

RECENT ATLAS RESULTS

Ilya Korolkov,
IFAE (Barcelona)

On behalf of the ATLAS/Spain Community
November 26, CPAN-V, Santiago de Compostela, 2013



Outline

- LHC and ATLAS
- Spanish Contributions
(thanks to everyone for the input)
- ATLAS Selected Results
- Conclusion

Fortunately, dedicated talks were given on some topics, including the experiment upgrade effort.

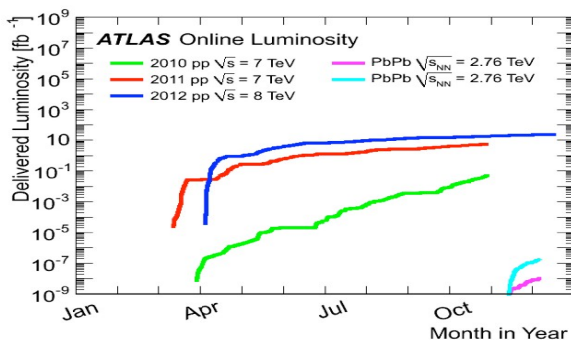
A comprehensive overview but somehow **centered on the Spanish contributions** in the last years.

Many results exist that will not be shown, apologies for that, ~100 paper, >100 conf. notes

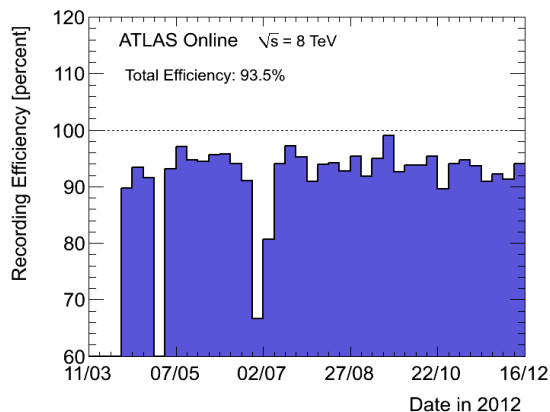
Spectacular LHC performance in 2012

ATLAS integrated luminosity in 2012

- Peak $L = 7.7 \times 10^{33} \text{ s}^{-1} \text{ cm}^{-2}$ (Aug)
- Max L/fill : 237 pb^{-1} (June)
- Weekly record: 1350 pb^{-1} (June)
- Longest stable beams: 22.8 h (July)
- Fastest turn-around between stable beams: 2.1 h (April)
- Best weekly data-taking efficiency: 92 h (55%) (July)



ATLAS Luminosity measured with dedicated systems (one of the system is managed by Spanish group), calibrated with beam separation scans. Uncertainty: $\sim 2\%$
 21.7 /fb @8TeV on tape in 2012,
 5.2 /fb in 2011



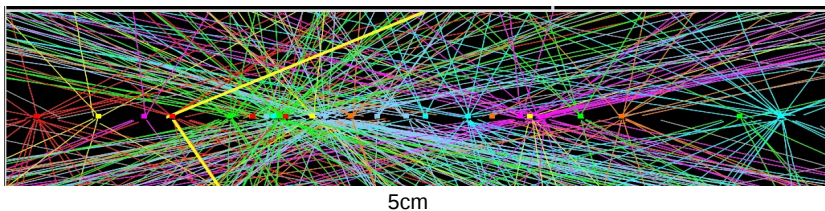
Data taking efficiency 93.5%,

Now the experiments are in maintenance mode until the end of 2014.

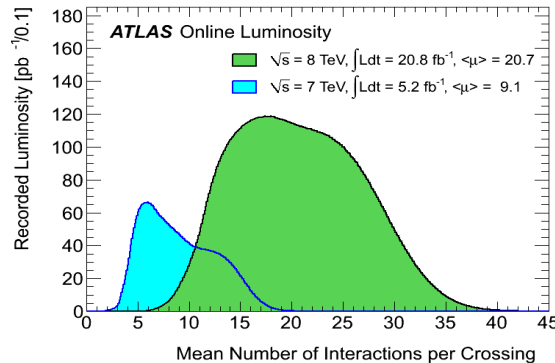
Spanish groups strongly commit to the detector operations.



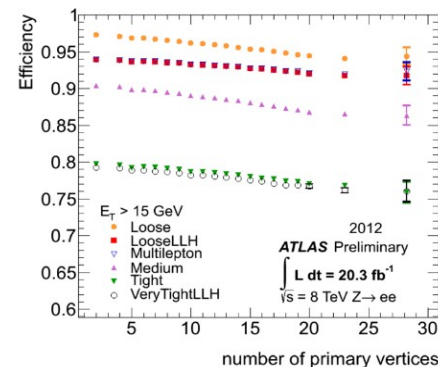
Luminosity comes with large pile-up. This is (and will remain) main challenge. While ATLAS handles it well.



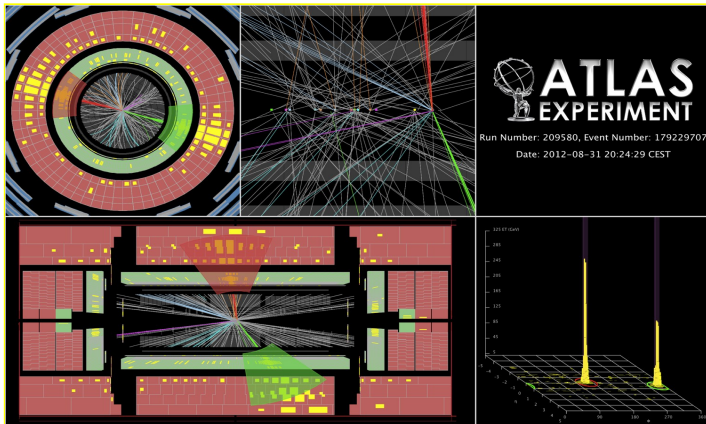
Z candidate, with 25 vertexes



Number of vertexes



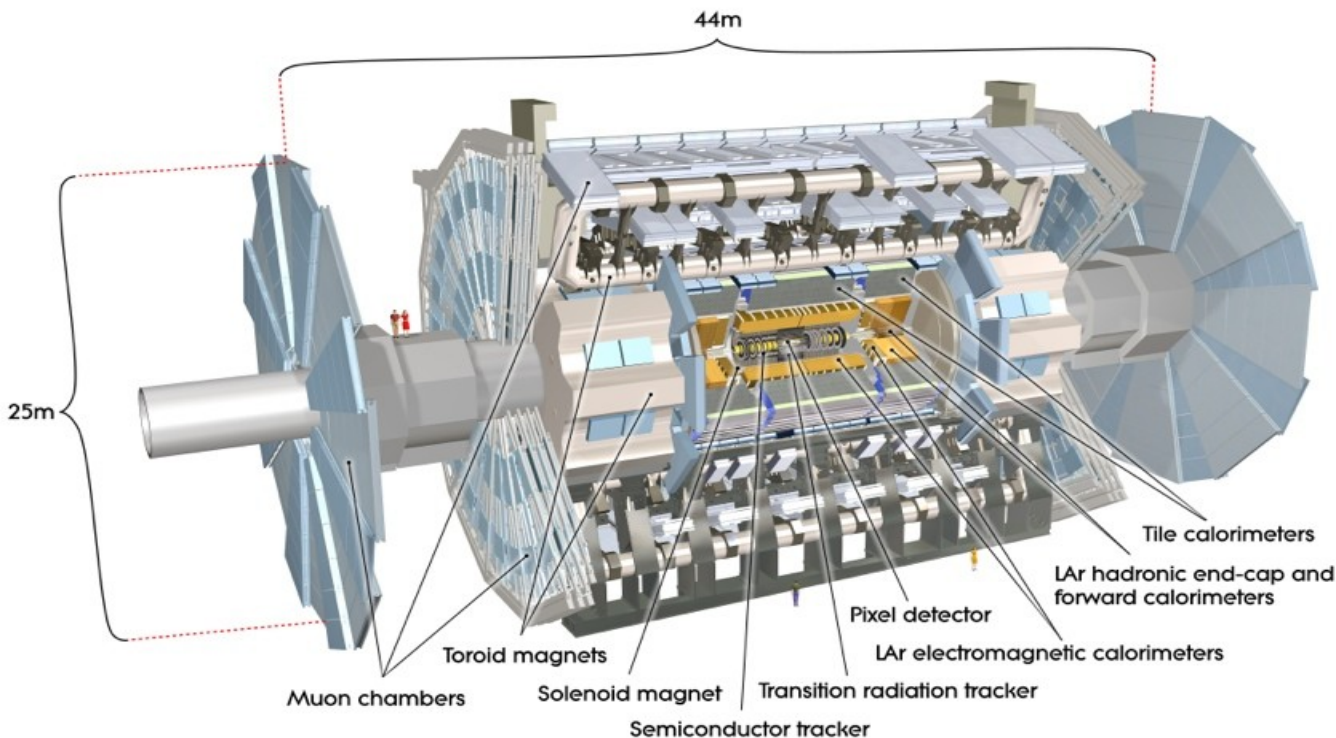
Electron rec. eff.



Di-jet event with 4.7TeV inv. mass

$m_{jj} = 4.7 \text{ TeV}$, $p_T(j_1, j_2) = 2.3-2.2 \text{ TeV}$
 Very well measured: $E_{T, \text{miss}} = 47 \text{ GeV}$

ATLAS detector



- **Inner tracker** $|\eta| < 2.5$
 $\frac{\sigma(p_T)}{p_T} \approx 0.05\% p_T \oplus 1\%$
- **Calorimetry** $|\eta| < 3.2$
 EM: $\frac{\sigma(E)}{E} \approx \frac{10\%}{\sqrt{E}} \oplus 0.7\%$
 Had: $\frac{\sigma(E)}{E} \approx \frac{50\%}{\sqrt{E}} \oplus 3\%$ $|\eta| < 4.9$
- **Muon spectrometer** $|\eta| < 2.7$
 $\frac{\sigma(p_T)}{p_T} \approx 2\%$ @50 GeV :
 $\frac{\sigma(p_T)}{p_T} \approx 13\%$ @ 1 TeV
- **Magnets**
 - ✓ solenoid : 2 T
 - ✓ toroid : 0.5 T (barrel), 1 T (endcap)
- **Trigger**
 - ✓ 3 Levels, 420 MHz \rightarrow 200 Hz

Spain @ ATLAS



Strong contributions to the experiment well-being:

**Pixel IBL,
SCT End Cap,
LAR End Cap,
TileCal,
Trigger,
Luminosity,
Computing,
Detector Operations,
Data Processing,
Detector Performance,
Combined Performance.**

Huge amount of work

About 70 physicists

Presence in the ATLAS top management

Chair Collab. Board (M. Bosman)
Speakers Committee Advisory Board Chair (I. Riu)
Speakers Committee (C. Padilla)

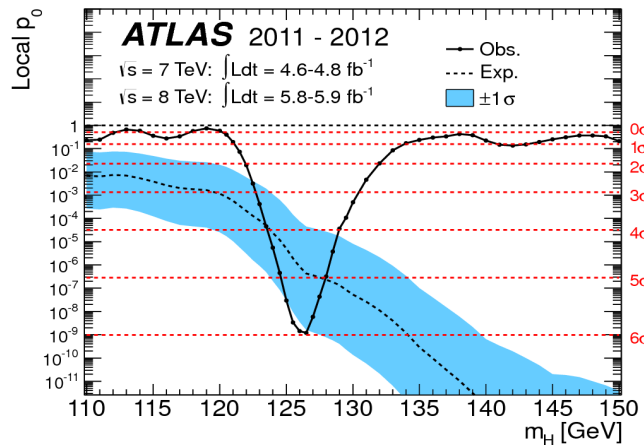
Recent Phys coord positions

TopPhysics (M. Bosman, M.J. Costa)
ExoticPhysics (E. Ros)
Data Preparation Coordinator (L. Fiorini)

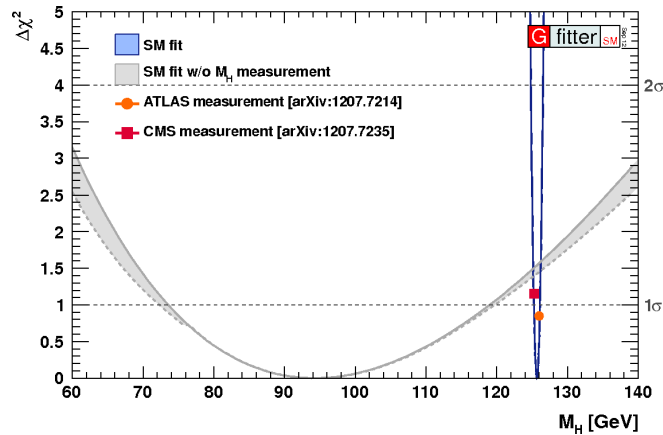
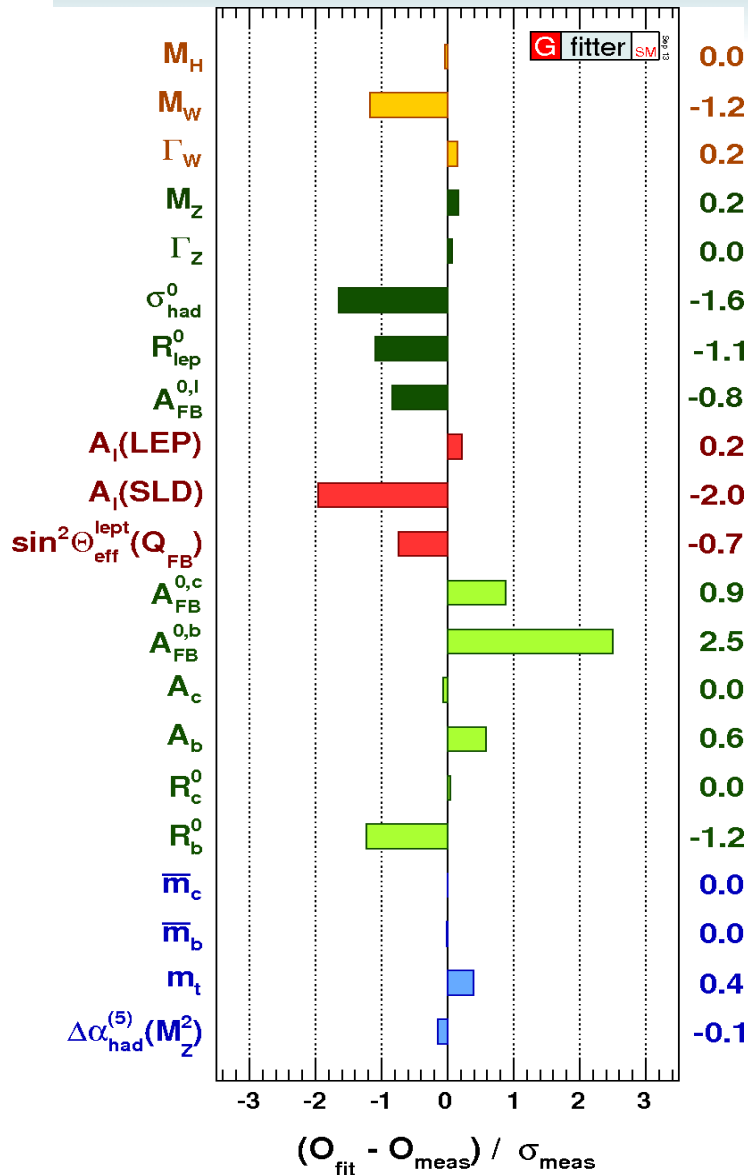
Many positions in operations

**Editors of many papers and members of many EdBs
Well represented in the conferences**

The Announcement (4th July 2012)

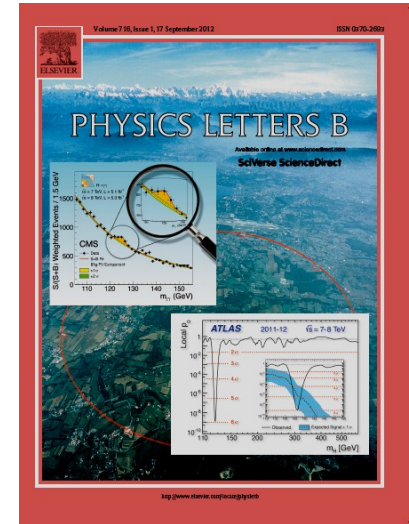


Physics ... Where do we stand?



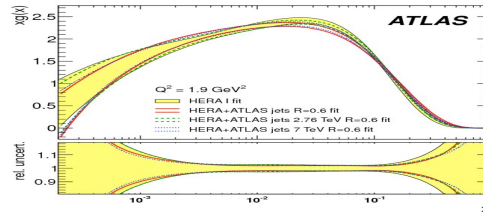
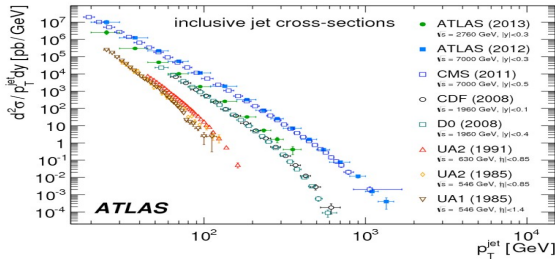
$$m_H = 125.5 \pm 0.2 \text{ (stat)} \begin{matrix} +0.5 \\ -0.6 \end{matrix} \text{ (sys) GeV. (ATLAS)}$$

Last year's **Higgs** discovery is probably the most important event in HEP in the last 30 years. And so these years will be remembered. While the **SM** measurements are necessary. And while there was no lack in effort looking for **BSM**.



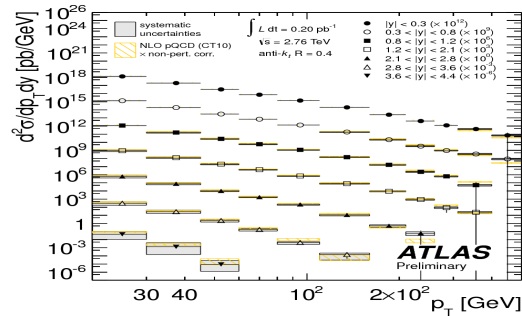
QCD

ATLAS has recently published the inclusive jet cross section at $\sqrt{s}=2.76$ TeV
 EPJC (2013) 73 2509, EPJC (2011) 71 1512,
 PRD 86 (2012) 014022

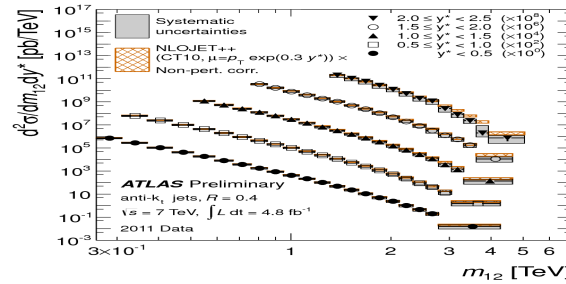


Gluon distribution harder when including ATLAS data

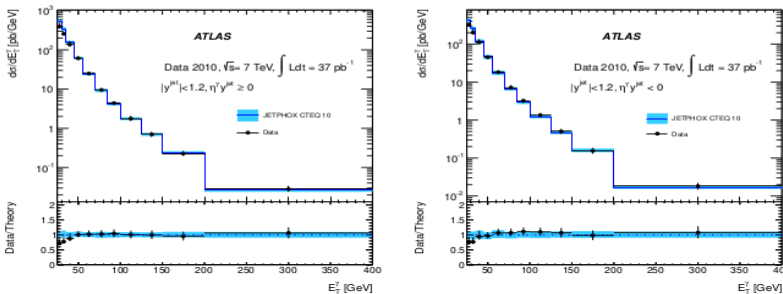
ATLAS-CONF-2012-021



ATLAS-CONF-2012-128



Kinematics of Photon+Jet Production with ATLAS



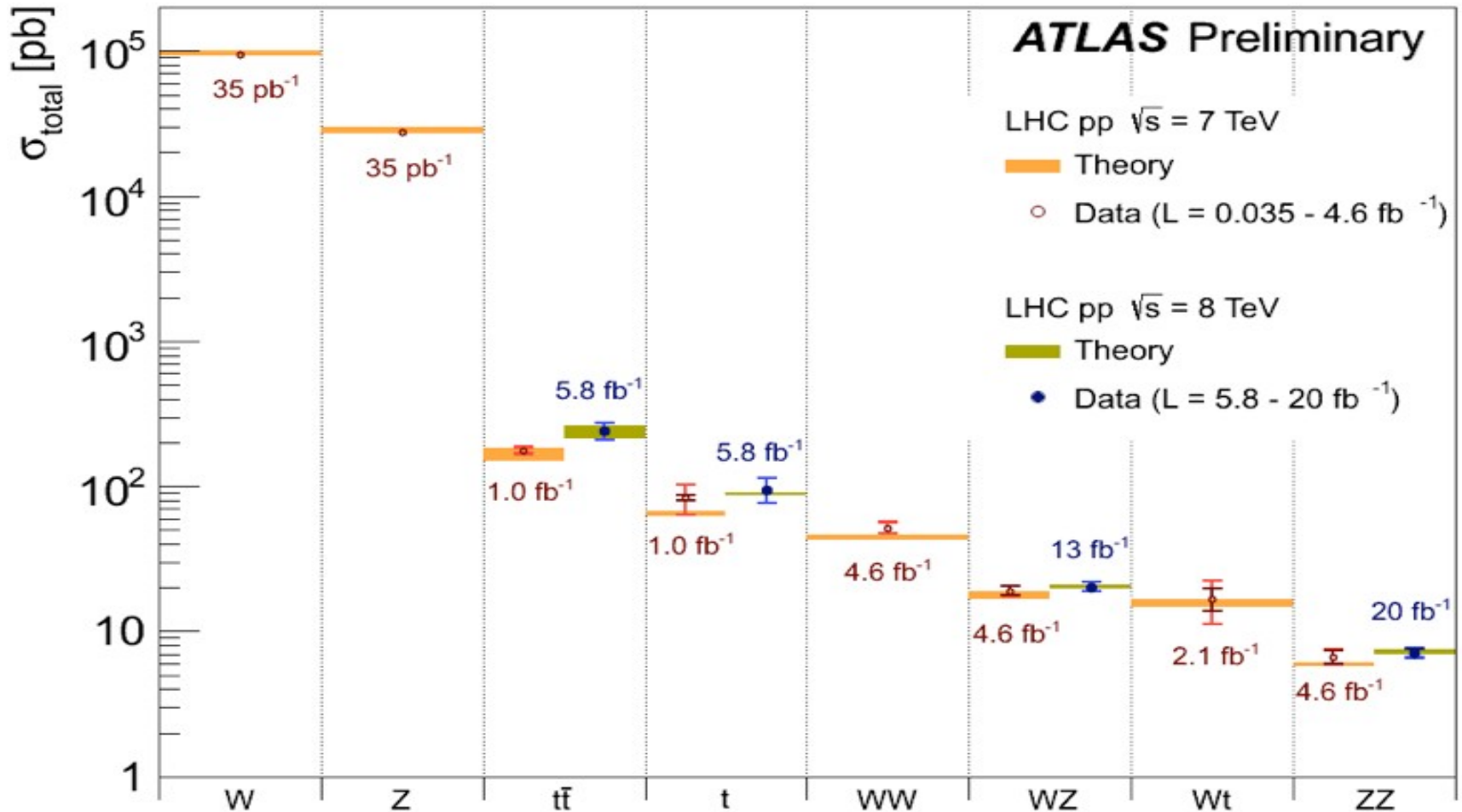
• Measurements of photon+jet production in pp collisions at $\sqrt{s} = 7$ TeV for photons with E_T^γ up to 400 GeV

• Same/Opposite side ($\eta^\gamma \cdot y^{jet}$) and three ranges in y^{jet}



Standard Model EW

Everything as expected, no 3sigma deviations

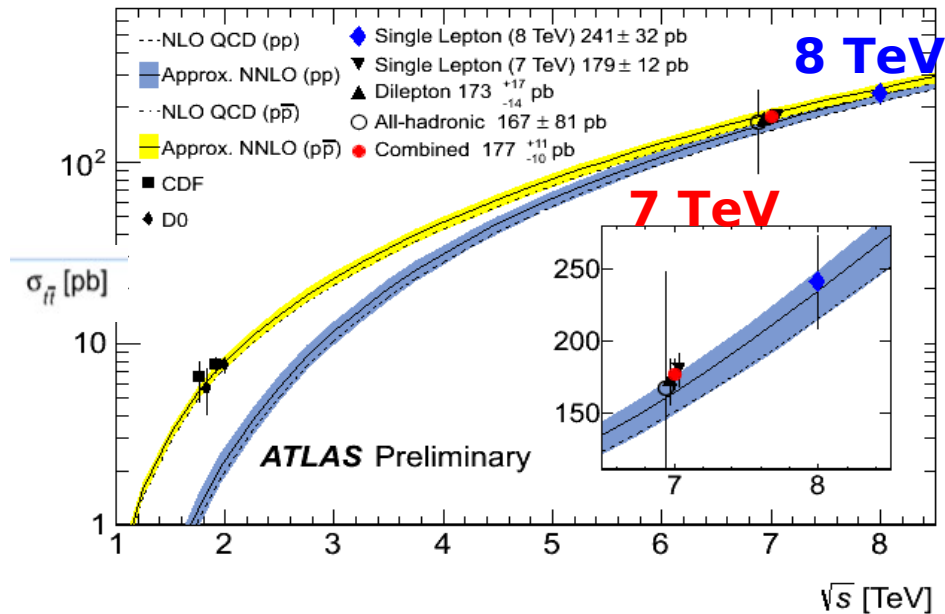
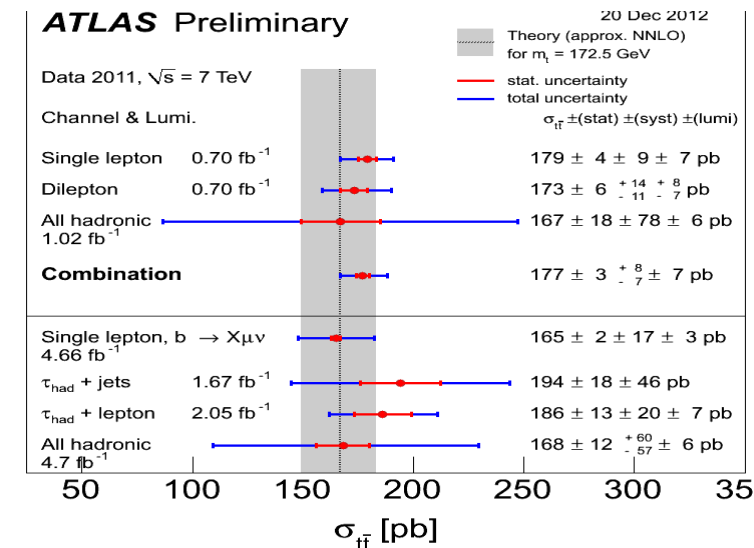
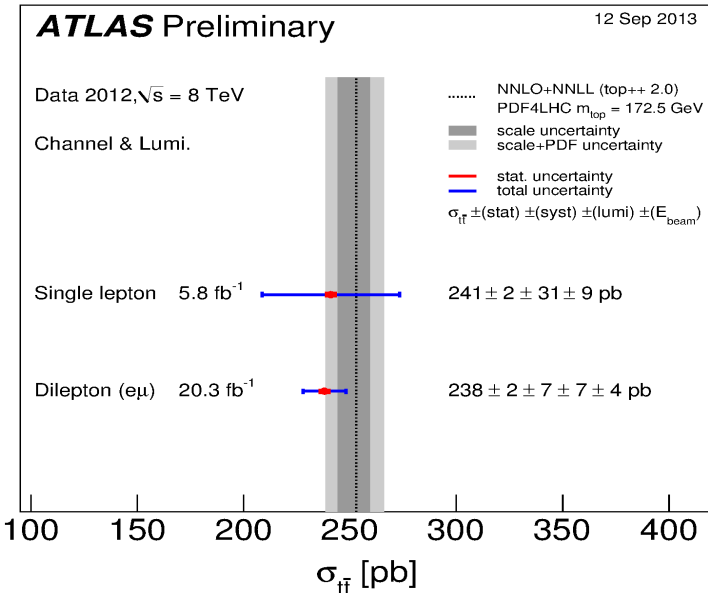


Top Physics:
one of the focal points of the Spanish
research in ATLAS

Top physics: production cross section $\sigma_{t\bar{t}}$



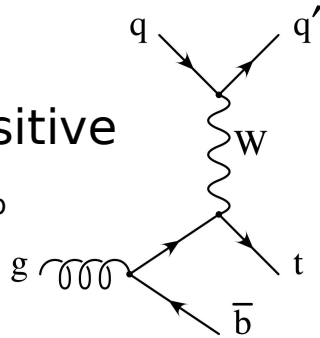
ATLAS-CONF-2012-024 combination
 ATLAS-CONF-2012-031 all hadronic
 ATLAS-CONF-2012-032 τ + jets
 ATLAS-CONF-2012-131 single lepton b tag.
 ATLAS-CONF-2012-149 8 TeV, single lepton
 Phys. Lett. B 717, (2012) 89-108 τ + lepton



$\sigma_{t\bar{t}}(8 \text{ TeV}) = 241 \pm 2 (\text{stat}) \pm 31 (\text{syst}) \pm 9 (\text{lumi}) \text{ pb}$

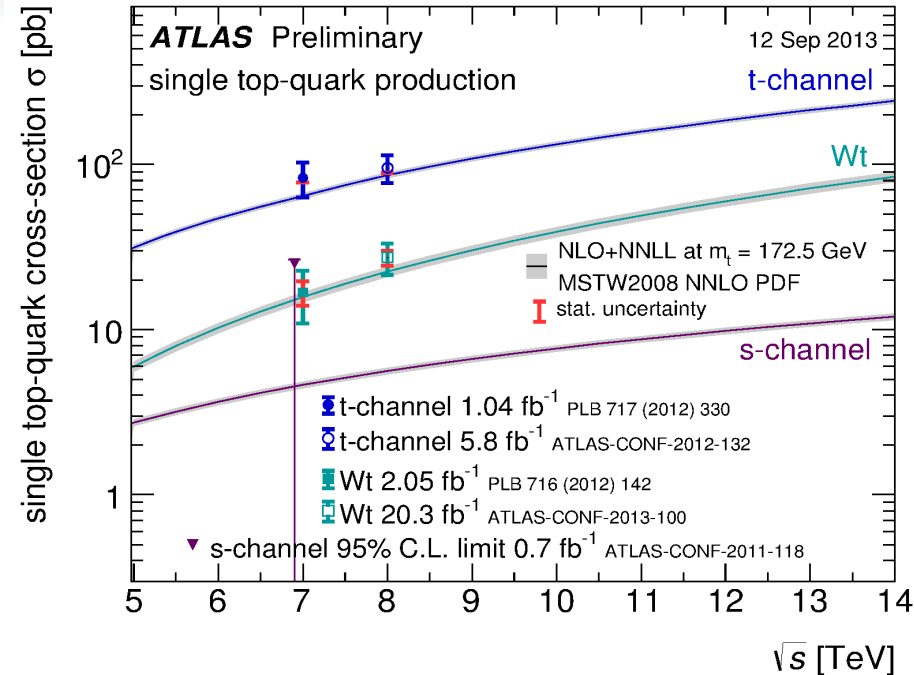
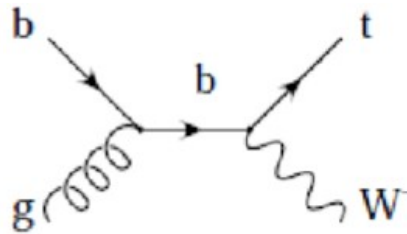
Single top cross section

• Sensitive to V_{tb}



$|V_{tb}| = 1.03^{+0.16}_{-0.19}$ (assuming $|V_{tb}| \gg |V_{ts}|, |V_{td}|$)
from Wt channel

First evidence of W+top channel



Comparison of different measurements in single top production with the theoretical NNLO prediction

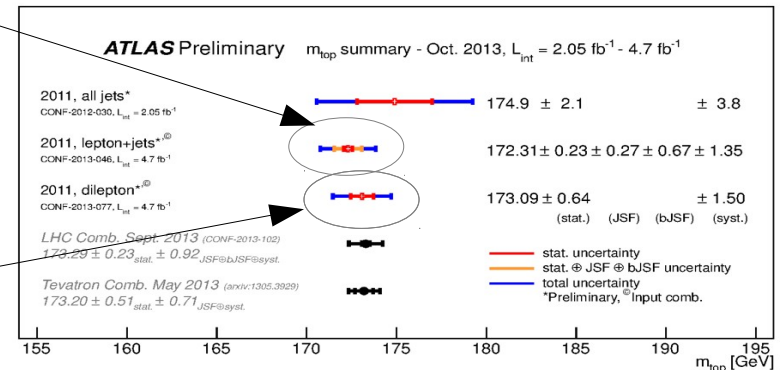
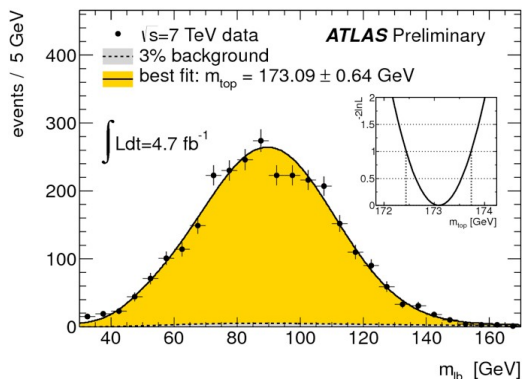
Top mass



Huge effort to reduce errors..

