NODE=M210

# $T_{c\overline{c}1}(3900)$

$I^G(J^{PC}) = 1^+(1^{+-})$

was $Z_c(3900)$, $X(3900)$

Properties incompatible with a $q\overline{q}$ structure (exotic state). See the review on non-$q\overline{q}$ states. NODE=M210

Charged $T_{c\overline{c}1}(3900)^{\pm}$ seen as a peak in the invariant mass distribution of the $J/\psi\pi^{\pm}$ system by BES III (ABLIKIM 13T) in $e^+e^- \to \pi^+\pi^- J/\psi$ at c.m. energy of 4.26 GeV and by radiative return from $e^+e^-$ collisions at $\sqrt{s}$ from 9.46 to 10.86 GeV at Belle (LIU 13B). Partial wave analysis of ABLIKIM 17J determines $J^P = 1^+$ with more than 7 $\sigma$ significance. Neutral $T_{c\overline{c}1}(3900)^0$ seen in the $J/\psi\pi^0$ invariant mass distribution in $e^+e^- \to \pi^0\pi^0 J/\psi$ at c.m. energies of 4.23, 4.26, and 4.36 GeV by BES III (ABLIKIM 15U) and at 4.17 GeV by XIAO 13A. Peaks in $(D\overline{D}^*)^{0,\pm}$ reported by BES III (ABLIKIM 14A, ABLIKIM 15AB) are assumed to be related.

## $T_{c\overline{c}1}(3900)$ MASS

NODE=M210M

NODE=M210M

| VALUE (MeV) | EVTS | DOCUMENT ID | | TECN | CHG | COMMENT |
|---|---|---|---|---|---|---|
| **3887.1±2.6 OUR AVERAGE** | | Error includes scale factor of 1.7. See the ideogram below. | | | | |
| $3893.1 \pm 2.2 \pm 3.0$ | | [1] ABLIKIM | 20N | BES3 | 0 | $e^+e^- \to \pi^0\pi^0 J/\psi$ |
| $3902.6^{+5.2}_{-5.0} {}^{+3.3}_{-1.4}$ | | [2,3] ABAZOV | 19 | D0 | ± | 1.96 TeV $p\overline{p} \to J/\psi\pi^+\pi^- X$ |
| $3881.2 \pm 4.2 \pm 52.7$ | 6k | [4] ABLIKIM | 17J | BES3 | ± | $e^+e^- \to \pi^+\pi^- J/\psi$ |
| $3885.7^{+4.3}_{-5.7} \pm 8.4$ | | [2,4] ABLIKIM | 15AB | BES3 | 0 | $e^+e^- \to \pi^0(D\overline{D}^*)^0$ |
| $3881.7 \pm 1.6 \pm 1.6$ | 1.2k | [2,4] ABLIKIM | 15AC | BES3 | ± | $e^+e^- \to \pi^{\pm}(D\overline{D}^*)^{\mp}$ |
| $3883.9 \pm 1.5 \pm 4.2$ | 1.2k | [2,4] ABLIKIM | 14A | BES3 | ± | $e^+e^- \to \pi^{\pm}(D\overline{D}^*)^{\mp}$ |
| $3894.5 \pm 6.6 \pm 4.5$ | 159 | [2] LIU | 13B | BELL | ± | $e^+e^- \to \gamma\pi^+\pi^- J/\psi$ |
| $3886 \pm 4 \pm 2$ | 81 | [2,5] XIAO | 13A | | ± | 4.17 $e^+e^- \to \pi^+\pi^- J/\psi$ |
| $3904 \pm 9 \pm 5$ | 25 | [2,5] XIAO | 13A | | 0 | 4.17 $e^+e^- \to \pi^0\pi^0 J/\psi$ OCCUR=2 |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | | |
| $3895.0 \pm 5.2^{+4.0}_{-2.7}$ | 502 | [2,6] ABAZOV | 18B | D0 | ± | 1.96 TeV $p\overline{p} \to J/\psi\pi^+\pi^- X$ |
| $3894.8 \pm 2.3 \pm 3.2$ | 356 | [2,7] ABLIKIM | 15U | BES3 | 0 | $e^+e^- \to \pi^0\pi^0 J/\psi$ |
| $3899.0 \pm 3.6 \pm 4.9$ | 307 | [2,8] ABLIKIM | 13T | BES3 | ± | $e^+e^- \to \pi^+\pi^- J/\psi$ |

