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SDC
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SDC MUON ACCEPTANCE AND MASS RESOLUTION STUDIES

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Abstract

This note summarizes recent studies of muon acceptance and (off-line) mass resolution for various benchmark physics processes of interest for SDC using the latest TDR muon momentum resolution parametrizations from Jim Wiss and using a modified version of the CDF W/Z radiative MC event generator for W, Z and heavy W', Z' bosons (up to 5 TeV/c^2 and the ISAJET V6.43 MC for ZZ pairs and Higgs $\rightarrow ZZ \rightarrow 4\mu$ final states, for $0.2 \leq M_H \leq 1.0\ TeV/c^2$.

Introduction

We have previously carried out studies of muon acceptance and (off-line) mass resolution for the EoI and LoI-type designs of the SDC muon subsystem [3-6]. This note summarizes expanded studies of the acceptance and mass resolution results for the SDC TDR-type design parameters associated with various benchmark physics processes of interest for SDC, using the latest TDR muon momentum resolution parametrizations from Jim Wiss [1,2], and using a modified version of the CDF W/Z radiative MC event generator for W, Z and heavy W', Z' bosons (up to 5 TeV/c^2 and the ISAJET V6.43 MC for ZZ pairs and Higgs $\rightarrow ZZ \rightarrow 4\mu$ final states, for $0.2 \leq M_H \leq 1.0\ TeV/c^2$. In addition, initial studies of the impact/ramifications of inner bremsstrahlung in the radiative decays of W, Z and heavy W', Z' bosons, at the trigger and off-line event selection level have been carried out. This latter study is discussed in greater detail in another, companion SDC note to this one.

Z and Z' Acceptance

Figs 1-3 show $\sigma \cdot B(Z' \rightarrow \mu^+\mu^-)$, $d\sigma/dM$ and $d\sigma/dy$ for the production and decay of heavy Z' bosons at the SSC. If the Z' couples to fermions with the same strength g as the Z^0 boson then the Z' cross section can be related to the Z^0 boson cross section times the ratio of masses, $(M_{Z^0}/M_{Z'})^2$, modulo additional channels kinematically available to the Z' that are not available to the Z^0 boson, such as $Z' \rightarrow t\,\bar{t}$ at $M_{Z'} \geq 2M_{top}$. Tables Ia & Ib summarize the geometrical acceptances for heavy Z' bosons as a function of their mass for no P_T cut and with a di-muon requirement of $P_T(\mu) > 20\ GeV/c$ for central-central (C-C), central-forward (C-F), central-very forward (C-V), forward-forward (F-F), forward-very forward (F-V) and very forward-very forward (V-V) Z' production and decay to muon pairs. The definitions of central (C), forward (F) and very forward (V) muons are: C : $|\eta_\mu| \leq 1.6$, F : $1.6 < |\eta_\mu| \leq 2.5$, and V : $|\eta_\mu| > 2.5$. Note that the division at $|\eta| = 1.6$ between the central and forward regions of the SDC muon detector(s) means that the intermediate (I) region of the muon system is included as part of the central/barrel detector. If the intermediate muon system were considered as part of the forward muon system (i.e. change the division between central and forward to $|\eta| = 1.5$, then the following acceptance results will be changed accordingly by $\sim$ 8%, a change which is commensurate with the uncertainty in the acceptance results due to the choice of proton structure functions. These acceptances were obtained for each of the 20K event data sets using a modified version of the CDF W/Z radiative MC event generator, using EHLQ-I structure functions from the CERN PDFLIB structure function library. Figs 4 & 5 summarize the acceptance results given in these two tables. The impact of an off-line P_T cut of $P_T(\mu) > 20\ GeV/c$ has essentially no impact except for conventional Z^0 boson production/decay, where the reduction for this physics process is only a few percent effect.

Z and Z' Mass Resolution

The Z and heavy Z' boson mass resolutions were obtained by $1/P_T$ smearing of the muon momenta for each event in the above 20K data sets generated with the modified version of the CDF radiative W/Z MC. The muons in each event were smeared $10\times$ for the perposes of enhancing the statistical power of each data sample. Tables IIa-c summarize the $Z' \rightarrow \mu^+\mu^-$ mass resolution, $\sigma_{M_{Z'}}$ for [1], the inner tracking system (which includes a beam constraint, silicon strips, the CTD and gas micro-strips in the forward direction), [2], the contribution of the barrel/forward muon systems to the overall combined inner tracking system + muon system, and [3], the mass resolution from the combined inner tracking system + muon systems. Figs 6-8 show the Z' mass resolution vs. the Z' mass for each of these three cases. The Z' natural width (assumed to couple to fermions with the same strength g as the Z^0 boson is included for reference. These mass resolutions, $\sigma_{M_{Z'}}$ quoted here should be clearly understood as the *first moment* of the mass resolution distribution - which is in general is *not* gaussian-distributed; more specifically it is a skewed-gaussian with a (relatively short) high-side tail. This is merely due to the fact that *curvature* (i.e. $1/P_T$) is the gaussian-distributed variable that is measured, and not P_T.

It can be seen that even with the full/combined system, the mass resolution for heavy Z' (or very high mass Drell-Yan pairs) is significantly worse (i.e. by a factor of $3-5\times$) that of the SM Z' natural width. Without the muon system(s), the mass resolution from the inner tracking system is significantly worse. The relatively large lever arm(s) of the barrel and forward toroidal muon systems help enormously in this regard. We note that in the forward/backward directions, the gas microstrips also make a crucial contribution to the momentum resolution. Tables IIIa-c summarize the fractional mass resolution $\sigma_{M_{Z'}}/M_{Z'}$ and figs 9-11 show the fractional mass resolution vs. the Z' mass. Tables IVa-c summarize the fraction of the time the sign one (or both) of the muons in $Z' \rightarrow \mu^+\mu^-$ decay is incorrectly measured vs. Z' mass for the three cases, expressed in terms

of the ratio of the # of bad charge measurements per Z' to the # of Z' with muons in that region (e.g. C-C, C-F, C-F, etc.). Figs 12-14 show these results vs. the Z' mass for th three cases. The inner tracking system on its own will mis-measure the charge sign $\sim$ 10% of the time for very heavy Z' bosons - which are predominantly in the forward/backward regions of the detector, whereas with the combined resolution of the inner tracking + muon system(s), mis-measurement of the muon charge sign is negligible for Z' masses up to $M_{Z'} \leq 5\ TeV/c^2$. Table Va-c summarizes this information based on the fraction of muon charge mis-measurements normalized to *all* events in the acceptance of the SDC muon system. These results are also shown in figs. 15-17.

W and W' Acceptance

Figs. 18 & 19 show $\sigma \cdot B(W' \rightarrow \mu\ \nu_\mu)$ and $d\sigma/dy$ for the production and leptonic decay of heavy W' bosons at the SSC. Tables VIa-c summarize the geometrical acceptances for heavy W' bosons as a function of their mass for no P_T cut and with the requirement $P_T(\mu) > 20,\ 50\ GeV/c$ respectively for central (C), forward (F) and very forward (V) muons passing the $P_T(\mu)$ requirement for $W' \rightarrow \mu\ \nu_\mu$ production and decay. Figs. 20-22 show these acceptances for the respective P_T cuts. We included the $P_T(\mu) > 50\ GeV/c$ result to indicate/emphasize the importance of having as low as possible single-muon level-1/level-2/level-3 trigger thresholds to maintain a healthy rate of $W \rightarrow \mu\ \nu_\mu$ events to tape - such events will be extremely useful, if not *crucial*, for obtaining an as-unbiased, well-understood single muon W-sample as possible for calibration, cross-calibration, muon chamber alignment and control of other potential systematic effects, not to mention their usefulness for physics purposes! The higher the single muon P_T threshold, the further out (and down) on the $d\sigma/dP_T$ tail we will be, for nominal running/data-taking. This also has significant ramifications for e.g. $t\ \bar{t} \rightarrow W^+\ b\ +\ W^-\ \bar{b}$ production and subsequent leptonic W-decay, where the $P_T(W)$ distribution is not expected to be *that* significantly different from single-W production/decay.

W and W' Mass Resolution

Although we have begun studies of the mass resolution for W and for heavy W' bosons, we do not at present include them here in this note. - such a study is much more complicated than for the Z and heavy Z' processes because the missing E_T (MET) from the neutrino is predominantly measured as the -ve P_T of the charge lepton, but also has important contributions from the underlying event and the jet(s) recoiling from the P_T of the produced W or W' boson. The latter two processes require information from the calorimetry of the detector, and are extremely important when considering the details associated with *resolution* effects in W and W' production and decay. These are extra-ordinarily time-consuming to carry out, to say the least!

Higgs $\rightarrow ZZ \rightarrow 4\mu$ and $ZZ \rightarrow 4\mu$ Acceptance

The ISAJET V6.43 MC event generator was used to generate 10K event data sets (each) of Higgs $\rightarrow ZZ \rightarrow 4\mu$ and $ZZ \rightarrow 4\mu$ samples of events. Fig. 23 shows the ISAJET MC cross section for Higgs $\rightarrow ZZ \rightarrow 4\mu$, fig. 24 shows an analytic calculation of the cross section for $\sqrt{s} = 40\ TeV\ \ p-p$ production of ZZ diboson pairs. Tables VIIa-b summarize the salient properties of these benchmark physics processes. Tables VIIIa-b summarize the acceptance for the Higgs $\rightarrow ZZ \rightarrow 4\mu$ and the $ZZ \rightarrow 4\mu$ processes for the various four-muon final state topologies in the SDC detector, e.g. CC+CC, CC+CF, ... FF+FF, etc. At least two muons with $P_T(\mu) > 20\ GeV/c$ are required. The SDC acceptance, summed over all observable final state configurations ranges from a minimum of $\sim$ 50% for $M_H \sim 200\ GeV/c^2$ (and for ZZ pair production), to a maximum of $\sim$ 80% for $M_H \sim 1000\ GeV/c^2$. Fig. 25 shows the acceptance vs. Higgs mass for Higgs $\rightarrow ZZ \rightarrow 4\mu$.

Higgs $\rightarrow ZZ \rightarrow 4\mu$ and $ZZ \rightarrow 4\mu$ Mass Resolution

The mass resolutions σ_{M_H}, $\sigma_{M_{ZZ}}$ and σ_{M_Z} were determined for each of the Higgs $\rightarrow ZZ \rightarrow 4\mu$ and $ZZ \rightarrow 4\mu$ MC data samples. As for the Z' data samples,

the muons in each event were $10\times\ 1/P_T$ smeared using Jim Wiss' momentum resolution parametrizations for enhanced statistical power.

Tables IXa-c summarize the Higgs $\rightarrow ZZ \rightarrow 4\mu$ Higgs mass resolution σ_{M_H} for [1] the inner tracking system, [2] the contribution from the muon system(s) to the combined inner tracking system + muon system(s) and [3] the mass resolution associated with the combined/full inner tracking system + muon system(s). Similarly, Table X summarizes the ZZ pair mass resolution $\sigma_{M_{ZZ}}$ for $ZZ \rightarrow 4\mu$ MC event data for the three cases. Figs. 26-28 show the Higgs mass resolution σ_{M_H} for the three cases. Also shown in these figures is the Higgs natural width, Γ_H for comparison. It can be seen that for $M_H\ >\ 200\ GeV/c^2$, that the mass resolution associated with the inner tracking system is smaller than the width of the Higgs; the contribution to the Higgs mass resolution is not significant for any value of the Higgs mass. For this physics process, the dominant function of the muon system is for obtaining high-efficiency and high-quality muon *identification*. This is also true for the $ZZ \rightarrow 4\mu$ process. Tables XIa-c summarize the fractional mass resolutions, σ_{M_H}/M_H for Higgs $\rightarrow ZZ \rightarrow 4\mu$ for the three cases; Tables XIIa-c summarize the ZZ pair fractional mass resolution $\sigma_{M_{ZZ}}/M_{ZZ}$ for the $ZZ \rightarrow 4\mu$ process for each case. Figs. 29-31 show the Higgs fractional mass resolution σ_{M_H}/M_H for the three cases. Also shown is the Higgs fractional width, Γ_H/M_H for comparison.

Tables XIIIa-c summarize the corresponding $Z \rightarrow \mu^+\mu^-$ mass resolution, σ_{M_Z} for the Higgs $\rightarrow ZZ \rightarrow 4\mu$ process for the three cases; Tables XIVa-c summarize the corresponding ZZ pair $Z \rightarrow \mu^+\mu^-$ Z mass resolution σ_{M_Z} for the $ZZ \rightarrow 4\mu$ process for each case. Figs. 32-34 show the Z mass resolution σ_{M_Z} for the three cases for the Higgs $\rightarrow ZZ \rightarrow 4\mu$ process. Also shown in these figures is the Z natural width, Γ_Z for comparison. Tables XVa-c summarize the corresponding fractional Z mass resolutions, σ_{M_Z}/M_Z for the Higgs $\rightarrow ZZ \rightarrow 4\mu$ process for the three cases; Tables XVIa-c summarize fractional Z mass resolution σ_{M_Z}/M_Z for the $ZZ \rightarrow 4\mu$ process for each case. Figs. 35-37 show the fractional Z mass resolution σ_{M_Z}/M_Z for the Higgs $\rightarrow ZZ \rightarrow 4\mu$ process for the three cases. Also

shown is the Z fractional width, Γ_Z/M_Z for comparison. From these figures, here again it can be seen that the momentum resolution of the inner tracking system is such that the Z mass resolution is roughly comparable to the natural width of the Z bosons from these two physics processes - actually it is better when all four muons are confined to the barrel region of the detector, and worse when one (or more) muons are in the forward/backward directions, consistent with one's expectations. It can also be seen that here again, the contribution to the overall Z mass resolution is not significant in any region of Higgs mass phase space from the muon system(s).

Conclusions

These studies indicate that the present design of the SDC inner tracking + muon system(s) will perform well for known, standard model W and Z type physics, with reasonably good acceptance and mass-resolution performance for these processes, as well as for Higgs $\rightarrow ZZ \rightarrow 4\mu$, $ZZ \rightarrow 4\mu$ (and related di-boson processes), modulo concerns r.e. the muon trigger thresholds for *single* muons from e.g. $W \rightarrow \mu\ \nu_\mu$, and e.g. $t\ \bar{t}$, WW, etc. processes. For potential new physics such as heavy W' and Z' gauge bosons, the SDC muon system has excellent geometrical acceptance for these high-mass processes, but rather poor momentum/mass resolution performance. However, it should still be quite possible to discover them with the present SDC/TDR design and to succeed in e.g. making reasonably precise measurement(s) of their masses, taking into proper account all relevant resolution effects and associated physical processes (e.g. brem, structure functions, alignment, etc.). However, with the current design, it will be extremely difficult to extract an accurate measurement of the *natural widths* of heavy W' and Z' bosons from their decays to muons, should they exist, and be observed at the SSC in the SDC detector, as currently envisaged with the SDC design.

References

[1] J. Wiss, Feb. 24, 1992 memo: "More Muon Momentum Resolution Calculations", SDC-92-xxx

[2] J. Wiss, Feb. 15, 1992 memo: "General Muon Resolution Calculations", SDC-92-xxx

[3] J. Wiss, S. Errede, "Muon Detector Momentum Resolution", Nov 15, 1989, SDC-89-15

[4] S. Errede, "SSC Muon Acceptance Studies", Nov 15,1989, SDC-89-16

[5] S. Errede, "Acceptance and Mass Resolution Studies for the SDC Muon EOI Subsystems Design", Oct 4, 1990, SDC-91-147

[6] S. Errede, J. Wiss, "Acceptance and OFFLINE Mass Resolution Studies for the SDC Muon LOI Subsystem Design", Jan. 8, 1991, SDC-91-149

[6] S. Errede, "Studies of Heavy $W' \to \mu\nu_\mu$ and $Z' \to \mu^+\mu^-$ Production and Radiative Decay", Feb. 25, 1992, SDC-92-xxx

$Z' \rightarrow \mu^+\mu^-$ Mass Resolution

[1] Inner Tracking System Only

Z' Mass	$\sigma \cdot B(Z' \rightarrow \mu^+\mu^-)$	Γ_{tot}	$\sigma_{M_{Z'}}$	$\sigma_{M_{Z'}}$	$\sigma_{M_{Z'}}$
(TeV/c^2)	(pb)	(GeV)	C-C	C-F	F-F
0.091174	3160.9	2.50	0.3897	0.6988	1.1790
0.2	405.52	5.49	1.8130	3.0570	5.8110
0.5	29.35	14.73	11.340	19.890	7.3100
1.0	3.39	30.48	45.070	67.540	93.220
2.0	0.323	60.96	186.50	242.20	333.10
3.0	0.072	91.48	426.50	500.10	546.30
4.0	0.023	121.94	817.40	869.40	746.20
5.0	0.008	152.42	1123.0	1100.0	971.40

[2] Muon System Only

Z' Mass	$\sigma \cdot B(Z' \rightarrow \mu^+\mu^-)$	Γ_{tot}	$\sigma_{M_{Z'}}$	$\sigma_{M_{Z'}}$	$\sigma_{M_{Z'}}$
(TeV/c^2)	(pb)	(GeV)	C-C	C-F	F-F
0.091174	3160.9	2.50	10.940	8.6700	6.8450
0.2	405.52	5.49	25.010	21.080	16.210
0.5	29.35	14.73	61.630	52.310	45.070
1.0	3.39	30.48	124.20	112.70	108.00
2.0	0.323	60.96	261.00	256.50	278.20
3.0	0.072	91.48	425.40	472.40	470.90
4.0	0.023	121.94	651.70	740.20	603.40
5.0	0.008	152.42	869.30	930.50	773.50

$Z' \rightarrow \mu^+\mu^-$ Mass Resolution

[3] Combined Inner Tracking + Muon Systems

Z' Mass	$\sigma \cdot B(Z' \rightarrow \mu^+\mu^-)$	Γ_{tot}	$\sigma_{M_{Z'}}$	$\sigma_{M_{Z'}}$	$\sigma_{M_{Z'}}$
(TeV/c^2)	(pb)	(GeV)	C-C	C-F	F-F
0.091174	3160.9	2.50	0.3894	0.6872	1.1460
0.2	405.52	5.49	1.8070	2.8770	5.1300
0.5	29.35	14.73	11.110	15.570	24.460
1.0	3.39	30.48	41.790	47.370	63.490
2.0	0.323	60.96	147.10	140.50	156.30
3.0	0.072	91.48	289.50	267.00	258.30
4.0	0.023	121.94	479.40	397.40	330.20
5.0	0.008	152.42	702.90	547.10	419.90

$Z' \rightarrow \mu^+\mu^-$ Mass Resolution

[1] Inner Tracking System Only

Z' Mass	$\sigma_{M_{Z'}}/M_{Z'}$	$\sigma_{M_{Z'}}/M_{Z'}$	$\sigma_{M_{Z'}}/M_{Z'}$
(TeV/c^2)	C-C	C-F	F-F
0.091174	0.0043	0.0077	0.0129
0.2	0.0091	0.0153	0.0291
0.5	0.0227	0.0398	0.0546
1.0	0.0451	0.0675	0.0932
2.0	0.0933	0.1211	0.1666
3.0	0.1422	0.1667	0.1821
4.0	0.2044	0.2174	0.1866
5.0	0.2246	0.2200	0.1943

[2] Muon System Only

Z' Mass	$\sigma_{M_{Z'}}/M_{Z'}$	$\sigma_{M_{Z'}}/M_{Z'}$	$\sigma_{M_{Z'}}/M_{Z'}$
(TeV/c^2)	C-C	C-F	F-F
0.091174	0.1200	0.0951	0.0751
0.2	0.1251	0.1054	0.0811
0.5	0.1233	0.1046	0.0901
1.0	0.1242	0.1127	0.1080
2.0	0.1305	0.1283	0.1391
3.0	0.1418	0.1575	0.1570
4.0	0.1629	0.1851	0.1509
5.0	0.1739	0.1861	0.1547

$Z' \rightarrow \mu^+\mu^-$ Mass Resolution

[3] Combined Inner Tracking + Muon Systems

Z' Mass	$\sigma_{M_{Z'}}/M_{Z'}$	$\sigma_{M_{Z'}}/M_{Z'}$	$\sigma_{M_{Z'}}/M_{Z'}$
(TeV/c^2)	C-C	C-F	F-F
0.091174	0.0043	0.0075	0.0126
0.2	0.0090	0.0144	0.0257
0.5	0.0222	0.0311	0.0489
1.0	0.0418	0.0474	0.0635
2.0	0.0736	0.0703	0.0782
3.0	0.0965	0.0890	0.0861
4.0	0.1199	0.0994	0.0826
5.0	0.1406	0.1094	0.0840

$Z' \rightarrow \mu^+\mu^-$ Geometrical Acceptance

Z' Mass	C-C	C-F	C-V	F-F	F-V	V-V	SDC	1-SDC
0.091174	0.1569	0.1348	0.1283	0.0350	0.1474	0.3977	0.3267	0.6734
0.2	0.1817	0.1491	0.1724	0.0305	0.1603	0.3059	0.3613	0.6387
0.5	0.2418	0.1797	0.2128	0.0494	0.1626	0.1538	0.4709	0.5291
1.0	0.3194	0.2236	0.2145	0.0647	0.1210	0.0568	0.6077	0.3923
2.0	0.4238	0.2893	0.1767	0.0349	0.0618	0.0136	0.7480	0.2521
3.0	0.5085	0.2879	0.1349	0.0307	0.0349	0.0031	0.8271	0.1729
4.0	0.6124	0.2440	0.0927	0.0214	0.0233	0.0061	0.8778	0.1222
5.0	0.6508	0.2499	0.0564	0.0150	0.0194	0.0085	0.9158	0.0842

$Z' \rightarrow \mu^+\mu^-$ P_T*Geometrical Acceptance

DiMuon $P_T > 20\ GeV/c$

Z' Mass	C-C	C-F	C-V	F-F	F-V	V-V	SDC	1-SDC
0.091174	0.1441	0.1147	0.0566	0.0312	0.1135	0.3462	0.2900	0.5163
0.2	0.1744	0.1475	0.1476	0.0283	0.1509	0.2997	0.3503	0.5982
0.5	0.2379	0.1788	0.2056	0.0487	0.1605	0.1525	0.4654	0.5186
1.0	0.3183	0.2221	0.2143	0.0647	0.1201	0.0561	0.6052	0.3905
2.0	0.4238	0.2878	0.1767	0.0349	0.0616	0.0014	0.7465	0.2518
3.0	0.5085	0.2866	0.1348	0.0307	0.0349	0.0031	0.8258	0.1728
4.0	0.6124	0.2428	0.0927	0.0214	0.0233	0.0061	0.8767	0.1222
5.0	0.6508	0.2489	0.0564	0.0140	0.0194	0.0085	0.9147	0.0843

$Z' \rightarrow \mu^+\mu^-$ Charge Resolution

[1] Inner Tracking System Only

Z' Mass	Fract Q_{bad}/Region (%)	Fract Q_{bad}/Region (%)	Fract Q_{bad}/Region (%)
(TeV/c^2)	C-C	C-F	F-F
0.091174	0.0000	0.0000	0.0000
0.2	0.0000	0.0000	0.0000
0.5	0.0000	0.0000	0.0000
1.0	0.0000	0.0106	0.3162
2.0	0.0000	0.8672	3.8802
3.0	0.0030	2.6915	10.760
4.0	0.1292	4.9678	13.258
5.0	0.7257	7.3515	11.492

[2] Muon System Only

Z' Mass	Fract Q_{bad}/Region (%)	Fract Q_{bad}/Region (%)	Fract Q_{bad}/Region (%)
(TeV/c^2)	C-C	C-F	F-F
0.091174	0.0000	0.0000	0.0000
0.2	0.0000	0.0000	0.0000
0.5	0.0000	0.0000	0.0000
1.0	0.0000	0.0000	0.0000
2.0	0.0000	0.0087	0.0260
3.0	0.0000	0.0965	0.6919
4.0	0.0000	0.4959	1.9806
5.0	0.0049	1.1204	2.2162

$Z' \rightarrow \mu^+\mu^-$ Charge Resolution

[3] Combined Inner Tracking + Muon Systems

Z' Mass	Fract Q_{bad}/Region (%)	Fract Q_{bad}/Region (%)	Fract Q_{bad}/Region (%)
(TeV/c^2)	C-C	C-F	F-F
0.091174	0.0000	0.0000	0.0000
0.2	0.0000	0.0000	0.0000
0.5	0.0000	0.0000	0.0000
1.0	0.0000	0.0000	0.0000
2.0	0.0000	0.0022	0.0173
3.0	0.0000	0.0000	0.0000
4.0	0.0000	0.0000	0.0081
5.0	0.0000	0.0076	0.0000

$Z' \rightarrow \mu^+\mu^-$ Charge Resolution

[1] Inner Tracking System Only

Z' Mass	Fract Q_{bad}/Total (%)	Fract Q_{bad}/Total (%)	Fract Q_{bad}/Total (%)
(TeV/c^2)	C-C	C-F	F-F
0.091174	0.0000	0.0000	0.0000
0.2	0.0000	0.0000	0.0000
0.5	0.0000	0.0000	0.0000
1.0	0.0000	0.0200	0.0145
2.0	0.0000	0.2005	0.2235
3.0	0.0010	0.7115	0.7150
4.0	0.0480	1.4675	0.8200
5.0	0.2970	2.4080	0.5315

[2] Muon System Only

Z' Mass	Fract Q_{bad}/Total (%)	Fract Q_{bad}/Total (%)	Fract Q_{bad}/Total (%)
(TeV/c^2)	C-C	C-F	F-F
0.091174	0.0000	0.0000	0.0000
0.2	0.0000	0.0000	0.0000
0.5	0.0000	0.0000	0.0000
1.0	0.0000	0.0000	0.0000
2.0	0.0000	0.0020	0.0015
3.0	0.0000	0.0255	0.0460
4.0	0.0000	0.1465	0.1225
5.0	0.0049	0.3670	0.1025

$Z' \rightarrow \mu^+\mu^-$ Charge Resolution

[3] Combined Inner Tracking + Muon Systems

Z' Mass	Fract Q_{bad}/Total (%)	Fract Q_{bad}/Total (%)	Fract Q_{bad}/Total (%)
(TeV/c^2)	C-C	C-F	F-F
0.091174	0.0000	0.0000	0.0000
0.2	0.0000	0.0000	0.0000
0.5	0.0000	0.0000	0.0000
1.0	0.0000	0.0000	0.0000
2.0	0.0000	0.0005	0.0010
3.0	0.0000	0.0000	0.0000
4.0	0.0000	0.0000	0.0005
5.0	0.0000	0.0025	0.0000

$W' \rightarrow \mu\ \nu_\mu$ Geometrical Acceptance

W' Mass	C	F	V	SDC	1-SDC
0.08014	0.2830	0.1566	0.5605	0.4395	0.5605
0.2	0.3445	0.1666	0.4889	0.5111	0.4889
0.5	0.4201	0.2138	0.3661	0.6339	0.3661
1.0	0.5066	0.2209	0.2725	0.7275	0.2725
2.0	0.6183	0.2256	0.1560	0.8440	0.1560
3.0	0.6763	0.2187	0.1050	0.8950	0.1050
4.0	0.6941	0.2083	0.0976	0.9024	0.0976
5.0	0.7356	0.1950	0.0694	0.9306	0.0694

