Measurement of the $t\bar{t}$ production cross-section using $e\mu$ events with b-tagged jets in pp collisions at $\sqrt{s} = 7$ and 8 TeV with the ATLAS detector

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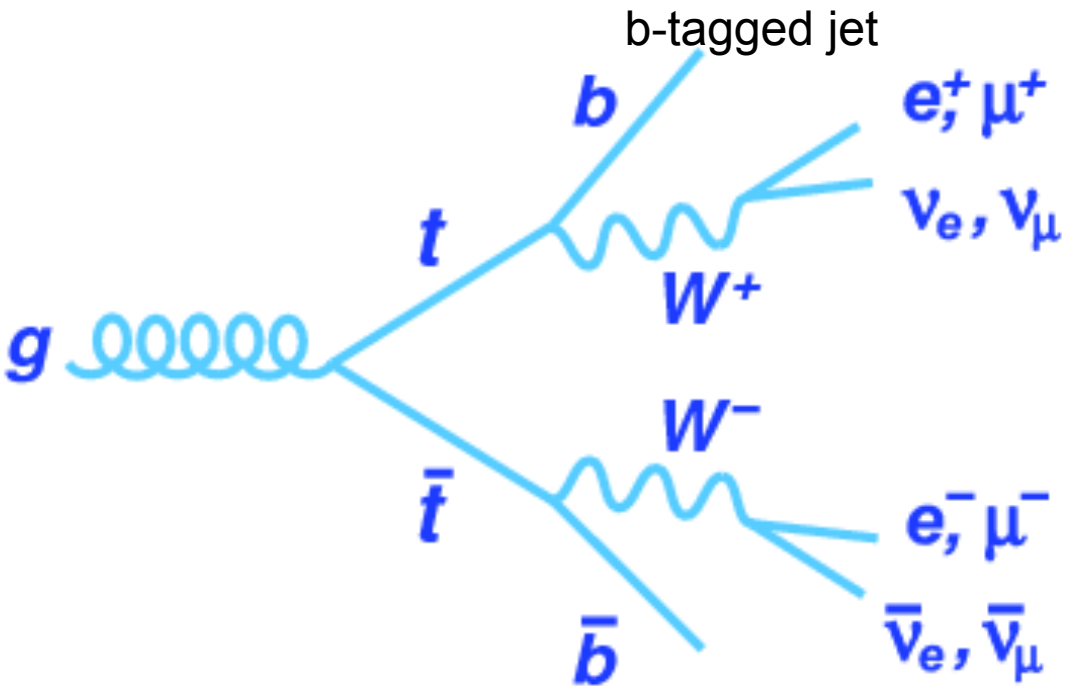
Outline

- $t\bar{t}$ decay
- ATLAS detector
- Event selection
- $t\bar{t}$-cross-section
- Results
- Conclusions

Goal: Measuring the $t\bar{t}$-production cross-section using the decay channel $e\mu$ in pp collisions at 7 and 8 TeV.