- Mainly reduce the major systematic, i.e. The jet energy scale. **Eur. Phys. J. C, 73 3 (2013) 2304**
- measured the jet shape and compared to different MC generators to evaluate parton modeling shower, fragmentation and event shape: **HEP 1205 (2012) 128**
- contributed to the measurement of the top mass: **Eur. Phys. J. C72 (2012) 2046 (*)**

ATLAS-CONF-2013-077



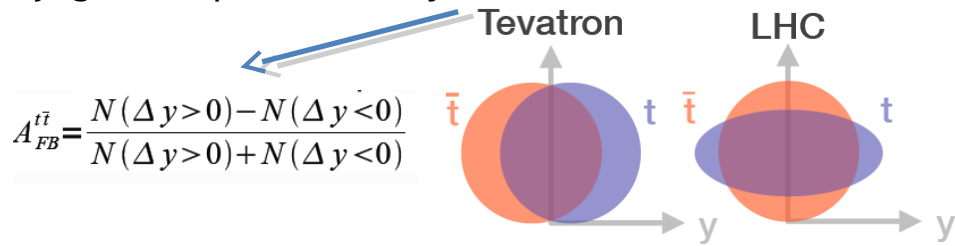
$M_{top} = 173.09 \pm 0.64(\text{stat}) \pm 1.50(\text{syst}) \text{ GeV}$

Top physics: charge asymmetry

- Charge asymmetry: there is a small asymmetry under C conjugation, predicted by the SM

$$A_C = \frac{N(\Delta|y| > 0) - N(\Delta|y| < 0)}{N(\Delta|y| > 0) + N(\Delta|y| < 0)}$$

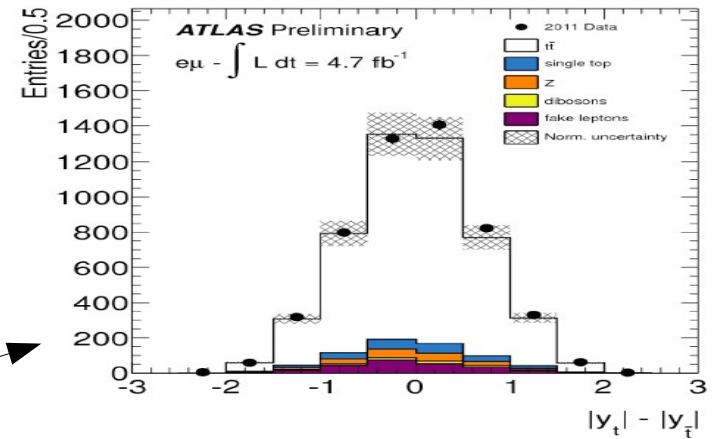
$$D|y| = |y_t| - |y_{\bar{t}}|$$



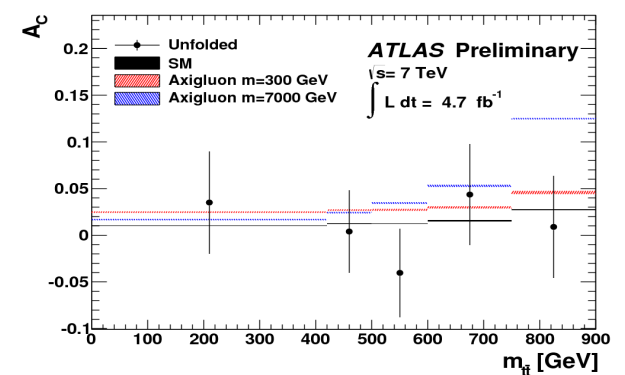
$$A_{FB}^{t\bar{t}} = \frac{N(\Delta y > 0) - N(\Delta y < 0)}{N(\Delta y > 0) + N(\Delta y < 0)}$$

- New Physics may enhance this effect
- Tensions between SM predictions and Tevatron value for forward/backward asymmetry at 2σ level
- LHC: charge asymmetry measured in dilepton and lepton+jet channels
- Combination of single and dilepton channels consistent with SM predictions

ATLAS-CONF-2012-057



ATLAS-CONF-2012-078



$$A_C = 0.006 \pm 0.010 \text{ (stat+sys)}$$

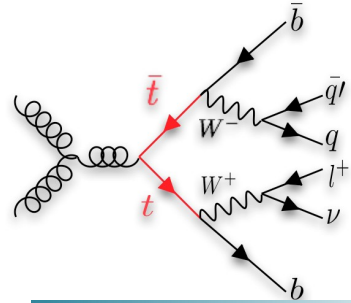
arXiv:1311.6724 [hep-ex]

Theory (MC@NLO): $A_C^{t\bar{t}} = 0.006 \pm 0.002$

Ilya Korolkov

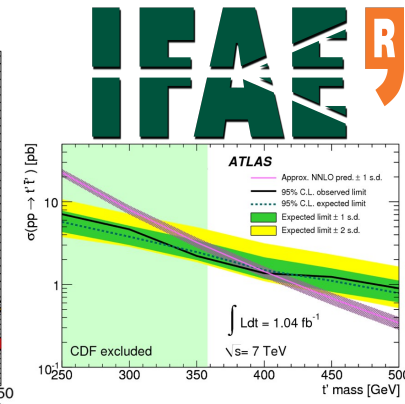
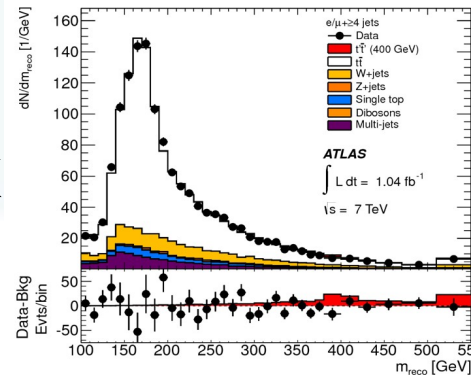


Search for pair production of a heavy quark decaying to a W boson and a b quark



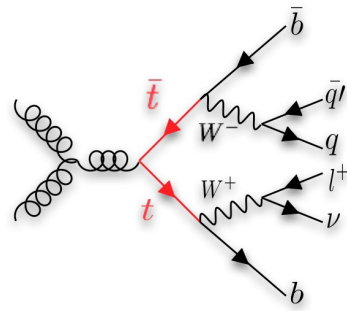
arXiv:1202.3076 [hep-ex]
PRL 108 (2012) 261802

Analysis based on 1 fb-1 of data resulting in an observed lower limit of $m_{t'} > 404$ GeV at 95% C.L.

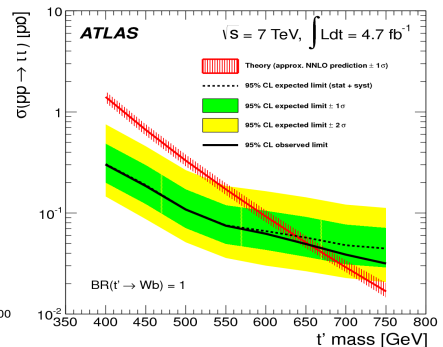
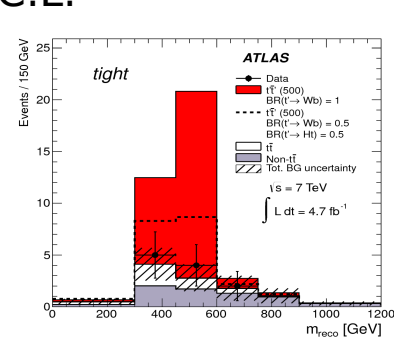


Phys. Lett. B 718 (2013) 1284-1302

t' searches



t' masses above 656 GeV excluded at 95% CL. Analysis optimized for $m(t') > 400$ GeV. Reconstruction of highly boosted W (hadronic decay). For vector-like quarks limits as a function of the mass and the BR ($t' \rightarrow Wb$) and ($t' \rightarrow Ht$)

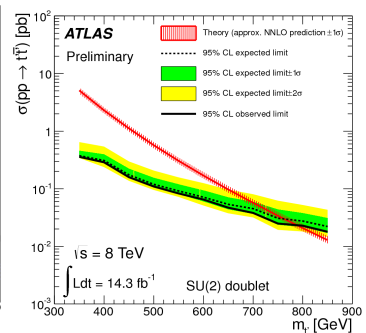
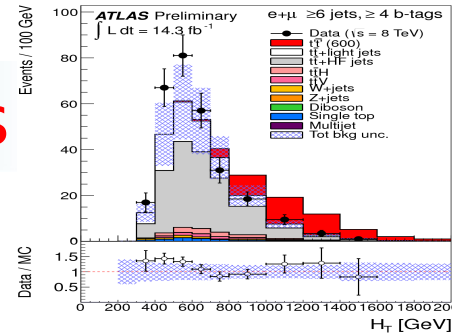


Search for vector-like quarks

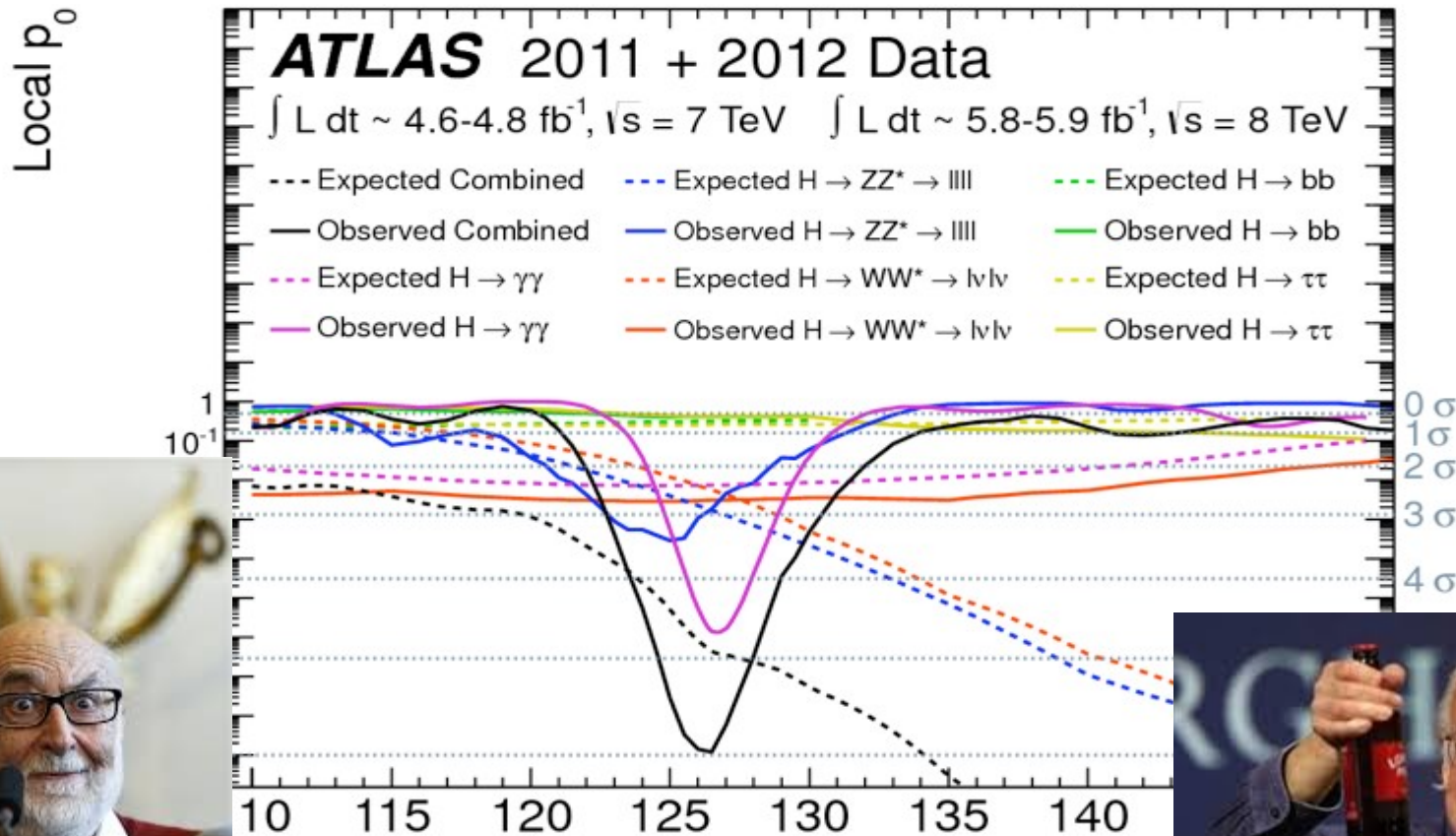
ATLAS-CONF-2013-018

Explores the decay $t' \rightarrow Ht$ ($H \rightarrow bb$)

Ilya Korolkov



Higgs boson discovered in 2012



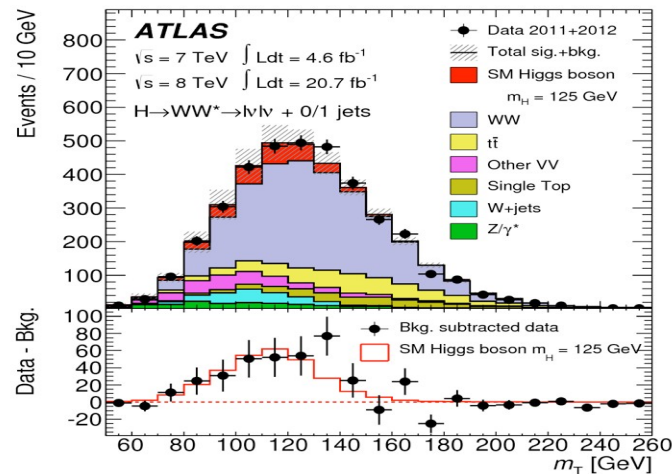
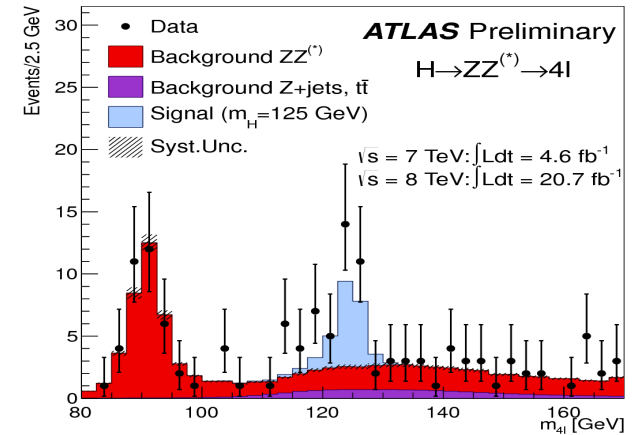
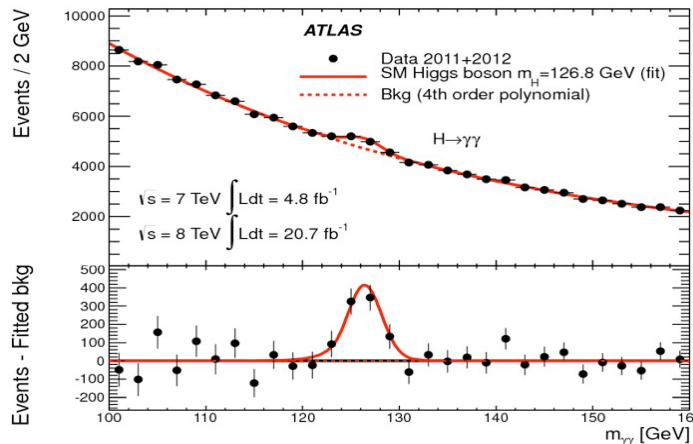
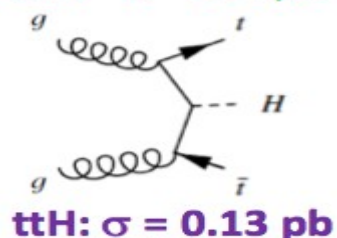
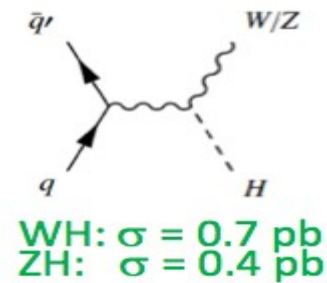
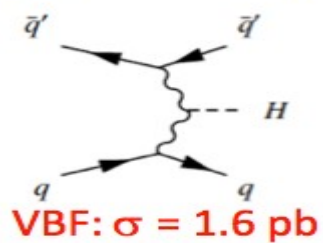
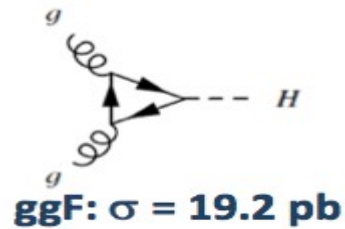
The 2013 Nobel prize for physics was awarded to François Englert and Peter Higgs: Congratulations!

Higgs boson: a reminder

LHC Higgs Xsec WG: <https://twiki.cern.ch/twiki/bin/view/LHCPhysics/CrossSections>

$\text{Br}(H \rightarrow WW) : 22\%$ $\text{Br}(H \rightarrow bb) : 57\%$
 $\text{Br}(H \rightarrow ZZ) : 2.8\%$ $\text{Br}(H \rightarrow \tau\tau) : 6.2\%$
 $\text{Br}(H \rightarrow \gamma\gamma) : 0.23\%$

For $m_H=125\text{GeV}$

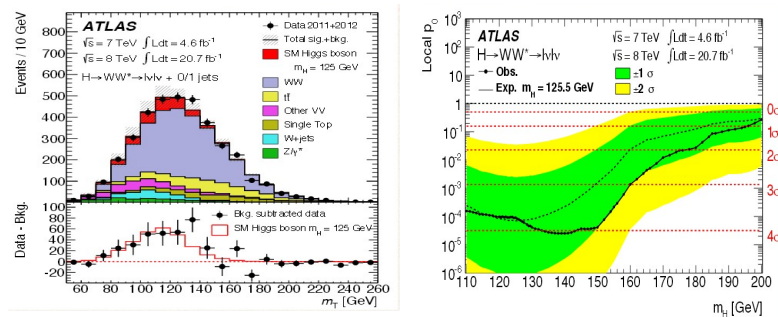




H[±] WW[±] lνlν analysis with ATLAS detector at LHC



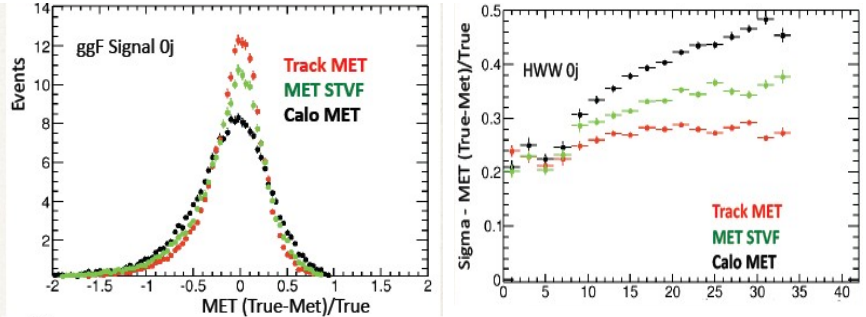
Situation @ Moriond 3.7σ expected sensitivity



Day after Moriond working on optimise to get 5σ!!

→ Introduced a new variable

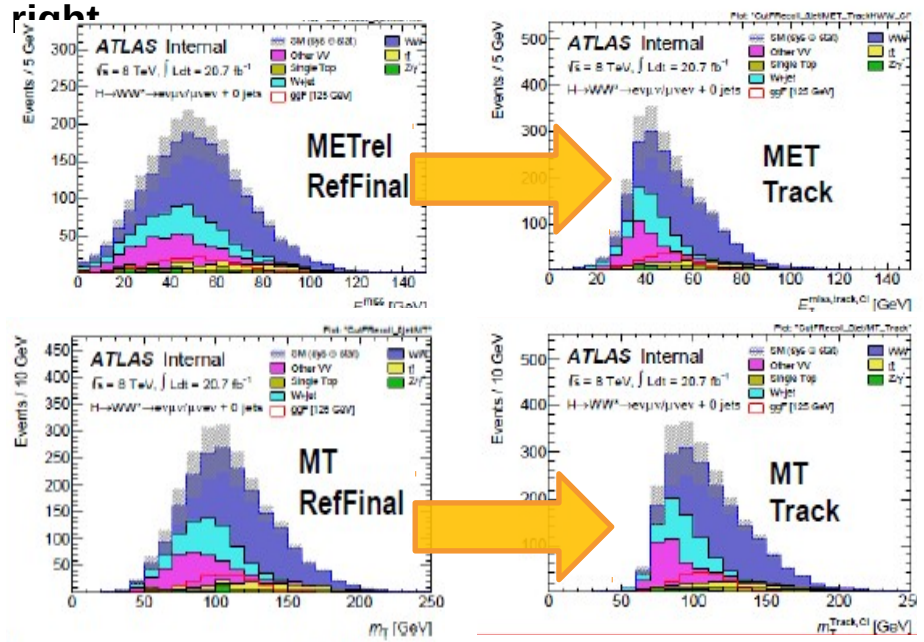
jet corrected Track based MET



Best resolution + **More robust against pileup events**

Main improvement developed using new MET cuts and MT (discriminant variable used in the fit)

Switching from left (used @Moriond) →



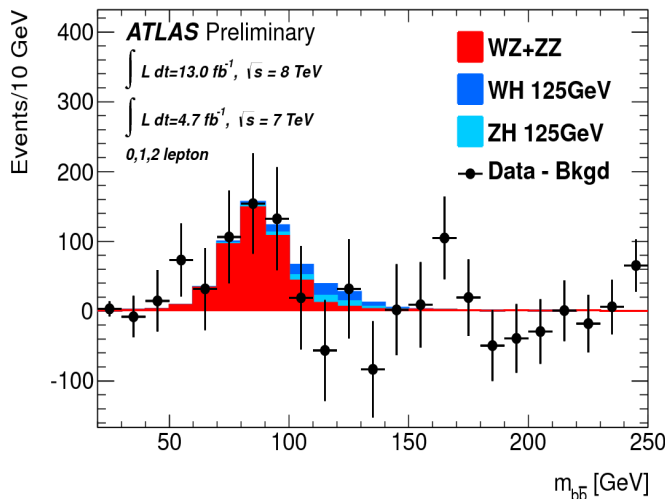
... we are able to improve the expected significance for Different Flavour 0/1j by

+9% from MT switch
+11% from MET switch

pp → Z/W + H → bb̄

Categories in Nleptons, jets, jets tagged as b, p_{TV}
 0-lepton+2 b-tag jets+ETmiss>120GeV
 1-lepton+2 b-tag jets+ETmiss>25GeV+m_{TW}<120 GeV
 2-leptons+2b-tag jets+ETmiss<60GeV+83<m_{ll}<99 GeV

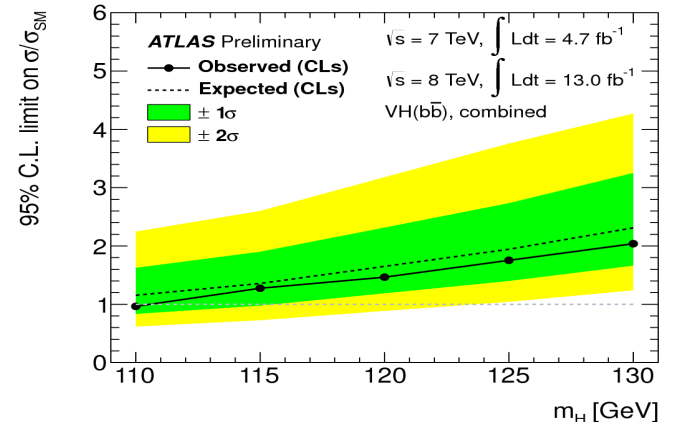
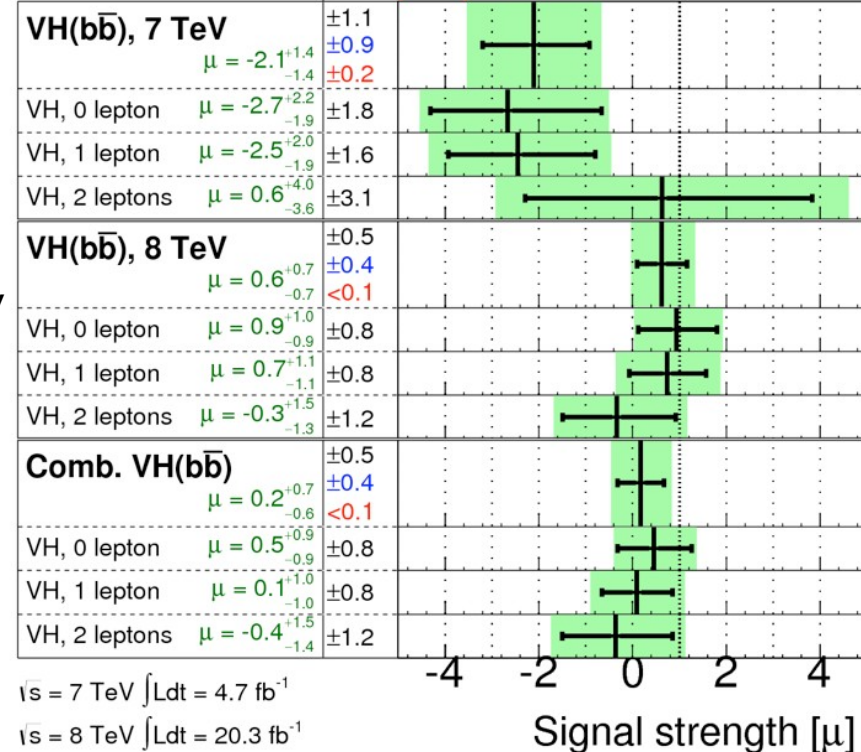
$\mu_{Hbb} = 0.2 \pm 0.5(\text{stat}) \pm 0.4(\text{syst})$



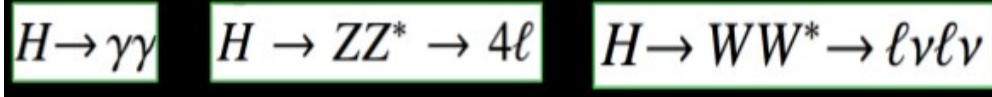
Diboson measurements in parallel as check of the analysis sensitivity, for control

Ilya Korolkov

ATLAS Prelim.
 $m_H = 125 \text{ GeV}$



Boson = Higgs boson? spin measurements

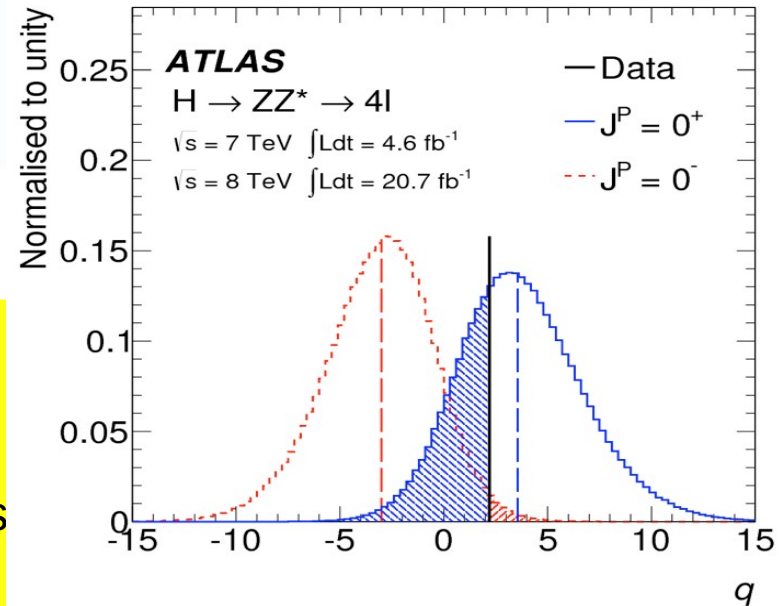


Data favour $J^P=0^+$

$J^P=0^-$ rejected at 97.8%CL with 4l alone

$J^P=1^\pm$ rejected at 99.7% CL with 4l & WW

$J^P=2^+$ rejected at 99.9% with these three channels
(limit uses minimal graviton-inspired model 2^+_{m})



Colleagues from UAM work on
Boosted Decision Trees in 4l channels

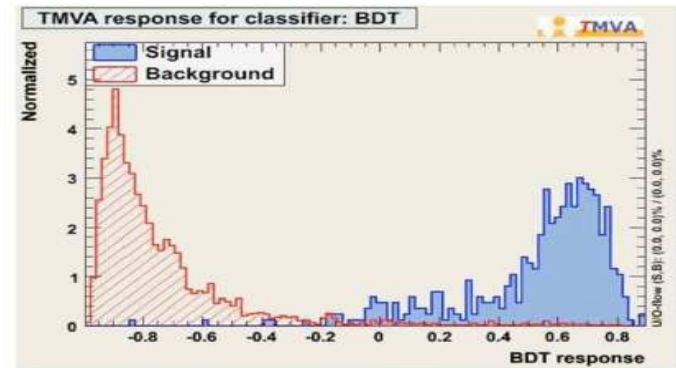
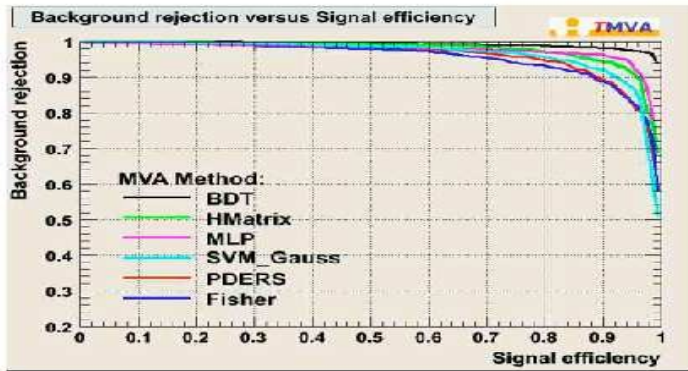


Figure 4: Background rejection versus signal efficiency for $H(130) \rightarrow 4\mu$ signal events and $Zb\bar{b}$, $t\bar{t}$, $ZZ \rightarrow 4\mu$ background events

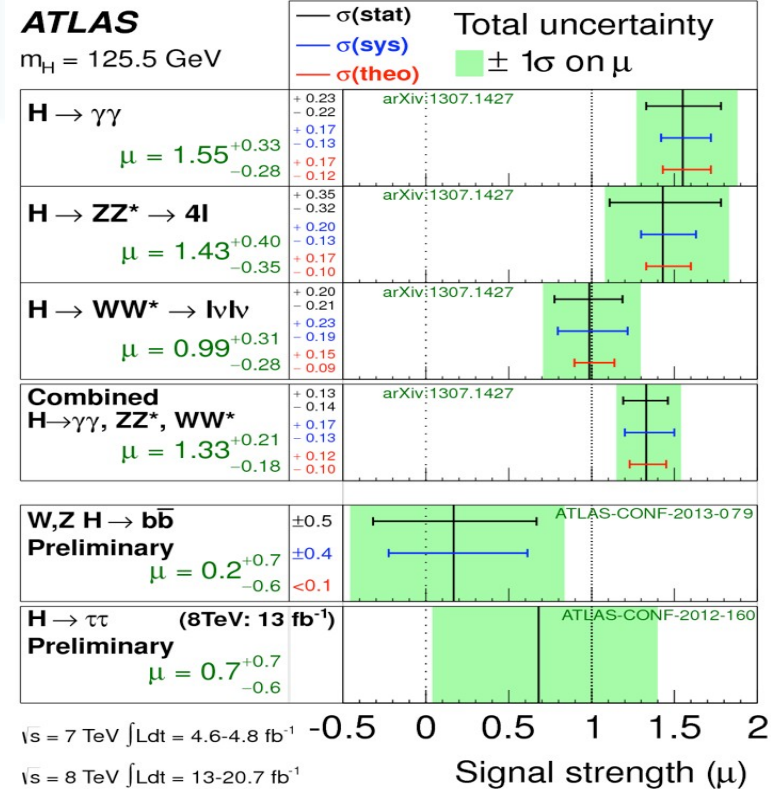
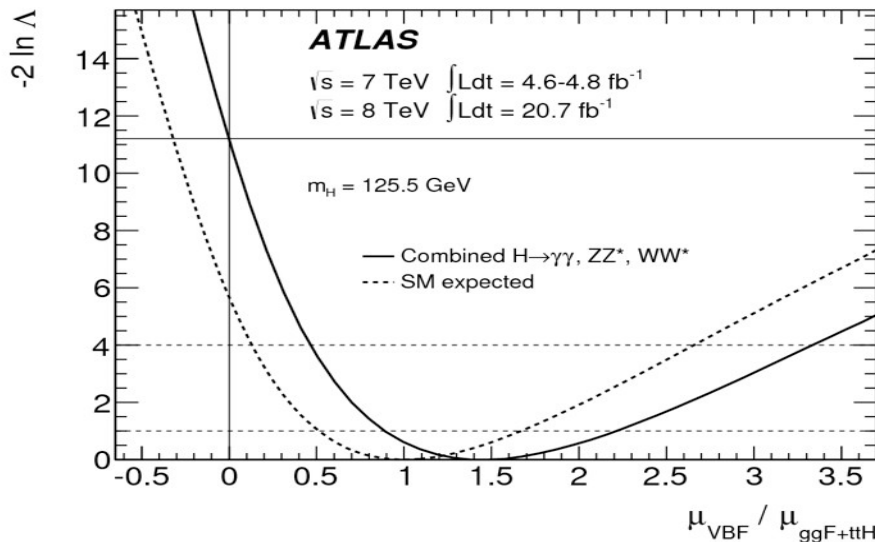
TMVA response of BDT classifier for $H(130) \rightarrow 4\mu$ signal events and $Zb\bar{b}$, $t\bar{t}$, $ZZ \rightarrow 4\mu$ background events

Higgs boson couplings & signal strength

arXiv:1307.1427



Evidence for VBF production



ATLAS (and CMS) discovered neutral boson with mass $\approx 125 \text{ GeV}$ with production cross section compatible with SM Higgs boson. **Fermion decay modes not yet discovered.**

Measurements of the new boson couplings are performed and they are all in agreement with SM predictions. **Both boson and fermion couplings measured**

Different spin/parity hypotheses were tested and the SM-predicted hypothesis, 0^+ , has strong preference.

