Overview of ATLAS results and prospects for physics at HL-LHC

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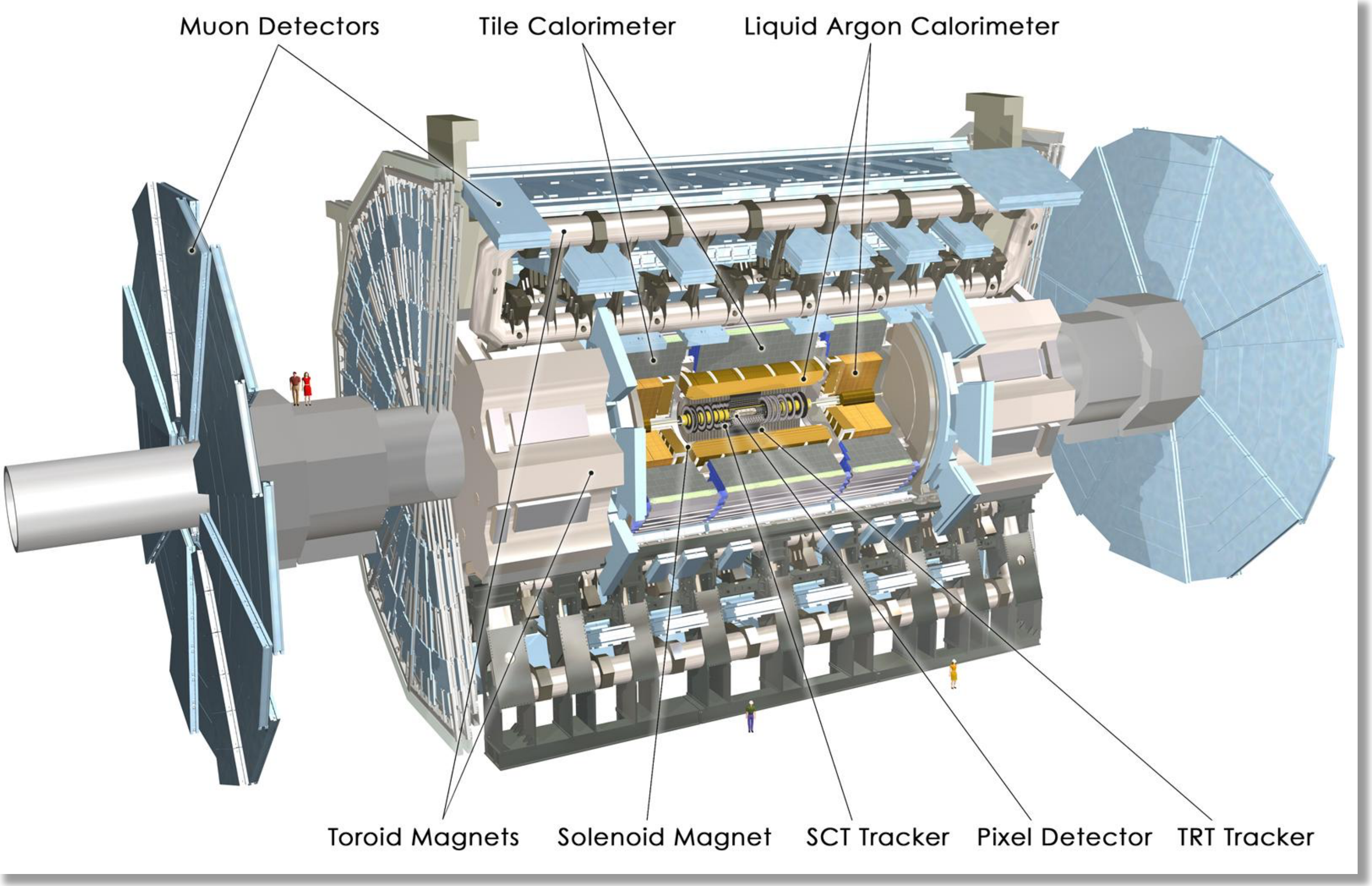
On behalf of the ATLAS Collaboration

Triggering Discoveries in HEP

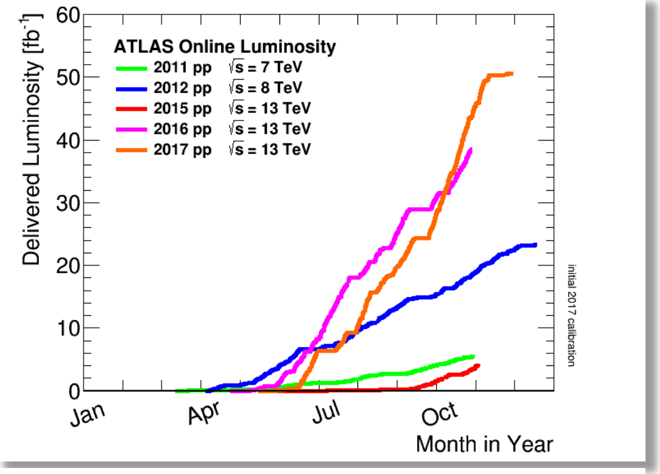
January 29th-February 2nd 2018, Puebla, Mexico

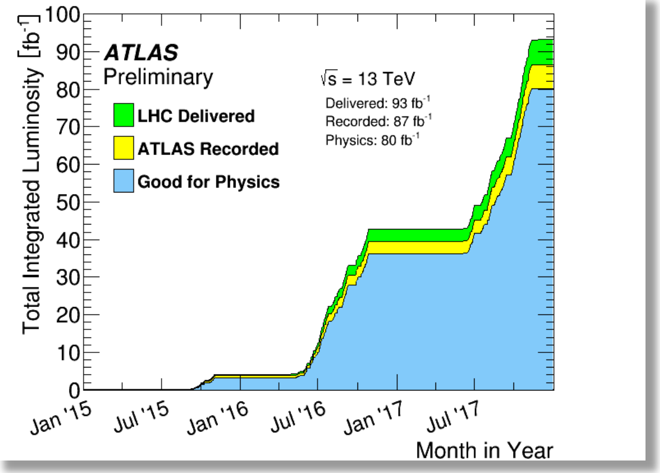
ATLAS Detector



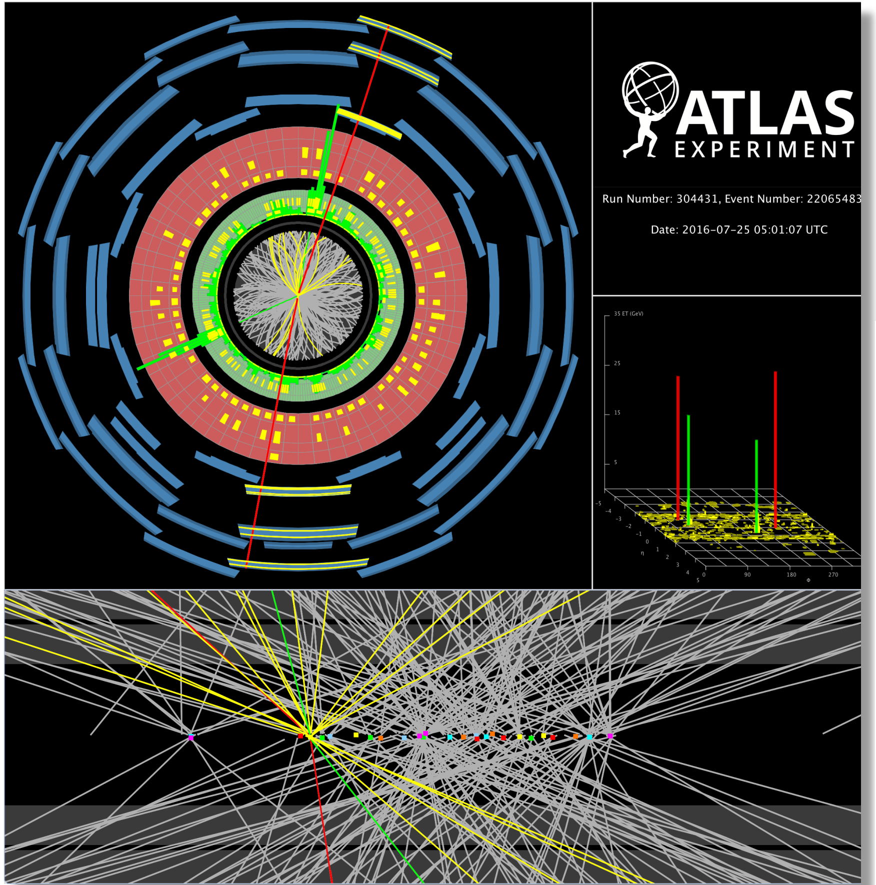
LHC and ATLAS Performance

- LHC:
  - Record instantaneus luminosity of 1.4×10^{34} $cm^{-2}s^{-1}$ for p-p interactions (2016)
  - Average pile-up of 25 interaction for bunch crossing (40 maximum) (2016)
  - Almost 40 fb^{-1} integrated Luminosity delivered in 2016 and 50 fb^{-1} in 2017
  - Heavy Ions collisions at 5 TeV and 8 TeV
- ATLAS:
  - Recorded 86.5 fb^{-1} in 2016/2017
  - With an efficiency of 93-95 %
  - Most results presented use 2015/2016 dataset (36.1 fb^{-1})
  - Luminosity uncertainty 3.2 %

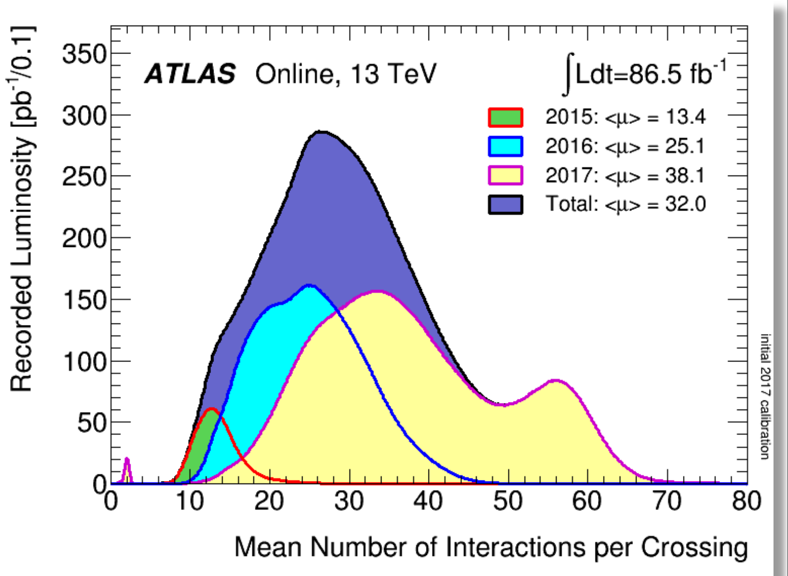




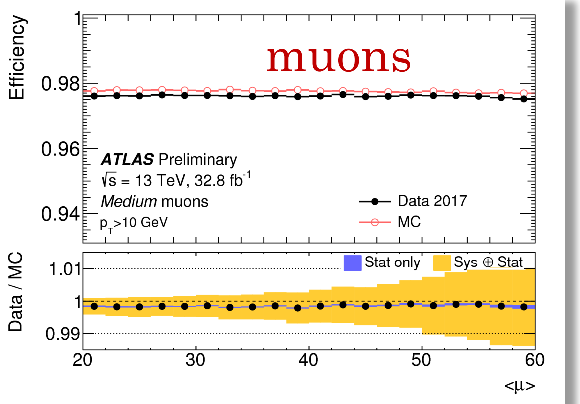
Mean Number of Interaction per Crossing

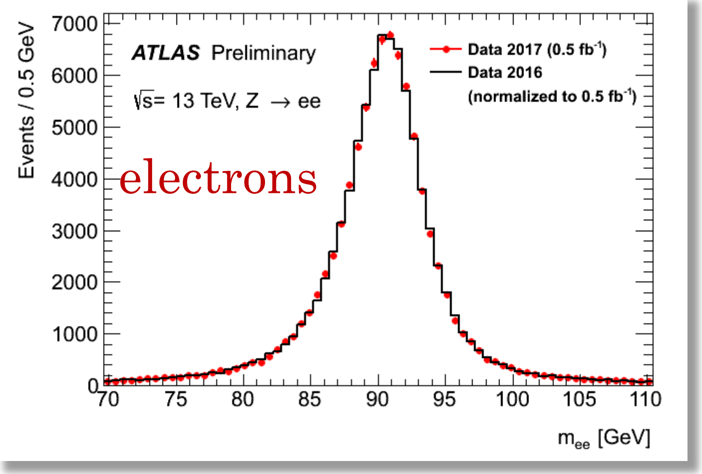


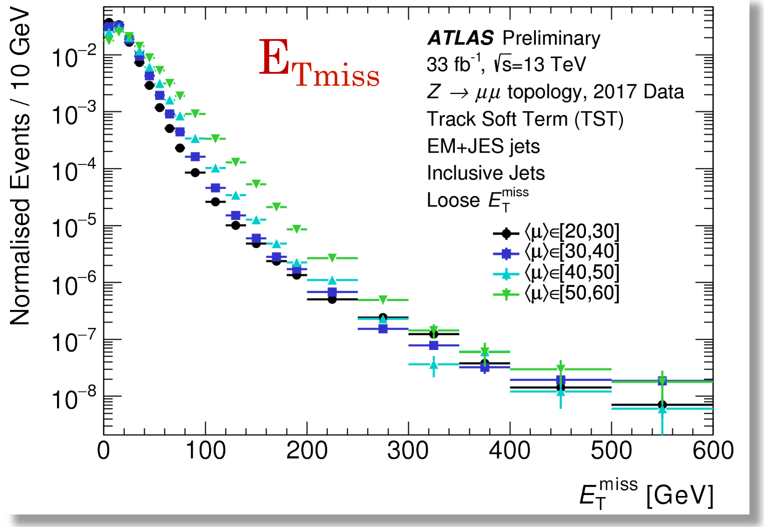
- ✓ Candidate Higgs Boson
- ✓ 25 reconstructed vertices

