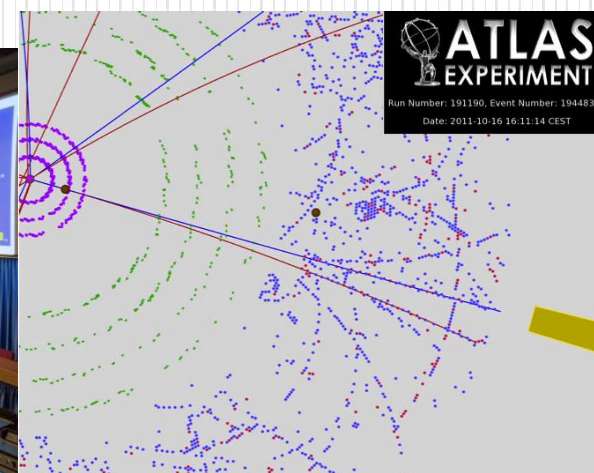
Физические результаты Большого адронного коллайдера

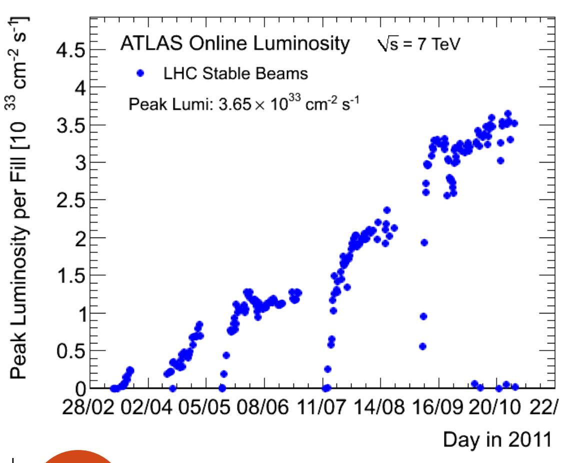
Л.Н.Смирнова

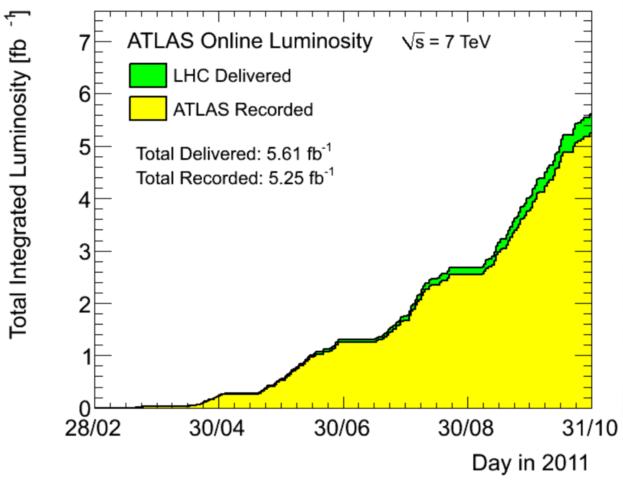
5 Черенковские чтения,
ФИАН,
10 апреля 2012г.

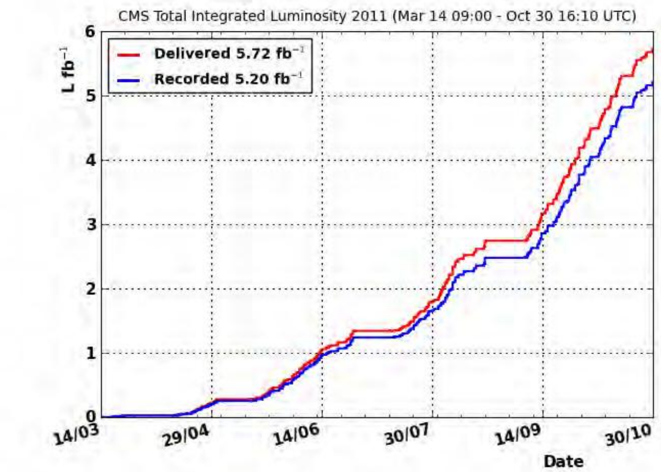


Итоги работы БАК в 2011г.

- В 2011г. БАК стал лидером не только по энергии соударения, но и по пиковой светимости ($3.65 \cdot 10^{33}$см$^{-2}$с$^{-1}$)
- Более сотни опубликованных работ от каждой из коллабораций ATLAS и CMS, десятки от ALICE и LHCb – обилие результатов
- В ATLAS и CMS зарегистрированы pp-соударения с интегральной светимостью 5.2фб-1, что эквивалентно $>10^{15}$ неупругих pp событий

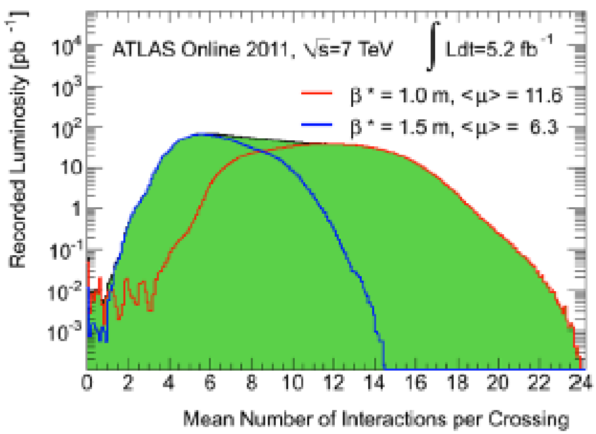


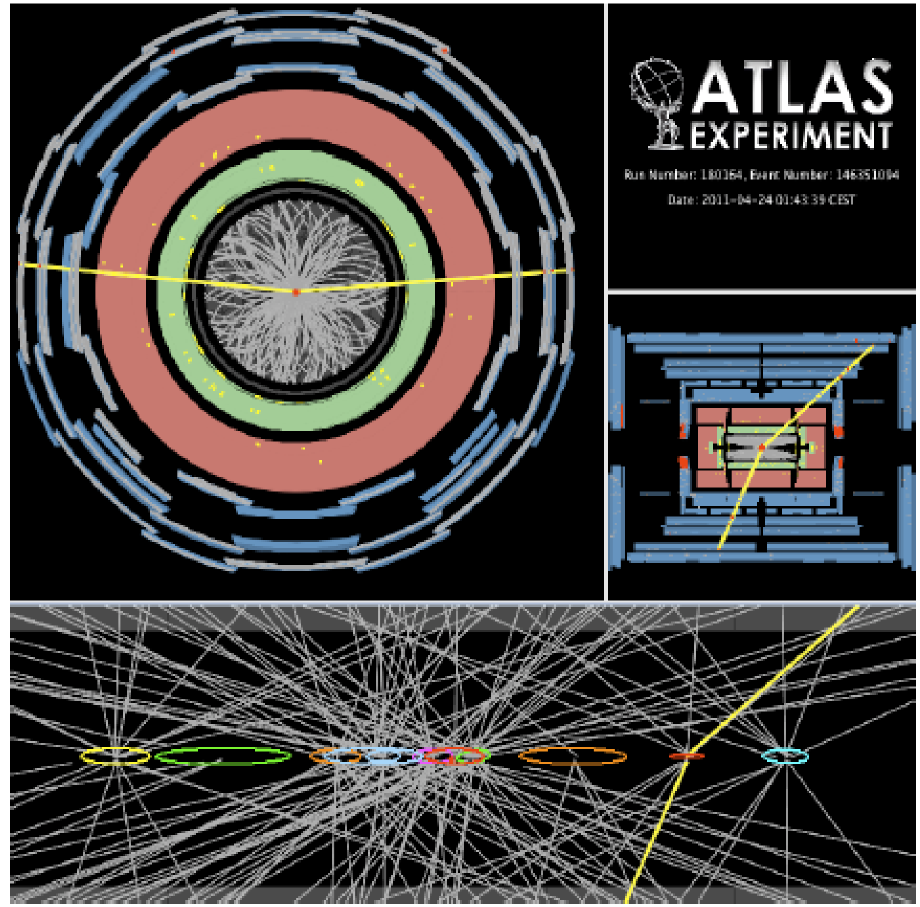




Pile-up

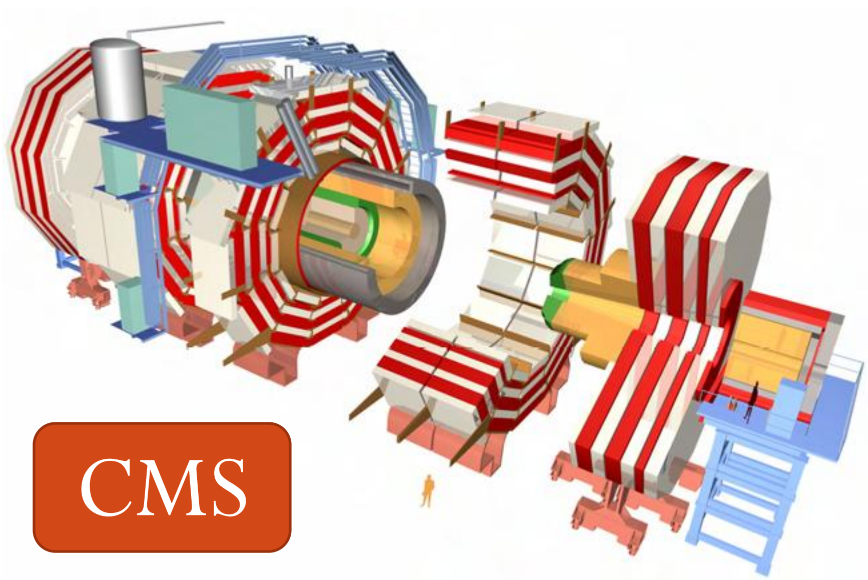
- 50 ns bunch trains for ~all 2011 data
- Substantial in- and out-of-time pileup
- Much progress understanding impact on performance, with data & simulation

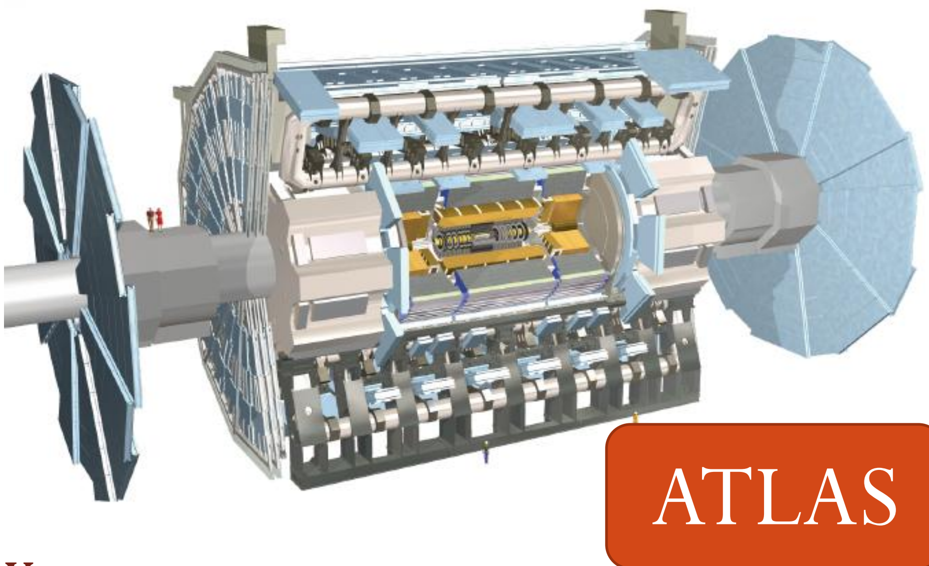




Z→μμ event with 11 primary vertices

Основные результаты ATLAS и CMS

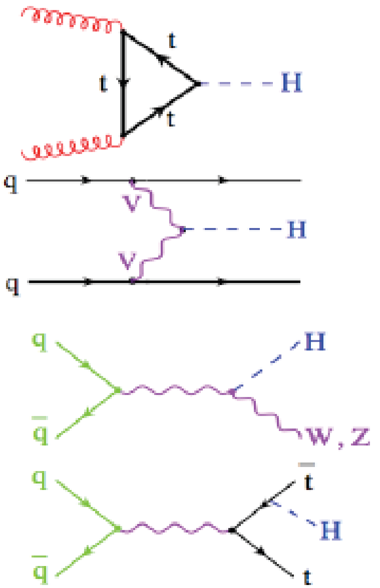


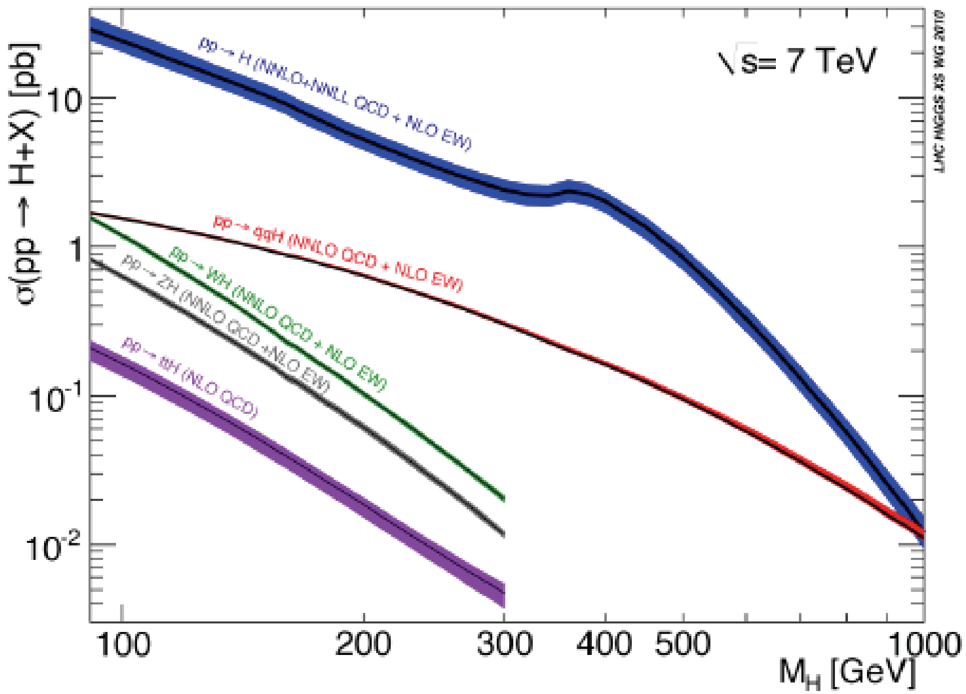


1. Поиск бозона Хиггса
2. Измерения векторных бозонов
3. Измерения топ-кварка
4. Поиск редкого распада B→μμ → LHCb, CMS, ATLAS
5. Поиск суперсиметрии и экзотики
6. Заключение

Higgs Production at 7 TeV

- Gluon fusion
- VBF
- VH
- ttH



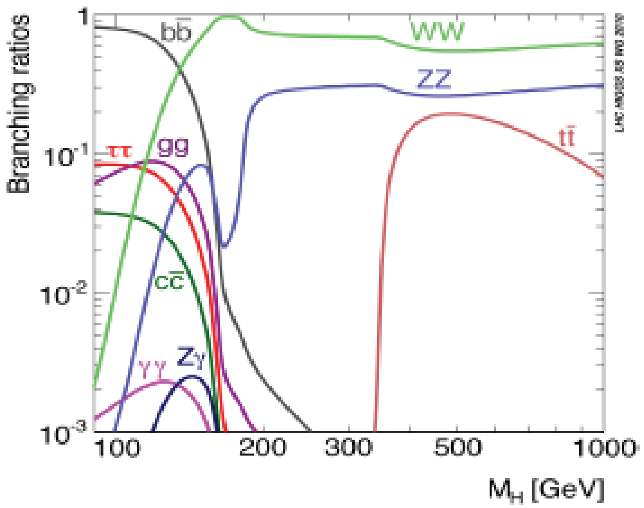


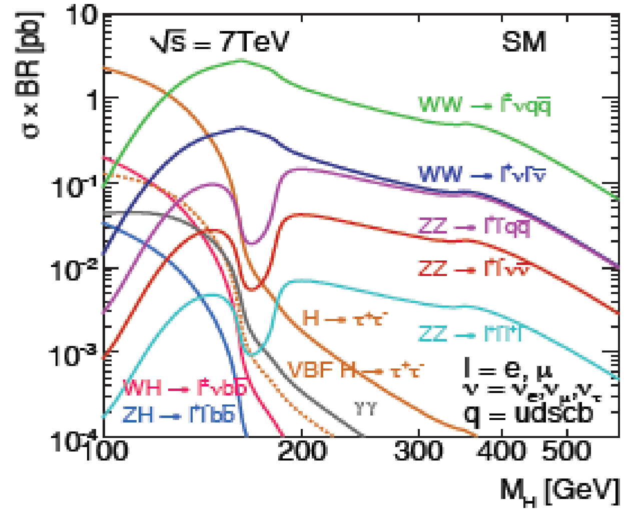
Gluon fusion (gg→H) is the dominant production mechanism at LHC. Glue-glue production is about x20 that of the Tevatron, whereas q-qbar production is about x4.

Irreducible backgrounds in H→WW, ZZ, γγ are from qq annihilation.

Signal-to-noise is better than at Tevatron except in VH.

Higgs Decay Modes and CMS Analyses





Mode	Mass Range	Data Used (fb^{-1})	Categories	Mass Resolution (%)
H → γγ	110-150	4.7	4	1.2-2.7
H → bb	110-135	4.7	5	10
H → ττ	110-145	4.6	9	20
H → WW → 2l 2ν	110-600	4.6	5	20
H → ZZ → 4l	110-600	4.7	3	1-2
H → ZZ → 2l2τ	180-600	4.7	8	10-15
H → ZZ → 2l2j	130-165/200-600	4.6	6	3
H → ZZ → 2l2ν	250-600	4.6	2	7

Набор исследованных каналов в ATLAS

Latest Scalar (H) Boson searches with ATLAS

Searches performend in 12 distinct channels using the full 2011 dataset.

