# $D_{s1}(2460)^{\pm}$

$I(J^P) = 0(1^+)$

## $D_{s1}(2460)^{\pm}$ MASS

The fit includes $D^{\pm}$, $D^0$, $D_s^{\pm}$, $D^{*\pm}$, $D^{*0}$, $D_s^{*\pm}$, $D_1(2420)^0$, $D_2^*(2460)^0$, and $D_{s1}(2536)^{\pm}$ mass and mass difference measurements.

| VALUE (MeV) | EVTS | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **2459.6±0.6 OUR FIT** Error includes scale factor of 1.1. | | | | | |
| **2459.6±0.9 OUR AVERAGE** Error includes scale factor of 1.3. | | | | | |
| 2460.1±0.2±0.8 | | [1] AUBERT | 06P | BABR | 10.6 $e^+e^-$ |
| 2458.0±1.0±1.0 | 195 | AUBERT | 04E | BABR | 10.6 $e^+e^-$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| 2459.5±1.2±3.7 | 920 | AUBERT | 06P | BABR | 10.6 $e^+e^- \to D_s^+\gamma X$ |
| 2458.6±1.0±2.5 | 560 | AUBERT | 06P | BABR | 10.6 $e^+e^- \to D_s^+\pi^0\gamma X$ |
| 2460.2±0.2±0.8 | 123 | AUBERT | 06P | BABR | 10.6 $e^+e^- \to D_s^+\pi^+\pi^- X$ |
| 2458.9±1.5 | 112 | [2] AUBERT,B | 04S | BABR | $B \to D_{s1}(2460)^+\overline{D}^{(*)}$ |
| 2461.1±1.6 | 139 | [3] AUBERT,B | 04S | BABR | $B \to D_{s1}(2460)^+\overline{D}^{(*)}$ |
| 2456.5±1.3±1.3 | 126 | [4,5] MIKAMI | 04 | BELL | 10.6 $e^+e^-$ |
| 2459.5±1.3±2.0 | 152 | [6,7] MIKAMI | 04 | BELL | 10.6 $e^+e^-$ |
| 2459.9±0.9±1.6 | 60 | [6,7] MIKAMI | 04 | BELL | 10.6 $e^+e^-$ |
| 2459.2±1.6±2.0 | 57 | KROKOVNY | 03B | BELL | 10.6 $e^+e^-$ |

[1] The average of the values obtained from the $D_s^+\gamma$, $D_s^+\pi^0\gamma$,$D_s^+\pi^+\pi^-$ final state.

[2] Systematic errors not evaluated. From the decay to $D_s^{*+}\pi^0$.

[3] Systematic errors not evaluated. From the decay to $D_s^+\gamma$.

[4] Not independent of the corresponding $m_{D_{s1}(2460)^{\pm}} - m_{D_s^{*\pm}}$.

[5] Using $m_{D_s^{*+}} = 2112.4 \pm 0.7$ MeV.

[6] Not independent of the corresponding $m_{D_{s1}(2460)^{\pm}} - m_{D_s^{\pm}}$.

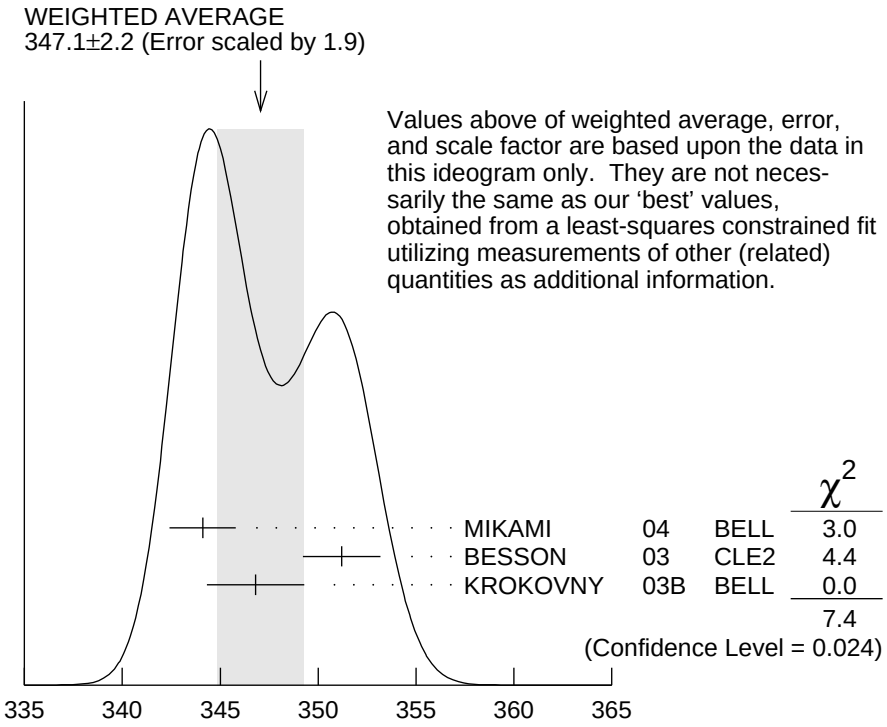
[7] Using $m_{D_s^+} = 1968.5 \pm 0.6$ MeV.

