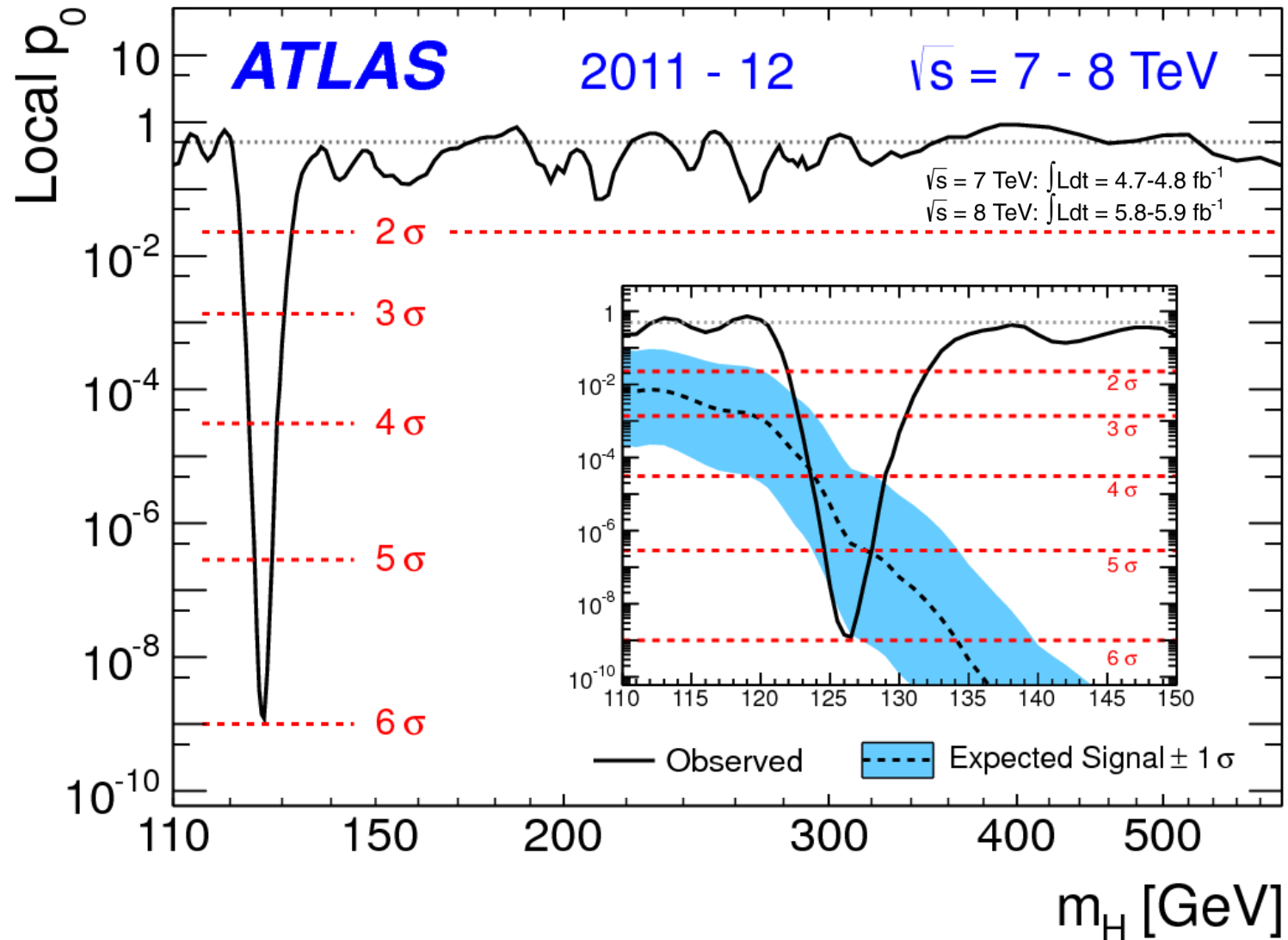


Status of the ATLAS Experiment

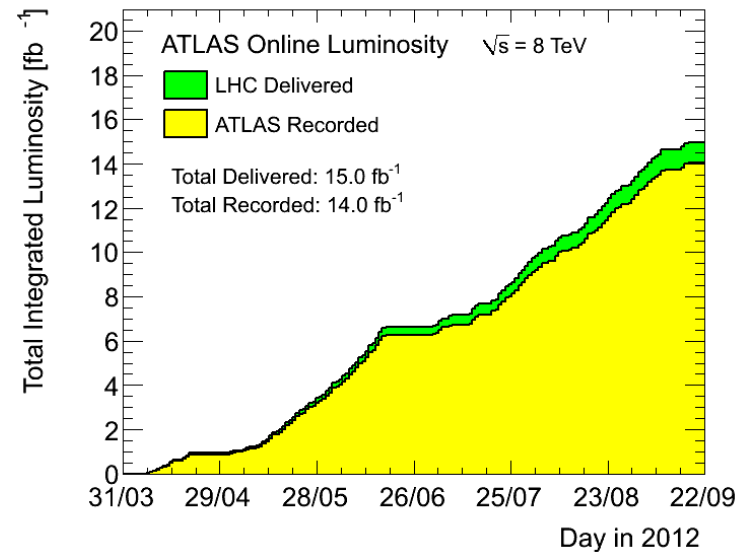


Outline

- A lot of new, exciting results since the last LHCC in June
- Status of data-taking and reconstruction
- Focus on the latest Physics results:
 - Heavy Ions
 - B-physics
 - Standard Model
 - Top
 - Exotics
 - SUSY
 - Higgs
- For more: **<http://atlasresults.web.cern.ch/atlasresults/>**

Data-Taking in 2012

- 15 fb⁻¹ delivered luminosity
- 14 fb⁻¹ recorded by ATLAS
- Data-quality efficiency ~ 94%
→ Stable over entire period April-Sep
- Total efficiency (delivered → physics) ~ 88%



ATLAS p-p run: April-June 2012

Inner Tracker			Calorimeters		Muon Spectrometer				Magnets	
Pixel	SCT	TRT	LAr	Tile	MDT	RPC	CSC	TGC	Solenoid	Toroid
100	99.6	100	96.2	99.1	100	99.6	100	100	99.4	100

All good for physics: 93.6%

Luminosity weighted relative detector uptime and good quality data delivery during 2012 stable beams in pp collisions at $\sqrt{s}=8$ TeV between April 4th and June 18th (in %) – corresponding to 6.3 fb⁻¹ of recorded data. The inefficiencies in the LAr calorimeter will partially be recovered in the future.

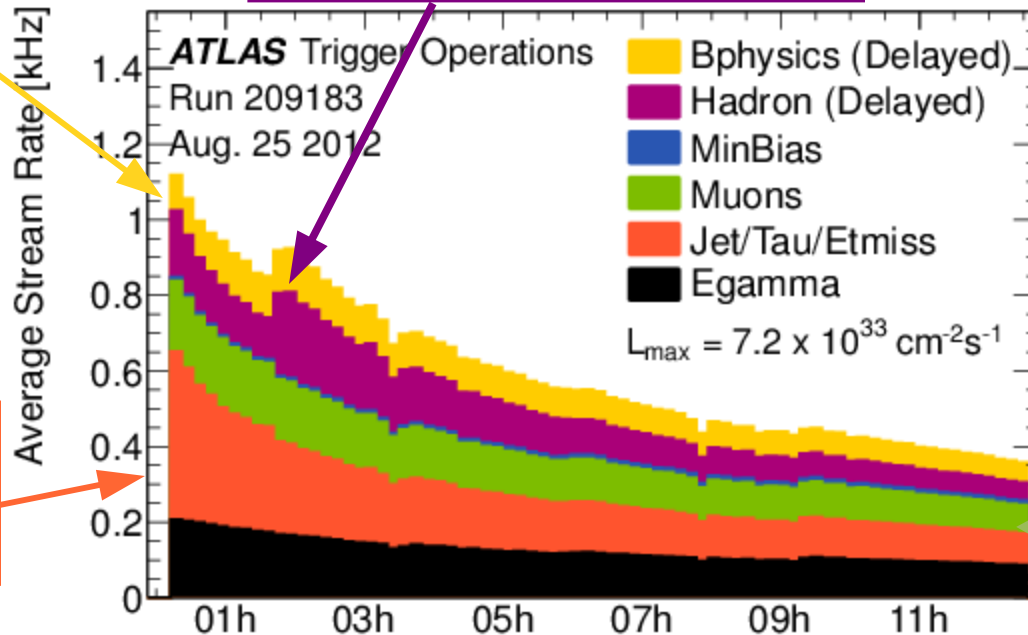
Trigger in 2012

Low-threshold dimuon triggers disabled at highest L due to Level 1 constraint of $\sim 75\text{kHz}$

Lower (60 GeV) threshold ETMISS trigger below $\sim 6 \times 10^{33}/\text{cm}^2/\text{s}$

Trigger optimized to make full use of current resources

Jet/ETMiss baseline triggers expected to hold till end of the year



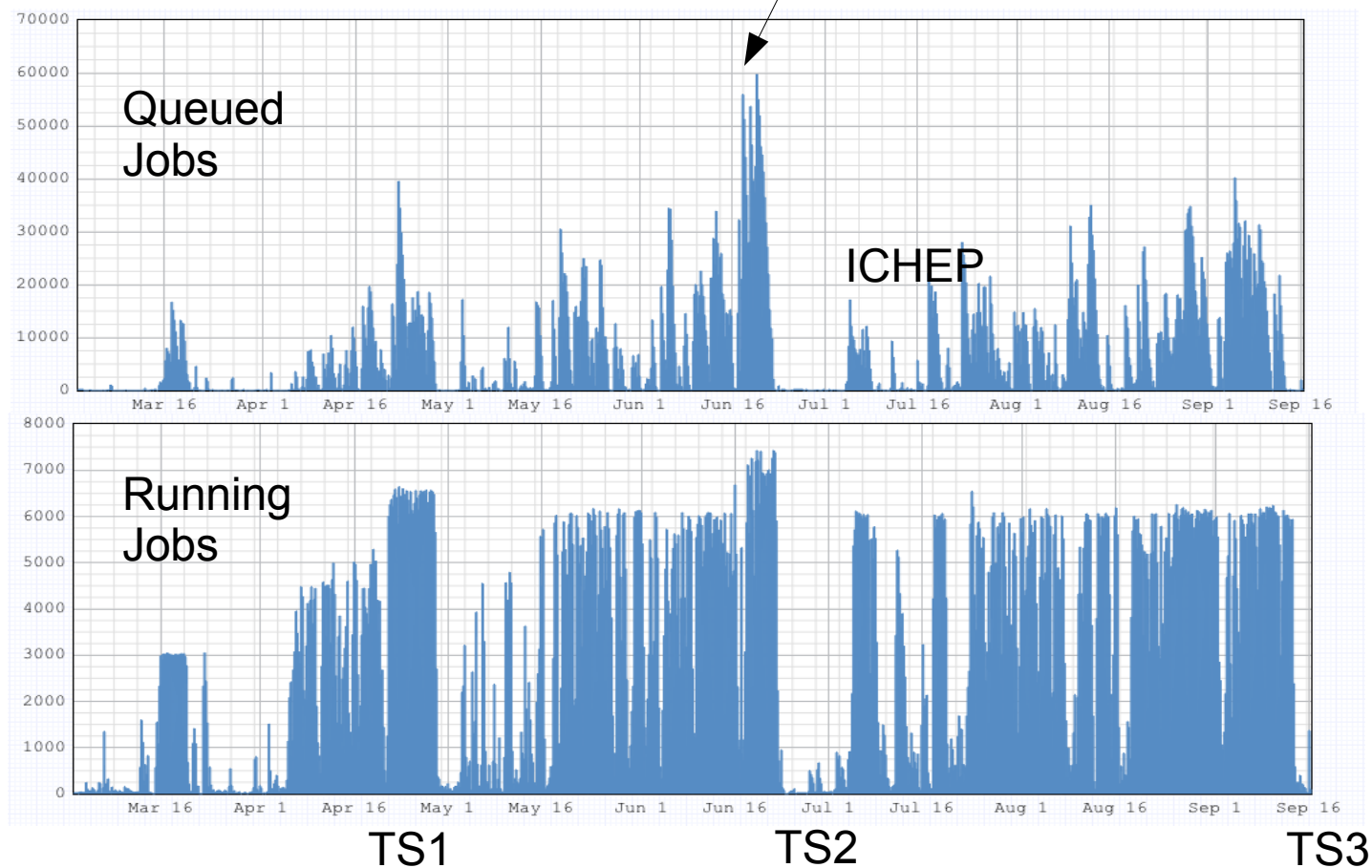
Single lepton threshold correspond to offline cuts $p_T > 25 \text{ GeV}$ (unchanged during 2012)

(Main) streams sizes up to 3rd technical stop:

Stream	Egamma	Muons	JetTauEtmis	Total prompt	Hadron delayed	Bphysics delayed	Total Delayed
Events (10^9)	0.47	0.48	0.54	1.62	0.22	0.23	0.47
Average Rate [Hz]	110	110	120	370	50	50	110

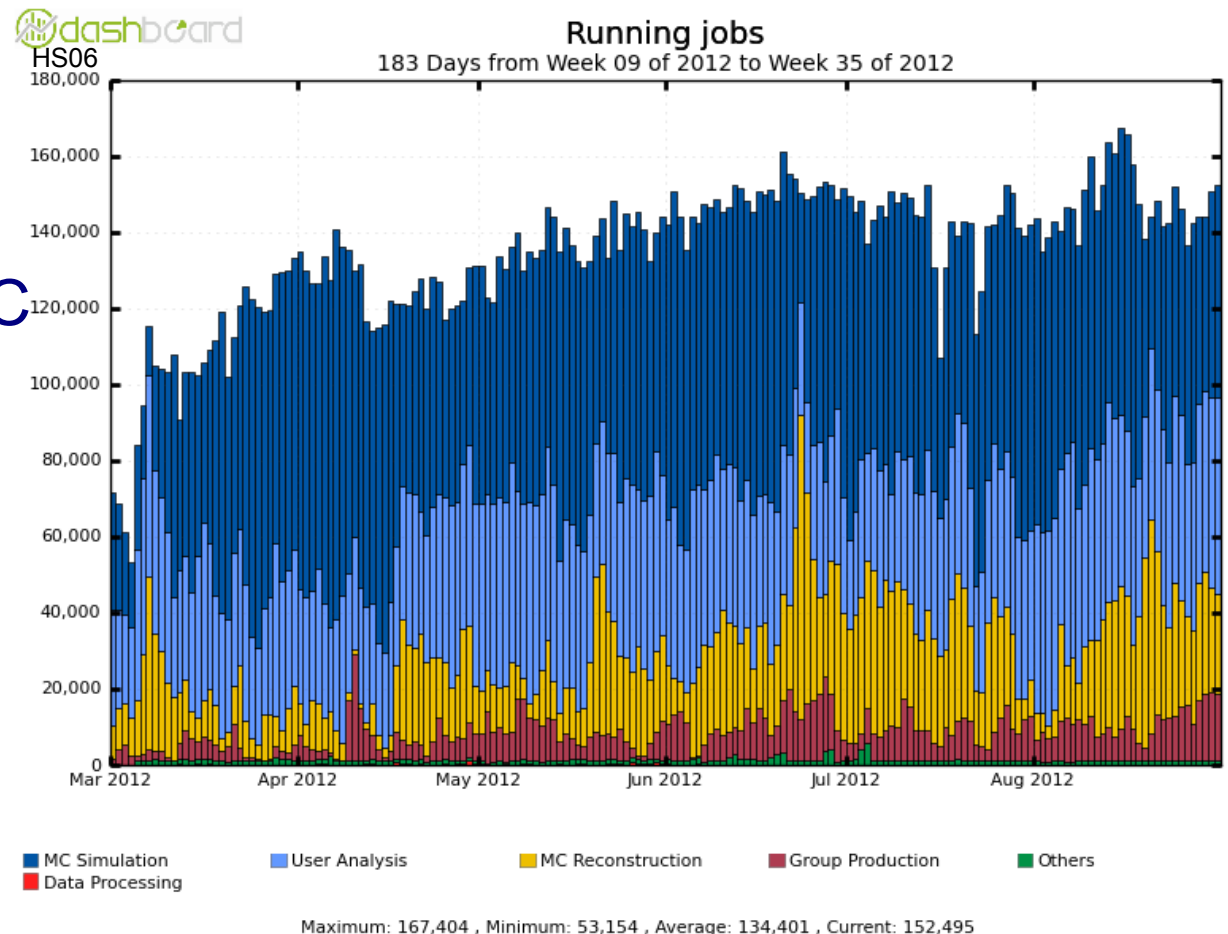
Tier0 Reconstruction

- Tier0 reconstruction coping well with luminosity / pile-up
- Tier0 capacity 6k slots. Increased to 7.5k for reprocessing of initial data during TS1 and during the ICHEP 'rush'.



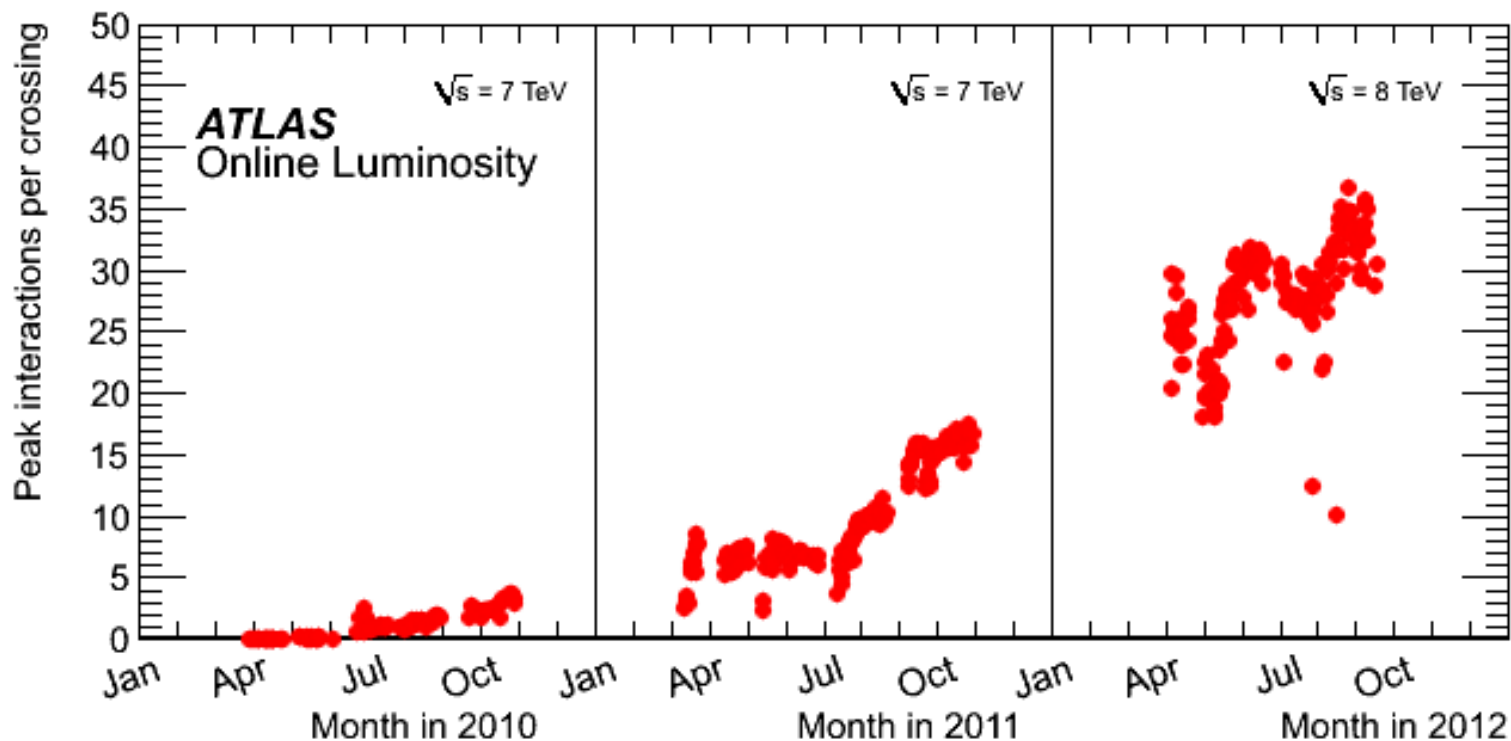
Grid Computing

- Efficiently using all the resources provided by the Grid sites
- 1500 distinct ATLAS users
- Massive 8 TeV MC production



