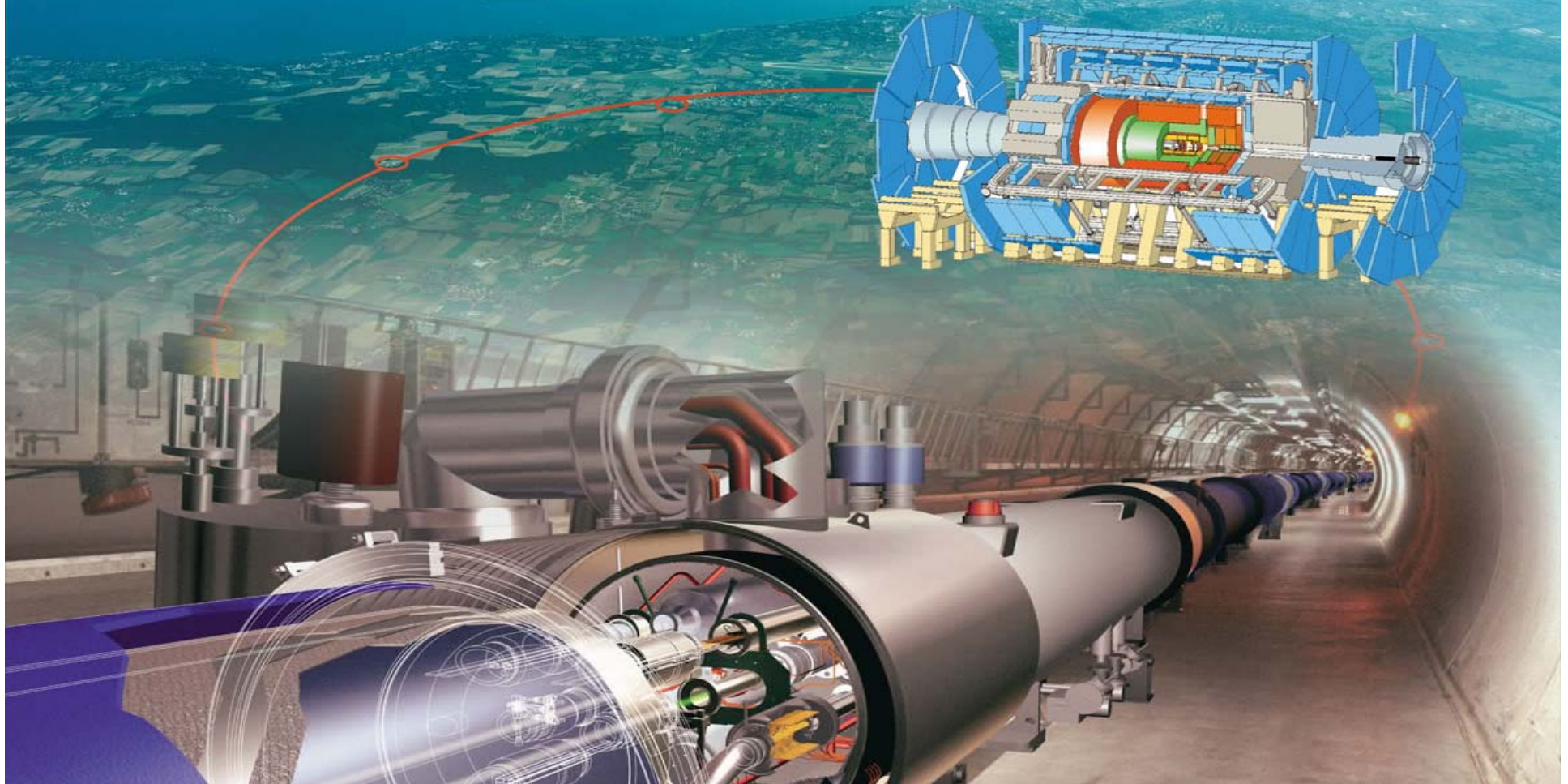
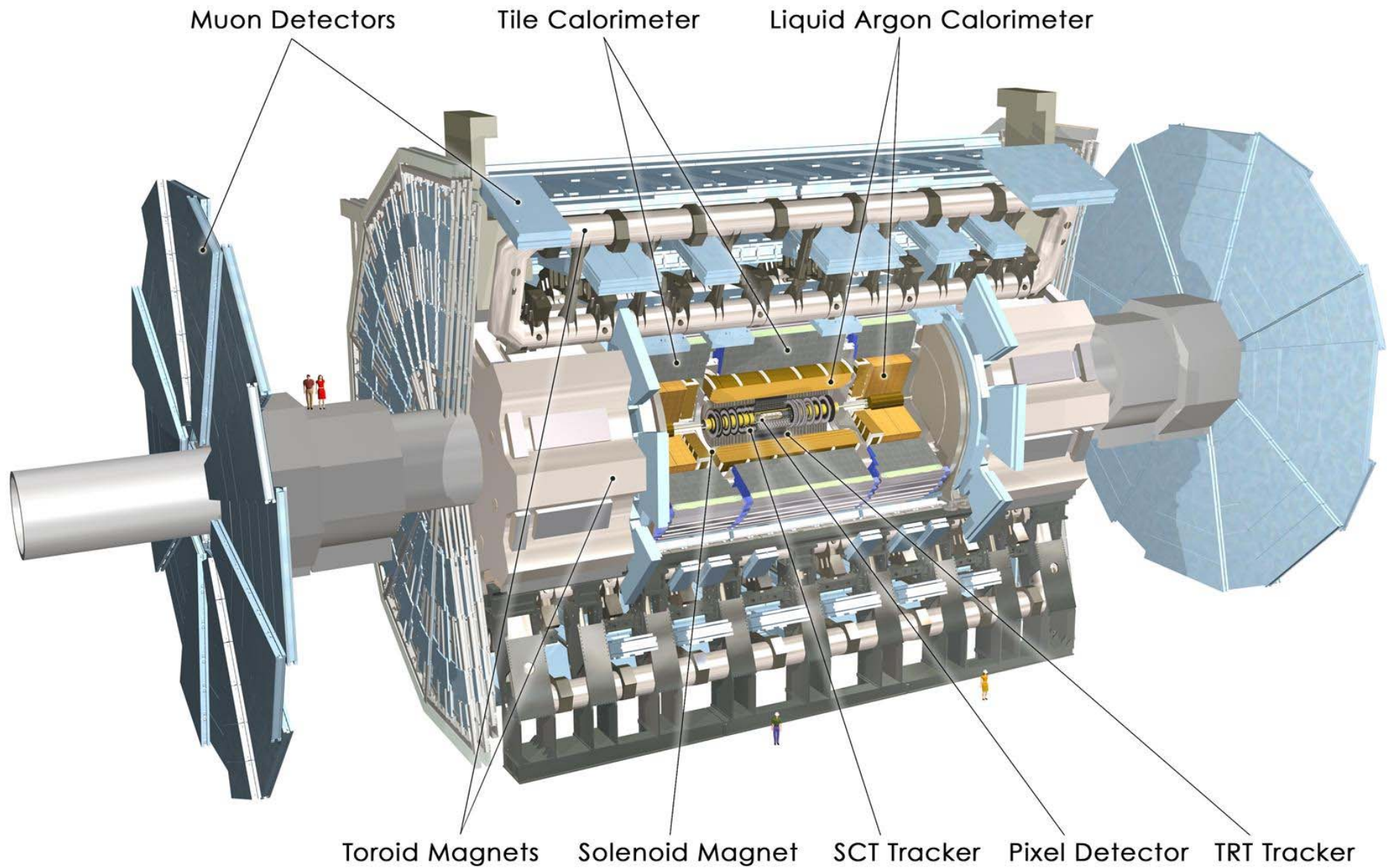
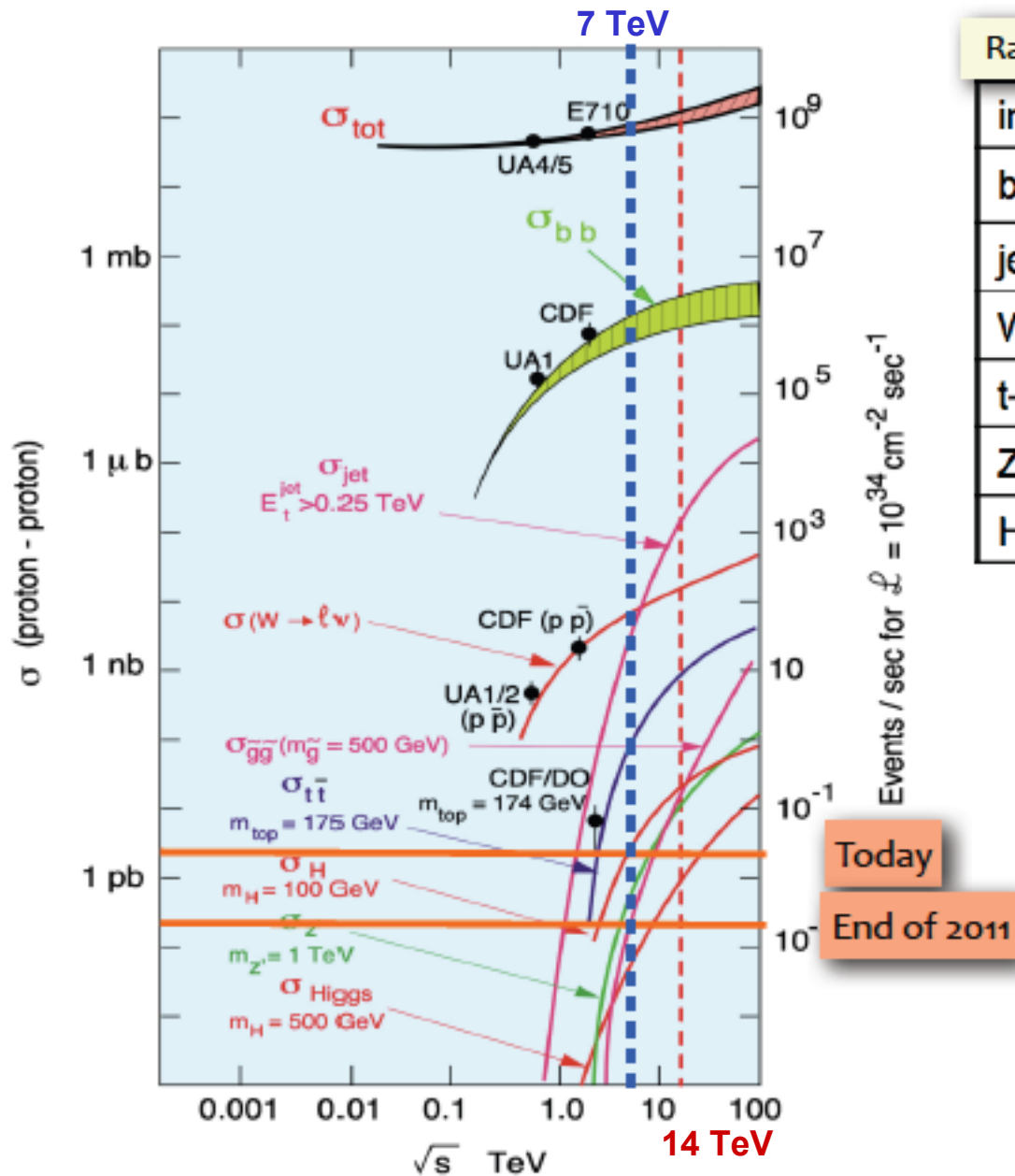


