# $\omega(782)$

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

## $\omega(782)$ MASS

| VALUE (MeV) | EVTS | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **782.66±0.13 OUR AVERAGE** | | Error includes scale factor of 2.0. See the ideogram below. | | | |
| 777.9 ±2.2 $^{+4.3}_{-2.2}$ | 900k | ANDREEV | 20 | H1 | $e p \to e \pi^+ \pi^- p$ |
| 783.20±0.13±0.16 | 18680 | AKHMETSHIN | 05 | CMD2 | 0.60–1.38 $e^+ e^- \to \pi^0 \gamma$ |
| 782.68±0.09±0.04 | 11200 | [1] AKHMETSHIN | 04 | CMD2 | $e^+ e^- \to \pi^+ \pi^- \pi^0$ |
| 782.79±0.08±0.09 | 1.2M | [2] ACHASOV | 03D | RVUE | 0.44–2.00 $e^+ e^- \to \pi^+ \pi^- \pi^0$ |
| 781.96±0.17±0.80 | 11k | [3] AMSLER | 94C | CBAR | 0.0 $\overline{p} p \to \omega \eta \pi^0$ |
| 782.08±0.36±0.82 | 3463 | [4] AMSLER | 94C | CBAR | 0.0 $\overline{p} p \to \omega \eta \pi^0$ |
| 781.96±0.13±0.17 | 15k | AMSLER | 93B | CBAR | 0.0 $\overline{p} p \to \omega \pi^0 \pi^0$ |
| 782.4 ±0.2 | 270k | WEIDENAUER | 93 | ASTE | $\overline{p} p \to 2\pi^+ 2\pi^- \pi^0$ |
| 782.4 ±0.5 | 7000 | [5] KEYNE | 76 | CNTR | $\pi^- p \to \omega n$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| 782.58±0.03±0.01 | | [6] HOID | 20 | RVUE | $e^+ e^- \to \pi^0 \gamma$ |
| 781.68±0.09±0.03 | | [7] COLANGELO | 19 | RVUE | $e^+ e^- \to \pi^+ \pi^-$ |
| 782.63±0.03±0.01 | | [8] HOFERICHT... | 19 | RVUE | $e^+ e^- \to \pi^+ \pi^- \pi^0$ |
| 781.91±0.24 | | [9] LEES | 12G | BABR | $e^+ e^- \to \pi^+ \pi^- \gamma$ |
| 782.7 ±0.1 ±1.5 | 19500 | [10] WURZINGER | 95 | SPEC | 1.33 $p d \to {}^3\mathrm{He}\,\omega$ |
| 781.78±0.10 | | [10] BARKOV | 87 | CMD | $e^+ e^- \to \pi^+ \pi^- \pi^0$ |
| 782.2 ±0.4 | 1488 | [11] KURDADZE | 83B | OLYA | $e^+ e^- \to \pi^+ \pi^- \pi^0$ |
| 783.3 ±0.4 | 433 | CORDIER | 80 | DM1 | $e^+ e^- \to \pi^+ \pi^- \pi^0$ |
| 782.5 ±0.8 | 33260 | ROOS | 80 | RVUE | 0.0–3.6 $\overline{p} p$ |
| 782.6 ±0.8 | 3000 | BENKHEIRI | 79 | OMEG | 9–12 $\pi^\pm p$ |
| 781.8 ±0.6 | 1430 | COOPER | 78B | HBC | 0.7–0.8 $\overline{p} p \to 5\pi$ |
| 782.7 ±0.9 | 535 | VANAPEL... | 78 | HBC | 7.2 $\overline{p} p \to \overline{p} p \omega$ |
| 783.5 ±0.8 | 2100 | GESSAROLI | 77 | HBC | 11 $\pi^- p \to \omega n$ |
| 782.5 ±0.8 | 418 | AGUILAR-... | 72B | HBC | 3.9,4.6 $K^- p$ |
| 783.4 ±1.0 | 248 | BIZZARRI | 71 | HBC | 0.0 $p \overline{p} \to K^+ K^- \omega$ |
| 781.0 ±0.6 | 510 | BIZZARRI | 71 | HBC | 0.0 $p \overline{p} \to K_1 K_1 \omega$ |
| 783.7 ±1.0 | 3583 | [12] COYNE | 71 | HBC | 3.7 $\pi^+ p \to p \pi^+ \pi^+ \pi^- \pi^0$ |
| 784.1 ±1.2 | 750 | ABRAMOVI... | 70 | HBC | 3.9 $\pi^- p$ |
| 783.2 ±1.6 | | [13] BIGGS | 70B | CNTR | <4.1 $\gamma \mathrm{C} \to \pi^+ \pi^- \mathrm{C}$ |
| 782.4 ±0.5 | 2400 | BIZZARRI | 69 | HBC | 0.0 $\overline{p} p$ |

[1] Update of AKHMETSHIN 00C.

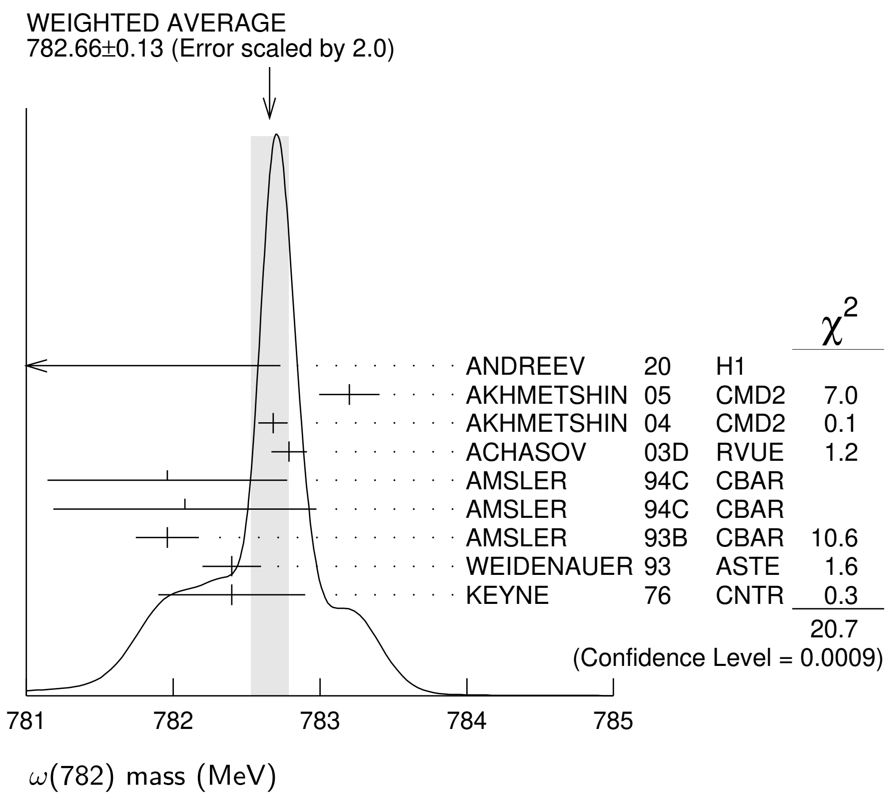
[2] From the combined fit of ANTONELLI 92, ACHASOV 01E, ACHASOV 02E, and ACHASOV 03D data on the $\pi^+ \pi^- \pi^0$ and ANTONELLI 92 on the $\omega \pi^+ \pi^-$ final states. Supersedes ACHASOV 99E and ACHASOV 02E.

[3] From the $\eta \to \gamma \gamma$ decay.

[4] From the $\eta \to 3\pi^0$ decay.

[5] Observed by threshold-crossing technique. Mass resolution = 4.8 MeV FWHM.

[6] The values were extracted from a dispersively improved Breit-Wigner parameterization and do not include vacuum polarization. Inclusion of vacuum polarization gives 782.736 ± 0.024 MeV.
[7] The $\omega$ mass was extracted from a dispersively improved Breit-Wigner parameterization, the $\omega$ width fixed at 8.49 ± 0.08 MeV. The value does not include vacuum polarization which would shift the mass to 781.81 ± 0.09 ± 0.03 MeV. The mixing parameter is assumed real valued.
[8] The values were extracted from a dispersively improved Breit-Wigner parameterization and do not include vacuum polarization.
[9] From the $\rho-\omega$ interference in the $\pi^+\pi^-$ mass spectrum using the Breit-Wigner for the $\omega$ and leaving its mass and width as free parameters of the fit.
[10] Systematic uncertainties underestimated.
[11] Systematic uncertainties not estimated.
[12] From best-resolution sample of COYNE 71.
[13] From $\omega$-$\rho$ interference in the $\pi^+\pi^-$ mass spectrum assuming $\omega$ width 12.6 MeV.




## $\omega$(782) WIDTH

| *VALUE* (MeV) | *EVTS* | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|---|
| **8.68±0.13 OUR AVERAGE** | | | | | |
| 8.68±0.23±0.10 | 11200 | [1] AKHMETSHIN | 04 | CMD2 | $e^+e^- \to \pi^+\pi^-\pi^0$ |
| 8.68±0.04±0.15 | 1.2M | [2] ACHASOV | 03D | RVUE | 0.44–2.00 $e^+e^- \to \pi^+\pi^-\pi^0$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| 8.65±0.06±0.01 | | [3] HOID | 20 | RVUE | $e^+e^- \to \pi^0\gamma$ |
| 8.71±0.04±0.04 | | [4] HOFERICHT... | 19 | RVUE | $e^+e^- \to \pi^+\pi^-\pi^0$ |
| 8.13±0.45 | | [5] LEES | 12G | BABR | $e^+e^- \to \pi^+\pi^-\gamma$ |

| | | | | | |
|---|---|---|---|---|---|
| 8.2 ±0.3 | 19500 | [6] WURZINGER | 95 | SPEC | 1.33 $p d \to {}^3\mathrm{He}\omega$ |
| 8.4 ±0.1 | | [7] AULCHENKO | 87 | ND | $e^+ e^- \to \pi^+ \pi^- \pi^0$ |
| 8.30±0.40 | | [6] BARKOV | 87 | CMD | $e^+ e^- \to \pi^+ \pi^- \pi^0$ |
| 9.8 ±0.9 | 1488 | [8] KURDADZE | 83B | OLYA | $e^+ e^- \to \pi^+ \pi^- \pi^0$ |
| 9.0 ±0.8 | 433 | [6] CORDIER | 80 | DM1 | $e^+ e^- \to \pi^+ \pi^- \pi^0$ |
| 12 ±2 | 1430 | COOPER | 78B | HBC | 0.7–0.8 $\overline{p} p \to 5\pi$ |
| 9.4 ±2.5 | 2100 | GESSAROLI | 77 | HBC | 11 $\pi^- p \to \omega n$ |
| 10.22±0.43 | 20000 | [9] KEYNE | 76 | CNTR | $\pi^- p \to \omega n$ |
| 13.3 ±2 | 418 | AGUILAR-... | 72B | HBC | 3.9,4.6 $K^- p$ |
| 9.1 ±0.8 | 451 | [6] BENAKSAS | 72B | OSPK | $e^+ e^- \to \pi^+ \pi^- \pi^0$ |
| 10.5 ±1.5 | | BORENSTEIN | 72 | HBC | 2.18 $K^- p$ |
| 7.70±0.9 ±1.15 | 940 | BROWN | 72 | MMS | 2.5 $\pi^- p \to n$MM |
| 10.3 ±1.4 | 510 | BIZZARRI | 71 | HBC | 0.0 $p\overline{p} \to K_1 K_1 \omega$ |
| 12.8 ±3.0 | 248 | BIZZARRI | 71 | HBC | 0.0 $p\overline{p} \to K^+ K^- \omega$ |
| 9.5 ±1.0 | 3583 | COYNE | 71 | HBC | 3.7 $\pi^+ p \to p \pi^+ \pi^+ \pi^- \pi^0$ |