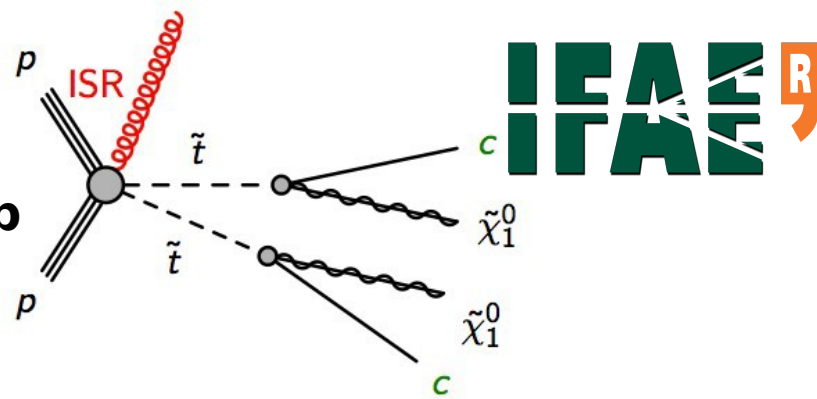
Beyond the Standard Model

yet another focal point of the Spanish
community research

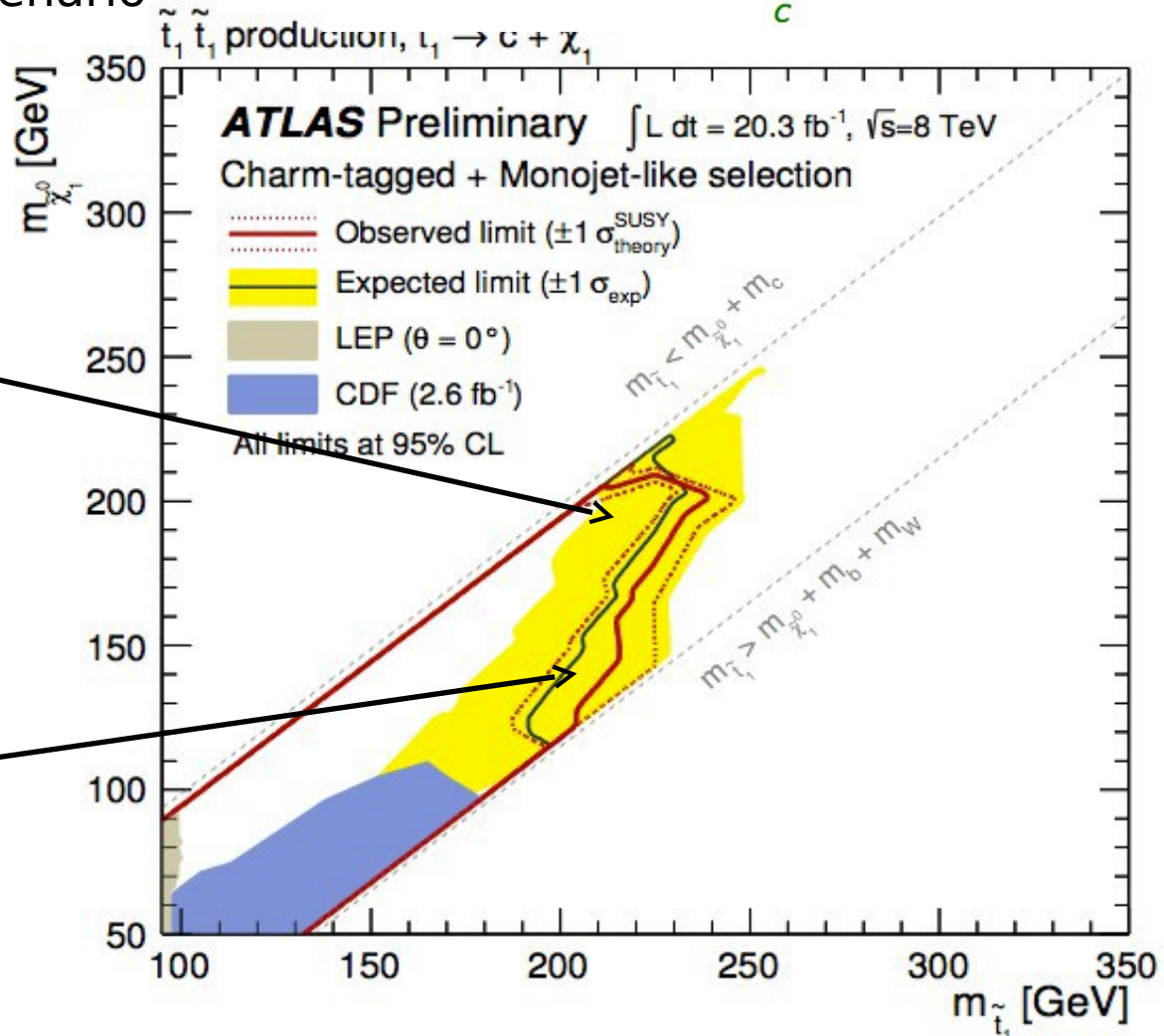
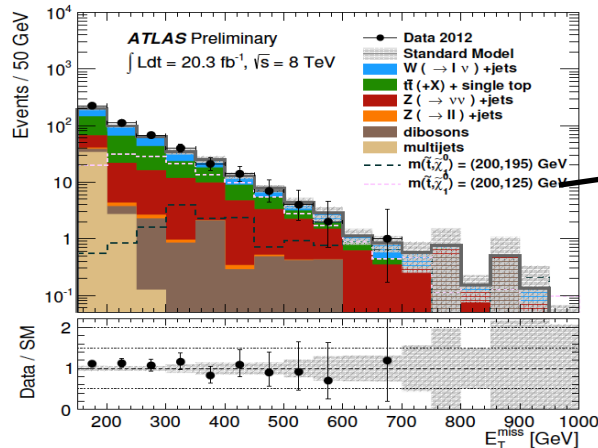
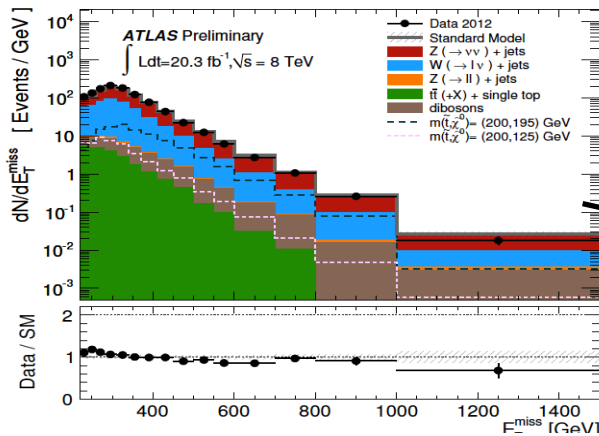
Direct Stop

ATLAS-CONF-2013-068

Very light stop

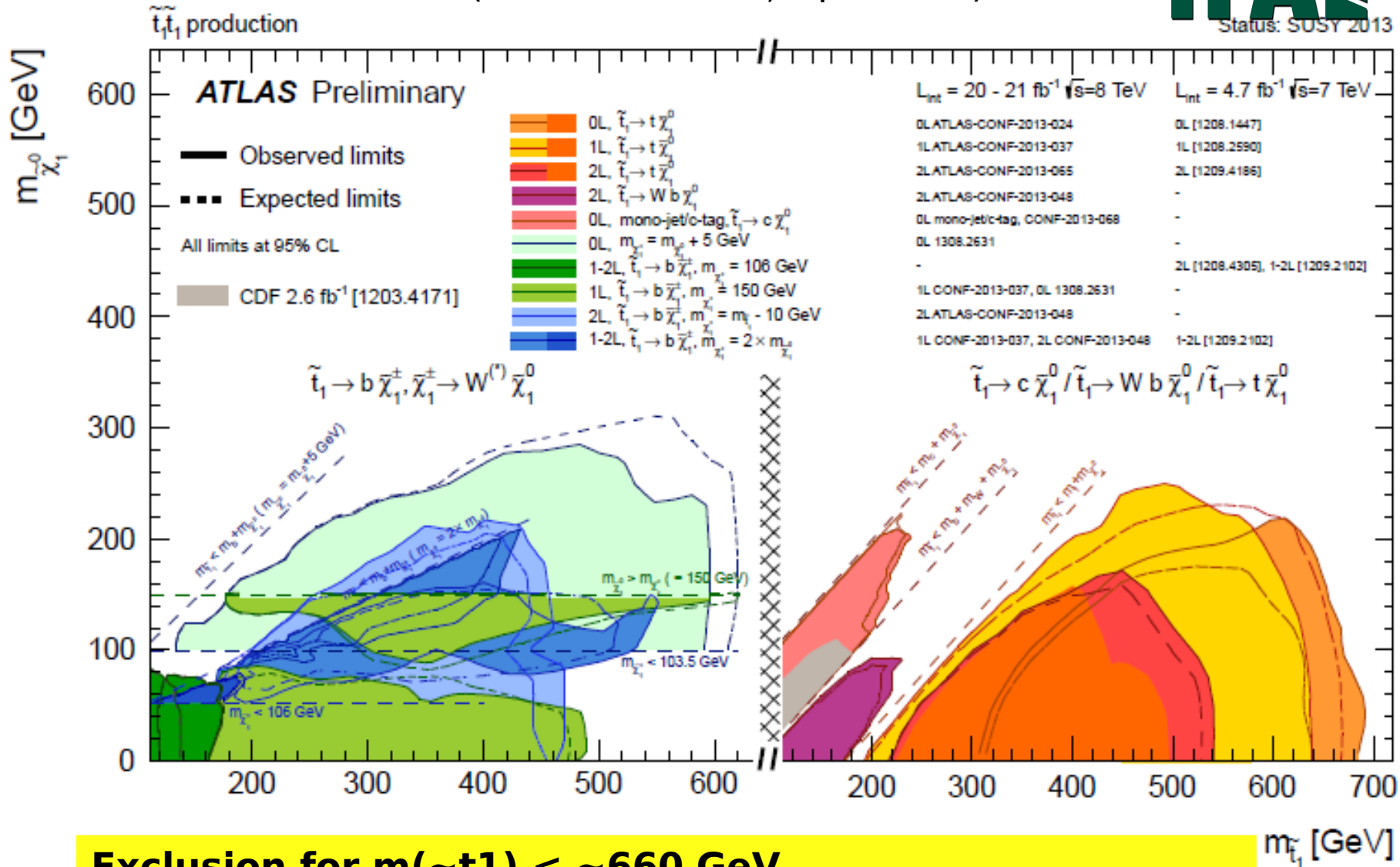


Two selections:
 Monojet for compressed scenario
 Large ETmiss and c-jets



Summary Searches for Stop

(different mass hierarchies, simplified models)



**Exclusion for $m(\tilde{t}_1) < \sim 660 \text{ GeV}$
 for massless LSP, exclusion up to $m(\text{LSP}) \sim 250 \text{ GeV}$**

$m_{\tilde{t}_1} [\text{GeV}]$

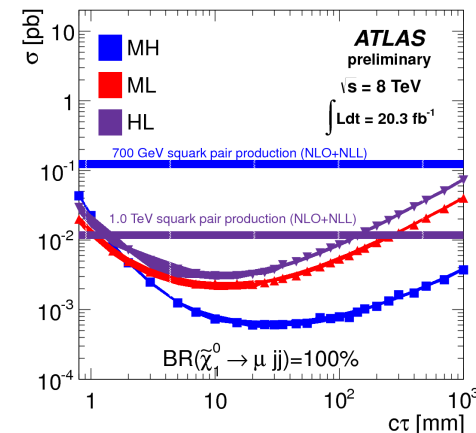
SUSY searches at IFIC

V. Mitsou coordinate "prompt R-parity violating searches"

- Bilinear R-parity violating (bRPV) terms introduce neutrino masses and mixings in a natural way
- Large MET due to copious neutrino production
 - MET-based searches applicable to bRPV
- SUSY1 lepton + 3-4 jets + MET
[PRD 85 (2012) 012006]
 - **First exclusion limits ever set on bRPV**
- 1 lepton + 7 jets + MET
[ATLAS-CONF-2012-109]

$$\tilde{\chi}_{\pm 1}^0 \rightarrow \mu q \bar{q}$$

Lightest neutralino may be long lived → displaced vertexes



ATLAS-CONF-2013-092

Long-lived sparticles

- trigger for secondary vertexes
- displaced b-jet pairs

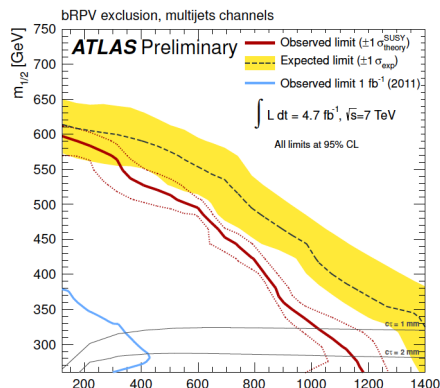
(More information E. Romero talk in the parallel session)

Ongoing studies:

- **Z(→ll)+MET+jets** search
 - bRPV and Gauge Mediation models

Other contributions:

- Leptones+jets+ MET: **Phys. Lett. B710 (2012) 67-85**, **Phys. Rev. Lett., 106 (2011) 131802**, **Phys. Rev. D86 (2012) 092002**
- Leptones+ 7 jets +MTE: **ATLAS-CONF-2012-140**
- RPV: **Phys. Lett. B719 (2013) 280-298**, Tambien se ha participado en la búsqueda de:
- Display vertexes: **Phys. Lett. B707 (2012) 478-496**.
- Stable particles: **Phys. Lett. B719 (2013) 280-298**.



ATLAS-CONF-2012-140



Mono-jet Searches

Phys.Lett. B705 (2011) 294-312



Motivated by a distinctive signature with rich phenomenology

- Large Extra Spatial Dimensions (LED)
- Dark Matter (WIMPs)
- SUSY searches
- Invisible Higgs
-

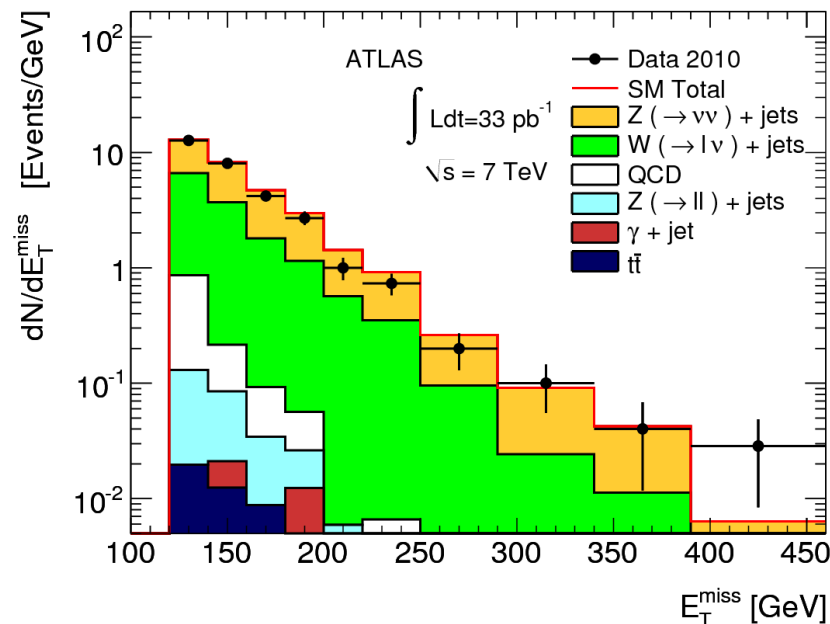
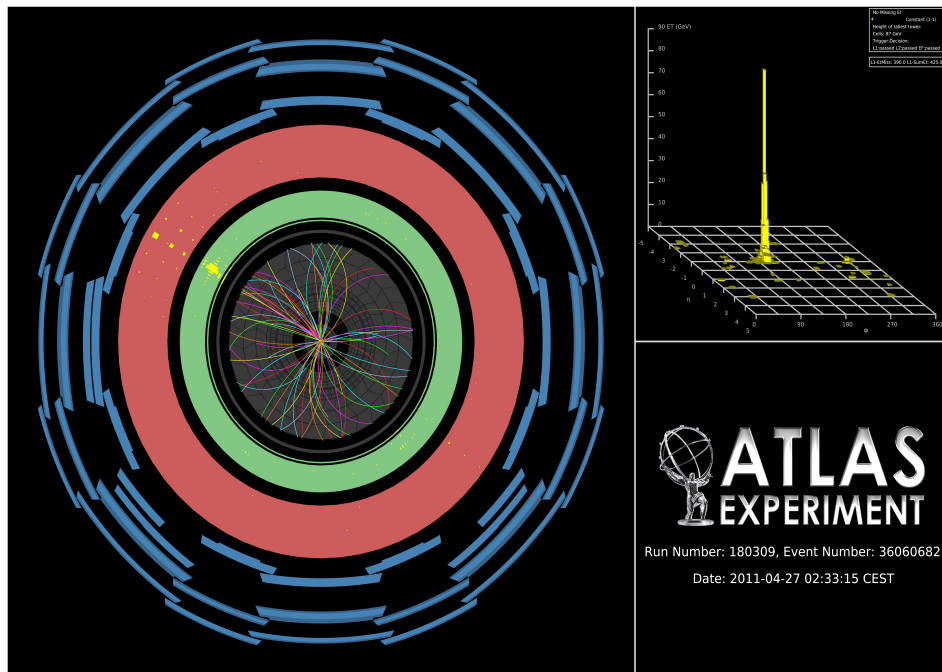
JHEP04(2013)075
PRL 110, 011802 (2013)

One energetic jet and large MET
Veto on a second jet
Veto on leptons

Two (lowPt and HighPt analyses)

Spanish community leads
the mono-jet searches in ATLAS

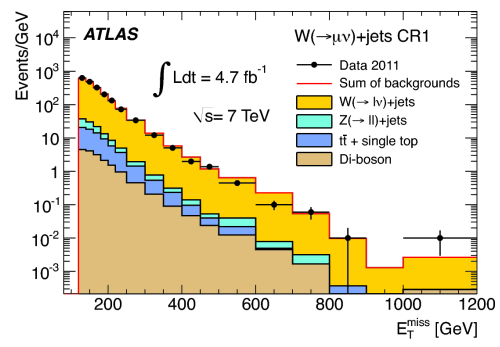
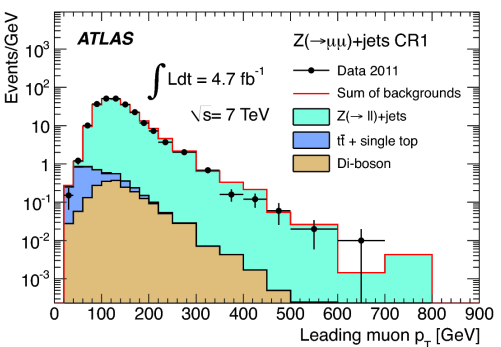
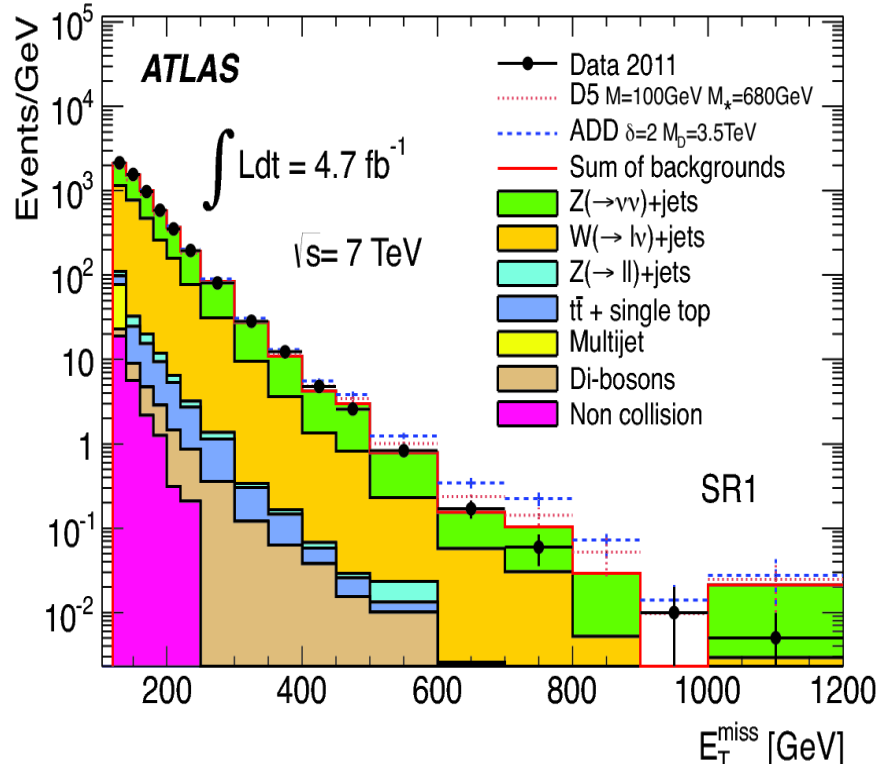
→ Improved limits on ADD LED



Mono-jet Searches



JHEP04(2013)075



Data driven estimation of the dominant Z+jets and W+jets background using control regions

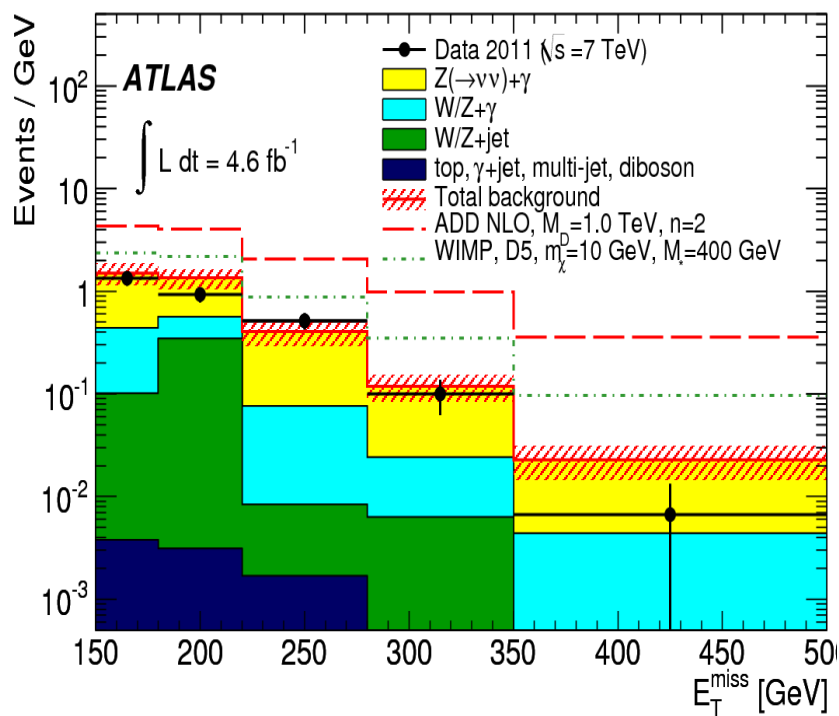
ETmiss > 120, 220, 350, 500 GeV
 pT (j1) > 120, 220, 350, 500 GeV
 Njet(pT > 30 GeV) < 3

Δφ (ETmiss, j2) > 0.5
 Lepton vetoes

Good agreement with the SM

	SR1	SR2	SR3	SR4
$Z \rightarrow \nu\bar{\nu} + \text{jets}$	63000 ± 2100	5300 ± 280	500 ± 40	58 ± 9
$W \rightarrow \tau\nu + \text{jets}$	31400 ± 1000	1853 ± 81	133 ± 13	13 ± 3
$W \rightarrow e\nu + \text{jets}$	14600 ± 500	679 ± 43	40 ± 8	5 ± 2
$W \rightarrow \mu\nu + \text{jets}$	11100 ± 600	704 ± 60	55 ± 6	6 ± 1
$t\bar{t} + \text{single } t$	1240 ± 250	57 ± 12	4 ± 1	-
Multijets	1100 ± 900	64 ± 64	8_{-8}^{+9}	-
Non-coll. Background	575 ± 83	25 ± 13	-	-
$Z/\gamma^* \rightarrow \tau\tau + \text{jets}$	421 ± 25	15 ± 2	2 ± 1	-
Di-bosons	302 ± 61	29 ± 5	5 ± 1	1 ± 1
$Z/\gamma^* \rightarrow \mu\mu + \text{jets}$	204 ± 19	8 ± 4	-	-
Total Background	124000 ± 4000	8800 ± 400	750 ± 60	83 ± 14
Events in Data (4.7 fb^{-1})	124703	8631	785	77

Mono-photon Searches



$p_{T\gamma} > 150$ GeV, $|\eta_\gamma| < 2.37$, isolated
 $E_{T\text{miss}} > 150$ GeV
 $N_{\text{jet}} < 2$ ($p_T > 30$ GeV)
 $\Delta\phi(\gamma, E_{T\text{miss}}) > 0.4$, $\Delta\phi(\text{jet}, E_{T\text{miss}}) > 0$
 Veto on leptons

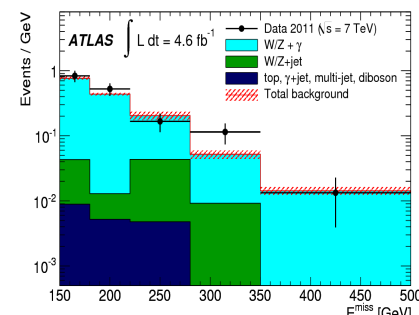
Good agreement with the SM

Phys. Rev. Lett 110, 011802, 2013

Background dominated by Z/W+ γ followed by contributions with jets faking photons plus other small contributions

- Z/W+ γ contributions from MC normalized in control regions ($\gamma + \mu + E_{T\text{miss}}$ control sample)

- Jet and electron fakes fully data driven



Background source	Prediction	\pm (stat.)	\pm (syst.)
$Z(\rightarrow \nu\bar{\nu}) + \gamma$	93	± 16	± 8
$Z/\gamma^*(\rightarrow \ell^+\ell^-) + \gamma$	0.4	± 0.2	± 0.1
$W(\rightarrow \ell\nu) + \gamma$	24	± 5	± 2
W/Z + jets	18	—	± 6
Top	0.07	± 0.07	± 0.01
WW, WZ, ZZ, $\gamma\gamma$	0.3	± 0.1	± 0.1
γ +jets and multi-jet	1.0	—	± 0.5
Total background	137	± 18	± 9
Events in data (4.6 fb^{-1})	116		

Conclusions

- **Superb performance** of LHC accelerator, of the ATLAS detector and very fruitful times for the ATLAS collaboration
- **Spanish groups are in front**, in both, the operation and in physics
- **New measurements** are probing observables at unprecedented level of accuracy and in never before exploited phase space regions
- In many cases, the systematics are becoming limiting: we are entering the **era of precision** measurements at the LHC
- Searches for New Physics in a vast number of topologies and theoretical scenarios
- Up to now, **all the data are consistent with SM**
- LHC and ATLAS are taking a short break until 2015 to come back at 14TeV at the new energy frontier giving new results and hopefully surprises



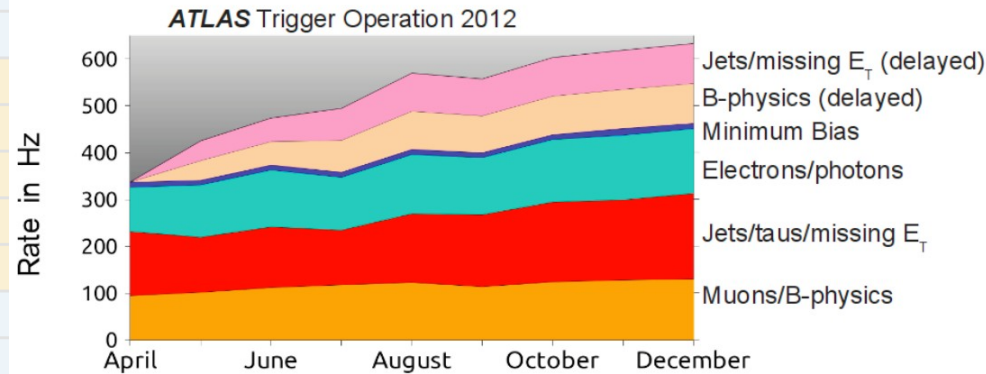
More Energy and
More Data!

Additional slides

and more details on the
impact of Spanish groups
in ATLAS

ATLAS detector Status and trigger

Subdetector	Number of Channels	Approximate Operational Fraction
Pixels	80 M	95.0%
SCT Silicon Strips	6.3 M	99.3%
TRT Transition Radiation Tracker	350 k	97.5%
LAr EM Calorimeter	170 k	99.9%
Tile calorimeter	9800	98.3%
Hadronic endcap LAr calorimeter	5600	99.6%
Forward LAr calorimeter	3500	99.8%
LVL1 Calo trigger	7160	100%
LVL1 Muon RPC trigger	370 k	100%
LVL1 Muon TGC trigger	320 k	100%
MDT Muon Drift Tubes	350 k	99.7%
CSC Cathode Strip Chambers	31 k	96.0%
RPC Barrel Muon Chambers	370 k	97.1%
TGC Endcap Muon Chambers	320 k	98.2%



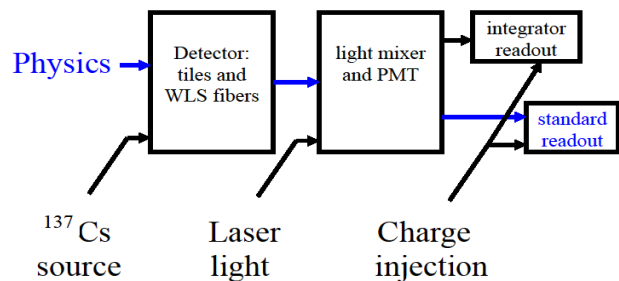
Total Efficiency (delivered → physics analysis) $\approx 90\%$

ATLAS p-p run: April-December 2012										
Inner Tracker			Calorimeters		Muon Spectrometer				Magnets	
Pixel	SCT	TRT	LAr	Tile	MDT	RPC	CSC	TGC	Solenoid	Toroid
99.9	99.4	99.8	99.1	99.6	99.6	99.8	100.	99.6	99.8	99.5

Luminosity weighted relative fraction of good quality data

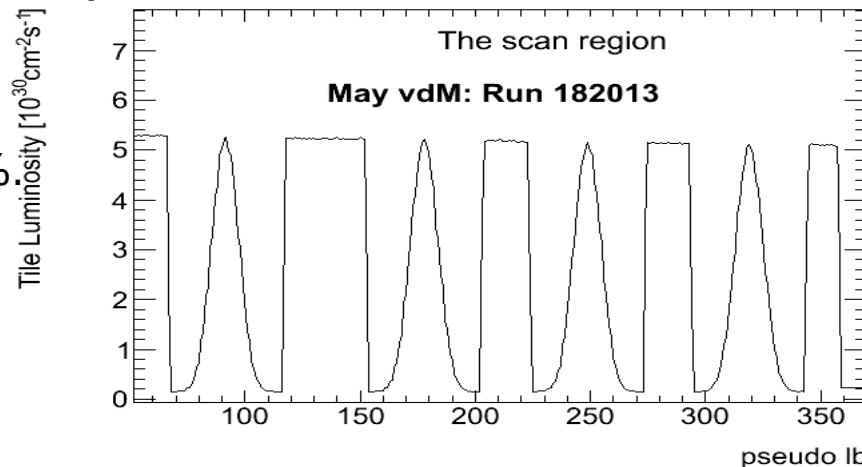
All good for physics: 95.8%³²

Tile as a luminosity monitor of ATLAS



Since Tile Calorimeter proved to be able to detect the currents from the LHC VdM scans, it is directly calibrated during scans and serves as one of the ATLAS luminosity monitors

The long term discrepancy between various ATLAS luminosity monitors is on order of 2%. This is taken as the systematic error on the ATLAS luminosity measurement.



