W, Z-Boson Mass Measurement at CEPC

Presented by [1]Pei-Zhu Lai（賴培築）

Supervisor: [2]Man-Qi Ruan, [2]Gang Li, [2]Bo Liu, [1]Chia-Ming Kuo

[1]National Central University, Taiwan

[2]Institute of High Energy Physics, China

EW Meeting

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Outline

Section 1 (W)

- The selection efficiencies of signal sample ($WW \to \mu\nu q\bar{q}$)
- Results after event selections
  - Without b- & c-tagging
  - With b-tagging score < 0.5 for two jets
  - With b-tagging score < 0.5 & c-tagging score < 0.6 for two jets
- Comparison between these three categories

Section 2 (Z)

- The selection efficiencies of signal sample($ZZ \to \mu\mu q\bar{q}$ & $ZZ \to \nu\nu q\bar{q}$)
- Kinematic distribution of $ZZ \to \mu\mu q\bar{q}$.
- Results after event selections
  - Without b- & c-tagging
  - With b-tagging score < 0.5 for two jets
  - With b-tagging score < 0.5 & c-tagging score < 0.6 for two jets
- Comparison between these three categories

(Signal)Select the Final State($\mu\nu q\bar{q}$) in V1

V1($WW \to \mu\nu q\bar{q}$)	# of event	Efficiency	Efficiency w.r.t. previous
Tot # of event	11206127	—	—
nTrack > 7	11167526	99.6%	—
Muon Selection	9538586	85.1%	85.4%
Detector acceptance $\|\cos(\theta_\mu)\| < 0.995$	9538586	85.1%	100%
Pt_{Miss} > 10 GeV	9166653	81.8%	96.1%
Visible mass > 0.5*√s	8453350	75.4%	92.2%
Two jets b-tag score < 0.5	7965154	71.0%	94.2%
Two jets c-tag score < 0.6	5485695	48.9%	68.8%

- The effective luminosity is 10 ab^{-1}.
- Muon selections: ID=13 & R0 < 0.01mm & E_μ >= 10 (GeV).
- Jet reconstruction: force all events to two jets
- There are three categories, without b- & c-tagging, with b-tagging, with b- & c-tagging.

$$R0 = \sqrt{D0^2 + Z0^2}$$

Results(without b- & c-tagging)

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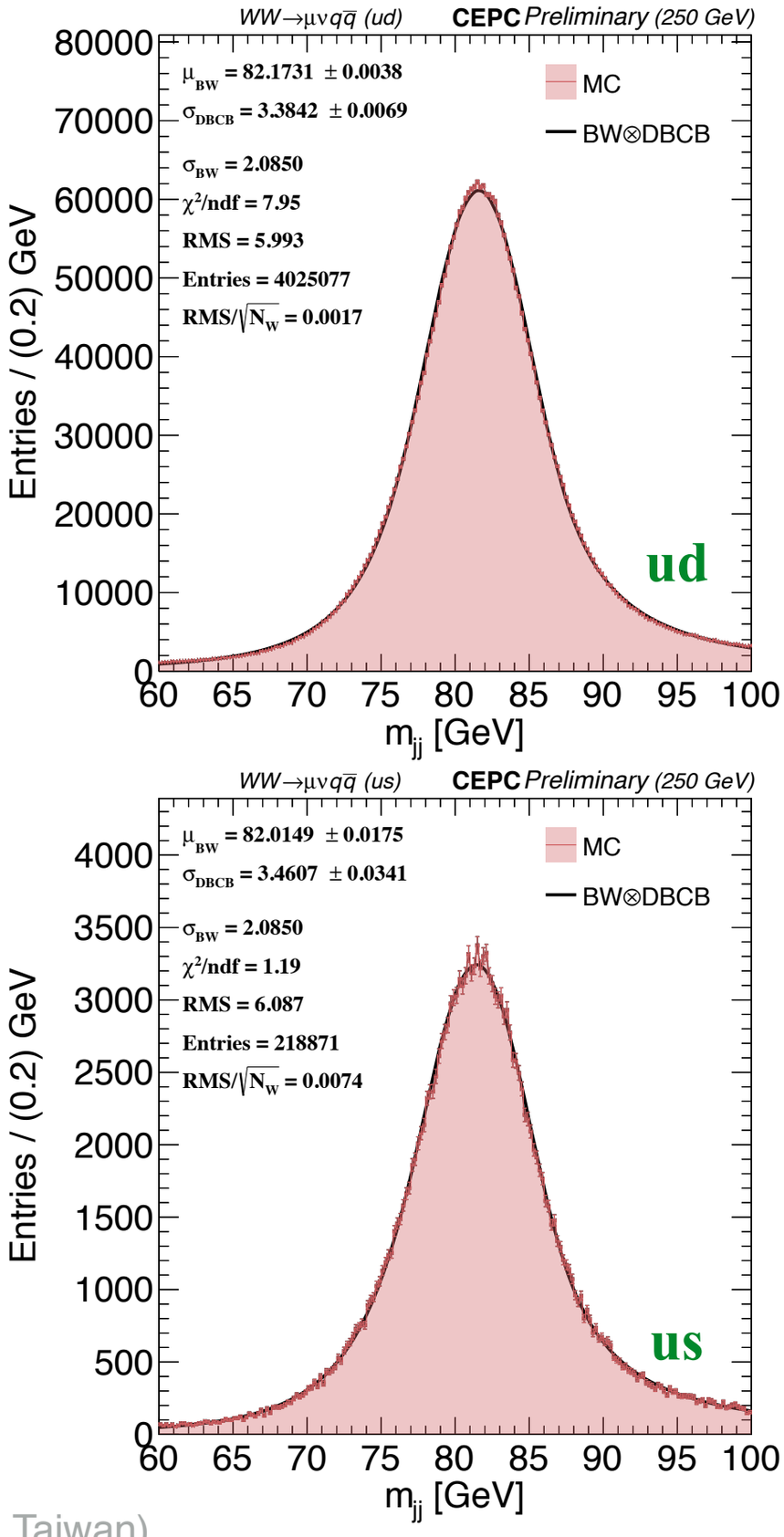
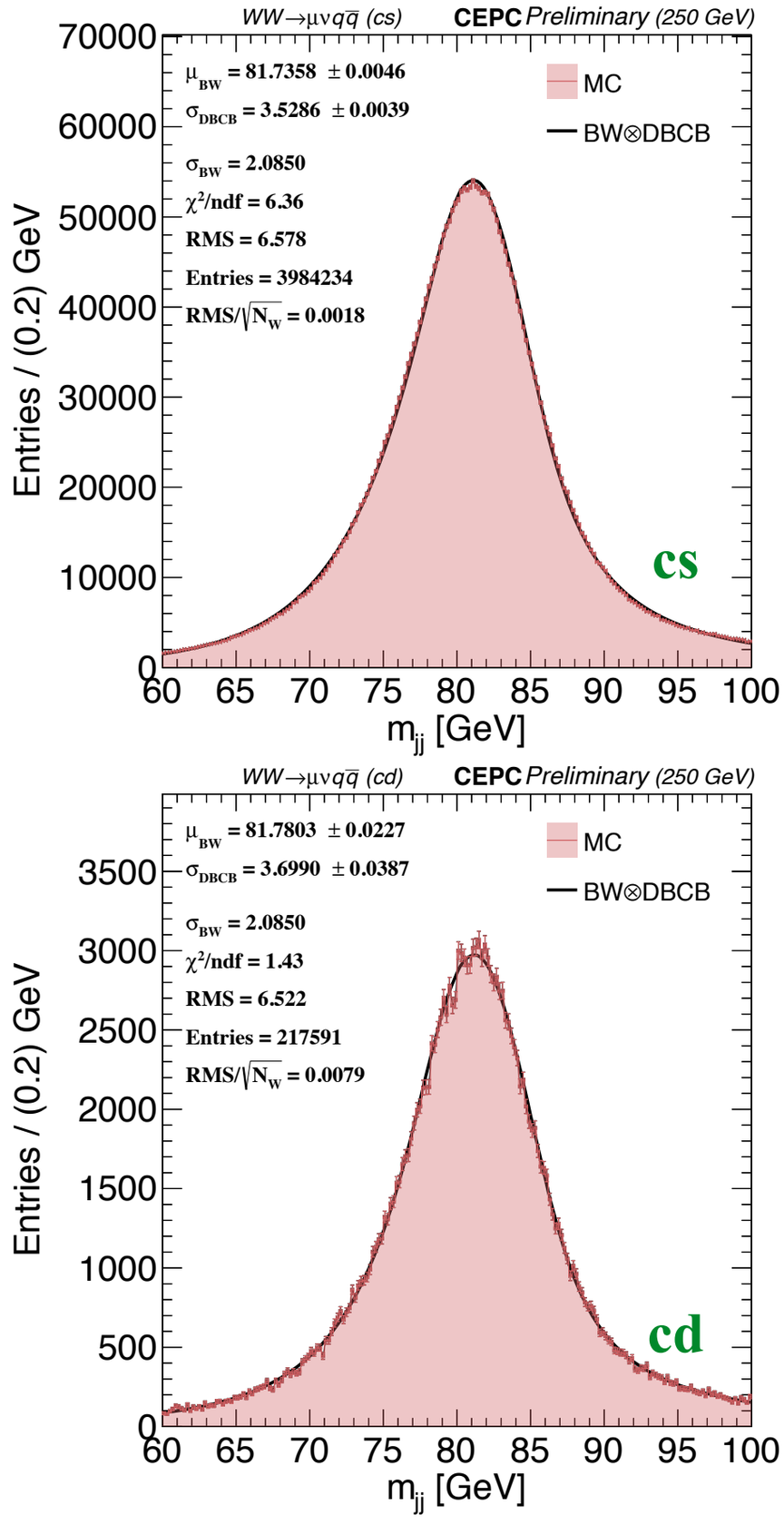
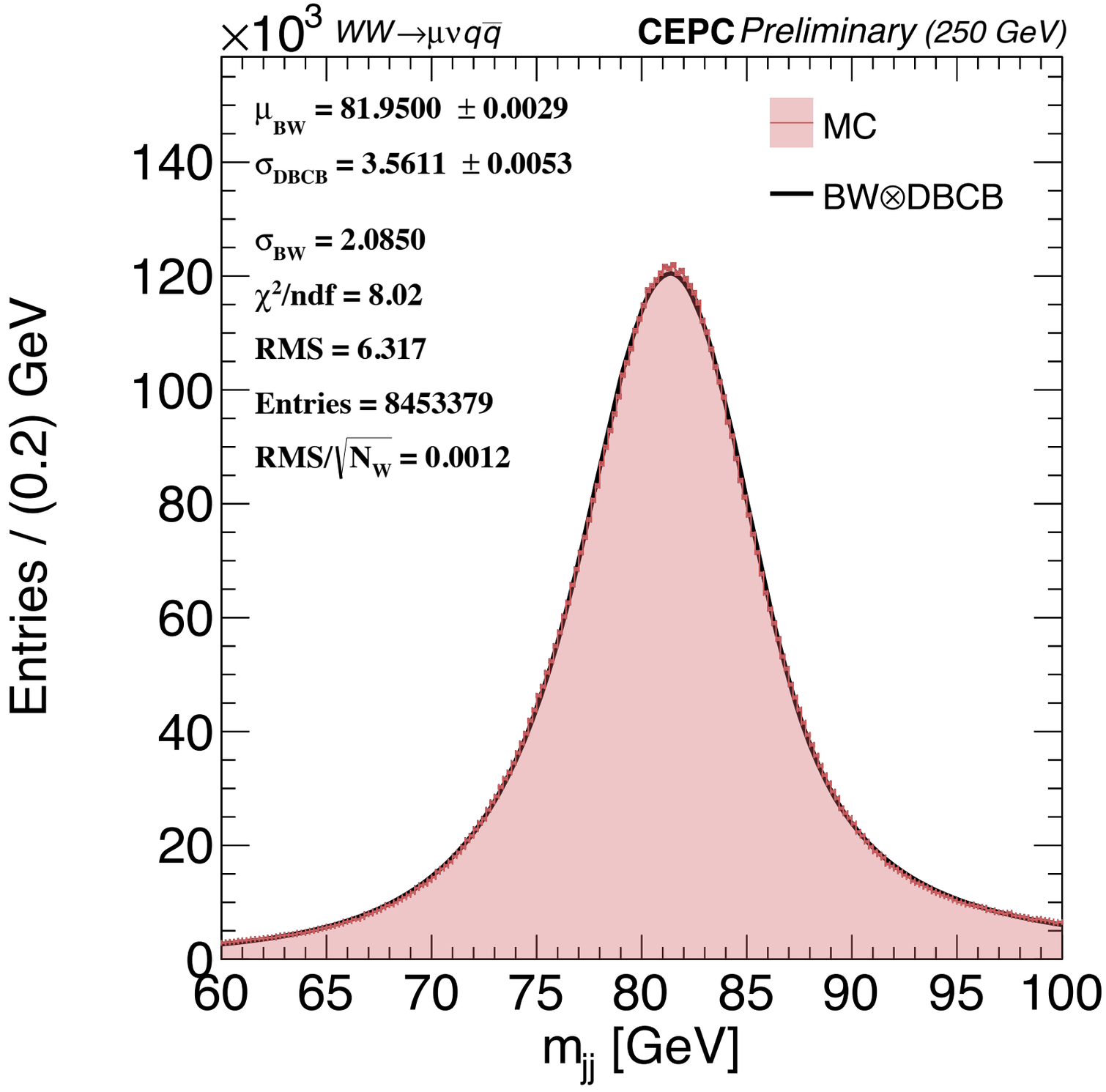




