

Horn Off Samples

Why we want more

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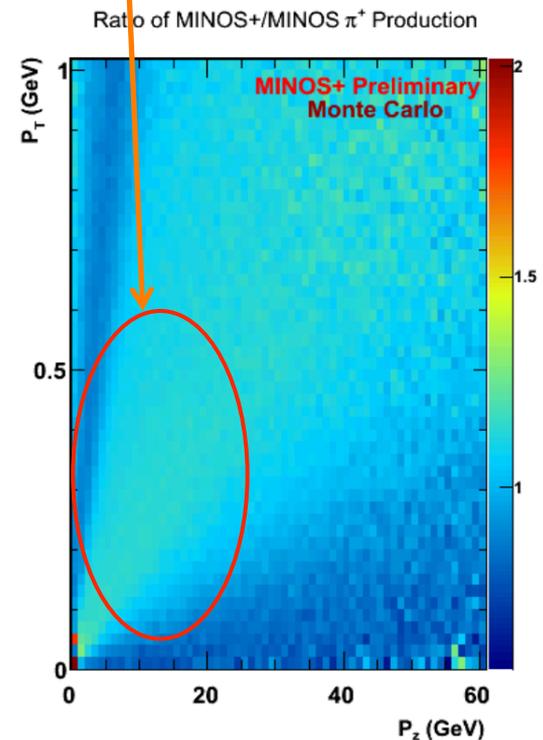
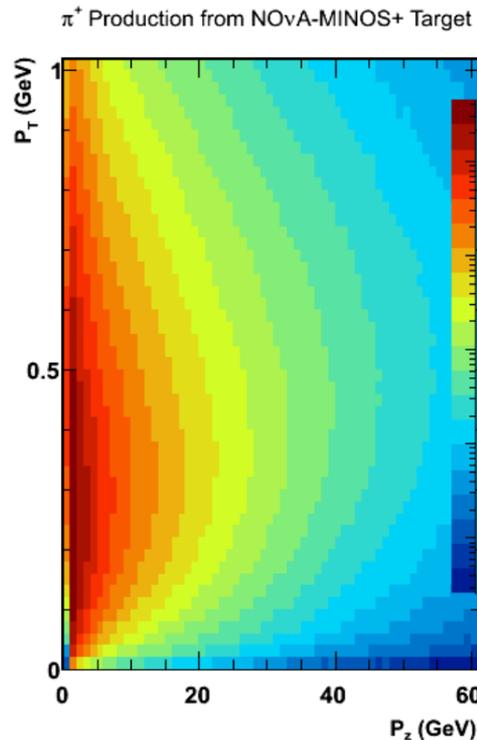
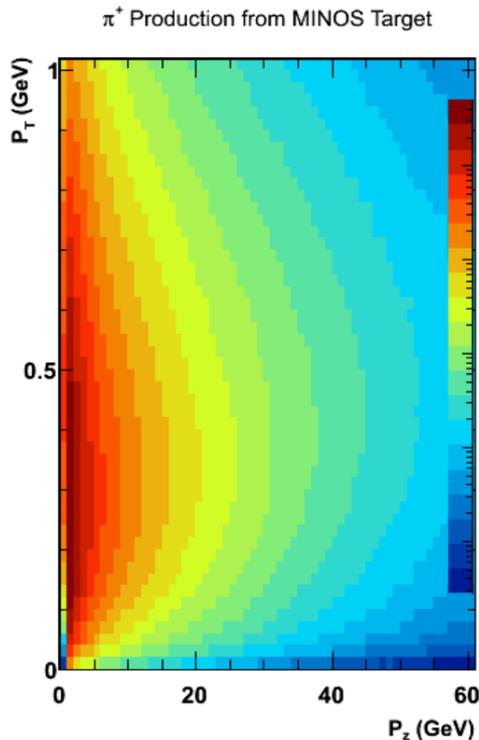
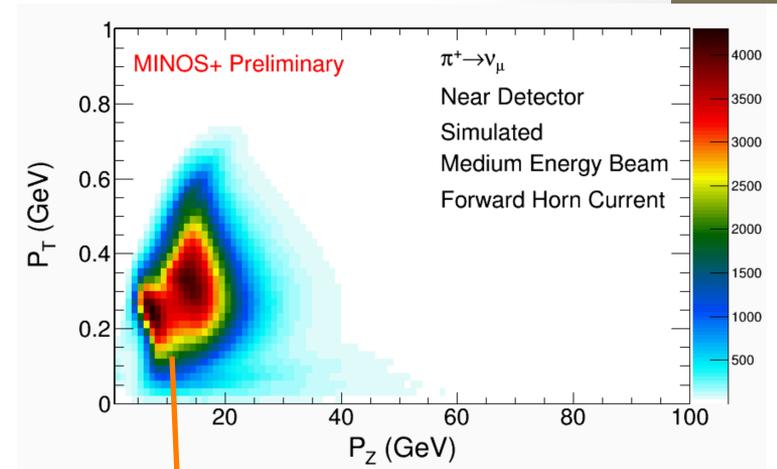
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Introduction - Horn Off