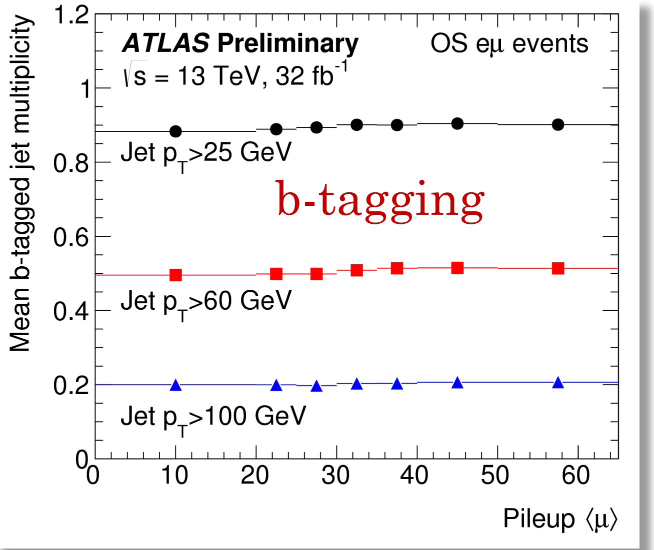


Detector Performance



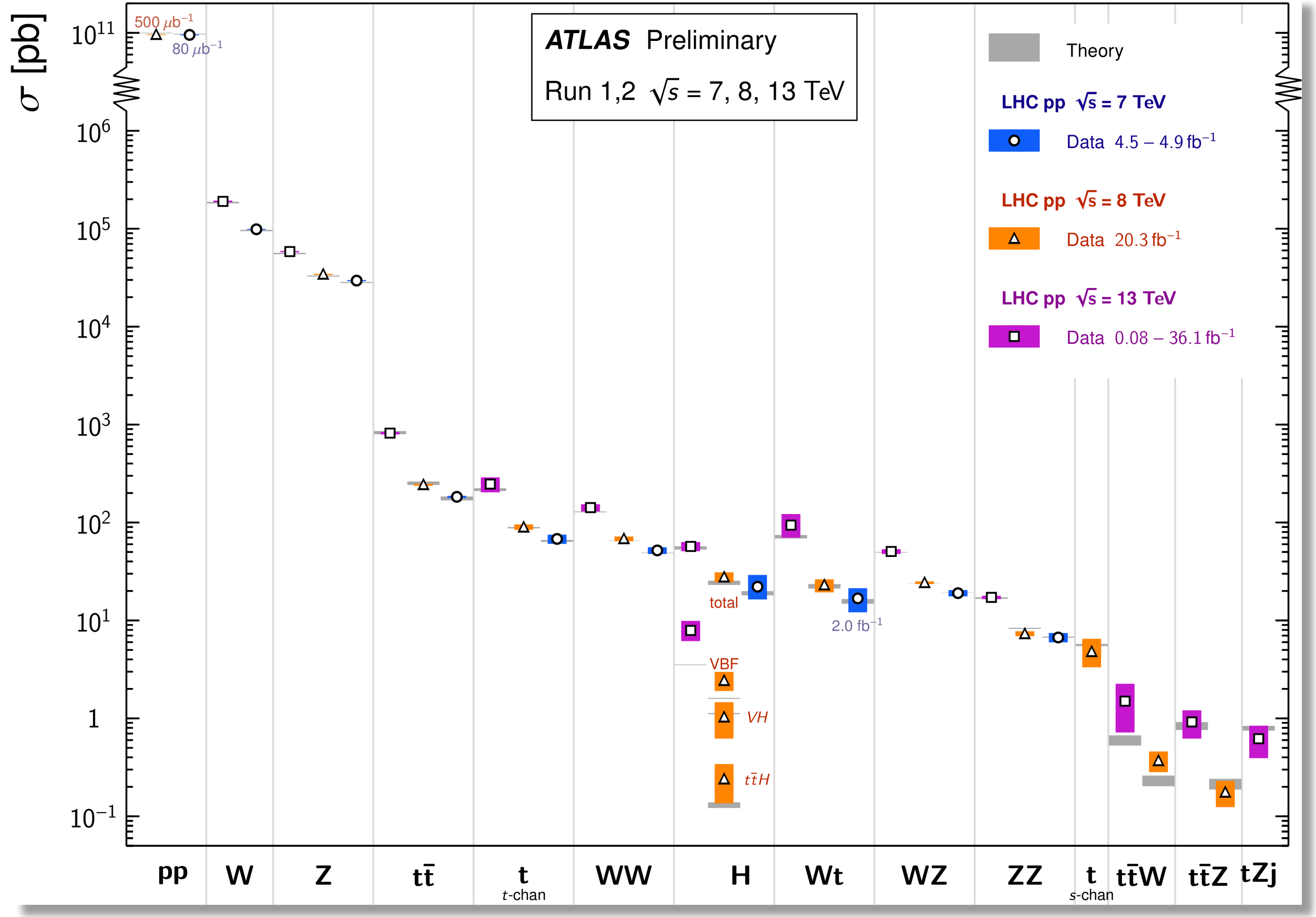






Recent Physics Results

Standard Model Total Production Cross-Sections

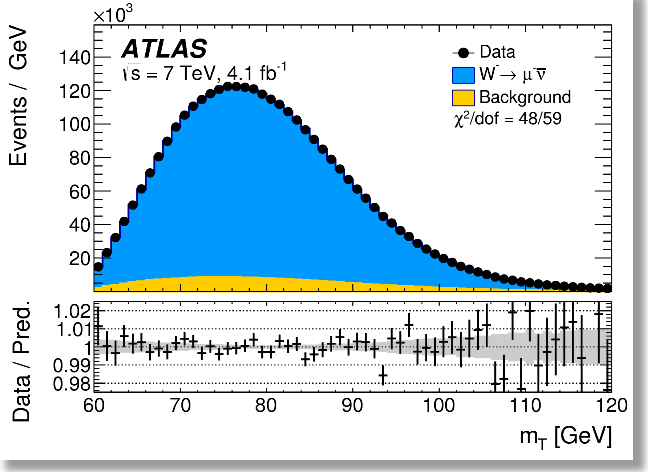


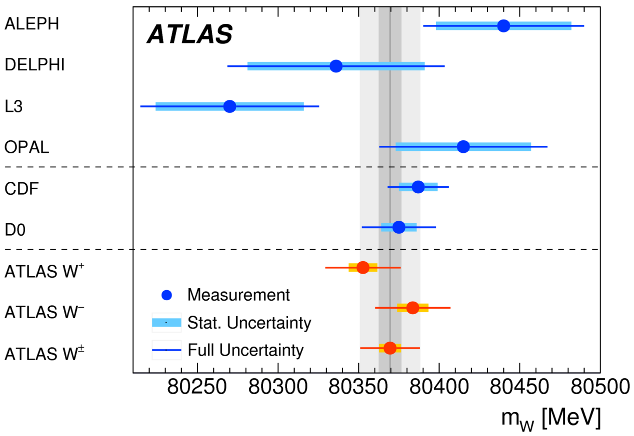
Measurements of W Boson Mass

arxiv:1701.07240

- ✓ Data taken at 7 TeV, 4.6 fb^{-1}(2011)
- ✓ Studied Semi-leptonic decays of W (μ/e)
- ✓ Huge amount of work to understand detector modelling of kinematic quantities
- ✓ Obtained precision is comparable to Tevatron Data
- ✓ Consistent with Standard Model
- ✓ First Measurement at LHC

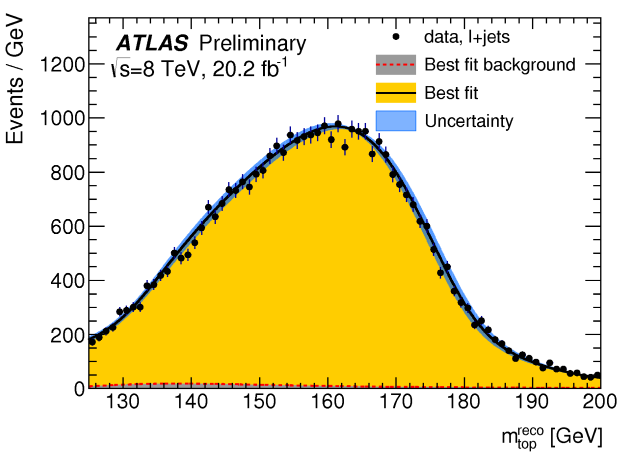
$M_W = 80370 \pm 7\ (stat)$
$\pm 11\ (exp.\ syst)$
$\pm 14\ (mod.\ syst)\ MeV$
Total Error: 19 MeV (0.02%)



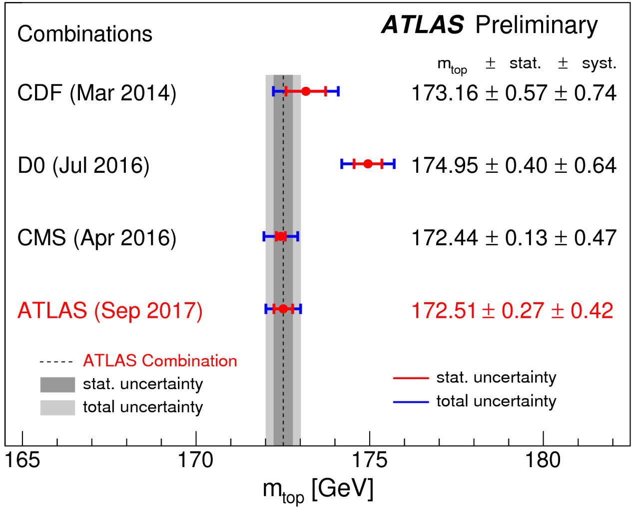


Top Quark Mass

ATLAS-CONF-2017-071

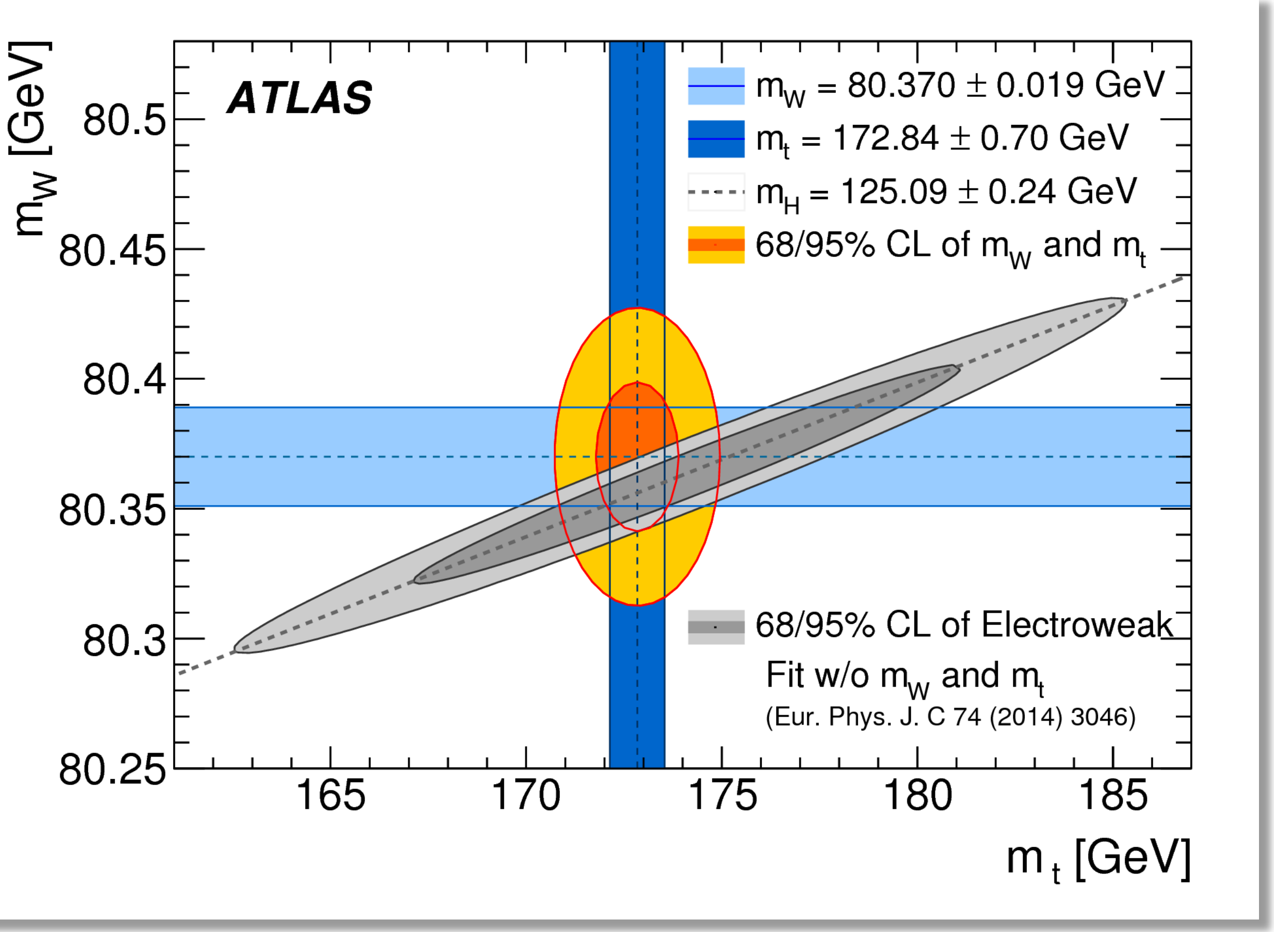


- ✓ New measurement with 8 TeV Run-1 Data (2012)
- ✓ Top quark Mass measured with
  - ✓ Lepton+jets(2b)
    $m_t = 172.08 \pm 0.39_{stat} \pm 0.82_{syst}$ GeV
  - ✓ Dileptons
    $m_t = 172.99 \pm 0.41_{stat} \pm 0.74_{syst}$ GeV
- ✓ ATLAS Combination with Run-1:
  $m_t = 172.51 \pm 0.27_{stat} \pm 0.42_{syst}$ GeV
- ✓ Systematics in combination reduced by correlation in measurements



