Recent Results on SUSY and BSM searches from ATLAS and CMS

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presented on behalf of the ATLAS and CMS collaborations

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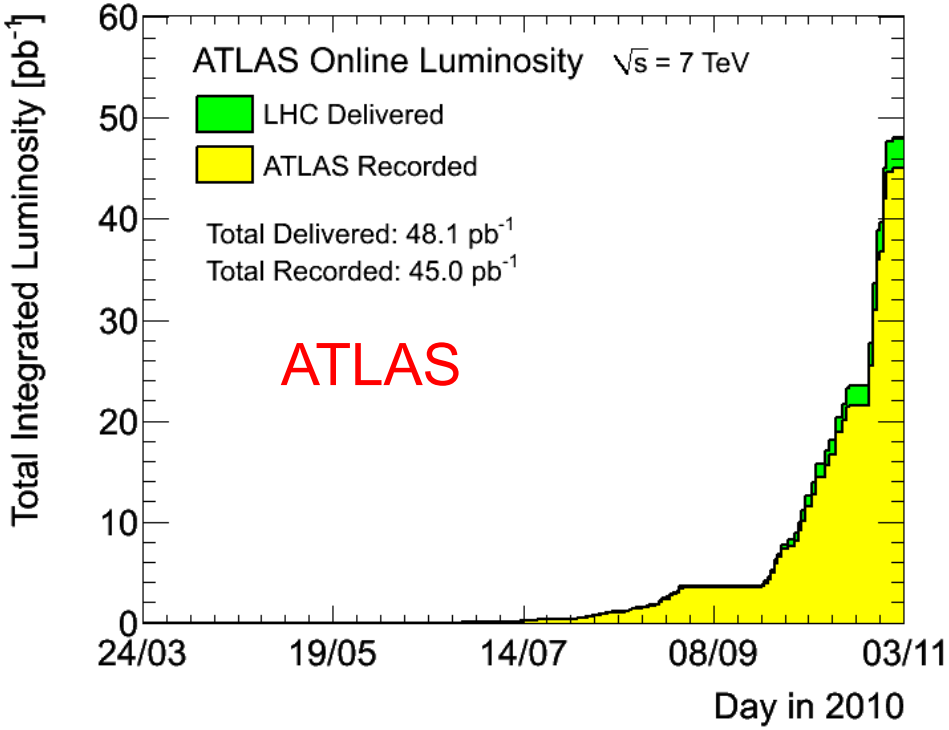
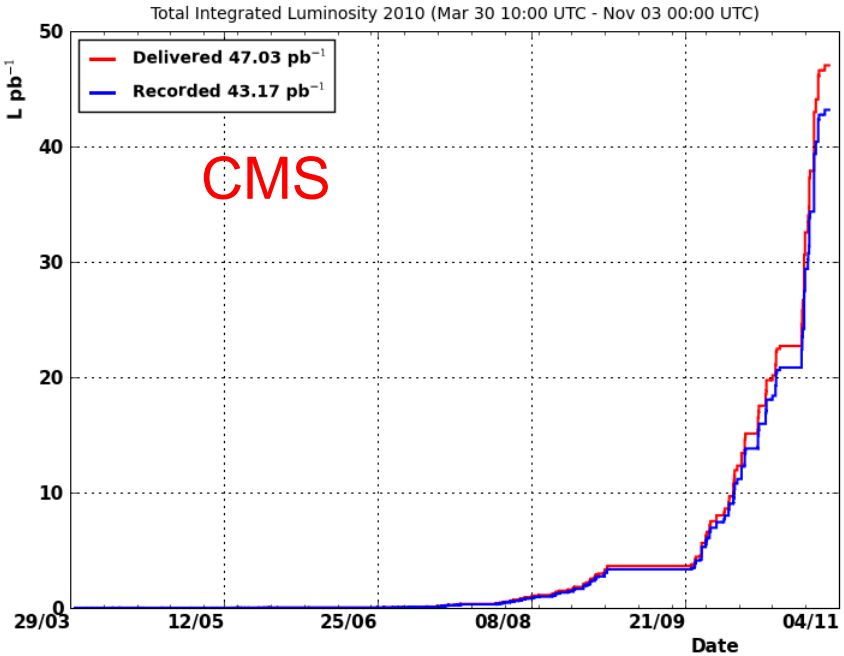
Outline

- Broad (and rapid) overview of BSM ("Exotics") and SUSY results from ATLAS and CMS from the 2010 data-taking
- Put priority on more recent results using the full 2010 dataset
- Grouped largely by experimental signature
  - Resonances (with some non-resonant stuff mixed in)
  - Non-resonant Exotics
  - SUSY

I will be broad but shallow. Please see the parallel session talks for details.

2010 data-taking





Peak stable luminosity: ~2 x 10^{32} cm^{-2} s^{-1}

Both experiments end up with approx 35-40 pb^{-1} useable for most 2010 physics results

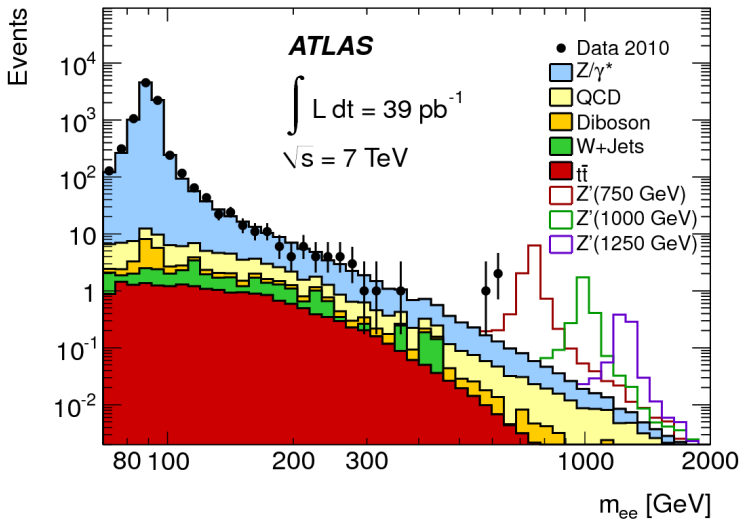
Leptonic/photonic resonances

Signature	ATLAS	CMS	Example
$\ell^+\ell^-$ (ℓ=e,μ)	arXiv:1103.6218	arXiv:1103.0981	Z'
$\ell\nu$ (ℓ=e,μ)	arXiv:1103.1391	arXiv:1103.0030 (μ), arXiv:1012.5945 (e)	W'
eμ	arXiv:1103.5559		RPV $\tilde{\nu}_\tau$
$\ell^+\ell^-\gamma$ (ℓ=e,μ)		EXO10016 (plots only)	e*, μ*
muon jets		EXO11013 (plots only)	"dark photon"
γγ	ATL-CONF-2011-044	EXO10019 (plots only)	RS graviton

(unless otherwise noted all entries in these tables use the full 2010 dataset)

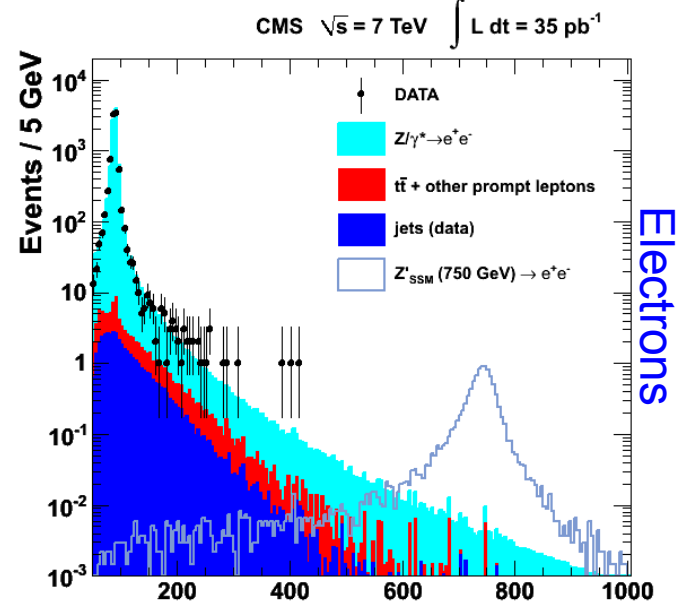
$\ell^+\ell^-$ resonance search

Bump hunt in invariant mass of pairs of isolated high p_T leptons (OSSF)



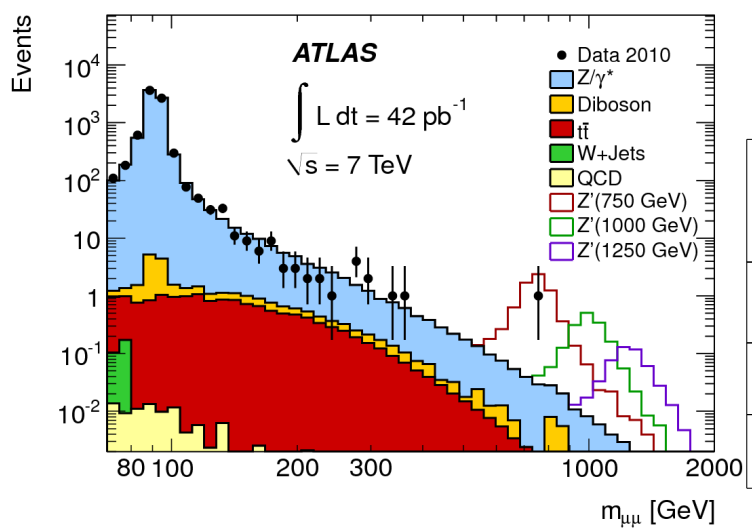
	ATLAS	CMS
p_T cut (e)	25 GeV	25 GeV
p_T cut (μ)	25 GeV	20 GeV
|η| cut (e)	2.47(excl. [1.37,1.52])	2.5(excl. [1.442,1.56])
|η| cut (μ)	2.4*	2.4

* but not full coverage (due to 3-station req.)

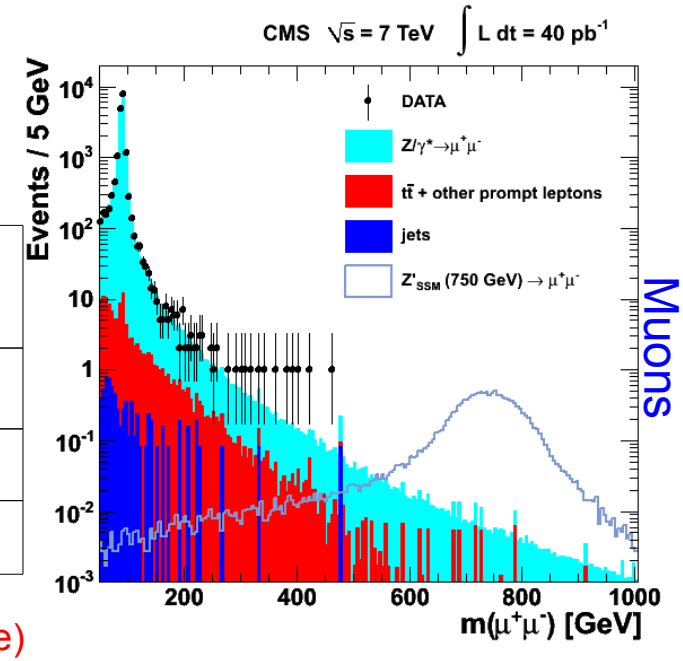


95% CL mass limits on Z'_{SSM} (in GeV)

Tevatron limit: 1071 GeV



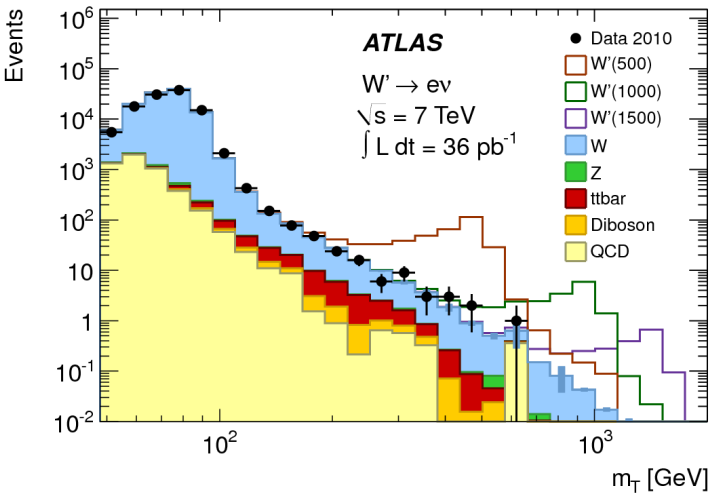
	ATLAS obs (exp)	CMS obs
Electron	957 (967)	958
Muon	834 (900)	1027
Comb	1048 (1088)	1140



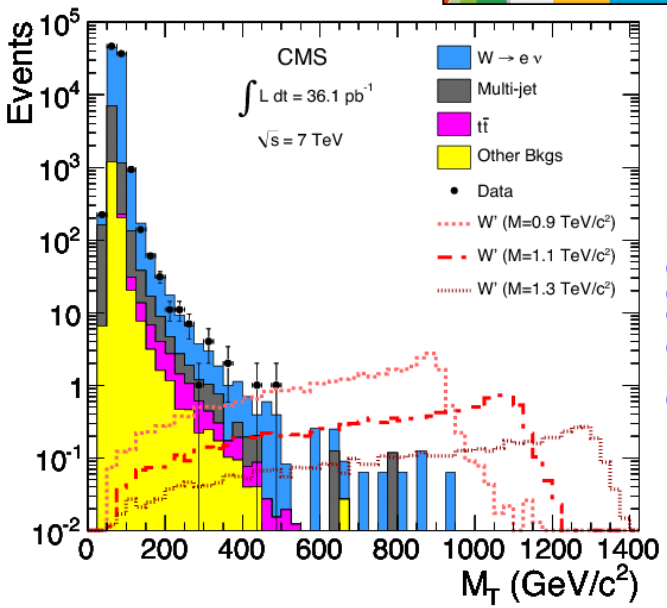
(Limits on other Z' models also available)

ℓν resonance search

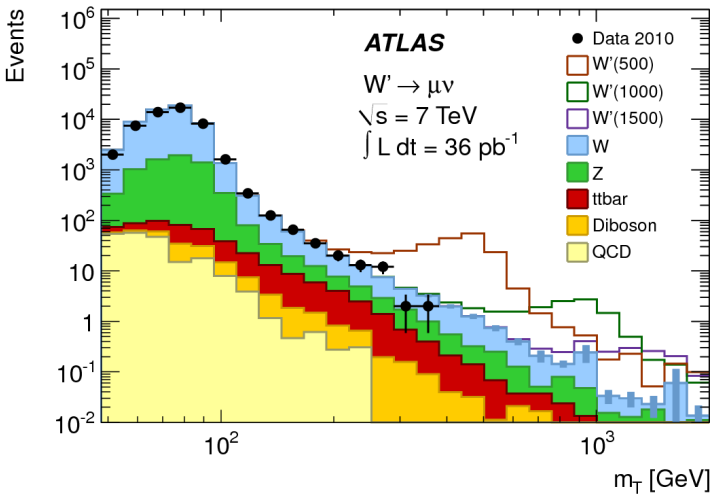
Bump hunt in transverse mass of isolated, high p_T lepton and MET



	ATLAS	CMS
p_T cut (e)	25 GeV	30 GeV
p_T cut (μ)	25 GeV	25 GeV
|η| cut (e)	2.47(excl. [1.37,1.52])	2.5(excl. [1.442,1.56])
|η| cut (μ)	1.05	2.1



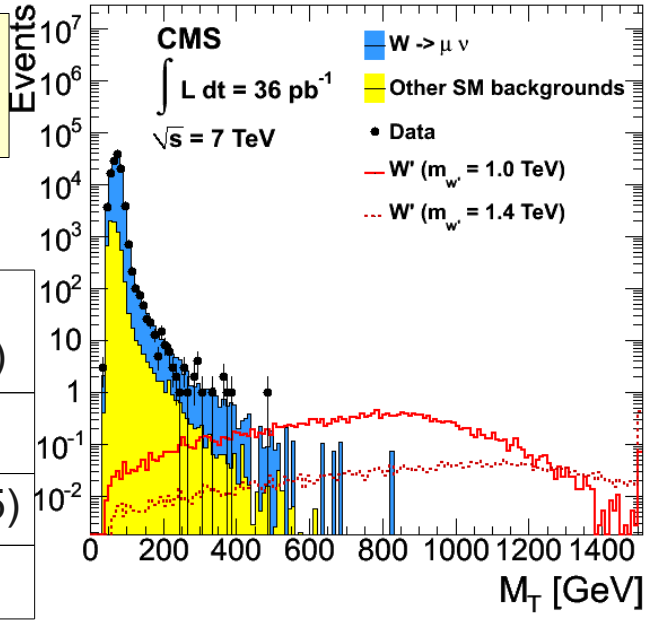
Electrons



95% CL mass limits on "SM-like" W' (in TeV)

Tevatron limit: 1.1 TeV

	ATLAS obs (exp)	CMS obs(exp)
Electron	1.37 (1.37)	1.36
Muon	1.21 (1.29)	1.40(1.35)
Comb	1.45 (1.49)	1.58



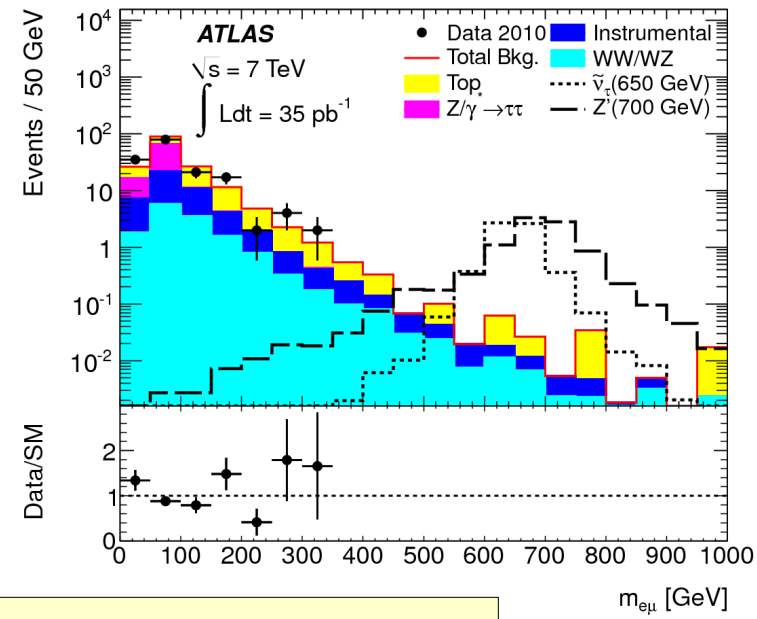
Muons

eμ resonance search

Bump search in invariant mass of isolated e and μ

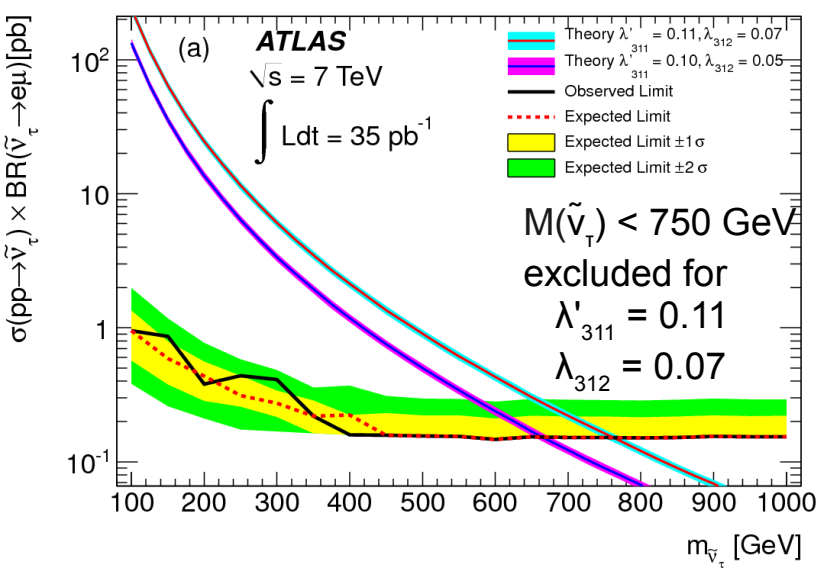
Require exactly one e and one μ, both with pt > 20 GeV and isolated.

