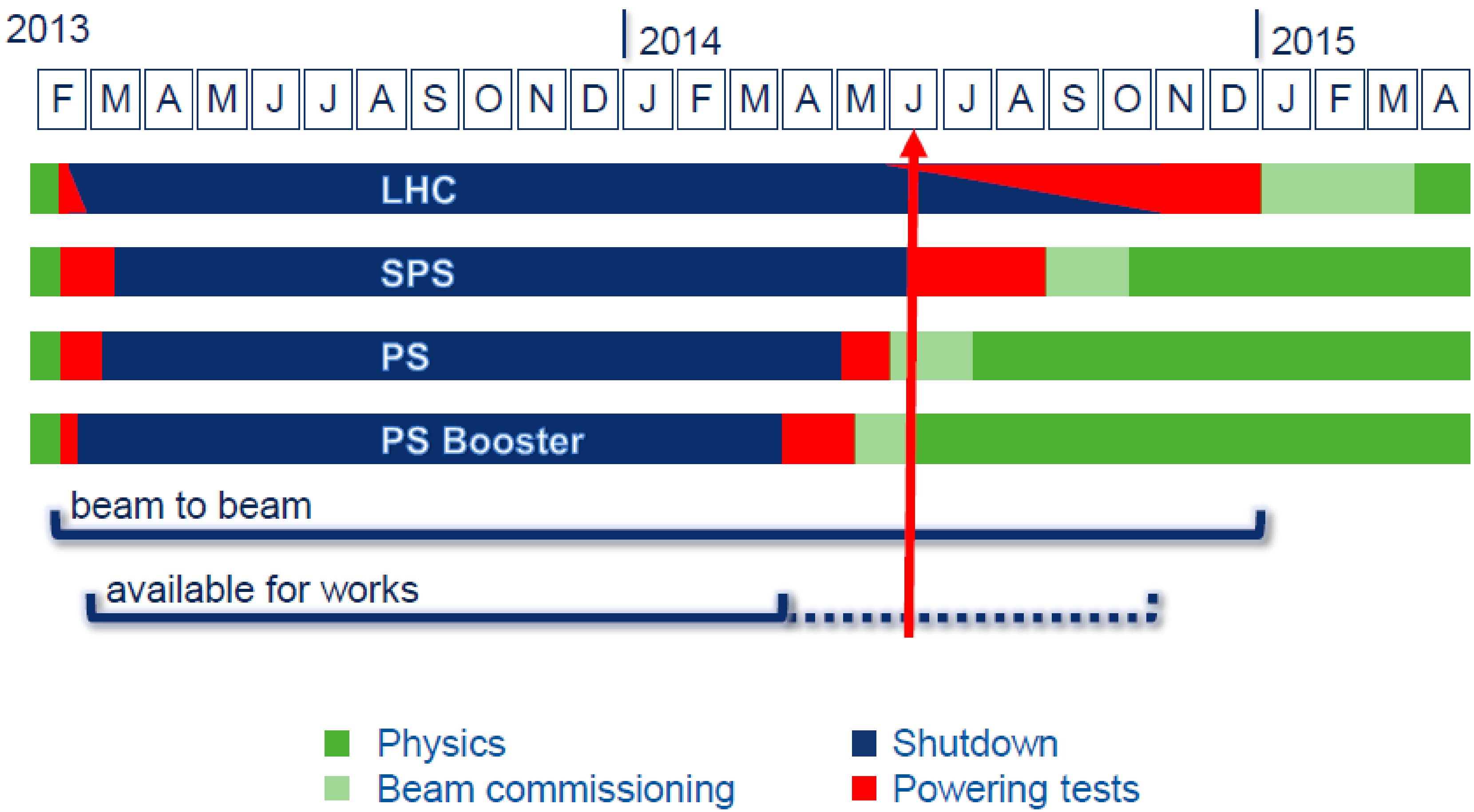
ATLAS

ATLAS

- 335 papers published (or submitted) at 06/07/2014
  - Covering a wide spectrum of physics analyses: B-physics, Exotics (BSM), Higgs, Heavy Ions, Standard Model, SUSY, Top quark physics,…
  - Using LHC Run I dataset: 4.5 fb^{-1} @7TeV and 20.3 fb^{-1} @8TeV
  - Data collected up to February 2013
- Run 2 starting early 2015 at 13 TeV pp center-of-mass energy, 25 ns bunch spacing, $L=1x10^{34}$ cm^{-2} s^{-1}, about 100 fb^{-1} expected
- Some ATLAS detector upgrades:
  - new pixel layer closer (3.3 cm) to the beam line (IBL) and a small radius Be beam pipe
  - fast track trigger at Level 2 (FTK)

LS1 - time span



ATLAS

- Concurrent efforts in the collaboration:
  - Finish RUN 1 analyses as soon as possible
  - Prepare RUN2 (commissioning detector, software,...)
- Short review of recent analyses results with Milano involvement
- Performance studies:
  - Tau lepton reconstruction
  - Etmiss reconstruction
  - e/γ calibration
  - tracking
- Physics analyses:
  - Dark matter searches
  - SUSY searches
  - Higgs properties measurements
  - QCD prompt photon(s) production

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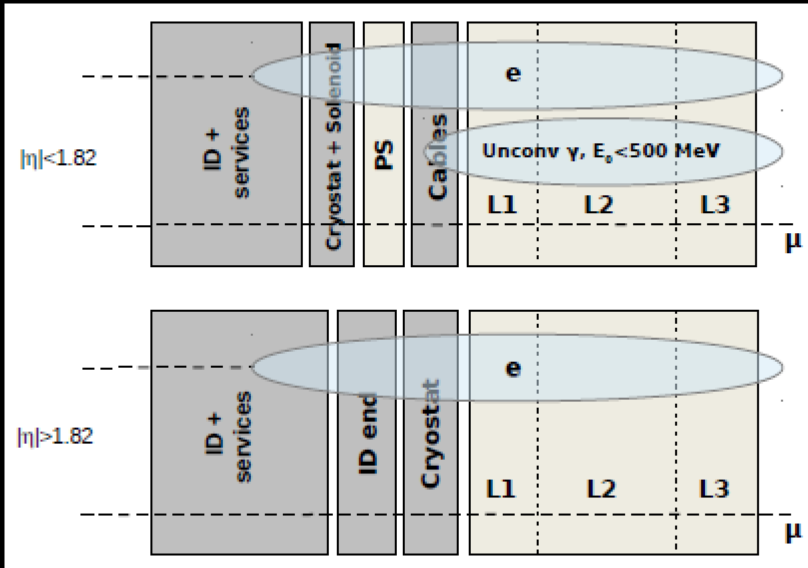
Performance studies

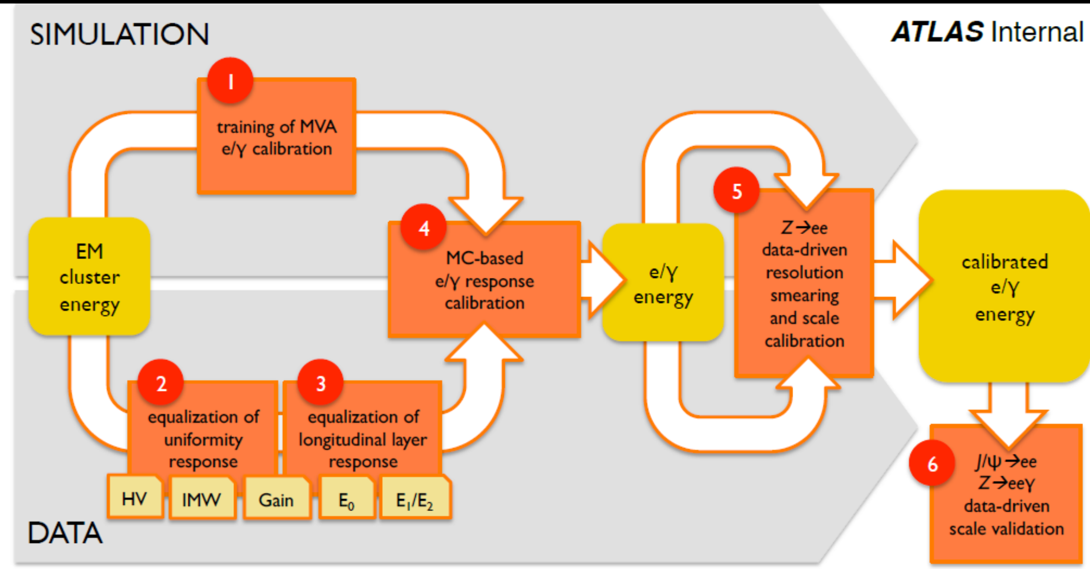
Performance studies

- Tau
  - Attilio Andreazza co-convenor of tau working group (October 2013-October 2015)
  - Studies of tau trigger performance with FTK using BDT techniques
- Etmiss
  - "Reconstruction and Missing ET Performance in the ATLAS detector using proton-proton collisions at sqrt(s)=8 TeV"
    - Contact editor: Caterina Pizio, paper in preparation
  - Prepared recommendation for Etmiss in RUN2: reconstruct soft term from primary vertex tracks instead of topocluster+tracks (less sensible to pile-up contribution)

E/gamma calibration

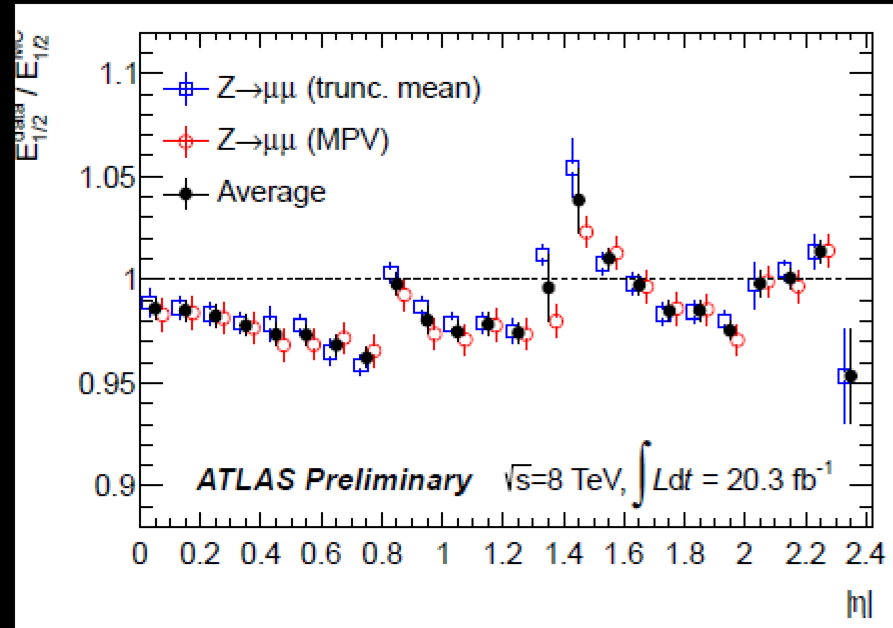
- Calibration of electrons and photons
  - Leonardi Carminati co-convenor of e/gamma calibration group up to May 2014; now replaced by Ruggero Turra
- "Electron and photon energy calibration with the ATLAS detector using LHC Run 1 data"
  - Contact editor: L. Carminati, to be submitted to Eur. Phys. J. C (2014)

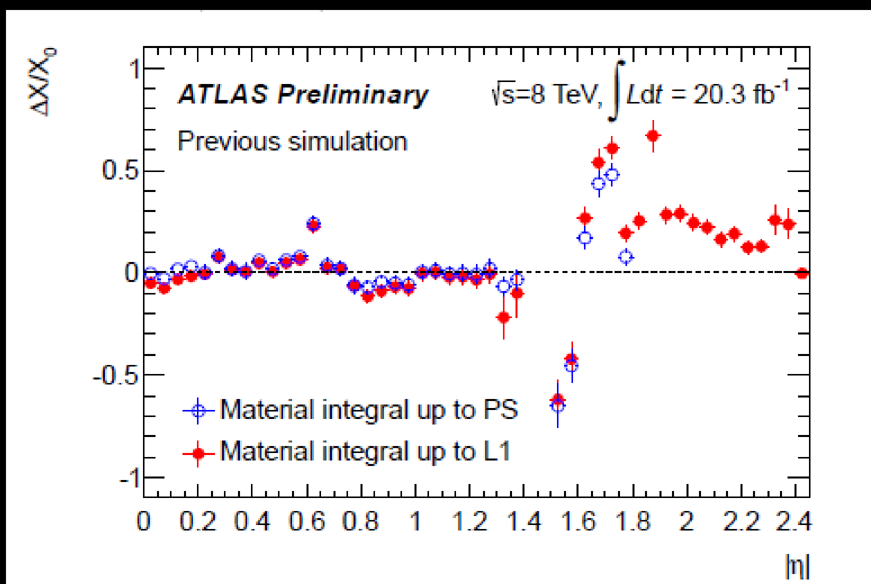


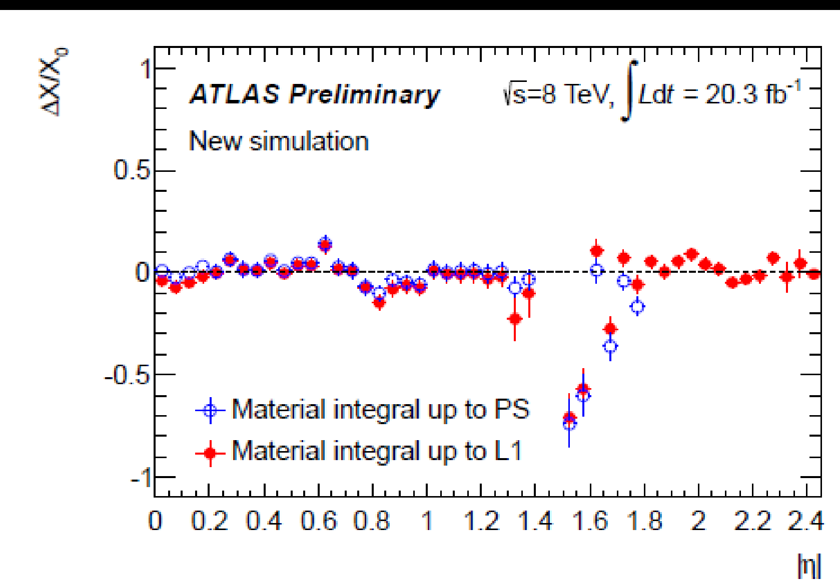


1. MC-based MVA technique to determine calibration constants for e/γ/converted γ:
   - Variables: total E in accordion, shower depth, cluster coordinates, conversion radius, conversion p_T/E_T,...
   - Need a good estimate of material in front of calorimeter estimate using E_1/E_2 → new detector simulation improving on passive material description
2. Correction of specific non simulated effects: High-Voltage differences, electronic calibration,...
3. Layer intercalibration
5. Energy scale and resolution smearing using $Z \rightarrow ee$
6. Energy scale validated with $J/\psi \rightarrow ee$ and extrapolation to photon with $Z \rightarrow ee\gamma$

