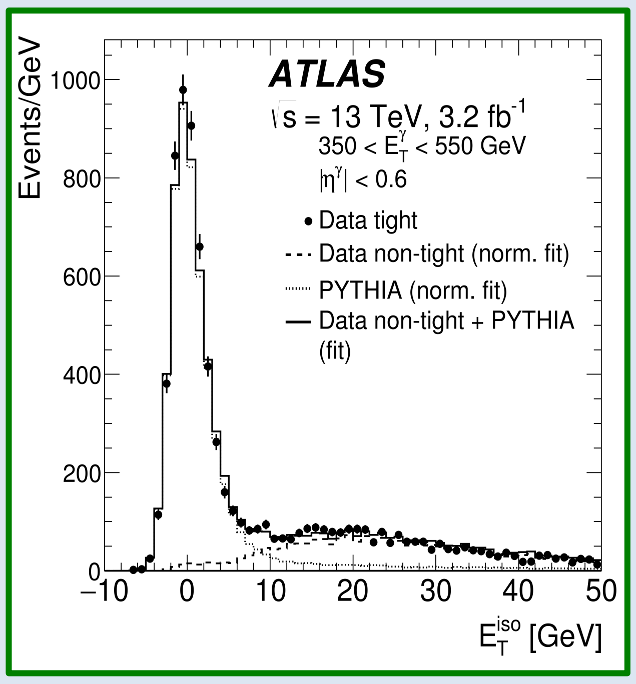
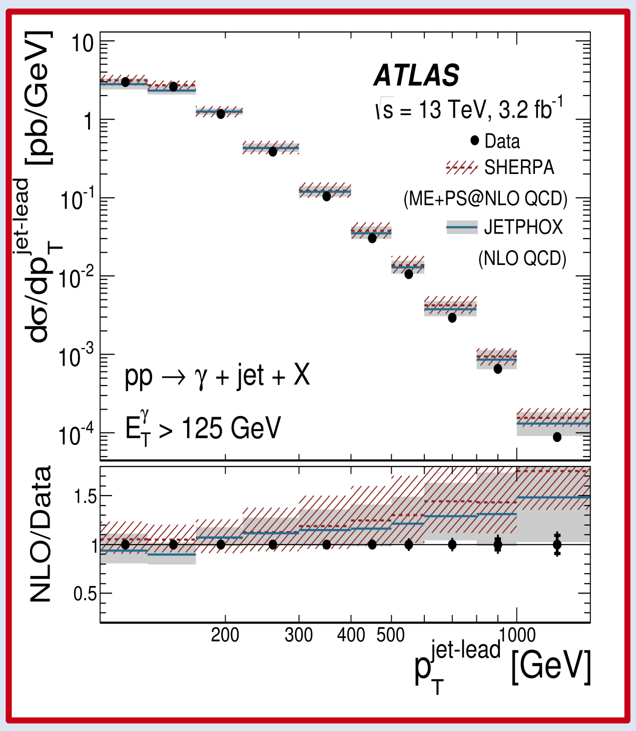
Test of perturbative QCD with photon final states at the ATLAS experiment.

Photon isolation





Inclusive Photon

σ(meas.) = 399 ± 15 pb

→ σ(jetphox) = 352 ± 37 pb

Photon plus jet

σ(meas.) = 300 ± 12 pb

→ σ(jetphox) = 291 ± 26 pb

→ σ(sherpa) = 319 ± 55 pb

Theor. calculations

- NLO QCD calculations using different PDF sets (Jetphox). → Fragmentation included in the calculation.
- NLO QCD @0j and @1j for photon plus jets production (Sherpa) → Frixione isolation. (fragmentation removed)