- We have a new target with different hadron production
- Horn Off is essentially only affected by hadron production off the target (and neutrino cross-section on iron + detector acceptance)
- So no focusing effects
- Differences in Old v New NuMI target should be visible
- Also look at weird Horn Off features...
 - Data POT for LE Run 1 and Run 2 $\sim 2.5e18$
 - Data POT for LE Run 3 $\sim 6.5e18$
 - Data POT for ME Horn Off $\sim 6e18$

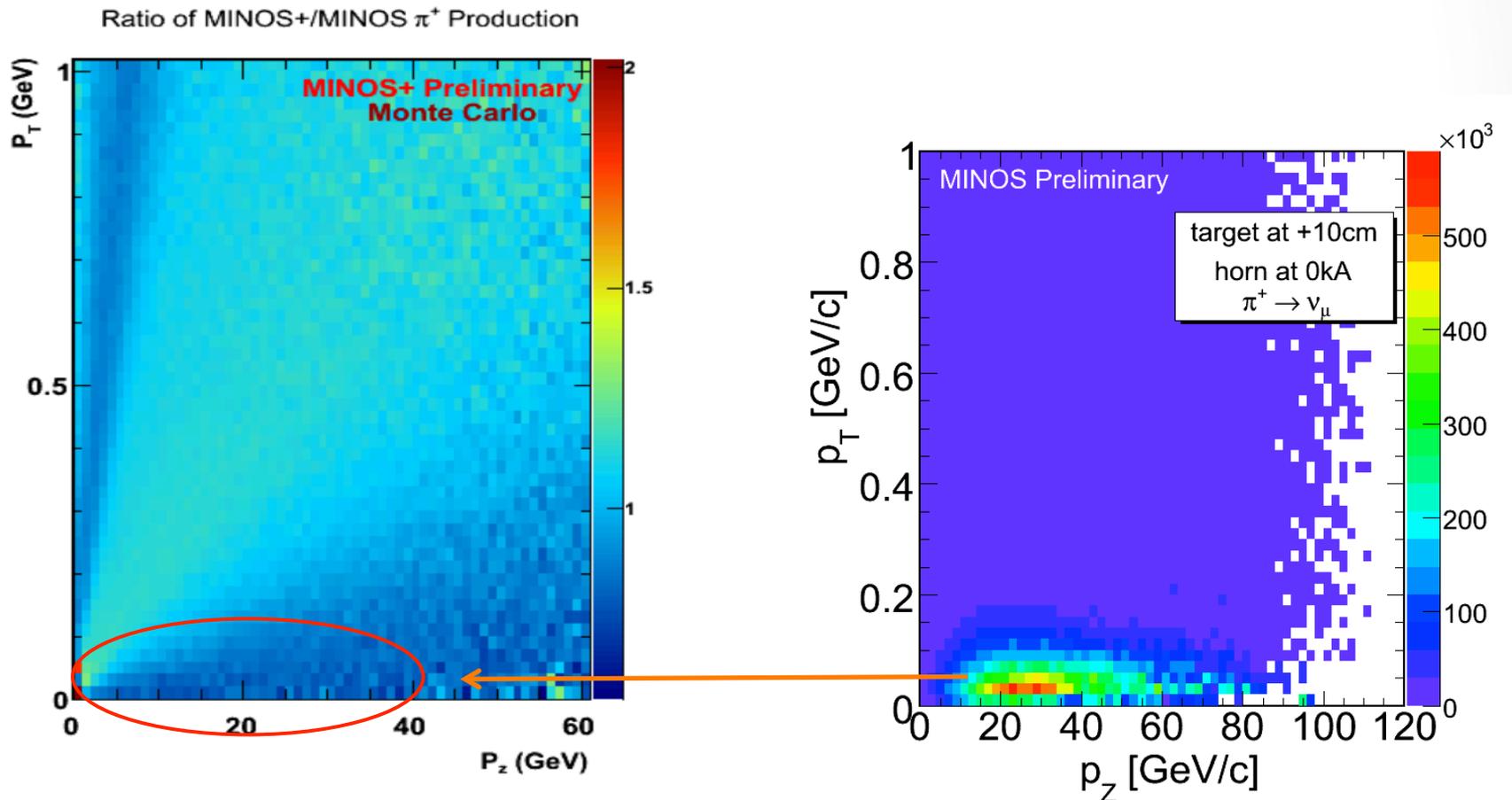
Old v New Target

- Just plotting from MC can see that there are differences between new and old target for the hadron production
- They are not trivial, 10-20% in ME beam phase space



