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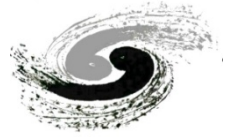
# W/Z physics in CDR

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IHEP,CAS

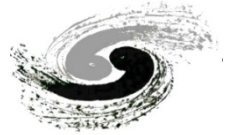
# Reminder of CEPC W/Z runs

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- **Some discussion about CEPC Z pole running .**
  - <http://indico.ihep.ac.cn/event/7709/>
    - $E=91.2\text{GeV}$ ,  $L=1.6 \times 10^{35} \text{ cm}^{-2}\text{s}^{-1}$ , solenoid field = 3T ( new default )
    - Two year running proposed by accelerator team
- **WW threshold scan**
  - Proposal from accelerator team
  - One year running about 160GeV
  - Total luminosity  $3.2 \text{ ab}^{-1}$

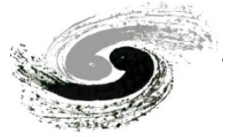
# CEPC W/Z physics Plan for CDR



- Plan to cover the prospects of 6-7 key parameters.
- Plan to have First draft of CDR about W/Z physics ready by end of May.
  - <http://cepcgit.ihep.ac.cn/cepcdoc/CDR>

Observable	LEP precision	CEPC precision	CEPC runs	$\int \mathcal{L}$ needed in CEPC
$m_Z$	2 MeV	0.5 MeV	Z threshold scan runs	$1\text{ab}^{-1}$
$m_W$	33 MeV	2-3 MeV	WW threshold, ZH runs	$5\text{ab}^{-1}$
$A_{FB}^b$	1.7%	0.1%	Z threshold scan runs	$1\text{ab}^{-1}$
$\sin^2 \theta_W^{\text{eff}}$	0.07%	0.01%	Z threshold scan runs	$1\text{ab}^{-1}$
$R_b$	0.3%	0.05%	Z pole	$1\text{ab}^{-1}$
$N_\nu$	1.7%	0.05%	ZH runs	$5\text{ab}^{-1}$
$R_\mu$	0.2%	0.01%	Z pole	$1\text{fb}^{-1}$

# R\_b measurement



- Sensitive to b/c tagging performance
- Study the major systematics
  - Hemisphere correlations

Bo Li (Yantai University)

Get From  
Mixed MC  
Sample

$$\frac{N_t}{2N_{had}}$$

$$= R_b \epsilon_b + R_c \epsilon_c + (1 - R_b - R_c) \epsilon_{uds}$$

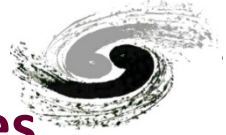
$$\frac{N_{tt}}{N_{had}}$$

$$= C_b R_b \epsilon_b^2 + C_c R_c \epsilon_c^2 + C_{uds} (1 - R_b - R_c) \epsilon_{uds}^2$$

$R_c, \epsilon_c, \epsilon_{uds}$   
 $C_b, C_c, C_{uds}$   
Get from MC

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

# R\_b measurement (2)



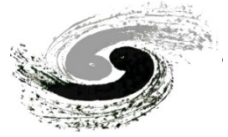
- Hemisphere tagging correlations study in MC samples

