Rb measurement at CEPC MC Level

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Introduction

- R_b : the relative decay width of Z into b quarks

$$\frac{\Gamma(Z \to b\bar{b})}{\Gamma(Z \to had)}$$

- ~1.5×10^{12} Z boson with $45ab^{-1}$ at CEPC
- Double tagging method :
  - The ratio of one jet tagged as b jet
  - The ratio of both jets tagged as b jets

Get From Mixed MC Sample

$$\frac{N_t}{2N_{had}} = R_b\varepsilon_b + R_c\varepsilon_c + (1 - R_b - R_c)\varepsilon_{uds}$$

$$\frac{N_{tt}}{N_{had}} = C_b R_b \varepsilon_b^2 + C_c R_c \varepsilon_c^2 + C_{uds}(1 - R_b - R_c)\varepsilon_{uds}^2$$

R_c, ε_c, ε_{uds}
C_b, C_c, C_{uds}
Get from MC

$$C_b = \frac{\varepsilon_{2jet-tagged}}{(\varepsilon_{1jet-tagged})^2}$$

Rb method

Double Tagging Method

Get From Mixed MC Sample

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R_c, ε_c, ε_{uds}
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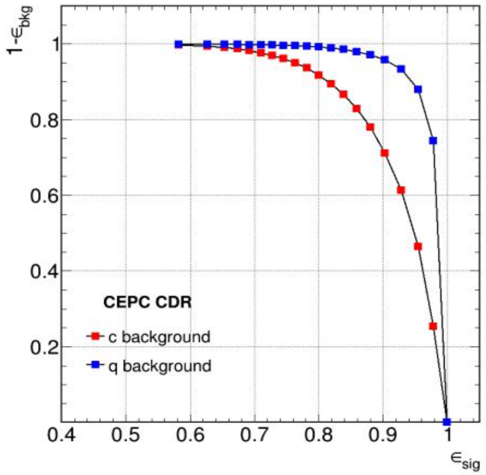
Get from MC

$$C_b = \frac{\varepsilon_{2jet-tagged}}{(\varepsilon_{1jet-tagged})^2}$$

- LEP measurement 0.21594 ±0.00066
  Syst error : ~0.2%
  Major systematics: hemisphere tag correlations, charm modeling, gluon spliting

- CEPC
  - Expected Syst error (0.02%)
    - hemisphere tag correlations depends on b tagging efficiency
    - with a high b-tagging efficiency above 80% and rejection of charm and light jet above 90%



Rb method

Double Tagging Method

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R_c, ε_c, ε_{uds}
C_b, C_c, C_{uds}
Get from MC

$$C_b = \frac{\varepsilon_{2jet-tagged}}{(\varepsilon_{1jet-tagged})^2}$$

$$\frac{N_t^I}{N_{had}} = \epsilon_b^I R_b + \epsilon_c^I R_c + \epsilon_{uds}^I R_{uds}$$

The ratio of jet tagged as b jet in Hemisphere ***I***

$$\frac{N_t^J}{N_{had}} = \epsilon_b^J R_b + \epsilon_c^J R_c + \epsilon_{uds}^J R_{uds}$$

The ratio of jet tagged as b jet in Hemisphere ***J***

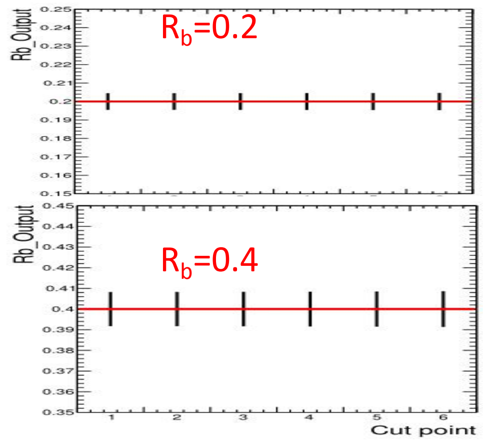
$$\frac{N_{tt}^{I,J}}{N_{had}} = \epsilon_b^I \epsilon_b^J C_b R_b + \epsilon_c^I \epsilon_c^J C_c R_c + \epsilon_{uds}^I \epsilon_{uds}^J C_{uds} R_{uds}$$

