

$\chi_{c1}(4140)$

$$I^G(J^{PC}) = 0^+(1^{++})$$

was $X(4140)$

This state shows properties different from a conventional $q\bar{q}$ state. A candidate for an exotic structure. See the review on non- $q\bar{q}$ states.

Seen by AALTONEN 09AH, ABAZOV 14A, CHATRCHYAN 14M, AAIJ 17C in $B^+ \rightarrow \chi_{c1} K^+$, $\chi_{c1} \rightarrow J/\psi\phi$, and by ABAZOV 15M separately in both prompt (4.7σ) and non-prompt (5.6σ) production in $p\bar{p} \rightarrow J/\psi\phi + \text{anything}$. Not seen by SHEN 10 in $\gamma\gamma \rightarrow J/\psi\phi$ and ABLIKIM 15 in $e^+e^- \rightarrow \gamma J/\psi\phi$ at $\sqrt{s} = 4.23, 4.26, 4.36$ GeV.

 $\chi_{c1}(4140)$ MASS

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
4146.8 ± 2.4 OUR AVERAGE		Error includes scale factor of 1.1.		
4146.5 ± 4.5 ^{+4.6} _{-2.8}	4289	¹ AAIJ 17C	LHCB	$B^+ \rightarrow J/\psi\phi K^+$
4143.4 ^{+2.9} _{-3.0} ± 0.6	19	² AALTONEN 17	CDF	$B^+ \rightarrow J/\psi\phi K^+$
4152.5 ± 1.7 ^{+6.2} _{-5.4}	616	³ ABAZOV 15M	D0	$p\bar{p} \rightarrow J/\psi\phi + \text{anything}$
4159.0 ± 4.3 ± 6.6	52	⁴ ABAZOV 14A	D0	$B^+ \rightarrow J/\psi\phi K^+$
4148.0 ± 2.4 ± 6.3	0.3k	⁵ CHATRCHYAN 14M	CMS	$B^+ \rightarrow J/\psi\phi K^+$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
4143.0 ± 2.9 ± 1.2	14	^{6,7} AALTONEN 09AH	CDF	$B^+ \rightarrow J/\psi\phi K^+$

¹ From an amplitude analysis of the decay $B^+ \rightarrow J/\psi\phi K^+$ with a significance of 8.4σ .

² Statistical significance of more than 5σ .

³ Statistical significance of more than 6σ .

⁴ Statistical significance of 3.1σ .

⁵ From a fit assuming an S-wave relativistic Breit-Wigner shape above a three-body phase-space non-resonant component with statistical significance of more than 5σ .

⁶ Statistical significance of 3.8σ .

⁷ Superseded by AALTONEN 17.

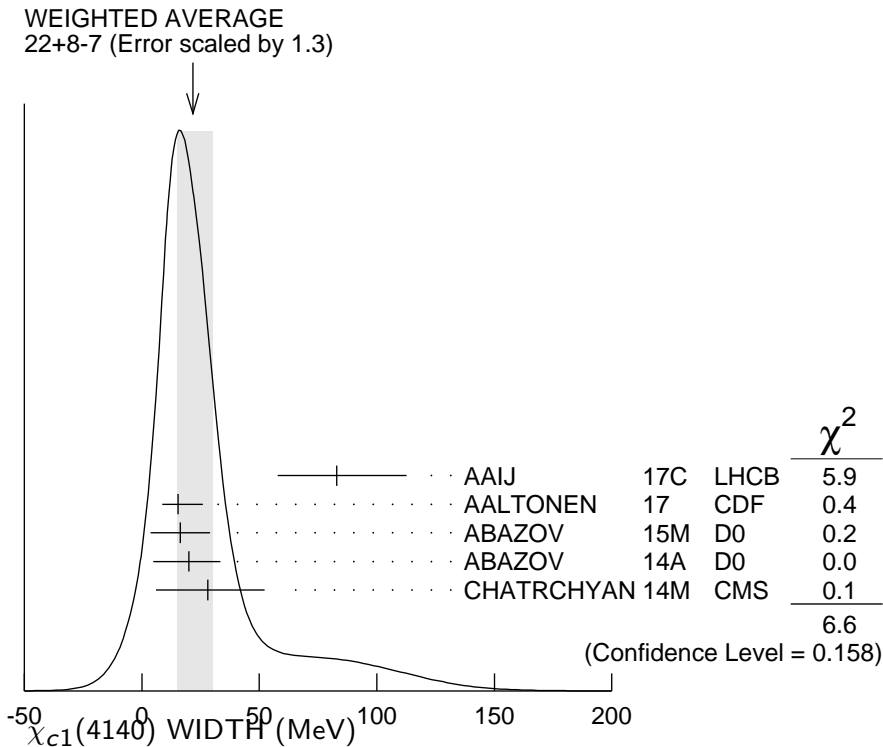
 $\chi_{c1}(4140)$ WIDTH

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
22⁺⁸₋₇ OUR AVERAGE		Error includes scale factor of 1.3. See the ideogram below.		
83 ± 21 ⁺²¹ ₋₁₄	4289	¹ AAIJ 17C	LHCB	$B^+ \rightarrow J/\psi\phi K^+$
15.3 ^{+10.4} _{-6.1} ± 2.5	19	² AALTONEN 17	CDF	$B^+ \rightarrow J/\psi\phi K^+$
16.3 ± 5.6 ± 11.4	616	³ ABAZOV 15M	D0	$p\bar{p} \rightarrow J/\psi\phi + \text{anything}$
20 ± 13 ⁺³ ₋₈	52	⁴ ABAZOV 14A	D0	$B^+ \rightarrow J/\psi\phi K^+$
28 ⁺¹⁵ ₋₁₁ ± 19	0.3k	⁵ CHATRCHYAN 14M	CMS	$B^+ \rightarrow J/\psi\phi K^+$

