Measuring efficiency using 3 particle final state events

Holly Szumila-Vance

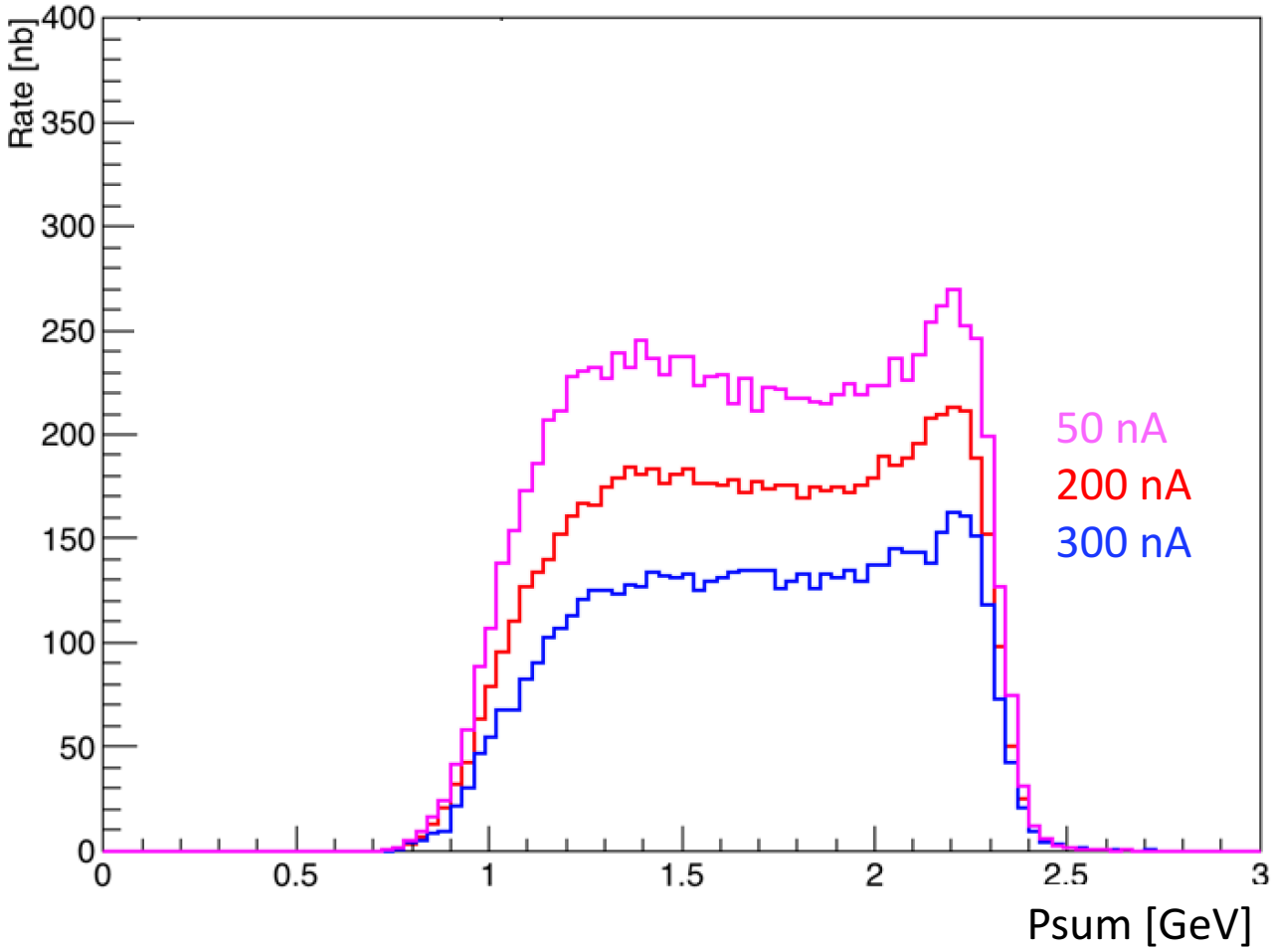
HPS Collaboration Meeting

3 May 2017

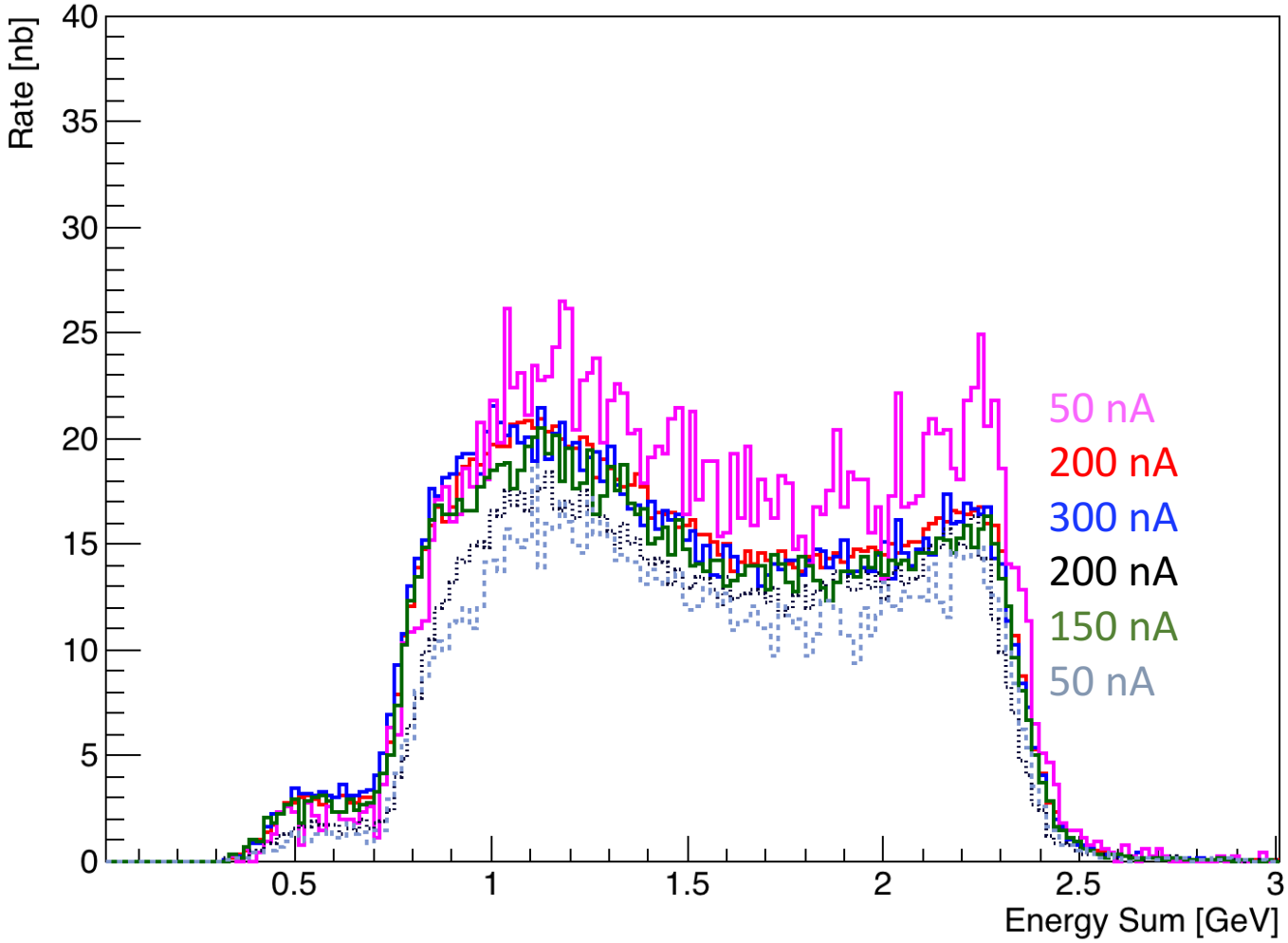
Outline:

- Rate effects and Ecal-only data
- 3 particle final state event selection
- Topologies
- Efficiencies
- Summary

2016 SVT data has rate dependency



Effect is not clear in Ecal-only selection



Ecal Only Selection - 2015

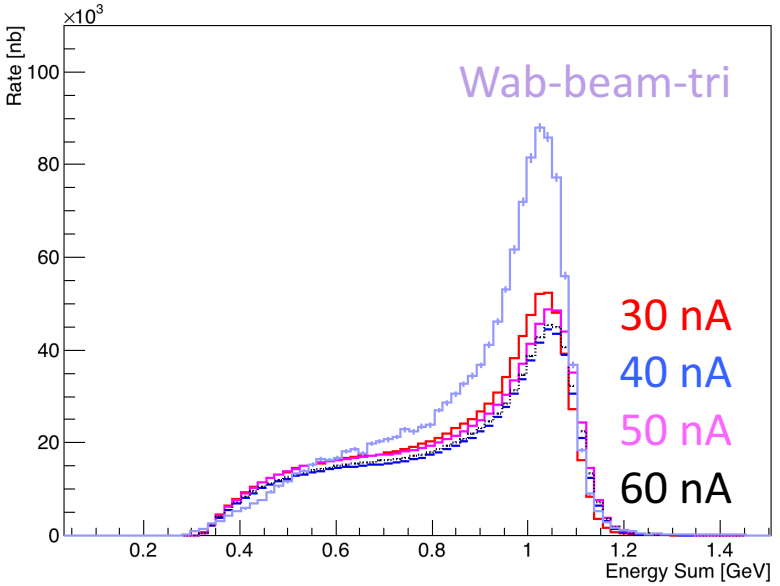
Run	Run Current (nA)	Fcup livetime	Q (nc)	Q (nc) x livetime
5749	30	0.97	14631	14193
5754	40	0.938	15330	14380
5755	60	0.87	17288	15041
5772	50	0.8822	333139	293895

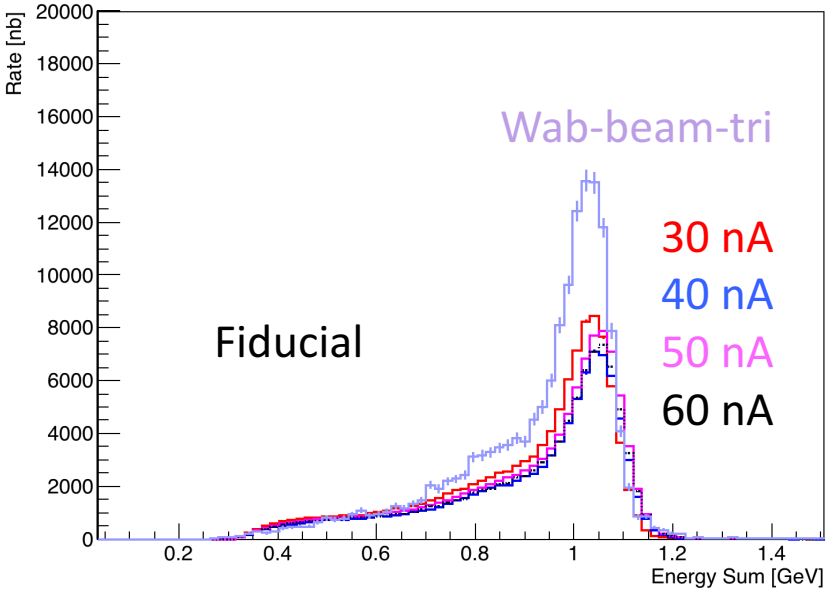
- All used v7tb-Lat147 trigger
- 5749, 5754 had unique pedestals for specified current
- 5755 and 5772 used 50 nA pedestals

2015 running

Loose selection (dominated by WABs):

- E < 0.8 GeV
- Time difference < 1.6 ns
- Pairs1
- Trigger time window
- 1 cluster in top, 1 in bottom
- 1 cluster left half, 1 cluster right half

