Study of muon acceptance in LAr+TMS

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TMS Meeting

Introduction

- Beam angle: downward at 101 mrad.
- Change of muon acceptance in TMS by moving y position.
- Toy simulation:

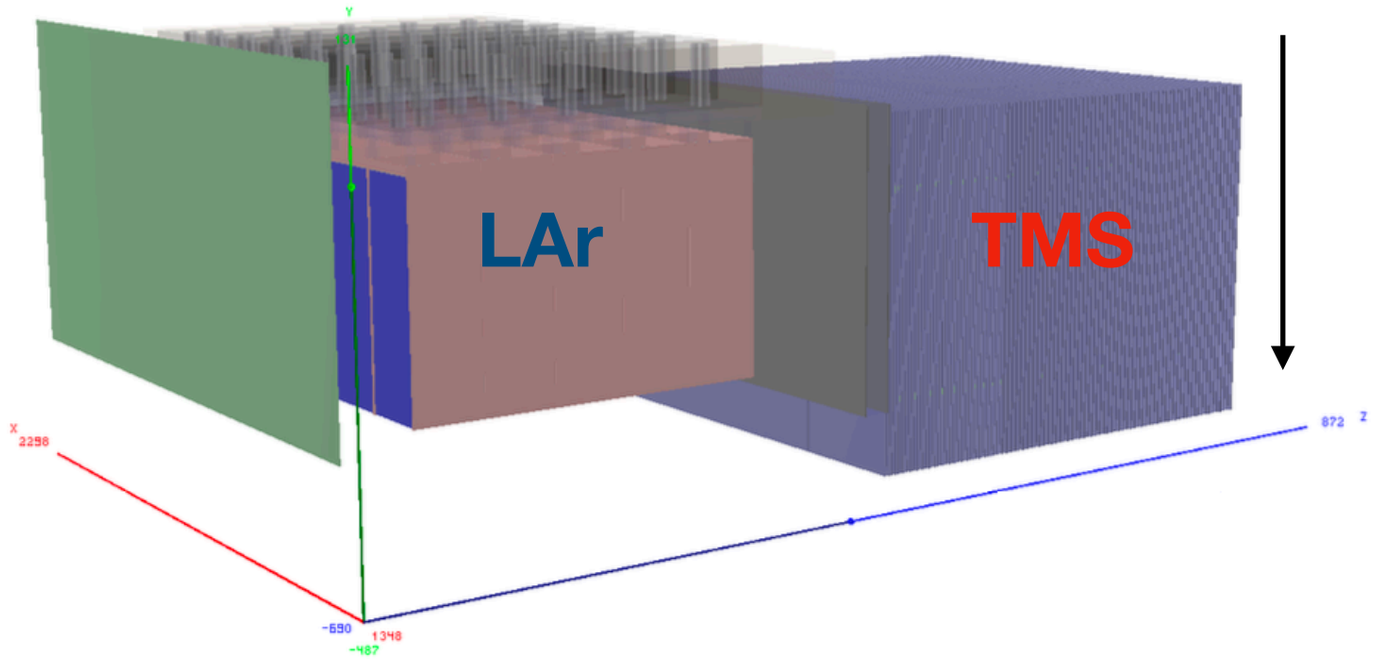
— Muon (up to 5 GeV) vertex in LAr fiducial volume.

— Pick $\theta_{\nu,\mu}$ and kinetic energy of muon.

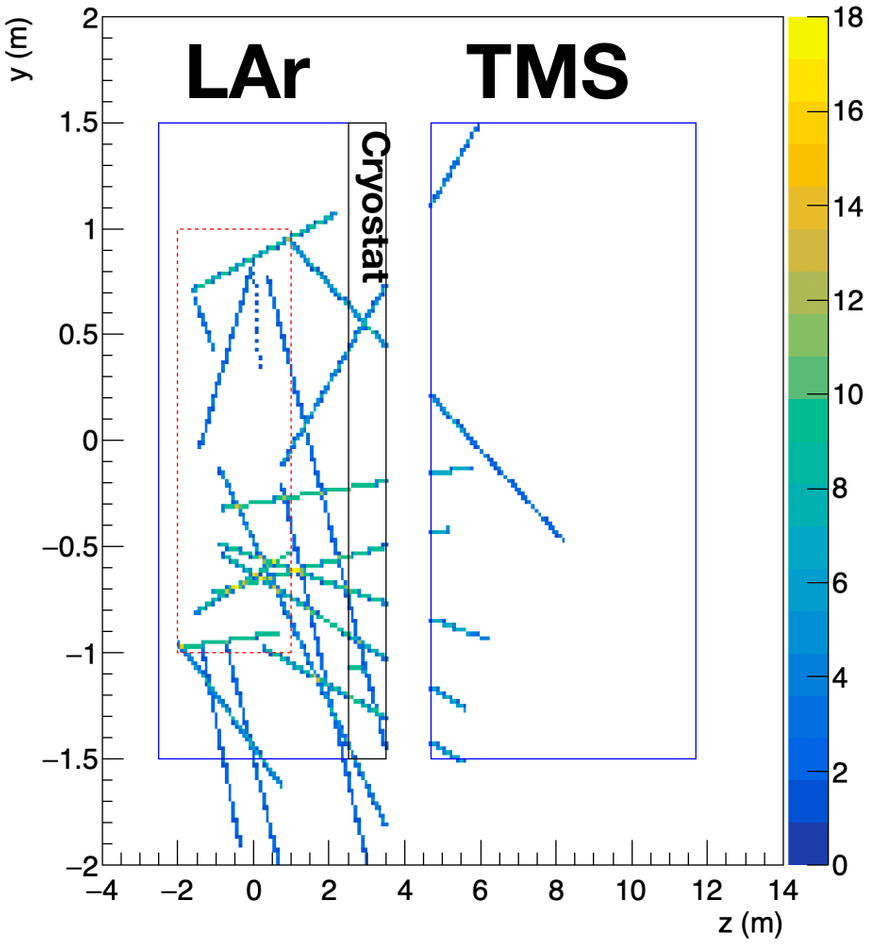
— Random azimuthal angle between 0 and 2π.

— Check the where the muon stop.

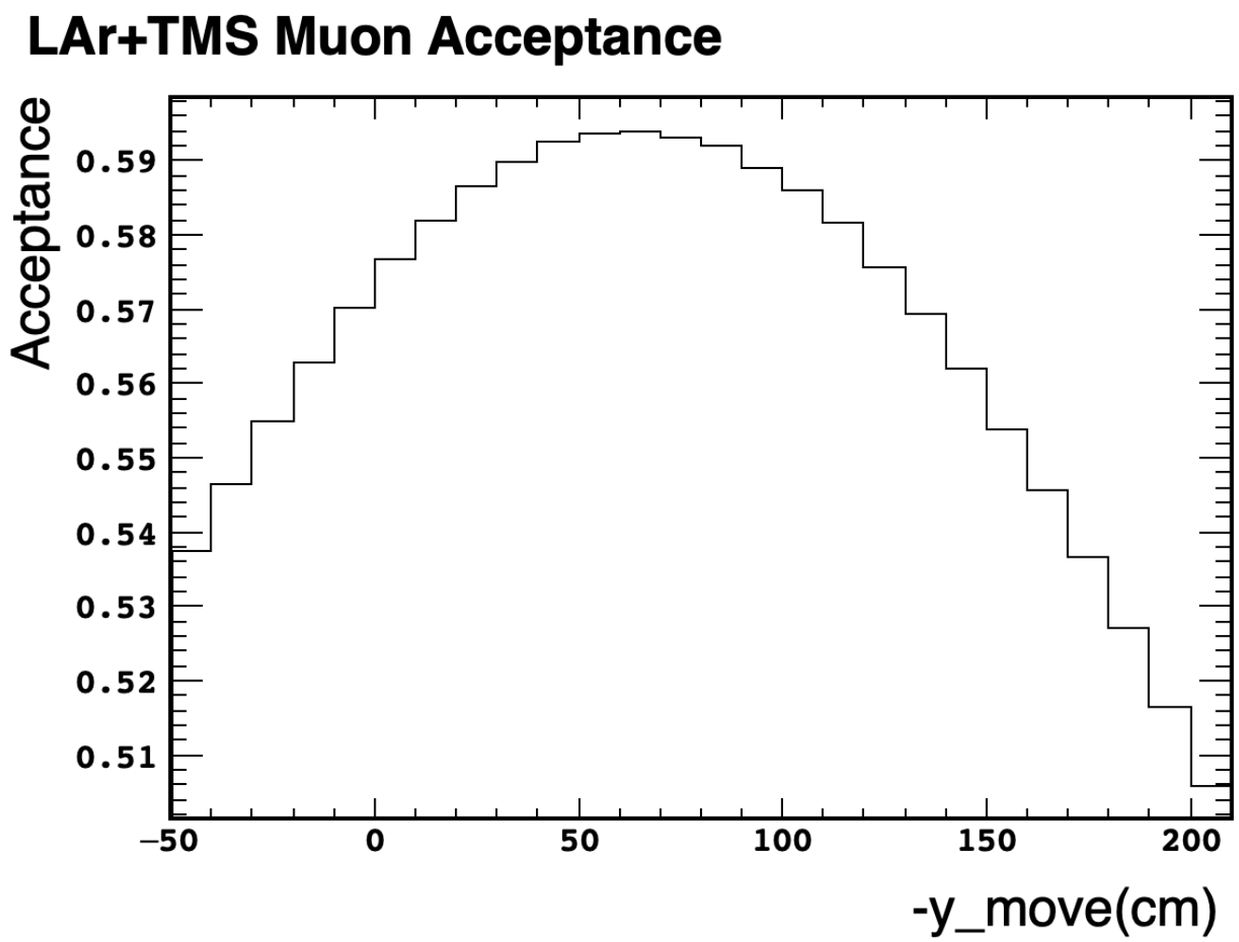
— When muon stop in ND LAr active or TMS's scintillator plane, muon is accepted.