• • • We do not use the following data for averages, fits, limits, etc. • • •

11.7⁺₋ 8.3[±] 3.7 14 6,7 AALTONEN 09AH CDF $B^+ \rightarrow J/\psi \phi K^+$

- ¹ From an amplitude analysis of the decay $B^+ \rightarrow J/\psi \phi K^+$ with a significance of 8.4σ .
- ² Statistical significance of more than 5σ .
- ³ Statistical significance of more than 6σ .
- ⁴ Statistical significance of 3.1σ .
- ⁵ From a fit assuming an S-wave relativistic Breit-Wigner shape above a three-body phase-space non-resonant component with statistical significance of more than 5σ .
- ⁶ Statistical significance of 3.8σ .
- ⁷ Superseded by AALTONEN 17.



$\chi_{c1}(4140)$ DECAY MODES

Mode	Fraction (Γ_i/Γ)
Γ_1 $J/\psi \phi$	seen
Γ_2 $\gamma\gamma$	not seen

$\chi_{c1}(4140)$ $\Gamma(i)\Gamma(\gamma\gamma)/\Gamma(\text{total})$

$\Gamma(\gamma\gamma) \times \Gamma(J/\psi \phi)/\Gamma_{\text{total}}$					Γ_2/Γ_1
VALUE (eV)	CL%	DOCUMENT ID	TECN	COMMENT	
<41	90	¹ SHEN	10	BELL 10.6 $e^+e^- \rightarrow e^+e^- J/\psi \phi$	

• • • We do not use the following data for averages, fits, limits, etc. • • •

< 6 90 ² SHEN 10 BELL 10.6 $e^+e^- \rightarrow e^+e^- J/\psi \phi$

- ¹ For $J^P = 0^+$.
- ² For $J^P = 2^+$.

$\chi_{c1}(4140)$ BRANCHING RATIOS

$\Gamma(J/\psi\phi)/\Gamma_{\text{total}}$					Γ_1/Γ
VALUE	EVTS	DOCUMENT ID	TECN	COMMENT	
seen	4289	¹ AAIJ	17C LHCb	$B^+ \rightarrow J/\psi\phi K^+$	
seen	616	² ABAZOV	15M D0	$p\bar{p} \rightarrow J/\psi\phi + \text{anything}$	
seen	52	³ ABAZOV	14A D0	$B^+ \rightarrow J/\psi\phi K^+$	
seen	0.3k	⁴ CHATRCHYAN	14M CMS	$B^+ \rightarrow J/\psi\phi K^+$	
seen	14	⁵ AALTONEN	09AH CDF	$B^+ \rightarrow J/\psi\phi K^+$	
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●					
not seen		⁶ ABLIKIM	15 BES3	$e^+e^- \rightarrow \gamma\phi J/\psi$	
not seen		⁷ AAIJ	12AA LHCb	$pp \rightarrow B^+ X$ at 7 TeV	

¹ From an amplitude analysis of the decay $B^+ \rightarrow J/\psi\phi K^+$ with a significance of 8.4σ .

² Statistical significance of more than 6σ .

³ ABAZOV 14A reports $B(B^+ \rightarrow \chi_{c1}(4140)K^+ \rightarrow J/\psi\phi K^+)/B(B^+ \rightarrow J/\psi\phi K^+) = (19 \pm 7 \pm 4)\%$ with 3.1σ significance.

⁴ From a fit assuming an *S*-wave relativistic Breit-Wigner shape above a three-body phase-space non-resonant component with statistical significance of more than 5σ .

⁵ Statistical significance of 3.8σ .

⁶ Reported $\sigma(e^+e^- \rightarrow \gamma\chi_{c1}(4140)) \cdot B(\chi_{c1}(4140) \rightarrow J/\psi\phi) < 0.35, 0.28,$ and 0.33 pb at 4.23, 4.26, and 4.36 GeV, respectively, at 90% CL.

⁷ Reported $B(B^+ \rightarrow \chi_{c1}(4140)K^+) \cdot B(\chi_{c1}(4140) \rightarrow J/\psi\phi)/B(B^+ \rightarrow J/\psi\phi K^+) < 0.07$ at 90% CL.

$\Gamma(\gamma\gamma)/\Gamma_{\text{total}}$				Γ_2/Γ
VALUE	DOCUMENT ID	TECN	COMMENT	
not seen	SHEN	10	BELL	$10.6 e^+e^- \rightarrow e^+e^- J/\psi\phi$

$\chi_{c1}(4140)$ REFERENCES

AAIJ	17C	PRL 118 022003	R. Aaij <i>et al.</i>	(LHCb Collab.) JP
Also		PR D95 012002	R. Aaij <i>et al.</i>	(LHCb Collab.)
AALTONEN	17	MPL A32 1750139	T. Altonen <i>et al.</i>	(CDF Collab.)
ABAZOV	15M	PRL 115 232001	V.M. Abazov <i>et al.</i>	(D0 Collab.)
ABLIKIM	15	PR D91 032002	M. Ablikim <i>et al.</i>	(BES III Collab.)
ABAZOV	14A	PR D89 012004	V.M. Abazov <i>et al.</i>	(D0 Collab.)
CHATRCHYAN	14M	PL B734 261	S. Chatrchyan <i>et al.</i>	(CMS Collab.)
AAIJ	12AA	PR D85 091103	R. Aaij <i>et al.</i>	(LHCb Collab.)
SHEN	10	PRL 104 112004	C.P. Shen <i>et al.</i>	(BELLE Collab.)
AALTONEN	09AH	PRL 102 242002	T. Aaltonen <i>et al.</i>	(CDF Collab.)