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Update on the evaluation of EW corrections for the AFB measurement: higher-orders and photon-induced contributions

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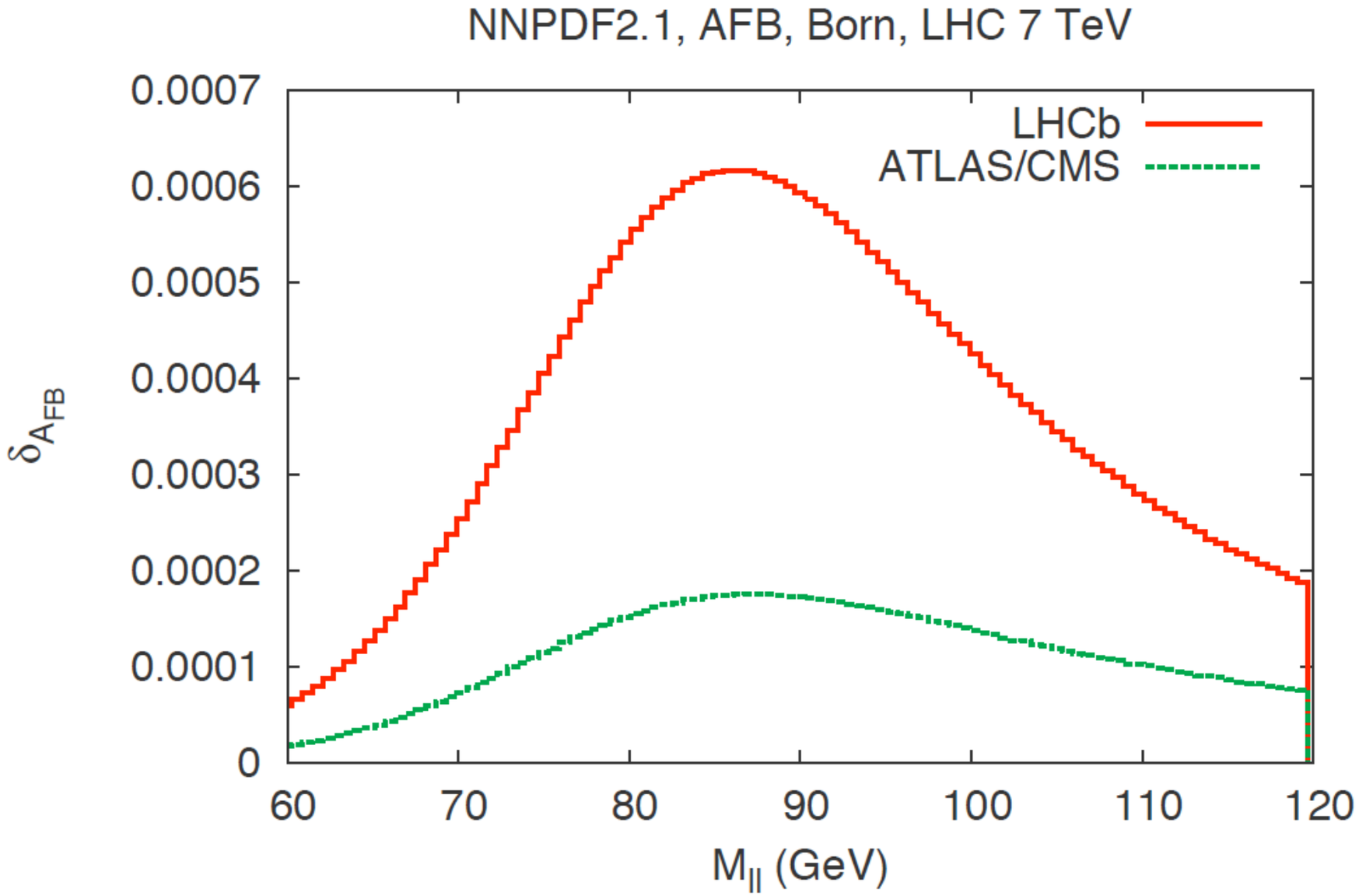
Sensitivity to $\sin^2\theta_W$

$$\delta A_{FB} = A_{FB}(\sin^2\theta_W + \delta\sin^2\theta_W) - A_{FB}(\sin^2\theta_W - \delta\sin^2\theta_W)$$

$$\delta\sin^2\theta_W = 0.0001$$



the maximal sensitivity to $\sin^2\theta_{eff}$ is observed in the Z resonance region

we need to predict A_{FB} having under control all the effects yielding $\delta A_{FB} \sim 1 \times 10^{-4}$

Updates on:

Prediction of AFB

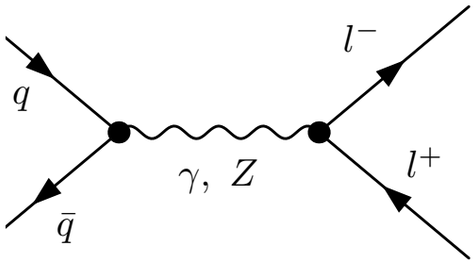
→ breakdown of the NLO-EW

→ access to different subsets of $O(\alpha^2)$ corrections

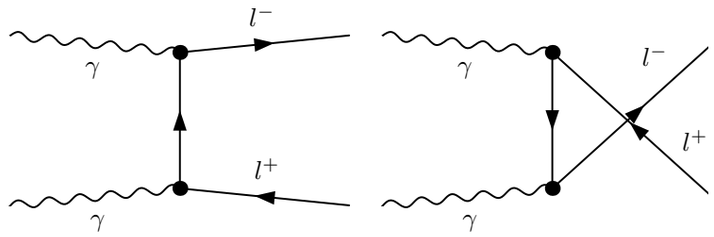
all preliminary (high statistics) results