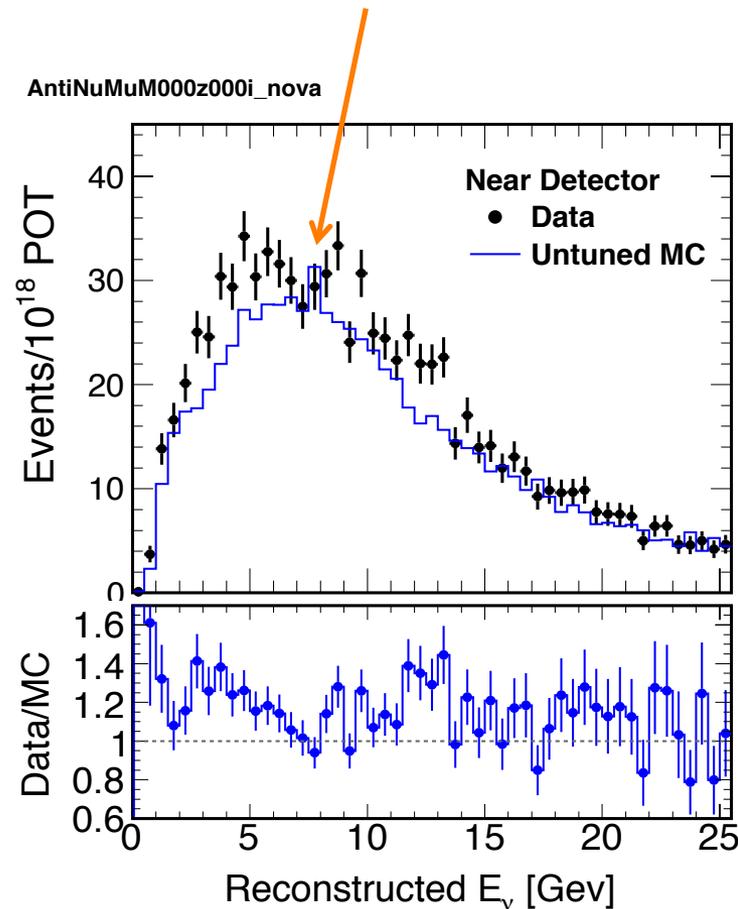
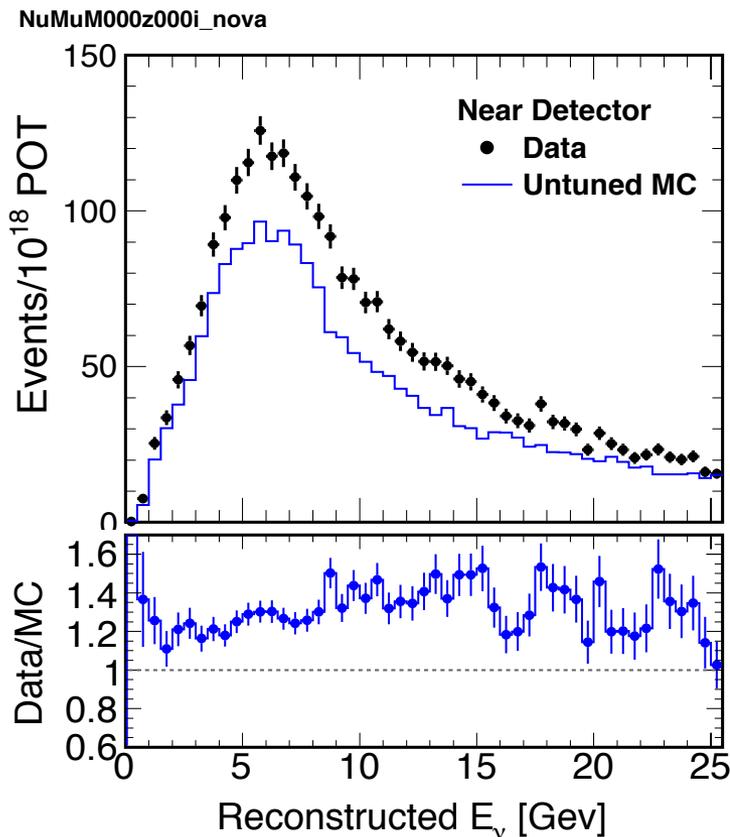
Old v New Target – Horn Off

- We expect to see less horn off data / same POT for the new target (although reconstruction differences and selection cut differences affect this obviously)
