The DESY ATLAS Group (I)

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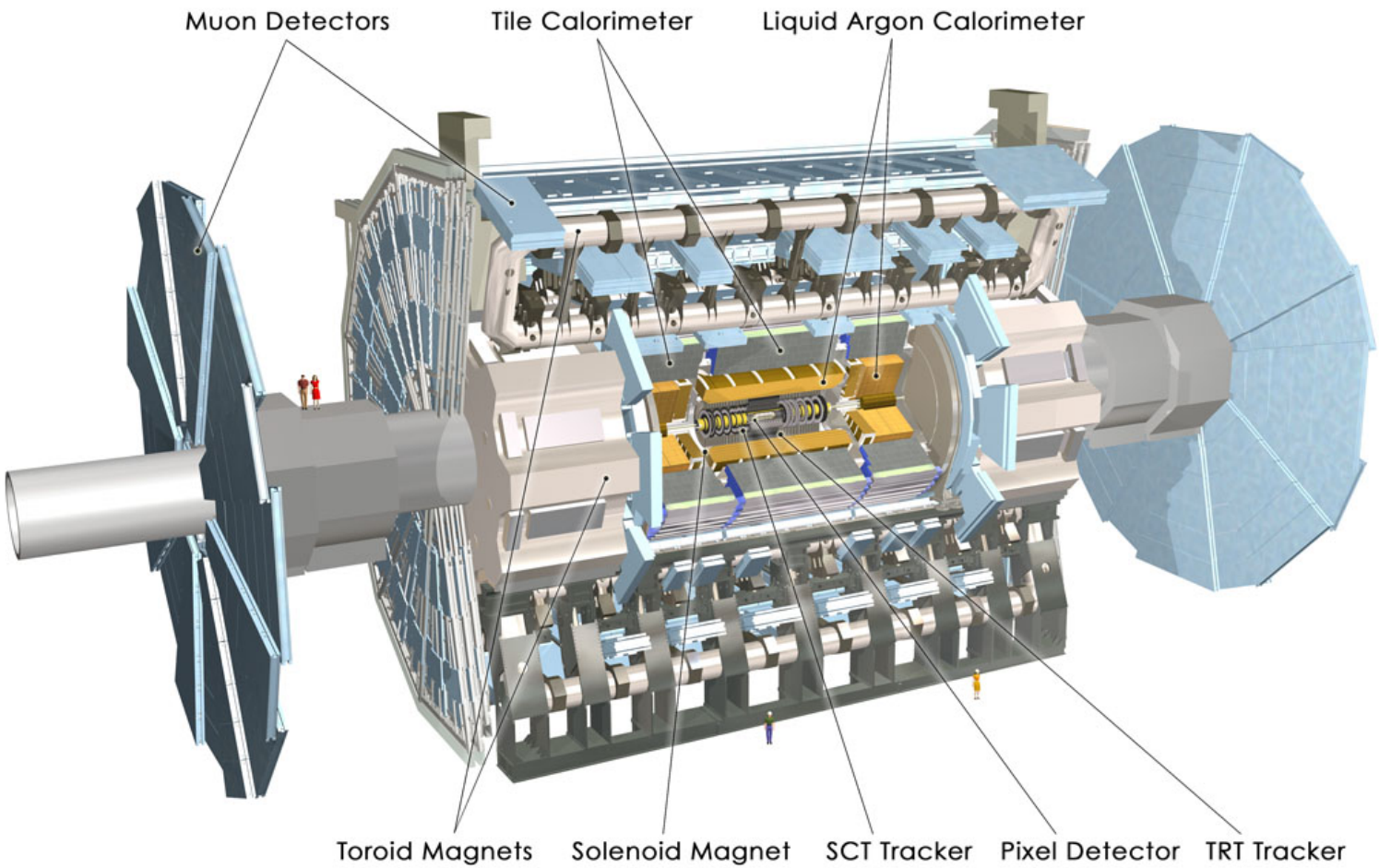
DESY

