

Highlights from physics analysis from ATLAS

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on behalf of the ATLAS Collaboration



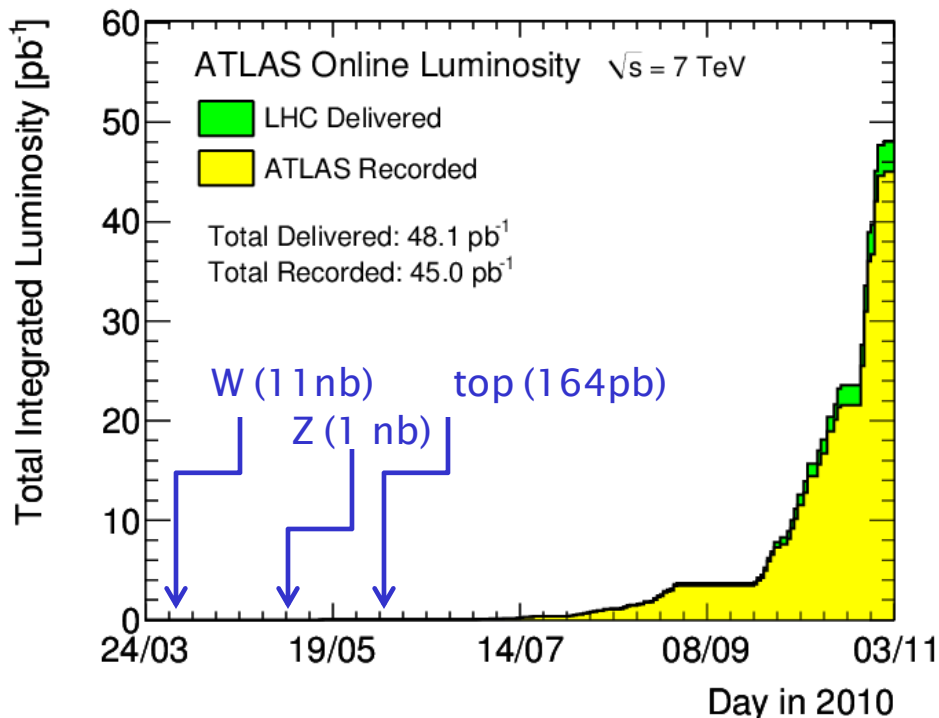
Data collection with ATLAS in 2010

Detector status:

- **98%** of channels operational
- worst sub-detector: $>97\%$

Integrated luminosity (pp): **45 pb⁻¹**

good for physics: 35 to 42 pb⁻¹



luminosity uncertainty: 11% \rightarrow 3%

Data taking efficiency:

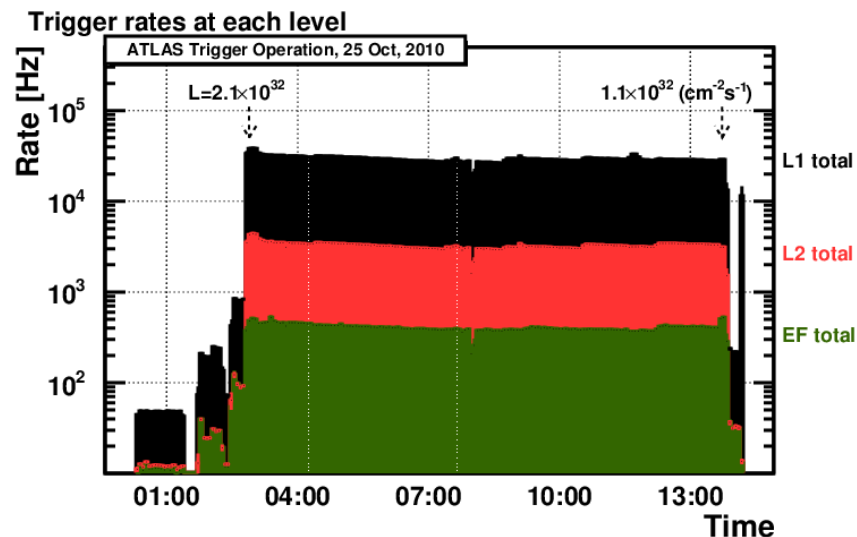
(for “stable beams”): **93.6%**

Peak luminosity: **2.1 $\times 10^{32}$ cm⁻² s⁻¹**

HI operation: 9.2 μb^{-1} @ 2.76 TeV

Trigger:

- 3 levels $\rightarrow \sim 300$ Hz
- trigger menus evolved to cope with 5 orders of magnitude change in lumi.



Outline

“Re-discovery” of the Standard Model:

- soft QCD
- B-physics
- pQCD (jets)
- W, Z
- top



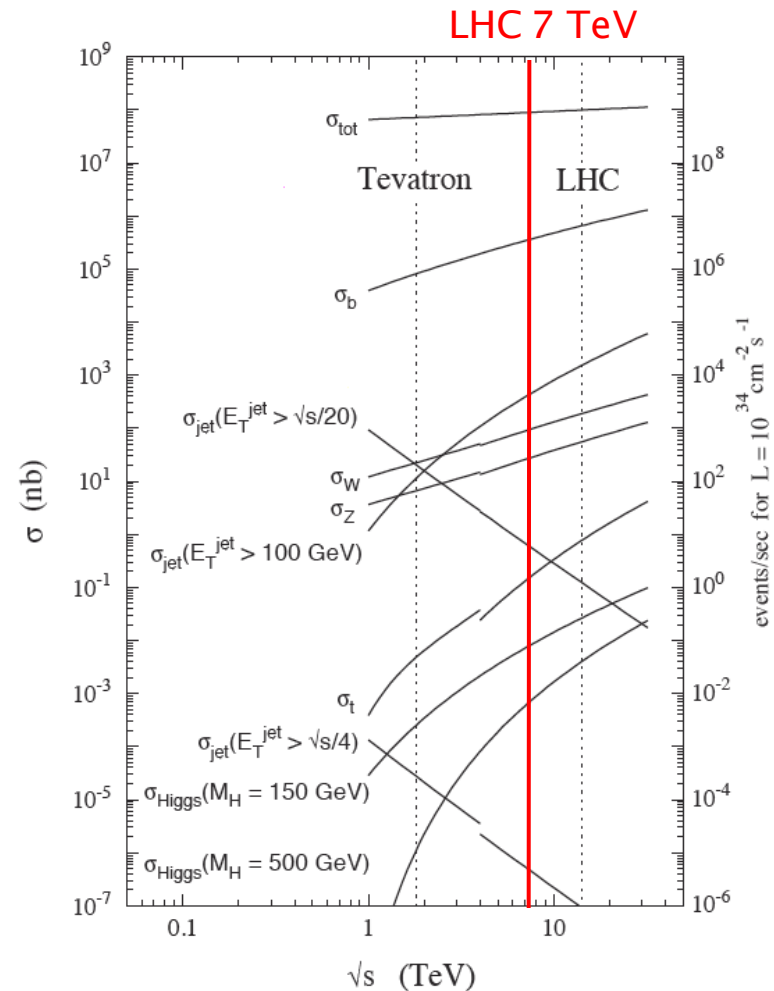
New Phenomena: the energy frontier

- in heavy ions collisions
- beyond the SM: W' , Z'
- beyond the SM: SUSY
- Higgs boson

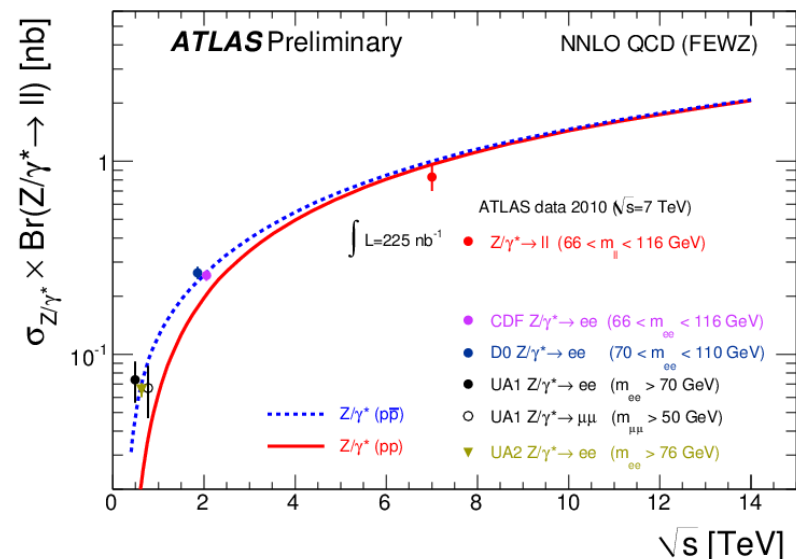
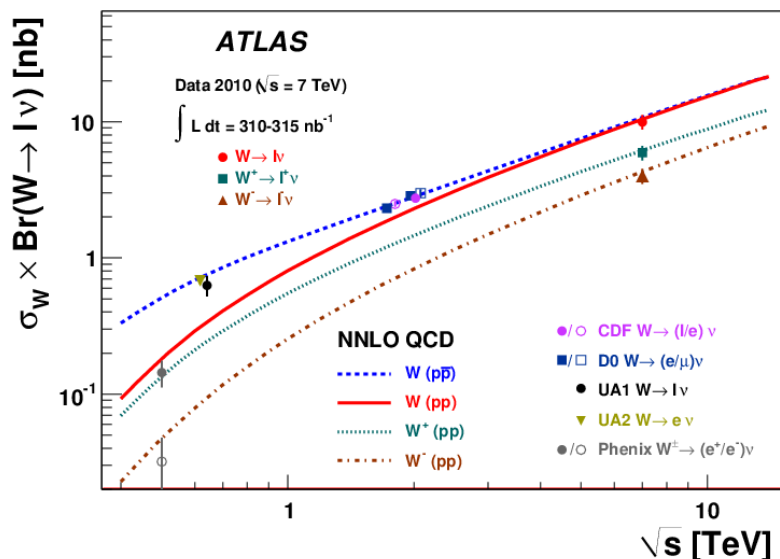
Disclaimer:

- already an impressive amount of results
- only a few topics selected in this talk:
- more information: winter conferences, publications

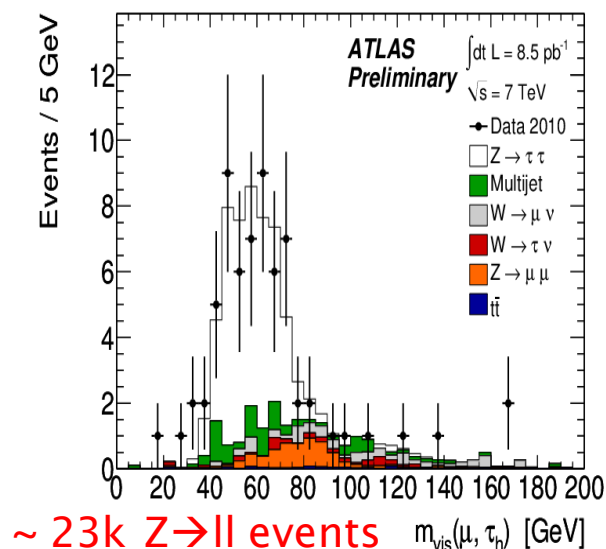
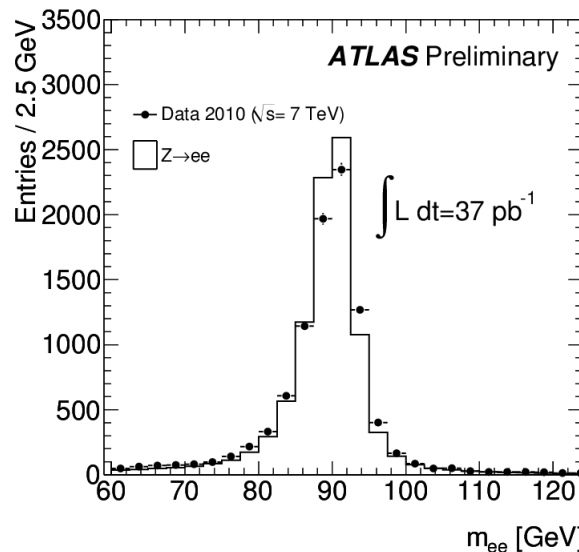
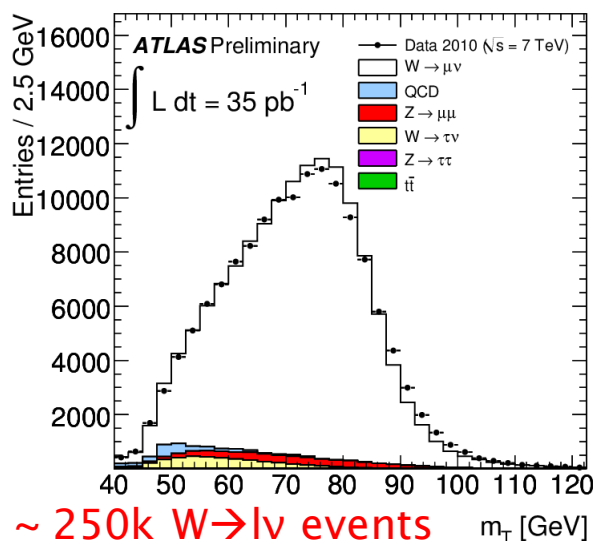
➔ See public results here: <https://twiki.cern.ch/twiki/bin/view/AtlasPublic>



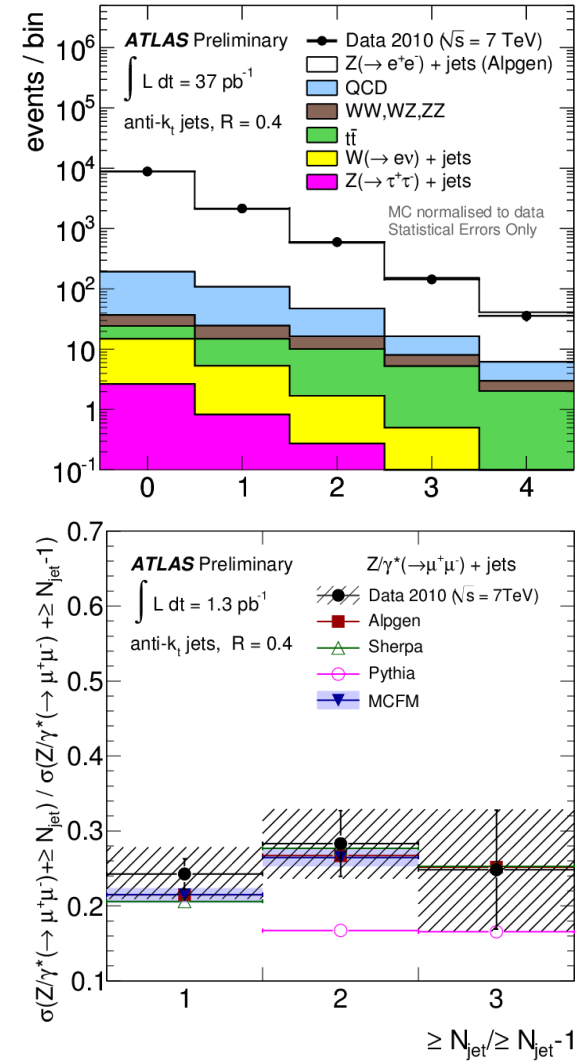
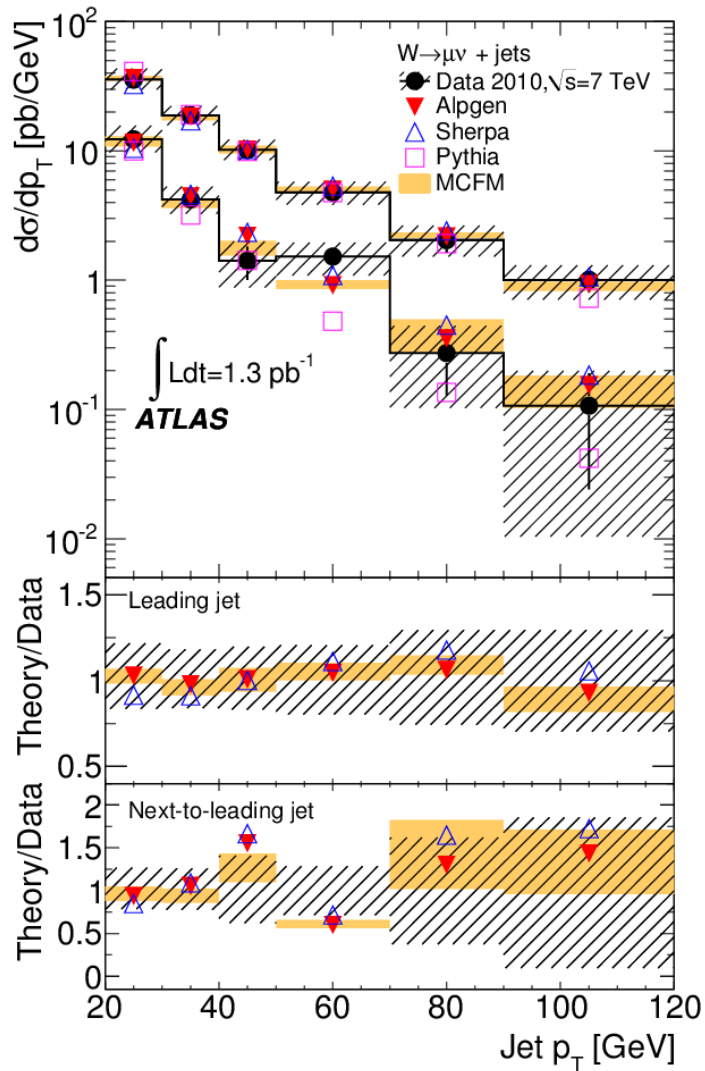
W/Z results



→ results being updated with 35 pb^{-1} (+charge asymmetry from W, $Z \rightarrow \text{taus}$, etc):

