Status report: Z-boson couplings to heavy fermions at the FCC-ee

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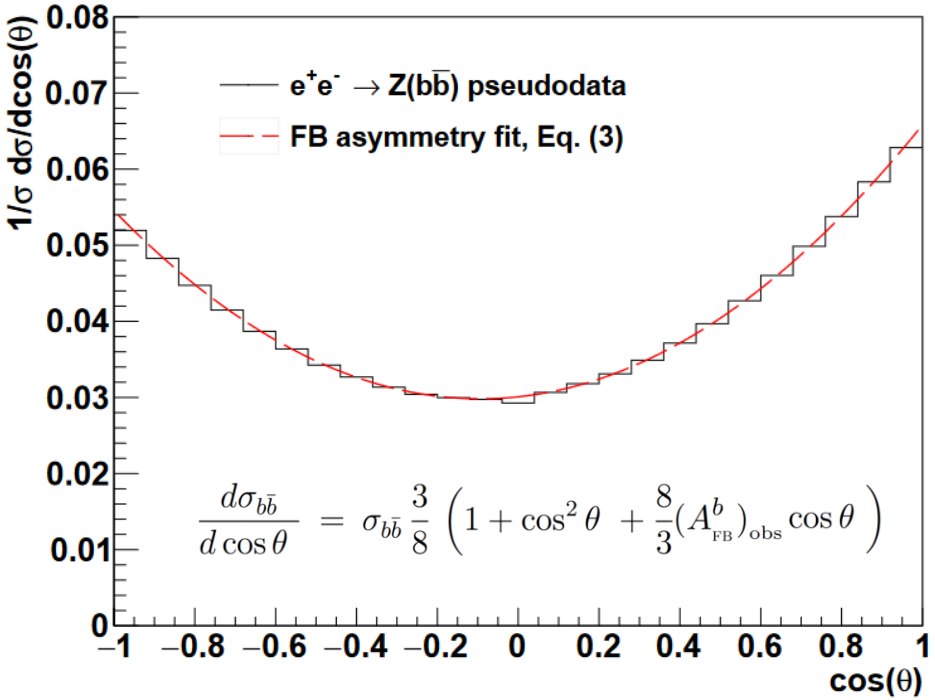
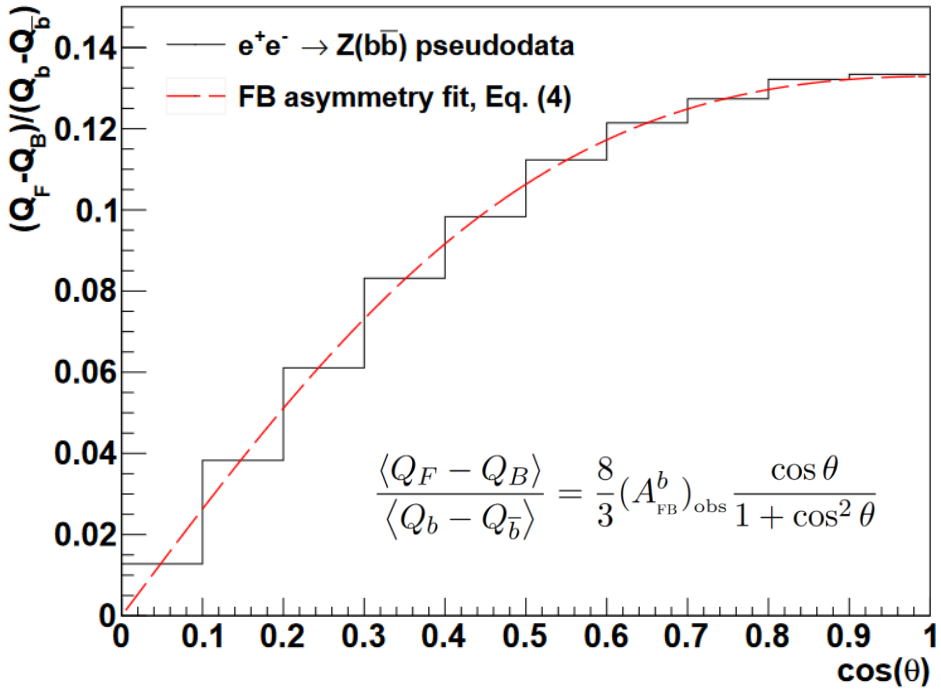
$A^{0,b}_{FB}$ estimation strategies

