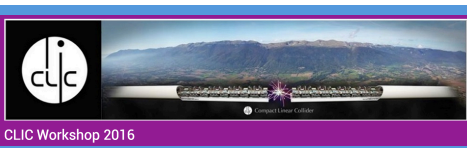
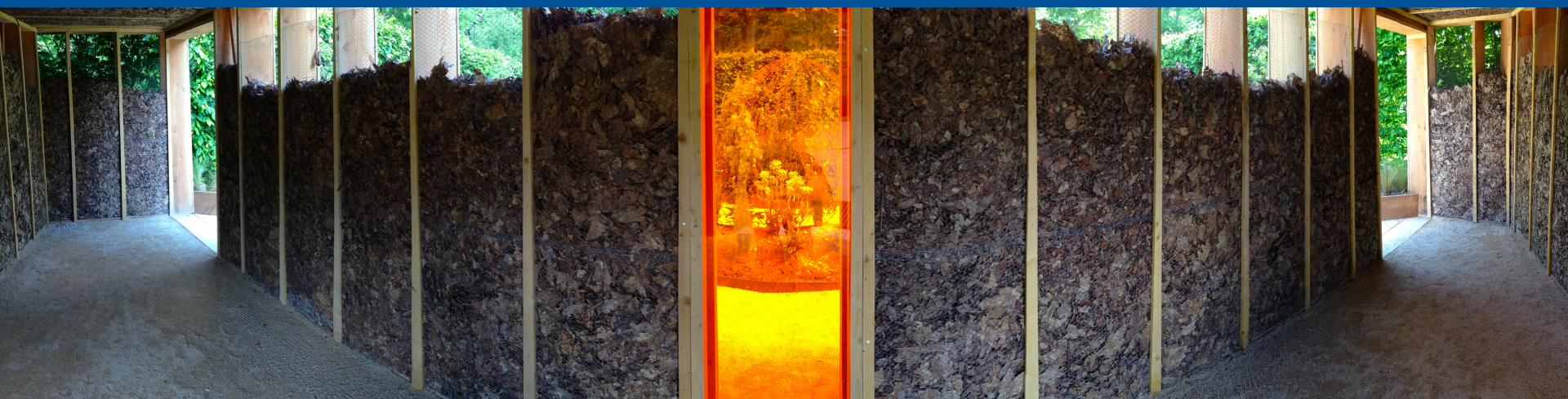


FIRST LHC OBSERVATIONS AT 13 TEV

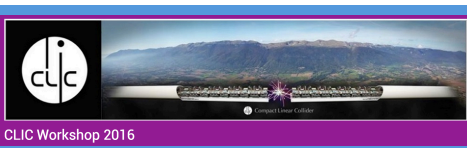
André David (CERN)
on behalf of the ATLAS and CMS collaborations





FIRST LHC MEASUREMENTS AT 13 TEV

André David (CERN)
on behalf of the ATLAS and CMS collaborations





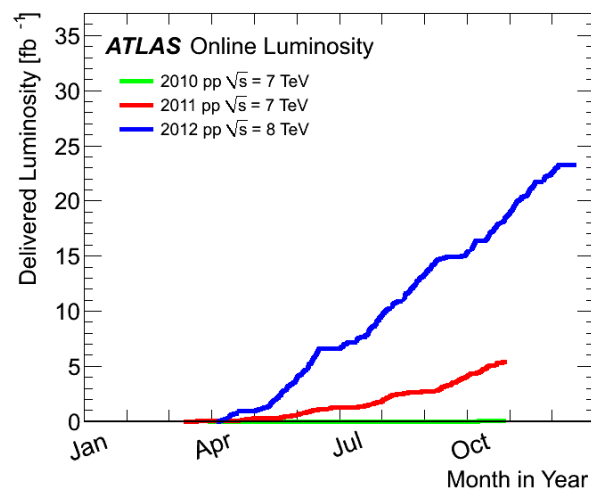
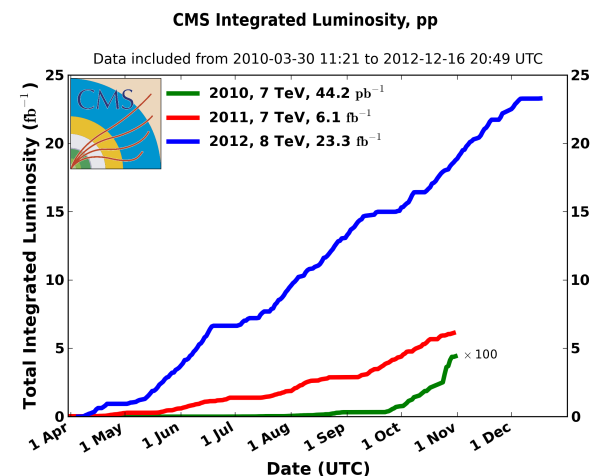
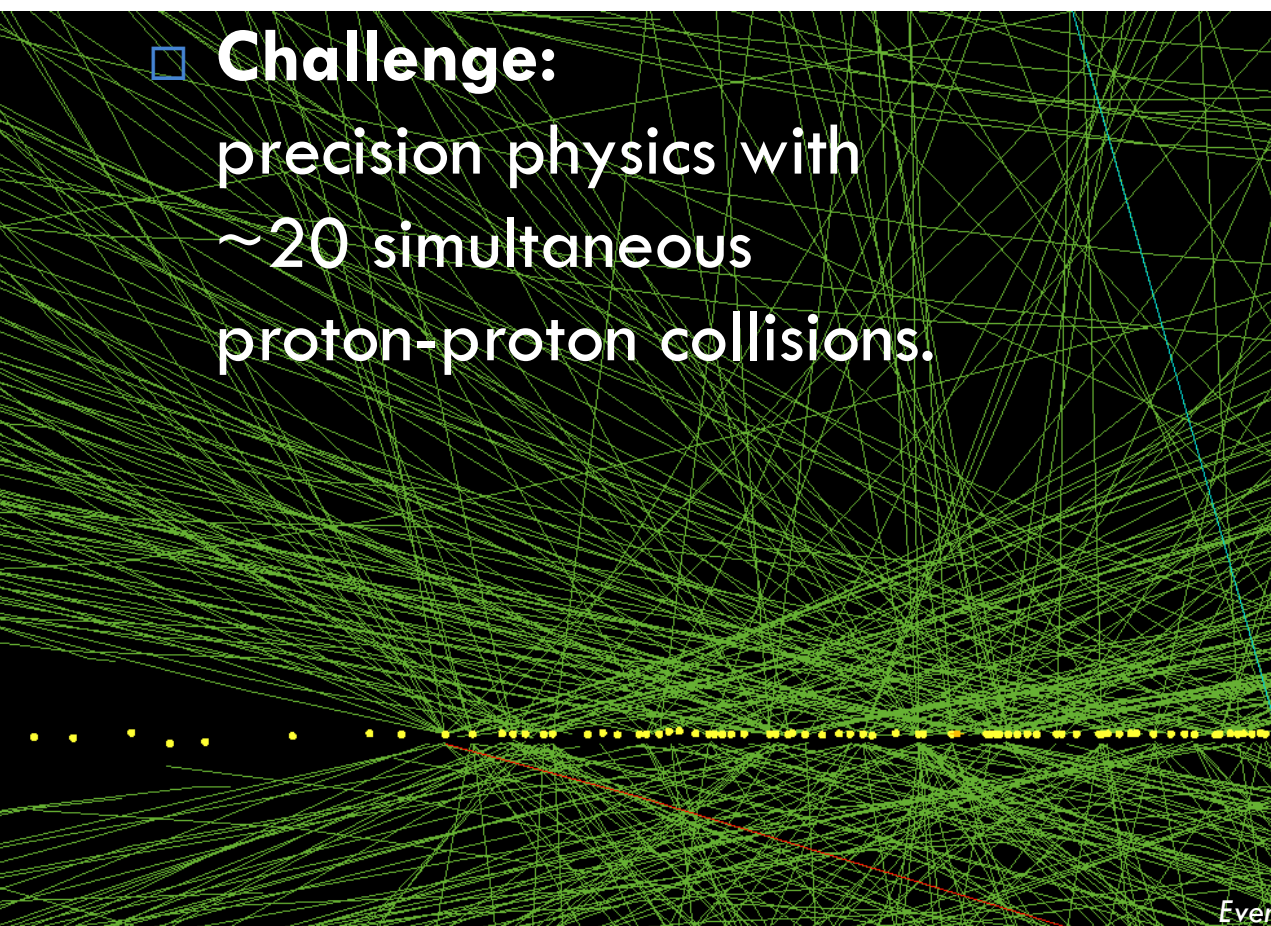
The LHC Run 1: a bountiful harvest

3

[<http://cern.ch/go/K8Tj>] [<http://cern.ch/go/ZW9S>]

□ LHC delivered $\sim 30 \text{ fb}^{-1}$.

□ **Challenge:**
precision physics with
 ~ 20 simultaneous
proton-proton collisions.



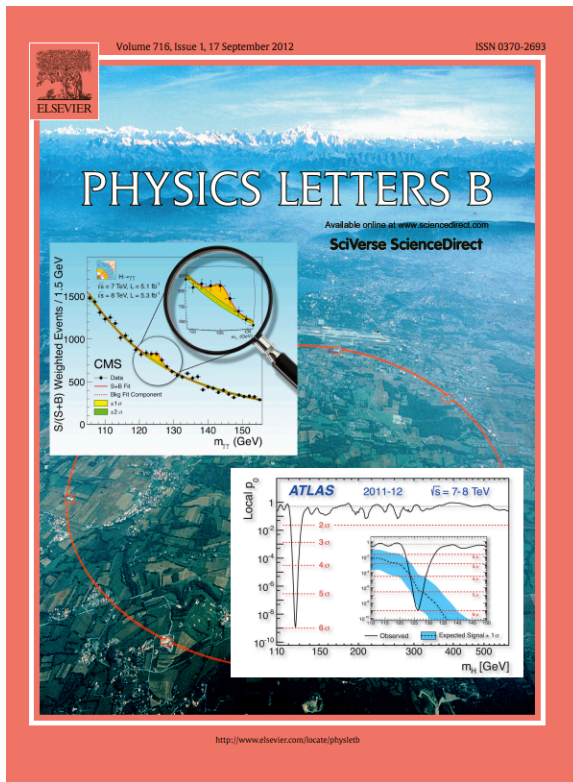
Event with 78 reconstructed vertices along $\sim 10 \text{ cm}$.

July 4, 2012

Looking up to a new boson

4

[<http://cern.ch/go/q8jx>]



2012 2011 2010 2009 2008

Who Should Be TIME's Person of the Year 2012? >

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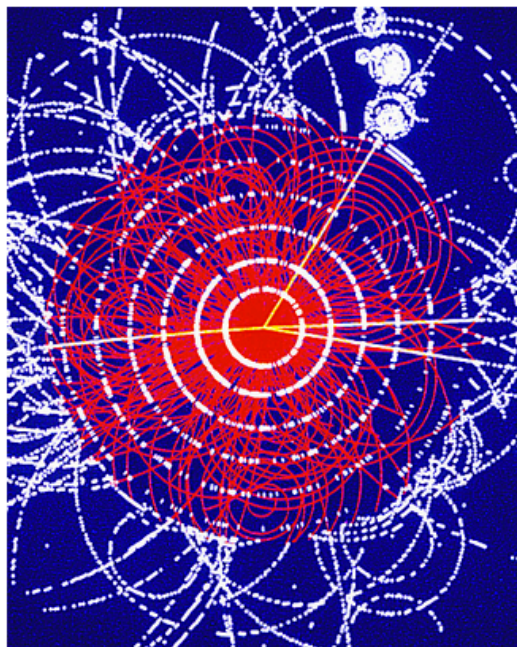
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THE CANDIDATES

The Higgs Boson

By Jeffrey Kluger | Monday, Nov. 26, 2012

◀ 18 of 40 ▶



SSPL/GETTY IMAGES

Simulation of a Higgs-Boson decaying into four muons, CERN, 1990.

What do you think?

Should **The Higgs Boson** be TIME's Person of the Year 2012?

Definitely No Way

VOTE

Take a moment to thank this little particle for all the work it does, because without it, you'd be just inchoate energy without so much as a bit of mass. What's more, the same would be true for the entire universe. It was in the 1960s that Scottish physicist Peter Higgs first posited the existence of a particle that causes energy to make the jump to matter. But it was not until last summer that a team of researchers at Europe's Large Hadron Collider — Rolf Heuer, Joseph Incandela and Fabiola Gianotti — at last sealed the deal and in so doing finally fully confirmed Einstein's general theory of relativity. The Higgs — as particles do — immediately decayed to more-fundamental particles, but the scientists would surely be happy to collect any honors or awards in its stead.

Photos: Step inside the Large Hadron Collider.

WHO SHOULD BE TIME'S PERSON OF THE YEAR 2012?

The Candidates

Video

Poll Results

PAST PERSONS OF THE YEAR



2011: The Protester



2010: Facebook's Mark Zuckerberg



2009: Ben Bernanke



2008: Barack Obama

Most Read

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- 1 Who Should Be TIME's Person of the Year 2012?
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2012 2011 2010 2009 2008

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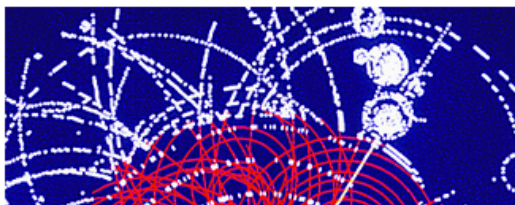
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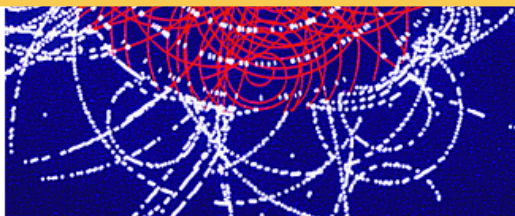
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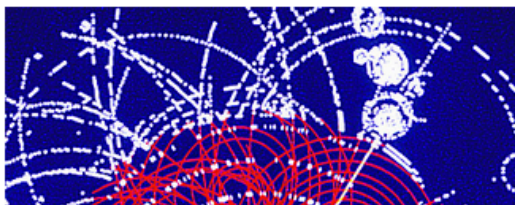
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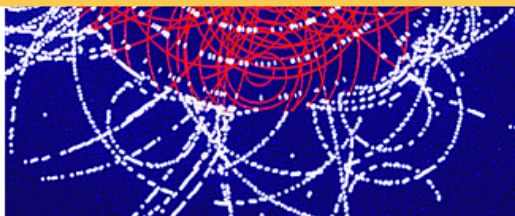
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~~1999~~ 1995

[<http://cds.cern.ch/record/39448>]



SSPL/GETTY IMAGES

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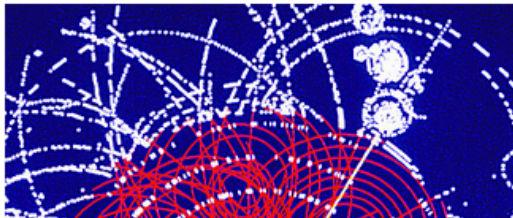
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Excluding SUSY scenarios...

