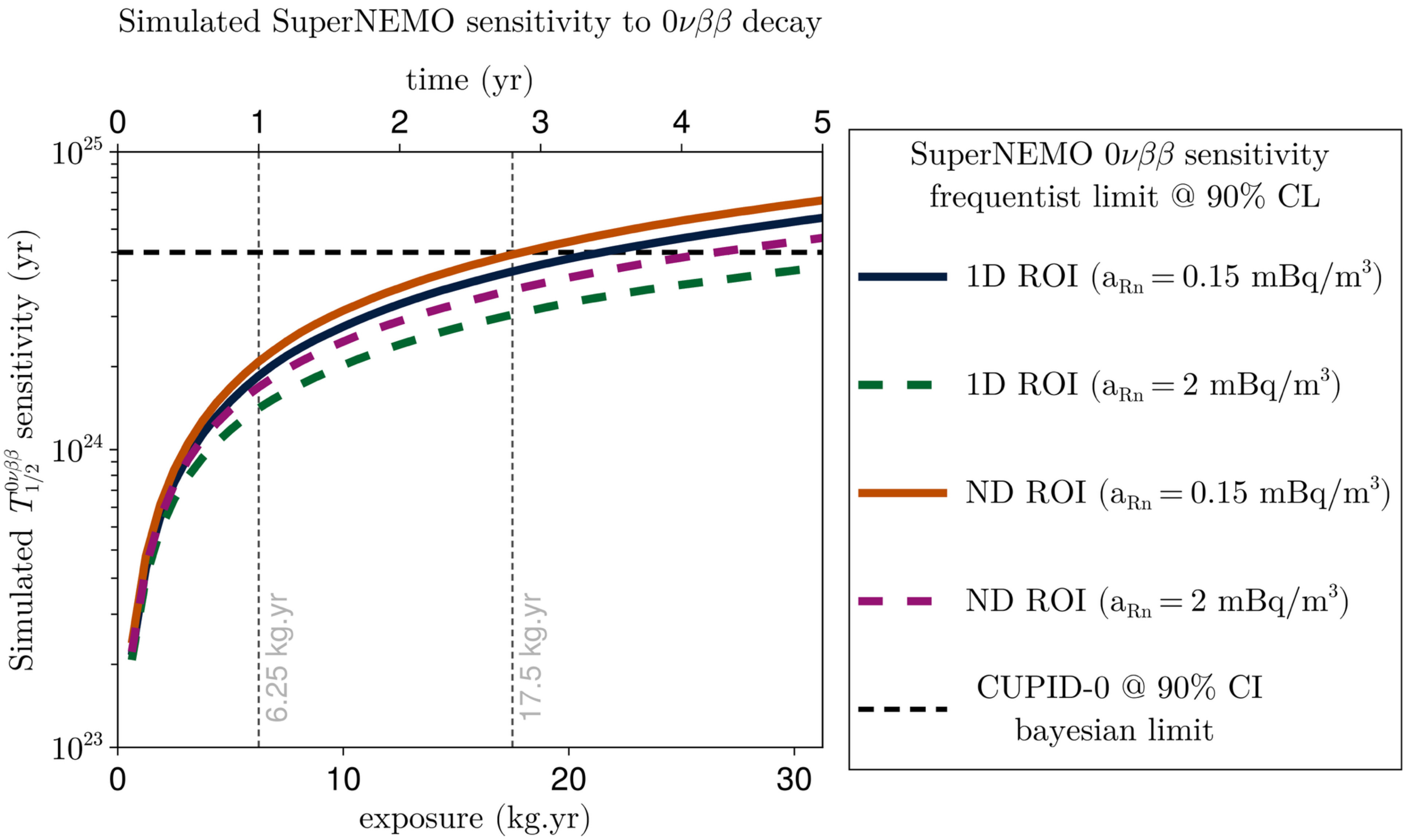
SuperNEMO sensitivity estimates for BSM physics

Maros Petro

0nubb



Simulated SuperNEMO sensitivity to $0\nu\beta\beta$ decay
time (yr)
0
1
2
3
4
5
10^{25}
10^{24}
10^{23}
Simulated $T_{1/2}^{0\nu\beta\beta}$ sensitivity (yr)
6.25 kg.yr
17.5 kg.yr
0
10
20
30
exposure (kg.yr)
SuperNEMO $0\nu\beta\beta$ sensitivity frequentist limit @ 90% CL
1D ROI ($a_{Rn} = 0.15$ mBq/m^3)
1D ROI ($a_{Rn} = 2$ mBq/m^3)
ND ROI ($a_{Rn} = 0.15$ mBq/m^3)
ND ROI ($a_{Rn} = 2$ mBq/m^3)
CUPID-0 @ 90% CI bayesian limit