[1] Pole mass obtained from a fit to a relativistic Breit-Wigner. NODE=M210M;LINKAGE=L

[2] Neglecting interference between the $T_{c\overline{c}1}(3900)$ and other processes. NODE=M210M;LINKAGE=A

[3] Measured in weak decays of $b$-flavored hadrons (nonprompt). NODE=M210M;LINKAGE=G

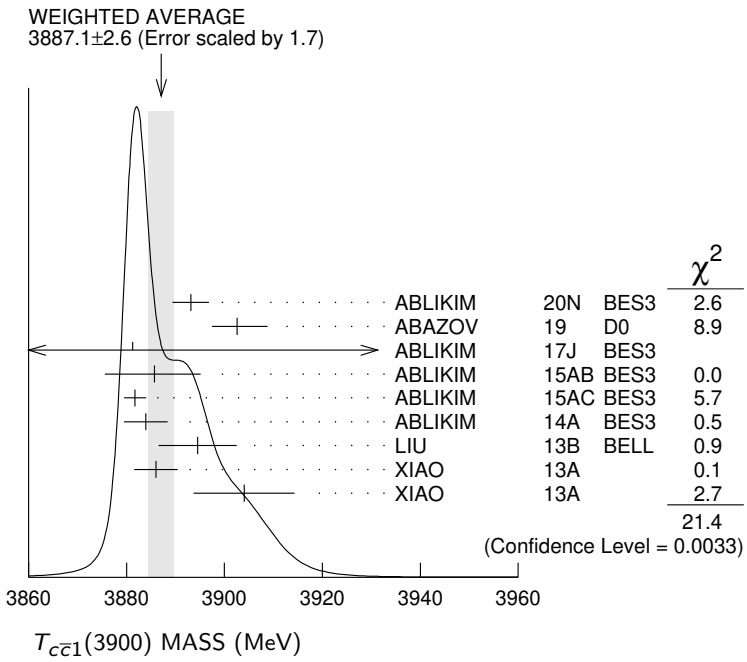
[4] Pole mass obtained from a fit to a Flatte-like formula. NODE=M210M;LINKAGE=E

[5] For $M^2(\pi^+\pi^-) < 0.65$ GeV$^2$. Obtained by analyzing CLEO-c data but not authored by the CLEO Collaboration. NODE=M210M;LINKAGE=B

[6] The signal of the $T_{c\overline{c}1}(3900)$ is correlated with a parent $J/\psi\pi^+\pi^-$ system in the invariant mass range 4.2–4.7 GeV. Superseded by ABAZOV 19. NODE=M210M;LINKAGE=F

[7] Superseded by ABLIKIM 20N. NODE=M210M;LINKAGE=J

[8] Superseded by ABLIKIM 17J. NODE=M210M;LINKAGE=K




## $T_{c\overline{c}1}(3900)$ WIDTH

NODE=M210W

NODE=M210W

| VALUE (MeV) | EVTS | DOCUMENT ID | | TECN | CHG | COMMENT |
|---|---|---|---|---|---|---|
| **28.4± 2.6 OUR AVERAGE** | | | | | | |
| 44.4± 5.2±14.0 | | [1] ABLIKIM | 20N | BES3 | 0 | $e^+e^- \to \pi^0\pi^0 J/\psi$ |
| $32\ ^{+28}_{-21}\ ^{+26}_{-7}$ | | [2,3] ABAZOV | 19 | D0 | ± | 1.96 TeV $p\overline{p} \to \pi^+\pi^- J/\psi X$ (non-prompt) |
| 51.8± 4.6±36.0 | 6 k | [4] ABLIKIM | 17J | BES3 | ± | $e^+e^- \to \pi^+\pi^- J/\psi$ |
| $35\ ^{+11}_{-12}$ ±15 | | [2,4] ABLIKIM | 15AB | BES3 | 0 | $e^+e^- \to \pi^0(D\overline{D}^*)^0$ |
| 26.6± 2.0± 2.1 | 1248 | [2,4] ABLIKIM | 15AC | BES3 | ± | $e^+e^- \to \pi^\pm(D\overline{D}^*)^\mp$ |
| 24.8± 3.3±11.0 | 1212 | [2,4] ABLIKIM | 14A | BES3 | ± | $e^+e^- \to \pi^\pm(D\overline{D}^*)^\mp$ |
| 63 ±24 ±26 | 159 | [2] LIU | 13B | BELL | ± | $e^+e^- \to \gamma\pi^+\pi^- J/\psi$ |
| 37 ± 4 ± 8 | 81 | [2,5] XIAO | 13A | | ± | 4.17 $e^+e^- \to \pi^+\pi^- J/\psi$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | | |
| 29.6± 8.2± 8.2 | 356 | [2,6] ABLIKIM | 15U | BES3 | 0 | $e^+e^- \to \pi^0\pi^0 J/\psi$ |
| 46 ±10 ±20 | 307 | [2,7] ABLIKIM | 13T | BES3 | ± | $e^+e^- \to \pi^+\pi^- J/\psi$ |

