Study of W gamma gamma tri-boson production
in proton-proton collisions with the ATLAS detector

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Introduction

- Standard Model precision measurement of **pp → W(lν) γγ** , with l=e,μ.
- Aim for first **5σ observation** using the 139 fb^{-1} of data recorded by **ATLAS from 2015 to 2018 at s = √13 TeV.**
- Previous analysis of 8TeV data results with 2.8σ [1][2].
- Process sensitive to aQGCs : will et limits on dim. 8 EFT parameters.

Analysis selection cuts:

- 2 isolated photons, pT > 25 GeV
- Exactly 1 lepton, pT > 25 GeV
- Missing transverse energy MET > 25 GeV
- Z veto
- No b-jets
- M_{TW} > 40GeV

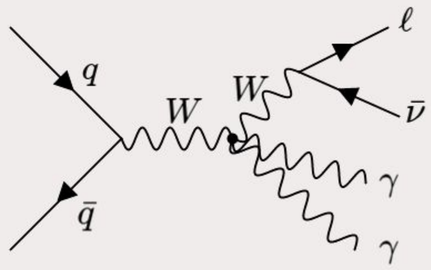


Fig. 1: Feynman diagram of the WWγγ quartic gauge coupling contribution to pp → W(lν)γγ.

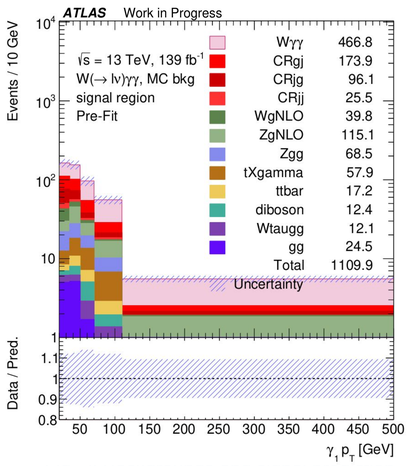


Fig. 2: Backgrounds and signal prediction in the signal region.

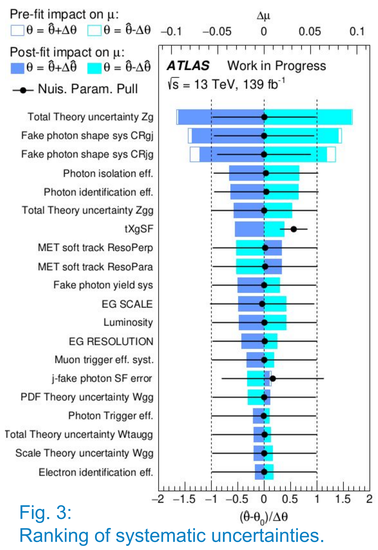


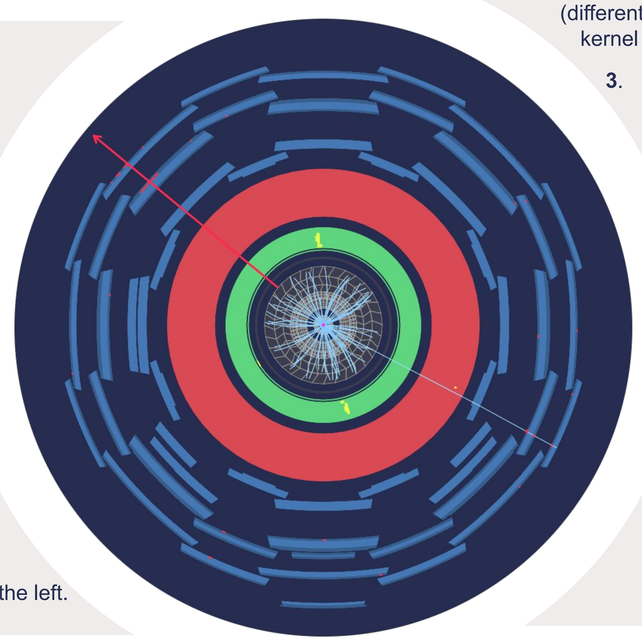
Fig. 3:
Ranking of systematic uncertainties.