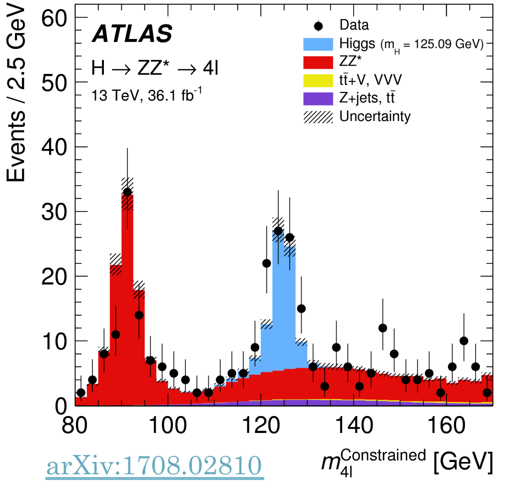
arXiv:1701.07240

Consistency Tests of SM



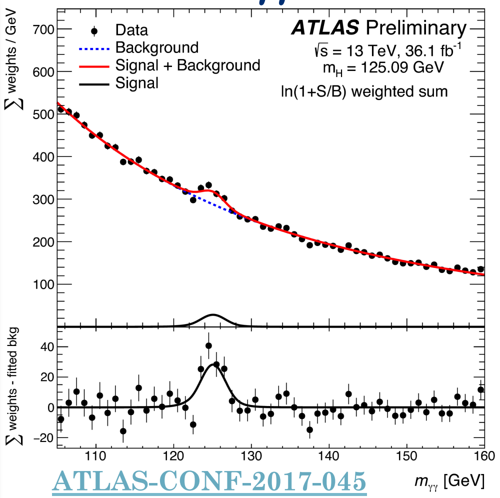
Higgs Boson Mass Measurement

H→ZZ*→4l

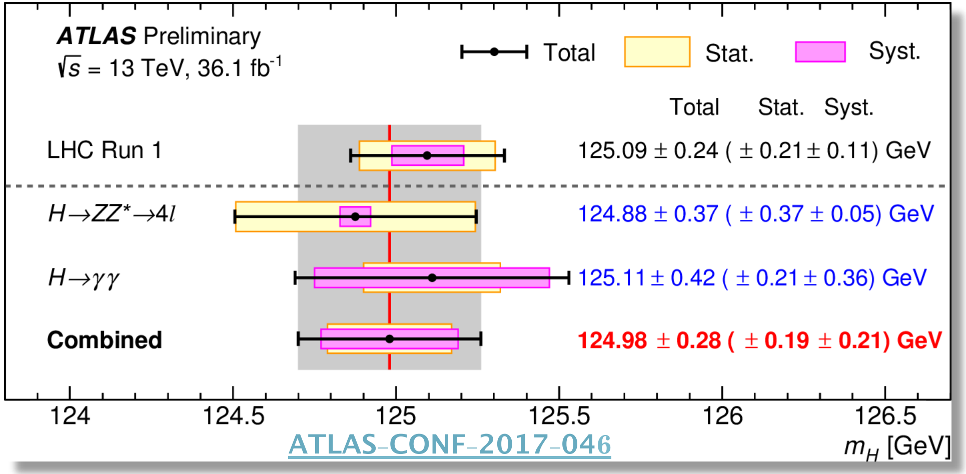


arXiv:1708.02810

H→γγ



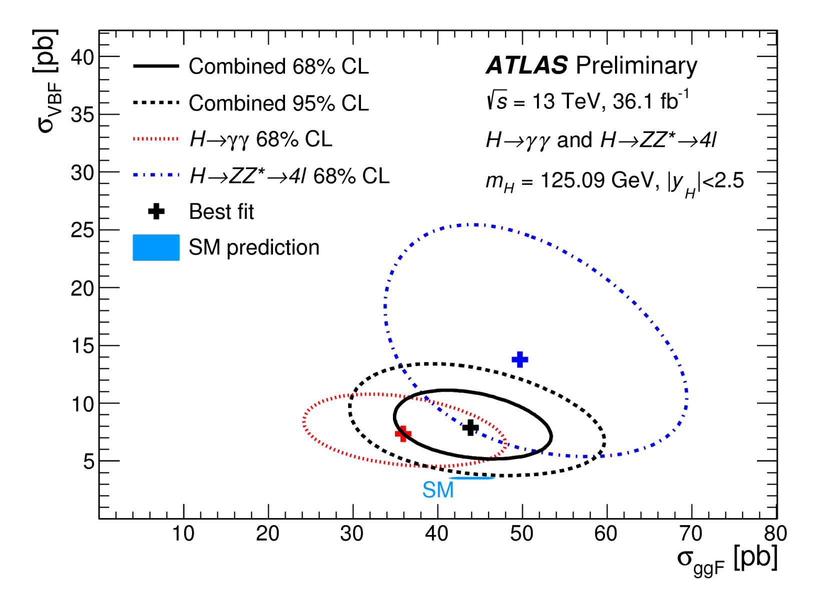
ATLAS-CONF-2017-045

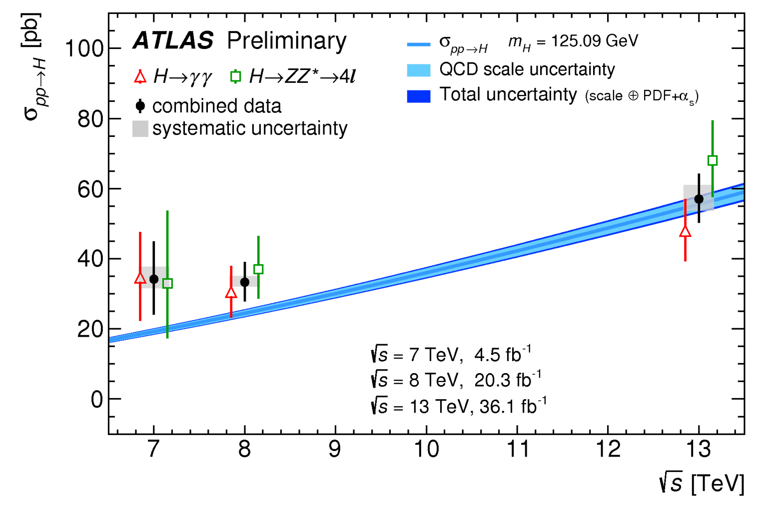


ATLAS-CONF-2017-046

- ✓ Preliminary Run-2 results almost as good as ATLAS+CMS Run-1 measurements
- ✓ Mostly systematics

Higgs Boson Production

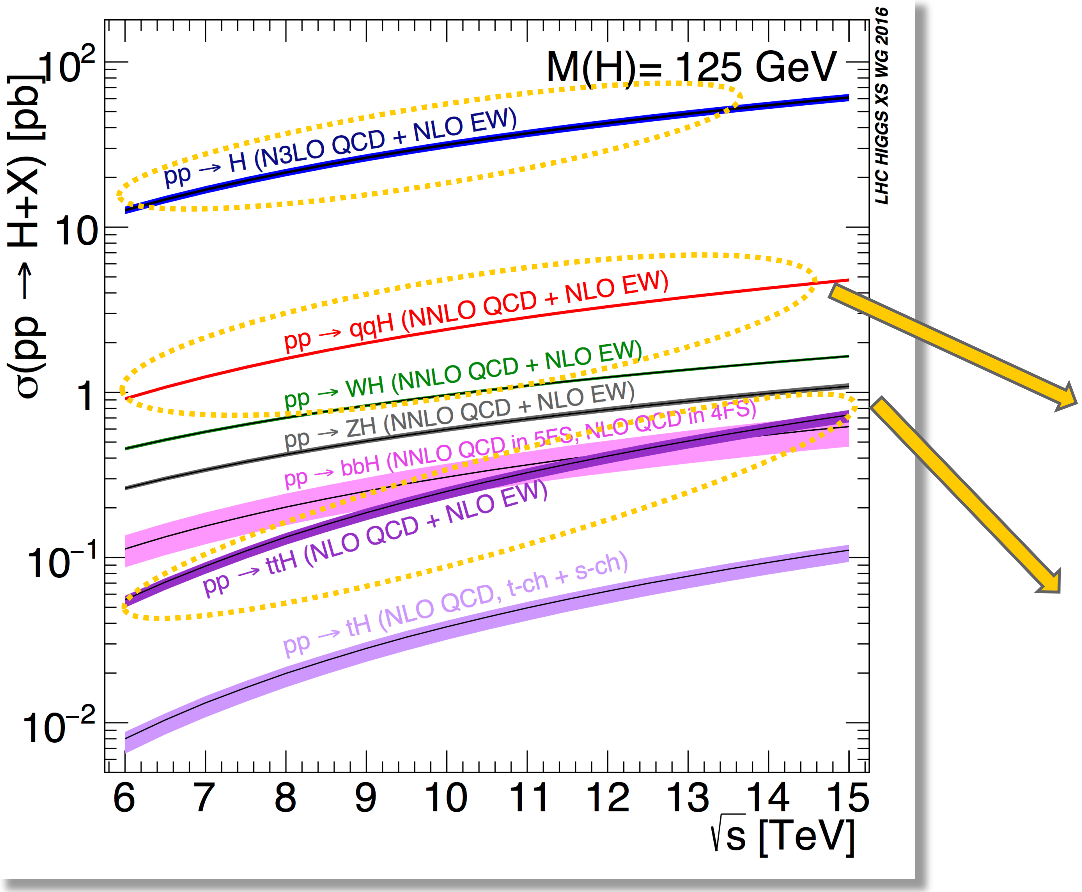


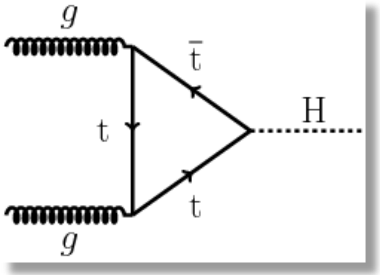


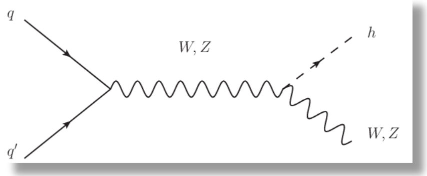
Combined signal strength

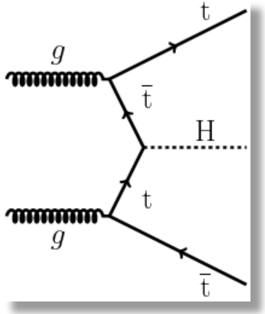
$$\mu = 1.09 \pm 0.12 = 1.09 \pm 0.09\ (\text{stat.})\ ^{+0.06}_{-0.05}\ (\text{exp.})\ ^{+0.06}_{-0.05}\ (\text{th.}).$$

Higgs: From direct to associated production



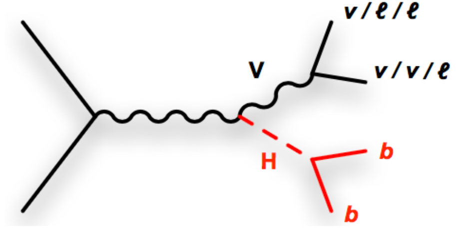


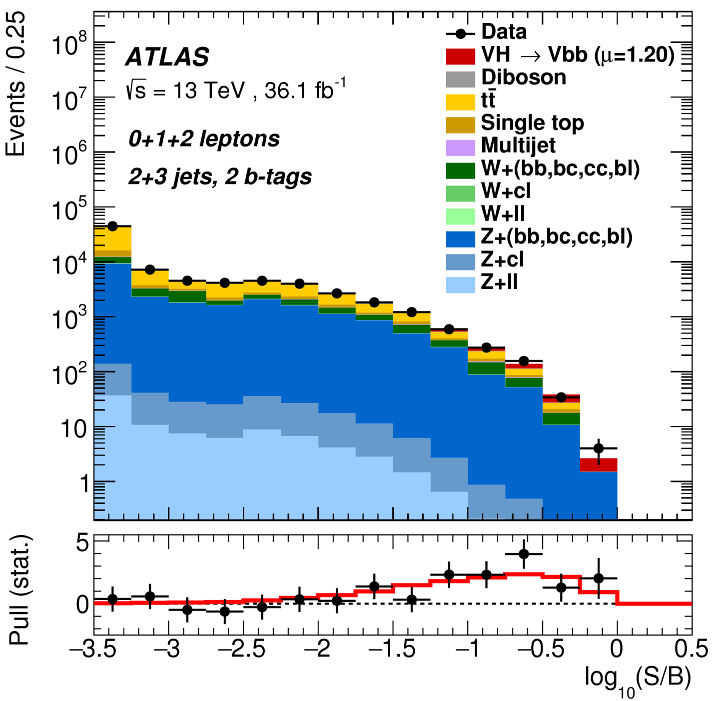




Search for Higgs to bb

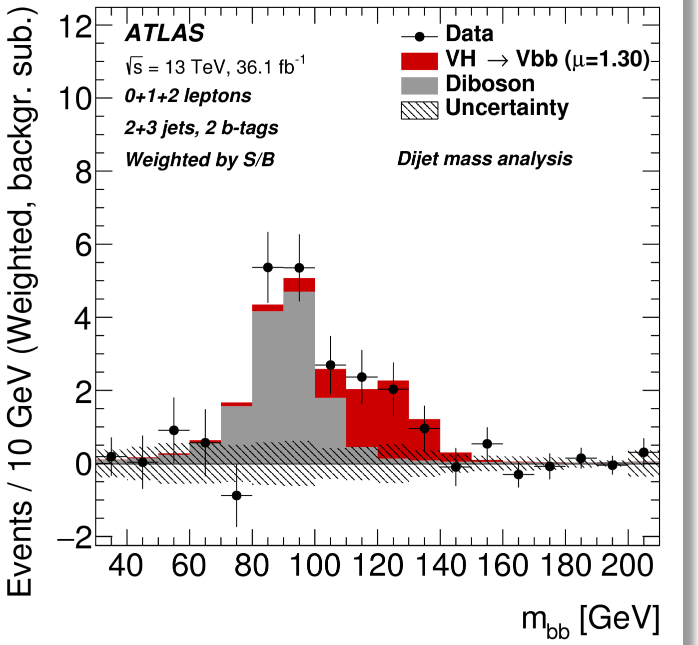
- ✓ Dominant Higgs decay (58%)
- ✓ Coupling to Vector Boson Associated production gives enough sensitivity
- ✓ Analysis at Tevatron (2.8σ) and in LHC Run-1 (ATLAS+CMS) (2.6σ)
- ✓ ATLAS searches for VH with H→bb and Z/W decays to 0/1/2 leptons
- ✓ MVA analysis (BDT Based) cross-checked by cut-based on m(bb)
- ✓ Validated by VZ (Z →bb) analysis
- ✓ Observed significance is 3.5σ (3.0σ expected)
- ✓ Combination with ATLAS Run-1 gives 3.6σ (4.0σ expected)
- ✓ Signal Strength consistent with SM