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

Cut:  $\Delta R < 0.4$  for jet1 and jet2

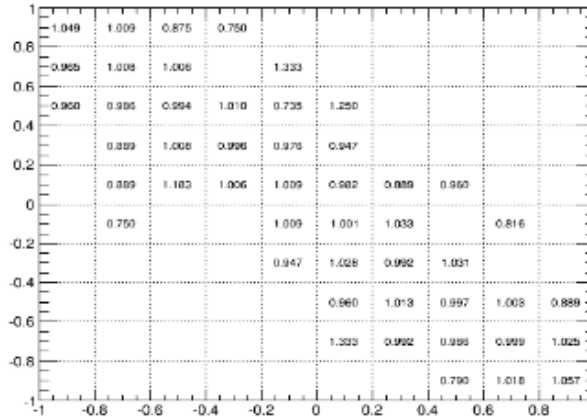
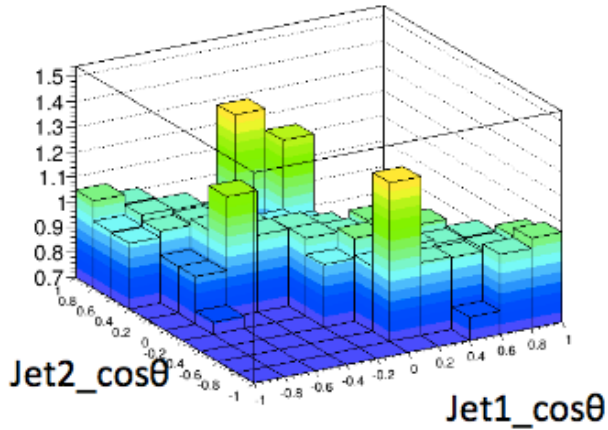
	Prob >0.6	>0.7	>0.8	>0.9	>0.95
Zbb	1.015+0.014	1.021+0.014	1.026+0.015	1.033+0.016	1.036+0.016
	1.008+0.014	1.012+0.015	1.017+0.015	1.021+0.016	1.024+0.017
zcc	1.159+0.085	1.173+0.123	1.452+0.212	1.980+0.416	2.686+0.760
	1.109+0.090	1.176+0.134	1.379+0.222	1.743+0.417	2.155+0.733
zuds	7.568+1.477	14.35+3.210	23.86+6.182	45.76+13.97	73.92+26.31
	4.467+1.278	6.078+2.285	11.43+4.698	15.09+8.571	34.21+20.49

# R\_b measurement (3)



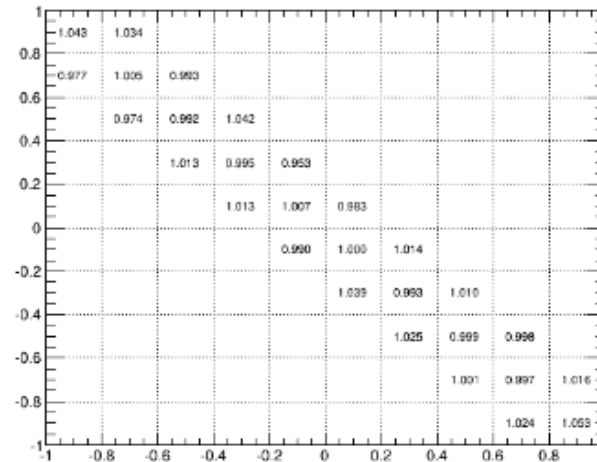
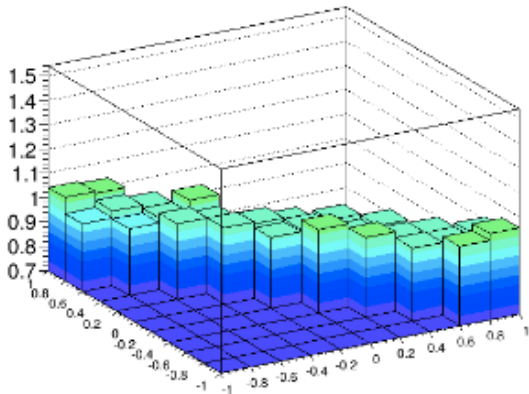
2D Correlation Factor

