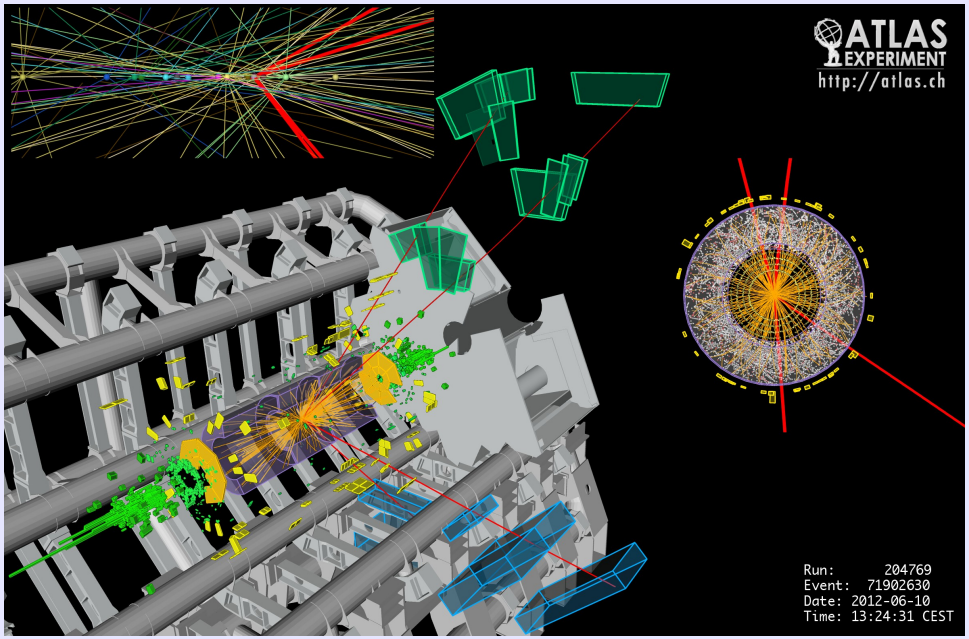
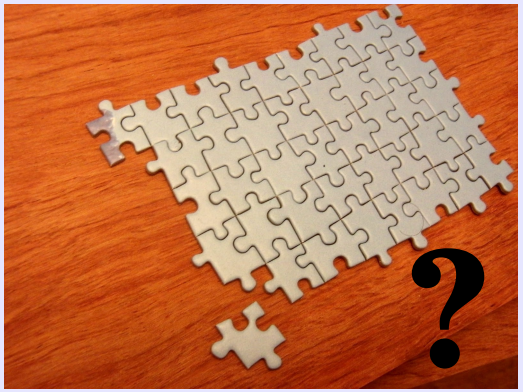




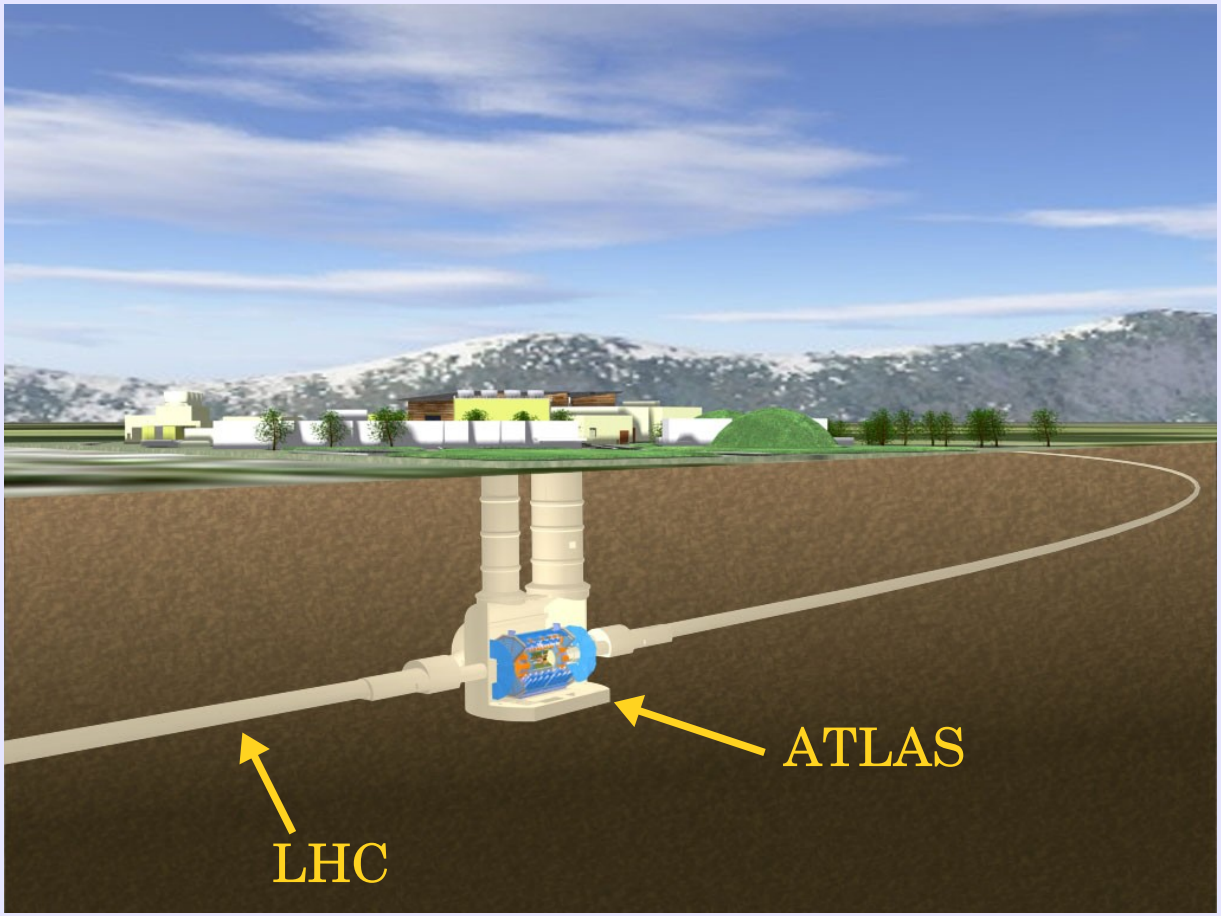
ATLAS Physics Results

Patricia Conde Muíño on behalf of the ATLAS Collaboration
(LIP-Lisboa)

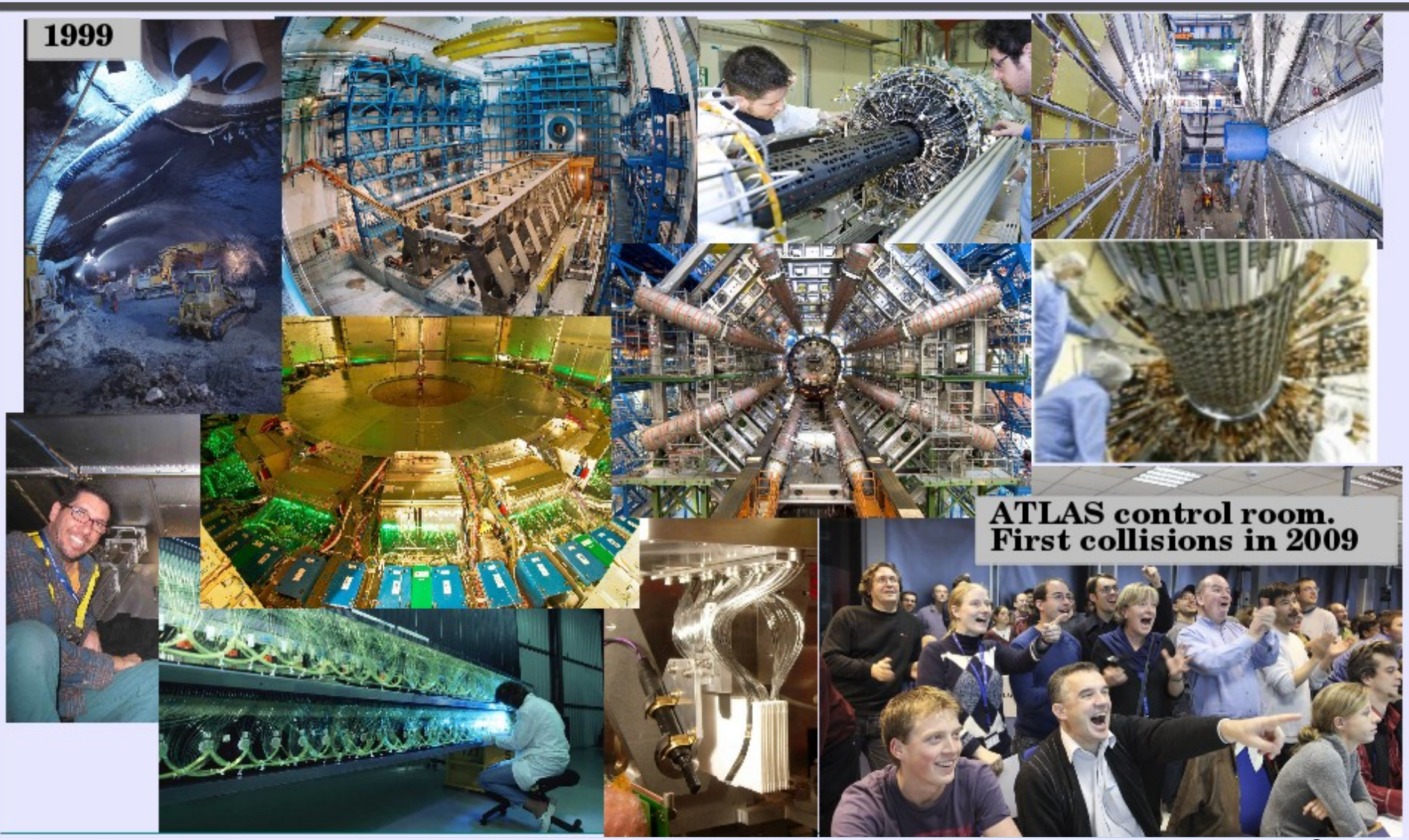
DISCRETE 2012, Lisbon (3-7 Dec 12)

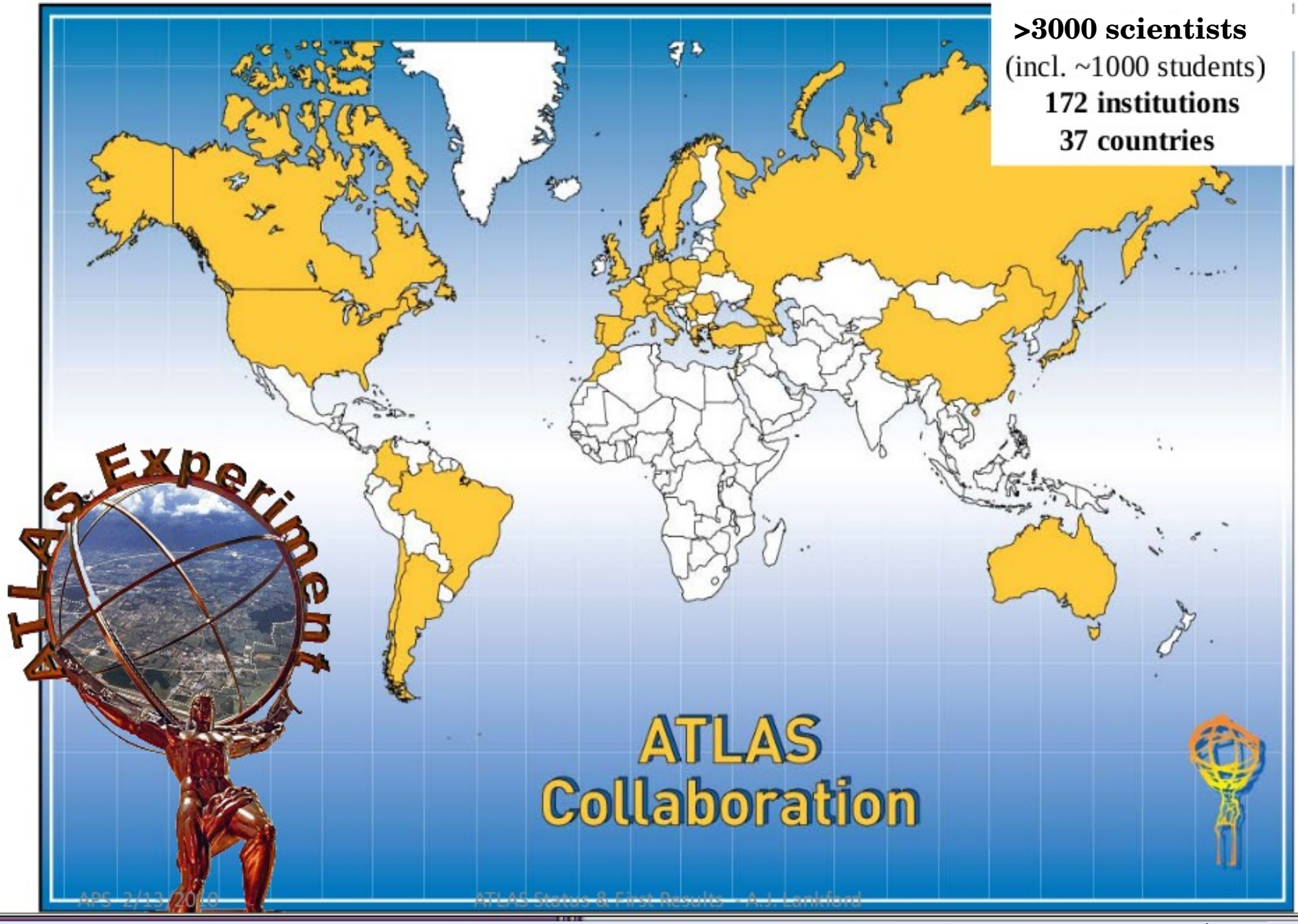
ATLAS

- ATLAS is one of the four LHC experiments at CERN



More than 20 years of continuous work...



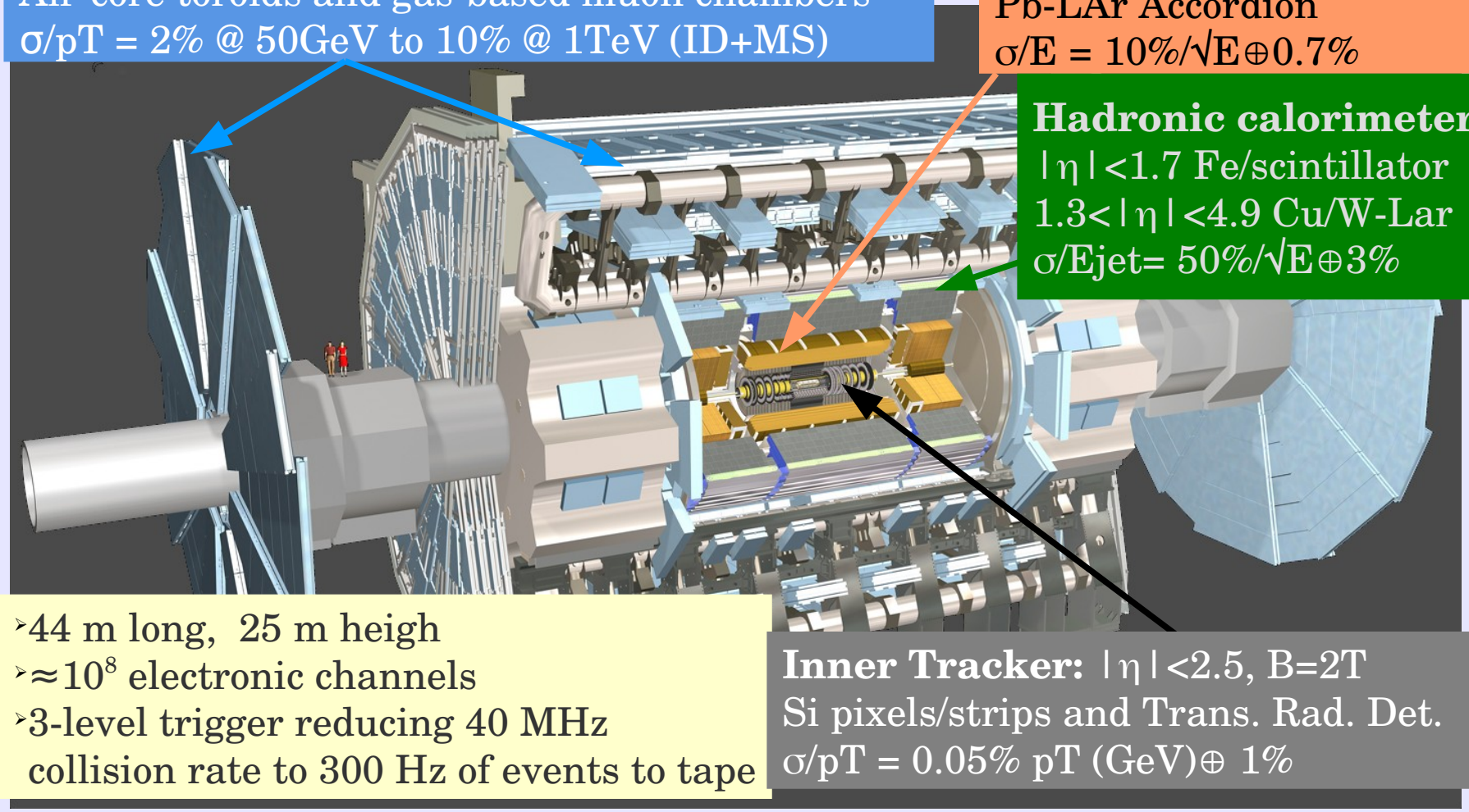

>3000 scientists
(incl. ~1000 students)
172 institutions
37 countries
ATLAS Experiment
ATLAS
Collaboration

The ATLAS detector

Muon Spectrometer: $|\eta|<2.7$
Air-core toroids and gas-based muon chambers
σ/pT = 2% @ 50GeV to 10% @ 1TeV (ID+MS)

EM calorimeter: $|\eta|<3.2$
Pb-LAr Accordion
$\sigma/E = 10\%/\sqrt{E}\oplus 0.7\%$

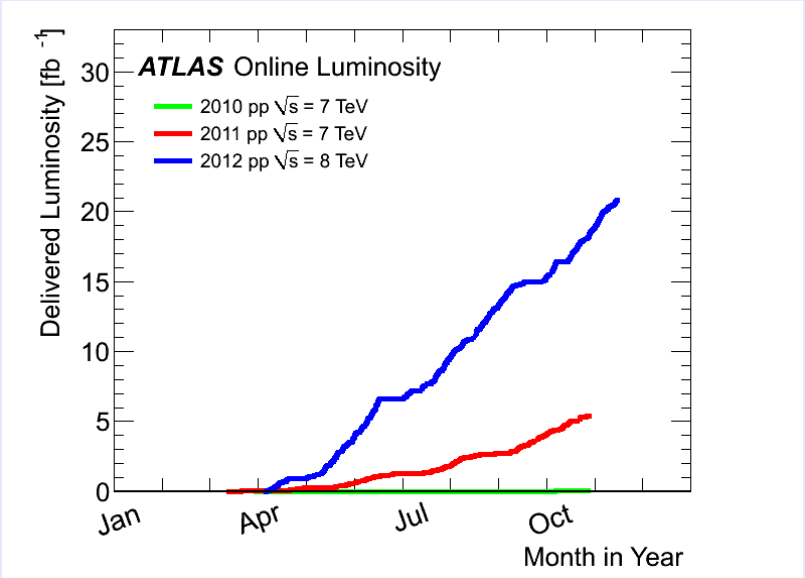
Hadronic calorimeter:
$|\eta|<1.7$ Fe/scintillator
$1.3<|\eta|<4.9$ Cu/W-Lar
$\sigma/Ejet = 50\%/\sqrt{E}\oplus 3\%$

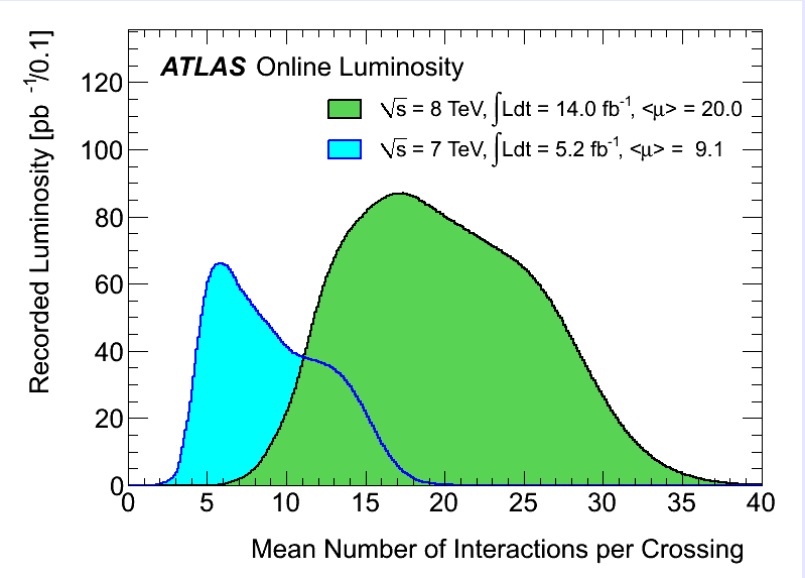


- 44 m long, 25 m heigh
- $\approx 10^8$ electronic channels
- 3-level trigger reducing 40 MHz collision rate to 300 Hz of events to tape

Inner Tracker: $|\eta|<2.5$, B=2T
Si pixels/strips and Trans. Rad. Det.
σ/pT = 0.05% pT (GeV)$\oplus$ 1%

LHC delivered data



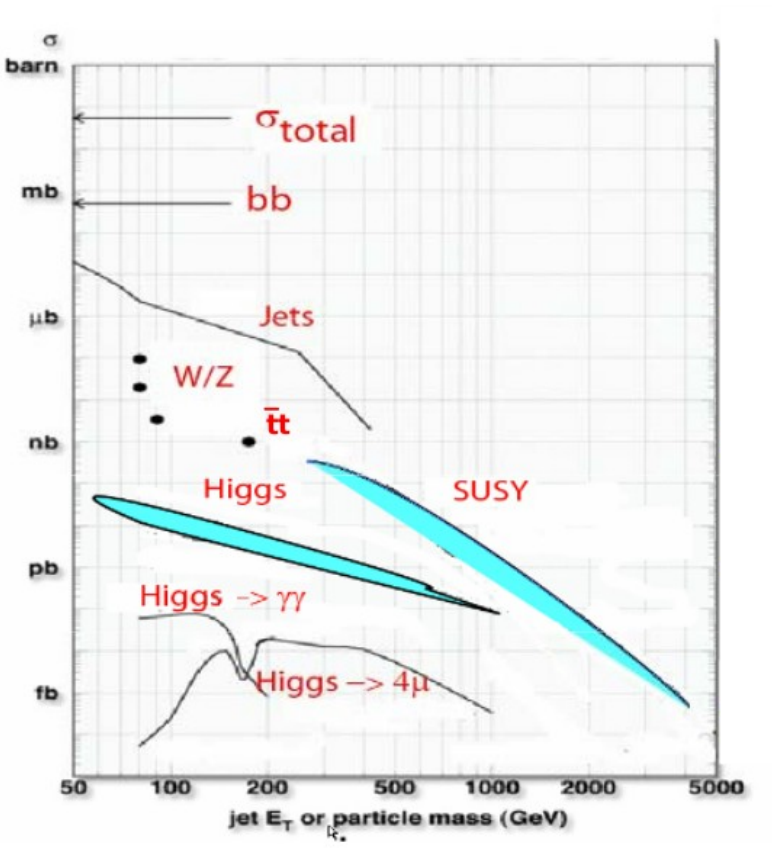


ATLAS p-p run: April-Sept. 2012										
Inner Tracker			Calorimeters		Muon Spectrometer				Magnets	
Pixel	SCT	TRT	LAr	Tile	MDT	RPC	CSC	TGC	Solenoid	Toroid
100	99.3	99.5	97.0	99.6	99.9	99.8	99.9	99.9	99.7	99.2
All good for physics: 93.7%										

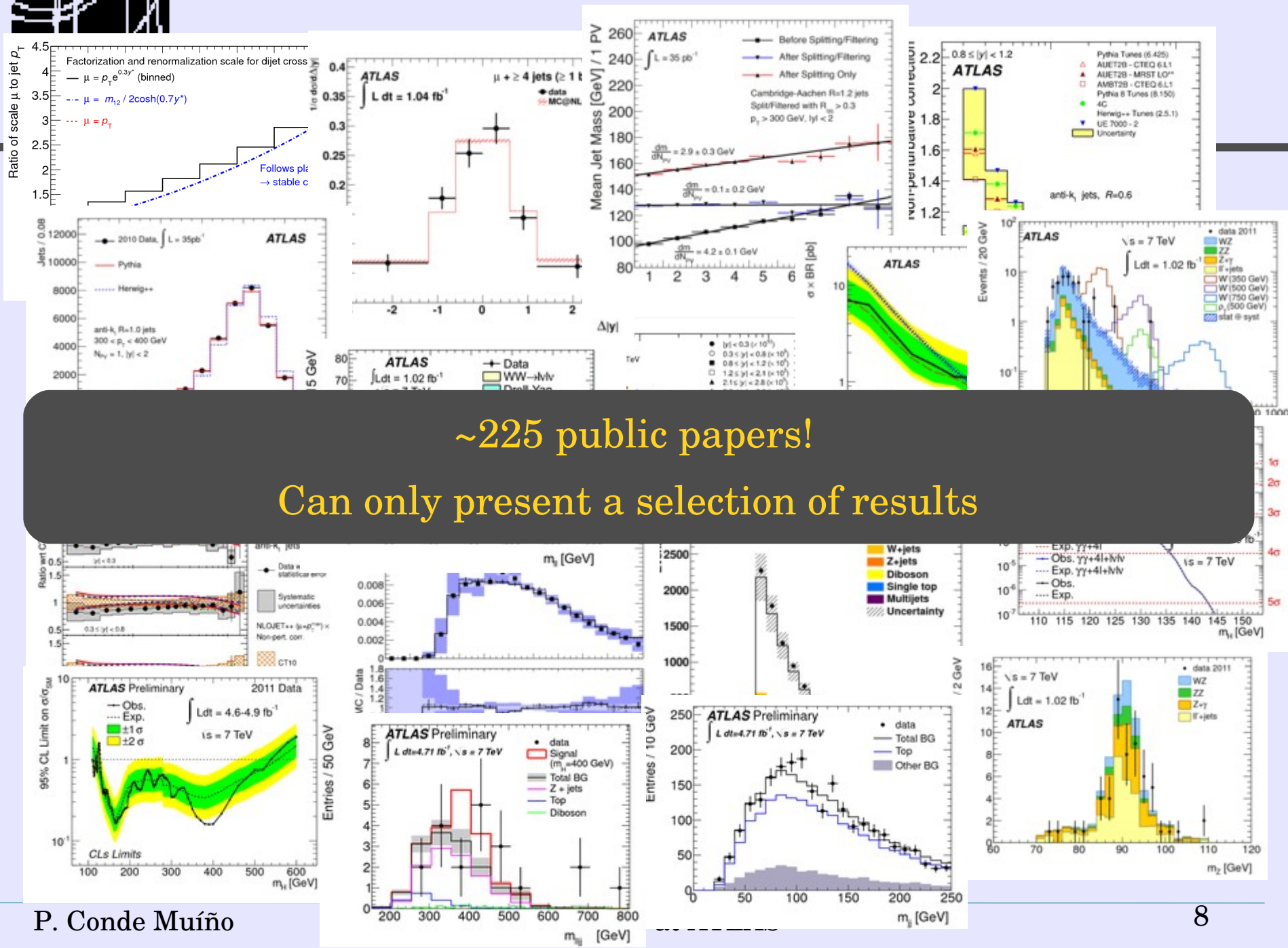
Luminosity weighted relative detector uptime and good quality data delivery during 2012 stable beams in pp collisions at √s=8 TeV between April 4th and September 17th (in %) – corresponding to 14.0 fb^{-1} of recorded data. The inefficiencies in the LAr calorimeter will partially be recovered in the future.

