## $\psi(2S)$ REFERENCES


| | | | | |
|---|---|---|---|---|
| ANTONIAZZI | 94 | PR D50 4258 | +Arenton+ | (E705 Collab.) |
| ARMSTRONG | 93B | PR D47 772 | +Bettoni, Bharadwaj+ | (FNAL E760 Collab.) |
| PDG | 92 | PR D45, 1 June, Part II | Hikasa, Barnett, Stone+ | (KEK, LBL, BOST+) |
| ALEXANDER | 89 | NP B320 45 | +Bonvicini, Drell, Frey, Luth | (LBL, MICH, SLAC) |
| GAISER | 86 | PR D34 711 | +Bloom, Bulos, Godfrey+ | (Crystal Ball Collab.) |
| FRANKLIN | 83 | PRL 51 963 | +Franklin, Feldman, Abrams, Alam+ | (LBL, SLAC) |
| EDWARDS | 82C | PRL 48 70 | +Partridge, Peck+ | (CIT, HARV, PRIN, STAN, SLAC) |
| LEMOIGNE | 82 | PL 113B 509 | +Barate, Astbury+ | (SACL, LOIC, SHMP, IND) |
| HIMEL | 80 | PRL 44 920 | +Abrams, Alam, Blocker+ | (LBL, SLAC) |
| OREGLIA | 80 | PRL 45 959 | +Partridge+ | (SLAC, CIT, HARV, PRIN, STAN) |
| SCHARRE | 80 | PL 97B 329 | +Trilling, Abrams, Alam, Blocker+ | (SLAC, LBL) |
| ZHOLENTZ | 80 | PL 96B 214 | +Kurdadze, Lelchuk, Mishnev+ | (NOVO) |
| Also | 81 | SJNP 34 814 | Zholentz, Kurdadze, Lelchuk+ | (NOVO) |
| | | Translated from YAF 34 1471. | | |
| BRANDELIK | 79B | NP B160 426 | +Cords+ | (DASP Collab.) |
| BRANDELIK | 79C | ZPHY C1 233 | +Cords+ | (DASP Collab.) |
| BARTEL | 78B | PL 79B 492 | +Dittmann, Duinker, Olsson, O'Neill+ | (DESY, HEIDP) |
| TANENBAUM | 78 | PR D17 1731 | +Alam, Boyarski+ | (SLAC, LBL) |
| BIDDICK | 77 | PRL 38 1324 | +Burnett+ | (UCSD, UMD, PAVI, PRIN, SLAC, STAN) |
| BRAUNSCH... | 77 | PL 67B 249 | Braunschweig+ | (DASP Collab.) |
| BURMESTER | 77 | PL 66B 395 | +Criegee+ | (DESY, HAMB, SIEG, WUPP) |
| FELDMAN | 77 | PRPL 33C 285 | +Perl | (LBL, SLAC) |
| YAMADA | 77 | Hamburg Conf. 69 | | (DASP Collab.) |
| BARTEL | 76 | PL 64B 483 | +Duinker, Olsson, Steffen, Heintze+ | (DESY, HEIDP) |
| TANENBAUM | 76 | PRL 36 402 | +Abrams, Boyarski, Bulos+ | (SLAC, LBL) IG |
| WHITAKER | 76 | PRL 37 1596 | +Tanenbaum, Abrams, Alam+ | (SLAC, LBL) |
| ABRAMS | 75 | Stanford Symp. 25 | | (LBL) |
| ABRAMS | 75B | PRL 34 1181 | +Briggs, Chinowsky, Friedberg+ | (LBL, SLAC) |
| BOYARSKI | 75C | Palermo Conf. 54 | +Breidenbach, Bulos, Abrams, Briggs+ | (SLAC, LBL) |
| HILGER | 75 | PRL 35 625 | +Beron, Ford, Hofstadter, Howell+ | (STAN, PENN) |
| LIBERMAN | 75 | Stanford Symp. 55 | | (STAN) |
| LUTH | 75 | PRL 35 1124 | +Boyarski, Lynch, Breidenbach+ | (SLAC, LBL) JPC |
| WIIK | 75 | Stanford Symp. 69 | | (DESY) |


