

The Higgs cross section at N³LO

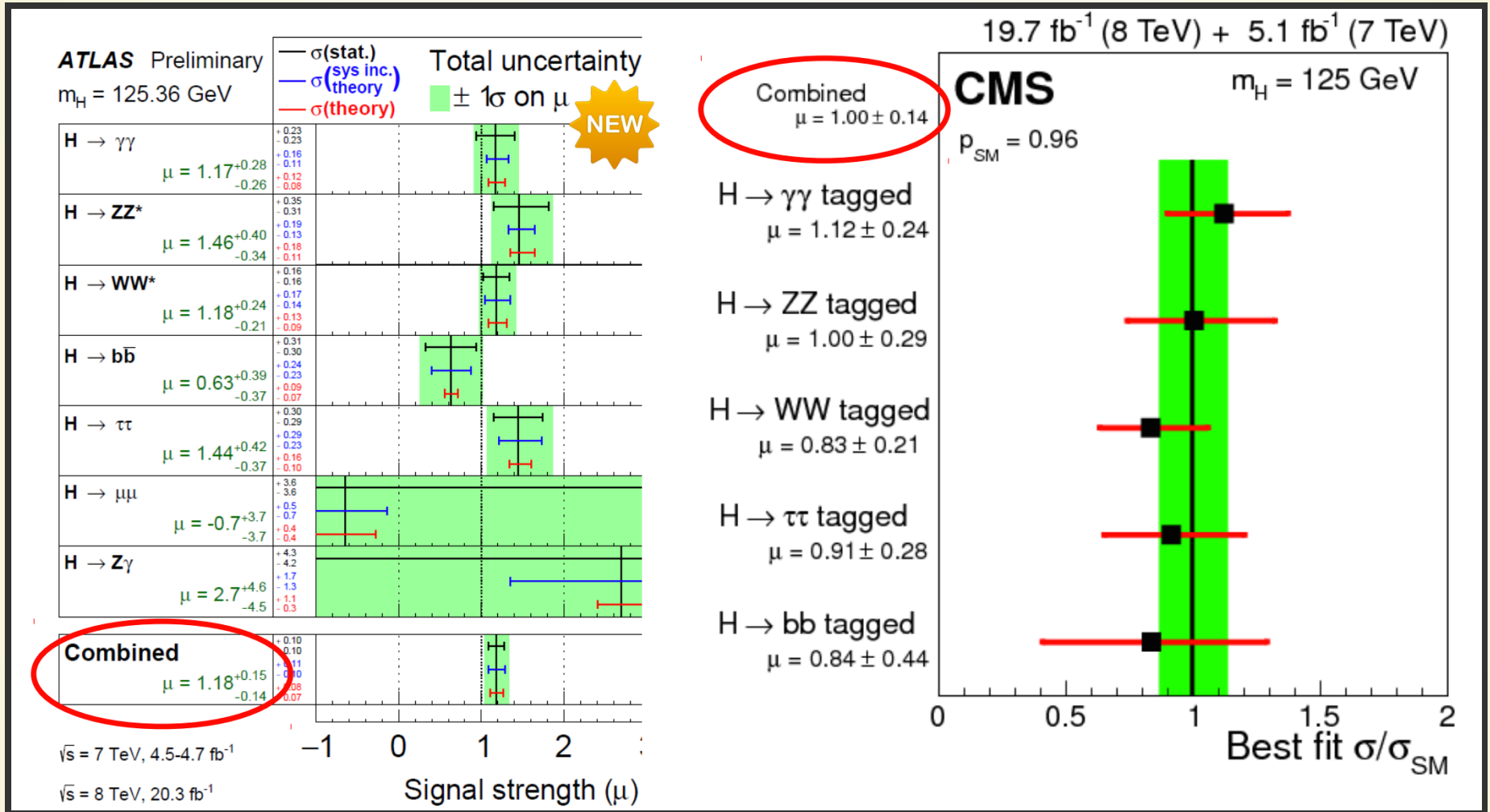
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PRECISION HIGGS PHYSICS AT THE LHC