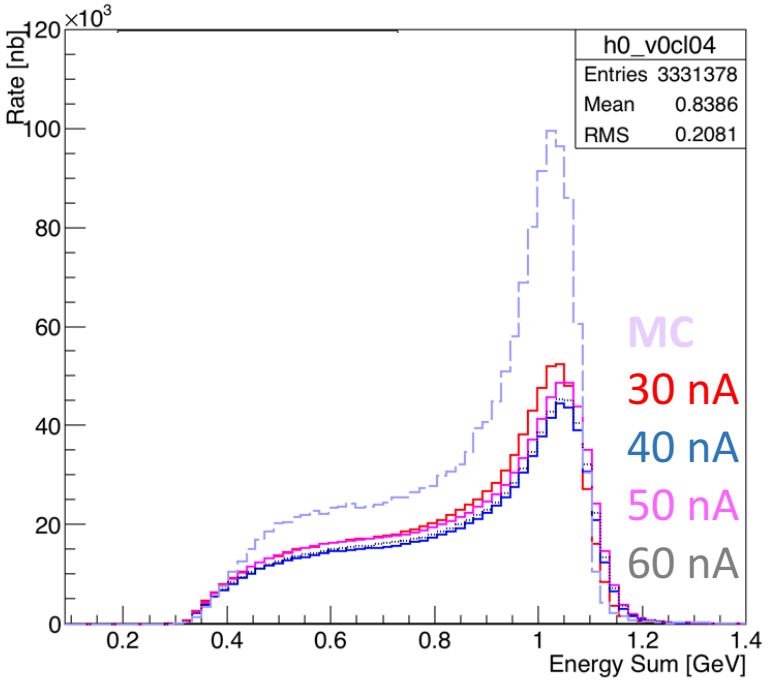


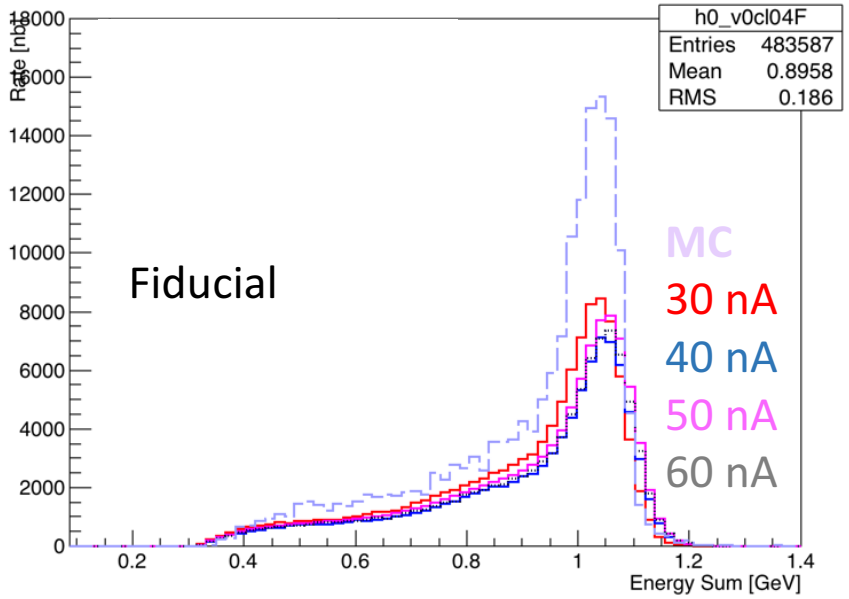


This wab-beam-tri MC uses MG5

Here's the same loose selection I showed in November where wab-beam-tri was using MG4.

→Not very different from now.

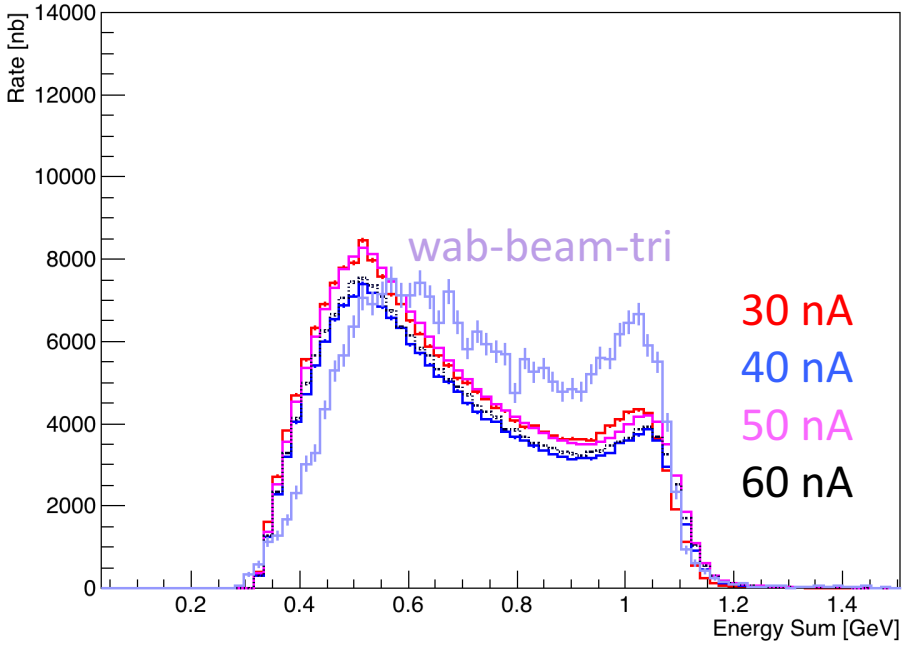


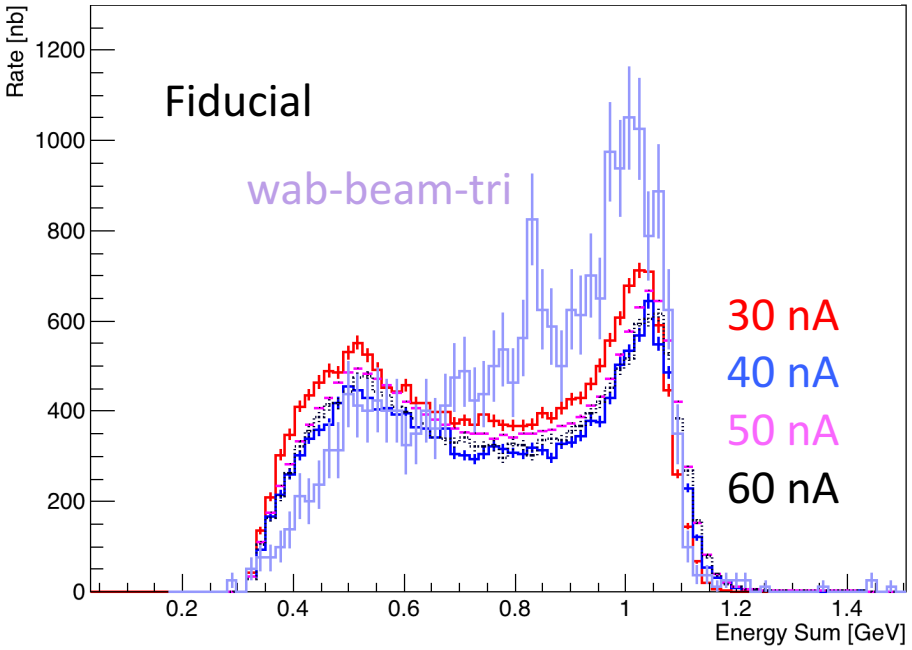


2015 running

Tight selection (reduce WABs):

- E < 0.8 GeV
- Time difference < 1.6 ns
- Pairs1
- Trigger time window
- 1 cluster in top, 1 in bottom
- 1 cluster left half, 1 cluster right half
- clusters within +/-200 MeV
- Coplanar 180 +/- 10 deg

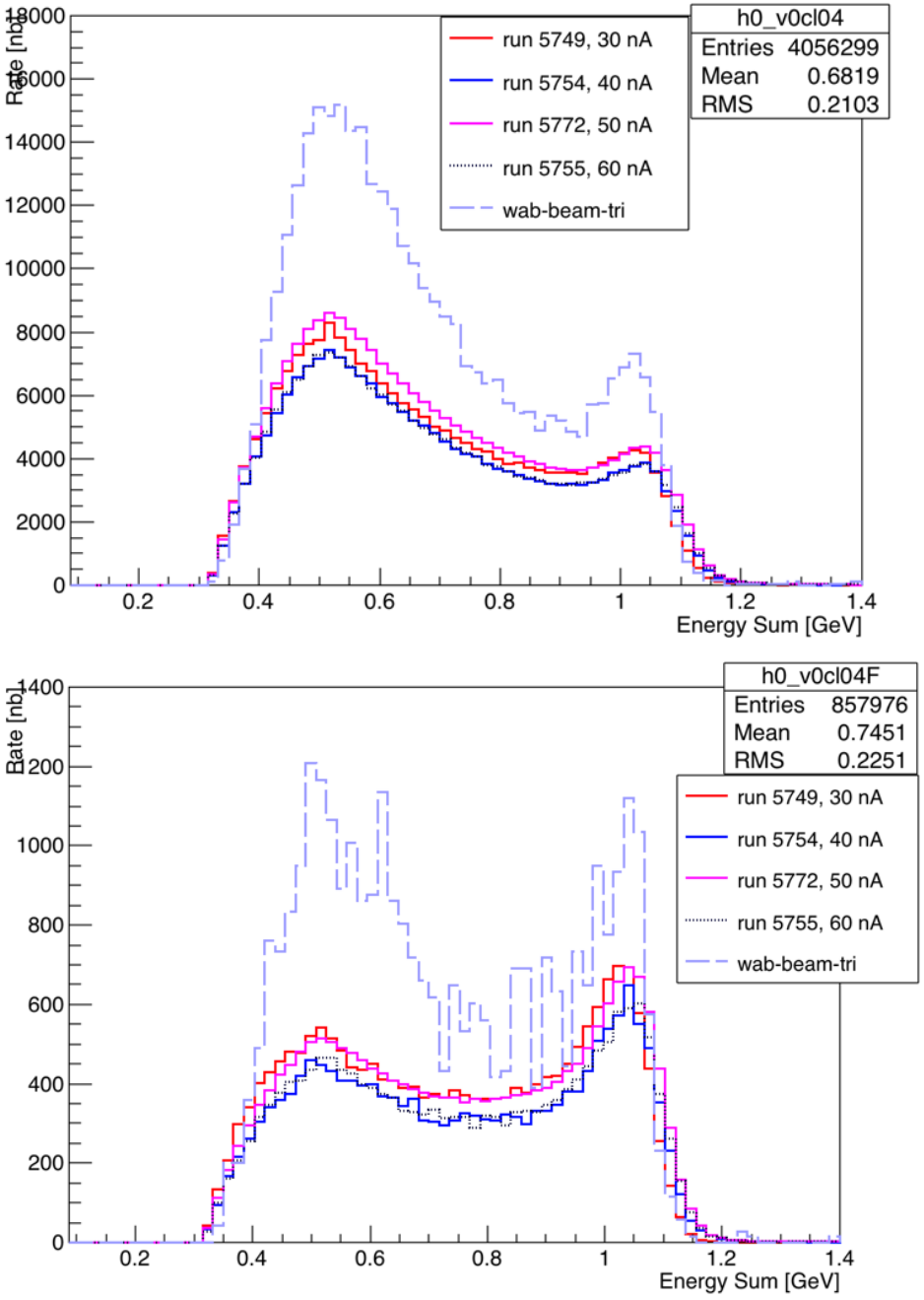




This wab-beam-tri MC uses MG5

Here's the same tight selection I showed in November where wab-beam-tri was using MG4.

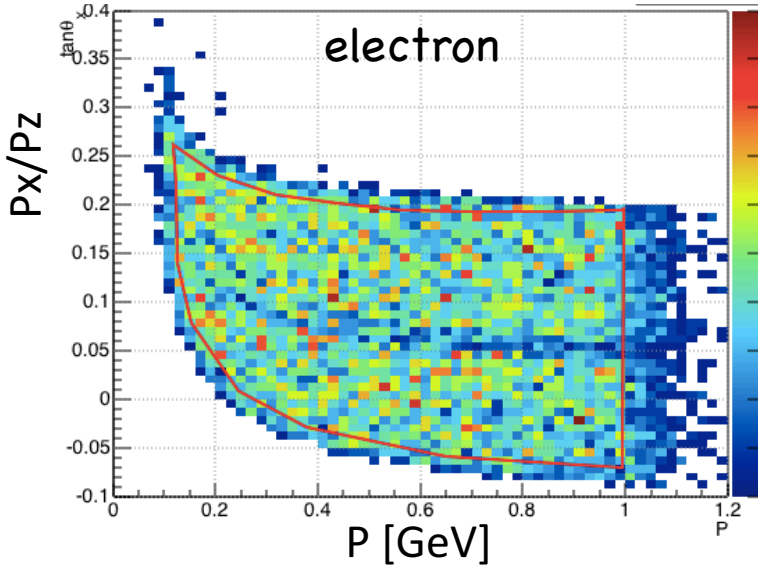
→Low Esum in MG5 looks much better!
→High Esum in MG5 unchanged

