# burn sample vs mc check

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(Dated: March 13, 2022)

To study the self-veto effect, We did data MC check based on pass2 11 year burn sample and pass2 MC simulation (muongun+nugen). The result shows, due to low statistic of data when we use small zenith and energy bin size we can not decide the best muon energy threshold for self-veto. The best way to decide it so far is to use [-1,0.2,0.6,1] as zenith bins and it indicates that 1000 GeV is the best value. At the same time, we found that the zenith distribution of up-going cascade events has a mismatch between MC and data.This problem also shown in previous pass1 cascade analysis. We tried to retrain the bdt to solve this problem, but it failed. Since we do not use zenith bins as fine as this, we purpose to leave it there at this moment.

## CONTENTS



## I. INTRODUCTION

During the unblinding of cascade sample, reviewer (Shigeru) concerned about the self veto. So he suggested to do a burn sample vs MC check. Here is the related results.

## II. UNCERTAINTY FROM SELF VETO MUON ENERGY THRESHOLD

In this section, we show the effect of different self-veto muon energy thresholds on final cascade sample.

### A. energy distribution all sky

Figure 1 shows the energy distribution of cascade sample. Muon energy threshold has a larger effect at relatively high energy part. But the effect is relatively small comparing with the disagreement of second bin from right.

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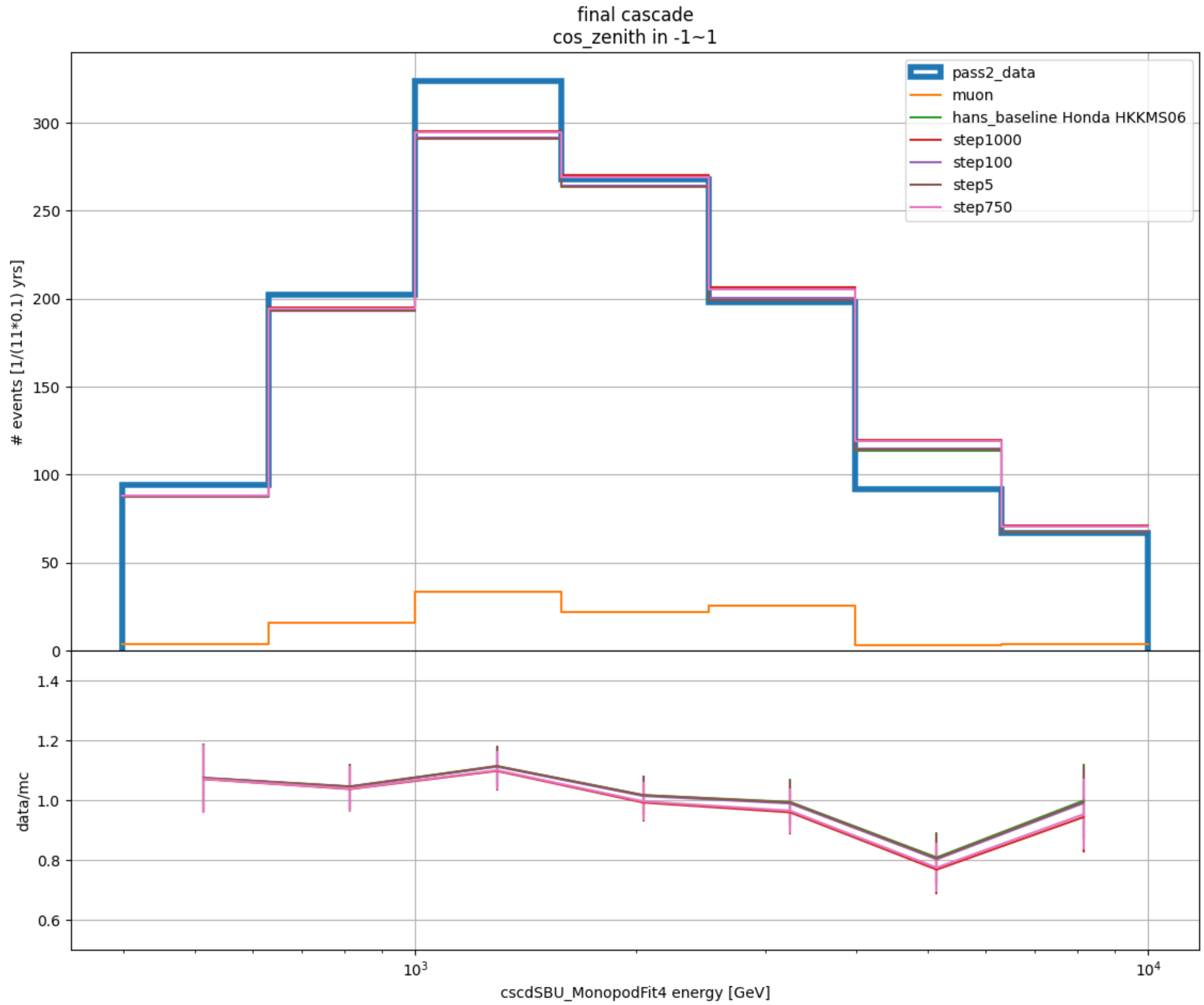



FIG. 1

### B. energy distribution in zenith bins

As for the energy distribution in zenith bins, it is shown in figure 2. According to the plots, following conclusion could be made:

- self-veto is more important for down-going events.
- if we use too many bins, the bin size get smaller and the statistic uncertainty gets larger and we can not chose a proper muon energy threshold from this plot.

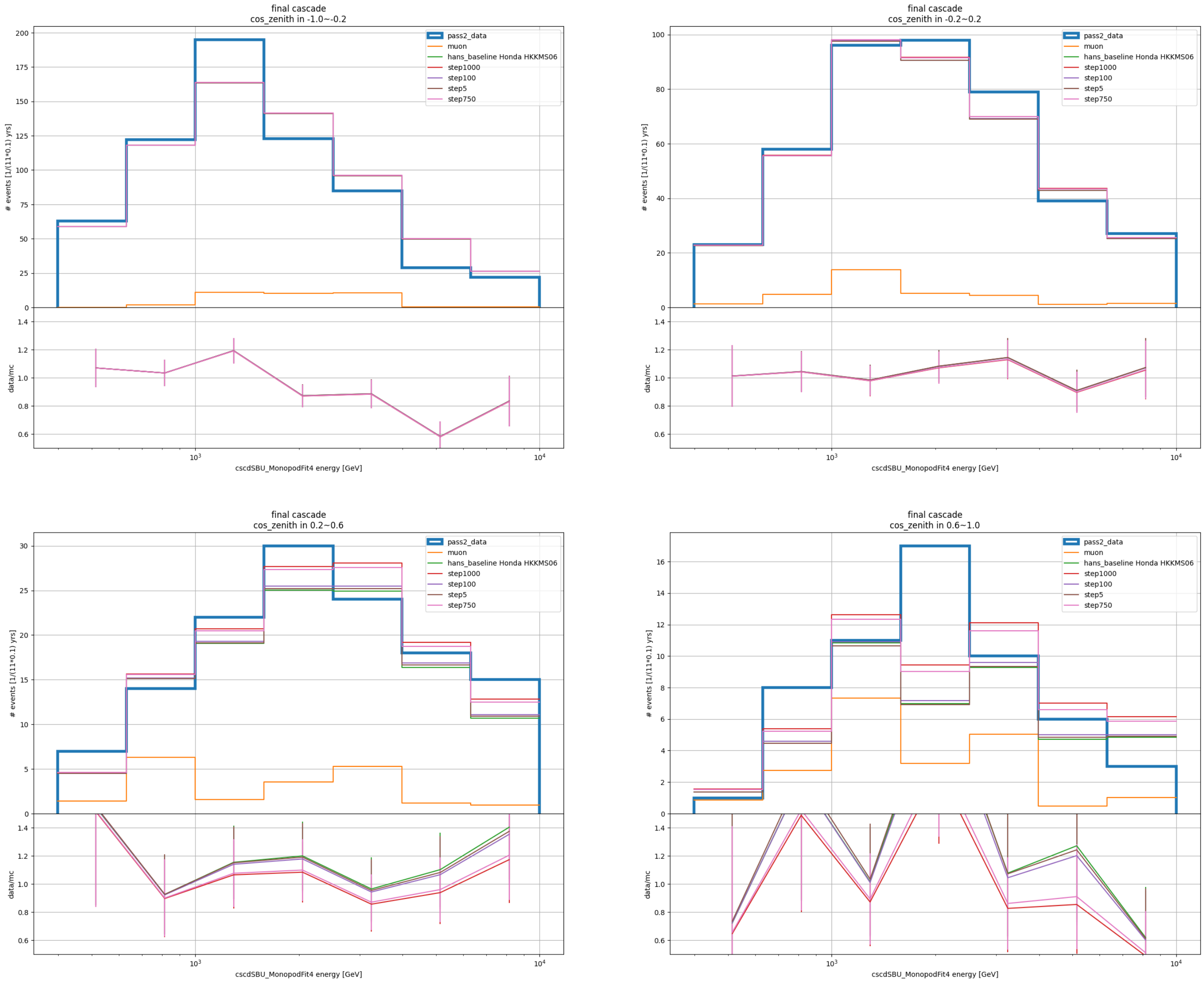



FIG. 2

### C. energy distribution in depth bins

Energy distribution is also split into depth bins. According to figure 3, events below and above dust layer show similar sensitivity to muon energy threshold of self-veto.