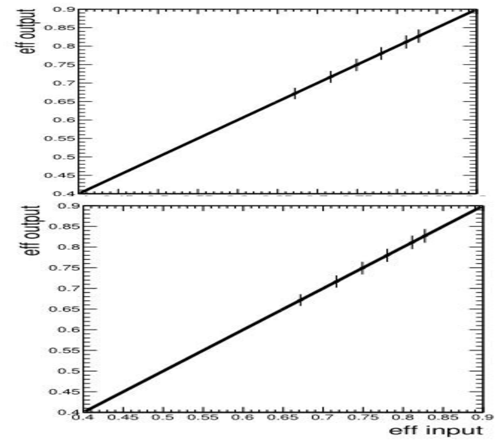
Rb method

preliminary study

Closure test:

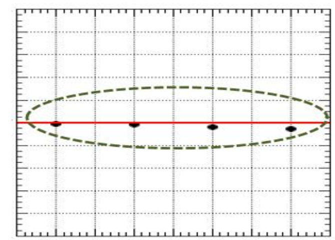
- Following this procedure, we can meausere the R_b, ε_b
- The Z hadronic pseudo'**DATA**' is mixed by MC samples: Zbb **sample**, Zcc **sample**, Zll sample
- We set Rb=0.2, Rb=0.4, Rb=0.6 as the Input Rb to mix the 'DATA'





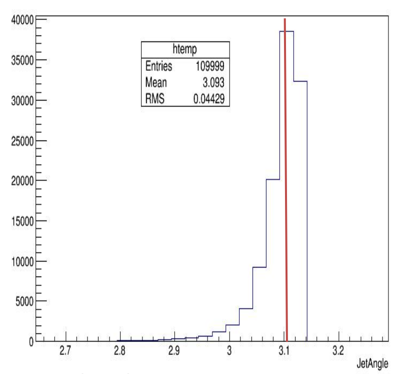
Effect from MC Eff

- input theory Rb=0.2158:
- I/O test with ε_c ±10%, ε_{uds} ±10%, C_b ±10%

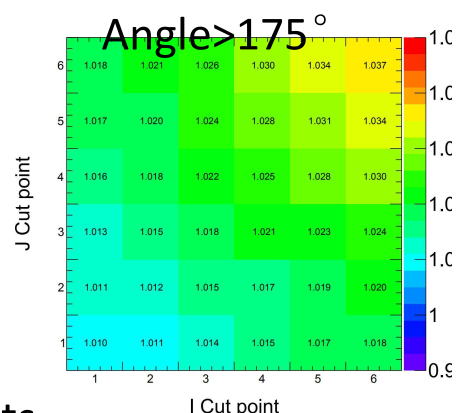


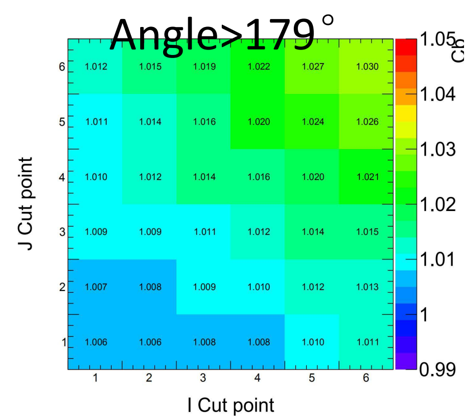
B-tagging correlation:

- **such as:** two jets are back to back



Angle between two jets





Plan

- Both the B-tagging efficiency for Z->bb and rejection for Z->cc, Z->uds are good for method

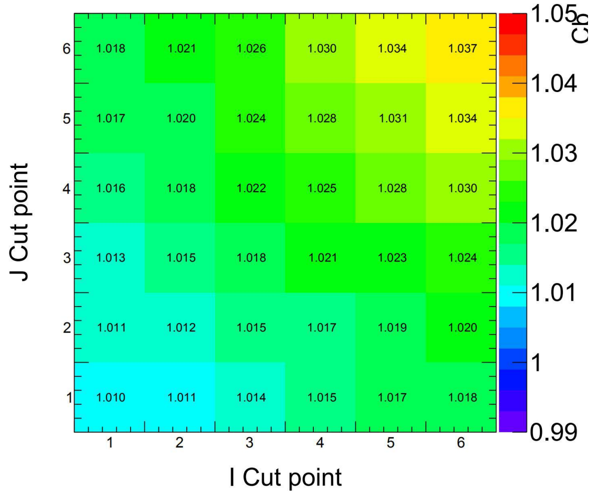
- The double tagging method procedure works well as shown in I/O test

- Next step :
  - Two independent B-tagging method to reduce the correlation
  - Study on the systematic errors such as the gluon splitting, charm physics modeling