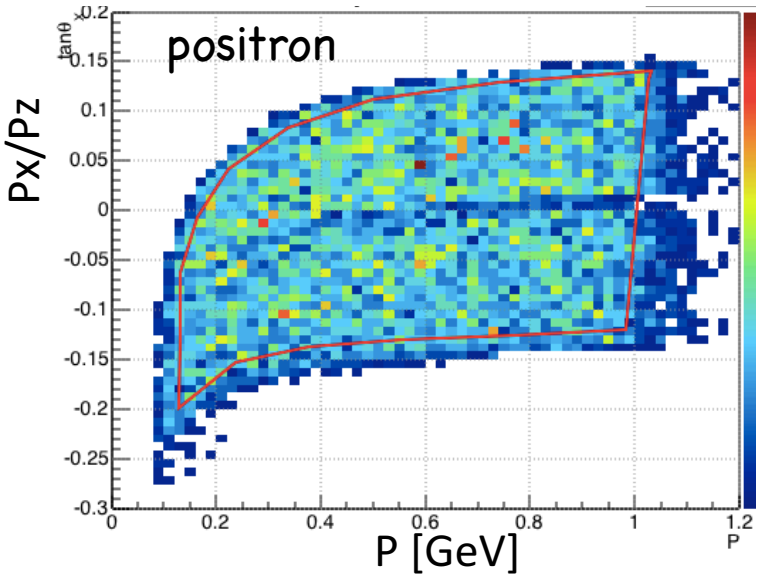


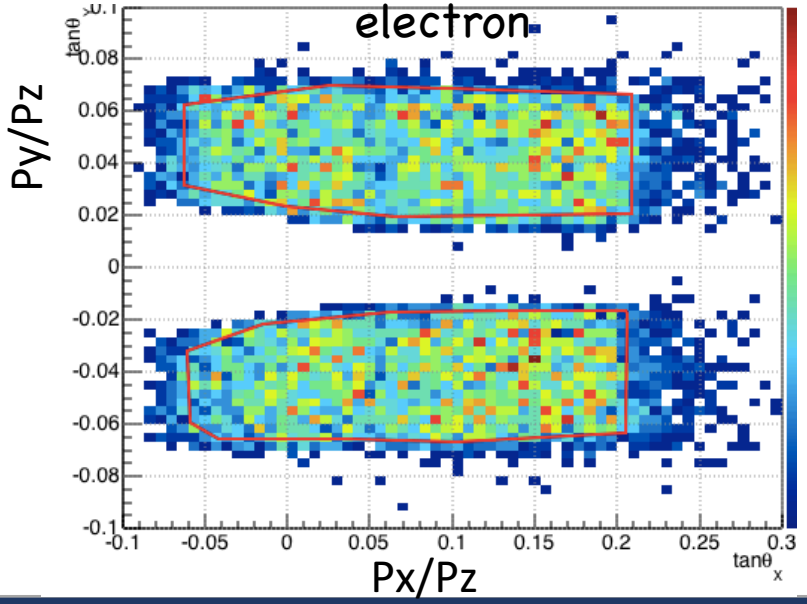
3 Particle Final State Event Selection

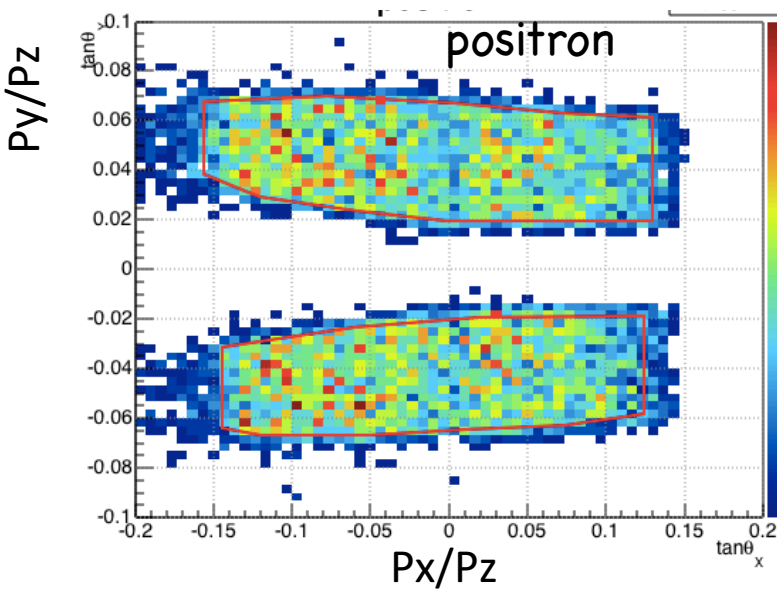
- Tracks:
  - P < 850 MeV (to avoid FEE)
  - Tracks can share no more than 3 hits with other tracks
  - GBL tracks (5+ hits)
  - 3rd track in fiducial region (see next slide)
- Clusters:
  - Cluster E < 850 MeV (to avoid FEE)
  - Energy-Distance Cut (shown 2 slides from now)
  - Clusters in trigger time window [40, 50]
  - Choose clusters at least ¾ crystal away from edge
  - Cluster energy sum > 0.9 GeV
- Track-Cluster Matching:
  - Matching within 10 sigma, based on position
- After matching, check matched clusters are in time. Choose the best, unmatched cluster as one that is in time, has smallest time difference, and energy sum of all clusters < 1.2 GeV
- Pairs1 trigger

3rd track Fiducial Cuts, from flat MC

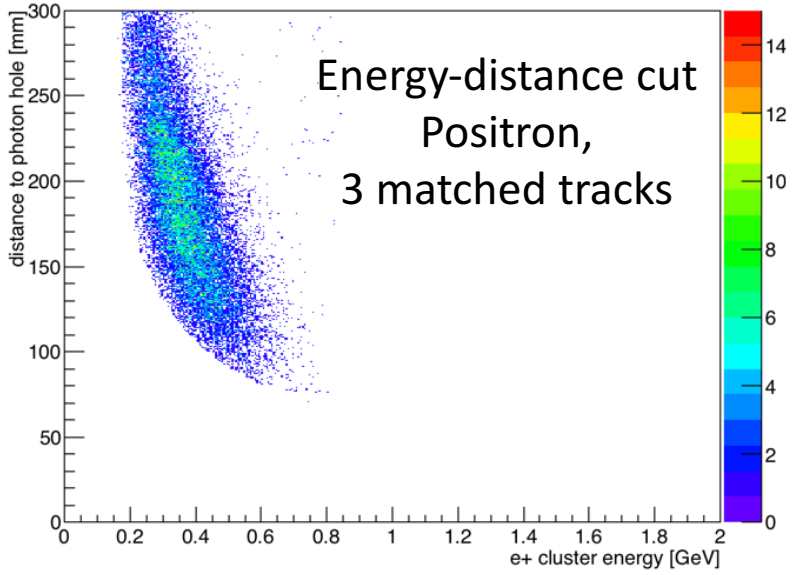


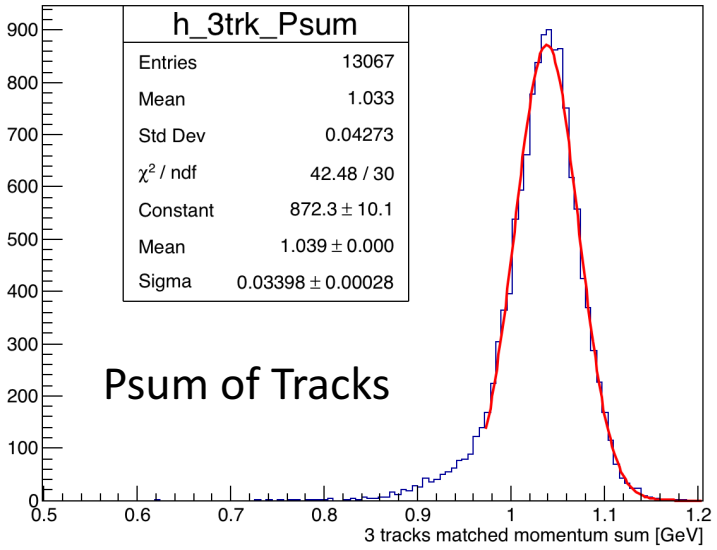


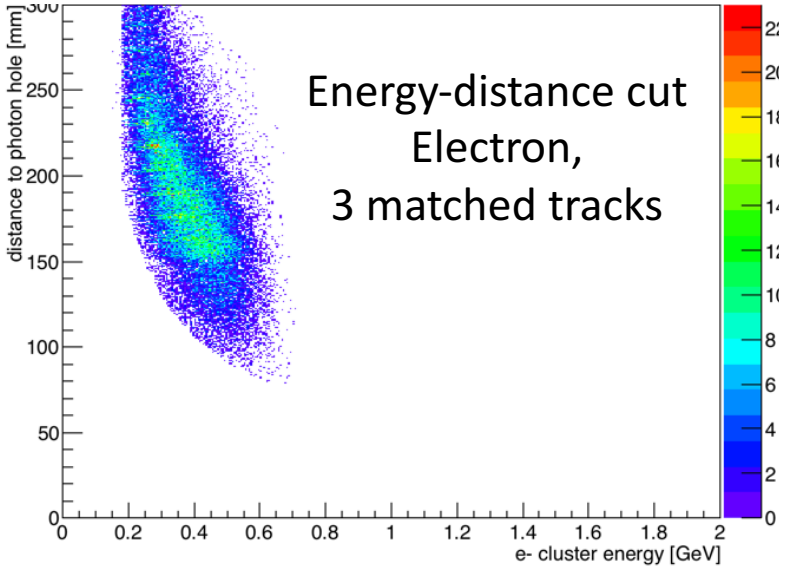


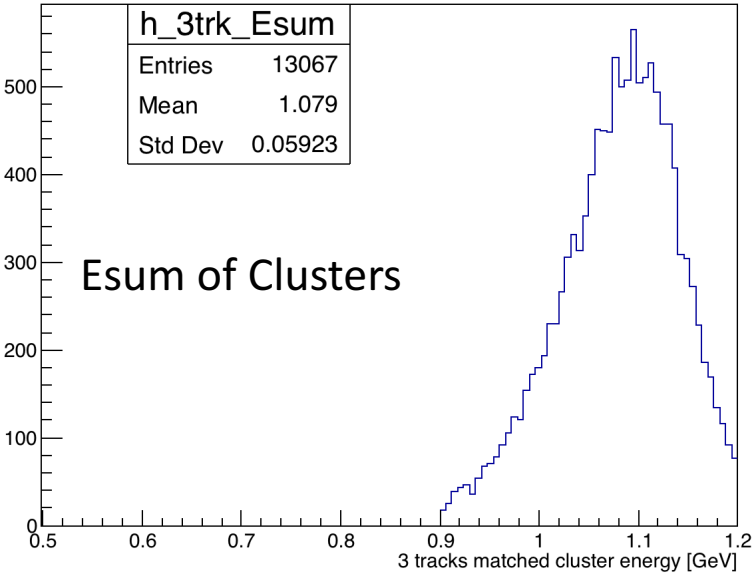


Results of final event selection









Consider these topologies:

e- (close), e+

e- (far), e+

e- (far)

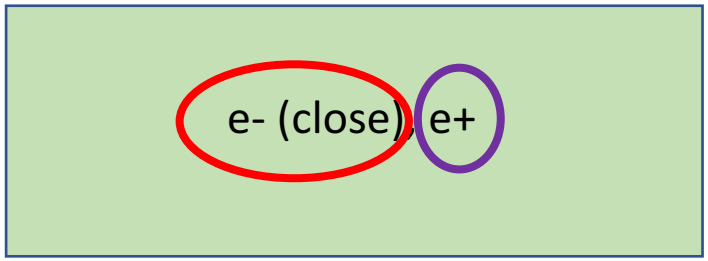
e- (close)

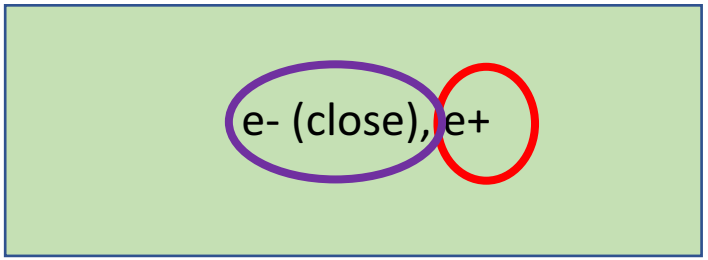
e+

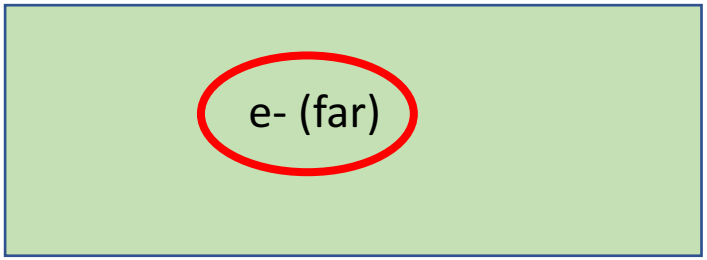
e- (close), e- (far)

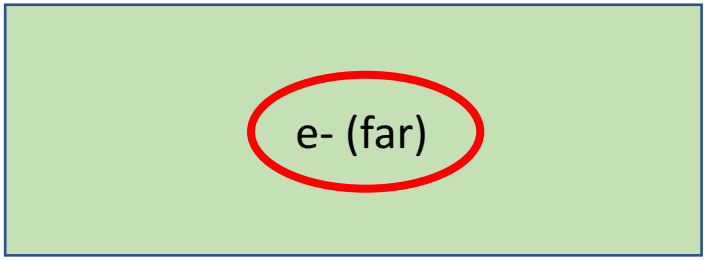
- Disambiguate the e- cluster using the cluster position in y.
- Consider each of these three cases with e+ top/bottom.

