Introduction

- Standard Model precision measurement of $pp \to Wl\nu y\gamma$, with $l=e,\mu$.
- Aim for first 5σ observation using the 139 fb$^{-1}$ of data recorded by ATLAS from 2015 to 2018 at $\sqrt{s}=13$ TeV.
- Previous analysis of 8TeV data results with 2.8σ [1][2].

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- $Z$ veto
- No b-jets
- $M_{T2}$ > 40 GeV

Analysis selection cuts:

- 2 isolated photons, $p_T > 25$ GeV
- Exactly 1 lepton, $p_T > 25$ GeV
- Missing transverse energy MET > 25 GeV

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

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 $gj$, 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 y). The $j$ template is 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 $(m_{\gamma\gamma})$, extrapolated from the $m_{\gamma\gamma}$ 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:

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

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 $Z$ modelling will but 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.
- Re-construction 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.

Preliminary results

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

$$\sigma = 4.52$$

- Deriving EFT constraints remains to be done.