

$T_{c\bar{c}s1}(4000)$

$$I(J^P) = \frac{1}{2}(1^+)$$

OMITTED FROM SUMMARY TABLE

was $Z_{cs}(4000)$

Properties incompatible with a $q\bar{q}$ structure (exotic state). See the review on "Heavy Non- $q\bar{q}$ Mesons."

Seen by AAIJ 21E in $B^+ \rightarrow T_{c\bar{c}s1}(4000)^+ \phi$ with $T_{c\bar{c}s1}(4000)^+ \rightarrow J/\psi K^+$ using an amplitude analysis of $B^+ \rightarrow J/\psi \phi K^+$ with a significance (accounting for systematic uncertainties) of 15σ . The $J^P = 1^+$ assignment is favored with high significance. ABLIKIM 21G also reports a $J^P = 1^+ Z_{cs}$ state in this mass region using $e^+ e^- \rightarrow K^+(D_s^- D^{*0} + D_s^{*-} D^0)$ with a significance of 5.3σ . The incompatible values for the widths reported by AAIJ 21E and ABLIKIM 21G could either indicate the existence of two separate states or possibly be explained in a coupled channel model (see ORTEGA 21).

 $T_{c\bar{c}s1}(4000)$ MASS

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
3980–4010 OUR EVALUATION				
3988 ± 5 OUR AVERAGE Error includes scale factor of 2.7.				
3991 $^{+12}_{-10}$ $^{+9}_{-17}$		¹ AAIJ	23AQ LHCb	$B^0 \rightarrow J/\psi \phi K_S^0$
3992.2 ± 1.7 ± 1.6		² ABLIKIM	22AE BES3	$e^+ e^- \rightarrow K_S^0 (D_s^- D^{*+} + D_s^{*-} D^+)$
4003 ± 6 $^{+4}_{-14}$	24k	³ AAIJ	21E LHCb	$B^+ \rightarrow J/\psi \phi K^+$
3982.5 $^{+1.8}_{-2.6}$ ± 2.1		⁴ ABLIKIM	21G BES3	$e^+ e^- \rightarrow K^+ (D_s^- D^{*0} + D_s^{*-} D^0)$

¹ From an amplitude analysis of the decay $B^0 \rightarrow J/\psi \phi K_S^0$ with a significance of 4.0σ . The mass difference with respect to the charged partner in AAIJ 21E is $-12^{+11}_{-10} +6_{-4}$ MeV.

² Pole mass for a mass-, width-dependent Breit-Wigner fit to the mass spectrum recoiling against K_S^0 at center of mass energies between 4.628 and 4.699 GeV, with a significance of 4.6σ .

³ From an amplitude analysis of the decay $B^+ \rightarrow J/\psi \phi K^+$ with a significance of 15σ .

⁴ Pole mass for a mass-dependent Breit-Wigner fit to the mass spectrum recoiling against K^+ at center of mass energies between 4.628 and 4.698 GeV, with a significance of 5.3σ .

 $T_{c\bar{c}s1}(4000)$ WIDTH

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
5–150 OUR EVALUATION				
14 ± 4 OUR AVERAGE Error includes scale factor of 1.1.				
105 $^{+29}_{-25}$ $^{+17}_{-23}$		¹ AAIJ	23AQ LHCb	$B^0 \rightarrow J/\psi \phi K_S^0$

$7.7^{+4.1}_{-3.8} \pm 4.3$	² ABLIKIM	22AE BES3	$e^+ e^- \rightarrow K_S^0 (D_s^- D^{*+} + D_s^{*-} D^+)$
131 ± 15 ± 26 24k	³ AAIJ	21E LHCb	$B^+ \rightarrow J/\psi \phi K^+$
$12.8^{+5.3}_{-4.4} \pm 3.0$	⁴ ABLIKIM	21G BES3	$e^+ e^- \rightarrow K^+ (D_s^- D^{*0} + D_s^{*-} D^0)$

¹ From an amplitude analysis of the decay $B^0 \rightarrow J/\psi \phi K_S^0$ with a significance of 4.0σ .

