SUSY Benchmarks

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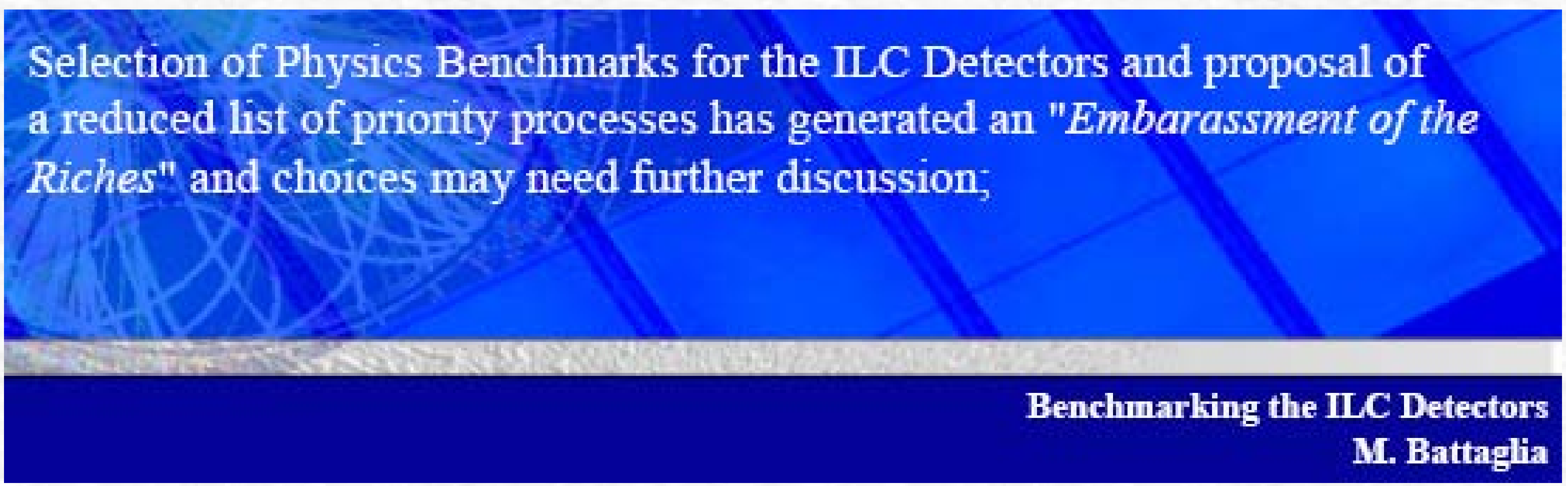
Why benchmarks

- Impossible to scan parameter space even in mSUGRA
- Resort to discrete points (or model lines) sampling the parameter space
- The choice depends on
  - exhibit characteristic features of the model(s)
  - setting exclusion/reach limits
  - study ‘typical’ experimental signatures
  - investigate experimental sensitivities/requiremets
  - incorporate existing data/limits (e.g. m_{top}, DM, ...)
  - develop strategies for combining info from different experiments -> synergy
  - ....

Basic requirements

Physics bechmarks ..., Battaglia et al..

- Central physics scenarios should be covered
- Be robust -- should not address a singular issue
- Have well defined goals for measurement accuracies



be pragmatic

Many sets of benchmarks

- Snowmass Points and Slopes (from Snowmass 2001)

B. Allanach et al., Eur.Phys.J. C 25 (2002) 113

	SPS			Point	
	mSUGRA:	m_0	$m_{1/2}$	A_0	$\tan\beta$
• bulk	1a	100	250	-100	10
• bulk	1b	200	400	0	30
• focus point	2	1450	300	0	10
• stau coann	3	90	400	0	10
• A funnel	4	400	300	0	50
• light stop	5	150	300	-1000	5

Isajet v 7.58, m_{top}=175 GeV (LE param: www.ippp.dur.ac.uk/~georg/sps)

Reference point SPS1a’