Channel	m_H range (GeV)	Backgrounds	$\mathcal{L}$ (fb^{-1})	Reference
low-m_H, good mass resolution				
$H \to \gamma\gamma$	110-150	$\gamma\gamma$, γj, jj	4.9	arXiv:1202.1414
$H \to ZZ^{(*)} \to 4\ell$	110-600	$ZZ^{(*)}$, $Z + jets$, $t\bar{t}$	4.8	arXiv:1202.1415
low-m_H, limited mass resolution				
$H \to WW^{(*)} \to \ell\nu\ell\nu$	110-600	WW, $t\bar{t}$, $W/Z + jet$	4.7	CONF-2012-012
$H \to \tau\tau(ll, lh, hh)$	100-150	$Z \to \tau\tau$, $t\bar{t}$	4.7	CONF-2012-014
$VH, H \to bb$	110-130	$W/Z + jets$, $t\bar{t}$	4.7	CONF-2012-015
high-m_H				
$H \to ZZ \to \ell\ell\nu\nu$	200-600	$diboson$, $t\bar{t}$, $Z + jets$	4.7	CONF-2012-016
$H \to ZZ \to \ell\ell jj$	200-600	$Z + jets$, $t\bar{t}$, $diboson$	4.7	CONF-2012-017
$H \to WW \to \ell\nu jj$	300-600	$W + jets$, $t\bar{t}$, multijets	4.7	CONF-2012-018

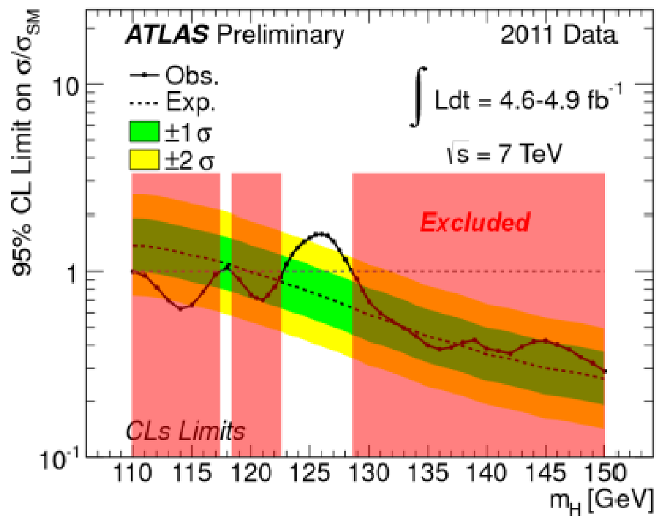
Sandra Kortner
on behalf of the ATLAS Collaboration

Recontres de Moriond EW • March 3rd - 10th, 2012

Суммарные результаты ATLAS и CMS

Combined exclusion limit

Zoom in:



CMS : $H_{SM} \rightarrow \gamma\gamma$, bb, ττ, WW, ZZ combined

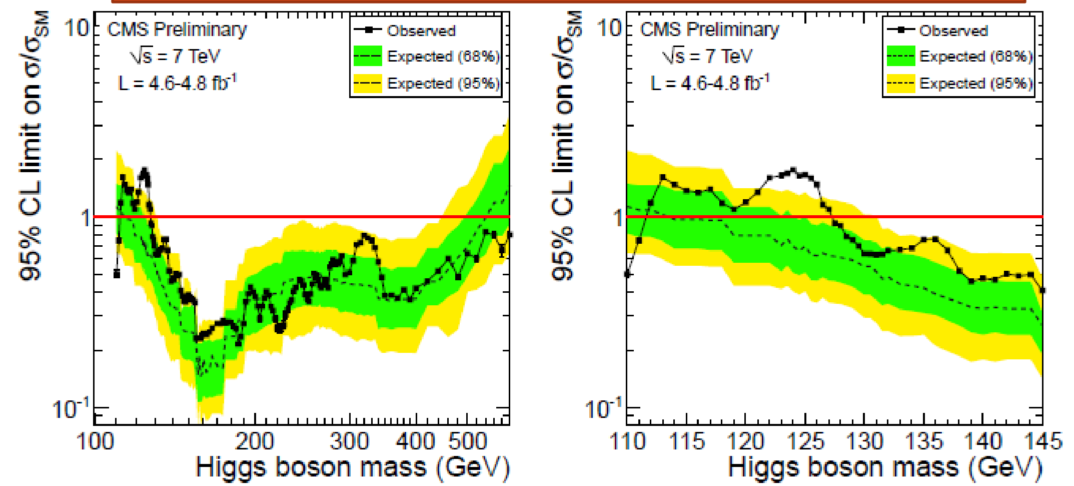


Figure 5: The observed and expected 95% CL upper limits on the signal strength parameter $\mu = \sigma/\sigma_{SM}$ for the SM Higgs boson hypothesis as a function of the Higgs boson mass in the range 110–600 GeV (left) and 110–145 GeV (right).

Expected exclusion at 95% CL: 120-555 GeV

Observed exclusion at 95% CL: 110-117.5, 118.5-122.5, 129-539 GeV

Observed exclusion at 99% CL: 130-486 GeV

Исследована область масс 110-600 ГэВ
Область 127.5 – 600 ГэВ исключена на 95% CL
Область 129 – 525 ГэВ Исключена на 99% CL
(CMS-PAS-HG-12-008)

Измерения канала H → γγ в ATLAS

CERN-PH-EP-2012-013
Submitted to Physical Review Letters

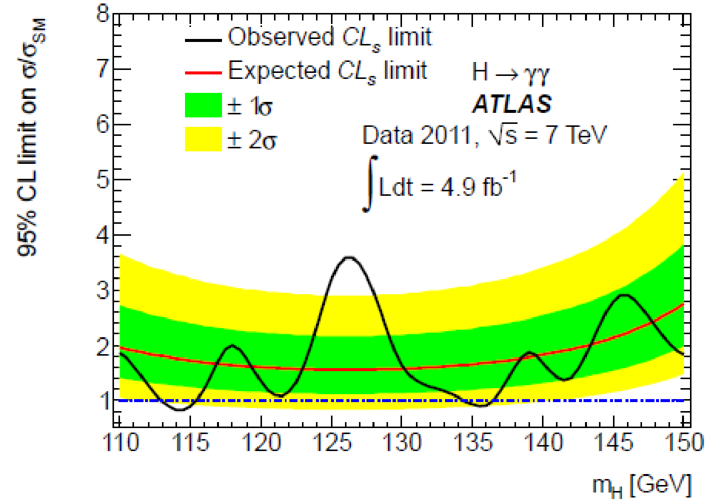


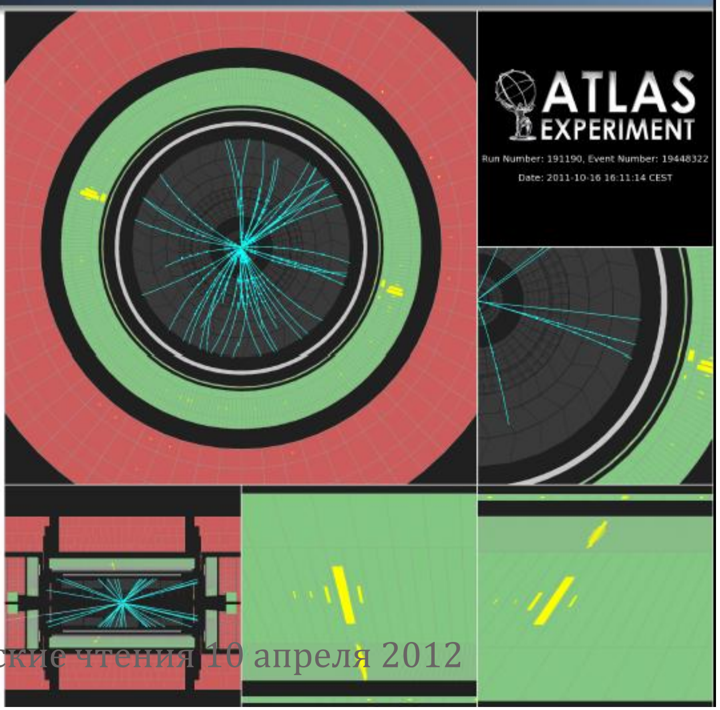
FIG. 4. Observed and expected 95% CL limits on the SM Higgs boson production normalized to the predicted cross section as a function of m_H.

$H \to \gamma\gamma$: The Beautiful

- $E_T(\gamma_1) > 40$ GeV, $E_T(\gamma_2) > 25$ GeV

Main backgrounds:
* irreducible $\gamma\gamma$ (30 pb);
* reducible γj (200 nb);
* reducible jj (500 μb).

- Powerful γ/jet separation is crucial.
- Need an excellent $m_{\gamma\gamma}$ mass resolution.



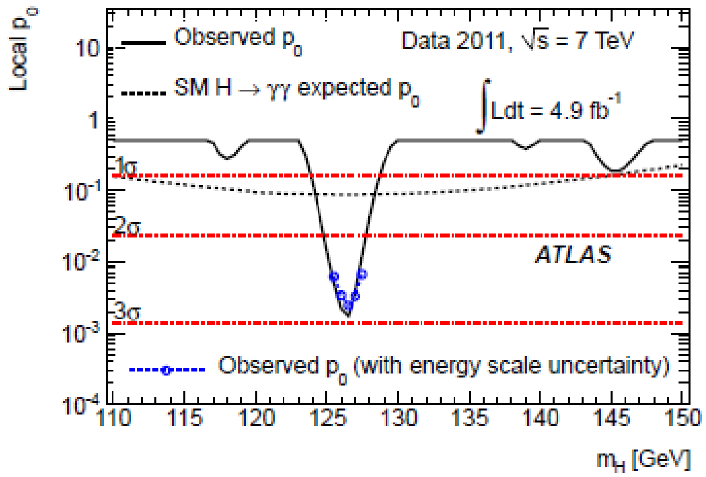


FIG. 3. The observed local p_0, the probability that the background fluctuates to the observed number of events or higher (solid line). The open points indicate the observed local p_0 value when energy scale uncertainties are taken into account. The dotted line shows the expected median local p_0 for the signal hypothesis when tested at m_H.

Сравнение результатов в разных каналах

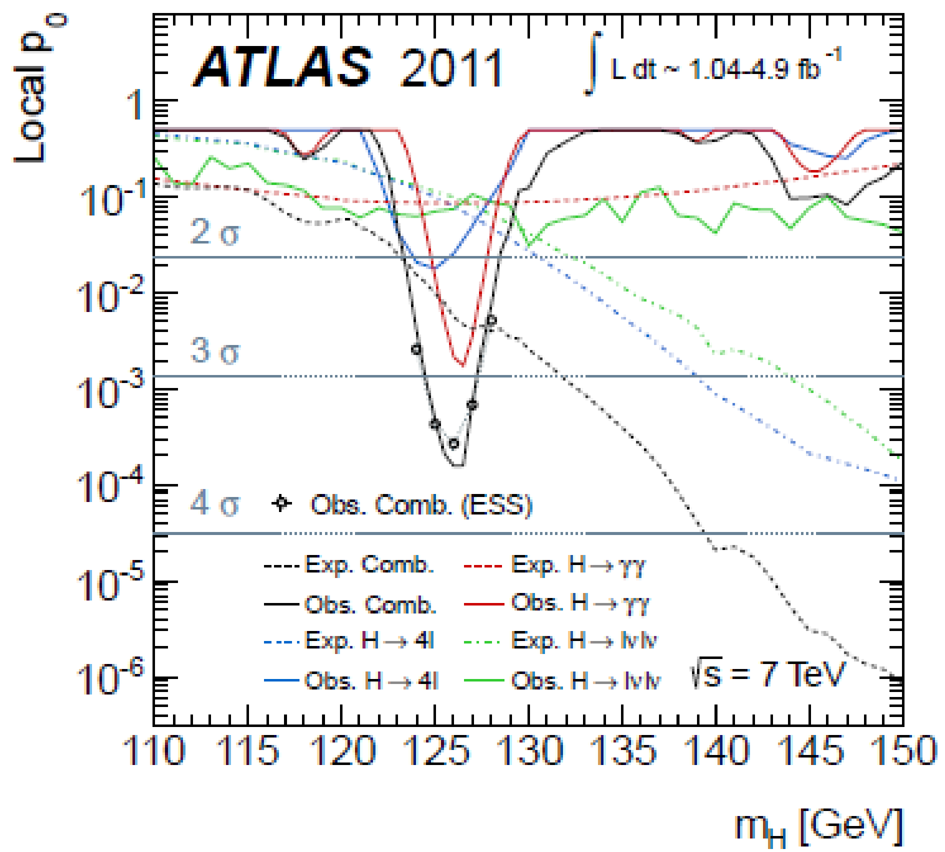


Figure 4: The local probability p_0 for a background-only experiment to be more signal-like than the observation. The solid curves give the individual and combined observed p_0, estimated using the asymptotic

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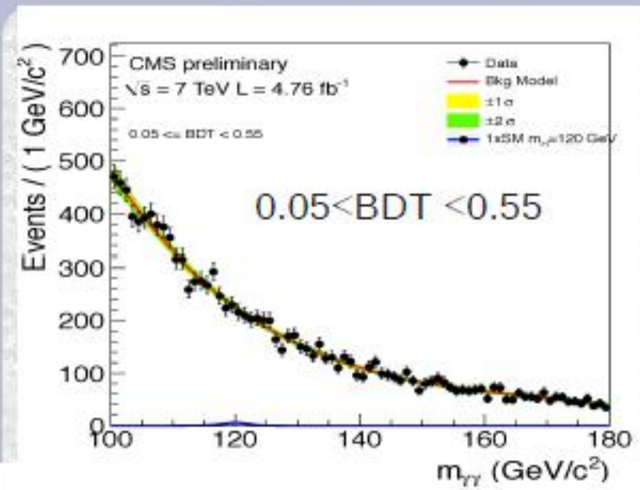
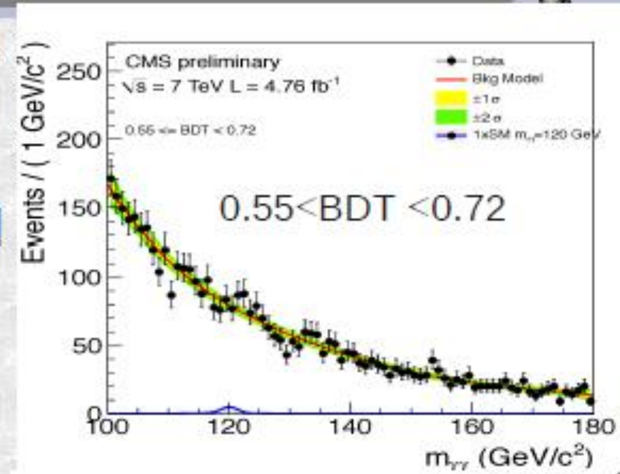
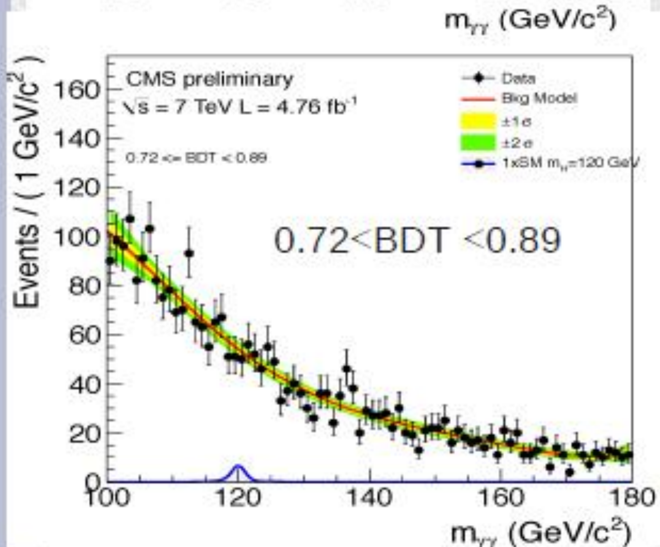
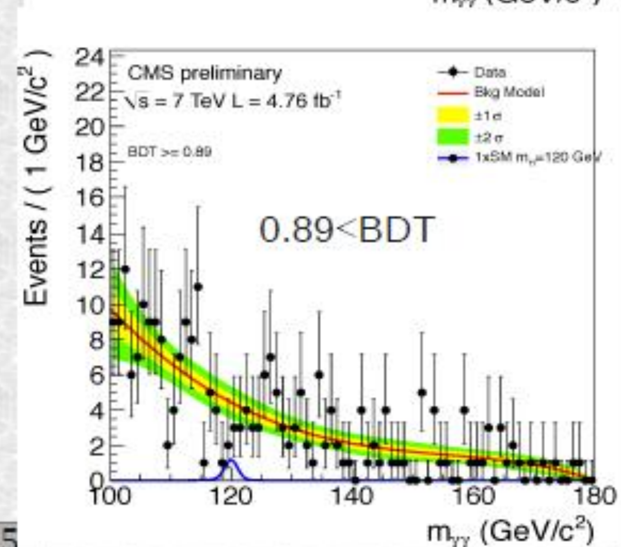
CMS $H \rightarrow \gamma\gamma$





- Dividing into 4 categories by BDT gives a more powerful search
- Selection of windows important
- Note the s/b rising markedly





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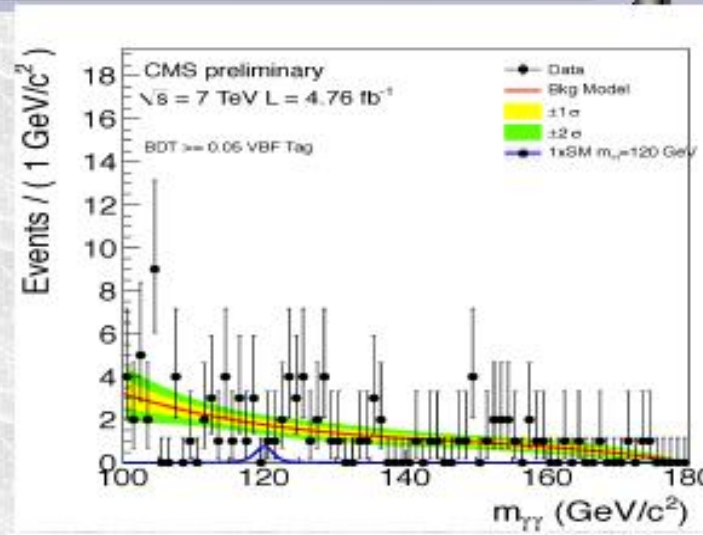
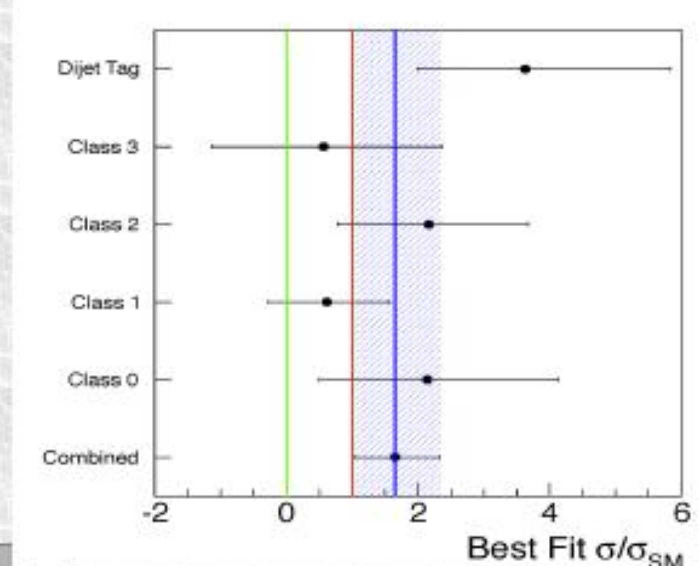
CMS H → γγ

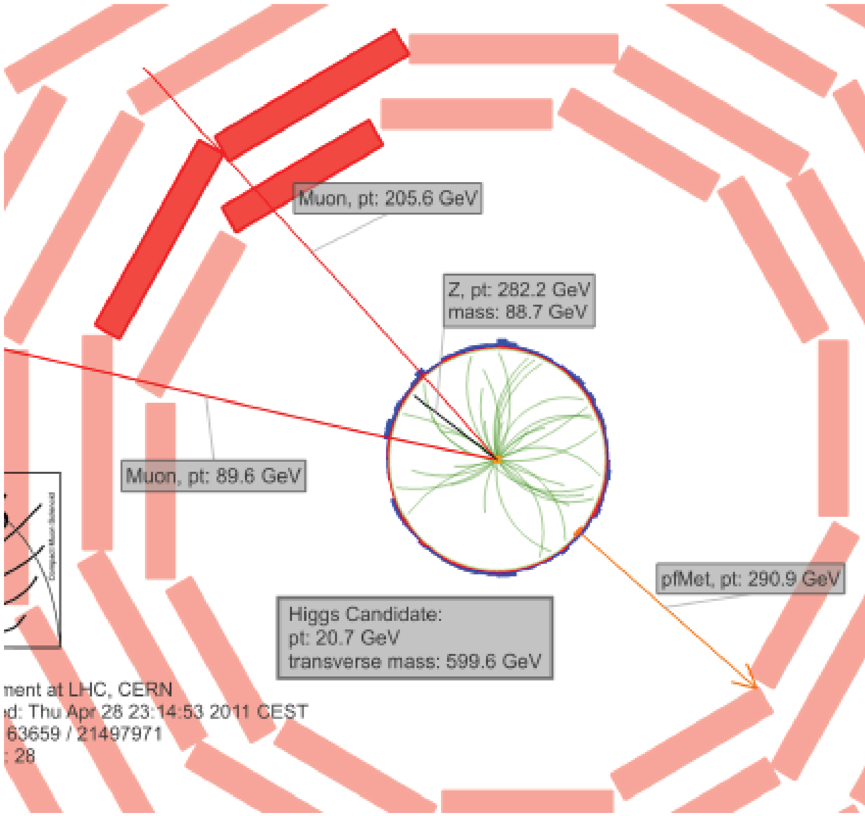
- VBF is also selected by BDT
  - Slightly less significant than original VBF channel
    - Not very different
- The data is compared with m_H=125GeV in all 5 categories
  - Excess in all channels at this mass
- Overall 2.9sigma
  - 1.6sigma with LEE