ATLAS SUSY Searches* - 95% CL Lower Limits

Status: July 2015

ATLAS Preliminary

$\sqrt{s} = 7, 8 \text{ TeV}$

Model	e, μ, τ, γ	Jets	E_T^{miss}	$\int \mathcal{L} dt [\text{fb}^{-1}]$	Mass limit		Reference		
					$\sqrt{s} = 7 \text{ TeV}$	$\sqrt{s} = 8 \text{ TeV}$			
Inclusive Searches	MSUGRA/CMSSM	0-3 $e, \mu/1-2 \tau$	2-10 jets/3 b	Yes	20.3	\tilde{g}, \tilde{q}	$m(\tilde{g})=m(\tilde{q})$	1507.05525	
	$\tilde{q}\tilde{q}, \tilde{q} \rightarrow q\tilde{k}_1^0$	0	2-6 jets	Yes	20.3	\tilde{q}	$m(\tilde{k}_1^0)=0 \text{ GeV}, m(\text{1st gen. } \tilde{q})=m(\text{2nd gen. } \tilde{q})$	1405.7875	
	$\tilde{q}\tilde{q}, \tilde{q} \rightarrow q\tilde{k}_1^0$ (compressed)	mono-jet	1-3 jets	Yes	20.3	\tilde{q}	$m(\tilde{q})=m(\tilde{k}_1^0)<10 \text{ GeV}$	1507.05525	
	$\tilde{q}\tilde{q}, \tilde{q} \rightarrow q(\ell\ell/\nu\nu)\tilde{k}_1^0$	2 e, μ (off-Z)	2 jets	Yes	20.3	\tilde{q}	$m(\tilde{k}_1^0)=0 \text{ GeV}$	1503.03290	
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow q\tilde{q}\tilde{k}_1^0$	0	2-6 jets	Yes	20.3	\tilde{g}	$m(\tilde{k}_1^0)=0 \text{ GeV}$	1405.7875	
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow q\tilde{q}\tilde{k}_1^0 \rightarrow q\tilde{q}W^{\pm}\tilde{\chi}_1^0$	0-1 e, μ	2-6 jets	Yes	20	\tilde{g}	$m(\tilde{k}_1^0)<300 \text{ GeV}, m(\tilde{k}^{\pm})=0.5(m(\tilde{k}_1^0)+m(\tilde{g}))$	1507.05525	
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow q\tilde{q}(\ell\ell/\nu\nu)\tilde{k}_1^0$	2 e, μ	0-3 jets	-	20	\tilde{g}	$m(\tilde{k}_1^0)=0 \text{ GeV}$	1501.03555	
	GMSB ($\tilde{\ell}$ NLSP)	1-2 $\tau + 0-1 \ell$	0-2 jets	Yes	20.3	\tilde{g}	$\tan\beta > 20$	1407.0603	
	GGM (bino NLSP)	2 γ	-	Yes	20.3	\tilde{g}	$c\tau(\text{NLSP})<0.1 \text{ mm}$	1507.05493	
	GGM (higgsino-bino NLSP)	γ	1 b	Yes	20.3	\tilde{g}	$m(\tilde{k}_1^0)<900 \text{ GeV}, c\tau(\text{NLSP})<0.1 \text{ mm}, \mu<0$	1507.05493	
	GGM (higgsino-bino NLSP)	γ	2 jets	Yes	20.3	\tilde{g}	$m(\tilde{k}_1^0)<850 \text{ GeV}, c\tau(\text{NLSP})<0.1 \text{ mm}, \mu>0$	1507.05493	
	GGM (higgsino NLSP)	2 e, μ (Z)	2 jets	Yes	20.3	\tilde{g}	$m(\text{NLSP})>430 \text{ GeV}$	1503.03290	
Gravitino LSP	0	mono-jet	Yes	20.3	$F^{1/2}$ scale	$m(\tilde{G})>1.8 \times 10^{-1} \text{ eV}, m(\tilde{g})=m(\tilde{q})=1.5 \text{ TeV}$	1502.01518		
$\tilde{\chi}_1^0$ gen. \tilde{g} med.	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow b\tilde{b}\tilde{\chi}_1^0$	0	3 b	Yes	20.1	\tilde{g}	$m(\tilde{k}_1^0)<400 \text{ GeV}$	1407.0600	
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow t\tilde{t}\tilde{\chi}_1^0$	0	7-10 jets	Yes	20.3	\tilde{g}	$m(\tilde{k}_1^0)<350 \text{ GeV}$	1308.1841	
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow t\tilde{b}\tilde{\chi}_1^0$	0-1 e, μ	3 b	Yes	20.1	\tilde{g}	$m(\tilde{k}_1^0)<400 \text{ GeV}$	1407.0600	
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow b\tilde{t}\tilde{\chi}_1^0$	0-1 e, μ	3 b	Yes	20.1	\tilde{g}	$m(\tilde{k}_1^0)<300 \text{ GeV}$	1407.0600	
$\tilde{\chi}_1^0$ gen. squarks direct production	$\tilde{b}_1\tilde{b}_1, \tilde{b}_1 \rightarrow b\tilde{k}_1^0$	0	2 b	Yes	20.1	\tilde{b}_1	$m(\tilde{k}_1^0)<90 \text{ GeV}$	1308.2631	
	$\tilde{b}_1\tilde{b}_1, \tilde{b}_1 \rightarrow t\tilde{k}_1^0$	2 e, μ (SS)	0-3 b	Yes	20.3	\tilde{b}_1	$m(\tilde{k}_1^0)=2 m(\tilde{k}_2^0)$	1404.2500	
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow b\tilde{k}_1^0$	1-2 e, μ	1-2 b	Yes	4.7/20.3	\tilde{t}_1	$m(\tilde{k}_1^0)=2 m(\tilde{k}_2^0), m(\tilde{k}_1^0)=55 \text{ GeV}$	1209.2102, 1407.0583	
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow Wb\tilde{k}_1^0$ or $t\tilde{k}_1^0$	0-2 e, μ	0-2 jets/1-2 b	Yes	20.3	\tilde{t}_1	$m(\tilde{k}_1^0)=1 \text{ GeV}$	1506.08616	
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow c\tilde{k}_1^0$	0	mono-jet/c-tag	Yes	20.3	\tilde{t}_1	$m(\tilde{t}_1), m(\tilde{k}_1^0)<85 \text{ GeV}$	1407.0608	
	$\tilde{t}_1\tilde{t}_1$ (natural GMSB)	2 e, μ (Z)	1 b	Yes	20.3	\tilde{t}_1	$m(\tilde{k}_1^0)>150 \text{ GeV}$	1403.5222	
$\tilde{t}_2\tilde{t}_2, \tilde{t}_2 \rightarrow \tilde{t}_1 + Z$	3 e, μ (Z)	1 b	Yes	20.3	\tilde{t}_2	$m(\tilde{k}_1^0)<200 \text{ GeV}$	1403.5222		
EW direct	$\tilde{\chi}_{1R}^0\tilde{\chi}_{1R}^0, \tilde{Z} \rightarrow \tilde{\chi}_1^0$	2 e, μ	0	Yes	20.3	\tilde{Z}	$m(\tilde{k}_1^0)=0 \text{ GeV}$	1403.5294	
	$\tilde{\chi}_1^0\tilde{\chi}_1^0, \tilde{\chi}_1^0 \rightarrow \tilde{\nu}(\tilde{\nu})$	2 e, μ	0	Yes	20.3	$\tilde{\chi}_1^0$	$m(\tilde{k}_1^0)=0 \text{ GeV}, m(\tilde{\nu}, \tilde{\nu})=0.5(m(\tilde{k}_1^0)+m(\tilde{k}_2^0))$	1403.5294	
	$\tilde{\chi}_1^0\tilde{\chi}_1^0, \tilde{\chi}_1^0 \rightarrow \tilde{\nu}(\nu\tilde{\nu})$	2 τ	-	Yes	20.3	$\tilde{\chi}_1^0$	$m(\tilde{k}_1^0)=0 \text{ GeV}, m(\tilde{\nu}, \tilde{\nu})=0.5(m(\tilde{k}_1^0)+m(\tilde{k}_2^0))$	1407.0350	
	$\tilde{\chi}_1^0\tilde{\chi}_1^0 \rightarrow \tilde{\nu}_1\nu\tilde{\chi}_1^0(\tilde{\nu}\nu), \tilde{\nu}\tilde{\nu}_1\ell(\tilde{\nu}\nu)$	3 e, μ	0	Yes	20.3	$\tilde{\chi}_1^0$	$m(\tilde{k}_1^0)=m(\tilde{k}_2^0), m(\tilde{k}_1^0)=0, m(\tilde{\nu}, \tilde{\nu})=0.5(m(\tilde{k}_1^0)+m(\tilde{k}_2^0))$	1402.7029	
	$\tilde{\chi}_1^0\tilde{\chi}_1^0 \rightarrow W\tilde{k}_1^0\tilde{Z}\tilde{k}_1^0$	2-3 e, μ	0-2 jets	Yes	20.3	$\tilde{\chi}_1^0$	$m(\tilde{k}_1^0)=m(\tilde{k}_2^0), m(\tilde{k}_1^0)=0, \text{ sleptons decoupled}$	1403.5294, 1402.7029	
	$\tilde{\chi}_1^0\tilde{\chi}_1^0 \rightarrow W\tilde{k}_1^0h\tilde{k}_1^0, h \rightarrow b\tilde{b}/WW/\tau\tau/\gamma\gamma$	e, μ, γ	0-2 b	Yes	20.3	$\tilde{\chi}_1^0$	$m(\tilde{k}_1^0)=m(\tilde{k}_2^0), m(\tilde{k}_1^0)=0, \text{ sleptons decoupled}$	1501.07110	
	$\tilde{\chi}_1^0\tilde{\chi}_1^0 \rightarrow \tilde{\nu}_1\nu\tilde{\chi}_1^0 \rightarrow \tilde{\nu}_1\ell$	4 e, μ	0	Yes	20.3	$\tilde{\chi}_1^0$	$m(\tilde{k}_2^0)=m(\tilde{k}_3^0), m(\tilde{k}_1^0)=0, m(\tilde{\nu}, \tilde{\nu})=0.5(m(\tilde{k}_2^0)+m(\tilde{k}_3^0))$	1405.5086	
	GGM (wino NLSP) weak prod.	1 $e, \mu + \gamma$	-	Yes	20.3	\tilde{W}	$c\tau<1 \text{ mm}$	1507.05493	
	Long-lived particles	Direct $\tilde{\chi}_1^0\tilde{\chi}_1^0$ prod., long-lived $\tilde{\chi}_1^{\pm}$	Disapp. trk	1 jet	Yes	20.3	$\tilde{\chi}_1^{\pm}$	$m(\tilde{k}_1^0)-m(\tilde{k}_2^0)\sim 160 \text{ MeV}, \tau(\tilde{\chi}_1^{\pm})=0.2 \text{ ns}$	1310.3675
		Direct $\tilde{\chi}_1^0\tilde{\chi}_1^0$ prod., long-lived $\tilde{\chi}_1^0$	dE/dx trk	-	Yes	18.4	$\tilde{\chi}_1^0$	$m(\tilde{k}_1^0)-m(\tilde{k}_2^0)\sim 160 \text{ MeV}, \tau(\tilde{\chi}_1^0)<15 \text{ ns}$	1506.05332
Stable, stopped \tilde{g} R-hadron		0	1-5 jets	Yes	27.9	\tilde{g}	$m(\tilde{k}_1^0)=100 \text{ GeV}, 10 \mu\text{s}<\tau(\tilde{g})<1000 \text{ s}$	1310.6584	
Stable \tilde{g} R-hadron		trk	-	-	19.1	\tilde{g}	$10<\tau(\tilde{g})<50$	1411.6795	
GMSB, stable $\tilde{\tau}, \tilde{\chi}_1^0 \rightarrow \tilde{\tau}(\tilde{\tau}, \tilde{\mu})+\tau(e, \mu)$		1-2 μ	-	-	19.1	$\tilde{\chi}_1^0$	$2<\tau(\tilde{k}_1^0)<3 \text{ ns}, \text{SPS8 model}$	1411.6795	
GMSB, $\tilde{\chi}_1^0 \rightarrow \gamma\tilde{G}$, long-lived $\tilde{\chi}_1^0$		2 γ	-	Yes	20.3	$\tilde{\chi}_1^0$	$7<c\tau(\tilde{k}_1^0)<470 \text{ mm}, m(\tilde{g})=1.3 \text{ TeV}$	1409.5542	
$\tilde{g}\tilde{g}, \tilde{\chi}_1^0 \rightarrow e\nu/\mu\nu/\mu\nu\nu$		displ. $e\ell/e\nu/\mu\nu$	-	-	20.3	$\tilde{\chi}_1^0$	$6<c\tau(\tilde{k}_1^0)<840 \text{ mm}, m(\tilde{g})=1.1 \text{ TeV}$	1504.05162	
GGM $\tilde{g}\tilde{g}, \tilde{\chi}_1^0 \rightarrow Z\tilde{G}$	displ. vtx + jets	-	-	20.3	$\tilde{\chi}_1^0$		1504.05162		
RPV	LFV $pp \rightarrow \tilde{\nu}_c + X, \tilde{\nu}_c \rightarrow e\mu/\tau\mu/\tau$	$e\mu, e\tau, \mu\tau$	-	-	20.3	$\tilde{\nu}_c$	$A_{311}^c=0.11, A_{132/133/233}=0.07$	1503.04430	
	Bilinear RPV CMSSM	2 e, μ (SS)	0-3 b	Yes	20.3	\tilde{q}, \tilde{g}	$m(\tilde{q})=m(\tilde{g}), c\tau_{13P}<1 \text{ mm}$	1404.2500	
	$\tilde{\chi}_1^0\tilde{\chi}_1^0, \tilde{\chi}_1^0 \rightarrow W\tilde{k}_1^0\tilde{\nu}^0 \rightarrow e\tilde{\nu}_c, e\mu\tilde{\nu}_c$	4 e, μ	-	Yes	20.3	$\tilde{\chi}_1^0$	$m(\tilde{k}_1^0)>0.2m(\tilde{k}_2^0), A_{121}\neq 0$	1405.5086	
	$\tilde{\chi}_1^0\tilde{\chi}_1^0, \tilde{\chi}_1^0 \rightarrow W\tilde{k}_1^0\tilde{\nu}^0 \rightarrow \tau\tilde{\nu}_c, e\tau\tilde{\nu}_c$	3 $e, \mu + \tau$	-	Yes	20.3	$\tilde{\chi}_1^0$	$m(\tilde{k}_1^0)>0.2m(\tilde{k}_2^0), A_{133}\neq 0$	1405.5086	
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow q\tilde{q}\tilde{\nu}^0$	0	6-7 jets	-	20.3	\tilde{g}	$BR(\tilde{g})=BR(\tilde{b})=BR(\tilde{c})=0\%$	1502.05686	
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow q\tilde{k}_1^0, \tilde{\nu}^0 \rightarrow q\tilde{q}\tilde{\nu}^0$	0	6-7 jets	-	20.3	\tilde{g}	$m(\tilde{k}_1^0)=600 \text{ GeV}$	1502.05686	
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow \tilde{t}_1 t, \tilde{t}_1 \rightarrow b\tilde{s}$	2 e, μ (SS)	0-3 b	Yes	20.3	\tilde{g}		1404.250	
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow b\tilde{s}$	0	2 jets + 2 b	-	20.3	\tilde{t}_1		ATLAS-CONF-2015-026	
$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow b\tilde{\ell}$	2 e, μ	2 b	-	20.3	\tilde{t}_1	$BR(\tilde{t}_1 \rightarrow b\ell/\mu)>20\%$	ATLAS-CONF-2015-015		
Other	Scalar charm, $\tilde{c} \rightarrow c\tilde{k}_1^0$	0	2 c	Yes	20.3	\tilde{c}	$m(\tilde{k}_1^0)<200 \text{ GeV}$	1501.01325	

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



...and Exotics scenarios

ATLAS Exotics Searches* - 95% CL Exclusion

Status: July 2015

ATLAS Preliminary

$\int \mathcal{L} dt = (4.7 - 20.3) \text{ fb}^{-1}$ $\sqrt{s} = 7, 8 \text{ TeV}$

	Model	ℓ, γ	Jets	E_{τ}^{miss}	$\int \mathcal{L} dt [\text{fb}^{-1}]$	Limit	Reference
Extra dimensions	ADD $G_{KK} + g/q$	-	$\geq 1j$	Yes	20.3	M_0 5.25 TeV	$n = 2$ 1502.01518
	ADD non-resonant $\ell\ell$	$2e, \mu$	-	-	20.3	M_{KK} 4.7 TeV	$n = 3 \text{ HLZ}$ 1407.2410
	ADD QBH $\rightarrow \ell q$	$1e, \mu$	$1j$	-	20.3	M_{KK} 5.2 TeV	$n = 6$ 1311.2006
	ADD QBH	-	$2j$	-	20.3	M_{KK} 5.82 TeV	$n = 6$ 1407.1376
	ADD BH high N_{trk}	2μ (SS)	-	-	20.3	M_{KK} 4.7 TeV	$n = 6, M_D = 3 \text{ TeV, non-rot BH}$ 1308.4075
	ADD BH high $\sum p_T$	$\geq 1e, \mu$	$\geq 2j$	-	20.3	M_{KK} 5.8 TeV	$n = 6, M_D = 3 \text{ TeV, non-rot BH}$ 1405.4254
	ADD BH high multijet	-	$\geq 2j$	-	20.3	M_{KK} 5.8 TeV	$n = 6, M_D = 3 \text{ TeV, non-rot BH}$ 1503.08988
	RS1 $G_{KK} \rightarrow \ell\ell$	$2e, \mu$	-	-	20.3	G_{KK} mass 2.68 TeV	$k/M_{Pl} = 0.1$ 1405.4123
	RS1 $G_{KK} \rightarrow \gamma\gamma$	2γ	-	-	20.3	G_{KK} mass 2.66 TeV	$k/M_{Pl} = 0.1$ 1504.05511
	Bulk RS $G_{KK} \rightarrow ZZ \rightarrow qq\ell\ell$	$2e, \mu$	$2j/1j$	-	20.3	G_{KK} mass 740 GeV	$k/M_{Pl} = 1.0$ 1409.6190
	Bulk RS $G_{KK} \rightarrow WW \rightarrow qq\ell\ell$	$1e, \mu$	$2j/1j$	Yes	20.3	W mass 760 GeV	$k/M_{Pl} = 1.0$ 1503.04677
	Bulk RS $G_{KK} \rightarrow HH \rightarrow b\bar{b}b\bar{b}$	-	$4b$	-	19.5	G_{KK} mass 500-720 GeV	$k/M_{Pl} = 1.0$ 1506.00285
	Bulk RS $g_{KK} \rightarrow t\bar{t}$	$1e, \mu$	$\geq 1b, \geq 1J/2j$	Yes	20.3	g_{KK} mass 2.2 TeV	$k/M_{Pl} = 1.0$ 1505.07018
	2UED / RPP	$2e, \mu$ (SS)	$\geq 1b, \geq 1j$	Yes	20.3	KK mass 960 GeV	$BR = 0.925$ 1504.04605
	Gauge bosons	SSM $Z' \rightarrow \ell\ell$	$2e, \mu$	-	-	20.3	Z' mass 2.9 TeV
SSM $Z' \rightarrow \tau\tau$		2τ	-	-	19.5	Z' mass 2.02 TeV	1502.07177
SSM $W' \rightarrow \ell\nu$		$1e, \mu$	-	Yes	20.3	W' mass 3.24 TeV	1407.7494
EGM $W' \rightarrow WZ \rightarrow \ell\nu\ell'\ell'$		$3e, \mu$	-	Yes	20.3	W' mass 1.52 TeV	1406.4456
EGM $W' \rightarrow WZ \rightarrow qq\ell\ell$		$2e, \mu$	$2j/1j$	-	20.3	W' mass 1.59 TeV	1409.6190
EGM $W' \rightarrow WZ \rightarrow qqqq$		-	$2J$	-	20.3	W' mass 1.3-1.5 TeV	1506.00962
HVT $W' \rightarrow WH \rightarrow \ell\nu b\bar{b}$		$1e, \mu$	$2b$	Yes	20.3	W' mass 1.47 TeV	1503.08089
LRSM $W'_R \rightarrow t\bar{b}$	$1e, \mu$	$2b, 0-1j$	Yes	20.3	W' mass 1.92 TeV	1410.4103	
LRSM $W'_R \rightarrow t\bar{b}$	$0e, \mu$	$\geq 1b, 1j$	-	20.3	W' mass 1.76 TeV	1408.0886	
CI	CI $qqqq$	-	$2j$	-	17.3	Λ 12.0 TeV $\eta_{LL} = -1$	1504.00357
	CI $qq\ell\ell$	$2e, \mu$	-	-	20.3	Λ 21.6 TeV $\eta_{LL} = -1$	1407.2410
	CI $uu\tau\tau$	$2e, \mu$ (SS)	$\geq 1b, \geq 1j$	Yes	20.3	Λ 4.3 TeV $ C_{LL} = 1$	1504.04605
DM	EFT D5 operator (Dirac)	$0e, \mu$	$\geq 1j$	Yes	20.3	M_* 974 GeV	at 90% CL for $m(\chi) < 100 \text{ GeV}$ 1502.01518
	EFT D9 operator (Dirac)	$0e, \mu$	$1j, \leq 1j$	Yes	20.3	M_* 2.4 TeV	at 90% CL for $m(\chi) < 100 \text{ GeV}$ 1309.4017
LQ	Scalar LQ 1 st gen	$2e$	$\geq 2j$	-	20.3	LQ mass 1.05 TeV	$\beta = 1$ Preliminary
	Scalar LQ 2 nd gen	2μ	$\geq 2j$	-	20.3	LQ mass 1.0 TeV	$\beta = 1$ Preliminary
	Scalar LQ 3 rd gen	$1e, \mu$	$\geq 1b, \geq 3j$	Yes	20.3	LQ mass 640 GeV	$\beta = 0$ Preliminary
Heavy quarks	VLQ $TT \rightarrow Ht + X$	$1e, \mu$	$\geq 2b, \geq 3j$	Yes	20.3	T mass 855 GeV	T in (T,B) doublet 1505.04306
	VLQ $YY \rightarrow Wb + X$	$1e, \mu$	$\geq 1b, \geq 3j$	Yes	20.3	Y mass 770 GeV	Y in (B,Y) doublet 1505.04306
	VLQ $BB \rightarrow Hb + X$	$1e, \mu$	$\geq 2b, \geq 3j$	Yes	20.3	B mass 735 GeV	isospin singlet 1505.04306
	VLQ $BB \rightarrow Zb + X$	$2\geq 3e, \mu$	$\geq 2\geq 1b$	-	20.3	B mass 755 GeV	B in (B,Y) doublet 1409.5500
	$T_{3/3} \rightarrow Wt$	$1e, \mu$	$\geq 1b, \geq 5j$	Yes	20.3	$T_{3/3}$ mass 840 GeV	1503.05425
Excited fermions	Excited quark $q^* \rightarrow q\gamma$	1γ	$1j$	-	20.3	q^* mass 3.5 TeV	only u' and d' , $\Lambda = m(q^*)$ 1309.3230
	Excited quark $q^* \rightarrow qg$	-	$2j$	-	20.3	q^* mass 4.09 TeV	only u' and d' , $\Lambda = m(q^*)$ 1407.1376
	Excited quark $b^* \rightarrow Wt$	1 or $2e, \mu$	$1b, 2j$ or $1j$	Yes	4.7	b^* mass 870 GeV	left-handed coupling 1301.1583
	Excited lepton $\ell^* \rightarrow \ell\gamma$	$2e, \mu, 1\tau$	-	-	13.0	ℓ^* mass 2.2 TeV	$\Lambda = 2.2 \text{ TeV}$ 1308.1364
	Excited lepton $\nu^* \rightarrow \ell W, \nu Z$	$3e, \mu, \tau$	-	-	20.3	ν^* mass 1.6 TeV	$\Lambda = 1.6 \text{ TeV}$ 1411.2921
Other	LSTC $a_\tau \rightarrow W\gamma$	$1e, \mu, 1\gamma$	-	Yes	20.3	a_τ mass 960 GeV	1407.8150
	LRSM Majorana ν	$2e, \mu$	$2j$	-	20.3	N^0 mass 2.0 TeV	$m(W_R) = 2.4 \text{ TeV, no mixing}$ 1506.06020
	Higgs triplet $H^{++} \rightarrow \ell\ell$	$2e, \mu$ (SS)	-	-	20.3	H^{++} mass 551 GeV	DY production, $BR(H^{++} \rightarrow \ell\ell)=1$ 1412.0237
	Higgs triplet $H^{++} \rightarrow \ell\tau$	$3e, \mu, \tau$	-	-	20.3	H^{++} mass 400 GeV	DY production, $BR(H^{++} \rightarrow \ell\tau)=1$ 1411.2921
	Monotop (non-res prod)	$1e, \mu$	$1b$	Yes	20.3	spin-1 invisible particle mass 657 GeV	$a_{\text{non-res}} = 0.2$ 1410.5404
	Multi-charged particles	-	-	-	20.3	multi-charged particle mass 785 GeV	DY production, $ q = 5e$ 1504.04188
	Magnetic monopoles	-	-	-	7.0	monopole mass 1.34 TeV	DY production, $ g = 1g_D, \text{spin } 1/2$ Preliminary

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

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



A possible Run1 summary

BBC | News | Sport | Weather | Shop | Earth | Travel | C

SPORT FOOTBALL

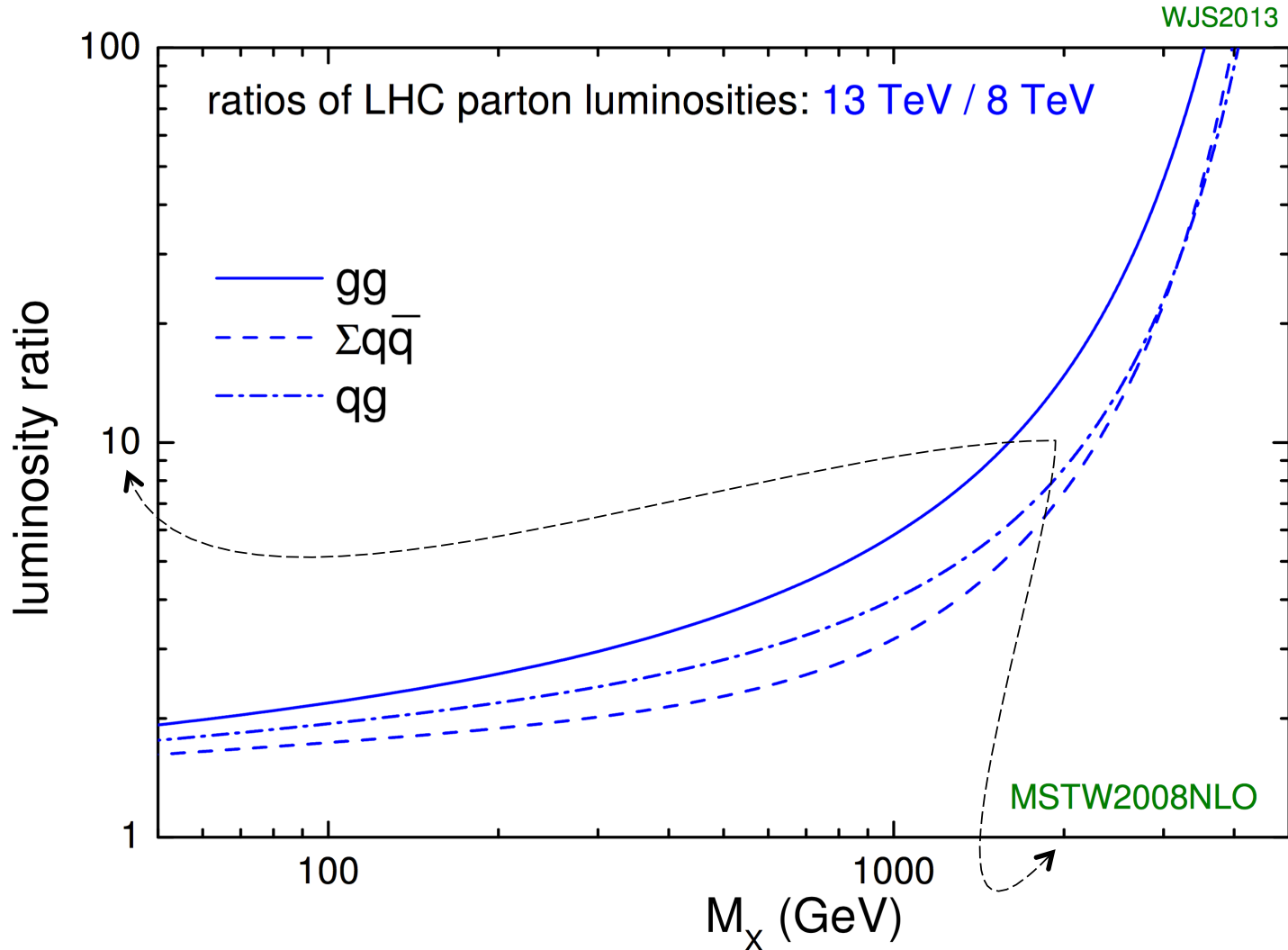
Home | **Football** | Formula 1 | Cricket | Rugby U | Tennis | Golf | Athletics | Cycling

Premier League > Results | Fixtures | Table | Predictor

	All BSM FC	0	1	SM Utd	
	Run1	5 yr		h(125) '12	



The reach of higher energies



Run2 preparation and operation

- 6.5 TeV.
- 25 ns bunch spacing.
- $\beta^* = 40$ cm.