The Large Hadron Collider and the ATLAS Experiment







Rates for $\mathcal{L}=10^{32} \text{ cm}^2\text{s}^{-1}$ @ 7 TeV

inelastic pp collision	10^7 Hz
b-quark pair production	10^4 Hz
jet production, $E_T > 250 \text{ GeV}$	1 Hz
$W \rightarrow \ell \nu$	1 Hz
t-quark pair production	10^{-2} Hz
Z' ($m_{Z'} = 1 \text{ TeV}$)	10^{-4} Hz
Higgs ($m_H = 500 \text{ GeV}$)	10^{-5} Hz

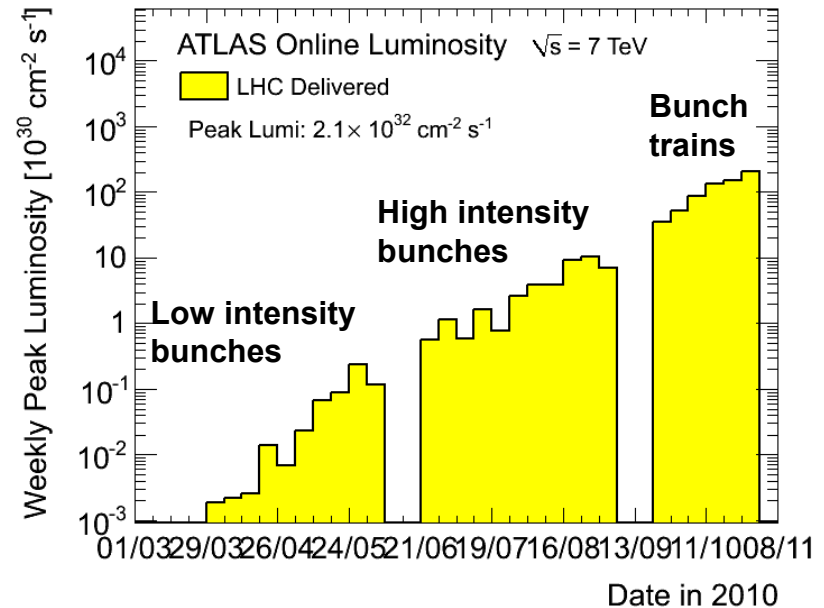
LHC Startup 2009/2010

First proton-proton collisions:

20 November 2009 at 0.9 TeV

11 December 2009 at 2.36 TeV

30 March 2010 at 7.0 TeV
centre-of-mass energy



2010: Peak inst. lumi $2.1 \times 10^{32} \text{ cm}^{-2} \text{ s}^{-1}$

with 368 proton bunches/ beam

with 150 ns time interval and

10^{11} protons/ bunch at 7 TeV

20 MJoule stored beam energy

LHC design luminosity $10^{34} \text{ cm}^{-2} \text{ s}^{-1}$

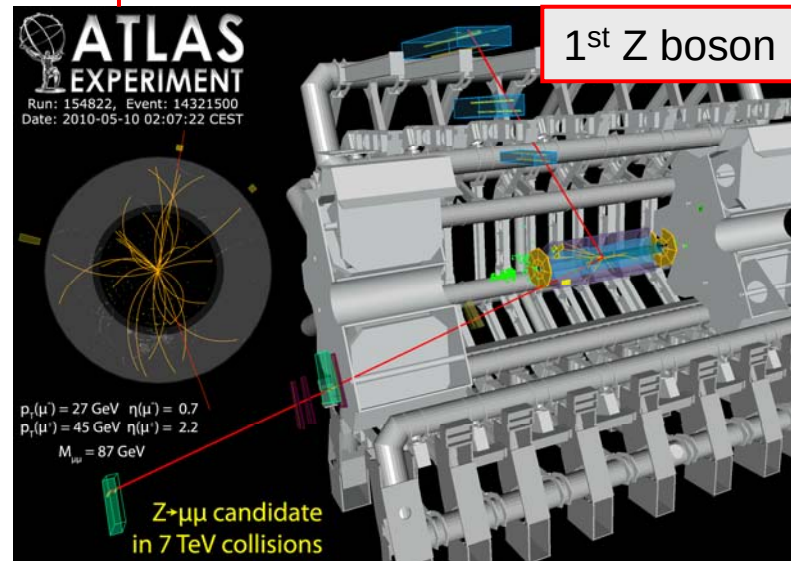
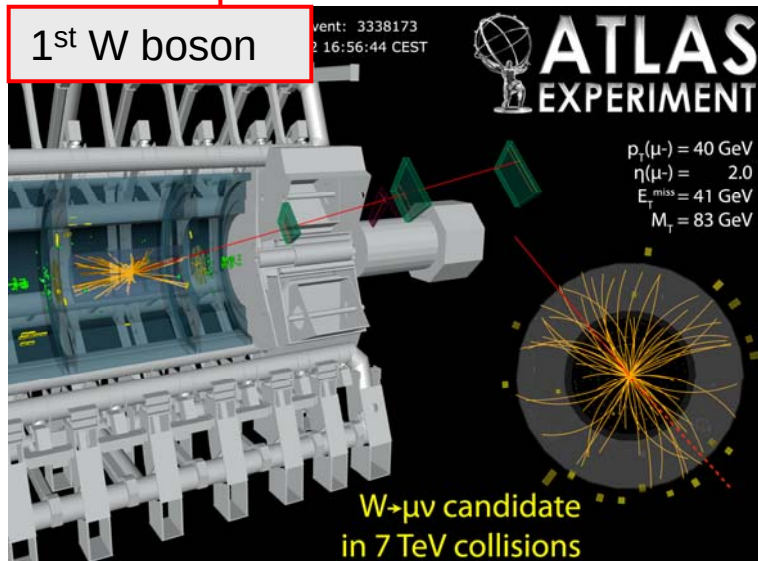
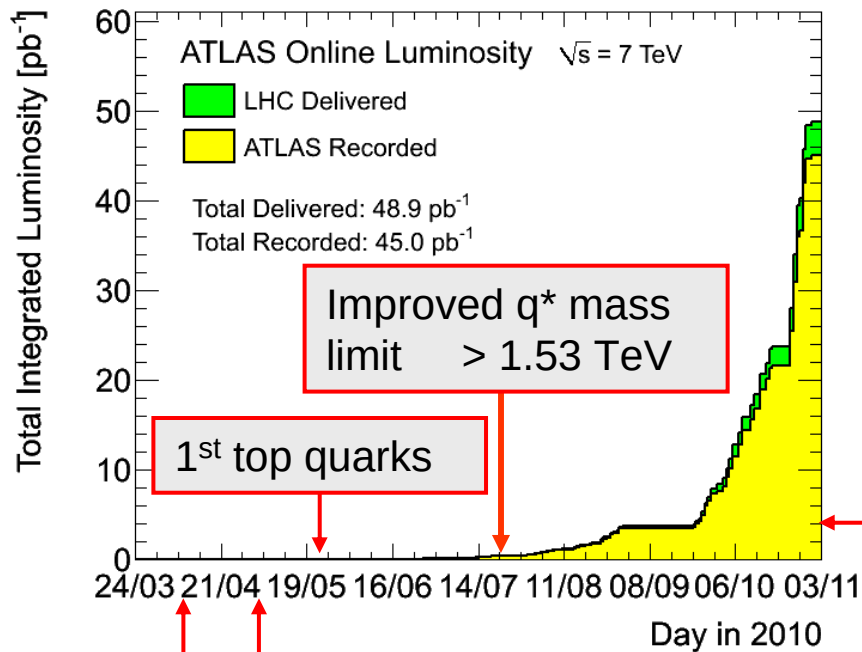
with 2835 proton bunches/ beam

and 25 ns time interval,

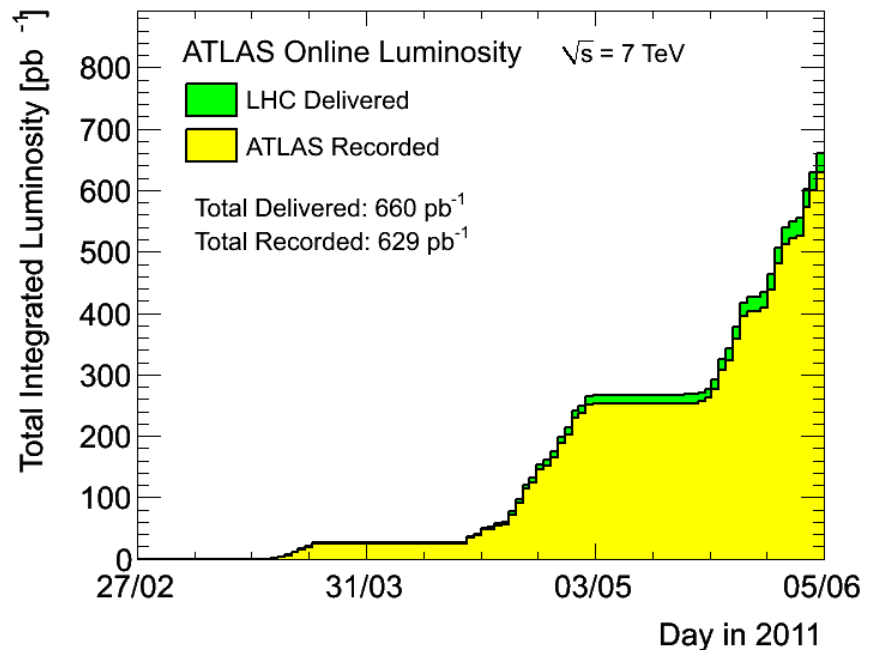
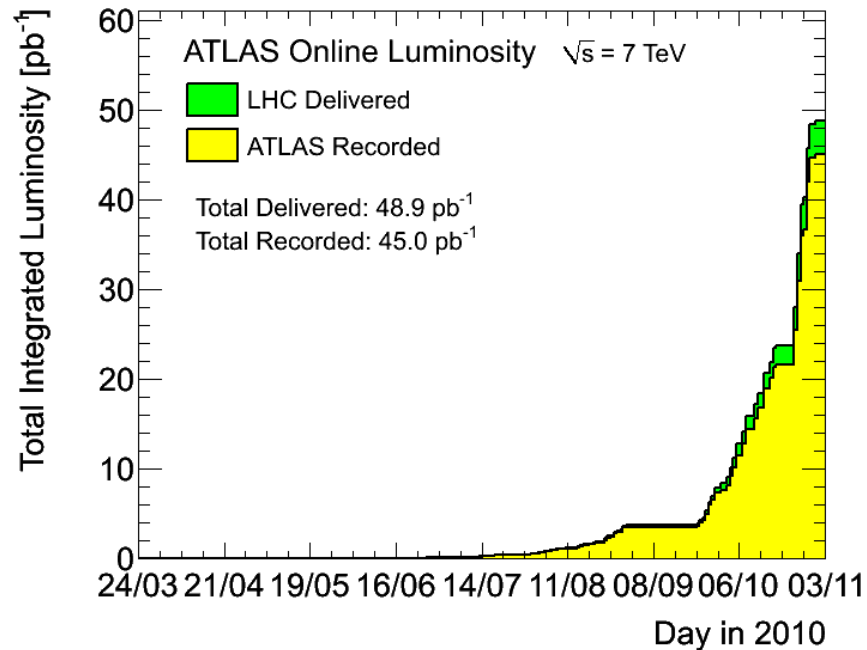
10^{11} protons/ bunch at 14 TeV

