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Measurement of the inclusive isolated prompt photon cross-section in pp collisions at $\sqrt{s} = 7$ TeV using 35 pb^{-1} of ATLAS data

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Abstract

A measurement of the differential cross-section for the inclusive production of isolated prompt photons in pp collisions at a center-of-mass energy $\sqrt{s} = 7$ TeV is presented. The measurement covers the pseudorapidity ranges $|\eta| < 1.37$ and $1.52 \leq |\eta| < 2.37$ in the transverse energy range $45 \leq E_{\mathrm{T}} < 400$ GeV. The results are based on an integrated luminosity of 35 pb^{-1}, collected with the ATLAS detector at the LHC. The yields of the signal photons are measured using a data-driven technique, based on the observed distribution of the hadronic energy in a narrow cone around the photon candidate and the photon selection criteria. The results are compared with next-to-leading order perturbative QCD calculations and found to be in good agreement over four orders of magnitude in cross-section.

Keywords:
Photon, ATLAS, LHC, Standard Model

The production of prompt photons at hadron colliders provides means for testing perturbative QCD predictions [1], providing a colorless probe of the hard scattering process. The measurement of the inclusive production of prompt photons could be used to constrain the parton distribution functions; in particular it is sensitive to the gluon content of the proton [2] through the $qg \rightarrow q\gamma$ sub-process, which at leading-order dominates the inclusive prompt photon cross-section at the LHC.

ATLAS has recently published a measurement of the inclusive photon cross-section in pp collisions at $\sqrt{s} = 7$ TeV using an integrated luminosity of 880 nb^{-1} [3]; a similar measurement has been performed by the CMS collaboration [4] using an integrated luminosity of 2.9 pb^{-1}. Analogous measurements have been perfomed in $p\bar{p}$ collisions at a lower center of mass at the Tevatron [5, 6], and in deep inelastic ep scattering at HERA [7, 8]. This letter presents the measurement of the differential production cross-section of isolated prompt photons with transverse energies E_{T} above 45 GeV using 34.6 ± 1.2 pb^{-1} of pp collision data at $\sqrt{s} = 7$ TeV collected in 2010. Isolated prompt photons in the pseudorapidity ranges $|\eta| < 0.6$, $0.6 \leq |\eta| < 1.37$, $1.52 \leq |\eta| < 1.81$ and $1.81 \leq |\eta| < 2.37$ are studied [9].

In the following, all photons produced in pp collisions and not coming from hadron decays are considered as *prompt*: they include both *direct* photons, which originate from the hard sub-process, and *fragmentation* photons, which are the result of the fragmentation of a colored high-p_{T} parton [10, 11]. *Isolated* photons are considered: from a theoretical perspective, photons are isolated if the transverse energy $E_{\mathrm{T}}^{\mathrm{iso}}$, within a cone of radius $R = \sqrt{(\Delta\eta)^2 + (\Delta\phi)^2} = 0.4$ centered around the photon direction in the pseudorapidity (η) and azimuthal angle (ϕ) plane [9], is smaller than $E_{\mathrm{T}}^{\mathrm{cut}}$. In JETPHOX [10], used for next-to-leading order (NLO) calculations, $E_{\mathrm{T}}^{\mathrm{iso}}$ is calculated from all partons. Similarly, a corresponding isolation prescription is applied experimentally on the reconstructed objects, based on the energy reconstructed in an $R = 0.4$ cone around the photon candidate, corrected for the effects associated with: the energy of the photon candidate itself, the underlying event and the collision pile-up [3]. The main background to these isolated prompt photons is composed of photons from decays of light neutral mesons, such as the π^0 or η.

Photons are detected in ATLAS by a lead-liquid Argon sampling electromagnetic calorimeter (ECAL) with an accordion geometry, divided into a barrel section covering the pseudorapidity region $|\eta| < 1.475$ and two end-cap sections covering the pseudorapidity regions $1.375 < |\eta| < 3.2$. It consists of three longitudinal layers. The first layer has a high granularity along the η direction (between 0.003 and 0.006 depending on η, with the exception of the regions $1.4 < |\eta| < 1.5$ and $|\eta| > 2.4$), sufficient to provide an event-by-event discrimination between single photon showers and showers coming from a π^0 decay. The second layer has a granularity of 0.025×0.025 in $\eta \times \phi$. A third layer is used to correct for the leakage beyond the electromagnetic calorimeter for high-energy showers, while in front of the accordion calorimeter a thin presampler layer, covering the pseudorapidity interval $|\eta| < 1.8$, is used to correct for the energy absorbed before the calorimeter.

