$\Upsilon\, p \rightarrow \pi^+ \pi^+ \pi^- n$
Part II

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Generate two sets of data

5000 signal events

1M pythia background events (including signal)

$\Upsilon\ p \rightarrow \pi^+ \pi^+ \pi^- n$

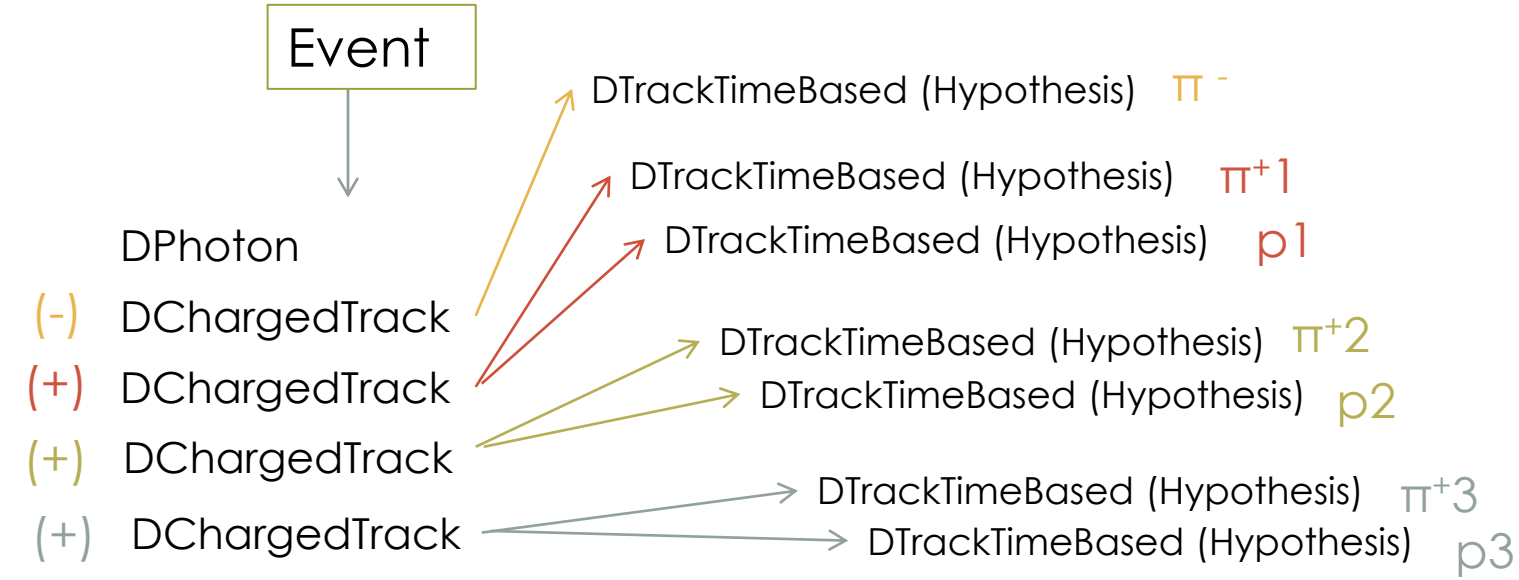
Possible backgrounds include $\pi^+ \pi^-$ p, $K^+ K^- \pi^+$ n, events with π^0 s, etc

Pass through hdgeant and mcsmear

Use signal to calculate efficiency

Use pythia data to reduce background

Reconstructed Data

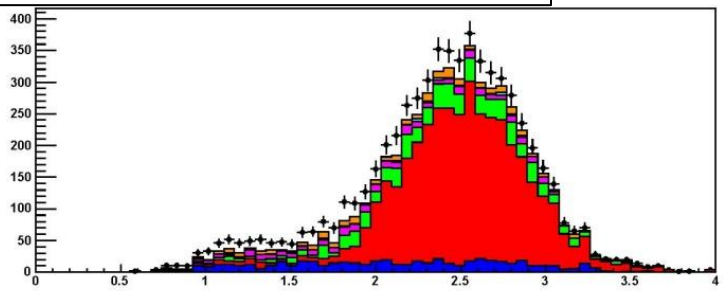


Make every combination (no duplicates) of 2 positively charged tracks (hypotheses) with a negatively charged track

