



Studies of prompt photon background for the analysis of $t\bar{t}$ + photon events with the ATLAS experiment

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- heaviest elementary particle
- discovery 1995 at Tevatron (CDF, D0)
- $t\bar{t}$ production via quark antiquark annihilation and gluon fusion
- $t\bar{t}\gamma$: measurement of the top-photon-coupling
- SM: coupling proportional to Q_t^2

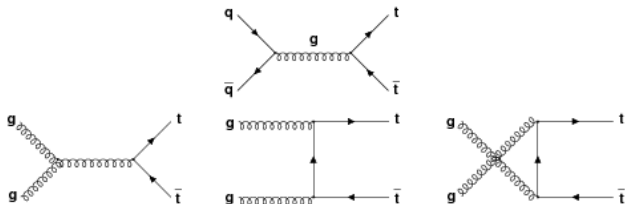
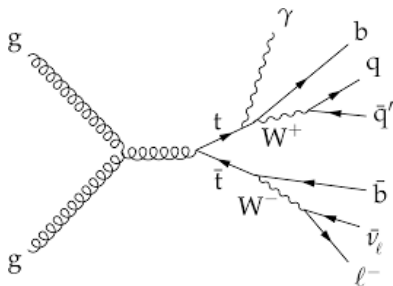
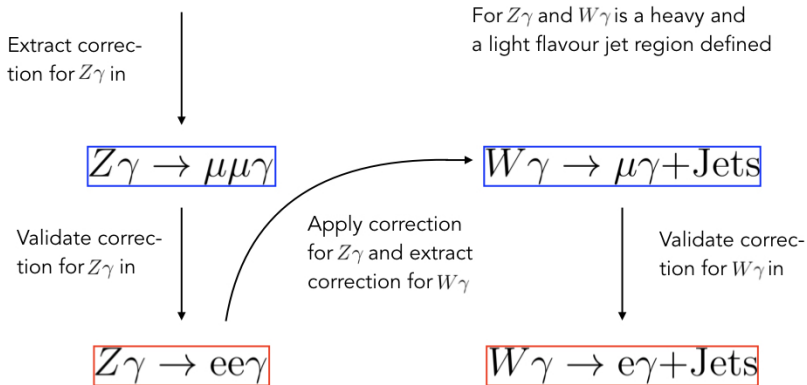


Figure: $t\bar{t}$ production via quark antiquark annihilation and gluon fusion

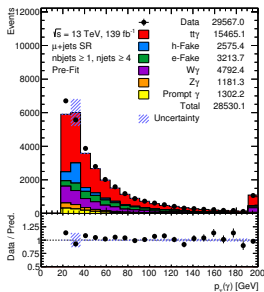


- Background processes:
 - W +jets+ γ
 - Z +jets+ γ
 - other $t\bar{t}$ background + γ
 - fakes
- discrepancies between data and simulations of the processes \rightarrow due to simulations of $W\gamma$ and $Z\gamma$?

Extraction and validation of corrections



- primary vertex
- ≥ 1 lepton trigger matched
- *good run list*
- one photon with $p_T(\gamma) \geq 20$ GeV
- ≥ 1 jet
- l +jets regions: exactly one electron (muon) and no muon (electron)
- ll regions: exactly two electrons (muons) and no muons (electrons), charges with opposite sign, $m(l, l) \geq 15$ GeV



Regions with light flavour jets

Definition of the control region for $Z\gamma$

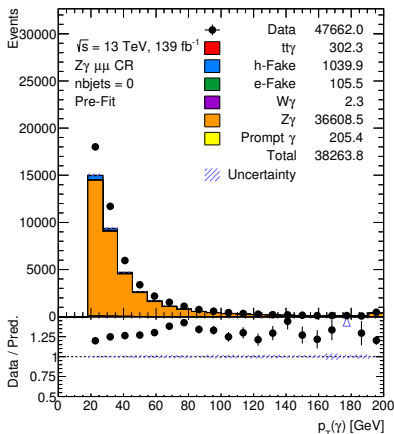


Figure: Distribution of $p_T(\gamma)$ in the control region.

