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SOLENOIDAL DETECTOR NOTES

EFFECTS OF DESCOPING OPTIONS FOR THE MUON SYSTEM

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Effects of Descoping Options for the Muon System

Here are some studies on the effects of descoping options for the muon system. These are partial responses to some M. Gilchriese questions, and some studies suggested by Gary Feldman. Here are Gilcriese's questions:

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1) What determines the thickness of the barrel steel toroid?

2) What is the justification for BW1? What radial space should be allocated for BW1 if it exists?

3) What is the momentum resolution as a function of Pt he region covered by the forward toroids for total iron thickness of 1.5m? of 3m? of 4m? Do this for LoI inner tracker and then for descoped system. Assume either only silicon for the intermediate angle central tracker or silicon plus outer intermediate tracker. We need a good simulation which combines central and muon tracking systems, which takes full account of multiple scattering.

We begin with some results on the thickness of the forward toroid

(1) Figure 1 shows the effects of full offline momentum resolution for muons in the forward region for various choices of forward iron toroid thickness. These resolutions are slightly better than the LOI figure on page 23 because the LOI has an intermediate chamber 1/2 through toroid and a bigger downstream lever arm to accommodate Cerenkov counter. At high rapidity and large Pt where the iron toroid is really supplying the bulk of the momentum information (rather than the intermediate tracker) the effects of reducing forward toroid thickness are evident.

The resolution from the intermediate tracker was obtained from the LOI and is of the form:

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A = .0053*eta
B = .00026+.0011*(abs(eta)-1.7)**2
Sigma Pt/Pt =sqrt(A**2+(B*P_t)**2)
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The reciprocal variance from the intermediate tracker is added to the reciprocal variance obtained from the forward iron toroid as a stand alone to estimate the reciprocal variance of the combined system.
If a simple detector model of the intermediate tracker could be obtained a better estimate of combined resolutions could be made.

(2) Figure 2 shows the effective momentum resolution for various toroid thicknesses for the case of no help from the intermediate tracker.
Here the effects of reducing the forward toroid are dramatic.

We next discuss the effects of descoping the barrel muon system (ie reducing the thickness of the barrel toroid and the radial extent of BW1).

(3) Figure 3 shows the effects of descoping the barrel toroid from the LOI 1.5 meter toroid to the 1 meter descope toroid. I also have included the effects of shrinking BW1 from its original 1 meter radial extent to the 0.5 meter radial extent in the descoped drawings.
This plot includes all central tracking including a model of silicon.
The dashed curve is the canonical central tracker resolution of 26% at 1 TeV. Clearly the muon system dramatically improves resolution at high momentum and the effects of descoping in a complete system

are not that crucial. We have modeled each muon detector with a Z and Rphi resolution of 250 microns.

(4) Figure 4 shows the effects of descoping (as described above in point 3) for the hi luminosity option where we assume that good quality information exists for the silicon and the muon system but not for any other central tracking. A significant degradation in resolution is observed at large rapidity and and hi Pt due to descoping.

(5) Figure 5 examines the performance of the barrel muon detector as a complete stand alone system (solid curve) and with a 1 mm beam constraint for the central and eta = 0 rapidity. This is for the original LOI proposal. The (optimistic?) beam constraint helps somewhat at eta = 0.

(6) Figure 6 compares the performance of the Loi and Descoped barrel muon toroid in stand alone mode (no beam constraint). The Descoping has created a significant degradation in performance at eta = 0.

(7) Figure 7 investigates the effects of reducing the thickness of BW1. We plot the LOI muon toroid at eta = 0 as a complete standalone system with no beam constraint. The lower solid, dashed, and dotted curves give the resolution for the case where the R-Z measuring planes of BW1 are radially separated by 1 meter, 0.5 meter, and .25 meter. Some degradation in performance is noted.

The upper solid, dashed, and dotted curves give the performance for 1 meter, 0.5 meter, and .25 meter Delta R BW1, where we have assumed that inner planes are randomly aligned in Z by 1 mm (RMS) relative to BW2 and BW3 (which we assume are perfectly aligned). If one has difficulty in maintaining alignment (owing to the presence of the toroid) at this level, one seriously degrades the muon toroid stand alone performance if one gives up the concept of a thick BW1. I think this is the argument which sets the thickness of BW1 and was first suggested to me by Duncan Carlsmith.

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(8) Figure 8 is a study suggested by Gary Feldman. It shows the momentum resolution obtainable by comparing the phi angle measured by the muon system and the angle measured by the outermost CTD layer. For these calculations, the bending power is provided by the magnetic flux returning through 2 meters of calorimetry with an assumed field strength of 0.523 Tesla. I assume that the CTD stub provides an angular resolution of 2 mrad. Furthermore I have turned off the solenoidal magnetic field in the CTD region which will tend to cancel a non-negligible fraction of the flux return bending power.

Calculations are presented for the phi angle as measured by BW1 alone (with an assumed angular resolution of 0.7 mrad), and the full barrel muon system consisting of BW1 --> BW3. The dashed curves use full MCS weighting of all space points, and are probably inappropriate at the trigger level. The solid curves use just the measured phi angle difference between the muon system and CTD stub and have no MCS weighting.