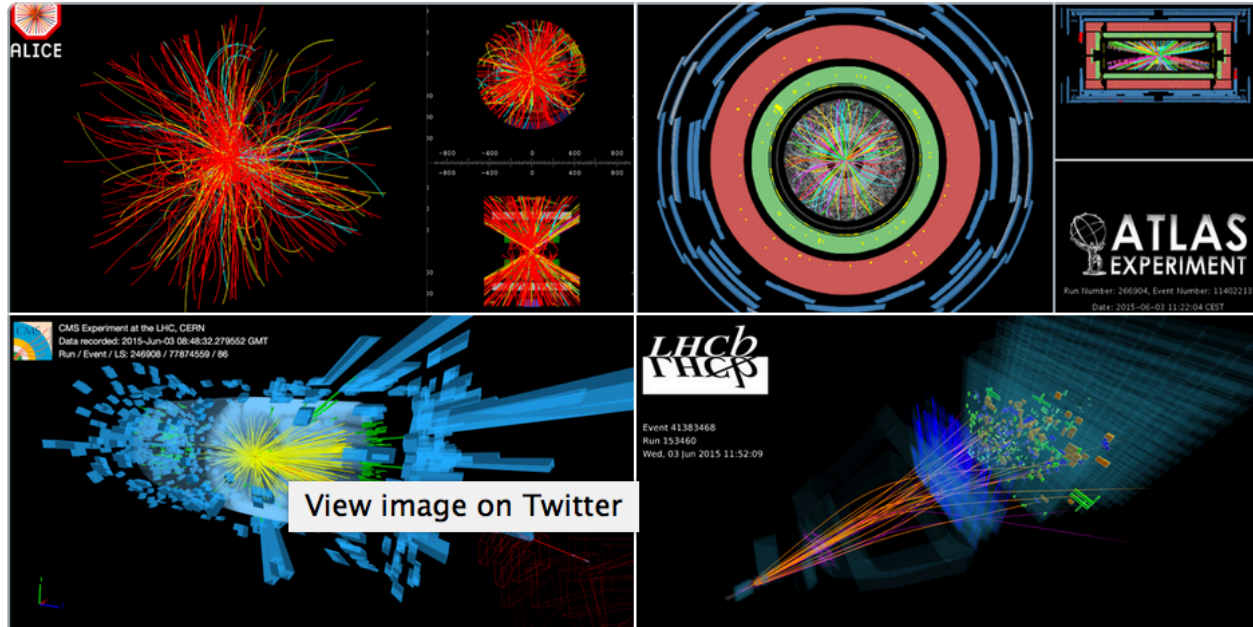
The main 2013-14 LHC consolidations

1695 Openings and final reclosures of the interconnections	Complete reconstruction of 3000 of these splices	Consolidation of the 10170 13kA splices, installing 27 000 shunts	Installation of 5000 consolidated electrical insulation systems	300 000 electrical resistance measurements	10170 orbital welding of stainless steel lines
18 000 electrical Quality Assurance tests	10170 leak tightness tests	3 quadrupole magnets to be replaced	15 dipole magnets to be replaced	Installation of 612 pressure relief devices to bring the total to 1344	Consolidation of the 13 kA circuits in the 16 main electrical feed-boxes

Back to the #13TeV future



14



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The LHC experiments are back in business with record energy collisions of #13TeV: cern.ch/go/D7z6

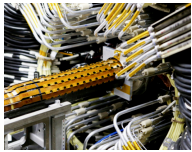
12:41 PM - 3 Jun 2015

853 558



Run2 preparation and operation

ATLAS

- **Inner b-layer (IBL).**
 - 4th Si pixel layer. 
- Finalize muon coverage.
- Trigger/DAQ
 - L1 rate: 75 to 100 kHz.
 - L1 Calo: better MET.
 - L1 Muon: rate reduction from coincidences.

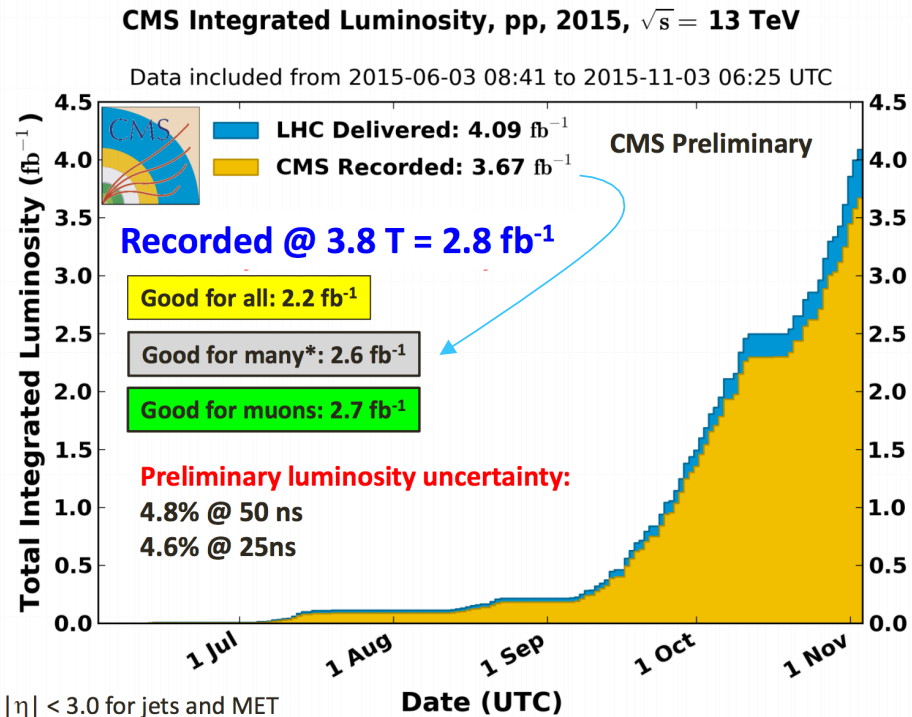
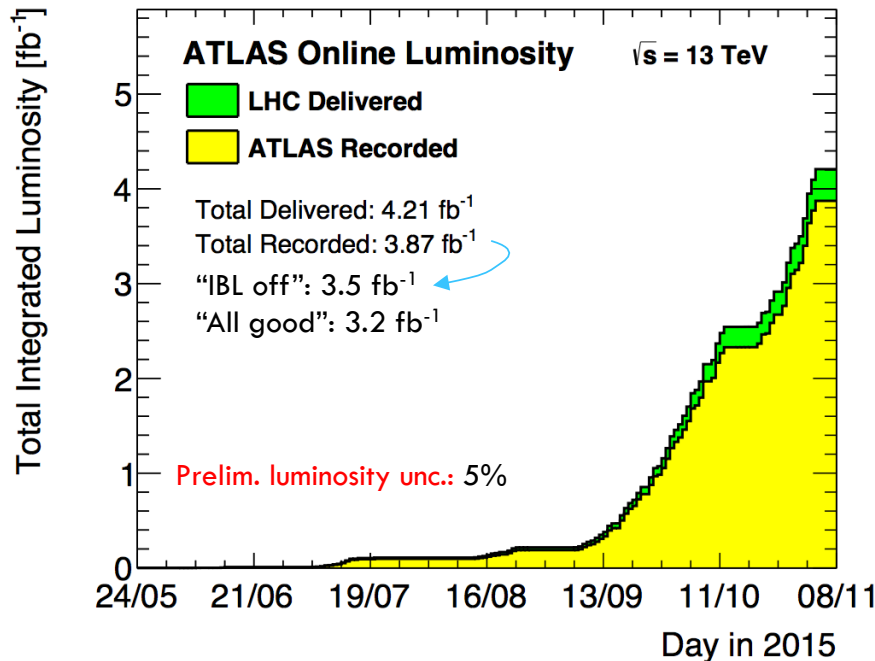
CMS

- **Liquid He supply to magnet.**
 - Field-off periods.
- New lumi. detectors.
- Trigger/DAQ
 - L1 Calo: better tau trigger.
 - DAQ2: new hardware.

The 2015 harvest



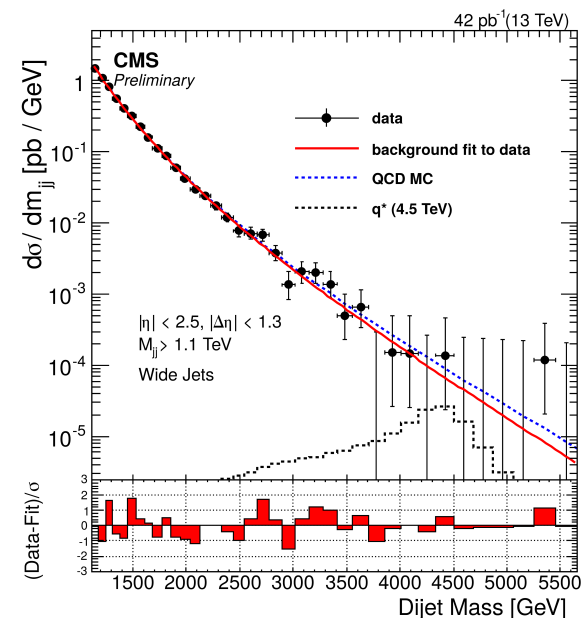
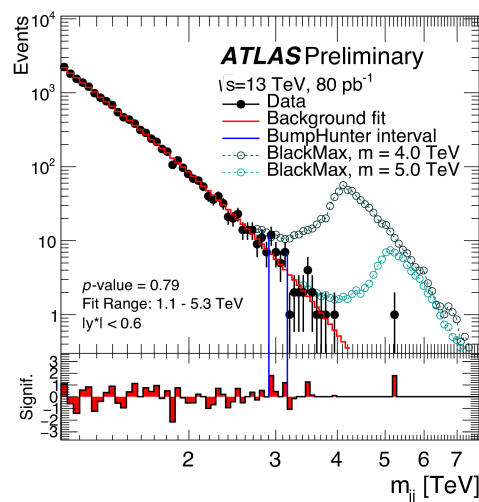
- Already average **13 interactions per bunch crossing at 25 ns.**
- Gaining experience for the long haul:
 - ▣ **ATLAS IBL** operation.
 - ▣ **CMS liquid Helium supply** for solenoid.



* $|\eta| < 3.0$ for jets and MET

Many early results during Summer

- Charged particle densities and correlations.
- (Single) top production.
- Single boson production.
- First (negative) search results.
 - ▣ *But the first events in the tails.*



On the shoulders of giants

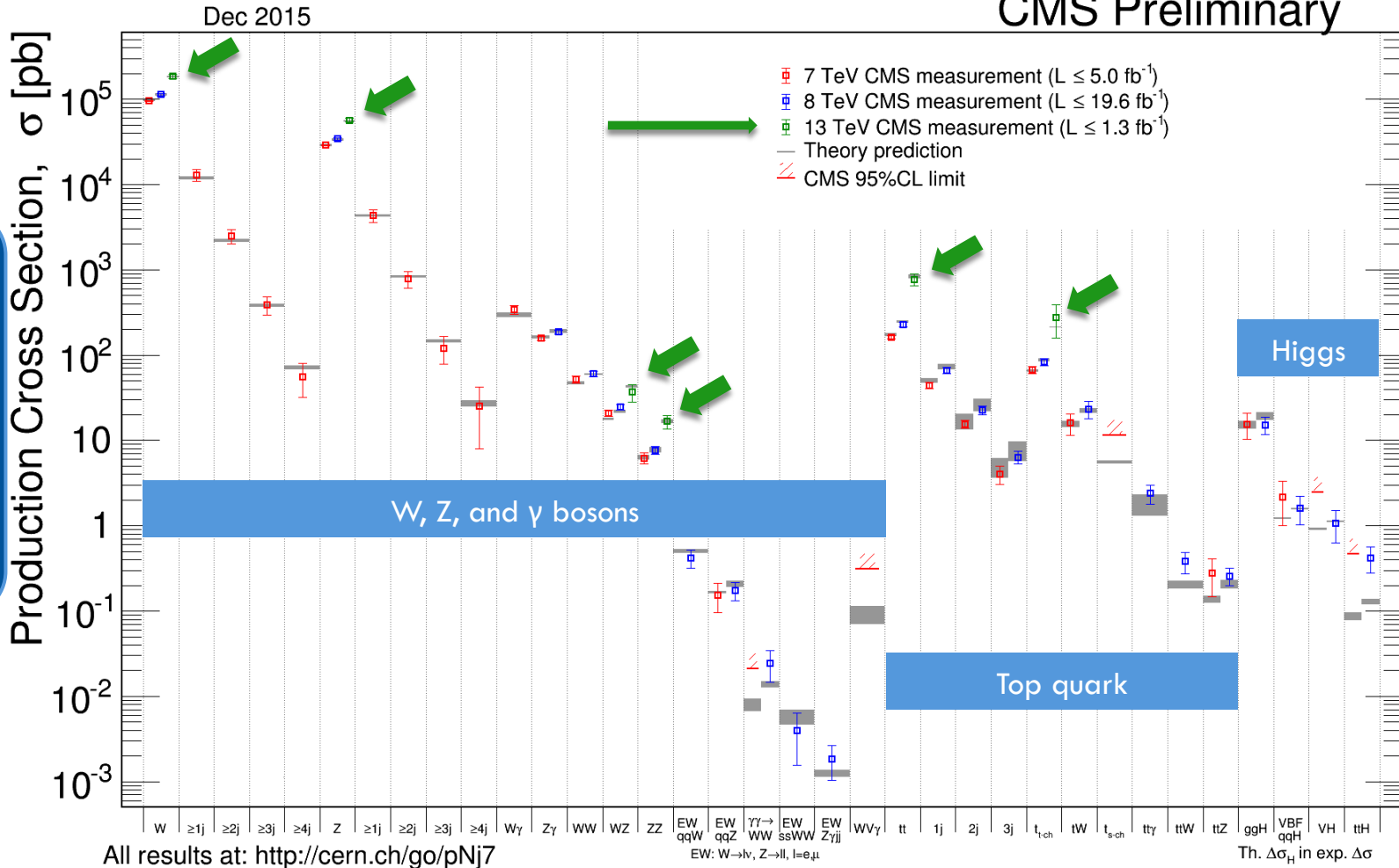
detector makers & theory calculators



Inelastic collisions: $\sim 7 \times 10^{10}$

CMS Preliminary

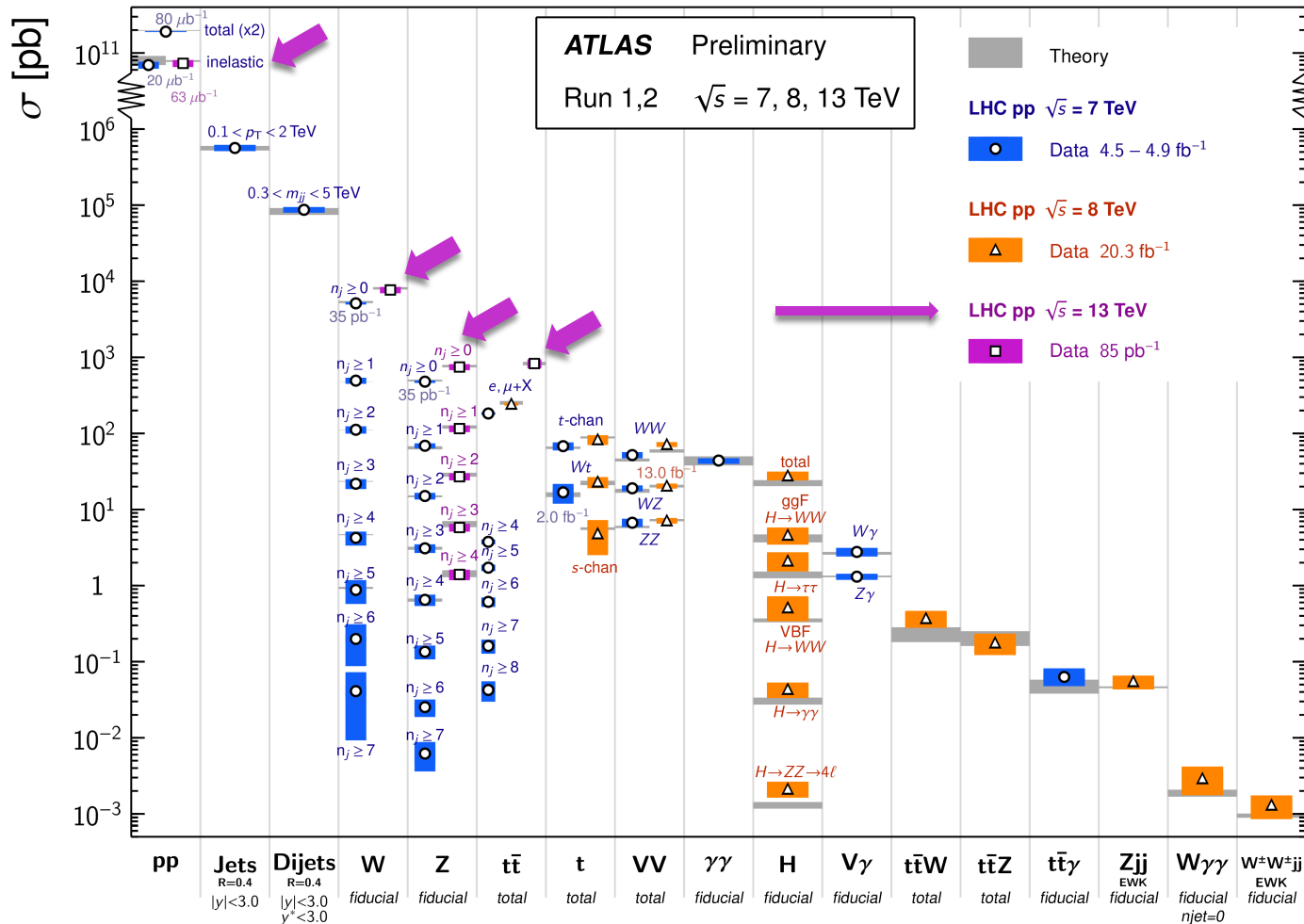
Eight orders of magnitude of EWK, top, and Higgs Physics



...on both sides of the ring

Standard Model Production Cross Section Measurements

Status: Nov 2015





47+ analyses on full 2015 dataset

20

[<http://cern.ch/go/hK8r>] [<http://cern.ch/go/Q77H>] [See also <https://indico.cern.ch/event/442432>]

ATLAS EXPERIMENT - Public Results

CONF notes of the ATLAS Collaboration

This page lists ATLAS CONF notes. This series of notes covers preliminary results using data.

See also: [List of ATLAS CONF notes by Group](#)

Full Title	Ref Code	Publication Date	Groups
A search for Supersymmetry in events containing a leptonically decaying Z boson, jets and missing transverse momentum in $\sqrt{s}=13\text{S}$ TeV pp collisions with the ATLAS detector	ATLAS-CONF-2015-082.pdf	2015/12/15	SUSY
Search for resonances decaying to photon pairs in 3.2fb^{-1} of pp collisions at $\sqrt{s} = 13\text{ TeV}$ with the ATLAS detector	ATLAS-CONF-2015-081.pdf	2015/12/15	EXOT / HIGG
Search for dark matter produced in association with a hadronically decaying vector boson in pp collisions at $\sqrt{s} = 13\text{ TeV}$ with the ATLAS detector at the LHC	ATLAS-CONF-2015-080.pdf	2015/12/15	EXOT
Measurement of the inclusive cross-section of single top-quark t-channel production in pp collisions at $\sqrt{s} = 13\text{ TeV}$	ATLAS-CONF-2015-079.pdf	2015/12/15	TOPQ
Search for supersymmetry at $\sqrt{s}=13\text{ TeV}$ in final states with jets and two same-sign leptons or three leptons with the ATLAS detector	ATLAS-CONF-2015-078.pdf	2015/12/14	SUSY
Search for new phenomena in final states with large jet multiplicities and missing transverse momentum with ATLAS using $\sqrt{s}=13\text{ TeV}$ proton-proton collisions	ATLAS-CONF-2015-077.pdf	2015/12/14	SUSY
Search for gluinos in events with an isolated lepton, jets and missing transverse momentum at $\sqrt{s} = 13\text{S}$ TeV with the ATLAS detector	ATLAS-CONF-2015-076.pdf	2015/12/15	SUSY
Search for WW/Z resonance production in the $\text{S}^0\text{N}u\text{qq}^{\text{S}}$ final state at $\sqrt{s}=13\text{S}$ TeV with the ATLAS detector at the LHC	ATLAS-CONF-2015-075.pdf	2015/12/14	EXOT / HIGG
Search for new physics in VH resonances at 13 TeV	ATLAS-CONF-2015-074.pdf	2015/12/14	EXOT / HIGG
Search for resonances with boson-tagged jets in $3.2\text{fb}^{\text{S}}(\text{t}^{\text{S}})$ of pp collisions at $\sqrt{s}=13\text{S}$ TeV collected with the ATLAS detector	ATLAS-CONF-2015-073.pdf	2015/12/15	EXOT / HIGG
Search for beyond the Standard Model phenomena in $\text{S}e\text{I}\mu\text{u}^{\text{S}}$ final states in Spp^{S} collisions at $\sqrt{s}=13\text{S}$ TeV with the ATLAS detector	ATLAS-CONF-2015-072.pdf	2015/12/14	EXOT
Search for diboson resonances in the $\text{S}^0\text{V}\ell\text{ll}^{\text{S}}$ final state in Spp^{S} collisions at $\sqrt{s}=13\text{S}$ TeV with the ATLAS detector	ATLAS-CONF-2015-071.pdf	2015/12/15	EXOT / HIGG
"Search for new phenomena in the dilepton final state using proton-proton collisions at $\sqrt{s} = 13\text{ TeV}$ with the ATLAS detector"	ATLAS-CONF-2015-070.pdf	2015/12/14	EXOT
Measurements of the total cross sections for Higgs boson production combining the $\text{H} \rightarrow \gamma\gamma$ and $\text{H} \rightarrow \text{ZZ}^* \rightarrow 4\text{t}$ decay channels at 7, 8 and 13 TeV center-of-mass energies with the ATLAS detector	ATLAS-CONF-2015-069.pdf	2015/12/14	HIGG / HIGG
Search for diboson resonances in the $\text{S}^0\text{N}u\text{nu}\text{qq}^{\text{S}}$ final state in Spp^{S} collisions at $\sqrt{s}=13\text{S}$ TeV with the ATLAS detector	ATLAS-CONF-2015-068.pdf	2015/12/15	EXOT / HIGG
Search for gluino-mediated stop and sbottom pair production in events with b-jets and large missing transverse momentum in $\sqrt{s}=13\text{ TeV}$ pp collisions with the ATLAS detector	ATLAS-CONF-2015-067.pdf	2015/12/14	SUSY
Search for Bottom Squark Pair Production with the ATLAS Detector in proton-proton Collisions at $\sqrt{s}=13\text{S}$ TeV	ATLAS-CONF-2015-066.pdf	2015/12/14	SUSY
Measurement of jets produced in top quark events using the di-lepton final state with 2 Sb^{S} -tagged jets in p p collisions at $\sqrt{s}=13\text{ TeV}$ with the ATLAS detector	ATLAS-CONF-2015-065.pdf	2015/12/15	TOPQ
$\text{Sb}^0\text{p}^{\text{S}}$ mass reconstruction in $\text{Sb}^0\text{p}^{\text{S}} \rightarrow \text{J}\psi\text{K}^0\text{p}^{\text{S}}$ decay at ATLAS at 13 TeV Spp^{S} collisions at the LHC	ATLAS-CONF-2015-064.pdf	2015/12/14	BPHY
Search for new resonances in events with one lepton and missing transverse momentum in pp collisions at $\sqrt{s} = 13\text{ TeV}$ with the ATLAS detector	ATLAS-CONF-2015-063.pdf	2015/12/15	EXOT
Search for squark and gluinos in final states with jets and missing transverse momentum at $\sqrt{s} = 13\text{ TeV}$ with the ATLAS detector	ATLAS-CONF-2015-062.pdf	2015/12/14	SUSY
Search for Neutral Minimal Supersymmetric Standard Model Higgs Bosons $\text{H}/\text{A} \rightarrow \tau\tau$ produced in pp collisions at $\sqrt{s} = 13\text{ TeV}$ with the ATLAS Detector	ATLAS-CONF-2015-061.pdf	2015/12/14	HIGG / EXOT
Measurement of the Higgs boson production cross section at 7, 8 and 13 TeV center-of-mass energies in the $\text{H} \rightarrow \gamma\gamma$ channel with the ATLAS detector	ATLAS-CONF-2015-060.pdf	2015/12/15	HIGG
Measurement of the fiducial cross sections of the Higgs boson and search for new physics in the $\text{ZZ}^* \rightarrow 4\text{t}$ final state with ATLAS using 2015 LHC pp collisions	ATLAS-CONF-2015-059.pdf	2015/12/14	HIGG

