

MCSANC update for QED(ISR,IFI) $pp \rightarrow \mu^+ \mu^-$ @ 8 TeV

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PRELIMINARY

SETUP:

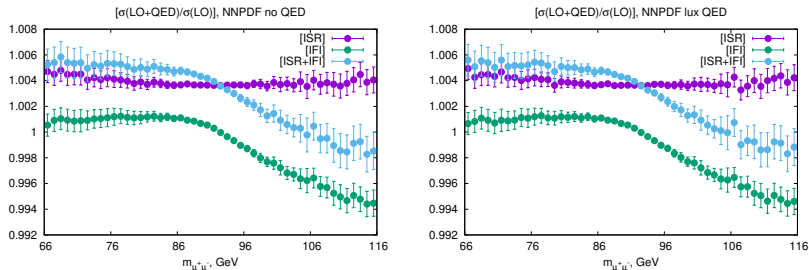
- LO QCD – no QCD corrections
- Initial-State-Radiation (ISR) and Initial-Final-Interference (IFI) QED effects – no WEAK and Final-State-Radiation (FSR) effects
- Photon-induced (PI) processes with initial photon in protons ($q\gamma$ and $\gamma\gamma$) at tree-level
- NNPDF31_nlo_as_0118 (no QED) and NNPDF31_nlo_as_0118_luxqed (lux QED) PDF-function
- G_μ EW-scheme: Born $\sim \alpha^2(G_\mu)$, Virt, Subt (DIS), Soft-, Hard-Brem $\sim \alpha_0 \alpha^2(G_\mu)$
($\alpha_0=1/137.0360, \alpha(G_\mu)=1/132.2332$)
- Fixed-width scheme: $\text{prop}(s, M_Z) = 1/(s - [M_Z^2 - iM_Z w_Z])$
- physical parameter are from the hep-ph:1606.02330
- cross section for $m_{ll}=[66-116]$ GeV, AFB for $m_{ll}=[66-80],[80-102],[102-116]$ GeV

Photon emission: $m_{\mu^+ \mu^-} = [66-116] \text{ GeV}$

Integrated cross-section σ (pb) and $\delta = \sigma(\text{QED})/\sigma(\text{LO})$ (%)

$\sigma(\text{LO})$	$\delta(\text{ISR})$	$\delta(\text{IFI})$	$\delta(\text{ISR} + \text{IFI})$	NNPDF
958.94(1)	0.367(1)	0.019(1)	0.386(2)	no QED
952.63(1)	0.367(1)	0.019(1)	0.386(2)	luxQED

Distribution of ratio $R = \sigma(\text{LO} + \text{QED})/\sigma(\text{LO})$ on $m_{\mu^+ \mu^-}$

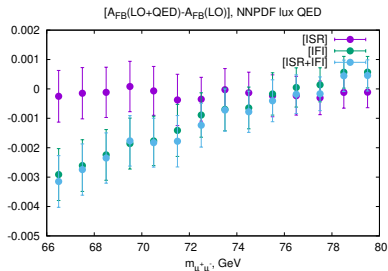
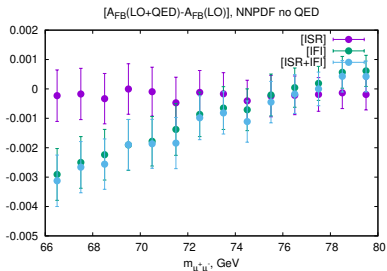


Photon emission: $m_{\mu^+ \mu^-} = [66-80]$ GeV

Integrated $A_{FB}(LO)$ and difference $[A_{FB}(LO+QED)-A_{FB}(LO)]$

[LO]	[ISR]	[IFI]	[ISR+IFI]	NNPDF
-0.20348(13)	-0.00022(14)	-0.00074(14)	-0.00096(23)	no QED
-0.20447(13)	-0.00018(14)	-0.00075(11)	-0.00093(23)	luxQED

Distribution of difference $[A_{FB}(LO+QED)-A_{FB}(LO)]$ on $m_{\mu^+ \mu^-}$

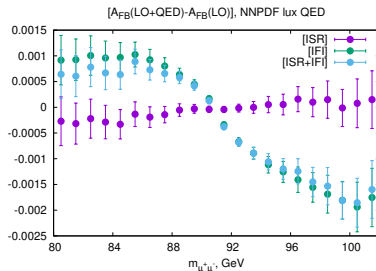
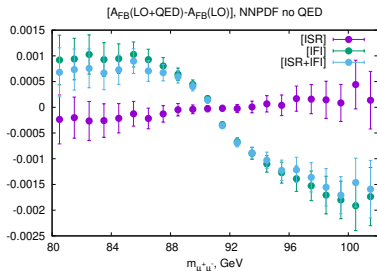