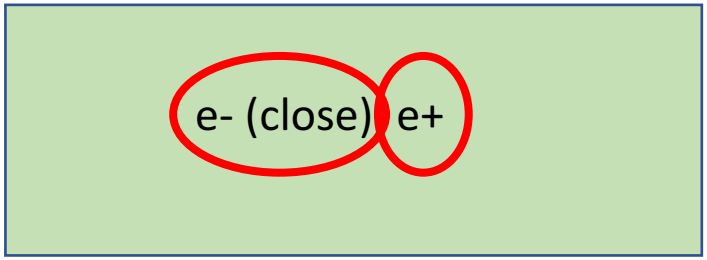
Tag and probe (slide shows 1 topology):

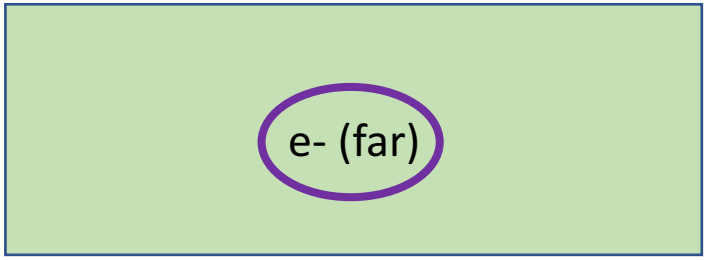










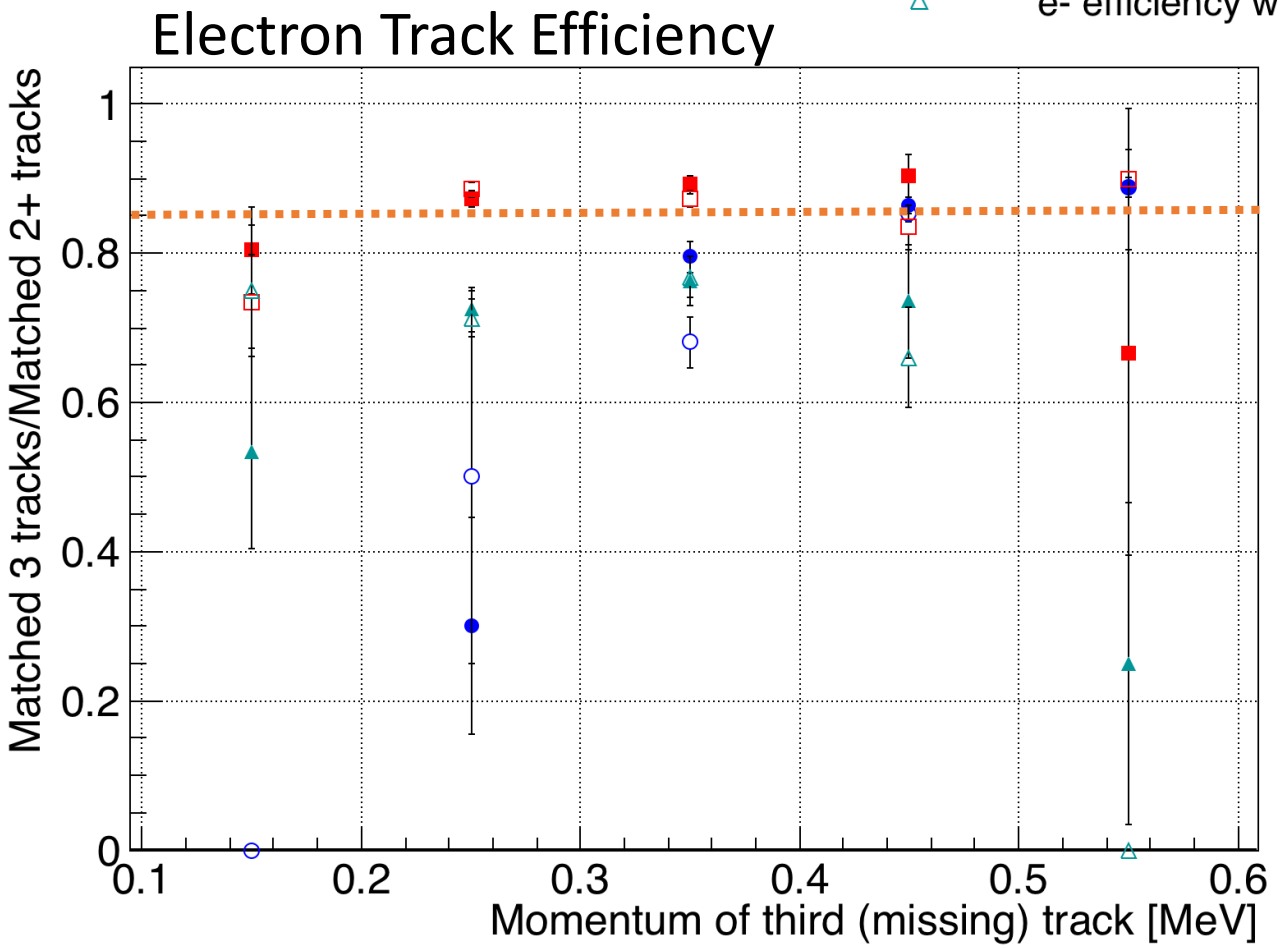


- Consider all combinations and keep top/bottom separate.

Tritrig-wab-beam-tri

(wab-beam-tri had not enough statistics)

- e- efficiency when alone in top half
- e- efficiency when alone in bot half
- e- efficiency when e+ in same top half
- e- efficiency when e+ in same bot half
- e- efficiency when e- in same top half
- e- efficiency when e- in same bot half



