Beyond the Standard Model: results from the Tevatron and LHC

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presented on behalf of the
ATLAS, CMS, CDF and D0 collaborations

at DPF 2011, Brown University

Desert (particle physics)

From Wikipedia, the free encyclopedia

In particle physics, the **desert** refers to a theorized gap in energy scales between the TeV scale and the GUT scale in which no new physics appears. The idea of the desert was motivated by the observation of approximate, order of magnitude, gauge coupling unification at the GUT scale. Adding additional new physics at an intermediate scale generically disrupts the gauge coupling unification. With the Minimal Supersymmetric Standard Model particle content, adjustment of parameters can make this unification exact. This unification is not unique, since alternative scenarios like the Katoptron model can also lead to exact unification after a similar energetic desert. If neutrino masses are due to a seesaw mechanism, the seesaw scale should lie within the desert.

The attraction of a desert is that, in such a scenario, measurements of TeV scale physics at the near-future colliders LHC and ILC will allow extrapolation all the way up to the GUT scale. An alternative to a desert is a series of new physical theories unfolding with every few orders of magnitude increase in energy scale.

What's New

By Bob Park

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Friday, July 29, 2011

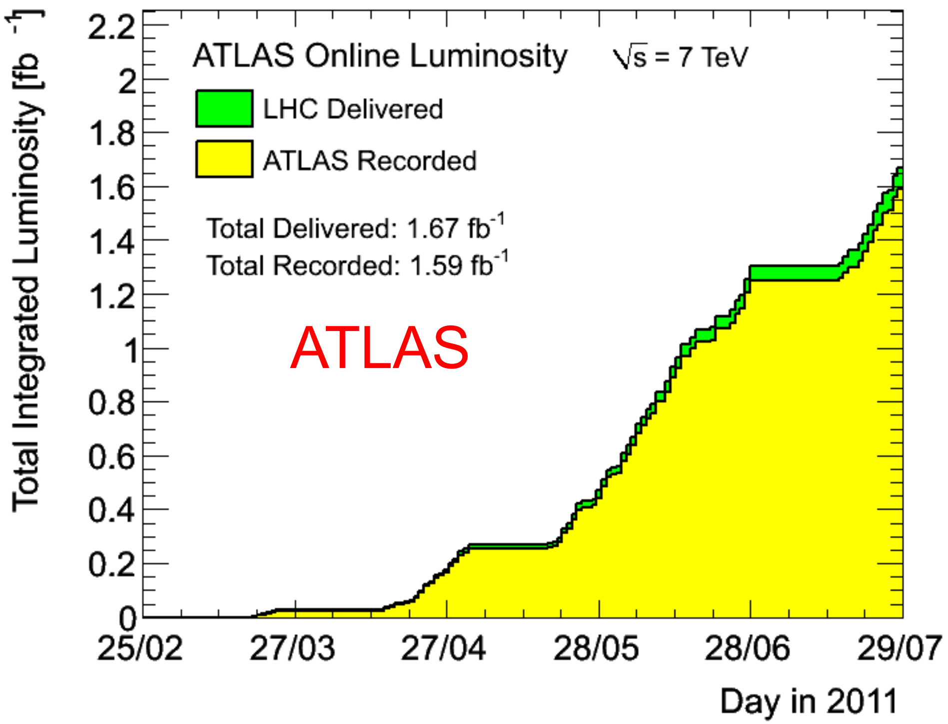
Peak energy of 7 TeV is scheduled for 2014, but theyve had their first good look now at 3.5 TeV. It reminds me of NASA's initial look w ith the Viking 2 Lander on Mars, 32 years ago. The Lander had just arrived; not gently, but intact. We w ere about to see the first pictures of Mars, close- up. Carl Sagan w as there, looking very nervous. The camera w ould rotate 360 giving a panoramic view . No one knew exactly w hat to expect; perhaps some unexpected this life form? Everything, including the sky, w as in shades of pink. Any hope of seeing something totally unexpected w as dashed. The desolate, boulder-strew n landscape, littered w ith sharp-edged boulders, w as utterly desolate. I can never forget the devastated look on Carl's face. Looking at LHC spectra this summer must have been like that for high-energy physicists. Everything you knew you should expect to find from the standard model w as there, and nothing else.

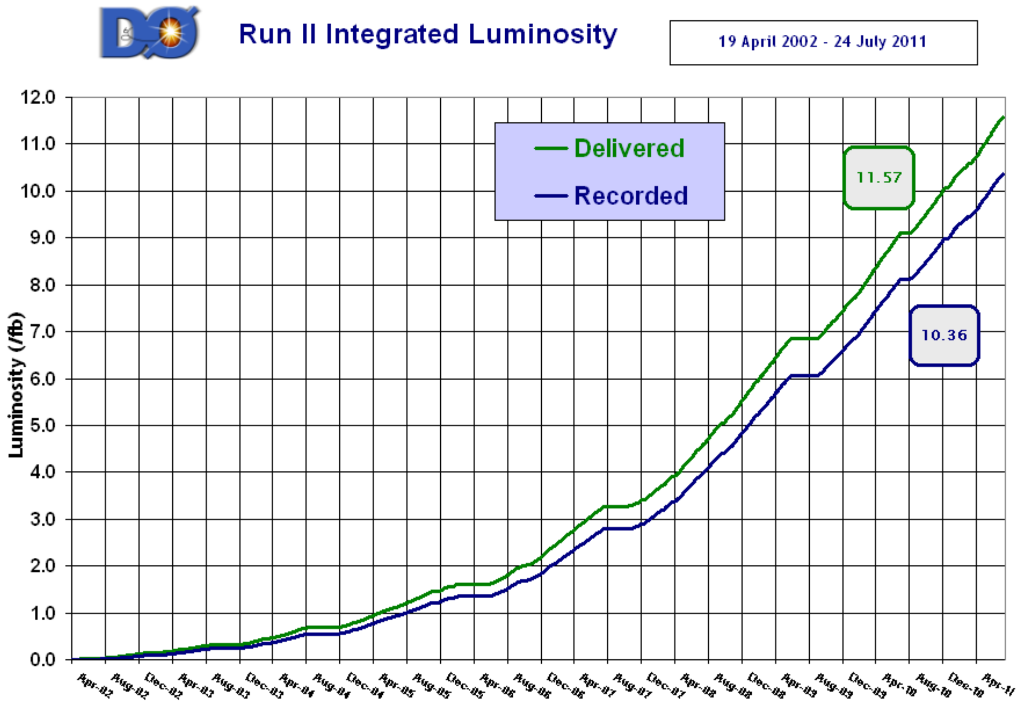
Plan for this talk

Not possible to cover all the searches that have been done.

- Tevatron searches:
  - Will give a one-page summary of the most recent results
  - However, I will focus only on two "anomalies" that have attracted attention in recent months
- LHC searches
  - Give priority to the latest results (1 fb^{-1}) from ATLAS and CMS
  - Searches involving top quarks will be covered elsewhere (K.Tollefson)
- Outlook and conclusion

Datasets





Peak stable luminosity: ~2 x 10^{33} cm^{-2} s^{-1}

CDF and D0 are showing results of BSM searches from typically 5-6 fb^{-1} (but up to ~9) analyzed

ATLAS and CMS have produced search results with up to 1 fb^{-1} of data analyzed


Results from the Tevatron
....?

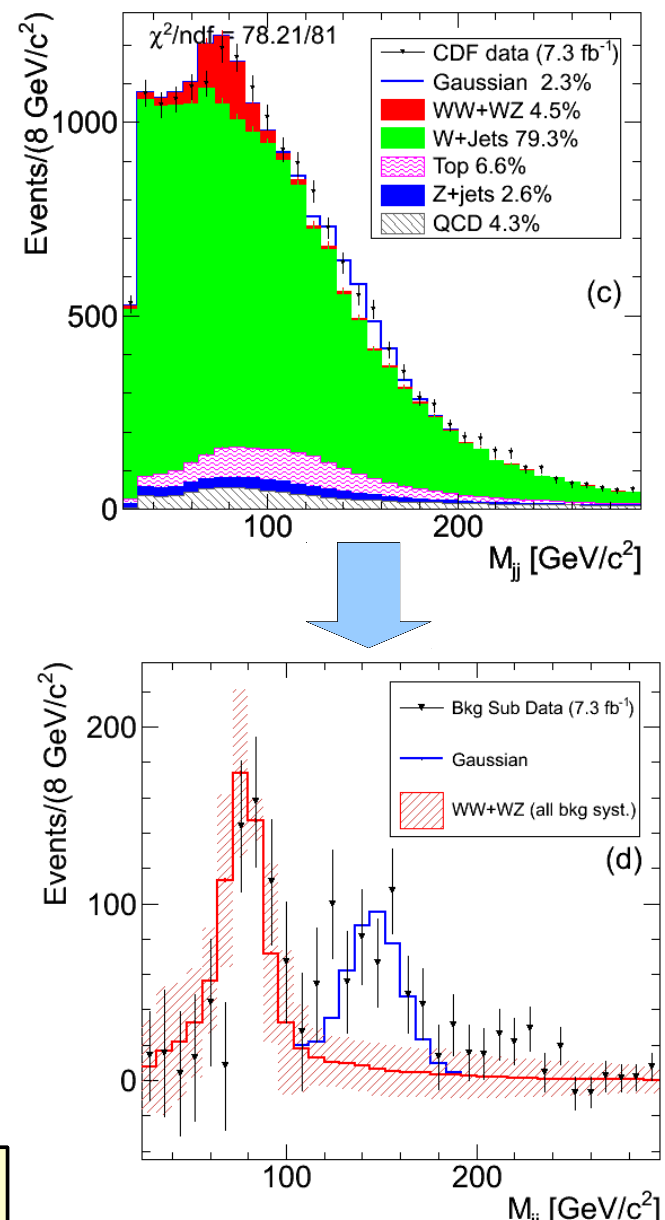
dijet mass in W+2jets (CDF)

In arXiv:1104.0699 (PRL 106 (2011) 171801)
CDF reported an excess in the 120-160 GeV mass range in W+2jets based on 4.3 fb^{-1}

The analysis has been recently extended to 7.3 fb^{-1}
(http://www-cdf.fnal.gov/physics/ewk/2011/wjj/7_3.html)

Using the same analysis methods, the excess increases from 3.2σ to 4.1σ

Exactly 2 jets with pt > 30
Exactly one isolated lepton with pt > 20
Lepton veto, Z veto
MET > 25
pt(jj) > 40
M_T(W) > 30
|Δη(jj)| < 2.5



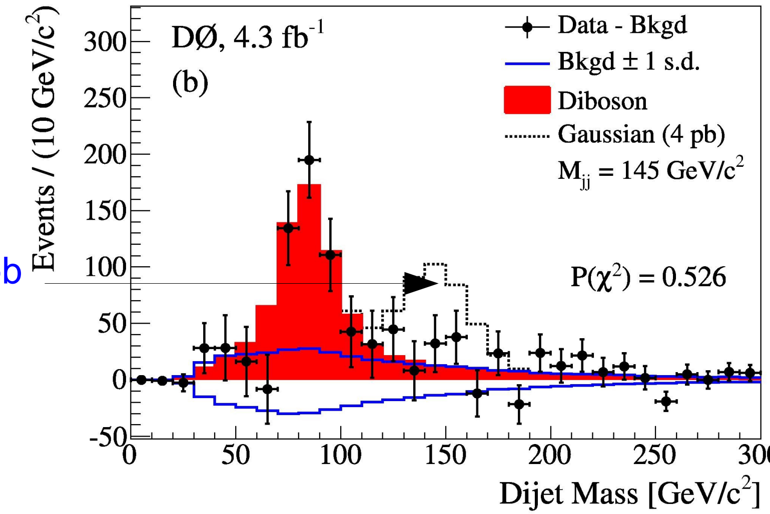
Cross section of the excess: 3.0 ± 0.7 pb

dijet mass in W+2jets (D0, ATLAS)

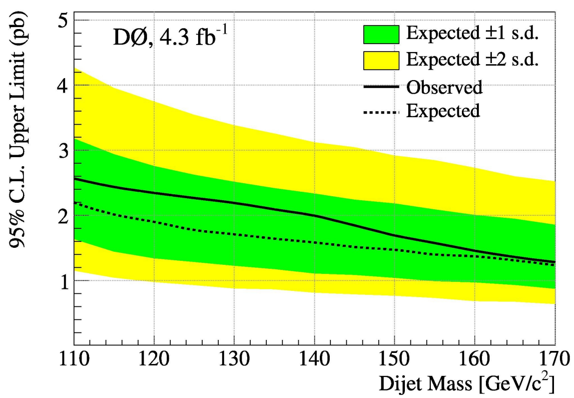
D0: arXiv:1106.1921 (PRL 107 (2011) 011804)

D0 ($4.3\ fb^{-1}$) does not confirm the CDF excess following the same analysis methodology

