$X(4020)$

$I(J^P) = 1(?^?)$

Charged X(4020) seen by ABLIKIM 13X from $e^+ e^- \rightarrow \pi^+ \pi^- h_c(1P)$ 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 $e^+ e^- \rightarrow (D^* \overline{D}^*)^\pm \pi^\mp$ events in $(D^* \overline{D}^*)^\pm$ mass. A neutral X(4020) seen by ABLIKIM 14P at three c.m. energies in the same range in $e^+ e^- \rightarrow \pi^0 \pi^0 h_c(1P)$ 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 $e^+ e^- \rightarrow (D^* \overline{D}^*)^0 \pi^0$ events using collisions at two c.m. energies. Production rates and mass values support grouping neutral and charged X(4020) together as manifestations of a single $I = 1$ particle.

$X(4020)$ MASS

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	CHG	COMMENT	
4024.1±1.9 OUR AVERAGE							
$4025.5^{+2.0}_{-4.7} \pm 3.1$	116	[1] ABLIKIM	15AA	BES3	0	$e^+ e^- \rightarrow (D^* \overline{D}^*)^0 \pi^0$	▮
$4026.3 \pm 2.6 \pm 3.7$	401	[1] ABLIKIM	14B	BES3	±	$e^+ e^- \rightarrow (D^* \overline{D}^*)^\pm \pi^\mp$	
$4023.9 \pm 2.2 \pm 3.8$	61	[1,2] ABLIKIM	14P	BES3	0	$e^+ e^- \rightarrow \pi^0 \pi^0 h_c$	▮
$4022.9 \pm 0.8 \pm 2.7$	253	[1] ABLIKIM	13X	BES3	±	$e^+ e^- \rightarrow \pi^+ \pi^- h_c$	

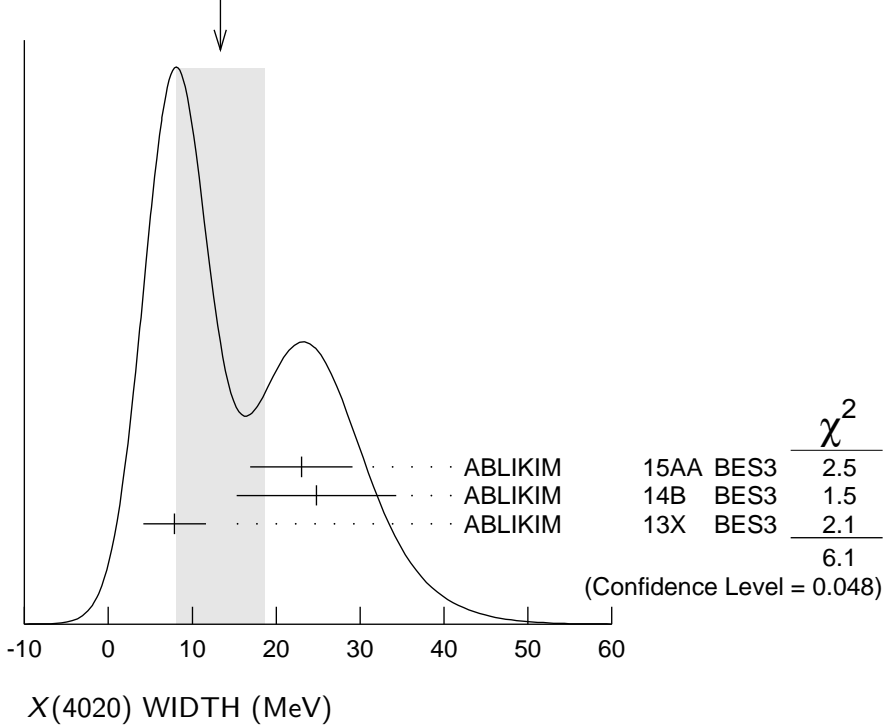[1] Neglecting interference between the $X(4020)$ and non-resonant continuum.
[2] Assuming $J^P = 1^+$ and width of 7.9 ± 2.6 MeV.

$X(4020)$ WIDTH

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	CHG	COMMENT	
13 ±5 OUR AVERAGE		Error includes scale factor of 1.7. See the ideogram below.					
$23.0 \pm 6.0 \pm 1.0$	116	[1] ABLIKIM	15AA	BES3	0	$e^+ e^- \rightarrow (D^* \overline{D}^*)^0 \pi^0$	▮
$24.8 \pm 5.6 \pm 7.7$	401	[1] ABLIKIM	14B	BES3	±	$e^+ e^- \rightarrow (D^* \overline{D}^*)^\pm \pi^\mp$	
$7.9 \pm 2.7 \pm 2.6$	253	[1] ABLIKIM	13X	BES3	±	$e^+ e^- \rightarrow \pi^+ \pi^- h_c$	

[1] Neglecting interference between the $X(4020)$ and non-resonant continuum.

WEIGHTED AVERAGE
13±5 (Error scaled by 1.7)

		χ^2
ABLIKIM	15AA BES3	2.5
ABLIKIM	14B BES3	1.5
ABLIKIM	13X BES3	2.1
		6.1

(Confidence Level = 0.048)

-10   0   10   20   30   40   50   60

X(4020) WIDTH (MeV)

X(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

X(4020) BRANCHING RATIOS

$\Gamma\big(h_c(1P)\pi\big)/\Gamma_{\text{total}}$ 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	$\pm$	$e^+e^- \to \pi^+\pi^- h_c$

$\Gamma\big(D^*\overline{D}^*\big)/\Gamma_{\text{total}}$ 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 $X(4020)$ and non-resonant continuum.

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

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

$\Gamma\left(\eta_c \pi^+ \pi^-\right)/\Gamma_{\text{total}}$ $\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad$ 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 B($B^+ \to K^+ X(4020)^0$) × B($X \to \eta_c \pi^+ \pi^-$) < 1.6×10^{-5} at 90% CL.

X(4020) REFERENCES

ABLIKIM	15AA	PRL 115 182002	M. Ablikim *et al.*	(BES III Collab.)
ABLIKIM	15AC	PR D92 092006	M. Ablikim *et al.*	(BES III Collab.)
VINOKUROVA	15	JHEP 1506 132	A. Vinokurova *et al.*	(BELLE Collab.)
ABLIKIM	14B	PRL 112 132001	M. Ablikim *et al.*	(BES III Collab.)
ABLIKIM	14P	PRL 113 212002	M. Ablikim *et al.*	(BES III Collab.)
ABLIKIM	13X	PRL 111 242001	M. Ablikim *et al.*	(BES III Collab.)