Double-β Decay

OMITTED FROM SUMMARY TABLE

See the related review(s):

Neutrinoless Double-β Decay

Half-life limits on the neutrino-less double-β decay

In most cases the transitions (Z,A) $\rightarrow$ (Z+2,A) $+ 2e^-$ to the 0^+ ground state of the final nucleus are listed. We also list transitions that decrease the nuclear charge ($2e^+$, e^+ CC and double EC) and transitions to an excited state of the final nucleus (0_i^+, 2^+, and 2_i^+). In the following Listings only the best or comparable limits for the half-lives of each transition are reported and only those with about $T_{1/2} > 10^{23}$ years that are relevant for particle physics.

$t_{1/2}$(10^{23} yr)	CL%	ISOTOPE	TRANSITION	METHOD	DOCUMENT ID	
• • • We do not use the following data for averages, fits, limits, etc. • • •						
$>$ 190	90	^{76}Ge		MAJORANA	[1] AALSETH	18
$>$ 800	90	^{76}Ge		GERDA	[2] AGOSTINI	18
$>$ 180	90	^{136}Xe		EXO-200	[3] ALBERT	18
$>$ 150	90	^{130}Te		CUORE	[4] ALDUINO	18
$>$ 530	90	^{76}Ge		GERDA	[5] AGOSTINI	17
$>$ 1.1	90	^{134}Xe		EXO-200	[6] ALBERT	17C
$>$ 1	90	^{116}Cd		NEMO-3	[7] ARNOLD	17
$>$ 40	90	^{130}Te		CUORE(CINO)	[8] ALDUINO	16
$>$ 260	90	^{136}Xe	g.s.$\rightarrow 2_1^+$	KamLAND-Zen	[9] ASAKURA	16
$>$ 260	90	^{136}Xe	g.s.$\rightarrow 2_2^+$	KamLAND-Zen	[10] ASAKURA	16
$>$ 240	90	^{136}Xe	g.s.$\rightarrow 0_1^+$	KamLAND-Zen	[11] ASAKURA	16
$>$1070	90	^{136}Xe		KamLAND-Zen	[12] GANDO	16
$>$ 11	90	^{100}Mo		NEMO-3	[13] ARNOLD	15
$>$ 110	90	^{136}Xe		EXO-200	[14] ALBERT	14B
$>$ 9.4	90	^{130}Te	$0^+ \rightarrow 0_1^+$	CUORICINO	[15] ANDREOTTI	12
$>$ 3.6	90	^{82}Se		NEMO-3	[16] BARABASH	11A
$>$ 30	90	^{130}Te		CUORICINO	[17] ARNABOLDI	08
$>$ 0.58	90	^{48}Ca		CaF_2 scint.	[18] UMEHARA	08
$>$ 0.89	90	^{100}Mo	$0^+ \rightarrow 0_1^+$	NEMO-3	[19] ARNOLD	07
$>$ 1.6	90	^{100}Mo	$0^+ \rightarrow 2^+$	NEMO-3	[20] ARNOLD	07
$>$ 1	90	^{82}Se		NEMO-3	[21] ARNOLD	05A
$>$ 1.1	90	^{128}Te		Cryog. det.	[22] ARNABOLDI	03
$>$ 1.7	90	^{116}Cd		$^{116}CdWO_4$ scint.	[23] DANEVICH	03
$>$ 157	90	^{76}Ge		Enriched HPGe	[24] AALSETH	02B
$>$ 190	90	^{76}Ge		Enriched HPGe	[25] KLAPDOR-K...	01

[1] AALSETH 18 uses the MAJORANA Demonstrator to search for the $0\nu\ \beta\beta$ decay. The exposure is 9.95 kg·year. The median sensitivity is 2.1×10^{25} yr.

[2] AGOSTINI 18 uses the GERDA detector to search for the $0\nu\ \beta\beta$ decay. The exposure is 46.7 kg·year. The median sensitivity is 5.8×10^{25} yr. Supersedes AGOSTINI 17.

[3] ALBERT 18 uses the EXO-200 detector to search for the 0ν $\beta\beta$ decay. The exposure is 177.6 kg·year. The median sensitivity is 3.7×10^{25} years.

[4] ALDUINO 18 uses the CUORE detector to search for the 0ν $\beta\beta$ decay of ^{130}Te. The exposure is 86.3 kg·year of natural TeO_2 corresponding to 24.0 kg·year for ^{130}Te. The median sensitivity is 0.7×10^{25} yr. The limit is obtained combining the new data from CUORE with those of CUORE0 (9.8 kg·year of ^{130}Te) and Cuoricino (19.8 kg·year of ^{130}Te).