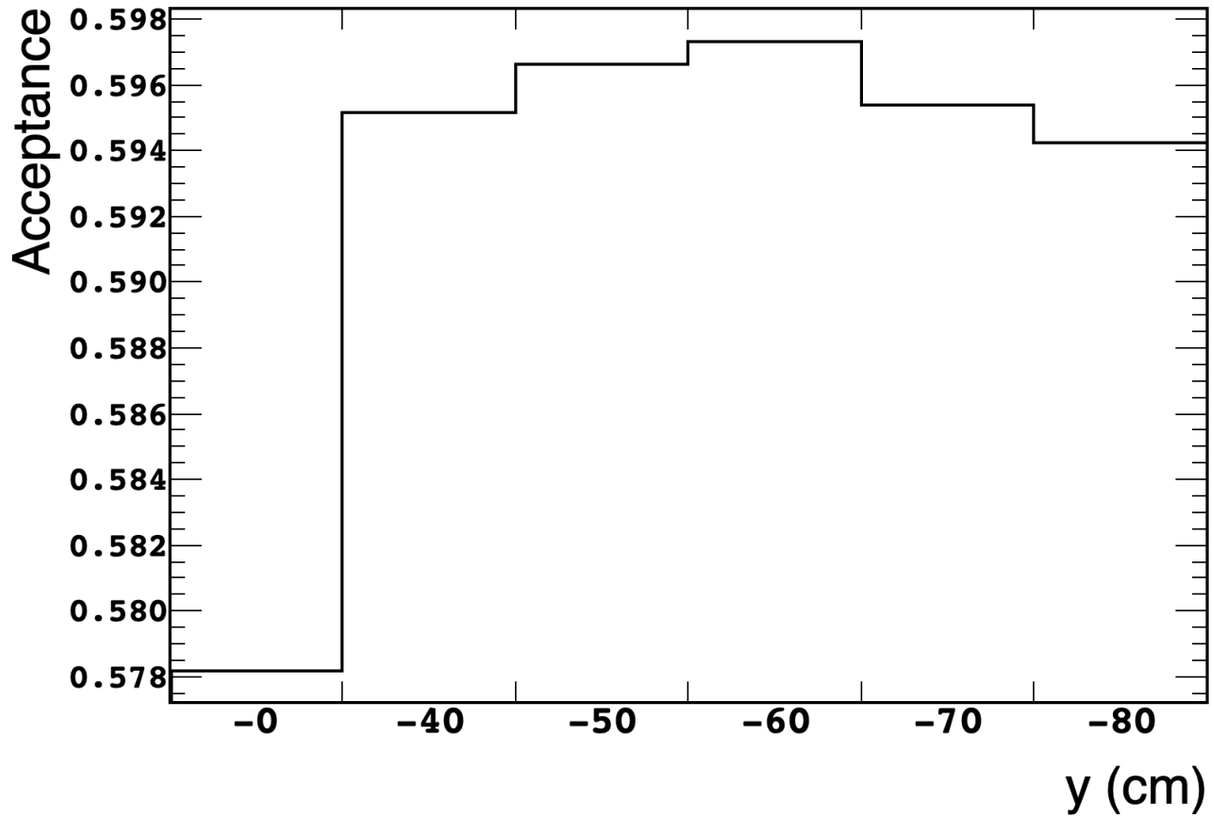


- LAr dimensions (cm): X (-350, 350), Y: (-150, 150), Z: (-250, 250).
- Fiducial volum of LAr : X (-300, 300), Y: (-100, 100), Z: (-200, 100).
- Cryostat dimension= (X: (-500, 500), Y: (—340 ,340), Z: (250, 350).
- TMS dimensions (cm) : X: (-350, 350), Y: (-150, 150), Z: (500, 1140).



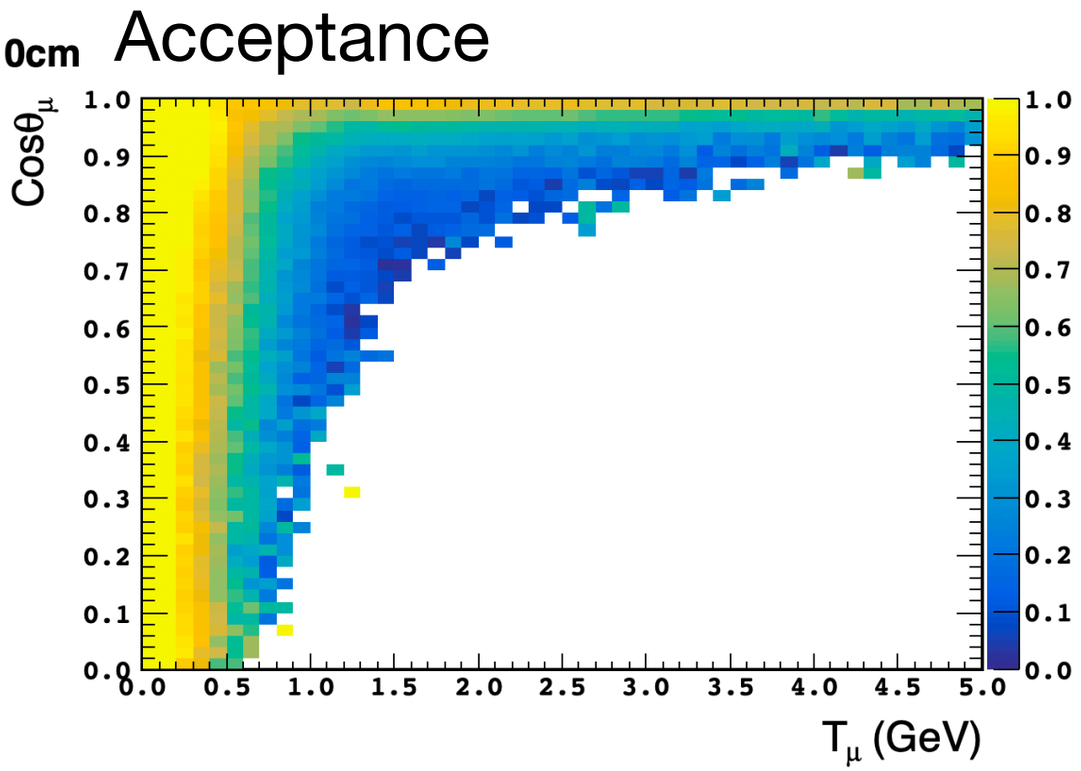
Acceptance in TMS+LAr

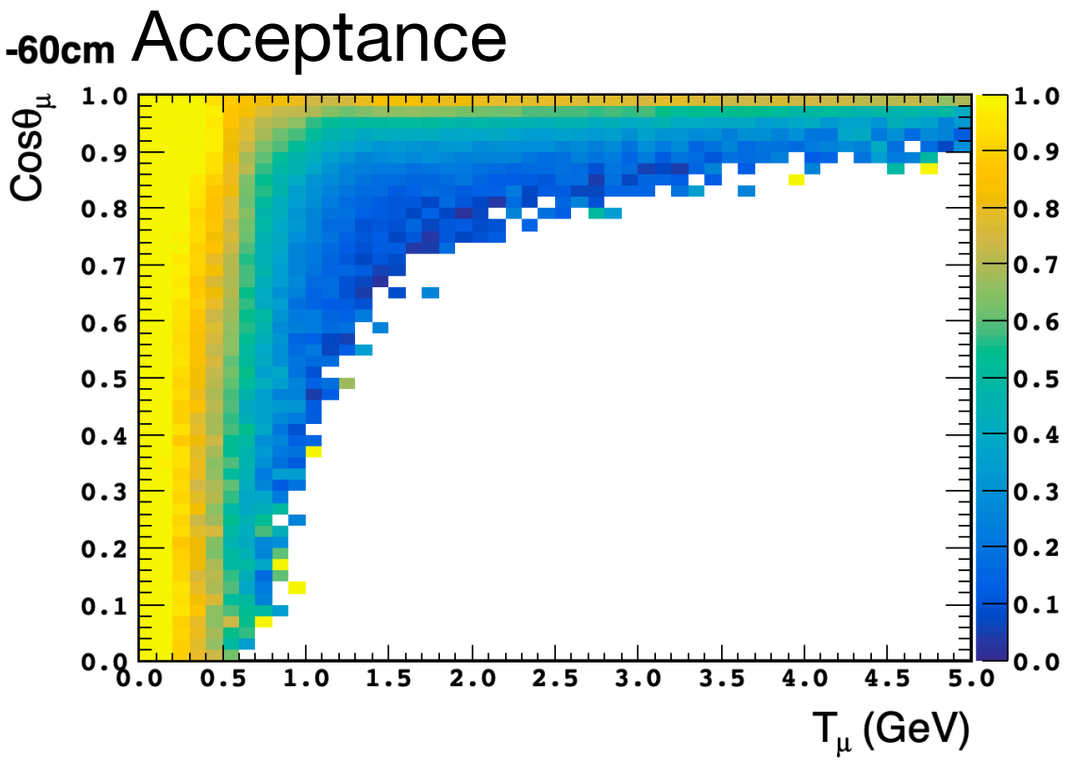


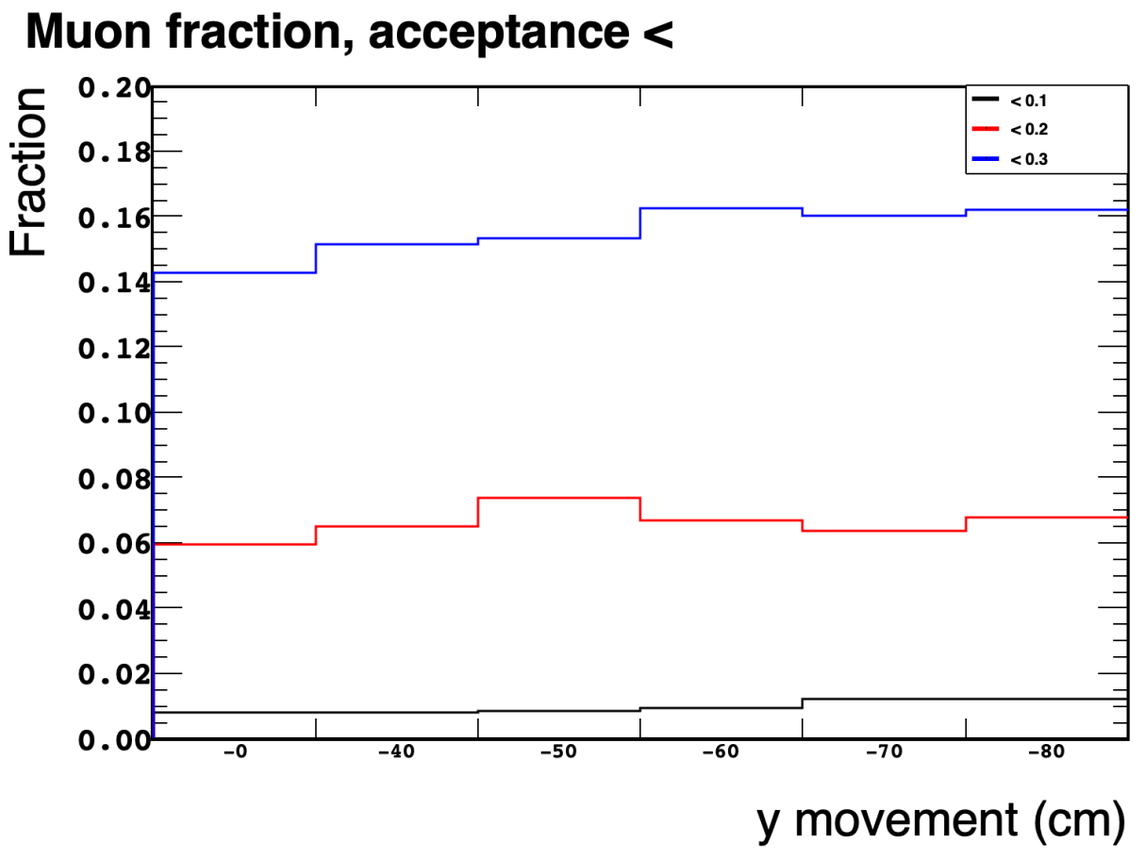


- 0cm means the center of the TMS lines the LAr's center on the y-axis.
- Moving TMS around -60cm increases the acceptance by about 2% more.
- Now, in TMS.gdml, the y position difference between the center of TMS's scintillator and the active LAr is around -90cm.