- Combo 1 π^- π^+1 π^+2
- Combo 2 π^- π^+2 π^+3
- Combo 3 π^- π^+1 π^+3

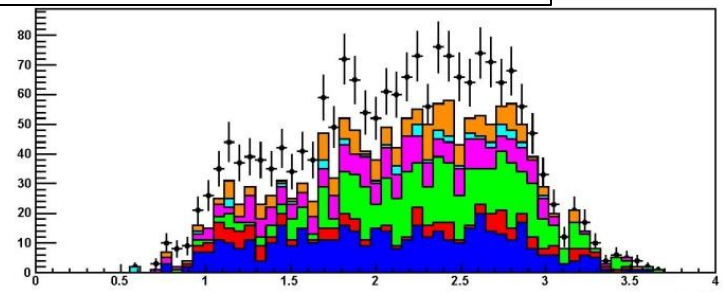
Require at least 2 positively charged tracks and 1 negatively charged track (net charge +1)

Three tracks only and missing mass cut



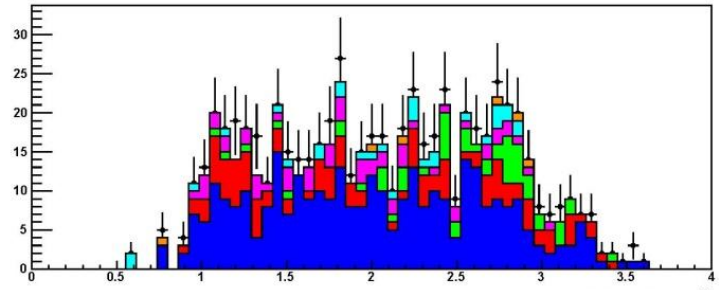
Mass($\pi^+\pi^+\pi^-$)

Add pion pt cut

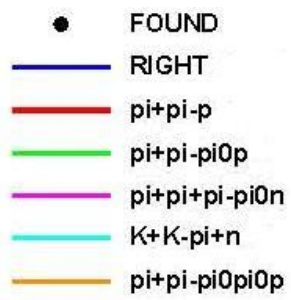


Mass($\pi^+\pi^+\pi^-$)

Add BCAL energy cut



Mass($\pi^+\pi^+\pi^-$)



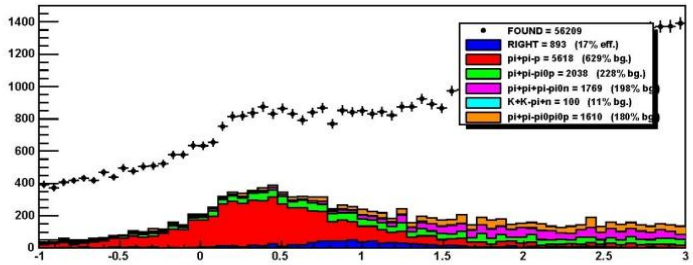
- Significant background contributions from $\pi^+ \pi^+ \pi^- \pi^0$ n and $\pi^+ \pi^-$ p
  - Additional π^0 s
- Some other large background?
  - Mostly removed with initial cuts
- Require 3 tracks
  - Removes significant amount of background

Missing Mass

$\Upsilon\, p \rightarrow \pi^+ \pi^+ \pi^- n$

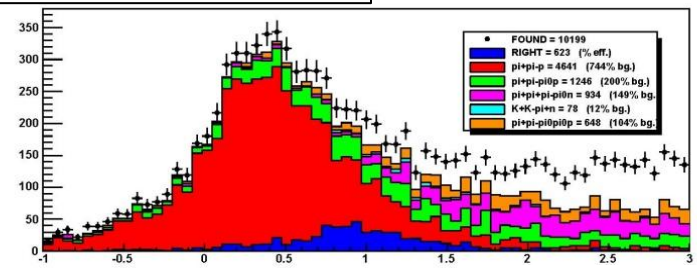
FOM = sig/sqrt(sig+bkg)