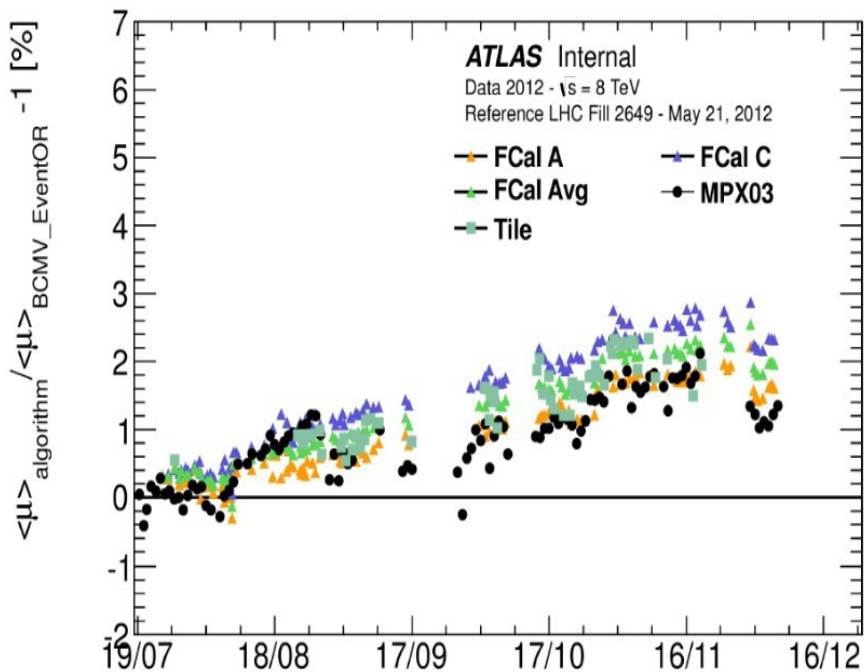
TileCal MB system recognized as part of the ATLAS Luminosity monitors ATLAS-CONF-2011-116

- A. Succurro, The ATLAS Tile Hadronic Calorimeter performance in the LHC collision era, TIPP, Chicago, June 2011

- G. Gonzalez, Integrator based readout in Tile Calorimeter of the ATLAS experiment, TIPP, Chicago, June 2011

- V. Gangiobbe, The TileCal Laser calibration system, TIPP, Chicago, June 2011

- P. Francavilla, The Tile hadronic calorimeter performance at the LHC, CALOR, Santa Fe, June 2012



sROD demonstrator



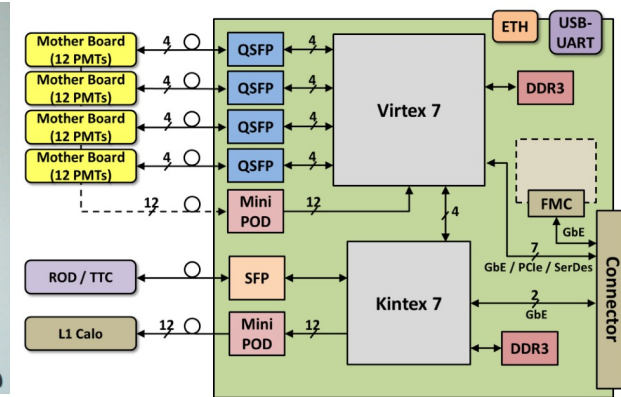
UNIVERSITAT ID VALÈNCIA

- Design an sROD prototype to process the data from one TileCal front-end module
 - State-of-the-art FPGAs, ~500 Gbps I/O, AMC format for ATCA carrier
 - Design in the later stage. First board early 2014

ATCA test-bench

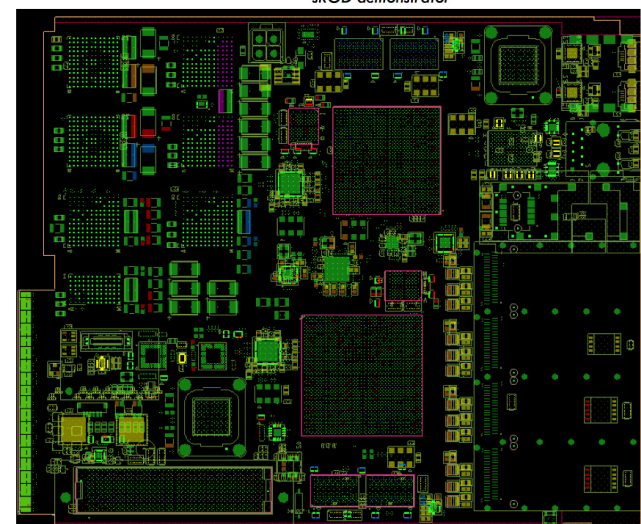


ATCA-1200 Carrier



sROD demonstrator

First tests done at CERN with commercial boards



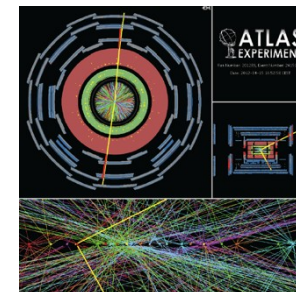
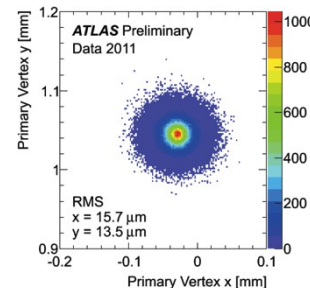
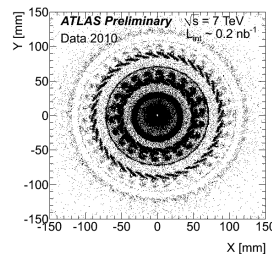
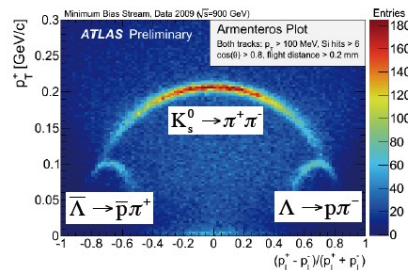
sROD demonstrator layout view (Cadence Allegro)

Vertex and track reconstruction

A. Wildauer: convenor of “Inner Tracking Combined Performance Group” (2008-2010)

Activities

- **Development** of software for vertex and track reconstruction.
- **Studies for data analysis** (characterization on primary and secondary vertices, photon conversion, stable particle, tracks in jets, etc). **Nuclear Science, IEEE Transactions**, vol.57, pp.760-767 , 2010.
- **Performance of vertex detector: EPJC 70 ,2010, 787**
- We have been main author of the **first ATLAS physics papers**, ei:
 - “*Charged-particle multiplicities in pp interactions at $\sqrt{s} = 900$ GeV measured with the ATLAS detector at the LHC*”, **Phys. Lett. B 688, 21-41 (2010)**, **New J Phys 13 (2011) 053033.**, **Phys. Rev. D83 (2011) 112001**,
 - Also to several articles on tracking, short live particles (KS, Λ , ...), estimation of detector material , vertices, and also providing input for the simulation.



Alignment of the Inner Detector

Objective: to know the position of the components of the detector as close as

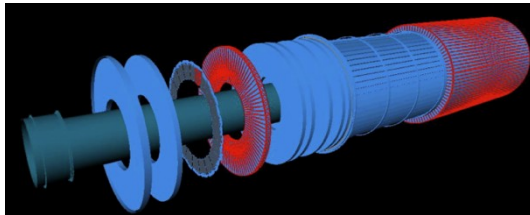
The IFIC has been heavily involved on track base alignment since 2004, at all stages of ATLAS commissioning and since 2009 with the collision data.

S. Martí: convener of “Inner Detector Alignment group” (2006-2011)

Position of modules (μm in $r\phi$)

PIXEL: 7 SCT:12 TRT:3

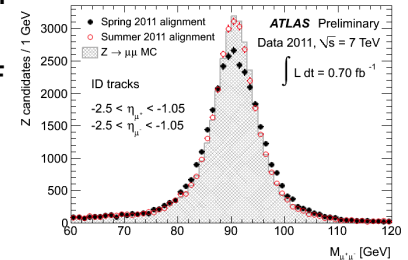
Two methods are used: **Global χ^2** (developed by IFIC) and **Local χ^2** , depending on the structure level to be considered.



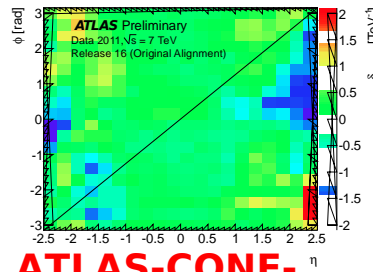
Level	Structures	# DoF	Method
Level 1	PIX: whole	41	Global χ^2
	SCT: barrel + 2 endcaps		
	TRT: barrel + 2 endcaps		
Level 2	PIX: half shells + disks	852	Global χ^2
	SCT: layers + disks		
	TRT: modules + wheels		
Level 3	PIX: modules	722104	Local χ^2
	SCT: modules		
	TRT: wires		

Achievements:

- We are able to align structures to the level of TRT wires.
- Weak mode correction using resonances: $J/\psi \rightarrow \mu\mu$ and $K_S \rightarrow \mu\mu$.
- Sensitive to movements of **Between interventions** (temperature changes, turn on of magnets ...) **changes up to 10 μm** were detected. During the running the detector is very stable,



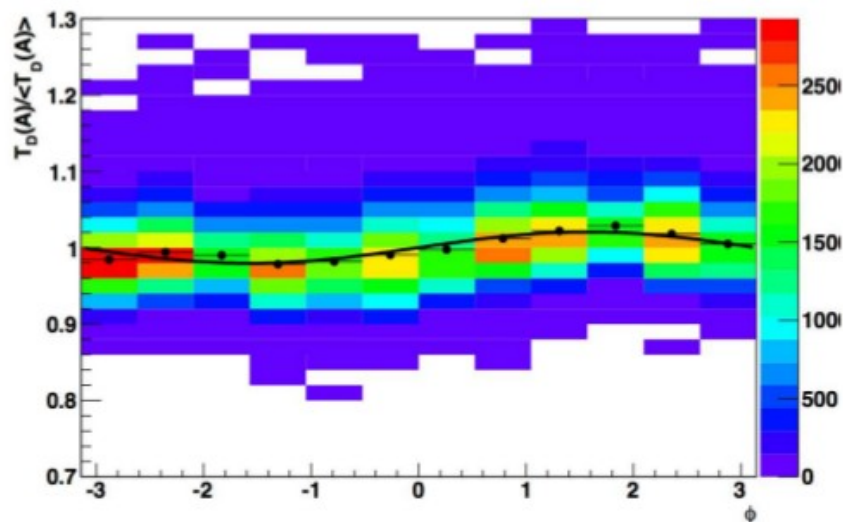
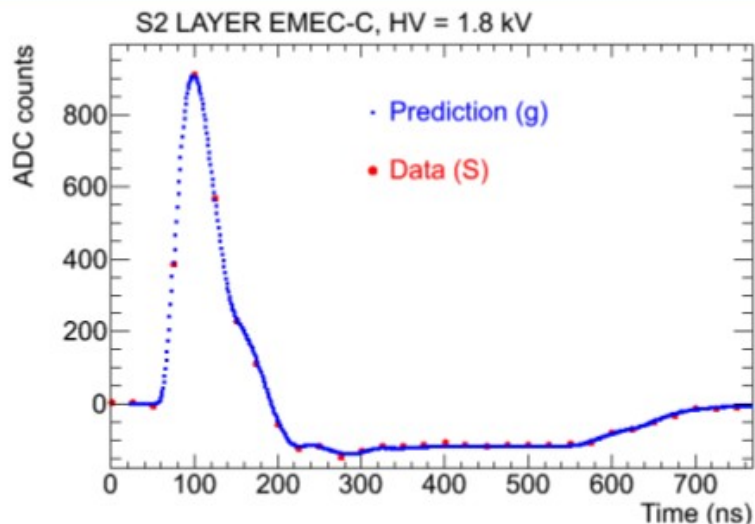
ATLAS-CONF-2012-14



ATLAS-CONF-2012-141

Study of the alignment uncertainties relevant to the determination of the mass of the Higgs-like particle through its decays to four charged leptons

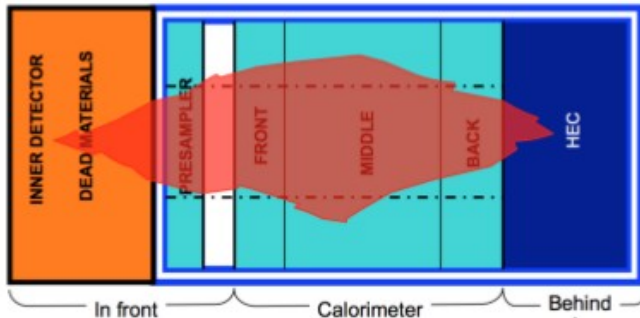
Operación del Calorímetro Electromagnético LAr de ATLAS



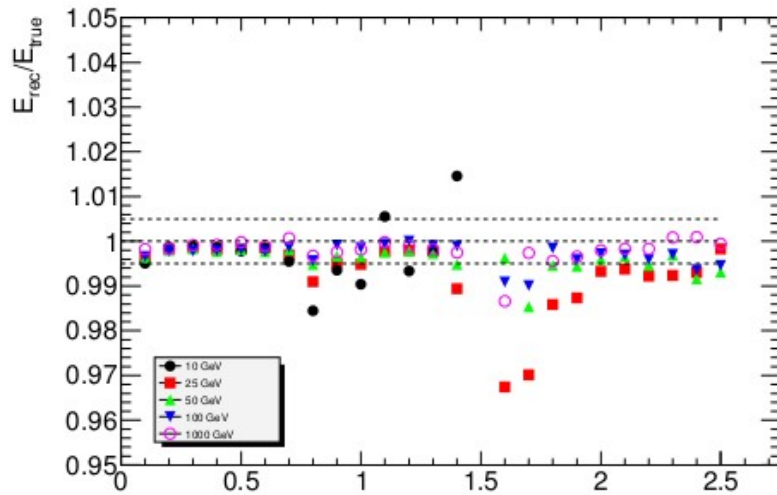
- Calibración del calorímetro LAr
- Reconstrucción de la energía de electrones y fotones
- Coordinación de la toma de datos del calorímetro LAr
- Experto online de software
- Medida del tiempo de deriva a partir de la respuesta de la señal → detección de no uniformidades en el calorímetro (e.g. “sagging”) → correcciones

Operación del Calorímetro Electromagnético LAr de ATLAS

Energy reconstruction



$$E_{\text{reco}} = E_{\text{infront}} + E_{\text{calo}} + E_{\text{behind}}$$



η



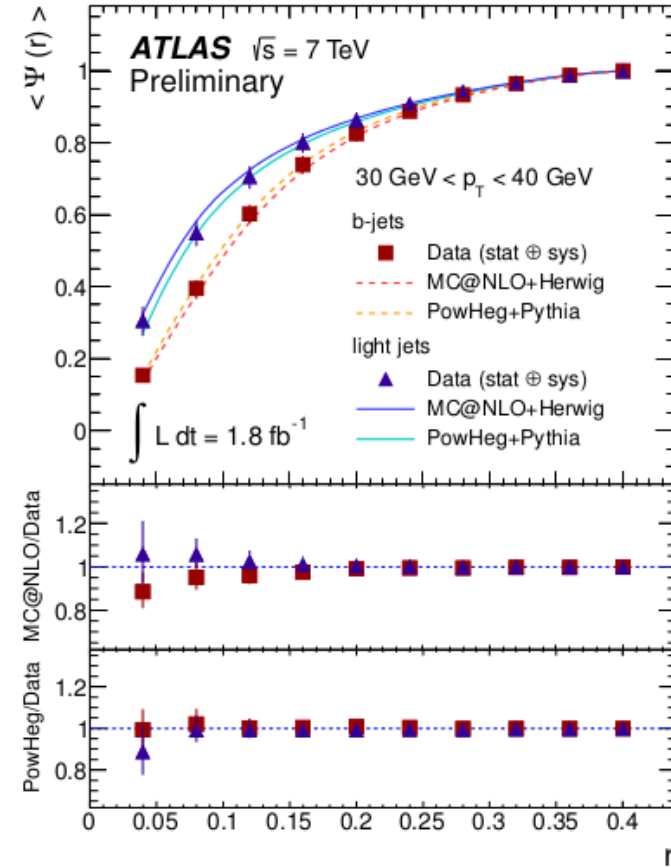
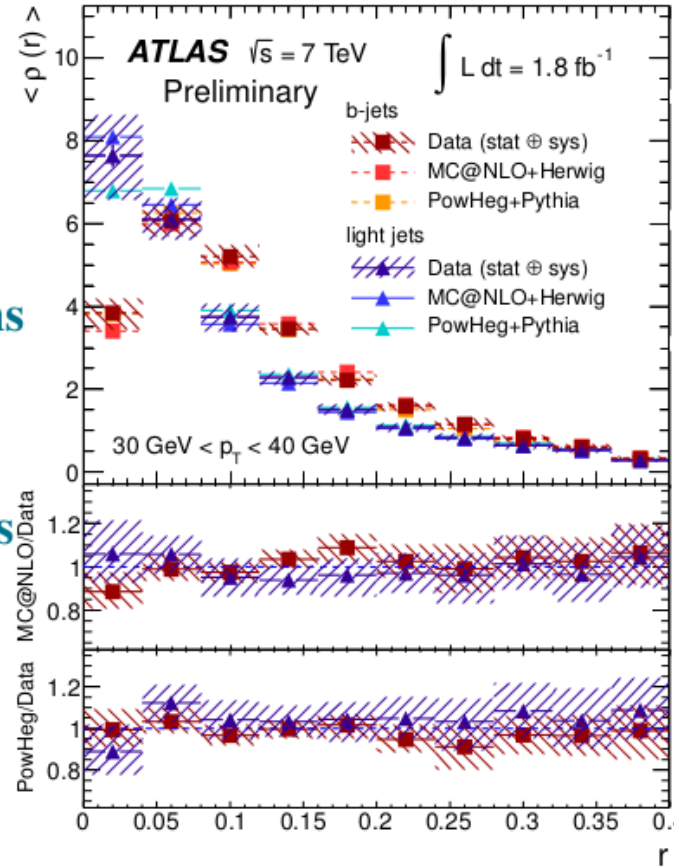
- **Reconstrucción de la energía de electrones y fotones basada en simulaciones Monte Carlo detalladas y usando las diversas capas del calorímetro electromagnético**

- **Linealidad de la respuesta del calorímetro electromagnético a electrones**

Jet shapes in $t\bar{t}$ events with ATLAS

- Comparison of the fragmentation of b-quarks and (u,d,c,s)-quarks in terms of jet internal structure

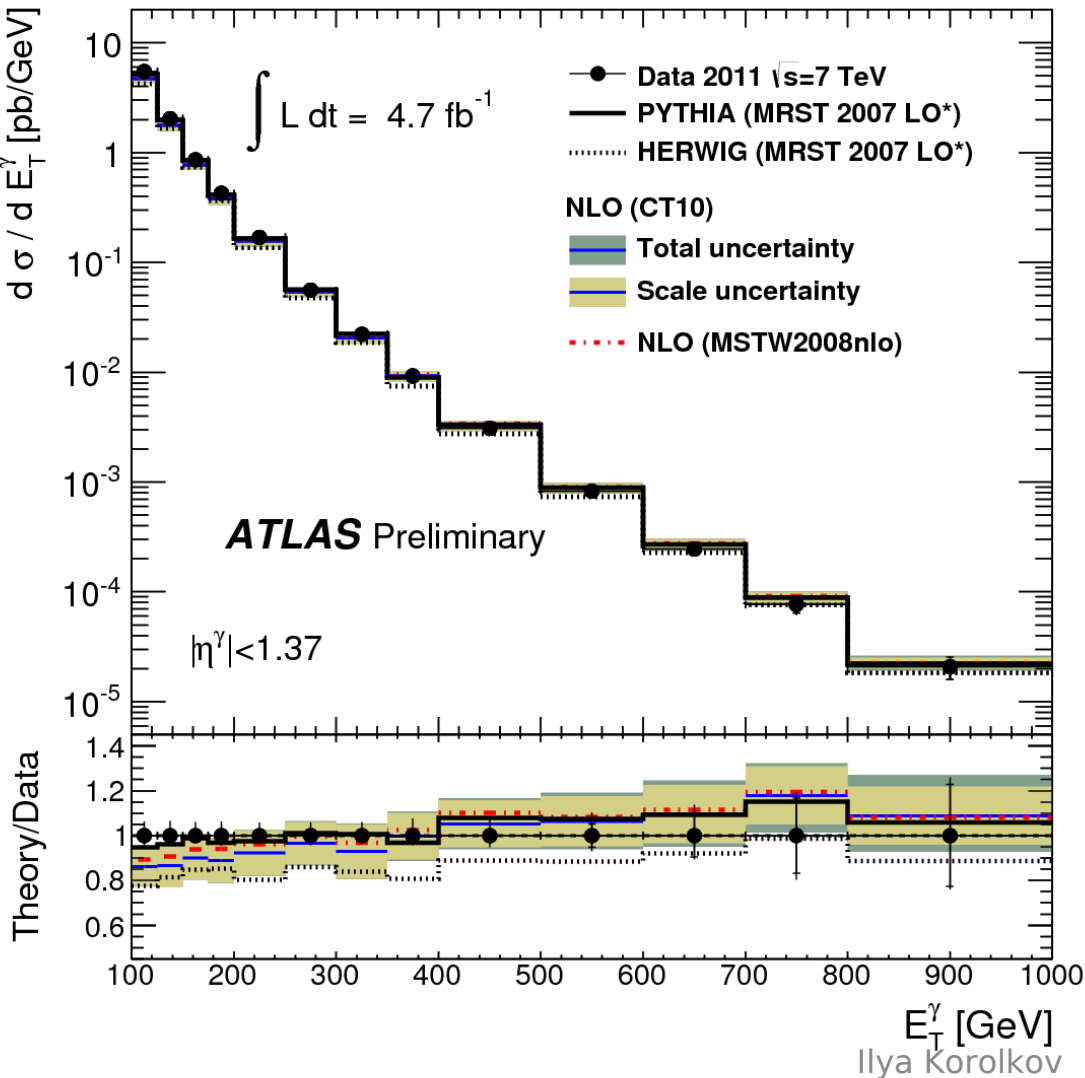
- Semileptonic $t\bar{t}$ events are a clean source of both types of quarks



→ Light jets are found to have a narrower energy distribution than b jets

→ Data well described by NLO + parton shower (Herwig/Pythia) expectations

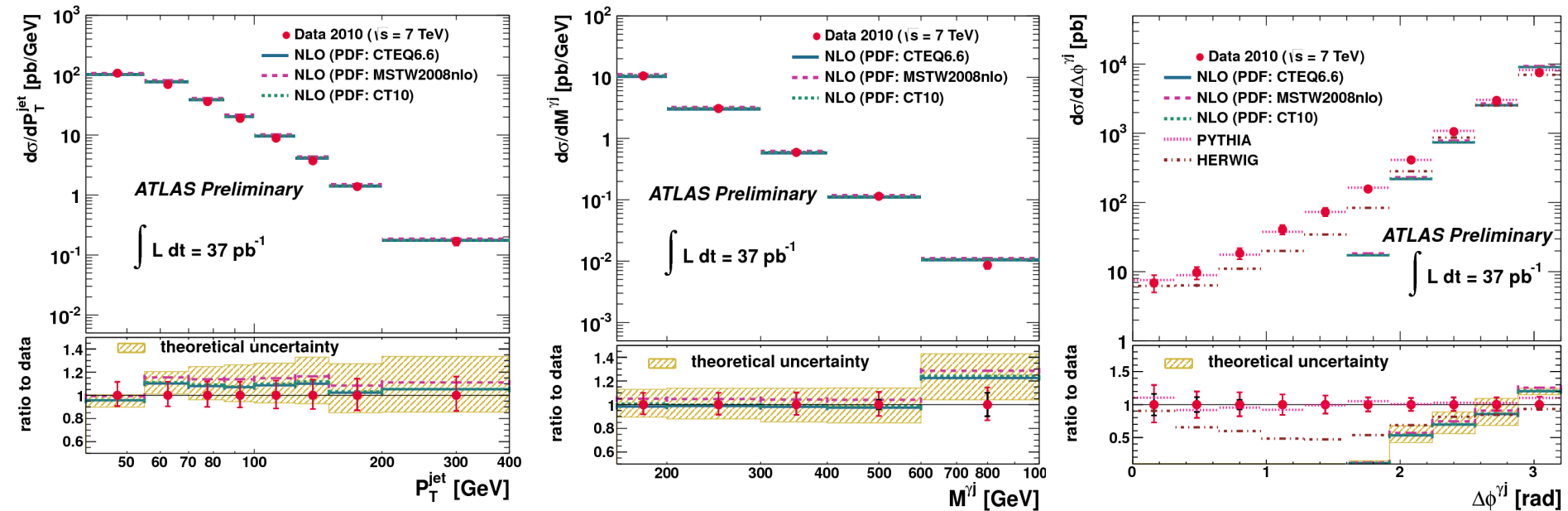
Inclusive photons



- 1 TeV region reached for $|\eta| < 1.37$
- Pythia in good agreement, Herwig is lower, but within error bars
- Highest disagreement at low E_T

ATLAS-CONF-2013-022

Photon Jets dynamics study



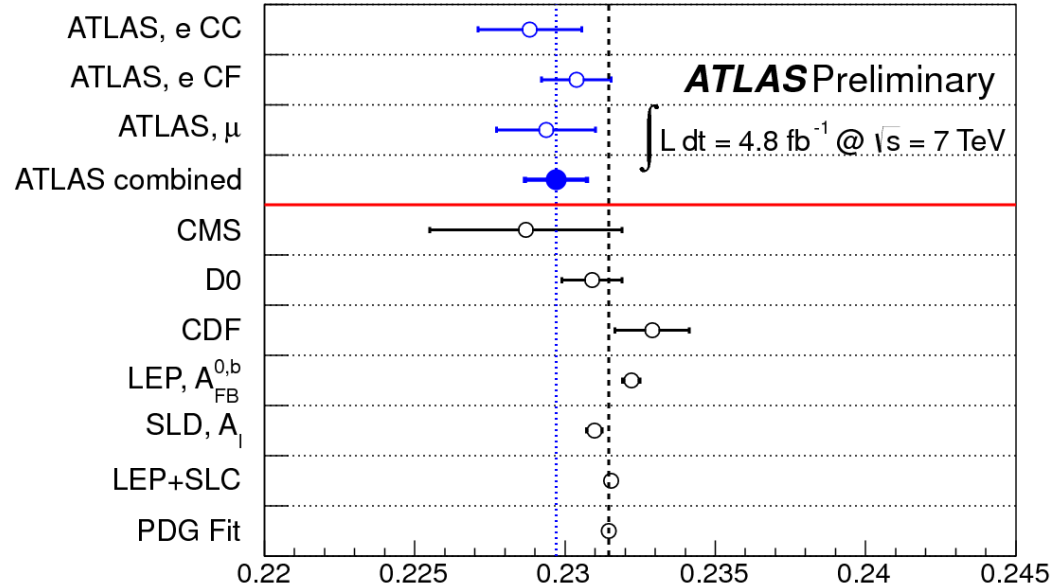
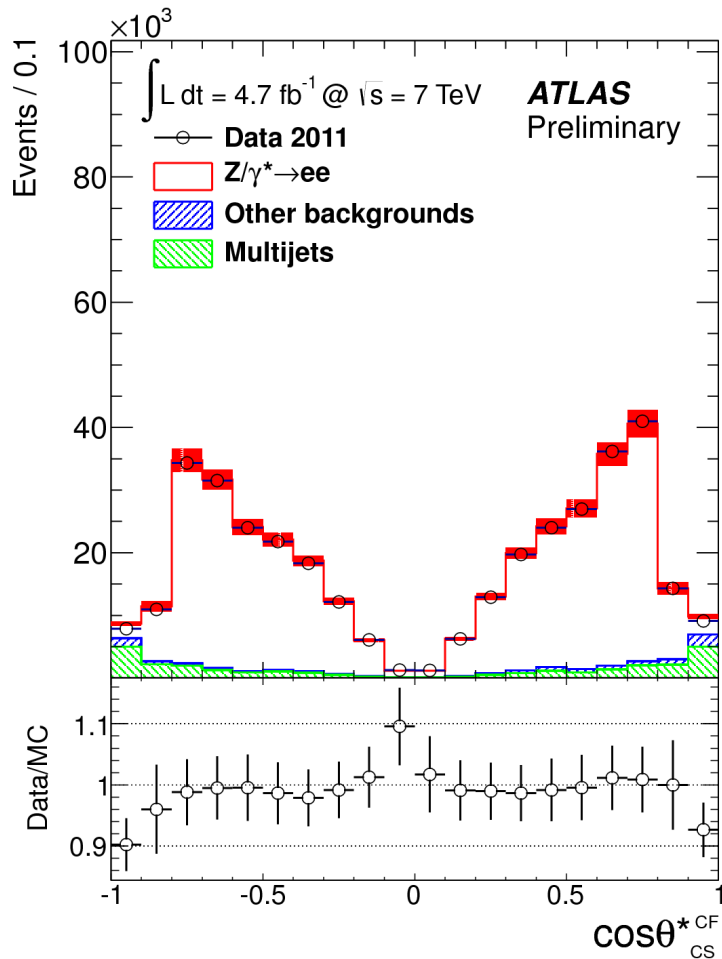
• Photon Jet dynamics study:

differential cross sections as a function of E_T^{γ} , p_T^{jet} , $|y^{\text{jet}}|$, $\Delta\Phi^{\gamma l}$, $M^{\gamma l}$ and $|\cos \theta^{\gamma l}|$.
 NLO QCD calculations provide a good description of the data, except in the case of the azimuthal angle.