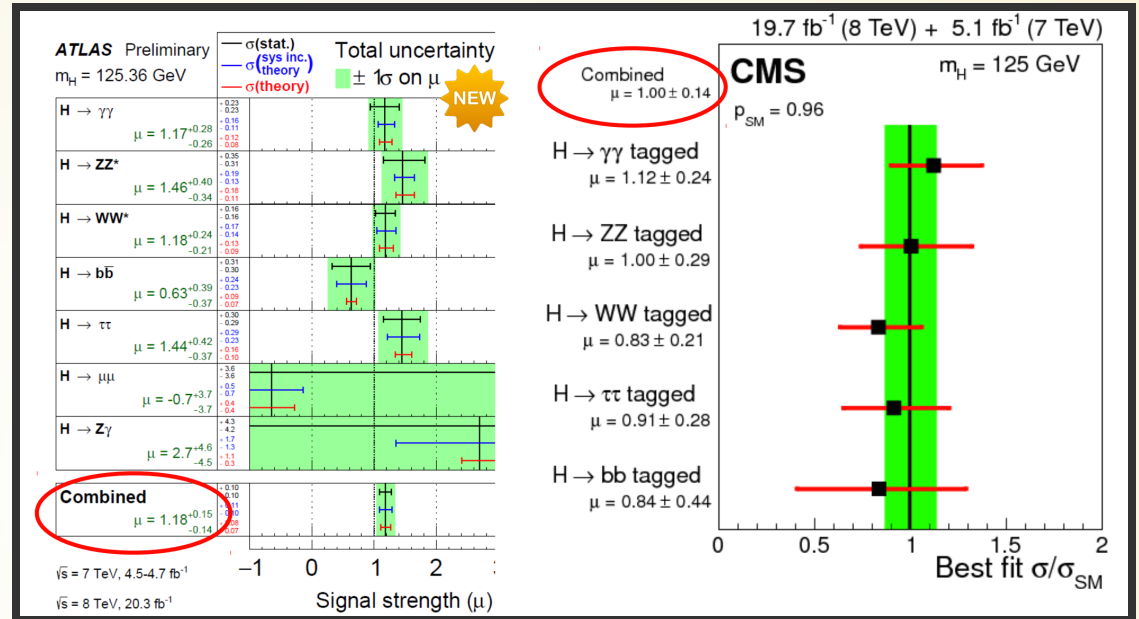


$$\mu_{\text{ATLAS}} = 1.17^{+0.15}_{-0.14}$$

$$\mu_{\text{CMS}} = 1.00 \pm 0.14$$

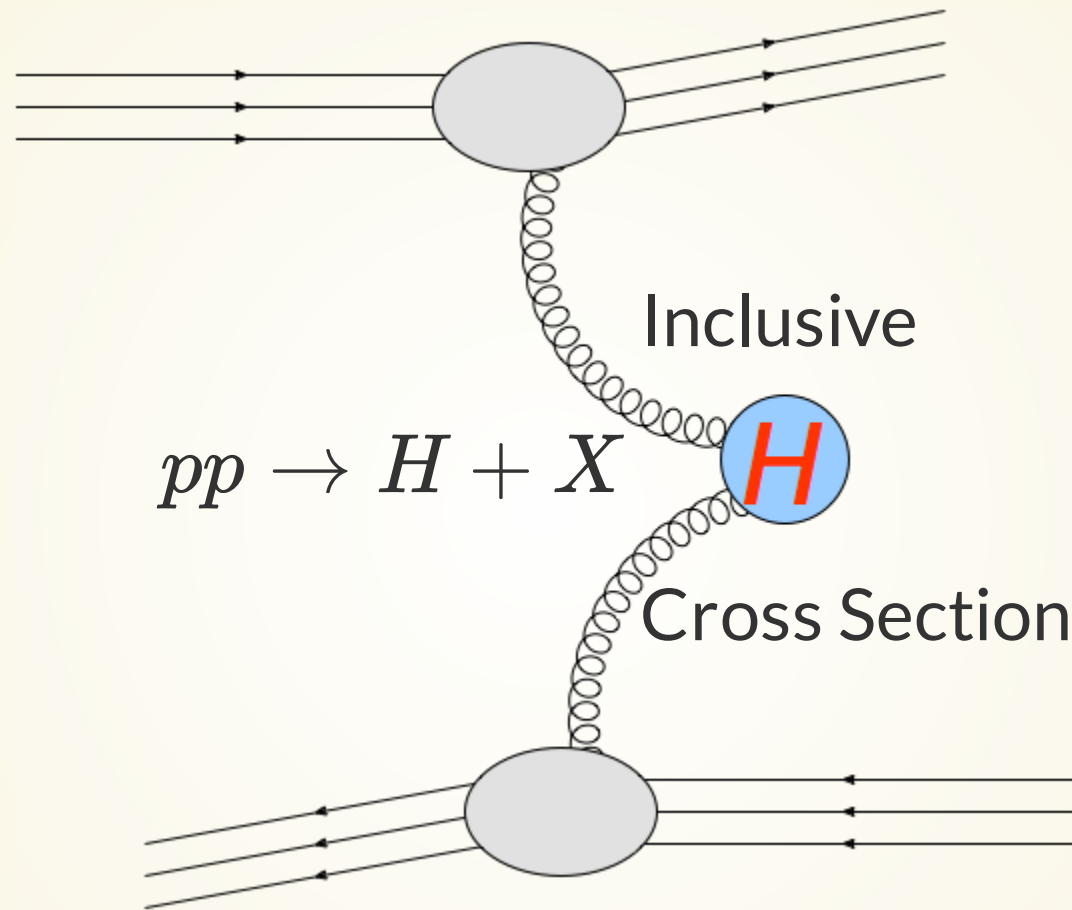
PRECISION HIGGS PHYSICS AT THE LHC

- The exact determination of the Higgs couplings is an important part of the LHC Higgs program



- Deviations from the standard model prediction can provide a window onto BSM physics
- Highly accurate measurements are in progress...
- We need to provide the best standard model predictions

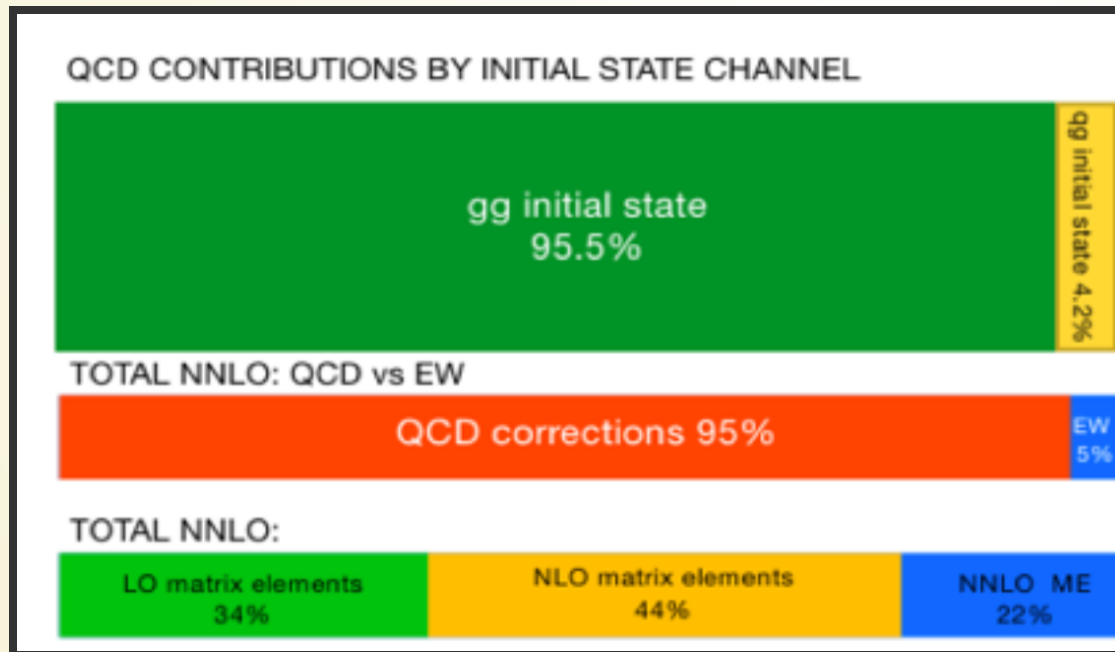
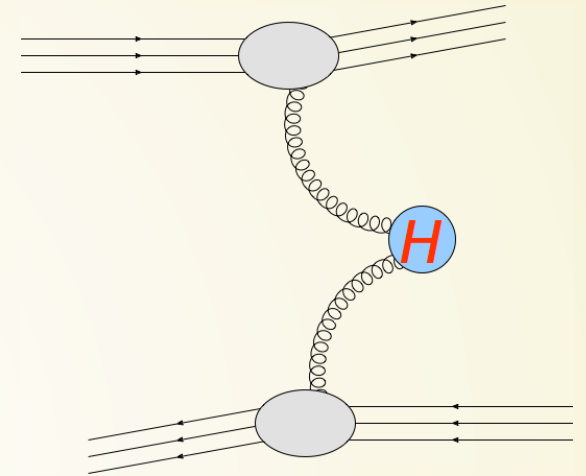
HIGGS PRODUCTION



$$\sigma_{pp \rightarrow H+X} = \int dx_1 dx_2 \text{pdf}_1(x_1) \text{pdf}_2(x_2) \hat{\sigma}(x_1 x_2)$$

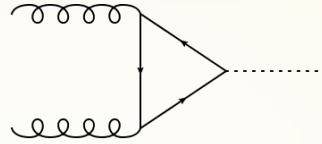
HIGGS PRODUCTION

- Calculate from fixed order QCD + PDFs
- Gluon fusion cross section dominates at the LHC

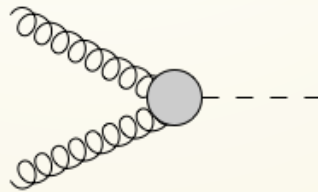


GLUON FUSION

- Loop induced process



- Higgs mass is small compared to the top mass
- Top loop can be integrated out
- Generates effective theory with tree level coupling



GLUON FUSION

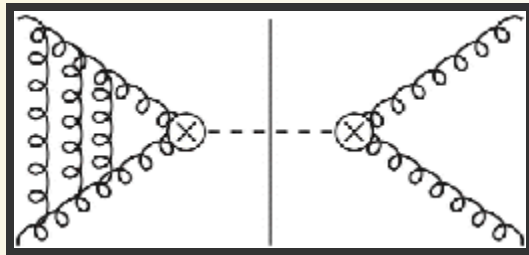
$$1978 \text{ LO } \sigma_{8\text{TeV}} = 9.6\text{pb} \pm 25\%$$

$$1991 \text{ NLO } \sigma_{8\text{TeV}} = 16.7\text{pb} \pm 20\%$$

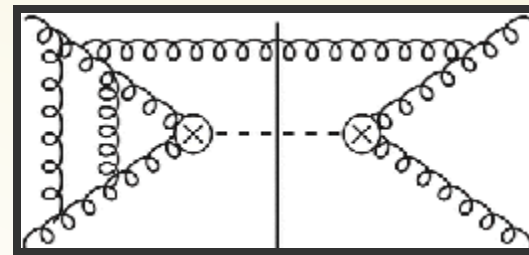
$$2002 \text{ NNLO } \sigma_{8\text{TeV}} = 19.6\text{pb} \pm 9\%$$