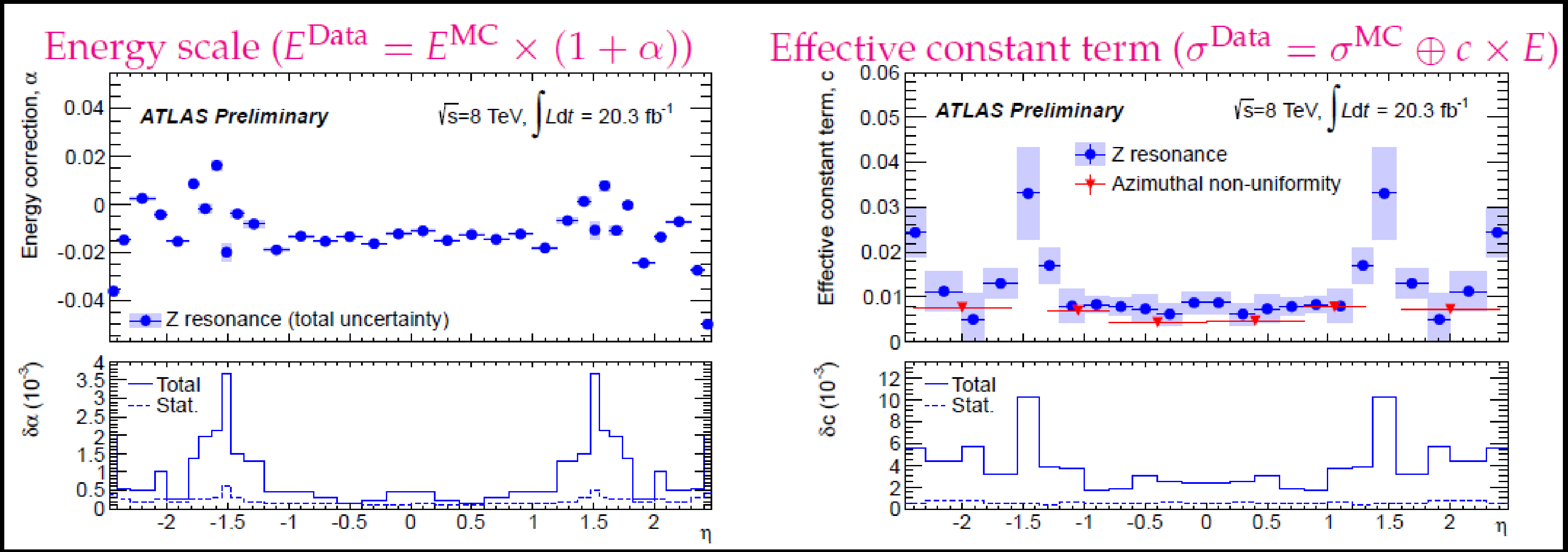
- Layer intercalibration:
  - correction up to 5%,
  - with a precision of 1% for $|\eta| < 1.2$ and $|\eta| > 1.82$
- $\mu \rightarrow e/\gamma$ extrapolation:
  - estimated at 1-1.5% uncertainty



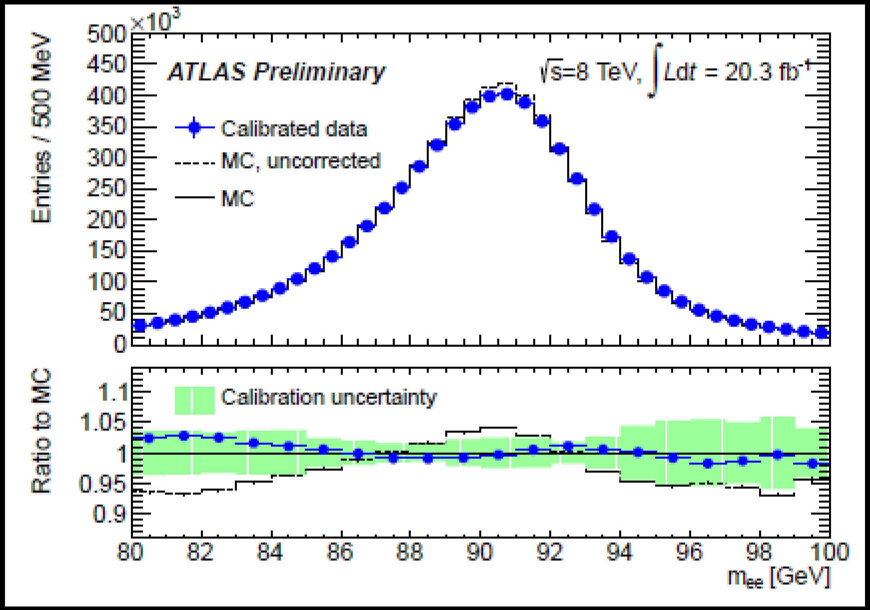


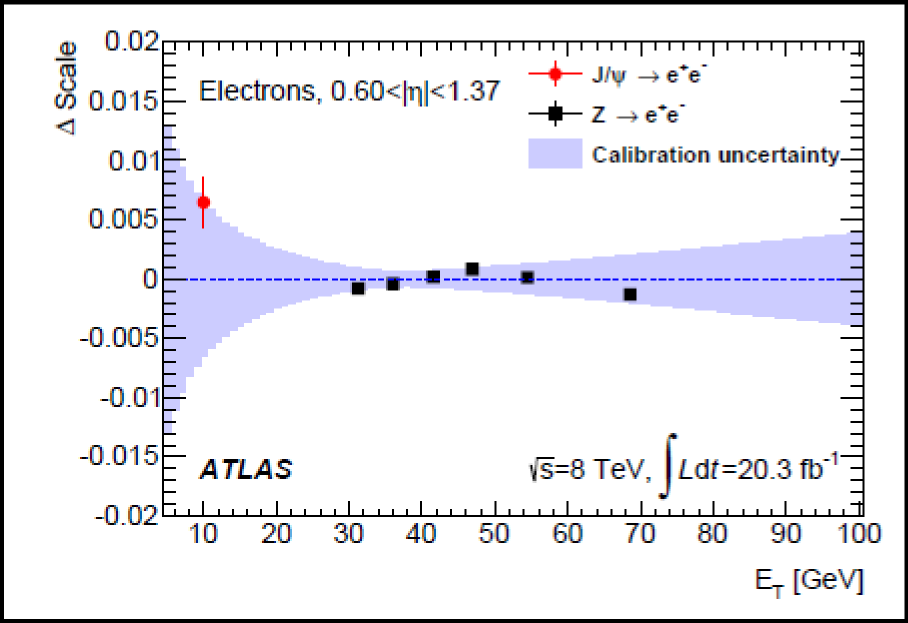


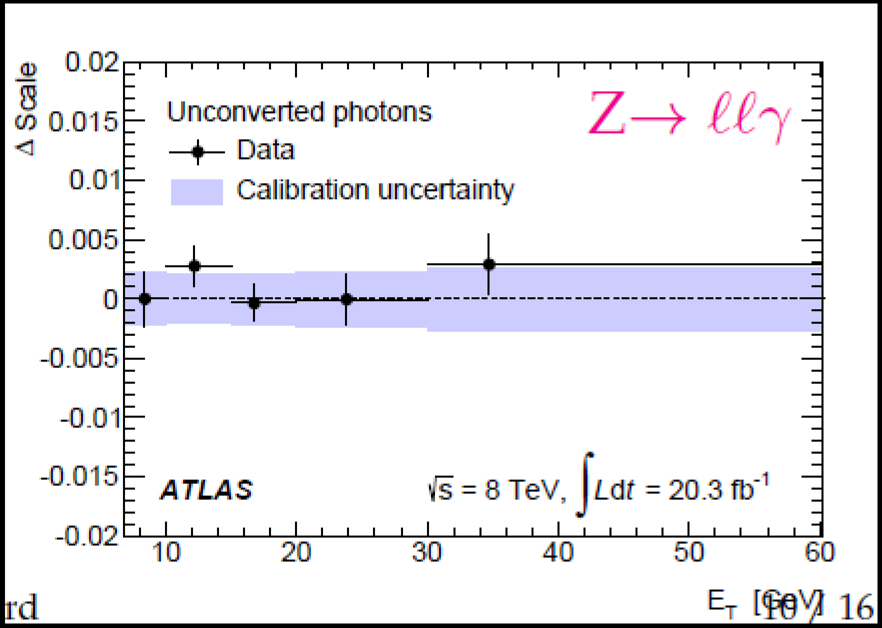
Provides also constrain on material to 2-5% X_0

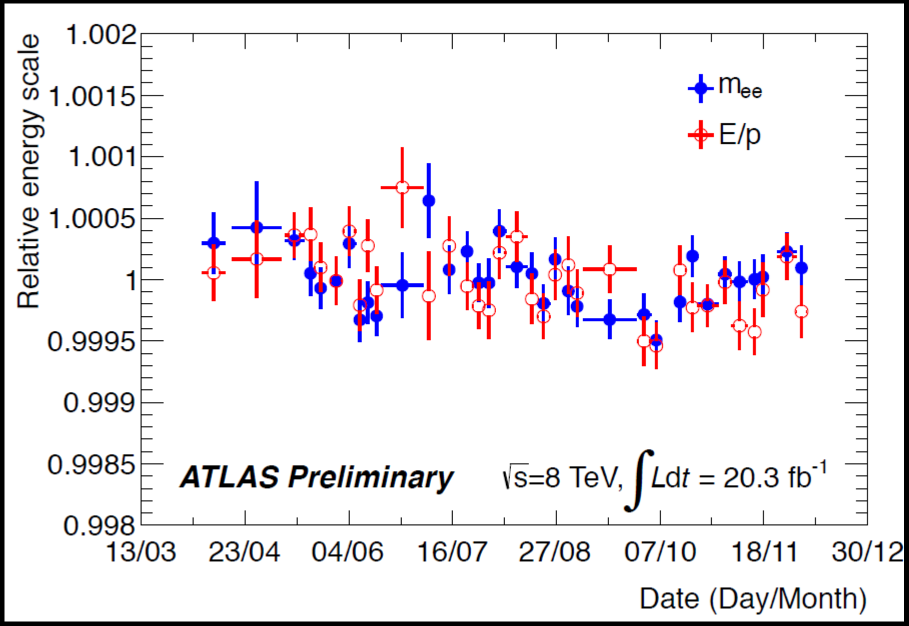


- Energy scale and resolution from $Z \to ee$
- Improved uncertainty per bins (without crack region $1.2 < |\eta| < 1.8$):
  - $\delta\alpha_{tot}$ ~ few 10^{-4}
  - $\delta\sigma_{tot}$ ~ few 10^{-3}


ATLAS Preliminary
√s=8 TeV, ∫Ldt = 20.3 fb⁻¹
Calibrated data
MC, uncorrected
MC
Entries / 500 MeV
×10³
Calibration uncertainty
Ratio to MC
m_ee [GeV]


Electrons, 0.60<|η|<1.37
J/ψ → e⁺e⁻
Z → e⁺e⁻
Calibration uncertainty
Δ Scale
ATLAS
√s=8 TeV, ∫Ldt=20.3 fb⁻¹
E_T [GeV]

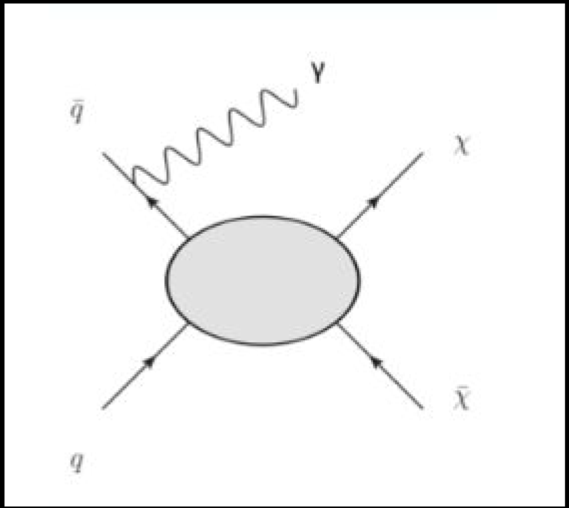

Unconverted photons
Data
Calibration uncertainty
Z → ℓℓγ
Δ Scale
ATLAS
√s = 8 TeV, ∫Ldt = 20.3 fb⁻¹
E_T [GeV]


m_ee
E/p
Relative energy scale
ATLAS Preliminary
√s=8 TeV, ∫Ldt = 20.3 fb⁻¹
Date (Day/Month)

Physics analyses

Dark Matter searches

- "Search for new phenomena in events with isolated photons and large missing transverse momentum at 8 TeV"
  - Contact editor: Donatella Cavalli, paper in preparation
- Looking for events with an energetic photon and large missing momentum as a signature of new physics:
  - Large extra dimensions (Graviton)
  - Dark matter (WIMPs)
  - SUSY interpretation

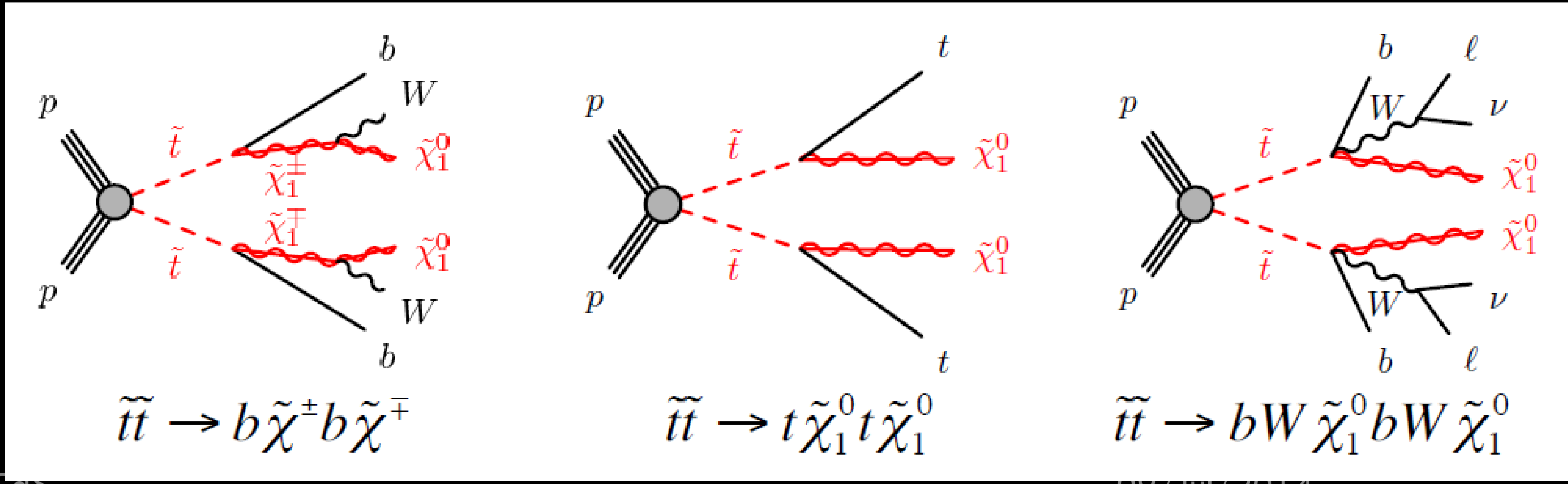


SUSY

- Search for stop/3rd generation squark production
  - T. Lari convenor of 3rd generation squark group; co-convenor of whole ATLAS SUSY group for two years starting next October
- "Third generation squark workshop", 23-27 June 2014, Milano
- "Search for direct top-squark pair production in final states with two leptons in pp collisions at sqrt(s)=8TeV with the ATLAS detector"
  - Contact editor: F. Meloni, JHEP06(2014)124

Stop search

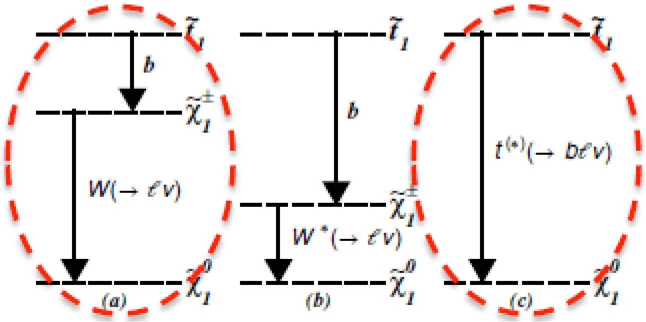
- Large mixing effects can lead to mass eigenstate t_1 that is significantly lighter than the other squarks
  - naturalness → mass O(1 TeV)
  - could be pair-produced with relatively large cross-sections at LHC
- Target final states containing exactly two isolated, high-pT leptons



Analysis

- Events with two isolated leptons (e, μ) with opposite charge, and two b-quarks, significant missing transverse momentum
- Analysis strategies target:
  - Large C_1-N_1 mass splittings (> M_W bosons mass), cut based
  - Small C_1-N_1 mass splittings (< M_W bosons mass), t_1 three-body decay, cut based
  - on-shell top $t_1 \rightarrow t + N_1$ decay mode, MVA

