Miscellaneous other allowed modes

$4h^- 3h^+ \geq 0$ neutrals ν_τ ("7-prong")	$< 1.9 \times 10^{-4}$	CL=90%	–
$K^*(892)^- \geq 0$ neutrals ν_τ	(1.43 ± 0.17) %		–
$K^*(892)^- \nu_\tau$	(1.45 ± 0.18) %		665
$K^*(892)^0 K^- \geq 0$ neutrals ν_τ	$(3.2 \pm 1.4) \times 10^{-3}$		–
$\overline{K}^*(892)^0 \pi^- \geq 0$ neutrals ν_τ	$(3.8 \pm 1.7) \times 10^{-3}$		–
$K^0 h^- \geq 0$ neutrals ν_τ	(1.30 ± 0.30) %		–
$K^- K^0 \geq 0$ neutrals ν_τ	$< 8 \times 10^{-3}$	CL=90%	–
$K^0 K^- \nu_\tau$	$< 2.6 \times 10^{-3}$	CL=95%	737
$K^0 K^- \geq 1$ neutrals ν_τ	$< 2.6 \times 10^{-3}$	CL=95%	–
$K^0 h^+ h^- h^- \geq 0$ neutrals ν_τ	$< 1.7 \times 10^{-3}$	CL=95%	–
$K_2^*(1430)^- \nu_\tau$	$< 3 \times 10^{-3}$	CL=95%	314
$\eta\pi^- \geq 0$ neutrals ν_τ	< 1.3 %	CL=95%	–
$\eta\pi^- \nu_\tau$	$< 3.4 \times 10^{-4}$	CL=95%	798
$\eta\pi^-\pi^0 \nu_\tau$	$(1.70 \pm 0.28) \times 10^{-3}$		778
$\eta\pi^-\pi^0\pi^0 \nu_\tau$	$< 4.3 \times 10^{-4}$	CL=95%	746
$\eta K^- \nu_\tau$	$< 4.7 \times 10^{-4}$	CL=95%	720
$\eta\pi^+\pi^-\pi^- \geq 0$ neutrals ν_τ	$< 3 \times 10^{-3}$	CL=90%	–
$\eta\eta\pi^- \geq 0$ neutrals ν_τ	$< 5 \times 10^{-3}$	CL=90%	–
$\eta\eta\pi^- \nu_\tau$	$< 1.1 \times 10^{-4}$	CL=95%	637
$\eta\eta\pi^-\pi^0 \nu_\tau$	$< 2.0 \times 10^{-4}$	CL=95%	559

Lepton Family number (*LF*), Lepton number (*L*), or Baryon number (*B*) violating modes
(In the modes below, ℓ means a sum over e and μ modes)

L means lepton number violation (*e.g.* $\tau^- \rightarrow e^+\pi^-\pi^-$). Following common usage, *LF* means lepton family violation *and not* lepton number violation (*e.g.* $\tau^- \rightarrow e^-\pi^+\pi^-$).

