A_{FB} from $PP \to \ell^+\ell^- + X$

sources:

- $q\bar{q} \to \gamma, Z \to \ell^+\ell^-$

  γ – Z interference $\sim Q_q\, a_q\, a_\ell$

  Z exchange $\sim v_\ell\, v_q\, a_\ell\, a_q$

- QED: $\gamma\gamma$ exchange (box diagrams)
  + initial–final γ emission

- electroweak loop contributions to $q\bar{q} \to \ell^+\ell^-$

- at large $m(\ell^+\ell^-)$:

  dominant γ–Z interference
  weak loops ($\sim$ box graphs)

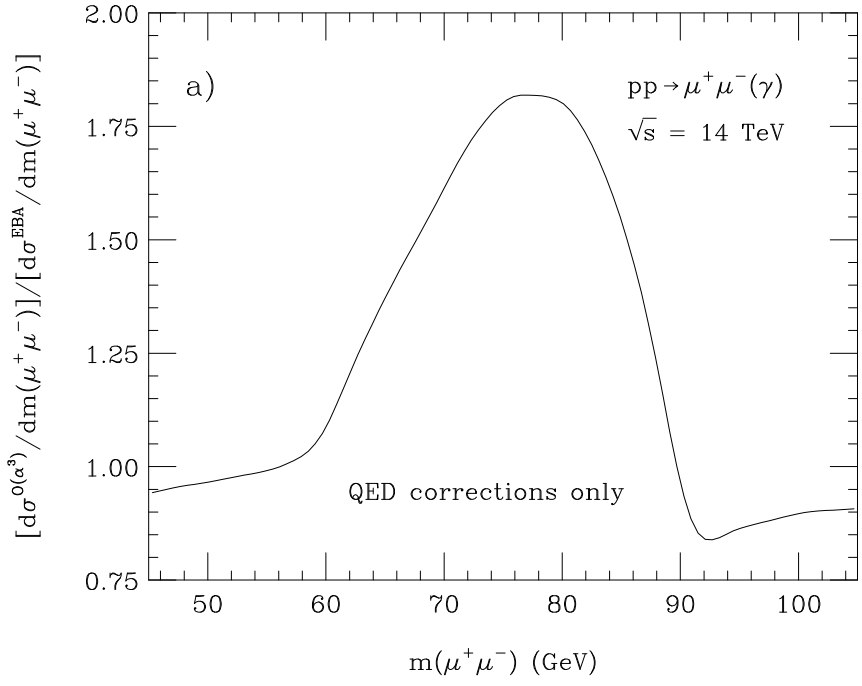
  sensitive to new physics, eg. Z'

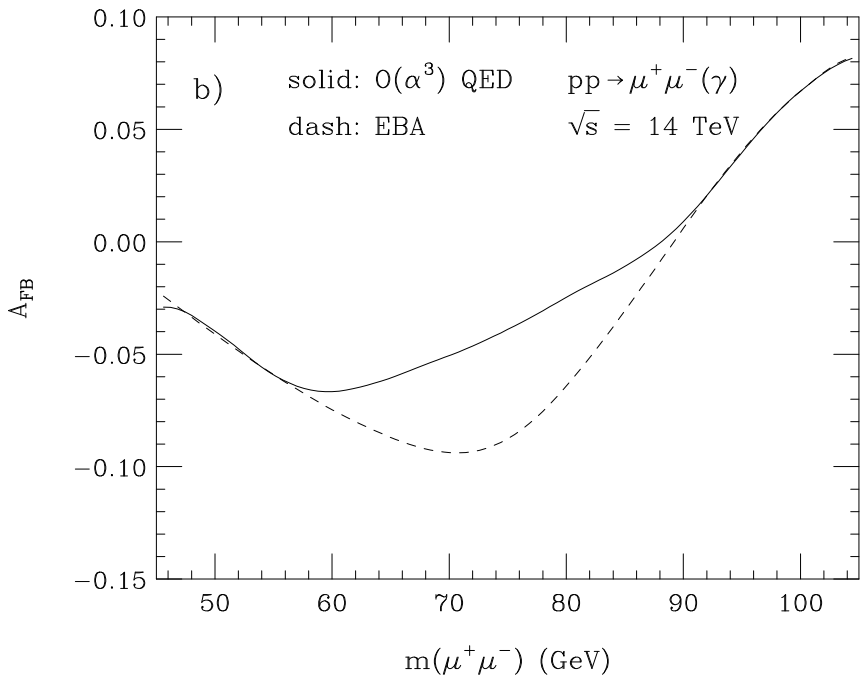
- around the Z resonance: $m(\ell^+\ell^-) \simeq M_Z$