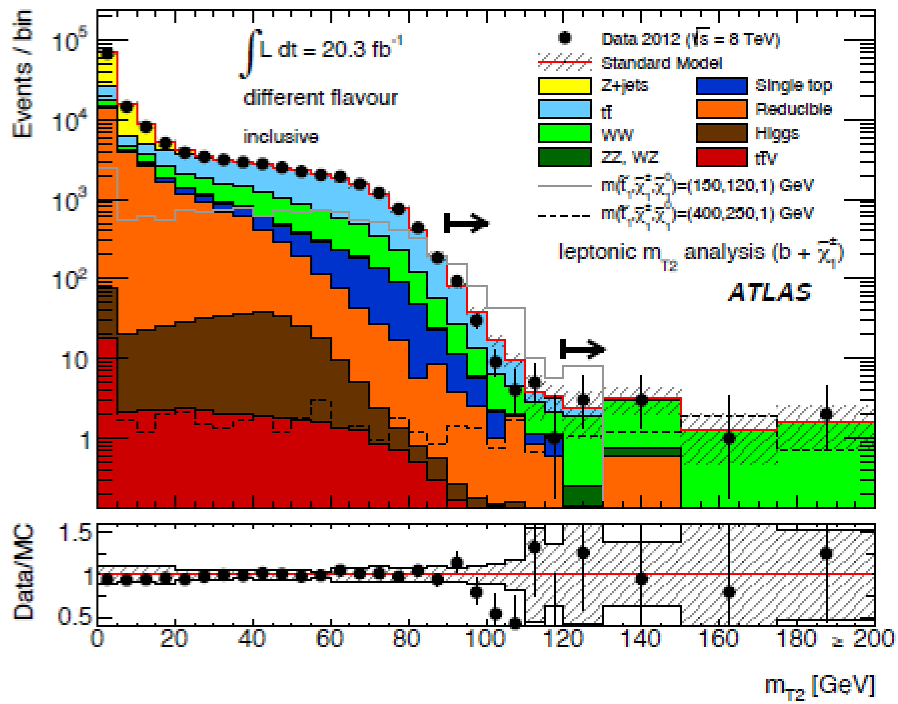
Leptonic m_{T2}



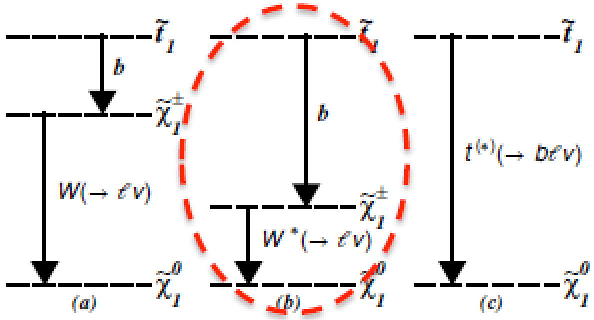
LEPTONIC STRANSVERSE MASS

$$m_{T2}^{\ell\ell}\left(\vec{p}_T^{\ell_1},\vec{p}_T^{\ell_2},\vec{p}_T\right)=\min_{\vec{q}_T^1+\vec{q}_T^2=\vec{p}_T}\left\{\max\left[m_T\left(p_T^{\ell_1},\vec{q}_T^1\right),m_T\left(p_T^{\ell_2},\vec{q}_T^2\right)\right]\right\}$$

MAIN DISCRIMINANT: m_{T2} computed from the momenta of the two leptons.



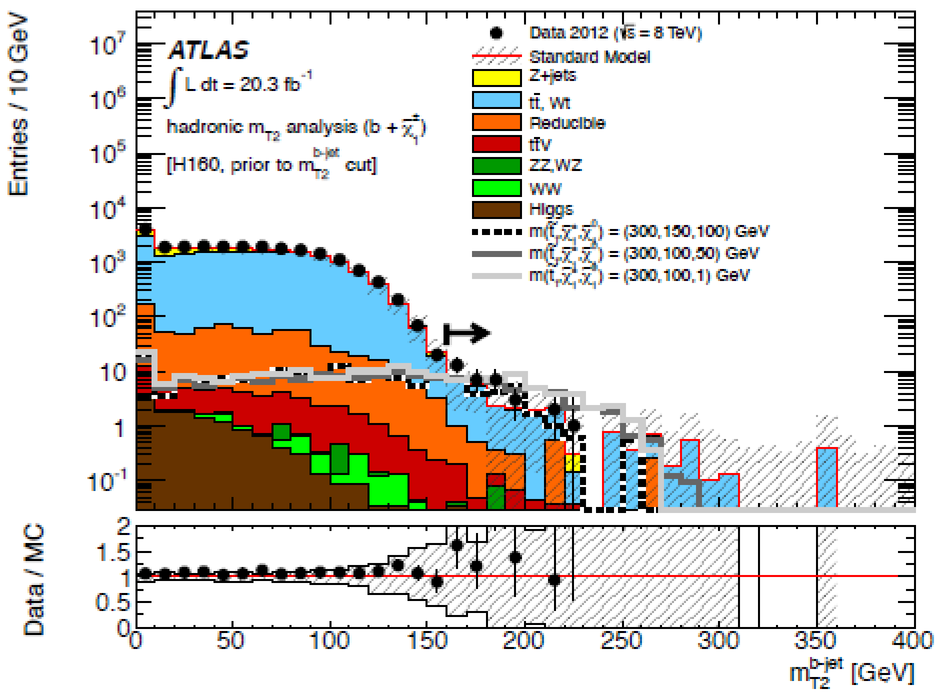
Hadronic m_{T2}



HADRONIC STRANSVERSE MASS

$$m_{T2}^{b-jet}\left(\vec{p}_T^{\,b_1},\vec{p}_T^{\,b_2},\vec{p\!\!/}_T\right)=\min_{\vec{q}_T^{\,1}+\vec{q}_T^{\,2}=\vec{p\!\!/}_T}\left\{\max\left[m_T\left(p_T^{b_1},\vec{q}_T^{\,1}\right),m_T\left(p_T^{b_2},\vec{q}_T^{\,2}\right)\right]\right\}$$

MAIN DISCRIMINANT: m_{T2} computed from the momenta of the two b-jets.



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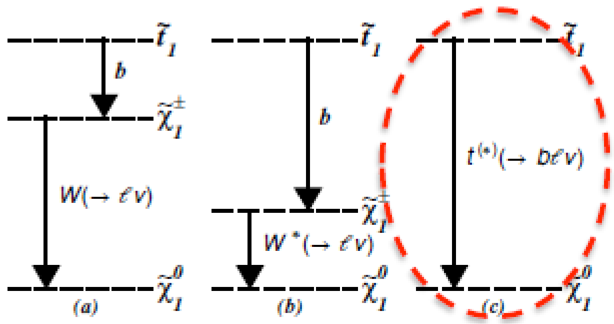
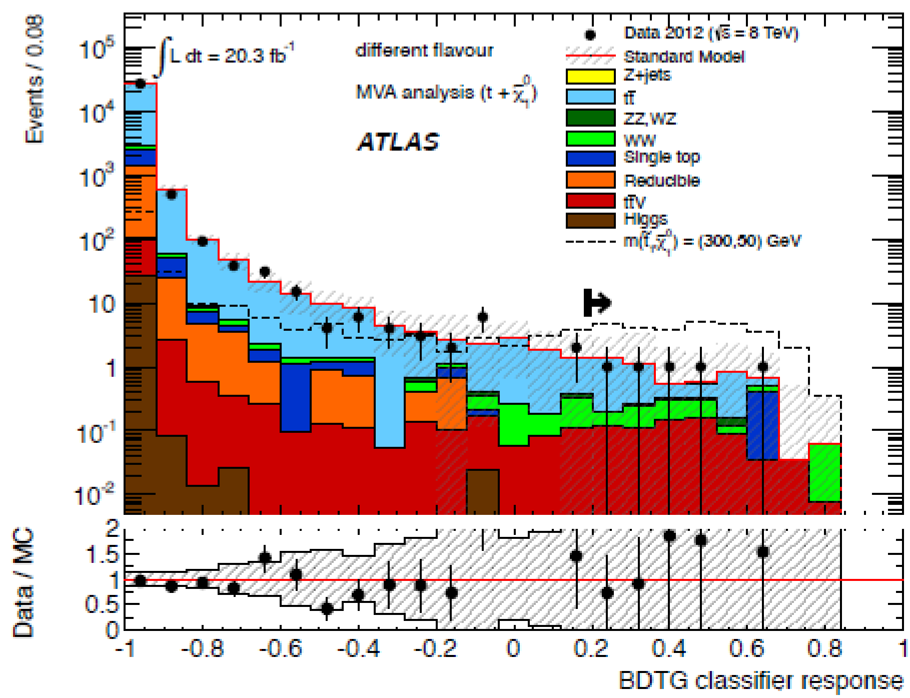
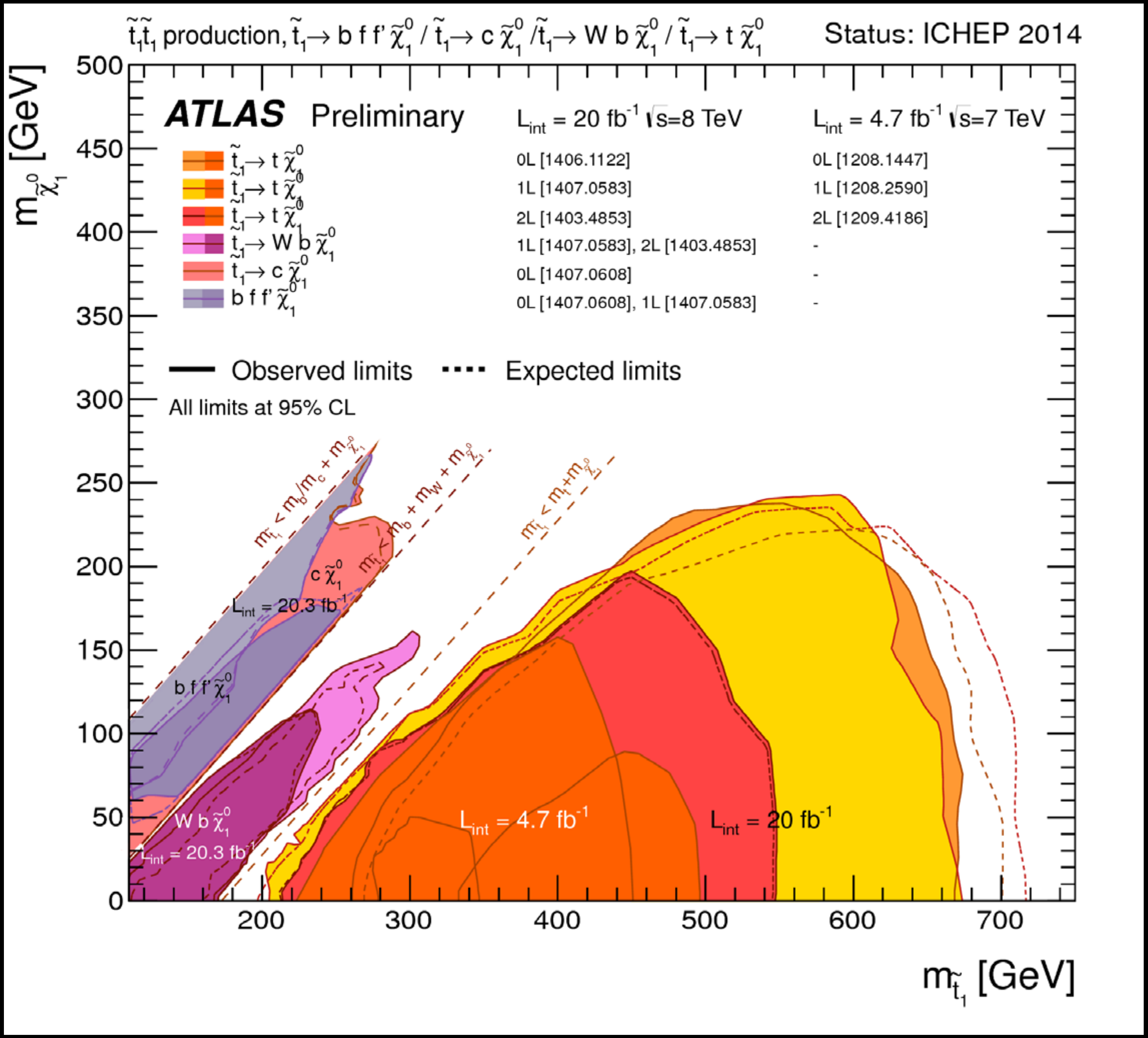
Multivariate Analysis



MVA discriminant (BDTG) based on:
E_T^{miss}, $m_{\ell\ell}$, m_{T2},
$\Delta\phi(\ell,\ell)$, $\Delta\theta(\ell,\ell)$, $\Delta\phi(\ell,E_T^{miss})$ and $\Delta\phi(j,\ell)$



- No signal observed: number of observed events consistent with SM expectations
- Four decay modes are considered separately with 100% BR:
  - $t_1 \rightarrow t + N_1$ (7 TeV: [1,2,3], 8 TeV [4,5,6], where the t_1 is mostly right)
  - $t_1 \rightarrow W + b + N_1$ (3- body decay for m(stop) < m(top) + m(N_1), 8 TeV [4,6]),
  - $t_1 \rightarrow c + N_1$ [7]
  - $t_1 \rightarrow f + f' + b + N_1$ (4-body decay, 8 TeV [4,7]).
- Papers
  - [1] arxiv:1208.1447 (0 lepton 7 TeV)
    [2] arxiv:1208.2590 (1 lepton 7 TeV)
    [3] arxiv:1209.4186 (2 leptons 7 TeV)
    [4] arxiv:1407.0583 (1 lepton 8 TeV, 20/fb)
    [5] arxiv:1406.1122 (0 lepton + 5/6 jets 8 TeV, 20/fb)
    [6] arxiv:1403.4853 (2 lepton + jets+ MET 8 TeV, 20/fb)
    [7] arxiv:1407.0608 (0 lepton + jets (c-jets) + MET 8 TeV, 20/fb)



$\tilde{t}_1\tilde{t}_1$ production, $\tilde{t}_1 \to b f f' \tilde{\chi}_1^0$ / $\tilde{t}_1 \to c \tilde{\chi}_1^0$ / $\tilde{t}_1 \to W b \tilde{\chi}_1^0$ / $\tilde{t}_1 \to t \tilde{\chi}_1^0$
Status: ICHEP 2014
ATLAS Preliminary
L_{int} = 20 fb^{-1} $\sqrt{s}$=8 TeV
L_{int} = 4.7 fb^{-1} $\sqrt{s}$=7 TeV
$\tilde{t}_1 \to t \tilde{\chi}_1^0$ 0L [1406.1122] 0L [1208.1447]
$\tilde{t}_1 \to t \tilde{\chi}_1^0$ 1L [1407.0583] 1L [1208.2590]
$\tilde{t}_1 \to t \tilde{\chi}_1^0$ 2L [1403.4853] 2L [1209.4186]
$\tilde{t}_1 \to W b \tilde{\chi}_1^0$ 1L [1407.0583], 2L [1403.4853] -
$\tilde{t}_1 \to c \tilde{\chi}_1^0$ 0L [1407.0608] -
$b f f' \tilde{\chi}_1^0$ 0L [1407.0608], 1L [1407.0583] -
Observed limits
Expected limits
All limits at 95% CL
$m_{\tilde{t}_1} < m_b/m_c + m_{\tilde{\chi}_1^0}$
$m_{\tilde{t}_1} < m_b + m_W + m_{\tilde{\chi}_1^0}$
$m_{\tilde{t}_1} < m_t + m_{\tilde{\chi}_1^0}$
$c \tilde{\chi}_1^0$
L_{int} = 20.3 fb^{-1}
$b f f' \tilde{\chi}_1^0$
$W b \tilde{\chi}_1^0$
L_{int} = 20.3 fb^{-1}
L_{int} = 4.7 fb^{-1}
L_{int} = 20 fb^{-1}
$m_{\tilde{\chi}_1^0}$ [GeV]
$m_{\tilde{t}_1}$ [GeV]
0
50
100
150
200
250
300
350
400
450
500
200
300
400
500
600
700