e: $|\eta| < 2.47$ excl. [1.37,1.52]
μ: $|\eta| < 2.4$

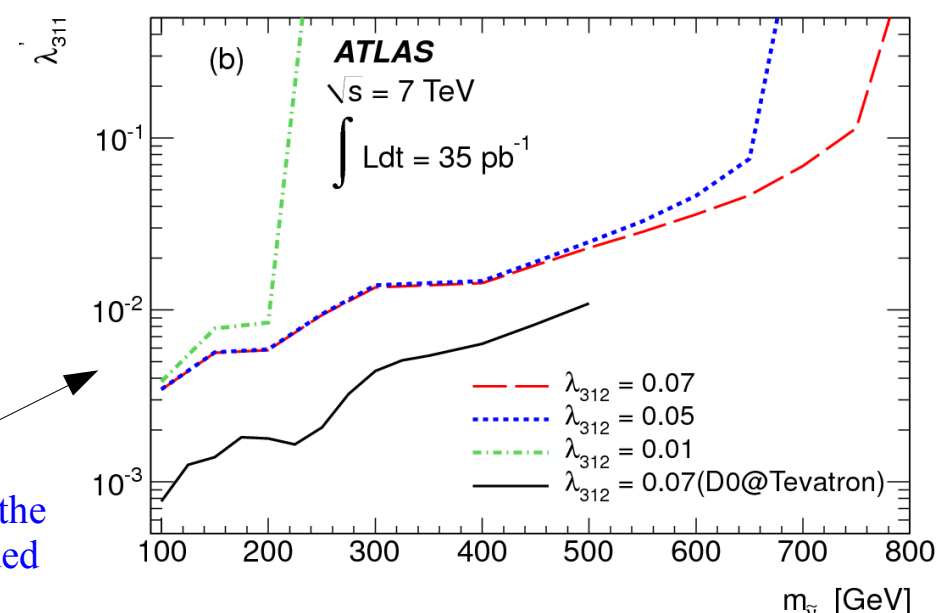


Set limits on σ·B

(theory curves for a R-parity violating $\tilde{\nu}_\tau \rightarrow e\mu$)



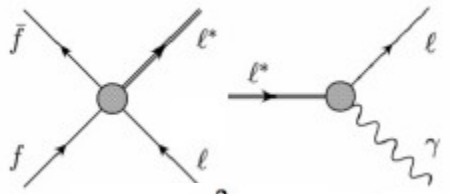
Limits on λ'_{311} vs $m(\tilde{\nu}_\tau)$



Regions above the lines are excluded

ℓ(ℓγ) resonance search

4-fermion contact interaction



$$\mathcal{L}_{CI} = \frac{g^2}{2\Lambda^2} j^\mu j_\mu$$

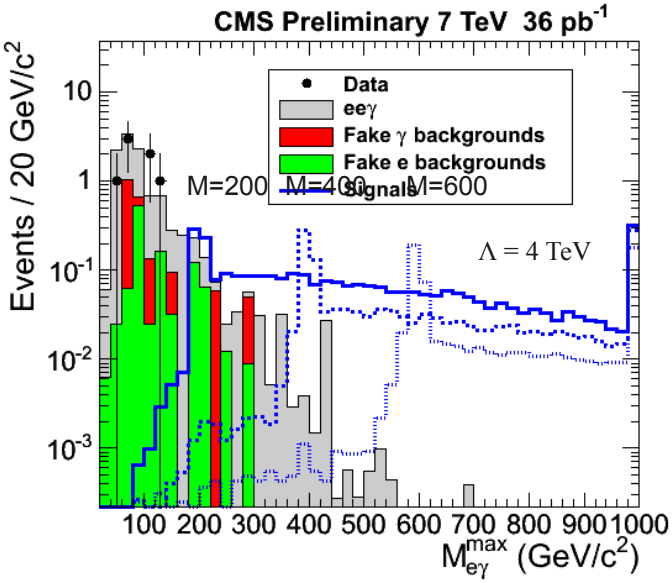
Bump hunt in invariant mass of lepton+photon in ℓℓγ events

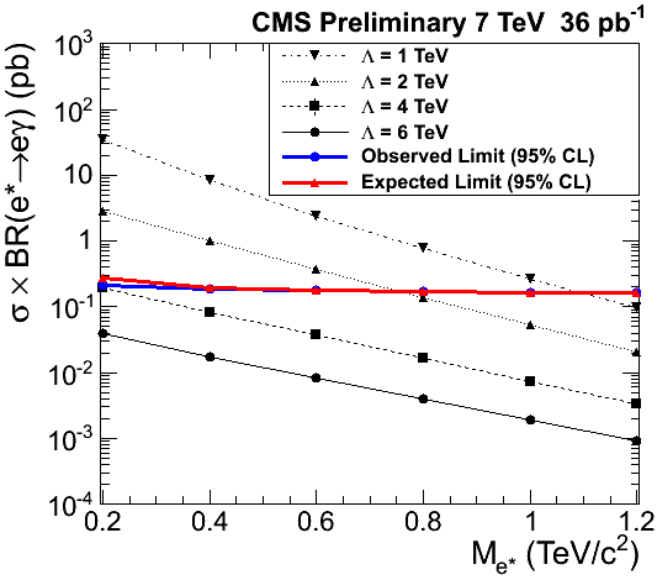
p_T > 20(e), 25(μ), 20(γ)
ΔR(γ,ℓ) > 0.5

95% CL mass limits (in GeV) on ℓ*, for Λ = 2 TeV

Electron	760
Muon	785

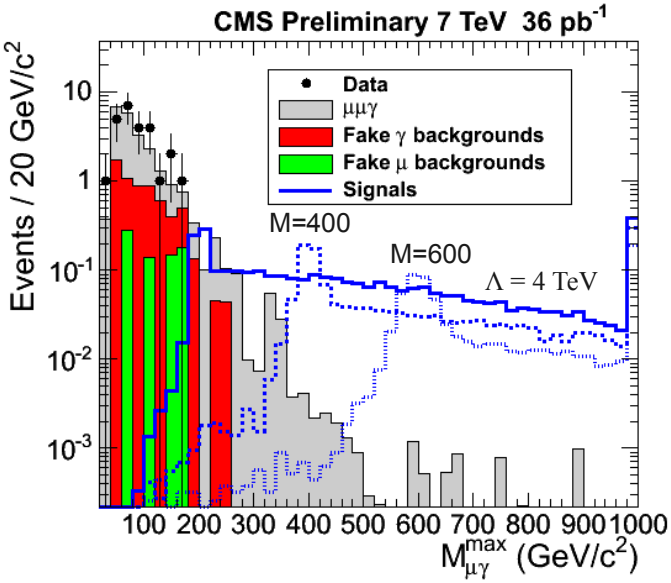
Electrons

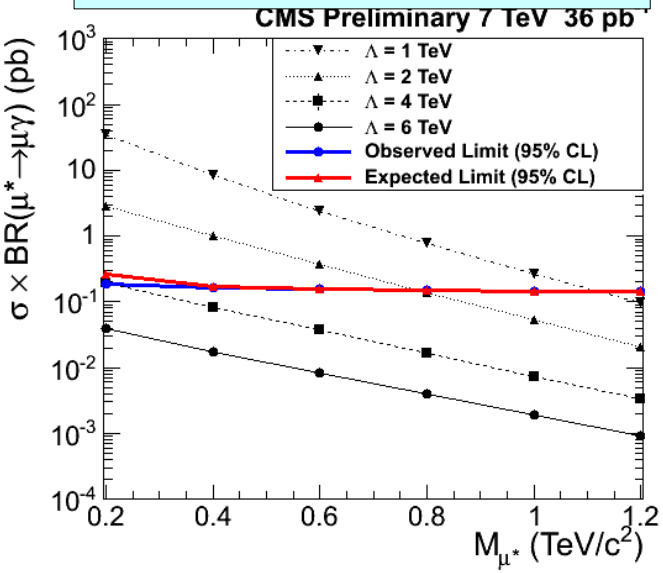




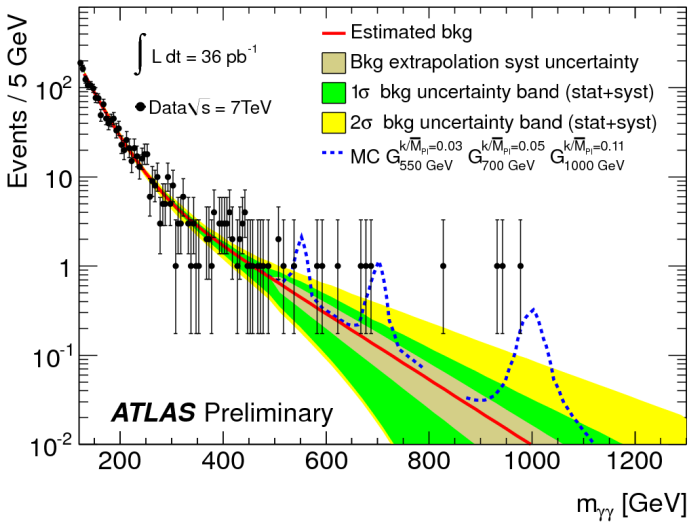
Cross section limits

Muons

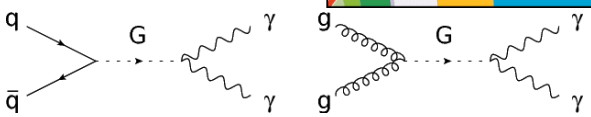




γγ resonances



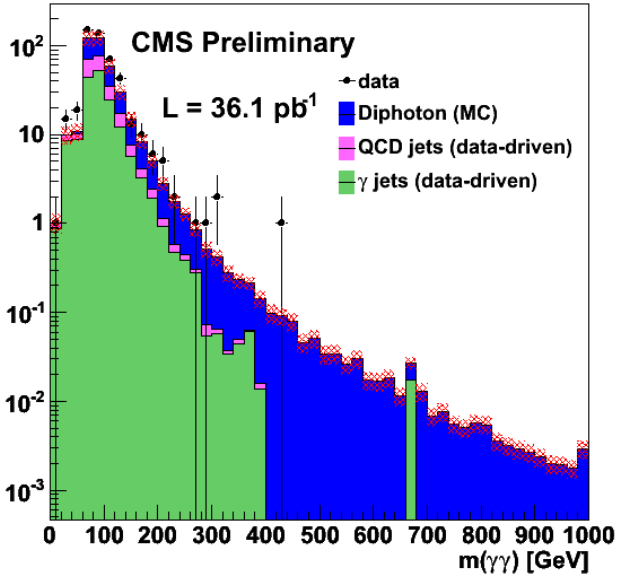
Bump hunt in γγ mass (at high mass!)



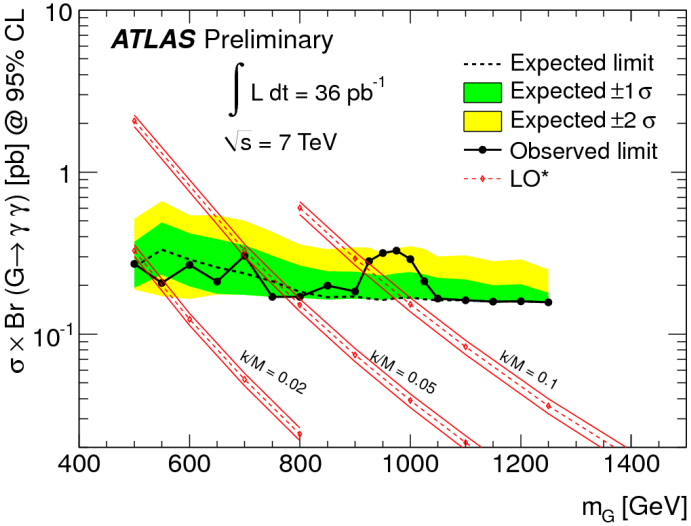
ATLAS: ≥ 2 "loose" photons, $E_T > 25$, $|\eta| < 2.37$ (exc. [1.37,1.52])

95% CL mass limits on RS graviton GeV)

k/M_{pl}	ATLAS	CMS
0.01	-	368
0.02	545	-
0.1	920	952

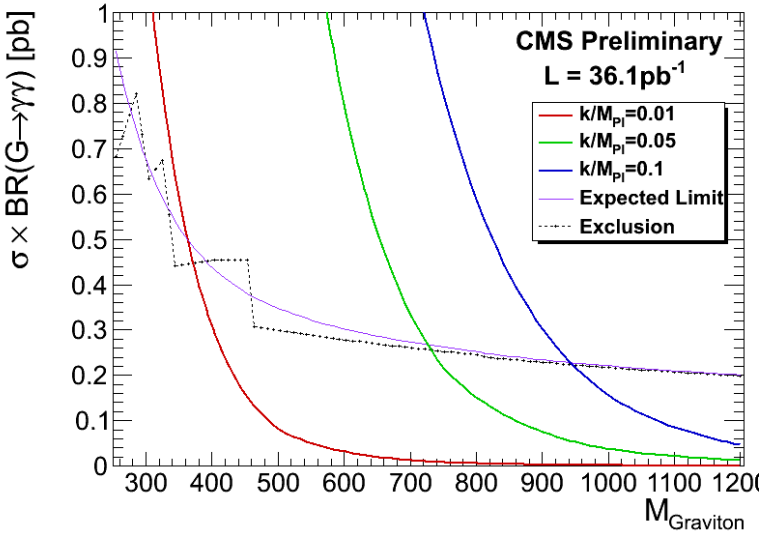


Cross section limits



Approaching the most stringent Tevatron limits

k/M_{pl}	D0 (G → γγ + G → ee)	CDF (G → γγ)
0.01	560	472
0.1	1050	976



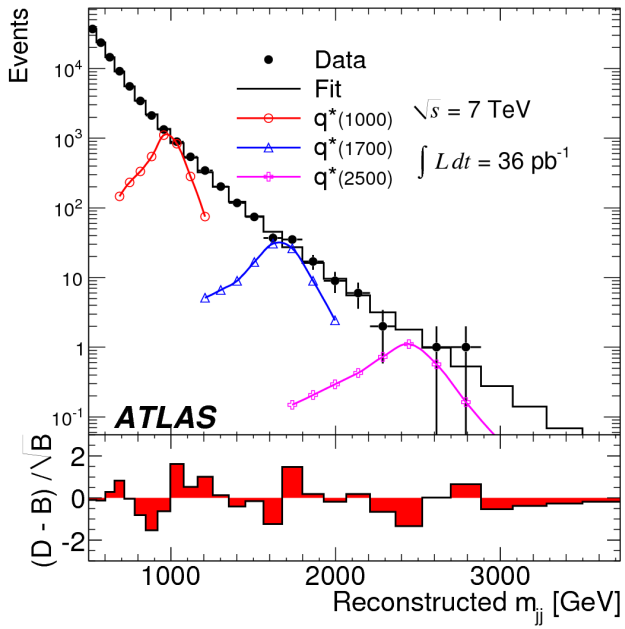
Hadronic resonances

Signature	ATLAS	CMS	Example
dijet mass	arXiv:1103.3864	2.9 pb^{-1}: PRL105, 211801	q*
dijet angular variables	arXiv:1103.3864	arXiv:1102.2020	q*, contact interaction
multijets		EXO11001 (plots only)	RPV SUSY gluino
ttbar (ℓ+jets) resonance		CMS-PAS-TOP-10-007	Z' → ttbar

Strictly speaking, not a resonance search

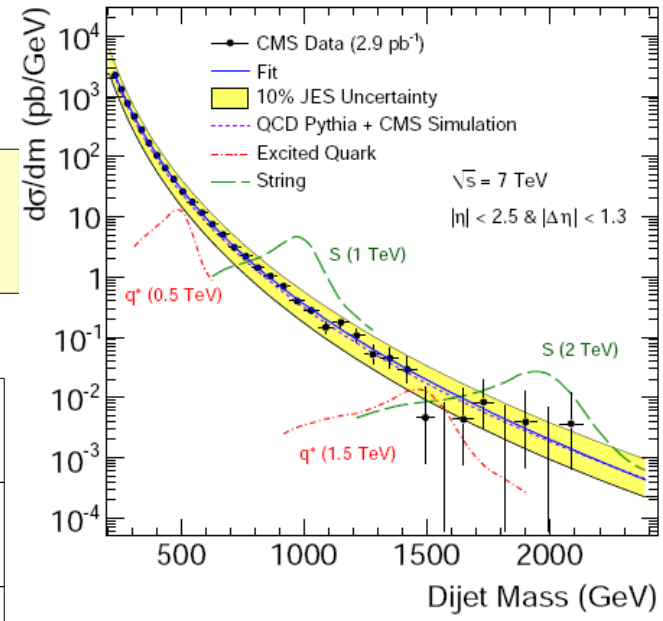
dijet mass resonance

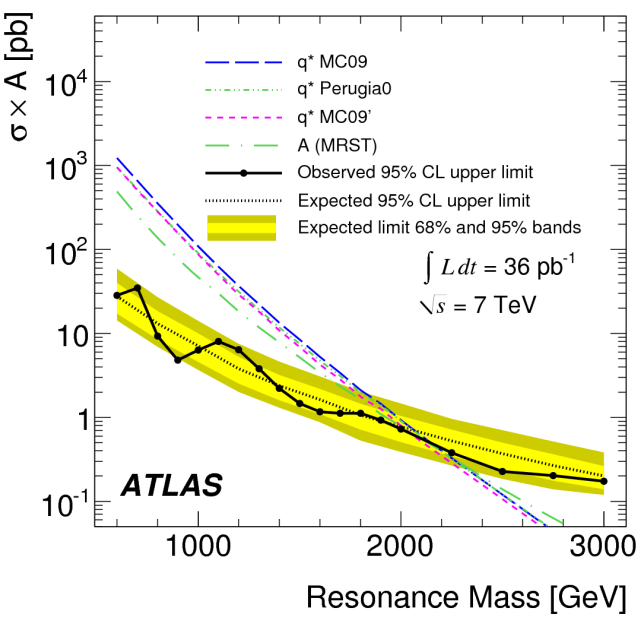
Bump hunt in the dijet invariant mass spectrum

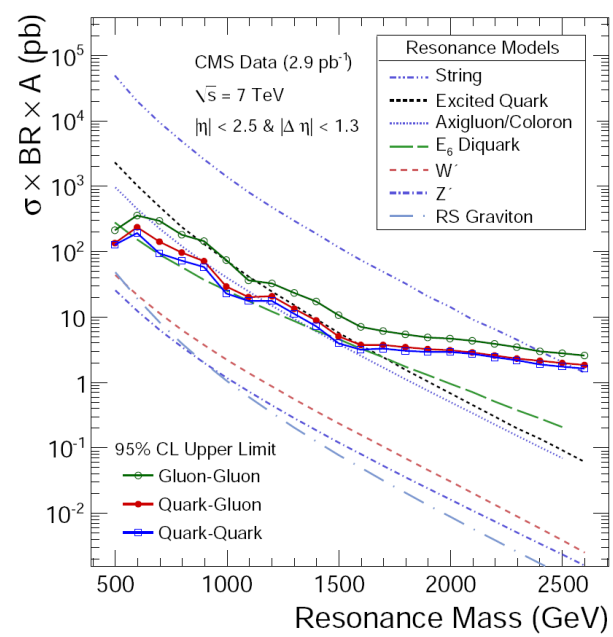


95% CL mass exclusion intervals (TeV) and expected limits

	(36 pb^{-1}) ATLAS obs (exp)	(2.9 pb^{-1}) CMS obs (exp)
q*	[0.60,2.15] (2.07)	[0.50,1.58] (1.32)
axigluon	[0.60,2.10] (2.01)	[0.50,1.17] [1.47,1.52] (1.23)
Randall-Meade QBH (n=6)	[0.75,3.67] (3.64)	
E6 diquark		[0.50,0.58] [0.97,1.08] [1.45,1.60] (1.05)