Results(without b- & c-tagging)

Combined four categories (ud, cs, us, cd)



Results(without b- & c-tagging)

V1($WW\to\mu\nu q\bar{q}$)	ud	cs	us	cd	Combined
μ_{BW}	82.1731 ± 0.0038	81.7358 ± 0.0046	82.0149 ± 0.0175	81.7803 ± 0.0227	81.9500 ± 0.0029
σ_{DBCB}	3.3842 ± 0.0069	3.5286 ± 0.0039	3.4607 ± 0.0341	3.6990 ± 0.0387	3.5611 ± 0.0053
Entries	4025077	3984234	218871	217591	8453379
RMS	5.993	6.578	6.087	6.522	6.317
RMS/$\sqrt{N_W}$	0.0017	0.0018	0.0074	0.0079	0.0012

- **The categories with c-quark would have less μ_{BW} and lower jet energy resolution.**
- **Entry of same generation are similar.(e.g. ud & cs)**

Results(with b-tagging score < 0.5)

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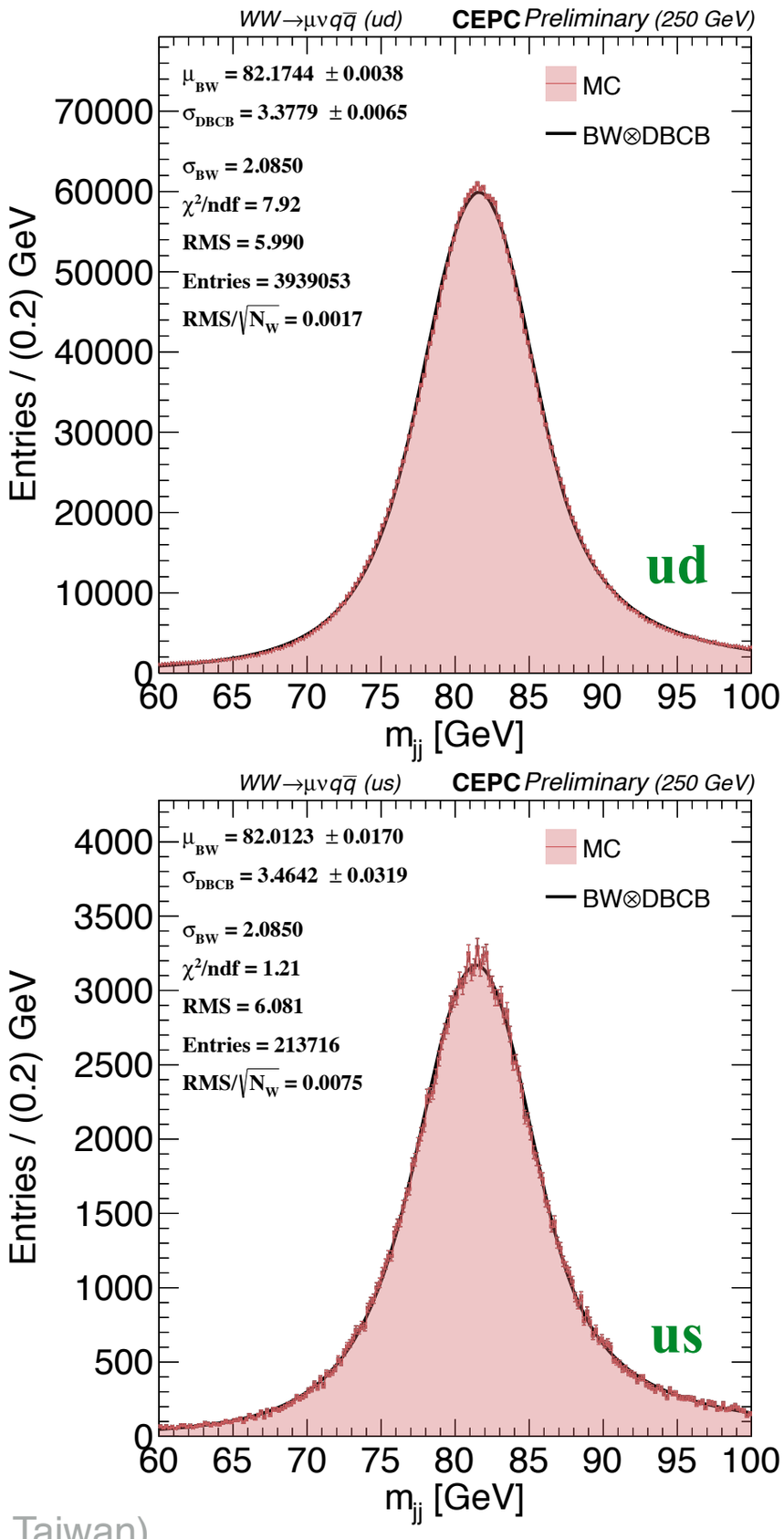

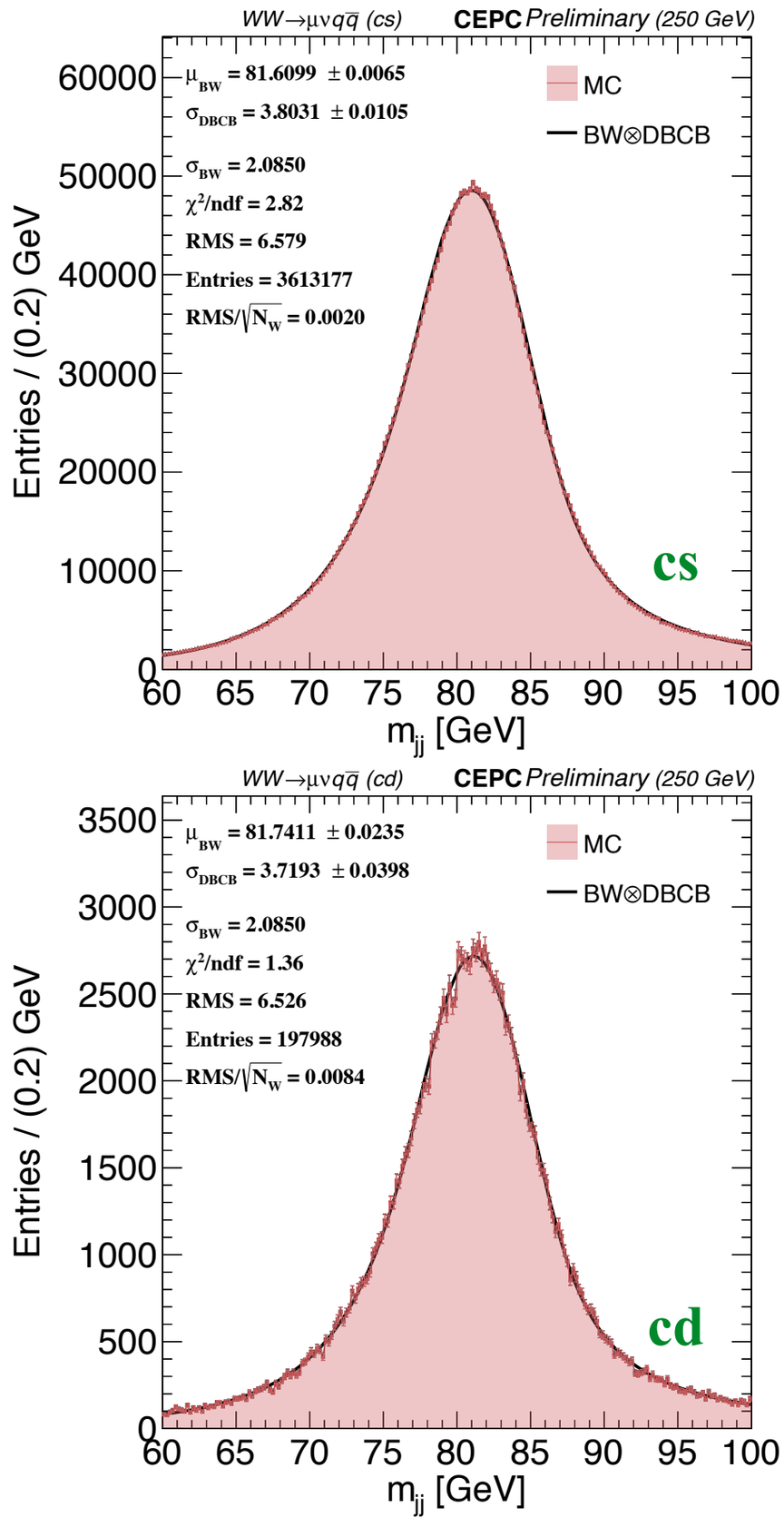

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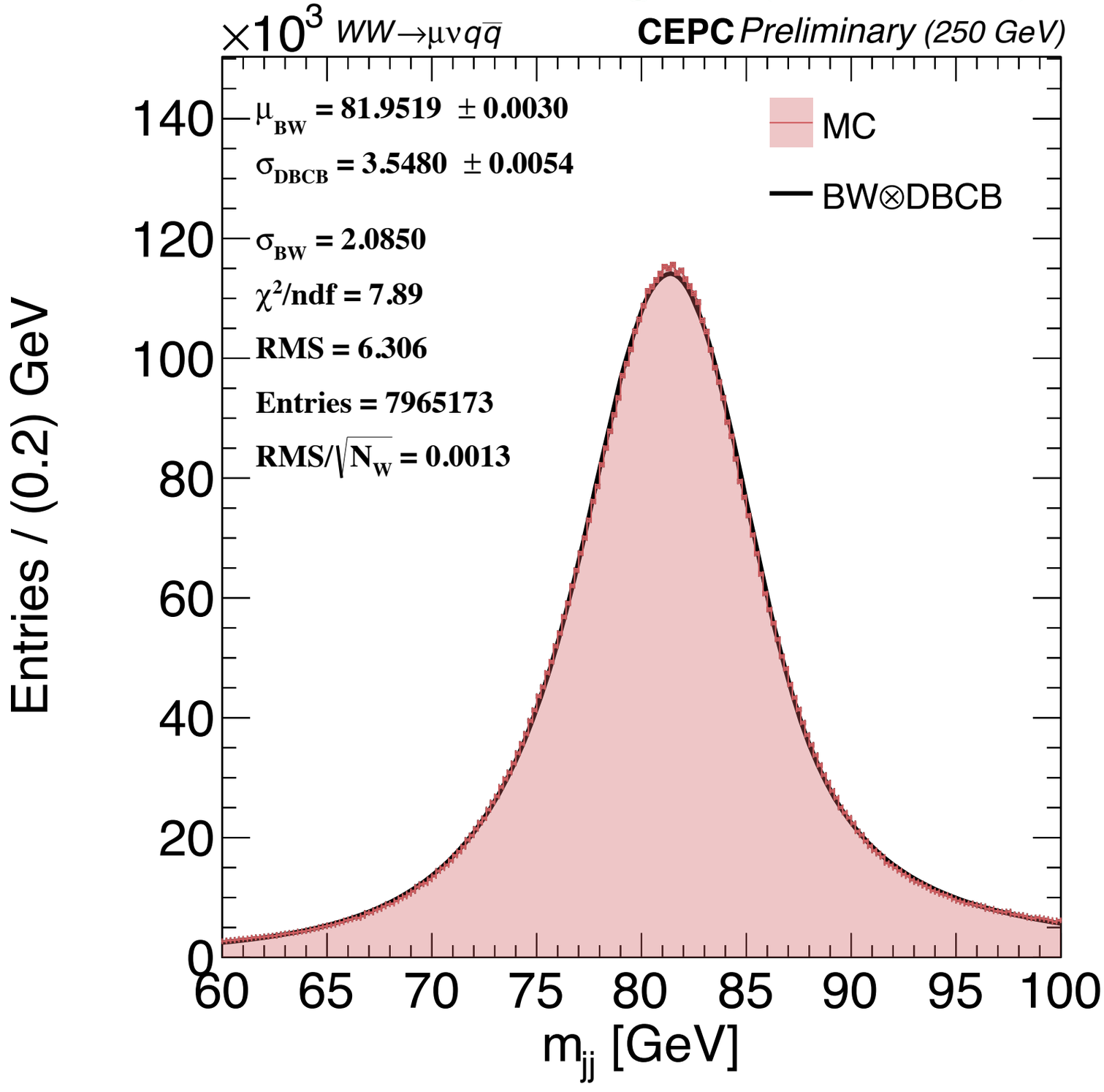


