Improving Particle Identification for the GlueX Experiment: Analysis of ω & ϕ

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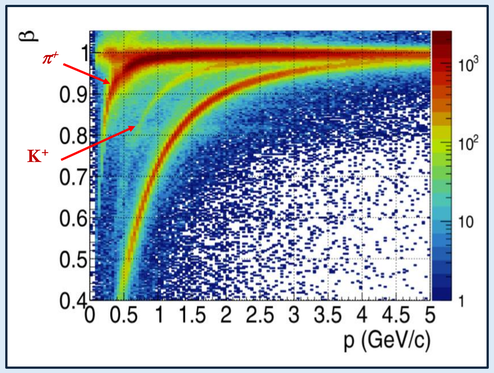
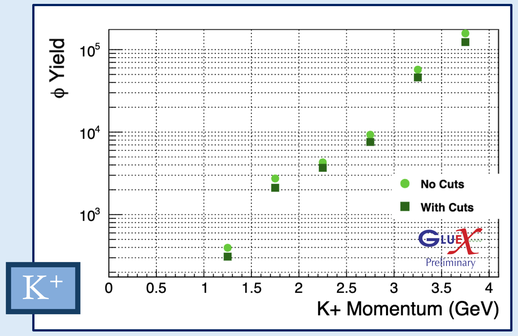
Intro to GlueX & PID

- GlueX's goal is to learn about **light mesons** and search for **hybrid mesons**. The GlueX detector allows the reconstruction of **exclusive final states**.
- We can take advantage of particles characteristics and apply **selections** to them. Certain selections needed to be systematically studied to determine if some had **momentum dependence.**
- Goal: Assess **systematic uncertainties** and improve understanding in GlueX's **Particle Identification (PID)** performance and event selection.

- Particles' **mass differences** allow for differentiation.
- **Pion** band is easily identified.
- **Kaon** band merges with pion band at higher momentum, harder to identify.

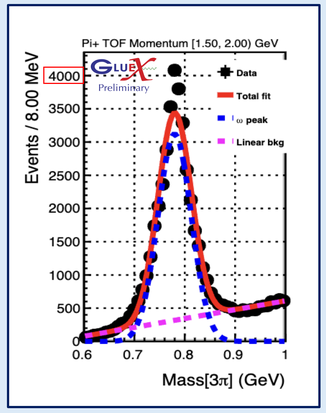


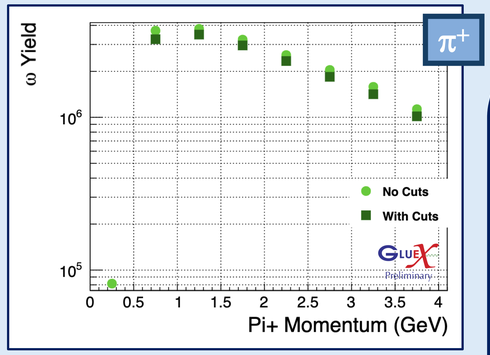
Analysis & Effect of STC



- **Before Cut** background **fluctuates** in vicinity of ϕ peak.
- **After cuts** background more **consistent** across momentum, **clearer** ϕ peak, **~10% reduction** in events.
- At **lower momentum,** the yield is very tiny (some at 0). Towards **higher momentum**, the yield increases. **Higher ϕ yield** without the standard cuts applied

- **Before Cuts,** background **fluctuates** as momentum increases.
- **After cuts,** ω signal is **cleaner**, signal to background ratio improves, STC reduces events by **~15%**.
- **Yield decreases** towards **higher momentum. ω** yield with no cuts applied **higher yield** than with cuts.





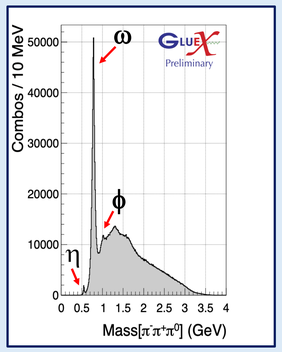
Conclusions

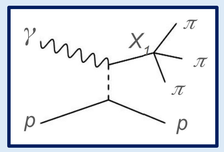
- Standard Timing Cuts had a **positive impact** on both $\omega \rightarrow \pi^+\pi^-\pi^0$ & $\phi \rightarrow K^+K^-$, leading to reduction in background and better signal clarity.
- In both data sets STC reduce yields only by **a small amount,** meaning we don't lose a lot of data, but gain background reduction.

In Progress & Future Analysis

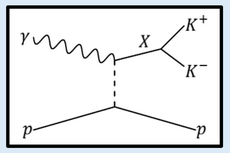
- To determine how sensitive the yield is to the tightness of the PID timing cuts, tight and loose **selection variation windows** are applied to the particles to study how the efficiency is impacted.
- Comparing **efficiency** for no particles in TOF, one particle in TOF, and all particles in TOF.
- Comparing results with **Monte Carlo.**

Particles Under Study

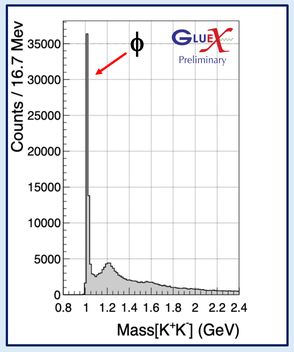




$\omega \rightarrow \pi^+\pi^-\pi^0$

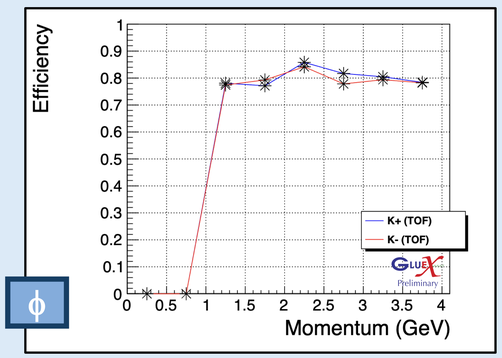


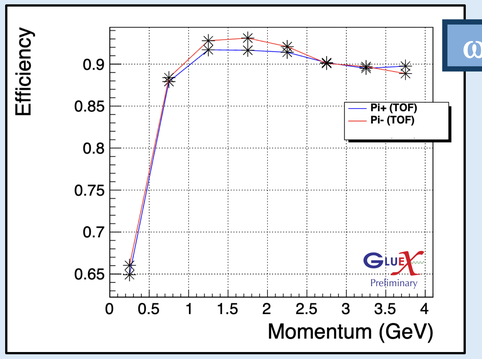
$\phi \rightarrow K^+K^-$



- Commonly used in GlueX analysis.
- **High** amount of **signal** with **small background**.
- Both represent **clean sources =** easier for detector to measure particles properties.
- We applied **Standard Timing Cuts (STC)** to both particles based on the Time of Flight (TOF) detector.

Efficiencies





$$Efficiency = \frac{Yield\ STC}{Yield\ No\ Cuts}$$

- Both efficiencies **track closely** as we increase in momentum, meaning PID cuts are **consistent** between particle and antiparticle.
- **Efficiencies go close to 1** as we increase in momentum, STC keeps ~80-85% of events for ϕ & ~90-95% of events for ω.

Acknowledgments

I want to thank my mentor Dr. Barriga for his constant support, patience, and encouragement. I'm grateful to have learned and experienced so much throughout the process.

References

This work is supported by the DOE under the award DE-FG02-92ER40735. Also, GlueX acknowledges the support of several funding agencies and computing facilities: http://gluex.org/thanks