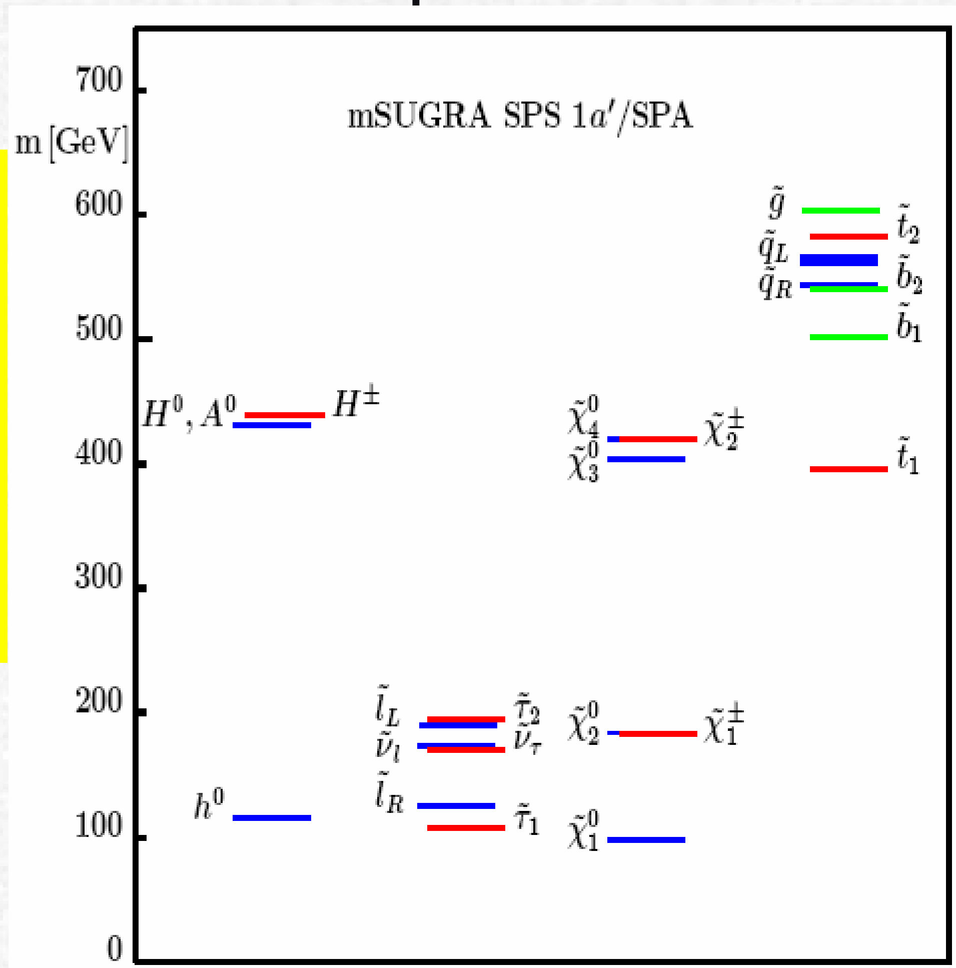
- SPS1a’- derivative of the SPS1a point

mSUGRA values:

m_0	70 GeV
$m_{1/2}$	250 GeV
A_0	-300 GeV
$\tan\beta$	10
sign μ	$+$

$$BR(b \to s\gamma) = 3.0 \times 10^{-4}$$
$$\Delta[g_\mu - 2]/2 = 33 \times 10^{-10}$$
$$\Omega_{cdm} h^2 = 0.10$$

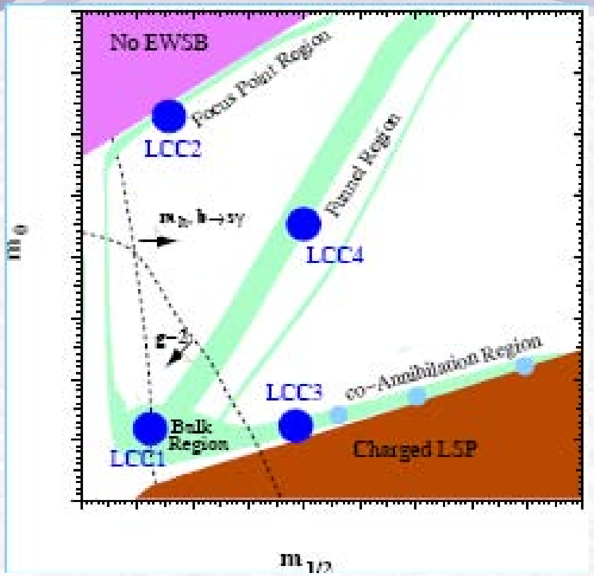
M_{top}=178 GeV



LCC benchmarks

Systematic study of ILC reach promoted by
White Paper on ILC-Cosmo Connections
(M.B., J.Feng, N.Graf, M.Peskin, M.Trodden Editors)