[1] Pole width obtained from a fit to a relativistic Breit-Wigner. NODE=M210W;LINKAGE=G
[2] Neglecting interference between the $T_{c\overline{c}1}(3900)$ and other processes. NODE=M210W;LINKAGE=A
[3] Measured in weak decays of $b$-flavored hadrons (nonprompt). NODE=M210W;LINKAGE=F
[4] Pole width obtained from a fit to a Flatte-like formula. NODE=M210W;LINKAGE=E
[5] For $M^2(\pi^+\pi^-) < 0.65$ GeV$^2$. Obtained by analyzing CLEO-c data but not authored by the CLEO Collaboration. NODE=M210W;LINKAGE=B
[6] Superseded by ABLIKIM 20N. NODE=M210W;LINKAGE=H
[7] Superseded by ABLIKIM 17J. NODE=M210W;LINKAGE=I

## $T_{c\overline{c}1}(3900)$ DECAY MODES

NODE=M210215;NODE=M210

| | Mode | Fraction ($\Gamma_i/\Gamma$) | |
|---|---|---|---|
| $\Gamma_1$ | $J/\psi\pi$ | seen | DESIG=1 |
| $\Gamma_2$ | $h_c\pi^\pm$ | not seen | DESIG=2 |
| $\Gamma_3$ | $\eta_c\pi^+\pi^-$ | not seen | DESIG=10 |
| $\Gamma_4$ | $\eta_c(1S)\rho(770)^\pm$ | seen | DESIG=11;OUR EVAL;→ UNCHECKED ← |
| $\Gamma_5$ | $(D\overline{D}^*)^\pm$ | seen | DESIG=3;OUR EVAL;→ UNCHECKED ← |
| $\Gamma_6$ | $D^0D^{*-}$ + c.c. | seen | DESIG=8 |
| $\Gamma_7$ | $D^-D^{*0}$ + c.c. | seen | DESIG=9 |
| $\Gamma_8$ | $\omega\pi^\pm$ | not seen | DESIG=4 |
| $\Gamma_9$ | $J/\psi\eta$ | not seen | DESIG=5 |
| $\Gamma_{10}$ | $D^+D^{*-}$ + c.c | seen | DESIG=6 |
| $\Gamma_{11}$ | $D^0\overline{D}^{*0}$ + c.c | seen | DESIG=7 |

## $T_{c\bar{c}1}(3900)$ BRANCHING RATIOS

NODE=M210225

### $\Gamma(J/\psi\pi)/\Gamma_{total}$ — $\Gamma_1/\Gamma$

NODE=M210R01
NODE=M210R01

| VALUE | EVTS | DOCUMENT ID | | TECN | CHG | COMMENT |
|---|---|---|---|---|---|---|
| **seen** | | ABLIKIM | 20N | BES3 | 0 | $e^+e^- \to \pi^0\pi^0 J/\psi$ |
| seen | | [1] ABAZOV | 19 | D0 | $\pm$ | 1.96 TeV $p\bar{p} \to \pi^+\pi^- J/\psi X$ (prompt) |
| seen | | ABLIKIM | 17J | BES3 | $\pm$ | $e^+e^- \to \pi^+\pi^- J/\psi$ |
| seen | 356 | ABLIKIM | 15U | BES3 | 0 | $e^+e^- \to \pi^0\pi^0 J/\psi$ |
| not seen | | [2] ADOLPH | 15D | COMP | $\pm$ | $\gamma N \to J/\psi\pi^\pm N$ |
| seen | 307 | ABLIKIM | 13T | BES3 | $\pm$ | $e^+e^- \to \pi^+\pi^- J/\psi$ |
| seen | 25 | [3] XIAO | 13A | | 0 | 4.17 $e^+e^- \to \pi^0\pi^0 J/\psi$ |

[1] But not seen in the "prompt" sample (no b-hadron enhancement). NODE=M210R01;LINKAGE=C