→ $e\mu$ decay because of the low background levels

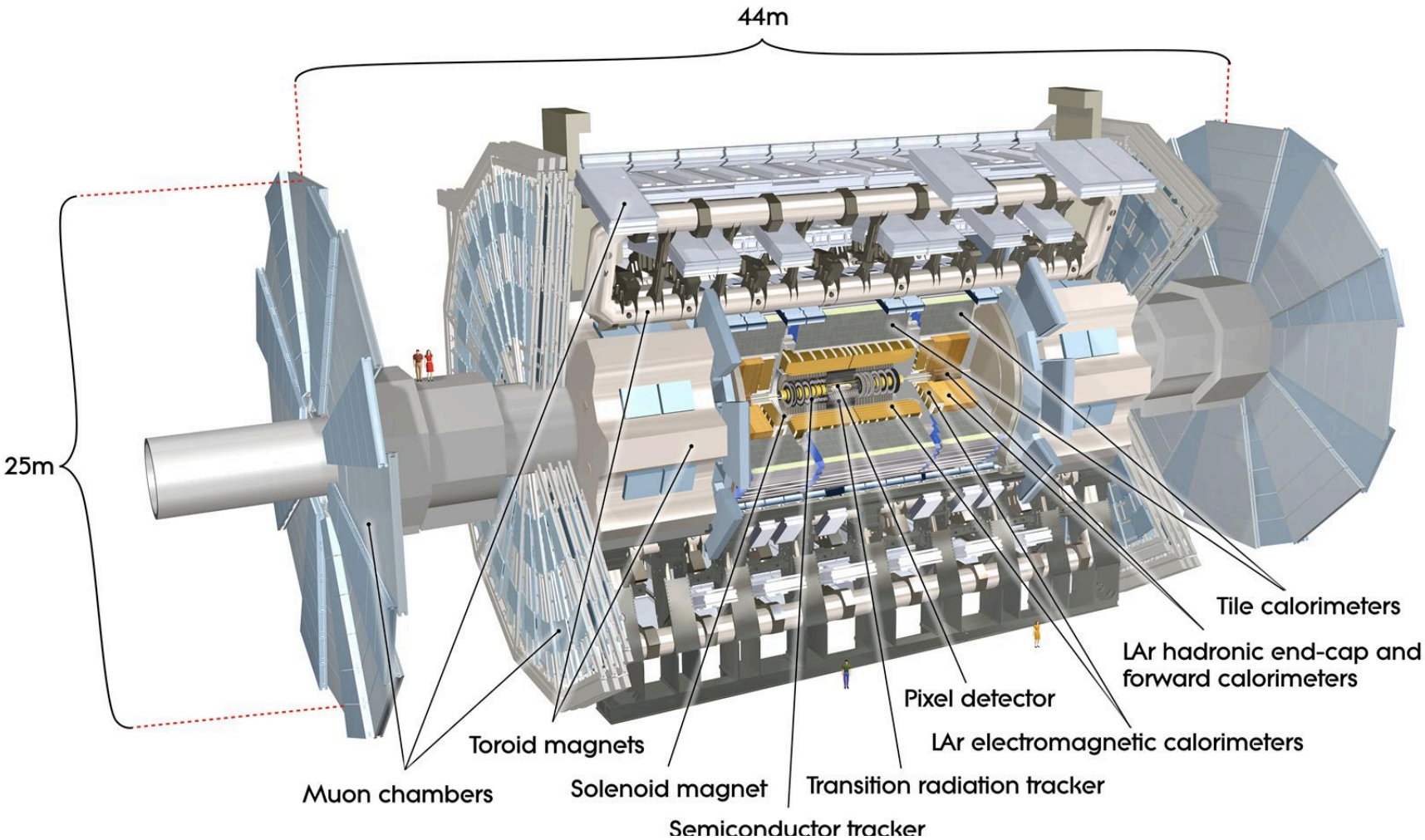
$t\bar{t}$ decay



Background:

- Wt (production of W boson and single top quark)
- Z → ττ → eμ + jets (+ 4ν)
- BR(W→ lν)=0.1082

ATLAS detector



Event selection

electrons	E_T>25 GeV, |η|<2.47, ΔR=0.2 for Et and ΔR=0.3 for pt
muon	p_T>25 GeV, |η|<2.5 ΔR=0.2 for Et and ΔR=0.3 for pt (for 7TeV) For 8 TeV replaced by cut at I<0.05
jets	b-tagged jets Reconstructed with anti-k_t-algorithm

Events
...were required to have at least one reconstructed primary vertex with five tracks
...compatible to cosmic rays or bremsstrahlung were removed
...had to have exactly one electron and one muon
→ only well reconstructed events