- **Theoretical uncertainties**

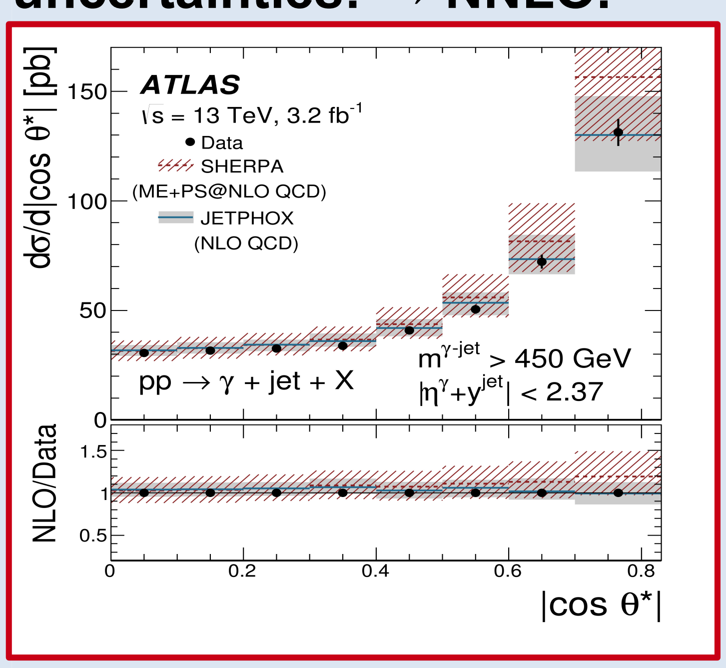
→ Main **uncertainties** due to renormalisation scales 10-30%.

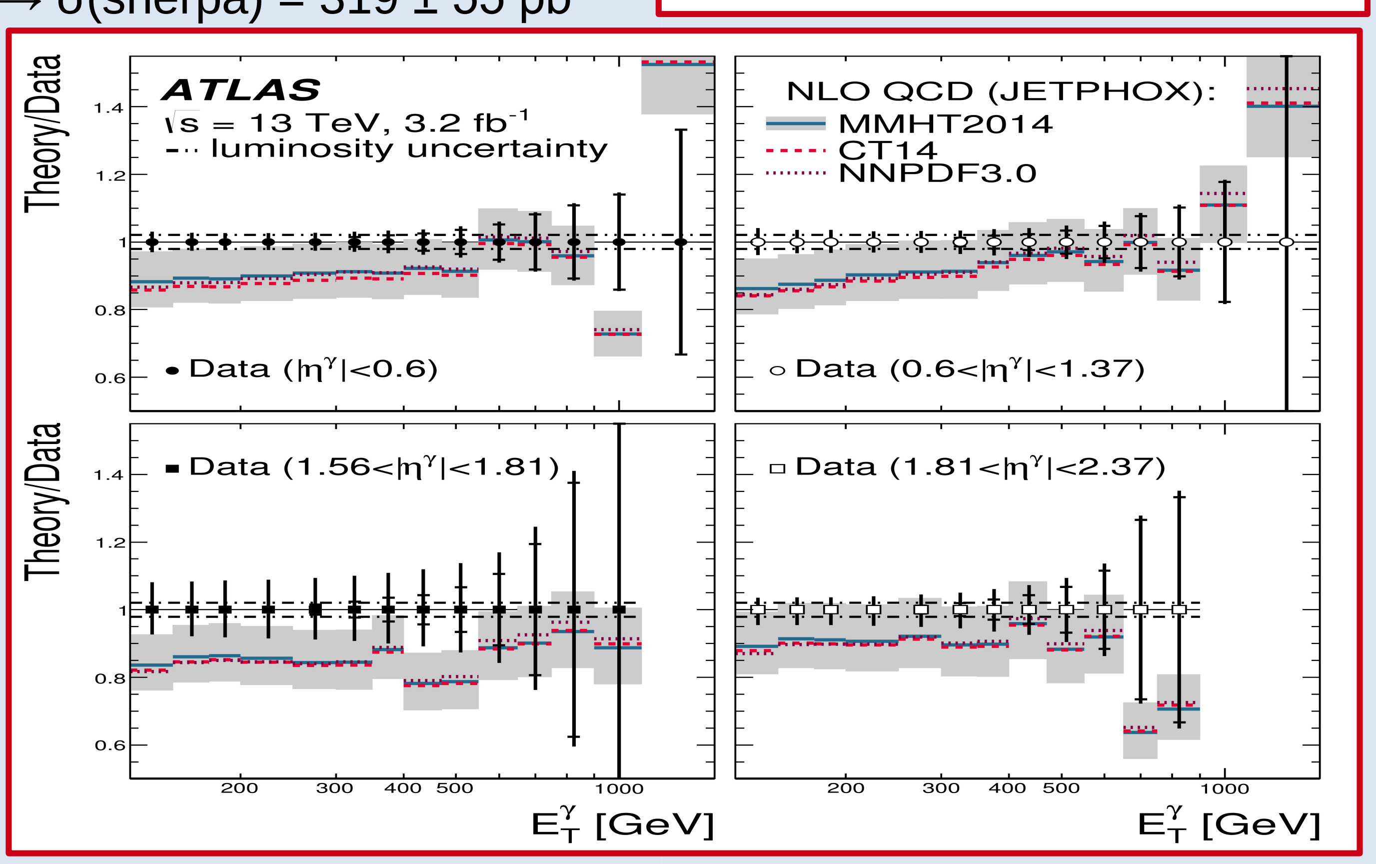
→ PDFs uncertainties about 1-3%.

