

# IFAE 2017 Poster Session

## Measurement of isolated-photon plus jet production in $pp$ collisions with the ATLAS detector



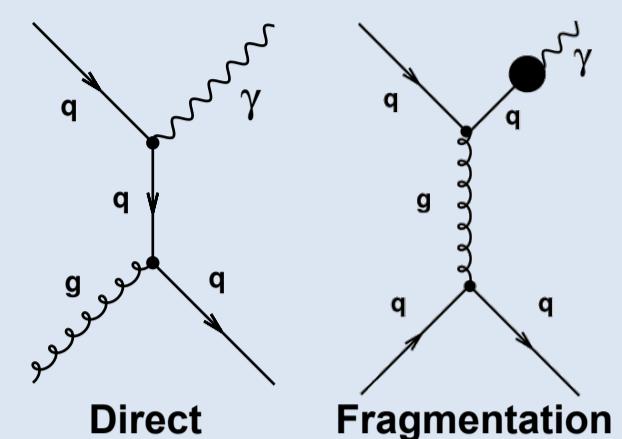
### Introduction

In  $pp$  collisions, high  $E_T^\gamma$  photons can be produced via two mechanisms:

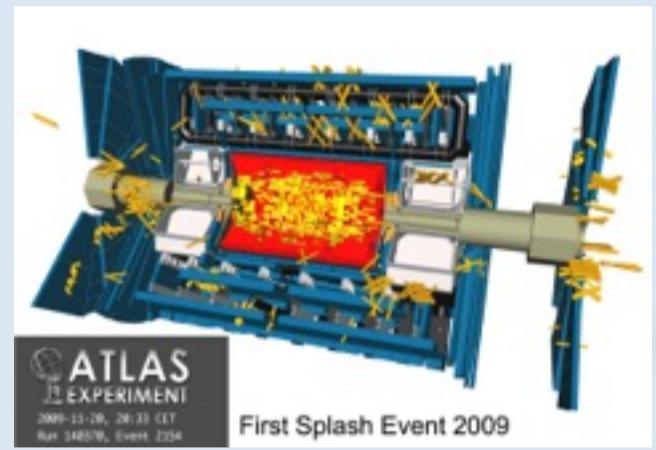
- Direct process: photon coming from the hard interaction
- Fragmentation process: photon coming from the fragmentation of a parton which is produced in the hard interaction.

Measurements of photon plus jet production allow to:

- test perturbative QCD;
- constrain the gluon PDF;
- control the background to Higgs studies and BSM searches.



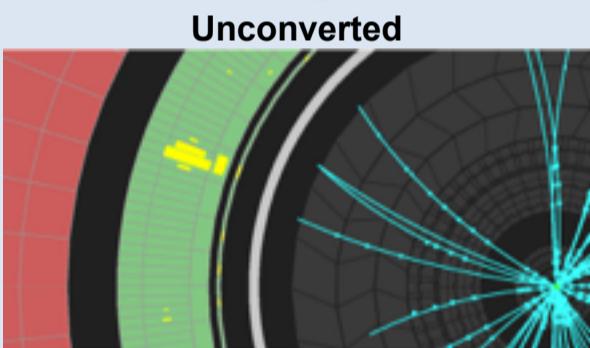
### ATLAS Detector



First Splash Event 2009

### Photon reconstruction

- Unconverted photon candidate → no match with any track
- Converted photon candidate → match with at least two tracks



### Unconverted



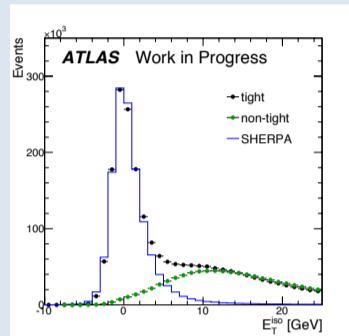
### Converted



### Photon Isolation

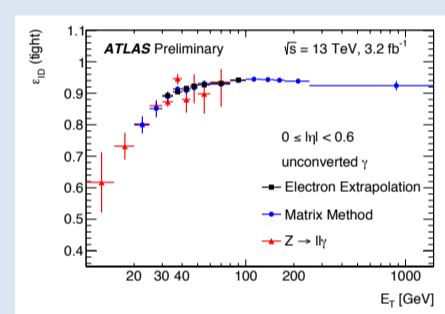
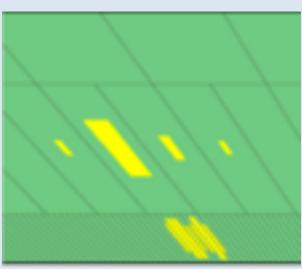
#### Photon Isolation