[5] AGOSTINI 17 result corresponds to data collected with GERDA phase 1 and first release of phase 2 for a total of 343 mol-yr exposure. Supersedes AGOSTINI 13A. The median sensitivity is 4.0 10^{25} yr.

[6] ALBERT 17C uses the EXO-200 detector that contains 19.098 ± 0.014% admixture of ^{134}Xe to search for the 0ν and 2ν $\beta\beta$ decay modes. The exposure is 29.6 kg·year. The median sensitivity is 1.9×10^{21} years.

[7] ARNOLD 17 use the NEMO-3 tracking calorimeter, containing 410 g of enriched ^{116}Cd exposed for 5.26 yr, to determine the half-life limit. Supersedes BARABASH 11A.

[8] ALDUINO 16 report result obtained with 9.8 kg y of data collected with the CUORE-0 bolometer, combined with data from the CUORICINO. Supersedes ALFONSO 15.

[9] ASAKURA 16 use the KamLAND-Zen liquid scintillator calorimeter (^{136}Xe 89.5 kg yr) to place a limit on the $0\nu\beta\beta$-decay into the first excited state of the daughter nuclide.

[10] ASAKURA 16 use the KamLAND-Zen liquid scintillator calorimeter (^{136}Xe 89.5 kg yr) to place a limit on the $0\nu\beta\beta$-decay into the second excited state of the daughter nuclide.

[11] ASAKURA 16 use the KamLAND-Zen liquid scintillator calorimeter (^{136}Xe 89.5 kg yr) to place a limit on the $0\nu\beta\beta$-decay into the third excited state of the daughter nuclide.

[12] GANDO 16 use the the KamLAND detector to search for the 0ν decay of ^{136}Xe. With a significant background reduction, the combination of results of the first (270.7 days) and the second phase (263.8 days) of the experiment leads to about six fold improvement over the previous limit. Supersedes GANDO 13A. The sensitivity is 5.6 10^{25} yr.

[13] ARNOLD 15 use the NEMO-3 tracking calorimeter with 34.3 kg yr exposure to determine the limit of $0\nu\beta\beta$-half life of ^{100}Mo. Supersedes ARNOLD 2005A and BARABASH 11A.

[14] ALBERT 14B use 100 kg yr of exposure of the EXO-200 tracking calorimeter to place a lower limit on the $0\nu\beta\beta$-half life of ^{136}Xe. Supersedes AUGER 12.

[15] ANDREOTTI 12 use high resolution TeO_2 bolometric calorimeter to search for the $0\nu\beta\beta$ decay of ^{130}Te leading to the excited 0_{+}^{1} state at 1793.5 keV.

[16] BARABASH 11A use the NEMO-3 detector to measure $2\nu\beta\beta$ rates and place limits on $0\nu\beta\beta$ half lives for various nuclides. Supersedes ARNOLD 05A, ARNOLD 04, ARNOLD 98, and ELLIOTT 92.

[17] Supersedes ARNABOLDI 04. Bolometric TeO_2 detector array CUORICINO is used for high resolution search for $0\nu\beta\beta$ decay. The half-life limit is derived from 3.09 kg yr ^{130}Te exposure.

[18] UMEHARA 08 use CaF_2 scintillation calorimeter to search for double beta decay of ^{48}Ca. Limit is significantly more stringent than quoted sensitivity: 18×10^{21} years.

[19] Limit on 0ν-decay to the first excited 0_1^+-state of daughter nucleus using NEMO-3 tracking calorimeter. Supersedes DASSIE 95.

[20] Limit on 0ν-decay to the first excited 2^+-state of daughter nucleus using NEMO-3 tracking calorimeter.

[21] NEMO-3 tracking calorimeter is used in ARNOLD 05A to place limit on $0\nu\beta\beta$ half-life of ^{82}Se. Detector contains 0.93 kg of enriched ^{82}Se. Supersedes ARNOLD 04.

[22] Supersedes ALESSANDRELLO 00. Array of TeO_2 crystals in high resolution cryogenic calorimeter. Some enriched in ^{128}Te. Ground state to ground state decay.

[23] Limit on $0\nu\beta\beta$ decay of ^{116}Cd using enriched $CdWO_4$ scintillators. Supersedes DANEVICH 00.