① High Mass Higgs: H → ZZ → 2l 2ν

$$M_T^2 = \left(\sqrt{P_{TZ}^2 + M_Z^2} + \sqrt{MET^2 + M_Z^2}\right)^2 - (\vec{P_{TZ}} + \vec{MET})^2$$



Selection criteria

- 2 categories - Z(2e), Z(2μ)
- Dilepton mass is $M_Z \pm 15$ GeV
- $p_T(ll) > 25$ GeV
- Large MET, not aligned with jets or leptons
- Build m_T distribution assuming MET comes from $Z \rightarrow \nu\nu$

Background

- Z+Jets, ttbar & WW
  - MET requirement to suppress Z + j by x10^5
  - Anti b-tag to suppress ttbar
- estimated from data
  - γ + jets (for Z+Jets) ; eμ sample (for ttbar +WW)
- ZZ, WZ background estimate from MC

Mass resolution is 7%

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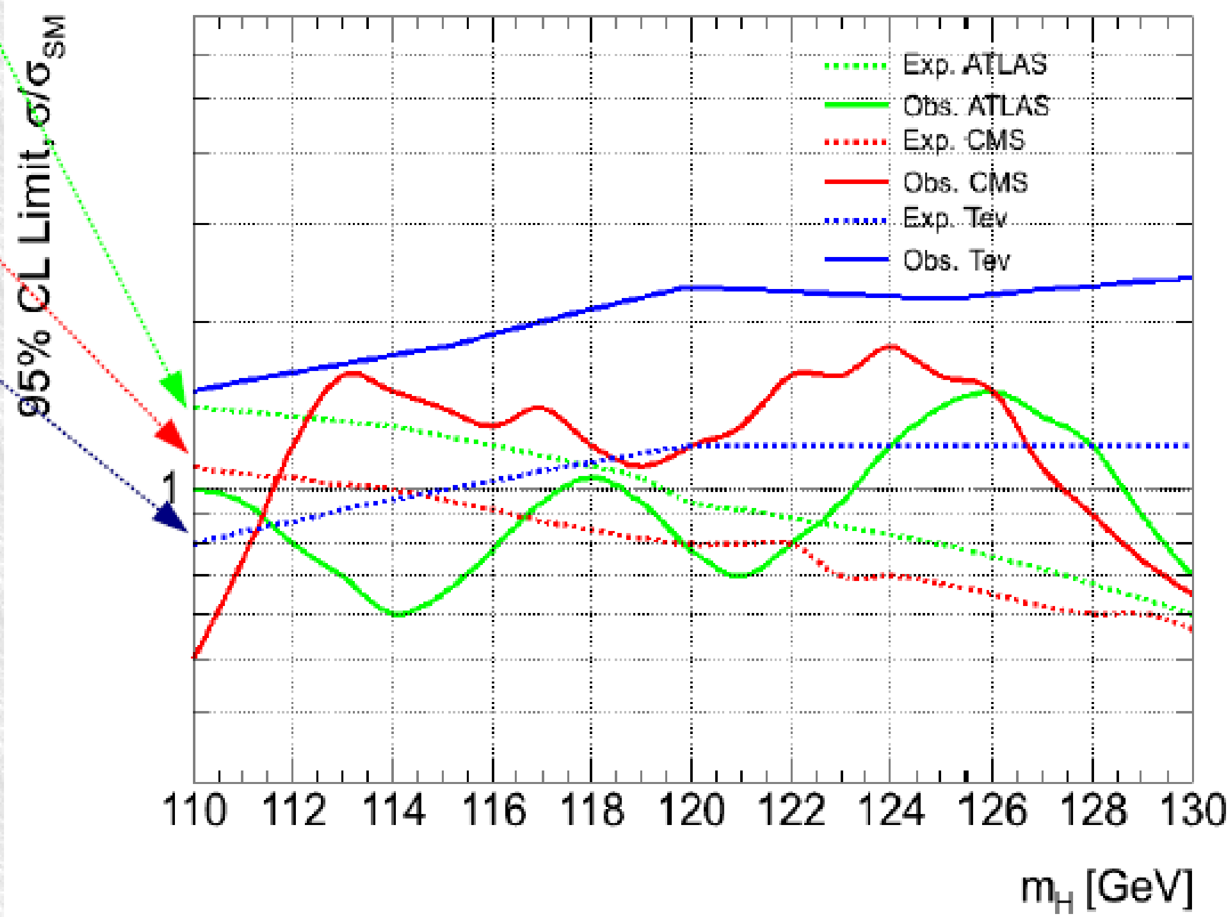
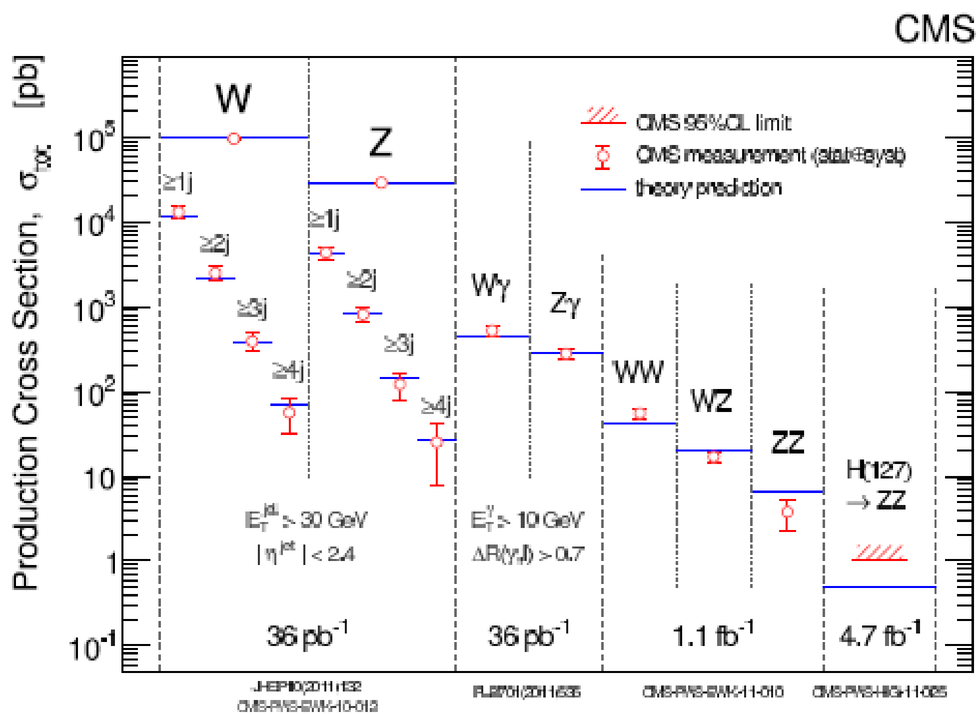
Comparison of limits

- ATLAS matches CMS in all but the BDT γγ
- Tevatron combined passes CMS below 114
  - Worth ~½ ATLAS at 125
- ATLAS & CMS anti-correlate
  - Except at 125GeV
- Would a combination exclude 110-122?



Electroweak measurements at LHC

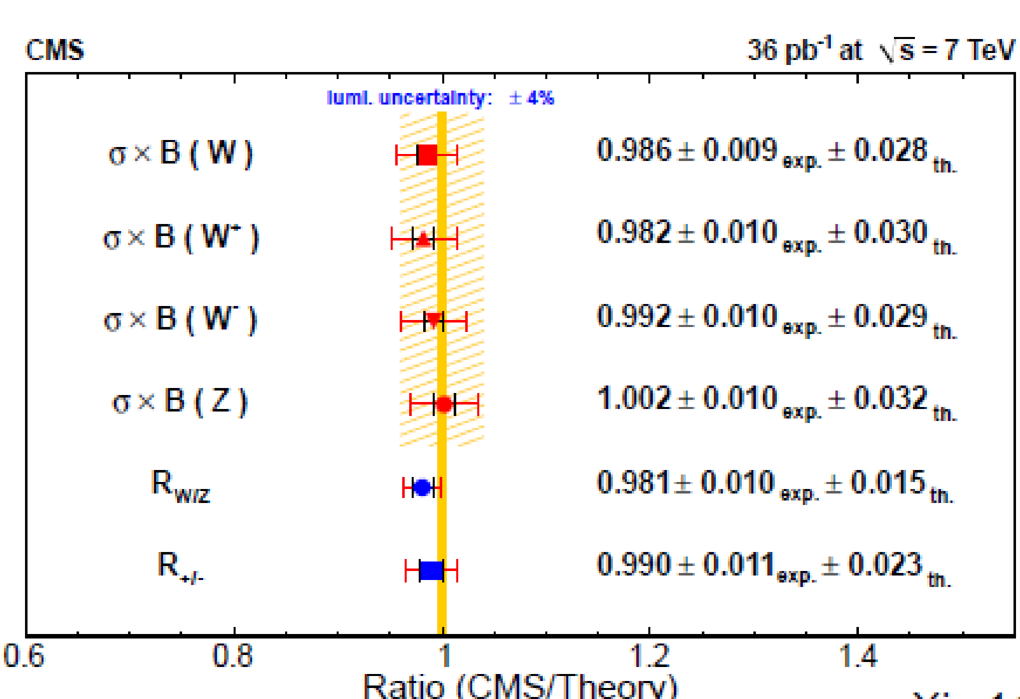
- QCD sector
  - Proton structure (W, Z inclusive and +heavy flavours)
  - Higher order processes (W, Z+jets)
  - W polarisation
- Electroweak sector
  - Lepton universality
  - τ polarisation in $W \to \tau\nu$
  - Electroweak mixing angle $\sin^2\theta$
  - Di-Boson production, triple gauge couplings

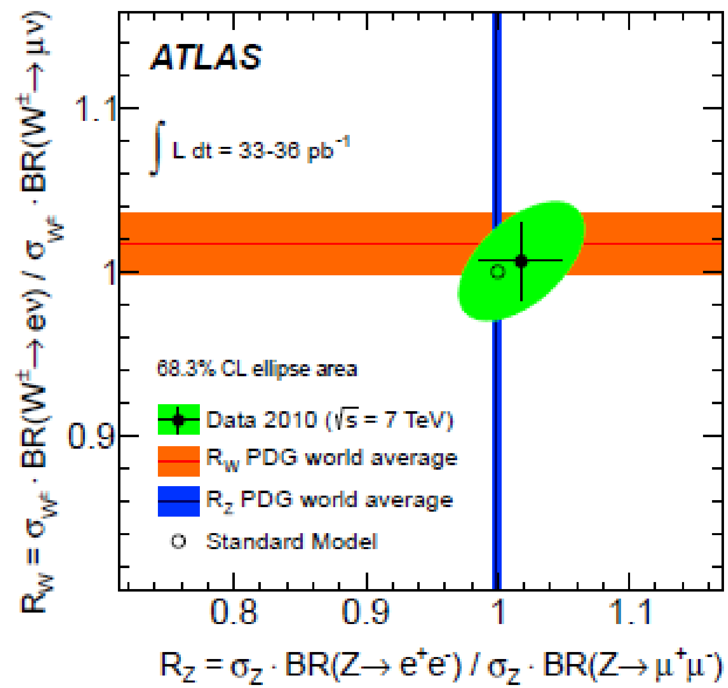


Jan Kretzschmar, 7.3.2012 – p.2

W and Z Production

- Cross section for inclusive production and leptonic decays, $W \to \ell\nu$ and $Z \to \ell\ell$ reached experimental accuracy of few % in $\ell = e, \mu$ channels with 2010 data
- QCD prediction at NNLO: precision test of proton PDFs and the SM
- Maximising sensitivity using ratios and correlation information; avoid extrapolation in theory comparison
- $e - \mu$ universality in W decays confirmed to 2%

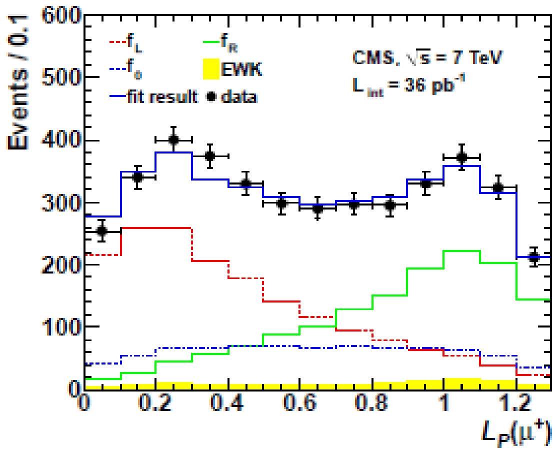


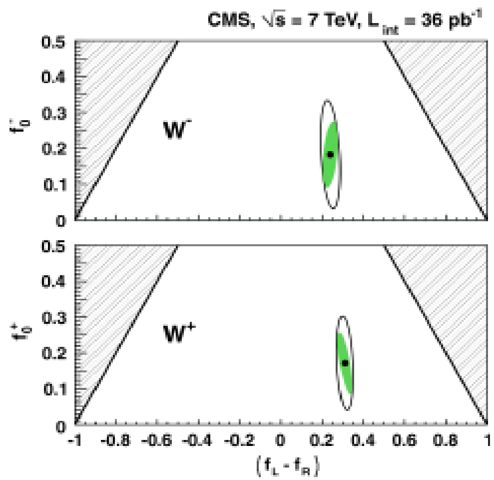


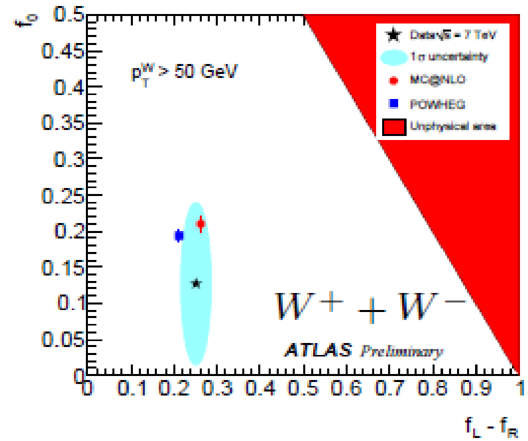
arXiv:1109.5141→PRD; JHEP 10 (2011) 132

W polarisation

- W bosons can be produced in three polarisation states: f_L, f_R, f_0
- Measured at significant $p_T^W > 35(50)$ GeV by analysing lepton p_T and angular distribution using e.g.: $L_P = \vec{p}_T^{\,\ell} \cdot \vec{p}_T^{\,W} / |\vec{p}_T^{\,W}|^2 \approx cos\theta$
- Predominantly left-handed W production and non-zero longitudinal component as predicted by NLO QCD
- Important for precision W physics at the LHC



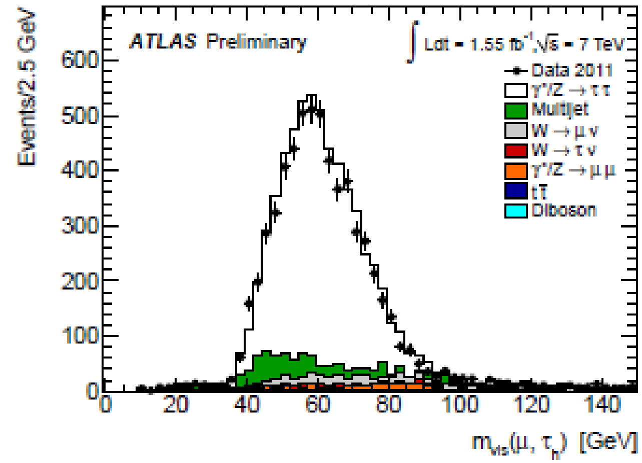


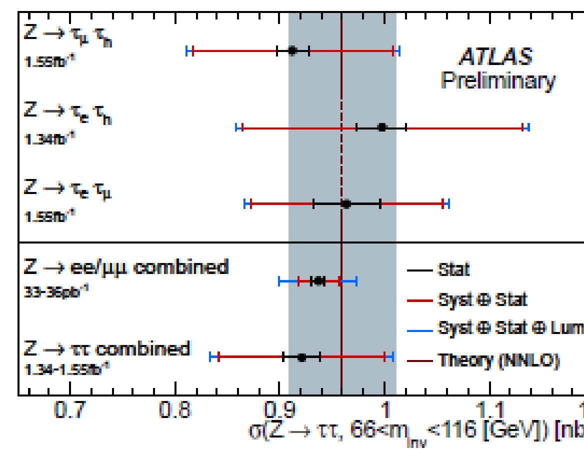


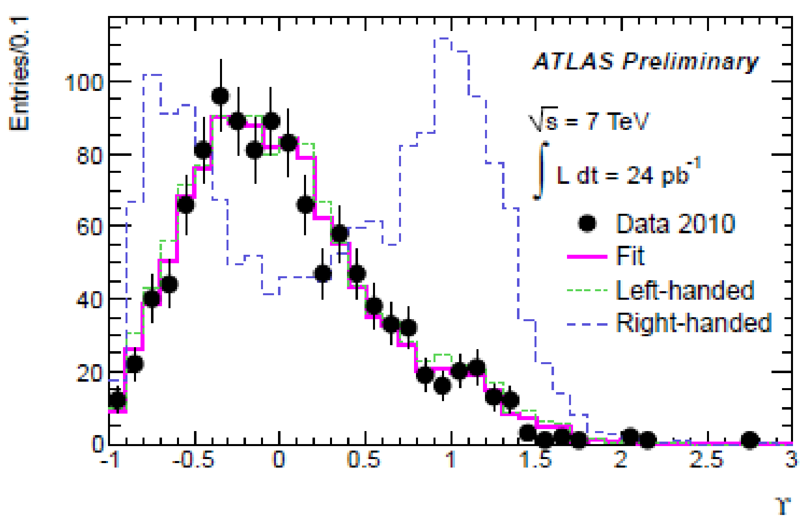
To be submitted to EPJC; PRL 107:021802, 2011

$W \to \tau\nu$ and $Z \to \tau\tau$

- W, Z cross sections measured in τ decays: latest result using $\mu\tau_h$, $e\tau_h$, and $e\mu$ channels with $\sim 10\%$ syst. unc.
- First measurement of τ polarisation in $W \to \tau_h\nu$ at hadron collider
- Using one-prong decays, energy sharing: $\Upsilon = (E_T^{\pi^-} - E_T^{\pi^0})/(E_T^{\pi^-} + E_T^{\pi^0})$
- $P_\tau = -1.06 \pm 0.04_{\text{stat}} \,{}^{+0.05}_{-0.07}\,{}_{\text{syst}}$
- Applications e.g. for $H \to \tau\tau$ ($P_\tau = 0$) and search for new physics