Zbb Prob>0.7

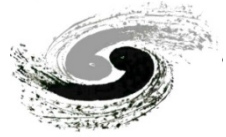


Adding this cut reduces the Hemisphere correlations

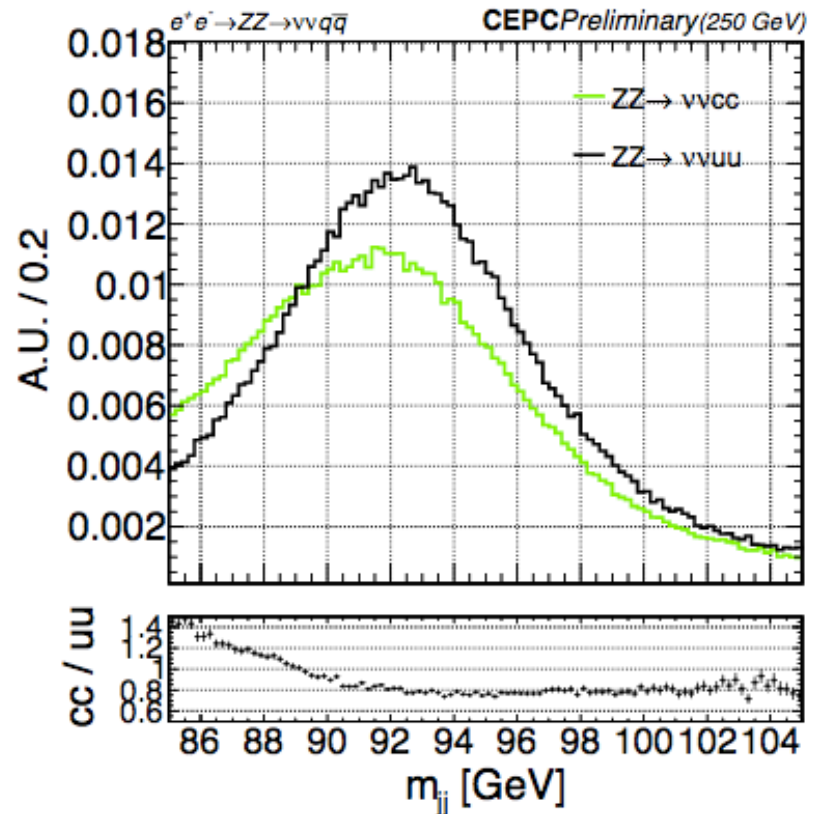
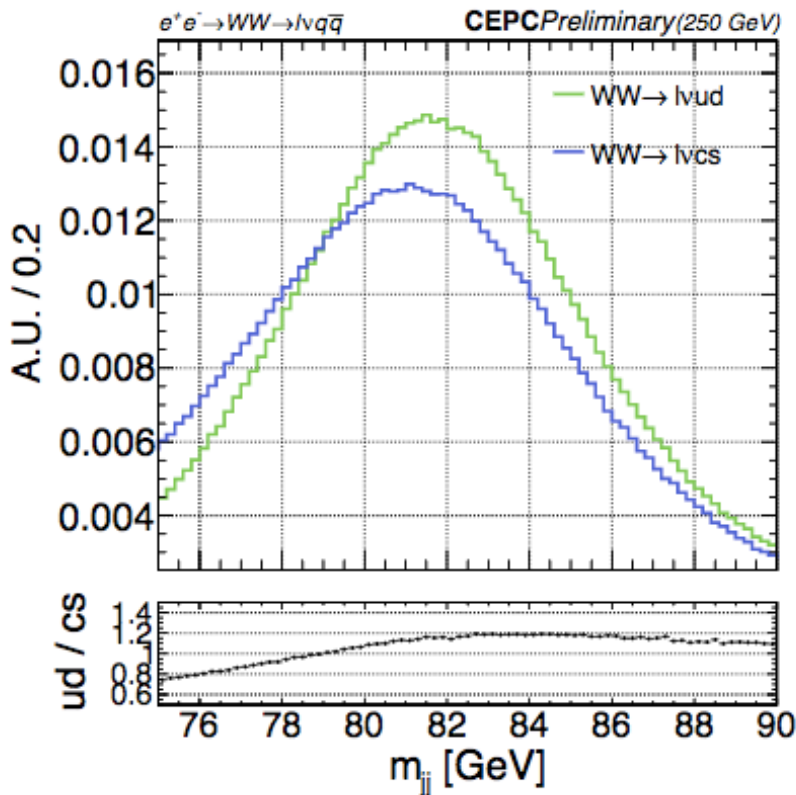
Cut:  $180^\circ - \Delta\theta(\text{jet1}, \text{jet2}) < 5^\circ$



