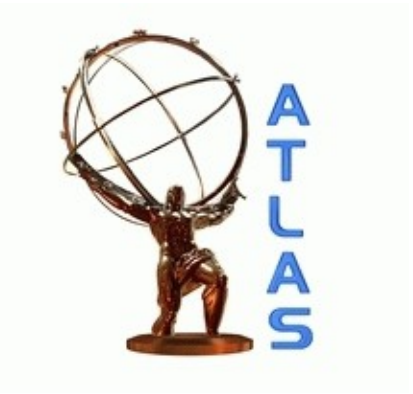


SUSY Trileptons

rel. 12.0.6

Tina Potter and Antonella De Santo
RHUL
19/10/07

In collaboration with csc 5/7

Samples and Object Definitions

Sample	Luminosity	Scale for 10 fb^{-1}
trig1_misal1_csc11.005402.SU2_jimmy_susy.recon.AOD.v12000601_tid005862	10.12 fb^{-1}	0.99
trig1_misal1_csc11.005403.SU3_jimmy_susy.recon.AOD.v12000601_tid006978	10.72 fb^{-1}	0.93
trig1_misal1_mc12.005200.T1_McAtNlo_Jimmy.recon.AOD.v12000601_tid005997	1.26 fb^{-1}	7.93
trig1_misal1_csc11.005900.PythiaZPhoton25.recon.AOD.v12000601_tid006248	3.78 fb^{-1}	2.65
trig1_misal1_csc11.005985.WW_Herwig.recon.AOD.v12000601_tid006070	1.65 fb^{-1}	6.05
trig1_misal1_csc11.005986.ZZ_Herwig.recon.AOD.v12000601_tid006068	21.1 fb^{-1}	0.47
trig1_misal1_csc11.005987.WZ_Herwig.recon.AOD.v12000601_tid006069	6.37 fb^{-1}	1.57
trig1_misal1_mc12.005178.Zb_acer_pythia.recon.AOD.v12000601_tid006708	0.18 fb^{-1}	54.69

EventView lxplus group area was used with Athena to produce ntuples from csc AODs

Insertion order : Muon, Electron, Photon,TauJet, JetTag, ParticleJet

Electron

ElectronCollection
p_T >10 GeV
Egamma author
isEM & 0x3FF == 0
Isolation Energy in ΔR(0.2) < 10 GeV
|η| < 2.5
Overlap ΔR <0.1 for other electrons and all

Muon

MuidMuonCollection
p_T > 10 GeV
Isolation Energy in ΔR(0.2) <10 GeV
|η| < 2.5
chi2Ndof cut : 5
chi2Match cut : 20
Overlap ΔR <0.4 for jets
Overlap ΔR <0.1 for other muons and all others

Photon

PhotonCollection
p_T > 10 GeV
isEM : isEM & 0x7FF == 0
Overlap ΔR <0.1 for other photons and all

Jet

Cone4TowerParticleJets
p_T >10 GeV
|η| < 2.5
Overlap ΔR <0.2 for other jets and all

Jet Tag

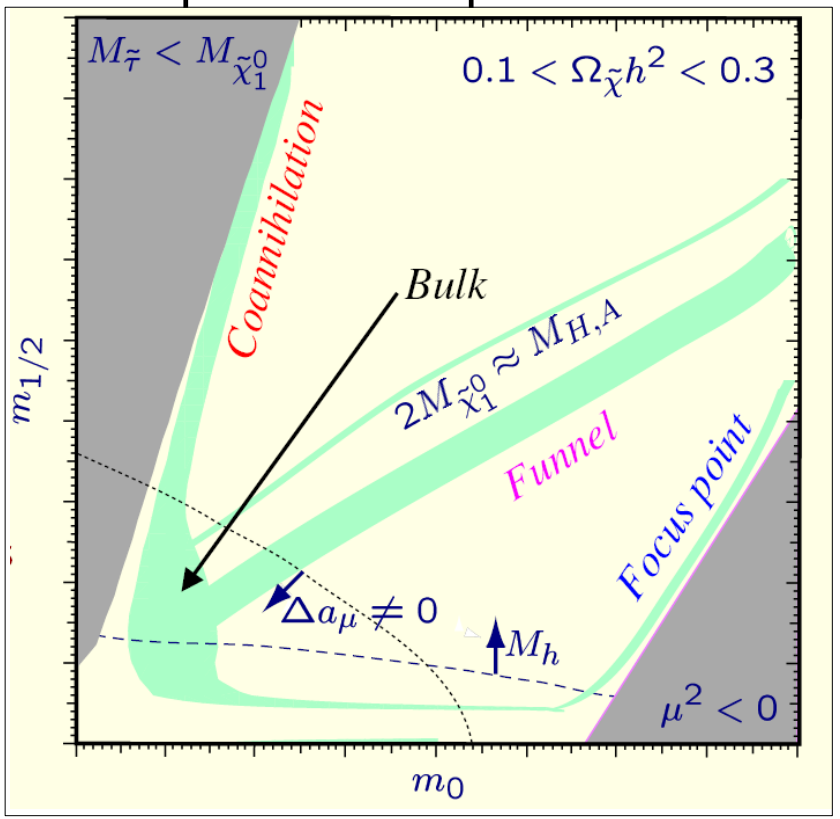
BjetCollection
p_T >10 GeV
|η| < 2.5
Overlap ΔR <0.2 for other jets and all
Weight cut 4