[24] AALSETH 02B limit is based on 117 mol·yr of data using enriched Ge detectors. Background reduction by means of pulse shape analysis is applied to part of the data set. Reported limit is slightly less restrictive than that in KLAPDOR-KLEINGROTHAUS 01 However, it excludes part of the allowed half-life range reported in KLAPDOR-KLEINGROTHAUS 01B for the same nuclide. The analysis has been criticized in KLAPDOR-KLEINGROTHAUS 04B. The criticism was addressed and disputed in AALSETH 04.

[25] KLAPDOR-KLEINGROTHAUS 01 is a continuation of the work published in BAUDIS 99. Isotopically enriched Ge detectors are used in calorimetric measurement. The most stringent bound is derived from the data set in which pulse-shape analysis has been used to reduce background. Exposure time is 35.5 kg y. Supersedes BAUDIS 99 as most stringent result.

Half-life measurements of the two-neutrino double-β decay

The measured half-life values for the transitions (Z,A) → (Z+2,A) + $2e^-$ + $2\overline{\nu}_e$ to the 0^+ ground state of the final nucleus are listed. We also list the transitions to an excited state of the final nucleus (0_i^+, etc.). We report only the measuremetnts with the smallest (or comparable) uncertainty for each transition.

$t_{1/2}(10^{21}$ yr)			*ISOTOPE*	*TRANSITION*	*METHOD*	*DOCUMENT ID*	
• • • We do not use the following data for averages, fits, limits, etc. • • •							
$>$ 0.87			^{134}Xe		EXO-200	[1] ALBERT	17C
0.82	$\pm$0.02	$\pm$0.06	^{130}Te		CUORE-0	[2] ALDUINO	17
0.00690	$\pm$0.00015	$\pm$0.00037	^{100}Mo		CUPID	[3] ARMENGAUD	17
0.0274	$\pm$0.0004	$\pm$0.0018	^{116}Cd		NEMO-3	[4] ARNOLD	17
0.064	$^{+0.007}_{-0.006}$	$^{+0.012}_{-0.009}$	^{48}Ca		NEMO-3	[5] ARNOLD	16
0.00934	$\pm$0.00022	$^{+0.00062}_{-0.00060}$	^{150}Nd		NEMO-3	[6] ARNOLD	16A
1.926	$\pm$0.094		^{76}Ge		GERDA	[7] AGOSTINI	15A
0.00693	$\pm$0.00004		^{100}Mo		NEMO-3	[8] ARNOLD	15
2.165	$\pm$0.016	$\pm$0.059	^{136}Xe		EXO-200	[9] ALBERT	14
9.2	$^{+5.5}_{-2.6}$	$\pm$1.3	^{78}Kr		BAKSAN	[10] GAVRILYAK	13
2.38	$\pm$0.02	$\pm$0.14	^{136}Xe		KamLAND-Zen	[11] GANDO	12A
0.7	$\pm$0.09	$\pm$0.11	^{130}Te		NEMO-3	[12] ARNOLD	11
0.0235	$\pm$0.0014	$\pm$0.0016	^{96}Zr		NEMO-3	[13] ARGYRIADES	10
0.69	$^{+0.10}_{-0.08}$	$\pm$0.07	^{100}Mo	$0^+ \rightarrow 0_1^+$	Ge coinc.	[14] BELLI	10
0.57	$^{+0.13}_{-0.09}$	$\pm$0.08	^{100}Mo	$0^+ \rightarrow 0_1^+$	NEMO-3	[15] ARNOLD	07
0.096	$\pm$0.003	$\pm$0.010	^{82}Se		NEMO-3	[16] ARNOLD	05A
0.029	$^{+0.004}_{-0.003}$		^{116}Cd		^{116}CdWO$_4$ scint.	[17] DANEVICH	03

[1] ALBERT 17C uses the EXO-200 detector that contains 19.098 $\pm$ 0.014% admixture of ^{134}Xe to search for the $2\nu\ \beta\beta$ decay mode. The exposure is 29.6 kg·year. The median sensitivity is 1.2×10^{21} years.

[2] ALDUINO 17 use the CUORE-0 detector containing 10.8 kg of ^{130}Te in 52 crystals of TeO$_2$. The exposure was 9.3 kg yr of ^{130}Te. This is a more accurate rate determination than in ARNOLD 11 and BARABASH 11A.

[3] ARMENGAUD 17 use 185.9 $\pm$ 0.1 g crystal of Li$_2{}^{100}$MoO$_4$ to determine the ^{100}Mo $2\nu\ \beta\beta$ half-life. The exposure was of 1303 $\pm$ 26 hours only, using novel technique.

[4] ARNOLD 17 use the NEMO-3 tracking calorimeter, containing 410 grams of enriched ^{116}Cd exposed for 5.26 years, to determine the half-life value.