Photon emission: $m_{\mu^+ \mu^-} = [80-102]$ GeV

Integrated $A_{FB}(LO)$ and $[A_{FB}(LO+QED)-A_{FB}(LO)]$

[LO]	[ISR]	[IFI]	[ISR+IFI]	NNPDF
0.044695(2)	-0.00003(2)	-0.00018(2)	-0.00021(3)	no QED
0.044967(2)	-0.00004(2)	-0.00018(2)	-0.00022(3)	luxQED

Distribution of difference $[A_{FB}(LO+QED)-A_{FB}(LO)]$ on $m_{\mu^+ \mu^-}$

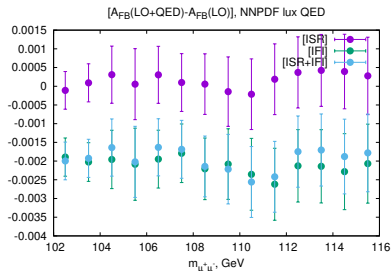
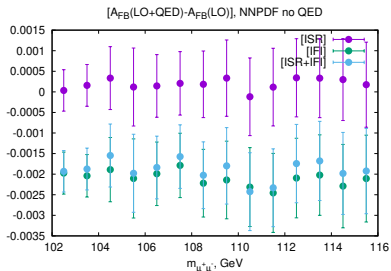


Photon emission: $m_{\mu^+ \mu^-} = [102-116]$ GeV

Integrated $A_{FB}(LO)$ and $[A_{FB}(LO+QED)-A_{FB}(LO)]$

[LO]	[ISR]	[IFI]	[ISR+IFI]	NNPDF
0.21281(15)	0.00017(15)	-0.00208(16)	-0.00190(27)	no QED
0.21387(15)	0.00012(15)	-0.00208(16)	-0.00195(27)	luxQED

Distribution of difference $[A_{FB}(LO+QED)-A_{FB}(LO)]$ on $m_{\mu^+ \mu^-}$

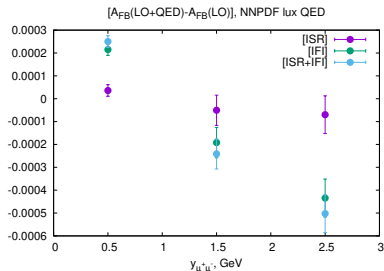
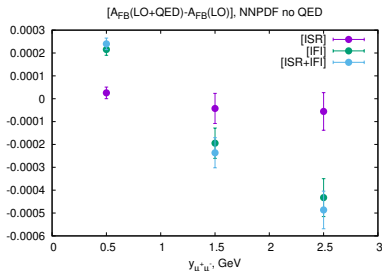


Photon emission: $y_{\mu^+ \mu^-} = [0-3]$

Integrated $A_{FB}(LO)$ and $[A_{FB}(LO+QED)-A_{FB}(LO)]$

[LO]	[ISR]	[IFI]	[ISR+IFI]	NNPDF
-0.01657(2)	0.00001(2)	0.00011(2)	0.00013(3)	no QED
-0.01667(2)	0.00002(2)	0.00011(2)	0.00013(3)	luxQED

Distribution of difference $[A_{FB}(LO+QED)-A_{FB}(LO)]$ on $y_{\mu^+ \mu^-}$

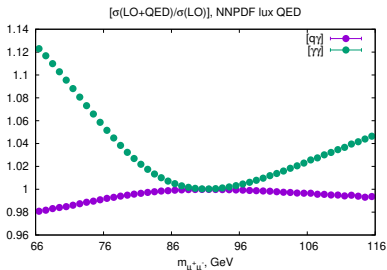


Photon-induced: $m_{\mu^+ \mu^-} = [66-116]$ GeV

Integrated cross-section σ (pb) and $\delta = \sigma(\text{PI})/\sigma(\text{LO})$ (%)