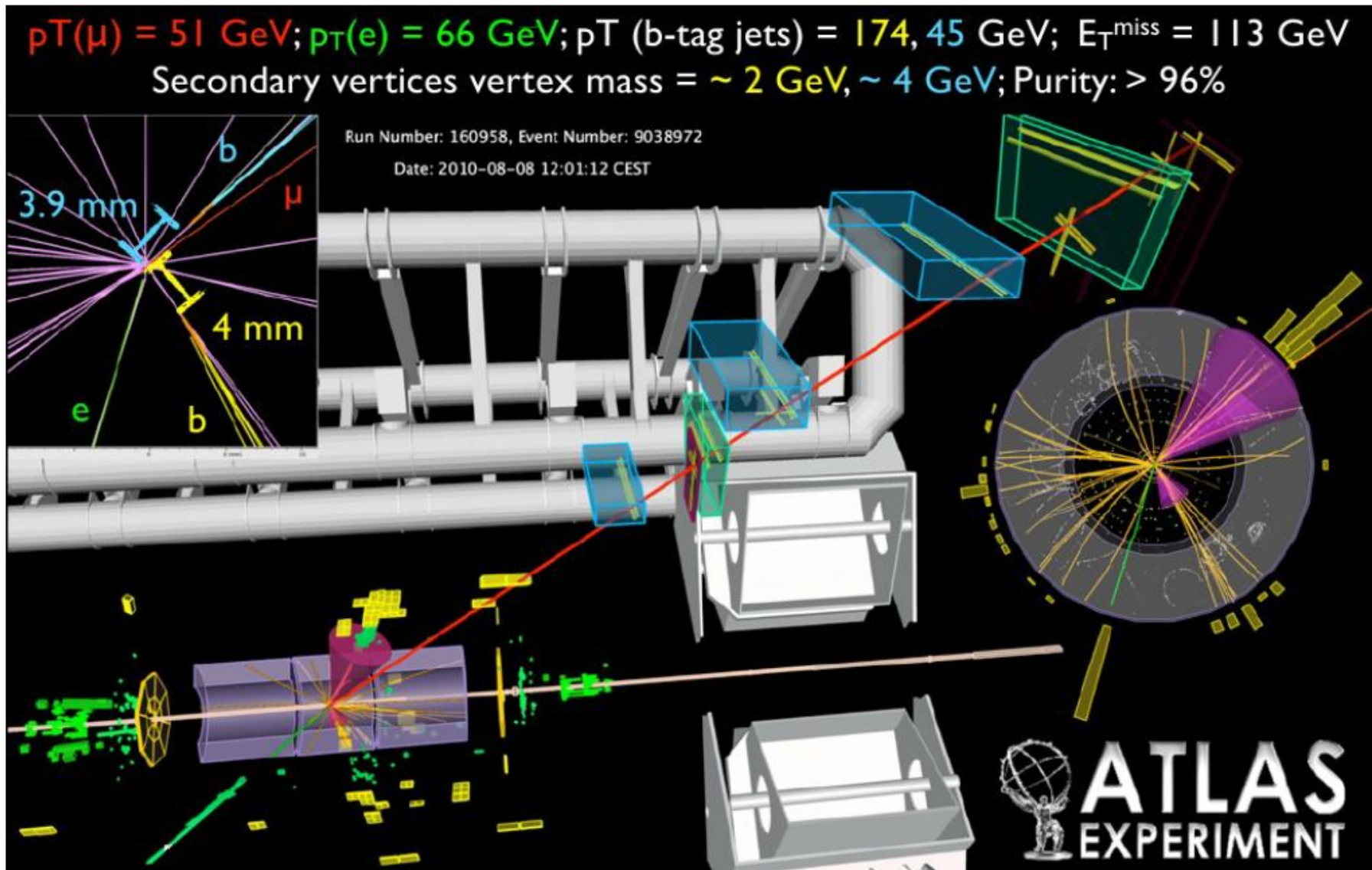


W/Z + jets



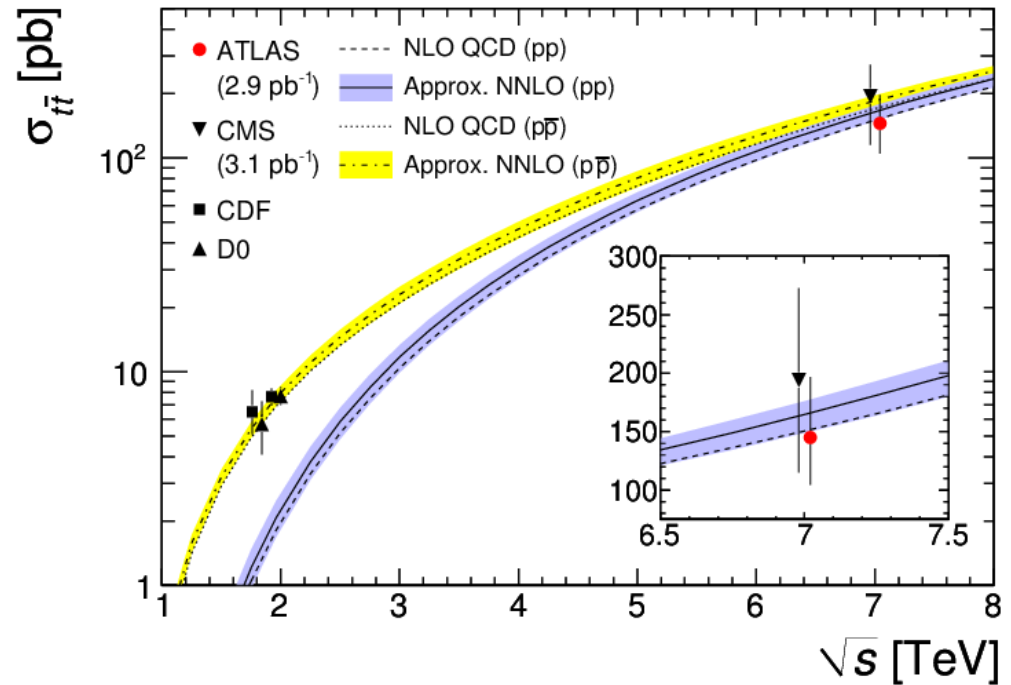
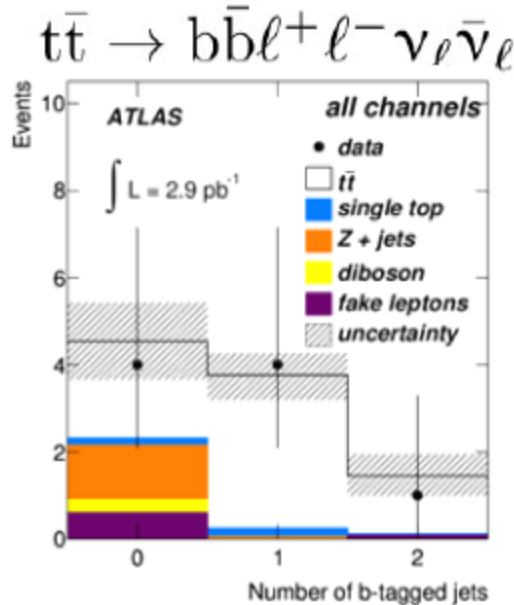
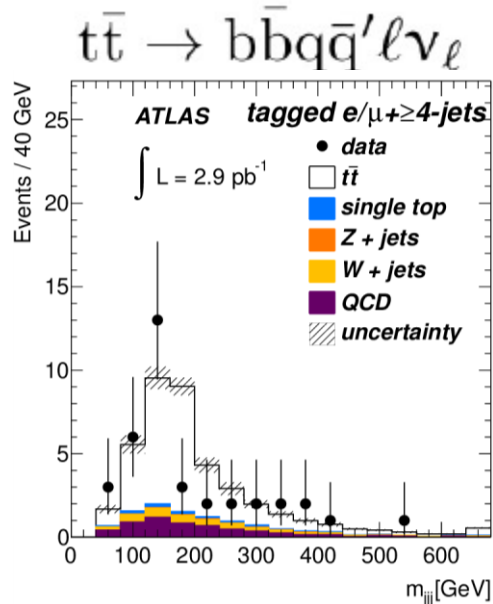
- results being updated with 35 pb^{-1}
- good agreement with simulation (if at least NLO)

Top quarks: di-lepton candidate



➔ more than 1000 top candidate events in 2010

Top quark production



	Cross-section (pb)	Significance (σ)
Single-lepton	$142 \pm 34^{+50}_{-31}$	4.0
Di-lepton	$151^{+78}_{-62}{}^{+37}_{-24}$	2.8
Combined	$145 \pm 31^{+42}_{-27}$	4.8