ATLAS-CONF-2013-023

Forward/backward asymmetry of Z/γ^*

ATLAS-CONF-2013-043



7 TeV data in lepton pairs from Z/γ^* decays

$$A_{FB} = \frac{\sigma_F - \sigma_B}{\sigma_F + \sigma_B}$$

$$\sin^2 \theta_W^{\text{eff}} = 0.2297 \pm 0.0004(\text{stat}) \pm 0.0009(\text{sys})$$

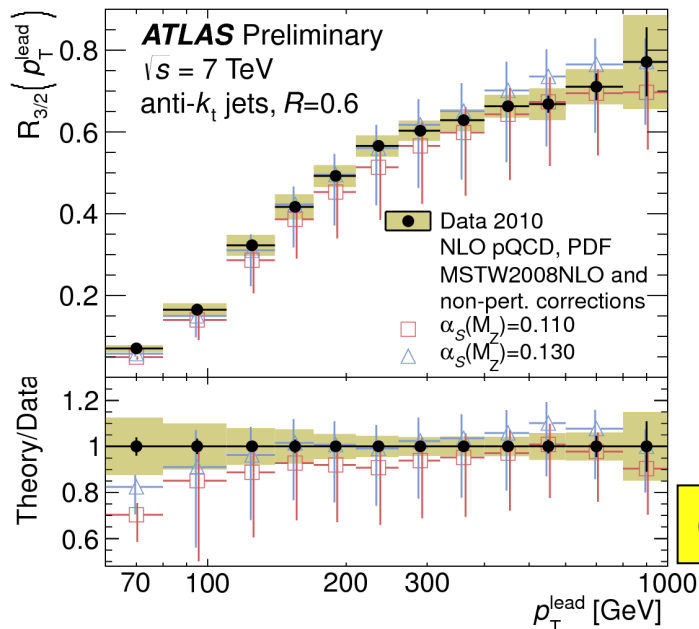
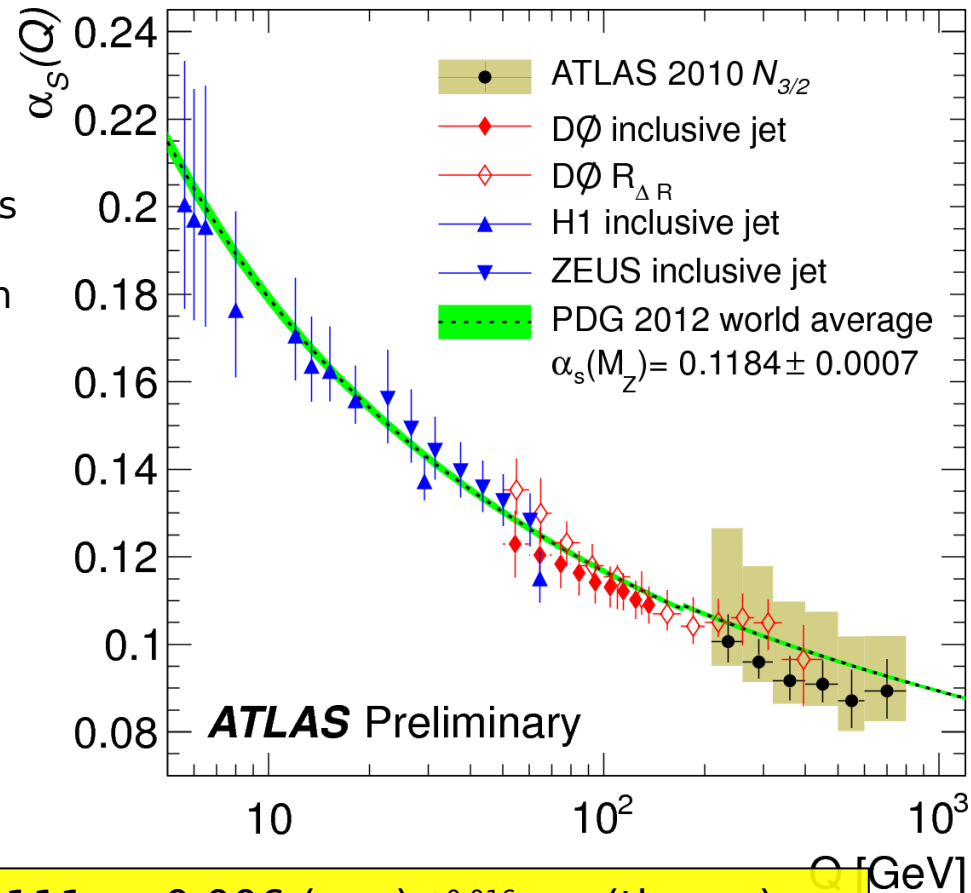
Running of α_s from multi jet cross-section ratios

$$R_{3/2}(p_T^{\text{lead}}) = \frac{d\sigma_{N_{\text{jet}} \geq 3}/dp_T^{\text{lead}}}{d\sigma_{N_{\text{jet}} \geq 2}/dp_T^{\text{lead}}}$$

ATLAS-CONF-2013-041

The ratio is sensitive to α_s and mostly insensitive experimental systematic uncertainties

- avoids direct dependence on PDFs
- eliminates dependence from lumi normalization
- Scale uncertainty dominates



$\alpha_s(M_Z) = 0.111 \pm 0.006 \text{ (exp)}^{+0.016}_{-0.003} \text{ (theory)}$

W± production in ass. with charm quark

The production of $pp \rightarrow WcX$ is directly sensitive to the s-quark distribution in the proton for $Q^2 \sim m_W^2$

Select events

with a W^\pm decaying to leptons (e,μ)

Reconstruct charm hadrons

$$D^+ \rightarrow K^- \pi^+ \pi^+$$

$$D^{*+} \rightarrow D^0 \pi^+$$

$$D^0 \rightarrow K^- \pi^+$$

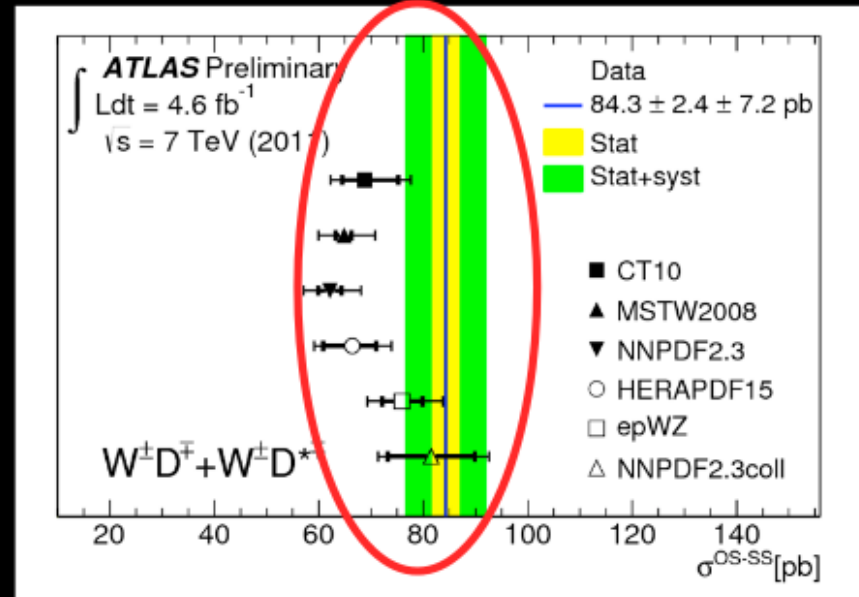
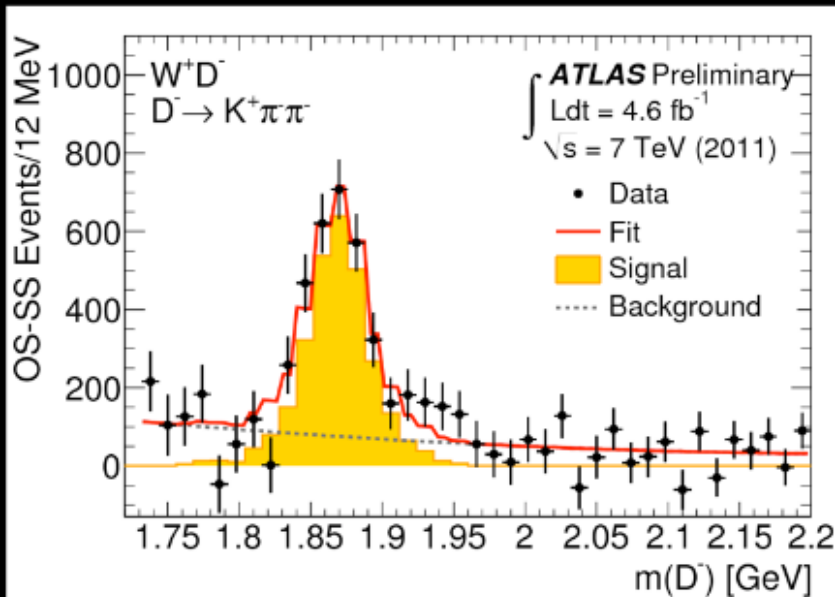
$$D^0 \rightarrow K^- \pi^+ \pi^0$$

$$D^0 \rightarrow K^- \pi^+ \pi^- \pi^+$$

Correlation btw W & c-meson charge (OS)

Single charm contribution obtained by subtracting contribution from SS events

Systematic error ~7-8%, dominated by tracking efficiency



Inclusive di-photon cross-section at $\sqrt{s}=7$ TeV

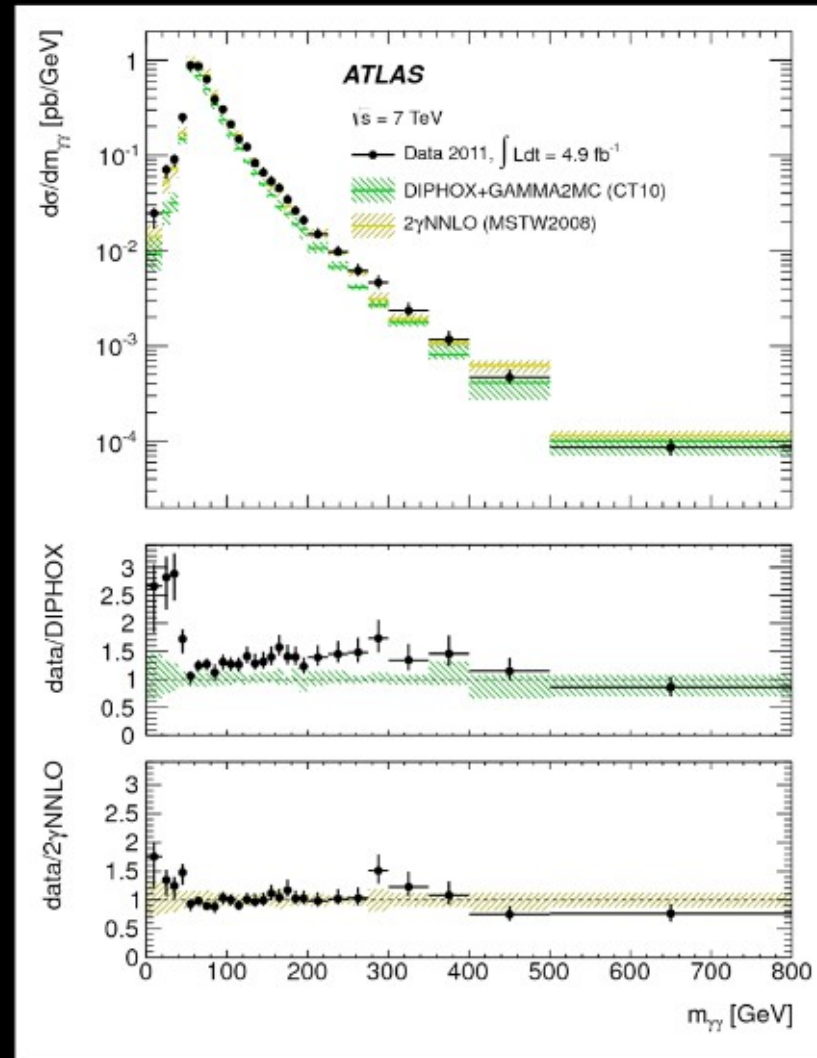
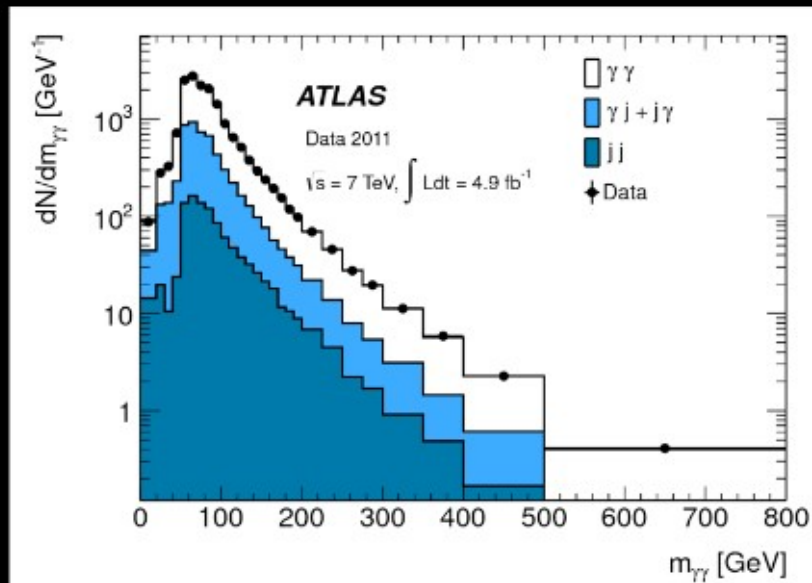
JHEP01(2013)086

Isolated photon pair candidate $E_T^1 > 25$ GeV & $E_T^2 > 22$ GeV

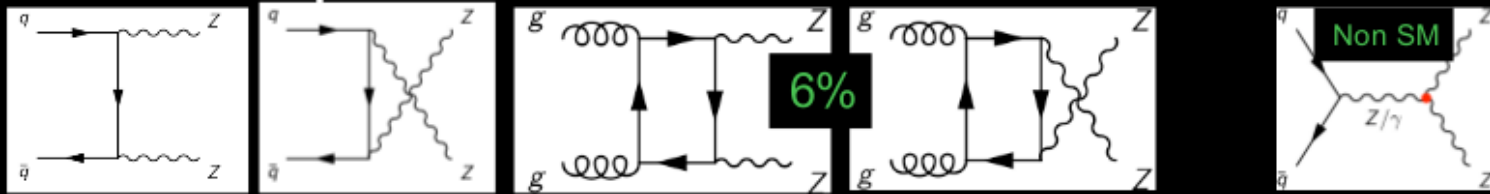
$\sigma_{\text{tot}} = 44^{+3.2}_{-4.2}$ pb at $\sqrt{s}=7$ TeV

Differential cross-sections to probe QCD

Exploiting isolation one can separate the three components: $\gamma\gamma$, γ -jet and jet-jet $m_{\gamma\gamma}$ spectrum being understood gives credit to $H \rightarrow \gamma\gamma$ discovery.



Diboson production at $\sqrt{s}=7$ TeV: $ZZ^{(*)} \rightarrow l+l+l+l$ $ZZ \rightarrow l+l-\nu\nu$



JHEP03(2013)128

Fundamental test of SM: gauge boson couplings

Probe for new physics

Anomalous Triple Gauge Coupling ?

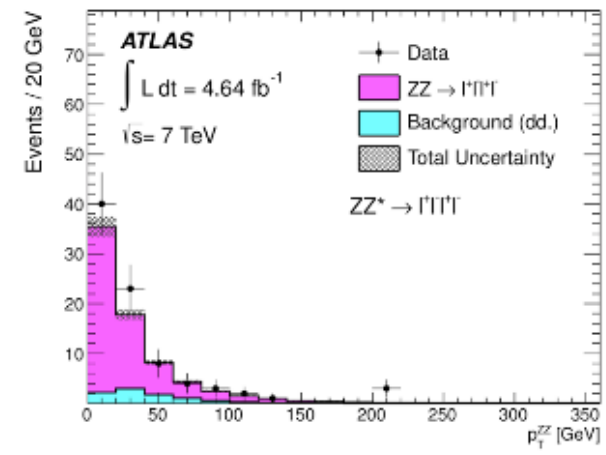
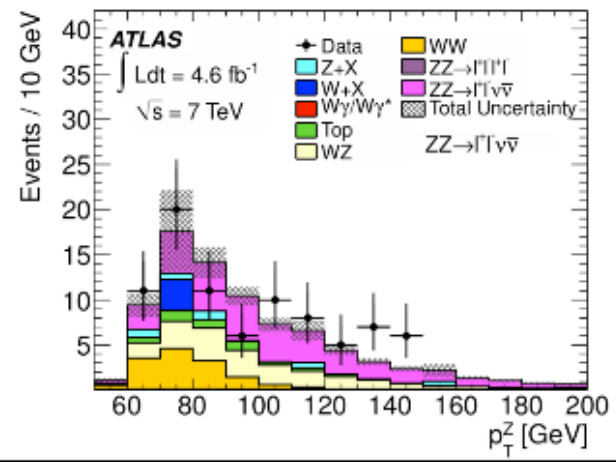
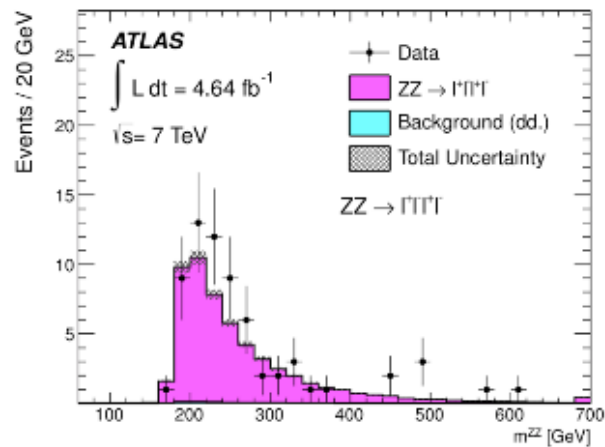
Search for resonances

Background to Higgs boson

Select events with

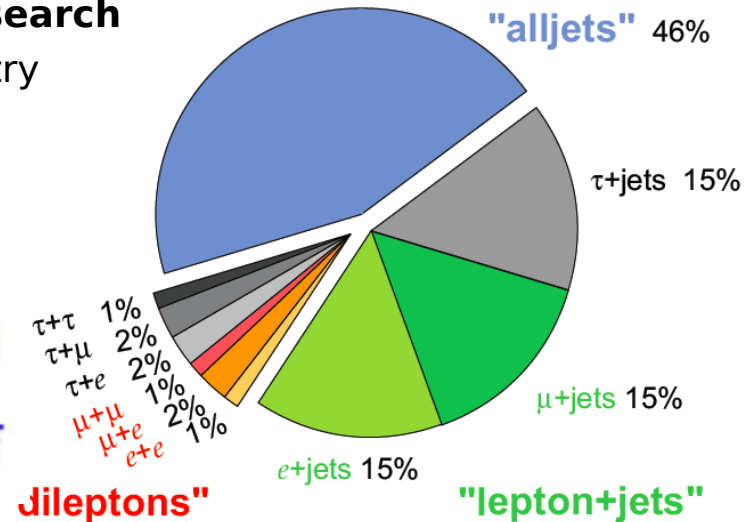
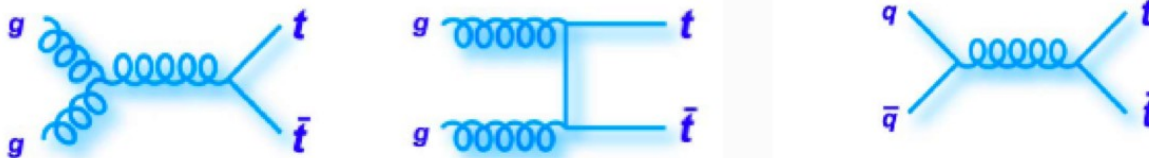
$4e, 4\mu, 2e2\mu$

$2e$ or $2\mu + E_T^{\text{miss}}$



Top quark physics at the LHC

- **One of the focal points of the Spanish groups research**
- Heaviest particle in the SM: special role in EW symmetry breaking? Large coupling to Higgs boson
- **LHC gives an unprecedented sample of top quarks:**
5 fb⁻¹ (@7 TeV) and 20 fb⁻¹ (@8 TeV) correspond to 5 600 000 top pairs and 2 700 000 single top events



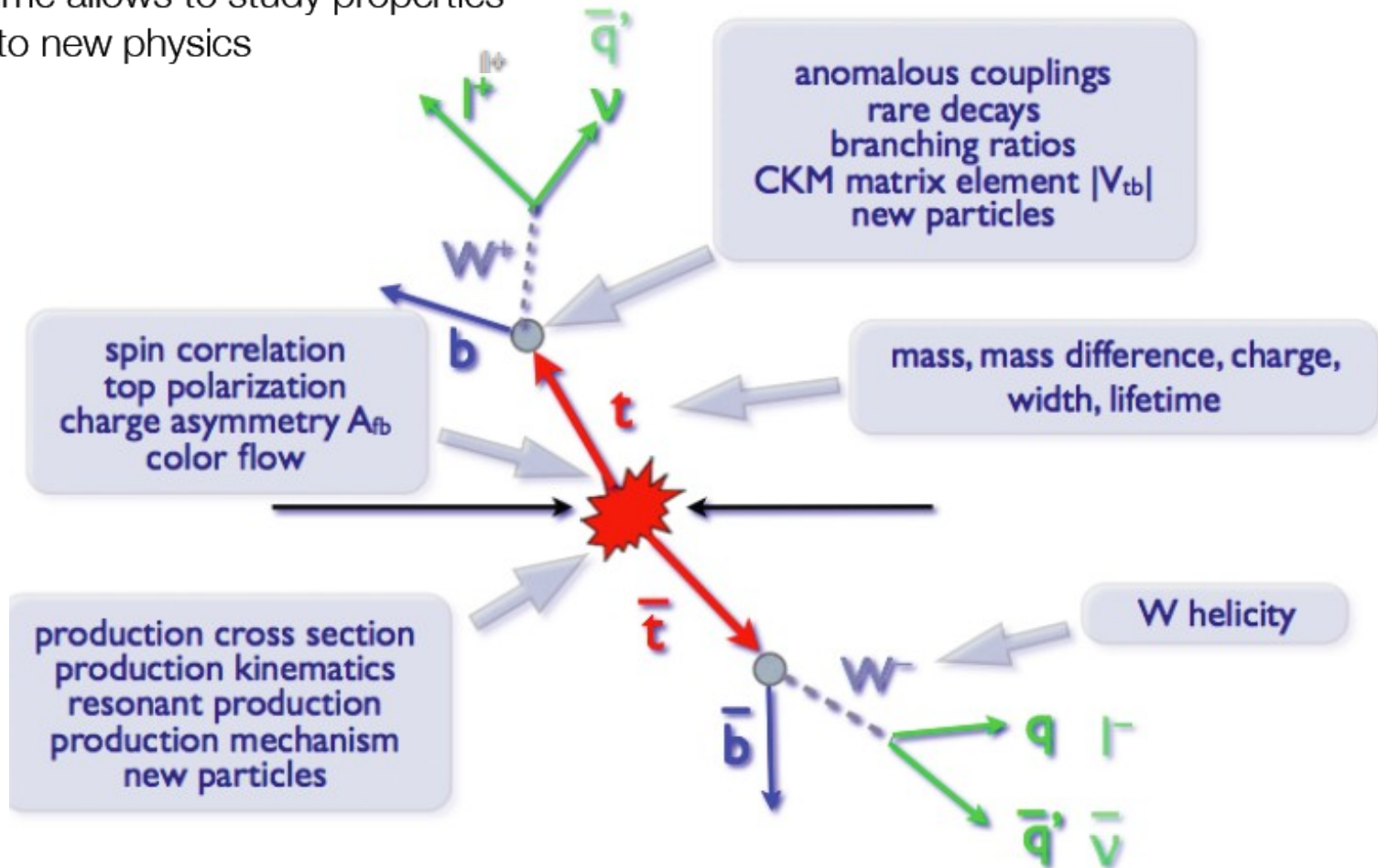
- **Top production** (dominated by gluon fusion at LHC) has to be well understood as it the **most important background to many New Physics signatures and Higgs.**
- **Sensitive to new physics ?**

final states,
Top decays through $t \rightarrow Wb$

- $t\bar{t}$ cross section is measured in all final states
- Top studies are a testing ground for NLO and NNLO calculations for QCD
- Large top samples: **Differential cross sections** measured as a function of observables sensitive to QCD predictions: $m_{t\bar{t}}, p_T, y(tt)$

Possible Top quark studies at LHC

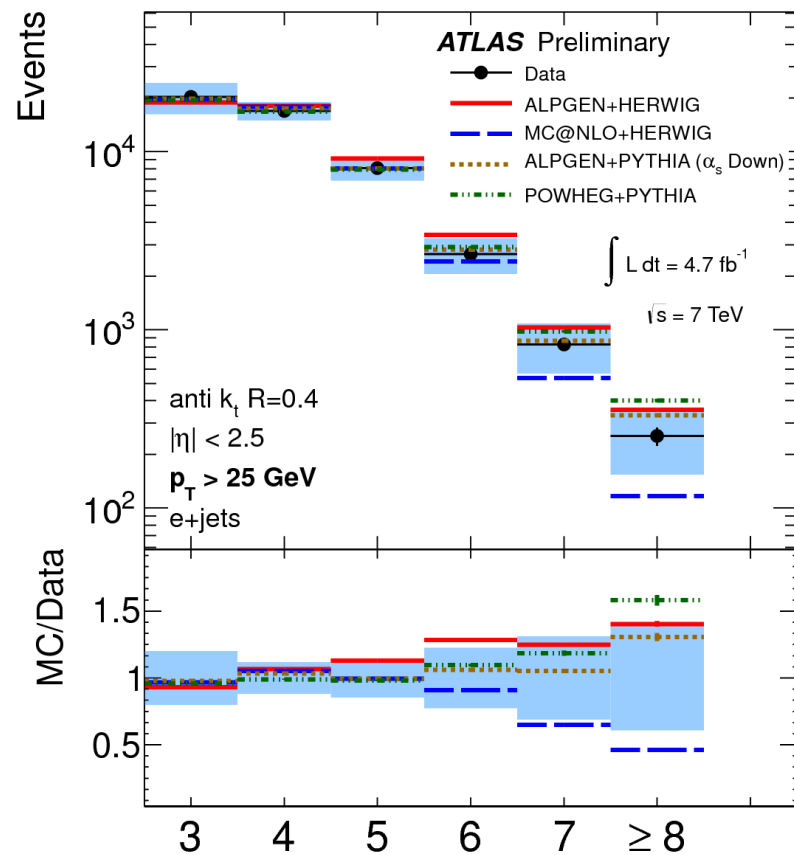
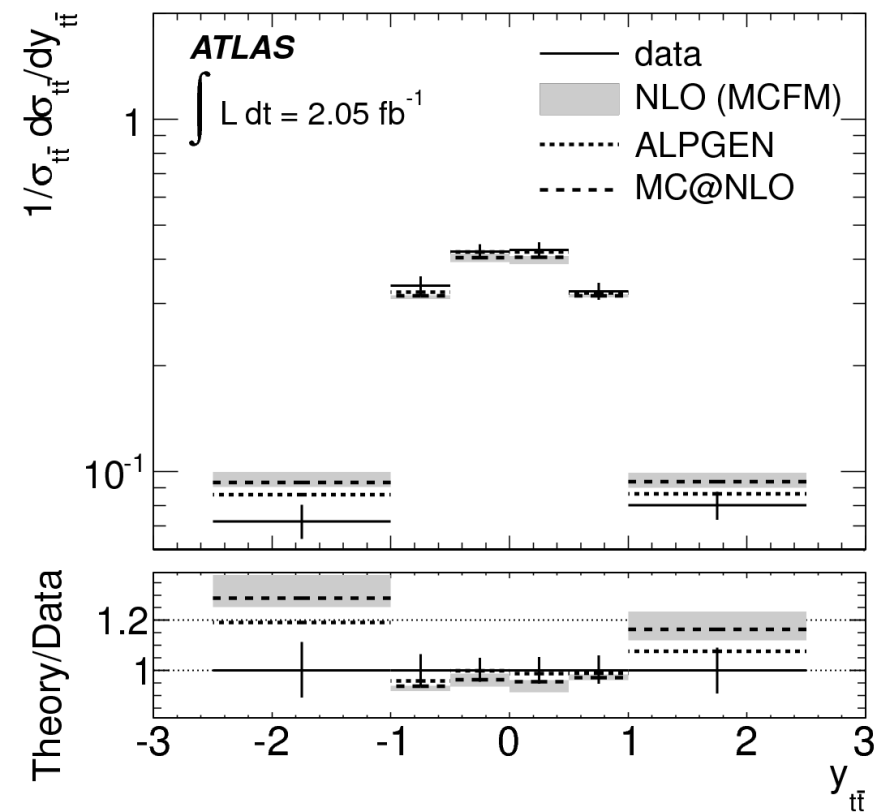
- ▶ probe of electroweak symmetry breaking
- ▶ short lifetime allows to study properties
- ▶ sensitive to new physics



Differential $t\bar{t}$ x-section; jet multiplicity

EPJC (2013) 73: 2261

ATLAS-CONF-2012-155



Lepton (e, mu) + jet channel:
 differential cross section
 $m_{t\bar{t}}, p_T, y(t\bar{t})$

Física del quark top

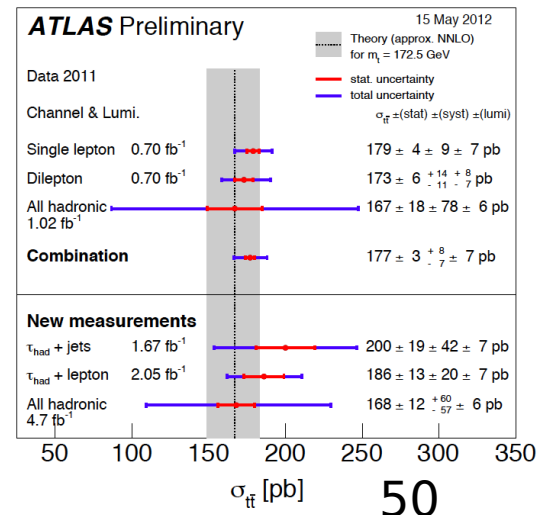
- The IFIC has contributed significantly to the study of physics of the top quark within groups: "Top Quark Physics" and "Physics exotic"..
- With important responsibilities in the coordination of these groups:
 - **“Top quark physics” convenor** (M.J.Costa, 2011- 2013)
 - **“Exotic Physics” convenor** (E.Ros,2007-2009)
- Also in analysis sub-grpoups:
 - Coordination of the sub-groups "Exotics/Jet+X" (M.Vos, 2009-2010) y "boosted objects" (M.Vos,2010-2011)
 - Top-Tau Liaison Contact (S.Cabrera, 2009 - 2011)
 - Top-Jet Liaison Contact (M.J.Costa, 2011)

Cross section of ttbar pair production with leptons taus in the final state:

this measure in the different channels, opens the door to new physics beyond the standard model. The final states with tau leptons can be increased if there are H^\pm

Phys. Lett. B 717 (2012) 89-108

On going efforts to reduce statistical and systematic uncertainty with a new technique based on fits of tau identification BDT distributions with improved background modeling

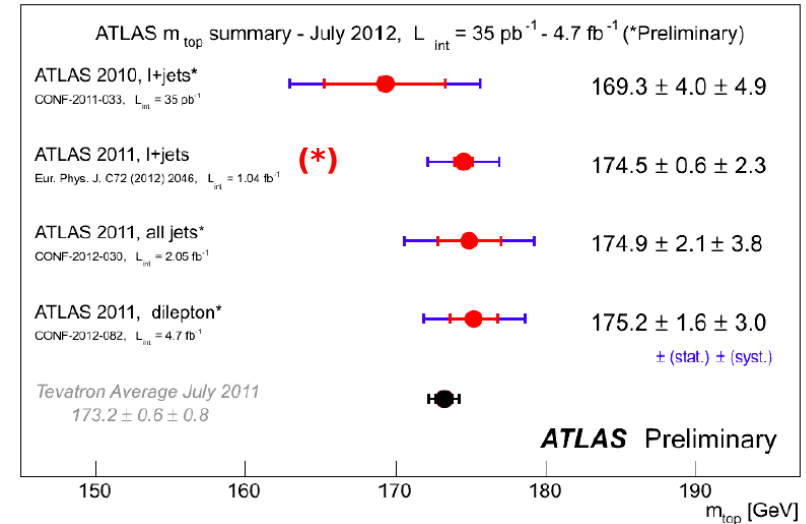


So far no deviations found from the Standard Model

Quark top mass

Top quark mass

- Fundamental parameter of the SM Model.
- Important for precision test of the SM.
- Test of New Physics.
- LHC measurement still very far from Tevatón measurement.



Huge effort to reduce errors..

- Mainly reduce the major systematic, i.e. The jet energy scale. **Eur. Phys. J. C, 73 3 (2013) 2304**
- We have measured the jet shape and compared to different MC generators to evaluate parton modeling shower, fragmentation and event shape: **HEP 1205 (2012) 128**
- We have contributed to the measurement of the top mass: **Eur. Phys. J. C72 (2012) 2046 (*)**

We have proposed an alternative method for the top mass determination based on the normalized cross section in $t\bar{t}+1\text{Jet}$ topologies. The theoretical uncertainties (scale and PDF) are small. **Eur. Phys. J C73 (2013) 2438** (theoretical-experimental study).

Mass renormalisation scheme of the top-quark mass is uniquely defined through NLO calculation

$$\mathcal{R}(m_{\text{Pole}}, \rho_s) = \frac{1}{\sigma_{t\bar{t}+1\text{Jet}}} \frac{d\sigma_{t\bar{t}+1\text{Jet}}}{d\rho_s}(m_{\text{Pole}})$$

with $\rho_s = \frac{2m_0}{\sqrt{s_{t\bar{t}+1\text{Jet}}}}$, $m_0 = O(m)$
 i.e. $m_0 = 170 \text{ GeV}$

Differential distribution to enhance the mass dependence, reaching sensitivities five larger times than in the inclusive case

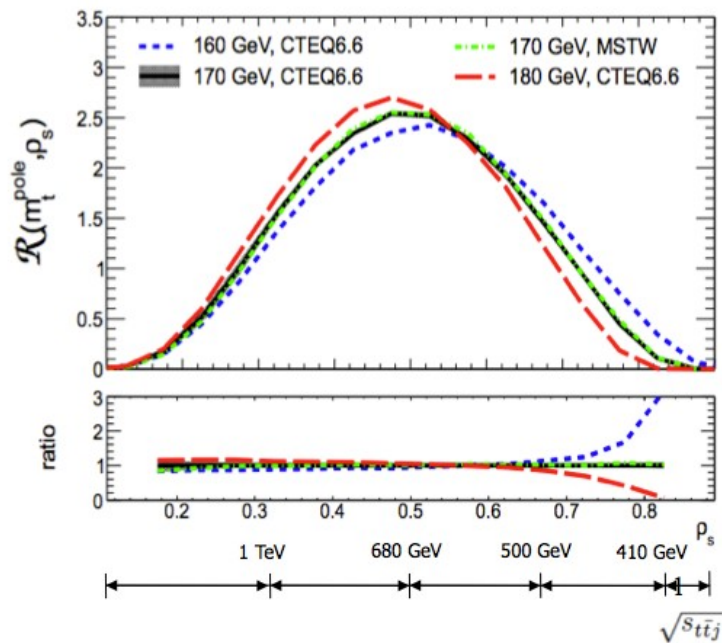
$$\frac{\Delta \sigma_{t\bar{t}+1\text{Jet}}}{\sigma_{t\bar{t}+1\text{Jet}}}(max) \sim -25 \frac{\Delta m_t}{m_t}$$

Normalized distribution: many theoretical and experimental uncertainties cancel in the ratio

Theoretical **uncertainties (scale, PDF)** estimated to be below **~500 MeV**

All major **experimental uncertainties** have been evaluated to be **below 1 GeV**, using general detector characteristics.

Not ATLAS public results... yet, so stay tuned!

