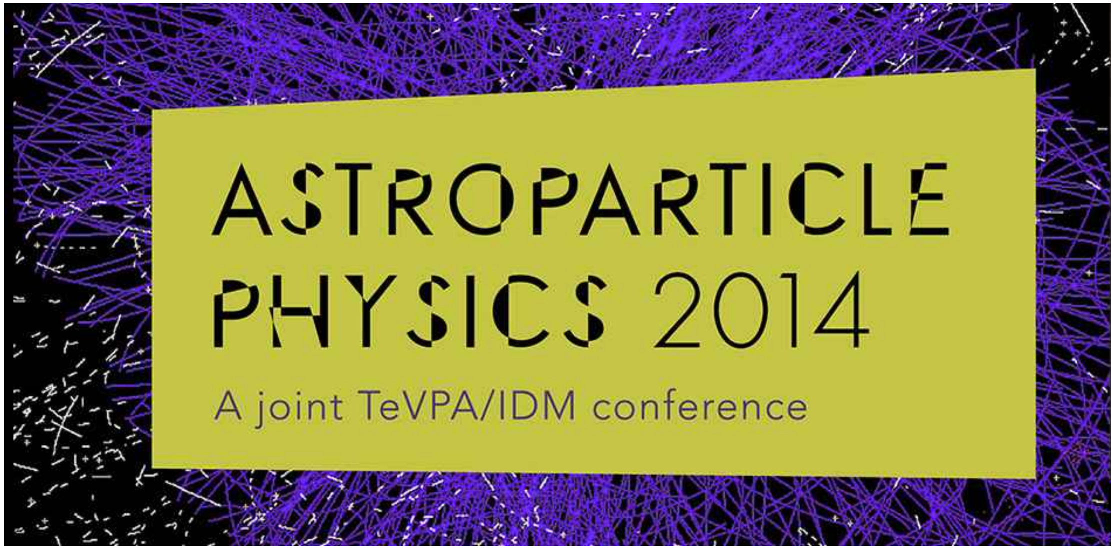


New physics searches in ATLAS and relation to astroparticle physics

V.Giangiobbe (IFAE Barcelona) on behalf of the ATLAS Collaboration

Amsterdam 23 – 28 June 2014

Outline

- Introduction
  - Evidence of Dark Matter
  - DM candidates
  - DM detection
- Search of DM at ATLAS
  - LHC and the ATLAS experiment
  - SUSY searches
  - Other searches

Evidence for Dark Matter

► From speed dispersion measurements in clusters of galaxies, and orbital speed of stars in galaxies

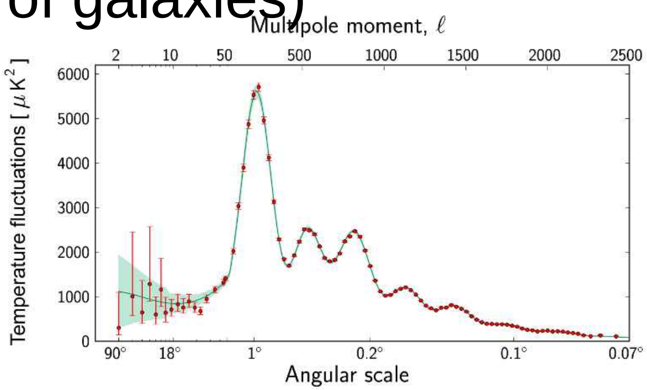
- mass of luminous objects $\ll$ total mass

► Weak gravitational lensing : get distribution of matter, in clusters

- most of it not accounted for by atoms

$$\Omega_{DM} \gtrsim 0.1 - 0.2$$

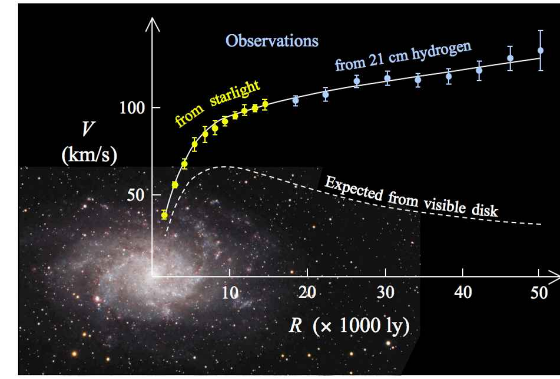
► From fit of cosmological parameters to measurements (CMB anisotropy, spacial distribution of galaxies)

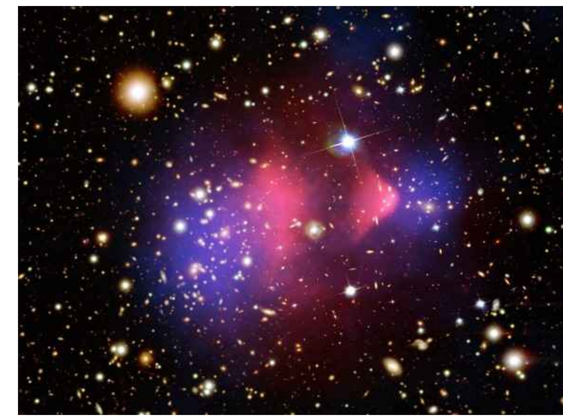


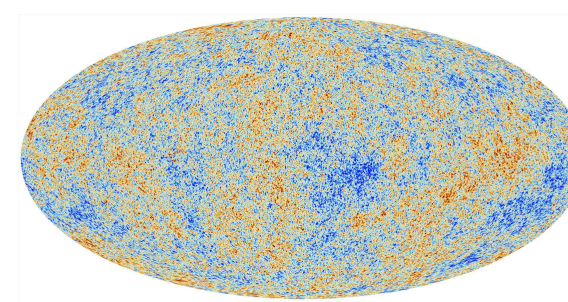
$$\Omega_b = 0.0499(22)$$

$$\Omega_{nbm} = 0.265(11)$$

► Predominance of non-baryonic matter in universe



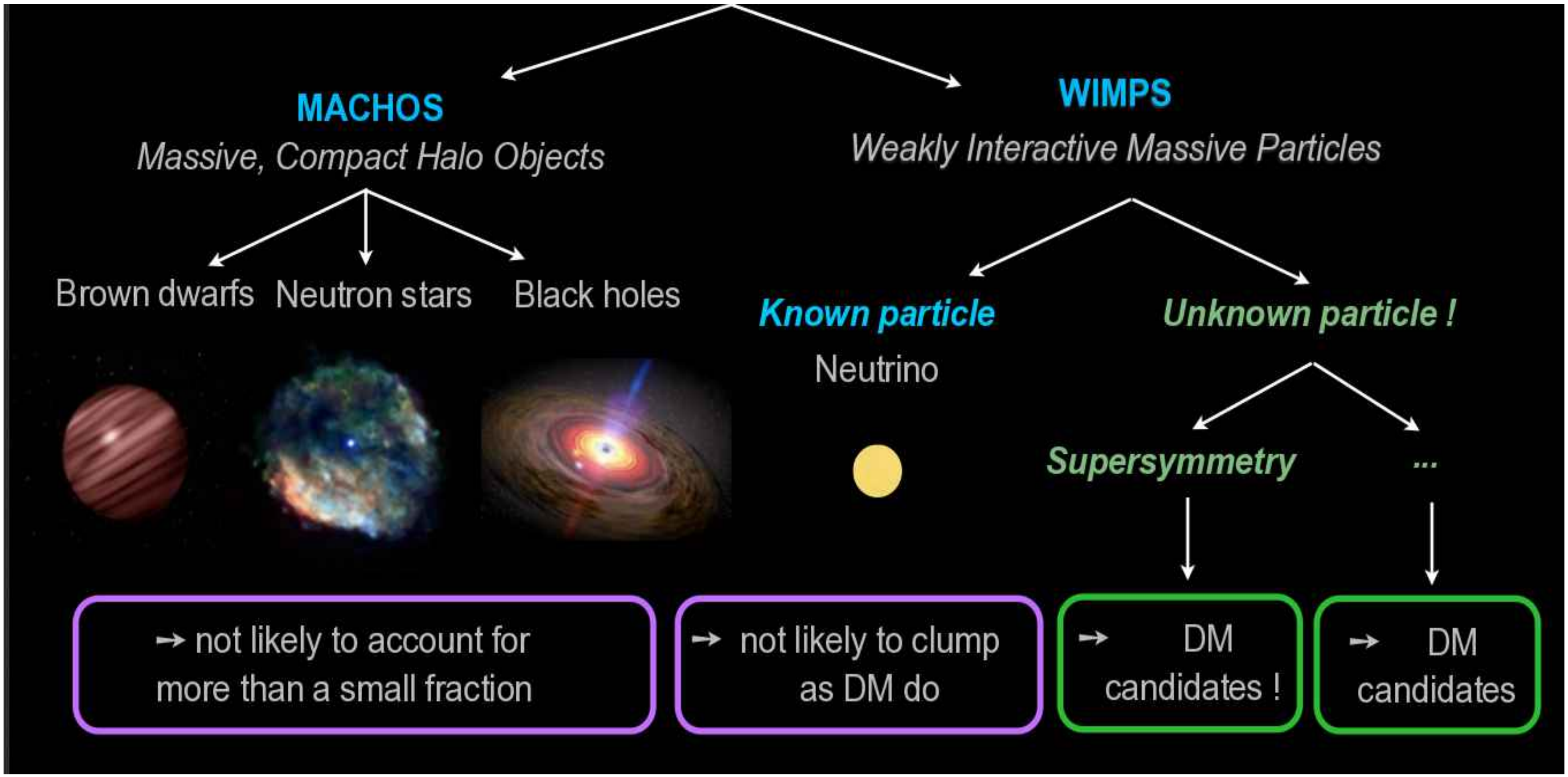




Dark matter candidates

- ► Few points DM candidate should satisfy (arXiv:0711.4996)
  - Neutral, "cold", consistent with relic density, ...

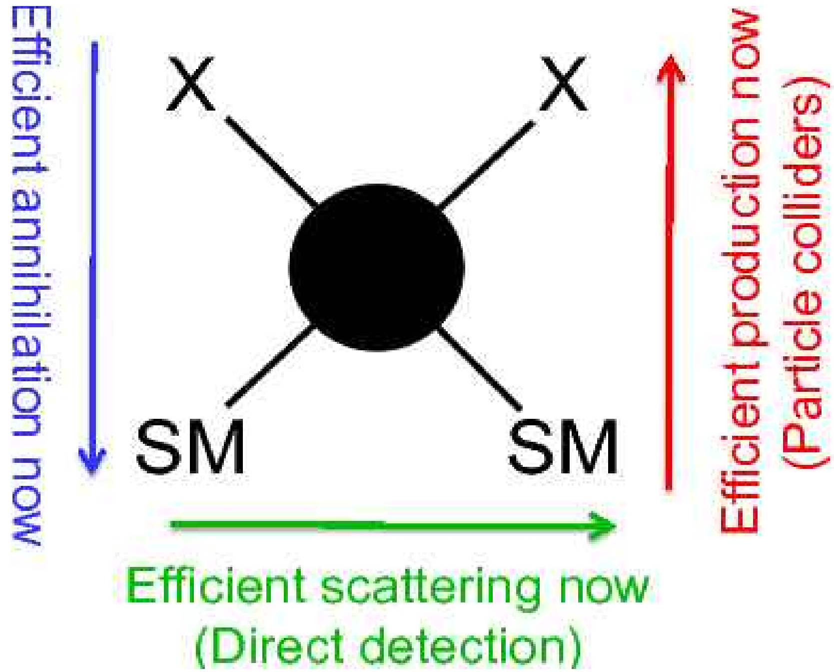
H. Sandaker
http://indico.cern.ch/event/240327/material/slides/0.pdf

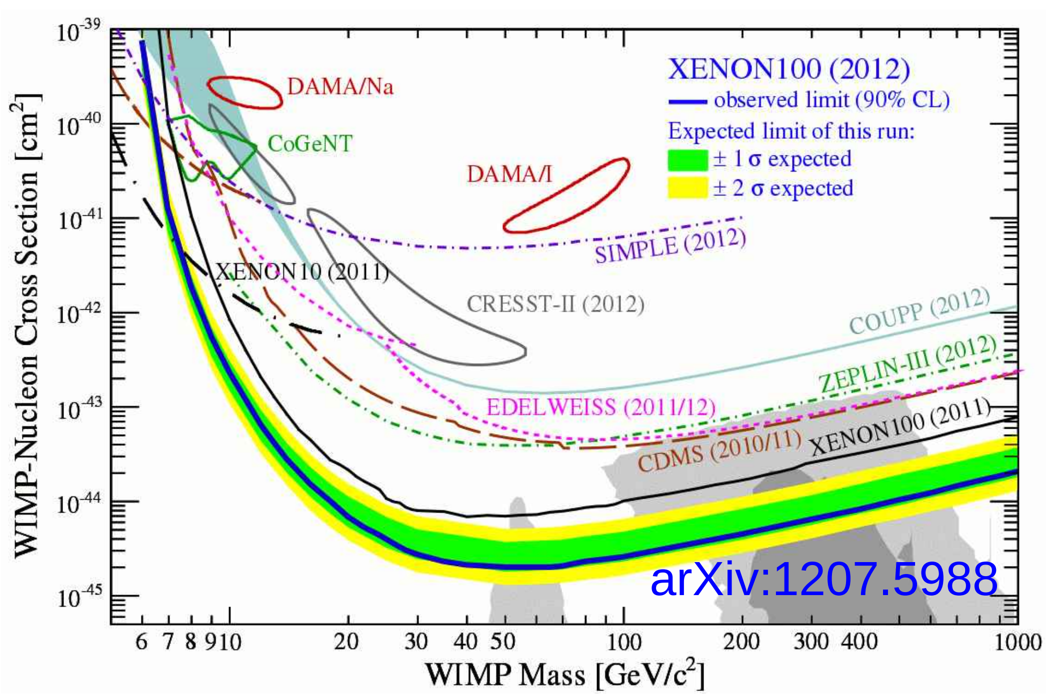


- ► Apparently none of the Standard Model particle has the right properties
- ► We need to look for new physics beyond the SM

Dark Matter detection

- Different types of experiments for DM search
  - Direct detection : elastic scattering between nuclei (detector) and DM halo
  - Indirect detection : look for decay products of DM annihilation
  - Particle colliders : search for DM production from SM particle interaction