2015 N3LO

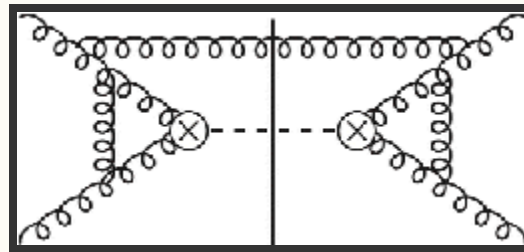
CONTRIBUTIONS TO N3LO



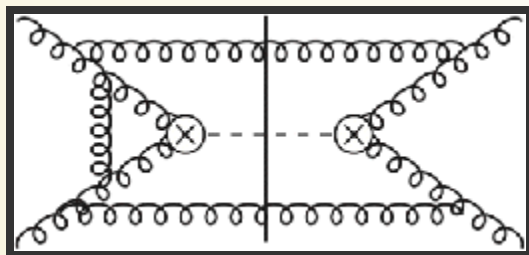
triple virtual



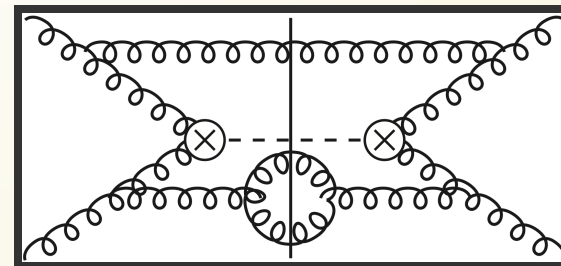
double virtual real



real virtual squared

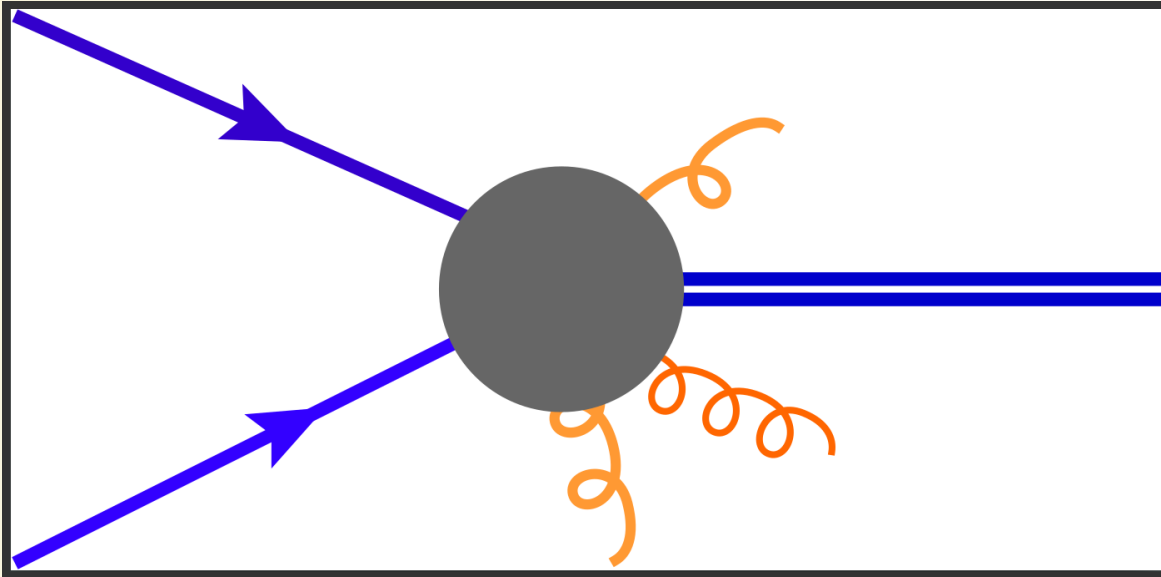