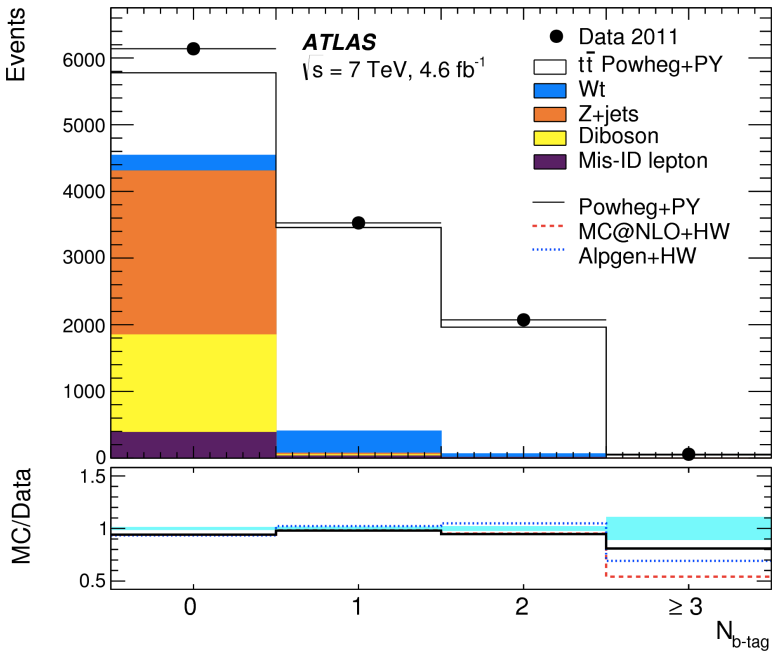
$t\bar{t}$-cross-section

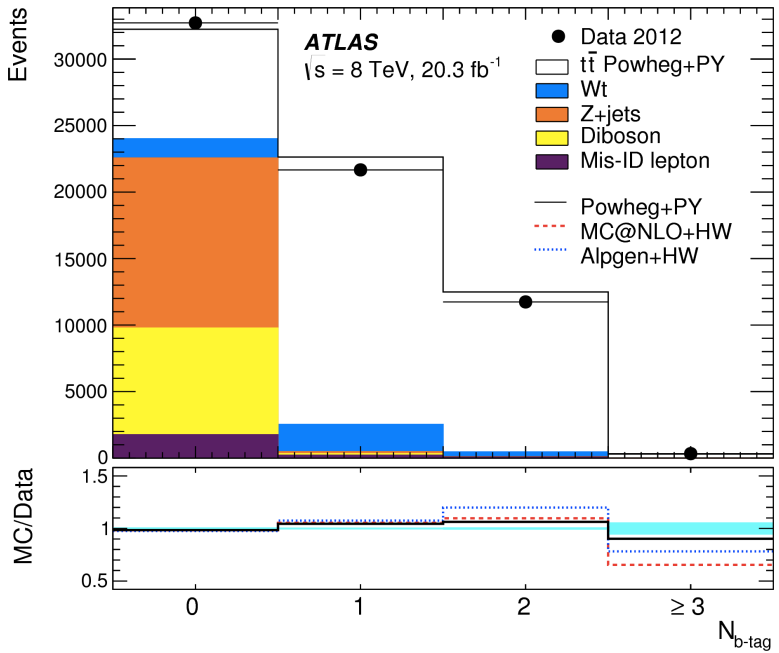
The tt production cross-section was determined by counting the numbers of opposite-sign eμ events with exactly one (N_1) and exactly two (N_2) b-tagged jets. The event counts can be expressed as:

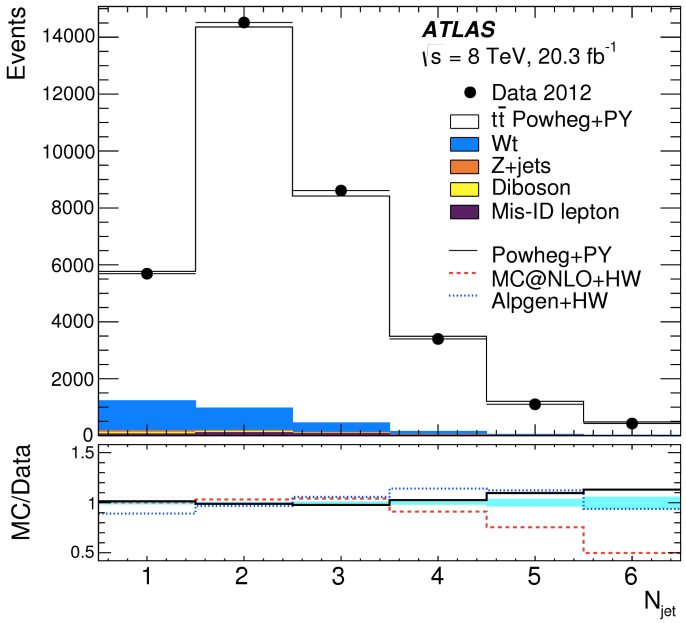
$$N_1 = L\sigma_{t\bar{t}}\epsilon_{e\mu}2\epsilon_b(1 - C_b\epsilon_b) + N_1^{bkg}$$

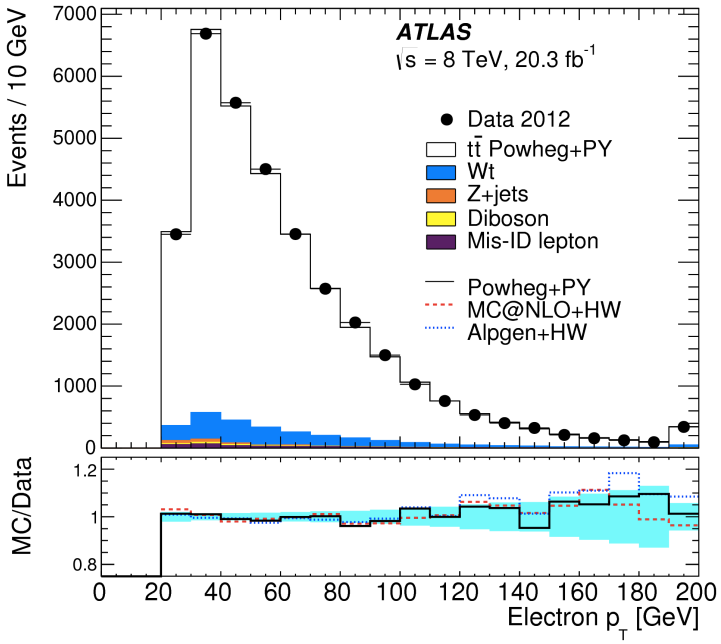
$$N_2 = L\sigma_{t\bar{t}}\epsilon_{e\mu}C_b\epsilon_b^2 + N_2^{bkg}$$

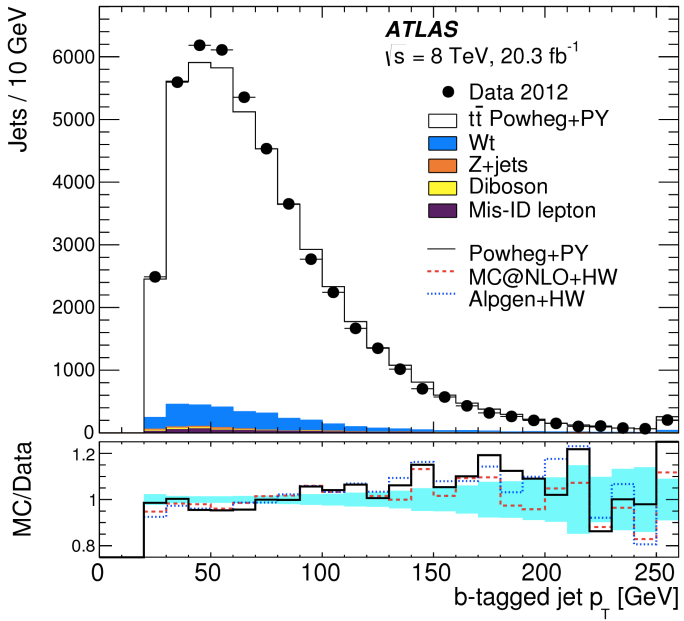
The equations have to be solved numerically yielding σ and ε