CMS Physics Results in Proton-Proton Collisions at 13 TeV

Forward Physics and Small-x QCD

- Pseudorapidity Distributions of Charged Hadrons
- Two-Particle Correlations (the "Ridge")
- Underlying Event

Standard Model

- Inclusive Jet Production
- Inclusive W and Z Production
- Z+jets Differential Cross Section
- WZ Production Cross Section
- ZZ Production Cross Section

Heavy Flavours

- B Production Cross Section

Top Quark

- Inclusive $t\bar{t}$ Cross Section in Dileptons
- Inclusive and Differential $t\bar{t}$ Cross Sections in $\ell^+\ell^-$ jets
- Differential $t\bar{t}$ Cross Sections in Dileptons
- Differential $t\bar{t}$ Distributions as a Function of Event Variables
- Underlying Event Measurements in $t\bar{t}+X$ Events
- Single Top-Quark Cross Section

125-GeV Higgs Boson

- Performance Studies

Search for Supersymmetry

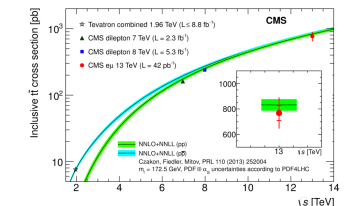
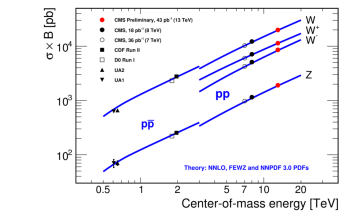
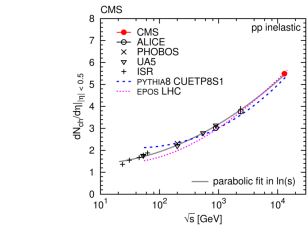
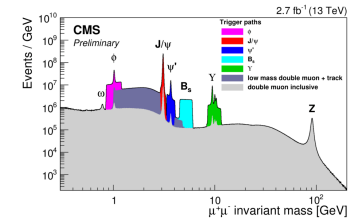
- Supersymmetry in Multijet + Missing E_T
- Supersymmetry in All-Hadronic Using M_{T2}
- Supersymmetry in All-Hadronic Using α_T
- Supersymmetry in All-Hadronic Using Razor Variables
- Supersymmetry in One-Lepton Events Using Large Radius Jets
- Supersymmetry in Same-Sign Dilepton Events
- Supersymmetry in Opposite-Sign Dilepton Events

Search for Exotic Phenomena

- Search for Resonances in Dijet Events
- Search for Quark Compositeness in Dijet Events
- Search for Z' in Dilepton Events
- Search for W' in Lepton+ E_T^{miss} Events
- Search for Resonances in Diphoton Events
- Search for Resonances in Diboson Events
- Search for Dark Matter in Monojet Events
- Search for Quantum Black Holes
- Search for Heavy Stable Charged Particles

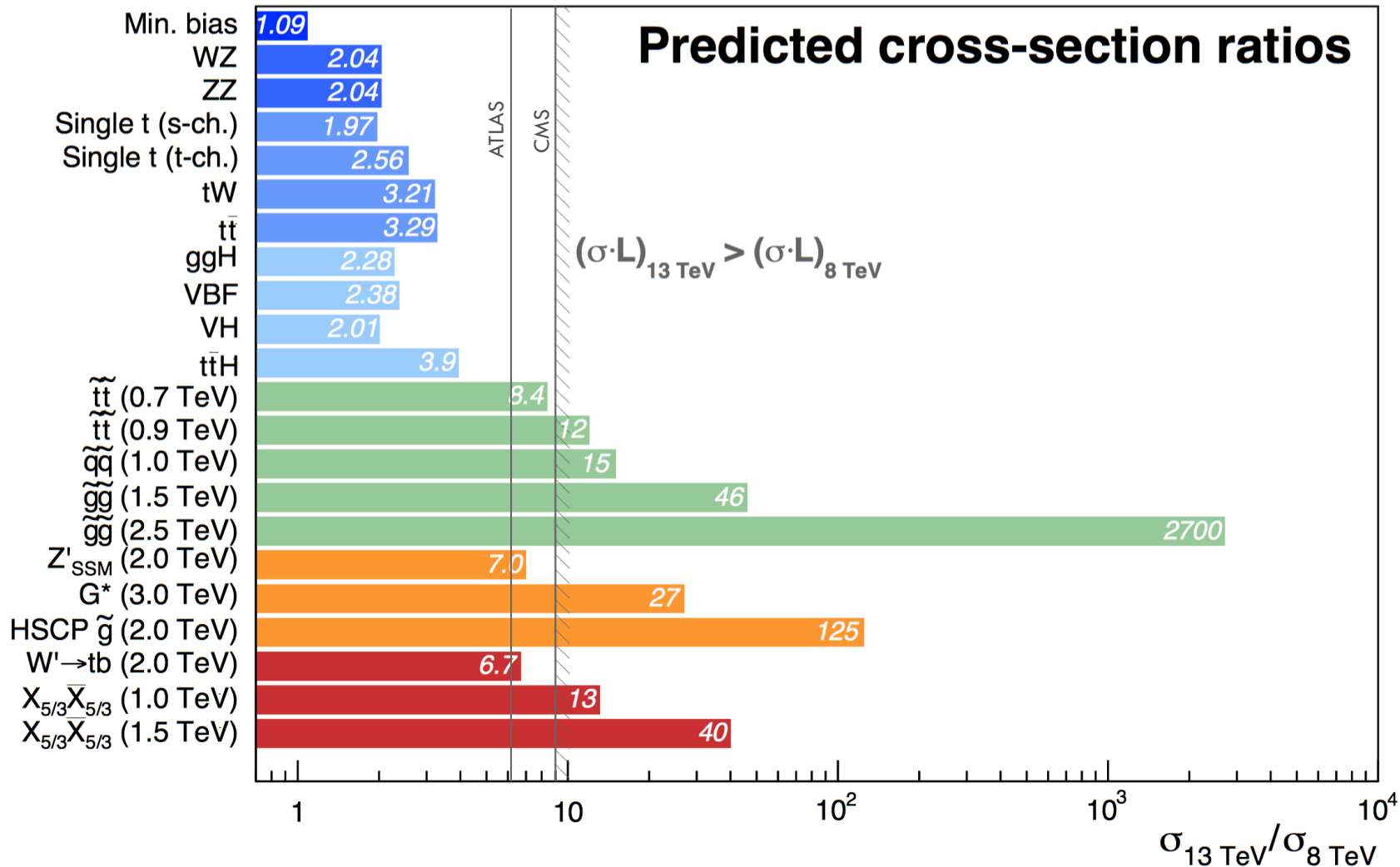
Search for Exotic Phenomena (Topologies with Heavy Quarks)

- Search for W' in $t\bar{t}$ Events
- Search for $X_{5/3}$ in SS Dilepton and Lepton+Jets Events

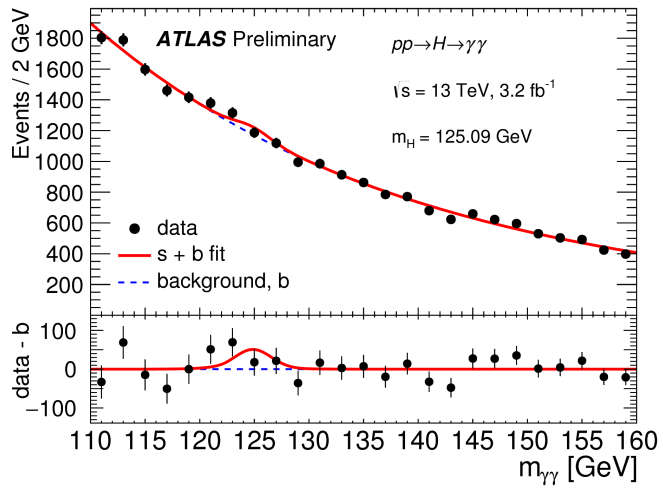


Cannot cover all. Focus on new reach and previous or new "hints".

Where 2015 goes beyond Run 1



h(125) in ATLAS

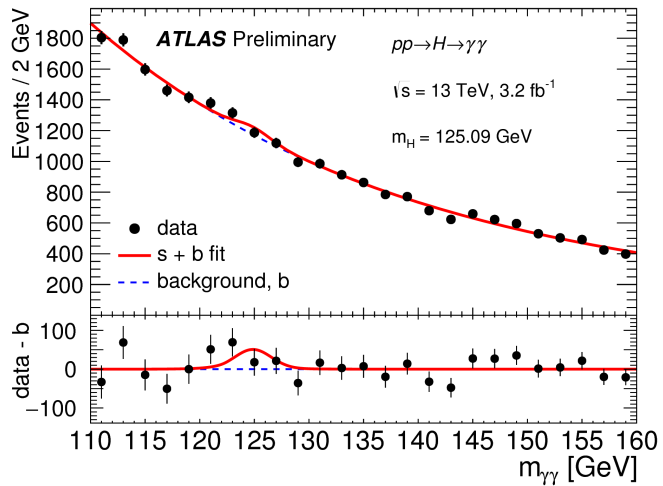


1.5 σ obs.
(1.9 σ exp.)

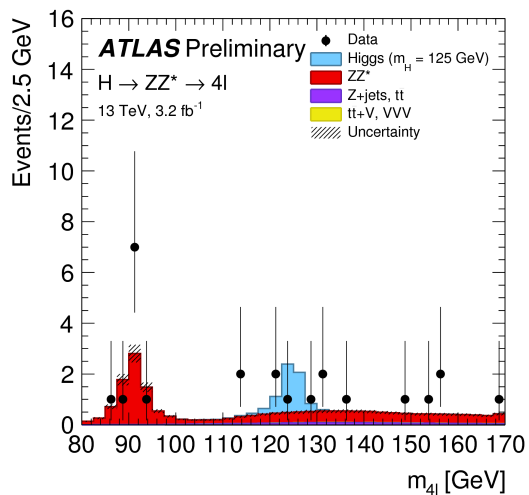


h(125) in ATLAS

23



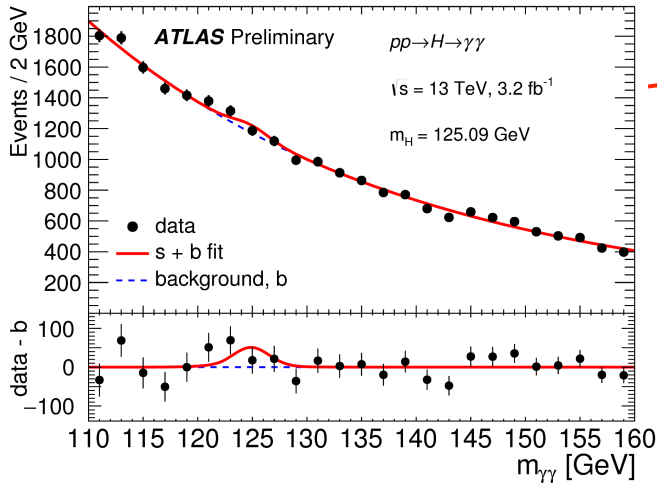
1.5 σ obs.
(1.9 σ exp.)



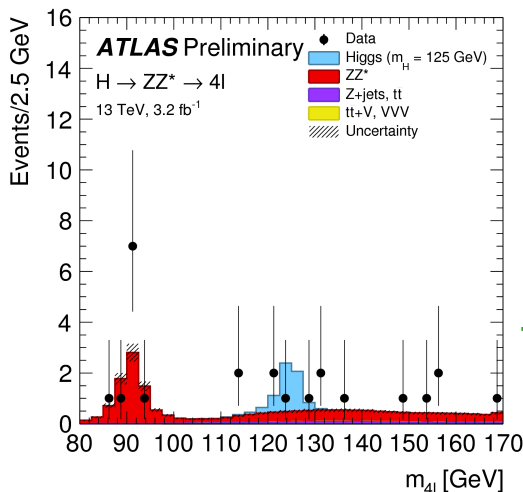
0.7 σ obs.
(2.8 σ exp.)



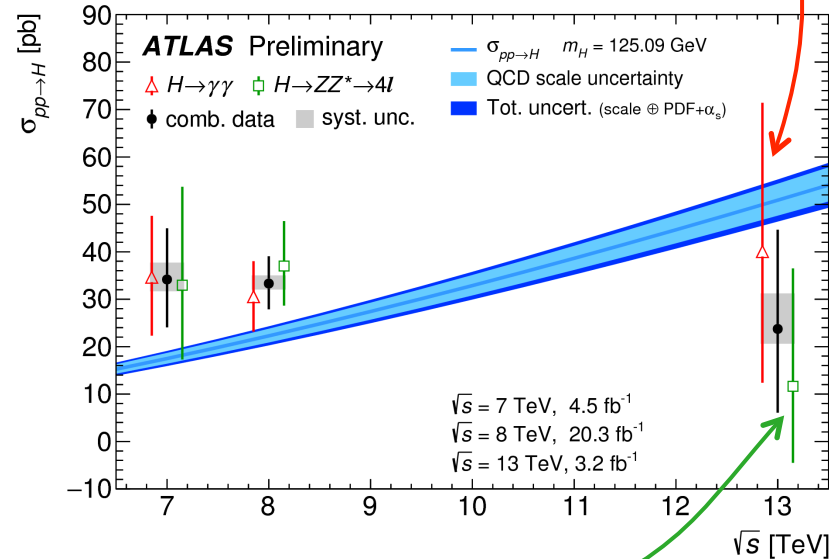
h(125) in ATLAS



1.5 σ obs.
(1.9 σ exp.)



0.7 σ obs.
(2.8 σ exp.)

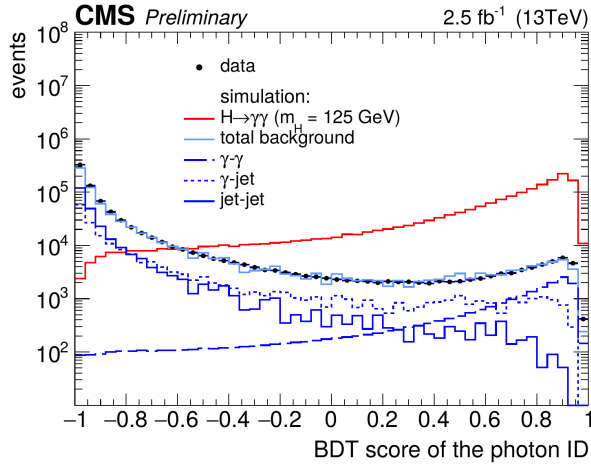


1.4 σ obs.
(3.4 σ exp.)
(-1.3 σ to SM)

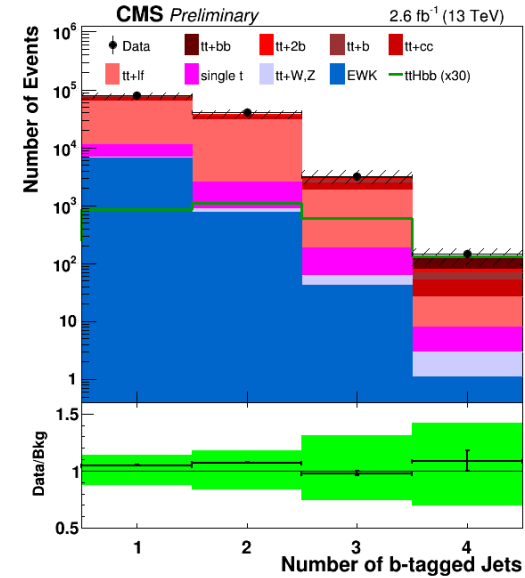
Towards $h(125)$ in CMS



25

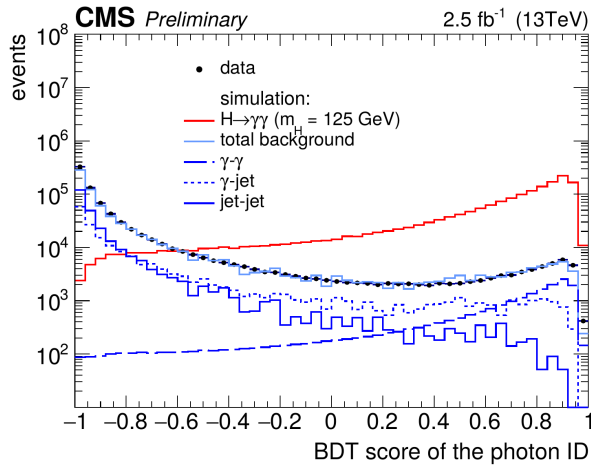


$H \rightarrow \gamma\gamma$: Photon identification score in diphoton events.

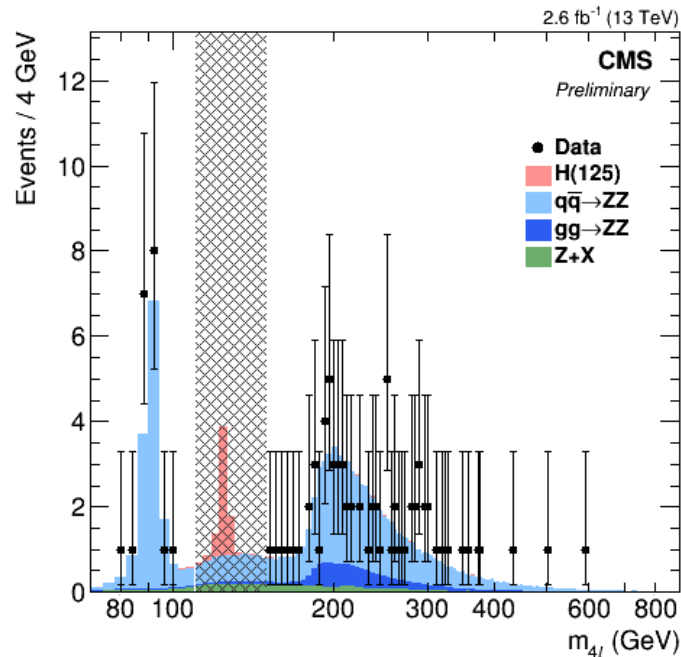


ttH , $H \rightarrow bb$: multiplicity of b-tagged jets.

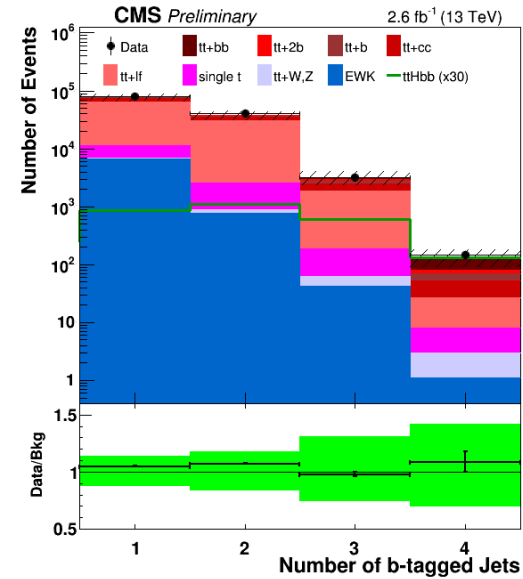
Towards $h(125)$ in CMS



$H \rightarrow \gamma\gamma$: Photon identification score in diphoton events.



$H \rightarrow ZZ$: four-lepton mass distribution; $Z \rightarrow 4\ell$ peak and on-shell ZZ turn-on visible.

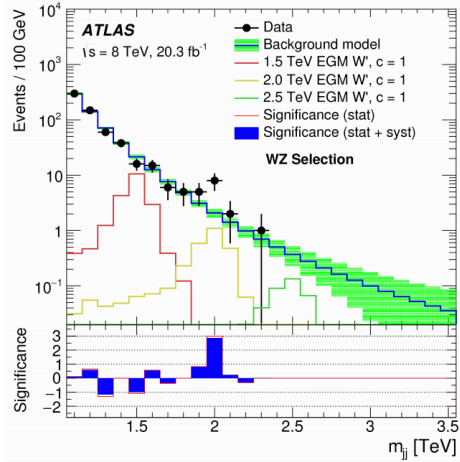


$ttH, H \rightarrow bb$: multiplicity of b-tagged jets.