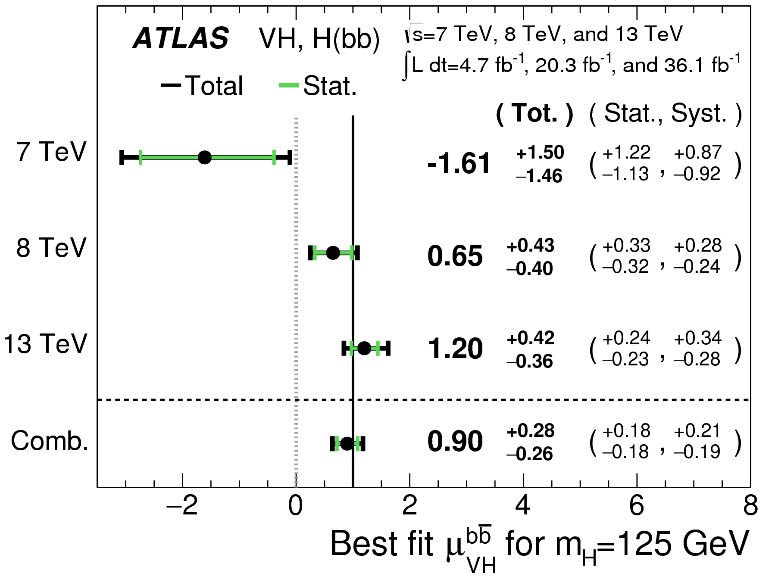




JHEP12(2017)024

Evidence of Higgs decay to bb

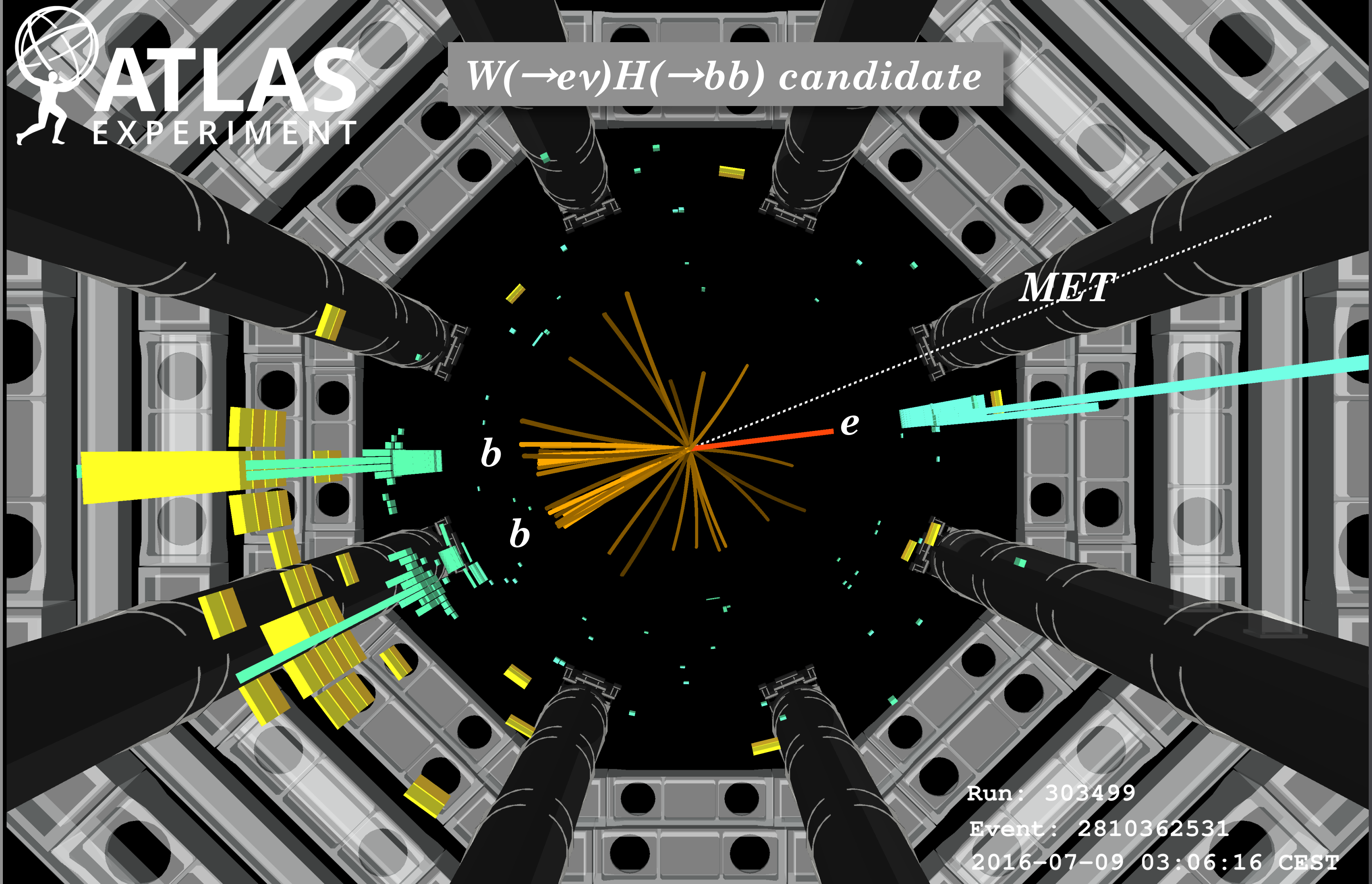




- ✓ m_{bb} distribution for data summed for all channels, pt intervals and jet categories
- ✓ background subtracted, except for the VV diboson processes
- ✓ obtained with the di-jet mass analysis

- ✓ Fitted values of the Higgs boson signal strength parameter μ
- ✓ m_H=125 GeV separately for the 7 TeV, 8 TeV and 13 TeV datasets and their combination.

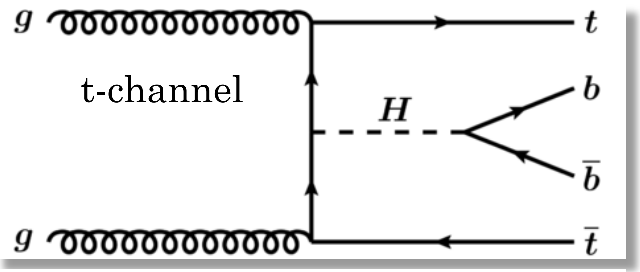
$W(\rightarrow e\nu)H(\rightarrow bb)$ candidate

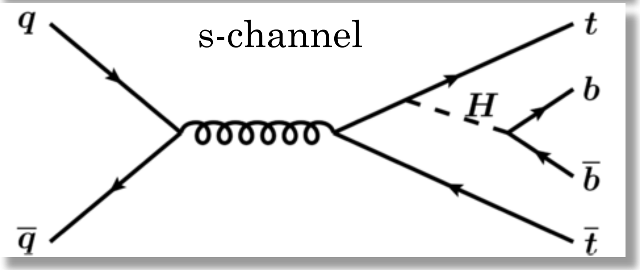


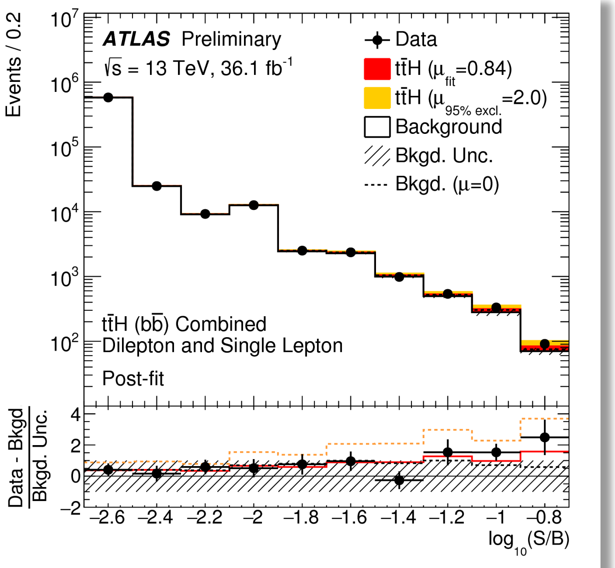
arxiv.:1712.08895

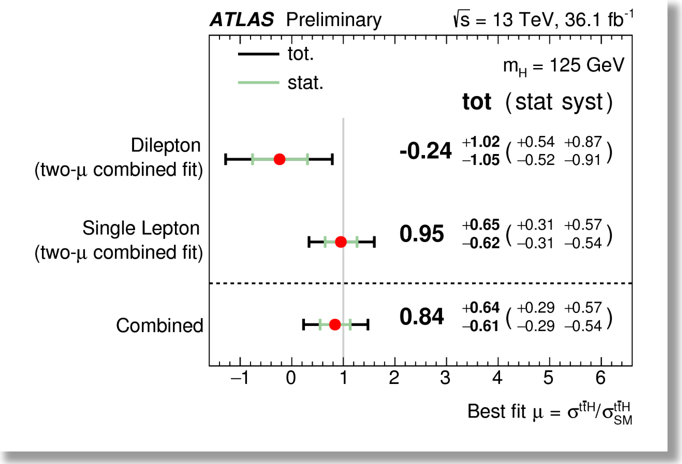
Search for ttH, H→bb

- ✓ Direct access to top Yukawa coupling at tree level
- ✓ Challenging backgrounds (tt+jets), require accurate modelling
- ✓ 1 or 2 electron or muons, and b-jets signature
- ✓ Multivariate techniques (BDT) gives 1.4σ (1.6σ expected)
- ✓ Signal strength μ<2.0 (μ<1.2 expected)









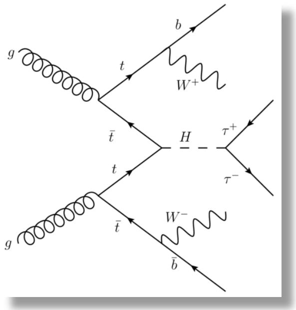
Evidence for ttH with H→WW,ZZ,ττ

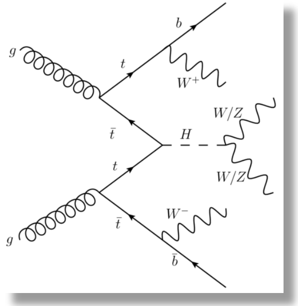
✓ Run-2 multi-lepton analysis with Higgs decaying in dibosons and hadronic tau channels

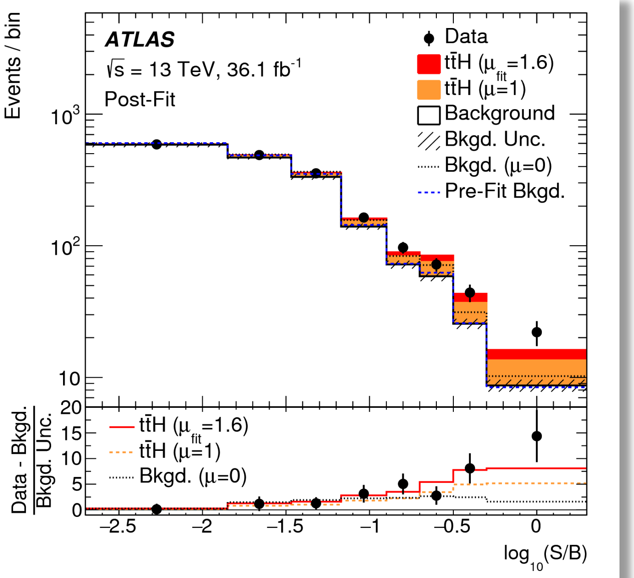
✓ Seven final states, Higgs in association with top pairs

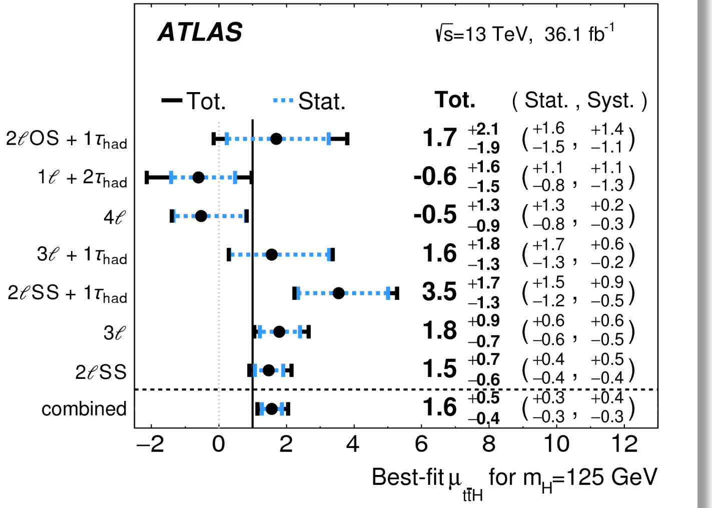
✓ Excess of events with a 4.1σ significance (2.8σ expected)

✓ Signal Strength in reasonable agreement with SM







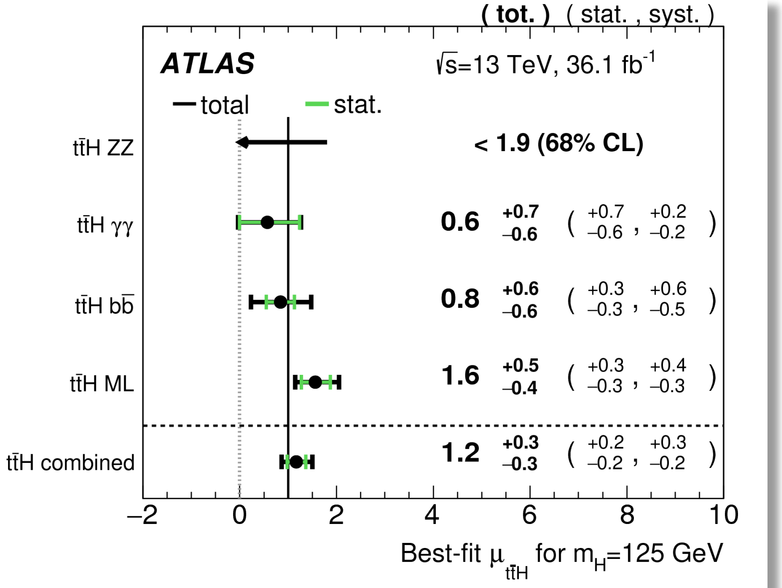


arxiv:1712.08891

ttH Searches Combination

- ✓Combination of the multilepton analysis (ML) with all other ATLAS ttH searches and results including searches in bb, γγ, 4l, WW, ZZ, ττ
- ✓Reaches 4.2σ significance (3.8σ expected), provides evidence for this mode
- ✓Signal Strength in quite good agreement with Standard Model

Channel	Best-fit μ Observed	Best-fit μ Expected	Significance Observed	Significance Expected
Multilepton	$1.6^{+0.5}_{-0.4}$	$1.0^{+0.4}_{-0.4}$	4.1σ	2.8σ
$H \to b\bar{b}$	$0.8^{+0.6}_{-0.6}$	$1.0^{+0.6}_{-0.6}$	1.4σ	1.6σ
$H \to \gamma\gamma$	$0.6^{+0.7}_{-0.6}$	$1.0^{+0.8}_{-0.6}$	0.9σ	1.7σ
$H \to 4\ell$	< 1.9	$1.0^{+3.2}_{-1.0}$	—	0.6σ
Combined	$1.2^{+0.3}_{-0.3}$	$1.0^{+0.3}_{-0.3}$	4.2σ	3.8σ