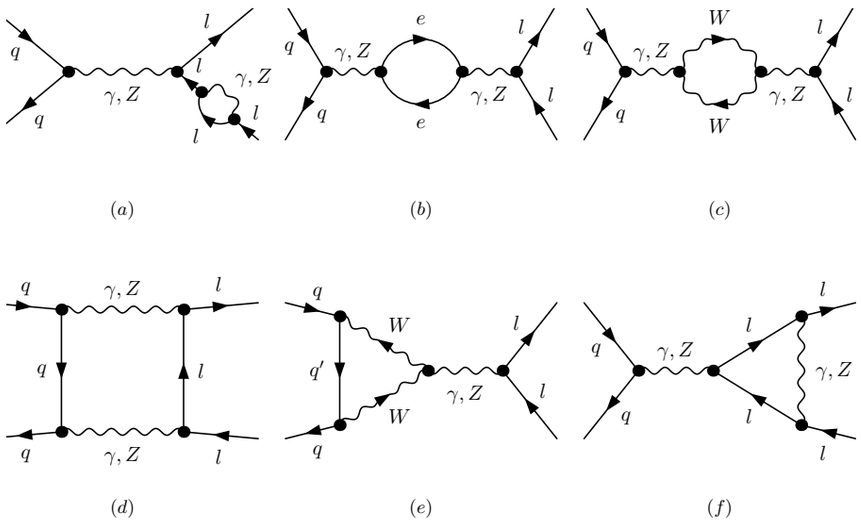
analysis of the results very preliminary

Partonic subprocesses contributing at O(α)

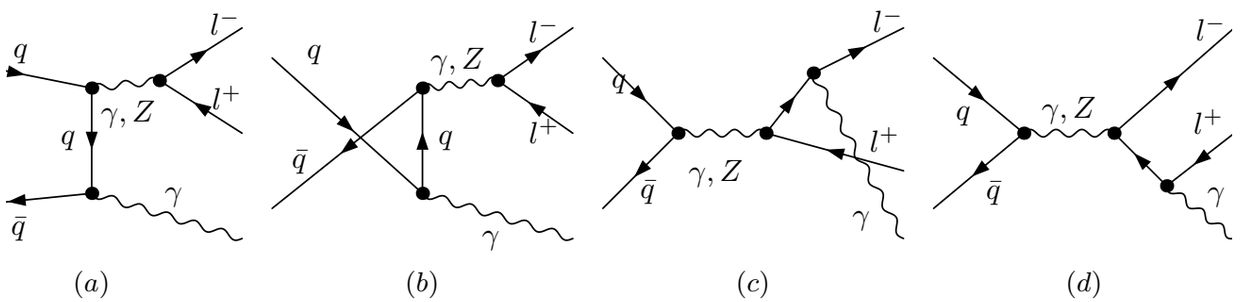


Born

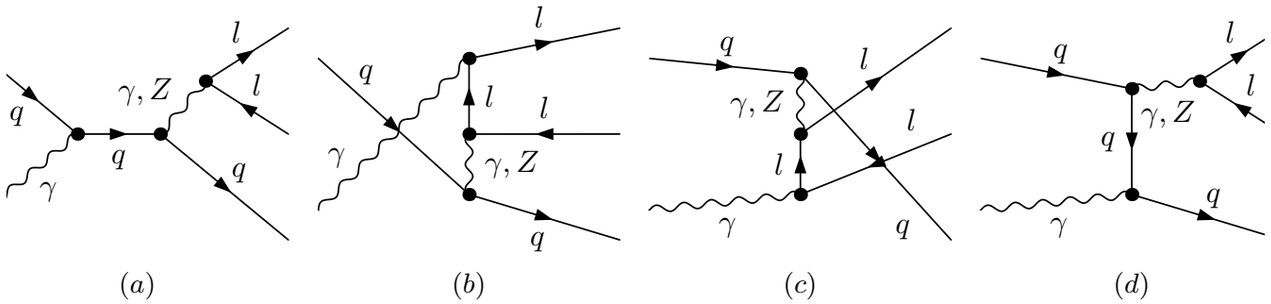




O(α) virtual: photonic and purely weak



O(α) real bremsstrahlung:
FSR, ISR, IFI



O(α) photon induced

The HORACE matching formulation

$$d\sigma^{\infty}_{matched} =$$

$$\Pi_S(Q^2) F_{SV} \sum_{n=0}^{\infty} d\hat{\sigma}_0 \frac{1}{n!} \prod_{i=0}^{n} \left(\frac{\alpha}{2\pi} P(x_i)\, I(k_i)\, dx_i\, d\cos\theta_i\, F_{H,i} \right)$$

$$F_{SV} = 1 + \frac{d\sigma^{\alpha,ex}_{SV} - d\sigma^{\alpha,PS}_{SV}}{d\sigma_0} \qquad F_{H,i} = 1 + \frac{d\sigma^{\alpha,ex}_{H,i} - d\sigma^{\alpha,PS}_{H,i}}{d\sigma^{\alpha,PS}_{H,i}}$$

The matched HORACE formula is based on the all-orders QED Parton Shower structure

The presence of the overall Sudakov form factor guarantees the "semi-classical" limit
The Sudakov form factor contains the (IR) LL virtual corrections