## $m_{D_{s1}(2460)^{\pm}} - m_{D_s^{*\pm}}$

The fit includes $D^{\pm}$, $D^0$, $D_s^{\pm}$, $D^{*\pm}$, $D^{*0}$, $D_s^{*\pm}$, $D_1(2420)^0$, $D_2^*(2460)^0$, and $D_{s1}(2536)^{\pm}$ mass and mass difference measurements.

| VALUE (MeV) | EVTS | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **347.2±0.7 OUR FIT** Error includes scale factor of 1.2. | | | | | |
| **347.1±2.2 OUR AVERAGE** Error includes scale factor of 1.9. See the ideogram below. | | | | | |
| 344.1±1.3±1.1 | 126 | MIKAMI | 04 | BELL | 10.6 $e^+e^-$ |
| 351.2±1.7±1.0 | 41 | BESSON | 03 | CLE2 | 10.6 $e^+e^-$ |
| 346.8±1.6±1.9 | 57 | [8] KROKOVNY | 03B | BELL | 10.6 $e^+e^-$ |

[8] Recalculated by us using $m_{D_s^{*+}} = 2112.4 \pm 0.7$ MeV.




## $m_{D_{s1}(2460)^\pm} - m_{D_s^\pm}$

The fit includes $D^\pm$, $D^0$, $D_s^\pm$, $D^{*\pm}$, $D^{*0}$, $D_s^{*\pm}$, $D_1(2420)^0$, $D_2^*(2460)^0$, and $D_{s1}(2536)^\pm$ mass and mass difference measurements.

| *VALUE* (MeV) | *EVTS* | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|---|
| **491.1±0.7 OUR FIT** Error includes scale factor of 1.1. | | | | | |
| **491.3±1.4 OUR AVERAGE** | | | | | |
| 491.0±1.3±1.9 | 152 | [9] MIKAMI | 04 | BELL | 10.6 $e^+e^-$ |
| 491.4±0.9±1.5 | 60 | [10] MIKAMI | 04 | BELL | 10.6 $e^+e^-$ |

[9] From the decay to $D_s^\pm\gamma$.

[10] From the decay to $D_s^\pm\pi^+\pi^-$.

## $D_{s1}(2460)^\pm$ WIDTH

| *VALUE* (MeV) | *CL%* | *EVTS* | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|---|---|
| **< 3.5** | 95 | 123 | AUBERT | 06P | BABR | 10.6 $e^+e^- \to D_s^+\pi^+\pi^- X$ |

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

| | | | | | | |
|---|---|---|---|---|---|---|
| $< 6.3$ | 95 | 560 | AUBERT | 06P | BABR | 10.6 $e^+e^- \to D_s^+\pi^0\gamma X$ |
| $<10$ | | 195 | AUBERT | 04E | BABR | 10.6 $e^+e^-$ |
| $< 5.5$ | 90 | 126 | MIKAMI | 04 | BELL | 10.6 $e^+e^-$ |
| $< 7$ | 90 | 41 | BESSON | 03 | CLE2 | 10.6 $e^+e^-$ |

## $D_{s1}(2460)^+$ DECAY MODES

$D_{s1}(2460)^-$ modes are charge conjugates of the modes below.

| | Mode | Fraction ($\Gamma_i/\Gamma$) | Scale factor/ Confidence level |
|---|---|---|---|
| $\Gamma_1$ | $D_s^{*+}\pi^0$ | (48 ±11 ) % | |
| $\Gamma_2$ | $D_s^+\gamma$ | (18 ± 4 ) % | |
| $\Gamma_3$ | $D_s^+\pi^+\pi^-$ | ( 4.3± 1.3) % | S=1.1 |
| $\Gamma_4$ | $D_s^{*+}\gamma$ | $<$ 8 % | CL=90% |
| $\Gamma_5$ | $D_{s0}^*(2317)^+\gamma$ | ( $3.7^{+\ 5.0}_{-\ 2.4}$) % | |
| $\Gamma_6$ | $D_s^+\pi^0$ | | |
| $\Gamma_7$ | $D_s^+\pi^0\pi^0$ | | |
| $\Gamma_8$ | $D_s^+\gamma\gamma$ | | |

## CONSTRAINED FIT INFORMATION

An overall fit to 7 branching ratios uses 8 measurements and one constraint to determine 5 parameters. The overall fit has a $\chi^2 = 3.4$ for 4 degrees of freedom.