$W' \rightarrow \mu\ \nu_\mu\ P_T$*Geometrical Acceptance

Muon $P_T\ >\ 20\ GeV/c$

W' Mass	C	F	V	SDC	1-SDC
0.08014	0.1962	0.1151	0.3694	0.3113	0.3694
0.2	0.3303	0.1473	0.4421	0.4775	0.4421
0.5	0.4171	0.2102	0.3592	0.6273	0.3592
1.0	0.5027	0.2195	0.2702	0.7221	0.2702
2.0	0.6182	0.2251	0.1545	0.8433	0.1545
3.0	0.6762	0.2187	0.1050	0.8949	0.1050
4.0	0.6940	0.2083	0.0976	0.9023	0.0976
5.0	0.7355	0.1950	0.0693	0.9305	0.0693

$W' \rightarrow \mu\ \nu_\mu\ P_T$*Geometrical Acceptance

Muon $P_T\ >\ 50\ GeV/c$

W' Mass	C	F	V	SDC	1-SDC
0.08014	0.0006	0.0021	0.0022	0.0027	0.0022
0.2	0.2696	0.1163	0.3367	0.3859	0.3367
0.5	0.3962	0.2010	0.3380	0.5972	0.3380
1.0	0.4951	0.2193	0.2619	0.7144	0.2619
2.0	0.6177	0.2227	0.1486	0.8405	0.1486
3.0	0.6761	0.2175	0.1035	0.8937	0.1035
4.0	0.6940	0.2083	0.0957	0.9023	0.0957
5.0	0.7355	0.1950	0.0693	0.9305	0.0693

$W' \rightarrow \mu\ \nu_\mu$ Cross Section

W' Mass	σ_{W+}	σ_{W-}	$\sigma_{W\pm}$
(TeV/c^2)	(pb)	(pb)	(pb)
0.08014	19750.	16094.	35844.
0.2	1877.1	1464.5	3341.6
0.5	141.09	102.30	243.39
1.0	17.027	11.309	28.337
2.0	1.7190	1.0001	2.7191
3.0	0.4024	0.2097	0.6120
4.0	0.1308	0.0618	0.1926
5.0	0.0503	0.0217	0.0719
6.0	0.0213	0.0084	0.0297

$H \rightarrow ZZ \rightarrow 4\mu$ Properties

Higgs Mass	Γ_{tot}	σ_H
(GeV/c^2)	(GeV)	(fb)
200	1.429	188.8
300	9.369	19.28
400	30.078	8.800
500	62.342	5.407
600	109.14	3.113
700	173.47	1.812
800	258.33	1.100
900	366.71	0.707
1000	501.58	0.471

ZZ Pairs $\rightarrow 4\mu$ Properties

$< M_{ZZ} >$	σ_H
(GeV/c^2)	(fb)
270	25.0

$H \rightarrow ZZ \rightarrow 4\mu$ H Mass Resolution

[1] Inner Tracking System Only

H Mass	σ_{M_H}	σ_{M_H}	σ_{M_H}	σ_{M_H}	σ_{M_H}	σ_{M_H}
(GeV/c^2)	CC+CC	CC+CF	CF+CF	CC+FF	CF+FF	FF+FF
200	0.8726	0.9934	1.4530	1.2620	2.1540	2.8150
300	2.1350	2.6800	3.7200	3.7820	5.4440	7.7050
400	4.0500	4.6580	6.6750	6.5830	10.1300	11.9900
500	6.6250	7.8600	9.3460	11.2600	14.7300	22.6600
600	9.8070	10.7700	12.2000	15.6100	21.1700	28.1000
700	13.3300	14.1500	15.3700	20.5800	24.2200	31.8900
800	17.8900	17.6000	17.4500	24.7100	29.9500	38.2900
900	22.5400	21.5200	18.9200	29.1700	31.9700	39.7900
1000	27.2300	25.5500	23.6300	33.1700	35.3600	44.4500

[2] Muon System Only

H Mass	σ_{M_H}	σ_{M_H}	σ_{M_H}	σ_{M_H}	σ_{M_H}	σ_{M_H}
(GeV/c^2)	CC+CC	CC+CF	CF+CF	CC+FF	CF+FF	FF+FF
200	19.7300	17.7100	16.0900	14.6900	14.3100	12.2800
300	28.9600	26.5900	23.8300	24.2300	21.4500	18.6700
400	36.3800	33.6700	29.7000	32.2900	28.1600	25.6900
500	43.8000	40.2200	35.9500	37.7200	34.1600	33.2500
600	55.3000	48.7000	40.5800	45.4000	39.0500	39.4500
700	63.6400	55.4000	45.4500	53.1000	45.5600	44.4500
800	73.2000	62.9800	50.7700	60.4400	51.2800	54.6100
900	81.3100	71.5000	57.7800	66.6200	57.0700	52.4400
1000	90.1700	76.8200	70.6100	77.5900	66.8300	61.5800

$H \rightarrow ZZ \rightarrow 4\mu$ H Mass Resolution

[3] Combined Inner Tracking + Muon Systems

H Mass	σ_{M_H}	σ_{M_H}	σ_{M_H}	σ_{M_H}	σ_{M_H}	σ_{M_H}
(GeV/c^2)	CC+CC	CC+CF	CF+CF	CC+FF	CF+FF	FF+FF
200	0.8695	0.9839	1.4000	1.2310	2.0250	2.5760
300	2.1250	2.5800	3.4320	3.4980	4.8220	6.3530
400	4.0120	4.4640	6.0660	5.9190	8.6230	10.2000
500	6.5270	7.2030	8.1810	9.3660	11.6800	16.7100
600	9.5860	10.0000	10.6000	12.8700	16.0100	20.1200
700	12.9600	13.0700	13.8500	16.6500	18.9500	24.2200
800	17.2300	16.4100	15.6500	20.8400	24.6600	32.6200
900	21.5700	19.9800	16.9500	24.5400	26.8600	32.3200
1000	26.1400	23.8100	21.8100	28.6600	30.9200	37.5800

$H \rightarrow ZZ \rightarrow 4\mu$ H Mass Resolution

[1] Inner Tracking System Only

H Mass	σ_{M_H}/M_H	σ_{M_H}/M_H	σ_{M_H}/M_H	σ_{M_H}/M_H	σ_{M_H}/M_H	σ_{M_H}/M_H
(GeV/c^2)	CC+CC	CC+CF	CF+CF	CC+FF	CF+FF	FF+FF
200	0.0044	0.0050	0.0073	0.0063	0.0108	0.0141
300	0.0071	0.0089	0.0124	0.0126	0.0181	0.0257
400	0.0101	0.0116	0.0167	0.0165	0.0253	0.0300
500	0.0132	0.0157	0.0187	0.0225	0.0295	0.0453
600	0.0163	0.0180	0.0203	0.0260	0.0353	0.0468
700	0.0190	0.0202	0.0220	0.0294	0.0346	0.0456
800	0.0224	0.0220	0.0218	0.0309	0.0374	0.0479
900	0.0250	0.0239	0.0210	0.0324	0.0355	0.0442
1000	0.0272	0.0255	0.0236	0.0332	0.0354	0.0444

[2] Muon System Only

H Mass	σ_{M_H}/M_H	σ_{M_H}/M_H	σ_{M_H}/M_H	σ_{M_H}/M_H	σ_{M_H}/M_H	σ_{M_H}/M_H
(GeV/c^2)	CC+CC	CC+CF	CF+CF	CC+FF	CF+FF	FF+FF
200	0.0987	0.0885	0.0804	0.0734	0.0716	0.0614
300	0.0965	0.0886	0.0794	0.0808	0.0715	0.0622
400	0.0910	0.0842	0.0743	0.0807	0.0704	0.0642
500	0.0876	0.0804	0.0719	0.0754	0.0683	0.0665
600	0.0922	0.0812	0.0676	0.0757	0.0651	0.0658
700	0.0909	0.0791	0.0649	0.0759	0.0651	0.0635
800	0.0915	0.0787	0.0635	0.0755	0.0641	0.0683
900	0.0903	0.0794	0.0642	0.0740	0.0634	0.0583
1000	0.0902	0.0768	0.0706	0.0776	0.0668	0.0616

$H \rightarrow ZZ \rightarrow 4\mu$ H Mass Resolution

[3] Combined Inner Tracking + Muon Systems

H Mass	σ_{M_H}/M_H	σ_{M_H}/M_H	σ_{M_H}/M_H	σ_{M_H}/M_H	σ_{M_H}/M_H	σ_{M_H}/M_H
(GeV/c^2)	CC+CC	CC+CF	CF+CF	CC+FF	CF+FF	FF+FF
200	0.0043	0.0049	0.0070	0.0062	0.0101	0.0129
300	0.0071	0.0086	0.0114	0.0117	0.0161	0.0212
400	0.0100	0.0112	0.0152	0.0148	0.0216	0.0255
500	0.0131	0.0144	0.0164	0.0187	0.0234	0.0334
600	0.0160	0.0167	0.0177	0.0214	0.0267	0.0335
700	0.0185	0.0187	0.0198	0.0238	0.0271	0.0346
800	0.0215	0.0205	0.0196	0.0260	0.0308	0.0408
900	0.0240	0.0222	0.0188	0.0273	0.0298	0.0359
1000	0.0261	0.0238	0.0218	0.0287	0.0309	0.0376

$H \rightarrow ZZ \rightarrow 4\mu$ Z Mass Resolution

[1] Inner Tracking System Only

H Mass	σ_{M_Z}	σ_{M_Z}	σ_{M_Z}	σ_{M_Z}	σ_{M_Z}	σ_{M_Z}
(GeV/c^2)	CC+CC	CC+CF	CF+CF	CC+FF	CF+FF	FF+FF
200	0.5063	0.5705	0.8331	0.7432	1.2640	1.6620
300	0.7186	0.8686	1.2530	1.2670	1.8260	2.5050
400	0.9793	1.1130	1.6300	1.6220	2.5730	3.1290
500	1.2470	1.4240	1.6790	2.1220	2.9950	4.3070
600	1.5130	1.6310	1.8750	2.5110	3.4840	4.9470
700	1.7670	1.8210	2.1120	2.9190	3.9650	5.2060
800	2.0390	2.0180	2.1040	3.3080	4.2270	6.2830
900	2.2920	2.2060	1.9950	3.6720	4.7820	6.3310
1000	2.5540	2.4230	2.2130	4.0350	4.9300	7.5400

[2] Muon System Only

H Mass	σ_{M_Z}	σ_{M_Z}	σ_{M_Z}	σ_{M_Z}	σ_{M_Z}	σ_{M_Z}
(GeV/c^2)	CC+CC	CC+CF	CF+CF	CC+FF	CF+FF	FF+FF
200	12.0360	11.0500	10.0100	9.2680	8.7760	7.5110
300	12.3700	11.1100	9.7620	10.0200	8.6580	7.5920
400	12.4500	11.0500	9.3140	10.3800	8.6330	7.5230
500	12.3500	10.9000	9.2090	10.4100	8.6780	7.7780
600	12.4300	10.8200	8.9650	10.3500	8.4850	7.9930
700	12.4300	10.8100	9.0160	10.2700	8.4950	7.9270
800	12.0100	10.5100	8.9620	10.0500	8.3480	8.2110
900	12.0400	10.5100	8.8460	10.0900	8.4530	8.2390
1000	12.4300	10.8900	9.0190	10.4100	8.5920	8.4850

$H \rightarrow ZZ \rightarrow 4\mu$ Z Mass Resolution

[3] Combined Inner Tracking + Muon Systems

H Mass	σ_{M_Z}	σ_{M_Z}	σ_{M_Z}	σ_{M_Z}	σ_{M_Z}	σ_{M_Z}
(GeV/c^2)	CC+CC	CC+CF	CF+CF	CC+FF	CF+FF	FF+FF
200	0.5047	0.5657	0.8070	0.7269	1.1950	1.5300
300	0.7155	0.8430	1.1720	1.1880	1.6470	2.1490
400	0.9718	1.0670	1.4560	1.4730	2.1480	2.5790
500	1.2320	1.3330	1.5160	1.8090	2.3980	3.1170
600	1.4860	1.5240	1.6330	2.0770	2.6640	3.4280
700	1.7260	1.7000	1.8520	2.3140	2.6970	3.5410
800	1.9770	1.8870	1.8930	2.5990	3.0290	4.2770
900	2.2060	2.0380	1.8090	2.7360	3.1030	3.9780
1000	2.4360	2.2230	2.0130	2.9220	3.3040	4.4720

$H \rightarrow ZZ \rightarrow 4\mu$ Z Mass Resolution

[1] Inner Tracking System Only

H Mass	σ_{M_Z}/M_Z	σ_{M_Z}/M_Z	σ_{M_Z}/M_Z	σ_{M_Z}/M_Z	σ_{M_Z}/M_Z	σ_{M_Z}/M_Z
(GeV/c^2)	CC+CC	CC+CF	CF+CF	CC+FF	CF+FF	FF+FF
200	0.0056	0.0063	0.0091	0.0082	0.0139	0.0182
300	0.0079	0.0095	0.0137	0.0139	0.0200	0.0275
400	0.0107	0.0122	0.0179	0.0178	0.0282	0.0343
500	0.0137	0.0156	0.0184	0.0233	0.0328	0.0472
600	0.0166	0.0179	0.0206	0.0275	0.0382	0.0543
700	0.0194	0.0200	0.0232	0.0320	0.0435	0.0571
800	0.0224	0.0221	0.0231	0.0363	0.0464	0.0689
900	0.0251	0.0242	0.0219	0.0403	0.0524	0.0694
1000	0.0280	0.0266	0.0243	0.0443	0.0541	0.0827

[2] Muon System Only

H Mass	σ_{M_Z}/M_Z	σ_{M_Z}/M_Z	σ_{M_Z}/M_Z	σ_{M_Z}/M_Z	σ_{M_Z}/M_Z	σ_{M_Z}/M_Z
(GeV/c^2)	CC+CC	CC+CF	CF+CF	CC+FF	CF+FF	FF+FF
200	0.1320	0.1212	0.1098	0.1017	0.0963	0.0824
300	0.1357	0.1219	0.1071	0.1099	0.0950	0.0833
400	0.1366	0.1212	0.1022	0.1138	0.0947	0.0825
500	0.1355	0.1196	0.1010	0.1142	0.0952	0.0853
600	0.1363	0.1187	0.0983	0.1135	0.0931	0.0877
700	0.1363	0.1186	0.0989	0.1126	0.0932	0.0869
800	0.1317	0.1153	0.0983	0.1102	0.0916	0.0901
900	0.1321	0.1153	0.0970	0.1107	0.0927	0.0904
1000	0.1363	0.1194	0.0989	0.1142	0.0942	0.0931

$H \rightarrow ZZ \rightarrow 4\mu$ Z Mass Resolution

[3] Combined Inner Tracking + Muon Systems

H Mass	σ_{M_Z}/M_Z	σ_{M_Z}/M_Z	σ_{M_Z}/M_Z	σ_{M_Z}/M_Z	σ_{M_Z}/M_Z	σ_{M_Z}/M_Z
(GeV/c^2)	CC+CC	CC+CF	CF+CF	CC+FF	CF+FF	FF+FF
200	0.0055	0.0062	0.0089	0.0080	0.0131	0.0168
300	0.0078	0.0092	0.0129	0.0130	0.0181	0.0236
400	0.0107	0.0117	0.0160	0.0162	0.0236	0.0283
500	0.0135	0.0146	0.0166	0.0198	0.0263	0.0342
600	0.0163	0.0167	0.0179	0.0228	0.0292	0.0376
700	0.0189	0.0186	0.0203	0.0254	0.0296	0.0388
800	0.0217	0.0207	0.0208	0.0285	0.0332	0.0469
900	0.0242	0.0224	0.0198	0.0300	0.0340	0.0436
1000	0.0267	0.0244	0.0221	0.0320	0.0362	0.0490

$H \rightarrow ZZ \rightarrow 4\mu$ P_T*Geometrical Acceptance

$\geq 2\mu$ $w/$ P_T $>$ 20 GeV/c

H Mass	CC+CC	CC+CF	CF+CF	CC+FF	CF+FF	FF+FF	SDC	1-SDC
200	0.2446	0.1650	0.0736	0.0107	0.0296	0.0066	0.5301	0.4559
300	0.2474	0.1967	0.0497	0.0394	0.0258	0.0038	0.5628	0.4342
400	0.2906	0.2031	0.0431	0.0530	0.0290	0.0064	0.6252	0.3704
500	0.3280	0.1922	0.0319	0.0721	0.0281	0.0069	0.6592	0.3316
600	0.3742	0.1863	0.0266	0.0778	0.0288	0.0088	0.7025	0.2889
700	0.3974	0.1760	0.0224	0.0929	0.0305	0.0123	0.7315	0.2577
800	0.4172	0.1579	0.0179	0.1069	0.0267	0.0134	0.7400	0.2477
900	0.4383	0.1473	0.0149	0.1195	0.0276	0.0144	0.7620	0.2227
1000	0.4665	0.1379	0.0129	0.1333	0.0251	0.0125	0.7882	0.1979

ZZ Pairs $\rightarrow 4\mu$ P_T*Geometrical Acceptance

$\geq 2\mu$ $w/$ P_T $>$ 20 GeV/c

$< M_{ZZ}$	CC+CC	CC+CF	CF+CF	CC+FF	CF+FF	FF+FF	SDC	1-SDC
270	0.2446	0.1650	0.0736	0.0107	0.0296	0.0066	0.5301	0.4559

ZZ Pairs $\rightarrow 4\mu$ ZZ Mass Resolution

[1] Inner Tracking System Only

$< M_{ZZ} >$	$\sigma_{M_{ZZ}}$	$\sigma_{M_{ZZ}}$	$\sigma_{M_{ZZ}}$	$\sigma_{M_{ZZ}}$	$\sigma_{M_{ZZ}}$	$\sigma_{M_{ZZ}}$
(GeV/c^2)	CC+CC	CC+CF	CF+CF	CC+FF	CF+FF	FF+FF
270	2.2200	3.9640	5.0200	6.1300	6.6740	7.2680

[2] Muon System Only

$< M_{ZZ} >$	$\sigma_{M_{ZZ}}$	$\sigma_{M_{ZZ}}$	$\sigma_{M_{ZZ}}$	$\sigma_{M_{ZZ}}$	$\sigma_{M_{ZZ}}$	$\sigma_{M_{ZZ}}$
(GeV/c^2)	CC+CC	CC+CF	CF+CF	CC+FF	CF+FF	FF+FF
270	22.5500	22.4300	21.1300	23.8200	19.5300	20.9400

[3] Combined Inner Tracking + Muon Systems

$< M_{ZZ} >$	$\sigma_{M_{ZZ}}$	$\sigma_{M_{ZZ}}$	$\sigma_{M_{ZZ}}$	$\sigma_{M_{ZZ}}$	$\sigma_{M_{ZZ}}$	$\sigma_{M_{ZZ}}$
(GeV/c^2)	CC+CC	CC+CF	CF+CF	CC+FF	CF+FF	FF+FF
270	2.0500	3.8040	4.5630	6.1240	6.0100	6.3290

ZZ Pairs $\rightarrow 4\mu$ ZZ Mass Resolution

[1] Inner Tracking System Only

$< M_{ZZ} >$	$\sigma_{M_{ZZ}}/M_{ZZ}$	$\sigma_{M_{ZZ}}/M_{ZZ}$	$\sigma_{M_{ZZ}}/M_{ZZ}$	$\sigma_{M_{ZZ}}/M_{ZZ}$	$\sigma_{M_{ZZ}}/M_{ZZ}$	$\sigma_{M_{ZZ}}/M_{ZZ}$
(GeV/c^2)	CC+CC	CC+CF	CF+CF	CC+FF	CF+FF	FF+FF
270	0.0082	0.0147	0.0186	0.0227	0.0247	0.0269

[2] Muon System Only

$< M_{ZZ} >$	$\sigma_{M_{ZZ}}/M_{ZZ}$	$\sigma_{M_{ZZ}}/M_{ZZ}$	$\sigma_{M_{ZZ}}/M_{ZZ}$	$\sigma_{M_{ZZ}}/M_{ZZ}$	$\sigma_{M_{ZZ}}/M_{ZZ}$	$\sigma_{M_{ZZ}}/M_{ZZ}$
(GeV/c^2)	CC+CC	CC+CF	CF+CF	CC+FF	CF+FF	FF+FF
270	0.0835	0.0831	0.0783	0.0882	0.0723	0.0776

[3] Combined Inner Tracking + Muon Systems

$< M_{ZZ} >$	$\sigma_{M_{ZZ}}/M_{ZZ}$	$\sigma_{M_{ZZ}}/M_{ZZ}$	$\sigma_{M_{ZZ}}/M_{ZZ}$	$\sigma_{M_{ZZ}}/M_{ZZ}$	$\sigma_{M_{ZZ}}/M_{ZZ}$	$\sigma_{M_{ZZ}}/M_{ZZ}$
(GeV/c^2)	CC+CC	CC+CF	CF+CF	CC+FF	CF+FF	FF+FF
270	0.0076	0.0141	0.0169	0.0227	0.0223	0.0234

ZZ Pairs $\rightarrow 4\mu$ Z Mass Resolution

[1] Inner Tracking System Only

$< M_{ZZ} >$	σ_{M_Z}	σ_{M_Z}	σ_{M_Z}	σ_{M_Z}	σ_{M_Z}	σ_{M_Z}
(GeV/c^2)	CC+CC	CC+CF	CF+CF	CC+FF	CF+FF	FF+FF
270	0.6277	0.9007	1.2190	1.3630	1.6330	1.9200

[2] Muon System Only

$< M_{ZZ} >$	σ_{M_Z}	σ_{M_Z}	σ_{M_Z}	σ_{M_Z}	σ_{M_Z}	σ_{M_Z}
(GeV/c^2)	CC+CC	CC+CF	CF+CF	CC+FF	CF+FF	FF+FF
270	11.9700	10.8600	9.8230	9.6590	8.6020	7.8070

[3] Combined Inner Tracking + Muon Systems

$< M_{ZZ} >$	σ_{M_Z}	σ_{M_Z}	σ_{M_Z}	σ_{M_Z}	σ_{M_Z}	σ_{M_Z}
(GeV/c^2)	CC+CC	CC+CF	CF+CF	CC+FF	CF+FF	FF+FF
270	0.6251	0.8494	1.1080	1.2360	1.4390	1.6930

ZZ Pairs $\rightarrow 4\mu$ Z Mass Resolution

[1] Inner Tracking System Only

$< M_{ZZ} >$	σ_{M_Z}/M_Z	σ_{M_Z}/M_Z	σ_{M_Z}/M_Z	σ_{M_Z}/M_Z	σ_{M_Z}/M_Z	σ_{M_Z}/M_Z
(GeV/c^2)	CC+CC	CC+CF	CF+CF	CC+FF	CF+FF	FF+FF
270	0.0069	0.0099	0.0134	0.0149	0.0179	0.0211

[2] Muon System Only

$< M_{ZZ} >$	σ_{M_Z}/M_Z	σ_{M_Z}/M_Z	σ_{M_Z}/M_Z	σ_{M_Z}/M_Z	σ_{M_Z}/M_Z	σ_{M_Z}/M_Z
(GeV/c^2)	CC+CC	CC+CF	CF+CF	CC+FF	CF+FF	FF+FF
270	0.1313	0.1191	0.1077	0.1059	0.0943	0.0856

[3] Combined Inner Tracking + Muon Systems

$< M_{ZZ} >$	σ_{M_Z}/M_Z	σ_{M_Z}/M_Z	σ_{M_Z}/M_Z	σ_{M_Z}/M_Z	σ_{M_Z}/M_Z	σ_{M_Z}/M_Z
(GeV/c^2)	CC+CC	CC+CF	CF+CF	CC+FF	CF+FF	FF+FF
270	0.0069	0.0093	0.0122	0.0136	0.0158	0.0186

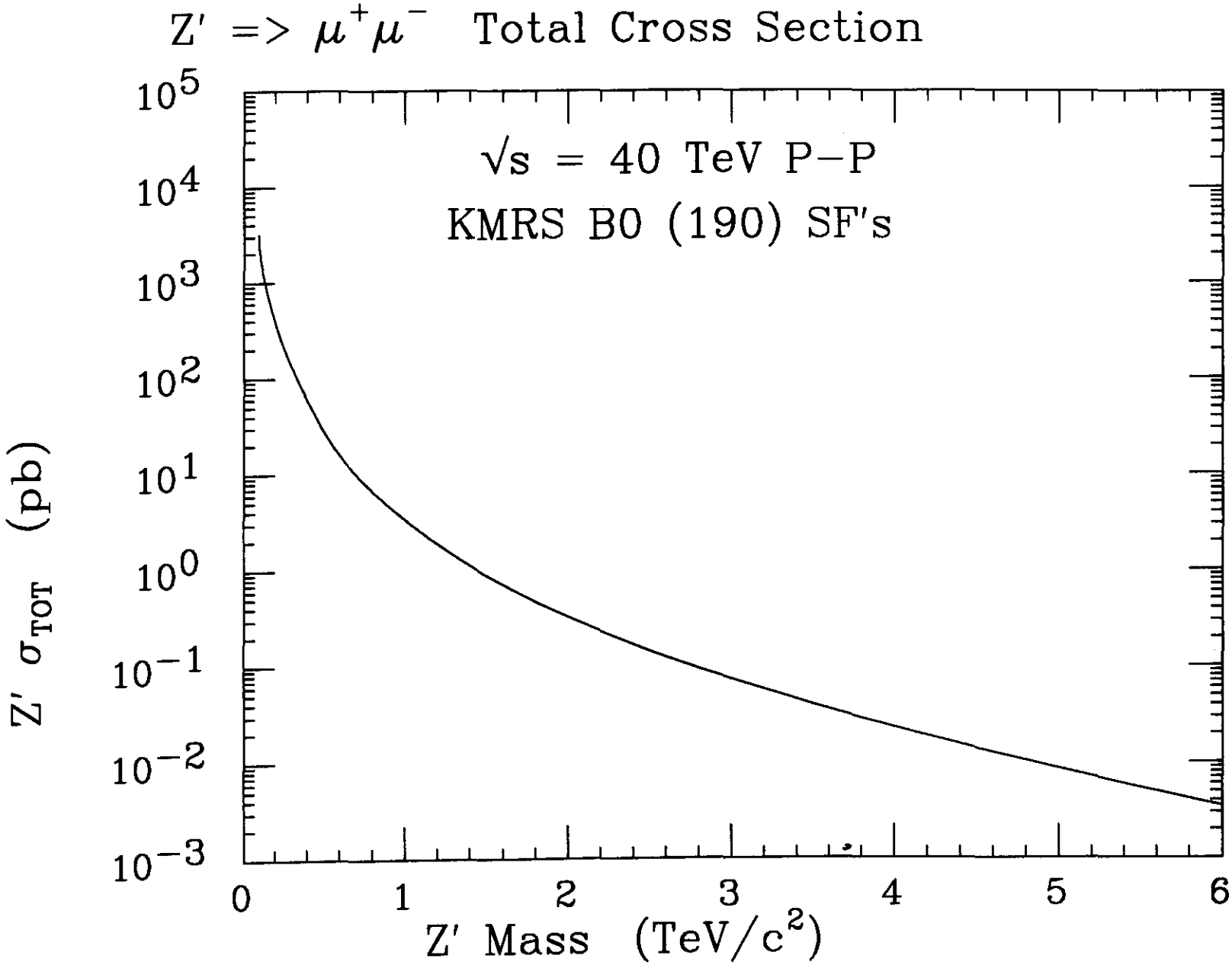
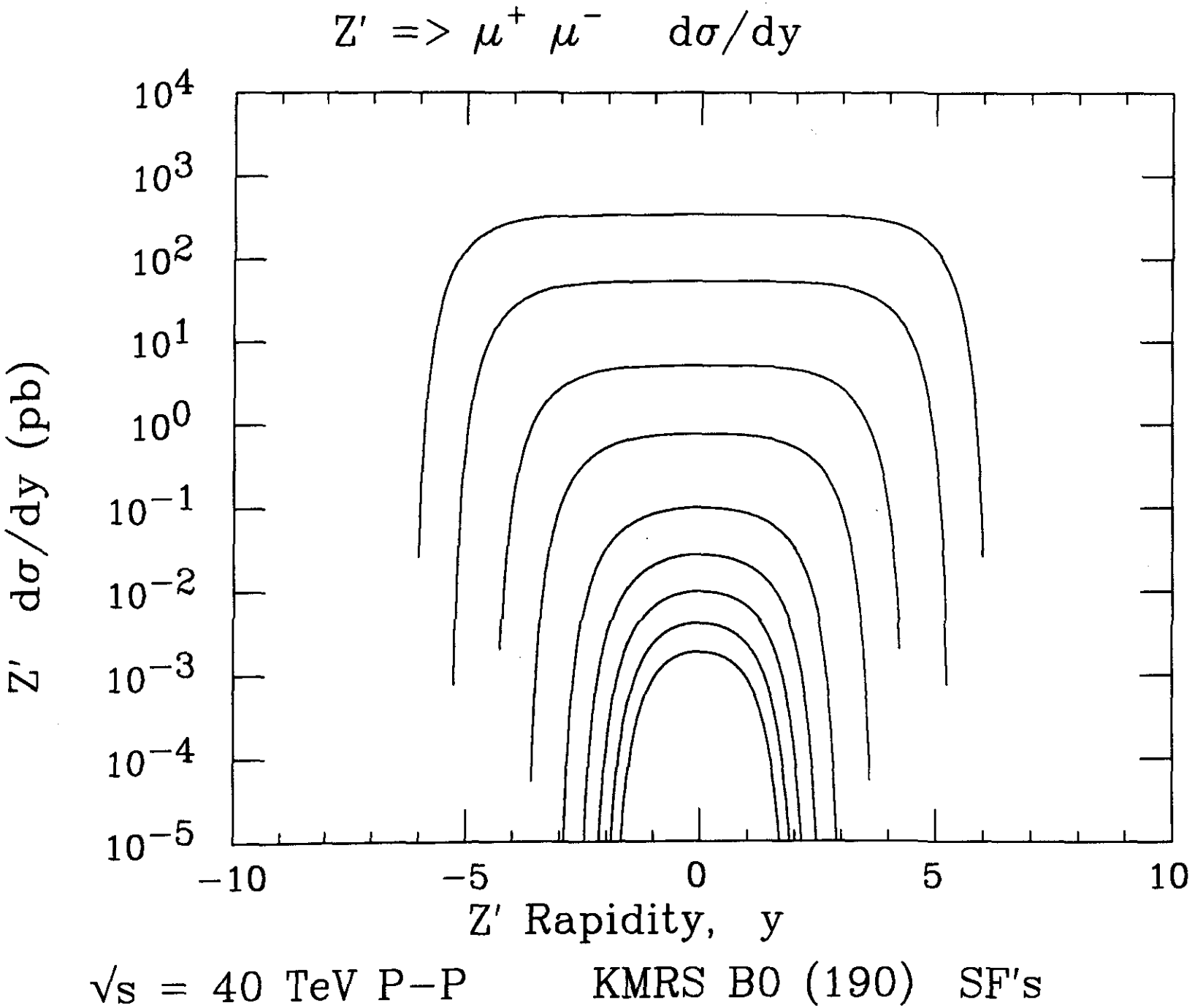