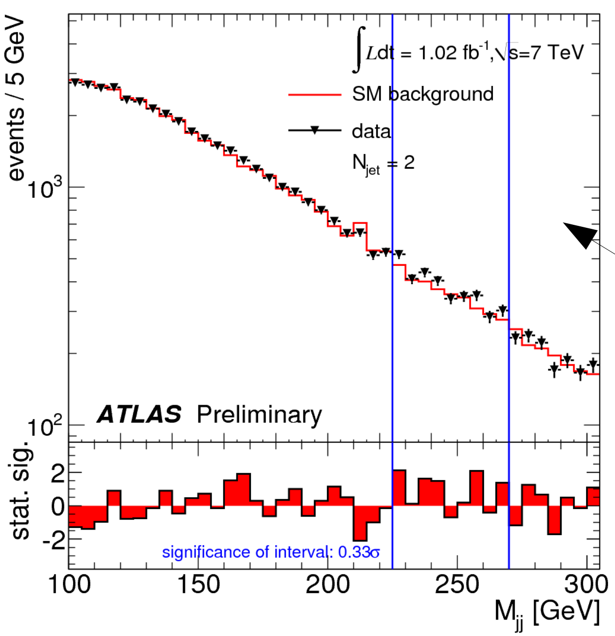
using original (crude) CDF xsec estimate of 4 pb



D0 cross section limit

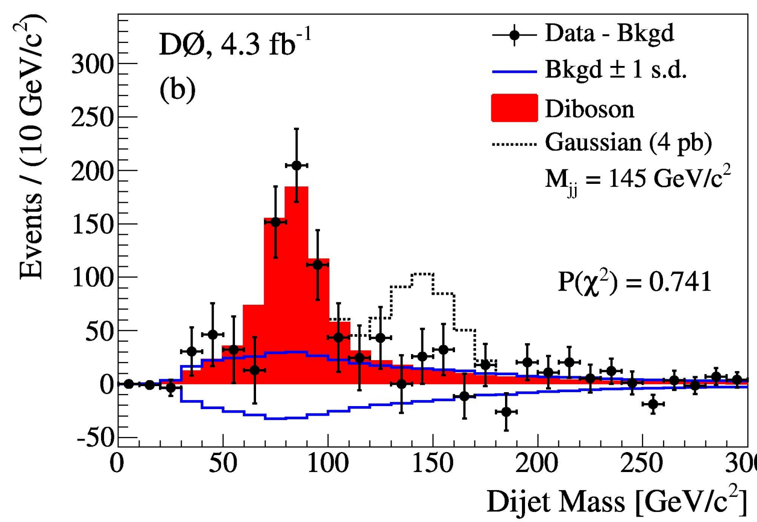


No change in conclusions when kinematic corrections are applied to the MC



ATLAS also sees nothing

ATLAS-CONF-2011-097



ttbar FB asymmetry (CDF)

$$A^{t\bar{t}} = \frac{N(\Delta y > 0) - N(\Delta y < 0)}{N(\Delta y > 0) + N(\Delta y < 0)} = \frac{N(y_t^{t\bar{t}} > 0) - N(y_t^{t\bar{t}} < 0)}{N(y_t^{t\bar{t}} > 0) + N(y_t^{t\bar{t}} < 0)}$$

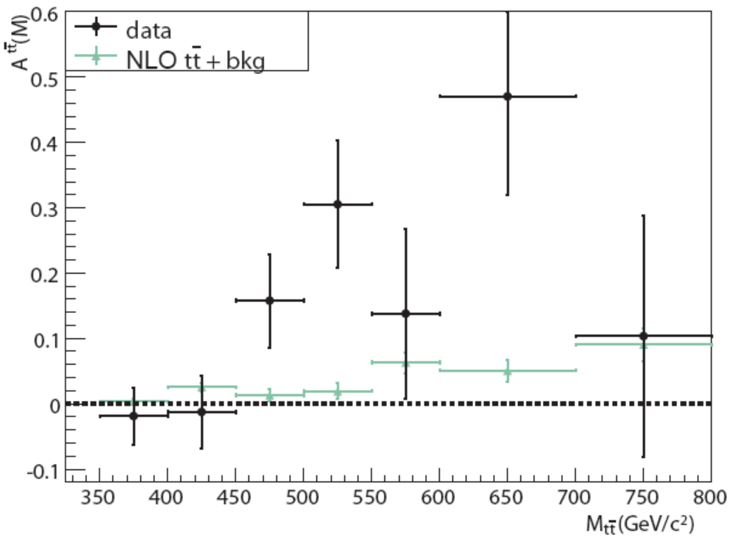
In arXiv:1101.0034 (PRD83 (2011) 112003)
CDF observed a significant departure from SM expectations in the FB asymmetry of ttbar production (l+jets) in both large Δy and large M(tt)

$A^{tt} = 0.475 \pm 0.114$ (at parton level in ttbar rest frame for M(tt)>450 GeV)

3.4 σ effect

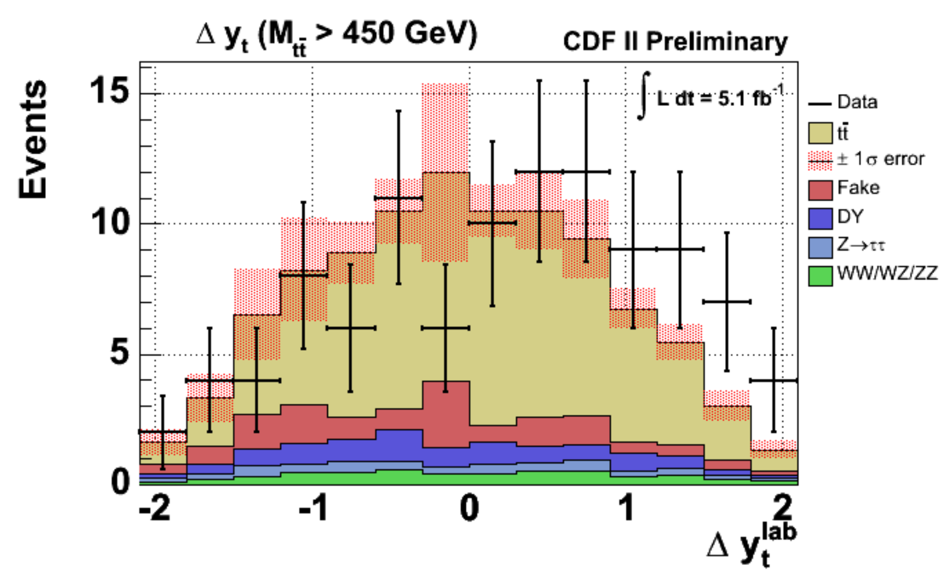
vs MCFM prediction: $A^{tt} = 0.088 \pm 0.013$

CDF 5.3 fb^{-1}



2.3 σ effect seen in dilepton channel (CDF Note 10436)

$A^{tt} = 0.42 \pm 0.15$ (stat) ± 0.05 (sys)



New physics or deficiency of NLO QCD calculations?

ttbar FB asymmetry (D0)

arXiv:1107.4995   lepton+jets channel

Also sees an asymmetry, but no particular enhancement at large Δy or large M(tt)

D0 5.4fb^{-1}

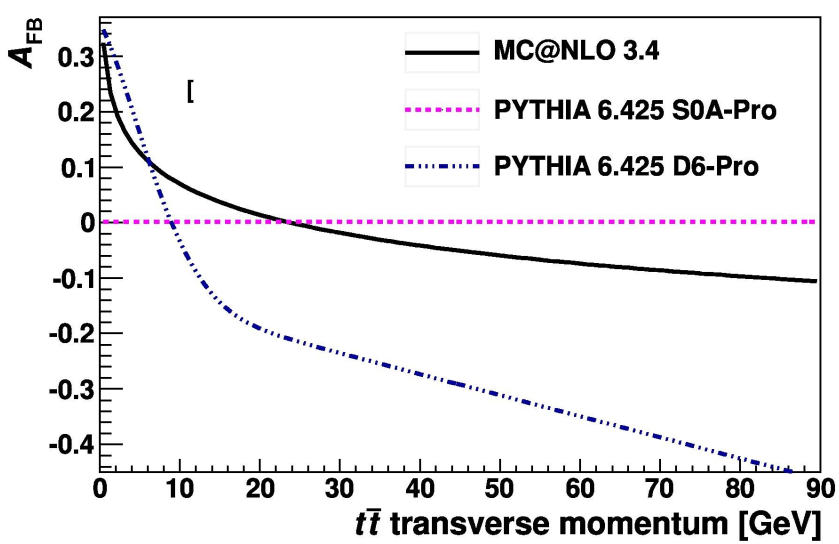
TABLE IV. Δy-based asymmetries.

	A_{FB} (%) Reconstruction level	Production level
Data	9.2 ± 3.7	19.6 ± 6.5
MC@NLO	2.4 ± 0.7	5.0 ± 0.1

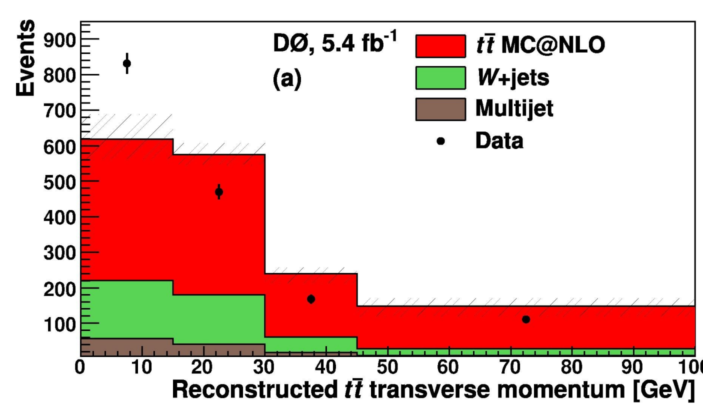
TABLE VI. Lepton-based asymmetries.

	A^l_{FB} (%) Reconstruction level	Production level
Data	14.2 ± 3.8	15.2 ± 4.0
MC@NLO	0.8 ± 0.6	2.1 ± 0.1

Sensitivity of A_{FB} to p_T(tt) predicted by some MC generators



Softer p_T(tt) spectrum in data (source of the discrepancy??)



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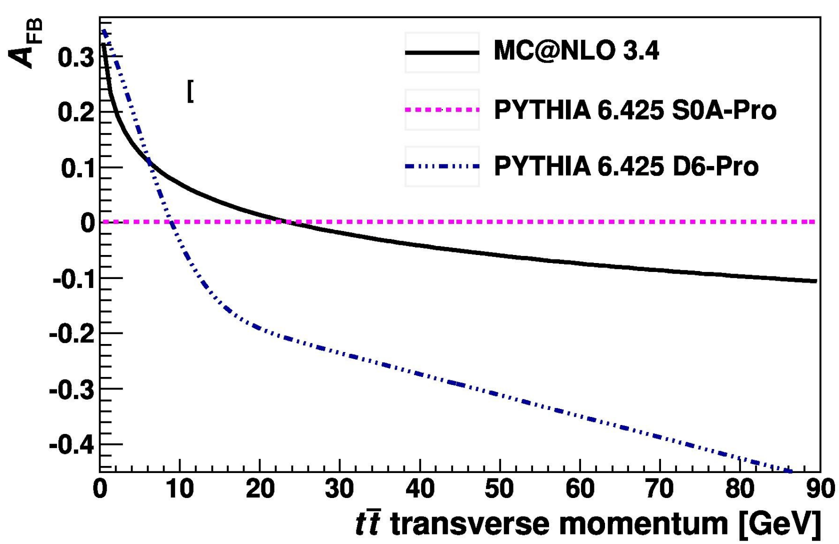

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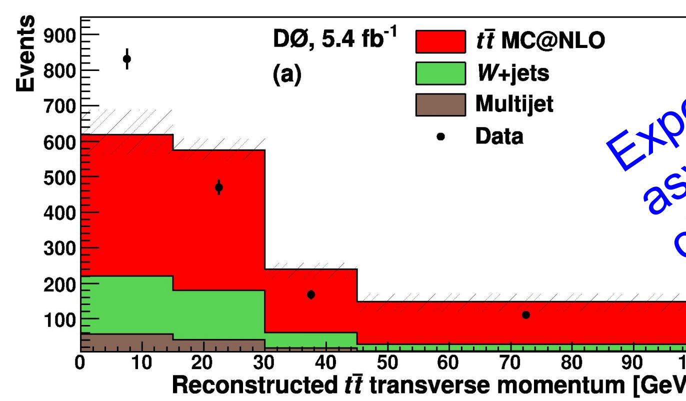


