$T_{c\overline{c}}(4020)$

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

was $X(4020)$

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

Charged $T_{c\overline{c}}(4020)$ seen by ABLIKIM 13X from $e^+e^- \to \pi^+\pi^- h_c(1P)$ at c.m. energy from 3.90 to 4.42 GeV as a peak in the invariant mass distribution of the $\pi^\pm h_c(1P)$ system, and by ABLIKIM 14B from $e^+e^- \to (D^*\overline{D}^*)^\pm\pi^\mp$ events in $(D^*\overline{D}^*)^\pm$ mass. A neutral $T_{c\overline{c}}(4020)$ seen by ABLIKIM 14P at three c.m. energies in the same range in $e^+e^- \to \pi^0\pi^0 h_c(1P)$ as a peak in the larger of the two masses recoiling against a π^0. ABLIKIM 15AA observes a 5.9 σ signal in $(D^*\overline{D}^*)^0$ in $e^+e^- \to (D^*\overline{D}^*)^0\ \pi^0$ events using collisions at two c.m. energies. Production rates and mass values support grouping neutral and charged $T_{c\overline{c}}(4020)$ together as manifestations of a single $I = 1$ particle.

$T_{c\overline{c}}(4020)$ MASS

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	CHG	COMMENT
4024.1±1.9 OUR AVERAGE						
$4025.5^{+2.0}_{-4.7}\pm3.1$	116	[1] ABLIKIM	15AA	BES3	0	$e^+e^- \to (D^*\overline{D}^*)^0\ \pi^0$
$4026.3\pm2.6\pm3.7$	401	[1] ABLIKIM	14B	BES3	±	$e^+e^- \to (D^*\overline{D}^*)^\pm\ \pi^\mp$
$4023.9\pm2.2\pm3.8$	61	[1,2] ABLIKIM	14P	BES3	0	$e^+e^- \to \pi^0\pi^0 h_c$
$4022.9\pm0.8\pm2.7$	253	[1] ABLIKIM	13X	BES3	±	$e^+e^- \to \pi^+\pi^- h_c$

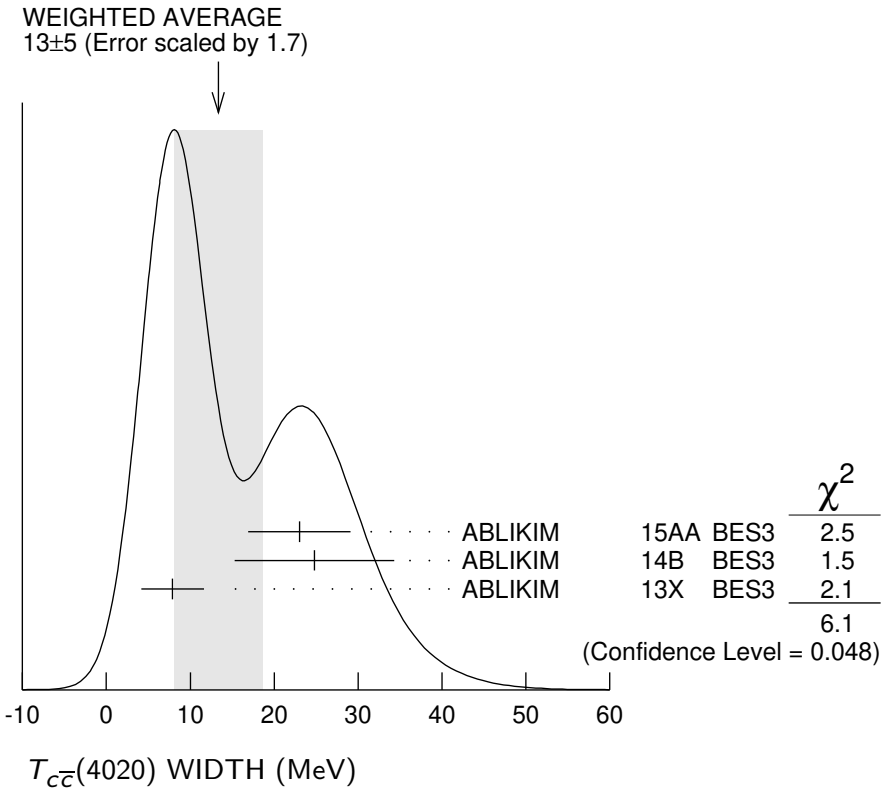
[1] Neglecting interference between the $T_{c\overline{c}}(4020)$ and non-resonant continuum.

[2] Assuming $J^P = 1^+$ and width of 7.9 ± 2.6 MeV.

