

Gluon Fusion Group part 1: inclusive XS

Achilleas Lazopoulos
10th workshop of the HXSWG
CERN, Thursday 16th of July

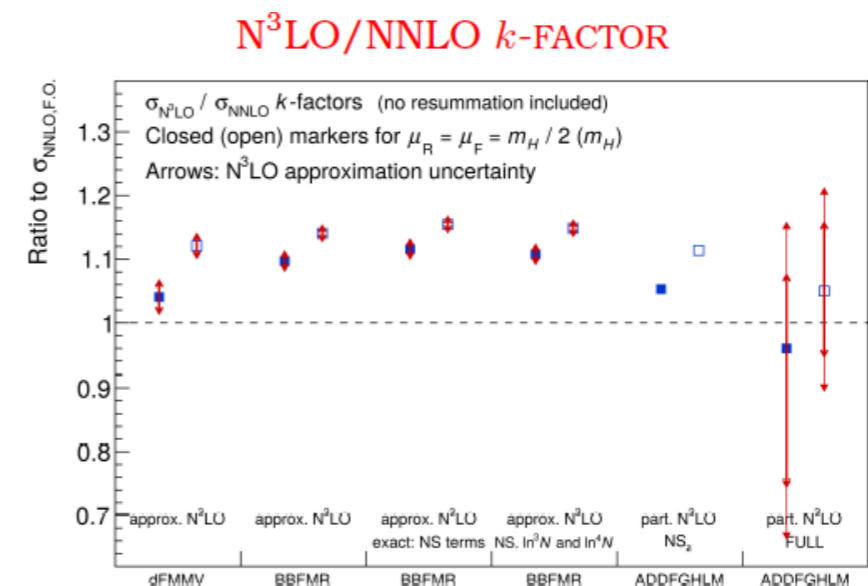
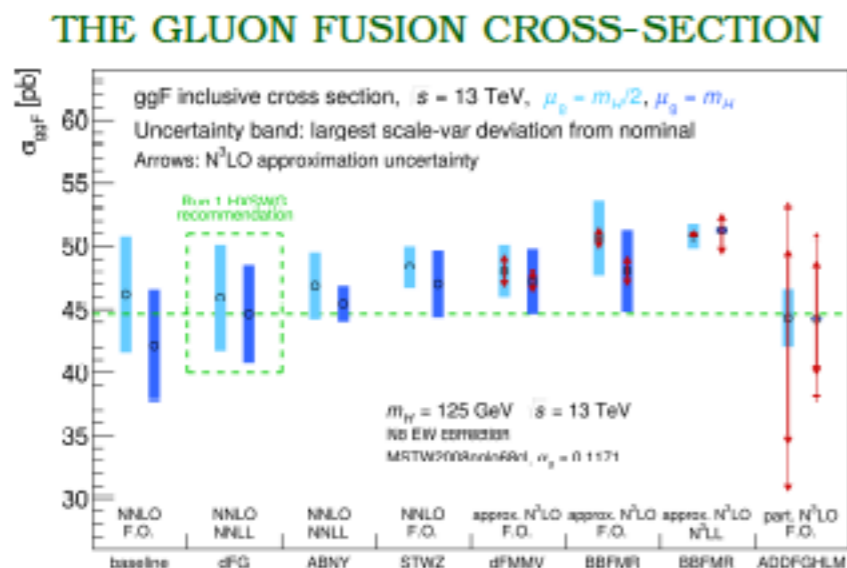
on behalf of the ggf task force:

S. Forte, D. Gillberg, C. Hays, AL, G. Petruciani, G. Zanderighi

Subgroup activity up to January meeting

Benchmarked re-summation contributions and different approximations to the N3LO inclusive cross section within the EFT approach.

Submitted a review of the benchmark process to the steering committee.



note k factor computed wr to NNLO at respective scale
UNCERTAINTIES (ARROWS)

from S. Forte's talk at the 9th workshop, Jan '15

Subgroup activities

Inclusive cross-section

- N3LO results [\[Anastasiou, Duhr, Dulat, Herzog, Mistlberger\]](#):
the N3LO scale uncertainty is $\sim 2-3\%$.
- Sub-leading sources of uncertainties become more important.
- Meeting within Les Houches on residual uncertainties.