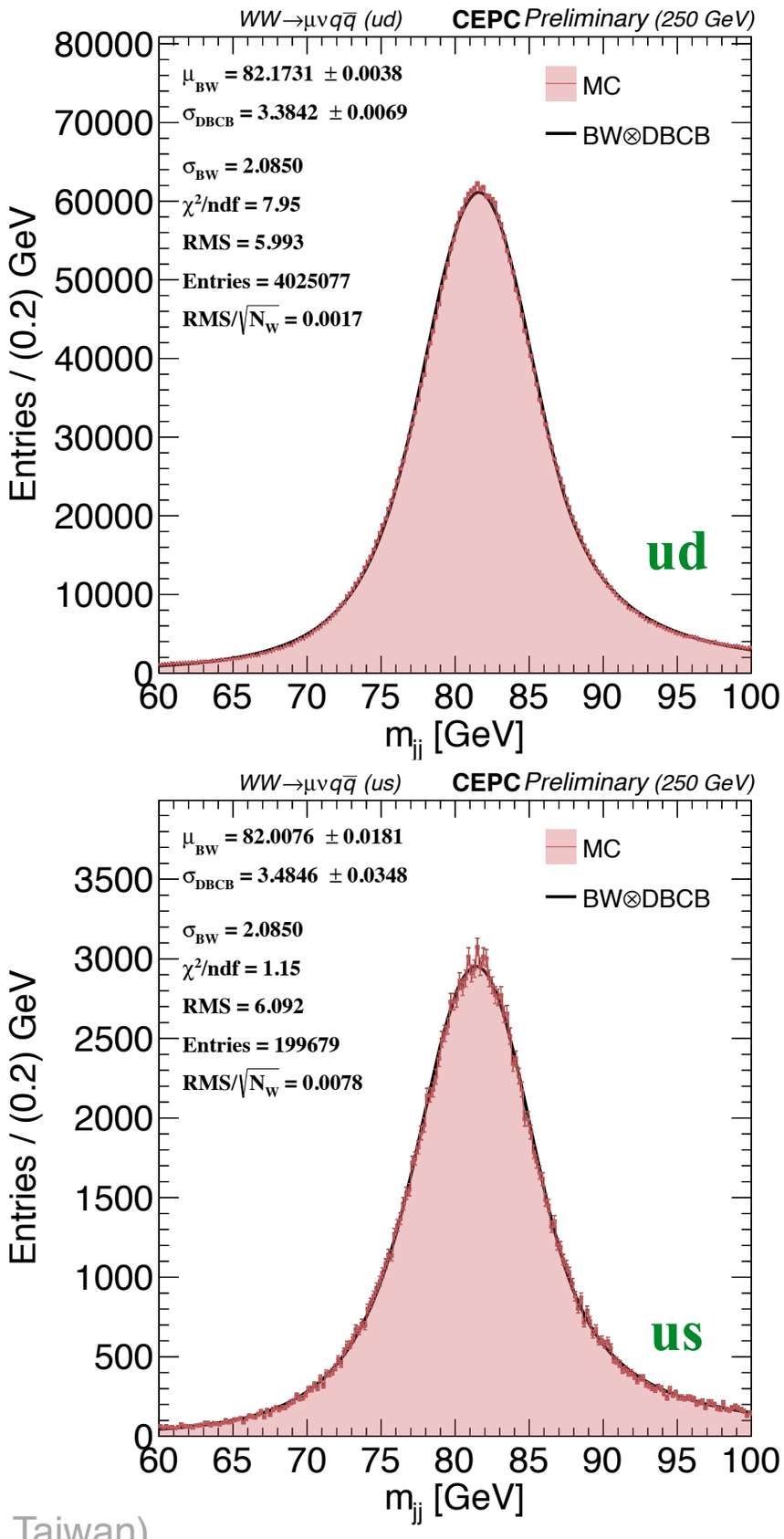
Results(with b-tagging score < 0.5)

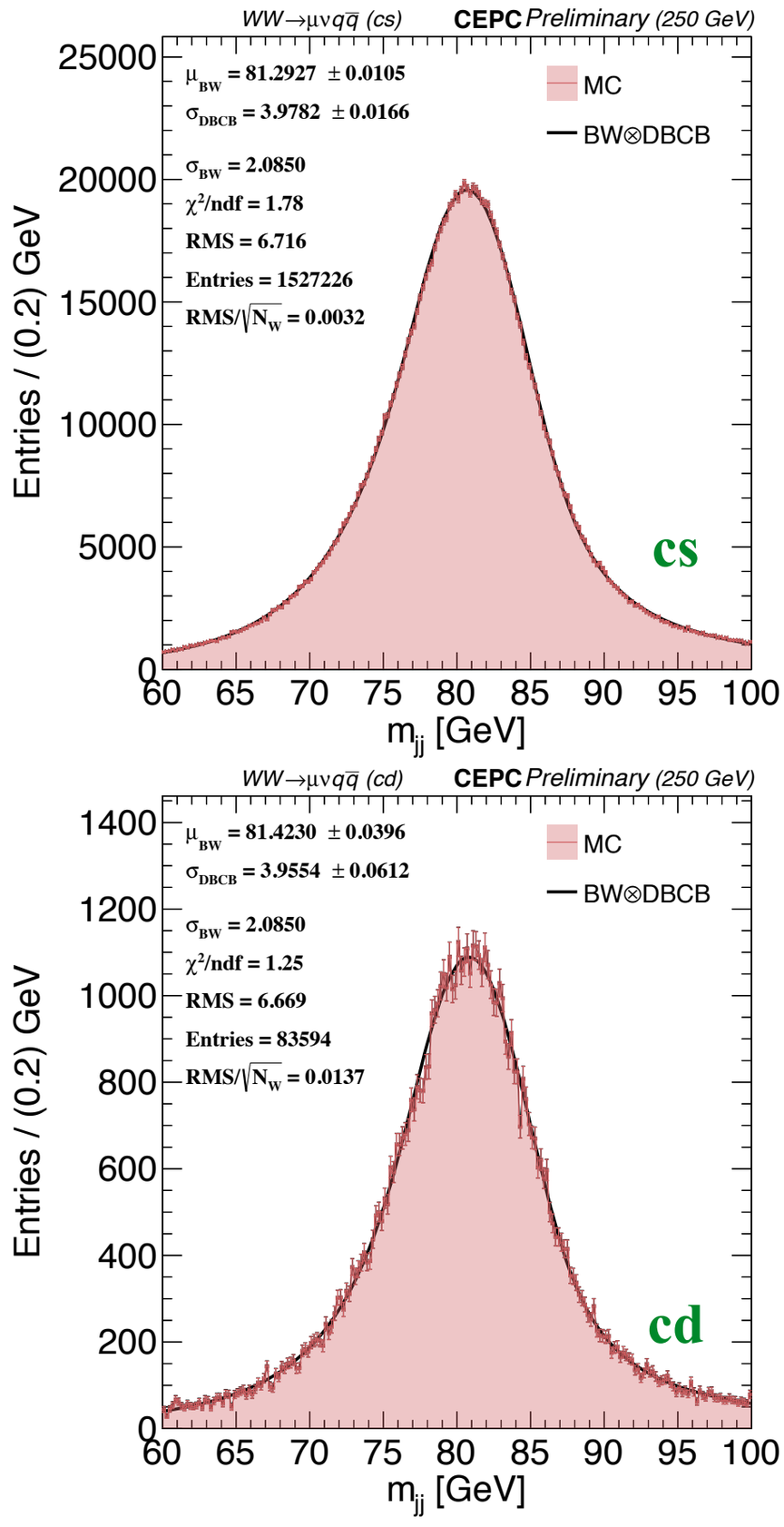
V1($WW \to \mu\nu q\bar{q}$)	ud	cs	us	cd	Combined
μ_{BW}	81.1744 ± 0.0038	81.6099 ± 0.0065	82.0123 ± 0.0170	81.7411 ± 0.0235	81.9519 ± 0.0030
σ_{DBCB}	3.3779 ± 0.0065	3.8031 ± 0.0105	3.4642 ± 0.0319	3.7193 ± 0.0398	3.5480 ± 0.0054
Entries	3939053	3613177	213716	197988	7965173
RMS	5.990	6.579	6.081	6.526	6.306
RMS/$\sqrt{N_W}$	0.0017	0.0020	0.0075	0.0084	0.0013

- **The categories with c-quark would have less μ_{BW} and lower jet energy resolution.**
- **Entry of same generation are similar.(e.g. ud & cs) However, the categories with c-quark would have a litter bit lower entries since b-vetoing may reject some c-quark.**

Results(with b- & c- tagging)

Results(with b-tagging < 0.5 & c-tagging < 0.6)





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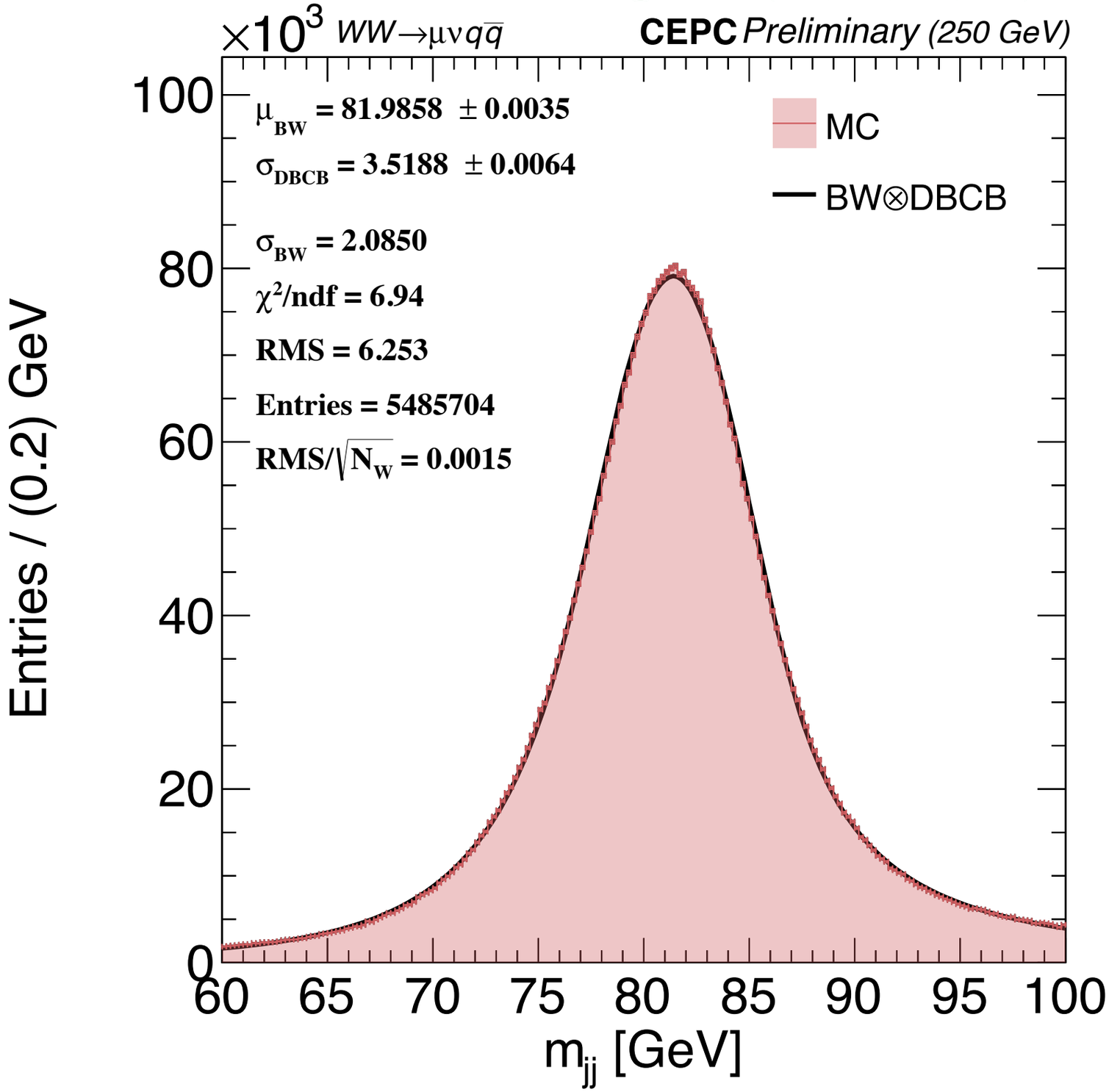

Results(with b-tagging < 0.5 & c-tagging < 0.6)

V1($WW \to \mu\nu q\bar{q}$)	ud	cs	us	cd	Combined
μ_{BW}	82.1731 ± 0.0038	81.2927 ± 0.0105	82.0076 ± 0.0181	81.4230 ± 0.0396	81.9858 ± 0.0035
σ_{DBCB}	3.3842 ± 0.0069	3.9782 ± 0.0166	3.4846 ± 0.0348	3.9554 ± 0.0612	3.5188 ± 0.0064
Entries	4025077	1527226	199679	83594	5485704
RMS	5.993	6.716	6.092	6.669	6.253
RMS/$\sqrt{N_W}$	0.0017	0.0032	0.0078	0.0137	0.0015

- **The categories with c-quark would have less μ_{BW} and lower jet energy resolution.**
- **Entry of same generation are similar.(e.g. ud & cs) However, the categories with c-quark would have a litter bit lower entries since b-vetoing may reject some c-quark.**
- **After adding c-vetoing, there are about 60% c-quarks been discarded. In addition, the μ_{BW} go lower. It seems that the fraction between c-jet and b-jet are changed. There fraction of b-quark jets becomes higher.**

Mass window (60,100), without b-tagging

V1(WW→μνqq̄)	ud	cs	us	cd	Combined
μ_{BW}	82.1731 ± 0.0038	81.7358 ± 0.0046	82.0149 ± 0.0175	81.7803 ± 0.0227	81.9500 ± 0.0029
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Mass window (60,100), with b-tagging < 0.5

V1(WW→μνqq̄)	ud	cs	us	cd	Combined
μ_{BW}	81.1744 ± 0.0038	81.6099 ± 0.0065	82.0123 ± 0.0170	81.7411 ± 0.0235	81.9519 ± 0.0030
σ_{DBCB}	3.3779 ± 0.0065	3.8031 ± 0.0105	3.4642 ± 0.0319	3.7193 ± 0.0398	3.5480 ± 0.0054
Entries	3939053	3613177	213716	197988	7965173
RMS	5.990	6.579	6.081	6.526	6.306
RMS/$\sqrt{N_W}$	0.0017	0.0020	0.0075	0.0084	0.0013