- Horn off events are clustered at low p_T



Horn Off Samples in ME Beam

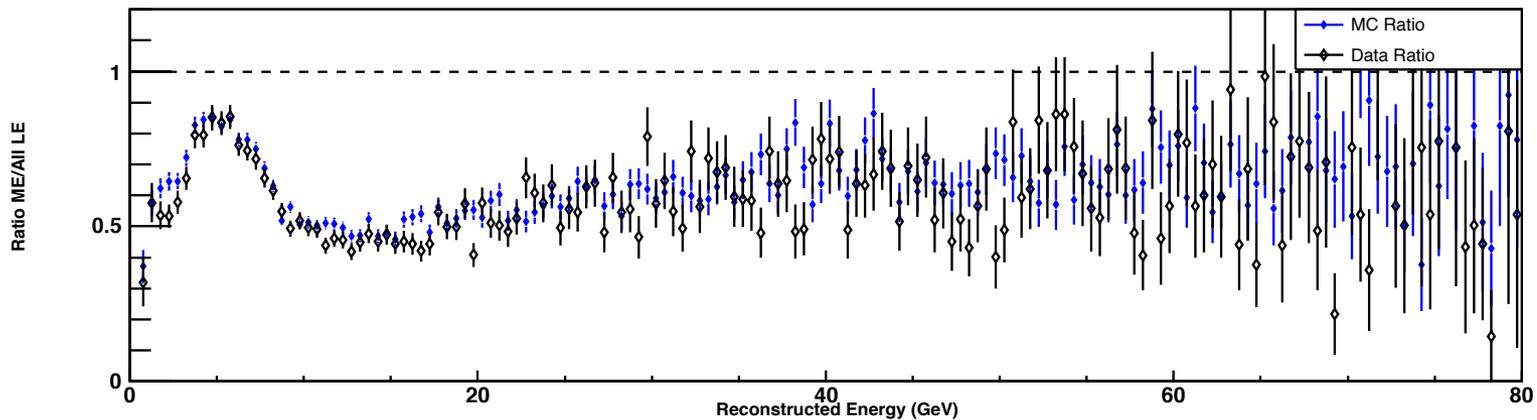
- MINOS+ Horn Off Sample MC definitely undershoots and we see more data
- Almost like a normalisation effect!
- But there also appears to be a dip feature in the AntiNuMu sample, but low stats