Experimental Particle Physics at DESY – Summer Student Colloquium

Hamburg – August 24, 2011

The ATLAS Detector at the LHC

- Multi-purpose detector collecting data at the LHC in Geneva
- pp collisions at $\sqrt{s} = 7\,\mathrm{TeV}$



DESY Is Involved in All Aspects at ATLAS

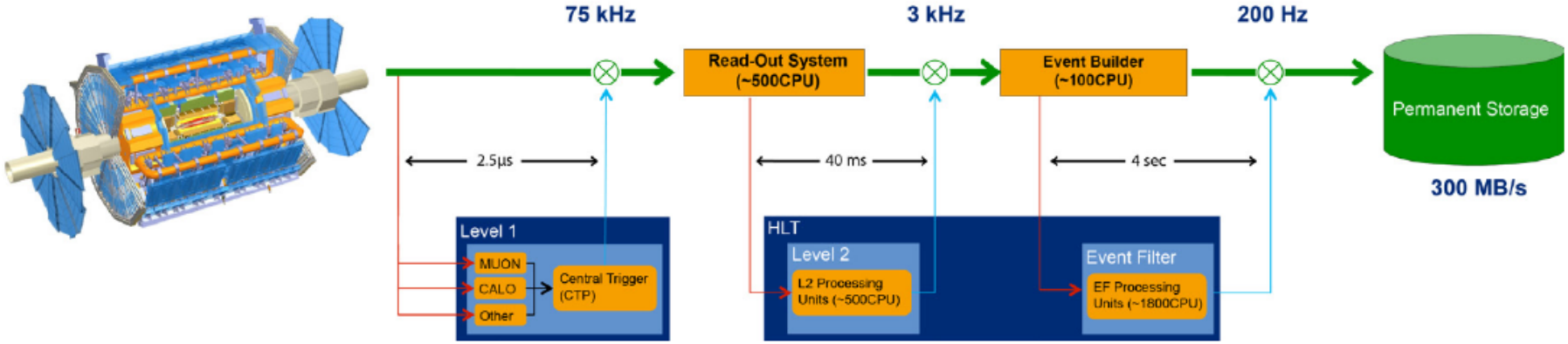
Many steps to get the final physics results

- → Detector development and simulation
  - ⋆ Ingrid will tell you about this part!
- → Operating and monitoring the detector
  - ⋆ Ingrid will tell you about this part, too!
- → Triggering the interesting events
- → Processing the data
- → Calibrating the detector
- → Simulating physics processes and the detector
- → Analyzing the data to get physics results
  - ⋆ DESY works on several topics: Higgs, SUSY, Standard Model, top

Will focus on activities in Hamburg (there's more in Zeuthen!)

