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## **Recent results from ATLAS**



### **Kyle Cranmer,** for the ATLAS Collaboration New York University

Kyle Cranmer (NYU)

## Outline

- A tremendous amount of physics produced from 2011 data
  - 59 papers submitted for publication in 2012 alone
- LHC Higgs results covered earlier today by Jake Anderson Overview of SUSY and Exotics results

Focus:

- Di-bosons
  - fiducial and inclusive cross sections, triple gauge couplings
- top-quark related measurements and searches
  - resonances, same-sign tops,
- Jet mass and substructure, new tools for the LHC
- Iong-lived heavy particles
  - slow, disappearing, and stopped

### **Overview of the ATLAS Detector**

10<sup>5</sup>

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**CENTER FOR** COSMOLOGY AND PARTICLE PHYSICS



E<sup>miss</sup><sub>T</sub> [GeV] nual Fermilab Users' Meeting, June 2012

### LHC

### The LHC has been performing very well

- >5 fb<sup>-1</sup> delivered in 2011 at 7 TeV (2  $\beta^*$  running conditions)
- already >5 fb<sup>-1</sup> delivered in 2012, running at 8 TeV
- peak luminosity 6.7 · 10<sup>33</sup> cm<sup>-2</sup>s<sup>-1</sup> (high pile-up environment)

ATLAS data taking efficiency >93%



### **Pile-up**





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### **Overview of the SUSY Searches**