Differential distributions

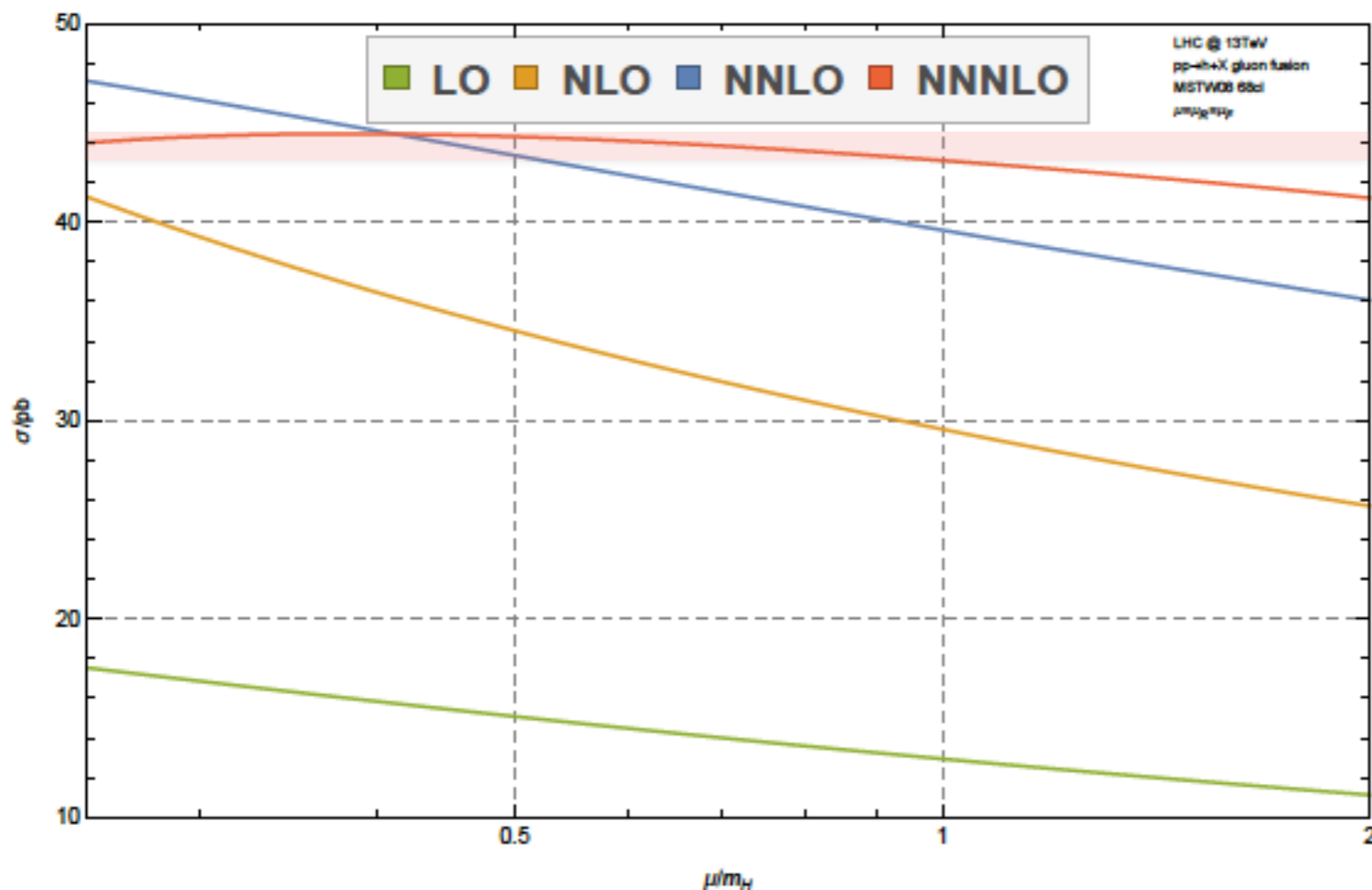
- Benchmark exercise on Higgs p_T and Jet bins, see talk by Giovanni

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N3LO inclusive XS

within the Effective Field Theory approach ($m_t \rightarrow \infty$)

$$\mathcal{L}_{\text{eff}} = -\frac{C}{4} H G_{\mu\nu}^a G^{a\mu\nu}$$



Good news: the residual scale uncertainty is 2-3%.