## OTHER RELATED PAPERS


| | | | | |
|---|---|---|---|---|
| LEE | 85 | SLAC 282 | | (SLAC) |
| BARATE | 83 | PL 121B 449 | +Bareyre, Bonamy+ | (SACL, LOIC, SHMP, IND) |
| FRANKLIN | 83B | Thesis SLAC-0254 | | (STAN) |
| AUBERT | 75B | PRL 33 1624 | +Becker, Biggs, Burger, Glenn+ | (MIT, BNL) |
| BRAUNSCH... | 75B | PL 57B 407 | Braunschweig, Konigs+ | (DASP Collab.) |
| CAMERINI | 75 | PRL 35 483 | +Learned, Prepost, Ash, Anderson+ | (WISC, SLAC) |
| FELDMAN | 75B | PRL 35 821 | +Jean-Marie, Sadoulet, Vannucci+ | (LBL, SLAC) |
| GRECO | 75 | PL 56B 367 | +Pancheri-Srivastava, Srivastava | (FRAS) |
| JACKSON | 75 | NIM 128 13 | +Scharre | (LBL) |
| SIMPSON | 75 | PRL 35 699 | +Beron, Ford, Hilger, Hofstadter+ | (STAN, PENN) |
| ABRAMS | 74 | PRL 33 1453 | +Briggs, Augustin, Boyarski+ | (LBL, SLAC) |


# $\psi(3770)$

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

## $\psi(3770)$ MASS

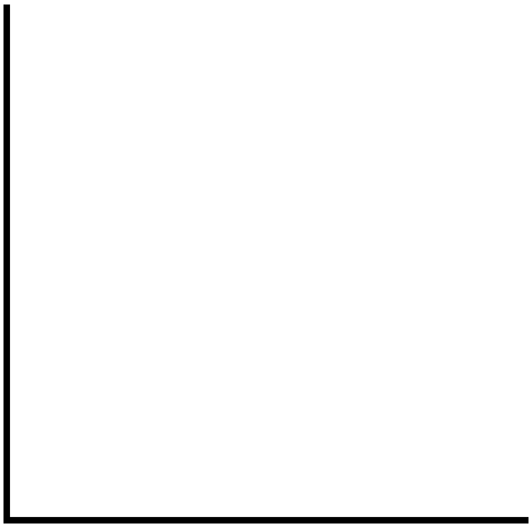
| *VALUE* (MeV) | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| **3769.9±2.5 OUR EVALUATION** | Error includes scale factor of 1.8. From $m_{\psi(3685)}$ and mass difference below. | | | |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 3764.0±5.0 | [1] SCHINDLER | 80 | MRK2 | $e^+e^-$ |
| 3770 ±6.0 | [1] BACINO | 78 | DLCO | $e^+e^-$ |
| 3772.0±6.0 | [1] RAPIDIS | 77 | MRK1 | $e^+e^-$ |

[1] Errors include systematic common to all experiments.

## $m_{\psi(3770)} - m_{\psi(2S)}$

| *VALUE* (MeV) | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| **83.9±2.4 OUR AVERAGE** | Error includes scale factor of 1.8. See the ideogram below. | | | |
| 80.0±2.0 | SCHINDLER | 80 | MRK2 | $e^+e^-$ |
| 86.0±2.0 | [2] BACINO | 78 | DLCO | $e^+e^-$ |
| 88.0±3.0 | RAPIDIS | 77 | MRK1 | $e^+e^-$ |

[2] SPEAR $\psi(2S)$ mass subtracted (see SCHINDLER 80).