Tau Jet

TauJetCollection
p_T > 10 GeV
|η| < 2.5
Overlap ΔR <0.2 for other jets and all
LikelihoodCut3p : 2
LikelihoodCut1p : 2
HadronicEnergyFraction : 0.1

SU2 : The Focus Point

SUSY parameter space



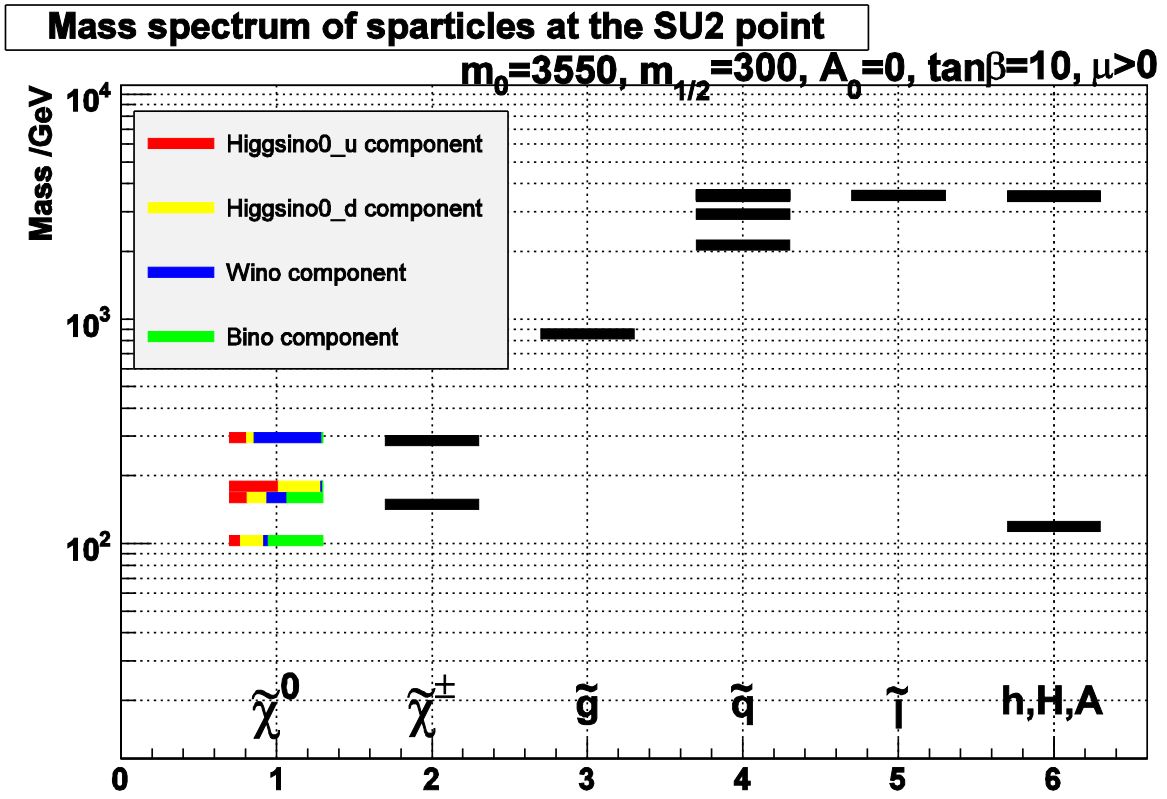
SU2 parameters

m_0 = 3550GeV
$m_{1/2}$ = 300GeV
A_0 = 0
tanβ = 10
μ > 0

Total σ = 4.86 pb

Sparticle	Mass (GeV)
$\tilde{\chi}^0$	103, 160, 180, 296
$\tilde{\chi}^\pm$	149, 288
$\tilde{g}$	857
$\tilde{q}$	3563, 3574, 3564, 3576, 2925, 3501, 2131, 2935
$\tilde{l}_{L,R}$	3548