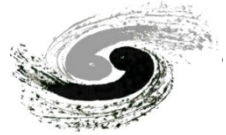
# W mass (direct measurement)



- Measure W mass directly from ZH runs using  $lvjj$  events.
- Major activity is from Peizhu Lai (NCU) with the help from Maarten Boonekamp (CEA) and Dr. Hengne Li
  - In jet energy scale systematics (jet flavor dependence)



# W mass (threshold scan)



- Peixun Shen (IHEP) is working on WW threshold scan optimization
  - With considering the systematics

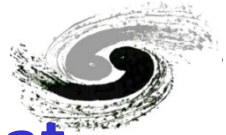
With :  $E_1=157.5\text{GeV}$ ,  $E_2=162.5\text{ GeV}$ ,  $\sigma^{sys}(\text{corr.}) = 2 \times 10^{-4}(\text{relative})$   
 $\Delta E_{BS}=1.6 \times 10^{-3}(\text{relative})$ ,  $\Delta E=0.5\text{ MeV}$

Just the quadratic sum without the  $\Delta E_{BS}$

F	$\Delta m_W$ (MeV)						$\Delta \Gamma_W$ (MeV)					
	Stat.	Sys.				Total	Stat.	Sys.				Total
		$\sigma(\text{corr.})$	$\Delta E$	$\Delta E_{BS}$	$\sigma_{tot}^{sys}$			$\sigma(\text{corr.})$	$\Delta E$	$\Delta E_{BS}$	$\sigma_{tot}^{sys}$	
0.1	0.71	0.47	0.35	-		0.92	4.6	0.31	0.52	0.43	0.74	4.7
0.15	0.73	0.47	0.37	-		0.94	3.7	0.28	0.52	0.55	0.8	3.8
0.2	0.76	0.45	0.37	-		0.96	3.3	0.26	0.52	0.60	0.84	3.4
0.25	0.78	0.46	0.37	-		0.98	3.0	0.23	0.51	0.76	0.94	3.1
0.3	0.81	0.48	0.38	-		1.02	2.7	0.22	0.54	0.88	1.06	2.9