Clearly under all scenario's, the calorimetric flux return alone provides poor momentum resolution for a second level trigger compared to the resolutions obtainable in Figure 7 where R-Z information from BW1-3 is used to measure momentum using the bending power of the muon toroid.

(9) Figure 9 gives some resolutions for the case where a 100 micron beam constraint (BC) is combined with information from the outer CTD layer and the phi information of BW1. Very good performance is obtained for the case (dashed curve) where the B.C. + CTD stub + BW1 information is weighted in accordance with multiple coulomb scattering (MCS). Again this is probably unsuitable for a 2nd level trigger. If no MCS weighting is used, one obtains the the nearly momentum independent solid curve. If only the beam constraint and outer CTD stub layer is used without any use of BW1, one gets the solid curve where relative resolution is roughly proportional to momentum.

Fig.1: Forward Fe toroid + intermed

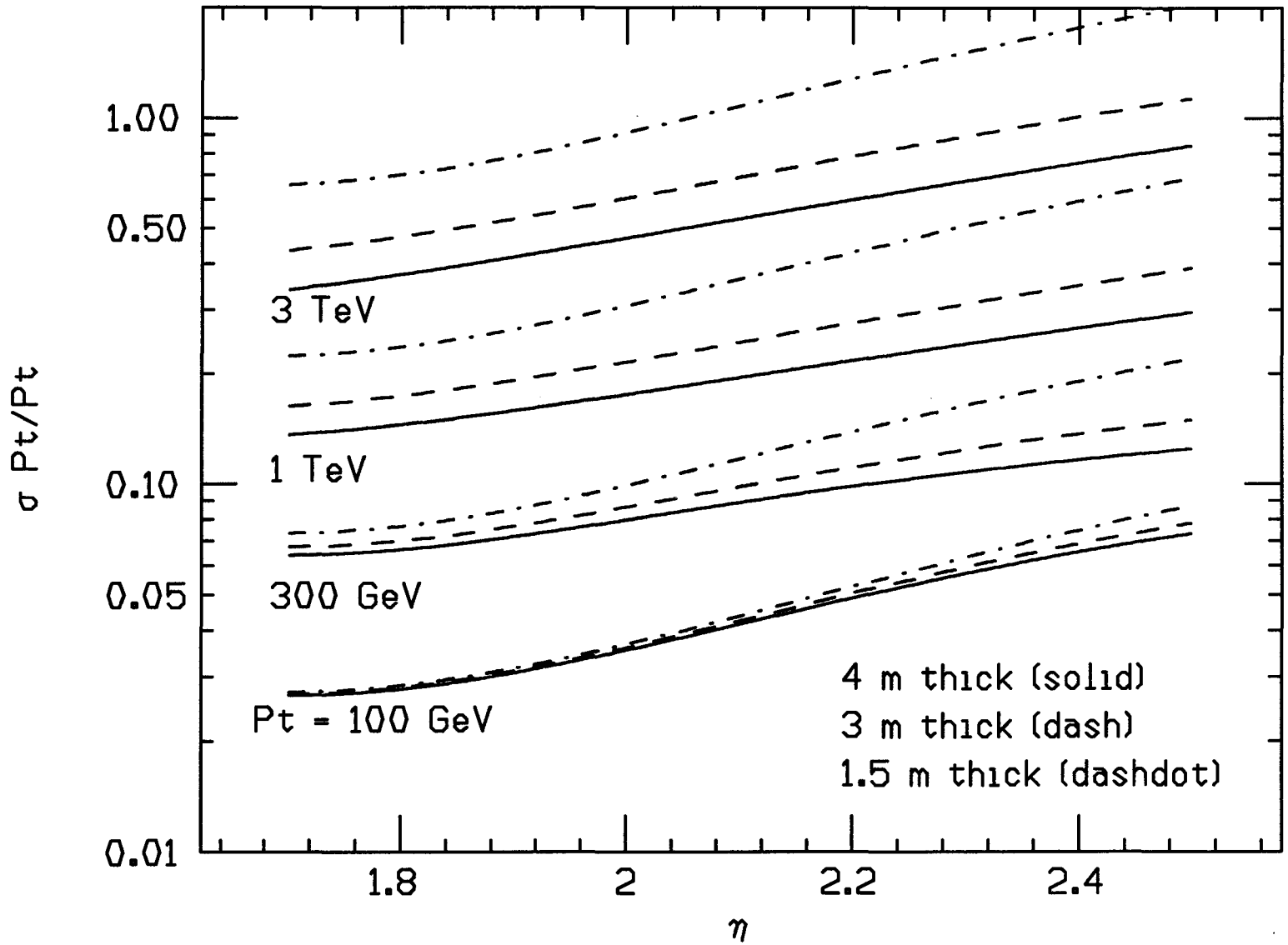

Fig 2: Forward Fe toroid S.A.