Pile-up

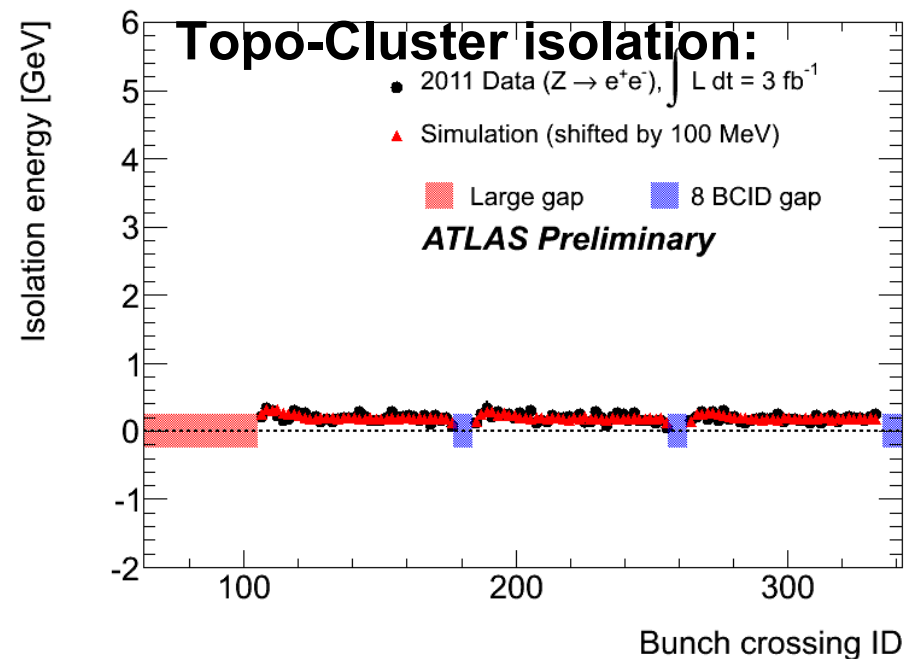
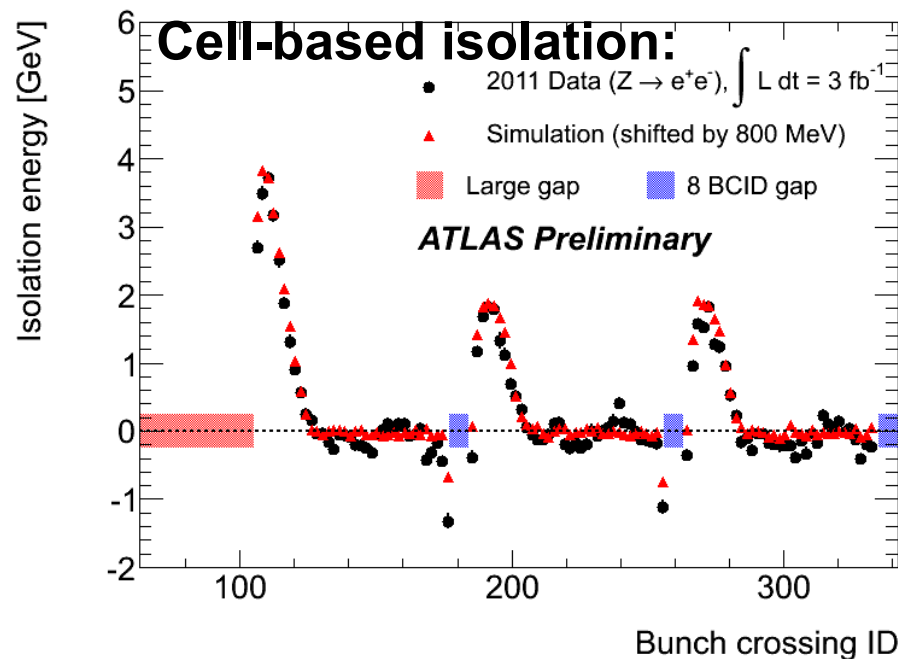
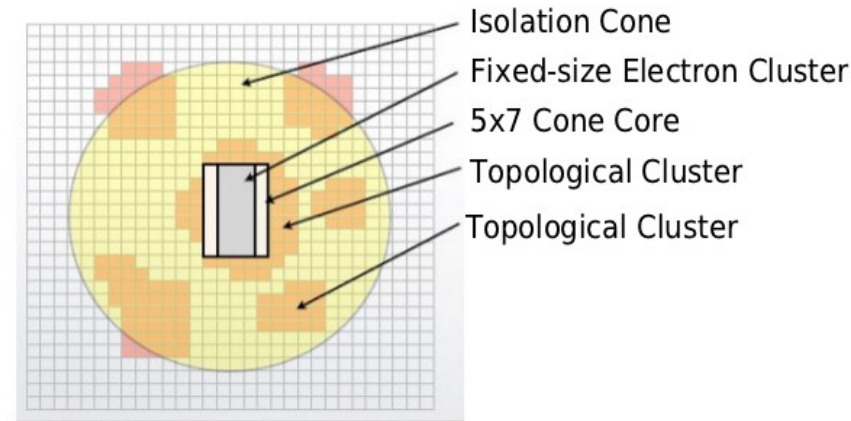
- Marginally more pile-up over the summer
- Efforts continue to understand and reduce the effect of pile-up



Pile-up and electron/photon ID

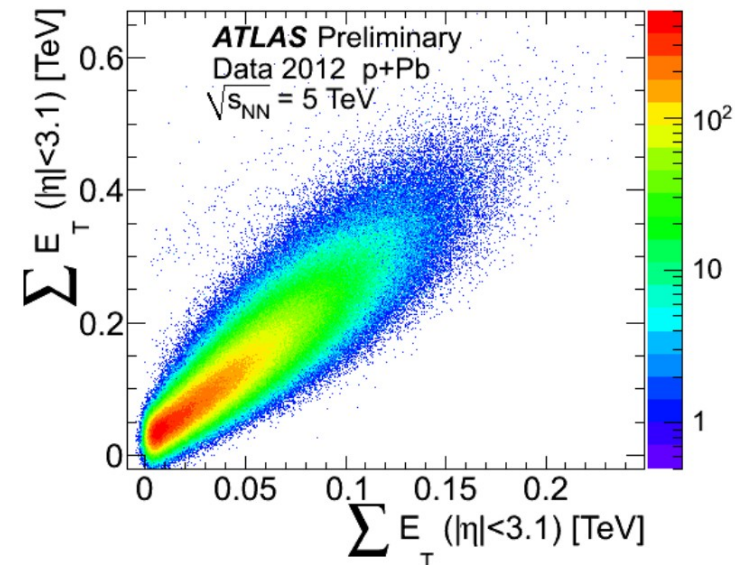
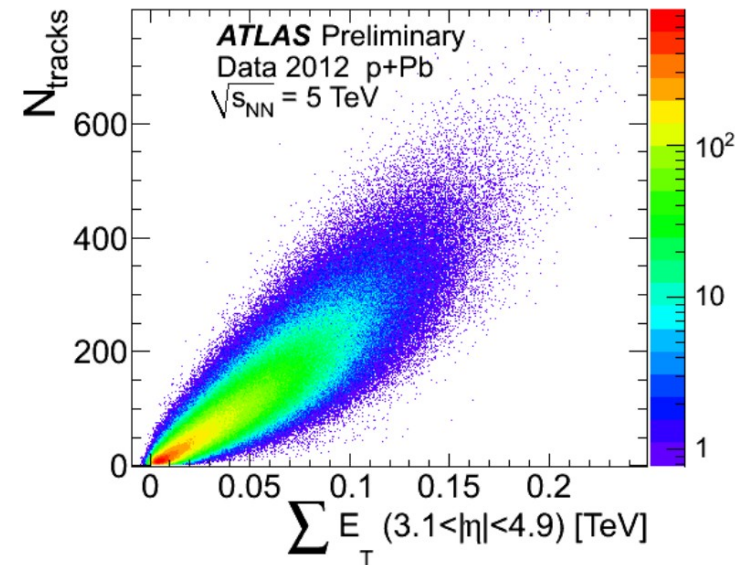
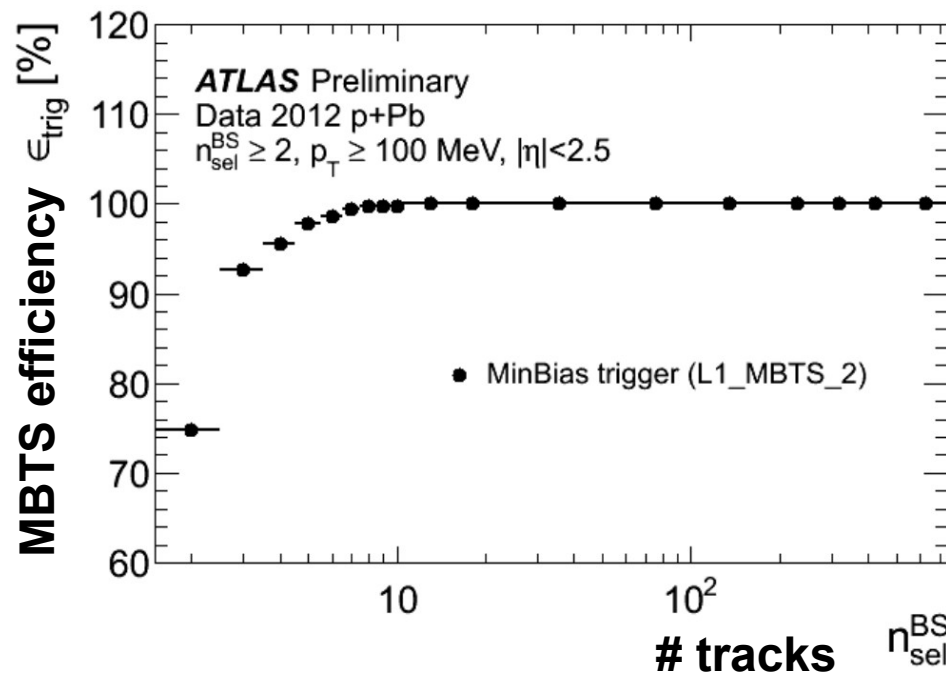
Calorimeter Isolation

- Now using 3D topological clusters when measuring isolation
- Sensitivity to out-of-time pile-up significantly reduced!



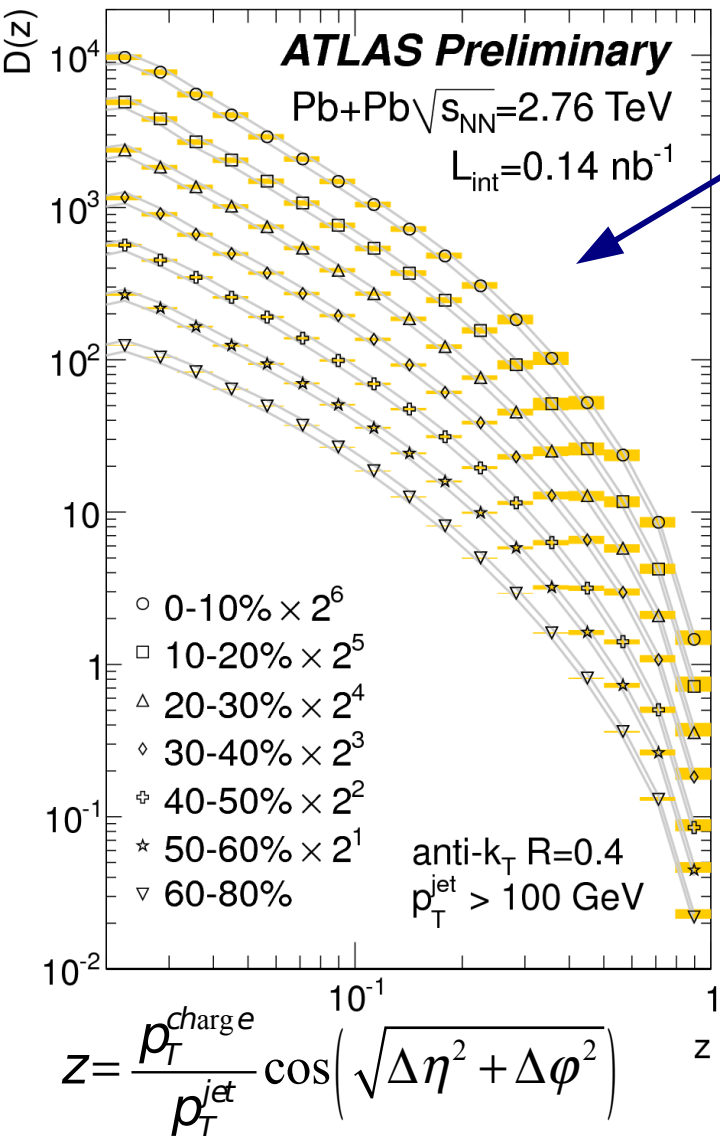
Heavy Ions: p-Pb at $\sqrt{s_{NN}} = 5$ TeV

- First look at p-Pb data taken on September 12
- About 3M events recorded with Minimum Bias trigger
- MBTS still functioning despite radiation damage



Heavy Ions: Pb-Pb at $\sqrt{s_{NN}} = 2.76$ TeV

Jet Fragmentation

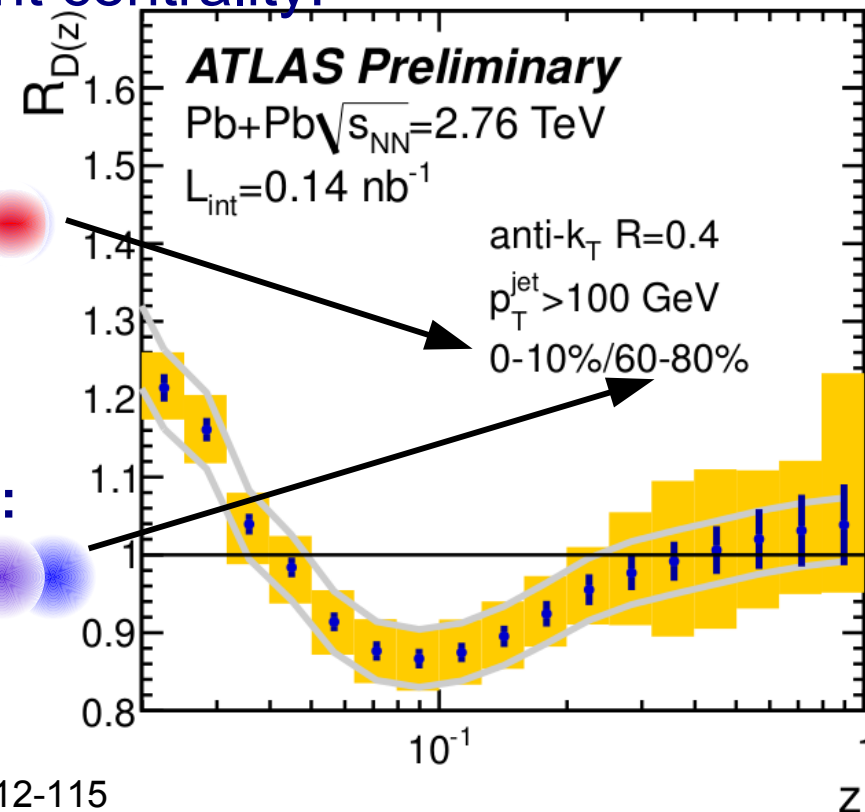


- Fragmentation functions unfolded for detector effects
- Ratio of fragmentation functions of different centrality:

Central:

over

Peripheral:



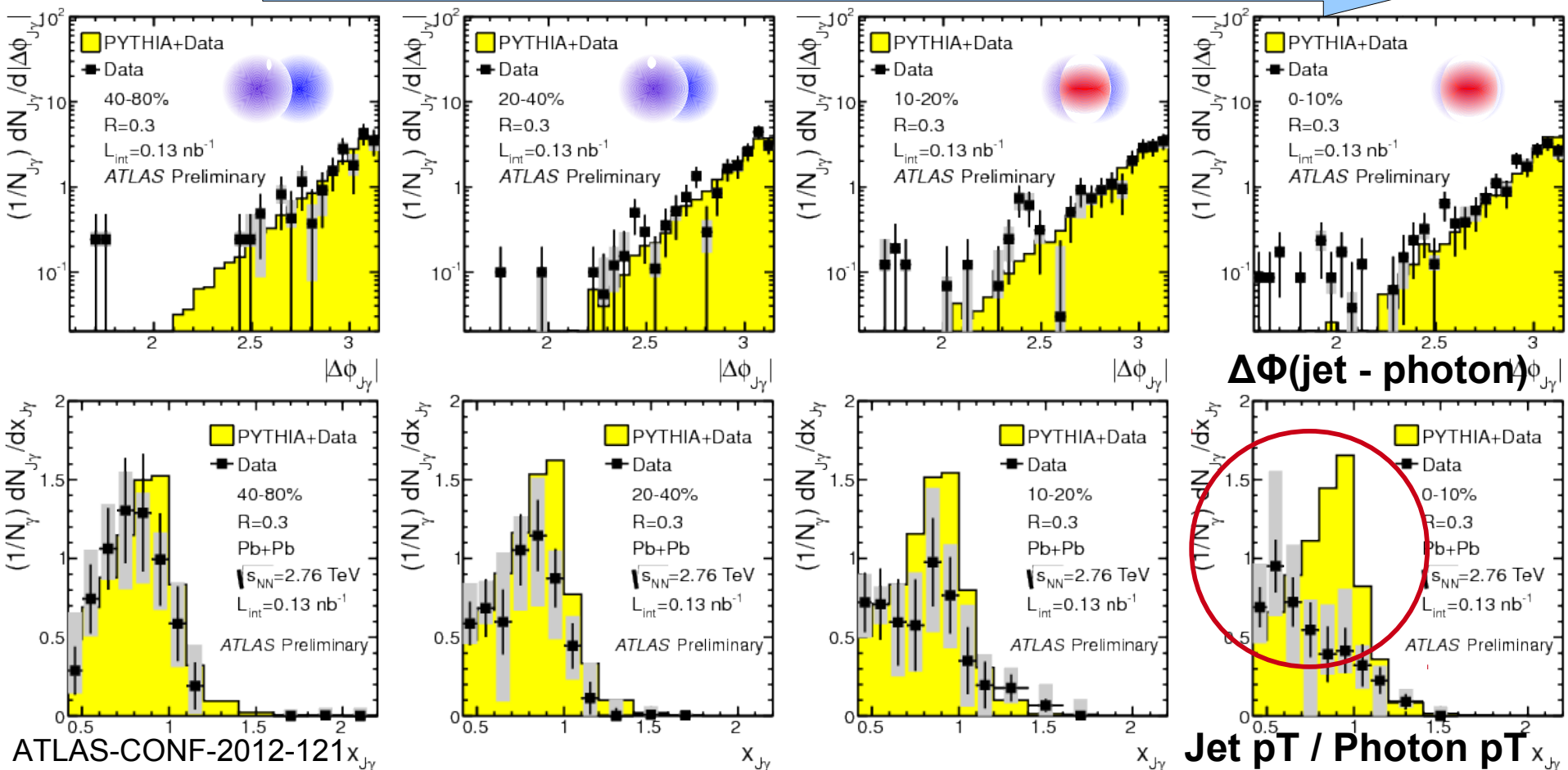
ATLAS-CONF-2012-115

Heavy Ions: Pb-Pb at $\sqrt{s_{NN}} = 2.76$ TeV

Photon-Jet Correlation

- Significant deviation from p-p in very central events

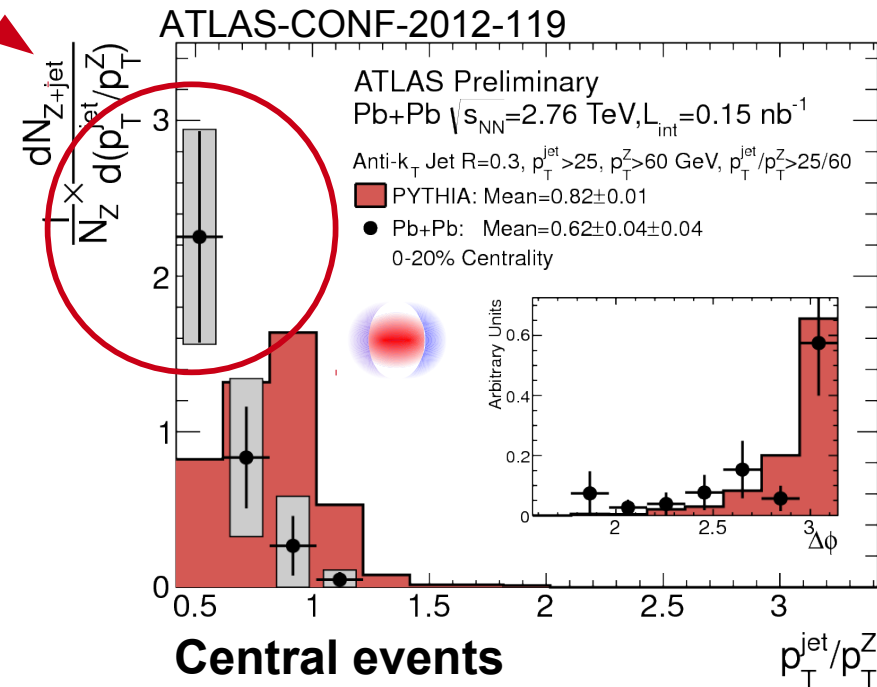
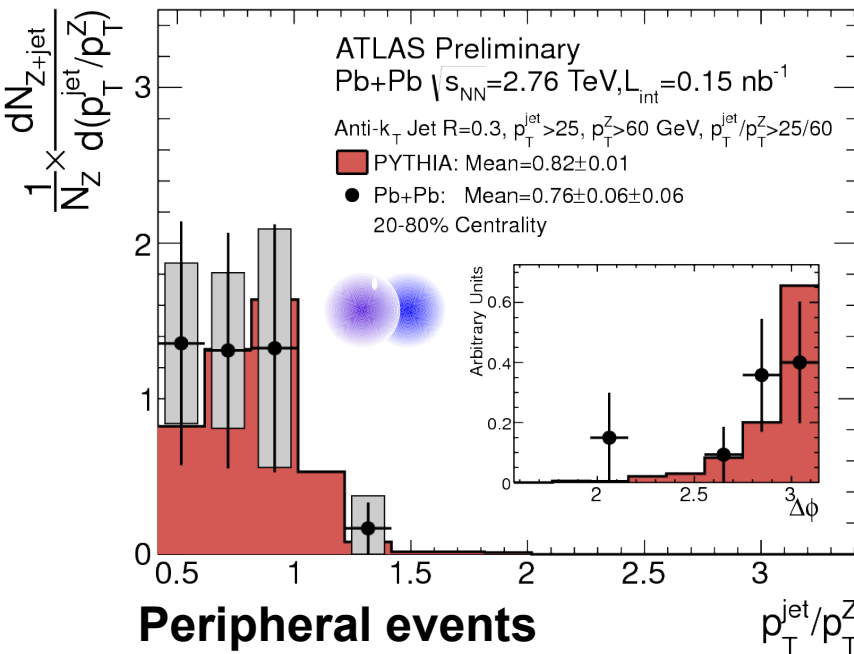
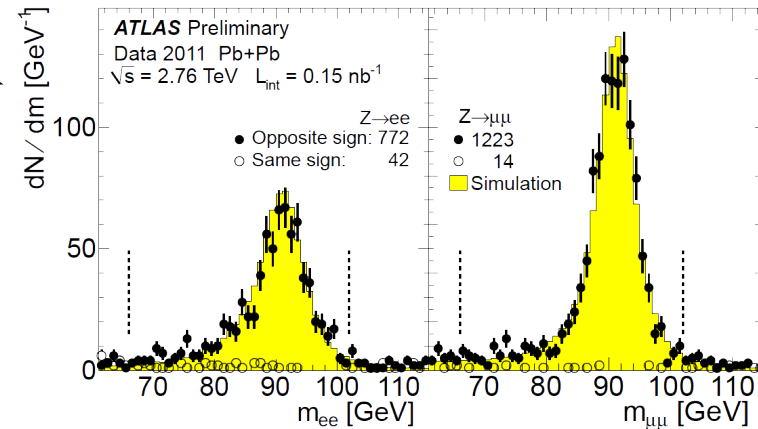
more central events see more quenching