Z′ => μ+μ− Total Cross Section
√s = 40 TeV P−P
KMRS B0 (190) SF's
Z′ σTOT (pb)
10^5
10^4
10^3
10^2
10^1
10^0
10^−1
10^−2
10^−3
0
1
2
3
4
5
6
Z′ Mass (TeV/c^2)

Fig 1



√s = 40 TeV P−P KMRS B0 (190) SF's

FIG 2

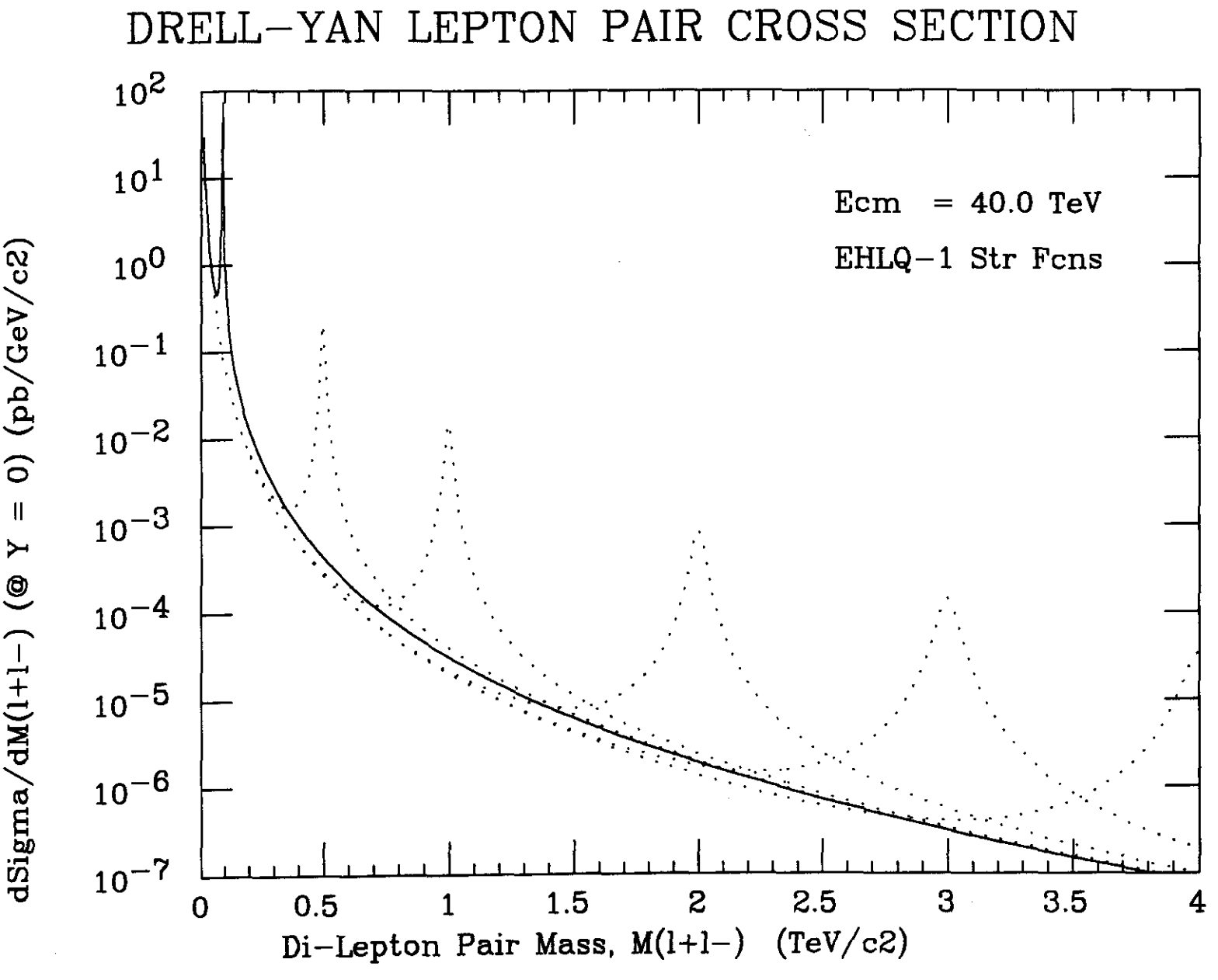

DRELL–YAN LEPTON PAIR CROSS SECTION
Ecm = 40.0 TeV
EHLQ–1 Str Fcns
dSigma/dM(l+l–) (@ Y = 0) (pb/GeV/c2)
Di–Lepton Pair Mass, M(l+l–) (TeV/c2)
10^2
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
0
0.5
1
1.5
2
2.5
3
3.5
4

Fig 3

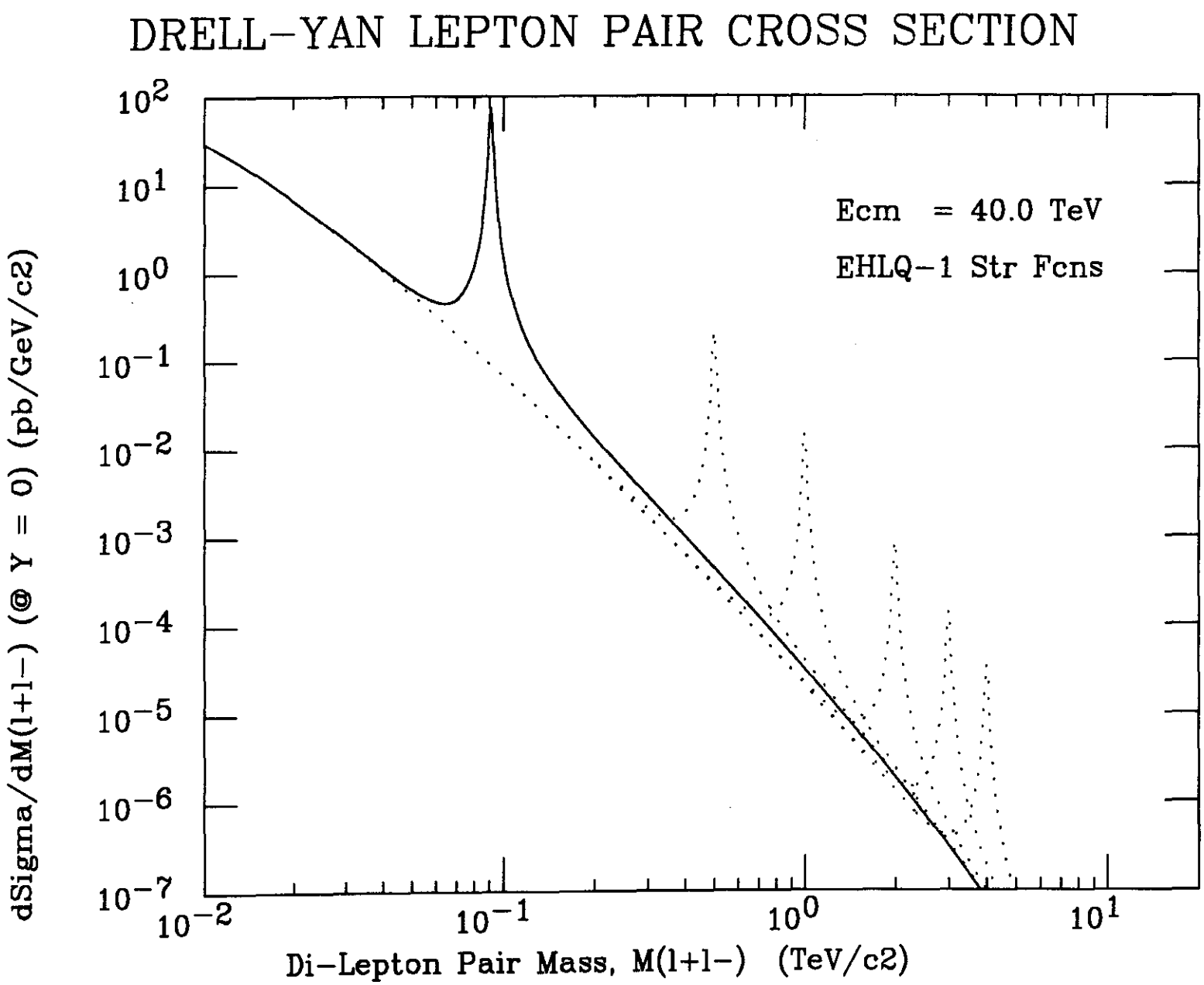

DRELL-YAN LEPTON PAIR CROSS SECTION
Ecm = 40.0 TeV
EHLQ-1 Str Fcns
dSigma/dM(l+l-) (@ Y = 0) (pb/GeV/c2)
Di-Lepton Pair Mass, M(l+l-) (TeV/c2)
10^{2}
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-2}
10^{-1}
10^{0}
10^{1}

Fig 3'

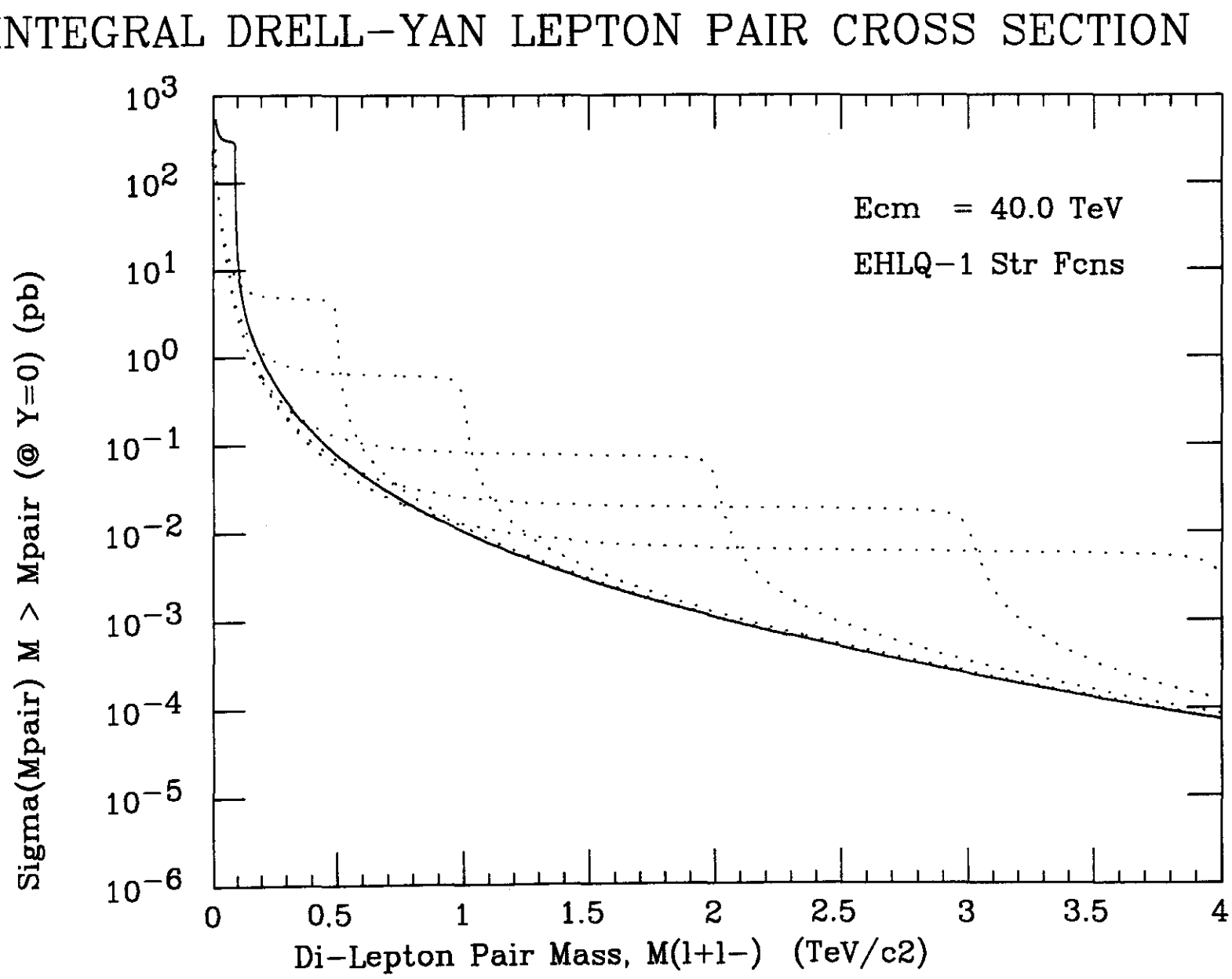

INTEGRAL DRELL-YAN LEPTON PAIR CROSS SECTION
Ecm = 40.0 TeV
EHLQ-1 Str Fcns
Sigma(Mpair) M > Mpair (@ Y=0) (pb)
Di-Lepton Pair Mass, M(l+l-) (TeV/c2)
10^3
10^2
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
0
0.5
1
1.5
2
2.5
3
3.5
4

Fig 3''

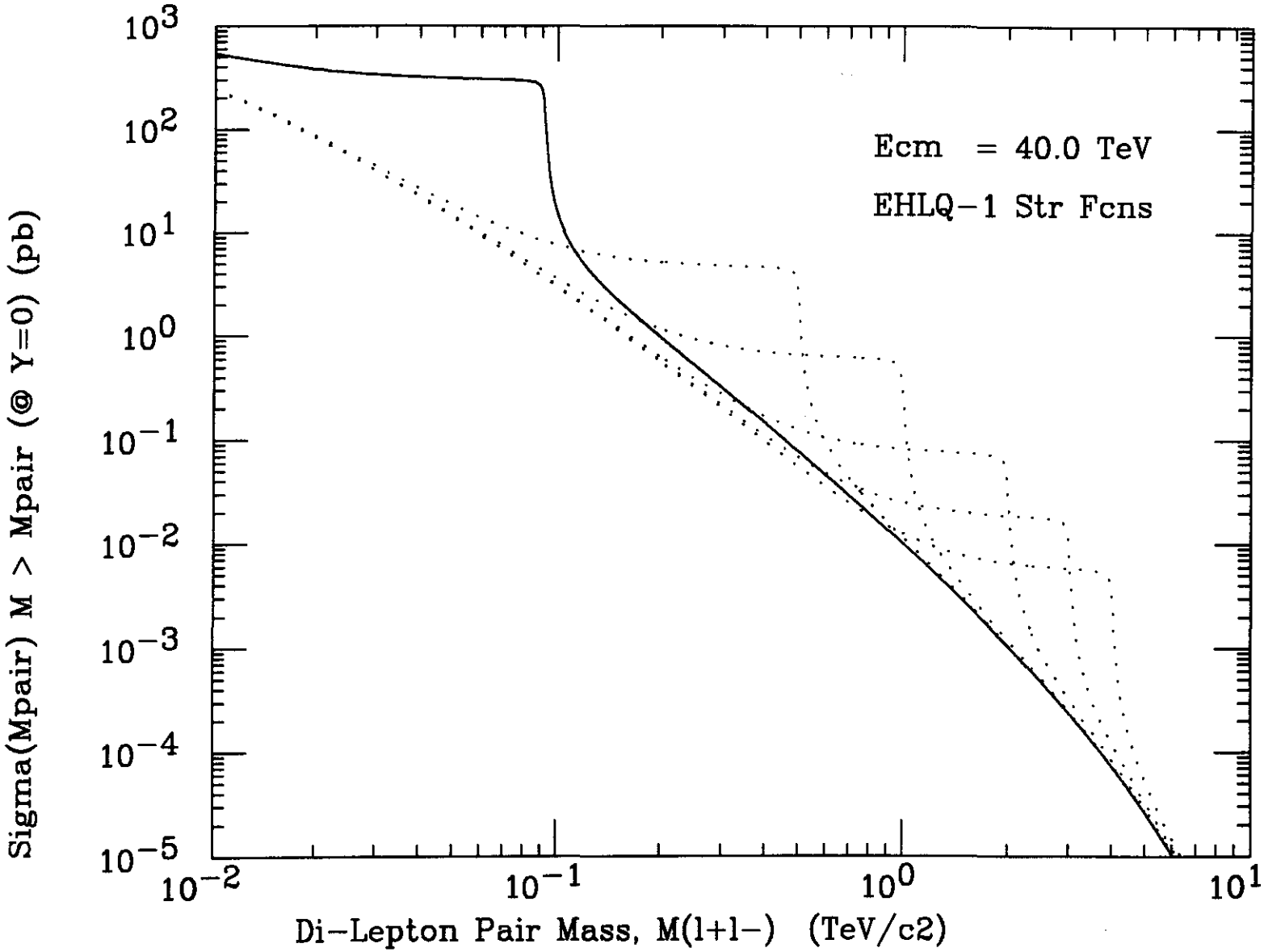

INTEGRAL DRELL-YAN LEPTON PAIR CROSS SECTION
Ecm = 40.0 TeV
EHLQ-1 Str Fcns
Sigma(Mpair) M > Mpair (@ Y=0) (pb)
Di-Lepton Pair Mass, M(l+l-) (TeV/c2)
10^{3}
10^{2}
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-2}
10^{-1}
10^{0}
10^{1}

Fig 3iv

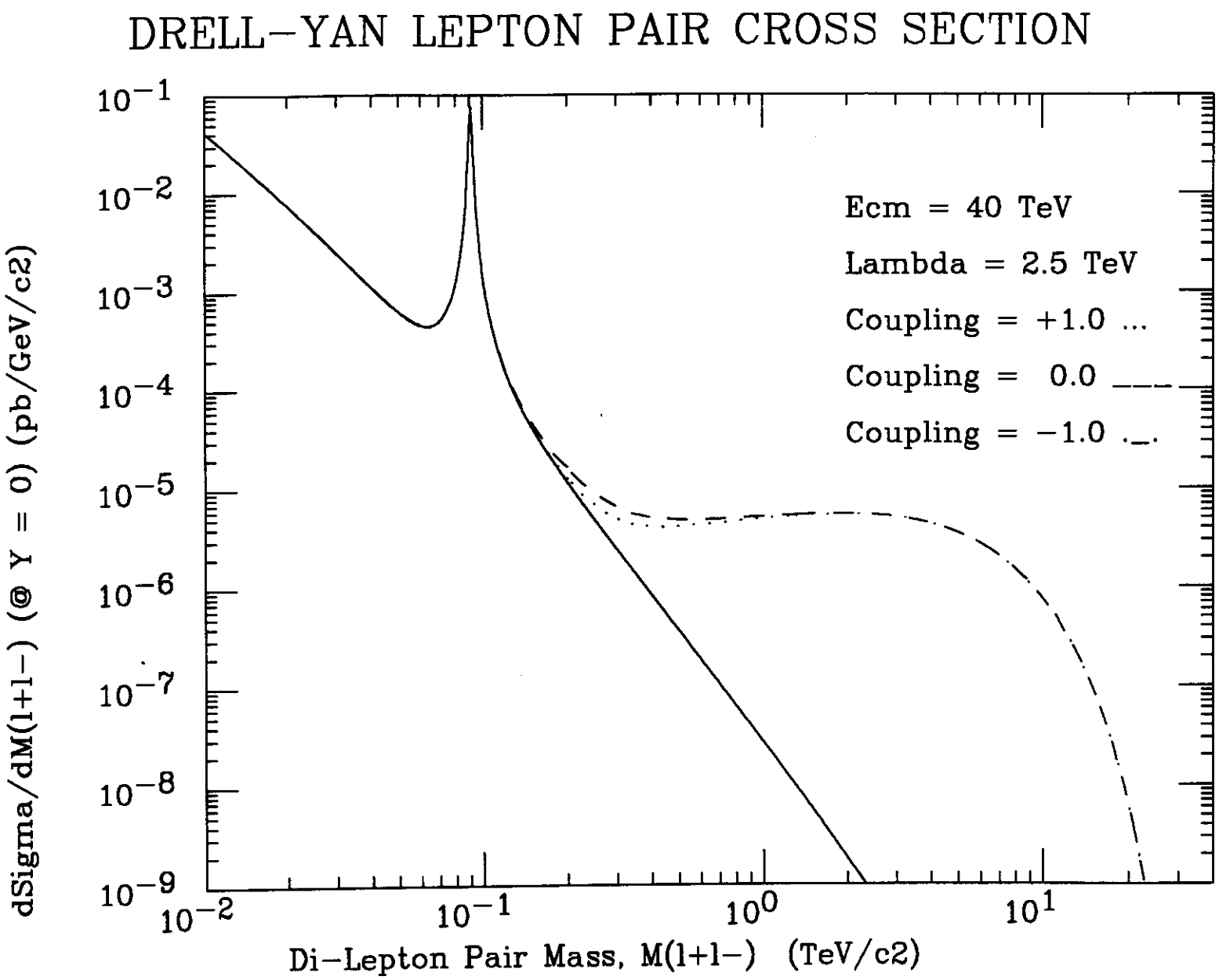

DRELL–YAN LEPTON PAIR CROSS SECTION
Ecm = 40 TeV
Lambda = 2.5 TeV
Coupling = +1.0 ...
Coupling = 0.0 ___
Coupling = −1.0 ._.
dSigma/dM(l+l−) (@ Y = 0) (pb/GeV/c2)
Di−Lepton Pair Mass, M(l+l−) (TeV/c2)
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^{-9}
10^{-2}
10^{-1}
10^{0}
10^{1}

Fig 3r

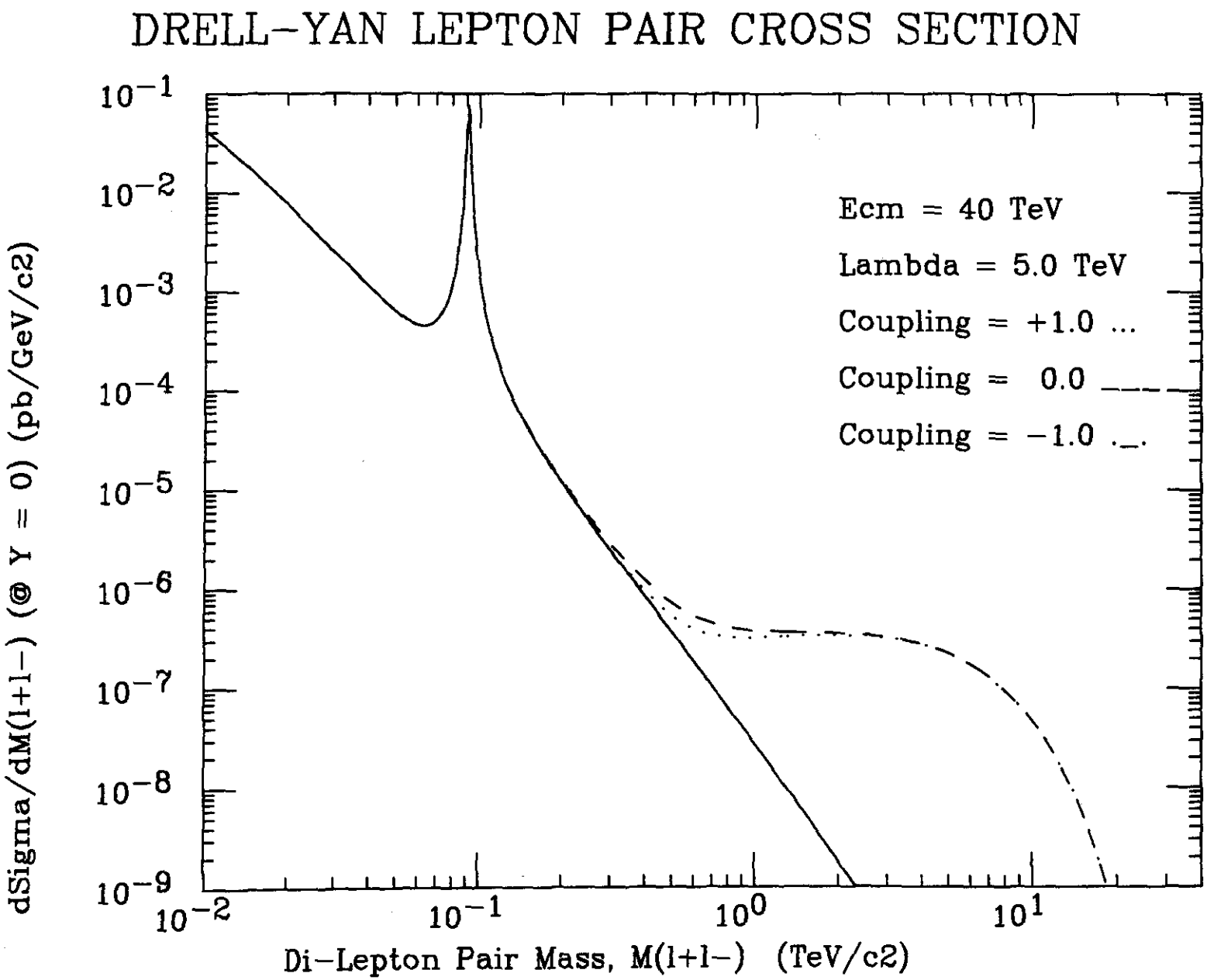

DRELL-YAN LEPTON PAIR CROSS SECTION
Ecm = 40 TeV
Lambda = 5.0 TeV
Coupling = +1.0 ...
Coupling = 0.0 ___
Coupling = −1.0 ._.
dSigma/dM(l+l−) (@ Y = 0) (pb/GeV/c2)
Di−Lepton Pair Mass, M(l+l−) (TeV/c2)
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^{-9}
10^{-2}
10^{-1}
10^{0}
10^{1}