- 20.4 fb^{-1} 8 TeV pp collisions
- 5.2 fb^{-1} 7 TeV pp collisions
- ~95% data taking efficiency
- 93.7% physics quality data

Physics objectives at the LHC

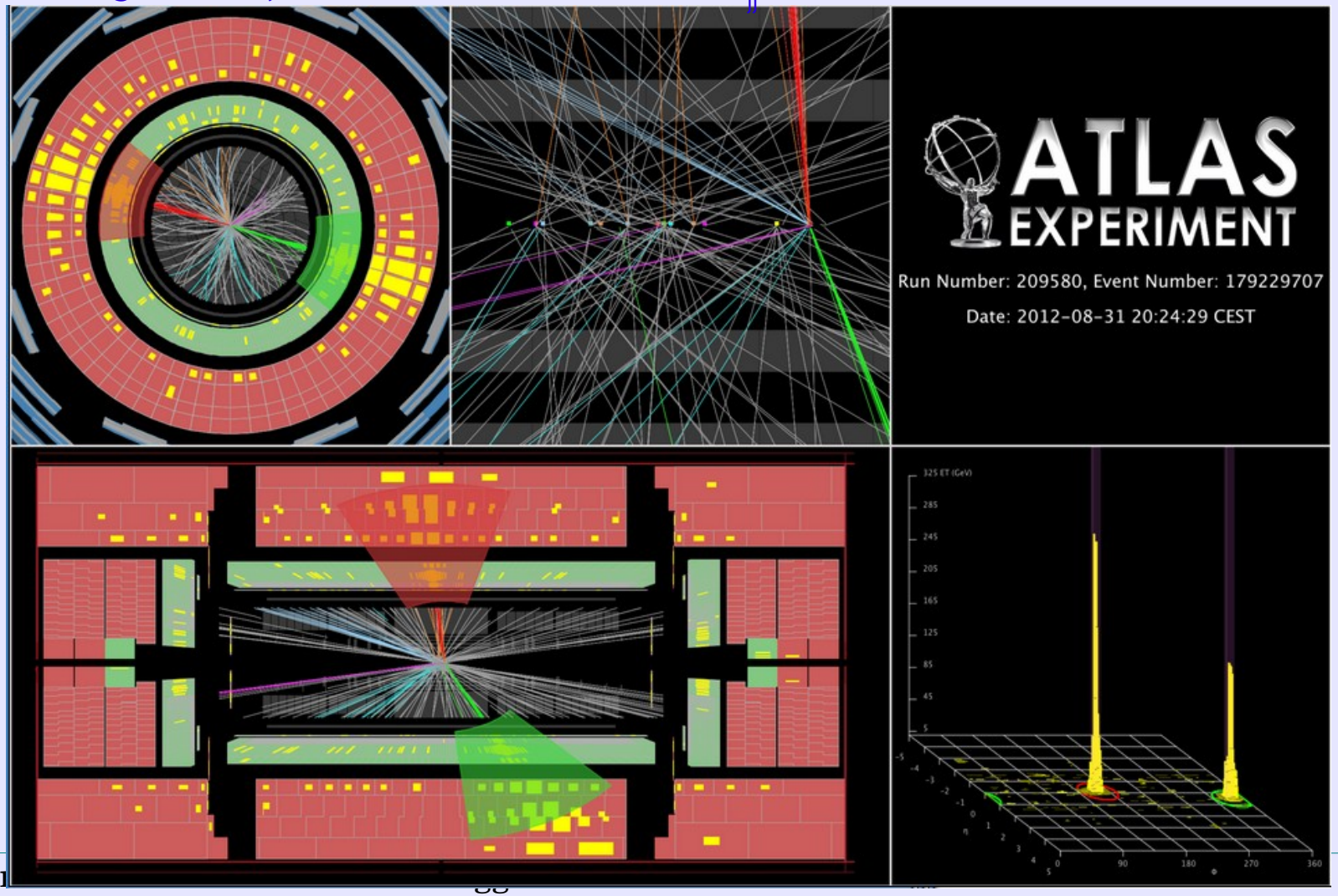


- Standard Model Physics
  - QCD
    - Jet production, jet properties
  - Electroweak boson production and properties
  - Top quark
    - Precision measurement of its properties
  - Di-boson production
    - Anomalous triple gauge couplings
- Electro Weak Symmetry Breaking mechanism
  - Search for the Higgs boson
- Are there new symmetries?
  - SUSY
  - Extra gauge bosons (W', Z', ...)
- Any other expected/unexpected New Physics?


~225 public papers!
Can only present a selection of results

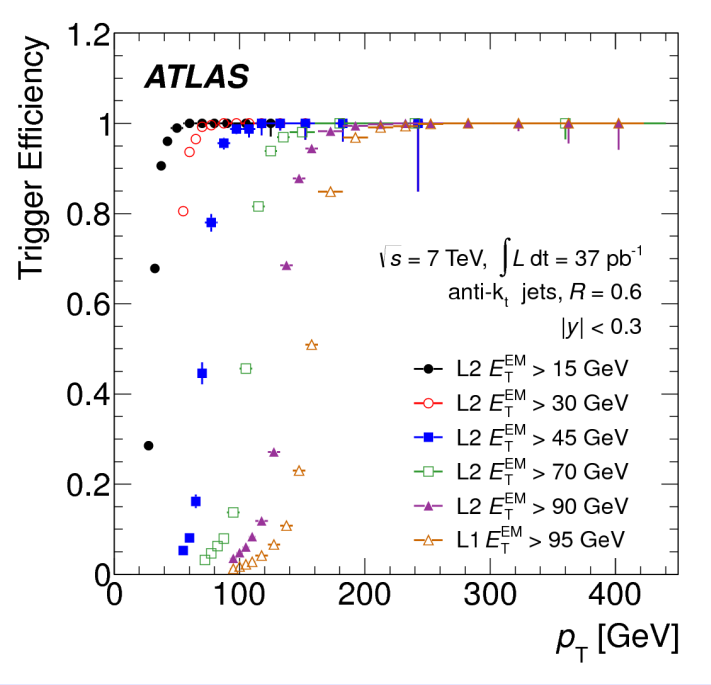
Jet production

- Highest di-jet mass event at 8 TeV (m_{jj} = 4.69 TeV)



Jet cross section

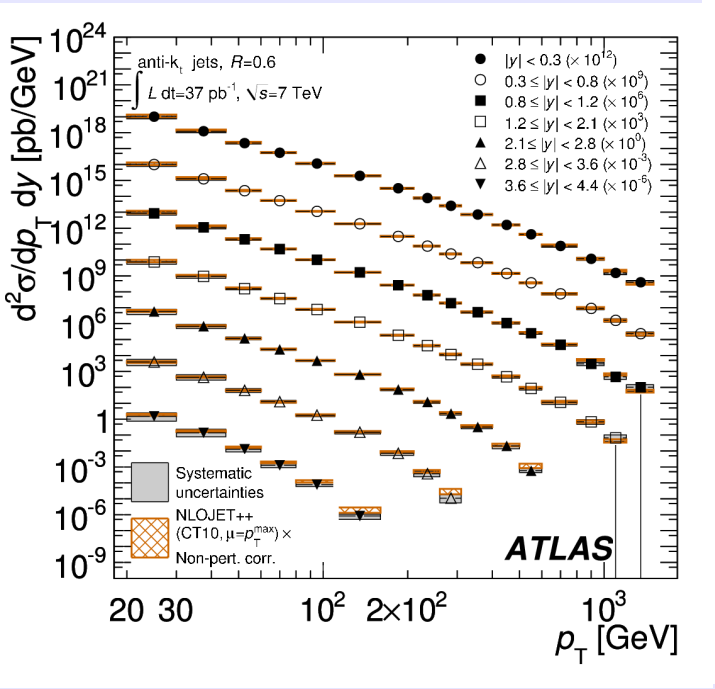
- Dominant high p_T process at LHC:
  - Provide precise information on the structure of the proton
  - Important tool to understand strong interaction and search for physics beyond SM
- Measurement includes forward jets
  - Sensitive to different dynamics
  - Better coverage than Tevatron experiments!

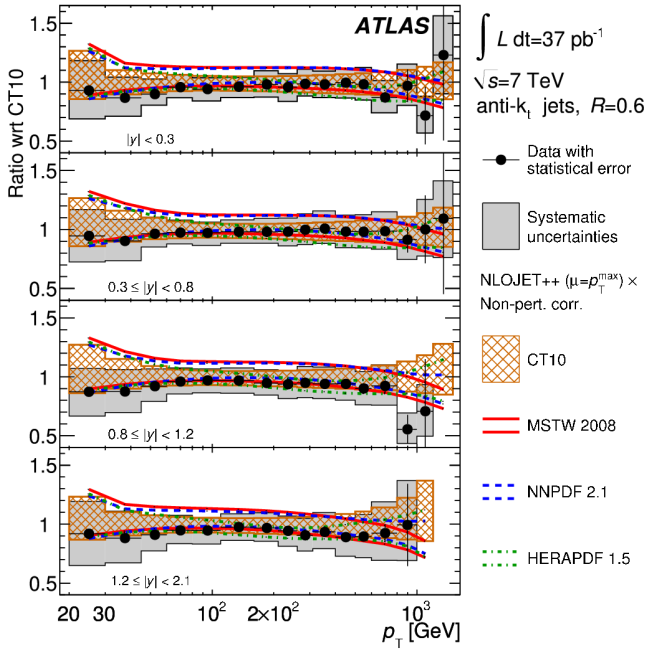


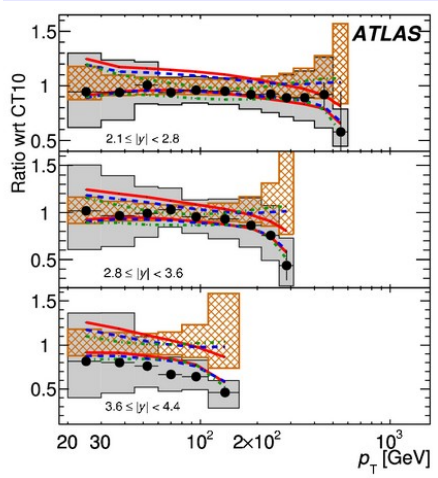
- Jet algorithm definition
  - Anti-kT with R=0.6 (and R=0.4), with topological clusters as input and corrected for JES
- Jet trigger efficient to provide unbiased, high statistics jet samples in all p_T bins

Inclusive jet cross section

Phys.Rev. D86 (2012) 014022



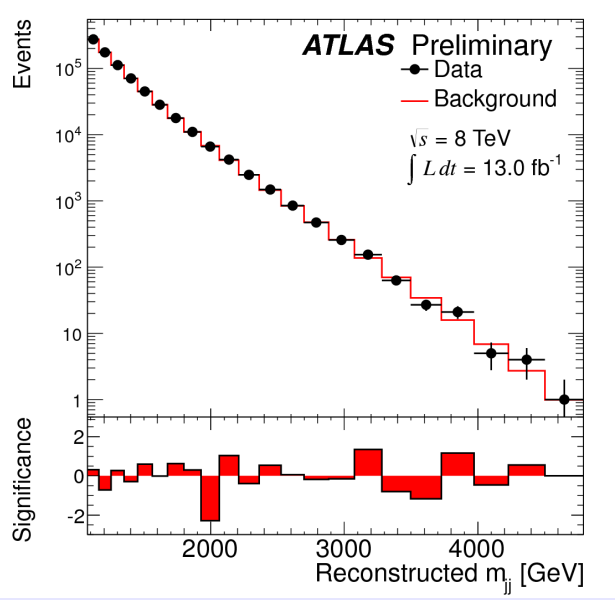


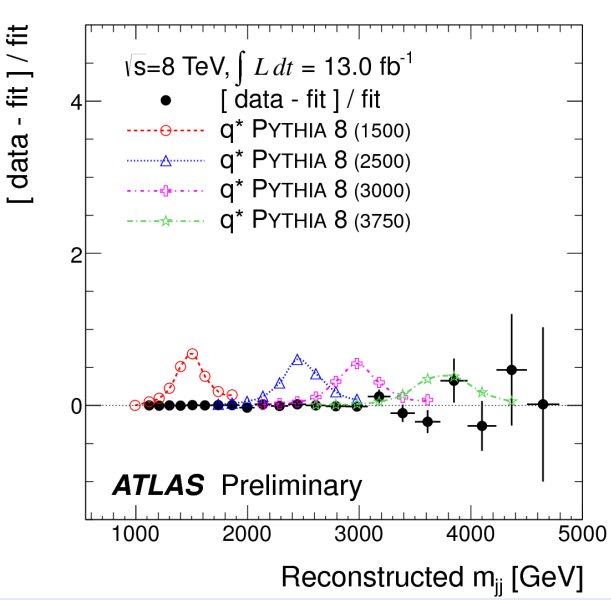


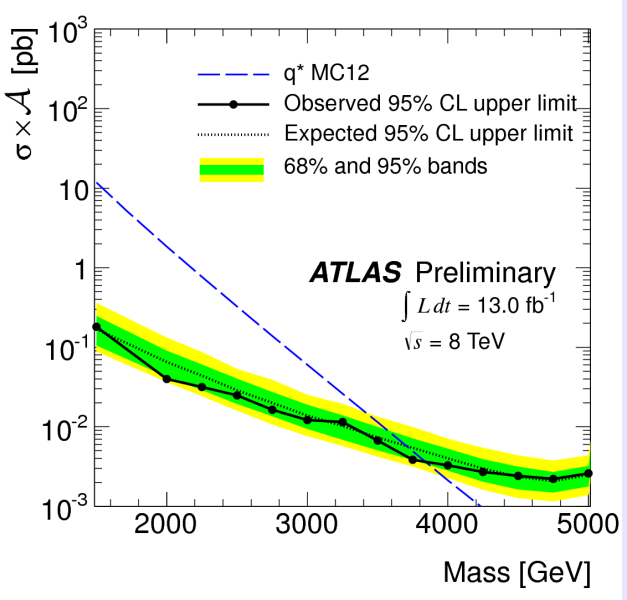
- Exploring a new kinematic regime in energy and rapidity
  - Forward region never measured with such precision in a Hadron Collider
- These results constitute a comprehensive test of pQCD in a large kinematic regime

Search for di-jet mass resonances @8 TeV

ATLAS-CONF-2012-148





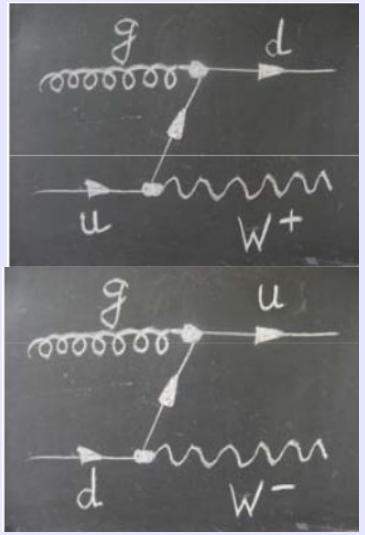


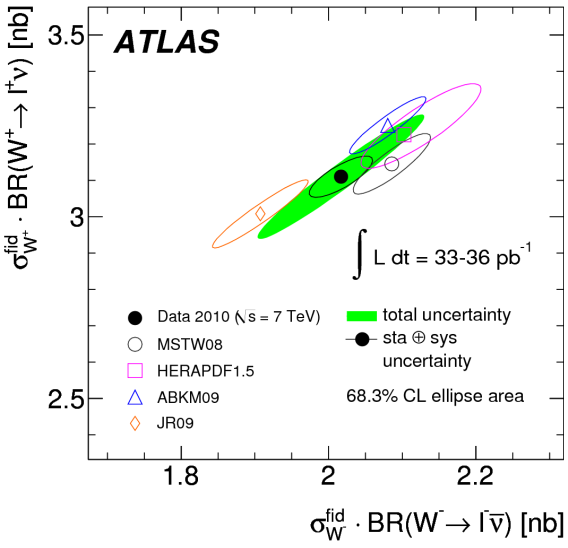
- SM extensions predict new particles decaying to two partons
  - Excited quarks q*: manifestation of quark compositeness
- Update of the analysis for 13 fb^{-1} of 8 TeV pp collisions
  - 95% CL for exited quarts: 3.84 TeV

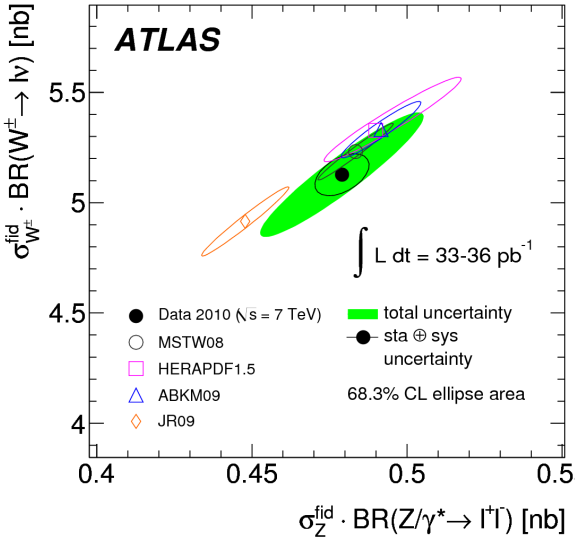
W/Z boson production

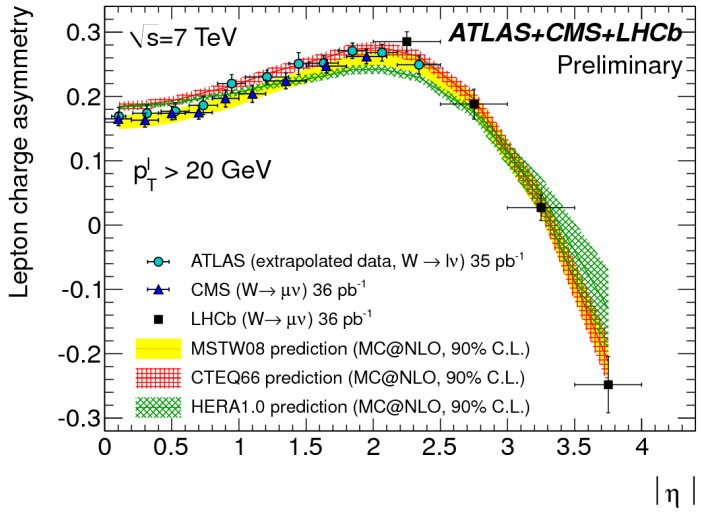
Phys. Rev. D85 (2012) 072004

- W/Z production provide a stringent test ground for pQCD, LO, NLO, NNLO at a new energy regime
- Provide constraints on the parton density functions
- W^+/W^- asymmetry provides information on
  - The quark content of the p
  - Fraction of momentum carried by the quarks

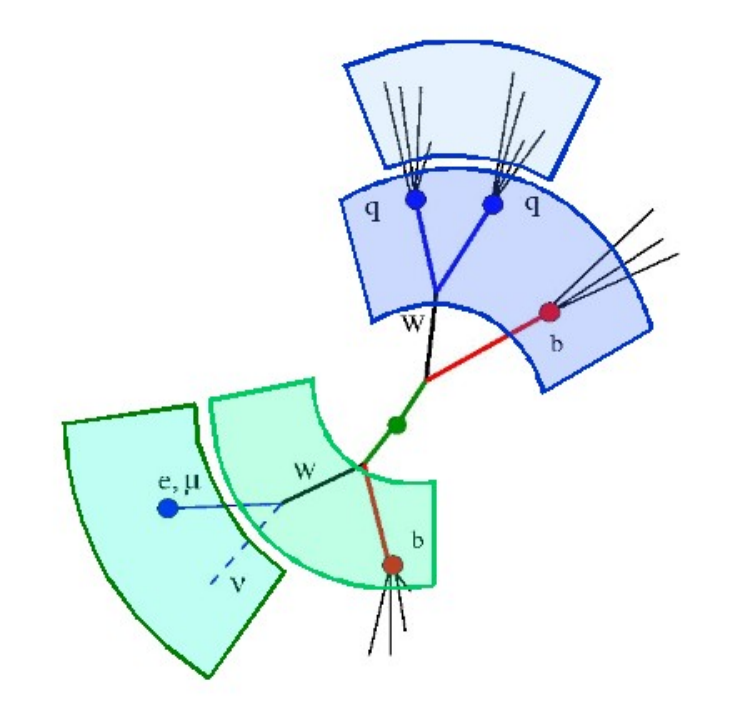




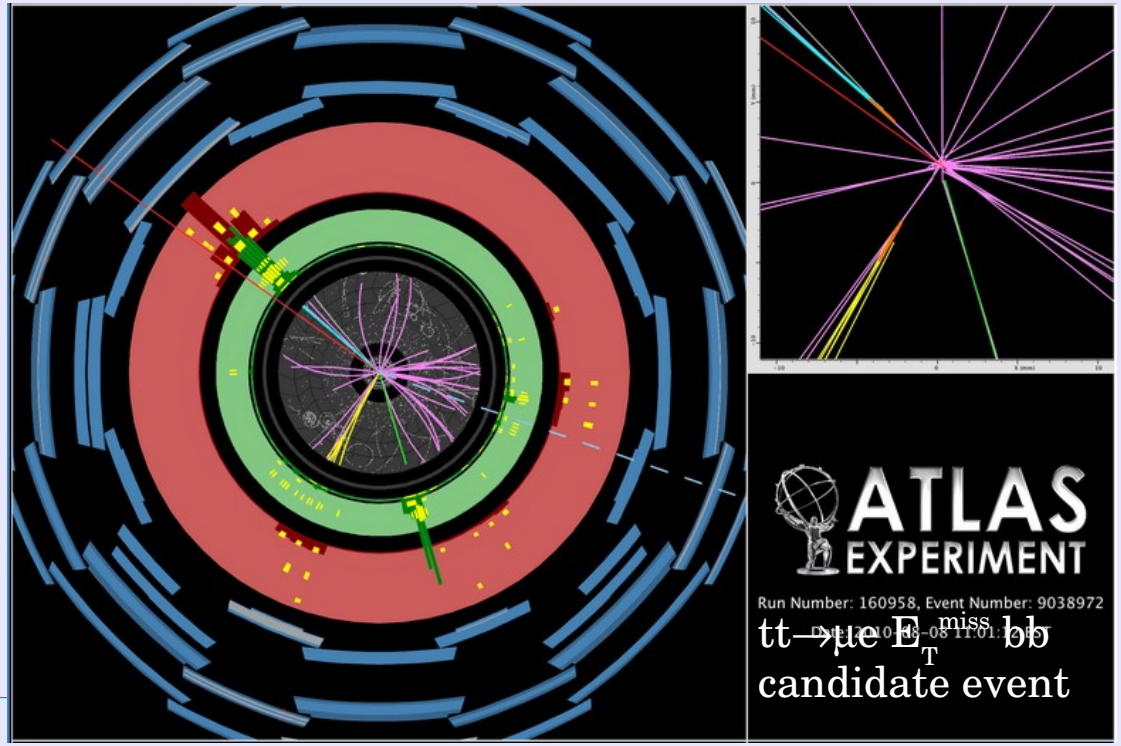




Top quark measurements at ATLAS



- LHC is a top quark factory
  - σ_{tt} ~20× Tevatron, backg.~8× Tevatron
- Predicted cross section:
  - $\sigma(tt)_{\text{approx NNLO}} = 165^{+11}_{-16}$ pb @7TeV
  - $\sigma(tt)_{\text{approx NNLO}} = 238^{+22}_{-24}$ pb @8TeV

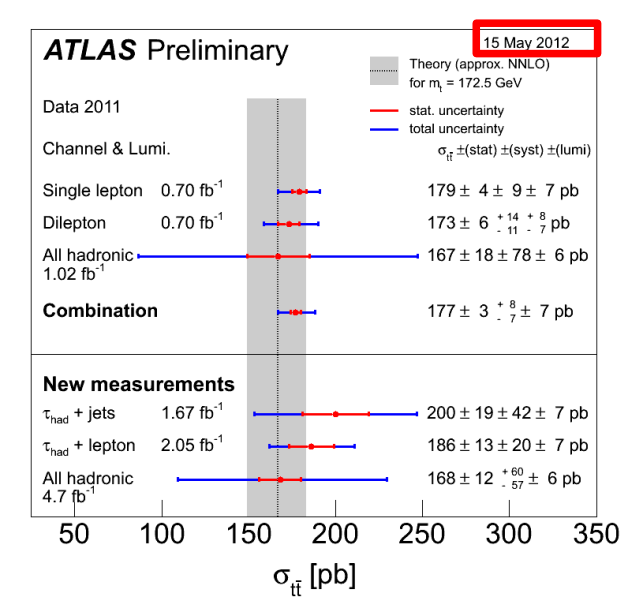


$tt \rightarrow \mu e\, E_T^{miss}\, bb$ candidate event

- Top signatures:
  - High p_T leptons, missing E_T, b-jets
- Main ackgrounds: multijet, W+jets

tt production cross section

ATLAS-CONF-2012-149



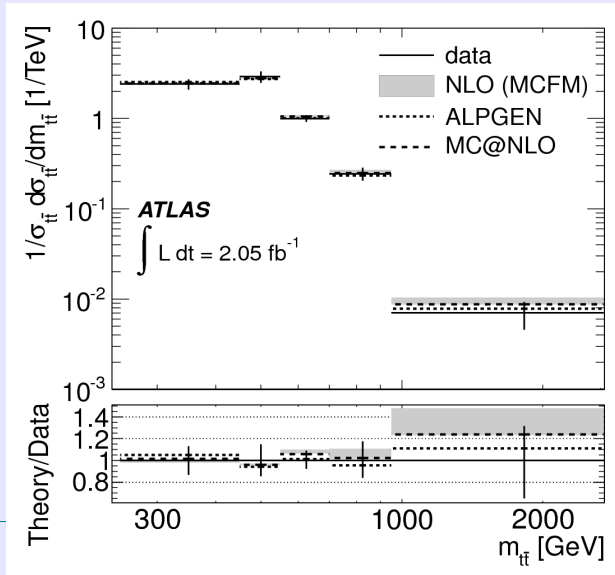
- New single-lepton channel measurements:
  - With 4.66 fb^{-1} of 7 TeV pp collisions using semileptonic B-decays