Phase space check

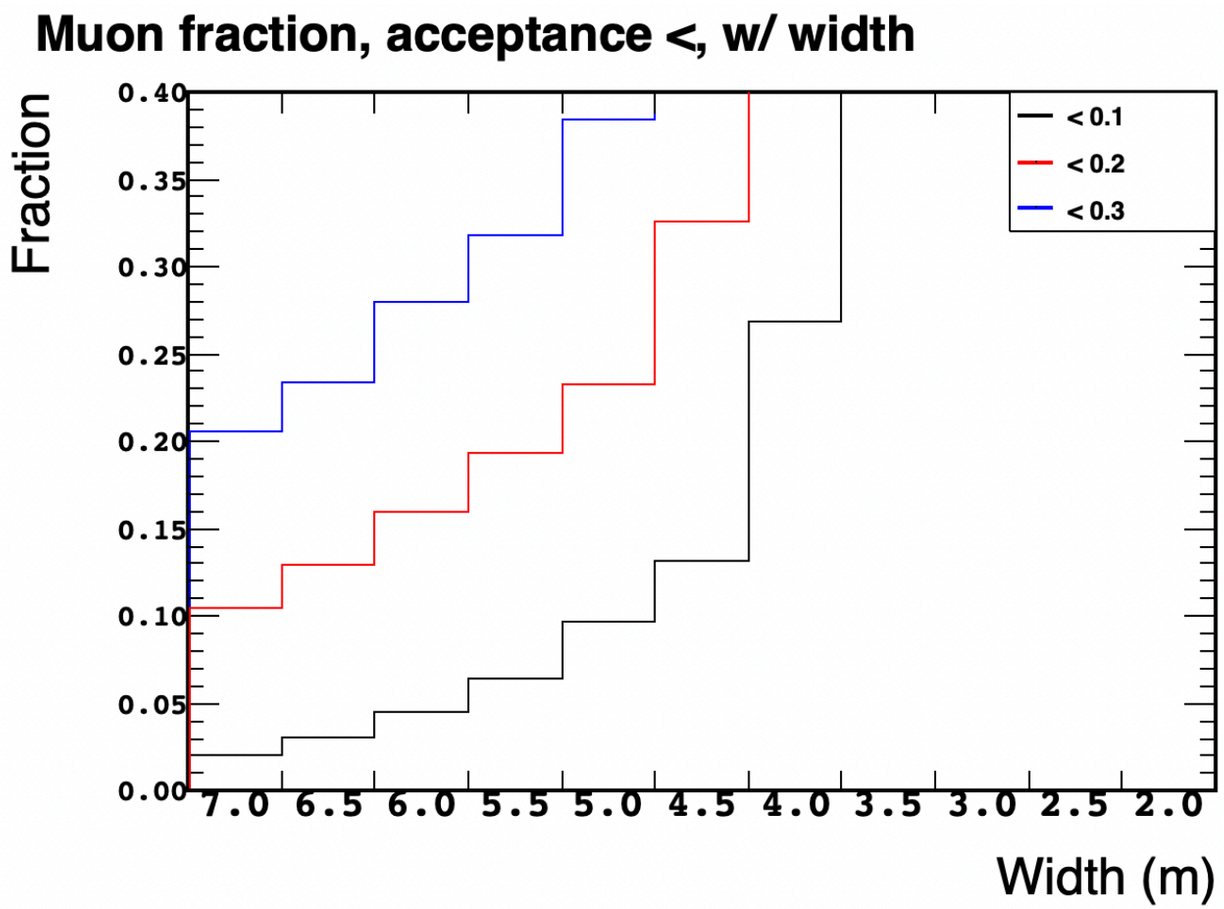


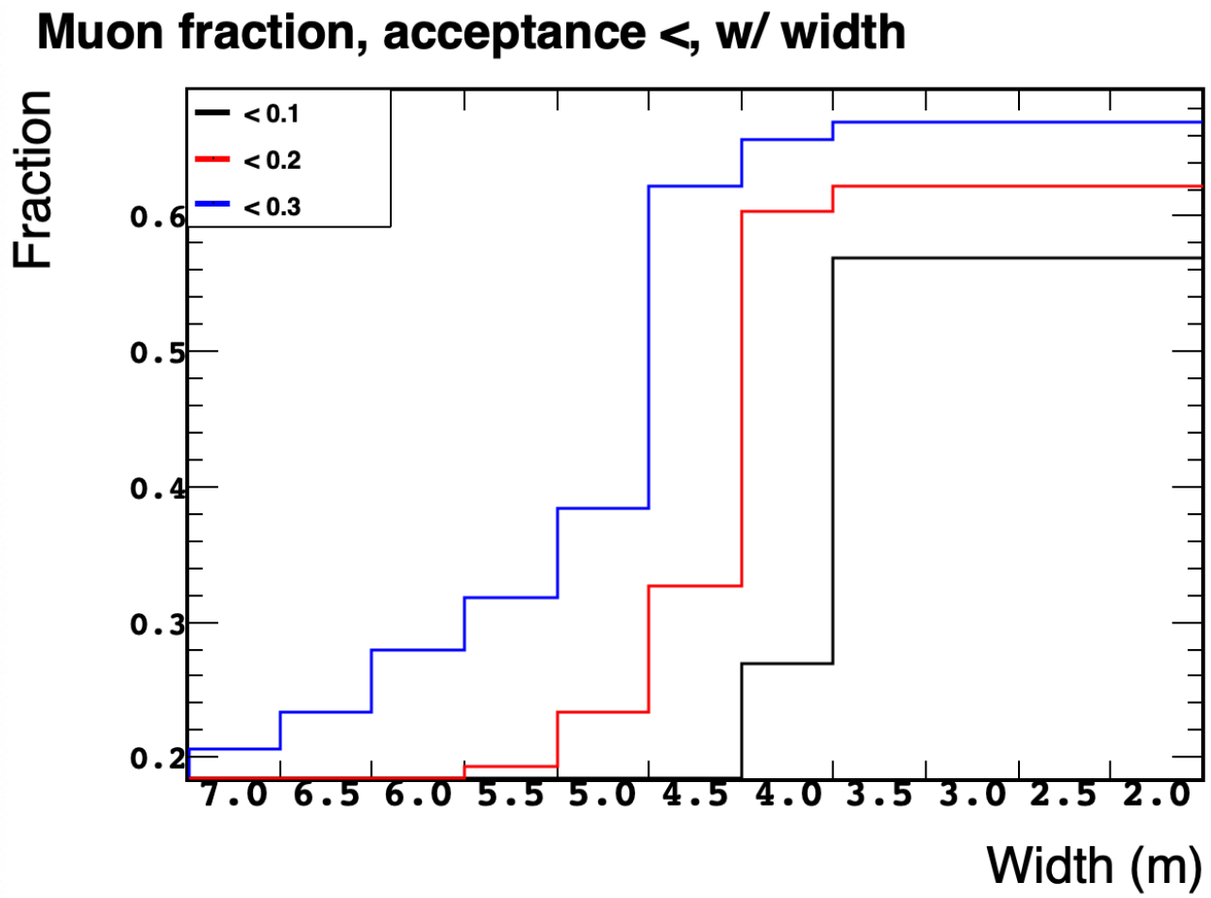




- We scanned all the bins that have acceptance below 0.1,0.2,0.3 in angle vs E. The muon fraction difference between 0 cm and -60cm is ~2% for the bin which has acceptance < 0.3.