The ECAL energy resolution is parametrized as $\sigma(E)/E = a/\sqrt{E\ (\mathrm{GeV})} \oplus c$ with the largest contribution coming from the sampling term a, corresponding to approximately 10% (20%) in the barrel (endcap) region. For energies above 200 GeV the global constant term c, estimated to be $(1.2 \pm 0.6)\%$ ($(1.8 \pm 0.6)\%$) in the barrel (endcap) for the 2010 data, starts to dominate [12]. In front of the electromagnetic calorimeter the inner detector allows the reconstruction of tracks from the primary pp collision point and also from secondary vertices, permitting an efficient reconstruction of photon conversions in the beam pipe and inner detector up to a radius of ~ 80 cm. Further details of the inner detector, the electromagnetic calorimeter and the whole ATLAS detector are documented in Ref. [13].

Event samples simulated with Pythia 6.4.21 [14] are used to study the characteristics of signal and background events. To estimate systematic uncertainties related to the choice of the event generator and the parton shower model, alternative samples are generated with Herwig 6.5 [15]. Events used in this analysis are triggered using a single-photon trigger with a nominal transverse energy threshold of 40 GeV. The trigger efficiency, $\varepsilon^{\mathrm{trig}}$, is measured using a bootstrap method to be $(99.4^{+0.6}_{-0.2})\%$ for prompt photon candidates with $E_{\mathrm{T}} > 45$ GeV passing the selection criteria presented below. The same trigger condition was used for the whole dataset, even though the mean number of events per collision rose from < 1 to ~ 3 as the instantaneous luminosity increased during 2010. Collision candidates are selected by requiring a primary vertex with at least three associated charged particle tracks, consistent with the beam interaction region. The total number of selected events in data after these requirements is almost 1.7 million, with a negligible amount of non-collision background.

Photon candidates are formed from clusters of energy deposits reconstructed in the electromagnetic calorimeter [16]. Clusters without matching tracks are classified as *unconverted* photon candidates. The presence of one or two tracks coming from a conversion vertex is used to distinguish *converted* photons from electrons. Converted photon clusters are rebuilt with a wider size in ϕ, to account for the opening angle between the conversion products due to the magnetic field. A specific energy calibration [16] is then applied separately for converted and unconverted photon candidates to account for energy loss in front of the ECAL and both lateral and longitudinal leakage. Photon clusters are removed if their barycenter lies in the transition between the barrel and endcap regions of the electromagnetic calorimeter, corresponding to $1.37 < |\eta| < 1.52$, where larger uncertainties related to the efficiency measurement are expected. Clusters containing cells overlapping with the small number of regions with problematic calorimeter readout or with very noisy cells are also removed. Over 0.8 million photon candidates with $E_{\mathrm{T}} > 45$ GeV remain in the data sample.

A measurement of the transverse isolation energy $E_{\mathrm{T}}^{\mathrm{iso}}$ is associated with each photon candidate, computed by summing the calorimeter energy in a cone of $R = 0.4$ around the candidate, as detailed in Ref. [3]. Corrections to this isolation energy are derived from simulation to remove the energy of the photon itself that leaks into the isolation cone. An event-by-event correction [17, 18] is applied to subtract the estimated contributions from the underlying event and in-time pileup (i.e. from additional proton-proton interactions). The correction to $E_{\mathrm{T}}^{\mathrm{iso}}$ is typically 900 MeV. After this subtraction, the remaining fluctuations are dominated by electronic noise from the calorimeter measurement. The effect of the out-of-time pileup, associated with collisions taking place in previous bunch-crossings, is found to be minimal (i.e. shifts of 200 MeV at most, towards lower isolation energies). The corrections mentioned above allow $E_{\mathrm{T}}^{\mathrm{iso}}$ to be directly compared to parton-level theoretical predictions.

