$h_c(1P)$

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

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

$h_c(1P)$ MASS

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
3525.37±0.14 OUR AVERAGE		Error includes scale factor of 1.2.			
3525.32±0.06±0.15	23k	ABLIKIM	22AQ	BES3	$\psi(2S) \to \pi^0$ hadrons; $\pi^0 \gamma(\eta_c)$
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. • • •					
3525.31±0.11±0.14	832	[2,3] ABLIKIM	12N	BES3	$\psi(2S) \to \pi^0 \gamma$ hadrons
3525.40±0.13±0.18	3679	[2] ABLIKIM	10B	BES3	$\psi(2S) \to \pi^0 \gamma \eta_c$
3525.6 ±0.5	92	ADAMS	09	CLEO	$\psi(2S) \to 2(\pi^+ \pi^- \pi^0)$
3524.4 ±0.6 ±0.4	168	[4] 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	[5] 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[2] Superseded by ABLIKIM 22AQ

[3] With floating width.

[4] Superseded by DOBBS 08A.

[5] 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
$0.78^{+0.27}_{-0.24}$±0.12		23k	ABLIKIM	22AQ	BES3	$\psi(2S) \to \pi^0$ hadrons; $\pi^0 \gamma(\eta_c)$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
0.70±0.28±0.22		832	[1,2] ABLIKIM	12N	BES3	$\psi(2S) \to \pi^0 \gamma$ hadrons
$<$ 1.44	90	3679	[3] ABLIKIM	10B	BES3	$\psi(2S) \to \pi^0 \gamma \eta_c$
$<$ 1		13	ANDREOTTI	05B	E835	$\overline{p}p \to \eta_c \gamma$
$<$ 1.1	90	59	ARMSTRONG	92D	E760	$\overline{p}p \to J/\psi \pi^0$

[1] Superseded by ABLIKIM 22AQ

[2] With floating mass.

[3] The central value is $\Gamma = 0.73 \pm 0.45 \pm 0.28$ MeV.

$h_c(1P)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)	Confidence level
Γ_1	$J/\psi(1S)\pi^0$	$< 5 \times 10^{-4}$	90%
Γ_2	$J/\psi(1S)\pi\pi$	$< 9 \times 10^{-5}$	90%
Γ_3	$J/\psi(1S)\pi^+\pi^-$	$< 9 \times 10^{-4}$	90%
Γ_4	$p\overline{p}$	$< 4 \times 10^{-5}$	90%
Γ_5	$p\overline{p}\pi^0$	$< 8 \times 10^{-4}$	90%
Γ_6	$p\overline{p}\pi^+\pi^-$	$(3.3 \pm 0.6) \times 10^{-3}$	
Γ_7	$p\overline{p}\pi^0\pi^0$	$< 6 \times 10^{-4}$	90%
Γ_8	$p\overline{p}\pi^+\pi^-\pi^0$	$(4.4 \pm 1.3) \times 10^{-3}$	
Γ_9	$p\overline{p}\eta$	$(7.4 \pm 2.2) \times 10^{-4}$	
Γ_{10}	$\pi^+\pi^-\pi^0$	$(1.57 \pm 0.13) \times 10^{-3}$	
Γ_{11}	$\pi^+\pi^-\eta$	$< 5 \times 10^{-4}$	90%
Γ_{12}	$\pi^+\pi^-\pi^0\eta$	$(8.3 \pm 2.4) \times 10^{-3}$	
Γ_{13}	$2\pi^+2\pi^-\pi^0\eta$	$(7.2 \pm 1.7) \times 10^{-3}$	
Γ_{14}	$2\pi^+2\pi^-\pi^0$	$(9.4 \pm 1.7) \times 10^{-3}$	
Γ_{15}	$2\pi^+2\pi^-\eta$	$< 6 \times 10^{-4}$	90%
Γ_{16}	$3\pi^+3\pi^-\pi^0$	$(9.1 \pm 1.5) \times 10^{-3}$	
Γ_{17}	$2\pi^+2\pi^-\omega$	$(3.9 \pm 1.0) \times 10^{-3}$	
Γ_{18}	$K^+K^-\pi^+\pi^-$	$< 7 \times 10^{-4}$	90%
Γ_{19}	$K^+K^-\pi^+\pi^-\pi^0$	$(3.8 \pm 0.8) \times 10^{-3}$	
Γ_{20}	$K^+K^-\pi^+\pi^-\eta$	$< 2.7 \times 10^{-3}$	90%
Γ_{21}	$K^+K^-\pi^0$	$(3.8 \pm 0.9) \times 10^{-4}$	
Γ_{22}	$K^+K^-\pi^0\eta$	$< 2.4 \times 10^{-3}$	90%
Γ_{23}	$K^+K^-\eta$	$(3.6 \pm 1.2) \times 10^{-4}$	
Γ_{24}	$2K^+2K^-\pi^0$	$< 2.8 \times 10^{-4}$	90%
Γ_{25}	$K^0_S K^\pm\pi^\mp$	$(7.1 \pm 1.9) \times 10^{-4}$	
Γ_{26}	$K^0_S K^\pm\pi^\mp\pi^+\pi^-$	$(3.2 \pm 1.0) \times 10^{-3}$	
	Radiative decays		
Γ_{27}	$\gamma\eta$	$(3.8 \pm 0.6) \times 10^{-4}$	
Γ_{28}	$\gamma\eta'(958)$	$(1.41 \pm 0.15) \times 10^{-3}$	
Γ_{29}	$\gamma\pi^0$	$< 5 \times 10^{-5}$	
Γ_{30}	$\gamma\eta_c(1S)$	(60 ± 4) %	
Γ_{31}	$e^+e^-\eta_c(1S)$	$(3.5 \pm 0.7) \times 10^{-3}$	