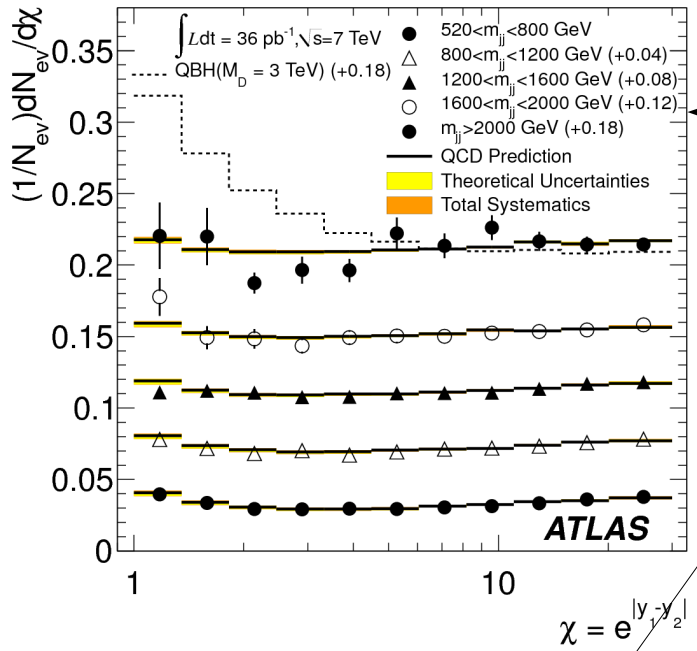






Cross section limits

dijet angular distributions

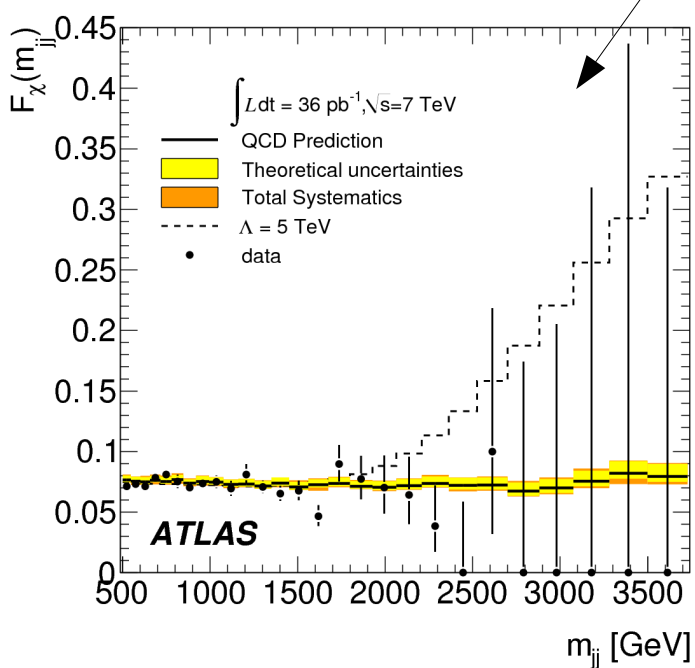


$\chi = \exp(|y_1 - y_2|) = \exp(2|y^*|)$

flat for Rutherford scattering

ATLAS has also measured

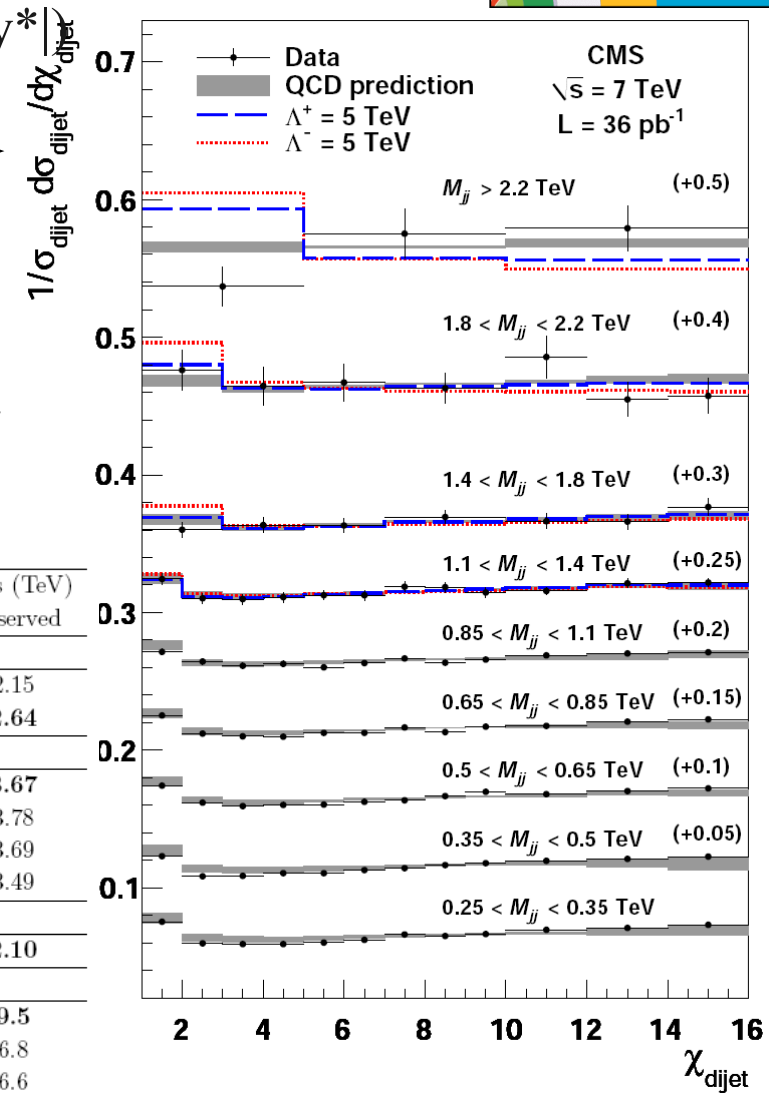
$$F_\chi\left(\left[m_{jj}^{min} + m_{jj}^{max}\right]/2\right) \equiv \frac{N_{events}(|y^*| < 0.6, m_{jj}^{min}, m_{jj}^{max})}{N_{events}(|y^*| < 1.7, m_{jj}^{min}, m_{jj}^{max})}$$



ATLAS limits

Model and Analysis Strategy	95% C.L. Limits (TeV) Expected	Observed
Excited Quark q^*		
Resonance in m_{jj}	2.07	2.15
$F_\chi(m_{jj})$	**2.12**	**2.64**
Randall-Meade Quantum Black Hole for $n = 6$		
Resonance in m_{jj}	**3.64**	**3.67**
$F_\chi(m_{jj})$	3.49	3.78
θ_{np} Parameter for $m_{jj} > 2$ TeV	3.37	3.69
11-bin χ Distribution for $m_{jj} > 2$ TeV	3.36	3.49
Axigluon		
Resonance in m_{jj}	**2.01**	**2.10**
Contact Interaction Λ		
$F_\chi(m_{jj})$	**5.7**	**9.5**
F_χ for $m_{jj} > 2$ TeV	5.2	6.8
11-bin χ Distribution for $m_{jj} > 2$ TeV	5.4	6.6

ATLAS expected limit on contact interactions: $\Lambda^+ > 5.7$ TeV



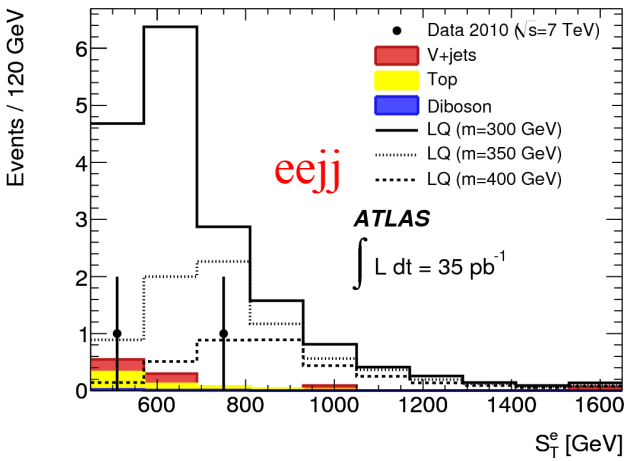
CMS sets limits on contact interactions:
$\Lambda^+ > 5.6$ TeV (exp limit: 5.0)

Lepton+jet resonances

Signature	ATLAS	CMS	Example
ejej	arXiv.1104.4481	arXiv:1012.4031	LQ(1)
ejνj	arXiv:1104.4481	EXO10006 (plots only)	LQ(1)
μjμj	arXiv:1104.4481	arXiv:1012.4033	LQ(2)
μjνj	arXiv:1104.4481		LQ(2)
WqWq→ ℓνqℓνq	ATL-CONF-2011-022		heavy quark

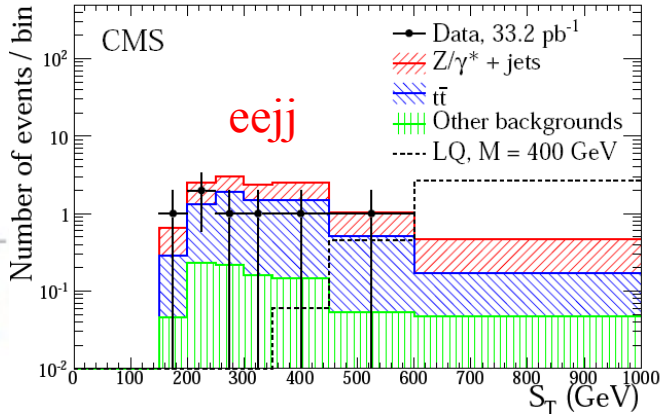
LQ(1) searches

Events with exactly 2 leptons
(or 1 for eqvq) and at least 2 jets



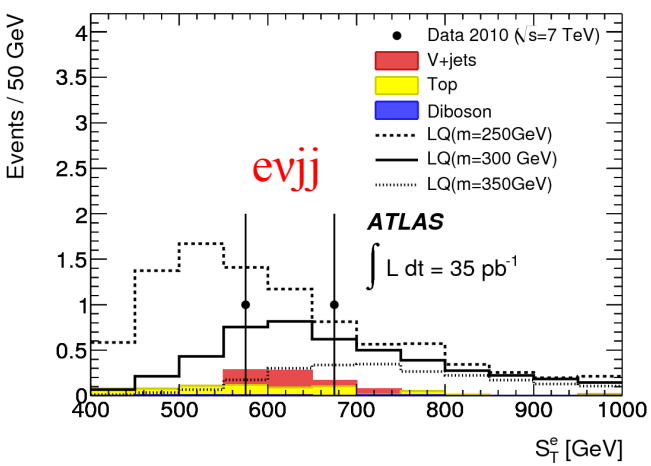
ATLAS

$ee\ell jj$ and $\mu\mu jj$	$e\nu jj$	$\mu\nu jj$
$M_{\ell\ell} > 120$ GeV	$M_T > 200$ GeV	$M_T > 160$ GeV
$M_{LQ} > 150$ GeV	$M_{LQ} > 180$ GeV	$M_{LQ} > 150$ GeV
$p_T^{all} > 30$ GeV	$M_{LQ}^T > 180$ GeV	$M_{LQ}^T > 150$ GeV
$S_T^\ell > 450$ GeV	$S_T^\nu > 410$ GeV	$S_T^\nu > 400$ GeV



Cuts optimized for each LQ mass hypo.
(CMS doesn't use M_{LQ} as discriminant)

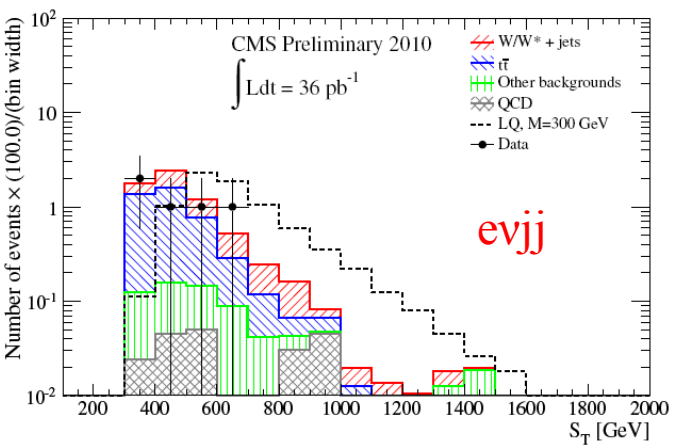
$$S_T^\ell = p_T^{\ell_1} + p_T^{\ell_2} + p_T^{j_1} + p_T^{j_2}$$



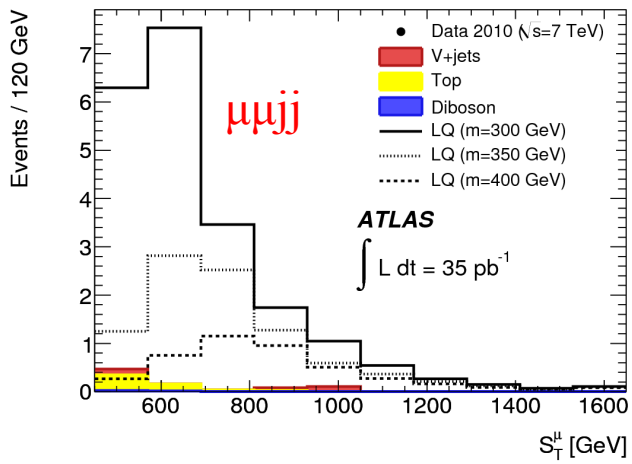
95% CL mass limits (GeV)
on LQ1. (eejj+evjj combined)

β	ATLAS	CMS	D0
0.1	-	255	-
0.5	319	340	284
1.0	376	384	299

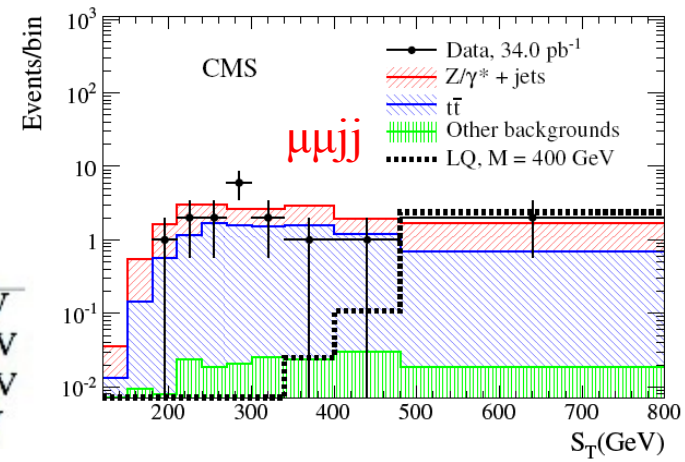
$\beta \equiv BR(LQ \rightarrow eq)$



LQ(2) searches



Events with exactly 2 leptons (or 1 for μqνq) and at least 2 jets

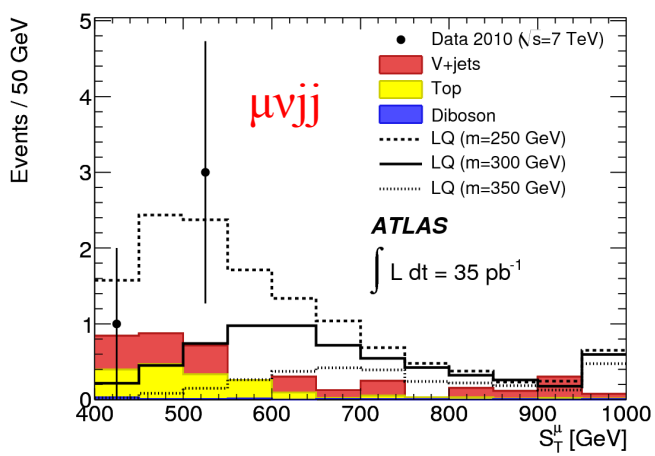


ATLAS

$ee jj$ and $\mu\mu jj$	$e\nu jj$	$\mu\nu jj$
$M_{ll} > 120$ GeV	$M_T > 200$ GeV	$M_T > 160$ GeV
$M_{LQ} > 150$ GeV	$M_{LQ} > 180$ GeV	$M_{LQ} > 150$ GeV
$p_T^{all} > 30$ GeV	$M_{LQ}^T > 180$ GeV	$M_{LQ}^T > 150$ GeV
$S_T^\ell > 450$ GeV	$S_T^\nu > 410$ GeV	$S_T^\nu > 400$ GeV

$$S_T^\ell = p_T^{\ell_1} + p_T^{\ell_2} + p_T^{j_1} + p_T^{j_2}$$

Cuts optimized for each LQ mass hypo.
(CMS doesn't use M_{LQ} as discriminant)

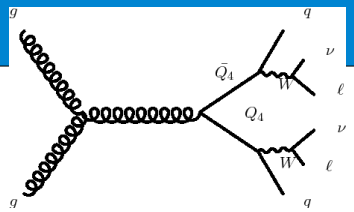


95% CL mass limits (GeV) on LQ2. (μμjj+μνjj combined)

β	ATLAS	CMS (μμjj)	D0
0.1	-	-	185
0.5	362	~290	270
1.0	422	394	316

$\beta \equiv BR(LQ \rightarrow \mu q)$

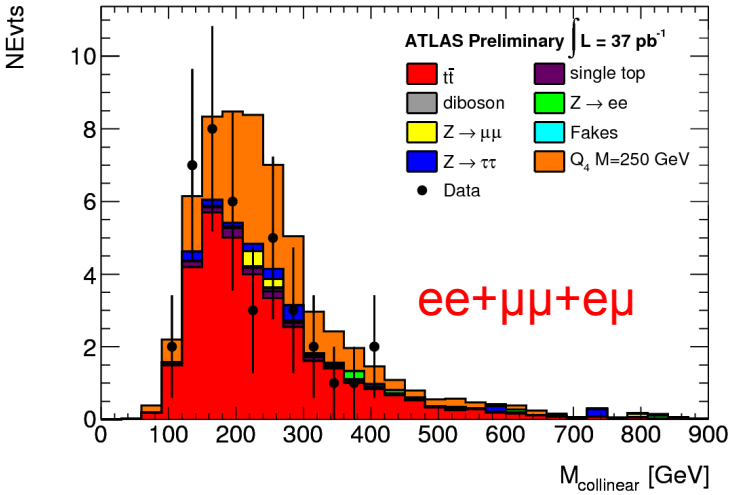
QQ → WqWq → ℓνqℓνq



Events with exactly 2 OS leptons and at least 2 jets

MET > 40

Z mass veto (if same flavor ℓ)



95% CL upper limit on Q_4 mass:
M < 270 GeV excluded

(CDF limit: 356 GeV)

Approximate mass reconstruction possible. Neutrinos are ~collinear with leptons (boosted W's)

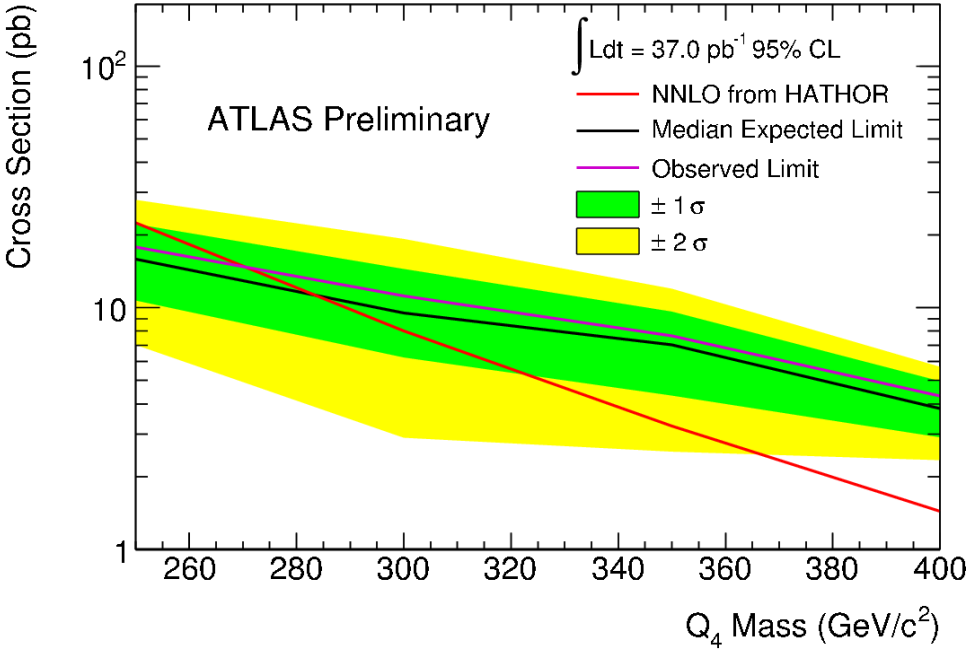
Allocate MET to the two sides to minimize mass difference

Cut in plane of HT vs M(collinear)

Table 4: List of final selection cuts for each Q_4 mass.

