

# Study of fermion pair productions at the ILC with center of mass energy of 250 GeV

1

Hiroaki Yamashiro (Kyushu University)

Kiyotomo Kawagoe, Taikan Suehara, Tamaki Yoshioka (Kyushu University)

Keisuke Fujii, Akiya Miyamoto (KEK)

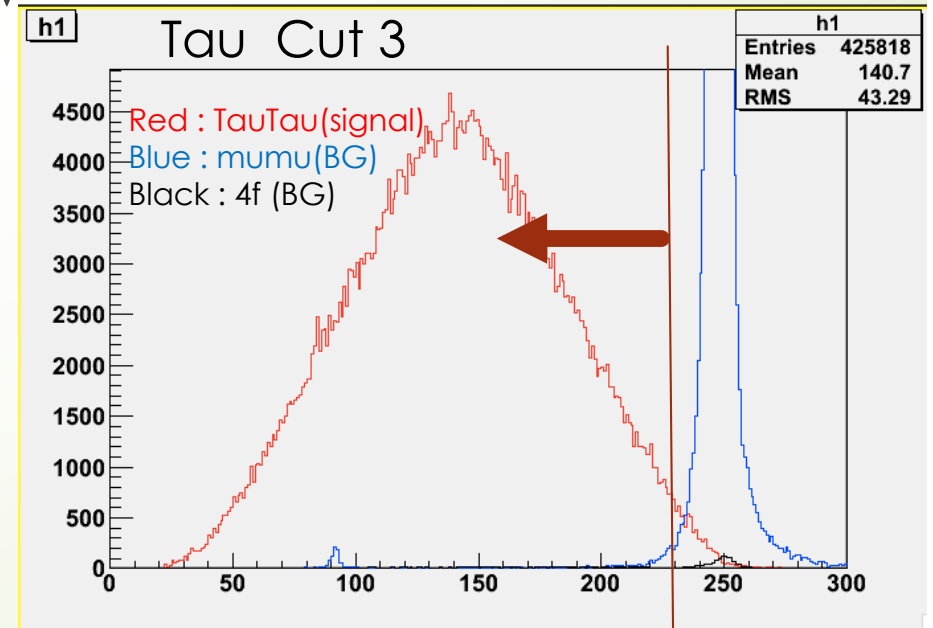
# Event Selection (1/2)

2

$$e^-e^+ \rightarrow \tau^- \tau^+$$

Tau clustering(TaJet)

- Selection : choose event included 2 jets
- Cut 1: Energy > 10 GeV
- Cut 2 : Opening angle > 178 degree
- Cut 3 : Visible Energy < 230 GeV
- Cut 4 :  $|\cos\theta| < 0.95$
- cut mumu events



# Cut Table

3

$$e^-e^+ \rightarrow \tau^- \tau^+$$

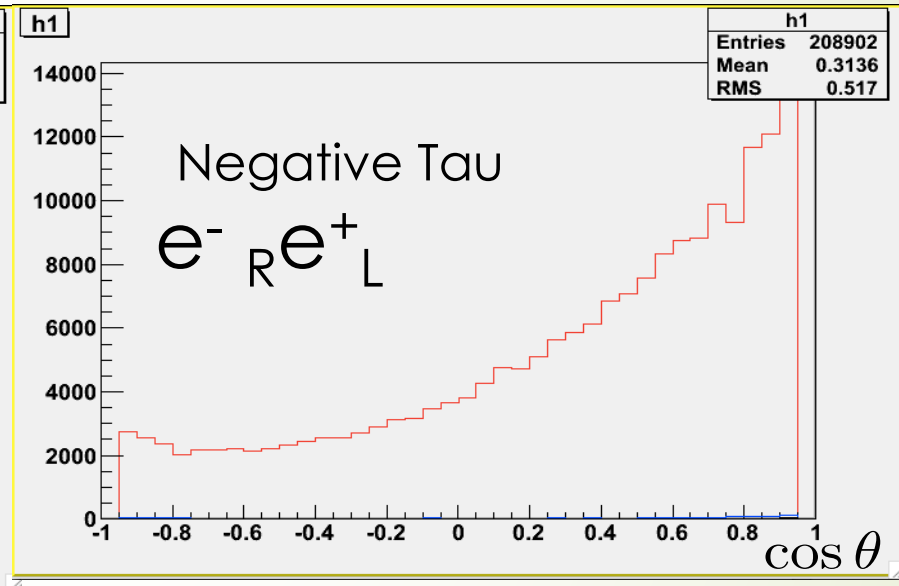
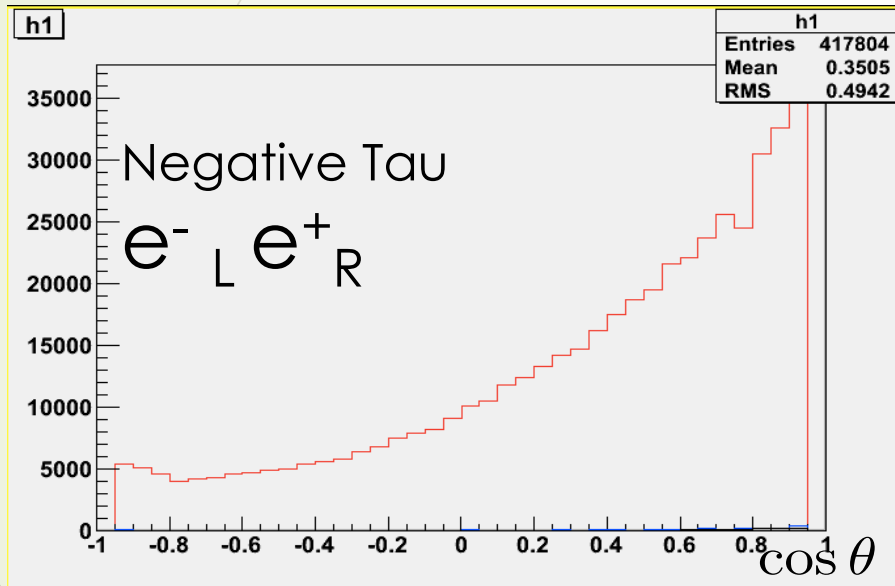
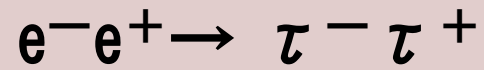
eL.pR 2 ab <sup>-1</sup>	Signal (tautau)	%	BG (mumu)	BG (WW/ZZ)	BG (single W/Z)
No Cut	1.45E+07		1.62E+07	3.07E+07	7.08E+06
Cut	1.94E+06	13%	13996	22200.9	3429.45