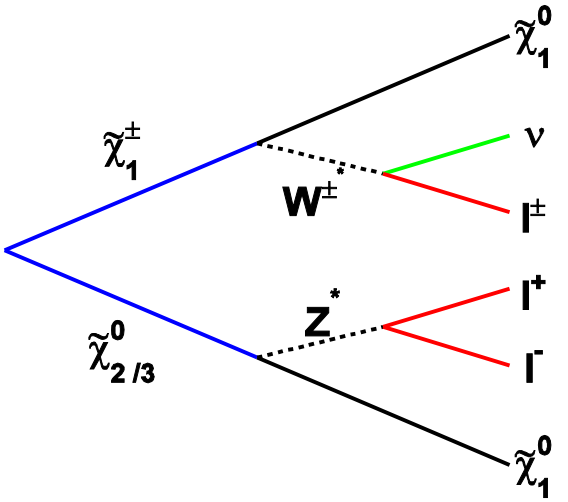
Heavy scalars are too massive so no decays through intermediate sleptons



SU2 Direct Gaugino Production : Event Selection

Event selection optimised with $S_f = S/\sqrt{S+B}$ for 10 fb^{-1}

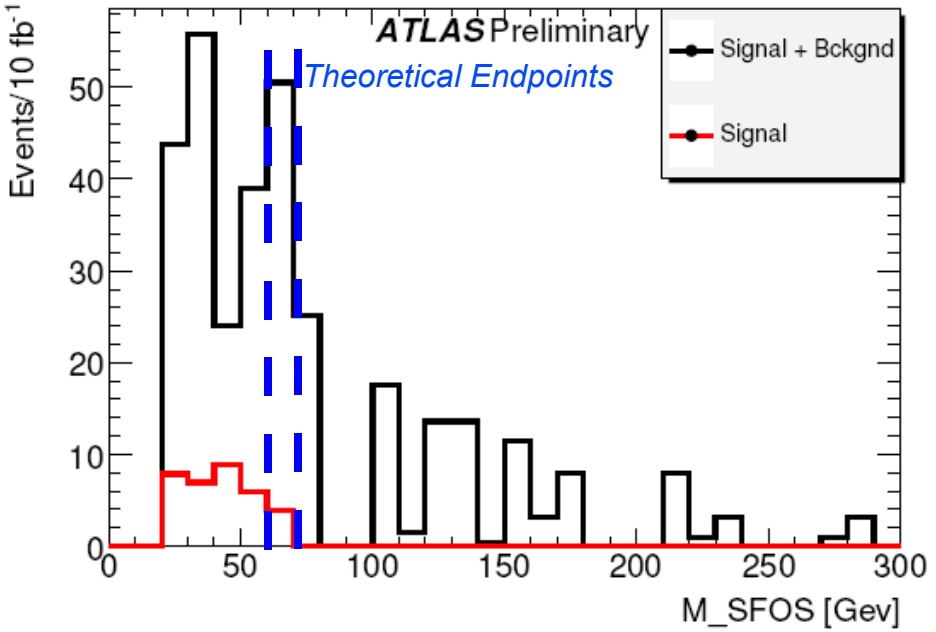
1. $N_l >= 3$: Number of leptons ($l = e, \mu, \neq \tau$)
2. 2 SFOS leptons : Same Flavour Opposite Sign leptons (e^+e^- , $\mu^+\mu^-$) with $M_{SFOS} > 20$ GeV
3. Track Isolation : in ΔR(0.2), $p_T^{max} < 1$ GeV
4. Impact Parameter : IP/$\sigma_{IP} < 6$
5. 80 GeV $< M_{SFOS} <$ 100 GeV : Invariant mass of any SFOS leptons, remove Z window
6. $\not{E}_T >$ 30 GeV : Missing transverse Energy
7. $N_{bjets} = 0$: Number of b-tagged jets