FIT INFORMATION

A multiparticle fit to $\eta_c(1S)$, $J/\psi(1S)$, $\psi(2S)$, $h_c(1P)$, and $B^\pm$ with the total width, 10 combinations of partial widths obtained from integrated cross section, and 38 branching ratios uses 113 measurements to determine 19 parameters. The overall fit has a $\chi^2 = 184.6$ for 94 degrees of freedom.

$h_c(1P)$ PARTIAL WIDTHS

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

$\Gamma(\gamma\eta_c(1S)) \times \Gamma(p\overline{p})/\Gamma_{total}$ — $\Gamma_{30}\Gamma_4/\Gamma$

VALUE (eV)	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
12.0 ± 4.5	13	[1] ANDREOTTI	05B	E835	$\overline{p}p \to \eta_c \gamma$

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

$h_c(1P)$ BRANCHING RATIOS

$\Gamma(J/\psi(1S)\pi^0)/\Gamma(\gamma\eta_c(1S))$ — Γ_1/Γ_{30}

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$<9 \times 10^{-4}$	90	[1] ABLIKIM	22N	BES3	$e^+e^- \to \pi^+\pi^- h_c$

[1] ABLIKIM 22N reports $[\Gamma(h_c(1P) \to J/\psi(1S)\pi^0)/\Gamma(h_c(1P) \to \gamma\eta_c(1S))]$ / $[B(\eta_c \to K^+K^-\pi^0)] < 7.5 \times 10^{-2}$ which we multiply by our best value $B(\eta_c \to K^+K^-\pi^0) = 1/6\ B(\eta_c(1S) \to K\overline{K}\pi) = 1/6\ (7.1 \times 10^{-2})$.

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

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

$\Gamma(J/\psi(1S)\pi^+\pi^-)/\Gamma_{total}$ — Γ_3/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$<9 \times 10^{-4}$	90	[1] ABLIKIM	24BY	BES3	$\psi(2S) \to \pi^0\pi^+\pi^- J/\psi$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$<2.7 \times 10^{-3}$	90	[2] ABLIKIM	18M	BES3	$\psi(2S) \to \pi^0\pi^+\pi^- J/\psi$

[1] ABLIKIM 24BY reports $[\Gamma(h_c(1P) \to J/\psi(1S)\pi^+\pi^-)/\Gamma_{total}] \times [B(\psi(2S) \to h_c(1P)\pi^0)] < 6.7 \times 10^{-7}$ which we divide by our best value $B(\psi(2S) \to h_c(1P)\pi^0) = 7.4 \times 10^{-4}$.

[2] ABLIKIM 18M reports $[\Gamma(h_c(1P) \to J/\psi(1S)\pi^+\pi^-)/\Gamma_{total}] \times [B(\psi(2S) \to h_c(1P)\pi^0)] < 2.0 \times 10^{-6}$ which we divide by our best value $B(\psi(2S) \to h_c(1P)\pi^0) = 7.4 \times 10^{-4}$.

$\Gamma(p\overline{p})/\Gamma_{total}$ — Γ_4/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$<4 \times 10^{-5}$	90	[1] ABLIKIM	24R	BES3	$\psi(2S) \to \pi^0 h_c(1P)$

[1] ABLIKIM 24R reports $[\Gamma(h_c(1P) \to p\overline{p})/\Gamma_{total}] \times [B(\psi(2S) \to h_c(1P)\pi^0)] < 3.22 \times 10^{-8}$ which we divide by our best value $B(\psi(2S) \to h_c(1P)\pi^0) = 7.4 \times 10^{-4}$.

$\Gamma(p\overline{p}\pi^0)/\Gamma_{total}$ — Γ_5/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$<8 \times 10^{-4}$	90	[1] ABLIKIM	22M	BES3	$\psi(2S) \to \pi^0 h_c(1P)$

[1] ABLIKIM 22M reports $[\Gamma(h_c(1P) \to p\overline{p}\pi^0)/\Gamma_{total}] \times [B(\psi(2S) \to h_c(1P)\pi^0)] < 5.67 \times 10^{-7}$ which we divide by our best value $B(\psi(2S) \to h_c(1P)\pi^0) = 7.4 \times 10^{-4}$.

