SM BKG Truth High Filter of smu Pair Seach at CEPC@240GeV Under 25.3.6

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WHY we need SM BKG truth Filter ?

Current SM BKG sample statistics is very poor for smu pair search BSM physics.

Truth filter can greatly improve SM BKG sample statistics in very short time and no hurt signals at all

Smu analysis syst. error is 5%, then statistical error should below 5%, current samples are far from this requirement and make the physical results to be **NO SENSE**!

Process	X-section (fb)	Sample Tag	20ab^{-1}预期数量 (k events)	MC已产生数量（ k events ）	Weight
ττ	4374.94	E3e3	87498.8	100	875
ννH,H → anything	3.07	nnh_X	61.4	10	6.14
ZZorWW → ττνν	205.84	**zzorww_l0tautau**	4116.8	10	412
ZZ → ττνν	9.2	**zz_l_zz_l0tautau**	184	10	18.4
ννZ, Z → ττ	14.57	**sznu_l_sznu_l0tautau**	291.4	10	29.1
ZZorWW → μμνν	214.81	**zzorww_l0mumu**	4296.2	10	430
ZZ→ μμνν	18.17	**zz_l_zz_l0mumu**	363.4	10	36.3
WW → ℓℓνν	392.96	**ww_l0ll**	7859.2	10	785
ννZ,Z → μμ	43.33	**sznu_l_sznu_l0mumu**	866.6	10	86.7
μμ	4967.58	e2e2	99351.6	100	994

/cefs/higgs/liugeliang/CEPC/202501/Production/4fermions/

sw_l0mu sw_sl0qq sze_l0mu sze_l0tau sze_sl0dd **sznu_l0mumu** sznu_sl0nu_down ww_h0ccbs ww_h0cuxx ww_h0uu ww_sl0muq zz_h0cc_nots zz_h0utut zz_l04mu **zz_l0mumu** **zz_l0tautau** zzorww_h0udud **zzorww_l0tautau** zz_sl0mu_ zz_sl0nu_up zz_sl0tau_up sw_l0tau sze_l0e sze_l0nunu szeorsw_l0l sze_sl0uu **sznu_l0tautau** sznu_sl0nu_up ww_h0cc ww_h0uubd **ww_l0ll** ww_sl0tauq zz_h0dtdt zz_h0uu_notd zz_l04tau zz_l0taumu zzorww_h0cscs **zzorww_l0mumu** zz_sl0mu_down zz_sl0nu_down zz_sl0tau_down

/cefs/higgs/zhangkl/Production/25036/E240_e2e2, E240_e3e3 : μμ , ττ

HOW MANY events at least in SM BKG samples we need ?

To reach 5% BKG statistical error to MAKE **SENSE**!

Process	X-section (fb)	Sample Tag	20ab^{-1}预期数量 (k events)	MC 过滤器需要输入的事例数（ k events ）	过滤后 event Weight
ττ	4374.94	E3e3	87498.8	4910k	17.82
ννH,H → anything	3.07	nnh_X	61.4	61.4	1.0
ZZorWW → ττνν	205.84	**zzorww_l0tauatu**	4116.8	4116.8	1.0
ZZ → ττνν	9.2	**zz_l_zz_l0tautau**	184	184	1.0
ννZ, Z → ττ	14.57	**sznu_l_sznu_l0tautau**	291.4	291.4k	1.0
ZZorWW → μμνν	214.81	**zzorww_l0mumu**	4296.2	1500k	2.864
ZZ→ μμνν	18.17	**zz_l_zz_l0mumu**	363.4	363.4k	1.0
WW → ℓℓνν	392.96	**ww_l0ll**	7859.2	**2800k**	2.807
ννZ,Z → μμ	43.33	**sznu_l_sznu_l0mumu**	866.6	866.6k	1.0
μμ	4967.58	e2e2	99351.6	**17190k**	5.78

/cefs/higgs/liugeliang/CEPC/202501/Production/4fermions/

sw_l0mu sw_sl0qq sze_l0mu sze_l0tau sze_sl0dd **sznu_l0mumu** sznu_sl0nu_down ww_h0ccbs ww_h0cuxx ww_h0uu ww_sl0muq zz_h0cc_nots zz_h0utut zz_l04mu **zz_l0mumu** **zz_l0tautau** zzorww_h0udud z**zorww_l0tautau** zz_sl0mu_ zz_sl0nu_up zz_sl0tau_up sw_l0tau sze_l0e sze_l0nunu szeorsw_l0l sze_sl0uu **sznu_l0tautau** sznu_sl0nu_up ww_h0cc ww_h0uubd **ww_l0ll** ww_sl0tauq zz_h0dtdt zz_h0uu_notd zz_l04tau zz_l0taumu zzorww_h0cscs **zzorww_l0mumu** zz_sl0mu_down zz_sl0nu_down zz_sl0tau_down

/cefs/higgs/zhangkl/Production/25036/E240_e2e2, E240_e3e3 : μμ, ττ

HOW to do smu analysis truth filter ?

CEPC truth/Rec are very well consistent ! See my last talk

CEPC@240 physics analysis was well finished by YUAN Jiarong four years ago: 5.05ab^{-1} smu upper limit is 117GeV, we can directly take it as a good reference (baseline) !