$E_T^{iso}$  is computed summing the transverse energy of clusters of calorimeter cells in a cone of radius 0.4, excluding the contribution from the photon.



### Photon Identification

The main background sources are  $\pi^0$  and  $\eta$  two photons decay. Two photon identification criteria ("Loose" and "Tight") are introduced according to the shower shapes in the ATLAS calorimeter system.



### Systematic uncertainties

- Photon energy scale  $\sim 2\%$ ;
- Photon energy resolution  $\sim 1\%$ ;
- Jet energy scale  $\sim 10\%$ ;
- Jet energy resolution  $\sim 1\%$ ;
- Parton shower and hadronization model dependence  $\sim 6\%$ ;
- Signal modelling  $\sim 1\%$ ;
- Isolation and identification correlation in the background  $\sim 1\%$ .

### Phase-space region

#### Photon

- $E_T^\gamma > 130$  GeV;
- $|\eta^\gamma| < 2.37$
- ( $1.37 < |\eta^\gamma| < 1.56$ ) excluding;
- $E_T^{iso} < 4.2 \cdot 10^{-3} \cdot E_T^\gamma + 4.8$  GeV;

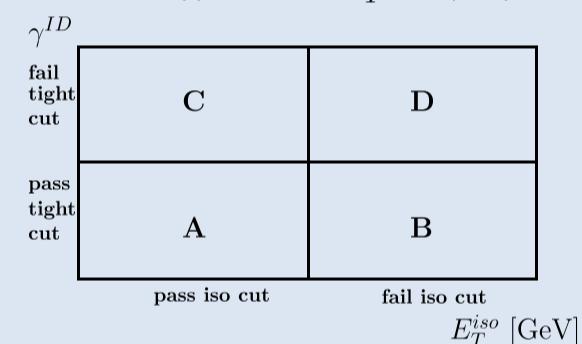
$$|\eta^\gamma + y^{jet}| < 2.37 \quad |\cos \theta^*| < 0.83 \quad m^{\gamma-jet} > 467 \text{ GeV}$$

#### Jets

- Anti- $k_T$   $R=0.6$ ;
- $P_T^{jet} > 100$  GeV;
- $|y^{jet}| < 4.4$ ;
- $\Delta R^{\gamma-jet} > 1$