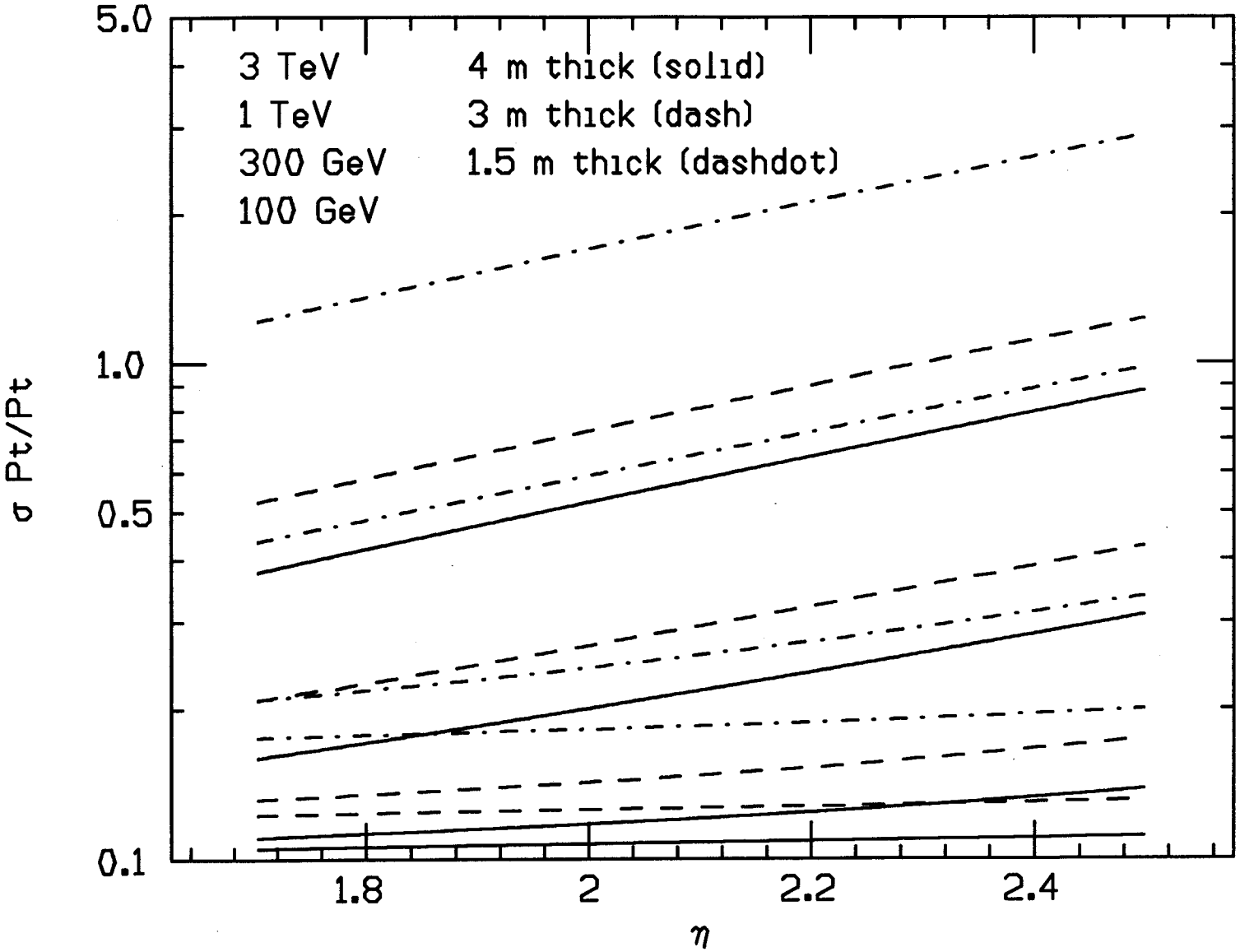

Fig 3:Resolution for muons

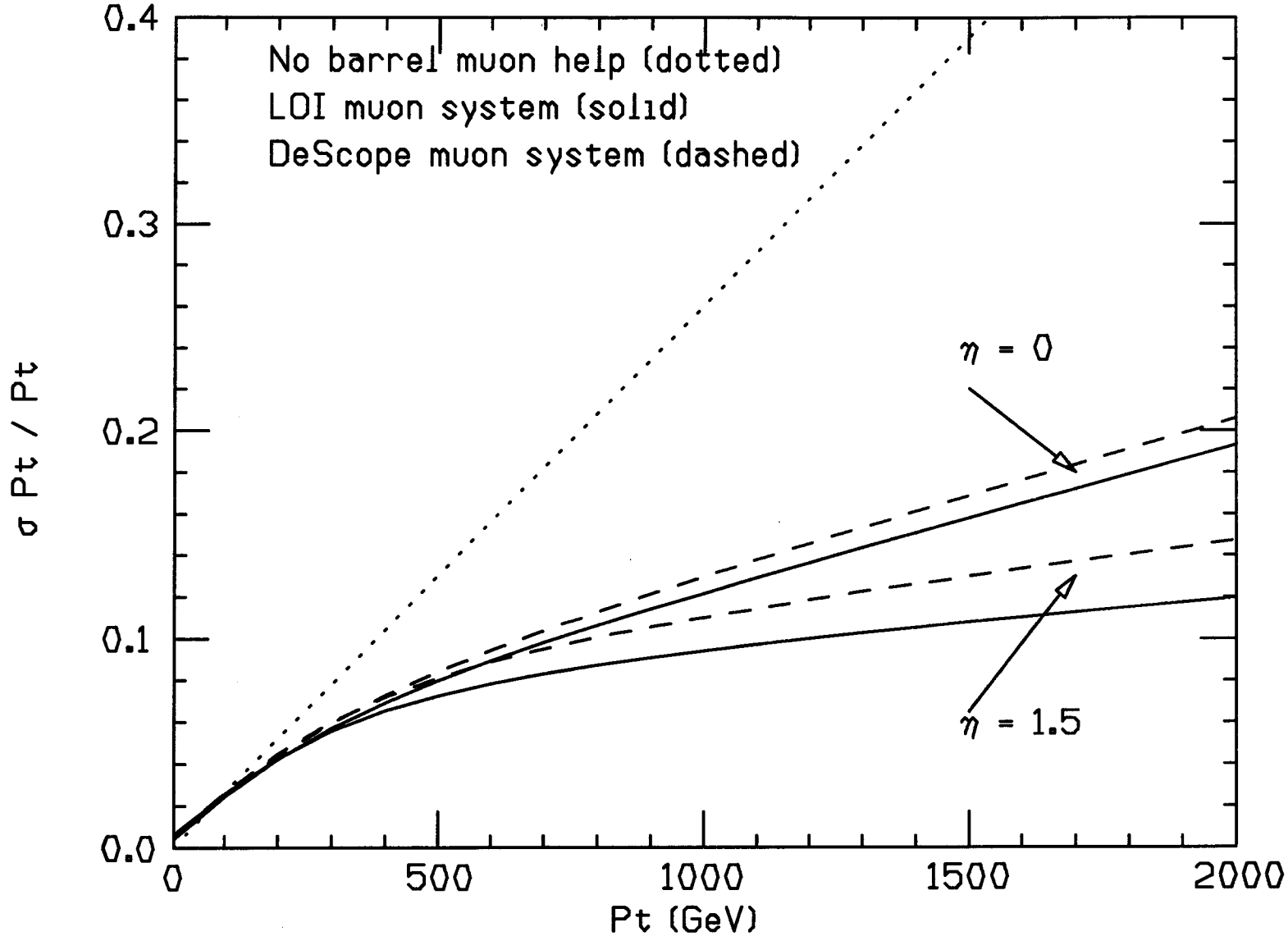

