### $A_\tau$

This quantity is derived from the measurement of the average $\tau$ polarization.

| VALUE | EVTS | DOCUMENT ID | TECN | COMMENT |
|---|---|---|---|---|
| **0.141±0.021 OUR AVERAGE** | | Error includes scale factor of 1.2. | | |
| 0.132±0.033 | 10732 | ADRIANI 93M | L3 | $E^{ee}_{cm}$= 88–94 GeV |
| 0.143±0.023 | | BUSKULIC 93P | ALEP | $E^{ee}_{cm}$= 88–94 GeV |
| 0.24 ±0.07 | 2021 | ABREU 92N | DLPH | $E^{ee}_{cm}$= 88–94 GeV |
| 0.01 ±0.09 | 3245 | ALEXANDER 91D | OPAL | $E^{ee}_{cm}$= 88–94 GeV |

## $A^{(0,e)}_{FB}$ CHARGE ASYMMETRY IN $e^+e^- \to e^+e^-$ (including radiative corrections)

For the $Z$ peak, we report the pole asymmetry defined by $(3/4)A_e^2$ as determined by the nine-parameter fit to cross-section and lepton forward-backward asymmetry data. For details see the "Note on the $Z$ boson."

| ASYMMETRY (%) | STD. MODEL | $\sqrt{s}$ (GeV) | DOCUMENT ID | TECN |
|---|---|---|---|---|
| **1.51±0.40 OUR FIT** | | | | |
| **1.5 ±0.4 OUR AVERAGE** | | | | |
| 2.5 ±0.9 | | 91.2 | ABREU 94 | DLPH |
| 1.04±0.92 | | 91.2 | ACCIARRI 94 | L3 |
| 0.62±0.80 | | 91.2 | AKERS 94 | OPAL |
| 1.85±0.66 | | 91.2 | BUSKULIC 94 | ALEP |

## $A^{(0,\mu)}_{FB}$ CHARGE ASYMMETRY IN $e^+e^- \to \mu^+\mu^-$ (including radiative corrections)

For the $Z$ peak, we report the pole asymmetry defined by $(3/4)A_eA_\mu$ as determined by the nine-parameter fit to cross-section and lepton forward-backward asymmetry data. For details see the "Note on the $Z$ boson."

| ASYMMETRY (%) | STD. MODEL | $\sqrt{s}$ (GeV) | DOCUMENT ID | TECN |
|---|---|---|---|---|
| **1.33± 0.26 OUR FIT** | | | | |
| **1.34± 0.24 OUR AVERAGE** | | | | |
| 1.4 ± 0.5 | | 91.2 | ABREU 94 | DLPH |
| 1.79± 0.61 | | 91.2 | ACCIARRI 94 | L3 |
| 0.99± 0.42 | | 91.2 | AKERS 94 | OPAL |
| 1.46± 0.48 | | 91.2 | BUSKULIC 94 | ALEP |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| $-29.0 ^{+5.0}_{-4.8}$ ±0.5 | −32.1 | 56.9 | [164] ABE 90I | VNS |
| 18 ± 8 | +1 | 91.28 | ADEVA 90D | L3 |
| − 9.9 ± 1.5 ±0.5 | −9.2 | 35 | HEGNER 90 | JADE |
| 0.05± 0.22 | 0.026 | 91.14 | [165] ABRAMS 89D | MRK2 |
| −43.4 ±17.0 | −24.9 | 52.0 | [166] BACALA 89 | AMY |
| −11.0 ±16.5 | −29.4 | 55.0 | [166] BACALA 89 | AMY |
| −30.0 ±12.4 | −31.2 | 56.0 | [166] BACALA 89 | AMY |
| −46.2 ±14.9 | −33.0 | 57.0 | [166] BACALA 89 | AMY |
| −29 ±13 | −25.9 | 53.3 | ADACHI 88C | TOPZ |
| + 5.3 ± 5.0 ±0.5 | −1.2 | 14.0 | ADEVA 88 | MRKJ |
| −10.4 ± 1.3 ±0.5 | −8.6 | 34.8 | ADEVA 88 | MRKJ |
| −12.3 ± 5.3 ±0.5 | −10.7 | 38.3 | ADEVA 88 | MRKJ |
| −15.6 ± 3.0 ±0.5 | −14.9 | 43.8 | ADEVA 88 | MRKJ |
| − 1.0 ± 6.0 | −1.2 | 13.9 | BRAUNSCH... 88D | TASS |
| − 9.1 ± 2.3 ±0.5 | −8.6 | 34.5 | BRAUNSCH... 88D | TASS |
| $-10.6 ^{+2.2}_{-2.3}$ ±0.5 | −8.9 | 35.0 | BRAUNSCH... 88D | TASS |
| $-17.6 ^{+4.4}_{-4.3}$ ±0.5 | −15.2 | 43.6 | BRAUNSCH... 88D | TASS |
| − 4.8 ± 6.5 ±1.0 | −11.5 | 39 | BEHREND 87C | CELL |
| −18.8 ± 4.5 ±1.0 | −15.5 | 44 | BEHREND 87C | CELL |
| + 2.7 ± 4.9 | −1.2 | 13.9 | BARTEL 86C | JADE |
| −11.1 ± 1.8 ±1.0 | −8.6 | 34.4 | BARTEL 86C | JADE |
| −17.3 ± 4.8 ±1.0 | −13.7 | 41.5 | BARTEL 86C | JADE |
| −22.8 ± 5.1 ±1.0 | −16.6 | 44.8 | BARTEL 86C | JADE |
| − 6.3 ± 0.8 ±0.2 | −6.3 | 29 | ASH 85 | MAC |
| − 4.9 ± 1.5 ±0.5 | −5.9 | 29 | DERRICK 85 | HRS |
| − 7.1 ± 1.7 | −5.7 | 29 | LEVI 83 | MRK2 |
| −16.1 ± 3.2 | −9.2 | 34.2 | BRANDELIK 82C | TASS |