² Pole width for a mass-, width-dependent Breit-Wigner fit to the mass spectrum recoiling against K_S^0 at center of mass energies between 4.628 and 4.699 GeV, with a significance of 4.6σ .

³ From an amplitude analysis of the decay $B^+ \rightarrow J/\psi \phi K^+$ with a significance of 15σ .

⁴ Pole width for a mass-dependent Breit-Wigner fit to the mass spectrum recoiling against K^+ at center of mass energies between 4.628 and 4.698 GeV, with a significance of 5.3σ .

Mode	Fraction (Γ_i/Γ)
Γ_1 $J/\psi K^+$	seen
Γ_2 $J/\psi K_S^0$	seen
Γ_3 $D_s^+ \bar{D}^{*0}$ or $D_s^{*+} \bar{D}^0$	seen
Γ_4 $D_s^+ D^{*-}$ or $D_s^{*+} D^-$	seen

$T_{c\bar{c}s1}(4000)$ DECAY MODES

$\Gamma(J/\psi K^+)/\Gamma_{\text{total}}$ Γ_1/Γ

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
seen	24k	¹ AAIJ	21E LHCb	$B^+ \rightarrow J/\psi \phi K^+$

¹ From an amplitude analysis of the decay $B^+ \rightarrow J/\psi \phi K^+$ with a significance of 15σ .

$\Gamma(J/\psi K_S^0)/\Gamma_{\text{total}}$ Γ_2/Γ

VALUE	DOCUMENT ID	TECN	COMMENT
seen	¹ AAIJ	23AQ LHCb	$B^0 \rightarrow J/\psi \phi K_S^0$

¹ From an amplitude analysis of the decay $B^0 \rightarrow J/\psi \phi K_S^0$ with a significance of 4.0σ .

$\Gamma(D_s^+ \bar{D}^{*0} \text{ or } D_s^{*+} \bar{D}^0)/\Gamma_{\text{total}}$ Γ_3/Γ

VALUE	DOCUMENT ID	TECN	COMMENT
seen	¹ ABLIKIM	21G BES3	$e^+ e^- \rightarrow K^+ (D_s^- D^{*0} + D_s^{*-} D^0)$

¹ Seen in the spectrum recoiling against K^+ in $e^+ e^- \rightarrow K^+ (D_s^- D^{*0} + D_s^{*-} D^0)$ collisions at center of mass energies between 4.628 and 4.698 GeV, with a significance of 5.3σ .

$\Gamma(J/\psi K^+)/\Gamma(D_s^+ \bar{D}^{*0} \text{ or } D_s^{*+} \bar{D}^0)$ Γ_1/Γ_3

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
<0.03	90	ABLIKIM	23BI BES3	$e^+ e^- \rightarrow K^+ K^- J/\psi$

$\Gamma(D_s^+ D^{*-} \text{ or } D_s^{*+} D^-) / \Gamma_{\text{total}}$				Γ_4 / Γ
VALUE	DOCUMENT ID	TECN	COMMENT	
seen	¹ ABLIKIM	22AE BES3	$e^+ e^- \rightarrow K_S^0 (D_s^- D^{*+} + D_s^{*-} D^+)$	

¹ Seen in the mass spectrum recoiling against K_S^0 at center of mass energies between 4.628 and 4.699 GeV, with a significance of 4.6 σ .

$T_{c\bar{c}s1}(4000)$ REFERENCES

AAIJ	23AQ PRL 131 131901	R. Aaij <i>et al.</i>	(LHCb Collab.)
ABLIKIM	23BI PRL 131 211902	M. Ablikim <i>et al.</i>	(BESIII Collab.)
ABLIKIM	22AE PRL 129 112003	M. Ablikim <i>et al.</i>	(BESIII Collab.)
AAIJ	21E PRL 127 082001	R. Aaij <i>et al.</i>	(LHCb Collab.) JP
ABLIKIM	21G PRL 126 102001	M. Ablikim <i>et al.</i>	(BESIII Collab.)
ORTEGA	21 PL B818 136382	P.G. Ortega, D.R. Entem, F. Fernandez	