Mass window (60,100), with b-tagging < 0.5 & c-tagging < 0.6

V1(WW→μνqq̄)	ud	cs	us	cd	Combined
μ_{BW}	82.1731 ± 0.0038	81.2927 ± 0.0105	82.0076 ± 0.0181	81.4230 ± 0.0396	81.9858 ± 0.0035
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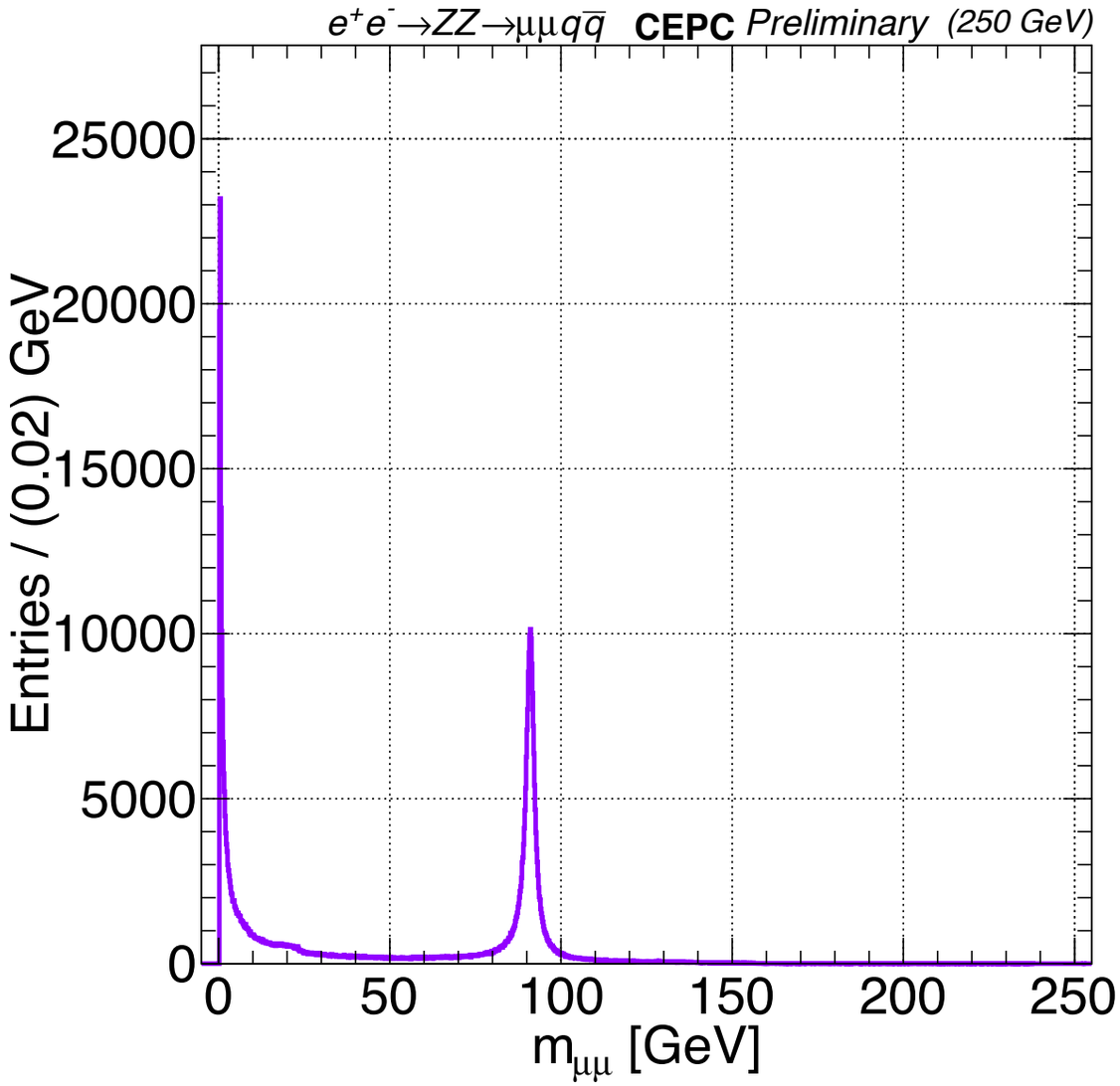
(Signal)Select the Final State(ZZ->$\mu\mu q\bar{q}$) in V1

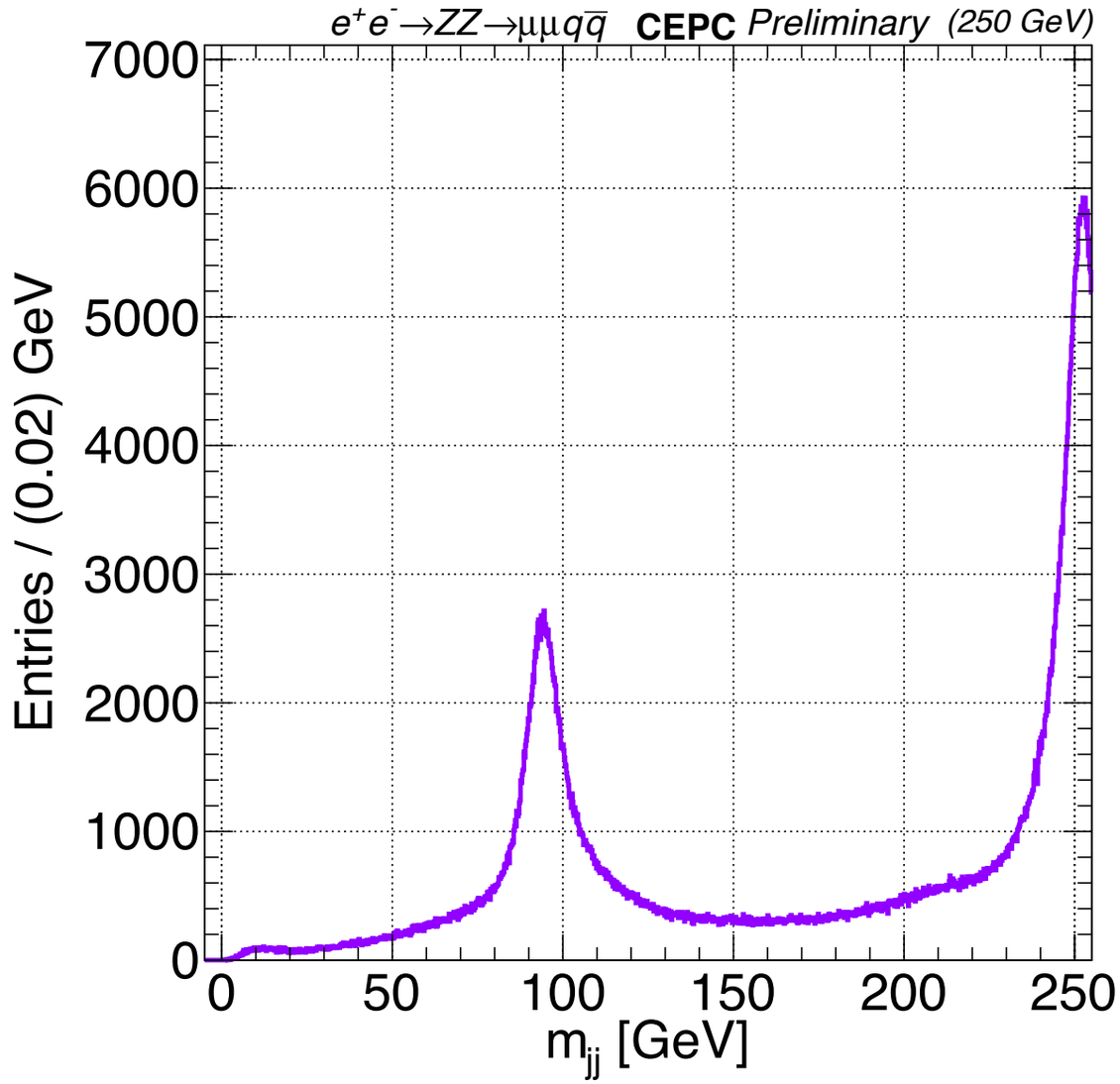
V1(WW→$\mu\nu q\bar{q}$)	# of event	Efficiency	Efficiency w.r.t. previous
Tot # of event	1051200	—	—
nTrack > 7	1037026	98.6%	—
Muon Selection	414803	39.4%	39.9%
Detector acceptance $\|\cos(\theta_\mu)\| < 0.995$	414803	39.4%	100%
Visible mass > 0.85*√s	381088	36.2%	91.8%
Two jets b-tag score < 0.5	272773	25.9%	71.5%
Two jets c-tag score < 0.6	230611	21.9%	84.5%

- **Muon selections: ID=13 & R0 < 0.01mm & E_μ >= 10 (GeV).**
- **Jet reconstruction: force all events to two jets**
- **I checked the efficiency of number of muon >= 2 in the PFOs. The efficiency is just 53.8%.**

$$R0 = \sqrt{D0^2 + Z0^2}$$

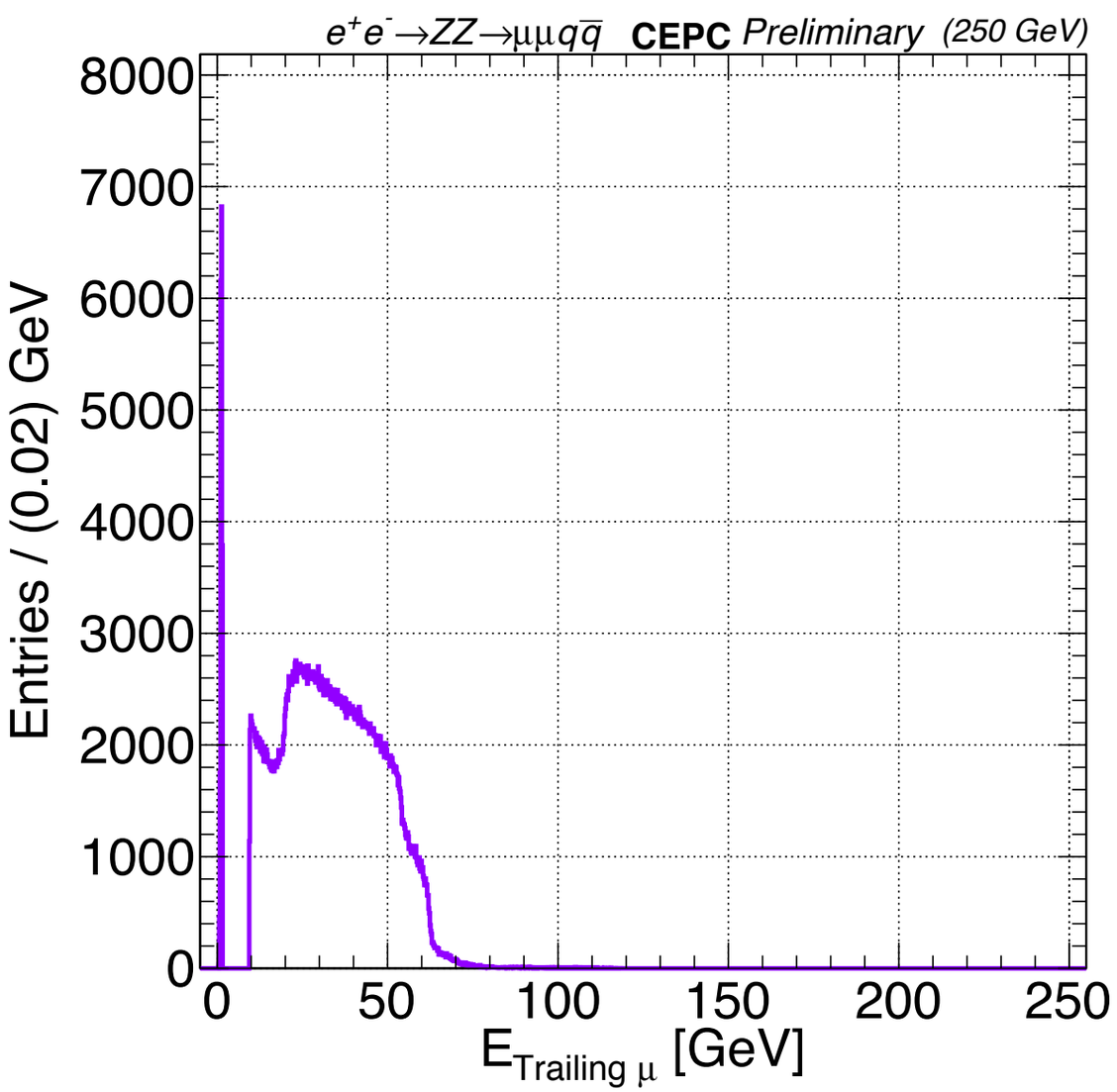
(Signal)dimoun & dijet Invariant Mass(ZZ->$\mu\mu q\bar{q}$) in V1