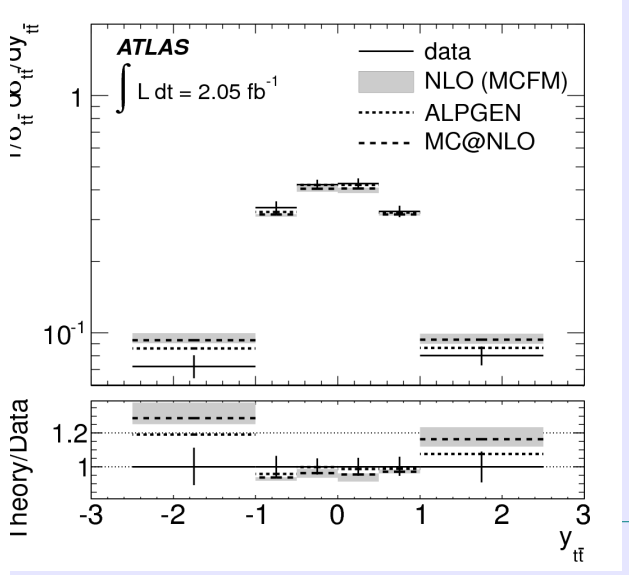
$$\sigma_{t\bar{t}} = 165 \pm 2\ (\text{stat.}) \pm 17\ (\text{syst.}) \pm 3\ (\text{lumi.})\ \text{pb}$$

  - With 5.8 fb^{-1} of 8 TeV pp collisions:

$$\sigma_{tt} = 241 \pm 2\ (\text{stat.}) \pm 31\ (\text{syst.}) \pm 9\ (\text{lumi})\ \text{pb}$$

  - Both in agreement with SM expectations

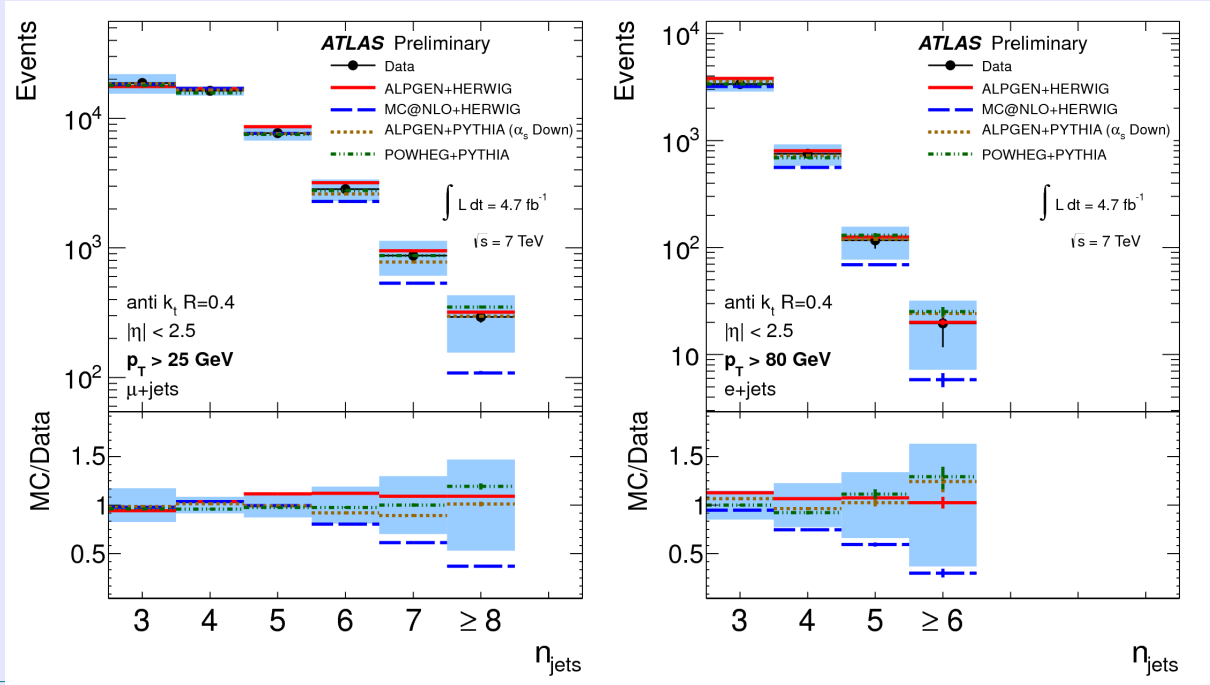




- Differential cross sections consistent with SM expectations

Jet multiplicities in tt events

- measurement of tt production with additional jets
  - Constrain ISR/FSR
  - Test of pQCD at the LHC energies
- MC@NLO: underestimates the data for $n_{jets} > 6$
  - P_T spectrum too soft
- All other predictions consistent with data



Top quark spin correlations

Phys. Rev. Lett. 108, 212001 (2012)

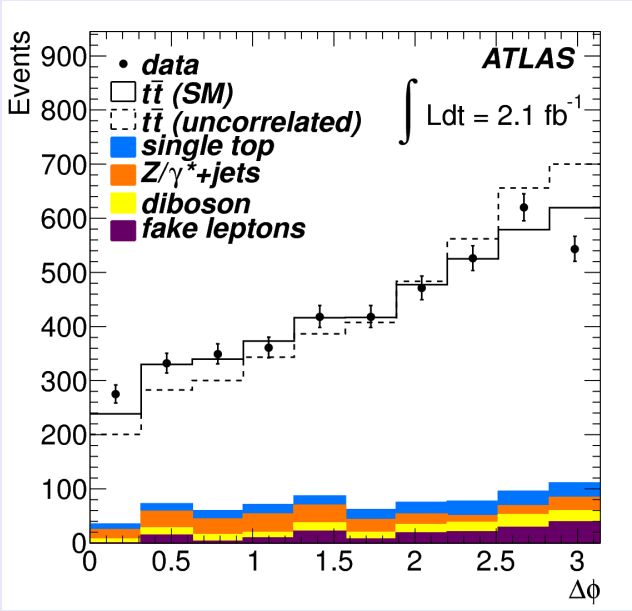
- Test precise predictions of tt production and decays

$$A = \frac{N(\uparrow\uparrow)+N(\downarrow\downarrow)-N(\uparrow\downarrow)-N(\downarrow\uparrow)}{N(\uparrow\uparrow)+N(\downarrow\downarrow)+N(\uparrow\downarrow)+N(\downarrow\uparrow)}$$

- Observable: angle between leptons ($\Delta\phi$)
  - Log-likelihood fit to SM template + uncorrelated template
- SM expectation:
  - $A_{hel} = 0.31$, $A_{max} = 0.44$
- Measured

$$A_{\mathrm{hel}}^{meas} = 0.40 \pm 0.04\ (\mathrm{stat.})\ ^{+0.08}_{-0.07}\ (\mathrm{syst.})$$

$$A_{\mathrm{max}}^{meas} = 0.57 \pm 0.06\ (\mathrm{stat.})\ ^{+0.12}_{-0.10}\ (\mathrm{syst.})$$



- Hypothesis of zero spin correlation excluded at 5.1σ level (expected 4.2σ)

Top quark polarization in tt events

ATLAS-CONF-2012-133

- QCD parity conservation + unpolarized initial state ⇒ top quark unpolarized
  - Sensitive to new physics models
- Study polar angle of charged lepton in top quark's rest frame
- Fraction of positively polarized top quarks:

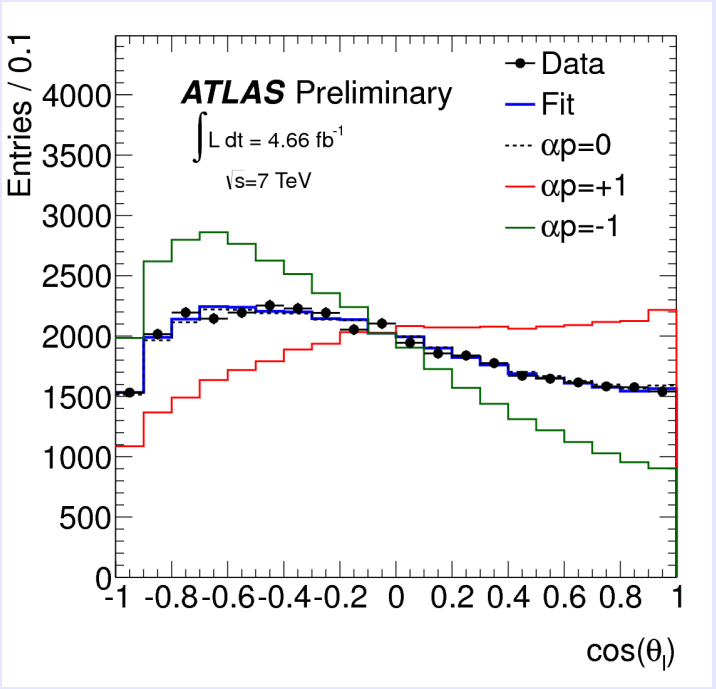
$$f = \frac{1}{2} + \frac{N(\cos\theta_l > 0) - N(\cos\theta_l < 0)}{N(\cos\theta_l > 0) + N(\cos\theta_l < 0)}.$$

- Results:

$$f = 0.470 \pm 0.009\,(\text{stat.})\,{}^{+0.023}_{-0.032}\,(\text{syst.})$$

- In agreement with SM predictions (f_{SM}=0.5)

Muon channel fit:

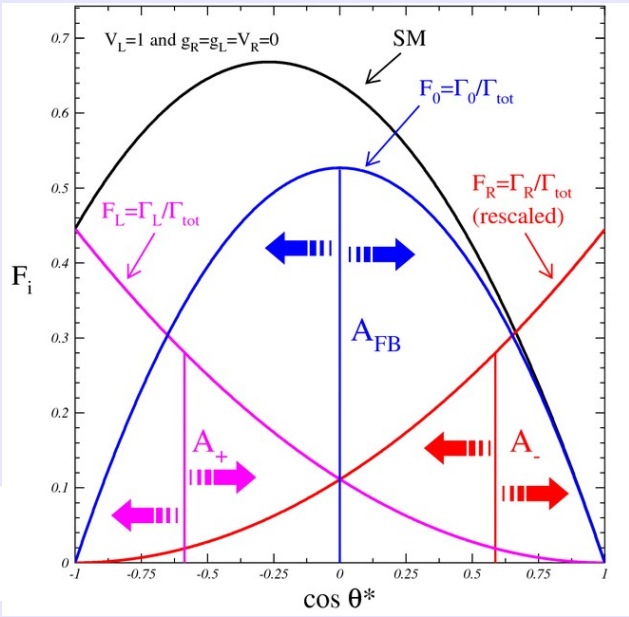


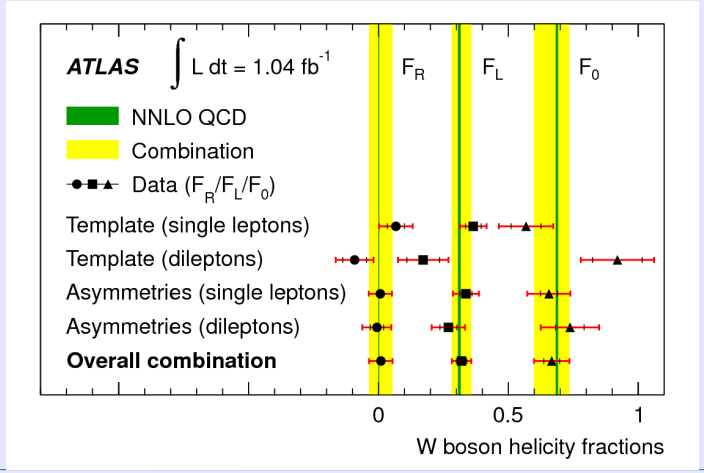
W polarization in top quark decays

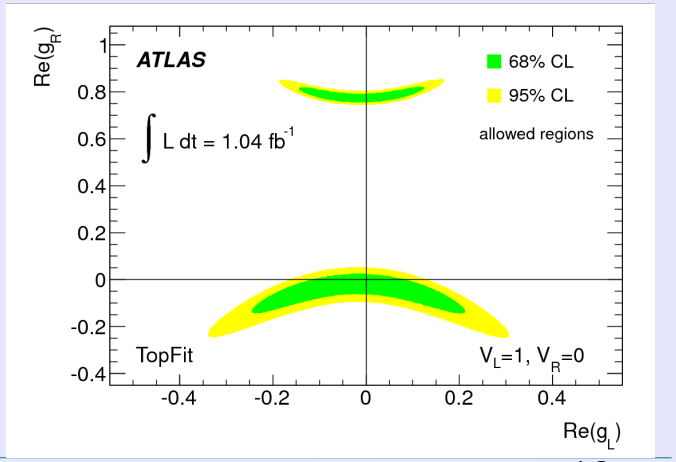
JHEP 1206 (2012) 088

- W polarization
  - reflects the V-A coupling of the Wtb vertex
  - Can be used to test anomalous couplings
- Measure angular distribution of the charged lepton in the W rest frame
- Helicity fractions

$$\frac{1}{\sigma}\frac{\mathrm{d}\sigma}{\mathrm{d}\cos\theta^*} = \frac{3}{4}\left(1-\cos^2\theta^*\right) F_0 + \frac{3}{8}\left(1-\cos\theta^*\right)^2 F_{\mathrm{L}} + \frac{3}{8}\left(1+\cos\theta^*\right)^2 F_{\mathrm{R}} .$$

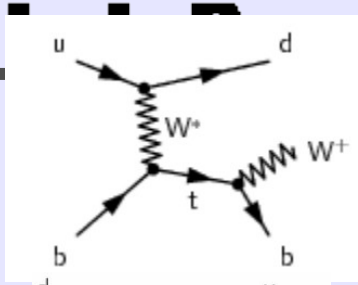


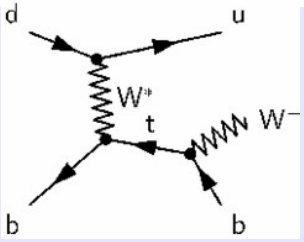




Single top production (t-channel)

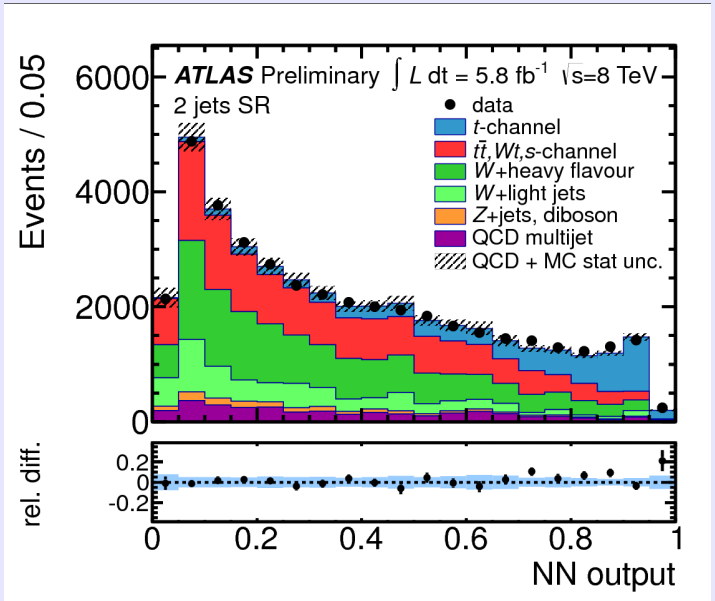
ATLAS-CONF-2012-132 Phys. Lett. B 717 (2012) 330-350 ATLAS-CONF-2012-056

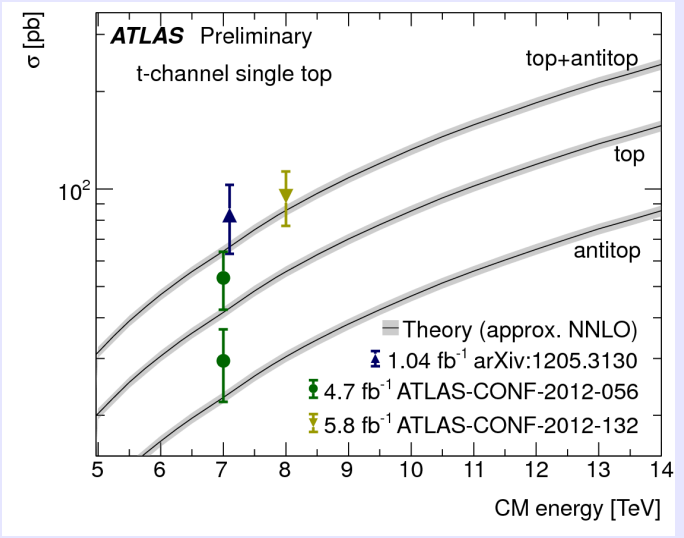




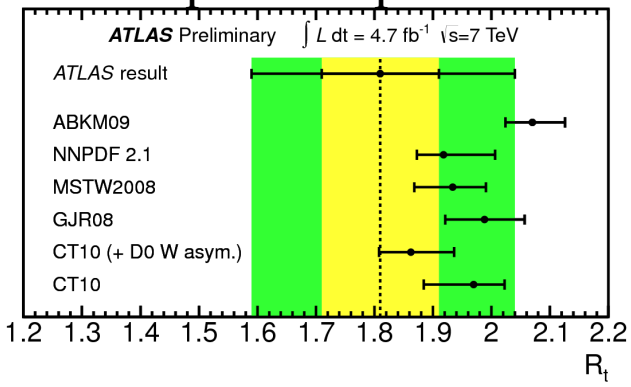
Single top production

- Probe W-t-b coupling: $\sigma \propto |V_{tb} \cdot f|^2$
- Sensitive to new physics





Ratio top/anti-top at 7 TeV



V_{tb} measurement at 8 TeV:

$$|V_{tb} \cdot f| = 1.04^{+0.10}_{-0.11}$$

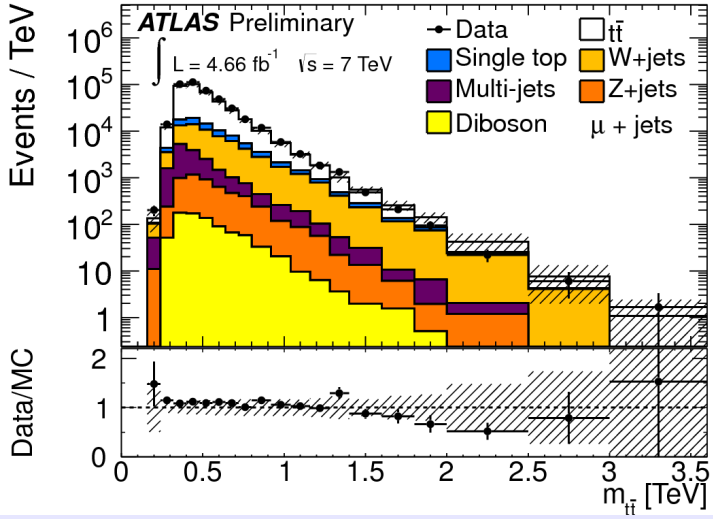
- Lower limit @95% CL: $|V_{tb}| > 0.80$ (assuming f=1)

Searches for tt resonances

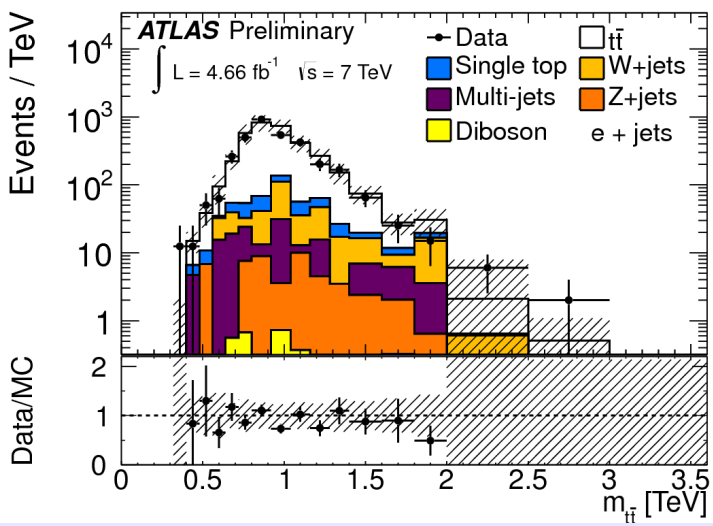
ATLAS-CONF-2012-136

- Using 4.66 fb^{-1} of 7 TeV pp collisions
- tt invariant mass distribution in good agreement with SM expectations

Inclusive selection



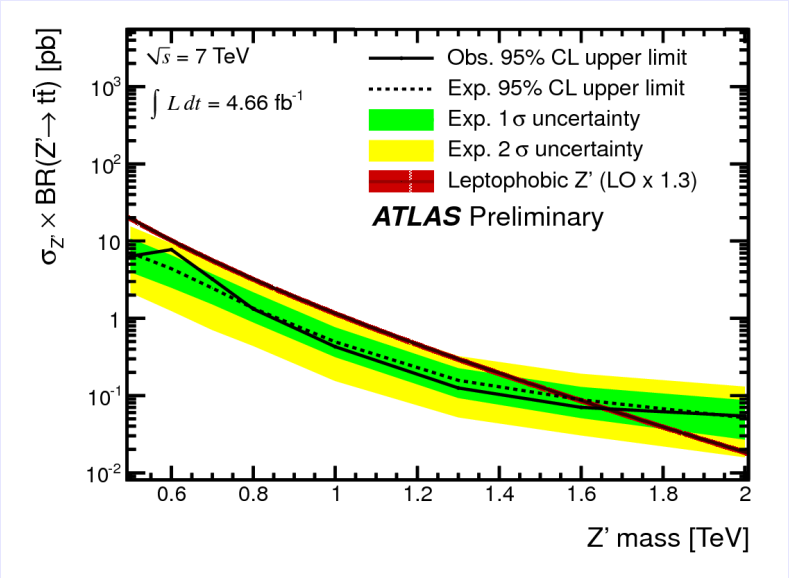
Boosted selection

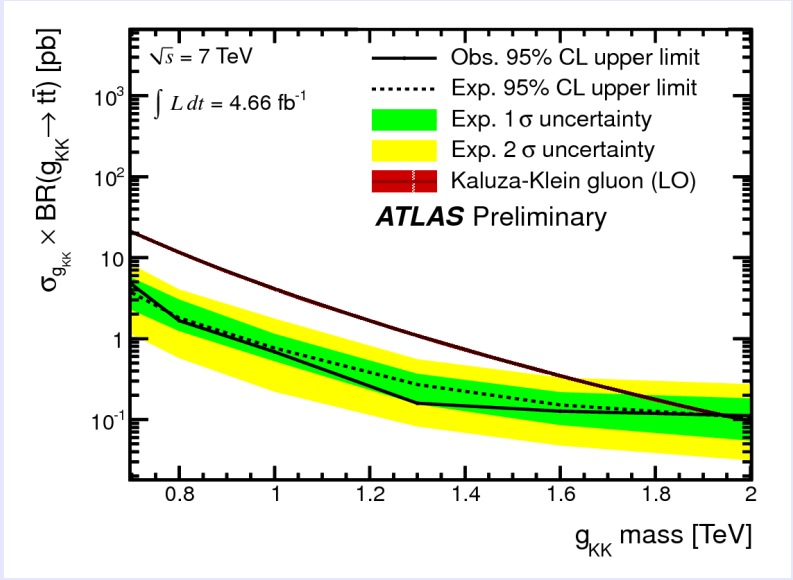


- Boosted selection:
  - One large jet containing all decay products of the hadronically decaying t→Wb
  - Use substructure information to reduce background

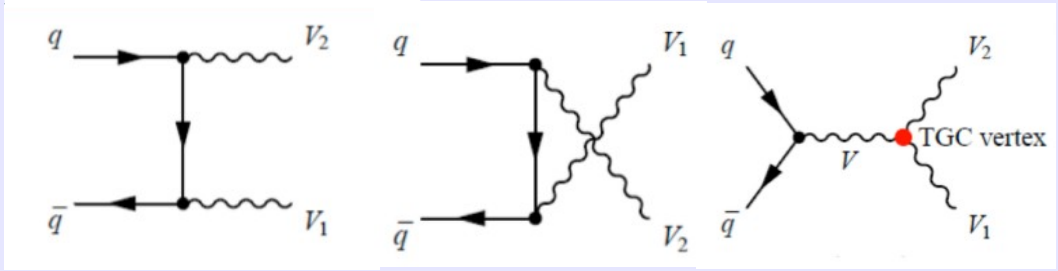
Searches for tt resonances (II)

- 95% CL exclusion limits on benchmark models:
  - Leptophobic topcolor Z' excluded for masses below 1.7 TeV
  - Randall–Sundrum Kaluza–Klein gluon excitations excluded for masses below 1.9 TeV

