Precise Electroweak Tests at LHC

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- Introduction
  - Precise W Mass Measurement
  - Precise Top Mass Measurements
  - Single Top Production
  - Triple gauge boson couplings (TGC)
  - Conclusions

Introduction

- First collisions at 14TeV center-of-mass energy will start in 2007.
- First 3 years with low luminosity: $2x10^{33}cm^{-2}s^{-1}$. 100 days of running corresponds to an integrated luminosity of $10fb^{-1}$. Reduced pile-up.
- ATLAS is a general purpose experiment and has many physical goals. It is possible to realize various studies:

  QCD processes
  Electroweak physics
  B-Physics
  Precision tests of the SM
  Higgs bosons
  Supersymmetry
  Beyond the SM Physics
  Heavy Ions
  Cosmic rays,
  etc .

Detailed description given by Neil Jackson (LISHEP 2006)

W Mass Measurement

Motivation:

SM m_W is related to other SM fundamental parameters

$$m_W^2 = \left(\frac{\pi \alpha}{G_F \sqrt{2}} \right) \frac{(1+\Delta r)}{\sin^2 \theta_W}$$

where

α *is the structure constante*

G_F *is the Fermi constante*

θ_W *is the Weinberg angle*

$\Delta r(m_t^2, \log(m_h))$ *is the radiative corrections*

Precise measurements of m_W and m_t will provide consistent check of m_h

There will be ca. 10^8 $W \rightarrow e\ \nu$ events

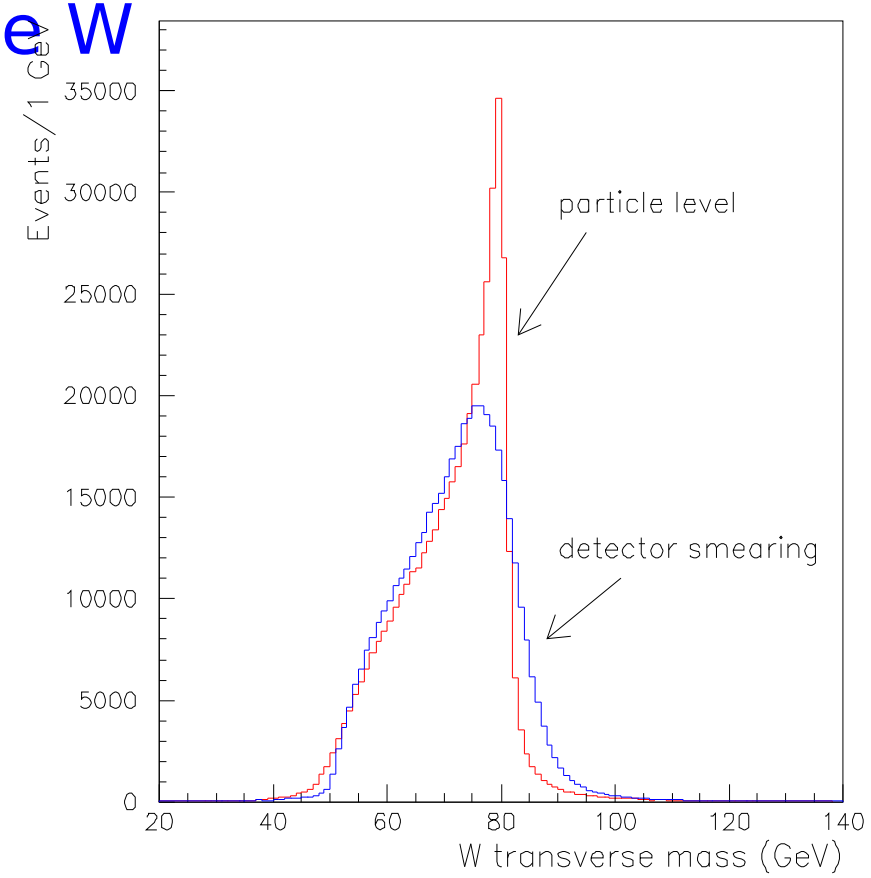
W Mass Measurement

Measurement:

- Envisaged decay is W→lν, where l=e,μ
- It will corresponds to 3 x 10^8 events/ year (Low Lum.)
- Selection single isolated charged lepton with $|\eta|<$ 2.4
- The W mass is extracted from the W transverse mass distribution

$$m_T^W = \sqrt{2\, p_T^l\, p_T^\nu \left(1 \;\; \cos\Delta\phi\right)}$$

The W mass is obtained by fitting to samples generated using different input values of m_W



W Mass Measurement

Expected precision:

- 60 M Ws reconstructed /year

Source	Δm_W
• Statistics	< 2 MeV
• W width	< 7 MeV
• PDFs	< 10 MeV
• Recoil Modelling	< 5 MeV
• Radiatvie Decays	< 10 MeV
• W P_T spectrum	< 5 MeV
• Background undestanding	< 5 MeV
• Lepton identification	< 5 MeV
• Lepton E-p scale	< 15 MeV
• Lepton E-p resolution	< 5 MeV
• Total	< 25 Mev
• Total CMS+ATLAS	< 15 MeV

Top Mass Measurement

Motivation:

- m_t and m_W precise measurements provide a consistent check of the SM Higgs mass, as mentioned before.
- Expected 8 10^6 t t-bar events/year (Low luminosity)

Measurement

- gg → t tbar 90%
- qq ➡ t tbar 10%

- t → b W (Dominant)

The t tbar events can be classified into three channels, depending on the W decay mode:

- Lepton plus jets (30%, considering electrons and muons only)
- Dilepton (5%)
- Full hadronic (44%)

Top Mass Measurement

Measurement(cont.)