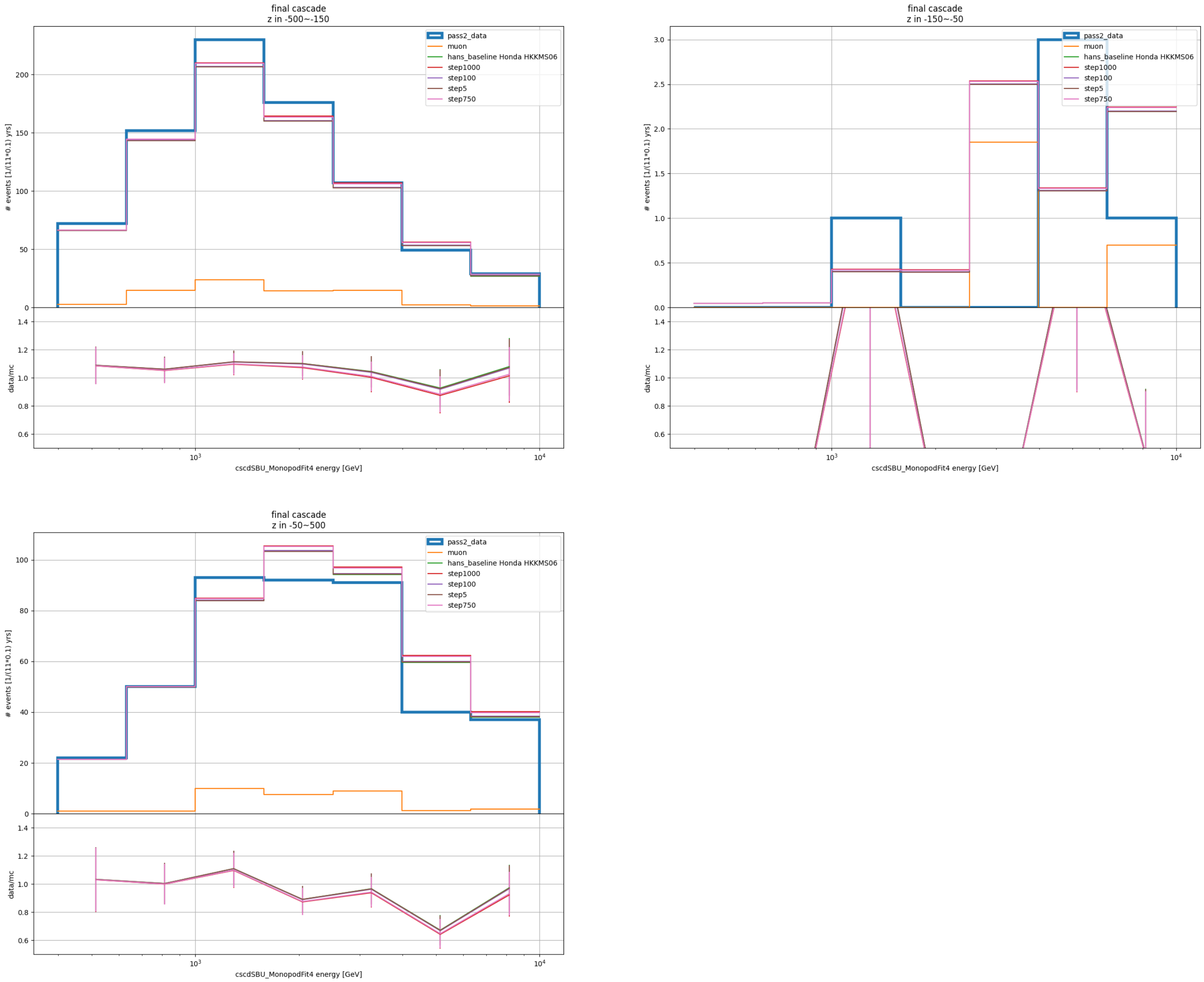



FIG. 3

### D. cos zenith distribution all sky

Figure 4 shows the zenith distribution of cascade sample. Consistent with previous conclusion, down-going events is more sensitive to self-veto. But since the very large uncertainty for down-going events and limited angular resolution, we can not decide the proper muon energy threshold from this plot. The best way to decide muon energy threshold is to increase the bin size, which turns to figure 5. And it indicates that 1000 GeV is a proper choice.

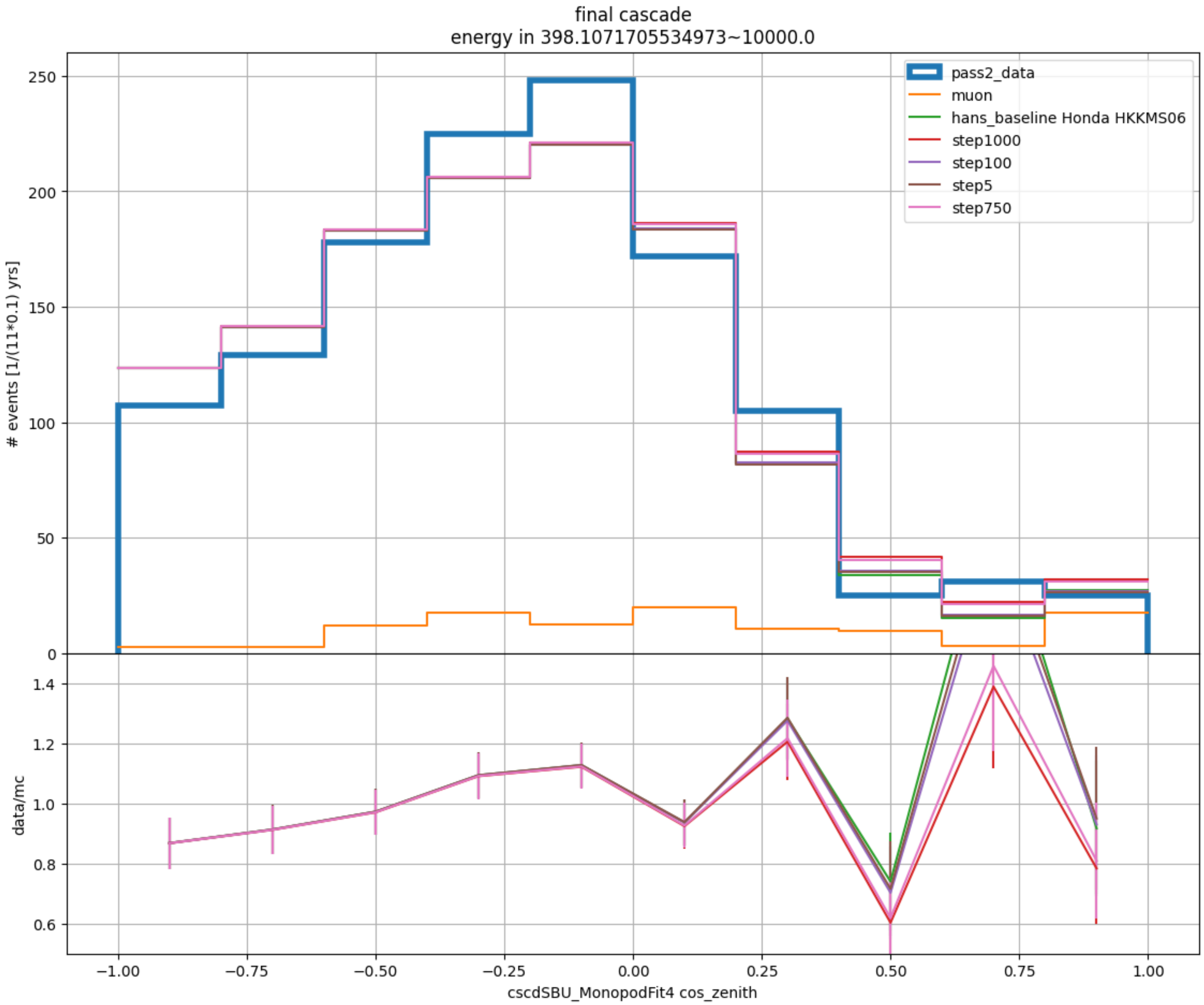
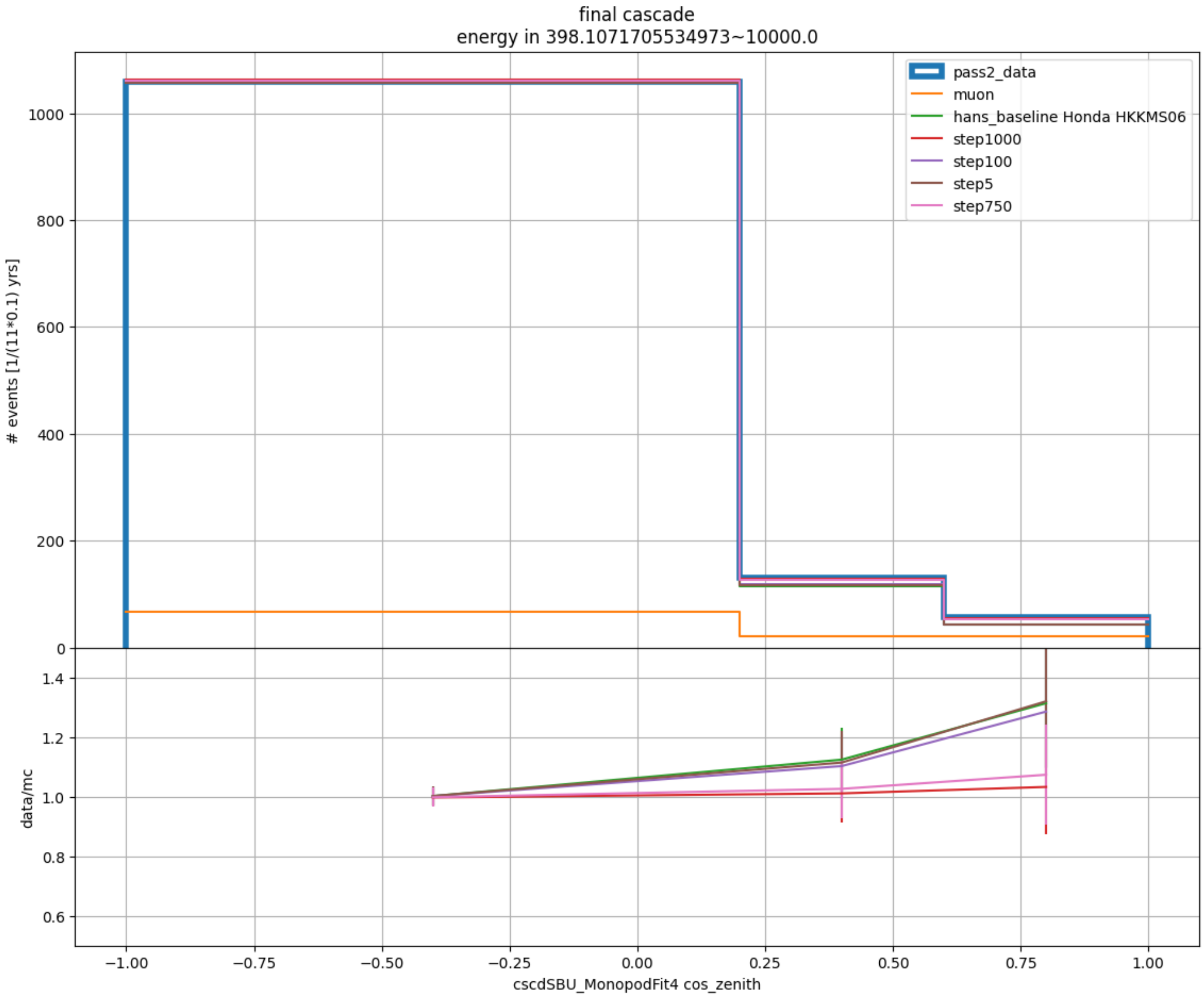