Exotics Searches

ATLAS Exotics Searches* - 95% CL Upper Exclusion Limits

Status: July 2017

ATLAS Preliminary

$\int \mathcal{L}\,dt = (3.2 - 37.0)\ \mathrm{fb}^{-1}$ $\sqrt{s}$ = 8, 13 TeV

	Model	ℓ, γ	Jets†	E_T^{miss}	$\int \mathcal{L}\,dt[\mathrm{fb}^{-1}]$	Limit		Reference
Extra dimensions	ADD $G_{KK} + g/q$	0 e, μ	1 − 4 j	Yes	36.1	M_D 7.75 TeV	$n = 2$	ATLAS-CONF-2017-060
	ADD non-resonant $\gamma\gamma$	2 γ	–	–	36.7	M_S 8.6 TeV	$n = 3$ HLZ NLO	CERN-EP-2017-132
	ADD QBH	–	2 j	–	37.0	M_{th} 8.9 TeV	$n = 6$	1703.09217
	ADD BH high $\sum p_T$	≥ 1 e, μ	≥ 2 j	–	3.2	M_{th} 8.2 TeV	$n = 6$, $M_D = 3$ TeV, rot BH	1606.02265
	ADD BH multijet	–	≥ 3 j	–	3.6	M_{th} 9.55 TeV	$n = 6$, $M_D = 3$ TeV, rot BH	1512.02586
	RS1 $G_{KK} \to \gamma\gamma$	2 γ	–	–	36.7	G_{KK} mass 4.1 TeV	$k/\overline{M}_{Pl} = 0.1$	CERN-EP-2017-132
	Bulk RS $G_{KK} \to WW \to qq\ell\nu$	1 e, μ	1 J	Yes	36.1	G_{KK} mass 1.75 TeV	$k/\overline{M}_{Pl} = 1.0$	ATLAS-CONF-2017-051
	2UED / RPP	1 e, μ	≥ 2 b, ≥ 3 j	Yes	13.2	KK mass 1.6 TeV	Tier (1,1), $\mathcal{B}(A^{(1,1)} \to tt) = 1$	ATLAS-CONF-2016-104
Gauge bosons	SSM $Z' \to \ell\ell$	2 e, μ	–	–	36.1	Z' mass 4.5 TeV		ATLAS-CONF-2017-027
	SSM $Z' \to \tau\tau$	2 τ	–	–	36.1	Z' mass 2.4 TeV		ATLAS-CONF-2017-050
	Leptophobic $Z' \to bb$	–	2 b	–	3.2	Z' mass 1.5 TeV		1603.08791
	Leptophobic $Z' \to tt$	1 e, μ	≥ 1 b, ≥ 1J/2j	Yes	3.2	Z' mass 2.0 TeV	$\Gamma/m = 3\%$	ATLAS-CONF-2016-014
	SSM $W' \to \ell\nu$	1 e, μ	–	Yes	36.1	W' mass 5.1 TeV		1706.04786
	HVT $V' \to WV \to qqqq$ model B	0 e, μ	2 J	–	36.7	V' mass 3.5 TeV	$g_V = 3$	CERN-EP-2017-147
	HVT $V' \to WH/ZH$ model B	multi-channel			36.1	V' mass 2.93 TeV	$g_V = 3$	ATLAS-CONF-2017-055
	LRSM $W'_R \to tb$	1 e, μ	2 b, 0-1 j	Yes	20.3	W' mass 1.92 TeV		1410.4103
	LRSM $W'_R \to tb$	0 e, μ	≥ 1 b, 1 J	–	20.3	W' mass 1.76 TeV		1408.0886
CI	CI $qqqq$	–	2 j	–	37.0	Λ 21.8 TeV η_{LL}^-		1703.09217
	CI $\ell\ell qq$	2 e, μ	–	–	36.1	Λ 40.1 TeV η_{LL}^-		ATLAS-CONF-2017-027
	CI $uutt$	2(SS)/≥3 e,μ	≥1 b, ≥1 j	Yes	20.3	Λ 4.9 TeV	$\lvert C_{RR}\rvert = 1$	1504.04605
DM	Axial-vector mediator (Dirac DM)	0 e, μ	1 − 4 j	Yes	36.1	m_{med} 1.5 TeV	g_q=0.25, g_χ=1.0, $m(\chi) < 400$ GeV	ATLAS-CONF-2017-060
	Vector mediator (Dirac DM)	0 e, μ, 1 γ	≤ 1 j	Yes	36.1	m_{med} 1.2 TeV	g_q=0.25, g_χ=1.0, $m(\chi) < 480$ GeV	1704.03848
	$VV\chi\chi$ EFT (Dirac DM)	0 e, μ	1 J, ≤ 1 j	Yes	3.2	M_* 700 GeV	$m(\chi) < 150$ GeV	1608.02372
LQ	Scalar LQ 1st gen	2 e	≥ 2 j	–	3.2	LQ mass 1.1 TeV	$\beta = 1$	1605.06035
	Scalar LQ 2nd gen	2 μ	≥ 2 j	–	3.2	LQ mass 1.05 TeV	$\beta = 1$	1605.06035
	Scalar LQ 3rd gen	1 e, μ	≥1 b, ≥3 j	Yes	20.3	LQ mass 640 GeV	$\beta = 0$	1508.04735
Heavy quarks	VLQ $TT \to Ht + X$	0 or 1 e, μ	≥ 2 b, ≥ 3 j	Yes	13.2	T mass 1.2 TeV	$\mathcal{B}(T \to Ht) = 1$	ATLAS-CONF-2016-104
	VLQ $TT \to Zt + X$	1 e, μ	≥ 1 b, ≥ 3 j	Yes	36.1	T mass 1.16 TeV	$\mathcal{B}(T \to Zt) = 1$	1705.10751
	VLQ $TT \to Wb + X$	1 e, μ	≥ 1 b, ≥ 1J/2j	Yes	36.1	T mass 1.35 TeV	$\mathcal{B}(T \to Wb) = 1$	CERN-EP-2017-094
	VLQ $BB \to Hb + X$	1 e, μ	≥ 2 b, ≥ 3 j	Yes	20.3	B mass 700 GeV	$\mathcal{B}(B \to Hb) = 1$	1505.04306
	VLQ $BB \to Zb + X$	2/≥3 e, μ	≥2/≥1 b	–	20.3	B mass 790 GeV	$\mathcal{B}(B \to Zb) = 1$	1409.5500
	VLQ $BB \to Wt + X$	1 e, μ	≥ 1 b, ≥ 1J/2j	Yes	36.1	B mass 1.25 TeV	$\mathcal{B}(B \to Wt) = 1$	CERN-EP-2017-094
	VLQ $QQ \to WqWq$	1 e, μ	≥ 4 j	Yes	20.3	Q mass 690 GeV		1509.04261
Excited fermions	Excited quark $q^* \to qg$	–	2 j	–	37.0	q^* mass 6.0 TeV	only u^* and d^*, $\Lambda = m(q^*)$	1703.09127
	Excited quark $q^* \to q\gamma$	1 γ	1 j	–	36.7	q^* mass 5.3 TeV	only u^* and d^*, $\Lambda = m(q^*)$	CERN-EP-2017-148
	Excited quark $b^* \to bg$	–	1 b, 1 j	–	13.3	b^* mass 2.3 TeV		ATLAS-CONF-2016-060
	Excited quark $b^* \to Wt$	1 or 2 e, μ	1 b, 2-0 j	Yes	20.3	b^* mass 1.5 TeV	$f_g = f_L = f_R = 1$	1510.02664
	Excited lepton ℓ^*	3 e, μ	–	–	20.3	ℓ^* mass 3.0 TeV	$\Lambda = 3.0$ TeV	1411.2921
	Excited lepton ν^*	3 e, μ, τ	–	–	20.3	ν^* mass 1.6 TeV	$\Lambda = 1.6$ TeV	1411.2921
Other	LRSM Majorana ν	2 e, μ	2 j	–	20.3	N^0 mass 2.0 TeV	$m(W_R) = 2.4$ TeV, no mixing	1506.06020
	Higgs triplet $H^{\pm\pm} \to \ell\ell$	2,3,4 e, μ (SS)	–	–	36.1	$H^{\pm\pm}$ mass 870 GeV	DY production	ATLAS-CONF-2017-053
	Higgs triplet $H^{\pm\pm} \to \ell\tau$	3 e, μ, τ	–	–	20.3	$H^{\pm\pm}$ mass 400 GeV	DY production, $\mathcal{B}(H_L^{\pm\pm} \to \ell\tau) = 1$	1411.2921
	Monotop (non-res prod)	1 e, μ	1 b	Yes	20.3	spin-1 invisible particle mass 657 GeV	$a_{non-res} = 0.2$	1410.5404
	Multi-charged particles	–	–	–	20.3	multi-charged particle mass 785 GeV	DY production, $\lvert q\rvert = 5e$	1504.04188
	Magnetic monopoles	–	–	–	7.0	monopole mass 1.34 TeV	DY production, $\lvert g\rvert = 1g_D$, spin 1/2	1509.08059

$\sqrt{s}$ = 8 TeV $\sqrt{s}$ = 13 TeV

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

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

†Small-radius (large-radius) jets are denoted by the letter j (J).

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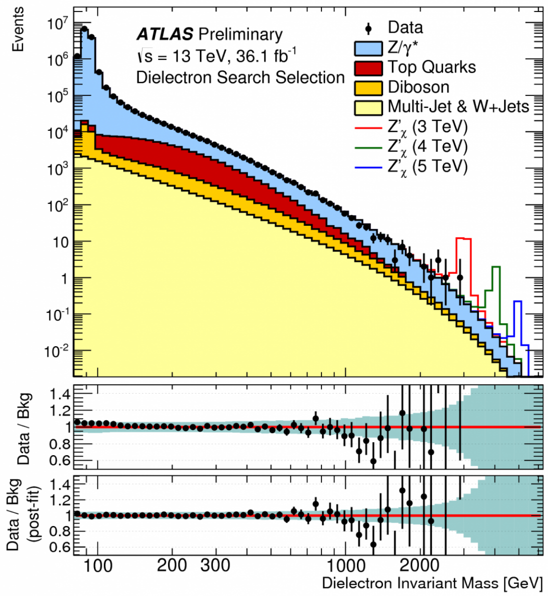
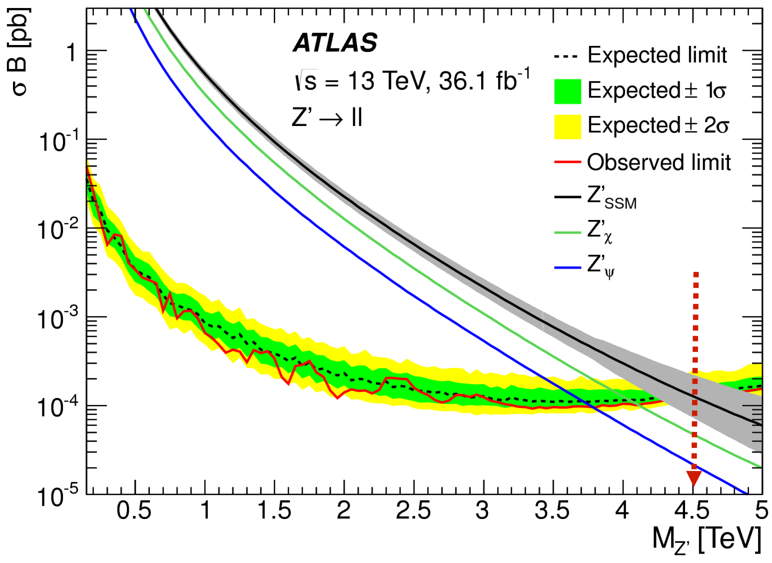
Search for Heavy Resonances (leptons)

- ✓ Search for new symmetries of nature, looking for heavy resonances decaying to dileptons (Z') or E_{Tmiss} and leptons (W')
- ✓ Using invariant mass distribution of di-lepton or transverse mass, dominant background is DY
- ✓ Data fits well with expectation from known processes, no bumps found
- ✓ Set new limits to existence of Z' at 4.5 TeV and 5.1 TeV for W'





Phys.Rev. D96, 052004

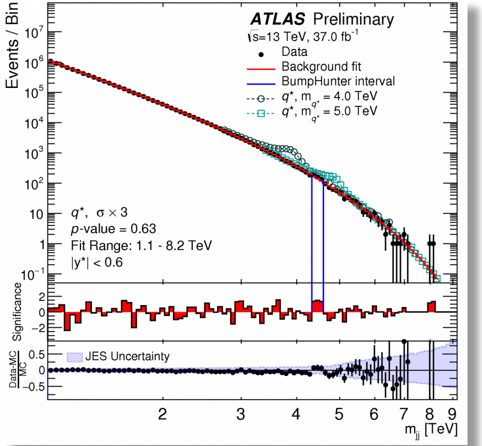
Search for Heavy Resonances (dijets)

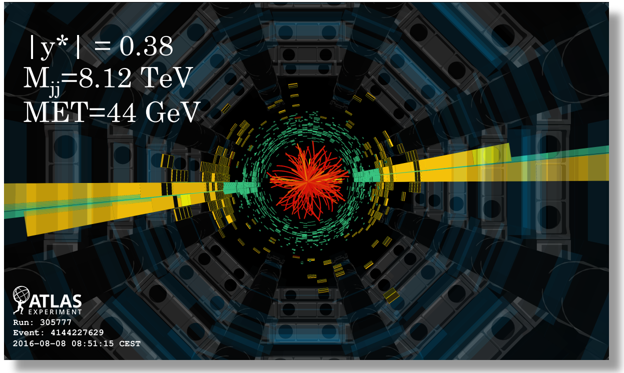
✓ Two complementary analyses: invariant mass distribution and angular distribution

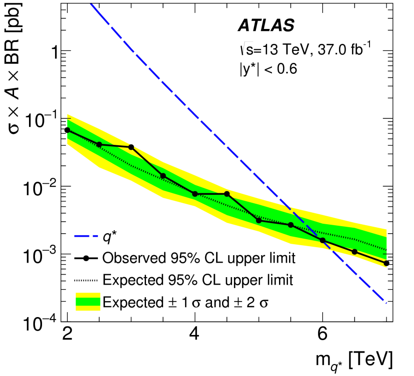
✓ Invariant mass data fits well with expectation , no significant deviations found