All photon candidates having reconstructed isolation energy < 3 GeV are considered as experimentally isolated. This definition is similar to applying a 4 GeV cut on the particle-level isolation, defined as the transverse energy of all stable particles in a cone of radius $R = 0.4$ around the photon direction (with the underlying event removed as before). The small difference between the two, caused by noise and other detector effects, is taken into account in the uncertainties associated with the photon reconstruction efficiency $\varepsilon^{\mathrm{reco}}$ discussed below. The particle-level isolation can in turn be related to the parton-level isolation in Jetphox that is used for the NLO predictions. The efficiency of the isolation criteria is found to be similar (i.e. within a few percent) at both the particle-level and the parton-level for simulated photons passing the selection described below.

As in Ref. [3], the reconstruction and preselection efficiency $\varepsilon^{\mathrm{reco}}$ is computed from simulated prompt photons as a function of the true photon E_{T}. It is defined as the ratio between the number of photons reconstructed in a given $|\eta|$ interval with reconstructed $E_{\mathrm{T}}^{\mathrm{iso}} < 3$ GeV, and the total number of true prompt photons with true pseudorapidity in the same $|\eta|$ interval, and with particle-level transverse isolation energy < 4 GeV. The estimated $\varepsilon^{\mathrm{reco}}$ for photons with $45 < E_{\mathrm{T}} < 400$ GeV is $\sim$ 85% (75%) in the barrel (endcap) region. The main inefficiency ($\sim$ 10%) is due to the acceptance loss originating from a few inoperative optical links in the calorimeter readout. A similar reduction is caused by the isolation requirement in the pseudorapidity region $1.52 \leq |\eta| < 1.81$ where the calorimetric isolation suffers from larger detector effects. The systematic uncertainty on $\varepsilon^{\mathrm{reco}}$ associated with the experimental isolation requirement is evaluated from the prompt photon simulation by varying the value of the isolation criterion by the average difference ($\sim$ 500 MeV) observed for electrons from $W \to e\nu$ events in data and simulation. The estimated uncertainty varies between 3% and 4% depending on η. The uncertainty associated with the imperfect knowledge of the material in front of the ECAL is estimated by comparing the expected efficiencies in a sample simulated with the nominal ATLAS setup, and one with increased material. It varies between 1% and 2.5%, depending on η.

Shape variables computed from the lateral and longitudinal energy profiles of the shower in the calorimeters are used to discriminate signal from background [16, 19]. As detailed in Ref. [3], selection criteria on these variables, optimized independently for unconverted and converted photons, are applied to reconstructed photon candidates. The requirements on these variables are applied in stages resulting in *tight* candidates: firstly jets are removed whilst still keeping a high photon efficiency and then secondly wide or closely spaced showers (i.e. those consistent with jets or meson decays) are rejected. The selection criteria have been revised to minimize the systematics on the efficiency extraction, especially in the region $1.81 \leq |\eta| < 2.37$. The photon identification efficiency $\varepsilon^{\mathrm{ID}}$ is computed from simulation as a function of transverse energy in each pseudorapidity region. It is defined as the efficiency for reconstructed (true) prompt photons, with measured $E_{\mathrm{T}}^{\mathrm{iso}} < 3$ GeV, to pass the identification criteria mentioned above.

Following the same method as Ref. [3], the value of $\varepsilon^{\mathrm{ID}}$ is determined after correcting the simulated shower shapes for the observed average differences with respect to data. In the present analysis, however, the corrections are estimated for unconverted and converted photons separately. This helps to reduce the systematic uncertainties associated with the correction procedure. The value of $\varepsilon^{\mathrm{ID}}$ varies from 90% to 97%, depending on η and increasing with E_{T}. The systematic uncertainty on $\varepsilon^{\mathrm{ID}}$ is also η dependent, ranging from 1.5% to 3%, with contributions from: detector simulation; background contamination; (un)converted photon misclassification; direct/fragmentation photon fraction; the choice of different Monte Carlo generators (MC). These uncertainties affect the reconstruction and identification efficiencies in a correlated way, and are treated as such in their combination. After applying the isolation criterion and the tight selection on the shape variables, almost 173,000 photon candidates remain in the data sample.