ATLAS Trigger

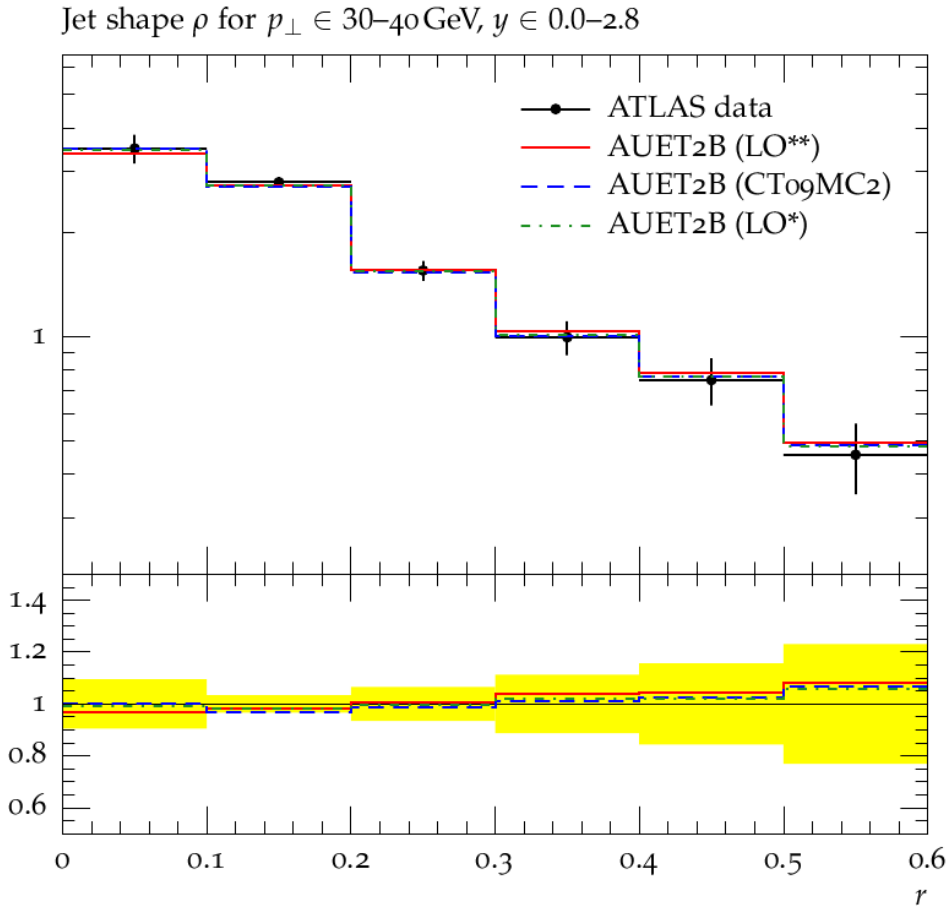
- LHC designed to collide proton bunches at $\mathbf{40\,MHz}$, ATLAS can record data at $\mathbf{200 - 600\,Hz}$
  - $\longrightarrow$ Need very fast and reliable trigger system to pick the interesting physics events
- DESY is contributing to
  - ⋆ Trigger steering and configuration tools
  - ⋆ High-Level Trigger selection for electrons and photons



Monte Carlo Tuning

- Monte Carlo event generators need to be tuned to provide a good simulation of data
  - ⋆ Hadronic underlying event
  - ⋆ Jet properties
- ATLAS performs tuning of the Pythia and Herwig generators including ATLAS results, as well as results from the Tevatron and LEP experiments

