New Measurements of $\psi(3770)$ Resonance Parameters & DD-bar Cross Section at BES-II & CLEO-c

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The review talk is based on the talks given at ICHEP’04 by Anders Ryd, Ian Shipsey, Gang Rong
Outline

- Introduction
- $\psi(3770)$ resonance parameters
- $D\bar{D}$ production at 3.773 GeV
  - Result from BES-II
  - Result from CLEO-c
- What indicate the new measurements?
- Summary
Introduction

◆ Puzzle of $\psi(3770)$ decay

It has long been a puzzle that the measured DD-bar cross section fail to fit the measured cross section for $\psi(3770)$ production at 3.770 GeV in e+e- experiments.

For example:

- $\psi(3770)$ production cross section at peak

\[
\sigma_{\psi(3770)}^{prd} = \frac{12\pi}{M_{\psi(3770)}^2} \times BF(\psi(3770) \rightarrow e^+e^-) = 11.6 \pm 1.8 \text{ nb}
\]

Mass and branching fraction (PDG02):

\[
M_{\psi(3770)} = 3769.9 \pm 2.5 \text{ MeV} \quad BF(\psi(3770) \rightarrow e^+e^-) = 1.12 \times 10^{-5}
\]
DD-bar cross section

MARK-III measured the observed DD-bar cross section (at $E_{cm} = 3.768$ GeV)

$$\sigma^{obs} (e^+e^- \rightarrow \bar{D}D) = 5.0 \pm 0.5 \text{ nb}$$

(Added all errors in quadrature)

production cross section

$$\sigma^{prd} (e^+e^- \rightarrow \bar{D}D) = 7.1 \pm 0.7 \text{ nb}$$

$f_{ISR} = 0.70$

Potential Models predict that $\psi(3770)$ decay into DD-bar with branching fraction of $\Delta 100\%$.

Non-saturate decay ?

About 39% of $\psi(3770)$ does not decay to DD-bar?
Theoretical prediction

There are theoretical arguments about $\psi(3770)$ decays

Lipkin pointed out that $\psi(3770)$ could decay to non-DD-bar final states with large branching fraction

$$\Gamma(\psi(3770) \to J/\psi\pi\pi) < 200 \text{ keV}, \quad \text{Y.P. Kuang, PRD41(1990)155}$$

$$\Gamma(\psi(3770) \to \gamma\chi_{cJ}) \leq 620 \text{ keV}, \quad \text{hep-ph/0405196, J.L. Rosner}$$

$$37 < \Gamma(\psi(3770) \to J/\psi\pi\pi) < 170 \text{ keV}, \quad \text{(Y.P. Kuang, PRD65, 2002)094024}$$

$$\Gamma(^3D_1 \to ggg) = 160 \text{ keV}, \quad \text{PLB267(1991)11}$$

$$\Gamma(\psi(3770) \to non-DD) \leq 950 \text{ keV}$$

$$BF(\psi(3770) \to non-DD) \leq 4.0\%$$

Added all above numbers up!
Are there non-DD-bar decay?

About 35% of $\psi(3770)$ missing?

If all measurements are all right, these mean that 35% of $\psi(3770)$ is missing.

Lipkin proposed a rescattering model many years ago [1].

PL B179,278(1986)

Very recently Jonathan L. Rosner proposed a new model --- re-annihilation model to deal with that $\psi(3770)$ decays to charmless final states [2].