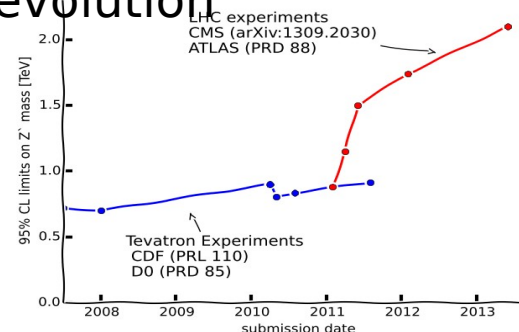


Boosted top quarks

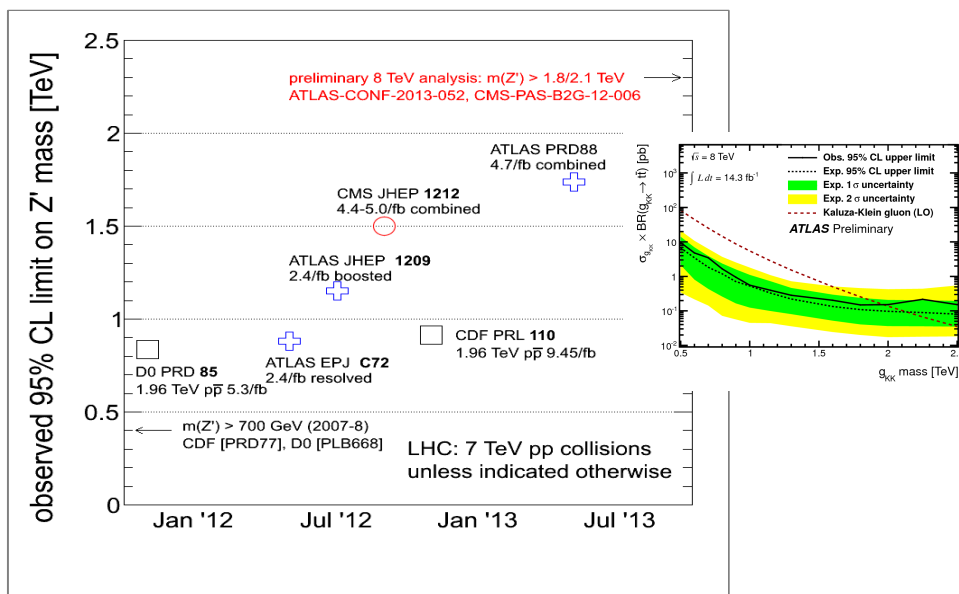
Boosted top quarks: a new handle on BSM physics

- First observation in 2011
- The most powerful technique for $t\bar{t}$ resonance searches in 2012/2013.
- Full 7 TeV data set: **Phys. Rev. D88 (2013)**
- $\frac{3}{4}$ of 8 TeV data: **ATLAS-CONF-2013-052**.

The boosted top quark revolution



"Sensitivity for massive new states decaying to top quark pairs"



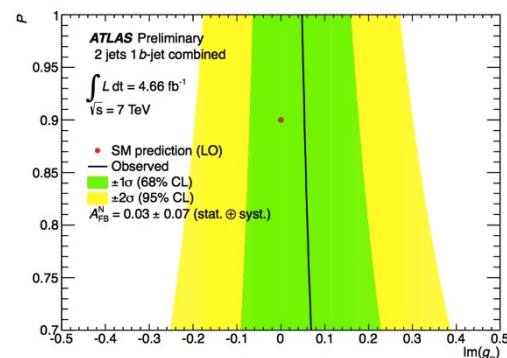
Other recent contributions:

- Boosted objects: A Probe of beyond the Standard Model physics, **Eur.Phys.J. C71 (2011) 1661**.
- Jet Substructure at the Tevatron and LHC: New results, new tools, new benchmarks. **J.Phys.G G39 (2012) 063001**.
- Jet mass and substructure of inclusive jets in $\sqrt{s} = 7$ TeV pp collisions with the ATLAS experiment. **JHEP 1205 (2012) 128**
- A search for $t\bar{t}$ resonances in lepton+jets events with highly boosted top quarks collected in pp collisions at $\sqrt{s} = 7$ TeV with the ATLAS detector. **Submitted to JHEP**.

Review of $t\bar{t}$ resonance searches in the lepton + jets final state, BOOST2012 report, arXiv:1311.2708

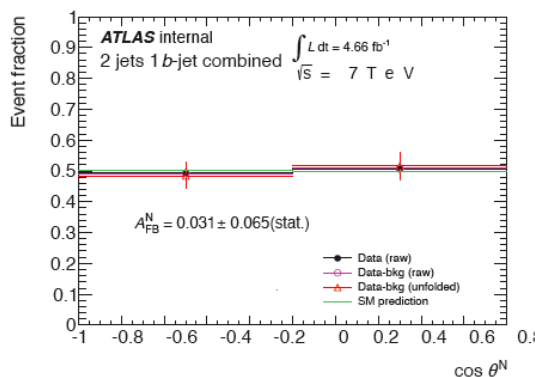
Single top

- Top almost decay exclusively to W, therefore exceeded to study Wtb vertex.
- Probe of anomalous coupling.
- In collaboration with J. Bernabeu (IFIC) and J.A. Aguilar-Saavedra (U. Granada)
- We are studying AFBN (sensitive to $\text{Im}(g_R)$) and AFBT.
- For AFN at 7TeV we get the first experimental limit of $\text{Im}(g_R)$: ATLAS-CONF-2013-032
- For AFBT work in progress (V. Lacusta talk in the parallel session)

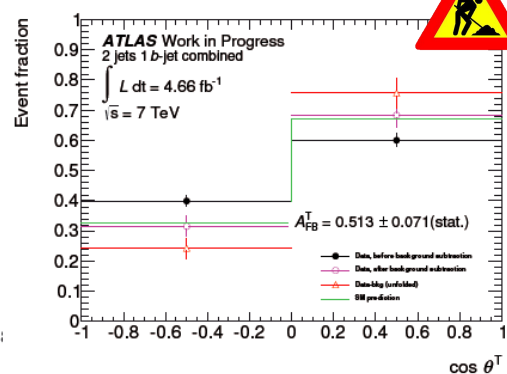


First $\text{Im}(g_R)$ limit

AFBN



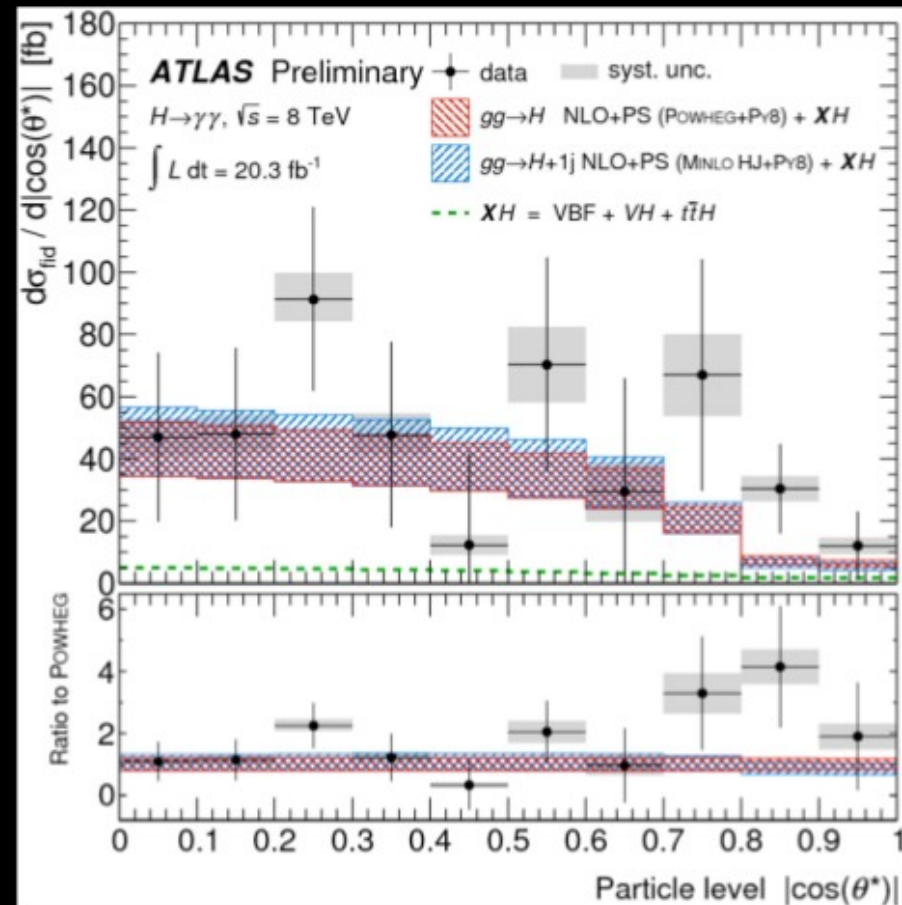
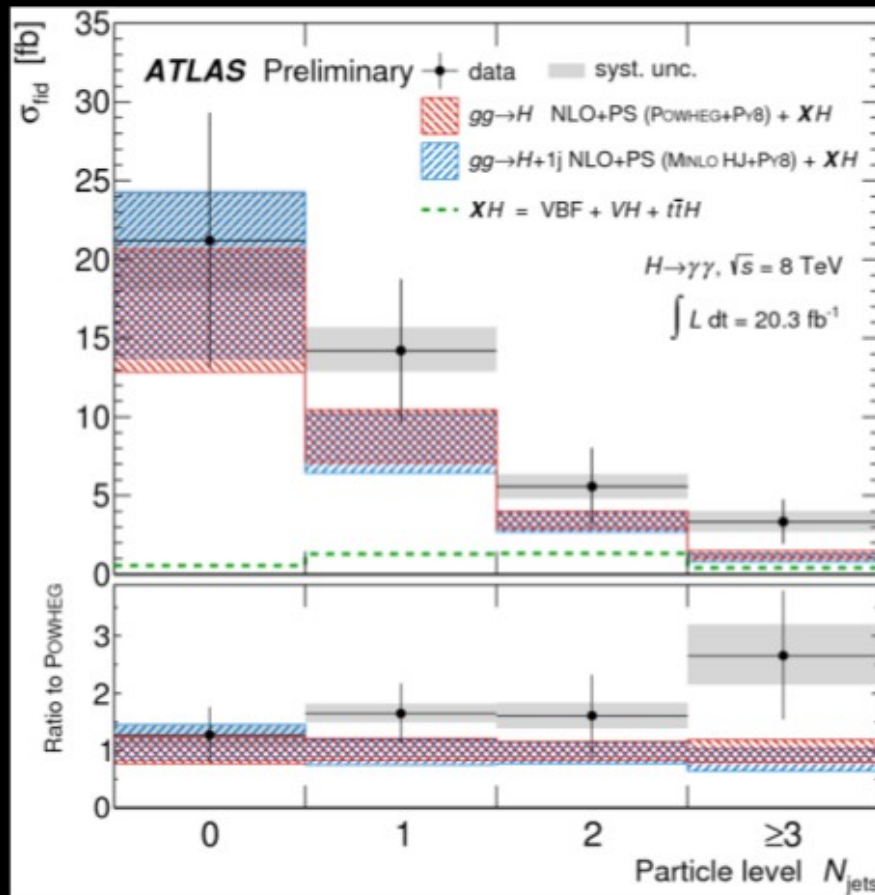
AFBT



Recent Higgs boson measurements in ATLAS

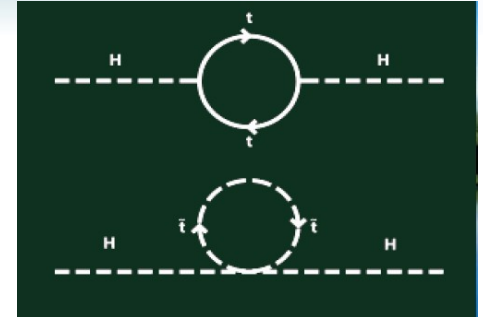
$H \rightarrow \gamma\gamma$ differential cross sections fully corrected to fiducial acceptance

ATLAS-CONF-2013-072



Motivations for SUSY?

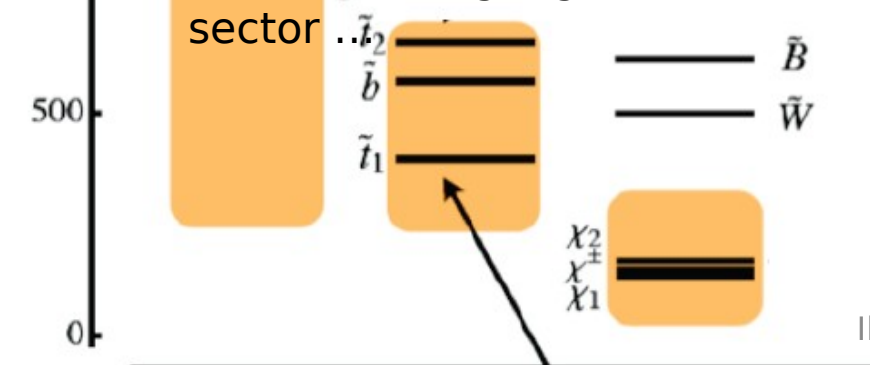
- SUSY is attractive for several reasons:
 - Stabilizes the Higgs boson mass and as bonus
 - Provides a dark matter candidate $m \sim O(100)$ GeV
 - Allows unification of gauge couplings at high E
- Difficult to keep MSSM “natural” with a $m_H = 125$ GeV, as this m_H would require very heavy stops. Large parts of MSSM parameter space are excluded.



MSSM: explore a space with ~ 100 free parameters.

- But EW scale SUSY is still possible with

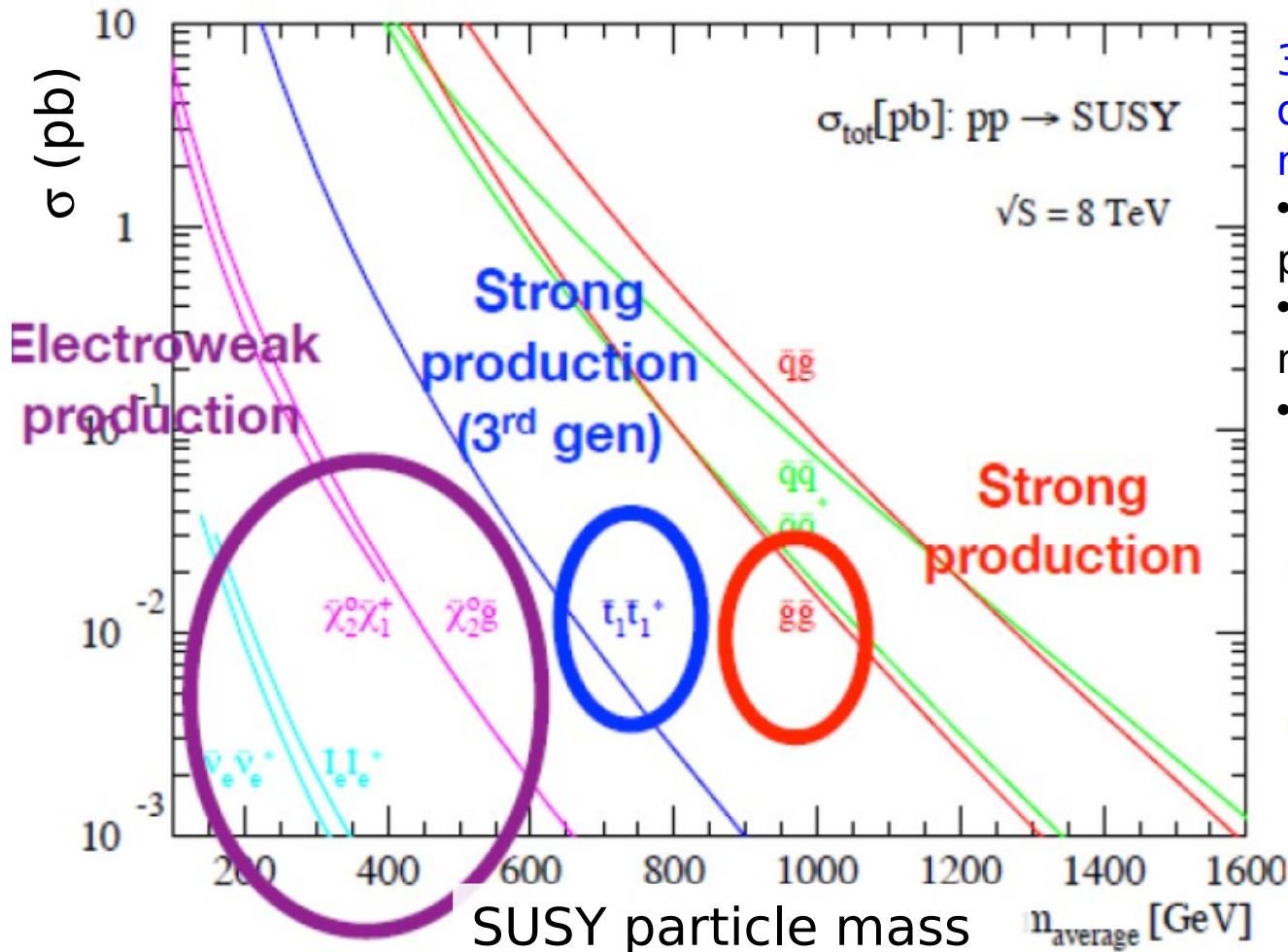
- large mixing in the stop sector (1 light stop and 1 heavy or both below ~ 1 TeV)
- Extra matter gauge fields : extra gauge Boson, more complicated Higgs sector



Natural SUSY scenario:

- lightest chargino, neutralino and stop ~ 500 GeV
- squark and gluino above 1 TeV.
- stop as to be light (< 1 TeV) to cancel large top contributions to Higgs mass

Production of SUSY particles



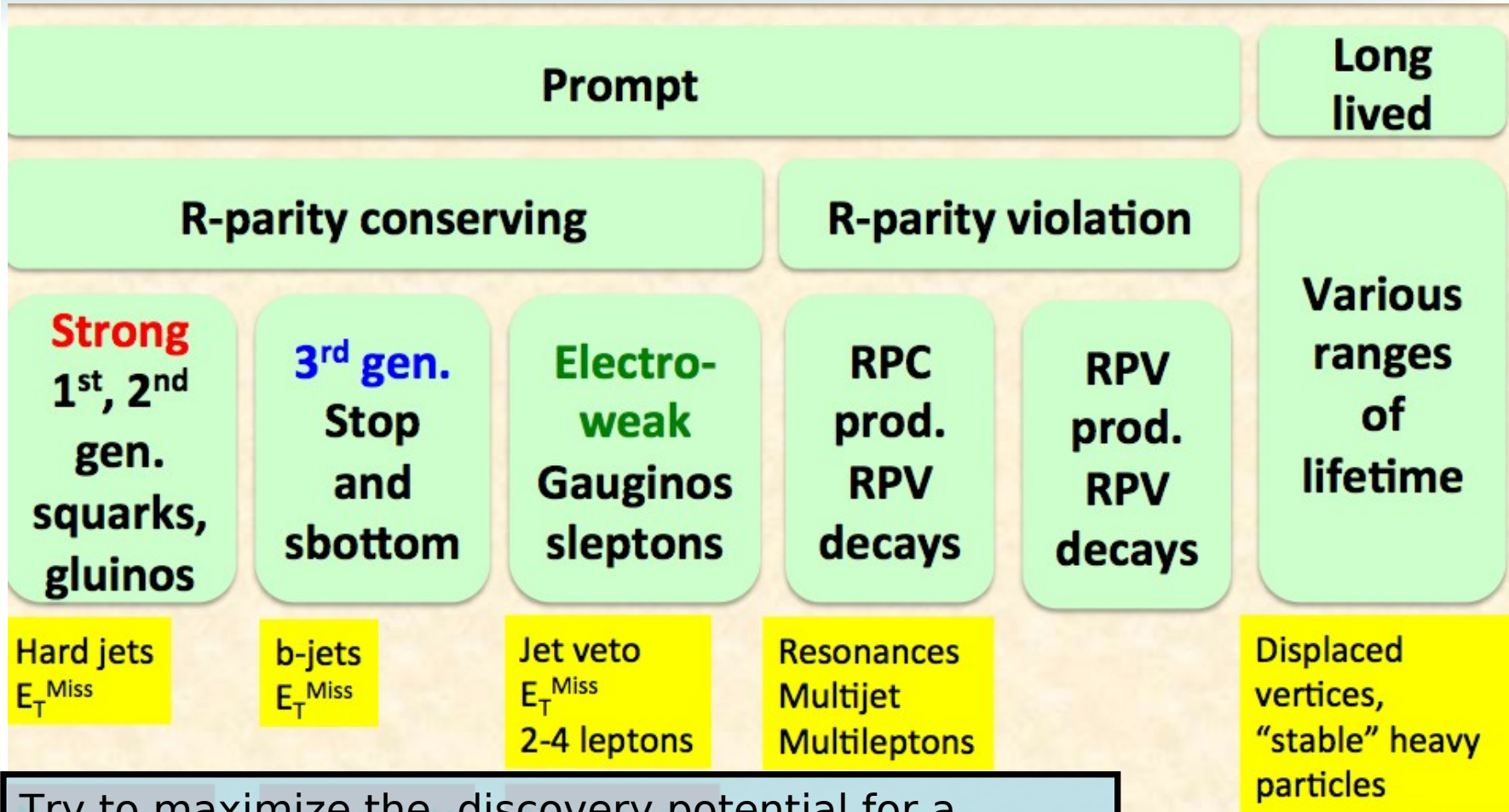
3rd generation scalar quarks (direct or gluino mediated)

- Significant σ for direct production
- key ingredients for natural SUSY
- Large top background

With 20/fb of LHC lumi, would have produced ~100 events for

1.2 TeV **gluinos**

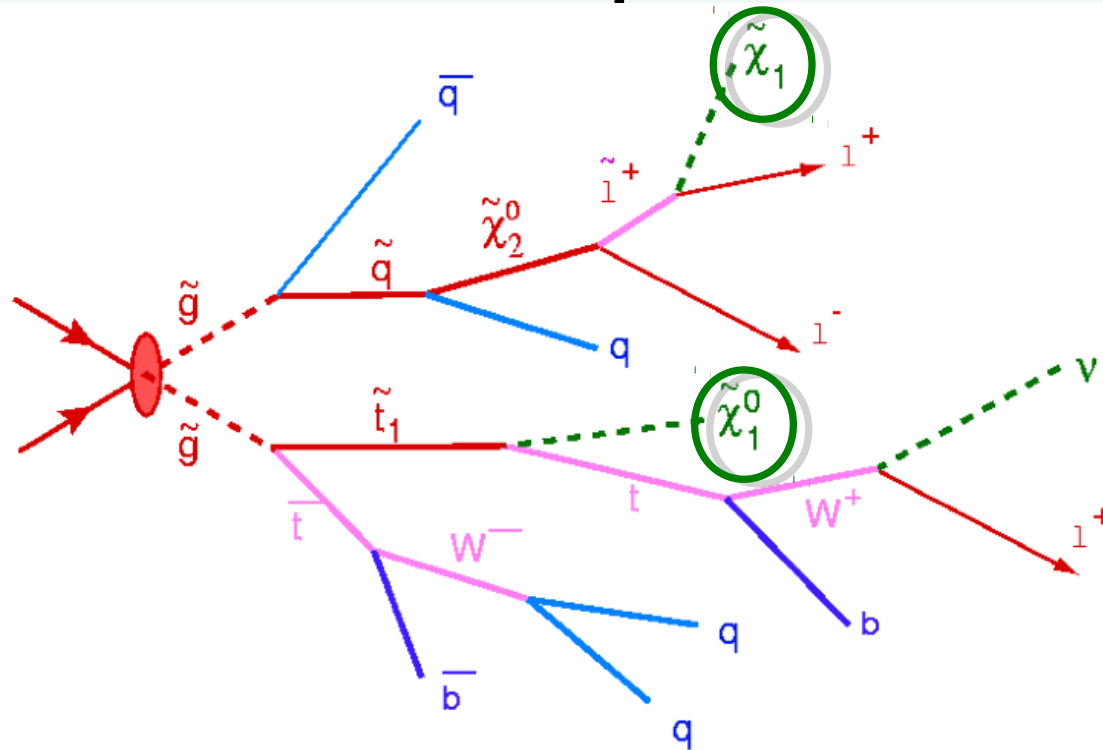
SUSY search strategy in ATLAS



Try to maximize the discovery potential for a variety of possible signals. Model independent searches also.

Benefit from efficient lepton ID, E_T^{miss} with no tails, excellent JES control and effective b tagging

General feature of RPC SUSY production



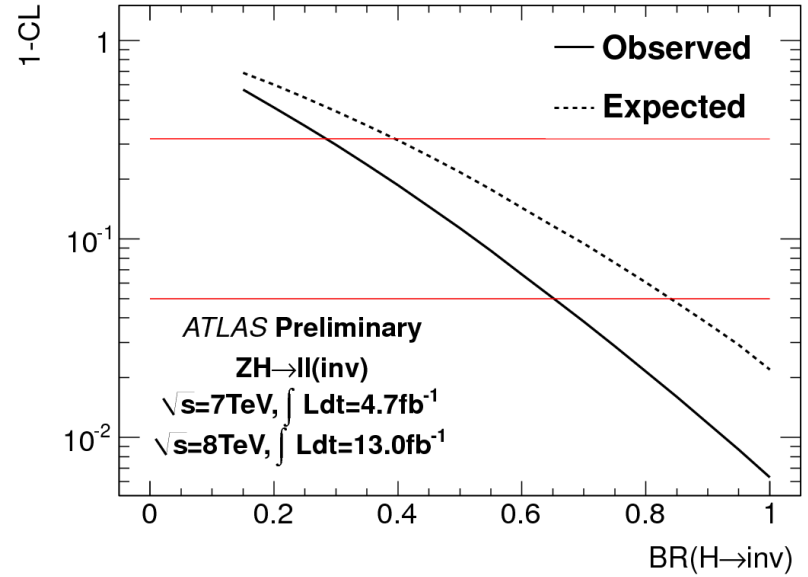
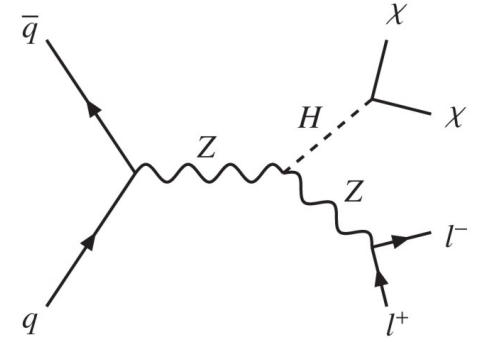
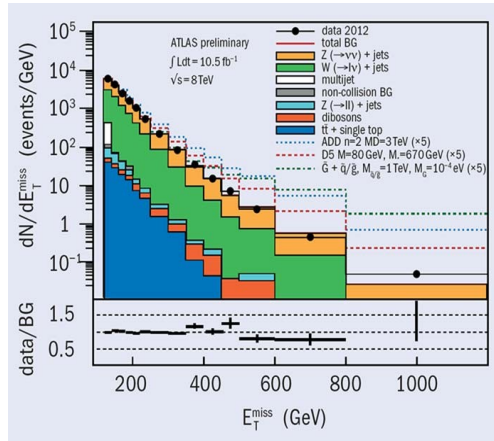
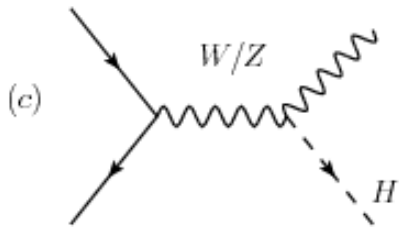
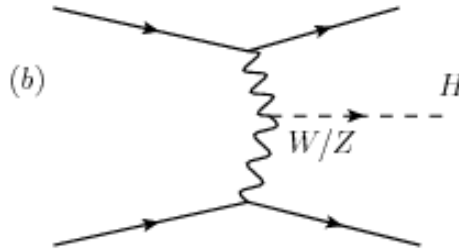
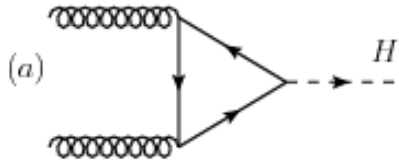
Many sparticles, no resonances

- 2 stable **Lightest SUSY Particles (LSP)** escape detection: Large missing E_T

- **Typical signatures:** Final states with **Missing E_T** and variable number of jets and 0 or multi leptons.

- Kinematic variables aiming at distinguishing between the tails of SM distributions and SUSY candidates events
- Necessity of **excellent background control**, typically measured in **Control Regions** and propagated to **Signal Regions** with MC simulations
- SUSY has many free parameters: conversion of results into exclusion limits requires assumptions on decay chains, masses and Br's.
- No signal: limits at 95% CL shown. Ilya Korolkov

Invisible Higgs



$BR(H \rightarrow \text{inv}) > 65\%$ excluded at 65% CL (only ZH (H \rightarrow inv) final state)

Happening now

New collaboration with ATLAS Higgs group re-interpretation of 7 + 8 TeV mono-jet results in terms of limits on SM Higgs \rightarrow inv BR

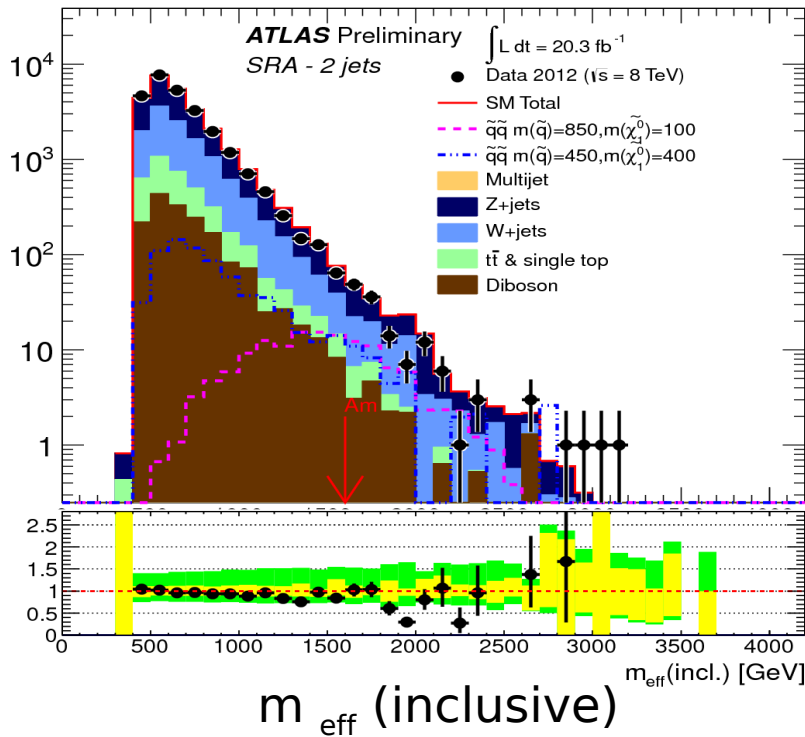
Plan to have results in time for Lepton-Photon

Search for generic RPC Susy

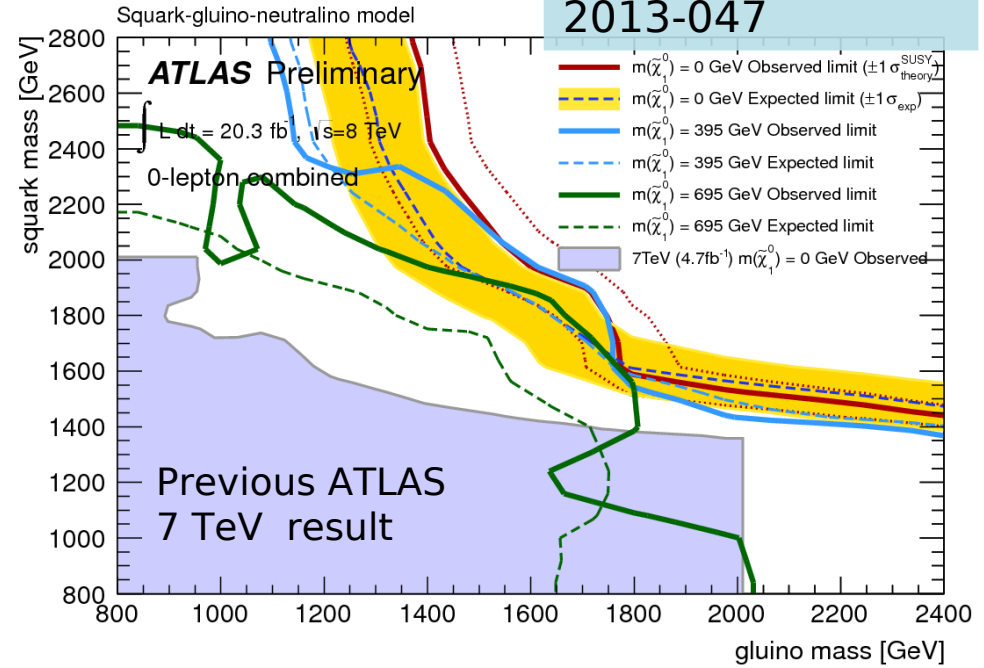
- Search for final states with 0 lepton, 2-6 jets, missing p_T

$$m_{\text{eff}} = H_T + E_{T\text{miss}} = \sum_{\text{objects } i} E_{T_i} + E_{T\text{miss}}$$

- Large effective mass



ATLAS-CONF-2013-047



- Limits for **MSSM model**, $m(\chi^0) = 0, m(\tilde{q}) = m(\tilde{g}) < 1.7 \text{ TeV}$