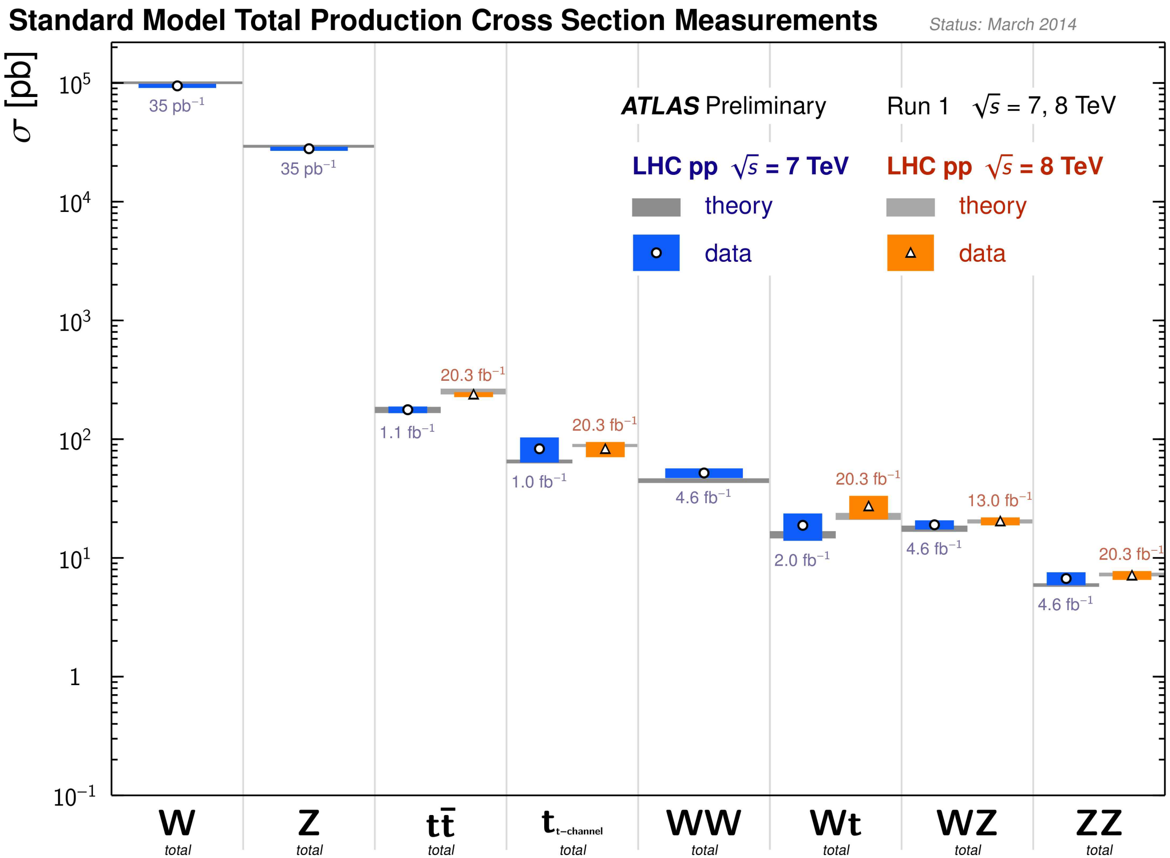


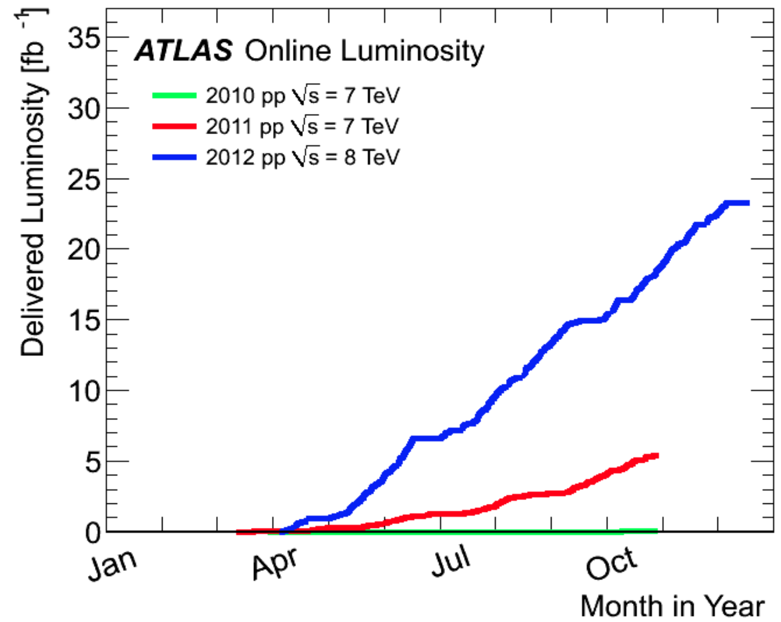


- Many results
  - Some experiments found evidence of WIMP signature
  - Some gave exclusion limits
  - Sensitivity is improving
  - LHC experiment can contribute with independent results

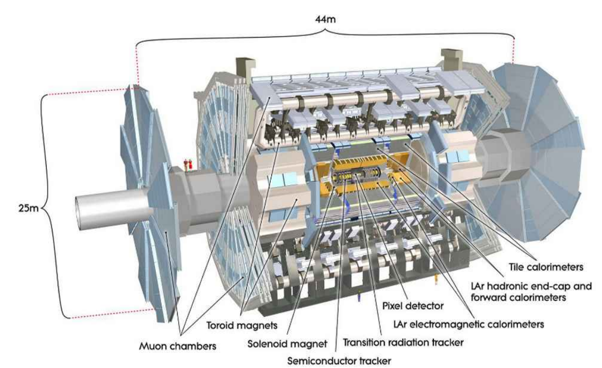
LHC and the ATLAS Experiment

- LHC performances from 2010 to 2012
  - pp run at 7 and 8 TeV
  - Delivered 28 fb^{-1} (>21 fb^{-1} collected data in ATLAS)
  - Restart in 2015 after technical stop with 13-14 TeV





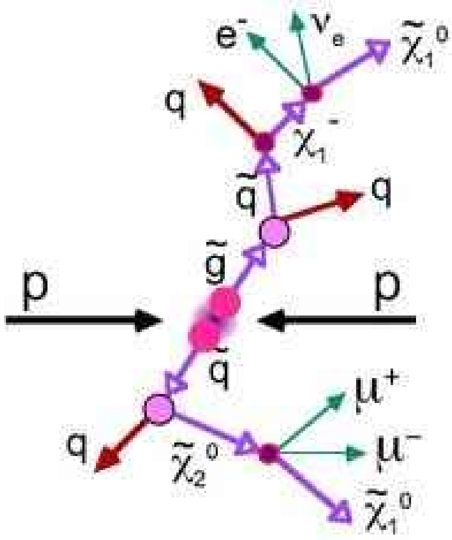
- Very good agreement between Standard Model theoretical and experimental cross sections



Search of Dark Matter in ATLAS

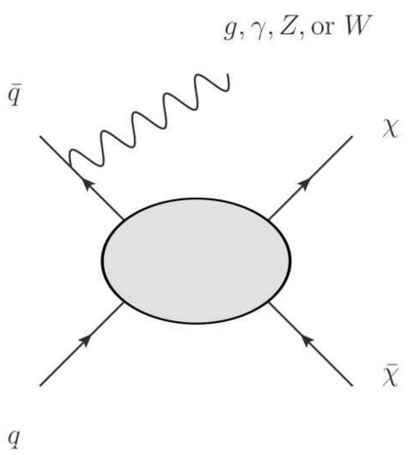
► SUSY searches

- Stability of DM ensured by imposing a symmetry that forbids the decay of DM into SM particle (R-parity conservation)
- Cascade ending with SM particles (jets, leptons) and LSP (missing Et)
- Most widely studied candidates : lightest neutralino (spin 1/2), light gravitino (spin 3/2)



► Alternative searches

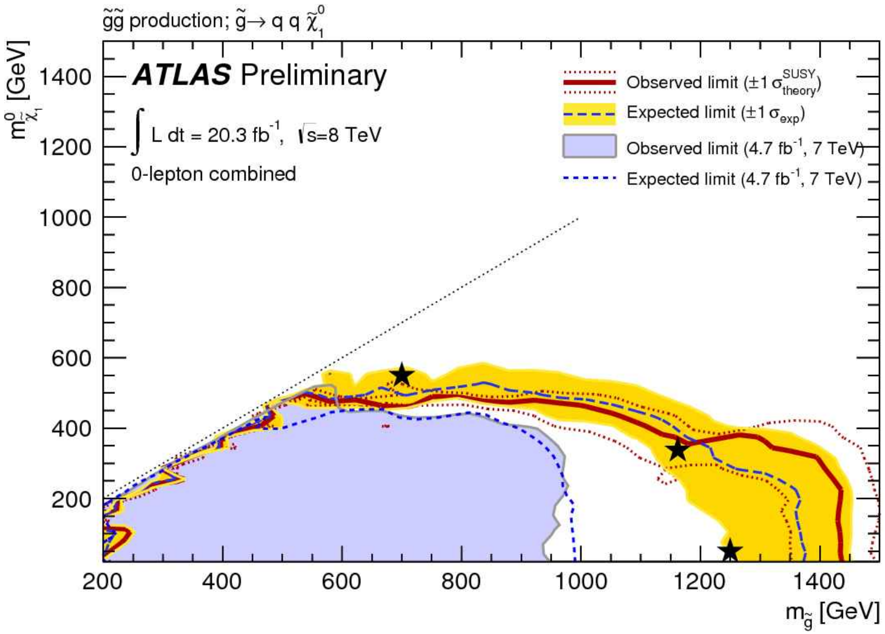
- Interaction SM-WIMP described by effective theory or simplified model
- WIMP pair production in association with an initial state radiation
  - – Mono-jet : see talk from Valerio Rossetti
  - – Mono-W/Z : see talk from Andy Nelson

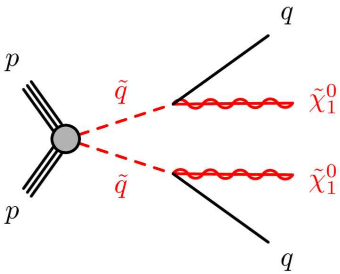


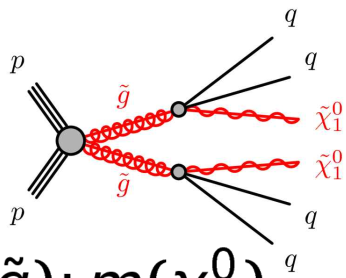
Search for SUSY DM candidates in ATLAS

SUSY : strong production

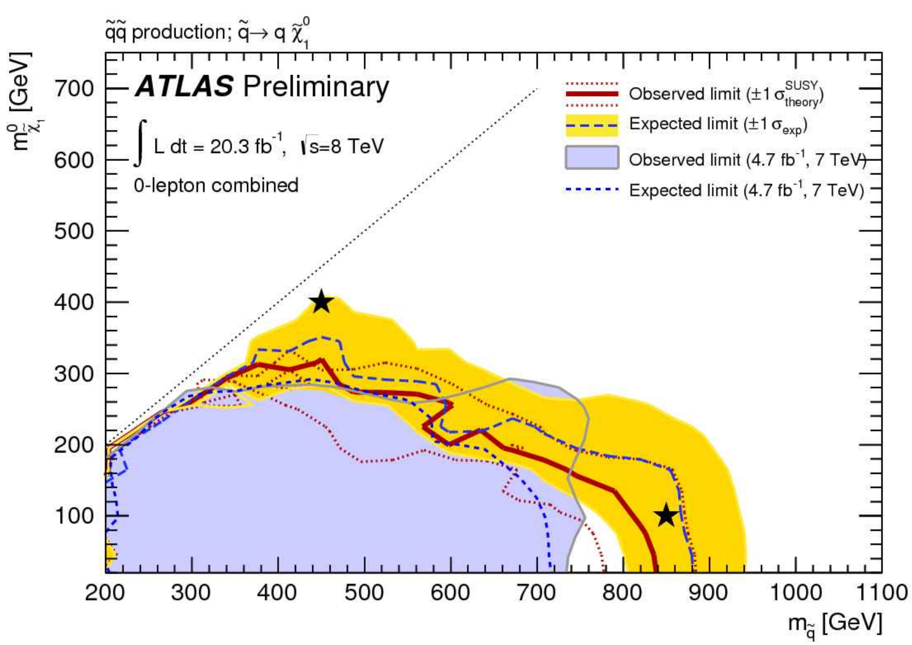
ATLAS-CONF-2012-147

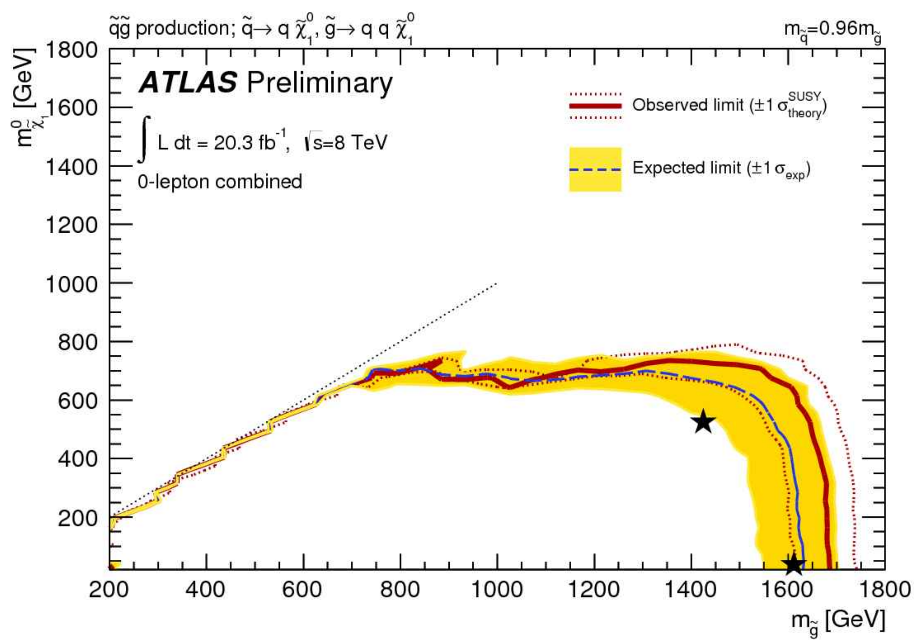






- ► R-parity conservation, LSP lightest neutralino (DM candidate)
- ► Simplified model : 3rd squark generation, other neutralinos, sleptons at very high mass scale
- ► Exclusion in the plane $m(\tilde{q},\tilde{g}); m(\chi^0_1)$