As in Ref. [3], a two-dimensional-sideband method is used to estimate the background contribution from data and to measure the prompt photon signal yield. The two dimensions are the transverse isolation energy $E_{\mathrm{T}}^{\mathrm{iso}}$ and the quality of the photon, defined by whether or not it passes the shower shape identification criteria. On the isolation axis, the signal region contains photon candidates with $E_{\mathrm{T}}^{\mathrm{iso}} < 3$ GeV, while the sideband region contains *non-isolated* photon candidates with $E_{\mathrm{T}}^{\mathrm{iso}} > 5$ GeV. On the other axis, the signal photon candidates are required to pass the tight identification criteria (*tight* candidates). Those failing the tight criteria but passing a background-enriching subset of these criteria (*non-tight* candidates) are contained in the sideband. A typical distribution of $E_{\mathrm{T}}^{\mathrm{iso}}$ for both tight and non-tight data is shown in Fig. 1 for photon candidates with 45 GeV $< E_{\mathrm{T}} <$ 55 GeV in $|\eta| < 0.6$. The non-tight distribution is normalized to the tight one above 5 GeV where a only small signal contamination is expected.

Corrections for the signal contamination in the background control regions are computed using prompt photon Monte Carlo samples. For the tight isolated signal leaking into the non-isolated region, these are as large as 17% at high E_{T}. Smaller leakages of up to 6% are expected for the other two background control regions. The purity of isolated prompt photons measured with this method increases with E_{T} from 91% at $E_{\mathrm{T}} = 45$ GeV to close to 100% at $E_{\mathrm{T}} > 200$ GeV.

The main contributions to the uncertainty on the yields come from the fragmentation fraction ($\lesssim 8\%$), estimated by conservatively varying the fraction from 0 to 100% in the signal sample, and pileup (5%, with fluctuations up to 8% for $1.52 \leq |\eta| < 1.81$), estimated by increasing the correction to $E_{\mathrm{T}}^{\mathrm{iso}}$ by 50% both in data and simulation. This scaling of the correction minimizes the residual dependency of the isolation on the number of primary vertices (i.e. pile-up) in data. The other contributions to the uncertainty are: correlated background in the two-dimensional-sideband regions ($\lesssim$5% barrel and $\lesssim$10% endcap, E_{T} dependent), definition of the two-dimensional-sideband regions ($\lesssim$ 5% non-tight and 1% non-isolated), photon energy scale (2-8%, η dependent), slightly narrower showers in simulation than in data (2-5%, η and E_{T} dependent), isolation shower leakage corrections (1-5%), Monte Carlo generator (2%), material effects ($<$ 1%), and prompt electron misidentification ($\sim$ 0.5%, varying with E_{T}). Globally, the uncertainties on the photon signal yields are less than 10%, and decrease with E_{T}.

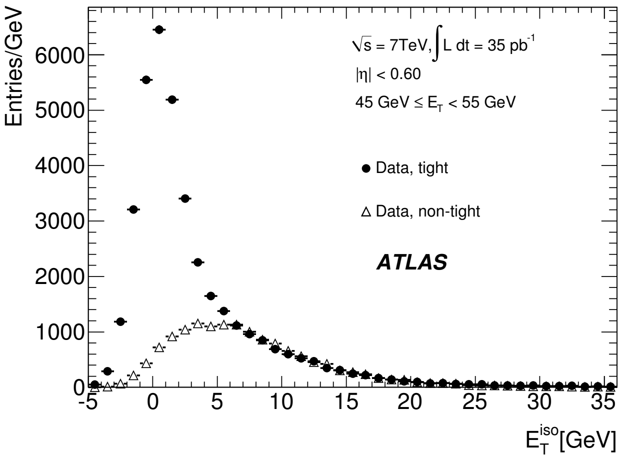

Figure 1: Distributions of $E_{\mathrm{T}}^{\mathrm{iso}}$ for photon candidates with 45 GeV $< E_{\mathrm{T}} <$ 55 GeV in $|\eta| < 0.6$ passing the tight (solid dots) and non-tight (open triangles) shower-shape-based selection criteria. The non-tight distribution is normalized to the tight distribution for $E_{\mathrm{T}}^{\mathrm{iso}} > 5$ GeV (non-isolated region), where the signal contamination is fairly small.