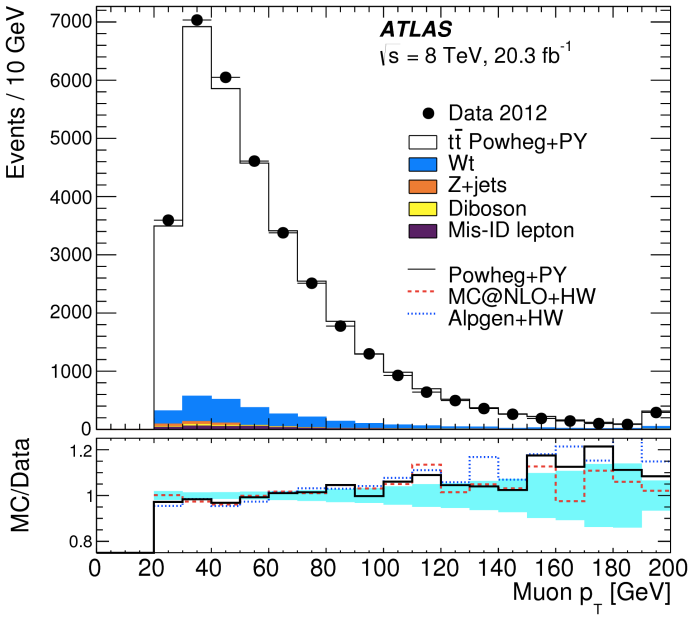





ATLAS
√s = 8 TeV, 20.3 fb-1
Data 2012
tt̄ Powheg+PY
Wt
Z+jets
Diboson
Mis-ID lepton
Powheg+PY
MC@NLO+HW
Alpgen+HW
Events
MC/Data
Njet


ATLAS
√s = 8 TeV, 20.3 fb-1
Data 2012
tt̄ Powheg+PY
Wt
Z+jets
Diboson
Mis-ID lepton
Powheg+PY
MC@NLO+HW
Alpgen+HW
Events / 10 GeV
MC/Data
Electron pT [GeV]