The exact O(α) accuracy is reached by adding
finite (no IR-div) soft+virtual effect in the overall factor F_SV (e.g. input scheme terms)
exact (vs. eikonal) hard matrix element effects to every photon emission F_H,i

Higher-order contributions appear because of the factorised formulation

Setup and naming conventions

PDF sets NNPDF31_nlo_as_0118
NNPDF31_nlo_as_0118_luxqed

$\mu = \hat{s}$

Gmu scheme

complex pole MZ and MW values

mll > 50 GeV ptlep > 25 GeV |etalep| < 2.5

Approximations under study

1) LO qqbar only or qqbar+γγ

2) NLO-EW qqbar only or qqbar+γγ

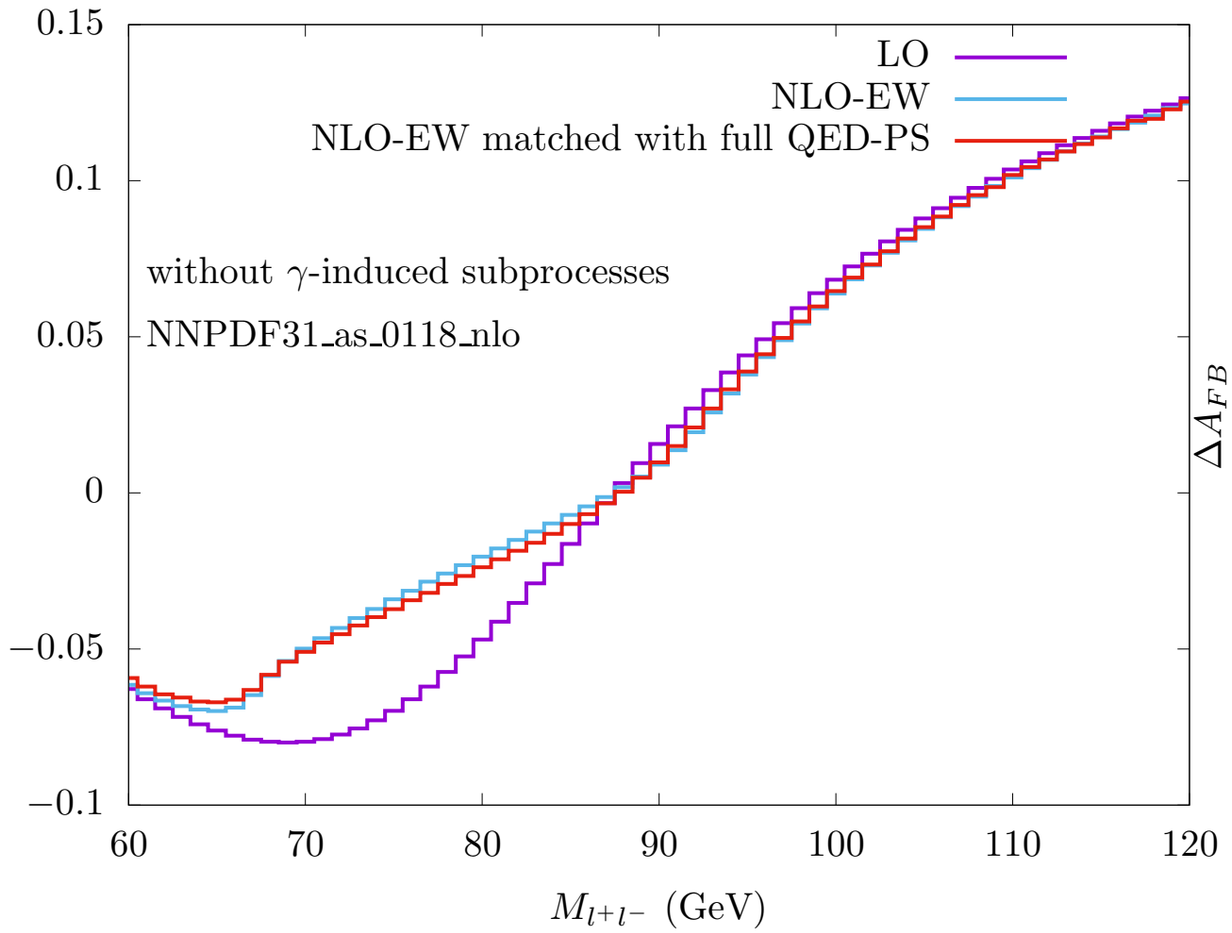
3) matched NLO-EW with full QED-PS (no γγ)