Expect central-forward asymmetry at LHC, but challenging measurement

Summary of recent searches

Exp.	Signature	L(int) (fb-1)	Reference	Comment
D0	W' → tb	2.3	PLB 699(2011)145	M(W') > 863 GeV
CDF	γγ resonance	5.7	CDF 10479	M(RS G) > 1111 GeV (ee,μμ,γγ) combined
CDF	ZZ resonance (ℓℓνν,ℓℓℓℓ,ℓℓjj)	6	CDF 10603	M(RS G) > ~600 GeV
D0	WW/WZ resonance	5.4	PRL107,011801	M(RS G) > 300-754 GeV
D0	eνjj resonance	5.4	arXiv:1107.1849	M(LQ(1)) > 326 GeV (BR=0.5)
CDF	ℓ+γ+MET+bjet (also ttbar+γ)	6	CDF 10270	σ(ttbar+γ) = 0.18 ± 0.07 pb
CDF	jjj resonance	3.2	PRL107,042001	xsec limits vs mass for RPV gluino
CDF	t' → bW	5.6	arXiv:1107.3875	M(t') > 358 GeV
D0	t' → qW	5.3	arXiv:1104.4522	M(t') > 285 GeV (2.5σ excess in μ channel)
CDF	b' → tW	4.8	arXiv:1101.5728	M(b') > 372 GeV
CDF	t' → t+invisible	5.7	arXiv:1107.3574	M(t') > 400 GeV for M(inv) < 70 GeV
D0	γγ + MET	6.3	PRL105,221802	Λ > 124 TeV (mGMSB)
CDF	ttbar resonance	4.8	CDF 10468	M(Z') > 900 GeV
D0	long-lived slow particle	5.2	in preparation	M > 230 (251) GeV for higgsino(gaugino)-like chargino
CDF	ZZ + MET	4	CDF 10539	xsec > 300 fb
CDF	same-sign dilepton	6.1	CDF 10464	consistent with Std Model
CDF	bbb resonance	2.6	arXiv:1106.4782	xsec limits as fn of mass
D0	stop → b ℓ $\tilde{\nu}$ (e+mu)	5.4	PLB 696(2011)321	M(stop) > 210 GeV for M($\tilde{\nu}$)<110 GeV
D0	dimuon asymmetry	9	arXiv:1106.6308	3.9 σ deviation from Std Model

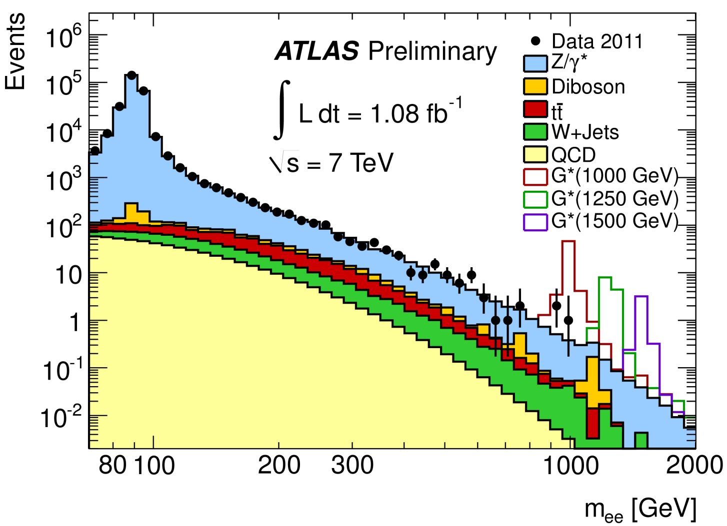
Note: not a complete list

Full list at: http://www-cdf.fnal.gov/physics/exotic/exotic.html
http://www-d0.fnal.gov/Run2Physics/WWW/results/np.htm

BSM searches at the LHC

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

(paper in preparation)

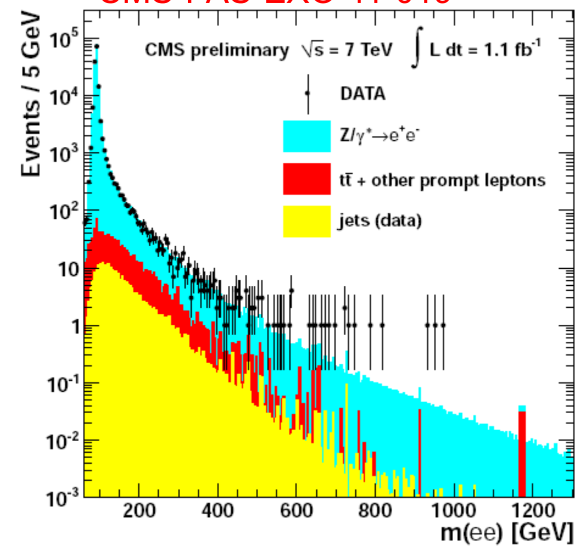


Bump hunt in invariant mass of pairs of isolated high p_T leptons (OSSF)

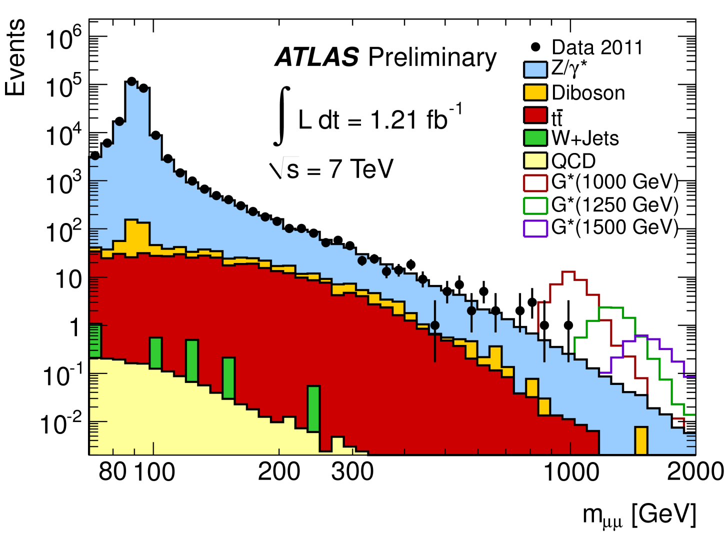
	ATLAS	CMS
p_T cut (e)	25 GeV	35 GeV
p_T cut (μ)	25 GeV	35 GeV
|η| cut (e)	2.47(excl. [1.37,1.52])	2.5(excl. [1.442,1.56])
|η| cut (μ)	2.4*	2.4

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

CMS-PAS-EXO-11-019



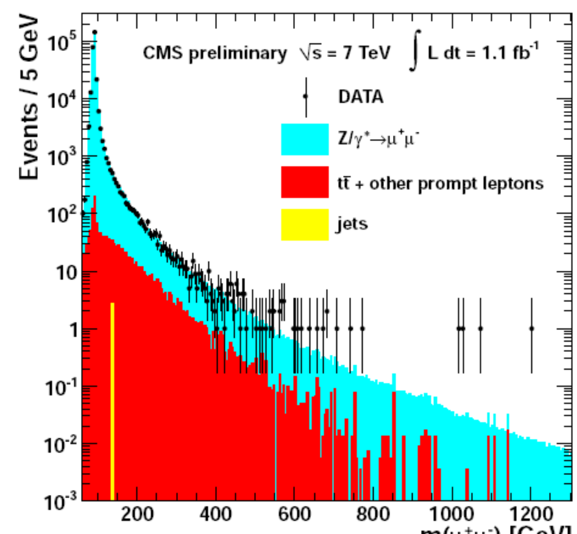
Electrons



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

now surpassing Tevatron limit: 1.071 TeV

	ATLAS obs (exp)	CMS obs
Electron	1.70 (1.70)	1.73
Muon	1.61 (1.61)	1.78
Comb	1.83 (1.83)	1.94



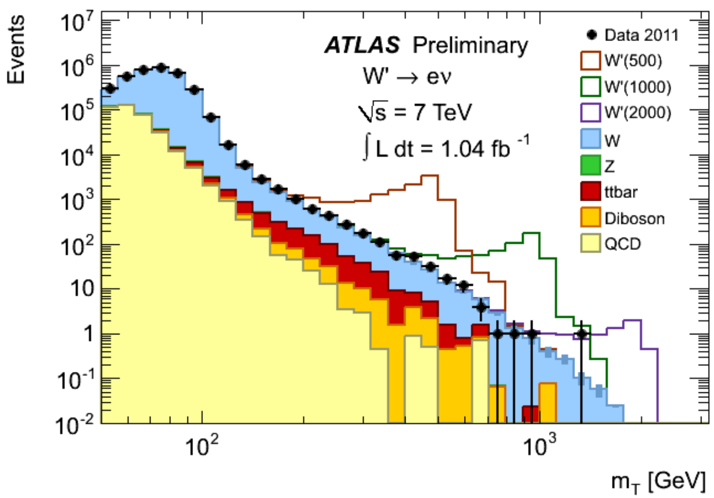
Muons

(Limits on other Z' and RS graviton models also available)

ℓν resonance search

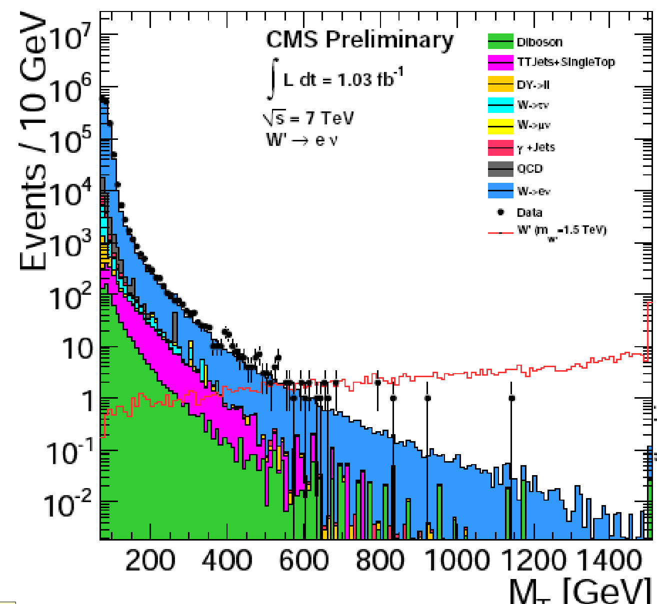
Bump hunt in transverse mass of isolated, high p_T lepton and MET

(paper in preparation)



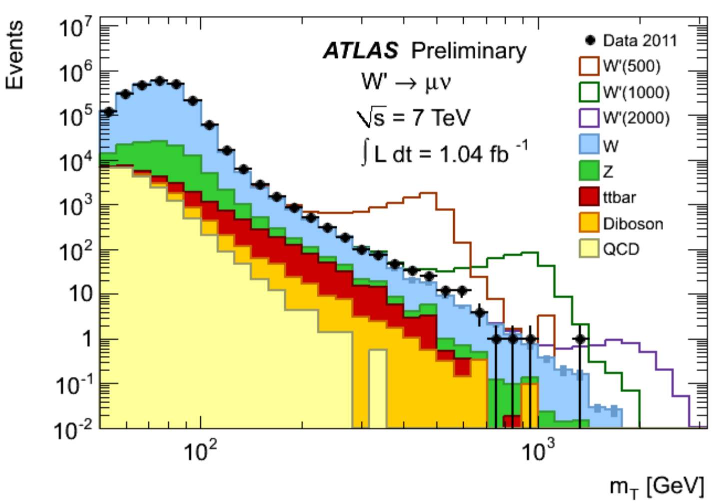
	ATLAS	CMS
p_T cut (e)	25 GeV	ET > 27,32 or MT> 40 (at trigger level)
p_T cut (μ)	25 GeV	pt > 24,30,40 (at trigger level)
|η| cut (e)	2.47(excl. [1.37,1.52])	
|η| cut (μ)	2.0 (excl [1.0,1.3])	

CMS-PAS-EXO-11-024



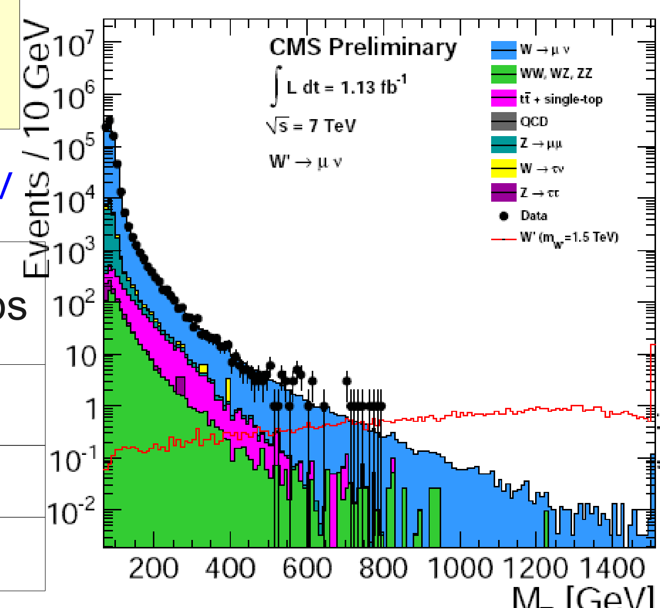
Electrons

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



extend prev. limits (35 pb^{-1}) by ~0.7 TeV

	ATLAS obs (exp)	CMS obs
Electron	2.08 (2.17)	-
Muon	1.98 (2.08)	-
Comb	2.15 (2.23)	2.27



Muons

eμ resonance search

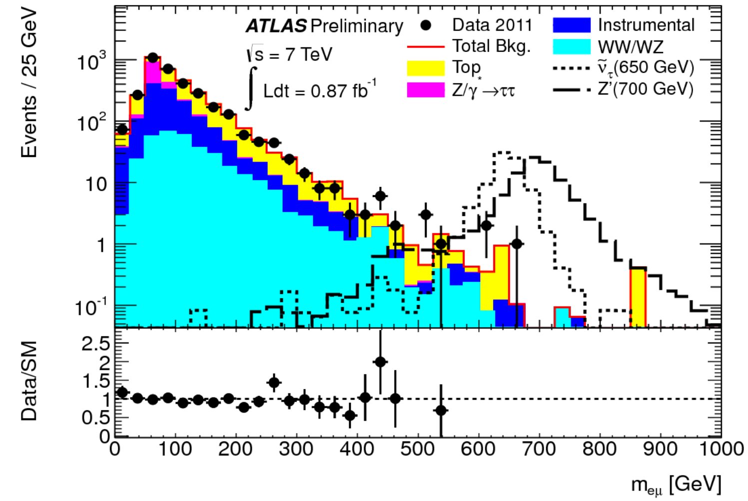
Bump search in invariant mass of isolated e and μ

Require exactly one e and one μ, both with pt > 25 GeV and isolated.

