L.E.T. Signals in $e^+e^- \to W^+W^-$ at $\sqrt{s} = 800$ GeV

2nd ECFA/DESY Study on Physics and Detectors for a Linear Electron–Positron Collider

May 07, 2000

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The process $e^+e^- \to W^+W^-$ is affected in two ways as $M_H \to \infty$

1. **Non-SM TGC's induced**

2. **$e^+e^- \to W_L^+W_L^-$ amplitude modified**

Chiral Lagangian

$$\mathcal{L}_{SB} = \mathcal{L}^{(2)} + \mathcal{L}^{(4)} + \cdots$$

where

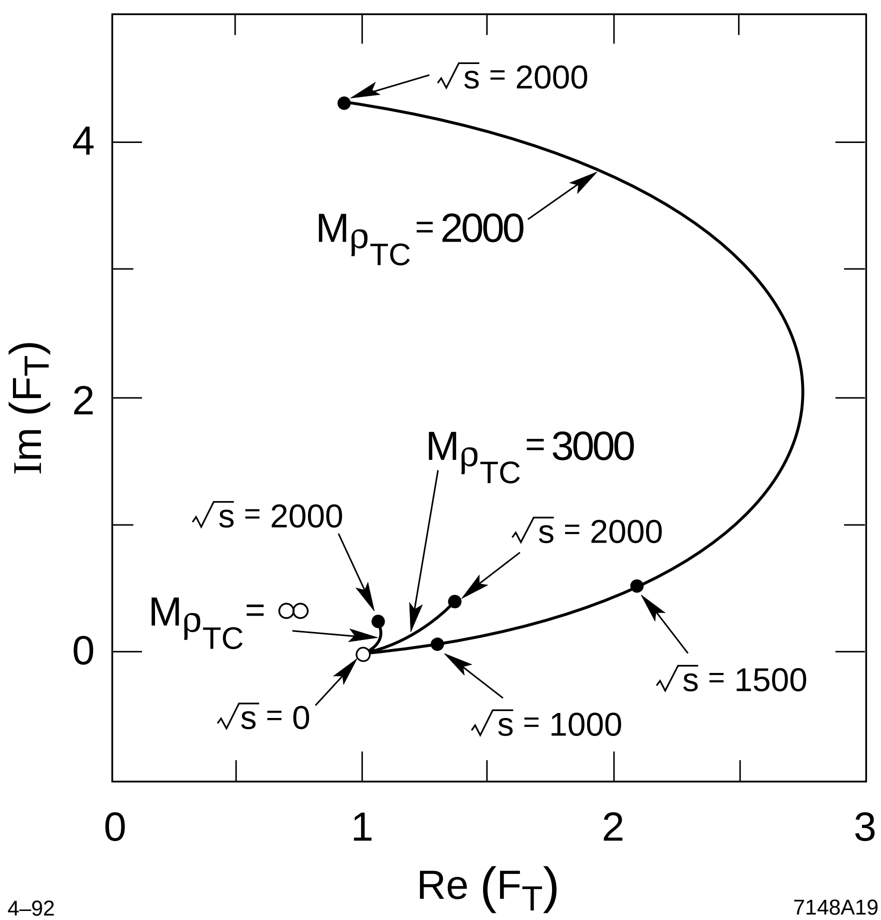
$$\begin{aligned}
\mathcal{L}^{(2)} &= \frac{1}{4}v^2 \mathrm{Tr} D^\mu \Sigma^\dagger D_\mu \Sigma, \\
\mathcal{L}^{(4)} &= \frac{L_1}{16\pi^2}[\mathrm{Tr}(D^\mu \Sigma^\dagger D_\mu \Sigma)]^2 + \frac{L_2}{16\pi^2}\mathrm{Tr}(D_\mu \Sigma^\dagger D_\nu \Sigma)\mathrm{Tr}(D^\mu \Sigma^\dagger D^\nu \Sigma) \\
&\quad -ig\frac{L_{9L}}{16\pi^2}\mathrm{Tr}(W^{\mu\nu} D_\mu \Sigma D_\mu \Sigma^\dagger) - ig'\frac{L_{9R}}{16\pi^2}\mathrm{Tr}(B^{\mu\nu} D_\mu \Sigma^\dagger D_\nu \Sigma) \\
&\quad +gg'\frac{L_{10}}{16\pi^2}\mathrm{Tr}(\Sigma B^{\mu\nu} \Sigma^\dagger W_{\mu\nu}) \quad .
\end{aligned}$$

