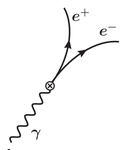
Properties of the Higgs boson in the two photon decay channel.

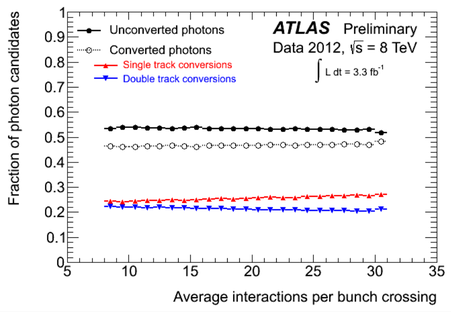
Matter & Universe – Fundamental Particles and Forces

Photon conversions



- Sizable amount of material in front of the calorimeter
- Photons convert to electron-positron pairs in tracker material
- Reconstruction of conversion vertices in tracker important for
- Optimal calibration of converted and unconverted photons
- Dedicated identification criteria for converted and unconverted photons

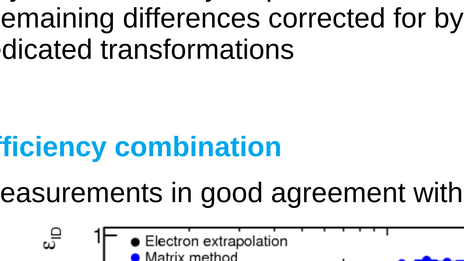
Reconstruction robust with number of proton-proton collisions per bunch-crossing (pile-up) during 2012 data-taking



Photon conversions reconstructed from tracks and electromagnetic clusters

Photon identification

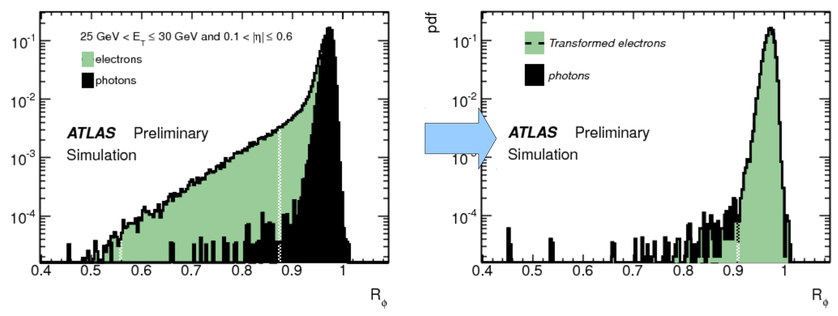
Discrimination of photons from hadronic background based on shower shapes in EM calorimeter



- Width of cluster allows to separate photons from hadronic jets
- Substructure of shower using the finely segmented first calorimeter layer allows to separate photons from hadronic jets with leading π^0
- $H \to \gamma\gamma$ analysis needs jet rejection of ~10^4 to be dominated by background from real photons
- Photon identification combines shower shape cuts sequentially (8 TeV data) or with a neural network (7 TeV data)

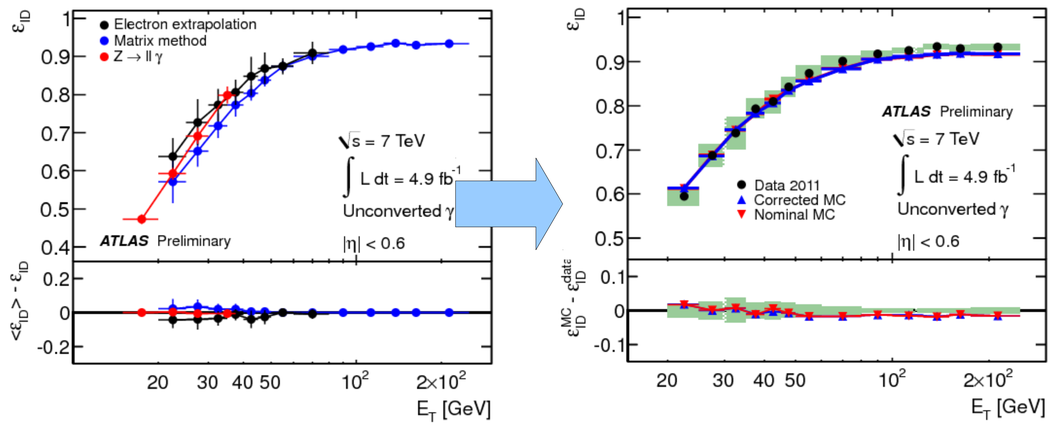
Efficiency extrapolation from $Z \to ee$

- Can select a very pure sample of electrons from $Z \to ee$ decays without biasing shower shapes
- Shower shapes of photons and electrons very similar in many respects
- Remaining differences corrected for by dedicated transformations



Efficiency combination

Measurements in good agreement with results from 2 other methods and combined



Uncertainties range from ~5% at low E_T to ~1-2% at higher E_T

Impact on $H \to \gamma\gamma$ analysis

Composition of the sample selected for $H \to \gamma\gamma$

γγ	75±3%
γ+jet and jet+γ	22±2%
jet+jet	2.6±0.5%

Id efficiency uncertainty on expected number of signal events

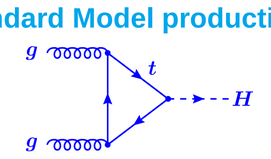
ICHEP 2012	10.8%
Council 2012	5.3%
Moriond 2013	2.4%

- Second-largest experimental uncertainty on the measured inclusive signal strength

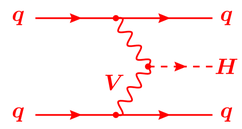
Properties of the Standard Model Higgs boson