$e^-\gamma$	LF		$< 1.2 \times 10^{-4}$	CL=90%	889
$\mu^-\gamma$	LF		$< 4.2 \times 10^{-6}$	CL=90%	885
$e^-\pi^0$	LF		$< 1.4 \times 10^{-4}$	CL=90%	883
$\mu^-\pi^0$	LF		$< 4.4 \times 10^{-5}$	CL=90%	880
$e^- K^0$	LF		$< 1.3 \times 10^{-3}$	CL=90%	819
$\mu^- K^0$	LF		$< 1.0 \times 10^{-3}$	CL=90%	815
$e^-\eta$	LF		$< 6.3 \times 10^{-5}$	CL=90%	804
$\mu^-\eta$	LF		$< 7.3 \times 10^{-5}$	CL=90%	800
$e^-\rho^0$	LF		$< 1.9 \times 10^{-5}$	CL=90%	723
$\mu^-\rho^0$	LF		$< 2.9 \times 10^{-5}$	CL=90%	718
$e^- K^*(892)^0$	LF		$< 3.8 \times 10^{-5}$	CL=90%	665
$\mu^- K^*(892)^0$	LF		$< 4.5 \times 10^{-5}$	CL=90%	660
$\pi^-\gamma$	L		$< 2.8 \times 10^{-4}$	CL=90%	883
$\pi^-\pi^0$	L		$< 3.7 \times 10^{-4}$	CL=90%	878
$\ell^-\ell^-\ell^+$	LF	[h]	$< 3.4 \times 10^{-5}$	CL=90%	–
$e^- e^+ e^-$	LF		$< 1.3 \times 10^{-5}$	CL=90%	889
$(e\mu\mu)^-$	LF		$< 2.7 \times 10^{-5}$	CL=90%	882
$e^-\mu^+\mu^-$	LF		$< 1.9 \times 10^{-5}$	CL=90%	882
$e^+\mu^-\mu^-$	LF		$< 1.6 \times 10^{-5}$	CL=90%	882
$(\mu e e)^-$	LF		$< 2.7 \times 10^{-5}$	CL=90%	885
$\mu^- e^+ e^-$	LF		$< 1.4 \times 10^{-5}$	CL=90%	885
$\mu^+ e^- e^-$	LF		$< 1.4 \times 10^{-5}$	CL=90%	885
$\mu^-\mu^+\mu^-$	LF		$< 1.7 \times 10^{-5}$	CL=90%	873
$\ell^\pm\pi^\mp\pi^-$	LF,L	[h,i]	$< 6.3 \times 10^{-5}$	CL=90%	–
$e^\mp\pi^\pm\pi^-$	LF,L	[i]	$< 6.0 \times 10^{-5}$	CL=90%	877
$e^-\pi^+\pi^-$	LF		$< 2.7 \times 10^{-5}$	CL=90%	877
$e^+\pi^-\pi^-$	L		$< 1.7 \times 10^{-5}$	CL=90%	877
$\mu^\mp\pi^\pm\pi^-$	LF,L	[i]	$< 3.9 \times 10^{-5}$	CL=90%	866
$\mu^-\pi^+\pi^-$	LF		$< 3.6 \times 10^{-5}$	CL=90%	866
$\mu^+\pi^-\pi^-$	L		$< 3.9 \times 10^{-5}$	CL=90%	866
$\ell^\pm\pi^\mp K^-$	LF,L	[h,i]	$< 1.2 \times 10^{-4}$	CL=90%	–
$(e\pi K)^-$, all charged	LF,L		$< 7.7 \times 10^{-5}$	CL=90%	814
$e^-\pi^\pm K^\mp$	LF	[i]	$< 5.8 \times 10^{-5}$	CL=90%	814
$e^-\pi^+ K^-$	LF		$< 2.9 \times 10^{-5}$	CL=90%	814
$e^-\pi^- K^+$	LF		$< 5.8 \times 10^{-5}$	CL=90%	814
$e^+\pi^- K^-$	L		$< 2.0 \times 10^{-5}$	CL=90%	814
$(\mu\pi K)^-$, all charged	LF,L		$< 7.7 \times 10^{-5}$	CL=90%	800
$\mu^-\pi^\pm K^\mp$	LF	[i]	$< 7.7 \times 10^{-5}$	CL=90%	800
$\mu^-\pi^+ K^-$	LF		$< 7.7 \times 10^{-5}$	CL=90%	800
$\mu^-\pi^- K^+$	LF		$< 7.7 \times 10^{-5}$	CL=90%	800
$\mu^+\pi^- K^-$	L		$< 4.0 \times 10^{-5}$	CL=90%	800
$\overline{p}\gamma$	L,B		$< 2.9 \times 10^{-4}$	CL=90%	641
$\overline{p}\pi^0$	L,B		$< 6.6 \times 10^{-4}$	CL=90%	632
$\overline{p}\eta$	L,B		$< 1.30 \times 10^{-3}$	CL=90%	476
e^- light spinless boson	LF		$< 3.2 \times 10^{-3}$	CL=95%	–
μ^- light spinless boson	LF		$< 6 \times 10^{-3}$	CL=95%	–

Number of Light Neutrino Types

(including ν_e, ν_μ, and ν_τ)

Number $N = 2.983 \pm 0.025$ (Standard Model fits to Z data)

Number $N = 2.97 \pm 0.17$ (Direct measurement of invisible Z width)

Heavy Lepton Searches

$L^\pm$ – charged lepton

Mass $m >$ 44.3 GeV, CL = 95% $m_\nu \approx 0$

$L^\pm$ – stable charged heavy lepton

Mass $m >$ 42.8 GeV, CL = 95%

L^0 – stable neutral heavy lepton

Mass $m >$ 45.0 GeV, CL = 95% (Dirac)
Mass $m >$ 39.5 GeV, CL = 95% (Majorana)

Neutral heavy lepton

Mass $m >$ 19.6 GeV, CL = 95% (all $|U_{\ell j}|^2$) (Dirac)
Mass $m >$ 45.7 GeV or $m < 25$, CL = 95% ($|U_{\ell j}|^2 > 10^{-13}$ (Dirac)

Searches for Massive Neutrinos and Lepton Mixing

For excited leptons, see Compositeness Limits below.

See the Full Listings for a Note giving details of neutrinos, masses, mixing, and the status of experimental searches.

No direct, uncontested evidence for massive neutrinos or lepton mixing has been obtained. Sample limits are:

ν oscillation: $\overline{\nu}_e \not\rightarrow \overline{\nu}_e$

$\Delta(m^2) < 0.0083$ eV^2, CL = 90% (if $\sin^2 2\theta = 1$)
$\sin^2 2\theta < 0.14$, CL = 68% (if $\Delta(m^2)$ is large)

ν oscillation: $\nu_\mu \rightarrow \nu_e$ (θ = mixing angle)

$\Delta(m^2) < 0.09$ eV^2, CL = 90% (if $\sin^2 2\theta = 1$)
$\sin^2 2\theta < 2.5 \times 10^{-3}$, CL = 90% (if $\Delta(m^2)$ is large)