ATLAS SUSY Searches* - 95% CL Lower Limits

Status: ICHEP 2014

ATLAS Preliminary

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

	Model	e, μ, τ, γ	Jets	E_T^{miss}	$\int \mathcal{L}\, dt [fb^{-1}]$	Mass limit		Reference
Inclusive Searches	MSUGRA/CMSSM	0	2-6 jets	Yes	20.3	$\tilde{q}, \tilde{g}$ 1.7 TeV	$m(\tilde{q})=m(\tilde{g})$	1405.7875
	MSUGRA/CMSSM	1 e, μ	3-6 jets	Yes	20.3	$\tilde{g}$ 1.2 TeV	any $m(\tilde{q})$	ATLAS-CONF-2013-062
	MSUGRA/CMSSM	0	7-10 jets	Yes	20.3	$\tilde{g}$ 1.1 TeV	any $m(\tilde{q})$	1308.1841
	$\tilde{q}\tilde{q}, \tilde{q}\to q\tilde{\chi}_1^0$	0	2-6 jets	Yes	20.3	$\tilde{q}$ 850 GeV	$m(\tilde{\chi}_1^0)$=0 GeV, $m(1^{st}$ gen. $\tilde{q})=m(2^{nd}$ gen. $\tilde{q})$	1405.7875
	$\tilde{g}\tilde{g}, \tilde{g}\to q\bar{q}\tilde{\chi}_1^0$	0	2-6 jets	Yes	20.3	$\tilde{g}$ 1.33 TeV	$m(\tilde{\chi}_1^0)$=0 GeV	1405.7875
	$\tilde{g}\tilde{g}, \tilde{g}\to qq\tilde{\chi}_1^{\pm}\to qqW^{\pm}\tilde{\chi}_1^0$	1 e, μ	3-6 jets	Yes	20.3	$\tilde{g}$ 1.18 TeV	$m(\tilde{\chi}_1^0)$<200 GeV, $m(\tilde{\chi}^{\pm})=0.5(m(\tilde{\chi}_1^0)+m(\tilde{g}))$	ATLAS-CONF-2013-062
	$\tilde{g}\tilde{g}, \tilde{g}\to qq(\ell\ell/\ell\nu/\nu\nu)\tilde{\chi}_1^0$	2 e, μ	0-3 jets	-	20.3	$\tilde{g}$ 1.12 TeV	$m(\tilde{\chi}_1^0)$=0 GeV	ATLAS-CONF-2013-089
	GMSB ($\tilde{\ell}$ NLSP)	2 e, μ	2-4 jets	Yes	4.7	$\tilde{g}$ 1.24 TeV	$\tan\beta$<15	1208.4688
	GMSB ($\tilde{\ell}$ NLSP)	1-2 τ + 0-1 ℓ	0-2 jets	Yes	20.3	$\tilde{g}$ 1.6 TeV	$\tan\beta$ >20	1407.0603
	GGM (bino NLSP)	2 γ	-	Yes	20.3	$\tilde{g}$ 1.28 TeV	$m(\tilde{\chi}_1^0)$>50 GeV	ATLAS-CONF-2014-001
	GGM (wino NLSP)	1 $e, \mu + \gamma$	-	Yes	4.8	$\tilde{g}$ 619 GeV	$m(\tilde{\chi}_1^0)$>50 GeV	ATLAS-CONF-2012-144
	GGM (higgsino-bino NLSP)	γ	1 b	Yes	4.8	$\tilde{g}$ 900 GeV	$m(\tilde{\chi}_1^0)$>220 GeV	1211.1167
	GGM (higgsino NLSP)	2 e, μ (Z)	0-3 jets	Yes	5.8	$\tilde{g}$ 690 GeV	m(NLSP)>200 GeV	ATLAS-CONF-2012-152
	Gravitino LSP	0	mono-jet	Yes	10.5	$F^{1/2}$ scale 645 GeV	$m(\tilde{G})>10^{-4}$ eV	ATLAS-CONF-2012-147
3^{rd} gen. $\tilde{g}$ med.	$\tilde{g}\to b\bar{b}\tilde{\chi}_1^0$	0	3 b	Yes	20.1	$\tilde{g}$ 1.25 TeV	$m(\tilde{\chi}_1^0)$<400 GeV	1407.0600
	$\tilde{g}\to t\bar{t}\tilde{\chi}_1^0$	0	7-10 jets	Yes	20.3	$\tilde{g}$ 1.1 TeV	$m(\tilde{\chi}_1^0)$ <350 GeV	1308.1841
	$\tilde{g}\to t\bar{t}\tilde{\chi}_1^0$	0-1 e, μ	3 b	Yes	20.1	$\tilde{g}$ 1.34 TeV	$m(\tilde{\chi}_1^0)$<400 GeV	1407.0600
	$\tilde{g}\to b\bar{t}\tilde{\chi}_1^+$	0-1 e, μ	3 b	Yes	20.1	$\tilde{g}$ 1.3 TeV	$m(\tilde{\chi}_1^0)$<300 GeV	1407.0600
3^{rd} gen. squarks direct production	$\tilde{b}_1\tilde{b}_1, \tilde{b}_1\to b\tilde{\chi}_1^0$	0	2 b	Yes	20.1	$\tilde{b}_1$ 100-620 GeV	$m(\tilde{\chi}_1^0)$<90 GeV	1308.2631
	$\tilde{b}_1\tilde{b}_1, \tilde{b}_1\to t\tilde{\chi}_1^{\pm}$	2 e, μ (SS)	0-3 b	Yes	20.3	$\tilde{b}_1$ 275-440 GeV	$m(\tilde{\chi}_1^{\pm})=2\, m(\tilde{\chi}_1^0)$	1404.2500
	$\tilde{t}_1\tilde{t}_1$(light), $\tilde{t}_1\to b\tilde{\chi}_1^{\pm}$	1-2 e, μ	1-2 b	Yes	4.7	$\tilde{t}_1$ 110-167 GeV	$m(\tilde{\chi}_1^0)$=55 GeV	1208.4305, 1209.2102
	$\tilde{t}_1\tilde{t}_1$(light), $\tilde{t}_1\to Wb\tilde{\chi}_1^0$	2 e, μ	0-2 jets	Yes	20.3	$\tilde{t}_1$ 130-210 GeV	$m(\tilde{\chi}_1^0)=m(\tilde{t}_1)-m(W)$-50 GeV, $m(\tilde{t}_1)<<m(\tilde{\chi}_1^{\pm})$	1403.4853
	$\tilde{t}_1\tilde{t}_1$(medium), $\tilde{t}_1\to t\tilde{\chi}_1^0$	2 e, μ	2 jets	Yes	20.3	$\tilde{t}_1$ 215-530 GeV	$m(\tilde{\chi}_1^0)$=1 GeV	1403.4853
	$\tilde{t}_1\tilde{t}_1$(medium), $\tilde{t}_1\to b\tilde{\chi}_1^{\pm}$	0	2 b	Yes	20.1	$\tilde{t}_1$ 150-580 GeV	$m(\tilde{\chi}_1^0)$<200 GeV, $m(\tilde{\chi}_1^{\pm})-m(\tilde{\chi}_1^0)$=5 GeV	1308.2631
	$\tilde{t}_1\tilde{t}_1$(heavy), $\tilde{t}_1\to t\tilde{\chi}_1^0$	1 e, μ	1 b	Yes	20	$\tilde{t}_1$ 210-640 GeV	$m(\tilde{\chi}_1^0)$=0 GeV	1407.0583
	$\tilde{t}_1\tilde{t}_1$(heavy), $\tilde{t}_1\to t\tilde{\chi}_1^0$	0	2 b	Yes	20.1	$\tilde{t}_1$ 260-640 GeV	$m(\tilde{\chi}_1^0)$=0 GeV	1406.1122
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1\to c\tilde{\chi}_1^0$	0	mono-jet/c-tag	Yes	20.3	$\tilde{t}_1$ 90-240 GeV	$m(\tilde{t}_1)-m(\tilde{\chi}_1^0)$<85 GeV	1407.0608
	$\tilde{t}_1\tilde{t}_1$(natural GMSB)	2 e, μ (Z)	1 b	Yes	20.3	$\tilde{t}_1$ 150-580 GeV	$m(\tilde{\chi}_1^0)$>150 GeV	1403.5222
	$\tilde{t}_2\tilde{t}_2, \tilde{t}_2\to\tilde{t}_1 + Z$	3 e, μ (Z)	1 b	Yes	20.3	$\tilde{t}_2$ 290-600 GeV	$m(\tilde{\chi}_1^0)$<200 GeV	1403.5222
EW direct	$\tilde{\ell}_{L,R}\tilde{\ell}_{L,R}, \tilde{\ell}\to\ell\tilde{\chi}_1^0$	2 e, μ	0	Yes	20.3	$\tilde{\ell}$ 90-325 GeV	$m(\tilde{\chi}_1^0)$=0 GeV	1403.5294
	$\tilde{\chi}_1^+\tilde{\chi}_1^-, \tilde{\chi}_1^+\to\tilde{\ell}\nu(\ell\tilde{\nu})$	2 e, μ	0	Yes	20.3	$\tilde{\chi}_1^{\pm}$ 140-465 GeV	$m(\tilde{\chi}_1^0)$=0 GeV, $m(\tilde{\ell}, \tilde{\nu})=0.5(m(\tilde{\chi}_1^{\pm})+m(\tilde{\chi}_1^0))$	1403.5294
	$\tilde{\chi}_1^+\tilde{\chi}_1^-, \tilde{\chi}_1^+\to\tilde{\tau}\nu(\tau\tilde{\nu})$	2 τ	-	Yes	20.3	$\tilde{\chi}_1^{\pm}$ 100-350 GeV	$m(\tilde{\chi}_1^0)$=0 GeV, $m(\tilde{\tau}, \tilde{\nu})=0.5(m(\tilde{\chi}_1^{\pm})+m(\tilde{\chi}_1^0))$	1407.0350
	$\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0\to\tilde{\ell}_L\nu\tilde{\ell}_L\ell(\tilde{\nu}\nu), \ell\tilde{\nu}\tilde{\ell}_L\ell(\tilde{\nu}\nu)$	3 e, μ	0	Yes	20.3	$\tilde{\chi}_1^{\pm}, \tilde{\chi}_2^0$ 700 GeV	$m(\tilde{\chi}_1^{\pm})=m(\tilde{\chi}_2^0)$, $m(\tilde{\chi}_1^0)$=0, $m(\tilde{\ell}, \tilde{\nu})=0.5(m(\tilde{\chi}_1^{\pm})+m(\tilde{\chi}_1^0))$	1402.7029
	$\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0\to W\tilde{\chi}_1^0 Z\tilde{\chi}_1^0$	2-3 e, μ	0	Yes	20.3	$\tilde{\chi}_1^{\pm}, \tilde{\chi}_2^0$ 420 GeV	$m(\tilde{\chi}_1^{\pm})=m(\tilde{\chi}_2^0)$, $m(\tilde{\chi}_1^0)$=0, sleptons decoupled	1403.5294, 1402.7029
	$\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0\to W\tilde{\chi}_1^0 h\tilde{\chi}_1^0$	1 e, μ	2 b	Yes	20.3	$\tilde{\chi}_1^{\pm}, \tilde{\chi}_2^0$ 285 GeV	$m(\tilde{\chi}_1^{\pm})=m(\tilde{\chi}_2^0)$, $m(\tilde{\chi}_1^0)$=0, sleptons decoupled	ATLAS-CONF-2013-093
	$\tilde{\chi}_2^0\tilde{\chi}_3^0, \tilde{\chi}_{2,3}^0\to\tilde{\ell}_R\ell$	4 e, μ	0	Yes	20.3	$\tilde{\chi}_{2,3}^0$ 620 GeV	$m(\tilde{\chi}_2^0)=m(\tilde{\chi}_3^0)$, $m(\tilde{\chi}_1^0)$=0, $m(\tilde{\ell}, \tilde{\nu})=0.5(m(\tilde{\chi}_2^0)+m(\tilde{\chi}_1^0))$	1405.5086
Long-lived particles	Direct $\tilde{\chi}_1^+\tilde{\chi}_1^-$ prod., long-lived $\tilde{\chi}_1^{\pm}$	Disapp. trk	1 jet	Yes	20.3	$\tilde{\chi}_1^{\pm}$ 270 GeV	$m(\tilde{\chi}_1^{\pm})-m(\tilde{\chi}_1^0)$=160 MeV, $\tau(\tilde{\chi}_1^{\pm})$=0.2 ns	ATLAS-CONF-2013-069
	Stable, stopped $\tilde{g}$ R-hadron	0	1-5 jets	Yes	27.9	$\tilde{g}$ 832 GeV	$m(\tilde{\chi}_1^0)$=100 GeV, 10 $\mu s<\tau(\tilde{g})$<1000 s	1310.6584
	GMSB, stable $\tilde{\tau}, \tilde{\chi}_1^0\to\tilde{\tau}(\tilde{e}, \tilde{\mu})+\tau(e, \mu)$	1-2 μ	-	-	15.9	$\tilde{\chi}_1^0$ 475 GeV	10<$\tan\beta$<50	ATLAS-CONF-2013-058
	GMSB, $\tilde{\chi}_1^0\to\gamma\tilde{G}$, long-lived $\tilde{\chi}_1^0$	2 γ	-	Yes	4.7	$\tilde{\chi}_1^0$ 230 GeV	0.4<$\tau(\tilde{\chi}_1^0)$<2 ns	1304.6310
	$\tilde{q}\tilde{q}, \tilde{\chi}_1^0\to qq\mu$ (RPV)	1 μ, displ. vtx	-	-	20.3	$\tilde{q}$ 1.0 TeV	1.5 <$c\tau$<156 mm, BR(μ)=1, $m(\tilde{\chi}_1^0)$=108 GeV	ATLAS-CONF-2013-092
RPV	LFV $pp\to\tilde{\nu}_\tau + X, \tilde{\nu}_\tau\to e+\mu$	2 e, μ	-	-	4.6	$\tilde{\nu}_\tau$ 1.61 TeV	λ'_{311}=0.10, λ_{132}=0.05	1212.1272
	LFV $pp\to\tilde{\nu}_\tau + X, \tilde{\nu}_\tau\to e(\mu)+\tau$	1 $e, \mu + \tau$	-	-	4.6	$\tilde{\nu}_\tau$ 1.1 TeV	λ'_{311}=0.10, $\lambda_{1(2)33}$=0.05	1212.1272
	Bilinear RPV CMSSM	2 e, μ (SS)	0-3 b	Yes	20.3	$\tilde{q}, \tilde{g}$ 1.35 TeV	$m(\tilde{q})=m(\tilde{g})$, $c\tau_{LSP}$<1 mm	1404.2500
	$\tilde{\chi}_1^+\tilde{\chi}_1^-, \tilde{\chi}_1^+\to W\tilde{\chi}_1^0, \tilde{\chi}_1^0\to ee\tilde{\nu}_\mu, e\mu\tilde{\nu}_e$	4 e, μ	-	Yes	20.3	$\tilde{\chi}_1^{\pm}$ 750 GeV	$m(\tilde{\chi}_1^0)>0.2\times m(\tilde{\chi}_1^{\pm})$, $\lambda_{121}\neq0$	1405.5086
	$\tilde{\chi}_1^+\tilde{\chi}_1^-, \tilde{\chi}_1^+\to W\tilde{\chi}_1^0, \tilde{\chi}_1^0\to\tau\tau\tilde{\nu}_e, e\tau\tilde{\nu}_\tau$	3 $e, \mu + \tau$	-	Yes	20.3	$\tilde{\chi}_1^{\pm}$ 450 GeV	$m(\tilde{\chi}_1^0)>0.2\times m(\tilde{\chi}_1^{\pm})$, $\lambda_{133}\neq0$	1405.5086
	$\tilde{g}\to qqq$	0	6-7 jets	-	20.3	$\tilde{g}$ 916 GeV	BR(t)=BR(b)=BR(c)=0%	ATLAS-CONF-2013-091
	$\tilde{g}\to\tilde{t}_1 t, \tilde{t}_1\to bs$	2 e, μ (SS)	0-3 b	Yes	20.3	$\tilde{g}$ 850 GeV		1404.250
Other	Scalar gluon pair, sgluon$\to q\bar{q}$	0	4 jets	-	4.6	sgluon 100-287 GeV	incl. limit from 1110.2693	1210.4826
	Scalar gluon pair, sgluon$\to t\bar{t}$	2 e, μ (SS)	2 b	Yes	14.3	sgluon 350-800 GeV		ATLAS-CONF-2013-051
	WIMP interaction (D5, Dirac χ)	0	mono-jet	Yes	10.5	M^* scale 704 GeV	$m(\chi)$<80 GeV, limit of<687 GeV for D8	ATLAS-CONF-2012-147