Fig 4: Hi Lum Option

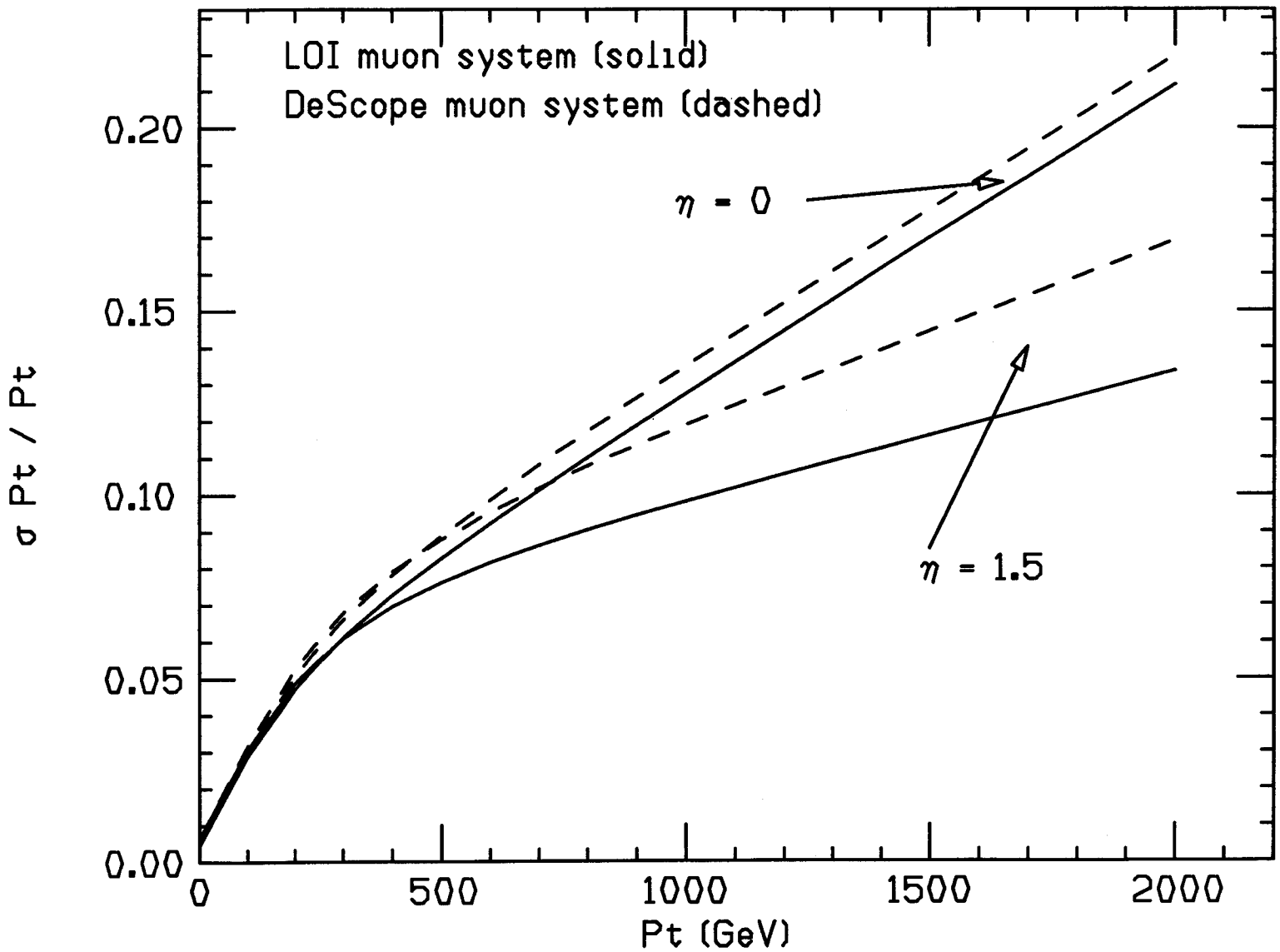

