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SOLENOIDAL DETECTOR NOTES

A STUDY OF THE KINEMATICAL PROPERTIES OF THE MUONS FROM HIGGS DECAY

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A STUDY OF THE KINEMATICAL PROPERTIES OF THE MUONS FROM HIGGS DECAY

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I present a simple study of the behavior of the muons from Higgs decays using the ISAJET program. The purpose is to determine the correlated location of the 4 muons from the process H→2Z's→ $4\mu's$ and to determine their momentum and P_t distributions.

We carried out this study for Higgs masses of 400 and 800 GeV/c^2 which represent both the average and the extreme masses that we expect to be able to observe. We generated 1992 events with M_H = 400 GeV/c^2 and 1972 events with M_H = 800 GeV/c^2. The angular distribution of the muons is shown in Fig. 1. It shows that a substantial number of the muons are directed in the forward and backward hemispheres with small differences between the two extreme mass cases. If we define the forward hemisphere as the region with $\theta \leq 35°$ and the identical region in the opposite direction, then 48% of all the events generated will have at least one muon in this region for a mass of 400 GeV/c^2. Also, 78 % of the events where all four muons are in the detector have at least one muon in the forward direction. The momentum and P_t distributions of the observed muons are shown in Fig. 2 and Fig. 3. In Fig. 4 and Fig. 5 we show the corresponding distributions for those muons observed in the forward region of the detector.

In Table 1 we present the detection efficiency for the various possible number of observable muons (out of 4) and in Table 2 we show where the various muons are observed, divided between the barrel and the forward direction. Those muons in the forward direction with an angle off the beam direction less than 9° are assumed lost.

TABLE 1

Detection Efficiency for Various Muon Combinations

Observed in the barrel region ($145° \geq \theta \geq 35°$)=B

Observed in the forward region ($\theta \leq 35°$ or $\geq 145°$)=F

Muon Locations	M_H=400 GeV/c^2 Generated	M_H=400 GeV/c^2 Observed	M_H=800 GeV/c^2 Generated	M_H=800 GeV/c^2 Observed
BBBB	274	274 (13.8 %)	426	426 (21.6 %)
BBBF	374	343 (17.2 %)	278	270 (13.7 %)
BBFF	528	351 (17.6 %)	679	457 (23.2 %)
BFFF	403	172 (8.6 %)	310	188 (9.5 %)
FFFF	413	85 (4.3 %)	279	141 (7.2 %)
TOTAL	1992	1225(61.5 %)	1972	1482 (75.2 %)

TABLE 2

Observed Location of Muons for Various Conditions
A Muon is Lost if $\theta \leq 9° or \geq 171°$

Muon Locations	M_H=400 GeV/c^2	M_H=800 GeV/c^2
1)No Muons Lost		
BBBB	274 (13.8 %)	426 (21.6 %)
BBBF	343 (17.2 %)	270 (13.7 %)
BBFF	351 (17.6 %)	457 (23.2 %)
BFFF	172 (8.6 %)	188 (9.5 %)
FFFF	85 (4.3 %)	141 (7.2 %)
TOTAL	1225 (61.5 %)	1482 (75.2 %)
2)One Muon Lost		
BBBB	0	0
BBBF	31 (1.6 %)	8 (0.4 %)
BBFF	152 (7.6 %)	128 (6.5 %)
BFFF	140 (7.0 %)	69 (3.5 %)
FFFF	118 (5.9 %)	64 (3.2 %)
TOTAL	441 (22.1 %)	269 (13.6 %)
3)Two Muons Lost		
BBBB	0	0
BBBF	0	0
BBFF	25 (1.3 %)	94 (4.8 %)
BFFF	83 (4.2 %)	50 (2.5 %)
FFFF	112 (5.6 %)	56 (2.8 %)
TOTAL	220 (11.0 %)	200 (10.1 %)

TABLE 2 Continued

Muon Locations	M_H=400 GeV/c^2	M_H=800 GeV/c^2
1)Three Muons Lost		
BBBB	0	0
BBBF	0	0
BBFF	0	0
BFFF	8 (0.4 %)	3 (0.2 %)
FFFF	71 (3.6 %)	14 (0.7 %)
TOTAL	79 (4.0 %)	17 (0.9 %)
2)Four Muons Lost		
BBBB	0	0
BBBF	0	0
BBFF	0	0
BFFF	0	0
FFFF	27 (1.4 %)	4 (0.2 %)
TOTAL	27 (1.4 %)	4 (0.2 %)

FIGURE CAPTIONS

1) The angular distribution of muons from Higgs decay via 2 Zs.

