Analysis Report

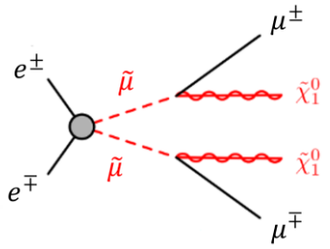
Jiarong Yuan

2020/09/24

1

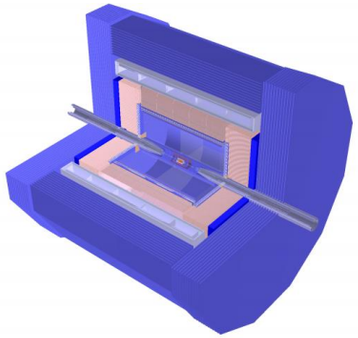
Direct Smuon

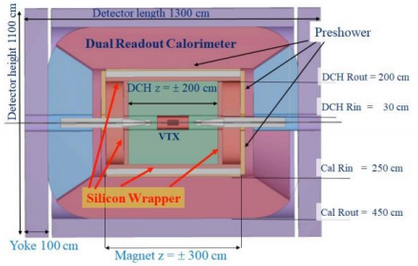
DSmuon



About CEPC
ECM=240GeV, higgs factory, 100 km circumference, 2Interaction Points.
ILD-like detector

signal samples: MadGraph+Pythia8
simulation: Mokka
reconstruction: Marlin





Signal process: smuon mass 80, 90, 100, 110, 115, 119 GeV with LSP mass 1, 10, 20, ... , (m_{smuon}-10), (m_{smuon}-5), (m_{smuon}-1) GeV, each with 100, 000 events.

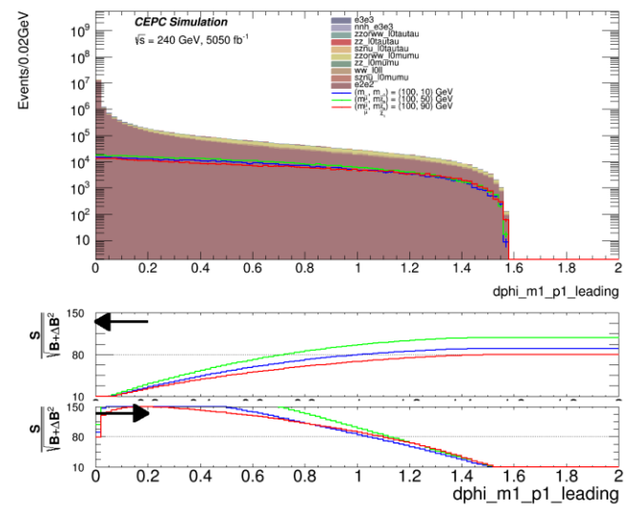
consider backgrounds with final state mumu or tautau.

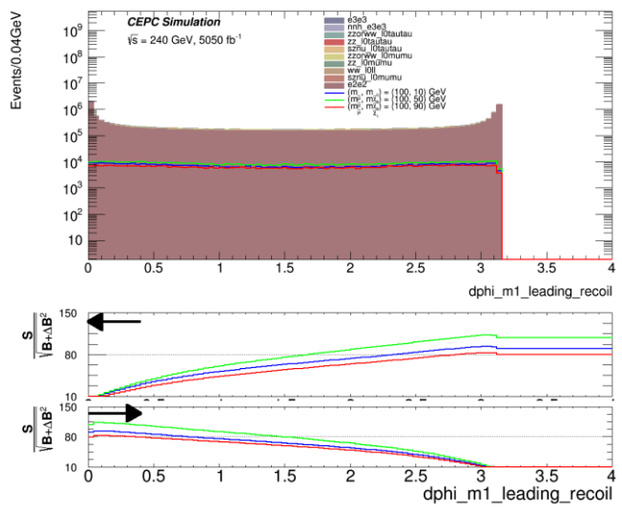
Quick sensitivity study

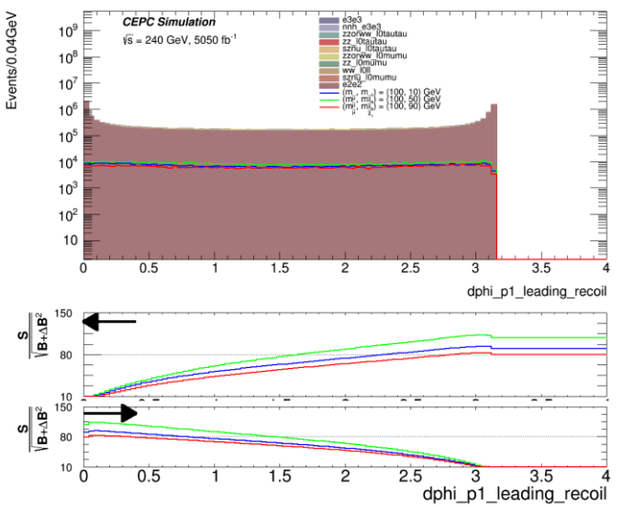
normalized to $5050\ \mathrm{fb}^{-1}$

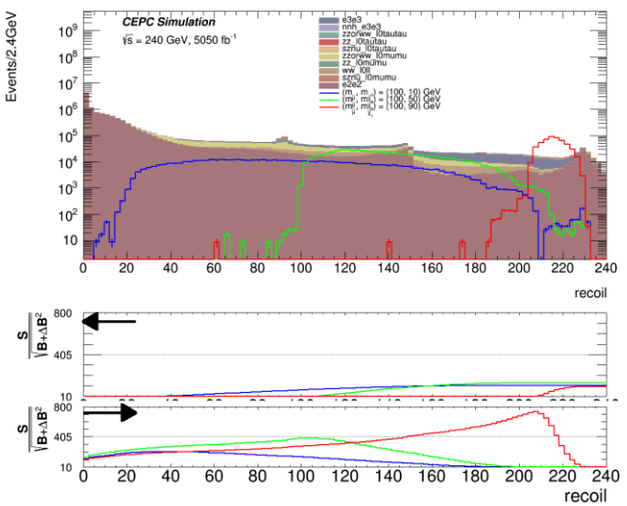
process	Cross Section [fb]
$m_{smuon} = 80GeV$	419.48
$m_{smuon} = 90GeV$	293.43
$m_{smuon} = 100GeV$	171.20
$m_{smuon} = 110GeV$	64.70
$m_{smuon} = 115GeV$	23.62
$m_{smuon} = 119GeV$	2.17
e3e3	4374.94
nnh_e3e3	3.07
zzorww_l0tautau	205.84
zz_l0tautau	9.2
sznu_l0tautau	14.57
zzorww_l0mumu	214.81
zz_l0mumu	18.17
ww_l0ll	392.96
sznu_l0mumu	43.33
e2e2	4967.58