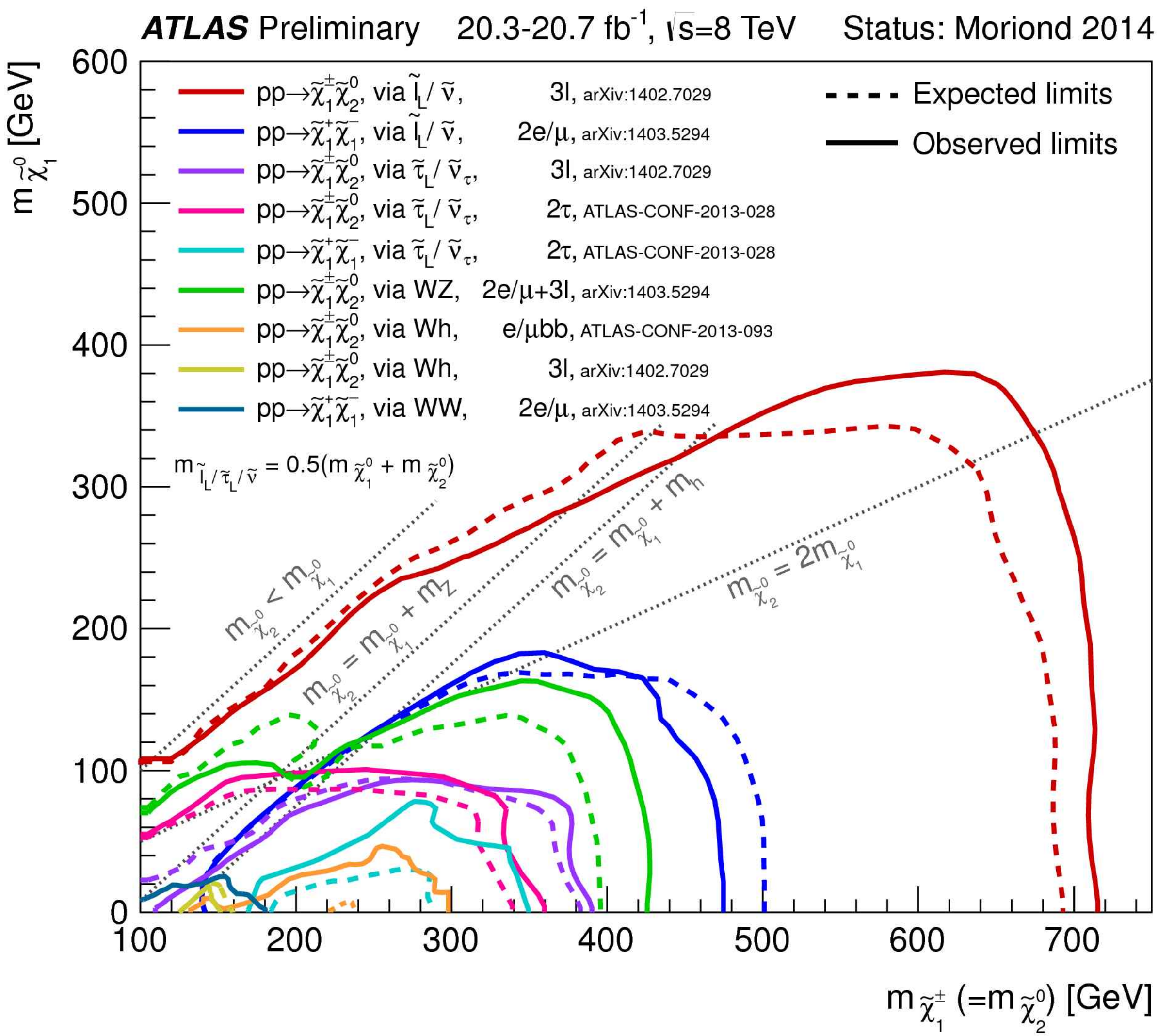


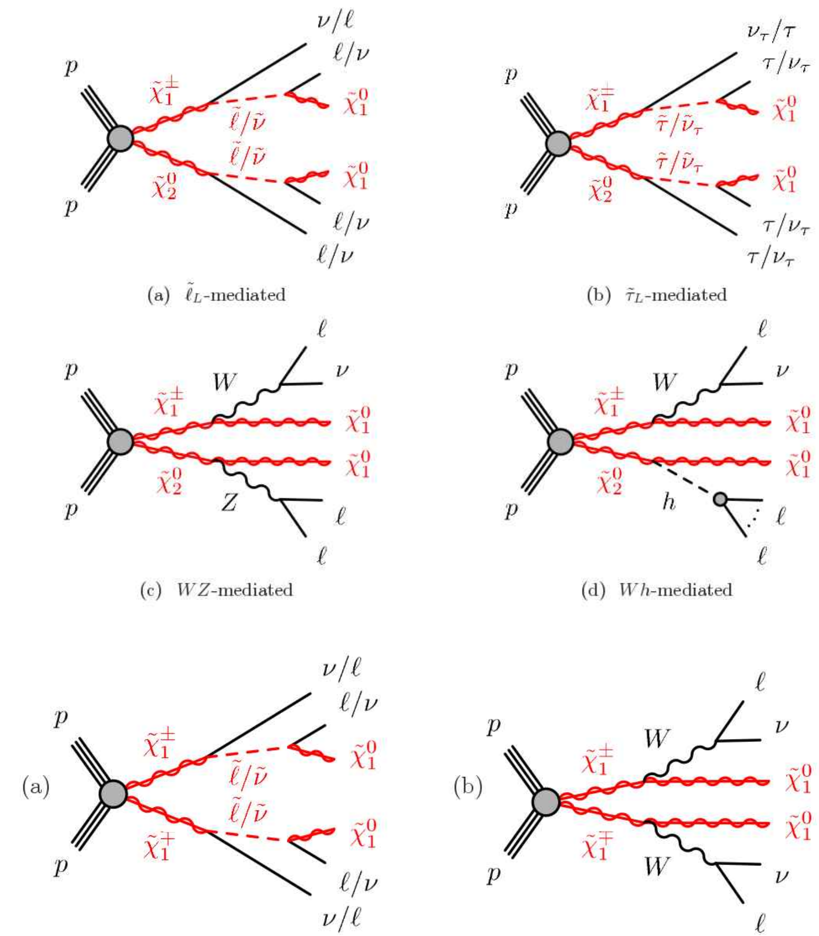


SUSY : electroweak production

- ► R-parity conservation, LSP lightest neutralino
- ► pMSSM, simplified model

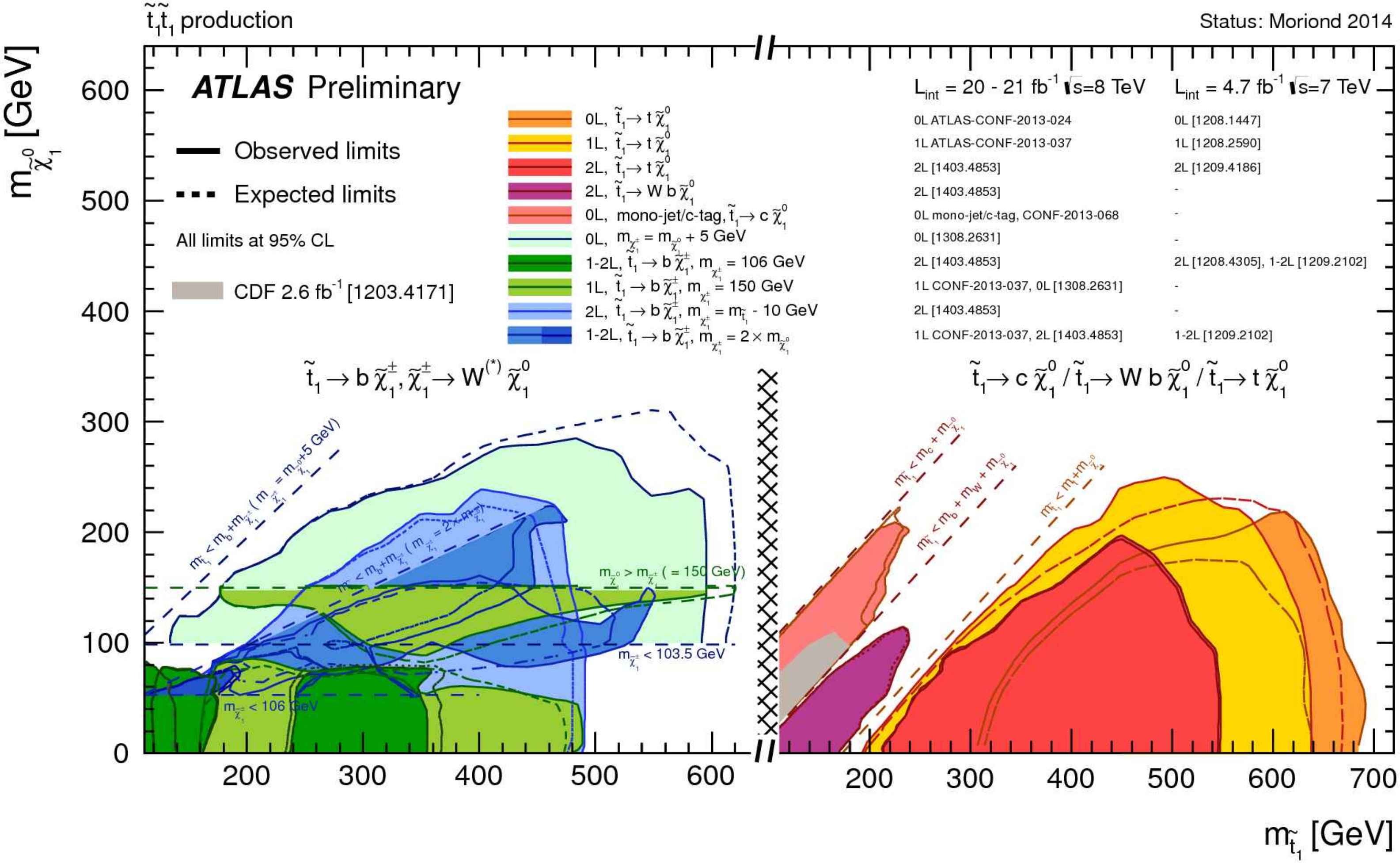
$$pp \to \tilde{\chi}_1^\pm \tilde{\chi}_1^\mp, \tilde{\chi}_2^0 \tilde{\chi}_1^\pm$$

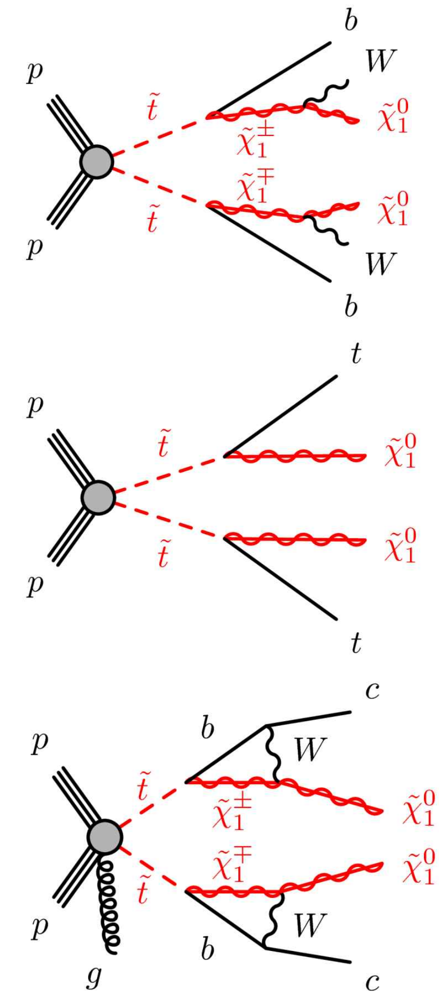




SUSY : third generation production

- R-parity conservation, LSP = lightest neutralino
- Simplified models
- Exclusions in the plane $m(\tilde{t}); m(\chi_1^0)$

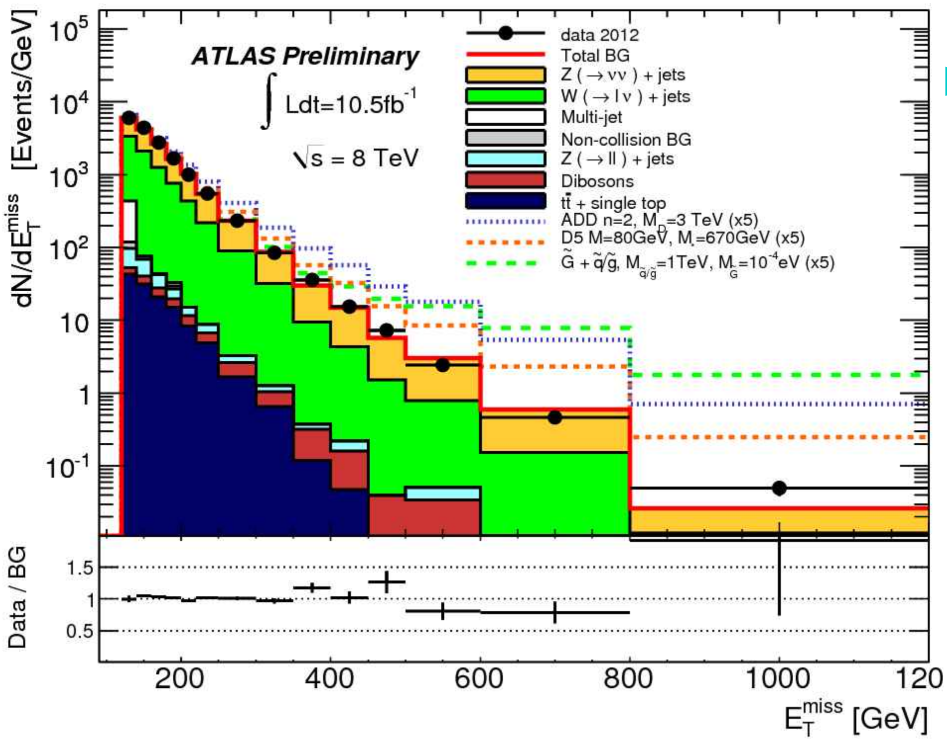




SUSY : summary of neutralino search

- Strong production
  - Neutralino (LSP) bellow 600 GeV excluded for squark/gravitino masses up to 1.6 TeV
- Electroweak and 3rd generation production
  - Neutralino (LSP) bellow 300 GeV excluded for chargino/stop masses up to ~700 GeV
- Simplified models (assume SUSY decays with 100% BR)
- Comparison with Direct DM detection experiments is non trivial
- In case an excess is seen by DM experiments, ATLAS SUSY results may help discriminating between models

SUSY searches : gravitino ATLAS-CONF-2012-147



► Events selection

Lepton veto

Njets (p_T>30 GeV) <3

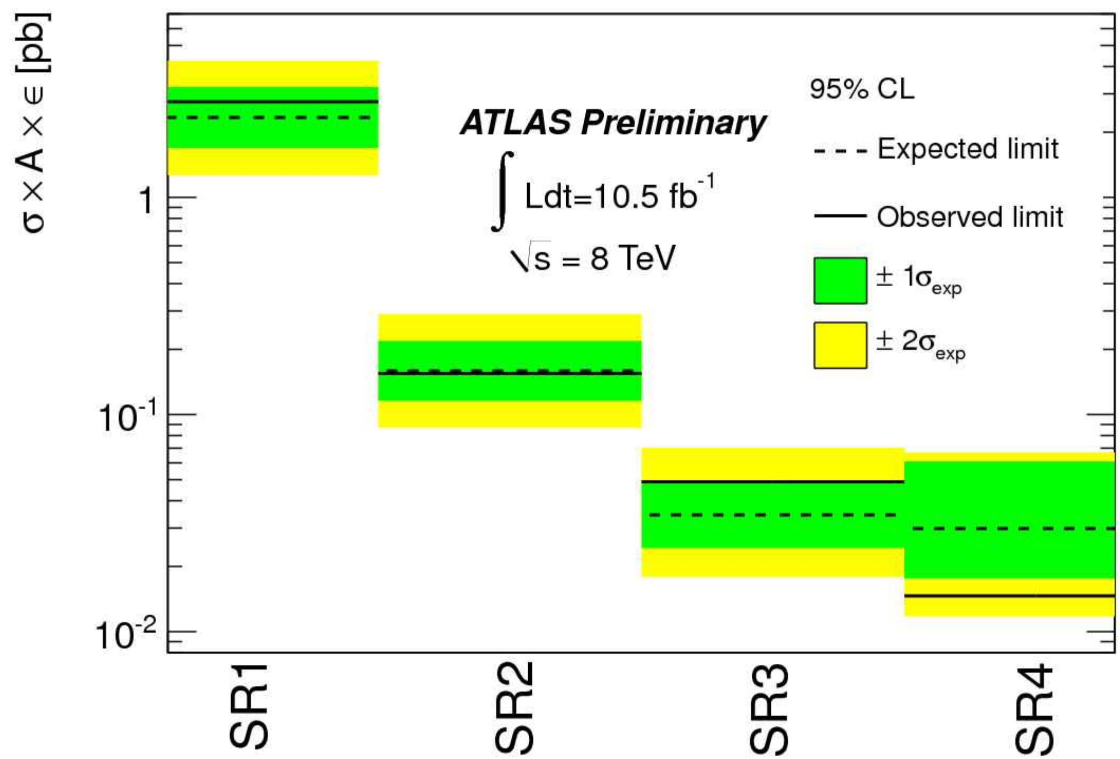
E_T^{miss} > 120, 220, 350, 500 GeV

Leading jet p_T > 120, 220, 350, 500 GeV

► Data driven determination of the dominant backgrounds W/Z+jets

► Good agreement with SM

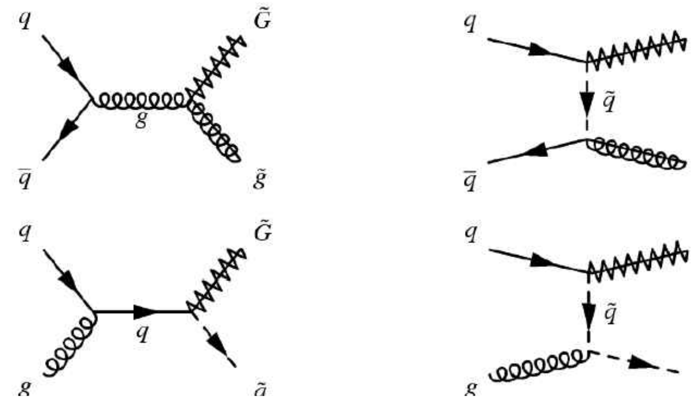
- Limits set on cross-section of physics Beyond the SM