		ATLAS SUSY Sea	rches* - 95% CL Lower Limits (Statເ	ıs: March 2012)	
			· · · · · · · · · · · · · · · · · · ·		
Inclusive searches	MSUGRA/CMSSM : 0-lep + j's + $E_{T,miss}$	L=4.7 fb <sup>-1</sup> (2011) [ATLAS-CONF-2012-033]	1.40 TeV $\widetilde{q} = \widetilde{g}$ mass	$\int Ldt = (0.03 - 4.7) \text{ fb}^{-1}$	
	MSUGRA/CMSSM : 1-lep + j's + $E_{T,miss}$	L=4.7 fb <sup>-1</sup> (2011) [ATLAS-CONF-2012-041]	1.20 TeV q̃ = g̃ mass		
	MSUGRA/CMSSM : multijets + $E_{T,miss}$	L=4.7 fb <sup>-1</sup> (2011) [ATLAS-CONF-2012-037]	<b>850 Gev</b> $\tilde{g}$ mass (large $m_0$ )	<b>≰</b> s = 7 TeV	
	Pheno model : 0-lep + j's + $E_{T,miss}$	L=4.7 fb <sup>-1</sup> (2011) [ATLAS-CONF-2012-033]	<u>1.38 теv</u> q̃ mass ( <i>m</i> (g̃) < 2 Те	/, light $\widetilde{\chi}_1^0$ ) <b>ATLAS</b>	
	Pheno model : 0-lep + j's + $E_{T,miss}$	L=4.7 fb <sup>-1</sup> (2011) [ATLAS-CONF-2012-033]	940 GeV $\tilde{g}$ mass $(m(\tilde{q}) < 2$ TeV, light	It $\widetilde{\chi}_1^0$ Preliminary	
	Gluino med. $\widetilde{\chi}^{\pm}$ ( $\widetilde{g} \rightarrow q\overline{q} \widetilde{\chi}^{\pm}$ ) : 1-lep + j's + $E_{T,miss}$	L=4.7 fb <sup>-1</sup> (2011) [ATLAS-CONF-2012-041]	900 GeV $\tilde{g}$ mass $(m(\tilde{\chi}_1^0) < 200 \text{ GeV})$ ,	$n(\widetilde{\chi}^{\pm}) = \frac{1}{2}(m(\widetilde{\chi}^{0}) + m(\widetilde{g}))$	
	GMSB : 2-lep OS <sub>SF</sub> + $E_{T,miss}$	L=1.0 fb <sup>-1</sup> (2011) [ATLAS-CONF-2011-156]	<b>810 Gev</b> $\tilde{g}$ mass (tan $\beta$ < 35)	2	
	$GMSB: 1\text{-}\tau + \mathbf{j}\mathbf{'}\mathbf{s} + \boldsymbol{E}_{\tau,miss}$	L=2.1 fb <sup>-1</sup> (2011) [ATLAS-CONF-2012-005]	920 GeV $\tilde{g}$ mass (tan $\beta$ > 20)		
	$GMSB: 2\text{-}\tau + j's + E_{T,miss}$	L=2.1 fb <sup>-1</sup> (2011) [ATLAS-CONF-2012-002]	990 GeV $\tilde{g}$ mass (tan $\beta$ > 20)		
	$GGM: \gamma\gamma + E_{T,miss}$	L=1.1 fb <sup>-1</sup> (2011) [1111.4116]	<b>805 GeV</b> $\widetilde{g}$ mass $(m(\widetilde{\chi}_1^0) > 50 \text{ GeV})$		
	Gluino med. $\tilde{b}$ ( $\tilde{g} \rightarrow b b \tilde{\chi}_1^0$ ) : 0-lep + b-j's + $E_{T,miss}$	L=2.1 fb <sup>-1</sup> (2011) [ATLAS-CONF-2012-003]	<b>900 Gev</b> $\tilde{g}$ mass $(m(\tilde{\chi}_1^0) < 300 \text{ GeV})$		
atior	Gluino med. $\tilde{t}$ ( $\tilde{g} \rightarrow t\bar{t}\chi_1^0$ ) : 1-lep + b-j's + $E_{T,miss}$	L=2.1 fb <sup>-1</sup> (2011) [ATLAS-CONF-2012-003]	<b>710 GeV</b> $\widetilde{g}$ mass $(m(\widetilde{\chi}_1^0) < 150 \text{ GeV})$		
nera	Gluino med. $\tilde{t}$ ( $\tilde{g} \rightarrow t\bar{t}\chi_1^0$ ) : 2-lep (SS) + j's + $E_{T,miss}$	L=2.1 fb <sup>-1</sup> (2011) [ATLAS-CONF-2012-004]	650 GeV $\widetilde{g}$ mass $(m(\widetilde{\chi}_1^0) < 210 \text{ GeV})$		