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

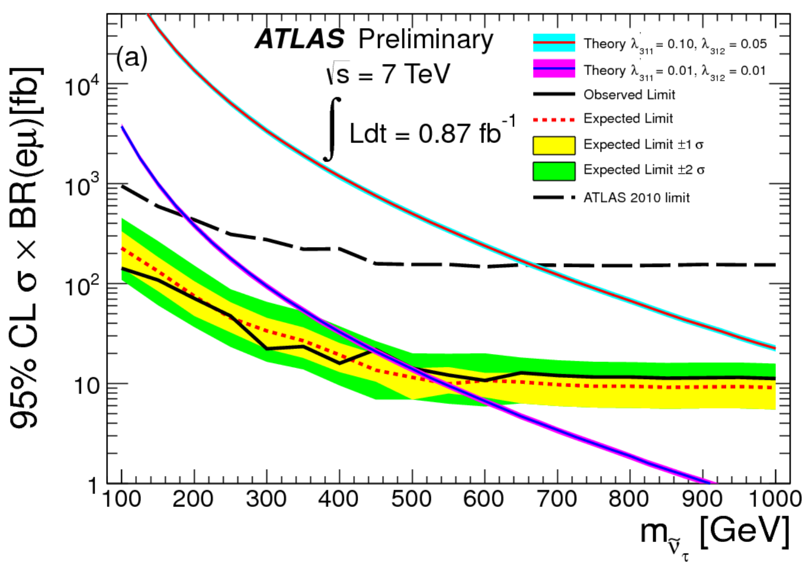
μ: $|\eta| < 2.4$

ATLAS-CONF-2011-109

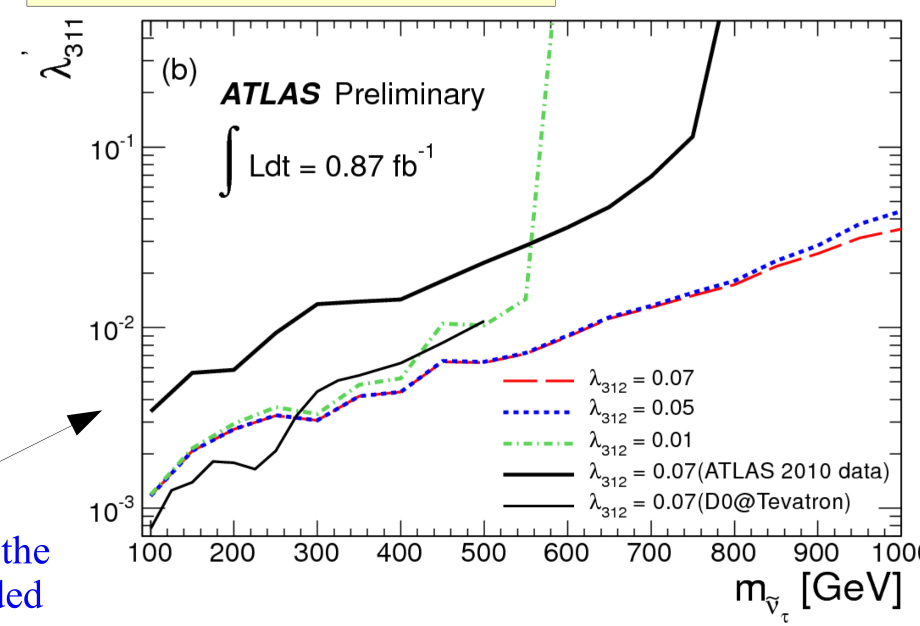


Set limits on σ·B

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



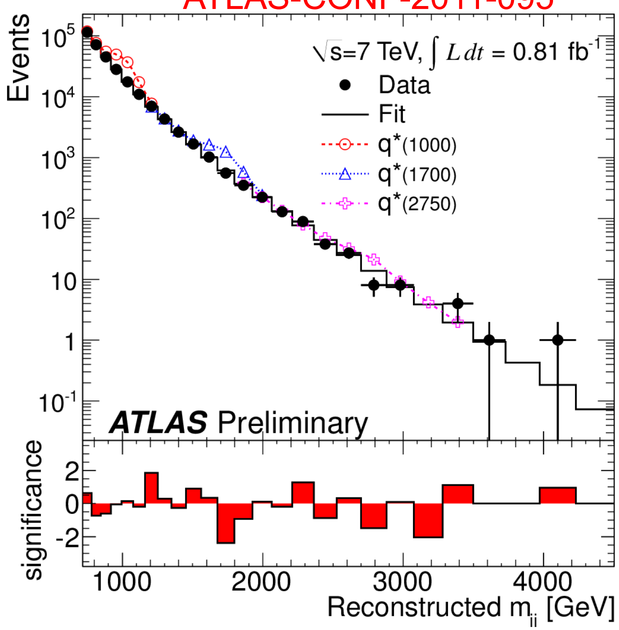
Limits on λ'_{311} vs $m(\tilde{\nu}_\tau)$



Regions above the lines are excluded

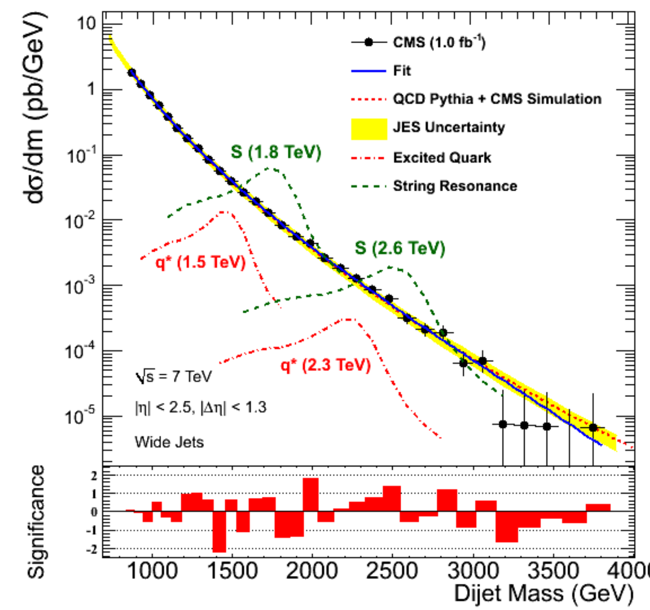
dijet mass resonance

ATLAS-CONF-2011-095



Bump hunt in the dijet invariant mass spectrum

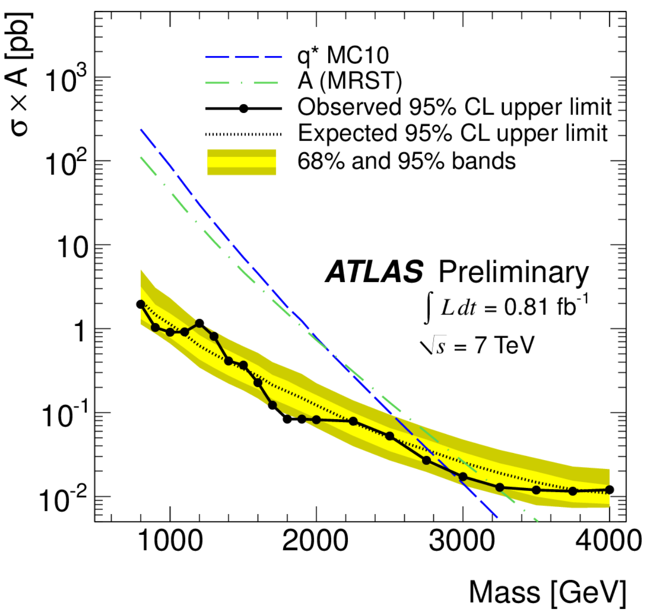
CERN-PH-EP/2011-119



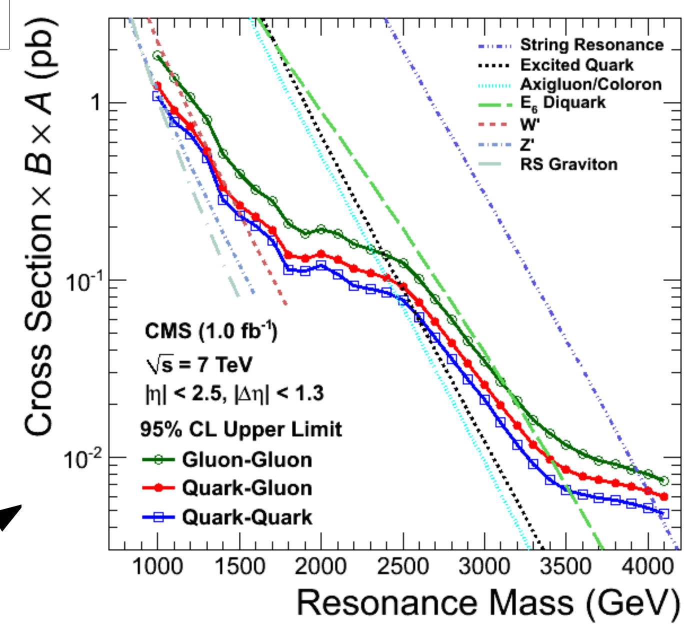
95% CL mass exclusion intervals (TeV) and expected limits

	ATLAS obs (exp)	CMS obs (exp)
q*	2.91 (2.77)	2.49 (2.68)
axigluon	3.21 (3.02)	2.47 (2.66)

(Mass limits on other models also available)



ATLAS mass limits increase by ~0.8-1.0 TeV when going from ~35 to ~810 pb^{-1}



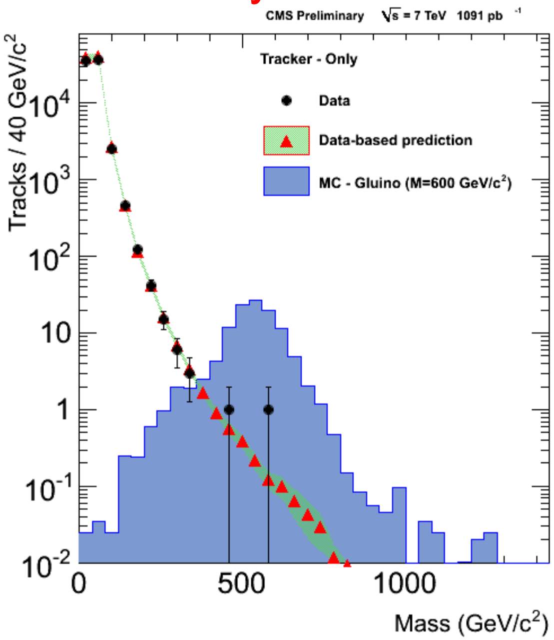
Cross section limits

slow, massive particle search

Tracker only

CMS-PAS-EXO-11-022

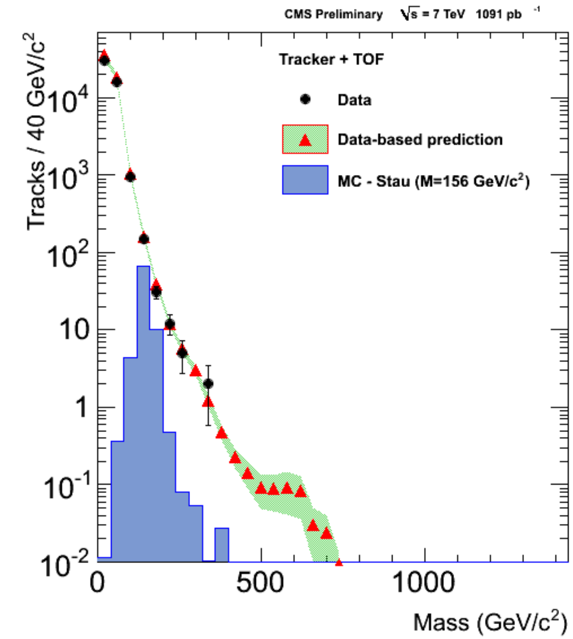
Tracker + muon



Mass measurement by combining tracker momentum with:

- tracker dE/dx
- muon system TOF

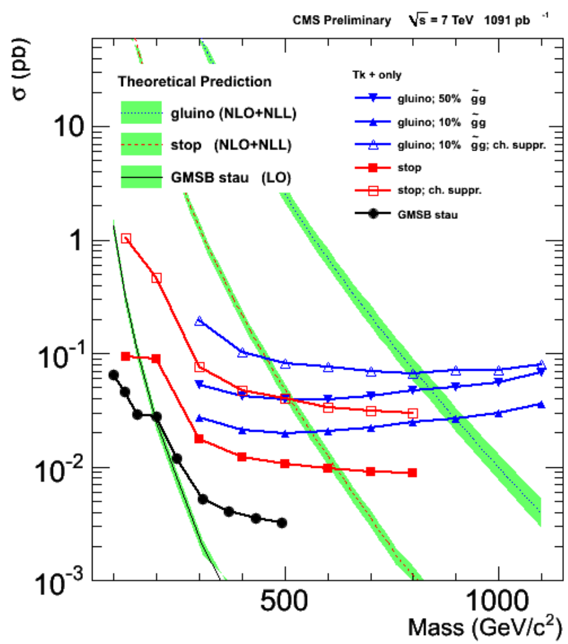
Background estimation via "ABCD" exploiting lack of correlation between momentum, dE/dx and TOF