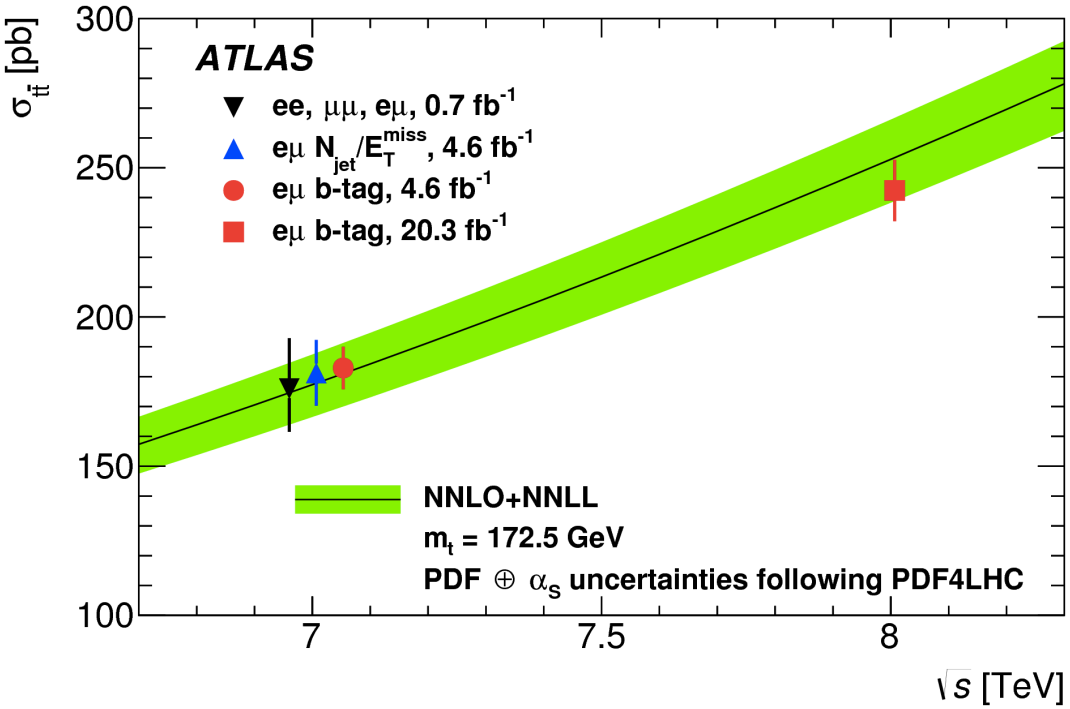

ATLAS
√s = 8 TeV, 20.3 fb-1
Data 2012
tt̄ Powheg+PY
Wt
Z+jets
Diboson
Mis-ID lepton
Powheg+PY
MC@NLO+HW
Alpgen+HW
Jets / 10 GeV
MC/Data
b-tagged jet pT [GeV]


ATLAS
√s = 8 TeV, 20.3 fb-1
Data 2012
tt̄ Powheg+PY
Wt
Z+jets
Diboson
Mis-ID lepton
Powheg+PY
MC@NLO+HW
Alpgen+HW
Events / 10 GeV
MC/Data
Muon pT [GeV]

Results

- Results of cross-section:
- At 7 TeV: $\sigma_{t\bar{t}} = 182.9 \pm 3.1 \pm 4.2 \pm 3.6 \pm 3.3$ pb
- At 8 TeV: $\sigma_{t\bar{t}} = 242.4 \pm 1.7 \pm 5.5 \pm 7.5 \pm 4.2$ pb
- Ratio: R= 1.326 ± 0.024 ± 0.015 ± 0.049 ± 0.001

Values of ε_b
At 7 TeV: 0.557 ± 0.009
At 8 TeV: 0.540 ± 0.006



Top quark mass determination

Dependence of the cross-section predictions on m:

$$\sigma_{t\bar{t}}^{theo}(m_t^{pole}) = \sigma(m_t^{ref}) \left(\frac{m_t^{ref}}{m_t^{pole}} \right)^4 (1 + a_1 x + a_2 x^2)$$

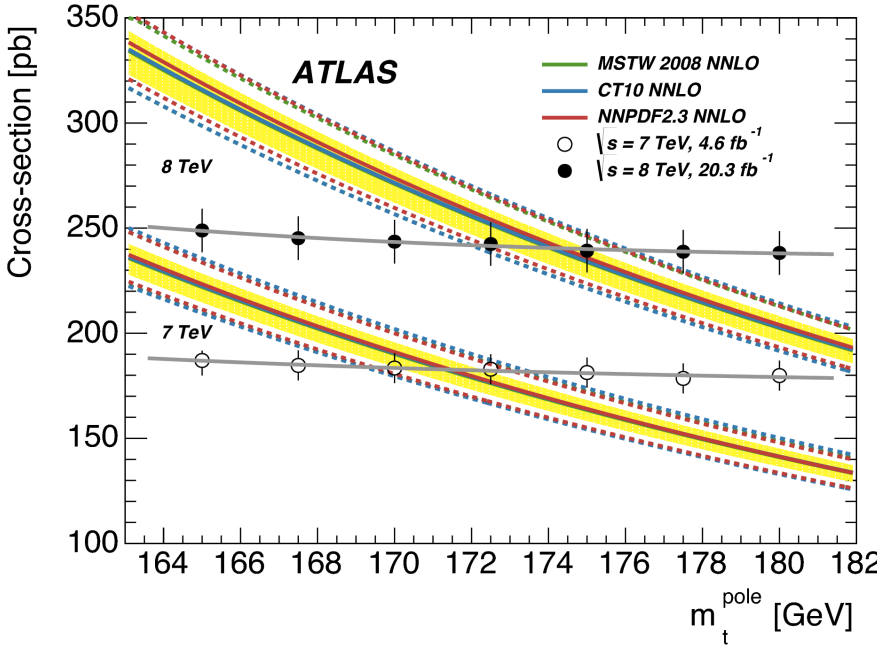
With $x = (m_t^{pole} - m_t^{ref})/m_t^{ref}$ $\qquad m_t^{ref} = 172.5\ GeV$