Fig 7vi

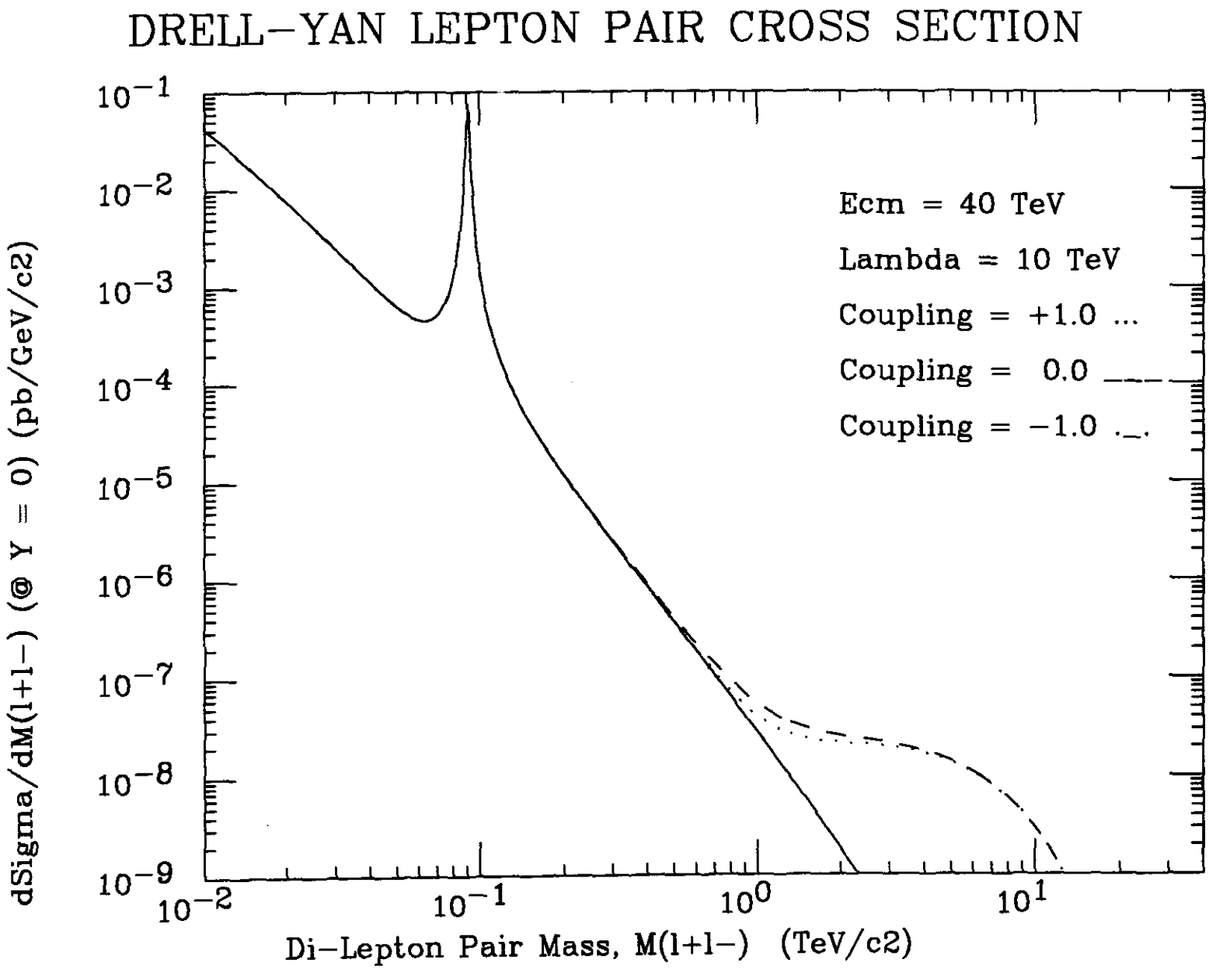

DRELL–YAN LEPTON PAIR CROSS SECTION
Ecm = 40 TeV
Lambda = 10 TeV
Coupling = +1.0 ...
Coupling = 0.0 ___
Coupling = −1.0 ._.
dSigma/dM(l+l−) (@ Y = 0) (pb/GeV/c2)
Di–Lepton Pair Mass, M(l+l−) (TeV/c2)
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^{-9}
10^{-2}
10^{-1}
10^{0}
10^{1}

Fig 3vii

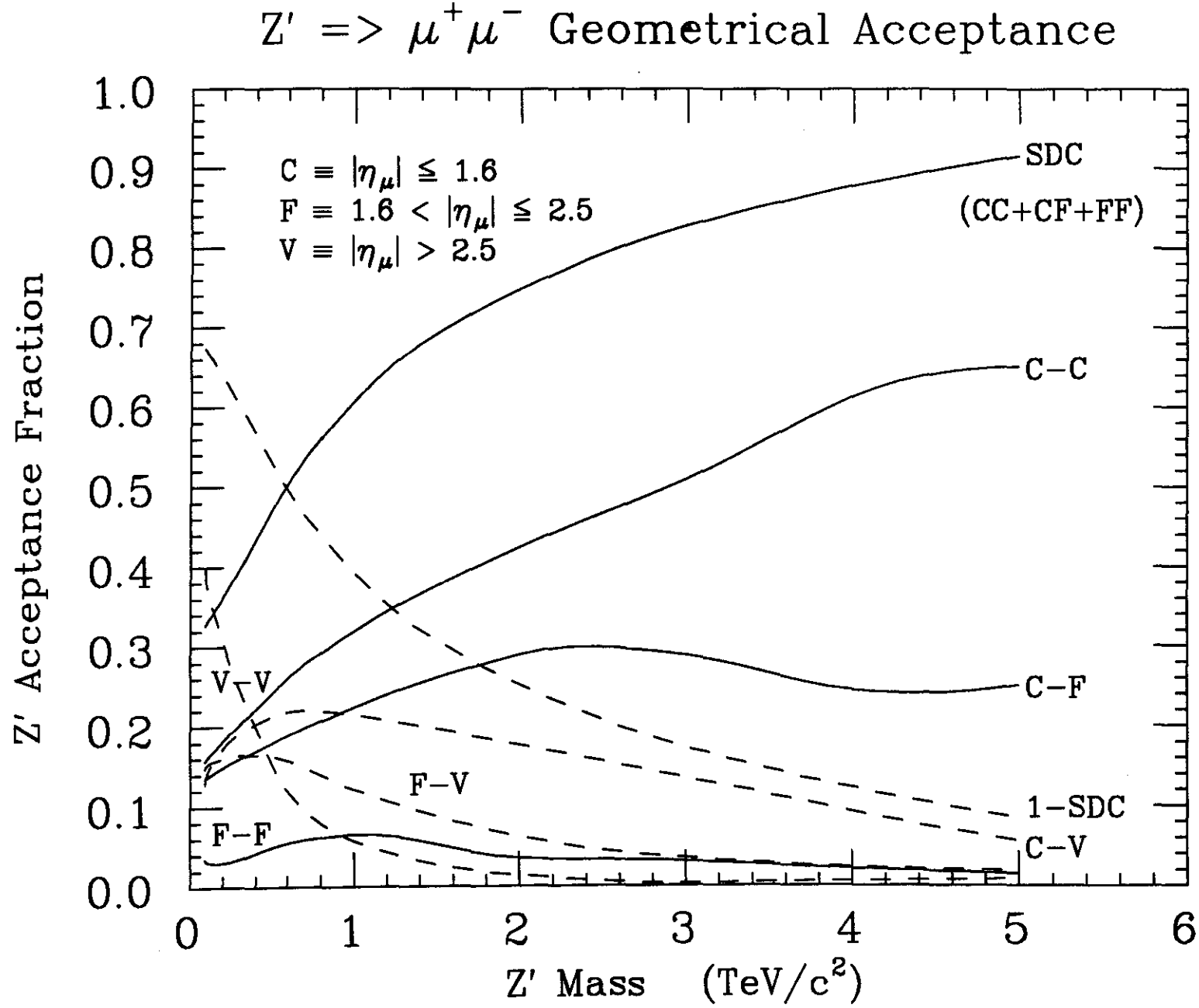

Z′ => μ+μ− Geometrical Acceptance
C ≡ |ημ| ≤ 1.6
F ≡ 1.6 < |ημ| ≤ 2.5
V ≡ |ημ| > 2.5
SDC
(CC+CF+FF)
C−C
C−F
1−SDC
C−V
V−V
F−V
F−F
Z′ Acceptance Fraction
Z′ Mass (TeV/c²)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
0
1
2
3
4
5
6

Fig 4

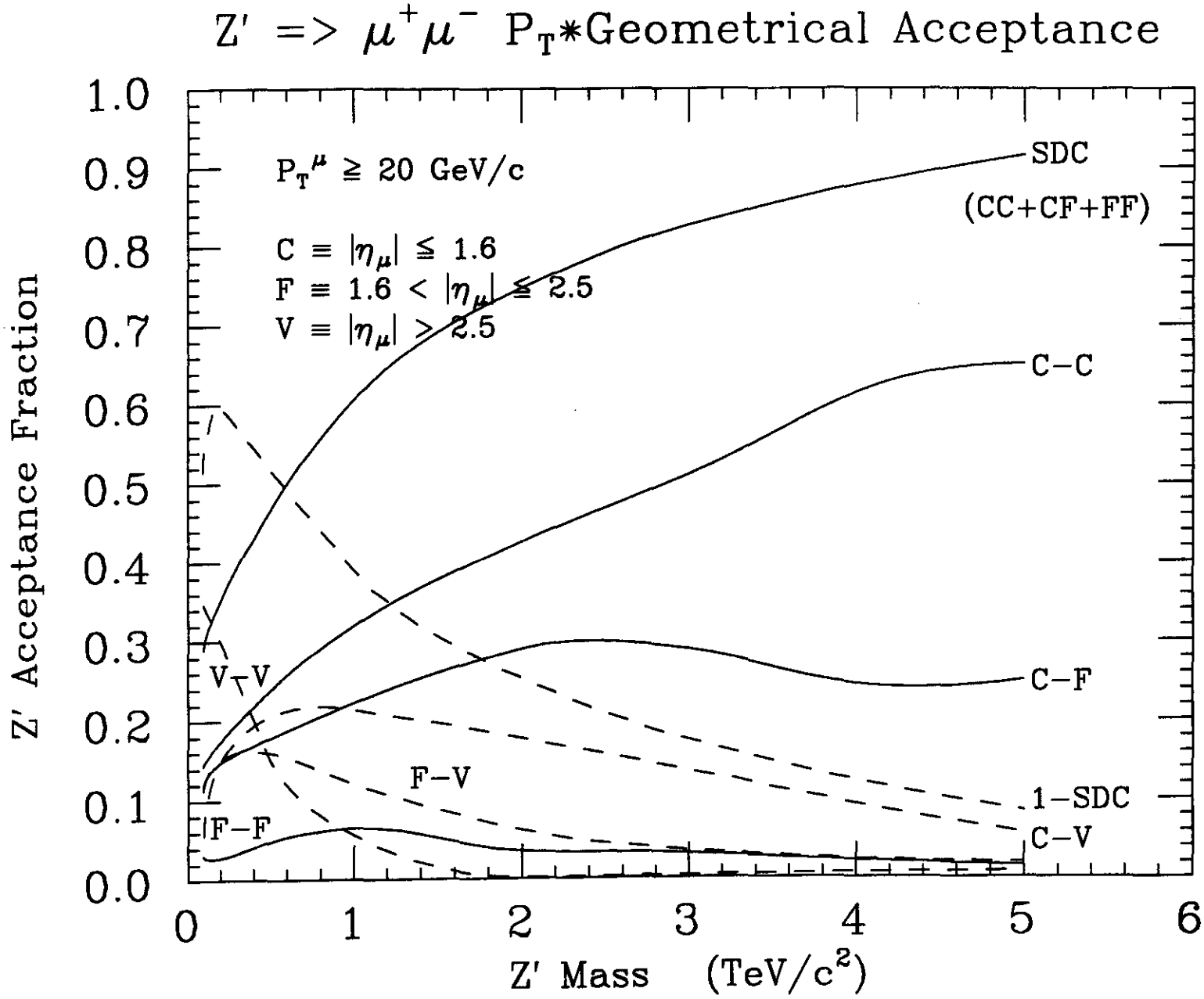
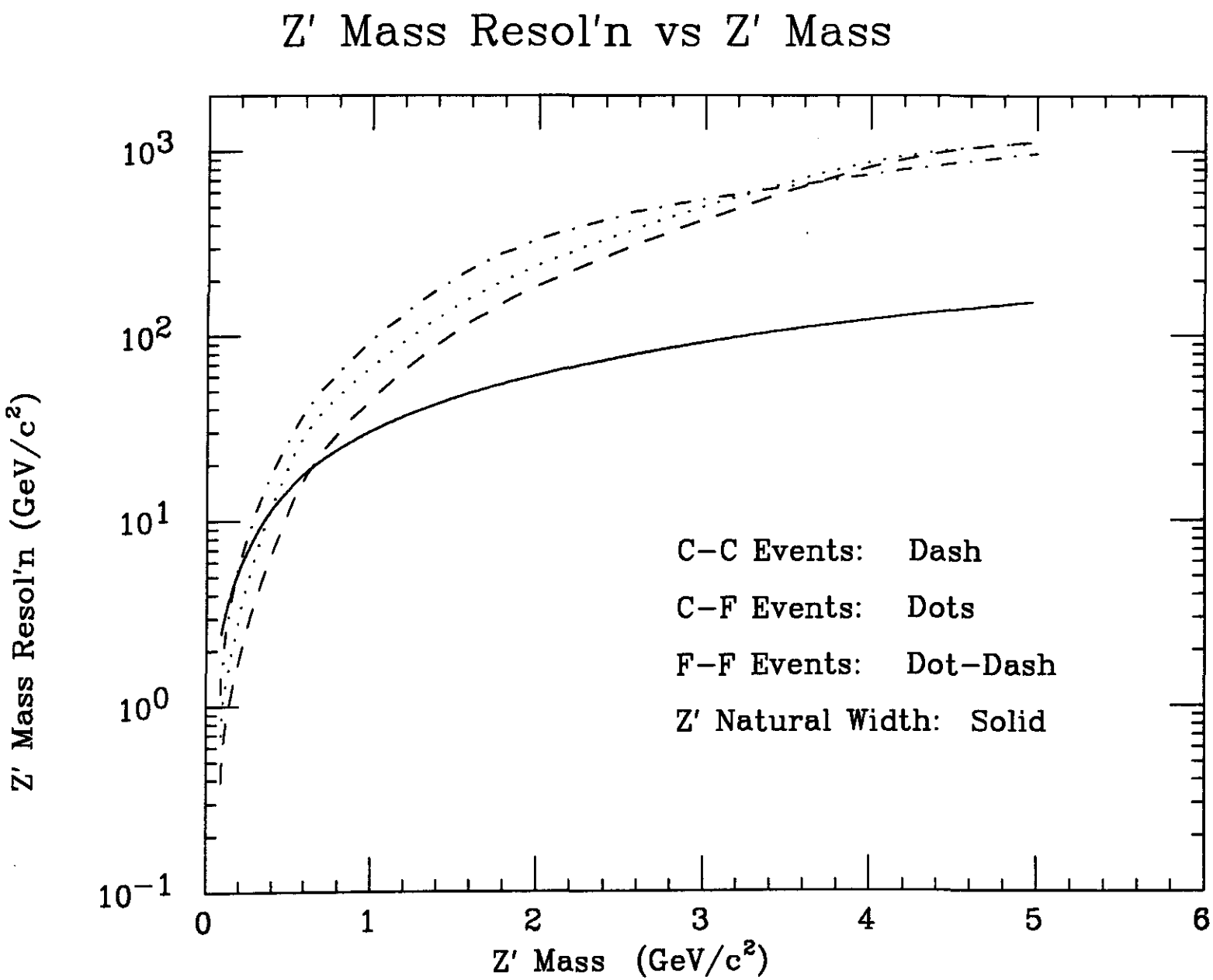
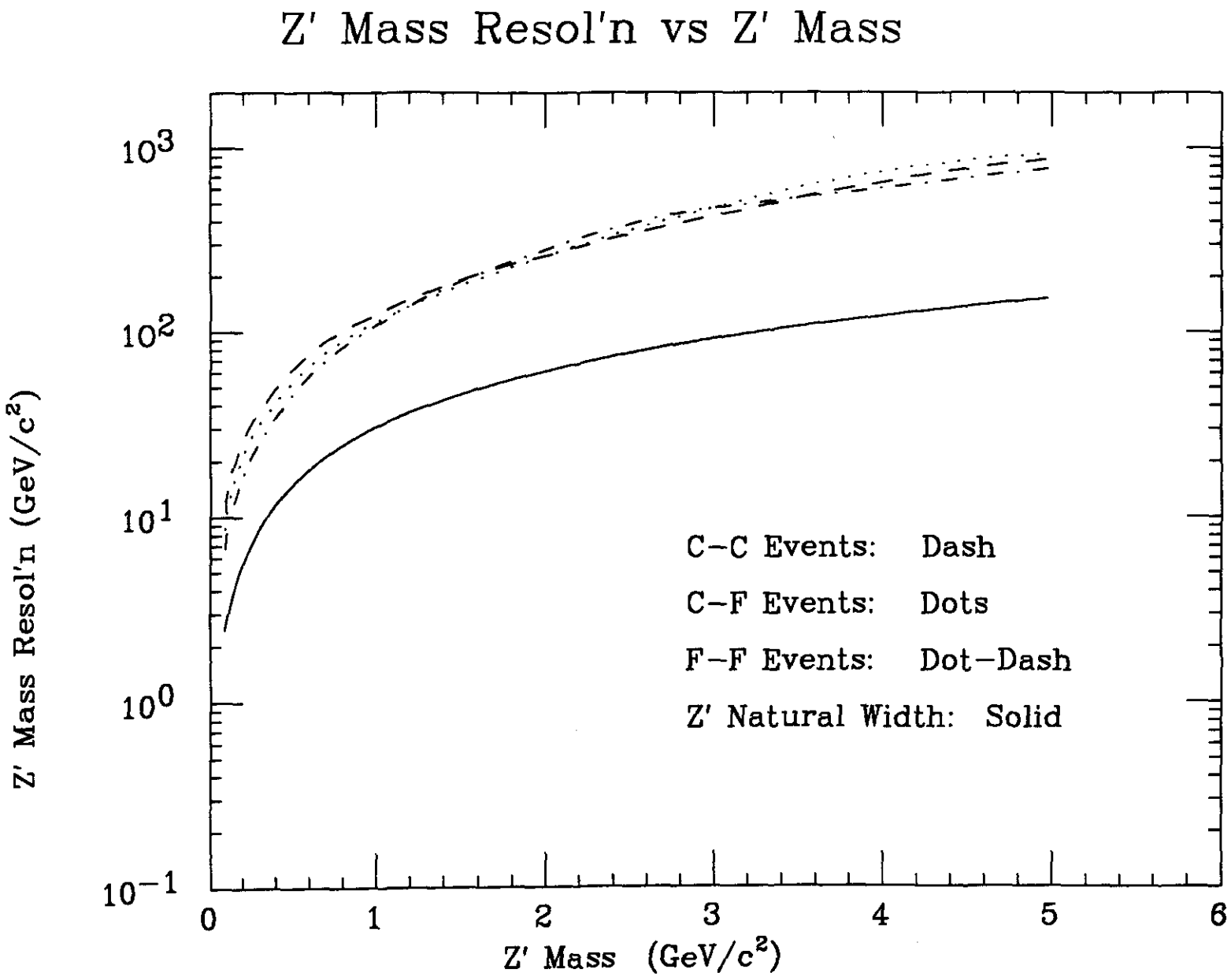

Z′ => μ⁺μ⁻ P_T*Geometrical Acceptance
P_T^μ ≧ 20 GeV/c
C ≡ |η_μ| ≦ 1.6
F ≡ 1.6 < |η_μ| ≦ 2.5
V ≡ |η_μ| > 2.5
SDC
(CC+CF+FF)
C−C
C−F
1−SDC
C−V
V−V
F−V
F−F
Z′ Acceptance Fraction
Z′ Mass (TeV/c²)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
0
1
2
3
4
5
6