R-hadron mass limits from tracker only analysis

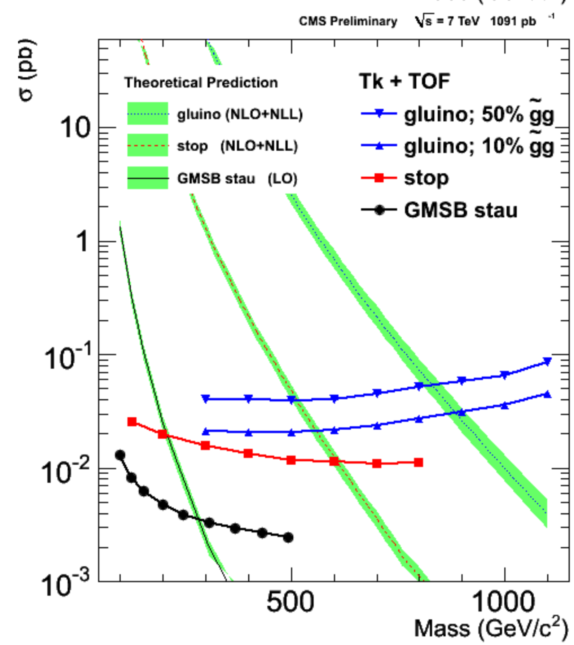
R-hadron	95% CL Mass limit (GeV)
stop	620
gluino*	899 (839)

* 10% (50%) $\tilde{g}g$



mGMSB (SPS line 7) stau mass limits from tracker+muon analysis:

m(stau) > 293 GeV (95% CL)



Stopped particle search

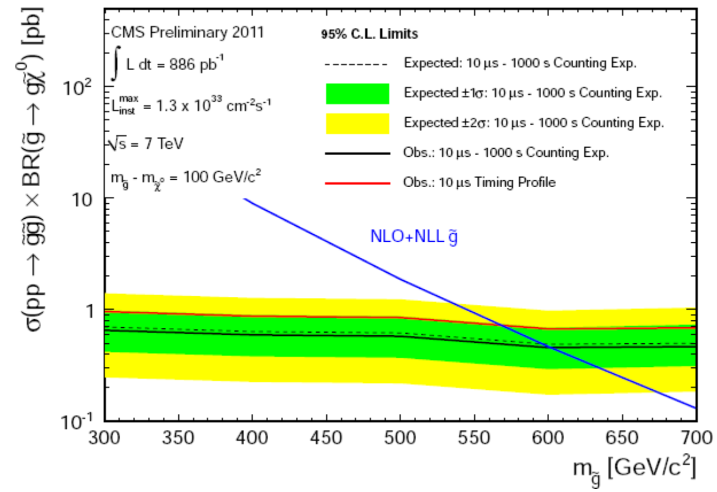
Search for calorimeter activity in gaps between colliding bunches or during interfill periods

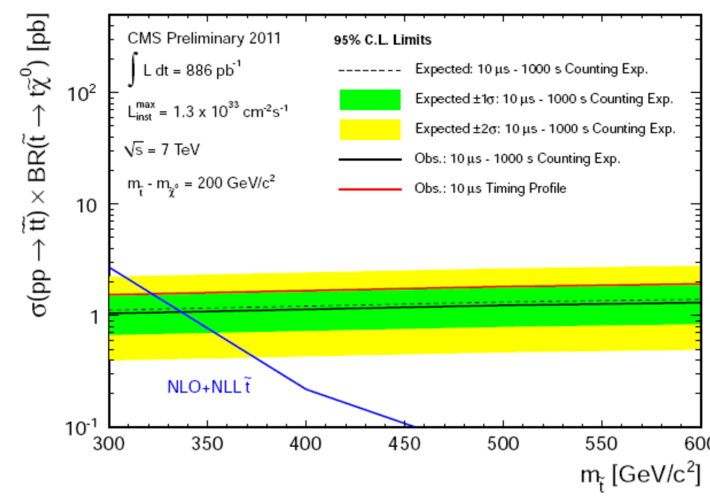
Background sources:
- detector noise
- beam halo
- cosmics

Backgrounds are estimated using 2010 data:
- Noise+cosmics rate estimated from periods of very low lumi (Lmax = 10^{28})
- Rate from beam bkg + noise + cosmics estimated from the rest of the 2010 run

Lifetime	$L_{eff}\,(pb^{-1})$	Expected Bg	Observed
75 ns	4.3	0.11 ± 0.05	0
100 ns	12.5	0.35 ± 0.14	0
1 μs	139	3.3 ± 1.3	4
10 μs	352	10.1 ± 4.1	9
30 μs - 10^3 s	360	10.4 ± 4.2	10
10^4 s	268	10.4 ± 4.2	10
10^5 s	65	10.4 ± 4.2	10
10^6 s	7.5	10.4 ± 4.2	10

CMS-PAS-EXO-11-020





Mass limits (95% CL) for lifetimes between 10 ps and 1000 s (assuming direct decay to LSP)
- m(gluino) > 601 GeV
- m(stop) > 337 GeV

SUSY search in jets+MET

(paper in preparation)

ATLAS: 5 signal regions

Signal Region	≥ 2 jets	≥ 3 jets	≥ 4 jets	High mass
E_T^{miss}	> 130	> 130	> 130	> 130
Leading jet p_T	> 130	> 130	> 130	> 130
Second jet p_T	> 40	> 40	> 40	> 80
Third jet p_T	–	> 40	> 40	> 80
Fourth jet p_T	–	–	> 40	> 80
$\Delta\phi(\text{jet}, E_T^{miss})_{min}$	> 0.4	> 0.4	> 0.4	> 0.4
E_T^{miss}/m_{eff}	> 0.3	> 0.25	> 0.25	> 0.2
m_{eff} [GeV]	> 1000	> 1000	$> 500/1000$	> 1100

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

events with e (pt>20) or μ (pt>10) discarded

Cut and count analysis

CMS-PAS-SUS-11-003

CMS: shape analysis in H_T bins

Use α_T as discriminating variable

$$\alpha_T = \frac{E_T^{jet_2}}{M_T} = \frac{E_T^{jet_2}}{\sqrt{\left(\sum_{i=1}^{2} E_T^{jet_i}\right)^2 - \left(\sum_{i=1}^{2} p_x^{jet_i}\right)^2 - \left(\sum_{i=1}^{2} p_y^{jet_i}\right)^2}},$$

(multijets merged into two “mega jets”)

Baseline selection:

- ≥ 2 jets
- 2 leading jets: pt > 100 (other > 50)
- HT > 275
- $\alpha_T > 0.55$
- MHT/MET(calo) < 1.25
- veto jets near masked calo regions
- e,μ veto, pt>10
- photon veto, pt > 25

SUSY search in jets+MET

Background estimation

ATLAS

Process	Signal Region				
	$\geq$ 2-jet	$\geq$ 3-jet	$\geq$ 4-jet, $m_{\mathrm{eff}} > 500$ GeV	$\geq$ 4-jet, $m_{\mathrm{eff}} > 1000$ GeV	High mass
Z/γ+jets	$32.5 \pm 2.6 \pm 6.8$	$25.8 \pm 2.6 \pm 4.9$	$208 \pm 9 \pm 37$	$16.2 \pm 2.1 \pm 3.6$	$3.3 \pm 1.0 \pm 1.3$
W+jets	$26.2 \pm 3.9 \pm 6.7$	$22.7 \pm 3.5 \pm 5.8$	$367 \pm 30 \pm 126$	$12.7 \pm 2.1 \pm 4.7$	$2.2 \pm 0.9 \pm 1.2$
$t\bar{t}$+ Single Top	$3.4 \pm 1.5 \pm 1.6$	$5.6 \pm 2.0 \pm 2.2$	$375 \pm 37 \pm 74$	$3.7 \pm 1.2 \pm 2.0$	$5.6 \pm 1.7 \pm 2.1$
QCD jets	$0.22 \pm 0.06 \pm 0.24$	$0.92 \pm 0.12 \pm 0.46$	$34 \pm 2 \pm 29$	$0.74 \pm 0.14 \pm 0.51$	$2.10 \pm 0.37 \pm 0.83$
Total	$62.3 \pm 4.3 \pm 9.2$	$55 \pm 3.8 \pm 7.3$	$984 \pm 39 \pm 145$	$33.4 \pm 2.9 \pm 6.3$	$13.2 \pm 1.9 \pm 2.6$
Data	58	59	1118	40	18

Systematics (ATLAS):

- W+jets: ~26%
- ttbar: ~50%
- Z+jets: ~20%

CMS

Table 2: Muon sample predictions with $1.1\mathrm{fb}^{-1}$. Errors quoted on predictions correspond to statistical errors and an additional conservative systematic uncertainty of 30%, as used in the previous analysis.

H_T Bin (GeV)	275–325	325–375	375–475	475–575
W + $t\bar{t}$ Prediction	$442.0 \pm 22.4_{stat} \pm 132.6_{syst}$	$149.1 \pm 11.9_{stat} \pm 44.7_{syst}$	$101.9 \pm 9.6_{stat} \pm 30.6_{syst}$	$35.2 \pm 5.6_{stat} \pm 10.6_{syst}$
H_T Bin (GeV)	575–675	675–775	775–875	875–∞
W + $t\bar{t}$ Prediction	$15.3 \pm 3.7_{stat} \pm 4.6_{syst}$	$4.5 \pm 2.0_{stat} \pm 1.4_{syst}$	$0.0 \pm 1.0_{stat}$	$0.0 \pm 1.0_{stat}$

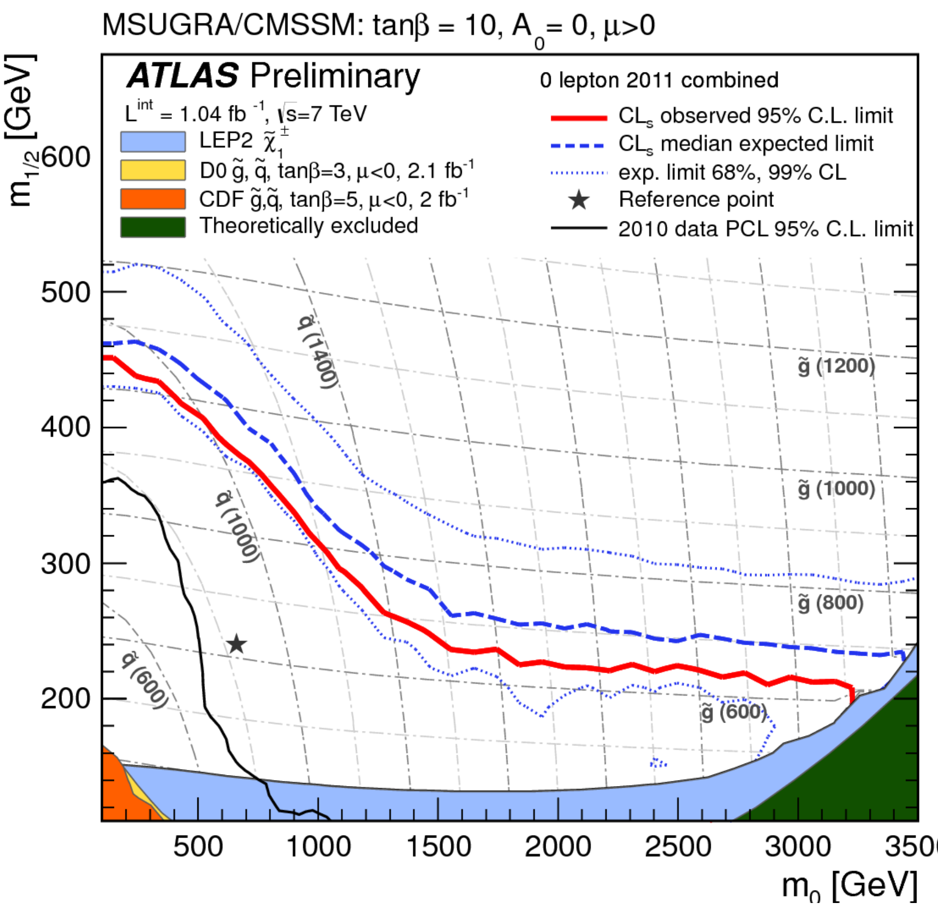
Systematics (CMS):