Backgrounds

Many processes contribute to the Wγγ background, some are modelled well enough to be estimated by **Monte Carlo simulations** (MC), other require **data-driven approaches.**

- Hadronic jets **mis-identified as photons** constitute the main background. (see right section)
- Hadronic jets can also be **mis-identified as leptons**. They are estimated using a fake factor method.
- Pile-up estimation is also data driven and leptons mis-identified as photons is normalised using data.
- Other backgrounds including Zγγ, ttbar, diboson and W(τν)γγ are estimated **from MC.**

The background distributions as a function of leading photon transverse momentum is shown on the left.



Jets faking photons

Jets faking photons are the largest background in this analysis. Fake photons are poorly modeled by Monte Carlo, therefore this background is estimated using a **data-driven 2D Template fit method** [3].

Background subdivided in **3 categories**: subleading fake **gj**, leading fake **jg,** both fake **jj.**

Template generation

Using photon isolation energy (E_{iso}) as discriminating variable.

1. Define E_{iso} **1D templates** in control regions (CR): for fakes losePrime4 not tight photons in data, real photons from MC.
2. Define **2D templates** by combining 1D templates (different for leading/sub-leading γ). The jj template iis a 2D kernel estimate.
3. Add the 2D templates, fit to extended signal region in data to obtain the **yields for each sub-background.**
4. **Differential cross-section** measurement: background shape in di-photon invariant mass (mγγ) extrapolated from the mγγ distributions in the different CR.
5. **Validation**: cross-check with ABCD estimation.

2D Template fit results

The blinded results yield in the signal region are:

gj fakes	174 ± 15 events
jg fakes	96 ± 8 events
jj fakes	25 ± 1 events

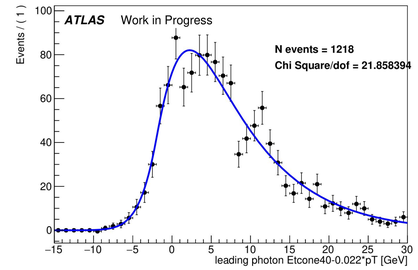


Fig. 4 : 1D Template for leading **fake** photon, Bukin function used.

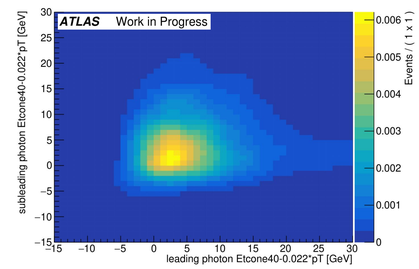


Fig. 5: 2D template of the jj background.

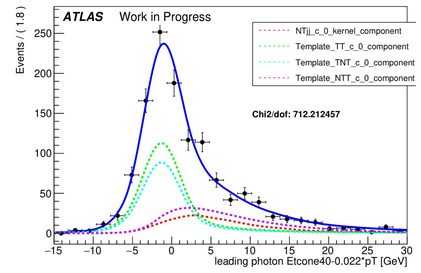


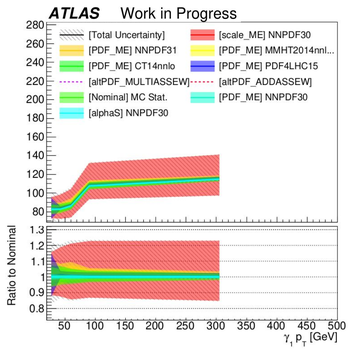
Fig. 6 : Projection of the final 2D fit results on the leading photon Esio.

Systematic uncertainties

The systematic uncertainties are separated into **three categories:** systematics on **data-driven backgrounds**, experimental uncertainties on the **event reconstruction** and **theoretical uncertainties** affecting the MC backgrounds and the signal process.

- Theory uncertainty on Zγ modelling dominant but will be reduced by normalising the background.
- Data driven estimate of fake photon shape is computed by comparing truth matched MC and data in the control regions. It is dominant.
- Reconstruction of photons and missing transverse energy are the third largest sources of uncertainty.
- Theoretical uncertainty on signal and MC background is computed for scale, PDF and αs variations.

Fig. 7 : Theoretical uncertainties on signal modelling.



Preliminary results

- Analysis is still **blinded** as the final cross checks are being computed.
- A **profile likelihood fit** is performed using the TRExFitter framework to extract the signal from data. The tt and tXγ backgrounds, are normalised in a data control region.
- The expected significance for the differential cross section is of:

σ = 4.52

- Deriving EFT constraints remains to be done.

[1] arXiv:1503.03243v2 [2] CDS:ATL-COM-PHYS-2013-910 [3] JHEP 01 (2011) 086

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