➔ imminent update with 35 pb^{-1}

Heavy Ions: dijet asymmetry

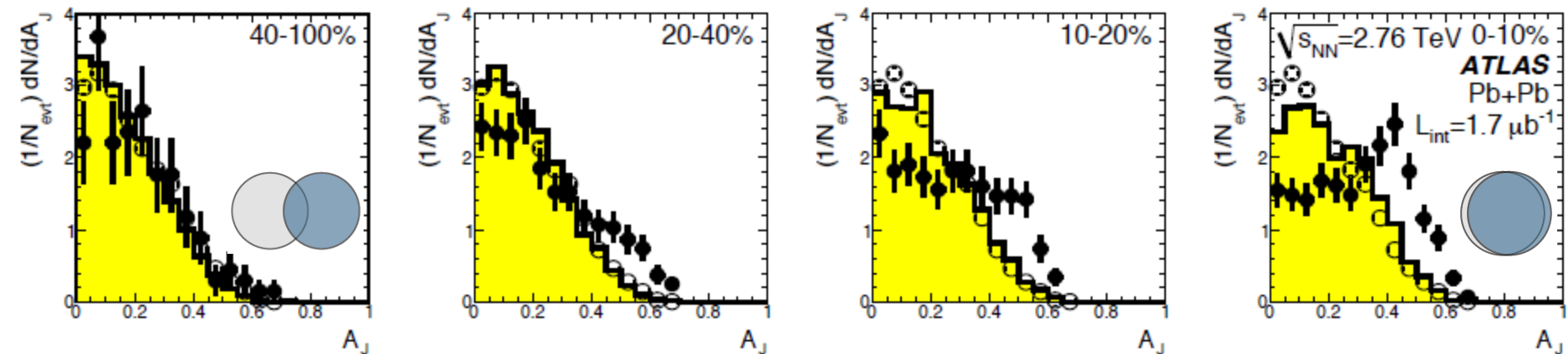
Lead-lead collisions in Nov-Dec 2010
2.76 TeV in the nucleon-nucleon CM
9.2 μb^{-1} collected

Di-jet asymmetry: 1.7 μb^{-1}

- $|\eta_1| < 4.7$, $|\eta_2| < 2.8$, $\Delta\phi_{12} > \pi/2$
- $E_{T1} > 100$ GeV, $E_{T2} > 25$ GeV

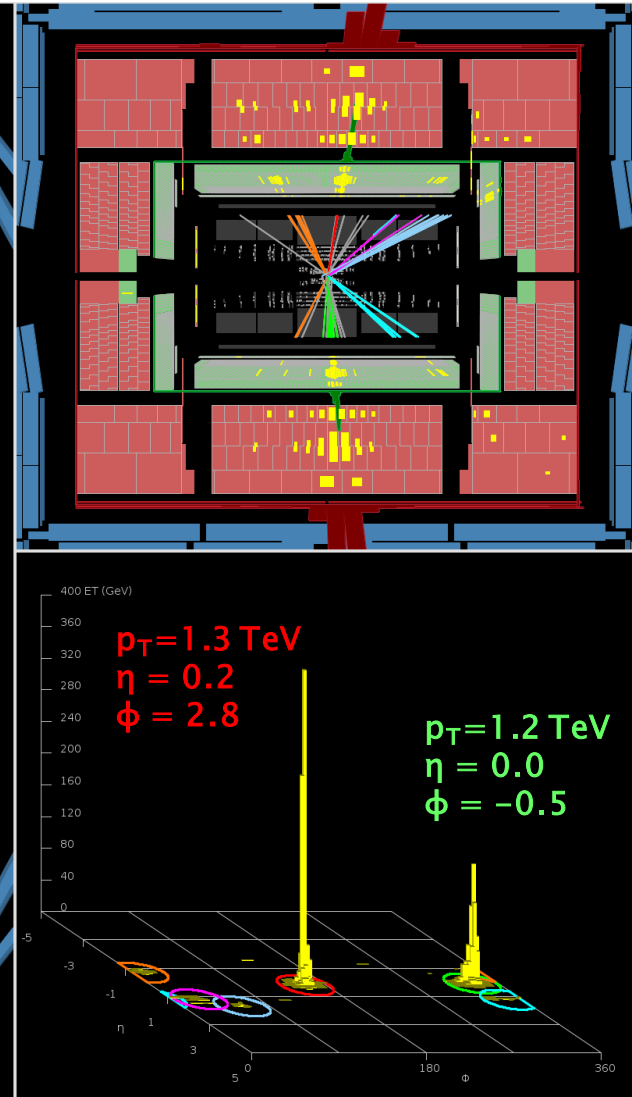
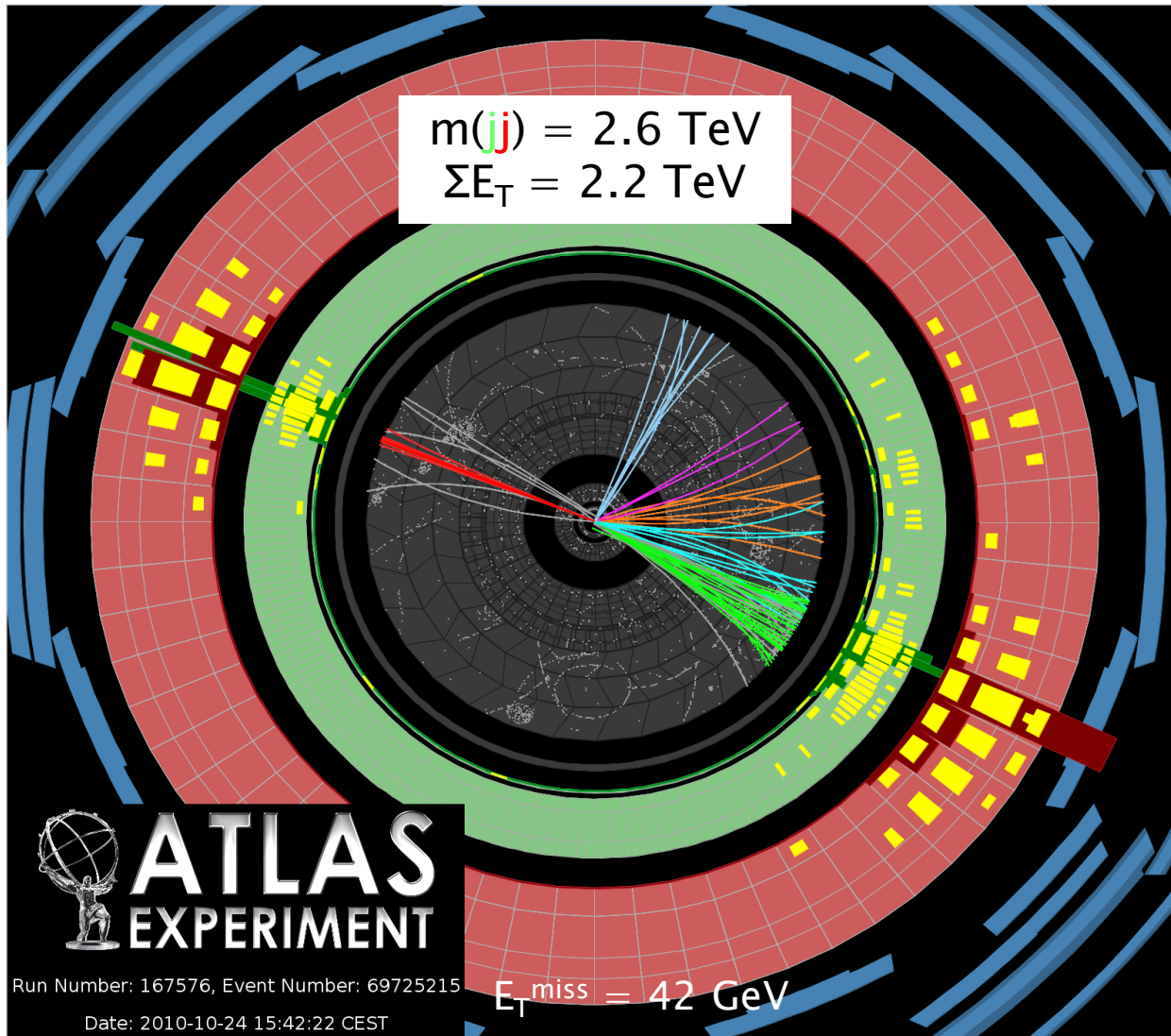
Results as function of centrality (peripheral vs central)

$$A_J = \frac{E_{T1} - E_{T2}}{E_{T1} + E_{T2}}$$



Search for new physics in di-jet events

The highest mass central dijet event and the highest- p_T jet collected by the end of October 2010