To clarify this situation, it is important to more precisely measure both DD-bar cross section and $\psi(3770)$ resonance parameters at same experiment simultaneously!
The Beijing Electron Positron Collider (BEPC)

$L \sim 1 \times 10^{31} /\text{cm}^2 \cdot \text{s}$ at $\psi(3770)$ peak

$E_{\text{cm}} \sim 2.5 \text{ GeV}$

One of the two $e^+e^-$ machines in the world in the $\tau$-charm energy region
BESII Detector

VC: $\sigma_{xy} = 100 \ \mu m$  TOF: $\sigma_T = 180 \ \text{ps}$  $\mu$ counter: $\sigma_{r\phi} = 3 \ \text{cm}$
MDC: $\sigma_{xy} = 220 \ \mu m$  BSC: $\Delta E/\sqrt{E} = 22 \ %$  $\sigma_z = 5.5 \ \text{cm}$
$\sigma_{dE/dx} = 8.5 \ %$  $\sigma_\phi = 7.9 \ \text{mr}$  $\Delta p/p = 1.7\%\sqrt{1+p^2}$  $\sigma_z = 3.1 \ \text{cm}$
B field: 0.4 T
Muon identification can be done for the charged track with momentum of great than 0.52 GeV/c
CESR-c

1 of the 12 wiggler magnets

- CESR-c had a pilot run Dec. '03 through Mar. '04.
  - 6 of the total of 12 wiggler magnets were installed.
  - The remaining magnets were installed this summer.
- We recorded 57.1 pb\(^{-1}\) at the \(\psi(3770)\).
- Will continue running this fall. Goal is to collect 3 fb\(^{-1}\) on the \(\psi(3770)\).
CLEO-c Detector

- 1 T B-field.
- New 6-layer inner drift chamber.
- Otherwise the CLEO III detector
◆ **BES-II \( \psi(3770) \) data sample**

- \(~18 \text{ pb}^{-1}\) of data taken at 3.773 GeV
- \(~7 \text{ pb}^{-1}\) of data taken at the region from 3.768 GeV to 3.778 GeV
- \(~8 \text{ pb}^{-1}\) of data taken in the energy region from 3.665 to 3.878 GeV

about \(~33 \text{ pb}^{-1}\) of data collected around 3.773 GeV in total.

◆ **CLEO-c \( \psi(3770) \) data sample**

about \(~57 \text{ pb}^{-1}\) of data taken at (around) 3.773 GeV
World $\psi(3770)$ Samples (pb$^{-1}$)

Largest sample from CLEO-c by Spring, 2004

<table>
<thead>
<tr>
<th>Energy [GeV]</th>
<th>Lum [pb$^{-1}$]</th>
<th>Exp.</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.60 – 3.89</td>
<td>~2</td>
<td>MARK-I parameters</td>
<td></td>
</tr>
<tr>
<td>3.60 – 3.89</td>
<td>~2</td>
<td>DELCO parameters</td>
<td></td>
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<td>MARK-II parameters</td>
<td></td>
</tr>
<tr>
<td>3.768</td>
<td>9.6</td>
<td>MARK-III D decays</td>
<td></td>
</tr>
</tbody>
</table>
$\psi(3770)$ Resonance Parameters

◆ Cross section scan experiment

The data were collected at 49 energy points from 3.66 to 3.89 GeV, which begin from off-resonance, cover $\psi(2S)$, $\psi(3770)$ and stop at DD* threshold.

Separated beam collision data at 3 energy points were collected to study beam associated background.

Some $J/\psi$, $\psi(2S)$ data were also taken to calibrate BEPC energy and determine $\epsilon_{\text{trg}}$.
Integrated luminosities

Luminosities were measured by using large angle Bhabha scattering

About 5.4 pb$^{-1}$ of data were collected for the experiment

Monte Carlo

Developed a inclusive hadronic event generator with high order ISR corrections to simulate the hadronic event productions (including Lorentz boost due to initial state photon emission) in the full energy region
Monte Carlo $e^+e^- \rightarrow$ hadrons production

