Testing Lepton Flavor Conservation Law(LFCL) in J/ψ Decay

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1 Motivation

1. Important to test LFCL
2. In the Standard Model,Total and Individual Lepton Numbers are conserved.
3. In many extensions of the SM,such as SUSY,Left-Right Symmetric Models,lepton numbers are violated.
4. Super-Kamiokande indicates $m_\nu \neq 0$,then LF symmetries are broken
5. In Lab,we have performed diffenent kind of Experiments to test LFCL at BES,I reported research in τ decay at 1997 BES Annual Meeting:

Decay channels	Branching Ratio
$\tau \to e\gamma$	$B < 5.8\text{x}10^{-4}$
$\tau \to e\pi^0$	$B < 6.1\text{x}10^{-4}$
$\tau \to \mu\gamma$	$B < 8.2\text{x}10^{-4}$
$\tau \to \mu\pi^0$	$B < 2.6\text{x}10^{-3}$

(E_{cm}=4.03GeV,L(E)=22.3pb^{-1})

Because the τ events aren't enough at BES,our conclusion aren't exciting,but our conclusion ($\tau \to e\gamma$,$\tau \to e\pi^0$) is the best results at the same energy region in the world.

2 Proposal[1]

1. We have very large samples(7.8x10^6) of J/ψ in the world, we trust we can obtain more accurate conclusion in the J/ψ Decay:

   J/$\psi \to e\mu$
2. Experimental Measurement on Br(J/$\psi \to e\mu$) is interesting(No data exists in Particle Data Book).

3. Theoretical Calculation[2]

   Br(J/$\psi \to e\tau$) $< 2.9\text{x}10^{-5}$

   Br(J/$\psi \to \mu\tau$) $< 4.9\text{x}10^{-5}$

   Br(J/$\psi \to e\mu$) $< 8.3\text{x}10^{-6}$

   With about $9\text{x}10^6 J/\psi$ events,signal events have been predicted as follows:

   For J/$\psi \to e\tau, <$ 243 events.

   For J/$\psi \to \mu\tau, <$ 441 events.

   For J/$\psi \to e\mu, <$ 75 events.

3 Preliminary results

Using all J/ψ experimental data,we found 4 J/$\psi \to e\mu$ candidates,and we can put an upper limit of Branching Ratio of J/$\psi \to e\mu$,or maybe we can find new law.Of course, it needs further study.

4 Events Selection of J/$\psi \to e\mu$

1. For charged tracks

   - $\theta_{acol} > 179^0$ (see Fig.1)
   - The momentum of charged tracks were required :
     $1.45 < p < 1.65 GeV$ (see Fig.1)
   - To identify e and μ
     Because the difference between the MC data and experimental data is obvious,we adjusted E/p of e and μ by using e and μ samples.Here e and μ samples were selected from J/ψ experimental data.

     (a) To identify e and μ/π
     E/p > 0.7 (e) (see Fig.2)
     E/p < 0.3 (μ or π) (see Fig.2)
     In MC data, the E/p need to be adjusted:
     E/p = 0.767* E/p_{mc} +0.212 (e) (see Fig.2)
     E/p = 0.861* E/p_{mc} +0.017 (μ) (see Fig.2)

     (b) To identify μ and π using information of μ counter with general criteria:

P_{xy}	μ_{hit}
$P_{xy} <$ 0.75GeV	$\mu_{hit} >0$
$0.75 < P_{xy} <$ 0.95GeV	$\mu_{hit} \geq 2$
$P_{xy} >$ 0.95GeV	$\mu_{hit}=3$

2. To reject events with isolated photon.

   The conditions for selecting isolated photons are as below:

$E_{sc} \geq 50MeV$

$\theta_{\gamma q} > 15^0$

$\alpha < 18^0$

3. Using two final states e and μ,to fit the invariant mass of J/ψ
   (J/$\psi \rightarrow e\mu$).
   2.96 $< M_{J/\psi} <$ 3.20 GeV (see Fig.3)

5 Results and Discussions

- With these cuts, using MC data (10000 events), the detector efficiency(ϵ=19.3%) has been obtained.

  Comment:

  Here the detector efficiency is greater than that in the report of BES Annual Meeting, because I donot use 4c-fit and I adjust E/p of e and μ now.

- We have analysed the different backgrounds by MC,which include:

  J/$\psi \rightarrow \mu\mu$

  J/$\psi \rightarrow e^+e^-$

  J/$\psi \rightarrow e^+e^-\gamma$

  We haven't found any event with these cuts.

- We have analysed all J/ψ experimental data.We didn't use the data between run462 and run761 which have no μ_{hit}=3 information,and the total numbers between run462 and run761 are about 1.3x10^6 J/ψ events,at last we found four events*.The irun/irec of four events are:1263/10266,1582/24773, 3589/21502,1859 /22352.Then we've studied the four events with de/dx information further.Since run462-961 and run1750-1940 are no de/dx information, they are about 3.96x10^6 J/ψ events.These data hve been given up.In three candidates,one candidate(3589/ 21502) was rejected by considering the de/dx of bhabha and dimu,finally we keep two events(1263/10266, 1582/24773)(see Fig.4):

  There are obvious difference between 4 events here and 32 events of the report at BES Annual Meeting. Because here we use E/p according to bhabha and dimu samples of experimental data;at BES Annual Meeting, we use E/p according to MC,the difference between MC and samlples is obvious(see Fig.2).