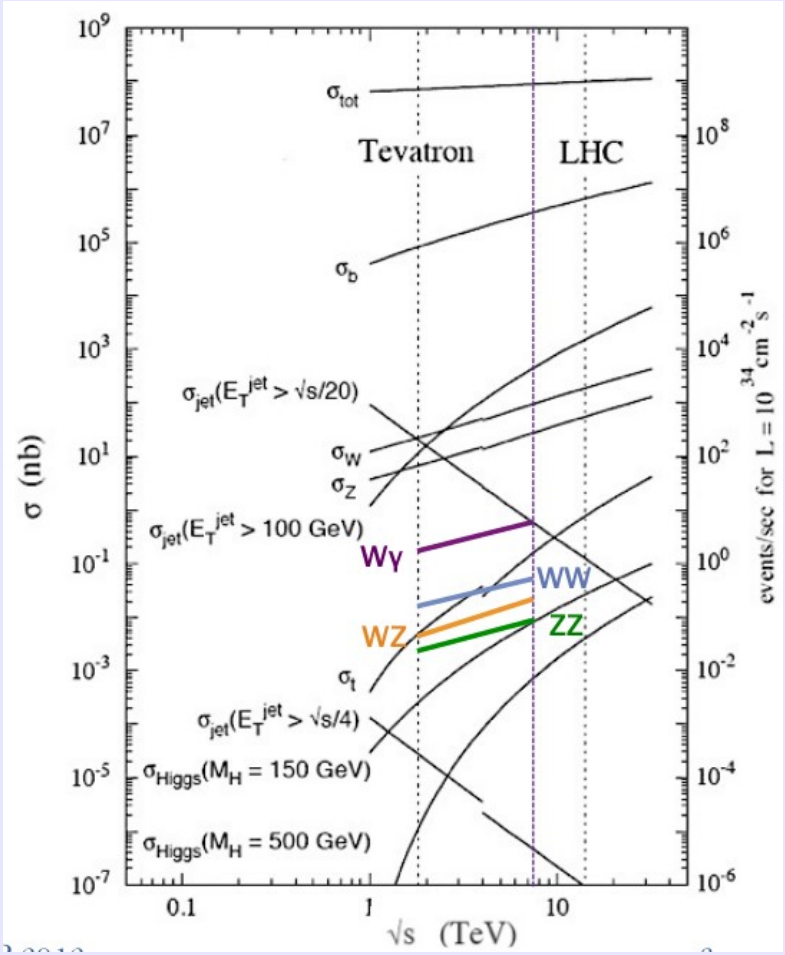




Di-boson production



- Standard model predicts TGC, fully constraint by EW symmetry
  - WWγ and WWZ vertices are predicted,
  - ZZγ and ZZZ are forbidden
- Beyond standard model physics could modify di-bosons cross sections and kinematics
- ATLAS measured WW, WZ, ZZ, Wγ, Zγ production cross sections

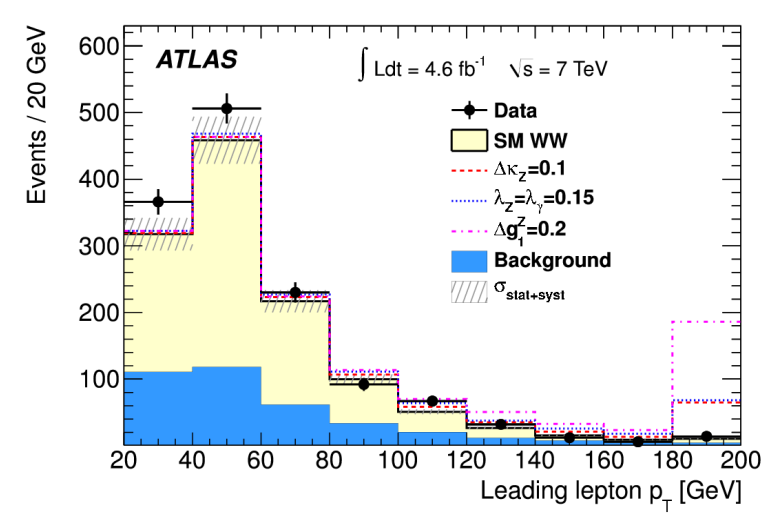


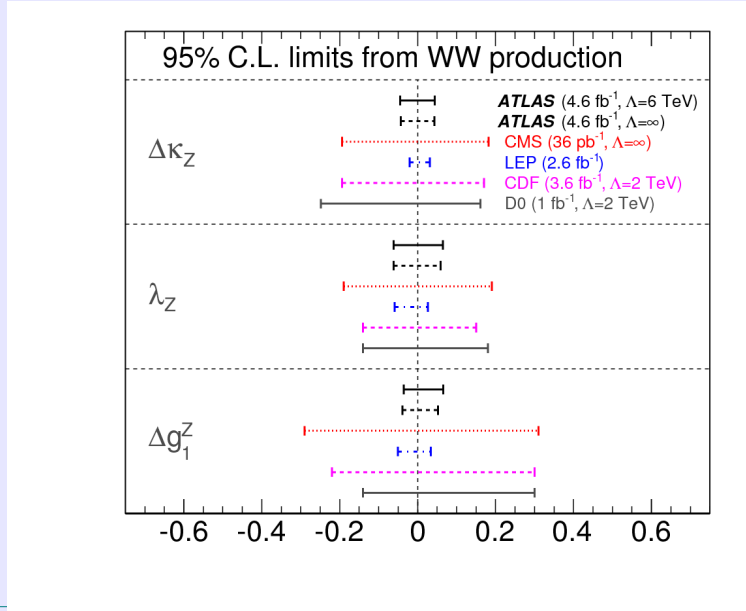
WW cross sections

arXiv:1203.6232

- Expected WW cross section: $44.7^{+2.1}_{-1.9}$ pb
- Measured value: $\sigma_{WW} = 51.9 \pm 2.0\,(\text{stat}) \pm 3.9\,(\text{syst}) \pm 2.0\,(\text{lumi})$ pb
- Use the leading lepton p_T to calculate limits on the anomalous couplings

$$\frac{\mathcal{L}_{WWV}}{g_{WWV}} = i\left[g_1^V(W^\dagger_{\mu\nu}W^\mu V^\nu - W_{\mu\nu}W^{\dagger\mu}V^\nu) + \kappa^V W^\dagger_\mu W_\nu V^{\mu\nu} + \frac{\lambda^V}{m_W^2}W^\dagger_{\rho\mu}W^\mu_\nu V^{\nu\rho}\right]$$



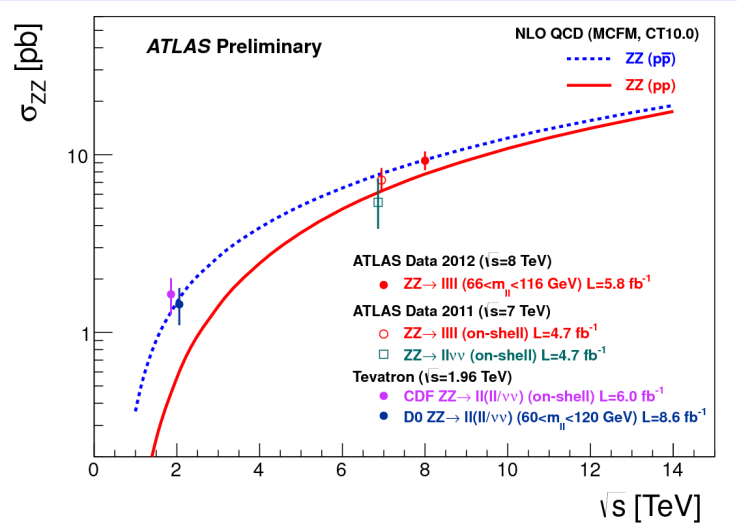


arXiv :1205.2531

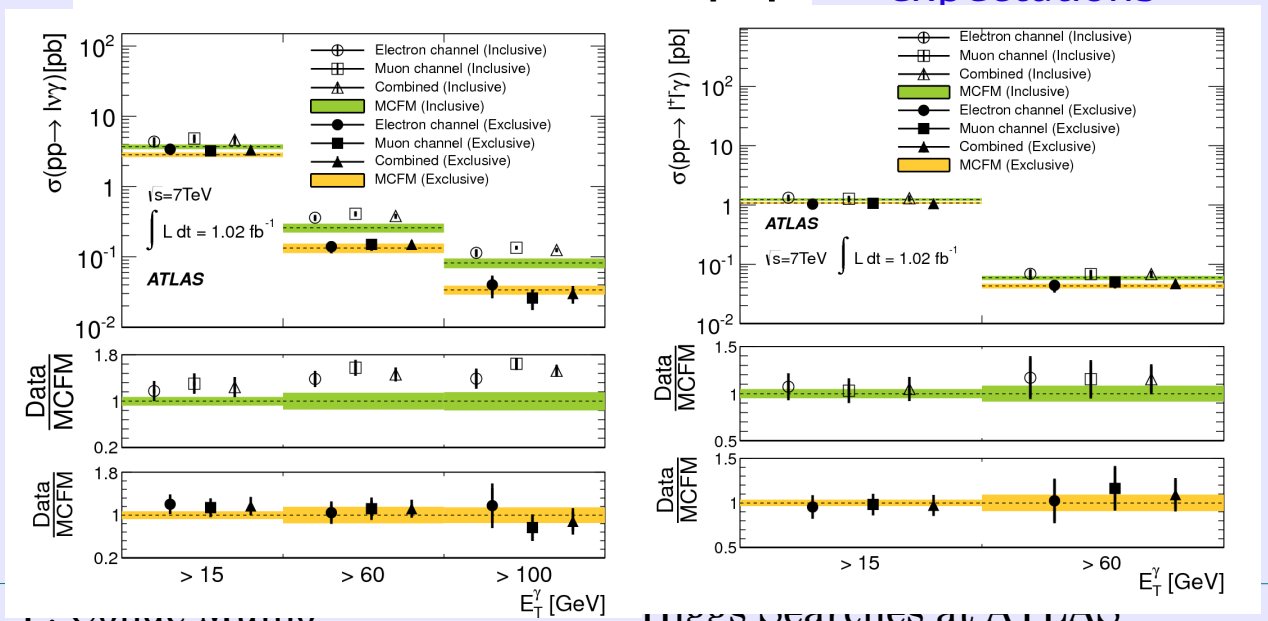
PRL 108, 041804 (2012)

ATLAS-CONF-2012-136

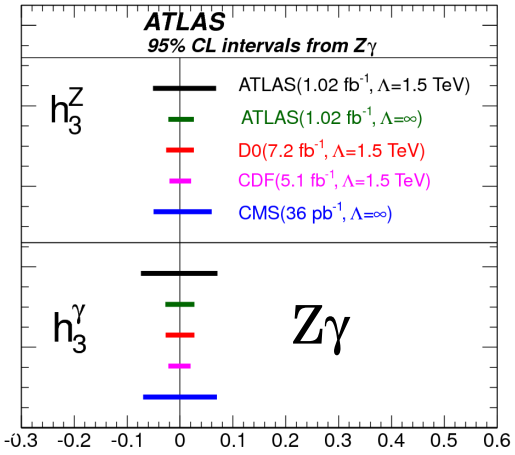
ZZ, Wγ, Zγ cross sections

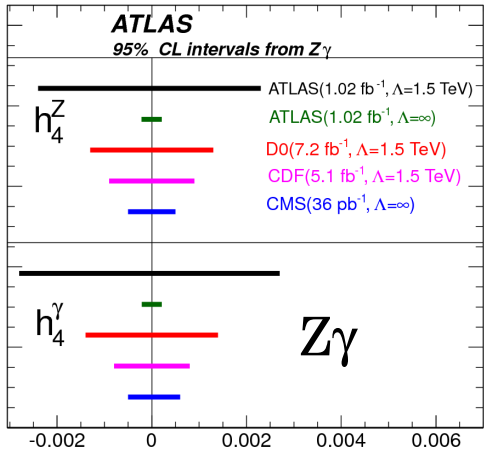


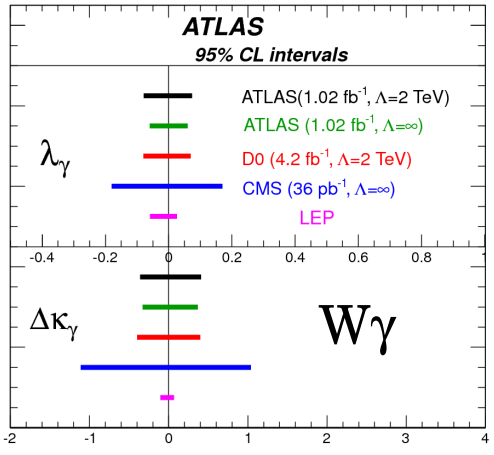
- Wγ, Zγ exclusive cross sections
  - Good agreement with SM NLO predictions
- Wγ, Zγ inclusive cross sections
  - Disagreement at high E_T^{γ} due to missing higher order QCD corrections in the MC
- ZZ cross section consistent with expectations

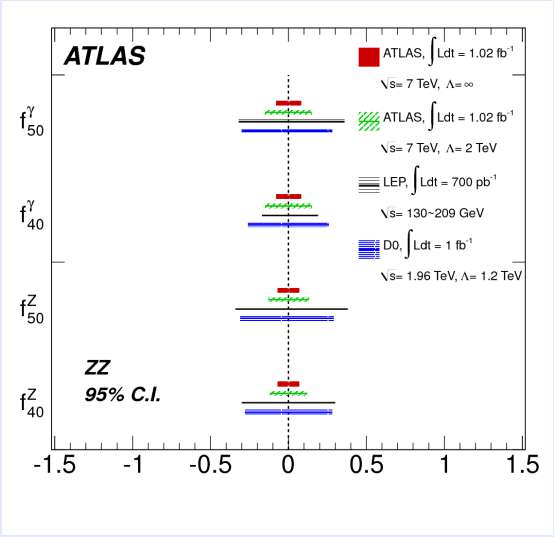


Limits on anomalous TGC

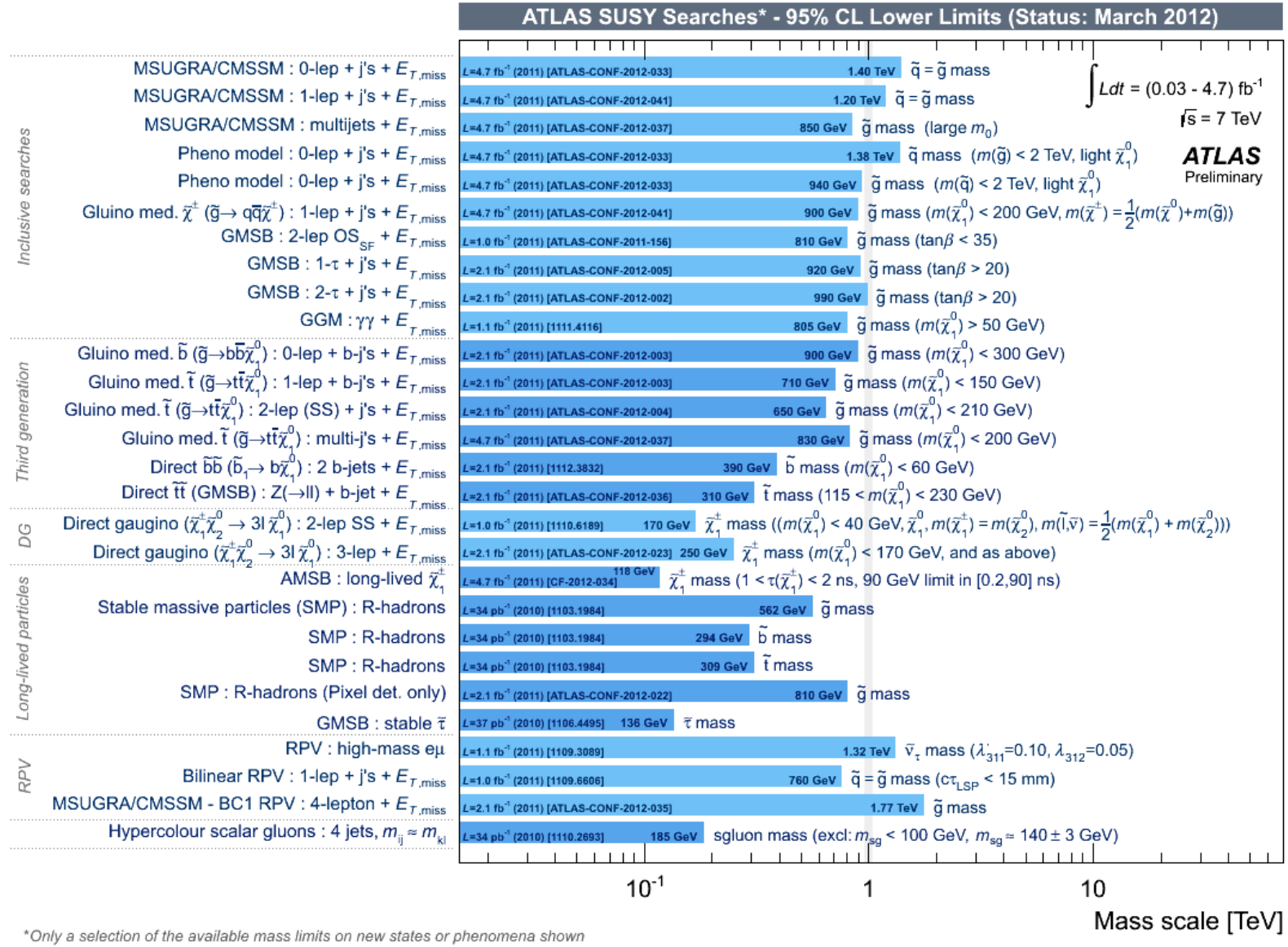






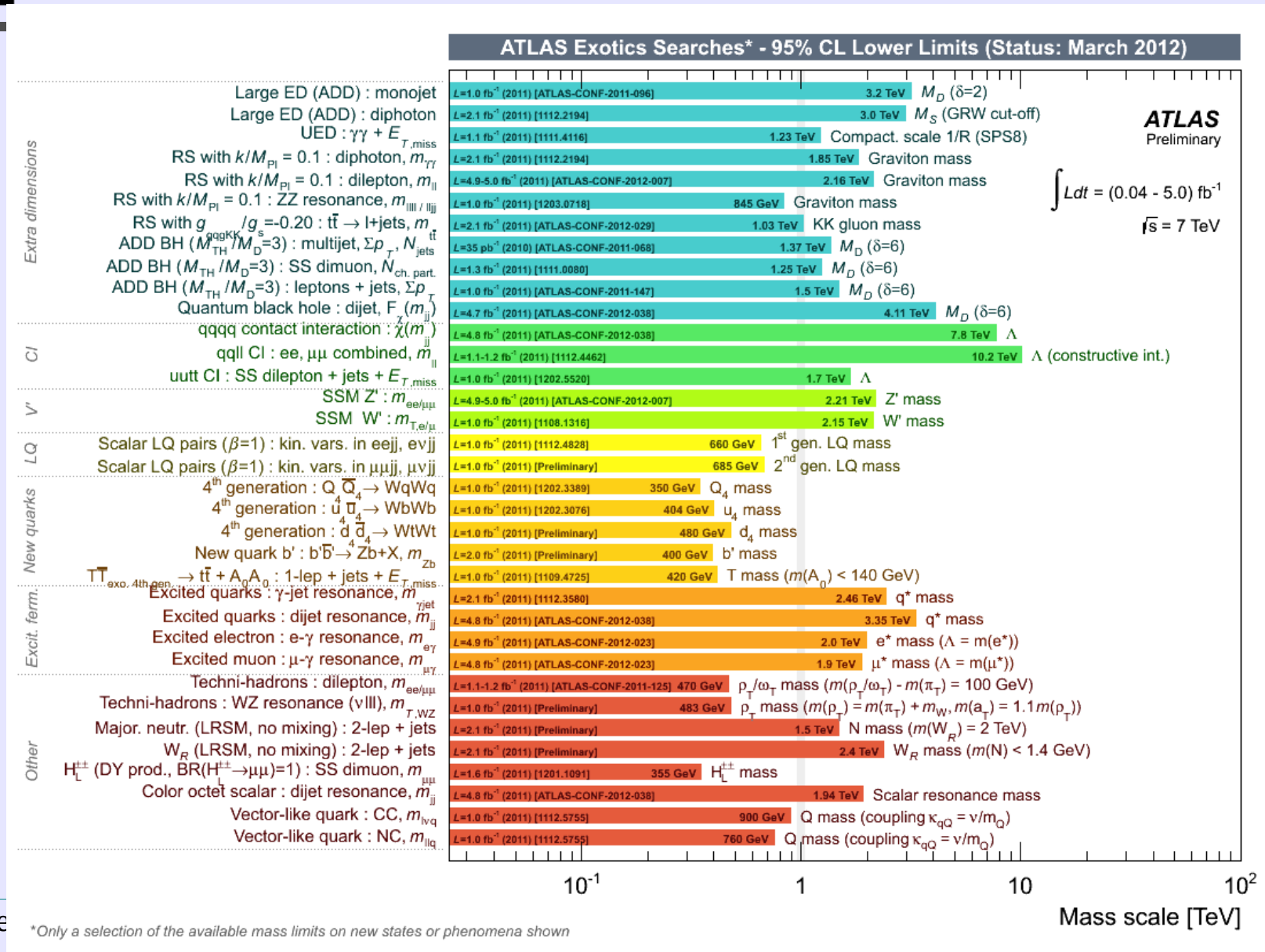


SUSY searches



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

Exotic searches



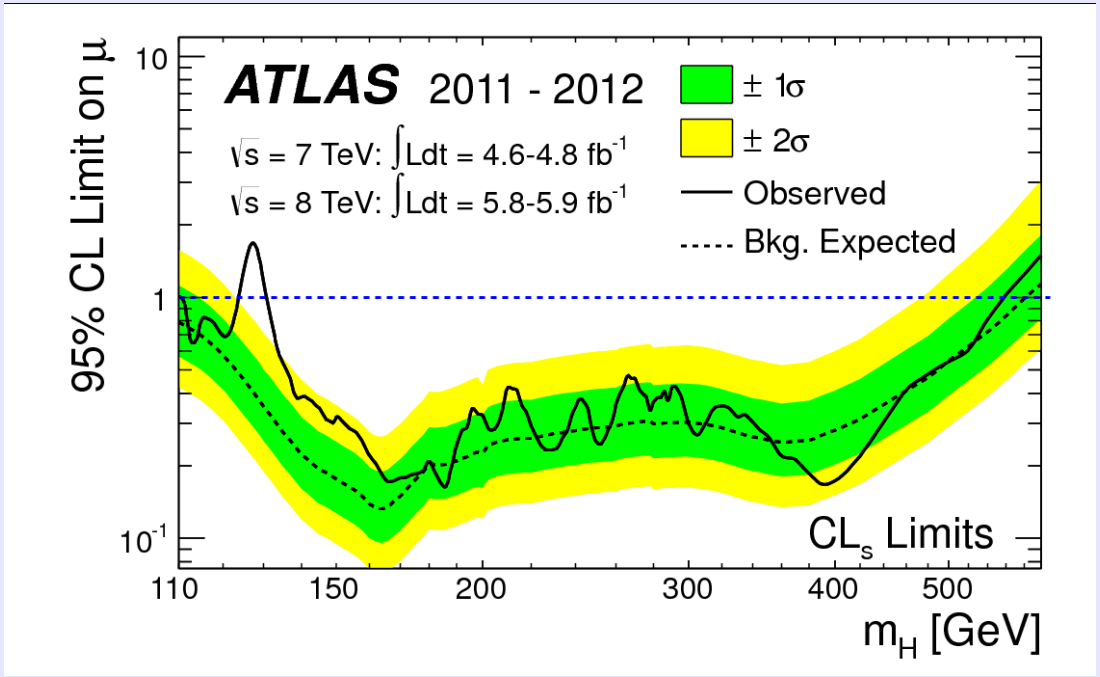
*Only a selection of the available mass limits on new states or phenomena shown

New boson observed in Higgs searches

arXiv:1207.7214

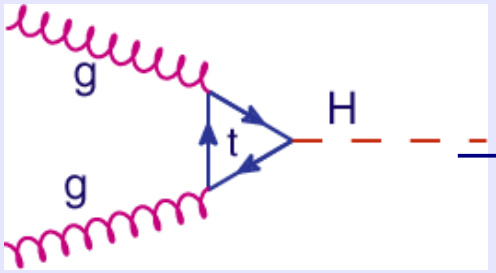
July 2012

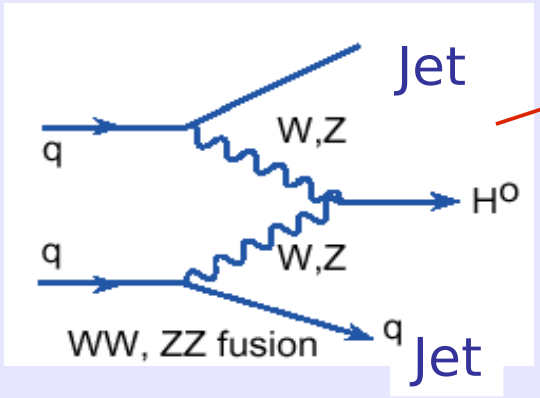
- Three channels used for 2012 data analysis
  - H→WW
  - H→γγ
  - H→ZZ

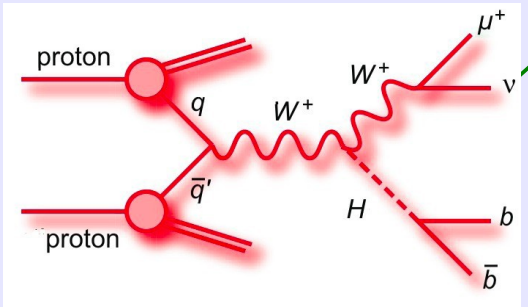


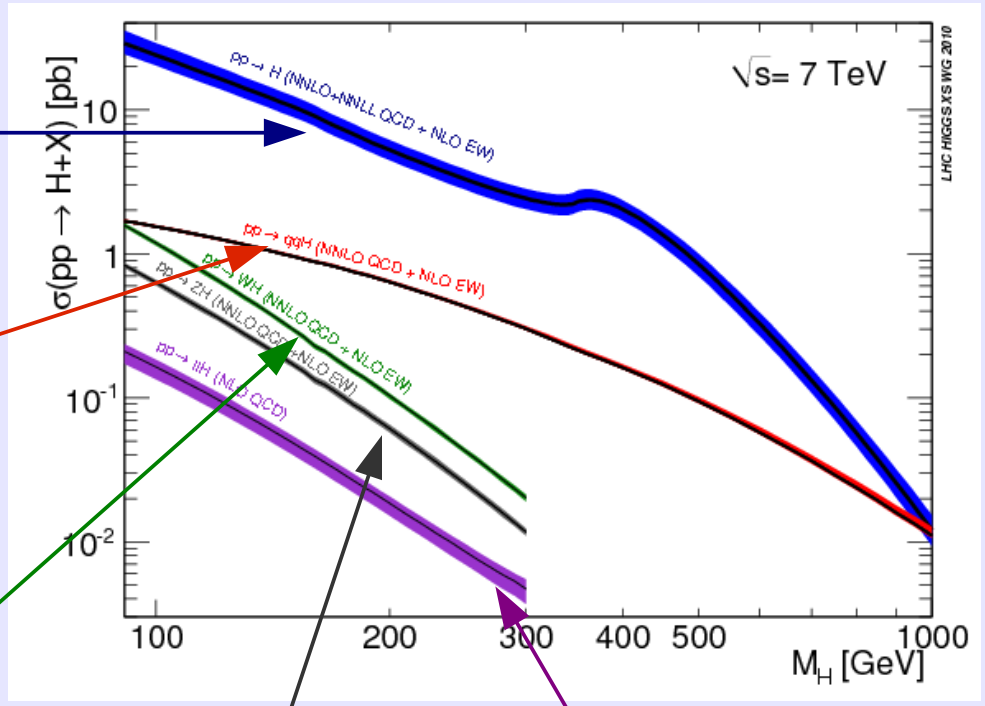
- SM excluded at 95% CL from 111-122, 131-559 GeV
- Excess of events observed at ~126 GeV
  - Local/global significance of 5.9σ/5.1σ
  - $P_0 = 1.7 \times 10^{-9}$
- Best fit mass: 126.0 ± 0.4 (stat) ± 0.4 (sys) GeV (only ZZ and γγ channels used)