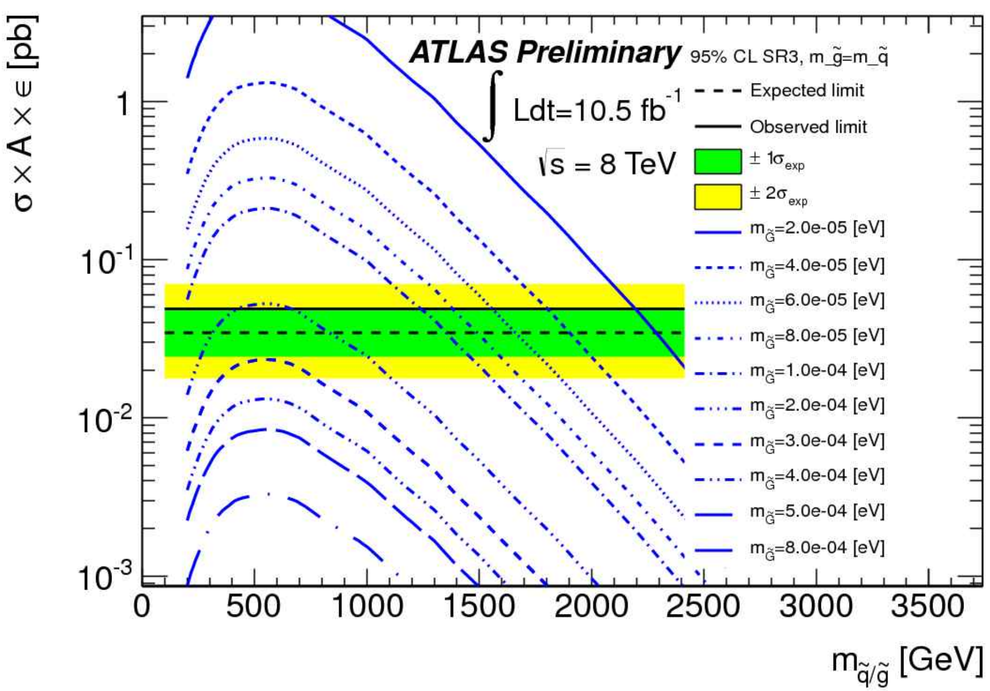


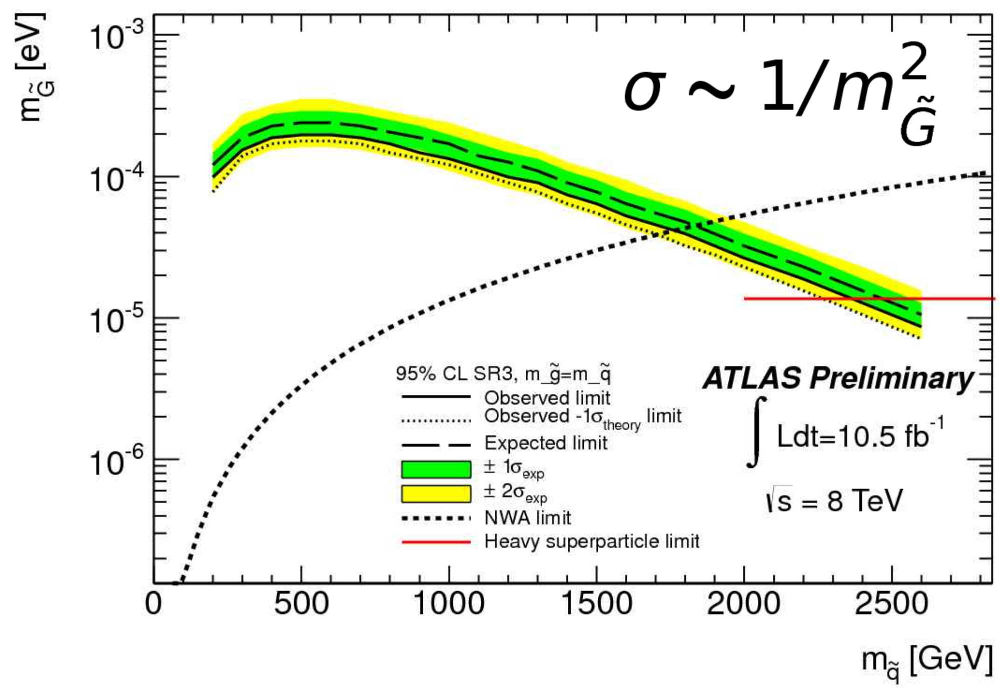
SUSY searches : gravitino

ATLAS-CONF-2012-147

- ► Interpretation in GMSB scenario
  - Gravitino LSP
  - Extremely heavy squark and gluino



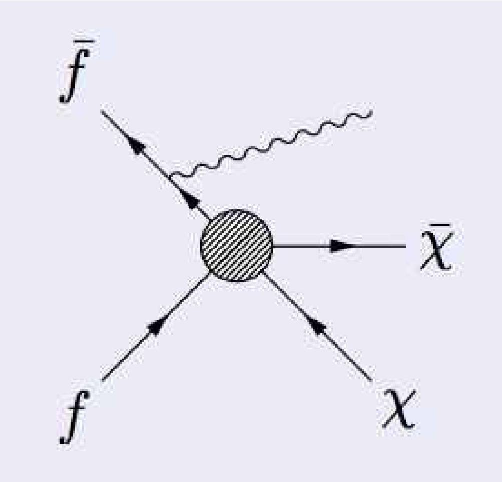




► Gravitino with m<10^{-4}eV (low $m(\tilde q, \tilde g)$) to m<10^{-5}eV (high $m(\tilde q, \tilde g)$) excluded at 95% CL

Alternative DM searches in ATLAS

Effective Field Theory (EFT) Phys.Rev.D82:116010,2010



- Effective Lagrangian
  - Contact interaction
  - Interaction mediated by a heavy particle of mass M with coupling g_1 to SM and g_2 to DM
  - 2 parameters : m_χ , $M^* = M^2/g_1 g_2$

- Limits : effective theory only valid for momentum transfer of the interaction $Q^2 \ll M^*$

- Different couplings SM-DM, with DM as Dirac fermion
  - D1, D11, D5 spin-independent
  - D8, D9 spin-dependent

Name	Initial state	Type	Operator
D1	qq	scalar	$\frac{m_q}{M_\star^3}\bar{\chi}\chi\bar{q}q$
D5	qq	vector	$\frac{1}{M_\star^2}\bar{\chi}\gamma^\mu\chi\bar{q}\gamma_\mu q$
D8	qq	axial-vector	$\frac{1}{M_\star^2}\bar{\chi}\gamma^\mu\gamma^5\chi\bar{q}\gamma_\mu\gamma^5 q$
D9	qq	tensor	$\frac{1}{M_\star^2}\bar{\chi}\sigma^{\mu\nu}\chi\bar{q}\sigma_{\mu\nu}q$
D11	gg	scalar	$\frac{1}{4M_\star^3}\bar{\chi}\chi\alpha_s(G^a_{\mu\nu})^2$

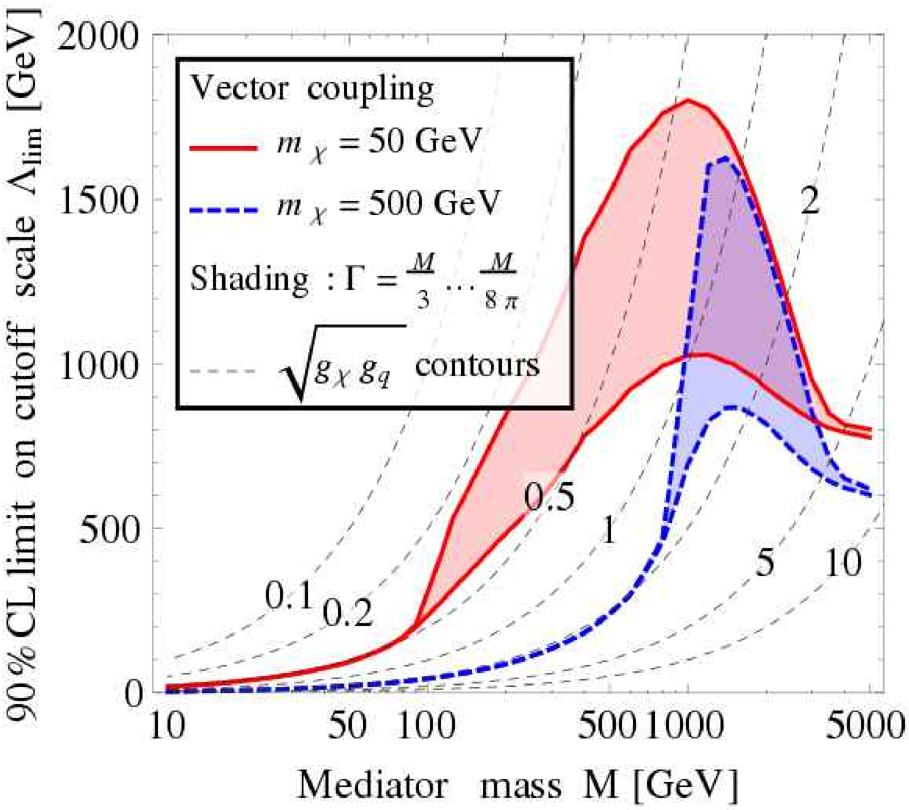
Validity of the EFT

PhysRevD.85.056011

► LHC operating at high energy scales, where the validity of the Effective Field Theory may not be satisfied

► Investigation on how the predictions of the effective theory are modified once a propagating particle of mass M is introduced to mediate the interaction of SM and DM :

$$\sigma(pp \to \bar{\chi}\chi + X) \sim \frac{g_q^2 g_\chi^2}{(q^2 - M^2)^2 + \Gamma^2/4} E^2$$



► To compare with EFT we define :

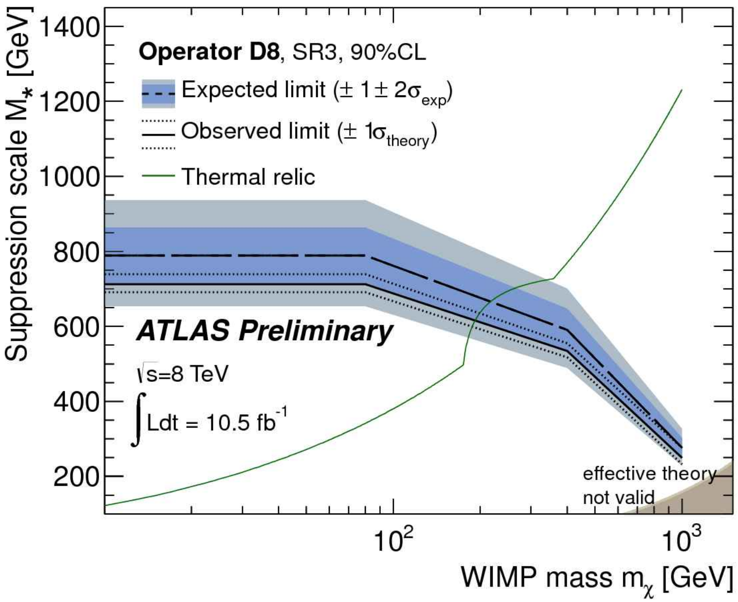
$$\Lambda = M/\sqrt{g_q g_\chi}$$

► At very large M (>5 TeV), limits on Λ asymptote to those of EFT

► For lighter mediator, (M～few×100 GeV) EFT limits are weaker due to resonant behavior of mediator

► For very light mediators, (M<100 GeV), limits on direct detection cross sections are considerably weakened

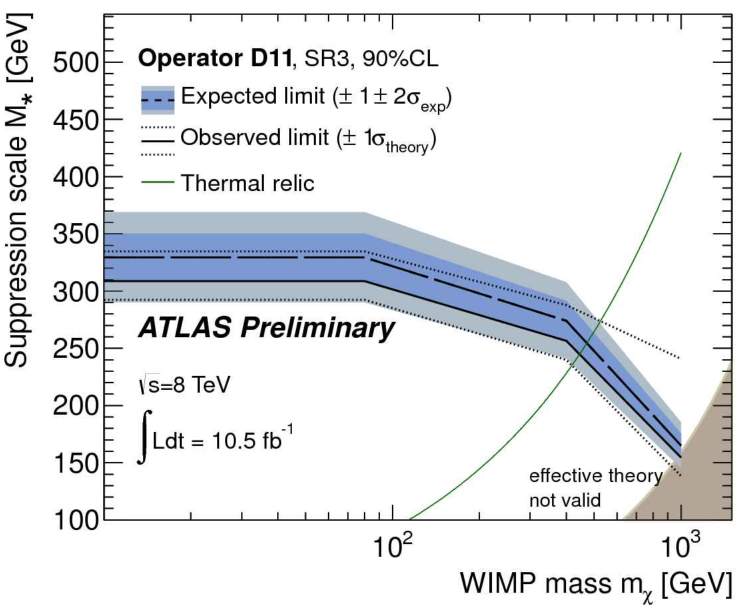
Mono-jet

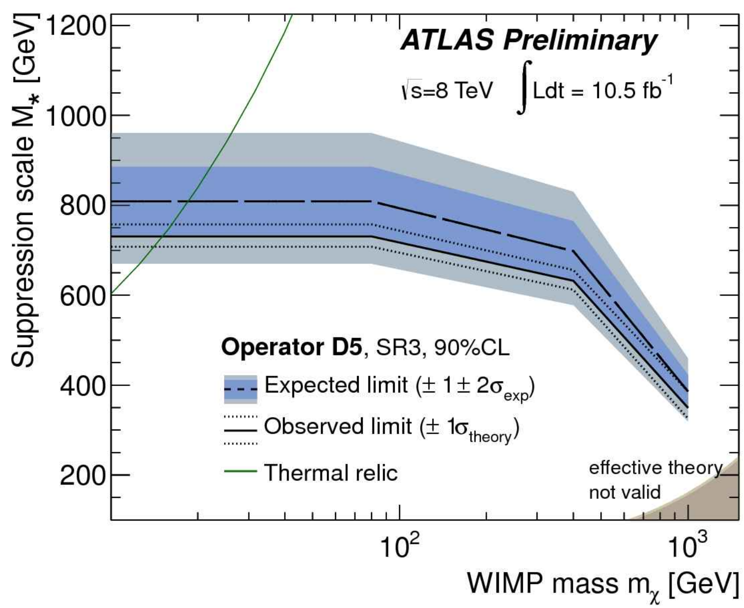


► Monojet selection : see slide #13

► 90% CL on the visible cross section for new physics translated into limits on M* for Effective Theory (assuming its validity) with operators :

- Operator D8 (axial vector) spin-dependent
- Operator D5 (vector) spin-dependent
- Operator D11 (scalar) spin-independent

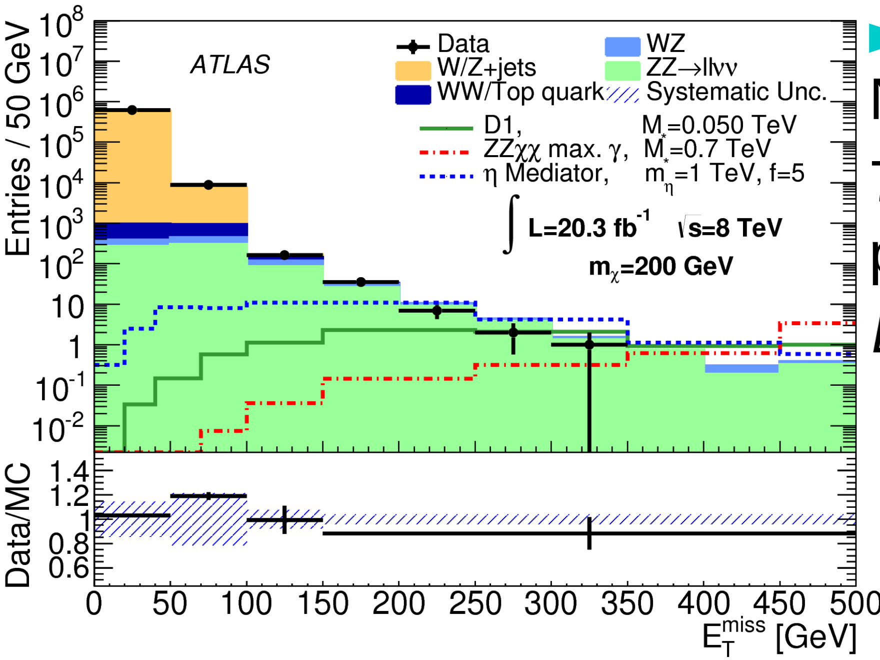




► Green line : M* and m_χ compatible with thermal relic abundance

Mono-Z(→ℓℓ)