Diboson resonance searches

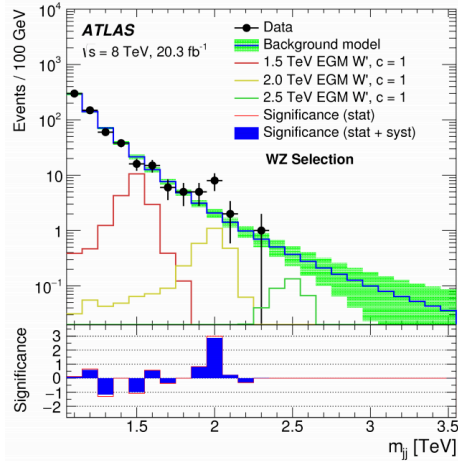


27



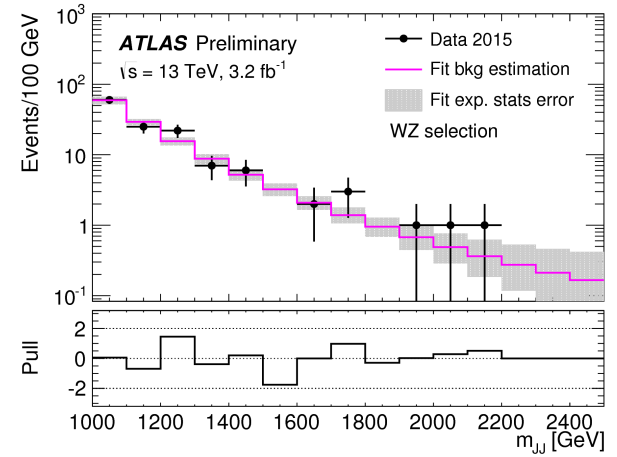
8 TeV
For $m \sim 2 \text{ TeV}$
 $3.4\sigma \rightarrow 2.5\sigma$ after LEE

Diboson resonance searches

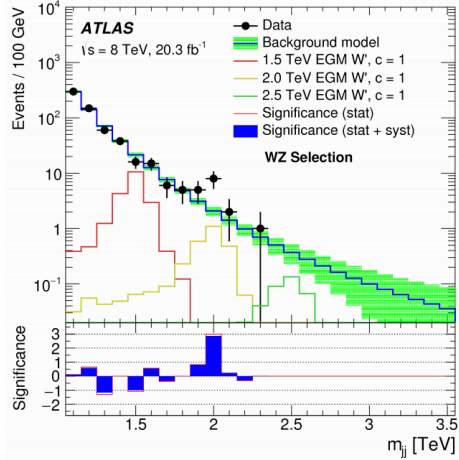


8 TeV
 For $m \sim 2$ TeV
 $3.4\sigma \rightarrow 2.5\sigma$ after LEE

13 TeV
 No significant excess,
 but not conclusive.

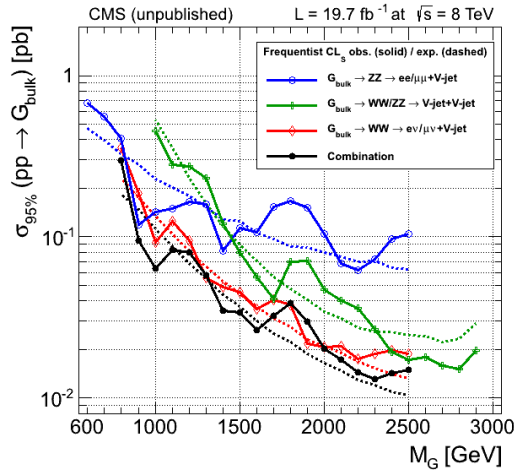
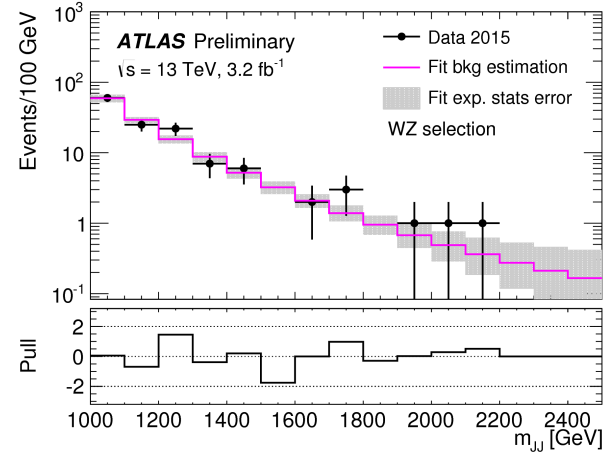


Diboson resonance searches



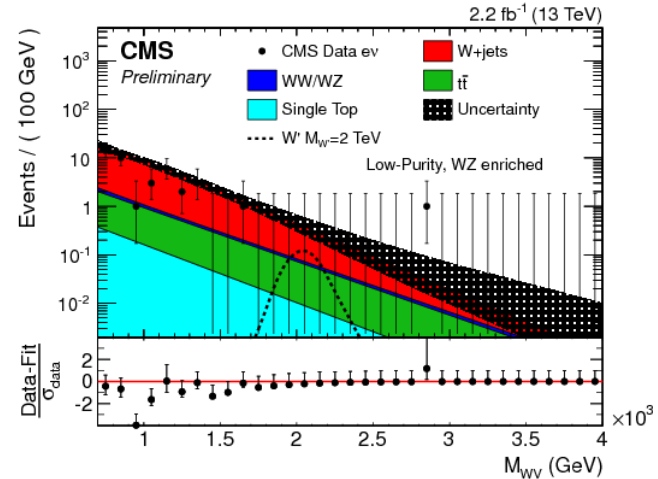
8 TeV
 For $m \sim 2 \text{ TeV}$
 $3.4\sigma \rightarrow 2.5\sigma$ after LEE

13 TeV
 No significant excess,
 but not conclusive.



8 TeV
 For $m \sim 1.8 \text{ TeV}$
 $\sim 2\sigma$

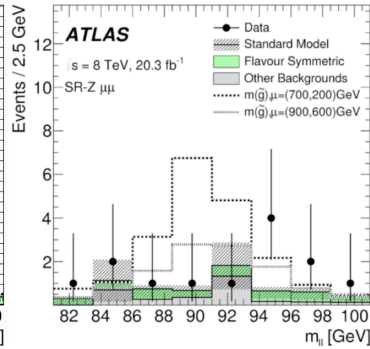
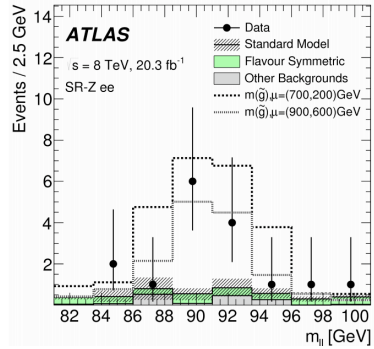
13 TeV
 No significant excess,
 but not conclusive.





SUSY opposite-sign dileptons

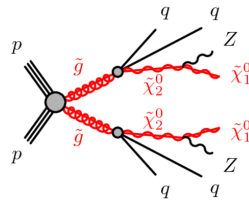
30



8 TeV [arXiv:1503.03290]

on-Z

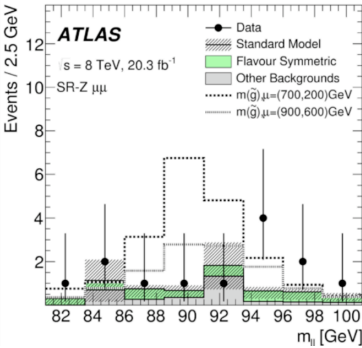
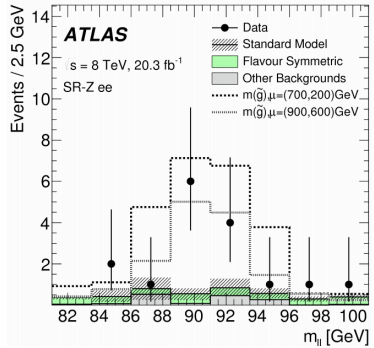
3.0 σ only in ATLAS



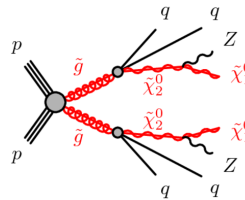
SUSY opposite-sign dileptons



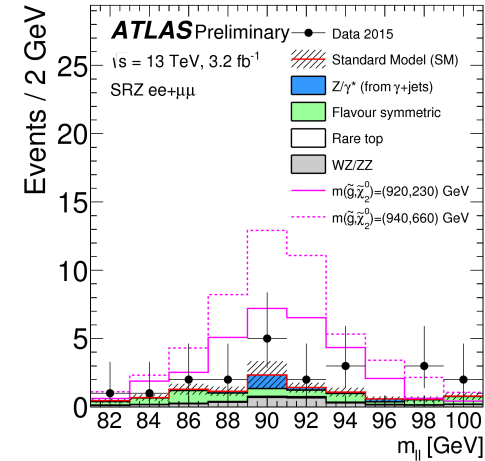
31



8 TeV [arXiv:1503.03290]
on-Z
3.0 σ only in ATLAS



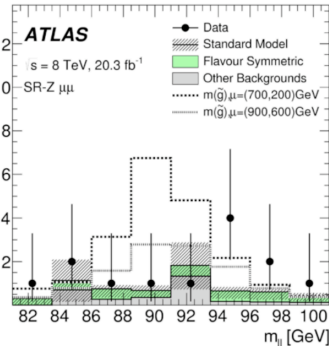
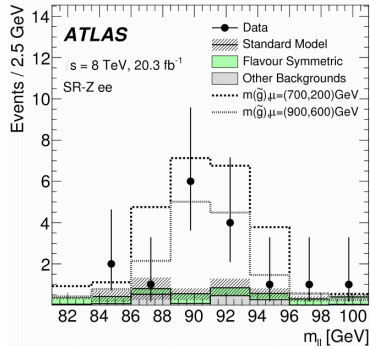
13 TeV
21 obs. (10.3 ± 2.3 exp.): **2.2 σ**



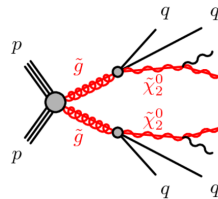


SUSY opposite-sign dileptons

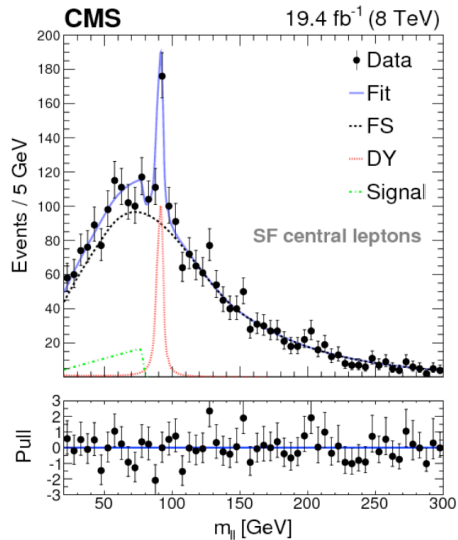
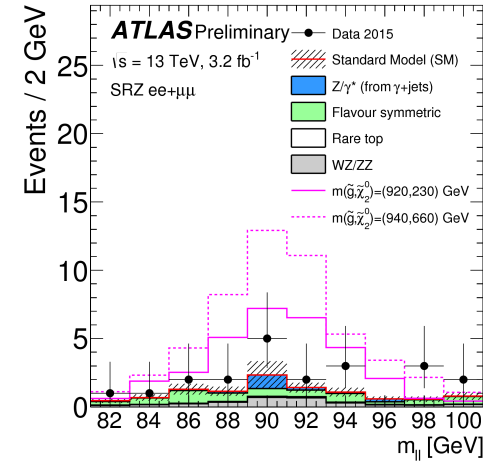
32



8 TeV [arXiv:1503.03290]
 on-Z
3.0 σ only in ATLAS

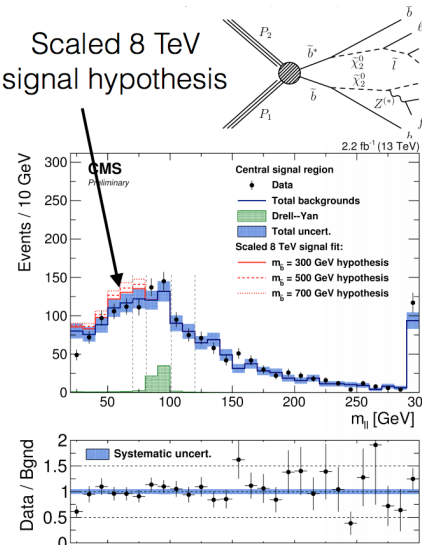


13 TeV
 21 obs. (10.3 ± 2.3 exp.): **2.2 σ**



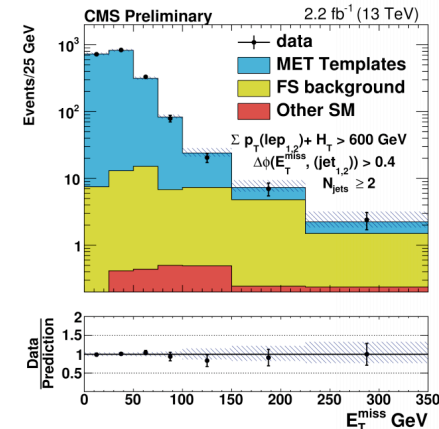
8 TeV [arXiv:1502.06031]
 Below Z
2.6 σ only in CMS

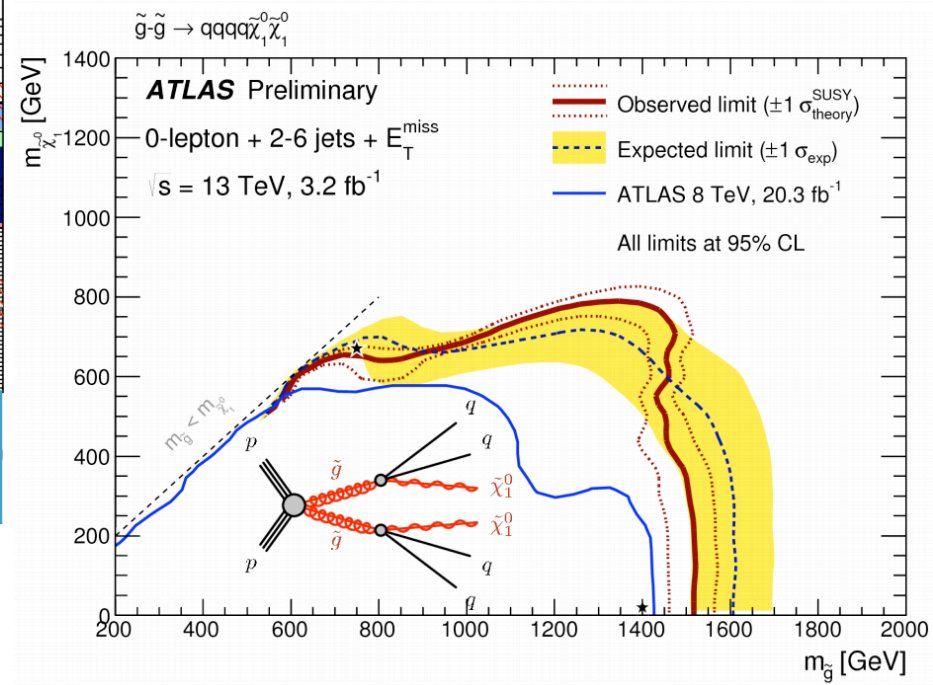
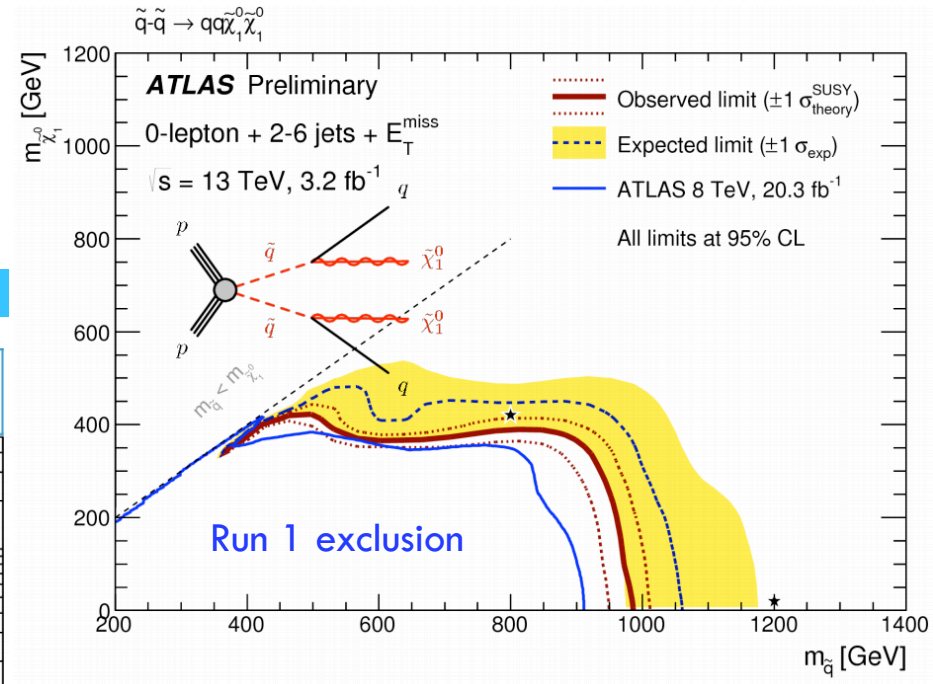
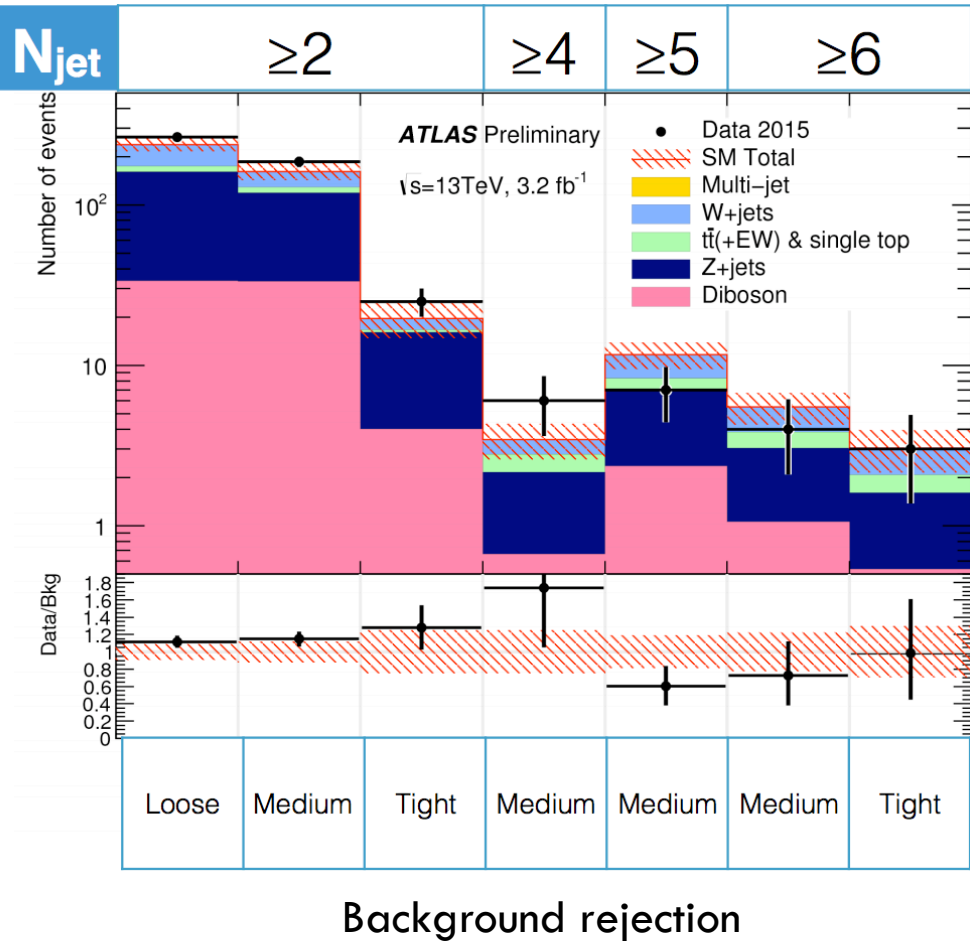
Scaled 8 TeV signal hypothesis



13 TeV
 Both 8 TeV
 excesses
 disfavored

No excess seen
 with ATLAS selection

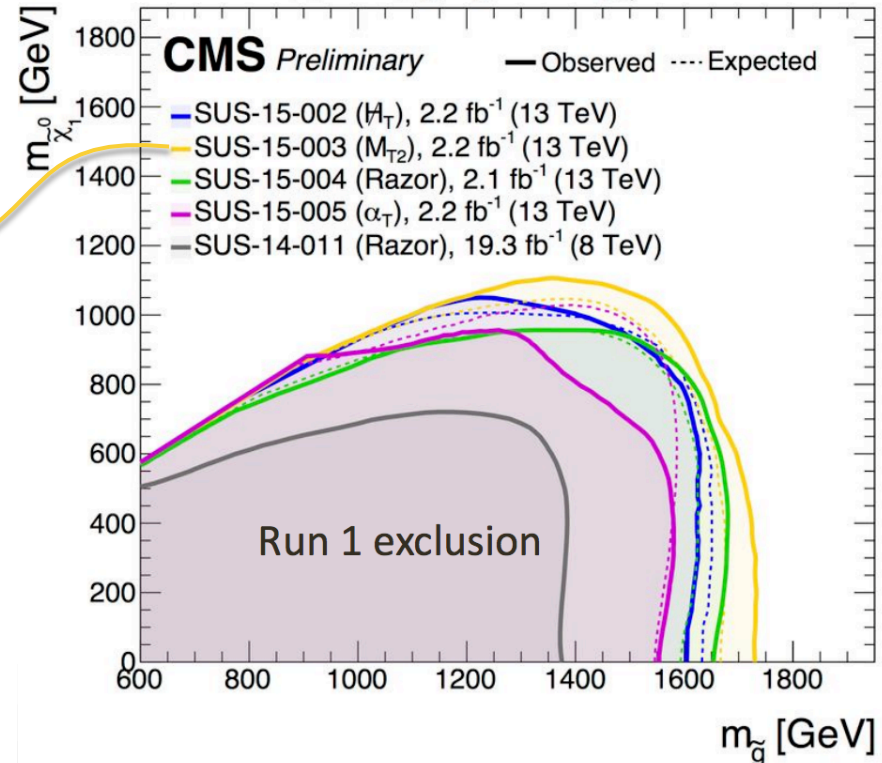
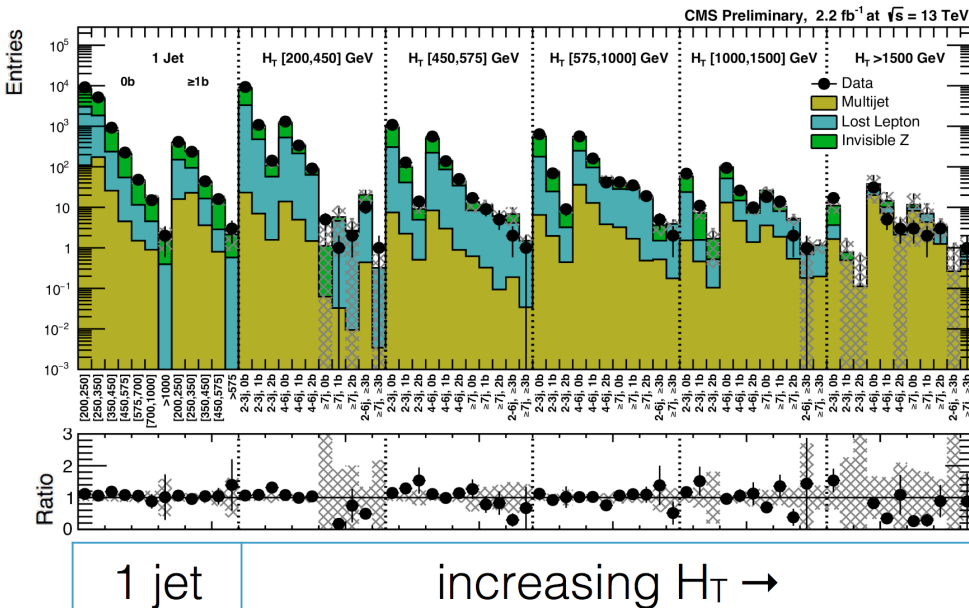




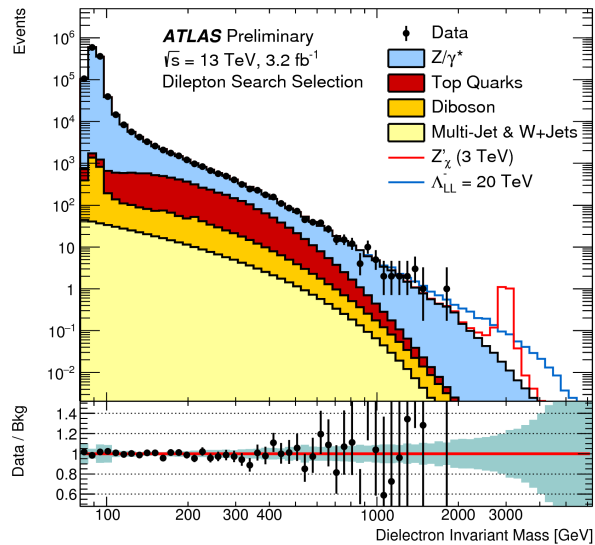
- Multiple analyses: M_{H_T} , H_T , M_{T2} , Razor, α_T .
- M_{T2} analysis in bins of H_T , N_i , N_b .