Third ge	Gluino med. $\tilde{t}$ ( $\tilde{g} \rightarrow t t \tilde{\chi}_{1}^{0}$ ) : multi-j's + $E_{T,miss}$	L=4.7 fb <sup>-1</sup> (2011) [ATLAS-CONF-2012-037]	830 GeV $\tilde{g}$ mass $(m(\tilde{\chi}_1^0) < 200 \text{ GeV})$		
	Direct $\widetilde{bb}$ ( $\widetilde{b}_1 \rightarrow b \widetilde{\chi}_1^0$ ) : 2 b-jets + $E_{T,miss}$	L=2.1 fb <sup>-1</sup> (2011) [1112.3832]	<b>390 GeV</b> $\widetilde{b}$ mass $(m(\widetilde{\chi}_1^0) < 60 \text{ GeV})$		
	Direct $\widetilde{t}\widetilde{t}$ (GMSB) : Z( $\rightarrow$ II) + b-jet + E	L=2.1 fb <sup>-1</sup> (2011) [ATLAS-CONF-2012-036]	<b>310 GeV</b> $\widetilde{t}$ mass (115 < $m(\widetilde{\chi}_1^0)$ < 230 GeV)		
DG	Direct gaugino $(\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0 \rightarrow 3I \tilde{\chi}_1^0)$ : 2-lep SS + $E_{T,\text{miss}}$	L=1.0 fb <sup>-1</sup> (2011) [1110.6189] 170 GeV	$\widetilde{\chi}_1^{\pm}$ mass $((m(\widetilde{\chi}_1^0) < 40 \text{ GeV}, \widetilde{\chi}_1^0, m(\widetilde{\chi}_1^{\pm}) = m(\widetilde{\chi}_2^0), m(\widetilde{I})$	$\widetilde{v}(\widetilde{v}) = \frac{1}{2}(m(\widetilde{\chi}_1^0) + m(\widetilde{\chi}_2^0)))$	
	Direct gaugino $(\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0 \rightarrow 3I \tilde{\chi}_1^0)$ : 3-lep + $E_{T,\text{miss}}$	L=2.1 fb <sup>-1</sup> (2011) [ATLAS-CONF-2012-023] 250	Gev $\tilde{\chi}_1^{\pm}$ mass $(m(\tilde{\chi}_1^0) < 170 \text{ GeV}, \text{ and as above})$		
es	AMSB : long-lived $\widetilde{\chi}_1^{\pm}$	L=4.7 fb <sup>-1</sup> (2011) [CF-2012-034] $~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~$	hass $(1 < \tau(\tilde{\chi}_1^{\pm}) < 2 \text{ ns}, 90 \text{ GeV limit in } [0.2,90] \text{ ns})$		
irtici	Stable massive particles (SMP) : R-hadrons	<i>L</i> =34 pb <sup>-1</sup> (2010) [1103.1984]	562 GeV g mass		
d pa	SMP : R-hadrons	L=34 pb <sup>·1</sup> (2010) [1103.1984] 2	94 GeV b mass		
live	SMP : R-hadrons	L=34 pb <sup>-1</sup> (2010) [1103.1984]	309 Gev t mass		
-buc	SMP : R-hadrons (Pixel det. only)	L=2.1 fb <sup>-1</sup> (2011) [ATLAS-CONF-2012-022]	810 GeV g mass		
Γc	GMSB : stable $\widetilde{\tau}$	L=37 pb <sup>-1</sup> (2010) [1106.4495] 136 GeV $\widetilde{ au}$ n	nass		
	$RPV$ : high-mass e $\mu$	L=1.1 fb <sup>-1</sup> (2011) [1109.3089]	1.32 TeV $\widetilde{v}_{\tau}$ mass ( $\lambda_{311}^{,}$ =0.10, $\lambda_{11}^{,}$	<sub>312</sub> =0.05)	
RP\	Bilinear RPV : 1-lep + j's + $E_{T,miss}$	L=1.0 fb <sup>-1</sup> (2011) [1109.6606]	<b>760 Gev</b> $\tilde{q} = \tilde{g}$ mass ( $c\tau_{LSP} < 15$ mm)		
	MSUGRA/CMSSM - BC1 RPV : 4-lepton + $E_{T,miss}$	L=2.1 fb <sup>-1</sup> (2011) [ATLAS-CONF-2012-035]	1.77 TeV g mass		
	Hypercolour scalar gluons : 4 jets, $m_{ij} \approx m_{kl}$	L=34 pb <sup>-1</sup> (2010) [1110.2693] 185 GeV	sgluon mass (excl: $m_{sg} < 100 \text{ GeV}, m_{sg} \approx 140 \pm$	3 GeV)	
		10 <sup>-1</sup>	1	10	
				Mass scale [TeV]	