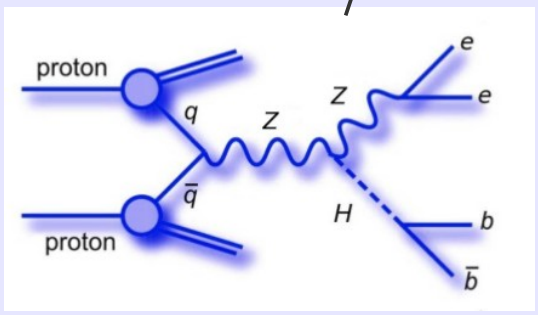
Higgs production

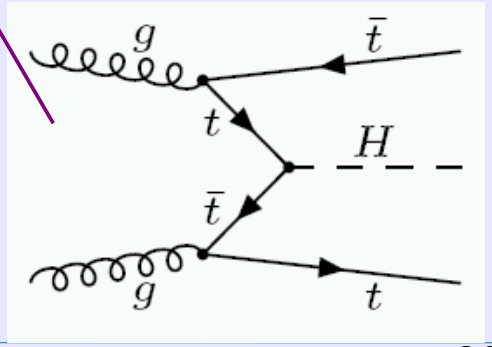




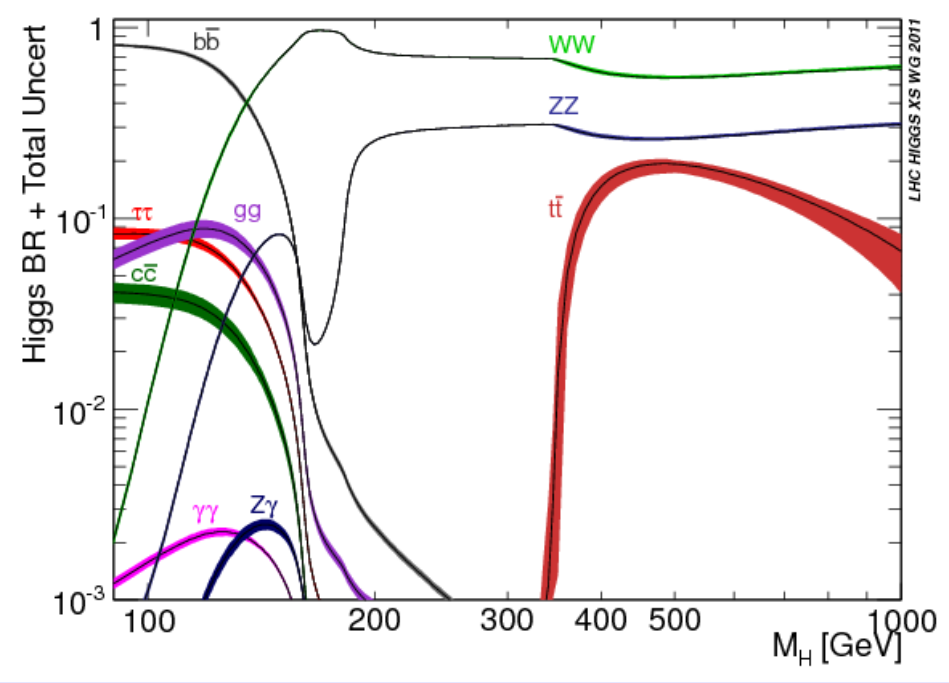








Higgs decays



- 5 different decay modes
  - High mass: ZZ, WW
  - Low mass: bb, γγ, WW, ZZ, ττ
- Low mass very challenging
- Best mass resolution: H→γγ, H→ZZ→llll

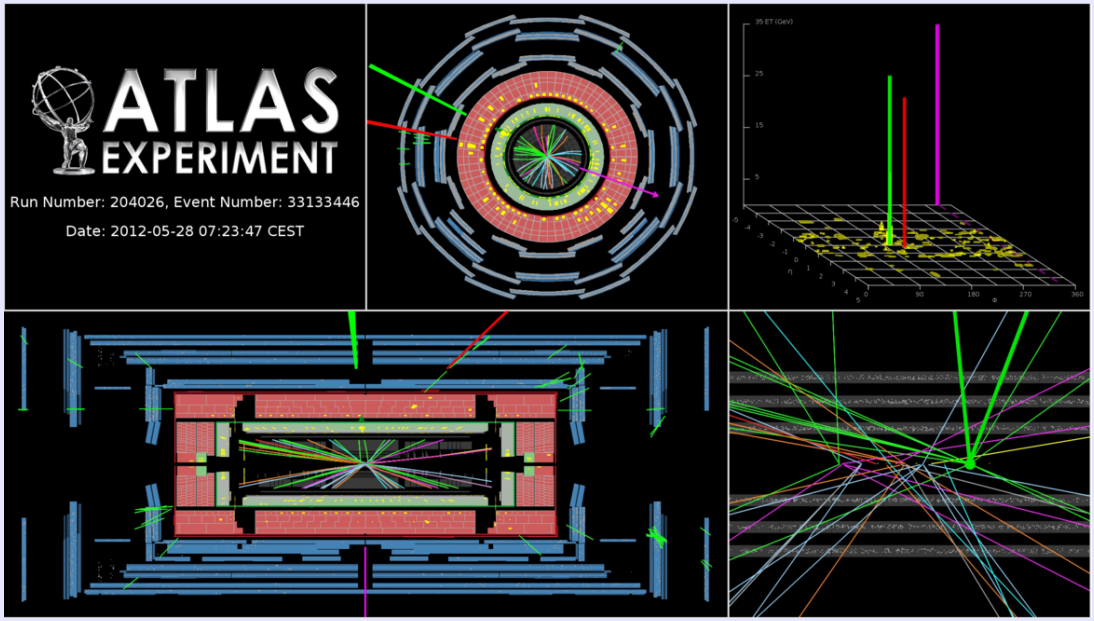
Showing new results with respect to July 2012:

- H→WW, VH (with H→bb), H→ττ

All channels did a blind analysis

- Signal region kept blind untill all the details of the analysis were fixed and backgrounds were understood using control regions

H→WW→lνlν



H→WW→μνeν candidate event

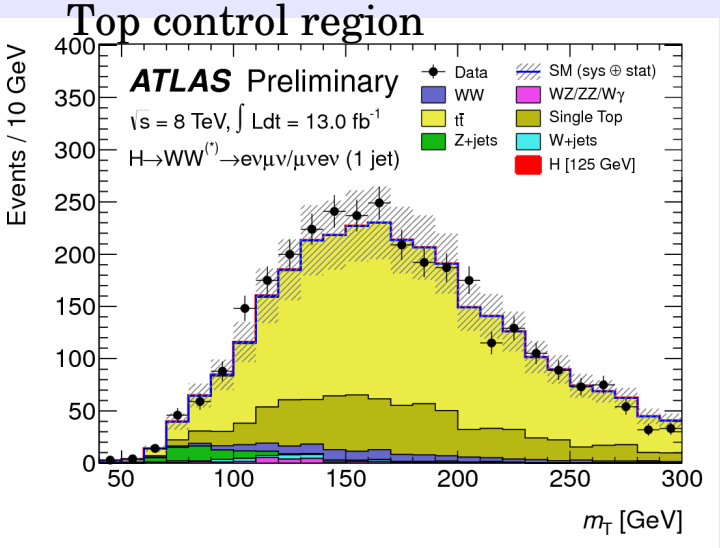
- Two opposite sign isolated leptons and large missing E_T
- Relies on the whole detector working perfectly
- 0-, 1-jet categories

Main backgrounds

- WW, tt, Wt
- W+jets, Wγ, ZZ, Drell-Yan

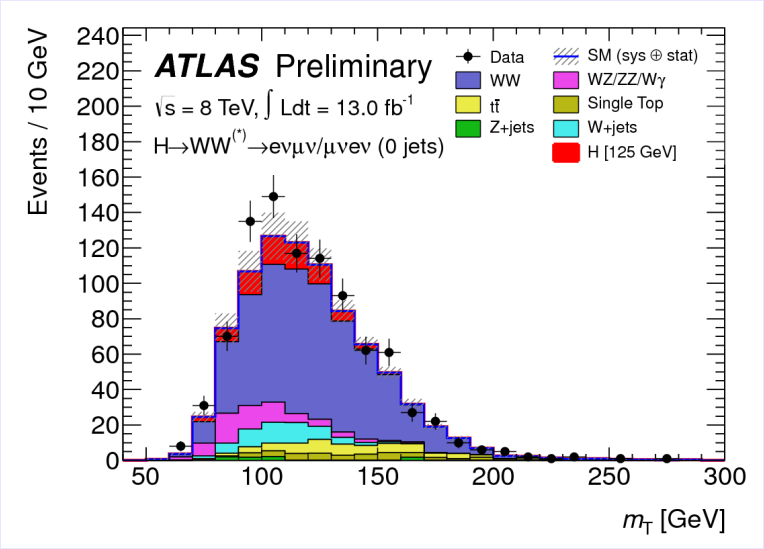
Updated with 13 fb^{-1} of 8 TeV pp collisions!

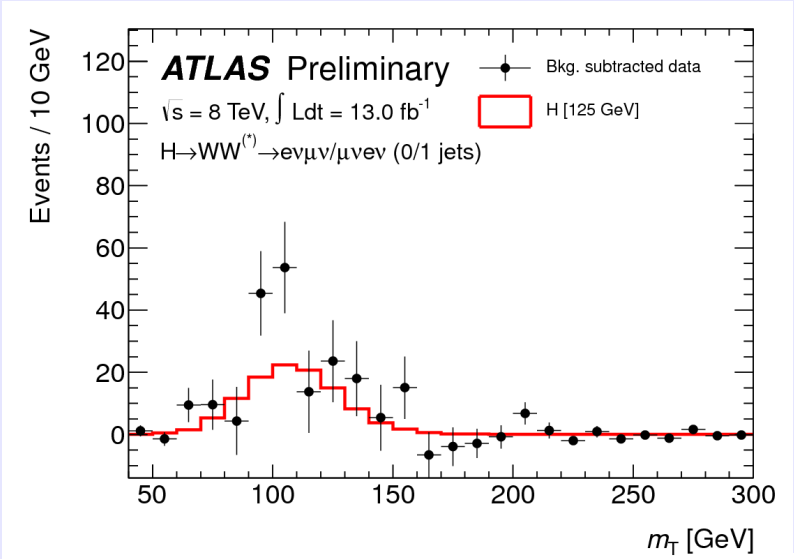
Top control region



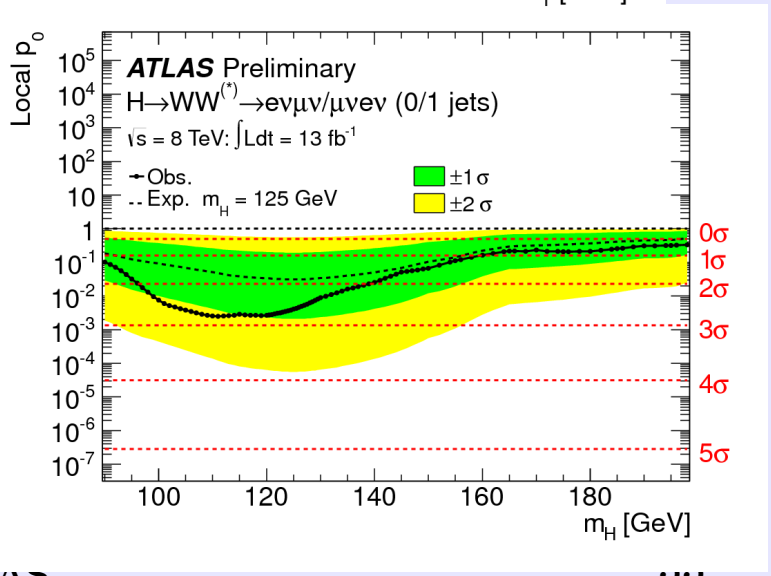
H→WW→lνlν results

ATLAS-CONF-2012-158

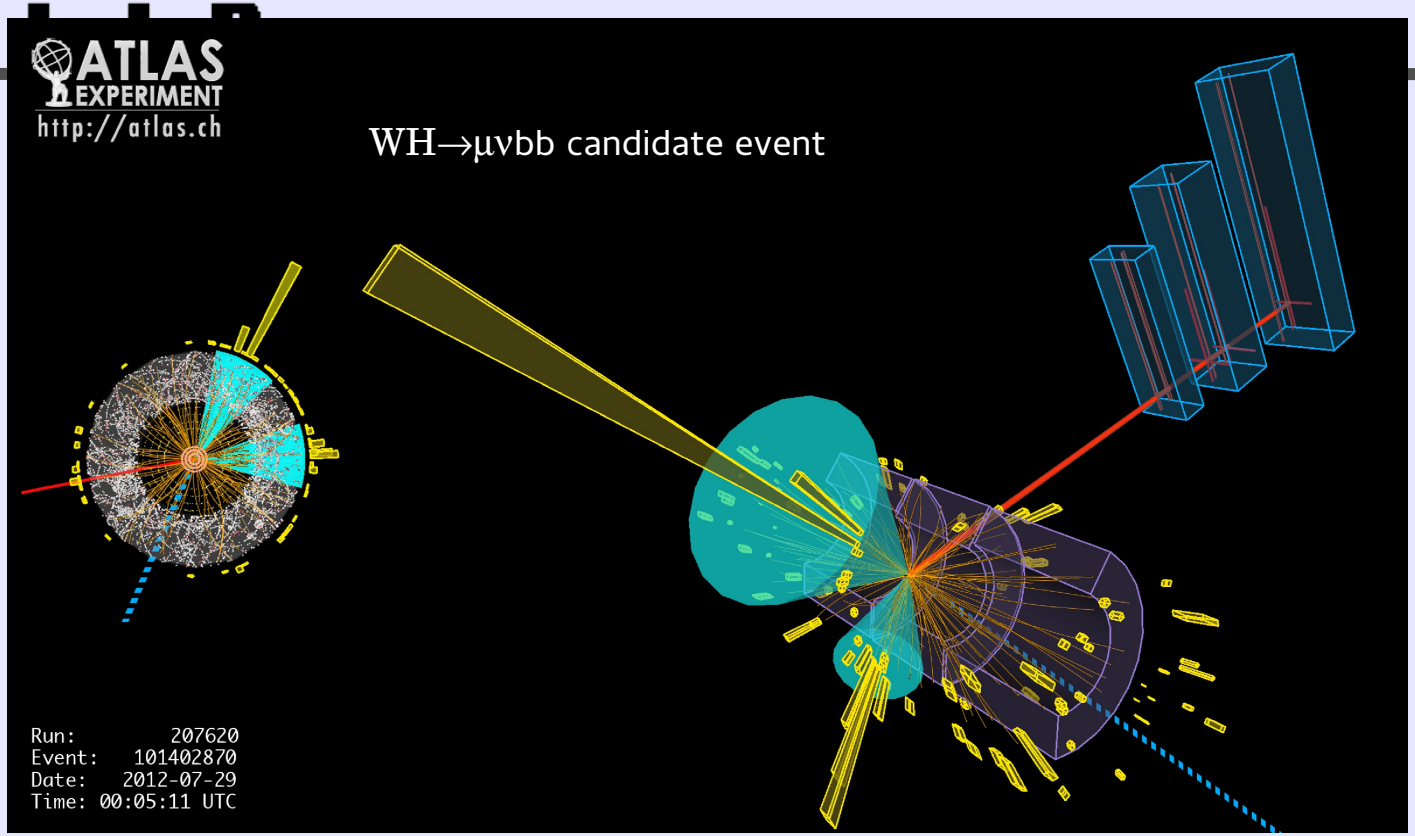




- Excess of events observed
  - Broad excess (poor mass resolution)
  - Minimum p0 at 111 GeV (p0 = 3×10^{-3})
  - Local significance at 111 GeV: 2.8σ
  - Local significance at 125 GeV 2.6σ



VH→bb ATLAS search

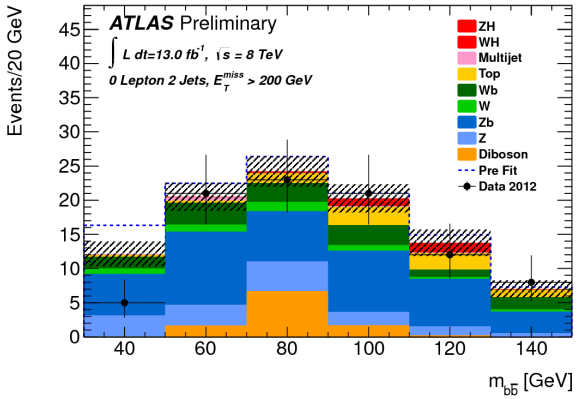


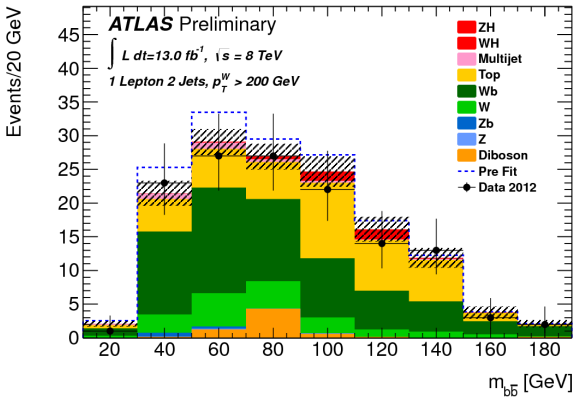
- Three channels
  - WH → lν bb
  - ZH → llbb
  - ZH → ννbb

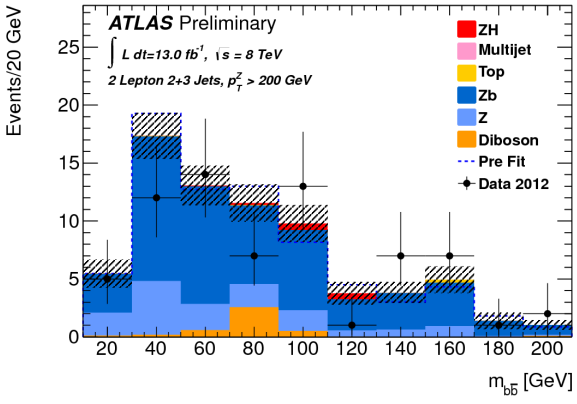
- Signatures
  - High p_T isolated leptons, 2 b-jets, Large missing E_T (lνbb, ννbb)
- Different categories based on p_T^V/E_T^{miss}
- Backgrounds: W/Z+jets, top, di-boson, QCD jets

VH→bb

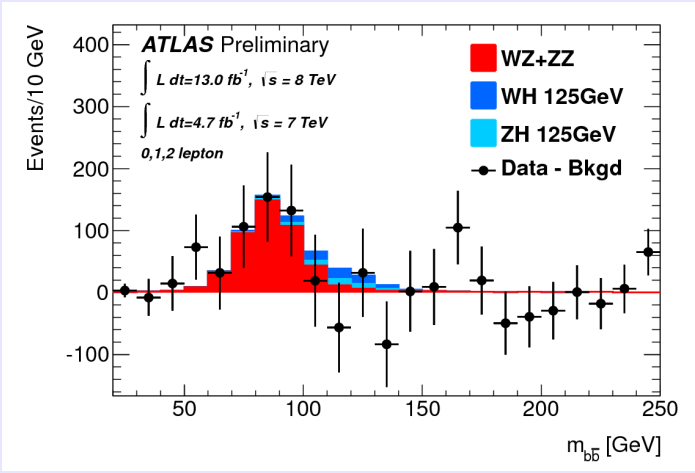
ATLAS-CONF-2012-161



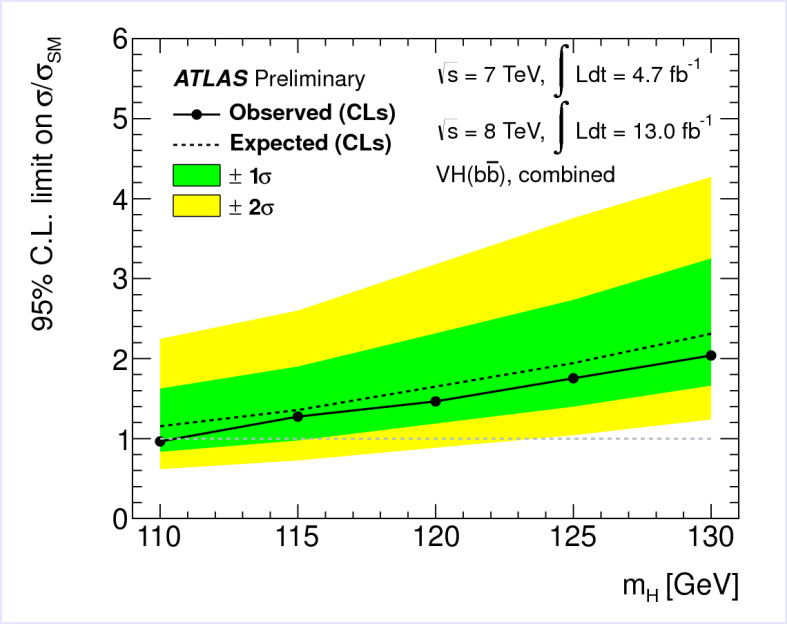


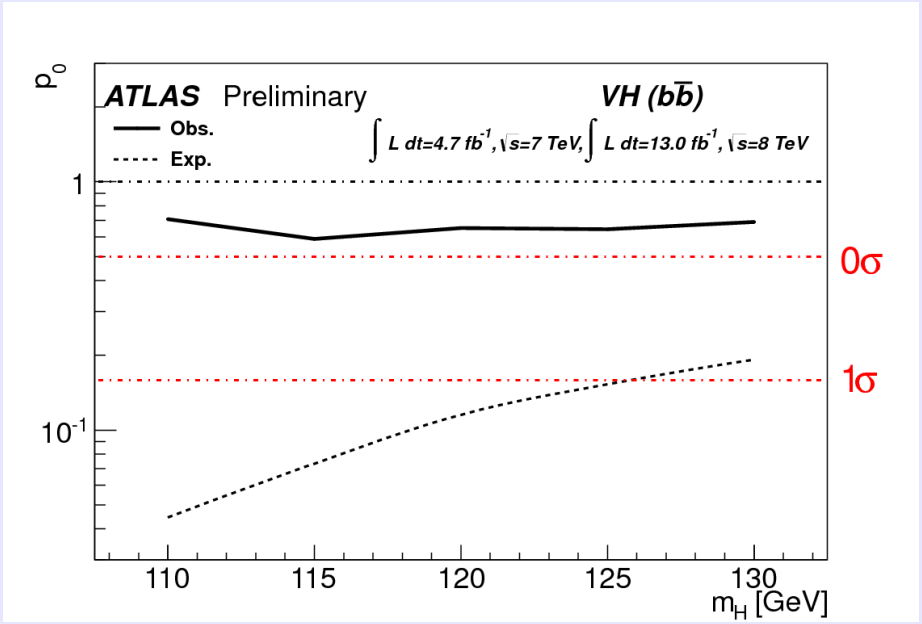


- Di-bjet invariant mass for the most sensitive p_T^V bin
- WZ & ZZ production with Z→bb similar signature, but 5 times larger cross-section
  - Analysis strategy validated by searching for di-boson signal
  - σ/σ_{SM} = 1.09 ± 0.20 (stat) ± 0.22 (syst)
  - Significance: 4.0σ



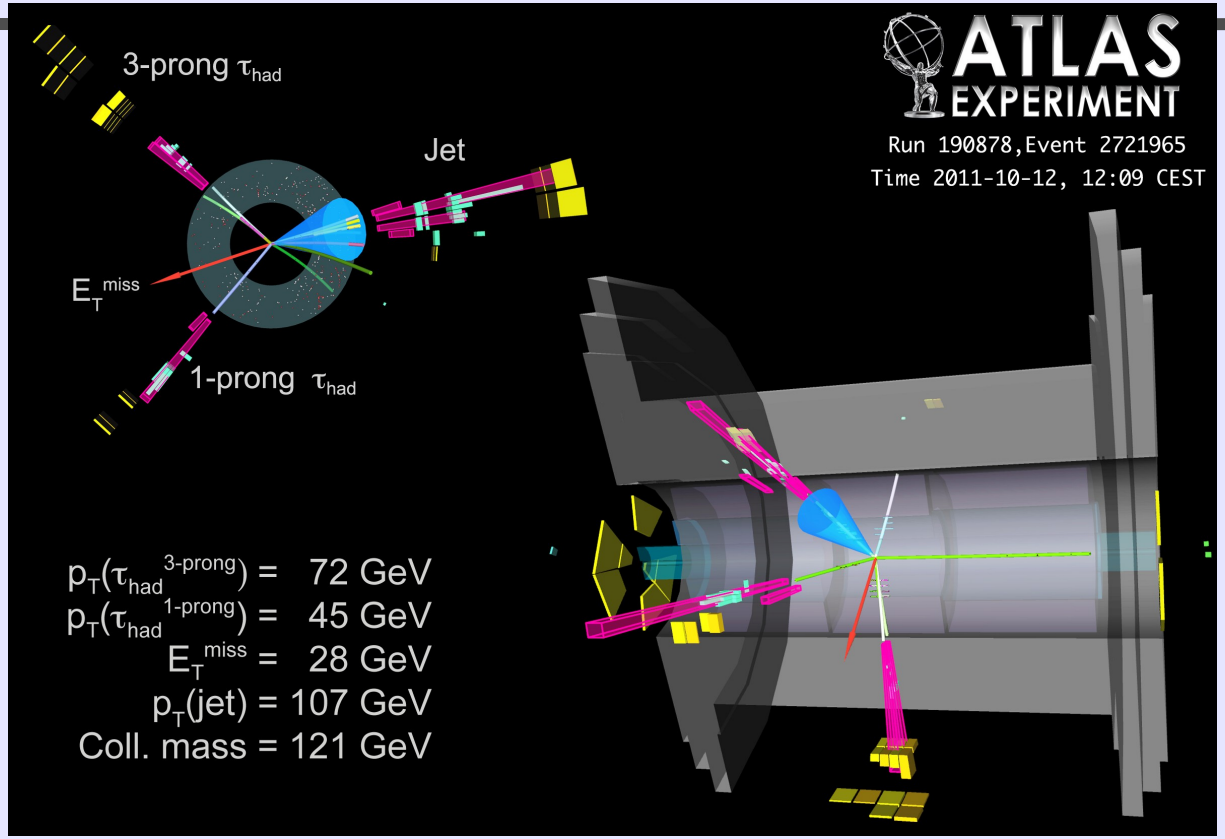
VH→bb results





- Observed (expected) limit at m_H =125 GeV
  - 1.8 (1.9) x SM prediction
- $\sigma/\sigma_{SM} = \mu = -0.4 \pm 0.7(\text{stat.}) \pm 0.8(\text{syst.})$
- Observed (expected) p^0 value: 0.64 (0.15)