CERN-PH-EP-2013-231



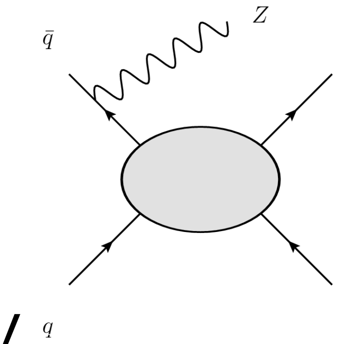
► Events selection

No central jet with p_T>25 GeV

76 <m($\ell\ell$)< 106 GeV

p_T(lepton)>20 GeV

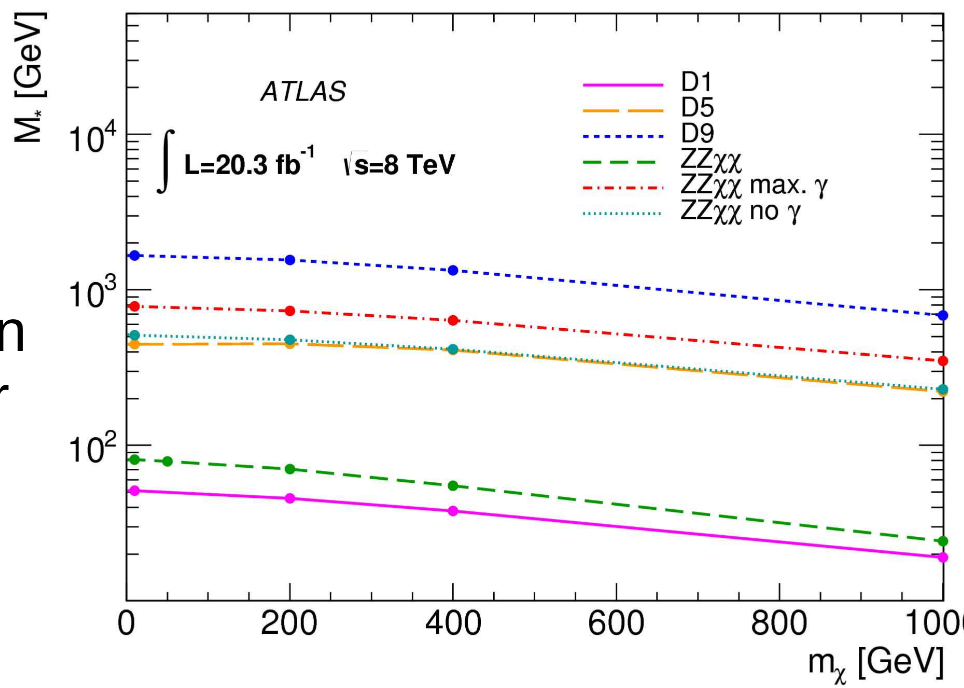
E_T^{miss}> 150, 250, 350, 450 GeV



► No excess over the background is observed

► Interpretation DM effective lagrangian

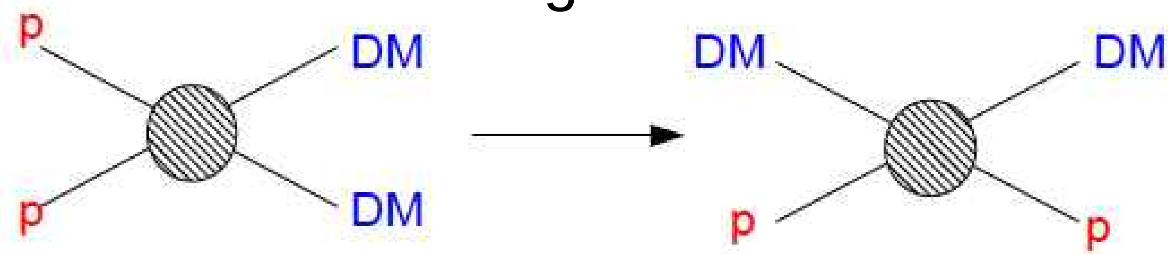
► 95% CL limit on M* for each operator

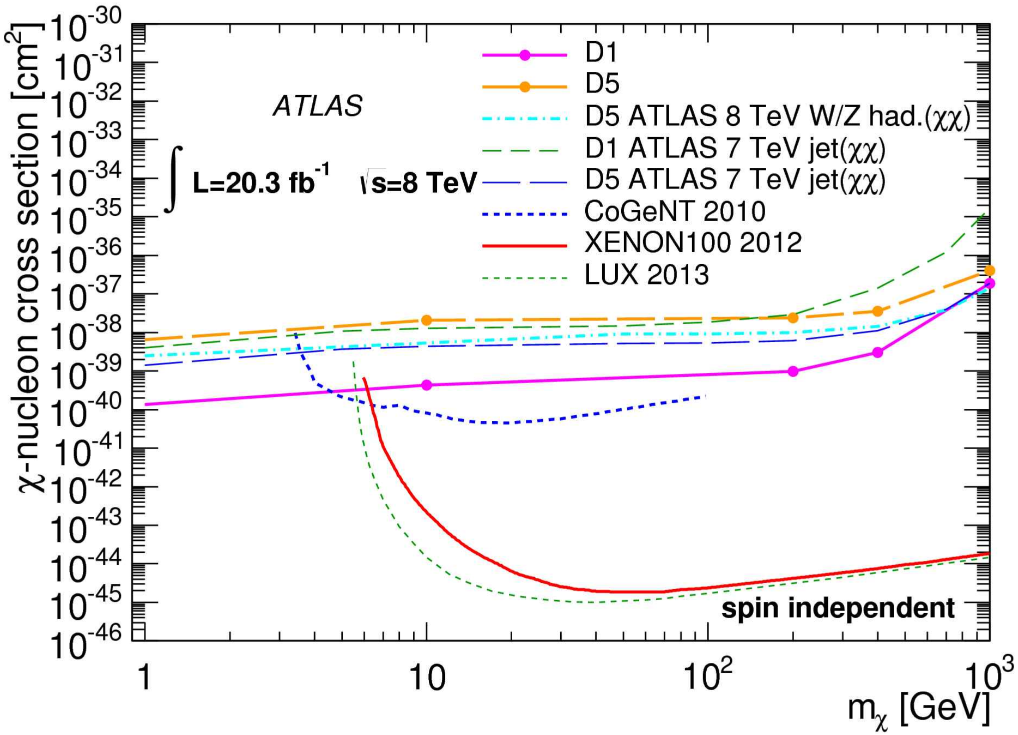


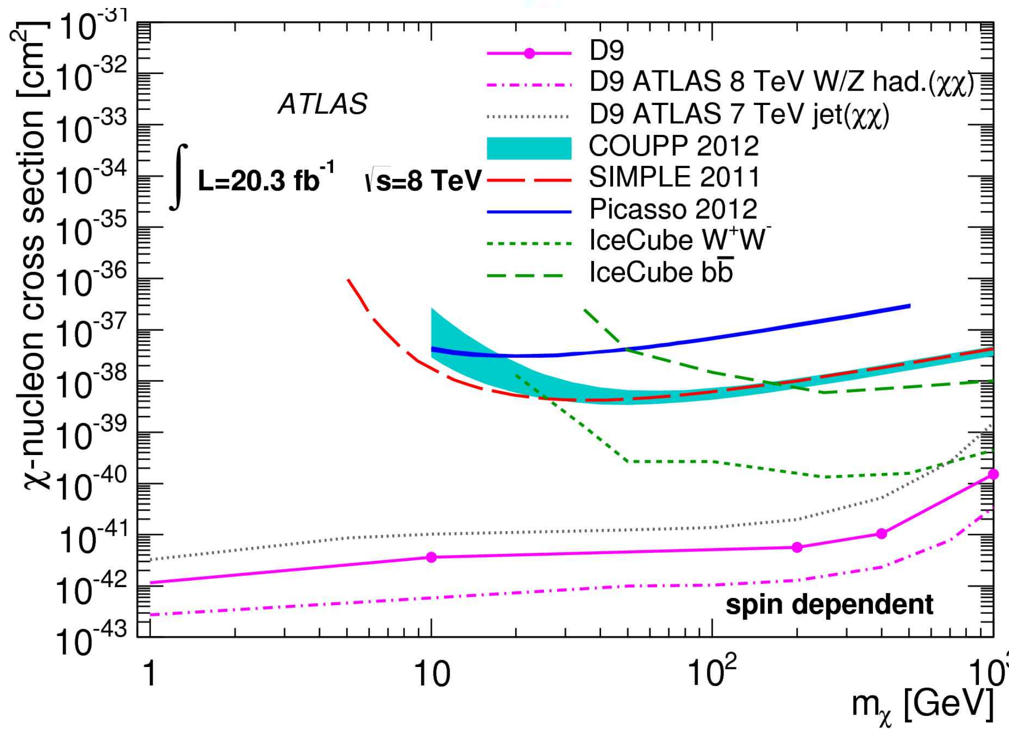
Mono-Z(→ℓℓ)

CERN-PH-EP-2013-231

- 95% CL on nucleon scattering cross section



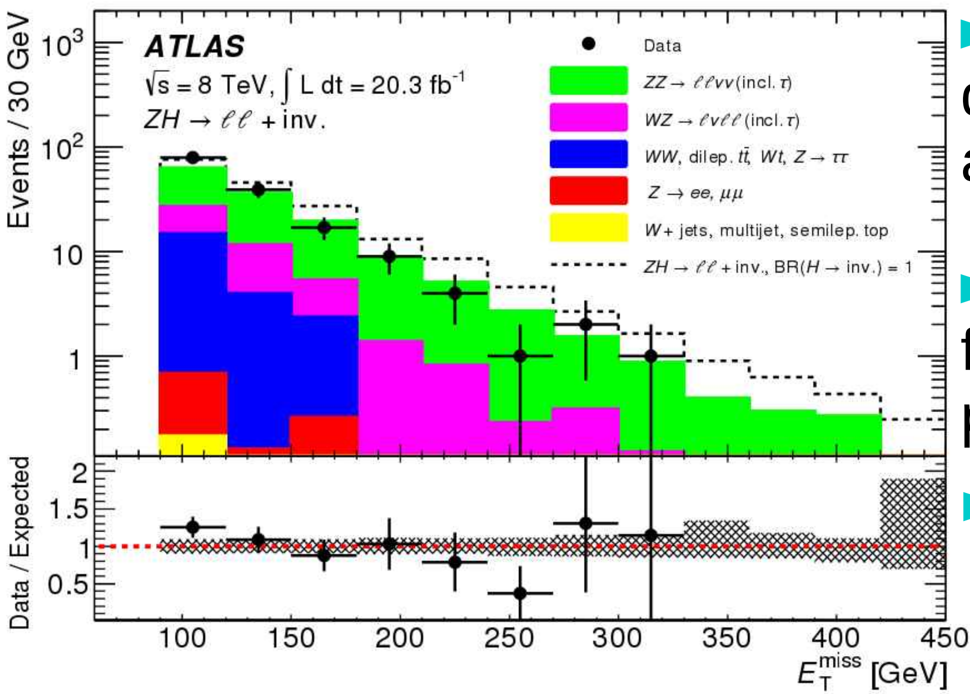




- Assuming the validity of the effective theory the results are competitive to direct detector experiments (particularly relevant at m_χ<10 GeV)

Mono-Z(→ℓℓ)

CERN-PH-EP-2013-210

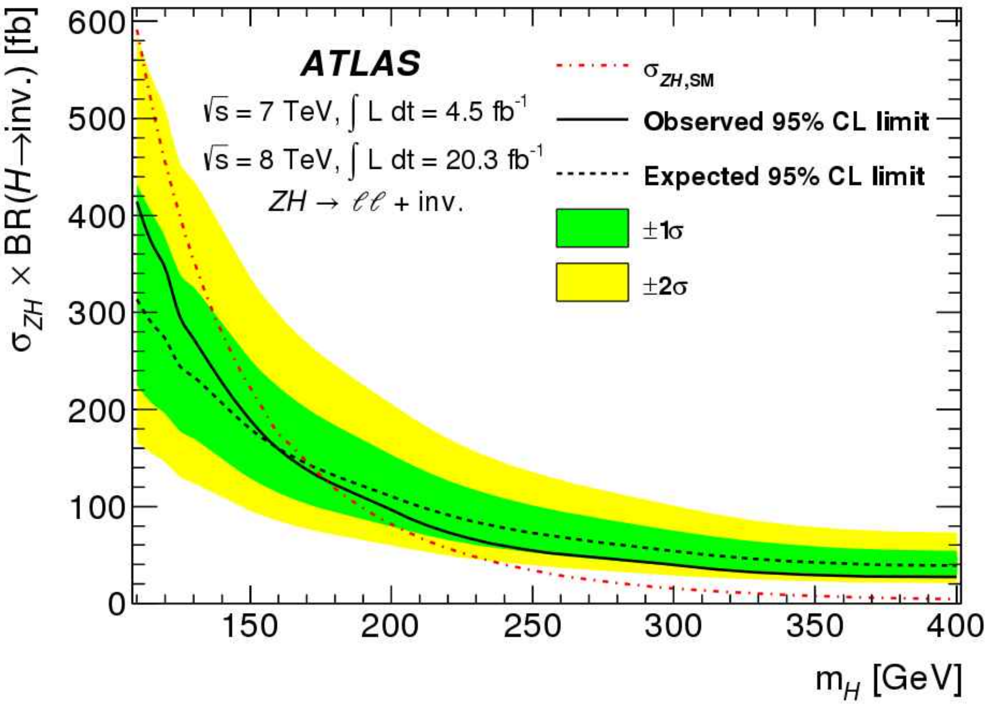


- Search for invisible decay of Higgs boson in association with a Z
- Search for enhancements in the decay fraction to invisible particle due to new physics
- Events selection
  - 2 leptons
  - $p_T(\ell)$>20 GeV
  - 76< m(ℓℓ) < 106 GeV
  - E_T^{miss} > 90 GeV

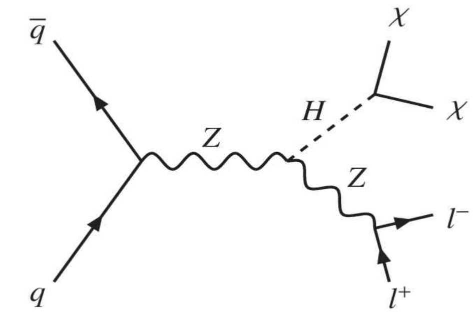
Data Period	2011 (7 TeV)	2012 (8 TeV)
$ZZ \to \ell\ell\nu\nu$	$20.0 \pm 0.7 \pm 1.6$	$91 \pm 1 \pm 7$
$WZ \to \ell\nu\ell\ell$	$4.8 \pm 0.3 \pm 0.5$	$26 \pm 1 \pm 3$
Dileptonic $t\bar{t}$, Wt, WW, $Z \to \tau\tau$	$0.5 \pm 0.4 \pm 0.1$	$20 \pm 3 \pm 5$
$Z \to ee$, $Z \to \mu\mu$	$0.13 \pm 0.12 \pm 0.07$	$0.9 \pm 0.3 \pm 0.5$
W + jets, multijet, semileptonic top	$0.020 \pm 0.005 \pm 0.008$	$0.29 \pm 0.02 \pm 0.06$
Total background	$25.4 \pm 0.8 \pm 1.7$	$138 \pm 4 \pm 9$
Signal ($m_H = 125.5$ GeV, $\sigma_{SM}(ZH)$, BR($H \to$ inv.) = 1)	$8.9 \pm 0.1 \pm 0.5$	$44 \pm 1 \pm 3$
Observed	28	152

Mono-Z(→ℓℓ)

CERN-PH-EP-2013-210



► No significant excess above SM



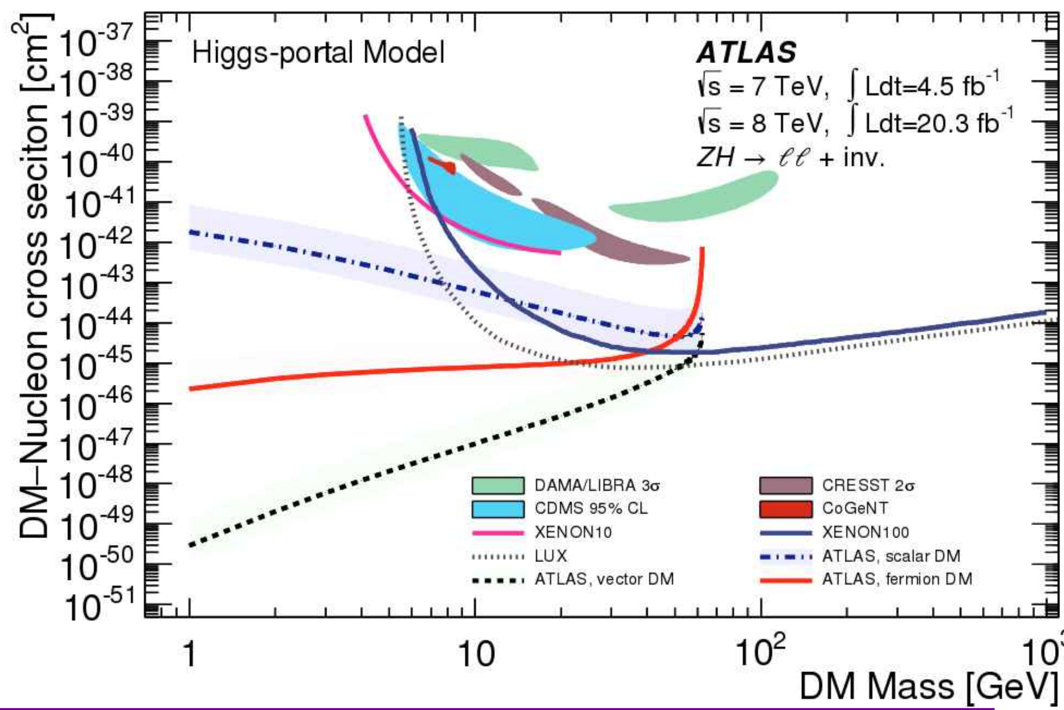
► Limit on DM-Nucleon cross section in Higgs-portal scenario [arXiv:hep-ph/0605188]