The average differential cross-section $\left\langle d\sigma_j^k / dE_{\mathrm{T}}^{\mathrm{true}} \right\rangle$ for the production of isolated prompt photons in a bin j of $E_{\mathrm{T}}^{\mathrm{true}}$ (integrated over one true $|\eta|$ bin k) is related to the signal yield $N_i^{\gamma,\mathrm{reco},k}$ (in the k'th $|\eta|$ bin and i'th E_{T} bin) by the relationship:

$$N_i^{\gamma,\mathrm{reco},k} = \left(\int \mathcal{L} dt \right) \varepsilon^{\mathrm{trig}} \varepsilon_i^{\mathrm{ID},k} \times \sum_j R_{ij}^k \varepsilon_j^{\mathrm{reco},k} \, \Delta E_{\mathrm{T},j}^{\mathrm{true}} \left\langle \frac{d\sigma_j^k}{dE_{\mathrm{T}}^{\mathrm{true}}} \right\rangle \quad (1)$$

where $\varepsilon_i^{\mathrm{ID},k}$ is the average identification efficiency and R_{ij}^k is the E_{T} *response matrix*. The elements of R_{ij}^k are evaluated from the ratio of the true to reconstructed E_{T} distributions of photon candidates, using simulated samples of isolated prompt photons. The migration from one E_{T} bin to another is less than 10% in most E_{T} and η regions. A larger migration of up to 18% is observed in the region $1.52 \leq |\eta| < 1.81$, where more material is present in front of the electromagnetic calorimeter. Migrations between η bins are neglected given the large bin size and the excellent ECAL η resolution. A singular value decomposition (SVD) [20] is used to unfold the E_{T} distribution for detector effects. The regularization of the resulting unfolded distribution is tuned using simulated events and chosen to be very loose to avoid a potential bias toward the truth reference spectrum. The simulation model dependence is tested with pseudo-experiments, using Pythia and Herwig simulated samples. The difference of the unfolded cross-section obtained in both cases is found to be < 3%. The uncertainty associated with the ECAL energy resolution is ∼ 1%. The lower and upper E_T constraints have negligible effect on the unfolded spectrum.

The measured inclusive isolated prompt photon production cross-sections are shown in Fig. 2. They are presented as a function of the photon transverse energy, for each of the four considered pseudorapidity intervals. They are also presented in tabular form in Appendix A. The error bars on the data points represent the combination of the statistical and systematic uncertainties: systematic uncertainties dominate over the entire kinematic range considered. The contribution from the luminosity uncertainty (3.4%) is shown separately as it represents a possible global change by a common multiplicative factor. The data agree with NLO pQCD calculations, obtained with JETPHOX 1.2.2 [10] using the CTEQ 6.6 PDFs [21] and the BFG set II [22] fragmentation functions (FF). These predictions are negligibly affected when using BFG set I instead. The nominal renormalization, factorization and fragmentation scales are set to the E_T of the photon. Theoretical calculations using MSTW 2008 [23] and NNPDF2.0 [24] PDFs show a similarly good agreement to data. The central values obtained with the MSTW 2008 (NNPDF2.0) PDFs are 3 to 5% (1 to 4%) higher than those predicted using the CTEQ 6.6 PDFs. The total systematic uncertainties on the theoretical predictions are represented with a solid band. The scale uncertainty (∼ 10 %) is the leading theoretical systematic uncertainty. It is estimated from the envelope of independent and coherent variations of the three scales, by a factor of two around the central value, with the renormalization scale (coherent variation) dominating this envelope at low (high) E_T, while the fragmentation scale produces the smallest variation. The scale error is summed in quadrature with the contributions from the PDF uncertainty (5% at 68% C.L.) and the uncertainty associated with the choice of the parton-level isolation criterion (2%). The same quantities are also shown in the bottom panels after having been normalized to the expected NLO pQCD cross-sections.