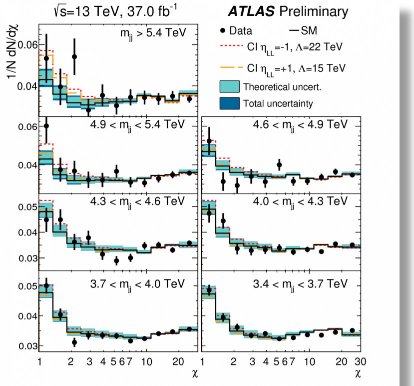
✓ Angular analysis looks for shape differences of the jet angle respect beam axis in 7 different regions comparing to contact interaction models: no deviations found

✓ Exclusion limits are set for different models:
- Excited quarks: m(q*) > 6.0 TeV (5.8 TeV exp.)
- Add. gauge bosons: m(W') > 3.6 TeV (3.7 TeV exp.)
- Quantum Black Holes: m(BH) > 8.9 TeV (8.9 TeV exp.)
- Contact Inter.: Λ > 13.1/21.8 TeV (η LL = +1/-1)

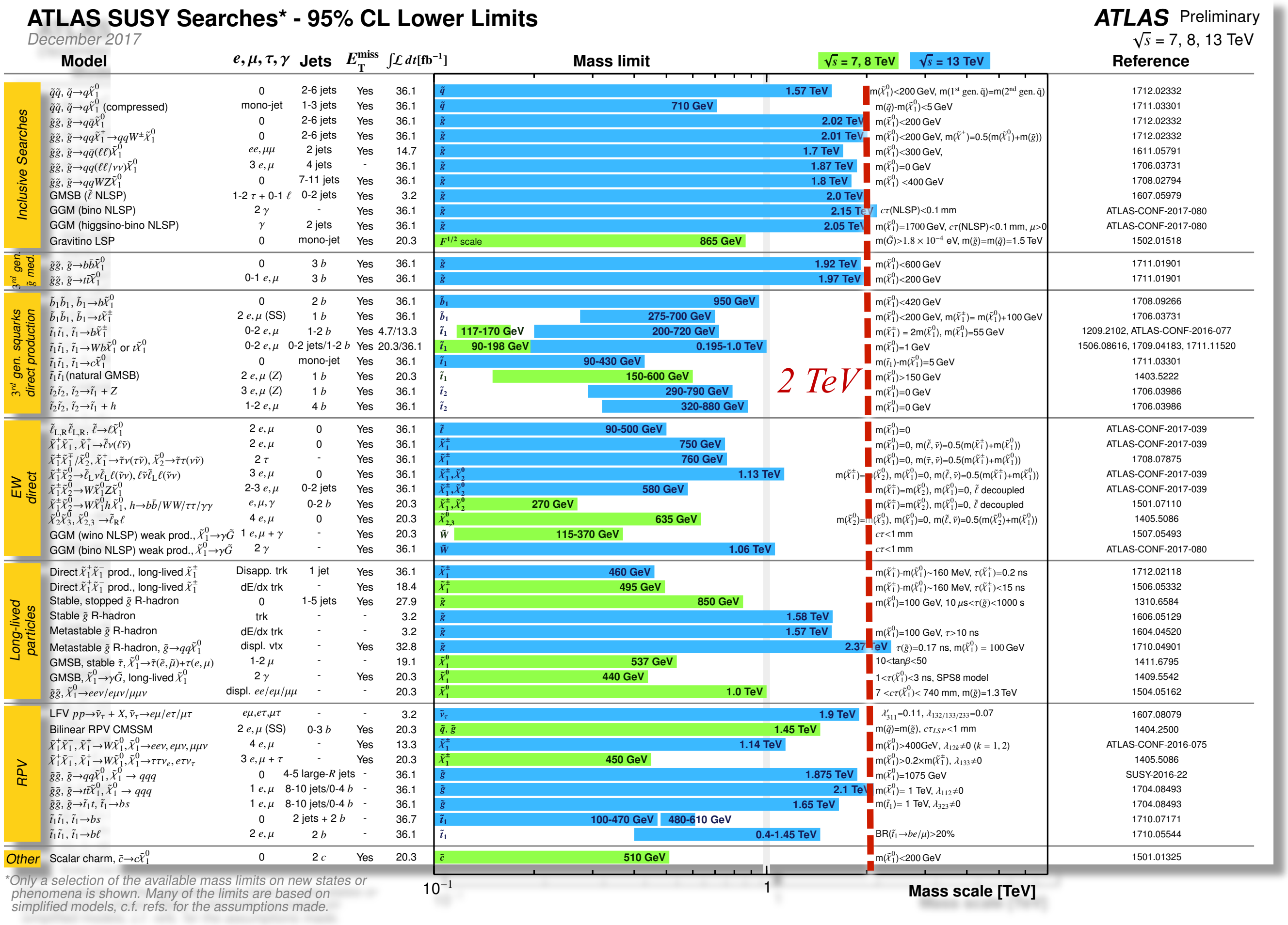








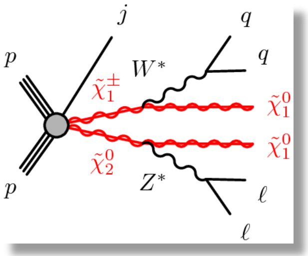
SUSY Searches

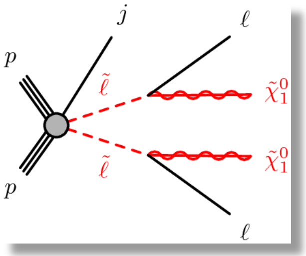


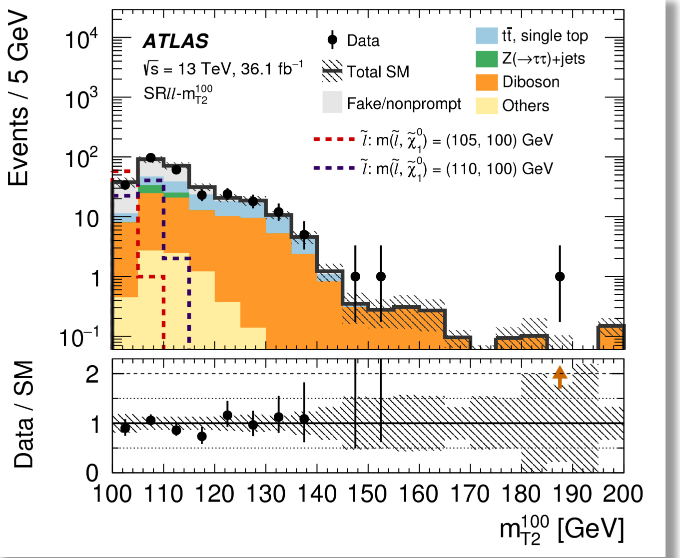
Search for sleptons in compressed scenario

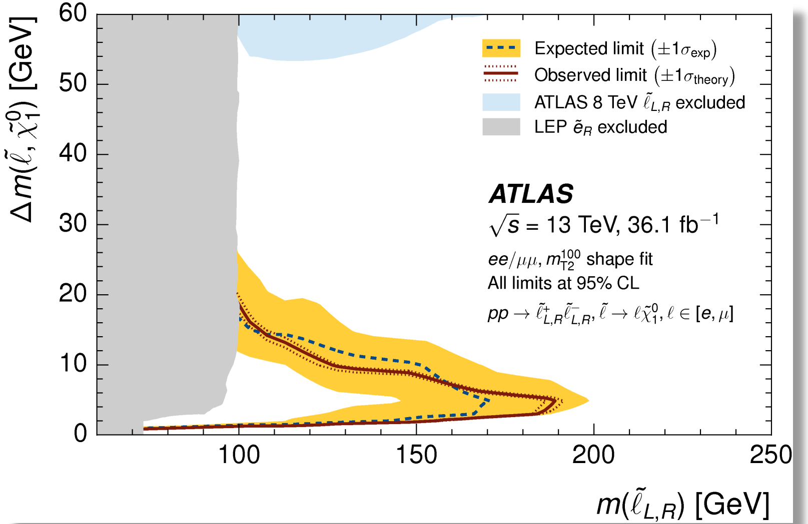
arXiv:1712.08119

- ✓ sleptons decay directly to the lightest SUSY partner that has a mass very close to the slepton mass.
- ✓ Search for two very low-momentum electrons or muons and missing energy from the Lightest Supersymmetric Particle
- ✓ Analysis makes use of *stransverse mass* m_{T2}
- ✓ No excess found, new limits on slepton masses (since LEP)





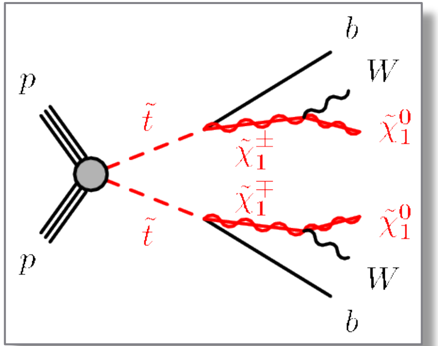


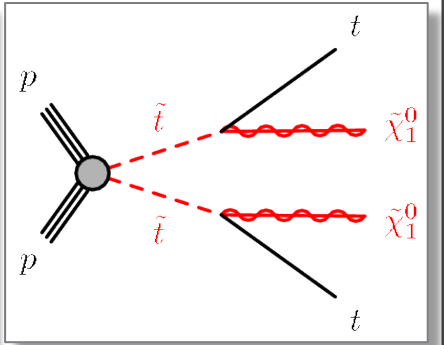


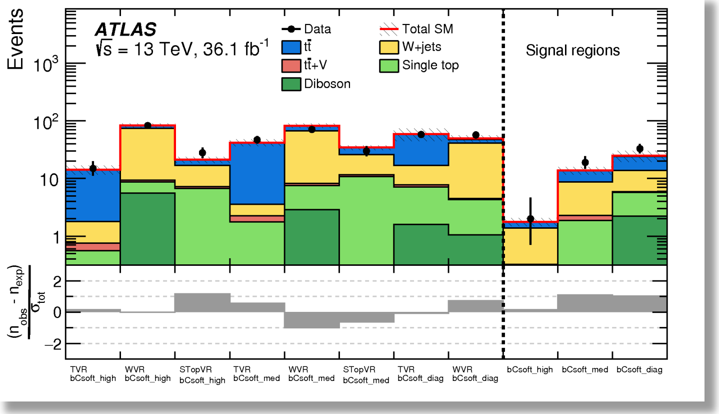
3rd generation: search for scalar top

0-lepton+b-jets **_1709.04183_**
1-lepton+b-jets **_1711.11520_**
2-leptons+b-jets **_1708.03247_**

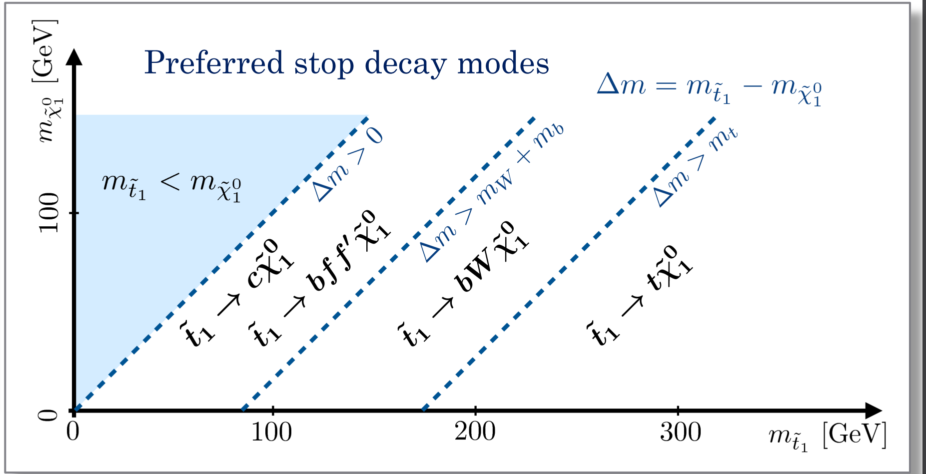
- ✓ Scalar partner of heavy quarks expected to be light in “natural SUSY” (to cancel loop correction to Higgs mass)
- ✓ Searches for the direct pair production of top squarks in final stets with 0/1/2 leptons + jets(b) and MET
- ✓ Target 2/3/4 body decays
- ✓ No significant excess over SM has been found