final cascade
energy in 398.1071705534973~10000.0
pass2_data
muon
hans_baseline Honda HKKMS06
step1000
step100
step5
step750
# events [1/(11*0.1) yrs]
data/mc
cscdSBU_MonopodFit4 cos_zenith

FIG. 4



final cascade
energy in 398.1071705534973~10000.0
pass2_data
muon
hans_baseline Honda HKKMS06
step1000
step100
step5
step750
# events [1/(11*0.1) yrs]
data/mc
cscdSBU_MonopodFit4 cos_zenith


FIG. 5

### E. cos zenith distribution in energy bins

Here are zenith distribution in energy bins. It is consistent with previous conclusion and no other conclusion could be made from these plots.

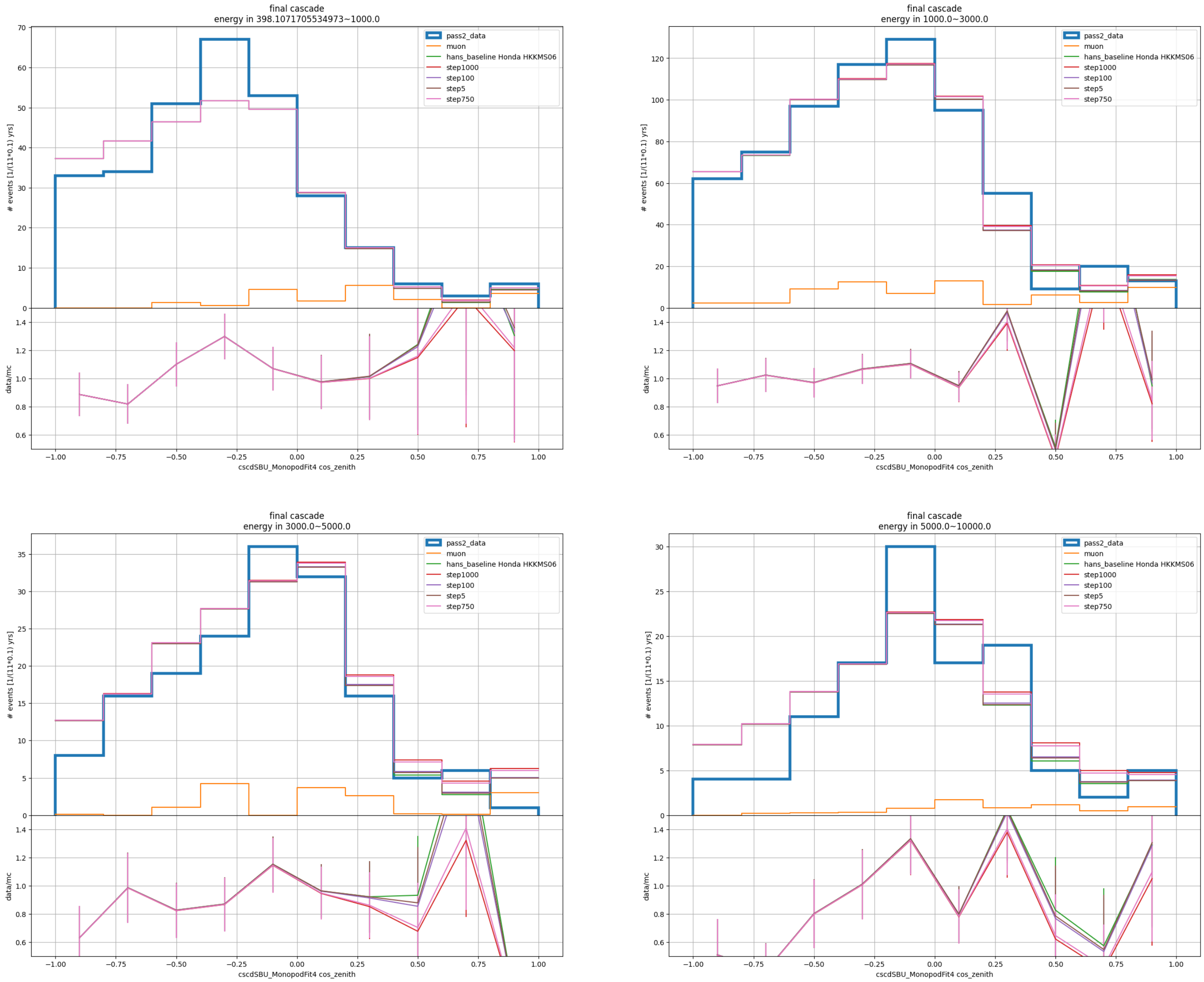



FIG. 6

### F. cos zenith distribution in depth bins

Similarly, the difference between events below and above dust layer is not significant.

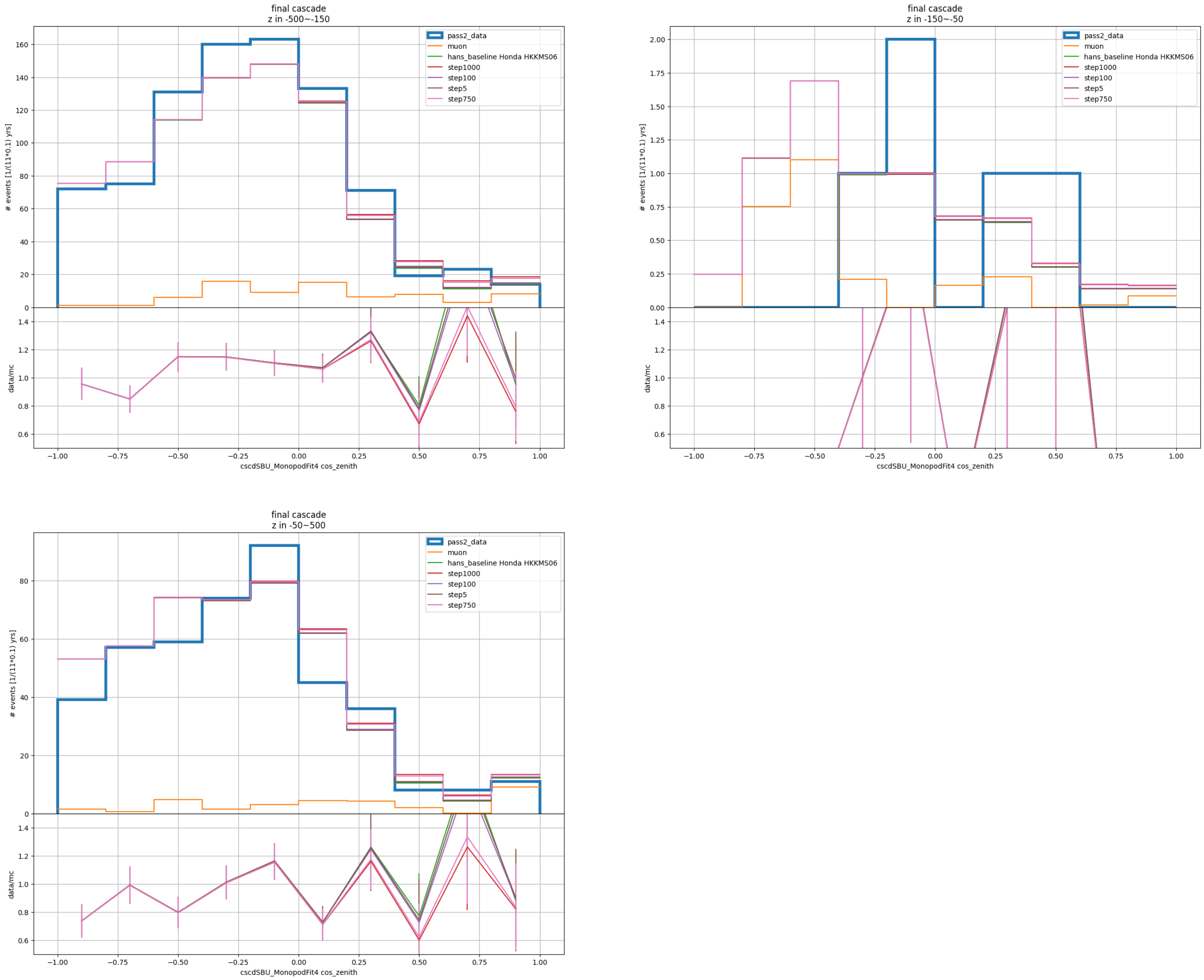
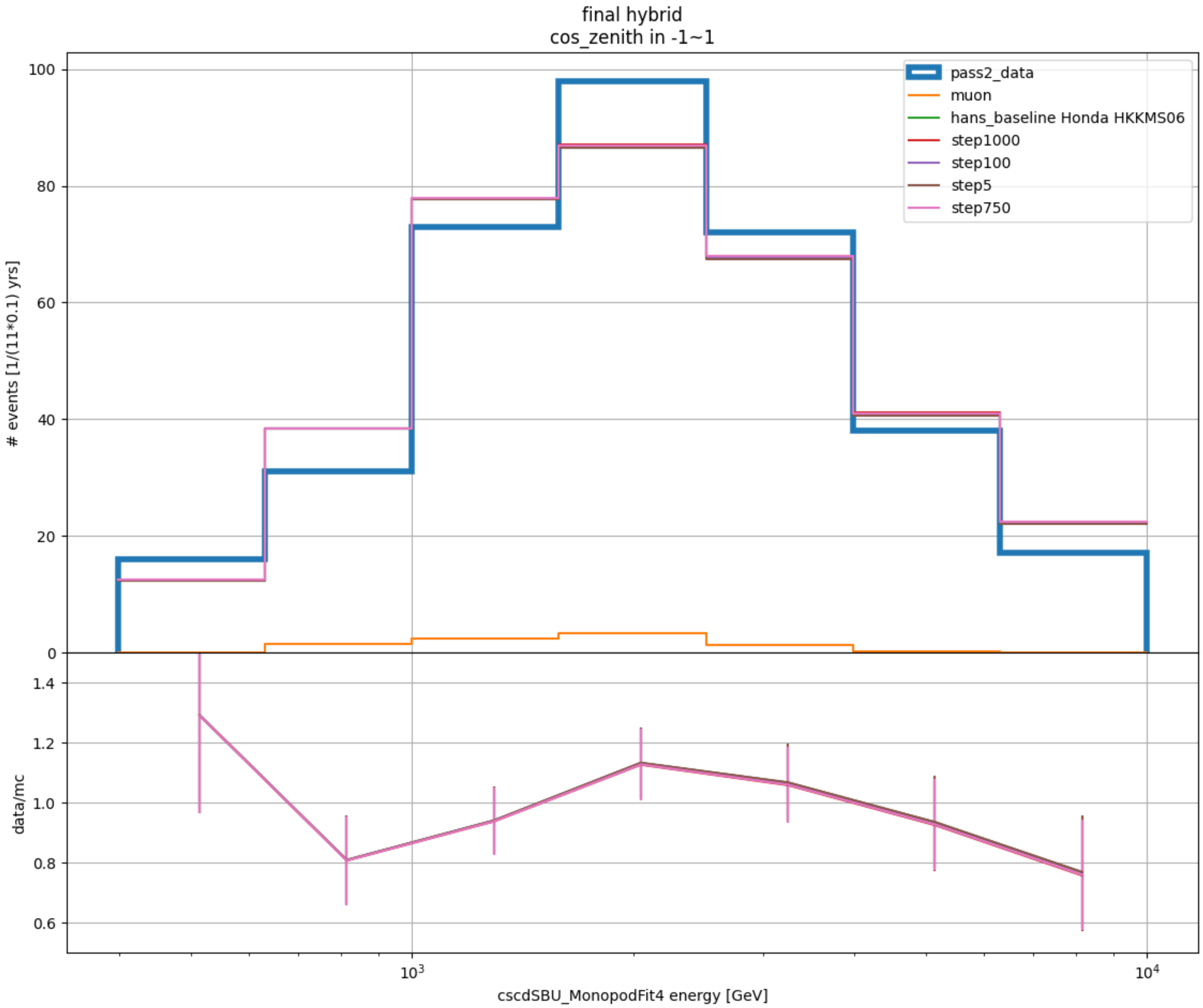



