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 $\sigma(e^+e^- \to f\bar{f})$ and $A_{FB}^{f\bar{f}}$ are correct:

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

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

- For what channels does this apply? $f = e, \mu, \tau, b, c,$ 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±0.0010					
$\Delta\alpha^{(5)}_{\rm had}(M_Z^2)$	0.02750±0.00033	±0.00003				
M_Z [GeV]	91.1875±0.0021	±0.0001				
m_t [GeV]	$173.1\pm0.6_{\rm exp}\pm0.5_{\rm th}$					$\pm0.014_{\rm stat}\pm0.050_{\rm th}$
M_H [GeV]	125.09±0.24				±0.007	
M_W [GeV]	80.379±0.012			±0.001		
Γ_W [GeV]	2.085±0.042			±0.0015		
Γ_Z [GeV]	2.4952±0.0023	±0.0001				
σ^0_h [nb]	41.540±0.037	±0.025				
R^0_ℓ	20.767±0.025	±0.001				
$A^{0,\ell}_{\rm FB}$	0.0171±0.0010	±0.00001				
$A_\tau(P^{\rm pol}_\tau)$	0.1465±0.0033	±0.00030				
$A_e(P^{\rm pol}_\tau)$		±0.00011				
A_ℓ	0.1513±0.0021		±0.000021			
A_c	0.670±0.027		±???			
A_b	0.923±0.020		±???			
$A^{0,c}_{\rm FB}$	0.0707±0.0035	±0.0008				
$A^{0,b}_{\rm FB}$	0.0992±0.0016	±0.0004				
R^0_c	0.1721±0.0030	±0.00050				
R^0_b	0.21629±0.00066	±0.00017				
$\Gamma_{\rm Inv}/\Gamma_\ell$	5.943±0.016			±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 $\Gamma_{\rm Inv}/\Gamma_\ell$ was obtained from the expected uncertainty for N_ν of ±0.001. The error for $\Delta\alpha^{(5)}_{\rm had}(M_Z^2)$ was extracted from the uncertainty $\delta\alpha^{-1}_{\rm em}(M_Z^2)/\alpha^{-1}_{\rm em}(M_Z^2) \sim 3\times10^{-5}$ from measuring A^{μ}_{FB} just below and above the Z pole [1]. Numbers in Red are the estimates provided by R. Tenchini. Finally, the quoted error for σ^0_h is the current theory systematic uncertainty associated to the understanding of low-angle Bhabha scattering.