[5] ARNOLD 16 use the NEMO-3 detector and a source of 6.99 g of ^{48}Ca. The half-life is based on 36.7 g year exposure. It is consistent, although somewhat longer, than the previous determinations of the half-life. Supersedes BARABASH 11A.

[6] ARNOLD 16A use the NEMO-3 tracking calorimeter, containing 36.6 g of ^{150}Nd exposed for 1918.5 days, to determine the half-life. Supersedes ARGYRIADES 09.

[7] AGOSTINI 15A use 17.9 kg yr exposure of the GERDA calorimeter to derive an improved measurement of the $2\nu\beta\beta$ decay half life of ^{76}Ge.

[8] ARNOLD 15 use the NEMO-3 tracking calorimeter with 34.3 kg yr exposure to determine the $2\nu\beta\beta$-half life of ^{100}Mo. Supersedes ARNOLD 05A and ARNOLD 04.

[9] ALBERT 14 use the EXO-200 tracking detector for a re-measurement of the $2\nu\beta\beta$-half life of ^{136}Xe. A nuclear matrix element of 0.0218 ± 0.0003 MeV^{-1} is derived from this data. Supersedes ACKERMAN 11.

[10] GAVRILYAK 13 use a proportional counter filled with Kr gas to search for the $2\nu 2K$ decay of ^{78}Kr. Data with the enriched and depleted Kr were used to determine signal and background. A 2.5σ excess of events obtained with the enriched sample is interpreted as an indication for the presence of this decay.

[11] GANDO 12A use a modification of the existing KamLAND detector. The $\beta\beta$ decay source/detector is 13 tons of enriched ^{136}Xe-loaded scintillator contained in an inner balloon. The $2\nu\beta\beta$ decay rate is derived from the fit to the spectrum between 0.5 and 4.8 MeV. This result is in agreement with ACKERMAN 11.

[12] ARNOLD 11 use enriched ^{130}Te in the NEMO-3 detector to measure the $2\nu\ \beta\beta$ decay rate. This result is in agreement with, but more accurate than ARNABOLDI 03.

[13] ARGYRIADES 10 use 9.4 ± 0.2 g of ^{96}Zr in NEMO-3 detector and identify its $2\nu\beta\beta$ decay. The result is in agreement and supersedes ARNOLD 99.

[14] BELLI 10 use enriched ^{100}Mo with 4 HP Ge detectors to record the 590.8 and 539.5 keV γ rays from the decay of the 0^+_1 state in ^{100}Ru both in singles and coincidences. This result confirms the measurement of KIDD 09 and ARNOLD 07 and supersedes them.

[15] First exclusive measurement of 2ν-decay to the first excited 0^+_1-state of daughter nucleus. ARNOLD 07 use the NEMO-3 tracking calorimeter to detect all particles emitted in decay. Result agrees with the inclusive ($0\nu + 2\nu$) measurement of DEBRAECKELEER 01.

[16] ARNOLD 05A use the NEMO-3 tracking detector to determine the $2\nu\beta\beta$ half-life of ^{82}Se with high statistics and low background (389 days of data taking). Supersedes ARNOLD 04.

[17] Calorimetric measurement of $2\nu\beta\beta$ ground state decay of ^{116}Cd using enriched CdWO$_4$ scintillators. Agrees with EJIRI 95 and ARNOLD 96. Supersedes DANEVICH 00.

$\langle m_\nu \rangle$, The Effective Weighted Sum of Majorana Neutrino Masses Contributing to Neutrinoless Double-β Decay

$\langle m_\nu \rangle = |\Sigma U^2_{ei} m_{\nu_i}|$, i = 1,2,3. It is assumed that ν_i are Majorana particles and that the transition is dominated by the known (light) neutrinos. Note that U^2_{ei} and not $|U_{ei}|^2$ occur in the sum, and that consequently cancellations are possible. The experiments obtain the limits on $\langle m_\nu \rangle$ from the measured ones on $T_{1/2}$ using a range of nuclear matrix elements (NME), which is reflected in the spread of $\langle m_\nu \rangle$. Different experiments may choose different NME. All assume $g_A = 1.27$. In the following Listings, only the best or comparable limits for each isotope are reported. When not mentioned explicitly the transition is between ground states, but transitions between excited states are also reported.