eR.pL 2 ab <sup>-1</sup>	Signal (tautau)	%	BG (mumu)	BG (WW/ZZ)	BG (single W/Z)
No Cut	4.33E+06		5.01E+06	5.70E+06	522975
Cut	516673	12%	3652.87	3911.07	130.908

# Angular distribution

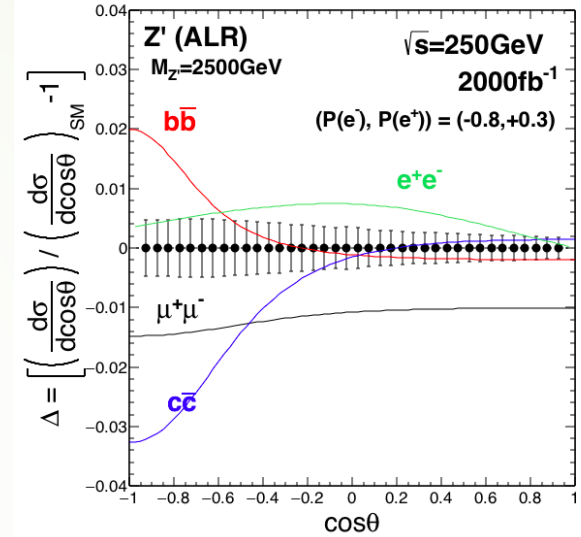
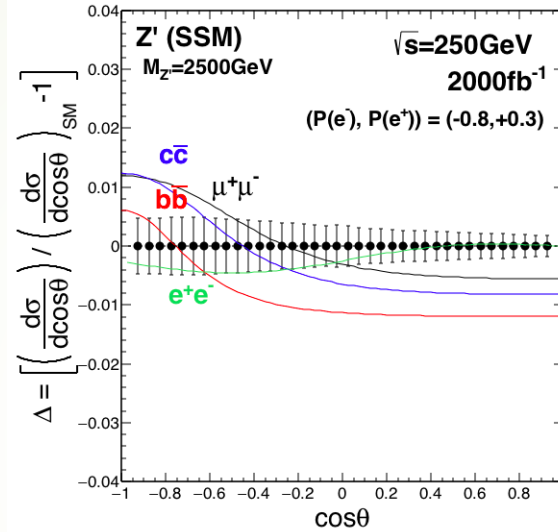
4