Extraction and validation of the corrections for $Z\gamma$

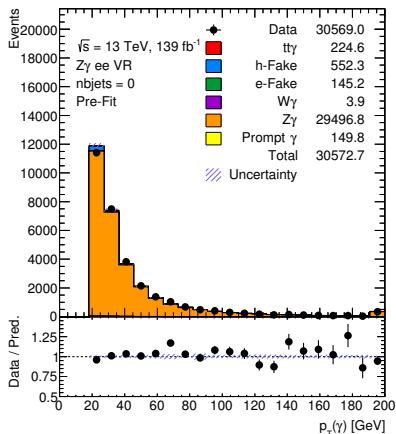
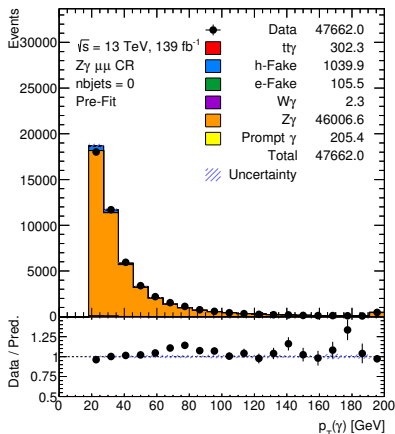


Figure: Distribution of $p_T(\gamma)$ with a constant correction for $Z\gamma$ of 1.256 ± 0.007

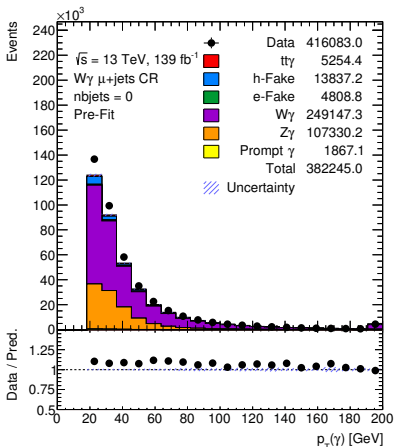


Figure: Distribution of $p_T(\gamma)$ in the control region.

Extraction and validation of the correction for $W\gamma$

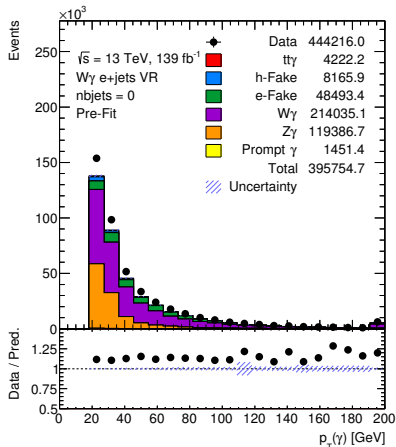
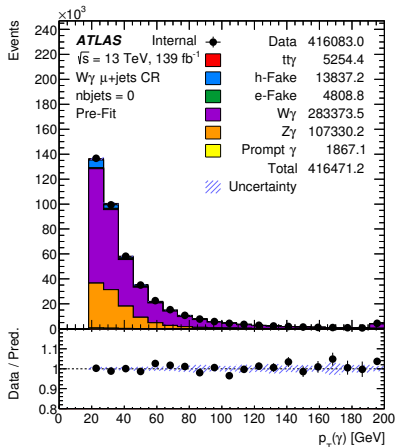


Figure: Distribution of $p_T(\gamma)$ with a linear correction for $W\gamma$ as a function of $p_T(\gamma)$ $(-8 \pm 1) \cdot 10^{-4} \text{ GeV}^{-1} \cdot p_T(\gamma) + (1.18 \pm 0.01)$ and the correction for Z γ in the $W\gamma$ regions.