- If MSSM and **strong production of quarks of the 1st 2 generations**, with decays to $m=0$ lightest neutralino,

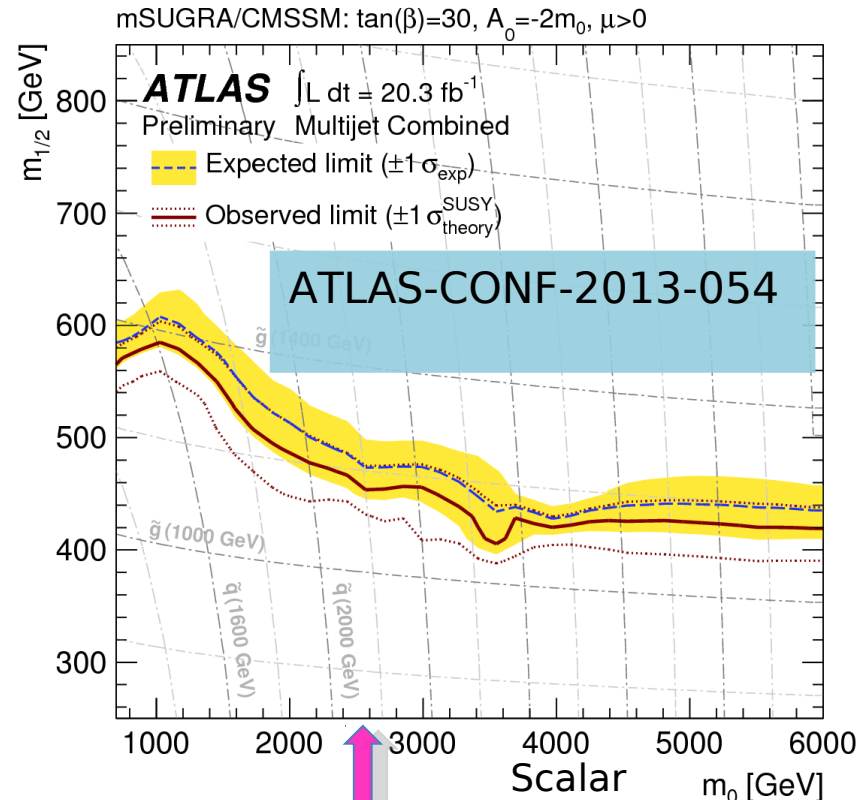
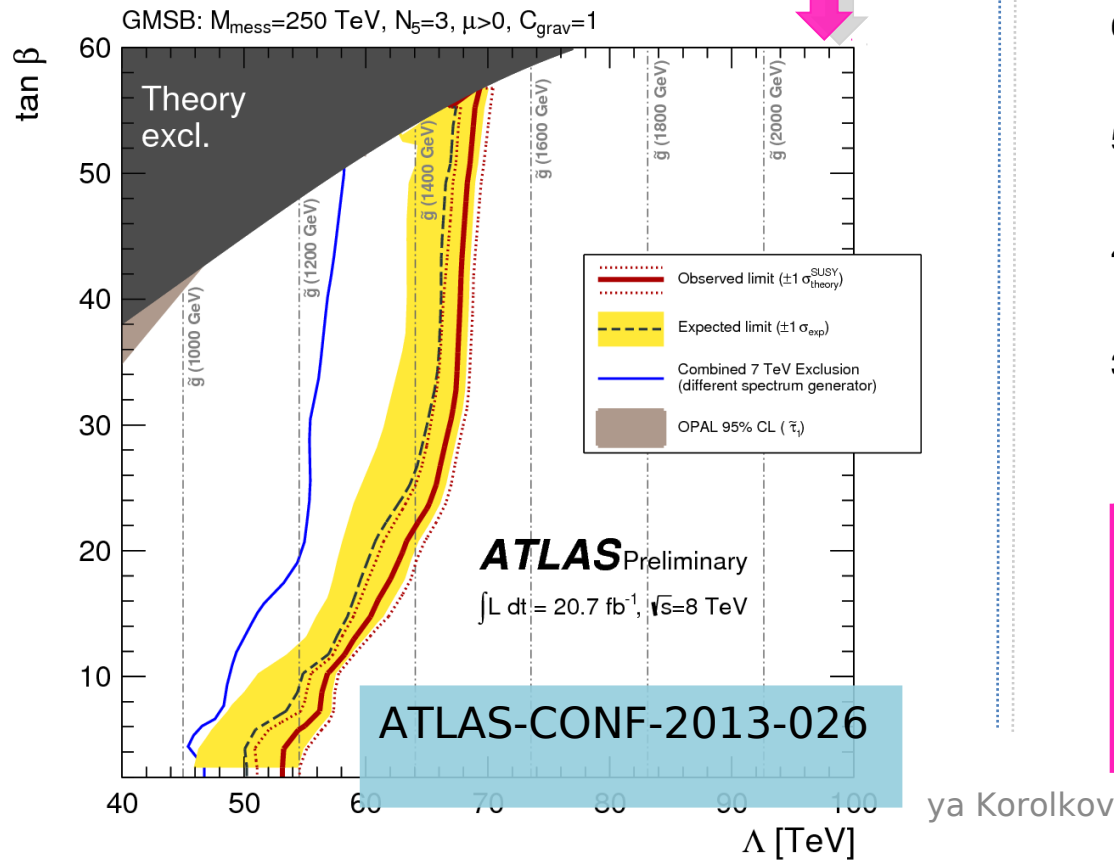
$$m(\tilde{q}) < 780 \text{ GeV}$$

Results also interpreted in a variety of SUSY models, non-universal Higgs mass model with gaugino mediation, (NUHMG), minimal extra dim model (mUED).

SUSY searches

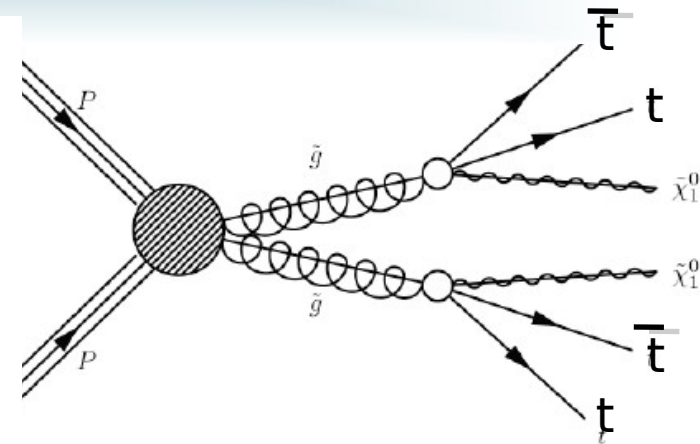
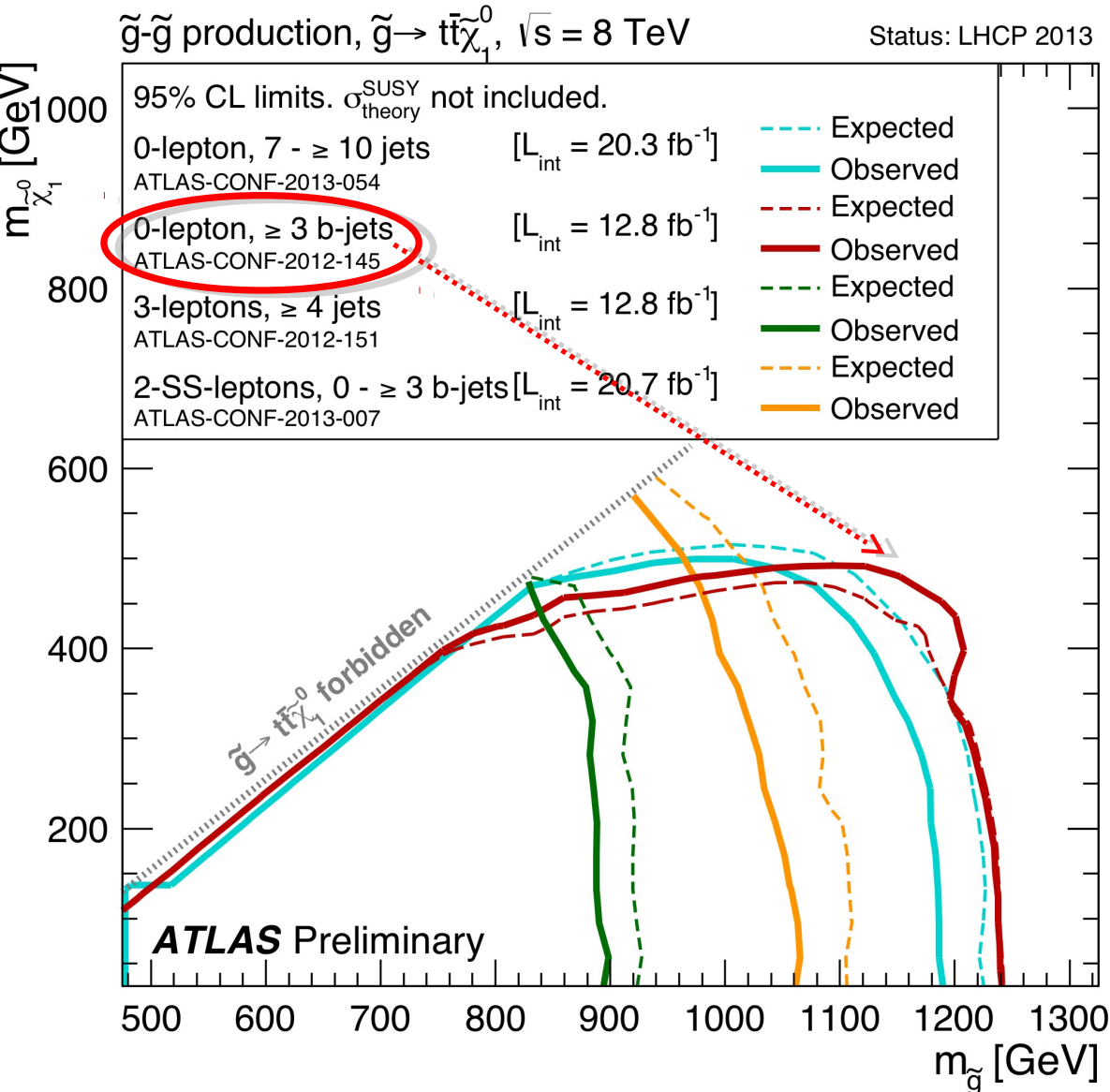
Searches with tau leptons+ jets+ missing E_T

- In minimal gauge-mediated SUSY (GMSB) breaking models, breaking scale Λ limit at 54 TeV, independently of $\tan\beta$.
- $m(\text{gluino}) < 1.14 \text{ TeV}$ excluded in a framework of natural gauge mediation (g only colored sparticle)



Final states: 7-10 jets, no isolated e or μ , missing p_T
 mSUGRA/CMSSM model limits:
 for large universal scalar mass m_0 ,
 $m(\text{gluino}) < 1.1 \text{ TeV}$ excluded

Glauino mediated stop production



Glauino mediated 3rd generation production

- Limits up to **1.2 TeV** on m_{gluino} for $m=0$ neutralino

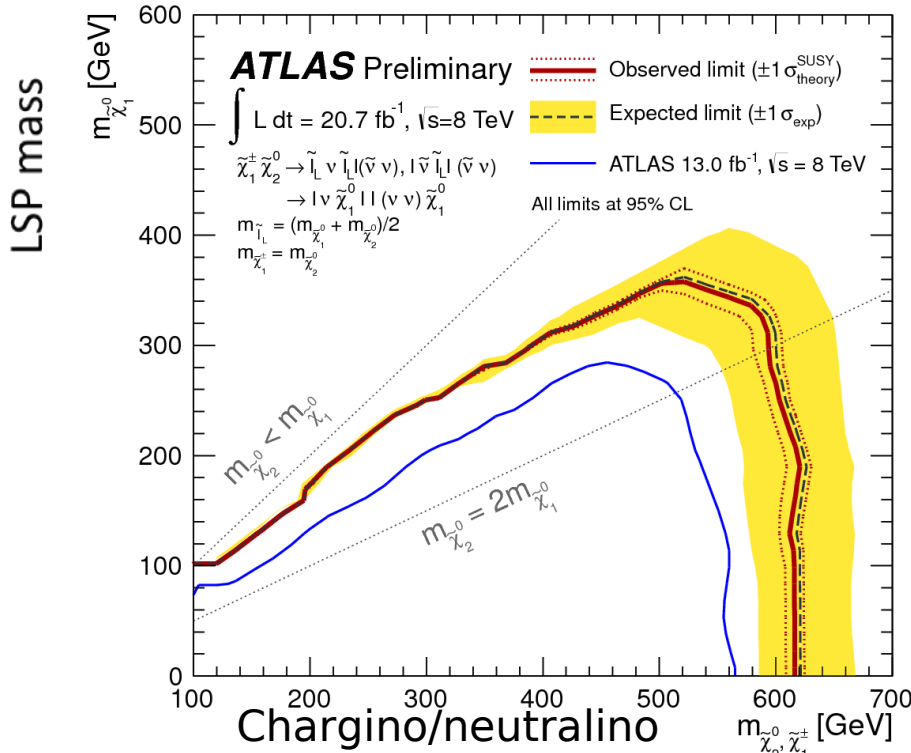
Sensitivity plateau around 500 GeV for m_{LSP}

- Exclusion limits for 8 TeV analyses in the $(m(\text{gluino}), m(\text{neutralino}))$ plane for the $g\bar{t}t$ simplified model where a pair of gluinos decays via off-shell stop to 4 top quarks and two neutralinos (LSP)

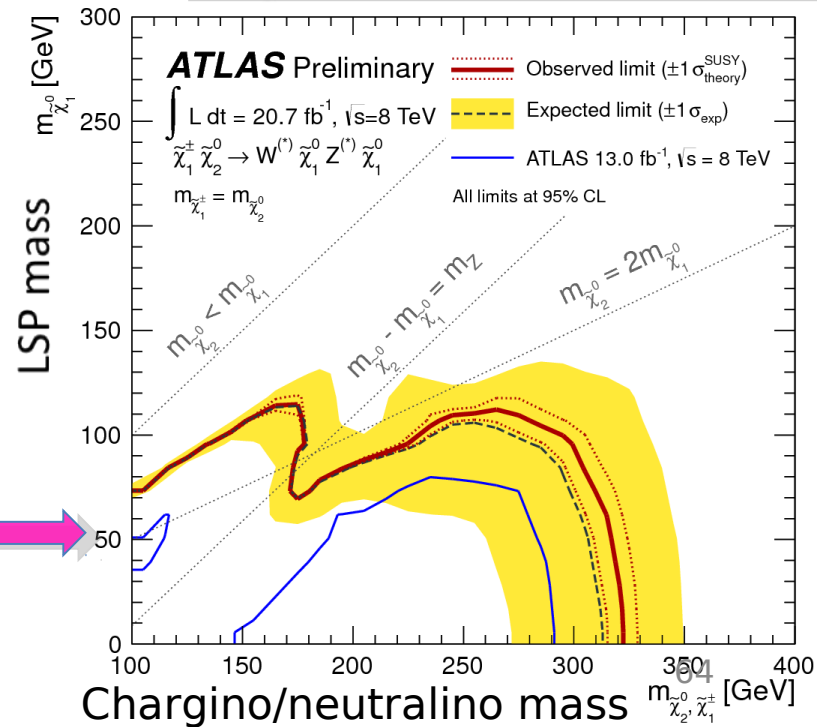
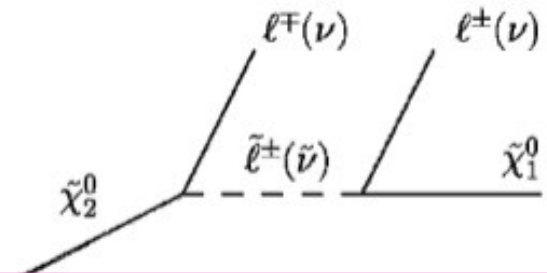
EW production: $\tilde{\chi}^0, \tilde{\chi}^\pm$

ATLAS-CONF-2013-035

- Signature 3 leptons + missing E_T
- Exclude chargino and heavy neutralino masses up to:

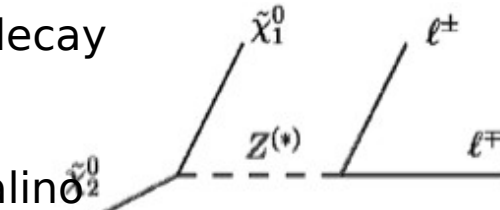


➤ **600 GeV** if they decay via sleptons



mass

➤ **315 GeV** if decay via W^*/Z^* to a massless lightest neutralino

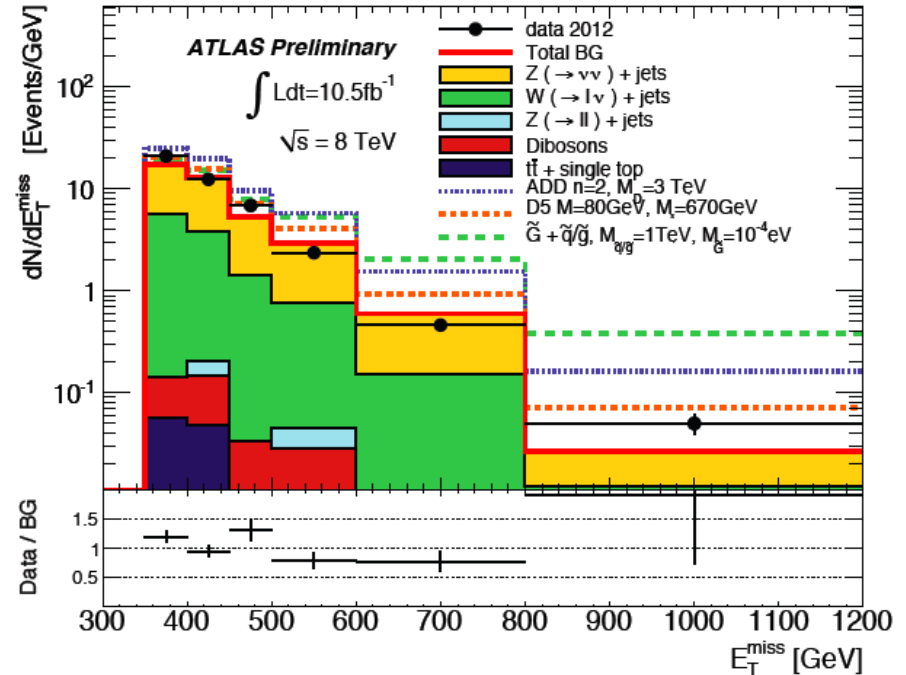
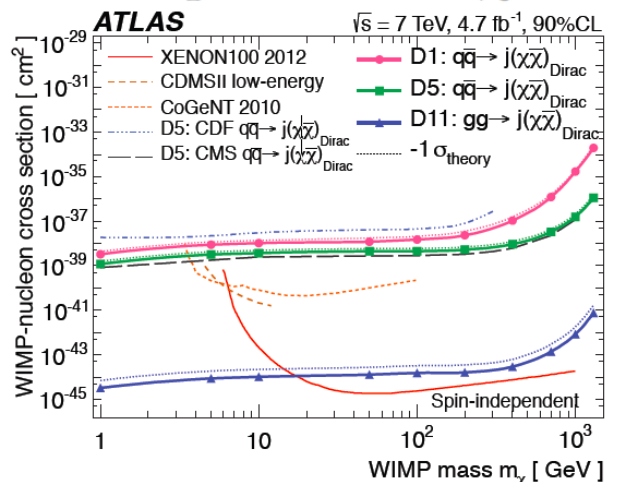
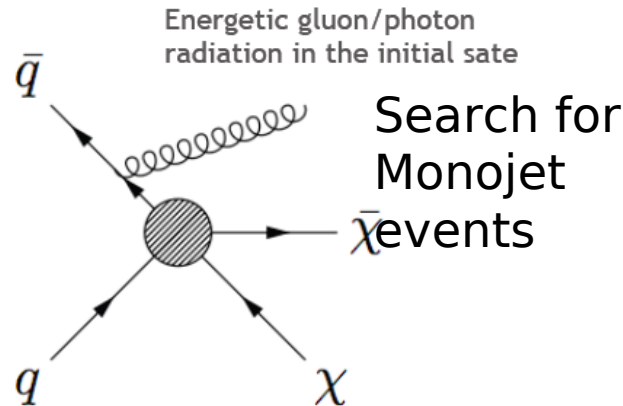


Ilya Korolkov

Monojets

Should we give up on natural SUSY and directly search for WIMP (dark matter) production in proton-proton collisions ?

Exploit “ISR technique” (huge potential!)



Interpretation in variety of models: extra dimensions, WIMP, **gravitinos**

ATLAS-CONF-2012-147

Exotics: summary of searches

Resonances predicted in Kaluza Klein graviton; GUT inspired theories; Little Higgs; heavy gauge bosons Z', W' ; technicolour: narrow technihadrons ...

- Heavy Resonances:

- Dilepton (see next slide)
- Dibosons WZ and ZZ ATLAS-CONF-2013-015 , ATLAS-CONF-2012-150
- Dijet: excludes excited quarks $m(q^*) < 3.84 \text{ TeV}$, ATLAS-CONF-2012-148
- Top anti-top: Limits on leptophobic topcolor Z' : 1.8 TeV, KK excitation of the gluon in Randall-Sundrum model: 2 TeV ATLAS-CONF-2013-052
- $W' \rightarrow t b$, excludes $W'_L(W'_R)$ below 1.74 TeV (1.84 TeV) ATLAS-CONF-2013-050

- Monojets ATLAS-CONF-2012-147

- Heavy top like quarks: $T' > 790(640) \text{ GeV}$ for weak isospin doublet (singlet) scenarios ATLAS-CONF-2013-018

- Same sign dileptons and b jets: vector like B(T) quarks excluded for masses $B(T) > 0.59 (0.54) \text{ TeV}$ if B(T) are singlets; chiral b' quarks excluded below 0.72 TeV;

inverse size of extra dimensions $> 0.90 \text{ TeV}$ ATLAS-CONF-2013-051

- Excited leptons / Type III Seesaw Model heavy fermions

ATLAS-CONF-2012-146 / ATLAS-CONF-2013-019

Heavy Dilepton Resonances

Experimental challenge: understand detector performance for a signal with (almost) no control sample at very high momentum: confidence in alignment, simulations...

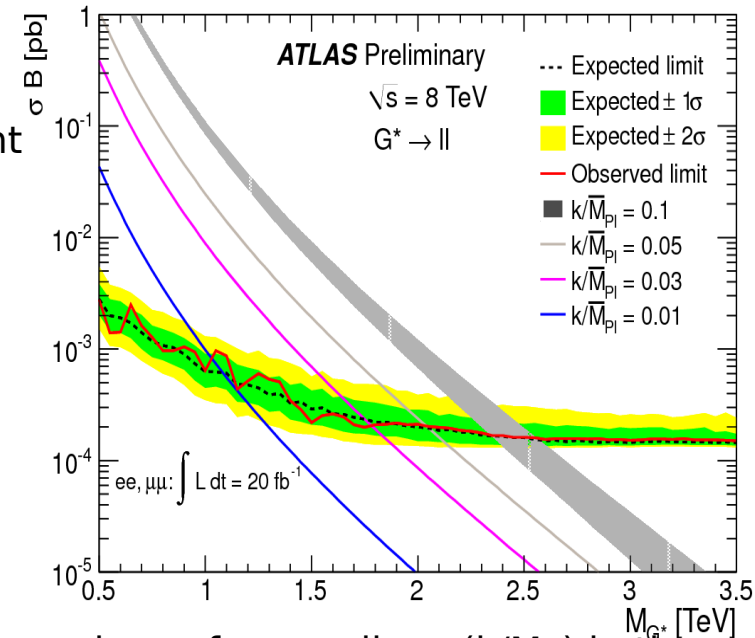
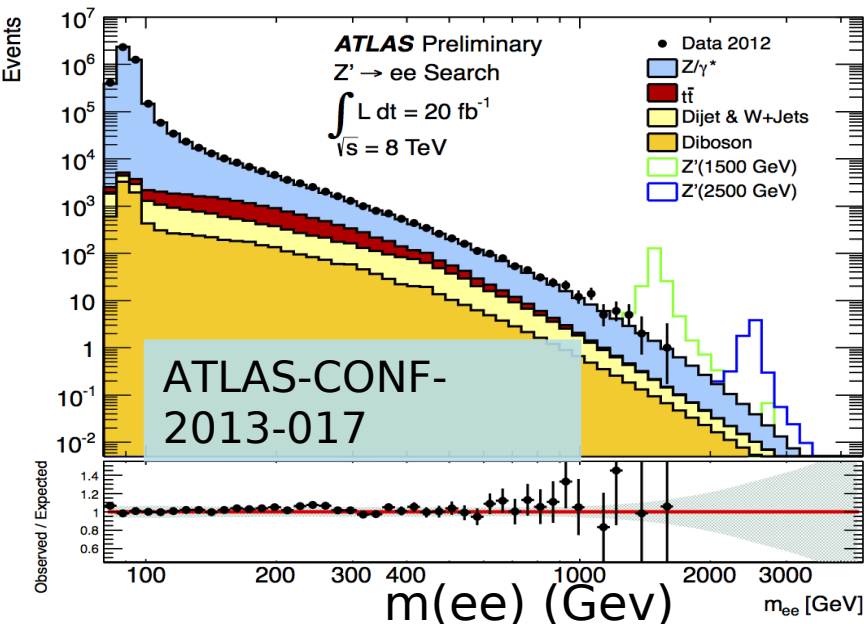
$$Z' \rightarrow e^+ e^- \text{ or } \mu^+ \mu^-$$

Dielectron: excellent resolution : <2% at high momentum.

Poor charge measurement: no charge requirement

Dimuon: Alignment is critical. Resolution 13% at Pt = 1 TeV

No discrepancy with the Standard Model



Several σ_B are shown for couplings (k/M_{Pl}) in the range of 0.01-0.1.

- Randall Sundrum Graviton G^* : $M < 2.47 \text{ TeV}$ (for $k/M_{Pl} = 0.1$, k : space-time curvature in the x_{dim})

- E6 gauge group Z'_ψ : $M < 2.38 \text{ TeV}$

Z' with SM couplings to fermions excluded $M < 2.86 \text{ TeV}$ for ee and $\mu\mu$ channels combined

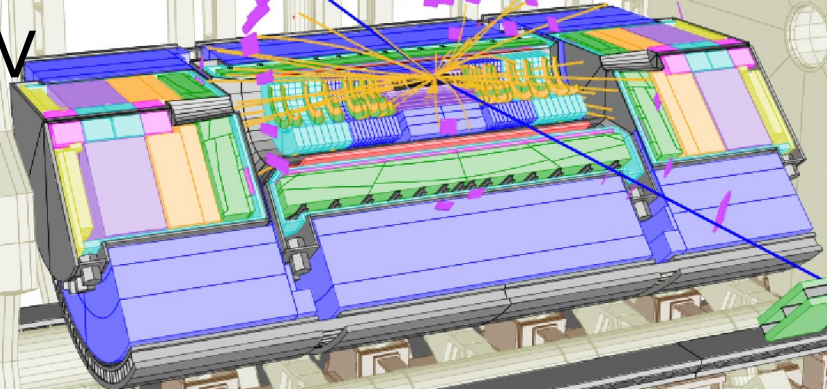
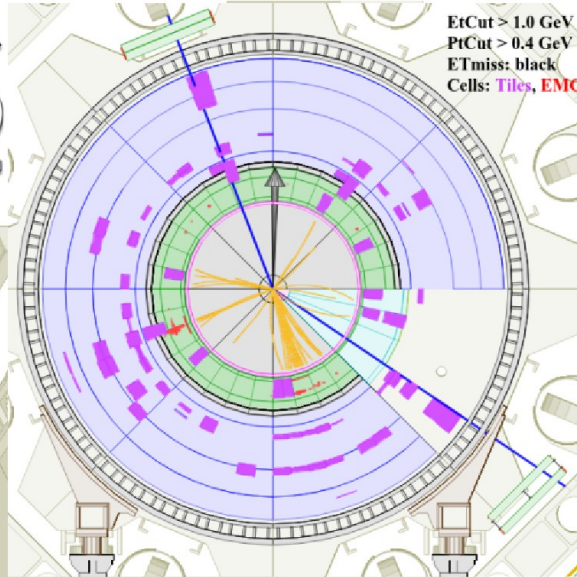
ATLAS EXPERIMENT

EtCut > 1.0 GeV
PtCut > 0.4 GeV
ETmiss: black
Cells: Tiles, EMC

Run Number: 209353
Event Number: 46681378
Date: 2012-08-27, 22:08:31 CET

EtCut > 0.5 GeV
PtCut > 0.4 GeV
Muon: blue
Cells: Tiles, EMC

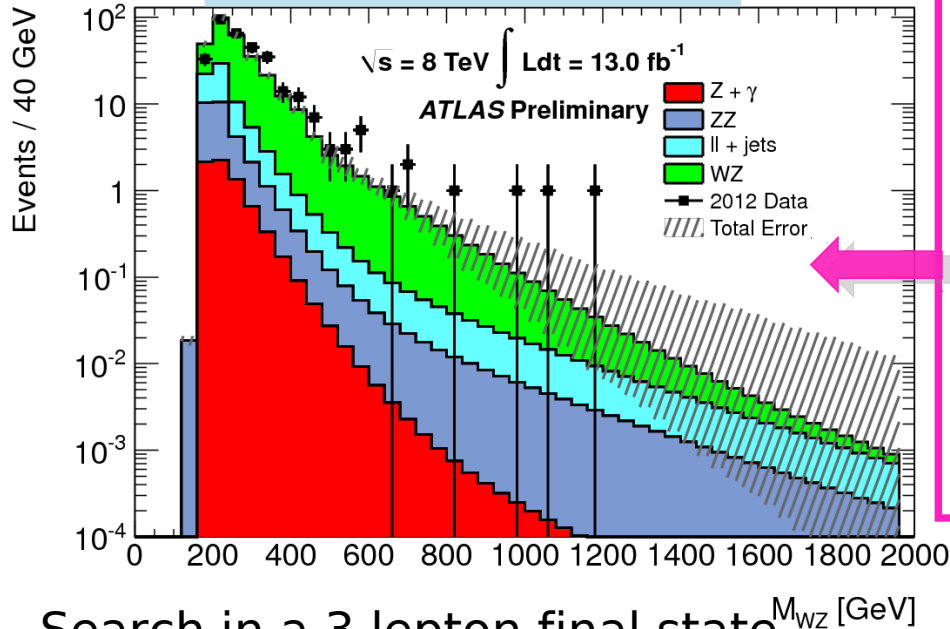
$$m(\mu^+ \mu^-) = 1.84 \text{ TeV}$$



- Track muon in MS and ID
- Require muon isolation
- Use muon op. sign with highest sum(p_T)
- Dominant BG: DY.
- Signal and BG evaluated with MC and rescaled using known Xsect.
- NNLO K-factors correct the LO MC.