$\sigma(\text{LO})$	$\delta(\text{q}\gamma)$	$\delta(\gamma\gamma)$	NNPDF
952.63(1)	-0.079(1)	0.463(1)	luxQED

Distribution of ratio $R = \sigma(\text{LO} + \text{PI})/\sigma(\text{LO})$ on $m_{\mu^+ \mu^-}$

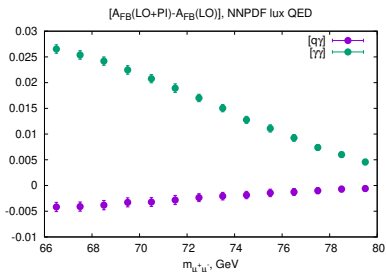


Photon-induced: $m_{\mu^+ \mu^-} = [66-80]$ GeV

Integrated $A_{FB}(LO)$ and $[A_{FB}(LO+PI)-A_{FB}(LO)]$

[LO]	[$q\gamma$]	[$\gamma\gamma$]	NNPDF
-0.20447(13)	-0.00192(14)	0.01355(13)	luxQED

Distribution of difference $[A_{FB}(LO+QED)-A_{FB}(LO)]$ on $m_{\mu^+ \mu^-}$

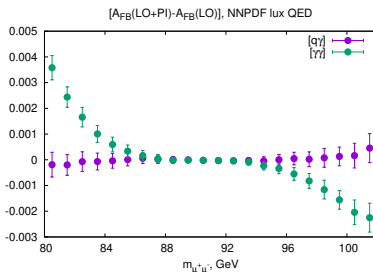


Photon-induced: $m_{\mu^+\mu^-} = [80-102]$ GeV

Integrated $A_{FB}(LO)$ and $[A_{FB}(LO+PI)-A_{FB}(LO)]$

[LO]	[q γ]	[$\gamma\gamma$]	NNPDF
0.04497(2)	0.00000(2)	-0.00009(2)	luxQED

Distribution of difference $[A_{FB}(LO+QED)-A_{FB}(LO)]$ on $m_{\mu^+\mu^-}$

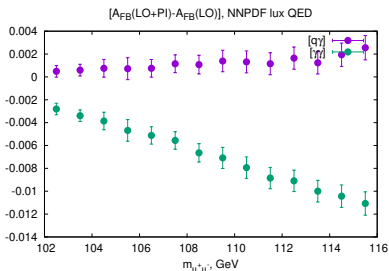


Photon-induced: $m_{\mu^+ \mu^-} = [80-102]$ GeV

Integrated $A_{FB}(LO)$ and $[A_{FB}(LO+PI)-A_{FB}(LO)]$

[LO]	[q γ]	[$\gamma\gamma$]	NNPDF
0.21387(15)	0.00095(16)	-0.00551(15)	luxQED

Distribution of difference $[A_{FB}(LO+QED)-A_{FB}(LO)]$ on $m_{\mu^+ \mu^-}$

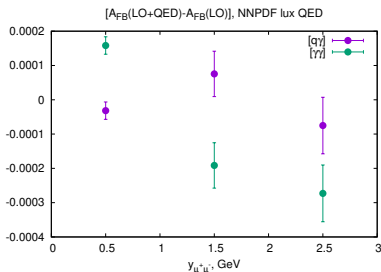


Photon-induced: $y_{\mu^+ \mu^-} = [0-3]$

Integrated $A_{FB}(LO)$ and $[A_{FB}(LO+PI)-A_{FB}(LO)]$

[LO]	[q γ]	[$\gamma\gamma$]	NNPDF
-0.01667(2)	-0.00002(2)	0.00008(2)	luxQED

Distribution of difference $[A_{FB}(LO+PI)-A_{FB}(LO)]$ on $y_{\mu^+ \mu^-}$



SUMMARY: near Z-pole

- the photon emission effects (without final radiation):
 - cross-section on leptons invariant mass [66-116] GeV are defined mainly by ISR $\sim 0.4\%$ vs. IFI $\sim 0.02\%$
 - AFB asymmetry difference [LO+QED]-[LO] are defined mainly by interference term
- the photon-induced effects: $q\gamma$ and $\gamma\gamma$
 - cross-section and AFB asymmetry difference [LO+QED]-[LO] are defined mainly by $\gamma\gamma$ term if no p_{Tl}, y_l cuts applied (strong cuts dependence)
- the statistics should be increased
- all preliminary results (especially for AFB) should be compared with another codes in details