double real virtual



triple real

THRESHOLD EXPANSION

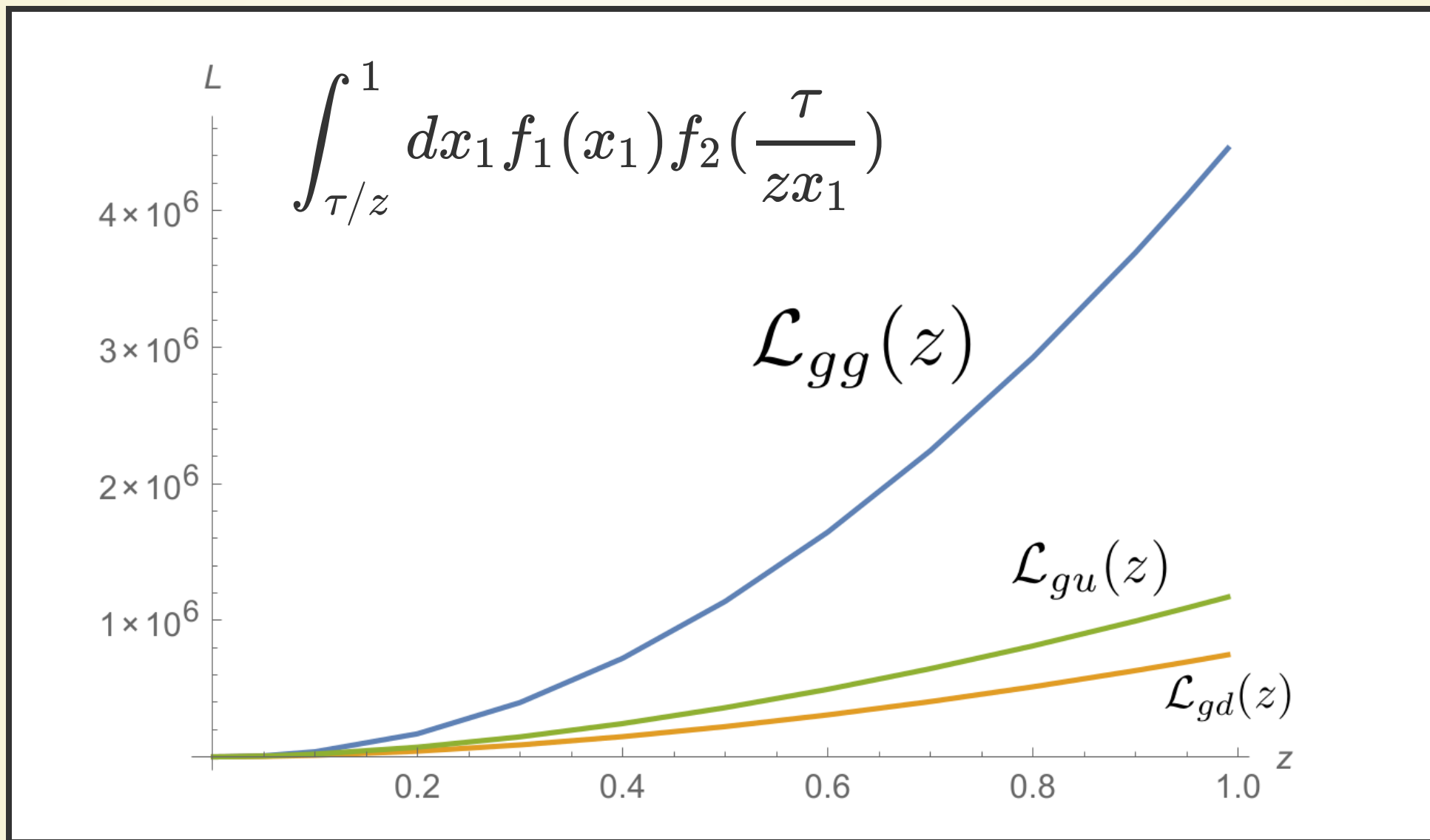


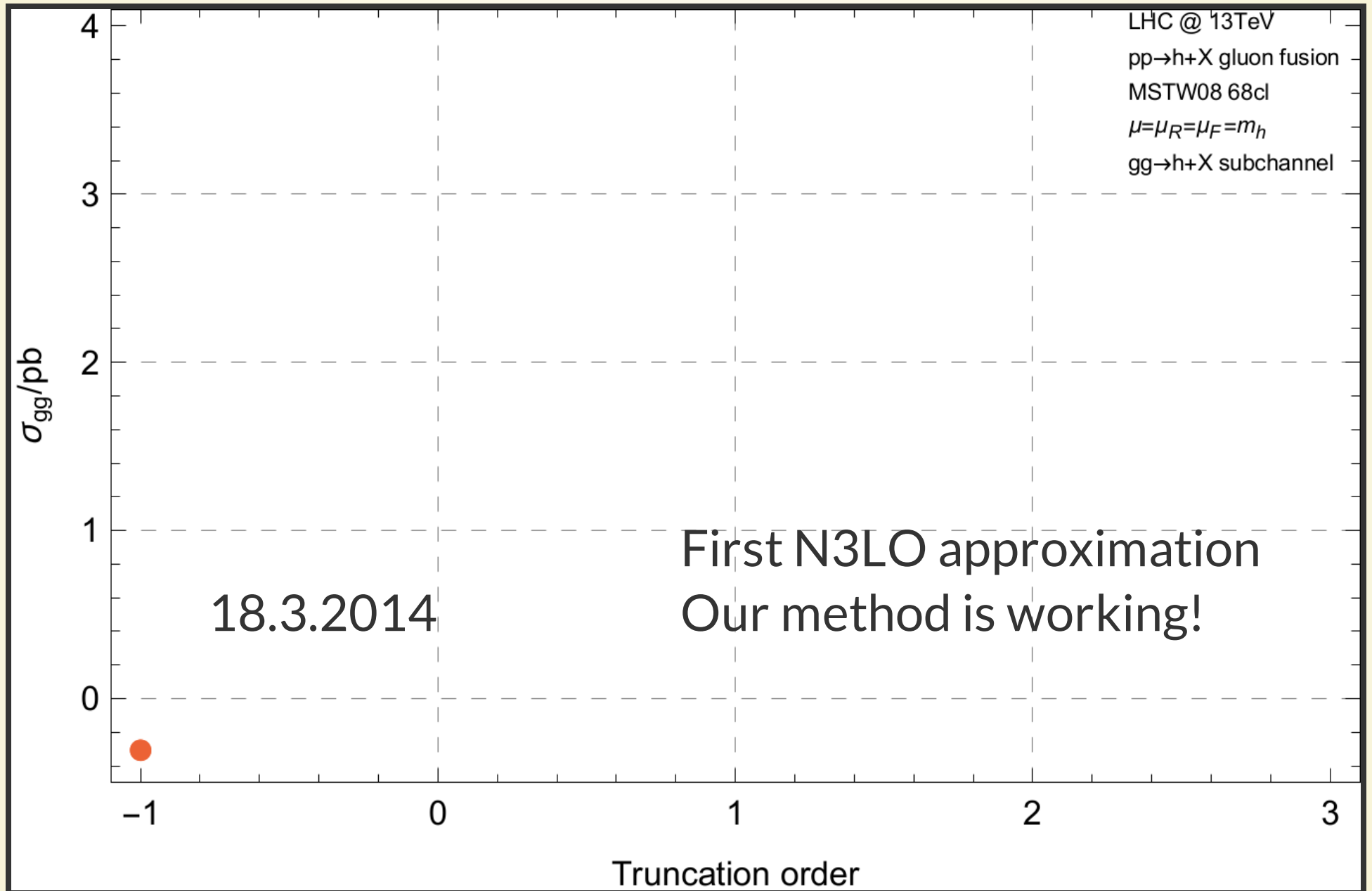
$$z = \frac{m_h^2}{s}$$

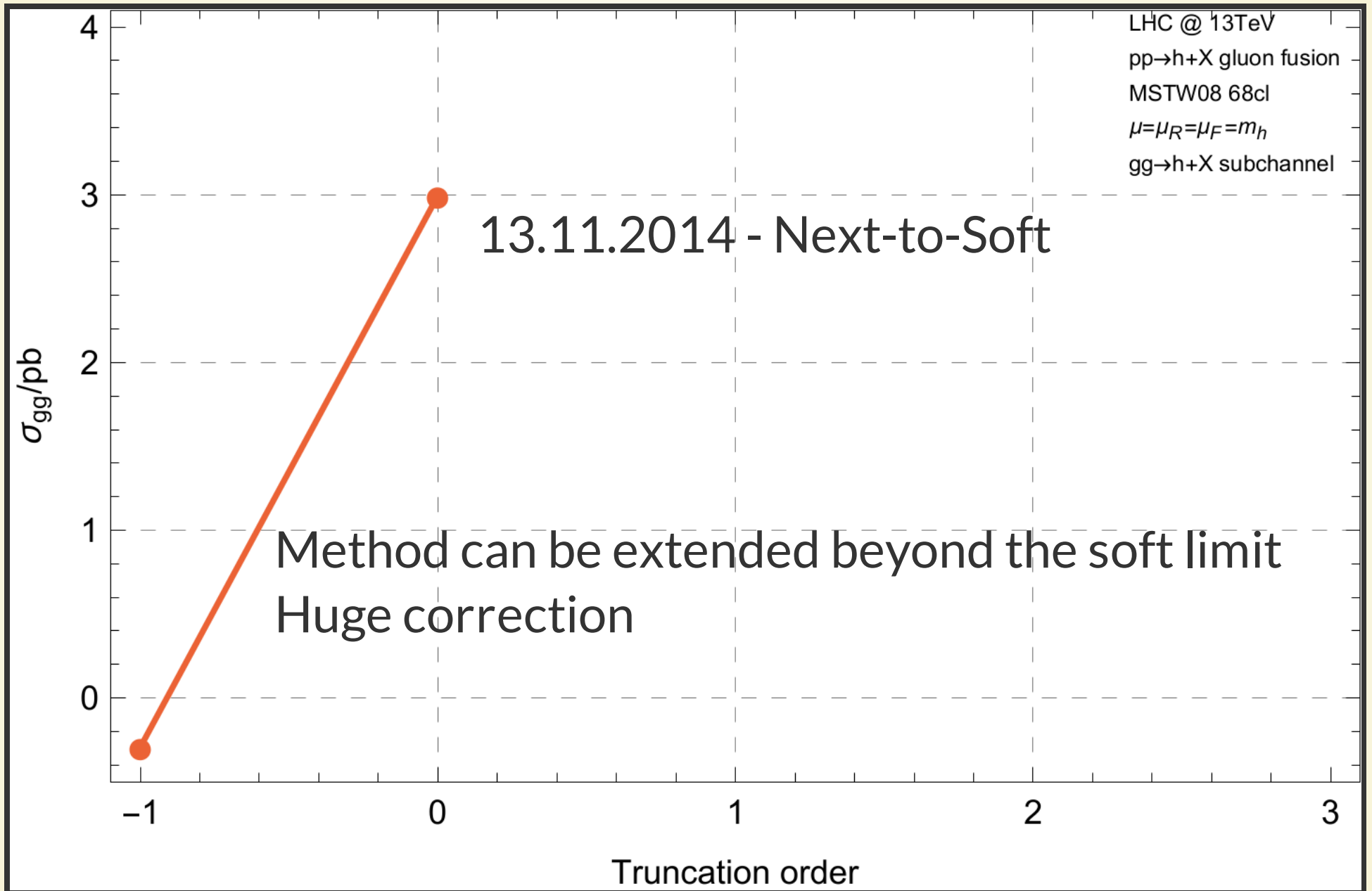
Expansion around the Higgs production threshold

