Particle ID: dE/dx :
Energy loss cut in the drift chambers to perform p/ K^+ separation

Missing mass squared Cuts

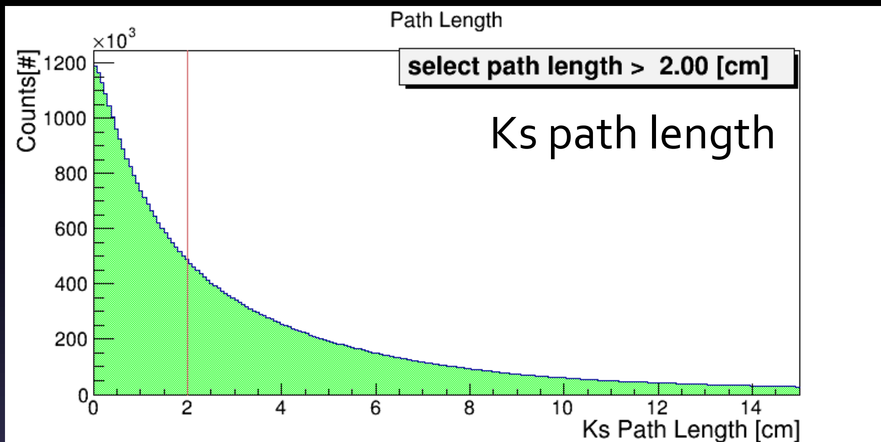
The absolute value of the selected missing mass squared range = 0.01 GeV/c^2