Smu pair Truth Filter

SR-highDeltaM	SR-midDeltaM	SR-lowDeltaM
	== 2 muons(OS, both energy > 0.5 GeV)	
Eμ > 32 GeV	3GeV< Eμ < 56 GeV	-------
ΔR(μ, recoil) < 3.25	1.2 < ΔR(μ, recoil) < 3.15	1.2 < ΔR(μ, recoil) < 3.15
Mμμ < 74 GeV	Mμμ < 88 GeV	--------
Mrecoil > 32 GeV	--------	Mrecoil > 210 GeV

能量/质量分辨< 2GeV，条件放松6-14 GeV； dR角度分辨<0.08，条件放松0.3-0.35

预留了今后信号事例终选进一步优化的空间

Smu pair Rec. 终选

SR-highDeltaM	SR-midDeltaM	SR-lowDeltaM
	== 2 muons(OS, both energy > 0.5 GeV)	
Eμ > 40 GeV	9GeV< Eμ < 48 GeV	-------
ΔR(μ, recoil) < 2.9	1.5 < ΔR(μ, recoil) < 2.8	1.5 < ΔR(μ, recoil) < 2.8
Mμμ < 60 GeV	Mμμ < 80 GeV	--------
Mrecoil > 60 GeV	--------	Mrecoil > 220 GeV

Smu Truth Filter **VALIDATION**

Smu pair Truth Filter SM bkg Validation

SM Process	20ab^{-1}预期事例数	20ab^{-1} yield H ,M, L	Tag	Truth Filter Rate	拟产生事例数，预期重建数，统计误差5%
μμ	99351.6k	2312, 32000, 8760	e2e2	11/10500= （10.71+-3.23）E-4	17190k, 18.4k
ττ	87498.8k	118, 14992, 7128	e3e3	53/10489= (5.053+-0.694) E-3	4910k, 25k
WW or ZZ→μμνν	4296.2k	2388, 72080, 672	zorww_l0mumu	515/8307= 0.062+-0.00273	1500k, 93k
WW→llνν	7859.2k	152, 30684, 1128	ww_l0ll	487/8400= 0.057+-0.0026	2800k, 160k

Truth Filter Rate= Truth Filter输出事例数 / 输入事例数， 5.7% to 0.11% from MCParticle tree

其他本底就产生20ab^{-1}的预期数量过Filter

Smu pair Signal Filter Validation

Mass point	Rec. 终选效率	Truth Filter 效率
115_20	6.78%	100%
115_70	38.80%	99.95%
115_100	52.18%	100%

效率定义：

Rec. 终选效率 = Rec. 终选事例数/preselection事例数

Truth Filter 效率 = （Rec. 终选 && Truth Filter）事例数/ Rec. 终选事例数

LIANG Shiyi BKG sample truth filter & MC samples production

Process	X-section (fb)	Sample Tag	20ab^{-1}预期数量 (k events)	Filter input，output 数量，Filter rate （ events ）	Event Weight
ττ	4374.94	e3e3	87498.8	4910000， 6211， 0.13%	875
vvH,H → anything	3.07	nnh_X	61.4	61400， 87.3， 1.42%	1.0
ZZorWW → ττvv	205.84	zzorww_l0tautau	4116.8	963917， 7468， 0.77%	412
ZZ → ττvv	9.2	zz_l_zz_l0tautau	184	184000， 1313 ， 0.71%	18.4
vvZ, Z → ττ	14.57	sznu_l_sznu_l0tautau	291.4	291400， 2096， 0.72%	29.1
ZZorWW → μμvv	214.81	zzorww_l0mumu	4296.2	756970， 33423， 4 .42%	430
ZZ→ μμvv	18.17	zz_l_zz_l0mumu	363.4	363400， 11241， 3.09%	36.3
WW → ℓℓvv	392.96	ww_l0ll	7859.2	919898， 16709， 1.82%	785
vvZ,Z → μμ	43.33	sznu_l_sznu_l0mumu	866.6	758891， 50000， 6.59%	86.7
μμ	4967.58	e2e2	99351.6	11817197， 39062， 0.33%	994

Smu pair signal generation info.

Msmu (GeV)	X-section (fb)	20ab^{-1}预期事例数
80	316.2 +- 0.5064	6324k
90	286.1 +- 0.6814	5722k
100	253.6 +- 0.7284	5072k
110	219.0 +- 0.8025	4380k
115	23.61 +- 1.741e-02	472.2k
118	6.088 +- 4.489e-03	121.76k
119	2.166 +- 1.597e-03	43.32k
119.2	1.552 +- 1.144e-03	31.04k
119.4	1.009 +- 7.441e-04	20.18k
119.5	0.7682 +- 5.664e-04	15.364k
119.7	0.3575 +- 2.636e-04	7.15k

新增了5个新的质量

/publicfs/atlas/atlasnew/SUSY/users/luf/DirectSmuon/hepmc_240GeV_MG5_aMC_v2_9_21/smusmu_nodecay_119*

信号事例**Weight = 20 ab^{-1} 预期事例数 / MC sample events Number**

每个点全模拟事例数从**5k** 增加到 **20k events**

Conclusion:

Truth filter works well

All smu Ana. necessary signal and BKG samples are reconstructed

First physics analysis result will be got within one day