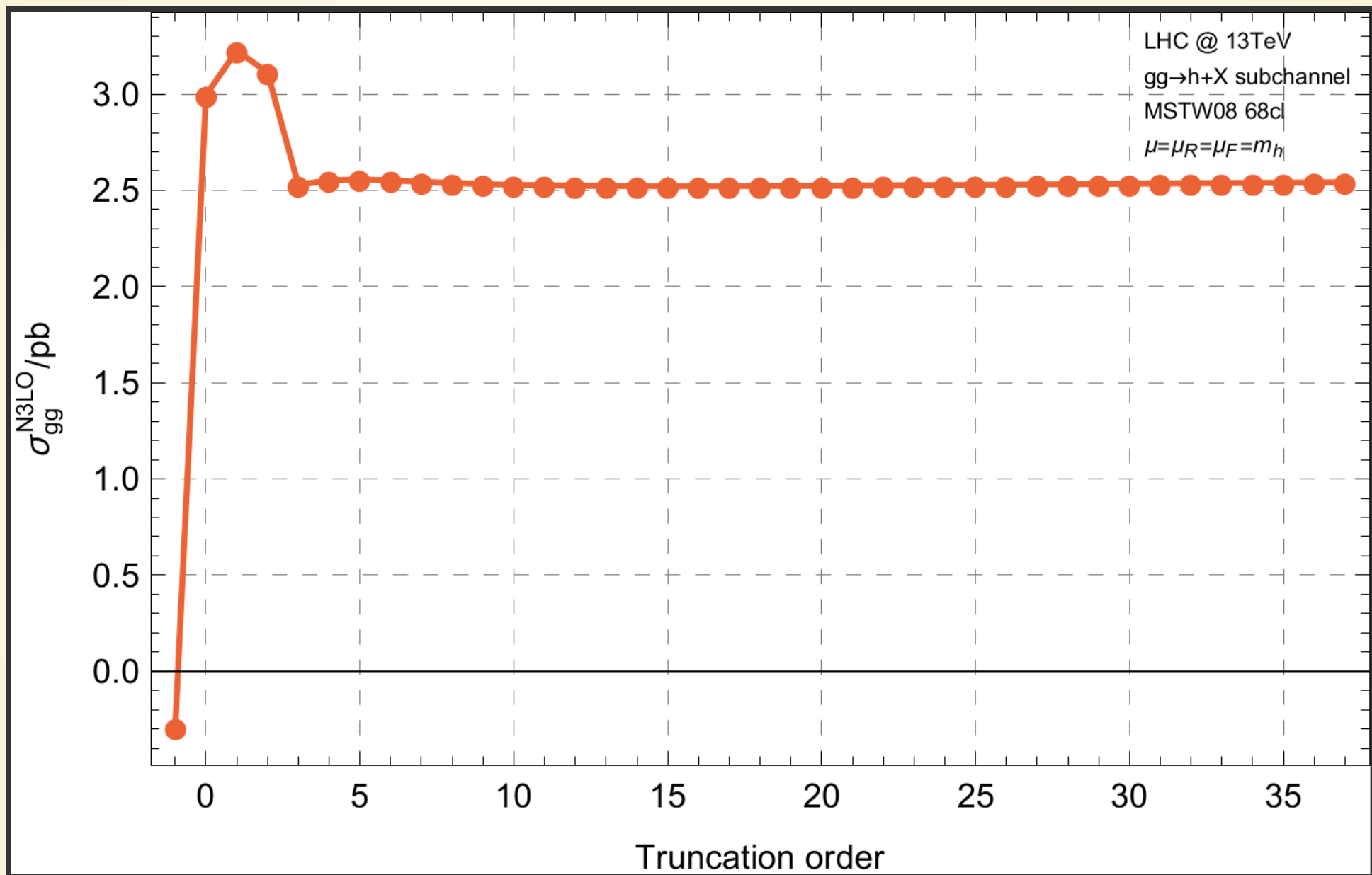
$$\hat{\sigma}(z) = \sigma^{\text{SV}} + \sigma^{(0)} + (1 - z)\sigma^{(1)} + \dots$$