[1] Update of AKHMETSHIN 00C.
[2] From the combined fit of ANTONELLI 92, ACHASOV 01E, ACHASOV 02E, and ACHASOV 03D data on the $\pi^+ \pi^- \pi^0$ and ANTONELLI 92 on the $\omega \pi^+ \pi^-$ final states. Supersedes ACHASOV 99E and ACHASOV 02E.
[3] The values were extracted from a dispersively improved Breit-Wigner parameterization and do not include vacuum polarization. Inclusion of vacuum polarization gives 8.63 ± 0.05 MeV.
[4] The values were extracted from a dispersively improved Breit-Wigner parameterization and do not include vacuum polarization.
[5] From the $\rho - \omega$ interference in the $\pi^+ \pi^-$ mass spectrum using the Breit-Wigner for the $\omega$ and leaving its mass and width as free parameters of the fit.
[6] Systematic uncertainties underestimated.
[7] Relativistic Breit-Wigner includes radiative corrections. Systematic uncertainties not estimated.
[8] Systematic uncertainties not estimated.
[9] Observed by threshold-crossing technique. Mass resolution = 4.8 MeV FWHM.

## $\omega(782)$ DECAY MODES

| | Mode | Fraction ($\Gamma_i/\Gamma$) | Scale factor/ Confidence level |
|---|---|---|---|
| $\Gamma_1$ | $\pi^+ \pi^- \pi^0$ | $(89.2 \pm 0.7)$ % | |
| $\Gamma_2$ | $\pi^0 \gamma$ | $(8.35 \pm 0.27)$ % | S=2.2 |
| $\Gamma_3$ | $\pi^+ \pi^-$ | $(1.53^{+0.11}_{-0.13})$ % | S=1.2 |
| $\Gamma_4$ | neutrals (excluding $\pi^0 \gamma$) | $(7\ {}^{+8}_{-4}) \times 10^{-3}$ | S=1.1 |
| $\Gamma_5$ | $\eta \gamma$ | $(4.5 \pm 0.4) \times 10^{-4}$ | S=1.1 |
| $\Gamma_6$ | $\pi^0 e^+ e^-$ | $(7.7 \pm 0.6) \times 10^{-4}$ | |
| $\Gamma_7$ | $\pi^0 \mu^+ \mu^-$ | $(1.34 \pm 0.18) \times 10^{-4}$ | S=1.5 |
| $\Gamma_8$ | $\eta e^+ e^-$ | | |
| $\Gamma_9$ | $e^+ e^-$ | $(7.38 \pm 0.22) \times 10^{-5}$ | S=1.9 |
| $\Gamma_{10}$ | $\pi^+ \pi^- \pi^0 \pi^0$ | $< 2 \times 10^{-4}$ | CL=90% |
| $\Gamma_{11}$ | $\pi^+ \pi^- \gamma$ | $< 3.6 \times 10^{-3}$ | CL=95% |

| | | | | | |
|---|---|---|---|---|---|
| $\Gamma_{12}$ | $\pi^+\pi^-\pi^+\pi^-$ | | < 1 | $\times 10^{-3}$ | CL=90% |
| $\Gamma_{13}$ | $\pi^0\pi^0\gamma$ | | ( 6.7 ±1.1 ) | $\times 10^{-5}$ | |
| $\Gamma_{14}$ | $\eta\pi^0\gamma$ | | < 3.3 | $\times 10^{-5}$ | CL=90% |
| $\Gamma_{15}$ | $\mu^+\mu^-$ | | ( 7.4 ±1.8 ) | $\times 10^{-5}$ | |
| $\Gamma_{16}$ | $3\gamma$ | | < 1.9 | $\times 10^{-4}$ | CL=95% |

**Charge conjugation ($C$) violating modes**

| | | | | | |
|---|---|---|---|---|---|
| $\Gamma_{17}$ | $\eta\pi^0$ | $C$ | < 2.1 | $\times 10^{-4}$ | CL=90% |
| $\Gamma_{18}$ | $2\pi^0$ | $C$ | < 2.2 | $\times 10^{-4}$ | CL=90% |
| $\Gamma_{19}$ | $3\pi^0$ | $C$ | < 2.3 | $\times 10^{-4}$ | CL=90% |
| $\Gamma_{20}$ | invisible | | < 7 | $\times 10^{-5}$ | CL=90% |

## CONSTRAINED FIT INFORMATION

An overall fit to 15 branching ratios uses 48 measurements and one constraint to determine 10 parameters. The overall fit has a $\chi^2 = 48.0$ for 39 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, $x_i \equiv \Gamma_i/\Gamma_{total}$. The fit constrains the $x_i$ whose labels appear in this array to sum to one.

| | $x_1$ | $x_2$ | $x_3$ | $x_4$ | $x_5$ | $x_6$ | $x_7$ | $x_9$ | $x_{13}$ |
|---|---|---|---|---|---|---|---|---|---|
| $x_2$ | 23 | | | | | | | | |
| $x_3$ | −18 | −4 | | | | | | | |
| $x_4$ | −92 | −55 | 1 | | | | | | |
| $x_5$ | 7 | 23 | −1 | −15 | | | | | |
| $x_6$ | −1 | 0 | 0 | 0 | 0 | | | | |
| $x_7$ | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| $x_9$ | −24 | −73 | 4 | 47 | −31 | 0 | 0 | | |
| $x_{13}$ | 1 | 4 | 0 | −2 | 1 | 0 | 0 | −3 | |
| $x_{15}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

## $\omega$(782) PARTIAL WIDTHS

### $\Gamma(\pi^0\gamma)$ $\Gamma_2$

| VALUE (keV) | EVTS | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| 880±50 | 7815 | [1] ACHASOV | 13 | SND | 1.05–2.00 $e^+e^- \to \pi^0\pi^0\gamma$ |
| 788±12±27 | 36500 | [2] ACHASOV | 03 | SND | 0.60–0.97 $e^+e^- \to \pi^0\gamma$ |
| 764±51 | 10625 | DOLINSKY | 89 | ND | $e^+e^- \to \pi^0\gamma$ |

[1] Systematic uncertainty not estimated.
[2] Using $\Gamma_\omega = 8.44 \pm 0.09$ MeV and B($\omega \to \pi^0\gamma$) from ACHASOV 03.

### $\Gamma(\eta\gamma)$ — $\Gamma_5$

| VALUE (keV) | DOCUMENT ID | TECN | COMMENT |
|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | |
| 6.1±2.5 | [1] DOLINSKY 89 | ND | $e^+e^- \to \eta\gamma$ |

[1] Using $\Gamma_\omega = 8.4 \pm 0.1$ MeV and B($\omega \to \eta\gamma$) from DOLINSKY 89.

### $\Gamma(e^+e^-)$ — $\Gamma_9$

| VALUE (keV) | EVTS | DOCUMENT ID | TECN | COMMENT |
|---|---|---|---|---|
| **0.60 ±0.02 OUR EVALUATION** | | | | |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 0.591±0.015 | 11200 | [1,2] AKHMETSHIN 04 | CMD2 | $e^+e^- \to \pi^+\pi^-\pi^0$ |
| 0.653±0.003±0.021 | 1.2M | [3] ACHASOV 03D | RVUE | 0.44–2.00 $e^+e^- \to \pi^+\pi^-\pi^0$ |
| 0.600±0.031 | 10625 | DOLINSKY 89 | ND | $e^+e^- \to \pi^0\gamma$ |

[1] Using B($\omega \to \pi^+\pi^-\pi^0$) = 0.891 ± 0.007 and $\Gamma_{total}$ = 8.44 ± 0.09 MeV.
[2] Update of AKHMETSHIN 00C.
[3] Using ACHASOV 03, ACHASOV 03D and B($\omega \to \pi^+\pi^-$) = (1.70 ± 0.28)%.

## $\omega$(782) $\Gamma(i)\Gamma(e^+e^-)/\Gamma(total)$

### $\Gamma(\pi^+\pi^-\pi^0) \times \Gamma(e^+e^-)/\Gamma_{total}$ — $\Gamma_1\Gamma_9/\Gamma$

| VALUE (eV) | DOCUMENT ID | TECN | COMMENT |
|---|---|---|---|
| **569.8±3.1±8.2** | [1] LEES 21B | BABR | 10.5 $e^+e^- \to \pi^+\pi^-\pi^0\gamma$ |

[1] From the cross section for $e^+e^- \to \pi^+\pi^-\pi^0$ with contributions from $\rho$(770), $\omega$(782), $\phi$(1020), $\omega$(1420), and $\omega$(1650).

