ICHEP 2020 | PRAGUE

40th INTERNATIONAL CONFERENCE ON HIGH ENERGY PHYSICS

VIRTUAL CONFERENCE

28 JULY - 6 AUGUST 2020

PRAGUE, CZECH REPUBLIC

Bundesministerium für Bildung und Forschung

Center for Particle Physics Siegen

UNIVERSITÄT SIEGEN

arXiv:2007.06946 [hep-ex]

EUROPEAN ORGANISATION FOR NUCLEAR RESEARCH (CERN)

ATLAS EXPERIMENT

Submitted to: JHEP

CERN

CERN-EP-2020-100

17th July 2020

Measurements of inclusive and differential cross-sections of combined $t\bar{t}\gamma$ and $tW\gamma$ production in the $e\mu$ channel at 13 TeV with the ATLAS detector

Accepted by JHEP

Poster presentation

John Meshreki for the ATLAS collaboration

ICHEP 2020 (online) - 29.07.2020

ATLAS EXPERIMENT

BMBF-ErUM-Forschungsschwerpunkt ATLAS-EXPERIMENT

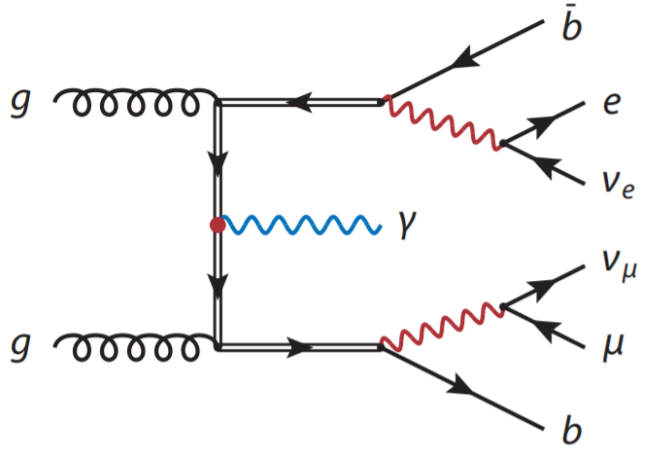
Ausbau von ATLAS am LHC: Physik mit dem ATLAS-Experiment

ErUM-FSP T02 ATLAS

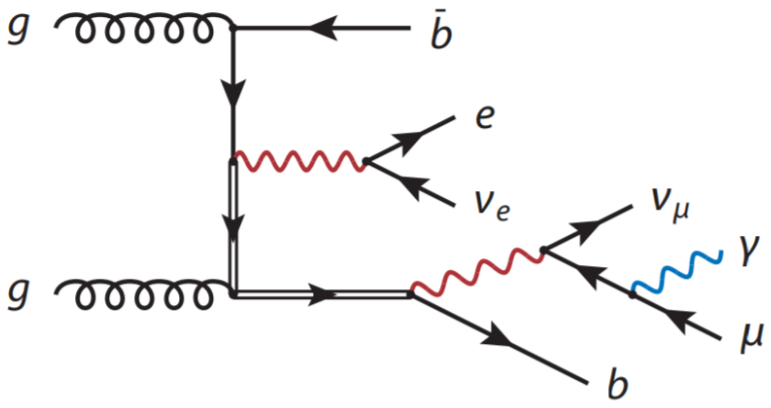
Motivation

- Precise measurement of top-quark pair production in association with a photon **probes the top-photon electroweak coupling**

- Measurements of **fiducial inclusive** and **differential $t\bar{t}\gamma$ + $tW\gamma$** cross-sections
  - in the $e\mu$ channel, **cleanest $t\bar{t}$ decay channel**
  - at **parton level**, to allow **comparison with the most recent theory prediction**