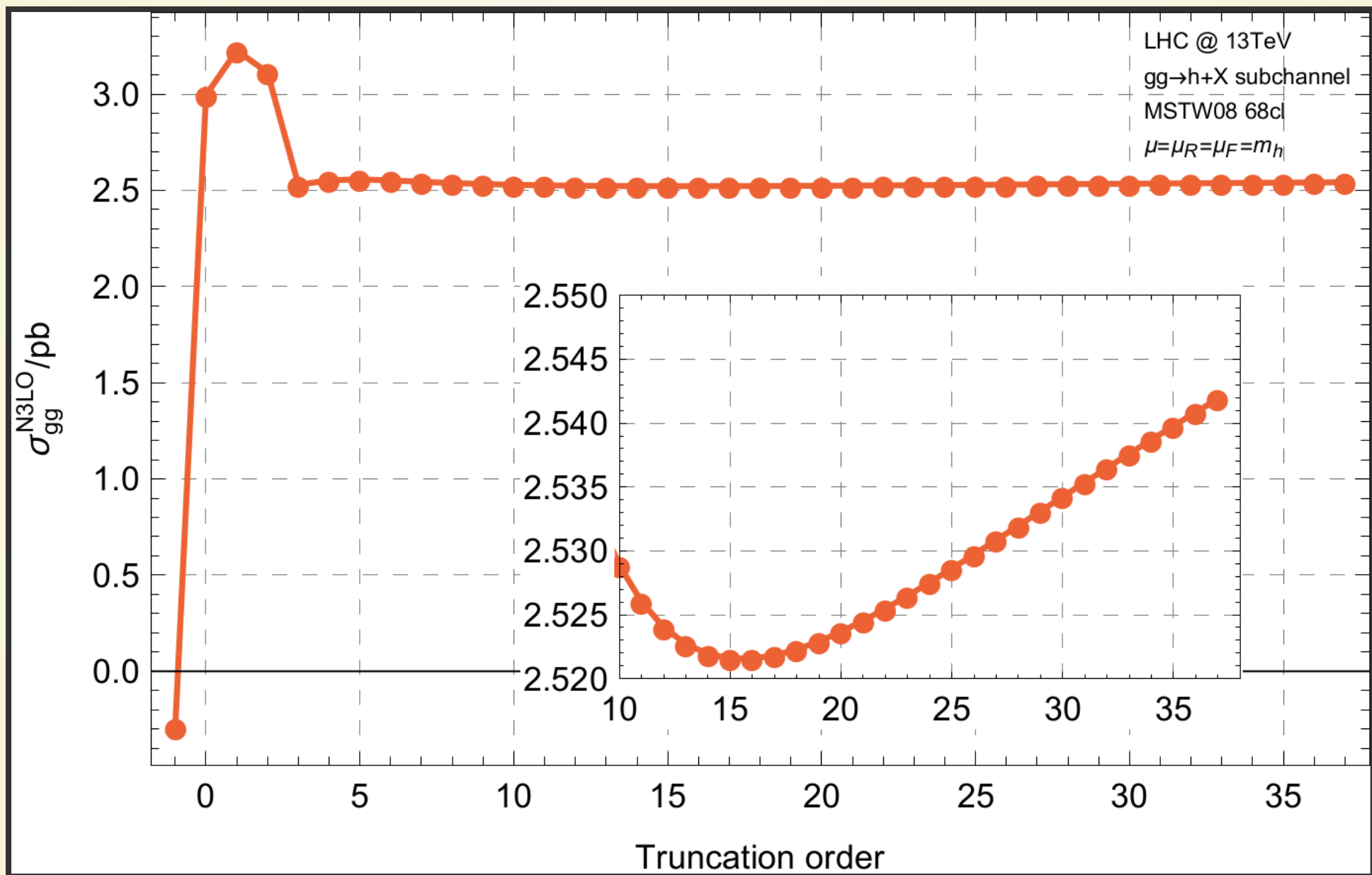
THRESHOLD EXPANSION

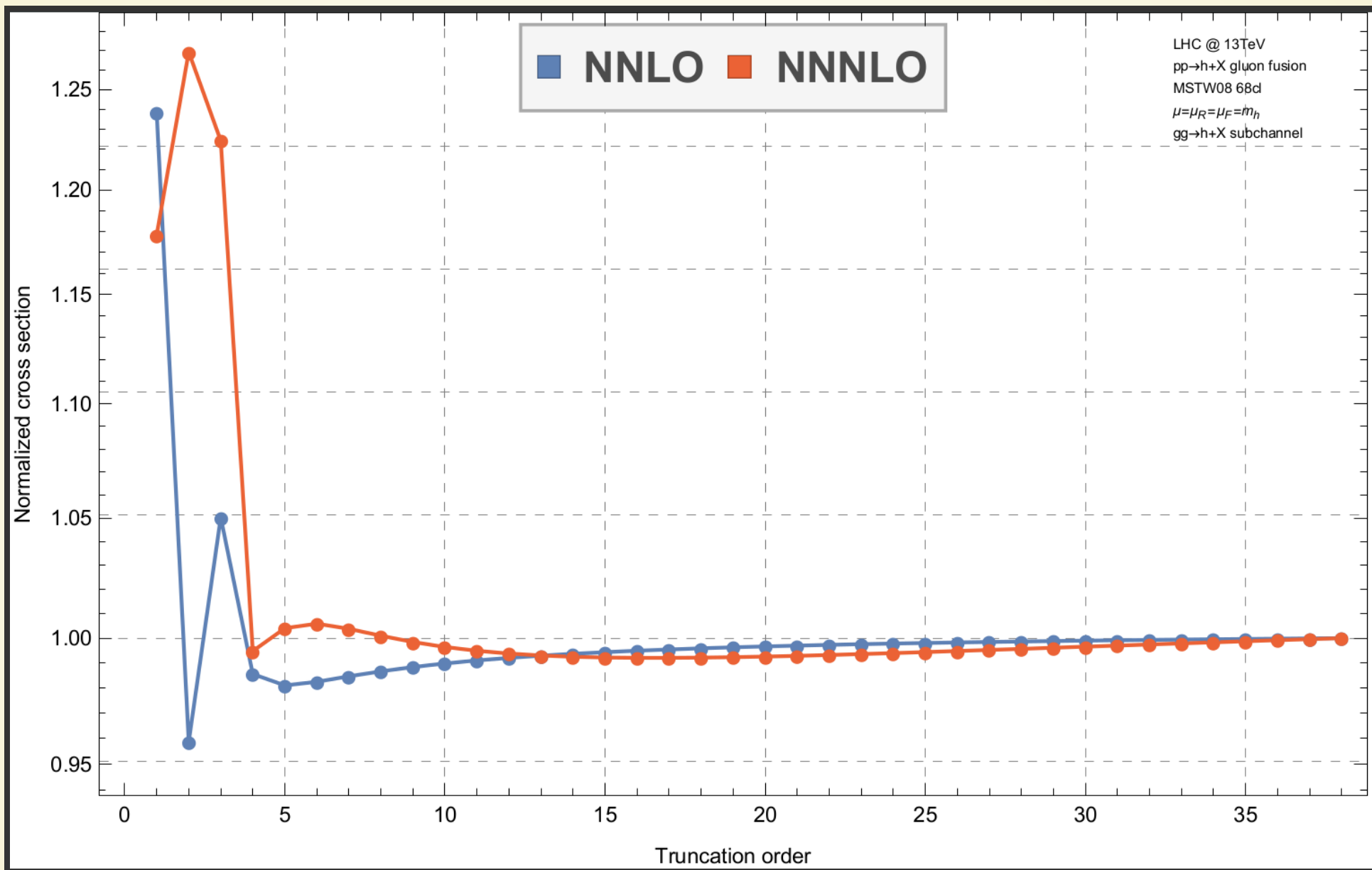


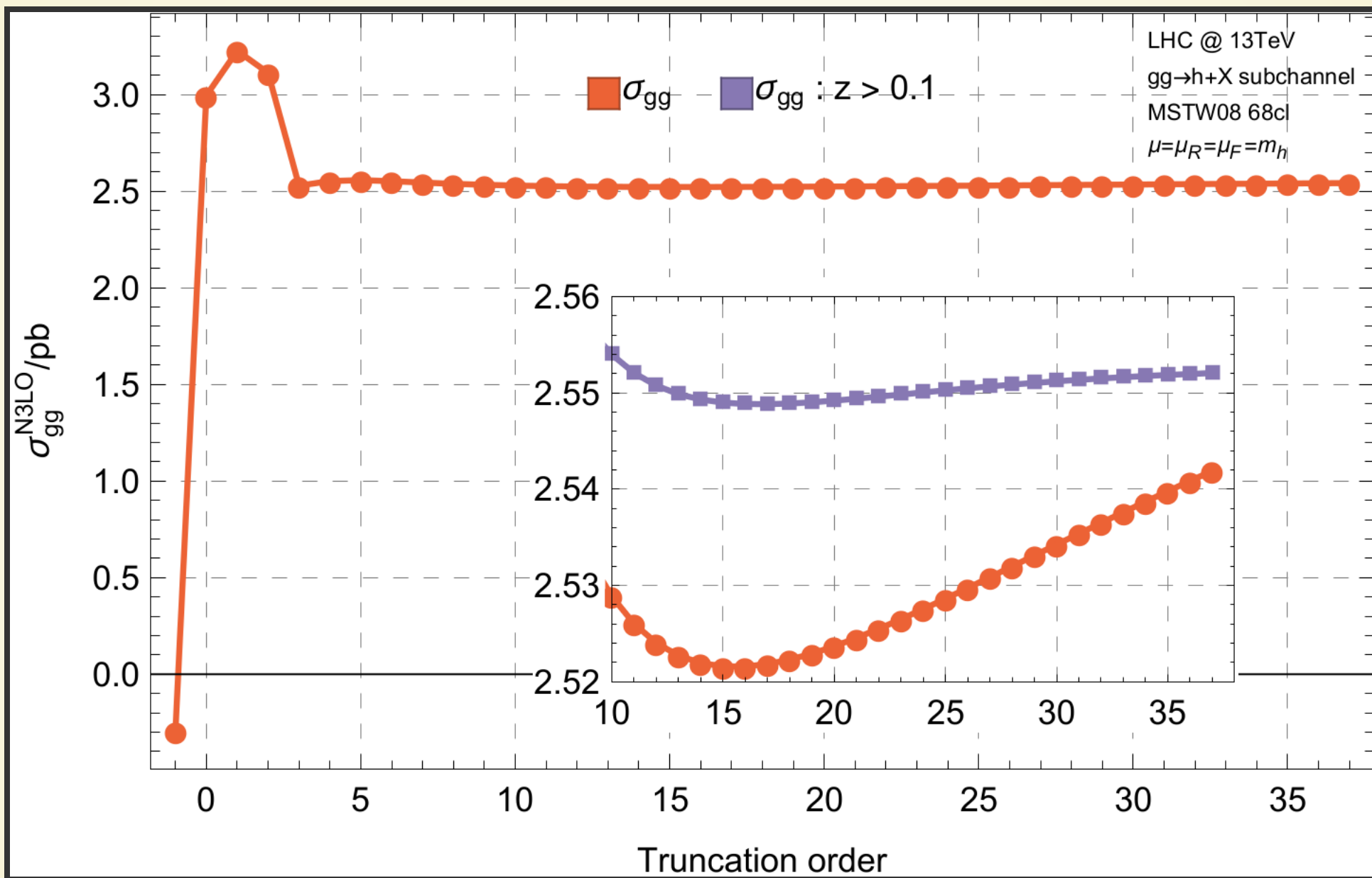


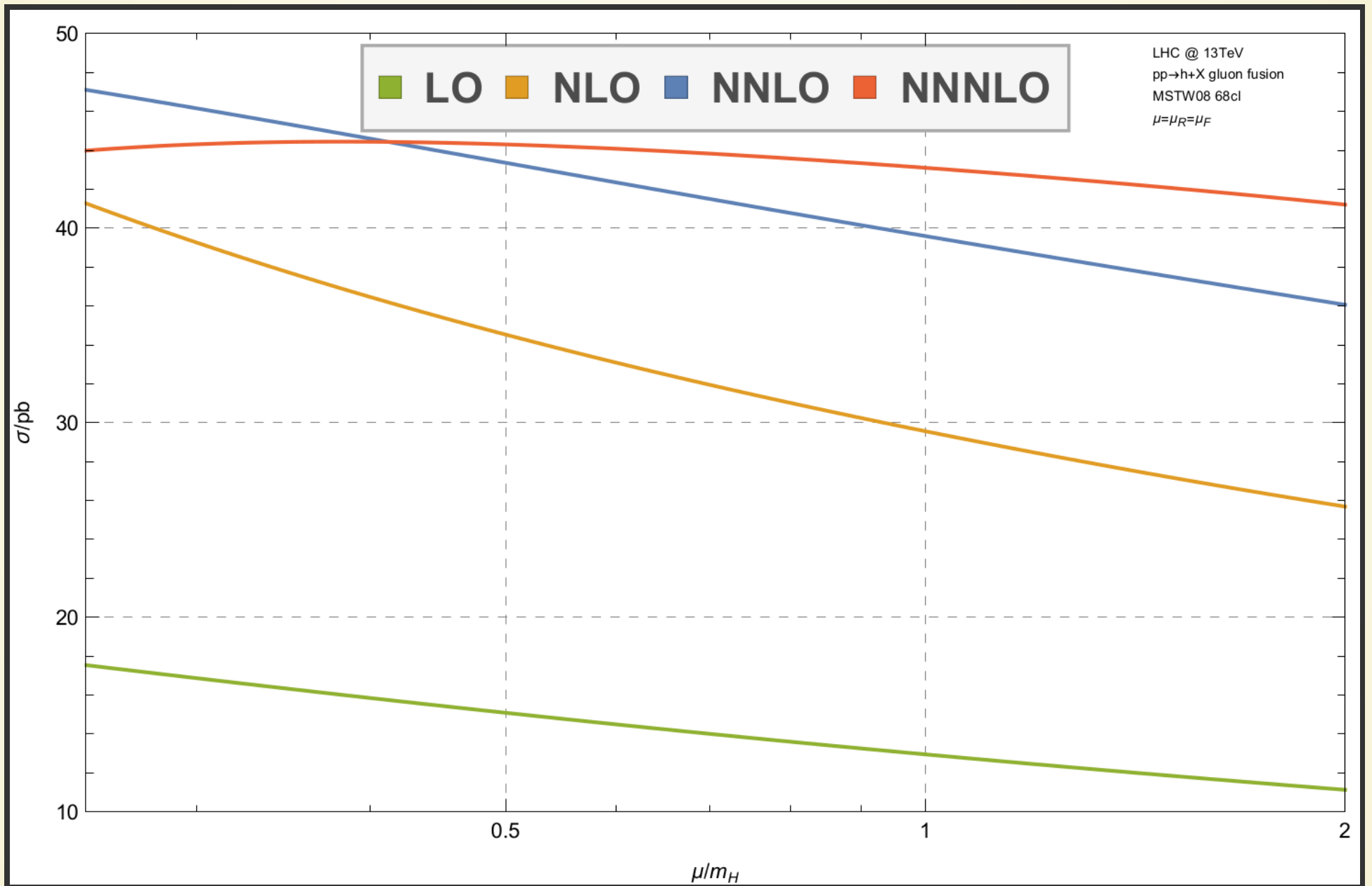


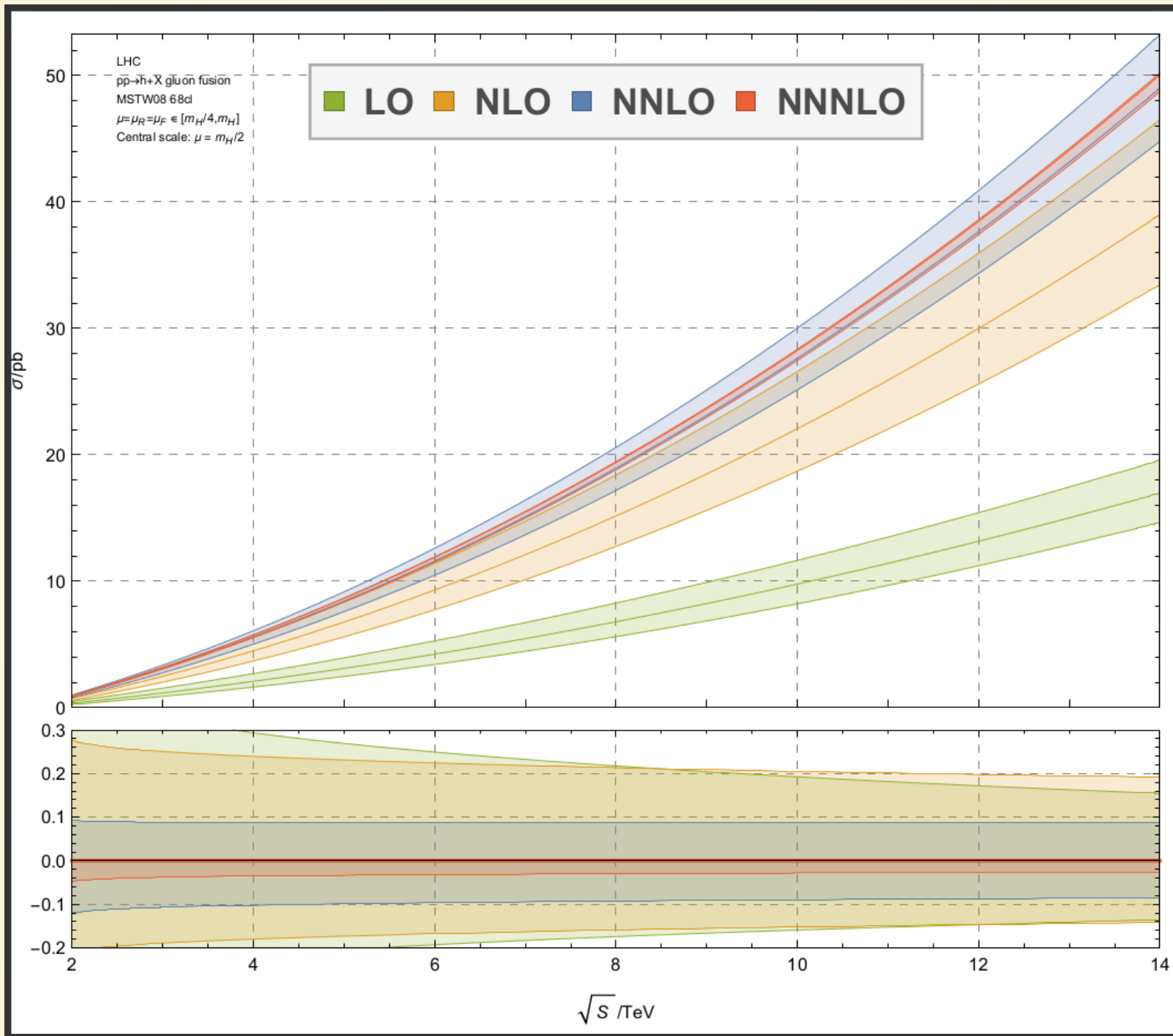












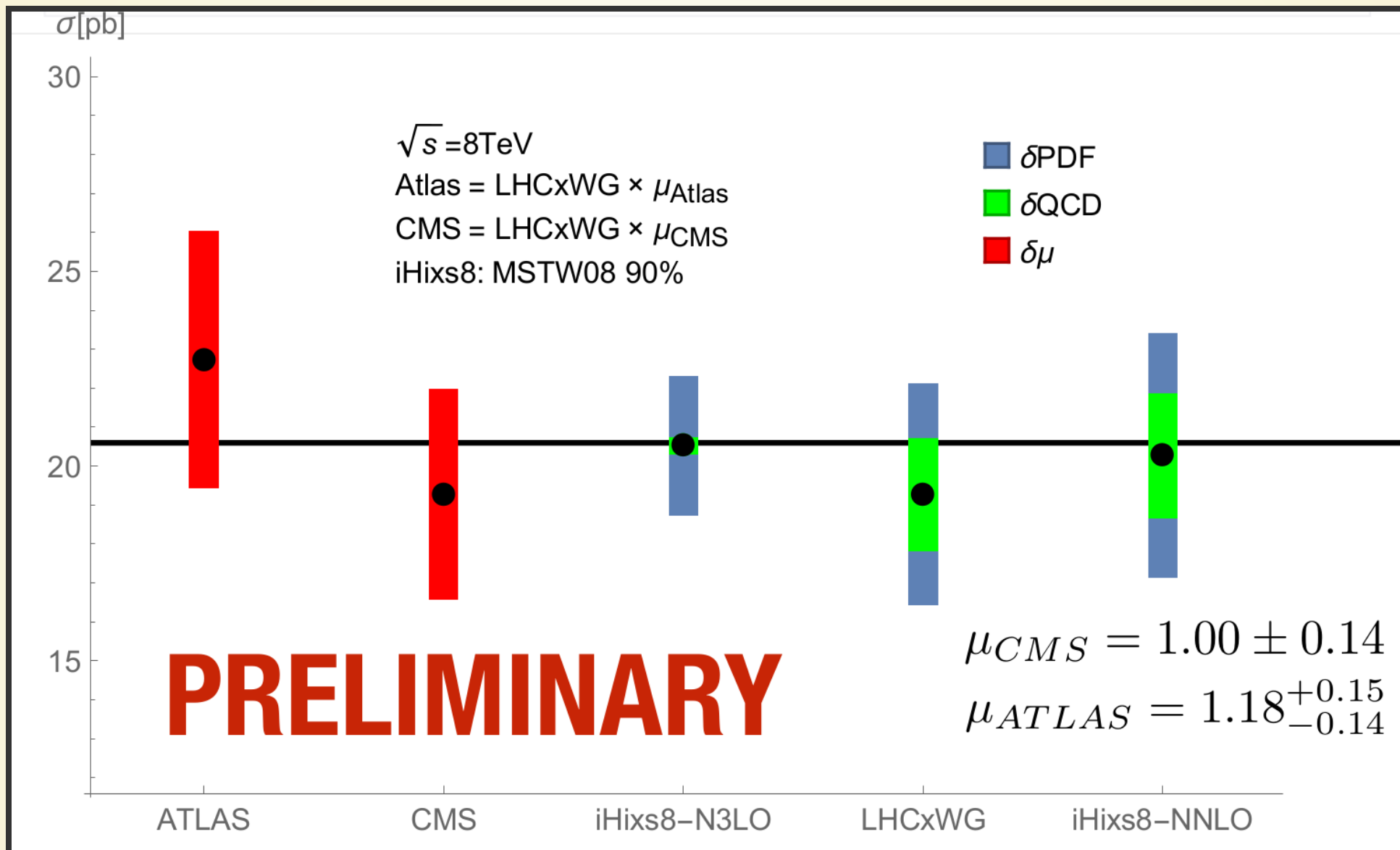
HIGH PRECISION HIGGS