  A_{FB} determined by $\sum_q (q\bar{q}) \frac{v_\ell}{a_\ell} \frac{v_q}{a_q}$

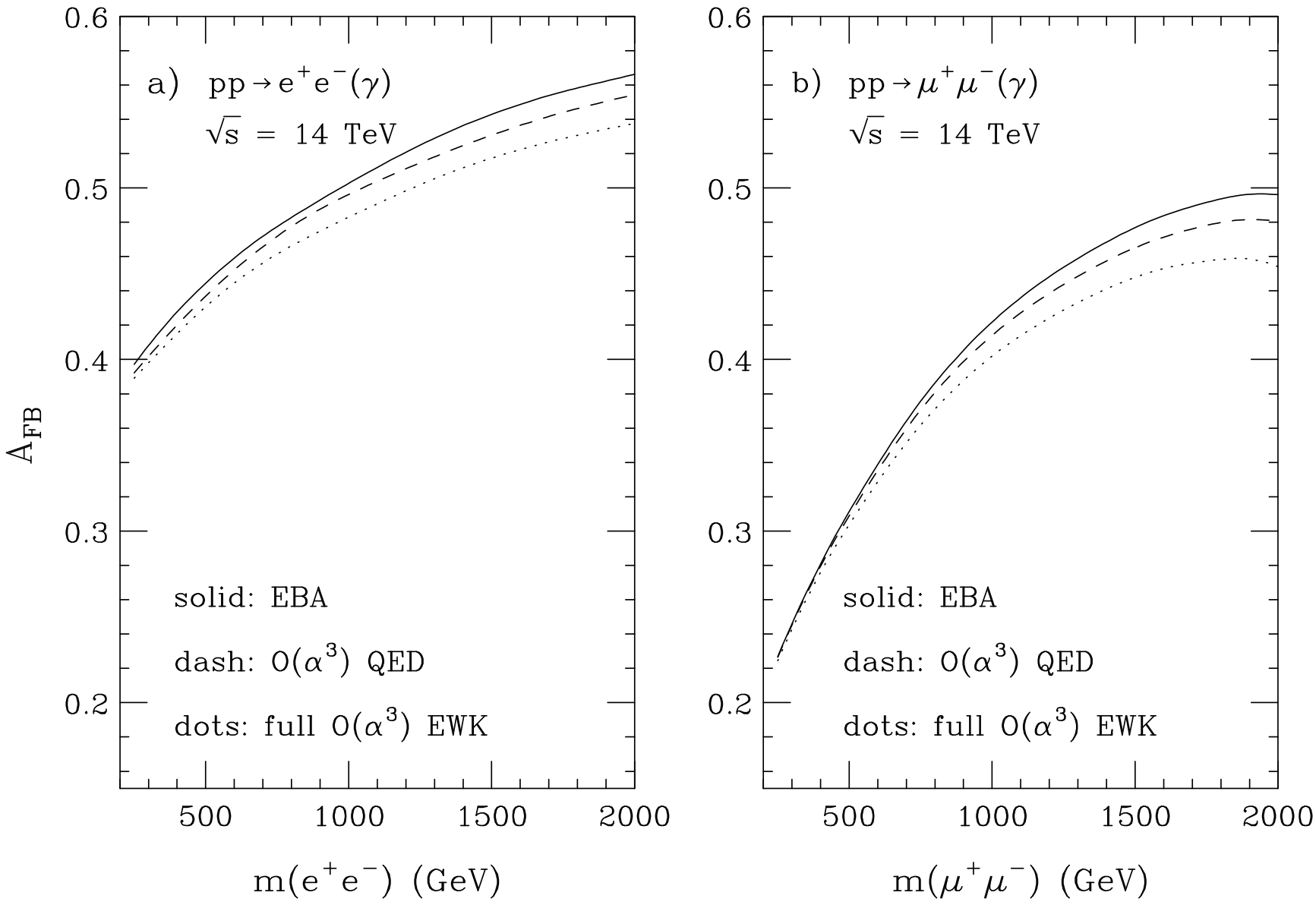
  $\longrightarrow \sin^2\theta_W$ with $\delta \sin^2\theta_W \simeq 0.0002$