$\Gamma(p\overline{p}\pi^+\pi^-)/\Gamma_{total}$ Γ_6/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
3.3±0.5±0.2	230	[1] ABLIKIM	19AG	BES3	$\psi(2S) \to \pi^0 h_c(1P)$

[1] ABLIKIM 19AG reports $[\Gamma(h_c(1P) \to p\overline{p}\pi^+\pi^-)/\Gamma_{total}] \times [B(\psi(2S) \to h_c(1P)\pi^0)] = (2.49 \pm 0.27 \pm 0.28) \times 10^{-6}$ which we divide by our best value $B(\psi(2S) \to h_c(1P)\pi^0) = (7.4 \pm 0.5) \times 10^{-4}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

$\Gamma(p\overline{p}\pi^0\pi^0)/\Gamma_{total}$ Γ_7/Γ

VALUE	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
<6 × 10^{-4}	90	12	[1] ABLIKIM	20AH	BES3	$\psi(2S) \to \pi^0 h_c(1P)$

[1] ABLIKIM 20AH reports $[\Gamma(h_c(1P) \to p\overline{p}\pi^0\pi^0)/\Gamma_{total}] \times [B(\psi(2S) \to h_c(1P)\pi^0)] < 4.4 \times 10^{-7}$ which we divide by our best value $B(\psi(2S) \to h_c(1P)\pi^0) = 7.4 \times 10^{-4}$.

$\Gamma(p\overline{p}\pi^+\pi^-\pi^0)/\Gamma_{total}$ Γ_8/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
4.4±1.2±0.3	86	[1] ABLIKIM	22M	BES3	$\psi(2S) \to \pi^0 h_c(1P)$

[1] ABLIKIM 22M reports $[\Gamma(h_c(1P) \to p\overline{p}\pi^+\pi^-\pi^0)/\Gamma_{total}] \times [B(\psi(2S) \to h_c(1P)\pi^0)] = (3.30 \pm 0.71 \pm 0.59) \times 10^{-6}$ which we divide by our best value $B(\psi(2S) \to h_c(1P)\pi^0) = (7.4 \pm 0.5) \times 10^{-4}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

$\Gamma(p\overline{p}\eta)/\Gamma_{total}$ Γ_9/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
7.4±2.1±0.5	20	[1] ABLIKIM	22M	BES3	$\psi(2S) \to \pi^0 h_c(1P)$

[1] ABLIKIM 22M reports $[\Gamma(h_c(1P) \to p\overline{p}\eta)/\Gamma_{total}] \times [B(\psi(2S) \to h_c(1P)\pi^0)] = (5.51 \pm 1.50 \pm 0.46) \times 10^{-7}$ which we divide by our best value $B(\psi(2S) \to h_c(1P)\pi^0) = (7.4 \pm 0.5) \times 10^{-4}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

$\Gamma(\pi^+\pi^-\pi^0)/\Gamma_{total}$ Γ_{10}/Γ

VALUE (units 10^{-3})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
1.57±0.06±0.11		472	[1] ABLIKIM	24BF	BES3	$\psi(2S) \to \pi^0 h_c(1P)$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
1.9 ±0.5 ±0.1		101	[2,3] ABLIKIM	19AG	BES3	$\psi(2S) \to \pi^0 h_c(1P)$
<2.6	90		[4] ADAMS	09	CLEO	$\psi(2S) \to \pi^0 \gamma \eta_c$

[1] ABLIKIM 24BF reports $(1.36 \pm 0.16 \pm 0.14) \times 10^{-3}$ from a measurement of $[\Gamma(h_c(1P) \to \pi^+\pi^-\pi^0)/\Gamma_{total}] \times [B(\psi(2S) \to h_c(1P)\pi^0)]$ assuming $B(\psi(2S) \to h_c(1P)\pi^0) = (8.6 \pm 1.3) \times 10^{-4}$, which we rescale to our best value $B(\psi(2S) \to h_c(1P)\pi^0) = (7.4 \pm 0.5) \times 10^{-4}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[2] ABLIKIM 19AG reports $[\Gamma(h_c(1P) \to \pi^+\pi^-\pi^0)/\Gamma_{total}] \times [B(\psi(2S) \to h_c(1P)\pi^0)] = (1.38 \pm 0.35 \pm 0.17) \times 10^{-6}$ which we divide by our best value $B(\psi(2S) \to h_c(1P)\pi^0) = (7.4 \pm 0.5) \times 10^{-4}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[3] Superseded by ABLIKIM 24BF.

[4] ADAMS 09 reports $[\Gamma(h_c(1P) \to \pi^+\pi^-\pi^0)/\Gamma_{total}] \times [B(\psi(2S) \to h_c(1P)\pi^0)] < 0.19 \times 10^{-5}$ which we divide by our best value $B(\psi(2S) \to h_c(1P)\pi^0) = 7.4 \times 10^{-4}$.