2) The momentum distribution of muons from Higgs decay via 2 Zs.

3) The transverse momentum distribution of muons from Higgs decay via 2 Zs.

4) The momentum distribution of muons from Higgs decay via 2 Zs for those observed in the forward region of the detector ($35° \geq \theta \geq 9°$ and $145° \leq \theta \leq 171°$).

5) The transverse momentum distribution of muons from Higgs decay via 2 Zs for those observed in the forward region of the detector ($35° \geq \theta \geq 9°$ and $145° \leq \theta \leq 171°$).

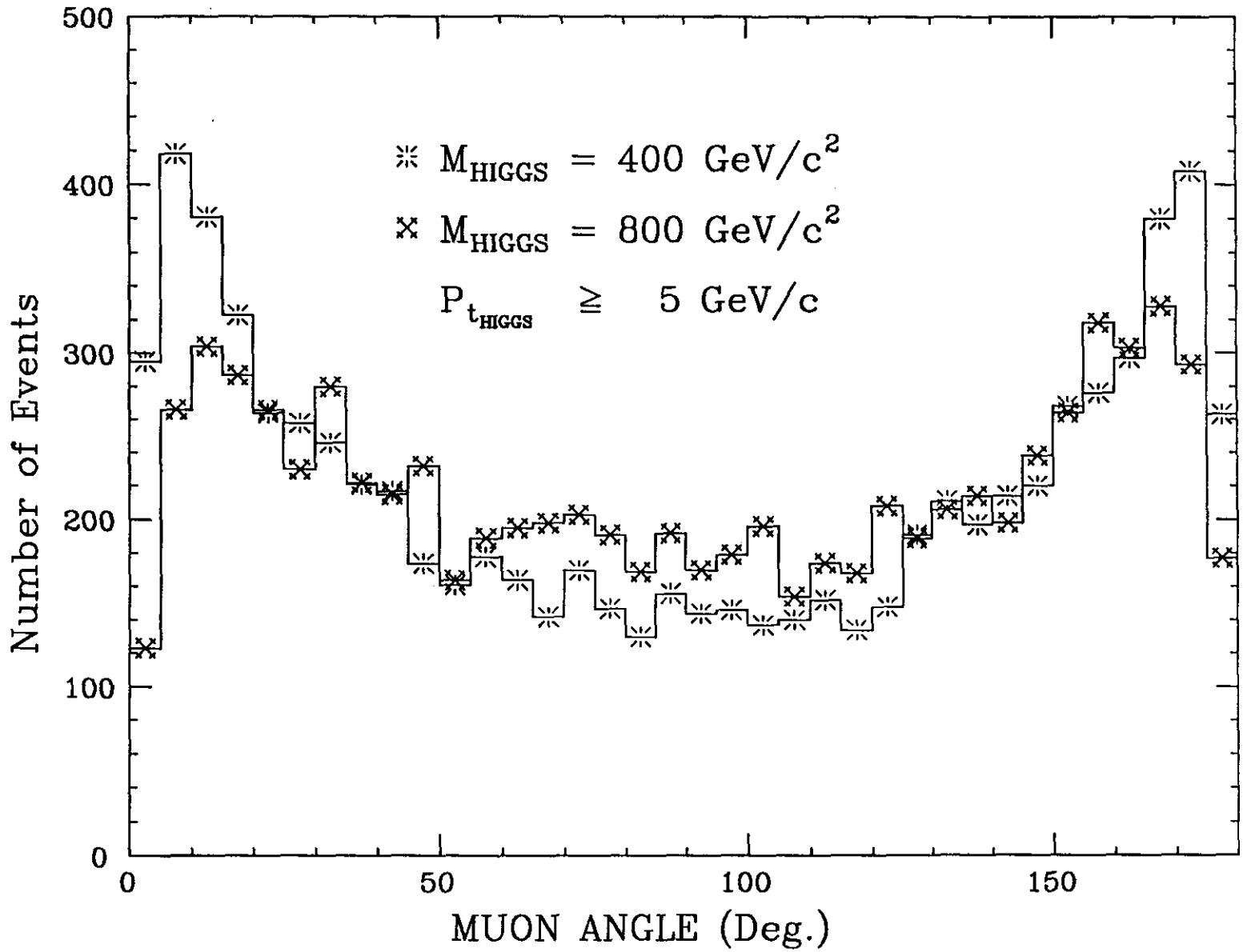
500
400
300
200
100
0
0
50
100
150
Number of Events
MUON ANGLE (Deg.)
M_{HIGGS} = 400 GeV/c^2
M_{HIGGS} = 800 GeV/c^2
$P_{t_{HIGGS}}$ ≧ 5 GeV/c