  WG Report 2000





Electroweak Physics WG 2000


a) pp → e+e−(γ)
√s = 14 TeV
solid: EBA
dash: O(α3) QED
dots: full O(α3) EWK
AFB
m(e+e−) (GeV)
b) pp → μ+μ−(γ)
√s = 14 TeV
solid: EBA
dash: O(α3) QED
dots: full O(α3) EWK
m(μ+μ−) (GeV)
0.2
0.3
0.4
0.5
0.6
500
1000
1500
2000

Complications

at parton level:

- $\sin^2\theta_W$ not unique, different for ℓ, u, d

  which $\sin^2\theta$ to be measured?
  $\sin^2\theta_\ell,\ \sin^2\theta_{\overline{MS}}, \ldots$
  differences are small, model dependent

- effective couplings v_f, a_f are complex

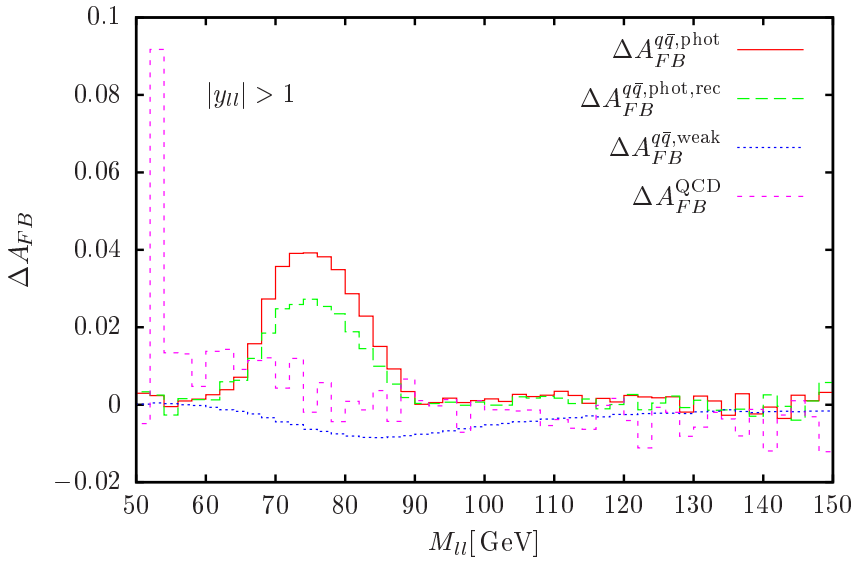
  $\sin^2\theta_f \leftrightarrow \mathrm{Re}\, v_f / \mathrm{Re}\, a_f$

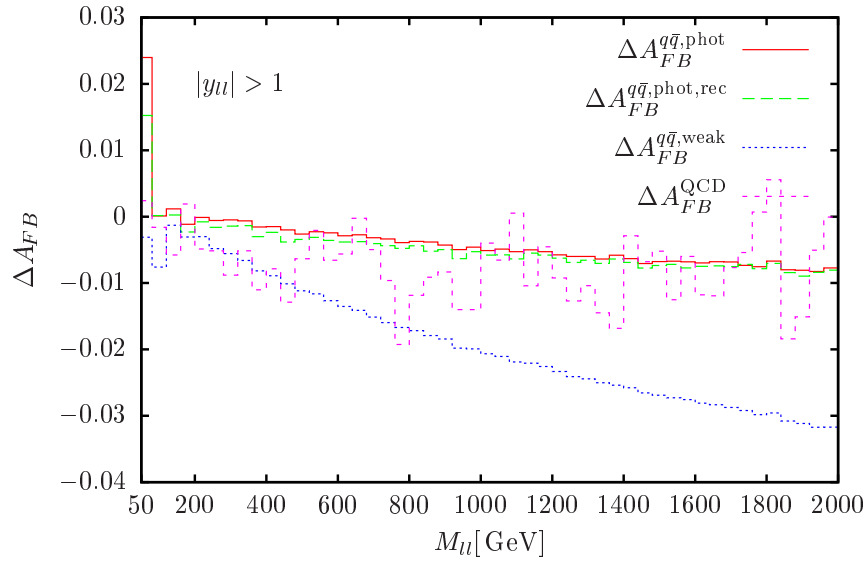
  imaginary parts give additional contributions,
  under control, but model dependent