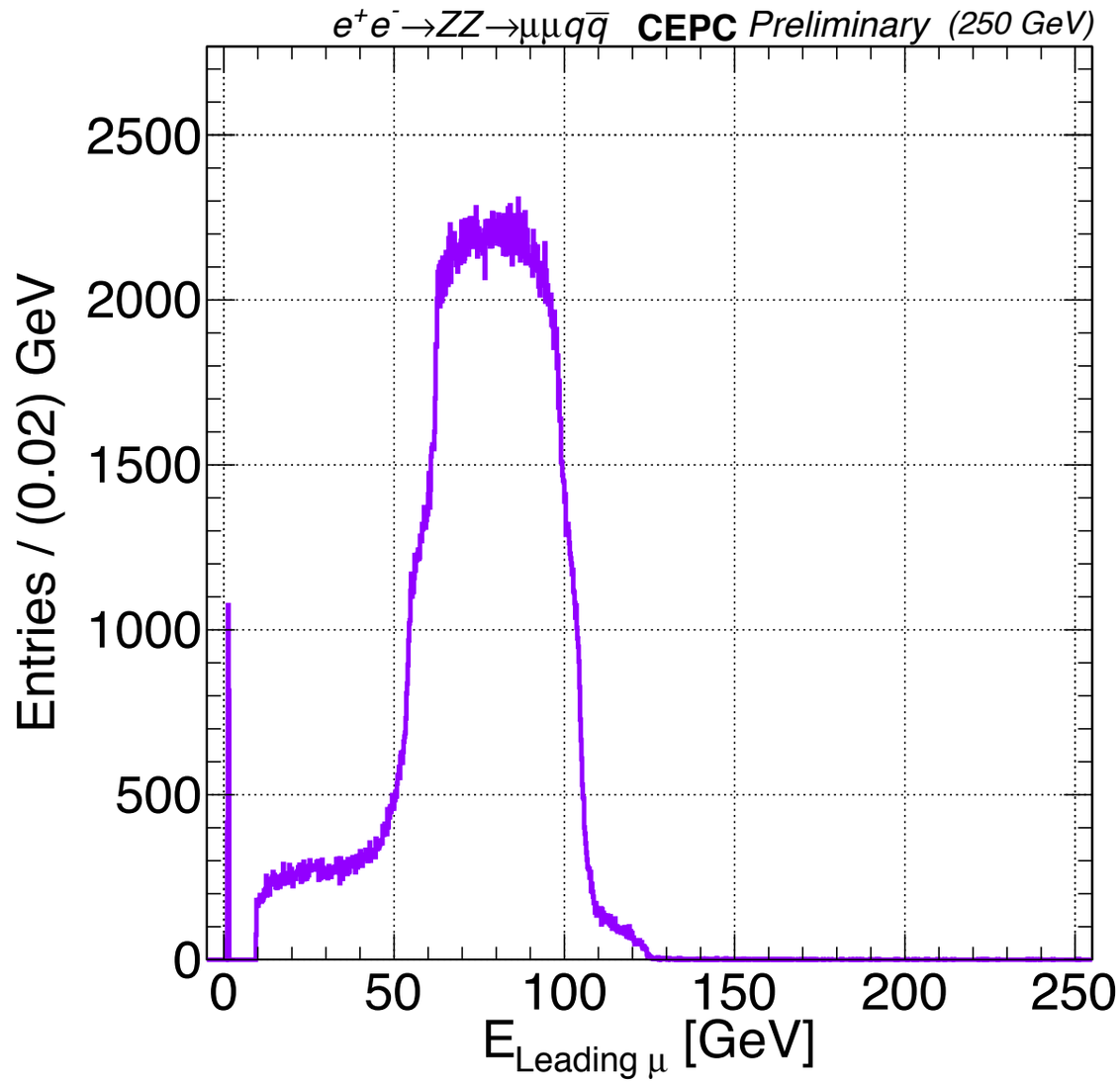




- **Both plots are on reconstruction level and before event selections.**

(Signal)Kinematic Distribution($ZZ\to\mu\mu q\bar{q}$) in V1





- **Both plots are on reconstruction level.**
- **If number of muon is greater that two, I choose the most energetic two muons.**

(Signal)Select the Final State(ZZ->ννqq̄) in V1

V1(WW→μνqq̄)	# of event	Efficiency	Efficiency w.r.t. previous
Tot # of event	1764775	–	–
nTrack > 7	1729322	97.9%	–
MET > 35 GeV	1222336	69.9%	70.6%
Visible mass > 0.2*√s	1173253	66.4%	95.9%
Two jets b-tag score < 0.5	885358	50.1%	75.4%
Two jets c-tag score < 0.6	684737	38.8%	77.3%

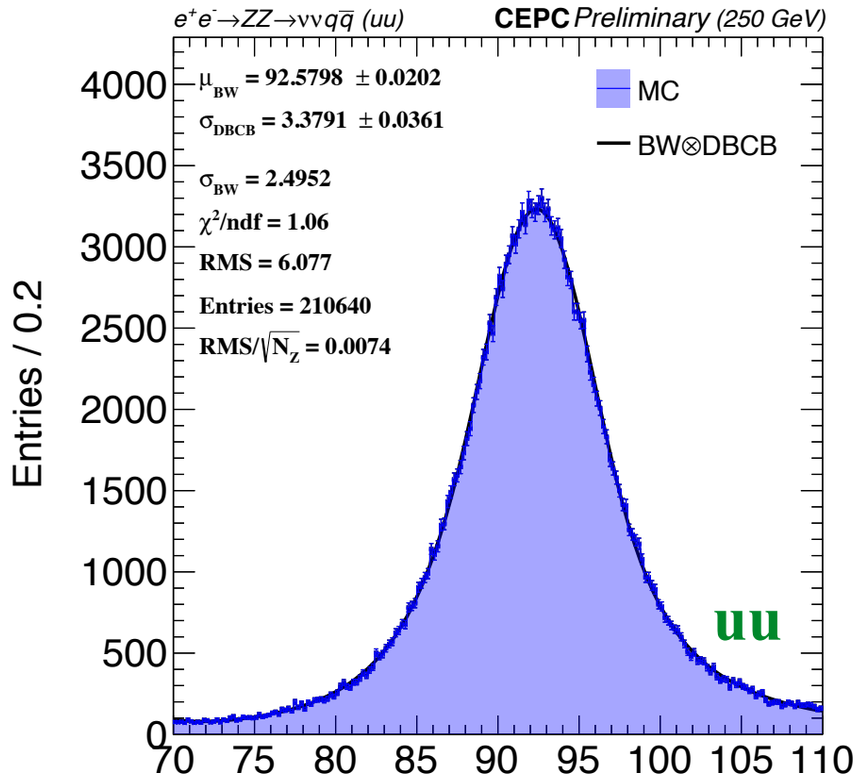
- The efficient luminosity is 1 ab^{-1}.
- Jet reconstruction: force all events to two jets
- There are three categories, without anti- b- & c-tagging, with anti- b-tagging, with anti- b- & anti-c-tagging.

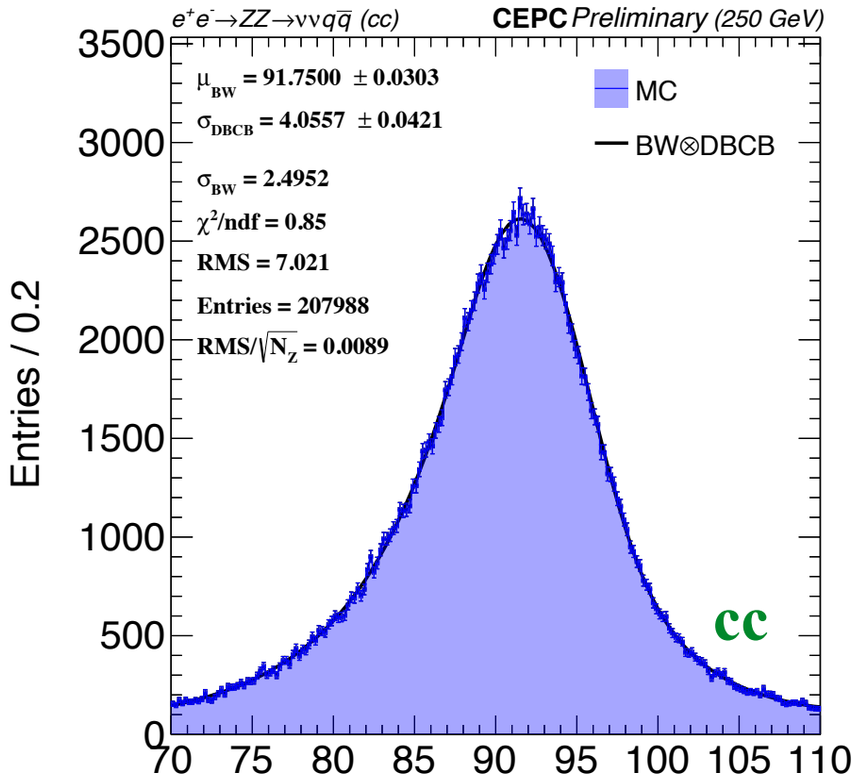
$$R0 = \sqrt{D0^2 + Z0^2}$$

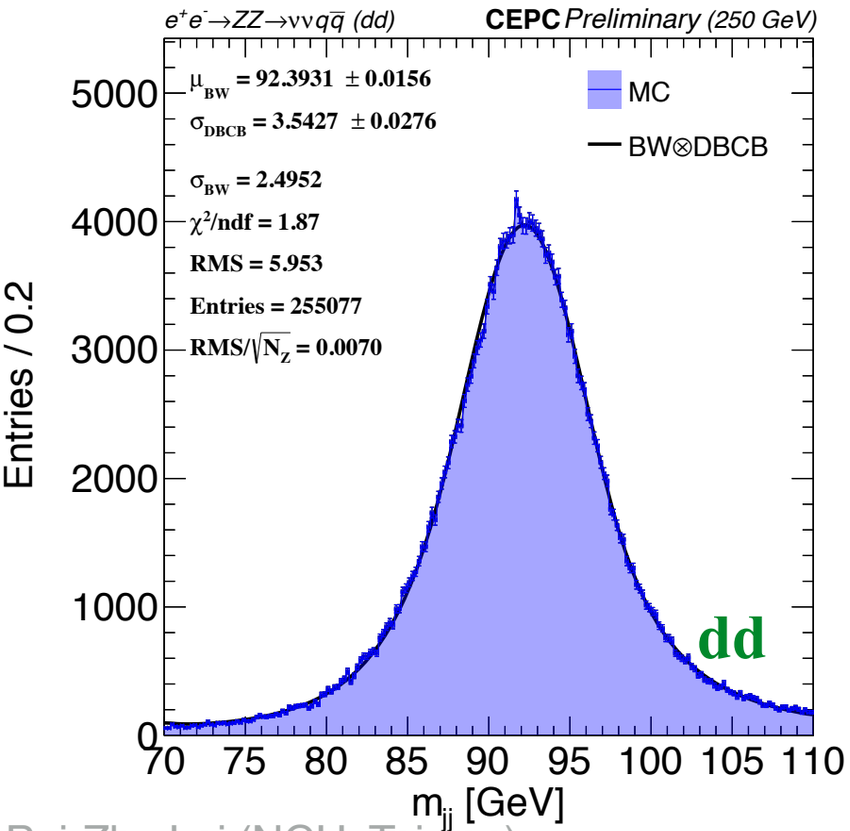
Results(without anti- b- & c-tagging)

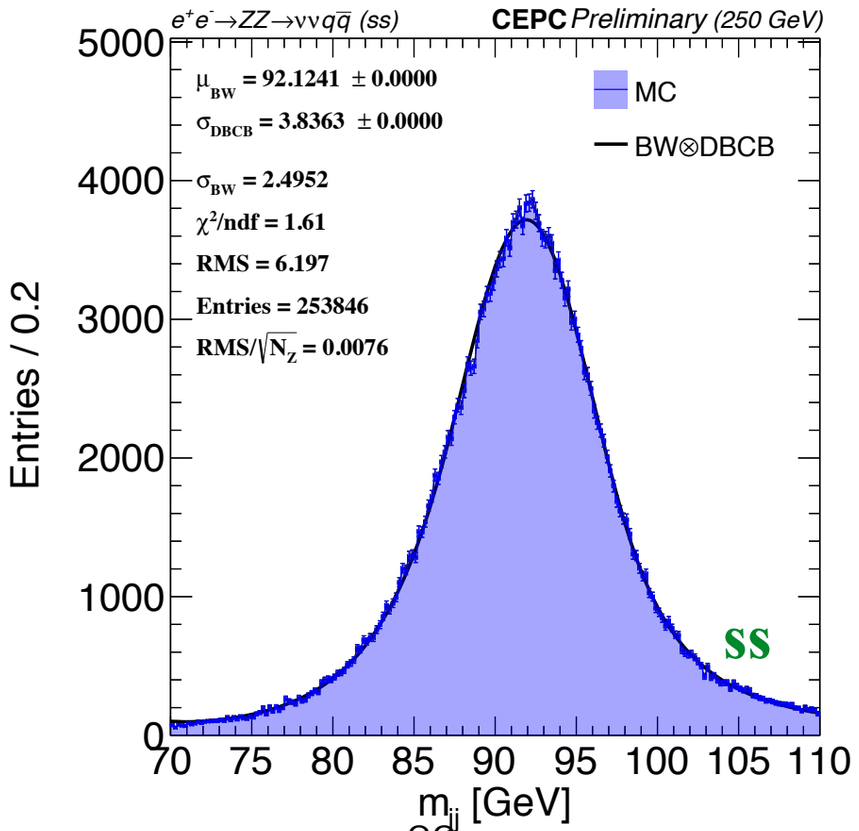
$ZZ\to\nu\nu q\bar{q}$

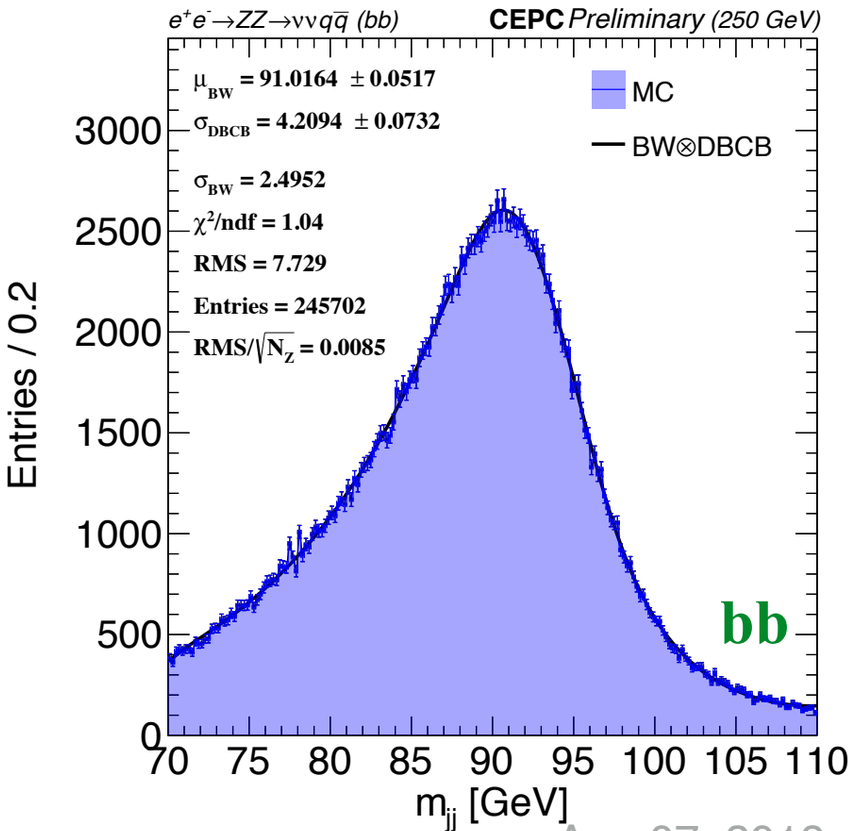
Results(without anti- b- & c-tagging)





