Identifying Overlapping Particle Reactions in GlueX Data

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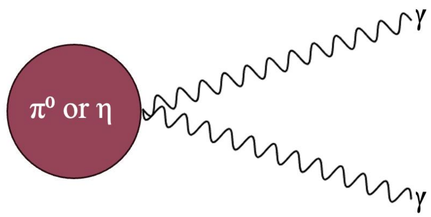
References

Introduction

- The GlueX experiment at the Jefferson Lab studies particle reactions by scattering a photon beam on a liquid hydrogen target.
- Different particles can decay into pairs of photons, making it difficult to identify their origin.
- We propose a tool that identifies the best origin hypothesis using physical constraints, such as conservation laws.

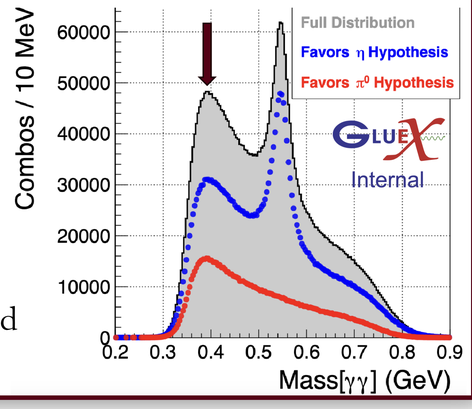


Example: π^0 and η mesons both decay to two photons.

Example: Mass Distribution

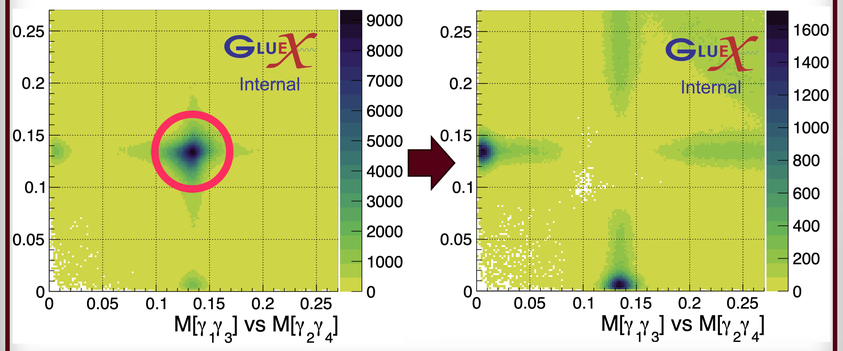
Here we compare the $\pi^+\pi^-\pi^0\eta$ and $\pi^+\pi^-\pi^0\pi^0$ hypotheses, which share the same $\pi^+\pi^-4\gamma$ final state.

- We can identify how different backgrounds influence the dataset.
- We can measure the effectiveness of our background removals.



Example: 2π⁰ Combinations

- The tool's effectiveness can be seen in the mass plot of correlated photon combinations.
- Events overlapping in the **π^0 range** likely contain 2 π^0 particles, suggesting they are background.
- The tool removes these events cleanly, avoiding invasive measures like removing the entire π^0 mass range.



Methods

Use of the tool involves the following:

- Form datasets containing all events matching the hypotheses using GlueX reconstruction software.
- Find identical events in both datasets by searching the secondary dataset for the unique event ID numbers of the primary dataset.
- When an identical event is found in a secondary dataset, add its χ^2 value the primary dataset.
- Write the modified copy to a new file.
- Use output file to remove unwanted contributions from the data.

Matching Process

Matched by Event IDs

π^0 hypothesis dataset:

Event ID	χ^2
2020	100
[...]	[...]

η hypothesis dataset:

Event ID	χ^2
2020	1
[...]	[...]

Output by tool:

Event ID	χ^2	Alt. χ^2
2020	100	1
[...]	[...]	[...]

Summary

- The tool enables the plotting, in any desired distribution, of alternative hypotheses contaminating the data.
- This could provide an improved approach to removing background from our data.
- Further study is needed to quantify the effectiveness of selecting signal and removing background events.

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