Let us consider the lepton + hadrons channel.
It will provide a large and clean sample of ttbar events.

The main background for this channel:

Process	Cross-section
Signal	205 pb
bbbar → $l\nu$+jets	2.2 10^6 pb
W+jets → $l\nu$+jets	7.8 10^3 pb
Z+jets → l^+l^-+jets	1.2 10^3 pb
WW → $l\nu$+jets	17.1 pb
WZ → $l\nu$+jets	3.4 pb
ZZ → l^+l^-+jets	9.2 pb

And before selection s/b ≈ 10^{-4}

Top Mass Measurement

Measurement(cont.)

Selection criteria:

Applied to Leptons(e and muons)

PT > 20 GeV/c and $|\eta|< 2.5$

ET > 20 GeV/c

Apllied to Jets:

4 jets with PT > 40 GeV/c , $|\eta|< 2.5$

Two of them tagged as b-jets

ΔR= 0.4 Jet definition

S/B = 30

64k events

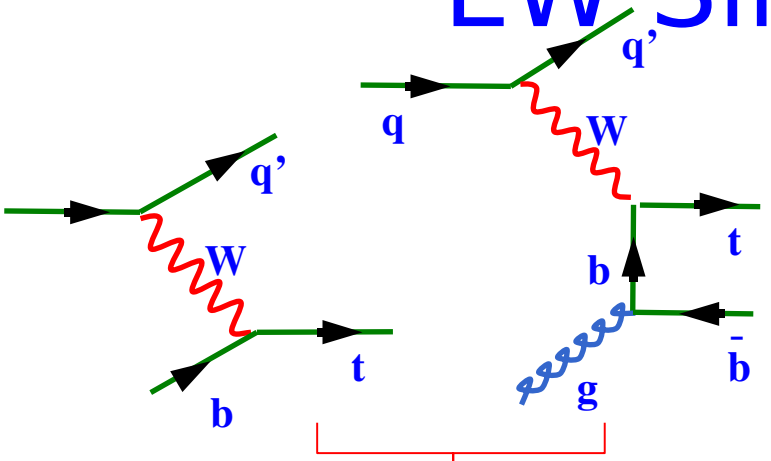
Statistical error 0.1 GeV/c^2

Top Mass Measurement

Measurement(cont.)

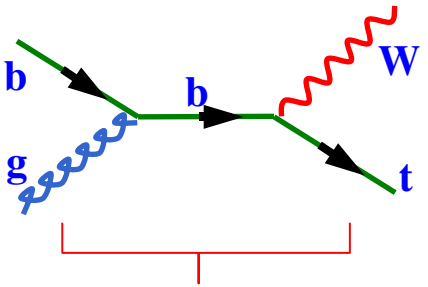
Source	Δm_t(GeV)
Statistics	0.1
b fragmentation	0.1
ISRadiation	0.1
FSRadiation	1.0
Background	0.1
Light quark jet energy scale calibration	0.2
b-quark jet energy scale calibration	0.7
TOTAL	1.2

EW Single Top Production



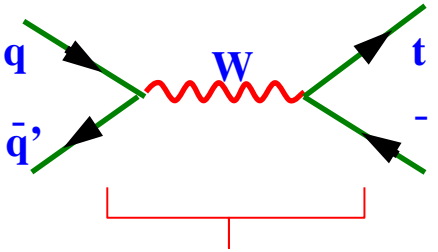
W-gluon fusion

σ_{wg} ~ 250 nb



Wt process

σ_{Wt}~ 60 pb



W* process

σ_{W^*}~ 10 pb

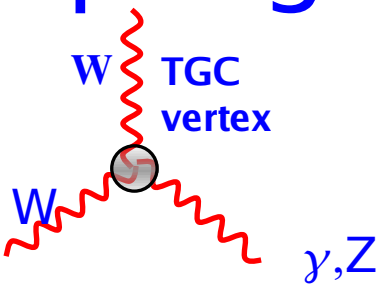
(lower theoretical uncertainties!)

- **Probe the t-W-b Vertex**
- **Directly measurement of the CKM matrix element V_{tb}**
- **Source of high ploarized tops.**
- **Discovery of New Physics, New Ws**
  - **e.g. the LHM enhances the single op production.**
- **Background: tt(833pb), Wbb(300nb, Wjj(18000nb)**
- **After selection: W-g(26800±1000), Backg(8720±1800)**

LHC will be capable of extend the Fermilab measurements.