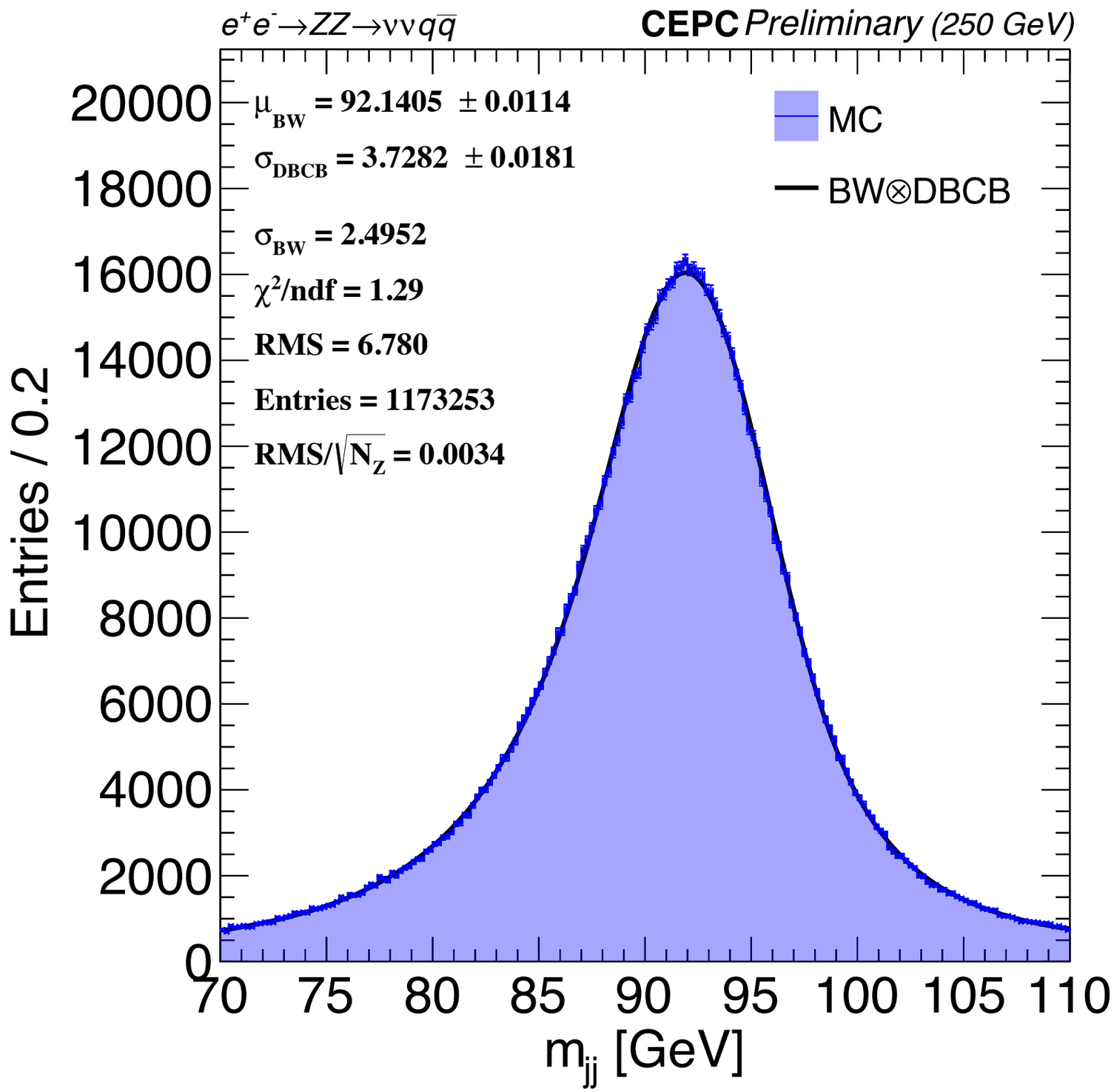






Results(without anti- b- & c-tagging)

Combined four categories (uu, dd, cc, ss, bb)



Results(without anti- b- & c-tagging)

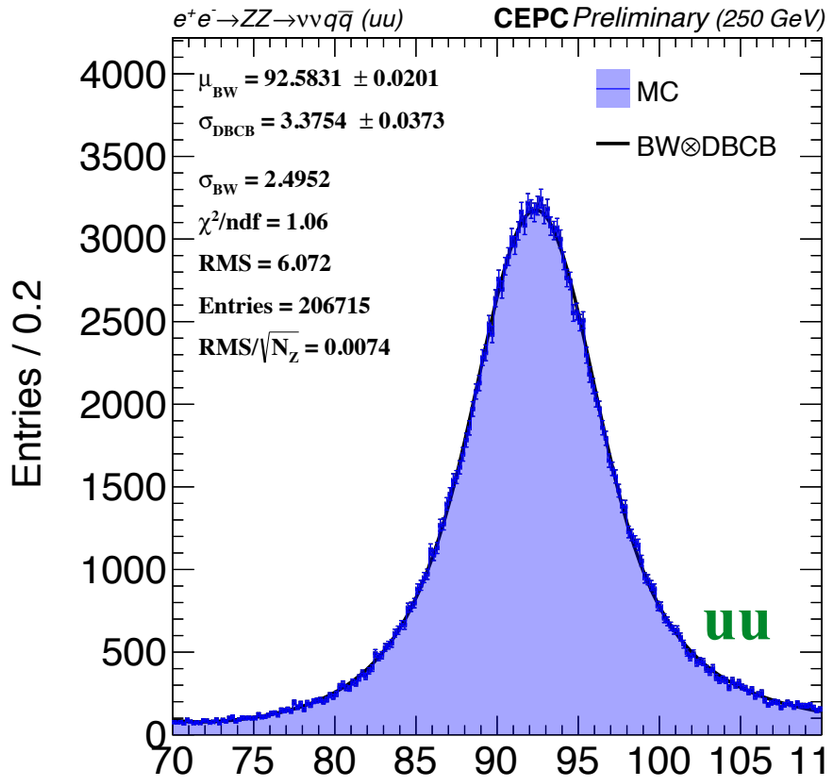
V1($ZZ \to \nu\nu q\bar{q}$)	uu	dd	cc	ss	bb	Combined
μ_{BW}	92.579 ± 0.0202	92.393 ± 0.0156	91.750 ± 0.0303	92.124 ± 0.0000	91.016 ± 0.0517	92.140 ± 0.0114
σ_{DBCB}	3.379 ± 0.0361	3.542 ± 0.0276	4.055 ± 0.0421	3.836 ± 0.0000	4.209 ± 0.0732	3.728 ± 0.0181
Entries	210640	255077	207988	253846	245702	1173253
RMS	6.077	5.953	7.021	6.197	7.729	6.780
RMS/$\sqrt{N_Z}$	0.0074	0.0070	0.0089	0.0076	0.0085	0.0034

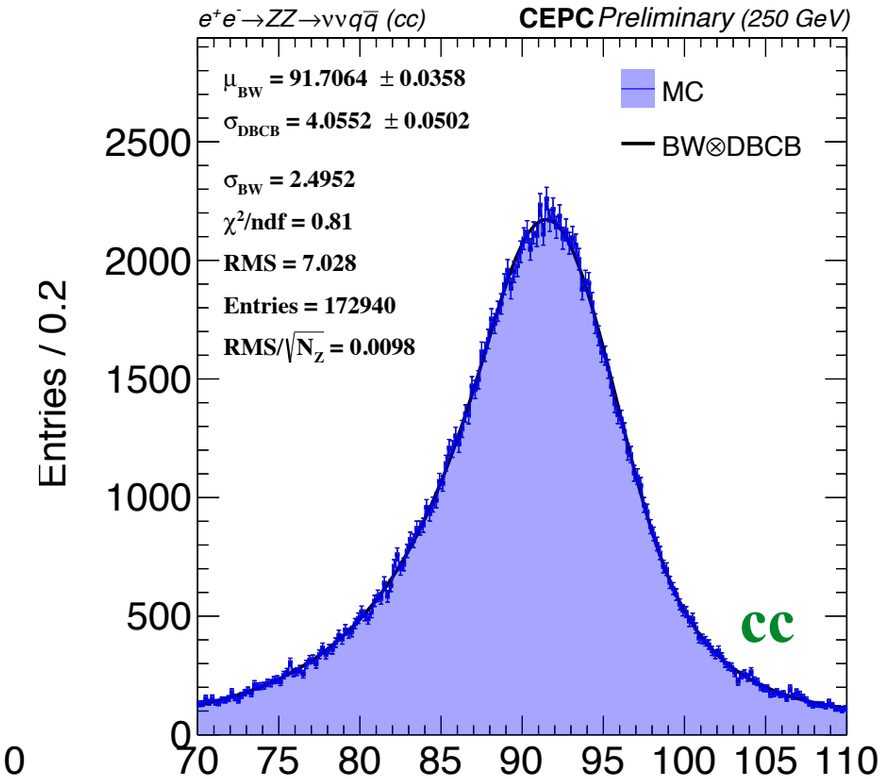
- The categories with c- & b-quark would have less μ_{BW} and lower jet energy resolution.

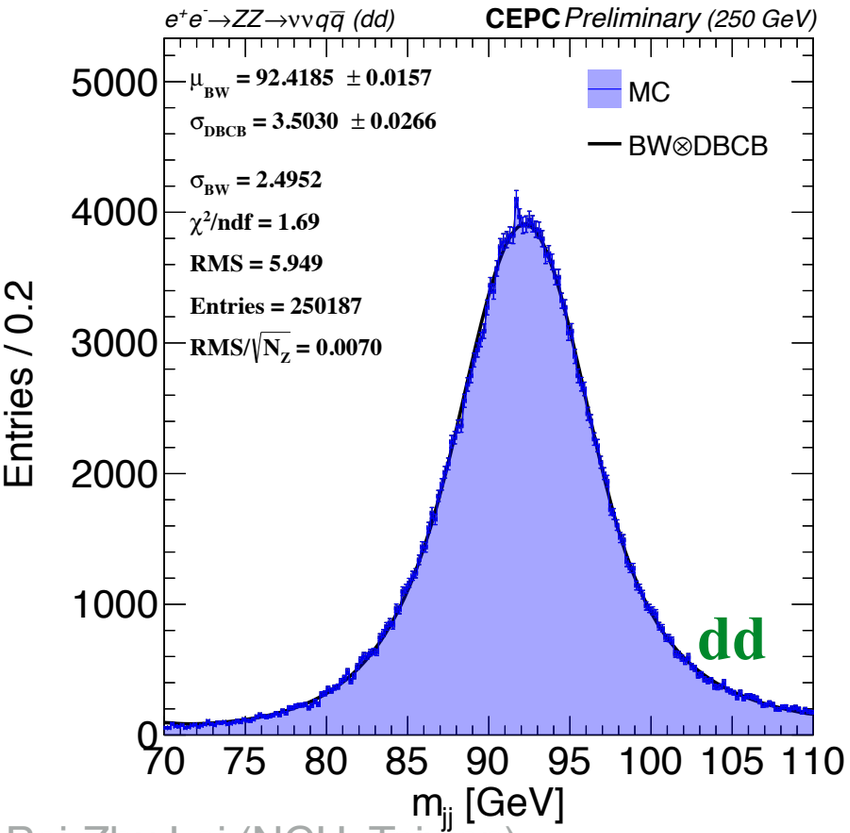
Results(with anit- b- tagging)