335 MJoule stored beam energy

LHC Startup 2009/2010



LHC 2010/2011



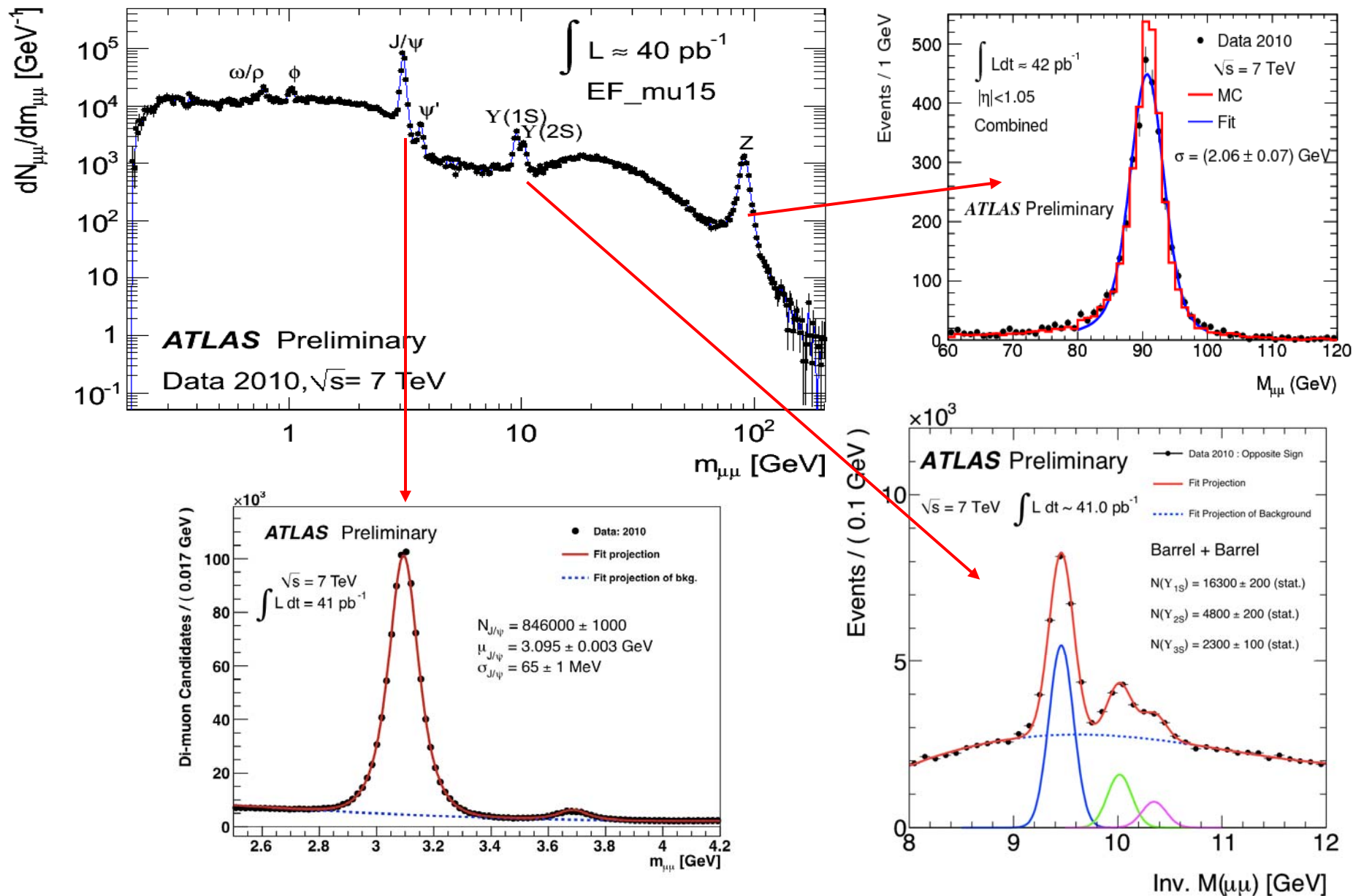
2011: Peak inst. lumi $1.25 \times 10^{33} \text{ cm}^{-2} \text{ s}^{-1}$

with 1092 proton bunches/ beam
 with 50 ns bunch spacing and
 1.2×10^{11} protons/ bunch at 7 TeV
 60 MJoule stored beam energy

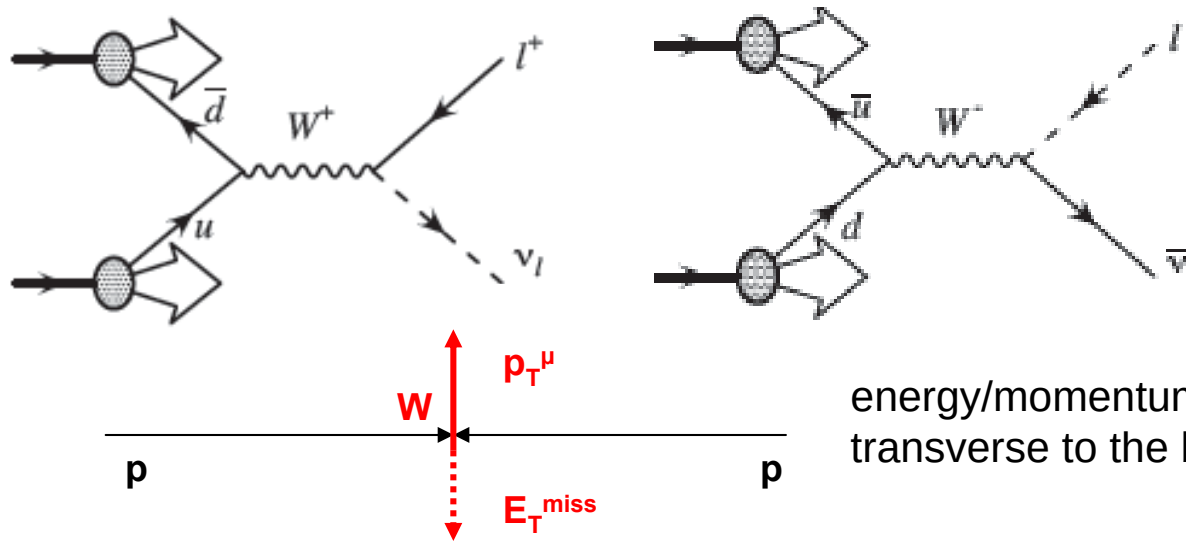
LHC design luminosity $10^{34} \text{ cm}^{-2} \text{ s}^{-1}$

with 2835 proton bunches/ beam
 and 25 ns time interval,
 10^{11} protons/ bunch at 14 TeV
 335 MJoule stored beam energy

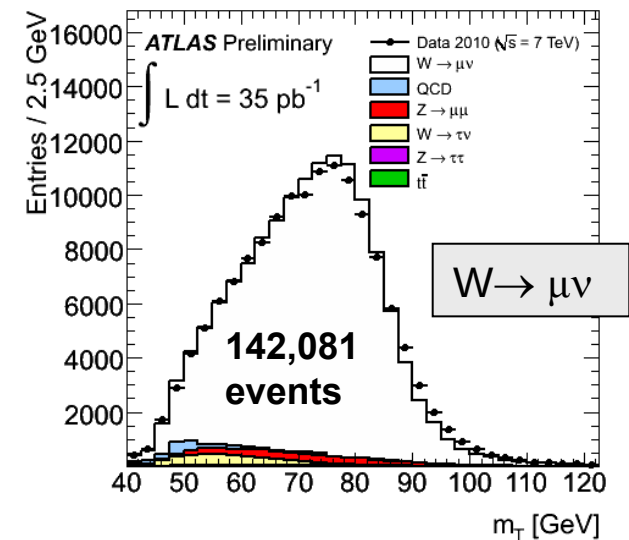
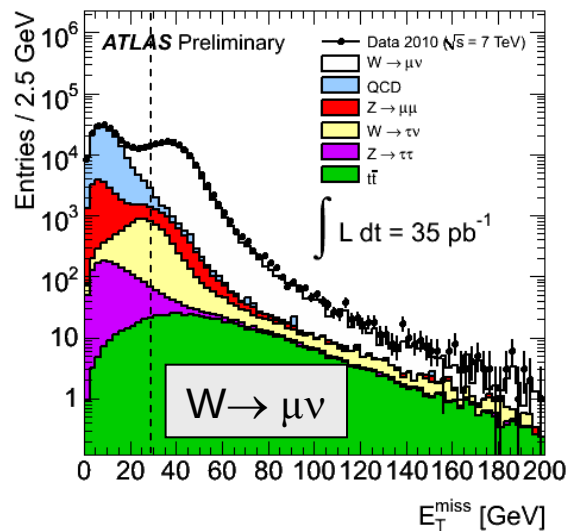
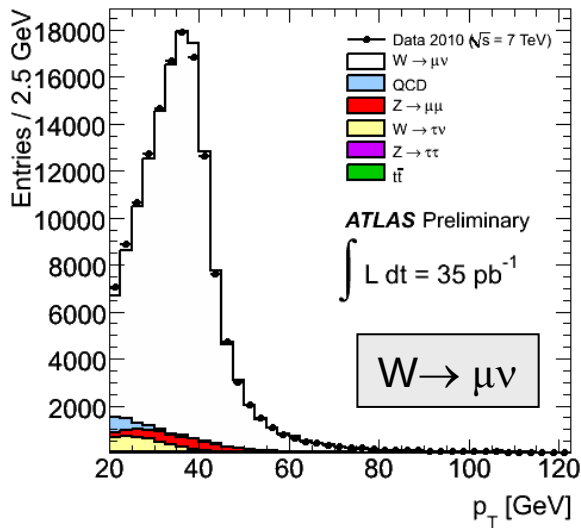
Rediscovery of the Standard Model: Di-Muon Resonances



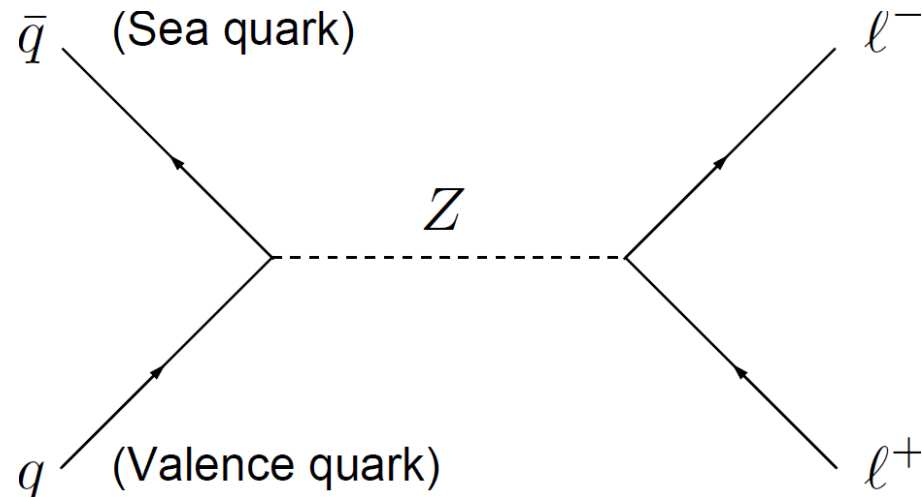
Electroweak Gauge Boson Production



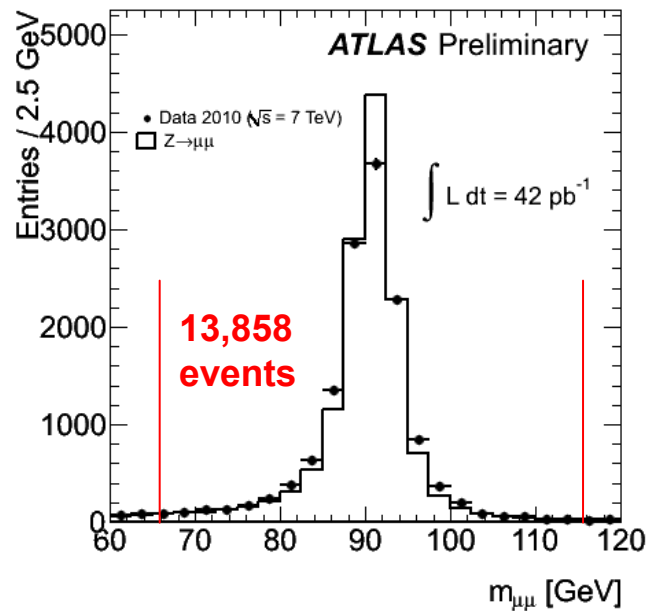
Observation of W, Z production already with $L_{\text{int}} = 6.4 \text{ nb}^{-1}$