In conclusion, the inclusive isolated prompt photon production cross-section in pp collisions at a center-of-mass energy $\sqrt{s}$ = 7 TeV has been measured using 35 pb^{-1} of integrated luminosity collected by the ATLAS detector at the LHC. The differential cross-section has been measured as a function of the prompt photon transverse energy between 45 and 400 GeV, in the pseudorapidity ranges $0.0 \leq |\eta| < 0.6$, $0.6 \leq |\eta| < 1.37$, $1.52 \leq |\eta| < 1.81$ and $1.81 \leq |\eta| < 2.37$. In general, good agreement between the data and the NLO pQCD predictions is observed. This measurement improves the precision and significantly extends the kinematic regime explored in the previous measurement [3] and is consistent in the region where the two measurements overlap.

Over most of this extended kinematic range the experimental errors are smaller than the theoretical ones. The large theoretical scale error limits the discrimination between PDFs. Future measurements of this process in finer pseudorapidity binning and those of the photon + jet system should provide more insight into the PDF differences.

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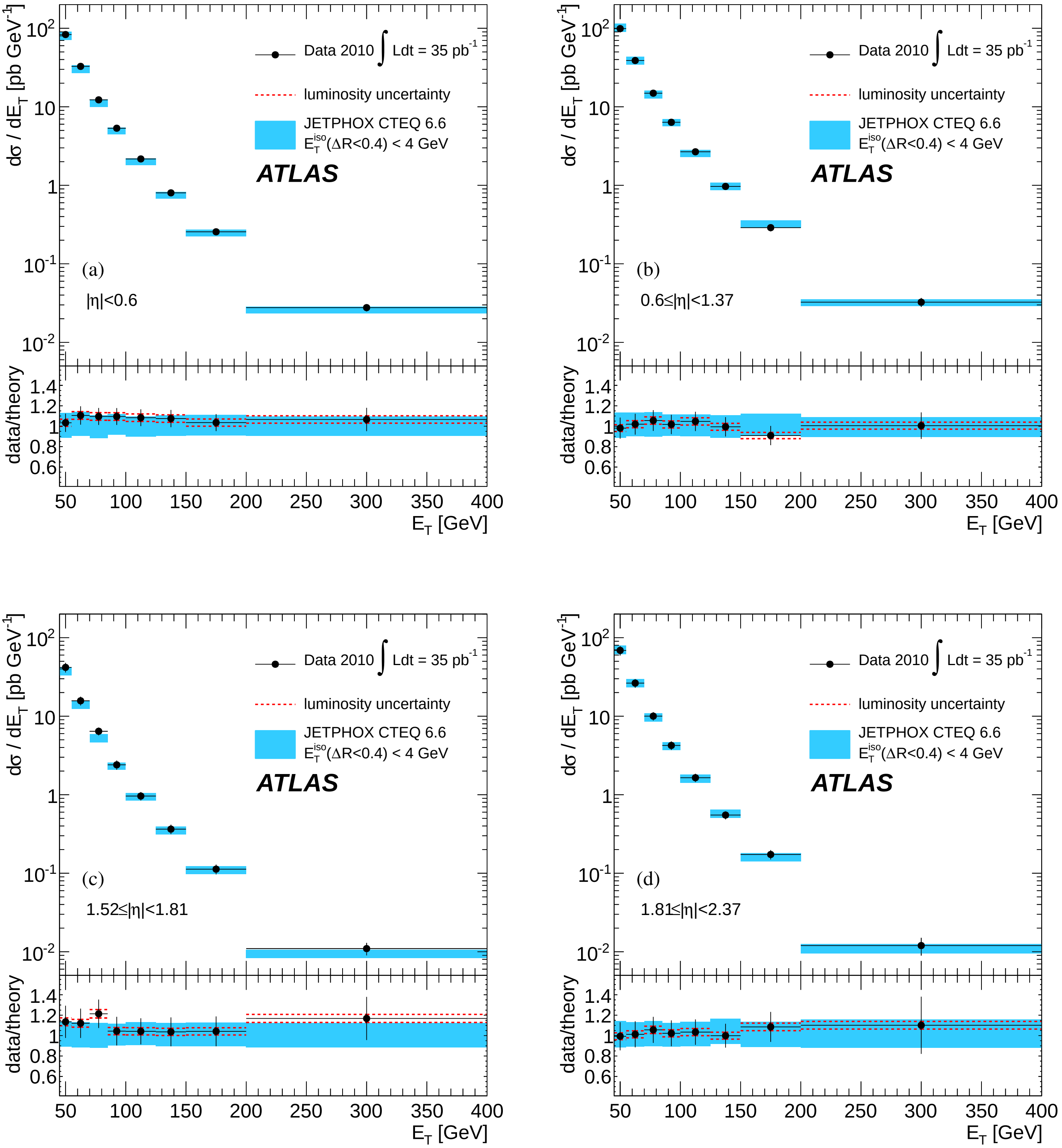

