

$\Upsilon(11020)$

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

$\Upsilon(11020)$ MASS

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
10992.9^{+10.0}_{-3.1} OUR AVERAGE			
10999.0 ^{+7.3+16.9} _{-7.8-1.0}	¹ MIZUK	16	BELL $e^+e^- \rightarrow h_b(1P, 2P)\pi^+\pi^-$
10987.5 ^{+6.4+9.1} _{-2.5-2.3}	² SANTEL	16	BELL $e^+e^- \rightarrow \Upsilon(1S, 2S, 3S)\pi^+\pi^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
11003.0 \pm 1.1 ^{+0.9} _{-1.0}	^{3,4} SANTEL	16	BELL $e^+e^- \rightarrow$ hadrons
10996 \pm 2	⁵ AUBERT	09E	BABR $e^+e^- \rightarrow$ hadrons
11019 \pm 5 \pm 7	BESSION	85	CLEO $e^+e^- \rightarrow$ hadrons
11020 \pm 30	LOVELOCK	85	CUSB $e^+e^- \rightarrow$ hadrons

¹ From a simultaneous fit to the $h_b(nP)\pi^+\pi^-$, $n = 1, 2$ cross sections at 22 energy points within $\sqrt{s} = 10.77$ –11.02 GeV to a pair of interfering Breit-Wigner amplitudes modified by phase space factors, with eight resonance parameters (a mass and width for each of $\Upsilon(10860)$ and $\Upsilon(11020)$, a single relative phase, a single relative amplitude, and two overall normalization factors, one for each n). The systematic error estimate is dominated by possible interference with a small nonresonant continuum amplitude.

² From a simultaneous fit to the $\Upsilon(nS)\pi^+\pi^-$, $n = 1, 2, 3$ cross sections at 25 energy points within $\sqrt{s} = 10.6$ –11.05 GeV to a pair of interfering Breit-Wigner amplitudes modified by phase space factors, with fourteen resonance parameters (a mass, width, and three amplitudes for each of $\Upsilon(10860)$ and $\Upsilon(11020)$, a single universal relative phase, and three decoherence coefficients, one for each n). Continuum contributions were measured (and therefore fixed) to be zero.

³ From a fit to the total hadronic cross sections measured at 60 energy points within $\sqrt{s} = 10.82$ –11.05 GeV to a pair of interfering Breit-Wigner amplitudes and two floating continuum amplitudes with $1/\sqrt{s}$ dependence, one coherent with the resonances and one incoherent, with six resonance parameters (a mass, width, and an amplitude for each of $\Upsilon(10860)$ and $\Upsilon(11020)$, one relative phase, and one decoherence coefficient).

⁴ Not including uncertain and potentially large systematic errors due to assumed continuum amplitude $1/\sqrt{s}$ dependence and related interference contributions.

⁵ In a model where a flat non-resonant $b\bar{b}$ -continuum is incoherently added to a second flat component interfering with two Breit-Wigner resonances. Systematic uncertainties not estimated.

$\Upsilon(11020)$ WIDTH

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
49⁺⁹₋₁₅ OUR AVERAGE			
27 ⁺²⁷⁺⁵ ₋₁₁₋₁₂	⁶ MIZUK	16	BELL $e^+e^- \rightarrow h_b(1P, 2P)\pi^+\pi^-$
61 ⁺⁹⁺² ₋₁₉₋₂₀	⁷ SANTEL	16	BELL $e^+e^- \rightarrow \Upsilon(1S, 2S, 3S)\pi^+\pi^-$

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

$39.3^{+1.7}_{-1.6}$	$^{+1.3}_{-2.4}$	8,9 SANTEL	16 BELL	$e^+e^- \rightarrow$ hadrons
37 ± 3		¹⁰ AUBERT	09E BABR	$e^+e^- \rightarrow$ hadrons
61 ± 13	± 22	BESSON	85 CLEO	$e^+e^- \rightarrow$ hadrons
90 ± 20		LOVELOCK	85 CUSB	$e^+e^- \rightarrow$ hadrons

⁶ From a simultaneous fit to the $h_b(nP)\pi^+\pi^-$, $n = 1, 2$ cross sections at 22 energy points within $\sqrt{s} = 10.77\text{--}11.02$ GeV to a pair of interfering Breit-Wigner amplitudes modified by phase space factors, with eight resonance parameters (a mass and width for each of $\Upsilon(10860)$ and $\Upsilon(11020)$, a single relative phase, a single relative amplitude, and two overall normalization factors, one for each n). The systematic error estimate is dominated by possible interference with a small nonresonant continuum amplitude.