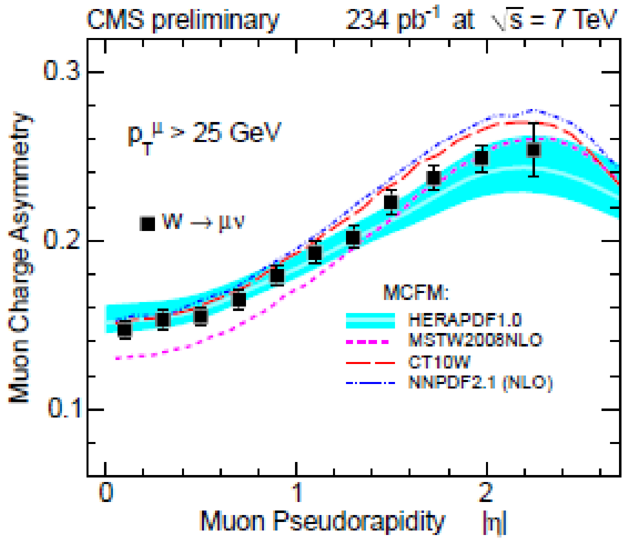


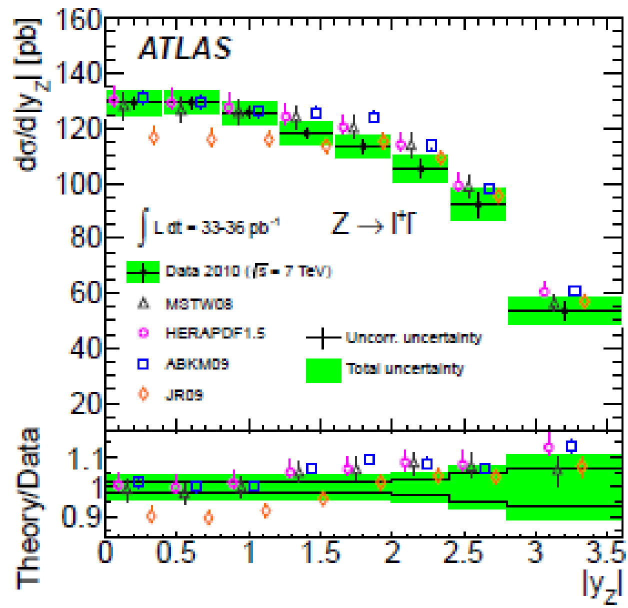


PRD 84 (2011) 112006; PLB 706 (2012) 276-294; ATLAS-CONF-2012-006; ATLAS-CONF-2012-009; JHEP 08 (2011) 117; CMS-PAS-EWK-11-019

W and Z Rapidity Differential Measurements

- Boson rapidity y directly linked to parton momentum fractions $x_{1,2} = M_{W,Z}/\sqrt{s} \cdot e^{\pm y}$
- W: charged lepton pseudo-rapidity η_ℓ used
- CMS:
  - *W lepton charge asymmetry* $A(\eta) = (\mathrm{d}\sigma^+(\eta) - \mathrm{d}\sigma^-(\eta))/(\mathrm{d}\sigma^+(\eta) + \mathrm{d}\sigma^-(\eta))$
  - *normalised Z rapidity* $1/\sigma \cdot \mathrm{d}\sigma/\mathrm{d}y$
- ATLAS: absolute differential cross sections for Z, W^+, W^- with correlation information
- Comparison to theory at NLO and NNLO shows broad agreement, but also indicates sensitivity to PDFs



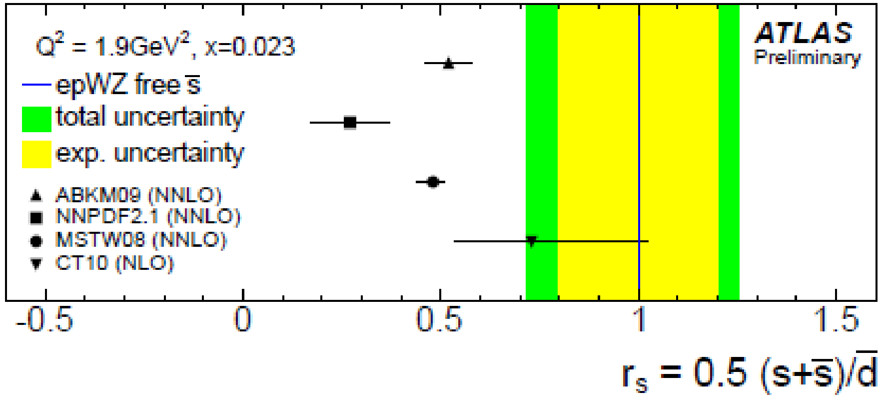


arXiv:1109.5141→PRD; arXiv:1110.4973→PRD; JHEP04(2011)050; CMS PAS EWK-11-005

W, Z data sensitivity to strange sea

- ATLAS performed NNLO QCD fit to Z, W^+, W^- + HERA ep DIS cross sections: significant tension for Z observed when suppressing strange by 50% at low scale $1.9\,\mathrm{GeV}^2$
- Fit with free strange sea gives no supression

$$r_s = 1.00 \pm 0.20_{\mathrm{exp}}\ {}^{+0.16}_{-0.20}\ \mathrm{sys}$$

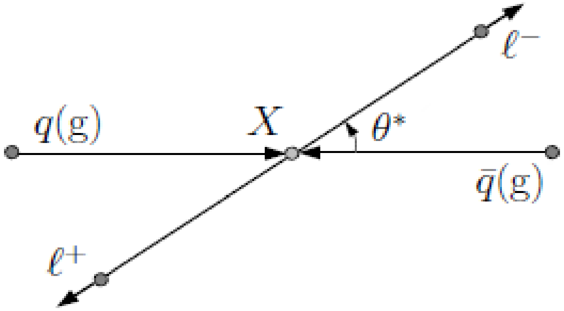


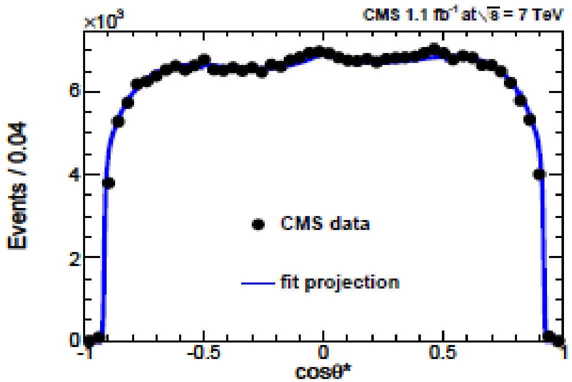
$W + c$ and $Z + b$ production

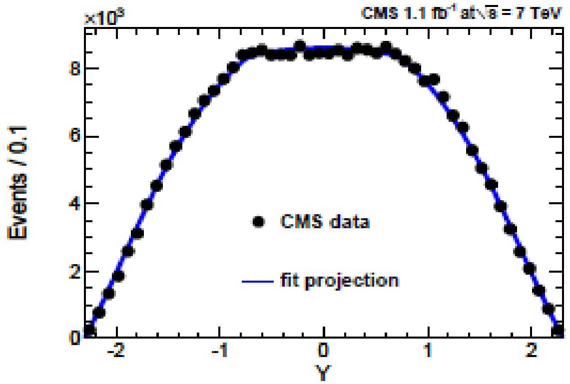
- Direct access to strange quark content by selecting Cabibbo-favoured processes $\bar{s}g \to W^+\bar{c}$ and $sg \to W^-c$
- First ratio measurements by CMS using W + secondary vertex tagged jets to $\sim 20\%$ precision; $R_c = \sigma(Wc)/\sigma(W + \mathrm{jet})$ indicates large s
- $W + b$ jet (ATLAS) and $Z + b(\bar{b})$ (ATLAS+CMS) were measured

Weak mixing angle $\sin^2\theta$

- Fundamental parameter of the SM, world average has 0.1% accuracy, but contains results with few σ tension
- CMS has used large amount of Z/γ^* to measure $\sin^2\theta_{\rm eff}$ from the *forward-backward asymmetry* in the $q\bar{q}\to Z/\gamma^*\to\mu^-\mu^+$ process
- Quark direction more likely in boost direction: three dimensional fit in decay angle $\cos\theta^*$, mass m and rapidity y to disentangle forward/backward direction on statistical basis
- Result with $\sim 1\%$ precision: $\sin^2\theta_{\rm eff} = 0.2287 \pm 0.0020_{\rm stat} \pm 0.0025_{\rm syst}$



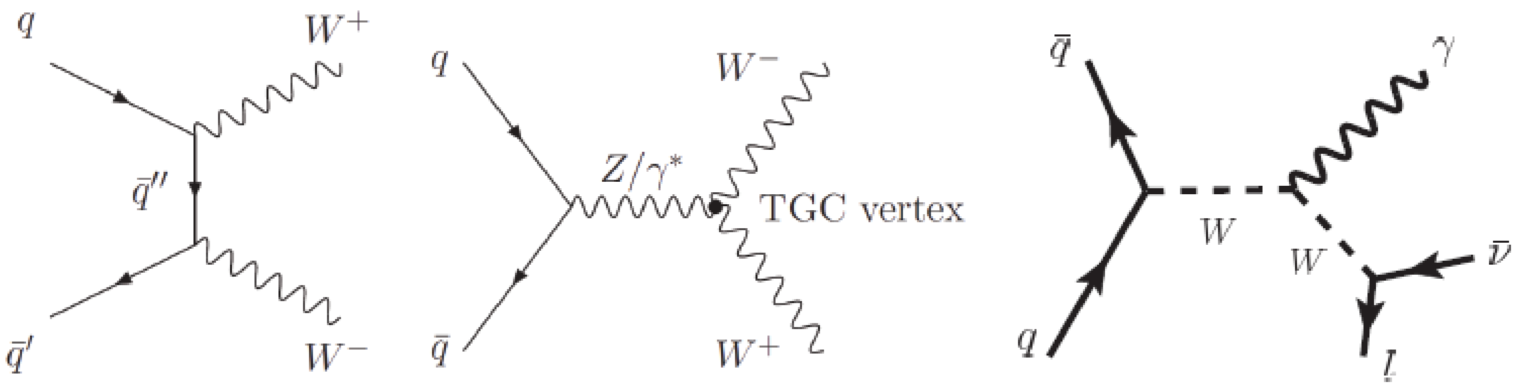




PRD 84, 112002 (2011)

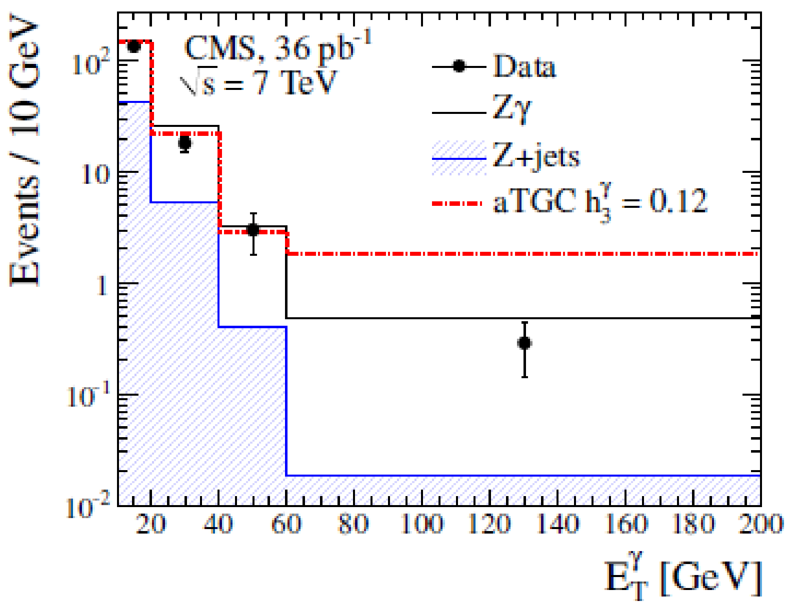
Di-Boson Production

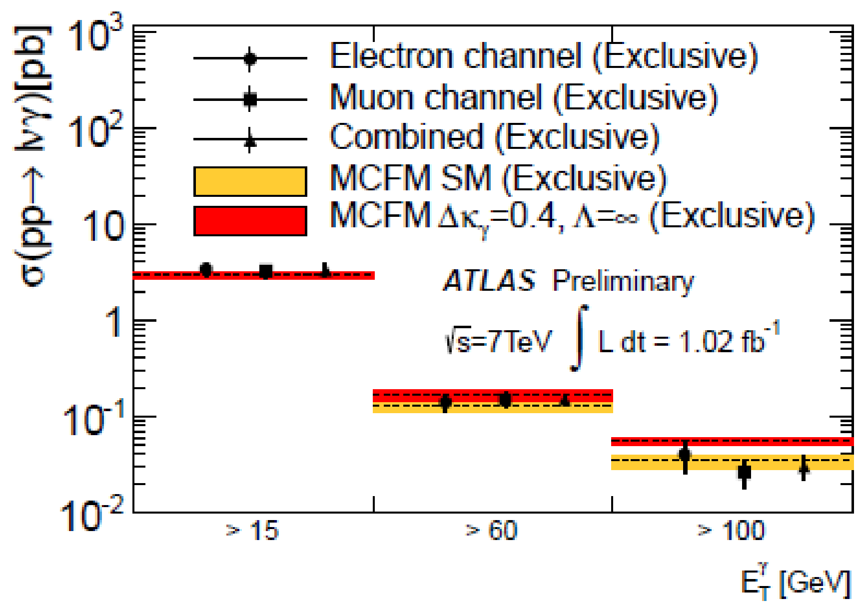
- Main production diagrams for di-bosons are in general t-channel quark exchange and FSR for γ
- In the standard model s-channel contribute with triple gauge coupling (TGC) due to non-Abelian $SU(2)_L \times U(1)_Y$ structure:
  - Allowed for $WW\gamma$ and WWZ vertices
  - Not allowed for "neutral" ZZZ, $ZZ\gamma$ or $Z\gamma\gamma$ vertices
- Select phase space with enhanced TGC contribution, limits on anomalous TGCs (aTGCs); cross sections compared to NLO predictions (both fiducial and total)
- Important irreducible background to some Higgs channels



$W^{\pm}\gamma$ and $Z\gamma$ Production

- Highest cross section di-boson processes: typical Z or W selection, additional isolated photon with $\Delta R(\ell, \gamma) > 0.7$ and $p_T^{\gamma} > 10..15$ GeV
- Cross sections with $\sim 10..15\%$ uncertainty, mostly good agreement with NLO predictions (especially in *exclusive* selection, jet veto)
- aTGCs on $WW\gamma$ and $ZZ\gamma, Z\gamma\gamma$ vertices on similar level as Tevatron and LEP analyses

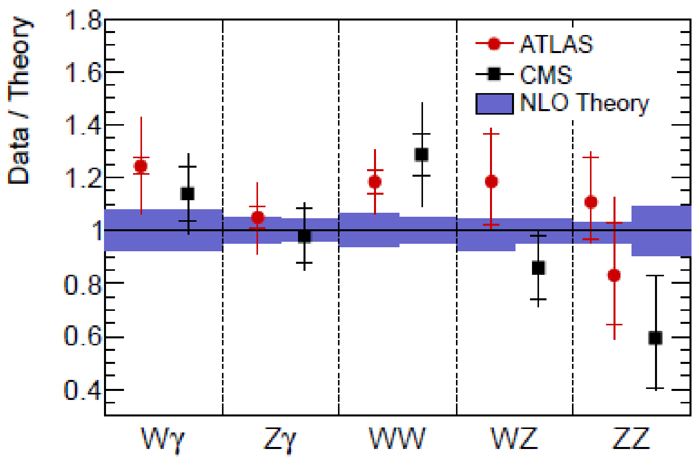


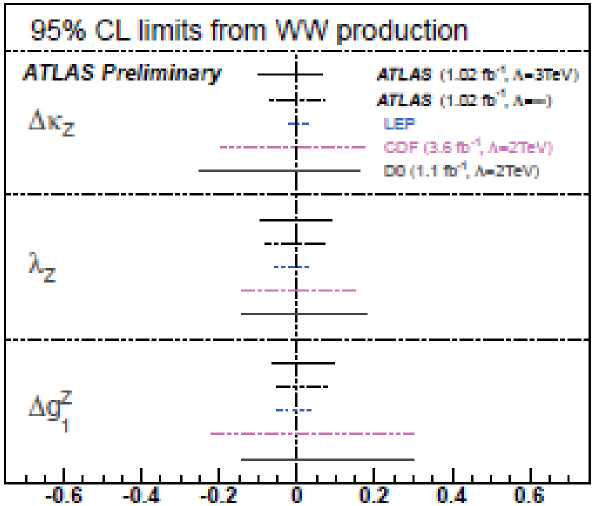


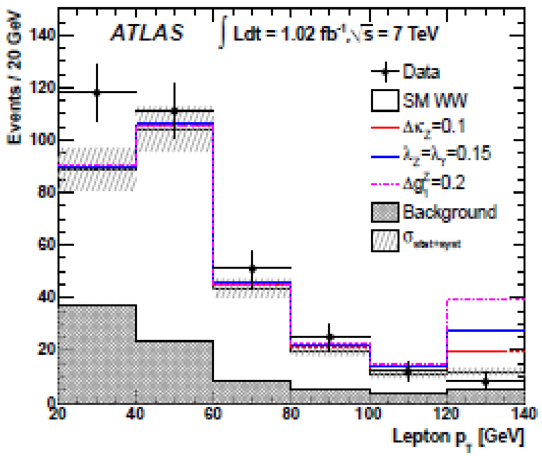
JHEP 09 (2011) 072; to be submitted to PLB; PLB 701 (2011) 535-555

W^+W^- Production

- Measured in leptonic channels $2e2\nu, 2\mu2\nu, e\mu2\nu$
- Large Drell-Yan bkg. (esp. in like-flavour channels): $\not{E}_T$ relative to lepton/jets; Z mass window veto; Top background controlled with jet/b-jet/soft muon tag vetos
- Cross section precision $\sim 10..15\%$ (largely systematic): ATLAS and CMS $\sim 1\sigma$ above NLO prediction
- aTGC limits sensitive to high leading lepton p_T: limits in between Tevatron and LEP







Топ-кварк исследования на БАК

Motivation

Large sample of top quarks at LHC

- With 5 fb^{-1} 10x more than at Tevatron
- Precision measurements surfacing in ATLAS and CMS
  - $\sigma(t\bar{t})$ at 6% level
  - m(top) below 2 GeV
  - Spin correlations, W helicity and many more