Figure 2: Measured (dots) and expected (shaded area) inclusive prompt photon production cross-sections, and their ratio, as a function of the photon E_T and in the range (a) $|\eta| < 0.6$, (b) $0.6 \leq |\eta| < 1.37$, (c) $1.52 \leq |\eta| < 1.81$ and (d) $1.81 \leq |\eta| < 2.37$. The data error bars combine the statistical and systematic uncertainties, with the luminosity uncertainty shown separately (dotted bands).

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Appendix A. Cross-section measurements

Tables A.1-A.4 list the values of the measured isolated prompt photon production cross-sections, for the $0.0 \leq |\eta| < 0.6$, $0.6 \leq |\eta| < 1.37$, $1.52 \leq |\eta| < 1.81$ and $1.81 \leq |\eta| < 2.37$ regions, respectively. The various systematic uncertainties originating from the purity measurement, the photon selection and identification efficiency and the luminosity are shown. In addition, the correlated uncertainties between the efficiency and the purity determination are propagated as such and included separately (σ_{corr}). The total uncertainty is the combination of the statistical and systematic uncertainties (summed in quadrature), except for the uncertainty on the luminosity.

Table A.1: Measured isolated prompt photon cross-section for $|\eta| < 0.6$ with statistical and systematic uncertainties. The total uncertainty includes both the statistical and all systematic uncertainties (summed in quadrature), except for the uncertainty on the luminosity.

E_T^{min} [GeV]	E_T^{max} [GeV]	$d\sigma/dE_T$ [pb/GeV]	δ_{stat} [pb/GeV]	δ_{yield} [pb/GeV]	$\delta_{\mathrm{efficiency}}$ [pb/GeV]	δ_{corr} [pb/GeV]	$\delta_{\mathrm{unfolding}}$ [pb/GeV]	δ_{tot} [pb/GeV]	δ_{lumi} [pb/GeV]
45	55	83.3	0.5	4.8	3.3	3.4	2.5	7.2	2.8
55	70	32.7	0.3	1.8	1.2	1.2	1.0	2.7	1.1
70	85	12.3	0.2	0.6	0.4	0.4	0.4	0.9	0.4
85	100	5.3	0.1	0.2	0.2	0.2	0.2	0.4	0.2
100	125	2.2	0.05	0.09	0.08	0.07	0.07	0.2	0.07
125	150	0.80	0.03	0.03	0.03	0.02	0.03	0.06	0.03
150	200	0.26	0.01	0.01	9×10^{-3}	7×10^{-3}	8×10^{-3}	0.02	9×10^{-3}
200	400	2.8×10^{-2}	2×10^{-3}	2×10^{-3}	1×10^{-3}	4×10^{-4}	8×10^{-4}	3×10^{-3}	9×10^{-4}

Table A.2: Measured isolated prompt photon cross-section for $0.6 \leq |\eta| < 1.37$, uncertainties as in Table A.1.