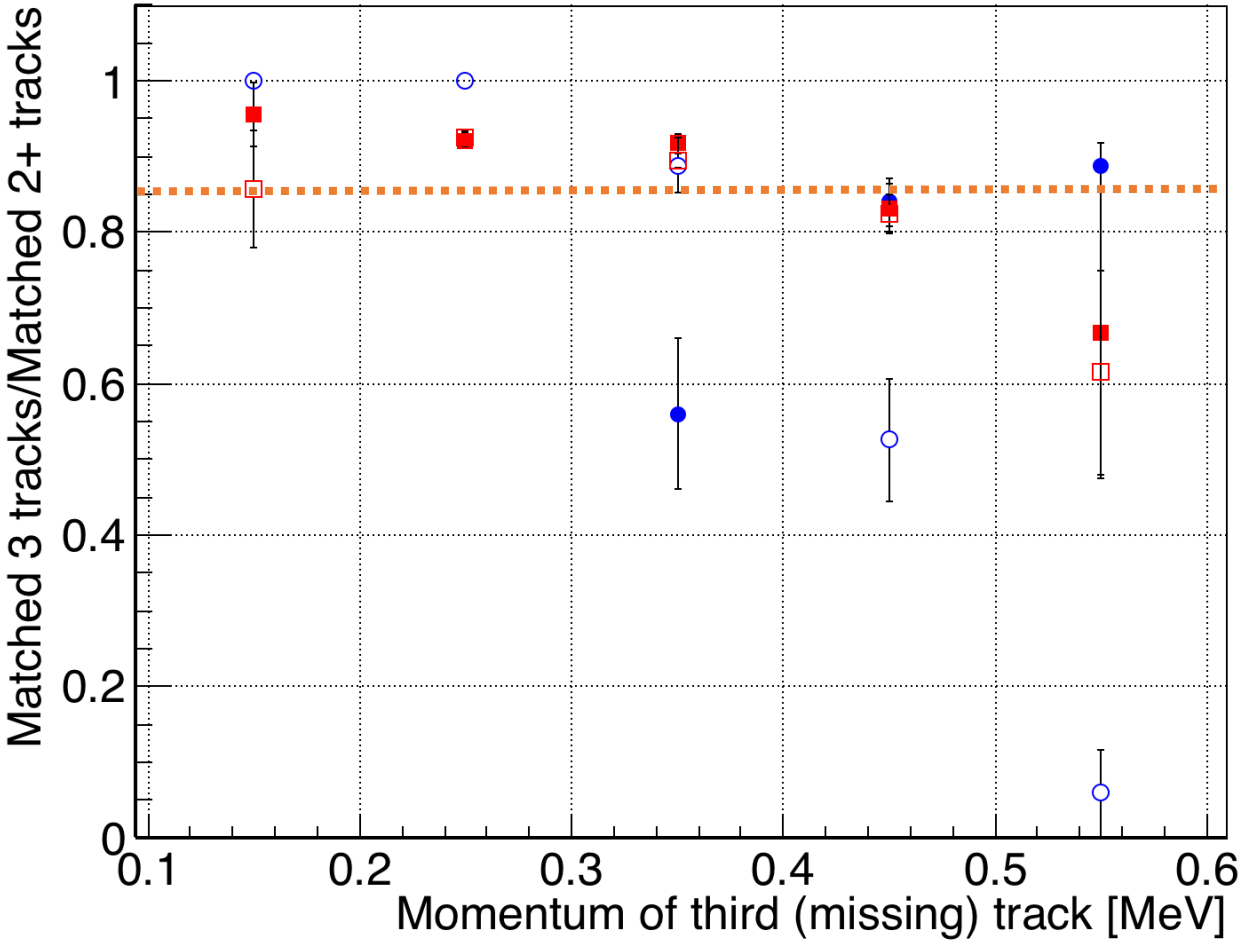
e+ efficiency when alone in top half

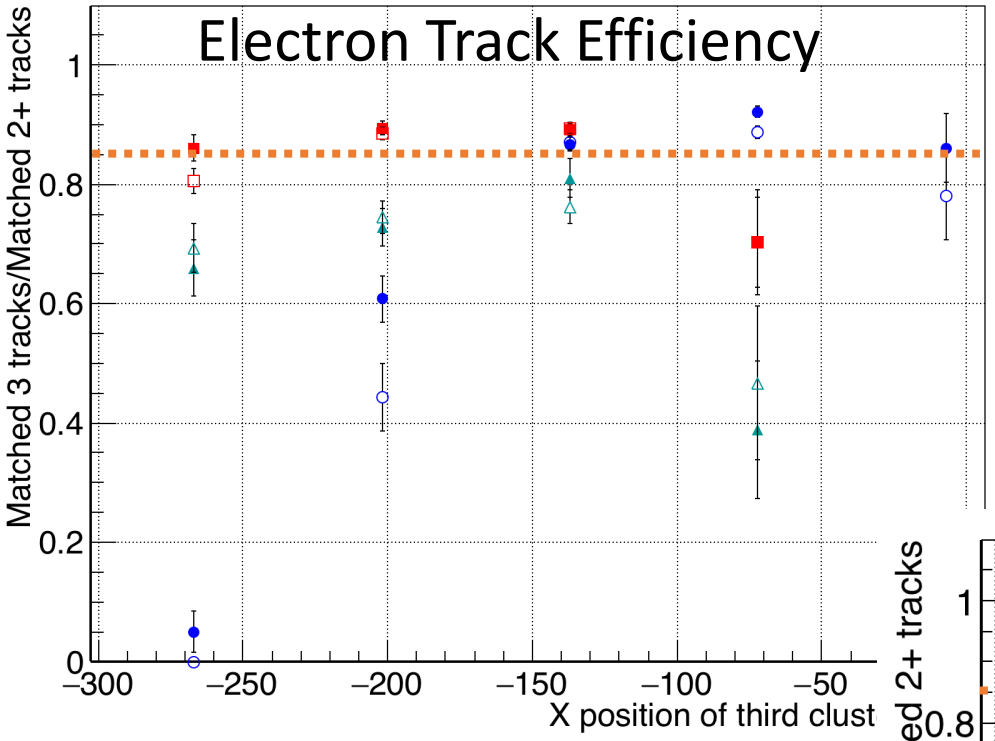
e+ efficiency when alone in bot half

e+ efficiency when e- in same top half

e+ efficiency when e- in same bot half

Positron Track Efficiency





- e- efficiency when alone in top half
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- e- efficiency when e+ in same top half
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- e- efficiency when e- in same top half
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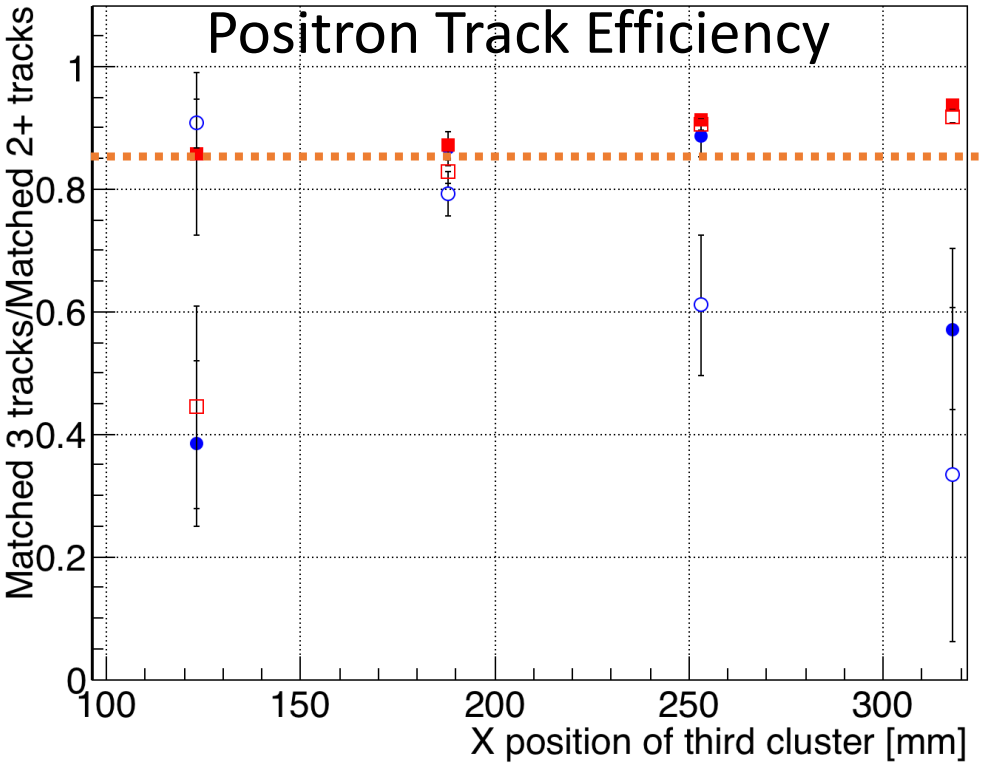
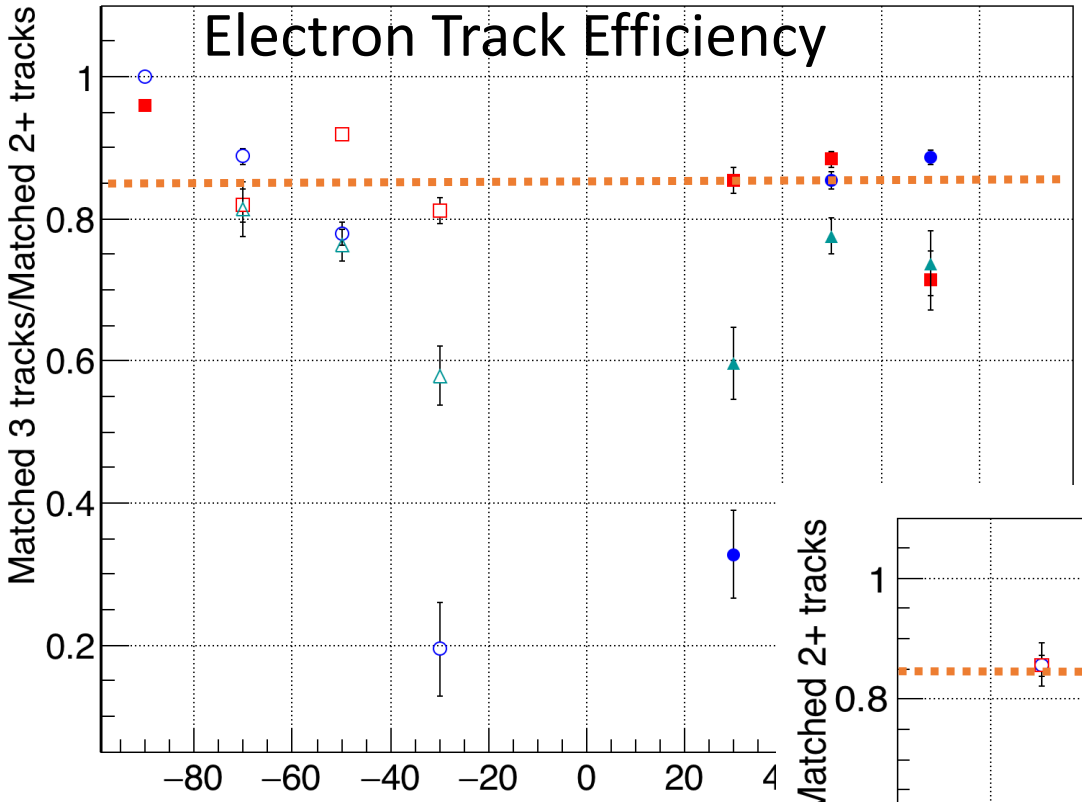
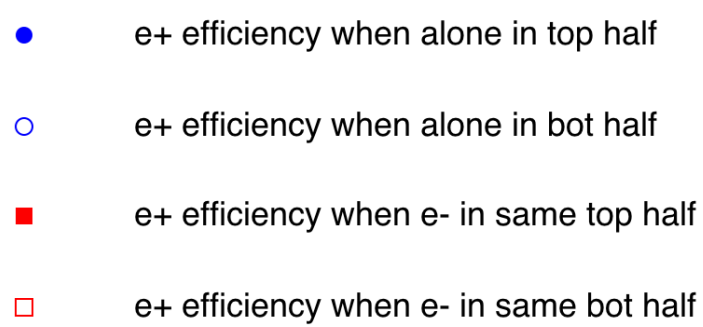
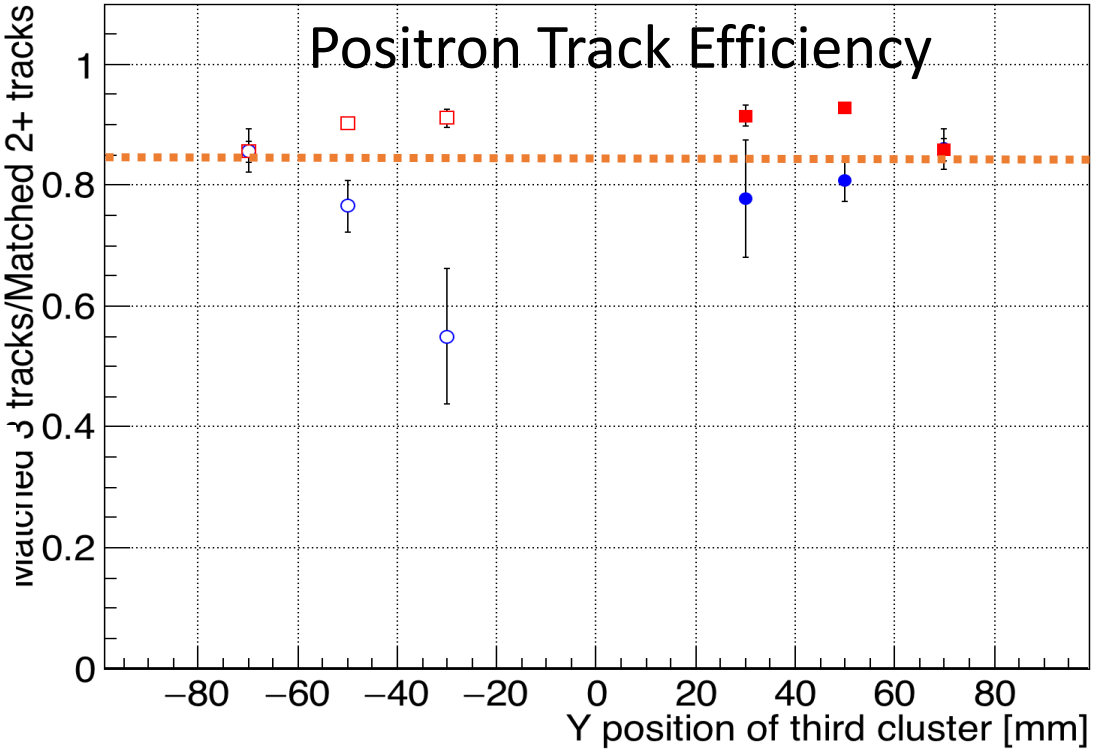


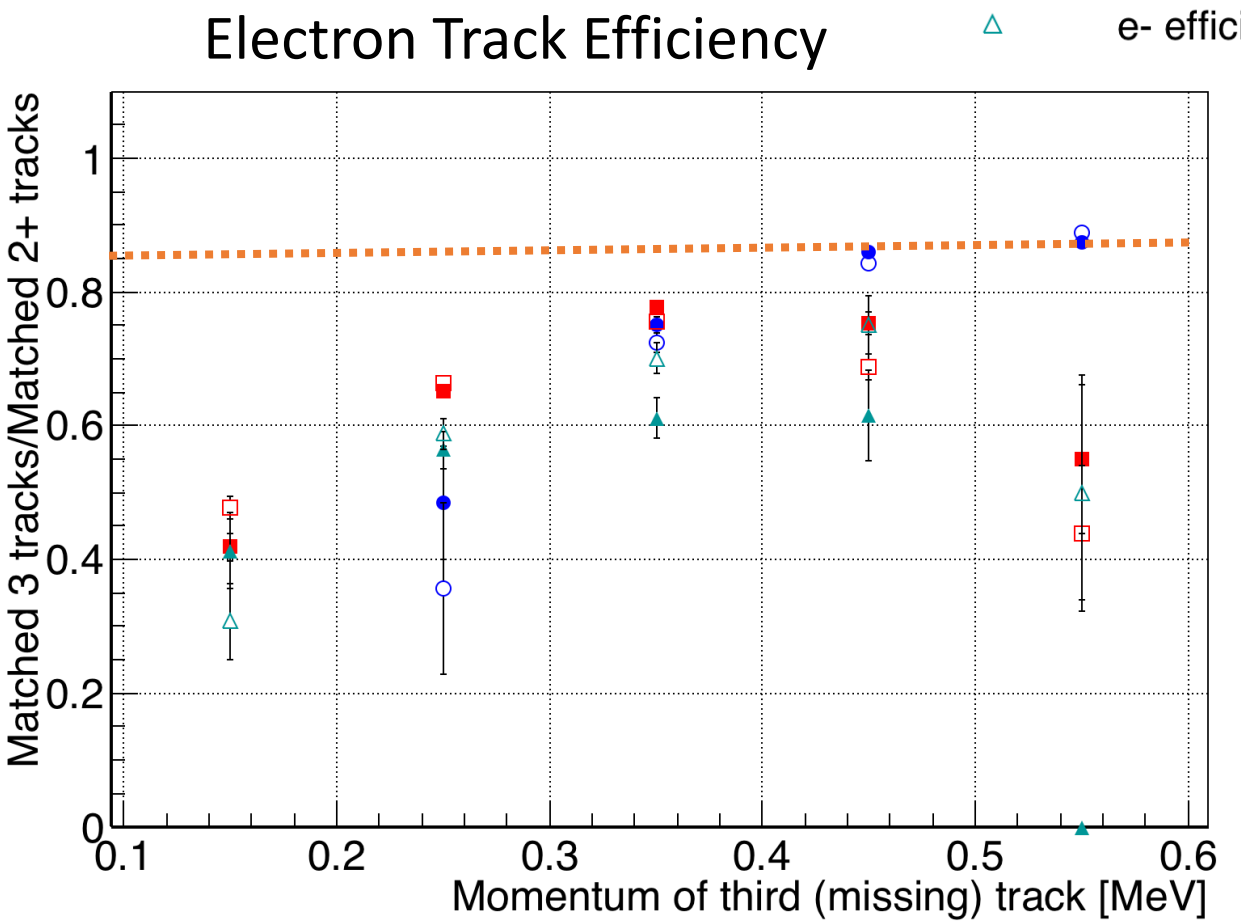
- e+ efficiency when alone in top half
- e+ efficiency when alone in bot half
- e+ efficiency when e- in same top half
- e+ efficiency when e- in same bot half


Electron Track Efficiency
Matched 3 tracks/Matched 2+ tracks
1
0.8
0.6
0.4
0.2
−80
−60
−40
−20
0
20
e- efficiency when alone in top half
e- efficiency when alone in bot half
e- efficiency when e+ in same top half
e- efficiency when e+ in same bot half
e- efficiency when e- in same top half
e- efficiency when e- in same bot half


e+ efficiency when alone in top half
e+ efficiency when alone in bot half
e+ efficiency when e- in same top half
e+ efficiency when e- in same bot half