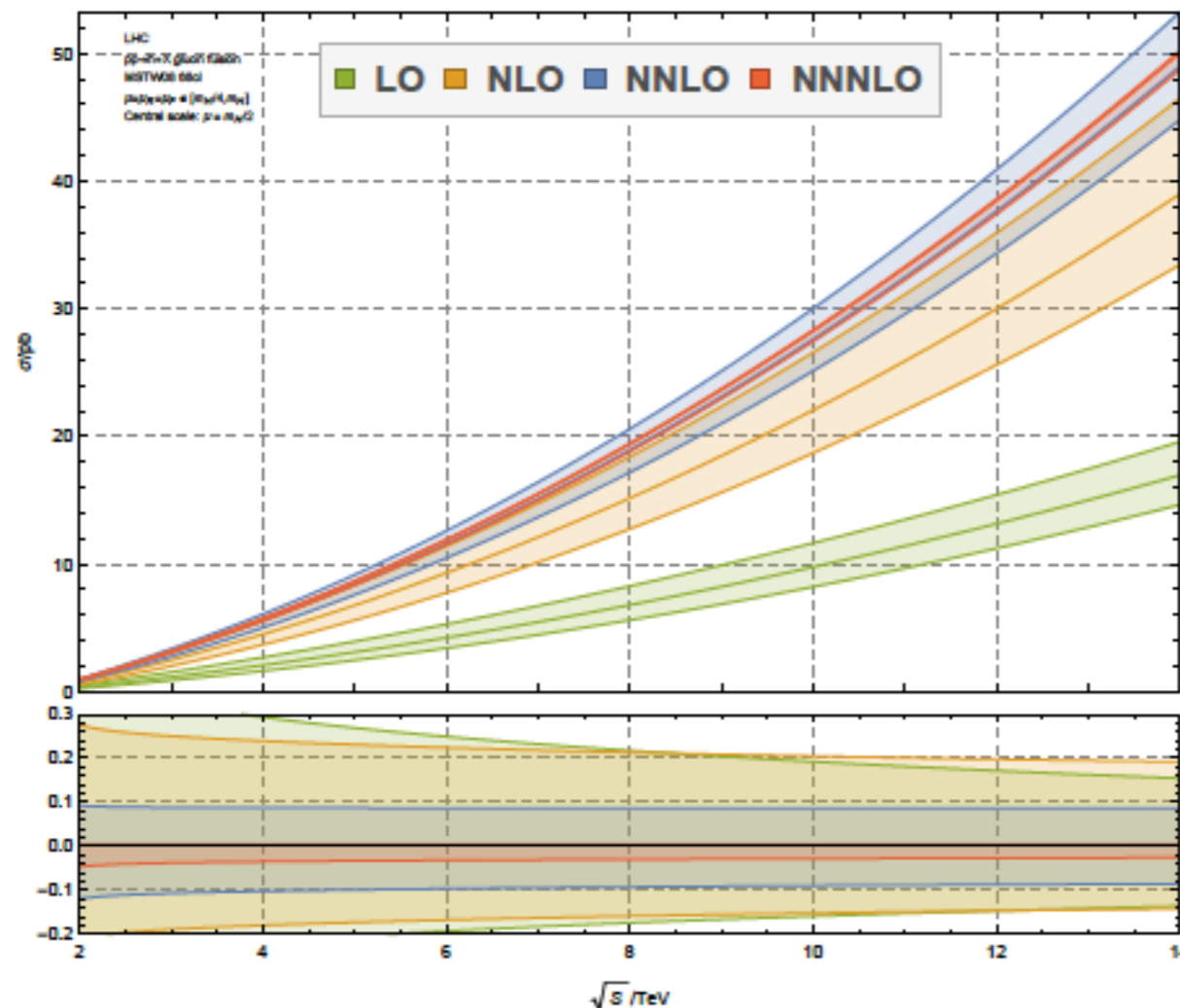
Q: Is the scale uncertainty capturing the effect of neglecting higher orders??