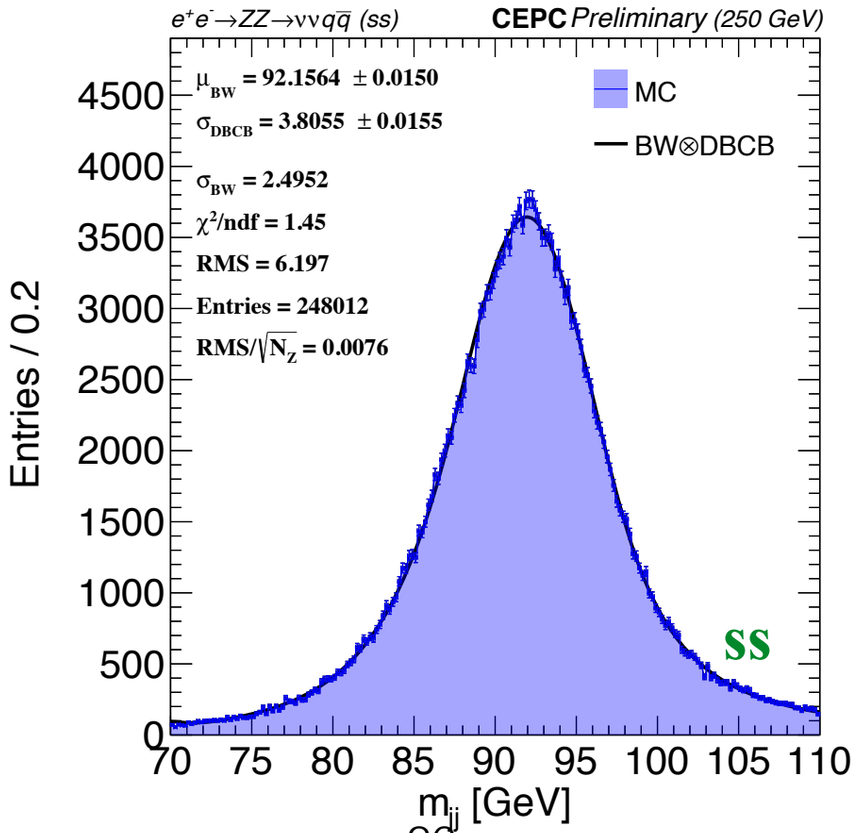
$ZZ \to \nu\nu q\bar{q}$

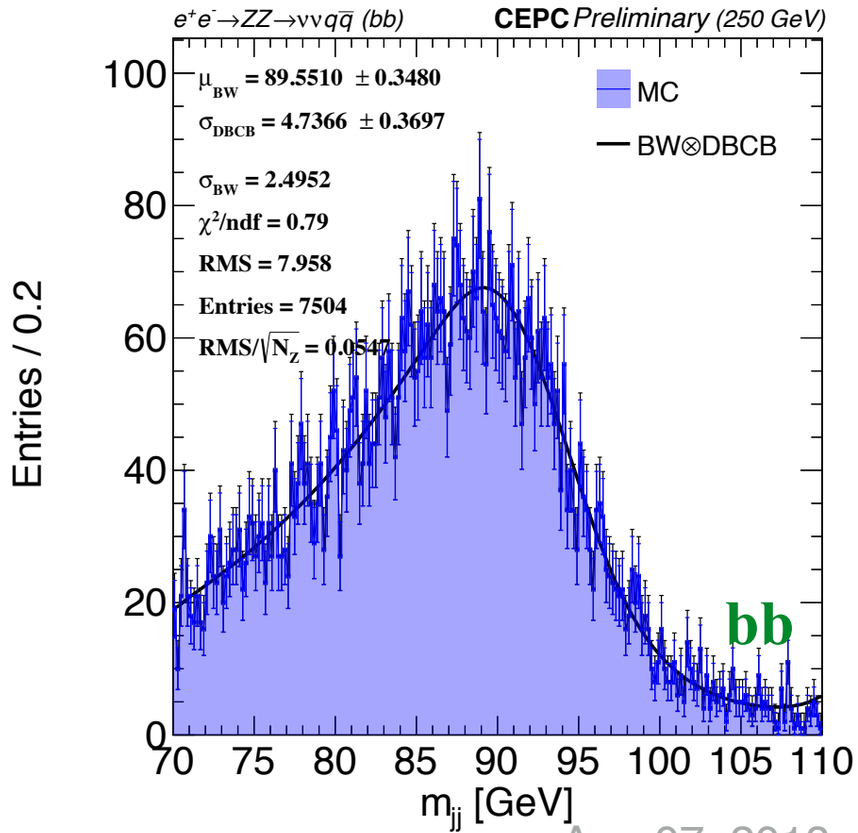
Results(with anti-b-tagging)





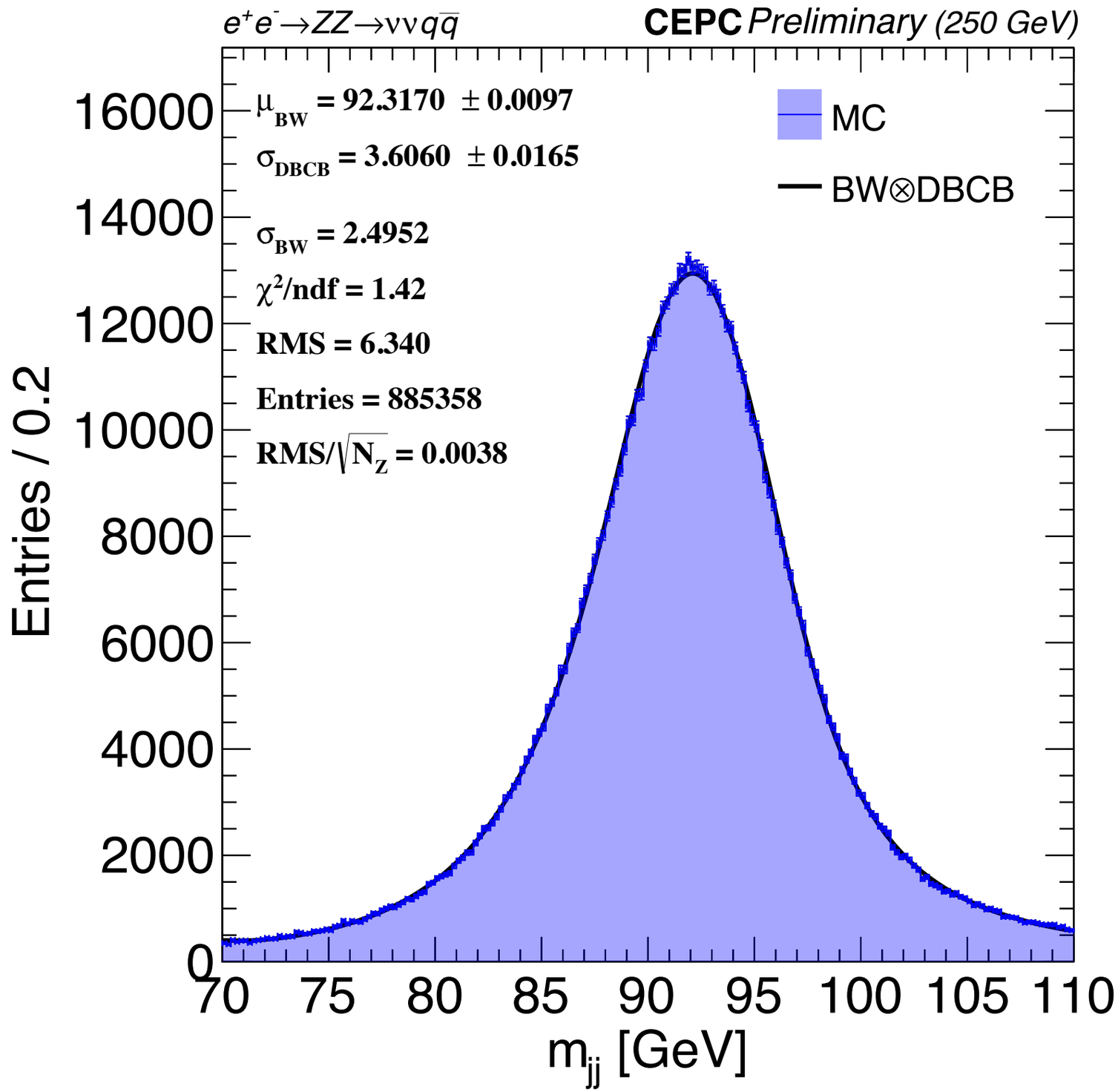






Results(with anti-b-tagging)

Combined four categories (uu, dd, cc, ss, bb)



Results(with anti-b-tagging)

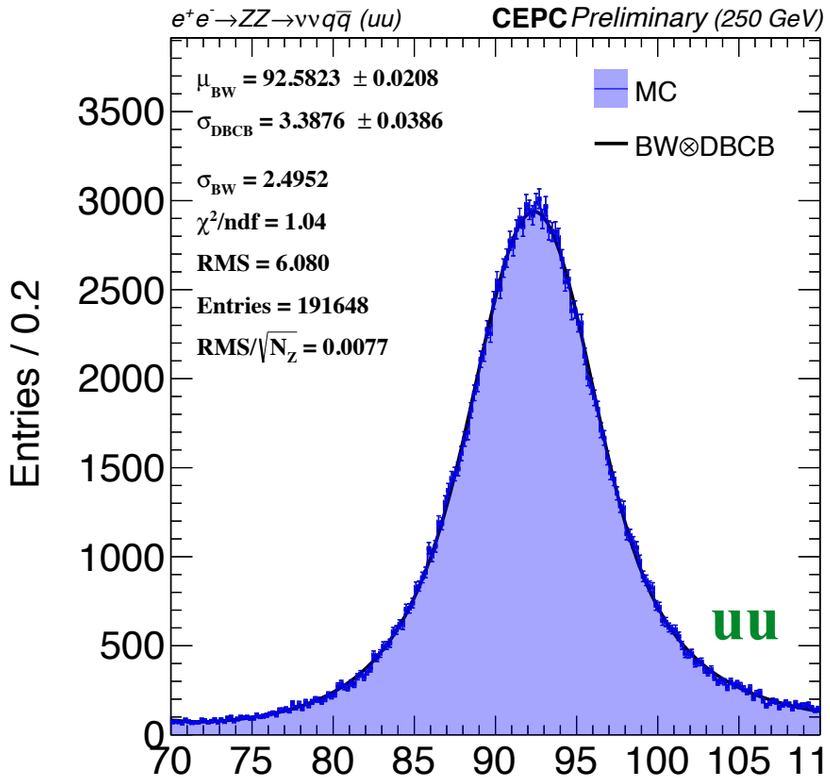
V1($ZZ \to \nu\nu q\bar{q}$)	uu	dd	cc	ss	bb	Combined
μ_{BW}	92.583 ± 0.0201	92.418 ± 0.0157	91.706 ± 0.0358	92.156 ± 0.0150	89.551 ± 0.3480	92.317 ± 0.0097
σ_{DBCB}	3.375 ± 0.0373	3.503 ± 0.0266	4.055 ± 0.0502	3.805 ± 0.0155	4.736 ± 0.3697	3.606 ± 0.0165
Entries	206715	250187	172940	248012	7504	885358
RMS	6.072	5.949	7.028	6.197	7.958	6.340
RMS/$\sqrt{N_Z}$	0.0074	0.0070	0.0098	0.0076	0.0547	0.0038

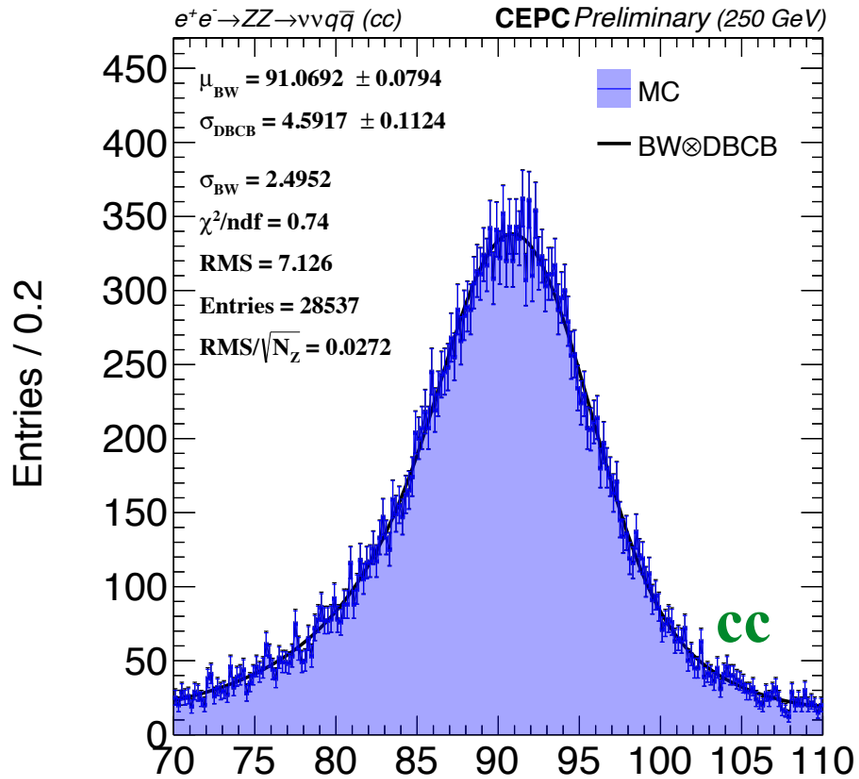
- The categories with c- & b-quark would have less μ_{BW} and lower jet energy resolution.