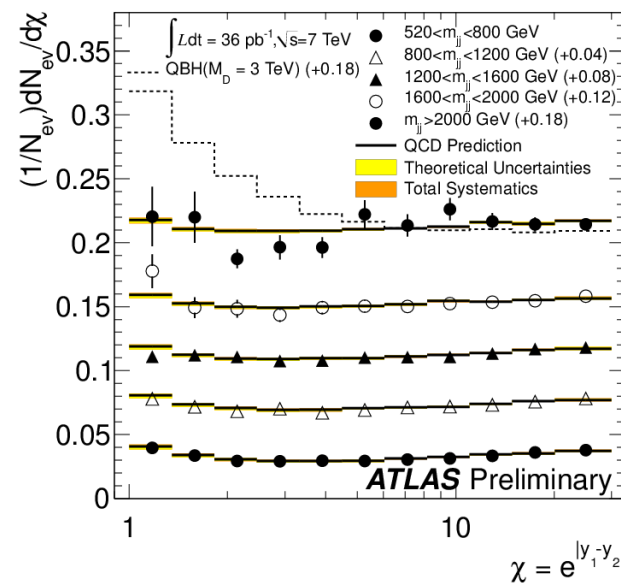
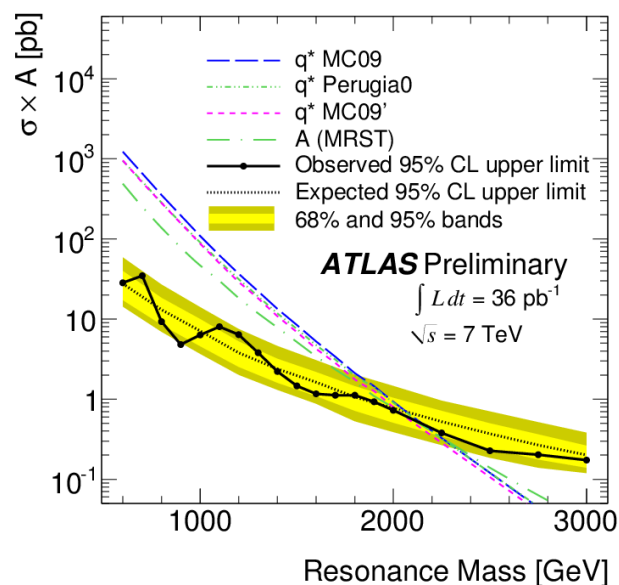
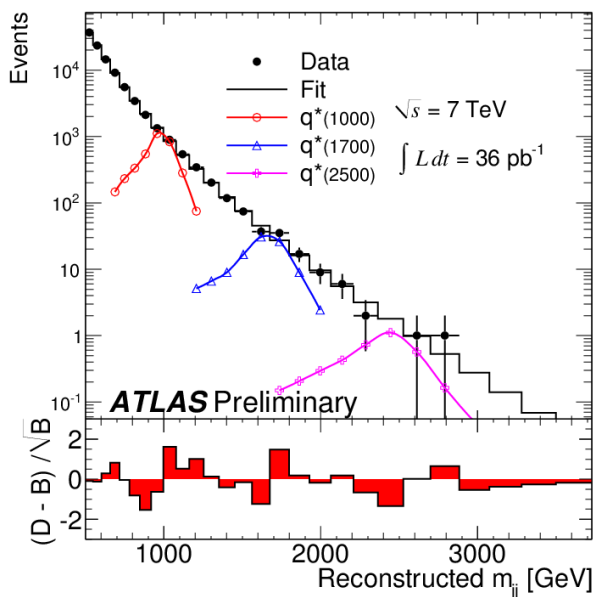
Search for new physics in di-jet events

BSM resonances decaying into 2 jets:

- build on well-understood QCD $2 \rightarrow 2$ scattering
- benchmark signals: excited quark q^*
- ➔ look for bumps in dijet invariant mass distribution

Quark compositeness:

- rapidity in CM frame
- angular correlations



➔ no evidence : **$m(q^*) > 2.15 \text{ TeV}$ (@95% CL)**

(NB: Tevatron with 30x more data: 0.87 TeV)

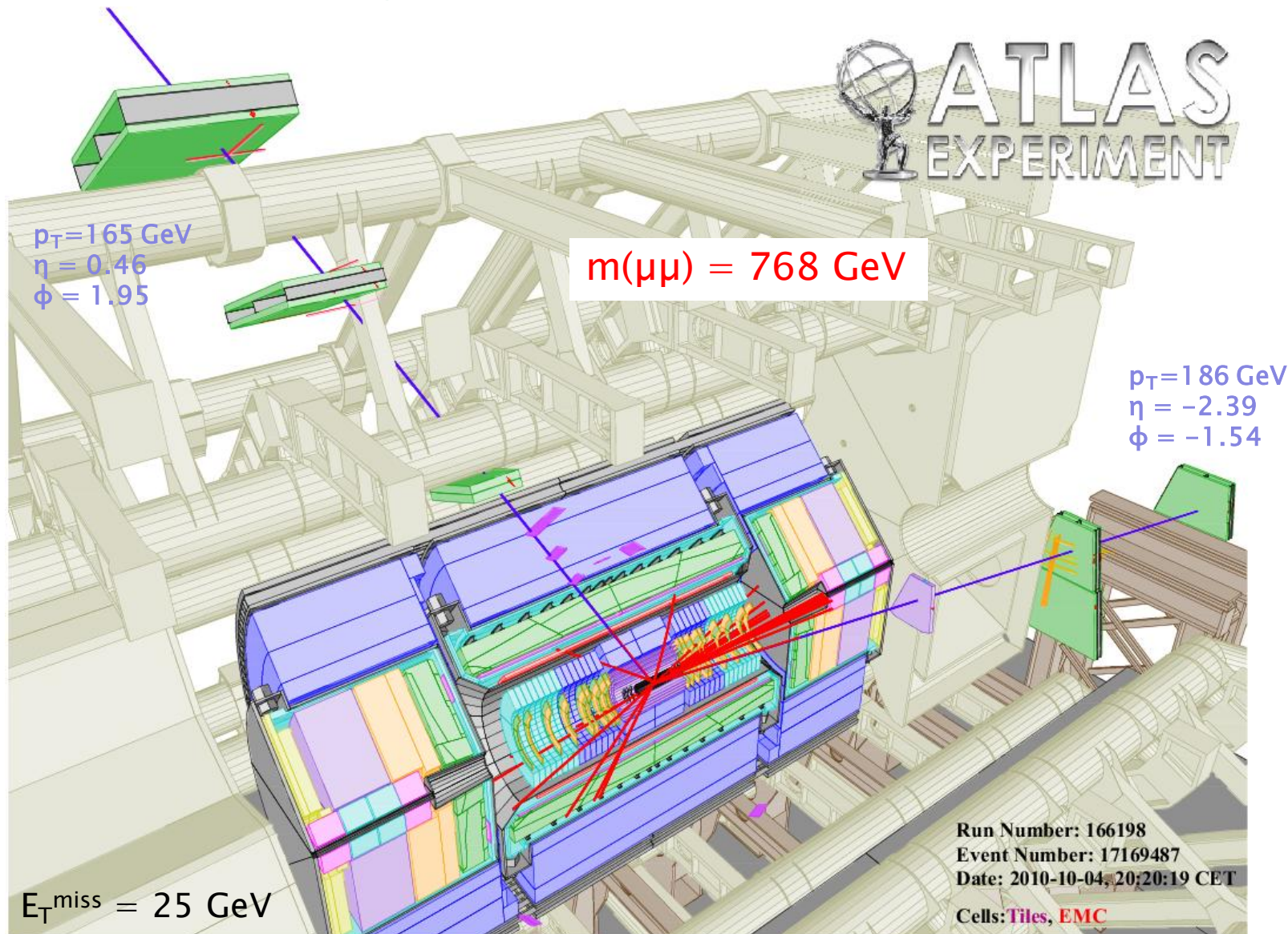
Derived limits on other models:

- axigluon 2.10 TeV
- QBH 3.67 TeV (for $n=6$)

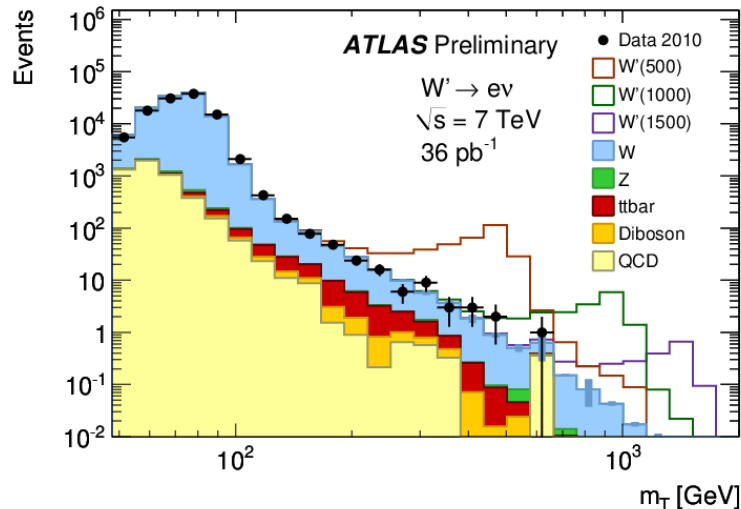
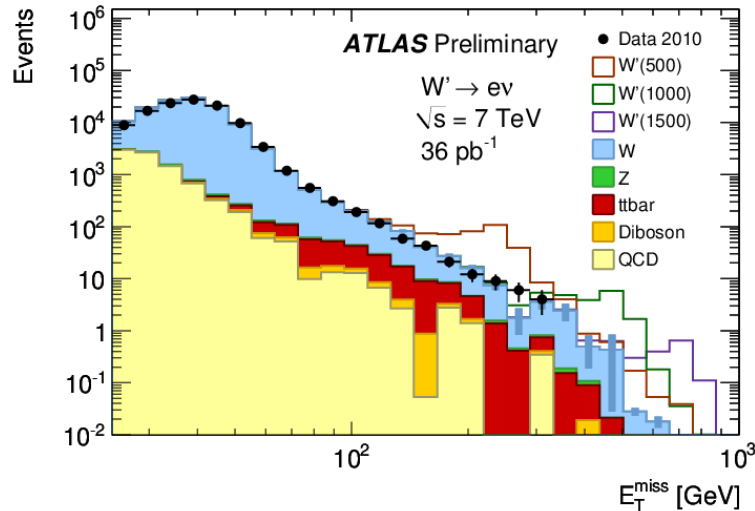
Result with 3.1 pb^{-1} :
quark contact interaction
terms with scale **$L < 3.4 \text{ TeV}$**
excluded at 95% CL.