► For 125.5 GeV Higgs, Expected (without new physics)

- BR(H→inv.) = 62% (at 95% CL)

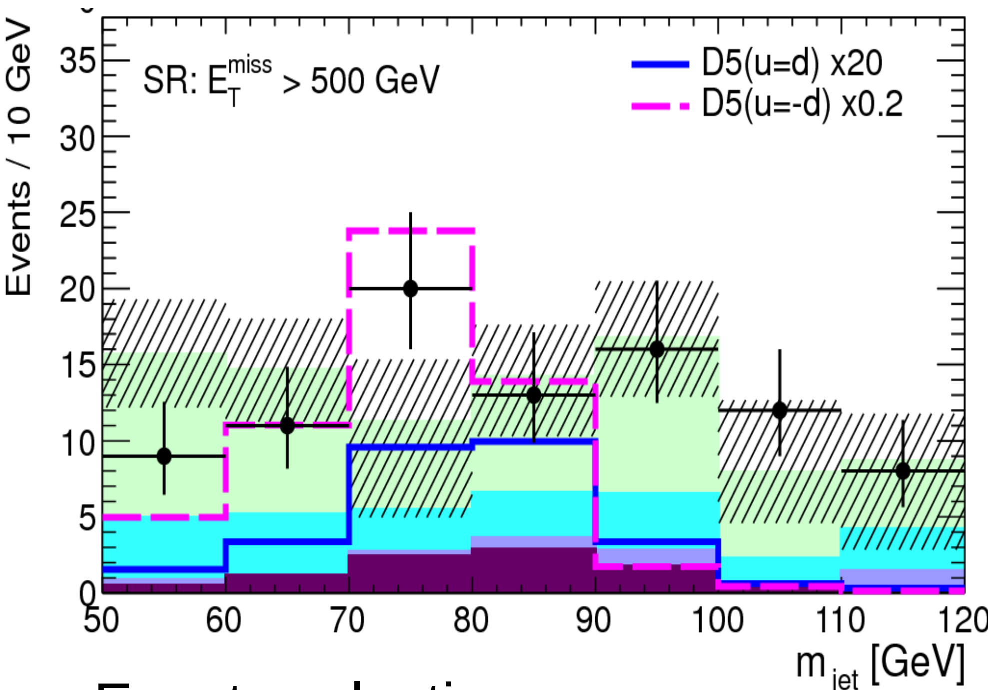
► Observed

- BR(H→inv.) = 75% (at 95% CL)

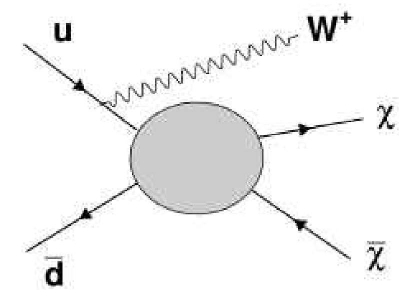


Mono-W(→jj)/Z(→jj)

Phys. Rev. Lett. 112, 041802



► WIMPs pair production via an unknown intermediate state, with initial-state radiation of W or Z, hadronic decay



► Use large-radius jets to capture the hadronic products of quarks from W or Z

► Events selection

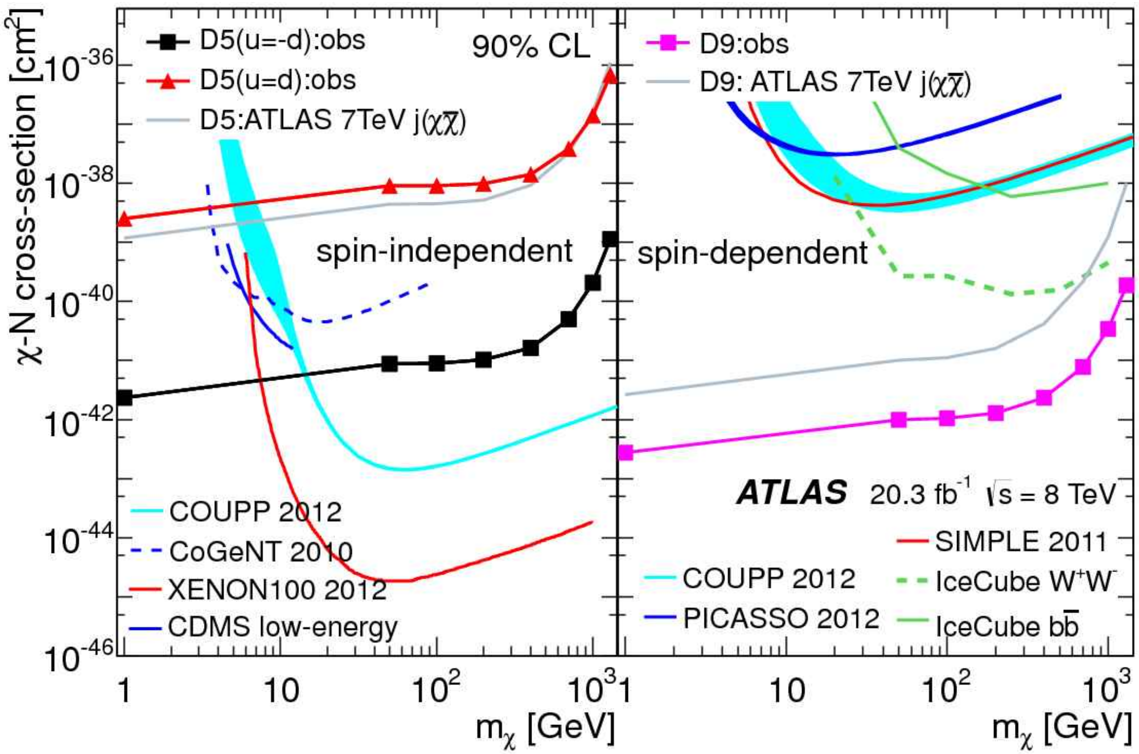
- 1 large-radius jet with p_T>250 GeV
- E_T^{miss} >350, 500 GeV
- No more than 1 narrow jet p_T>40 GeV
- No isolated leptons

Process	$E_T^{miss} > 350$ GeV	$E_T^{miss} > 500$ GeV
$Z \to \nu\bar{\nu}$	402^{+39}_{-34}	54^{+8}_{-10}
$W \to \ell^{\pm}\nu, Z \to \ell^{\pm}\ell^{\mp}$	210^{+20}_{-18}	22^{+4}_{-5}
WW, WZ, ZZ	57^{+11}_{-8}	$9.1^{+1.3}_{-1.1}$
$t\bar{t}$, single t	39^{+10}_{-4}	$3.7^{+1.7}_{-1.3}$
Total	707^{+48}_{-38}	89^{+9}_{-12}
Data	705	89

► Good agreement with SM expectation. Limits set on physics BSM

Mono-W(→jj)/Z(→jj)

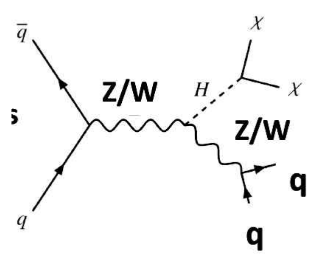
Phys. Rev. Lett. 112, 041802

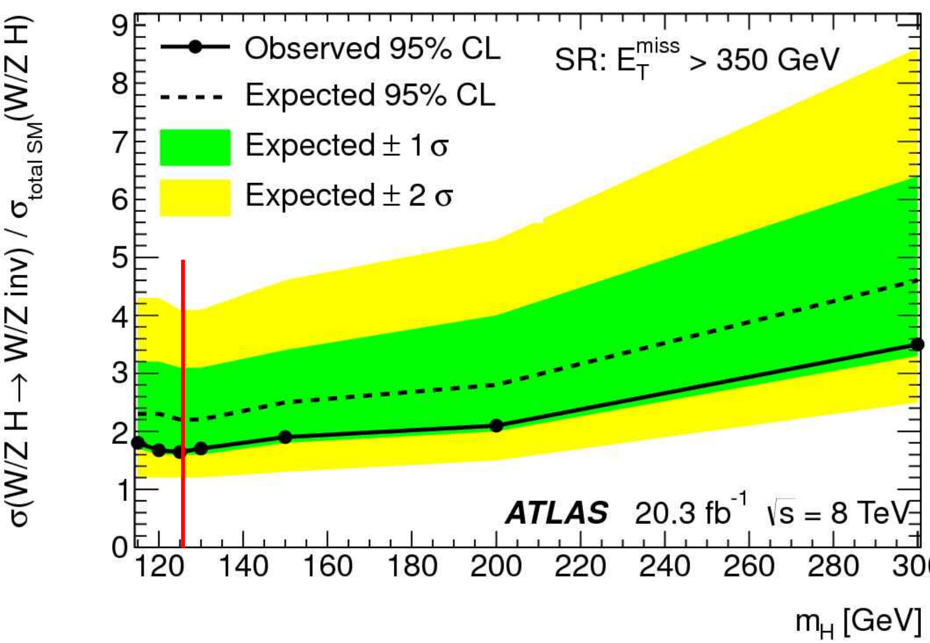


- ► Limit on WIMP-Nucleon cross section with effective field theory

- ► Interpretation with invisible $H \to \chi\chi$
  - For 125 GeV Higgs :

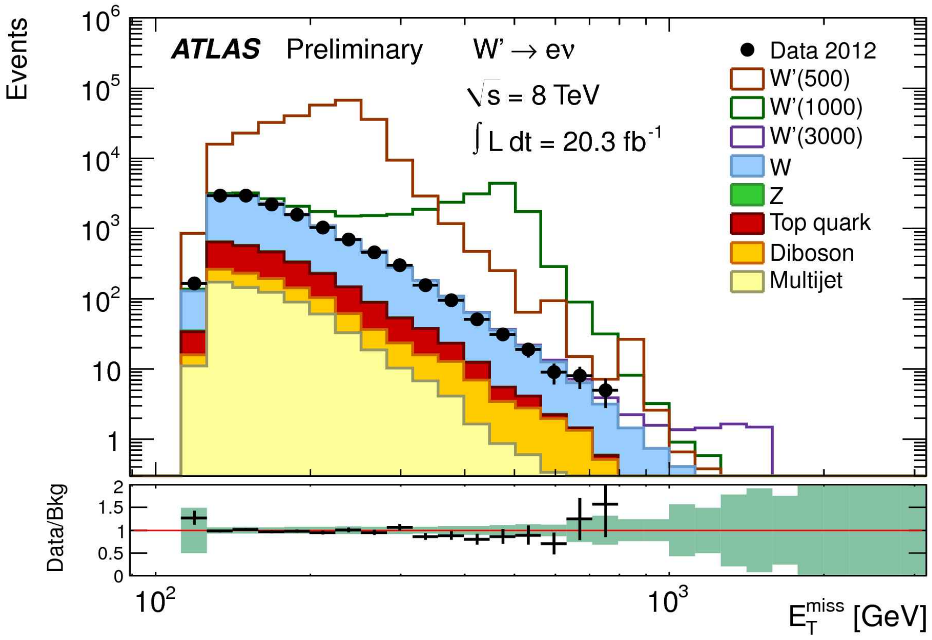
$$\frac{\sigma(WH, ZH, H \to \text{inv.})}{\sigma(WH, ZH, \text{Standard model})} < 1.6$$



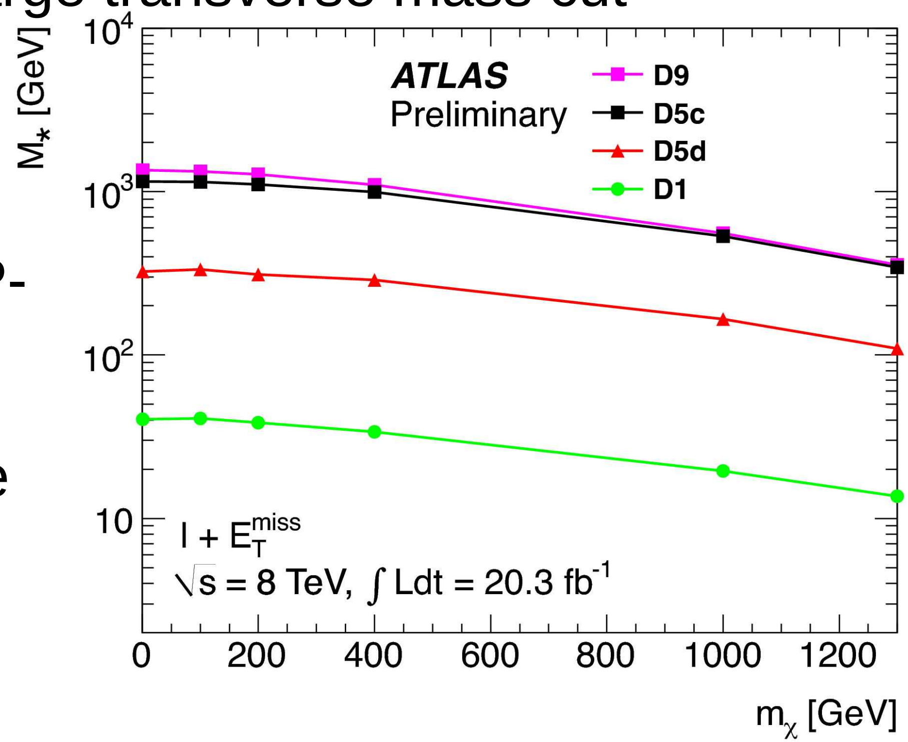


Mono W(→ℓν)/Z(→ℓℓ)

ATLAS-CONF-2014-017



- ► WIMPs pair production via an unknown intermediate state, with initial-state radiation of W or Z, leptonic decay
- ► Events selection
  - At least 1 e (p_T>125 GeV) or 1 μ (p_T>45 GeV)
  - E_T^{miss} >125 GeV (e), 45 GeV (μ)
  - Large transverse mass cut



- ► No excess with respect to SM expectation
- ► Limits set on effective theory of WIMP-SM interaction
  - D9 tensor
  - D5 vector (constructive & destructive interference)
  - D1 scalar

Conclusion

► Very successful LHC operations during the last 3 years : more than 26 fb^{-1} of data on tape for ATLAS/CMS (7 TeV & 8 TeV)

► Large expected signal in ATLAS for many of the most interesting theories for Dark Matter.