E_T^{min} [GeV]	E_T^{max} [GeV]	$d\sigma/dE_T$ [pb/GeV]	δ_{stat} [pb/GeV]	δ_{yield} [pb/GeV]	$\delta_{\mathrm{efficiency}}$ [pb/GeV]	δ_{corr} [pb/GeV]	$\delta_{\mathrm{unfolding}}$ [pb/GeV]	δ_{tot} [pb/GeV]	δ_{lumi} [pb/GeV]
45	55	99.0	0.7	8.1	4.4	3.8	3.0	10.4	3.4
55	70	38.9	0.3	3.0	1.7	1.2	1.2	3.9	1.3
70	85	14.9	0.2	1.1	0.7	0.4	0.5	1.4	0.5
85	100	6.3	0.1	0.4	0.3	0.1	0.2	0.6	0.2
100	125	2.7	0.06	0.2	0.1	0.06	0.08	0.2	0.09
125	150	1.0	0.03	0.06	0.04	0.02	0.03	0.1	0.03
150	200	0.29	0.01	0.02	0.01	7×10^{-3}	9×10^{-3}	0.03	0.01
200	400	3.2×10^{-2}	2×10^{-3}	3×10^{-3}	2×10^{-3}	9×10^{-4}	1×10^{-3}	4×10^{-3}	1×10^{-3}

Table A.3: Measured isolated prompt photon cross-section for $1.52 \leq |\eta| < 1.81$, uncertainties as in Table A.1.

E_T^{min} [GeV]	E_T^{max} [GeV]	$d\sigma/dE_T$ [pb/GeV]	δ_{stat} [pb/GeV]	δ_{yield} [pb/GeV]	$\delta_{\mathrm{efficiency}}$ [pb/GeV]	δ_{corr} [pb/GeV]	$\delta_{\mathrm{unfolding}}$ [pb/GeV]	δ_{tot} [pb/GeV]	δ_{lumi} [pb/GeV]
45	55	41.9	0.4	4.6	3.1	1.2	1.3	5.8	1.4
55	70	15.7	0.2	1.6	1.0	0.4	0.5	2	0.5
70	85	6.4	0.2	0.5	0.4	0.2	0.2	0.7	0.2
85	100	2.4	0.08	0.2	0.2	0.05	0.08	0.3	0.08
100	125	1.0	0.04	0.07	0.08	0.02	0.03	0.1	0.03
125	150	0.36	0.02	0.03	0.03	8×10^{-3}	0.01	0.05	0.01
150	200	0.11	9×10^{-3}	0.01	7×10^{-3}	3×10^{-3}	4×10^{-3}	0.02	4×10^{-3}
200	400	1.1×10^{-2}	1×10^{-3}	1×10^{-3}	8×10^{-4}	2×10^{-4}	3×10^{-4}	2×10^{-3}	4×10^{-4}

Table A.4: Measured isolated prompt photon cross-section for $1.81 \leq |\eta| < 2.37$, uncertainties as in Table A.1.

E_T^{min} [GeV]	E_T^{max} [GeV]	$d\sigma/dE_T$ [pb/GeV]	δ_{stat} [pb/GeV]	δ_{yield} [pb/GeV]	$\delta_{\mathrm{efficiency}}$ [pb/GeV]	δ_{corr} [pb/GeV]	$\delta_{\mathrm{unfolding}}$ [pb/GeV]	δ_{tot} [pb/GeV]	δ_{lumi} [pb/GeV]
45	55	68.9	0.6	7.6	3.8	3.9	2.1	9.6	2.3
55	70	26.4	0.3	2.7	1.3	1.3	0.8	3.3	0.9
70	85	10.0	0.2	0.9	0.5	0.5	0.3	1.2	0.3
85	100	4.2	0.1	0.3	0.3	0.2	0.1	0.5	0.1
100	125	1.7	0.06	0.1	0.1	0.08	0.05	0.2	0.06
125	150	0.55	0.03	0.03	0.03	0.02	0.02	0.06	0.02
150	200	0.17	0.01	0.01	0.01	6×10^{-3}	6×10^{-3}	0.02	6×10^{-3}
200	400	1.2×10^{-2}	1×10^{-3}	6×10^{-4}	3×10^{-3}	3×10^{-4}	4×10^{-4}	3×10^{-3}	4×10^{-4}

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