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

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

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.

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 σ 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

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.				
$3893.1\pm2.2\pm3.0$		[1] ABLIKIM	20N	BES3	0	$e^+e^- \to \pi^0\pi^0 J/\psi$
$3902.6^{+5.2+3.3}_{-5.0-1.4}$		[2,3] ABAZOV	19	D0	±	1.96 TeV $p\overline{p} \to J/\psi\pi^+\pi^- X$
$3881.2\pm4.2\pm52.7$	6k	[4] ABLIKIM	17J	BES3	±	$e^+e^- \to \pi^+\pi^- J/\psi$
$3885.7^{+4.3}_{-5.7}\pm8.4$		[2,4] ABLIKIM	15AB	BES3	0	$e^+e^- \to \pi^0(D\overline{D}^*)^0$
$3881.7\pm1.6\pm1.6$	1.2k	[2,4] ABLIKIM	15AC	BES3	±	$e^+e^- \to \pi^{\pm}(D\overline{D}^*)^{\mp}$
$3883.9\pm1.5\pm4.2$	1.2k	[2,4] ABLIKIM	14A	BES3	±	$e^+e^- \to \pi^{\pm}(D\overline{D}^*)^{\mp}$
$3894.5\pm6.6\pm4.5$	159	[2] LIU	13B	BELL	±	$e^+e^- \to \gamma\pi^+\pi^- J/\psi$
$3886 \pm4 \pm2$	81	[2,5] XIAO	13A		±	4.17 $e^+e^- \to \pi^+\pi^- J/\psi$
$3904 \pm9 \pm5$	25	[2,5] XIAO	13A		0	4.17 $e^+e^- \to \pi^0\pi^0 J/\psi$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
$3895.0\pm5.2^{+4.0}_{-2.7}$	502	[2,6] ABAZOV	18B	D0	±	1.96 TeV $p\overline{p} \to J/\psi\pi^+\pi^- X$
$3894.8\pm2.3\pm3.2$	356	[2,7] ABLIKIM	15U	BES3	0	$e^+e^- \to \pi^0\pi^0 J/\psi$
$3899.0\pm3.6\pm4.9$	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.

[2] Neglecting interference between the $T_{c\overline{c}1}(3900)$ and other processes.

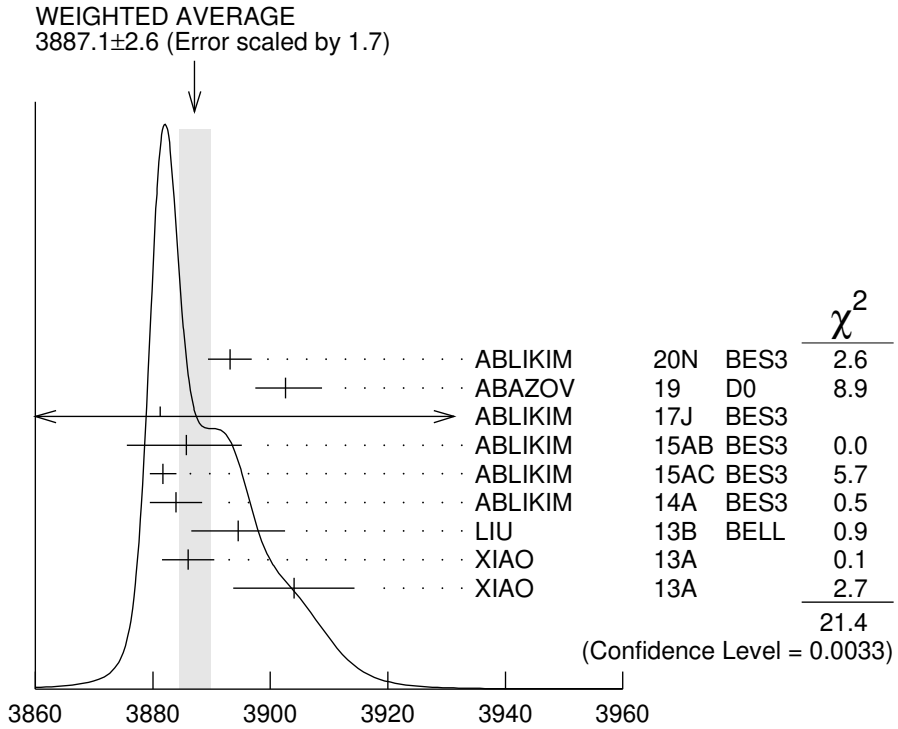
[3] Measured in weak decays of b-flavored hadrons (nonprompt).

[4] Pole mass obtained from a fit to a Flatte-like formula.

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

[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.

[7] Superseded by ABLIKIM 20N.
[8] Superseded by ABLIKIM 17J.