VALUE (eV)	*ISOTOPE*	*TRANSITION*	*METHOD*	*DOCUMENT ID*	
• • • We do not use the following data for averages, fits, limits, etc. • • •					
< 0.24–0.52	^{76}Ge		MAJORANA Dem	[1] AALSETH	18
< 0.12–0.26	^{76}Ge		GERDA	[2] AGOSTINI	18
< 0.15–0.40	^{136}Xe		EXO-200	[3] ALBERT	18
< 0.11–0.52	^{130}Te		CUORE	[4] ALDUINO	18
< 0.15–0.33	^{76}Ge		GERDA	[5] AGOSTINI	17
< 1.4–2.5	^{116}Cd		NEMO-3	[6] ARNOLD	17
< 0.27–0.76	^{130}Te		CUORE(CINO)	[7] ALDUINO	16
< 1.6–5.3	^{150}Nd		NEMO-3	[8] ARNOLD	16A
< 0.061–0.165	^{136}Xe		KamLAND-Zen	[9] GANDO	16
< 0.33–0.62	^{100}Mo		NEMO-3	[10] ARNOLD	15
< 0.19–0.45	^{136}Xe		EXO-200	[11] ALBERT	14B
< 0.89–2.43	^{82}Se		NEMO-3	[12] BARABASH	11A
< 7.2–19.5	^{96}Zr		NEMO-3	[13] ARGYRIADES	10
< 3.5–22	^{48}Ca		CaF$_2$ scint.	[14] UMEHARA	08
< 0.2–1.1	^{130}Te		Cryog. det.	[15] ARNABOLDI	05
< 0.37–1.9	^{130}Te		Cryog. det.	[16] ARNABOLDI	04
< 1.5–1.7	^{116}Cd		^{116}CdWO$_4$ scint.	[17] DANEVICH	03
< 0.350	^{76}Ge		Enriched HPGe	[18] KLAPDOR-K...	01
<8.3	^{48}Ca		CaF$_2$ scint.	YOU	91

[1] AALSETH 18 uses the MAJORANA Demonstrator detector to establish this limit.

[2] AGOSTINI 18 uses the GERDA detector to establish this limit.

[3] ALBERT 18 uses the EXO-200 experiment to obtain this limit.

[4] ALDUINO 18 use the combined data of CUORE, CUORE0, and Cuoricino to obtain this limit.

[5] AGOSTINI 17 is based on 343 mol yr of data from GERDA phase 1 and phase 2 first part and the corresponding limit on $T_{1/2}$ using the different nuclear matrix elements mentioned by the authors. Supersedes AGOSTINI 13A.

[6] ARNOLD 17 utilize NEMO-3 data, taken with enriched ^{116}Cd to limit the effective Majorana neutrino mass. The reported range results from the use of different nuclear matrix elements. Supersedes BARABASH 11A.

[7] ALDUINO 16 place a limit on the effective Majorana neutrino mass using the combined data of the CUORE-0 and CUORICINO experiments. The range reflects the authors' evaluation of the variability of the nuclear matrix elements. Supersededs ALFONSO 15.

[8] ARNOLD 16A limit is derived from data taken with the NEMO-3 detector and ^{150}Nd. A range of nuclear matrix elements that include the effect of nuclear deformation have been used. Supersedes ARGYRIADES 09.

[9] GANDO 16 result is based on the 2016 KamLAND-Zen half-life limit. The stated range reflects different nuclear matrix elements, an unquenched $g_A = 1.27$ is used. Supersedes GANDO 13A.

[10] ARNOLD 15 use the NEMO-3 tracking calorimeter with 34.3 kg yr exposure to determine the neutrino mass limit based on the $0\nu\beta\beta$-half life of ^{100}Mo. The spread range reflects different nuclear matrix elements. Supersedes ARNOLD 14 and BARABASH 11A.

[11] ALBERT 14B is based on 100 kg yr of exposure of the EXO-200 tracking calorimeter. The mass range reflects the nuclear matrix element calculations. Supersedes AUGER 12.

[12] BARABASH 11A limit is based on NEMO-3 data for ^{82}Se. The reported range reflects different nuclear matrix elements. Supersedes ARNOLD 05A and ARNOLD 04.

[13] ARGYRIADES 10 use ^{96}Zr and the NEMO-3 tracking detector to obtain the reported mass limit. The range reflects the fluctuation of the nuclear matrix elements considered.

[14] Limit was obtained using CaF_2 scintillation calorimeter to search for double beta decay of ^{48}Ca. Reported range of limits reflects spread of QRPA and SM matrix element calculations used. Supersedes OGAWA 04.

[15] Supersedes ARNABOLDI 04. Reported range of limits due to use of different nuclear matrix element calculations.

[16] Supersedes ARNABOLDI 03. Reported range of limits due to use of different nuclear matrix element calculations.