Nominal c.m. energy $\sqrt{s} = 3.78$ GeV
Events Recorded by BESII

Events collected at BESII

$N_{b}$

$N_{had}$

$\nu_e^{-}-e^{-}$

Colliding-Beam Experiments

Cosmic-ray and beam associated background

Distributions of the vertex of events

physics background $N_{b}$ could be estimated based on cross sections, luminosities and acceptances
**Observed cross section**

\[
\sigma_{\text{had}}^{\text{obs}}(E_{\text{cm}}) = \frac{n_{\text{had}}}{L(E_{\text{cm}})} \frac{\epsilon_{\text{had}}(E_{\text{cm}})}{\epsilon_{\text{trg}}}
\]

\[
\sigma_{\text{had}}^{\text{expect}}(s) = \int_0^1 dx \ f(x, s) \ \sigma^B(s(1-x))
\]

\[
\sigma^B(s) = \frac{12 \pi \Gamma_{ee} \Gamma_f(s)}{(s - M^2)^2 + M^2 \Gamma_{tot}^2(s)}
\]

\[f(x, s) \text{ is sampling function}
\]

(Kuraev and Fadin)
To get right resonance parameters, the two resonance productions and decays should be considered simultaneously. In this way the “correct” QED background ( \( R_{uds} \) ) can be determined correctly!

\[ \psi(3770) \]

\[ \sigma_{\text{had}}^{\text{obs}} \]

\[ E_{cm} \ [\text{GeV}] \]

BES-II Preliminary!
Comparison of $\psi(3770)$ Resonance Parameters

<table>
<thead>
<tr>
<th>Experiment</th>
<th>$M_{\psi(3770)}$ (MeV)</th>
<th>$\Gamma_{\text{tot}}$ (MeV)</th>
<th>$\Gamma_{ee}$ (eV)</th>
<th>$\Delta M$ (MeV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MARK-I</td>
<td>3772 ± 6</td>
<td>28 ± 5</td>
<td>370 ± 90</td>
<td>88 ± 3</td>
</tr>
<tr>
<td>DELCO</td>
<td>3770 ± 6</td>
<td>24 ± 5</td>
<td>180 ± 60</td>
<td>86 ± 2</td>
</tr>
<tr>
<td>MARK-II</td>
<td>3764 ± 5</td>
<td>24 ± 5</td>
<td>276 ± 50</td>
<td>80 ± 2</td>
</tr>
<tr>
<td>PDG02</td>
<td>3769.9 ± 2.5</td>
<td>23.6 ± 2.7</td>
<td>260 ± 40</td>
<td>83.9 ± 2.4</td>
</tr>
<tr>
<td>BES-II</td>
<td>3772.8 ± 1.3</td>
<td>25.5 ± 4.0</td>
<td>225 ± 36</td>
<td>86.8 ± 1.3</td>
</tr>
</tbody>
</table>

\[ \sigma_{\psi(3770)}^{\text{prd}} \bigg|_{\sqrt{s}=3772.8 \text{ MeV}} = 9.11 \pm 0.99 \text{ nb} \]
Comparison of $\psi(2s)$ Resonance Parameters

<table>
<thead>
<tr>
<th>experiment</th>
<th>$M_\psi$ (MeV)</th>
<th>$\Gamma_{\psi}^{\text{tot}}$ (keV)</th>
<th>$\Gamma_{\psi}^{ee}$ (keV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>This measurement (preliminary !)</td>
<td>$3685.7 \pm 0.1 \pm 0.3$</td>
<td>$275\pm60\pm28$</td>
<td>$2.25\pm0.12\pm0.02$</td>
</tr>
<tr>
<td>BES-II published</td>
<td>$N.A.$</td>
<td>$264\pm27$</td>
<td>$2.44\pm0.21$</td>
</tr>
<tr>
<td>(PLB550(2002)24)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PDG2002</td>
<td>$3685.96 \pm 0.09$</td>
<td>$300\pm25$</td>
<td>$2.19\pm0.15$</td>
</tr>
</tbody>
</table>

Using a constant for vacuum polarization correction
DD-bar Cross Section at 3.773 GeV

◆ BES-II: \( L = 17.3 \text{ pb}^{-1} \) of data @ 3.773 GeV

Using Kinematical fit method to improve momentum resolution and select the singly tagged D meson