Heavy Ions: Pb-Pb at $\sqrt{s_{NN}} = 2.76$ TeV

Z-Jet Correlation

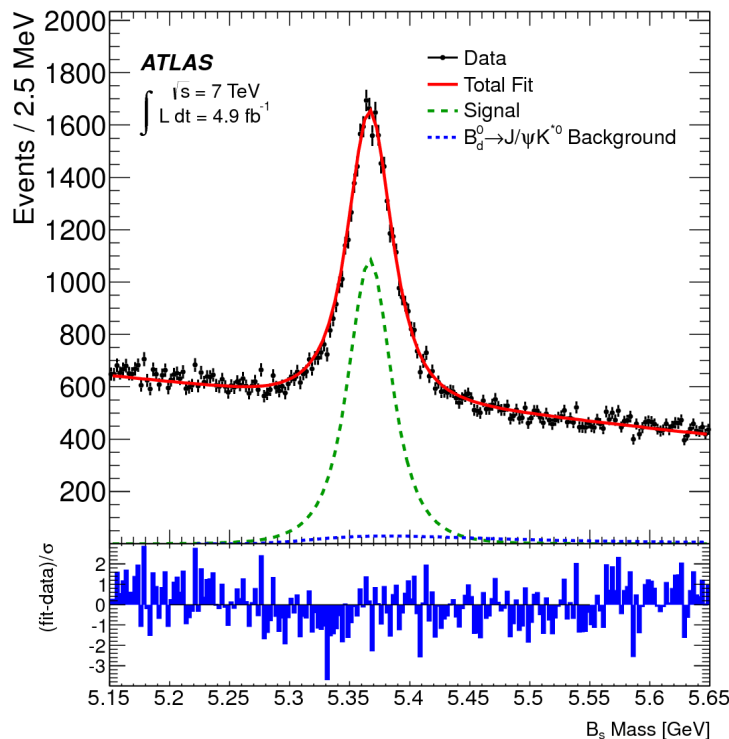
- Observation of 1995 Z events
- Indication of the same jet-quenching effect as in photon-jet (although with large uncertainties)
- Unfolded distr of $p_T(\text{jet})/p_T(Z)$:



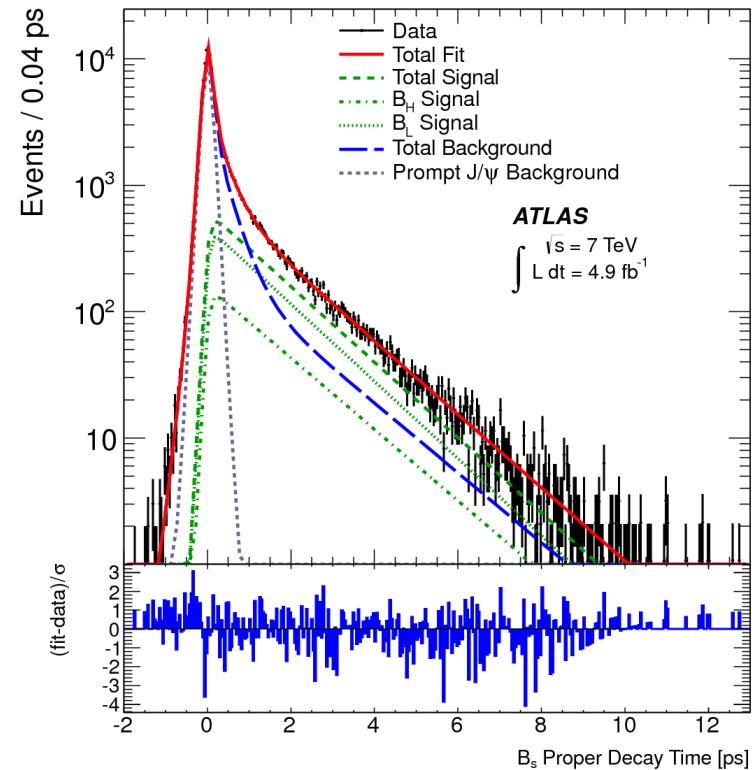
B-Physics:

Mixing and CP-violation in $B_s \rightarrow J/\psi \phi$

- Untagged analysis: decay time distribution and angular correlation between muons and kaons provide information on $CP=\pm 1$ amplitudes and their interference.



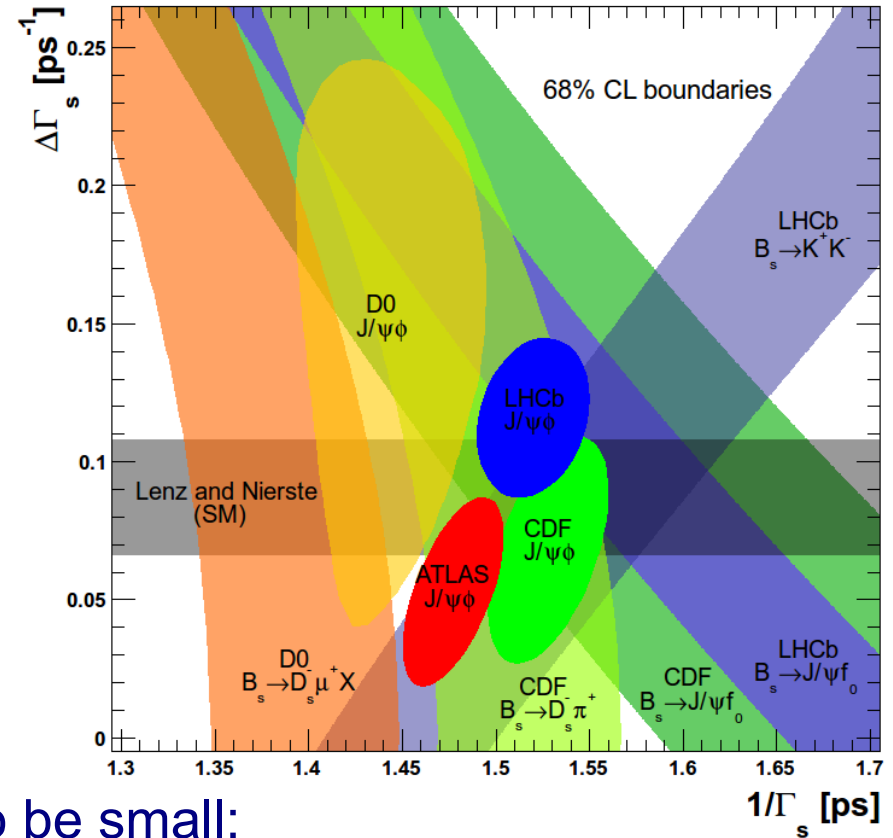
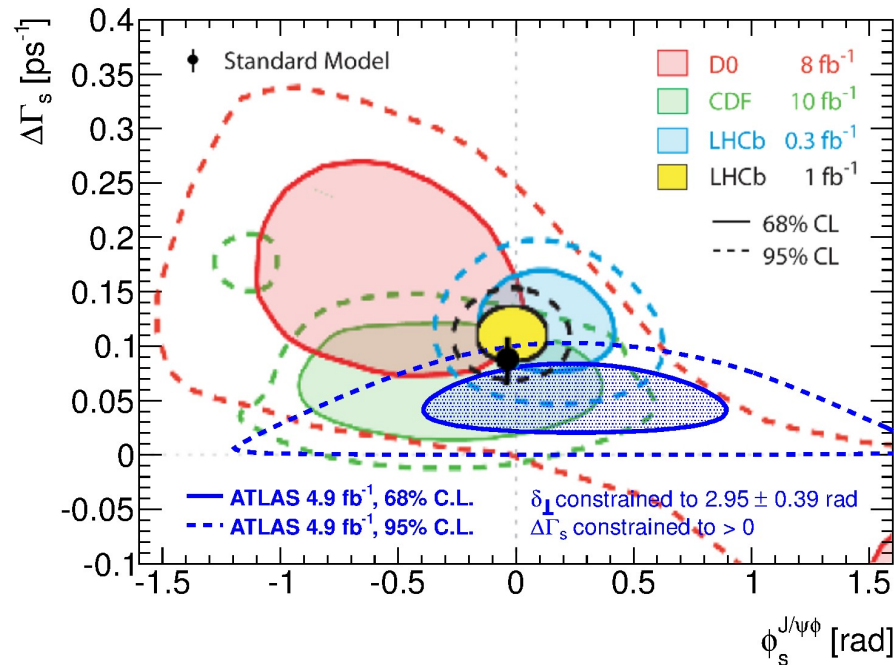
B_s Mass



B_s proper decay time

- Large sample: 23k reconstructed B_s in 2011 data

B-Physics: Mixing and CP-violation in $B_s \rightarrow J/\Psi \phi$



- CP violating phase is confirmed to be small:
 $\phi_s = 0.22 \pm 0.41 \pm 0.10$ rad.
- Average B_s lifetime and width difference $\Delta\Gamma_s$ are measured with high accuracy

[arXiv:1208.0572](https://arxiv.org/abs/1208.0572)

Standard Model: WZ Cross-Section and Triple Gauge Coupling

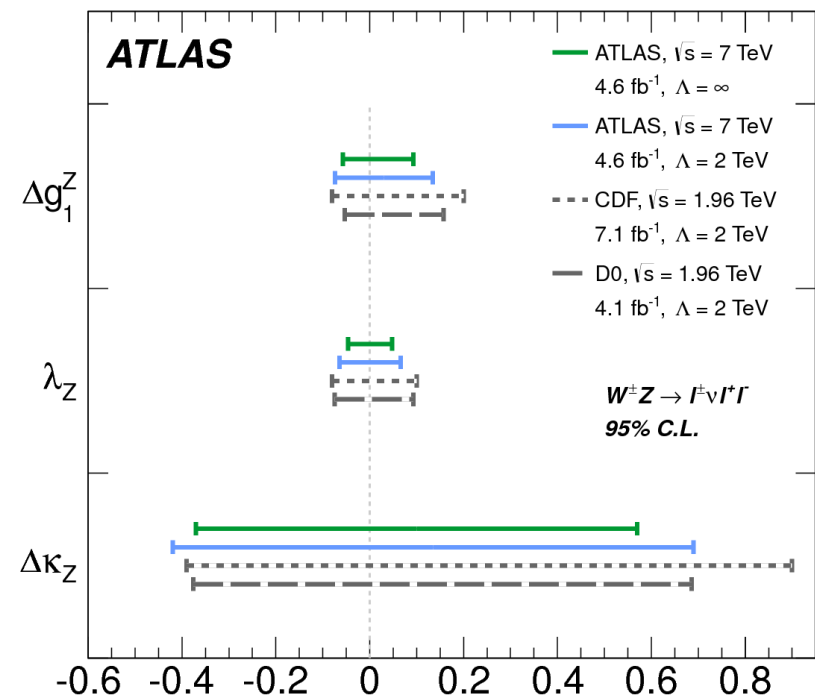
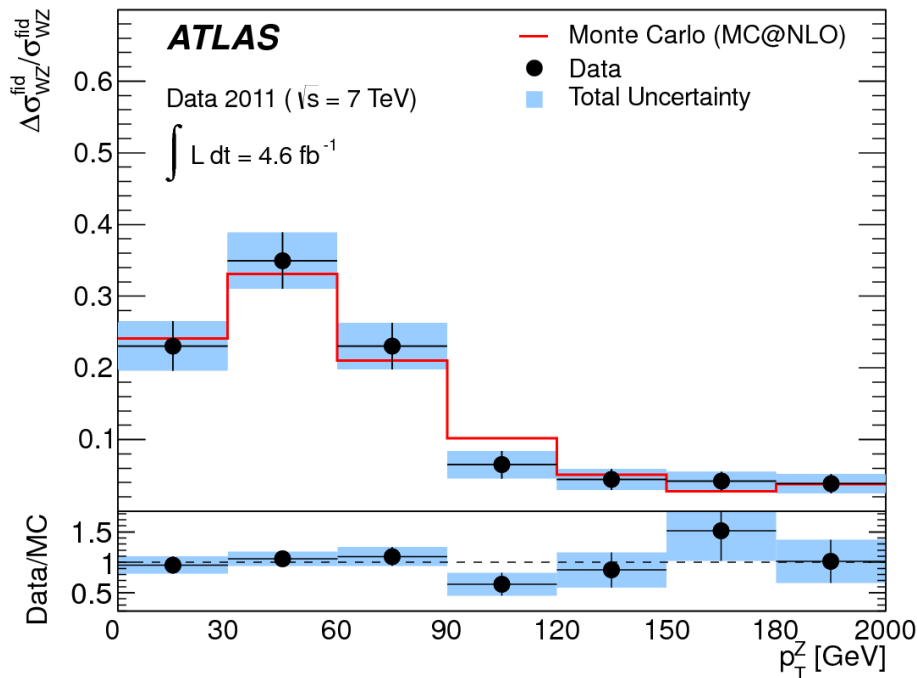
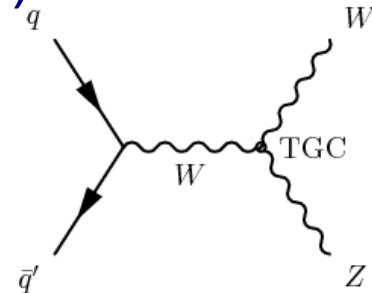
- Isolate 317 candidate events $WZ \rightarrow l\nu l$ ($l = e$ or μ)

- Inclusive cross-section:

$$\sigma_{WZ}^{\text{tot}} = 19.0_{-1.3}^{+1.4}(\text{stat.}) \pm 0.9(\text{syst.}) \pm 0.4(\text{lumi.}) \text{ pb}$$

- SM expectation: $17.6_{-1.0}^{+1.1} \text{ pb}$

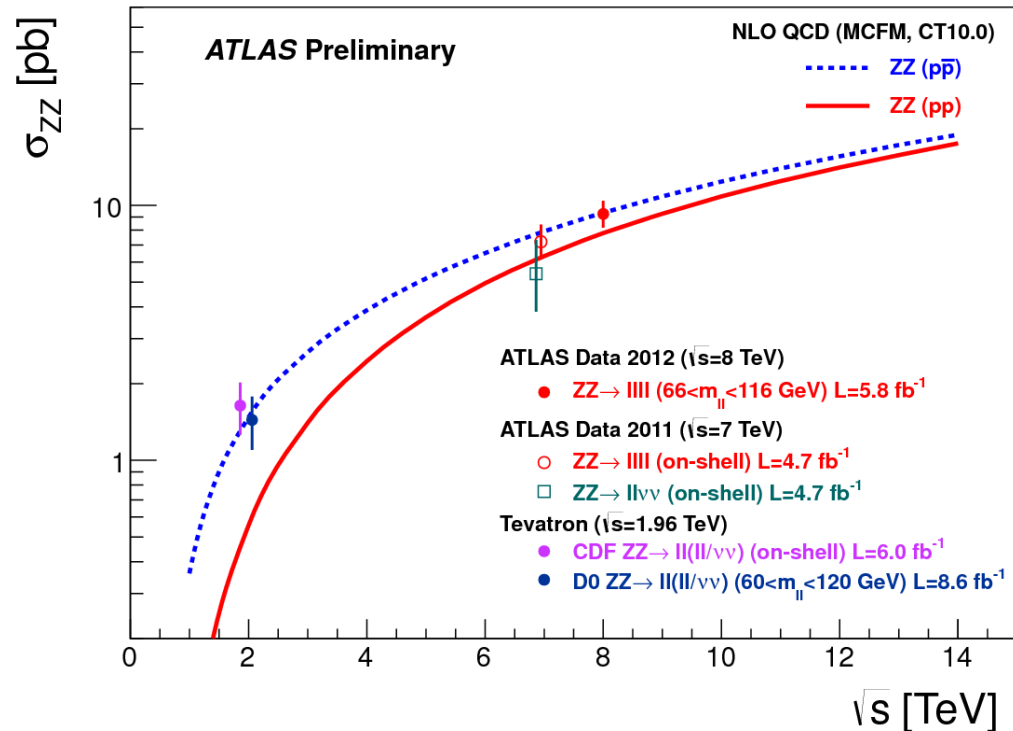
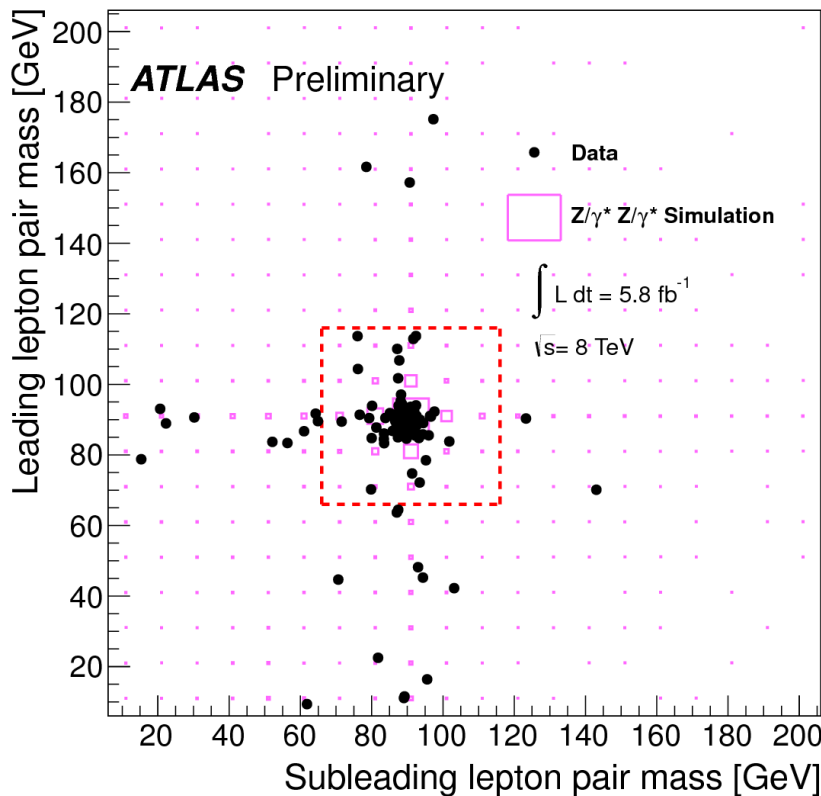
- Set limits on anomalous TGC



arXiv:1208.1390

Standard Model: ZZ Cross-Section at 8 TeV

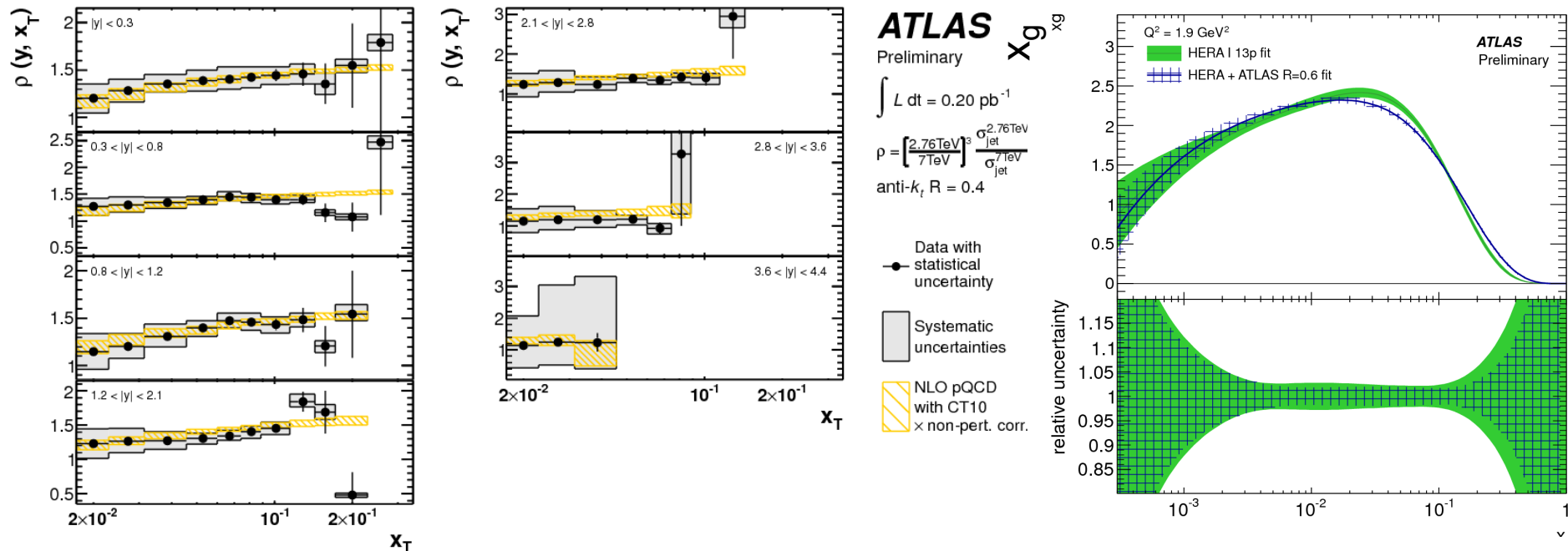
- $ZZ \rightarrow 4 \text{ leptons}$, using 5.8 fb^{-1} of 8 TeV data:
- Total c-s = $9.3_{-1.0}^{+1.1}(\text{stat.})_{-0.3}^{+0.4}(\text{syst.}) \pm 0.3(\text{lumi.}) \text{ pb}$
- Consistent with SM prediction: $7.4 \pm 0.4 \text{ pb}$