Triple gauge boson coupling

- **It provides a direct test of the Non-Abelian strucure of the SM.**
- **New physics: deviations from SM**



- **This sector of the SM is often described by 5 parameters:**

g_1^Z, κ_γ, κ_Z, λ_γ **and** λ_γ.

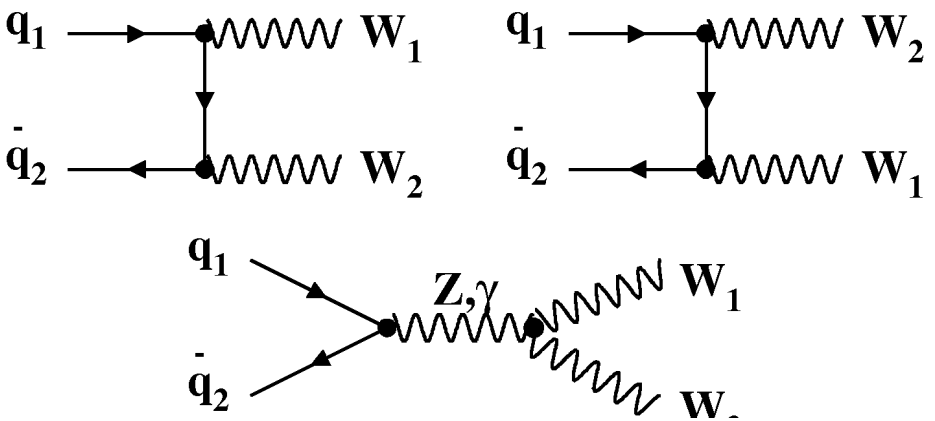
- **SM values at tree level are equal to**

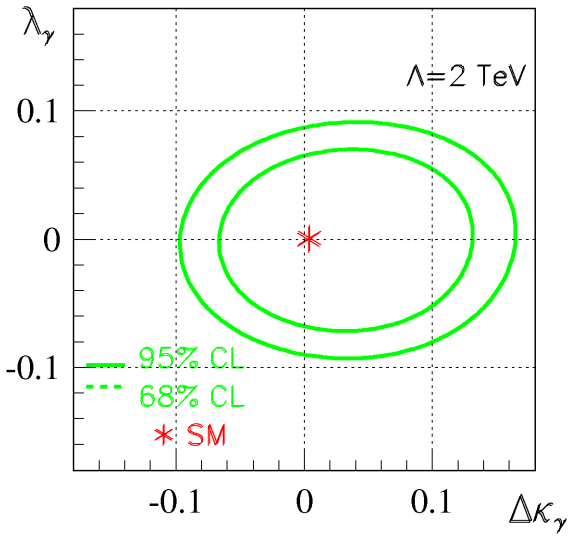
$g_1^Z = \kappa_\gamma = \kappa_Z = 1$ **and** $\lambda_\gamma = \lambda_\gamma = 0$

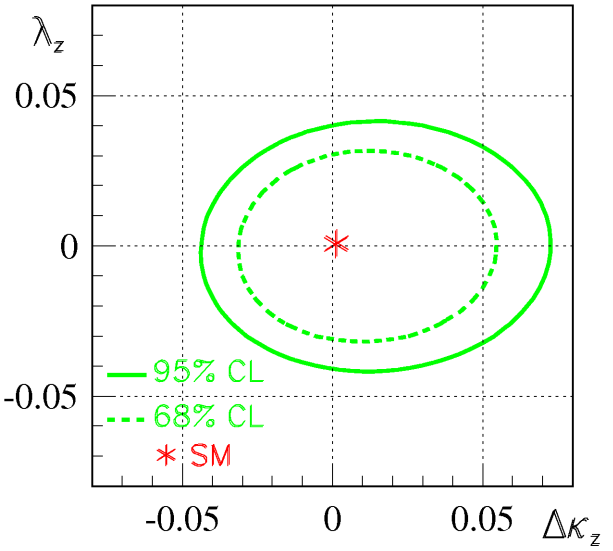
- **Anomalous contribution to TGC is enhanced at high √s (increase of production cross-section).**

Measuring triple gauge boson coupling in WW production

- Luminosity: 30 fb^{-1}







CONCLUSIONS

- ATLAS: valuable precision measurements of SM parameters;
- W mass can be measured with a precision of 15 MeV (combinnig e/μ and ATLAS + CMS);
- Top mass: ~ 1.2 GeV
- Indirect Higgs mass: ~ 18% at 115 GeV;
- EW single top production: direct measurement of V_{tb};
- Sensitivity to anomalous TGC's: indicative of new physics!
- TCG parameters:

$$\Delta k_z,\ \lambda_z \approx 0.03\text{-}0.07 \quad \text{at 95\% C.L.}$$

$$\Delta k_\gamma,\ \lambda_\gamma \approx 0.06\text{-}0.14 \quad \text{at 95\% C.L.}$$