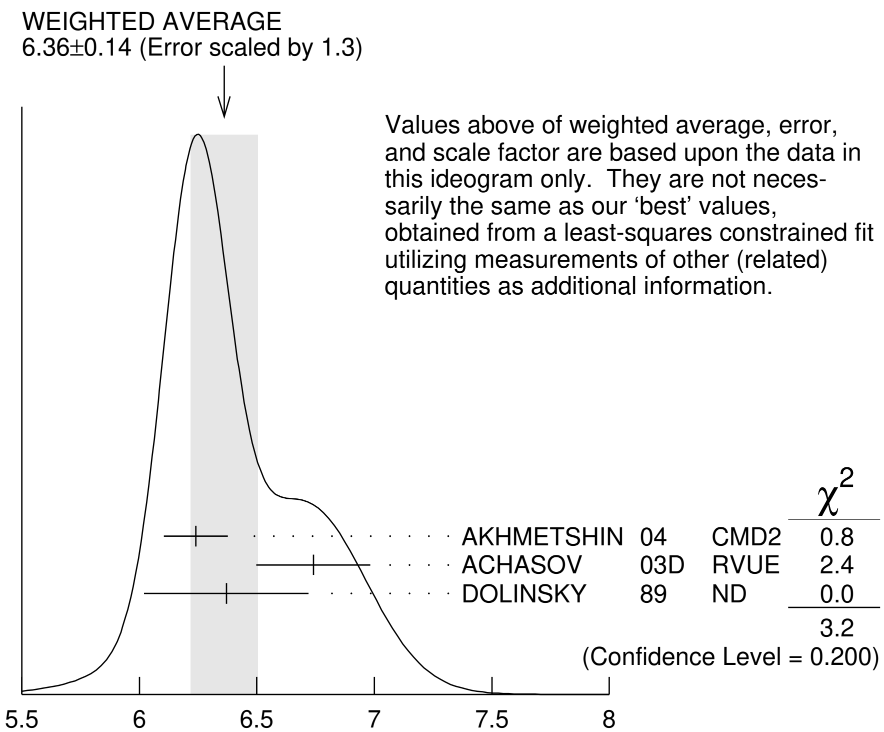
## $\omega$(782) $\Gamma(e^+e^-)\Gamma(i)/\Gamma^2(total)$

### $\Gamma(e^+e^-)/\Gamma_{total} \times \Gamma(\pi^+\pi^-\pi^0)/\Gamma_{total}$ — $\Gamma_9/\Gamma \times \Gamma_1/\Gamma$

| VALUE (units $10^{-5}$) | EVTS | DOCUMENT ID | TECN | COMMENT |
|---|---|---|---|---|
| **6.59±0.19 OUR FIT** Error includes scale factor of 2.1. | | | | |
| **6.36±0.14 OUR AVERAGE** Error includes scale factor of 1.3. See the ideogram below. | | | | |
| 6.24±0.11±0.08 | 11.2k | [1] AKHMETSHIN 04 | CMD2 | $e^+e^- \to \pi^+\pi^-\pi^0$ |
| 6.74±0.04±0.24 | 1.2M | [2,3] ACHASOV 03D | RVUE | 0.44–2.00 $e^+e^- \to \pi^+\pi^-\pi^0$ |
| 6.37±0.35 | | [2] DOLINSKY 89 | ND | $e^+e^- \to \pi^+\pi^-\pi^0$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 6.20±0.13 | | [4] BENAYOUN 10 | RVUE | 0.4–1.05 $e^+e^-$ |
| 6.70±0.06±0.27 | | [5] AUBERT,B 04N | BABR | 10.6 $e^+e^- \to \pi^+\pi^-\pi^0\gamma$ |
| 6.45±0.24 | | [6] BARKOV 87 | CMD | $e^+e^- \to \pi^+\pi^-\pi^0$ |
| 5.79±0.42 | 1488 | [7] KURDADZE 83B | OLYA | $e^+e^- \to \pi^+\pi^-\pi^0$ |
| 5.89±0.54 | 433 | [6] CORDIER 80 | DM1 | $e^+e^- \to \pi^+\pi^-\pi^0$ |
| 7.54±0.84 | 451 | [6] BENAKSAS 72B | OSPK | $e^+e^- \to \pi^+\pi^-\pi^0$ |

[1] Update of AKHMETSHIN 00C.
[2] Recalculated by us from the cross section in the peak.

[3] From the combined fit of ANTONELLI 92, ACHASOV 01E, ACHASOV 02E, and ACHASOV 03D data on the $\pi^+\pi^-\pi^0$ and ANTONELLI 92 on the $\omega\pi^+\pi^-$ final states. Supersedes ACHASOV 99E and ACHASOV 02E.
[4] A simultaneous fit of $e^+e^- \to \pi^+\pi^-$, $\pi^+\pi^-\pi^0$, $\pi^0\gamma$, $\eta\gamma$ data.
[5] Superseeded by LEES 21B.
[6] Recalculated by us from the cross section in the peak. Systematic uncertainties underestimated.
[7] Recalculated by us from the cross section in the peak. Systematic uncertainties not estimated.




$\Gamma(e^+e^-)/\Gamma_{total} \times \Gamma(\pi^+\pi^-\pi^0)/\Gamma_{total}$ (units $10^{-5}$)

## $\Gamma(e^+e^-)/\Gamma_{total} \times \Gamma(\pi^0\gamma)/\Gamma_{total}$ $\qquad$ $\Gamma_9/\Gamma \times \Gamma_2/\Gamma$

| VALUE (units $10^{-6}$) | EVTS | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **6.16 ±0.14 OUR FIT** Error includes scale factor of 1.8. | | | | | |
| **6.34 ±0.10 OUR AVERAGE** | | | | | |
| 6.336±0.056±0.089 | | [1] ACHASOV | 16A | SND | 0.60–1.38 $e^+e^- \to \pi^0\gamma$ |
| 6.47 ±0.14 ±0.39 | 18k | AKHMETSHIN | 05 | CMD2 | 0.60-1.38 $e^+e^- \to \pi^0\gamma$ |
| 6.34 ±0.21 ±0.21 | 10k | [2] DOLINSKY | 89 | ND | $e^+e^- \to \pi^0\gamma$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| 6.80 ±0.13 | | [3] BENAYOUN | 10 | RVUE | 0.4–1.05 $e^+e^-$ |
| 6.50 ±0.11 ±0.20 | 36k | [4] ACHASOV | 03 | SND | 0.60–0.97 $e^+e^- \to \pi^0\gamma$ |

[1] From the VMD model with the interfering $\rho(770)$, $\omega(782)$, $\phi(1020)$, and an additional resonance describing the total contribution of the $\rho(1450)$ and $\omega(1420)$ states. Supersedes ACHASOV 03.
[2] Recalculated by us from the cross section in the peak.
[3] A simultaneous fit of $e^+e^- \to \pi^+\pi^-$, $\pi^+\pi^-\pi^0$, $\pi^0\gamma$, $\eta\gamma$ data.
[4] Using $\sigma(\phi \to \pi^0\gamma)$ from ACHASOV 00 and $m_\omega$ = 782.57 MeV in the model with the energy-independent phase of $\rho$-$\omega$ interferenceequal to $(-10.2 \pm 7.0)^\circ$.

## $\Gamma(e^+e^-)/\Gamma_{total} \times \Gamma(\pi^+\pi^-)/\Gamma_{total}$ — $\Gamma_9/\Gamma \times \Gamma_3/\Gamma$

| VALUE (units $10^{-6}$) | EVTS | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **1.28 ±0.05 OUR AVERAGE** | | | | | |
| 1.318±0.051±0.021 | | [1] ACHASOV | 21 | SND | $e^+e^- \rightarrow \pi^+\pi^-$ |
| 1.225±0.058±0.041 | 800k | [2] ACHASOV | 06 | SND | $e^+e^- \rightarrow \pi^+\pi^-$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| 1.166±0.036 | | [3] BENAYOUN | 13 | RVUE | 0.4–1.05 $e^+e^-$ |
| 1.05 ±0.08 | | [4] DAVIER | 13 | RVUE | $e^+e^- \rightarrow \pi^+\pi^-(\gamma)$ |

[1] From a fit of the cross section in the energy range $0.525 < \sqrt{s} < 0.883$ GeV parameterized by the sum of the Breit-Wigner amplitudes for the $\rho(770)$, $\omega$ and $\rho(1450)$ resonances. The measured phase of the $\rho(770)$—$\omega$ interference is $(110.7 \pm 1.5 \pm 1.0)^\circ$.

[2] Supersedes ACHASOV 05A.

[3] A simultaneous fit to $e^+e^- \rightarrow \pi^+\pi^-$, $\pi^+\pi^-\pi^0$, $\pi^0\gamma$, $\eta\gamma$, $K\overline{K}$, and $\tau^- \rightarrow \pi^-\pi^0\nu_\tau$ data. Supersedes BENAYOUN 10.

[4] From $e^+e^- \rightarrow \pi^+\pi^-(\gamma)$ data of LEES 12G.

## $\Gamma(e^+e^-)/\Gamma_{total} \times \Gamma(\eta\gamma)/\Gamma_{total}$ — $\Gamma_9/\Gamma \times \Gamma_5/\Gamma$

| VALUE (units $10^{-8}$) | EVTS | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **3.32±0.28 OUR FIT** Error includes scale factor of 1.1. | | | | | |
| **3.18±0.28 OUR AVERAGE** | | | | | |
| 3.10±0.31±0.11 | 33k | [1] ACHASOV | 07B | SND | 0.6–1.38 $e^+e^- \rightarrow \eta\gamma$ |
| $3.17^{+1.85}_{-1.31}$±0.21 | 17.4k | [2] AKHMETSHIN | 05 | CMD2 | 0.60-1.38 $e^+e^- \rightarrow \eta\gamma$ |
| 3.41±0.52±0.21 | 23k | [3,4] AKHMETSHIN | 01B | CMD2 | $e^+e^- \rightarrow \eta\gamma$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| 4.50±0.10 | | [5] BENAYOUN | 10 | RVUE | 0.4–1.05 $e^+e^-$ |

[1] From a combined fit of $\sigma(e^+e^- \rightarrow \eta\gamma)$ with $\eta \rightarrow 3\pi^0$ and $\eta \rightarrow \pi^+\pi^-\pi^0$, and fixing $B(\eta \rightarrow 3\pi^0) / B(\eta \rightarrow \pi^+\pi^-\pi^0) = 1.44 \pm 0.04$. Recalculated by us from the cross section at the peak. Supersedes ACHASOV 00D and ACHASOV 06A.

[2] From the $\eta \rightarrow 2\gamma$ decay and using $B(\eta \rightarrow \gamma\gamma) = 39.43 \pm 0.26\%$.

[3] From the $\eta \rightarrow 3\pi^0$ decay and using $B(\eta \rightarrow 3\pi^0) = (32.24 \pm 0.29) \times 10^{-2}$.