[17] Limit for $\langle m_\nu \rangle$ is based on the nuclear matrix elements of STAUDT 90 and ARNOLD 96. Supersedes DANEVICH 00.

[18] KLAPDOR-KLEINGROTHAUS 01 uses the calculation by STAUDT 90. Using several other models in the literature could worsen the limit up to 1.2 eV. This is the most stringent experimental bound on m_ν. It supersedes BAUDIS 99B.

Limits on Lepton-Number Violating (V+A) Current Admixture

For reasons given in the discussion at the beginning of this section, we list only results from 1989 and later. $\langle\lambda\rangle = \lambda \sum U_{ej} V_{ej}$ and $\langle\eta\rangle = \eta \sum U_{ej} V_{ej}$, where the sum is over the number of neutrino generations. This sum vanishes for massless or unmixed neutrinos. In the following Listings, only best or comparable limits or lifetimes for each isotope are reported.

$\langle\lambda\rangle$ (10^{-6})	CL%	$\langle\eta\rangle$ (10^{-8})	CL%	ISOTOPE	METHOD	DOCUMENT ID	
• • • We do not use the following data for averages, fits, limits, etc. • • •							
< 0.9–1.3	90	< 0.5–0.8	90	^{100}Mo	NEMO-3	[1] ARNOLD	14
<120	90			^{100}Mo	$0^+ \rightarrow 2^+$	[2] ARNOLD	07
$0.692^{+0.058}_{-0.056}$	68	$0.305^{+0.026}_{-0.025}$	68	^{76}Ge	Enriched HPGe	[3] KLAPDOR-K...	06A
< 2.5	90			^{100}Mo	0ν, NEMO-3	[4] ARNOLD	05A
< 3.8	90			^{82}Se	0ν, NEMO-3	[5] ARNOLD	05A
< 1.5–2.0	90			^{100}Mo	0ν, NEMO-3	[6] ARNOLD	04
< 3.2–3.8	90			^{82}Se	0ν, NEMO-3	[7] ARNOLD	04
< 1.6–2.4	90	< 0.9–5.3	90	^{130}Te	Cryog. det.	[8] ARNABOLDI	03
< 2.2	90	<2.5	90	^{116}Cd	$^{116}CdWO_4$ scint.	[9] DANEVICH	03
< 3.2–4.7	90	< 2.4–2.7	90	^{100}Mo	ELEGANT V	[10] EJIRI	01
< 1.1	90	<0.64	90	^{76}Ge	Enriched HPGe	[11] GUENTHER	97
< 4.4	90	<2.3	90	^{136}Xe	TPC	[12] VUILLEUMIER	93
		<5.3		^{128}Te	Geochem	[13] BERNATOW...	92

[1] ARNOLD 14 is based on 34.7 kg yr of exposure of the NEMO-3 tracking calorimeter. The reported range limit on $\langle\lambda\rangle$ and $\langle\eta\rangle$ reflects the nuclear matrix element uncertainty in ^{100}Mo.

[2] ARNOLD 07 use NEMO-3 half life limit for 0ν-decay of ^{100}Mo to the first excited 2^+-state of daughter nucleus to limit the right-right handed admixture of weak currents $\langle\lambda\rangle$. This limit is not competitive when compared to the decay to the ground state.

[3] Re-analysis of data originally published in KLAPDOR-KLEINGROTHAUS 04A. Modified pulse shape analysis leads the authors to claim 6σ statistical evidence for observation of 0ν-decay. Authors use matrix element of MUTO 89 to determine $\langle\lambda\rangle$ and $\langle\eta\rangle$. Uncertainty of nuclear matrix element is not reflected in stated errors.

[4] ARNOLD 05A derive limit for $\langle\lambda\rangle$ based on ^{100}Mo data collected with NEMO-3 detector. No limit for $\langle\eta\rangle$ is given. Supersedes ARNOLD 04.

[5] ARNOLD 05A derive limit for $\langle\lambda\rangle$ based on ^{82}Se data collected with NEMO-3 detector. No limit for $\langle\eta\rangle$ is given. Supersedes ARNOLD 04.

[6] ARNOLD 04 use the matrix elements of SUHONEN 94 to obtain a limit for $\langle\lambda\rangle$, no limit for $\langle\eta\rangle$ is given. This limit is more stringent than the limit in EJIRI 01 for the same nucleus.

[7] ARNOLD 04 use the matrix elements of TOMODA 91 and SUHONEN 91 to obtain a limit for $\langle \lambda \rangle$, no limit for $\langle \eta \rangle$ is given.