Revised QCD effects on the $Z \to \overline{bb}$ forward-backward asymmetry, D. d'Enterria and C. Yan, e-Print: 2011.00530, 2020

Fitting the distribution of polar angles θ between the e^- and the thrust axis.

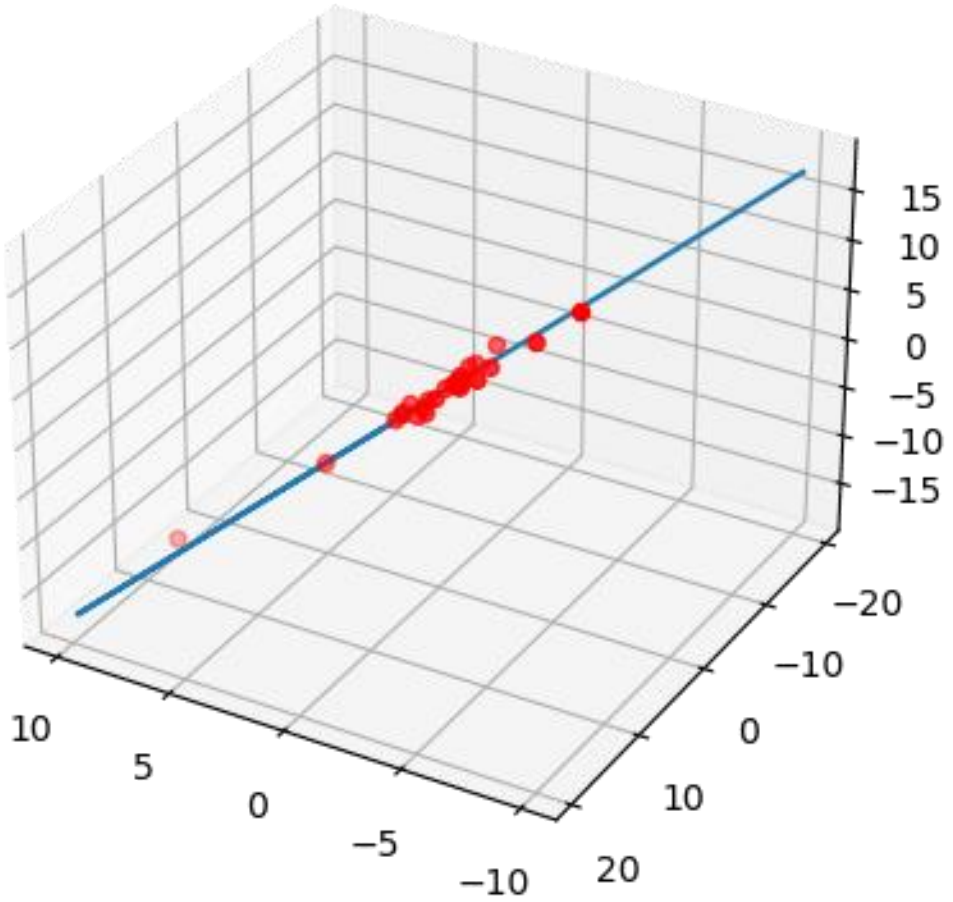


Fitting the charge flow distribution wrt $\cos\theta$.