[4] The combined fit from 600 to 1380 MeV taking into account $\rho(770)$, $\omega(782)$, $\phi(1020)$, and $\rho(1450)$ (mass and width fixed at 1450 MeV and 310 MeV respectively).

[5] A simultaneous fit of $e^+e^- \rightarrow \pi^+\pi^-$, $\pi^+\pi^-\pi^0$, $\pi^0\gamma$, $\eta\gamma$ data.

## $\Gamma(e^+e^-)/\Gamma_{total} \times \Gamma(\mu^+\mu^-)/\Gamma_{total}$ — $\Gamma_9/\Gamma \times \Gamma_{15}/\Gamma$

| VALUE (units $10^{-9}$) | EVTS | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **4.3±1.8±2.2** | 4.5M | [1] ANASTASI | 17 | KLOE | $e^+e^- \rightarrow \mu^+\mu^-\gamma$ |

[1] From a fit of the real part of the vacuum polarization by a sum of the leptonic and hadronic contributions, where the hadronic contribution is parametrized as a sum of Breit-Wigner resonances $\omega(782)$, $\phi(1020)$ and using a GOUNARIS 68 parametrization for the $\rho(770)$, and a non-resonant term.

# $\omega(782)$ BRANCHING RATIOS

## $\Gamma(\pi^+\pi^-\pi^0)/\Gamma_{total}$ — $\Gamma_1/\Gamma$

NIECKNIG 12 describes final-state interactions between the three pions in a dispersive framework using data on the $\pi\pi$ $P$-wave scattering phase shift.

| VALUE | EVTS | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| 0.9024±0.0019 | | [1] AMBROSINO | 08G | KLOE | 1.0–1.03 $e^+e^- \rightarrow \pi^+\pi^-2\pi^0$, $2\pi^0\gamma$ |
| 0.8965±0.0016±0.0048 | 1.2M | [2,3] ACHASOV | 03D | RVUE | 0.44–2.00 $e^+e^- \rightarrow \pi^+\pi^-\pi^0$ |
| 0.880 ±0.020 ±0.032 | 11200 | [3,4] AKHMETSHIN | 00C | CMD2 | $e^+e^- \rightarrow \pi^+\pi^-\pi^0$ |
| 0.8942±0.0062 | | [3] DOLINSKY | 89 | ND | $e^+e^- \rightarrow \pi^+\pi^-\pi^0$ |

[1] Not independent of $\Gamma(\pi^0\gamma)$ / $\Gamma(\pi^+\pi^-\pi^0)$ from AMBROSINO 08G.
[2] Using ACHASOV 03, ACHASOV 03D and B($\omega \rightarrow \pi^+\pi^-$) = (1.70 ± 0.28)%.
[3] Not independent of the corresponding $\Gamma(e^+e^-) \times \Gamma(\pi^+\pi^-\pi^0)/\Gamma^2_{total}$.
[4] Using $\Gamma(e^+e^-)$=0.60 ± 0.02 keV.

## $\Gamma(\pi^0\gamma)/\Gamma_{total}$ — $\Gamma_2/\Gamma$

| VALUE (units $10^{-2}$) | EVTS | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| 8.88±0.18 | | [1] ACHASOV | 16A | SND | 0.60–1.38 $e^+e^- \rightarrow \pi^0\gamma$ |
| 8.09±0.14 | | [2] AMBROSINO | 08G | KLOE | $e^+e^- \rightarrow \pi^+\pi^-2\pi^0$, $2\pi^0\gamma$ |
| 9.06±0.20±0.57 | 18k | [3,4] AKHMETSHIN | 05 | CMD2 | 0.60-1.38 $e^+e^- \rightarrow \pi^0\gamma$ |
| 9.34±0.15±0.31 | 36k | [4] ACHASOV | 03 | SND | 0.60–0.97 $e^+e^- \rightarrow \pi^0\gamma$ |
| 8.65±0.16±0.42 | 1.2M | [5,6] ACHASOV | 03D | RVUE | 0.44–2.00 $e^+e^- \rightarrow \pi^+\pi^-\pi^0$ |
| 8.39±0.24 | 9k | [7] BENAYOUN | 96 | RVUE | $e^+e^- \rightarrow \pi^0\gamma$ |
| 8.88±0.62 | 10k | [4] DOLINSKY | 89 | ND | $e^+e^- \rightarrow \pi^0\gamma$ |

[1] Using B($\omega \rightarrow e^+e^-$) from PDG 15. Supersedes ACHASOV 03.
[2] Not independent of $\Gamma(\pi^0\gamma)$ / $\Gamma(\pi^+\pi^-\pi^0)$ from AMBROSINO 08G.
[3] Using B($\omega \rightarrow e^+e^-$)= (7.14 ± 0.13) × $10^{-5}$.
[4] Not independent of the corresponding $\Gamma(e^+e^-) \times \Gamma(\pi^0\gamma)/\Gamma^2_{total}$.
[5] Using ACHASOV 03, ACHASOV 03D and B($\omega \rightarrow \pi^+\pi^-$) = (1.70 ± 0.28)%.
[6] Not independent of the corresponding $\Gamma(e^+e^-) \times \Gamma(\pi^+\pi^-\pi^0)/\Gamma^2_{total}$.
[7] Reanalysis of DRUZHININ 84, DOLINSKY 89, DOLINSKY 91 taking into account the triangle anomaly contributions.

## $\Gamma(\pi^0\gamma)/\Gamma(\pi^+\pi^-\pi^0)$ — $\Gamma_2/\Gamma_1$

| VALUE (units $10^{-2}$) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **9.35±0.30 OUR FIT** Error includes scale factor of 2.4. | | | | |
| **9.05±0.27 OUR AVERAGE** Error includes scale factor of 1.8. | | | | |
| 8.97±0.16 | AMBROSINO | 08G | KLOE | $e^+e^- \rightarrow \pi^+\pi^-2\pi^0$, $2\pi^0\gamma$ |
| 9.94±0.36±0.38 | [1] AULCHENKO | 00A | SND | $e^+e^- \rightarrow \pi^+\pi^-2\pi^0$, $2\pi^0\gamma$ |
| 8.4 ±1.3 | KEYNE | 76 | CNTR | $\pi^- p \rightarrow \omega n$ |
| 10.9 ±2.5 | BENAKSAS | 72C | OSPK | $e^+e^- \rightarrow \pi^0\gamma$ |
| 8.1 ±2.0 | BALDIN | 71 | HLBC | 2.9 $\pi^+ p$ |
| 13 ±4 | JACQUET | 69B | HLBC | 2.05 $\pi^+ p \rightarrow \pi^+ p\omega$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 9.7 ±0.2 ±0.5 | [2,3] ACHASOV | 03D | RVUE | 0.44–2.00 $e^+e^- \rightarrow \pi^+\pi^-\pi^0$ |
| 9.9 ±0.7 | [2] DOLINSKY | 89 | ND | $e^+e^- \rightarrow \pi^0\gamma$ |

[1] From $\sigma_0^{\omega\pi^0 \to \pi^0\pi^0\gamma}(m_\phi)/\sigma_0^{\omega\pi^0 \to \pi^+\pi^-\pi^0\pi^0}(m_\phi)$ with a phase-space correction factor of 1/1.023.
[2] Not independent of the corresponding $\Gamma(e^+e^-) \times \Gamma(\pi^0\gamma)/\Gamma^2_{total}$.
[3] Using ACHASOV 03. Based on 1.2M events.

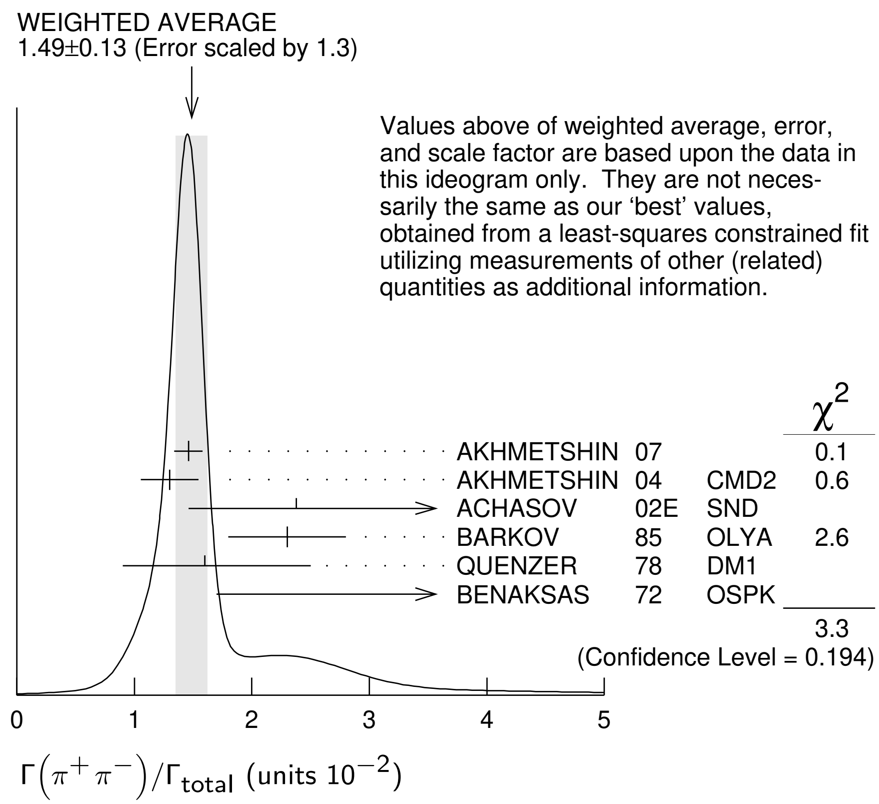
## $\Gamma(\pi^+\pi^-)/\Gamma_{total}$ $\Gamma_3/\Gamma$

See also $\Gamma(\pi^+\pi^-)/\Gamma(\pi^+\pi^-\pi^0)$.