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

10^{-1} — 1 — Mass scale [TeV]

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

Higgs

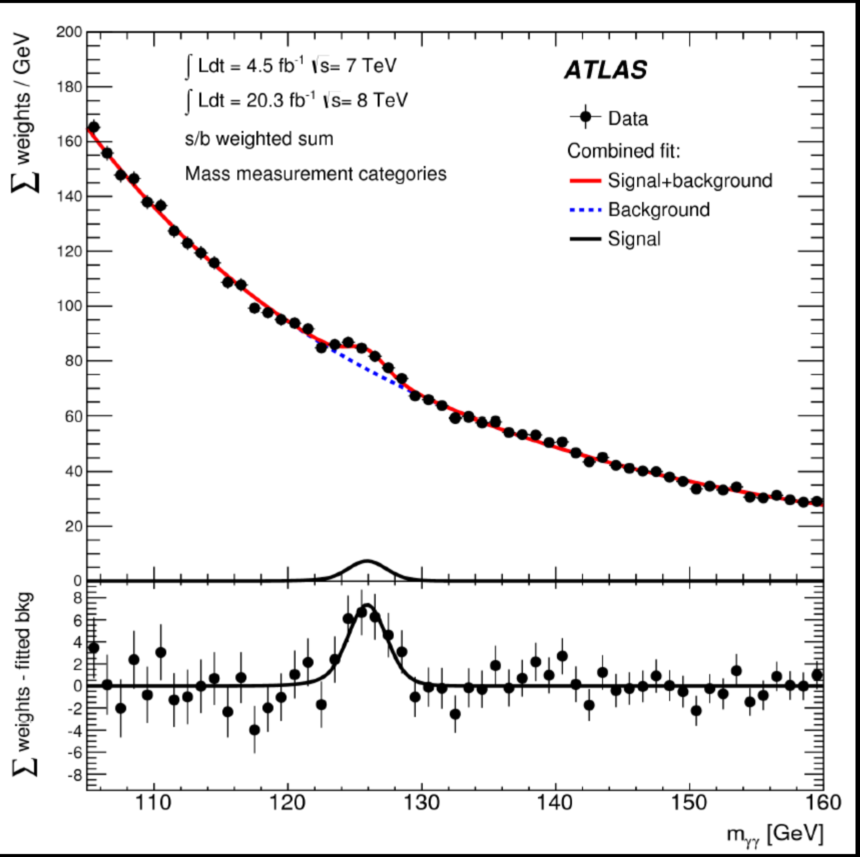
- “Measurement of Higgs boson production in the diphoton decay channel with the ATLAS detector using 25 fb^{-1} of proton-proton collisions data”
  - Contact Editor: L. Carminati, to be submitted to Phys. Rev. D (2014).
- “Studies of the spin of the Higgs boson in the diphoton channel with the ATLAS detector”
  - Contact Editor: M. Fanti, in preparation
- “Measurement of the Higgs boson mass from the $H \to \gamma\gamma$ and $H \to ZZ^* \to 4l$ channels with the ATLAS detector using 25 fb^{-1} of pp collision data”
  - Editor: L. Carminati, R. Turra, arXiv:1406.3827v1, submitted to Phys. Rev. D

Higgs Mass

- Pre LHCP2014, ICHEP2014 ATLAS mass results:
  - Using 25 fb^{-1} of data
  - M_H = 125.5 ± 0.2(stat)+0.5−0.6(sys) GeV
  - μ = 1.33+0.21−0.18
- Great effort to re-optimize analysis and reduce systematic error
  - Great contribution to $H \rightarrow \gamma\gamma$ and $H \rightarrow 4l$ from improved energy-scale calibrations for photons/electrons (and muons)
  - $\gamma\gamma$ mass resolution better by 10% (uncertainty reduced by a factor 2)
  - Combine track momentum and cluster energy measurements to improve electron resolution
    - 20% for $E_T < 30$ GeV ($ZZ \rightarrow 4l$)

H → γγ analysis

- Two isolated high-energy photons
  - Excellent mass resolution 1.2-2.4 GeV (1.7 GeV on average)
  - Good e/γ ID: 75% purity after cuts
- New wrt old analysis:
  - Background modelling using analytical functions
  - categories based on: photon conversion status, photon p_T, p_{Tt} (di-photon p transverse to thrust axis)
- 20% improvement in exp. statistical error over inclusive analysis
- New electron and photon calibrations



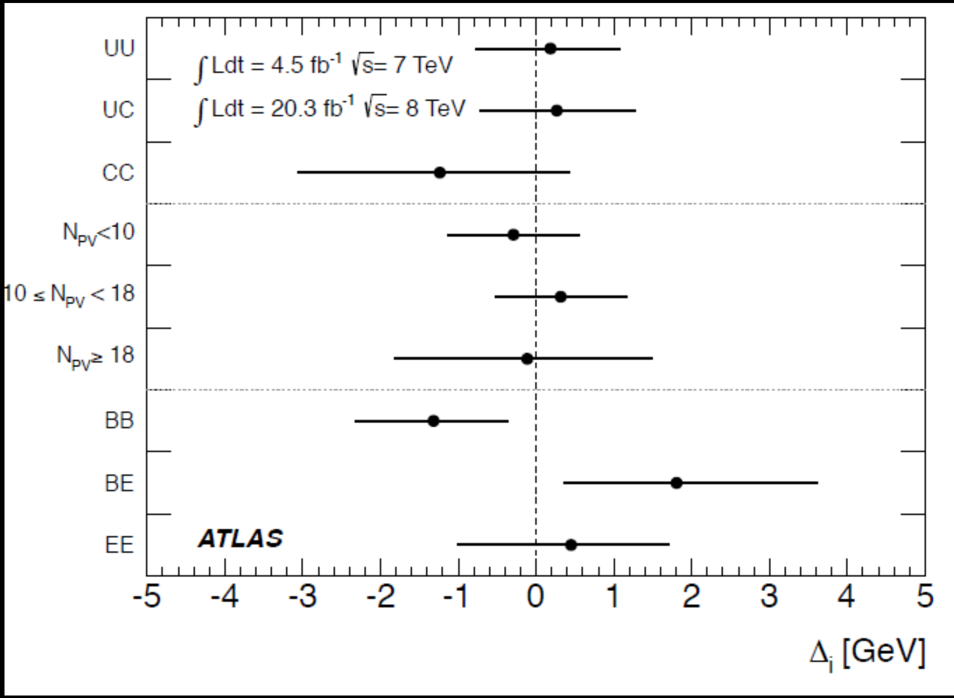
$H \rightarrow \gamma\gamma$ mass measurement

$M_H = 125.98 \pm 0.42(stat) \pm 0.28(sys)$ GeV $= 125.98 \pm 0.50$ GeV [$\mu = 1.29 \pm 0.30$]

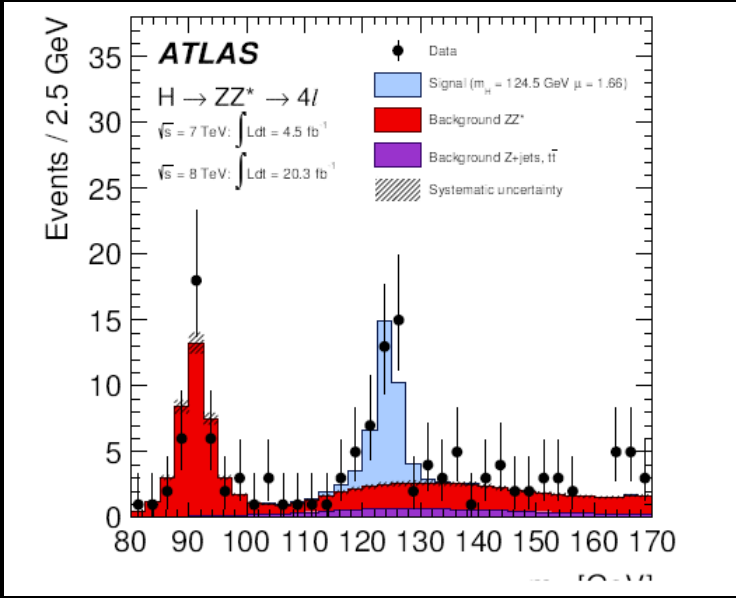
Old result: $M_H = 126.8 \pm 0.24(stat) \pm 0.7(sys)$ GeV [$\mu = 1.55 + 0.33 - 0.28$]

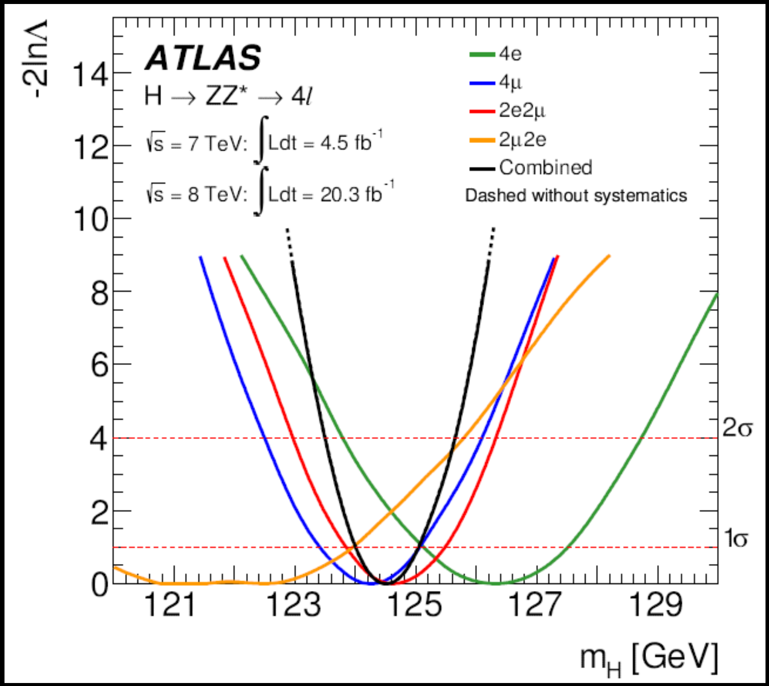
- Systematic uncertainties dominated by energy scale, reduced by factor of 2.5
- Statistical error compatible with expectation: 0.35 (0.45) GeV for μ=1.3 (1.0)
- Cross-checks:
  - Data divided into subsamples based on conversion status, number primary vertices and detector regions
  - No deviation above 1.5σ from fit of combined categories

Difference, Δ_i, between the mass measured in a given subsample and the combined mass:



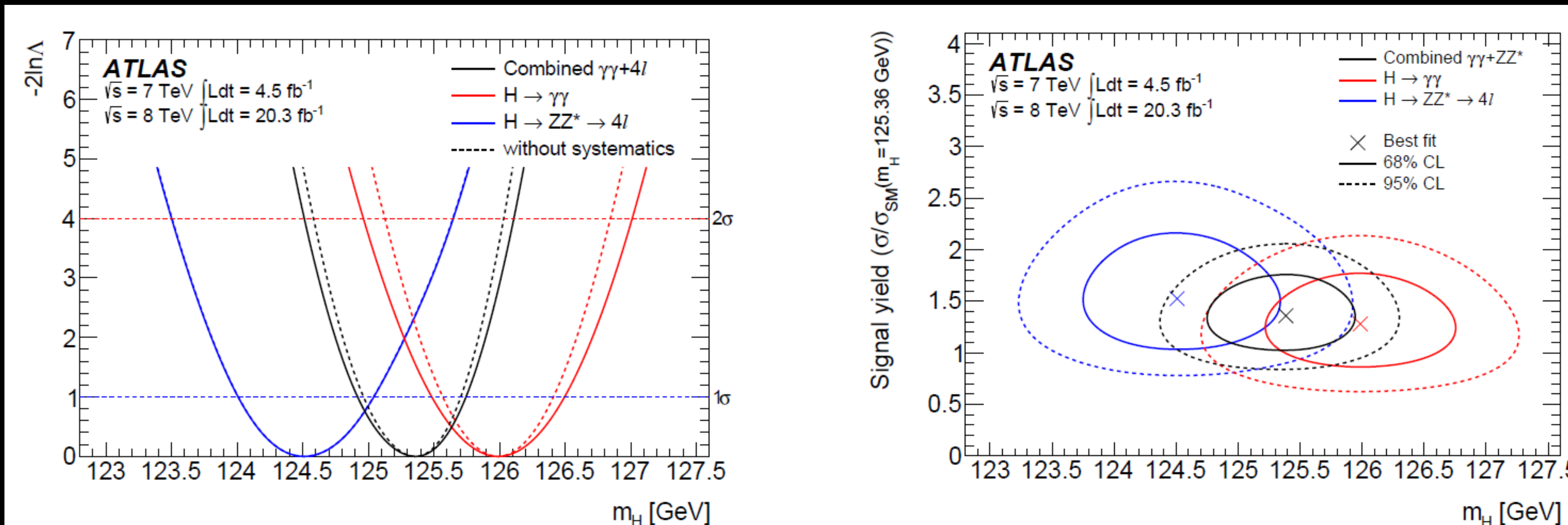
H → ZZ → 4l mass





- Input for BDT variable:
  - matrix-element kinematic discriminant, Higgs p_T and $|\eta|$ (8% improvement M_H uncertainty)
- $M_H = 124.51 \pm 0.52(\text{stat}) \pm 0.06(\text{sys})$ GeV $= 124.51 \pm 0.52$ GeV
- $\mu = 1.66{+0.45}{-0.38}$
- Previous result:
  - $M_H = 124.3{+0.6}{-0.5}(\text{stat}){+0.5}{-0.3}(\text{sys})$GeV
  - $\mu = 1.43{+0.40}{-0.35}$

Combined mass



- M_H = 125.36 ± 0.37(stat) ± 0.18(sys) GeV = 125.36 ± 0.41 GeV
  - *Previous result: M_H = 125.5 ± 0.2(stat)+0.5−0.6(sys) GeV*
- Total uncertainty reduced by 40%
- Systematic uncertainties reduced by factor 3
- Compatibility between channels:
  - 2.0σ (4.8%) for observed μ_{4l} and $\mu_{\gamma\gamma}$
  - 1.6σ for μ = 1 (previous compatibility 2.5σ)

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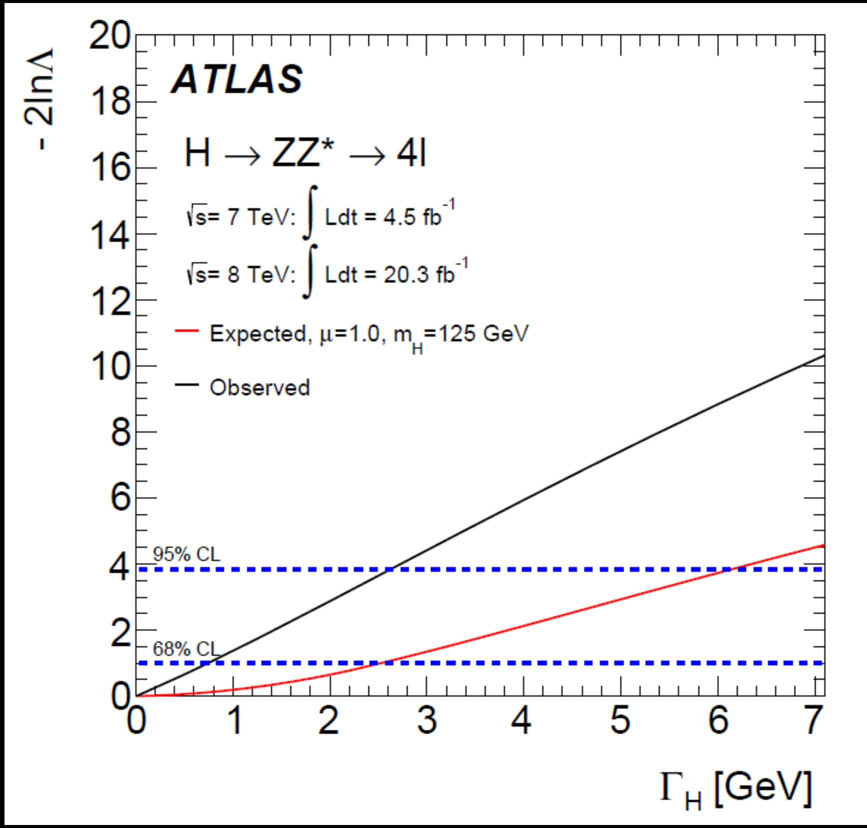
Backup