FIG. 1

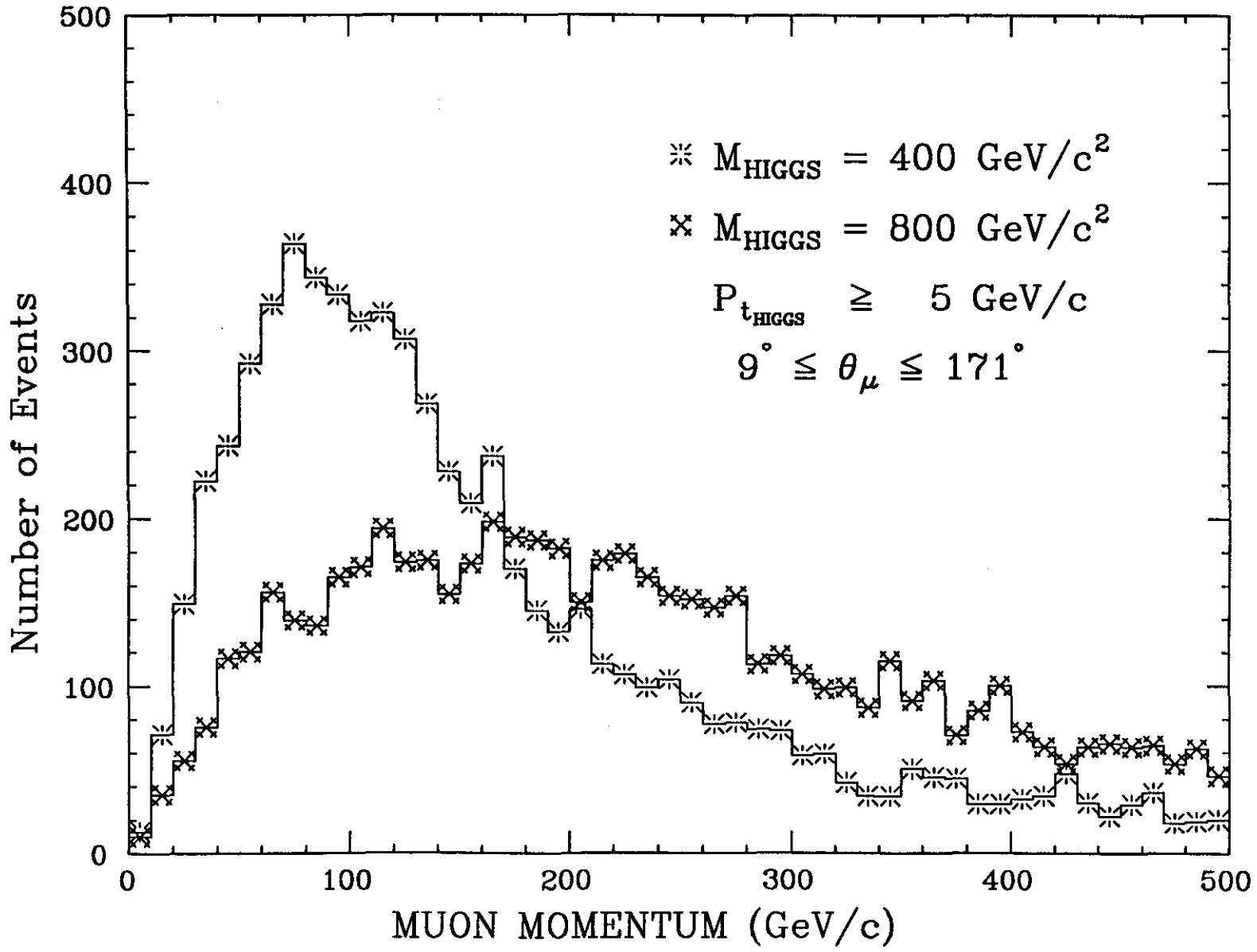
500
400
300
200
100
0
Number of Events
0
100
200
300
400
500
MUON MOMENTUM (GeV/c)
M_{HIGGS} = 400 GeV/c^2
M_{HIGGS} = 800 GeV/c^2
$P_{t_{HIGGS}}$ ≧ 5 GeV/c
$9^\circ \leq \theta_\mu \leq 171^\circ$

