Measurements of isolated prompt photons in pp collisions with the ATLAS detector

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This article summarizes the cross-section measurements of inclusive isolated photons and di-photon events at the LHC at $\sqrt{s} = 7\,\text{TeV}$ with the ATLAS detector [1]. These processes are important because they provide a colorless probe of the hard scattering process, can be used to constrain the PDFs, and are the background for new physics signatures like Higgs boson and graviton decay into two photons and others.

Two analyses for the inclusive isolated photon are presented with luminosities of $800\,\text{nb}^{-1}$ [2] and $35\,\text{pb}^{-1}$ [3], covering the photon transverse momentum p_T^γ region between 15 and 400 GeV. For the di-photon analysis [4], $37\,\text{pb}^{-1}$ are used with a cut at 16 GeV on p_T^γ. In all analyses a cut on the isolation energy, defined as the energy in a cone within $\Delta R = \sqrt{\Delta\eta^2 + \Delta\phi^2} < 0.4$ around the photon, of 4 GeV is applied and the acceptance region is $|\eta| < 2.37$, except $1.37 < |\eta| < 1.52$.

Photons are reconstructed from the energy deposited in the electromagnetic calorimeter (ECAL). The photon selection is based on the energy fraction leaking into the hadronic calorimeter, on the shower shape measured in the ECAL and on the presence of two maxima detected in the first layer of the ECAL. The efficiency is extracted from Monte Carlo simulations to be greater than 90% for a 50 GeV photons.

The QCD background is estimated with data-driven methods, based on the isolation energy E_T^{isol} measured by the ECAL, correcting the value for the residual photon energy leakage and for the underlying event and pile-up. The distribution for E_T^{isol} can be extracted directly from data, both for photons and for the background. The inclusive channel uses a 2D sideband method, based on three control regions, defined by photons not passing the E_T^{isol} or the selection cuts. For the di-photon channel every event has an associated weight, computed using the isolation energies of the two photons and the efficiencies and fake rate for the isolation cut. In both analyses the electron background is subtracted by applying the $e \to \gamma$ fake rate measured under the $Z \to ee$ peak. For the inclusive isolated photon the purity is $\sim 90\%$ and it is $\sim 62\%$ for the di-photon.

The unfolded final cross-sections (Fig. 1) are compared with NLO predictions. The isolated inclusive photons are compared with JETPHOX using CTEQ 6.6 PDFs. The agreement is good except for the region at small p_T (< 30 GeV) where the

contribution of the fragmentation component is important. Three differential cross-sections are produced for the di-photon as a function of the invariant mass of the two photons ($m_{\gamma\gamma}$), the azimuthal angle between the photon pairs ($\Delta\phi_{\gamma\gamma}$), and the total transverse momentum of the system ($p_{T,\gamma\gamma}$). The di-photon cross-sections are compared with DIPHOX and ResBos generators. The agreement is good except for the region at low $m_{\gamma\gamma}$ and at high $\Delta\phi_{\gamma\gamma}$, where the contribution from single or double fragmentation is important.

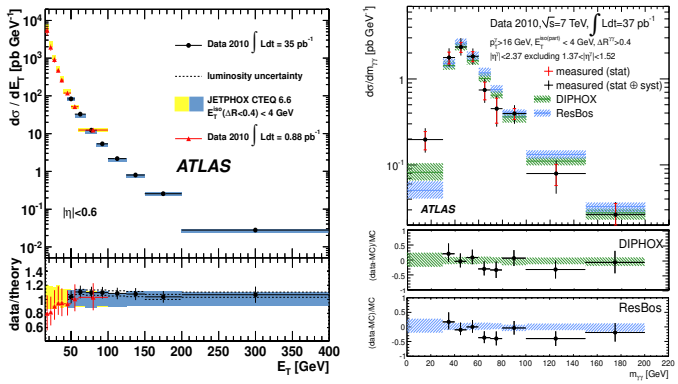

Figure 1: Cross-section measurements for the inclusive isolated photon (left) and di-photon (right).

References

[1] ATLAS Collaboration, "The ATLAS Experiment at the CERN Large Hadron Collider", JINST **3**, S08003 (2008).

[2] ATLAS Collaboration, "Measurement of the inclusive isolated prompt photon cross section in pp collisions at $\sqrt{s}$=7 TeV with the ATLAS detector", Phys. Rev. D **83**, 052005 (2011).

[3] ATLAS Collaboration, "Measurement of the inclusive isolated prompt photon cross-section in pp collisions at $\sqrt{s}$= 7 TeV using 35 pb^{-1} of ATLAS data", arXiv:1108.0253 hep-ex.

[4] ATLAS Collaboration, "Measurement of the isolated di-photon cross-section in pp collisions at $\sqrt{s} = 7$ TeV with the ATLAS detector", arXiv:1107.0581 hep-ex.