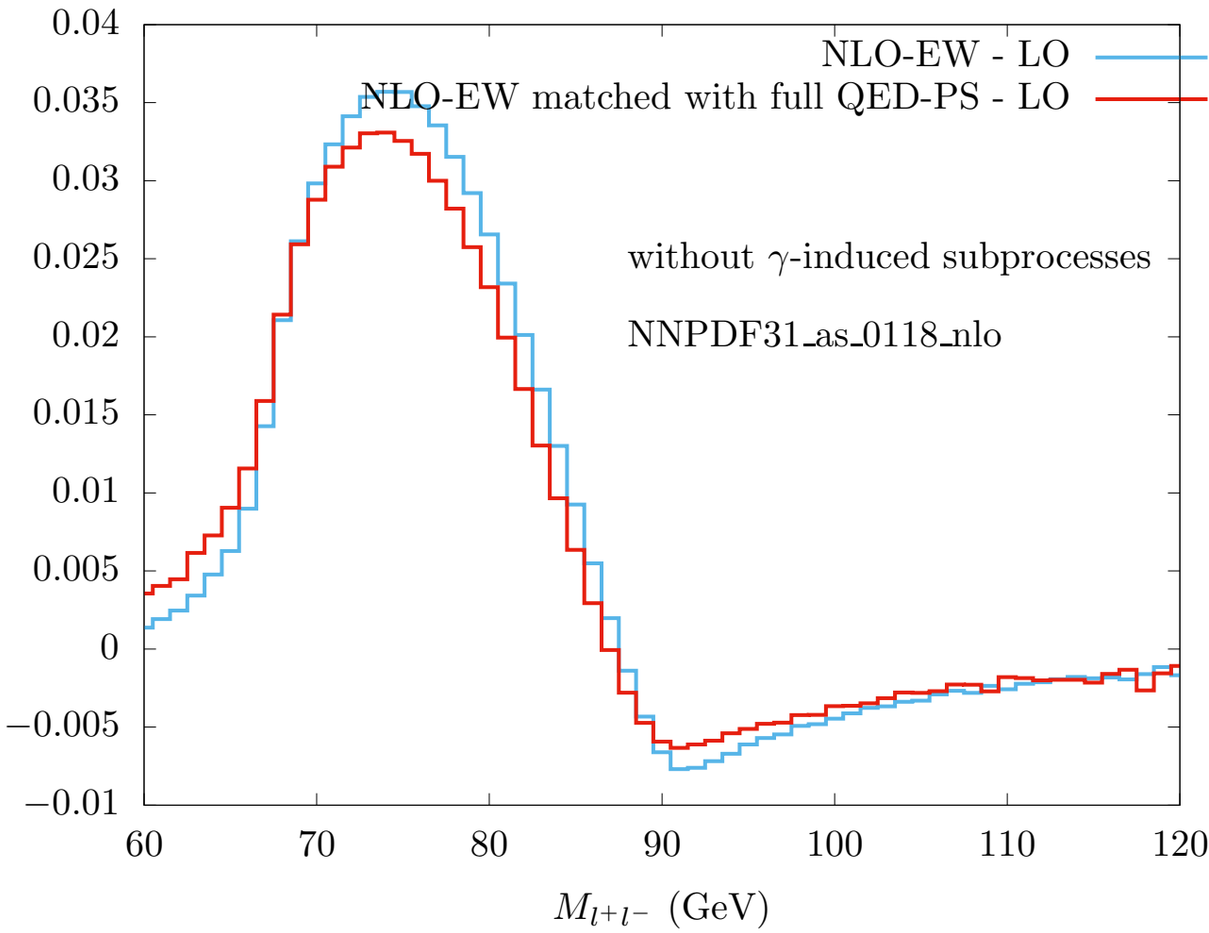
4) O(α) QED-FSR (no γγ)

5) exp QED FSR (all orders) (no γγ)