The N3LO corrections dramatically reduce the perturbative uncertainty

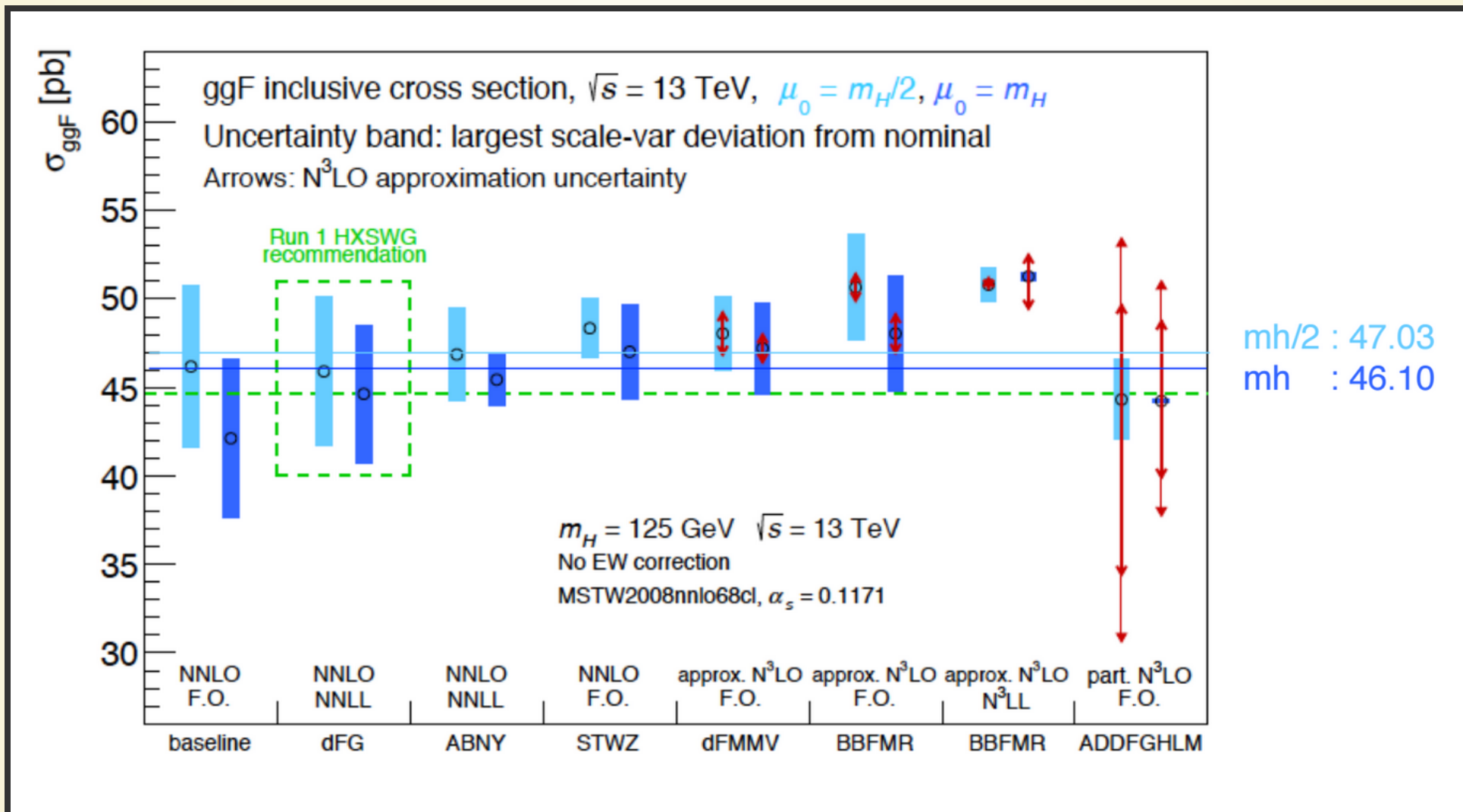
Previously negligible effects now become important:

- N4LO QCD
- PDF+ α_s !
- Electro-weak corrections
- Subleading terms in the heavy top approximation
- Bottom/Charm/Strange quark loops

We will reevaluate these effects and update the prediction and our code soon!



COMPARISON WITH PREVIOUS RESULTS



CONCLUSIONS

First complete calculation of an observable at N3LO

We have 30 orders in threshold expansion

Dramatic reduction of the scale dependence

Soon we will have an updated prediction for the LHC

Other processes and channels at N3LO will follow

Welcome to the N3LO precision era!