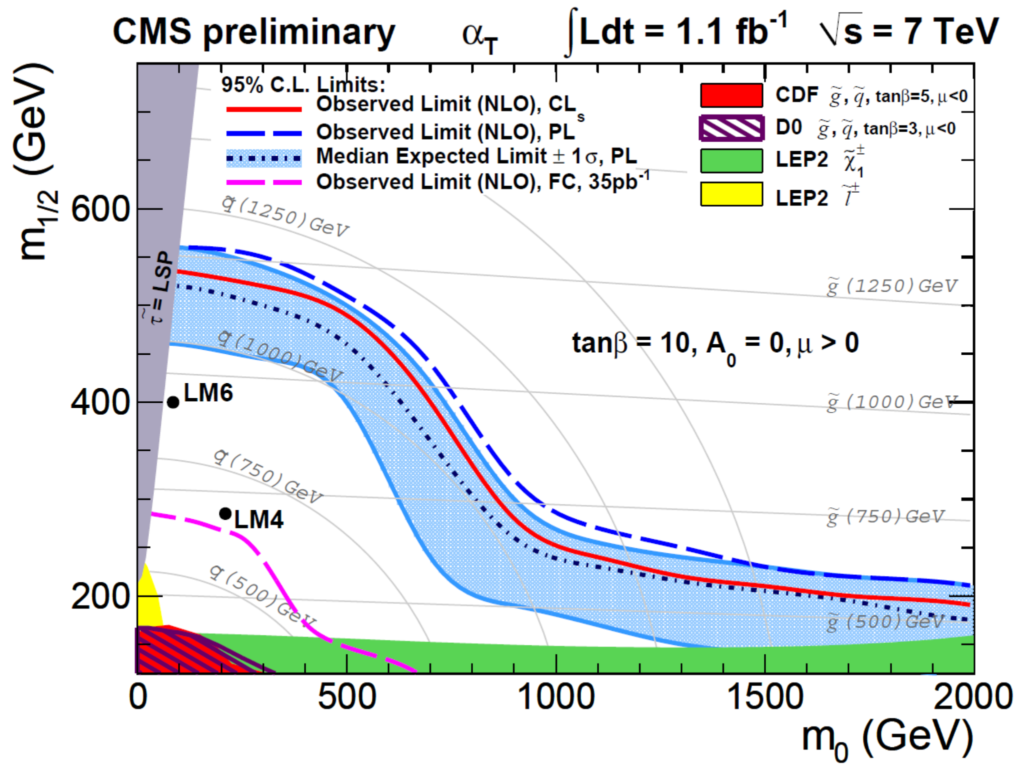
- W&ttbar: 30%
- Z+jets: 40%

Table 3: Photon Sample Predictions $1.1\mathrm{fb}^{-1}$

H_T Bin (GeV)	275–325	325–375	375–475	475–575
$Z \to \nu\bar{\nu}$ Prediction	$276.8 \pm 9.5_{stat} \pm 110.7_{syst}$	$105.3 \pm 6.0_{stat} \pm 42.1_{syst}$	$93.5 \pm 6.4_{stat} \pm 37.4_{syst}$	$29.8 \pm 3.6_{stat} \pm 11.9_{syst}$
H_T Bin (GeV)	575–675	675–775	775–875	875–∞
$Z \to \nu\bar{\nu}$ Prediction	$10.7 \pm 2.2_{stat} \pm 4.3_{syst}$	$5.3 \pm 1.5_{stat} \pm 2.1_{syst}$	$1.8 \pm 0.9_{stat} \pm 0.7_{syst}$	$1.8 \pm 0.9_{stat} \pm 0.7_{syst}$

MSUGRA/CMSSM interpretation





CMS outperforms for m_0 < ~750 GeV

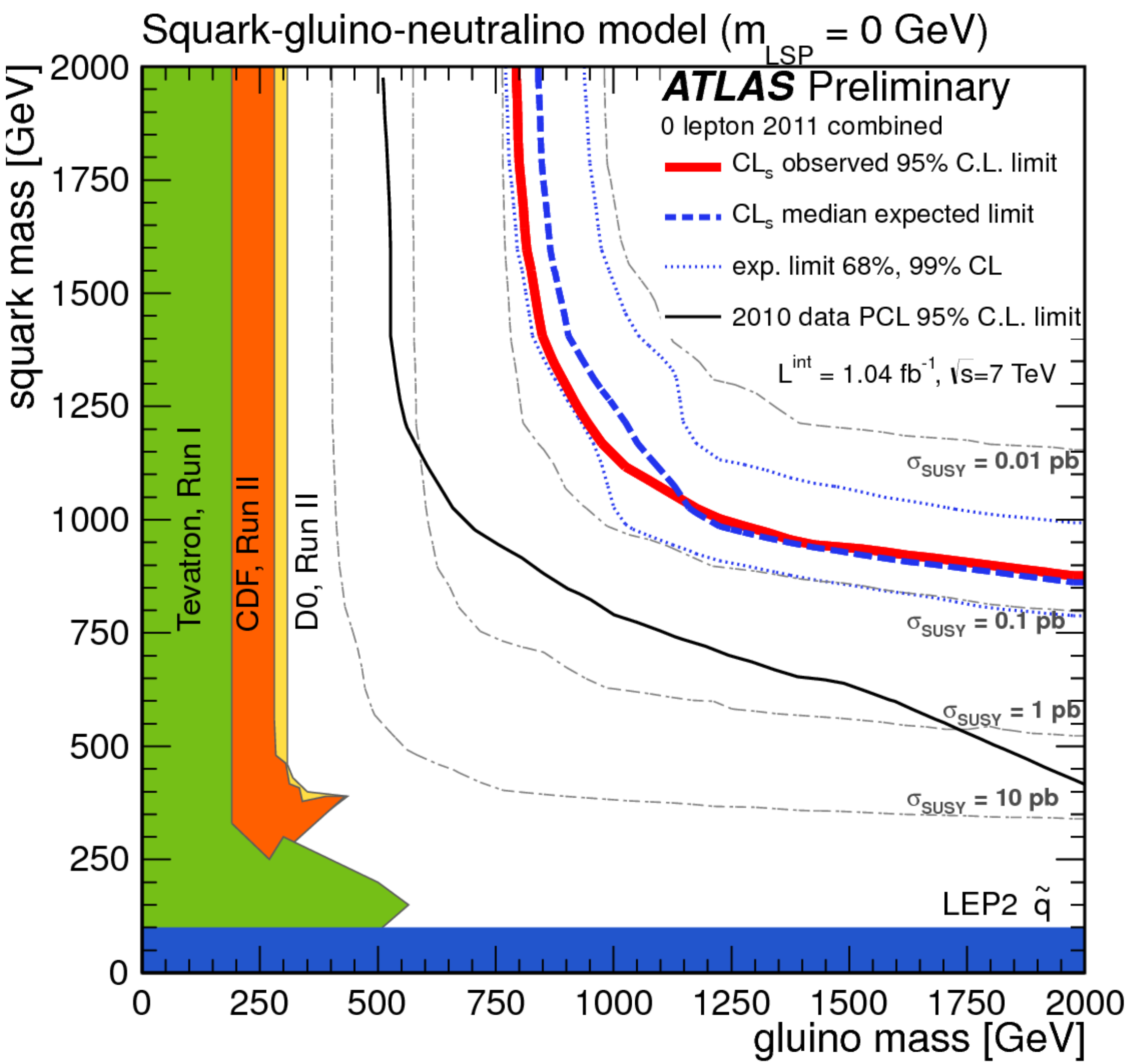
ATLAS outperforms for m_0 > ~750 GeV

Squark and gluino mass limits approaching (sometimes exceeding) 1 TeV!

simplified model interpretation

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

Limits insensitive to m(LSP) for LSP masses up to 200 GeV



SUSY search in bjets+MET

ATLAS-CONF-2011-098

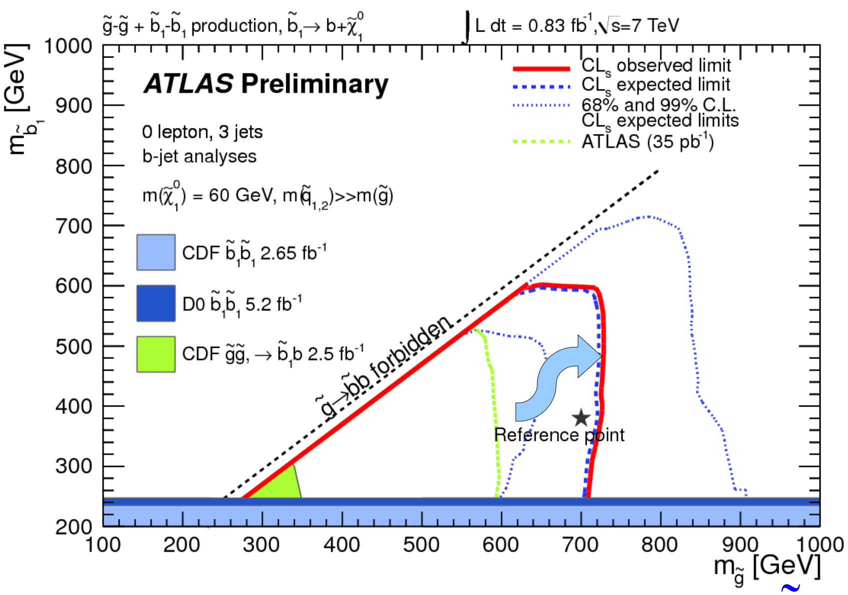
$\geq$ 3 jets, with at least 1 btag
4 signal regions based on Meff and N(btags) requirements

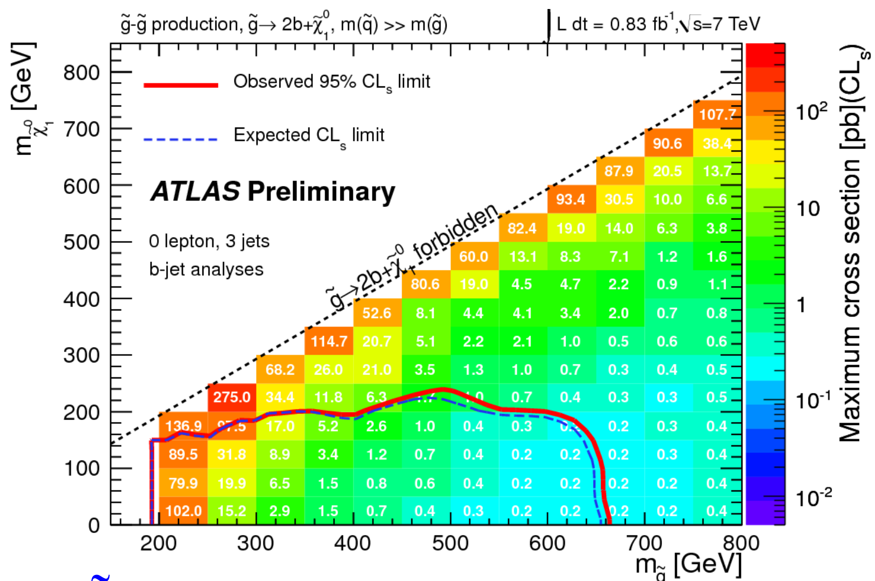
estimated bkg

Sig. Reg.	Data ($0.83\ \mathrm{fb}^{-1}$)	Top	W/Z	QCD	Total
3JA (1 btag m_{eff} >500 GeV)	361	221^{+82}_{-68}	121 ± 61	15 ± 7	356^{+103}_{-92}
3JB (1 btag m_{eff} >700 GeV)	63	37^{+15}_{-12}	31 ± 19	1.9 ± 0.9	70^{+24}_{-22}
3JC (2 btag m_{eff} >500 GeV)	76	55^{+25}_{-22}	20 ± 12	3.6 ± 1.8	79^{+28}_{-25}
3JD (2 btag m_{eff} >700 GeV)	12	$7.8^{+3.5}_{-2.9}$	5 ± 4	0.5 ± 0.3	$13.0^{+5.6}_{-5.2}$

QCD bkg from jet smearing

ttbar and W/Z+jets bkg from MC (cross checked with data in control regions)





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

dileptons + jets + MET

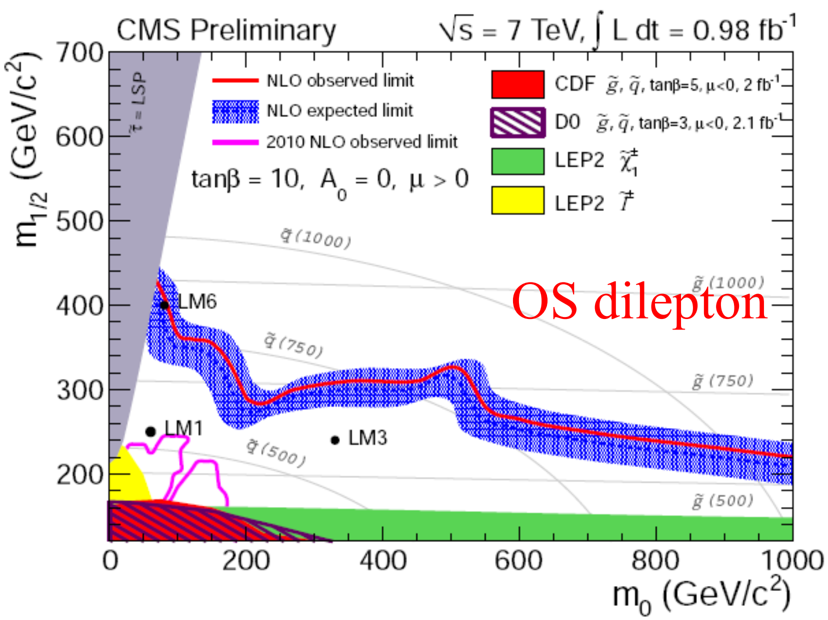
OS dilepton analysis

CMS-PAS-SUS-11-011

- 2 leptons, pt > (20,10), OS, Z veto
- ≥ 2 jets, pt > 30
- HT > 300 (600), MET > 275 (200)