Fig 5



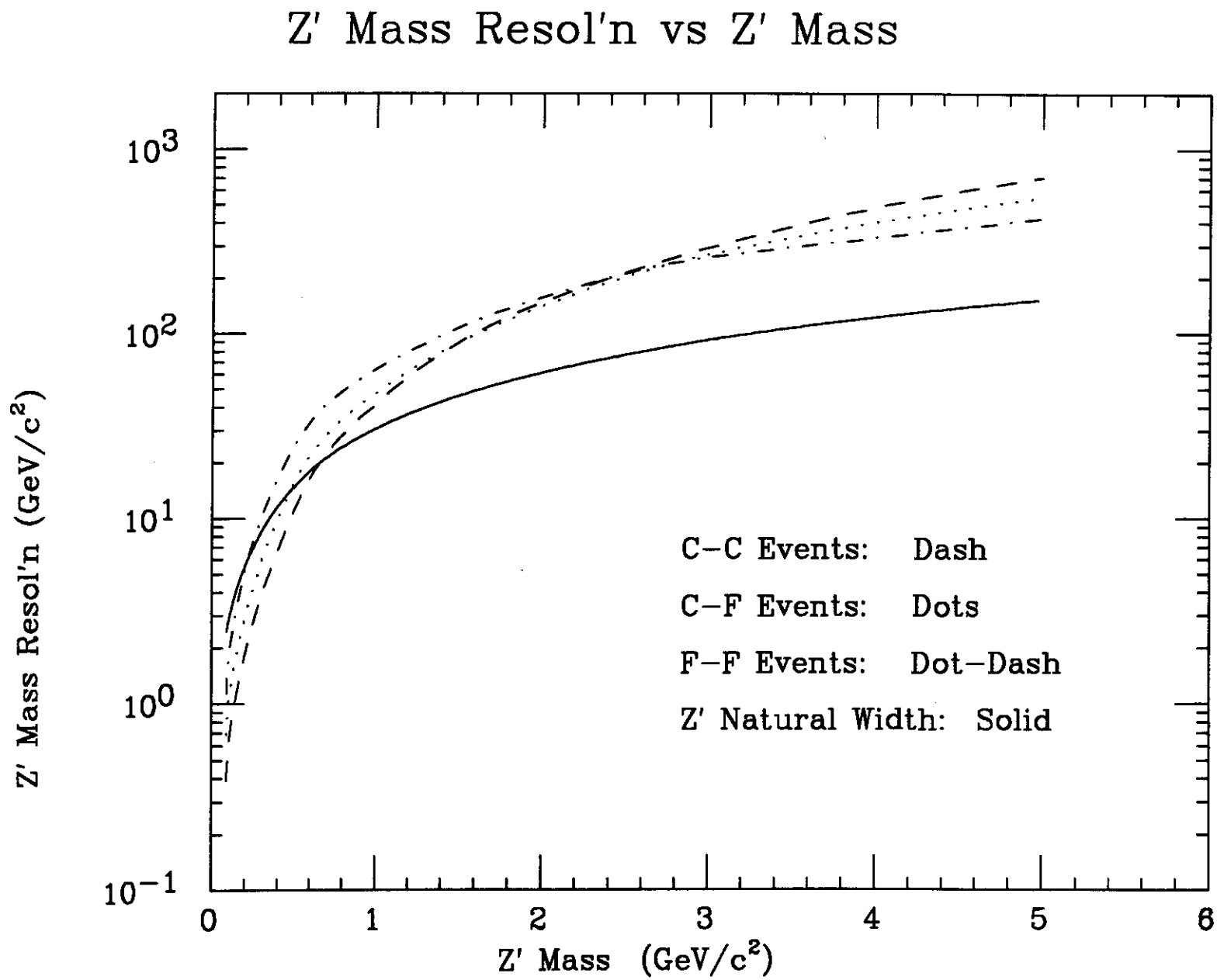
[1] Inner Tracking System

Fig



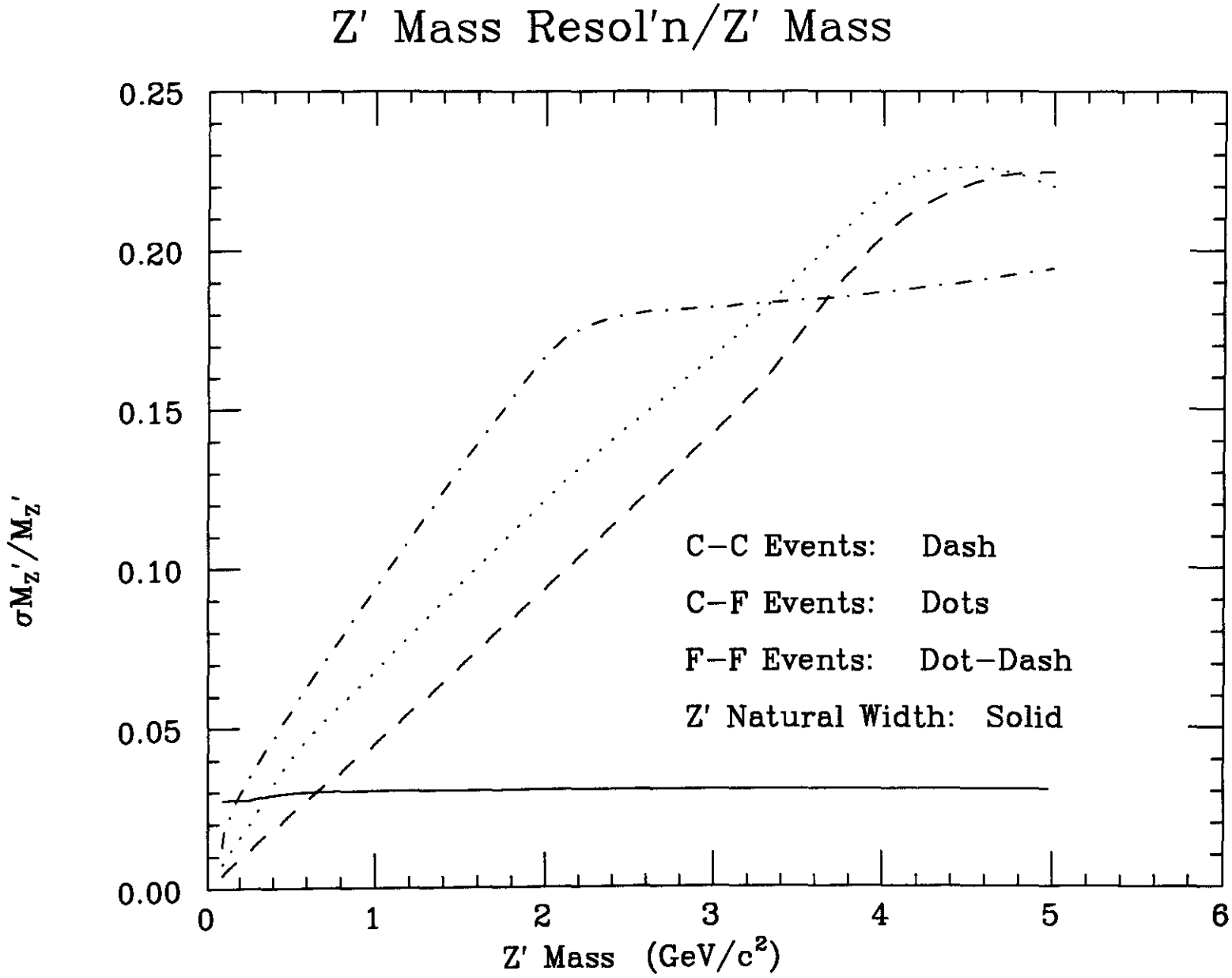
[2] Muon System Only

Fig 7



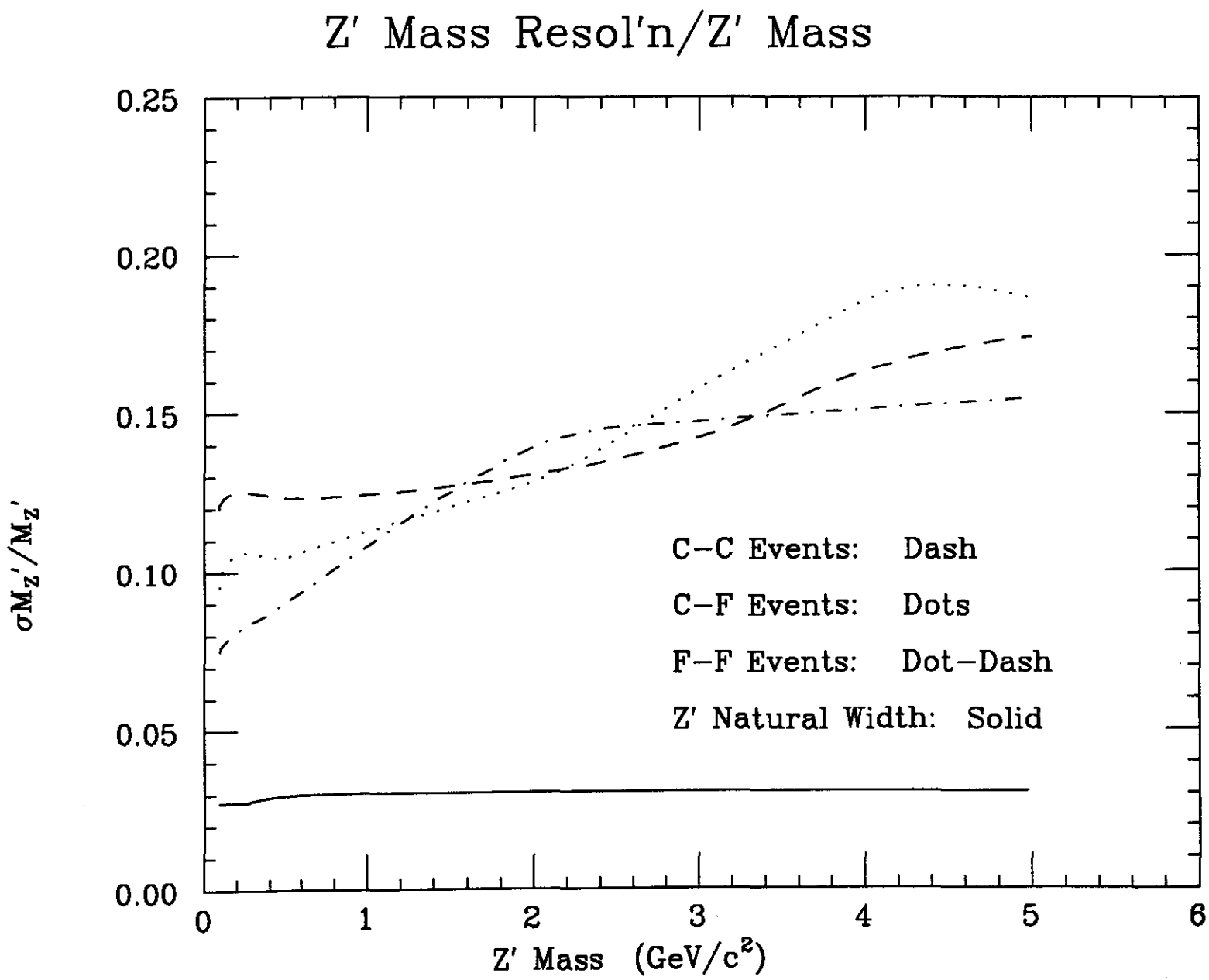
[3] Combined/Full Tracking

F

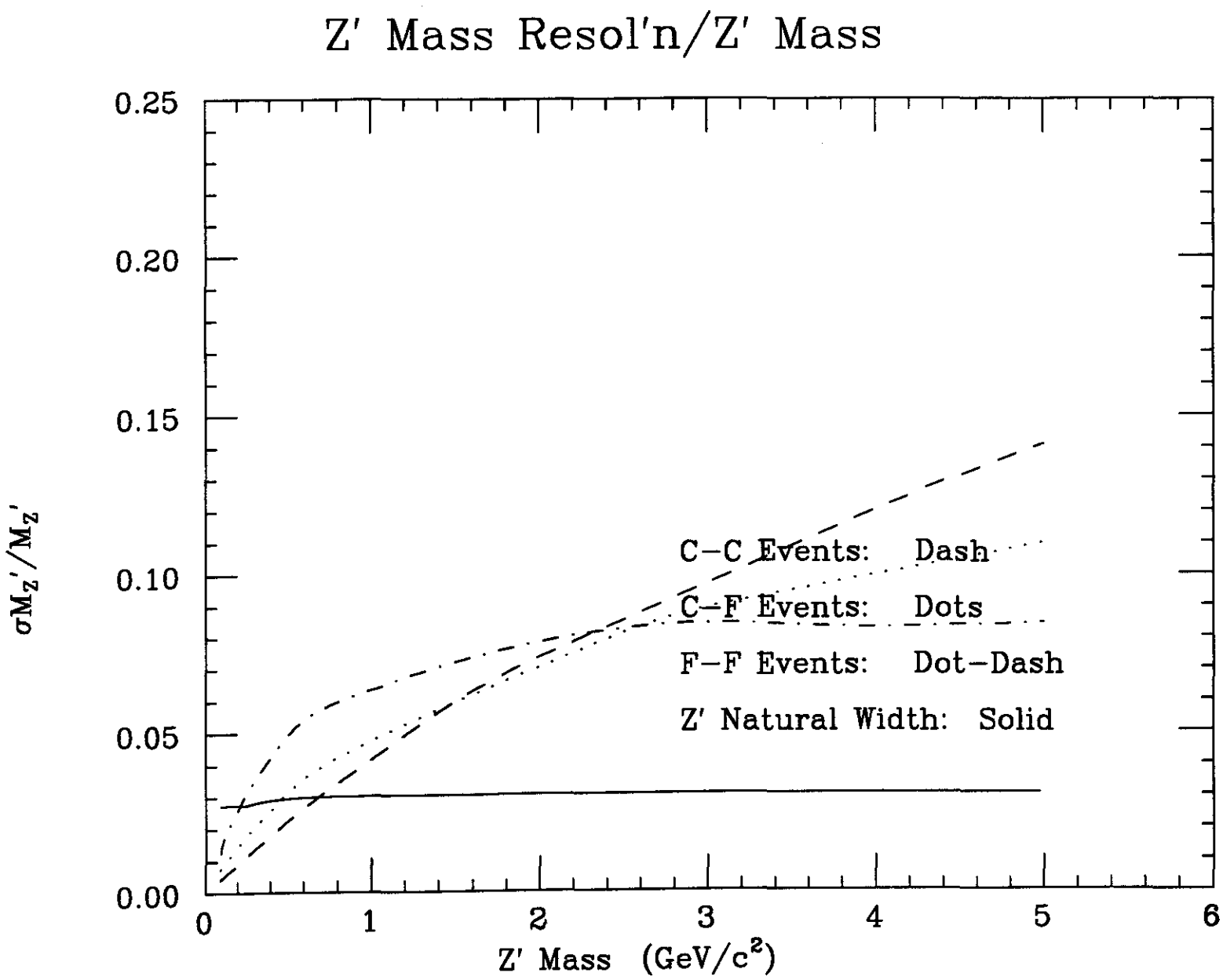


[1] Inner Tracking System

Fig 9

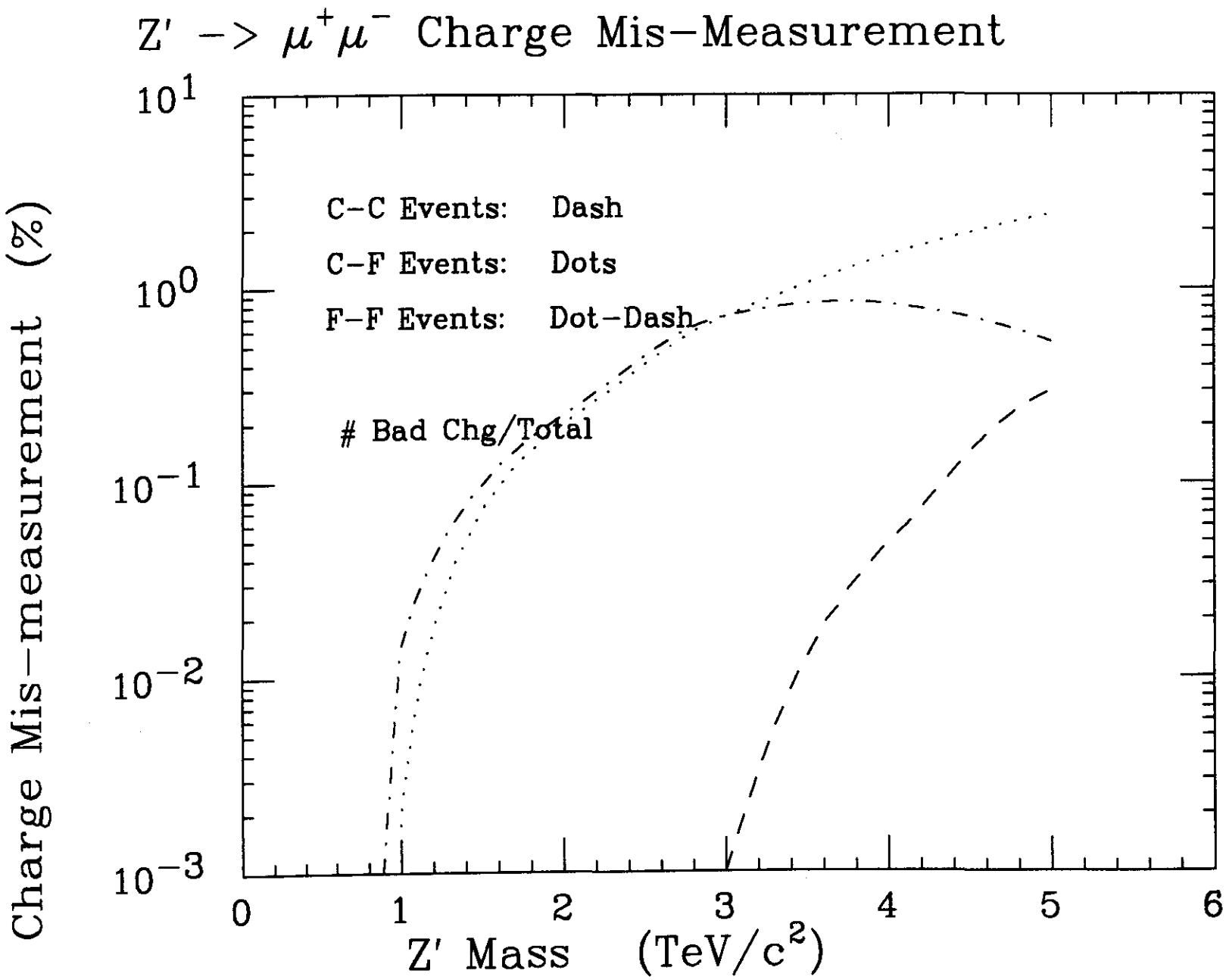


[2] Muon System Only



[3] Combined/Full Tracking

Fig 11



[1] Inner Tracking System Only

Fig 2

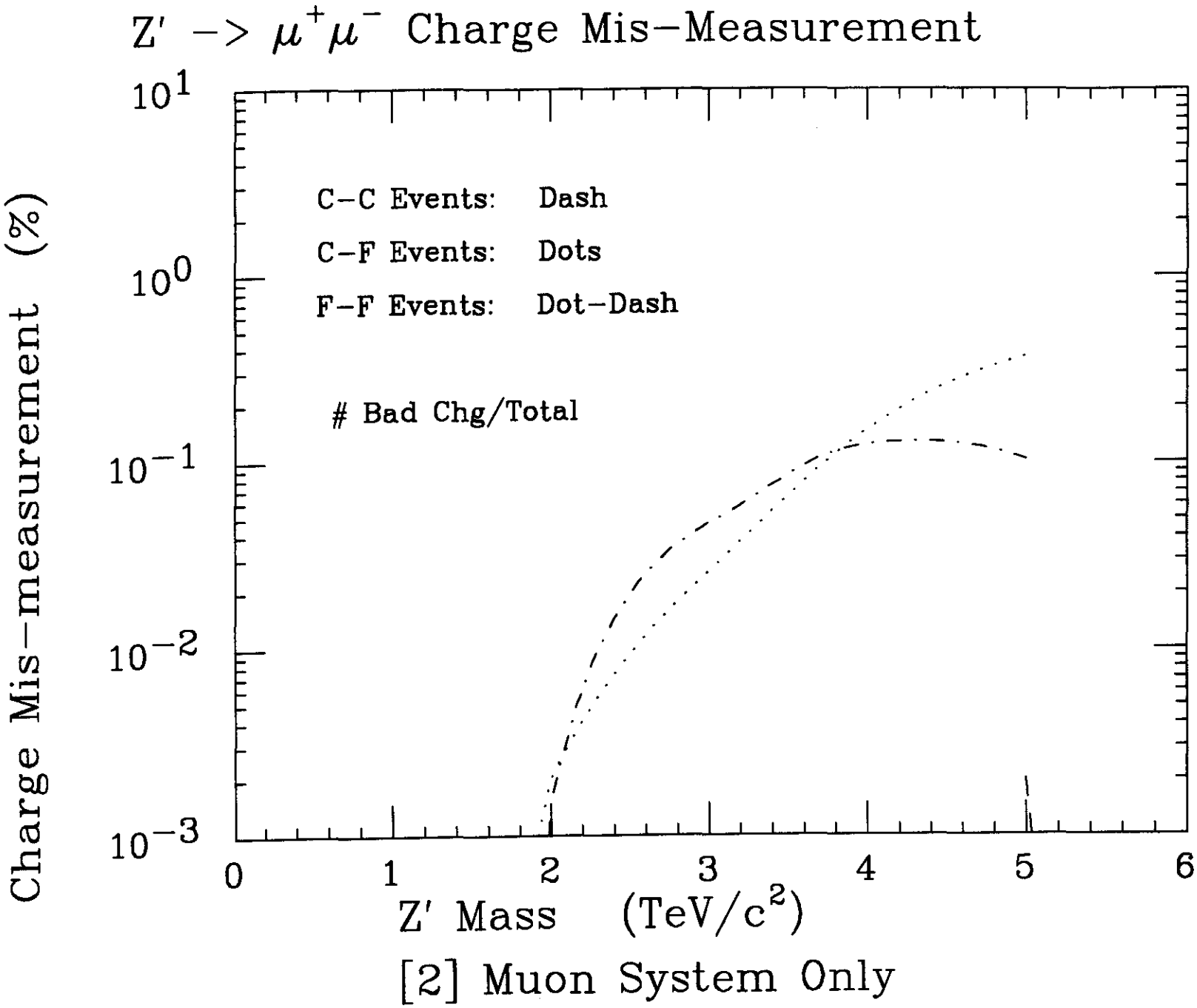
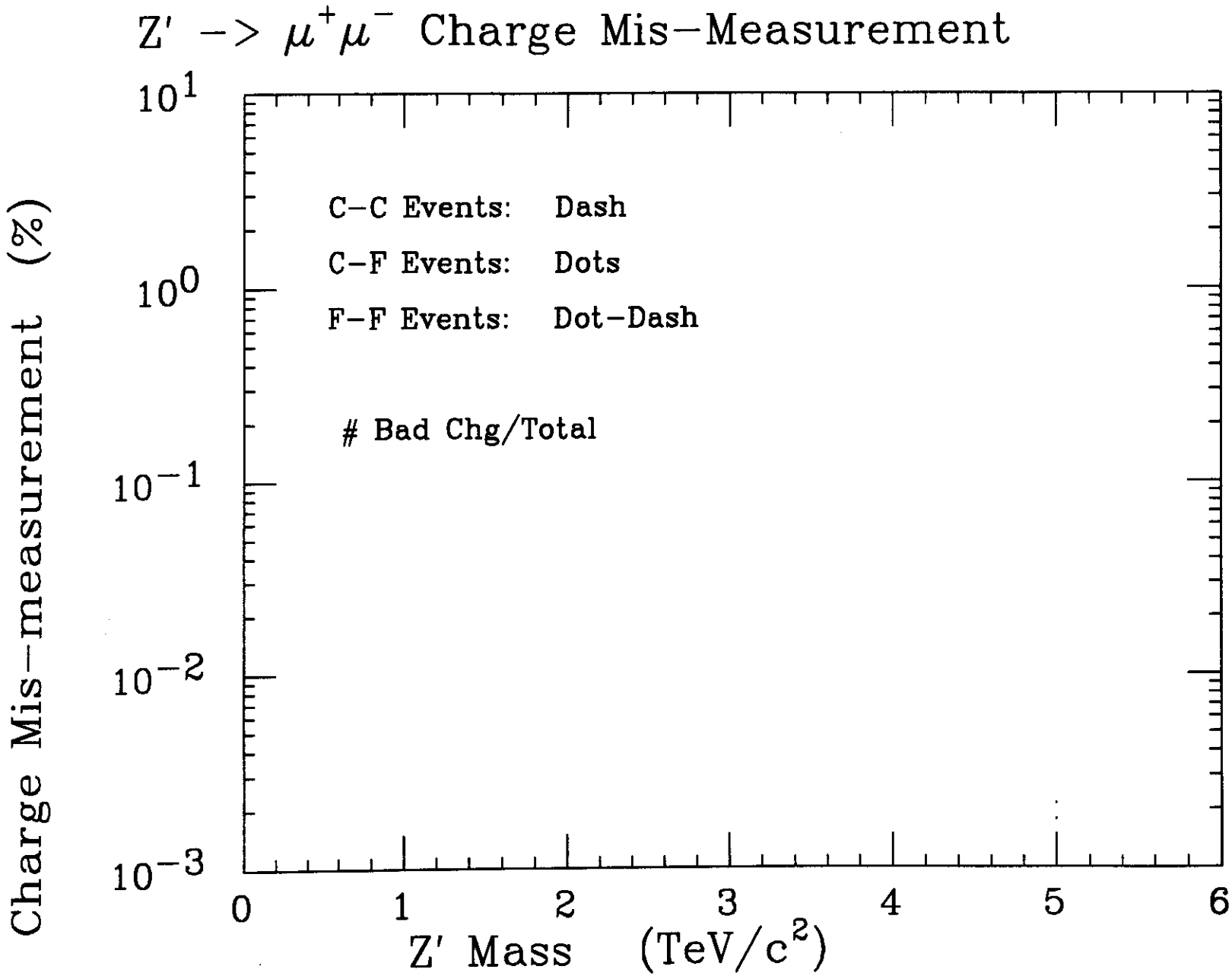
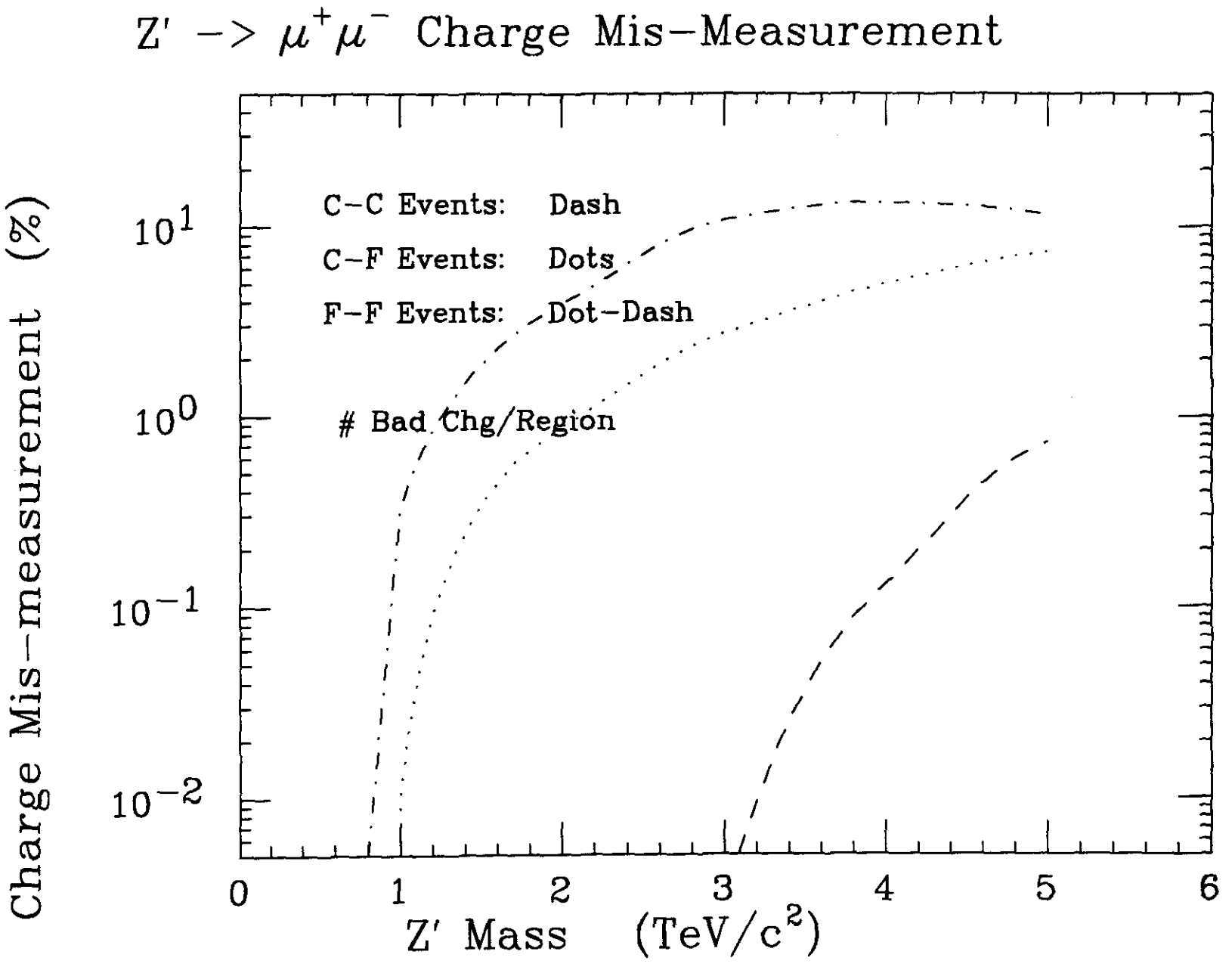

Z' -> $\mu^+\mu^-$ Charge Mis-Measurement
C-C Events: Dash
C-F Events: Dots
F-F Events: Dot-Dash
Bad Chg/Total
Charge Mis-measurement (%)
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
0
1
2
3
4
5
6
Z' Mass (TeV/c^2)
[2] Muon System Only