Q_4 Mass (GeV)	Final selection
250	$H_T > 500 - 0.7 \times M_{collinear}$
300	$H_T > 600 - 0.5 \times M_{collinear}$
350	$H_T > 600 - 0.2 \times M_{collinear}$
400	$H_T > 700 - 0.3 \times M_{collinear}$

Cross section limit (for Q_4)

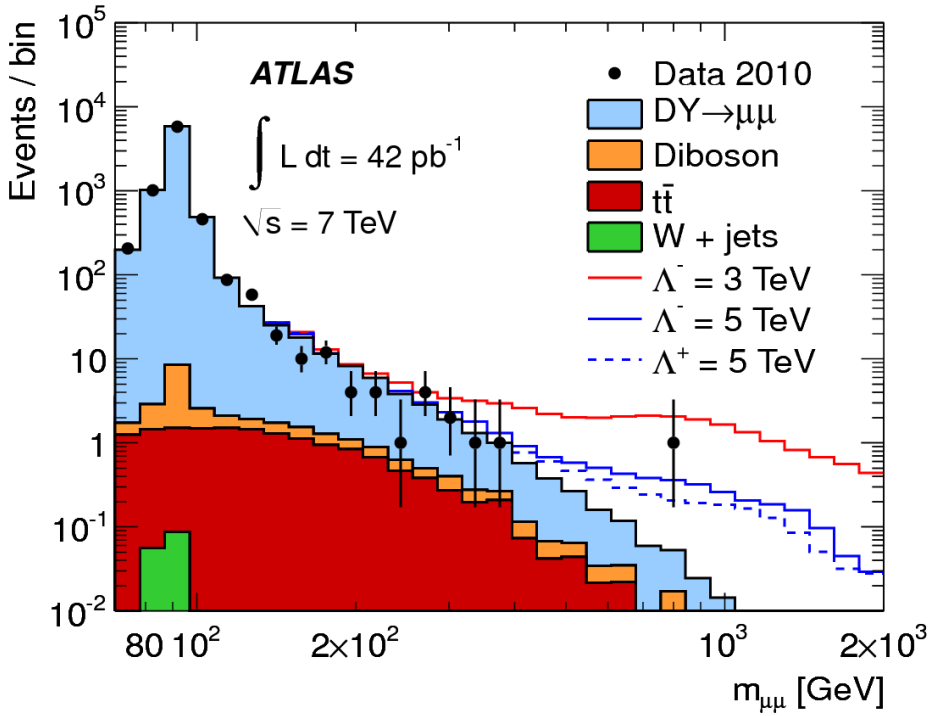


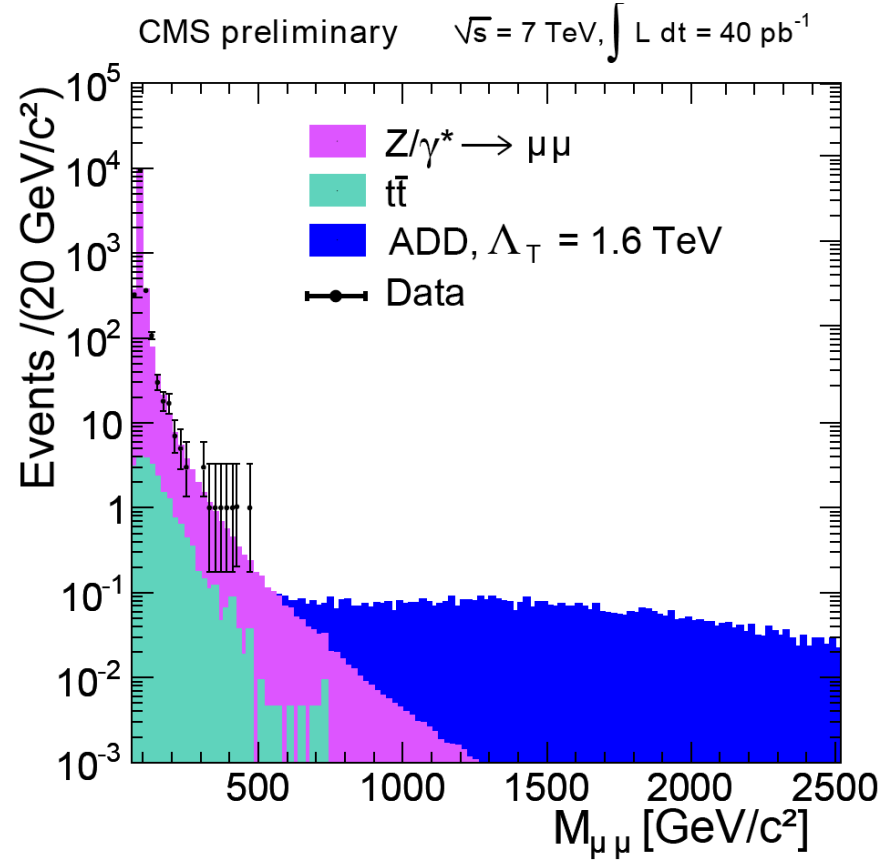
non-resonant production

Signature	ATLAS	CMS	Example
μμ (OS)	arXiv:1104.4398	CMS-PAS-EXO-10-020	ADD,contact interaction
γγ		arXiv:1103.4279	ADD
monojet		EXO11003 (plots only)	ADD
μμ (SS)	ATLAS-CONF-2011-065		black holes
multi-object	ATLAS-CONF-2010-088 (315 nb^{-1})	PLB697(2011)434	black holes
trilepton or SS dilepton + jets		arXiv:1102.4746	$b' \rightarrow tW$
ttbar + MET	ATLAS-CONF-2011-036		$t' \rightarrow t$ + "χ^0"

non-resonant $\mu^+ \mu^-$ production

Similar selections to the Z' analysis





95% CL lower limit on scale of μμqq contact interactions (in TeV)

	ATLAS	CDF
Λ^-	4.9	4.2
Λ^+	4.5	2.9

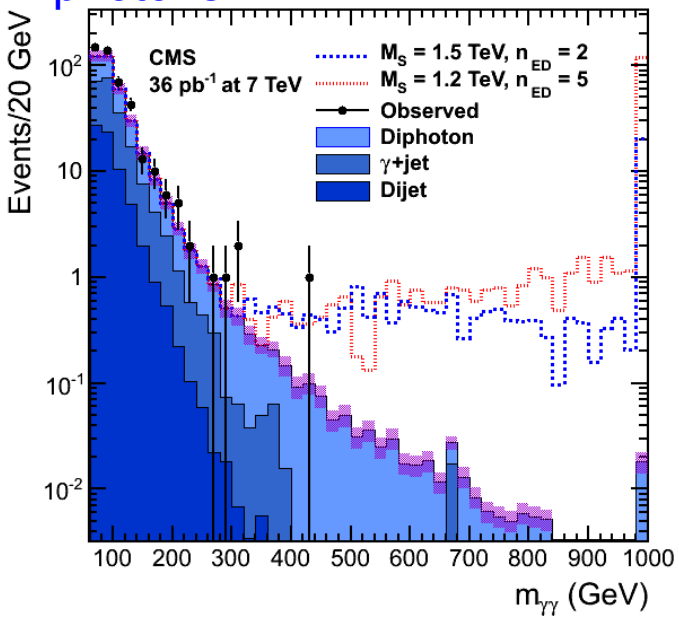
95% CL lower limits on the ADD cutoff scale M_S

	Λ_T [TeV] (GRW)	M_S [TeV/c^2] (HLZ)					
		$n=2$	$n=3$	$n=4$	$n=5$	$n=6$	$n=7$
Full	1.80	1.75	2.15	1.80	1.63	1.52	1.43
Truncated	1.68	1.67	2.09	1.68	1.49	1.34	1.24

(K-factor of 1.3 applied)

other ADD-inspired searches

Diphotons



Count number of events with M(γγ) > 500 GeV

Diphotons

Set 95% CL upper limits on the cutoff scale M_S

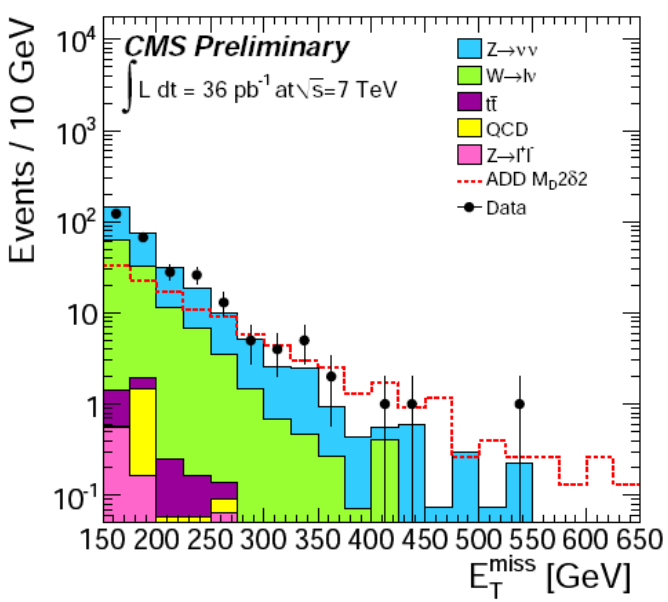
	GRW	Hewett		HLZ					
		Pos.	Neg.	$n_{ED} = 2$	$n_{ED} = 3$	$n_{ED} = 4$	$n_{ED} = 5$	$n_{ED} = 6$	$n_{ED} = 7$
Full	1.94	1.74	1.71	1.89	2.31	1.94	1.76	1.63	1.55
Trunc.	1.84	1.60	1.50	1.80	2.23	1.84	1.63	1.46	1.31

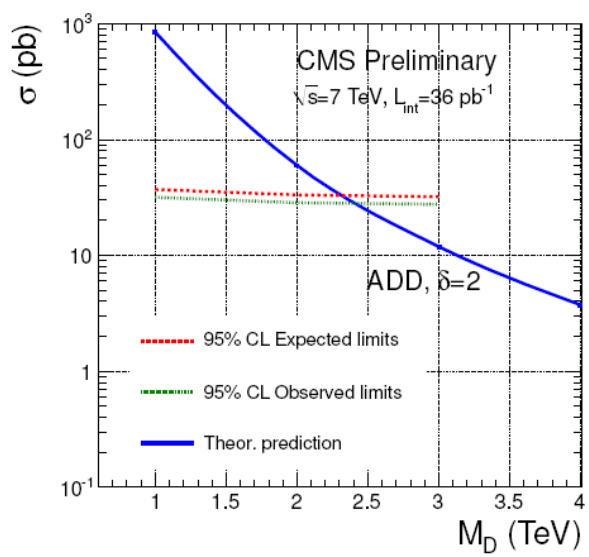
Also model indep xsec limit: $S \equiv (\sigma_{\text{total}} - \sigma_{\text{SM}}) \times \beta \times \mathcal{A}$ > 0.11 pb (95% CL)

c.f. D0 limits from diphoton & dielectron channels

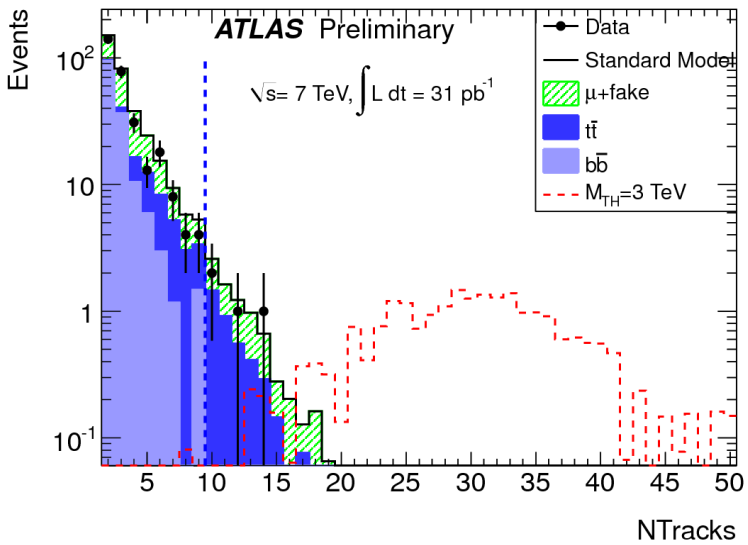
	GRW	HLZ					
		n_d 2	3	4	5	6	7
Obs.	1.62	2.09	1.94	1.62	1.46	1.36	1.29
Exp.	1.66	2.16	2.01	1.66	1.49	1.38	1.31

Monojet





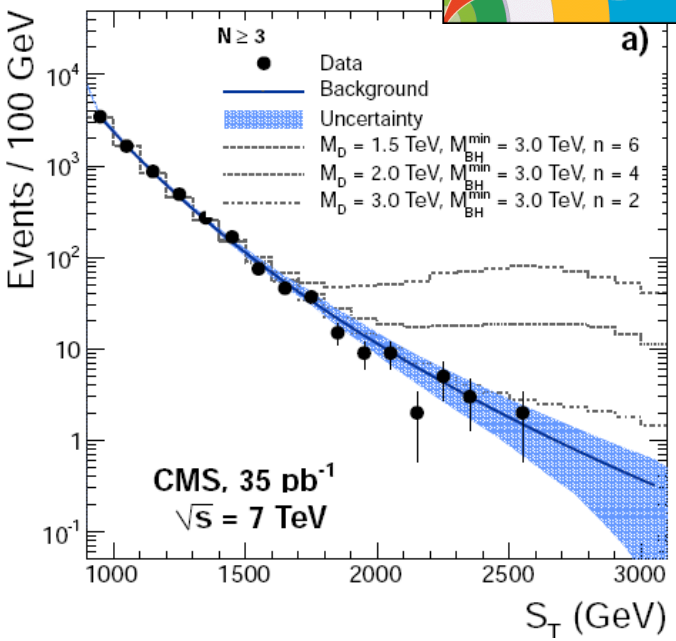
black hole-inspired searches

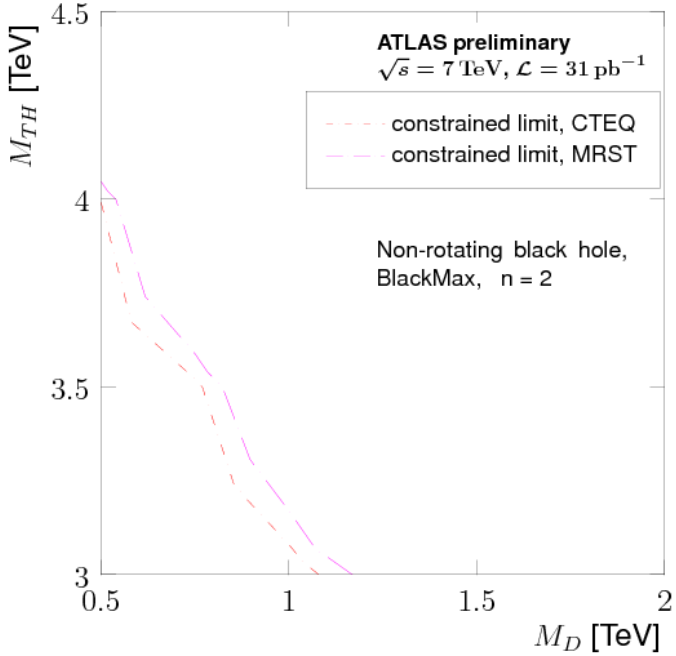


ATLAS:

High Ntrk region in SS dimuon sample

Model-indep limit:
$\sigma \cdot B \cdot A < 0.184$ pb (95%CL)

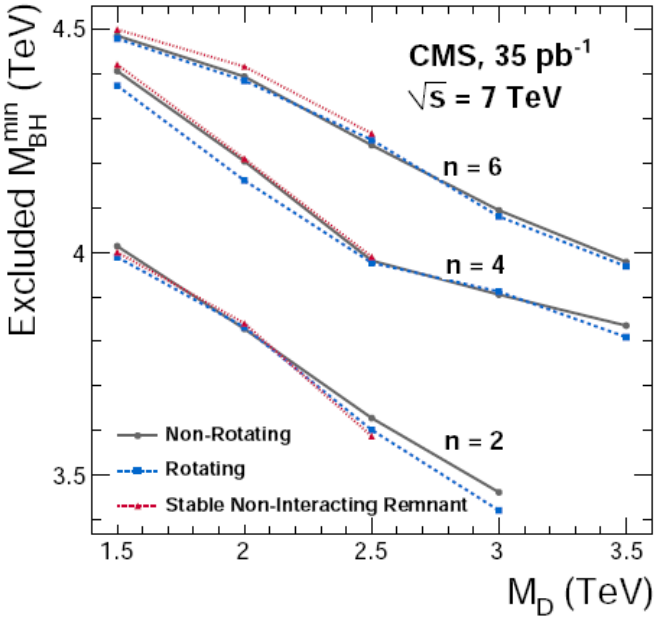




CMS:

Search in S_T vs N(obj)

Model-indep limits provided asa function of S_T(cut) for N(obj) ≥ 3,4,5

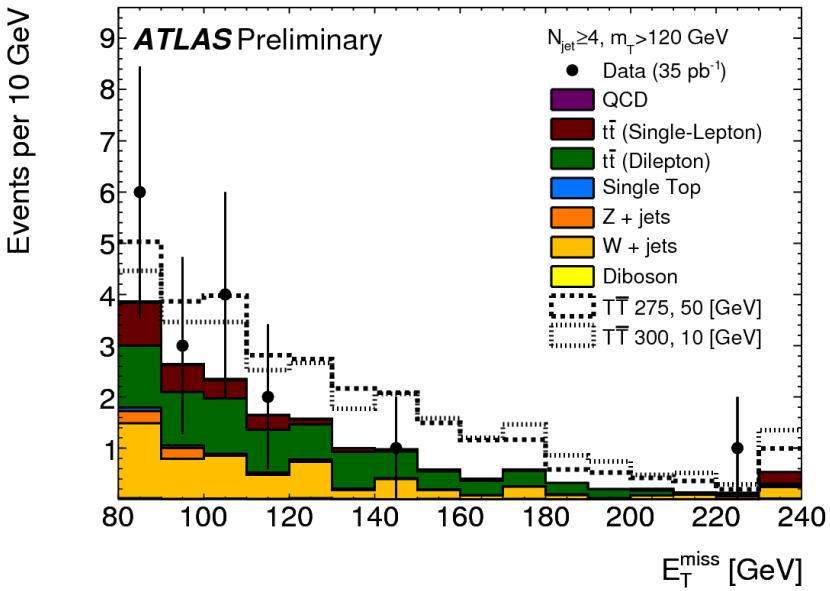


heavy quark-inspired searches

$T \rightarrow t + A_0$

ATLAS: search for anomalous ttbar+MET

- Lepton (pt > 20) + ≥ 4 jets (pt > 20)
- MET > 80, MT > 120
- 2nd lepton veto (inc. isolated trk veto)