FIG. 2

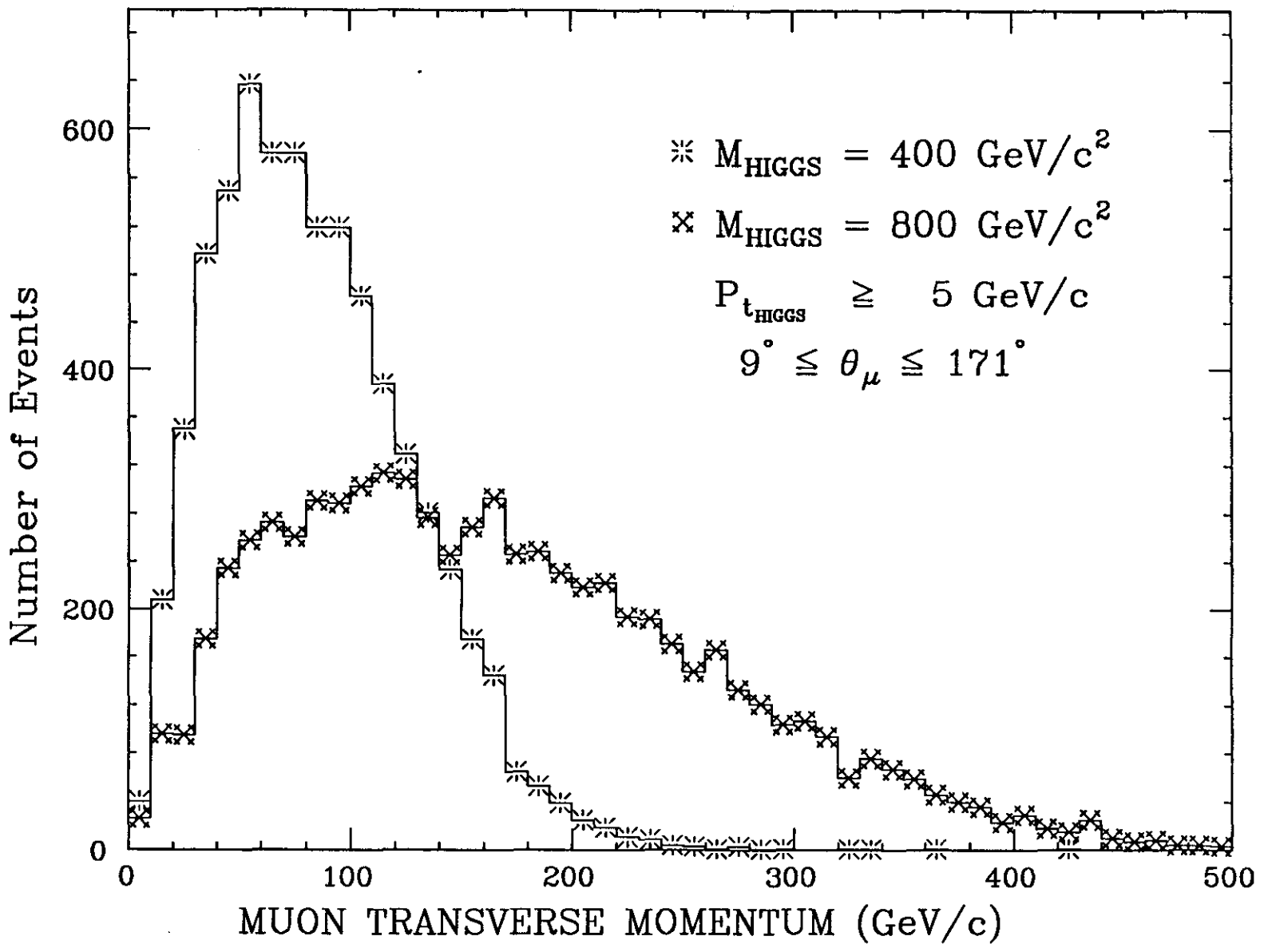
M_{HIGGS} = 400 GeV/c^2
M_{HIGGS} = 800 GeV/c^2
$P_{t_{HIGGS}} \geq$ 5 GeV/c
$9^\circ \leq \theta_\mu \leq 171^\circ$
Number of Events
0
200
400
600
0
100
200
300
400
500
MUON TRANSVERSE MOMENTUM (GeV/c)