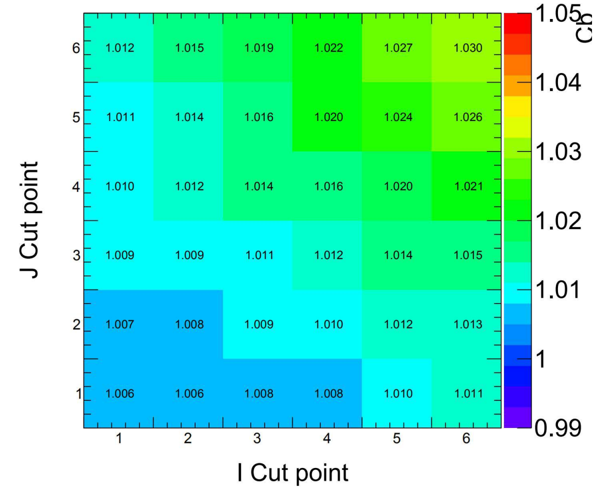
B-tagging correlation

Jet back to back cut

JetAngle>175°



JetAngle>179°



$Cutpoint$	1	2	3	4	5	6
$Prob$	>0.45	>0.5	>0.6	>0.7	>0.8	>0.9

Method

Effect of C_b

Follow the procedure in : *Measurement of Rb and Br(b → ℓνX) at LEP Using Double-Tag Methods (L3 Collaboration)*

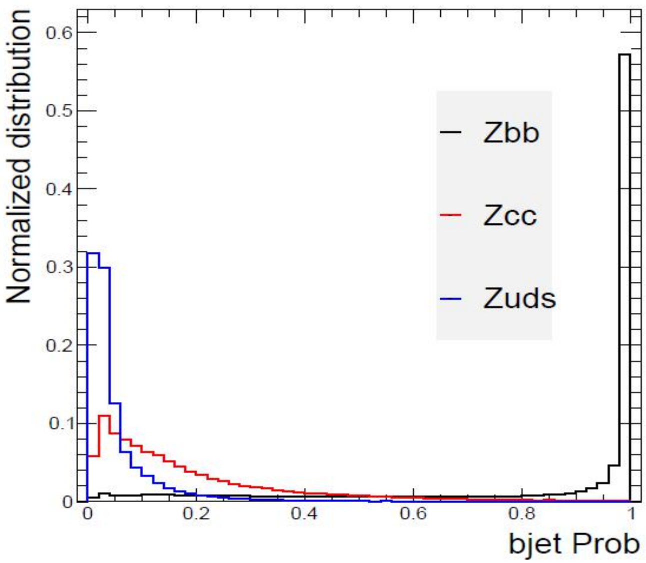
In section 4.3.3 Systematics from Hemisphere Correlation

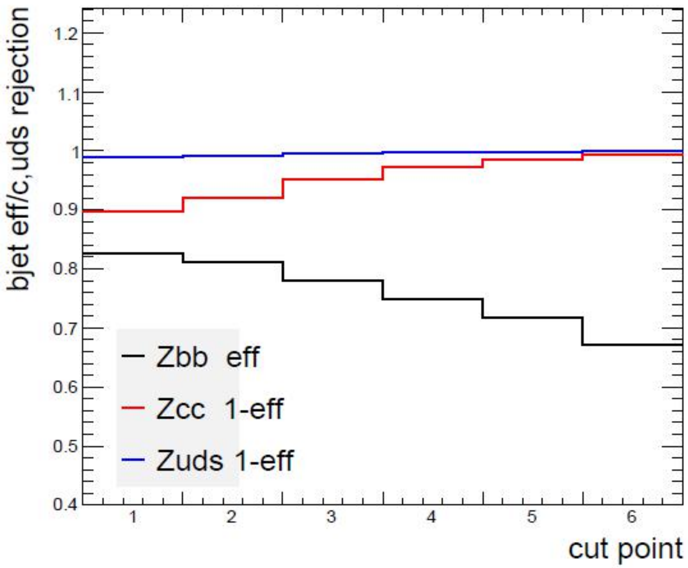
1. The normalised distribution of λ for all hemispheres, N(λ).
2. The single-hemisphere tagging effiffifficiency as a function of λ, ϵ(λ).
3. The normalised distribution of λ in a co-tagged hemisphere, C(λ). A co-tagged hemisphere is the one opposite to a tagged hemisphere, regardless of whether it is itself tagged.

$$C_b^{\lambda} = \frac{\int \epsilon(\lambda)\, C(\lambda)\, d\lambda}{\int \epsilon(\lambda)\, N(\lambda)\, d\lambda}.$$

B-tagging method

- Based on the LCFIPlus: combines more than 60 variables to calculate the b jet probability by BDT method





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