Fig 13



[3] Combined/Full Tracking System

Fig



[1] Inner Tracking System Only

Fig 15

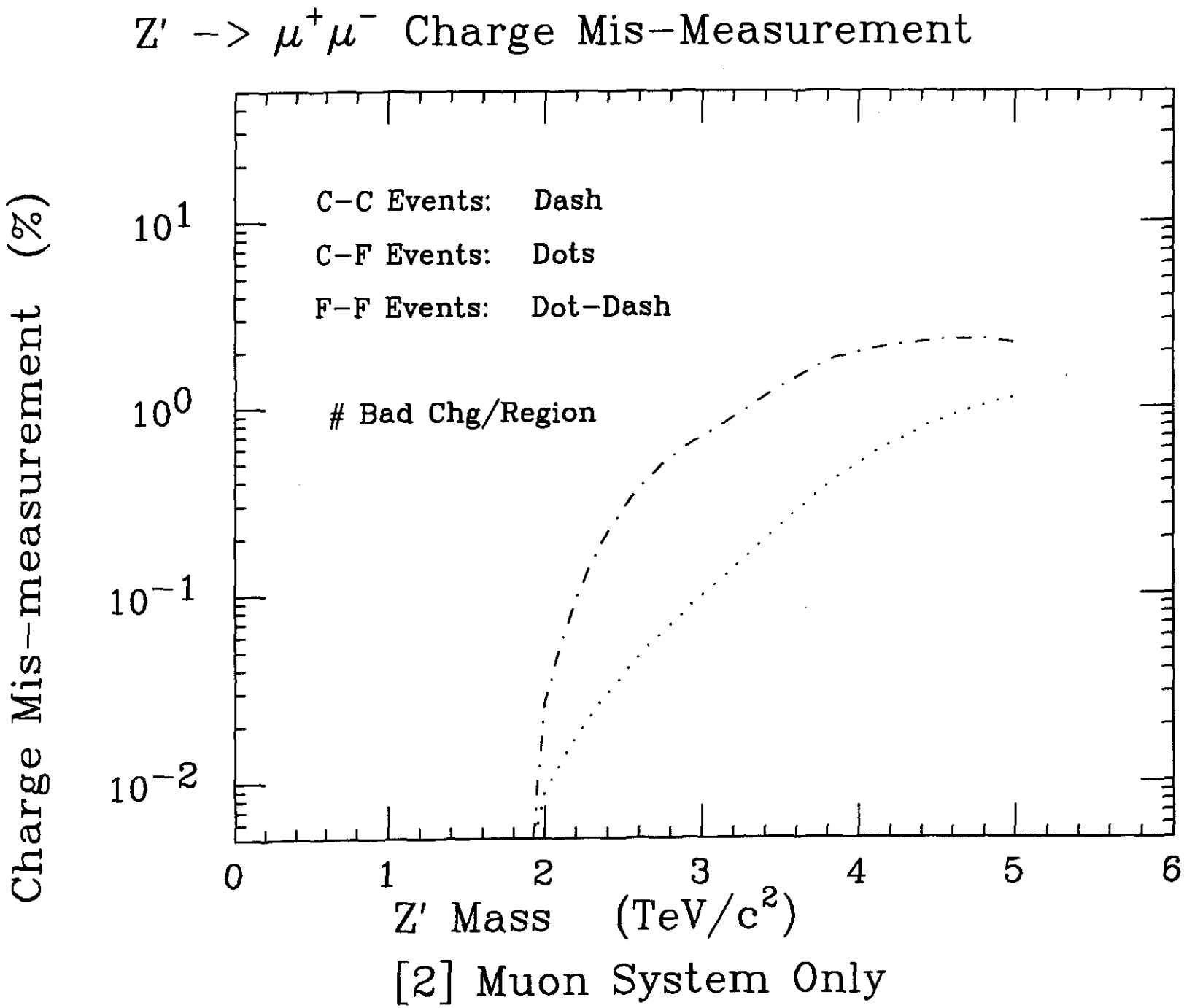
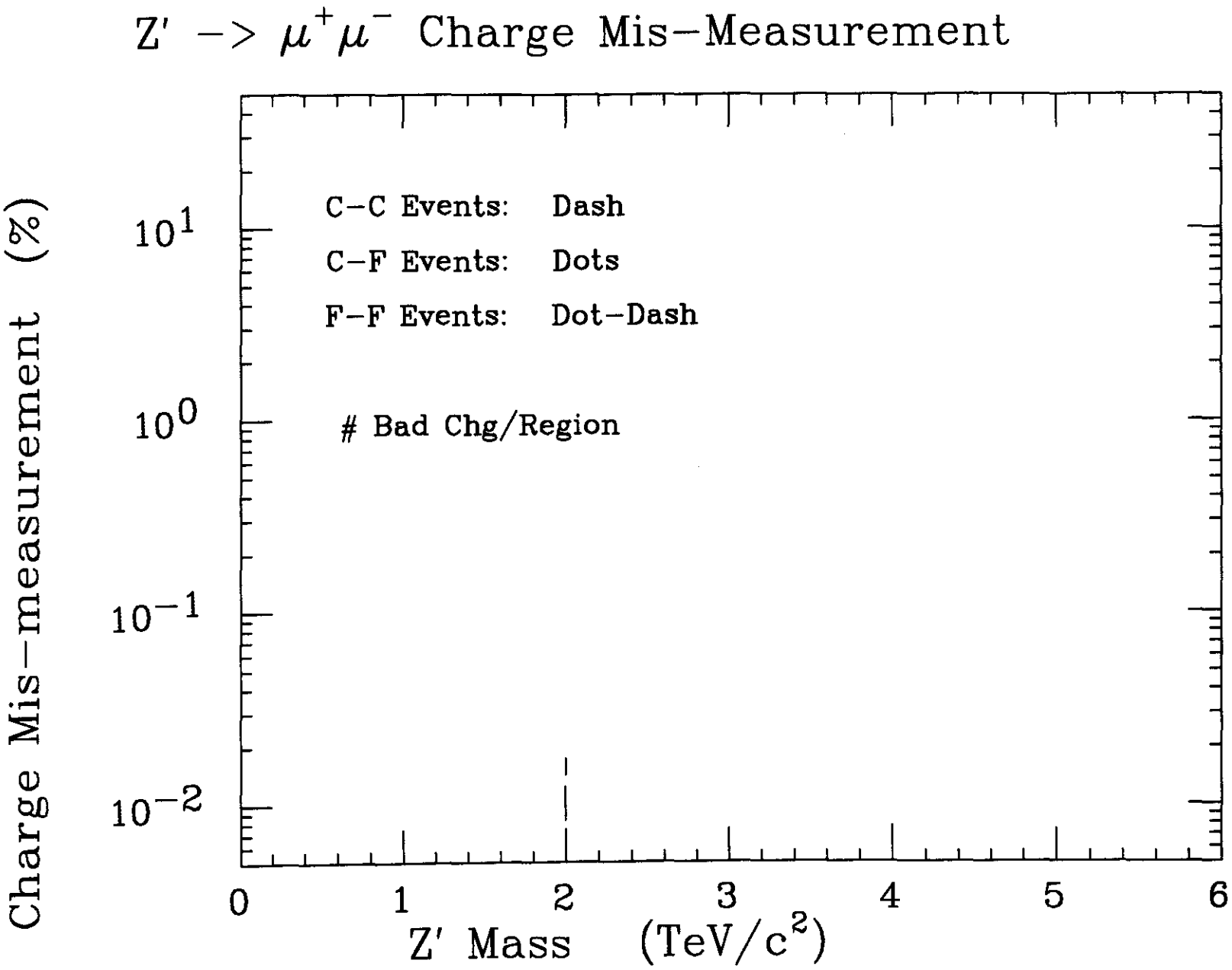

Z' -> $\mu^+\mu^-$ Charge Mis-Measurement
C-C Events: Dash
C-F Events: Dots
F-F Events: Dot-Dash
Bad Chg/Region
Charge Mis-measurement (%)
10^1
10^0
10^{-1}
10^{-2}
0
1
2
3
4
5
6
Z' Mass (TeV/c^2)
[2] Muon System Only

Fig.



[3] Combined/Full Tracking System

Fig 17

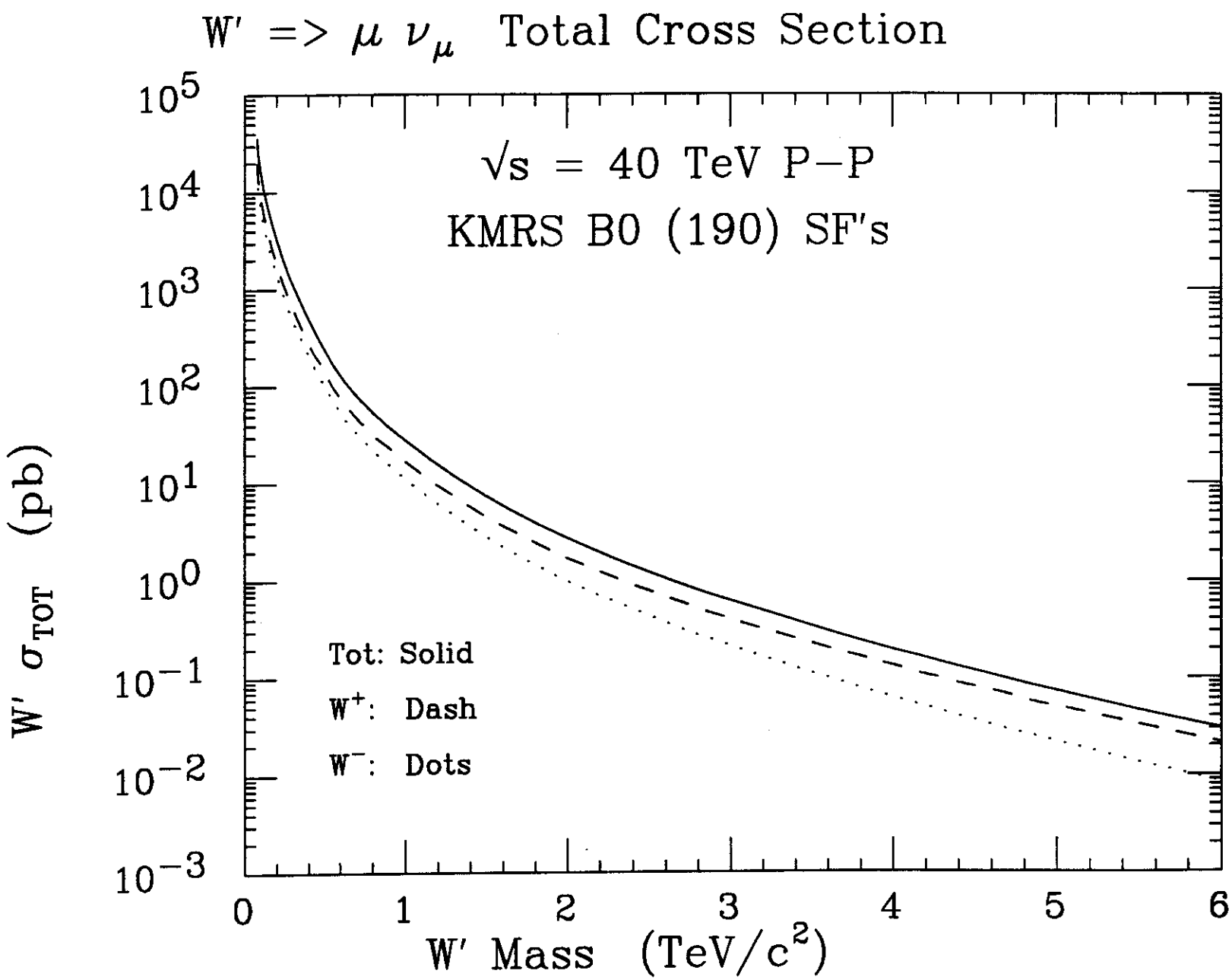

W′ => μ ν_μ Total Cross Section
√s = 40 TeV P−P
KMRS B0 (190) SF's
Tot: Solid
W+: Dash
W−: Dots
W′ σ_TOT (pb)
W′ Mass (TeV/c²)
10^5
10^4
10^3
10^2
10^1
10^0
10^−1
10^−2
10^−3
0
1
2
3
4
5
6

Fig 18

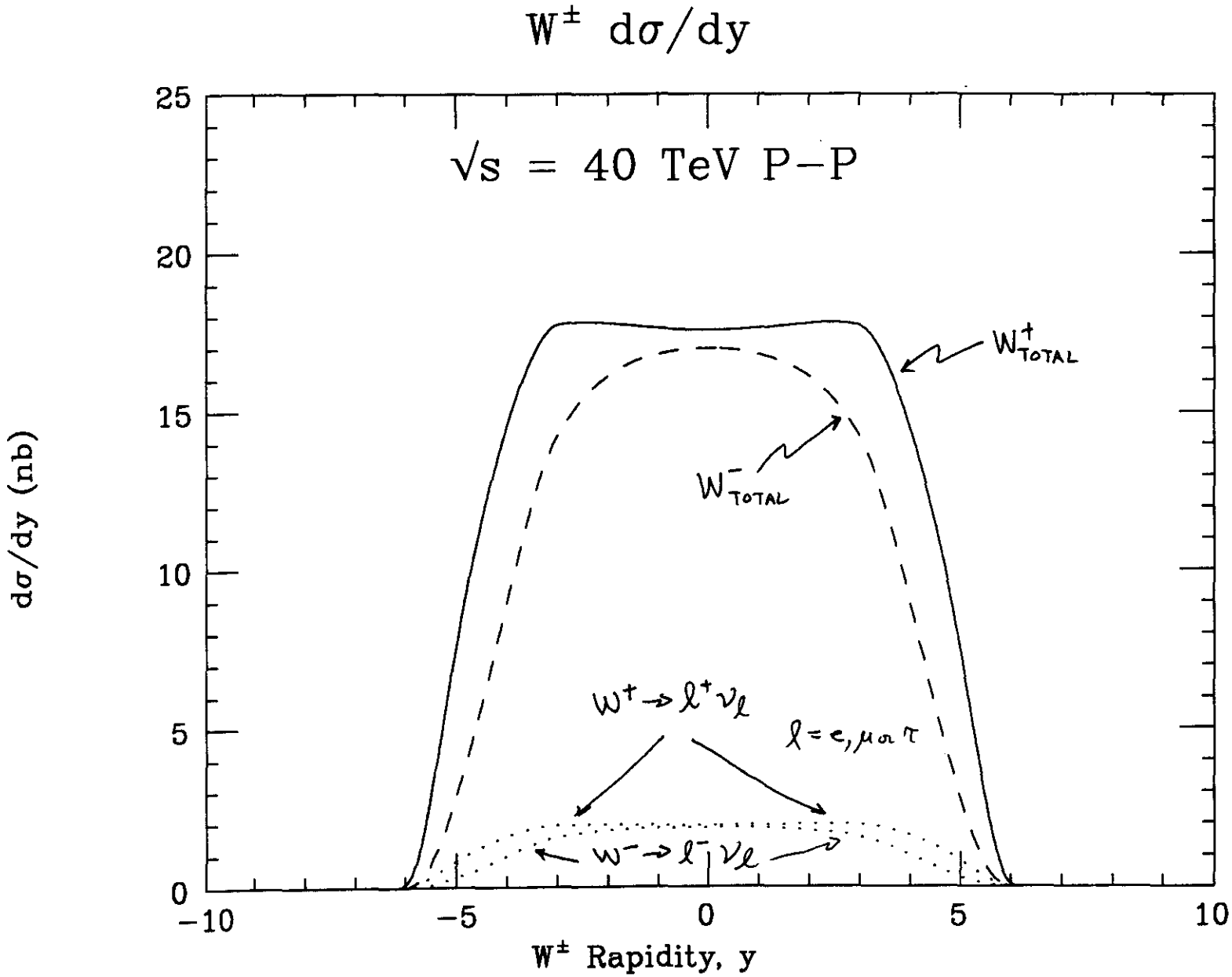

W± dσ/dy
√s = 40 TeV P−P
dσ/dy (nb)
W± Rapidity, y
25
20
15
10
5
0
−10
−5
0
5
10
W+TOTAL
W−TOTAL
W+ → ℓ+ νℓ
ℓ = e, μ or τ
W− → ℓ− νℓ

FIG 19

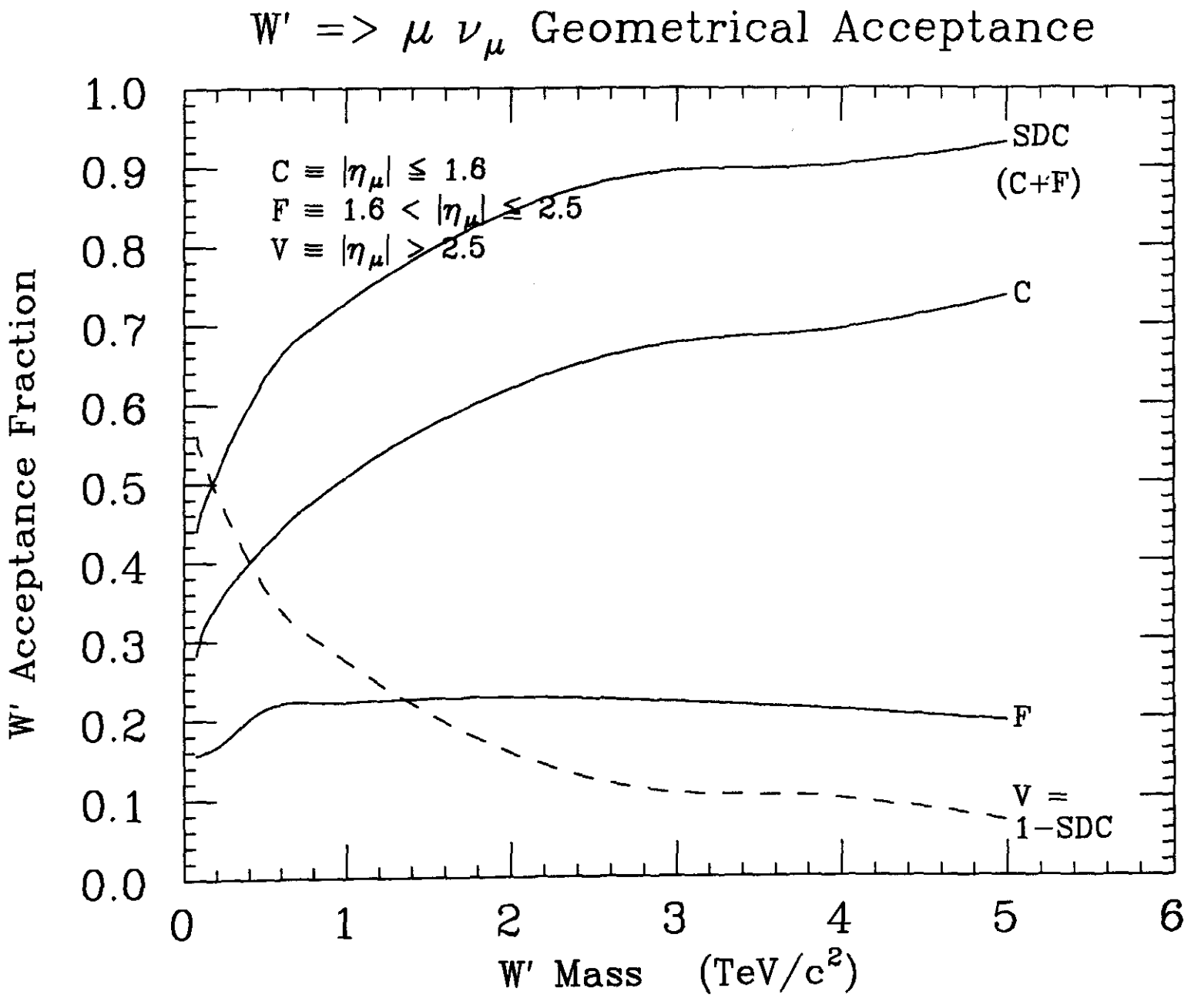

W' => μ ν_μ Geometrical Acceptance
C ≡ |η_μ| ≤ 1.6
F ≡ 1.6 < |η_μ| ≤ 2.5
V ≡ |η_μ| > 2.5
SDC
(C+F)
C
F
V =
1−SDC
W' Acceptance Fraction
W' Mass (TeV/c²)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
0
1
2
3
4
5
6

FIG 2C

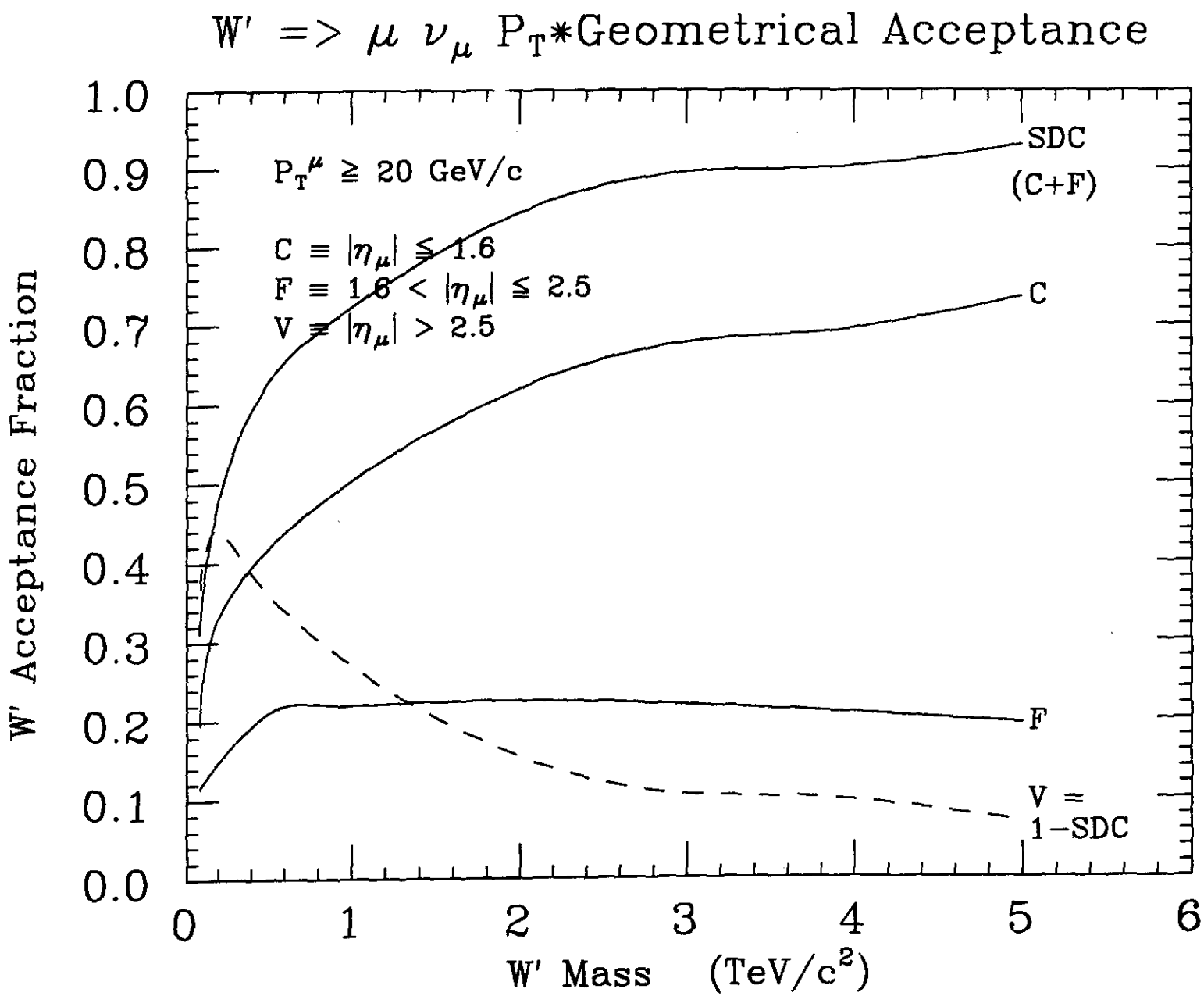
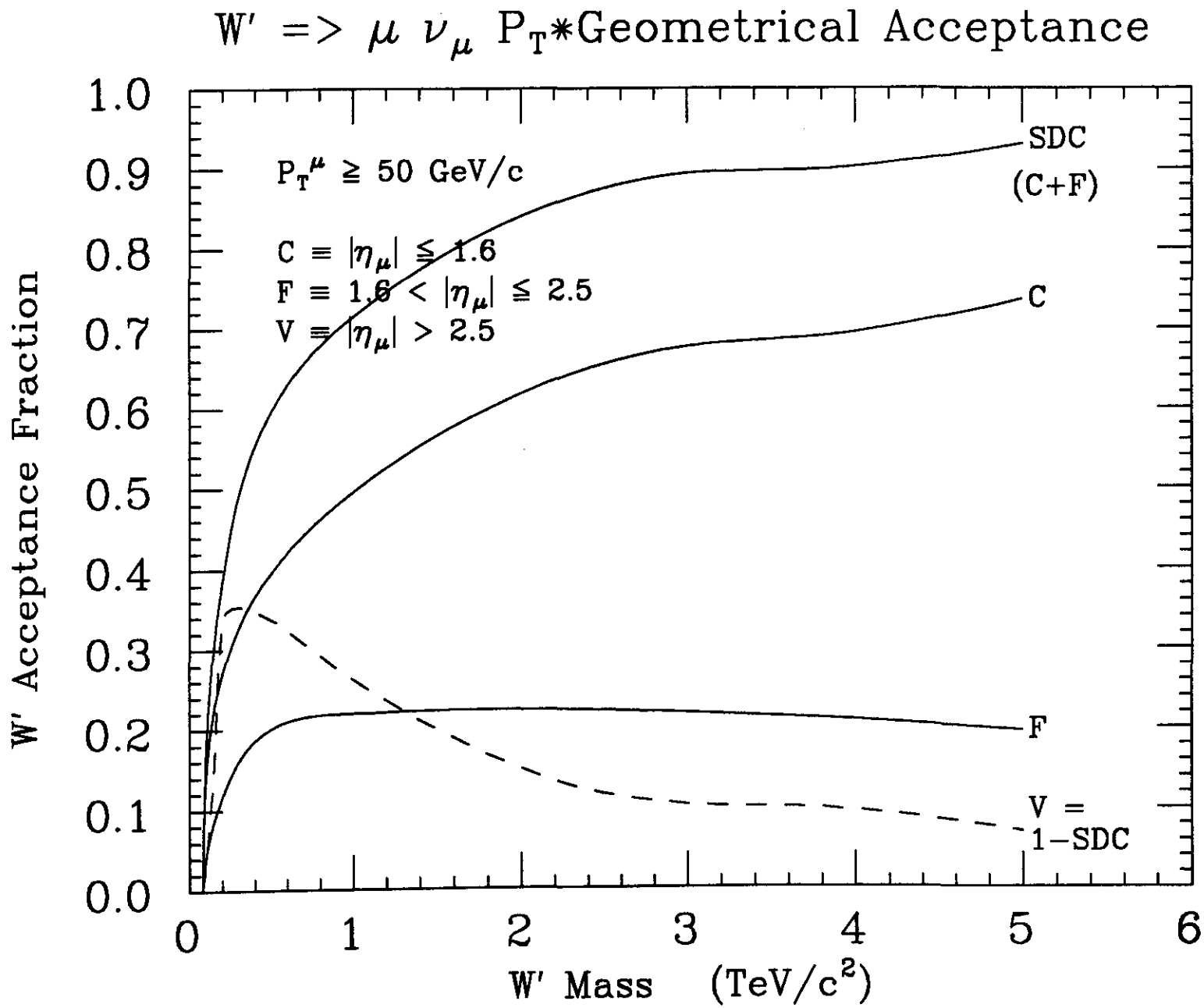

W' => μ ν_μ P_T*Geometrical Acceptance
P_T^μ ≧ 20 GeV/c
C ≡ |η_μ| ≦ 1.6
F ≡ 1.6 < |η_μ| ≦ 2.5
V ≡ |η_μ| > 2.5
SDC
(C+F)
C
F
V =
1−SDC
W' Acceptance Fraction
W' Mass (TeV/c²)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
0
1
2
3
4
5
6

Fig 21


W' => μ ν_μ P_T*Geometrical Acceptance
P_T^μ ≥ 50 GeV/c
C ≡ |η_μ| ≤ 1.6
F ≡ 1.6 < |η_μ| ≤ 2.5
V ≡ |η_μ| > 2.5
SDC
(C+F)
C
F
V =
1−SDC
W' Acceptance Fraction
W' Mass (TeV/c²)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
0
1
2
3
4
5
6

F 22

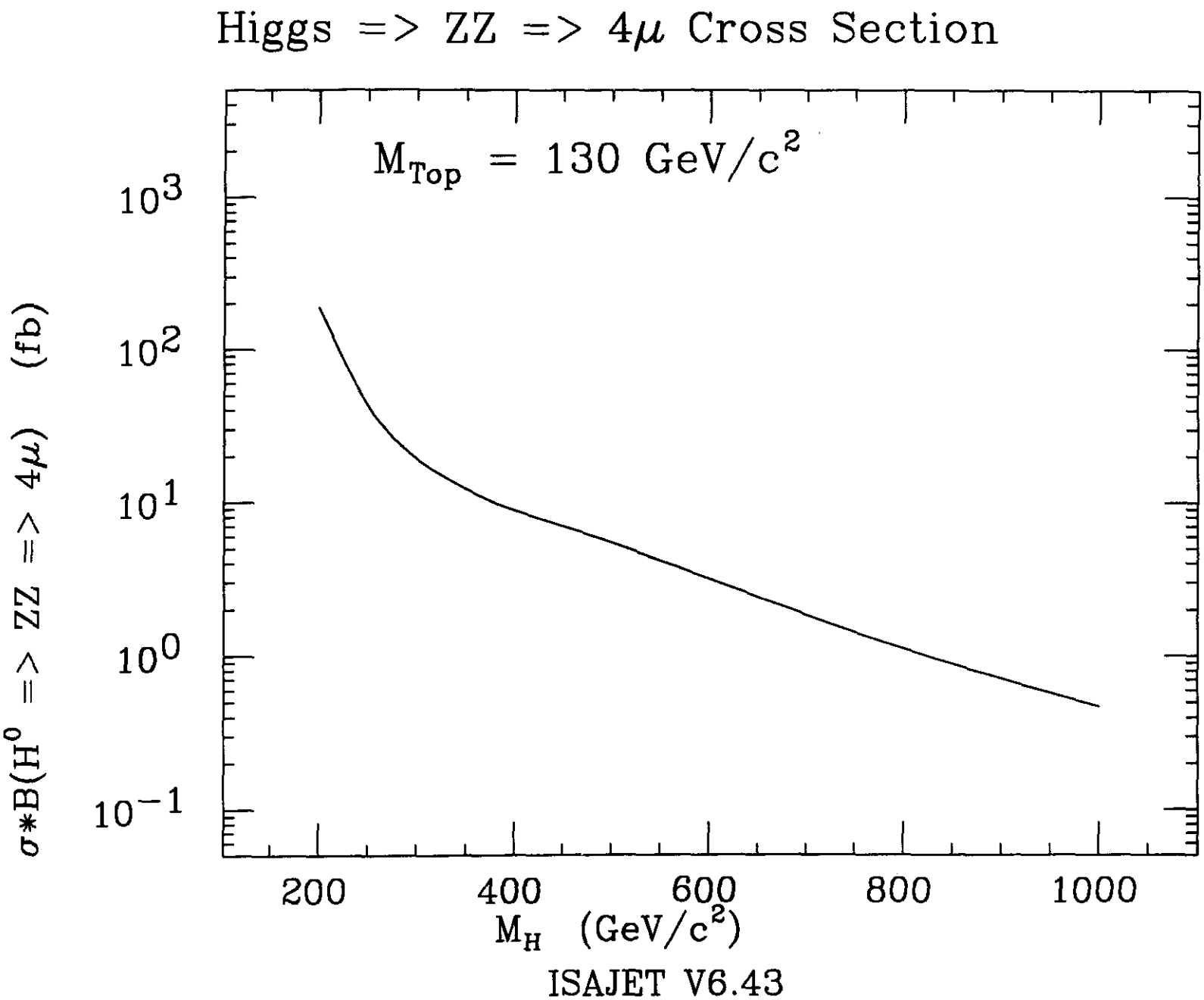

Higgs => ZZ => 4μ Cross Section
M_Top = 130 GeV/c²
10³
10²
10¹
10⁰
10⁻¹
σ*B(H⁰ => ZZ => 4μ) (fb)
200
400
600
800
1000
M_H (GeV/c²)
ISAJET V6.43