$m_{\psi(3770)} - m_{\psi(2S)}$ (MeV)

## $\psi(3770)$ WIDTH

| *VALUE* (MeV) | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| **23.6±2.7 OUR FIT** Error includes scale factor of 1.1. | | | | |
| **25.3±2.9 OUR AVERAGE** | | | | |
| 24.0±5.0 | SCHINDLER | 80 | MRK2 | $e^+e^-$ |
| 24.0±5.0 | BACINO | 78 | DLCO | $e^+e^-$ |
| 28.0±5.0 | RAPIDIS | 77 | MRK1 | $e^+e^-$ |

## $\psi(3770)$ DECAY MODES

| | Mode | Fraction ($\Gamma_i/\Gamma$) | Scale factor |
|---|---|---|---|
| $\Gamma_1$ | $D\overline{D}$ | dominant | |
| $\Gamma_2$ | $e^+e^-$ | $(1.12\pm0.17)\times10^{-5}$ | 1.2 |

## $\psi(3770)$ PARTIAL WIDTHS

### $\Gamma(e^+e^-)$ — $\Gamma_2$

| *VALUE* (keV) | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| **0.26 ±0.04 OUR FIT** Error includes scale factor of 1.2. | | | | |
| **0.24 ±0.05 OUR AVERAGE** Error includes scale factor of 1.2. | | | | |
| 0.276±0.050 | SCHINDLER | 80 | MRK2 | $e^+e^-$ |
| 0.18 ±0.06 | BACINO | 78 | DLCO | $e^+e^-$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 0.37 ±0.09 | [3] RAPIDIS | 77 | MRK1 | $e^+e^-$ |

[3] See also $\Gamma(e^+e^-)/\Gamma_{\text{total}}$ below.

## $\psi(3770)$ BRANCHING RATIOS

### $\Gamma(D\overline{D})/\Gamma_{\text{total}}$ — $\Gamma_1/\Gamma$

| *VALUE* | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| **dominant** | PERUZZI | 77 | MRK1 | $e^+e^-\to D\overline{D}$ |

### $\Gamma(e^+e^-)/\Gamma_{\text{total}}$ — $\Gamma_2/\Gamma$

| *VALUE* (units $10^{-5}$) | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| **1.12±0.17 OUR FIT** Error includes scale factor of 1.2. | | | | |
| **1.3 ±0.2** | RAPIDIS | 77 | MRK1 | $e^+e^-$ |

*CITATION: L. Montanet et al., Physical Review D50, 1173 (1994) and 1995 off-year partial update for the 1996 edition (URL: http://pdg.lbl.gov/)

## $\psi(3770)$ REFERENCES


| | | | | |
|---|---|---|---|---|
| SCHINDLER | 80 | PR D21 2716 | +Siegrist, Alam, Boyarski+ | (Mark II Collab.) |
| BACINO | 78 | PRL 40 671 | +Baumgarten, Birkwood+ | (SLAC, UCLA, UCI) |
| PERUZZI | 77 | PRL 39 1301 | +Piccolo, Feldman+ | (SLAC, LBL, NWES, HAWA) |
| RAPIDIS | 77 | PRL 39 526 | +Gobbi, Luke, Barbaro-Galtieri+ | (Mark I Collab.) |


# $\psi(4040)$

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

$J^{PC}$ for the $\psi(4040)$ is known by its production in $e^+e^-$ collisions via single-photon annihilation. $I^G$ is not known, and the interpretation of this state as a single resonance is unclear because of the expectation of substantial threshold effects in this energy region.

## $\psi(4040)$ MASS

| *VALUE* (MeV) | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| **4040.0±10.0** | BRANDELIK | 78C | DASP | $e^+e^-$ |

## $\psi(4040)$ WIDTH

| *VALUE* (MeV) | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| **52.0±10.0** | BRANDELIK | 78C | DASP | $e^+e^-$ |

## $\psi(4040)$ DECAY MODES

| | Mode | Fraction ($\Gamma_i/\Gamma$) |
|---|---|---|
| $\Gamma_1$ | $e^+e^-$ | $(1.4\pm0.4)\times10^{-5}$ |
| $\Gamma_2$ | $D^0\overline{D}^0$ | seen |
| $\Gamma_3$ | $D^*(2007)^0\overline{D}^0$ + c.c. | seen |
| $\Gamma_4$ | $D^*(2007)^0\overline{D}^*(2007)^0$ | seen |
| $\Gamma_5$ | $J/\psi(1S)$hadrons | |
| $\Gamma_6$ | $\mu^+\mu^-$ | |