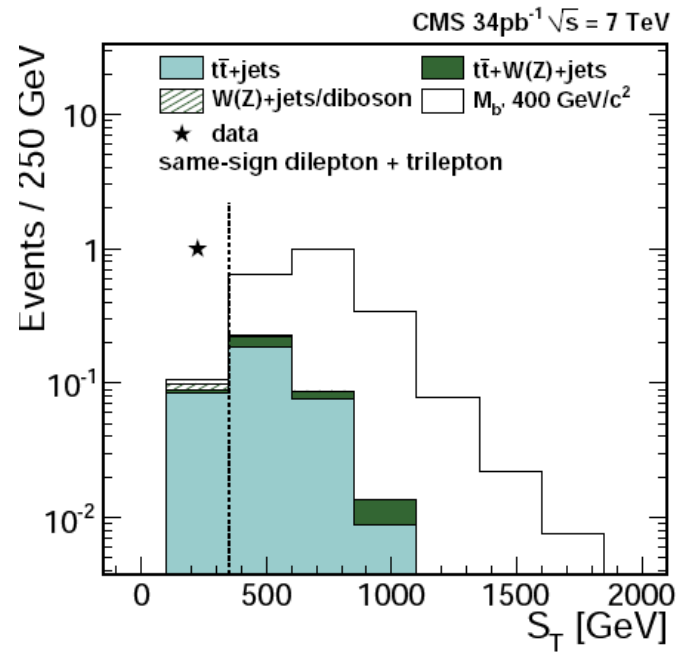


Exclude m(T) < 275 (300) GeV at 95% CL for $m(A_0)$ < 50 (10) GeV

(where T is a spin 1/2 quark-like object)

CMS: search for b' → tW via anomalous trilepton or SS dilepton production

- Lepton pt > 20, |η| < 2.5
- ≥ 4 (2) jets, pt>25 for SS dilepton (trilepton)
- Z mass veto
- S_T > 350 $\quad S_T = \sum p_T(\text{jets}) + \sum p_T(\text{leptons}) + \not{E}_T$



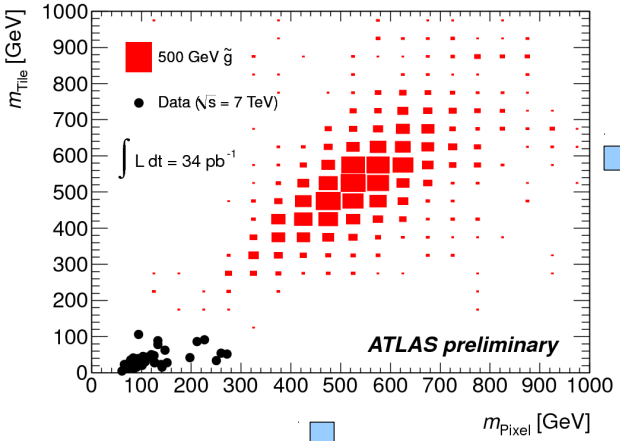
Exclude m(b') < 361 GeV at 95% CL

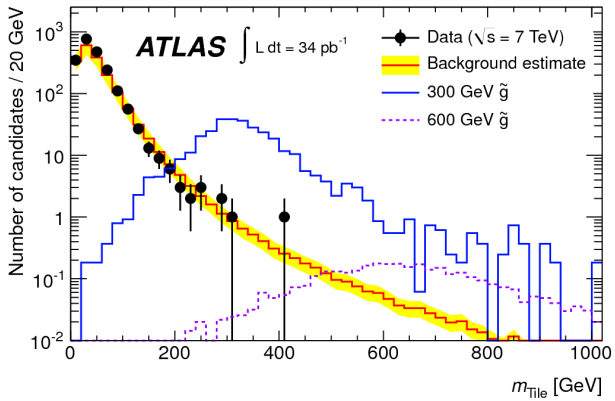
(CDF limit in this channel: 338 GeV)

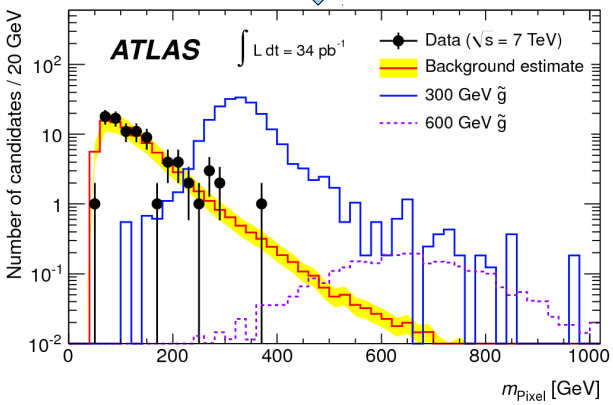
slow/highly-ionising/stopped particle

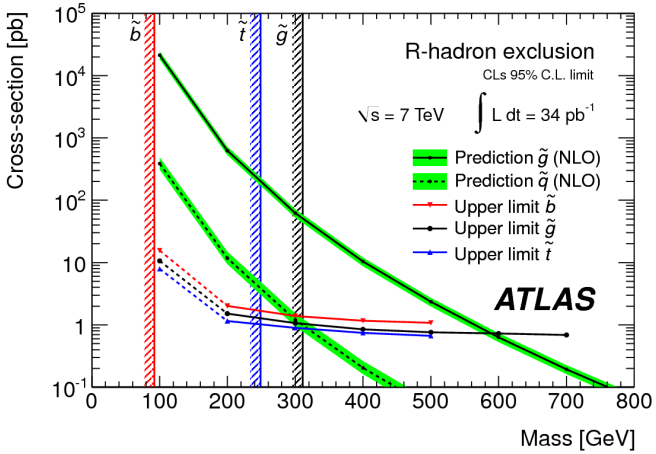
Signature	ATLAS	CMS	Example
highly-ionising particle	arXiv:1102.0459 (3.1 pb^{-1})		highly charged object
slow particle	arXiv:1103.1984	JHEP03(2011)024 (3.1 pb^{-1})	R-hadron
empty bunch crossing		PRL106,011801 (10 pb^{-1})	stopped gluino

slow, massive particle search









ATLAS

β from HCAL TOF and pix. dE/dx

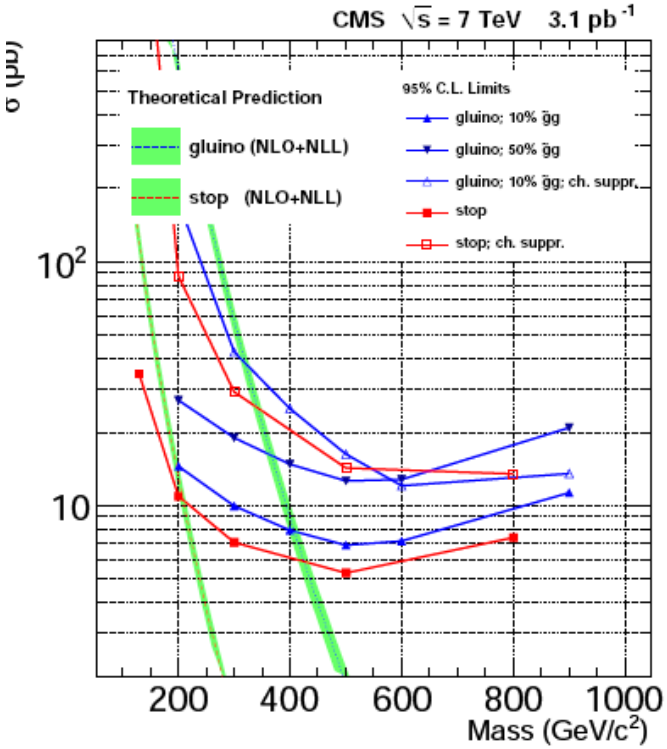
CMS

β from dE/dx in Tracker only

Both

Combine with p to get mass

Fully data-driven bkg estimates



95%CL R-hadron mass limits (GeV)

R-hadron	ATLAS	CMS (3.1 pb⁻¹)
sbottom	294	-
stop	309	202
gluino*	586	398

(* 10% g̃g)

SUSY searches in jets+(lepton)+MET (incl b)

Signature	ATLAS	CMS
jets+MET	arXiv:1102.5290	CMS-PAS-SUS-10-005 (MHT v MET) CMS-PAS-SUS-11-001 (α_t reloaded) CMS-PAS-SUS-10-009 (R vs M_R) "Razor" PLB 698 (2011) 196 (α_T)
lepton + jets + MET	PRL 106, 131802	SUS10006 (plots only)
bjets + (lepton) + MET	arXiv:1103.4344	CMS-PAS-SUS-10-011

SUSY search in jets+MET

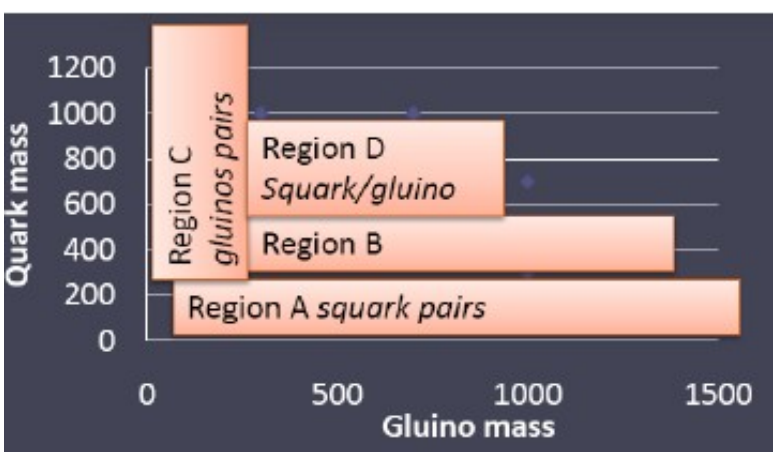
ATLAS: 4 signal regions

		A	B	C	D
Pre-selection	Number of required jets	≥ 2	≥ 2	≥ 3	≥ 3
	Leading jet p_T [GeV]	> 120	> 120	> 120	> 120
	Other jet(s) p_T [GeV]	> 40	> 40	> 40	> 40
	E_T^{miss} [GeV]	> 100	> 100	> 100	> 100
Final selection	$\Delta\phi(\text{jet}, \vec{p}_T^{miss})_{min}$	> 0.4	> 0.4	> 0.4	> 0.4
	E_T^{miss}/m_{eff}	> 0.3	–	> 0.25	> 0.25
	m_{eff} [GeV]	> 500	–	> 500	> 1000
	m_{T2} [GeV]	–	> 300	–	–

$$m_{T2}\left(\mathbf{p}_T^{(1)}, \mathbf{p}_T^{(2)}, \mathbf{p}_T\right) \equiv \min_{\mathbf{q}_T^{(1)}+\mathbf{q}_T^{(2)}=\vec{E}_T^{miss}} \left\{\max\left(m_T\left(\mathbf{p}_T^{(1)}, \mathbf{q}_T^{(1)}\right), m_T\left(\mathbf{p}_T^{(2)}, \mathbf{q}_T^{(2)}\right)\right)\right\}$$

$$m_{eff} \equiv \sum_{i=1}^{n} |\mathbf{p}_T^{(i)}| + E_T^{miss}$$

events with e or μ (pt>10) discarded



(figure: S. Caron)

CMS (MHT vs HT analysis)

Baseline selection:

- ≥ 3 jets, pt > 50
- HT > 300 (scalar sum, jets w pt>50)
- MHT > 150 (vec sum, jets w pt>30)
- Δφ(jet,MHT)>(0.5,0.5,0.3)
- e,μ veto, pt>10

2 signal regions

- HT > 500
- MHT > 250

SUSY search in jets+MET

Background estimates

CMS

Method	Baseline selection		High-$\not{H}_T$ selection		High-H_T selection	
$Z \to \nu\bar{\nu}$ from γ+jets	26.3	±4.8	7.1	±2.2	8.4	±2.3
$t\bar{t}/W \to e, \mu$+X lost-lepton method	33.0	±8.1	4.8	±1.9	10.9	±3.4
$t\bar{t}/W \to \tau_{hadr}$+X method	22.3	±4.6	6.7	±2.1	8.5	±2.5
QCD Rebalance+Smear method	29.7	±15.2	0.16	±0.10	16.0	±7.9
QCD factorization method	25.2	±13.4	0.4	±0.3	17.3	±9.4
Total data-driven background	111.3	±18.5	18.8	±3.5	43.8	±9.2
Observed in 36 pb^{-1} of data	111		15		40	
95% C.L. limit on signal events	40.4		9.6		19.6	

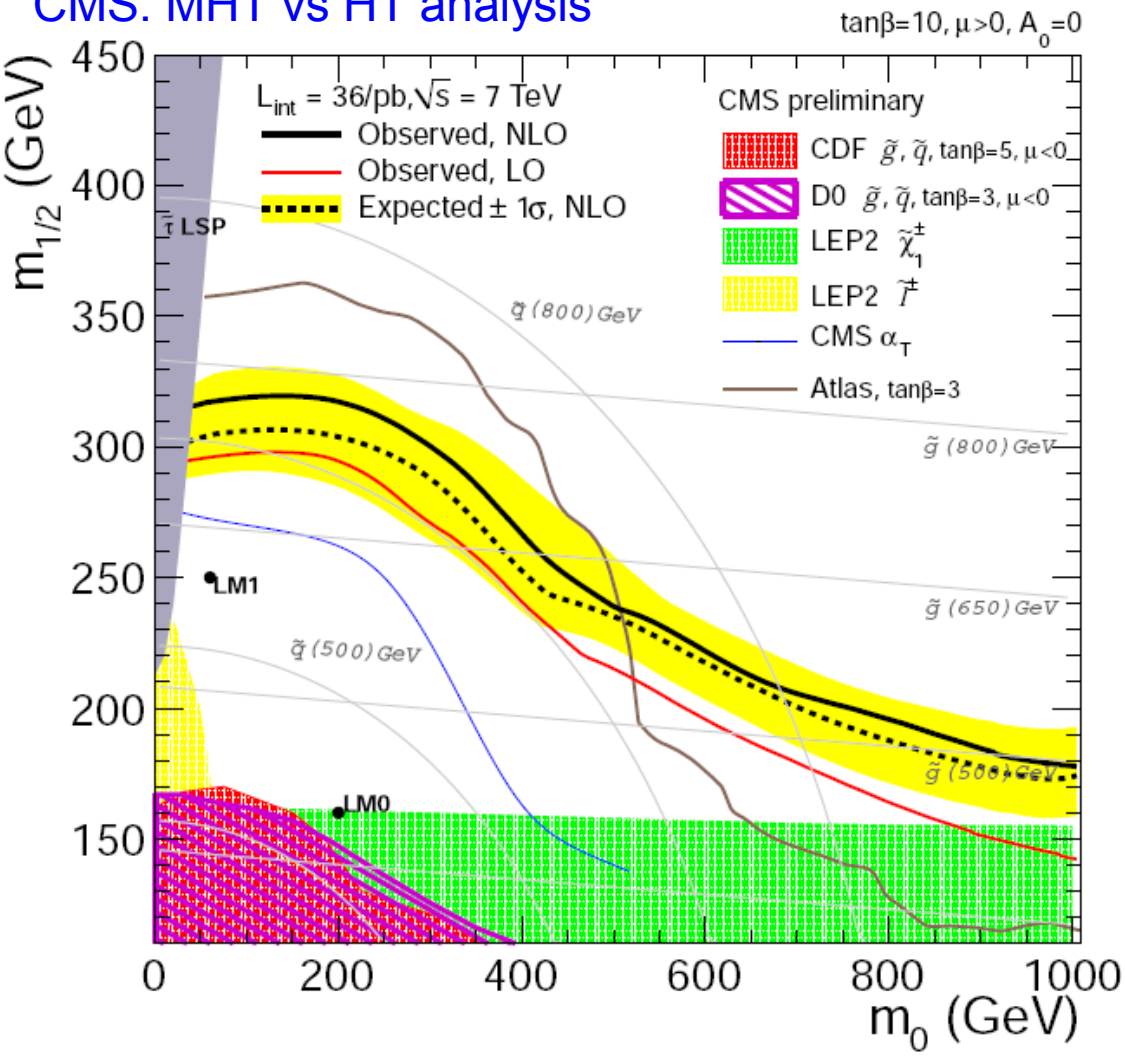
~20% bkg uncertainty!