Results

- Overall adequate description of the measurements by the NLO QCD calculations.
- Calculations overestimate the measurements at high values of leading jet p_T .

→ Experimental smaller than theoretical uncertainties! → NNLO.

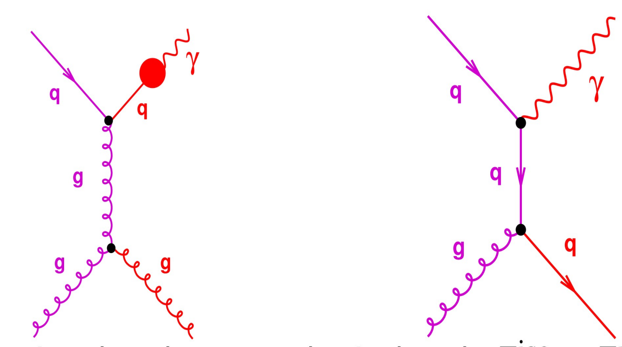




PHYSICS WITH PHOTONS

- Photon production allows to test QCD and constraint PDFs.
- Prompt photons represent a cleaner probe of a hard interaction than jet production.
- Inclusive photons can be produced by two main mechanism:
  - → Direct photon: γ produced in the hard interaction.
  - → Fragmentation: γ coming from high-p_T parton fragmentation.

$$\sigma_{pp\to\gamma+X} = \sum_{i,j,b}\int dx_1\, f_{i/1}(x_1,Q)\int dx_2\, f_{j/2}(x_2,Q)\,\hat{\sigma}_{ij\to\gamma b} + \sum_{i,j,a,b}\int_{z_{min}}^{1} dz\, D_a^{\gamma}(z,\mu_f)\int dx_1\, f_{i/1}(x_1,Q)\int dx_2\, f_{j/2}(x_2,Q)\,\hat{\sigma}_{ij\to ab}$$



- Essential to require the photon to be isolated; $E_T^{iso} < E_T^{max}$ in a cone of radius R=0.4 (suppress $\pi^0(\eta^0...) \to \gamma\gamma$ and fragmentation contribution)

- Jets are reconstructed with the anti-kT algorithm, with R=0.4 from 3D topological clusters of calorimeter cells.