Fig 5: LOI barrel muon toroid StandAlone

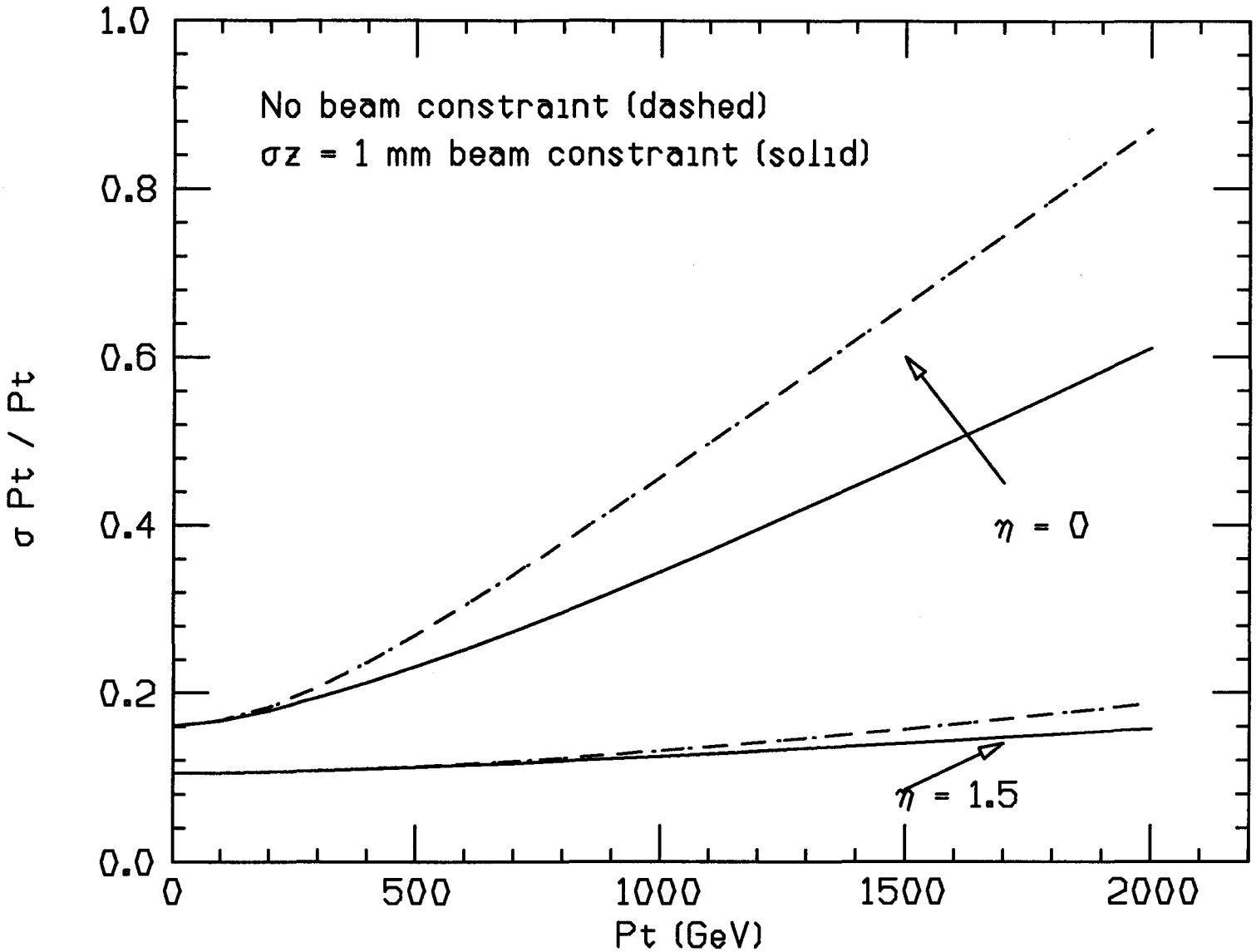

Fig 6: Barrel Muon