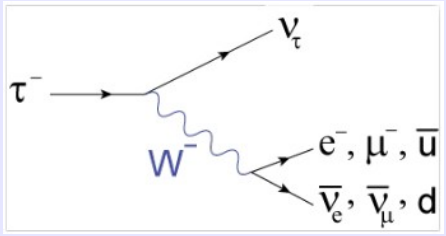
H→ττ ATLAS search

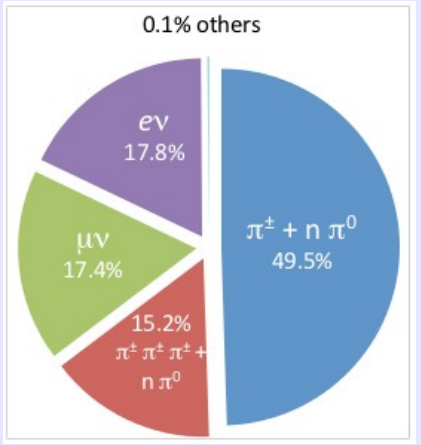


- Analysis categories:
  - 0,1 jet (dominated by gg fusion), 2 jet (VH and VBF)
- Backgrounds
  - Z→ττ (irreducible), estimated from embedded Z→μμ data
  - τ/lepton fakes, data control regions

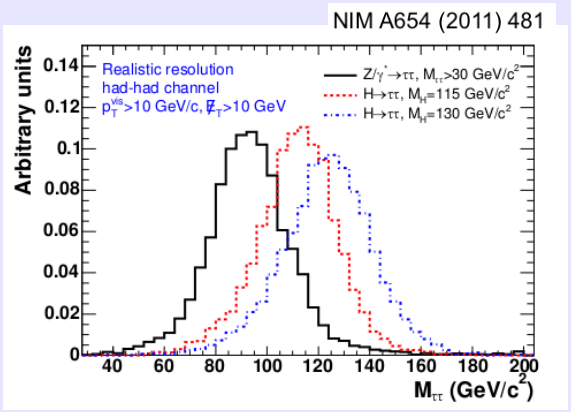
Tau reconstruction

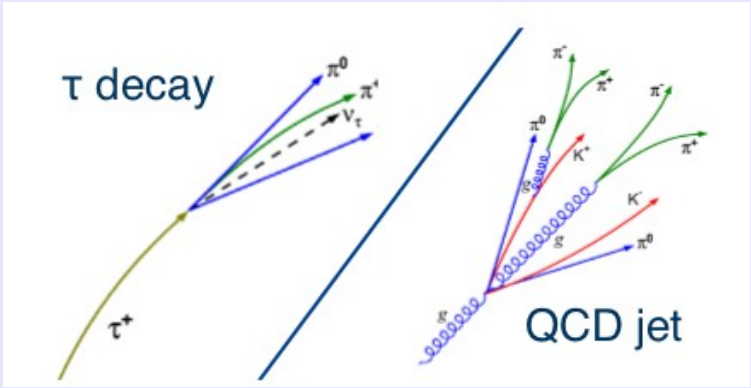
- Neutrinos in the final state
  - Difficult to reconstruct di-τ mass
  - Challenging to suppress jet background





- Constrain the neutrino momenta using tau decay kinematics to improve di-τ mass resolution



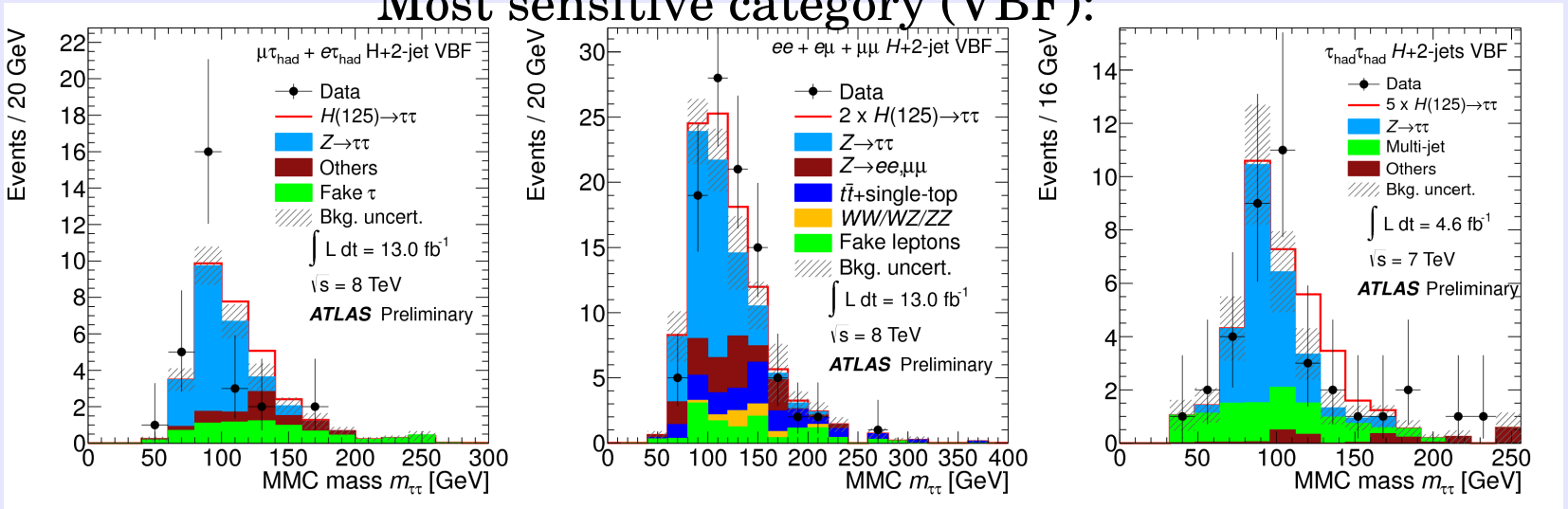


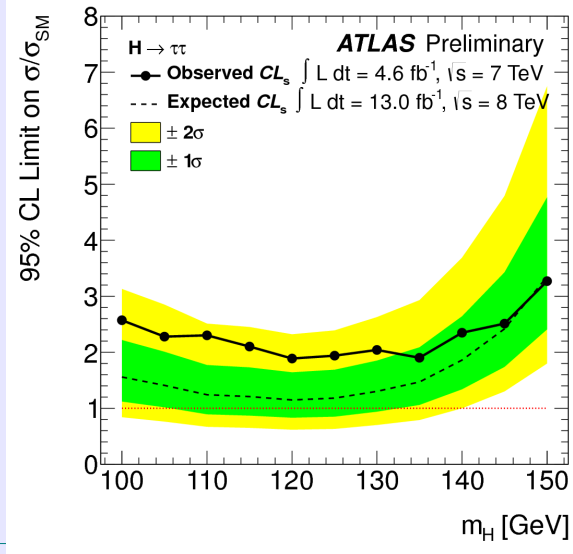
- Use a MVA to select hadronic τ's
- Efficiency: 60% (h/H/A), 30%(H^+)
- Miss-identification: 5% (h/H/A) 0.1-1% (H^+)

H→ττ results

ATLAS-CONF-2012-160

Most sensitive category (VBF):

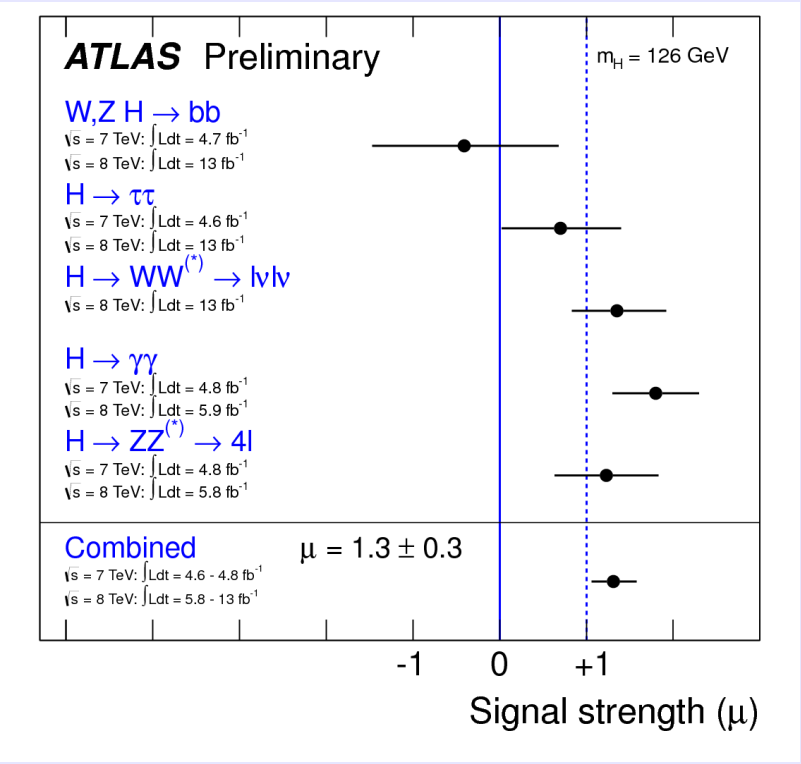




- Broad excess observed
- Observed (expected) limit at 125 GeV:
  - 1.9 (1.2) x SM value
- Results consistent with either background or SM Higgs hypothesis

Signal strength

ATLAS-CONF-2012-162



- $\mu = 1.3 \pm 0.3$ for m_H=126 GeV
- Compatibility between individual m measurements: 36%
- Compatibility with the SM hypothesis: 23%
  - Consistent with SM expectations

Couplings of the new boson

ATLAS-CONF-2012-127

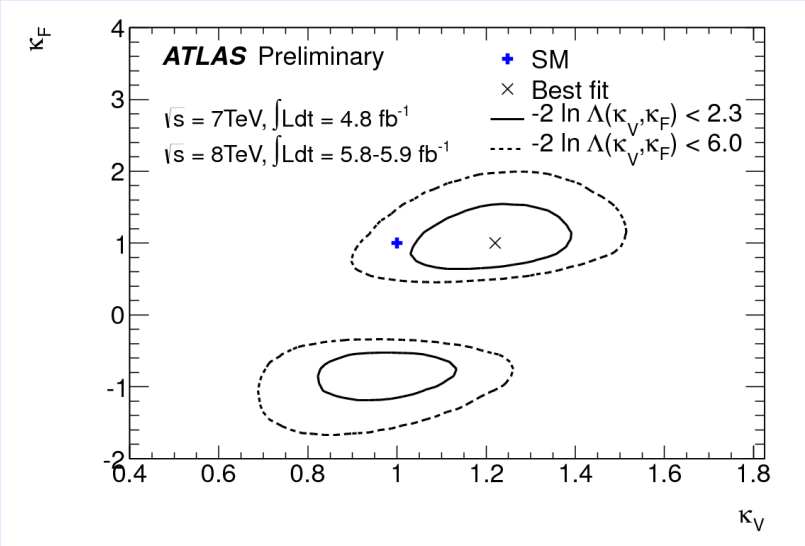
- Define scale factors k_i. Example:

$$(\sigma \cdot \mathrm{BR})(gg \to H \to \gamma\gamma) = \sigma_{SM}(gg \to H) \cdot \mathrm{BR}_{SM}(H \to \gamma\gamma) \cdot \frac{\kappa_g \cdot \kappa_\gamma}{\kappa_H}$$

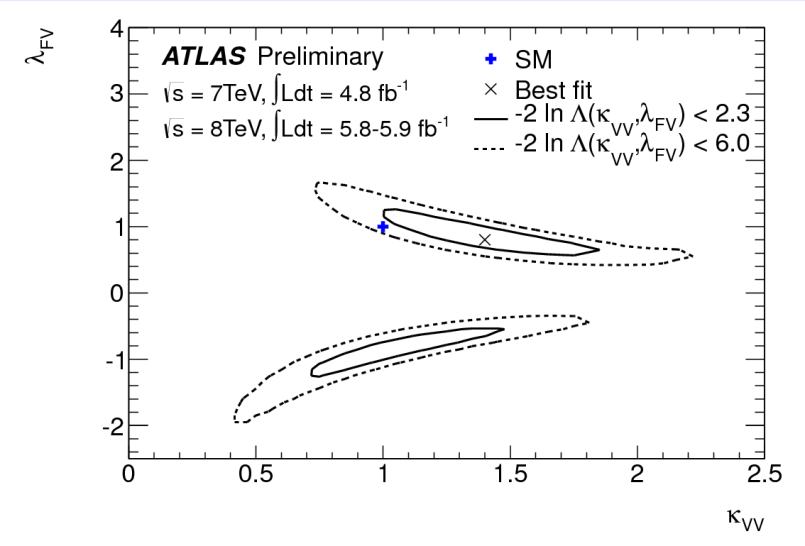
- Scale vectorial and fermionic couplings by k_V and k_F

$$\lambda_{FV} = \kappa_F / \kappa_V$$
$$\kappa_{VV} = \kappa_V \cdot \kappa_V / \kappa_H$$

Assume SM total width:

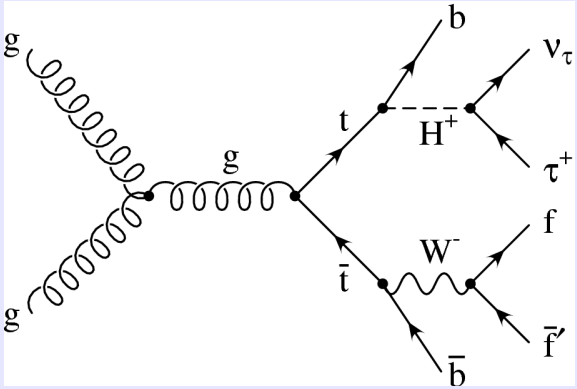


No assumption on total width



- No significant deviation from the SM observed

Charged Higgs searches $H^{\pm} \rightarrow \tau\nu$



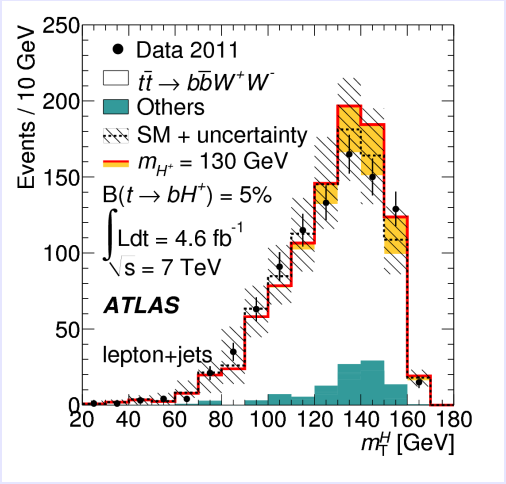
- Search focus on a light charged Higgs produced in top decays
- For $\tan\beta > 3$, $H^{\pm} \rightarrow \tau\nu$ dominates
- Channel topology organized according to W and Higgs decay

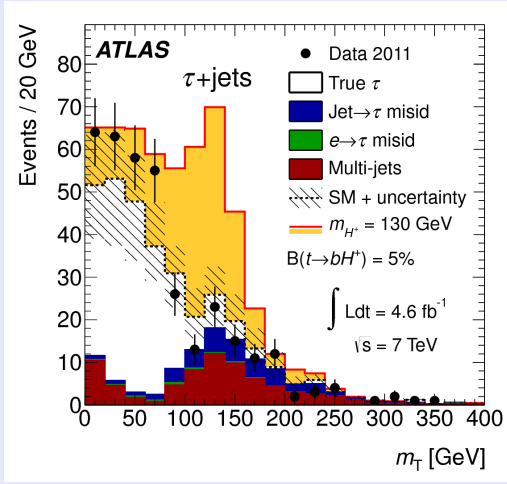
$$t\bar{t} \rightarrow b\bar{b}H^{\pm}W^{\mp} \rightarrow b\bar{b}(\tau_{lep}\nu)(q\bar{q})$$
$$t\bar{t} \rightarrow b\bar{b}H^{\pm}W^{\mp} \rightarrow b\bar{b}(\tau_{had}\nu)(\ell\nu)$$
$$t\bar{t} \rightarrow b\bar{b}H^{\pm}W^{\mp} \rightarrow b\bar{b}(\tau_{had}\nu)(q\bar{q})$$

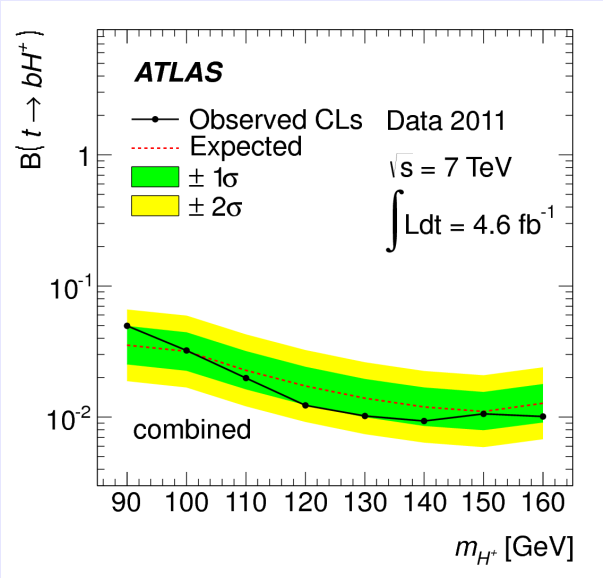
- Selection:

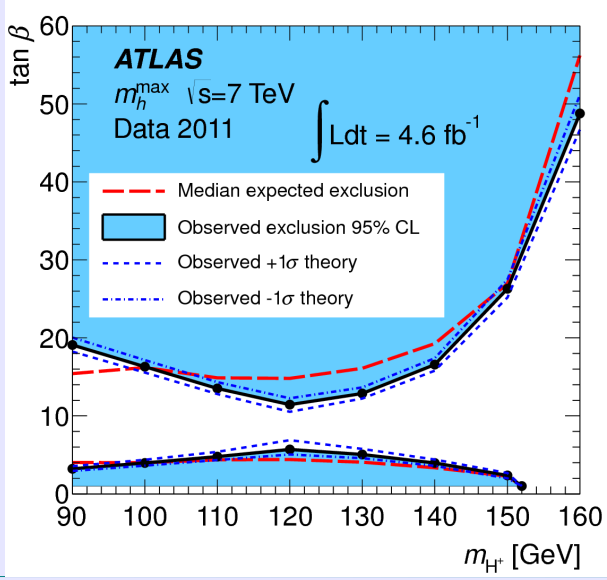
Tau(lep) + W(→ jets)	Tau(had) + W(→ jets)	Tau(had) + W(→ lν)
1 isolated e/μ, p_T > 25/20 GeV	1 τ_{had} with p_T > 40 GeV	1 isolated e/μ, p_T > 25/20 GeV
		1 τ_{had} with p_T > 20 GeV
At least 4 jets (pT>20 GeV) with exactly 2 b-tagged	At least 4 jets (pT>20 GeV) with at least 1 b-tagged	At least 2 jets (pT>20 GeV), with at least 1 b-tagged
MET & Topological cuts	MET & Topological cuts	vertex Σp_T > 100 GeV

Charged Higgs searches $H^{\pm} \to \tau\nu$ results





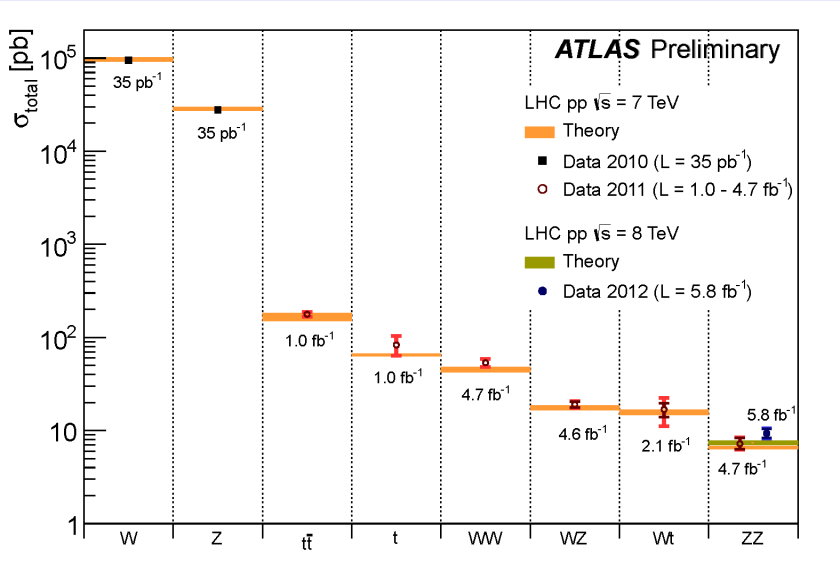




- No signal observed
- Calculated limits on BR($t \to bH^{\pm}$)
- Low mass $H^{\pm}$ allowed phase space in the MSSM scenario is heavily constrained

Summary and conclusions

- Wide range of physics studies performed by ATLAS
  - SM physics: jets, W/Z boson production, top quark production and properties, triple gauge couplings, …
  - Searches for Physics Beyond the SM

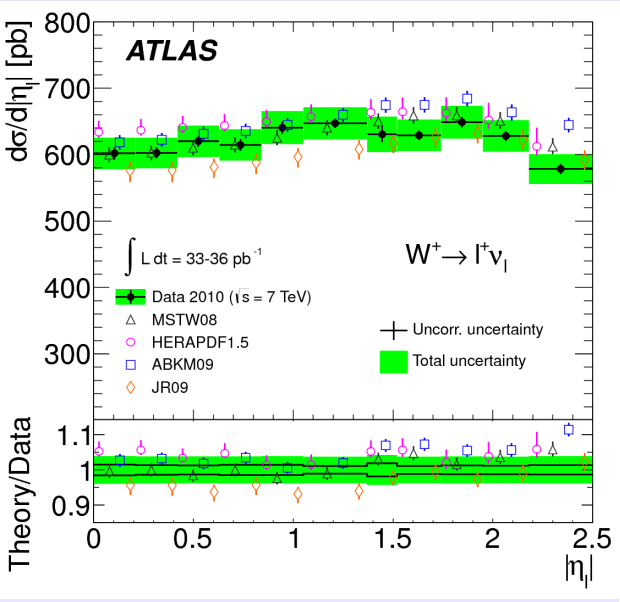


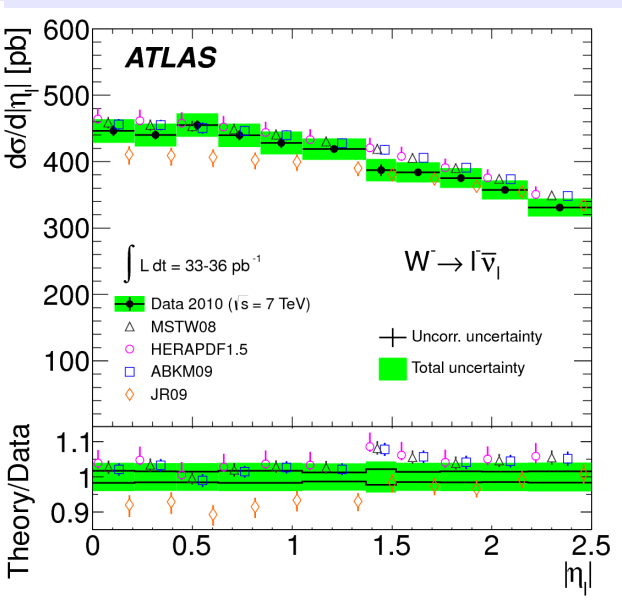
- Higgs searches
  - The new boson discovered on July is under study
  - 3 channels updated with 13 fb^{-1} of 2012 data ($H \to WW$, $H \to bb$, $H \to \tau\tau$)
  - Up to now results compatible with the SM Higgs boson hypothesis, but uncertainties are quite large