Single tag analysis

\[
\sigma_{DD}^{obs} = \frac{N_{D_{tag}}}{2 \, L \, Br \, \varepsilon}
\]

From Monte Carlo

PDG02 Br

Requiring \( M_{fit} = M_X \)
Observed cross sections for DD-bar production at 3.773 GeV

\[ \sigma_{D^0 D^0}^{obs} = 3.58 \pm 0.09 \pm 0.31 \text{ nb} \]
\[ \sigma_{D^+ D^-}^{obs} = 2.56 \pm 0.08 \pm 0.26 \text{ nb} \]
\[ \sigma_{DD}^{obs} = 6.14 \pm 0.12 \pm 0.50 \text{ nb} \]
Radiative correction

**Assuming that** $\psi(3770)$ decay exclusively into $D\bar{D}$

\[
\sigma_{DD}^{obs}(s) = \int_{0}^{1-4M_D^2/s} dx \, f(x, s) \, \sigma^B (s(1-x)) \left| 1 - \Pi(s(1-x)) \right|^{-2}
\]

\[
\left| 1 - \Pi(s(1-x)) \right|^{-2} = (1 + \delta_{vp}) = 1.047 \pm 0.024
\]

\[
\sigma^B (s) = \frac{12\pi\Gamma_{ee} \Gamma_f (s)}{(s - M^2)^2 + M^2 \Gamma_{tot}^2 (s)}
\]

**Initial State Radiation correction factor**

\[
g = \frac{\sigma^{obs}}{\sigma^B}
\]
At $\sqrt{s} = 3.773$ GeV

Radiative correction factor

Obtained based on PDG02

$\psi(3770)$ resonance parameters:

$M = 3769.9 \pm 2.5$ MeV

$\Gamma_{tot}^{\psi} = 23.6 \pm 2.7$ MeV

$\Gamma_{ee}^{\psi} = 260 \pm 40$ eV

$g = \frac{\sigma_{obs}}{\sigma_{Tree}} = 0.779 \pm 0.036$

Due to the uncertainties in resonance parameters and vacuum polarization $(1 + \delta_{\psi})$

$\sigma_{tree}^{D^{0} D^{0}} = 4.60 \pm 0.12 \pm 0.45$ nb

$\sigma_{tree}^{D^{+} D^{-}} = 3.29 \pm 0.10 \pm 0.37$ nb

$\sigma_{tree}^{DD} = 7.88 \pm 0.15 \pm 0.74$ nb

@ $\sqrt{s} = 3.773$ GeV

preliminary
\( R_{\bar{D}D} \) and \( R \)

1. \( R_{\bar{D}D} \)

\[
R_{\bar{D}D} = \frac{\sigma_{D\bar{D}}^{\text{free}}}{\sigma_{e^+e^-\to\mu^+\mu^-}} = 1.29 \pm 0.02 \pm 0.12
\]

2. \( R \)

Assuming that \( \psi(3770) \) decays exclusively into DD-bar

\[
R = R_{\bar{D}D} + R_{uds} \quad \text{or} \quad R = R_{\bar{D}D} + \bar{R}_{uds}
\]

The contribution to \( R \) in the charm threshold region from the light quarks is estimated to be \( R_{uds} = 2.26 \pm 0.14 \), which is obtained by fitting to the \( R \) values from 2.0 to 3.0 GeV measured by BES-II. The theoretical expectation is that \( R_{uds} \) is approximately independent of center of mass energy in this region.

yielding \( R = 3.55 \pm 0.02 \pm 0.18 \) (preliminary !)