ATLAS-CONF-2012-090

Standard Model: Dijet Cross-Section, 2.76 TeV / 7 TeV

- Measurement of the double differential (p_T , rapidity) inclusive jet cross section using the 2.76 TeV data
- Ratio of cross-sections at 2.76 TeV and 7 TeV
→ Impact on pdf's



Top Physics

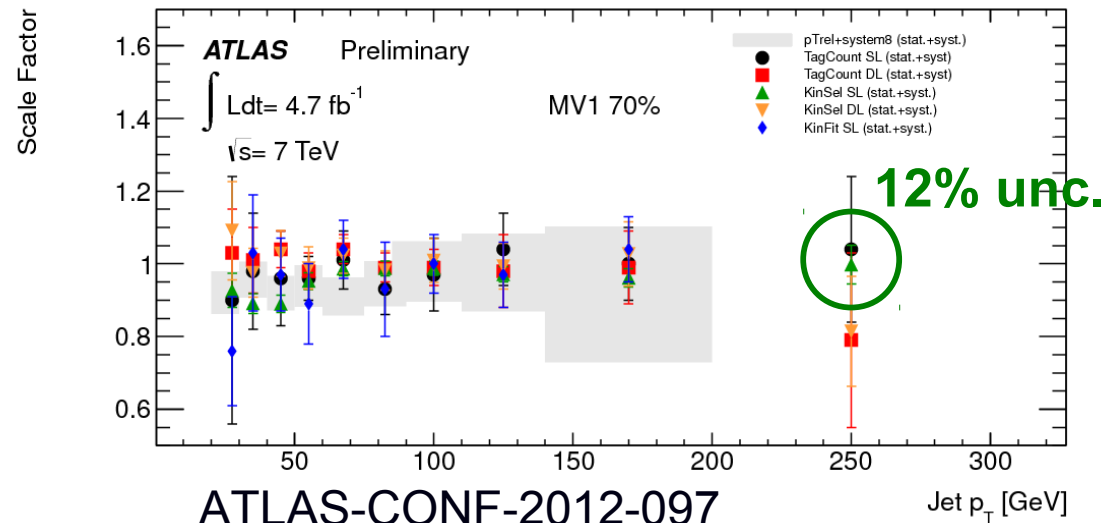
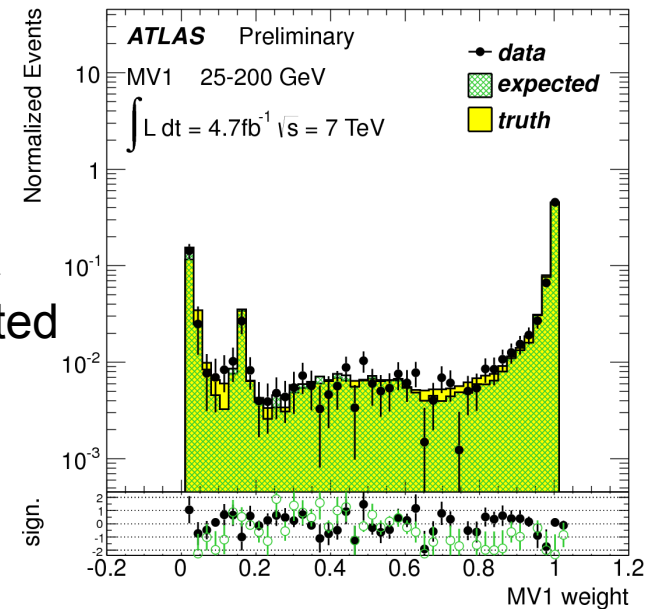
b-Tagging Calibration with t-tbar Events

3 techniques:

- Tag-counting: fit ϵ_b to the number of events with 0, 1, and 2 b-tags
- Kinematic fit
- Kinematic selection

$$\epsilon_b = \frac{1}{f_b} (f_{tag} - \epsilon_c \cdot f_c - \epsilon_l \cdot f_l - \epsilon_{fake} \cdot f_{fake})$$

- All consistent with muon-based techniques
- Significant reduction of systematic uncertainty on ϵ_b at high jet p_T

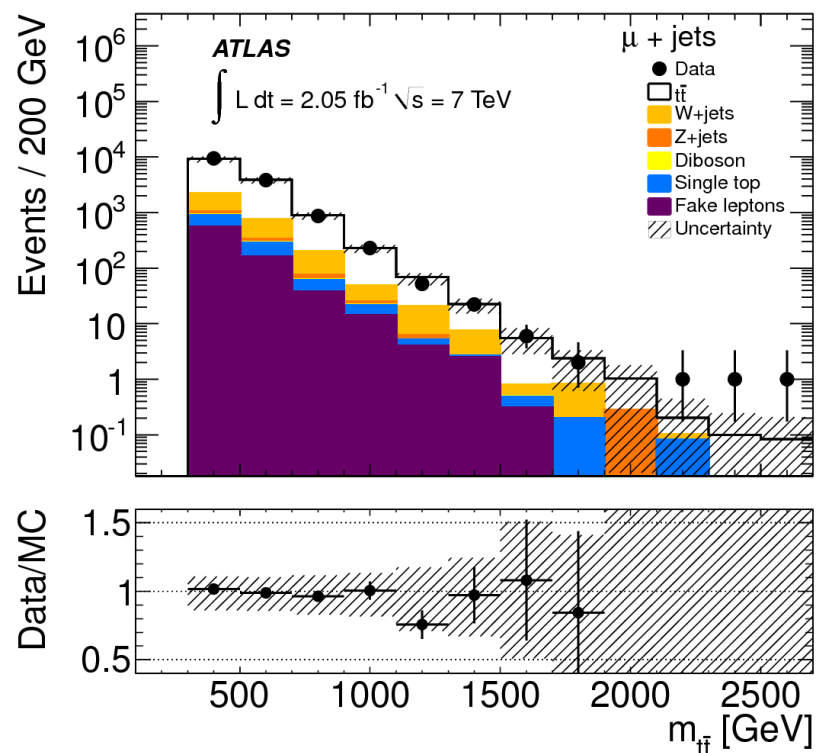


ATLAS-CONF-2012-097

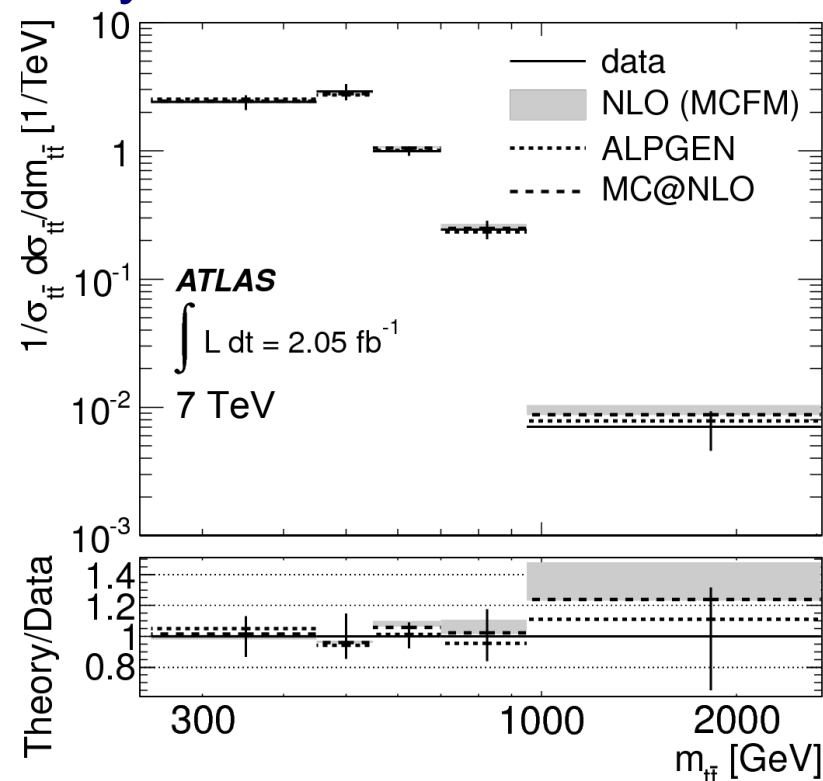
Top Physics

t-tbar Differential Cross-Section

- Differential ttbar cross-sections relative to the inclusive cross-section measured in the lepton+jets channel.
- Data unfolded for detector effects and corrected acceptance
- Consider mass, p_T and y of the t-tbar system arXiv:1207.5644



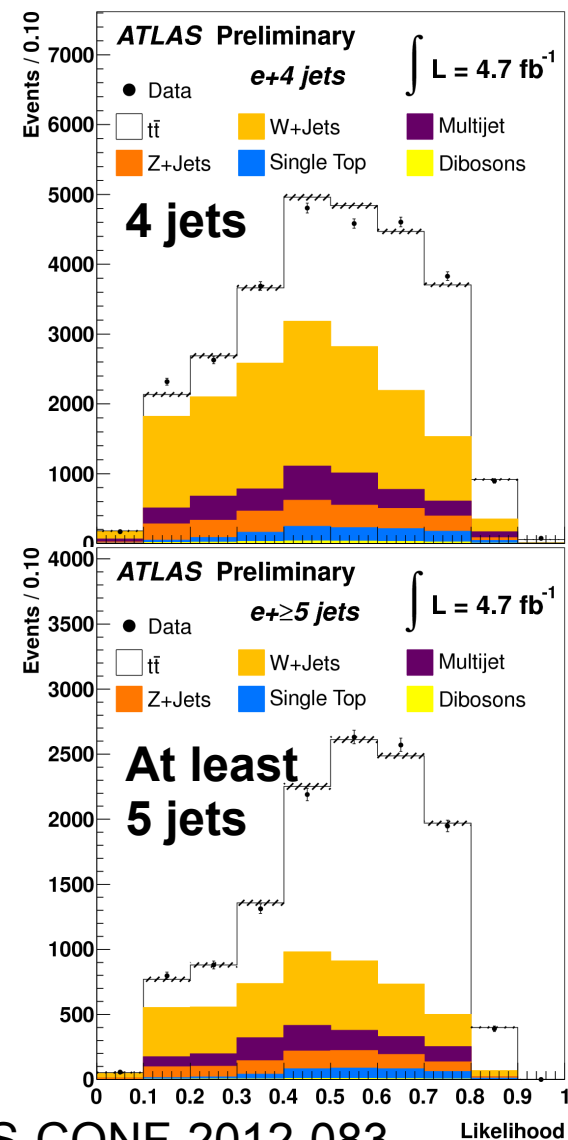
unfolding



Top Physics

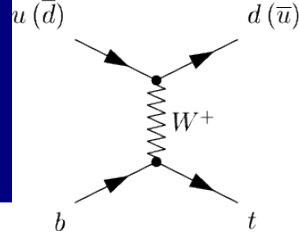
t-tbar + Jet Cross-Section

- Lepton+Jets channel, multivariate technique used to reject W+jets background
 - Jet definition at reco-level:
 - $p_T > 25$ GeV and $|\mu| < 2.5$ (anti-kt, R=0.4)
 - Compare 4-jet and ≥ 5 -jet yields
 - Define extra-jet at particle level as any jet not matched to partons (q,g, γ) from top
- $$\sigma_{t\bar{t}j} = 102 \pm 2(\text{stat.})_{-26}^{+23}(\text{syst.}) \text{ pb}$$
- $$\sigma_{t\bar{t}j} / \sigma_{t\bar{t}}^{\text{incl}} = 0.54 \pm 0.01(\text{stat.})_{-0.08}^{+0.05}(\text{syst.})$$
- Dominant systematics (t-tbar modelling and JES) cancel in the ratio

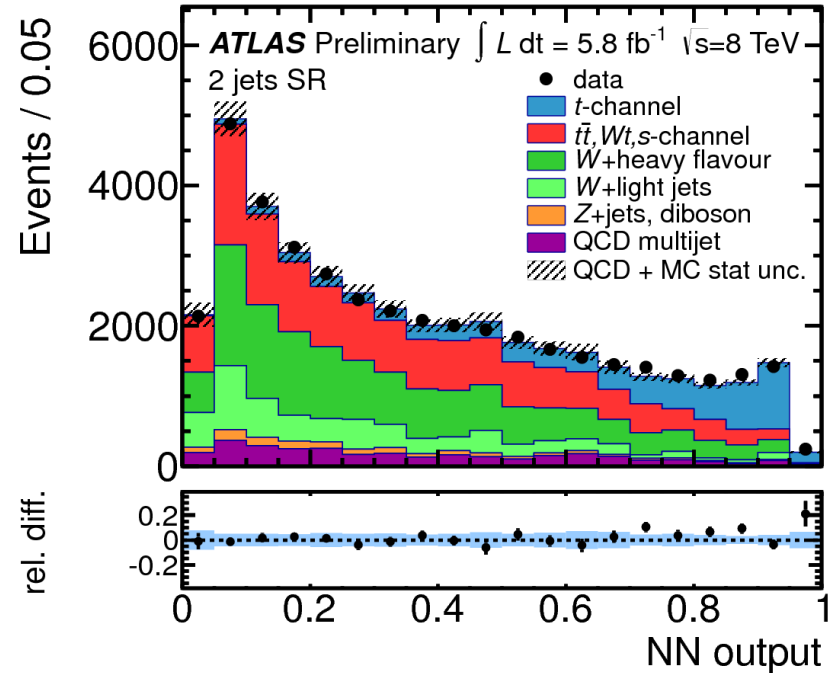
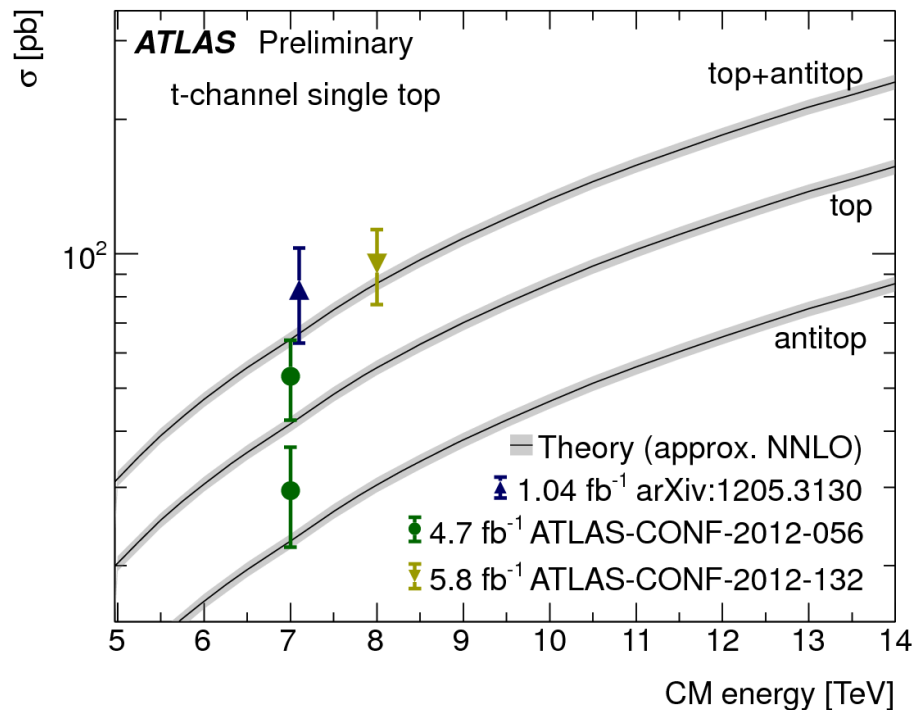


ATLAS-CONF-2012-083

Single-Top t-channel Cross Section at 8 TeV



- Using events with 2/3 jets, exactly 1 b-tag.
- Multivariate analysis with maximum likelihood fit on full neural network output



$$\sigma_t = 95 \pm 2 (\text{stat.}) \pm 18 (\text{syst.}) \text{ pb}$$

$$|V_{tb}| \gg |V_{ts}|, |V_{td}| \rightarrow |V_{tb}| = 1.04^{+0.10}_{-0.11}$$

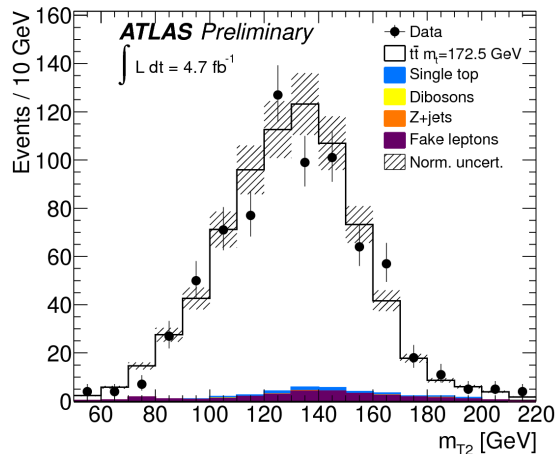
$$|V_{tb}| \leq 1 \rightarrow |V_{tb}| > 0.80 @ 95\% \text{CL}$$

ATLAS-CONF-2012-132

Top Properties

Top Mass:

- First ATLAS measurement in the dilepton channel
 - $e\mu$ channel with 2-btags
 - Calibration curve of $\langle m_{T2} \rangle$ vs input top quark mass

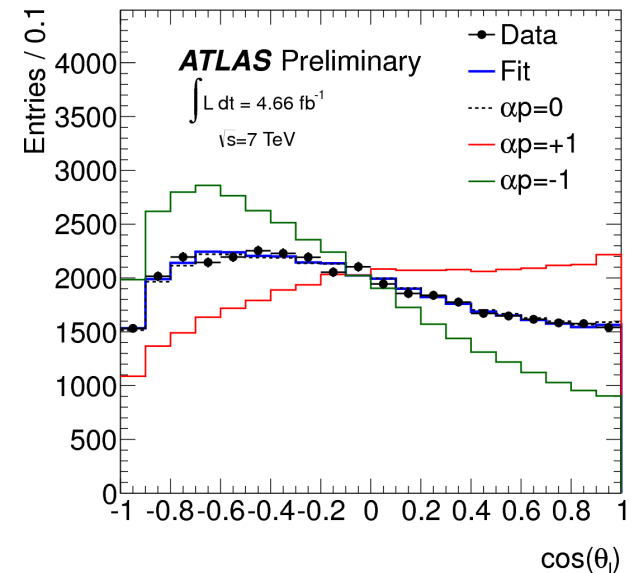
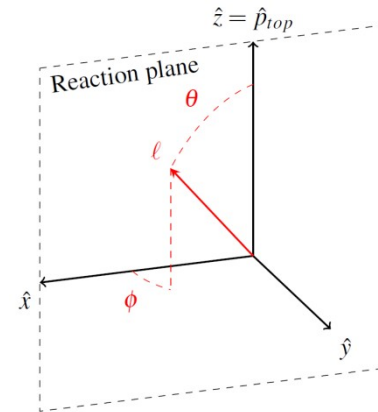


$$m_{\text{top}} = 175.2 \pm 1.6(\text{stat.})_{-2.8}^{+3.1}(\text{syst.}) \text{ GeV}$$