Point	m_0	$m_{1/2}$	$\tan\beta$	A_0	$M(t)$	$M(\chi_1^0)$
LCC 1	100	250	10	-100	178.	96.1
LCC 2	3280	300	10	0	175.	107.7
LCC 3	210	360	40	0	178.	142.5
LCC 4	380	420	53	0	178.	169



Compute RGEs with Isajet 7.69 and estimate dark matter density from Isajet spectrum and couplings with MicrOMEGAS 1.3 and DarkSUSY 4.0

Point	DarkSUSY 4.0	MicroMEGAS 1.3
LCC 1	0.193	0.193
LCC 2	0.108	0.110
LCC 3	0.059	0.057
LCC 4	0.113	0.106

With Isajet 7.71 and MicrOMEGA 1.4

0.195
1.79
0.057
0.099

Benchmarking the detector

Physics Benchmarks for the ILC Detectors

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Point	Ref.	m_0 GeV	$m_{1/2}$ GeV	$\tan\beta$	A	$m_{\chi_1^0}$ GeV	$m_{\tilde{\tau}_1}$ GeV	$m_{\chi_2^0}$ GeV
1	SPS1a/LCC1 [15, 16]	100	250	10	-100	96.1	133.2	176.4
2	LCC2 [16]	3280	300	10	0	107.7		166.3
3	D' [18]	**110**	**525**	10	0	220	225	424
4	LCC4 [16]	380	420	53	0	169.1	195	327
5	-	230	265	37	0	104	220	200
6	[20]		300	10	0		219	

$\mu<0$

Isajet 7.69, m_{top}=178 GeV, (except LCC2, where 175 GeV)

Bulk point

Isajet 7.71	(SPS1a)/LCC1	SPS1a'	SPS1a'
nt_1	95.19	95.93	95.82
nt_2	180.45	184.06	183.73
ch_1	180.37	184.18	183.84
gluino	611.41	610.87	610.79
h0	113.79	116.77	115.77
A0	394.43	424.21	421.24
sel_L	203.22	190.63	190.58
sel_R	144.04	125.35	125.34
stau_1	134.76	109.08	109.19
stau_2	206.71	194.89	194.81
su_L	559.53	554.63	554.76
su_R	544.01	538.69	538.60
stop_1	401.80	366.59	364.94
stop_2	583.38	577.28	577.94
omega	0.195	0.126	0.127
m_top	178	178	175

	(SPS1a)	SPS1a'
m0	100	70
m1/2	250	250
$\tan\beta$	10	10
A0	-100	-300
μ	>0	

Focus point

	(SPS2)	SPS2'	LCC2
nt_1	119.97	106.42	107.7
nt_2	234.29	166.46	166.3
ch_1	235.01	158.69	250.7 ?
gluino	797.00	822.70	
h0	115.66	115.89	
A0	1502.23	2132.45	3242
sel_L	1460.55	2154.19	
sel_R	1452.90	2150.44	3270
stau_1	1440.43	2133.14	
stau_2	1455.19	2145.68	
su_L	1558.52	2209.27	3300
su_R	1555.83	2212.18	
stop_1	970.75	1367.22	
stop_2	1313.55	1844.14	
omega	1.13	0.111	0.11

	Isajet		
	7.71	7.71	7.69
	(SPS2)	SPS2’	LCC2
m0	1400	2150	3280
m1/2	300	300	300
tanβ	10	10	10
A0	0	0	0
μ	>0		
m_{top}	175	172.7	175