\( \bar{R}_{uds} = 2.24 \pm 0.14 \)

which is obtained in measurement of \( \psi(3770) \) resonance parameters
DD-bar Cross Section at 3.773 GeV

- CLEO-c: \( L = 57.2 \text{ pb}^{-1} \) of data @ 3.773 GeV

Using ‘double tag’ method, pioneered by MARK-III
Single Tag Yields

<table>
<thead>
<tr>
<th>$D$ or $\bar{D}$ Mode</th>
<th>Yield ($10^3$)</th>
<th>Efficiency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$D^0 \to K^-\pi^+$</td>
<td>5.14 ± 0.07</td>
<td>65.1 ± 0.6</td>
</tr>
<tr>
<td>$\bar{D}^0 \to K^+\pi^-$</td>
<td>5.16 ± 0.08</td>
<td>66.3 ± 0.6</td>
</tr>
<tr>
<td>$D^0 \to K^-\pi^+\pi^0$</td>
<td>9.62 ± 0.12</td>
<td>33.6 ± 0.4</td>
</tr>
<tr>
<td>$\bar{D}^0 \to K^+\pi^-\pi^0$</td>
<td>9.58 ± 0.12</td>
<td>34.0 ± 0.4</td>
</tr>
<tr>
<td>$D^0 \to K^-\pi^+\pi^-\pi^-$</td>
<td>7.39 ± 0.10</td>
<td>45.1 ± 0.5</td>
</tr>
<tr>
<td>$\bar{D}^0 \to K^+\pi^-\pi^-\pi^+$</td>
<td>7.39 ± 0.10</td>
<td>45.5 ± 0.5</td>
</tr>
<tr>
<td>$D^+ \to K^-\pi^+\pi^+$</td>
<td>7.58 ± 0.09</td>
<td>52.2 ± 0.5</td>
</tr>
<tr>
<td>$D^- \to K^+\pi^-\pi^-$</td>
<td>7.57 ± 0.09</td>
<td>51.9 ± 0.5</td>
</tr>
<tr>
<td>$D^+ \to K^0_S\pi^+$</td>
<td>1.09 ± 0.04</td>
<td>45.6 ± 0.5</td>
</tr>
<tr>
<td>$D^- \to K^0_S\pi^-$</td>
<td>1.12 ± 0.04</td>
<td>45.9 ± 0.5</td>
</tr>
</tbody>
</table>

$N_{D^0(\bar{D}^0)} = 44780$

Preliminary!

$N_{D^+(\bar{D}^-)} = 17360$

ICHEP, Beijing, Aug. 16-22, 2004
Anders Ryd, Cornell University
# Double Tag Yields