$t\bar{t}\gamma$



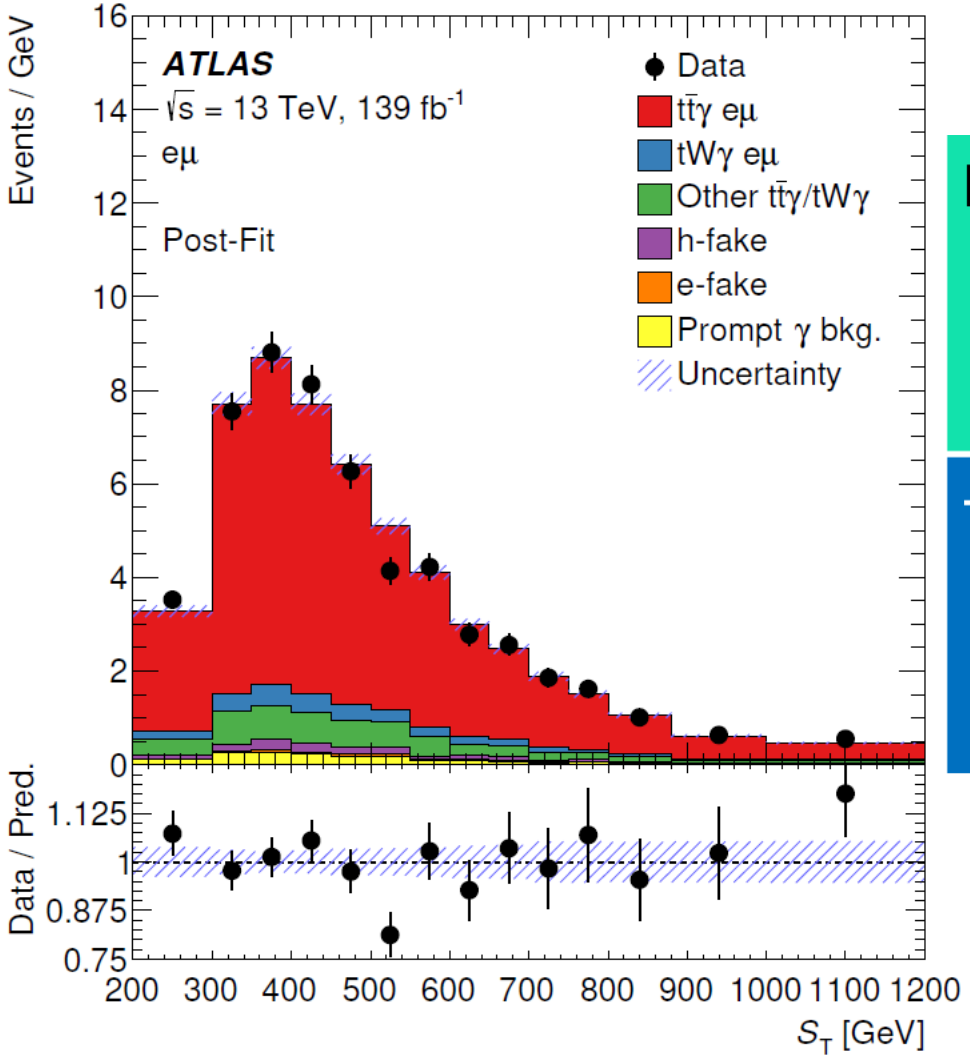
$tW\gamma$

- The measurements are compared with **leading order (LO) Monte Carlo (MC) simulations** and **state-of-the-art calculation** [1], where the latter is the **first full computation** of $t\bar{t}$ with a hard γ **at next-to-leading-order (NLO)** in quantum chromodynamics, for $pp \rightarrow bW\bar{b}W\gamma$ including all resonant and non-resonant diagrams, interferences, and off-shell effects

[1] JHEP 10 (2018) 158

Inclusive results

- **Fiducial inclusive cross-section** is extracted using a **binned Maximum Likelihood Fit to the S_T** distribution (S_T: scalar sum of all transverse momenta in the event, including leptons, photons, jets and missing transverse momentum)



Measured:

$$\sigma_{fiducial} = 39.6 \pm 0.8(stat)^{+2.6}_{-2.2}(syst)\ \text{fb} = 39.6\ ^{+2.7}_{-2.3}\ \text{fb}$$

Theory NLO:

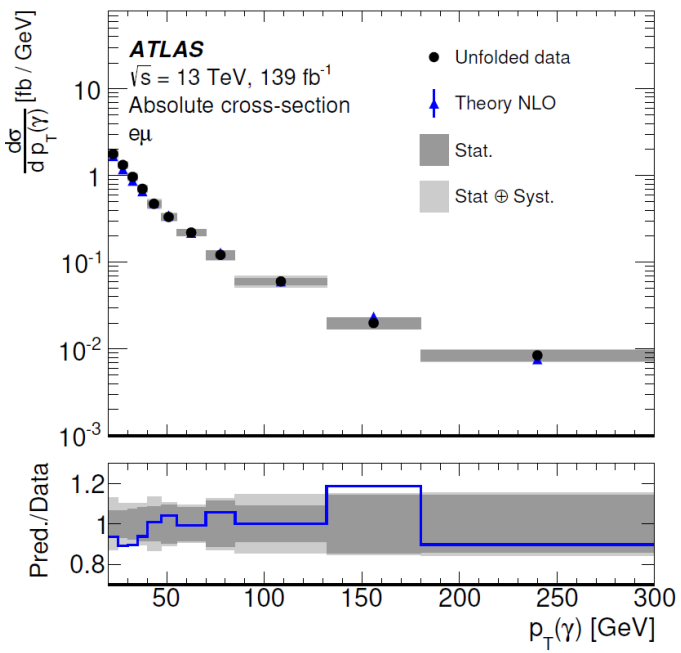
$$\sigma_{NLO} = 38.5\ ^{+1.2}_{-2.5}\ \text{fb}$$