► So far no significant excess indicating physics beyond the Standard Model

► ATLAS results put strong constraint on different SUSY models which may constrain/discriminate possible models for Dark Matter particles

► DM search within Effective Theory (model independent), simplified models, with comparison to direct DM search experiments is a very active topic

► LHC will restart soon, with higher energy. If DM is within reach of LHC
- We should be able to detect it, and measure its mass and properties
- We could be able to say something about the physics theory behind Dark Matter, possibly predict the right model

► Effort to share and discuss ATLAS results with astroparticle physics Communities : ATLAS Astro Forum (see backup)

Backup

ATLAS Exotics Searches* - 95% CL Exclusion

Status: April 2014

ATLAS Preliminary

$\int \mathcal{L}\, dt = (1.0 - 20.3)\ \text{fb}^{-1}$ $\sqrt{s} = 7, 8$ TeV

	Model	ℓ, γ	Jets	E_T^{miss}	$\int \mathcal{L}\, dt[\text{fb}^{-1}]$	Mass limit		Reference
Extra dimensions	ADD $G_{KK} + g/q$	–	1-2 j	Yes	4.7	M_D 4.37 TeV	$n = 2$	1210.4491
	ADD non-resonant $\ell\ell/\gamma\gamma$	2γ or $2e,\mu$	–	–	4.7	M_S 4.18 TeV	$n = 3$ HLZ NLO	1211.1150
	ADD QBH $\rightarrow \ell q$	$1\ e,\mu$	1 j	–	20.3	M_{th} 5.2 TeV	$n = 6$	1311.2006
	ADD BH high N_{trk}	$2\ \mu$ (SS)	–	–	20.3	M_{th} 5.7 TeV	$n = 6$, $M_D = 1.5$ TeV, non-rot BH	1308.4075
	ADD BH high $\sum p_T$	$\geq 1\ e,\mu$	≥ 2 j	–	20.3	M_{th} 6.2 TeV	$n = 6$, $M_D = 1.5$ TeV, non-rot BH	ATLAS-CONF-2014-016
	RS1 $G_{KK} \rightarrow \ell\ell$	$2\ e,\mu$	–	–	20.3	G_{KK} mass 2.47 TeV	$k/\overline{M}_{Pl} = 0.1$	ATLAS-CONF-2013-017
	RS1 $G_{KK} \rightarrow ZZ \rightarrow \ell\ell qq/\ell\ell\ell\ell$	2 or 4 e,μ	2 j or –	–	1.0	G_{KK} mass 845 GeV	$k/\overline{M}_{Pl} = 0.1$	1203.0718
	RS1 $G_{KK} \rightarrow WW \rightarrow \ell\nu\ell\nu$	$2\ e,\mu$	–	Yes	4.7	G_{KK} mass 1.23 TeV	$k/\overline{M}_{Pl} = 0.1$	1208.2880
	Bulk RS $G_{KK} \rightarrow HH \rightarrow b\bar{b}b\bar{b}$	–	4 b	–	19.5	G_{KK} mass 590-710 GeV	$k/\overline{M}_{Pl} = 1.0$	ATLAS-CONF-2014-005
	Bulk RS $g_{KK} \rightarrow t\bar{t}$	$1\ e,\mu$	≥ 1 b, ≥ 1J/2j	Yes	14.3	g_{KK} mass 0.5-2.0 TeV	BR = 0.925	ATLAS-CONF-2013-052
	S^1/Z_2 ED	$2\ e,\mu$	–	–	5.0	$M_{KK} \approx R^{-1}$ 4.71 TeV		1209.2535
	UED	$2\ \gamma$	–	Yes	4.8	Compact. scale R^{-1} 1.41 TeV		ATLAS-CONF-2012-072
Gauge bosons	SSM $Z' \rightarrow \ell\ell$	$2\ e,\mu$	–	–	20.3	Z' mass 2.86 TeV		ATLAS-CONF-2013-017
	SSM $Z' \rightarrow \tau\tau$	$2\ \tau$	–	–	19.5	Z' mass 1.9 TeV		ATLAS-CONF-2013-066
	SSM $W' \rightarrow \ell\nu$	$1\ e,\mu$	–	Yes	20.3	W' mass 3.28 TeV		ATLAS-CONF-2014-017
	EGM $W' \rightarrow WZ \rightarrow \ell\nu\, \ell'\ell'$	$3\ e,\mu$	–	Yes	20.3	W' mass 1.52 TeV		ATLAS-CONF-2014-015
	LRSM $W'_R \rightarrow t\bar{b}$	$1\ e,\mu$	2 b, 0-1 j	Yes	14.3	W' mass 1.84 TeV		ATLAS-CONF-2013-050
CI	CI $qqqq$	–	2 j	–	4.8	Λ 7.6 TeV	$\eta = +1$	1210.1718
	CI $qq\ell\ell$	$2\ e,\mu$	–	–	5.0	Λ 13.9 TeV	$\eta_{LL} = -1$	1211.1150
	CI $uutt$	$2\ e,\mu$ (SS)	≥ 1 b, ≥ 1 j	Yes	14.3	Λ 3.3 TeV	$\lvert C\rvert = 1$	ATLAS-CONF-2013-051
DM	EFT D5 operator	–	1-2 j	Yes	10.5	M_* 731 GeV	at 90% CL for $m(\chi) < 80$ GeV	ATLAS-CONF-2012-147
	EFT D9 operator	–	1 J, ≤ 1 j	Yes	20.3	M_* 2.4 TeV	at 90% CL for $m(\chi) < 100$ GeV	1309.4017
LQ	Scalar LQ 1st gen	$2\ e$	≥ 2 j	–	1.0	LQ mass 660 GeV	$\beta = 1$	1112.4828
	Scalar LQ 2nd gen	$2\ \mu$	≥ 2 j	–	1.0	LQ mass 685 GeV	$\beta = 1$	1203.3172
	Scalar LQ 3rd gen	$1\ e,\mu$, $1\ \tau$	1 b, 1 j	–	4.7	LQ mass 534 GeV	$\beta = 1$	1303.0526
Heavy quarks	Vector-like quark $TT \rightarrow Ht + X$	$1\ e,\mu$	≥ 2 b, ≥ 4 j	Yes	14.3	T mass 790 GeV	T in (T,B) doublet	ATLAS-CONF-2013-018
	Vector-like quark $TT \rightarrow Wb + X$	$1\ e,\mu$	≥ 1 b, ≥ 3 j	Yes	14.3	T mass 670 GeV	isospin singlet	ATLAS-CONF-2013-060
	Vector-like quark $BB \rightarrow Zb + X$	$2\ e,\mu$	≥ 2 b	–	14.3	B mass 725 GeV	B in (B,Y) doublet	ATLAS-CONF-2013-056
	Vector-like quark $BB \rightarrow Wt + X$	$2\ e,\mu$ (SS)	≥ 1 b, ≥ 1 j	Yes	14.3	B mass 720 GeV	B in (T,B) doublet	ATLAS-CONF-2013-051
Excited fermions	Excited quark $q^* \rightarrow q\gamma$	$1\ \gamma$	1 j	–	20.3	q^* mass 3.5 TeV	only u^* and d^*, $\Lambda = m(q^*)$	1309.3230
	Excited quark $q^* \rightarrow qg$	–	2 j	–	13.0	q^* mass 3.84 TeV	only u^* and d^*, $\Lambda = m(q^*)$	ATLAS-CONF-2012-148
	Excited quark $b^* \rightarrow Wt$	1 or 2 e,μ	1 b, 2 j or 1 j	Yes	4.7	b^* mass 870 GeV	left-handed coupling	1301.1583
	Excited lepton $\ell^* \rightarrow \ell\gamma$	$2\ e,\mu$, $1\ \gamma$	–	–	13.0	ℓ^* mass 2.2 TeV	$\Lambda = 2.2$ TeV	1308.1364
Other	LRSM Majorana ν	$2\ e,\mu$	2 j	–	2.1	N^0 mass 1.5 TeV	$m(W_R) = 2$ TeV, no mixing	1203.5420
	Type III Seesaw	$2\ e,\mu$	–	–	5.8	$N^{\pm}$ mass 245 GeV	$\lvert V_e\rvert$=0.055, $\lvert V_\mu\rvert$=0.063, $\lvert V_\tau\rvert$=0	ATLAS-CONF-2013-019
	Higgs triplet $H^{\pm\pm} \rightarrow \ell\ell$	$2\ e,\mu$ (SS)	–	–	4.7	$H^{\pm\pm}$ mass 409 GeV	DY production, BR($H^{\pm\pm} \rightarrow \ell\ell$)=1	1210.5070
	Multi-charged particles	–	–	–	4.4	multi-charged particle mass 490 GeV	DY production, $\lvert q\rvert = 4e$	1301.5272
	Magnetic monopoles	–	–	–	2.0	monopole mass 862 GeV	DY production, $\lvert g\rvert = 1g_D$	1207.6411

$\sqrt{s}$ = 7 TeV | $\sqrt{s}$ = 8 TeV

10^{-1} | 1 | 10 — Mass scale [TeV]