$pp \rightarrow \tilde{g}\tilde{g}, \tilde{g} \rightarrow b\bar{b}\tilde{\chi}_1^0$ Dec 2015

For each topological region below, bins in M_{T2}

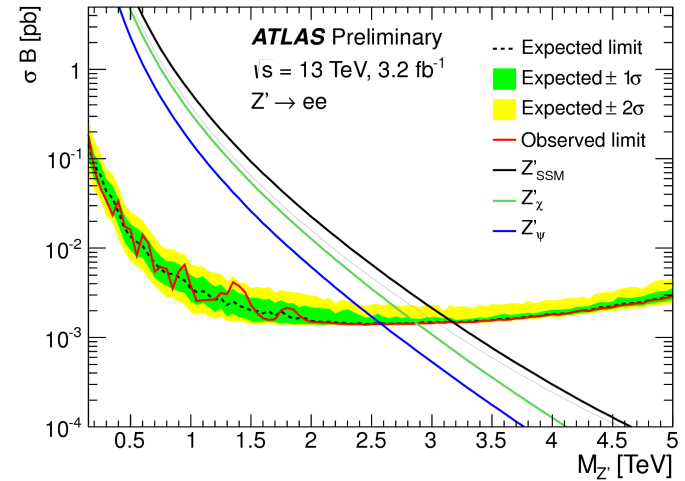
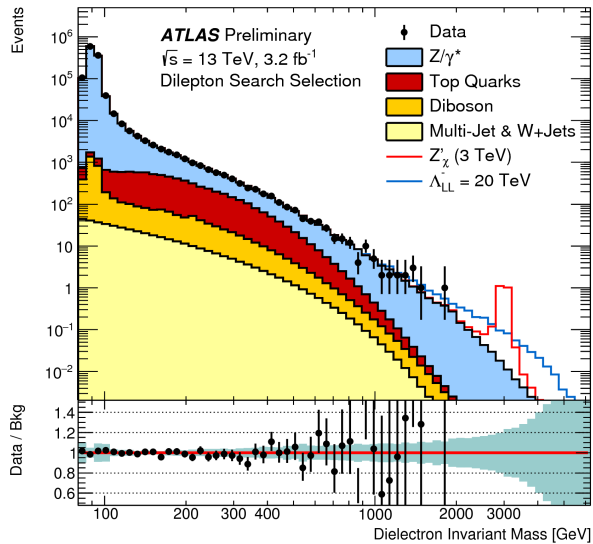


Dielectron resonance searches



Dielectron resonance searches

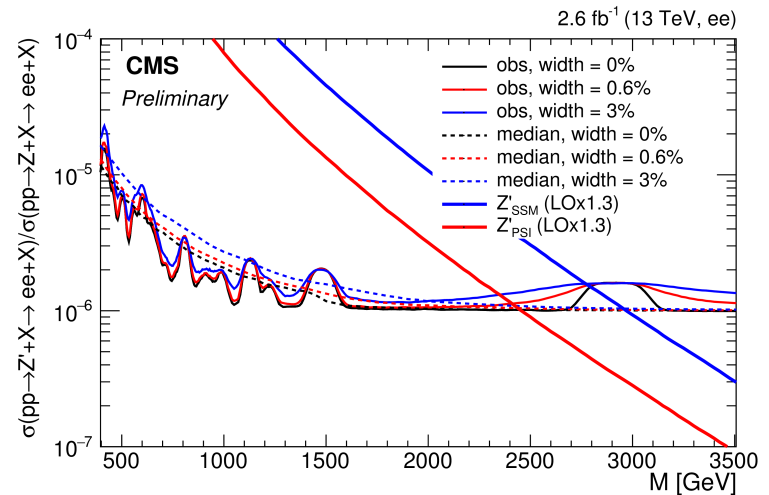
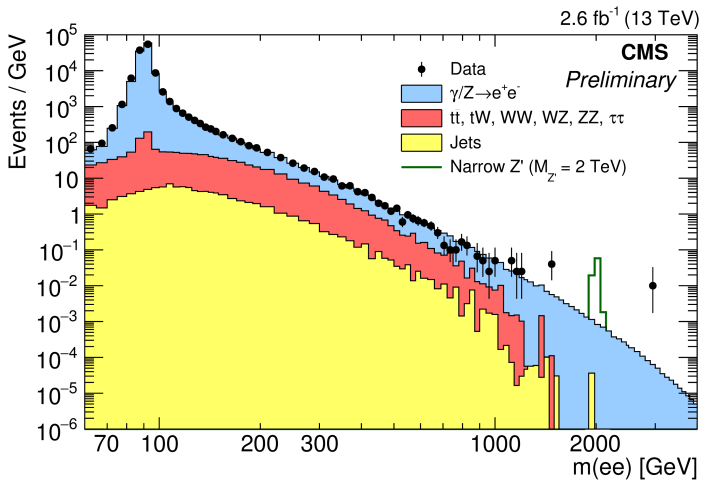
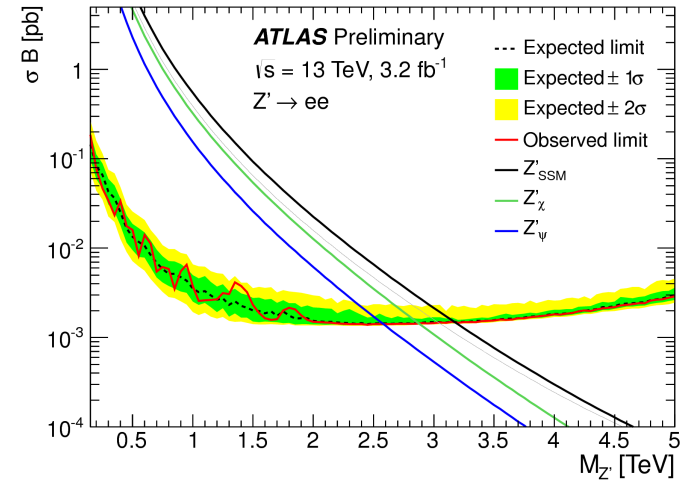
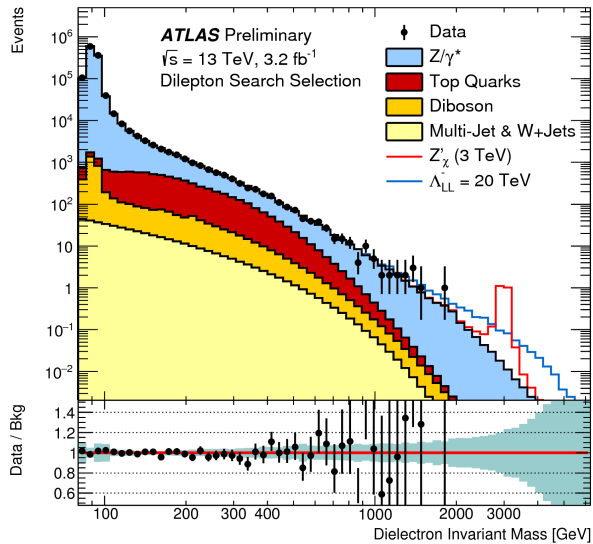
Similarly for dimuons.



Dielectron resonance searches



Similarly for dimuons.

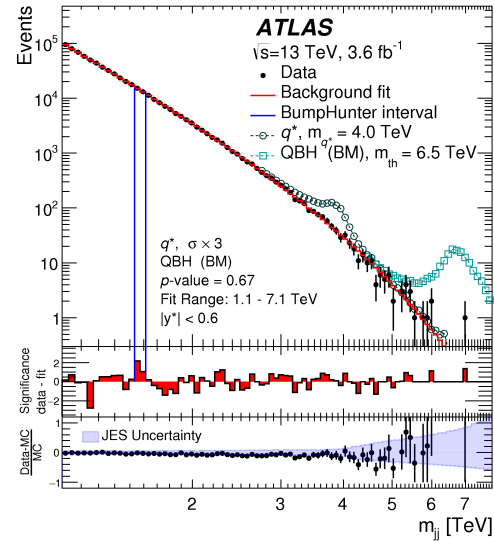


Dijet resonance searches



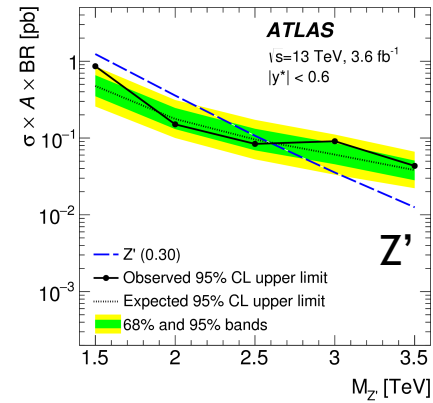
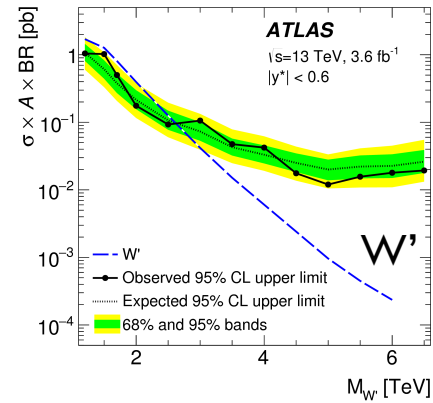
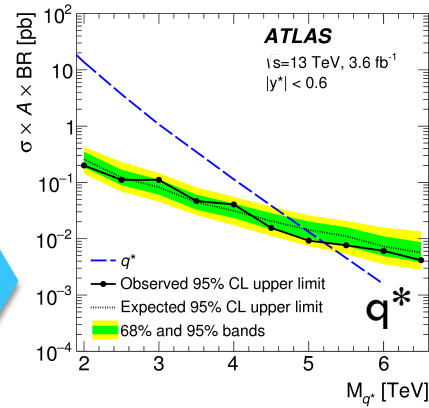
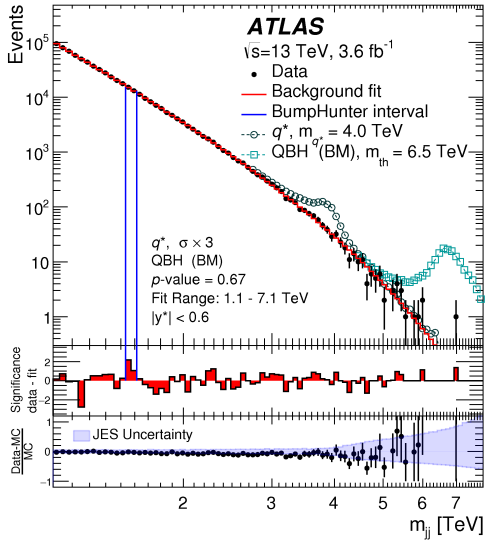
38

[arXiv:1512.01530] [arXiv:1512.01224]

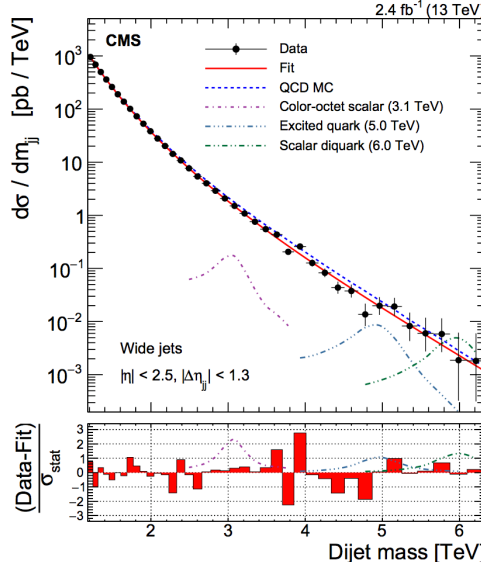
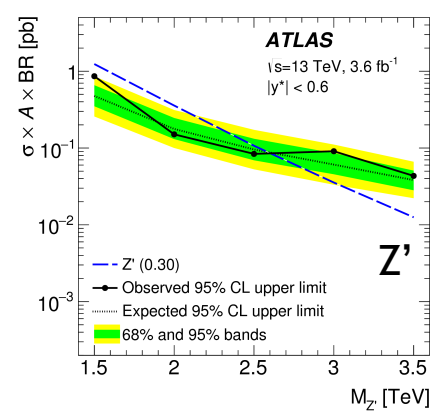
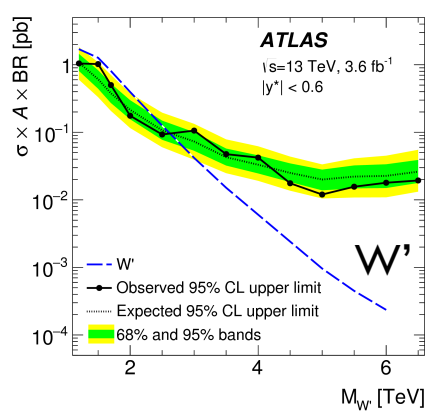
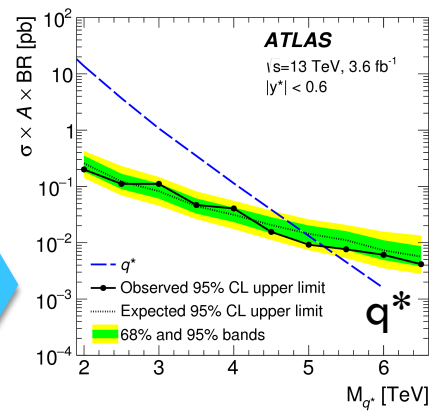
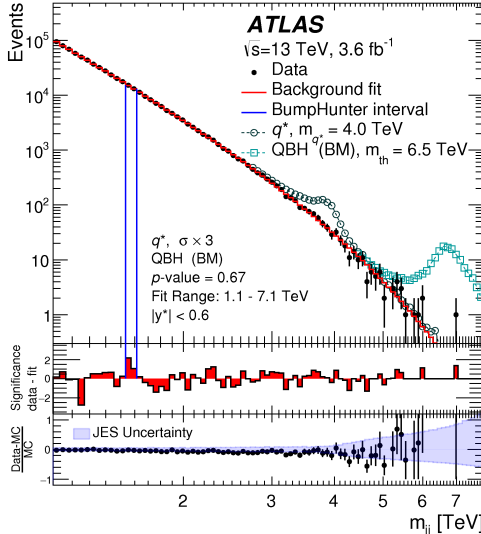


Z'

Dijet resonance searches



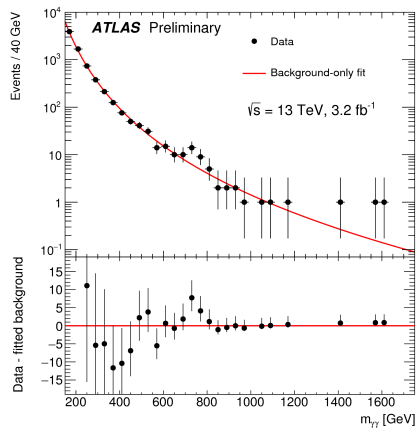
Dijet resonance searches



Resonance Type	Exclusion Range (TeV)
String	1.5 - 7.0
Scalar diquark	1.5 - 6.0
Axigluon/coloron	1.5 - 5.1
Excited quark	1.5 - 5.0
Color-octet scalar	1.5 - 3.1
W'	1.5 - 2.6

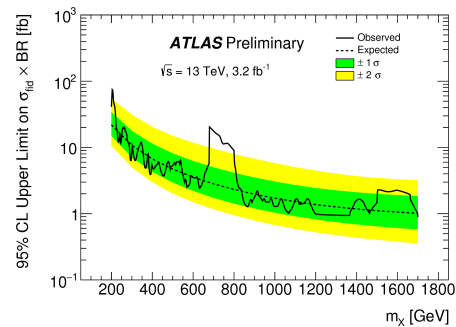
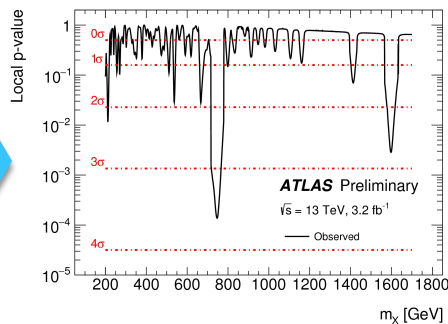
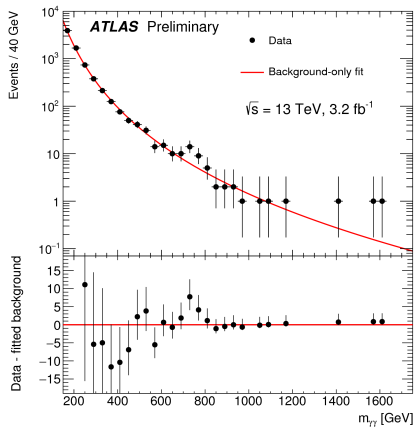
Legend: Green bars represent 20 fb⁻¹ (8 TeV), Red bars represent 2.4 fb⁻¹ (13 TeV).

Diphoton resonances



>90% prompt-prompt, $\sigma_m/m \sim 1\%$

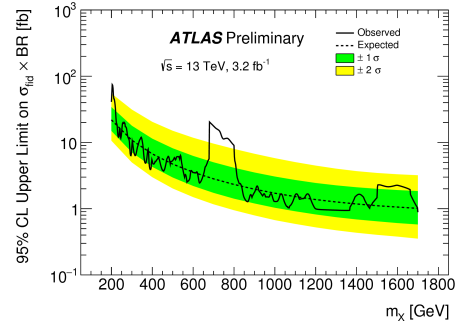
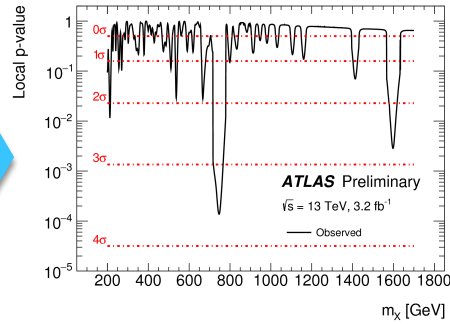
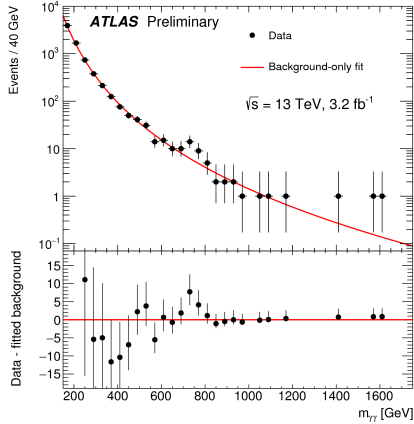
Diphoton resonances



>90% prompt-prompt, $\sigma_m/m \sim 1\%$

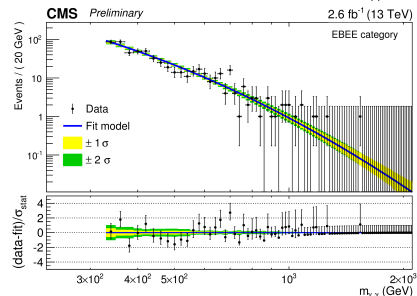
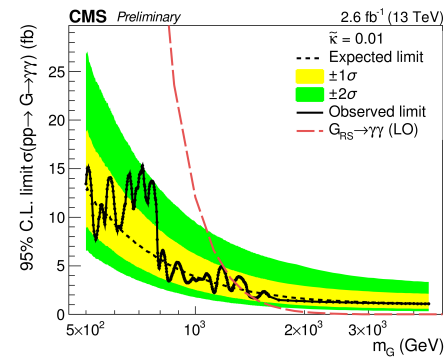
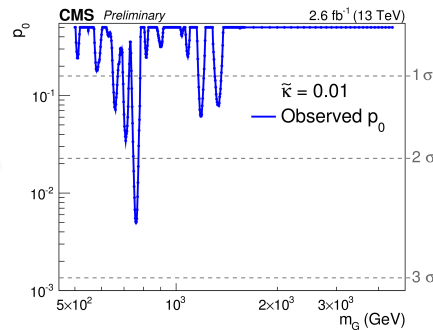
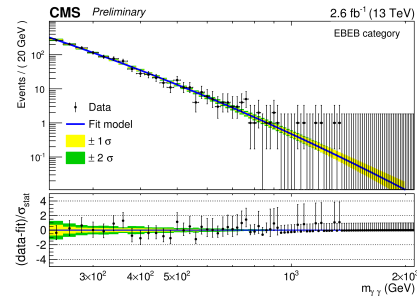
For $m_{\chi} = 750$ GeV
 $3.6\sigma \rightarrow 2.0\sigma$ after LEE
 ($3.9\sigma \rightarrow 2.3\sigma$ for $\Gamma = 6\%$)