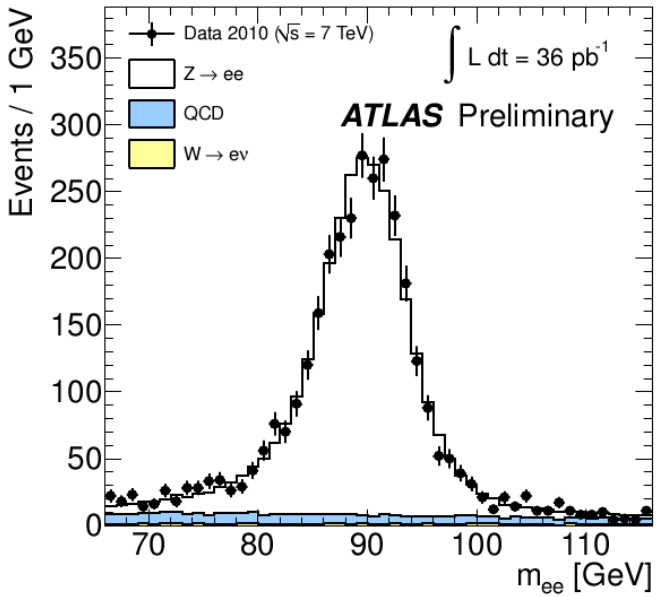
Jet shape: data vs Monte Carlo



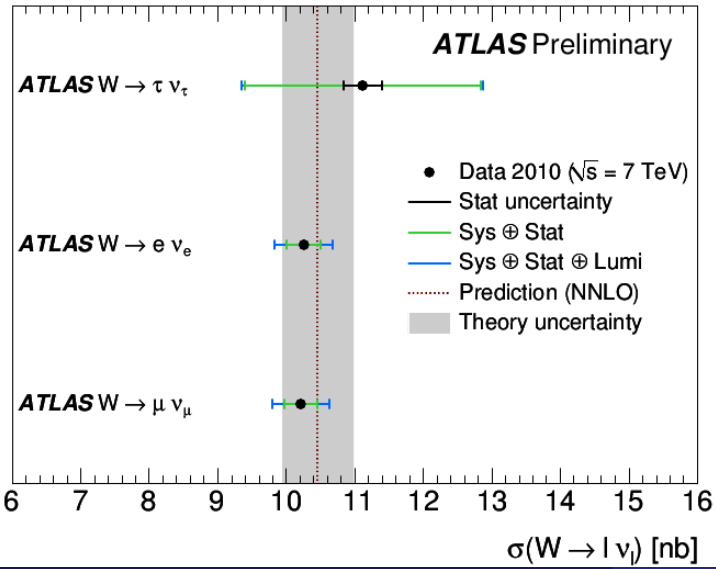
Standard Model: $Z \longrightarrow e^+e^-$ and $W \longrightarrow \tau\nu$

- Important milestone: Z cross section measurement with $Z \longrightarrow e^+e^-$
  - ⋆ Precision tests of different aspects of QCD
  - ⋆ Electrons from Z crucial for detector studies

Invariant e^+e^- mass



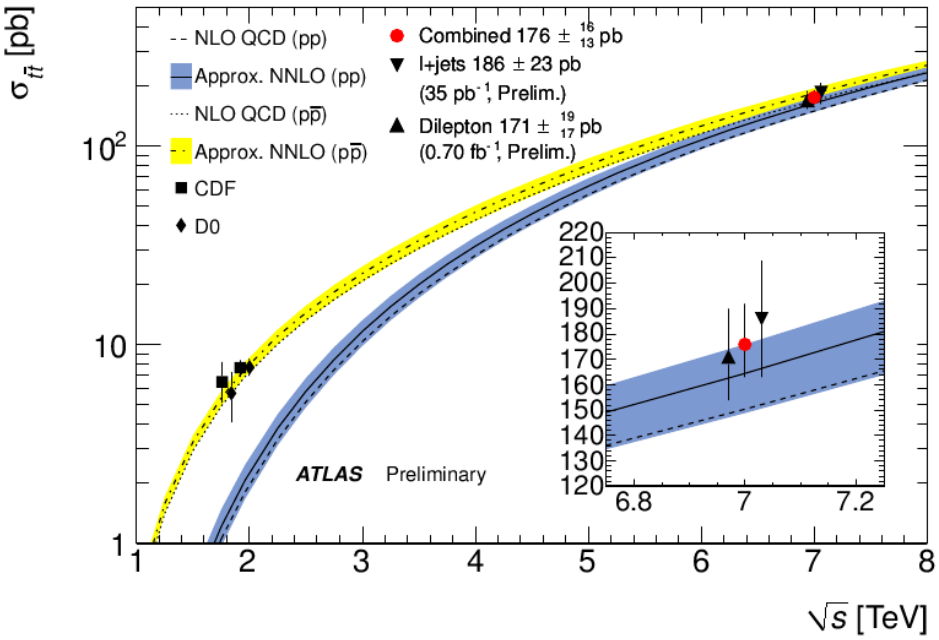
W cross section



- First $W \longrightarrow \tau\nu$ cross section measurement at LHC
- Excellent agreement with theoretical predictions
- Also important background for Higgs and SUSY searches with τ