A_{FB} distribution: LO, NLO-EW, NLO-EW matched with QED-PS

basic approximations



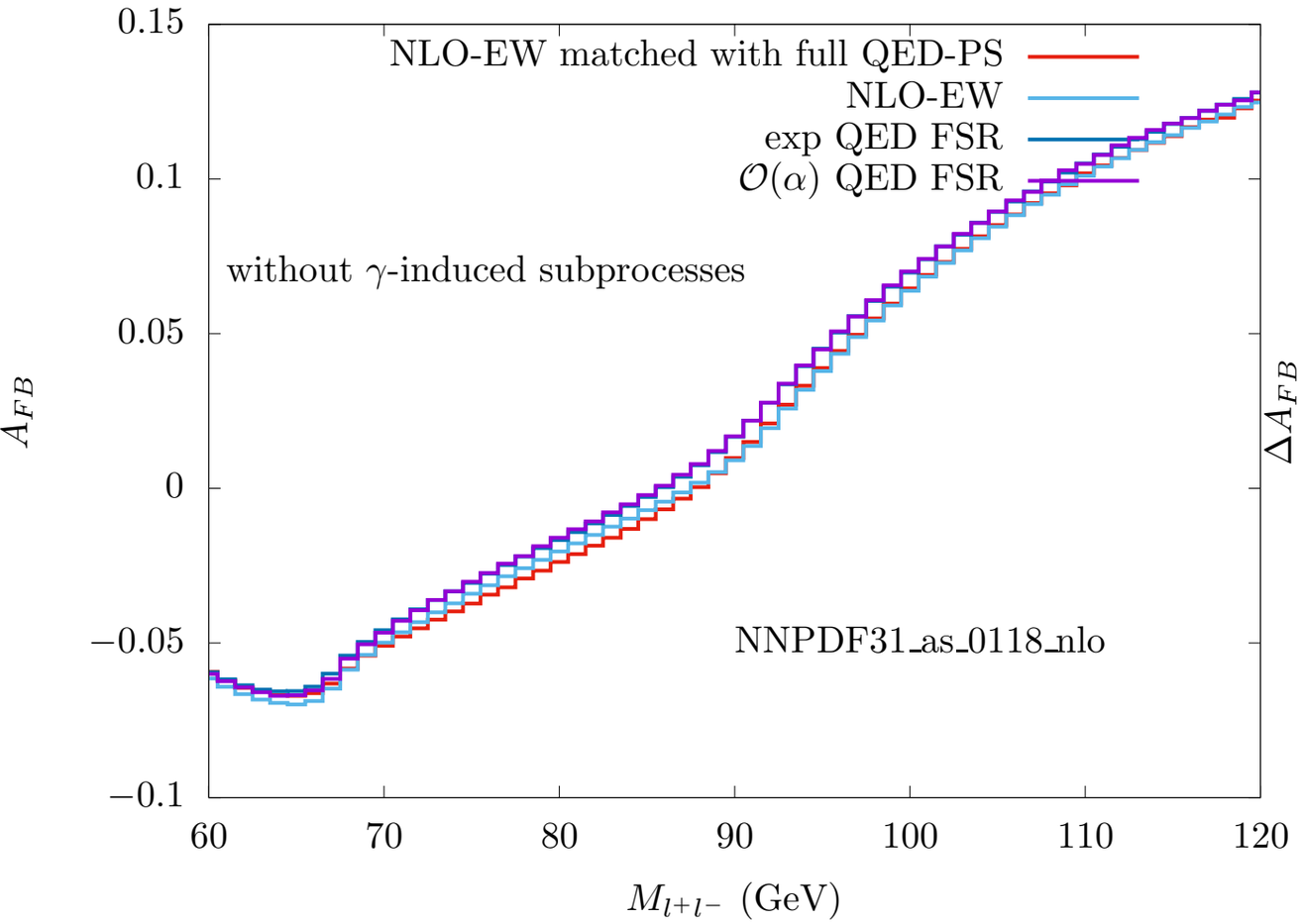


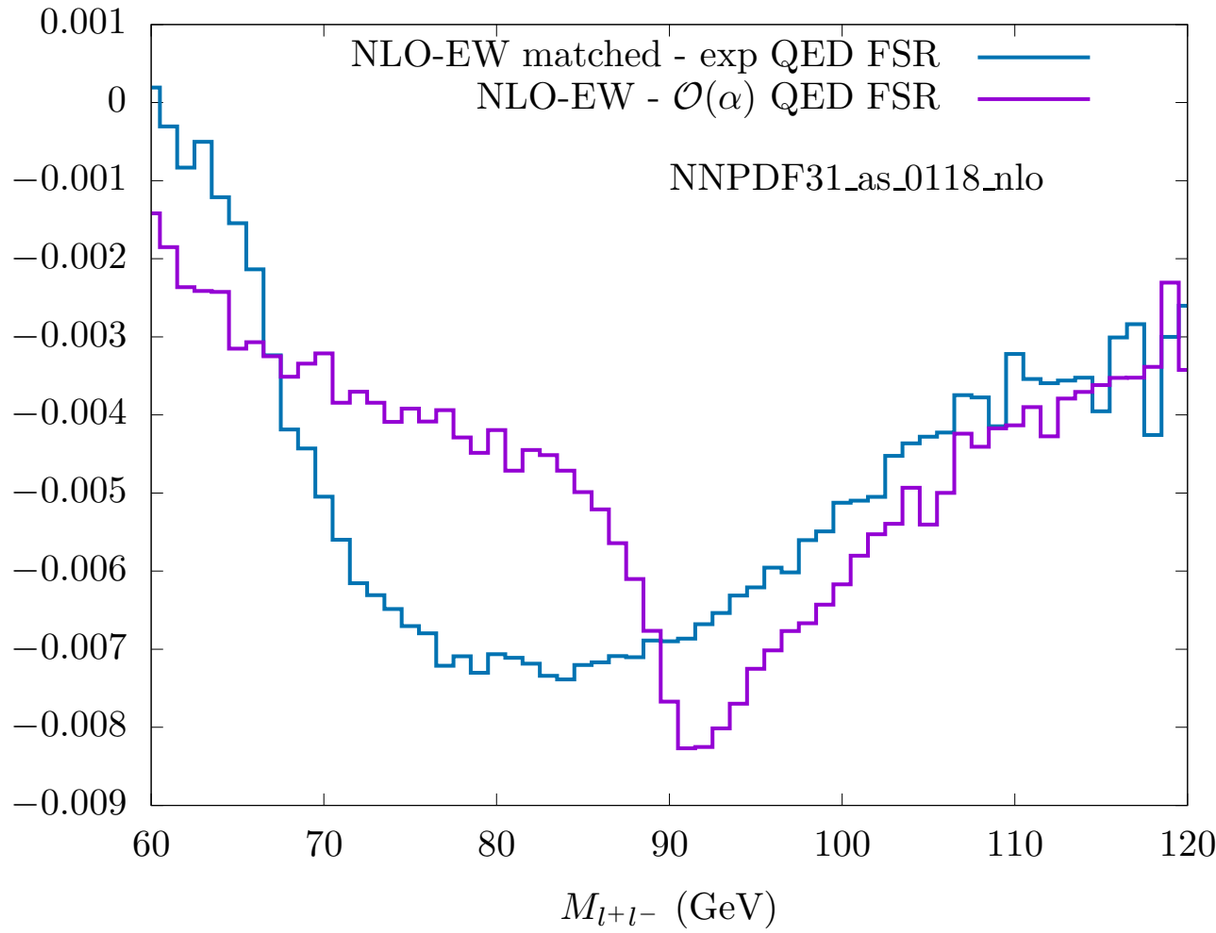
A_{FB} distribution: QED-FSR, NLO-EW, NLO-EW matched with QED-PS

NLO-EW - O(α) QED-FSR

matched - exp QED-FSR

Combined effect at O(α) subleading of :
- weak corrections
- QED-ISR
- QED-IFI
- subleading QED-FSR