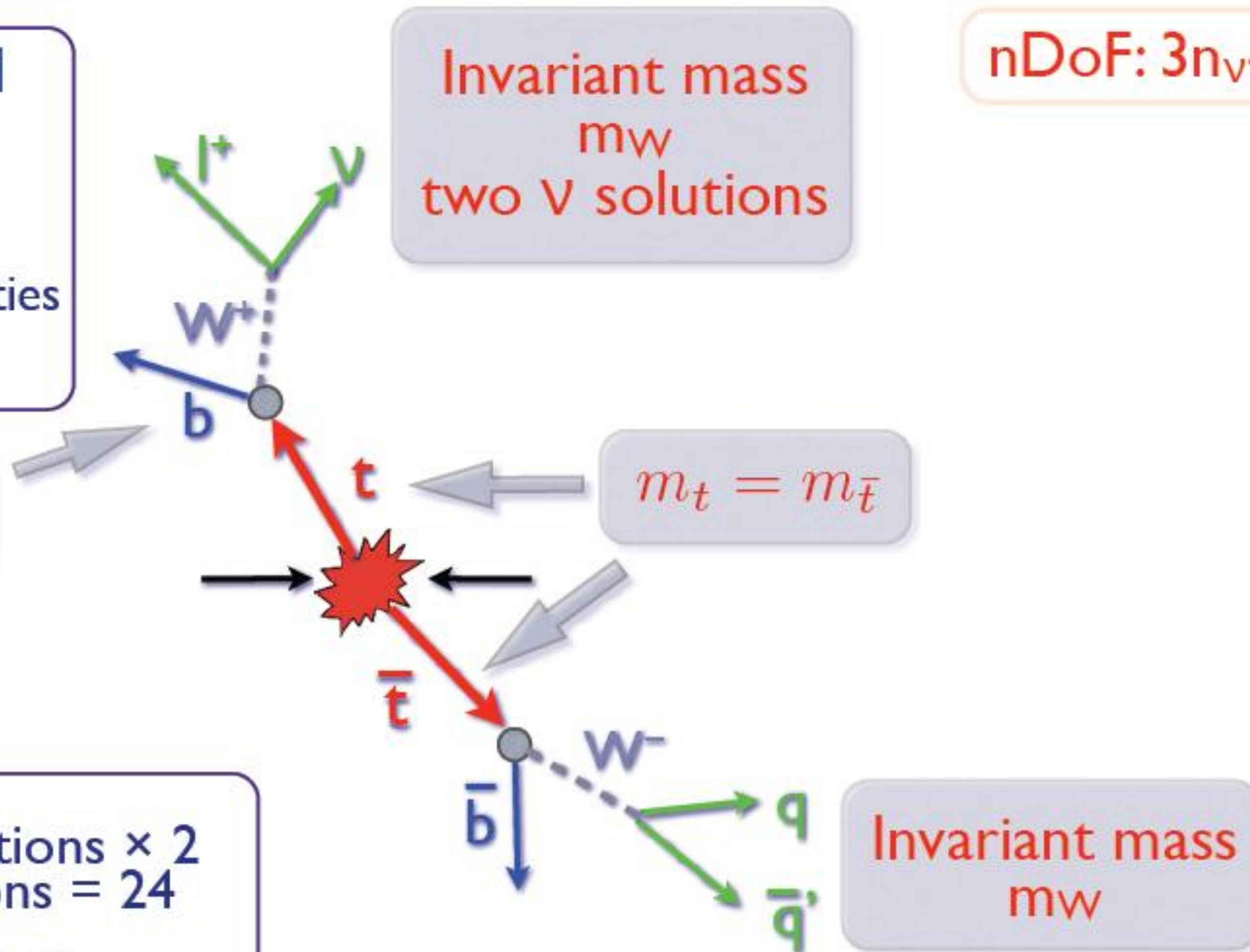
Top event reconstruction: l+jets

nDoF: $3n_\nu-5$

Over constrained kinematic (-2)

- 18 variables
- 17 measured quantities
- 3 constraints

b-tag



- 12 jet configurations × 2 neutrino solutions = 24
- b-tag: 12 permutation
- 2 b-tags: 4 permutations

Presence of hadronic W allows to constrain JES

Preliminary top mass combination

G. Cortiana, M. Mulders

Same categories as at Tevatron

n/a = not applicable
n/e = not evaluated

Note is currently being updated

	ATLAS			CMS				LHC	Tev. 2011
	2010	2011		2010		2011			
	l+jets	l+jets	all jets	di-l	l+jets	di-l	μ+jets	comb.	comb.
[GeV]									
Measured m_{top}	169.33	174.53	174.90	175.50	173.10	173.30	172.64	173.21	173.18
Stat	4.00	0.61	2.10	4.60	2.10	1.20	0.37	0.45	0.56
iJES	n/a	0.43	n/a	n/a	n/a	n/a	0.43	0.40	0.39
aJES	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.09
bJES	2.51	1.58	1.40	0.90	0.90	1.11	0.66	0.65	0.15
cJES	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.05
dJES	2.07	0.66	2.10	2.06	2.06	1.95	0.23	0.06	0.20
rJES	n/a	n/a	n/a	3.28	n/a	n/a	n/a	0.03	0.12
Lept	n/e	n/e	n/e	0.30	n/e	0.15	n/e	0.01	0.10
MC	0.95	0.37	0.50	0.40	n/e	0.14	n/e	0.02	0.51
Rad	2.45	1.01	1.70	0.94	1.19	0.77	0.80	0.70	
CR	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	
PDF	0.51	0.10	0.60	0.50	0.10	0.39	0.05	0.01	
DTMO	1.18	0.33	0.47	0.65	0.42	0.74	0.28	0.21	0.10
UE	n/e	0.59	n/e	1.40	0.20	n/e	n/e	0.14	0.00
BGMC	1.77	0.12	n/a	0.10	0.22	n/a	0.09	0.01	0.14
BGDT	0.64	0.50	1.90	n/a	0.41	0.40	n/a	0.12	0.11
Meth	0.42	0.07	0.98	0.30	0.10	0.40	0.15	0.14	0.09
MHI	0.69	0.01	n/e	1.00	0.10	0.19	0.38	0.29	0.08
[GeV]									
Total Syst. Unc	4.86	2.31	3.87	4.58	2.69	2.65	1.37	1.25	0.75
Total Unc.	6.29	2.39	4.40	6.49	3.41	2.91	1.42	1.33	0.94
Comb. Coeff. [%]	-6.1	22.8	0.2	-0.8	-3.1	-4.2	91.1	χ^2/ndf = 2.7/6	
Pull	-0.6	0.7	0.4	0.4	-0.0	0.0	-1.2	χ^2 prob = 87%	

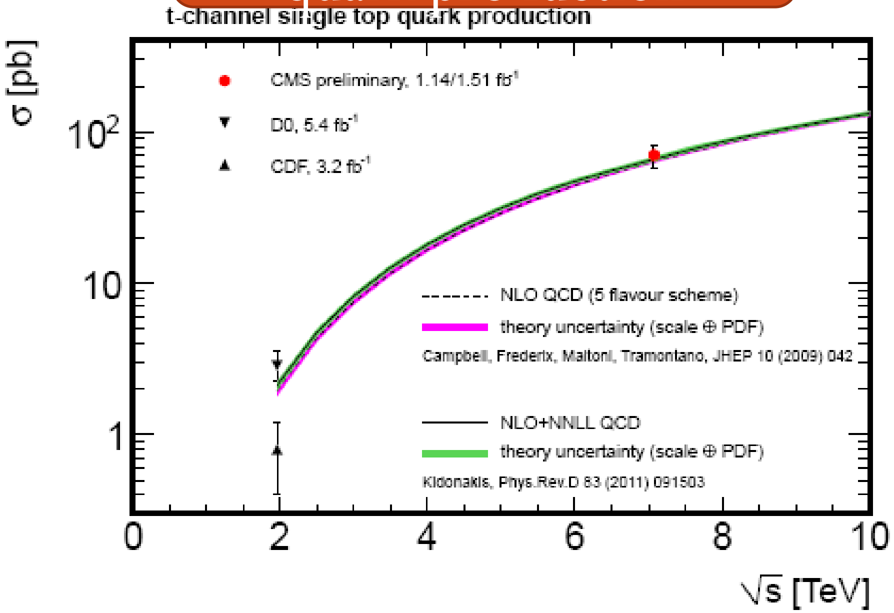
$m_{top}^{LHC} = 173.21 \pm 0.45_{stat} \pm 1.25_{syst}$ GeV

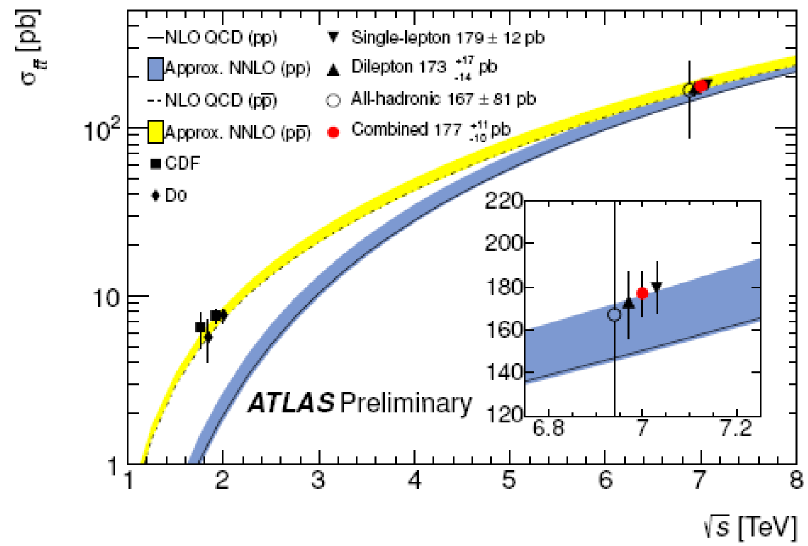
173.2 ± 0.6(stat) ± 0.8(syst)
Tevatron September 2011

Energy dependences for cross sections

t-channel single top quark production

$t\bar{t}$ -production





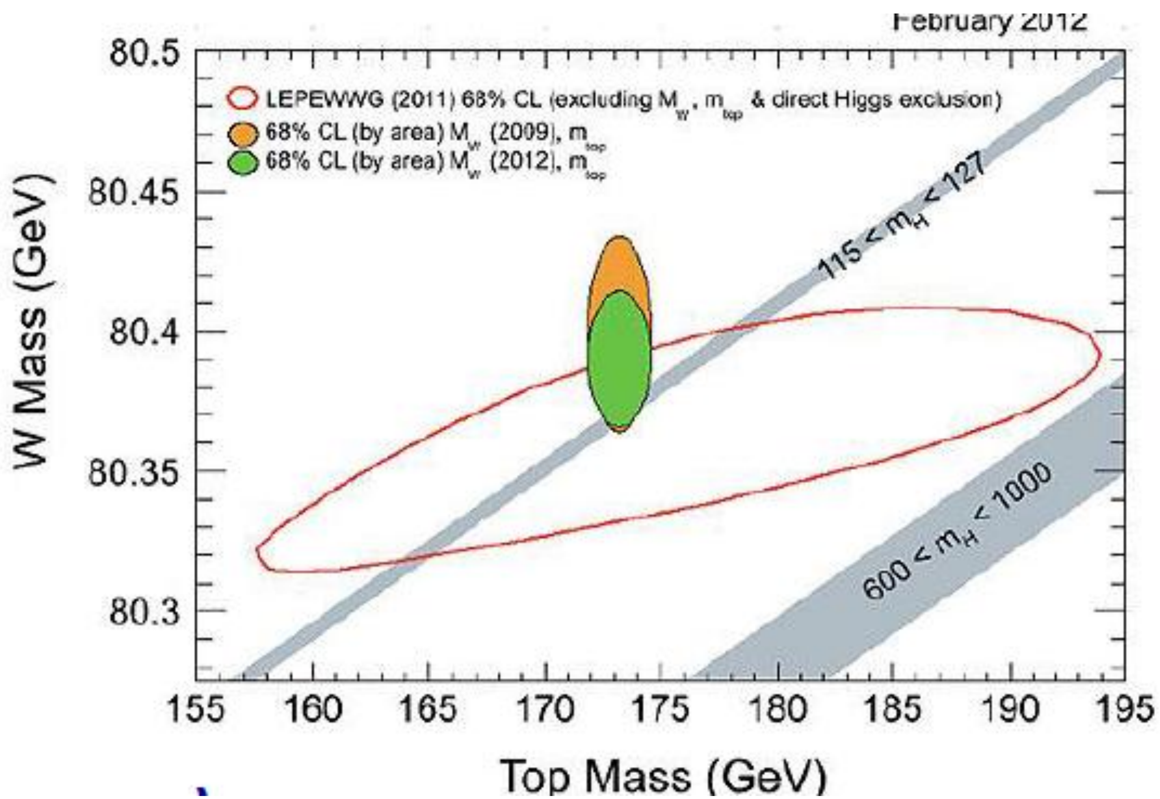
$$\sigma_{t-\text{ch.}} = 70.2 \pm 5.2(\text{stat.}) \pm 10.4(\text{syst.}) \pm 3.4(\text{lumi.})\ \text{pb} \qquad (\text{combined})$$

ATLAS-CONF-2012-024

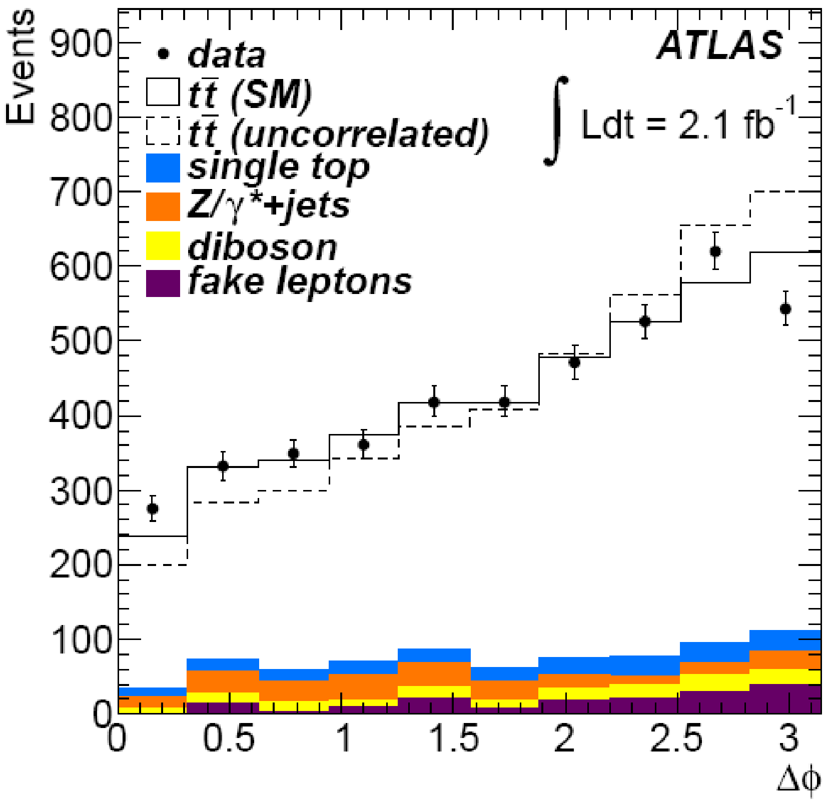
March 16, 2012

Достигнутые точности измерений масс

- Precision measurements surfacing in ATLAS and CMS
  - $\sigma(t\bar{t})$ at 6% level
  - m(top) below 2 GeV
  - Spin correlations, W helicity and many more



Корреляции спинов топ-кварков

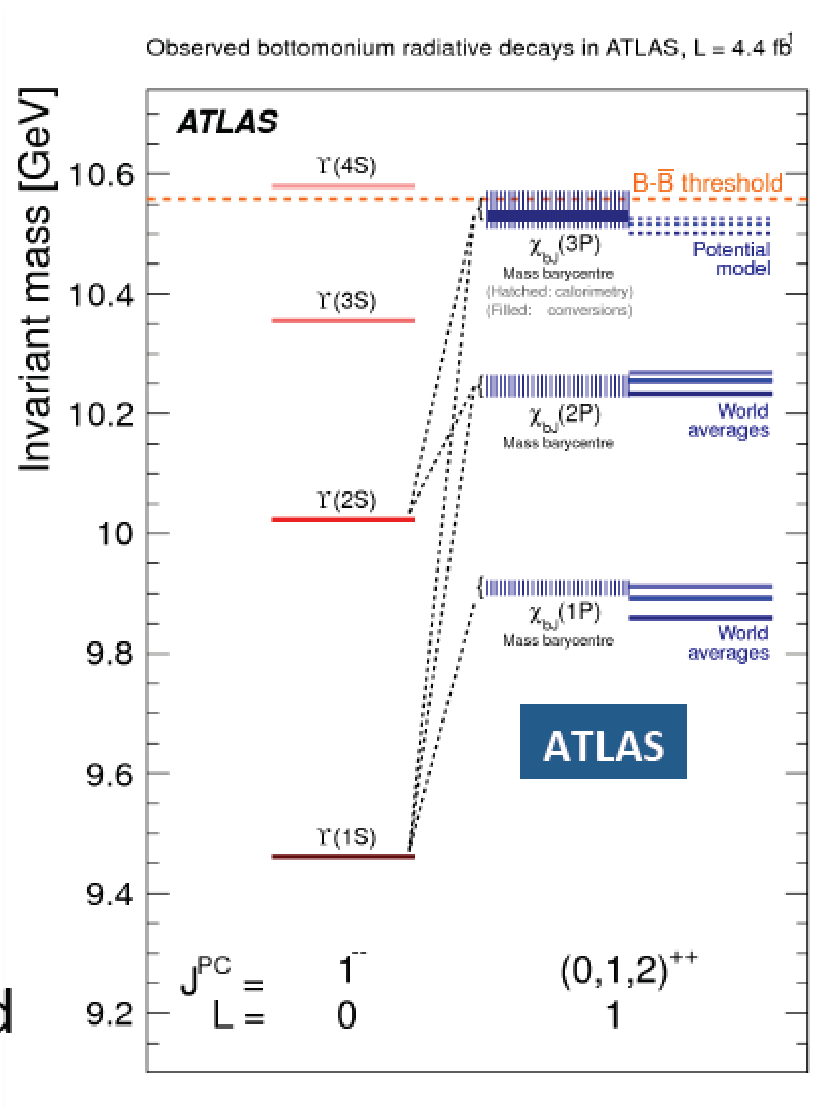


CERN-PH-EP-2012-074
Submitted to: Physical Review Letters

Result consistent with SM predictions
Uncorrelated $t\bar{t}$ production excluded at the level of 5.1 standard deviation

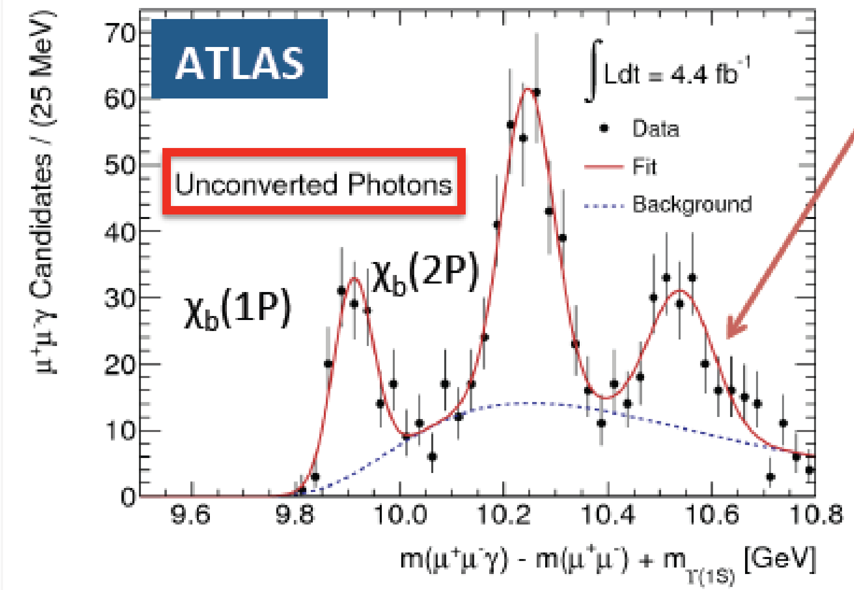
Observation of a new χ_b state

- quarkonium bb-state with with parallel spins
  - $b\bar{b}$ S-wave state: Υ
  - $b\bar{b}$ P-wave state: χ_b with J=0,1,2 triplet spin state
  - χ_b(1P) and χ_b(2P) experimentally studied