[8] Supersedes ALESSANDRELLO 00. Cryogenic calorimeter search. Reported a range reflecting uncertainty in nuclear matrix element calculations.

[9] Limits for $\langle \lambda \rangle$ and $\langle \eta \rangle$ are based on nuclear matrix elements of STAUDT 90. Supersedes DANEVICH 00.

[10] The range of the reported $\langle \lambda \rangle$ and $\langle \eta \rangle$ values reflects the spread of the nuclear matrix elements. On axis value assuming $\langle m_\nu \rangle$=0 and $\langle \lambda \rangle$=$\langle \eta \rangle$=0, respectively.

[11] GUENTHER 97 limits use the matrix elements of STAUDT 90. Supersedes BALYSH 95 and BALYSH 92.

[12] VUILLEUMIER 93 uses the matrix elements of MUTO 89. Based on a half-life limit 2.6×10^{23} y at 90%CL.

[13] BERNATOWICZ 92 takes the measured geochemical decay width as a limit on the 0ν width, and uses the SUHONEN 91 coefficients to obtain the least restrictive limit on η. Further details of the experiment are given in BERNATOWICZ 93.

Double-β Decay REFERENCES

AALSETH	18	PRL 120 132502	C.E. Aalseth *et al.*	(MAJORANA Collab.)
AGOSTINI	18	PRL 120 132503	M. Agostini *et al.*	(GERDA Collab.)
ALBERT	18	PRL 120 072701	J. B. Albert *et al.*	(EXO-200 Collab.)
ALDUINO	18	PRL 120 132501	C. Alduino *et al.*	(CUORE Collab.)
AGOSTINI	17	NAT 544 47	M. Agostini *et al.*	(GERDA Collab.)
ALBERT	17C	PR D96 092001	J.B. Albert *et al.*	(EXO-200 Collab.)
ALDUINO	17	EPJ C77 13	C. Alduino *et al.*	(CUORE Collab.)
ARMENGAUD	17	EPJ C77 785	E. Armengaud *et al.*	(CUPID Collab.)
ARNOLD	17	PR D95 012007	R. Arnold *et al.*	(NEMO-3 Collab.)
ALDUINO	16	PR C93 045503	C. Alduino *et al.*	(CUORE Collab.)
ARNOLD	16	PR D93 112008	R. Arnold *et al.*	(NEMO-3 Collab.)
ARNOLD	16A	PR D94 072003	R. Arnold *et al.*	(NEMO-3 Collab.)
ASAKURA	16	NP A946 171	K. Asakura *et al.*	(KamLAND-Zen Collab.)
GANDO	16	PRL 117 082503	A. Gando *et al.*	(KamLAND-Zen Collab.)
AGOSTINI	15A	EPJ C75 416	M. Agostini *et al.*	(GERDA Collab.)
ALFONSO	15	PRL 115 102502	K. Alfonso *et al.*	(CUORE Collab.)
ARNOLD	15	PR D92 072011	R. Arnold *et al.*	(NEMO-3 Collab.)
ALBERT	14	PR C89 015502	J. Albert *et al.*	(EXO-200 Collab.)
ALBERT	14B	NAT 510 229	J.B. Albert *et al.*	(EXO-200 Collab.)
ARNOLD	14	PR D89 111101	R. Arnold *et al.*	(NEMO-3 Collab.)
AGOSTINI	13A	PRL 111 122503	M. Agostini *et al.*	(GERDA Collab.)
GANDO	13A	PRL 110 062502	A. Gando *et al.*	(KamLAND-Zen Collab.)
GAVRILYAK	13	PR C87 035501	Yu.M. Gavrilyuk *et al.*	
ANDREOTTI	12	PR C85 045503	E. Andreotti *et al.*	(CUORICINO Collab.)
AUGER	12	PRL 109 032505	M. Auger *et al.*	(EXO-200 Collab.)
GANDO	12A	PR C85 045504	A. Gando *et al.*	(KamLAND-Zen Collab.)
ACKERMAN	11	PRL 107 212501	N. Ackerman *et al.*	(EXO Collab.)
ARNOLD	11	PRL 107 062504	R. Arnold *et al.*	(NEMO-3 Collab.)
BARABASH	11A	PAN 74 312	A.S. Barabash *et al.*	(NEMO-3 Collab.)
		Translated from YAF 74 330.		
ARGYRIADES	10	NP A847 168	J. Argyriades *et al.*	(NEMO-3 Collab.)
BELLI	10	NP A846 143	P. Belli *et al.*	(DAMA-INR Collab.)
ARGYRIADES	09	PR C80 032501	J. Argyriades *et al.*	(NEMO-3 Collab.)
KIDD	09	NP A821 251	M. Kidd *et al.*	
ARNABOLDI	08	PR C78 035502	C. Arnaboldi *et al.*	(CUORICINO Collab.)
UMEHARA	08	PR C78 058501	S. Umehara *et al.*	
ARNOLD	07	NP A781 209	R. Arnold *et al.*	(NEMO-3 Collab.)
KLAPDOR-K...	06A	MPL A21 1547	H.V. Klapdor-Kleingrothaus, I.V. Krivosheina	
ARNABOLDI	05	PRL 95 142501	C. Arnaboldi *et al.*	(CUORICINO Collab.)
ARNOLD	05A	PRL 95 182302	R. Arnold *et al.*	(NEMO-3 Collab.)
AALSETH	04	PR D70 078302	C.E. Aalseth *et al.*	
ARNABOLDI	04	PL B584 260	C. Arnaboldi *et al.*	
ARNOLD	04	JETPL 80 377	R. Arnold *et al.*	(NEMO-3 Collab.)
		Translated from ZETFP 80 429.		