$\Gamma(\pi^+\pi^-\eta)/\Gamma_{total}$ — Γ_{11}/Γ

VALUE	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
<5 × 10^{-4}	90	44.5	[1] ABLIKIM	24BF	BES3	$\psi(2S) \to \pi^0 h_c(1P)$

[1] ABLIKIM 24BF reports $< 4.0 \times 10^{-4}$ from a measurement of $[\Gamma(h_c(1P) \to \pi^+\pi^-\eta)/\Gamma_{total}] \times [B(\psi(2S) \to h_c(1P)\pi^0)]$ assuming $B(\psi(2S) \to h_c(1P)\pi^0) = (8.6 \pm 1.3) \times 10^{-4}$, which we rescale to our best value $B(\psi(2S) \to h_c(1P)\pi^0) = 7.4 \times 10^{-4}$.

$\Gamma(\pi^+\pi^-\pi^0\eta)/\Gamma_{total}$ — Γ_{12}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
8.3±2.3±0.6	35	[1] ABLIKIM	20AH	BES3	$\psi(2S) \to \pi^0 h_c(1P)$

[1] ABLIKIM 20AH reports $[\Gamma(h_c(1P) \to \pi^+\pi^-\pi^0\eta)/\Gamma_{total}] \times [B(\psi(2S) \to h_c(1P)\pi^0)] = (6.2 \pm 1.6 \pm 0.7) \times 10^{-6}$ which we divide by our best value $B(\psi(2S) \to h_c(1P)\pi^0) = (7.4 \pm 0.5) \times 10^{-4}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

$\Gamma(2\pi^+2\pi^-\pi^0\eta)/\Gamma_{total}$ — Γ_{13}/Γ

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
7.2±1.7±0.5	[1] ABLIKIM	24R	BES3	$\psi(2S) \to \pi^0 h_c(1P)$

[1] ABLIKIM 24R reports $[\Gamma(h_c(1P) \to 2\pi^+2\pi^-\pi^0\eta)/\Gamma_{total}] \times [B(\psi(2S) \to h_c(1P)\pi^0)] = (5.33 \pm 1.10 \pm 0.56) \times 10^{-6}$ which we divide by our best value $B(\psi(2S) \to h_c(1P)\pi^0) = (7.4 \pm 0.5) \times 10^{-4}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

$\Gamma(2\pi^+2\pi^-\pi^0)/\Gamma_{total}$ — Γ_{14}/Γ

VALUE (units 10^{-2})	EVTS	DOCUMENT ID		TECN	COMMENT
0.94±0.17 OUR AVERAGE					
0.86±0.16±0.06	254	[1] ABLIKIM	19AG	BES3	$\psi(2S) \to \pi^0 h_c(1P)$
$2.5\ ^{+0.9}_{-0.7}\ \pm 0.2$	92	[2] ADAMS	09	CLEO	$\psi(2S) \to \pi^0\gamma\eta_c$

[1] ABLIKIM 19AG reports $[\Gamma(h_c(1P) \to 2\pi^+2\pi^-\pi^0)/\Gamma_{total}] \times [B(\psi(2S) \to h_c(1P)\pi^0)] = (6.40 \pm 0.81 \pm 0.87) \times 10^{-6}$ which we divide by our best value $B(\psi(2S) \to h_c(1P)\pi^0) = (7.4 \pm 0.5) \times 10^{-4}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[2] ADAMS 09 reports $[\Gamma(h_c(1P) \to 2\pi^+2\pi^-\pi^0)/\Gamma_{total}] \times [B(\psi(2S) \to h_c(1P)\pi^0)] = (1.88^{+0.48}_{-0.45}{}^{+0.47}_{-0.30}) \times 10^{-5}$ which we divide by our best value $B(\psi(2S) \to h_c(1P)\pi^0) = (7.4 \pm 0.5) \times 10^{-4}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

$\Gamma(2\pi^+2\pi^-\eta)/\Gamma_{total}$ — Γ_{15}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<6 × 10^{-4}	90	[1] ABLIKIM	24R	BES3	$\psi(2S) \to \pi^0 h_c(1P)$

[1] ABLIKIM 24R reports $[\Gamma(h_c(1P) \to 2\pi^+2\pi^-\eta)/\Gamma_{total}] \times [B(\psi(2S) \to h_c(1P)\pi^0)] < 4.53 \times 10^{-7}$ which we divide by our best value $B(\psi(2S) \to h_c(1P)\pi^0) = 7.4 \times 10^{-4}$.