Search for new boson vectors

Event with the highest di-lepton invariant mass collected in 2010

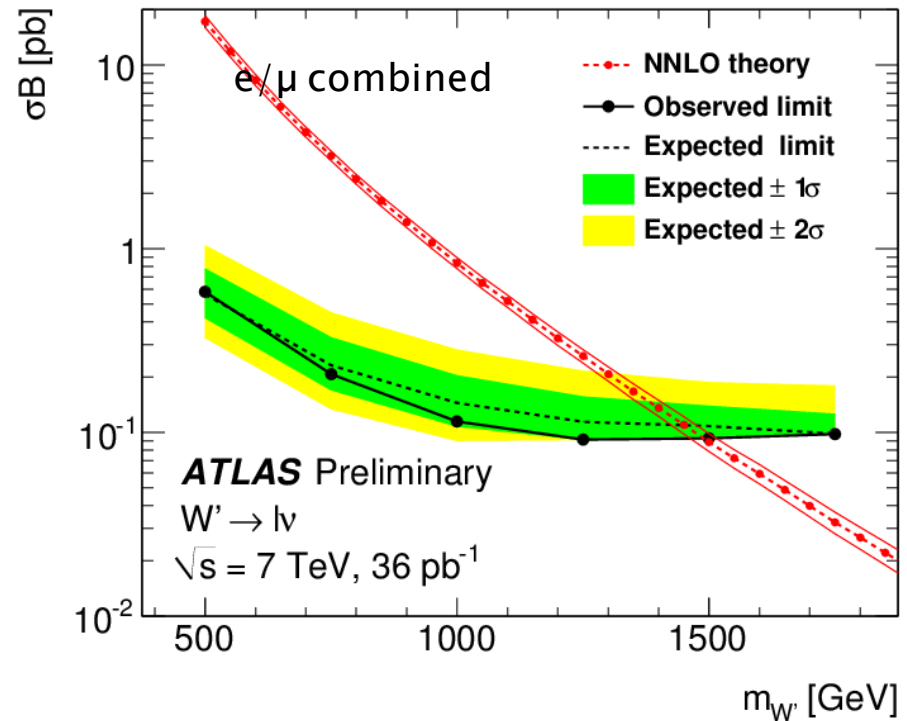


Search for new boson vectors: W'



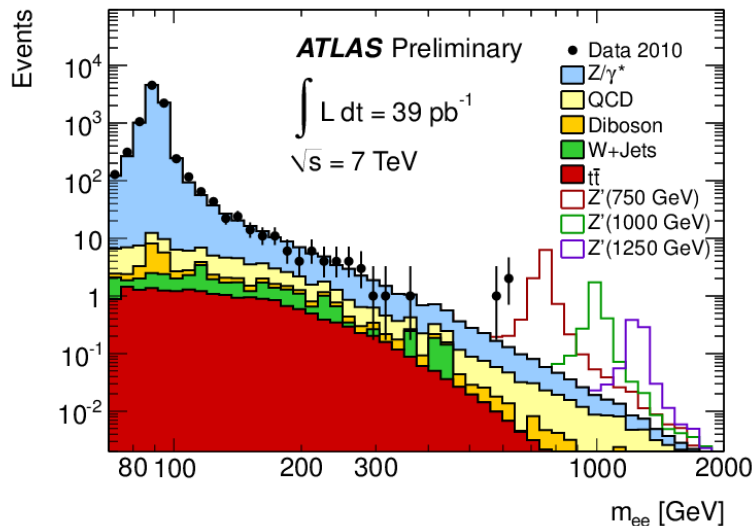
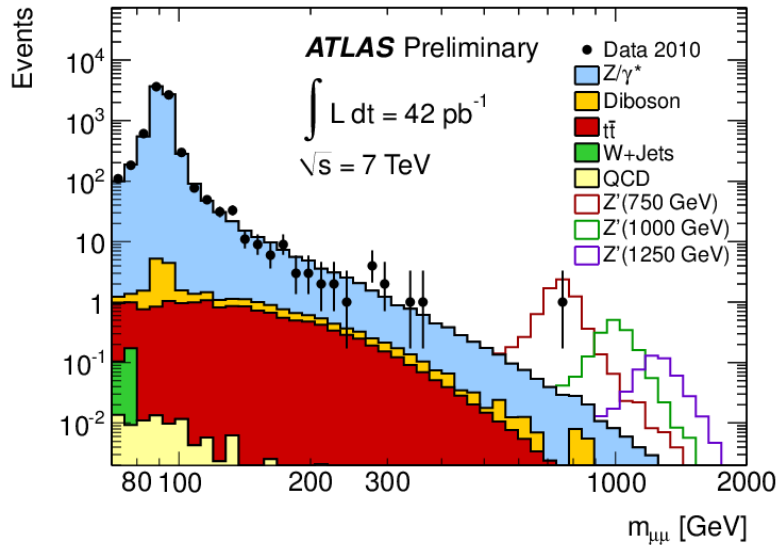
$$m_T = \sqrt{2p_T^\ell E_T^{\text{miss}}(1 - \cos\phi_{\ell\nu})}$$

- benchmark model: Sequential Standard Model
- signature: high- p_T isolated lepton, large E_T^{miss} and large $m_T \rightarrow$ good understanding of tails from W

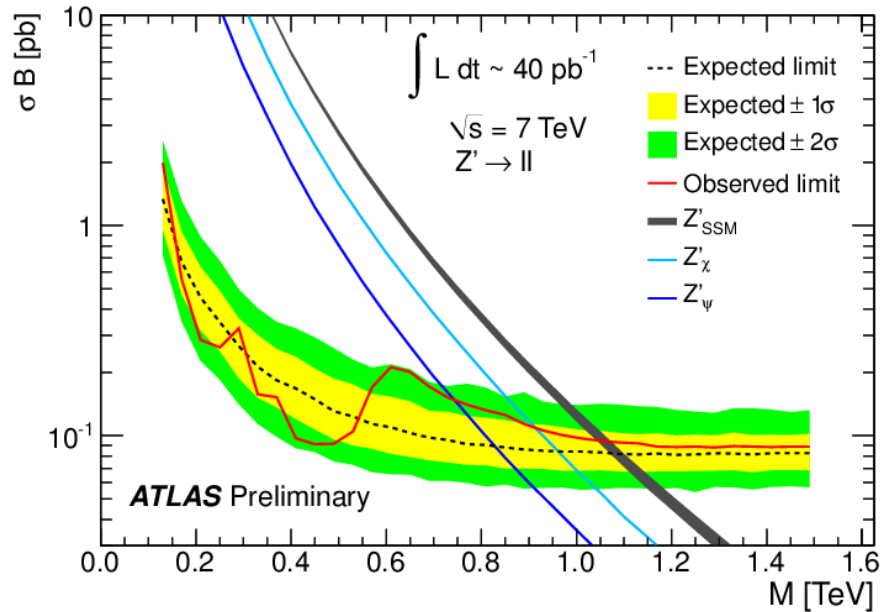


no evidence found \rightarrow
 $m(W' \text{ SSM}) > 1.49 \text{ TeV}$ (@95% CL)
 (NB: Tevatron limit 1 TeV)

Search for new boson vectors: Z'



- di-electron or di-muon resonances on top of falling background



no evidence found \rightarrow
 $m(Z'_{\text{SSM}}) > 1.048 \text{ TeV}$ (@95% CL)
 (NB: Tevatron limit 1.071 TeV)