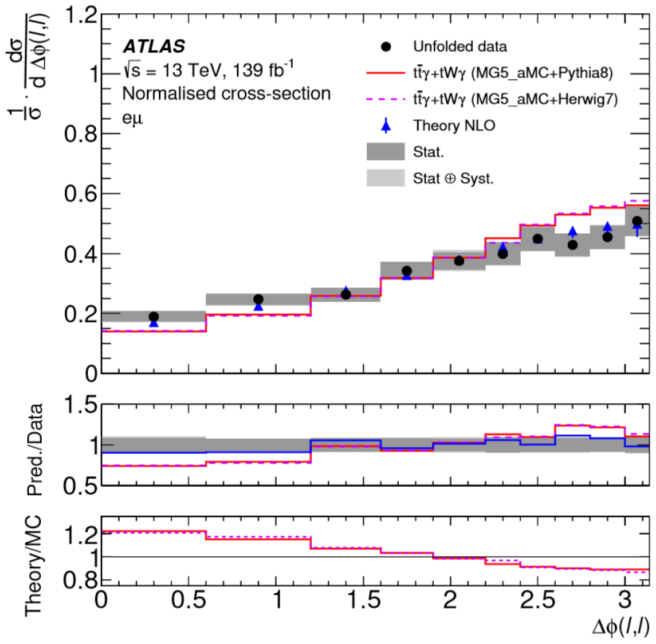
Good agreement within uncertainty!

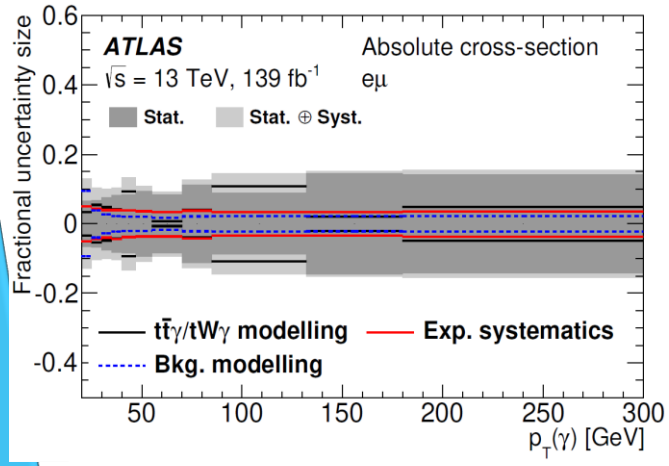
Category	Uncertainty
$t\bar{t}\gamma/tW\gamma$ modelling	3.8%
Background modelling	2.1%
Photons	1.9%
Luminosity	1.8%
Jets	1.6%
Pile-up	1.3%
Leptons	1.1%
Flavour-tagging	1.1%
MC statistics	0.4%
Soft term E_T^{miss}	0.2%
$tW\gamma$ parton definition	2.8%
Total syst.	6.3%

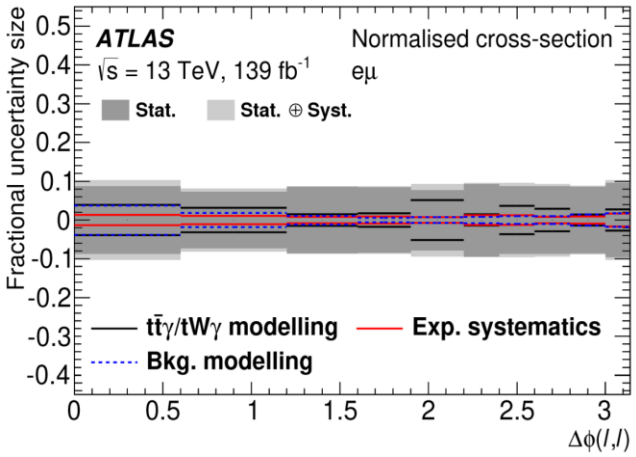
Differential results

- **Fiducial differential** (absolute and normalised) **cross-sections** are measured as functions of $P_T(\gamma)$, $|\eta(\gamma)|$, $\Delta R(l,\gamma)$, $\Delta\eta(l,l)$, $\Delta\Phi(l,l)$ using the **Iterative Bayesian Unfolding** method









- The shape of the measured fiducial differential cross-sections is well described by the NLO calculation, while the LO MC simulation fails to describe such shape for some variables, such as $\Delta\Phi(l,l)$

- The precision of the measurements is dominated by the statistical uncertainties

- The systematic uncertainties of the measurements are dominated by the background and signal modelling