$$\begin{aligned}
\kappa_\gamma &= 1 + \frac{e^2}{32\pi^2 s_w^2}(L_{9L} + L_{9R}) \\
\kappa_Z &= 1 + \frac{e^2}{32\pi^2 s_w^2}(L_{9L} - \frac{s_w^2}{c_w^2}L_{9R}) \\
g_1^Z &= 1 + \frac{e^2}{32\pi^2 s_w^2}\frac{L_{9L}}{c_w^2}
\end{aligned}$$

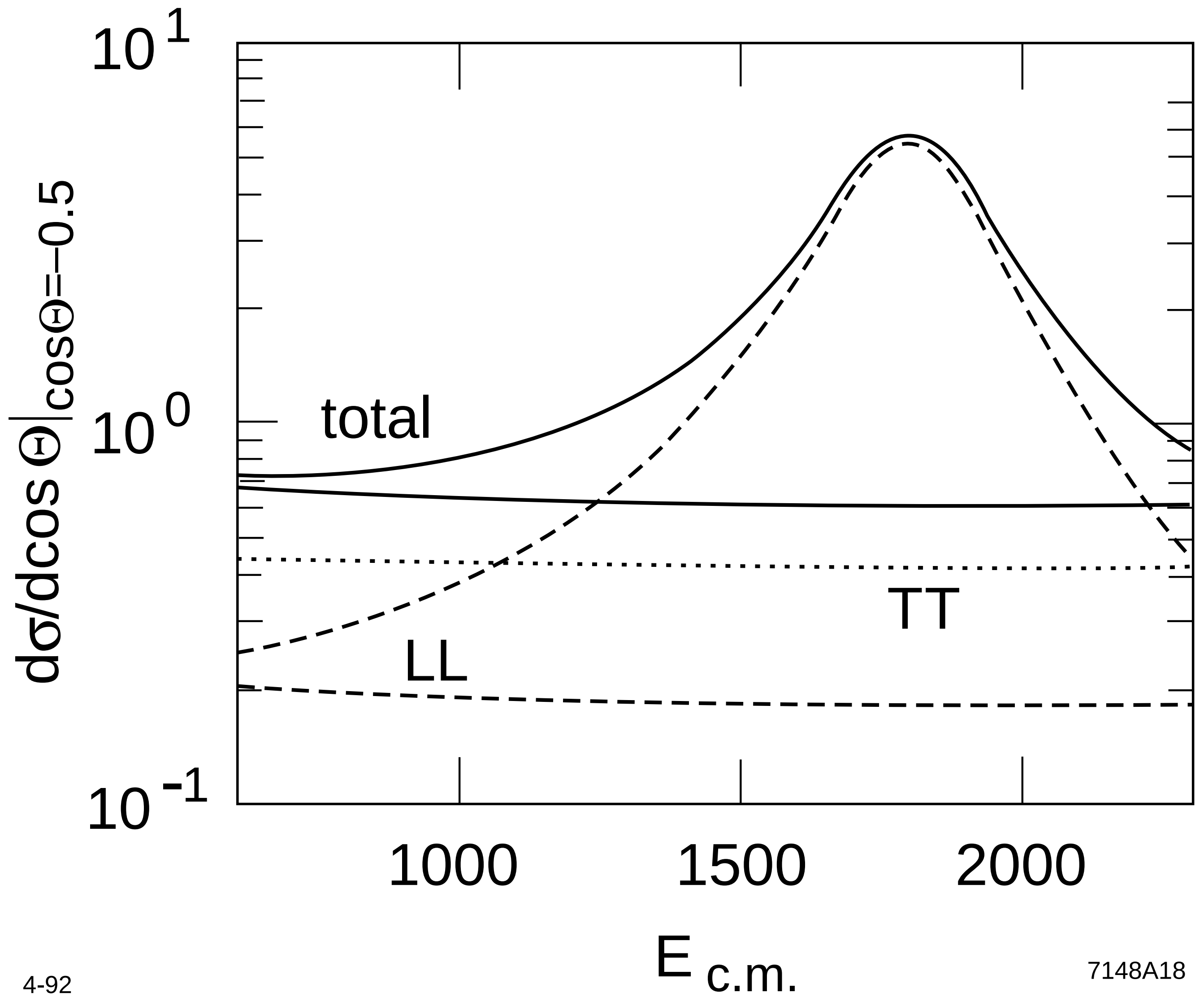
$e^+e^- \to W_L^+ W_L^-$ Amplitude

$$F_T = \exp[\frac{1}{\pi}\int_0^\infty ds'\delta(s', M_\rho, \Gamma_\rho)\{\frac{1}{s'-s-i\epsilon} - \frac{1}{s'}\}]$$

$$\delta(s) = \frac{1}{96\pi}\frac{s}{v^2} + \frac{3\pi}{8}\left[tanh(\frac{s-M_\rho^2}{M_\rho\Gamma_\rho}) + 1\right]$$