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

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

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

	Mode	Fraction (Γ_i/Γ)
Γ_1	$J/\psi\pi$	seen
Γ_2	$h_c\pi^\pm$	not seen
Γ_3	$\eta_c\pi^+\pi^-$	not seen
Γ_4	$\eta_c(1S)\rho(770)^\pm$	seen
Γ_5	$(D\overline{D}^*)^\pm$	seen
Γ_6	D^0D^{*-} + c.c.	seen
Γ_7	D^-D^{*0} + c.c.	seen
Γ_8	$\omega\pi^\pm$	not seen
Γ_9	$J/\psi\eta$	not seen
Γ_{10}	D^+D^{*-} + c.c	seen
Γ_{11}	$D^0\overline{D}^{*0}$ + c.c	seen

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

$\Gamma(J/\psi\pi)/\Gamma_{total}$ Γ_1/Γ

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 $p\overline{p} \to \pi^+\pi^- J/\psi X$ (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).
[2] ADOLPH 15D measure $B(T_{c\overline{c}1}(3900)^\pm \to J/\psi\pi^\pm)\ \sigma(\gamma N \to T_{c\overline{c}1}(3900)^\pm N)/\sigma(\gamma N \to J/\psi N) < 3.7\times10^{-3}$ at 90% CL.
[3] Obtained by analyzing CLEO-c data but not authored by the CLEO Collaboration.

$\Gamma(h_c\pi^\pm)/\Gamma_{total}$ Γ_2/Γ

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

$\Gamma(\eta_c\pi^+\pi^-)/\Gamma_{\text{total}}$ Γ_3/Γ

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

[1] VINOKUROVA 15 reports $B(B^+ \to K^+ Z_c(3900)^0) \times B(X \to \eta_c\pi^+\pi^-) < 4.7 \times 10^{-5}$ at 90% CL.

$\Gamma(\eta_c(1S)\rho(770)^\pm)/\Gamma(J/\psi\pi)$ Γ_4/Γ_1

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 $e^+e^- \to \pi^\mp(T_{c\overline{c}1}(3900)^\pm \to J/\psi\pi^\pm)$ cross section at 4.23 and 4.26 GeV from ABLIKIM 17J.

$\Gamma((D\overline{D}^*)^\pm)/\Gamma(J/\psi\pi)$ Γ_5/Γ_1

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

[1] Assuming the same origin of the $(D\overline{D}^*)^\pm$ and $\pi^\pm J/\psi$ decay modes.

$\Gamma(D^0D^{*-}+\text{c.c.})/\Gamma_{\text{total}}$ Γ_6/Γ

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

$\Gamma(D^-D^{*0}+\text{c.c.})/\Gamma_{\text{total}}$ Γ_7/Γ

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

$\Gamma(\omega\pi^\pm)/\Gamma_{\text{total}}$ Γ_8/Γ

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

$\Gamma(J/\psi\eta)/\Gamma_{\text{total}}$ Γ_9/Γ

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

$\Gamma(J/\psi\eta)/\Gamma(J/\psi\pi)$ Γ_9/Γ_1

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 $e^+e^- \to J/\psi\eta\pi^0$

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

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

$\Gamma(D^0\overline{D}^{*0}+\text{c.c})/\Gamma_{\text{total}}$ Γ_{11}/Γ

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

$\Gamma(D^+ D^{*-} + \text{c.c})/\Gamma(D^0 \overline{D}^{*0} + \text{c.c})$ Γ_{10}/Γ_{11}

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

ABLIKIM	20N	PR D102 012009	M. Ablikim *et al.*	(BESIII Collab.) JP
ABAZOV	19	PR D100 012005	V.M. Abazov *et al.*	(D0 Collab.)
ABLIKIM	19BC	PR D100 111102	M. Ablikim *et al.*	(BESIII Collab.)
ABAZOV	18B	PR D98 052010	V.M. Abazov *et al.*	(D0 Collab.)
ABLIKIM	17J	PRL 119 072001	M. Ablikim *et al.*	(BESIII Collab.) JP
ABLIKIM	15AB	PRL 115 222002	M. Ablikim *et al.*	(BESIII Collab.)
ABLIKIM	15AC	PR D92 092006	M. Ablikim *et al.*	(BESIII Collab.) JP
ABLIKIM	15Q	PR D92 012008	M. Ablikim *et al.*	(BESIII Collab.)
ABLIKIM	15R	PR D92 032009	M. Ablikim *et al.*	(BESIII Collab.)
ABLIKIM	15U	PRL 115 112003	M. Ablikim *et al.*	(BESIII Collab.)
ADOLPH	15D	PL B742 330	C. Adolph *et al.*	(COMPASS Collab.)
VINOKUROVA	15	JHEP 1506 132	A. Vinokurova *et al.*	(BELLE Collab.)
Also		JHEP 1702 088 (errat.)	A. Vinokurava *et al.*	(BELLE Collab.)
ABLIKIM	14A	PRL 112 022001	M. Ablikim *et al.*	(BESIII Collab.) JP
ABLIKIM	13T	PRL 110 252001	M. Ablikim *et al.*	(BESIII Collab.)
ABLIKIM	13X	PRL 111 242001	M. Ablikim *et al.*	(BESIII Collab.)
LIU	13B	PRL 110 252002	Z.Q. Liu *et al.*	(BELLE Collab.)
XIAO	13A	PL B727 366	T. Xiao *et al.*	(NWES)