

THEORY UNCERTAINTIES UPDATE

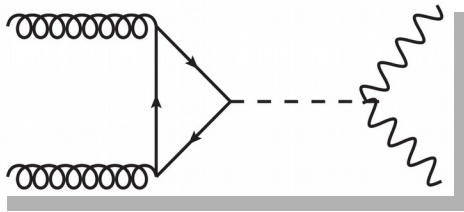
OFFSHELL INTERPRETATIONS MEETING

LHCHXSWG OFFSHELL SUBGROUP

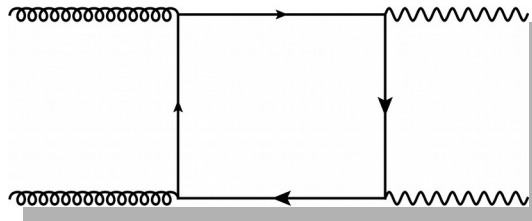
Raoul Röntsch
8 July 2020

Summary

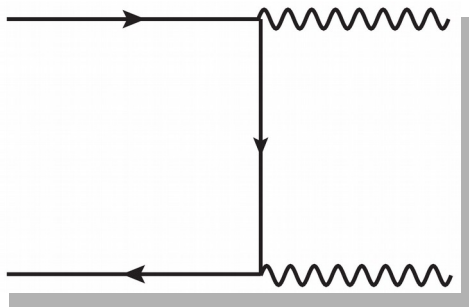
- Focus of subgroup: theory uncertainty treatment for **interfering** and **non-interfering** backgrounds.



“Higgs signal”



“Interfering background”



“Non-Interfering background”

(Interference at NLO.)

➔ Modeling issues:

- Higher-order QCD corrections
- Jet binning
- Electroweak corrections
- Assigning theory uncertainty

Meeting 19/04/2020

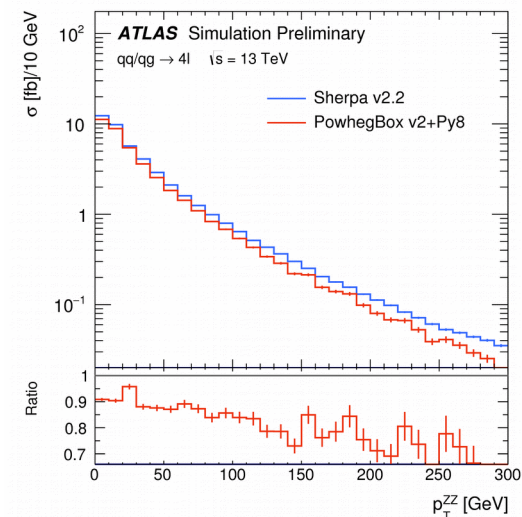
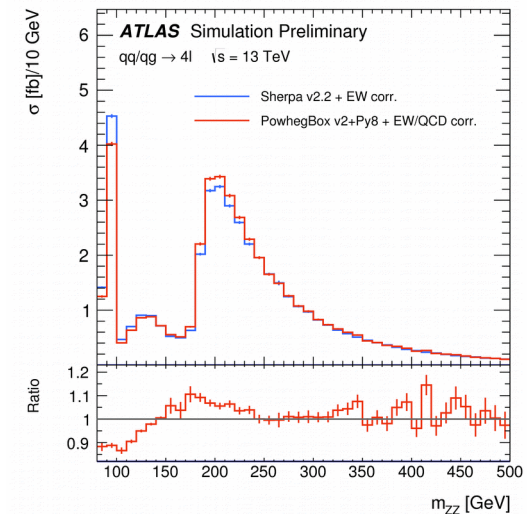
- First meeting on 19 April [\[Indico link\]](#)
- Presentations of current treatment of **non-interfering background** by ATLAS and CMS.

Systematic uncertainty	95% CL upper limit on $\mu_{\text{off-shell}}$		
	$ZZ \rightarrow 4\ell$	$ZZ \rightarrow 2\ell 2\nu$	Combined
QCD scale $q\bar{q} \rightarrow ZZ$	4.2	3.9	3.2
QCD scale $gg \rightarrow (H^* \rightarrow)ZZ$	4.2	3.6	3.1
Luminosity	4.1	3.5	3.1
Remaining systematic uncertainties	4.1	3.5	3.0
All systematic uncertainties	4.3	4.4	3.4
No systematic uncertainties	4.0	3.4	3.0

From ATLAS presentation.

Ongoing Work

- Careful study of event generation:
 - **Merging** using SHERPA and MEPS@NLO [ATLAS]
 - **Matching** PS+NLO using POWHEG [CMS]
- Building on preliminary study by ATLAS.
- Extending this to further understand generation and associated uncertainties:
 - *Merge with fewer jets?*
 - *Don't reweight with NNLO?*
 - ...
- Still in **preliminary stages**, no results as yet.



Treatment of EW corrections

- **ATLAS**: NLO EW corrections as function of m_{ZZ} .

[Biedermann, Denner, Dittmaier, Hofer, Jäger 1601.07787]

- **CMS**: virtual EW corrections as function of \hat{s} and t .

[Bierweiler, Kasprzik, Kühn 1305.5402; Gieseke, Kasprzik, Kühn 1401.3964]

How to combine with QCD corrections?

- **Mixed NLO QCD-EW** corrections very challenging theoretically.
- Combine (separate) QCD and EW corrections assuming that these **factorize**.
- How good is this assumption?
- How to estimate its associated uncertainty?

Treatment of EW corrections

Define parameter $\rho = \left| \sum_i \vec{p}_{T,i} \right| / \sum_i |\vec{p}_{T,i}|$ i : lepton from VV decay

[Bierweiler, Kasprzik, Kühn 1305.5402; Gieseke, Kasprzik, Kühn 1401.3964]

- $\rho < 0.3$: Factorization is **well motivated**.
 - ATLAS: **No additional uncertainty**
 - CMS: **Uncertainty** $\delta_{EW} \times \delta_{NLOQCD}$
- $\rho > 0.3$: Factorization is **poorly motivated**.
 - ATLAS: 100% systematic uncertainty
 - CMS: 100% of EW corrections as systematic uncertainty

Recent study [Grazzini, Kallweit, Lindert, Pozzorini, Wieseemann 1912.00068] looked into this issue – **talk by Jonas Lindert**.

Summary

- Ongoing work focusing on non-interfering background.
- Welcome more ideas and/or contributions.
- Latest updates on [\[Twiki link\]](#)
- Deadline for complete first version of documentation is **31 Oct 2020**.

THANK YOU FOR YOUR ATTENTION!