

~~Uniqueness Tracking~~
EVENT COUNTING

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Introduction

Consider EVENT COUNTING for cross section purposes!
NO Dalitz analyses and the likes, where intermediate states are an important part of the analysis!

Get the basics right first.

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The issue of uniqueness of a Final State (FS) within an event.
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good combo: Set of Final State particles in combination with a beam photon that satisfies all analysis cuts.

- **prompt** beam photon: **EVENT** NO MASS CONSTRAINT!
- **out-of-time** beam photon: **ACCIDENTAL**
- **different FS particles OR mass constraints**

Examples 1

- $\gamma + p \rightarrow \eta + p$
 $\rightarrow \pi^0 + \pi^0 + \pi^0 + p$
 $\rightarrow \gamma + \gamma + \gamma + \gamma + \gamma + \gamma + p$ with m_{π^0} NOT constrained.

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- Many ways to combine the 6 γ s can make up 3 π^0 s. Each such combo is in the tree if the KinFit converged. (same χ^2 if M unconstrained.)
 However, this is irrelevant for the task of event counting.

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good combo: Combo of FS particles with beam photon that survives all analysis cuts, including KinFit!

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- All combos will have the same KinFit χ^2 and all Momenta are the same.
- Case of $N_C^{event} > 1$ and/or $N_S^{event} > 6$: More than one combo of 6 γ s with **the same prompt** beam photon makes a **good** combo! (Not all 6 γ s are the same)
What to do then?
 this is the issue to discuss here!

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- Additional photons, same issue as example 1

Some Comments On Counting

Cases Of More Than One Unique FS **good** combo per event:

- $N_c^{event} = N_c^{FS}$ and $N_s^{event} = N_s^{FS}$ PLUS more than one **prompt** beam photon
This is taken care off by accidental subtraction, UNLESS ($N_{c+or-}^{FS} > 1$)

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What to do in these cases?

- Select the good combo with the best χ^2/df ?
- Count all good combos and weight them by $1/\sum(goodFScombo)$. If you do accidental subtraction this weight has to be multiplied to $1/N_{acc-p}$?

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- This does NOT address the issue of background subtraction!
 - This does NOT address the issue of intermediate final states (e.q. Dalitz plot analysis)

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- Outline of the problem needs careful language!
- Do not ask for intermediate state (η, π^0) mass constraints! (Need KinFit in DSelector) **The task at hand is event counting only.**
- PID choice (charged particle) is like mass constraint for neutrals.
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That is all at this point.

Simplest Final State Example

Simplest Final State: 1 Charted track, 2 photons

Examples: $\gamma + p \rightarrow p + \pi^0$ or $\gamma + p \rightarrow p + \eta$ with $\pi^0(\eta) \rightarrow \gamma\gamma$

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- Events with only 1 charged track and 2 neutrals. **DONE.**

There is only one Final State combo! At this point all beam photons in combination with the 3 FS particles are either in the "prompt" peak or in the side peaks "accidentals". Most of the time there is only one prompt beam photon, but some times you will have more than one and usually they do not have the same energy. One of them is the correct beam photon that initiated the event (most likely, modulo efficiency) and all others are "accidentals". These are the accidentals underneath the prompt peak that need to be subtracted. And this subtraction is done by using the accidental beam photons, those that are in the side peaks. This assumes that the number of accidentals underneath the prompt peak is the same amount as in the side peaks, which we know is almost true but not quite, hence the accidental scaling factor.

Simplest Final State Example

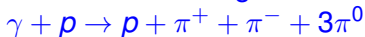
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- **Events with only 1 charged track and 2 neutrals. DONE.**
There is only one Final State combo! At this point all beam photons in combination with the 3 FS particles are either in the "prompt" peak or in the side peaks "accidentals".
- **Events with more than one charged track and/or more than 2 neutrals. Additional charged tracks and/or unused energy in the tree for the event!** In This case there is a potential to have **more than one UNIQUE FS** combo that survives with a prompt beam photon all analysis cuts. In this case we have to count all these FS combos (=N) in the event and weight all combos that survive all cuts with an additional factor 1/N. (This is one way to handle it! This is OPEN for debate, this is our JOB to give a recommendation of what to do!)

Event Statistics

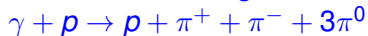
Final State 3 charged tracks and 6 neutrals:



**EVEN IF THE EVENT HAS EXACTLY THE SAME NUMBER
AND TYPE OF PARTICLES AS THE FS THERE IS
POTENTIAL FOR MORE THAN ONE FS COMOBO!**

Event Statistics

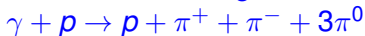
Final State 3 charged tracks and 6 neutrals:



- Events with exactly 6 FS γ s: 44.8%

Event Statistics

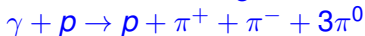
Final State 3 charged tracks and 6 neutrals:



- Events with exactly 6 FS γ s: 44.8%
- and with exactly 3 charged tracks: 95.3% of those
- of those: 86% have exactly one prompt beam photon
12.2% have two prompt beam photons
1.6% have tree prompt beam photons
- Only 0.15% have more than one Q combo

Event Statistics

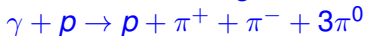
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$$\gamma + p \rightarrow p + \pi^+ + \pi^- + 3\pi^0$$

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