<table>
<thead>
<tr>
<th>$D$ Mode</th>
<th>$\bar{D}$ Mode</th>
<th>Yield ($10^2$)</th>
<th>Efficiency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$D^0 \rightarrow K^+\pi^+$</td>
<td>$\bar{D}^0 \rightarrow K^-\pi^-$</td>
<td>1.09 ± 0.11</td>
<td>42.6 ± 0.5</td>
</tr>
<tr>
<td>$D^0 \rightarrow K^-\pi^+\pi^0$</td>
<td>$\bar{D}^0 \rightarrow K^+\pi^-\pi^0$</td>
<td>4.84 ± 0.23</td>
<td>12.1 ± 0.3</td>
</tr>
<tr>
<td>$D^0 \rightarrow K^-\pi^+\pi^-\pi^+$</td>
<td>$\bar{D}^0 \rightarrow K^+\pi^-\pi^-\pi^+$</td>
<td>2.80 ± 0.17</td>
<td>20.8 ± 0.4</td>
</tr>
<tr>
<td>$D^0 \rightarrow K^-\pi^+$</td>
<td>$\bar{D}^0 \rightarrow K^+\pi^-\pi^0$</td>
<td>2.45 ± 0.16</td>
<td>23.2 ± 0.4</td>
</tr>
<tr>
<td>$D^0 \rightarrow K^-\pi^+\pi^0$</td>
<td>$\bar{D}^0 \rightarrow K^+\pi^-\pi^-$</td>
<td>2.62 ± 0.16</td>
<td>22.6 ± 0.4</td>
</tr>
<tr>
<td>$D^0 \rightarrow K^-\pi^+$</td>
<td>$\bar{D}^0 \rightarrow K^+\pi^-\pi^-\pi^+$</td>
<td>2.05 ± 0.14</td>
<td>29.6 ± 0.4</td>
</tr>
<tr>
<td>$D^0 \rightarrow K^-\pi^+\pi^-$</td>
<td>$\bar{D}^0 \rightarrow K^+\pi^-\pi^-$</td>
<td>1.97 ± 0.14</td>
<td>29.6 ± 0.4</td>
</tr>
<tr>
<td>$D^0 \rightarrow K^-\pi^+\pi^0$</td>
<td>$\bar{D}^0 \rightarrow K^+\pi^-\pi^-\pi^+$</td>
<td>3.59 ± 0.20</td>
<td>15.2 ± 0.3</td>
</tr>
<tr>
<td>$D^0 \rightarrow K^-\pi^+\pi^-\pi^+$</td>
<td>$\bar{D}^0 \rightarrow K^+\pi^-\pi^-\pi^+$</td>
<td>3.40 ± 0.19</td>
<td>15.5 ± 0.3</td>
</tr>
<tr>
<td>$D^+ \rightarrow K_{S}^0\pi^+$</td>
<td>$D^- \rightarrow K_{S}^0\pi^-$</td>
<td>3.79 ± 0.20</td>
<td>26.7 ± 0.4</td>
</tr>
<tr>
<td>$D^+ \rightarrow K_{S}^0\pi^+$</td>
<td>$D^- \rightarrow K_{S}^0\pi^-$</td>
<td>0.090 ± 0.030</td>
<td>20.6 ± 0.4</td>
</tr>
<tr>
<td>$D^+ \rightarrow K_{S}^0\pi^+$</td>
<td>$D^- \rightarrow K_{S}^0\pi^-$</td>
<td>0.609 ± 0.079</td>
<td>23.7 ± 0.4</td>
</tr>
<tr>
<td>$D^+ \rightarrow K_{S}^0\pi^+$</td>
<td>$D^- \rightarrow K_{S}^0\pi^-$</td>
<td>0.530 ± 0.073</td>
<td>23.9 ± 0.4</td>
</tr>
</tbody>
</table>

- **2480 neutral double tags**
- **502 charged double tags**

Preliminary!

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\[ N_i = 2\varepsilon_i B_i N_{DD} \]
\[ N_{\bar{u}} = \varepsilon_{\bar{u}} B_i^2 N_{DD} \]

\[
N_{DD} = \frac{N_i^2}{4N_{ii} \varepsilon_i^2}
\]

\[ N_{D^0\bar{D}^0} = (1.98 \pm 0.04 \pm 0.03) \times 10^5 \]
\[ N_{D^+\bar{D}^-} = (1.48 \pm 0.06 \pm 0.04) \times 10^5 \]

\[
\sigma_{obs}^{D^0\bar{D}^0} = (3.47 \pm 0.07 \pm 0.15) \text{ nb}
\]
\[
\sigma_{obs}^{D^+\bar{D}^-} = (2.59 \pm 0.11 \pm 0.11) \text{ nb}
\]
\[
\sigma_{obs}^{DD} = (6.06 \pm 0.13 \pm 0.22) \text{ nb}
\]

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What indicate the new measurements?

What information can we obtain from the new measurements at BES-II and CLEO-c?