Extraction by maximising the expression:

$$\mathfrak{L}(m_t^{pole}) = \int G(\sigma'_{t\bar{t}} | \sigma_{t\bar{t}}(m_t^{pole}), \rho_{exp}) \cdot G(\sigma'_{t\bar{t}} | \sigma_{t\bar{t}}^{theo}(m_t^{pole}), \rho_{theo}^{\pm}) d\sigma'_{t\bar{t}}$$

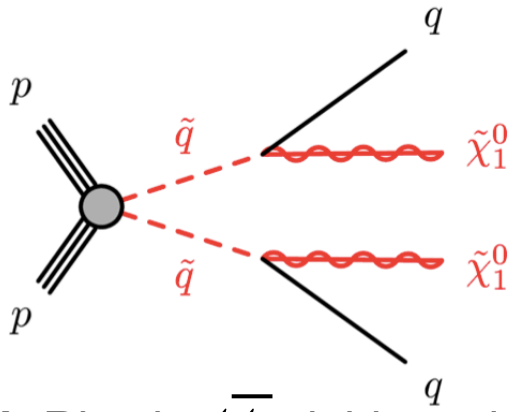
Resulting value:

$$m_t^{pole} = 172.9^{+2.5}_{-2.6} GeV$$



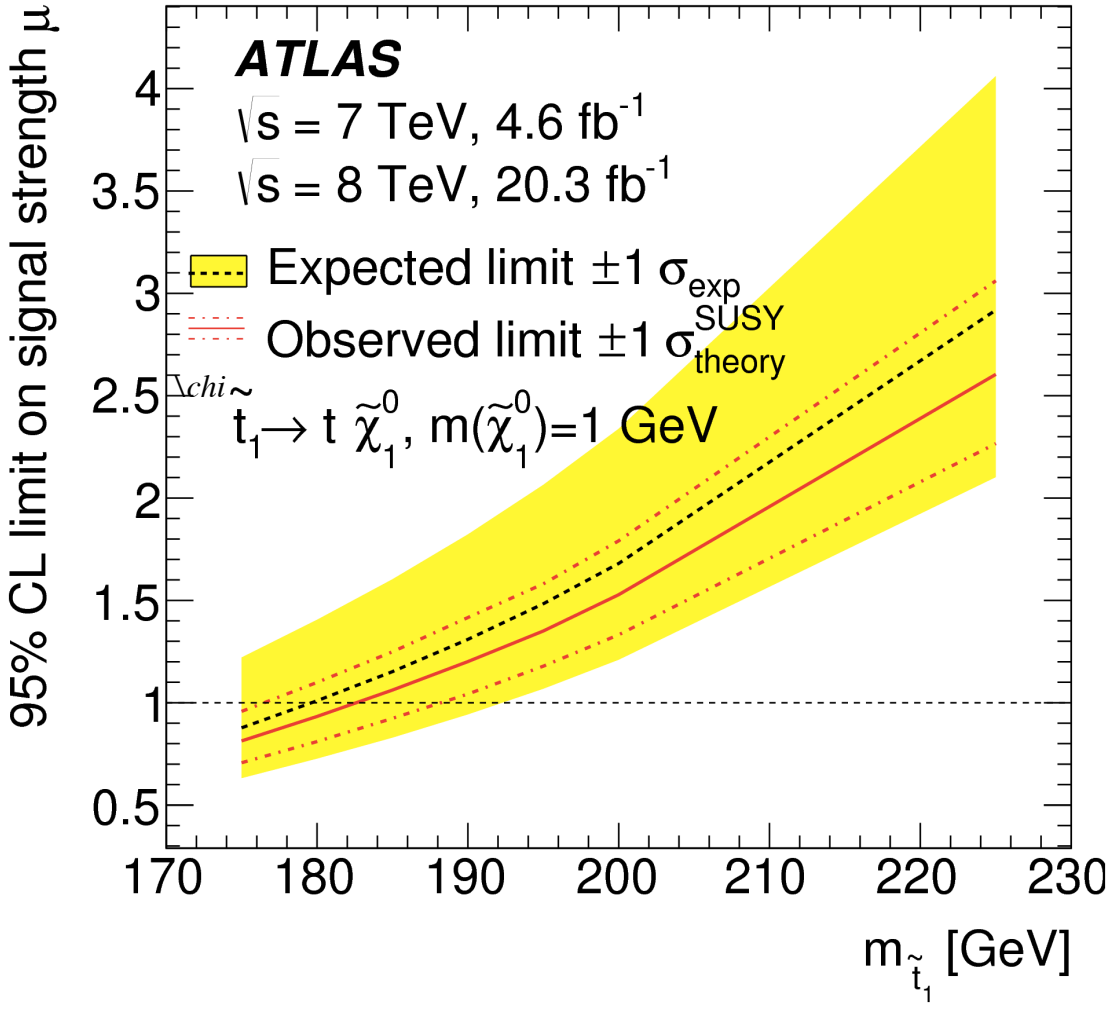
Constraints on stop-pair production