Fig 23

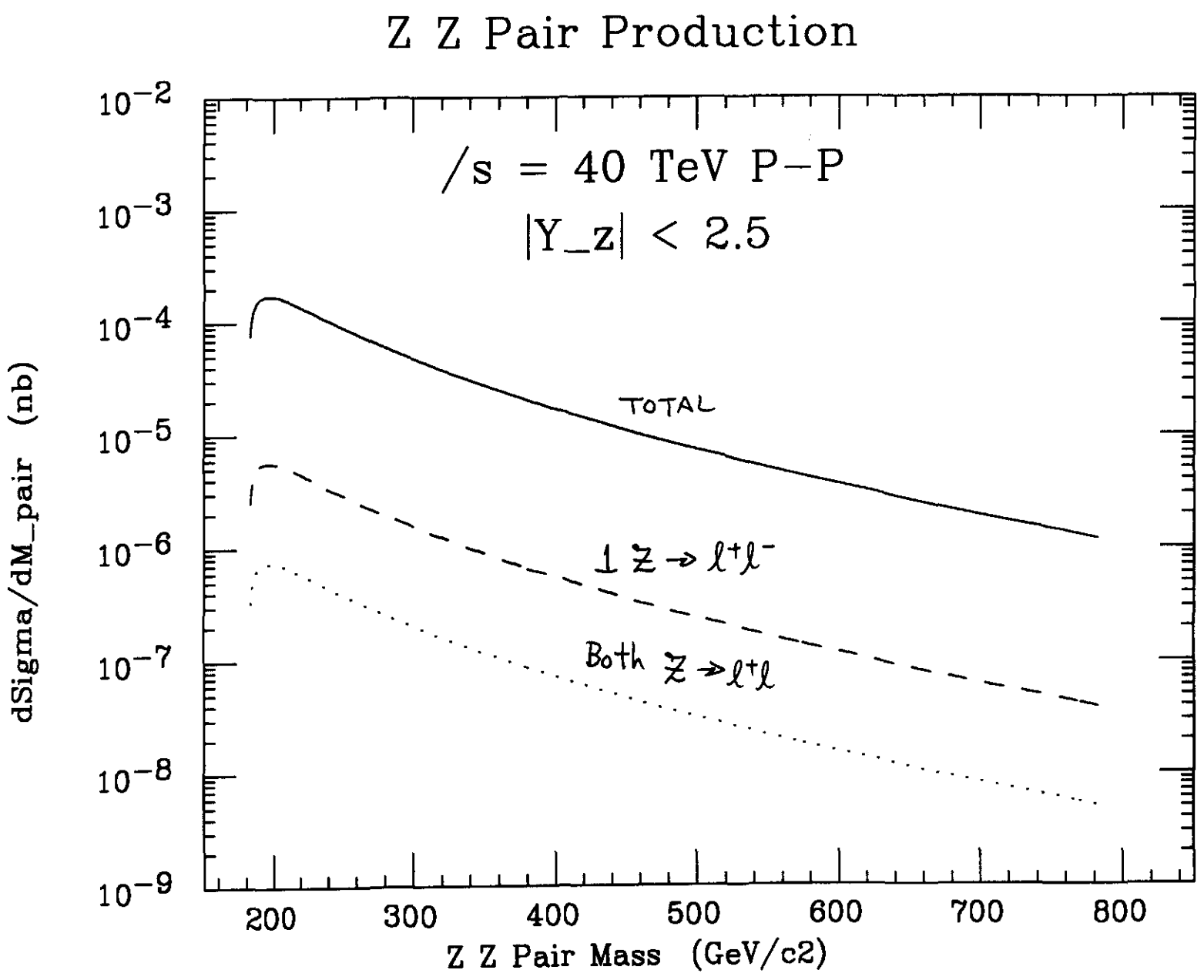

Z Z Pair Production
/s = 40 TeV P−P
|Y_z| < 2.5
TOTAL
1 Z → ℓ+ℓ−
Both Z → ℓ+ℓ
dSigma/dM_pair (nb)
Z Z Pair Mass (GeV/c2)
10−2
10−3
10−4
10−5
10−6
10−7
10−8
10−9
200
300
400
500
600
700
800

Fig 24

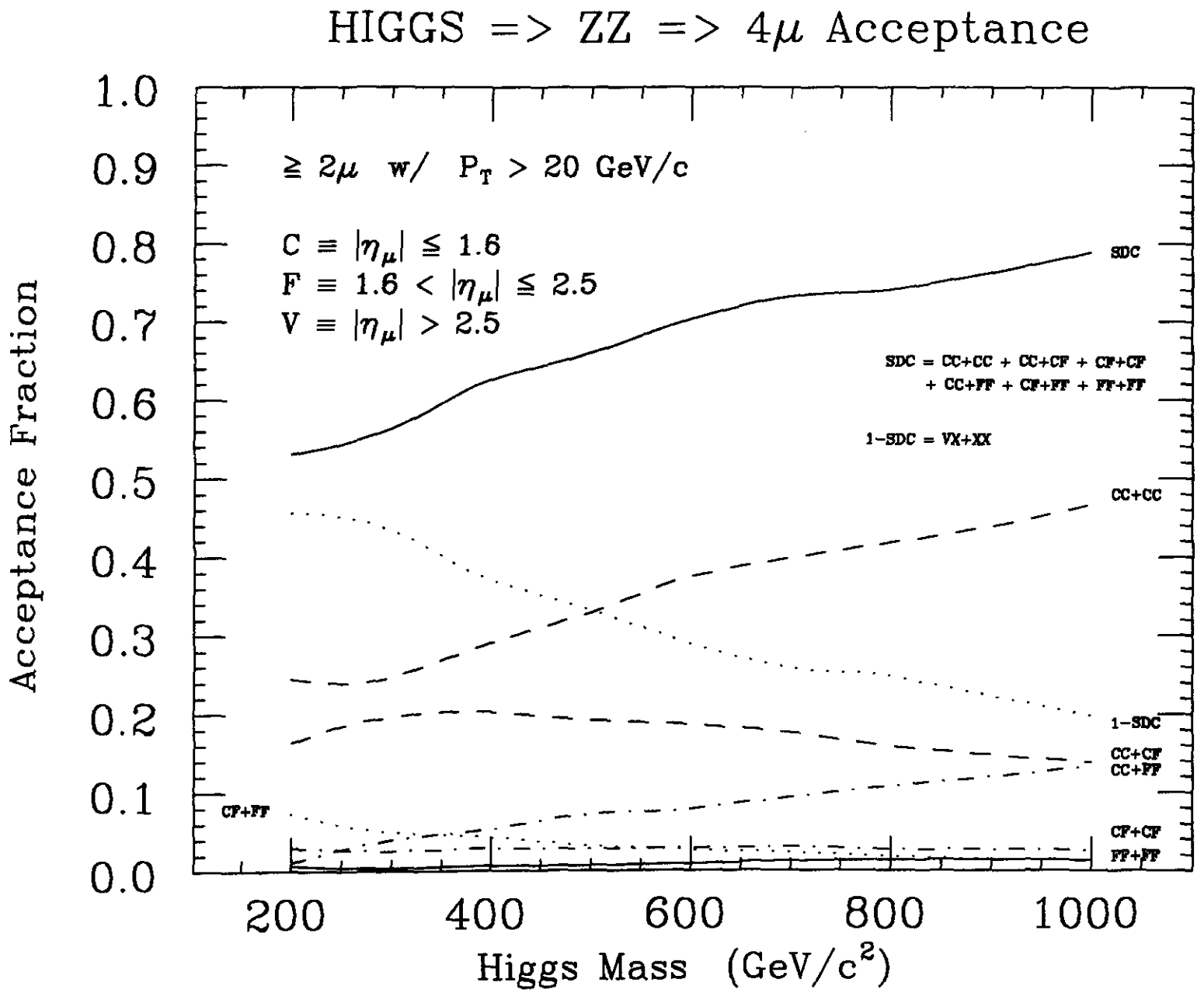
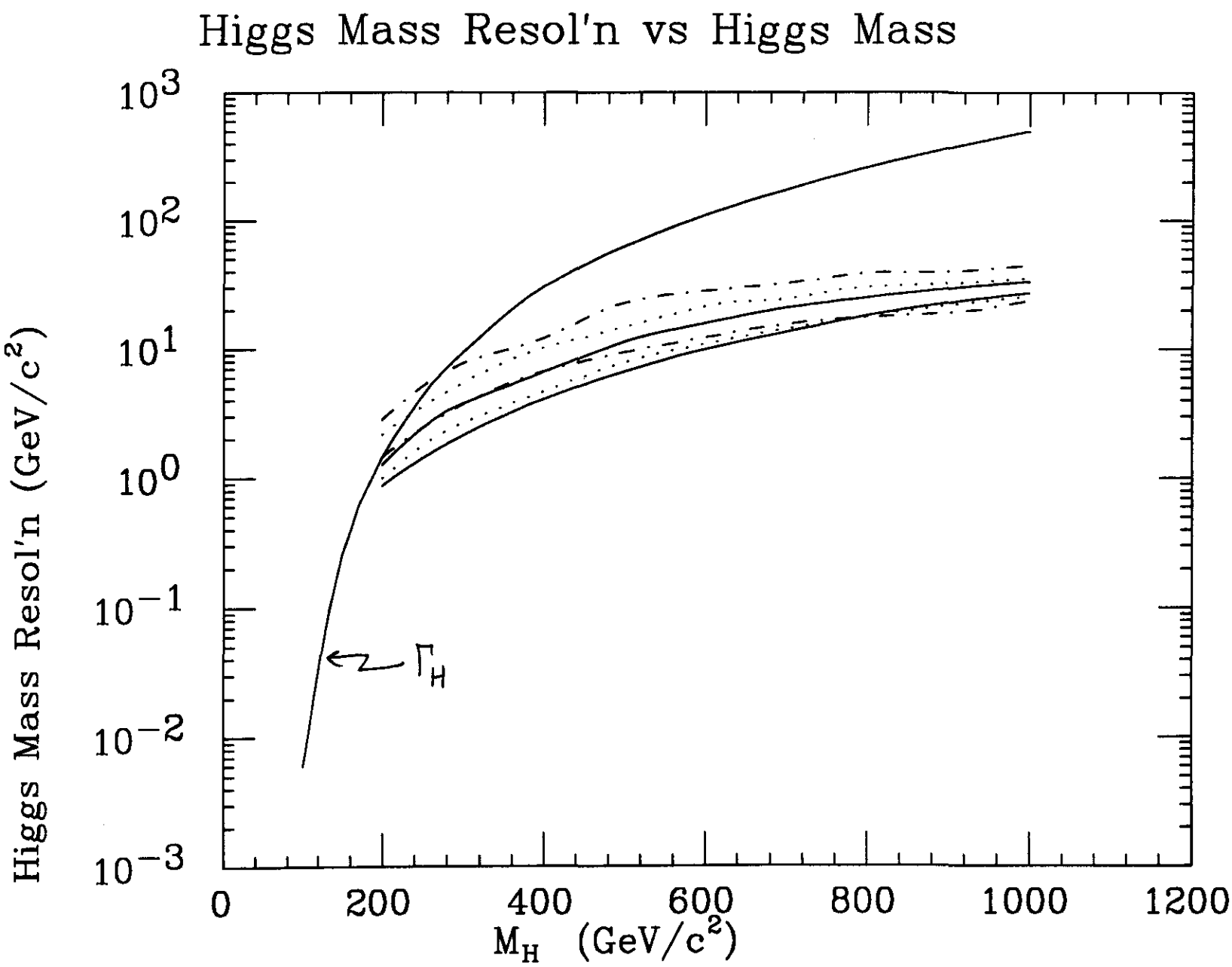
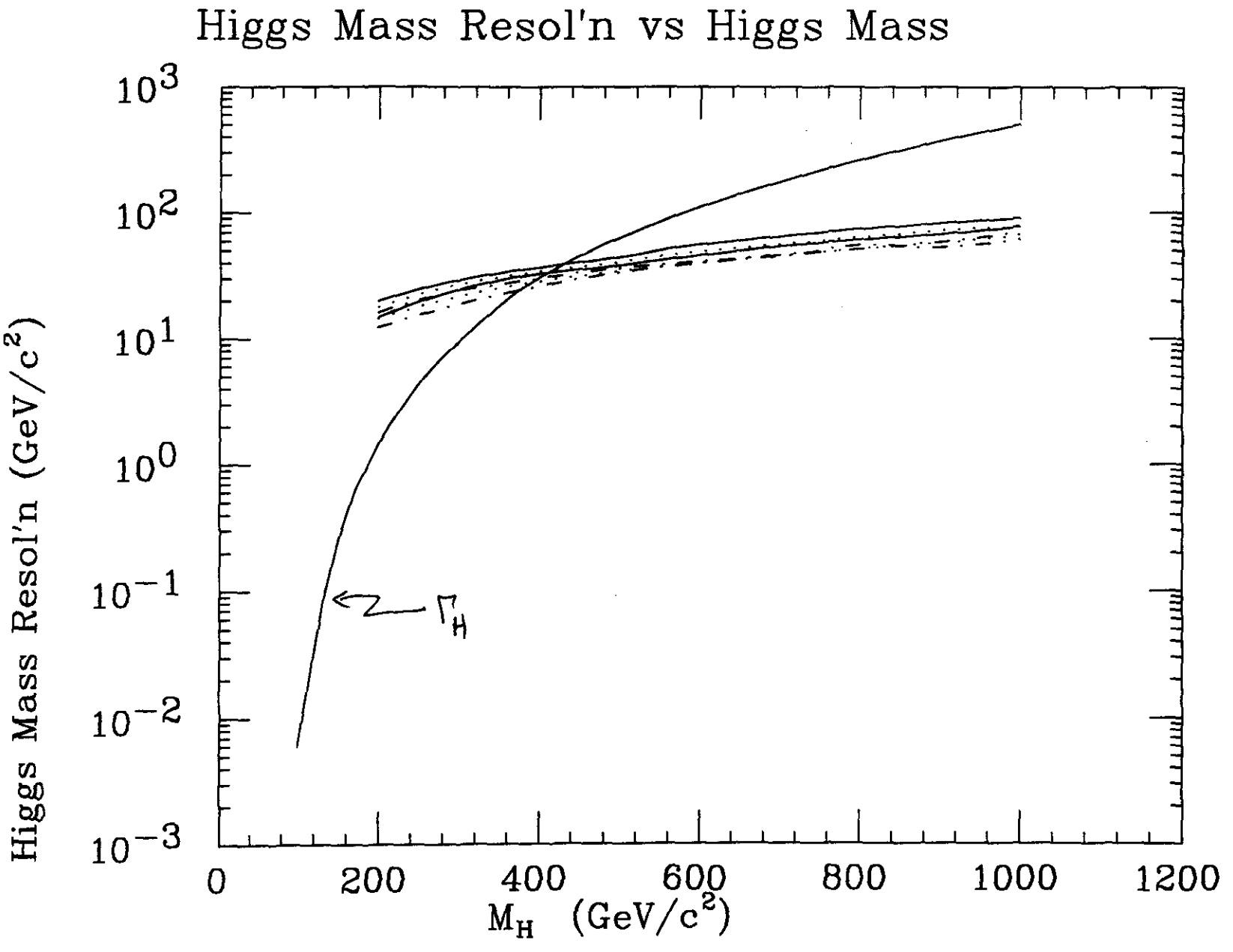

HIGGS => ZZ => 4μ Acceptance
≧ 2μ w/ P_T > 20 GeV/c
C ≡ |η_μ| ≦ 1.6
F ≡ 1.6 < |η_μ| ≦ 2.5
V ≡ |η_μ| > 2.5
SDC
SDC = CC+CC + CC+CF + CF+CF
+ CC+FF + CF+FF + FF+FF
1-SDC = VX+XX
CC+CC
1-SDC
CC+CF
CC+FF
CF+FF
CF+CF
FF+FF
Acceptance Fraction
Higgs Mass (GeV/c²)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
200
400
600
800
1000