$\Gamma(3\pi^+3\pi^-\pi^0)/\Gamma_{total}$ — Γ_{16}/Γ

VALUE (units 10^{-3})	CL%	DOCUMENT ID		TECN	COMMENT
9.1±1.3±0.6		[1] ABLIKIM	24R	BES3	$\psi(2S) \to \pi^0 h_c(1P)$

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

<10	90	[2] ABLIKIM	19AG	BES3	$\psi(2S) \to \pi^0 h_c(1P)$
<34	90	[3] ADAMS	09	CLEO	$\psi(2S) \to \pi^0 \gamma \eta_c$

[1] ABLIKIM 24R reports $[\Gamma(h_c(1P) \to 3\pi^+ 3\pi^- \pi^0)/\Gamma_{total}] \times [B(\psi(2S) \to h_c(1P)\pi^0)] = (6.79 \pm 0.83 \pm 0.56) \times 10^{-6}$ which we divide by our best value $B(\psi(2S) \to h_c(1P)\pi^0) = (7.4 \pm 0.5) \times 10^{-4}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[2] ABLIKIM 19AG reports $[\Gamma(h_c(1P) \to 3\pi^+ 3\pi^- \pi^0)/\Gamma_{total}] \times [B(\psi(2S) \to h_c(1P)\pi^0)] < 7.5 \times 10^{-6}$ which we divide by our best value $B(\psi(2S) \to h_c(1P)\pi^0) = 7.4 \times 10^{-4}$. Superseded by ABLIKIM 24R.

[3] ADAMS 09 reports $[\Gamma(h_c(1P) \to 3\pi^+ 3\pi^- \pi^0)/\Gamma_{total}] \times [B(\psi(2S) \to h_c(1P)\pi^0)] < 2.5 \times 10^{-5}$ which we divide by our best value $B(\psi(2S) \to h_c(1P)\pi^0) = 7.4 \times 10^{-4}$.

$\Gamma(2\pi^+ 2\pi^- \omega)/\Gamma_{total}$ — Γ_{17}/Γ

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
3.9±0.9±0.3	[1] ABLIKIM	24R	BES3	$\psi(2S) \to \pi^0 h_c(1P)$

[1] ABLIKIM 24R reports $[\Gamma(h_c(1P) \to 2\pi^+ 2\pi^- \omega)/\Gamma_{total}] \times [B(\psi(2S) \to h_c(1P)\pi^0)] = (2.93 \pm 0.63 \pm 0.26) \times 10^{-6}$ which we divide by our best value $B(\psi(2S) \to h_c(1P)\pi^0) = (7.4 \pm 0.5) \times 10^{-4}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

$\Gamma(K^+ K^- \pi^+ \pi^-)/\Gamma_{total}$ — Γ_{18}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<7 × 10⁻⁴	90	[1] ABLIKIM	19AG	BES3	$\psi(2S) \to \pi^0 h_c(1P)$

[1] ABLIKIM 19AG reports $[\Gamma(h_c(1P) \to K^+ K^- \pi^+ \pi^-)/\Gamma_{total}] \times [B(\psi(2S) \to h_c(1P)\pi^0)] < 0.5 \times 10^{-6}$ which we divide by our best value $B(\psi(2S) \to h_c(1P)\pi^0) = 7.4 \times 10^{-4}$.

$\Gamma(K^+ K^- \pi^+ \pi^- \pi^0)/\Gamma_{total}$ — Γ_{19}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
3.8±0.8±0.3	80	[1] ABLIKIM	20AH	BES3	$\psi(2S) \to \pi^0 h_c(1P)$

[1] ABLIKIM 20AH reports $[\Gamma(h_c(1P) \to K^+ K^- \pi^+ \pi^- \pi^0)/\Gamma_{total}] \times [B(\psi(2S) \to h_c(1P)\pi^0)] = (2.8 \pm 0.5 \pm 0.3) \times 10^{-6}$ which we divide by our best value $B(\psi(2S) \to h_c(1P)\pi^0) = (7.4 \pm 0.5) \times 10^{-4}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

$\Gamma(K^+ K^- \pi^+ \pi^- \eta)/\Gamma_{total}$ — Γ_{20}/Γ

VALUE	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
<2.7 × 10⁻³	90	24	[1] ABLIKIM	20AH	BES3	$\psi(2S) \to \pi^0 h_c(1P)$

[1] ABLIKIM 20AH reports $[\Gamma(h_c(1P) \to K^+ K^- \pi^+ \pi^- \eta)/\Gamma_{total}] \times [B(\psi(2S) \to h_c(1P)\pi^0)] < 2.0 \times 10^{-6}$ which we divide by our best value $B(\psi(2S) \to h_c(1P)\pi^0) = 7.4 \times 10^{-4}$.