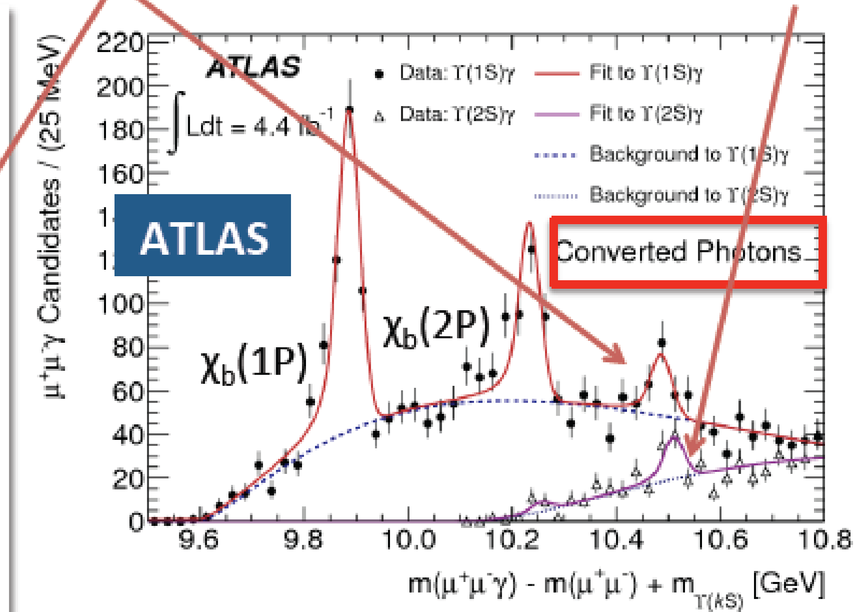
Observation of a new χ_b state

accepted by Phys. Rev. Lett
(arXiv: 1112:5154)



$\chi_b(3P) \rightarrow \Upsilon(1S)\gamma$

$\chi_b(3P) \rightarrow \Upsilon(2S)\gamma$



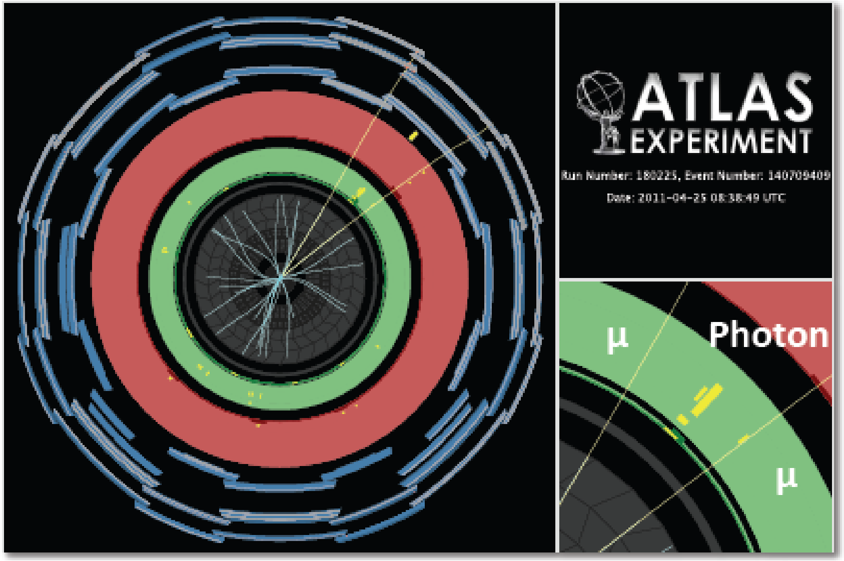
m_3=10.541±0.011(stat.)±0.030(syst.) GeV

m_3=10.530±0.005(stat.)±0.009(syst.) GeV

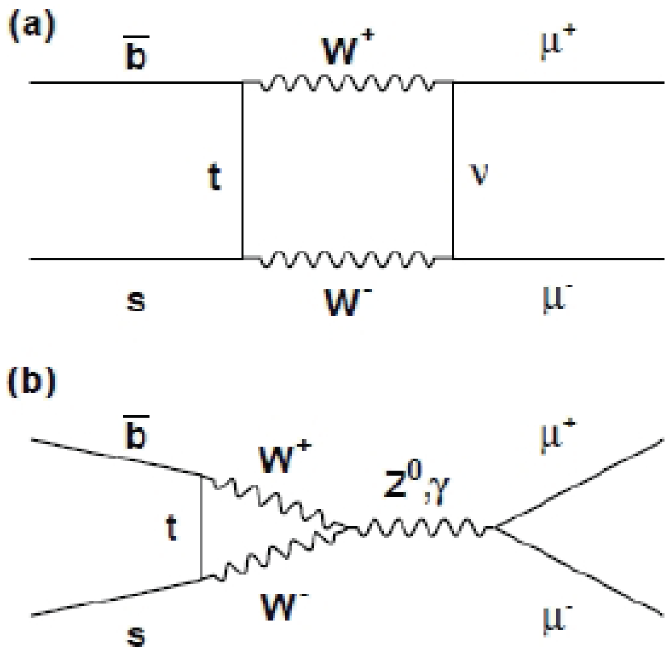
Theory (spin averaged): 10.525 GeV

Observation of a new χ_b state

- reconstruction of χ_b through radiative decays
  - $\chi_b(nP) \rightarrow \Upsilon(1S)\,\gamma$ and $\chi_b(nP) \rightarrow \Upsilon(2S)\,\gamma$
  - γ well reconstructed with calorimeter measurement or via conversion to e^+e^--pairs



Search for Rare B-Decays



- flavour changing neutral currents (FCNC) are highly suppressed in the Standard Model

$$Br(B_s \to \mu^+\mu^-) = (3.2 \pm 0.2) \times 10^{-9}$$

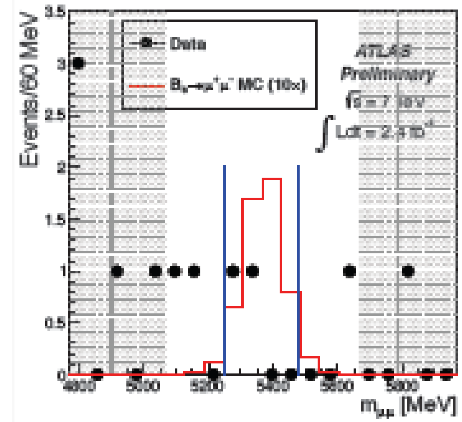
$$Br(B_d \to \mu^+\mu^-) = (1.0 \pm 0.1) \times 10^{-10}$$

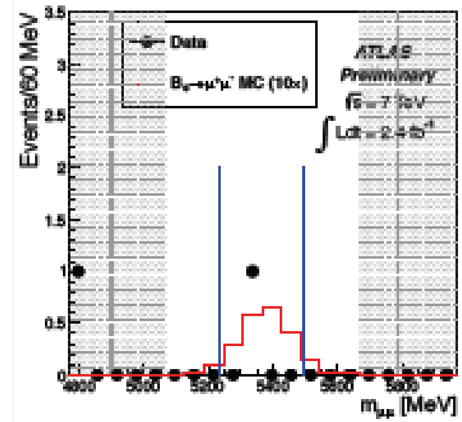
- branching ratio might be substantially enhanced by coupling to non-SM particles
- orthogonal search for physics beyond the standard model

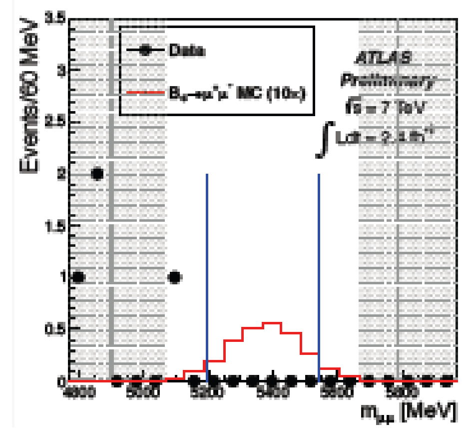
Search for Rare Decays

- optimization and estimation of background events performed on different sideband event samples
  - avoid bias on expected limit
- use different categories in mass resolution (in η)

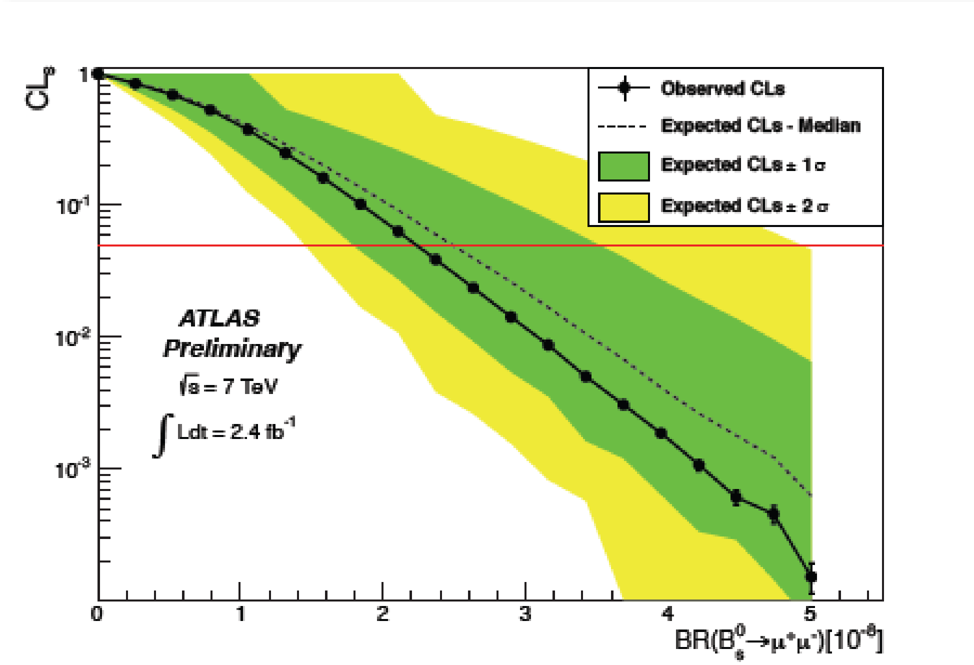
$\|\eta_{max}\|$	0-1.0	1.0-1.5	1.5-2.5
side band count N_{bg} (even numbered events)	5	0	2
bkg. scaling factor	1.29	1.14	0.88
expected resonant bg	0.1	0.06	0.08
search region count N_{sig}	2	1	0







Search for Rare Decays



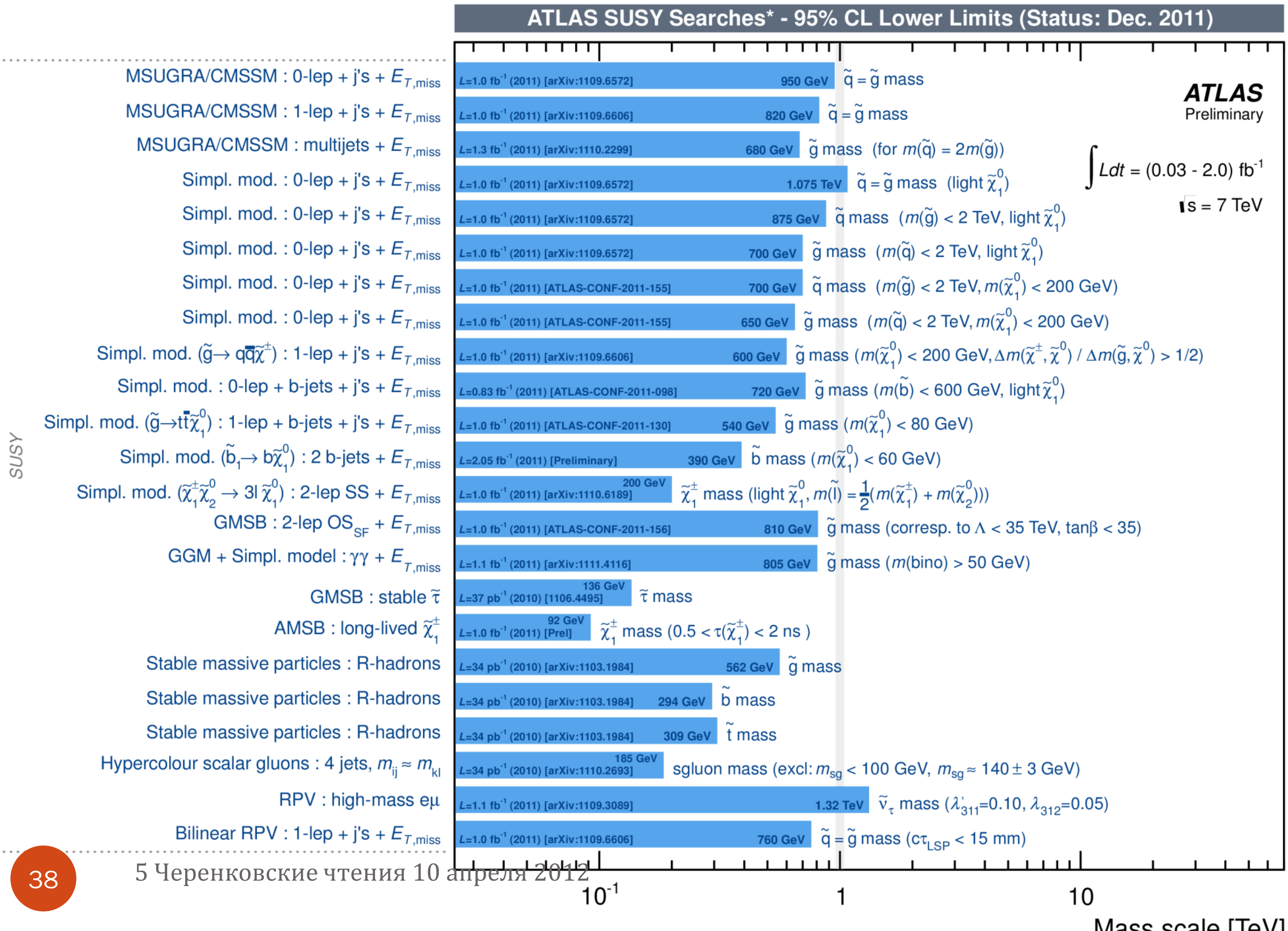
- no excess of signal events over expected background observed
  - limit on branching ratio
  - expected limit: Br_{exp}:$(2.3+1.0-0.5)x10^{-8}$
- measurement consistent with expectation from SM (Br_{SM}: $(3.5\pm0.3)x10^{-9}$)

ATLAS: $Br(B_s \to \mu^+\mu^-) < 2.2$ x 10^{-8} (2.4 fb^{-1})

CMS: $Br(B_s \to \mu^+\mu^-) < 7.7$ x 10^{-9} (4.9 fb^{-1})

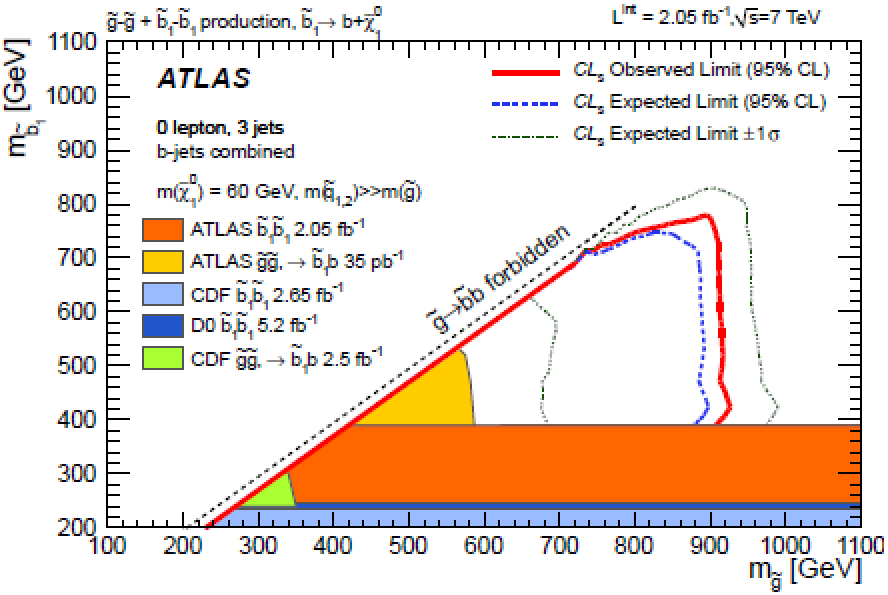
LHCb: $Br(B_s \to \mu^+\mu^-) < 4.5$ x 10^{-9} (1 fb^{-1})

(at 95% CL)



ATLAS SUSY Searches* - 95% CL Lower Limits (Status: Dec. 2011)
ATLAS
Preliminary
∫Ldt = (0.03 - 2.0) fb-1
√s = 7 TeV
SUSY
MSUGRA/CMSSM : 0-lep + j's + ET,miss
L=1.0 fb-1 (2011) [arXiv:1109.6572] 950 GeV q̃ = g̃ mass
MSUGRA/CMSSM : 1-lep + j's + ET,miss
L=1.0 fb-1 (2011) [arXiv:1109.6606] 820 GeV q̃ = g̃ mass
MSUGRA/CMSSM : multijets + ET,miss
L=1.3 fb-1 (2011) [arXiv:1110.2299] 680 GeV g̃ mass (for m(q̃) = 2m(g̃))
Simpl. mod. : 0-lep + j's + ET,miss
L=1.0 fb-1 (2011) [arXiv:1109.6572] 1.075 TeV q̃ = g̃ mass (light χ̃10)
Simpl. mod. : 0-lep + j's + ET,miss
L=1.0 fb-1 (2011) [arXiv:1109.6572] 875 GeV q̃ mass (m(g̃) < 2 TeV, light χ̃10)
Simpl. mod. : 0-lep + j's + ET,miss
L=1.0 fb-1 (2011) [arXiv:1109.6572] 700 GeV g̃ mass (m(q̃) < 2 TeV, light χ̃10)
Simpl. mod. : 0-lep + j's + ET,miss
L=1.0 fb-1 (2011) [ATLAS-CONF-2011-155] 700 GeV q̃ mass (m(g̃) < 2 TeV, m(χ̃10) < 200 GeV)
Simpl. mod. : 0-lep + j's + ET,miss
L=1.0 fb-1 (2011) [ATLAS-CONF-2011-155] 650 GeV g̃ mass (m(q̃) < 2 TeV, m(χ̃10) < 200 GeV)
Simpl. mod. (g̃→ qq̄χ̃±) : 1-lep + j's + ET,miss
L=1.0 fb-1 (2011) [arXiv:1109.6606] 600 GeV g̃ mass (m(χ̃10) < 200 GeV, Δm(χ̃±, χ̃0) / Δm(g̃, χ̃0) > 1/2)
Simpl. mod. : 0-lep + b-jets + j's + ET,miss
L=0.83 fb-1 (2011) [ATLAS-CONF-2011-098] 720 GeV g̃ mass (m(b̃) < 600 GeV, light χ̃10)
Simpl. mod. (g̃→tt̄χ̃10) : 1-lep + b-jets + j's + ET,miss
L=1.0 fb-1 (2011) [ATLAS-CONF-2011-130] 540 GeV g̃ mass (m(χ̃10) < 80 GeV)
Simpl. mod. (b̃1→ bχ̃10) : 2 b-jets + ET,miss
L=2.05 fb-1 (2011) [Preliminary] 390 GeV b̃ mass (m(χ̃10) < 60 GeV)
Simpl. mod. (χ̃1±χ̃20 → 3l χ̃10) : 2-lep SS + ET,miss
L=1.0 fb-1 (2011) [arXiv:1110.6189] 200 GeV χ̃1± mass (light χ̃10, m(l̃) = 1/2(m(χ̃1±) + m(χ̃20)))
GMSB : 2-lep OSSF + ET,miss
L=1.0 fb-1 (2011) [ATLAS-CONF-2011-156] 810 GeV g̃ mass (corresp. to Λ < 35 TeV, tanβ < 35)
GGM + Simpl. model : γγ + ET,miss
L=1.1 fb-1 (2011) [arXiv:1111.4116] 805 GeV g̃ mass (m(bino) > 50 GeV)
GMSB : stable τ̃
L=37 pb-1 (2010) [1106.4495] 136 GeV τ̃ mass
AMSB : long-lived χ̃1±
L=1.0 fb-1 (2011) [Prel] 92 GeV χ̃1± mass (0.5 < τ(χ̃1±) < 2 ns)
Stable massive particles : R-hadrons
L=34 pb-1 (2010) [arXiv:1103.1984] 562 GeV g̃ mass
Stable massive particles : R-hadrons
L=34 pb-1 (2010) [arXiv:1103.1984] 294 GeV b̃ mass
Stable massive particles : R-hadrons
L=34 pb-1 (2010) [arXiv:1103.1984] 309 GeV t̃ mass
Hypercolour scalar gluons : 4 jets, mij ≈ mkl
L=34 pb-1 (2010) [arXiv:1110.2693] 185 GeV sgluon mass (excl: msg < 100 GeV, msg ≈ 140 ± 3 GeV)
RPV : high-mass eμ
L=1.1 fb-1 (2011) [arXiv:1109.3089] 1.32 TeV ν̃τ mass (λ'311=0.10, λ312=0.05)
Bilinear RPV : 1-lep + j's + ET,miss
L=1.0 fb-1 (2011) [arXiv:1109.6606] 760 GeV q̃ = g̃ mass (cτLSP < 15 mm)
10-1
1
10
Mass scale [TeV]