[164] ABE 90I measurements in the range $50 \leq \sqrt{s} \leq 60.8$ GeV.
[165] ABRAMS 89D asymmetry includes both 9 $\mu^+\mu^-$ and 15 $\tau^+\tau^-$ events.
[166] BACALA 89 systematic error is about 5%.

## $A^{(0,\tau)}_{FB}$ CHARGE ASYMMETRY IN $e^+e^- \to \tau^+\tau^-$ (including radiative corrections)

For the $Z$ peak, we report the pole asymmetry defined by $(3/4)A_eA_\tau$ as determined by the nine-parameter fit to cross-section and lepton forward-backward asymmetry data. For details see the "Note on the $Z$ boson."

| ASYMMETRY (%) | STD. MODEL | $\sqrt{s}$ (GeV) | DOCUMENT ID | TECN |
|---|---|---|---|---|
| **2.12± 0.32 OUR FIT** | | | | |
| **2.13± 0.31 OUR AVERAGE** | | | | |
| 2.2 ± 0.7 | | 91.2 | ABREU 94 | DLPH |
| 2.65± 0.88 | | 91.2 | ACCIARRI 94 | L3 |
| 2.05± 0.52 | | 91.2 | AKERS 94 | OPAL |
| 1.97± 0.56 | | 91.2 | BUSKULIC 94 | ALEP |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| $-32.8 ^{+6.4}_{-6.2}$ ±1.5 | −32.1 | 56.9 | [167] ABE 90I | VNS |
| − 8.1 ± 2.0 ±0.6 | −9.2 | 35 | HEGNER 90 | JADE |
| −18.4 ±19.2 | −24.9 | 52.0 | [168] BACALA 89 | AMY |
| −17.7 ±26.1 | −29.4 | 55.0 | [168] BACALA 89 | AMY |
| −45.9 ±16.6 | −31.2 | 56.0 | [168] BACALA 89 | AMY |
| −49.5 ±18.0 | −33.0 | 57.0 | [168] BACALA 89 | AMY |
| −20 ±14 | −25.9 | 53.3 | ADACHI 88C | TOPZ |
| −10.6 ± 3.1 ±1.5 | −8.5 | 34.7 | ADEVA 88 | MRKJ |
| − 8.5 ± 6.6 ±1.5 | −15.4 | 43.8 | ADEVA 88 | MRKJ |
| − 6.0 ± 2.5 ±1.0 | 8.8 | 34.6 | BARTEL 85F | JADE |
| −11.8 ± 4.6 ±1.0 | 14.8 | 43.0 | BARTEL 85F | JADE |
| − 5.5 ± 1.2 ±0.5 | −0.063 | 29.0 | FERNANDEZ 85 | MAC |
| − 4.2 ± 2.0 | 0.057 | 29 | LEVI 83 | MRK2 |
| −10.3 ± 5.2 | −9.2 | 34.2 | BEHREND 82 | CELL |
| − 0.4 ± 6.6 | −9.1 | 34.2 | BRANDELIK 82C | TASS |

[167] ABE 90I measurements in the range $50 \leq \sqrt{s} \leq 60.8$ GeV.
[168] BACALA 89 systematic error is about 5%.