\*Only a selection of the available mass limits on new states or phenomena shown

### **Overview of exotic searches**

		ATLAS Exotics Searches* - 95% CL Lower Limits (Status: March 2012)
ensions	Large ED (ADD) : monojet Large ED (ADD) : diphoton UED : $\gamma\gamma + E_{\tau,miss}$ RS with $k/M_{Pl} = 0.1$ : diphoton, $m_{\gamma\gamma}$ RS with $k/M_{Pl} = 0.1$ : dilepton, $m_{II}$	L=1.0 fb <sup>-1</sup> (2011) [ATLAS-CONF-2011-096]    3.2 TeV $M_D$ ( $\delta$ =2)      L=2.1 fb <sup>-1</sup> (2011) [1112.2194]    3.0 TeV $M_S$ (GRW cut-off)    ATLAS      L=1.1 fb <sup>-1</sup> (2011) [1112.2194]    1.23 TeV    Compact. scale 1/R (SPS8)    Preliminary      L=2.1 fb <sup>-1</sup> (2011) [1112.2194]    1.85 TeV    Graviton mass    Let = (0.04, 5.0) fb <sup>-1</sup>
Extra dime	RS with $k/M_{Pl} = 0.1$ : ZZ resonance, $m_{IIII / IIjj}$ RS with $g_{gqgKK}/g_s =-0.20$ : tt $\rightarrow$ I+jets, $m_{eff}$ ADD BH ( $M_{TH}/M_D = 3$ ) : multijet, $\Sigma p_T$ , $N_{jets}$ ADD BH ( $M_{TH}/M_D = 3$ ) : SS dimuon, $N_{ch. part.}$ ADD BH ( $M_{TH}/M_D = 3$ ) : leptons + jets, $\Sigma p_T$ Quantum black hole : dijet, $F_{\chi}(m_j)$	L=1.0 fb <sup>-1</sup> (2011) [1203.0718]    845 GeV    Graviton mass $\int Ldt = (0.04 - 3.0)$ fb      L=2.1 fb <sup>-1</sup> (2011) [ATLAS-CONF-2012-029]    1.03 TeV    KK gluon mass $[s = 7 \text{ TeV}]$ L=35 pb <sup>-1</sup> (2010) [ATLAS-CONF-2011-068]    1.37 TeV $M_D$ ( $\delta=6$ ) $[s = 7 \text{ TeV}]$ L=1.3 fb <sup>-1</sup> (2011) [ATLAS-CONF-2011-147]    1.5 TeV $M_D$ ( $\delta=6$ ) $L=4.7$ fb <sup>-1</sup> (2011) [ATLAS-CONF-2012-038]    4.11 TeV $M_D$ ( $\delta=6$ )
CI	qqll CI : ee, $\mu\mu$ combined, $\vec{m}_{\mu}$	L=4.8 fb <sup>-1</sup> (2011) [ATLAS-CONF-2012-038]      7.8 TeV      Λ        L=1.1-1.2 fb <sup>-1</sup> (2011) [1112.4462]      10.2 TeV      Λ (CONStructive int.)
	uutt CI : SS dilepton + jets + $E_{T,miss}$	L=1.0 fb <sup>-1</sup> (2011) [1202.5520] 1.7 TeV Λ
$\sim$	SSM Z': m <sub>ee/µµ</sub> SSM W': m	L=4.9-5.0 fb <sup>-1</sup> (2011) [ATLAS-CONF-2012-007] 2.21 TeV Z' mass
ГQ	Scalar LQ pairs ( $\beta$ =1) : kin. vars. in eejj, evjj Scalar LQ pairs ( $\beta$ =1) : kin. vars. in eejj, evjj	L=1.0 fb <sup>-1</sup> (2011) [1108.1316]  2.15 TeV  VV  Inlass    L=1.0 fb <sup>-1</sup> (2011) [1112.4828]  660 GeV  1 <sup>st</sup> gen. LQ mass    L=1.0 fb <sup>-1</sup> (2011) [Preliminary]  685 GeV  2 <sup>nd</sup> gen. LQ mass