$B < \lambda(N_{obs})/[2\Sigma N_T \epsilon(\mathrm{E})]$

Here $\lambda(N_{obs})$ is the average value for a possion distribution such that there is a 90% probability. N_{obs} is the number of events observed. N_T is the total number of J/ψ. ϵ(E) is the detector efficency, and E is the center-of-mass energy.As discussed above,we can obtain:

Not use de/dx information:

$$B < 3.18\text{x}10^{-6} \text{ (with } 6.50\text{x}10^6 \text{ J}/\psi \text{ events)}$$

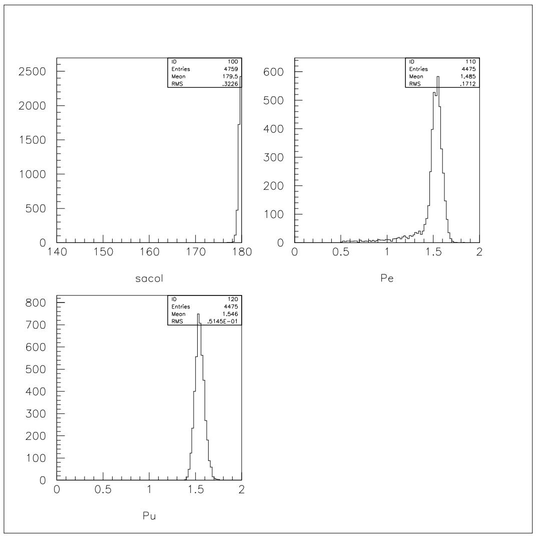

Figure 1:

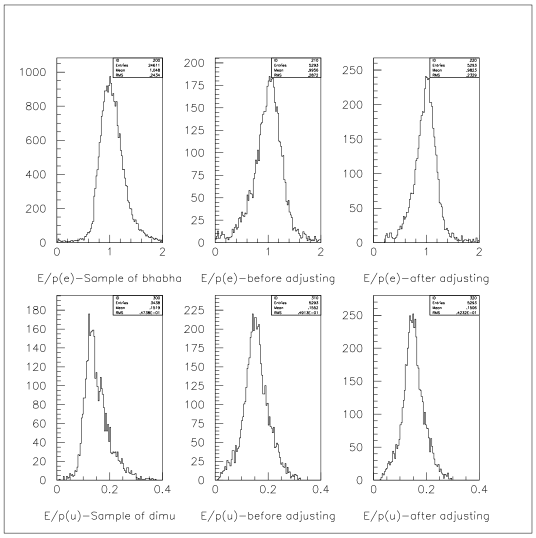

Figure 2:

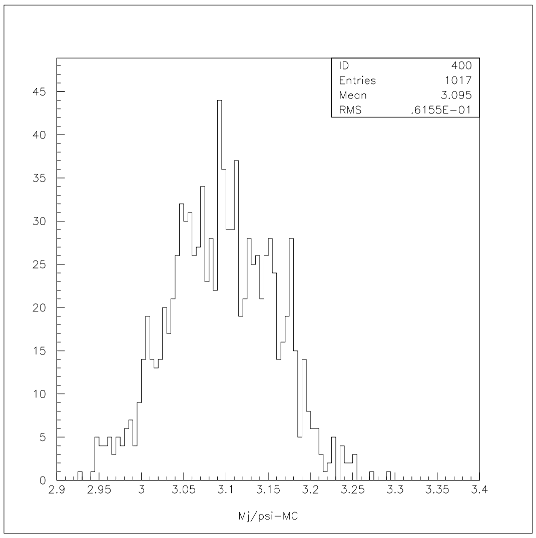

Figure 3:

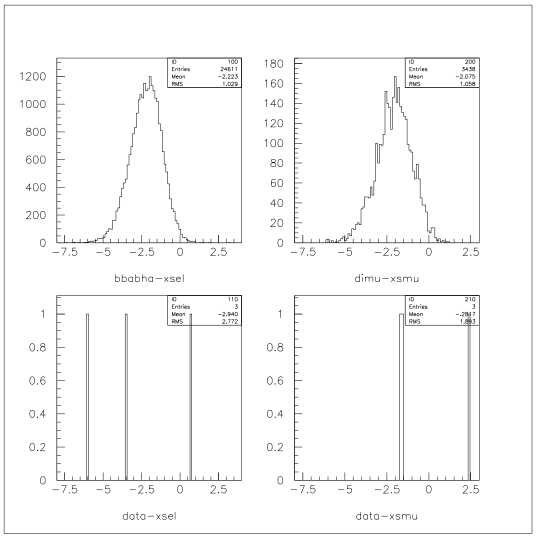

Figure 4:

To use de/dx information:

$$B < 3.59\text{x}10^{-6} \text{ (with } 3.84\text{x}10^{6} \text{ J}/\psi \text{ events)}$$

We also started to search:

J/$\psi \to e\tau$

J/$\psi \to \mu\tau$

and need further study.If we can accumulate 50x10^6 events or build τ-C Factory,our conclusion will be much improved.

Acknowledgements

We are greatly indebted to Prof.ZHANG Xinmin, Prof.WANG Jianxong and Prof. ZHAO Zhengguo.

References

[1] X.Zhang Invited Talk given at the National Conference on High Energy Physics,Chengde,China,March 1998.

[2] R.D.Peccei,J.Wang and X.Zhang May 1998(Unfinished Note).