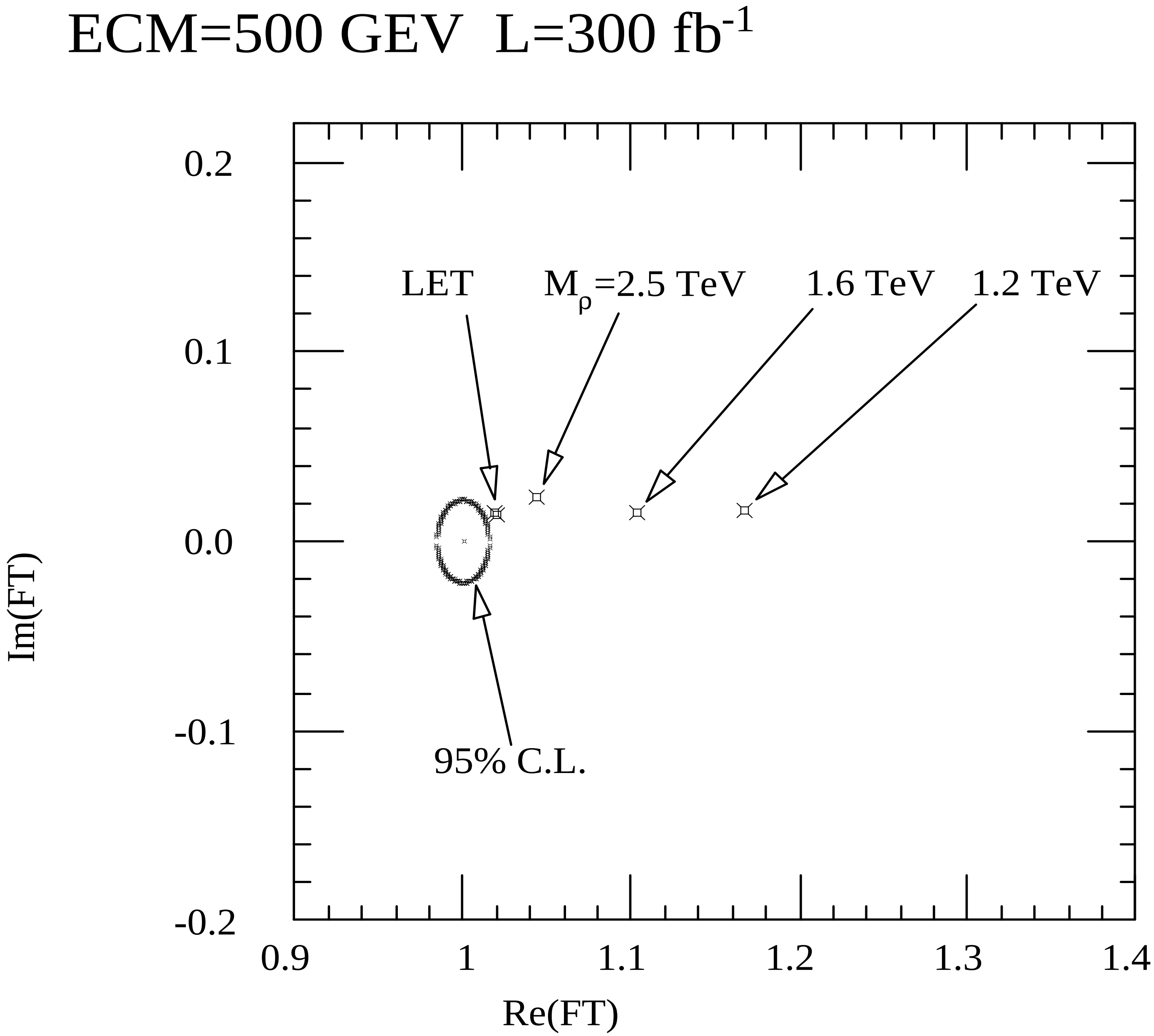


$e^+e^- \to W^+W^-$ Cross-section in the Presence of 1.8 TeV Technirho

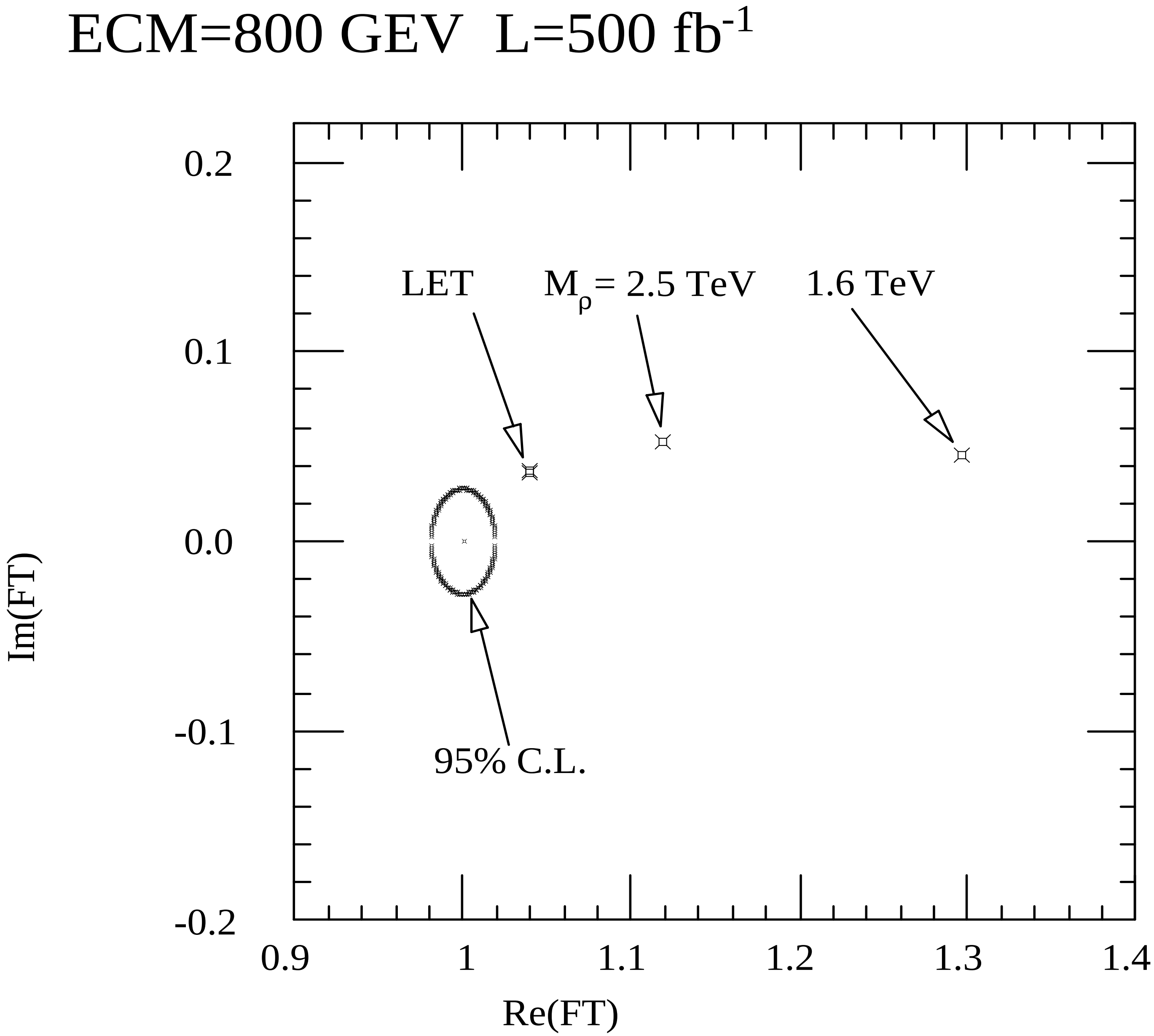