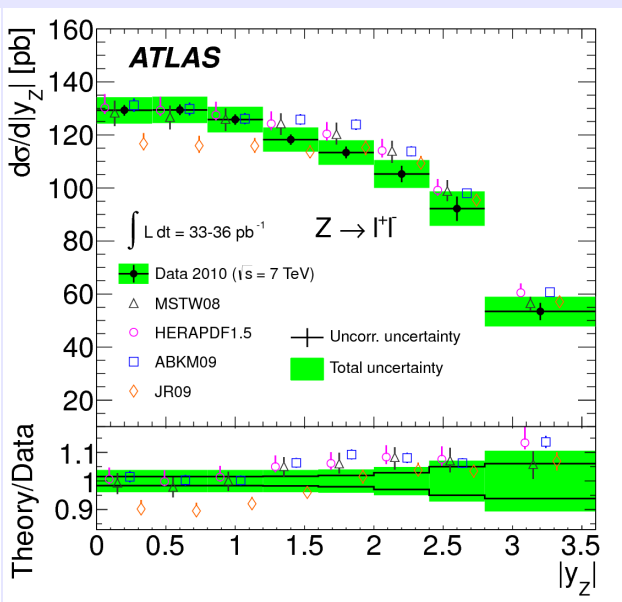
Backup

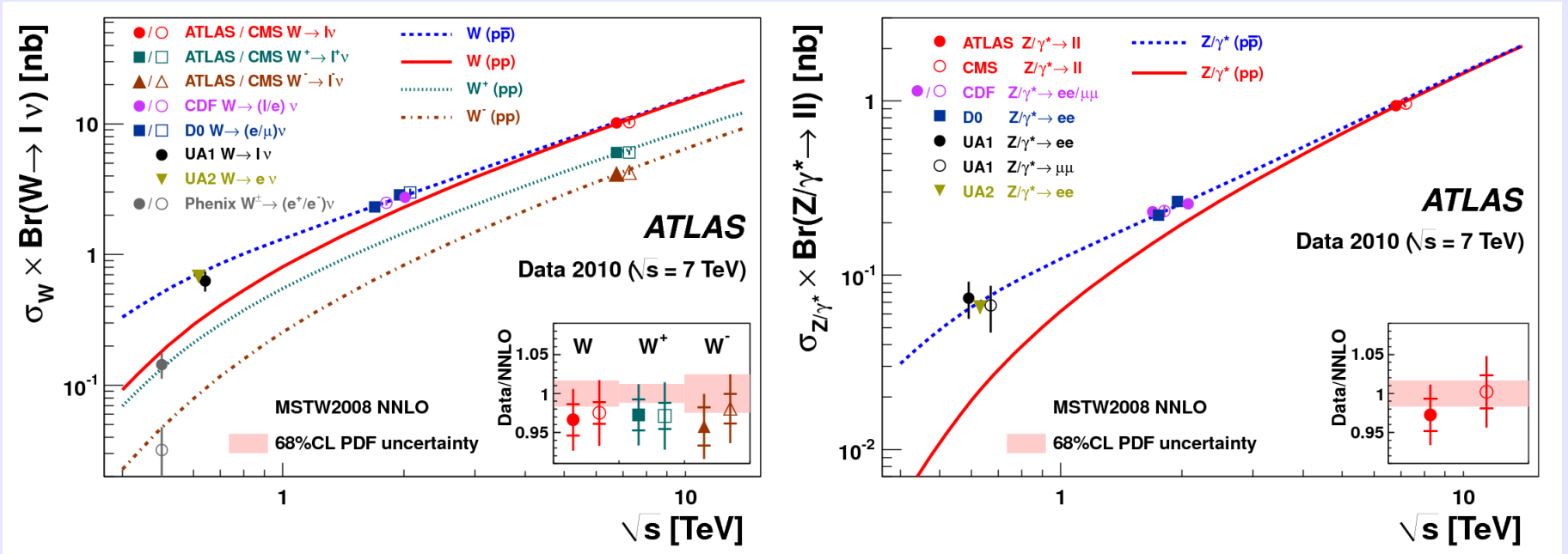
W/Z differencial cross sections

- Differential cross sections calculated in the fiducial volume
  - 2-3% accuracy
- Overall agreement with the considered PDFs
- These measurements can be used to constraint the PDFs



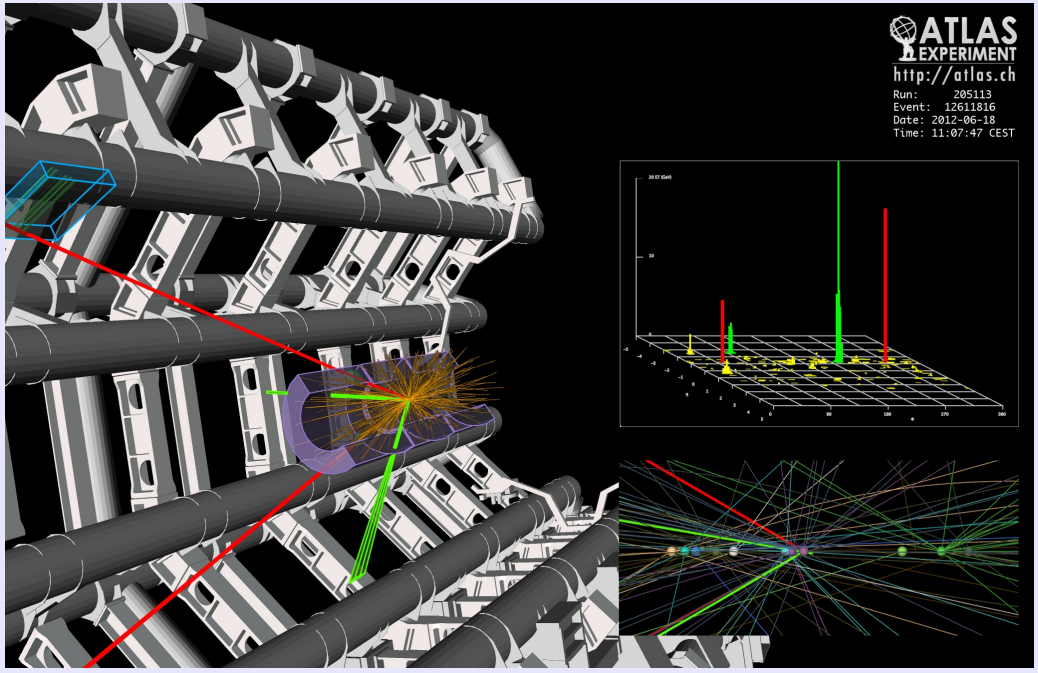





ATLAS / CMS W → lν
ATLAS / CMS W+ → l+ν
ATLAS / CMS W- → l-ν
CDF W → (l/e) ν
D0 W → (e/μ)ν
UA1 W → l ν
UA2 W → e ν
Phenix W± → (e+/e-)ν
W (pp̄)
W (pp)
W+ (pp)
W- (pp)
ATLAS
Data 2010 (√s = 7 TeV)
MSTW2008 NNLO
68%CL PDF uncertainty
Data/NNLO
W
W+
W-
σW × Br(W→ l ν) [nb]
√s [TeV]
ATLAS Z/γ*→ ll
CMS Z/γ*→ ll
CDF Z/γ*→ ee/μμ
D0 Z/γ*→ ee
UA1 Z/γ*→ ee
UA1 Z/γ*→ μμ
UA2 Z/γ*→ ee
Z/γ* (pp̄)
Z/γ* (pp)
σZ/γ* × Br(Z/γ*→ ll) [nb]

H→ZZ→4l analysis

arXiv:1207.7214



$H \to ZZ^* \to \mu\mu$ ee candidate event

Selection:

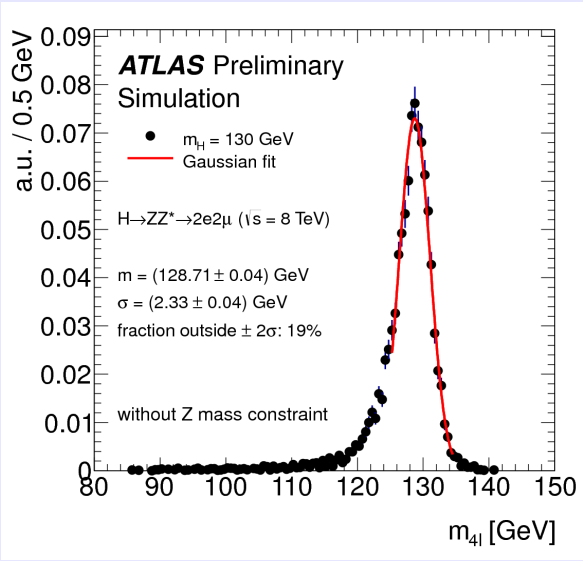
- 4 isolated leptons
- Z mass constraint on one l pair

Main backgrounds:

- Continuum $ZZ^* \to 4l$ production
- Z+jets, tt

Discriminating variable: m_{4l}

- Excellent mass resolution of 1.8-2.5 GeV (4μ, 4e)



H→ZZ→4l analysis (II)

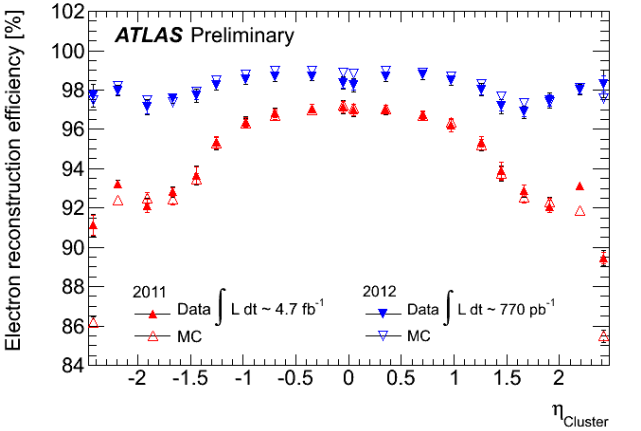
Excellent mass resolution

- 1.8-2.5 GeV (4μ, 4e)

Very good e/μ reconstruction efficiency

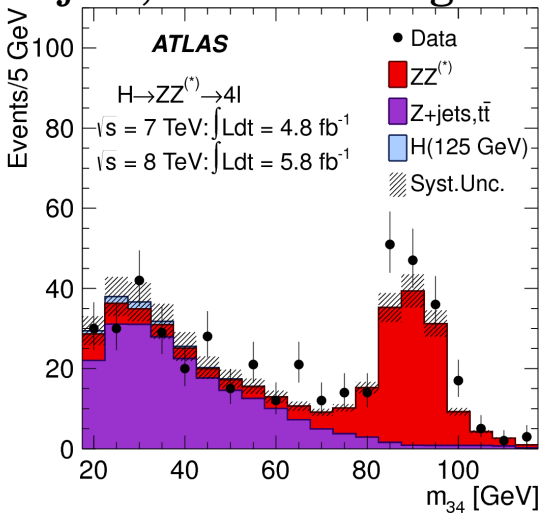
- ~97% for muons with p_T>6 GeV
- ~98% /95% for e reconstruction/ID

Z+jets and tt backgrounds estimated using control regions

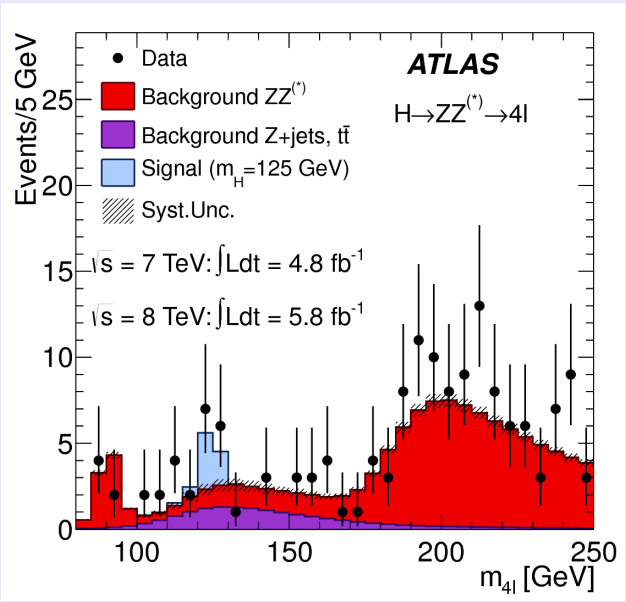


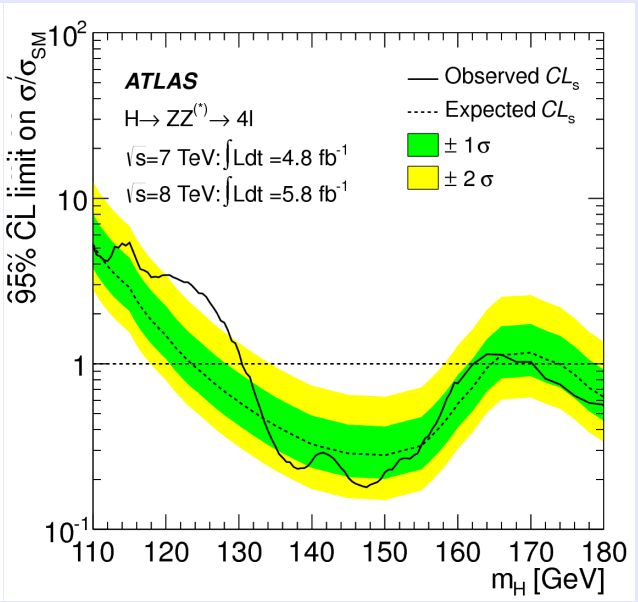
- No isolation & transverse impact parameter requirements on the sub-leading lepton pair

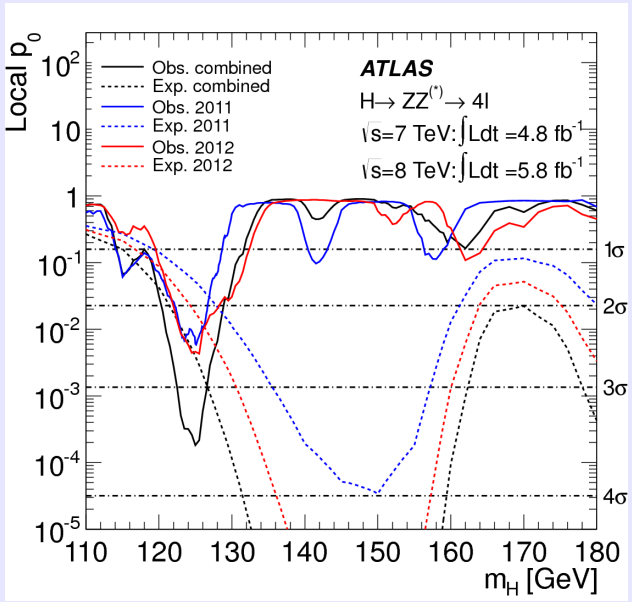
Z+jets, tt control region:



H→ZZ→4l results







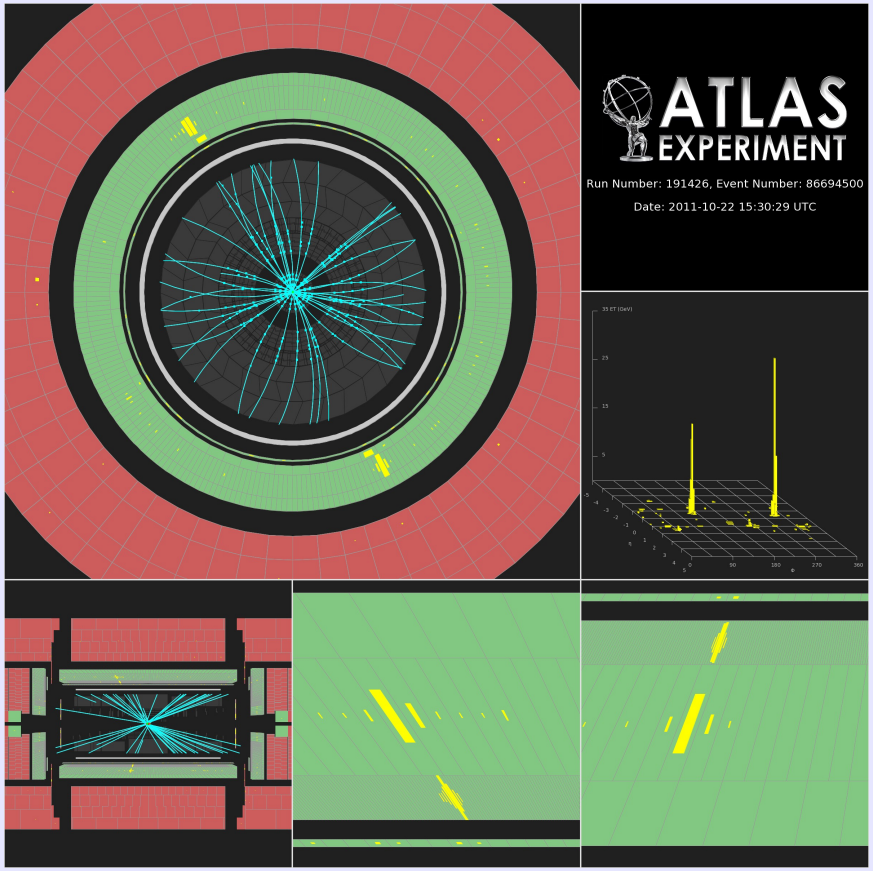
- Expected exclusion:
  - 124-164 GeV, 176-500 GeV
- Observed exclusion:
  - 131-162 GeV, 170-460 GeV

Excess of events observed near 125 GeV

- Maximum significance: 3.4σ at 125 GeV
- Probability of background fluctuation
  - 3×10^{-4}

H→γγ analysis

arXiv:1207.7214



H→γγ candidate event

- Two isolated photons
- Search for a narrow peak on a large continuum

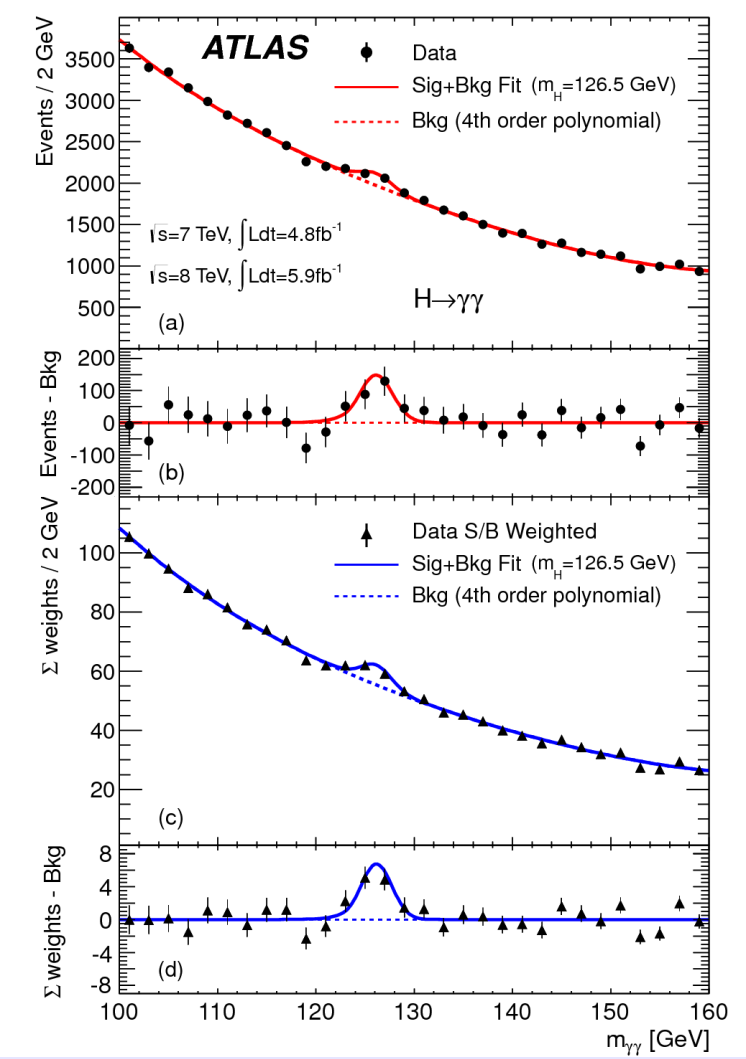
Main background:

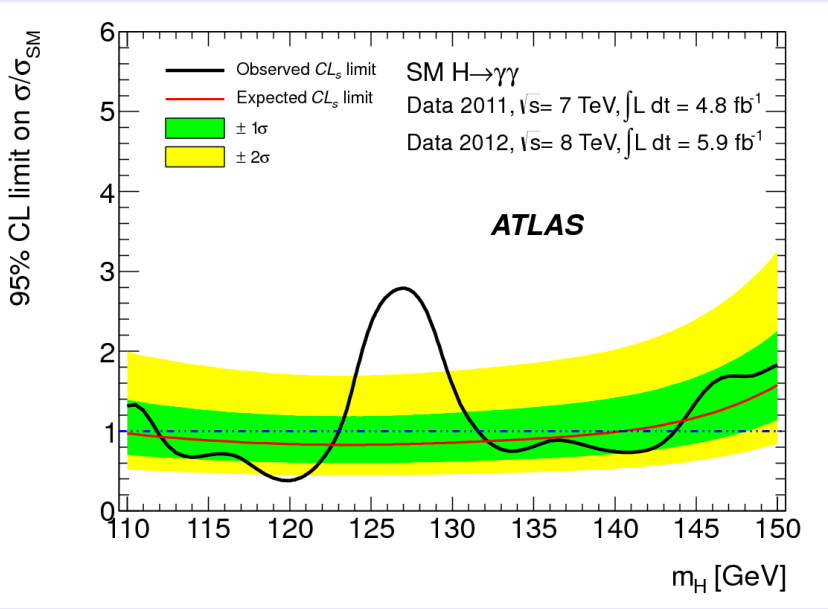
- Continuum γγ production
- γ+jet, jet+jet

10 different analysis categories

- Converted/unconverted photons
- Photon location in the detector
- Di-photon transverse momentum
- New two jet category sensitive to vector boson fusion production

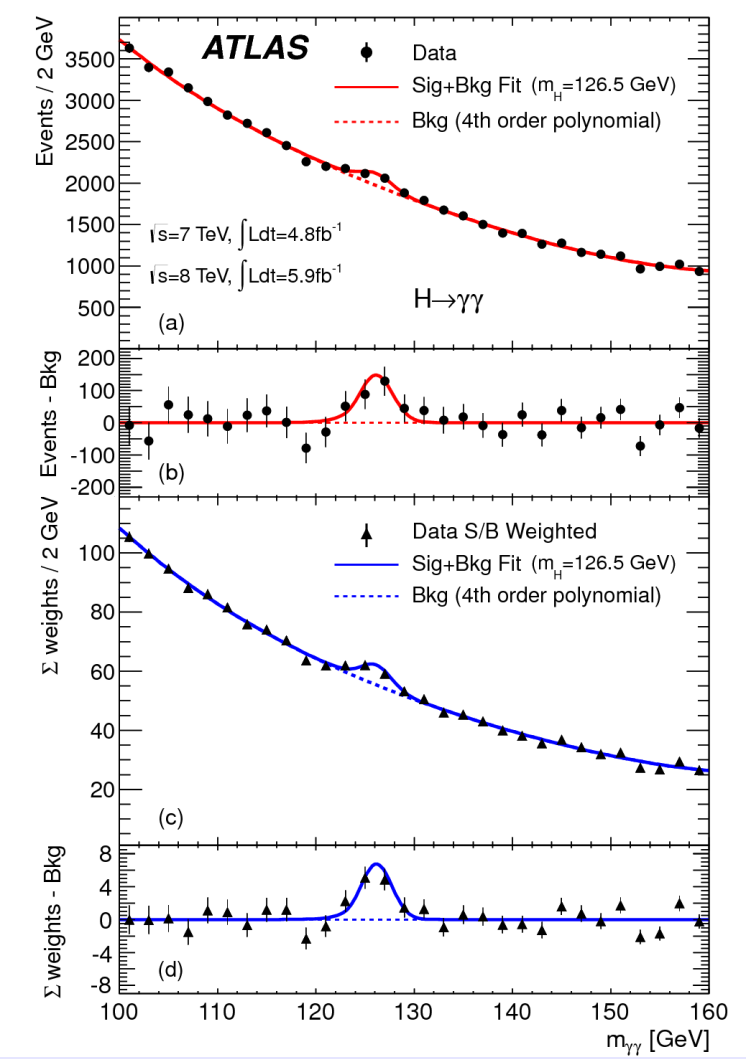
H→γγ results

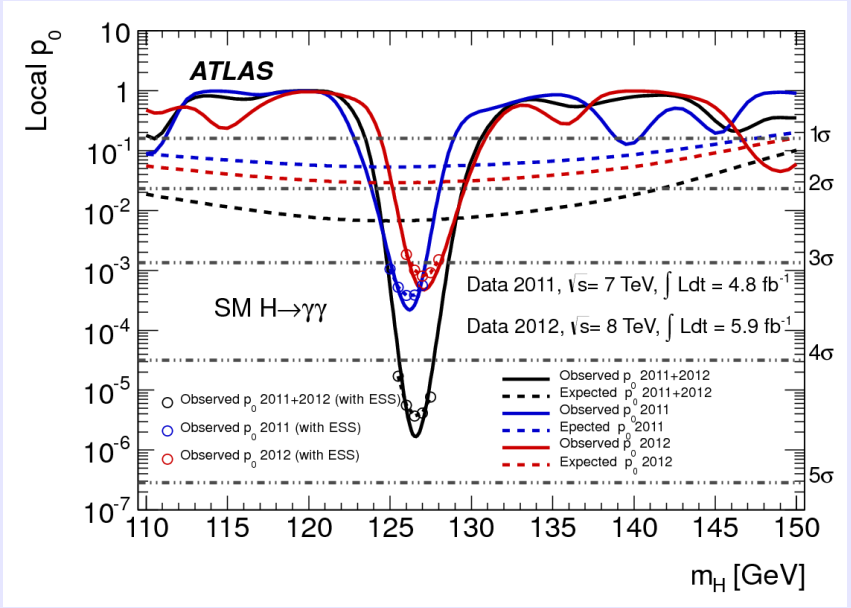




- Exclusion at 95% CL:
  - Expected: 110-139.5 GeV
  - Observed: 112−122.5 GeV,132−143 GeV
- Excess of events at 126.5 GeV
  - Local significance of 4.5σ (expected 2.4σ)
  - Consistent results in 2011 and 2012 data