FIG. 7

## III. APPENDIX

### A. self-veto uncertainty



final hybrid
cos_zenith in -1~1
pass2_data
muon
hans_baseline Honda HKKMS06
step1000
step100
step5
step750
# events [1/(11*0.1) yrs]
data/mc
cscdSBU_MonopodFit4 energy [GeV]


FIG. 8

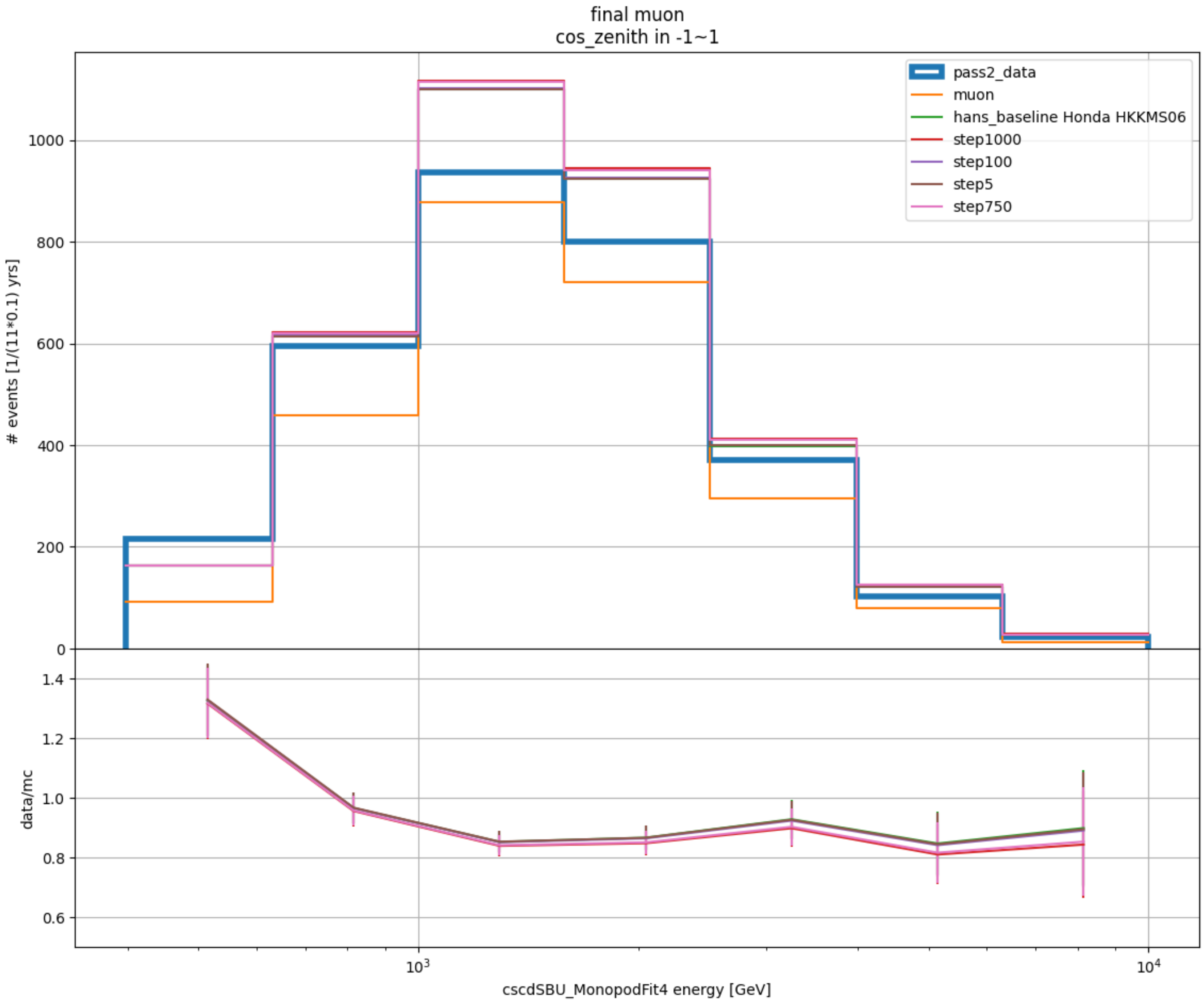
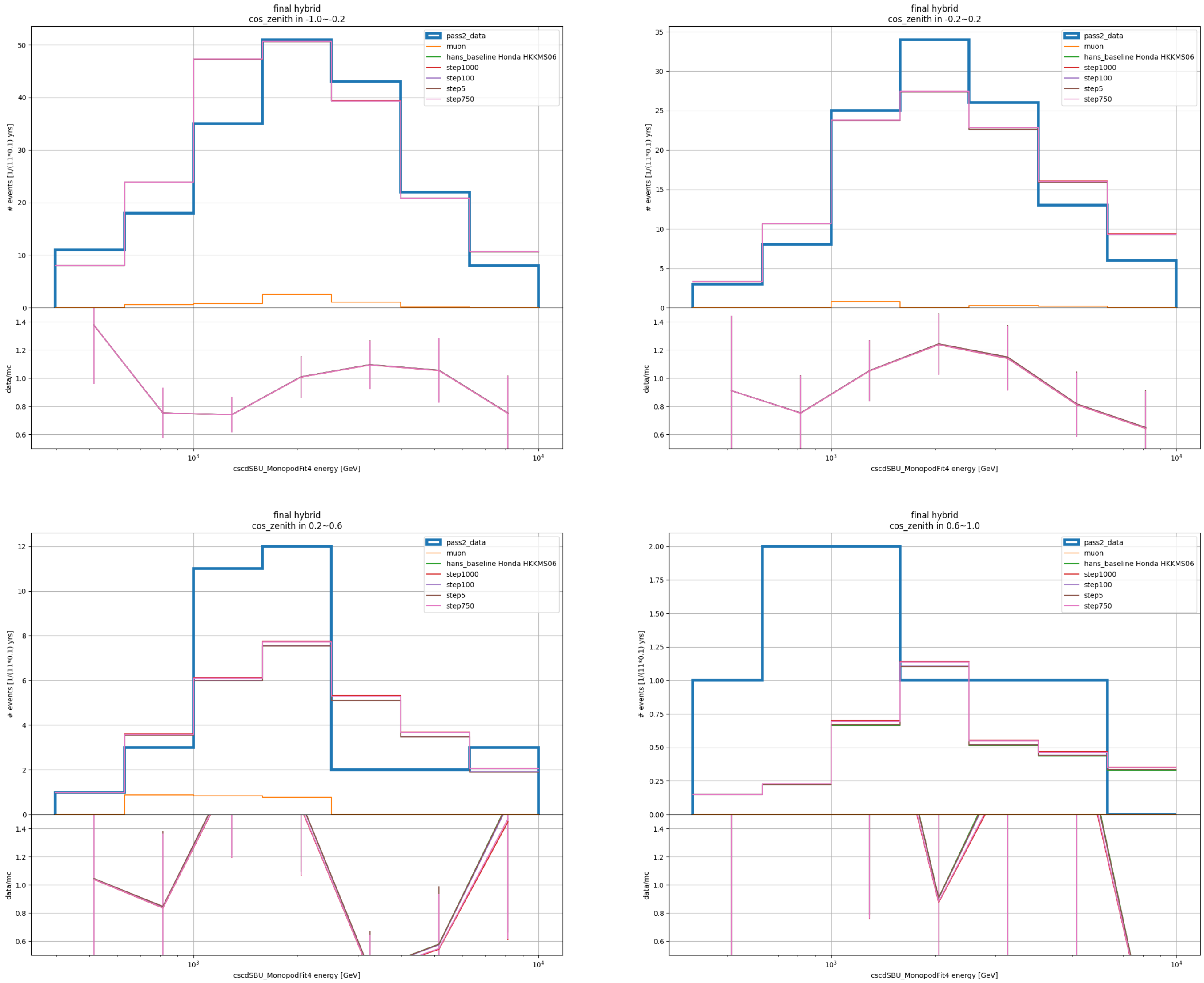

