Sbottom Search At p-p Collider

Wu Yongcheng, Su Shufang, Han Tao, Zhang Bin

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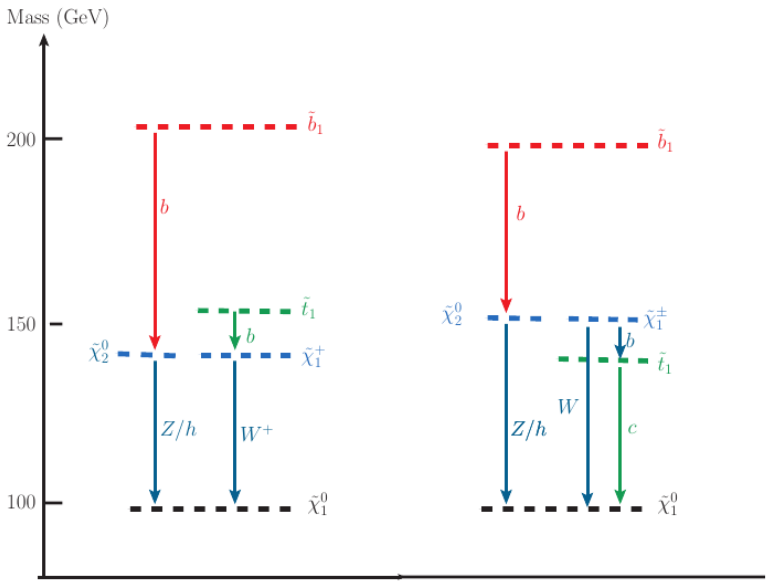
Previous Works

arXiv:1203.3207(Neil Christensen, Tao Han, Shufang Su);
arXiv:1306.3229(Tao Han, Tong Li, Shufang Su, Lian-Tao Wang);
From the new discovered SM-like Higgs, checking the related parameter region of MSSM under some experimental restrictions.
Light sbottom with different channel:



Parameters

Model: non-universal MSSM:(Softsusy-3.4.0)
Input:

$$\tan\beta = 13 \quad \mu = +1 \text{ TeV} \quad m_A = 1.1 \text{ TeV}$$
$$A_b = 900 \text{ GeV} \quad m_{Q_3} = 770 \text{ GeV} \quad m_{b_R} = 2.9 \text{ TeV}$$
$$M_1 = 0 \text{ GeV} \quad M_2 : \ 100 \text{ GeV} - -350 \text{ GeV}$$

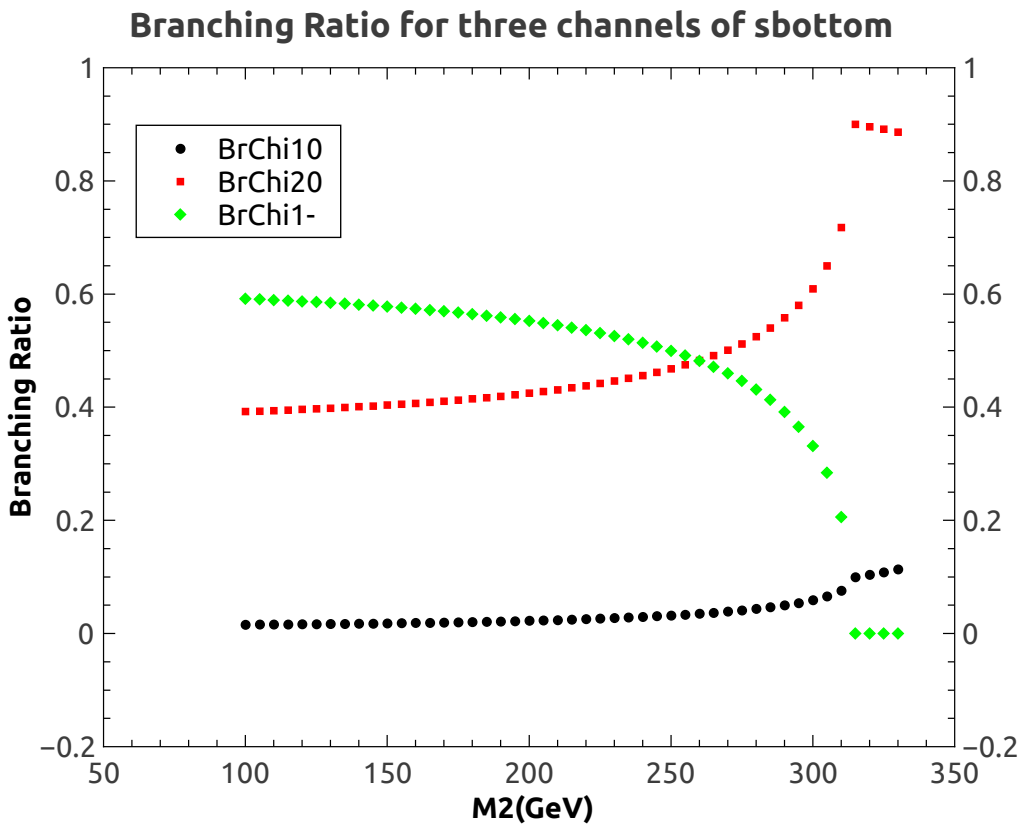
Output:

$$m_{\tilde{b}_1} \approx 500 \text{ GeV} \quad m_h \approx 124.6 \text{ GeV}$$
$$m_{\chi_1^0} \approx 0 \text{ GeV} \quad m_{\chi_2^0} \sim m_{\chi_1^\pm} \sim M_2$$

Decay Channel for sbottom

Three main channels:

$$\tilde{b}_1 \to b\ \chi_2^0$$
$$\tilde{b}_1 \to t\ \chi_1^-$$
$$\tilde{b}_1 \to b\ \chi_1^0$$



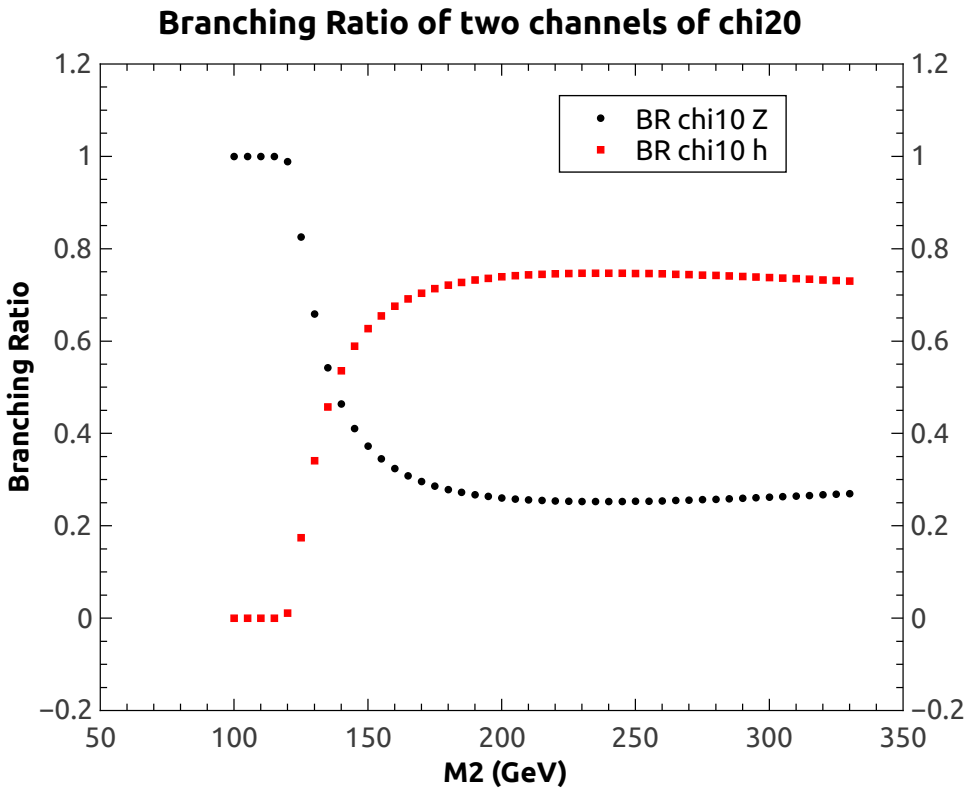
Decay Channel for χ_2^0 and $\chi_1^\pm$

Two main channels of χ_2^0:

$$\chi_2^0 \to \chi_1^0\ h$$
$$\chi_2^0 \to \chi_1^0\ Z$$

For $\chi_1^\pm$:

$$\chi_1^\pm \to \chi_1^0\ W^\pm \quad 100\%$$



Possible Signal Processes

Cross Section for $p\ p \to \tilde{b}_1\ \bar{\tilde{b}}_1$ is about 370fb (CS_{tot})