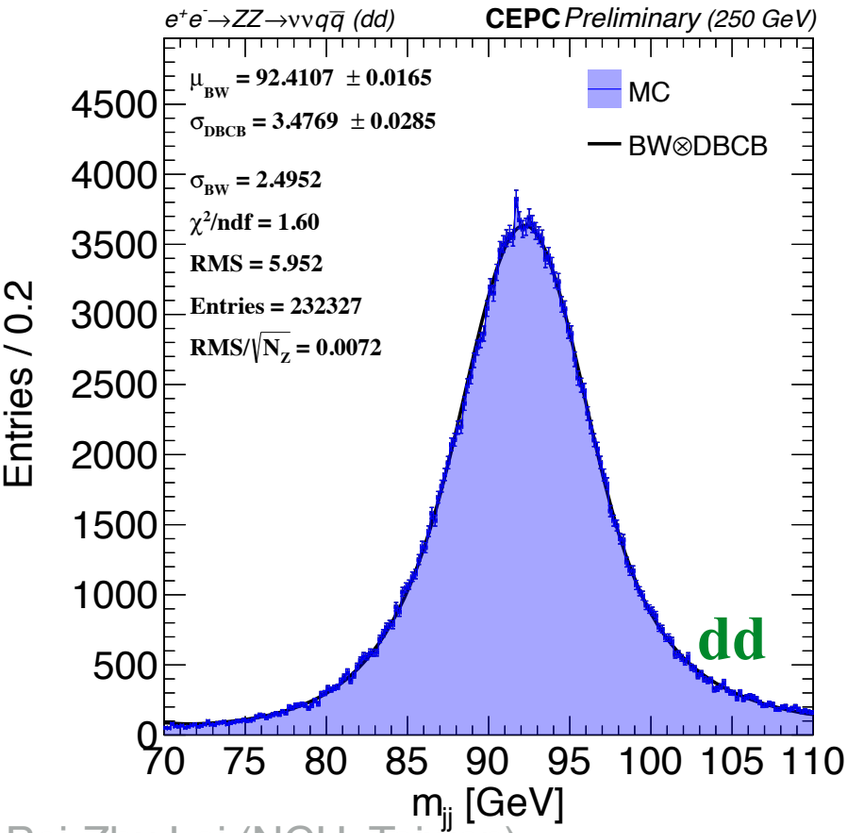
Results(with anit-c- & anti-b- tagging)

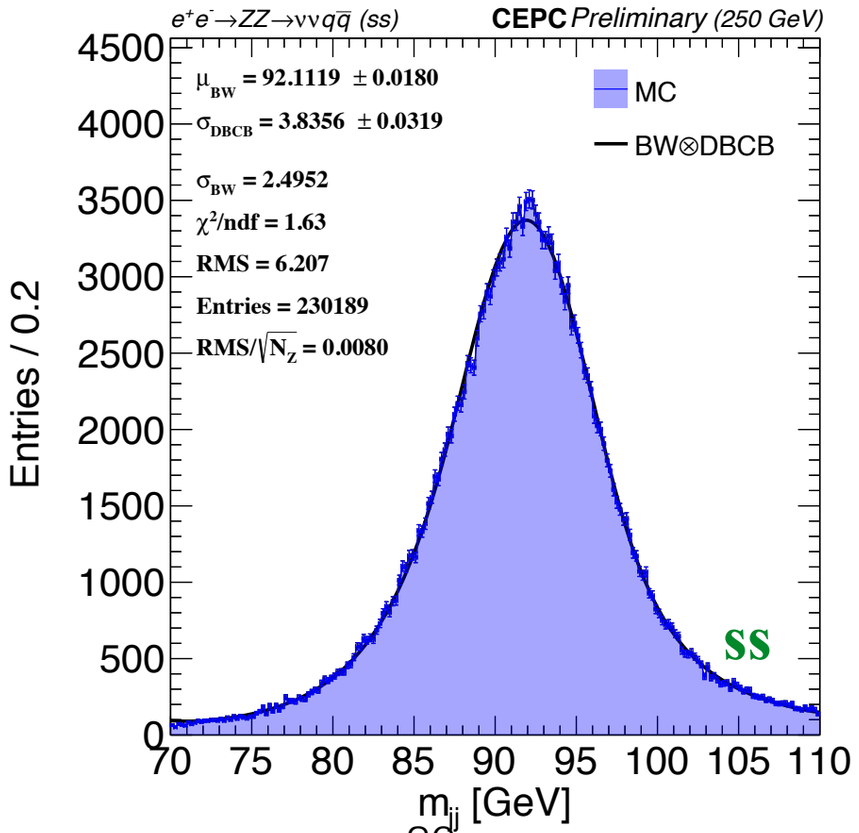
$ZZ\to\nu\nu q\bar{q}$

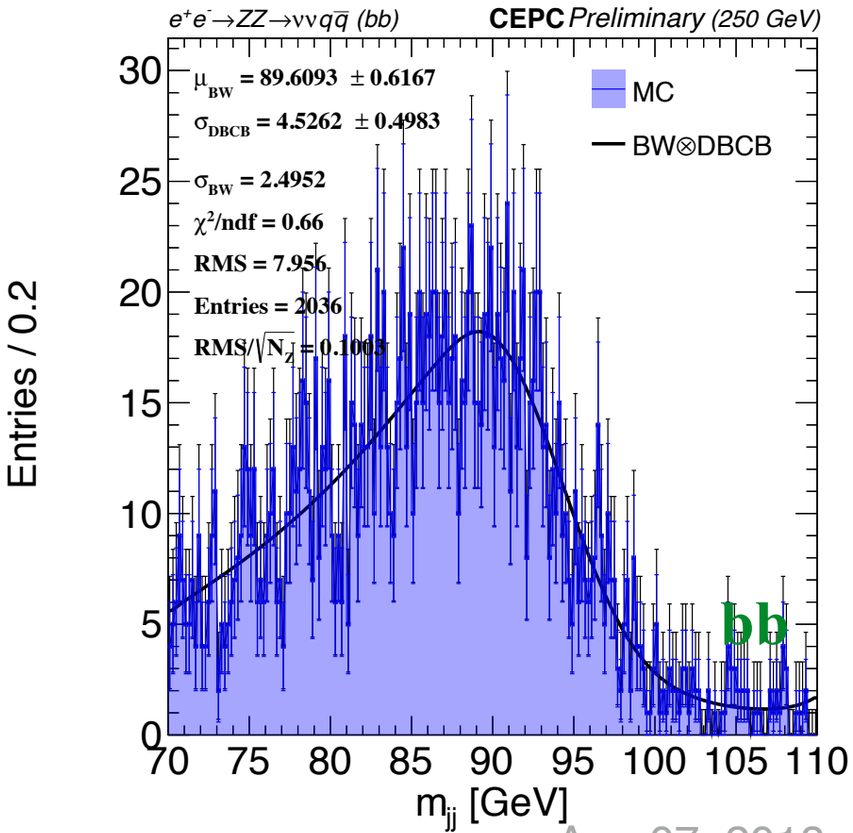
Results(with anti-b and anti-c- tagging)











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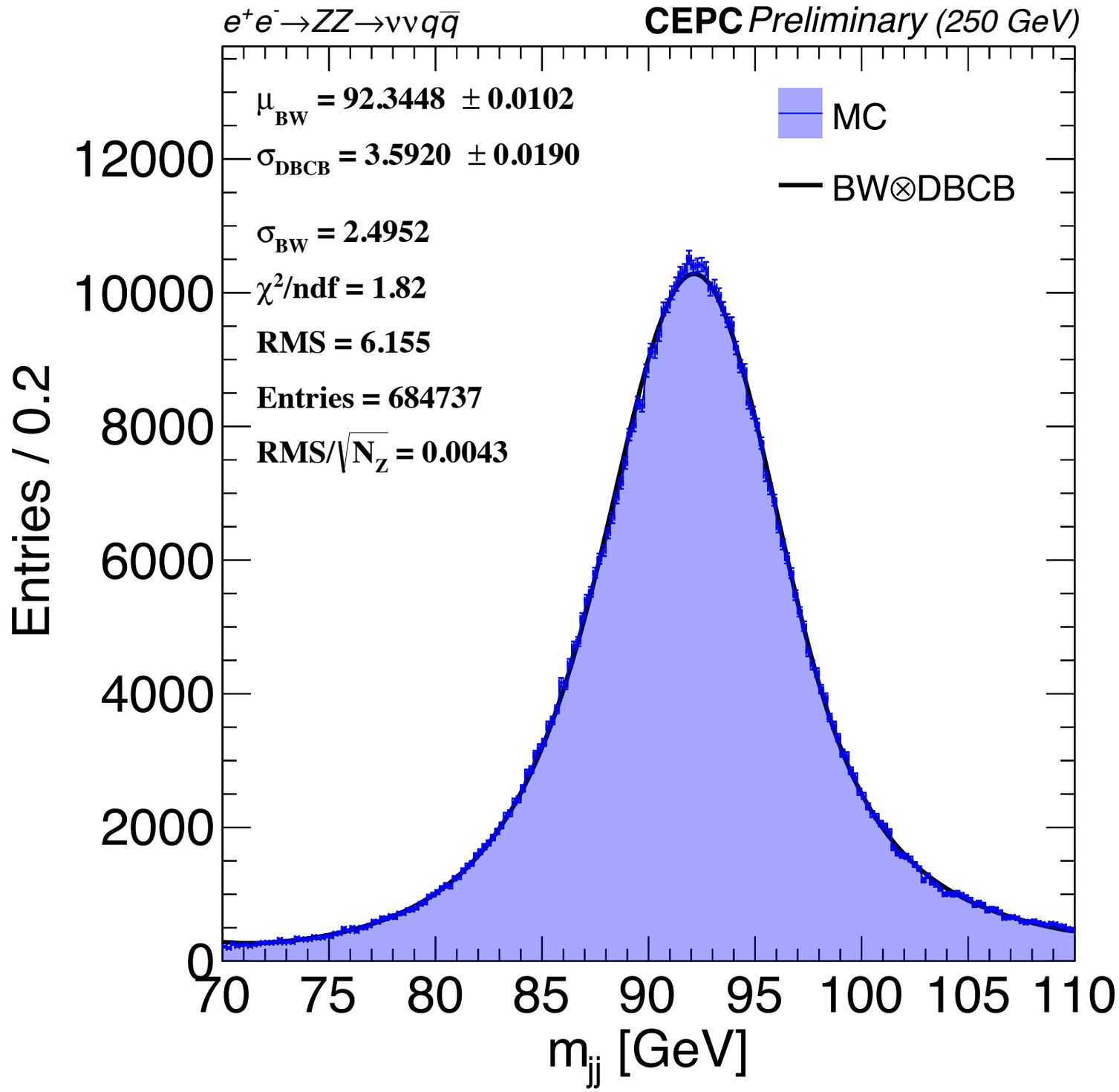

Results(with anti-b and anti-c- tagging)

V1($ZZ \to \nu\nu q\bar{q}$)	uu	dd	cc	ss	bb	Combined
μ_{BW}	92.582 ± 0.0208	92.410 ± 0.0165	91.069 ± 0.0794	92.111 ± 0.0180	89.609 ± 0.6167	92.344 ± 0.0102
σ_{DBCB}	3.387 ± 0.0386	3.476 ± 0.0285	4.591 ± 0.1124	3.835 ± 0.0319	4.526 ± 0.4983	3.592 ± 0.0190
Entries	191648	232327	28537	230189	2036	684737
RMS	6.080	5.952	7.126	6.207	7.956	6.155
RMS/$\sqrt{N_Z}$	0.0077	0.0072	0.0272	0.0080	0.1003	0.0043

- The categories with c- & b-quark would have less μ_{BW} and lower jet energy resolution.

Mass window (70,110), without b-tagging

V1(ZZ→ννqq̄)	uu	dd	cc	ss	bb	Combined
μ_{BW}	92.579 ± 0.0202	92.393 ± 0.0156	91.750 ± 0.0303	92.124 ± 0.0000	91.016 ± 0.0517	92.140 ± 0.0114
σ_{DBCB}	3.379 ± 0.0361	3.542 ± 0.0276	4.055 ± 0.0421	3.836 ± 0.0000	4.209 ± 0.0732	3.728 ± 0.0181
Entries	210640	255077	207988	253846	245702	1173253
RMS	6.077	5.953	7.021	6.197	7.729	6.780
RMS/$\sqrt{N_Z}$	0.0074	0.0070	0.0089	0.0076	0.0085	0.0034

Mass window (70,110), with b-tagging < 0.5

V1(ZZ→ννqq̄)	uu	dd	cc	ss	bb	Combined
μ_{BW}	92.583 ± 0.0201	92.418 ± 0.0157	91.706 ± 0.0358	92.156 ± 0.0150	89.551 ± 0.3480	92.317 ± 0.0097
σ_{DBCB}	3.375 ± 0.0373	3.503 ± 0.0266	4.055 ± 0.0502	3.805 ± 0.0155	4.736 ± 0.3697	3.606 ± 0.0165
Entries	206715	250187	172940	248012	7504	885358
RMS	6.072	5.949	7.028	6.197	7.958	6.340
RMS/$\sqrt{N_Z}$	0.0074	0.0070	0.0098	0.0076	0.0547	0.0038

Mass window (70,110), with b-tagging < 0.5 & c-tagging < 0.6

V1(ZZ→ννqq̄)	uu	dd	cc	ss	bb	Combined
μ_{BW}	92.582 ± 0.0208	92.410 ± 0.0165	91.069 ± 0.0794	92.111 ± 0.0180	89.609 ± 0.6167	92.344 ± 0.0102
σ_{DBCB}	3.387 ± 0.0386	3.476 ± 0.0285	4.591 ± 0.1124	3.835 ± 0.0319	4.526 ± 0.4983	3.592 ± 0.0190
Entries	191648	232327	28537	230189	2036	684737
RMS	6.080	5.952	7.126	6.207	7.956	6.155
RMS/$\sqrt{N_Z}$	0.0077	0.0072	0.0272	0.0080	0.1003	0.0043