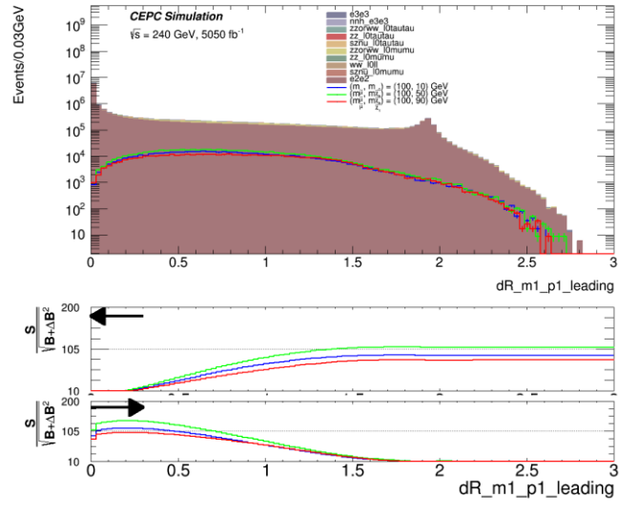
DSmuon

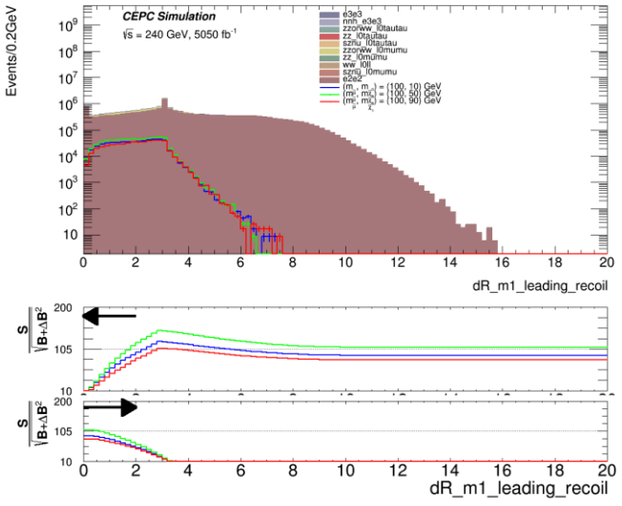


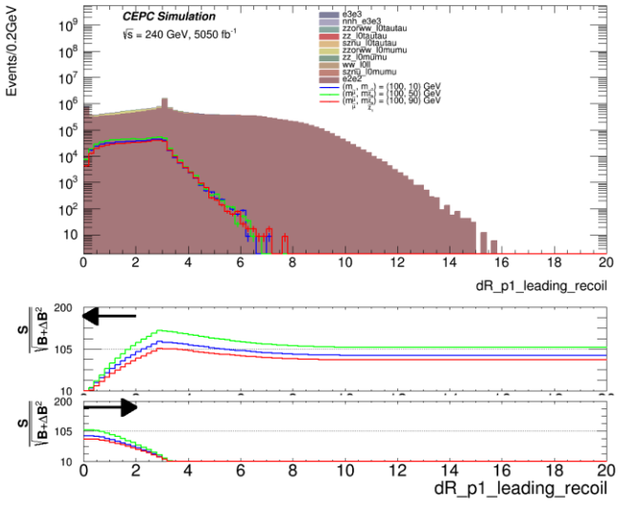


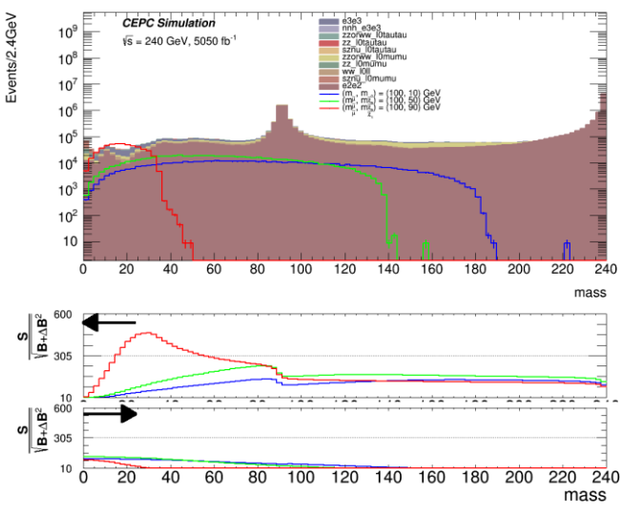












2 OS muon distribution

DSmuon

SR1	SR2
=2 OS muon	
$\Delta R(\mu, recoil) < 3$	
$\Delta\varphi(\mu,\mu) > 0.3$	
E_μ>40GeV	$E_\mu < 45GeV$
$M_{\mu\mu} < 60GeV$	
$M_{recoil} > 25GeV$	$M_{recoil} > 140GeV$

(100,10)
(119,1/10/20/30/40/50/60)

$\Delta m \geq 60$

(100,50)(100,90)
(119,70/80/90/100/110/115/117)

$\Delta m \leq 50$

SR definition

DSmuon

Selection	(100,10)	(100,50)	(100,90)	e3e3	nnh_e3e3	zzorww_l0tautau	zz_l0tautau	sznu_l0tautau	zzorww_l0mumu	zz_l0mumu	ww_l0ll	sznu_l0mumu	e2e2	total background
N RAW	864535.75	864534.75	864534.75	22093447	15500	1039492	46400	73578.5	1084790.5	91758.5	1984448	218816.5	25086279	51734570
OSmuon==1	566351	682116	500416	588543	444.385	30897.9	1356.62	2205.96	906777	49231.6	312610	103079	1.78E+07	1.98E+07
$\Delta R(\mu, recoil) < 3$	452860	547367	392881	308954	339.295	21795.8	895.12	1502.75	682886	31595.3	217136	63956.3	6.09E+06	7.42E+06
$\Delta\varphi(\mu,\mu) > 0.3$	305264	367300	265298	34308.8	191.27	13240.7	516.168	849.927	417951	15640.6	134819	29519	845825	1.49E+06
$E_{\mu} > 40GeV$	176877	115817	0	805.85	3.565	920.82	2.68	2.964	302255	5675.78	31265.9	7726.45	448241	796899
$M_{\mu\mu} < 60GeV$	13615.9	4486.75	0	2.27	0	1.03	0	0	1733.36	460.872	74.679	491.946	639.135	3403.3
$M_{recoil} > 25GeV$	13607.2 ± 116.65	4486.75±66.98	0	2.27±1.51	0	1.03±1.01	0	0	1726.96±41.56	460.872±21.47	74.679±8.64	488.607±22.10	121.74±11.03	2876.15±53.63
Efficiency	1.574%	0.519%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.159%	0.502%	0.004%	0.223%	0.000%	0.006%

SR1 cutflow

DSmuon

Selection	(100, 10)	(100, 50)	(100, 90)	e3e3	nnh_e3e3	zzorww_l0tautau	zz_l0tautau	sznu_l0tautau	zzorww_l0mumu	zz_l0mumu	ww_l0ll	sznu_l0mumu	e2e2	total background
N RAW	864535.75	864534.75	864534.75	22093447	15500	1039492	46400	73578.5	1084790.5	91758.5	1984448	218816.5	25086279	51734570
OSmuon==1	566351	682116	500416	588543	444.385	30897.9	1356.62	2205.96	906777	49231.6	312610	103079	1.78E+07	1.98E+07
$\Delta R(\mu, recoil) < 3$	452860	547367	392881	308954	339.295	21795.8	895.12	1502.75	682886	31595.3	217136	63956.3	6.09E+06	7.42E+06
$\Delta\varphi(\mu,\mu) > 0.3$	305264	367300	265298	34308.8	191.27	13240.7	516.168	849.927	417951	15640.6	134819	29519	845825	1.49E+06
$E_{\mu} < 45GeV$	30369.9	98414.7	265298	23744.2	142.91	8850.79	415.4	737.295	31084.1	1612.36	26014.9	10501.2	25662.8	128766
$M_{recoil} > 140GeV$	27975.2±167.26	94706±307.74	265298±515.07	3927.1±62.67	137.95±11.75	8459.39±91.97	398.784±19.97	724.698±26.92	28221.9±167.99	1274.66±35.70	24343.3±156.02	10068.2±100.34	7608.75±87.23	85164.7±291.83
Efficiency	3.236%	10.955%	30.687%	0.018%	0.890%	0.814%	0.859%	0.985%	2.602%	1.389%	1.227%	4.601%	0.030%	0.165%

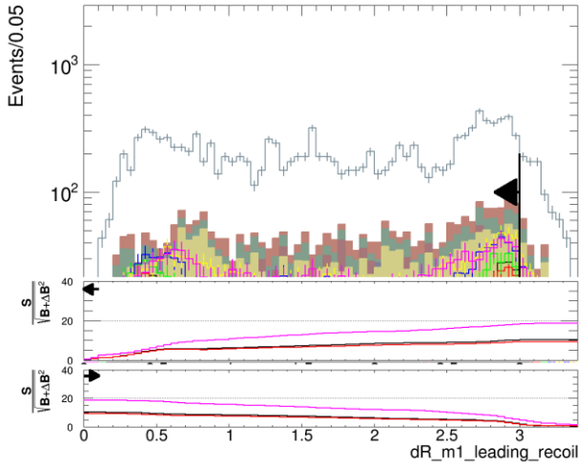
SR2 cutflow

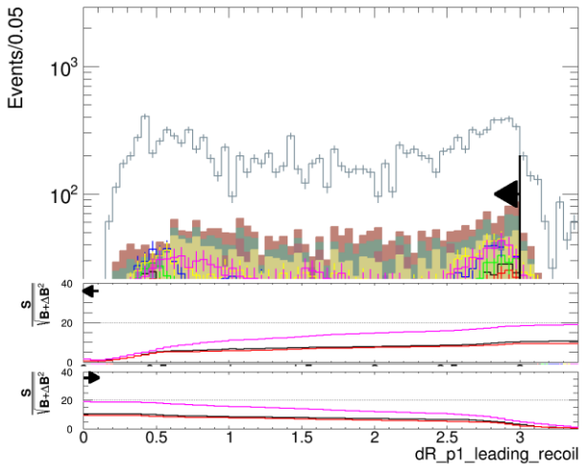
DSmuon

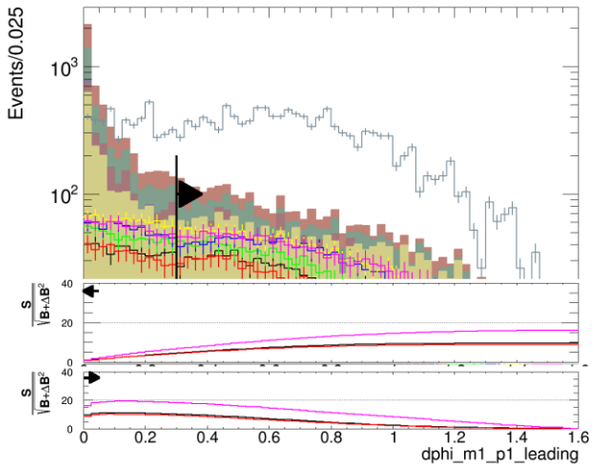
Process	SR1 Yield	SR2 Yield
(100, 10)	13607.2±116.65	27975.2±167.26
(100, 50)	4486.75±66.98	94706±307.74
(100, 90)	0	265298±515.07
e3e3	2.27±1.51	3927.1±62.67
nnh_e3e3	0	137.95±11.75
zzorww_l0tautau	1.03±1.01	8459.39±91.97
zz_l0tautau	0	398.784±19.97
sznu_l0tautau	0	724.698±26.92
zzorww_l0mumu	1726.96±41.56	28221.9±167.99
zz_l0mumu	460.872±21.47	1274.66±35.70
ww_l0ll	74.679±8.64	24343.3±156.02
sznu_l0mumu	488.607±22.10	10068.2±100.34
e2e2	121.74±11.03	7608.75±87.23
total background	2876.15±53.63	85164.7±291.83