| VALUE (units $10^{-2}$) | EVTS | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **$1.53^{+0.11}_{-0.13}$ OUR FIT** Error includes scale factor of 1.2. | | | | | |
| **1.49±0.13 OUR AVERAGE** Error includes scale factor of 1.3. See the ideogram below. | | | | | |
| 1.46±0.12±0.02 | 900k | [1] AKHMETSHIN | 07 | | $e^+e^- \to \pi^+\pi^-$ |
| 1.30±0.24±0.05 | 11.2k | [2] AKHMETSHIN | 04 | CMD2 | $e^+e^- \to \pi^+\pi^-$ |
| $2.38^{+1.77}_{-0.90}$±0.18 | 5.4k | [3] ACHASOV | 02E | SND | 1.1–1.38 $e^+e^- \to \pi^+\pi^-\pi^0$ |
| 2.3 ±0.5 | | BARKOV | 85 | OLYA | $e^+e^- \to \pi^+\pi^-$ |
| 1.6 $^{+0.9}_{-0.7}$ | | QUENZER | 78 | DM1 | $e^+e^- \to \pi^+\pi^-$ |
| 3.6 ±1.9 | | BENAKSAS | 72 | OSPK | $e^+e^- \to \pi^+\pi^-$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| 1.29±0.22±0.03 | 970k | [4,5] ABLIKIM | 18C | BES3 | $\eta'(958) \to \gamma\pi^+\pi^-$ |
| 1.28±0.22±0.03 | 970k | [6,7] ABLIKIM | 18C | BES3 | $\eta'(958) \to \gamma\pi^+\pi^-$ |
| 1.52±0.08 | | [8] HANHART | 18 | RVUE | $e^+e^- \to \pi^+\pi^-$ |
| 1.75±0.11 | 4.5M | [9] ACHASOV | 05A | SND | $e^+e^- \to \pi^+\pi^-$ |
| 2.01±0.29 | | [10] BENAYOUN | 03 | RVUE | $e^+e^- \to \pi^+\pi^-$ |
| 1.9 ±0.3 | | [11] GARDNER | 99 | RVUE | $e^+e^- \to \pi^+\pi^-$ |
| 2.3 ±0.4 | | [12] BENAYOUN | 98 | RVUE | $e^+e^- \to \pi^+\pi^-$, $\mu^+\mu^-$ |
| 1.0 ±0.11 | | [13] WICKLUND | 78 | ASPK | 3,4,6 $\pi^\pm N$ |
| 1.22±0.30 | | ALVENSLEB... | 71C | CNTR | Photoproduction |
| 1.3 $^{+1.2}_{-0.9}$ | | MOFFEIT | 71 | HBC | 2.8,4.7 $\gamma p$ |
| $0.80^{+0.28}_{-0.20}$ | | [14] BIGGS | 70B | CNTR | $4.2\gamma C \to \pi^+\pi^- C$ |

[1] A combined fit of AKHMETSHIN 07, AULCHENKO 06, and AULCHENKO 05.
[2] Update of AKHMETSHIN 02.
[3] From the $m_{\pi^+\pi^-}$ spectrum taking into account the interference of the $\rho\pi$ and $\omega\pi$ amplitudes.
[4] From a fit to $\pi^+\pi^-$ mass using $\rho(770)$ (parametrized with the Gounaris-Sakurai approach), $\omega(782)$, and box anomaly components.
[5] ABLIKIM 18C reports $[\Gamma(\omega(782) \to \pi^+\pi^-)/\Gamma_{total}] \times [B(\eta'(958) \to \omega\gamma)] = (3.25 \pm 0.21 \pm 0.52) \times 10^{-4}$ which we divide by our best value $B(\eta'(958) \to \omega\gamma) = (2.52 \pm 0.07) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.
[6] From a fit to $\pi^+\pi^-$ mass using $\rho(770)$ (parametrized with the Gounaris-Sakurai approach), $\omega(782)$, and $\rho(1450)$ components.
[7] ABLIKIM 18C reports $[\Gamma(\omega(782) \to \pi^+\pi^-)/\Gamma_{total}] \times [B(\eta'(958) \to \omega\gamma)] = (3.22 \pm 0.21 \pm 0.52) \times 10^{-4}$ which we divide by our best value $B(\eta'(958) \to \omega\gamma) = (2.52 \pm 0.07) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

[8] Dispersive analysis. Value extracted from average of data from AUBERT 09AS, AKHMETSHIN 07, ACHASOV 06, AMBROSINO 11A, BABUSCI 13D, ABLIKIM 16B normalised by PDG 16 evaluation for $\Gamma(\omega \to e^+e^-)$.
[9] Using $\Gamma(\omega \to e^+e^-)$ from the 2004 Edition of this Review (PDG 04).
[10] Using the data of AKHMETSHIN 02 in the hidden local symmetry model.
[11] Using the data of BARKOV 85.
[12] Using the data of BARKOV 85 in the hidden local symmetry model.
[13] From a model-dependent analysis assuming complete coherence.
[14] Re-evaluated under $\Gamma(\pi^+\pi^-)/\Gamma(\pi^+\pi^-\pi^0)$ by BEHREND 71 using more accurate $\omega \to \rho$ photoproduction cross-section ratio.




## $\Gamma(\pi^+\pi^-)/\Gamma(\pi^+\pi^-\pi^0)$ $\Gamma_3/\Gamma_1$

See also $\Gamma(\pi^+\pi^-)/\Gamma_{total}$.

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **0.0172±0.0014 OUR FIT** Error includes scale factor of 1.2. | | | | |
| **0.026 ±0.005 OUR AVERAGE** | | | | |
| $0.021\ ^{+0.028}_{-0.009}$ | [1,2] RATCLIFF | 72 | ASPK | $15\ \pi^- p \to n 2\pi$ |
| $0.028 \pm 0.006$ | [1] BEHREND | 71 | ASPK | Photoproduction |
| $0.022\ ^{+0.009}_{-0.01}$ | [3] ROOS | 70 | RVUE | |

[1] The fitted width of these data is 160 MeV in agreement with present average, thus the $\omega$ contribution is overestimated. Assuming $\rho$ width 145 MeV.
[2] Significant interference effect observed. NB of $\omega \to 3\pi$ comes from an extrapolation.
[3] ROOS 70 combines ABRAMOVICH 70 and BIZZARRI 70.

### $\Gamma(\pi^+\pi^-)/\Gamma(\pi^0\gamma)$ — $\Gamma_3/\Gamma_2$

| VALUE | EVTS | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **0.20±0.04** | 1.98M | [1] ALOISIO | 03 | KLOE | 1.02 $e^+e^- \to \pi^+\pi^-\pi^0$ |

[1] Using the data of ALOISIO 02D.

### $\Gamma(\text{neutrals})/\Gamma_{\text{total}}$ — $(\Gamma_2+\Gamma_4)/\Gamma$

| VALUE | EVTS | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **0.091±0.006 OUR FIT** | | | | | |
| **0.081±0.011 OUR AVERAGE** | | | | | |
| 0.075±0.025 | | BIZZARRI | 71 | HBC | 0.0 $p\overline{p}$ |
| 0.079±0.019 | | DEINET | 69B | OSPK | 1.5 $\pi^- p$ |
| 0.084±0.015 | | BOLLINI | 68C | CNTR | 2.1 $\pi^- p$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| 0.073±0.018 | 42 | BASILE | 72B | CNTR | 1.67 $\pi^- p$ |

### $\Gamma(\text{neutrals})/\Gamma(\pi^+\pi^-\pi^0)$ — $(\Gamma_2+\Gamma_4)/\Gamma_1$

| VALUE | EVTS | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **0.102±0.008 OUR FIT** | | | | | |
| **$0.103^{+0.011}_{-0.010}$ OUR AVERAGE** | | | | | |
| 0.15 ±0.04 | 46 | AGUILAR-... | 72B | HBC | 3.9,4.6 $K^- p$ |
| 0.10 ±0.03 | 19 | BARASH | 67B | HBC | 0.0 $\overline{p}p$ |
| 0.134±0.026 | 850 | DIGIUGNO | 66B | CNTR | 1.4 $\pi^- p$ |
| 0.097±0.016 | 348 | FLATTE | 66 | HBC | 1.4 – 1.7 $K^- p \to \Lambda$MM |
| $0.06^{+0.05}_{-0.02}$ | | JAMES | 66 | HBC | 2.1 $\pi^+ p$ |
| 0.08 ±0.03 | 35 | KRAEMER | 64 | DBC | 1.2 $\pi^+ d$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| 0.11 ±0.02 | 20 | BUSCHBECK | 63 | HBC | 1.5 $K^- p$ |

### $\Gamma(\pi^0\gamma)/\Gamma(\text{neutrals})$ — $\Gamma_2/(\Gamma_2+\Gamma_4)$

| VALUE | CL% | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| 0.78±0.07 | | [1] DAKIN | 72 | OSPK | 1.4 $\pi^- p \to n$MM |
| >0.81 | 90 | DEINET | 69B | OSPK | |

[1] Error statistical only. Authors obtain good fit also assuming $\pi^0\gamma$ as the only neutral decay.

### $\Gamma(\text{neutrals})/\Gamma(\text{charged particles})$ — $(\Gamma_2+\Gamma_4)/(\Gamma_1+\Gamma_3)$

| VALUE | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| **0.100±0.008 OUR FIT** | | | | |
| **0.124±0.021** | FELDMAN | 67C | OSPK | 1.2 $\pi^- p$ |

## $\Gamma(\eta\gamma)/\Gamma_{total}$ — $\Gamma_5/\Gamma$

| VALUE (units $10^{-4}$) | EVTS | DOCUMENT ID | TECN | COMMENT |
|---|---|---|---|---|
| **4.5 ±0.4 OUR FIT** Error includes scale factor of 1.1. | | | | |
| **6.3 ±1.3 OUR AVERAGE** Error includes scale factor of 1.2. | | | | |
| 6.6 ±1.7 | | [1] ABELE 97E | CBAR | 0.0 $\overline{p}p \to 5\gamma$ |
| 8.3 ±2.1 | | ALDE 93 | GAM2 | $38\pi^- p \to \omega n$ |
| $3.0\ ^{+2.5}_{-1.8}$ | | [2] ANDREWS 77 | CNTR | 6.7–10 $\gamma$Cu |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| 4.2 ±0.4 ±0.1 | 33k | [3] ACHASOV 07B | SND | 0.6–1.38 $e^+e^- \to \eta\gamma$ |
| $4.44^{+2.59}_{-1.83}\pm0.28$ | 17.4k | [4,5] AKHMETSHIN 05 | CMD2 | 0.60-1.38 $e^+e^- \to \eta\gamma$ |
| 5.10±0.72±0.34 | 23k | [6] AKHMETSHIN 01B | CMD2 | $e^+e^- \to \eta\gamma$ |
| 0.7 to 5.5 | | [7] CASE 00 | CBAR | 0.0 $p\overline{p} \to \eta\eta\gamma$ |
| $6.56^{+2.41}_{-2.55}$ | 3525 | [2,8] BENAYOUN 96 | RVUE | $e^+e^- \to \eta\gamma$ |
| 7.3 ±2.9 | | [2,4] DOLINSKY 89 | ND | $e^+e^- \to \eta\gamma$ |