ATLAS

	Signal region A	Signal region B	Signal region C	Signal region D
QCD	$7\ ^{+8}_{-7}$[u+j]	$0.6\ ^{+0.7}_{-0.6}$[u+j]	$9\ ^{+10}_{-9}$[u+j]	$0.2\ ^{+0.4}_{-0.2}$[u+j]
W+jets	50 ± 11[u] $^{+14}_{-10}$[j] $\pm$ 5[$\mathcal{L}$]	4.4 ± 3.2[u] $^{+1.5}_{-0.8}$[j] ± 0.5[$\mathcal{L}$]	35 ± 9[u] $^{+10}_{-8}$[j] $\pm$ 4[$\mathcal{L}$]	1.1 ± 0.7[u] $^{+0.2}_{-0.3}$[j] ± 0.1[$\mathcal{L}$]
Z+jets	52 ± 21[u] $^{+15}_{-11}$[j] $\pm$ 6[$\mathcal{L}$]	4.1 ± 2.9[u] $^{+2.1}_{-0.8}$[j] ± 0.5[$\mathcal{L}$]	27 ± 12[u] $^{+10}_{-6}$[j] $\pm$ 3[$\mathcal{L}$]	0.8 ± 0.7[u] $^{+0.6}_{-0.0}$[j] ± 0.1[$\mathcal{L}$]
$t\bar{t}$ and t	10 ± 0[u] $^{+3}_{-2}$[j] $\pm$ 1[$\mathcal{L}$]	0.9 ± 0.1[u] $^{+0.4}_{-0.3}$[j] ± 0.1[$\mathcal{L}$]	17 ± 1[u] $^{+6}_{-4}$[j] $\pm$ 2[$\mathcal{L}$]	0.3 ± 0.1[u] $^{+0.2}_{-0.1}$[j] ± 0.0[$\mathcal{L}$]
Total SM	118 ± 25[u] $^{+32}_{-23}$[j] $\pm$ 12[$\mathcal{L}$]	10.0 ± 4.3[u] $^{+4.0}_{-1.9}$[j] ± 1.0[$\mathcal{L}$]	88 ± 18[u] $^{+26}_{-18}$[j] $\pm$ 9[$\mathcal{L}$]	2.5 ± 1.0[u] $^{+1.0}_{-0.4}$[j] ± 0.2[$\mathcal{L}$]
Data	87	11	66	2

MSUGRA/CMSSM interpretation

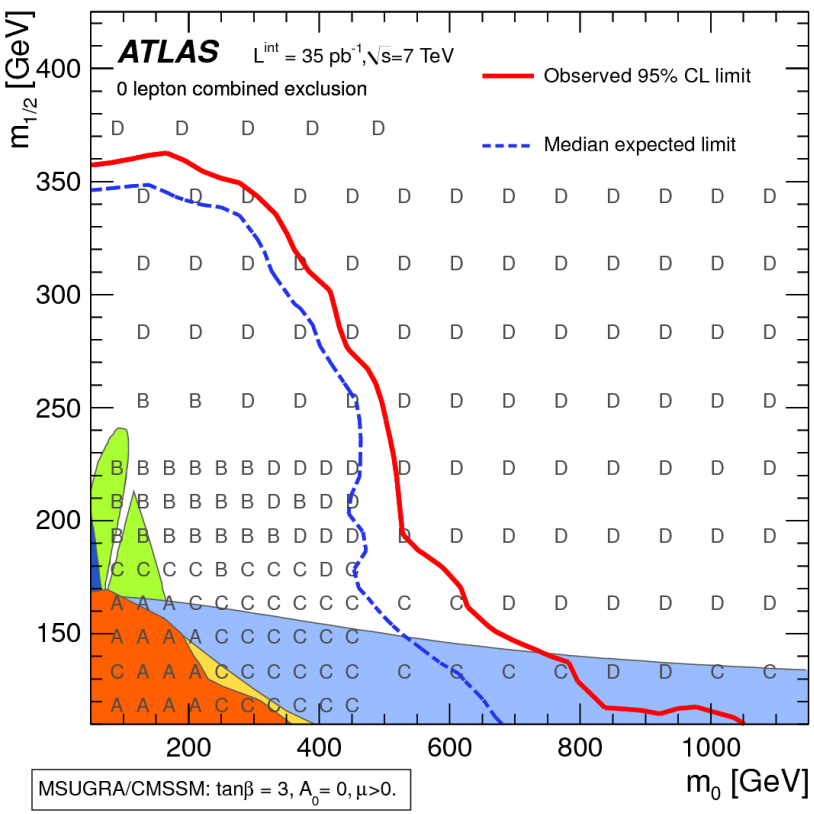
CMS: MHT vs HT analysis



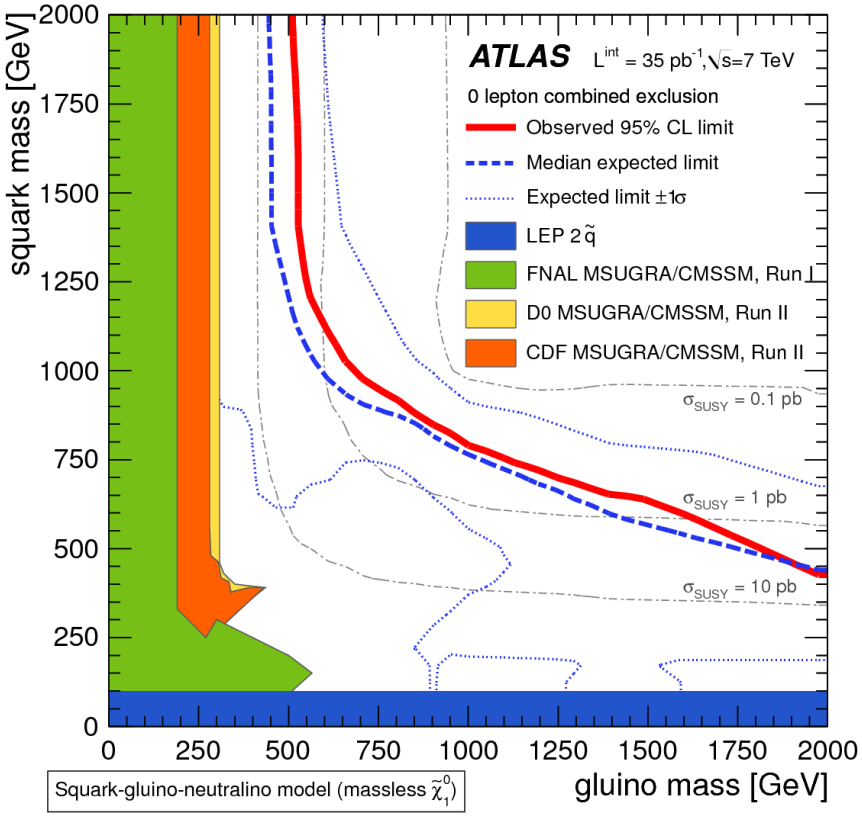
CMS:

- MHT selection more powerful for m0 < 450 GeV
- HT selection more powerful for large m0

ATLAS:

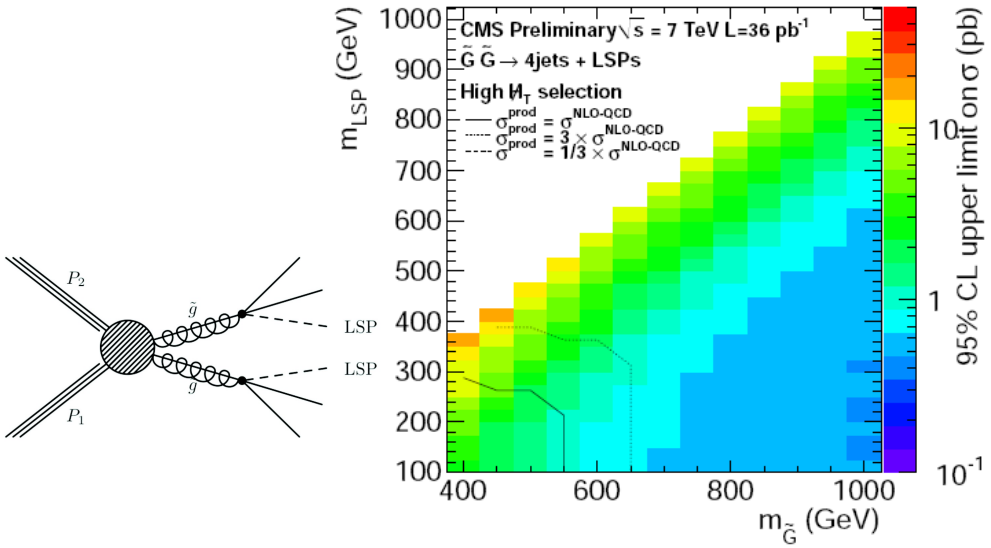


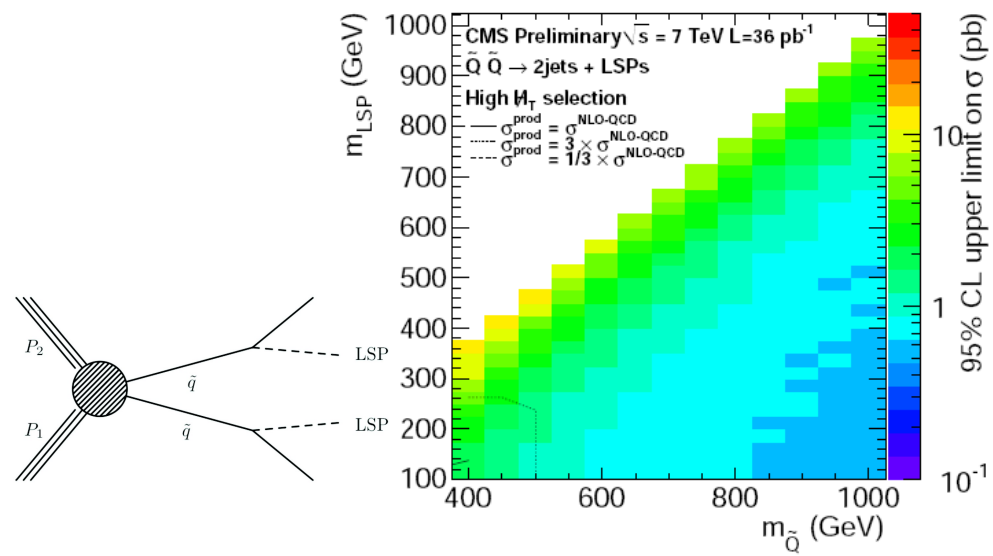
simplified model interpretation



Simplified MSSM model containing only gluino, squarks of 1st and 2nd generation and massless χ_1^0

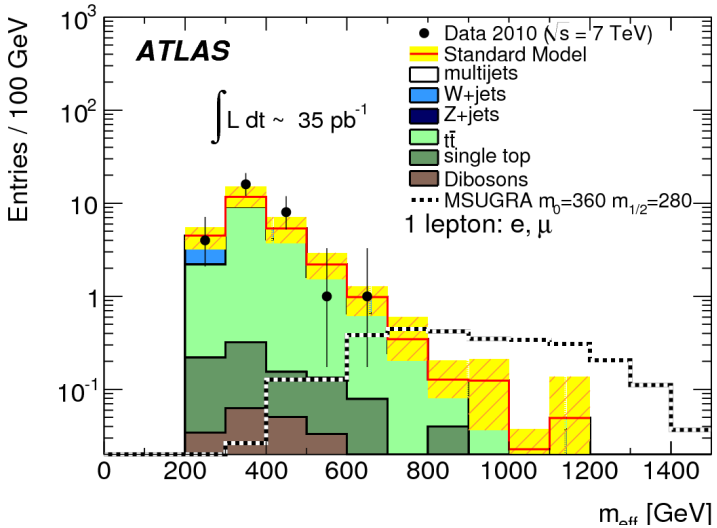
Limits from MHT analysis

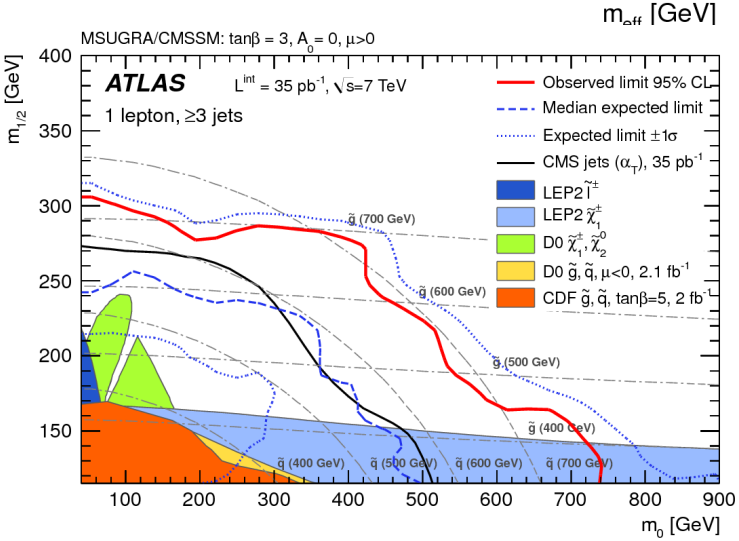




1 lepton + jets + MET

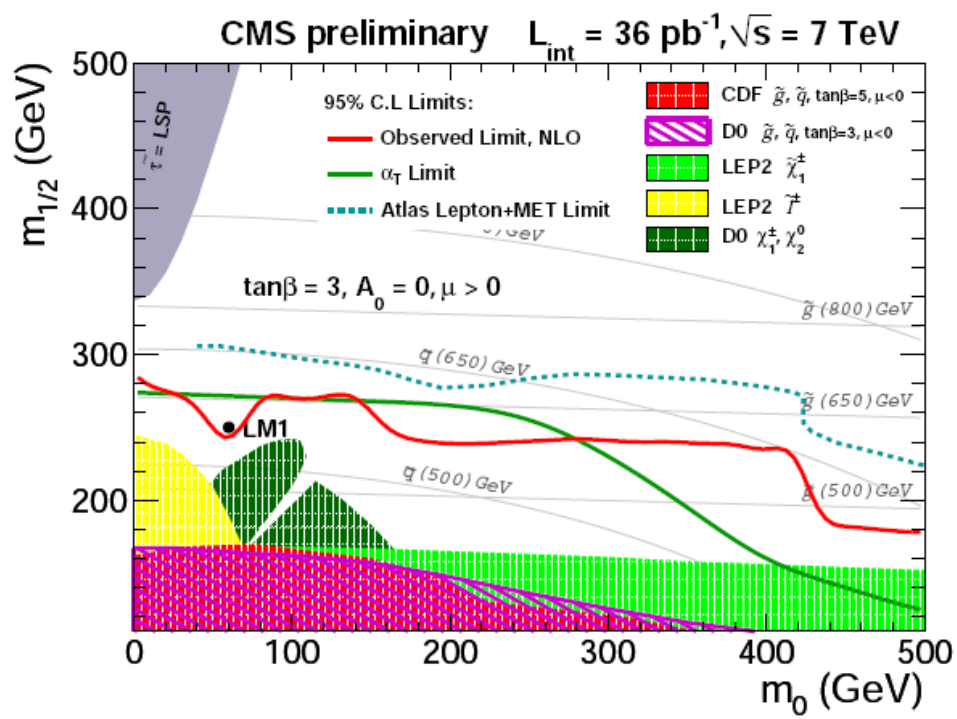
1 e or μ (pt > 20)
≥ 3 jets, pt > (60,30,30)
MET > 125, Meff > 500





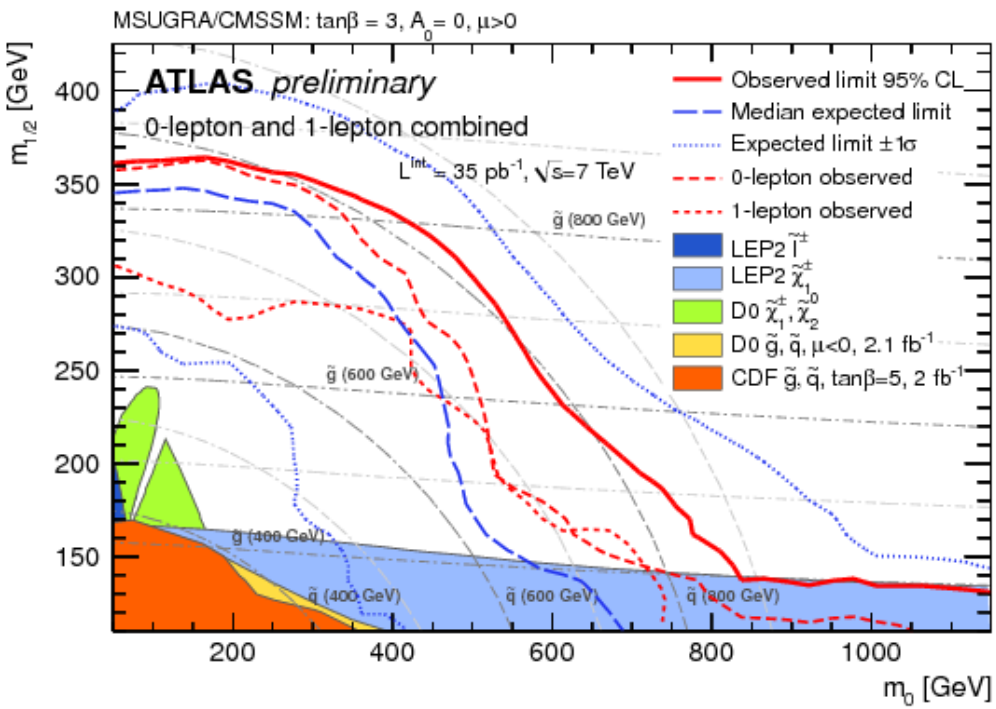
1 e or μ (pt > 20)
≥ 4 jets, pt > 30
MET > 250, HT > 500

Sample	$\ell = \mu$	$\ell = e$
Predicted SM 1 ℓ	1.7 ± 1.4	1.2 ± 1.0
Predicted SM dilepton	$0.0^{+0.8}_{-0.0}$	$0.0^{+0.6}_{-0.0}$
Predicted single τ	0.29 ± 0.22	$0.32^{+0.38}_{-0.32}$
Predicted QCD background	0.09 ± 0.09	$0.0^{+0.16}_{-0.0}$
Total predicted SM	2.1 ± 1.5	1.5 ± 1.2
Observed signal region	2	0

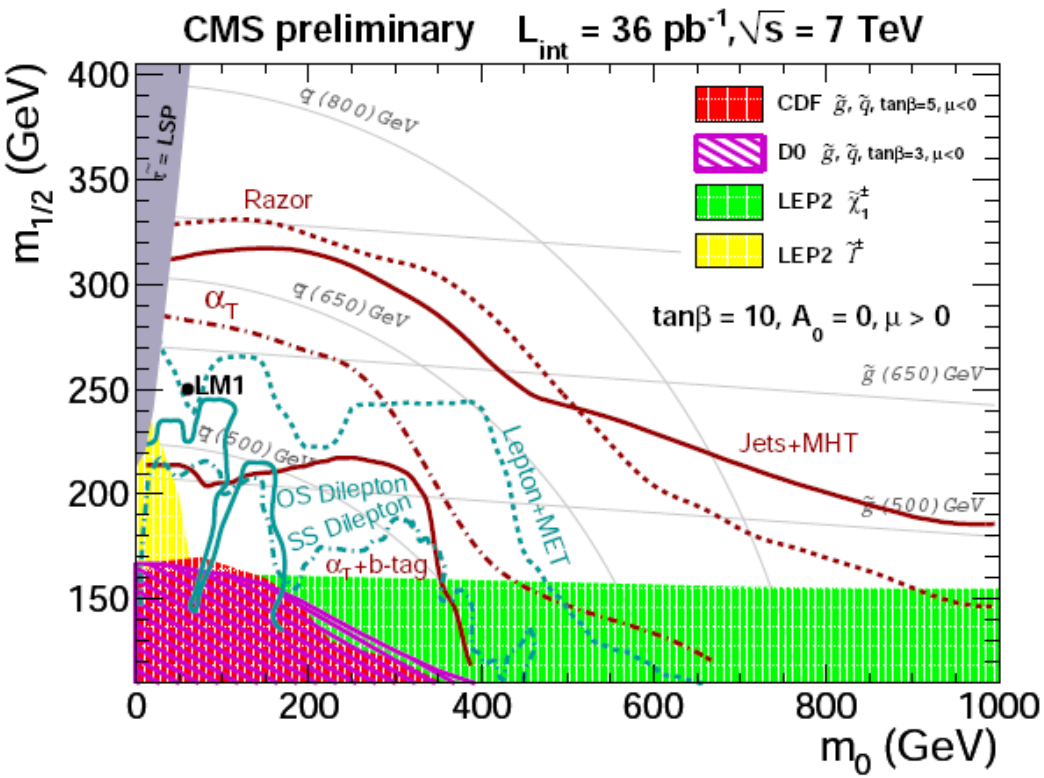


MSUGRA/CMSSM: the state of the art

ATLAS: combination of 0-lepton and 1-lepton channels



CMS: summary of SUSY searches 2010



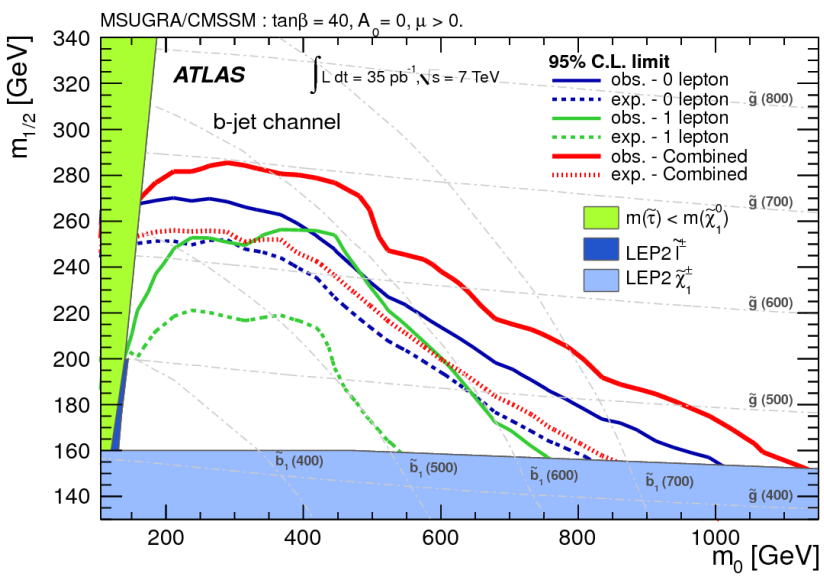
SUSY search in bjets+MET

$\geq$ 3 jets, with at least 1 btag
Two analyses: with/without 1 lepton

MET & HT define the signal region

estimated bkg

	0-lepton	1-lepton Monte Carlo	1-lepton data-driven
$t\bar{t}$ and single top	12.2 ± 5.0	12.3 ± 4.0	14.7 ± 3.7
W and Z	6.0 ± 2.0	0.8 ± 0.4	-
QCD	1.4 ± 1.0	0.4 ± 0.4	$0^{+0.4}_{-0.0}$
Total SM	19.6 ± 6.9	13.5 ± 4.1	14.7 ± 3.7
Data	15	9	9