Positron Track Efficiency
Matched 3 tracks/Matched 2+ tracks
1
0.8
0.6
0.4
0.2
0
−80
−60
−40
−20
0
20
40
60
80
Y position of third cluster [mm]

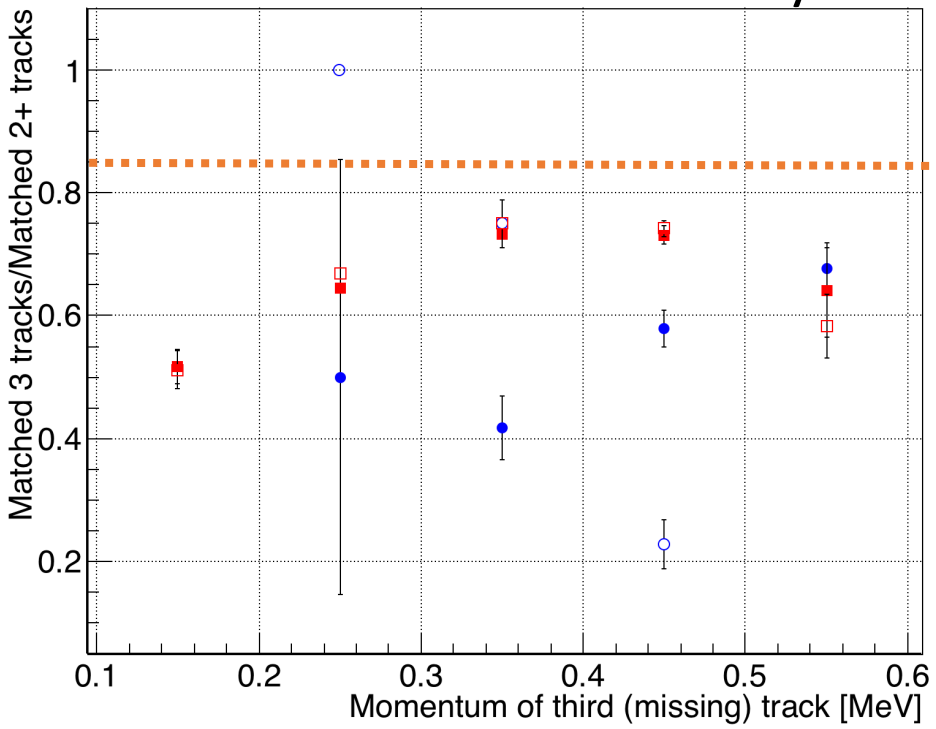
5772

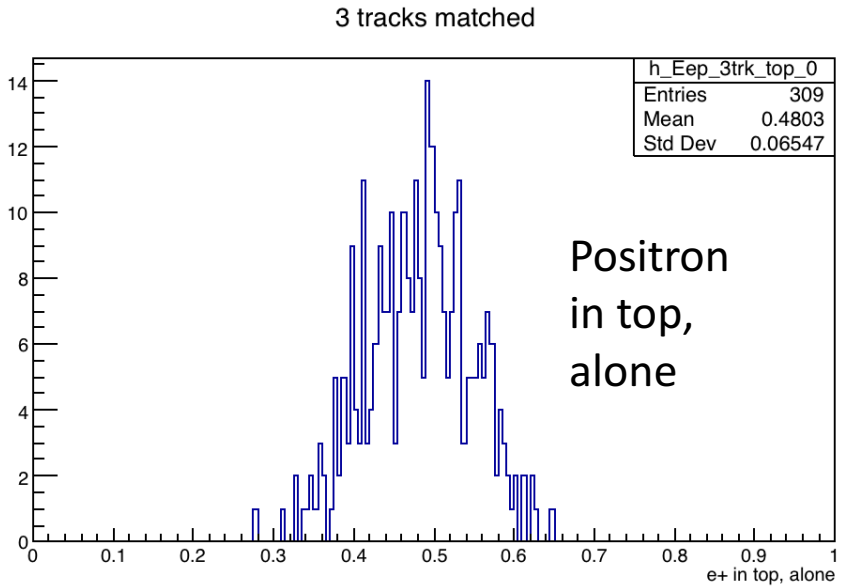

Electron Track Efficiency
e- efficiency when alone in top half
e- efficiency when alone in bot half
e- efficiency when e+ in same top half
e- efficiency when e+ in same bot half
e- efficiency when e- in same top half
e- efficiency when e- in same bot half
Matched 3 tracks/Matched 2+ tracks
Momentum of third (missing) track [MeV]
0
0.2
0.4
0.6
0.8
1
0.1
0.2
0.3
0.4
0.5
0.6

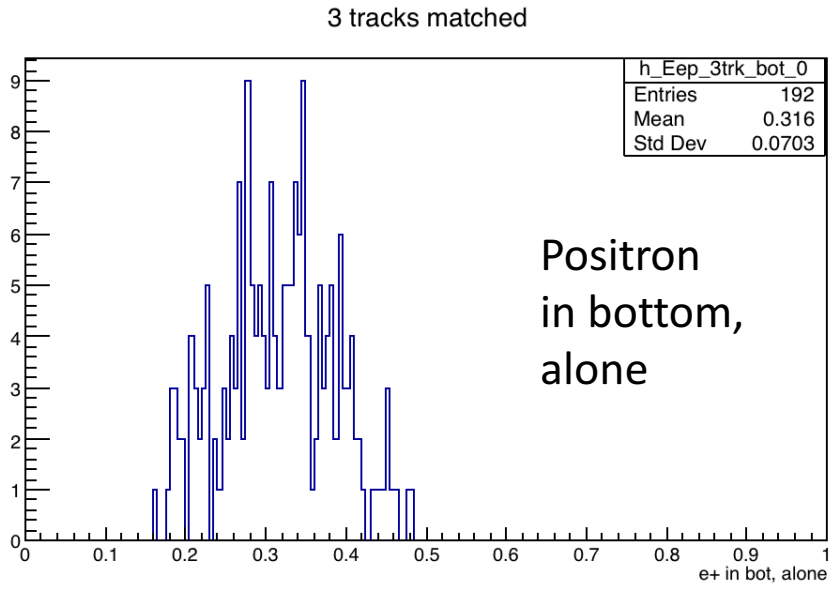
5772

- e+ efficiency when alone in top half
- e+ efficiency when alone in bot half
- e+ efficiency when e- in same top half
- e+ efficiency when e- in same bot half

Positron Track Efficiency







5772

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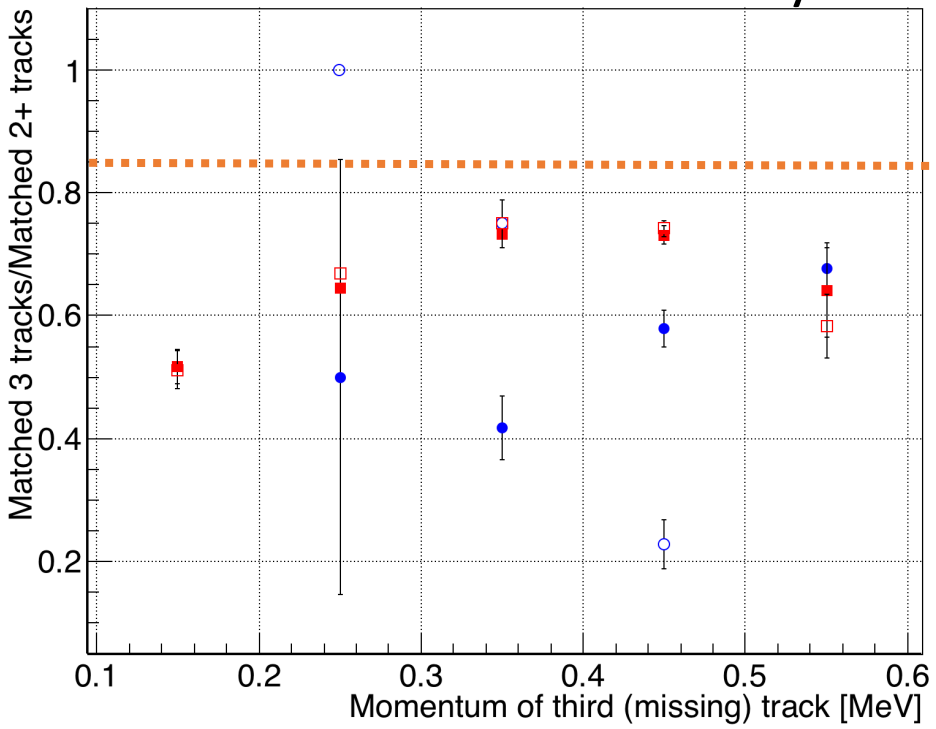
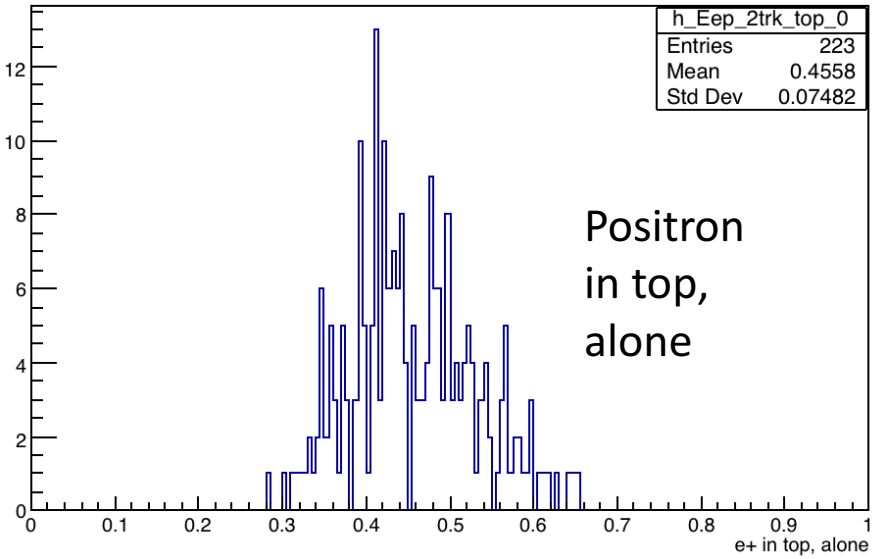
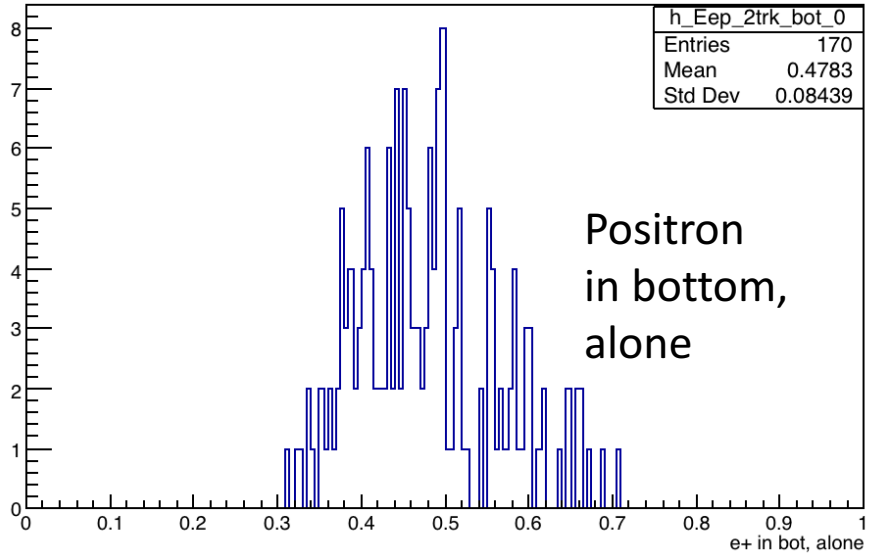
Positron Track Efficiency