[1] No flat $\eta\eta\gamma$ background assumed.
[2] Solution corresponding to constructive $\omega$-$\rho$ interference.
[3] ACHASOV 07B reports $[\Gamma(\omega(782) \to \eta\gamma)/\Gamma_{total}] \times [B(\omega(782) \to e^+e^-)] = (3.10 \pm 0.31 \pm 0.11) \times 10^{-8}$ which we divide by our best value $B(\omega(782) \to e^+e^-) = (7.38 \pm 0.22) \times 10^{-5}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. Supersedes ACHASOV 00D and ACHASOV 06A.
[4] Not independent of the corresponding $\Gamma(e^+e^-) \times \Gamma(\eta\gamma)/\Gamma^2_{total}$.
[5] Using $B(\omega \to e^+e^-) = (7.14 \pm 0.13) \times 10^{-5}$ and $B(\eta \to \gamma\gamma) = 39.43 \pm 0.26\%$.
[6] Using $B(\omega \to e^+e^-) = (7.07 \pm 0.19) \times 10^{-5}$ and using $B(\eta \to 3\pi^0) = (32.24 \pm 0.29) \times 10^{-2}$. Solution corresponding to constructive $\omega$-$\rho$ interference. The combined fit from 600 to 1380 MeV taking into account $\rho(770)$, $\omega(782)$, $\phi(1020)$, and $\rho(1450)$ (mass and width fixed at 1450 MeV and 310 MeV respectively). Not independent of the corresponding $\Gamma(e^+e^-) \times \Gamma(\eta\gamma)/\Gamma^2_{total}$.
[7] Depending on the degree of coherence with the flat $\eta\eta\gamma$ background and using $B(\omega \to \pi^0\gamma) = (8.5 \pm 0.5) \times 10^{-2}$.
[8] Reanalysis of DRUZHININ 84, DOLINSKY 89, DOLINSKY 91 taking into account the triangle anomaly contributions.

## $\Gamma(\eta\gamma)/\Gamma(\pi^0\gamma)$ — $\Gamma_5/\Gamma_2$

| VALUE | DOCUMENT ID | TECN | COMMENT |
|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | |
| 0.0098±0.0024 | [1] ALDE 93 | GAM2 | $38\pi^- p \to \omega n$ |
| 0.0082±0.0033 | [2] DOLINSKY 89 | ND | $e^+e^- \to \eta\gamma$ |
| 0.010 ±0.045 | APEL 72B | OSPK | 4–8 $\pi^- p \to n 3\gamma$ |

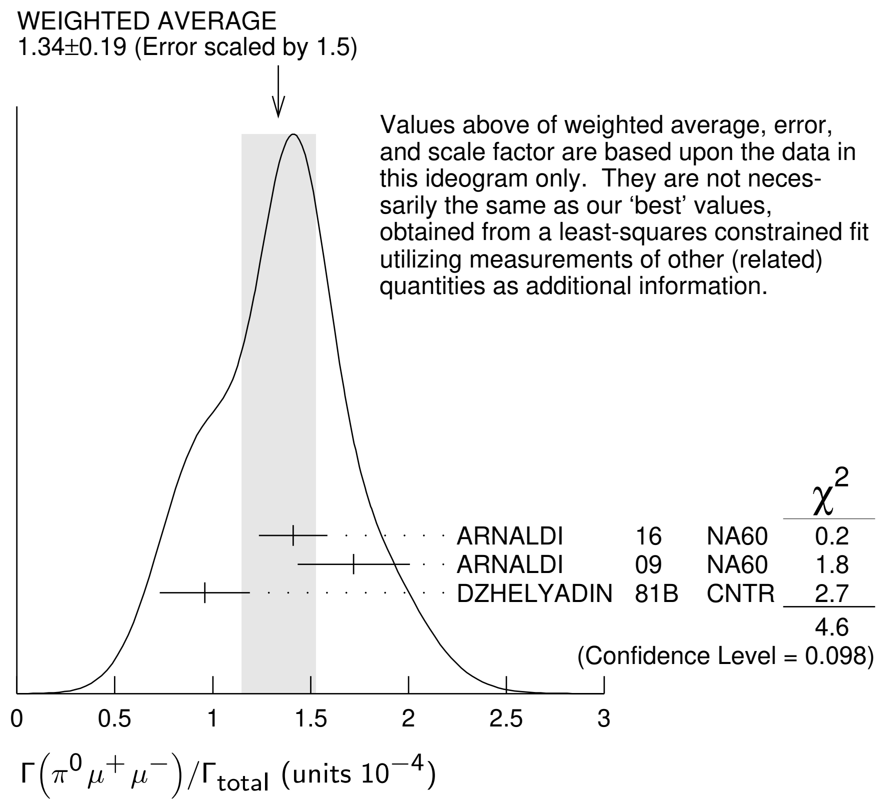
[1] Model independent determination.
[2] Solution corresponding to constructive $\omega$-$\rho$ interference.

## $\Gamma(\pi^0 e^+e^-)/\Gamma_{total}$ — $\Gamma_6/\Gamma$

| VALUE (units $10^{-4}$) | EVTS | DOCUMENT ID | TECN | COMMENT |
|---|---|---|---|---|
| **7.7 ±0.6 OUR FIT** | | | | |
| **7.7 ±0.6 OUR AVERAGE** | | | | |
| 7.61±0.53±0.64 | | ACHASOV 08 | SND | 0.36–0.97 $e^+e^- \to \pi^0 e^+e^-$ |
| 8.19±0.71±0.62 | | AKHMETSHIN 05A | CMD2 | 0.72-0.84 $e^+e^-$ |
| 5.9 ±1.9 | 43 | DOLINSKY 88 | ND | $e^+e^- \to \pi^0 e^+e^-$ |

## $\Gamma(\pi^0\mu^+\mu^-)/\Gamma_{total}$ $\Gamma_7/\Gamma$

| VALUE (units $10^{-4}$) | EVTS | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **1.34±0.18 OUR FIT** Error includes scale factor of 1.5. | | | | | |
| **1.34±0.19 OUR AVERAGE** Error includes scale factor of 1.5. See the ideogram below. | | | | | |
| 1.41±0.09±0.15 | | ARNALDI | 16 | NA60 | 400 GeV ($p$-$A$) collisions |
| 1.72±0.25±0.14 | 3k | ARNALDI | 09 | NA60 | 158$A$ In−In collisions |
| 0.96±0.23 | | DZHELYADIN | 81B | CNTR | 25–33 $\pi^- p \to \omega n$ |




## $\Gamma(\eta e^+ e^-)/\Gamma_{total}$ $\Gamma_8/\Gamma$

| VALUE (units $10^{-5}$) | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| <1.1 | AKHMETSHIN | 05A | CMD2 | 0.72-0.84 $e^+e^-$ |

## $\Gamma(e^+e^-)/\Gamma_{total}$ $\Gamma_9/\Gamma$

| VALUE (units $10^{-4}$) | EVTS | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **0.738±0.022 OUR FIT** Error includes scale factor of 1.9. | | | | | |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| 0.700±0.016 | 11200 | [1,2] AKHMETSHIN | 04 | CMD2 | $e^+e^- \to \pi^+\pi^-\pi^0$ |
| 0.752±0.004±0.024 | 1.2M | [2,3] ACHASOV | 03D | RVUE | 0.44–2.00 $e^+e^- \to \pi^+\pi^-\pi^0$ |
| 0.714±0.036 | | [2] DOLINSKY | 89 | ND | $e^+e^- \to \pi^+\pi^-\pi^0$ |
| 0.72 ±0.03 | | [2] BARKOV | 87 | CMD | $e^+e^- \to \pi^+\pi^-\pi^0$ |
| 0.64 ±0.04 | 1488 | [2] KURDADZE | 83B | OLYA | $e^+e^- \to \pi^+\pi^-\pi^0$ |

| | | | | | |
|---|---|---|---|---|---|
| 0.675±0.069 | 433 | [2] CORDIER | 80 | DM1 | $e^+ e^- \to \pi^+ \pi^- \pi^0$ |
| 0.83 ±0.10 | 451 | [2] BENAKSAS | 72B | OSPK | $e^+ e^- \to \pi^+ \pi^- \pi^0$ |
| 0.77 ±0.06 | | [4] AUGUSTIN | 69D | OSPK | $e^+ e^- \to \pi^+ \pi^- \pi^0$ |
| 0.65 ±0.13 | 33 | [5] ASTVACAT... | 68 | OSPK | Assume SU(3)+mixing |

[1] Using B($\omega \to \pi^+ \pi^- \pi^0$) = 0.891 ± 0.007. Update of AKHMETSHIN 00C.
[2] Not independent of the corresponding $\Gamma(e^+ e^-) \times \Gamma(\pi^+ \pi^- \pi^0)/\Gamma^2_{total}$.
[3] Using ACHASOV 03, ACHASOV 03D and B($\omega \to \pi^+ \pi^-$) = (1.70 ± 0.28)%.
[4] Rescaled by us to correspond to $\omega$ width 8.4 MeV. Systematic errors underestimated.
[5] Not resolved from $\rho$ decay. Error statistical only.