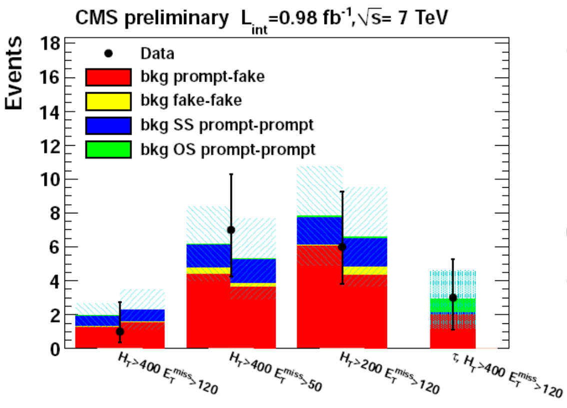
(results from Z peak region also available CMS-PAS-SUS-11-017)

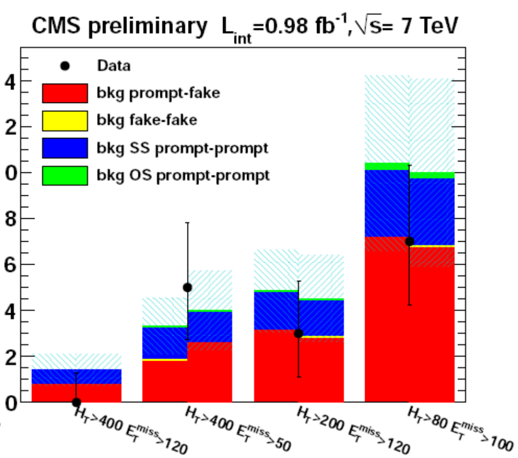
	high E_T^{miss} signal region	high H_T signal region
observed yield	8	4
MC prediction	7.3 ± 2.2	7.1 ± 2.2
ABCD′ prediction	4.0 ± 1.0 (stat) ± 0.8 (syst)	4.5 ± 1.6 (stat) ± 0.9 (syst)
$p_T(\ell\ell)$ prediction	14.3 ± 6.3 (stat) ± 5.3 (syst)	10.1 ± 4.2 (stat) ± 3.5 (syst)
N_{bkg}	4.2 ± 1.3	5.1 ± 1.7
non-SM yield UL	10	5.3
LM1	49 ± 11	38 ± 12
LM3	18 ± 5.0	19 ± 6.2
LM6	8.1 ± 1.0	7.4 ± 1.2

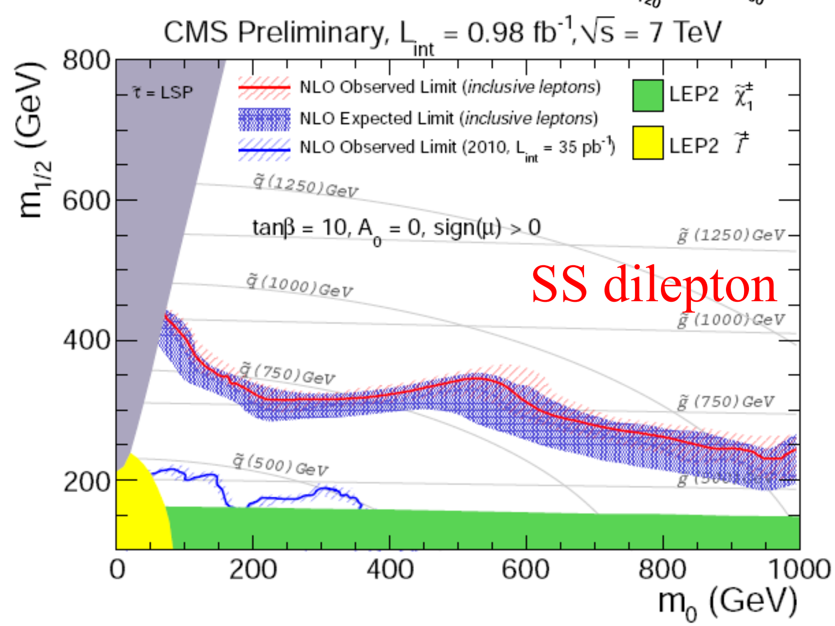


SS dilepton analysis (incl taus!)

CMS-PAS-SUS-11-010





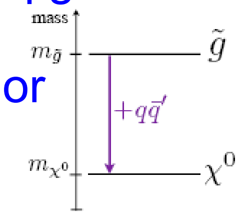


Simple parametrizations of detector efficiency, response are provided for model testing

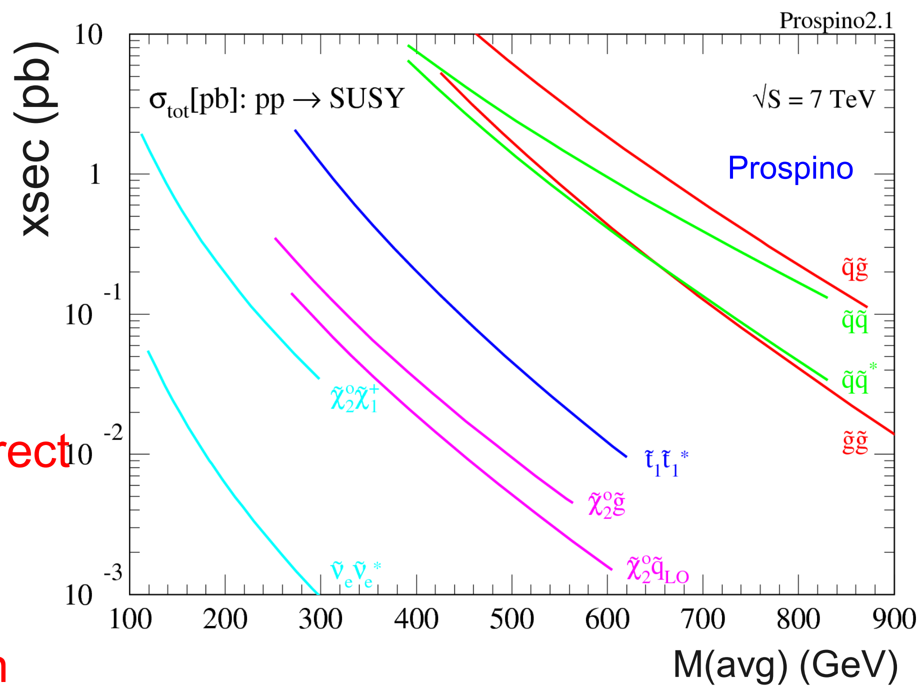
Outlook for SUSY

Push to higher masses for squark/gluino

Try to attack challenging sq/gl cascade decay chains, e.g. compressed models or highly boosted LSP's



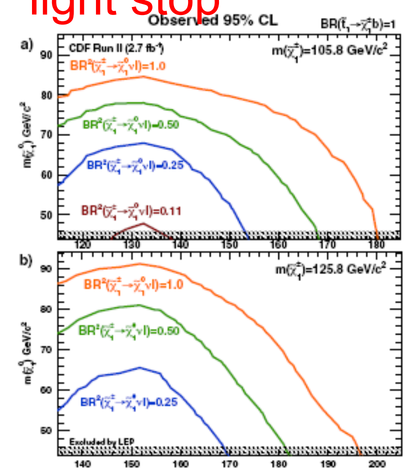
(fig from arXiv:1102.5338)

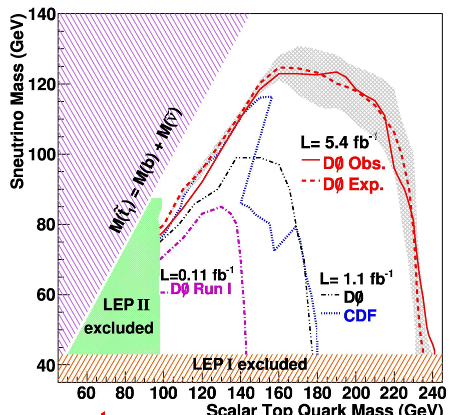


Access direct stop, sbottom, gaugino production

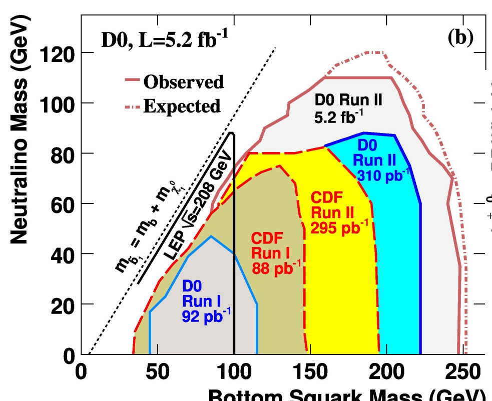
Tevatron experiments still have the best limits here.