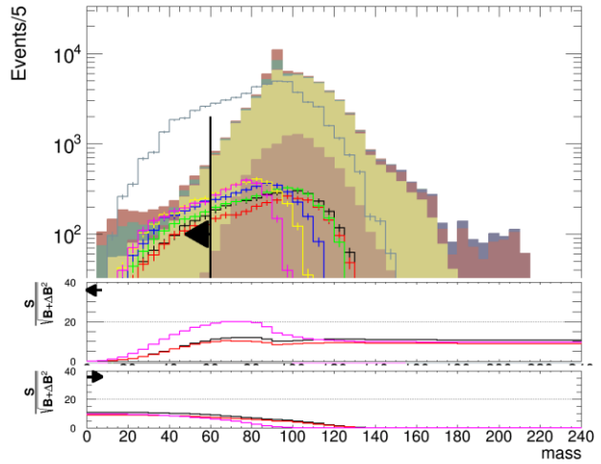
Yield

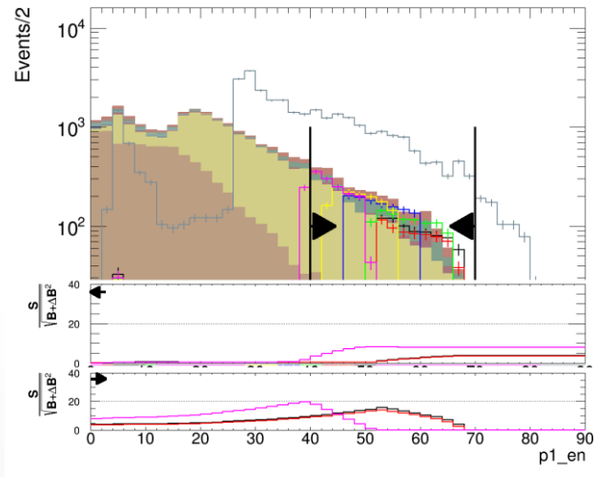
DSmuon

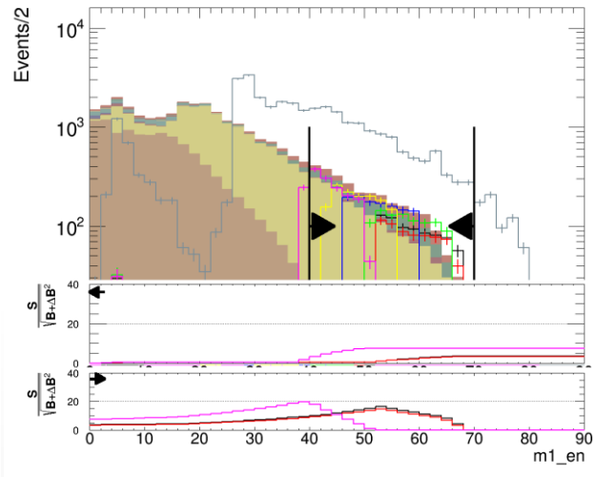


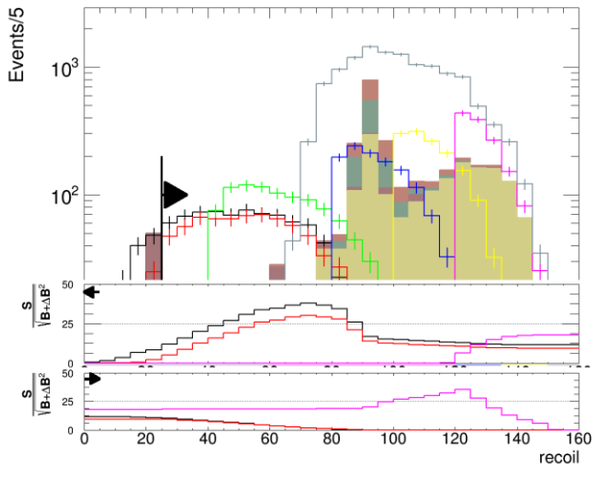


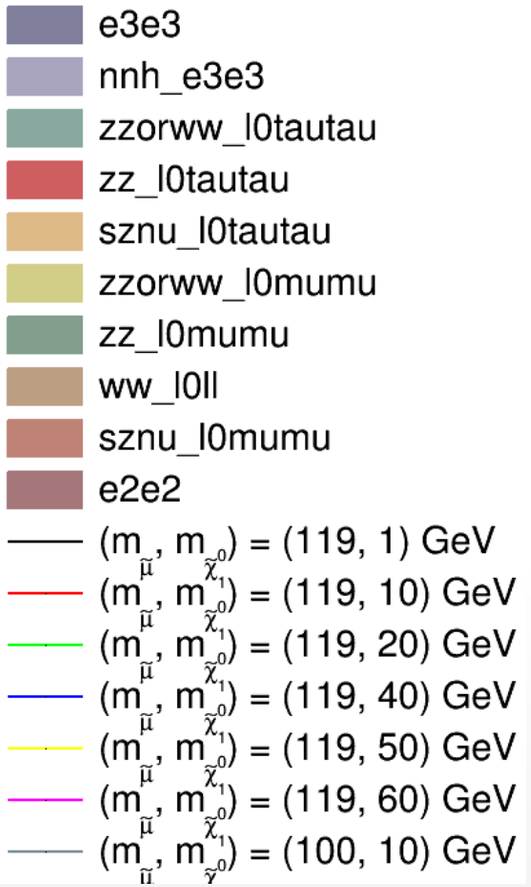






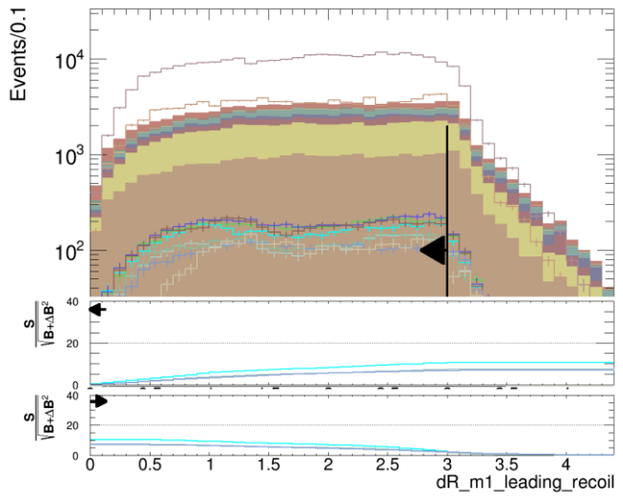


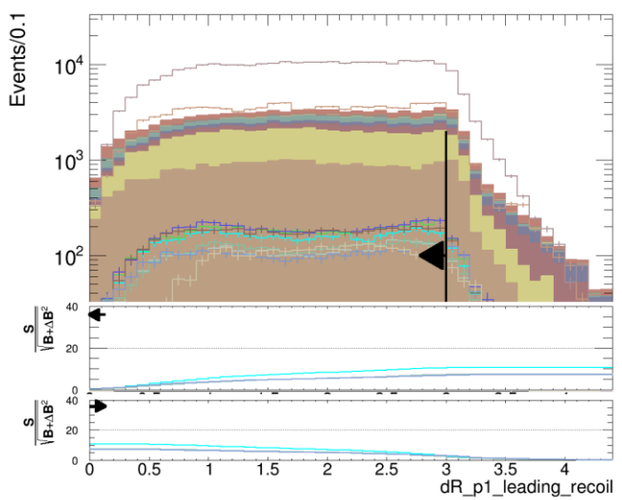


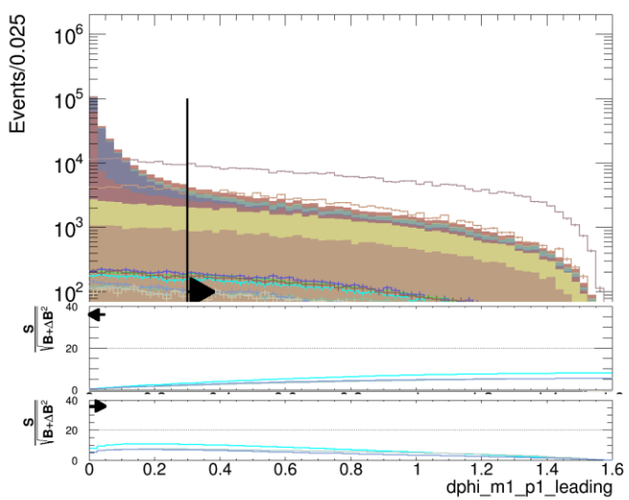


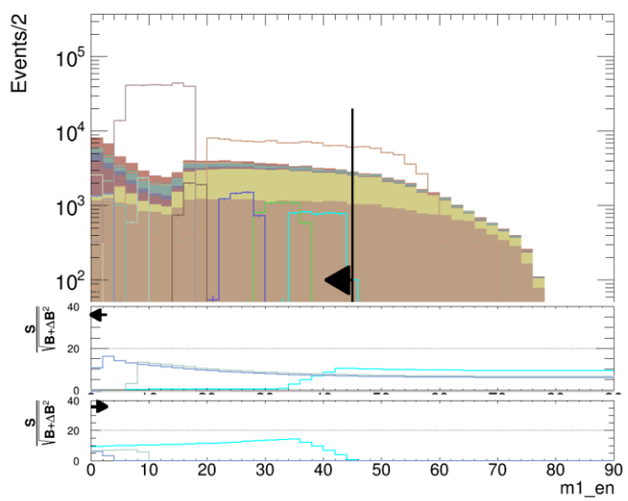
N-1 SR1