Direct Higgs width measurement

- Analytical m4l (non-relativistic Breit-Wigner) model convoluted with detector resolution with width Γ_H (M_H and μ free parameters)
  - Γ_H = 4 MeV at 125 GeV
- Analysis assumes no interference with background processes
- $H \rightarrow ZZ \rightarrow 4l$:
  - Event-by-event modelling of detector resolution
  - Validated by fitting mass peak for Z $\rightarrow$ 4l using convolution of detector response with BW for Z mass
  - 95% CL: Γ_H < 2.6 GeV (exp. limit 3.5 GeV for μ = 1.7, 6.2 GeV for μ = 1)
- $H \rightarrow \gamma\gamma$:
  - 95% CL: Γ_H < 5.0 GeV (expected limit 6.2 GeV for μ = 1)



New for ICHEP 2014

ATLAS-CONF-2014-042

Constraints on Γ_H from $\sigma_H^{\text{off-shell}}$

- High-mass $H \rightarrow ZZ$ ($m>2m_Z$) provides strong constraints on Γ_H
  - Kauer and Passarino, JHEP 1208 (2012) 116
  - Caola and Melnikov, PRD 88 (2013) 054024
  - Campbell, Ellis, and Williams, PRD 89 (2014) 053011
  - CMS arXiv:1405.3455

$$\sigma_{off-shell}^{gg \to H^* \to ZZ} \propto g^2_{Hgg(off-shell)} g^2_{HVV(off-shell)}$$

$$\sigma_{on-shell}^{gg \to H^* \to ZZ} \propto \frac{g^2_{Hgg(on-shell)} g^2_{HVV(on-shell)}}{\Gamma_H / \Gamma_H^{SM}}$$

- Assuming on-shell and off-shell couplings are the same:

$$\Rightarrow \quad \frac{\sigma_{off-shell}^{gg \to H \to ZZ}}{\sigma_{on-shell}^{gg \to H \to ZZ}} \propto \frac{\Gamma_H}{\Gamma_H^{SM}}$$

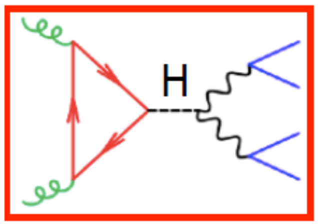
New for ICHEP 2014

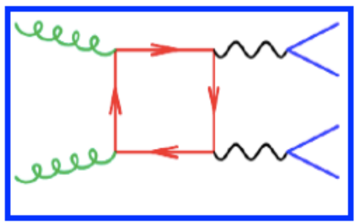
ATLAS-CONF-2014-042

Differential cross-section for gg→(H→)ZZ

Contributions at $m_{ZZ}>2m_Z$

- Signal: gg→H→ZZ
- Background: SM gg→ZZ
- S-B interference:
  - Large and negative





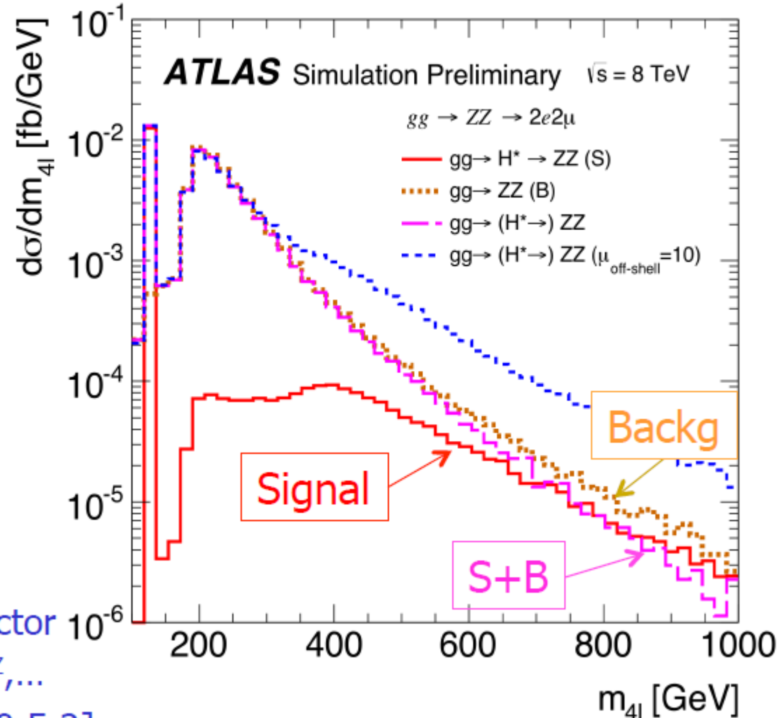
Large theory uncertainties

- gg→ZZ known to LO: no (N)NLO K factor

→ Inclusive analysis: no cuts in n_{jets}, p_T^{ZZ},…

→ Results for $R_H^B = K_{gg\to ZZ}/K_{gg\to H\to ZZ}$=[0.5,2]

- Soft-collinear approx.: $K_{gg\to ZZ} \sim K_{gg\to H\to ZZ}$
- Main result quoted for R_H^B =1



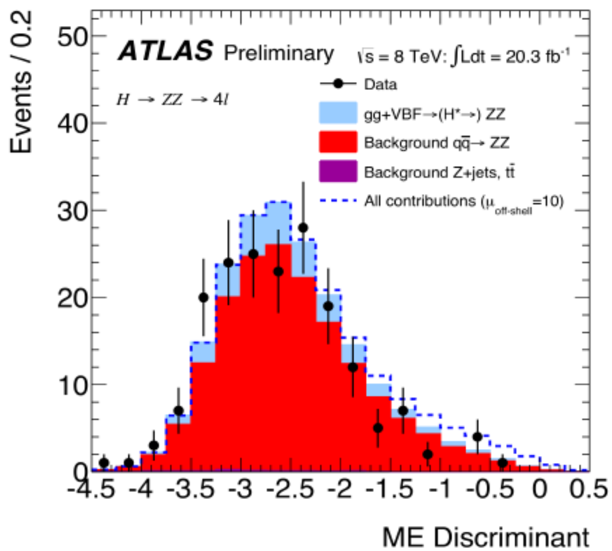
To increase statistics, reconstruct ZZ in both 4l and 2l2ν

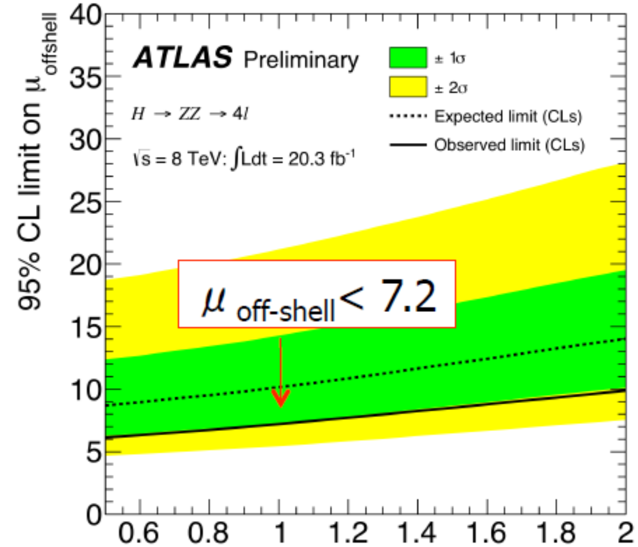
New for ICHEP 2014

ATLAS-CONF-2014-042

$\mu_{\text{off-shell}}$ from H→ZZ→4l

- H→4l reconstruction as in arXiv:1406.3827
  - Define off-peak region as m_{4l}=[220,1000] GeV
- Matrix element (ME) kinematic discriminant
  - Using 8 kinematic variables to separate gg→H→ZZ from gg→ZZ and $q\bar{q}$→ZZ
- Max likelihood fit to ME discriminant; limits on $\mu_{\text{off-shell}}$ from CL_s method





$$R^{B}_{H^*} = \frac{K(gg\to ZZ)}{K(gg\to H^*\to ZZ)}$$

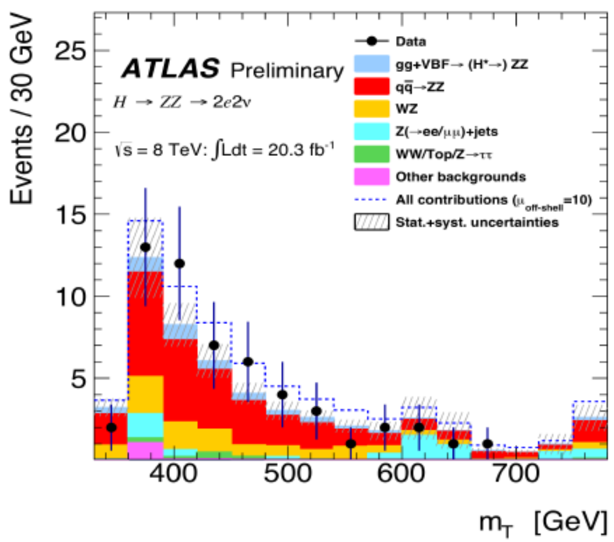
Systematics dominated by QCD scale of gg→ZZ, gg→(H→)ZZ and qq→ZZ

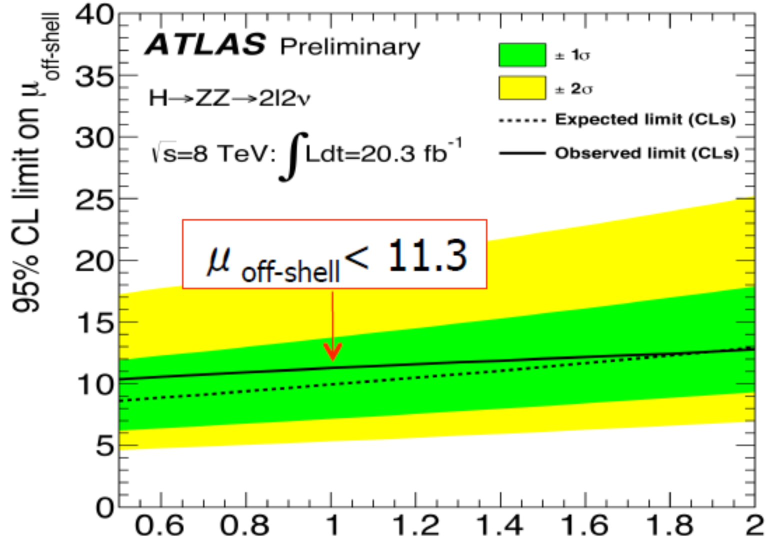
New for ICHEP 2014

ATLAS-CONF-2014-042

$\mu_{off\text{-}shell}$ from H→ZZ→llνν

- Reconstruction as in PRL 112(2014)201802
  - $76 < m_{ll} < 106$, MET>150 GeV
  - Veto on 3rd lepton to reject WZ; b-jet veto to reject top
  - $|p_T(Z) - MET|/p_T(Z) < 0.3$; $\Delta\phi(MET, p_T^{miss}) < 0.5$ to reject top and Z+jets
- Off-peak region: $m_T^{ZZ} > 350$ GeV
- Limits on $\mu_{off\text{-}shell}$ from CL_s method





$$R^B_{H^*} = \frac{K(gg\to ZZ)}{K(gg\to H^*\to ZZ)}$$

G. Sciolla (Brandeis U.)

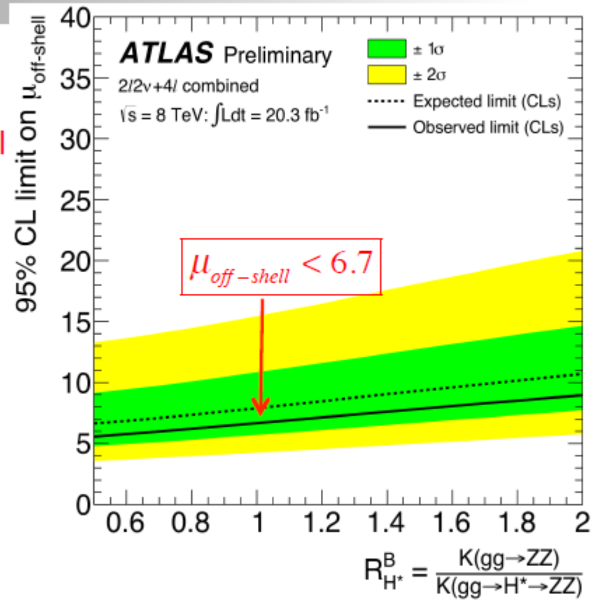
Systematics dominated by QCD scale of gg→ZZ, gg→(H→)ZZ and qq→ZZ

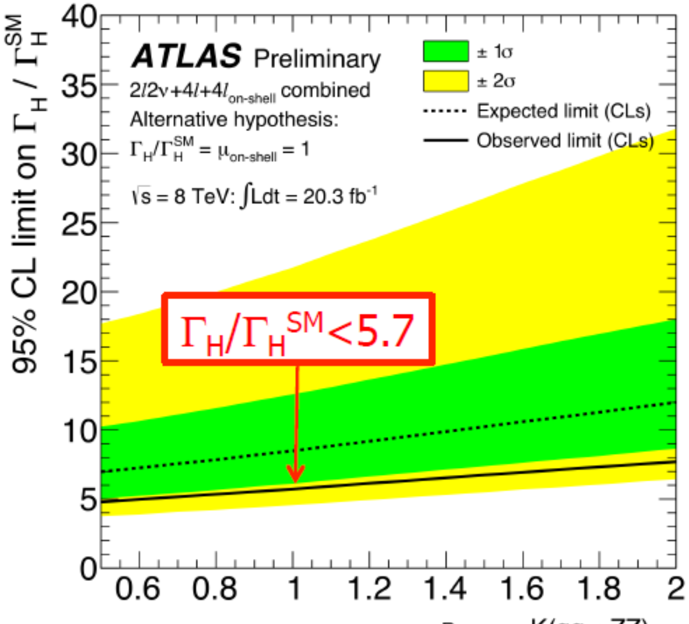
New for ICHEP 2014

ATLAS-CONF-2014-042

Combined results

- Combine 4l and 2ν2l to fit $\mu_{off\text{-}shell}$
- Include low-mass region (4l) to fit $\mu_{on\text{-}shell}$
  - Assuming $g_{on\text{-}shell} = g_{off\text{-}shell}$
- Ratio of $\mu_{on\text{-}shell}$ / $\mu_{off\text{-}shell}$ yields Γ_H



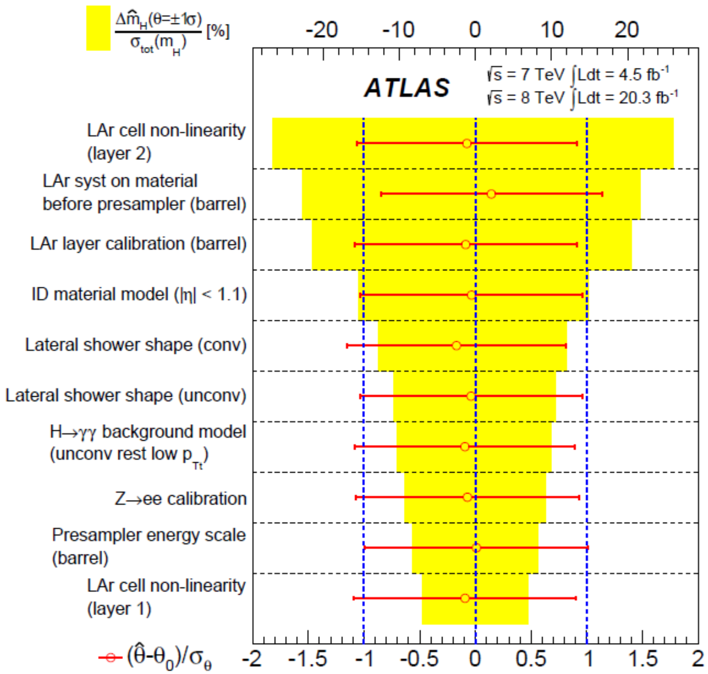


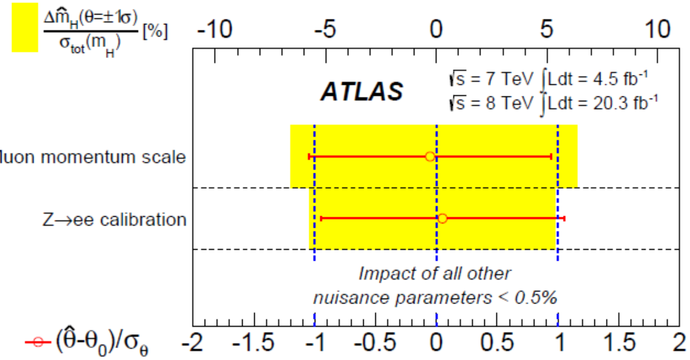
Γ_H/Γ_{SM}	Observed	Expected μ =1
R_H^B=0.5	4.8	7.0
R_H^B=1	5.7	8.5
R_H^B=2	7.7	12.0

m_H systematics

Table 4: Principal systematic uncertainties on the combined mass. Each uncertainty is determined from the change in the 68% CL range for m_H when the corresponding nuisance parameter is removed (fixed to its best fit value), and is calculated by subtracting this reduced uncertainty from the original uncertainty in quadrature.