Regions with heavy flavour jets

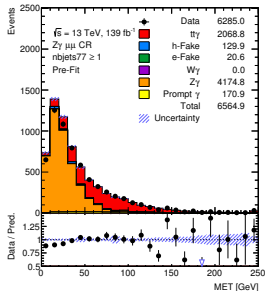
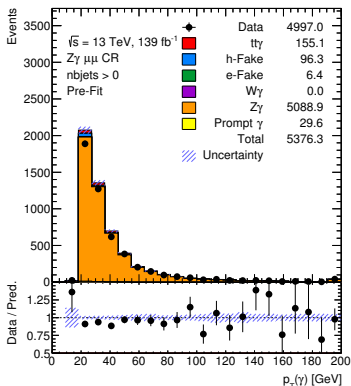


Figure: Distribution of $p_T(\gamma)$ in the control region with the applied cuts.

→ no correction for $Z\gamma$ needed in heavy flavour regions!

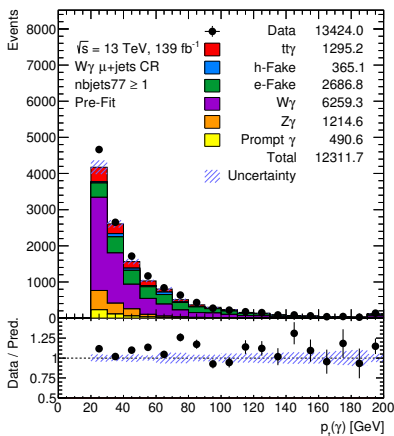


Figure: Distribution of $p_T(\gamma)$ in the $W\gamma$ regions with no correction for $Z\gamma$ and the light flavour correction for $W\gamma$.

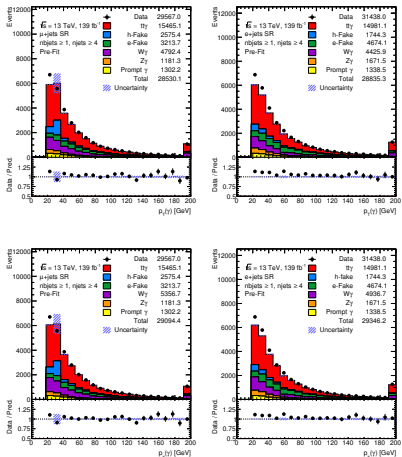


Figure: Distribution of $p_T(\gamma)$ with and without correction

Table: Correction of the simulations of $Z\gamma$ and $W\gamma$ in the light and heavy flavour jet regions

| Simulation | Correction in the light flavour region |
|------------|---|
| $Z\gamma$ | 1.256 ± 0.007 |
| $W\gamma$ | $(-8 \pm 1) \cdot 10^{-4} \text{ GeV}^{-1} \cdot p_T(\gamma) + (1.18 \pm 0.01)$ |

| Simulation | Correction in the heavy flavour region (incl. SR) |
|------------|---|
| $Z\gamma$ | 1 |
| $W\gamma$ | $(-8 \pm 1) \cdot 10^{-4} \text{ GeV}^{-1} \cdot p_T(\gamma) + (1.18 \pm 0.01)$ |

Backup

- $n_{b\text{-jets}}(85\%) \geq 1$
- $n_{\text{jets}} \geq 4$

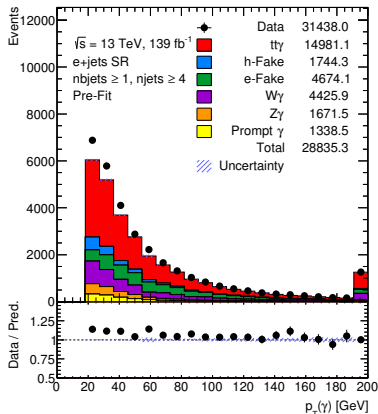
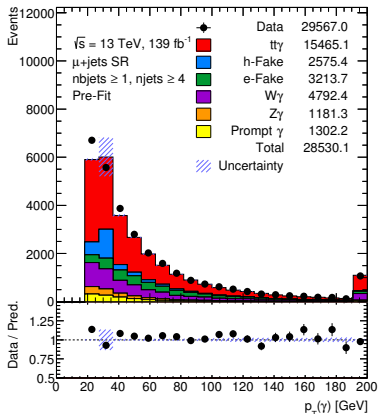


Figure: Distribution of $p_T(\gamma)$ in the $\mu\text{-jets SR}$ (left) and $e\text{-jets SR}$ (right).