Kinematic Cut / Sample	No Cuts	N_l	SFOS	TrackIsol	ImpPara	ZWindow	$\not{E}_T$	N_{bjets}
SU2 Signal	310	79	67	55	51	45	38	34
SU2 Bckgnd	48299	307	236	131	124	93	89	41
$t\bar{t}$	4609947	19596	12953	840	491	420	380	151
ZZ	20998	429	411	276	252	32	7	6
ZW	78000	1131	1103	859	789	168	112	110
WW	244985	48	30	6	0	0	0	0
Z+Photon	25799	85	79	19	16	5	3	3
Zb	1020006	10938	10173	2297	1313	273	0	0
S	310	79	67	55	51	45	38	34
B	6048033	32535	24985	4429	2984	992	591	310
$S/sqrt(B)$	0.13	0.44	0.43	0.83	0.94	1.44	1.54	1.91
$S/sqrt(S+B)$	0.13	0.44	0.42	0.83	0.93	1.41	1.50	1.81

5σ discovery within 100 fb^{-1}

M_{SFOS}



SU2 Inclusive: Event Selection

Event selection optimised with $S_f = S/\sqrt{S+B}$ for 10 fb^{-1}

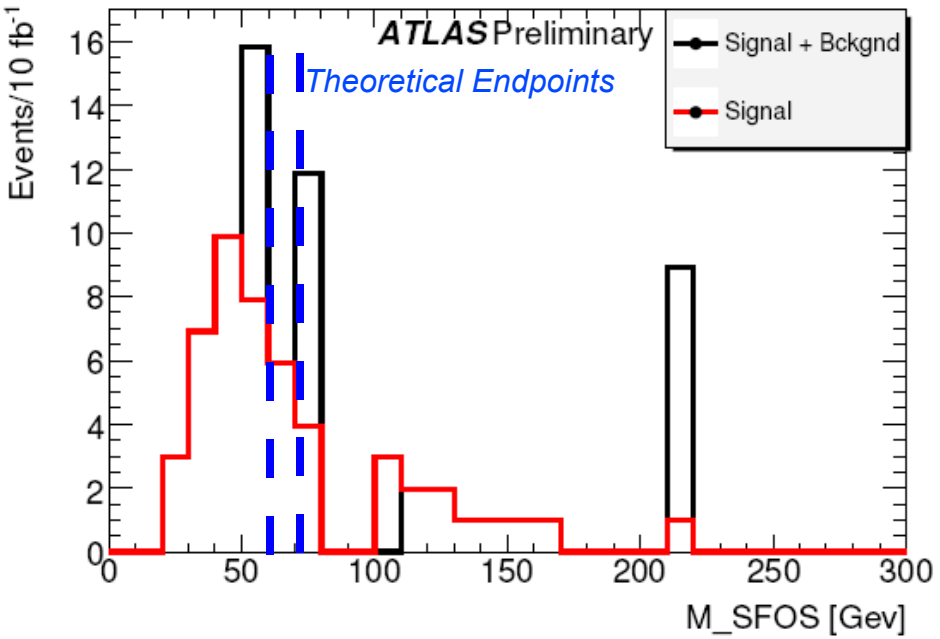
1. $N_l >= 3$: Number of leptons ($l = e, \mu, \neq \tau$)
2. 2 SFOS leptons : Same Flavour Opposite Sign leptons (e^+e^- , $\mu^+\mu^-$) with $M_{SFOS} > 20$ GeV
3. Track Isolation : in ΔR(0.2), $p_T^{max} < 1$ GeV
4. Impact Parameter : IP/$\sigma_{IP} < 6$
5. 80 GeV $< M_{SFOS}$ ¡ 100 GeV : Invariant mass of any SFOS leptons, remove Z window
6. $\not{E}_T >$ 30 GeV : Missing transverse Energy
7. At least 1 jet $p_T^{jet1} > 200$ GeV : transverse momentum of leading jet