Excit. ferm. New quarks	$\begin{array}{c} 4^{\text{th}} \text{ generation }: \mathbb{Q} \ \overline{\mathbb{Q}}_{4} \rightarrow \mathbb{W} \mathbb{Q} \mathbb{Q} \\ 4^{\text{th}} \text{ generation }: \mathbb{Q} \ \overline{\mathbb{Q}}_{4} \rightarrow \mathbb{W} \mathbb{W} \mathbb{Q} \\ 4^{\text{th}} \text{ generation }: \mathbb{Q} \ \overline{\mathbb{Q}}_{4} \rightarrow \mathbb{W} \mathbb{W} \mathbb{D} \\ 4^{\text{th}} \text{ generation }: \mathbb{Q} \ \overline{\mathbb{Q}}_{4} \rightarrow \mathbb{W} \mathbb{W} \mathbb{D} \\ 4^{\text{th}} \text{ generation }: \mathbb{Q} \ \overline{\mathbb{Q}}_{4} \rightarrow \mathbb{W} \mathbb{W} \mathbb{D} \\ \mathbb{W} \text{ uark } \mathbb{D} : \mathbb{D} \ \mathbb{D}^{-1} \rightarrow \mathbb{Z} \mathbb{D} + \mathbb{X}, m \\ \mathbb{W} \text{ uark } \mathbb{D} : \mathbb{D}^{-1} \rightarrow \mathbb{Z} \mathbb{D} + \mathbb{X}, m \\ \mathbb{W} \text{ uark } \mathbb{D} : \mathbb{D}^{-1} \rightarrow \mathbb{Z} \mathbb{D} + \mathbb{X}, m \\ \mathbb{W} \text{ uark } \mathbb{D} : \mathbb{D}^{-1} \rightarrow \mathbb{Z} \mathbb{D} + \mathbb{X}, m \\ \mathbb{W} \text{ uark } \mathbb{D} : \mathbb{D}^{-1} \rightarrow \mathbb{U} \rightarrow \mathbb{U} + \mathbb{U} \\ \mathbb{W} \text{ uark } \mathbb{U} : \mathbb{U} : \mathbb{U} \rightarrow \mathbb{U} \rightarrow \mathbb{U} = \mathbb{U} \\ \mathbb{W} \text{ uark } \mathbb{U} : \mathbb{U} : \mathbb{U} \rightarrow \mathbb{U} = \mathbb{U} \\ \mathbb{W} \text{ uark } \mathbb{U} : \mathbb{U} : \mathbb{U} = \mathbb{U} = \mathbb{U} \\ \mathbb{W} \text{ uark } \mathbb{U} : \mathbb{U} : \mathbb{U} = \mathbb{U} \\ \mathbb{W} \text{ uark } \mathbb{U} : \mathbb{U} = \mathbb{U} = \mathbb{U} \\ \mathbb{W} \text{ uark } \mathbb{U} : \mathbb{U} : \mathbb{U} = \mathbb{U} \\ \mathbb{W} \text{ uark } \mathbb{U} : \mathbb{U} : \mathbb{U} : \mathbb{U} = \mathbb{U} \\ \mathbb{W} \text{ uark } \mathbb{U} : \mathbb{U} : \mathbb{U} : \mathbb{U} = \mathbb{U} \\ \mathbb{U} : \mathbb{U} :$	L=1.0 fb <sup>-1</sup> (2011) [1202.3389]    350 GeV    Q <sub>4</sub> mass      L=1.0 fb <sup>-1</sup> (2011) [1202.3076]    404 GeV    U <sub>4</sub> mass      L=1.0 fb <sup>-1</sup> (2011) [Preliminary]    480 GeV    d <sub>4</sub> mass      L=2.0 fb <sup>-1</sup> (2011) [Preliminary]    400 GeV    b' mass      L=2.0 fb <sup>-1</sup> (2011) [Preliminary]    400 GeV    b' mass      L=2.1 fb <sup>-1</sup> (2011) [Preliminary]    400 GeV    b' mass      L=2.1 fb <sup>-1</sup> (2011) [I1109.4725]    420 GeV    T mass (m(A <sub>0</sub> ) < 140 GeV)
Other	Techni-hadrons : dilepton, $m_{ee/\mu\mu}$ Techni-hadrons : WZ resonance (vIII), $m_{T,WZ}$ Major. neutr. (LRSM, no mixing) : 2-lep + jets $W_R$ (LRSM, no mixing) : 2-lep + jets $H_L^{\pm\pm}$ (DY prod., BR( $H_L^{\pm\pm} \rightarrow \mu\mu$ )=1) : SS dimuon, $m_{\mu\mu}$ Color octet scalar : dijet resonance, $m_{jj}$ Vector-like quark : CC, $m_{lvq}$ Vector-like quark : NC, $m_{llq}$	$ \begin{array}{c c c c c c c c c c c c c c c c c c c $
		10 <sup>-1</sup> 1 10 10