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

ATLAS SUSY Searches* - 95% CL Lower Limits

Status: Moriond 2014

ATLAS Preliminary

$\int \mathcal{L}\,dt = (4.6 - 22.9)\ \mathrm{fb}^{-1}$ $\sqrt{s} = 7, 8$ TeV

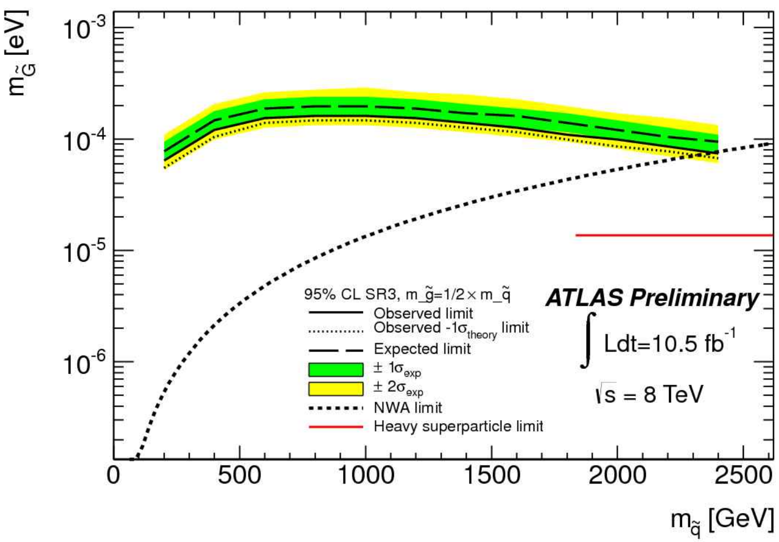
	Model	e, μ, τ, γ	Jets	E_T^{miss}	$\int \mathcal{L}\,dt[\mathrm{fb}^{-1}]$	Mass limit			Reference
Inclusive Searches	MSUGRA/CMSSM	0	2-6 jets	Yes	20.3	$\tilde{q}, \tilde{g}$	1.7 TeV	$m(\tilde{q})=m(\tilde{g})$	ATLAS-CONF-2013-047
	MSUGRA/CMSSM	1 e,μ	3-6 jets	Yes	20.3	$\tilde{g}$	1.2 TeV	any $m(\tilde{q})$	ATLAS-CONF-2013-062
	MSUGRA/CMSSM	0	7-10 jets	Yes	20.3	$\tilde{g}$	1.1 TeV	any $m(\tilde{q})$	1308.1841
	$\tilde{q}\tilde{q}, \tilde{q}\to q\tilde{\chi}_1^0$	0	2-6 jets	Yes	20.3	$\tilde{q}$	740 GeV	$m(\tilde{\chi}_1^0)$=0 GeV	ATLAS-CONF-2013-047
	$\tilde{g}\tilde{g}, \tilde{g}\to q\bar{q}\tilde{\chi}_1^0$	0	2-6 jets	Yes	20.3	$\tilde{g}$	1.3 TeV	$m(\tilde{\chi}_1^0)$=0 GeV	ATLAS-CONF-2013-047
	$\tilde{g}\tilde{g}, \tilde{g}\to qq\tilde{\chi}_1^{\pm}\to qqW^{\pm}\tilde{\chi}_1^0$	1 e,μ	3-6 jets	Yes	20.3	$\tilde{g}$	1.18 TeV	$m(\tilde{\chi}_1^0)$<200 GeV, $m(\tilde{\chi}^{\pm})=0.5(m(\tilde{\chi}_1^0)+m(\tilde{g}))$	ATLAS-CONF-2013-062
	$\tilde{g}\tilde{g}, \tilde{g}\to qq(\ell\ell/\ell\nu/\nu\nu)\tilde{\chi}_1^0$	2 e,μ	0-3 jets	-	20.3	$\tilde{g}$	1.12 TeV	$m(\tilde{\chi}_1^0)$=0 GeV	ATLAS-CONF-2013-089
	GMSB ($\tilde{\ell}$ NLSP)	2 e,μ	2-4 jets	Yes	4.7	$\tilde{g}$	1.24 TeV	$\tan\beta$<15	1208.4688
	GMSB ($\tilde{\ell}$ NLSP)	1-2 τ	0-2 jets	Yes	20.7	$\tilde{g}$	1.4 TeV	$\tan\beta$>18	ATLAS-CONF-2013-026
	GGM (bino NLSP)	2 γ	-	Yes	20.3	$\tilde{g}$	1.28 TeV	$m(\tilde{\chi}_1^0)$>50 GeV	ATLAS-CONF-2014-001
	GGM (wino NLSP)	1 $e,\mu+\gamma$	-	Yes	4.8	$\tilde{g}$	619 GeV	$m(\tilde{\chi}_1^0)$>50 GeV	ATLAS-CONF-2012-144
	GGM (higgsino-bino NLSP)	γ	1 b	Yes	4.8	$\tilde{g}$	900 GeV	$m(\tilde{\chi}_1^0)$>220 GeV	1211.1167
	GGM (higgsino NLSP)	2 e,μ (Z)	0-3 jets	Yes	5.8	$\tilde{g}$	690 GeV	$m(\tilde{H})$>200 GeV	ATLAS-CONF-2012-152
	Gravitino LSP	0	mono-jet	Yes	10.5	$F^{1/2}$ scale	645 GeV	$m(\tilde{g})>10^{-4}$ eV	ATLAS-CONF-2012-147
3rd gen. $\tilde{g}$ med.	$\tilde{g}\to b\bar{b}\tilde{\chi}_1^0$	0	3 b	Yes	20.1	$\tilde{g}$	1.2 TeV	$m(\tilde{\chi}_1^0)$<600 GeV	ATLAS-CONF-2013-061
	$\tilde{g}\to t\bar{t}\tilde{\chi}_1^0$	0	7-10 jets	Yes	20.3	$\tilde{g}$	1.1 TeV	$m(\tilde{\chi}_1^0)$ <350 GeV	1308.1841
	$\tilde{g}\to t\bar{t}\tilde{\chi}_1^0$	0-1 e,μ	3 b	Yes	20.1	$\tilde{g}$	1.34 TeV	$m(\tilde{\chi}_1^0)$<400 GeV	ATLAS-CONF-2013-061
	$\tilde{g}\to b\bar{t}\tilde{\chi}_1^+$	0-1 e,μ	3 b	Yes	20.1	$\tilde{g}$	1.3 TeV	$m(\tilde{\chi}_1^0)$<300 GeV	ATLAS-CONF-2013-061
3rd gen. squarks direct production	$\tilde{b}_1\tilde{b}_1, \tilde{b}_1\to b\tilde{\chi}_1^0$	0	2 b	Yes	20.1	$\tilde{b}_1$	100-620 GeV	$m(\tilde{\chi}_1^0)$<90 GeV	1308.2631
	$\tilde{b}_1\tilde{b}_1, \tilde{b}_1\to t\tilde{\chi}_1^{\pm}$	2 e,μ (SS)	0-3 b	Yes	20.7	$\tilde{b}_1$	275-430 GeV	$m(\tilde{\chi}_1^{\pm})=2\,m(\tilde{\chi}_1^0)$	ATLAS-CONF-2013-007
	$\tilde{t}_1\tilde{t}_1$(light), $\tilde{t}_1\to b\tilde{\chi}_1^{\pm}$	1-2 e,μ	1-2 b	Yes	4.7	$\tilde{t}_1$	110-167 GeV	$m(\tilde{\chi}_1^0)$=55 GeV	1208.4305, 1209.2102
	$\tilde{t}_1\tilde{t}_1$(light), $\tilde{t}_1\to Wb\tilde{\chi}_1^0$	2 e,μ	0-2 jets	Yes	20.3	$\tilde{t}_1$	130-210 GeV	$m(\tilde{\chi}_1^0)=m(\tilde{t}_1)-m(W)-50$ GeV, $m(\tilde{t}_1)<<m(\tilde{\chi}_1^{\pm})$	1403.4853
	$\tilde{t}_1\tilde{t}_1$(medium), $\tilde{t}_1\to t\tilde{\chi}_1^0$	2 e,μ	2 jets	Yes	20.3	$\tilde{t}_1$	215-530 GeV	$m(\tilde{\chi}_1^0)$=1 GeV	1403.4853
	$\tilde{t}_1\tilde{t}_1$(medium), $\tilde{t}_1\to b\tilde{\chi}_1^{\pm}$	0	2 b	Yes	20.1	$\tilde{t}_1$	150-580 GeV	$m(\tilde{\chi}_1^0)$<200 GeV, $m(\tilde{\chi}_1^{\pm})-m(\tilde{\chi}_1^0)$=5 GeV	1308.2631
	$\tilde{t}_1\tilde{t}_1$(heavy), $\tilde{t}_1\to t\tilde{\chi}_1^0$	1 e,μ	1 b	Yes	20.7	$\tilde{t}_1$	200-610 GeV	$m(\tilde{\chi}_1^0)$=0 GeV	ATLAS-CONF-2013-037
	$\tilde{t}_1\tilde{t}_1$(heavy), $\tilde{t}_1\to t\tilde{\chi}_1^0$	0	2 b	Yes	20.5	$\tilde{t}_1$	320-660 GeV	$m(\tilde{\chi}_1^0)$=0 GeV	ATLAS-CONF-2013-024
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1\to c\tilde{\chi}_1^0$	0	mono-jet/c-tag	Yes	20.3	$\tilde{t}_1$	90-200 GeV	$m(\tilde{t}_1)-m(\tilde{\chi}_1^0)$<85 GeV	ATLAS-CONF-2013-068
	$\tilde{t}_1\tilde{t}_1$(natural GMSB)	2 e,μ (Z)	1 b	Yes	20.3	$\tilde{t}_1$	150-580 GeV	$m(\tilde{\chi}_1^0)$>150 GeV	1403.5222
	$\tilde{t}_2\tilde{t}_2, \tilde{t}_2\to\tilde{t}_1+Z$	3 e,μ (Z)	1 b	Yes	20.3	$\tilde{t}_2$	290-600 GeV	$m(\tilde{\chi}_1^0)$<200 GeV	1403.5222
EW direct	$\tilde{\ell}_{L,R}\tilde{\ell}_{L,R}, \tilde{\ell}\to\ell\tilde{\chi}_1^0$	2 e,μ	0	Yes	20.3	$\tilde{\ell}$	90-325 GeV	$m(\tilde{\chi}_1^0)$=0 GeV	1403.5294
	$\tilde{\chi}_1^+\tilde{\chi}_1^-, \tilde{\chi}_1^+\to\tilde{\ell}\nu(\ell\tilde{\nu})$	2 e,μ	0	Yes	20.3	$\tilde{\chi}_1^{\pm}$	140-465 GeV	$m(\tilde{\chi}_1^0)$=0 GeV, $m(\tilde{\ell},\tilde{\nu})=0.5(m(\tilde{\chi}_1^{\pm})+m(\tilde{\chi}_1^0))$	1403.5294
	$\tilde{\chi}_1^+\tilde{\chi}_1^-, \tilde{\chi}_1^+\to\tilde{\tau}\nu(\tau\tilde{\nu})$	2 τ	-	Yes	20.7	$\tilde{\chi}_1^{\pm}$	180-330 GeV	$m(\tilde{\chi}_1^0)$=0 GeV, $m(\tilde{\tau},\tilde{\nu})=0.5(m(\tilde{\chi}_1^{\pm})+m(\tilde{\chi}_1^0))$	ATLAS-CONF-2013-028
	$\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0\to\tilde{\ell}_L\nu\tilde{\ell}_L\ell(\tilde{\nu}\nu), \ell\tilde{\nu}\tilde{\ell}_L\ell(\tilde{\nu}\nu)$	3 e,μ	0	Yes	20.3	$\tilde{\chi}_1^{\pm}, \tilde{\chi}_2^0$	700 GeV	$m(\tilde{\chi}_1^{\pm})=m(\tilde{\chi}_2^0)$, $m(\tilde{\chi}_1^0)=0$, $m(\tilde{\ell},\tilde{\nu})=0.5(m(\tilde{\chi}_1^{\pm})+m(\tilde{\chi}_1^0))$	1402.7029
	$\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0\to W\tilde{\chi}_1^0Z\tilde{\chi}_1^0$	2-3 e,μ	0	Yes	20.3	$\tilde{\chi}_1^{\pm}, \tilde{\chi}_2^0$	420 GeV	$m(\tilde{\chi}_1^{\pm})=m(\tilde{\chi}_2^0)$, $m(\tilde{\chi}_1^0)=0$, sleptons decoupled	1403.5294, 1402.7029
	$\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0\to W\tilde{\chi}_1^0h\tilde{\chi}_1^0$	1 e,μ	2 b	Yes	20.3	$\tilde{\chi}_1^{\pm}, \tilde{\chi}_2^0$	285 GeV	$m(\tilde{\chi}_1^{\pm})=m(\tilde{\chi}_2^0)$, $m(\tilde{\chi}_1^0)=0$, sleptons decoupled	ATLAS-CONF-2013-093
Long-lived particles	Direct $\tilde{\chi}_1^+\tilde{\chi}_1^-$ prod., long-lived $\tilde{\chi}_1^{\pm}$	Disapp. trk	1 jet	Yes	20.3	$\tilde{\chi}_1^{\pm}$	270 GeV	$m(\tilde{\chi}_1^{\pm})-m(\tilde{\chi}_1^0)$=160 MeV, $\tau(\tilde{\chi}_1^{\pm})$=0.2 ns	ATLAS-CONF-2013-069
	Stable, stopped $\tilde{g}$ R-hadron	0	1-5 jets	Yes	22.9	$\tilde{g}$	832 GeV	$m(\tilde{\chi}_1^0)$=100 GeV, 10 μs<$\tau(\tilde{g})$<1000 s	ATLAS-CONF-2013-057
	GMSB, stable $\tilde{\tau}$, $\tilde{\chi}_1^0\to\tilde{\tau}(\tilde{e},\tilde{\mu})+\tau(e,\mu)$	1-2 μ	-	-	15.9	$\tilde{\chi}_1^0$	475 GeV	10<$\tan\beta$<50	ATLAS-CONF-2013-058
	GMSB, $\tilde{\chi}_1^0\to\gamma\tilde{G}$, long-lived $\tilde{\chi}_1^0$	2 γ	-	Yes	4.7	$\tilde{\chi}_1^0$	230 GeV	0.4<$\tau(\tilde{\chi}_1^0)$<2 ns	1304.6310
	$\tilde{q}\tilde{q}, \tilde{\chi}_1^0\to qq\mu$ (RPV)	1 μ, displ. vtx	-	-	20.3	$\tilde{q}$	1.0 TeV	1.5 <$c\tau$<156 mm, BR(μ)=1, $m(\tilde{\chi}_1^0)$=108 GeV	ATLAS-CONF-2013-092
RPV	LFV $pp\to\tilde{\nu}_\tau+X, \tilde{\nu}_\tau\to e+\mu$	2 e,μ	-	-	4.6	$\tilde{\nu}_\tau$	1.61 TeV	λ'_{311}=0.10, λ_{132}=0.05	1212.1272
	LFV $pp\to\tilde{\nu}_\tau+X, \tilde{\nu}_\tau\to e(\mu)+\tau$	1 $e,\mu+\tau$	-	-	4.6	$\tilde{\nu}_\tau$	1.1 TeV	λ'_{311}=0.10, $\lambda_{1(2)33}$=0.05	1212.1272
	Bilinear RPV CMSSM	1 e,μ	7 jets	Yes	4.7	$\tilde{q}, \tilde{g}$	1.2 TeV	$m(\tilde{q})=m(\tilde{g})$, $c\tau_{LSP}$<1 mm	ATLAS-CONF-2012-140
	$\tilde{\chi}_1^+\tilde{\chi}_1^-, \tilde{\chi}_1^+\to W\tilde{\chi}_1^0, \tilde{\chi}_1^0\to ee\tilde{\nu}_\mu, e\mu\tilde{\nu}_e$	4 e,μ	-	Yes	20.7	$\tilde{\chi}_1^{\pm}$	760 GeV	$m(\tilde{\chi}_1^0)$>300 GeV, λ_{121}>0	ATLAS-CONF-2013-036
	$\tilde{\chi}_1^+\tilde{\chi}_1^-, \tilde{\chi}_1^+\to W\tilde{\chi}_1^0, \tilde{\chi}_1^0\to\tau\tau\tilde{\nu}_e, e\tau\tilde{\nu}_\tau$	3 $e,\mu+\tau$	-	Yes	20.7	$\tilde{\chi}_1^{\pm}$	350 GeV	$m(\tilde{\chi}_1^0)$>80 GeV, λ_{133}>0	ATLAS-CONF-2013-036
	$\tilde{g}\to qqq$	0	6-7 jets	-	20.3	$\tilde{g}$	916 GeV	BR(t)=BR(b)=BR(c)=0%	ATLAS-CONF-2013-091
	$\tilde{g}\to\tilde{t}_1t, \tilde{t}_1\to bs$	2 e,μ (SS)	0-3 b	Yes	20.7	$\tilde{g}$	880 GeV		ATLAS-CONF-2013-007
Other	Scalar gluon pair, sgluon$\to q\bar{q}$	0	4 jets	-	4.6	sgluon	100-287 GeV	incl. limit from 1110.2693	1210.4826
	Scalar gluon pair, sgluon$\to t\bar{t}$	2 e,μ (SS)	2 b	Yes	14.3	sgluon	350-800 GeV		ATLAS-CONF-2013-051
	WIMP interaction (D5, Dirac χ)	0	mono-jet	Yes	10.5	M* scale	704 GeV	$m(\chi)$<80 GeV, limit of<687 GeV for D8	ATLAS-CONF-2012-147

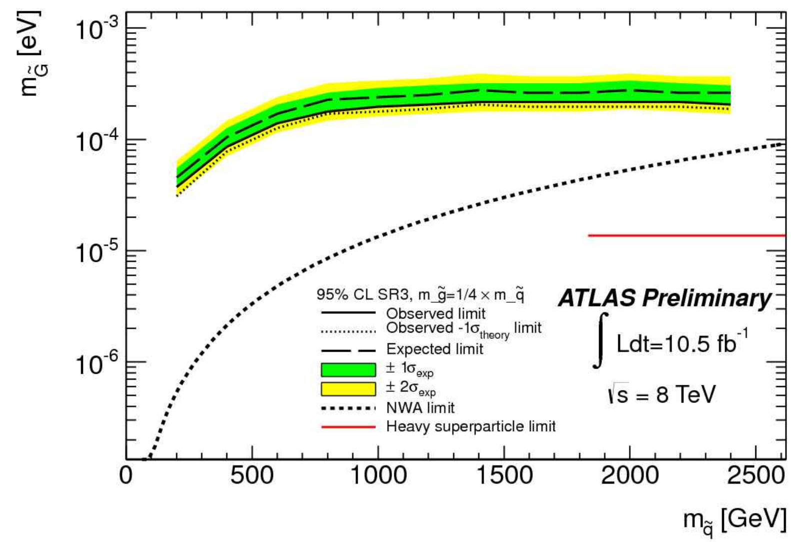
$\sqrt{s}$ = 7 TeV full data | $\sqrt{s}$ = 8 TeV partial data | $\sqrt{s}$ = 8 TeV full data

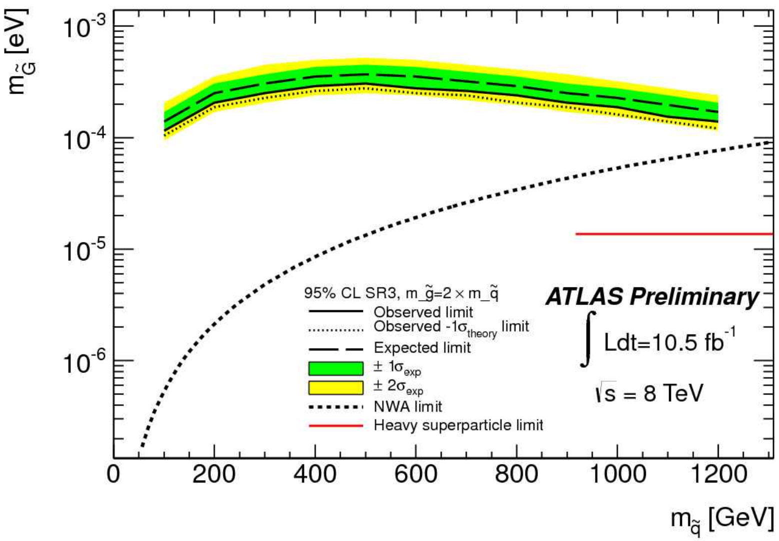
10^{-1} 1 Mass scale [TeV]

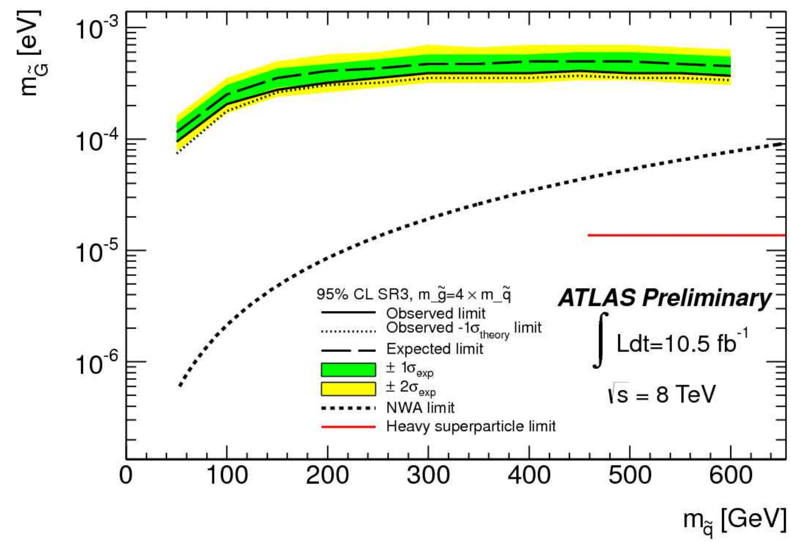
*Only a selection of the available mass limits on new states or phenomena is shown. All limits quoted are observed minus 1σ theoretical signal cross section uncertainty.

SUSY searches : gravitino









ATLAS Astroparticle Forum

Exchange ideas about opportunities of using the capability of ATLAS to contribute to the unsolved problems in cosmology and astrophysics.
• Invite astroparticle physics experts from other experiments or theorists to discuss recent developments or results and their possible cross feed with ATLAS analyses.

•Follow up and coordinate astroparticle physics aspects of analyses within existing ATLAS physics working groups and provide expertise of a broader astroparticle physics context.
• Propose astroparticle physics interpretation to an existing analysis and contribute to the work within the relevant physics group.
•Propose re-optimization of an existing analysis for an astroparticle physics interpretation and contribute to the work within the relevant physics group.
•Propose new analyses related to astroparticle physics and contribute to the work within the relevant physics group.

Work on publicizing ATLAS results with astroparticle relevance in the astroparticle community.

The AAF will work proactively on invitations for ATLAS talks (which would be assigned via the normal procedures) by contacting conference organisers and submitting abstracts (together with the physics group in which the analysis of interest is done).

LHC New Physics signals may be related to measurements of astroparticle experiments in terms of Dark Matter. And results from astroparticle experiments may serve to guide some of the ATLAS data analysis and interpretations.

►**relevant analyses, compiled based on the ATLAS astro workshop**

a) Monojets / photons

- Search for pair production of WIMPs, tagged by ISR photon or jet

b) Top-philic Dark Matter searches

- Motivation: if WIMP miracle is reality, WIMPs may be related to electroweak symmetry breaking and sizable couplings to top quarks would be expected. See e.g.http://arxiv.org/abs/0912.0004 for a model where top couples via Z' to WIMPs
- Signatures to search for at the LHC: four top and ttbar plus MET final states

c) High tan beta analysis (contact: Anna Lipniacka, Heidi Sandaker)

- Motivation: High tan-beta studies are very interesting to the astroparticle physics community, both in terms of ATLAS reach but also to show overlap or complementarity between the particle and astroparticle experiments. See references and arguments in this talk:

d) Grid searches (Contact: Anna Lipniacka, Christophe Clement, Heidi Sandaker)

- Motivation: Often ATLS experiments present models/results which are already partially excluded by astroparticle physics data or other experiments.