Signal = Anything -> 3 leptons

Kinematic Cut	No Cuts	N_l	SFOS	TrackIsol	ImpPara	ZWindow	$\not{E}_T$	PtJet
Sample								
SU2	48610	386	303	187	175	138	126	49
$t\bar{t}$	4609947	19596	12953	840	491	420	380	32
ZZ	20998	429	411	276	252	32	7	0
ZW	78000	1131	1103	859	789	168	112	0
WW	244985	48	30	6	0	0	0	0
Z+Photon	25799	85	79	19	16	5	3	0
Zb	1020006	10938	10173	2297	1313	273	0	0
S	48610	386	303	187	175	138	126	49
B	5999734	32228	24749	4298	2860	899	502	32
$S/sqrt(B)$	19.85	2.15	1.93	2.85	3.27	4.61	5.65	8.77
$S/sqrt(S+B)$	19.77	2.14	1.92	2.79	3.17	4.30	5.05	5.49

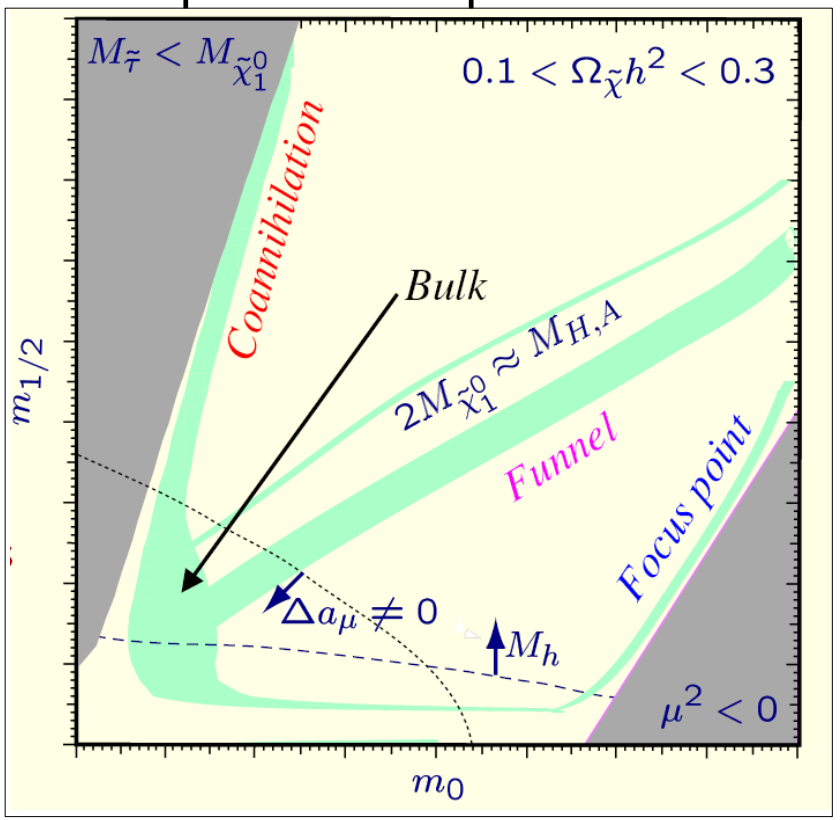
5σ discovery within 10 fb^{-1}

M_{SFOS}



SU3 : The Bulk Region

SUSY parameter space



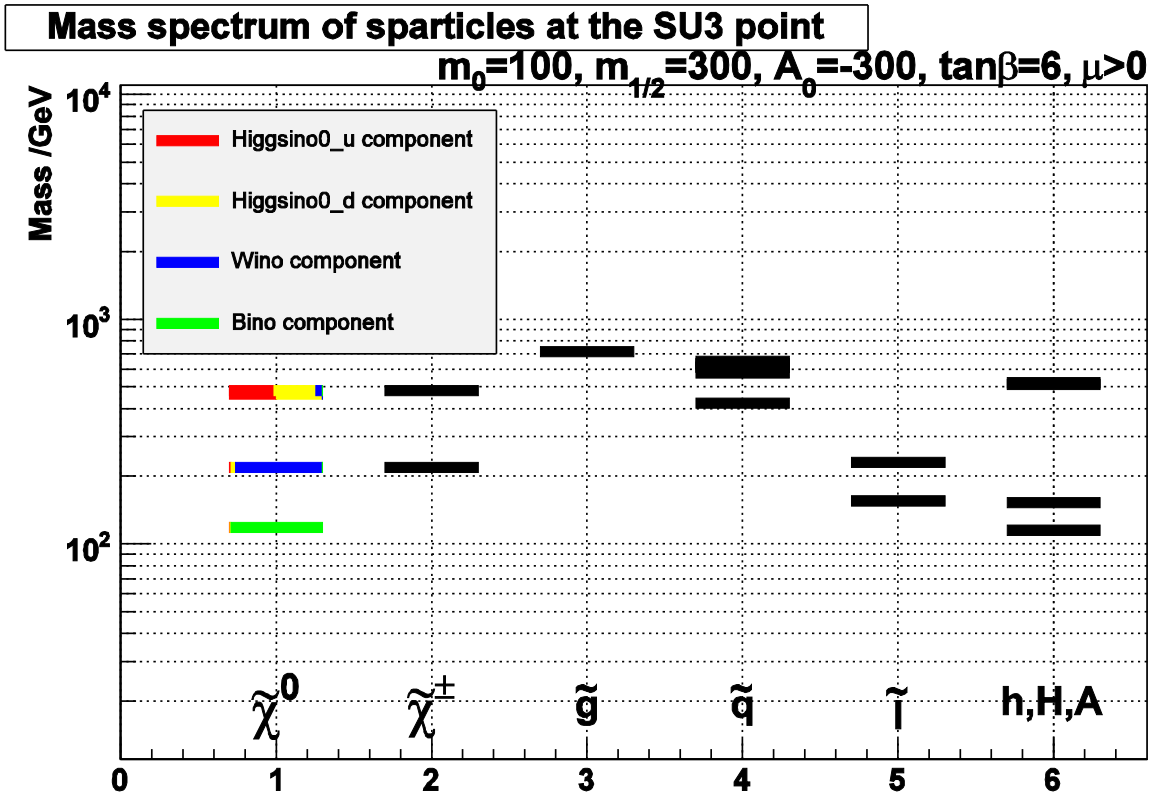
SU3 parameters

m_0 = 100 GeV
$m_{1/2}$ = 300 GeV
A_0 = -300 GeV
tanβ = 6
μ > 0

Total σ = 18.59 pb

Sparticle	Mass (GeV)
$\tilde{\chi}^0$	118, 219, 464, 481
$\tilde{\chi}^\pm$	218, 480
$\tilde{g}$	717
$\tilde{q}$	632, 612, 636, 611, 575, 611, 424, 651
$\tilde{l}_{L,R}$	230, 155

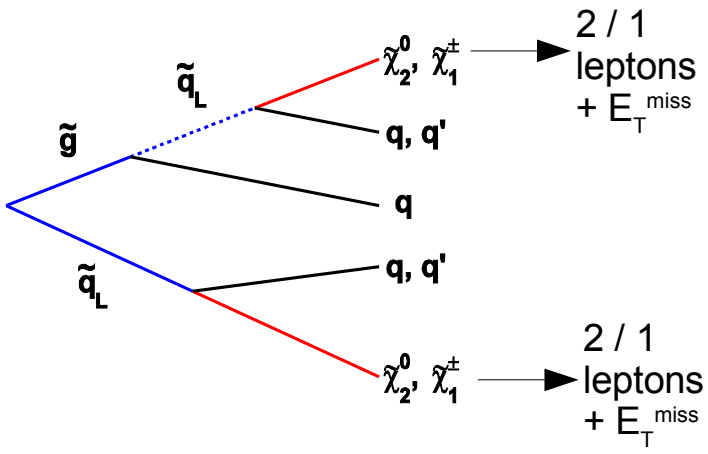
All sparticles within reach of the LHC – decays through intermediate sleptons allowed