SUSY results



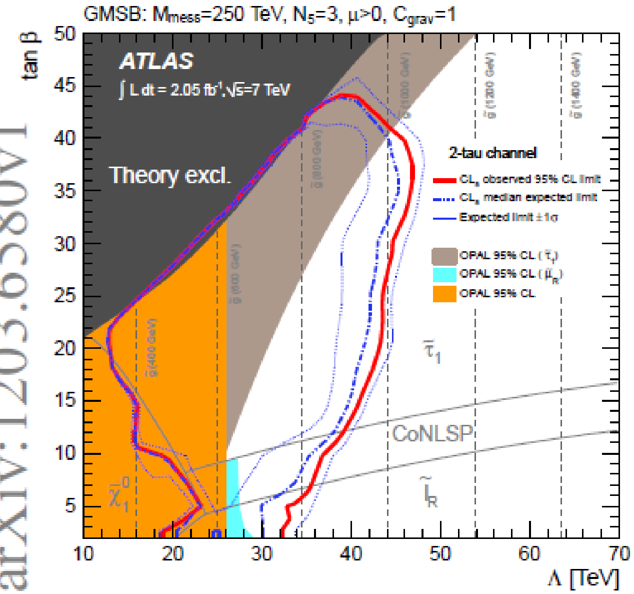
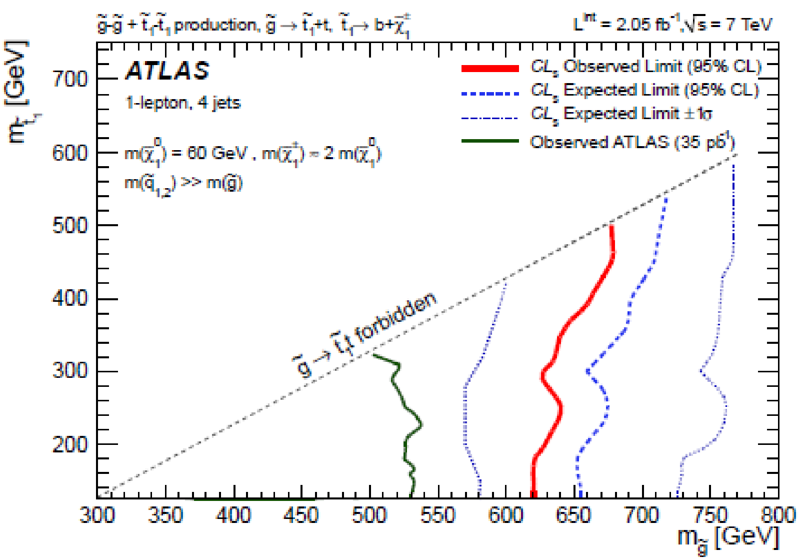


Figure 3: Expected and observed 95 % CL limits on the minimal GMSB model parameters Λ and tan β. The dark grey area indicates



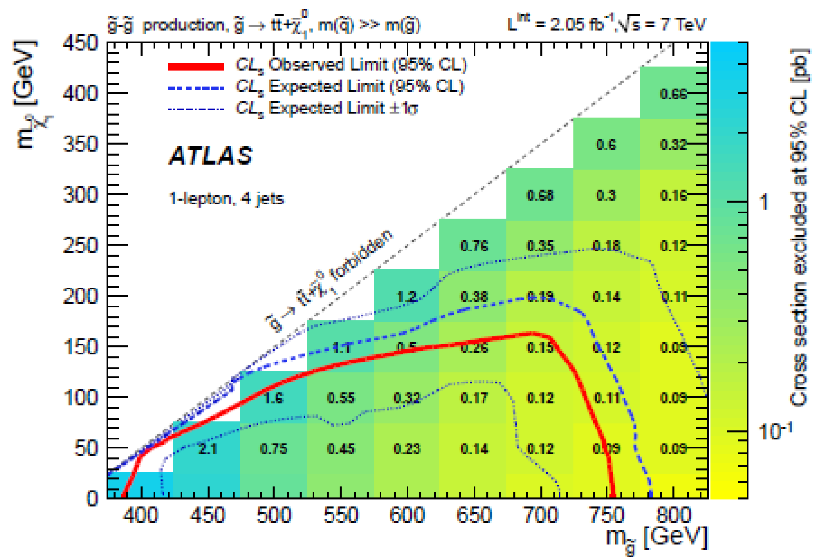
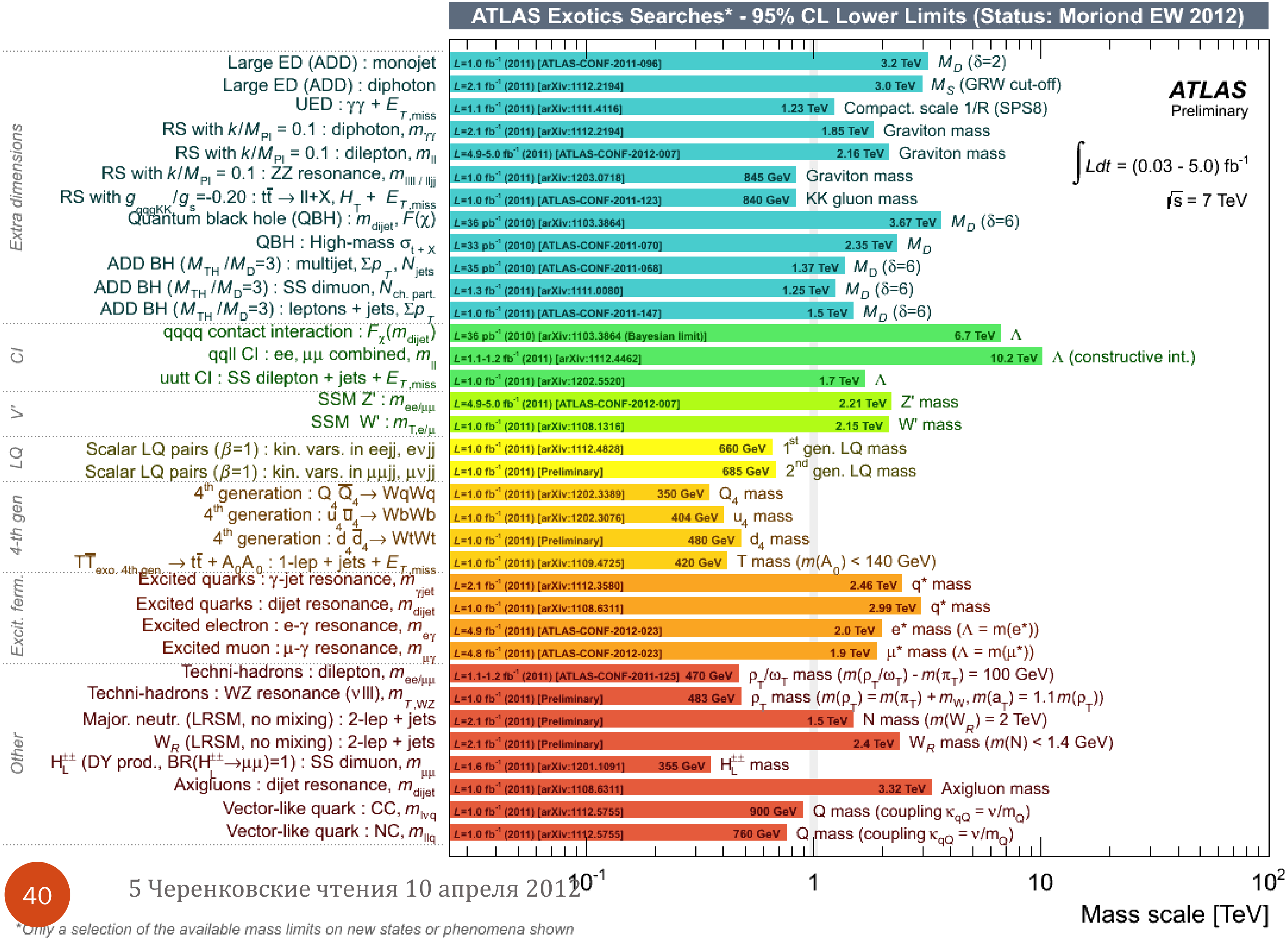


FIG. 8: The observed and expected 95% CL exclusion limits in the $(m_{\tilde{g}}, m_{\tilde{t}})$ plane (gluino-stop models) using

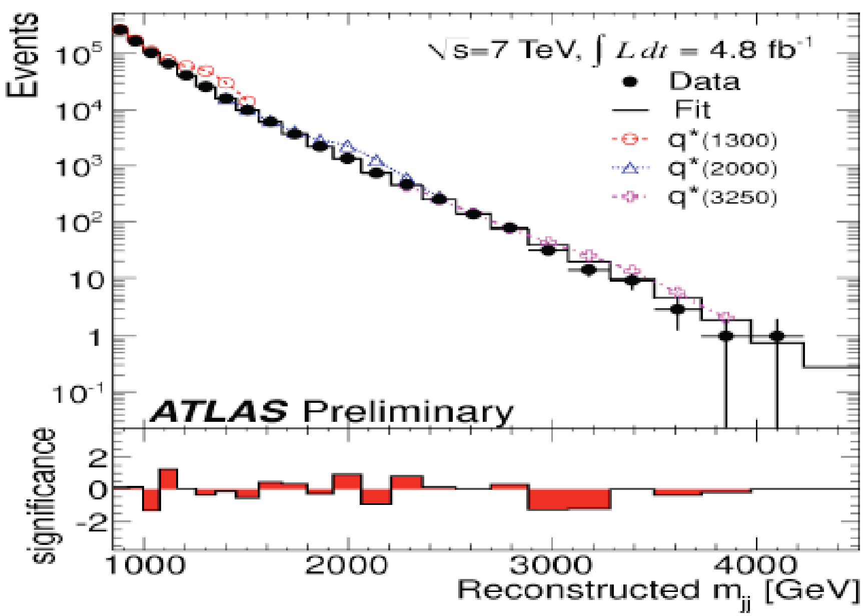
FIG. 9: The observed and expected 95% CL exclusion limits in the $(m_{\tilde{g}}, m_{\tilde{\chi}^0_1})$ plane (Gtt) using the best ex-

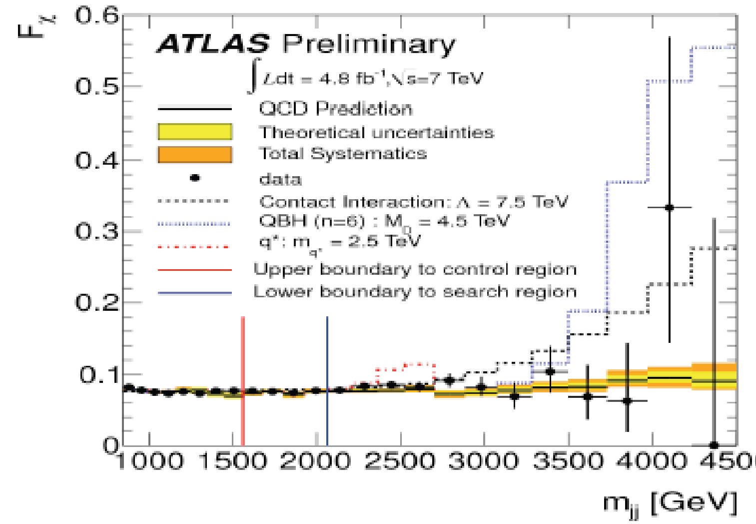

ATLAS Exotics Searches* - 95% CL Lower Limits (Status: Moriond EW 2012)
ATLAS
Preliminary
∫Ldt = (0.03 - 5.0) fb-1
√s = 7 TeV
Extra dimensions
Large ED (ADD) : monojet
L=1.0 fb-1 (2011) [ATLAS-CONF-2011-096] 3.2 TeV M_D (δ=2)
Large ED (ADD) : diphoton
L=2.1 fb-1 (2011) [arXiv:1112.2194] 3.0 TeV M_S (GRW cut-off)
UED : γγ + E_T,miss
L=1.1 fb-1 (2011) [arXiv:1111.4116] 1.23 TeV Compact. scale 1/R (SPS8)
RS with k/M_Pl = 0.1 : diphoton, m_γγ
L=2.1 fb-1 (2011) [arXiv:1112.2194] 1.85 TeV Graviton mass
RS with k/M_Pl = 0.1 : dilepton, m_ll
L=4.9-5.0 fb-1 (2011) [ATLAS-CONF-2012-007] 2.16 TeV Graviton mass
RS with k/M_Pl = 0.1 : ZZ resonance, m_llll / lljj
L=1.0 fb-1 (2011) [arXiv:1203.0718] 845 GeV Graviton mass
RS with g_qqKK/g_s=-0.20 : tt̄ → ll+X, H_T + E_T,miss
L=1.0 fb-1 (2011) [ATLAS-CONF-2011-123] 840 GeV KK gluon mass
Quantum black hole (QBH) : m_dijet, F(χ)
L=36 pb-1 (2010) [arXiv:1103.3864] 3.67 TeV M_D (δ=6)
QBH : High-mass σ_t+X
L=33 pb-1 (2010) [ATLAS-CONF-2011-070] 2.35 TeV M_D
ADD BH (M_TH/M_D=3) : multijet, Σp_T, N_jets
L=35 pb-1 (2010) [ATLAS-CONF-2011-068] 1.37 TeV M_D (δ=6)
ADD BH (M_TH/M_D=3) : SS dimuon, N_ch. part.
L=1.3 fb-1 (2011) [arXiv:1111.0080] 1.25 TeV M_D (δ=6)
ADD BH (M_TH/M_D=3) : leptons + jets, Σp_T
L=1.0 fb-1 (2011) [ATLAS-CONF-2011-147] 1.5 TeV M_D (δ=6)
CI
qqqq contact interaction : F_χ(m_dijet)
L=36 pb-1 (2010) [arXiv:1103.3864 (Bayesian limit)] 6.7 TeV Λ
qqll CI : ee, μμ combined, m_ll
L=1.1-1.2 fb-1 (2011) [arXiv:1112.4462] 10.2 TeV Λ (constructive int.)
uutt CI : SS dilepton + jets + E_T,miss
L=1.0 fb-1 (2011) [arXiv:1202.5520] 1.7 TeV Λ
V'
SSM Z' : m_ee/μμ
L=4.9-5.0 fb-1 (2011) [ATLAS-CONF-2012-007] 2.21 TeV Z' mass
SSM W' : m_T,e/μ
L=1.0 fb-1 (2011) [arXiv:1108.1316] 2.15 TeV W' mass
LQ
Scalar LQ pairs (β=1) : kin. vars. in eejj, eνjj
L=1.0 fb-1 (2011) [arXiv:1112.4828] 660 GeV 1st gen. LQ mass
Scalar LQ pairs (β=1) : kin. vars. in μμjj, μνjj
L=1.0 fb-1 (2011) [Preliminary] 685 GeV 2nd gen. LQ mass
4-th gen
4th generation : Q_4 Q̄_4 → WqWq
L=1.0 fb-1 (2011) [arXiv:1202.3389] 350 GeV Q_4 mass
4th generation : u_4 ū_4 → WbWb
L=1.0 fb-1 (2011) [arXiv:1202.3076] 404 GeV u_4 mass
4th generation : d_4 d̄_4 → WtWt
L=1.0 fb-1 (2011) [Preliminary] 480 GeV d_4 mass
TT̄_exo. 4th gen. → tt̄ + A_0A_0 : 1-lep + jets + E_T,miss
L=1.0 fb-1 (2011) [arXiv:1109.4725] 420 GeV T mass (m(A_0) < 140 GeV)
Excit. ferm.
Excited quarks : γ-jet resonance, m_γjet
L=2.1 fb-1 (2011) [arXiv:1112.3580] 2.46 TeV q* mass
Excited quarks : dijet resonance, m_dijet
L=1.0 fb-1 (2011) [arXiv:1108.6311] 2.99 TeV q* mass
Excited electron : e-γ resonance, m_eγ
L=4.9 fb-1 (2011) [ATLAS-CONF-2012-023] 2.0 TeV e* mass (Λ = m(e*))
Excited muon : μ-γ resonance, m_μγ
L=4.8 fb-1 (2011) [ATLAS-CONF-2012-023] 1.9 TeV μ* mass (Λ = m(μ*))
Other
Techni-hadrons : dilepton, m_ee/μμ
L=1.1-1.2 fb-1 (2011) [ATLAS-CONF-2011-125] 470 GeV ρ_T/ω_T mass (m(ρ_T/ω_T) - m(π_T) = 100 GeV)
Techni-hadrons : WZ resonance (νlll), m_T,WZ
L=1.0 fb-1 (2011) [Preliminary] 483 GeV ρ_T mass (m(ρ_T) = m(π_T) + m_W, m(a_T) = 1.1 m(ρ_T))
Major. neutr. (LRSM, no mixing) : 2-lep + jets
L=2.1 fb-1 (2011) [Preliminary] 1.5 TeV N mass (m(W_R) = 2 TeV)
W_R (LRSM, no mixing) : 2-lep + jets
L=2.1 fb-1 (2011) [Preliminary] 2.4 TeV W_R mass (m(N) < 1.4 GeV)
H_L^±± (DY prod., BR(H_L^±±→μμ)=1) : SS dimuon, m_μμ
L=1.6 fb-1 (2011) [arXiv:1201.1091] 355 GeV H_L^±± mass
Axigluons : dijet resonance, m_dijet
L=1.0 fb-1 (2011) [arXiv:1108.6311] 3.32 TeV Axigluon mass
Vector-like quark : CC, m_lνq
L=1.0 fb-1 (2011) [arXiv:1112.5755] 900 GeV Q mass (coupling κ_qQ = ν/m_Q)
Vector-like quark : NC, m_llq
L=1.0 fb-1 (2011) [arXiv:1112.5755] 760 GeV Q mass (coupling κ_qQ = ν/m_Q)
10-1
1
10
102
Mass scale [TeV]
*Only a selection of the available mass limits on new states or phenomena shown