$e^+e^- \to W^+W^-$ Analysis

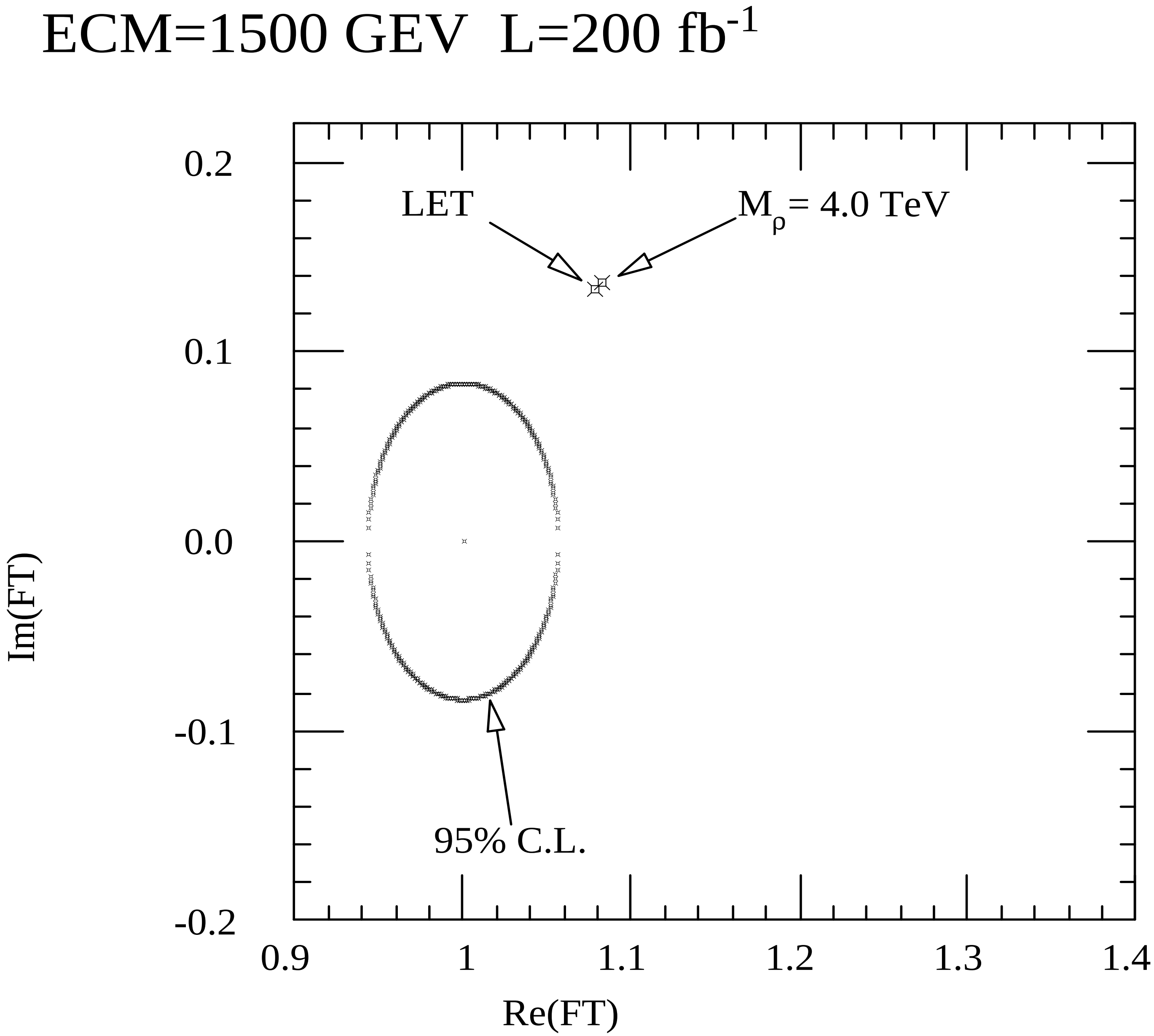
- 80/0% e^-/e^+ polarization – all e^-_L
- Likelihood fit of production angle & 4 decay angles
- $e\nu q\overline{q}$ and $\mu\nu q\overline{q}$ channels only
- Charm jets tagged with 100/65% purity/efficiency
- Solid angle $|\cos\Theta| < 0.9$
- Statistical errors only