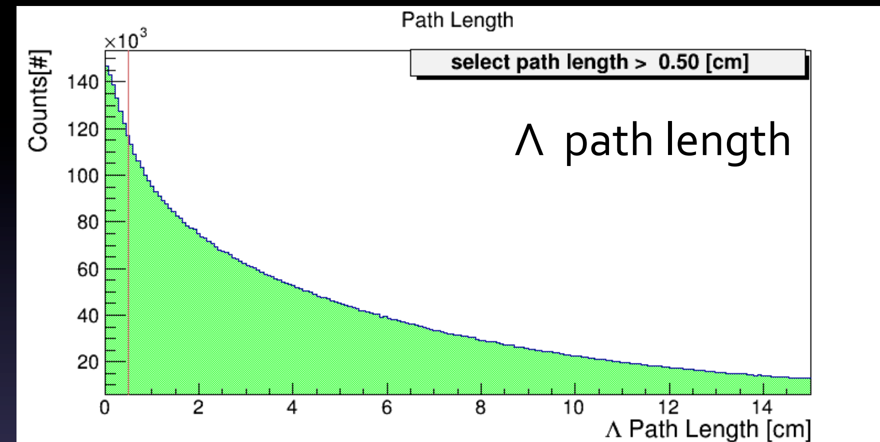






Path Length Cuts



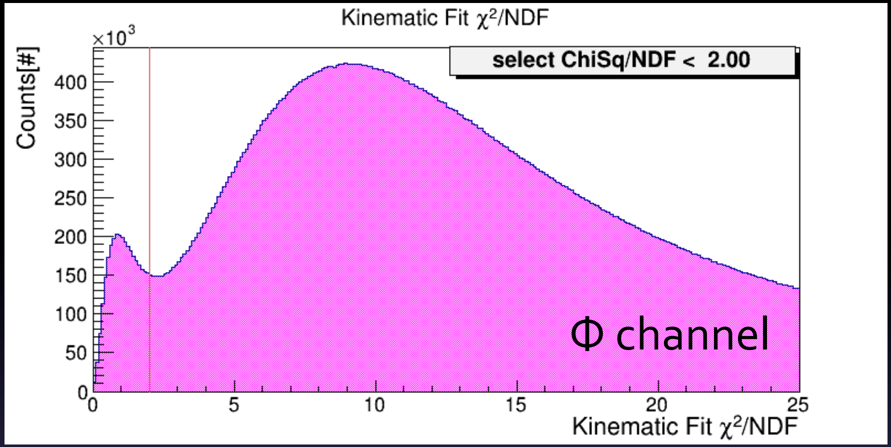


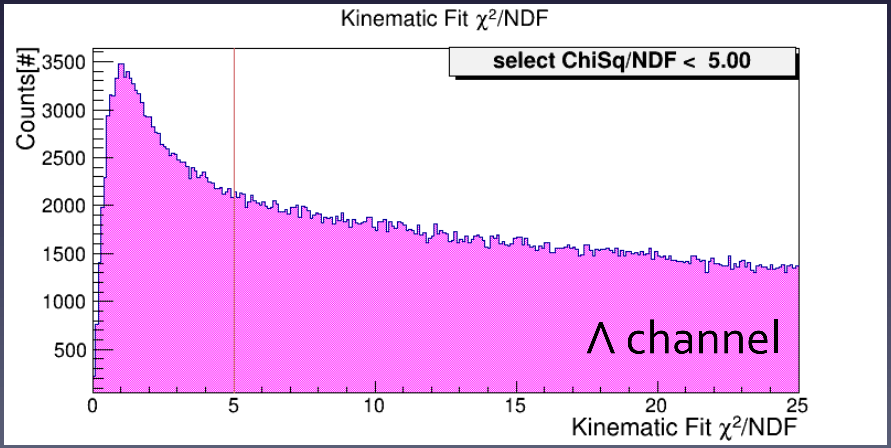
- Select path lengths for Ks and Λ more than 2, 0.5 cm respectively

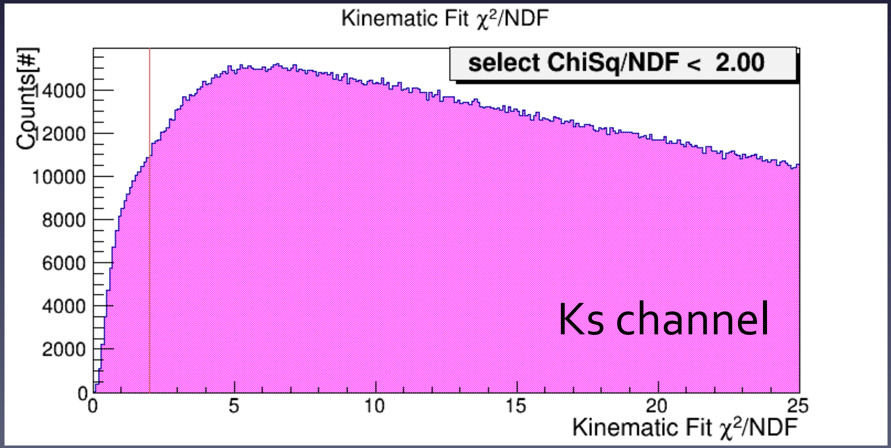
- The absolute value of the selected primary vertex On X Y plane = 1.0 cm and the selected Z value range between 55 - 75 cm

Kinematic Fit Cuts

The Kinematic fit requiring χ^2/NDF smaller than 2, 2, 5 for for Φ, Ks, and Λ respectively.