## $\psi(4040)$ PARTIAL WIDTHS

### $\Gamma(e^+e^-)$ $\Gamma_1$

| *VALUE* (keV) | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| **0.75±0.15** | BRANDELIK | 78C | DASP | $e^+e^-$ |

## $\psi(4040)$ BRANCHING RATIOS

### $\Gamma(e^+e^-)/\Gamma_{\text{total}}$ $\Gamma_1/\Gamma$

| *VALUE* (units $10^{-5}$) | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| ~ 1.0 | FELDMAN | 77 | MRK1 | $e^+e^-$ |

### $\Gamma(D^0\overline{D}^0)/\Gamma(D^*(2007)^0\overline{D}^0 + \text{c.c.})$ $\Gamma_2/\Gamma_3$

| *VALUE* | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| **0.05 ±0.03** | [1] GOLDHABER | 77 | MRK1 | $e^+e^-$ |

[1] Phase-space factor ($p^3$) explicitly removed.

### $\Gamma(D^*(2007)^0\overline{D}^*(2007)^0)/\Gamma(D^*(2007)^0\overline{D}^0 + \text{c.c.})$ $\Gamma_4/\Gamma_3$

| *VALUE* | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| **32.0±12.0** | [2] GOLDHABER | 77 | MRK1 | $e^+e^-$ |

[2] Phase-space factor ($p^3$) explicitly removed.

## $\psi(4040)$ REFERENCES


| | | | | |
|---|---|---|---|---|
| BRANDELIK | 78C | PL 76B 361 | +Cords+ | (DASP Collab.) |
| Also | 79C | ZPHY C1 233 | Brandelik, Cords+ | (DASP Collab.) |
| FELDMAN | 77 | PRPL 33C 285 | +Perl | (LBL, SLAC) |
| GOLDHABER | 77 | PL 69B 503 | +Wiss, Abrams, Alam+ | (LBL, SLAC) |

## OTHER RELATED PAPERS


| | | | | |
|---|---|---|---|---|
| HEIKKILA | 84 | PR D29 110 | +Tornqvist, Ono | (HELS, AACHT) |
| ONO | 84 | ZPHY C26 307 | | (ORSAY) |
| SIEGRIST | 82 | PR D26 969 | +Schwitters, Alam, Chinowsky+ | (SLAC, LBL) |
| AUGUSTIN | 75 | PRL 34 764 | +Boyarski, Abrams, Briggs+ | (SLAC, LBL) |
| BACCI | 75 | PL 58B 481 | +Bidoli, Penso, Stella+ | (ROMA, FRAS) |
| BOYARSKI | 75B | PRL 34 762 | +Breidenbach, Abrams, Briggs+ | (SLAC, LBL) |
| ESPOSITO | 75 | PL 58B 478 | +Felicetti, Peruzzi+ | (FRAS, NAPL, PADO, ROMA) |


# $\psi(4160)$

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

$J^{PC}$ for the $\psi(4160)$ is known by its production in $e^+e^-$ collisions via single-photon annihilation. $I^G$ is not known, and the interpretation of this state as a single resonance is unclear because of the expectation of substantial threshold effects in this energy region.