Diphoton resonances



>90% prompt-prompt, $\sigma_m/m \sim 1\%$

For $m_{\chi} = 750$ GeV
 $3.6\sigma \rightarrow 2.0\sigma$ after LEE
 ($3.9\sigma \rightarrow 2.3\sigma$ for $\Gamma = 6\%$)



For $m_G = 760$ GeV
 $2.6\sigma \rightarrow 1.2\sigma$ after LEE



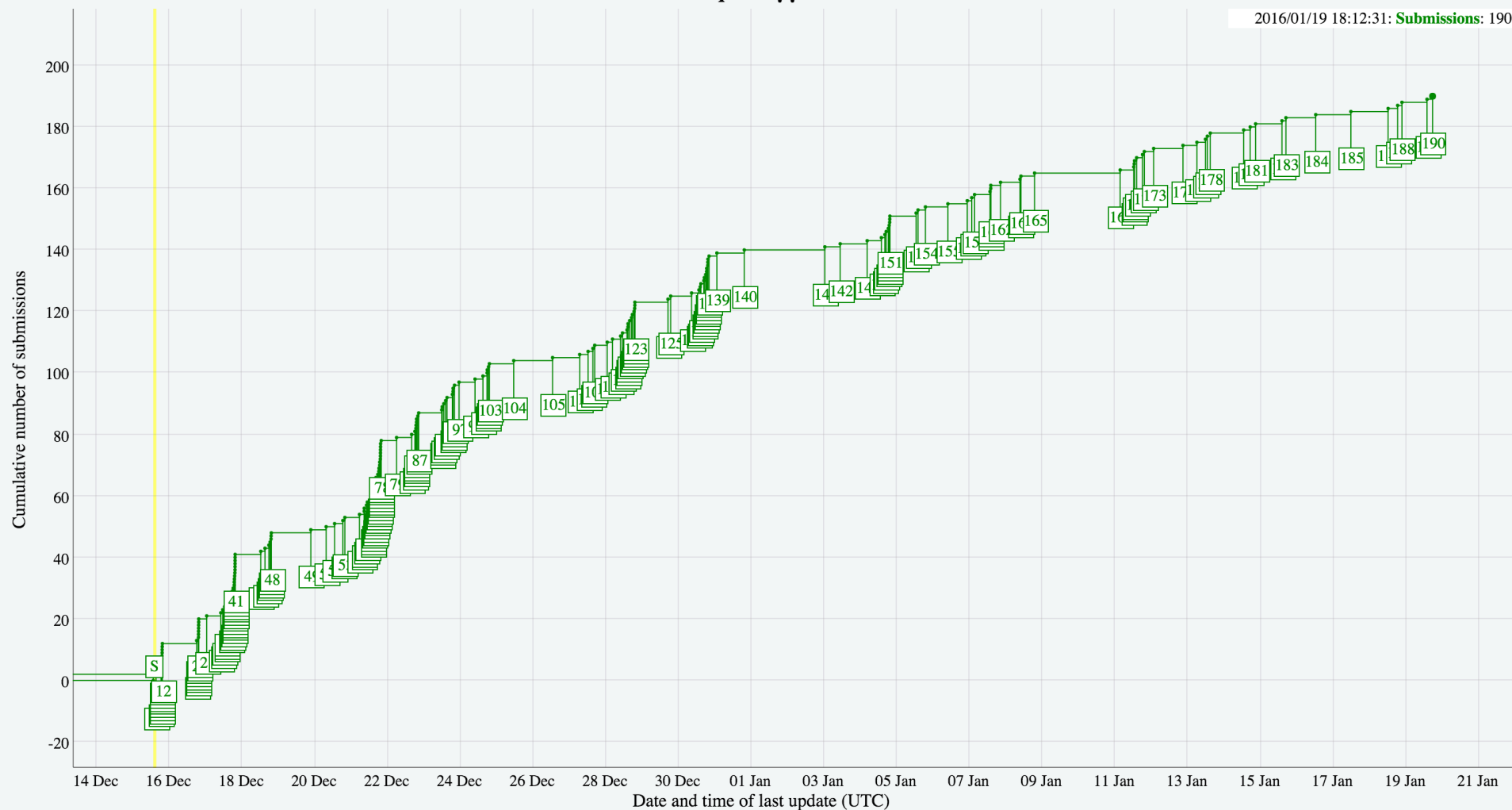
Post-seminar stampede

44

[<http://cern.ch/go/DZt8>]

#Run2Seminar and subsequent $\gamma\gamma$ -related arXiv submissions

2016/01/19 18:12:31: Submissions: 190

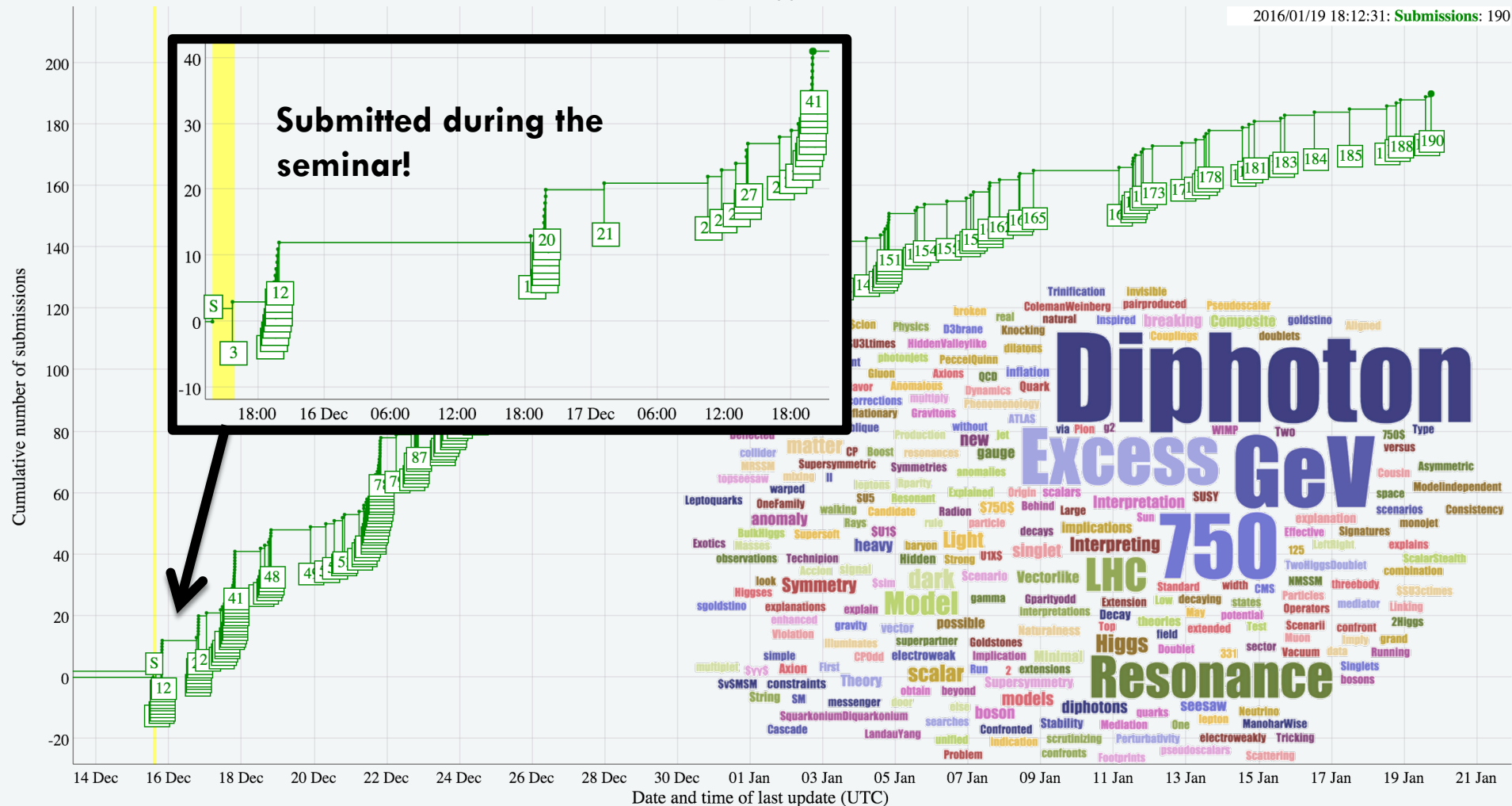




Post-seminar stampede

#Run2Seminar and subsequent $\gamma\gamma$ -related arXiv submissions

2016/01/19 18:12:31: **Submissions:** 190



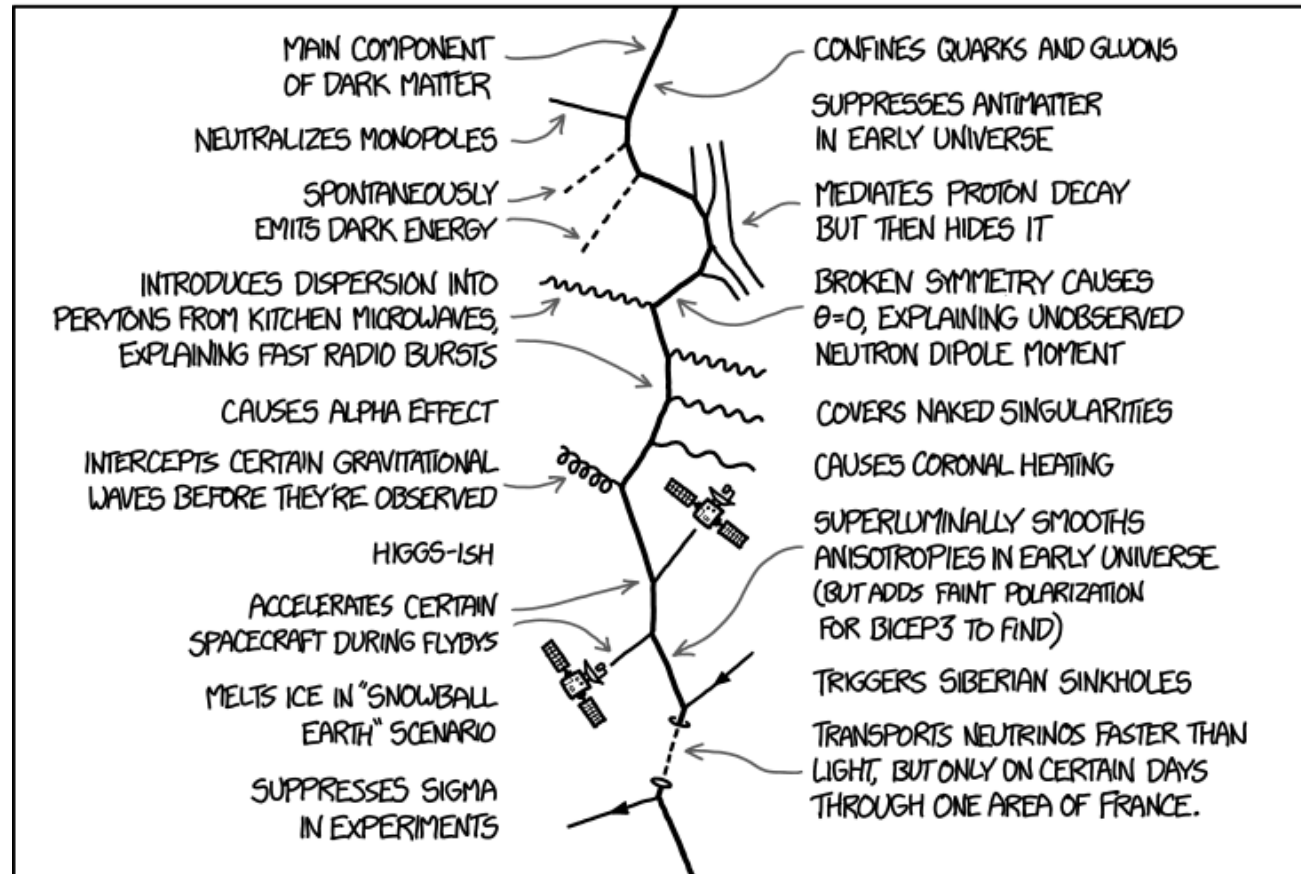
Perhaps a whole fixion sector?



A CHRISTMAS GIFT FOR PHYSICISTS:

THE FIXION

A NEW PARTICLE THAT EXPLAINS EVERYTHING





Is it trivial to combine significances?

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[<http://cern.ch/go/9spl>]

Mythology of Two Data Sets

Very common myth re bump-hunting:

Look for bump in one data set (or one experiment), and identify candidate bump and its location in spectrum. Then in the next data set (or other experiment), look in same location. *Then no LEE correction needed.*

This is “bad” on several levels, and the Gross-Vittels paper gives another reason why.

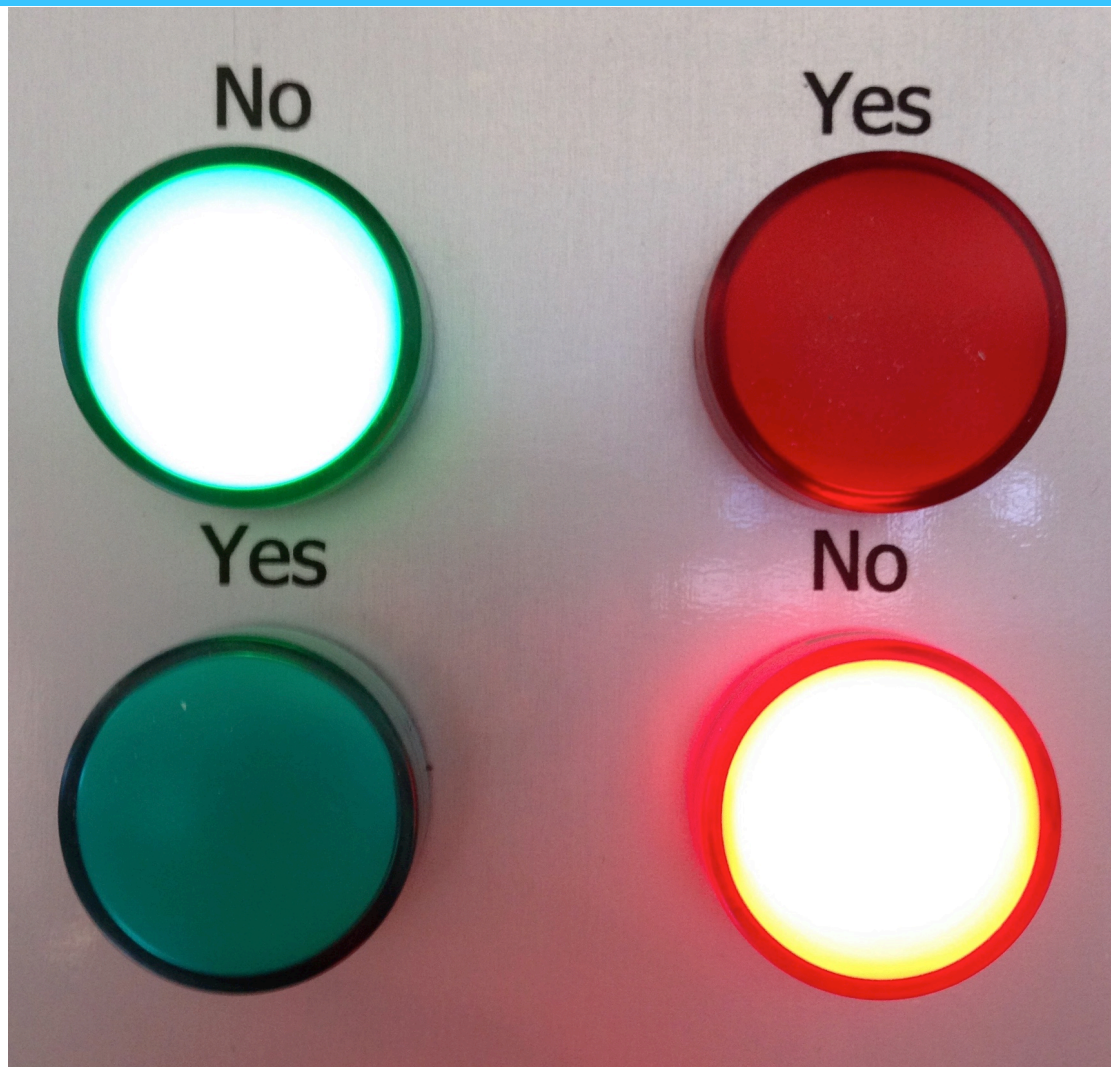
This is presumably known to experts, but I think it is useful to advertize, given the persistence of the myth.

Bob Cousins, LEE, LL Wkshp, 13 Feb 2013



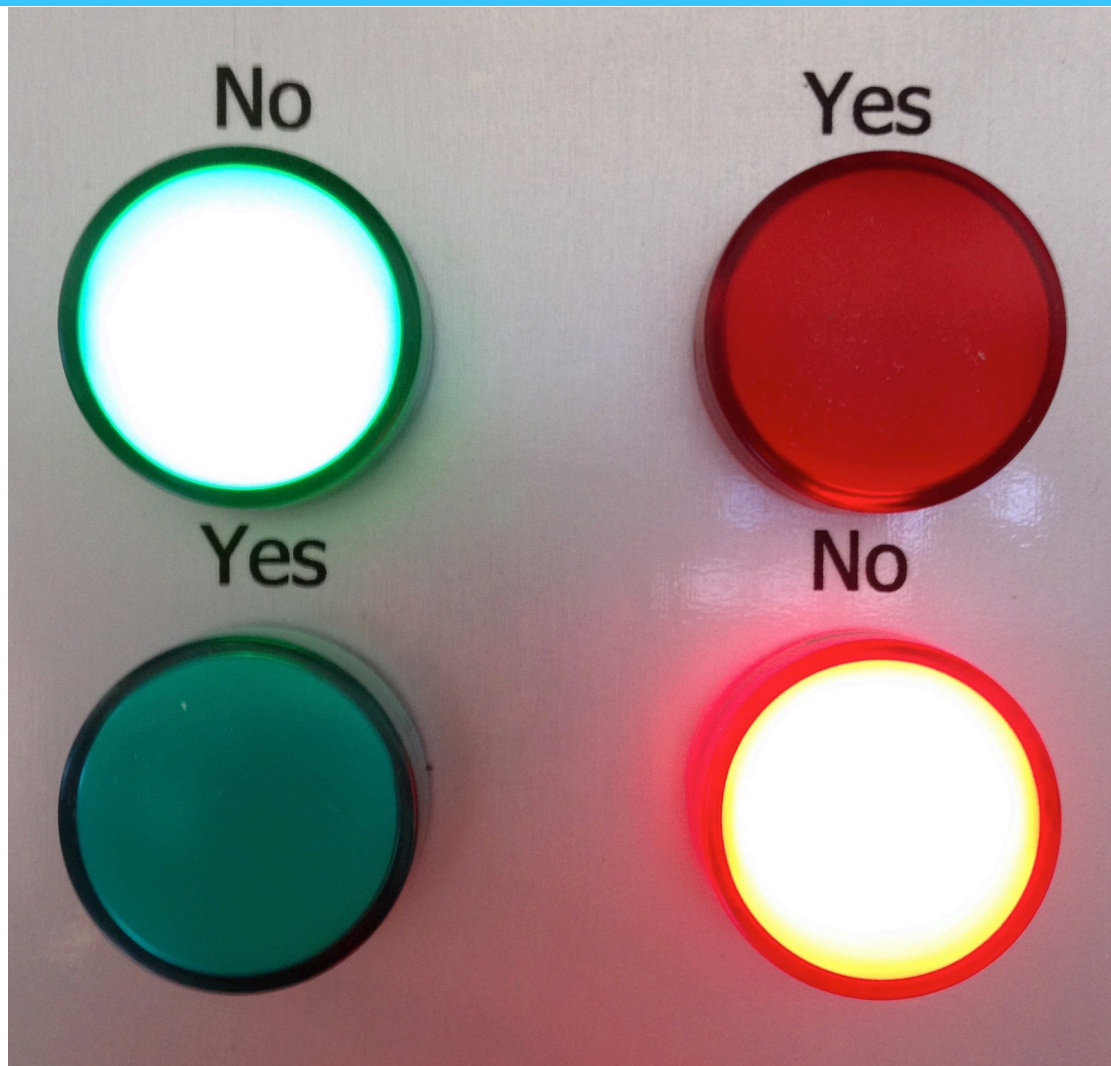
Summary

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Summary

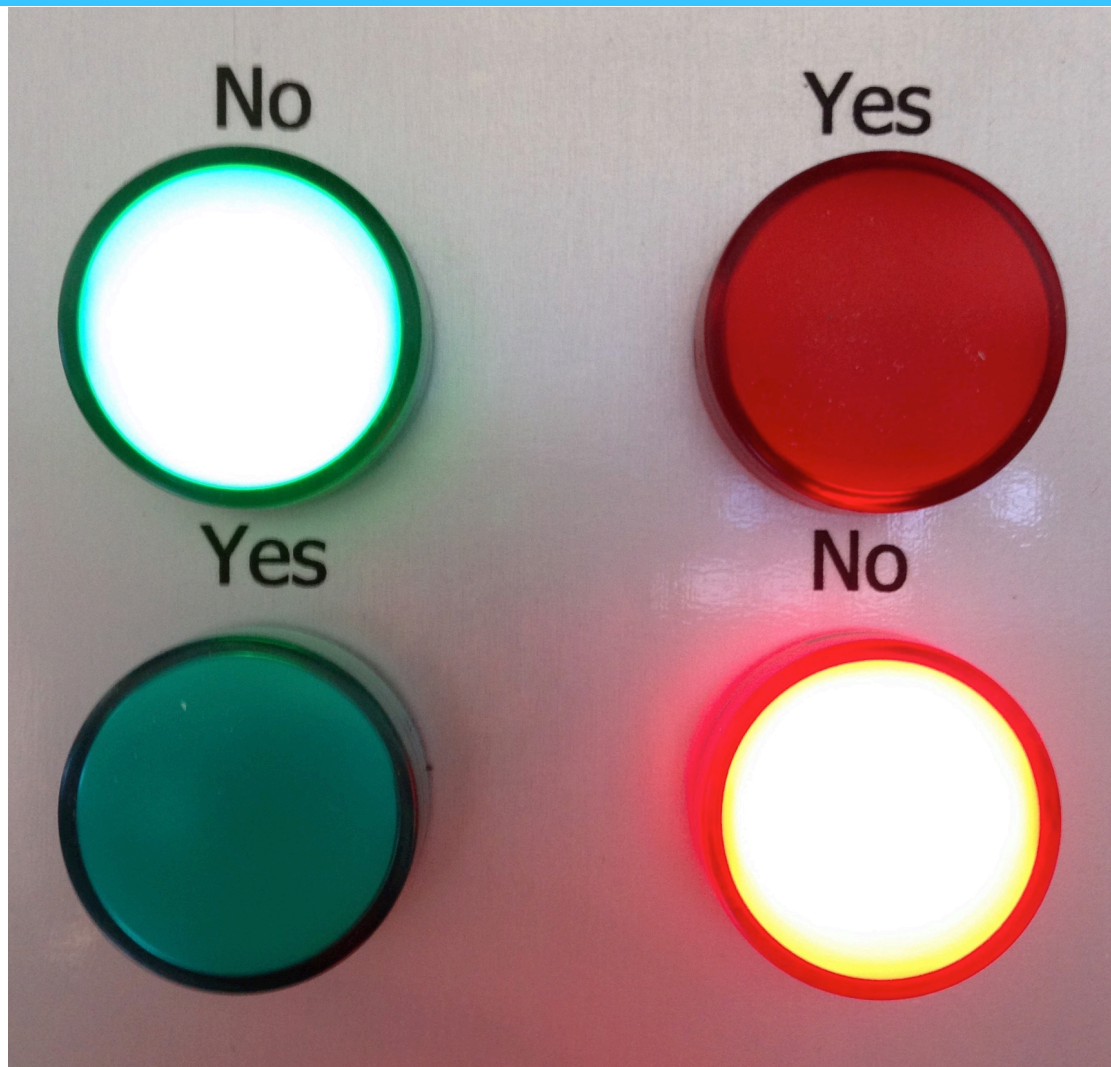
Is the SM all
there is?