ATLAS-CONF-2012-082

Top polarization:

- Lepton+jets channel
- Template fit to $\cos(\theta_l)$
- θ_l = lepton polar angle in top rest frame
- f = fraction of positively polarised top quarks

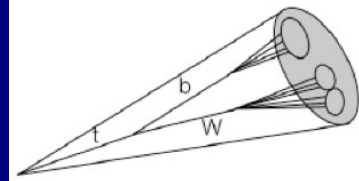


$$f = 0.470 \pm 0.009(\text{stat})_{-0.032}^{+0.023}(\text{syst})$$

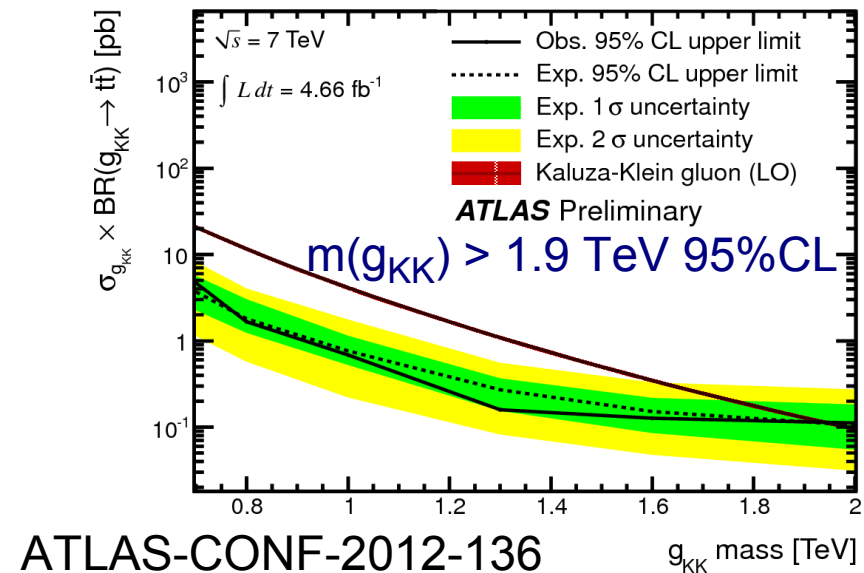
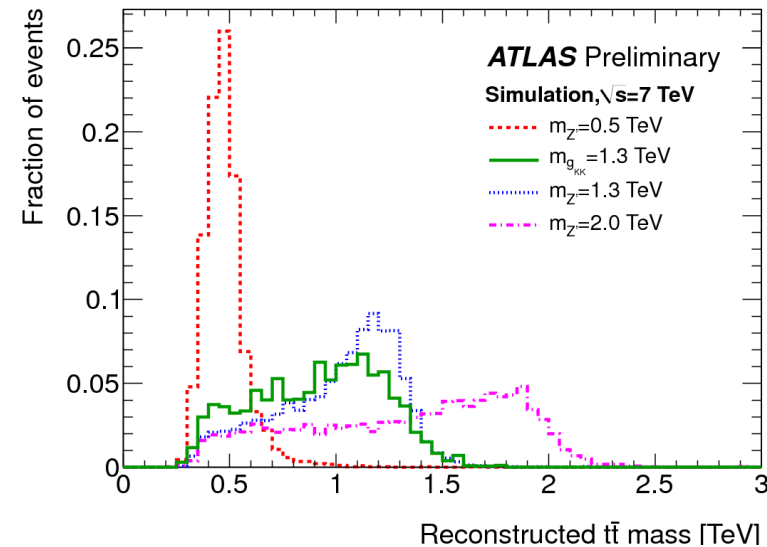
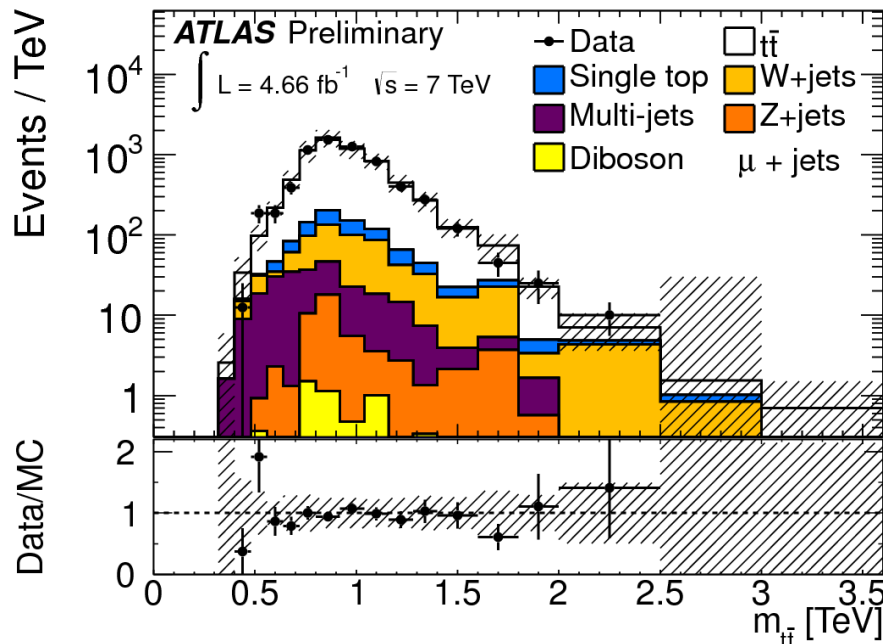
Compatible with $f_{\text{SM}} = 0.5$

ATLAS-CONF-2012-133

Exotics t-tbar Heavy Resonance

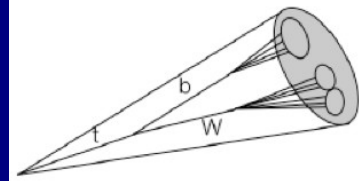


- Lepton+jets channel
- Taking full advantage of boosted techniques
- Combining resolved and boosted reconstructions

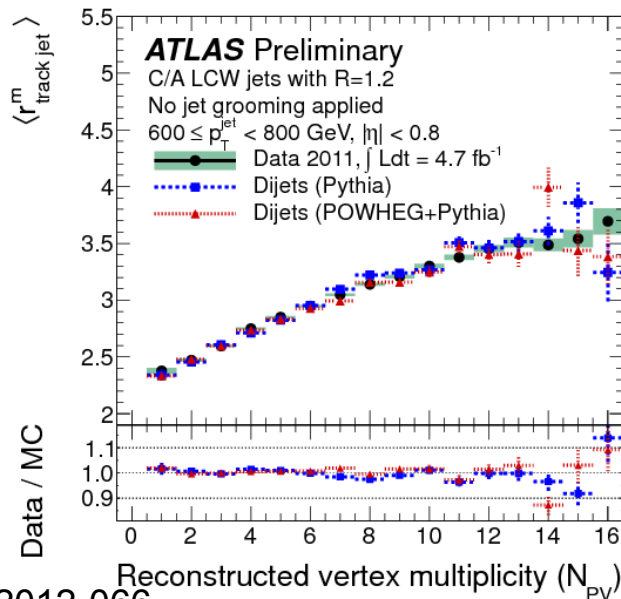
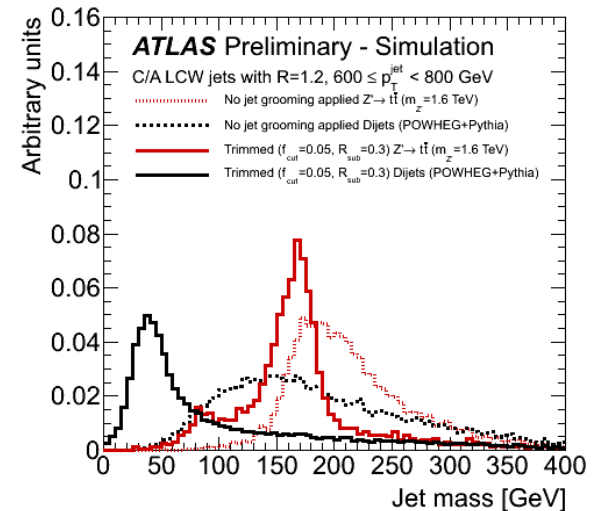
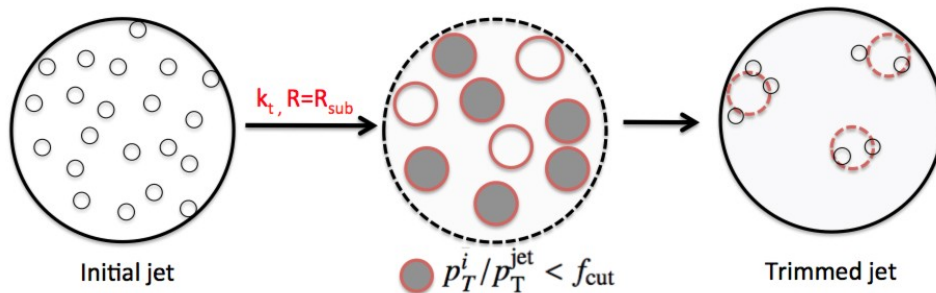


ATLAS-CONF-2012-136

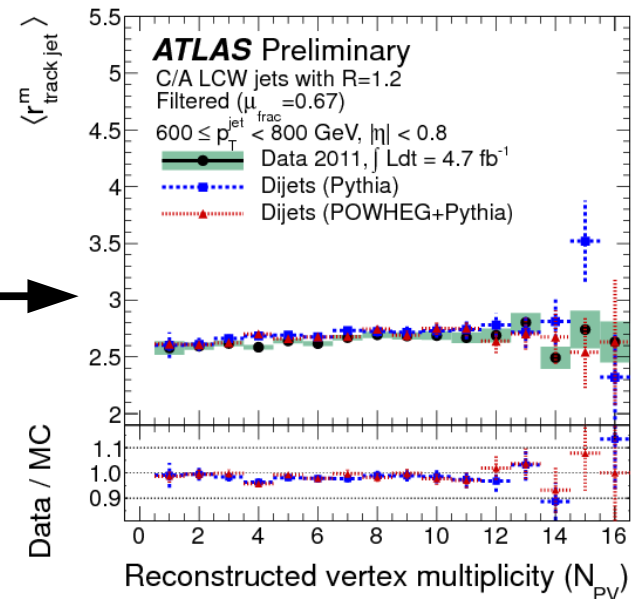
Reconstruction of Boosted Objects



- Reconstruct boosted objects (top or W/Z/H) with a “fat” jet ($R \sim 1$)



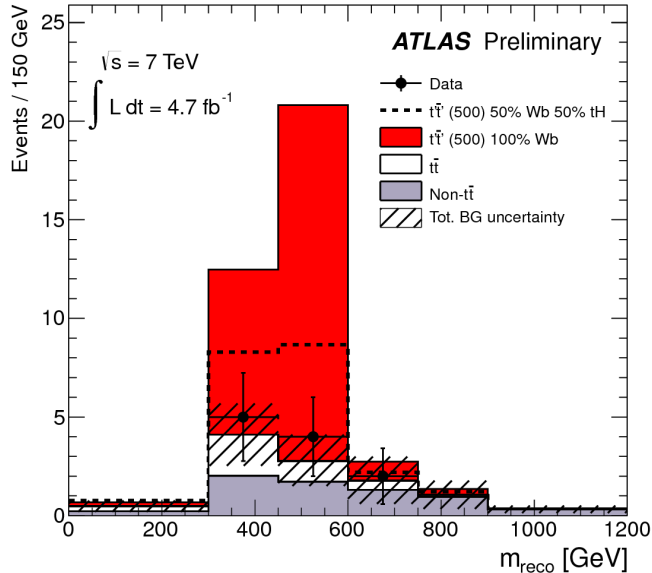
“grooming”



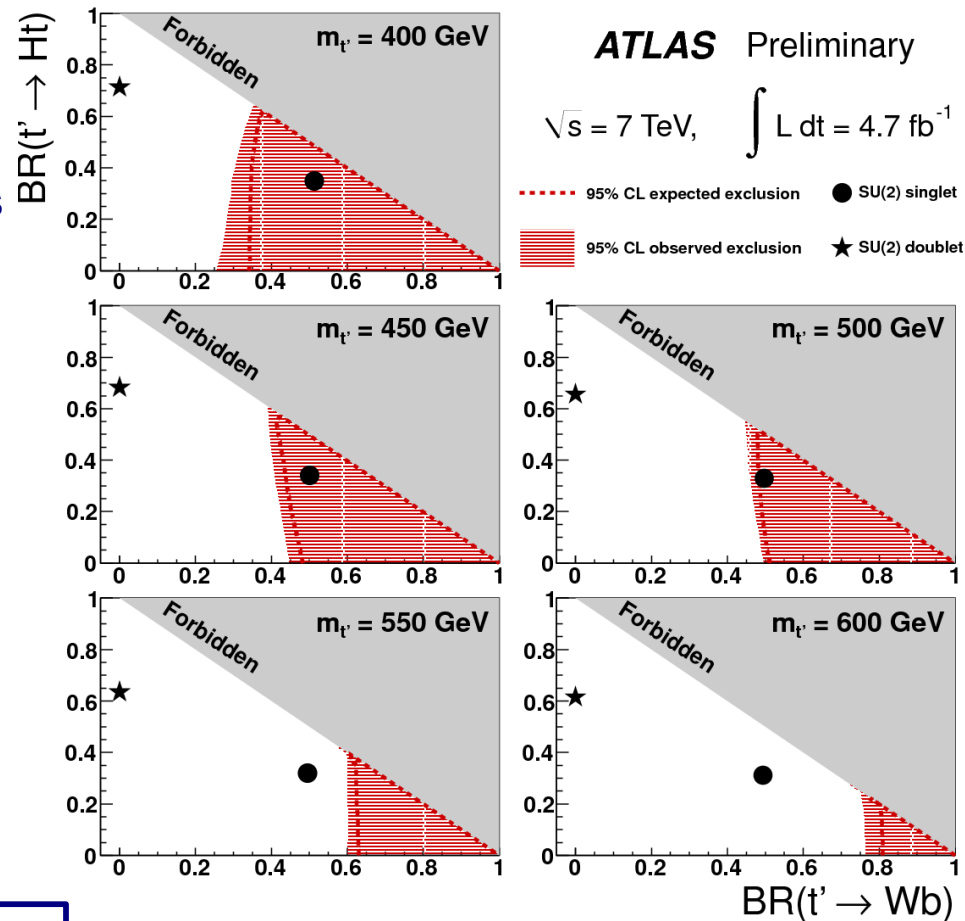
Exotics

Search for Heavy Quarks

- Up-type heavy quark: $t't' \rightarrow WbWb$
- Lepton + jets channel
- Reconstructing boosted hadronic W decays
 $m(t') > 656 \text{ GeV}$ at 95% CL (exp. 638 GeV)



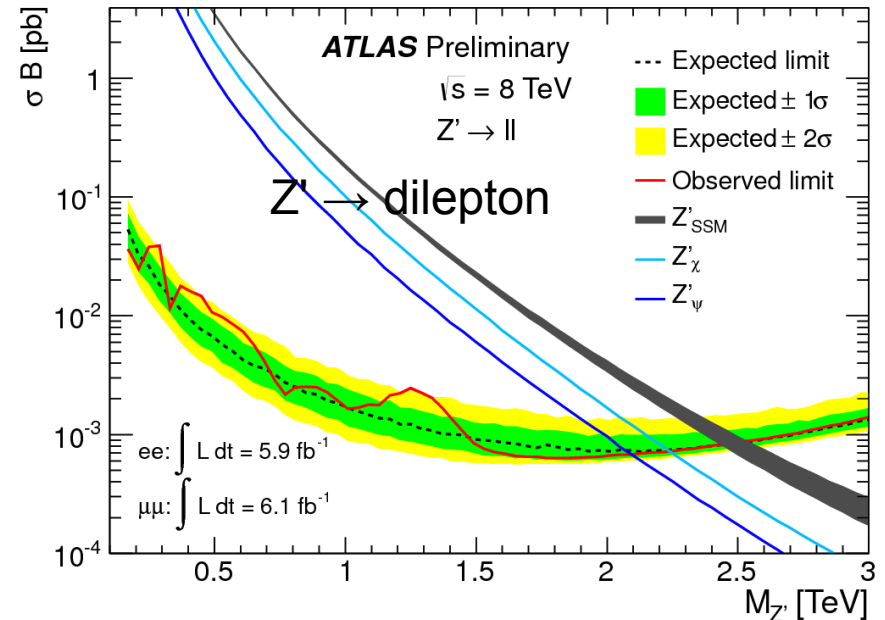
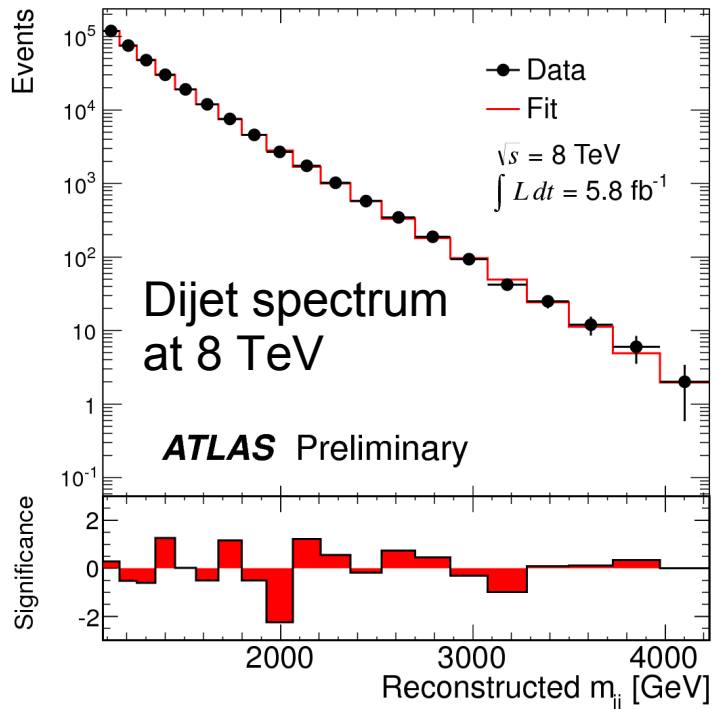
- Also new result on down-type quark:
- $b'b' \rightarrow WtWt$, same-sign dilepton channel
 $m(b') > 670 \text{ GeV}$ at 95% CL (expected: 640 GeV)
 ATLAS-CONF-2012-130



- Vector-Like Quark
 interpretation: setting limits on
 branching ratios to Wb , tH , tZ

Exotics

Dilepton and Dijet Resonances at 8 TeV



$m(\text{SSM } Z') > 2.49 \text{ TeV at } 95\% \text{ CL}$

$m(q^*) > 3.66 \text{ TeV at } 95\% \text{ CL}$

- 7 TeV \rightarrow 8 TeV brings significant gain in sensitivity, even with \sim same luminosity. Expected limits improved by:
+300 GeV for $Z' \rightarrow \text{dilepton}$
+700 GeV for $q^* \rightarrow \text{dijet}$

Exotics: A Summary

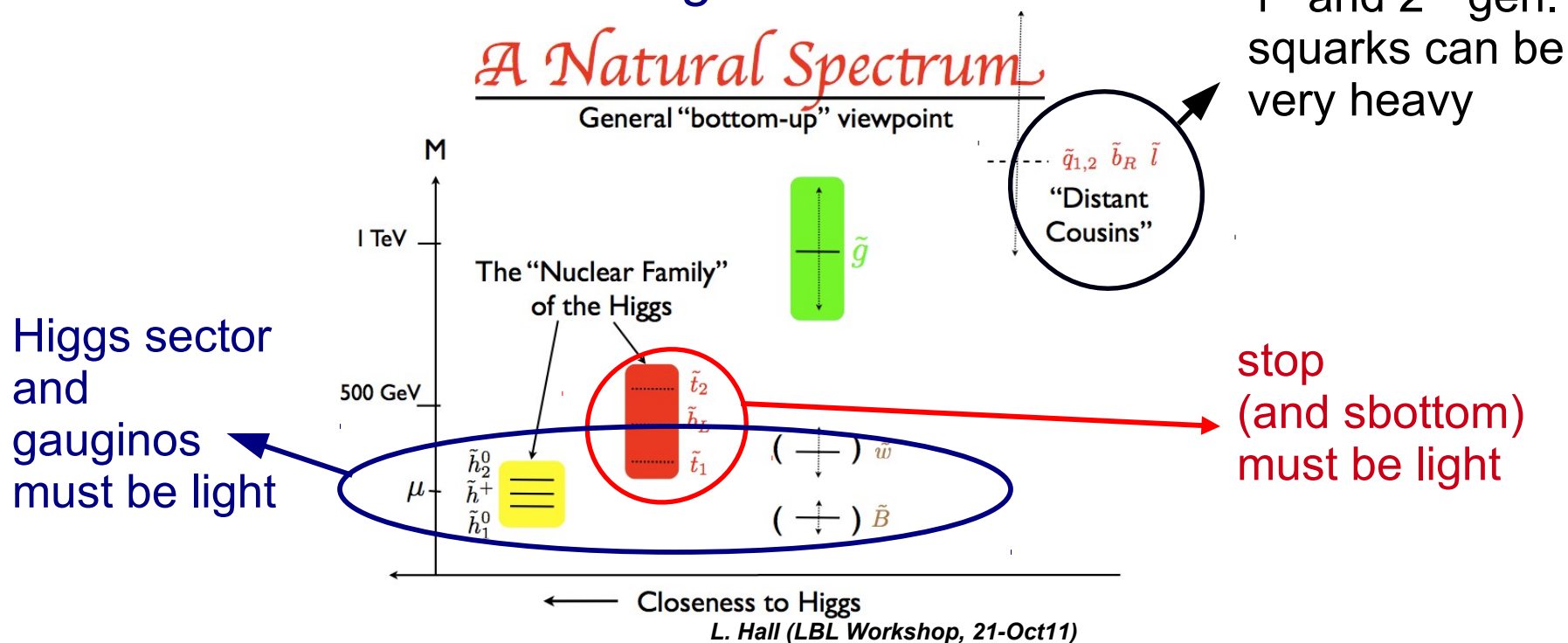
- Effort on 7 TeV data coming to a conclusion:
→ 33 papers on 2011 data. Finishing with the most complex final states.