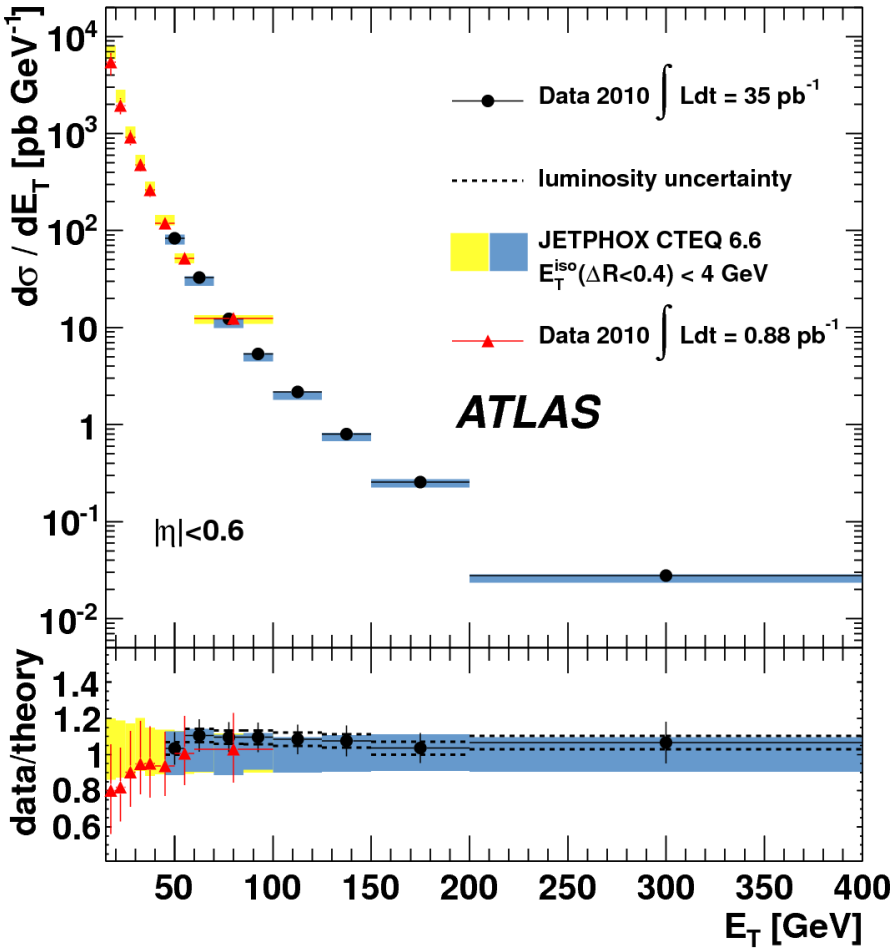
Top and Photon Production Cross Sections

$t\bar{t}$ cross section



- $t\bar{t}$ reconstructed in 1-lepton and 2-lepton channel
- Test of perturbative QCD
- Important background for Higgs and New Physics searches

Photon cross section



- Precision tests for QCD

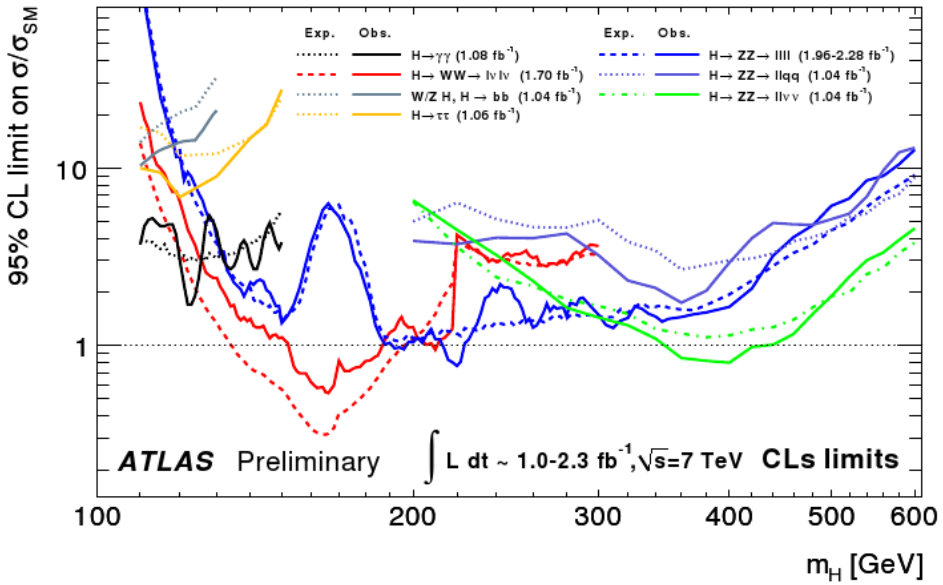
$H \to \gamma\gamma$ Search

- Higgs boson searched for in various decay channels at ATLAS:
  $H \to W^+W^-$, $H \to ZZ$,
  $H \to \gamma\gamma$ (DESY), $H \to b\bar{b}$,
  $H \to \tau^+\tau^-$
  - ⋆ Already quite a large mass range excluded