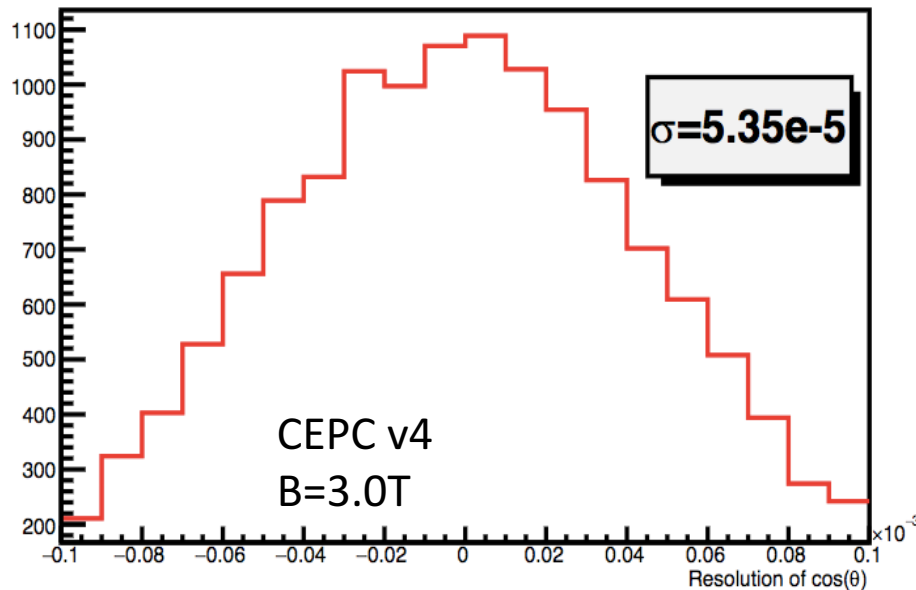


# Afb : muon angular resolution

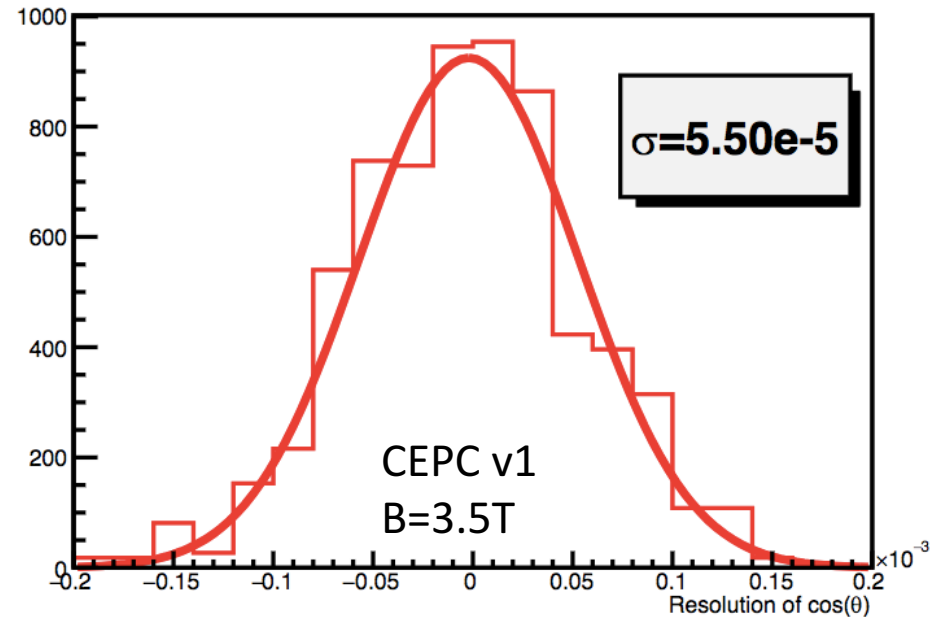


- Mengran Li (IHEP) is working on Afb in Z->mmumu at Z threshold scan runs.
  - Simulated 100k full sim Z->mmumu samples at Z pole
  - Study one key performance (muon angular resolution)

$|\cos(\theta)|$  in  $[0,0.2]$

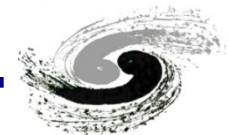


$|\cos(\theta)|$  in  $[0,0.2]$



# MC requests with CEPC v4

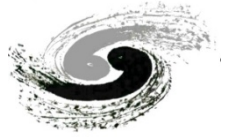
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- **W mass direct measurement**
  - 240GeV , WW->lvjj, 5M full simulation
  - 240GeV , ZZ->vvjj, 1M full simulation
- **R<sub>b</sub> measurement**
  - 91.2GeV, Z->bb , Z->cc, Z->light jets, 3M full simulation

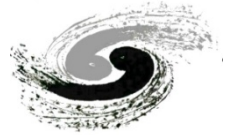
# Summary

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- Plan to converge on W mass study by the end of May.
  - Analysis which don't need full simulation
    - WW Threshold scan is in good shape
  - Analysis need new MC:
    - W mass (direct measurement)
      - First round with CEPC v1 simulation
      - needs two more weeks after new fullsim sample ready.
    - R\_b (Z->bb) measurements
      - needs 2~3 weeks to update after full simulation samples ready.
    - Z->mumu
      - Fullsim sample ready, next 2~3weeks to go through 1<sup>st</sup> round.
-

# Performance input



- Identify some performance input needed to support the W/Z physics prospect study
  - May need to repeat some study with 3T magnetic field and new detector geometry
- $A_{fb}(l)$ : lepton angular resolution
- $R_b$ : “B jet efficiency” vs “cjet/light rejection”
- W mass (direct approach) : jet energy resolution
- W mass (threshold scan): ?
- $N_v$  : photon energy resolution