- 8 TeV programme well advanced

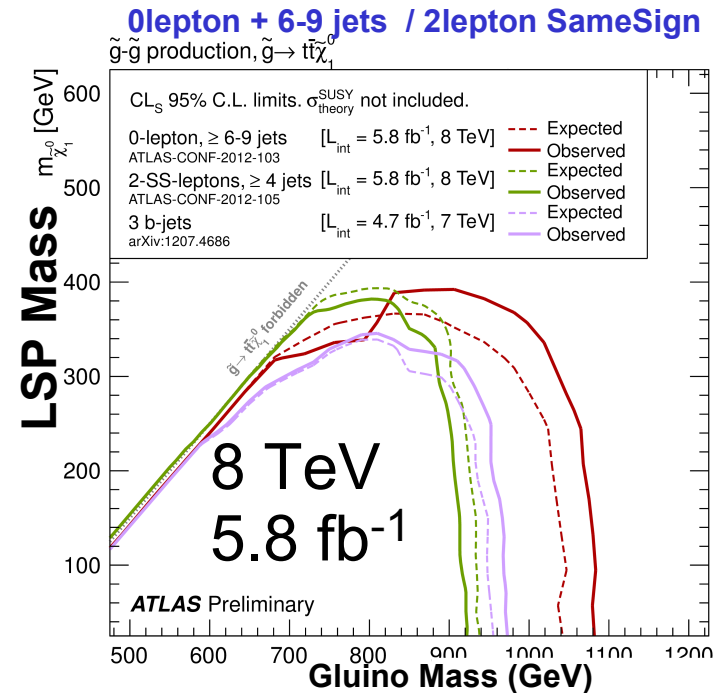
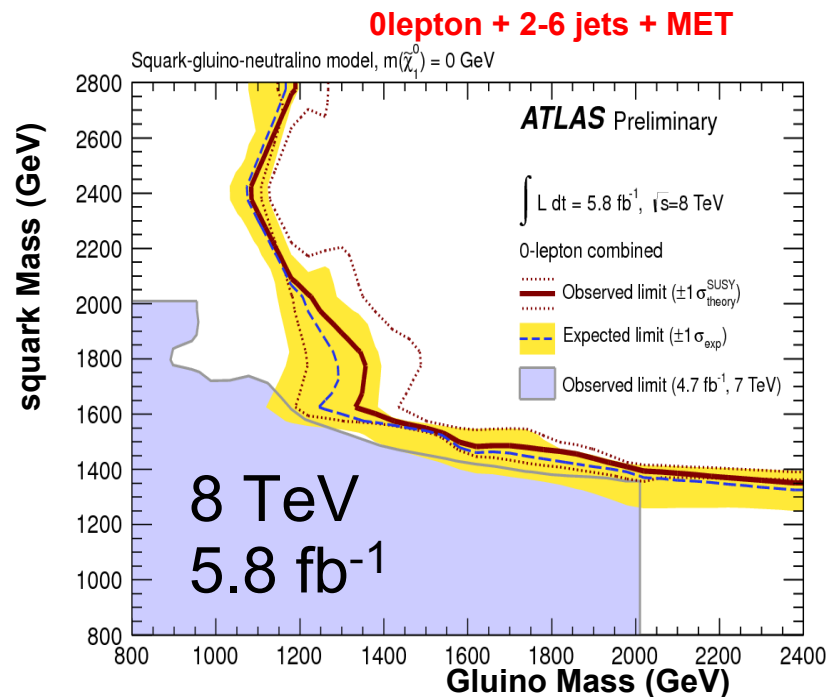
Supersymmetry

- “Standard” SUSY (mSUGRA) limits are beyond 1 TeV
- Now focusing on more general models
- Minimal requirements for a Weak Scale SUSY:
i.e. how to avoid fine-tuning?



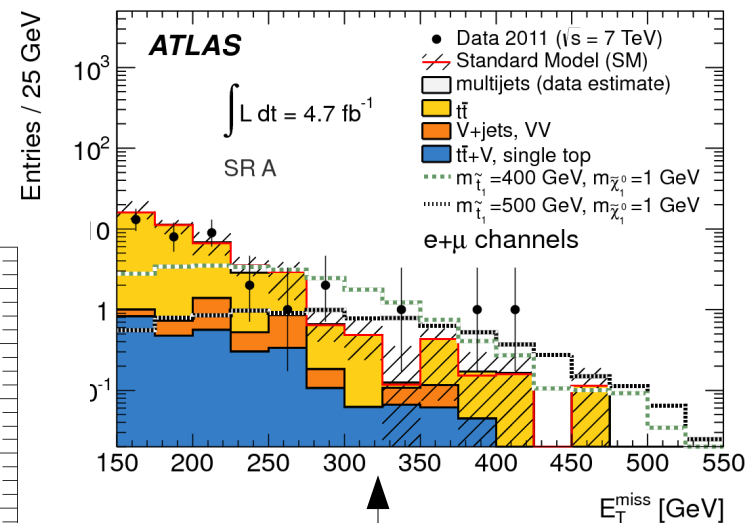
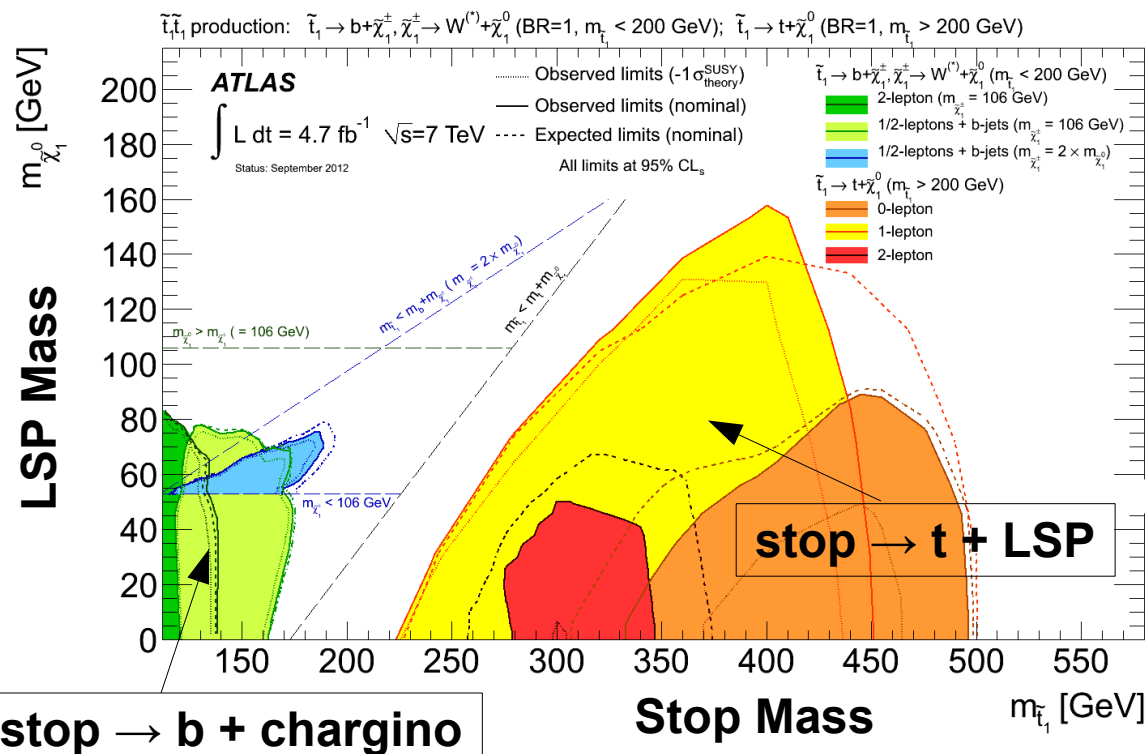
SUSY: 1st and 2nd generation squarks / gluinos

- “Standard” SUSY search: 0-lepton + jets + Missing ET
- Gluino production decaying only to top and neutralino. Final state: gluino gluino \rightarrow 4-top + 2 LSP's
- Sensitive to 1st-2nd squarks, gluinos masses beyond 1 TeV



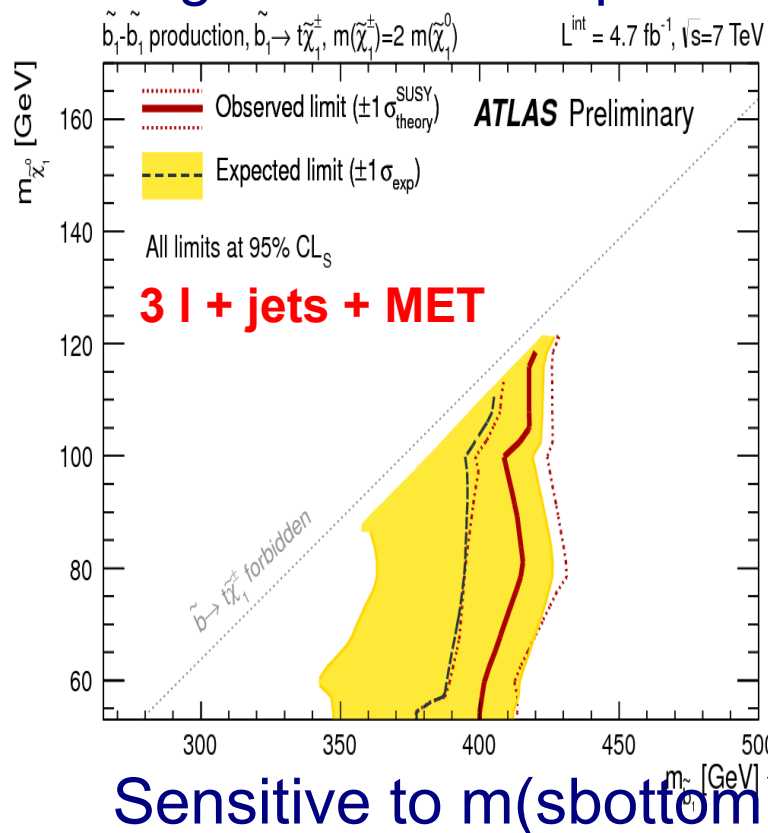
SUSY Exclusive Searches: Direct Stop Production

- Looking for stop pair production
- 5 different dedicated analyses with 0, 1, 2 leptons, w/ or w/o b-jets
- Sensitive up to 500 GeV
- If $m(\text{stop}) > m(\text{top}) + m(\text{LSP})$, signature is $t\text{-}\bar{t} + \text{MET}$

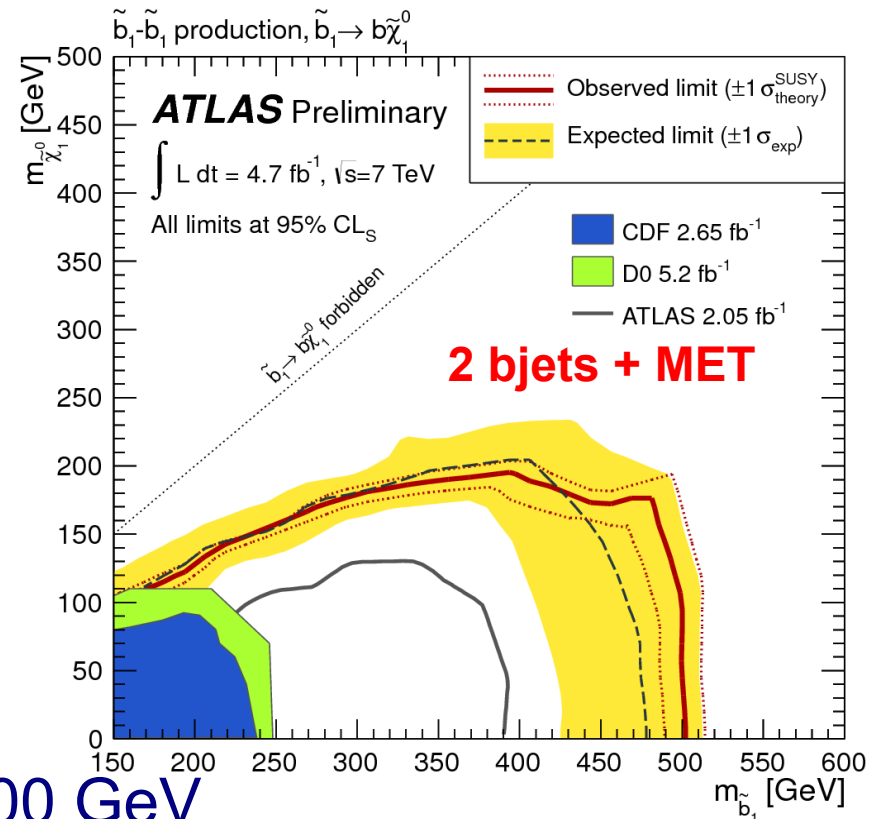


SUSY Exclusive Searches: Direct Sbottom Production

- Looking for sbottom pair production:
- Sbottom \rightarrow t + chargino
- Signature: multilepton



- Sbottom \rightarrow b + LSP
- Signature: 2b's + MET



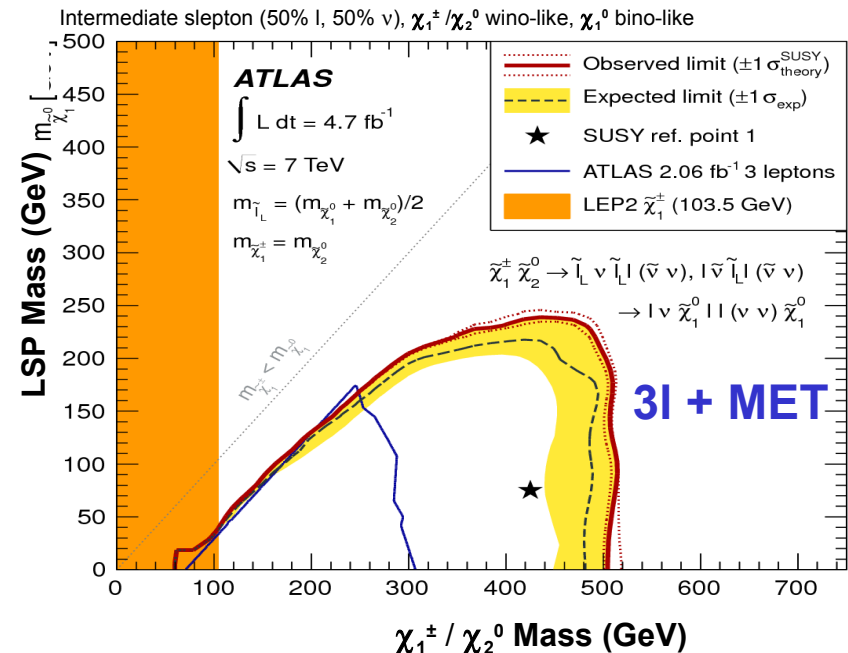
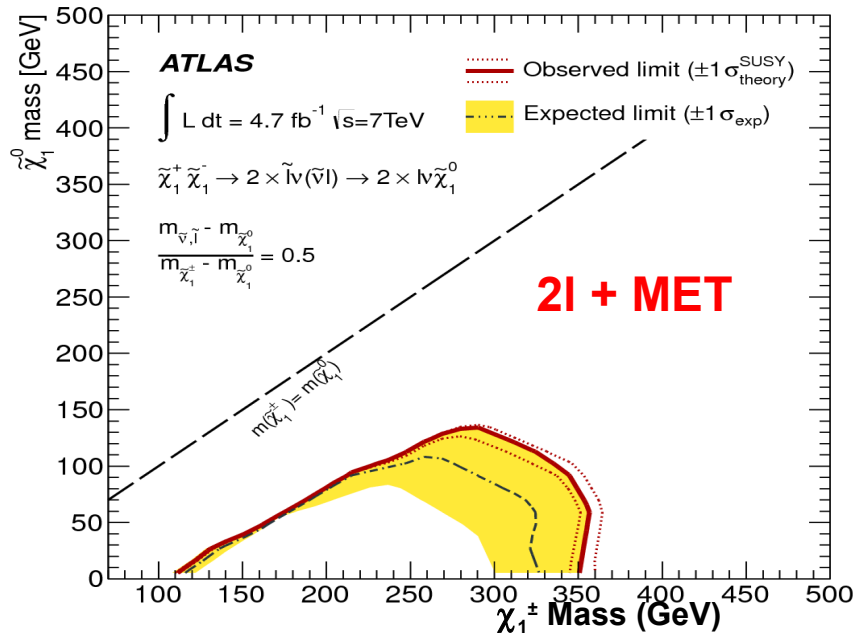
SUSY Exclusive Searches: Direct Gaugino Production

- Looking for gaugino pair production:

$$\tilde{\chi}_1^+ \tilde{\chi}_1^- \rightarrow 2 \times \tilde{l} \nu(\tilde{\nu} l) \rightarrow 2 \times l \nu \tilde{\chi}_1^0$$

$$\tilde{\chi}_1^\pm \tilde{\chi}_2^0 \rightarrow \tilde{l}_L \nu \tilde{l}_L l (\tilde{\nu} \nu), l \tilde{\nu} \tilde{l}_L l (\tilde{\nu} \nu)$$

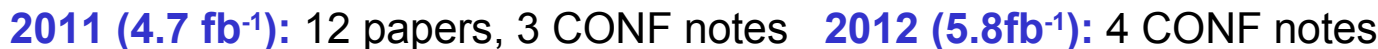
Intermediate slepton (50% l, 50% ν), χ_1^\pm wino-like, χ_1^0 bino-like