Toroid StandAlone

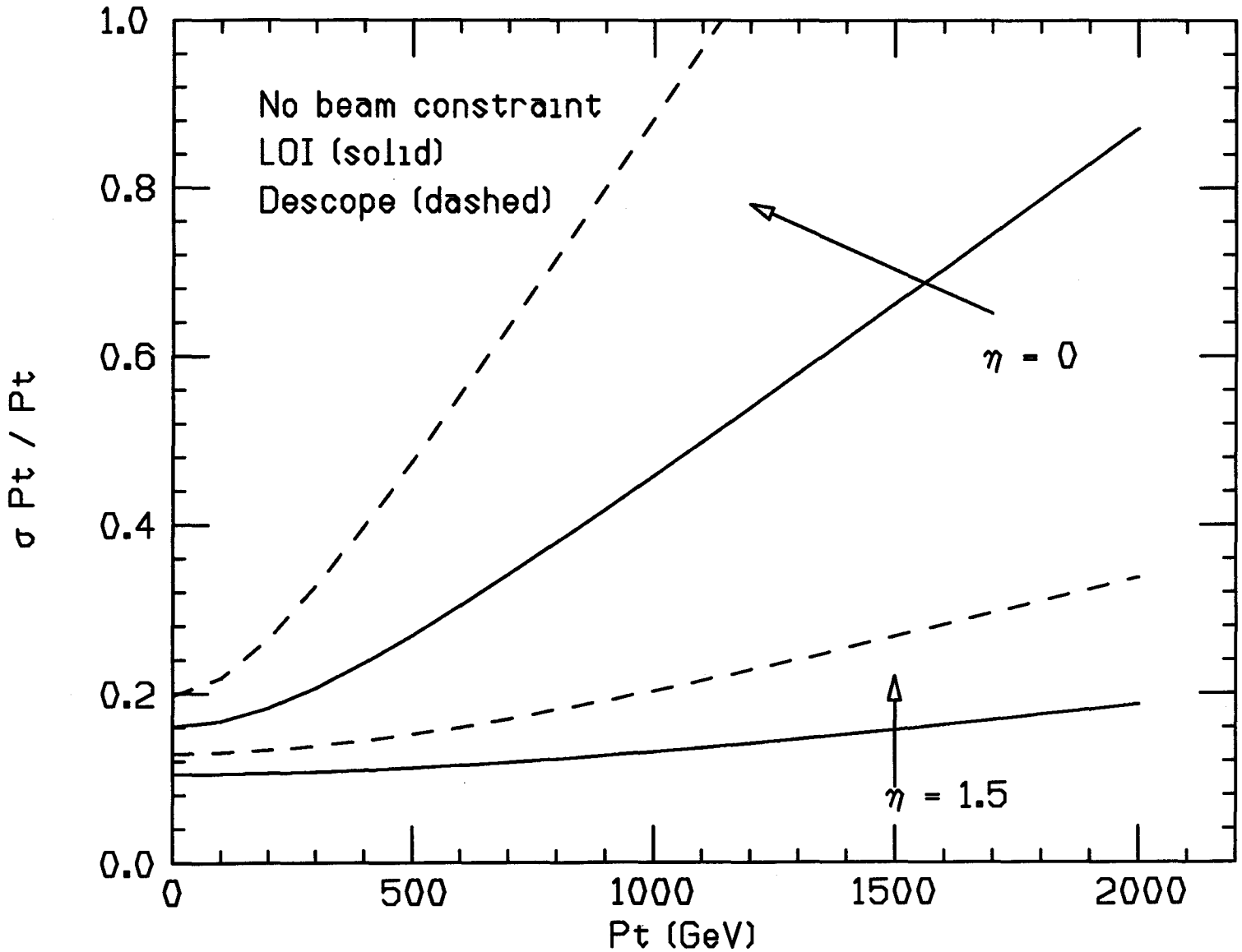

Fig 7: 1.5 m thick Muon Toroid StandAlone