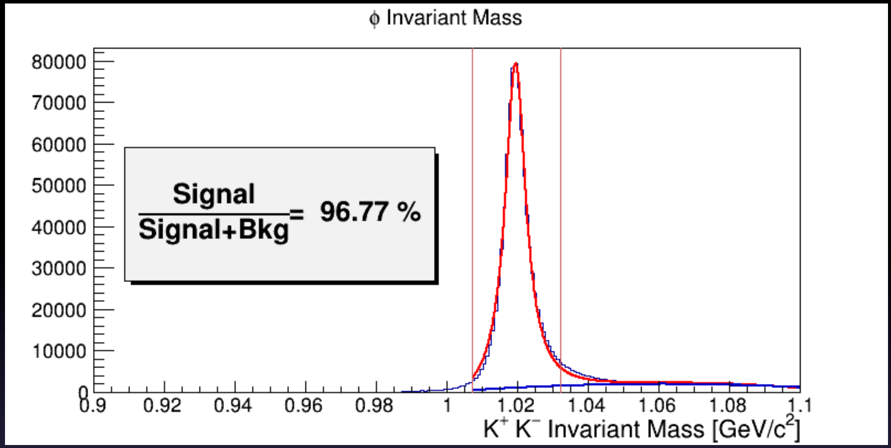


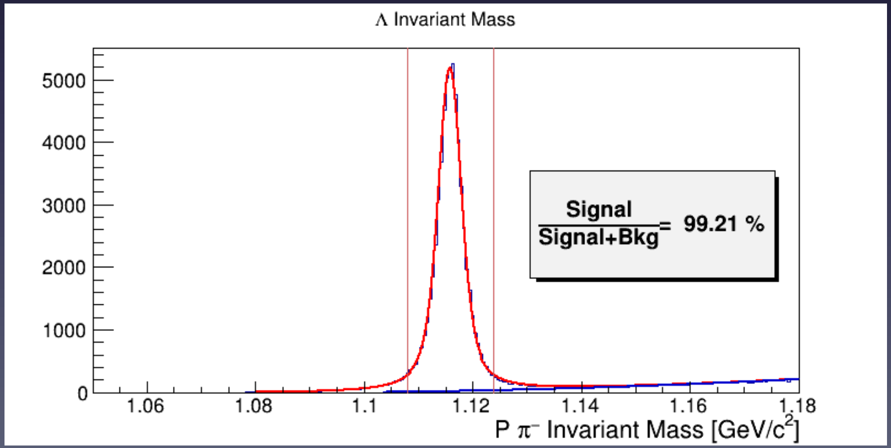


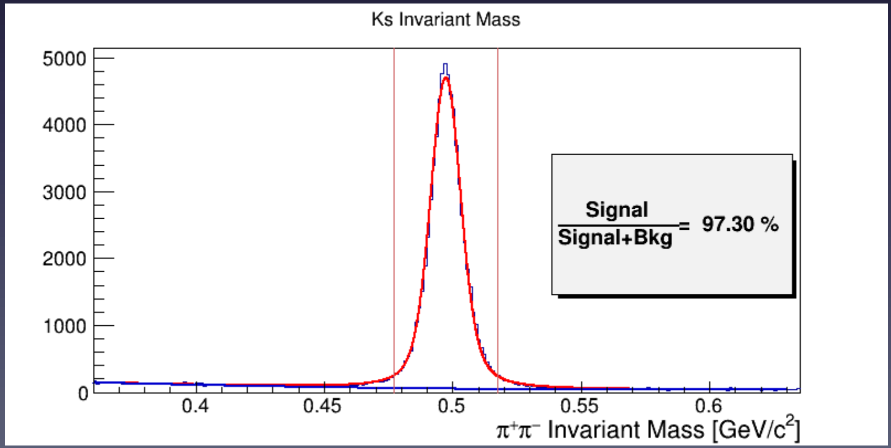
No mass constrains applied

Sample Purity Estimation

Sample purity estimation for Φ, Ks, and Λ correspond to 96.77 %, 97.30%, 99.21 respectively.