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

| *VALUE* (units $10^{-4}$) | *CL%* | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|---|
| **< 2** | 90 | ACHASOV | 09A | SND | $e^+ e^- \to \pi^+ \pi^- \pi^0 \pi^0$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| <200 | 90 | KURDADZE | 86 | OLYA | $e^+ e^- \to \pi^+ \pi^- \pi^0 \pi^0$ |

## $\Gamma(\pi^+ \pi^- \gamma)/\Gamma_{total}$ $\Gamma_{11}/\Gamma$

| *VALUE* | *CL%* | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|---|
| **<0.0036** | 95 | WEIDENAUER | 90 | ASTE | $p\overline{p} \to \pi^+ \pi^- \pi^+ \pi^- \gamma$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| <0.004 | 95 | BITYUKOV | 88B | SPEC | 32 $\pi^- p \to \pi^+ \pi^- \gamma X$ |

## $\Gamma(\pi^+ \pi^- \gamma)/\Gamma(\pi^+ \pi^- \pi^0)$ $\Gamma_{11}/\Gamma_1$

| *VALUE* | *CL%* | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| <0.066 | 90 | KALBFLEISCH | 75 | HBC | 2.18 $K^- p \to \Lambda \pi^+ \pi^- \gamma$ |
| <0.05 | 90 | FLATTE | 66 | HBC | 1.2 – 1.7 $K^- p \to \Lambda \pi^+ \pi^- \gamma$ |

## $\Gamma(\pi^+ \pi^- \pi^+ \pi^-)/\Gamma_{total}$ $\Gamma_{12}/\Gamma$

| *VALUE* | *CL%* | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|---|
| **<1 × $10^{-3}$** | 90 | KURDADZE | 88 | OLYA | $e^+ e^- \to \pi^+ \pi^- \pi^+ \pi^-$ |

## $\Gamma(\pi^0 \pi^0 \gamma)/\Gamma_{total}$ $\Gamma_{13}/\Gamma$

| *VALUE* (units $10^{-5}$) | *EVTS* | *DOCUMENT ID* | | *TECN* | *COMMENT* |
|---|---|---|---|---|---|
| **6.7±1.1 OUR FIT** | | | | | |
| **6.5±1.2 OUR AVERAGE** | | | | | |
| $6.4^{+2.4}_{-2.0}$±0.8 | 190 | [1] AKHMETSHIN | 04B | CMD2 | 0.6–0.97 $e^+ e^- \to \pi^0 \pi^0 \gamma$ |
| $6.6^{+1.4}_{-1.3}$±0.6 | 295 | ACHASOV | 02F | SND | 0.36–0.97 $e^+ e^- \to \pi^0 \pi^0 \gamma$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| $11.8^{+2.1}_{-1.9}$±1.4 | 190 | [2] AKHMETSHIN | 04B | CMD2 | 0.6–0.97 $e^+ e^- \to \pi^0 \pi^0 \gamma$ |
| 7.8±2.7±2.0 | 63 | [1,3] ACHASOV | 00G | SND | $e^+ e^- \to \pi^0 \pi^0 \gamma$ |
| 12.7±2.3±2.5 | 63 | [2,3] ACHASOV | 00G | SND | $e^+ e^- \to \pi^0 \pi^0 \gamma$ |

[1] In the model assuming the $\rho \to \pi^0 \pi^0 \gamma$ decay via the $\omega \pi$ and $f_0(500)\gamma$ mechanisms.
[2] In the model assuming the $\rho \to \pi^0 \pi^0 \gamma$ decay via the $\omega \pi$ mechanism only.
[3] Superseded by ACHASOV 02F.

### $\Gamma(\pi^0\pi^0\gamma)/\Gamma(\pi^+\pi^-\pi^0)$ — $\Gamma_{13}/\Gamma_1$

| VALUE | CL% | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **<0.00045** | 90 | DOLINSKY | 89 | ND | $e^+e^- \to \pi^0\pi^0\gamma$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| <0.08 | 95 | JACQUET | 69B | HLBC | 2.05 $\pi^+ p \to \pi^+ p\omega$ |

### $\Gamma(\pi^0\pi^0\gamma)/\Gamma(\pi^0\gamma)$ — $\Gamma_{13}/\Gamma_2$

| VALUE (units $10^{-4}$) | CL% | EVTS | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|---|
| **8.0±1.3 OUR FIT** | | | | | | |
| **8.5±2.9** | | 40 ± 14 | ALDE | 94B | GAM2 | $38\pi^- p \to \pi^0\pi^0\gamma n$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | | |
| < 50 | 90 | | DOLINSKY | 89 | ND | $e^+e^- \to \pi^0\pi^0\gamma$ |
| <1800 | 95 | | KEYNE | 76 | CNTR | $\pi^- p \to \omega n$ |
| <1500 | 90 | | BENAKSAS | 72C | OSPK | $e^+e^-$ |
| <1400 | | | BALDIN | 71 | HLBC | 2.9 $\pi^+ p$ |
| <1000 | 90 | | BARMIN | 64 | HLBC | 1.3–2.8 $\pi^- p$ |

### $\Gamma(\pi^0\pi^0\gamma)/\Gamma(\text{neutrals})$ — $\Gamma_{13}/(\Gamma_2+\Gamma_4)$

| VALUE | CL% | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| 0.22±0.07 | | [1] DAKIN | 72 | OSPK | 1.4 $\pi^- p \to n$MM |
| <0.19 | 90 | DEINET | 69B | OSPK | |

[1] See $\Gamma(\pi^0\gamma)/\Gamma(\text{neutrals})$.

### $\Gamma(\eta\pi^0\gamma)/\Gamma_{\text{total}}$ — $\Gamma_{14}/\Gamma$

| VALUE (units $10^{-5}$) | CL% | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **<3.3** | 90 | AKHMETSHIN | 04B | CMD2 | 0.6–0.97 $e^+e^- \to \eta\pi^0\gamma$ |

### $\Gamma(\mu^+\mu^-)/\Gamma_{\text{total}}$ — $\Gamma_{15}/\Gamma$

| VALUE (units $10^{-5}$) | EVTS | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **7.4±1.8 OUR FIT** | | | | | |
| **7.4±1.8 OUR AVERAGE** | | | | | |
| 6.6±1.4±1.7 | 4.5M | [1] ANASTASI | 17 | KLOE | $e^+e^- \to \mu^+\mu^-\gamma$ |
| 9.0±2.9±1.1 | 18 | HEISTER | 02C | ALEP | $Z \to \mu^+\mu^- + X$ |

[1] Assuming lepton universality in the decay $\omega \to \ell^+\ell^-$ and correcting for different phase space between electron and muon final states.

### $\Gamma(\mu^+\mu^-)/\Gamma(\pi^+\pi^-\pi^0)$ — $\Gamma_{15}/\Gamma_1$

| VALUE (units $10^{-3}$) | CL% | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **<0.2** | 90 | WILSON | 69 | OSPK | 12 $\pi^-$ C $\to$ Fe |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| <1.7 | 74 | FLATTE | 66 | HBC | 1.2 – 1.7 $K^- p \to \Lambda\mu^+\mu^-$ |
| <1.2 | | BARBARO-... | 65 | HBC | 2.7 $K^- p$ |

### $\Gamma(\pi^0\mu^+\mu^-)/\Gamma(\mu^+\mu^-)$ — $\Gamma_7/\Gamma_{15}$

| VALUE | EVTS | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| 1.2±0.6 | 30 | [1] DZHELYADIN | 79 | CNTR | 25–33 $\pi^- p$ |

[1] Superseded by DZHELYADIN 81B result above.

### $\Gamma(3\gamma)/\Gamma_{total}$ — $\Gamma_{16}/\Gamma$

| VALUE (units $10^{-4}$) | CL% | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **<1.9** | 95 | [1] ABELE | 97E | CBAR | 0.0 $\overline{p}p \rightarrow 5\gamma$ |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| <2 | 90 | [1] PROKOSHKIN | 95 | GAM2 | 38 $\pi^- p \rightarrow 3\gamma n$ |

[1] From direct $3\gamma$ decay search.

### $\Gamma(\eta\pi^0)/\Gamma_{total}$ — $\Gamma_{17}/\Gamma$

Violates $C$ conservation.

| VALUE | CL% | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| <0.001 | 90 | ALDE | 94B | GAM2 | $38\pi^- p \rightarrow \eta\pi^0 n$ |

### $[\Gamma(\eta\gamma)+\Gamma(\eta\pi^0)]/\Gamma(\pi^+\pi^-\pi^0)$ — $(\Gamma_5+\Gamma_{17})/\Gamma_1$

| VALUE | CL% | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **<0.016** | 90 | [1] FLATTE | 66 | HBC | 1.2 – 1.7 $K^- p \rightarrow \Lambda\pi^+\pi^-$ MM |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| <0.045 | 95 | JACQUET | 69B | HLBC | 2.05 $\pi^+ p \rightarrow \pi^+ p\omega$ |

[1] Restated by us using B($\eta \rightarrow$ charged modes) = 29.2%.

### $\Gamma(\eta\pi^0)/\Gamma(\pi^0\gamma)$ — $\Gamma_{17}/\Gamma_2$

Violates $C$ conservation.

| VALUE (units $10^{-3}$) | CL% | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **<2.6** | 90 | [1] STAROSTIN | 09 | CRYM | $\gamma p \rightarrow \eta\pi^0 p$ |

[1] STAROSTIN 09 reports $[\Gamma(\omega(782) \rightarrow \eta\pi^0)/\Gamma(\omega(782) \rightarrow \pi^0\gamma)] \times [B(\eta \rightarrow 2\gamma)] < 1.01 \times 10^{-3}$ which we divide by our best value $B(\eta \rightarrow 2\gamma) = 39.36 \times 10^{-2}$.

### $\Gamma(2\pi^0)/\Gamma(\pi^0\gamma)$ — $\Gamma_{18}/\Gamma_2$

Violates $C$ conservation and Bose-Einstein statistics.

| VALUE (units $10^{-3}$) | CL% | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **<2.59** | 90 | STAROSTIN | 09 | CRYM | $\gamma p \rightarrow 2\pi^0 p$ |

### $\Gamma(3\pi^0)/\Gamma_{total}$ — $\Gamma_{19}/\Gamma$

Violates $C$ conservation.

| VALUE | CL% | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| $<3 \times 10^{-4}$ | 90 | PROKOSHKIN | 95 | GAM2 | 38 $\pi^- p \rightarrow 3\pi^0 n$ |

### $\Gamma(3\pi^0)/\Gamma(\pi^0\gamma)$ — $\Gamma_{19}/\Gamma_2$

Violates $C$ conservation.

| VALUE (units $10^{-3}$) | CL% | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **<2.72** | 90 | STAROSTIN | 09 | CRYM | $\gamma p \rightarrow 3\pi^0 p$ |

### $\Gamma(3\pi^0)/\Gamma(\pi^+\pi^-\pi^0)$ — $\Gamma_{19}/\Gamma_1$

Violates *C* conservation.

| VALUE | CL% | DOCUMENT ID | | COMMENT |
|---|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| <0.009 | 90 | BARBERIS | 01 | 450 $p p \to p_f 3\pi^0 p_s$ |

### $\Gamma(\text{invisible})/\Gamma(\pi^+\pi^-\pi^0)$ — $\Gamma_{20}/\Gamma_1$

| VALUE | CL% | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **$<8.1 \times 10^{-5}$** | 90 | ABLIKIM | 18S | BES3 | $J/\psi \to \omega\eta \to \omega\pi^+\pi^-\pi^0$ |

## PARAMETER $\Lambda$ IN $\omega \to \pi^0 \ell^+ \ell^-$ DECAY

In the pole approximation the electromagnetic transition form factor for a resonance of mass $M$ is given by the expression:

$$|F|^2 = (1 - M^2/\Lambda^2)^{-2},$$

where for the parameter $\Lambda$ vector dominance predicts $\Lambda = M_\rho \approx 0.770$ GeV. The ARNALDI 09 measurement is in obvious conflict with this expectation. Note that for $\eta \to \gamma\mu^+\mu^-$ decay ARNALDI 09 and DZHELYADIN 80 obtain the value of $\Lambda$ consistent with vector dominance.