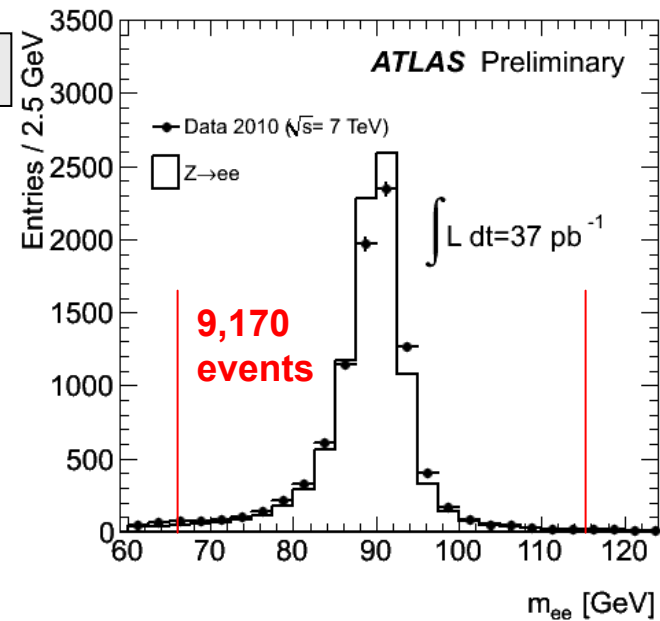
Electroweak Gauge Bosons



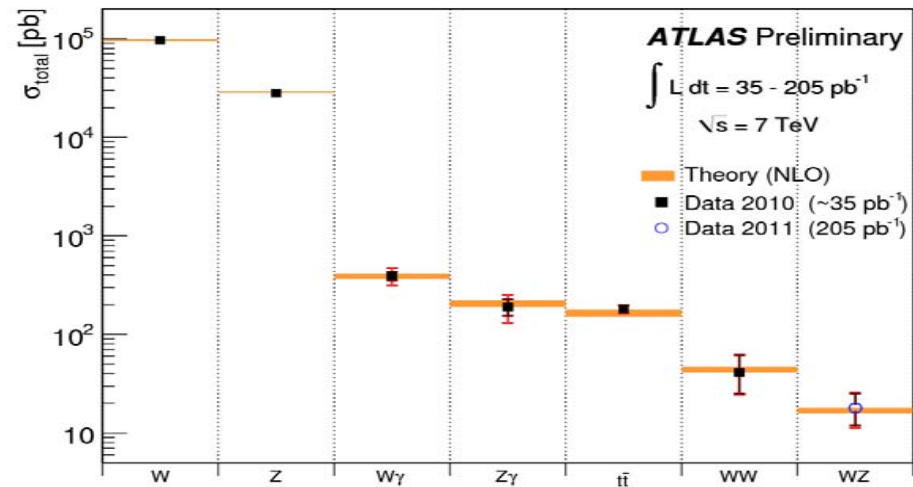
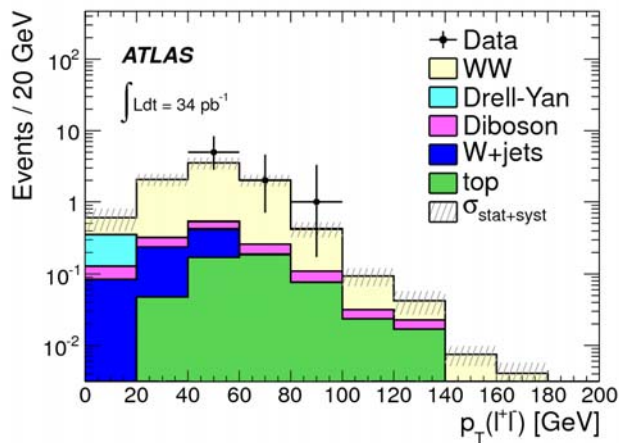
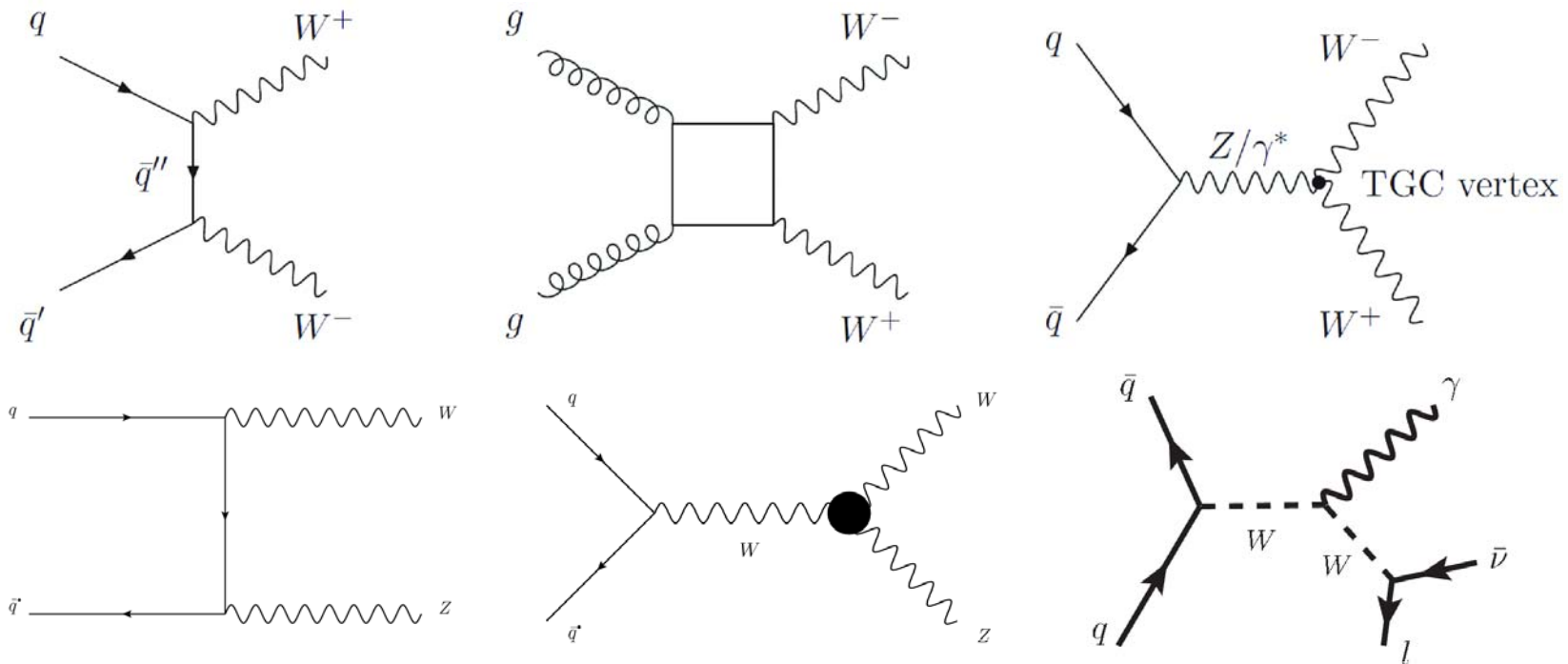
$Z \rightarrow \mu\mu$