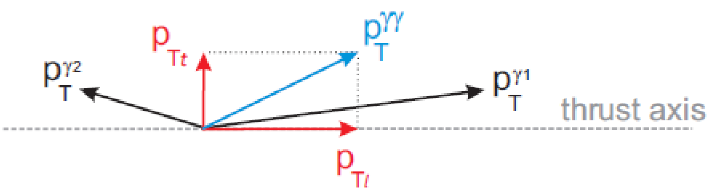
Systematic	Uncertainty on m_H [MeV]
LAr syst on material before presampler (barrel)	70
LAr syst on material after presampler (barrel)	20
LAr cell non-linearity (layer 2)	60
LAr cell non-linearity (layer 1)	30
LAr layer calibration (barrel)	50
Lateral shower shape (conv)	50
Lateral shower shape (unconv)	40
Presampler energy scale (barrel)	20
ID material model ($\|\eta\| < 1.1$)	50
$H \to \gamma\gamma$ background model (unconv rest low p_{Tt})	40
$Z \to ee$ calibration	50
Primary vertex effect on mass scale	20
Muon momentum scale	10
Remaining systematic uncertainties	70
Total	180





$H \to \gamma\gamma$ categories

- 10 categories optimised to minimize expected mass measurement uncertainty:
  - converted and unconverted - energy resolution better for unconverted photons, energy scale systematic uncertainties different
  - photon η:
    - *central* region: both photons in central region, has best mass resolution and S-B ratio, smallest energy scale uncertainties
    - *transition* region: at least 1 photon in transition region, has worse energy resolution due to material in front of calorimeter, larger E-scale uncertainties
    - the *rest*
- p_T transverse variable: component of diphoton transverse momentum orthogonal to diphoton thrust axis in the transverse plane; high p_{Tt}: better S-B ratio and mass resolution, but small yield



Transverse mass

This is a generalized transverse mass for **systems with two invisible particles**

SM EXAMPLE: top pair dileptonic decay

The lepton-neutrino transverse mass obeys on both sides:

$$m_T(l,\nu) = \sqrt{2 p_T(l)\, p_T(\nu)\left[1-\cos(\varphi_l - \varphi_\nu)\right]} < m(W)$$

$$\max\left[m_T\left(p_T^1, \vec{q}_T^{\,1}\right), m_T\left(p_T^2, \vec{q}_T^{\,2}\right)\right] < m(W)$$

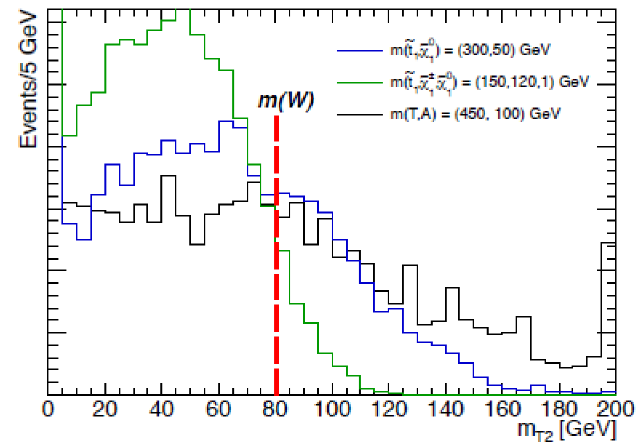
- The direction of the two neutrinos is unknown, but it's possible to **try all possibilities and take the minimum.**

$$m_{T2}\left(\vec{p}_T^{\,1}, \vec{p}_T^{\,2}, \vec{\not{p}}_T\right) = \min_{\vec{q}_T^{\,1}+\vec{q}_T^{\,2}=\vec{\not{p}}_T} \left\{\max\left[m_T\left(p_T^1, \vec{q}_T^{\,1}\right), m_T\left(p_T^2, \vec{q}_T^{\,2}\right)\right]\right\}$$

- **m_{T2} < m(W)** for *top pairs*, *Wt* and *WW*.

SIGNAL can extend to higher values, depending on the mass splitting of the involved particles

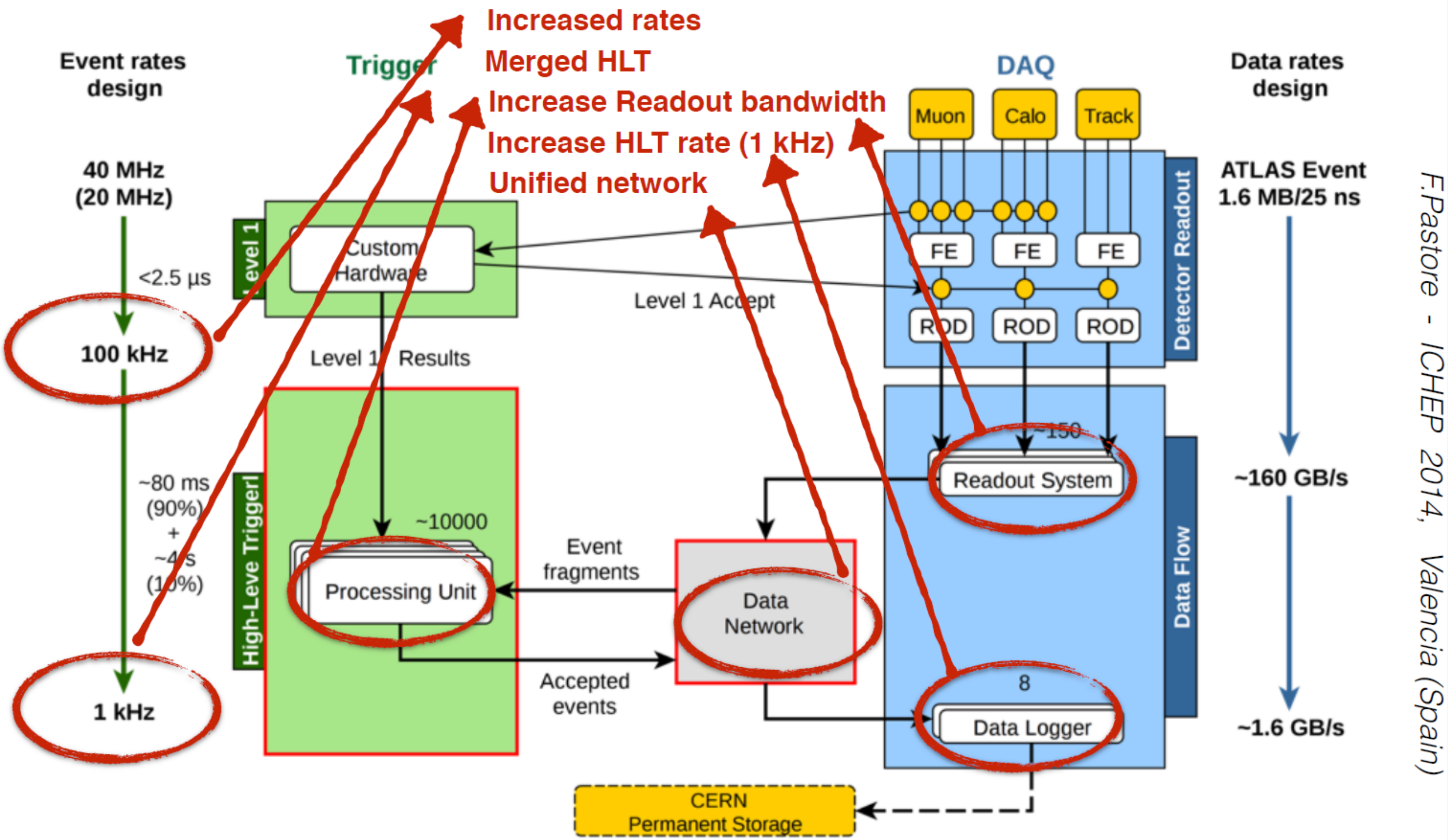
- A cut and count approach is sensitive to large $\Delta m\left(\tilde{t}_1, \tilde{\chi}_1^0\right)$ or $\Delta m\left(\tilde{\chi}_1^\pm, \tilde{\chi}_1^0\right)$



Systematic Uncertainties

Experimental Uncertainties:	JES, JER, SoftTerm, pile-up, b-tagging, JVF, etc..
Top generator:	comparison between MC@NLO and Powheg+Jimmy
Top parton shower:	comparison between Powheg+Pythia and Powheg+Jimmy
Top ISRFSR:	AcerMC dedicated samples
Diboson generator:	compare Powheg vs Sherpa samples
Fake lepton:	limited statistics of the CRs discrepancy of the fake rate estimated from the different QCD control samples
Z+jets generator:	compare Sherpa vs Alpgen samples
top + Wt interference:	compare MC@NLO with AcerMC

Run2 TDAQ architecture



- L1 output limit will be decided by detector occupancy
- New architecture tested successfully

11

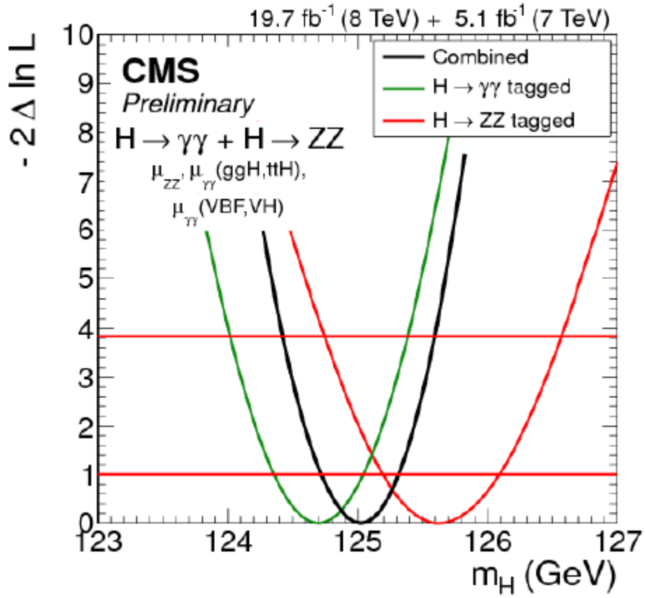
Combination

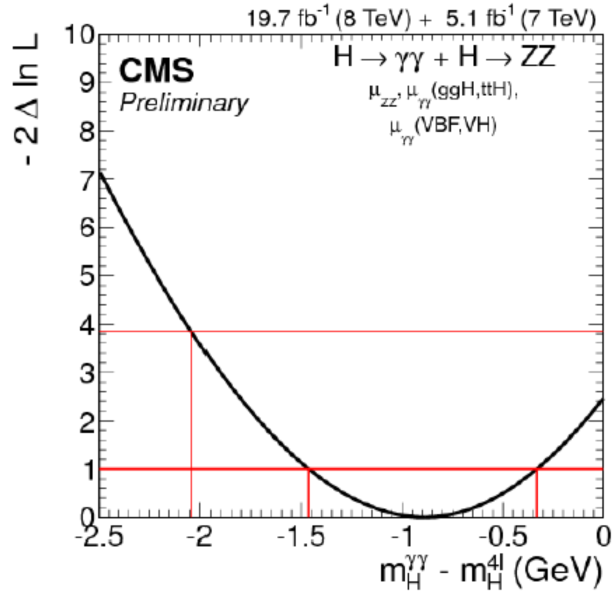
(CMS-PAS-HIG-14-009)

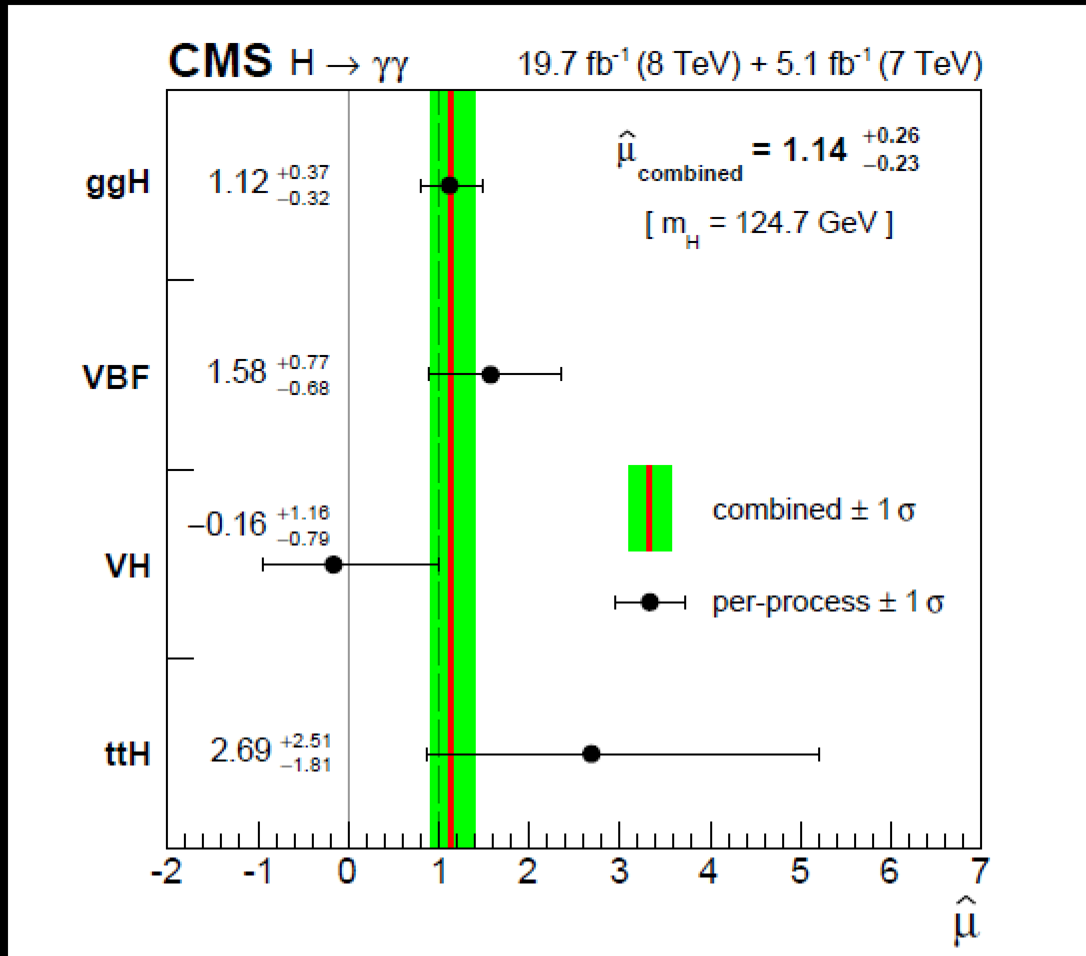
- Signal strength modifiers for (ggH,ttH)→γγ, (VBF,VH)→γγ and H→ZZ are not fixed to the SM expectation to get an estimate of m_H as much as possible model independent:

$$m_H = 125.03^{+0.26}_{-0.27}(stat)^{+0.13}_{-0.15}(syst) = 125.03^{+0.29}_{-0.31}(tot)\, GeV$$

  - The measurements of the single channels have been checked to **agree** at the **1.6σ level**.