Mass scale [TeV]

\*Only a selection of the available mass limits on new states or phenomena shown







Run 166466 Event 26227945 Time 2010-10-07 22:16:39 UTC

 $\mu^+$ 

# WZ→evµµ Candidate

MET

μ



# Anomalous TGCs



Effective Lagrangian to model generic new contributions to TGCs

- In SM, all new couplings are zero, except  $g_1^V = \kappa^V = 1$
- For WW $\gamma$  vertex analysis, fix  $g_1^{\gamma}=1$  to ensure EM gauge invariance
- Form factor, with scale  $\Lambda,$  can be used to suppress divergent cross section at large  $\sqrt{s}$  and preserve unitarity



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**CENTER FOR**  $WZ \rightarrow IvII, ZZ \rightarrow 4I \& WW \rightarrow IvIv$ COSMOLOGY AND PARTICLE PHYSICS 10Ge\ Fiducial and inclusive cross sections measure ATLAS Preliminarv Data Diboson 500  $Ldt = 4.70 \text{ fb}^{-1}$ W+jet/dijet Events vs = 7TeV top 400 Drell-Yan WW→lvlv math σ<sub>stat+svst</sub> 300 WZ→IvII Selection:  $ZZ \rightarrow 4I$  Selection: 200 Exactly 2 opposite-charge, isolated • At least 3 isolated leptons, p<sub>T</sub>>15 G • Four isolated leptons with pT>7 GeV • E<sup>Tmiss</sup> > 25 GeV Heptons with p<sub>T</sub>>20 GeV Leading lepton pT>20, 25 GeV (µ,e) 100-7 Veto • A Z candidate with |m<sub>ll</sub>-M<sub>Z</sub><sup>pole</sup>|<10 G Two Z candidates with A W candidate with m<sub>T</sub> > 20 GeV o iet/b=iet with n-≯2<del>5-20</del>.GeV |m<sub>ll</sub>-M<sub>Z</sub><sup>pole</sup>|<25 GeV <sup>20</sup> m<sub>ll</sub>≯495,15,910 G€V (µµ,ee,êµ) • E<sub>T rel</sub> miss>55,50,25 GeV (qui geete) [GeV] GeV [GeV] 50 350⊢ Expected Background in signal region: 0.7<sup>+1.3</sup> -0.7 (stat) +1.3 -0.7 (sta ATLAS Preliminary Data Data ATLAS WZ Diboson  $Ldt = 4.70 \text{ fb}^{-1}$ က 300F pair mass **ATLAS** Preliminarv  $40 \vdash Ldt = 1.02 fb^{-1} \sqrt{s} = 7 TeV$ W+jet/dijet 160 ±₽.1 s = 7TeV top  $(stat) \pm 4.5(svs) \pm 2.1$ 250 140 Drell-Yan L dt = 4.7 fbWW→lvlv Leading lepton 120 t + svs200 σ<sub>stat+svst</sub> vents / 3 GeV 150 100 100 ATI AS 20 expected  $\sigma^{fid}$  (fb) measured  $\sigma^{fid}$  (fb)  $\Delta \sigma_{lumi}$  (fb)  $\Delta \sigma_{stat}$  (fb)  $\Delta \sigma_{syst}$  (fb) Channels 40 50  $3.4 \pm 2.1$  (stat)  $\pm 4.5$  (s  $44.9 \pm 3.7$ 41.4 +6.5+5.7 $\pm 1.6$ evev 20 0  $38.0 \pm 3.1$ 48.2  $\pm 4.6$ +3.8 $\pm 1.9$ μνμν 40 60 80 20 60 20 40 237.4±19.4 284.9 +12.7 $\pm 14.1$ Sublead evuv  $\pm 11.1$ Ge< ATLAS Preliminar 22 ر مور **20**⊨ Ge + Data UWZ ATLAS Total Cross Section 23 77 Si а õ Tota expected  $\sigma^{fid}$  (fb) measured  $\sigma^{fid}$  (fb) Channels 0.7 <sup>+1.3</sup><sub>-0.7</sub> (stat) <sup>+1.3</sup><sub>-0.7</sub> (syst) Measured:  $7.2_{-0.9}^{+1.1}(stat) + 0.3_{-0.3}^{+0.4}(sys) \pm 0.3(lumi) pb$ Meas mi) pb 44.9±3.7 41.4 ± 8.8 evev SM NLO prediction:  $6.5^{+0.3}_{-0.2} pb$ SM N  $48.2 \pm 6.3$ 38.0±3.1 μνμν 237.4±19.4  $284.9 \pm 22$ evuv **Fiducial Cross Section** Fidı Measured:  $21.2_{-27}^{+3.2}(stat)_{-0.9}^{+1.0}(sys) \pm 0.8(lumi)$  fb 40 60 80 100 140 20 120 Meas ) fb 600 p<sub>T</sub><sup>Z</sup> [GeV] mass [GeV] 2012 12

# Summary of Diboson measurements



### All diboson cross sections measured

agree with SM within uncertainty

#### Limits on anomalous TGC derived

Competitive with LEP and Tevatron



### Outlook

- Update cross section and anomalous TGC analyses to 5 fb<sup>-1</sup>
- WZ and ZZ will move to differential distributions for anomalous TGC analysis

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# Top Physics



# **Top physics**

The large mass of the top quark hints that electroweak symmetry breaking and BSM

- A<sub>FB</sub><sup>tt</sup> anomaly at the Tevatron -- many
- tt resonances common in non-SUSY Sources to meratory provident