Sensitive to m (gauginos) ~ 200 - 300 GeV

ATLAS seriously bites into Weak Scale SUSY

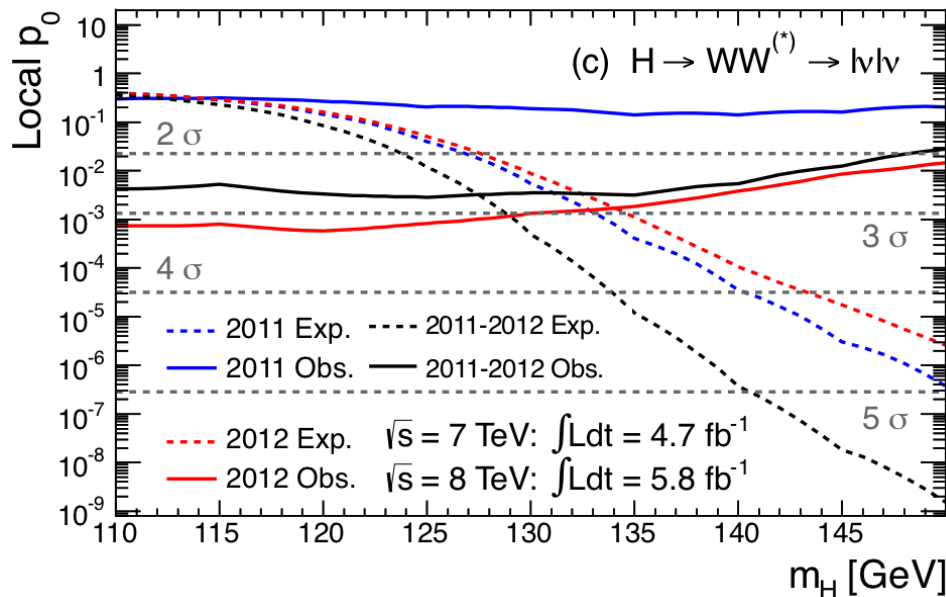
4.RPV



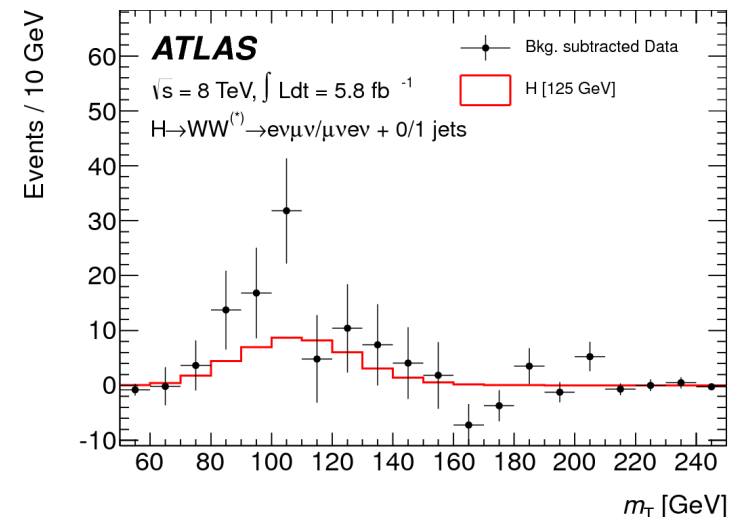
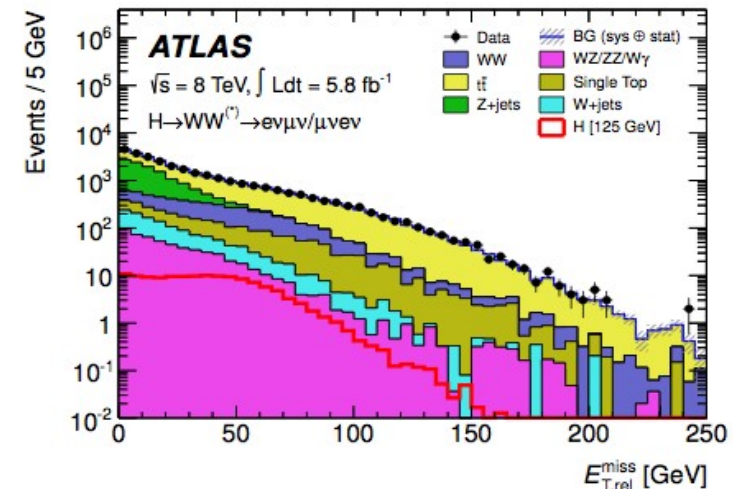
Higgs:

$H \rightarrow WW \rightarrow e\nu\mu\nu$ with 8 TeV data

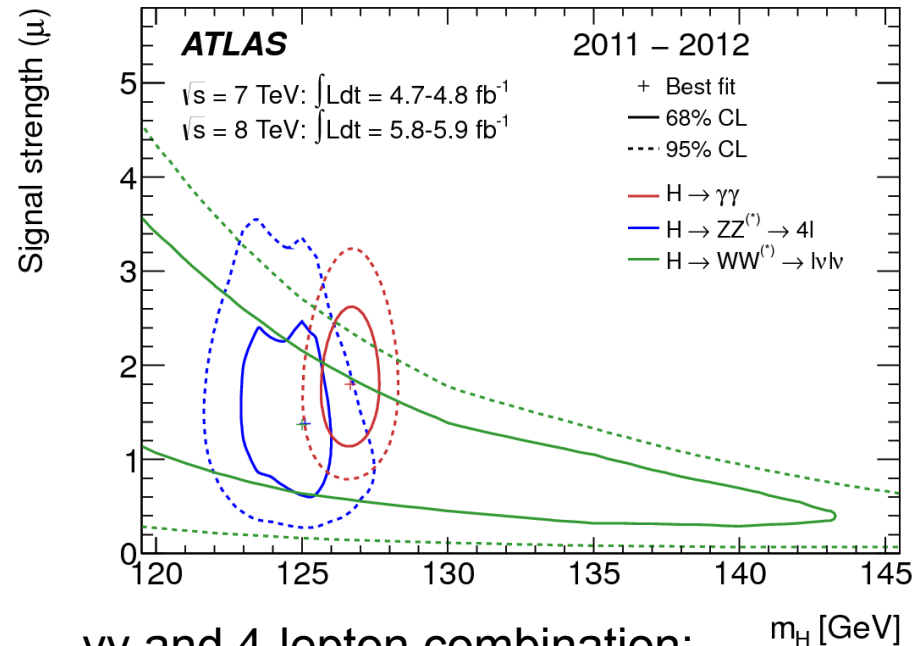
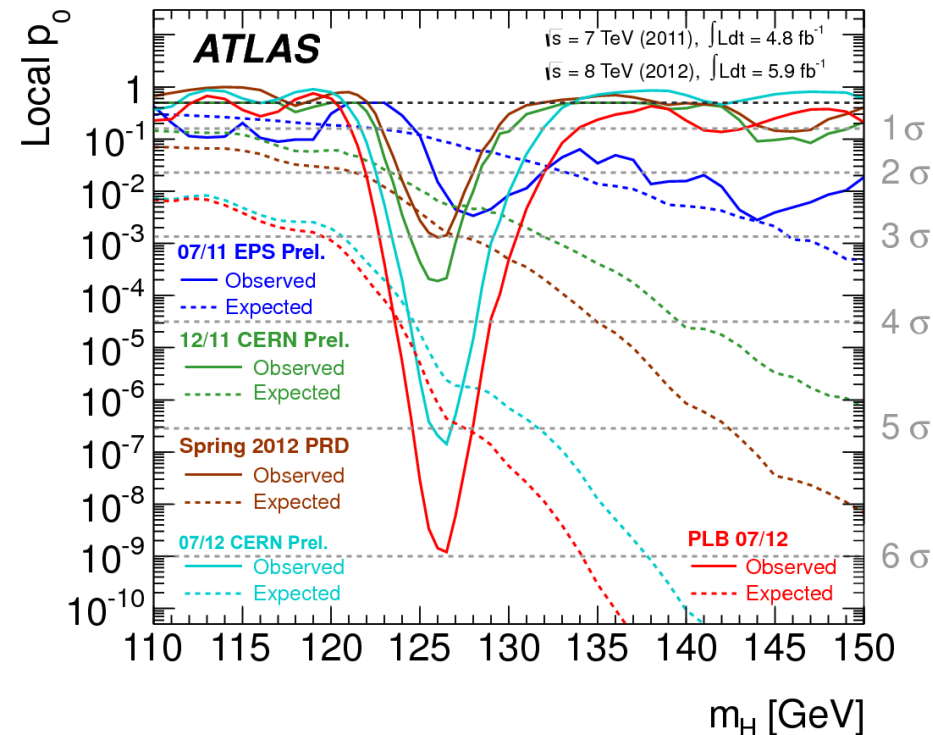
- Since July 4th, publication of observation paper including 8 TeV $WW \rightarrow e\nu\mu\nu$ channel
- 2.8 sigma excess in this channel alone (7+8 TeV data)



[*Phys. Lett. B* 716 \(2012\) 1-29](#)



Higgs Combination: Update since 4th July CERN Council



$\gamma\gamma$ and 4-lepton combination:
 $m(H) = 126.0 \pm 0.4 \pm 0.4 \text{ GeV}$

4th July → [Phys. Lett. B 716 \(2012\) 1-29](#)

Expected : 4.6 σ → 4.9 σ

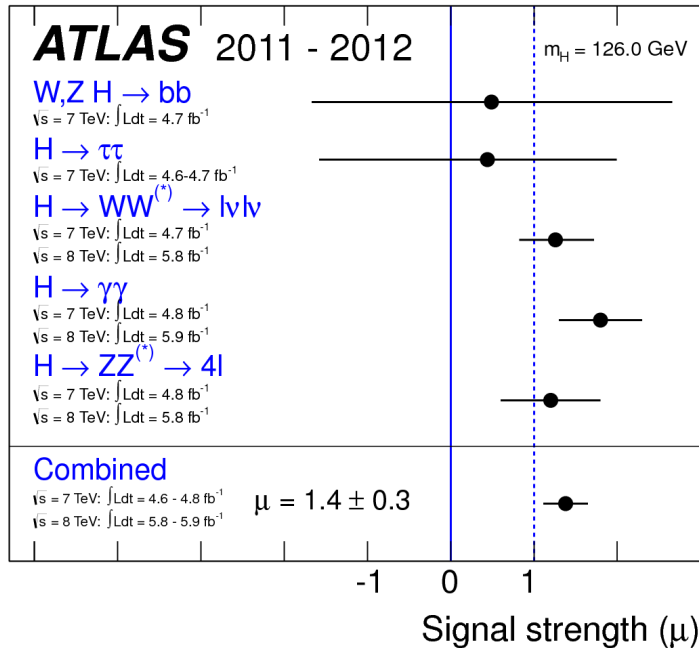
Observed local : 5.0 σ → 5.9 σ

Observed global* : 4.1 σ → 5.1 σ

* full range

Higgs Couplings

ATLAS-CONF-2012-127



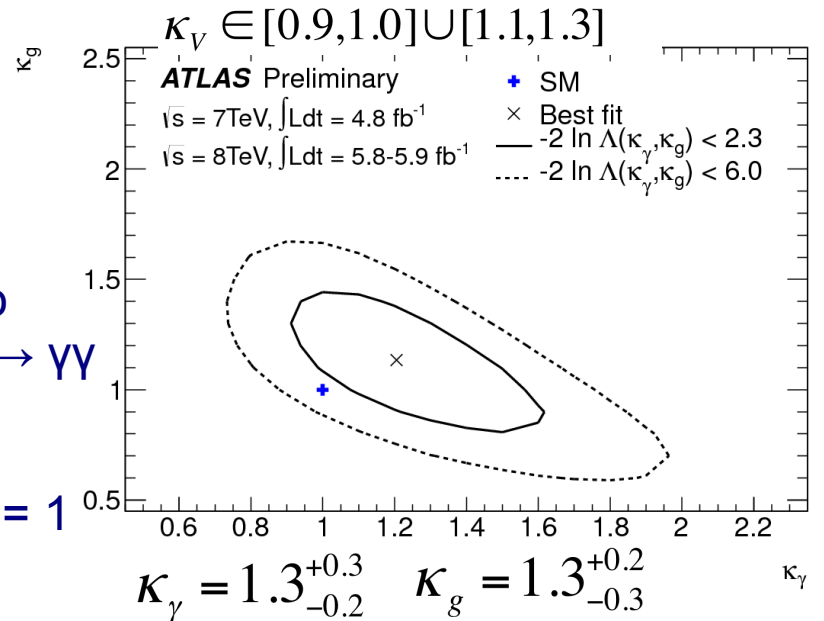
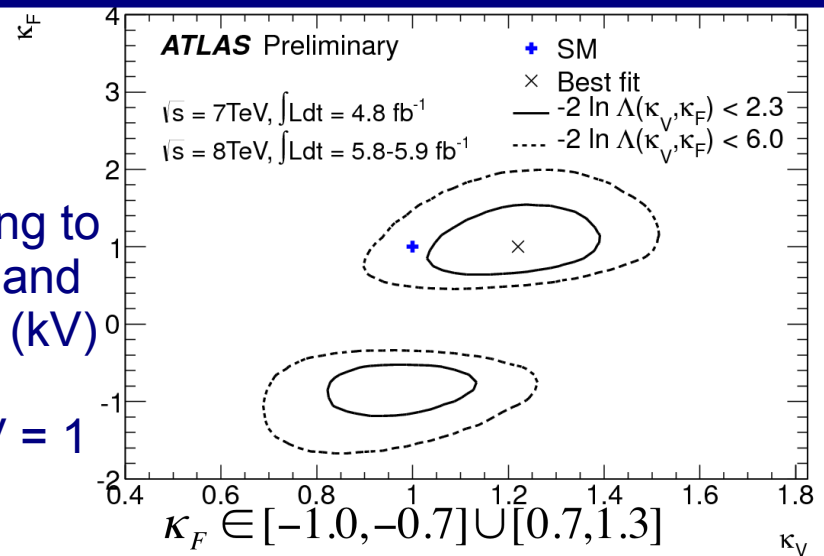
- Using the Higgs LHC cross-section working group formalism: hep-ph: 1209.0040
- Projected sensitivity for 300 and 3000 fb^{-1} studied in the context of ESPP: ATL-PHYS-PUB-2012-001

2D fit of coupling to Fermions (k_F) and Vector bosons (k_V)

In SM: $k_F = k_V = 1$

Probe non-SM contributions to $gg \rightarrow H$ and $H \rightarrow \gamma\gamma$ loops

In SM: $k_g = k_\gamma = 1$

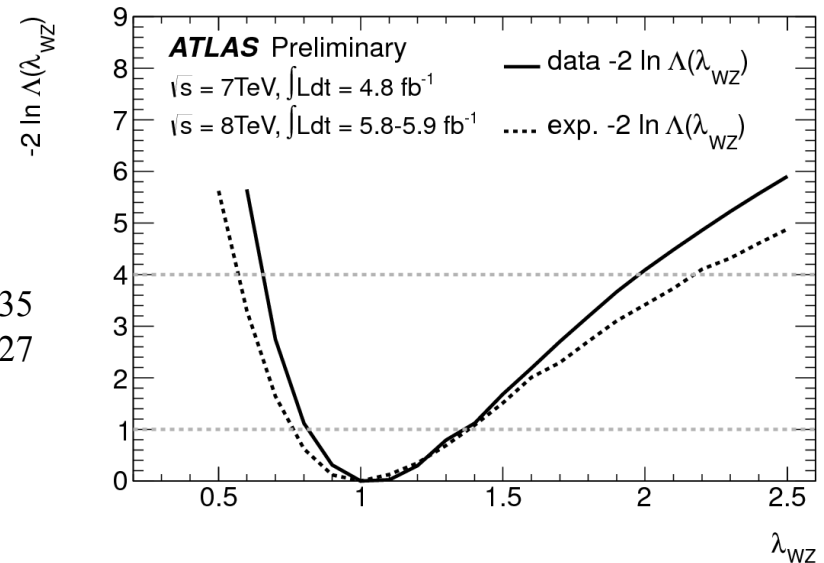


Higgs Couplings

- Test of custodial symmetry:

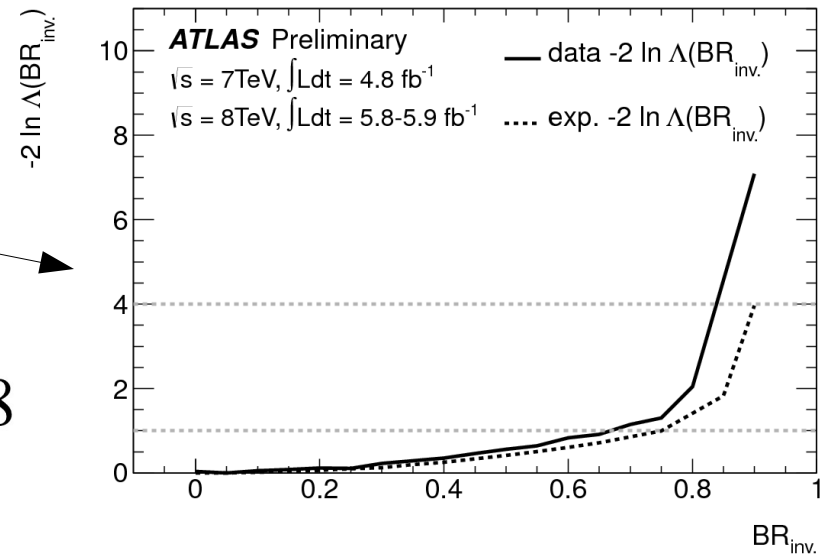
$$\lambda_{WZ} = k_W/k_Z \quad (= 1 \text{ in SM})$$

$$\lambda_{WZ} = 1.07^{+0.35}_{-0.27}$$



- Probe potential non-SM contribution to $gg \rightarrow H$ and $H \rightarrow \gamma\gamma$ loops, assuming a possible invisible Higgs branching ratio

$$B_{inv.,und.} < 0.68$$

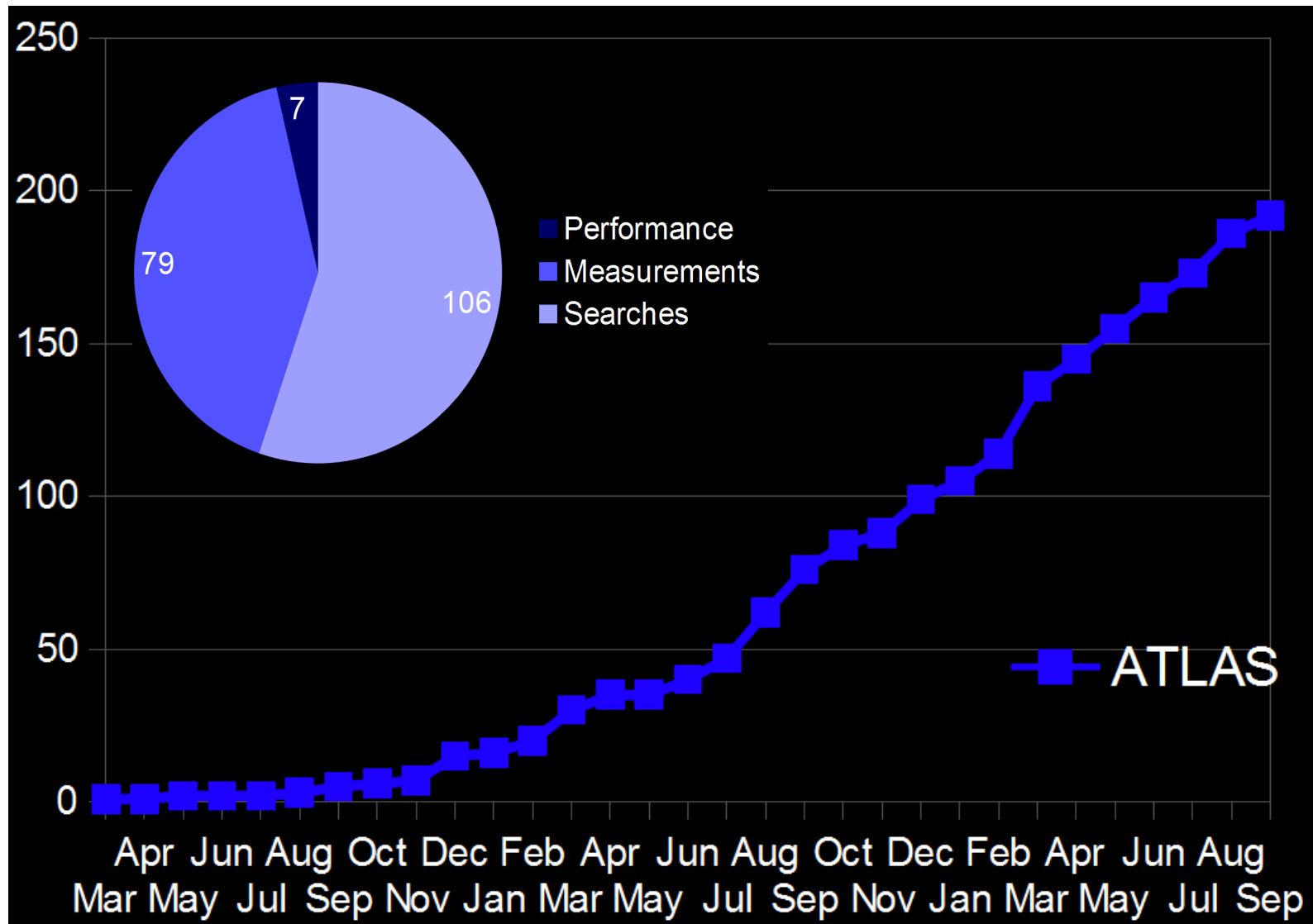


Conclusion

- **Many thanks to the LHC team for the superb performance of the LHC !**
- **ATLAS detector continues to operate well**
 - High data-taking efficiency and data-quality
 - Successful high-luminosity operation (trigger, pile-up under control)
- **A wealth of data being analyzed in all directions**
 - Heavy ions
 - Precision measurements using all center-of-mass energy datasets
 - BSM searches on 7 TeV data completed, on 8 TeV well underway
- **Quickly entering the era of Higgs measurements**
 - More data ($\sim 25 \text{ fb}^{-1}$ at 8 TeV) would be extremely useful!
- **Very good progress also on upgrade activities and physics studies for HL-LHC (input submitted to the European Strategy Symposium in Cracow)**

Backup

ATLAS Publications



<http://atlasresults.web.cern.ch/atlasresults/>

Fast Reprocessing

- Planning a reprocessing of the 2012 data with improved conditions (Inner detector and muon spectrometer alignments etc...).
- This reprocessing will happen at the Tier-1's and will be used for results shown at Moriond 2013.
- Data taken so far to be reprocessed is ~1.5B events.

ttbar-based b-tagging calibration

ATLAS-CONF-2012-097

b-tag eff measured in $t\bar{t}$ events with three complementary methods:

- **Kinematic selection (lepton+jets and dilepton):**

Tight kinematic selection to get high signal purity.

One b-tagged jet at preselection stage (lepton+jets).

$$\varepsilon_b = \frac{1}{f_b} (f_{tag} - \varepsilon_c \cdot f_c - \varepsilon_l \cdot f_l - \varepsilon_{fake} \cdot f_{fake})$$

- **Tag counting (lepton+jets and dilepton):**

ε_b from fit to the number of b-tagged jets per event.