## $\psi(4160)$ MASS

| *VALUE* (MeV) | *DOCUMENT ID* | *TECN* | *COMMENT* |
|---|---|---|---|
| **4159.0±20.0** | BRANDELIK 78C | DASP | $e^+e^-$ |

## $\psi(4160)$ WIDTH

| *VALUE* (MeV) | *DOCUMENT ID* | *TECN* | *COMMENT* |
|---|---|---|---|
| **78.0±20.0** | BRANDELIK 78C | DASP | $e^+e^-$ |

## $\psi(4160)$ DECAY MODES

| | Mode | Fraction ($\Gamma_i/\Gamma$) |
|---|---|---|
| $\Gamma_1$ | $e^+e^-$ | $(10\pm4)\times10^{-6}$ |

## $\psi(4160)$ PARTIAL WIDTHS

### $\Gamma(e^+e^-)$ $\Gamma_1$

| *VALUE* (keV) | *DOCUMENT ID* | *TECN* | *COMMENT* |
|---|---|---|---|
| **0.77±0.23** | BRANDELIK 78C | DASP | $e^+e^-$ |

## $\psi(4160)$ REFERENCES


| | | | | |
|---|---|---|---|---|
| BRANDELIK | 78C | PL 76B 361 | +Cords+ | (DASP Collab.) |


## OTHER RELATED PAPERS


| | | | | |
|---|---|---|---|---|
| ONO | 84 | ZPHY C26 307 | | (ORSAY) |
| KIRKBY | 79B | Fermilab Symp. 107 | | (SLAC) |
| BURMESTER | 77 | PL 66B 395 | +Criegee+ | (DESY, HAMB, SIEG, WUPP) |

# $\psi(4415)$

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

$J^{PC}$ for the $\psi(4415)$ is known by its production in $e^+e^-$ collisions via single-photon annihilation. $I^G$ is not known, and the interpretation of this state as a single resonance is unclear because of the expectation of substantial threshold effects in this energy region.

## $\psi(4415)$ MASS

| *VALUE* (MeV) | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| **4415 ± 6 OUR AVERAGE** | | | | |
| 4417.0±10.0 | BRANDELIK | 78C | DASP | $e^+e^-$ |
| 4414 ± 7 | SIEGRIST | 76 | MRK1 | $e^+e^-$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| ~ 4400 | KNIES | 77 | PLUT | $e^+e^- \rightarrow \mu^+\mu^-$ |

## $\psi(4415)$ WIDTH

| *VALUE* (MeV) | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| **43 ±15 OUR AVERAGE** Error includes scale factor of 1.8. | | | | |
| 66.0±15.0 | BRANDELIK | 78C | DASP | $e^+e^-$ |
| 33 ±10 | SIEGRIST | 76 | MRK1 | $e^+e^-$ |

## $\psi(4415)$ DECAY MODES

| | Mode | Fraction ($\Gamma_i/\Gamma$) |
|---|---|---|
| $\Gamma_1$ | hadrons | dominant |
| $\Gamma_2$ | $e^+e^-$ | $(1.1\pm0.4)\times10^{-5}$ |

## $\psi(4415)$ PARTIAL WIDTHS

### $\Gamma(e^+e^-)$ — $\Gamma_2$

| *VALUE* (keV) | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| **0.47±0.10 OUR AVERAGE** | | | | |
| 0.49±0.13 | BRANDELIK | 78C | DASP | $e^+e^-$ |
| 0.44±0.14 | SIEGRIST | 76 | MRK1 | $e^+e^-$ |

## $\psi(4415)$ BRANCHING RATIOS

### $\Gamma(\text{hadrons})/\Gamma_{\text{total}}$ — $\Gamma_1/\Gamma$

| *VALUE* | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|
| **dominant** | SIEGRIST | 76 | MRK1 | $e^+e^-$ |

## $\psi(4415)$ REFERENCES


| | | | | |
|---|---|---|---|---|
| BRANDELIK | 78C | PL 76B 361 | +Cords+ | (DASP Collab.) |
| KNIES | 77 | Hamburg Symp. 93 | | (PLUTO Collab.) |
| SIEGRIST | 76 | PRL 36 700 | +Abrams, Boyarski, Breidenbach+ | (LBL, SLAC) |


## OTHER RELATED PAPERS


| | | | | |
|---|---|---|---|---|
| BURMESTER | 77 | PL 66B 395 | +Criegee+ | (DESY, HAMB, SIEG, WUPP) |
| LUTH | 77 | PL 70B 120 | +Pierre, Abrams, Alam, Boyarski+ | (LBL, SLAC) |