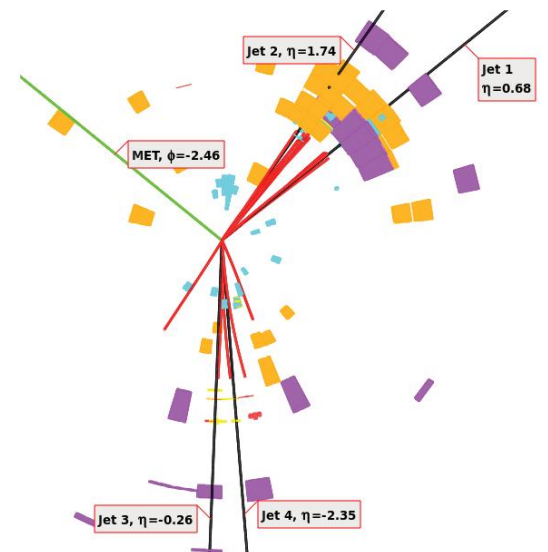
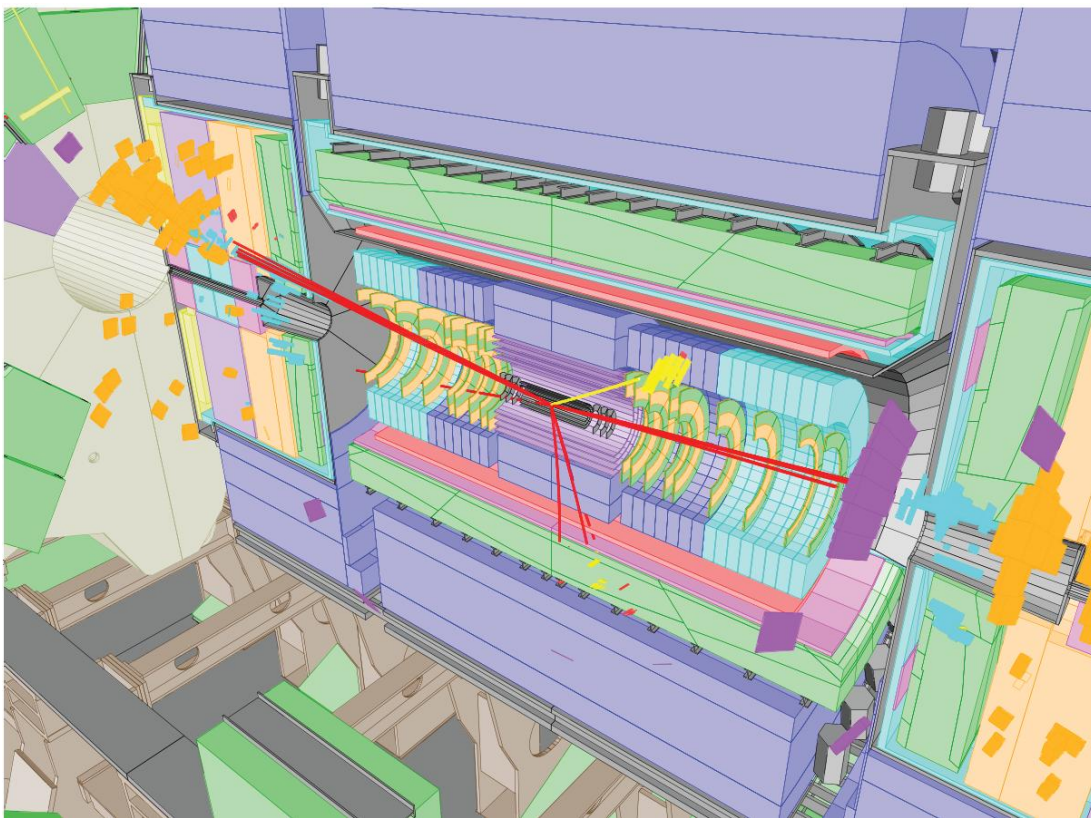
Limits on E6 Z' models:

- $m(Z'_{\chi}) > 892 \text{ GeV}$
- $m(Z'_{\psi}) > 727 \text{ GeV}$

Searches for SUSY

strong production \rightarrow copious
squarks & gluinos \rightarrow energetic jets
R-parity \rightarrow LSP \rightarrow missing energy
charginos \rightarrow LSP + lepton

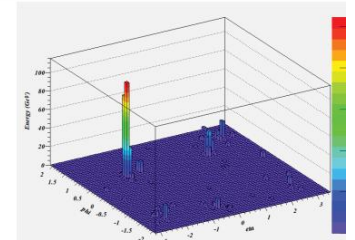
Event in signal region for electron+jets+ E_T^{miss} search:



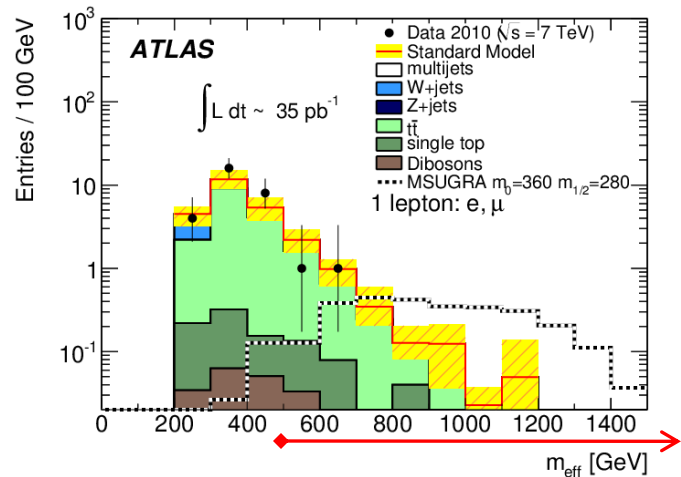
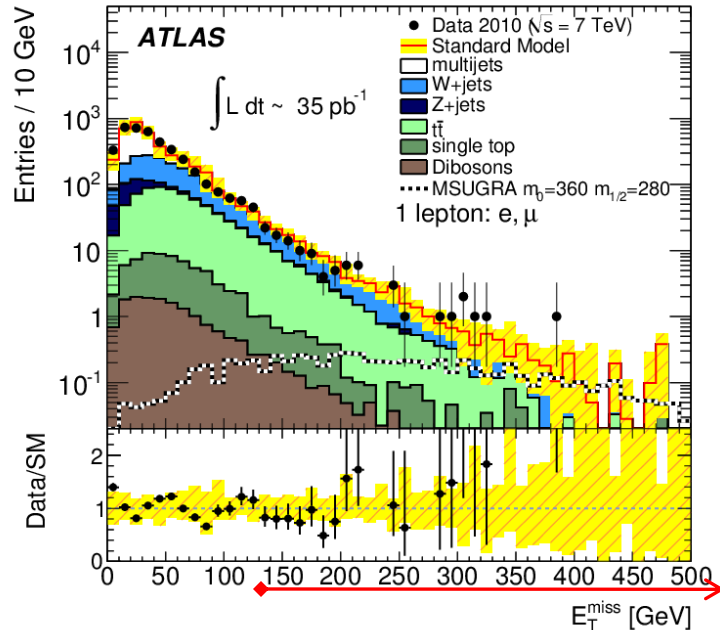
Run Number: 167661
Event Number: 18412580
Date: 2010-10-26, 05:59:35 CET

Cells: Tiles, EMC

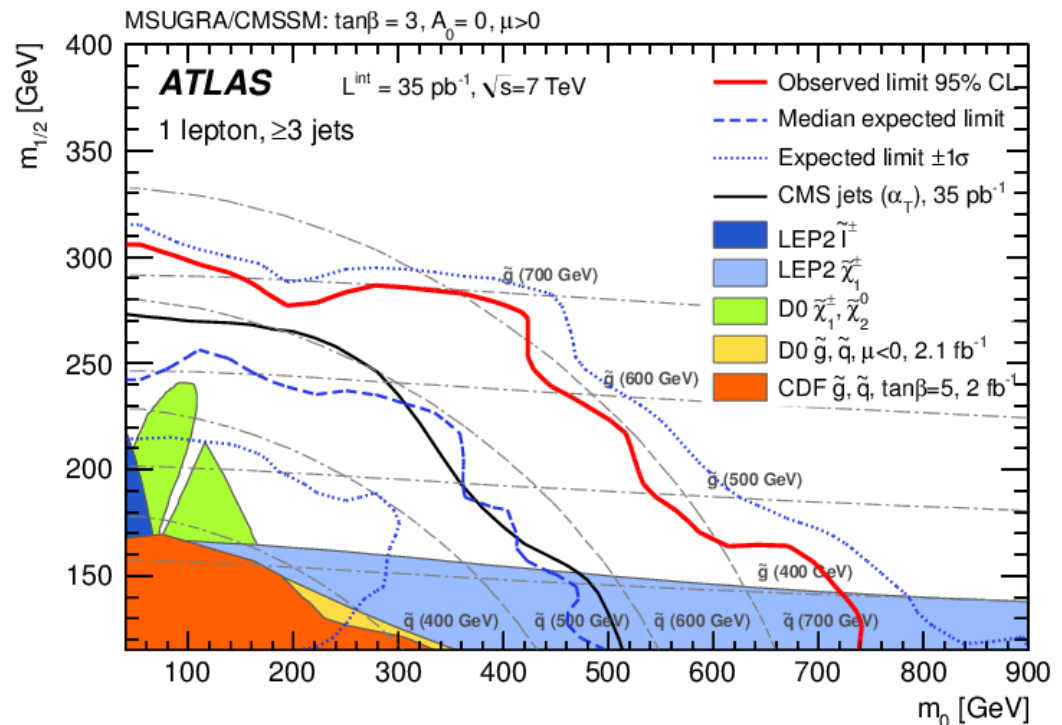
Collection: e/γ



Search for SUSY: lepton+jets+ETmiss



- one high- p_T isolated lepton: $p_T > 20 \text{ GeV}$
- ≥ 3 jets with $p_T > 30 \text{ GeV}$ (leading: $p_T > 60 \text{ GeV}$)
- large missing E_T ($> 125 \text{ GeV}$)
- $M_{\text{eff}} > 500 \text{ GeV}$ (M_{eff} : 3 leading jets+lepton+ E_{Tmiss})
- background estimates from data control regions
- found 1 event in each channel, 2 ± 1 expected
- signal interpretation: mSUGRA