[2] ADOLPH 15D measure $B(T_{c\bar{c}1}(3900)^\pm \to J/\psi\pi^\pm)\ \sigma(\gamma N \to T_{c\bar{c}1}(3900)^\pm N)/\sigma(\gamma N \to J/\psi N) < 3.7\times10^{-3}$ at 90% CL. NODE=M210R01;LINKAGE=A

[3] Obtained by analyzing CLEO-c data but not authored by the CLEO Collaboration. NODE=M210R01;LINKAGE=XI

### $\Gamma(h_c\pi^\pm)/\Gamma_{total}$ — $\Gamma_2/\Gamma$

NODE=M210R02
NODE=M210R02

| VALUE | DOCUMENT ID | | TECN | CHG | COMMENT |
|---|---|---|---|---|---|
| **not seen** | ABLIKIM | 13X | BES3 | $\pm$ | $e^+e^- \to h_c\pi^+\pi^-$ |

### $\Gamma(\eta_c\pi^+\pi^-)/\Gamma_{total}$ — $\Gamma_3/\Gamma$

NODE=M210R11
NODE=M210R11

| VALUE | DOCUMENT ID | | TECN | CHG | COMMENT |
|---|---|---|---|---|---|
| **not seen** | [1] VINOKUROVA | 15 | BELL | 0 | $B^+ \to K^+\eta_c\pi^+\pi^-$ |

[1] VINOKUROVA 15 reports $B(B^+ \to K^+ Z_c(3900)^0) \times B(X \to \eta_c\pi^+\pi^-) < 4.7\times10^{-5}$ at 90% CL. NODE=M210R11;LINKAGE=VI

### $\Gamma(\eta_c(1S)\rho(770)^\pm)/\Gamma(J/\psi\pi)$ — $\Gamma_4/\Gamma_1$

NODE=M210R12
NODE=M210R12

| VALUE | EVTS | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **2.3±0.8** | 332 | [1] ABLIKIM | 19BC | BES3 | $e^+e^- \to \pi^+\pi^-\pi^0\eta_c(1S)$ |

[1] Using $e^+e^- \to \pi^\mp(T_{c\bar{c}1}(3900)^\pm \to J/\psi\pi^\pm)$ cross section at 4.23 and 4.26 GeV from ABLIKIM 17J. NODE=M210R12;LINKAGE=A

### $\Gamma((D\bar{D}^*)^\pm)/\Gamma(J/\psi\pi)$ — $\Gamma_5/\Gamma_1$

NODE=M210R03
NODE=M210R03

| VALUE | DOCUMENT ID | | TECN | CHG | COMMENT |
|---|---|---|---|---|---|
| **6.2±1.1±2.7** | [1] ABLIKIM | 14A | BES3 | $\pm$ | $e^+e^- \to \pi^\pm(D\bar{D}^*)^\mp$ |

[1] Assuming the same origin of the $(D\bar{D}^*)^\pm$ and $\pi^\pm J/\psi$ decay modes. NODE=M210R03;LINKAGE=A

### $\Gamma(D^0D^{*-}+\text{c.c.})/\Gamma_{total}$ — $\Gamma_6/\Gamma$

NODE=M210R09
NODE=M210R09

| VALUE | DOCUMENT ID | | TECN | CHG | COMMENT |
|---|---|---|---|---|---|
| **seen** | ABLIKIM | 15AC | BES3 | $\pm$ | $e^+e^- \to \pi^+D^0D^{*-}$ + c.c. |
| **seen** | ABLIKIM | 14A | BES3 | $\pm$ | $e^+e^- \to \pi^+D^0D^{*-}$ + c.c. |

### $\Gamma(D^-D^{*0}+\text{c.c.})/\Gamma_{total}$ — $\Gamma_7/\Gamma$

NODE=M210R10
NODE=M210R10

| VALUE | DOCUMENT ID | | TECN | CHG | COMMENT |
|---|---|---|---|---|---|
| **seen** | ABLIKIM | 15AC | BES3 | $\pm$ | $e^+e^- \to \pi^+D^-D^{*0}$ + c.c. |
| **seen** | ABLIKIM | 14A | BES3 | $\pm$ | $e^+e^- \to \pi^+D^-D^{*0}$ + c.c. |