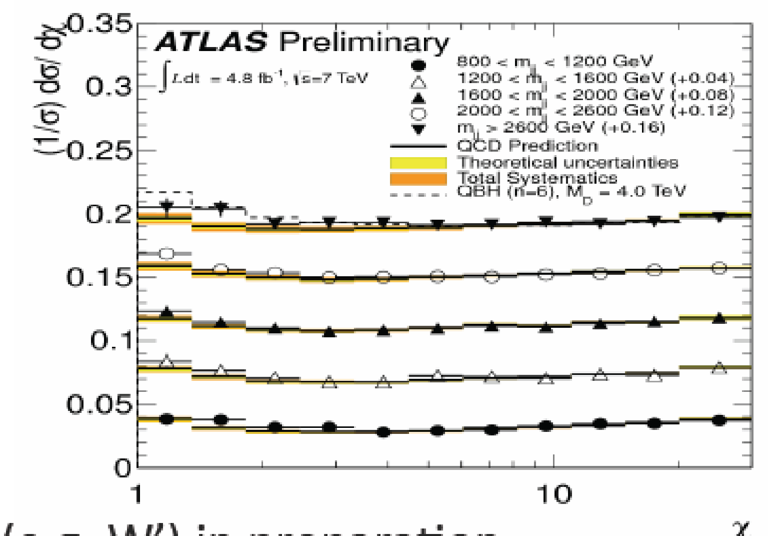
Dijet Searches

- Look for bumps in m_{jj} and deviations in χ, F_χ

ATLAS-CONF-2012-038





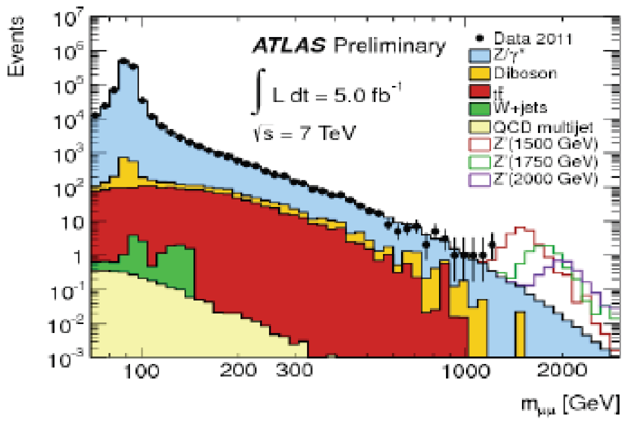


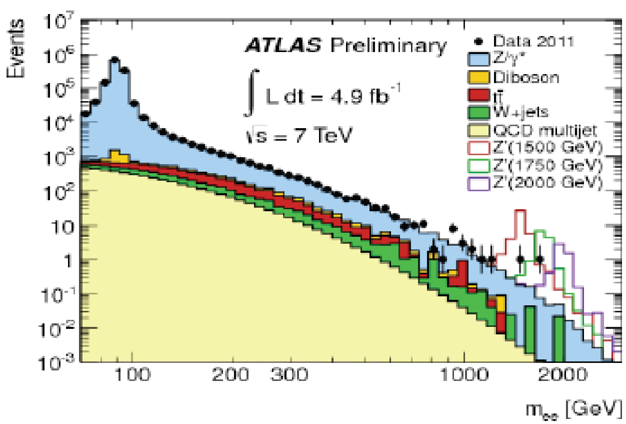
- 95% C.L. limit on:
  - $m_{q*} > 3.35$ TeV (3.09 TeV)
    - was $m_{q*} > 2.15$ (2.07) TeV with 2010 data
  - Contact interaction: $\Lambda > 7.8$ TeV (8.7 TeV)
- Publication with latest JES and new models (e.g. W') in preparation

$$\chi \equiv \exp(|y1 - y2|) = exp(2|y*|).$$

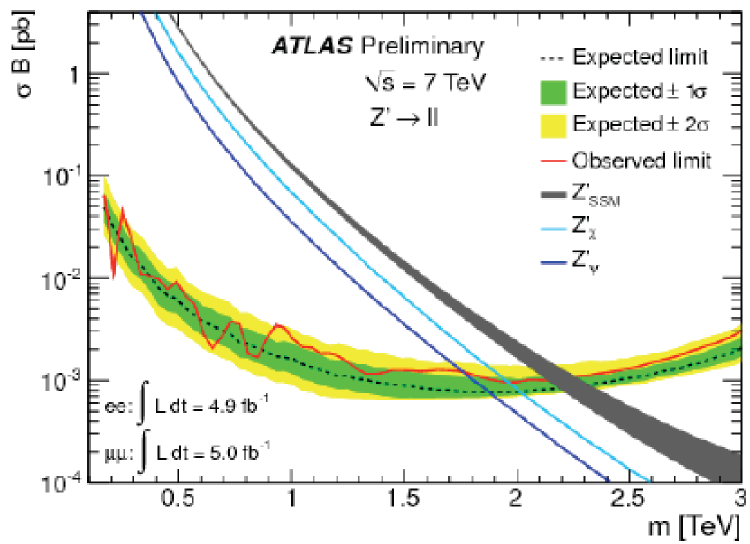
Dilepton Resonances

- Template shape fit to entire dilepton mass spectrum above Z pole
- New: Muon channel uses well understood 2-station muons





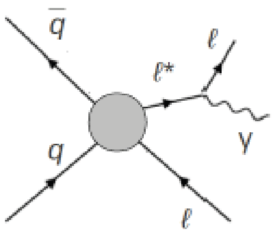
ATLAS-CONF-2012-007

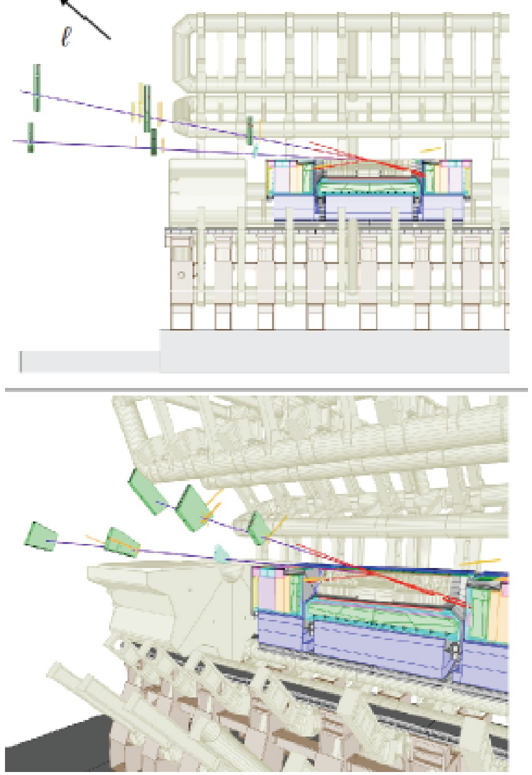


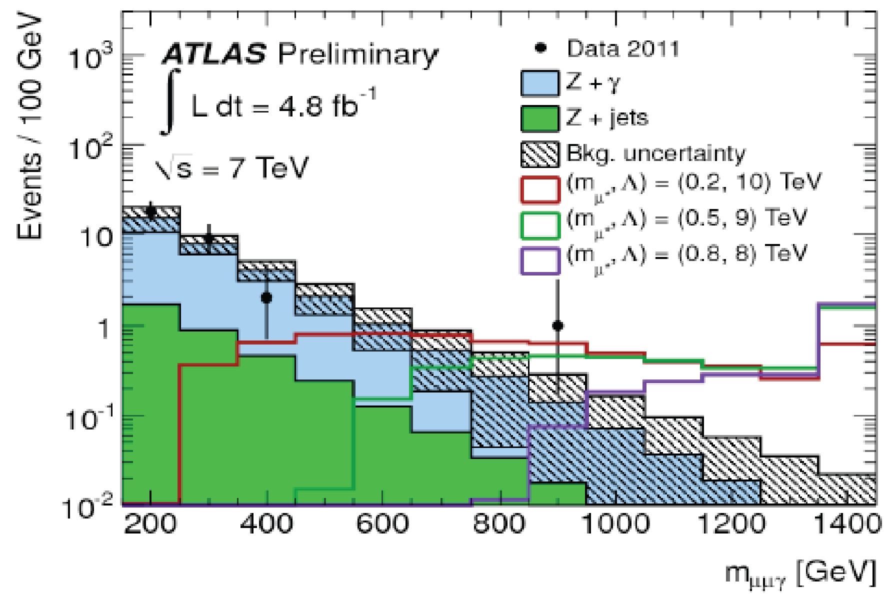
- 95% C.L. limit on spin-1 and -2 resonances
  - m_{SSM} > 2.21 TeV (2.26 TeV)
    - was m_{SSM} > 1.05 (1.09) TeV with 2010 data
  - $m_{G*}(k/M_{Pl}=0.1)$ > 2.16 TeV (2.17 TeV)

Excited Lepton

- Look for excess in dilepton + photon invariant mass ATLAS-CONF-2012-008





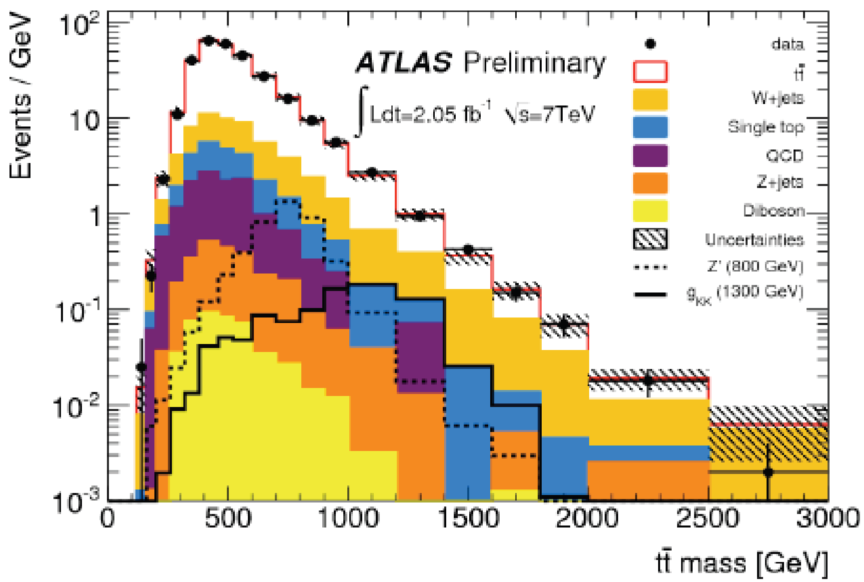


- 95% C.L. limit on compositeness scale
  - For $m(l^*) = \Lambda$
    - $m(e^*) > 2.0$ TeV (2.0 TeV)
    - $m(\mu^*) > 1.9$ TeV (1.9 TeV)
- Fast 5 fb^{-1} update after 2 fb^{-1} paper

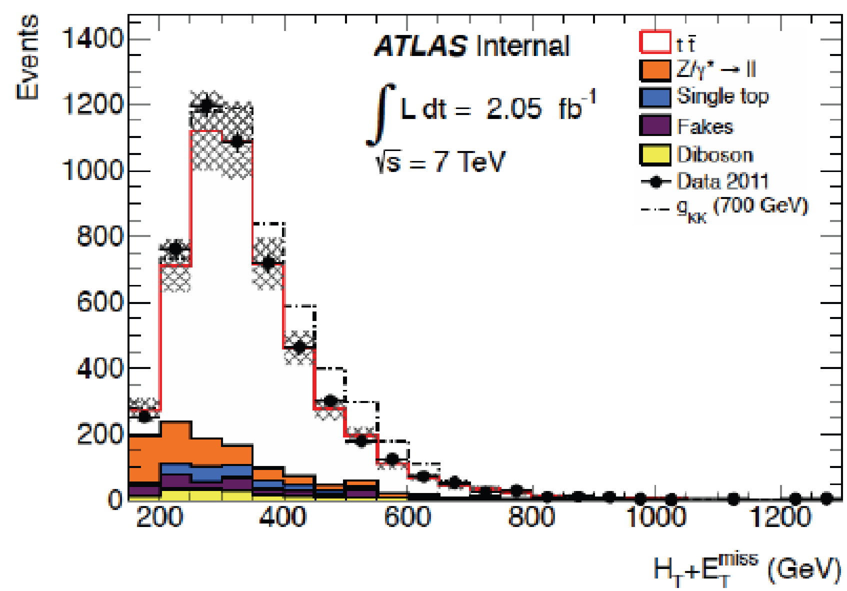
Resolved TTbar Resonances

- Search for peak in ttbar mass distribution for l+jets channel

ATLAS-CONF-2012-029



- Look for excess in $H_T+E_t^{miss}$ distribution for dilepton channel

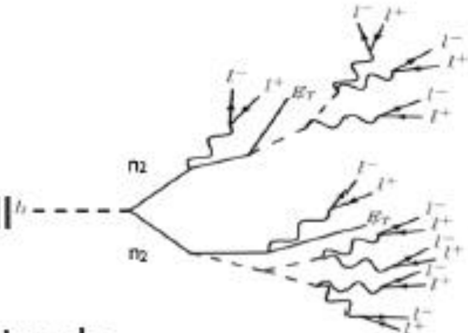


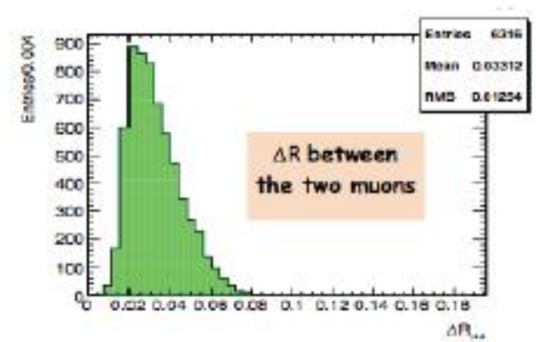
- Combined l+jets and dilepton paper awaiting Edboard approval

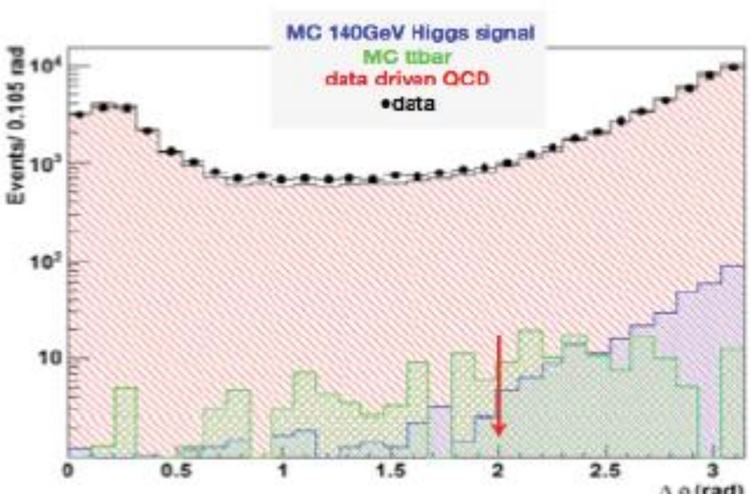
- 95% C.L. limit on KK Gluon in Randall-Sandrum
  - L+Jets: $M_{KKGluon}$>1.13 TeV (1.36 TeV), $M_{Z'}$>0.88 TeV (1.01 TeV)
  - Dilepton: $M_{KKGluon}$>1.08 TeV (1.07 TeV)

New: Displaced Muon Jets

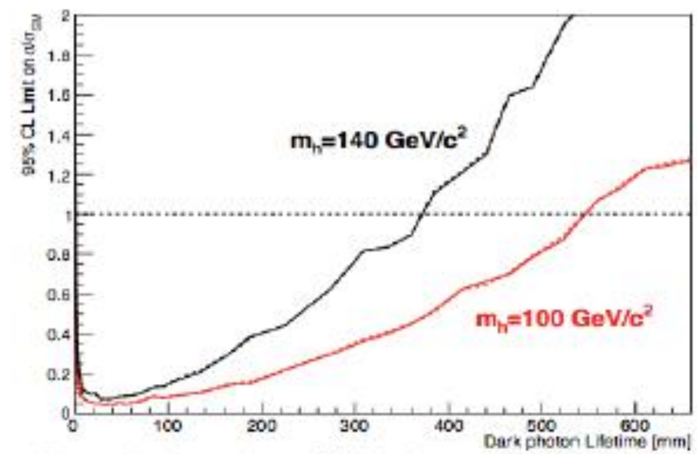
- "Hidden Valley" scenarios predict higgs decay into light particles, that can decay back into the standard sector via collimated jets of leptons
- Signature:
  - 2 back to back dark photons
  - Resulting muon pairs with small opening angle
  - Displaced muons, use MUIDSA tracks







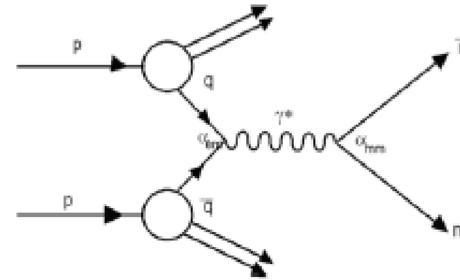
Δφ> 2



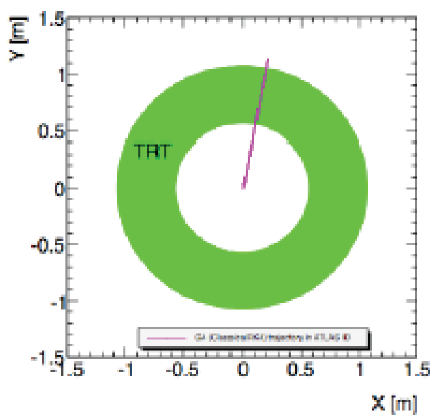
We exclude at the 95% CL the ranges
[1.1 mm - 545 mm] for the signal with m_{Higgs} =100 GeV
[1.1 mm - 370 mm] for the signal with m_{Higgs} =140 GeV

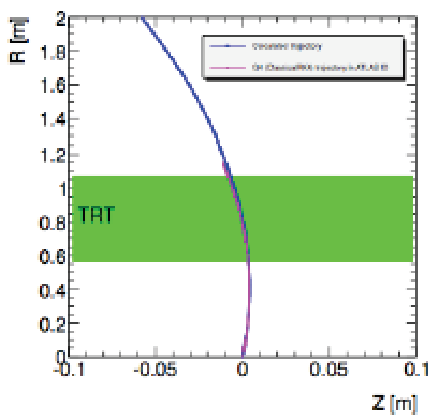
New: Monopoles

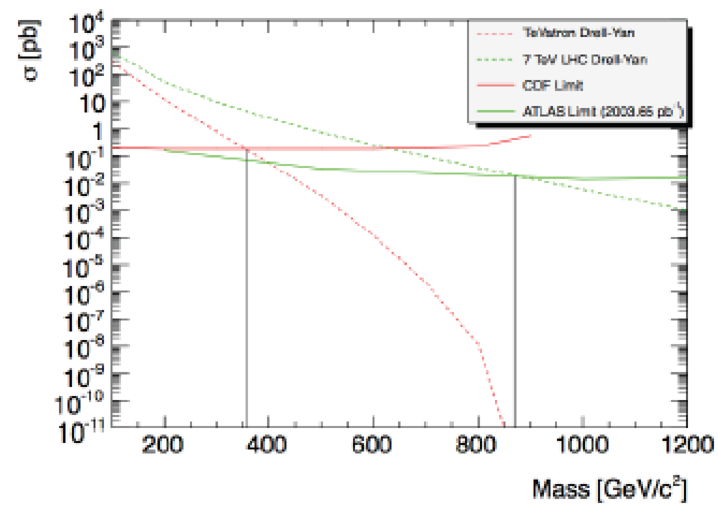
- Benchmark signal: Monopole pair production



- Characteristics:
  - Bend in z, straight line in r-ϕ
  - Highly ionizing
    - Localized energy deposit in LAr of EM calorimeter
    - TRT high threshold hits
- Sensitivity ~M_M>0.86 TeV







Заключение

- Остался незакрытым узкий интервал масс для наблюдения скалярного бозона (бозона Хиггса) Стандартной модели. Существует вероятность его наблюдения при массе ~125 ГэВ
- Все полученные результаты по измерениям векторных бозонов согласуются с предсказаниями СМ.
- Измерены сечения парного и одиночного рождения топ-кварка, выполнены измерения его массы
- Не обнаружено эффектов новой физики за пределами Стандартной модели
- Значительно уменьшено поле параметров простейших вариантов суперсимметричных моделей