Standard Model predicts production cross sections and decay branching fractions of the Higgs boson (for a given mass m_H)

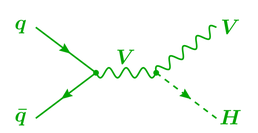
Standard Model production modes



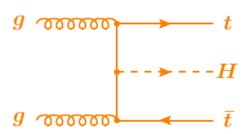
Gluon fusion 88% (ggF)



Vector-boson fusion 7.3% (VBF)



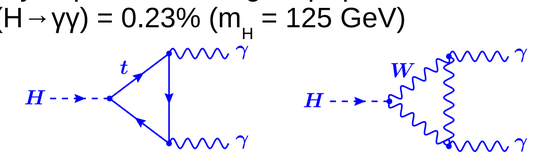
Production with vector bosons 4.2% (VH)



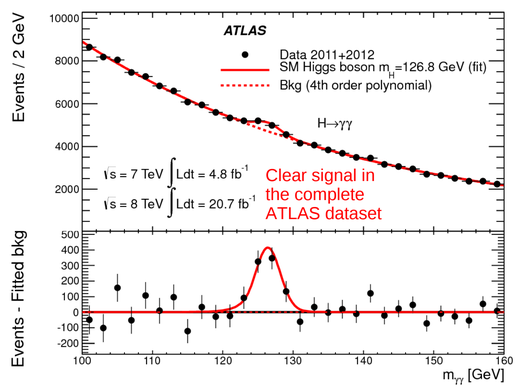
Production with top quarks 0.5%

Higgs boson decay to two photons

- Decay to photons through top-quark and W-boson loop
- BR($H \to \gamma\gamma$) = 0.23% (m_H = 125 GeV)



July 2012: Higgs boson discovery



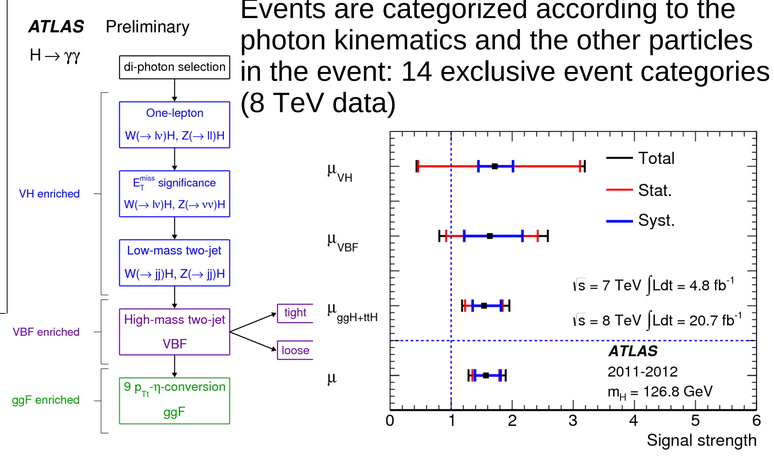
Production modes and couplings

Signal strength: $\mu = \frac{N_{observed}}{N_{SM\,Higgs}}$ = 0: background only; = 1: SM Higgs boson

Inclusive measurement in $H \to \gamma\gamma$ consistent with the SM predicition within 1.9σ:

$\mu = 1.55\ ^{+0.33}_{-0.28}$

Measurement of signal strength for different production modes in $H \to \gamma\gamma$

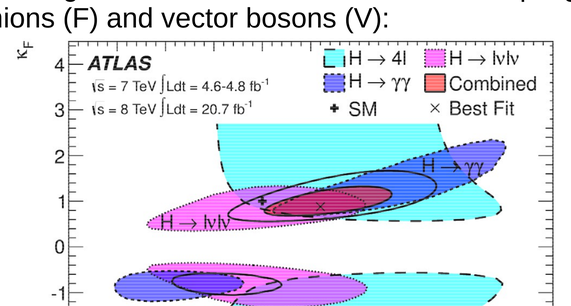


Events are categorized according to the photon kinematics and the other particles in the event: 14 exclusive event categories (8 TeV data)

Measurements in agreement with Standard Model predictions.

Coupling measurements from combination with other decay channels

Measuring effective scale factors κ for the coupling to fermions (F) and vector bosons (V):

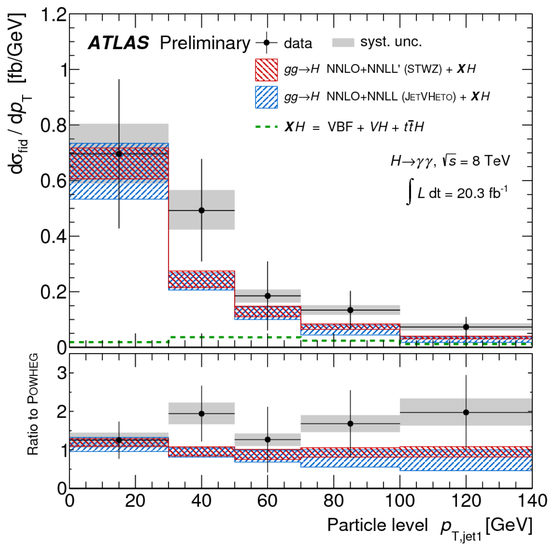


In agreement with SM prediction κ=1.

Differential cross-sections

First measurements of Higgs boson differential cross sections: studying production and decay kinematics

- High signal efficiency makes $H \to \gamma\gamma$ well suited for these measurements
- Higgs boson studies evolved from searches for a new particle to measurements of its properties within less than one year



Connection to DESY theory group: STWZ calculation

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