$$\cos \theta = \frac{P_z}{E}$$

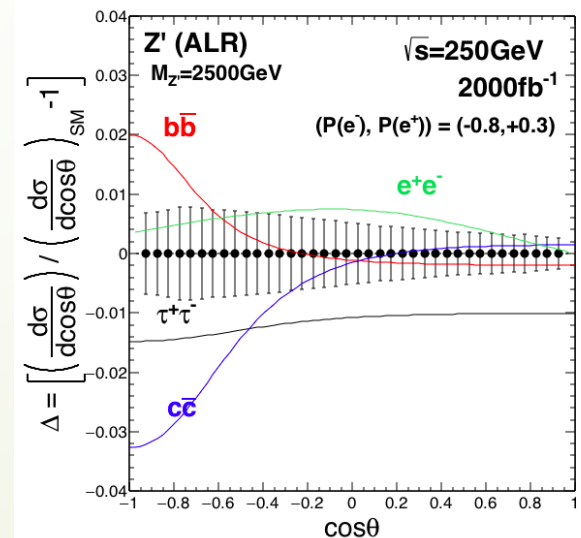
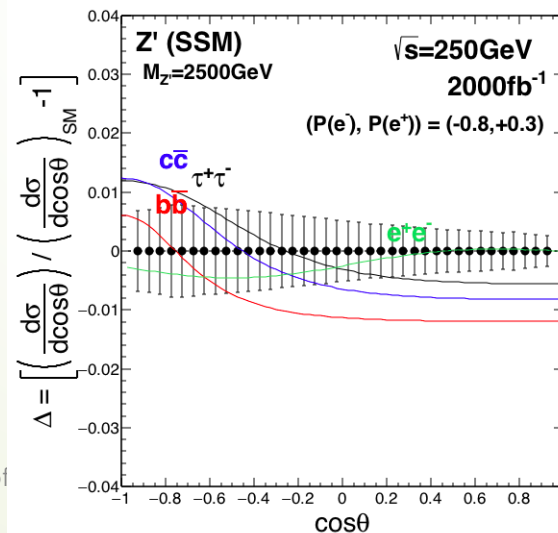


# investigation the deviation to SM ( $M_{Z'} = 2.5 \text{ TeV}$ )

$$e^-e^+ \rightarrow \mu^- \mu^+$$



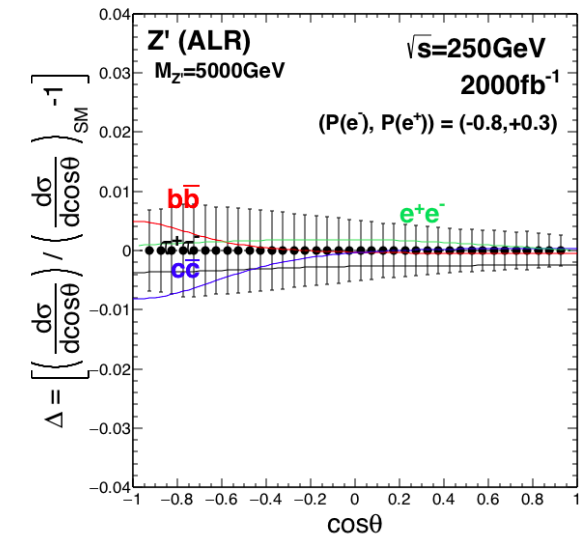
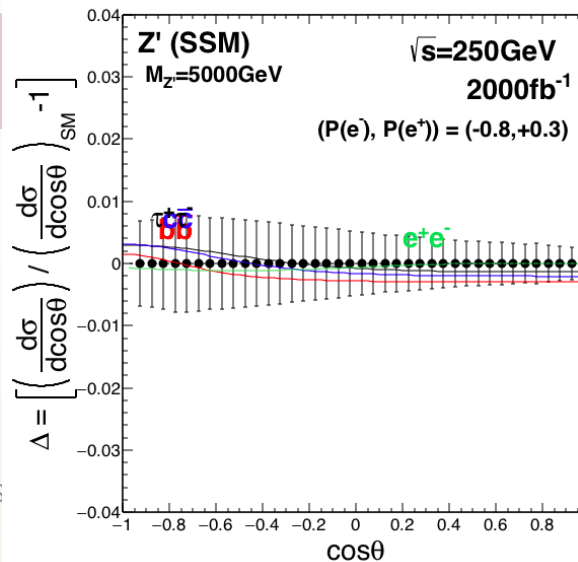
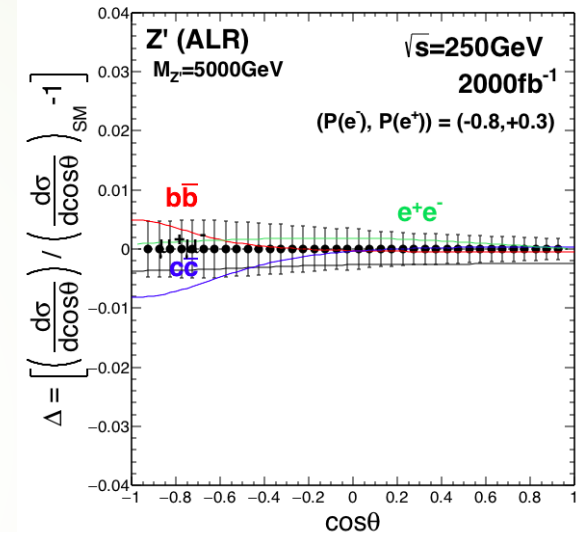
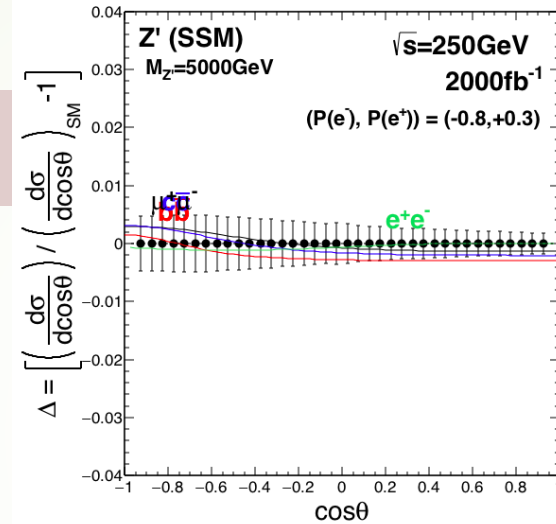
$$e^-e^+ \rightarrow \tau^- \tau^+$$