The following *off-diagonal* array elements are the correlation coefficients $\left\langle \delta x_i \delta x_j \right\rangle / (\delta x_i \cdot \delta x_j)$, in percent, from the fit to the branching fractions, $x_i \equiv \Gamma_i/\Gamma_{\text{total}}$. The fit constrains the $x_i$ whose labels appear in this array to sum to one.

| | | | |
|---|---|---|---|
| $x_2$ | 80 | | |
| $x_3$ | 68 | 62 | |
| $x_5$ | −3 | 25 | 26 |
| | $x_1$ | $x_2$ | $x_3$ |

## $D_{s1}(2460)^\pm$ BRANCHING RATIOS

### $\Gamma(D_s^{*+}\pi^0)/\Gamma_{\text{total}}$ $\Gamma_1/\Gamma$

| VALUE | EVTS | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **0.48±0.11 OUR FIT** | | | | | |
| **0.56±0.13±0.09** | | [11] AUBERT | 06N | BABR | $B \to D_{s1}(2460)^-\overline{D}^{(*)}$ |

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

| | | | | | |
|---|---|---|---|---|---|
| seen | 41 | BESSON | 03 | CLE2 | 10.6 $e^+e^-$ |

[11] Evaluated in AUBERT 06N including measurements from AUBERT,B 04S.

## $\Gamma(D_s^+\gamma)/\Gamma_{total}$ $\Gamma_2/\Gamma$

| VALUE | DOCUMENT ID | TECN | COMMENT |
|---|---|---|---|
| **0.18±0.04 OUR FIT** | | | |
| **0.16±0.04±0.03** | [12] AUBERT 06N | BABR | $B \to D_{s1}(2460)^- \overline{D}^{(*)}$ |

[12] Evaluated in AUBERT 06N including measurements from AUBERT,B 04S.

## $\Gamma(D_s^+\gamma)/\Gamma(D_s^{*+}\pi^0)$ $\Gamma_2/\Gamma_1$

| VALUE | CL% | EVTS | DOCUMENT ID | TECN | COMMENT |
|---|---|---|---|---|---|
| **0.38 ±0.05 OUR FIT** | | | | | |
| **0.44 ±0.09 OUR AVERAGE** | | | | | |
| 0.55 ±0.13 ±0.08 | | 152 | MIKAMI 04 | BELL | 10.6 $e^+e^-$ |
| 0.38 ±0.11 ±0.04 | | 38 | KROKOVNY 03B | BELL | 10.6 $e^+e^-$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| 0.274±0.045±0.020 | | 251 | [13] AUBERT,B 04S | BABR | $B \to D_{s1}(2460)^+ \overline{D}^{(*)}$ |
| < 0.49 | 90 | | BESSON 03 | CLE2 | 10.6 $e^+e^-$ |

[13] Used by AUBERT 06N in their measurement of $B(D_s^{*-}\pi^0)$ and $B(D_s^-\gamma)$.

## $\Gamma(D_s^+\pi^+\pi^-)/\Gamma(D_s^{*+}\pi^0)$ $\Gamma_3/\Gamma_1$

| VALUE | CL% | EVTS | DOCUMENT ID | TECN | COMMENT |
|---|---|---|---|---|---|
| **0.090±0.020 OUR FIT** Error includes scale factor of 1.2. | | | | | |
| **0.14 ±0.04 ±0.02** | | 60 | MIKAMI 04 | BELL | 10.6 $e^+e^-$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| <0.08 | 90 | | BESSON 03 | CLE2 | 10.6 $e^+e^-$ |

## $\Gamma(D_s^{*+}\gamma)/\Gamma(D_s^{*+}\pi^0)$ $\Gamma_4/\Gamma_1$

| VALUE | CL% | DOCUMENT ID | TECN | COMMENT |
|---|---|---|---|---|
| **<0.16** | 90 | BESSON 03 | CLE2 | 10.6 $e^+e^-$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| <0.31 | 90 | MIKAMI 04 | BELL | 10.6 $e^+e^-$ |

## $\Gamma(D_{s0}^*(2317)^+\gamma)/\Gamma(D_s^{*+}\pi^0)$ $\Gamma_5/\Gamma_1$

| VALUE | CL% | DOCUMENT ID | TECN | COMMENT |
|---|---|---|---|---|
| **<0.22** | 95 | AUBERT 04E | BABR | 10.6 $e^+e^-$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| <0.58 | 90 | BESSON 03 | CLE2 | 10.6 $e^+e^-$ |