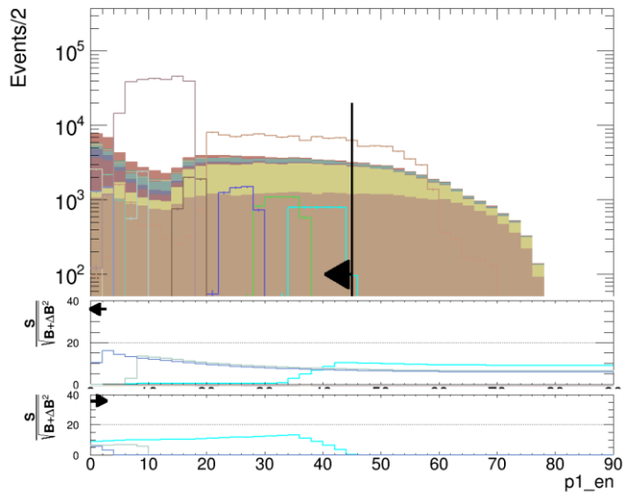
DSmuon

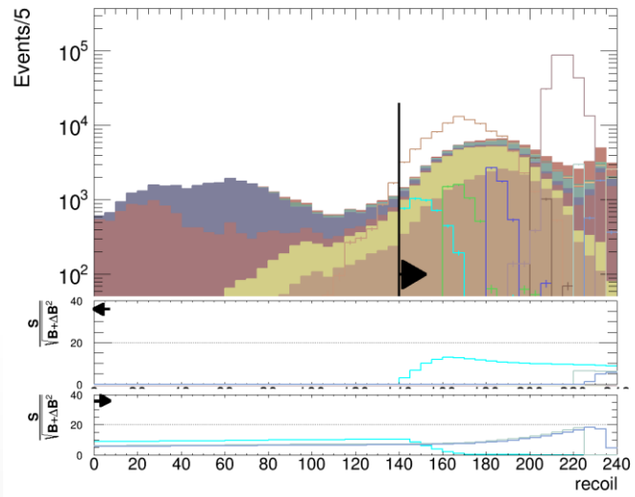


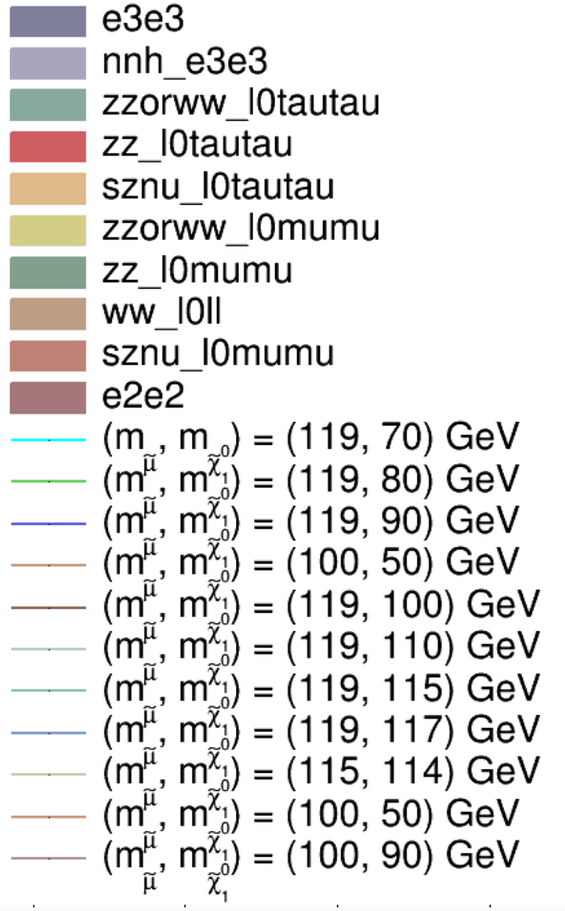






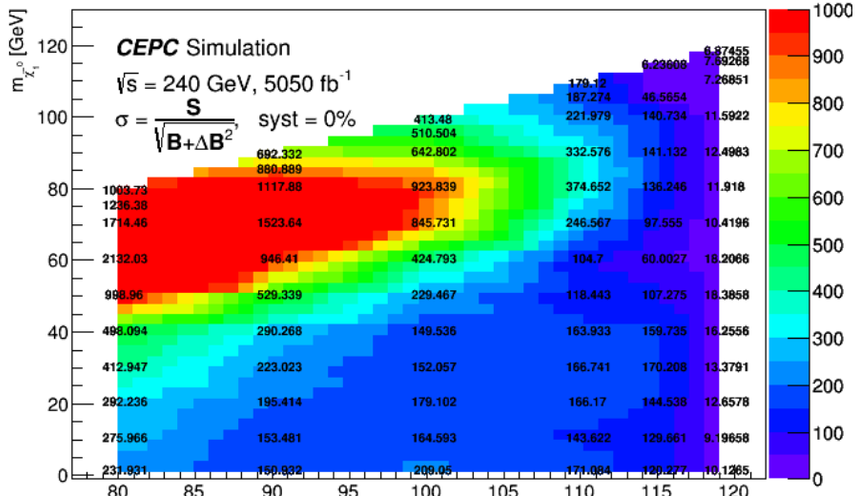


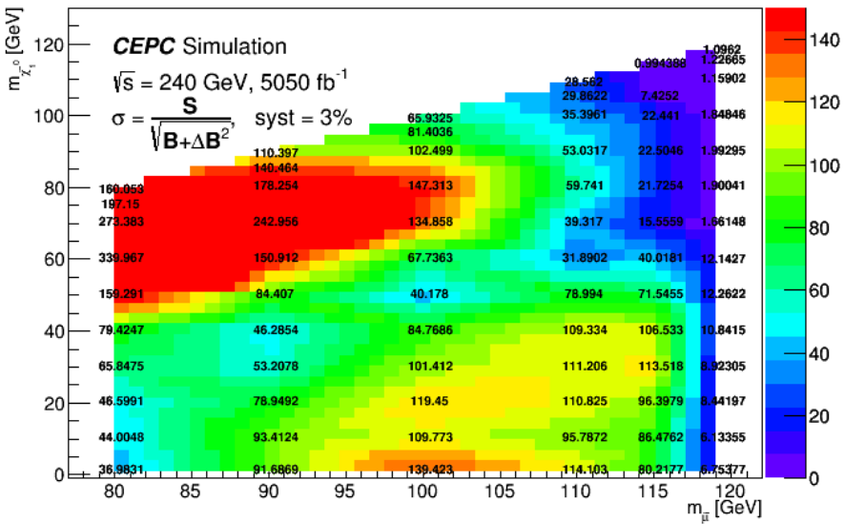


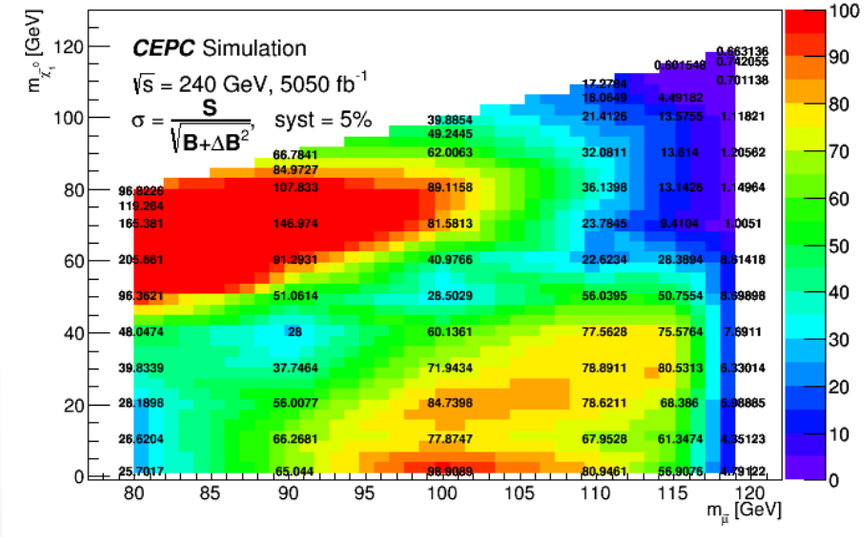


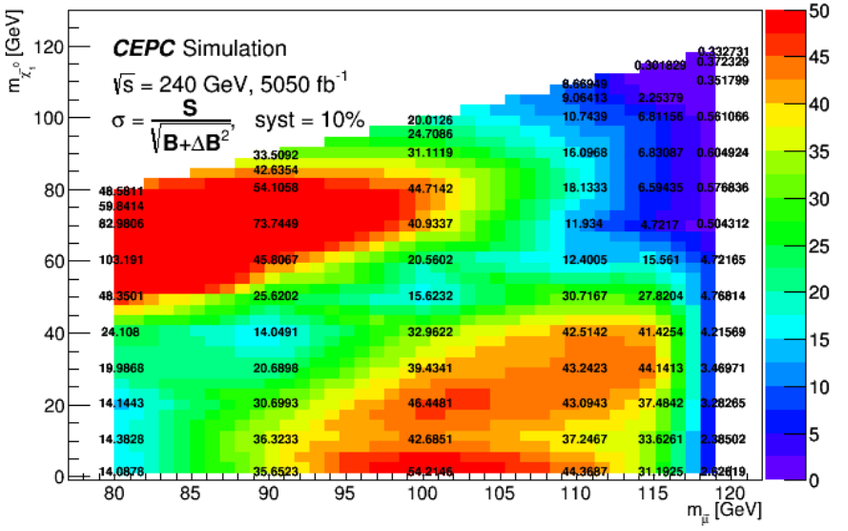
N-1 SR2

DSmuon



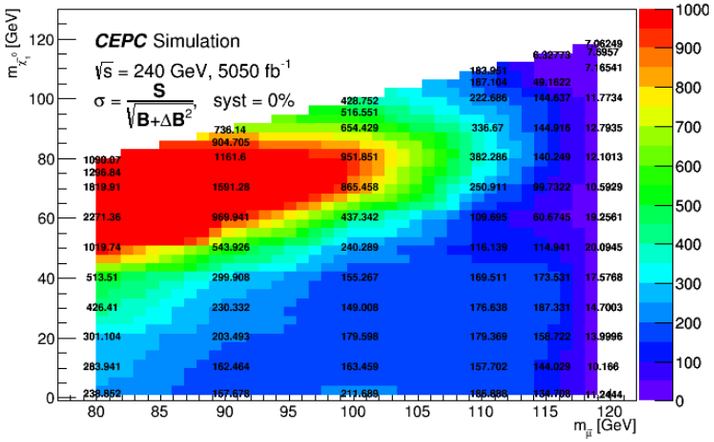


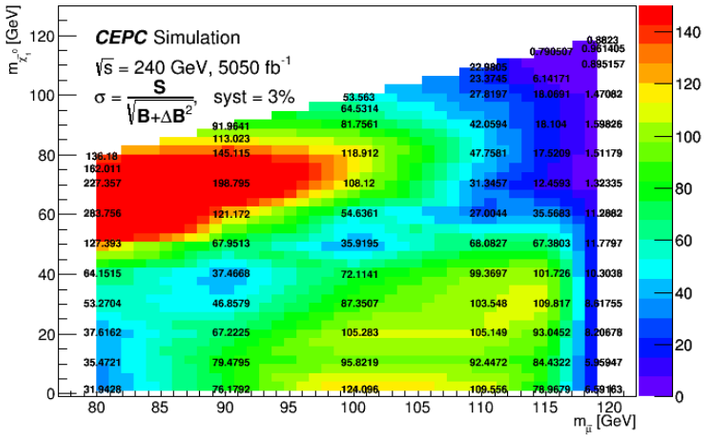


