Marina Cobal, Giovanni Guerrieri, Hamzeh Khanpour,
Giancarlo Panizzo, Michele Pinamonti and Leonardo Toffolin

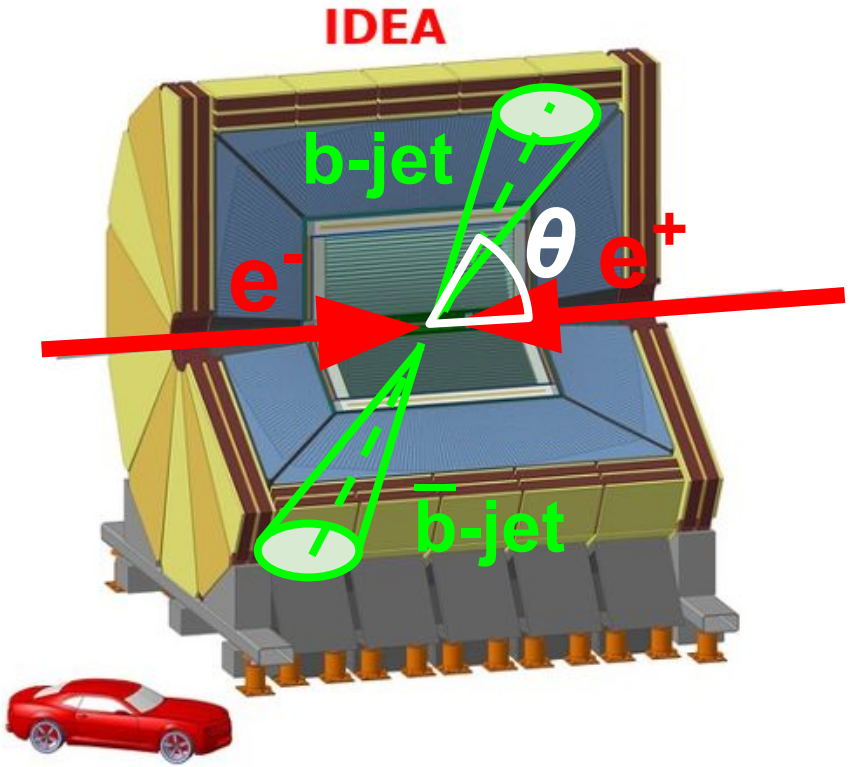
A^b_{FB}@FCCee
Current status and future plans

IDEA Physics and Software Meeting
30 March 2023

Current status

- Key point: ***b*-quark charge determination**
- Two classes of methods implemented:
  a. *Jet charge*: weighted sum of charges of jet consituents tracks
     - private Madgraph+Pythia8+Delphes
  b. *Semi-leptonic b-hadron decay*: charge of electron/muon
     - central **FCCAnalysis** framework + different tools

Precise measurement of Forward-Backward asymmetry in $e^+e^- \to Z \to b\bar{b}$ events at FCCee



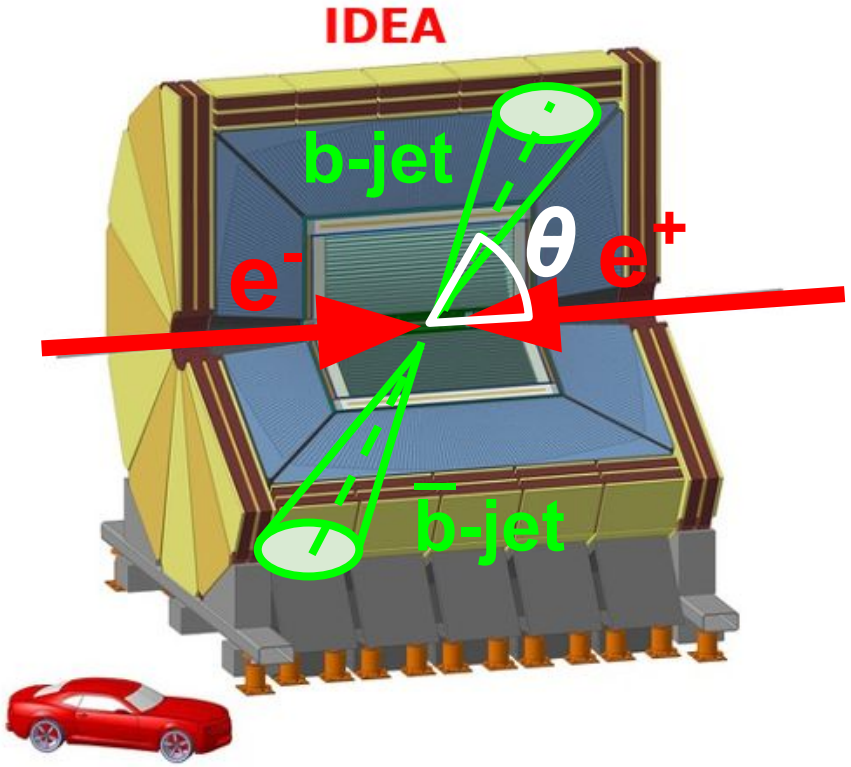
Ongoing tasks

- Implementing the ***jet-charge method*** within the official **FCCAnalyses** framework *(see next slides)*