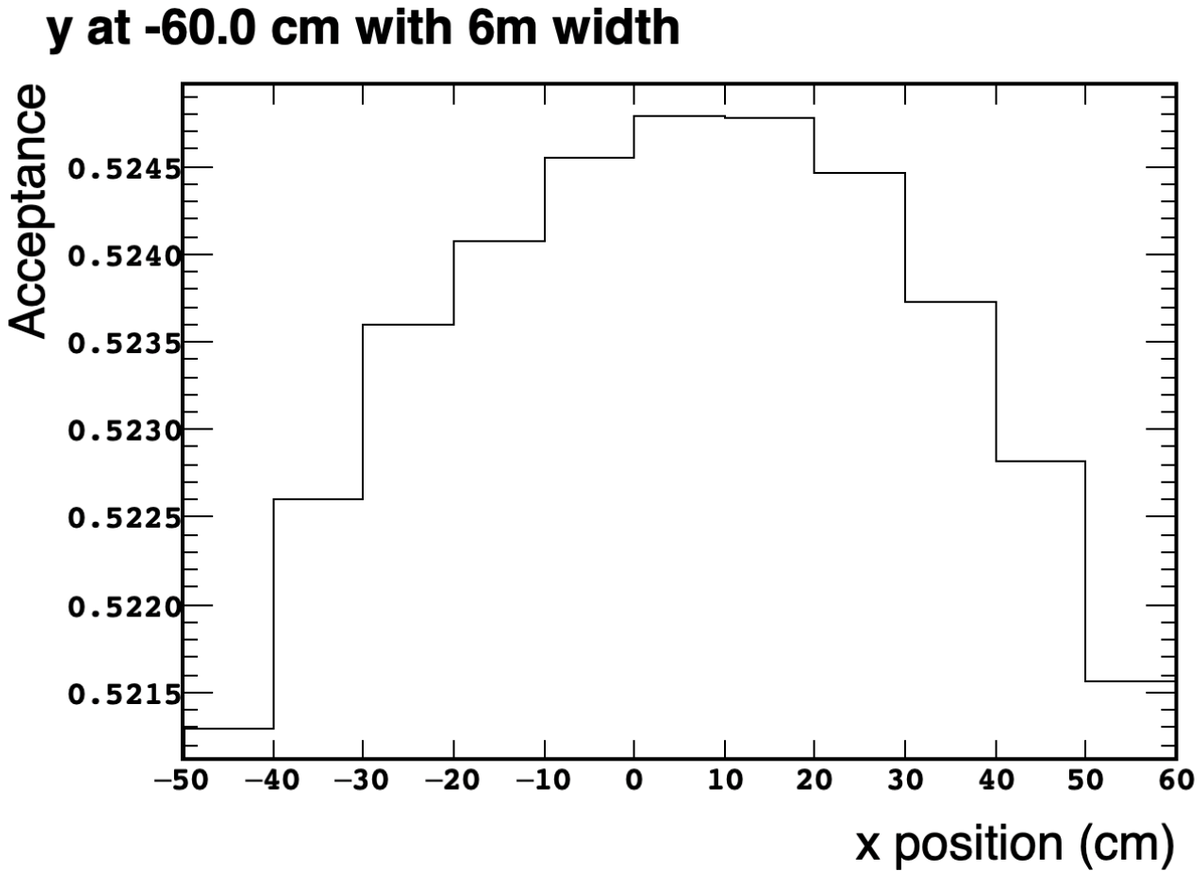
TMS width

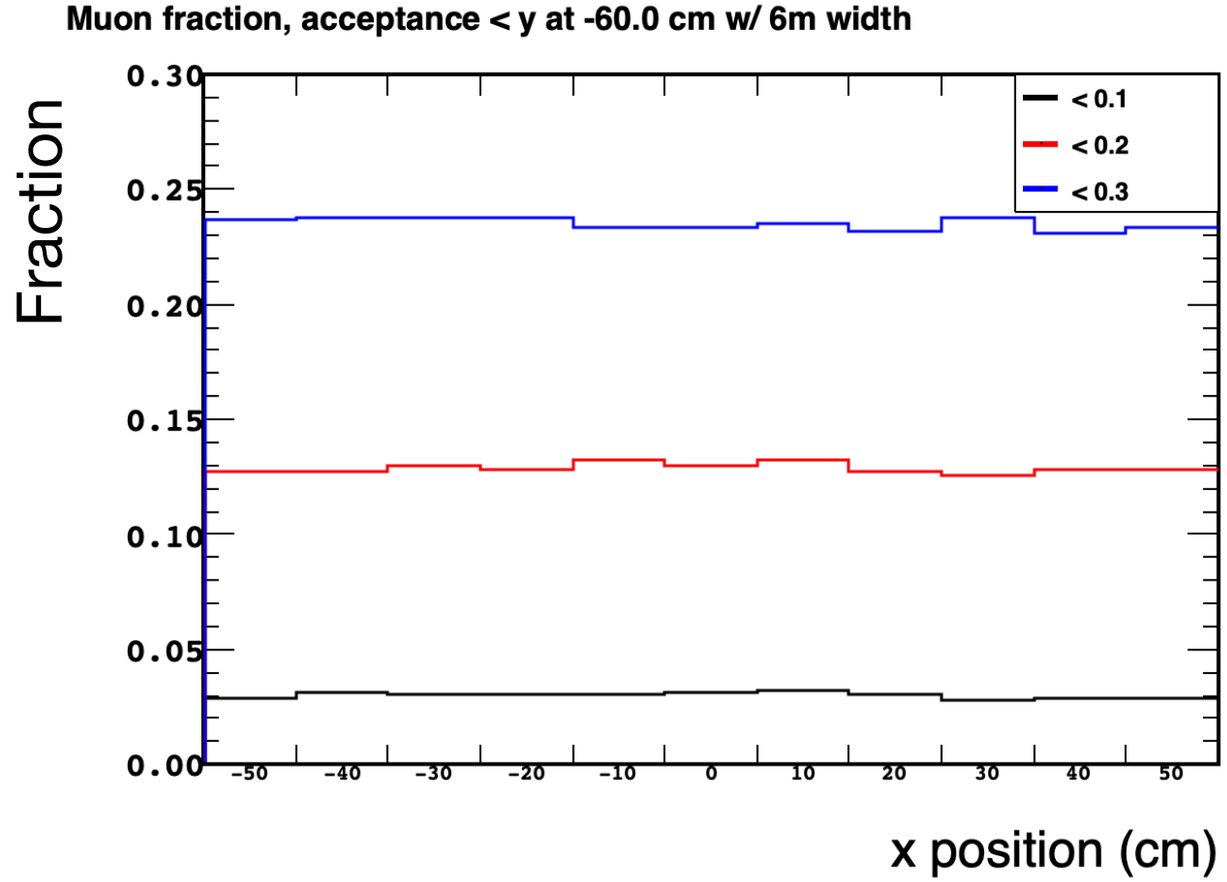




- Phase loss is significant when the TMS width is reduced to 4m.
- After 3.5m width, the phase loss is flat.

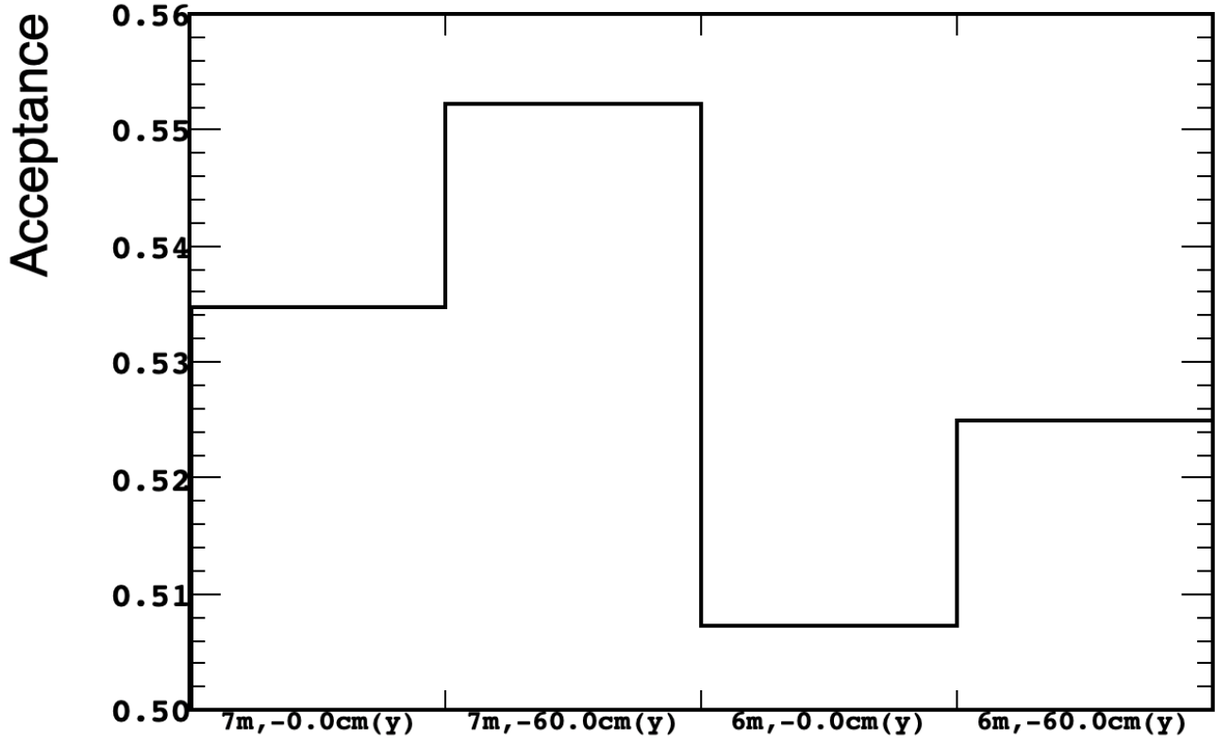
TMS x position



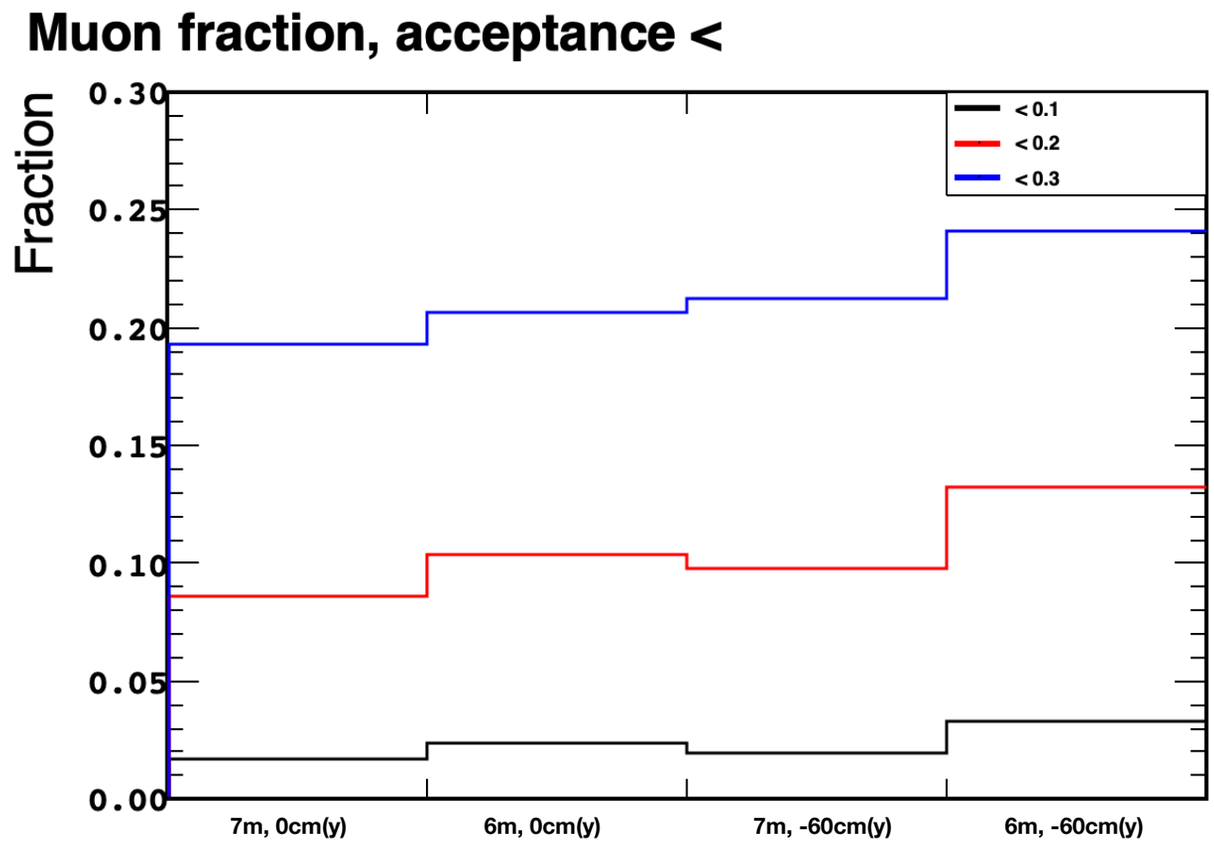


- X position of TMS does’t give any change in acceptance and muon fraction loss.