final muon
cos_zenith in -1~1
pass2_data
muon
hans_baseline Honda HKKMS06
step1000
step100
step5
step750
# events [1/(11*0.1) yrs]
data/mc
cscdSBU_MonopodFit4 energy [GeV]

FIG. 9



final hybrid
cos_zenith in -1.0~-0.2
final hybrid
cos_zenith in -0.2~0.2
final hybrid
cos_zenith in 0.2~0.6
final hybrid
cos_zenith in 0.6~1.0
pass2_data
muon
hans_baseline Honda HKKMS06
step1000
step100
step5
step750
# events [1/(11*0.1) yrs]
data/mc
cscdSBU_MonopodFit4 energy [GeV]


FIG. 10

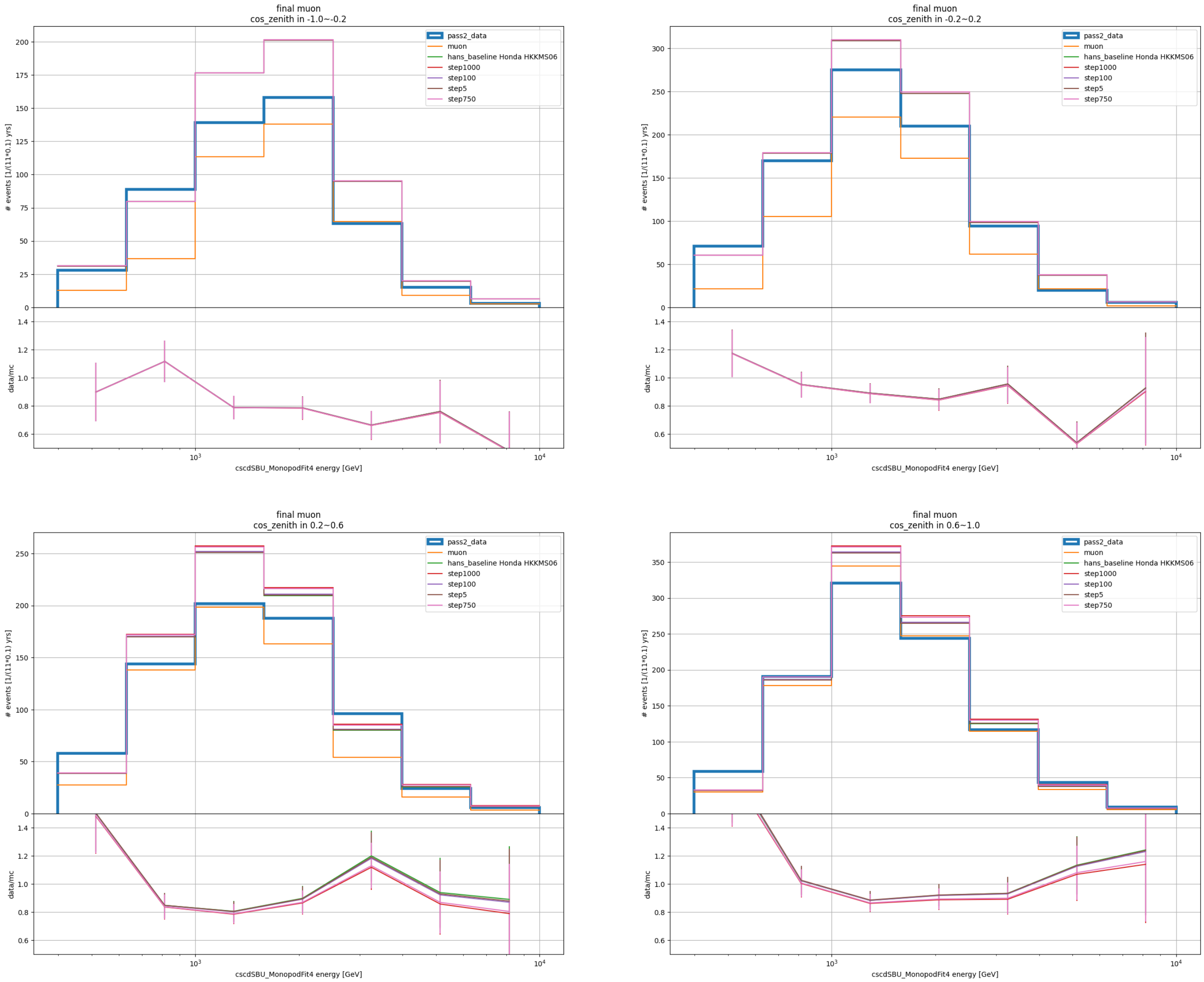

final muon
cos_zenith in -1.0~-0.2
final muon
cos_zenith in -0.2~0.2
final muon
cos_zenith in 0.2~0.6
final muon
cos_zenith in 0.6~1.0
pass2_data
muon
hans_baseline Honda HKKMS06
step1000
step100
step5
step750
# events [1/(11*0.1) yrs]
data/mc
cscdSBU_MonopodFit4 energy [GeV]

FIG. 11

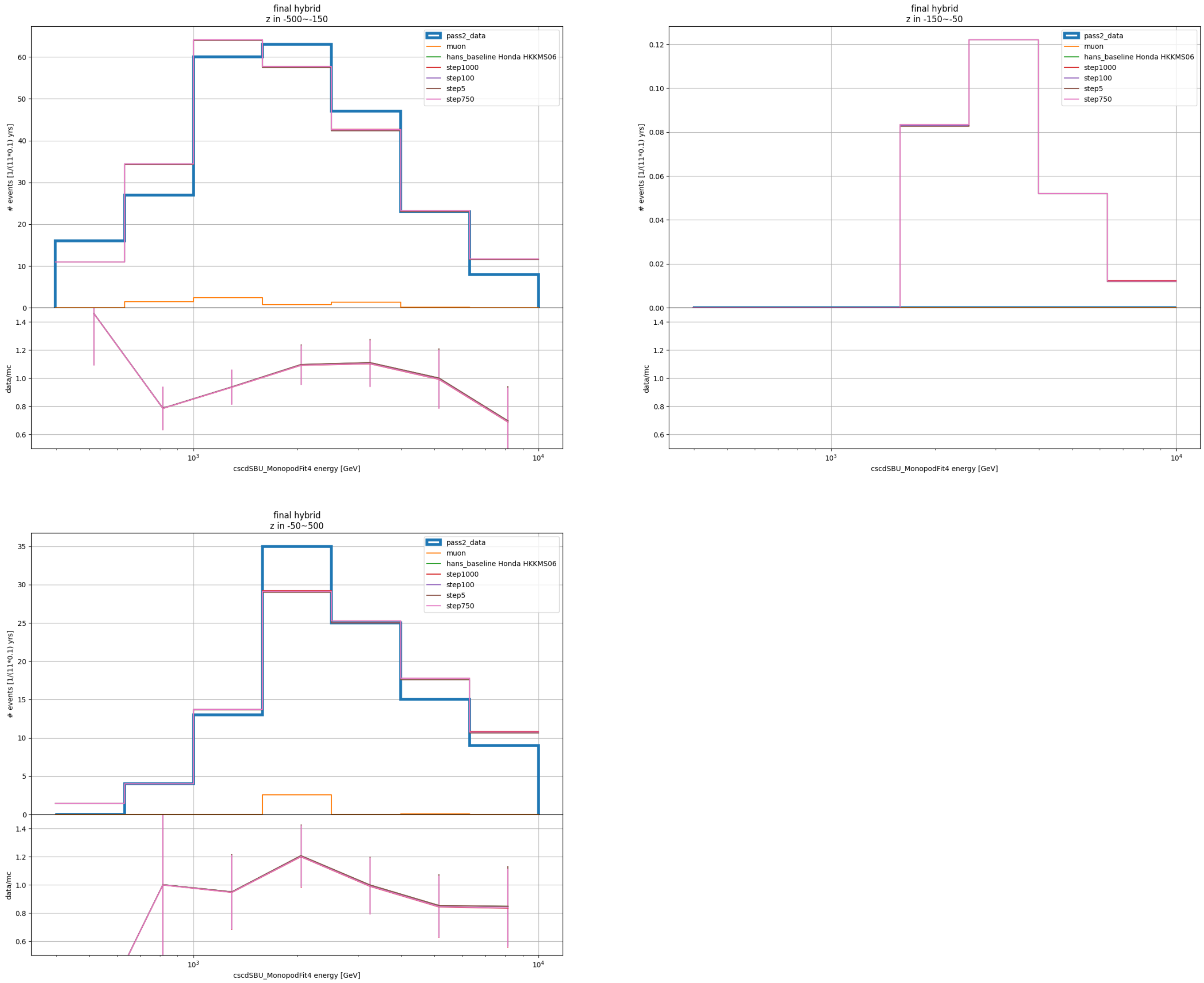

final hybrid
z in -500~-150
pass2_data
muon
hans_baseline Honda HKKMS06
step1000
step100
step5
step750
# events [1/(11*0.1) yrs]
data/mc
cscdSBU_MonopodFit4 energy [GeV]
final hybrid
z in -150~-50
final hybrid
z in -50~500