Stau co-annihilation

	(SPS3)	SPS3'	LCC3	D'
nt_1	157.91	157.86	142	220
nt_2	303.77	303.67	222	424
ch_1	304.22	304.14	274	424
gluino	940.13	939.82		
h0	116.76	116.76		
A0	580.38	578.67		735
sel_L	290.03	285.78		
sel_R	181.00	174.10	252	232
stau_1	173.46	166.33	151	225
stau_2	291.65	287.46		
su_L	853.61	852.14		
su_R	825.38	824.35		
stop_1	654.50	653.94		
stop_2	842.33	841.62		
omega	0.210	0.110	0.057	0.184
Δm	16.6	8.5	9	5

Isajet

	(SPS3)	SPS3'	LCC3	D'
Isajet	7.71	7.71	7.69	7.69
m0	90	75	210	110
m1/2	400	400	360	525
$\tan\beta$	10	10	40	10
A0	0	0	0	0
μ	>0			
m_{top}	175	175	178	178

A funnel

	(SPS4)	LCC4
nt_1	118.26	169.05
nt_2	226.05	327.14
ch_1	226.42	327.46
gluino	737.88	993.61
h0	115.10	118.93
A0	340.72	416.50
sel_L	450.05	475.97
sel_R	417.13	413.05
stau_1	254.56	195.84
stau_2	413.11	441.33
su_L	759.00	961.74
su_R	743.09	935.34
stop_1	549.67	716.98
stop_2	696.21	876.34
omega	0.105	0.0995

	(SPS4)	LCC4
m0	400	380
m1/2	300	420
$\tan\beta$	50	53
A0	0	0
μ	>0	
m_{top}	175	178

Stop co-annihilation

nt_1	107.2
nt_2	196.1
ch_1	194.3
gluino	
h0	117
A0	800
sel_1	204.2
sel_2	2000
stau_1	204.2
stau_2	2000
su_L	4000
su_R	4000
stop_1	122.5
stop_2	4203
omega	0.112

Motivated by EW baryogenesis

Carena et al.., hep-ph/0508151

Stop --> c χ^0

small mass difference

h0 mass in 1-loop ! Has to be checked

(another possibility: point 2 from PRD71 075002)

Model with $\chi_2 \to \chi_1 Z$

	Point 5	α
nt_1	103.75	113
nt_2	198.82	215
ch_1	198.17	215
gluino	650.80	711
h0	114.66	115
A0	310.17	265
sel_L	295.52	299
sel_R	253.98	216
stau_1	197.70	213
stau_2	301.10	300
su_L	622.33	674
su_R	606.91	661
stop_1	459.60	492
stop_2	602.06	662
omega	0.105	0.12

Similar feature in SPS6

NUHM

deRoeck et al.., hep-ph/0508198

	point5	α
m0	400	293
m1/2	300	206
$\tan\beta$	50	10
A0	0	0
μ	< 0	>0
m_{top}	178	178

Gravitino DM

	point 6	ε
nt_1	115.70	175
nt_2	220.83	339
ch_1	221.02	340
gluino	721.00	1025
h0	115.81	115
A0	444.81	626
sel_L	210.11	306
sel_R	121.54	171
stau_1	112.00	153
stau_2	213.24	309
su_L	651.57	935
su_R	631.74	902
stop_1	489.41	710
stop_2	665.05	900

Stau=NLSM long-lived
Similar to SPS7

GDM
deRoeck et al.., hep-ph/0508198

	point6	ε
m0	0	20
m1/2	300	440
tanβ	10	15
A0	0	0
μ	>0	>0
m_{top}	178	178

Feng, Smith hep-ph/0409278

Proposition

- Many sets of benchmarks proposed
- Old good SPS benchmarks - many studies exist, still useful
- For new detector studies/ synergy - try to converge/unify

Our proposal:

- For SPS1a/LCC1 detailed experimental results exist, can be reinterpreted for shifted parameters, e.g. m_{top}
- for detector simulations replace

LCC2	->	SPS2'		(studied by LHC?)
LCC3/D'	->	SPS3'		
point 5	->	NUHM	α	(studied by CMS)
point 6	->	GDM	ε	(studied by CMS)

- possible additional scenario – stop co-ann (if m_h0 OK)

THE END