light stop

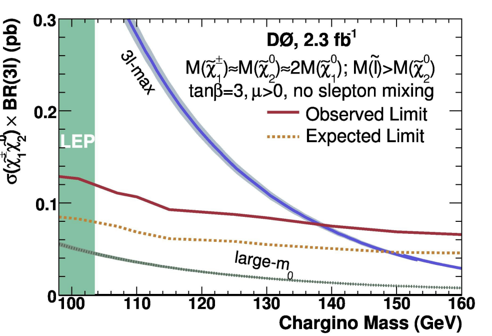




stop



sbottom

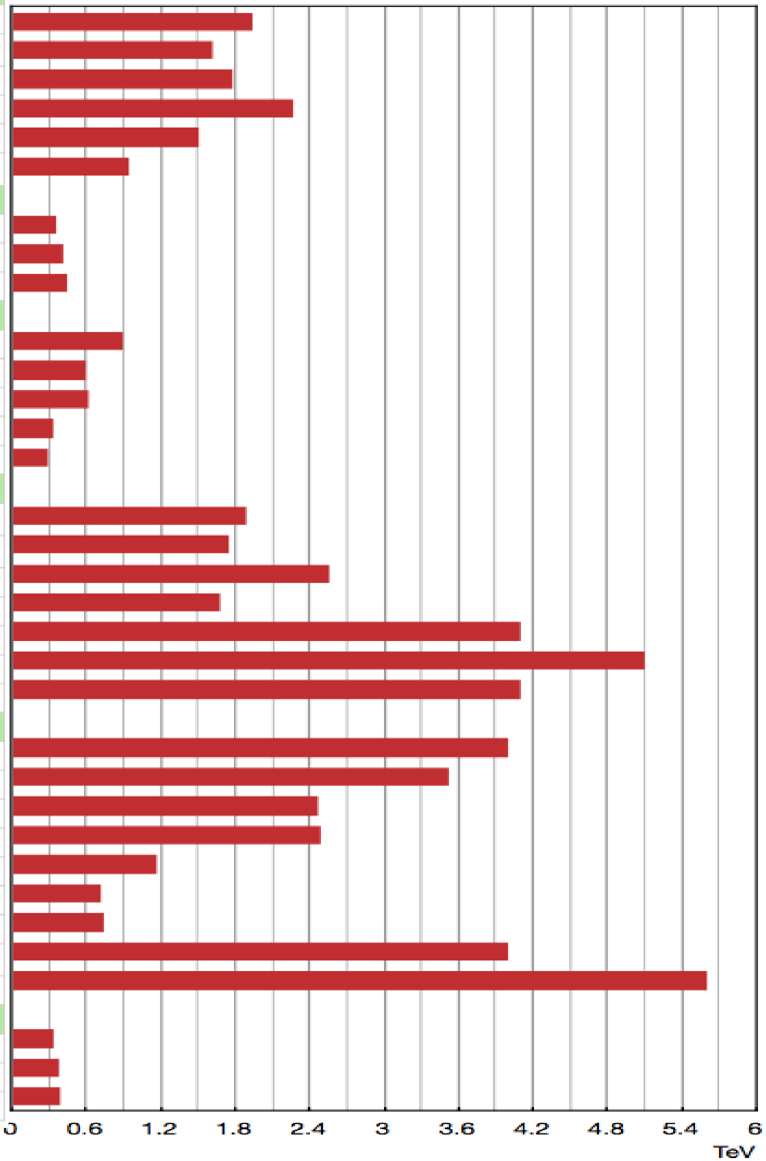


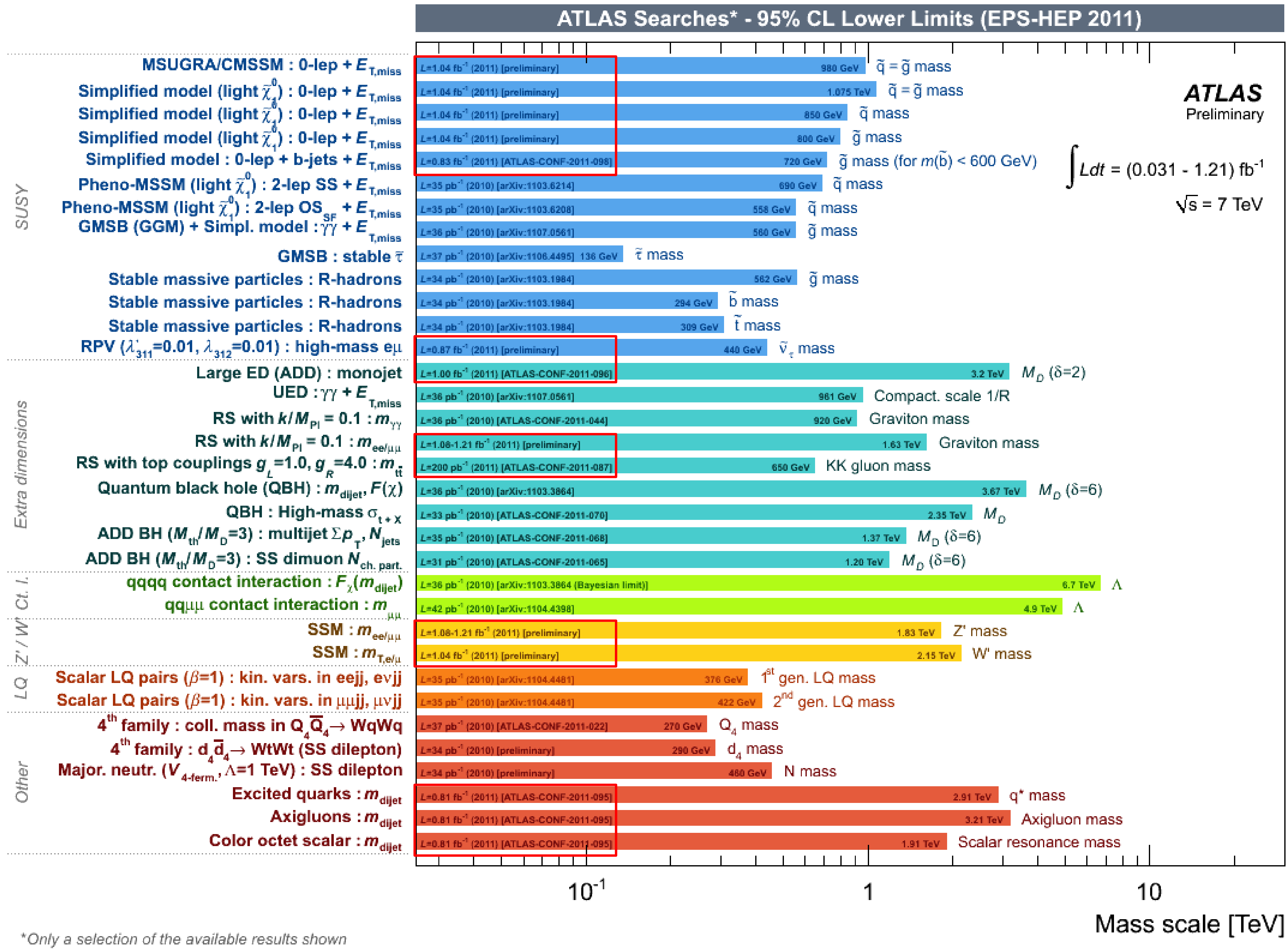
gaugino

Sampling of searches at CMS

(non-SUSY)

	Limits in TeV	
	Heavy Bosons	
Z'_{SSM} ll	1.94	2011
Z'_{Ψ} ll	1.62	2011
G_{KK} ll k/M = 0.1	1.78	2011
W' lν	2.27	2011
W' dijet	1.51	2011
G_{KK} γγ k/M = 0.1 (2010)	0.945	2010
	4th Generation	
$M_{b'}$, b' ⇒ tW (2010)	0.361	2010
$M_{t'}$, t' ⇒ tZ (100%)	0.417	2011
$M_{t'}$, t' ⇒ bW (100%), l+jets	0.45	2011
	Heavy Stable Particles	
M_{gluino}, HSCP	0.899	2011
M_{gluino}, Stopped Gluino	0.601	2011
M_{stop}, HSCP	0.620	2011
M_{stop}, Stopped Gluino	0.337	2011
M_{stau}, HSCP	0.293	2011
	Large Extra Dimensions	
M_s, γγ, GRW (2010)	1.89	2010
M_s, μμ, GRW (2010)	1.75	2010
M_D, monojet, n_{ED} = 2 (2010)	2.56	2010
M_D, monojet, n_{ED} = 6 (2010)	1.68	2010
M_{BH}, rotating, M_D=3.5 TeV, n_{ED} = 2	4.1	2011
M_{BH}, non-rot, M_D=1.5 TeV, n_{ED} = 6	5.1	2011
String Ball M, M_D=2.1, M_s=1.7, g_s=0.4	4.1	2011
	Compositeness and Contact Interactions	
String Resonances	4.0	2011
E_6 diquarks	3.52	2011
Axigluon/Coloron	2.47	2011
q* , dijet	2.49	2011
q* , boosted Z	1.17	2010
e*, Λ = 2 TeV	0.720	2010
μ*, Λ = 2 TeV	0.745	2010
C.I. Λ , dijet mass (3 pb^{-1})	4.0	2010
C.I. Λ , X analysis	5.6	2010
	LeptoQuark	
LQ1, β=0.5 (2010)	0.340	2010
LQ1, β=1.0 (2010)	0.384	2010
LQ2, β=1.0 (2010)	0.394	2010





ATLAS Searches* - 95% CL Lower Limits (EPS-HEP 2011)
ATLAS
Preliminary
∫Ldt = (0.031 - 1.21) fb⁻¹
√s = 7 TeV
SUSY
MSUGRA/CMSSM : 0-lep + E_T,miss
L=1.04 fb⁻¹ (2011) [preliminary] 980 GeV q̃ = g̃ mass
Simplified model (light χ̃₁⁰) : 0-lep + E_T,miss
L=1.04 fb⁻¹ (2011) [preliminary] 1.075 TeV q̃ = g̃ mass
Simplified model (light χ̃₁⁰) : 0-lep + E_T,miss
L=1.04 fb⁻¹ (2011) [preliminary] 850 GeV q̃ mass
Simplified model (light χ̃₁⁰) : 0-lep + E_T,miss
L=1.04 fb⁻¹ (2011) [preliminary] 800 GeV g̃ mass
Simplified model : 0-lep + b-jets + E_T,miss
L=0.83 fb⁻¹ (2011) [ATLAS-CONF-2011-098] 720 GeV g̃ mass (for m(b̃) < 600 GeV)
Pheno-MSSM (light χ̃₁⁰) : 2-lep SS + E_T,miss
L=35 pb⁻¹ (2010) [arXiv:1103.6214] 690 GeV q̃ mass
Pheno-MSSM (light χ̃₁⁰) : 2-lep OS_SF + E_T,miss
L=35 pb⁻¹ (2010) [arXiv:1103.6208] 558 GeV q̃ mass
GMSB (GGM) + Simpl. model : γγ + E_T,miss
L=36 pb⁻¹ (2010) [arXiv:1107.0561] 560 GeV g̃ mass
GMSB : stable τ̃
L=37 pb⁻¹ (2010) [arXiv:1106.4495] 136 GeV τ̃ mass
Stable massive particles : R-hadrons
L=34 pb⁻¹ (2010) [arXiv:1103.1984] 562 GeV g̃ mass
Stable massive particles : R-hadrons
L=34 pb⁻¹ (2010) [arXiv:1103.1984] 294 GeV b̃ mass
Stable massive particles : R-hadrons
L=34 pb⁻¹ (2010) [arXiv:1103.1984] 309 GeV t̃ mass
RPV (λ'₃₁₁=0.01, λ₃₁₂=0.01) : high-mass eμ
L=0.87 fb⁻¹ (2011) [preliminary] 440 GeV ν̃_τ mass
Extra dimensions
Large ED (ADD) : monojet
L=1.00 fb⁻¹ (2011) [ATLAS-CONF-2011-096] 3.2 TeV M_D (δ=2)
UED : γγ + E_T,miss
L=36 pb⁻¹ (2010) [arXiv:1107.0561] 961 GeV Compact. scale 1/R
RS with k/M_Pl = 0.1 : m_γγ
L=36 pb⁻¹ (2010) [ATLAS-CONF-2011-044] 920 GeV Graviton mass
RS with k/M_Pl = 0.1 : m_ee/μμ
L=1.08-1.21 fb⁻¹ (2011) [preliminary] 1.63 TeV Graviton mass
RS with top couplings g_L=1.0, g_R=4.0 : m_tt̄
L=200 pb⁻¹ (2011) [ATLAS-CONF-2011-087] 650 GeV KK gluon mass
Quantum black hole (QBH) : m_dijet, F(χ)
L=36 pb⁻¹ (2010) [arXiv:1103.3864] 3.67 TeV M_D (δ=6)
QBH : High-mass σ_t+X
L=33 pb⁻¹ (2010) [ATLAS-CONF-2011-070] 2.35 TeV M_D
ADD BH (M_th/M_D=3) : multijet Σp_T, N_jets
L=35 pb⁻¹ (2010) [ATLAS-CONF-2011-068] 1.37 TeV M_D (δ=6)
ADD BH (M_th/M_D=3) : SS dimuon N_ch. part.
L=31 pb⁻¹ (2010) [ATLAS-CONF-2011-065] 1.20 TeV M_D (δ=6)
Ct. I.
qqqq contact interaction : F_χ(m_dijet)
L=36 pb⁻¹ (2010) [arXiv:1103.3864 (Bayesian limit)] 6.7 TeV Λ
qqμμ contact interaction : m_μμ
L=42 pb⁻¹ (2010) [arXiv:1104.4398] 4.9 TeV Λ
Z' / W'
SSM : m_ee/μμ
L=1.08-1.21 fb⁻¹ (2011) [preliminary] 1.83 TeV Z' mass
SSM : m_T,e/μ
L=1.04 fb⁻¹ (2011) [preliminary] 2.15 TeV W' mass
LQ
Scalar LQ pairs (β=1) : kin. vars. in eejj, eνjj
L=35 pb⁻¹ (2010) [arXiv:1104.4481] 376 GeV 1st gen. LQ mass
Scalar LQ pairs (β=1) : kin. vars. in μμjj, μνjj
L=35 pb⁻¹ (2010) [arXiv:1104.4481] 422 GeV 2nd gen. LQ mass
Other
4th family : coll. mass in Q₄Q̄₄ → WqWq
L=37 pb⁻¹ (2010) [ATLAS-CONF-2011-022] 270 GeV Q₄ mass
4th family : d₄d̄₄ → WtWt (SS dilepton)
L=34 pb⁻¹ (2010) [preliminary] 290 GeV d₄ mass
Major. neutr. (V_4-ferm., Λ=1 TeV) : SS dilepton
L=34 pb⁻¹ (2010) [preliminary] 460 GeV N mass
Excited quarks : m_dijet
L=0.81 fb⁻¹ (2011) [ATLAS-CONF-2011-095] 2.91 TeV q* mass
Axigluons : m_dijet
L=0.81 fb⁻¹ (2011) [ATLAS-CONF-2011-095] 3.21 TeV Axigluon mass
Color octet scalar : m_dijet
L=0.81 fb⁻¹ (2011) [ATLAS-CONF-2011-095] 1.91 TeV Scalar resonance mass
10⁻¹
1
10
Mass scale [TeV]
*Only a selection of the available results shown

Conclusion and outlook

Very rich program of BSM searches at CDF and D0.
Best limits are still coming from the Tevatron in a number of cases.

A few anomalies have attracted attention recently (W+2jets and ttbar asymmetry).
Situation is still unclear, and are being followed up with analysis of the full dataset

ATLAS and CMS are exploring a wide variety of signatures for signs of New Physics.

Results with 1 fb^{-1} are becoming available now.

No sign of New Physics yet.

Can look forward to O(3-4) fb^{-1} of data at the LHC by the end of this year and another full year ot data-taking in 2012.

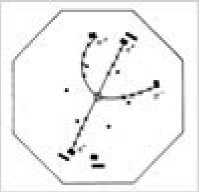
Conclusion and outlook

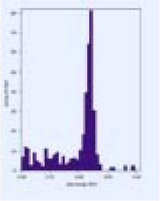
After 40 years of wandering in the desert, Moses finally saw the Promised Land.

Conclusion and outlook

After 40 years of wandering in the desert, Moses finally saw the Promised Land.

2011 is the 40th anniversary of the birth of supersymmetry
(and the 37th anniversary of the November Revolution)





EXTENSION OF THE ALGEBRA OF POINCARE GROUP GENERATORS AND VIOLATION OF P INVARIANCE

Yu.A. Gol'fand and E.P. Likhtman
Physics Institute, USSR Academy of Sciences
Submitted 10 March 1971
ZhETF Pis. Red. 13, No. 8, 452 - 455 (20 April 1971)

One of the main requirements imposed on quantum field theory is invariance of the theory to the Poincare group [1]. However, only a fraction of the interactions satisfying this requirement is realized in nature. It is possible that these interactions, unlike others, have a higher degree of symmetry. It is therefore of interest to study different algebras and groups, the invariance with respect to which imposes limitations on the form of the elementary particle interaction. In the present paper we propose, in constructing the Hamiltonian formulation of the quantum field theory, to use as the basis a special algebra $\mathcal{R}$, which is an extension of the algebra $\mathcal{P}$ of the Poincare group generators. The purpose of the paper is to find such a realization of the algebra $\mathcal{R}$, in which the Hamiltonian operator describes the interaction of quantized fields.

Golfand and Likhtman,
JETP Lett 13 (1971) 323

Could this be the year we realize the Promise of the LHC "no lose theorem"?