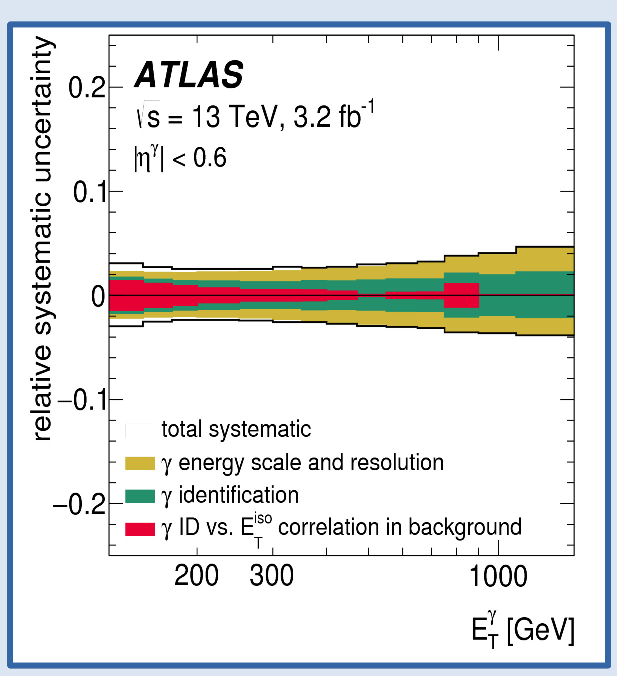
Inclusive photon

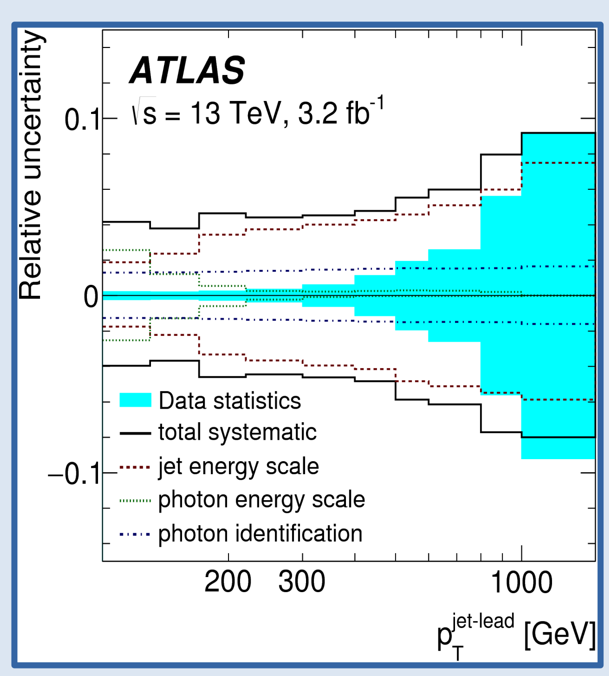
	Phase-space region			
Requirement on E_T^{γ}	$E_T^{\gamma} > 125$ GeV			
Isolation requirement	$E_T^{iso} < 4.8 + 4.2\cdot 10^{-3}\cdot E_T^{\gamma}$ [GeV]			
Requirement on $\lvert\eta^{\gamma}\rvert$	$\lvert\eta^{\gamma}\rvert < 0.6$	$0.6 < \lvert\eta^{\gamma}\rvert < 1.37$	$1.56 < \lvert\eta^{\gamma}\rvert < 1.81$	$1.81 < \lvert\eta^{\gamma}\rvert < 2.37$
Number of events	356 604	480 466	140 955	275 483

Photon plus jet

Requirements on photons
$E_T^{\gamma} > 125$ GeV, $\lvert\eta^{\gamma}\rvert < 2.37$ (excluding $1.37 < \lvert\eta^{\gamma}\rvert < 1.56$)
$E_T^{iso} < 4.2\cdot 10^{-3}\cdot E_T^{\gamma} + 10$ GeV
Requirements on jets
anti-k_t algorithm with $R = 0.4$
the leading jet within $\lvert y^{jet}\rvert < 2.37$ and $\Delta R^{\gamma-jet} > 0.8$ is selected
$p_T^{jet-lead} > 100$ GeV
UE subtraction using $k_\perp$ algorithm with $R = 0.5$ (cf. Section ??)
Additional requirements for $d\sigma/dm^{\gamma-jet}$ and $d\sigma/d\lvert\cos\theta^*\rvert$
$\lvert\eta^{\gamma} + y^{jet-lead}\rvert < 2.37$, $\lvert\cos\theta^*\rvert < 0.83$ and $m^{\gamma-jet} > 450$ GeV

Systematic uncertainties





Josu Cantero (Oklahoma State University)

Phys. Lett. B 770 (2018) 473 (Inclusive Photon)

Phys. Lett. B 780 (2018) 578 (Photon plus jet)

QCD@WORK 2018 (Matera, Italy): 25th-28th June