  HEP-FCC/
  FCCAnalyses

- Studying other sources of **systematics**
- Documentation of the analysis *(see next slides)*
  - will be finalized by end of April
- Working for the presentation of final results at the FCC week in London

Precise measurement of Forward-Backward asymmetry in $e^+e^- \rightarrow Z \rightarrow b\bar{b}$ events at FCCee



Ongoing tasks: Analysis code

master ▾ FCCAnalyses / examples / FCCee / **AFB** /

Go to file

This branch is 75 commits ahead, 303 commits behind HEP-FCC:master.

hamzeh-khanpour AFB - FCCee ✕ b5ca242 yesterday History

..		
analysis_AFB_stage1_10.py	Update analysis_AFB_stage1_10.py	6 months ago
analysis_AFB_stage1_14_sig_bkgs.py	Create analysis_AFB_stage1_14_sig_bkgs.py	5 months ago
analysis_AFB_stage1_20_Systematic_Uncertainty_eeKT.py	ee kt Durham	4 months ago
analysis_AFB_stage1_20_sig_bkgs.py	ee kt Durham	4 months ago
analysis_AFB_stage1_20_sig_bkgs_Jet_Method_Leonardo....	analysis_AFB_stage1_20_sig_bkgs_Jet_Method	3 weeks ago
analysis_AFB_stage1_6.py	get_flavour_noabsvalue	8 months ago
analysis_AFB_stage1_7.py	Create analysis_AFB_stage1_7.py	8 months ago
analysis_AFB_stage1_9.py	Update analysis_AFB_stage1_9.py	6 months ago
analysis_AFB_stage1_FCCee_sig_bkgs.py	AFB - FCCee	yesterday

Link to Github code

Implementation of the ***jet-charge method*** by Leonardo:

- will allow to study vertexing requirements (*b*-tagging)

Ongoing tasks: Analysis code

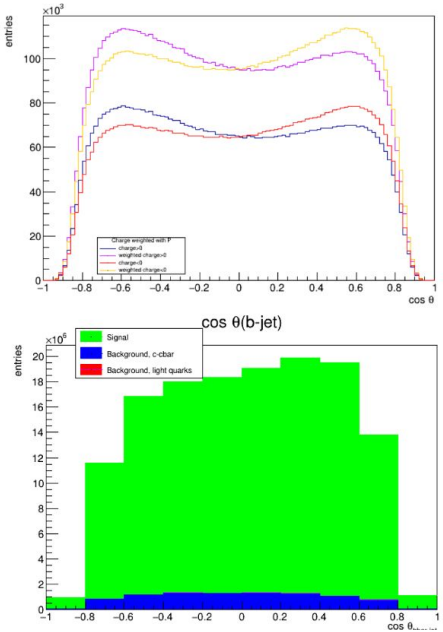
Plot from Kracow

Jet-charge study

- Based on private MadGraph+Delphes simulation (with IDEA card)
- Durham jet algorithm used
- Simplified b-tagging (flat 80% eff., 10%/1% c/light-mis-tagging)
- Jet charge built with weighted sum of charges of tracks (as saved by Delphes)
  - $\Delta R < 0.4$ from jet axis
  - weight = p_L (track) w.r.t. jet axis