$\geq$ 2 jets, with at least 1 btag

$$\alpha_T = \frac{E_T^{j2}}{M_T^{j1,j2}}$$

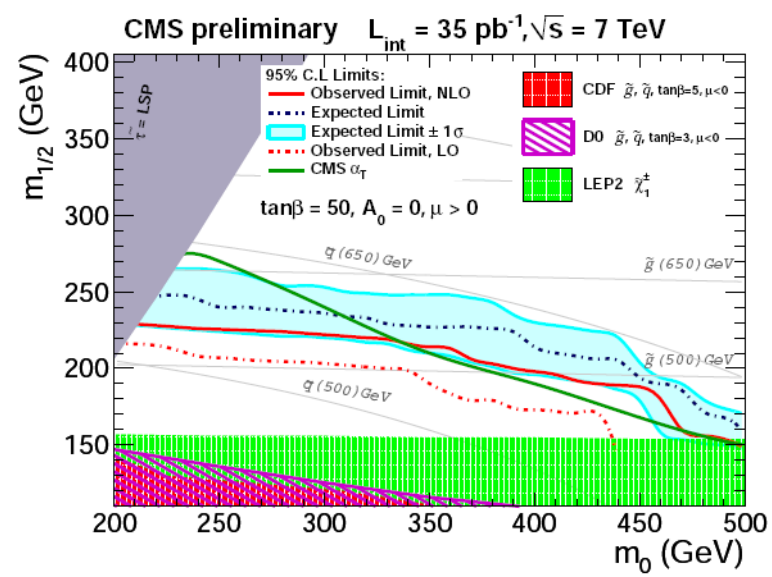
α_T & HT define the signal region

bkg from MC

N-jets	QCD	$t\bar{t}$	W	$Z \to \nu\bar{\nu}$	$Z \to l^+l^-$	total
2	0 ± 0.11	0.01 ± 0.01	0 ± 0.1	0 ± 0.09	0 ± 0.09	0.01 ± 0.21
≥ 3	0.05 ± 0.05	1.08 ± 0.07	0.10 ± 0.10	0.38 ± 0.18	0 ± 0.09	1.61 ± 0.26

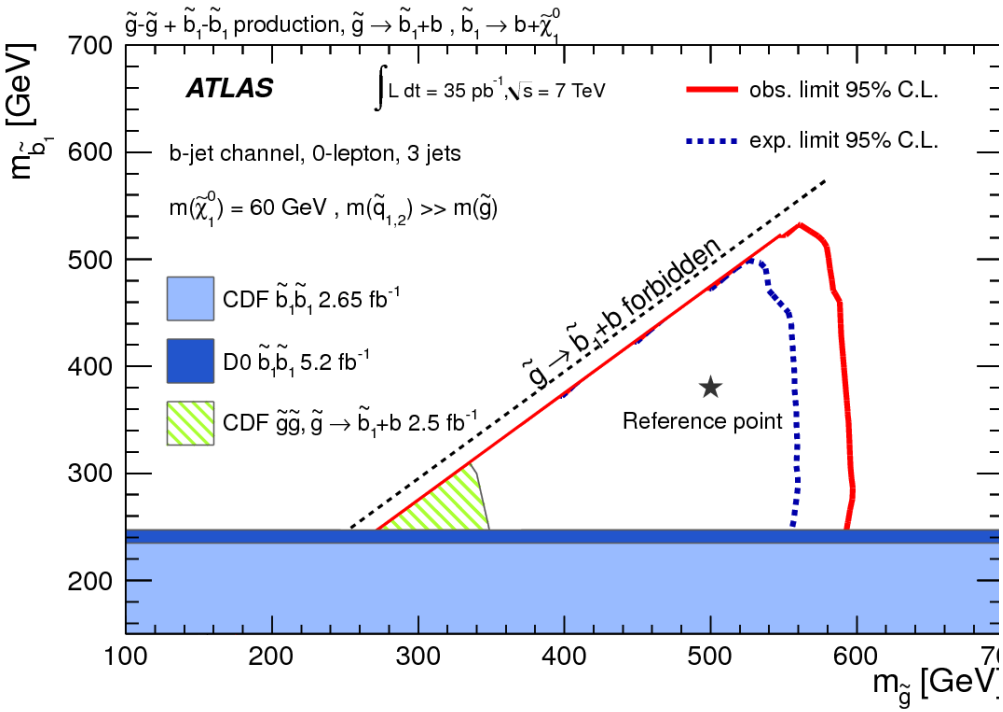
bkg from data

N-jets	MC	Background Prediction	Data	LM0
≥ 2	1.61 ± 0.26	$0.33^{+0.43}_{-0.33}$ (stat) ± 0.13 (syst)	1	14.2 ± 0.3

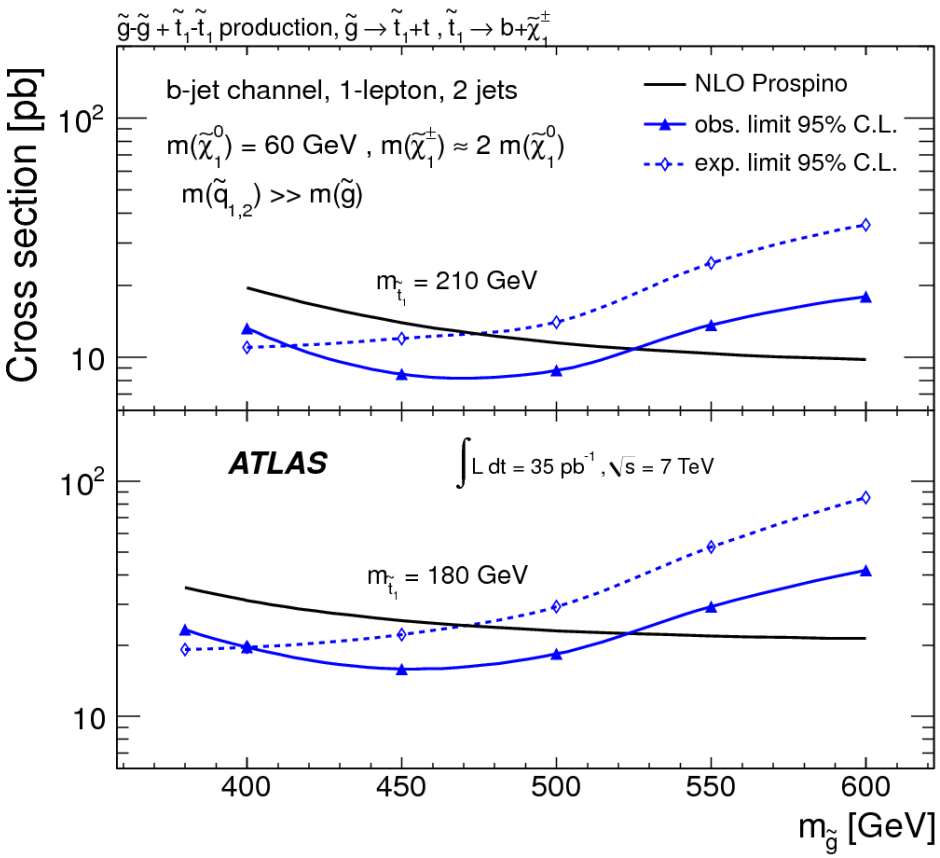


bjet channel: add'l interpretation

$\tilde{g} \rightarrow \tilde{b}_1 b \quad \tilde{b}_1 \rightarrow b\tilde{\chi}_1^0$



$\tilde{g} \rightarrow \tilde{t}_1 t \quad \tilde{t}_1 \rightarrow b\tilde{\chi}_1^{\pm}$



SUSY w. leptons + jets + MET

Signature	ATLAS	CMS
2leptons + (jets) + MET	arXiv:1103.6214 (OS+SS) arXiv:1103.6208 (FS)	arXiv:1103.1348 (OS) arXiv:1104.3168 (SS)
multileptons + jets + MET	ATLAS-CONF-2011-039	SUS10008 (plots only)

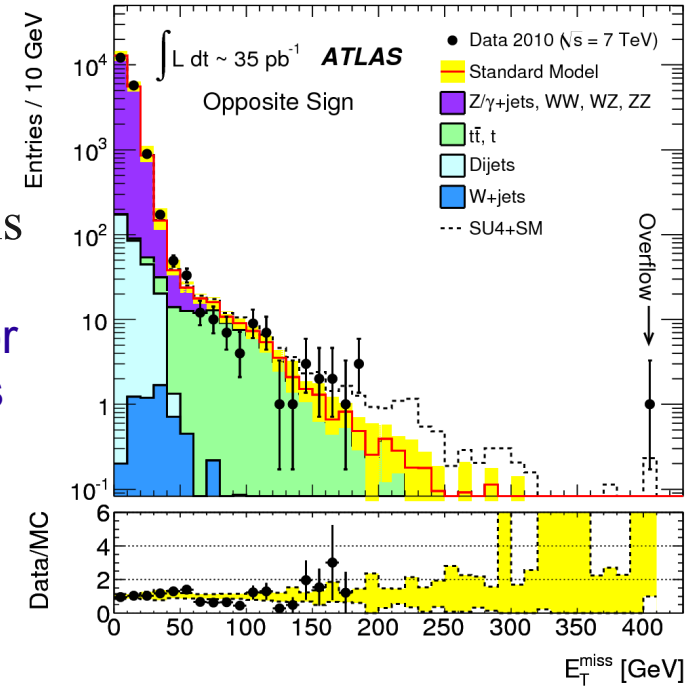
FS = "flavor subtraction" : measure yield of $e^+e^- + \mu^+\mu^- - e^+\mu^-$

OS dileptons + (jets) + MET

2 OS leptons, pt > 20, MET > 150 (100 for FS analysis), no jet requirement

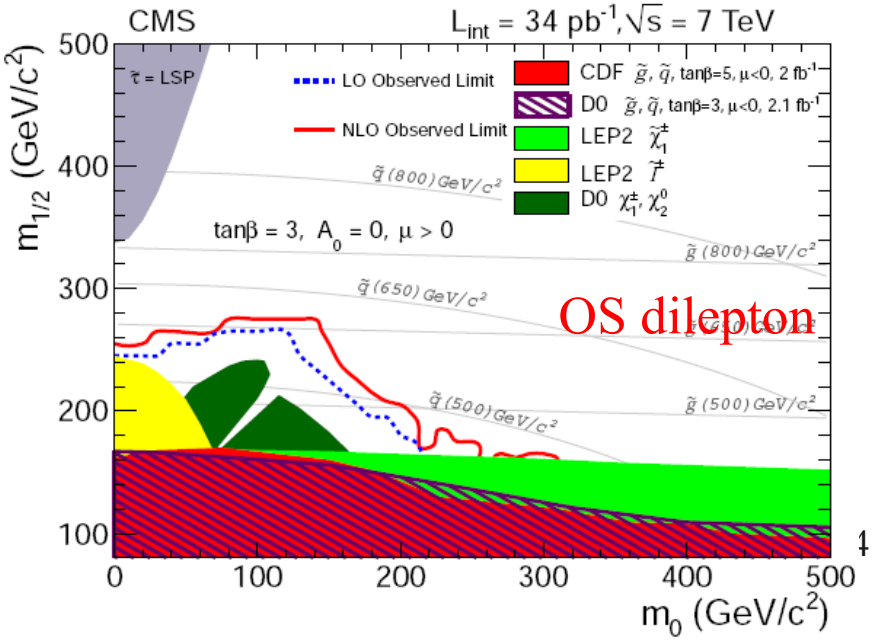
Consistent with expectations

See next slide for example of limits



2 leptons, pt > (20,10), OS, Z veto
≥ 2 jets, pt > 30
HT > 300, MET/√HT > 8.5

sample	N_A	N_B	N_C	N_D	$N_A \times N_C/N_B$
$t\bar{t} \to \ell^+\ell^-$	8.44 ± 0.18	32.83 ± 0.35	4.78 ± 0.14	1.07 ± 0.06	1.23 ± 0.05
$t\bar{t} \to$ other	0.12 ± 0.02	0.78 ± 0.05	0.16 ± 0.02	0.02 ± 0.01	0.02 ± 0.01
Drell Yan	0.17 ± 0.08	1.18 ± 0.22	0.04 ± 0.04	0.12 ± 0.07	0.01 ± 0.01
$W^\pm$ + jets	0.00 ± 0.00	0.09 ± 0.09	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
W^+W^-	0.11 ± 0.01	0.29 ± 0.02	0.02 ± 0.01	0.03 ± 0.01	0.01 ± 0.00
$W^\pm Z$	0.01 ± 0.00	0.04 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
ZZ	0.01 ± 0.00	0.02 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
single top	0.29 ± 0.01	1.04 ± 0.03	0.04 ± 0.01	0.01 ± 0.00	0.01 ± 0.00
total SM MC	9.14 ± 0.20	36.26 ± 0.43	5.05 ± 0.14	1.27 ± 0.10	1.27 ± 0.05
data	12	37	4	1	1.30 ± 0.78
LM0	4.04 ± 0.19	4.45 ± 0.20	13.92 ± 0.36	8.63 ± 0.27	12.63 ± 0.88
LM1	0.52 ± 0.02	0.26 ± 0.02	1.64 ± 0.04	3.56 ± 0.06	3.33 ± 0.27



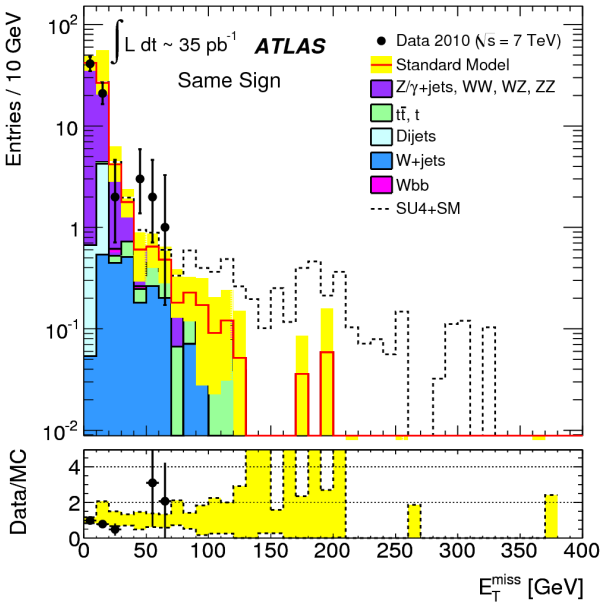
ATLAS flavor subtraction analysis sets limits on "S"

$$\mathcal{S} = \frac{N(e^\pm e^\mp)}{\beta(1-(1-\tau_e)^2)} - \frac{N(e^\pm \mu^\mp)}{1-(1-\tau_e)(1-\tau_\mu)} + \frac{\beta N(\mu^\pm \mu^\mp)}{(1-(1-\tau_\mu)^2)}$$

$S_s < 8.8$ at 95% CL

SS dileptons + (jets) + MET

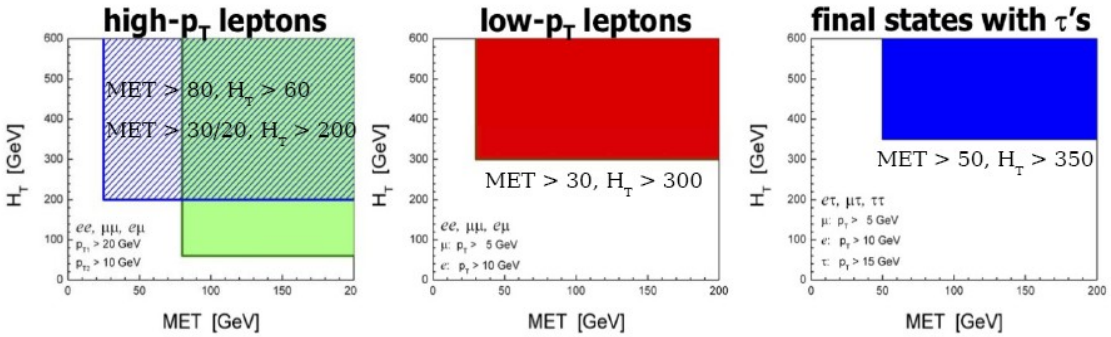
2 SS leptons, pt > 20, MET > 100
No jet requirement



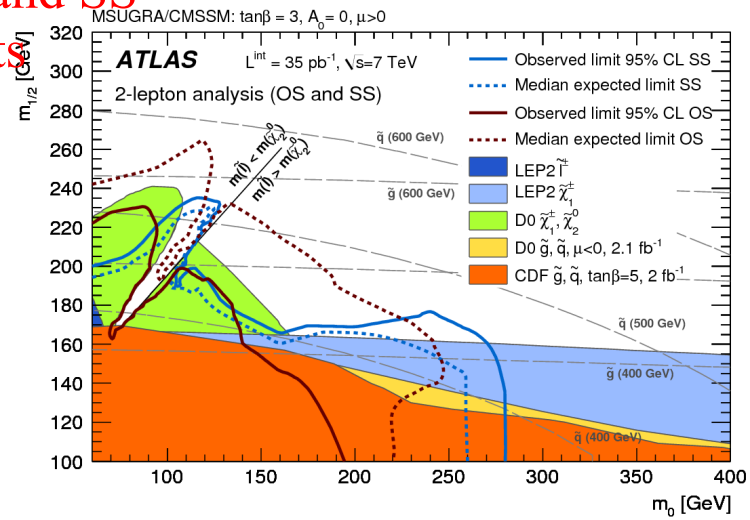
Consistent with expectations

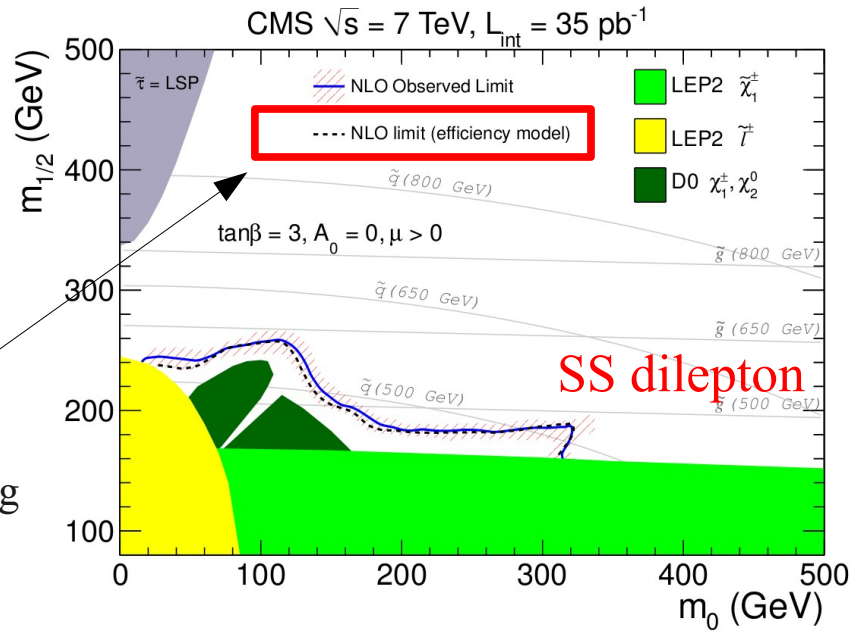
4 search regions; OR of leptonic and hadronic triggers