$Z \rightarrow ee$



Gauge Boson Pair Production

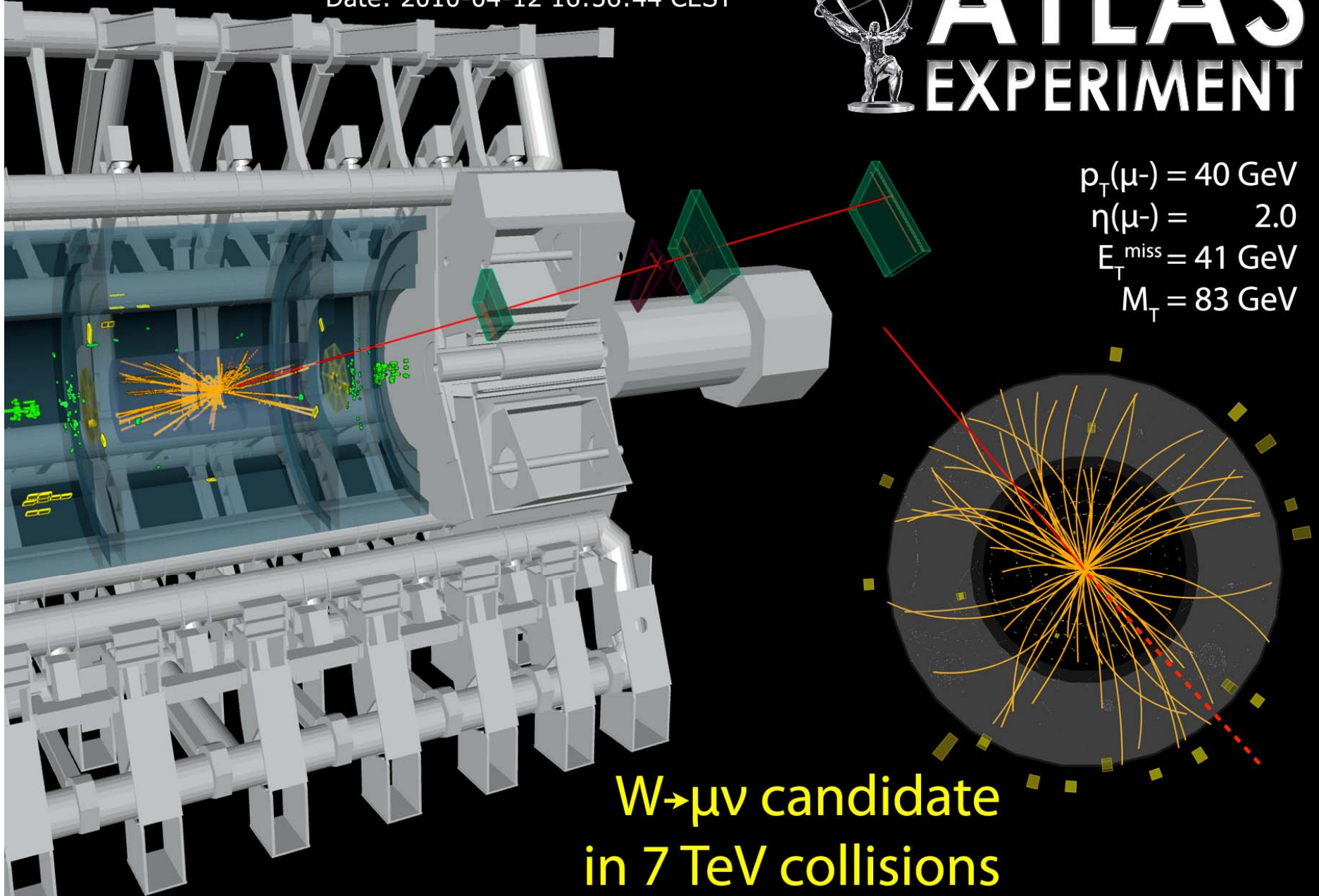


Run: 152845, Event: 3338173
Date: 2010-04-12 16:56:44 CEST



ATLAS EXPERIMENT

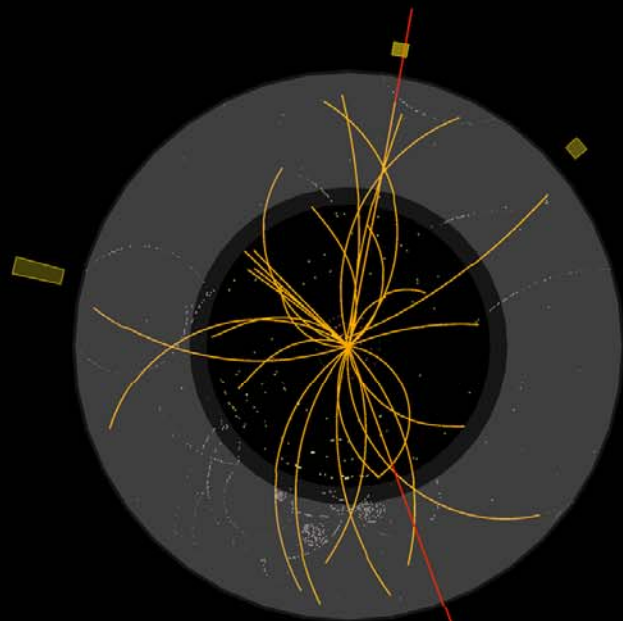
$p_T(\mu^-) = 40 \text{ GeV}$
 $\eta(\mu^-) = 2.0$
 $E_T^{\text{miss}} = 41 \text{ GeV}$
 $M_T = 83 \text{ GeV}$



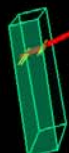


ATLAS EXPERIMENT

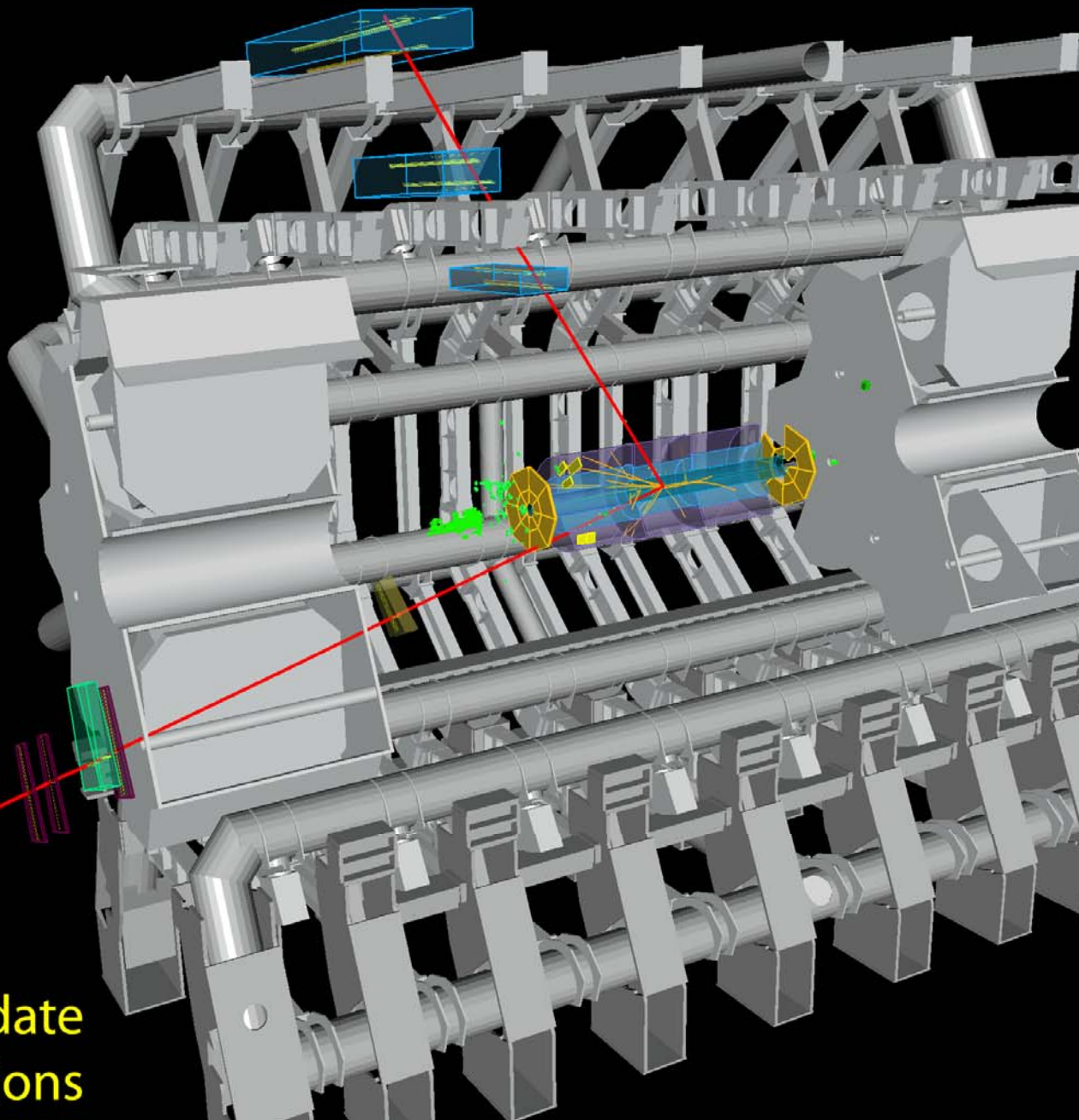
Run: 154822, Event: 14321500
Date: 2010-05-10 02:07:22 CEST



$$\begin{aligned} p_T(\mu^-) &= 27 \text{ GeV} & \eta(\mu^-) &= 0.7 \\ p_T(\mu^+) &= 45 \text{ GeV} & \eta(\mu^+) &= 2.2 \\ M_{\mu\mu} &= 87 \text{ GeV} \end{aligned}$$

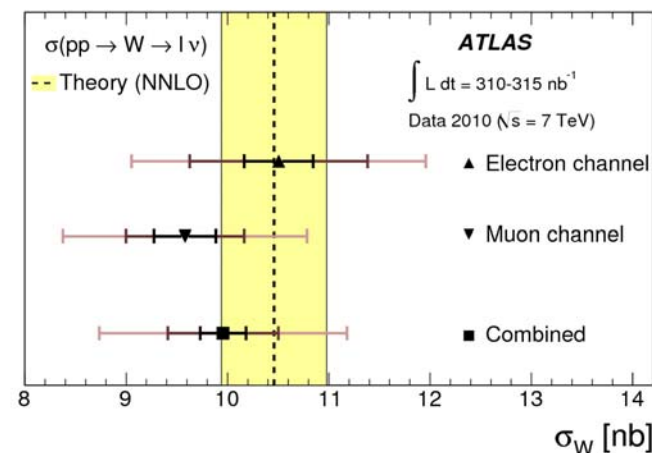
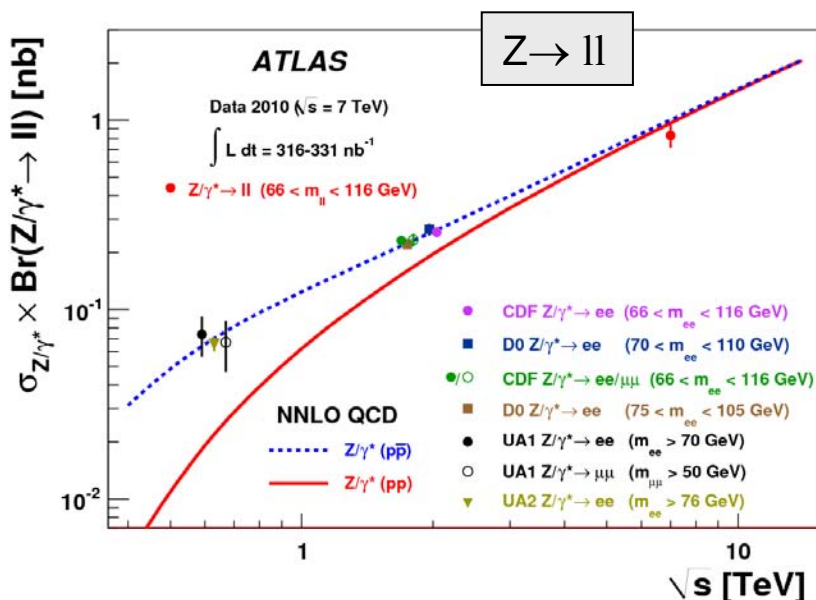
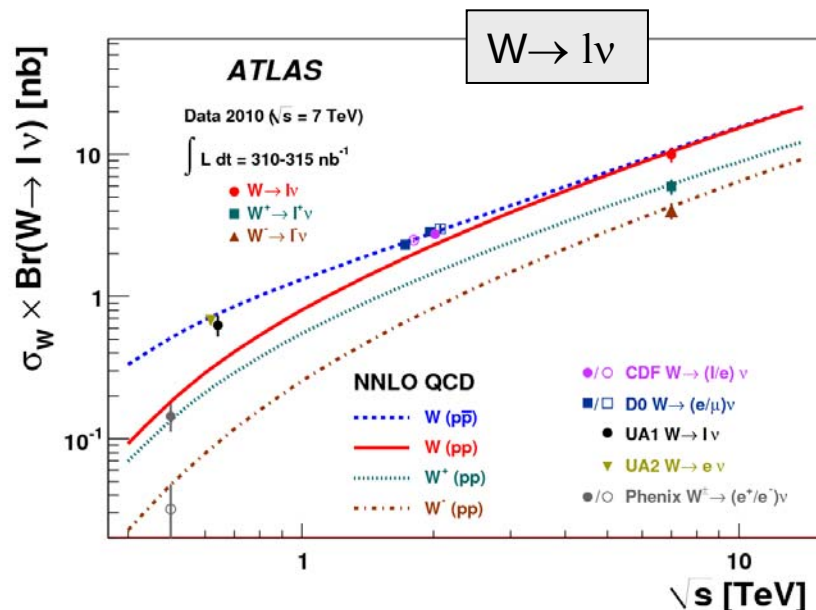