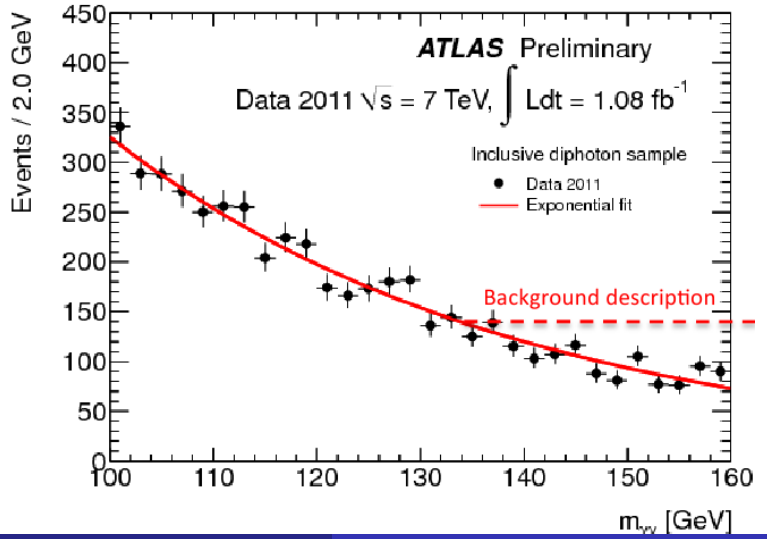
- $H \to \gamma\gamma$ is important channel at low Higgs masses
  $110\,\mathrm{GeV} < m_H < 150\,\mathrm{GeV}$

- Observed exclusion limits in $H \to \gamma\gamma$ between 2 and $6\times$ SM cross section

Higgs exclusion limits



Diphoton invariant mass

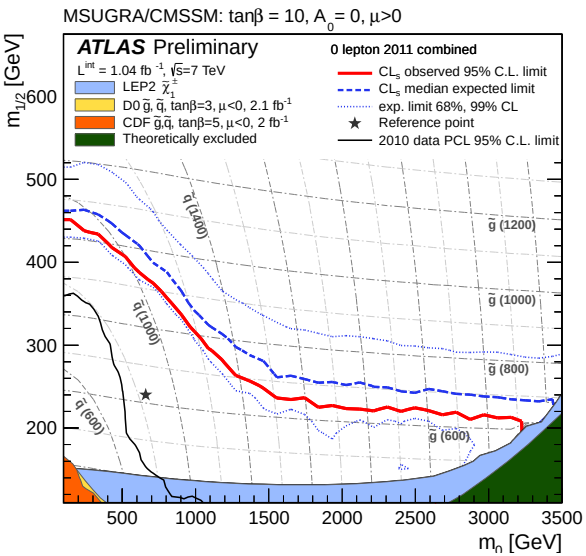


SUSY

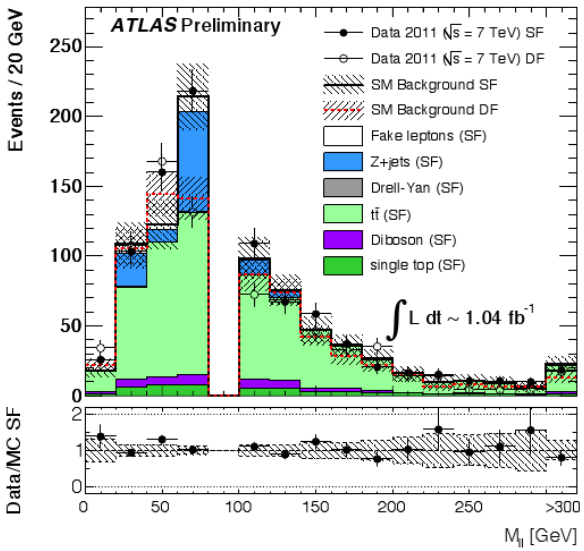
Supersymmetric models predict existence of new particles, which are searched for in many different decay channels