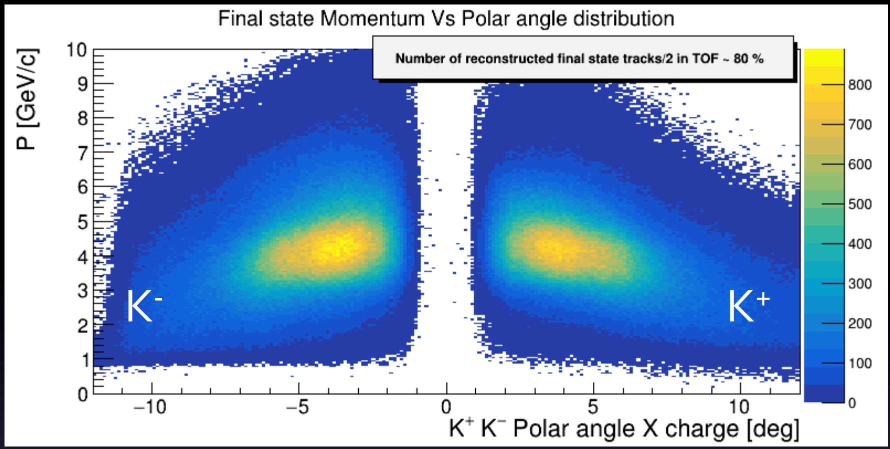


DIRC calibrations

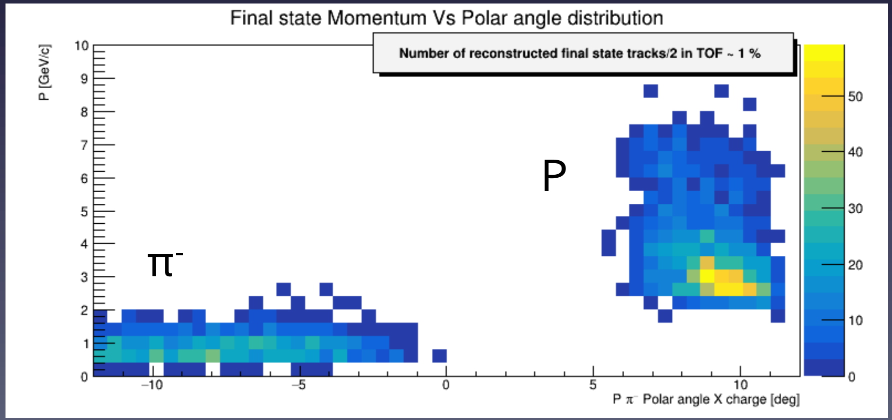
- Analysis of GlueX Data
  - Identify clean reaction channels for GlueX DIRC
  - Estimate statistics in bins of P, Θ for each sample in ~ 1 month of production running
- Analysis of Simulation
  - Use identified reactions to generate ~ 1 month of simulated event with DIRC
  - Calculate Θ_c, photon yield, single photon resolution, separation power, etc.
  - Intentionally alter mirror angles, bar box alignment in simulated geometry

Final state P Vs θ distribution

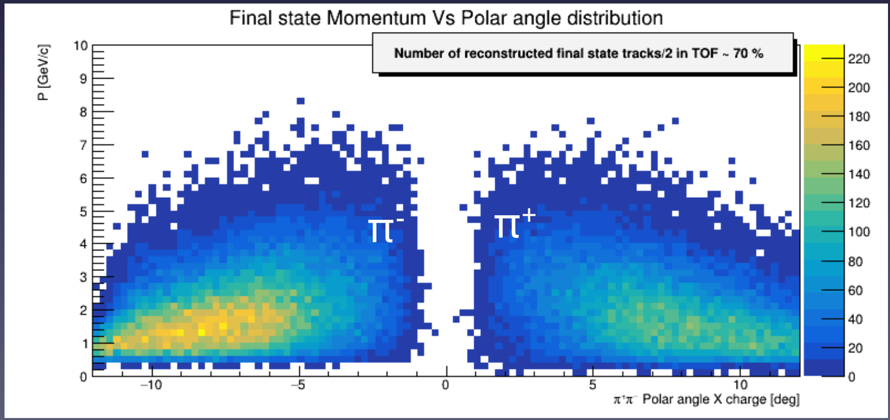
- Number of reconstructed final state tracks / 2 (polar angle between 0° to 12° on the TOF system) for Φ, Ks, and Λ correspond to ~ 80%, 70% , 1 % respectively.
- Slight asymmetric distributions between final states $\pi^+ \pi^-$ and K^+K^- were observed.



Φ final stat particles



Λ final stat particles



K_s final stat particles

Conclusions & Outlook

- Sample purity estimation for Φ, Ks, and Λ channels are 96.77 %, 97.30%, 99.21 respectively.
- Number of reconstructed final state tracks / 2 (polar angle between 0° to 12° on the TOF system) for Φ, Ks, and Λ correspond to ~ 80%, 70% , 1 % respectively.
- Slight asymmetric distributions between final states $\pi^+ \pi^-$ and K^+K^- for Ks and Φ respectively were observed.
- $\phi \rightarrow K^+ K^-$ is promising channel for calibration study: High yield, desirable final state Kaons momentum range.

Next step:

- Use ϕ channel to generate ~ 1 month of simulated event with and without DIRC.