ECM=500 GEV L=300 fb^{-1}
LET
M_ρ=2.5 TeV
1.6 TeV
1.2 TeV
95% C.L.
0.2
0.1
0.0
-0.1
-0.2
Im(FT)
0.9
1
1.1
1.2
1.3
1.4
Re(FT)



ECM=800 GEV L=500 fb-1
0.2
0.1
0.0
-0.1
-0.2
0.9
1
1.1
1.2
1.3
1.4
Re(FT)
Im(FT)
LET
Mρ= 2.5 TeV
1.6 TeV
95% C.L.


ECM=1500 GEV L=200 fb-1
LET
Mρ = 4.0 TeV
95% C.L.
0.2
0.1
0.0
-0.1
-0.2
0.9
1
1.1
1.2
1.3
1.4
Re(FT)
Im(FT)

LC / LHC Comparison

	Final State	$\sqrt{s}$ TeV	$\mathcal{L}$ fb^{-1}	$M_\rho =$ 1.2 TeV	$M_\rho =$ 1.6 TeV	$M_\rho =$ 2.5 TeV	LET
TESLA	W^+W^-	0.5	300	27σ	16σ	7σ	3σ
TESLA	W^+W^-	0.8	500	73σ	38σ	16σ	6σ
NLC	W^+W^-	1.5	200	114σ	204σ	24σ	5σ
LHC	qqW^+Z	14	100	8σ	6σ	–	–
LHC	qqW^+W^+	14	100	1σ	1σ	–	5σ

LET Signal versus c-tag efficiency

				c tag efficiency			
	Final State	$\sqrt{s}$ TeV	$\mathcal{L}$ fb^{-1}	0%	65%	80%	100%
TESLA	W^+W^-	0.8	500	4.6σ	5.6σ	5.8σ	6.1σ

Conclusions

- e^+e^- Linear Colliders provide a significant enhancement over LHC in I=J=1 W^+W^- scattering channel. Even at $\sqrt{s} = 500$ GeV TESLA outperforms LHC in this scattering channel.
- TESLA with 500 fb^{-1} at $\sqrt{s} = 800$ GeV gives a larger LET signal than LHC with 100 fb^{-1}
- TESLA with 500 fb^{-1} at $\sqrt{s} = 800$ GeV gives a larger LET signal than NLC with 200 fb^{-1} at $\sqrt{s} = 1500$ GeV.
- Charm tagging in $e\nu q\bar{q}$ & $\mu\nu q\bar{q}$ channels improves LET signal; improvement is equivalent to a 50% increase in luminosity.