FIG. 12

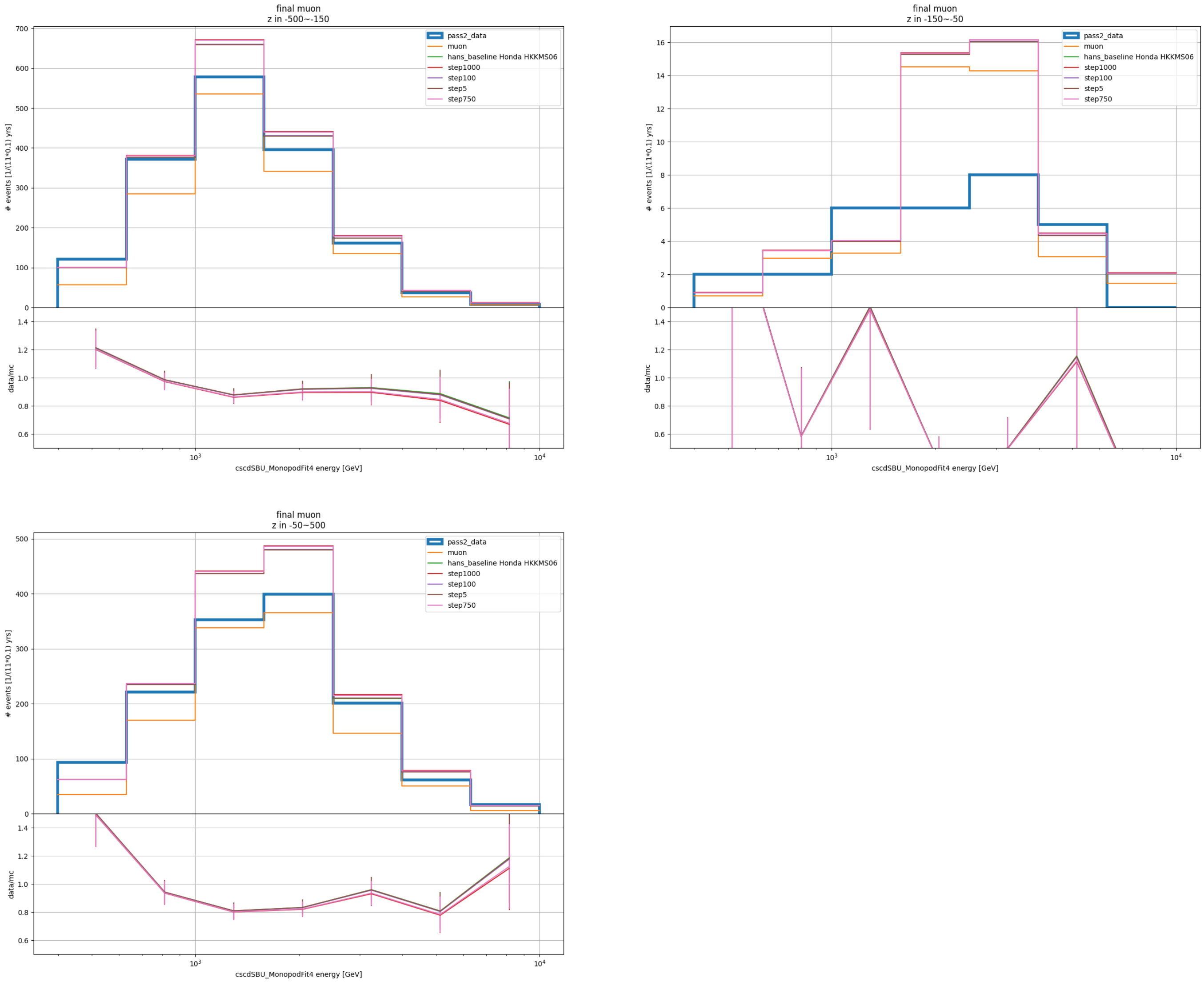
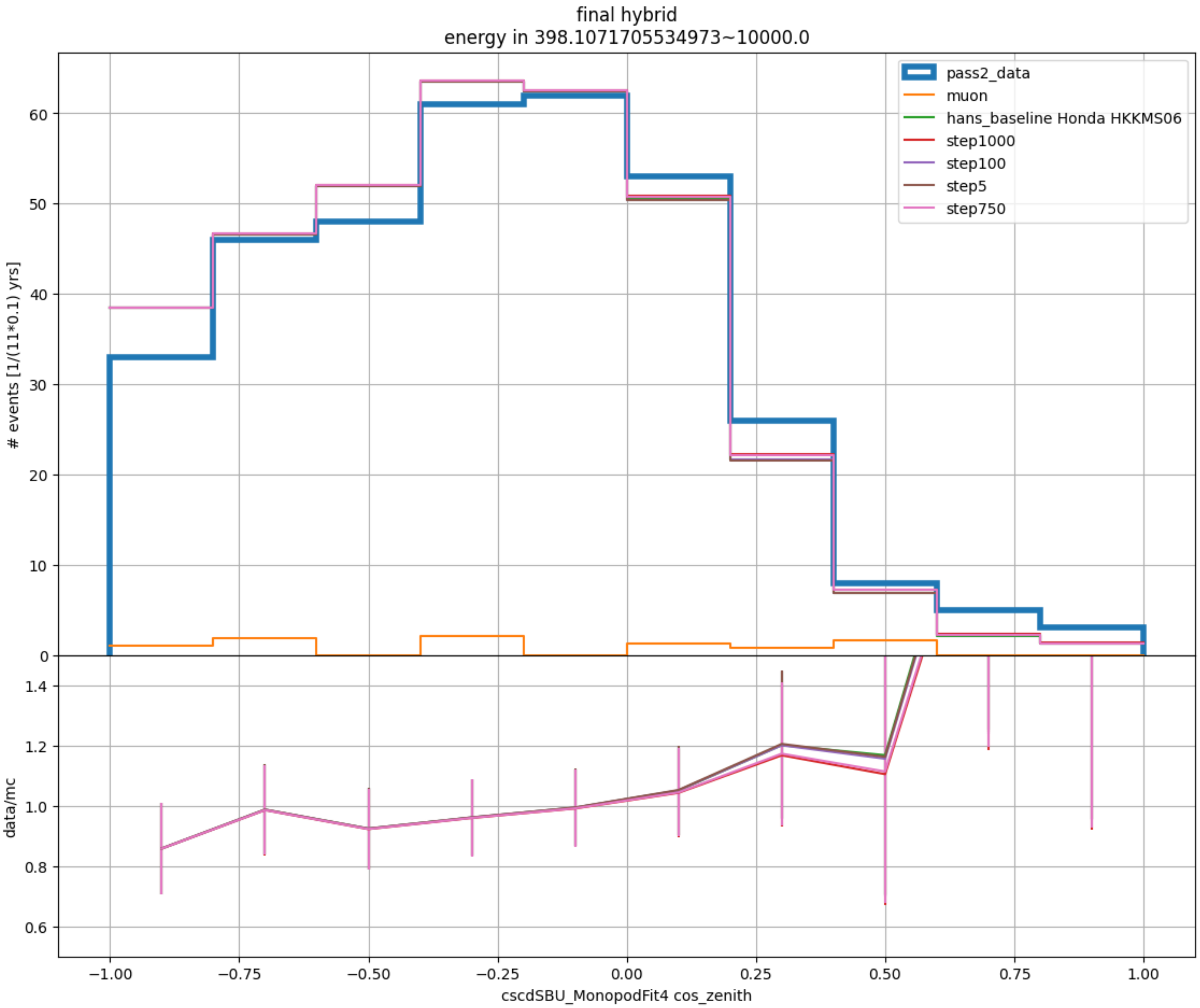

final muon
z in -500~-150
pass2_data
muon
hans_baseline Honda HKKMS06
step1000
step100
step5
step750
# events [1/(11*0.1) yrs]
data/mc
cscdSBU_MonopodFit4 energy [GeV]
final muon
z in -150~-50
pass2_data
muon
hans_baseline Honda HKKMS06
step1000
step100
step5
step750
# events [1/(11*0.1) yrs]
data/mc
cscdSBU_MonopodFit4 energy [GeV]
final muon
z in -50~500
pass2_data
muon
hans_baseline Honda HKKMS06
step1000
step100
step5
step750
# events [1/(11*0.1) yrs]
data/mc
cscdSBU_MonopodFit4 energy [GeV]

FIG. 13



final hybrid
energy in 398.1071705534973~10000.0
pass2_data
muon
hans_baseline Honda HKKMS06
step1000
step100
step5
step750
# events [1/(11*0.1) yrs]
data/mc
cscdSBU_MonopodFit4 cos_zenith