Status

- Thrust axis computation
- Thrust direction assignement (jet charge/negative charged leading lepton)
- Modifying basic analysis `FCCAnalyses-master/examples/FCCee/flavour/generic-analysis`



Tools and algorithms: FCCAnalyses*

- ROOT files at:
  - `/eos/experiment/fcc/ee/generation/DelphesEvents/spring2021/IDEA/p8_ee_Zbb_ecm91/`

- Samples produced with Pythia, EvtGen and Delphes in EDM4hep with post – processing in FCCAnalyses to calculate thrust and hemisphere energy info

Systematics

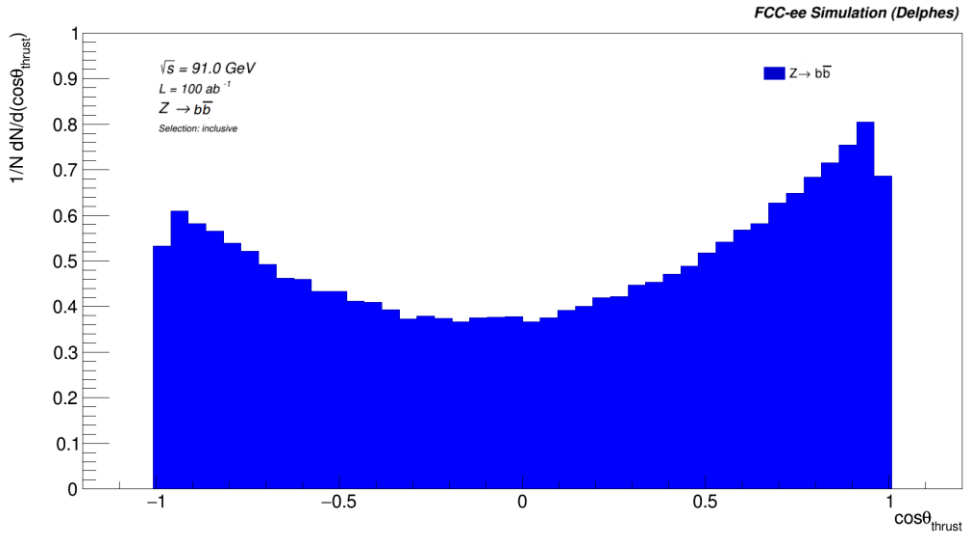
B-tagging
Soft lepton tagging

- Mixing parameters
- Showering model and b-tagging algorithm implementation
  - Need detailed studies
- B and c semileptonic branching ratios and fragmentation parameters
- Fraction of fake or non-prompt leptons selected
- Need to check JES impact, expected to be negligible (for our current analysis)
- QED ISR: should be included in the theoretical definition
- FSR: need to recheck that it should not influence the measure
- c_f : should be estimated using NLO predictions on σ_f

Plans

Giovanni (phd), Leonardo (ms) working on the subject.
Collaboration with Grenoble (Dr. Fairouz Malek's group) initiated.

- First step: fast MC studies ongoing
  - Training on EDM4HEP
  - Check b/b directions vs thrust axis, truth level
  - Look at $\delta_{b,c}$ distributions



- Second step: complete EDM4HEP analysis for AbFB only on signal.
  - Focus on the two methods Jet charge, soft muon pTrel
  - Add decayed b with EvtGen
  - Add backgrounds from c, light jets

Backup

Complete expression for $A^{0,b}_{FB}$

The Physics of the W and Z bosons,
R. Tenchini, C. Verzegnassi
World Scientific, 2008
ISBN:13 978 981 270 702 4

- With both methods, ideal case: $\varepsilon_b = 1, \quad \varepsilon_{c,l} = 0$:

$$2\langle Q^b \rangle \equiv \delta^b$$

$$Q^b_{FB} \equiv \langle Q^b_F - Q^b_B \rangle = \delta_b A^b_{FB}$$

- In real life one measures together:

$$\langle Q^b_{FB} \rangle = \sum_f c_f \delta^f A^f_{FB}$$

$$c_f = \frac{\sigma_f \ \epsilon_f}{\sum_i \sigma_i \ \epsilon_i}$$