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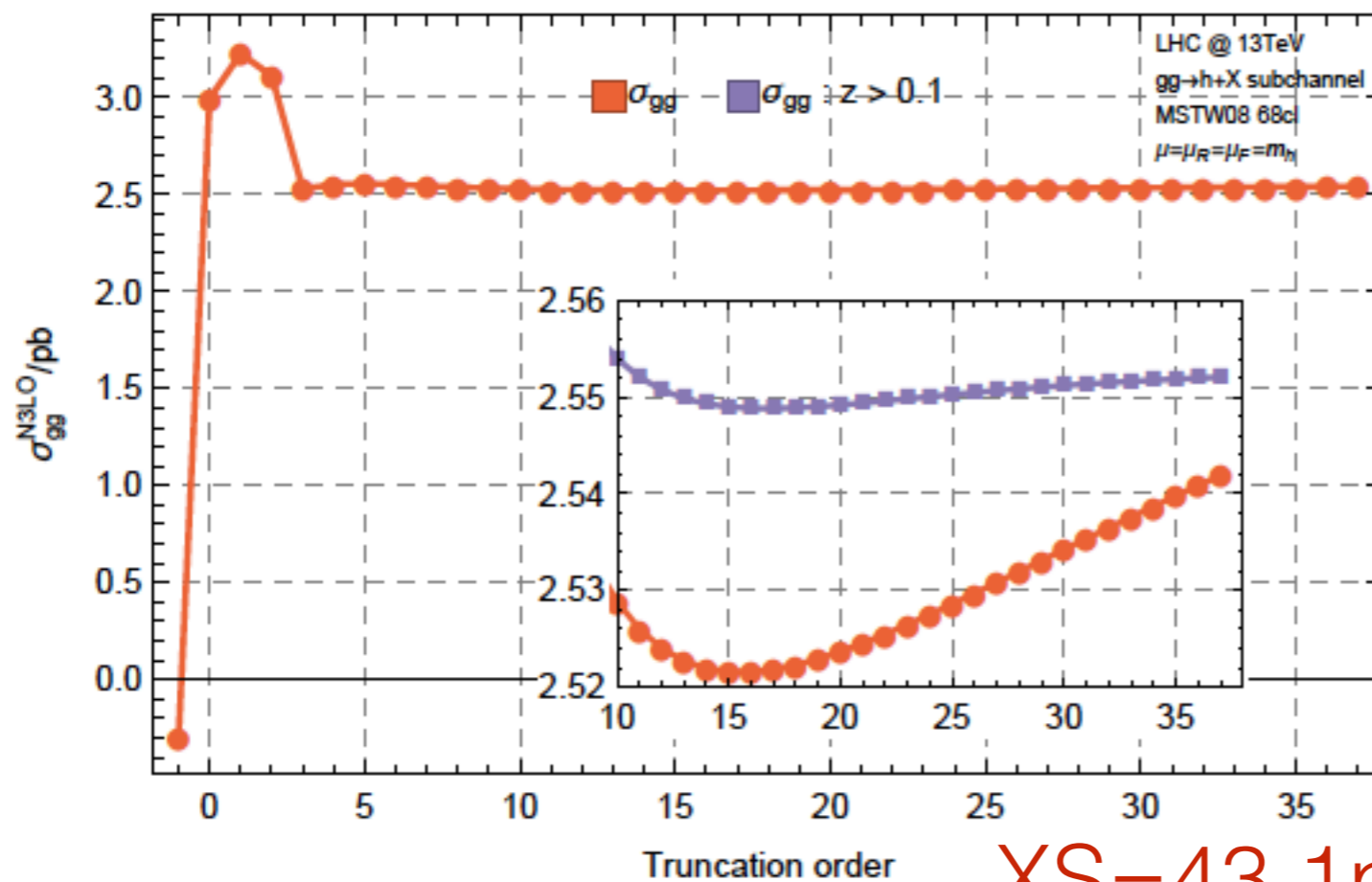
Good news:
perturbative series
converges well (at
least for central
scale $\mu = m_H/2$).

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N3LO inclusive XS

within the Effective Field Theory approach ($m_t \rightarrow \infty$)

$$\mathcal{L}_{\text{eff}} = -\frac{C}{4} H G_{\mu\nu}^a G^{a\mu\nu}$$



XS=43.1 pb

- The formally sub-leading $\log(1-z)$ coefficients are calculated as an expansion around threshold ($z=1$), to 36 terms.
- The slight increase is due to the small- z region and it is numerically insignificant (due to luminosity suppression).
- Numerical comparisons of the contributions of the leading logs (5,4,3) where full expressions are known corroborate this.
- Also happening at NNLO (where it also has no numerical impact to the cross-section).

Residual Uncertainties

PDFs and a_s

- New PDF4LHC recommendation (see talk by S. Forte on Friday)
- PDF uncertainty disentangled from a_s
- Almost perfect agreement among the PDF fits included: pure PDF uncertainty expected to drop to $\sim 2\%$.
- a_s uncertainty: dominant ($\sim 2-4\%$?) but hard to quantify
- Global issue that concerns the whole HXSWG (see talk by M. Grazzini and R. Harlander)

Residual Uncertainties

EW corrections: only known exactly to LO in QCD $\mathcal{O}(a_{ew}a_s^2)$

However, the QCD corrections to that are expected to be large

- Mixed QCD/EW corrections: known only for light quarks, as an expansion over m_H/m_W [Anastasiou, Petriello, Boughezal]
- Complete factorization: assumes EW K-factor same as LO: 5-6%
- Partial factorization: ignores EW corrections beyond LO in QCD: 1-2%
- EFT approach with light quark EW graphs only: assumes light quarks dominate (as in LO) and that the weak wilson coefficient doesn't change too much while crossing the (single) W threshold: 5-6%

Residual Uncertainties

Other uncertainties:

- Top mass effects at NNLO: below 1% [Harlander et al], [Steinhauser et al.]
- Top-bottom interference at NNLO: **UNKNOWN**
- Mass scheme dependence (OS vs MSbar)
- Parametric uncertainties: <1% if masses varied within PDG uncertainties.

Future plans

- The N3LO contributions will be published soon, along with a phenomenological study of most of the effects discussed here, and an updated version of ihixs.
- The ggf task force will then process this information, and in conjunction with the WG1 decisions on PDF and input parameters, will proceed towards a new proposal for a HXSWG recommendation on the inclusive cross-section (hopefully on time for the upcoming YR).