$\Gamma(K^+ K^- \pi^0)/\Gamma_{total}$ — Γ_{21}/Γ

VALUE (units 10^{-4})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
3.8±0.9±0.3		62	[1] ABLIKIM	24BF	BES3	$\psi(2S) \to \pi^0 h_c(1P)$

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

<6	90	20	[2,3] ABLIKIM	20AH	BES3	$\psi(2S) \to \pi^0 h_c(1P)$

[1] ABLIKIM 24BF reports $(3.26 \pm 0.84 \pm 0.36) \times 10^{-4}$ from a measurement of $[\Gamma(h_c(1P) \to K^+ K^- \pi^0)/\Gamma_{total}] \times [B(\psi(2S) \to h_c(1P)\pi^0)]$ assuming $B(\psi(2S) \to h_c(1P)\pi^0) = (8.6 \pm 1.3) \times 10^{-4}$, which we rescale to our best value $B(\psi(2S) \to h_c(1P)\pi^0) = (7.4 \pm 0.5) \times 10^{-4}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. Significance 3.5σ.

[2] ABLIKIM 20AH reports $[\Gamma(h_c(1P) \to K^+ K^- \pi^0)/\Gamma_{total}] \times [B(\psi(2S) \to h_c(1P)\pi^0)] < 4.8 \times 10^{-7}$ which we divide by our best value $B(\psi(2S) \to h_c(1P)\pi^0) = 7.4 \times 10^{-4}$.

[3] Superseded by ABLIKIM 24BF.

$\Gamma(K^+ K^- \pi^0 \eta)/\Gamma_{total}$ — Γ_{22}/Γ

VALUE	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
<2.4 × 10⁻³	90	20	[1] ABLIKIM	20AH	BES3	$\psi(2S) \to \pi^0 h_c(1P)$

[1] ABLIKIM 20AH reports $[\Gamma(h_c(1P) \to K^+ K^- \pi^0 \eta)/\Gamma_{total}] \times [B(\psi(2S) \to h_c(1P)\pi^0)] < 1.8 \times 10^{-6}$ which we divide by our best value $B(\psi(2S) \to h_c(1P)\pi^0) = 7.4 \times 10^{-4}$.

$\Gamma(K^+ K^- \eta)/\Gamma_{total}$ — Γ_{23}/Γ

VALUE (units 10^{-4})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
3.6±1.2±0.3		32	[1] ABLIKIM	24BF	BES3	$\psi(2S) \to \pi^0 h_c(1P)$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<10	90	18	[2,3] ABLIKIM	20AH	BES3	$\psi(2S) \to \pi^0 h_c(1P)$

[1] ABLIKIM 24BF reports $(3.13 \pm 1.08 \pm 0.38) \times 10^{-4}$ from a measurement of $[\Gamma(h_c(1P) \to K^+ K^- \eta)/\Gamma_{total}] \times [B(\psi(2S) \to h_c(1P)\pi^0)]$ assuming $B(\psi(2S) \to h_c(1P)\pi^0) = (8.6 \pm 1.3) \times 10^{-4}$, which we rescale to our best value $B(\psi(2S) \to h_c(1P)\pi^0) = (7.4 \pm 0.5) \times 10^{-4}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. Significance 3.3σ.

[2] ABLIKIM 20AH reports $[\Gamma(h_c(1P) \to K^+ K^- \eta)/\Gamma_{total}] \times [B(\psi(2S) \to h_c(1P)\pi^0)] < 7.5 \times 10^{-7}$ which we divide by our best value $B(\psi(2S) \to h_c(1P)\pi^0) = 7.4 \times 10^{-4}$.

[3] Superseded by ABLIKIM 24BF.

$\Gamma(2K^+ 2K^- \pi^0)/\Gamma_{total}$ — Γ_{24}/Γ

VALUE	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
<2.8 × 10⁻⁴	90	11	[1] ABLIKIM	20AH	BES3	$\psi(2S) \to \pi^0 h_c(1P)$

[1] ABLIKIM 20AH reports $[\Gamma(h_c(1P) \to 2K^+ 2K^- \pi^0)/\Gamma_{total}] \times [B(\psi(2S) \to h_c(1P)\pi^0)] < 2.1 \times 10^{-7}$ which we divide by our best value $B(\psi(2S) \to h_c(1P)\pi^0) = 7.4 \times 10^{-4}$.

$\Gamma(K^0_S K^\pm \pi^\mp)/\Gamma_{total}$ — Γ_{25}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
7.1±1.8±0.5		[1] ABLIKIM	24Y	BES3	$\psi(2S) \to \pi^0 h_c(1P)$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<6	90	[2,3] ABLIKIM	20AH	BES3	$\psi(2S) \to \pi^0 h_c(1P)$

[1] ABLIKIM 24Y reports $[\Gamma(h_c(1P) \to K^0_S K^\pm \pi^\mp)/\Gamma_{total}] \times [B(\psi(2S) \to h_c(1P)\pi^0)] = (5.3 \pm 1.3 \pm 0.4) \times 10^{-7}$ which we divide by our best value $B(\psi(2S) \to h_c(1P)\pi^0) = (7.4 \pm 0.5) \times 10^{-4}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[2] ABLIKIM 20AH reports $[\Gamma(h_c(1P) \to K^0_S K^\pm \pi^\mp)/\Gamma_{total}] \times [B(\psi(2S) \to h_c(1P)\pi^0)] < 4.8 \times 10^{-7}$ which we divide by our best value $B(\psi(2S) \to h_c(1P)\pi^0) = 7.4 \times 10^{-4}$.