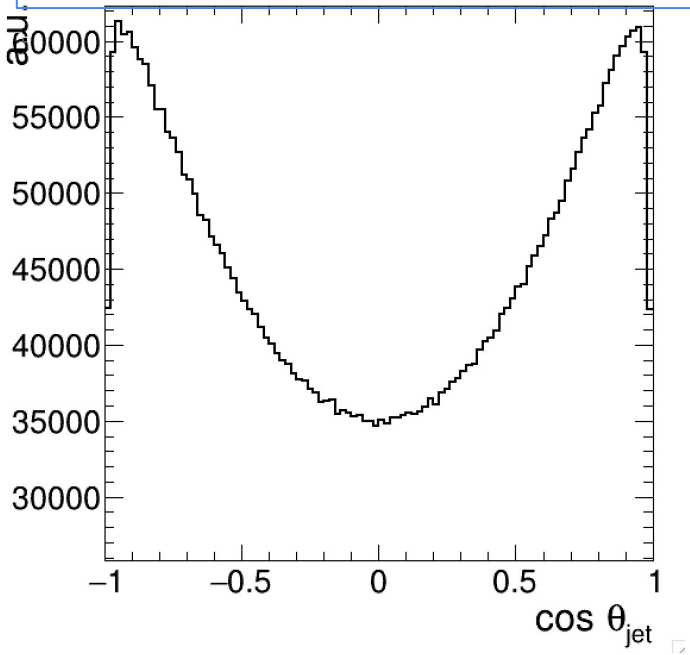
Event Selection

- ≥ 2 b-tagged jets
- ≥ 1 jet with charge > 0
- ≥ 1 jet with charge < 0

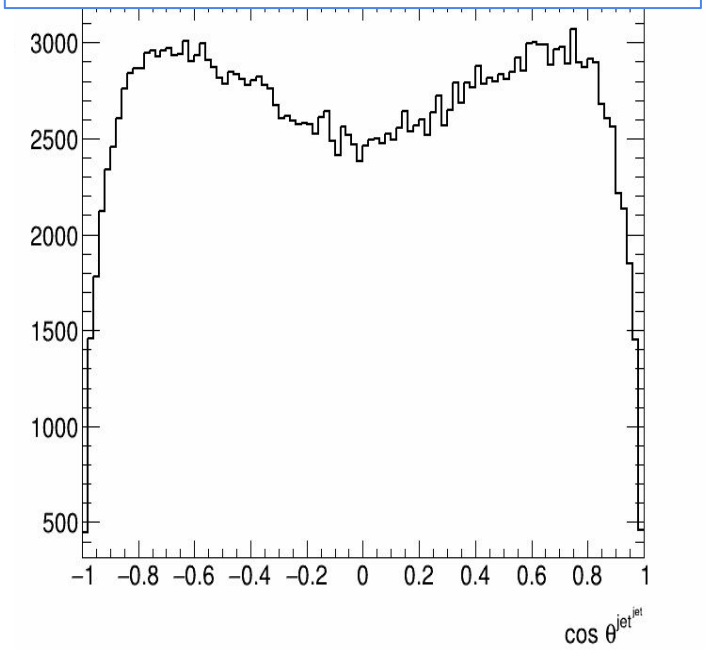


Ongoing tasks: Analysis code

Plot from FCCAnalyses



Plot from old ntuples



Why we think that moving to official framework is going to (partially) help

Ongoing tasks: Analysis code

master ▾ **FCCAnalyses** / examples / FCCee / **AFB** /

Go to file

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hamzeh-khanpour AFB - FCCee — b5ca242 yesterday — History

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analysis_AFB_stage1_FCCee_sig_bkgs.py	AFB - FCCee	yesterday

Link to Github code

Urgent to merge analysis code to official FCCAnalyses framework, both for the jet-charge method and the lepton-based method

Ongoing tasks: Documentation

Bottom quark forward-backward asymmetry at the future electron-positron collider FCC-ee

Marina Cobal[1],* Giovanni Guerrieri[2],† Hamzeh Khanpour[1,2,3],‡
Giancarlo Panizzo[2,3],§ Michele Pinamonti[2,5],¶ and Leonardo Toffolin[2,5]**
[1] *Dipartimento Politecnico di Ingegneria ed Architettura, University of Udine, Via della Scienze 206, 33100 Udine, Italy.*
[2] *The Abdus Salam International Centre for Theoretical Physics (ICTP), Strada Costiera 11, 34151 Trieste, Italy.*
[3] *School of Particles and Accelerators, Institute for Research in Fundamental Sciences (IPM), P.O.Box 19395-5531, Tehran, Iran.*
[4] *EP Department, CERN, Geneva, Switzerland.*
[5] *Physics Department, University of Trieste, Via Valerio 2, 34127 Trieste, Italy.*
(Dated: March 30, 2023)

In this work, we present our study on the b-quark forward-backward (FB) asymmetry at the future collider FCC-ee at the Z pole. The Standard Model (SM) prediction for the b-quarks FB asymmetry is calculated to be $(A_{FB}^{0,b})_{th} = 0.1030 \pm 0.0002$. From the experimental point of view, the A_{FB}^{b} in electron-positron collisions measured by large electron-positron (LEP) collider at the Z pole is $A_{FB}^{0,b} = 0.0992 \pm 0.0016$ which remains today the electroweak precision observable with the largest disagreement with respect to the SM prediction. The LEP measurements suffer from both the dominant statistical and the different sources of systematic uncertainties as well. We show that the proposed high-luminosity electron-positron collider FCC-ee in which collecting orders-of-magnitude more data at the Z pole with respect to the LEP could significantly reduce the $A_{FB}^{0,b}$) statistical uncertainties. We also have studied and discussed to what extent the new tools, the QCD developments in the last years, the new official FCCAnalysis framework, ... could have improved our understanding of the different sources of systematic uncertainties.

CONTENTS

I. INTRODUCTION

- Finalizing the first draft of the note for the midterm report
- By 15 April, it will be finished to shared with the internal Udine/ICTP FCC group members
- By end of April, we will have the final draft

Other possible related studies in the near future

- Probing the bbe^+e^- four fermions contact interaction at a future electron-positron collider
  - Analysis almost done considering the simulation with IDEA detector in Delphes
  - Preliminary note ready

THANK YOU
FOR YOUR
ATTENTION
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