FIG. 3

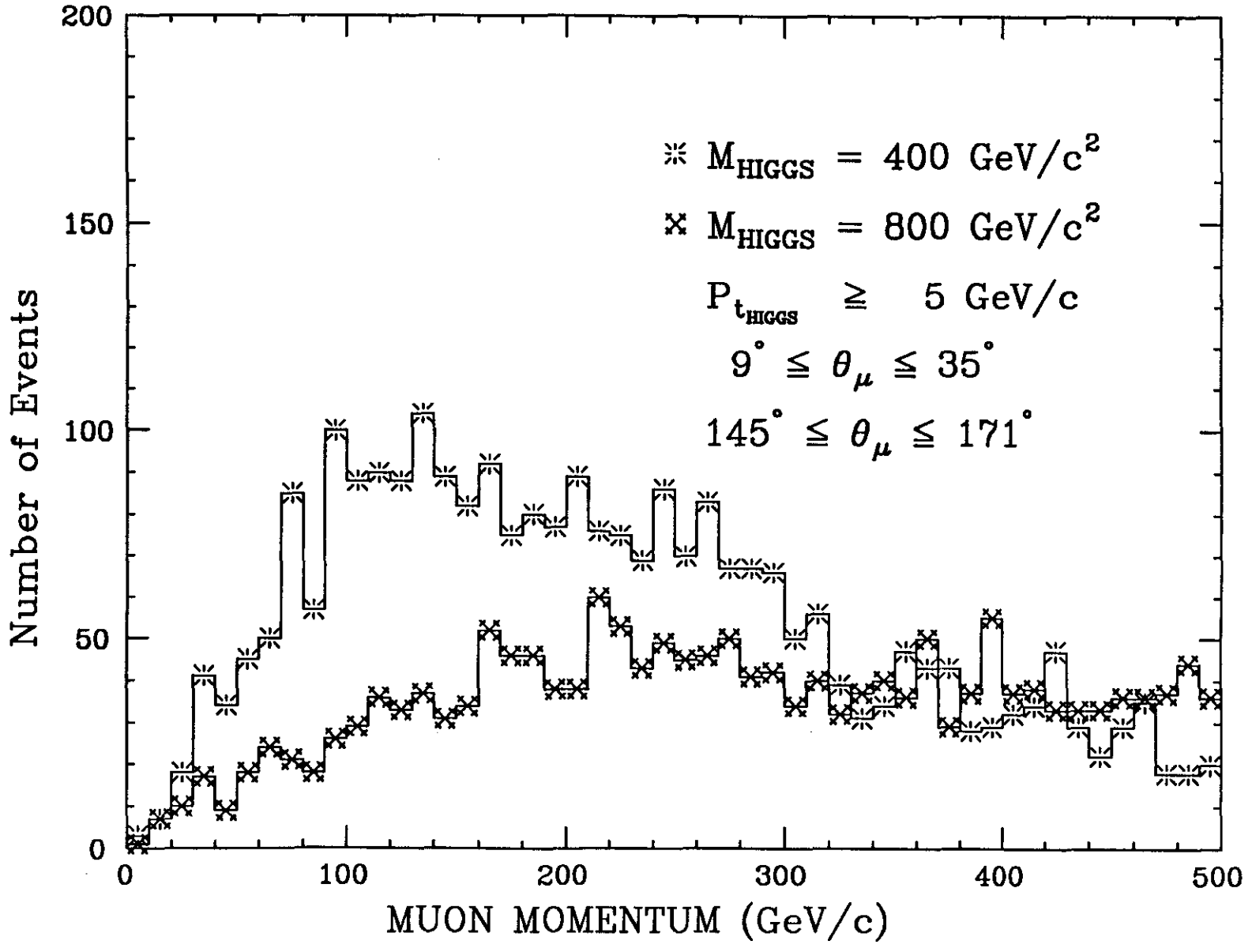
200
150
100
50
0
0
100
200
300
400
500
Number of Events
MUON MOMENTUM (GeV/c)
M_{HIGGS} = 400 GeV/c^2
M_{HIGGS} = 800 GeV/c^2
$P_{t_{HIGGS}} \geq$ 5 GeV/c
$9^\circ \leq \theta_\mu \leq 35^\circ$
$145^\circ \leq \theta_\mu \leq 171^\circ$