TMS's width and height



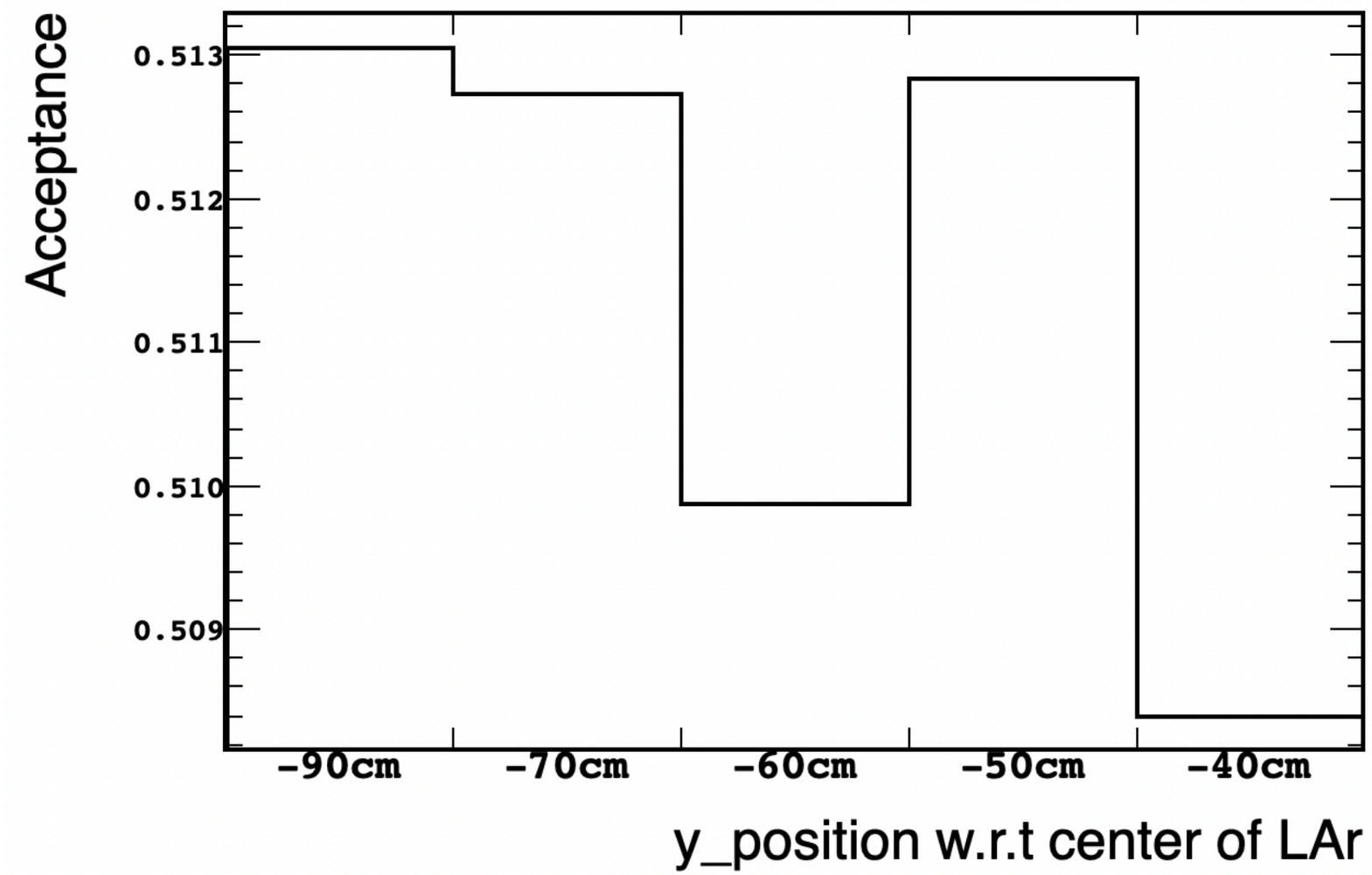
width, y_movement



width,movement

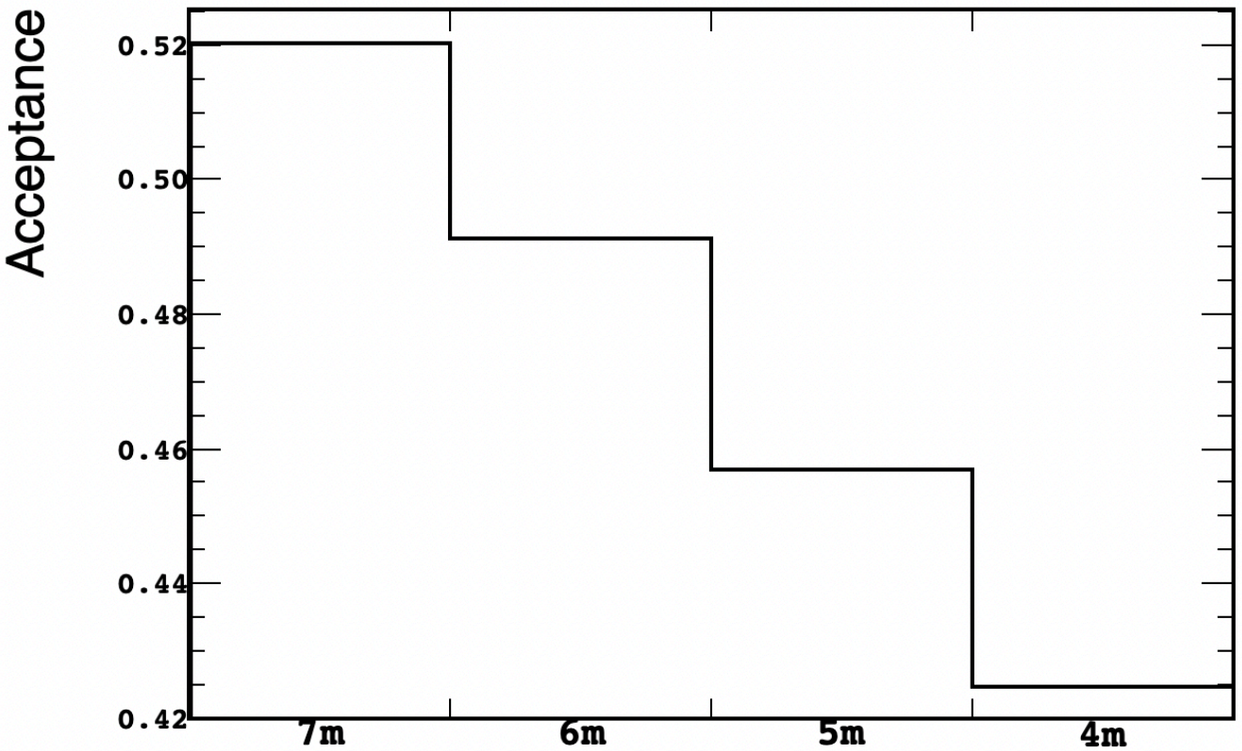
Width, height	7m, 0cm	7m, -60cm	6m, 0cm	6m, -60cm
Acceptance	53.5%	55.2%	50.7%	52.5%
μ Fraction (0.1, 0.2, 0.3)	(1.8%,8%,19%)	(1.9%,9%,21%)	(2.1%,11%,20%)	(3.5%,13%, 24%)

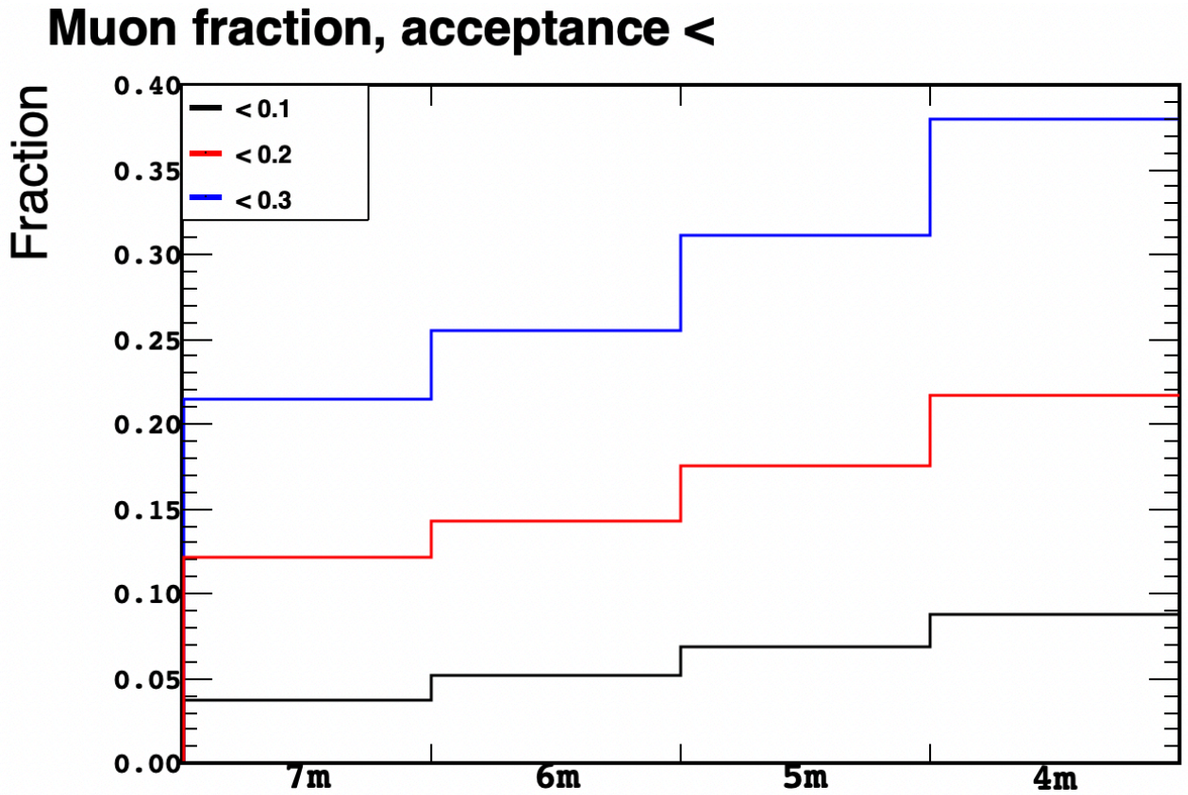
Muon acceptance from edepsim



- Muon acceptance of TMS when the y position is between -90cm and -40cm is similar.