- Jets and missing E_T (0-lepton channel)
  - → Tighter and tighter exclusion limits as we add data (so far)

Limits from 0-lepton search



Invariant 2-lepton mass

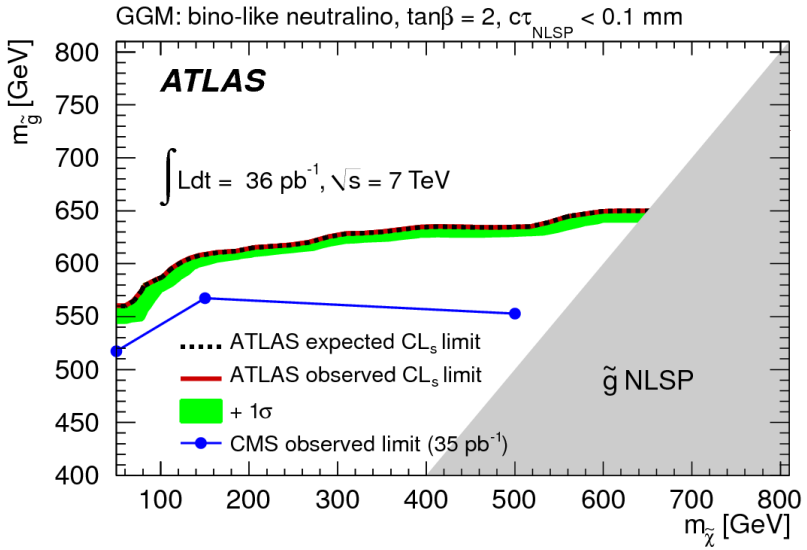


- 2-lepton channel and missing E_T
  - → Looking for an excess of same-flavor dilepton events compared to opposite flavor events
- Also searches in 1-lepton channel and in 2-τ channel

SUSY

- Diphoton and missing E_T
  - $\longrightarrow$ Limits on gauge-mediated SUSY models
    - $\star$ Tightest existing limits even with the 2010 data

Gluino mass constraints from 2γ+MET



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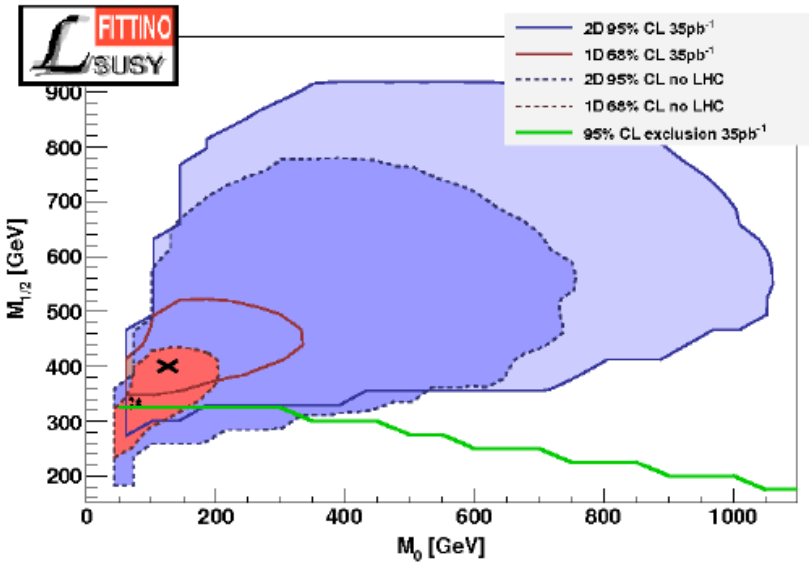

- Fittino: global fit approach
  - $\star$ Combine constraints from precision measurements, astrophysics (dark matter) and exclusion limits from direct searches

New students are very welcome!