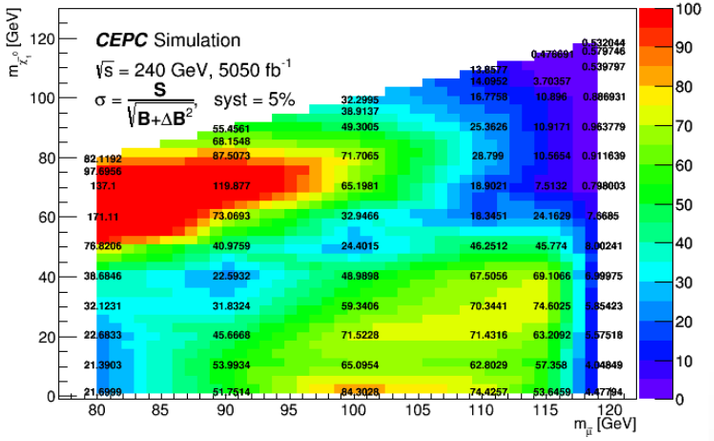


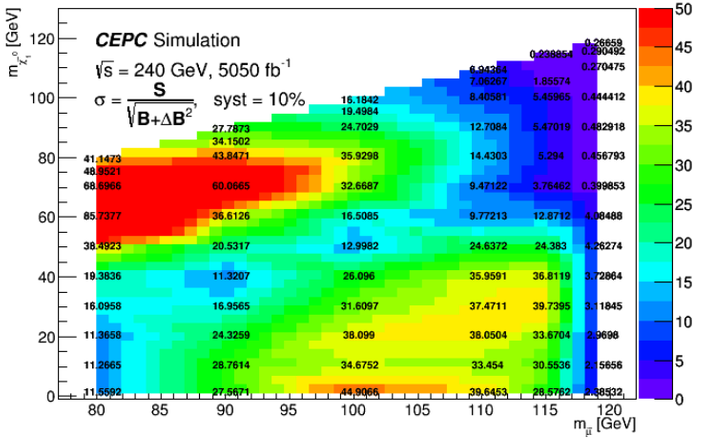
sensitivity map

DSmuon









SR1	SR2
=2 OS muon	
$\Delta R(\mu, recoil) < 3$	
$\Delta\varphi(\mu,\mu) > 0.1$	
E_μ>40GeV	$E_\mu < 45GeV$
$M_{\mu\mu} < 60GeV$	
$M_{recoil} > 25GeV$	$M_{recoil} > 140GeV$

When use $\Delta\varphi(\mu,\mu) > 0.1$, there are more bkg events, which decreases sensitivity with large systematic uncertainty.