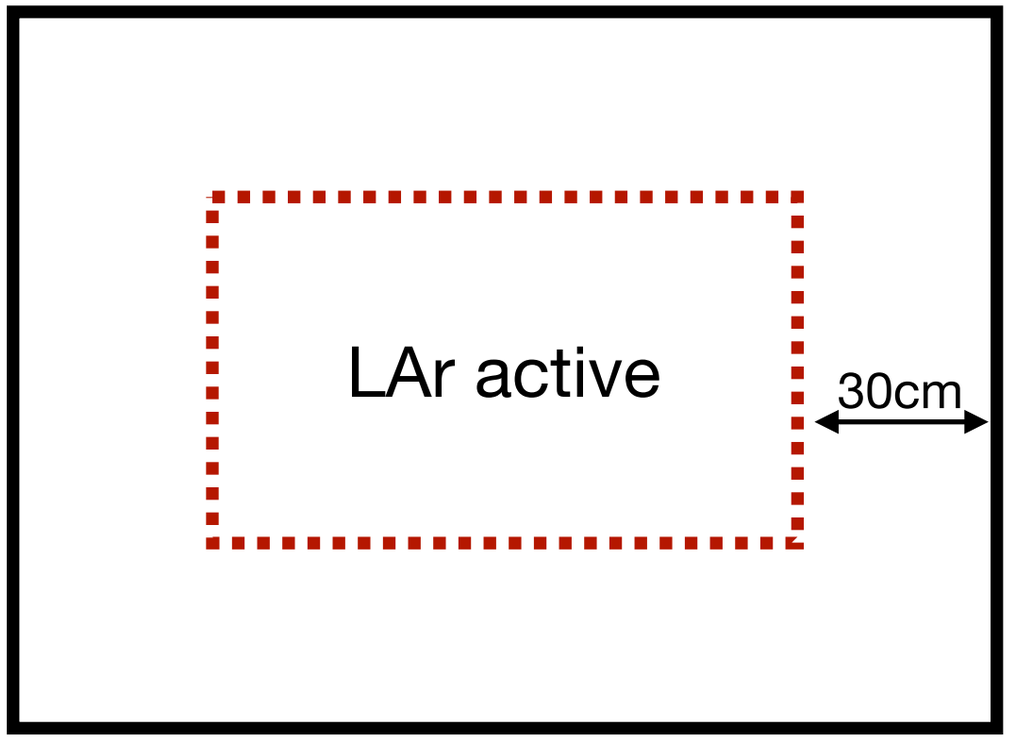
TMS width result from edepsim

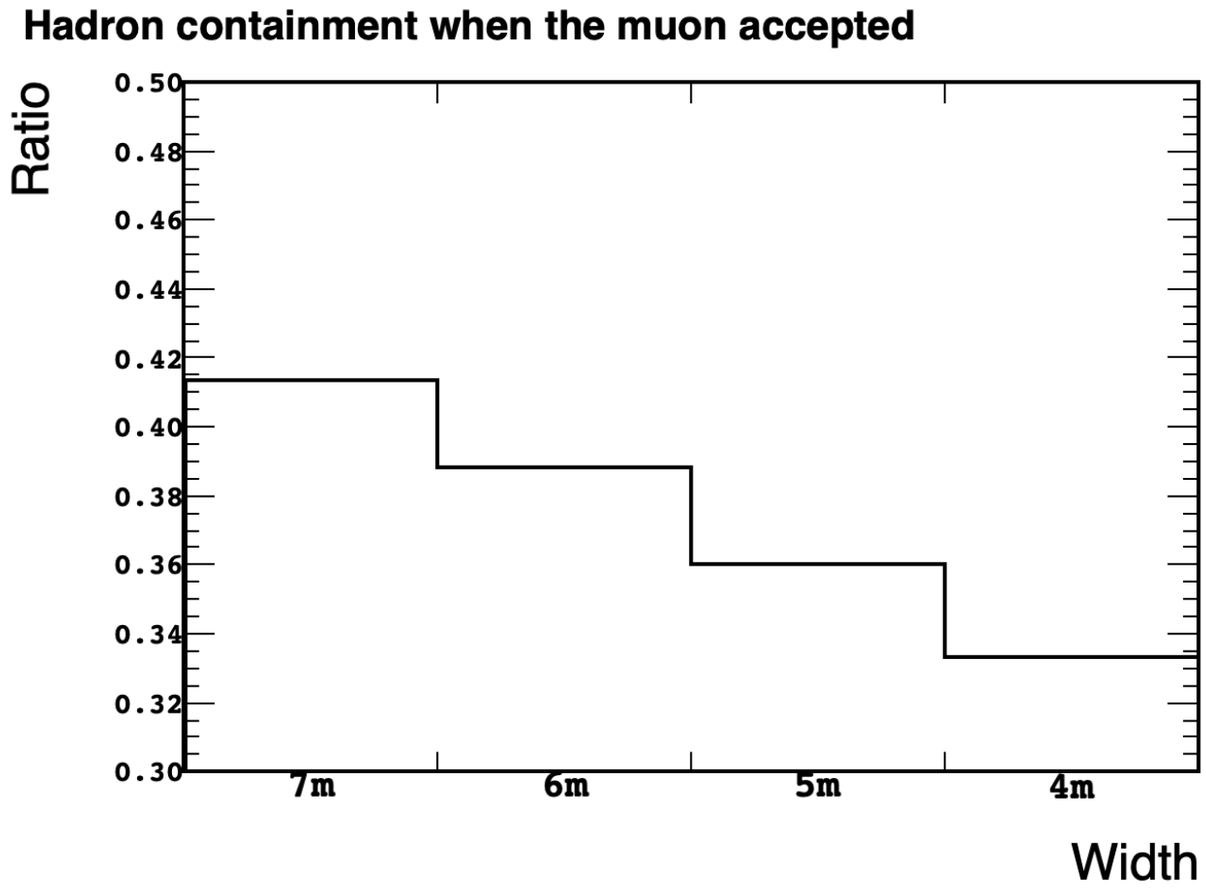




Width	7m	6m	5m	4m
Acceptance	52%	49%	45%	42%
μ Fraction (0.1, 0.2, 0.3)	(4%,12%,21%)	(5%,14%,26%)	(7%,18%,31%)	(8%,22%, 38%)

