$h_c(1P)$

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

Quantum numbers are quark model prediction, $C = -$ established by $\eta_c \gamma$ decay.

$h_c(1P)$ MASS

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
3525.42±0.29 OUR AVERAGE	Error includes scale factor of 1.7.				
3525.20±0.18±0.12	1282	[1] DOBBS	08A	CLEO	$\psi(2S) \to \pi^0 \eta_c \gamma$
3525.8 ±0.2 ±0.2	13	ANDREOTTI	05B	E835	$\overline{p}p \to \eta_c \gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
3525.6 ±0.5	92^{+23}_{-22}	ADAMS	09	CLEO	$\psi(2S) \to 2(\pi^+ \pi^- \pi^0)$
3524.4 ±0.6 ±0.4	168 ± 40	[2] ROSNER	05	CLEO	$\psi(2S) \to \pi^0 \eta_c \gamma$
3527 ±8	42	ANTONIAZZI	94	E705	300 $\pi^\pm$, pLi $\to$ $J/\psi \pi^0 X$
3526.28±0.18±0.19	59	[3] ARMSTRONG	92D	E760	$\overline{p}p \to J/\psi \pi^0$
3525.4 ±0.8 ±0.4	5	BAGLIN	86	SPEC	$\overline{p}p \to J/\psi X$

[1] Combination of exclusive and inclusive analyses for the reaction $\psi(2S) \to \pi^0 h_c \to \pi^0 \eta_c \gamma$. This result is the average of DOBBS 08A and ROSNER 05.
[2] Superseded by DOBBS 08A.
[3] Mass central value and systematic error recalculated by us according to Eq. (16) in ARMSTRONG 93B, using the value for the $\psi(2S)$ mass from AULCHENKO 03.

$h_c(1P)$ WIDTH

VALUE (MeV)	*CL%*	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
<1		13	ANDREOTTI	05B	E835	$\overline{p}p \to \eta_c \gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<1.1	90	59	ARMSTRONG	92D	E760	$\overline{p}p \to J/\psi \pi^0$

$h_c(1P)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)
Γ_1	$J/\psi(1S)\pi^0$	
Γ_2	$J/\psi(1S)\pi\pi$	not seen
Γ_3	$p\overline{p}$	
Γ_4	$\eta_c \gamma$	seen
Γ_5	$\pi^+ \pi^- \pi^0$	not seen
Γ_6	$2\pi^+ 2\pi^- \pi^0$	seen
Γ_7	$3\pi^+ 3\pi^- \pi^0$	not seen

$h_c(1P)$ PARTIAL WIDTHS

$h_c(1P)$ $\Gamma(i)\Gamma(\overline{p}p)/\Gamma(\text{total})$

$\Gamma(\eta_c\gamma) \times \Gamma(p\overline{p})/\Gamma_{\text{total}}$ $\Gamma_4\Gamma_3/\Gamma$

VALUE (eV)	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
12.0 ± 4.5	13	[4] ANDREOTTI	05B	E835	$\overline{p}p \to \eta_c\gamma$

[4] Assuming $\Gamma = 1$ MeV.

$h_c(1P)$ BRANCHING RATIOS

$\Gamma(J/\psi(1S)\pi\pi)/\Gamma(J/\psi(1S)\pi^0)$ Γ_2/Γ_1

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.18	90	ARMSTRONG	92D	E760	$\overline{p}p \to J/\psi\pi^0$

$\Gamma(\eta_c\gamma)/\Gamma_{\text{total}}$ Γ_4/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
seen	1282	[5] DOBBS	08A	CLEO	$\psi(2S) \to \pi^0\eta_c\gamma$
seen	168 ± 40	[6] ROSNER	05	CLEO	$\psi(2S) \to \pi^0\eta_c\gamma$

[5] DOBBS 08A measures the product $B(\psi(2S) \to \pi^0 h_c) \times B(h_c \to \eta_c\gamma)$ to be $(4.19 \pm 0.32 \pm 0.45) \times 10^{-4}$ from the combination of exclusive and inclusive analyses.

[6] ROSNER 05 measures the product $B(\psi(2S) \to \pi^0 h_c) \times B(h_c \to \eta_c\gamma)$ to be $(4.0 \pm 0.8 \pm 0.7) \times 10^{-4}$.

$\Gamma(\pi^+\pi^-\pi^0)/\Gamma_{\text{total}}$ Γ_5/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
not seen	[7] ADAMS	09	CLEO	$\psi(2S) \to \pi^+\pi^-2\pi^0$

[7] ADAMS 09 measures the branching fractions product $B(h_c(1P) \to \pi^+\pi^-\pi^0) \times B(\psi(2S) \to \pi^0 h_c(1P)) < 0.19 \times 10^{-5}$.

$\Gamma(2\pi^+2\pi^-\pi^0)/\Gamma_{\text{total}}$ Γ_6/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
seen	92^{+23}_{-22}	[8] ADAMS	09	CLEO	$\psi(2S) \to 2\pi^+2\pi^-2\pi^0$

[8] ADAMS 09 measures the branching fractions product $B(h_c(1P) \to 2\pi^+2\pi^-\pi^0) \times B(\psi(2S) \to \pi^0 h_c(1P)) = (1.88^{+0.48}_{-0.45}{}^{+0.47}_{-0.30}) \times 10^{-5}$.

$\Gamma(3\pi^+3\pi^-\pi^0)/\Gamma_{\text{total}}$ Γ_7/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
not seen	[9] ADAMS	09	CLEO	$\psi(2S) \to 3\pi^+3\pi^-2\pi^0$

[9] ADAMS 09 measures the branching fractions product $B(h_c(1P) \to 3\pi^+3\pi^-\pi^0) \times B(\psi(2S) \to \pi^0 h_c(1P)) < 2.5 \times 10^{-5}$.

$h_c(1P)$ REFERENCES

ADAMS	09	PR D80 051106	G.S. Adams *et al.*	(CLEO Collab.)
DOBBS	08A	PRL 101 182003	S. Dobbs *et al.*	(CLEO Collab.)
ANDREOTTI	05B	PR D72 032001	M. Andreotti *et al.*	(FNAL E835 Collab.)
ROSNER	05	PRL 95 102003	J.L. Rosner *et al.*	(CLEO Collab.)
AULCHENKO	03	PL B573 63	V.M. Aulchenko *et al.*	(KEDR Collab.)
ANTONIAZZI	94	PR D50 4258	L. Antoniazzi *et al.*	(E705 Collab.)
ARMSTRONG	93B	PR D47 772	T.A. Armstrong *et al.*	(FNAL E760 Collab.)
ARMSTRONG	92D	PRL 69 2337	T.A. Armstrong *et al.*	(FNAL, FERR, GENO+)
BAGLIN	86	PL B171 135	C. Baglin *et al.*	(LAPP, CERN, TORI, STRB+)