SU3 Non Direct Gaugino Production : Event Selection

Event selection optimised with $S_f = S/\sqrt{S+B}$ for 10 fb^{-1}

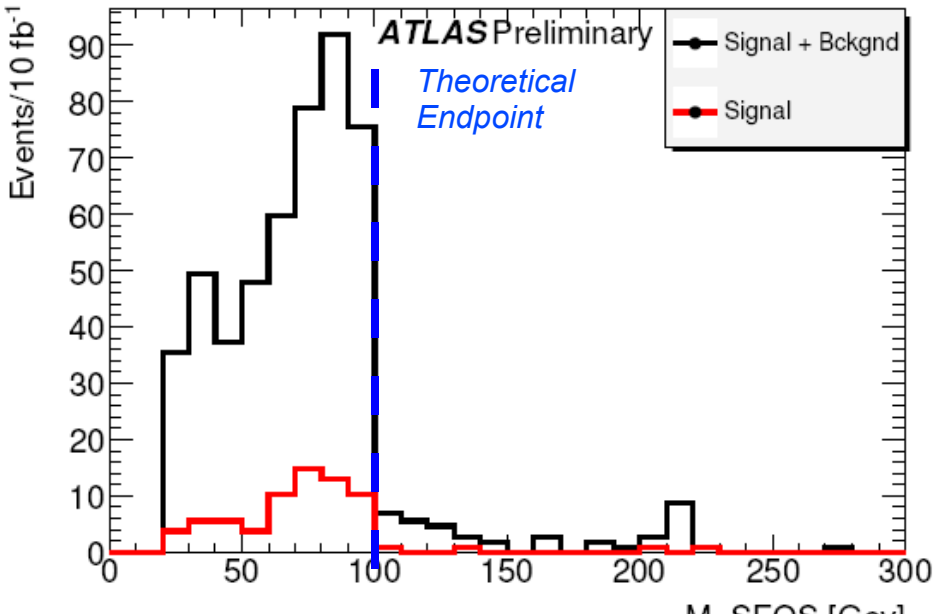
1. $N_l >= 3$: Number of leptons ($l = e, \mu, \neq \tau$)
2. 2 SFOS leptons : Same Flavour Opposite Sign leptons (e^+e^- , $\mu^+\mu^-$) with $M_{SFOS} > 20$ GeV
3. Track Isolation : in $\Delta R(0.2)$, $p_T^{max} < 1$ GeV
4. Impact Parameter : $IP/\sigma_{IP} < 6$
5. $\not{E}_T > 30$ GeV : Missing transverse Energy
6. At least 1 jet $p_T^{jet1} > 200$ GeV : transverse momentum of leading jet



Kinematic Cut	No Cuts	N_l	SFOS	TrackIsol	ImpPara	$\not{E}_T$	p_T^{jets}
Sample							
SU3 Signal	403	142	135	95	89	85	71
SU3 Bckgnd	185497	1456	1205	712	545	534	412
$t\bar{t}$	4609947	19596	12953	840	491	452	48
ZZ	20998	429	411	276	252	54	2
ZW	78000	1131	1103	859	789	567	3
WW	244985	48	30	6	0	0	0
Z+Photon	25799	85	79	19	16	3	0
Zb	1020006	10938	10173	2297	1313	55	0
S	403	142	135	95	89	85	71
B	6185231	33684	25954	5009	3405	1664	465
$S/sqrt(B)$	0.16	0.77	0.84	1.34	1.52	2.08	3.29
$S/sqrt(S+B)$	0.16	0.77	0.84	1.33	1.50	2.03	3.06

5σ discovery within 30 fb^{-1}

M_{SFOS}



SU3 Inclusive : Event Selection

Event selection optimised with $S_f = S/\sqrt{S+B}$ for 10 fb^{-1}

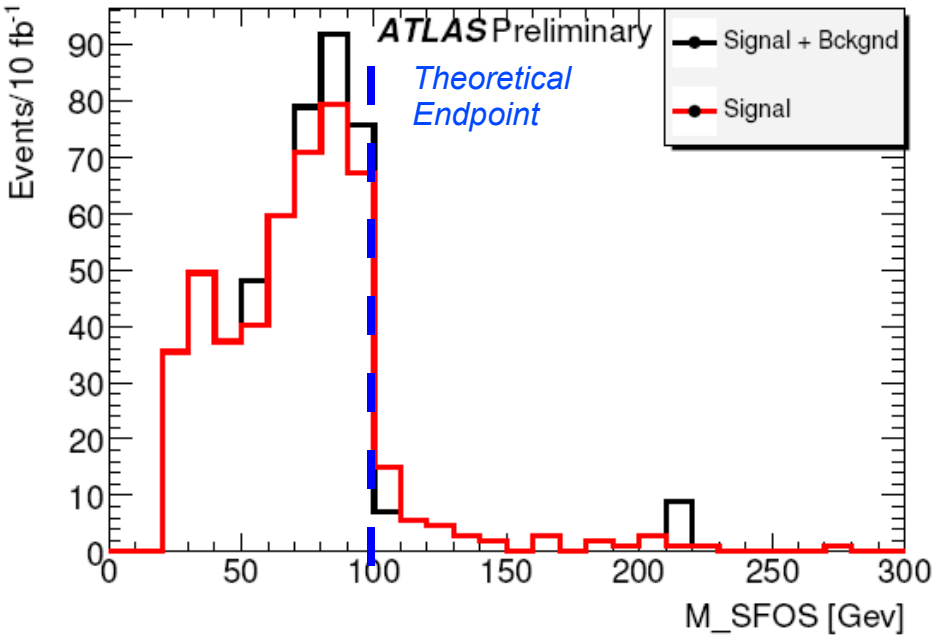
1. $N_l >= 3$: Number of leptons ($l = e, \mu, \neq \tau$)
2. 2 SFOS leptons : Same Flavour Opposite Sign leptons (e^+e^- , $\mu^+\mu^-$) with $M_{SFOS} > 20$ GeV
3. Track Isolation : in ΔR(0.2), $p_T^{max} < 1$ GeV
4. Impact Parameter : IP/$\sigma_{IP} < 6$
5. $\not{E}_T > 30$ GeV : Missing transverse Energy
6. At least 1 jet $p_T^{jet1} > 200$ GeV : transverse momentum of leading jet