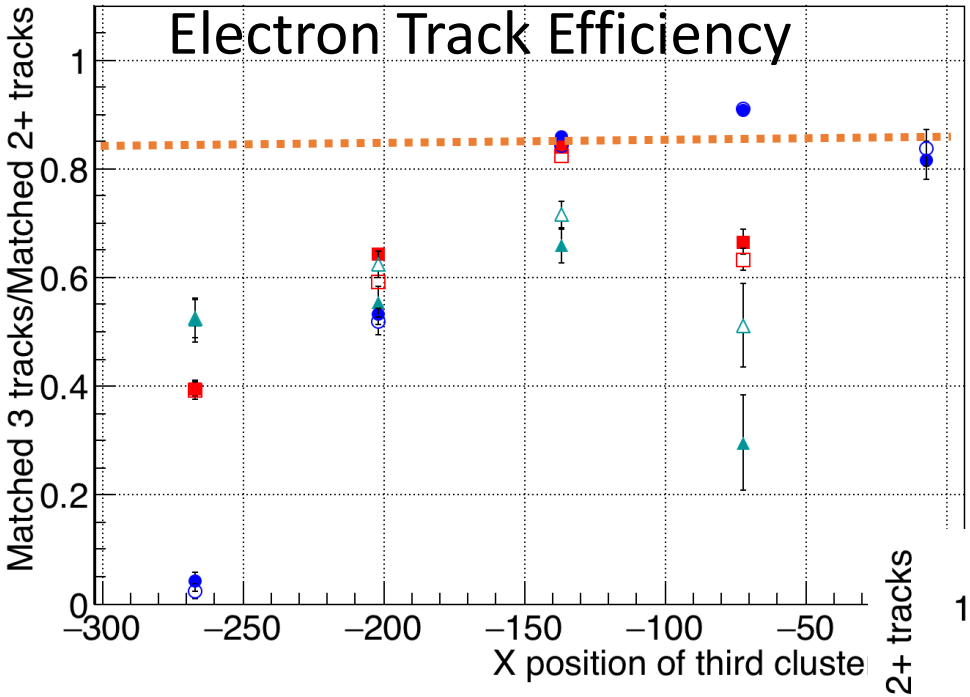


2 tracks matched



2 tracks matched





- e- efficiency when alone in top half
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- e- efficiency when e+ in same top half
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- e- efficiency when e- in same top half
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5772

- e+ efficiency when alone in top half
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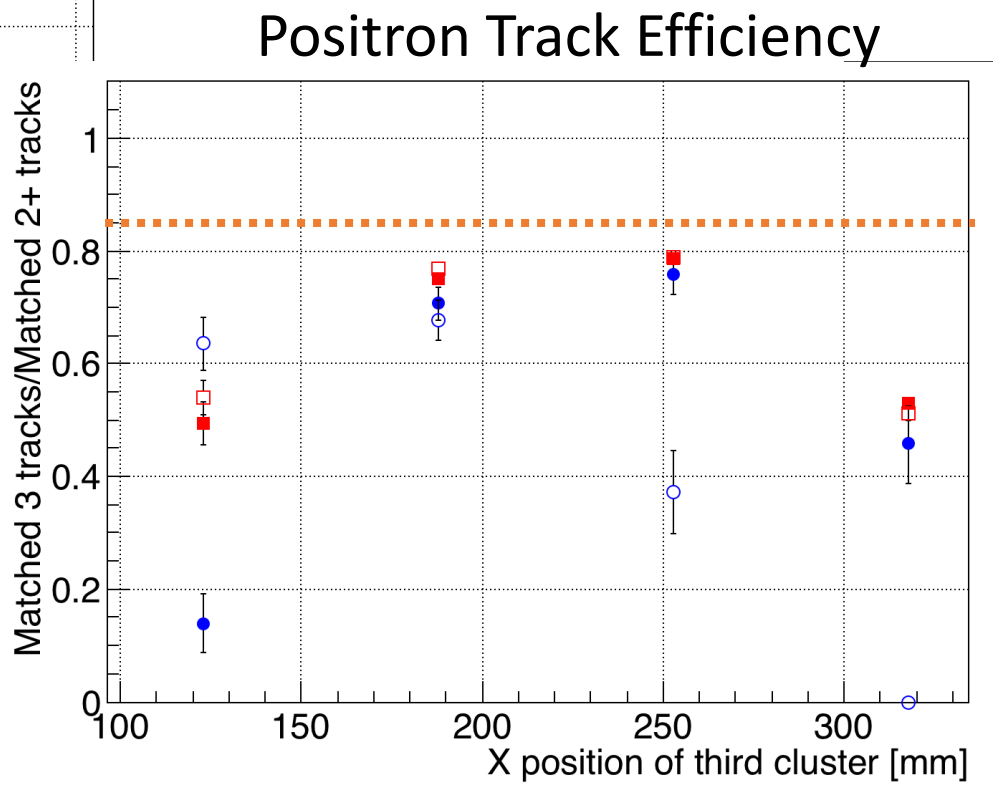

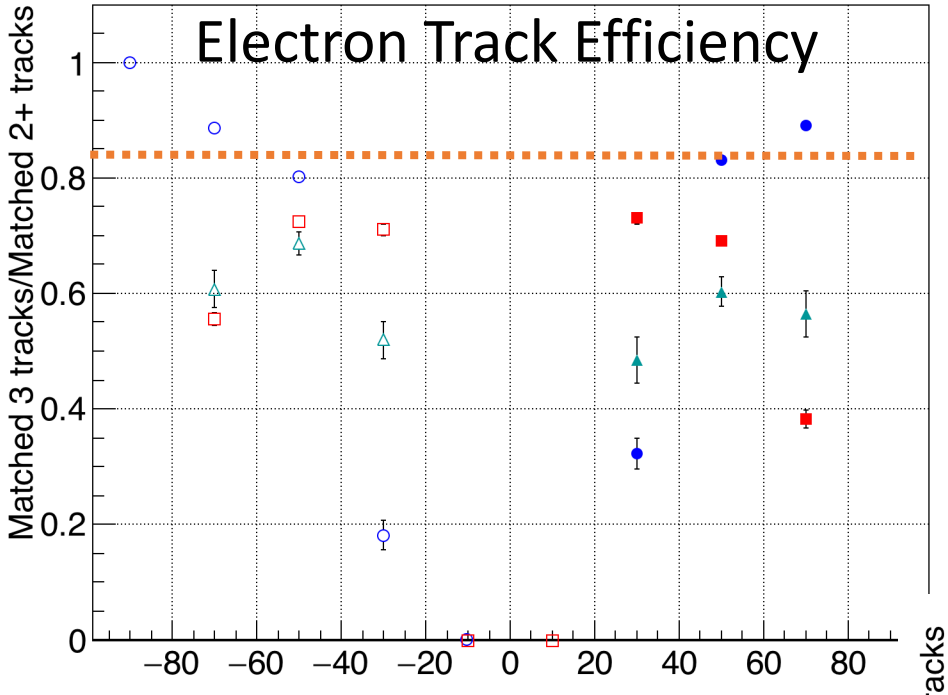

- e- efficiency when alone in top half
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- e- efficiency when e- in same bot half

5772

- e+ efficiency when alone in top half
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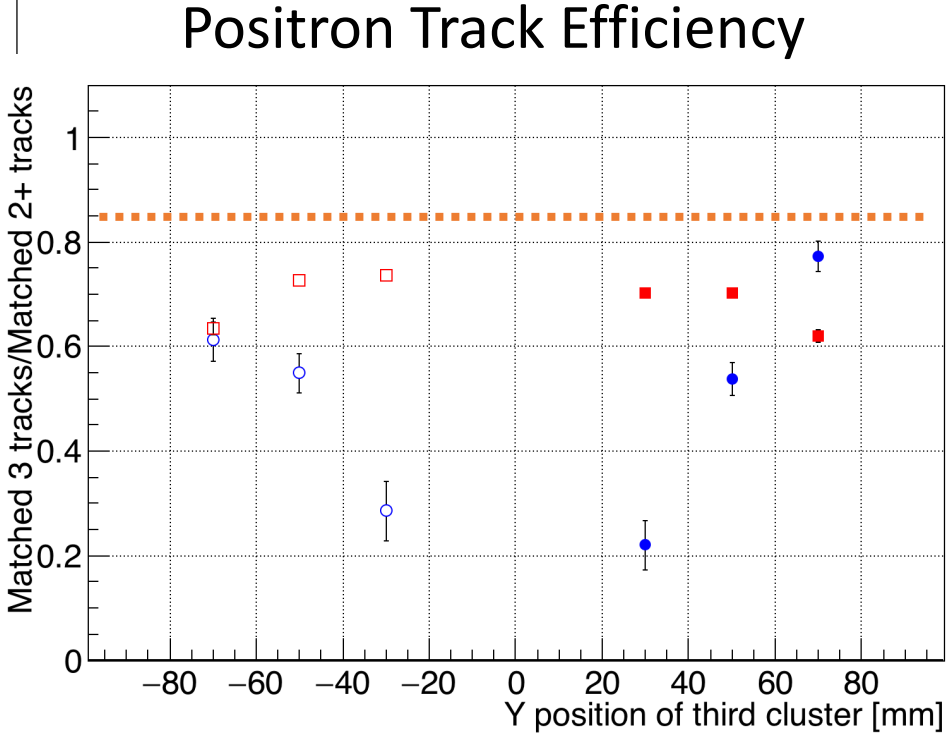
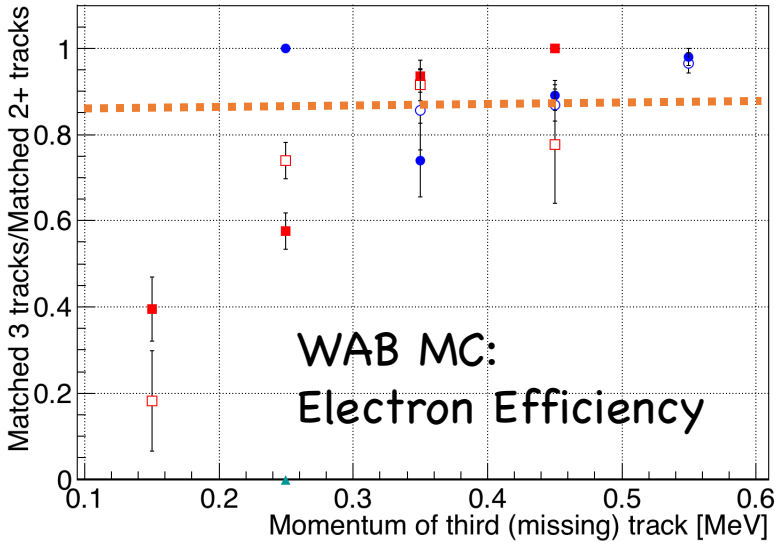
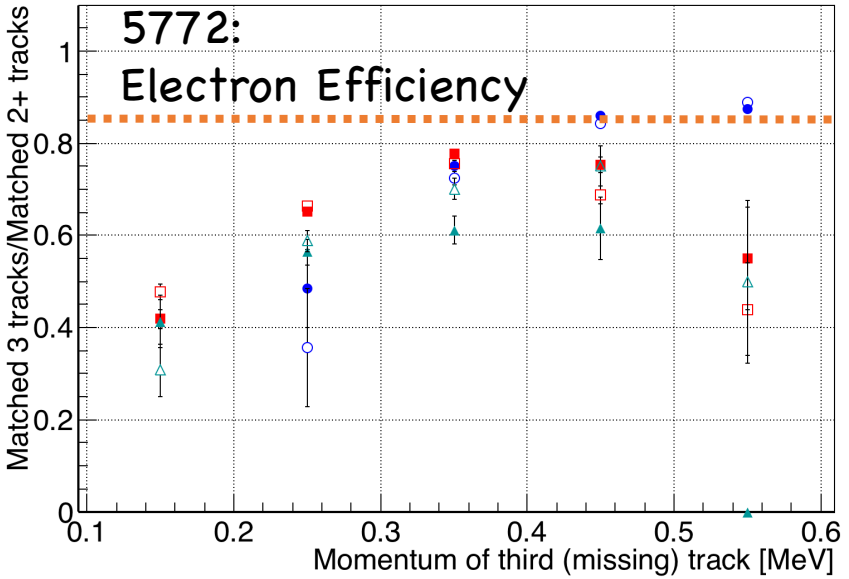
- e+ efficiency when e- in same bot half