At least 3 tracks



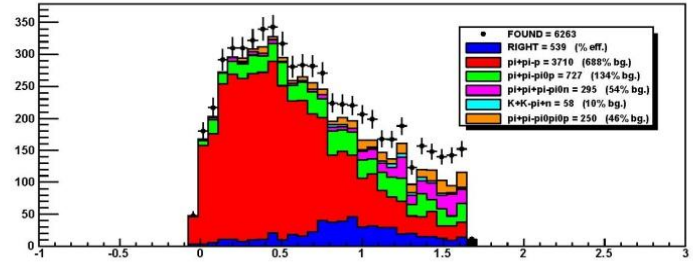
$(\text{Missing Mass})^2$

3 Tracks Only

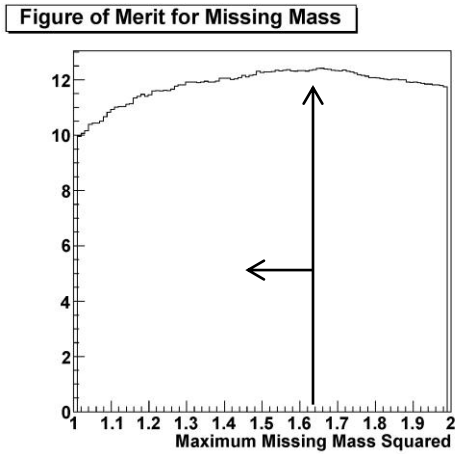


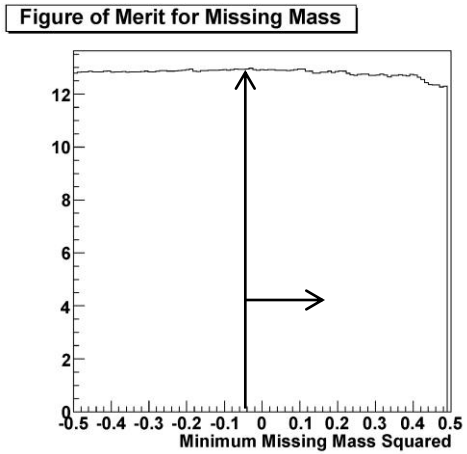
$(\text{Missing Mass})^2$

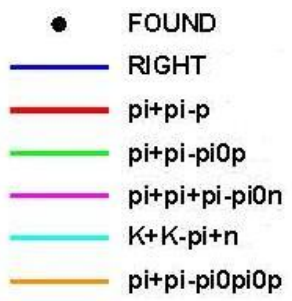
3 Tracks Only Plus MM Cut



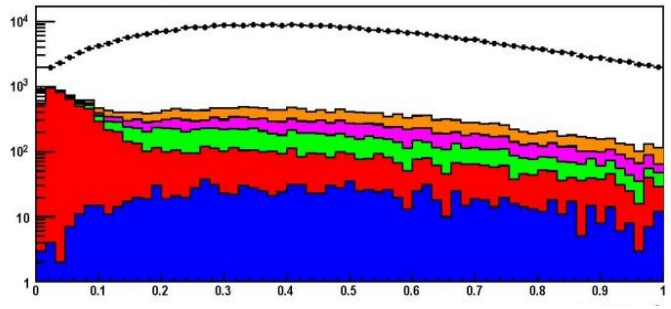
$(\text{Missing Mass})^2$





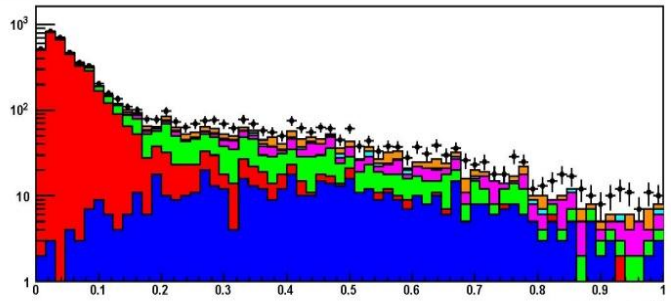


At least 3 tracks



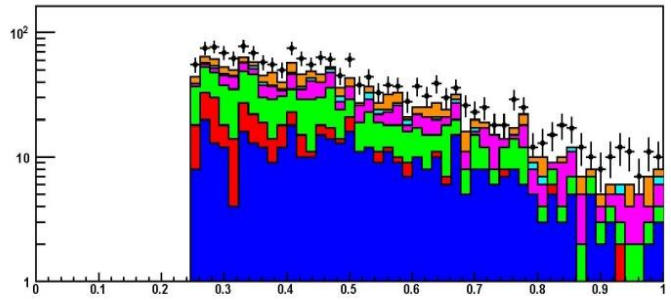
Pion Transverse Momentum

3 tracks only and MM cut



Pion Transverse Momentum

Add pion pt cut



Pion Transverse Momentum

Transverse momentum of "pions" seems to isolate $\pi^+ \pi^- p$ background

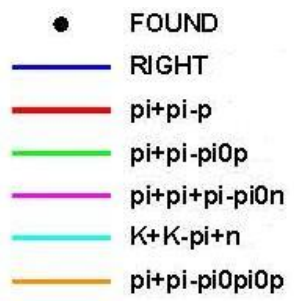
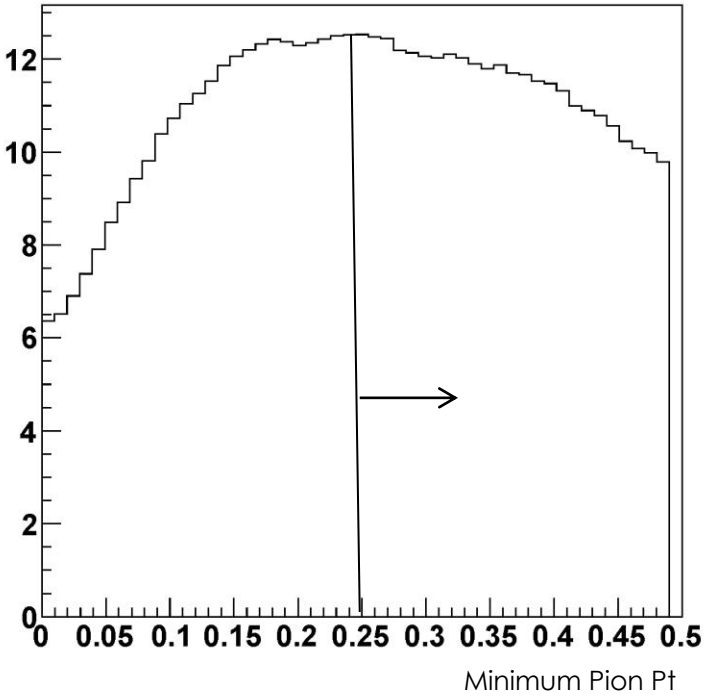