FIG. 14

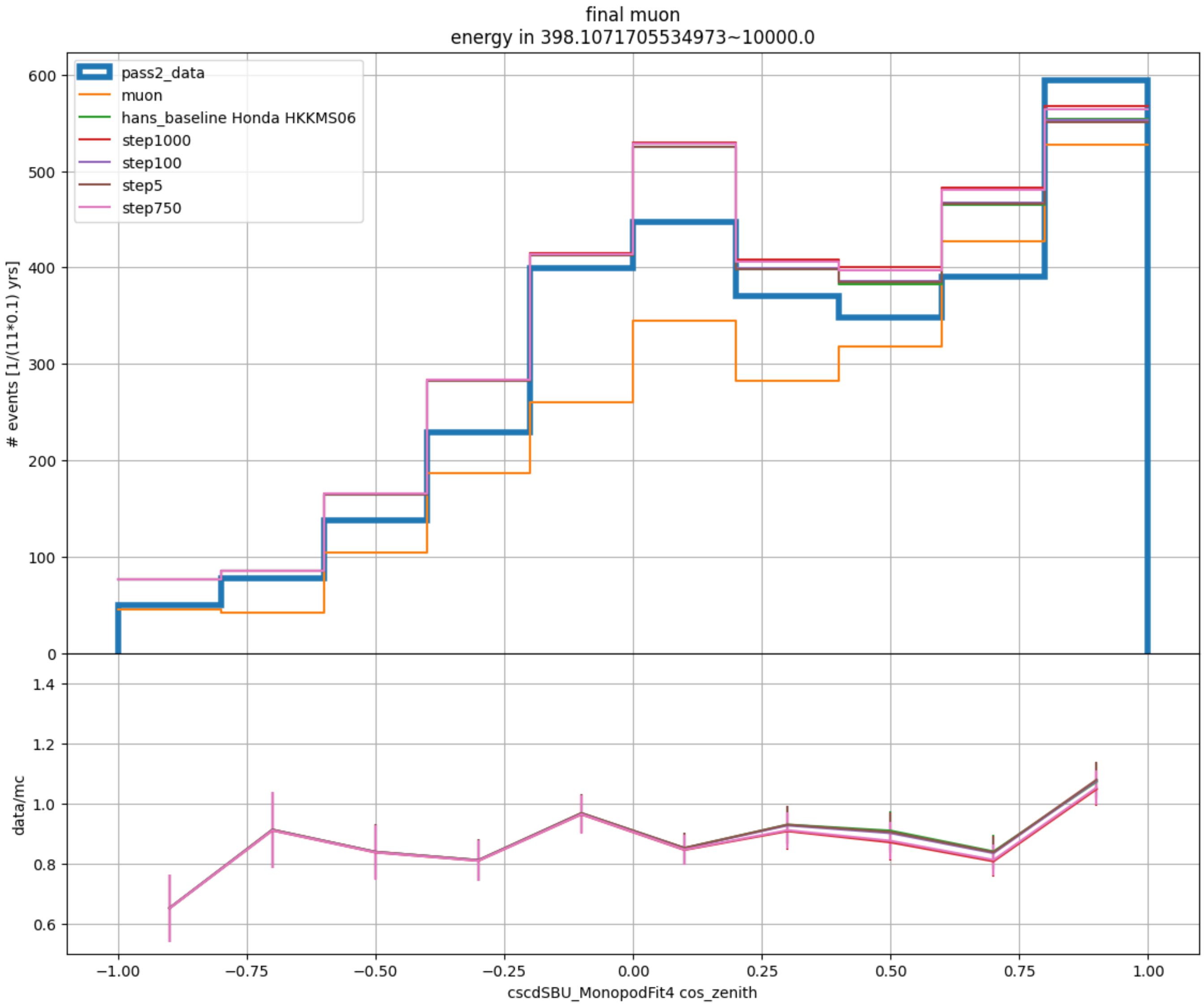
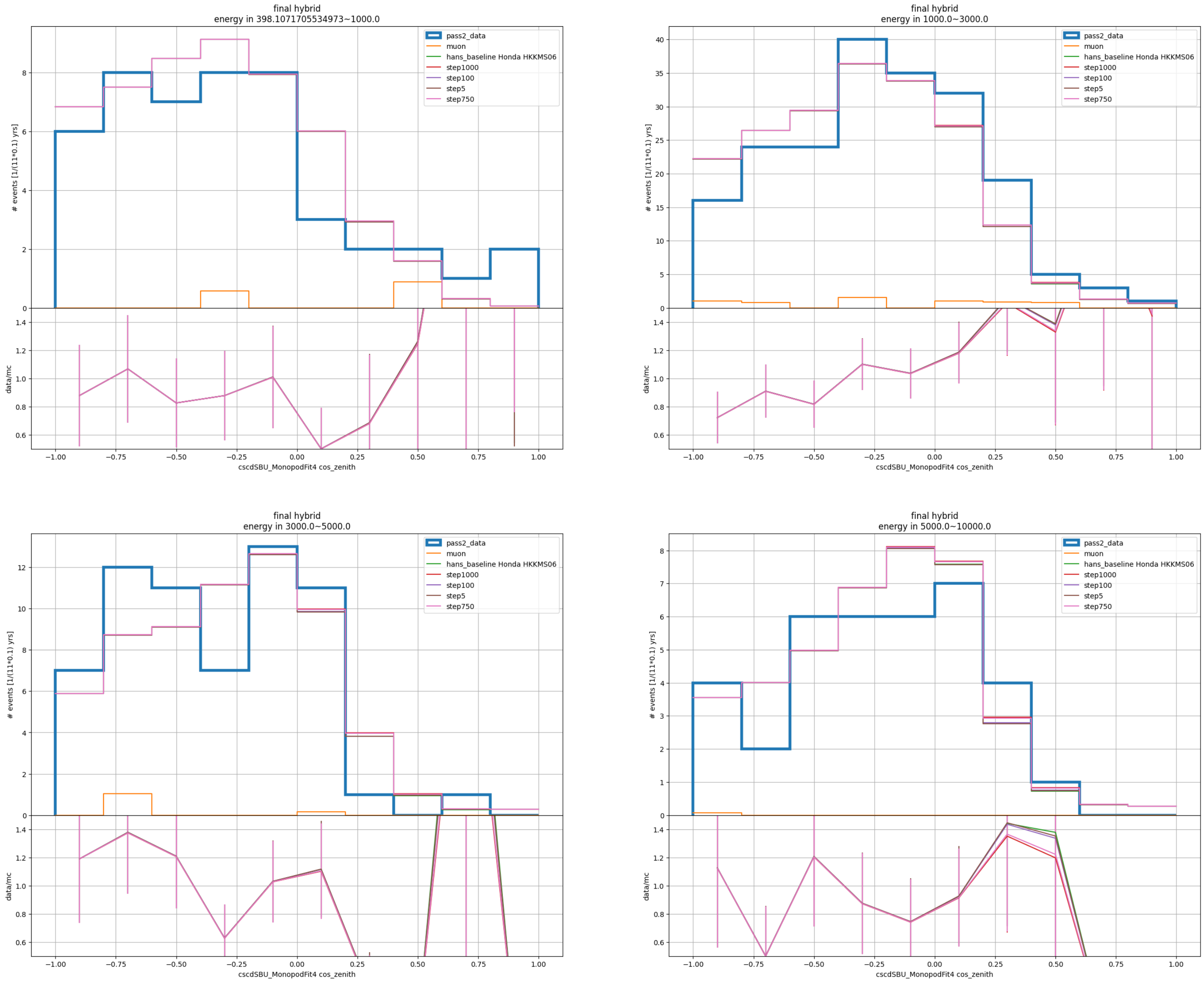

final muon
energy in 398.1071705534973~10000.0
pass2_data
muon
hans_baseline Honda HKKMS06
step1000
step100
step5
step750
# events [1/(11*0.1) yrs]
data/mc
cscdSBU_MonopodFit4 cos_zenith

FIG. 15



final hybrid
energy in 398.1071705534973~1000.0
final hybrid
energy in 1000.0~3000.0
final hybrid
energy in 3000.0~5000.0
final hybrid
energy in 5000.0~10000.0
pass2_data
muon
hans_baseline Honda HKKMS06
step1000
step100
step5
step750
# events [1/(11*0.1) yrs]
data/mc
cscdSBU_MonopodFit4 cos_zenith


