

Projections for EWPO uncertainties at the FCC-ee

1 Fermion pair production above the Z-pole at FCC-ee

Questions:

- Please check that the following expected precisions for $\sigma(e^+e^- \rightarrow f\bar{f})$ and $A_{FB}^{f\bar{f}}$ are correct:

$$\frac{\delta_{\text{sys}}\sigma_{f\bar{f}}}{\sigma_{f\bar{f}}} \sim 10^{-4}, \quad \frac{\delta_{\text{stat}}\sigma_{f\bar{f}}}{\sigma_{f\bar{f}}} \sim \text{Negligible?} \quad (1)$$

$$\frac{\delta_{\text{sys}}A_{FB}^{f\bar{f}}}{A_{FB}^{f\bar{f}}} \sim \text{Negligible?}, \quad \frac{\delta_{\text{stat}}A_{FB}^{f\bar{f}}}{A_{FB}^{f\bar{f}}} \sim \frac{\sqrt{1 - (A_{FB}^{f\bar{f}})^2}}{\sqrt{N}}? \quad (2)$$

- For what channels does this apply? $f = e, \mu, \tau, b, c, \text{had}$?
- Does the systematic uncertainty for $\sigma_{f\bar{f}}$ of 10^{-4} approximately apply to all energies above the Z-pole (160, 240 and 350 GeV)?

2 Precision measurements at FCC-ee

- Please check that the expected uncertainties for the different electroweak precision observables in Table 1 are accurate/updated, taking into account the latest FCC-ee studies. (See caption of the Table for the origin of the different numbers.)
- Please provide estimates for the uncertainties for the measurements of the Left Right asymmetries for the b and c quarks, A_b and A_c , that would be possible with polarization. These would be needed to study the impact of using polarized beams in the determination of the quark couplings.

References

- [1] P. Janot, JHEP **1602** (2016) 053 doi:10.1007/JHEP02(2016)053 [arXiv:1512.05544 [hep-ph]].

	Current Data	FCCee-Z (no pol.)	FCCee-Z	FCCee-WW	FCCee-HZ	FCCee-t \bar{t}
$\alpha_s(M_Z^2)$	0.1180 \pm 0.0010					
$\Delta\alpha_{\text{had}}^{(5)}(M_Z^2)$	0.02750 \pm 0.00033	\pm 0.00003				
M_Z [GeV]	91.1875 \pm 0.0021	\pm 0.0001				
m_t [GeV]	173.1 \pm 0.6 _{exp} \pm 0.5 _{th}					\pm 0.014 _{stat} \pm 0.050 _{th}
M_H [GeV]	125.09 \pm 0.24				\pm 0.007	
M_W [GeV]	80.379 \pm 0.012			\pm 0.001		
Γ_W [GeV]	2.085 \pm 0.042			\pm 0.0015		
Γ_Z [GeV]	2.4952 \pm 0.0023	\pm 0.0001				
σ_h^0 [nb]	41.540 \pm 0.037	\pm 0.025				
R_ℓ^0	20.767 \pm 0.025	\pm 0.001				
$A_{\text{FB}}^{0,\ell}$	0.0171 \pm 0.0010	\pm 0.00001				
$A_\tau(P_\tau^{\text{pol}})$	0.1465 \pm 0.0033	\pm 0.00030				
$A_e(P_\tau^{\text{pol}})$		\pm 0.00011				
A_ℓ	0.1513 \pm 0.0021		\pm 0.000021			
A_c	0.670 \pm 0.027		\pm ???			
A_b	0.923 \pm 0.020		\pm ???			
$A_{\text{FB}}^{0,c}$	0.0707 \pm 0.0035	\pm 0.0008				
$A_{\text{FB}}^{0,b}$	0.0992 \pm 0.0016	\pm 0.0004				
R_c^0	0.1721 \pm 0.0030	\pm 0.00050				
R_b^0	0.21629 \pm 0.00066	\pm 0.00017				
$\Gamma_{\text{Inv}}/\Gamma_\ell$	5.943 \pm 0.016			\pm 0.002		

Table 1: Expected sensitivities at the FCC-ee for the different observables included in the electroweak fits. Numbers in Blue come from the TLEP paper (arXiv:1308.6176) or more recent FCC-ee Talks. The error on $\Gamma_{\text{Inv}}/\Gamma_\ell$ was obtained from the expected uncertainty for N_ν of \pm 0.001. The error for $\Delta\alpha_{\text{had}}^{(5)}(M_Z^2)$ was extracted from the uncertainty $\delta\alpha_{\text{em}}^{-1}(M_Z^2)/\alpha_{\text{em}}^{-1}(M_Z^2) \sim 3 \times 10^{-5}$ from measuring A_{FB}^μ just below and above the Z pole [1]. Numbers in Red are the estimates provided by R. Tenchini. Finally, the quoted error for σ_h^0 is the current theory systematic uncertainty associated to the understanding of low-angle Bhabha scattering.