KLAPDOR-K...	04A	PL B586 198	H.V. Klapdor-Kleingrothaus *et al.*	
KLAPDOR-K...	04B	PR D70 078301	H.V. Klapdor-Kleingrothaus, A. Dietz, I.V. Krivosheina	
OGAWA	04	NP A730 215	I. Ogawa *et al.*	
ARNABOLDI	03	PL B557 167	C. Arnaboldi *et al.*	
DANEVICH	03	PR C68 035501	F.A. Danevich *et al.*	
AALSETH	02B	PR D65 092007	C.E. Aalseth *et al.*	(IGEX Collab.)
DEBRAECKEL...	01	PRL 86 3510	L. De Braeckeleer *et al.*	
EJIRI	01	PR C63 065501	H. Ejiri *et al.*	
KLAPDOR-K...	01	EPJ A12 147	H.V. Klapdor-Kleingrothaus *et al.*	
KLAPDOR-K...	01B	MPL A16 2409	H.V. Klapdor-Kleingrothaus *et al.*	
ALESSAND...	00	PL B486 13	A. Alessandrello *et al.*	
DANEVICH	00	PR C62 045501	F.A. Danevich *et al.*	
ARNOLD	99	NP A658 299	R. Arnold *et al.*	(NEMO Collab.)
BAUDIS	99	PR D59 022001	L. Baudis *et al.*	(Heidelberg-Moscow Collab.)
BAUDIS	99B	PRL 83 41	L. Baudis *et al.*	(Heidelberg-Moscow Collab.)
ARNOLD	98	NP A636 209	R. Arnold *et al.*	(NEMO-2 Collab.)
GUENTHER	97	PR D55 54	M. Gunther *et al.*	(Heidelberg-Moscow Collab.)
ARNOLD	96	ZPHY C72 239	R. Arnold *et al.*	(BCEN, CAEN, JINR+)
BALYSH	95	PL B356 450	A. Balysh *et al.*	(Heidelberg-Moscow Collab.)
DASSIE	95	PR D51 2090	D. Dassie *et al.*	(NEMO Collab.)
EJIRI	95	JPSJ 64 339	H. Ejiri *et al.*	(OSAK, KIEV)
SUHONEN	94	PR C49 3055	J. Suhonen, O. Civitarese	
BERNATOW...	93	PR C47 806	T. Bernatowicz *et al.*	(WUSL, TATA)
VUILLEUMIER	93	PR D48 1009	J.C. Vuilleumier *et al.*	(NEUC, CIT, VILL)
BALYSH	92	PL B283 32	A. Balysh *et al.*	(MPIH, KIAE, SASSO)
BERNATOW...	92	PRL 69 2341	T. Bernatowicz *et al.*	(WUSL, TATA)
ELLIOTT	92	PR C46 1535	S.R. Elliott *et al.*	(UCI)
SUHONEN	91	NP A535 509	J. Suhonen, S.B. Khadkikar, A. Faessler	(JYV+)
TOMODA	91	RPP 54 53	T. Tomoda	
YOU	91	PL B265 53	K. You *et al.*	(BHEP, CAST+)
STAUDT	90	EPL 13 31	A. Staudt, K. Muto, H.V. Klapdor-Kleingrothaus	
MUTO	89	ZPHY A334 187	K. Muto, E. Bender, H.V. Klapdor	(TINT, MPIH)