#	Process $M_2 = 200$GeV	BR	CS_{tot}*BR
I	$p\ p \to \tilde{b}_1\ \tilde{b}_1 \to b\ h\ t\ W\ \not{E}_T$	34.67%	–
I-1	$\to 4b + 2jets + 1lep + \not{E}_T$	6.716%	24.85fb
II	$p\ p \to \tilde{b}_1\ \tilde{b}_1 \to t\ t\ W\ W\ \not{E}_T$	29.897%	–
II-1	$\to 2b + 6jets + 1lep + \not{E}_T$	7.89%	29.19fb
II-2	$\to 2b + 4jets + 2lep + \not{E}_T$	3.74%	13.84fb
II-3	$\to 2b + 2jets + 3lep + \not{E}_T$	0.788%	2.92fb
II-4	$\to 2b + 4lep + \not{E}_T$	0.062%	0.23fb

#	Process $M_2 = 350$GeV	BR	CS_{tot}*BR
III	$p\ p \to \tilde{b}_1\ \tilde{b}_1 \to b\ h\ b\ h\ \not{E}_T$	38.832%	–
III-1	$\to 4b + 2jets + 1lep + \not{E}_T$	2.73%	10.10fb
IV	$p\ p \to \tilde{b}_1\ \tilde{b}_1 \to b\ b\ h\ Z\ \not{E}_T$	30.244%	–
IV-1	$\to 4b + 2lep + \not{E}_T$	1.37%	5.069fb
IV-2	$\to 2b + 4jets + 1lep + \not{E}_T$	1.1%	4.07fb

Signal and Backgrounds For I-1 at 14TeV

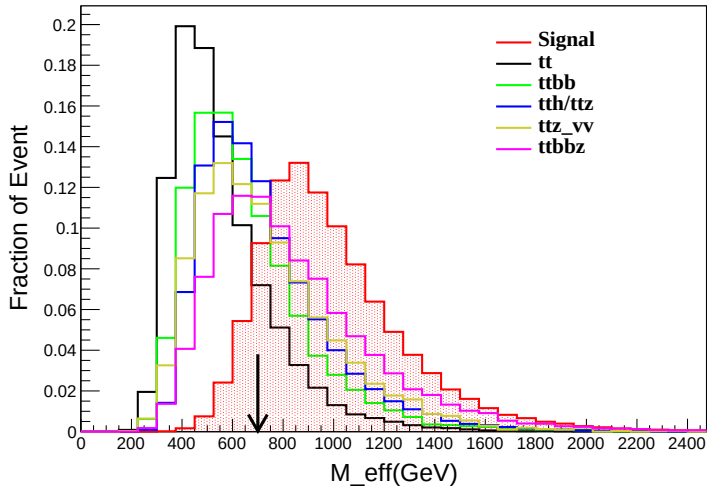
MadGraph5-2.1.0→ Pythia (in MG5-package)
→ Delphes-3.0.12 with Snowmass Card No Pileup

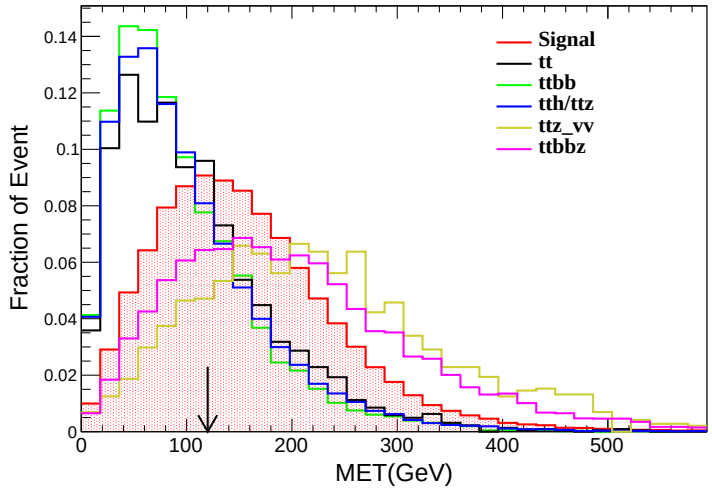
Signal	$p\ p \to \tilde{b}_1\ \bar{\tilde{b}}_1 \to b\ h\ t\ W\ \not{E}_T \to 4b + 2jets + 1lep + \not{E}_T$	21.42fb
Background	$p\ p \to t\ \bar{t} \to 2b + 2jet + 1lep + \not{E}_T$	149.7pb
	$p\ p \to t\ \bar{t}\ b\ \bar{b} \to 4b + 2jet + 1lep + \not{E}_T$	3.86pb
	$p\ p \to t\ \bar{t}\ Z/h \to 4b + 2jet + 1lep + \not{E}_T$	121.7fb
	$p\ p \to t\ \bar{t}\ Z(\to \nu\bar{\nu}) \to 2b + 2jet + 1lep + \not{E}_T$	33.96fb
	$p\ p \to t\ \bar{t}\ b\ \bar{b}\ Z(\to \nu\bar{\nu}) \to 4b + 2jet + 1lep + \not{E}_T$	0.981fb