FIG. 16

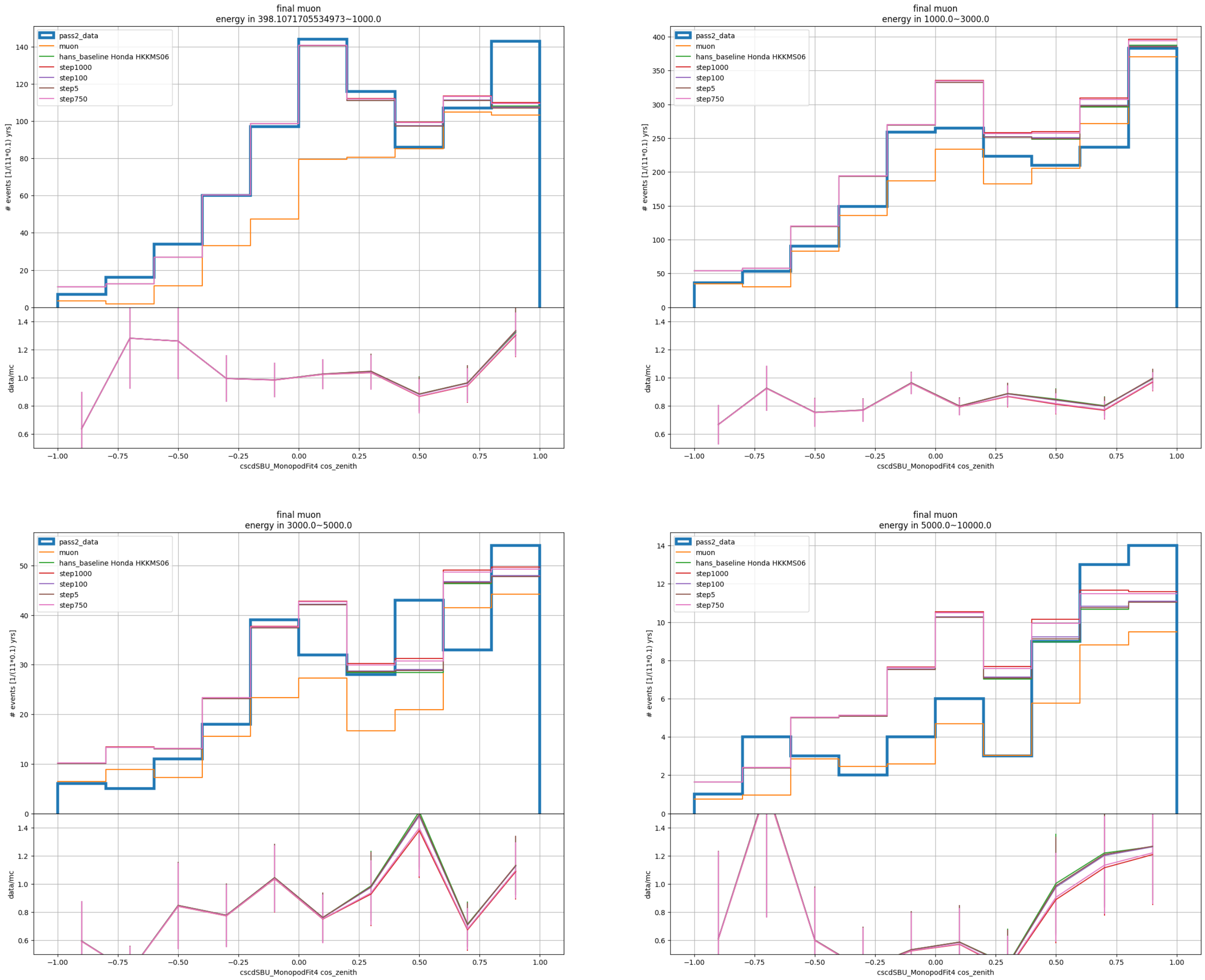

final muon
energy in 398.1071705534973~1000.0
final muon
energy in 1000.0~3000.0
final muon
energy in 3000.0~5000.0
final muon
energy in 5000.0~10000.0
pass2_data
muon
hans_baseline Honda HKKMS06
step1000
step100
step5
step750
# events [1/(11*0.1) yrs]
data/mc
cscdSBU_MonopodFit4 cos_zenith

FIG. 17

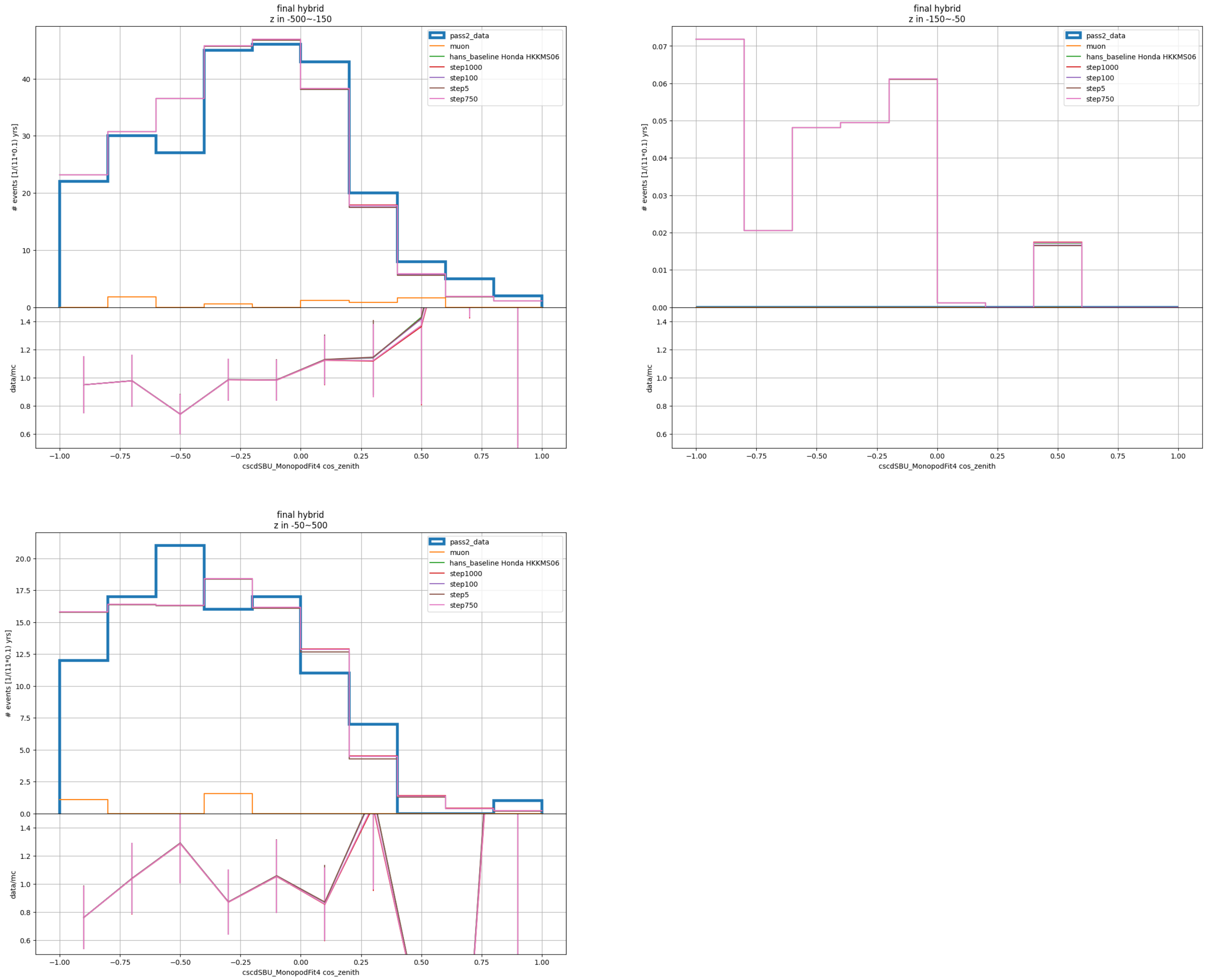

final hybrid
z in -500~-150
pass2_data
muon
hans_baseline Honda HKKMS06
step1000
step100
step5
step750
# events [1/(11*0.1) yrs]
data/mc
cscdSBU_MonopodFit4 cos_zenith
final hybrid
z in -150~-50
final hybrid
z in -50~500

FIG. 18

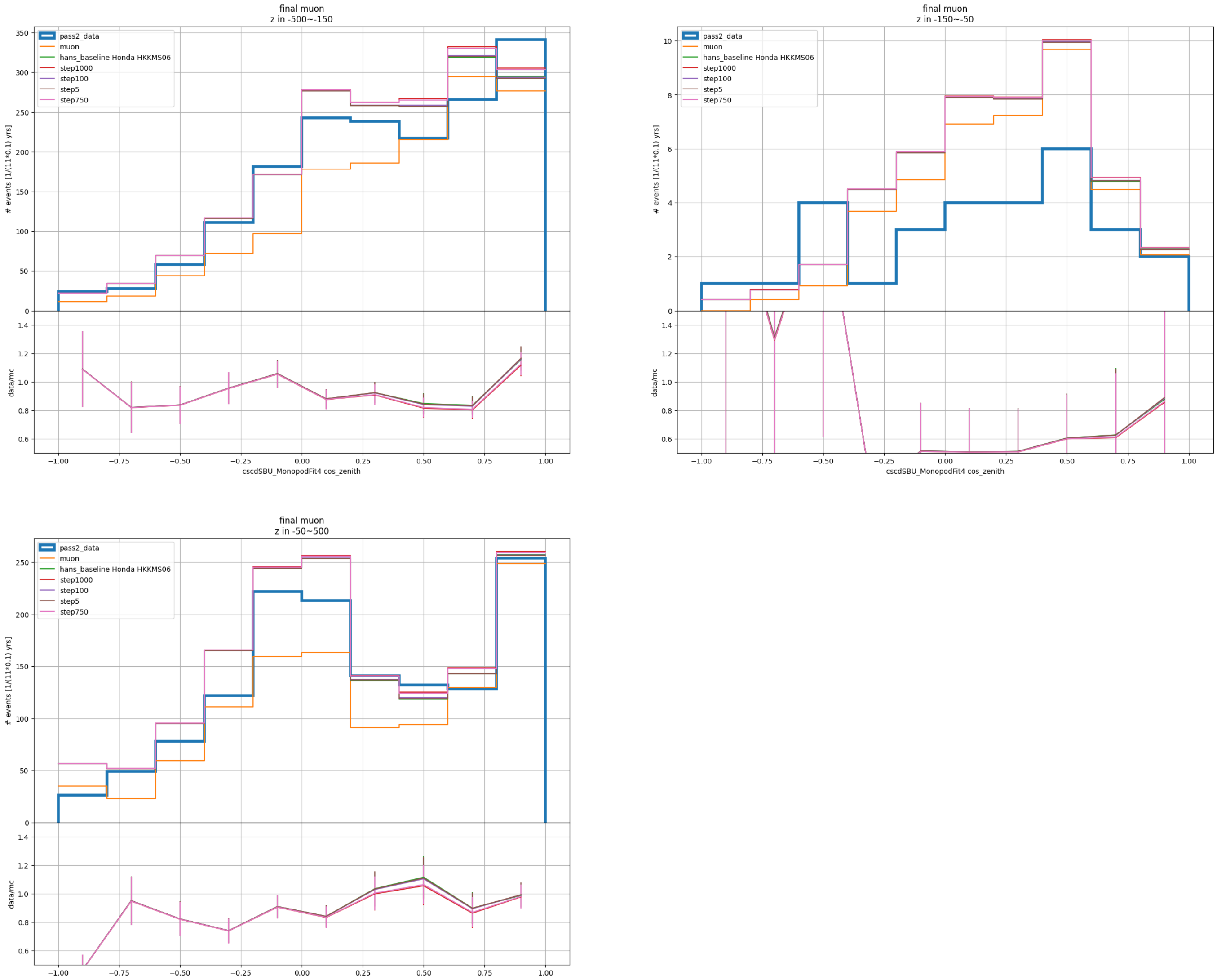

final muon
z in -500~-150
final muon
z in -150~-50
final muon
z in -50~500
pass2_data
muon
hans_baseline Honda HKKMS06
step1000
step100
step5
step750
# events [1/(11*0.1) yrs]
data/mc
cscdSBU_MonopodFit4 cos_zenith

FIG. 19