0.99

0.98

0.97

171

 $\mu + jets$  $\int L dt = 1.04 \text{ fb}^{-1}$ 

173

174

175

176

177

178

179

172

tt production is a background to almost all searches





 $m_{top} = 175.0 \pm 0.9_{stat+JSF}$  GeV

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# Same-sign top & 4th gen down-type quarks

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- tt<sub>BB</sub> Z' 100GeV(× 10)

JHEP04(2012)069

800

900

data

real

///// uncertainty

700

ATLAS

charge flip fakes

Experimental signature:

- Same sign lepton pair (ee, eµ, µµ)
- Large missing transverse energy

Background:

- ✓ Fake lep (hadron, photon conversion)
- ✓ Charge mid identification

✓ Di-boson (using MC)



Events / 200 GeV

25

20

15

10

L dt = 1.04 fb<sup>-1</sup>  $\sqrt{s}$  = 7 TeV

300

200

 $+\ell+:H_T>150$ GeV, $m_{\ell\ell}>100$ GeV

400

500

600

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# *tt* resonance (*dilepton channel*)

arXiv:1205.5371



# *tt* resonance (lepton+jets channel)

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arXiv:1205.5371



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# Jet mass & substructure

Boosted topologies & jet substructure offer promising tool for new physics searches at LHC Study based on large anti-kT (R=1) and Cambridge-Aachen (R=1.2) jets in 4 pT bins



Butterworth, Davison, Rubin, Salam PRL 100, 242001 (2008)

Iterative Dynamically Stabilized Unfolding technique (matrices published to HEPData) Jet mass shows largest disagreement with LO MC, improved after splitting & filtering



# Jet mass & substructure



Jet mass, kT splitting scales, and N-subjettiness measured before and after unfolding

- Described reasonably well, large systematic uncertainties
  - sub-jet properties generally agree better
  - · jet-mass after splitting and filtering shows less dependence on pile-up



# **Charged long-lived heavy particles**

ATLAS-CONF-2012-022

**ATLAS**Prelim Good Clusters =

Data 2010

dE/dx (MeV g<sup>-1</sup> cm<sup>2</sup>)

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K

0 0.5

Ldt=2.06fb

Prediction g (NLO)

-0.5

500 600

400

5

π

1

CLs 95% CL UL g̃ (10% gluinoball prob.)

CLs 95% CL UL g̃ (50% gluinoball prob.)

UL expected  $\pm 1\sigma$ 

UL expected  $\pm 2\sigma$ 

▲ UL expected (10% gluinoball prob.)

700 800

1.5

q p (GeV)

900 1000

Mass [GeV]

10<sup>5</sup>

10<sup>4</sup>

 $10^{3}$ 

 $10^{2}$ 

10

2.5



- mass determined from inverting Most Prob. Value
- Using pixel only less sensitive to modeling of R-hadron in calorimeter
- several hadronization & material interaction models
  Data-driven background estimates
  Trigger: E<sub>T</sub><sup>miss</sup>>70



# Disappearing-track search

Long lived charged particle might decay in the tracking volume, giving rise to a `disappearing' track

 for example, Anomaly mediated SUSY breaking with small mass splitting between χ<sub>1</sub><sup>±</sup> and χ<sub>1</sub><sup>0</sup>

Disappearing track has <5 hits in TRT

Backgrounds from material interaction and 'bad tracks' estimated from data





arXiv:1202.4847

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# Stopped, Long-Lived Particles

arXiv:1201.5595

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Even longer lived particles can stop in calorimeter, decay later



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## Summary

### 2011 was a fantastic year for the LHC and for ATLAS

- accelerator and detector both performing beyond expectations
- hundreds of papers submitted for publication
- high-precision measurements for electroweak and top physics
- stringent constraints for supersymmetry and exotica
- an intriguing excess in the search for the Higgs
- 2012 promises to be a year to remember
  - already >5 fb<sup>-1</sup> of pp collisions at 8 TeV
  - the Higgs story will unfold
  - will deploy several new tools commissioned in 2011

## More results from ATLAS can be found here:

https://twiki.cern.ch/twiki/bin/view/AtlasPublic/