[3] Superseded by ABLIKIM 24Y.

$\Gamma(K^0_S K^\pm \pi^\mp \pi^+ \pi^-)/\Gamma_{total}$ — Γ_{26}/Γ

VALUE (units 10^{-3})	*EVTS*	*DOCUMENT ID*	*TECN*	*COMMENT*
3.2±1.0±0.2	41	[1] ABLIKIM 20AH	BES3	$\psi(2S) \to \pi^0 h_c(1P)$

[1] ABLIKIM 20AH reports $[\Gamma(h_c(1P) \to K^0_S K^\pm \pi^\mp \pi^+ \pi^-)/\Gamma_{total}] \times [B(\psi(2S) \to h_c(1P)\pi^0)] = (2.4 \pm 0.7 \pm 0.3) \times 10^{-6}$ which we divide by our best value $B(\psi(2S) \to h_c(1P)\pi^0) = (7.4 \pm 0.5) \times 10^{-4}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

RADIATIVE DECAYS

$\Gamma(\gamma\eta)/\Gamma_{total}$ — Γ_{27}/Γ

VALUE (units 10^{-4})	*EVTS*	*DOCUMENT ID*	*TECN*	*COMMENT*
3.8±0.6 OUR AVERAGE				
3.8±0.6±0.3		[1] ABLIKIM 24BJ	BES3	$\psi(2S) \to \pi^0 h_c(1P)$
4.7±1.5±1.4	18	ABLIKIM 16I	BES3	$\psi(2S) \to \pi^0 \gamma\eta$

[1] ABLIKIM 24BJ reports $(3.77 \pm 0.55 \pm 0.29) \times 10^{-4}$ from a measurement of $[\Gamma(h_c(1P) \to \gamma\eta)/\Gamma_{total}] \times [B(\psi(2S) \to h_c(1P)\pi^0)]$ assuming $B(\psi(2S) \to h_c(1P)\pi^0) = (7.4 \pm 0.5) \times 10^{-4}$.

$\Gamma(\gamma\eta'(958))/\Gamma_{total}$ — Γ_{28}/Γ

VALUE (units 10^{-3})	*EVTS*	*DOCUMENT ID*	*TECN*	*COMMENT*
1.41±0.15 OUR AVERAGE				
1.40±0.11±0.11		[1] ABLIKIM 24BJ	BES3	$\psi(2S) \to \pi^0 \gamma\eta'$
1.52±0.27±0.29	44	ABLIKIM 16I	BES3	$\psi(2S) \to \pi^0 \gamma\eta'(958)$

[1] ABLIKIM 24BJ reports $(1.40 \pm 0.11 \pm 0.11) \times 10^{-3}$ from a measurement of $[\Gamma(h_c(1P) \to \gamma\eta'(958))/\Gamma_{total}] \times [B(\psi(2S) \to h_c(1P)\pi^0)]$ assuming $B(\psi(2S) \to h_c(1P)\pi^0) = (7.4 \pm 0.5) \times 10^{-4}$.

$\Gamma(\gamma\pi^0)/\Gamma_{total}$ — Γ_{29}/Γ

VALUE	*DOCUMENT ID*	*TECN*	*COMMENT*
$<5 \times 10^{-5}$	[1] ABLIKIM 24BJ	BES3	$\psi(2S) \to \pi^0 h_c(1P)$

[1] ABLIKIM 24BJ reports $< 5.0 \times 10^{-5}$ from a measurement of $[\Gamma(h_c(1P) \to \gamma\pi^0)/\Gamma_{total}] \times [B(\psi(2S) \to h_c(1P)\pi^0)]$ assuming $B(\psi(2S) \to h_c(1P)\pi^0) = (7.4 \pm 0.5) \times 10^{-4}$.

$\Gamma(\gamma\eta_c(1S))/\Gamma_{total}$ — Γ_{30}/Γ

VALUE (units 10^{-2})	*EVTS*	*DOCUMENT ID*	*TECN*	*COMMENT*
60± 4 OUR FIT				
57± 5 OUR AVERAGE				
57± 4±4	23k	[1] ABLIKIM 22AQ	BES3	$\psi(2S) \to \pi^0$ hadrons; $\pi^0\gamma(\eta_c)$

$56\pm\ 6\pm4$		[2] DOBBS	08A	CLEO	$\psi(2S)\to\ \pi^0\eta_c\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$62\pm\ 9\pm4$	3679	[3,4] ABLIKIM	10B	BES3	$\psi(2S)\to\ \pi^0\eta_c\gamma$
$56\pm\ 7\pm4$	1282	[5] DOBBS	08A	CLEO	$\psi(2S)\to\ \pi^0\eta_c\gamma$
$54\pm14\pm4$	168	[6] ROSNER	05	CLEO	$\psi(2S)\to\ \pi^0\eta_c\gamma$