⁷ From a simultaneous fit to the $\Upsilon(nS)\pi^+\pi^-$, $n=1, 2, 3$ cross sections at 25 energy points within $\sqrt{s} = 10.6\text{--}11.05$ GeV to a pair of interfering Breit-Wigner amplitudes modified by phase space factors, with fourteen resonance parameters (a mass, width, and three amplitudes for each of $\Upsilon(10860)$ and $\Upsilon(11020)$, a single universal relative phase, and three decoherence coefficients, one for each n). Continuum contributions were measured (and therefore fixed) to be zero.

⁸ From a fit to the total hadronic cross sections measured at 60 energy points within $\sqrt{s} = 10.82\text{--}11.05$ GeV to a pair of interfering Breit-Wigner amplitudes and two floating continuum amplitudes with $1/\sqrt{s}$ dependence, one coherent with the resonances and one incoherent, with six resonance parameters (a mass, width, and an amplitude for each of $\Upsilon(10860)$ and $\Upsilon(11020)$, one relative phase, and one decoherence coefficient).

⁹ Not including uncertain and potentially large systematic errors due to assumed continuum amplitude $1/\sqrt{s}$ dependence and related interference contributions.

¹⁰ In a model where a flat non-resonant $b\bar{b}$ -continuum is incoherently added to a second flat component interfering with two Breit-Wigner resonances. Systematic uncertainties not estimated.

$\Upsilon(11020)$ DECAY MODES

Mode	Fraction (Γ_i/Γ)
Γ_1 e^+e^-	$(2.7^{+1.0}_{-0.8}) \times 10^{-6}$
Γ_2 $\chi_{bJ}(1P)\pi^+\pi^-\pi^0$	$(9^{+9}_{-8}) \times 10^{-3}$
Γ_3 $\chi_{b1}(1P)\pi^+\pi^-\pi^0$	seen
Γ_4 $\chi_{b2}(1P)\pi^+\pi^-\pi^0$	seen

$\Upsilon(11020)$ PARTIAL WIDTHS

$\Gamma(e^+e^-)$				Γ_1
VALUE (keV)	DOCUMENT ID	TECN	COMMENT	
0.130 ± 0.030 OUR AVERAGE				
$0.095 \pm 0.03 \pm 0.035$	BESSON	85	CLEO $e^+e^- \rightarrow$ hadrons	
0.156 ± 0.040	LOVELOCK	85	CUSB $e^+e^- \rightarrow$ hadrons	
$\Gamma(\chi_{bJ}(1P)\pi^+\pi^-\pi^0)/\Gamma_{\text{total}}$				Γ_2/Γ
VALUE (units 10^{-3})	DOCUMENT ID	TECN	COMMENT	
$8.7 \pm 4.3^{+7.6}_{-6.6}$	YIN	18	BELL $e^+e^- \rightarrow$ hadrons	

$\Gamma(\chi_{b1}(1P)\pi^+\pi^-\pi^0)/\Gamma_{\text{total}}$				Γ_3/Γ
<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
seen	YIN	18	BELL	$e^+e^- \rightarrow$ hadrons

$\Gamma(\chi_{b2}(1P)\pi^+\pi^-\pi^0)/\Gamma_{\text{total}}$				Γ_4/Γ
<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
seen	YIN	18	BELL	$e^+e^- \rightarrow$ hadrons

$\Gamma(\chi_{b2}(1P)\pi^+\pi^-\pi^0)/\Gamma(\chi_{b1}(1P)\pi^+\pi^-\pi^0)$				Γ_4/Γ_3
<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
0.4 ± 0.2	YIN	18	BELL	$e^+e^- \rightarrow$ hadrons

$\Upsilon(11020)$ REFERENCES

YIN	18	PR D98 091102	J.H. Yin <i>et al.</i>	(BELLE Collab.)
MIZUK	16	PRL 117 142001	R. Mizuk <i>et al.</i>	(BELLE Collab.)
SANTEL	16	PR D93 011101	D. Santel <i>et al.</i>	(BELLE Collab.)
AUBERT	09E	PRL 102 012001	B. Aubert <i>et al.</i>	(BABAR Collab.)
BESSION	85	PRL 54 381	D. Besson <i>et al.</i>	(CLEO Collab.)
LOVELOCK	85	PRL 54 377	D.M.J. Lovelock <i>et al.</i>	(CUSB Collab.)