H→γγ results

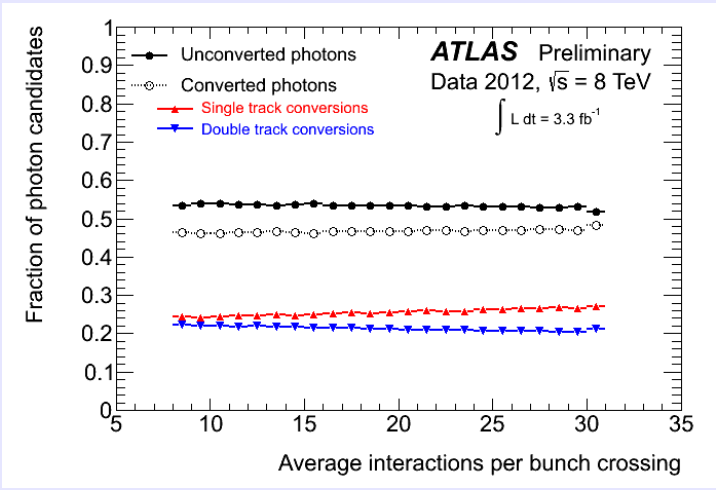


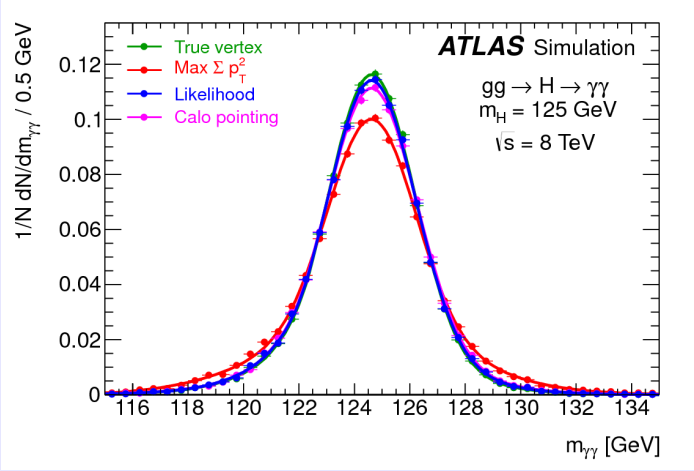


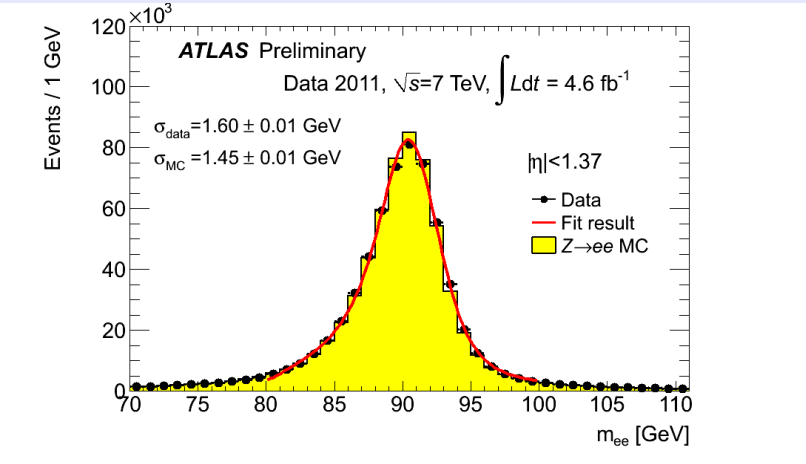
- Exclusion at 95% CL:
  - Expected: 110-139.5 GeV
  - Observed: 112−122.5 GeV,132−143 GeV
- Excess of events at 126.5 GeV
  - Local significance of 4.5σ (expected 2.4σ)
  - Consistent results in 2011 and 2012 data

γ identification & energy measurement

- Stable photon ID peformance with pile-up
- Calorimeter E response studied with Z, J/ψ and W decays
  - Energy scale at m_Z known to ~ 0.5%
  - Linearity better than 1%
- Excellent mass resolution (1.6-3.1 GeV)
  - Use calorimeter segmentation to associate photon to primary vertex (σ_z ~ 15 mm)



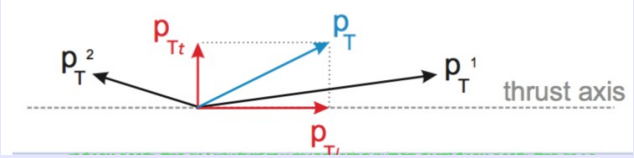


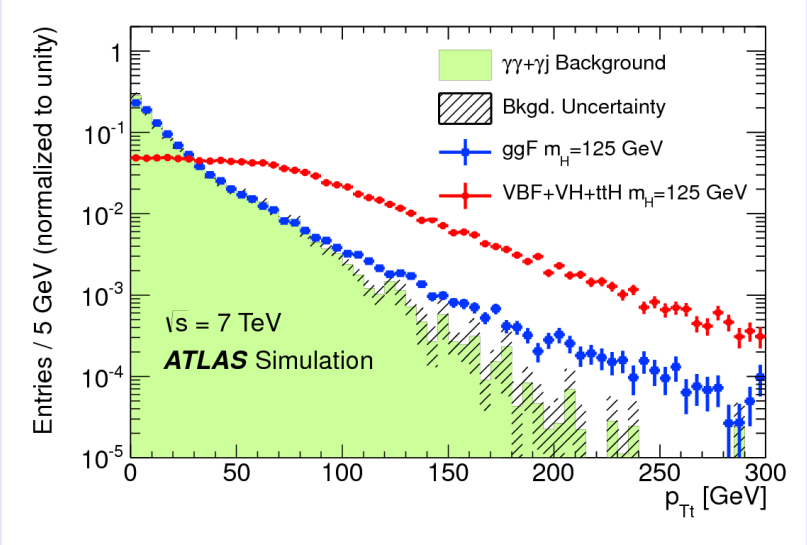


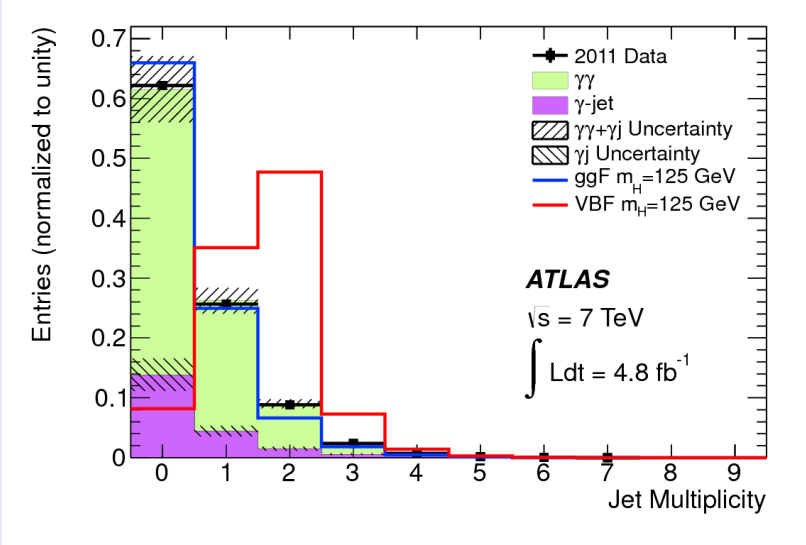
H→γγ analysis categories

10 analysis categories based

- Converted/unconverted photons
- Photon location in the detector
- Di-photon transverse momentum with respect to thrust
- New two jet category: $\Delta\eta_{jj}>2.8$, $m_{jj}>400$ GeV, di-jet and di-γ back to back
  - Sensitive to vector boson fusion production







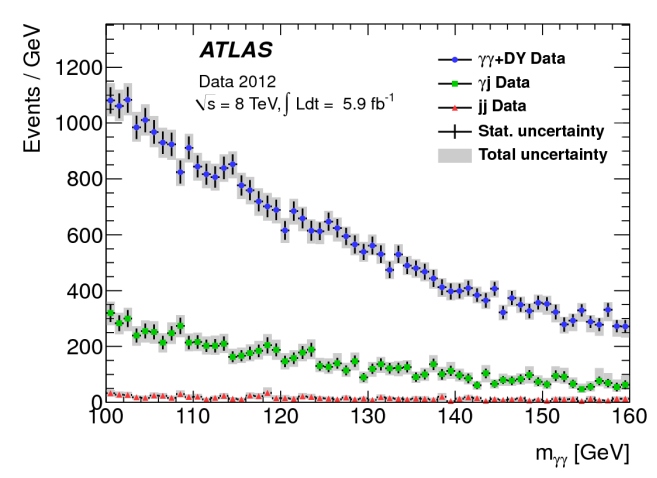
H→γγ background modelling

Background composition:

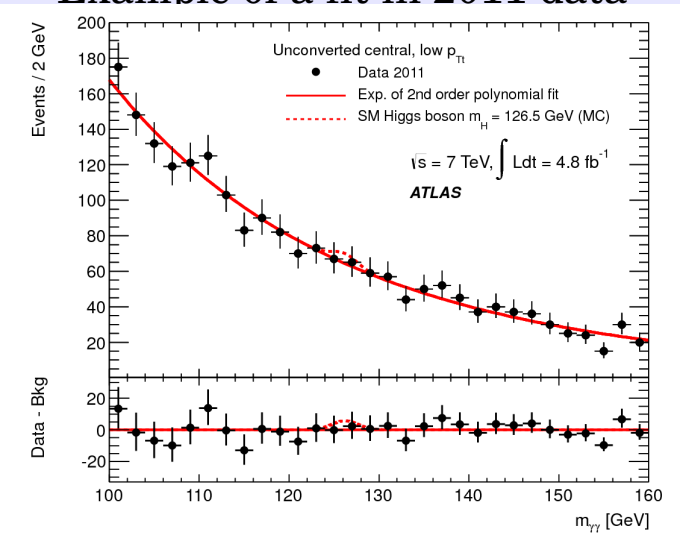
- Dominated by continuum γγ production, followed by γ+jet, jet+jet

Background estimated by fitting the di-photon mass distribution

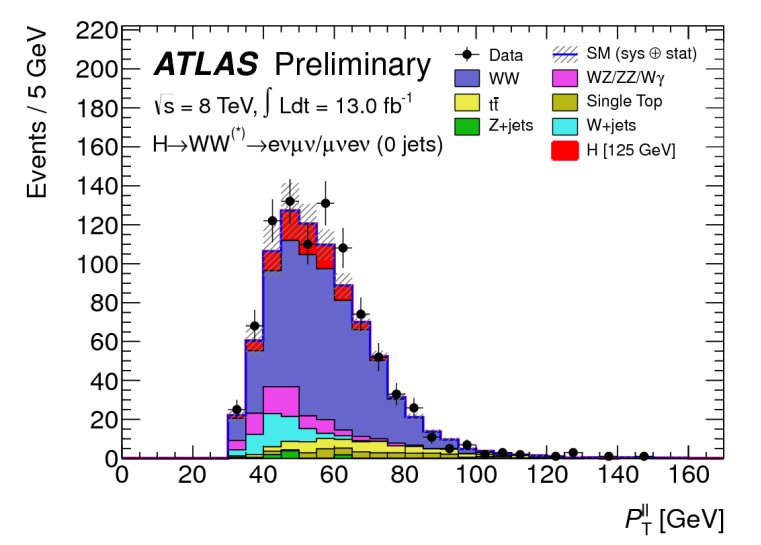
- Studied for each category with high-statistics MC before looking at data
- Considered: n-order Bernstein polynomial, exp(P2), exponential
- Choice based on largest expected sensitivity for 125 GeV signal
- Largest residual bias seen in MC experiments over 110-150 GeV taken as signal yield systematic

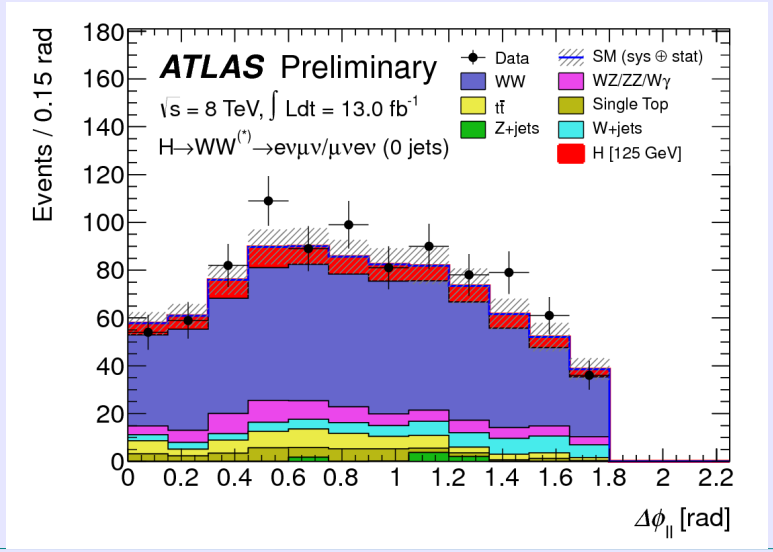


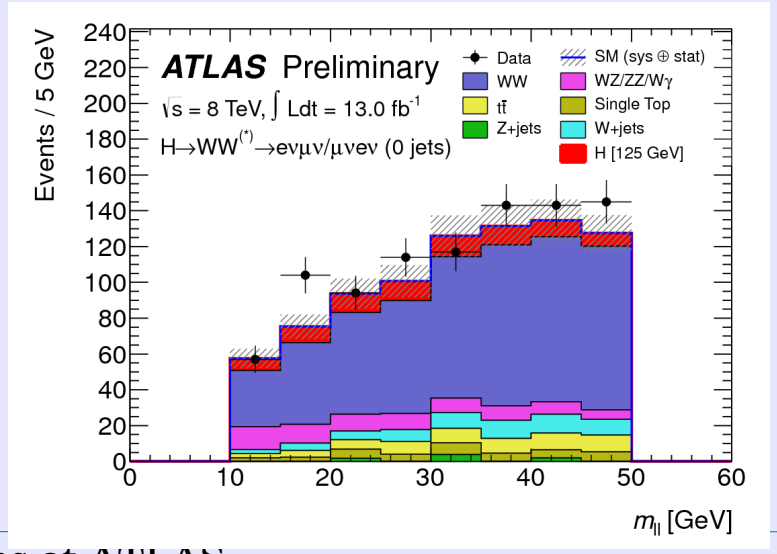
Example of a fit in 2011 data



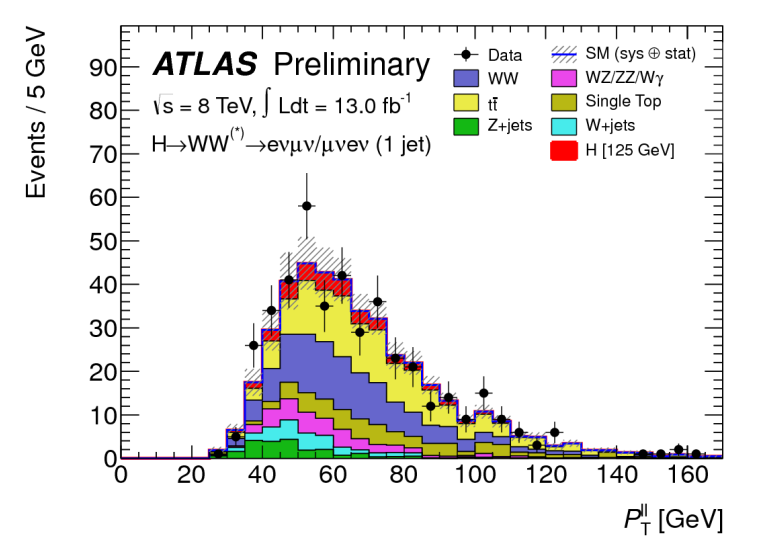
Signal region distributions

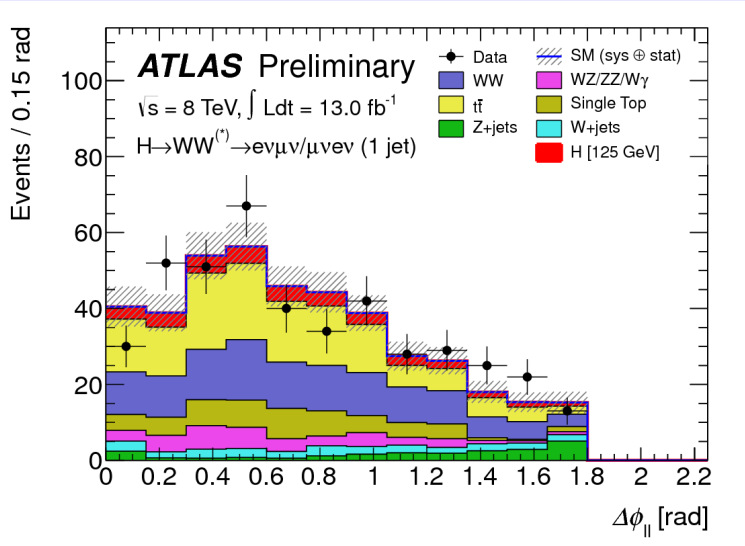


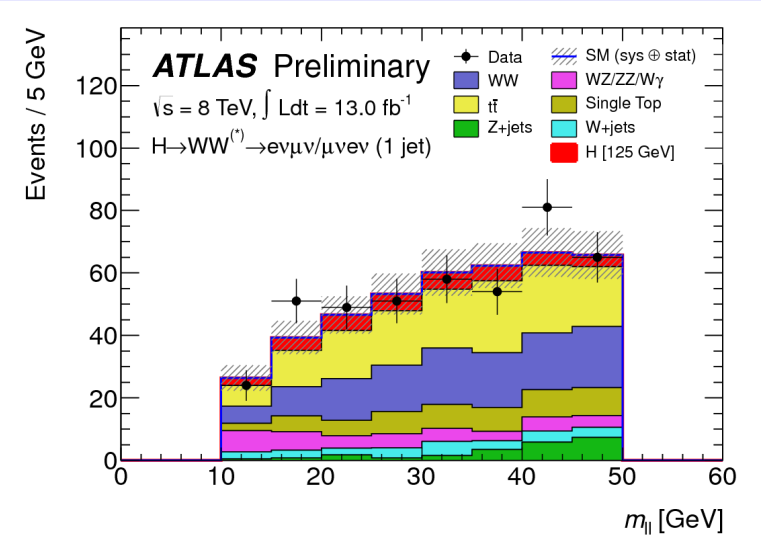


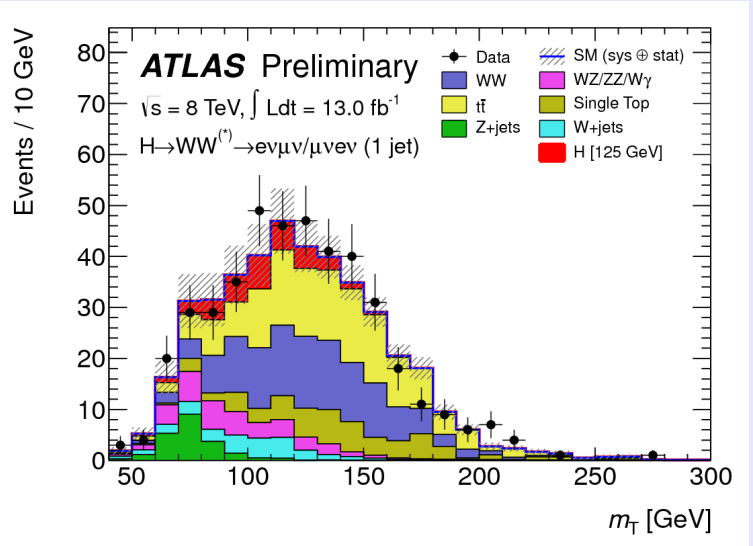


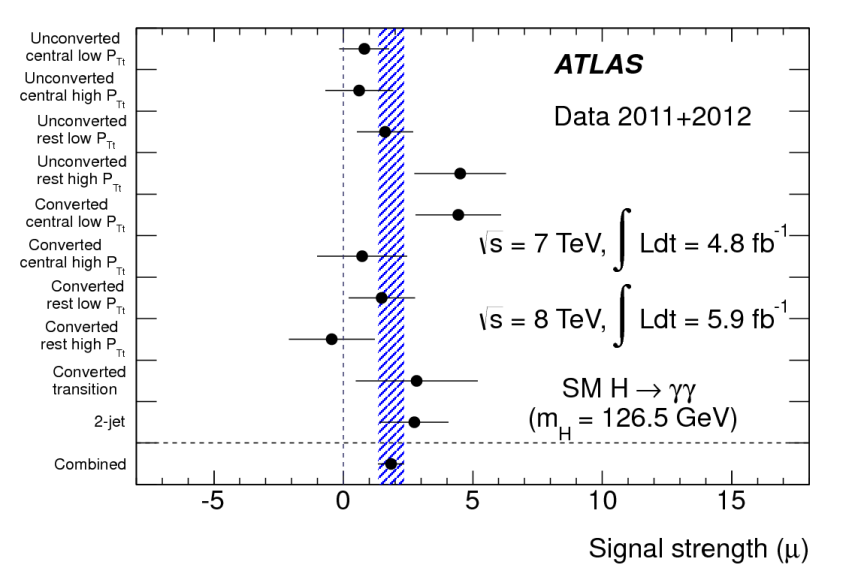
Signal region distributions (1-jet channel)









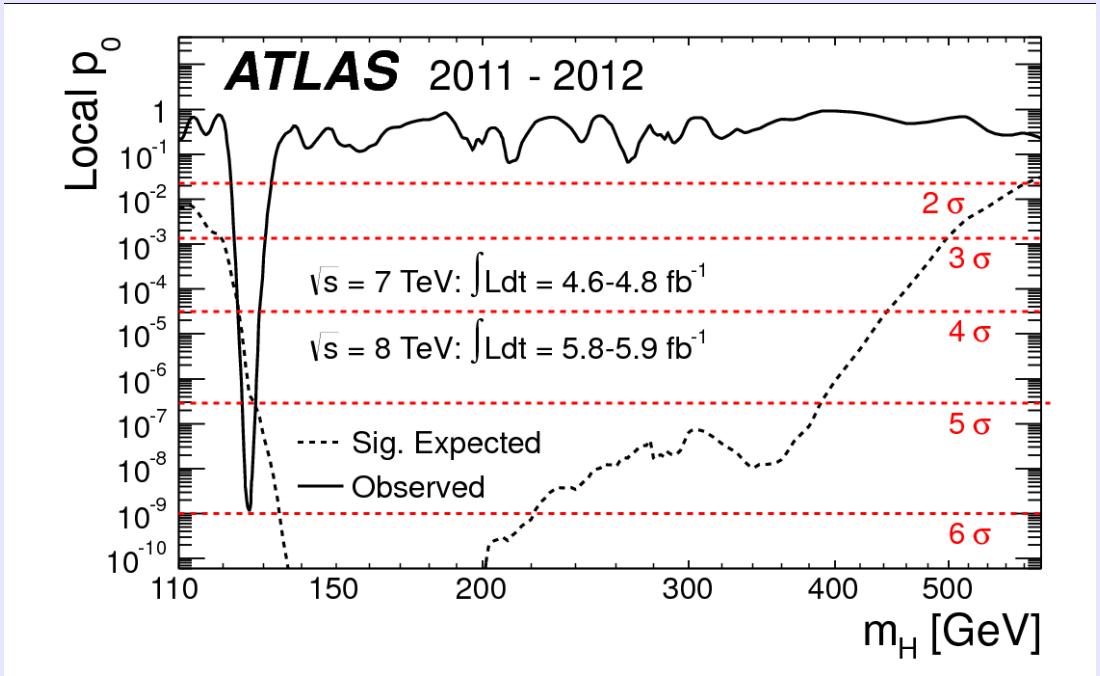

Unconverted central low P_{Tt}
Unconverted central high P_{Tt}
Unconverted rest low P_{Tt}
Unconverted rest high P_{Tt}
Converted central low P_{Tt}
Converted central high P_{Tt}
Converted rest low P_{Tt}
Converted rest high P_{Tt}
Converted transition
2-jet
Combined
ATLAS
Data 2011+2012
$\sqrt{s}$ = 7 TeV, $\int$ Ldt = 4.8 fb^{-1}
$\sqrt{s}$ = 8 TeV, $\int$ Ldt = 5.9 fb^{-1}
SM H → γγ
(m_H = 126.5 GeV)
-5
0
5
10
15
Signal strength (μ)

Combination of 2011+2012 results

Higgs decay channel	Sub-channel	Mass range (GeV)	L(fb^{-1})
$H \to ZZ$	$ll\ l'l'$	110-600	4.8+5.8
	$ll\nu\nu$	200-600	4.7
	$llqq$	200-600	4.7
$H \to \gamma\gamma$		110-150	4.8+5.9
$H \to WW$	$l\nu qq$	300-600	4.7
	$l\nu l\nu$	110-600	4.7+5.8
$H \to \tau\tau$	$ll4\nu$	110-150	4.7
	$l\tau_{had}3\nu$		4.7
	$\tau_{had}\tau_{had}2\nu$		4.7
$VH \to bb$	$l\nu bb$	110-130	4.7
	$llbb$		4.7
	$\nu\nu bb$		4.6

References: https://twiki.cern.ch/twiki/bin/view/AtlasPublic/HiggsPublicResults

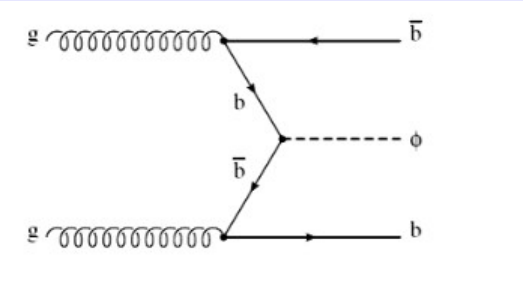
Combination of 2011+2012 results



- SM excluded at 95% CL from 111-122, 131-559 GeV
- Excess of events observed at ~126 GeV
  - Local/global significance of 5.9σ/5.1σ
  - $P_0 = 1.7 \times 10^{-9}$
- Best fit mass: 126.0 ± 0.4 (stat) ± 0.4 (sys) GeV (only ZZ and γγ channels used)

Higgs searches beyond the SM

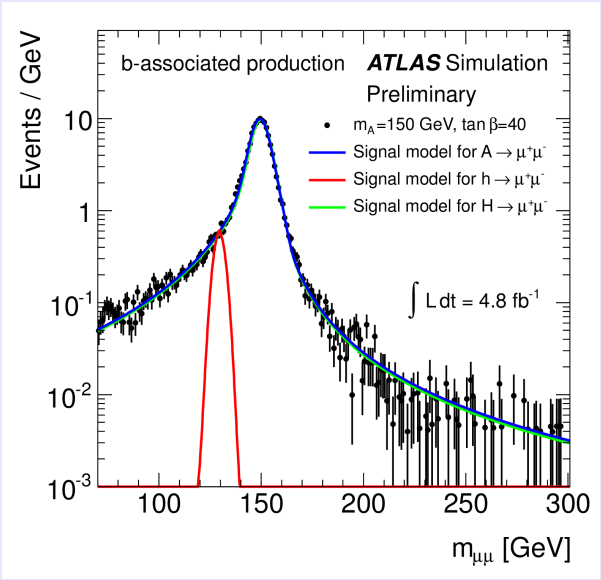
MSSM neutral Higgs boson searches



- 3 neutral Higgs bosons: h, H, A
- Production via gluon fusion and b-quark annihilation
- Cross section rises with tanβ
- Decay to bb (10%), ττ (10%) and μμ (0.04%)

Search performed in

- ττ channel:
  - Similar to SM search but with b-tagged/vetoed selection
  - τ final states: $ll4\nu$, $l\tau_{had}3\nu$, $\tau_{had}\tau_{had}2\nu$
- μμ
  - clean, good mass resolution
  - Two analysis (b-tagging/vetoed selections)
  - 2011 complete data sample



MSSM neutral Higgs boson searches

No excess of events observed

- Combined exclusion at 95% CL in m_A-tanβ
- There is still room for MSSM Higgses in large region
- Calculated also more model independent production cross section limit vs m_ϕ