sensitivity map

2

C1C1 decay via WW

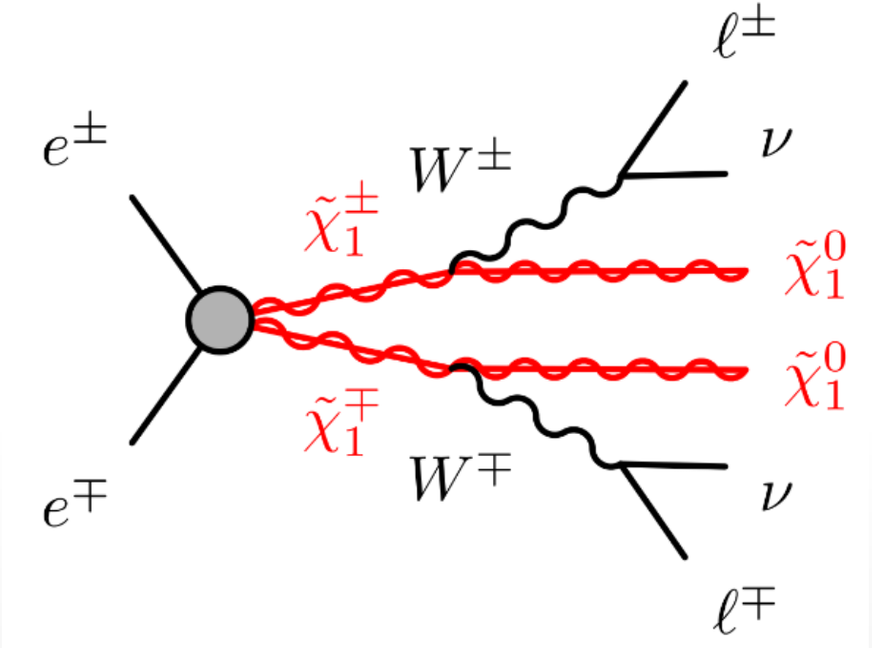
C1C1

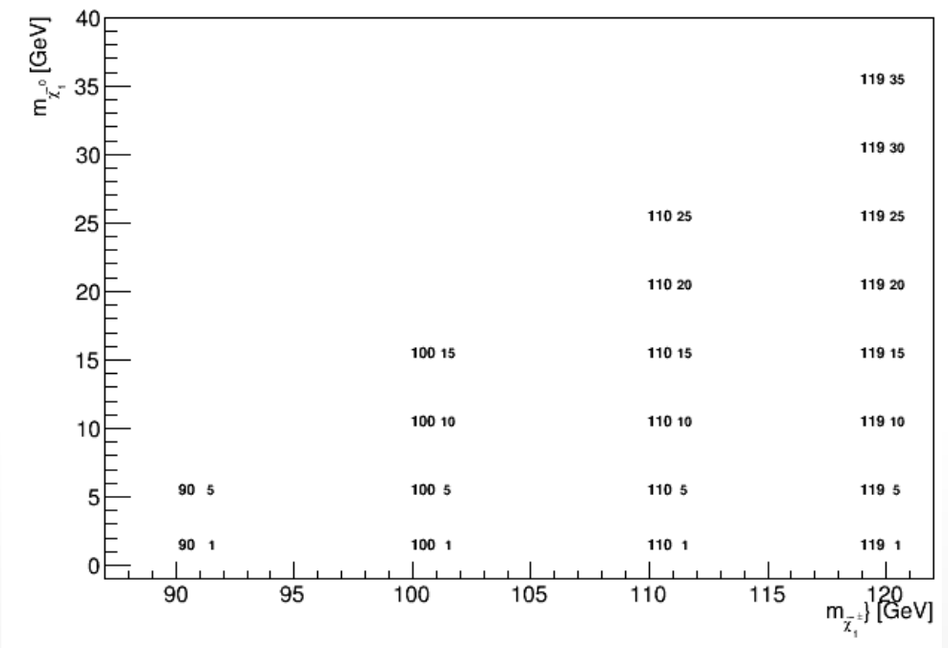
signal samples: MadGraph+Pythia8(W forced leptonically decay)

simulation: Mokka

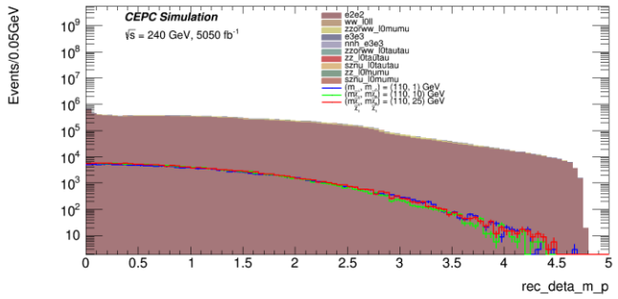
reconstruction: Marlin

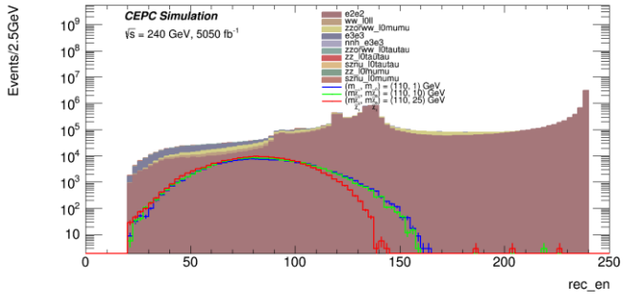
Generated 20 signal points, each with 500k events.(done by Huajie cheng)

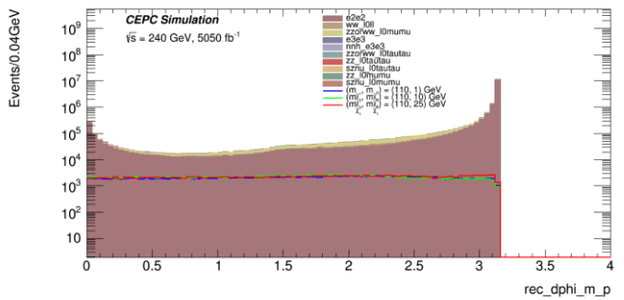


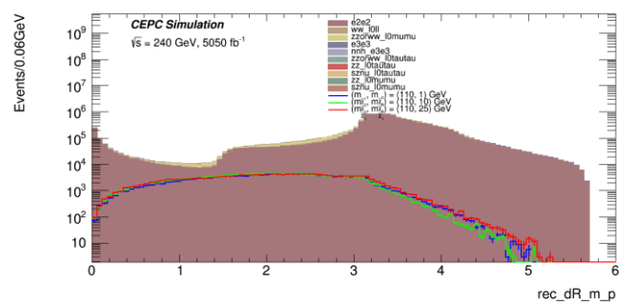


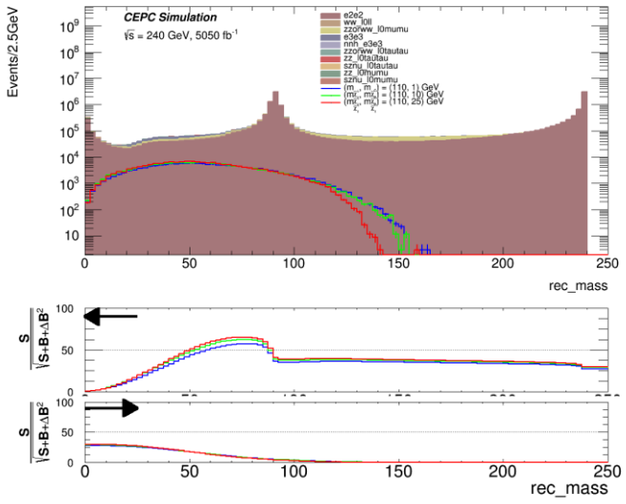
C1C1

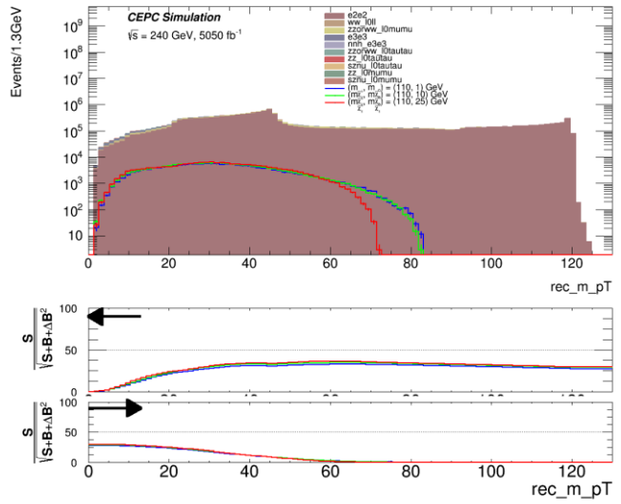


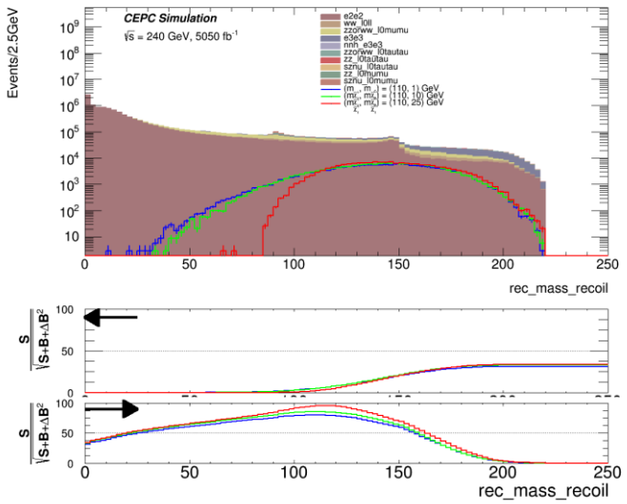


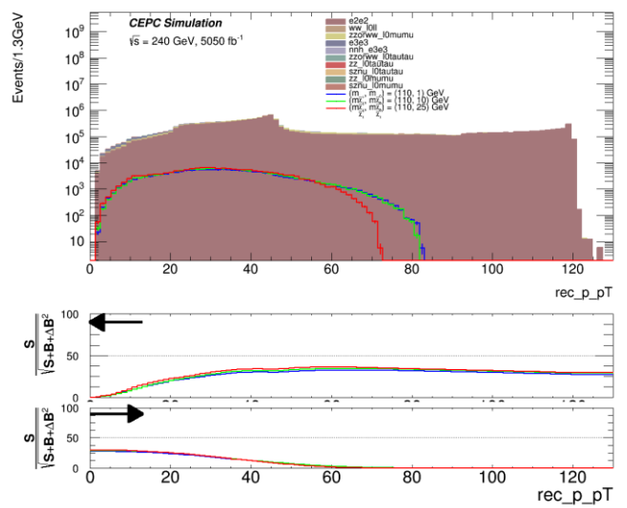












2 OS muon distribution

Signal Region
OSmuon==1
$0.4 < \Delta R(\mu, \mu) < 1.6$
$M_{recoil} > 130$
$p_T^{\mu} > 20$