## $A^{(0,\ell)}_{FB}$ CHARGE ASYMMETRY IN $e^+e^- \to \ell^+\ell^-$ (including radiative corrections)

For the $Z$ peak, we report the pole asymmetry defined by $(3/4)A_\ell^2$ as determined by the five-parameter fit to cross-section and lepton forward-backward asymmetry data assuming lepton universality. For details see the "Note on the $Z$ boson."

| ASYMMETRY (%) | STD. MODEL | $\sqrt{s}$ (GeV) | DOCUMENT ID | TECN |
|---|---|---|---|---|
| **1.59±0.18 OUR FIT** | | | | |
| **1.60±0.18 OUR AVERAGE** | | | | |
| 1.77±0.37 | | 91.2 | ABREU 94 | DLPH |
| 1.84±0.45 | | 91.2 | ACCIARRI 94 | L3 |
| 1.28±0.30 | | 91.2 | AKERS 94 | OPAL |
| 1.71±0.33 | | 91.2 | BUSKULIC 94 | ALEP |

## $A^{(0,c)}_{FB}$ CHARGE ASYMMETRY IN $e^+e^- \to c\overline{c}$

Our estimate of the asymmetry is the value for the $Z$ pole only. To estimate this average pole asymmetry, the various systematic errors were split into uncorrelated and correlated parts (model dependence, semileptonic branching ratios, fragmentation, $\Gamma(c\overline{c})/\Gamma(b\overline{b})$, and $D^*$ branching ratios). QCD and QED corrections are also taken into account.

| ASYMMETRY (%) | STD. MODEL | $\sqrt{s}$ (GeV) | DOCUMENT ID | TECN |
|---|---|---|---|---|
| **5.8± 2.2 OUR ESTIMATE** | | | | |
| 1.4± 3.0±2.0 | 5.6 | 91.24 | [169] ACTON 93K | OPAL |
| 5.2± 2.8±1.2 | 5.4 | 91.28 | [170] AKERS 93D | OPAL |
| 8.3± 3.8±2.7 | 5.6 | 91.24 | [171] ADRIANI 92D | L3 |
| 6.4± 3.9±3.0 | | 91.2 | [172] DECAMP 91E | ALEP |
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | |
| −14 ±14 ±3 | −2 | 89.75 | [170] AKERS 93D | OPAL |
| 18 ±12 ±3 | 12 | 92.64 | [170] AKERS 93D | OPAL |
| −12.9± 7.8±5.5 | −13.6 | 35 | BEHREND 90D | CELL |
| 7.7±13.4±5.0 | −22.1 | 43 | BEHREND 90D | CELL |
| −12.8± 4.4±4.1 | −13.6 | 35 | ELSEN 90 | JADE |
| −10.9±12.9±4.6 | −23.2 | 44 | ELSEN 90 | JADE |
| −14.9± 6.7 | −13.3 | 35 | OULD-SAADA 89 | JADE |

[169] ACTON 93K use the lepton tagging technique.
[170] AKERS 93D identify the $b$ and $c$ decays using $D^*$.
[171] ADRIANI 92D use both electron and muon semileptonic decays.
[172] DECAMP 91E use the lepton-tagging technique.

## $A^{(0,b)}_{FB}$ CHARGE ASYMMETRY IN $e^+e^- \to b\overline{b}$

Our estimate of the asymmetry is the value at the $Z$ pole only and uses an average LEP $B^0$-$\overline{B}^0$ mixing parameter of $(12.2 \pm 1.1)$%. To estimate this average pole asymmetry, the various systematic errors were split into uncorrelated and correlated parts (model dependence, semileptonic branching ratios, fragmentation, $\Gamma(c\overline{c})/\Gamma(b\overline{b})$, mixing, and $c\overline{c}$ asymmetry). QCD and QED corrections are also taken into account.

| ASYMMETRY (%) | STD. MODEL | $\sqrt{s}$ (GeV) | DOCUMENT ID | TECN |
|---|---|---|---|---|
| **10.7± 1.3 OUR ESTIMATE** | | | | |
| 9.2± 1.8± 0.8 | 8.5 | 91.24 | [173] ACTON 93K | OPAL |
| 13.9± 9.7± 4.9 | 9.4 | 91.28 | [174] AKERS 93D | OPAL |
| 16.1± 6.0± 2.1 | | 91.2 | [175] ABREU 92H | DLPH |
| 9.7± 1.7± 0.7 | 8.2 | 91.24 | [176] ADRIANI 92D | L3 |
| 12.6± 2.8± 1.2 | | 91.2 | [177] DECAMP 91E | ALEP |