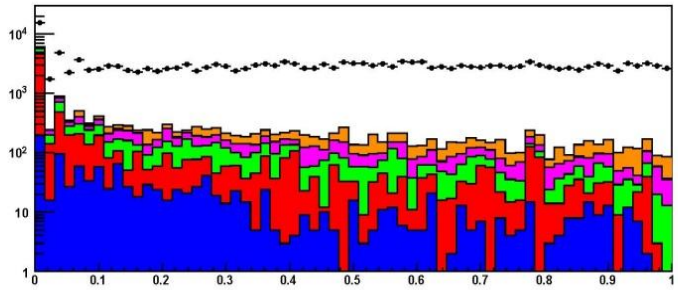
Figure of Merit for PionPt



Minimum Pion Pt

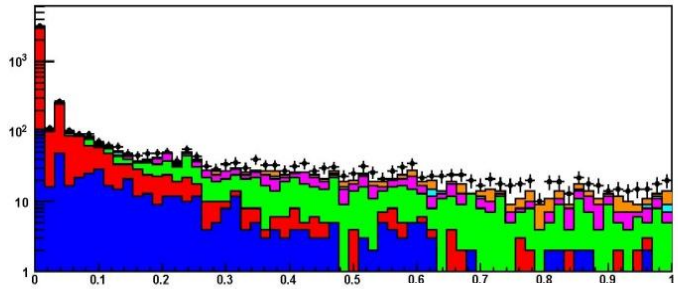
FOUND
RIGHT
pi+pi-p
pi+pi-pi0p
pi+pi+pi-pi0n
K+K-pi+n
pi+pi-pi0pi0p