$T_{c\overline{c}}(4020)$ WIDTH

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	CHG	COMMENT
13 ±5 OUR AVERAGE		Error includes scale factor of 1.7. See the ideogram below.				
$23.0\pm6.0\pm1.0$	116	[1] ABLIKIM	15AA	BES3	0	$e^+e^- \to (D^*\overline{D}^*)^0\ \pi^0$
$24.8\pm5.6\pm7.7$	401	[1] ABLIKIM	14B	BES3	±	$e^+e^- \to (D^*\overline{D}^*)^\pm\pi^\mp$
$7.9\pm2.7\pm2.6$	253	[1] ABLIKIM	13X	BES3	±	$e^+e^- \to \pi^+\pi^- h_c$

[1] Neglecting interference between the $T_{c\overline{c}}(4020)$ and non-resonant continuum.



$T_{c\overline{c}}(4020)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)
Γ_1	$h_c(1P)\pi$	seen
Γ_2	$D^*\overline{D}^*$	seen
Γ_3	$D\overline{D}^*$ + c.c.	not seen
Γ_4	$\eta_c\pi^+\pi^-$	not seen
Γ_5	$\eta_c(1S)\rho(770)^\pm$	not seen
Γ_6	$J/\psi(1S)\pi^\pm$	not seen

$T_{c\overline{c}}(4020)$ BRANCHING RATIOS

$\Gamma(h_c(1P)\pi)/\Gamma_{\text{total}}$ Γ_1/Γ

VALUE	EVTS	DOCUMENT ID		TECN	CHG	COMMENT
seen	61	ABLIKIM	14P	BES3	0	$e^+e^- \to \pi^0\pi^0 h_c$
seen	253	ABLIKIM	13X	BES3	$\pm$	$e^+e^- \to \pi^+\pi^- h_c$

$\Gamma(D^*\overline{D}^*)/\Gamma_{\text{total}}$ Γ_2/Γ

VALUE	EVTS	DOCUMENT ID		TECN	CHG	COMMENT
seen	116	[1] ABLIKIM	15AA	BES3	0	$e^+e^- \to (D^*\overline{D}^*)^0\ \pi^0$
seen	401	[1] ABLIKIM	14B	BES3	$\pm$	$e^+e^- \to (D^*\overline{D}^*)^\pm\pi^\mp$

[1] Neglecting interference between the $T_{c\overline{c}}(4020)$ and non-resonant continuum.

$\Gamma(D\overline{D}^* + \text{c.c.})/\Gamma_{\text{total}}$ Γ_3/Γ

VALUE	DOCUMENT ID		TECN	CHG	COMMENT
not seen	ABLIKIM	15AC	BES3	$\pm$	$e^+e^- \to \pi^\pm(D\overline{D}^*)^\mp$

$\Gamma(\eta_c\pi^+\pi^-)/\Gamma_{\text{total}}$ Γ_4/Γ

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

[1] VINOKUROVA 15 reports $\text{B}(B^+ \to K^+ T_{c\overline{c}}(4020)^0) \times \text{B}(T_{c\overline{c}} \to \eta_c\pi^+\pi^-) < 1.6 \times 10^{-5}$ at 90% CL.

$\Gamma(\eta_c(1S)\rho(770)^\pm)/\Gamma(h_c(1P)\pi)$ Γ_5/Γ_1

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<1.2	90	[1] ABLIKIM	19BC	BES3	$e^+e^- \to \pi^+\pi^-\pi^0\eta_c(1S)$

[1] Using $e^+e^- \to \pi^\mp(Z_c(4020)^\pm \to h_c(1P)\pi^\pm)$ cross section at 4.23, 4.26 and 4.36 GeV from ABLIKIM 13X.

$\Gamma(J/\psi(1S)\pi^\pm)/\Gamma_{\text{total}}$ Γ_6/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
not seen	[1] ABLIKIM	17J	BES3	$e^+e^- \to \pi^+\pi^- J/\psi$

[1] From Partial Wave Analysis assuming $J^P = 1^+$.

$T_{c\overline{c}}(4020)$ REFERENCES

ABLIKIM	19BC	PR D100 111102	M. Ablikim *et al.*	(BESIII Collab.)
ABLIKIM	17J	PRL 119 072001	M. Ablikim *et al.*	(BESIII Collab.)
ABLIKIM	15AA	PRL 115 182002	M. Ablikim *et al.*	(BESIII Collab.)
ABLIKIM	15AC	PR D92 092006	M. Ablikim *et al.*	(BESIII Collab.)
VINOKUROVA	15	JHEP 1506 132	A. Vinokurova *et al.*	(BELLE Collab.)
Also		JHEP 1702 088 (errat.)	A. Vinokurava *et al.*	(BELLE Collab.)
ABLIKIM	14B	PRL 112 132001	M. Ablikim *et al.*	(BESIII Collab.)
ABLIKIM	14P	PRL 113 212002	M. Ablikim *et al.*	(BESIII Collab.)
ABLIKIM	13X	PRL 111 242001	M. Ablikim *et al.*	(BESIII Collab.)