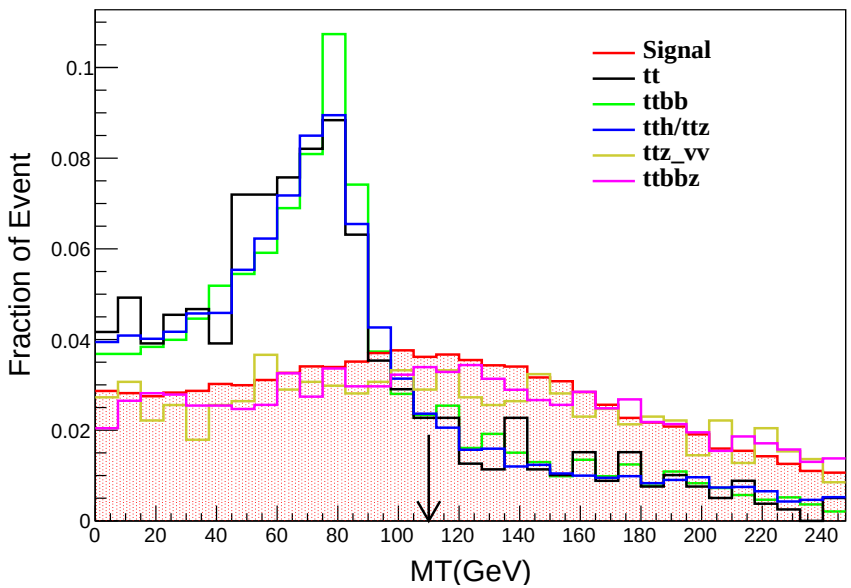
Cuts

1. Tag at least 3 B-jets
2. $M_{eff} \geq 700$ GeV[1]
3. $\not{E}_T \geq 120$ GeV
4. $M_T \geq 110$ GeV[2]

[1] $M_{eff} = \sum |P_T|$
[2] $M_T = \sqrt{2P_T^l \not{E}_T (1 - \cos \Delta\phi)}$


Fraction of Event
M_eff(GeV)
Signal
tt
ttbb
tth/ttz
ttz_vv
ttbbz


Fraction of Event
MET(GeV)
Signal
tt
ttbb
tth/ttz
ttz_vv
ttbbz


Fraction of Event
MT(GeV)
Signal
tt
ttbb
tth/ttz
ttz_vv
ttbbz

Results at 14TeV

Process	No-Cuts	Cut1	Cut2	Cut3	Cut4
Signal	400000	106193	94054	58378	19583
fb	21.42	5.69	5.04	3.13	1.05
ttbar	2000000	11673	2231	792	13
fb	149700	873.724	166.99	59.28	0.973
ttbb	400000	19519	6657	1928	84
fb	3860	188.36	64.24	18.61	0.811
tth/ttz	400000	60461	27119	8415	306
fb	121.7	18.40	8.25	2.56	0.093
ttbbz	240000	14698	8906	6605	2580
fb	0.981	0.060	0.036	0.027	0.0105
ttz_vv	400000	3100	1443	1174	429
fb	33.96	0.263	0.123	0.0997	0.0364
$S/\sqrt{B}$	$L = 100 fb^{-1}$	1.73	3.25	3.48	7.56

Further Works

Further Works:

- 95% C.L. reach and/or 5-sigma reach contour on (M_{sb}, M_1) plane.
- Do the similar analysis on other possible channel such as II-1 and III-1

Simply Extension to 100TeV

MadGraph5-2.1.0→ Pythia (in MG5-package)
→ Delphes-3.0.12 with Snowmass Card No Pileup

Cuts:

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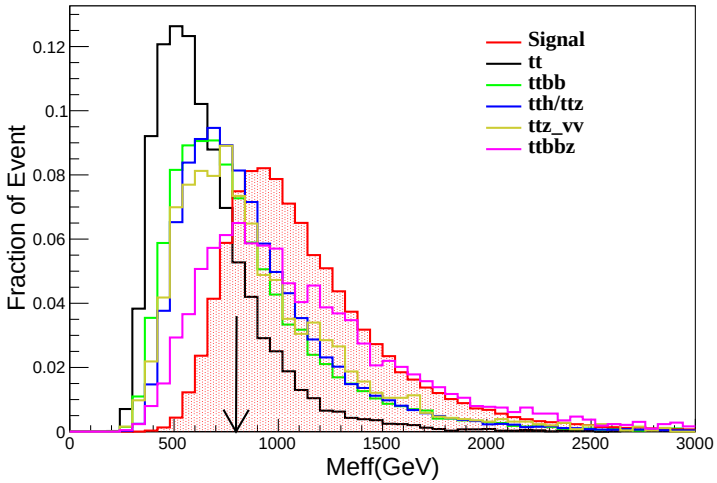
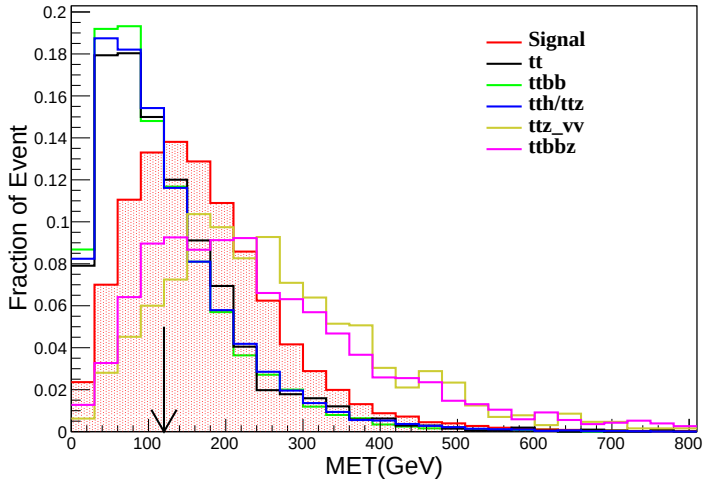
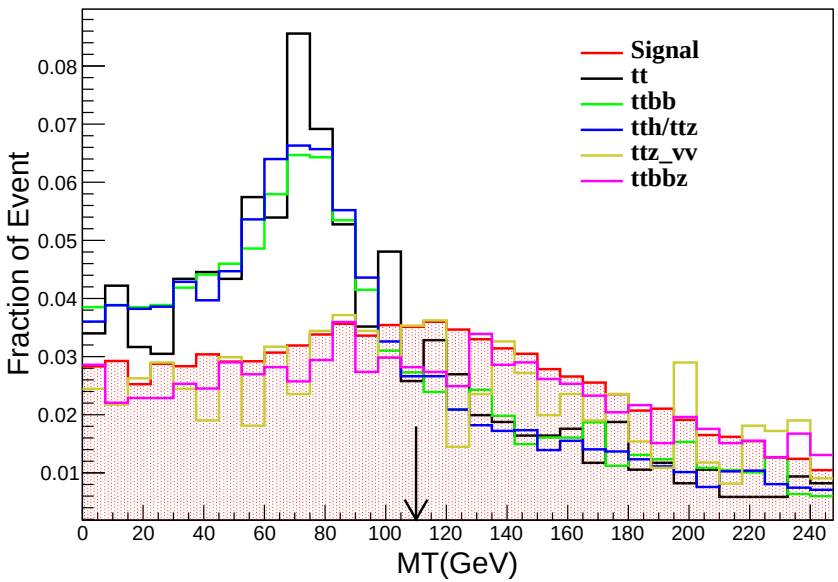
2. $M_{eff} \geq 800$ GeV
3. $\not{E}_T \geq 120$ GeV
4. $M_T \geq 110$ GeV


Signal
tt
ttbb
tth/ttz
ttz_vv
ttbbz
Fraction of Event
Meff(GeV)


Signal
tt
ttbb
tth/ttz
ttz_vv
ttbbz
Fraction of Event
MET(GeV)


Signal
tt
ttbb
tth/ttz
ttz_vv
ttbbz
Fraction of Event
MT(GeV)

Results at 100TeV

Process	No-Cuts	Cut1	Cut2	Cut3	Cut4
Signal	400000	72562	60516	40111	11938
fb	3293(153.7)	597.37	498.20	330.21	98.28(93.6)
ttbar	2000000	9784	2074	853	39
fb	7181000(47.9)	35129.5	7446.7	3062.7	140.03(143.9)
ttbb	400000	16245	7039	2675	173
fb	341200(88.4)	13856.9	6004.3	2281.8	147.6(182.1)
tth/ttz	400000	42190	20790	8189	382
fb	8387(68.9)	884.62	435.9	171.7	8.01(86.0)
ttbbz	80000	4261	3057	2448	734
fb	155.8(158.8)	8.30	5.95	4.77	1.43(136.2)
ttz_vv	400000	2560	1283	1104	352
fb	2524(74.3)	16.15	8.10	6.97	2.22(61.0)
$S/\sqrt{B}$	$L = 100 fb^{-1}$	26.74	42.26	44.41	56.81(7.5)