FIG. 4

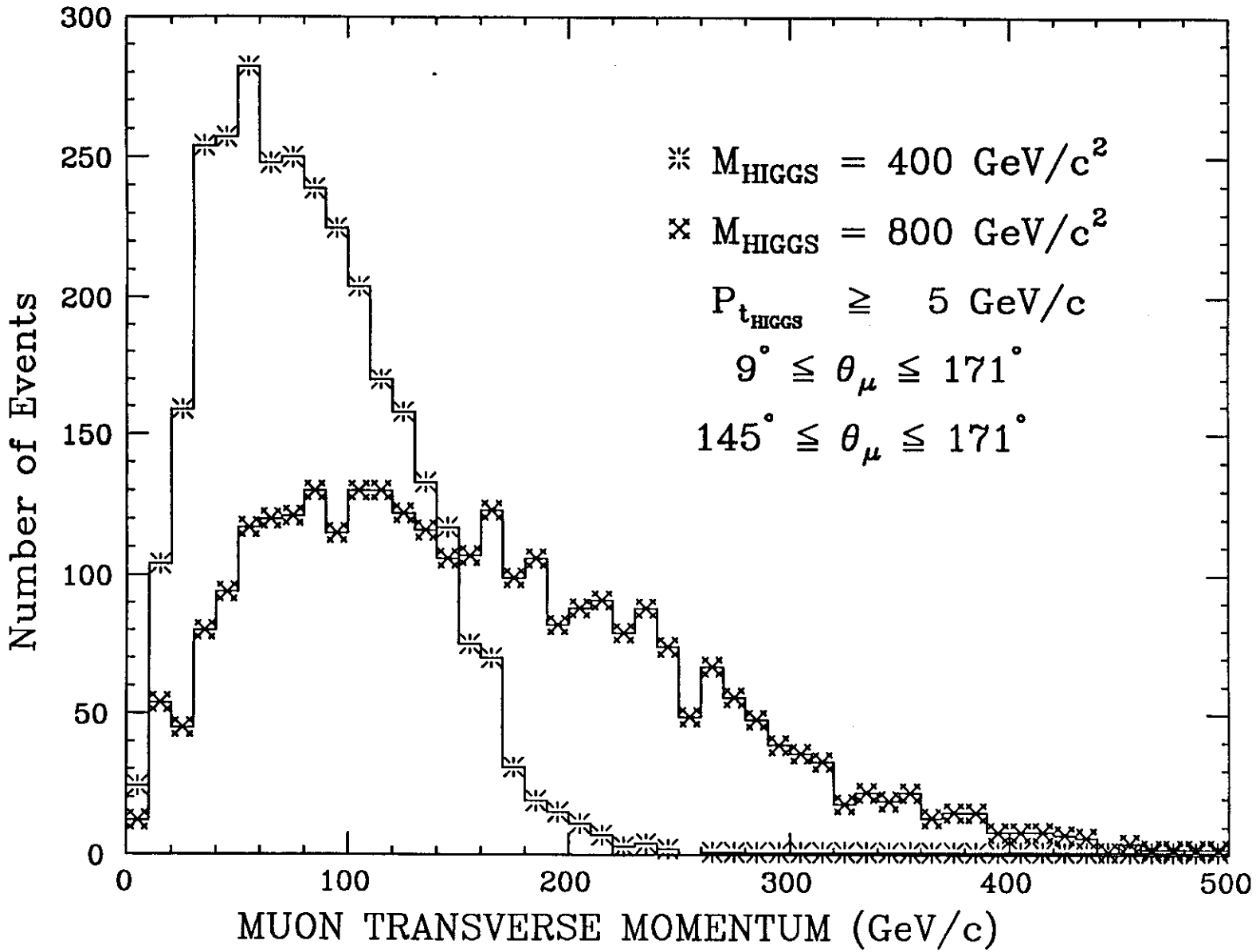
300
250
200
150
100
50
0
Number of Events
0
100
200
300
400
500
MUON TRANSVERSE MOMENTUM (GeV/c)
M_{HIGGS} = 400 GeV/c^2
M_{HIGGS} = 800 GeV/c^2
$P_{t_{HIGGS}} \geq$ 5 GeV/c
$9^\circ \leq \theta_\mu \leq 171^\circ$
$145^\circ \leq \theta_\mu \leq 171^\circ$

FIG. 5