# investigation the deviation to SM ( $M_{Z'} = 5 \text{ TeV}$ )

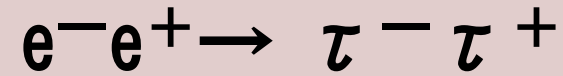
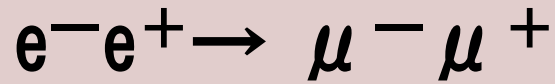
$$e^-e^+ \rightarrow \mu^- \mu^+$$

$$e^-e^+ \rightarrow \tau^- \tau^+$$



# Results

7



Z' = 2.5 TeV		eL.pR			eR.pL		
BSM model	$\chi^2$	ndf	probability	$\chi^2$	ndf	probability	
SSM	169	38	1.35E-18	67.9416	38	2.01E-03	
ALR	569	38	6.84E-96	93.0471	38	1.62E-06	
$\chi$	216	38	6.97E-27	44.3083	38	0.222	
$\Psi$	45.1	38	1.99E-01	40.3235	38	0.368	
$\eta$	42.1	38	2.98E-01	43.7011	38	0.242	

Z' = 5 TeV		eL.pR			eR.pL		
BSM model	$\chi^2$	ndf	probability	$\chi^2$	ndf	probability	
SSM	46.1	38	0.171	39.8413	38	0.388	
ALR	70.8	38	9.67E-04	41.4027	38	0.324	
$\chi$	49.0	38	0.108	38.3891	38	0.452	
$\Psi$	38.43	38	0.450	38.143	38	0.463	
$\eta$	38.3	38	0.458	38.3513	38	0.454	

Z' = 2.5 TeV		eL.pR			eR.pL		
BSM model	$\chi^2$	ndf	probability	$\chi^2$	ndf	probability	
SSM	94.1	38	1.15E-06	50.3342	38	0.0869	
ALR	262	38	2.71E-35	60.5777	38	0.0114	
$\chi$	113	38	1.86E-09	40.5966	38	0.357	
$\Psi$	41.0	38	0.339	38.9542	38	0.427	
$\eta$	39.7	38	0.393	40.3091	38	0.368	

Z' = 5 TeV		eL.pR			eR.pL		
BSM model	$\chi^2$	ndf	probability	$\chi^2$	ndf	probability	
SSM	41.5	38	0.322	38.8	38	0.435	
ALR	51.9	38	0.0662	39.4	38	0.407	
$\chi$	42.7	38	0.277	38.1	38	0.462	
$\Psi$	38.2	38	0.461	38.0	38	0.466	
$\eta$	38.1	38	0.465	38.1	38	0.463	

## $\mu, \tau$ combined

Z' = 2.5 TeV		$\chi^2$	ndf	probability
BSM model	$\chi^2$	ndf	probability	
SSM	382.2996	152	8.07E-22	
ALR	984.8688	152	5.52E-122	
$\chi$	415.1739	152	2.72E-26	
$\Psi$	165.4235	152	0.215845	
$\eta$	165.844	152	0.209237	

Z' = 5 TeV		$\chi^2$	ndf	probability
BSM model	$\chi^2$	ndf	probability	
SSM	166.1795	152	0.204058	
ALR	203.4928	152	3.35792E-3	
$\chi$	168.2413	152	0.174079	
$\Psi$	152.8263	152	0.465917	
$\eta$	152.853	152	0.465311	



# Plan

- ▶ include bhabha sample (until September)
- ▶ analysis ee  $\rightarrow$  ee channel (until LCWS2017)