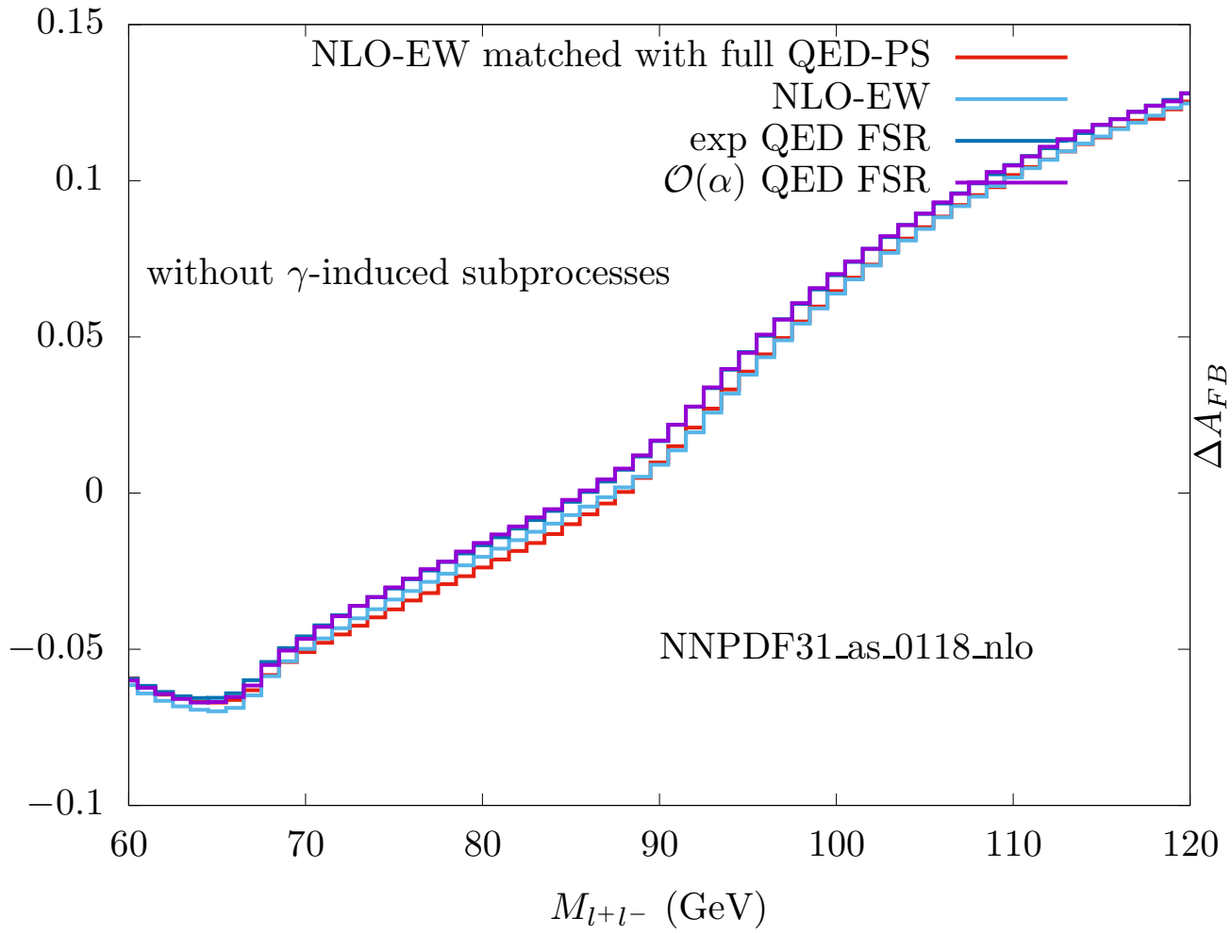
the matching between exact NLO-EW and the full QED-PS modifies the the impact of O(α) subleading corrections

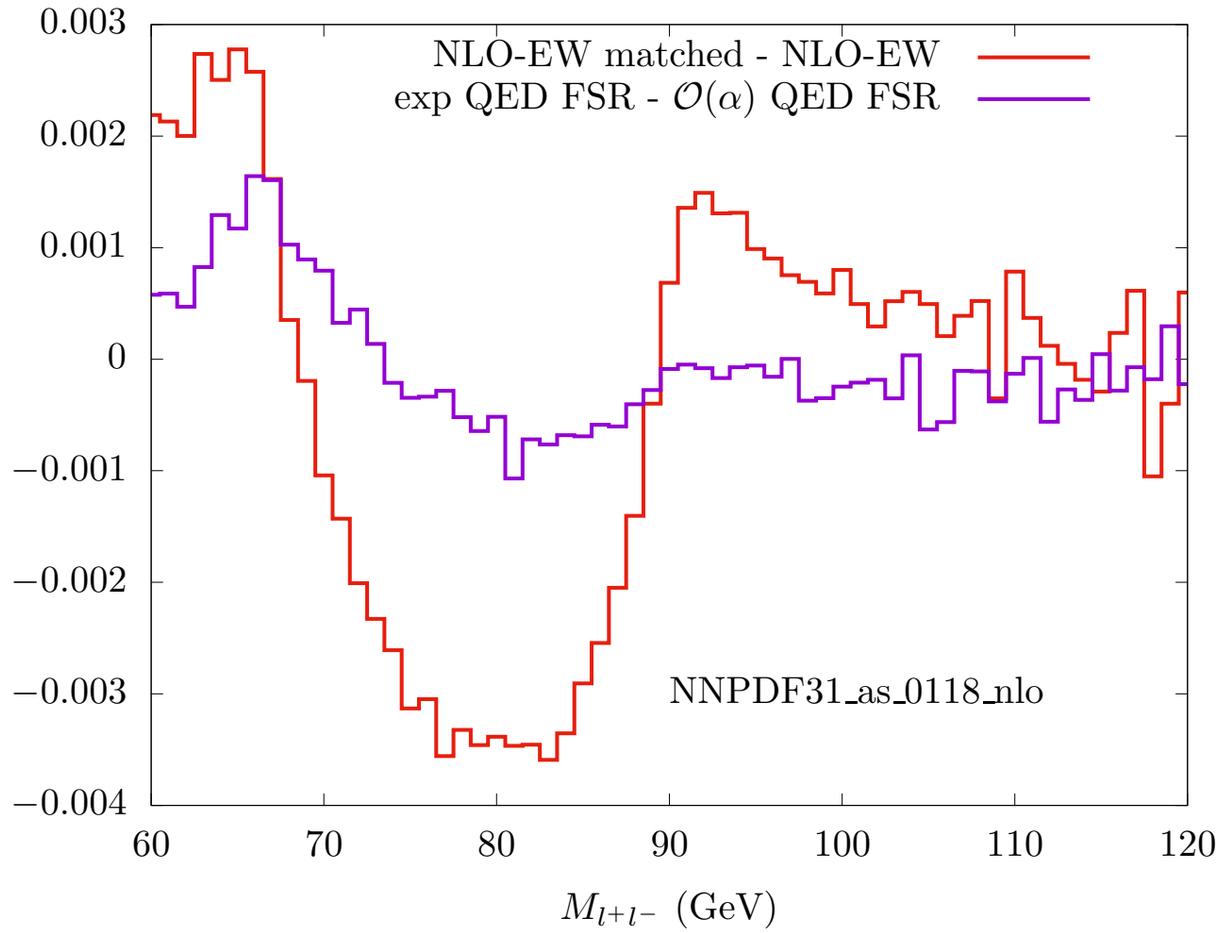
A_{FB} distribution: QED-FSR, NLO-EW, NLO-EW matched with QED-PS

