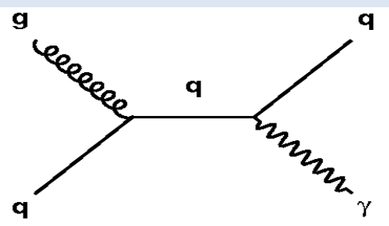
# LHCC Poster Session - CERN, 13 March 2013

## Direct Photon Production in 7 TeV pp Collisions in ATLAS

A measurement of the cross section for the production of isolated prompt photons in pp collisions at a center-of-mass energy of $\sqrt{s}$= 7 TeV is presented. The results are based on an integrated luminosity of 4.7 fb$^{-1}$ collected with the ATLAS detector at the LHC. The cross section is measured as a function of photon transverse energy $E_T^\gamma$ in the kinematic range of $100 \le E_T^\gamma < 1000$ GeV and in the pseudorapidity regions of $|\eta^\gamma| < 1.37$ and $1.52 \le |\eta^\gamma| < 2.37$. The results are compared to leading-order parton-shower Monte Carlo models and next-to-leading order perturbative QCD calculations.

### Why are photons important?

They provide a colorless probe of the hard scattering process. The measurement is **sensitive to the gluon content of the proton through the qg → qγ process**, which dominates the prompt photon production cross section at the LHC, and could thus be used to constrain parton density functions (PDFs).




### Cross Section Definition

**Kinematic region:**

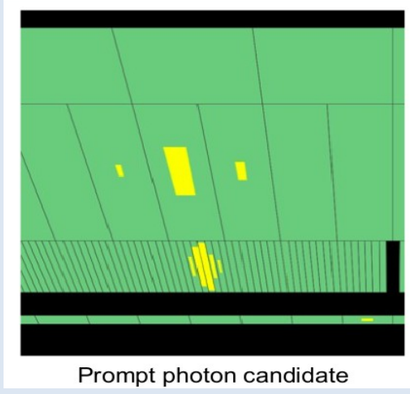
- 100 GeV<$E_T^\gamma$<1000 GeV
- $|\eta^\gamma|$<1.37 and 1.52<$|\eta^\gamma|$<2.37
- $E_T^{iso}$<7 GeV

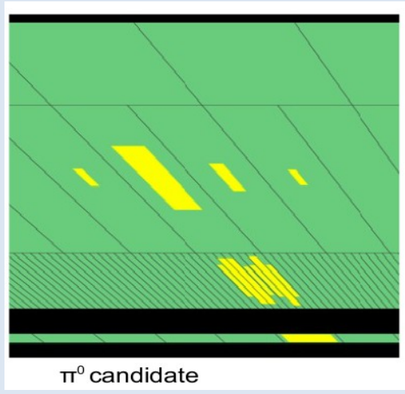
**Luminosity:**

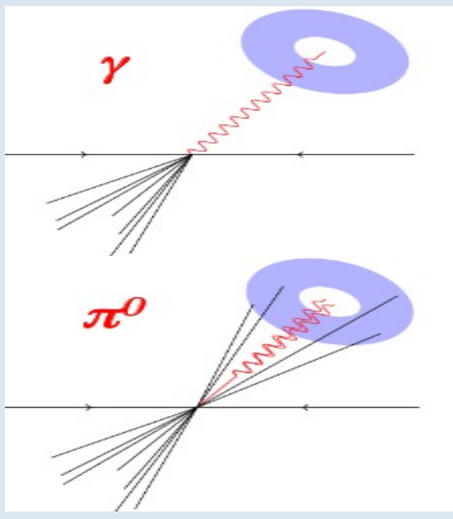
- 4.71 ± 0.09 fb$^{-1}$

**All photons produced in pp collisions and not coming from hadron decays are considered as "prompt".** They include both "direct" photons, which originate from all the hard subprocesses calculated at fixed-order perturbation theory, and "fragmentation" photons, which are the result of the soft fragmentation of a colored high $p_T$ parton.