## PARAMETER $\Lambda$ IN $\omega \to \pi^0 \mu^+ \mu^-$ DECAY

| VALUE (GeV) | EVTS | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **0.670 ±0.006 OUR AVERAGE** | | | | | |
| 0.6707±0.0039±0.0056 | | [1] ARNALDI | 16 | NA60 | 400 GeV ($p$-$A$) collisions |
| 0.668 ±0.009 ±0.003 | 3k | [2] ARNALDI | 09 | NA60 | 158$A$ In–In collisions |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| 0.65 ±0.03 | | DZHELYADIN | 81B | CNTR | 25–33 $\pi^- p \to \omega n$ |

[1] ARNALDI 16 reports $\Lambda^{-2}(\omega) = 2.223 \pm 0.026 \pm 0.037$ GeV$^{-2}$ which we converted to the quoted $\Lambda$ value.

[2] ARNALDI 09 reports $\Lambda^{-2}(\omega) = 2.24 \pm 0.06 \pm 0.02$ GeV$^{-2}$ which we converted to the quoted $\Lambda$ value.

## PARAMETER $\Lambda$ IN $\omega \to \pi^0 e^+ e^-$ DECAY

| VALUE (GeV) | EVTS | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **0.709±0.037** | 1.1k | [1] ADLARSON | 17B | A2MM | $\gamma p \to \omega p$ |

[1] ADLARSON 17B reports $\Lambda^{-2}(\omega\pi^0) = 1.99 \pm 0.21$ GeV$^{-2}$ that we converted to the quoted $\Lambda$ value.

## ENERGY DEPENDENCE OF $\omega \to \pi^+\pi^-\pi^0$ DALITZ PLOT

The following experiments fit to one or more of the coefficients $\alpha$, $\beta$, $\gamma$ for $|\text{matrix element}|^2 \propto P\,(1 + 2\alpha\,Z + 2\beta\,Z^{3/2}\,\sin(3\phi) + 2\gamma Z^2 + O(Z^{5/2}))$ where $P$ is the $P$-wave phase-space factor and Z, $\phi$ are kinematical variables as defined in ADLARSON 17.

| VALUE | EVTS | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| **0.133 ±0.008 OUR AVERAGE** | | | | | |
| 0.1321±0.0067±0.0046 | 260k | [1] ABLIKIM | 18AD | BES3 | $J/\psi \to \omega\eta$ |
| 0.147 ±0.036 | 44k | ADLARSON | 17 | WASA | $\alpha$ in $p d \to {}^3\text{He}\,\omega$, $p p \to p p \omega$ |

[1] Keeping a term linear in Z only. A fit with the terms proportional to Z and $Z^{3/2}$ gives $\alpha = 0.133 \pm 0.041$ and $\beta = 0.037 \pm 0.054$.

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| BARKOV | 87 | JETPL 46 164 | L.M. Barkov *et al.* | (NOVO) |
| | | Translated from ZETFP 46 132. | | |
| KURDADZE | 86 | JETPL 43 643 | L.M. Kurdadze *et al.* | (NOVO) |
| | | Translated from ZETFP 43 497. | | |
| BARKOV | 85 | NP B256 365 | L.M. Barkov *et al.* | (NOVO) |
| DRUZHININ | 84 | PL 144B 136 | V.P. Druzhinin *et al.* | (NOVO) |
| KURDADZE | 83B | JETPL 36 274 | A.M. Kurdadze *et al.* | (NOVO) |
| | | Translated from ZETFP 36 221. | | |
| DZHELYADIN | 81B | PL 102B 296 | R.I. Dzhelyadin *et al.* | (SERP) |
| CORDIER | 80 | NP B172 13 | A. Cordier *et al.* | (LALO) |
| DZHELYADIN | 80 | PL 94B 548 | R.I. Dzhelyadin *et al.* | (SERP) |
| ROOS | 80 | LNC 27 321 | M. Roos, A. Pellinen | (HELS) |
| BENKHEIRI | 79 | NP B150 268 | P. Benkheiri *et al.* | (EPOL, CERN, CDEF+) |
| DZHELYADIN | 79 | PL 84B 143 | R.I. Dzhelyadin *et al.* | (SERP) |
| COOPER | 78B | NP B146 1 | A.M. Cooper *et al.* | (TATA, CERN, CDEF+) |
| QUENZER | 78 | PL 76B 512 | A. Quenzer *et al.* | (LALO) |
| VANAPEL... | 78 | NP B133 245 | G.W. van Apeldoorn *et al.* | (ZEEM) |
| WICKLUND | 78 | PR D17 1197 | A.B. Wicklund *et al.* | (ANL) |
| ANDREWS | 77 | PRL 38 198 | D.E. Andrews *et al.* | (ROCH) |
| GESSAROLI | 77 | NP B126 382 | R. Gessaroli *et al.* | (BGNA, FIRZ, GENO+) |
| KEYNE | 76 | PR D14 28 | J. Keyne *et al.* | (LOIC, SHMP) |
| Also | | PR D8 2789 | D.M. Binnie *et al.* | (LOIC, SHMP) |
| KALBFLEISCH | 75 | PR D11 987 | G.R. Kalbfleisch, R.C. Strand, J.W. Chapman | (BNL+) |
| AGUILAR-... | 72B | PR D6 29 | M. Aguilar-Benitez *et al.* | (BNL) |
| APEL | 72B | PL 41B 234 | W.D. Apel *et al.* | (KARLK, KARLE, PISA) |
| BASILE | 72B | Phil. Conf. 153 | M. Basile *et al.* | (CERN) |
| BENAKSAS | 72 | PL 39B 289 | D. Benaksas *et al.* | (ORSAY) |
| BENAKSAS | 72B | PL 42B 507 | D. Benaksas *et al.* | (ORSAY) |
| BENAKSAS | 72C | PL 42B 511 | D. Benaksas *et al.* | (ORSAY) |
| BORENSTEIN | 72 | PR D5 1559 | S.R. Borenstein *et al.* | (BNL, MICH) |
| BROWN | 72 | PL 42B 117 | R.M. Brown *et al.* | (ILL, ILLC) |
| DAKIN | 72 | PR D6 2321 | J.T. Dakin *et al.* | (PRIN) |
| RATCLIFF | 72 | PL 38B 345 | B.N. Ratcliff *et al.* | (SLAC) |
| ALVENSLEB... | 71C | PRL 27 888 | H. Alvensleben *et al.* | (DESY) |
| BALDIN | 71 | SJNP 13 758 | A.B. Baldin *et al.* | (ITEP) |
| | | Translated from YAF 13 1318. | | |

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| BEHREND | 71 | PRL 27 61 | H.J. Behrend *et al.* | (ROCH, CORN, FNAL) |
| BIZZARRI | 71 | NP B27 140 | R. Bizzarri *et al.* | (CERN, CDEF) |
| COYNE | 71 | NP B32 333 | D.G. Coyne *et al.* | (LRL) |
| MOFFEIT | 71 | NP B29 349 | K.C. Moffeit *et al.* | (LRL, UCB, SLAC+) |
| ABRAMOVI... | 70 | NP B20 209 | M. Abramovich *et al.* | (CERN) |
| BIGGS | 70B | PRL 24 1201 | P.J. Biggs *et al.* | (DARE) |
| BIZZARRI | 70 | PRL 25 1385 | R. Bizzarri *et al.* | (ROMA, SYRA) |
| ROOS | 70 | DNPL/R7 173 | M. Roos | (CERN) |
| Proc. Daresbury Study Weekend No. 1. | | | | |
| AUGUSTIN | 69D | PL 28B 513 | J.E. Augustin *et al.* | (ORSAY) |
| BIZZARRI | 69 | NP B14 169 | R. Bizzarri *et al.* | (CERN, CDEF) |
| DEINET | 69B | PL 30B 426 | W. Deinet *et al.* | (KARL, CERN) |
| JACQUET | 69B | NC 63A 743 | F. Jacquet *et al.* | (EPOL, BERG) |
| WILSON | 69 | Private Comm. | R. Wilson | (HARV) |
| Also | | PR 178 2095 | A.A. Wehmann *et al.* | (HARV, CASE, SLAC+) |
| ASTVACAT... | 68 | PL 27B 45 | R.G. Astvatsaturov *et al.* | (JINR, MOSU) |
| BOLLINI | 68C | NC 56A 531 | D. Bollini *et al.* | (CERN, BGNA, STRB) |
| GOUNARIS | 68 | PRL 21 244 | G.J. Gounaris, J.J. Sakurai | |
| BARASH | 67B | PR 156 1399 | N. Barash *et al.* | (COLU) |
| FELDMAN | 67C | PR 159 1219 | M. Feldman *et al.* | (PENN) |
| DIGIUGNO | 66B | NC 44A 1272 | G. Di Giugno *et al.* | (NAPL, FRAS, TRST) |
| FLATTE | 66 | PR 145 1050 | S.M. Flatte *et al.* | (LRL) |
| JAMES | 66 | PR 142 896 | F.E. James, H.L. Kraybill | (YALE, BNL) |
| BARBARO-... | 65 | PRL 14 279 | A. Barbaro-Galtieri, R.D. Tripp | (LRL) |
| BARMIN | 64 | JETP 18 1289 | V.V. Barmin *et al.* | (ITEP) |
| | | Translated from ZETF 45 1879. | | |
| KRAEMER | 64 | PR 136 B496 | R.W. Kraemer *et al.* | (JHU, NWES, WOOD) |
| BUSCHBECK | 63 | Siena Conf. 1 166 | B. Buschbeck *et al.* | (VIEN, CERN, ANIK) |