SUSY predicts new particles which are produced in pairs



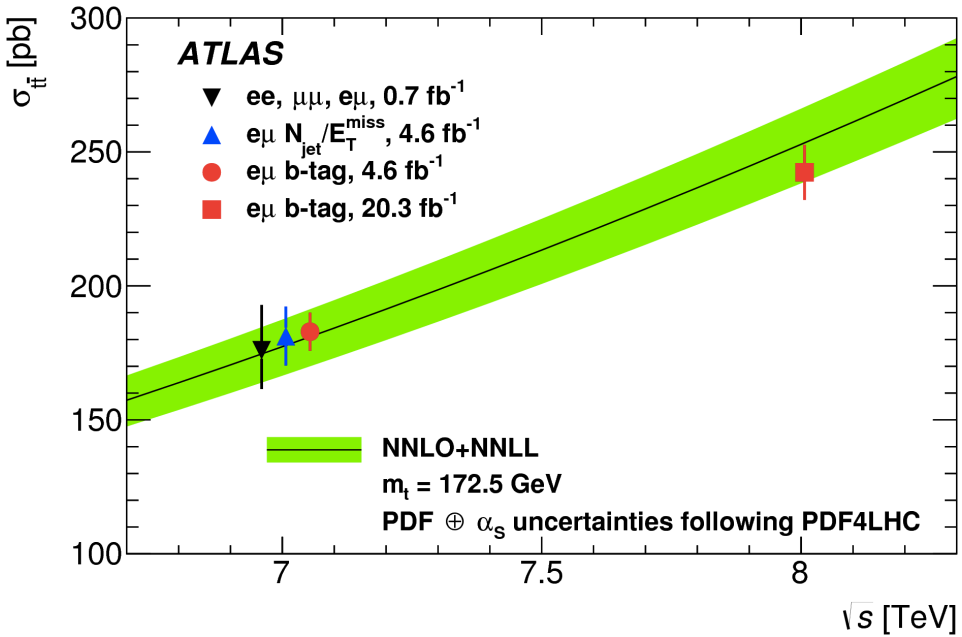
→ Rise in $t\bar{t}$ yields and missing transverse momentum

Top squark masses between top quark mass and 177 GeV excluded with 95% CL.



Conclusions

- At 7 TeV: 182.9 ± 3.1 ± 4.2 ± 3.6 ± 3.3 pb
- At 8 TeV: 242.4 ± 1.7 ± 5.5 ± 7.5 ± 4.2 pb
- Top quark pole mass m=172.9 GeV
- Top squark masses between top quark mass and 177 GeV have been excluded at 95% CL.



Thanks for your attention!