## $\Gamma(D_s^{*+}\pi^0)/[\Gamma(D_s^{*+}\pi^0)+\Gamma(D_{s0}^*(2317)^+\gamma)]$ $\Gamma_1/(\Gamma_1+\Gamma_5)$

| VALUE | DOCUMENT ID | TECN | COMMENT |
|---|---|---|---|
| **0.93±0.09 OUR FIT** | | | |
| **0.97±0.09±0.05** | AUBERT 06P | BABR | 10.6 $e^+e^-$ |

## $\Gamma(D_s^+\gamma)/[\Gamma(D_s^{*+}\pi^0)+\Gamma(D_{s0}^*(2317)^+\gamma)]$ $\Gamma_2/(\Gamma_1+\Gamma_5)$

| VALUE | DOCUMENT ID | TECN | COMMENT |
|---|---|---|---|
| **0.35 ±0.04 OUR FIT** | | | |
| **0.337±0.036±0.038** | AUBERT 06P | BABR | 10.6 $e^+e^-$ |

$\Gamma(D_s^+\pi^+\pi^-)/[\Gamma(D_s^{*+}\pi^0)+\Gamma(D_{s0}^*(2317)^+\gamma)]$ $\Gamma_3/(\Gamma_1+\Gamma_5)$

| VALUE | DOCUMENT ID | TECN | COMMENT |
|---|---|---|---|
| **0.083±0.017 OUR FIT** Error includes scale factor of 1.2. | | | |
| **0.077±0.013±0.008** | AUBERT | 06P BABR | 10.6 $e^+e^-$ |

$\Gamma(D_s^{*+}\gamma)/[\Gamma(D_s^{*+}\pi^0)+\Gamma(D_{s0}^*(2317)^+\gamma)]$ $\Gamma_4/(\Gamma_1+\Gamma_5)$

| VALUE | CL% | DOCUMENT ID | TECN | COMMENT |
|---|---|---|---|---|
| **<0.24** | 95 | AUBERT | 06P BABR | 10.6 $e^+e^-$ |

$\Gamma(D_{s0}^*(2317)^+\gamma)/[\Gamma(D_s^{*+}\pi^0)+\Gamma(D_{s0}^*(2317)^+\gamma)]$ $\Gamma_5/(\Gamma_1+\Gamma_5)$

| VALUE | CL% | DOCUMENT ID | TECN | COMMENT |
|---|---|---|---|---|
| **<0.25** | 95 | AUBERT | 06P BABR | 10.6 $e^+e^-$ |

$\Gamma(D_s^+\pi^0)/[\Gamma(D_s^{*+}\pi^0)+\Gamma(D_{s0}^*(2317)^+\gamma)]$ $\Gamma_6/(\Gamma_1+\Gamma_5)$

| VALUE | CL% | DOCUMENT ID | TECN | COMMENT |
|---|---|---|---|---|
| **<0.042** | 95 | AUBERT | 06P BABR | 10.6 $e^+e^-$ |

$\Gamma(D_s^+\pi^0\pi^0)/[\Gamma(D_s^{*+}\pi^0)+\Gamma(D_{s0}^*(2317)^+\gamma)]$ $\Gamma_7/(\Gamma_1+\Gamma_5)$

| VALUE | CL% | DOCUMENT ID | TECN | COMMENT |
|---|---|---|---|---|
| **<0.68** | 95 | AUBERT | 06P BABR | 10.6 $e^+e^-$ |

$\Gamma(D_s^+\gamma\gamma)/[\Gamma(D_s^{*+}\pi^0)+\Gamma(D_{s0}^*(2317)^+\gamma)]$ $\Gamma_8/(\Gamma_1+\Gamma_5)$

| VALUE | CL% | DOCUMENT ID | TECN | COMMENT |
|---|---|---|---|---|
| **<0.33** | 95 | AUBERT | 06P BABR | 10.6 $e^+e^-$ |

## $D_{s1}(2460)^\pm$ REFERENCES


| | | | | |
|---|---|---|---|---|
| AUBERT | 06N | PR D74 031103R | B. Aubert *et al.* | (BABAR Collab.) |
| AUBERT | 06P | PR D74 032007 | B. Aubert *et al.* | (BABAR Collab.) |
| AUBERT | 04E | PR D69 031101R | B. Aubert *et al.* | (BABAR Collab.) |
| AUBERT,B | 04S | PRL 93 181801 | B. Aubert *et al.* | (BABAR Collab.) |
| MIKAMI | 04 | PRL 92 012002 | Y. Mikami *et al.* | (BELLE Collab.) |
| BESSON | 03 | PR D68 032002 | D. Besson *et al.* | (CLEO Collab.) |
| KROKOVNY | 03B | PRL 91 262002 | P. Krokovny *et al.* | (BELLE Collab.) |