C1C1

Only consider mu mu final state signal

Selection	(110,1)	(110,10)	(110,25)	e3e3	nnh_e3e3	zzorww_l0tautau	zz_l0tautau	sznu_l0tautau	zzorww_l0mumu	zz_l0mumu	ww_l0ll	sznu_l0mumu	e2e2	total background
N Raw	207842.3	218595.7	229187.6	22093447	15500	1039492	46400	73578.5	1084790.5	91758.5	1984448	218816.5	25086279	51734570
OSmuon==1	161984	170754	174808	322331	229.299	11912.5	403.726	720.662	872793	40228.7	228461	60942.3	1.59E+07	1.74E+07
$0.4 < \Delta R(\mu,\mu) < 1.6$	46791.8	52547.4	51278	2808.2	0	280.774	33.1614	61.948	41217.3	4367.9	7432.1	7349.14	232292	295843
$M_{recoil} > 130$	32560.1	37620.4	37559.8	2592.71	0	280.774	32.1086	61.948	23016.5	871.92	6559.48	3333.44	19374.9	56123.8
$p_T^{\mu} > 20$	20976.8±144.83	23893.6±154.58	25647.7±160.15	419.642±20.49	0	20.0023±4.47	2.10548±1.45	8.25973±2.87	9024.6±95.00	139.784±11.82	1358.54±36.86	297.171±17.24	3146.98±56.10	14417.1±120.07
Efficiency	10.093%	10.930%	11.191%	0.002%	0.000%	0.002%	0.005%	0.011%	0.832%	0.152%	0.068%	0.136%	0.013%	0.028%

cutflow

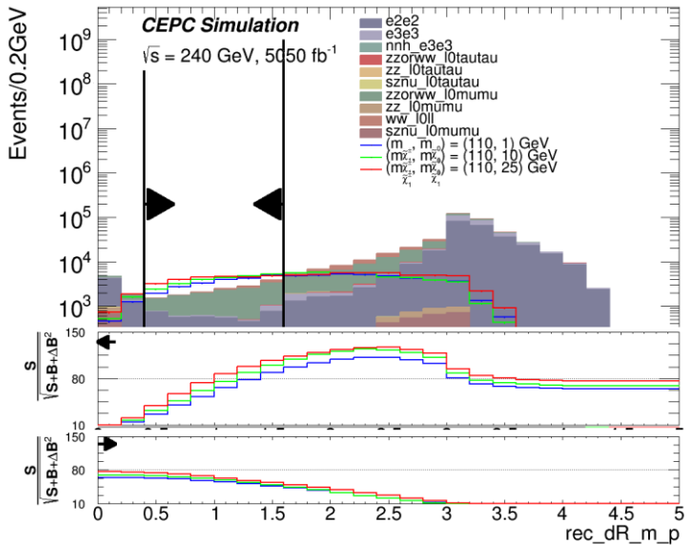
C1C1

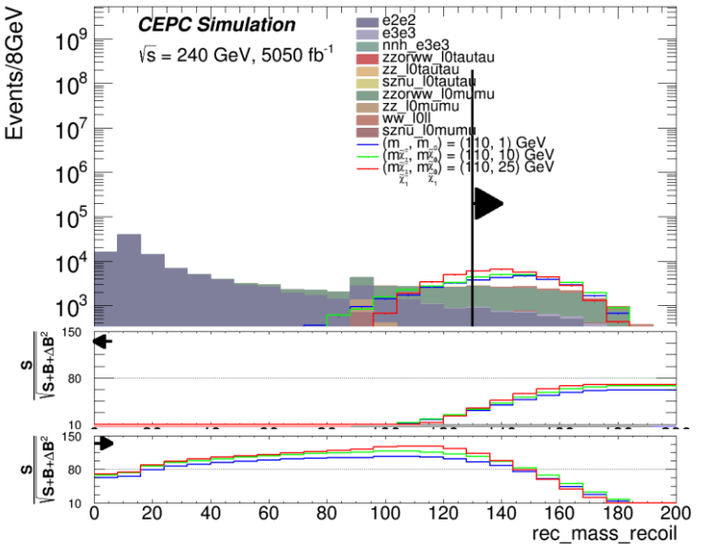
Only consider mu mu final state signal

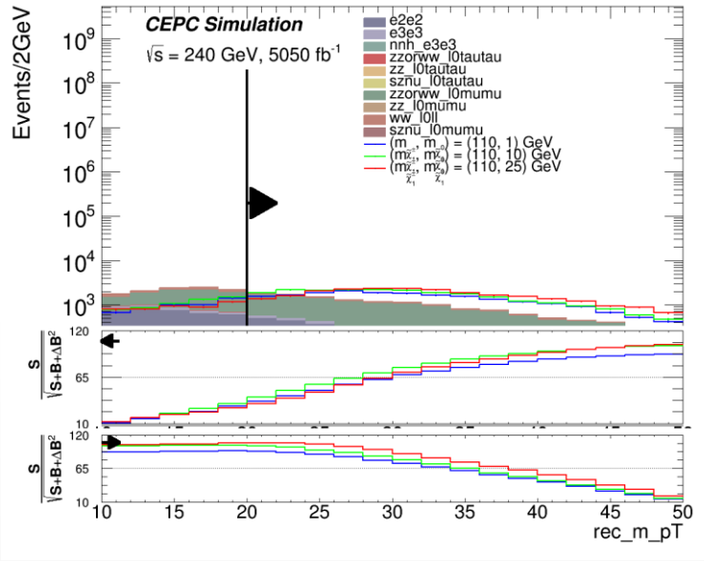
Process	Yield
(110,1)	20976.8±144.83
(110,10)	23893.6±154.58
(110,25)	25647.7±160.15
e3e3	419.642±20.49
nnh_e3e3	0
zzorww_l0tautau	20.0023±4.47
zz_l0tautau	2.10548±1.45
sznu_l0tautau	8.25973±2.87
zzorww_l0mumu	9024.6±95.00
zz_l0mumu	139.784±11.82
ww_l0ll	1358.54±36.86
sznu_l0mumu	297.171±17.24
e2e2	3146.98±56.10
total background	14417.1±120.07

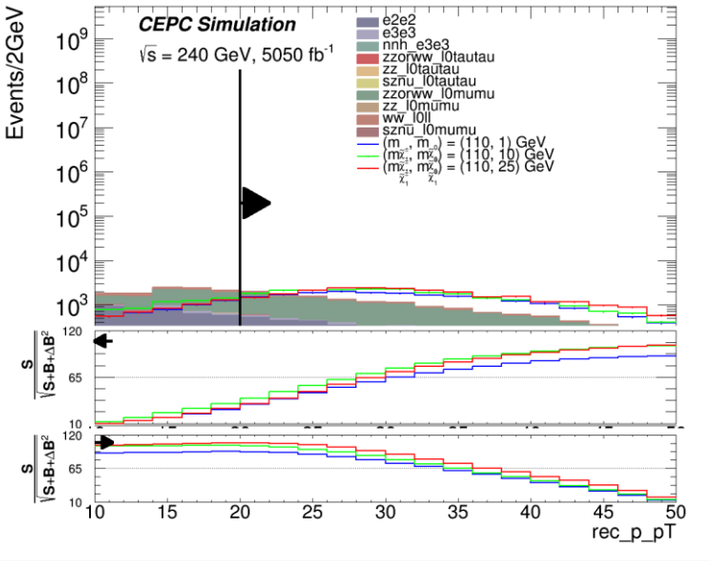
Yield

C1C1


CEPC Simulation
√s = 240 GeV, 5050 fb-1
e2e2
e3e3
nnh_e3e3
zzorww_l0tautau
zz_l0tautau
sznu_l0tautau
zzorww_l0mumu
zz_l0mumu
ww_l0ll
sznu_l0mumu
(m_χ̃1, m_χ̃1) = (110, 1) GeV
(mχ̃1, mχ̃1) = (110, 10) GeV
(mχ̃1, mχ̃1) = (110, 25) GeV
Events/0.2GeV
S/√(S+B+ΔB²)
rec_dR_m_p