Signal = Anything -> 3 leptons

Kinematic Cut / Sample	No Cuts	N_l	SFOS	TrackIsol	ImpPara	$\not{E}_T$	p_T^{jets}
SU3	185900	1598	1340	807	634	619	483
$t\bar{t}$	4609947	19596	12953	840	491	452	48
ZZ	20998	429	411	276	252	54	2
ZW	78000	1131	1103	859	789	567	3
WW	244985	48	30	6	0	0	0
Z+Photon	25799	85	79	19	16	3	0
Zb	1020006	10938	10173	2297	1313	55	0
S	185900	1598	1340	807	634	619	483
B	5999734	32228	24749	4298	2860	1130	53
$S/sqrt(B)$	75.9	8.9	8.5	12.3	11.8	18.4	66.6
$S/sqrt(S+B)$	74.7	8.7	8.3	11.3	10.7	14.8	20.9

5σ discovery within 600 pb^{-1}

M_{SFOS}



Summary

SU2 Focus Point Region:

Direct chargino-neutralino production

After all cuts, S_f = 1.81 for 10 fb^{-1} of data (5σ discovery within ~100 fb^{-1} of data)

Inclusive

After all cuts, S_f = 5.49 for 10 fb^{-1} of data (5σ discovery within ~10 fb^{-1} of data)

SU3 Bulk Region:

Trileptons + jets signature, requiring the leptons are from gauginos.

After all cuts, S_f = 3.06 for 10 fb^{-1} of data (5σ discovery within ~30 fb^{-1} of data)

Inclusive

After all cuts, S_f = 20.9 for 10 fb^{-1} of data (5σ discovery within ~600 pb^{-1} of data)

- Event selection has been kept as consistant as possible across the trilepton studies.
- Lepton track isolation and impact parameter cuts are important to reduce ttbar and Zb backgrounds.
- Z mass window cuts are used for Focus Point studies but not for Bulk region, due to M_{SFOS} measurement possibilities.
- Jet Veto is important for Focus Point direct gaugino production due to low hadronic activity.
- Requiring high pt jets in the inclusive studies and non-direct gaugino production is very effective.

CSC notes

This work is going into CSC 7 *(gauginos)* and CSC 5 *(inclusive)* notes.

Oxford and Wisconsin also working on trilepton SUSY signatures. All using different analysis methods (RHUL – EventView, Oxford – SANs, Wisconsin – directly from AOD).

Currently converging our analyses for the notes – a difficult task!
Comparing SFOS and SFSS trilepton signals.

Step 1: Object definitions and overlaps agreed (see slide 2). done
Trying to match these within and across csc notes.
Step 2: Simple event kinematics compared after preselection. done
e.g. Electron/Muon/Jet multiplicities and p_T, Etmiss. – now very near to agreement

Step 3: Sub-samples used to compare # of events after simple cuts applied in progress
can also be used for event by event comparisons

Step 4: Agree on a set of well motivated cuts for trilepton SUSY selection. to be done
Step 5: Write up sections, make final plots based on event selections to be done

Deadlines (csc7):
23rd Oct: outline of section contents, including list of plots required to be circulated.
30th Oct: paper plots ready & circulated.
6th Nov: first draft of sections.
20th Nov: final drafts of sections.