**$Z \rightarrow \mu\mu$ candidate
in 7 TeV collisions**

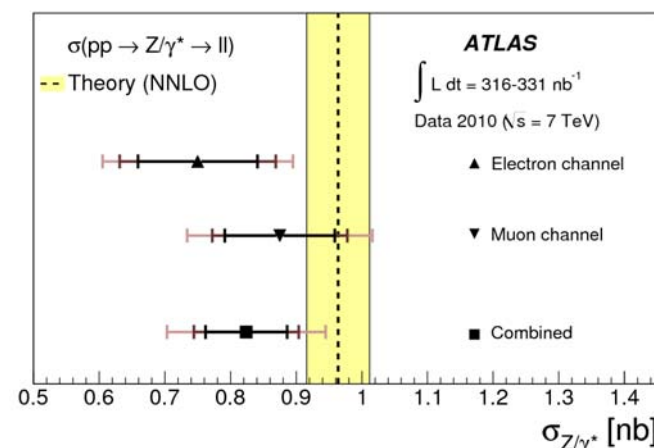


Electroweak Gauge Bosons

W, Z prod. cross section measurement,
good agreement with SM NNLO prediction



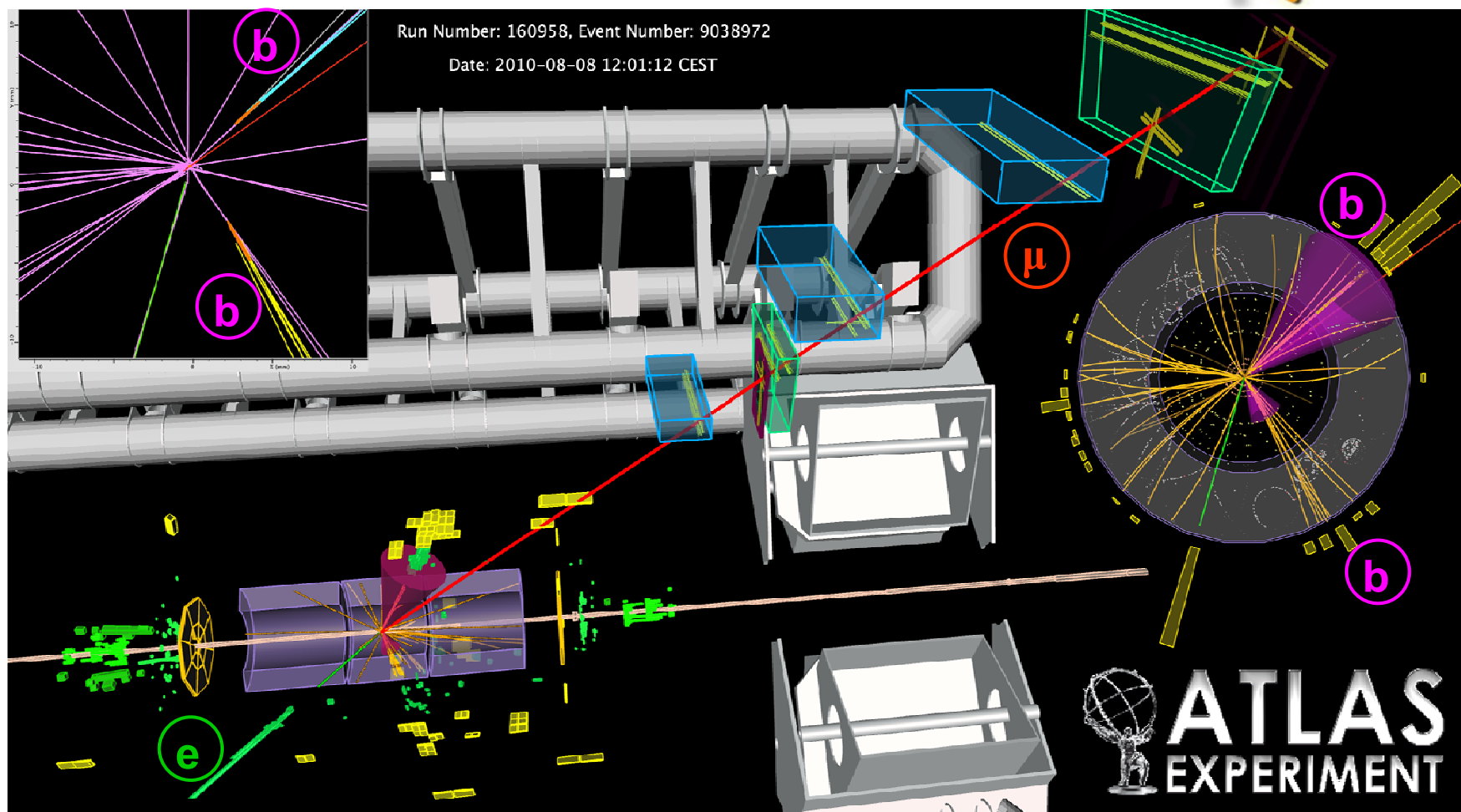
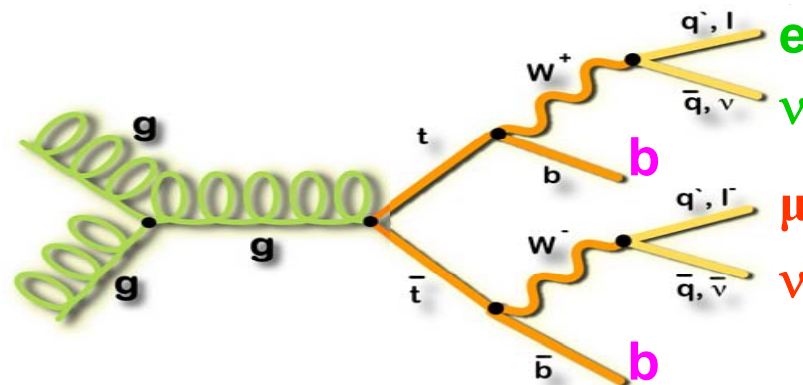
$$\sigma_W \times \text{Br}(W \rightarrow l\nu) = 9.96 \pm 0.23 \pm 0.50 \pm 1.10 \text{ nb}$$



$$\sigma_{\gamma/Z} \times \text{Br}(\gamma^*/Z \rightarrow ll) = 0.82 \pm 0.06 \pm 0.05 \pm 0.09 \text{ nb}$$

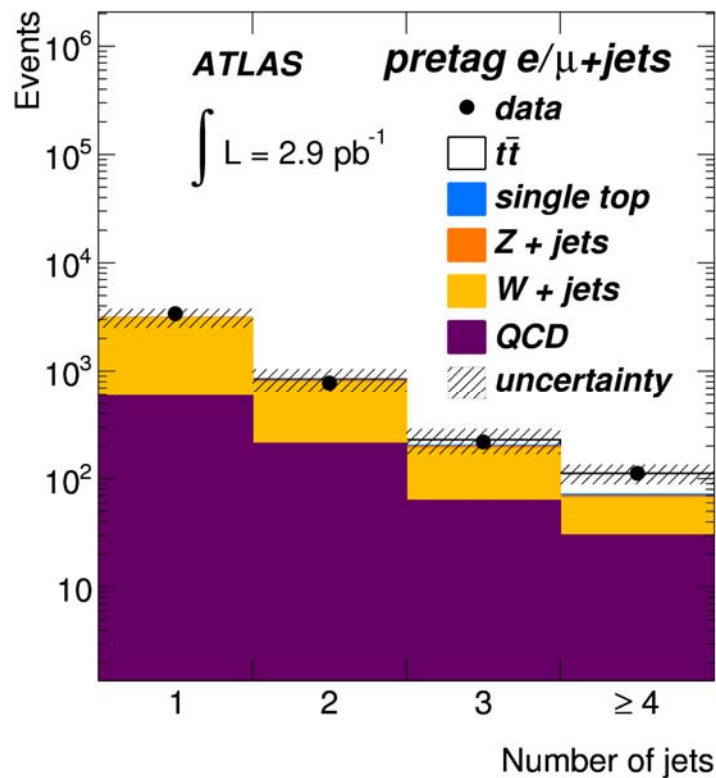
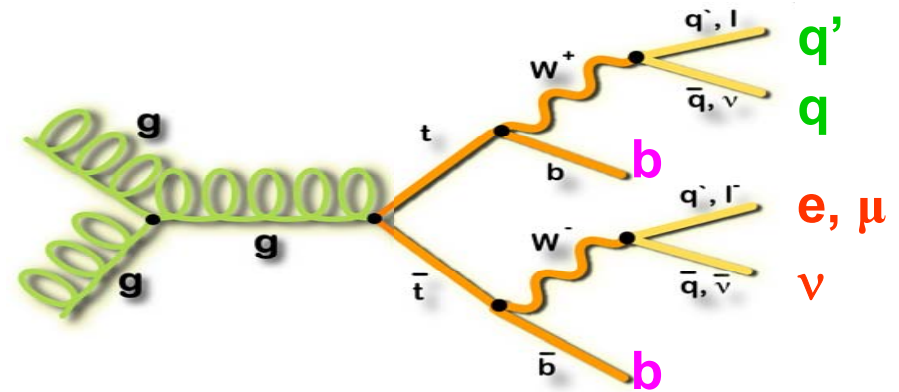
Top Quark Production