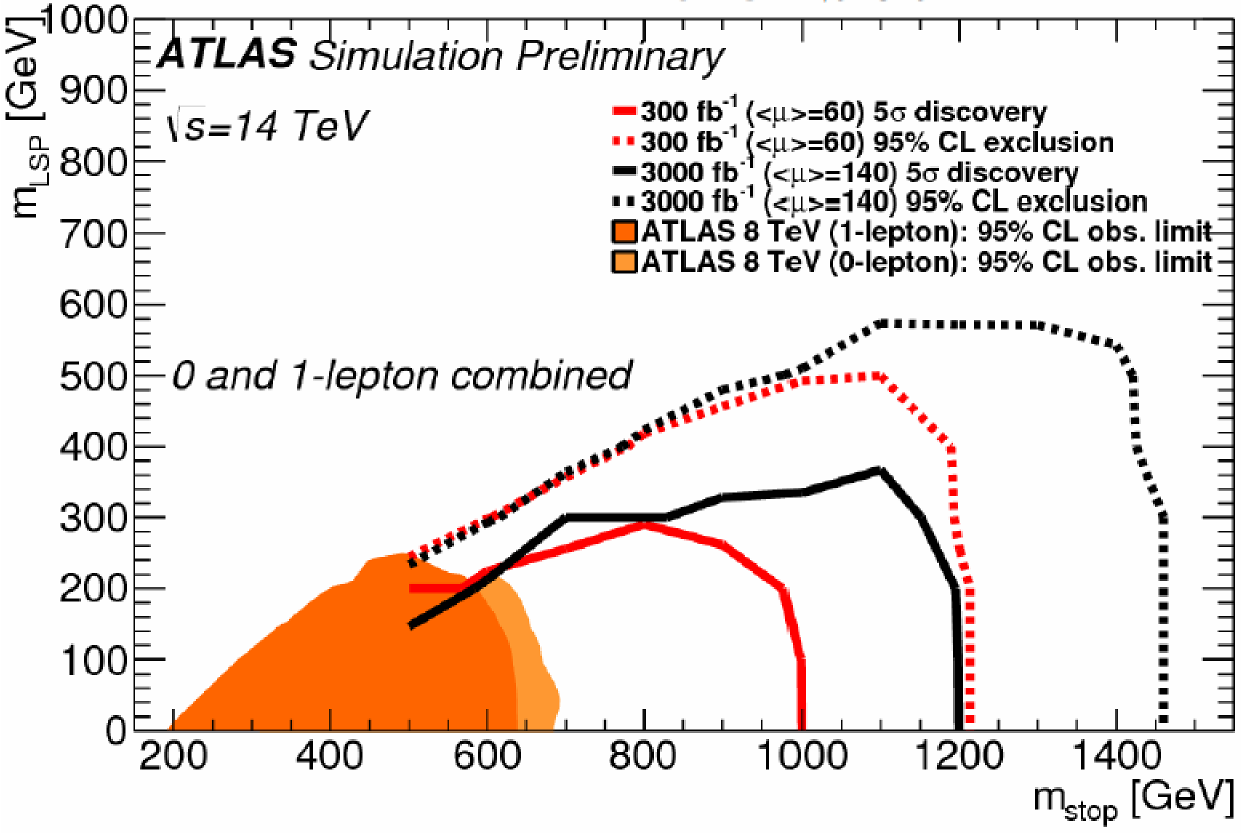




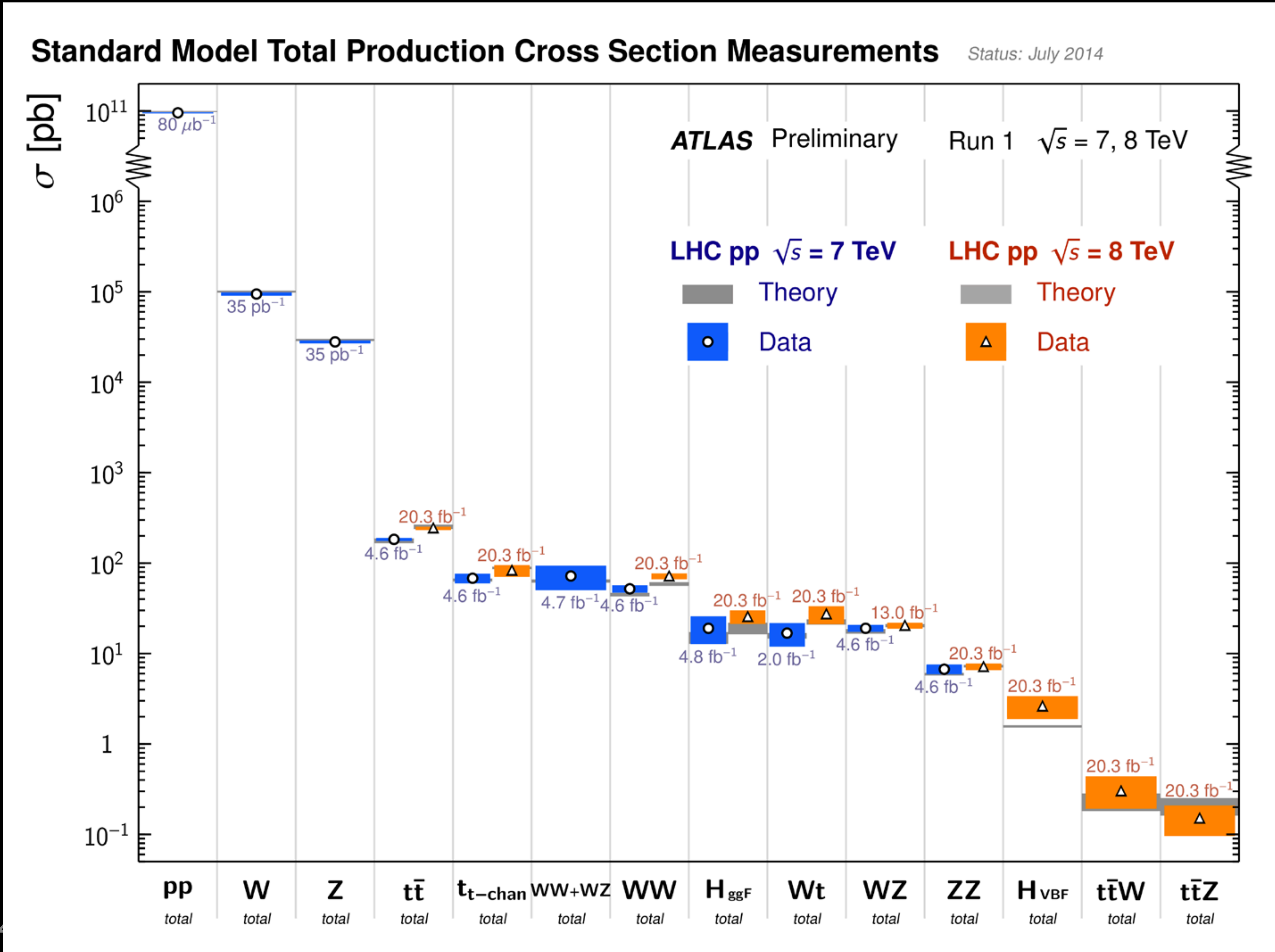

CMS H → γγ
19.7 fb-1 (8 TeV) + 5.1 fb-1 (7 TeV)
μ̂ combined = 1.14 +0.26 −0.23
[mH = 124.7 GeV]
ggH
1.12 +0.37 −0.32
VBF
1.58 +0.77 −0.68
VH
−0.16 +1.16 −0.79
ttH
2.69 +2.51 −1.81
combined ± 1 σ
per-process ± 1 σ
-2
-1
0
1
2
3
4
5
6
7
μ̂

Expected 14 TeV coverage

ATL-PHYS-PUB-2013-011



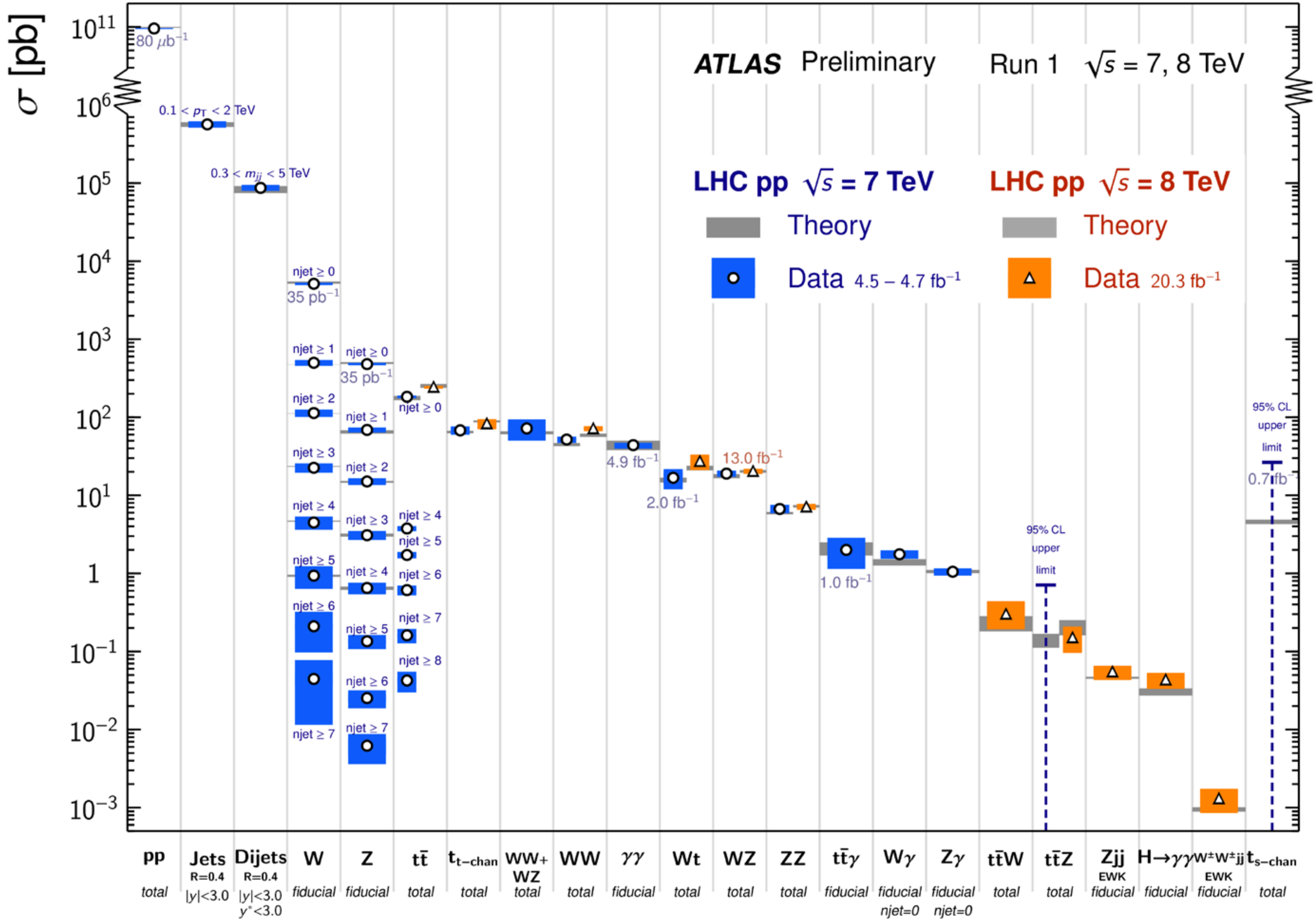
Looking forward for Run II with increased center of mass energy and increased luminosity.

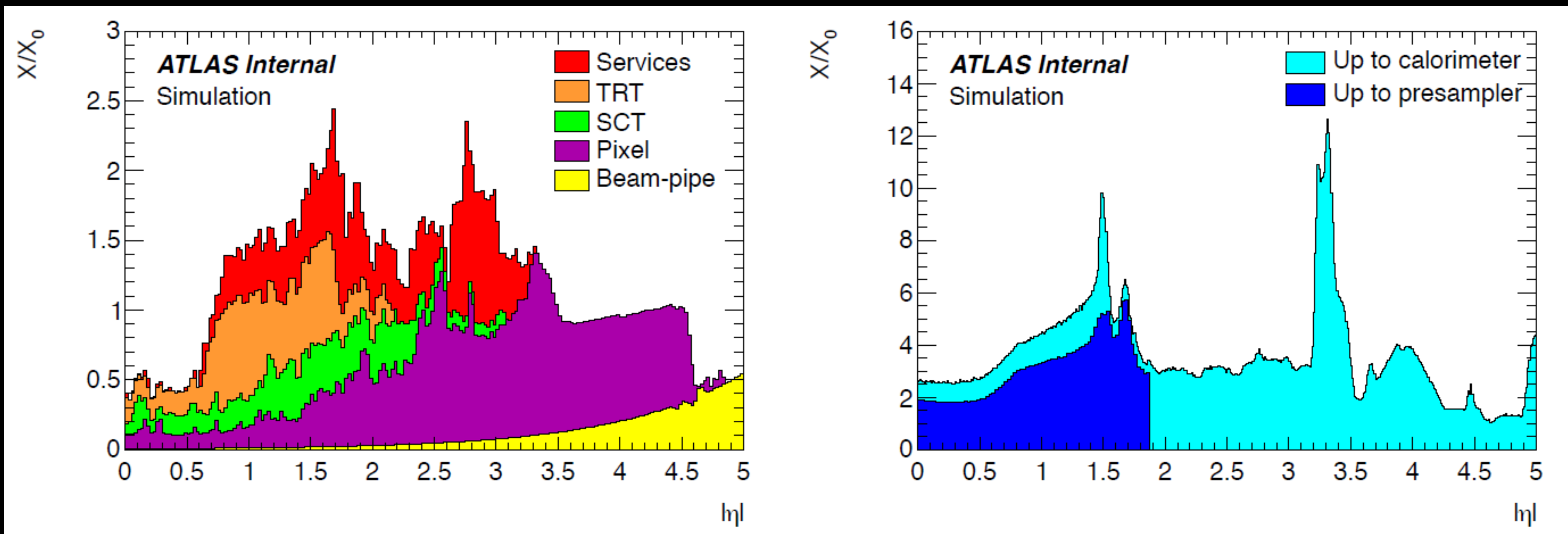


Standard Model Total Production Cross Section Measurements
Status: July 2014
σ [pb]
ATLAS Preliminary
Run 1 √s = 7, 8 TeV
LHC pp √s = 7 TeV
Theory
Data
LHC pp √s = 8 TeV
Theory
Data
80 μb⁻¹
35 pb⁻¹
35 pb⁻¹
4.6 fb⁻¹
20.3 fb⁻¹
4.6 fb⁻¹
20.3 fb⁻¹
4.7 fb⁻¹
4.6 fb⁻¹
20.3 fb⁻¹
4.8 fb⁻¹
20.3 fb⁻¹
2.0 fb⁻¹
20.3 fb⁻¹
4.6 fb⁻¹
13.0 fb⁻¹
4.6 fb⁻¹
20.3 fb⁻¹
20.3 fb⁻¹
20.3 fb⁻¹
20.3 fb⁻¹
pp total
W total
Z total
tt̄ total
t t-chan total
WW+WZ total
WW total
H ggF total
Wt total
WZ total
ZZ total
H VBF total
tt̄W total
tt̄Z total

Standard Model Production Cross Section Measurements

Status: July 2014




X/X0
ATLAS Internal
Simulation
Services
TRT
SCT
Pixel
Beam-pipe
|η|
X/X0
ATLAS Internal
Simulation
Up to calorimeter
Up to presampler
|η|