Flavor fractions largely from simulated events.

- **Kinematic fit (lepton+jets):**

χ^2 -fit to map jets to top- and W -decays.

Use b-jet on hadronic side to measure ε_b .

Data-driven background subtraction.

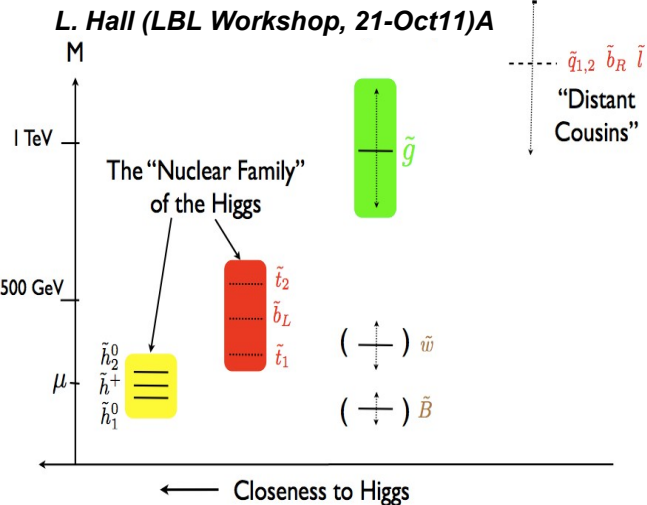
- **Results consistent with μ -based methods.**

- **Significantly reduces uncertainties on data-to-MC SFs at high jet pT.**

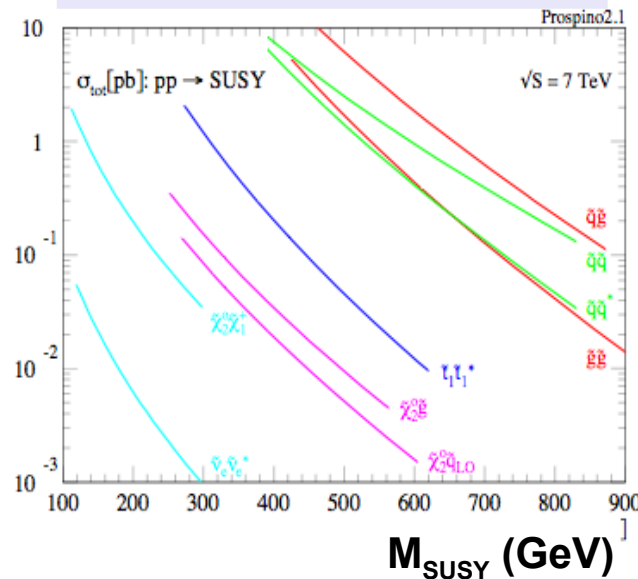
ATLAS SUSY Search strategy

Inclusive searches

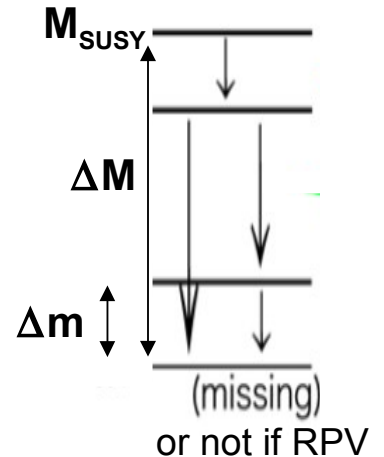
Mass Spectrum



Production cross-section



Decay



Phenomenology

1. Strong production (low, high $\Delta M/M_{\text{SUSY}}$)
2. Natural spectrum
3. Low Δm , tiny RPV, weak coupling to \tilde{G}
4. 'Sizeable' RPV
5. MSSM Extensions?

Signature

Inclusive jets+MET

Dedicated searches with bjets, multileptons, jet/Z veto

Long Lived or meta-stable sparticles

Multileptons (inc. tau), No Z, jet resonances, LFV

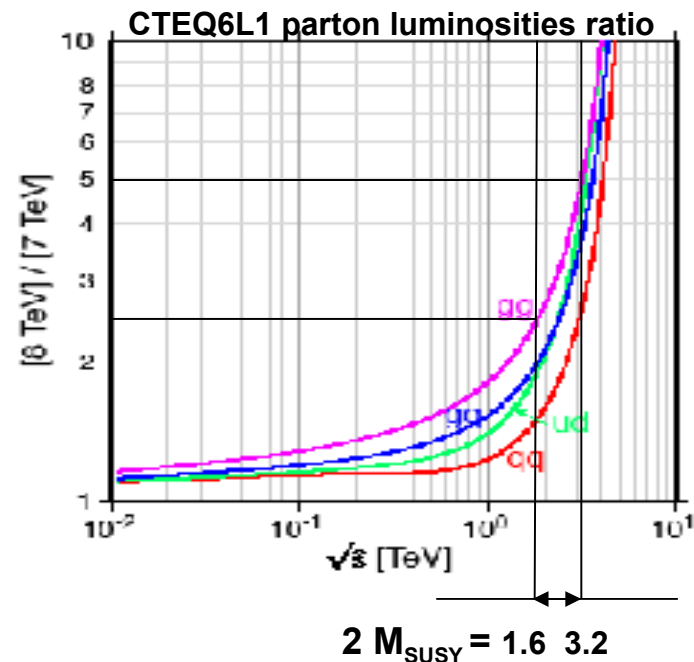
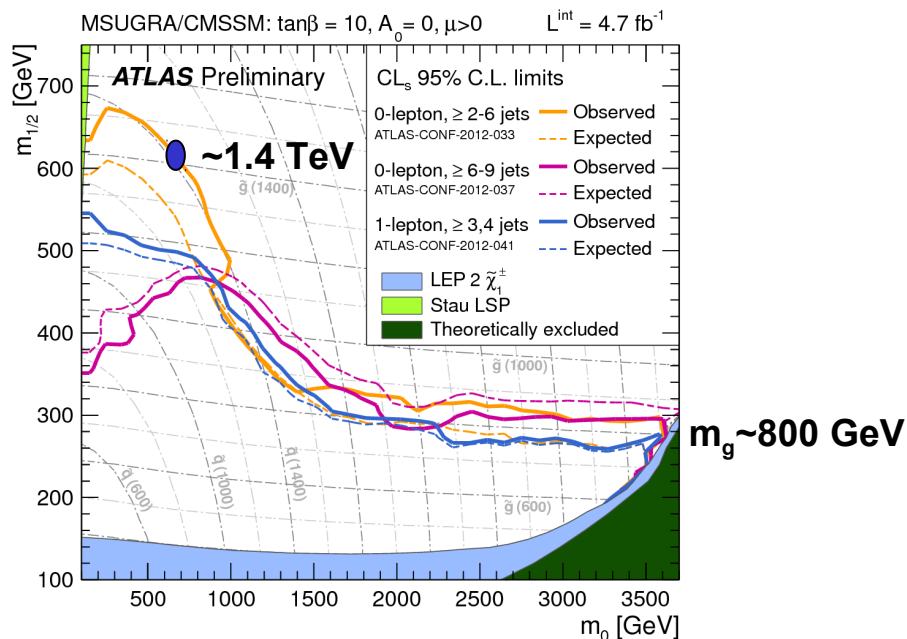
Scalar Gluon

→ Phenomenology oriented searches

Inclusive searches

□ Status and outlooks on SUSY energy frontier search

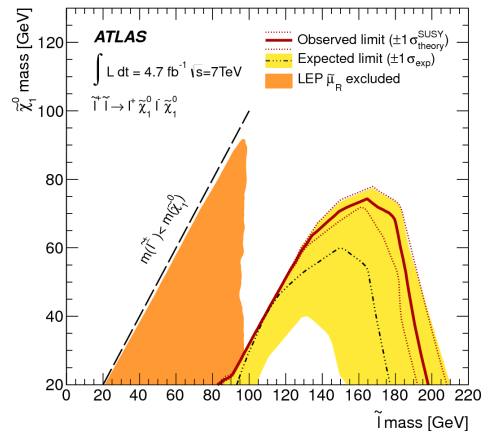
- Exclude up to 1.4 TeV @ $\sqrt{s}=7$ TeV ($m_{\tilde{g}}=m_{\tilde{q}}$) and $m_{\tilde{g}} > 800$ GeV
- At the energy frontier $\sqrt{s}=8$ TeV can gain ~ 2.5 -5 in parton luminosity wrt 7 TeV
 ➔ Expect a sensitivity increase of few hundreds GeV



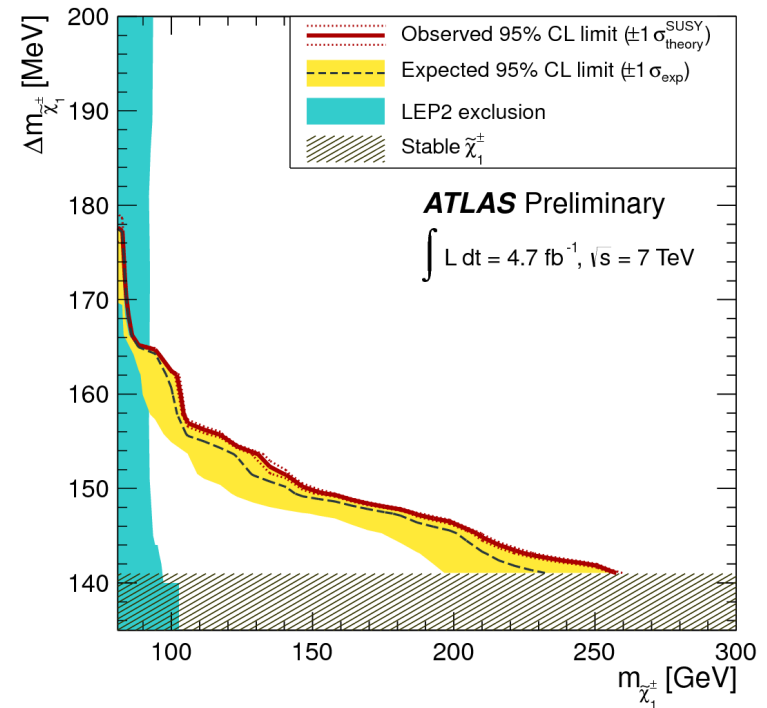
➔ Worth to look at $\sqrt{s}=8$ TeV with $L(7 \text{ TeV}) \sim L(8 \text{ TeV})$!

Long-Lived Particles Direct sleptons

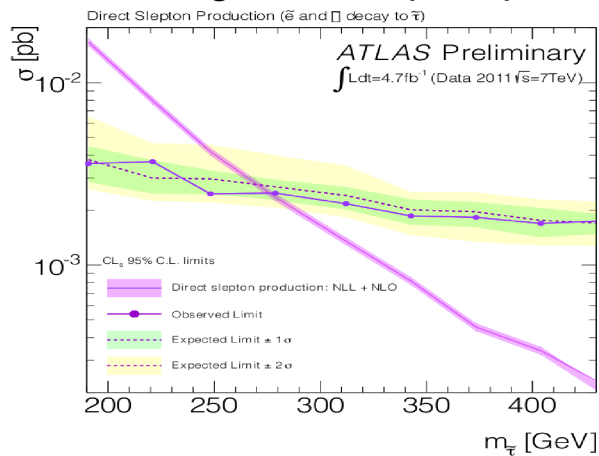
Direct Slepton production (first LHC limit)



Disappearing track (sensitivity beyond LEP2)



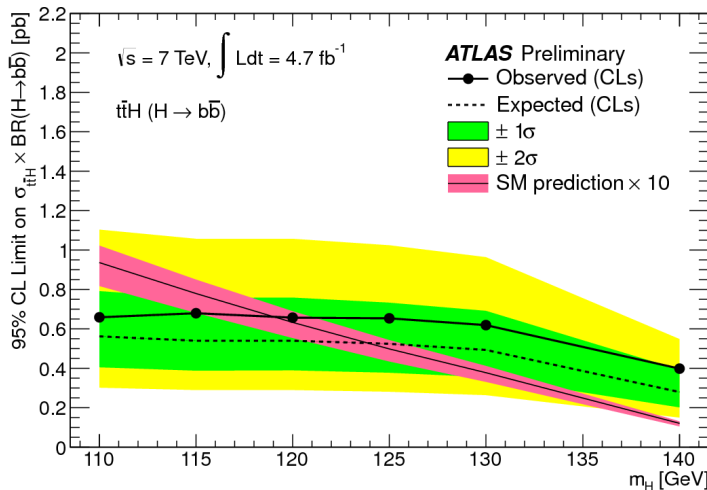
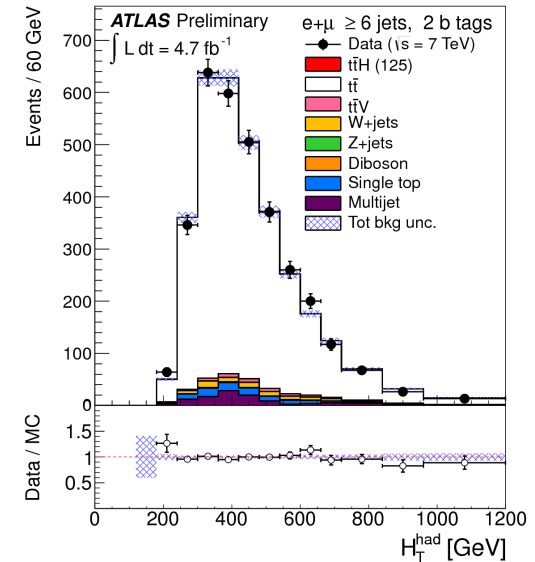
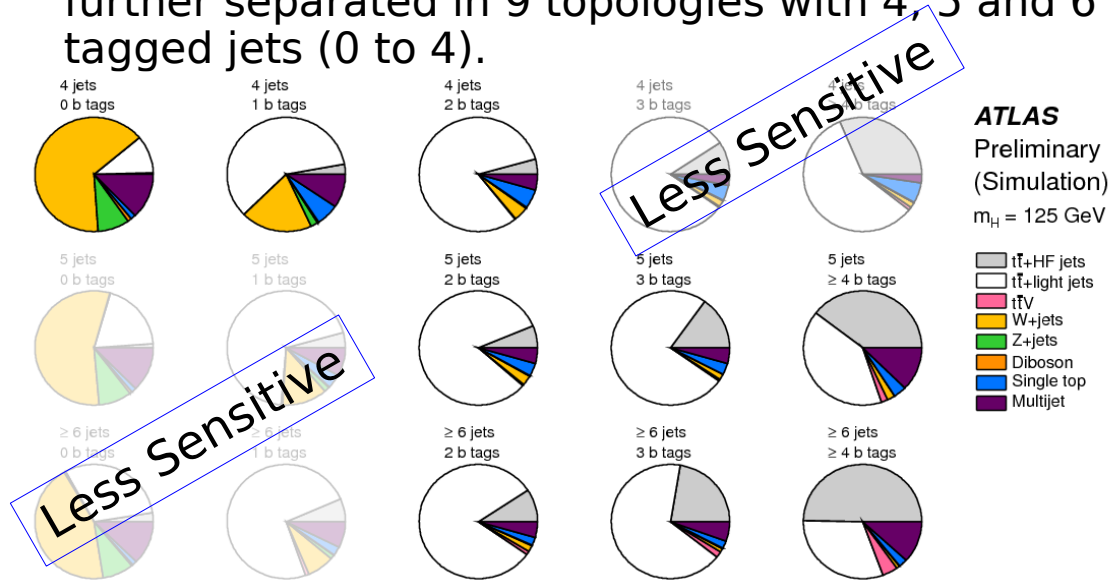
Direct long-lived Slepton production



Search for the SM-Higgs boson in the
With 7 TeV (4.7 fb⁻¹) 2011 data only

Channel $t\bar{t}(H \rightarrow b\bar{b})$

→ Semi leptonic topologies with four or more jets (pT_{jet} > 25 GeV and $|\eta| < 2.5$) further separated in 9 topologies with 4, 5 and 6 or more jets and number of *b*-tagged jets (0 to 4).



→ Result :

- Dominant background (tt+jets)
- Uncertainty on tt+HF prediction

50%

- Result :

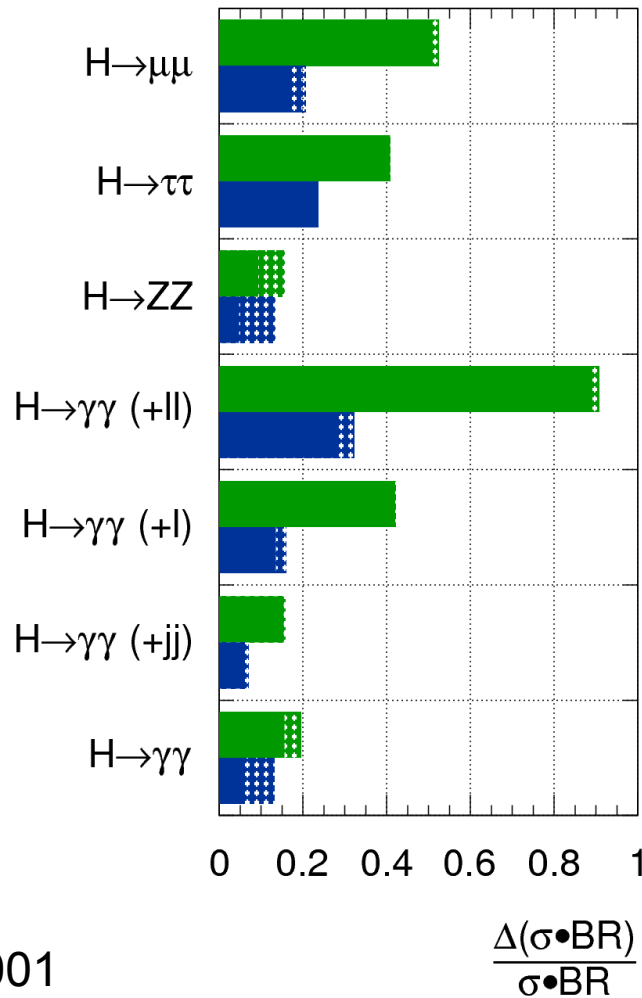
**O(10) x SM expected cross
section**
ATLAS-CONF-2012-135

Physics at High Luminosity

- Expected precision on Higgs BR and partial width with 300 and 3000 fb⁻¹

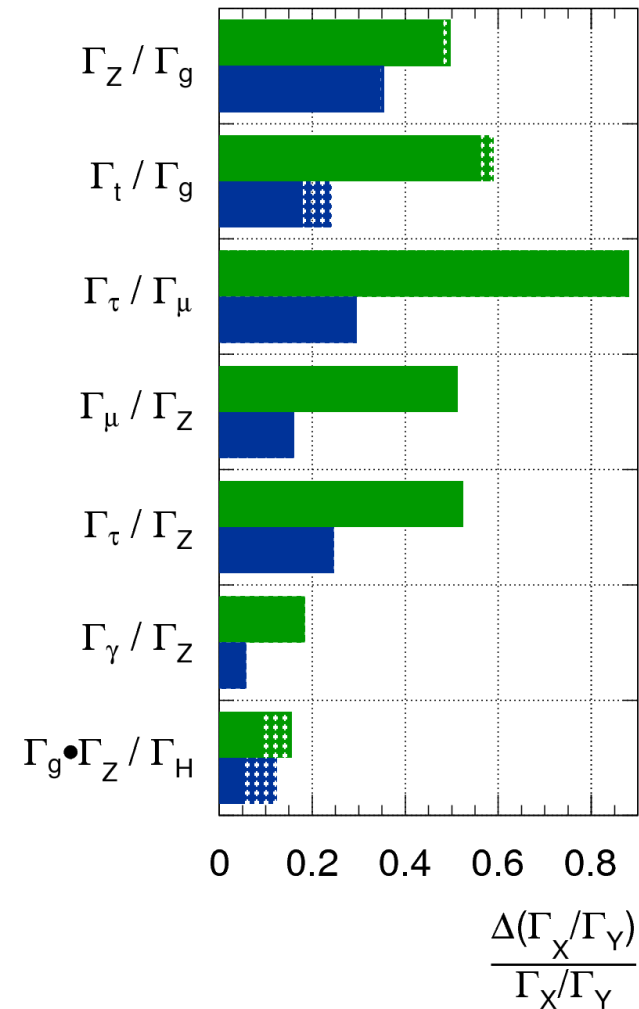
ATLAS Preliminary (Simulation)

$\sqrt{s} = 14$ TeV: $\int L dt = 300 \text{ fb}^{-1}$; $\int L dt = 3000 \text{ fb}^{-1}$



ATLAS Preliminary (Simulation)

$\sqrt{s} = 14$ TeV: $\int L dt = 300 \text{ fb}^{-1}$; $\int L dt = 3000 \text{ fb}^{-1}$



ATL-PHYS-PUB-2012-001

Fast Reprocessing

- Planning a reprocessing of the 2012 data with improved conditions (Inner detector and muon spectrometer alignments etc...).
- This reprocessing will happen at the Tier-1's and will be used for results shown at Moriond 2013.
- Data taken so far to be reprocessed is ~1.5B events.