WAB


WAB MC:
Electron Efficiency
Matched 3 tracks/Matched 2+ tracks
Momentum of third (missing) track [MeV]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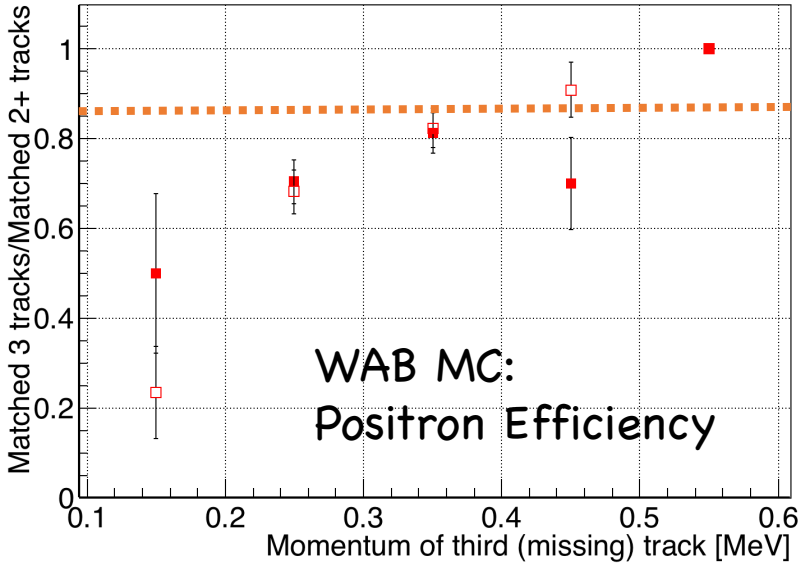
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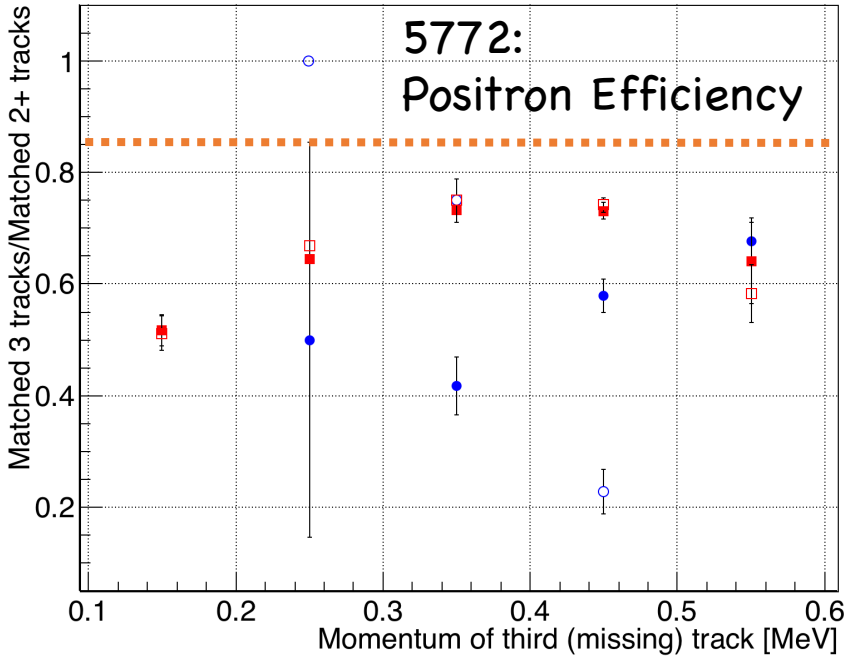
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Positron Efficiency
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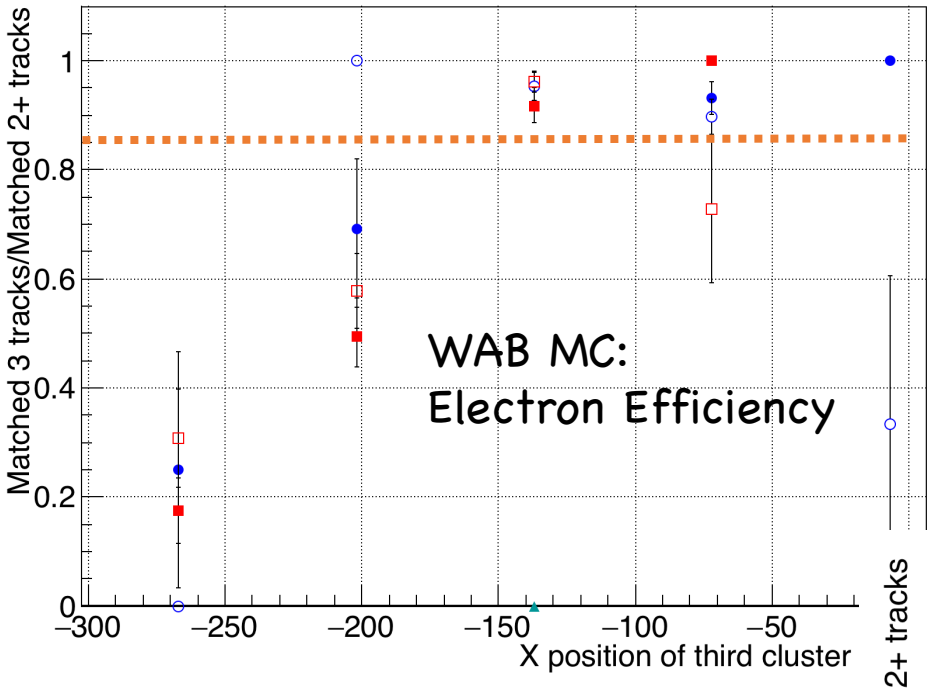

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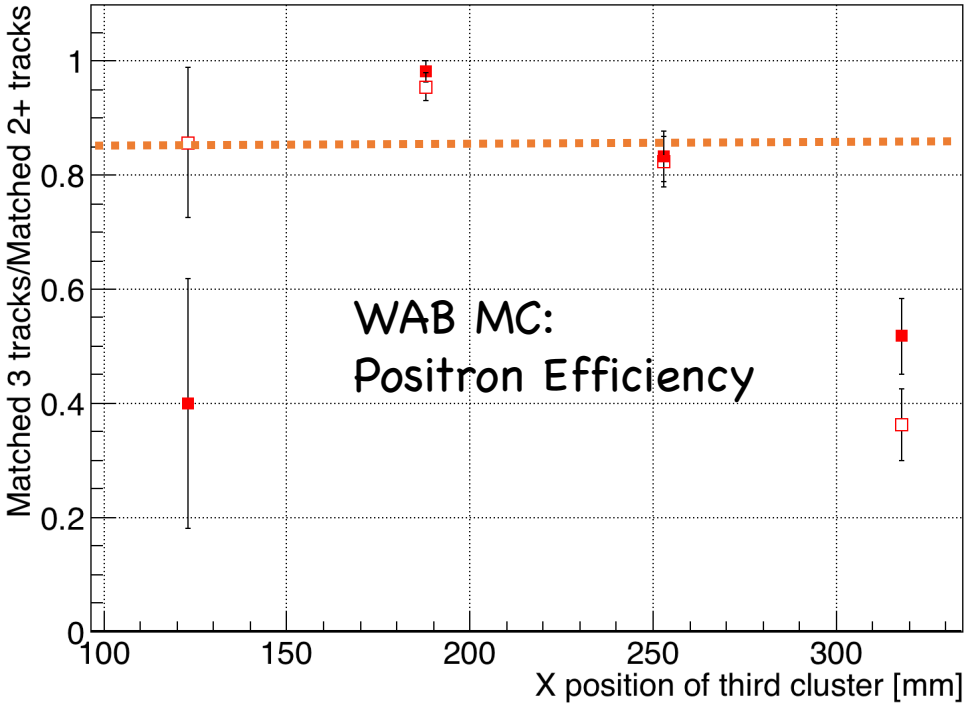
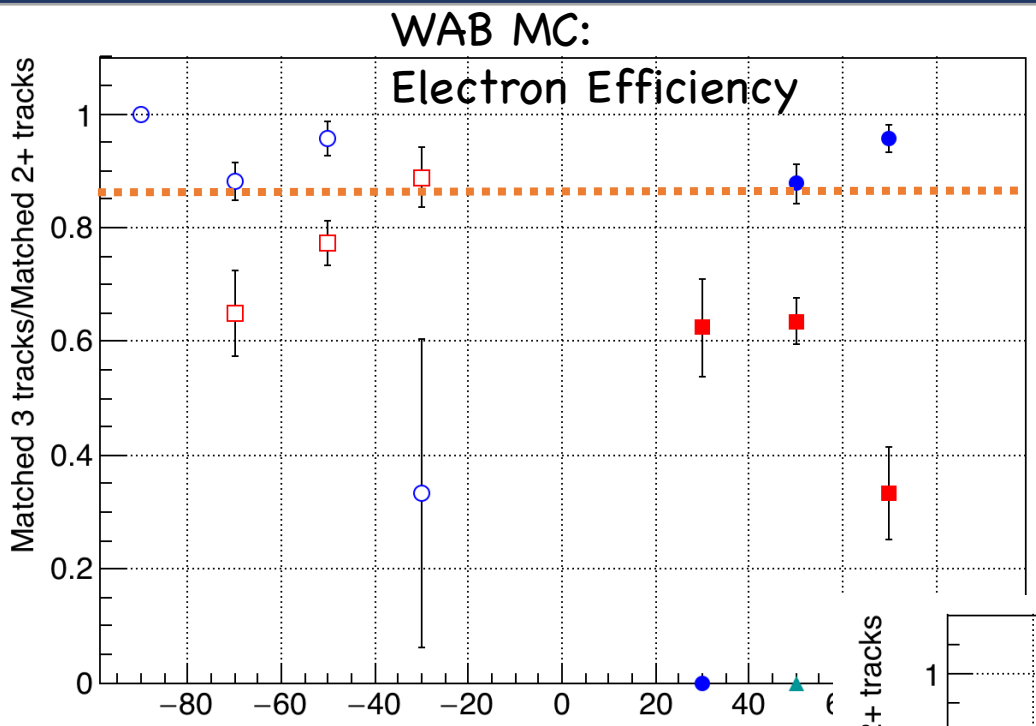
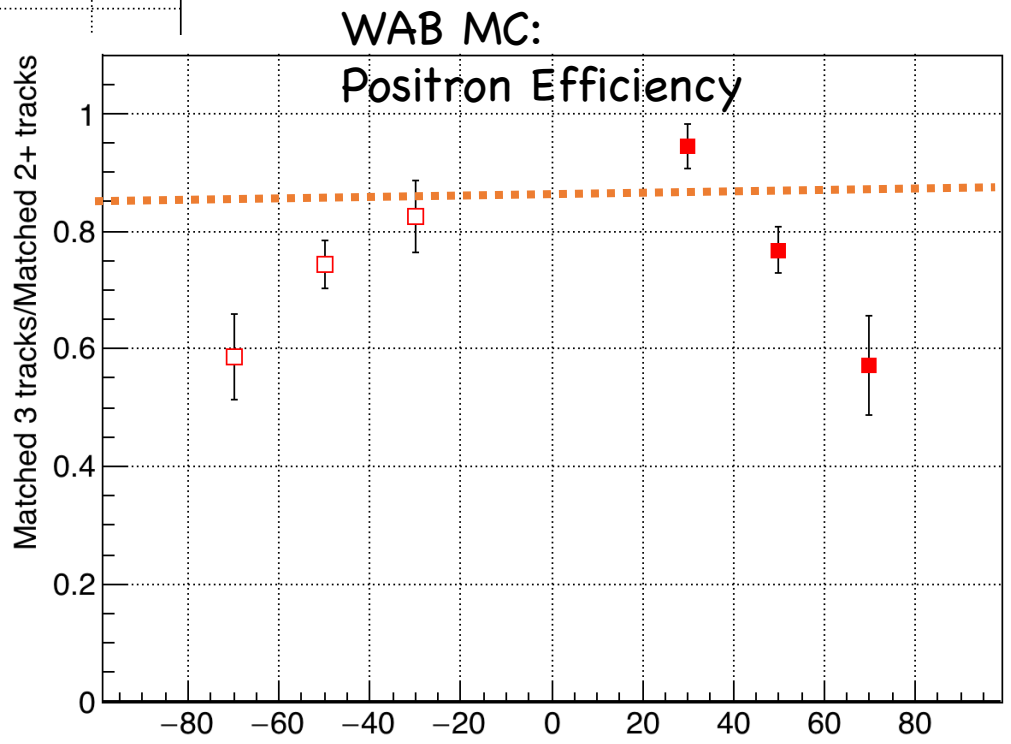
- e- efficiency when alone in bot half
- e- efficiency when e+ in same top half
- e- efficiency when e+ in same bot half
- e- efficiency when e- in same top half
- e- efficiency when e- in same bot half



- e+ efficiency when alone in top half
- e+ efficiency when alone in bot half
- e+ efficiency when e- in same top half
- e+ efficiency when e- in same bot half



- e- efficiency when alone in top half
- e- efficiency when alone in bot half
- e- efficiency when e+ in same top half
- e- efficiency when e+ in same bot half
- e- efficiency when e- in same top half
- e- efficiency when e- in same bot half



- e+ efficiency when alone in top half
- e+ efficiency when alone in bot half
- e+ efficiency when e- in same top half
- e+ efficiency when e- in same bot half

Conclusions:

- Three particle final state events probably mostly WABs
- Efficiencies could by systematically low in regions by 5-10%
- Don’t see huge top/bottom difference
- Need to run over more data
- Difficult to find clear correction with 3 prong events
- Being able to vertex 3 tracks could help (and useful to vertex analysis tail studies)