### Background subtraction

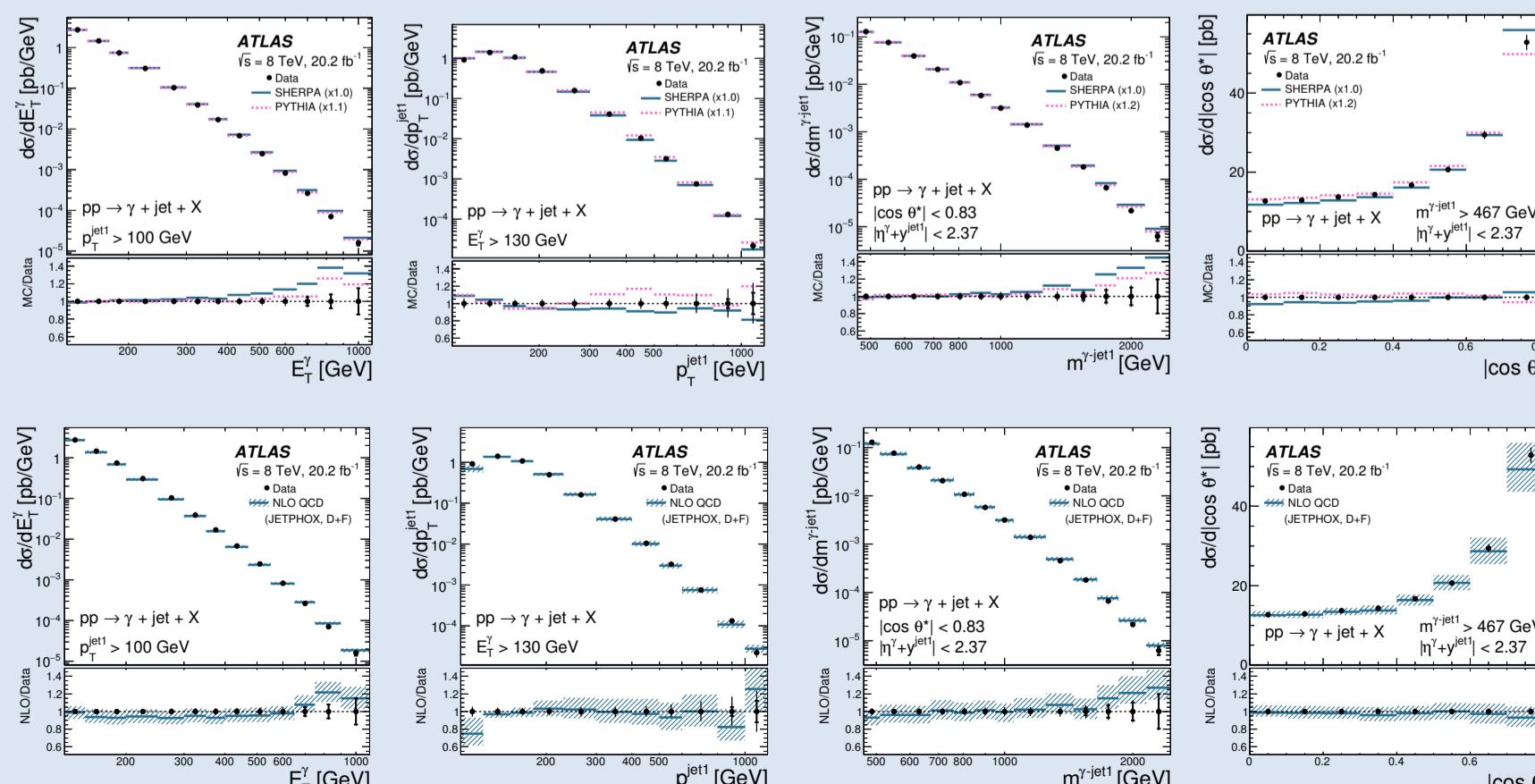
Background was subtracted using a data-driven method based on a "2D-sideband" method applied in the  $E_T^{iso} - \gamma^{ID}$  plane.



### NLO QCD calculations

- JETPHOX program for both direct and fragmentation contributions:  $\mu_R = \mu_f = \mu_F = E_T^\gamma$ ; CT10 proton PDFs and BFG set II photon fragmentation functions
- The predictions were corrected with non-perturbative effects;
- Theoretical uncertainties due to higher orders, hadronization, proton PDFs and  $\alpha_s$  were studied.

### Results



### Summary and conclusions

- The differential cross sections as function of  $E_T^\gamma$ ,  $P_T^{jet}$ ,  $m^{\gamma-jet}$  and  $|\cos \theta^*|$  were measured.
- The NLO QCD descriptions with JETPHOX, corrected for hadronization and underlying-event effects, give a good description of the measured differential cross section distributions.
- Differential cross section for the photon plus two jets and photon plus three jets were also measured with the 2012 data.
- First measurement of isolated-photon plus jet production in  $pp$  collisions at  $\sqrt{s} = 13$  TeV in internal review.

### Bibliography

- [1] ATLAS Collaboration, Nucl. Phys. B 875 (2013) 483
- [1] ATLAS Collaboration, Phys. Rev. D 83 (2011) 052005
- [3] ATLAS Collaboration, Phys. Rev. D 85 (2012) 092014
- [4] ATLAS Collaboration, JHEP 1608 (2016) 005