Fig 25



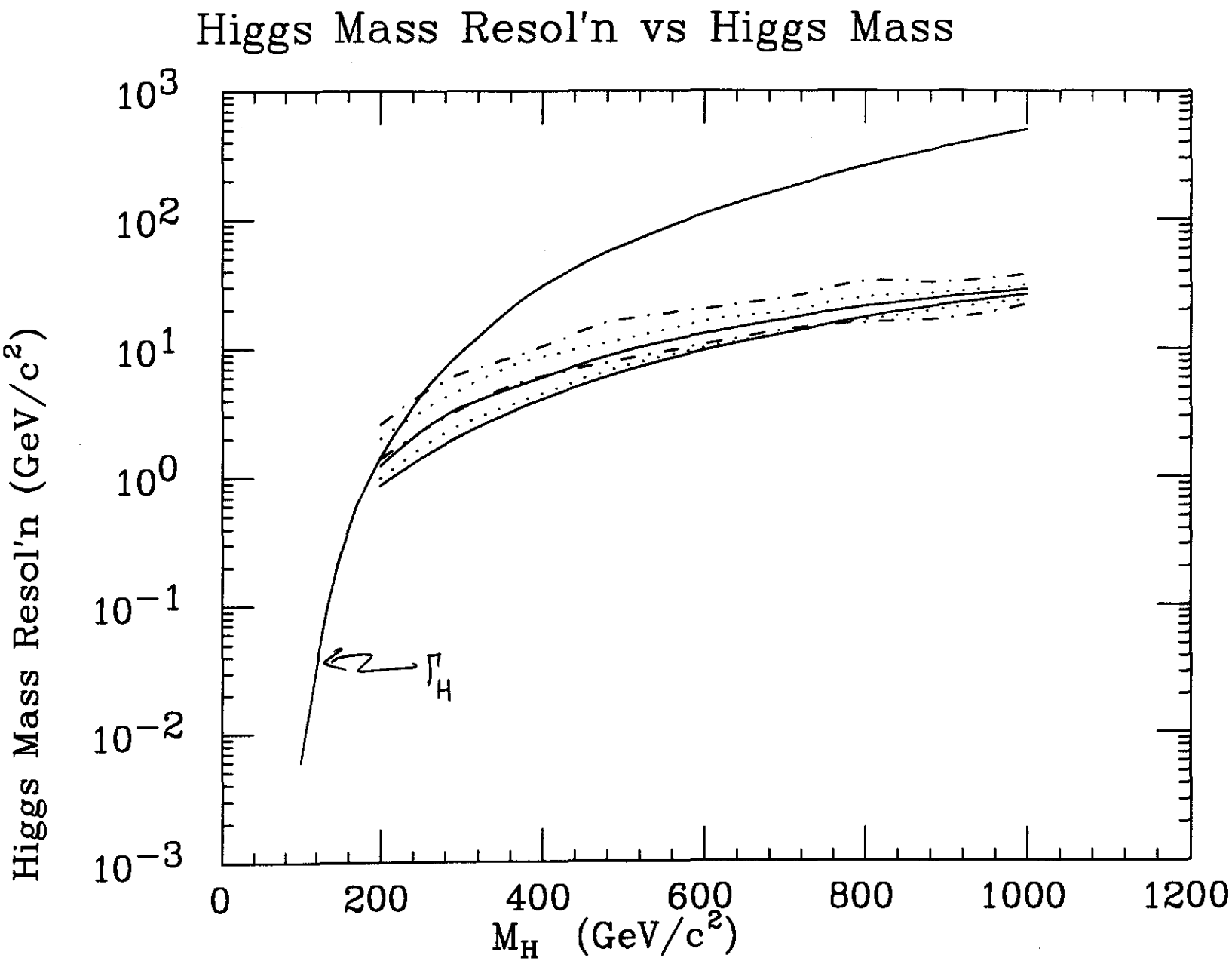
[1] Inner Tracking System

Fig



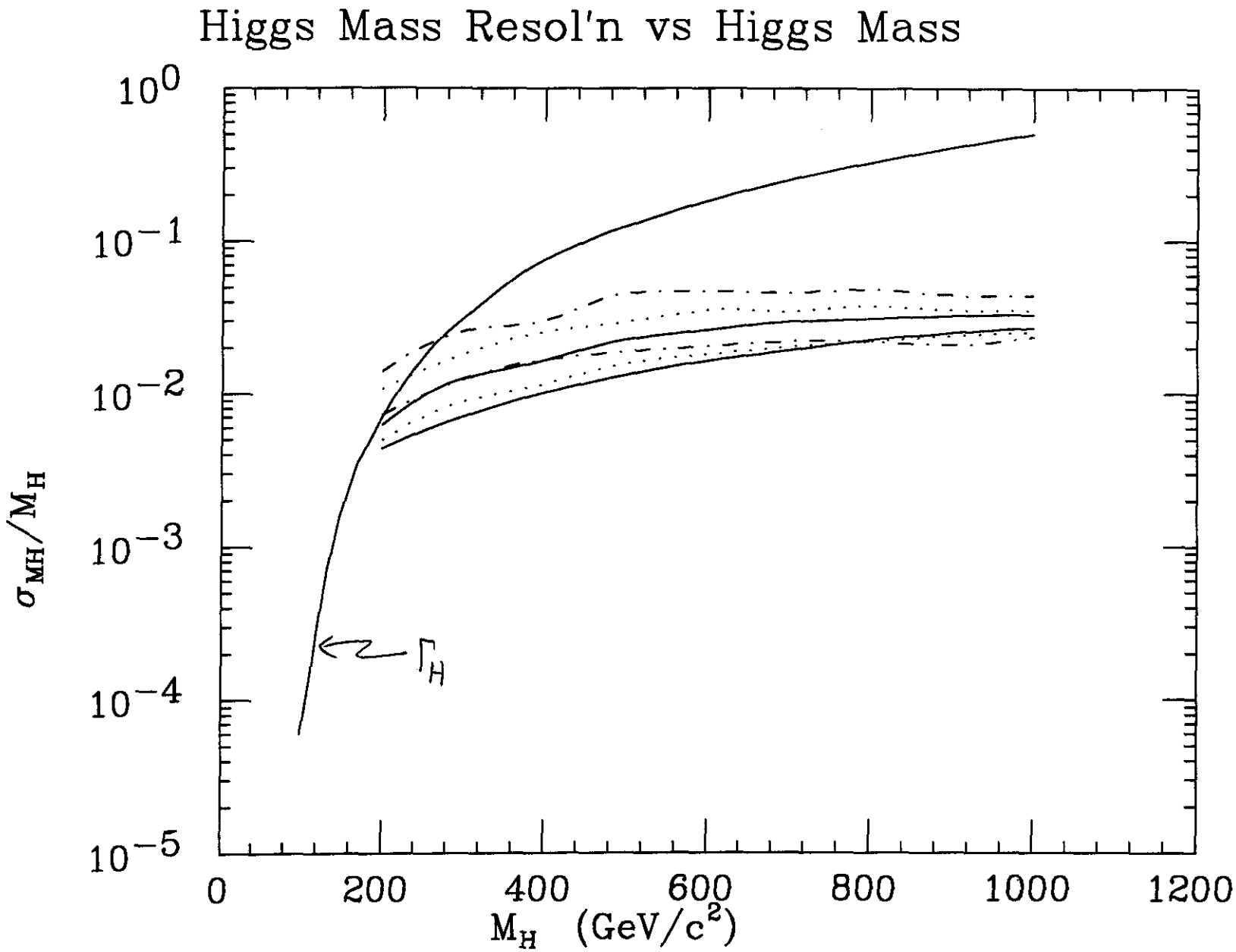
[2] Muon System Only

Fig 27



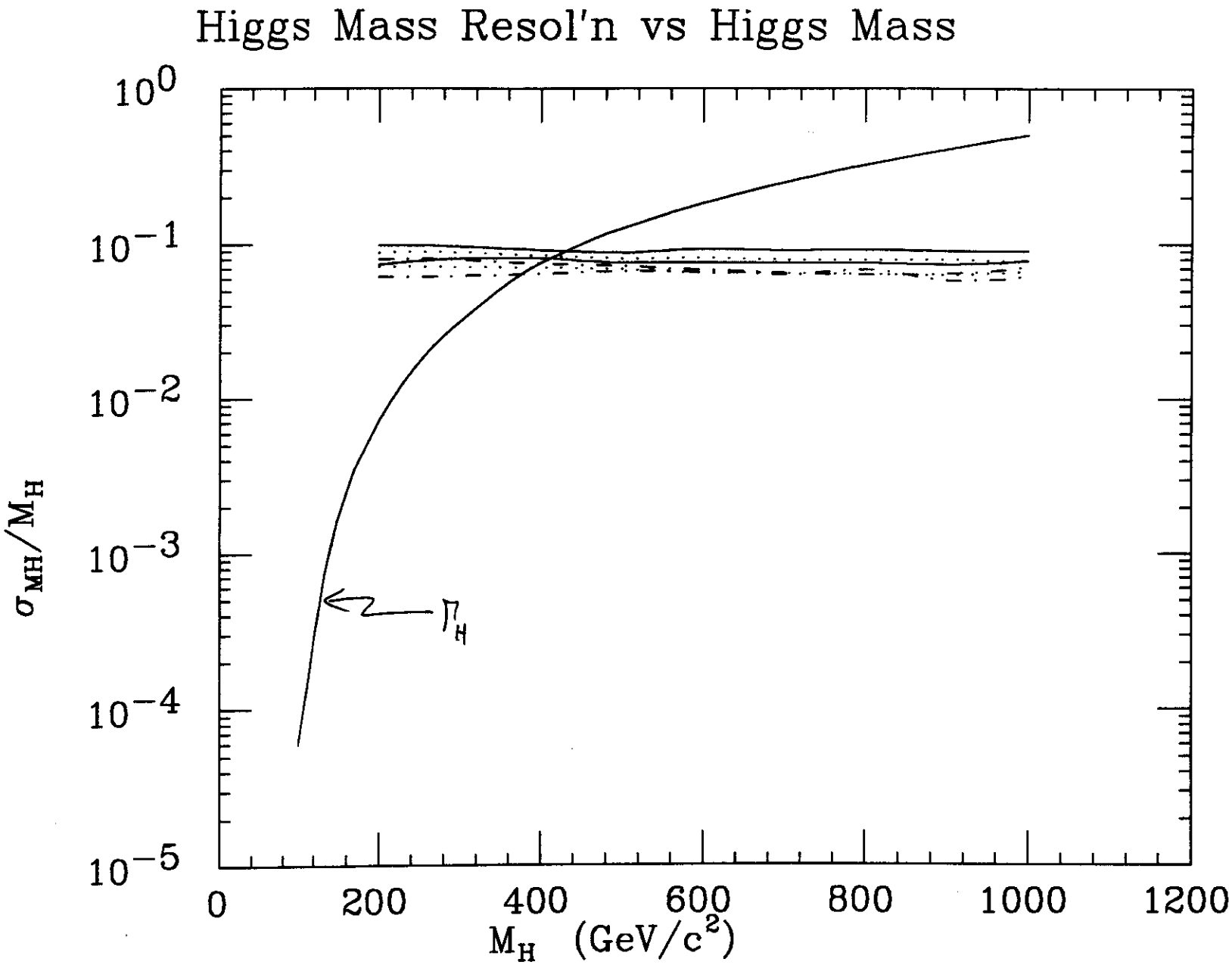
[3] Combined/Full Tracking

Fig 3

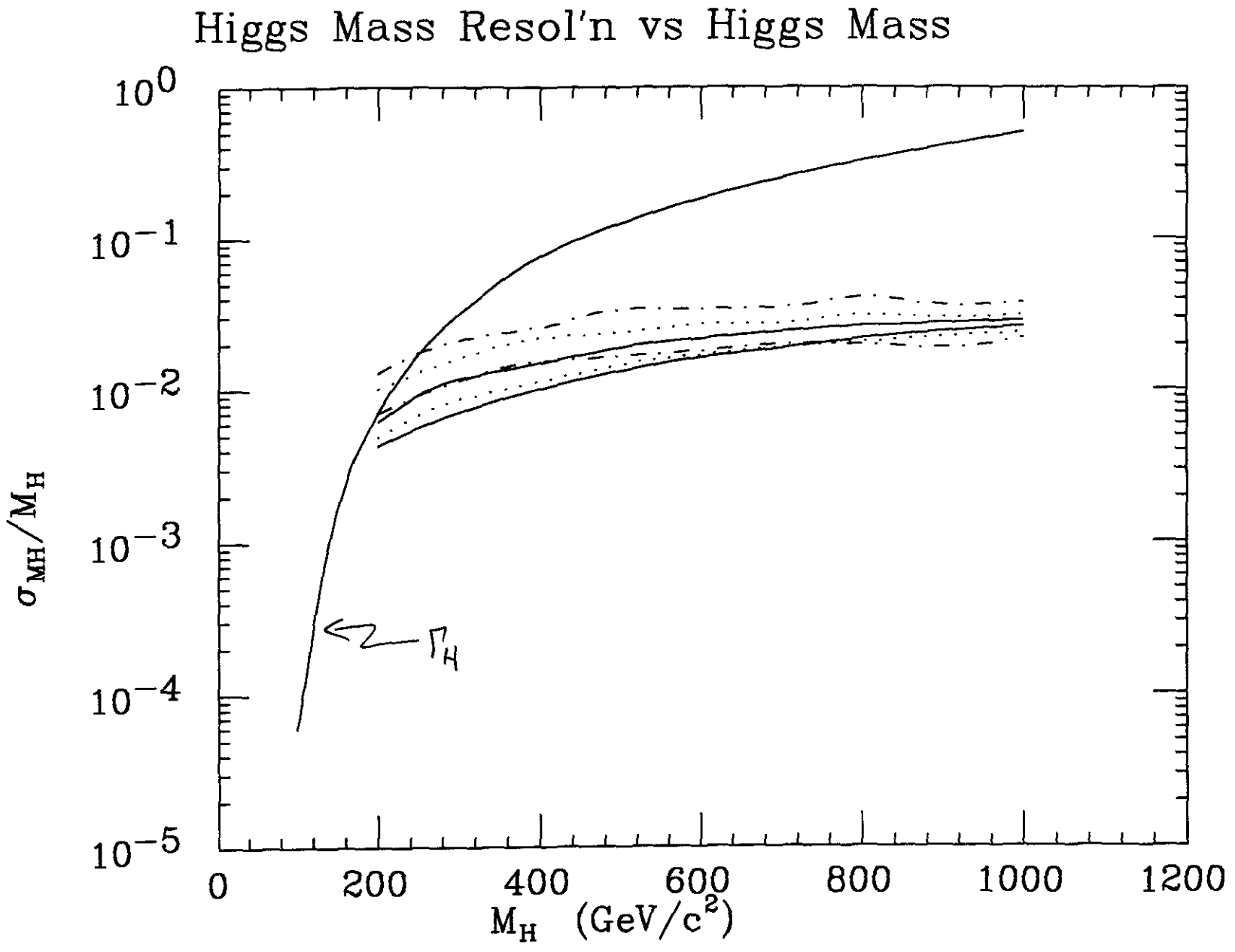


[1] Inner Tracking System

Fig 29

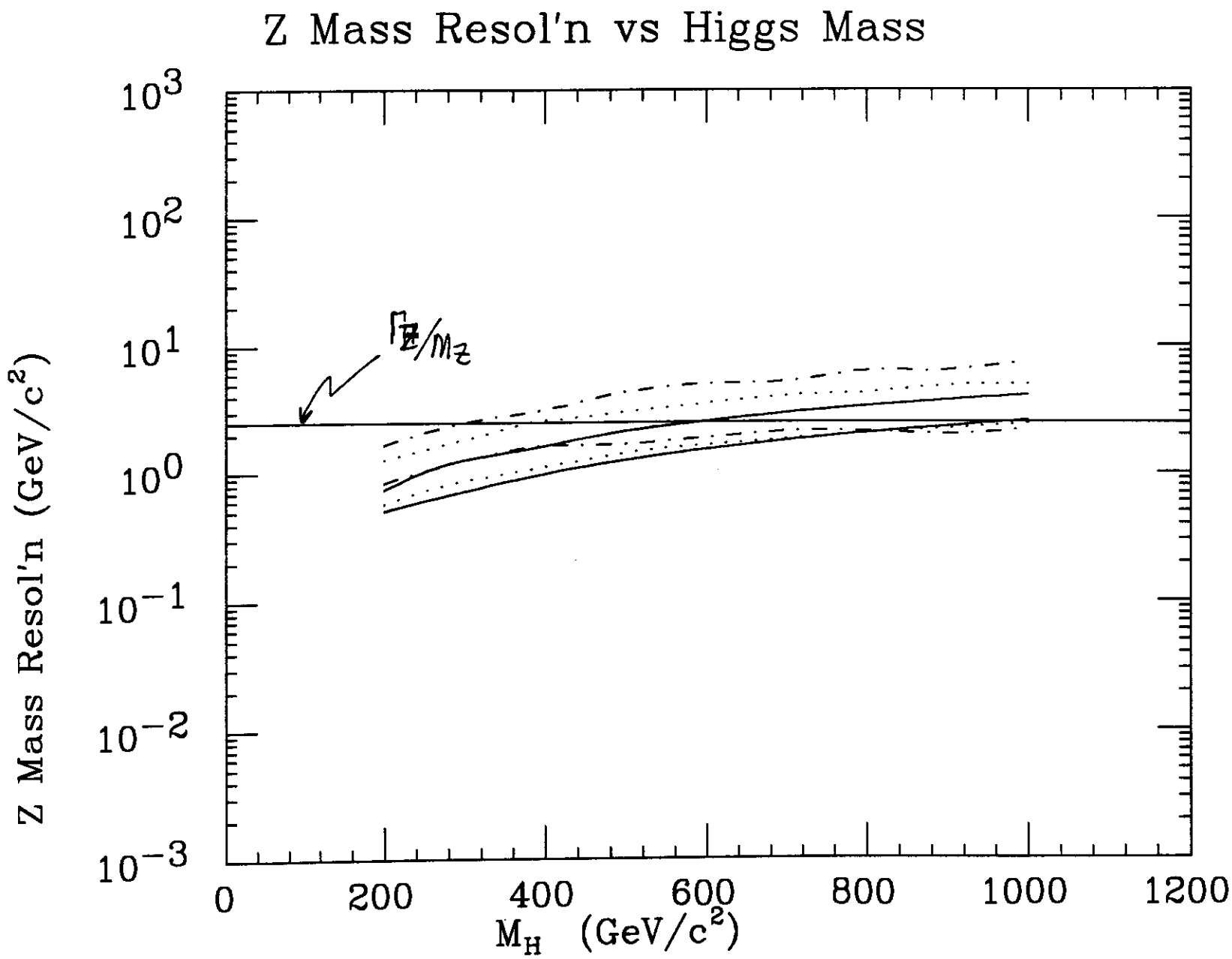


[2] Muon System Only

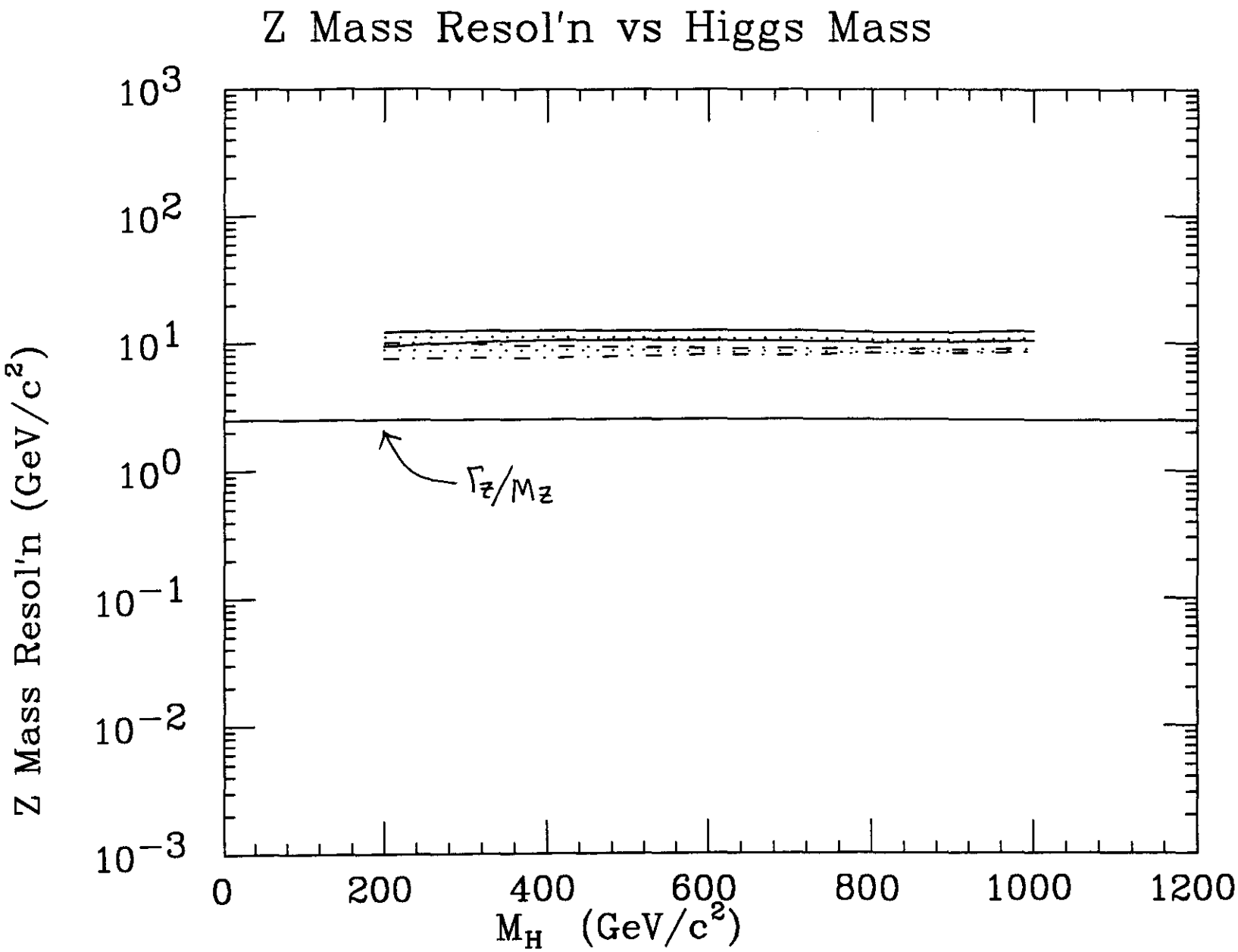


[3] Combined/Full Tracking

Fig 31

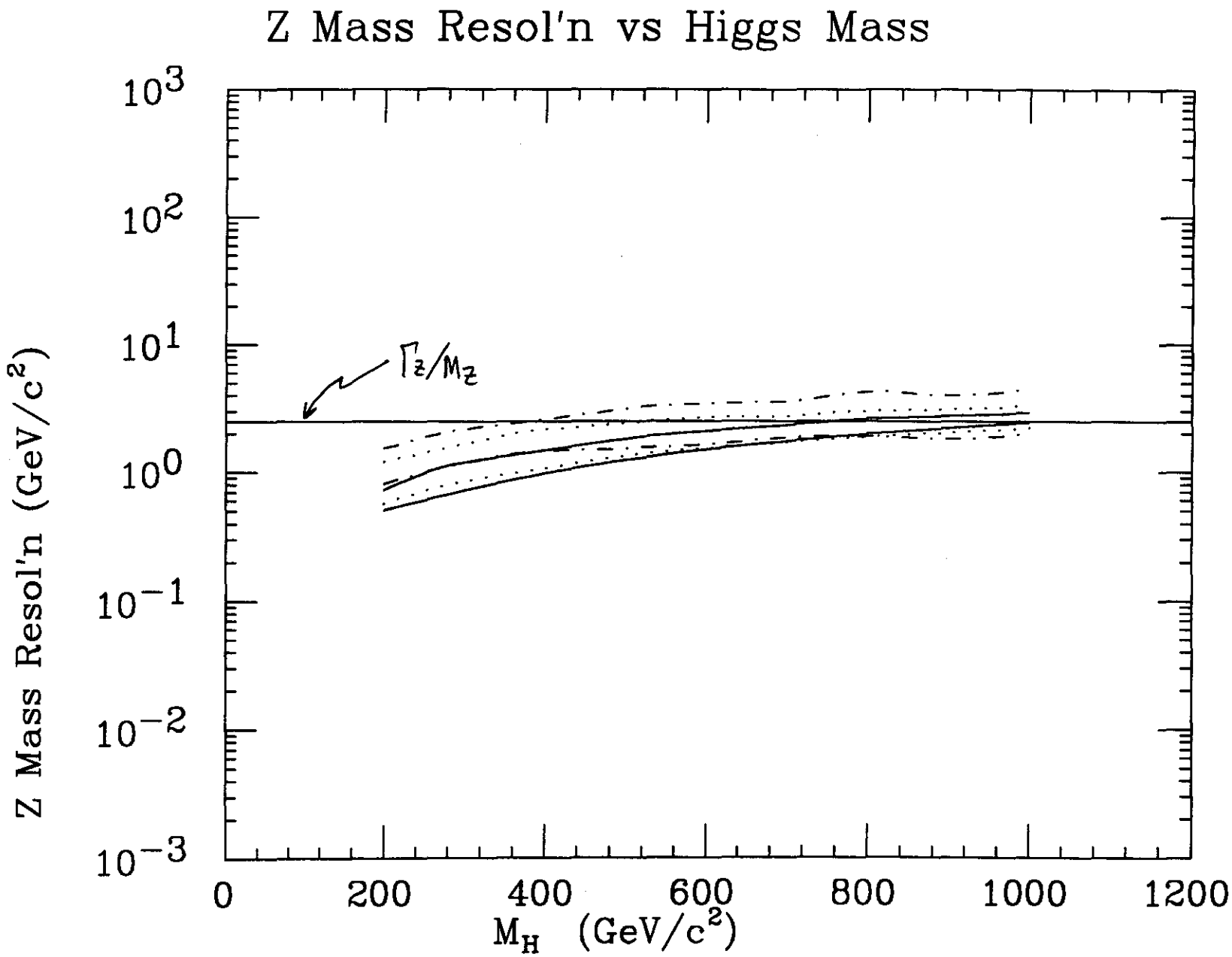


[1] Inner Tracking System



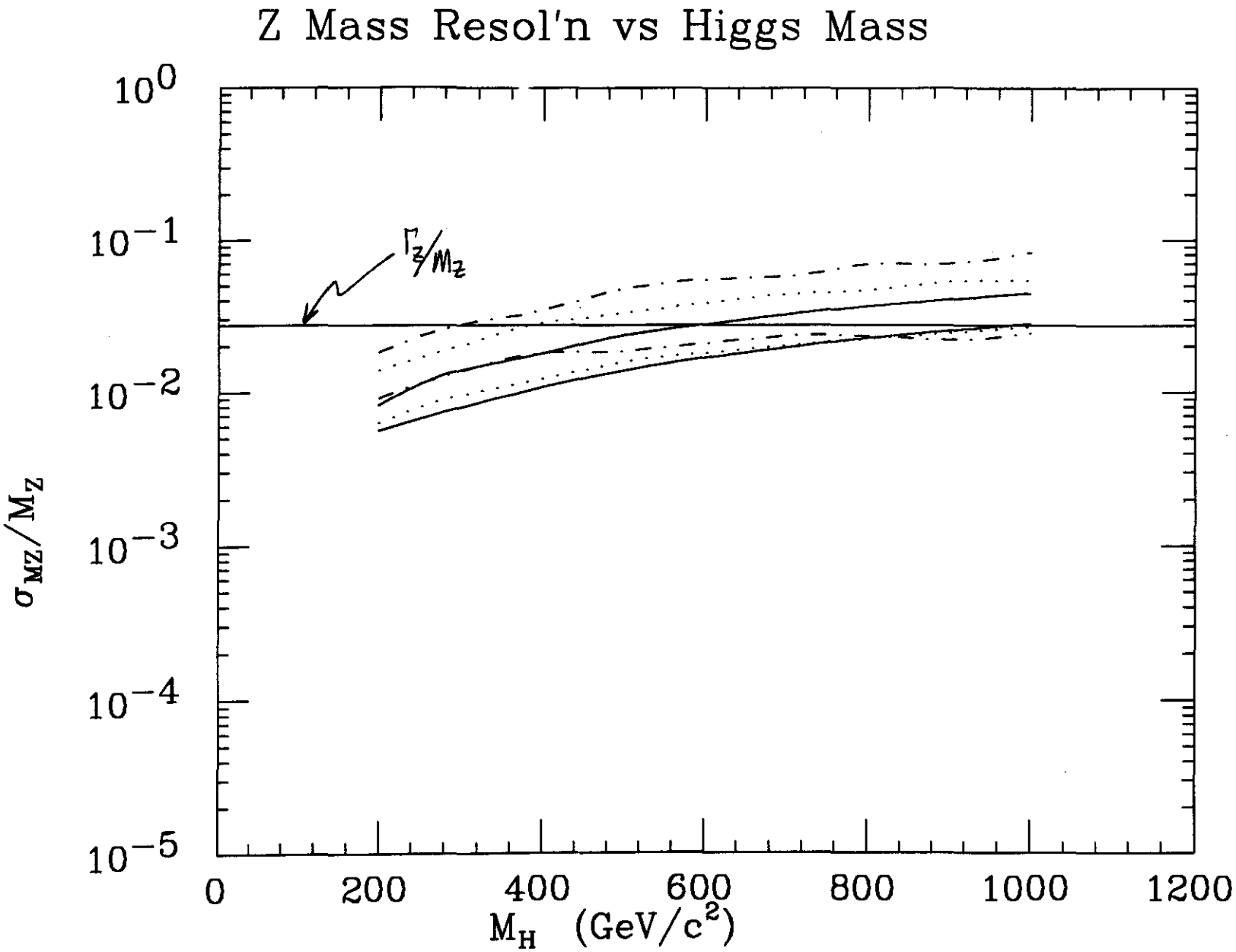
[2] Muon System Only

Fig 33



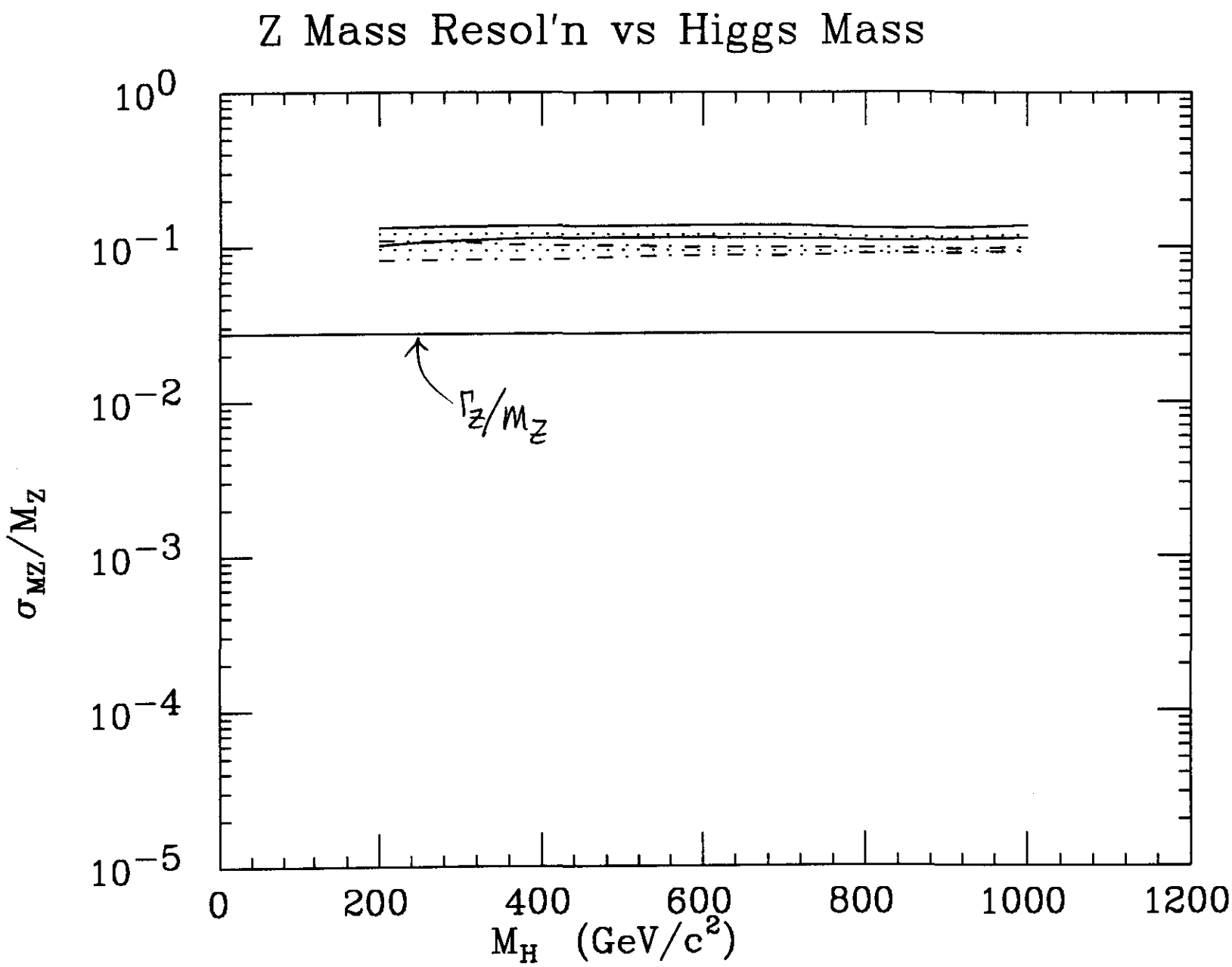
[3] Combined/Full Tracking

Fig



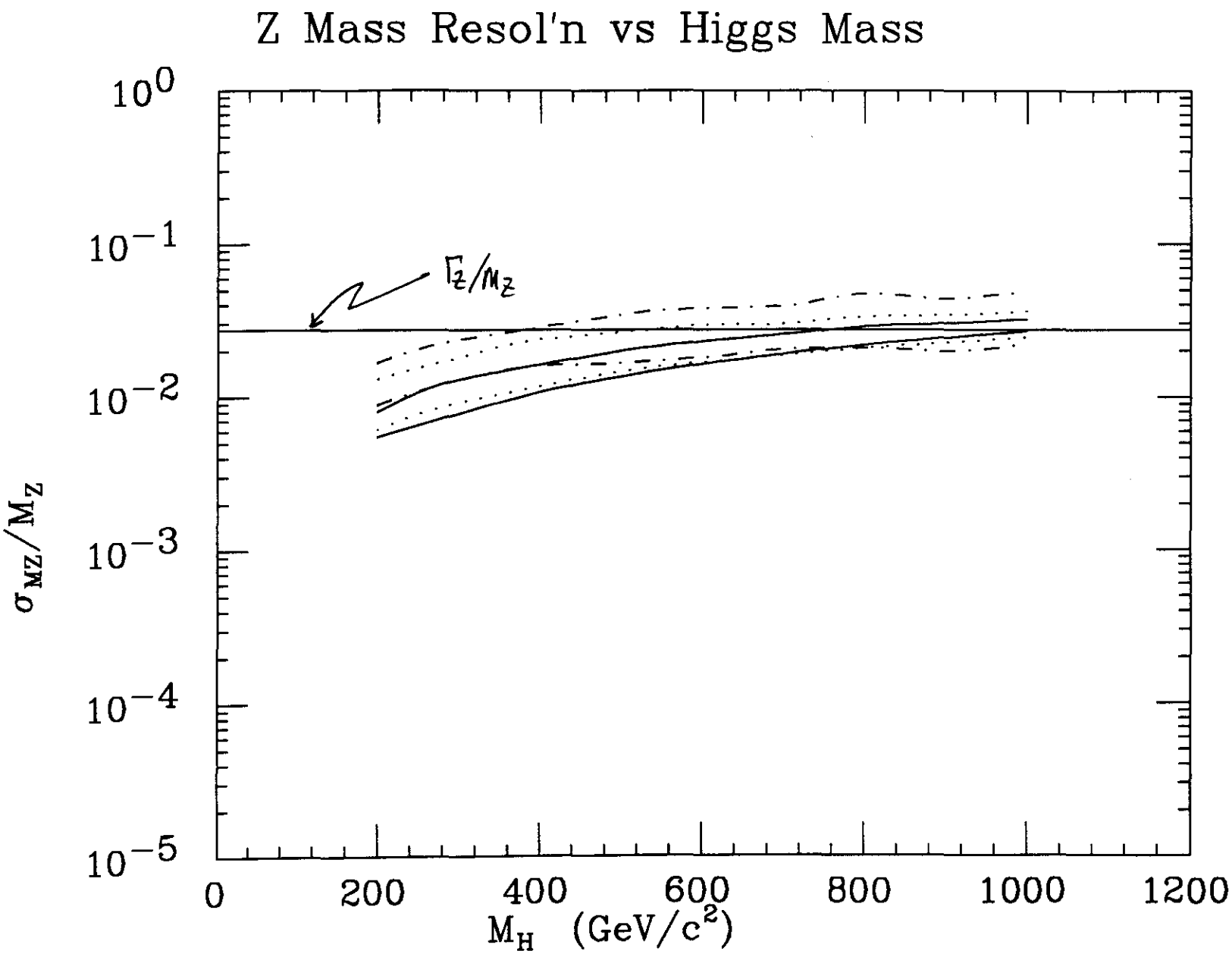
[1] Inner Tracking System

Fig 35



[2] Muon System Only

Fig 36



[3] Combined/Full Tracking

Fig 37