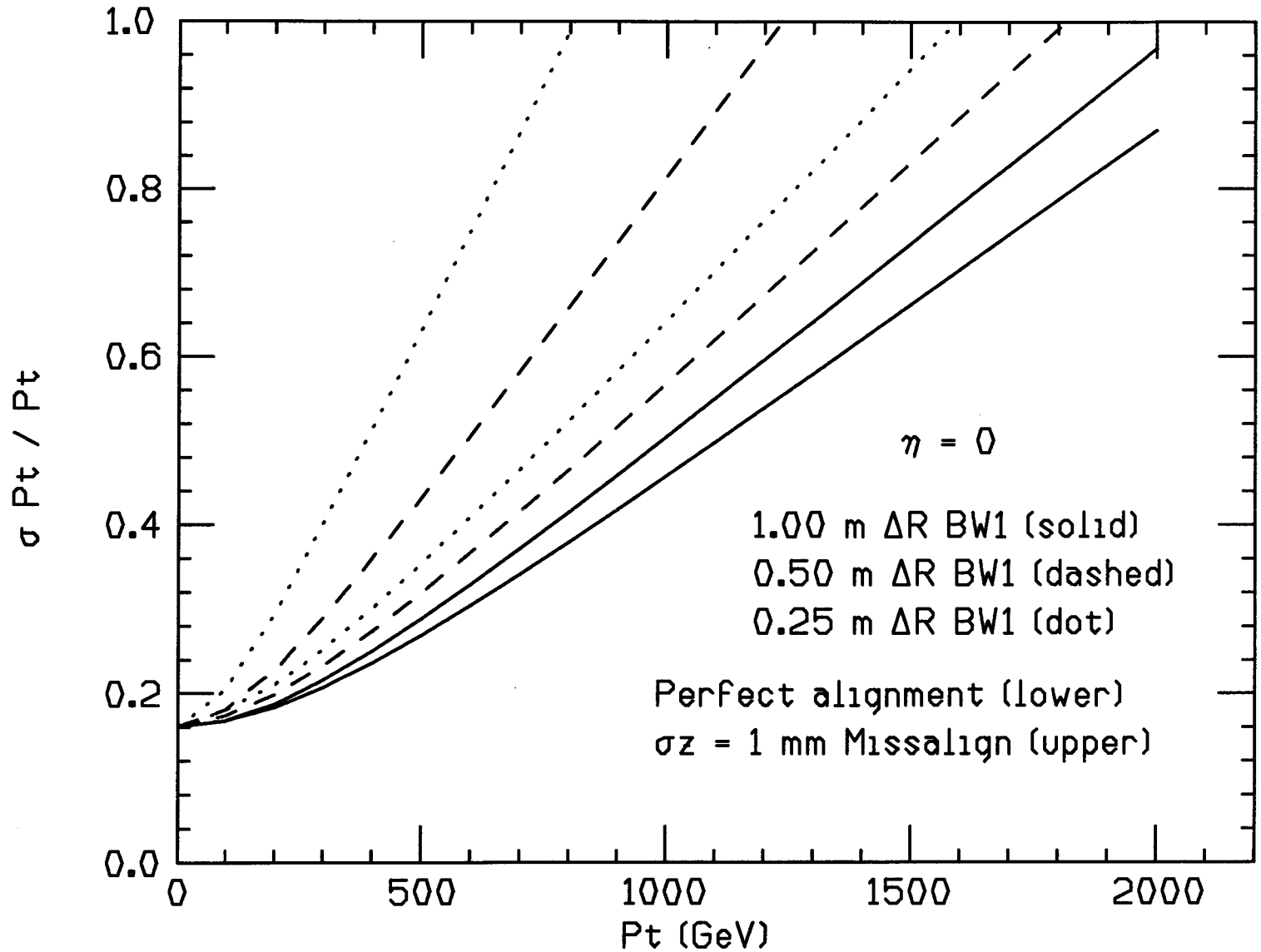

Fig 8: Δφ MUON + CTD STUB