exp QED-FSR - O(α) QED-FSR

matched - NLO-EW

→ Effect of : O(α²) and higher QED corrections from all charged legs



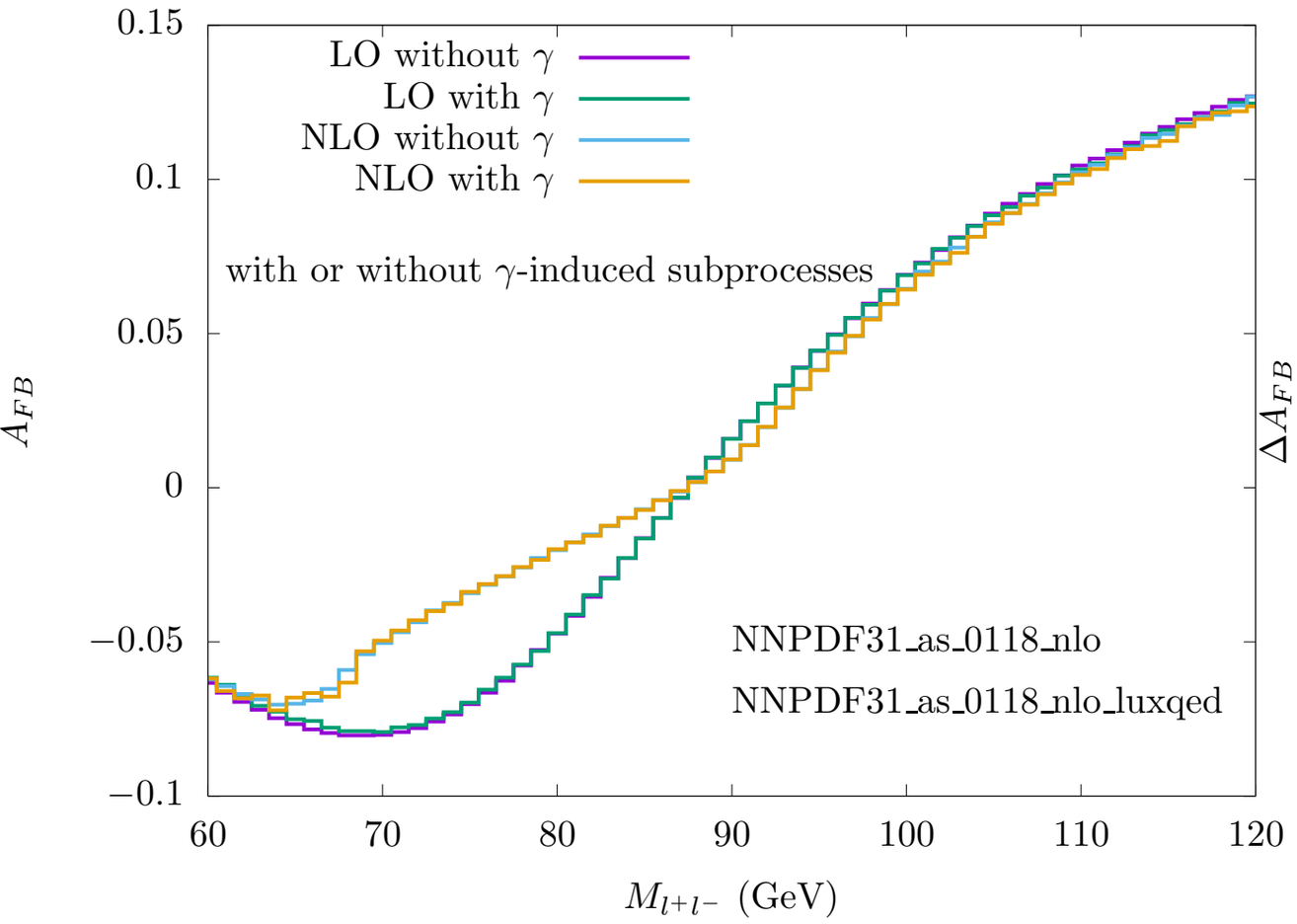


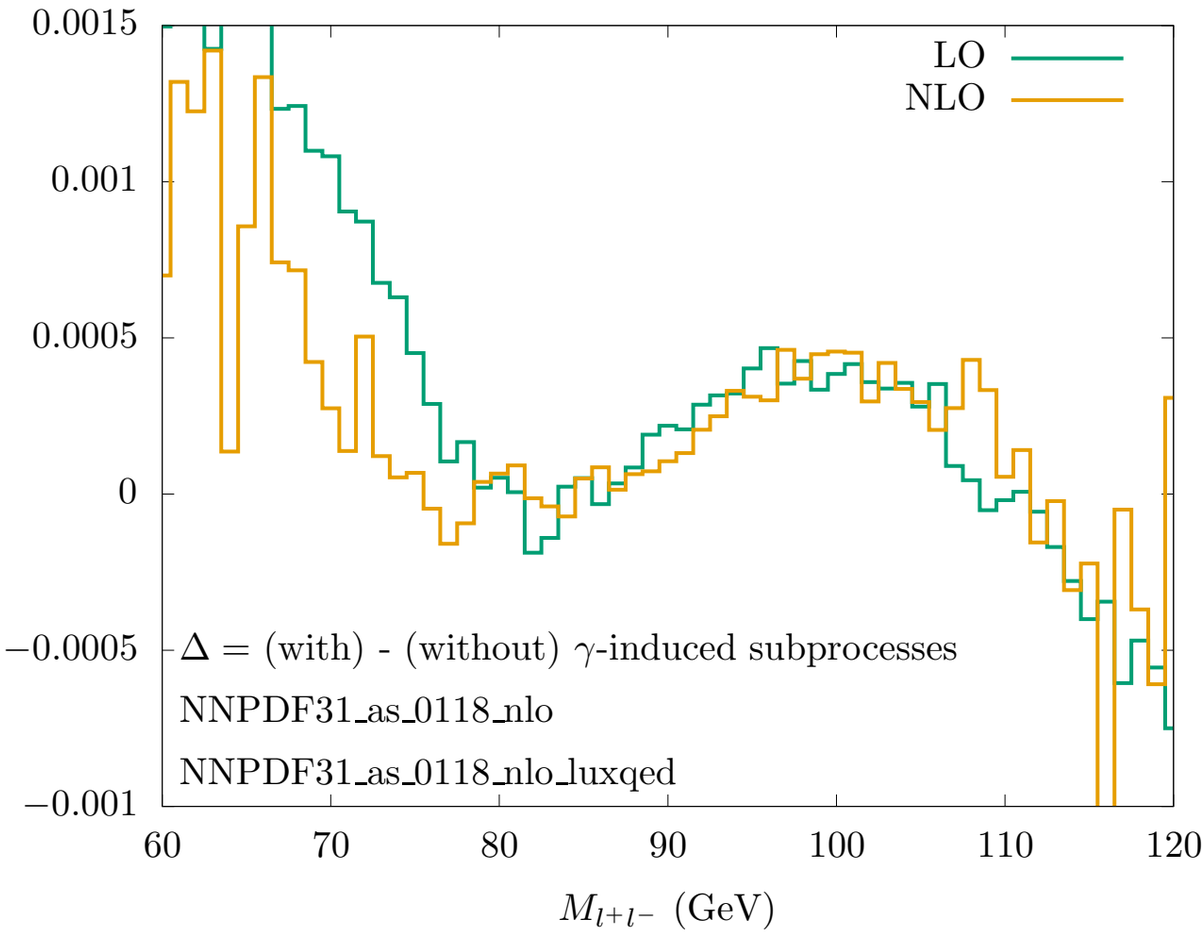
the matching between exact NLO-EW and the full QED-PS modifies the the impact of higher order QED LL terms

A_{FB} distribution: photon-induced contributions

simulation with γ-induced: NNPDF31_nlo_as_0118_luxqed and γ-induced subprocesses

simulation without γ-induced: NNPDF31_nlo_as_0118 and NO γ-induced subprocesses





bulk of the contribution given by LO subprocesses
in the interval [80,100] GeV, increasing AFB from 0 to 0.0005

Integrated asymmetries for benchmarking and comparison

	LO	NLO-EW	NLO-EW matched with QED-PS	O(α) QED FSR	exp QED FSR
66 GeV < Mll < 116 GeV, ptlep > 25 GeV, |etalep| <2.5					
QED-PDF	0.018122(5)	0.011128(6)			
no QED-PDF	0.017926(5)	0.010998(6)	0.01128(1)	0.01811(1)	0.018124(6)
80 GeV < Mll < 102 GeV, ptlep > 25 GeV, |etalep| <2.5					
QED-PDF	0.018944(5)	0.011965(6)			
no QED-PDF	0.018732(5)	0.011831(6)	0.01224(1)	0.01910(2)	0.019100(6)

Conclusions

AFB exhibits a non trivial sensitivity to higher order EW corrections

matching NLO-EW results with QED PS yields possibly sizeable effects

→ need systematic check of these preliminary results

→ POWHEG QCD+EW implements a different EW matching scheme

a comparison of the matching effects would be important