Summary

Is the SM all
there is?

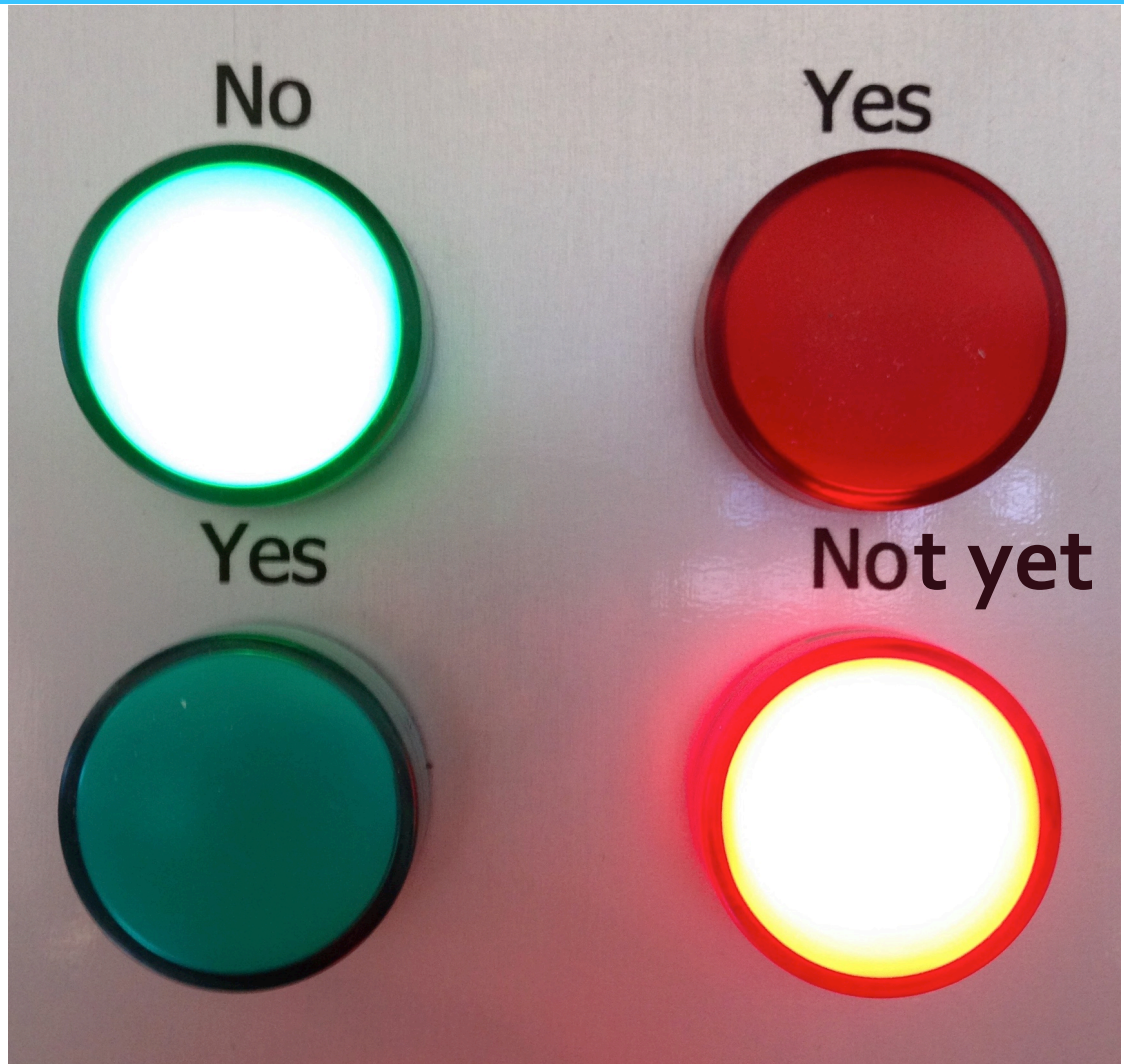
Do we know
what's next?



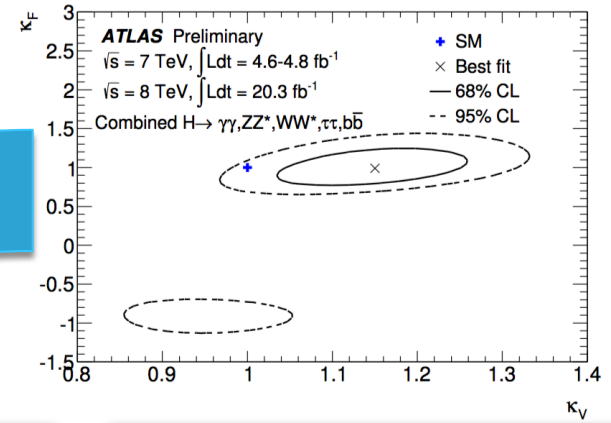
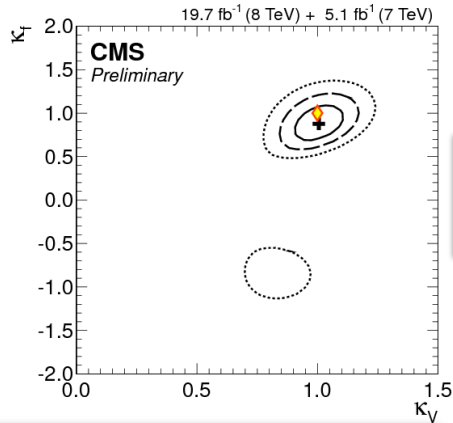
Summary

Is the SM all
there is?

Do we know
what's next?



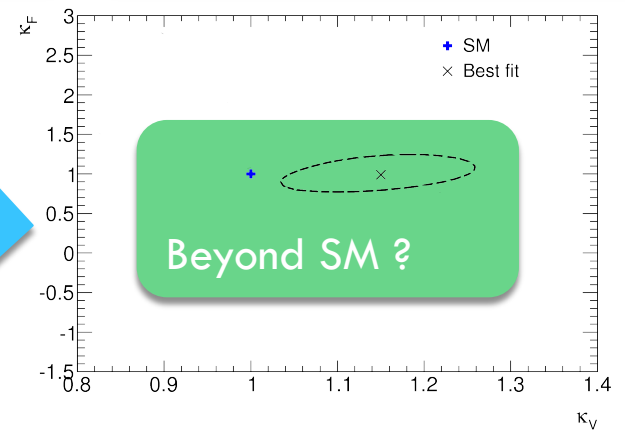
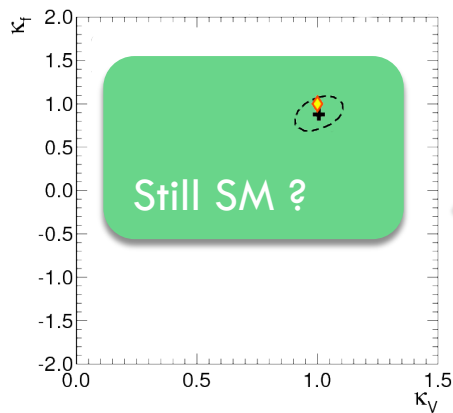
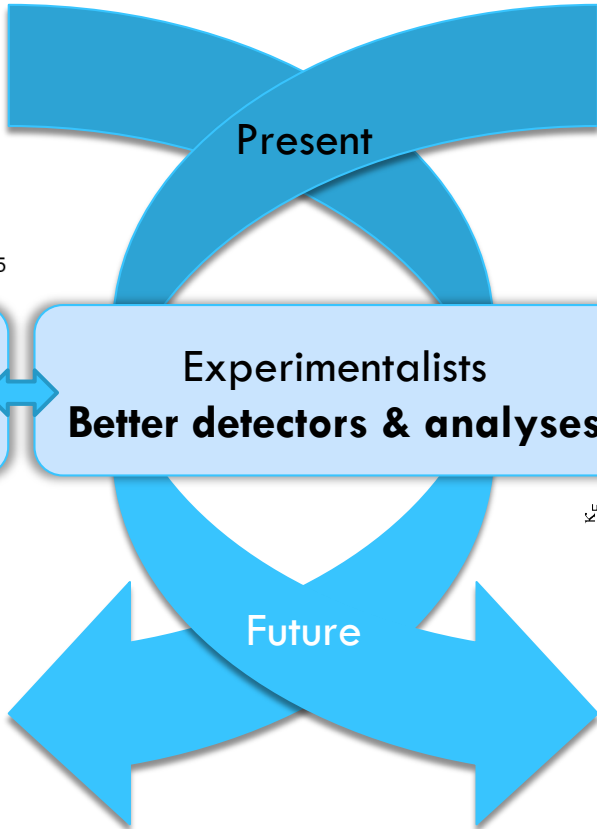
Outlook



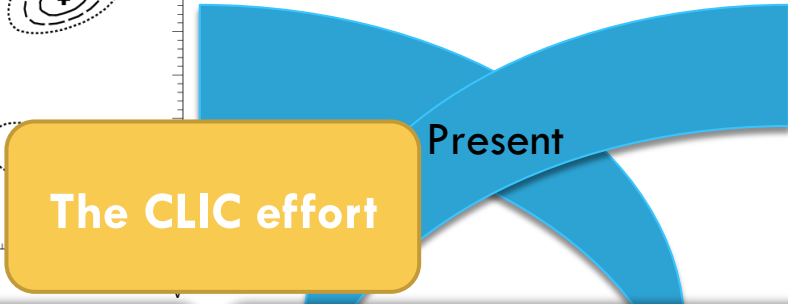
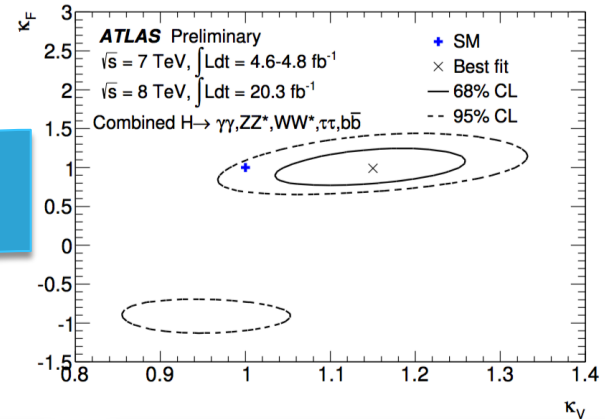
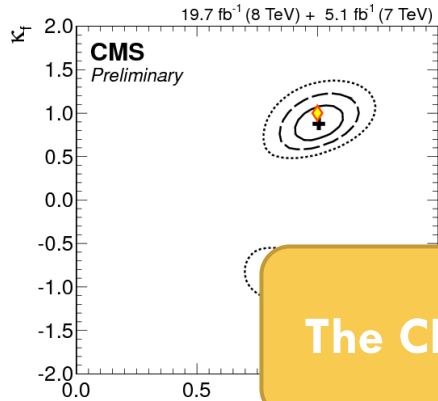
Accelerator physicists
More & other collisions

Experimentalists
Better detectors & analyses

Theorists
Better predictions & tools



Outlook



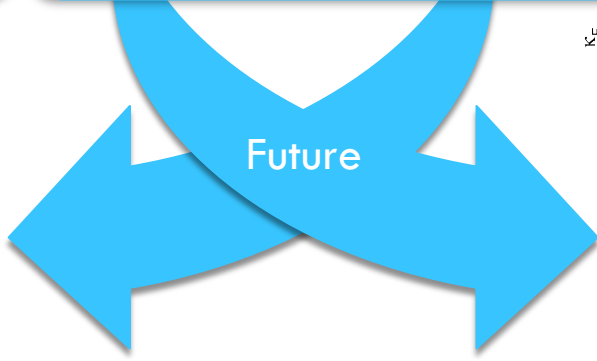
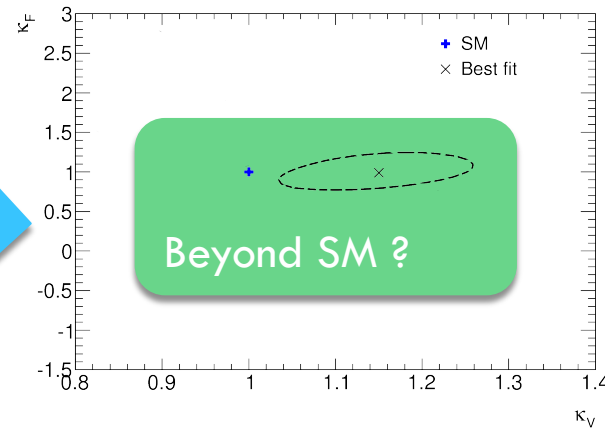
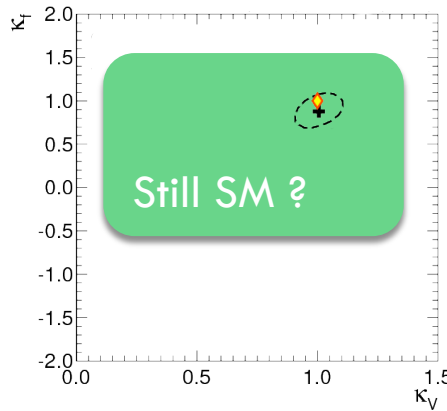
The CLIC effort

Present

Accelerator physicists
More & other collisions

Experimentalists
Better detectors & analyses

Theorists
Better predictions & tools

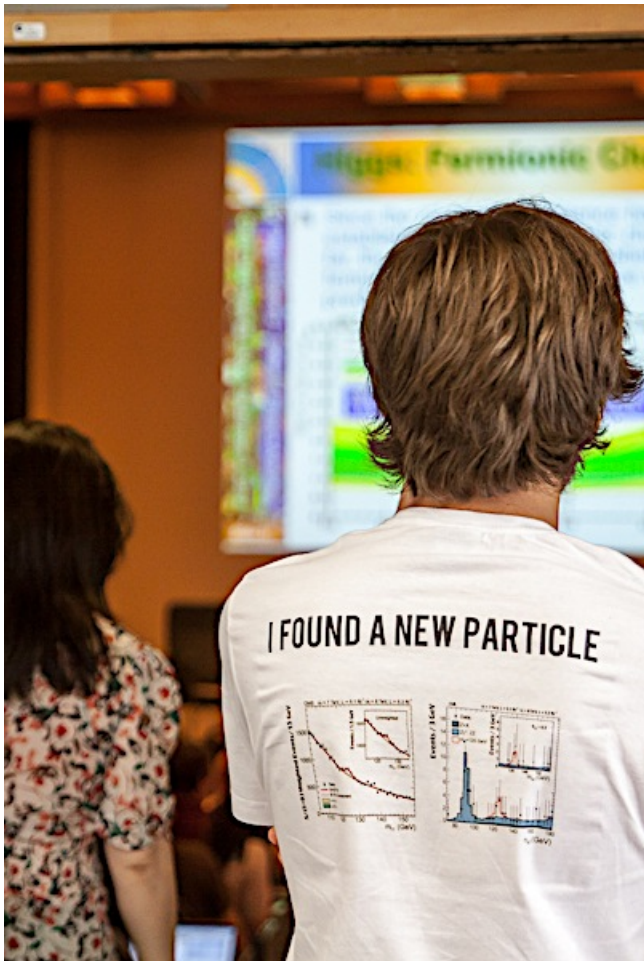


Future

Outlook



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- **LHC13: last chance before “direct BSM desert”.**
 - Tevatron: Run I → top discovery, Run II → SM precision.
 - LHC 2010: early SUSY and EXO exclusions.

- **Run2 potential still to be fully explored.**
 - Higgs physics barely started.
 - Top physics to open new chapters.
 - SM measurements to be improved.
 - Much BSM phase-space still to be probed.

- **We have a long way to go.
All it takes is one deviation.**

CLIC workshop 2019 ?



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Cricket

Rugby U

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Golf

Athletics

Cycling

European Football > Results

Fixtures

Tables

Champions League

Europa League

All BSM FC

2

1

SM Utd

Resonance '16, '18

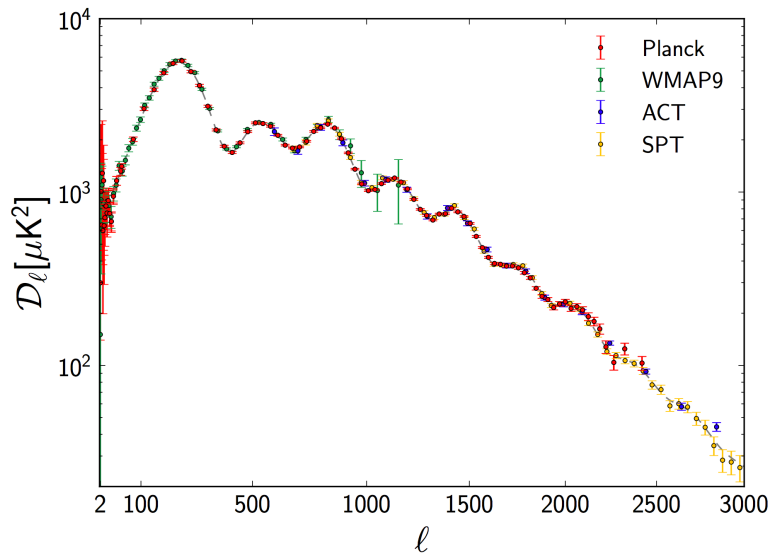
Run2 4 yr
HT 0-1

Higgs '12

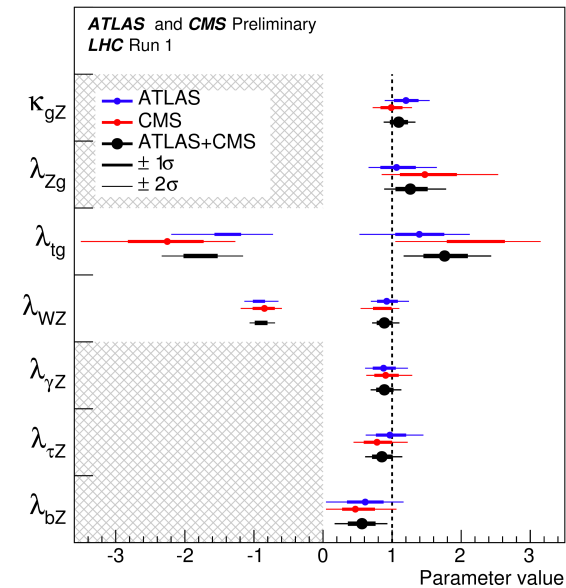


The ~~beautiful boring~~ Universe today

- **Up above:** “Simple six-parameter Λ CDM”.



- **Down below:** (Not-as-simple) ~ 20 -parameter Standard Model of Particle Physics.



Looking forward to surprises at higher energies: PeV neutrinos, LHC 13 TeV, ...

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For discussion



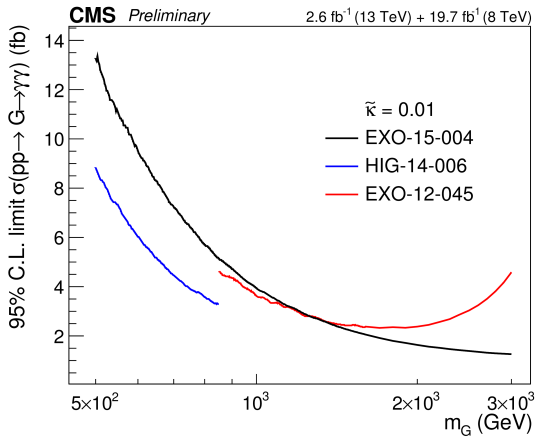
Diphoton resonance searches

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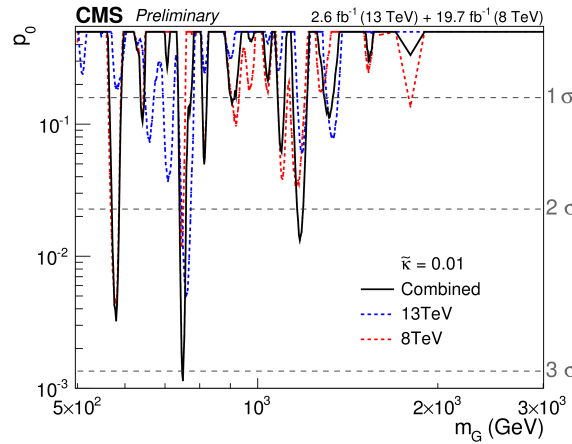
[\[http://cern.ch/go/8KNW \]](http://cern.ch/go/8KNW)

Reference	Exp.	Collision energy [TeV]	m_χ search range [GeV]	Interpretation benchmark
PRL 113 171801	ATLAS	8	65 – 600	Scalar
PRD 93 (2015) 3032004			500 – 2800	Spin-2
PLB 750 (2015) 494	CMS		150 – 800	Scalar and Spin-2
CMS-PAS-EXO-12-045			500 – 3000	Spin-2
ATLAS-CONF-2015-081	ATLAS	13	200 – 2000	Scalar
CMS-PAS-EXO-15-004	CMS		500 – 4500	Spin-2

CMS: combination with 8 TeV



Expected limits.
8 TeV cross-section
scaled to 13 TeV
assuming G_{RS} .



For $m_G = 750$ GeV
 $3.0\sigma \rightarrow 1.7\sigma$ after LEE