### Photon Identification




Tight

- Narrow energy in the first layer
- One single maxima in the first layer

Non-Tight

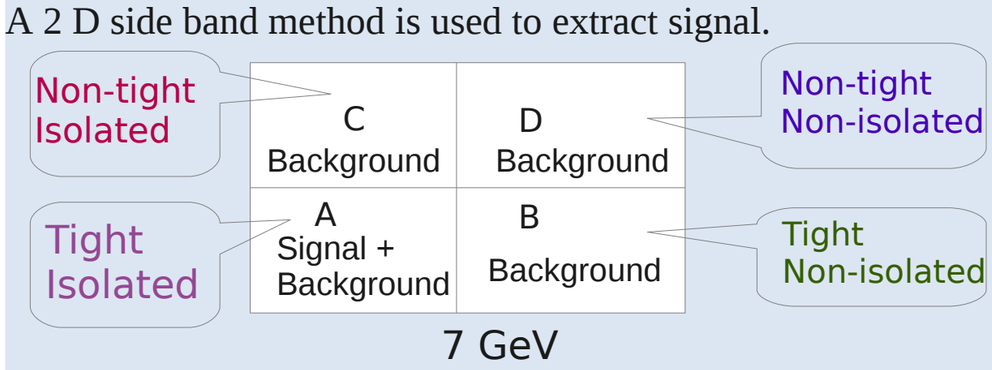
- Larger energy deposited in the first layer
- Two separate maxima in that layer

Cone Isolation:

- Require that < 7 GeV be inside the cone radius after excluding the photon and contributions from underlying events and pileup

### Background Estimation

A 2 D side band method is used to extract signal.




- No knowledge of signal is required
- Background is deduced from observed data

Two assumptions:

- Background has weak signal contamination
- The shape of the background is independent of tight or non-tight.

Given these assumptions the eq. is:

$$N_{SIG}^A = N^A - N_{BKG}^A$$

$$N_{SIG}^A = N^A - \frac{N^C N^B}{N^D}$$

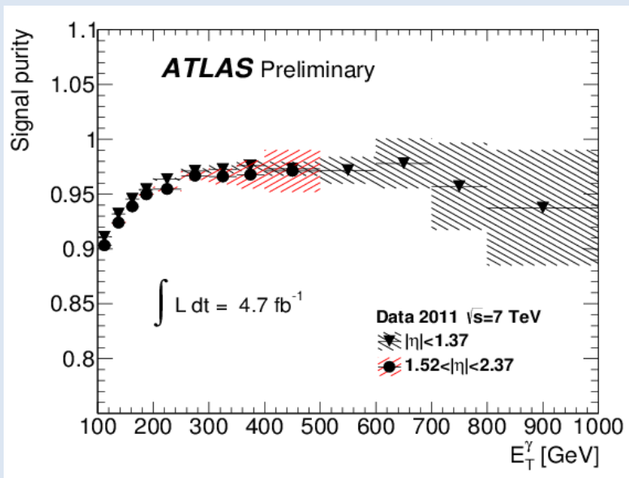
Taking into account the signal leakage and the shape difference one gets:

$$R = \frac{N_{BKG}^A N_{BKG}^D}{N_{BKG}^B N_{BKG}^C}$$

$$N_S^A = N^A - R\frac{(N^B - N_{SIG}^B)(N^C - N_{SIG}^C)}{(N^D - N_{SIG}^D)}$$

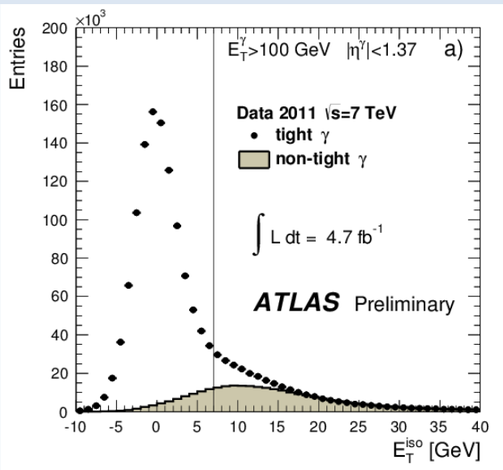
For this measurement R=1.