[1] ABLIKIM 22AQ reports $[\Gamma(h_c(1P)\to\ \gamma\eta_c(1S))/\Gamma_{total}]\times[B(\psi(2S)\to\ h_c(1P)\pi^0)] = (4.22^{+0.27}_{-0.26}\pm0.19)\times10^{-4}$ which we divide by our best value $B(\psi(2S)\to\ h_c(1P)\pi^0) = (7.4\pm0.5)\times10^{-4}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[2] Average of DOBBS 08A and ROSNER 05. DOBBS 08A reports $[\Gamma(h_c(1P)\to\ \gamma\eta_c(1S))/\Gamma_{total}]\times[B(\psi(2S)\to\ h_c(1P)\pi^0)] = (4.16\pm0.30\pm0.37)\times10^{-4}$ which we divide by our best value $B(\psi(2S)\to\ h_c(1P)\pi^0) = (7.4\pm0.5)\times10^{-4}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[3] ABLIKIM 10B reports $[\Gamma(h_c(1P)\to\ \gamma\eta_c(1S))/\Gamma_{total}]\times[B(\psi(2S)\to\ h_c(1P)\pi^0)] = (4.58\pm0.40\pm0.50)\times10^{-4}$ which we divide by our best value $B(\psi(2S)\to\ h_c(1P)\pi^0) = (7.4\pm0.5)\times10^{-4}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[4] Superseded by ABLIKIM 22AQ

[5] DOBBS 08A reports $[\Gamma(h_c(1P)\to\ \gamma\eta_c(1S))/\Gamma_{total}]\times[B(\psi(2S)\to\ h_c(1P)\pi^0)] = (4.19\pm0.32\pm0.45)\times10^{-4}$ which we divide by our best value $B(\psi(2S)\to\ h_c(1P)\pi^0) = (7.4\pm0.5)\times10^{-4}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[6] ROSNER 05 reports $[\Gamma(h_c(1P)\to\ \gamma\eta_c(1S))/\Gamma_{total}]\times[B(\psi(2S)\to\ h_c(1P)\pi^0)] = (4.0\pm0.8\pm0.7)\times10^{-4}$ which we divide by our best value $B(\psi(2S)\to\ h_c(1P)\pi^0) = (7.4\pm0.5)\times10^{-4}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

$\Gamma(e^+e^-\eta_c(1S))/\Gamma(\gamma\eta_c(1S))$ — Γ_{31}/Γ_{30}

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
5.9±1.0±0.4	961	[1] ABLIKIM	24CC	BES3	$\psi(3686)\to\ \pi^0 h_c$, $e^+e^-\to\ \pi^+\pi^- h_c$

[1] Average between $\pi^0 h_c$ $(4.6\pm1.2\pm0.5)\times10^{-3}$ and $\pi^+\pi^- h_c$ $(8.9\pm1.8\pm0.9)\times10^{-3}$.

$h_c(1P)$ REFERENCES

ABLIKIM	24BF	PR D110 032023	M. Ablikim et al.	(BESIII Collab.)
ABLIKIM	24BJ	JHEP 2408 180	M. Ablikim et al.	(BESIII Collab.)
ABLIKIM	24BY	PR D110 112010	M. Ablikim et al.	(BESIII Collab.)
ABLIKIM	24CC	PR D110 L111101	M. Ablikim et al.	(BESIII Collab.)
ABLIKIM	24R	PR D109 072018	M. Ablikim et al.	(BESIII Collab.)
ABLIKIM	24Y	PR D110 012007	M. Ablikim et al.	(BESIII Collab.)
ABLIKIM	22AQ	PR D106 072007	M. Ablikim et al.	(BESIII Collab.)
ABLIKIM	22M	JHEP 2205 108	M. Ablikim et al.	(BESIII Collab.)
Also		JHEP 2303 022 (errat.)	M. Ablikim et al.	(BESIII Collab.)
ABLIKIM	22N	JHEP 2205 003	M. Ablikim	(BESIII Collab.)
ABLIKIM	20AH	PR D102 112007	M. Ablikim et al.	(BESIII Collab.)
ABLIKIM	19AG	PR D99 072008	M. Ablikim et al.	(BESIII Collab.)
ABLIKIM	18M	PR D97 052008	M. Ablikim et al.	(BESIII Collab.)
ABLIKIM	16I	PRL 116 251802	M. Ablikim et al.	(BESIII Collab.)
ABLIKIM	12N	PR D86 092009	M. Ablikim et al.	(BESIII Collab.)
ABLIKIM	10B	PRL 104 132002	M. Ablikim et al.	(BESIII Collab.)
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+)