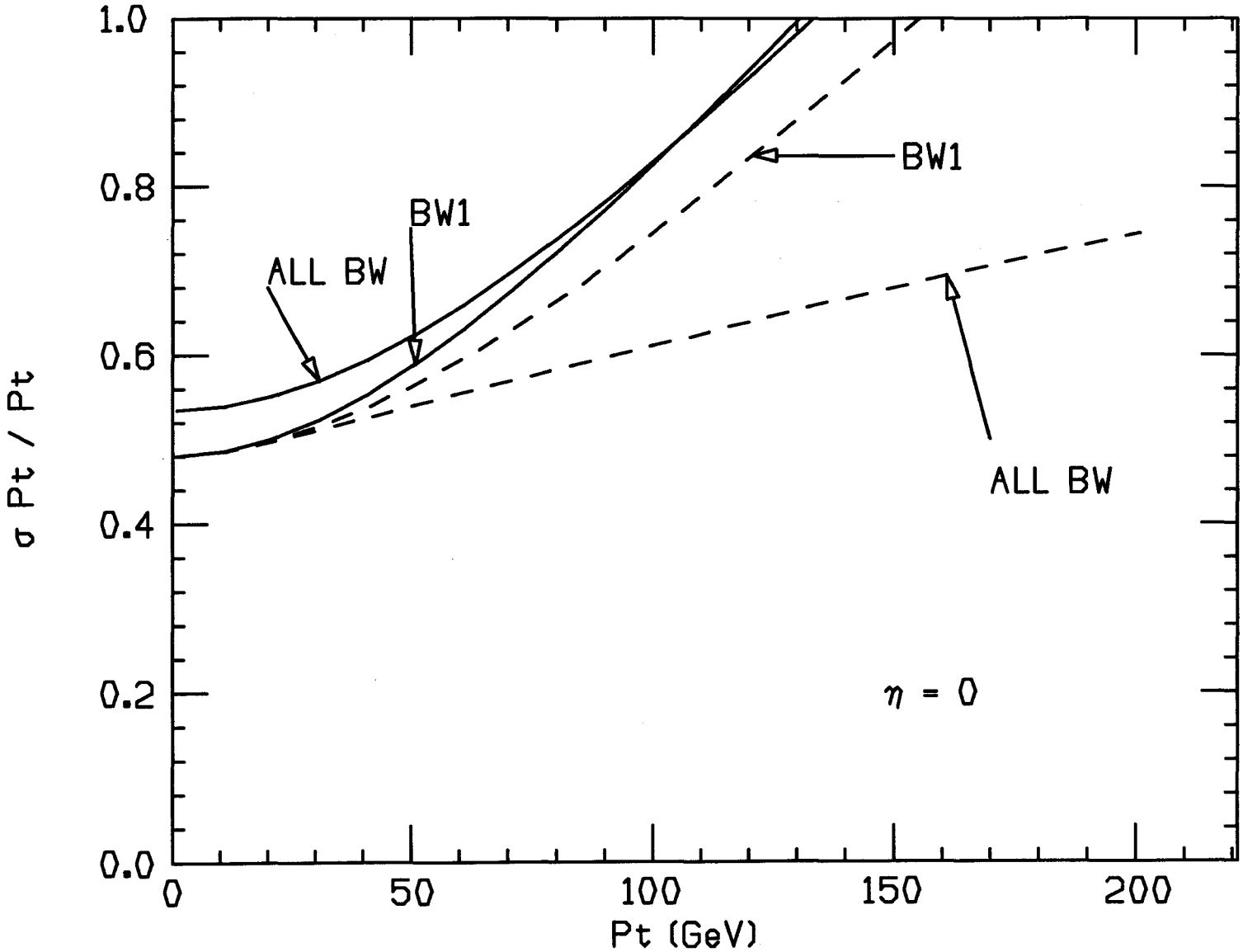
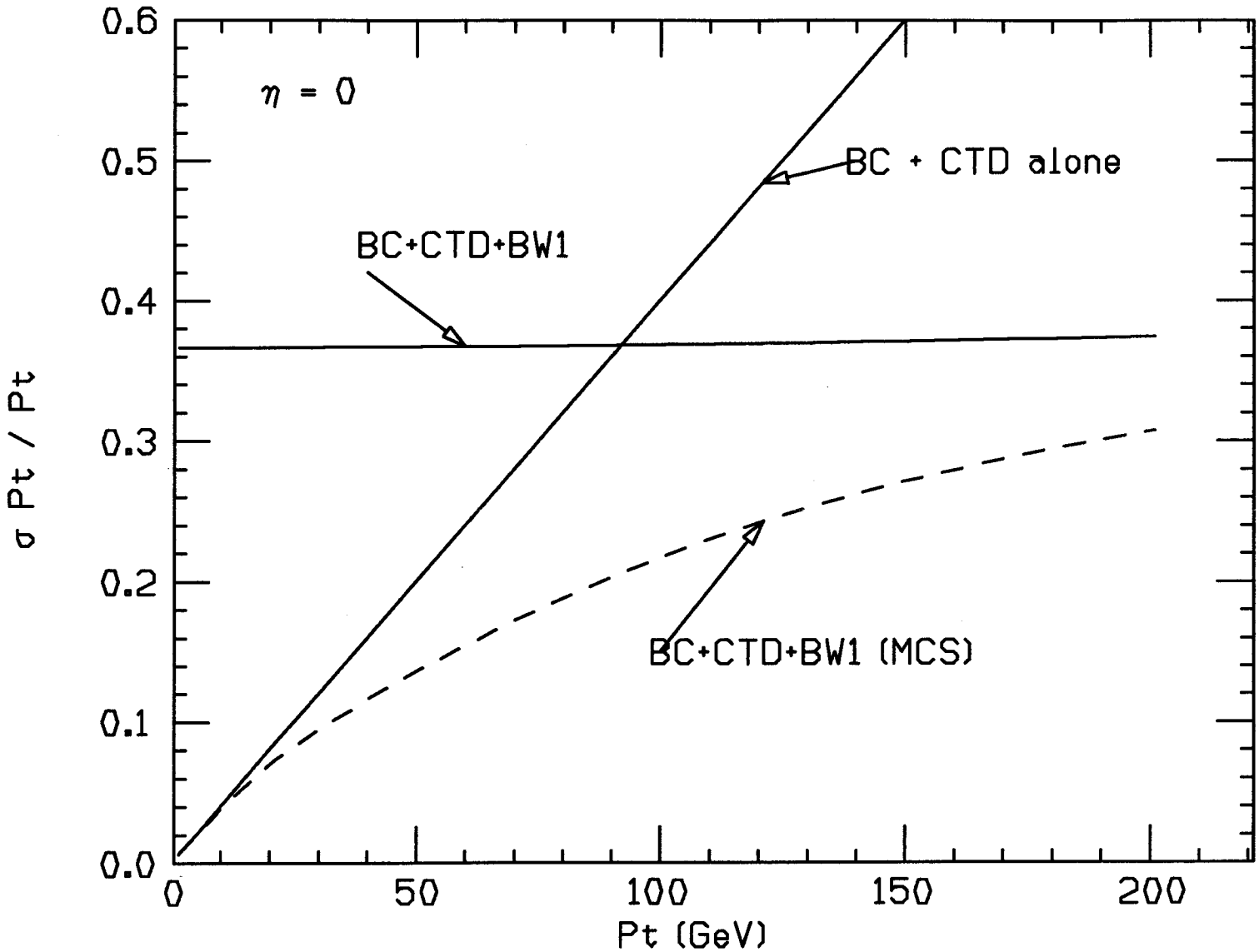
Fig 9: B.C. CTD Stub + BW1