At least 3 tracks



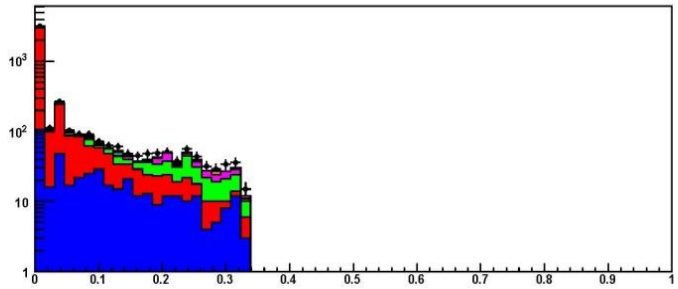
Total BCAL Energy

3 tracks only and MM cut



Total BCAL Energy

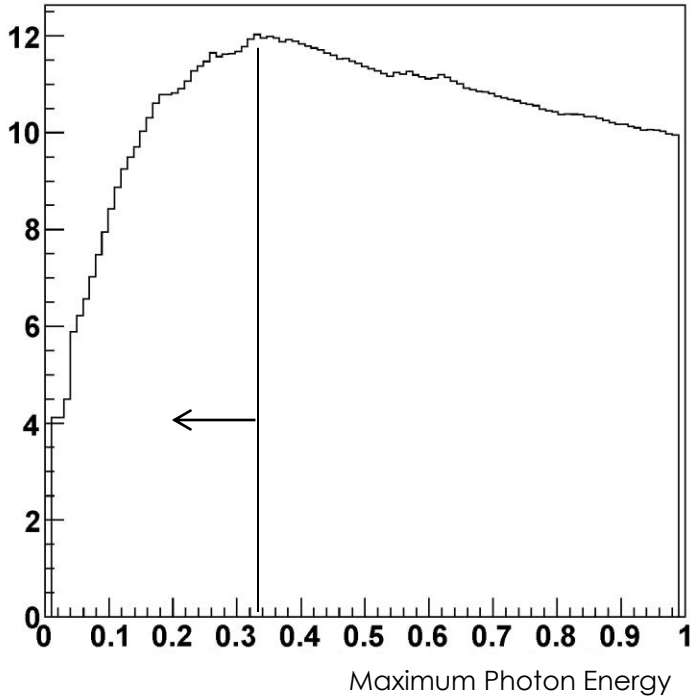
Add photon energy cut



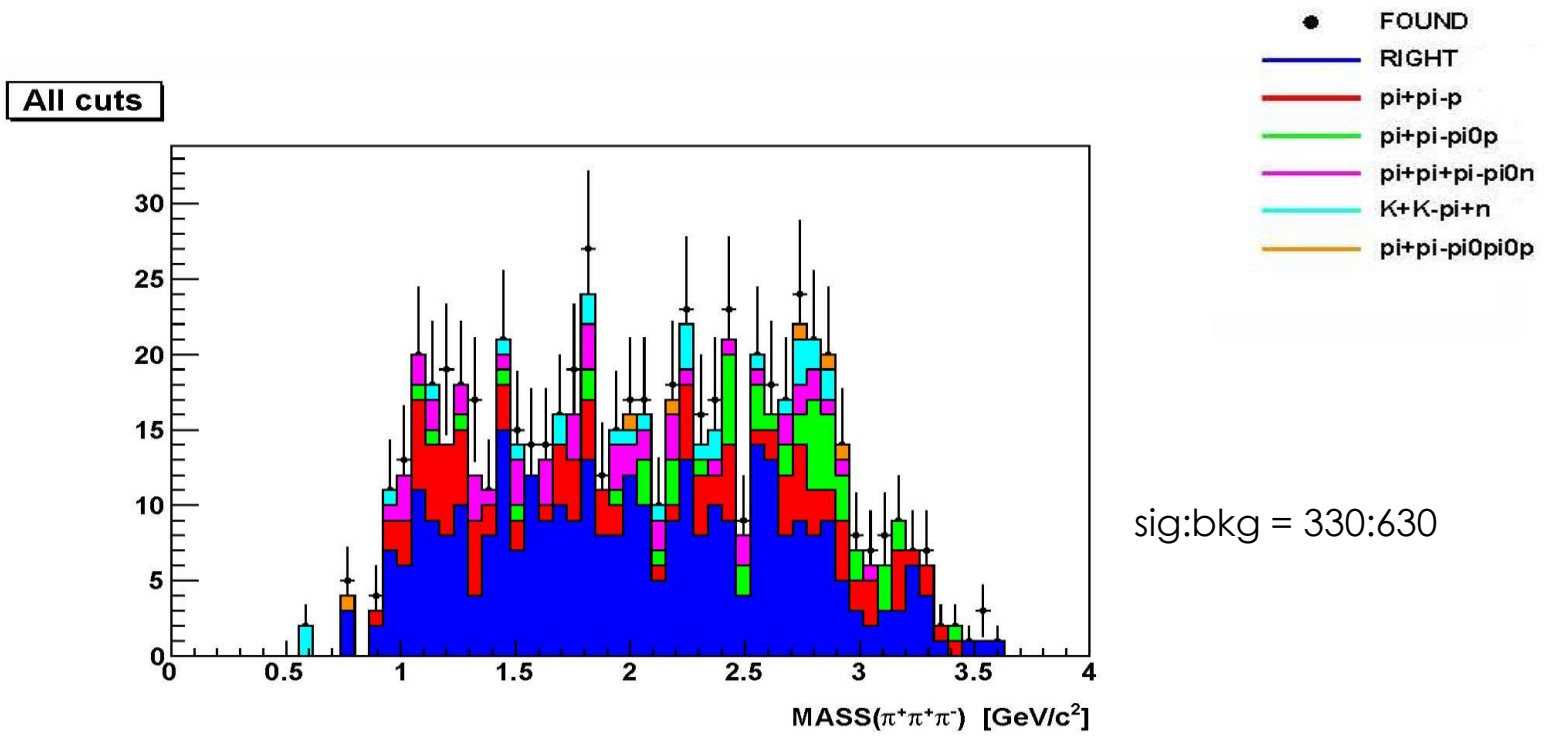
Total BCAL Energy

Look at the energy of photons in the BCAL

Figure of Merit for Photon Energy



Maximum Photon Energy



sig:bkg = 330:630

Cut	Sig Efficiency	FOM
Initial	0.77	2.105
3 Tracks only	0.68	4.368
Missing mass	0.54	6.815
Pion Pt	0.37	9.730
Calorimeter energy	0.32	13.15

FOM = sig/sqrt(sig+bkg)

Work in Progress

Kinematic fit to $\pi^+ \pi^- p$ and use χ^2 as a cut

Doesn't turn out to be very useful

PID should improve signal FOM

Any improvement on this?

Investigate low signal efficiency

Looks a little better… Why?