Definition of the regions for $Z\gamma$

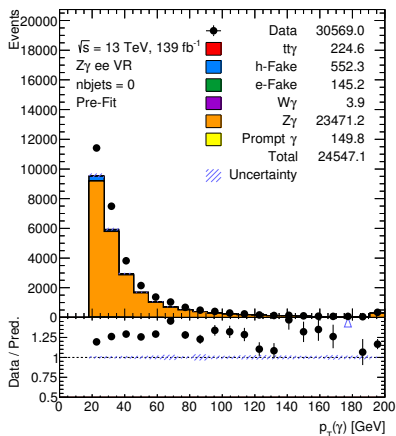
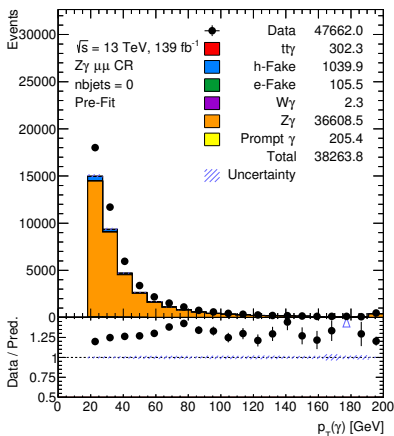


Figure: Distribution of $p_T(\gamma)$ in the control region (left) and the validation region (right) without any cuts.

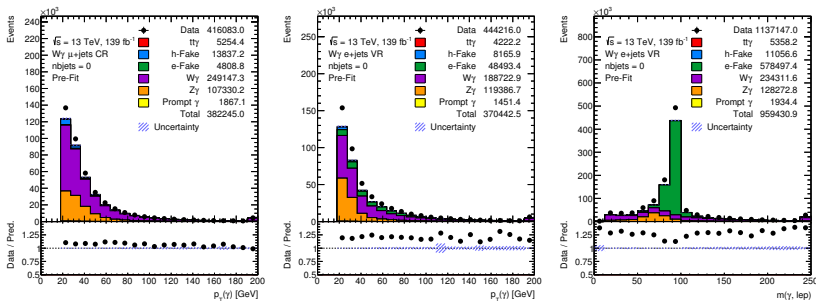


Figure: Distribution of $p_T(\gamma)$ in the control region (left) without any cuts and the validation region (middle) with a veto on the invariant mass $m(\gamma, \ell)$ (right) of $91.2 \pm 15 \text{ GeV}$.

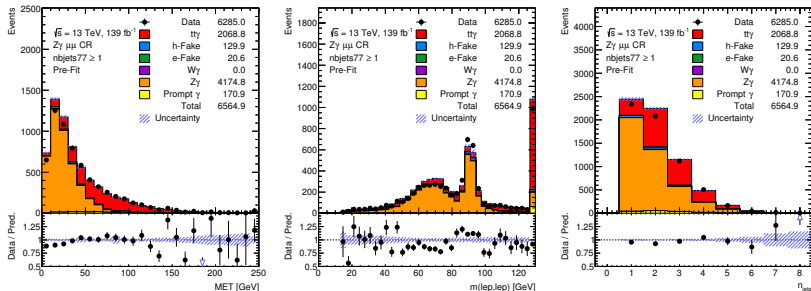


Figure: Distribution of the variables used for the cuts in the region $Z\gamma \mu\mu$.
Applied cuts: $E_T^{\text{miss}} < 40$ GeV, $m(\ell, \ell) < 110$ GeV and $n_{\text{jets}} \leq 2$.

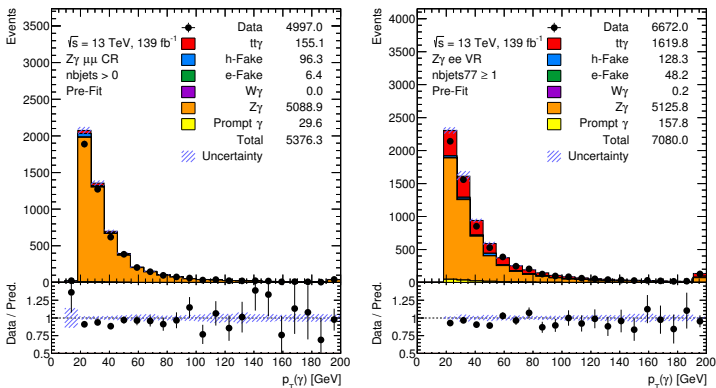


Figure: Distribution of $p_T(\gamma)$ in the control region (left) with the applied cuts and the validation region (right) without any cuts.