Dibosons; Same sign leptons

ATLAS-CONF-2013-015



Search in a 3 lepton final state M_{WZ} [GeV]

Same sign leptons predicted in many New Physics scenarios:

- b' , $T_{5/3}$, tt , 4-tops, gluino mediated Stop, $H^{++}/--$
- Heavy neutrino (seesaw)
- TeV-scale gravity (mini-black holes)

Ilya Korolkov

• diboson $WZ \rightarrow l\nu ll$ resonances predicted:

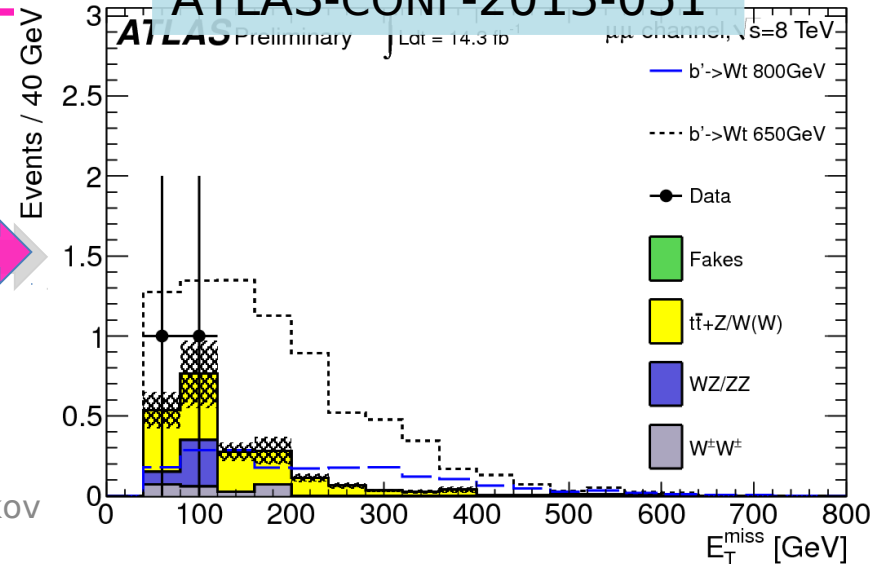
➤ Technirho meson (ρ_T) in Technicolor models excluded

$$m(\rho_T) < 920 \text{ GeV}$$

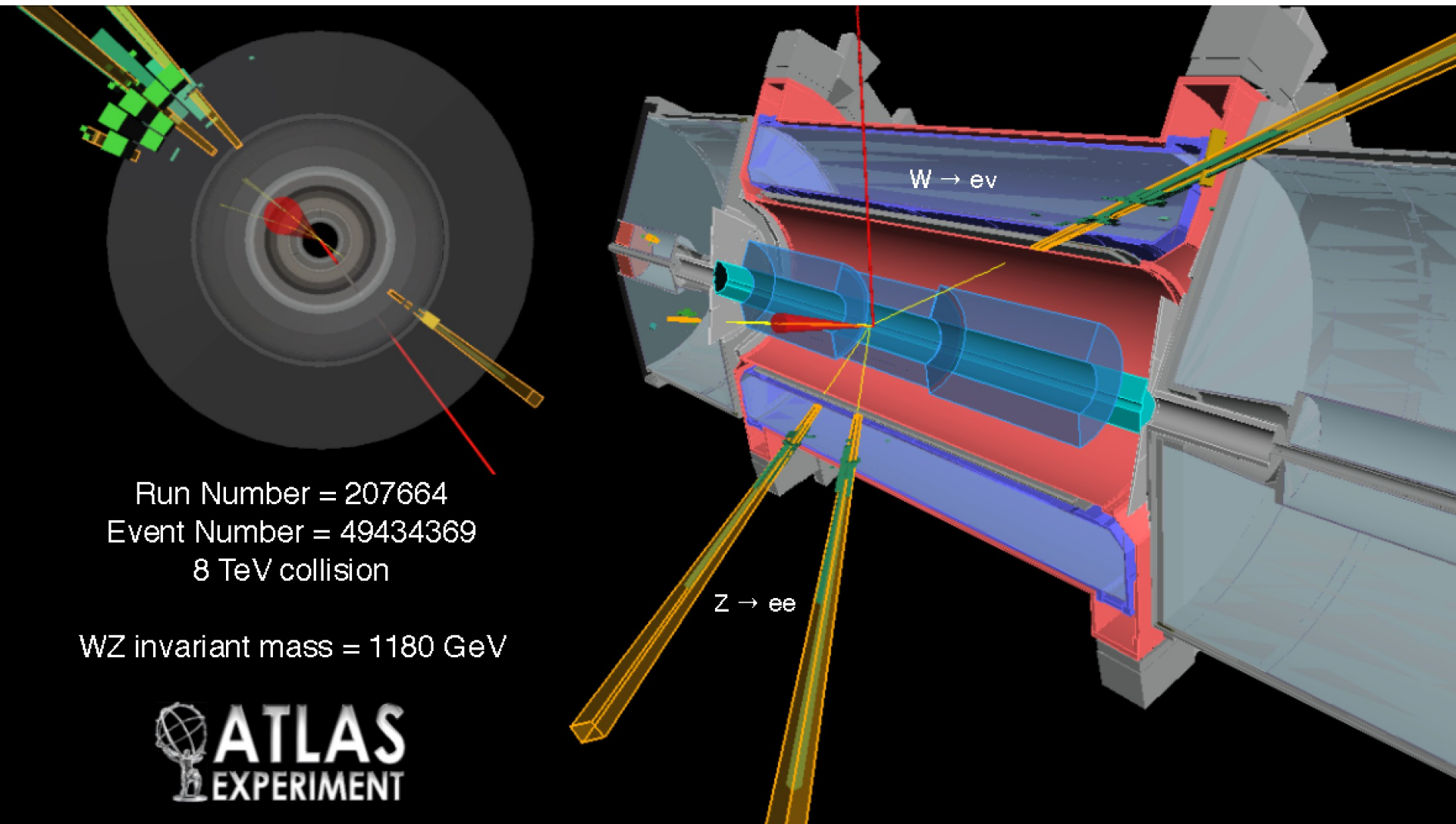
➤ heavy gauge bosons in composite Higgs models: Extended Gauge Model

$$m(W') < 1.18 \text{ TeV}$$

ATLAS-CONF-2013-051



Highest mass WZ candidate



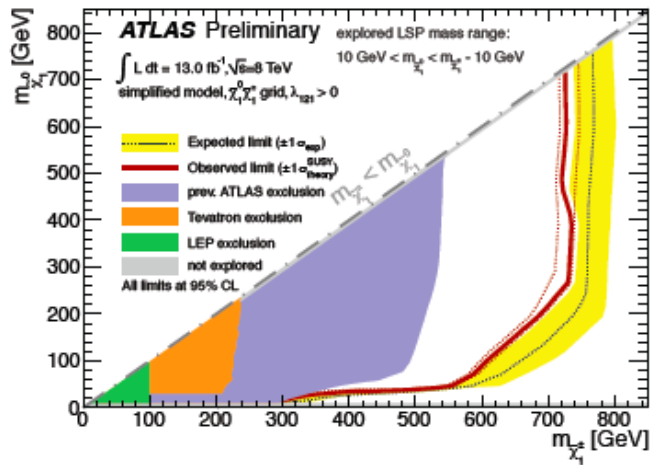
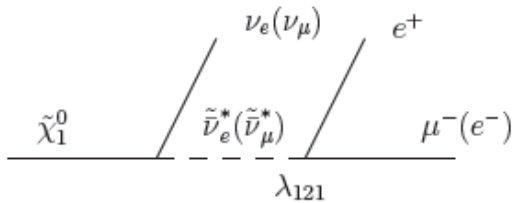
Run Number = 207664
Event Number = 49434369
8 TeV collision

WZ invariant mass = 1180 GeV

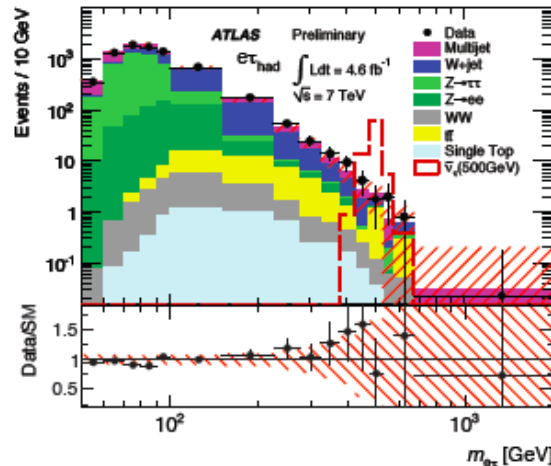
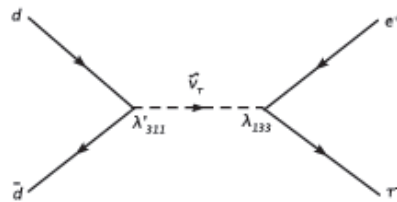
SUSY with R parity violation

Dedicated research programme designed to assess extremely broad RPV phenomenology

Search for strong and EW SUSY-RPV production in events with $\geq 4-L$

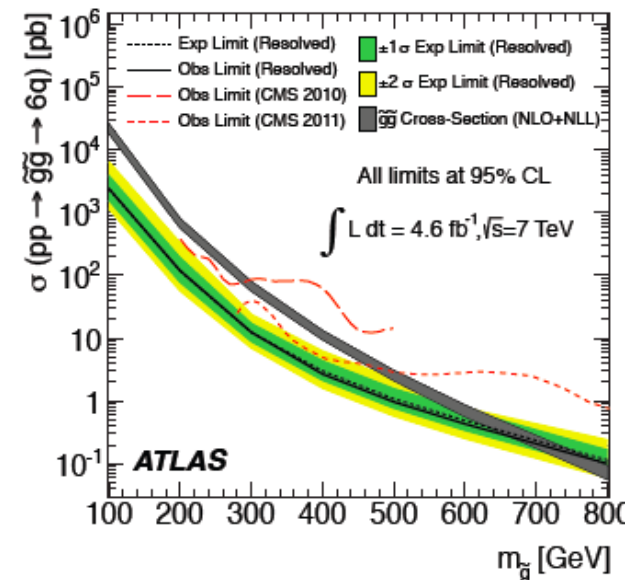


Search for RPV sneutrino production and decay through LFV into LL'



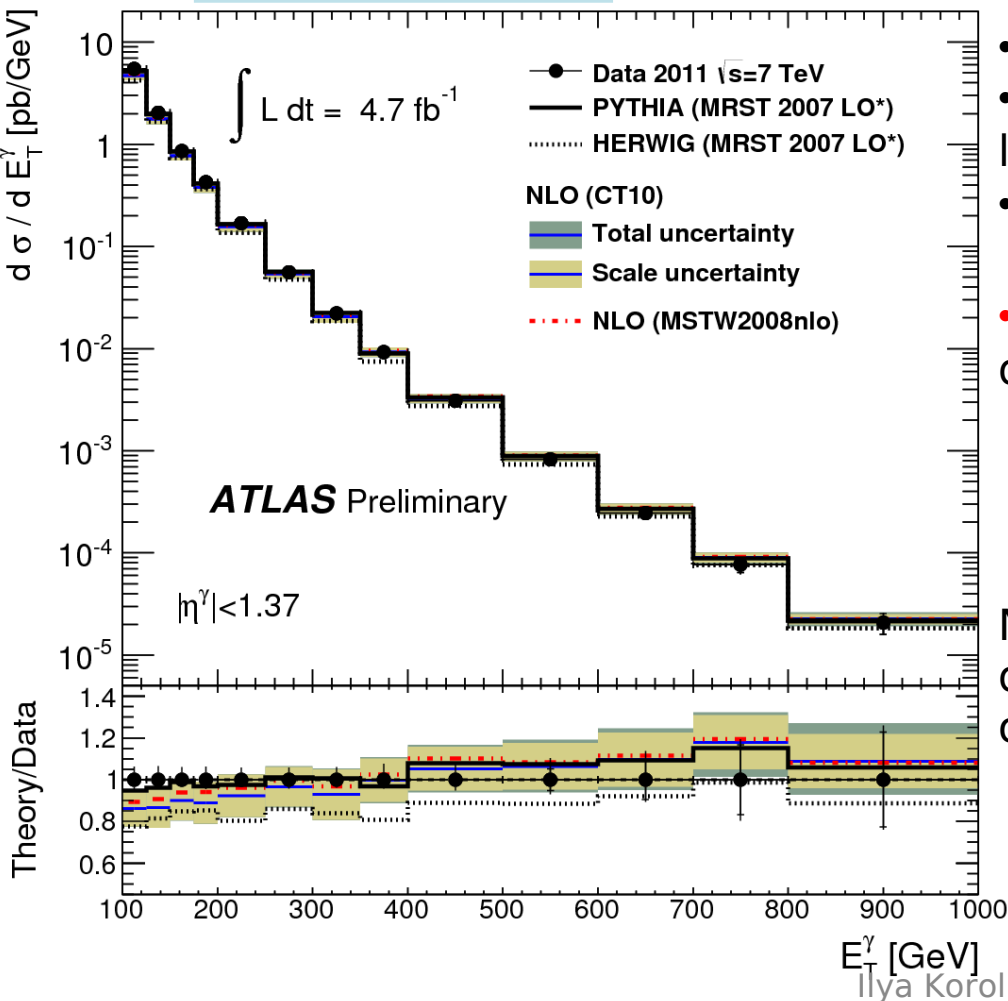
Search pairs of gluino decays to 3 q

- Powerful limit from jet multiplicity and p_T (no mass reconstruction)
- Boosted and resolved jets analysis



Inclusive photons

ATLAS-CONF-2013-022



- 1 TeV region reached for $|\eta| < 1.37$
- Pythia in good agreement, Herwig is lower, but within error bars
- Highest disagreement at low E_T

• **Photon Jet dynamics study:**
differential cross sections as a function of

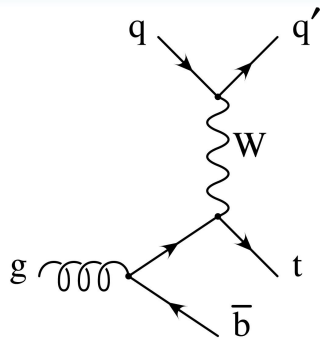
$$E_T^\gamma, p_T^{\text{jet}}, |y^{\text{jet}}|, \Delta\Phi^{\gamma j}, M^{\gamma j} \text{ and } |\cos \theta^{\gamma j}|$$

NLO QCD calculations provide a good description of the data, except in the case of the azimuthal angle.

ATLAS-CONF-2013-023

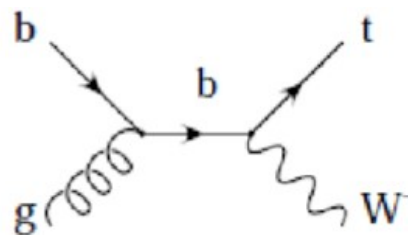
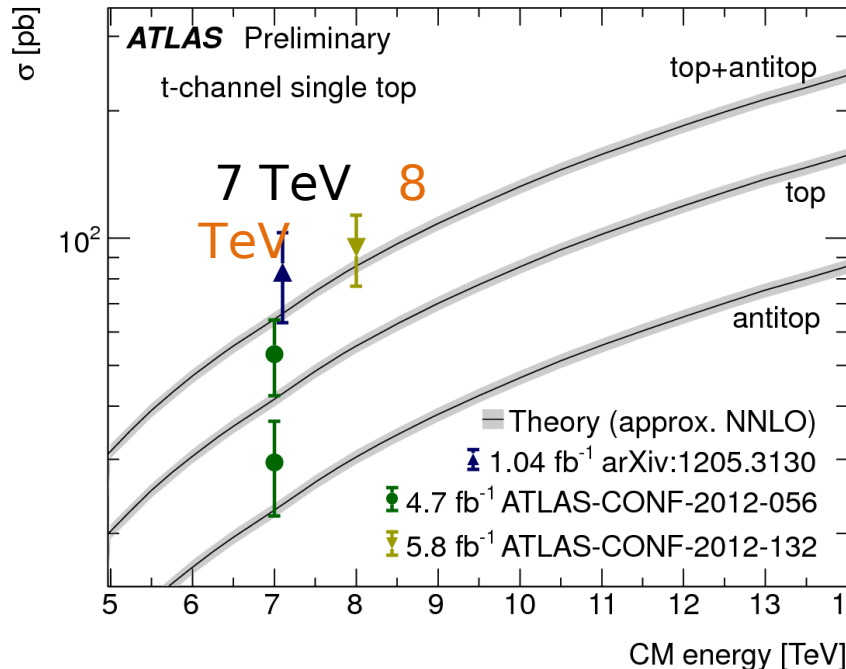
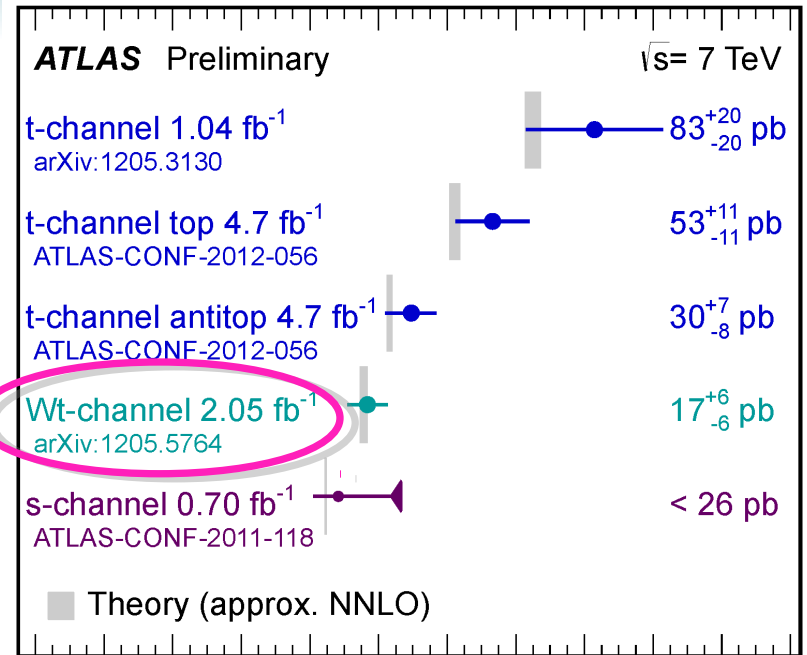
Single top cross section

• Sensitive to V_{tb}



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

$|V_{tb}| > 0.80$ at 95% C.L. assuming $|V_{tb}| \leq 1$



single top cross section [pb]

First evidence of W+top channel

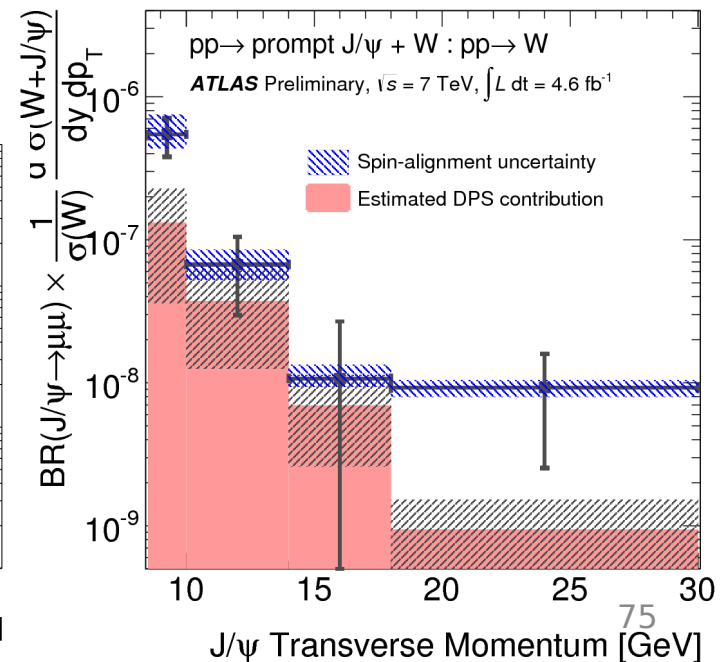
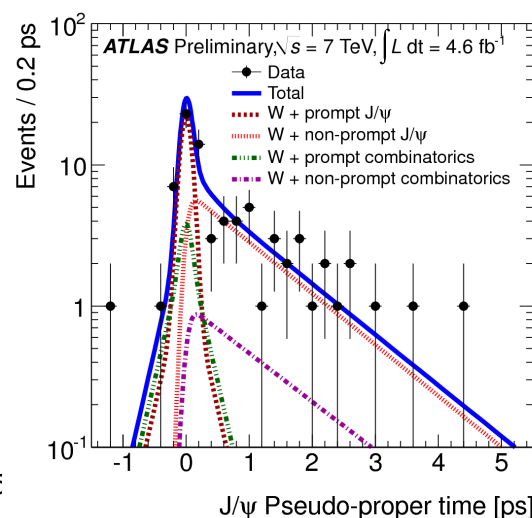
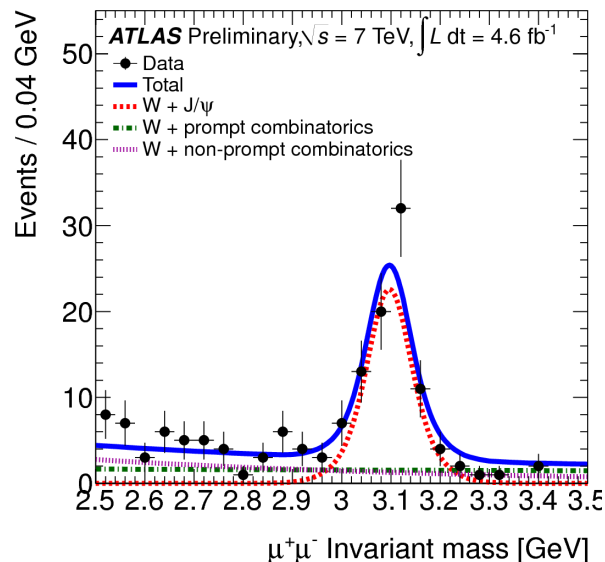
Comparison of different measurements in single top production with the theoretical NNLO prediction

Heavy Flavour

Heavy Flavour: J/ψ + W associate production

ATLAS-CONF-2013-042

- **Probes of charmonium production mechanisms**
- Sensitive to multiple parton interactions
- Look at final states $W \rightarrow \mu \nu$ and $J/\psi \rightarrow \mu \mu$
- Unbinned maximum likelihood fit gives $29.2^{+7.5}_{-6.5}$ events: background only hypothesis rejected at 5σ
- **Estimate Double Parton Scattering (DPS)** contribution from ansatz
- Compare DPS-subtracted value to theoretical predictions
- Data suggests a value close to an order of magnitude larger than what is predicted



Very heavy quarks: B


ATLAS-CONF-2013-056


ATLAS-CONF-2013-060

Status: Lepton-Photon 2013

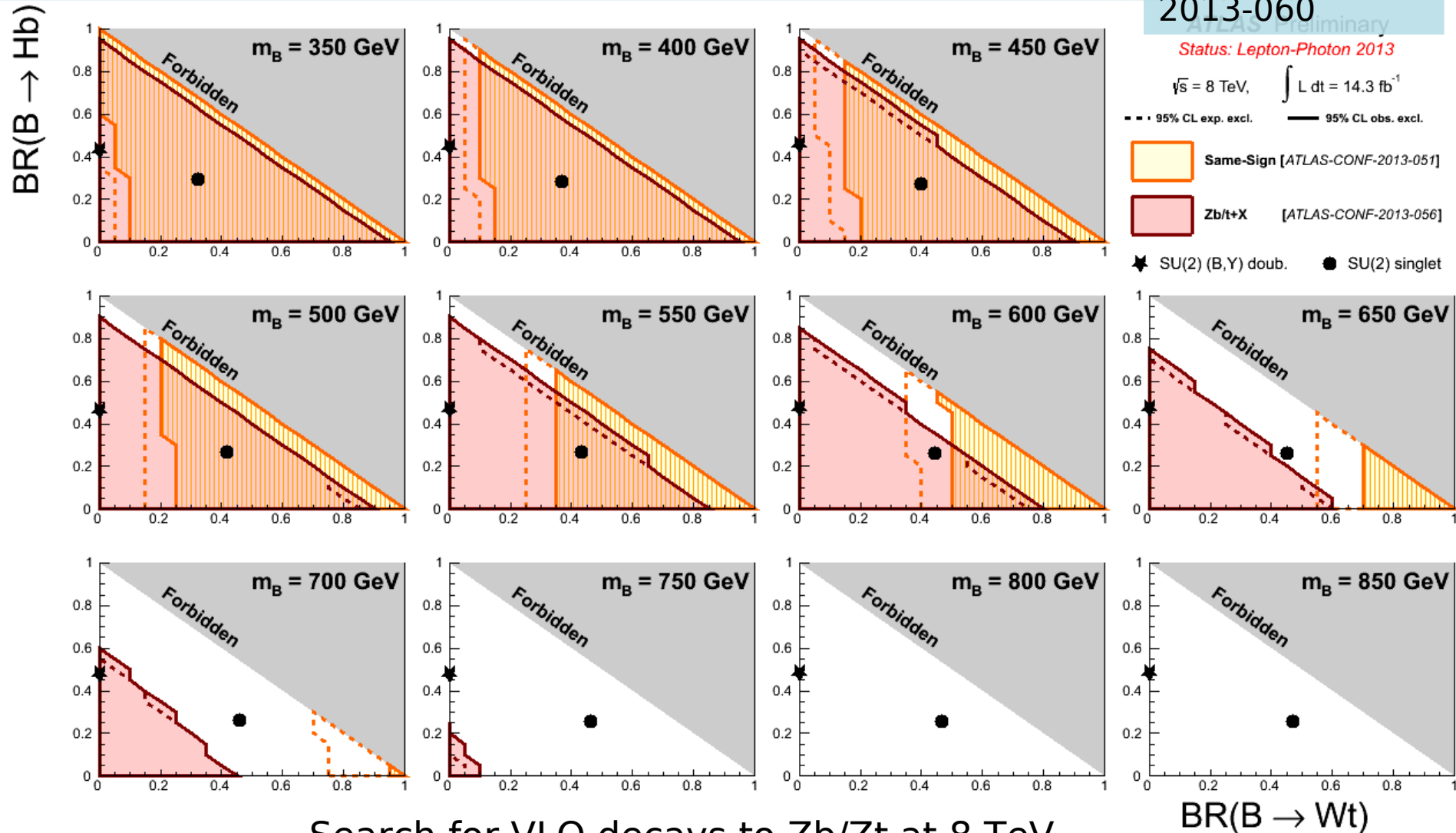
$\sqrt{s} = 8 \text{ TeV}$, $\int L dt = 14.3 \text{ fb}^{-1}$

--- 95% CL exp. excl. — 95% CL obs. excl.

 Same-Sign [ATLAS-CONF-2013-051]

 Zb/t+X [ATLAS-CONF-2013-056]

★ SU(2) (B,Y) doub. ● SU(2) singlet



Search for VLQ decays to Zb/Zt at 8 TeV
 Search for VLQ decays to Wb at 8 TeV

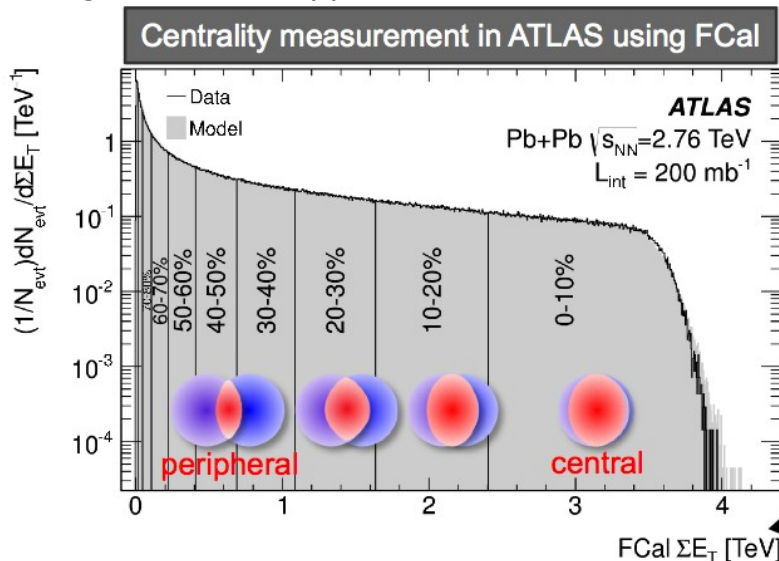
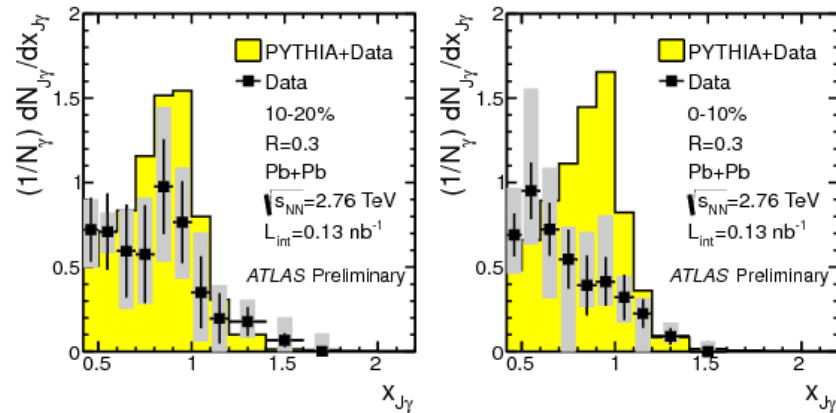
$BR(B \rightarrow Wt)$

Heavy Ions In Atlas

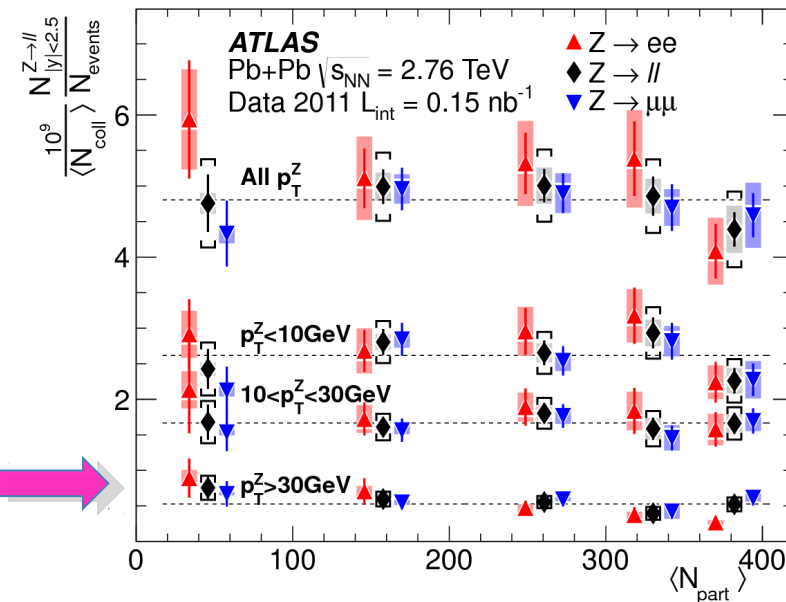
Heavy ions in Atlas

- Two **Pb-Pb** collision data taking periods in **2010 and 2011, $160\mu\text{b}^{-1}$ @ 2.76 TeV/nu .**

- Centrality measured. Large **dijet imbalance** measured.
- Clear boson-jet energy violation**
- Jet fragmentation, azimuthal dependence
- charged hadron suppression



- A **clear scaling of Z with collision centrality** (number of binary collisions) measured, in 3 Pt ranges (<10 , $10-30$, $>30\text{ GeV}$). Important result to be able to use Z bosons as probes.

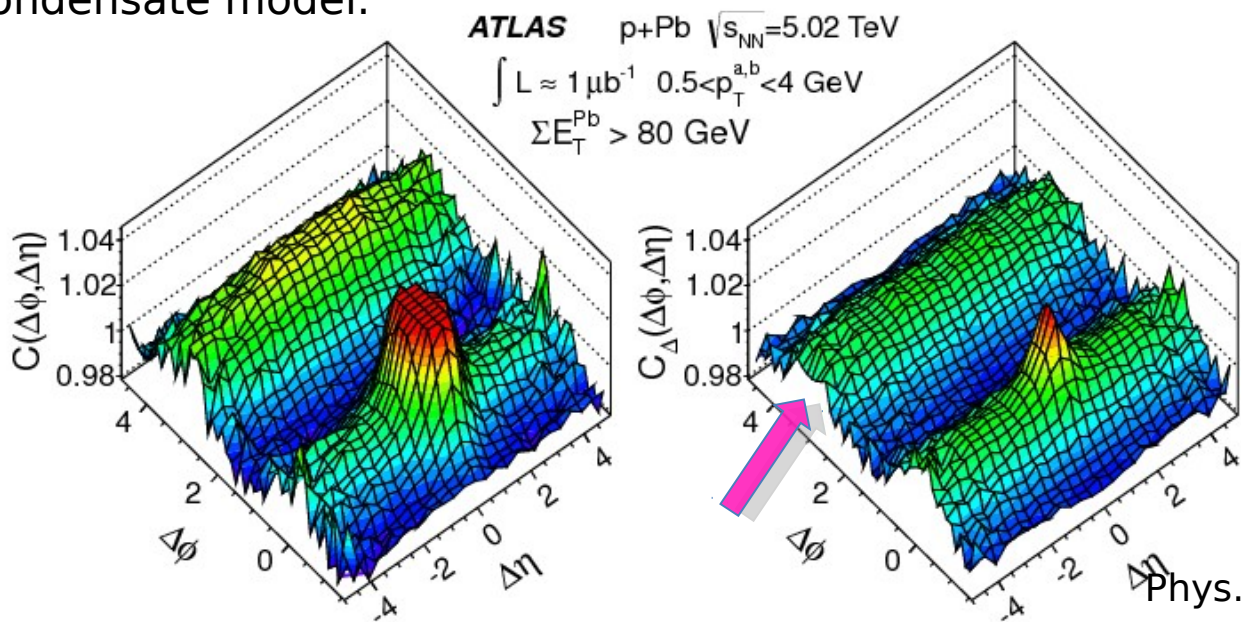


Ilya Korolkov

Phys.Rev.Lett 110, 0022301 (2013)

Heavy Ions: particle correlations

- proton-Pb pilot run in Sept 2012, 5.02 TeV/nu, $1 \mu\text{b}^{-1}$ (4 TeV p + 1.57 TeV/nu Pb)
- 2 particle correlations called “the ridge”. Long range ($2 < \Delta\eta < 5$) correlations at small $\Delta\phi$, seen also in p-p and Pb-Pb collisions.
- **New**: discovery of correlated **away side ridge, at $\Delta\phi = \pi$** (also seen in Alice).
- Still debates as to what is the source of this signal. Predicted in color glass condensate model.



Two charged-particle correlation function C vs $\Delta\eta$ and $\Delta\phi$.
 S : same event, B : mixed event

$$C(\Delta\phi, \Delta\eta) = \frac{S(\Delta\phi, \Delta\eta)}{B(\Delta\phi, \Delta\eta)}$$

Phys. Rev. Lett. 110, 182302 (2013)

Plots before and after the subtraction of recoil dijets contribution. Away side correlation matches the near side one in magnitude, shape and ΣE_T^{Pb} dependence.

- Jan-Feb 2013, p+Pb @ 5.02 TeV/nu., 30 nb^{-1}