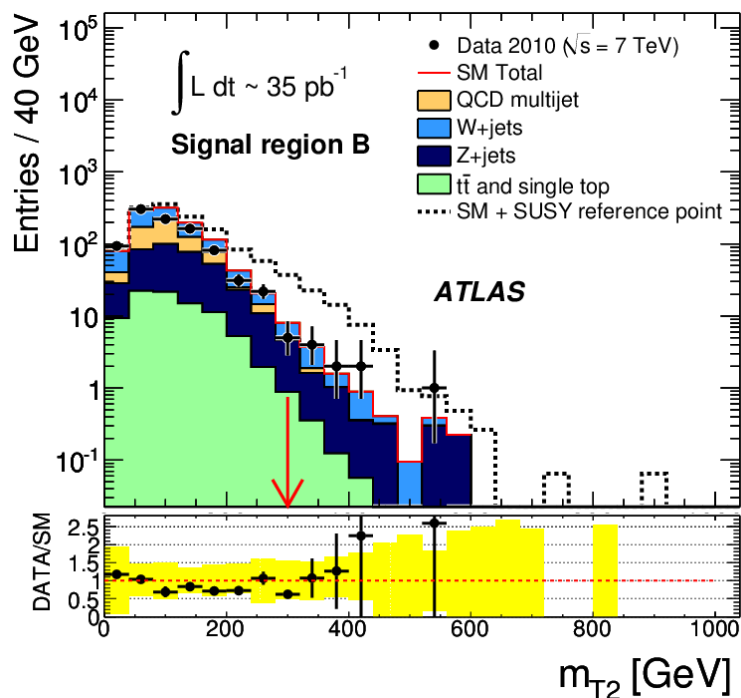


→ exceed substantially previous limits
 → $m(\sim g) > 700 \text{ GeV}$ (@95%CL) for $m(\sim q)=m(\sim g)$

Search for SUSY: jets+ETmiss

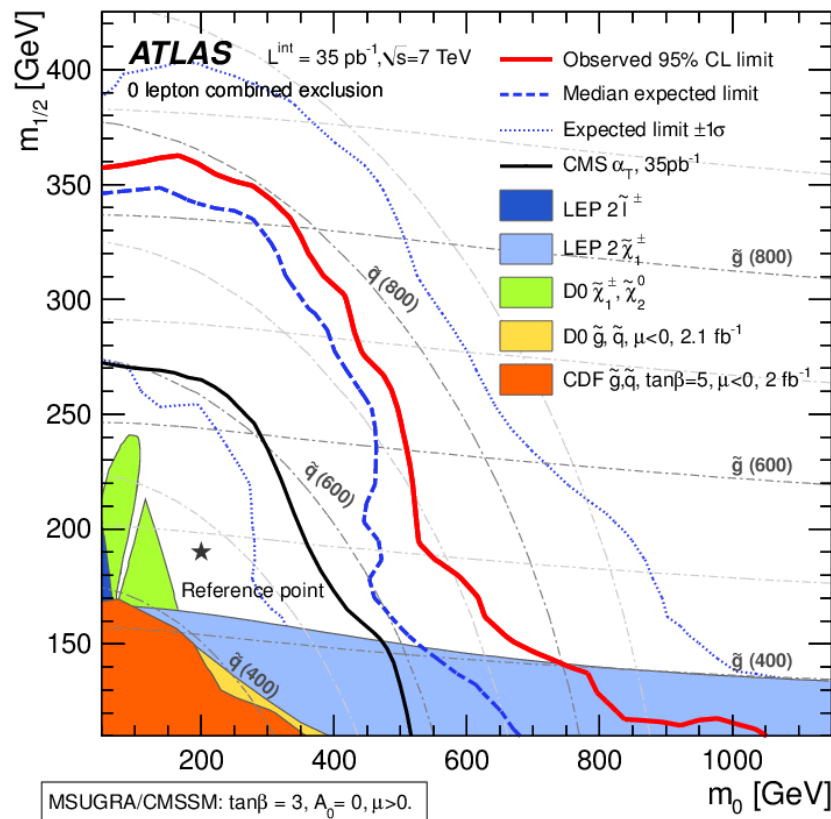
- lepton veto
- several jets
- $E_T^{\text{miss}} > 100$ GeV
- discriminants:

- M_{eff} (2 leading jets + Etmiss)
- Transverse mass M_{T2}



ref: $m_{1/2}=190, m_0=200,$
 $A_0=0, \tan\beta=30, \mu>0$

- results compatible with SM
- interpreted in different models, here mSUGRA:



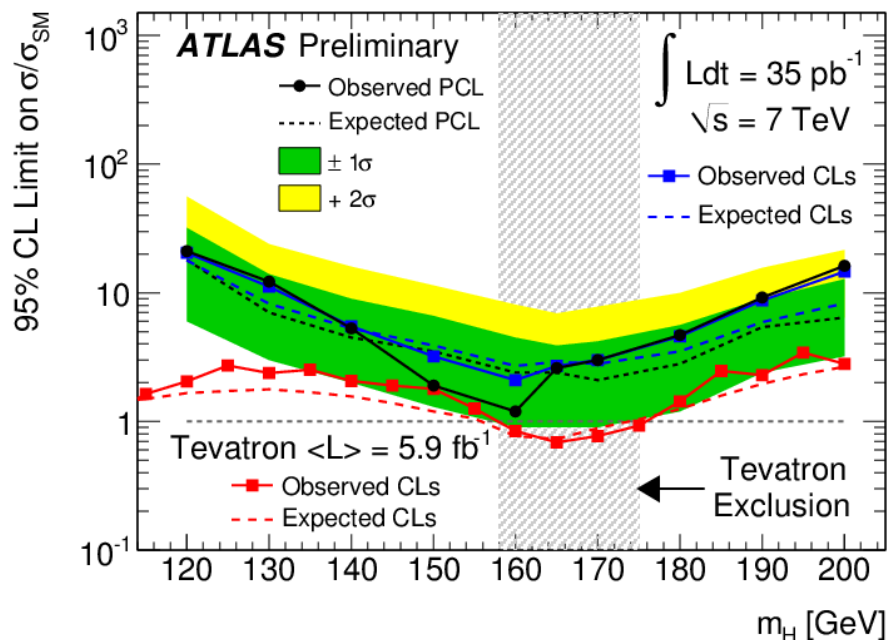
→ exceed substantially previous limits
 → $m(\sim g) > 775$ GeV (@95%CL) for $m(\sim q)=m(\sim g)$

Search for the Higgs boson

- LEP: $m_H > 114.4$ GeV
- theory: $m_H < 185$ GeV
- Tevatron exclusion: $158 < m_H < 175$ GeV

Results with $H \rightarrow WW \rightarrow l\nu l\nu$:

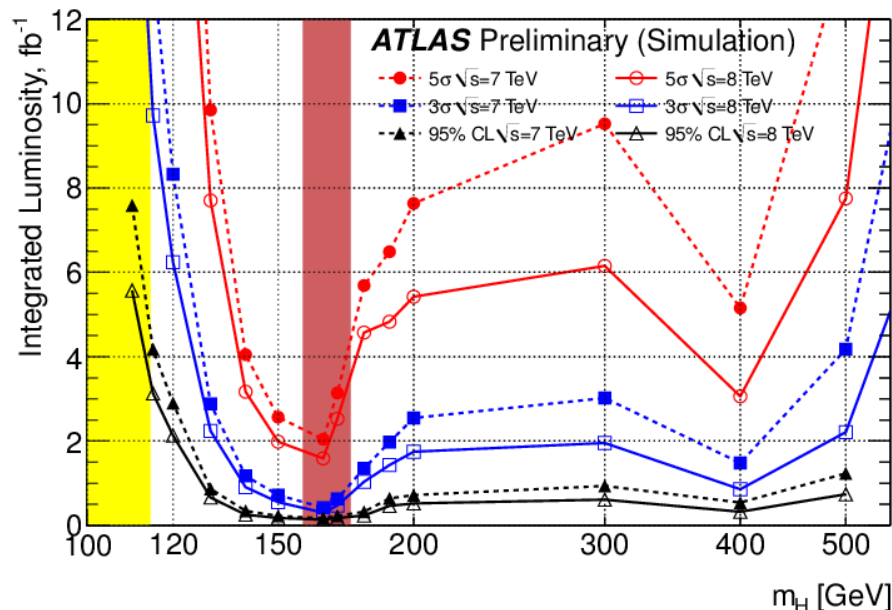
(most sensitive channel for now)



➔ best limit: cross-sections lower than $1.2 \times \sigma_{\text{SM}}$ are excluded for $m_H = 160$ GeV

➔ some way to go but getting closer to Tevatron limit

Prospects for 2011:



with 3 fb^{-1} (@7 TeV):

- exclusion: $120 < m_H < 500$ GeV
- evidence: $130 < m_H < 450$ GeV
- discovery: $150 < m_H < 175$ GeV

➔ exciting year ahead of us !

Conclusion & prospects for 2011

2010:

- Impressive increase of the luminosity delivered by the LHC
- ATLAS worked extremely well, collected 45 pb^{-1} of pp data at 7 TeV
- Standard Model ‘re-discovered’ up to and including top quark
- Started exploring uncharted territories !!
 - for many models/channels, sensitivity to New Physics is already similar or better than previous experiments
 - most impressive case: SUSY mass limits: $\sim 300 \text{ GeV}$ @ Tevatron, now $\sim 700 \text{ GeV}$ @ LHC
- Heavy ions collisions: first observation of dijet asymmetry

2011:

- Expecting between $1 - 3 - 5 \text{ fb}^{-1}$ per experiment at 7 TeV
- ATLAS detector working even better now after fixes during shutdown
- Detailed SM measurements will be pursued
- An important year for New Physics searches
 - hoping for something unexpected soon !
 - some models could be disfavored by the end of the year
- This year the SM Higgs boson could be either excluded (down to 120 GeV) or seen (evidence down to 130 GeV), maybe observed if $\sim 150 \text{ GeV}$