Determination of J/ψ Total Number via Lepton-pair

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A Small Proposal for Discussion

For more information in detail, go to:
http://hpws3.ihep.ac.cn/~ huanggs/work.html

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— every road leads to Rome

OUTLINE

1. Motivation
2. Different ways
3. Lepton-pair channel
4. Data set: J/ψ data only
5. Data set: with QED background data
6. Summary

Ideas

1. $\psi' \to \pi^+\pi^- J/\psi, J/\psi \to anything$

Proposed by Yuan Changzheng.

Advantages:	obtain ε by data, rely little on MC
Disadvantages:	extra beam-time needed
	difficult efficiency correction
	(moving J/ψ, etc.)

2. $J/\psi \to anything$

J/ψ decay generator by Chen Jiangchuan

Advantages:	careful comparison (data and MC)
	ready codes developed by R group
Disadvantages:	incomplete decay modes,
	some inaccurate branching ratios

3. $J/\psi \to l^+l^- \quad (l = e, \mu)$

Advantages:	known branching ratio(6.02±0.19%)
	well-studied final states
Disadvantages:	QED background

Lepton-pair

KEY problem: QED background

1. e^+e^- final states

$$e^+e^- \to e^+e^-$$

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

exactly same behavior in detector,

different in angular distribution

2. $\mu^+\mu^-$ final states

$$e^+e^- \to \mu^+\mu^-$$

$$e^+e^- \to J/\psi \to \mu^+\mu^-$$

same behavior in detector,

AND same angular distribution

Simplest way: to subtract QED background directly!

$$N_{J/\psi\to ll} = N_{ll} - N_{ee\to ll} = N_{ll} - L \cdot \varepsilon_{ee\to ll} \cdot \sigma_{ee\to ll}$$

But, How can we obtain L?

One way is from channel

$$e^+e^- \to \gamma \;\; \gamma \;\; (\gamma)$$

It suffers little from resonance decay:
$Br(J/\psi \to \gamma\gamma) \leq 5 \times 10^{-4}$,
$Br(J/\psi \to \gamma\gamma\gamma) < 5.5 \times 10^{-5}$,
$Br(J/\psi \to \gamma\eta_c) = 1.3\%$, $Br(\eta_c \to \gamma\gamma) = 3 \times 10^{-4}$,
$Br(J/\psi \to n\bar{n}) = 1.9 \times 10^{-3}$.

very simple in event selection, but shower simulation in ribbons should be improved!

Another way is:

angular distribution $\Longrightarrow N_{J/\psi \to ee}$ and $N_{ee \to ee}$,

$$N_{ee \to ee} \Longrightarrow L$$

A good cross-check! meanwhile,

$$N_{J/\psi \to ee} \Longrightarrow N_{J/\psi}$$

By a generator? or worked out by $(1 + cos^2\theta)$?

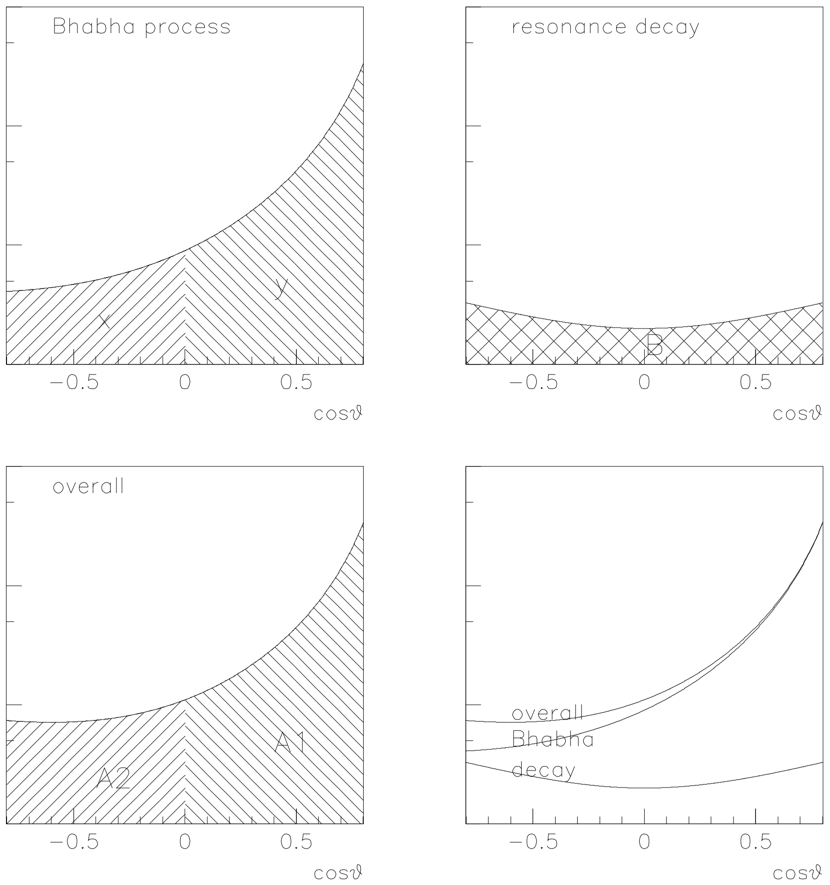

Figure 1: Angular distributions of e^+e^- final states

Obviously, $A_1 = y + B/2, \quad A_2 = x + B/2$

Let $\alpha = x/(x+y)$

Then

$$N_{ee\to ee} = x + y = \frac{A_1 - A_2}{1 - 2\alpha}$$

$$N_{J/\psi\to ee} = B = \frac{2(1-\alpha)A_2 - 2\alpha A_1}{1 - 2\alpha}$$

QED data

With help of QED data, better at 3.0 GeV,

$$N_{J/\psi\to ee} = N_{ee} - N'_{ee}(L\sigma)_{ee}/(L\sigma)'_{ee}$$

$$N_{J/\psi\to\mu\mu} = N_{\mu\mu} - N'_{\mu\mu}(L\sigma)_{ee}/(L\sigma)'_{ee}$$

L at 3.0 GeV: Bhabha, dimu, $\gamma\gamma$

L at J/ψ: $\gamma\gamma$, Bhabha

numbers for reference:
R data at 3.0 GeV in Spring '99,
T = 31.5 hour, L = 138 nb^{-1},
$\sim$750 dimuons, $\sim$2200 hadrons

From view of statistics, 3 days beam-time for QED data is enough.

Summary

1. Various methods, all worth trying;

2. Lepton-pair: simple and clear, and different ways for cross-check;

3. J/ψ data itself works;

4. QED data also helps a little;

5. Works to be done:
– improvement of shower simulation in ribbon;
– new generator of $J/\psi \to ee$.