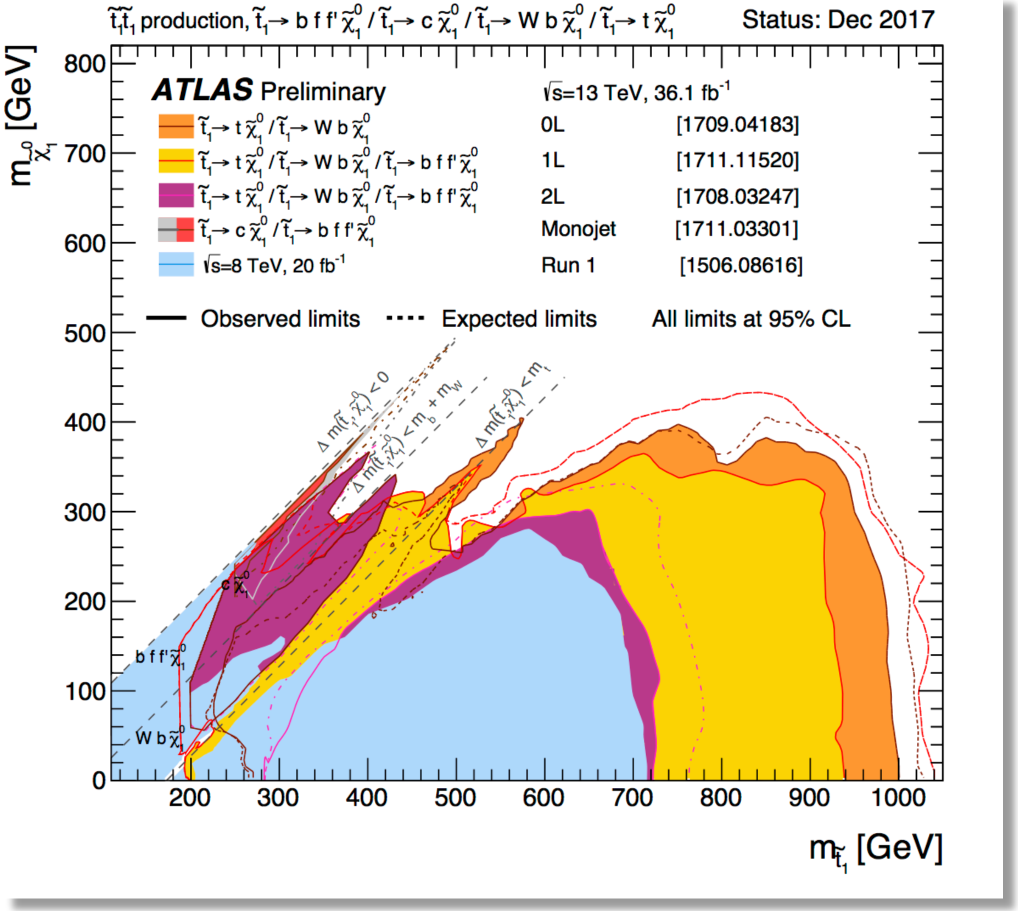




1-lepton+b-jets arXiv:*1711.11520*



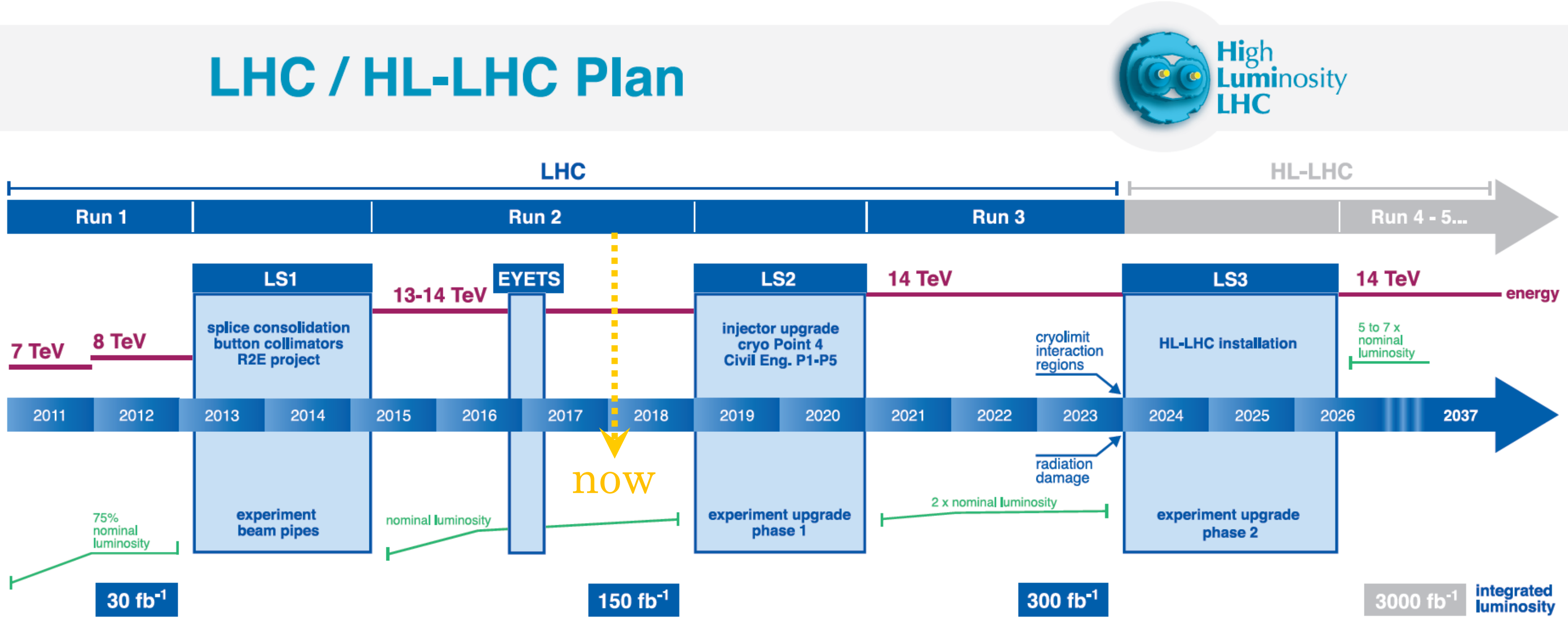
Summary of searches for top squark pair production



- ✓ Four decay modes considered (100% BR):
  - ✓ 2 body,
  - ✓ 3-body
  - ✓ 4-body
- ✓ Exclusion limits at 95% shown in the $\tilde{t}_1$ and neutralino plane
- ✓ All uncertainties included except theoretical signal cross-sections
- ✓ Big improvements between 8 TeV and 13 TeV data

Prospects for Physics at HL-LHC

LHC/HL-LHC Plan

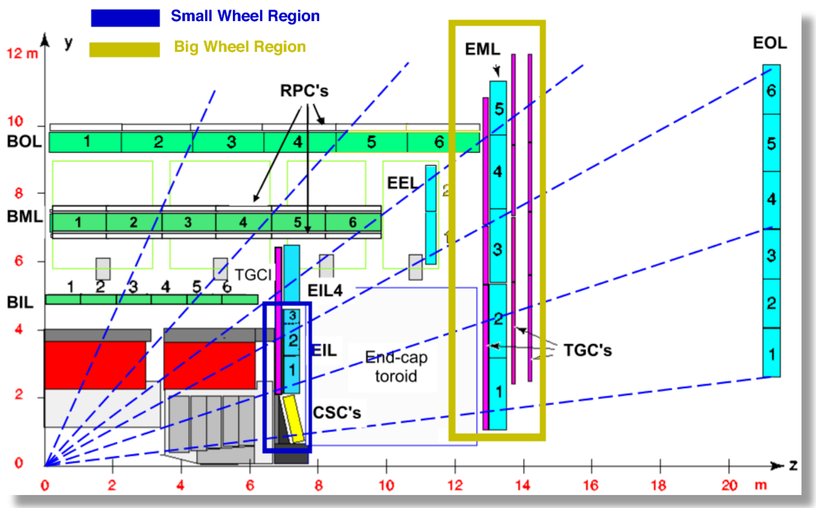


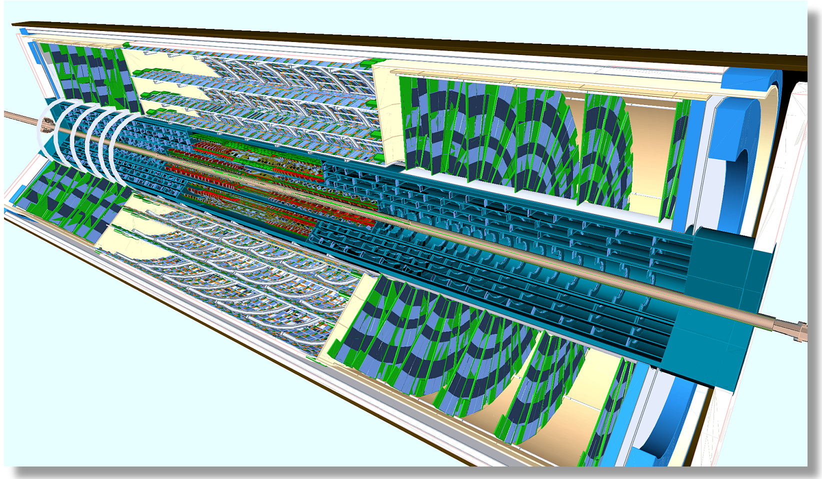
High luminosity means $<\mu>$ = 140-200

3 ab^{-1} will allow precision measurements of the properties of the Higgs boson and direct searches for new physics

ATLAS Upgrades

- ✓**Phase 1 (Installation 2019-2020):**
  - ✓FTK (fast track)
  - ✓NSW (New Small Wheel)
  - ✓LAr Electronics
  - ✓Trigger-DAQ
- ✓**Phase II (Installation 2024-2026)**
  - ✓ITK Tracker, all-Si
  - ✓Muon, new barrel inner chambers
  - ✓LAr & Tile
  - ✓TDAQ and Pixel
  - ✓High Granularity Timing Detector
  - ✓Large Eta Muon Tagger

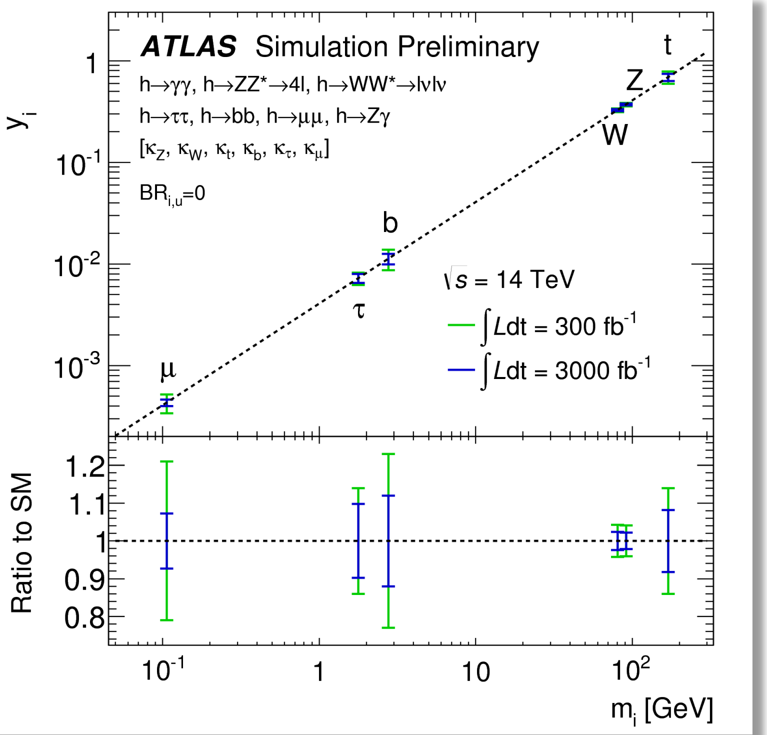


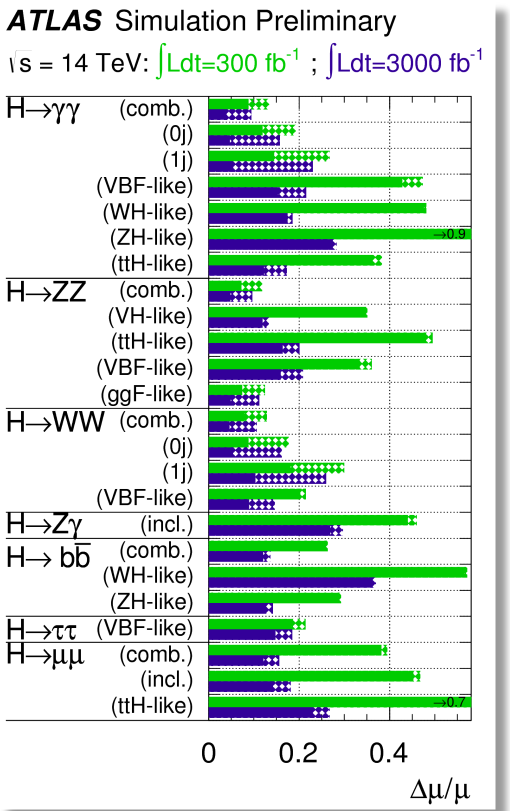


Higgs Boson Couplings

ATL-PHYS-PUB-2014-016

ATL-PHYS-PUB-2014-017

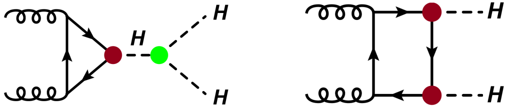




- ✓ Fit results for the reduced coupling scale factors for weak bosons and for fermions as a function of the particle mass
- ✓ Assume 300 fb^{-1} or 3000 fb^{-1} of 14 TeV data and a SM Higgs boson with a mass of 125 GeV.

- ✓ Relative uncertainty on the signal strength μ for all Higgs final states in the different experimental categories

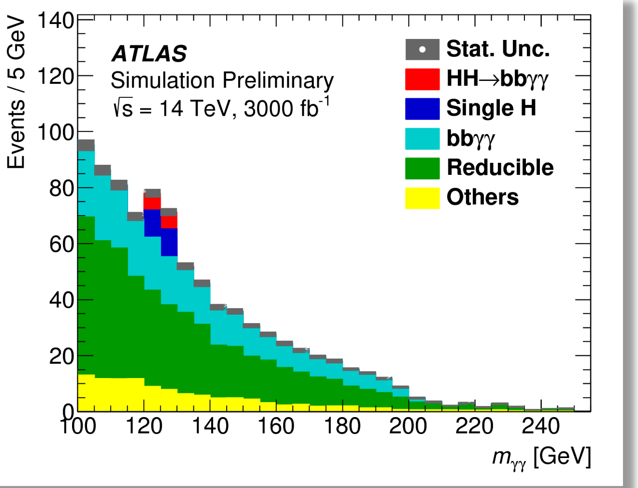
Higgs Self Coupling



HH→bbɣɣ

ATL_PHYS_PUB_2017_001

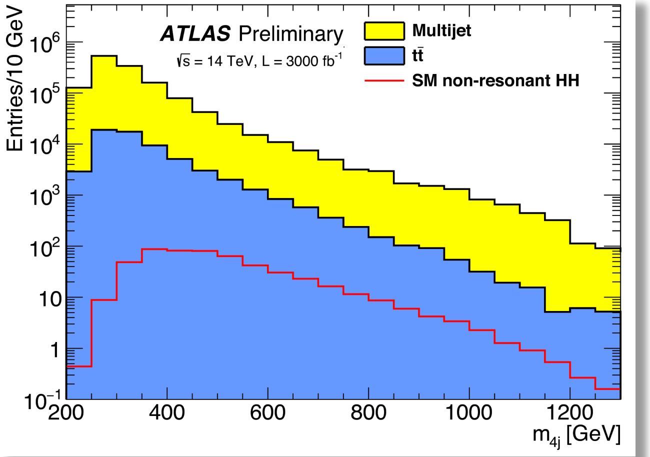
- ✓ Background from multiple photons and jets
- ✓ expect 9.5 signal events on 90.5 bckg
- ✓ Expected Significance of 1.05σ
- ✓ Higgs boson self-coupling is expected (95%CL no sys.) to be constrained to $-0.8 < \lambda / \lambda_{SM} < 7.7$



HH→bbbb

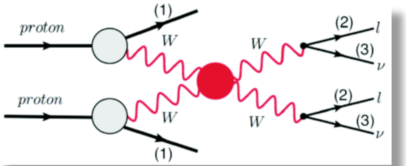
ATL_PHYS_PUB_2016-024

- ✓ Dominant decay mode but large multijets and top backgrounds
- ✓ At least 4 b-jets, Higgs separation, m4j as discriminant variable
- ✓ Extrapolation from 13 TeV data (10/fb)
- ✓ Higgs boson self-coupling is expected (95%CL no sys.) to be constrained to $0.2 < \lambda / \lambda_{SM} < 7.0$