(fig: S.Padhi)



OS and SS limits



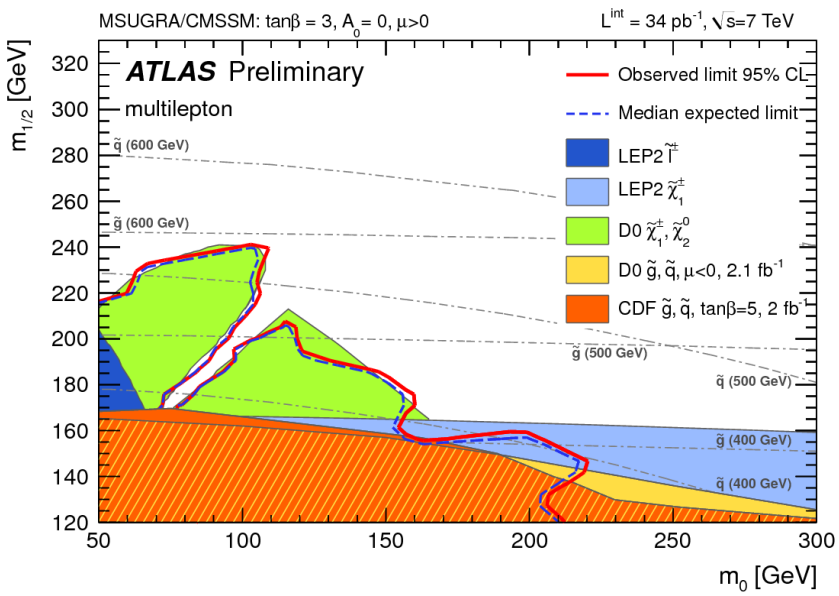


limits also derived using a simple efficiency model

Multileptons + jets + MET

e and μ, pt > 20,20,20(e) or 10(μ)
Z veto, m(ℓℓ) < 20 also vetoed
≥ 2 jets, pt > 50
MET > 50

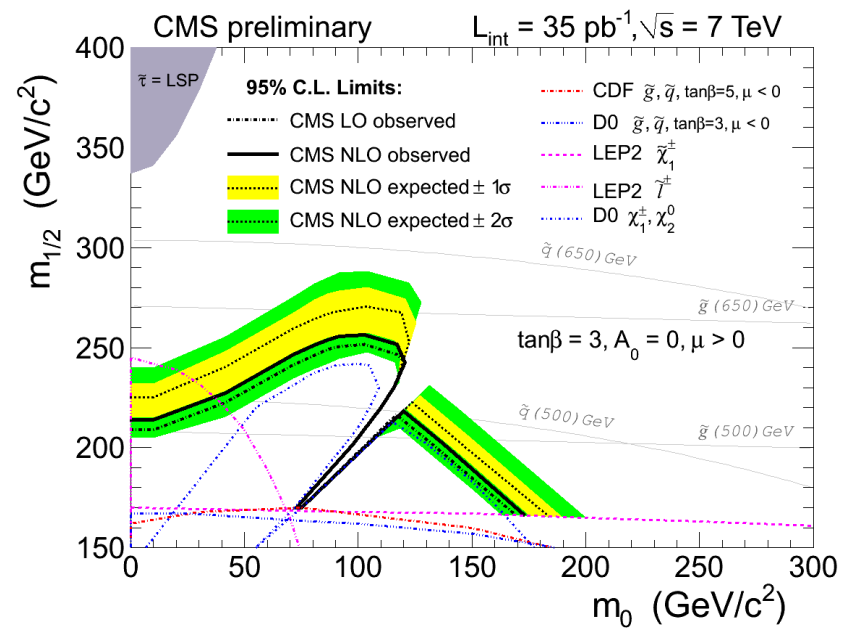
- 19 events with 3 leptons (before other cuts). 0 events after cuts
- 0 events with 4 or more leptons



Limits also set in simplified MSSM models

≥ 3 leptons, including taus! pt from 8 GeV
Tau: full tau ID; also isolated track
MET > 50 or H_T > 200

Complex analysis: many exclusive search channels



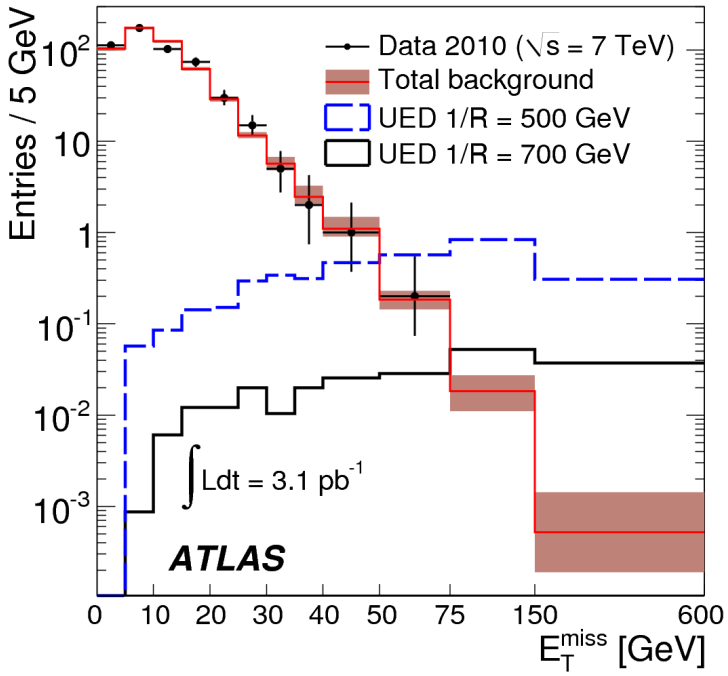
Limits also set in other models:
RPV, slepton co-NLSP

photon(s)+(lepton)+MET

Signature	ATLAS	CMS
diphoton+MET	arXiv:1012.4272 (3.1 pb^{-1})	arXiv:1103.0953
lepton+photon +MET		SUS110002 (plots only)

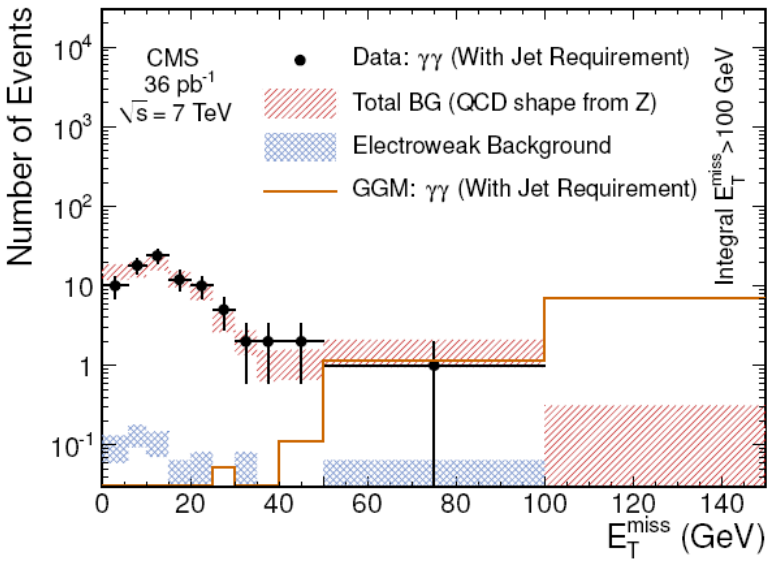
diphoton + (jet) + MET

2 photons, Et > 25
No jet requirement
MET > 75

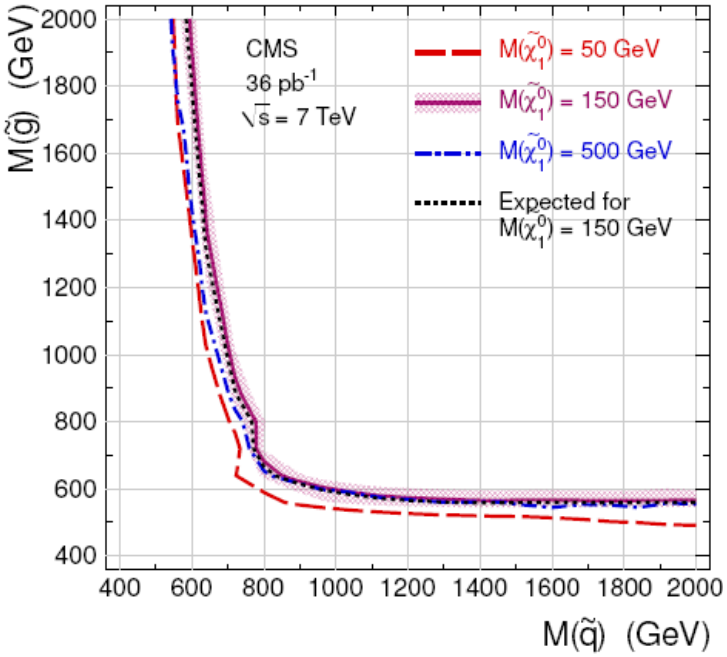


Set limits on UED model:
1/R < 729 GeV at 95% CL

2 photons, Et > 30
≥ 1 jets, Et > 30
MET > 50



Set limits in a simplified General Gauge Mediation model



Conclusion and outlook

ATLAS and CMS have explored a wide variety of signatures for signs of New Physics with integrated luminosities ~40 pb^{-1} for each experiment

A variety of objects have been studied in a number of combinations.

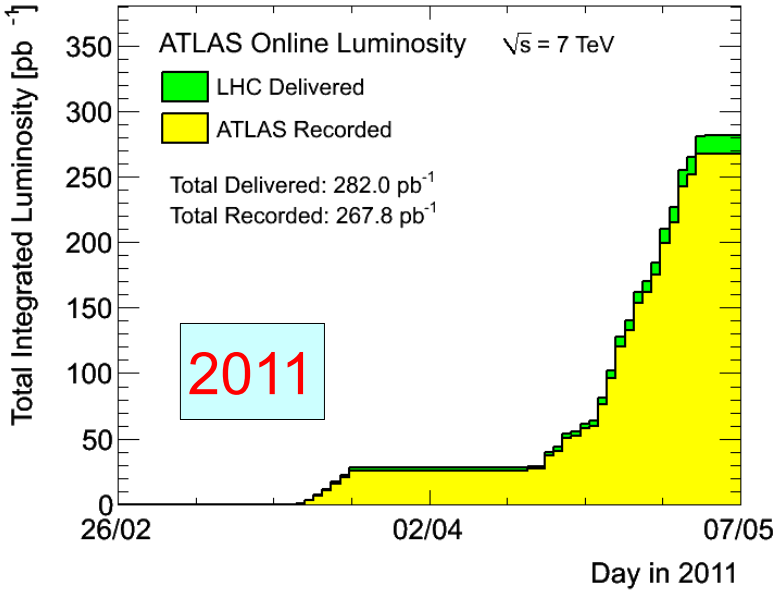
- e, μ, tracks, jets, MET are routine
- bjets and taus starting to get looked at

No sign of New Physics yet. Limits significantly improve over Tevatron in many cases. SUSY was not "just around the corner"

Both experiments are starting to explore ways to present their results in less model-dependent ways.

Expect 30-100 times more data by the end of 2011.

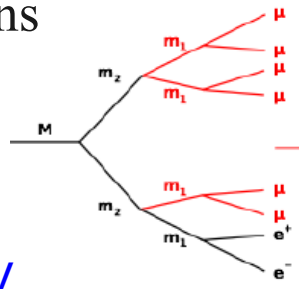
Collected x7 of 2010 dataset already! →



Extra material

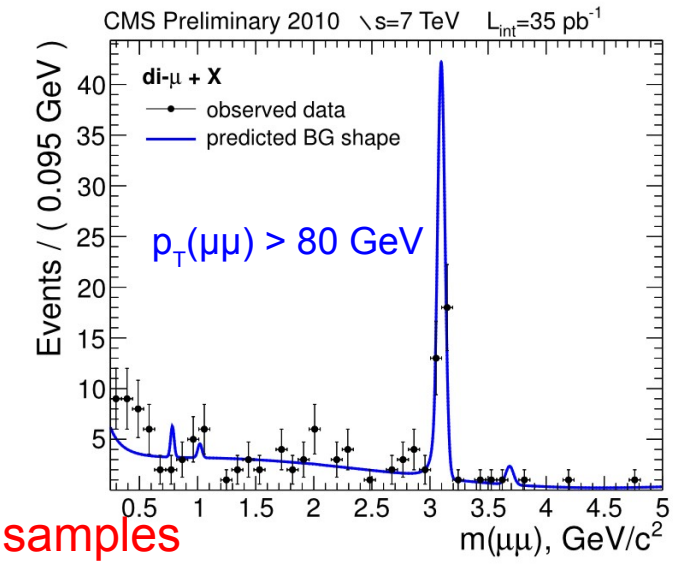
muon jets

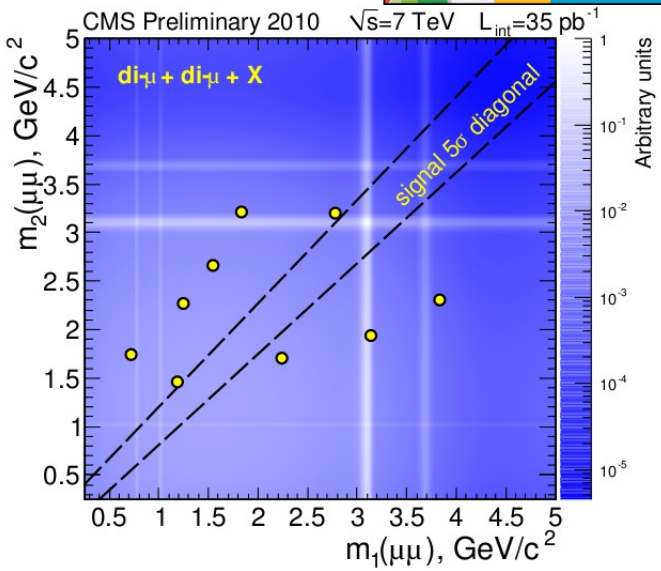
Inclusive search for collimated groups of dimuons



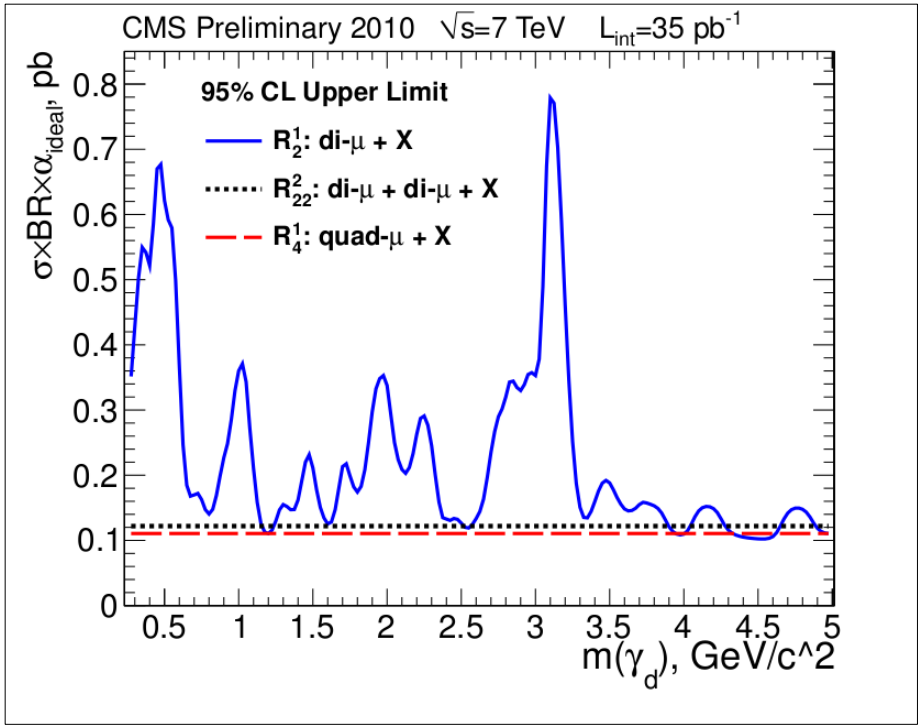
m(μμ) < 9 GeV
look for μμ, μμ+μμ, μμμμ

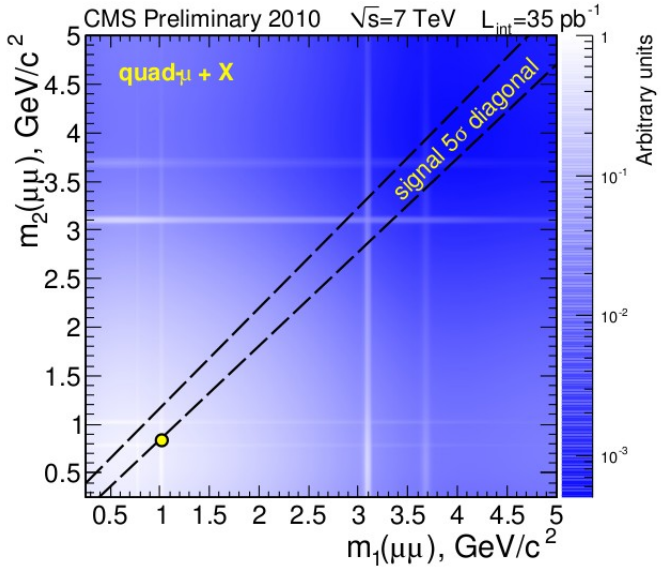
bkg templates from low p_T(μμ) samples





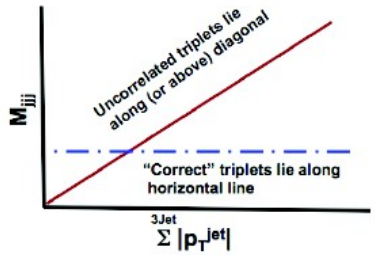
Model -independent limits on σ·Br·A

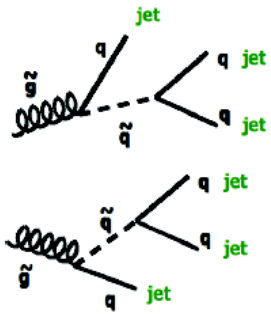




multijet & ttbar resonances

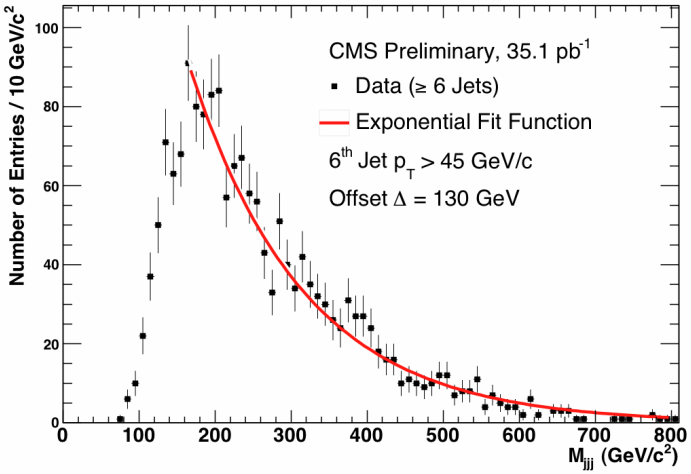
Search for 3-jet resonances in multijet events (≥6 jet events)





Require:

- $\sum|p_T(\text{jet})| > 425$ GeV
- $M_{jjj} < \sum|p_T(\text{jet})|$ - "Δ offset"



Exclude gluino pair production with RPV decay for gluino masses < 280 GeV

Search for ttbar resonance in lepton+jets.

Simultaneous fit to 8 distributions
2(e,μ) x [3j1btag + 4j(0,1,2)btag]

Set limits on σ·Br