Hadron containment & muon acceptance

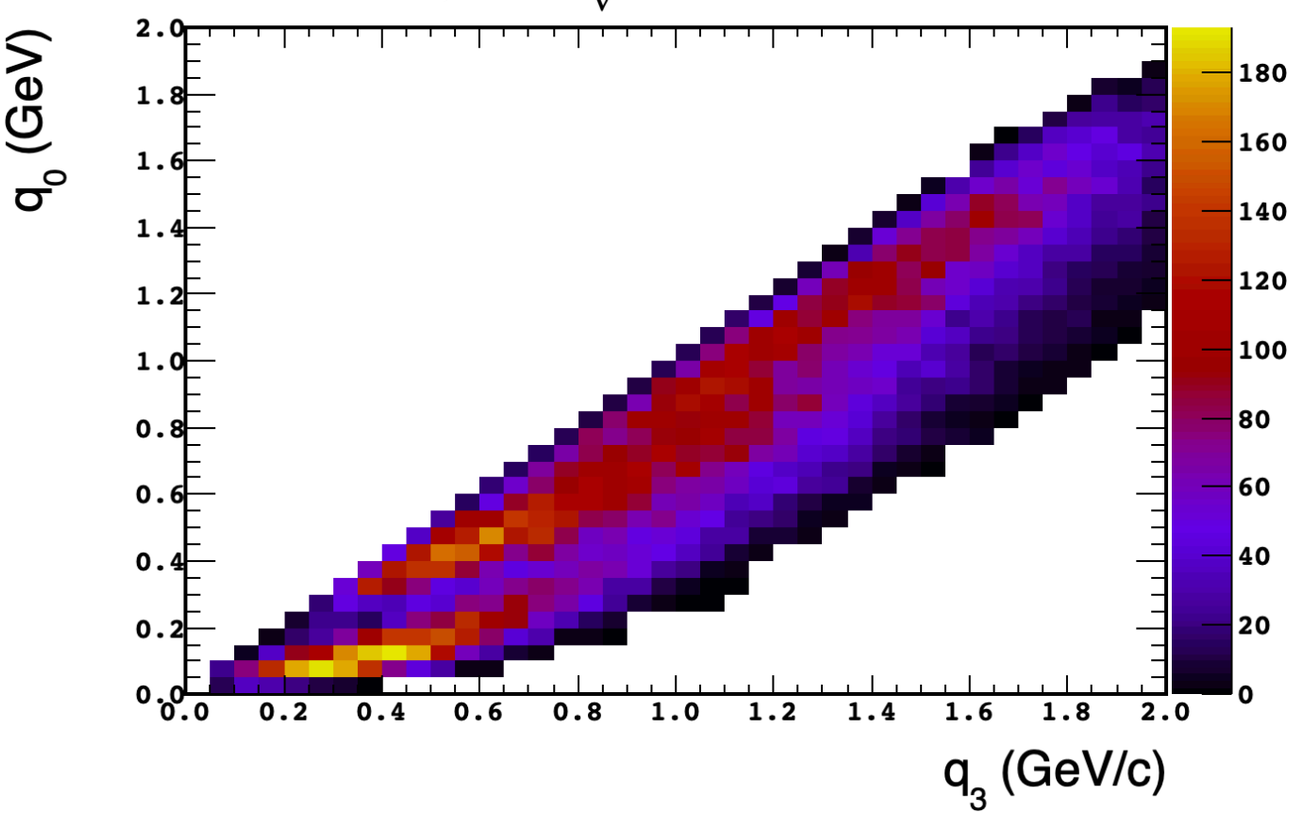


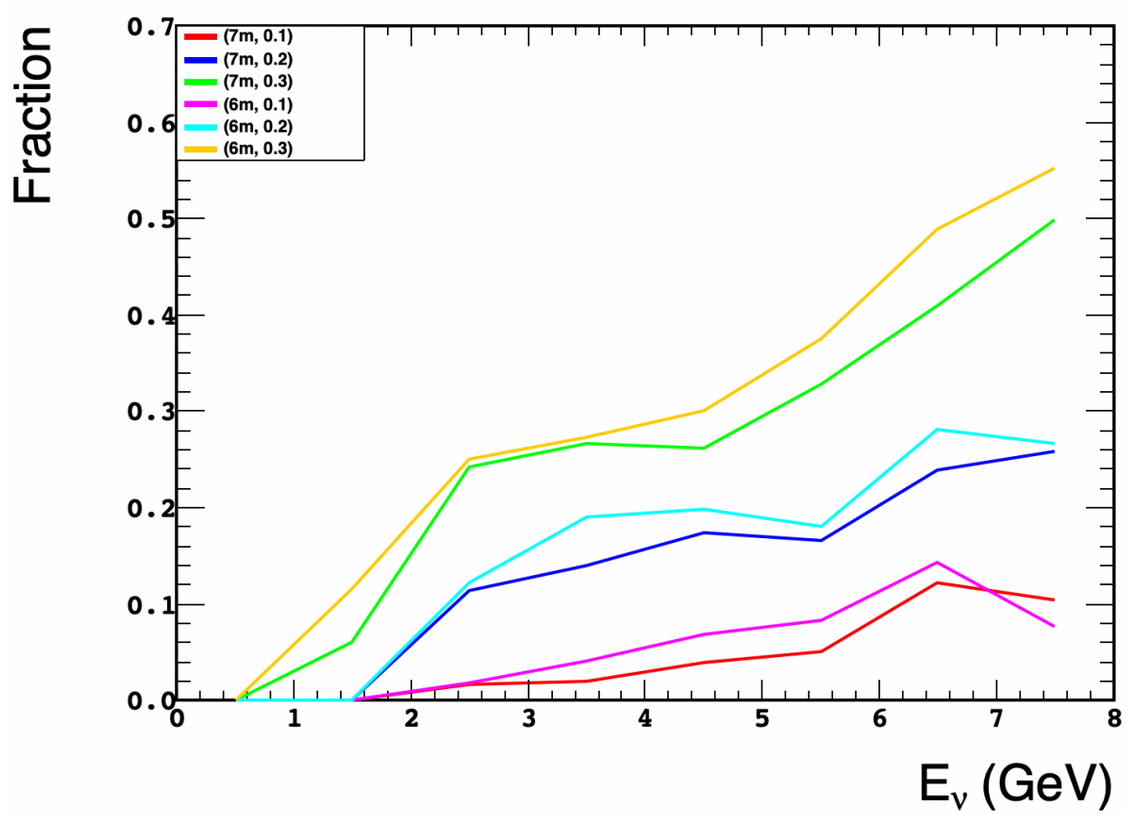


- Collect the hadron's deposit energy in outmost 30cm of active LAr region.
  if E deposit <30 MeV, hadron is contained in LAr.

Width	7m	6m	5m	4m
Hadron acceptance ratio	41%	38%	36%	33%

Phase space check for hadron & muon acceptance





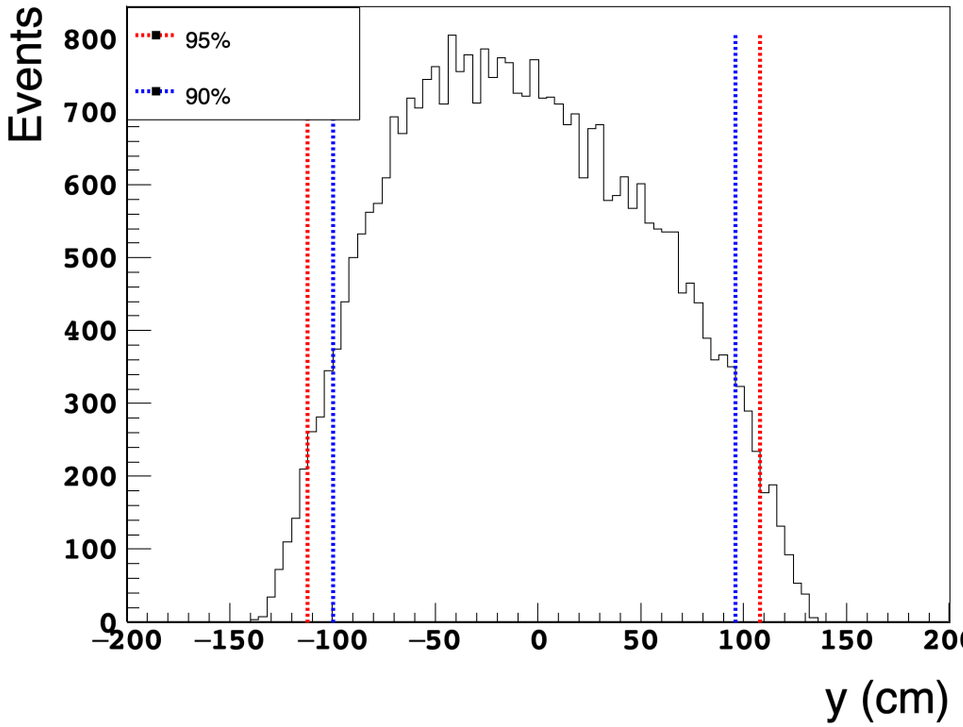
- Like before, we scanned all bins in q_{3} vs q_{0} region.
- At the neutrino energy (2 GeV,3 GeV), the hadron fraction is less than 1% difference for every acceptance.

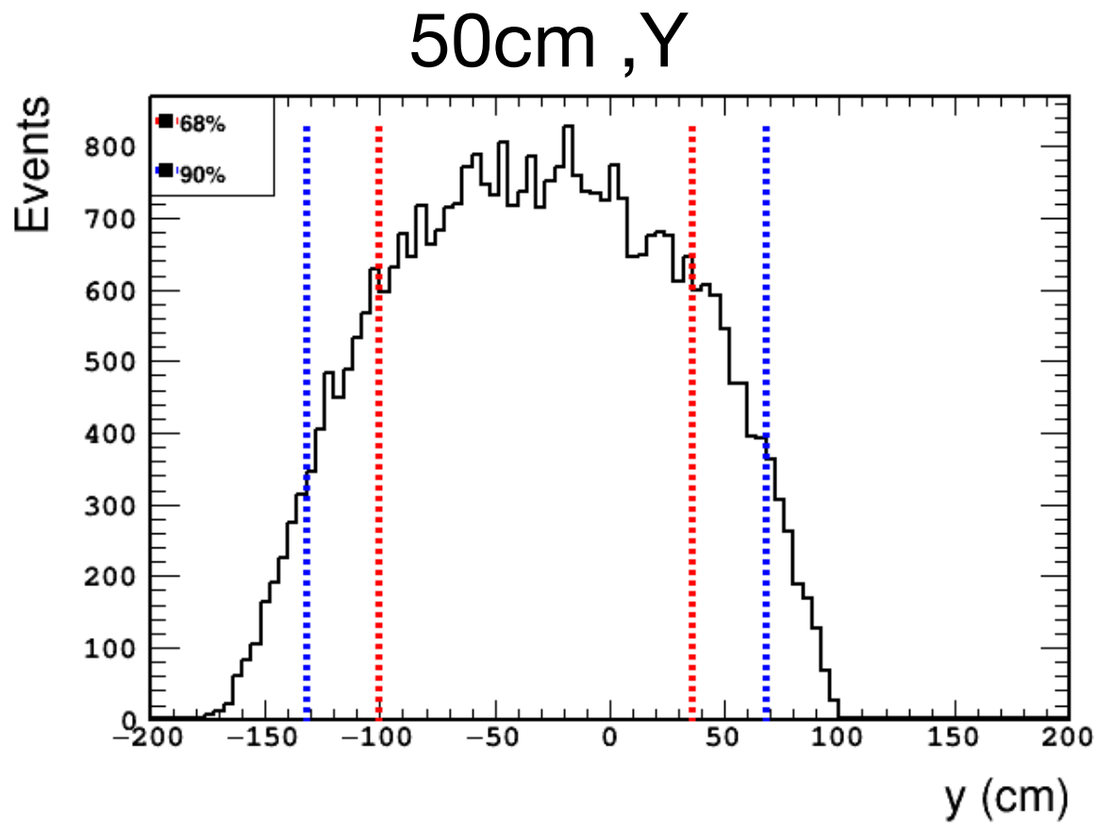
Summary

- We can get the muon 2% more comparing the position at 0 cm by adjusting the y position around -40~80 cm.
- Phase loss gets severe when TMS's width shrinks from 4m.
- The phase loss of Hadron and muon containment between 7m and 6m width doesn't have a big difference at the neutrino peak region.