Based on the measured DD-bar cross sections from BES-II & CLEO-c, we obtain the averaged DD-bar cross section

\[ \sigma_{D^0 \overline{D}^0}^{\text{obs}} = (3.49 \pm 0.15) \text{ nb} \]
\[ \sigma_{D^+ \overline{D}^-}^{\text{obs}} = (2.58 \pm 0.14) \text{ nb} \]
\[ \sigma_{D \overline{D}}^{\text{obs}} = (6.08 \pm 0.23) \text{ nb} \]

Using the new \( \psi(3770) \) resonance parameters measured by BES-II, we obtain the ISR correction factor at 3.773 GeV

\[ g = 0.76 \]
Tree level cross sections

\[
\sigma^{\text{tree}}_{D^0\bar{D}^0} = (4.59 \pm 0.20) \text{ nb} \\
\sigma^{\text{tree}}_{D^+D^-} = (3.39 \pm 0.18) \text{ nb} \\
\sigma^{\text{tree}}_{DD} = (7.99 \pm 0.30) \text{ nb}
\]

averaged cross sections from BES-II and CLEO-c

From BES-II preliminary result of

\[
\sigma^{\text{prd}}_{\psi(3770)} \big|_{\sqrt{s}=37728 \text{ MeV}} = 9.11 \pm 0.99 \text{ nb}
\]

We can obtain the tree level cross section for \(\psi(3770)\) production to be

\[
\sigma^{\text{tree}}_{\sigma_{\psi(3770)}} = (8.70 \pm 0.95) \text{ nb}
\]
Branching fractions of $\psi(3770)$ decays

Using the BES-II & CLEO-c preliminary results on $\sigma_{D\bar{D}}$ and $\sigma_{\psi(3770)}$ presented at ICHEP’04, we can obtain

<table>
<thead>
<tr>
<th>Decay Mode</th>
<th>Branching fraction [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\psi(3770) \rightarrow D^0 \bar{D}^0$</td>
<td>52.8 ± 6.2</td>
</tr>
<tr>
<td>$\psi(3770) \rightarrow D^+ D^-$</td>
<td>39.0 ± 4.7</td>
</tr>
<tr>
<td>$\psi(3770) \rightarrow D\bar{D}$</td>
<td>91.8 ± 10.6</td>
</tr>
<tr>
<td>$\psi(3770) \rightarrow non - D\bar{D}$</td>
<td>8.2 ± 10.6</td>
</tr>
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SUMMARY

- BES measured $\psi(3770)$ resonance parameters

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<tr>
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<th>$M_{\psi(3770)}$ (MeV)</th>
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$\sigma_{\psi(3770)}^{prd} = 9.11 \pm 0.99$ nb (BES-II preliminary !)

$\overline{R}_{uds} = 2.24\pm0.14$ From 3.66 to 3.87 GeV

- BES measured the DD-bar Cross Section at 3.773 GeV to be

$\sigma_{DD}^{\text{tree}} = 7.88 \pm 0.15 \pm 0.74$ nb (ISR based on PDG02) (BES-II preliminary !)
SUMMARY

- Measured the Observed cross section at 3.773 GeV

<table>
<thead>
<tr>
<th></th>
<th>BES-II (preliminary !)</th>
<th>CLEO-c (preliminary !)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\sigma_{D^0\bar{D}^0}^{obs}$</td>
<td>$(3.58 \pm 0.09 \pm 0.31) \text{ nb}$</td>
<td>$(3.47 \pm 0.07 \pm 0.15) \text{ nb}$</td>
</tr>
<tr>
<td>$\sigma_{D^+D^-}^{obs}$</td>
<td>$(2.56 \pm 0.08 \pm 0.26) \text{ nb}$</td>
<td>$(2.59 \pm 0.11 \pm 0.11) \text{ nb}$</td>
</tr>
<tr>
<td>$\sigma_{D\bar{D}}^{obs}$</td>
<td>$(6.14 \pm 0.12 \pm 0.50) \text{ nb}$</td>
<td>$(6.06 \pm 0.13 \pm 0.22) \text{ nb}$</td>
</tr>
</tbody>
</table>

- What is the non-DD-bar branching fraction of $\psi(3770)$

It is reduced to about $(8 \pm 11)\%$ from $39\%$ using the new measurements at BES-II and CLEO-c.

Both the BES-II and the CLEO-c results were reported at ICHEP'04 as well.
Thank You