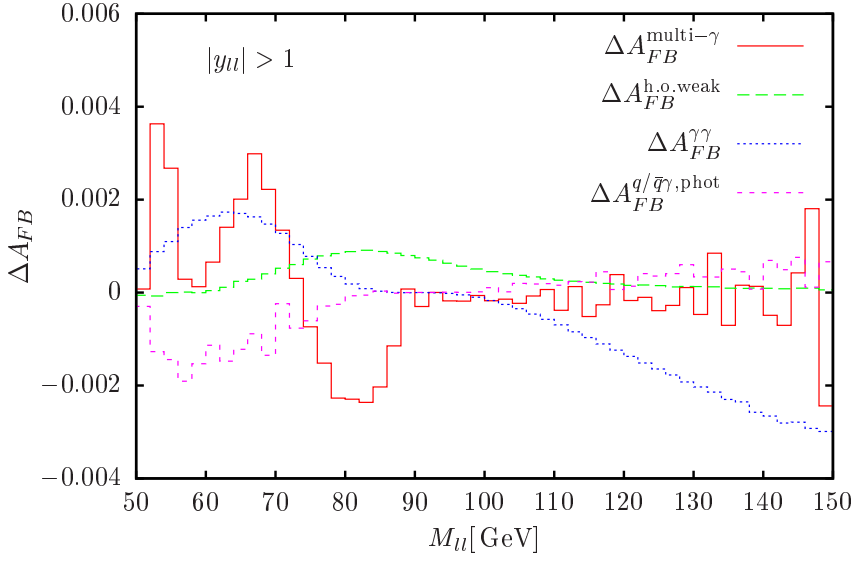
- incomplete at 2-loop order ,
  QCD–electroweak terms missing

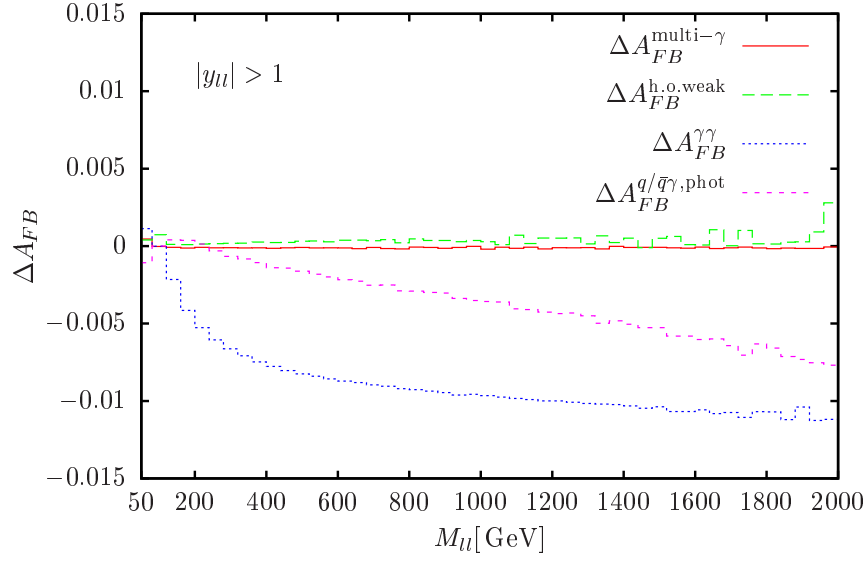
at hadron level:

- need incoming quark direction $\rightarrow$ $y(\ell^+\ell^-)$ cut
- other parton pocesses contribute
  photon induced $\gamma\gamma \rightarrow \ell^+\ell^-$, $\gamma q \rightarrow \ell^+\ell^- q$
- need QED evolution of parton distributions
- need control of $(u\bar{u})/(d\bar{d})$









M. Huber, Thesis 2010