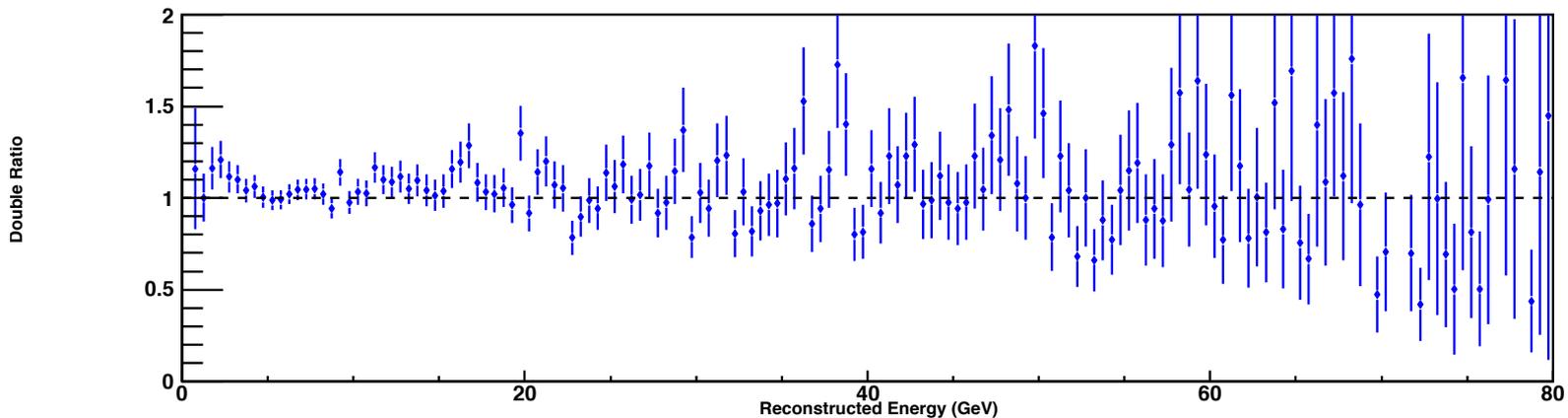
Ratio of ME/LE Horn Off - Data v MC

- Has the target hadron production changed the way we think it has?
- Not in the Low E region – up to 20% differences between data / MC

Ratio of ME/All LE



Double Ratio MC/Data ME/LE



Why do we want more Horn Off?

- Horn Off is key to fitting hadron production in the beam fits
- Change in target has affected data and MC Horn Off differently in Low E
- We would like more statistics, especially for the NuMuBars, for the beam fits
- Also a weird dip in NuMuBar Horn Off spectrum – would want to find out whether this is real – if so then it is NOT modeled by the MC
- Horn Off is also used in appearance analyses – Horn On/Off method – to decompose the ND data spectrum into its sub-components for extrapolating – higher statistics help here
- NOvA think they do not need Horn Off, but it may prove useful if the Horn On data throws up something weird that is not understood
- I would recommend that we should try and take at least about 1-2 weeks of extra Horn Off data if we can