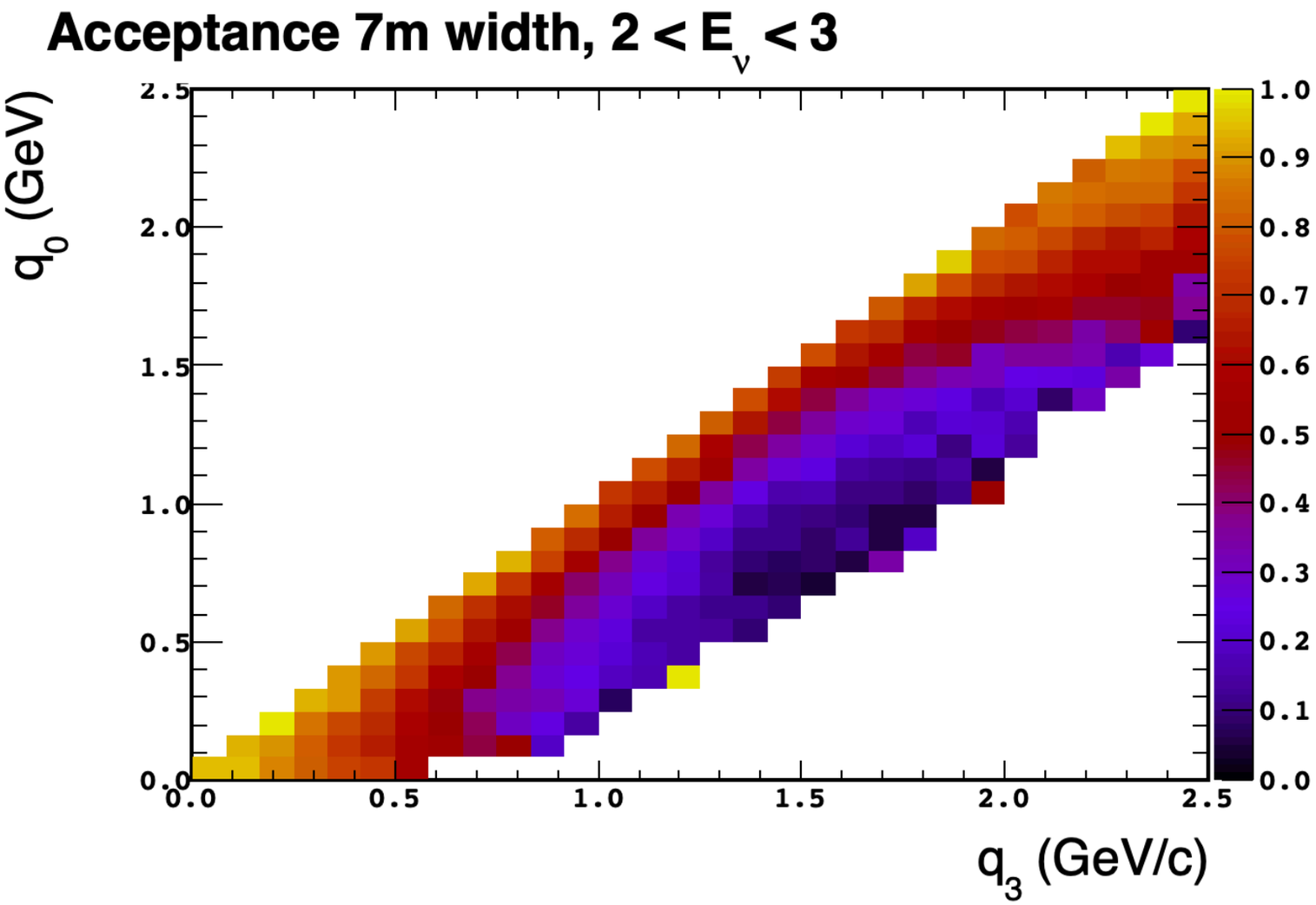
Backup

- TMS'center on 0 cm

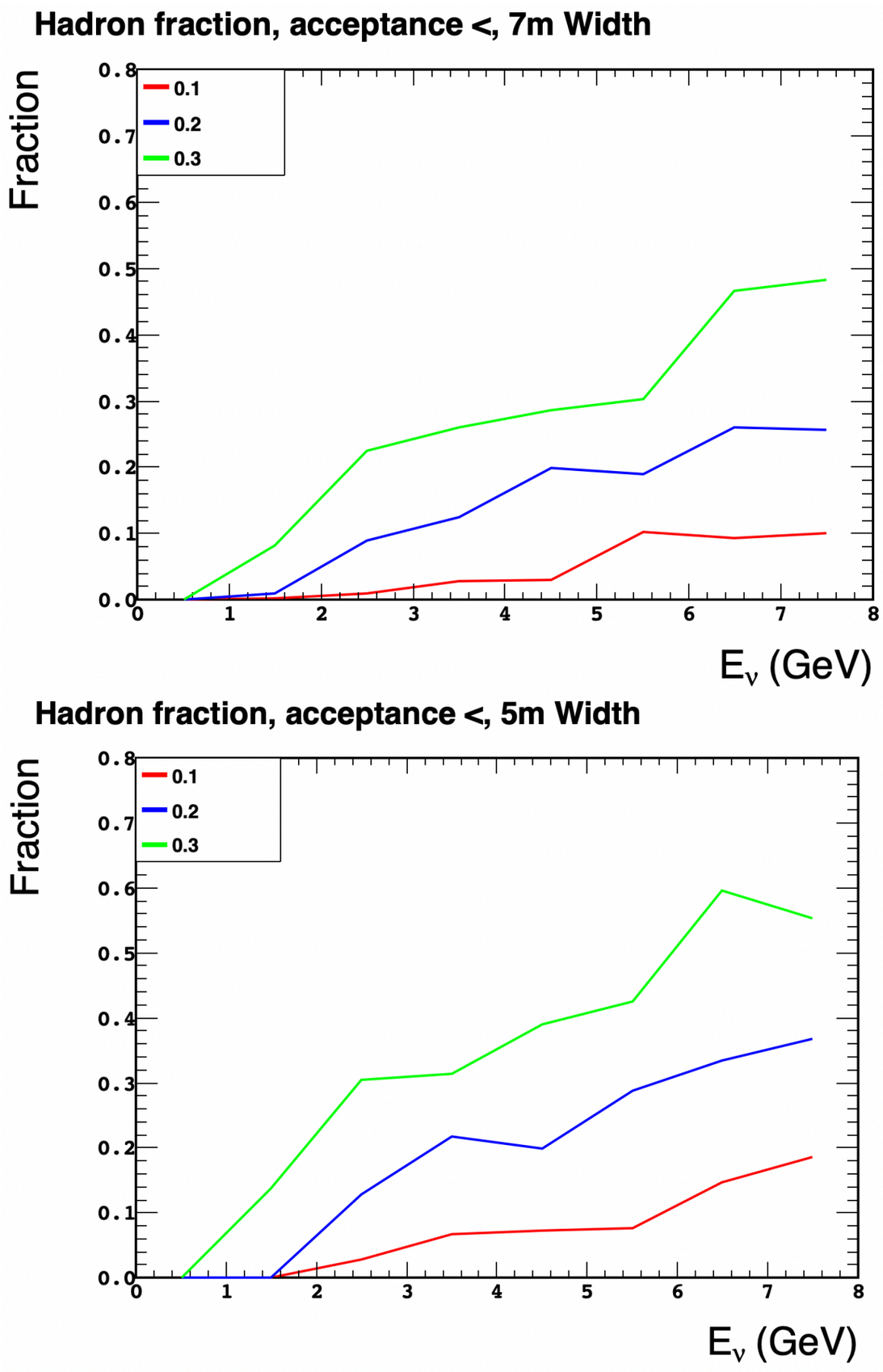


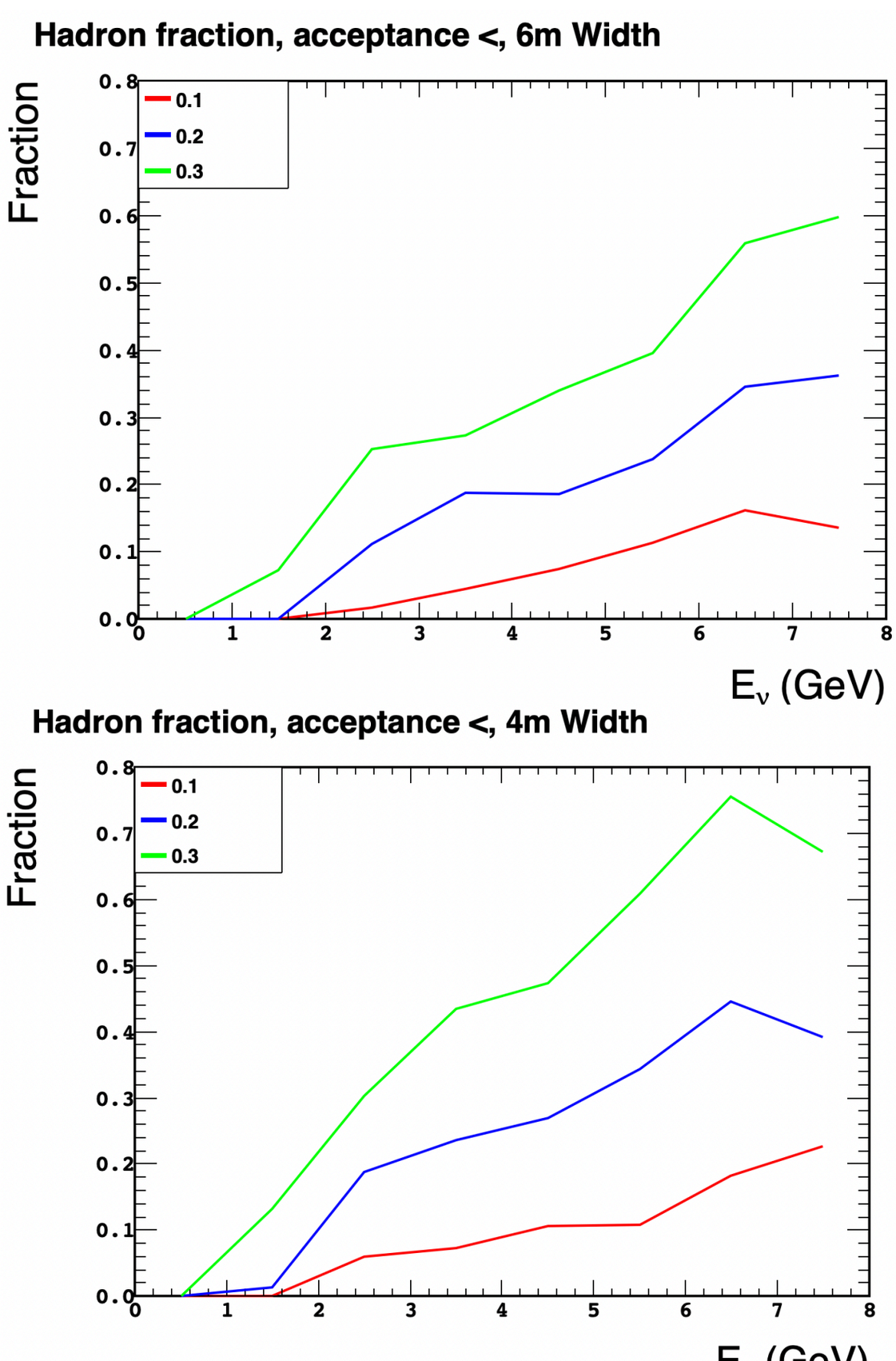


Backup


Acceptance 7m width, 2 < E_ν < 3
q0 (GeV)
q3 (GeV/c)
0.0
0.5
1.0
1.5
2.0
2.5
0.1
0.2
0.3
0.4
0.6
0.7
0.8
0.9

Backup


Hadron fraction, acceptance <, 7m Width
Fraction
0.1
0.2
0.3
E_ν (GeV)


Hadron fraction, acceptance <, 6m Width
Fraction
0.1
0.2
0.3
E_ν (GeV)

Hadron fraction, acceptance <, 5m Width
Fraction
0.1
0.2
0.3
E_ν (GeV)

Hadron fraction, acceptance <, 4m Width
Fraction
0.1
0.2
0.3
E_ν (GeV)