First top quark pair candidate events end of May 2010

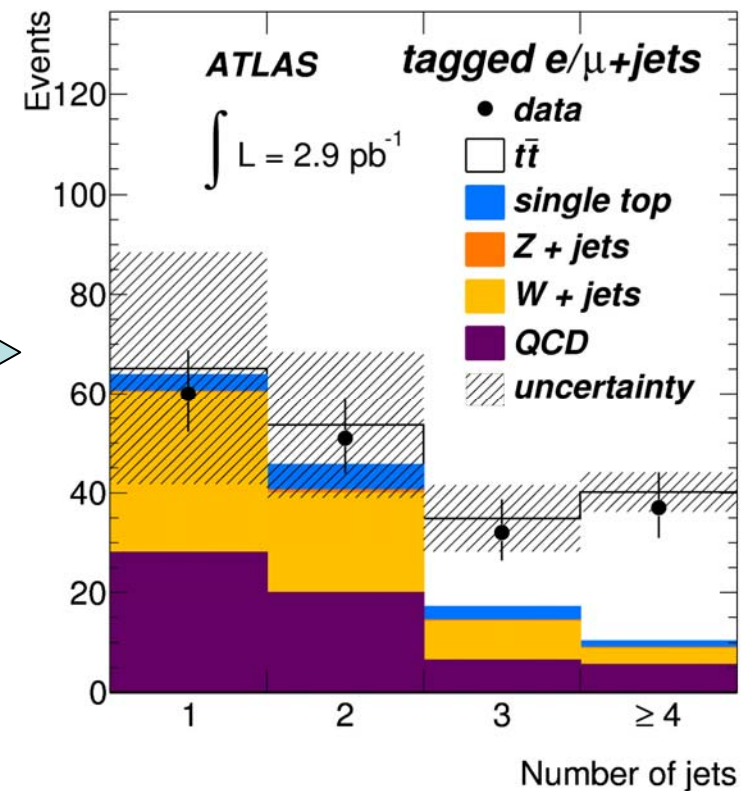


Top Quark Production

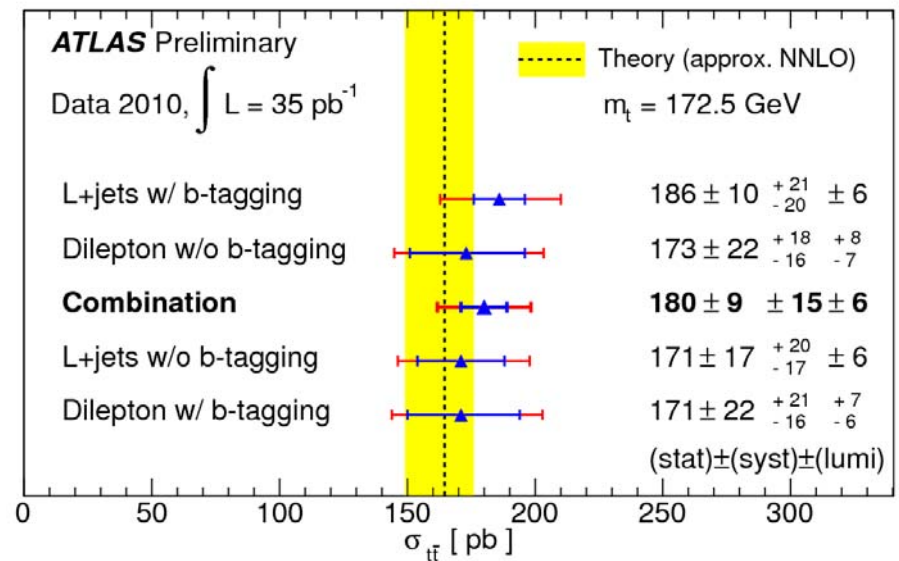
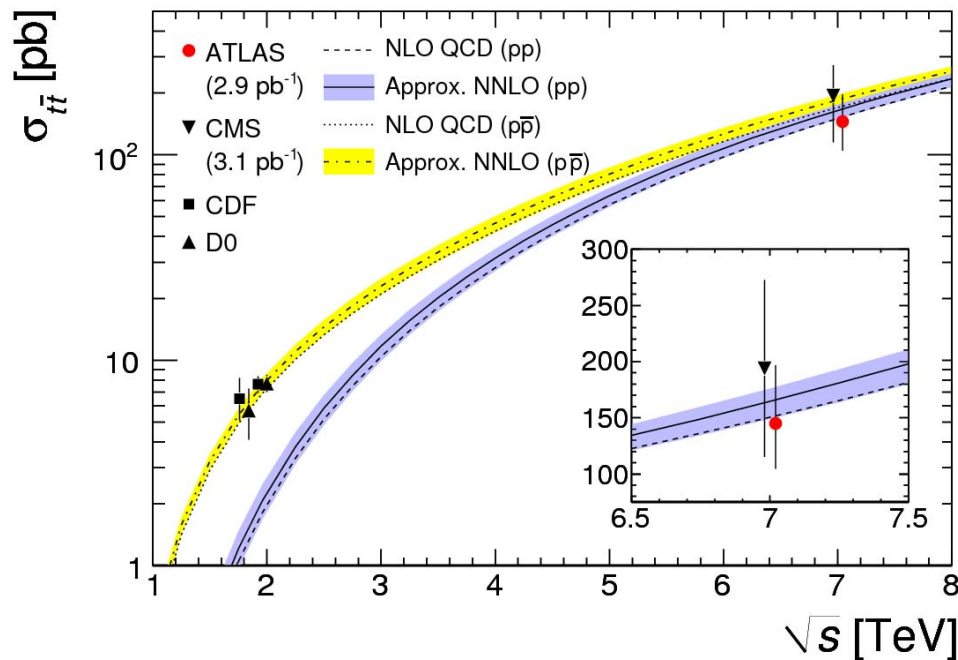
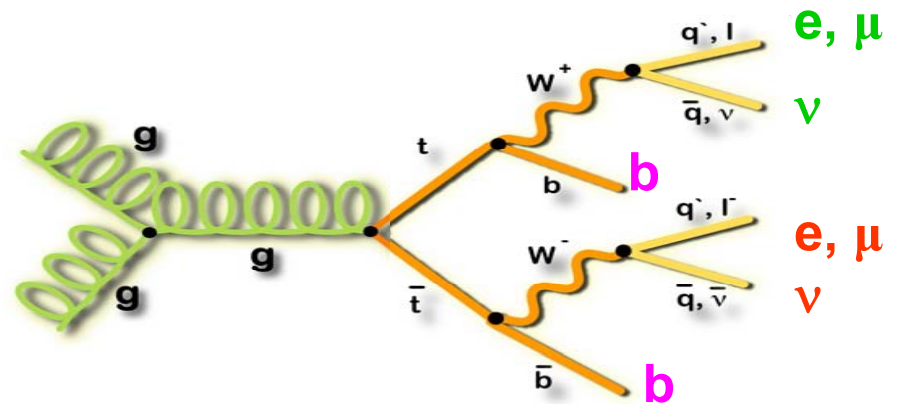
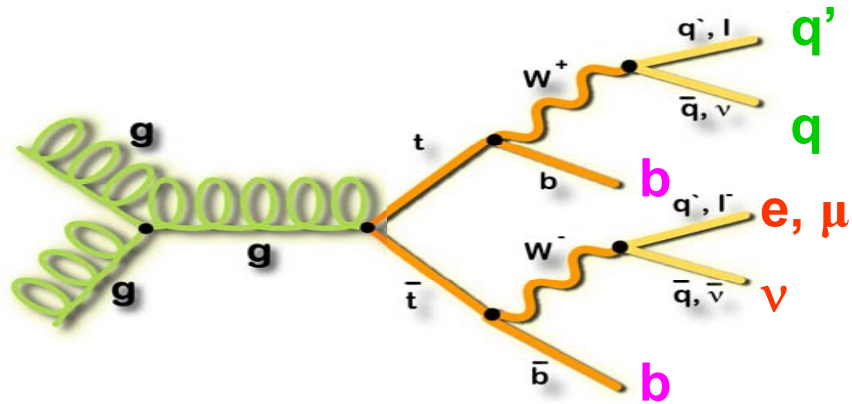
Search for $t\bar{t}$ events in lepton + jets
+ missing energy



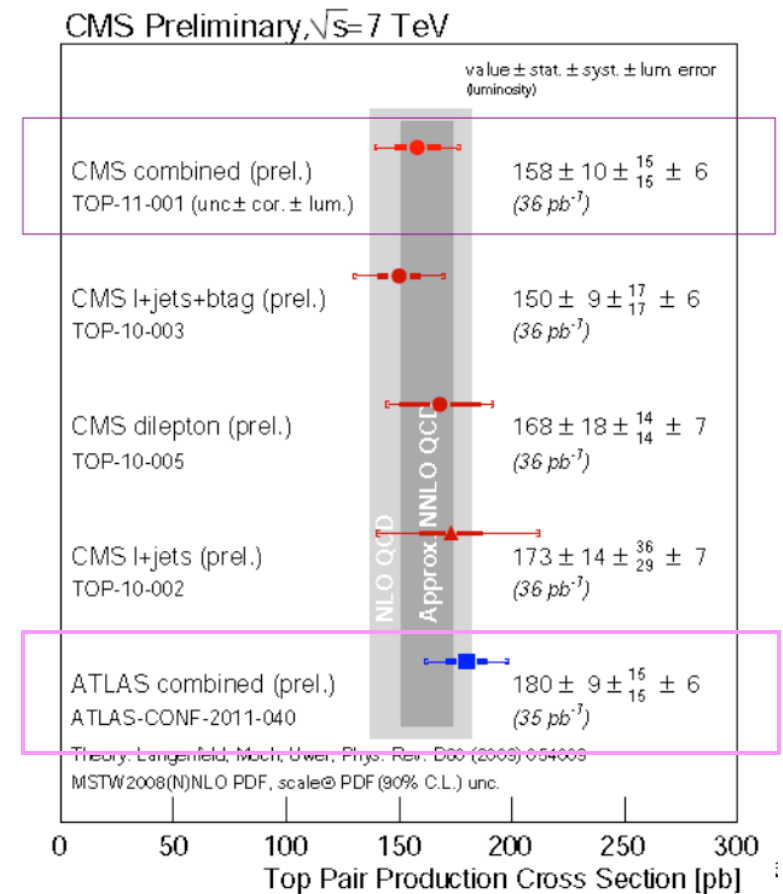
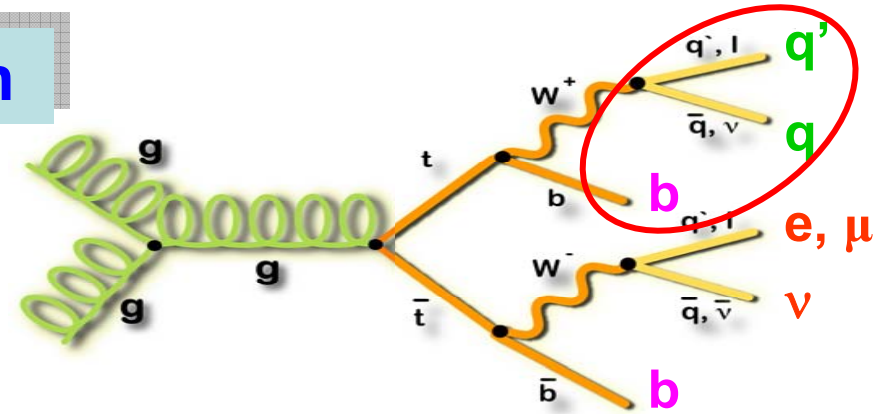
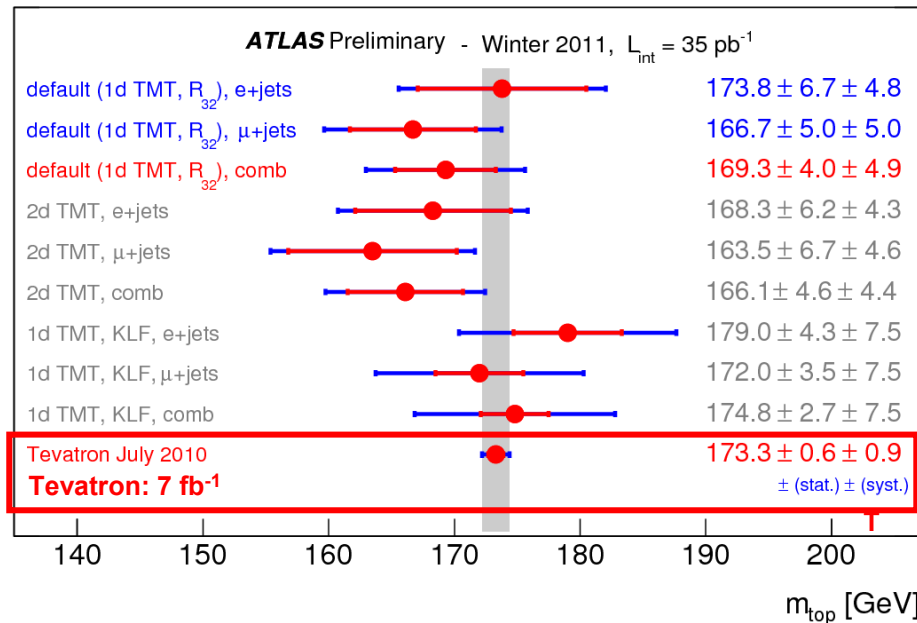
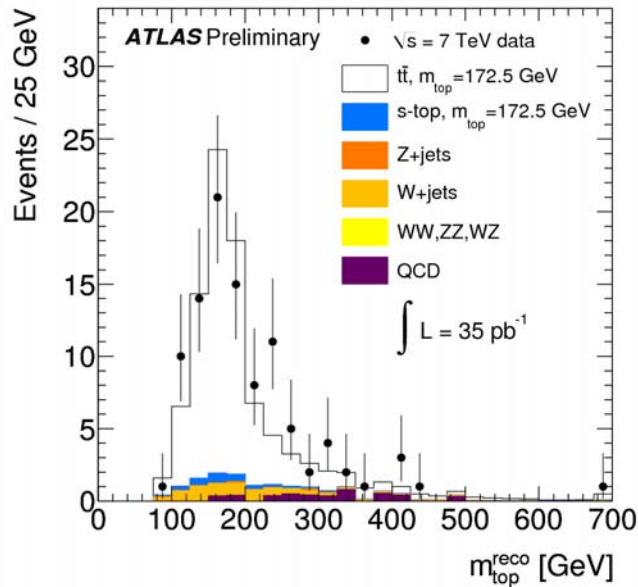
**b quark jet
identification:
b tagging**