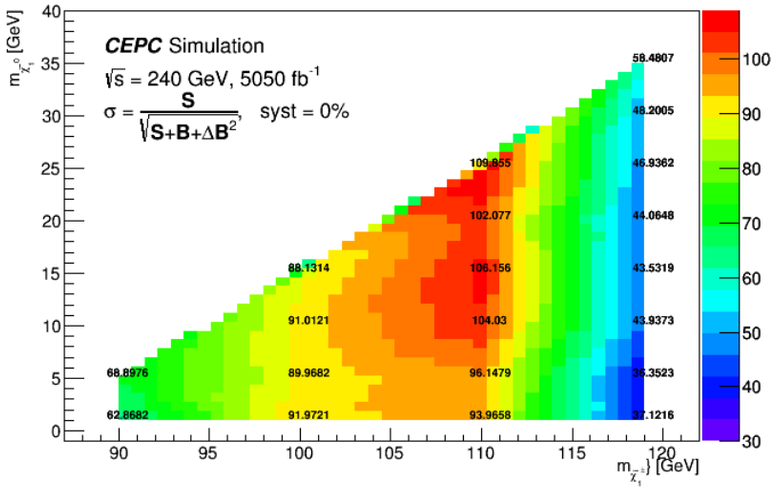

CEPC Simulation
√s = 240 GeV, 5050 fb-1
e2e2
e3e3
nnh_e3e3
zzorww_l0tautau
zz_l0tautau
sznu_l0tautau
zzorww_l0mumu
zz_l0mumu
ww_l0ll
sznu_l0mumu
(m_χ̃1, m_χ̃1) = (110, 1) GeV
(mχ̃1, mχ̃1) = (110, 10) GeV
(mχ̃1, mχ̃1) = (110, 25) GeV
Events/8GeV
S/√(S+B+ΔB²)
rec_mass_recoil

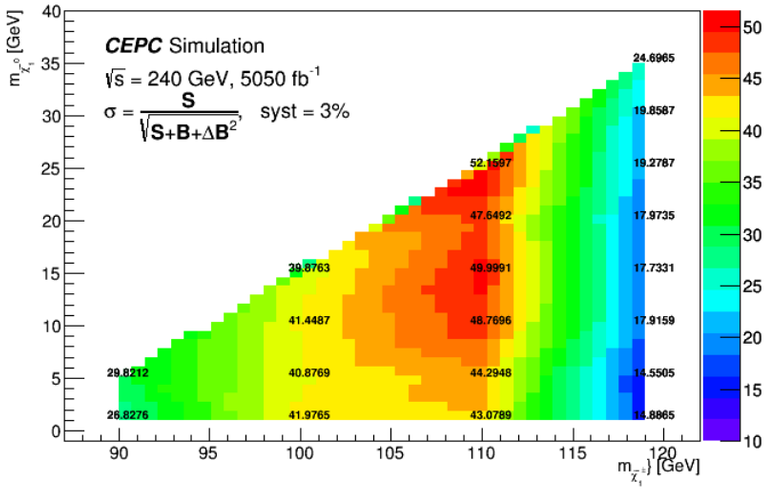

CEPC Simulation
√s = 240 GeV, 5050 fb-1
e2e2
e3e3
nnh_e3e3
zzorww_l0tautau
zz_l0tautau
sznu_l0tautau
zzorww_l0mumu
zz_l0mumu
ww_l0ll
sznu_l0mumu
(m_χ̃1, m_χ̃1) = (110, 1) GeV
(mχ̃1, mχ̃1) = (110, 10) GeV
(mχ̃1, mχ̃1) = (110, 25) GeV
Events/2GeV
S/√(S+B+ΔB²)
rec_m_pT

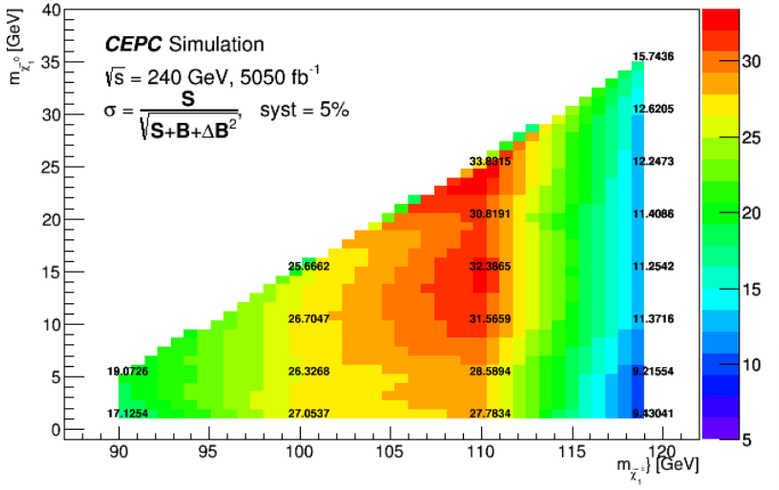

CEPC Simulation
√s = 240 GeV, 5050 fb-1
e2e2
e3e3
nnh_e3e3
zzorww_l0tautau
zz_l0tautau
sznu_l0tautau
zzorww_l0mumu
zz_l0mumu
ww_l0ll
sznu_l0mumu
(m_χ̃1, m_χ̃1) = (110, 1) GeV
(mχ̃1, mχ̃1) = (110, 10) GeV
(mχ̃1, mχ̃1) = (110, 25) GeV
Events/2GeV
S/√(S+B+ΔB²)
rec_p_pT

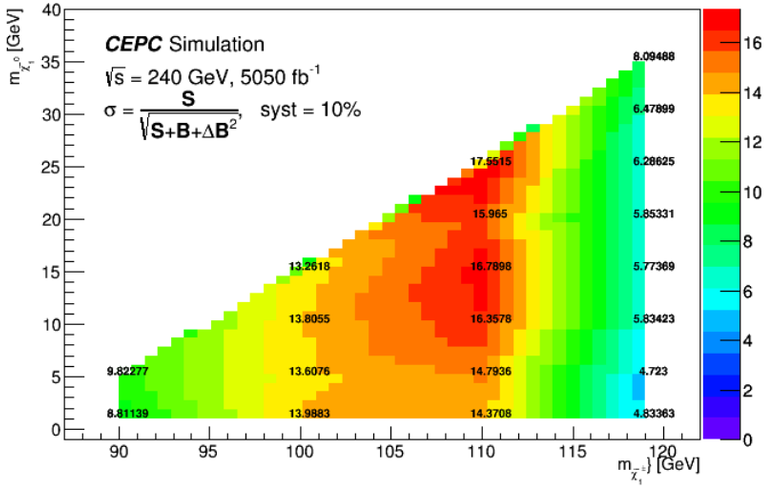
Nm1

C1C1









Sensitivity map

Smummary

A sensitivity study is done for direct smuon and C1C1 decay via WW in CEPC.

Dominant backgrounds are considered.

Signal Region is from cut scan, evaluated by sensitivity.

The result sensitivity is promising.

Although the sensitivity of some signal processes at the edge is not good enough with large systematic uncertainty, the sensitivity can be improved in the future.

Thank you.

Back up

C1C1

Process	xSec [fb]	FiltEff	N Raw	effective Lumi [fb^{-1}]	N selected	Acceptance
(90, 1)	4049	0.1024	500 k	1205.9	76462	15.3%
(90, 5)					79426	15.9%
(100, 1)	3551	0.1024	500 k	1375.1	79487	15.9%
(100, 5)					78571	15.7%
(100, 10)					81067	16.2%
(100, 15)					78526	15.7%
(110, 1)	2789	0.1024	500 k	1750.7	72055	14.4%
(110, 5)					72166	14.4%
(110, 10)					75783	15.2%
(110, 15)					77332	15.5%
(110, 20)					79865	16.0%
(110, 25)					79455	15.9%
(119, 1)	927.7	0.1024	500 k	5263.4	72730	14.5%
(119, 5)					72666	14.5%
(119, 10)					75399	15.1%
(119, 15)					74328	14.9%
(119, 20)					79075	15.8%
(119, 25)					71898	14.4%
(119, 30)					71601	14.3%
(119, 35)					78271	15.7%

From Huajie Cheng

Signal Sample