### Purity



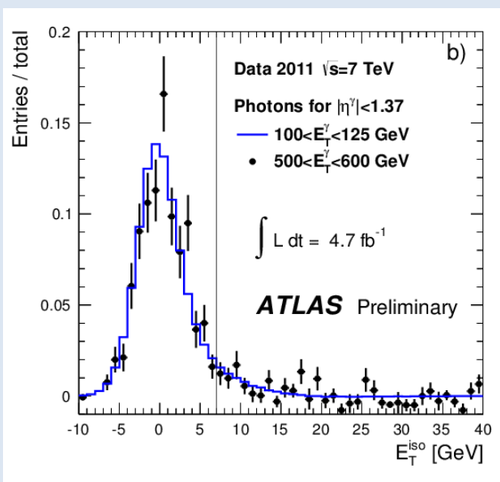

- Signal Purity in region A
- Estimated using the 2D sidebands method

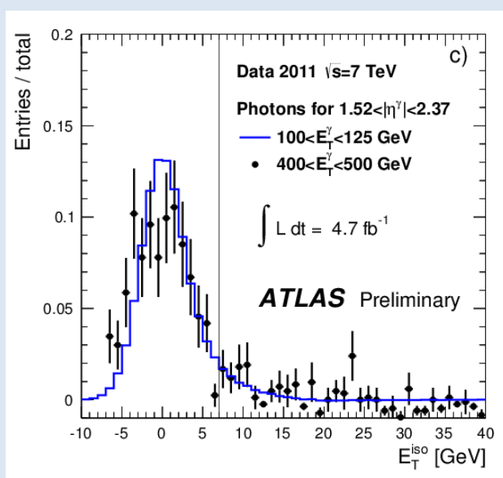
### Isolation Distributions in Data




$E_T^{iso}$ distribution of tight (points) and non-tight (shaded gray region)

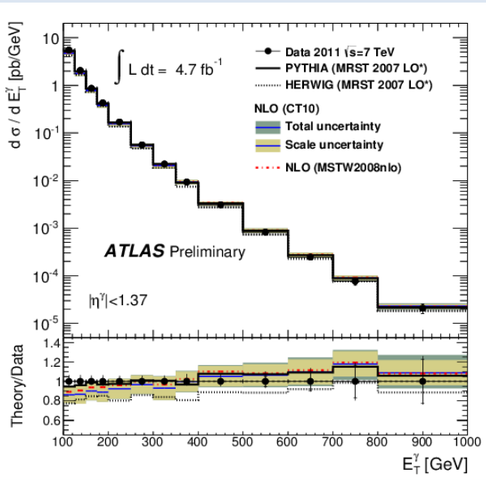
- The latter is normalized to the former for $E_T^{iso}$ > 15 GeV.
- The excess of tight candidates over the normalized non-tight candidates shows a clear peak from signal
- The vertical lines show the selection cut $E_T^{iso}$< 7 GeV used to define the final cross sections.

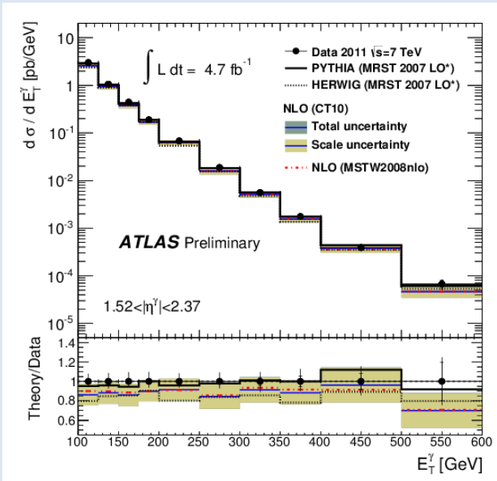


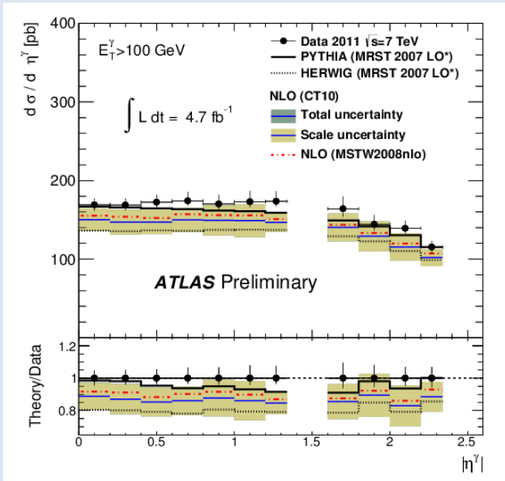




$E_T^{iso}$ distributions of tight photons in the barrel and end-cap regions after subtracting the normalized non-tight distribution, for two representative $E_T^\gamma$ regions

### Cross Section Results




- This cross section measurement extends the previous analysis from 400 GeV to 1 TeV

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|---|---|---|
| Barrel | Data | 234 ± 2 (stat) $^{+13}_{-9}$ (sys) ± 4(lumi) |
| | Jetphox CT10 | 203 ± 25 |
| | Jetphox MSTW | 212 ± 24 |
| End Cap | Data | 122 ± 2 (stat) $^{+9}_{-7}$ (sys) ± 2(lumi) |
| | Jetphox CT10 | 105 ± 15 |
| | Jetphox MSTW | 109 ± 15 |

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ATLAS EXPERIMENT