Top Quark Production Cross Section

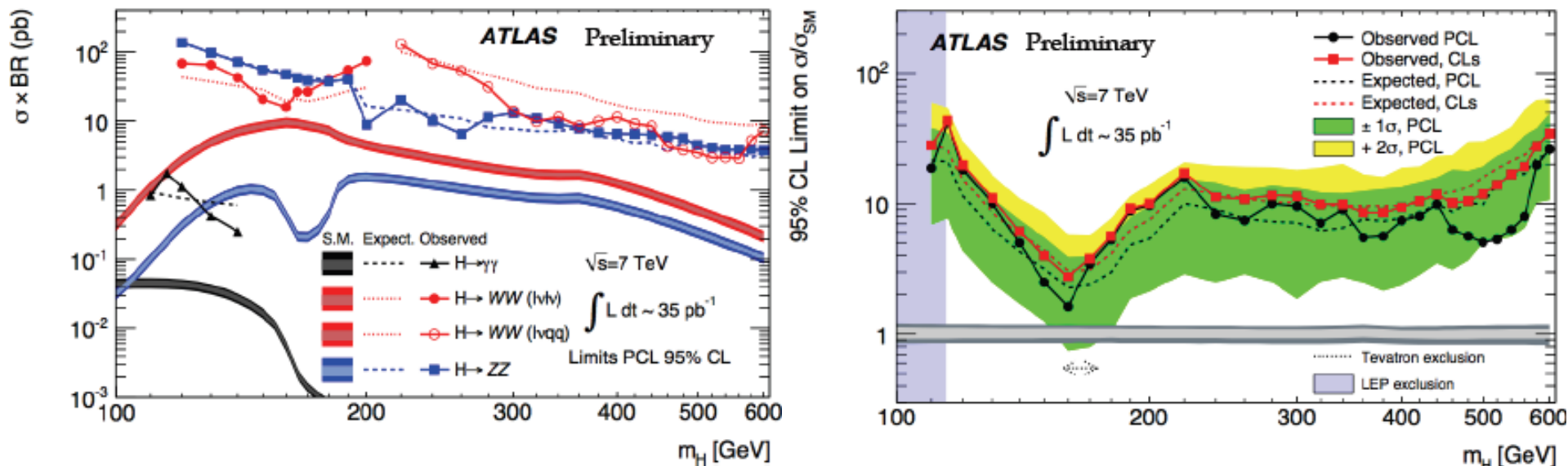


Top Quark Mass Reconstruction

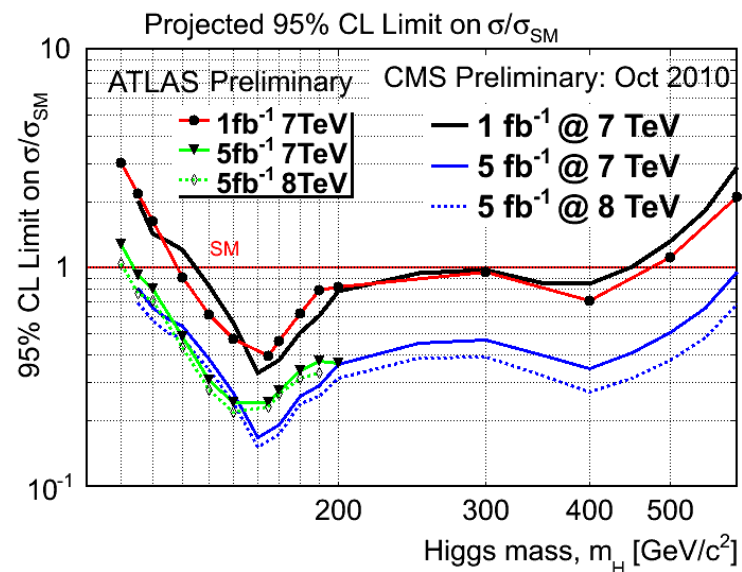


Higgs Boson Searches

Present status with the data from 2010:

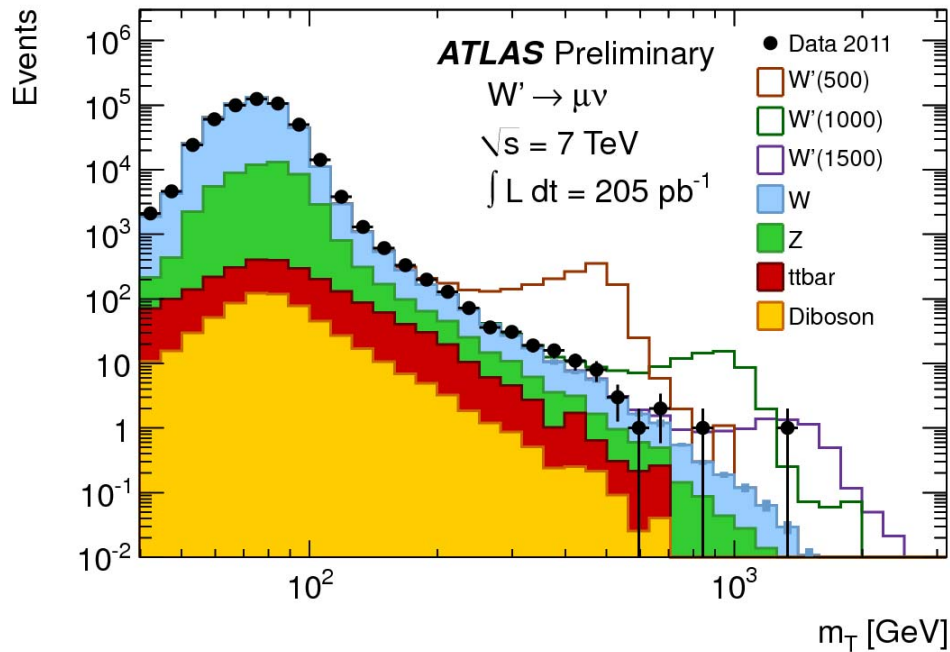


Prospects with data from 2011:

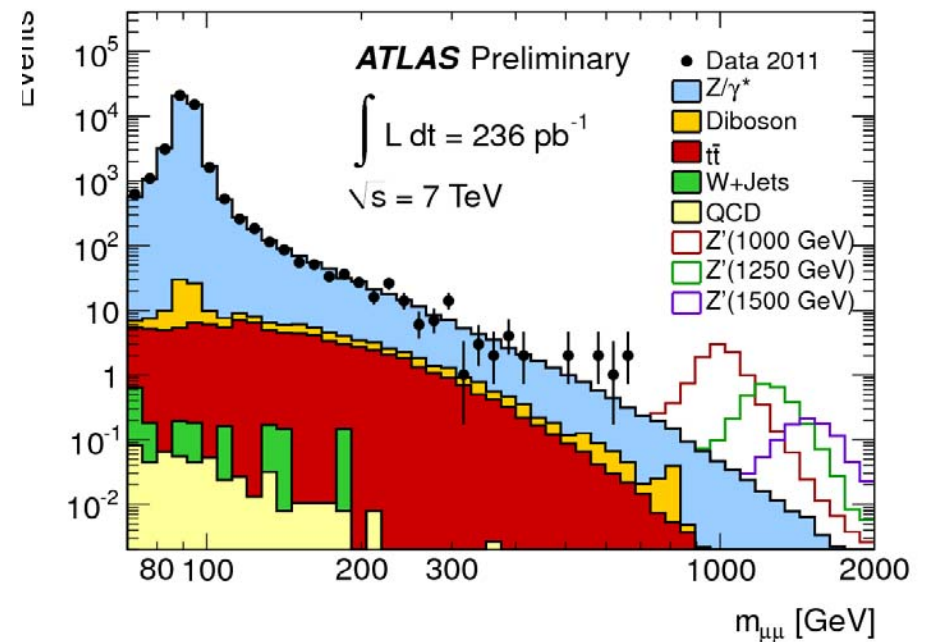


New Heavy Weak Gauge Bosons: W' , Z'

Assumption: same coupling strengths as SM gauge bosons



$M_{W'} > 1.7 \text{ TeV (95\% CL)}$

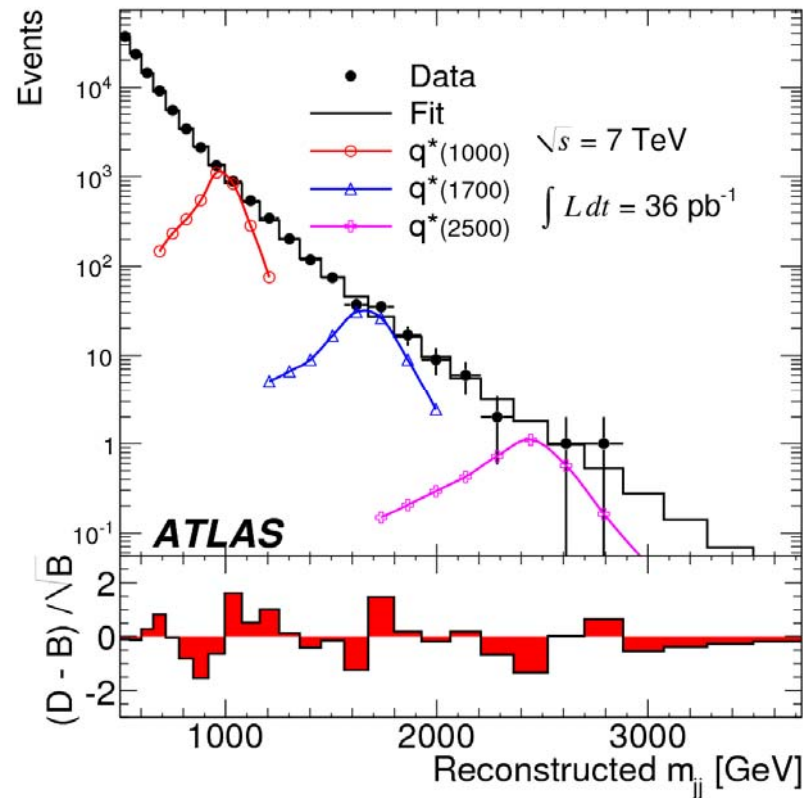


$M_{Z'} > 1.4 \text{ TeV (95\% CL)}$

Tevatron limits (D0: W' , CDF: Z'): 1 TeV (95% CL)

Substructure of Quarks:

- Excited Quark States $q^* \rightarrow qq'$
- New effective $qq' \rightarrow qq'$ “contact” interactions (Fermi 4-fermion interaction)



$M_{q^*} > 2.6 \text{ TeV (95\% CL)}$

Excited quark mass

$\Lambda_c > 9.5 \text{ TeV (95\% CL)}$

Compositeness energy scale