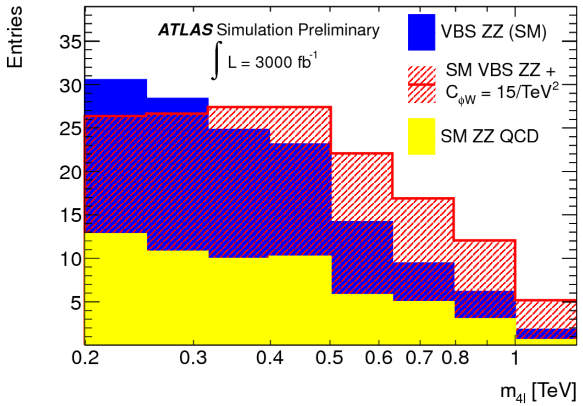


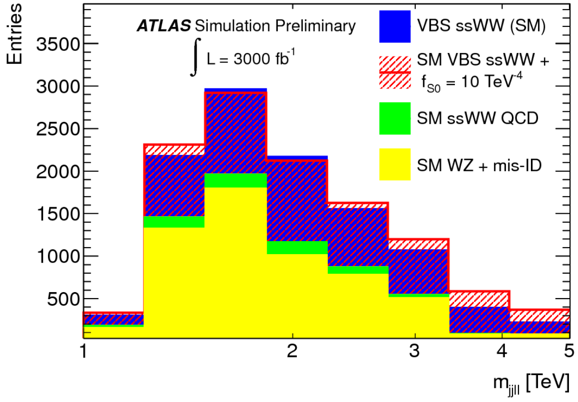
ATLAS-PHYS-PUB-2013-006

Vector Boson Scattering



- ✓The Phase II upgrade of the ATLAS detector would greatly increase the sensitivity to an extended electroweak symmetry-breaking sector beyond the Standard Model Higgs mechanism.
- ✓A common feature of such an extended sector is the enhancement of vector boson scattering at high energy.
- ✓Sensitive to new physics at TeV scale
- ✓Clean observation of $W^{\pm}W^{\pm}$,ZZ and WZ scattering above bckgs
- ✓High significance (11σ) for $W^{\pm}W^{\pm}jj$ production
- ✓High precision on cross-section expected (6%)

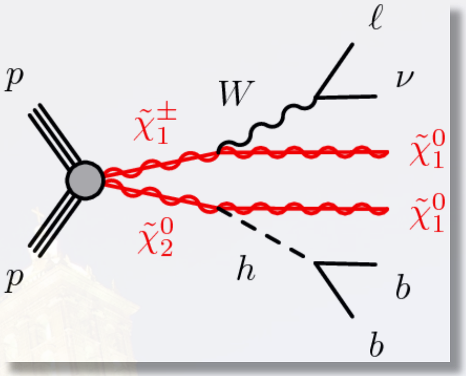


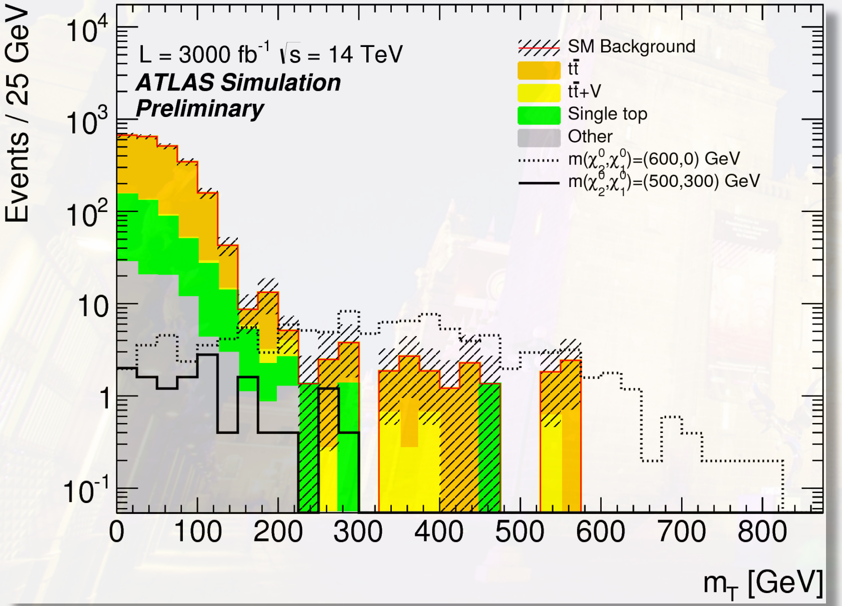


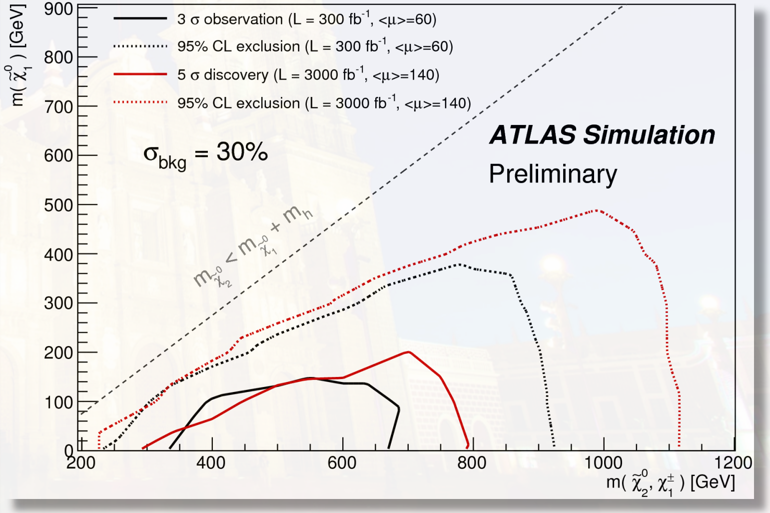
ATL_PHYS_PUB_2015-032

BSM: direct production chargino and neutralinos to Wh

- ✓ Signature is large MET, leptonic W, h to bb
- ✓ Backgrounds W+jets, tt, single top, tt+V
- ✓ Cut and count approach
- ✓ Discovery reach is about 800 GeV

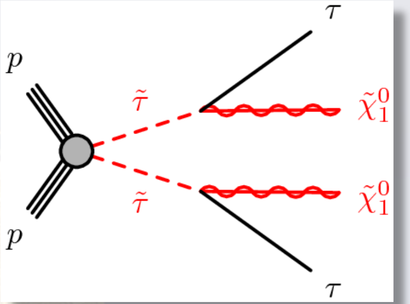


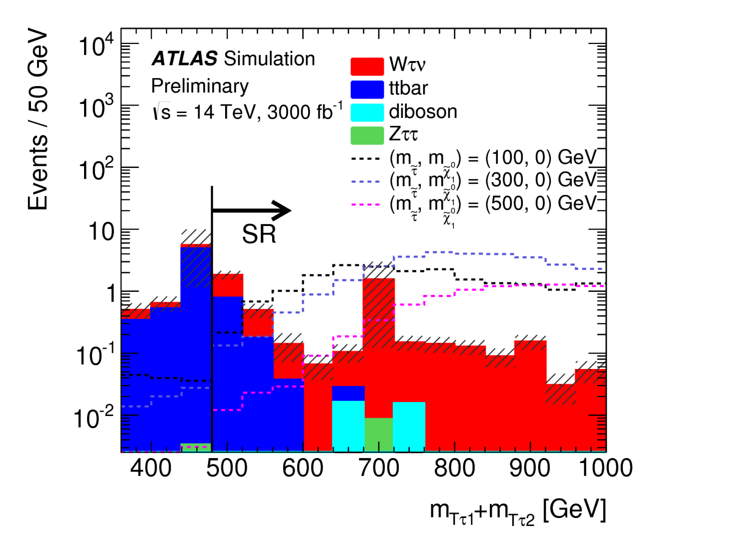




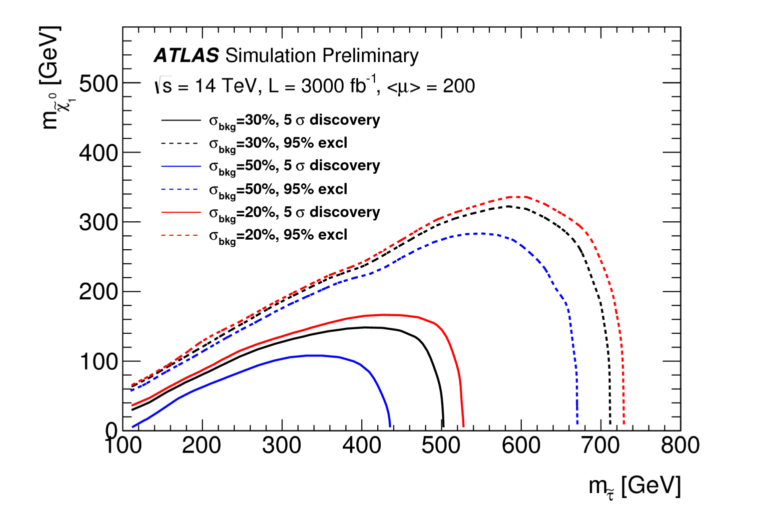
BSM: direct production of stau pairs

- ✓ Assume 100 % BR
- ✓ Final state with two hadronically decaying taus, low jet activity, large MET
- ✓ Main backgrounds from W+jets and ttbar,
- ✓ Discovery reach is 430-520 GeV (depending on systematics.



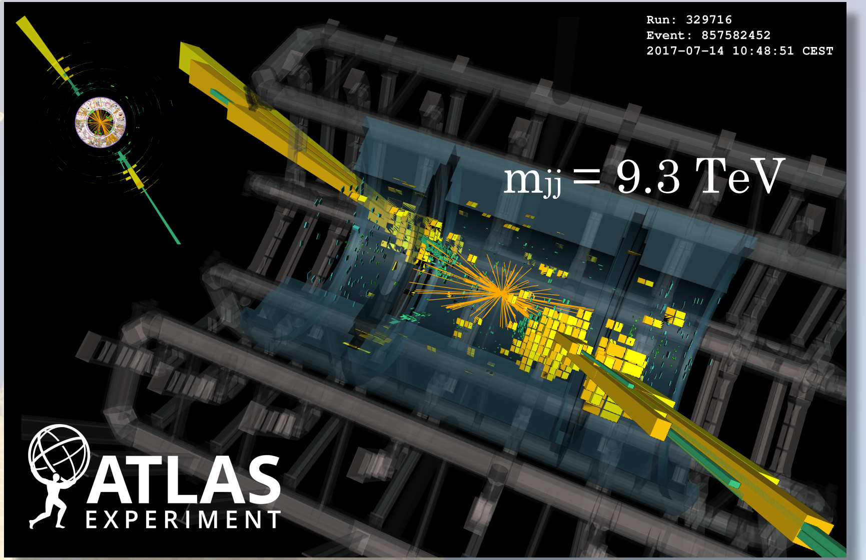


95 % CL exclusion reaches ~700 GeV



Conclusions

- ✓ Presented here a small selection of the full ATLAS results of the last couple of years (part of Run-2 Dataset)

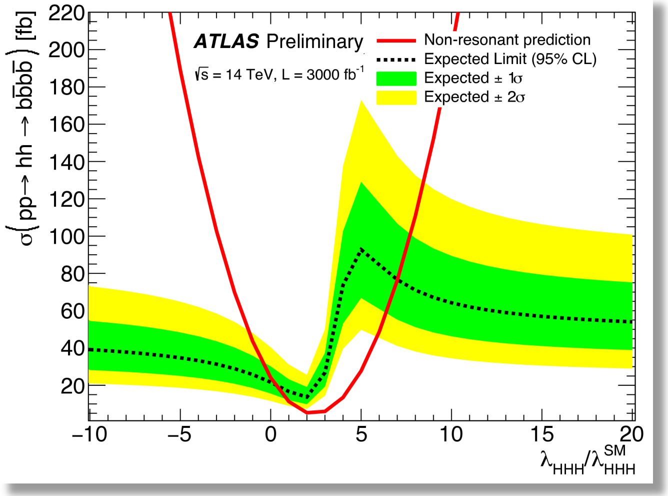


- ✓ Apologize for all other results and analysis not mentioned (Heavy Ions for example).
- ✓ Harvested data in 2017 is larger than the one presented here
- ✓ Much more expected in 2018 for both pp and heavy ions collisions
- ✓ The ATLAS Upgrade program is proceeding well to cope with very challenging environment of increased pile-up and large backgrounds
- ✓ This will allow us to be in the best possible position to gain the most from the HL-LHC data
- ✓ Hopefully the High Luminosity LHC will provide us the precision needed to further test the Standard Model, Higgs Boson physics and better constraining (or discovery) BSM

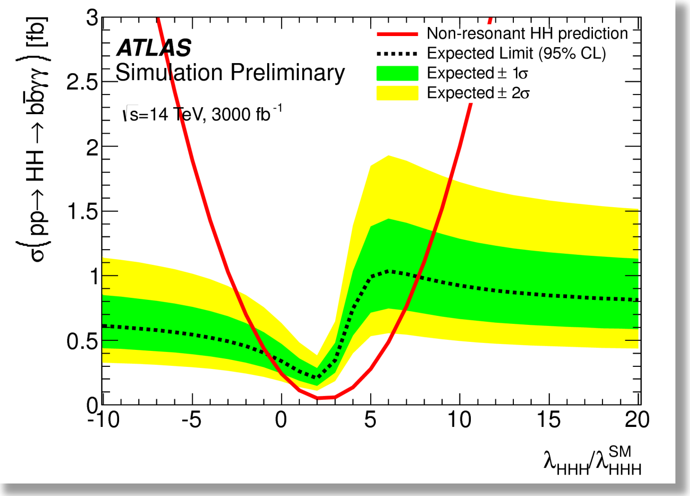
Muchas Gracias

Backup

Higgs Self Coupling, HH Searchs



σ(HH→ bbγγ)



σ(HH→ bbbb)

- ✓ Expected 95% C.L. upper limit on the cross-section with $\int Ldt = 3000 fb^{-1}$ as a function of the Higgs self-coupling constant λ_{HHH} assuming systematic uncertainties are negligible
- ✓ The cross-section exclusion limit grows less stringent in the range $3<\lambda_{HHH}/\lambda_{HHH}^{SM}<5$ due to the shift of m_{HH} towards lower values where the analysis acceptance is decreased and the backgrounds are higher
- ✓ This gives an asymmetry in the λ_{HHH} prediction