### $\Gamma(\omega\pi^\pm)/\Gamma_{total}$ — $\Gamma_8/\Gamma$

NODE=M210R00
NODE=M210R00

| VALUE | DOCUMENT ID | | TECN | CHG | COMMENT |
|---|---|---|---|---|---|
| **not seen** | ABLIKIM | 15R | BES3 | $\pm$ | $e^+e^- \to \omega\pi^+\pi^-$ |

### $\Gamma(J/\psi\eta)/\Gamma_{total}$ — $\Gamma_9/\Gamma$

NODE=M210R04
NODE=M210R04

| VALUE | DOCUMENT ID | | TECN | CHG | COMMENT |
|---|---|---|---|---|---|
| **not seen** | ABLIKIM | 15Q | BES3 | 0 | 4.0–4.6 $e^+e^- \to J/\psi\eta\pi^0$ |

### $\Gamma(J/\psi\eta)/\Gamma(J/\psi\pi)$ — $\Gamma_9/\Gamma_1$

NODE=M210R05
NODE=M210R05

| VALUE | CL% | DOCUMENT ID | | TECN | CHG | COMMENT |
|---|---|---|---|---|---|---|
| <0.15 | 90 | ABLIKIM | 15Q | BES3 | 0 | 4.226 $e^+e^- \to J/\psi\eta\pi^0$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | | |
| <0.65 | 90 | ABLIKIM | 15Q | BES3 | 0 | 4.257 $e^+e^- \to J/\psi\eta\pi^0$ OCCUR=2 |

### $\Gamma(D^+D^{*-}+\text{c.c})/\Gamma_{total}$ — $\Gamma_{10}/\Gamma$

NODE=M210R06
NODE=M210R06

| VALUE | DOCUMENT ID | | TECN | CHG | COMMENT |
|---|---|---|---|---|---|
| **seen** | ABLIKIM | 15AB | BES3 | 0 | $e^+e^- \to \pi^0(D\bar{D}^*)^0$ |

### $\Gamma(D^0\overline{D}^{*0}+c.c)/\Gamma_{total}$ — $\Gamma_{11}/\Gamma$

NODE=M210R07
NODE=M210R07

| VALUE | DOCUMENT ID | | TECN | CHG | COMMENT |
|---|---|---|---|---|---|
| **seen** | ABLIKIM | 15AB | BES3 | 0 | $e^+e^- \to \pi^0(D\overline{D}^*)^0$ |

### $\Gamma(D^+D^{*-}+c.c)/\Gamma(D^0\overline{D}^{*0}+c.c)$ — $\Gamma_{10}/\Gamma_{11}$

NODE=M210R08
NODE=M210R08

| VALUE | DOCUMENT ID | | TECN | CHG | COMMENT |
|---|---|---|---|---|---|
| **0.96±0.18±0.12** | ABLIKIM | 15AB | BES3 | 0 | $e^+e^- \to \pi^0(D\overline{D}^*)^0$ |

## $T_{c\bar{c}1}(3900)$ REFERENCES

NODE=M210


| | | | | | |
|---|---|---|---|---|---|
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| ABAZOV | 19 | PR D100 012005 | V.M. Abazov *et al.* | (D0 Collab.) | REFID=59903 |
| ABLIKIM | 19BC | PR D100 111102 | M. Ablikim *et al.* | (BESIII Collab.) | REFID=60036 |
| ABAZOV | 18B | PR D98 052010 | V.M. Abazov *et al.* | (D0 Collab.) | REFID=59442 |
| ABLIKIM | 17J | PRL 119 072001 | M. Ablikim *et al.* | (BESIII Collab.) JP | REFID=57950 |
| ABLIKIM | 15AB | PRL 115 222002 | M. Ablikim *et al.* | (BESIII Collab.) | REFID=56954 |
| ABLIKIM | 15AC | PR D92 092006 | M. Ablikim *et al.* | (BESIII Collab.) JP | REFID=56967 |
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| VINOKUROVA | 15 | JHEP 1506 132 | A. Vinokurova *et al.* | (BELLE Collab.) | REFID=56706 |
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| ABLIKIM | 13T | PRL 110 252001 | M. Ablikim *et al.* | (BESIII Collab.) | REFID=55409 |
| ABLIKIM | 13X | PRL 111 242001 | M. Ablikim *et al.* | (BESIII Collab.) | REFID=55635 |
| LIU | 13B | PRL 110 252002 | Z.Q. Liu *et al.* | (BELLE Collab.) | REFID=55410 |
| XIAO | 13A | PL B727 366 | T. Xiao *et al.* | (NWES) | REFID=55593 |