→ no correction for $Z\gamma$ needed in heavy flavour regions!

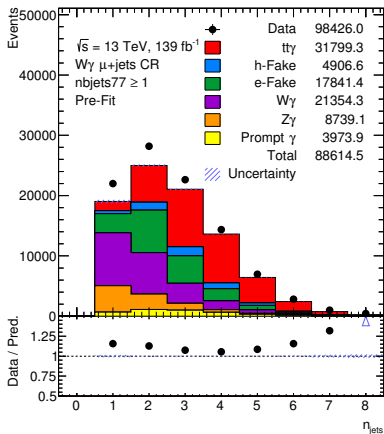
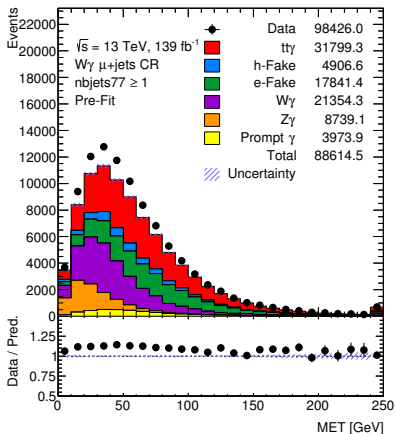


Figure: Distribution of the variables used for the cuts in the region $W\gamma \mu+jets$, applied cuts: $E_T^{miss} > 30 \text{ GeV}$ and $n_{jets} = 1$.

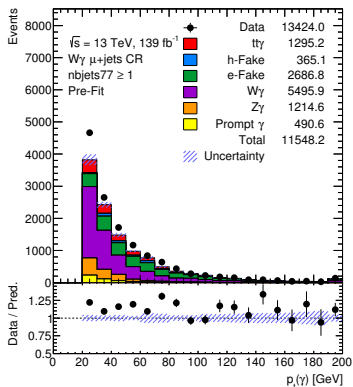


Figure: Distribution of $p_T(\gamma)$ in the control region with the applied cuts.

Validation of light flavour correction in $W\gamma$ regions

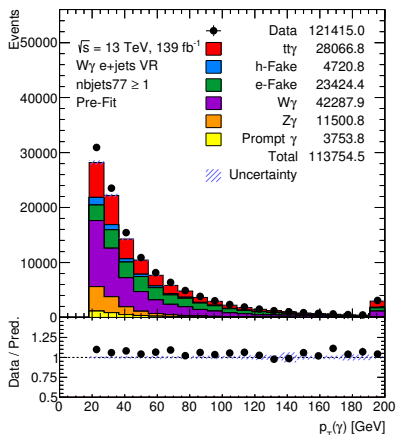
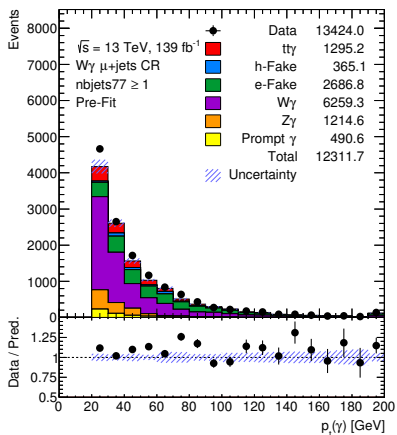


Figure: Distribution of $p_T(\gamma)$ in the $W\gamma$ regions with no correction for $Z\gamma$ and the light flavour correction for $W\gamma$ $(-8 \pm 1) \cdot 10^{-4} \text{ GeV}^{-1} \cdot p_T(\gamma) + (1.18 \pm 0.01)$.