0nubb comparison ND ROIs

Radon 0.15 uBq/m3

Quantity	Value
Sensitivity $T^{0\nu}_{1/2}$	4.59×10^{24} yr
Signal efficiency ε	0.18
Expected background $\bar{b}$	1.24 events

Observable	Optimized ROI
φ (deg)	(15, 180)
E_{sum} (keV)	(2700, 3000)
r (mm)	(0, 200)
E_{single} (keV)	(0, 2650)
Δy (mm)	(0, 135)
Δz (mm)	(0, 140)
P_{int}	$(3 \times 10^{-5}, 1.0)$
P_{ext}	(0.0, 0.003)
l_1 (mm)	(0, 3000)
l_2 (mm)	(0, 3000)

Radon 2 mBq/m3

Quantity	Value
Sensitivity $T^{0\nu}_{1/2}$	3.51×10^{24} yr
Signal efficiency ε	0.171
Expected background $\bar{b}$	2.80 events

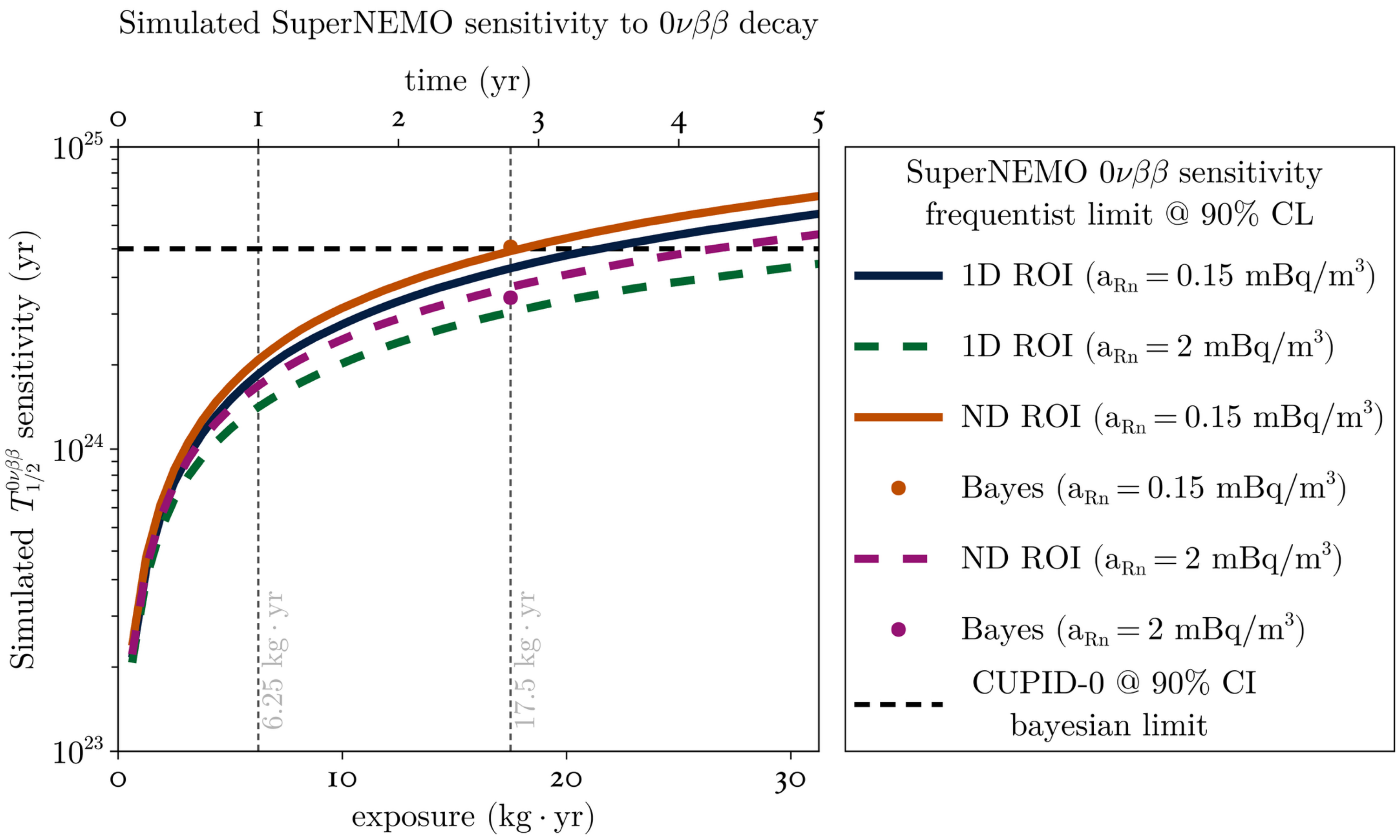
Observable	Optimized ROI
φ (deg)	(35, 175)
E_{sum} (keV)	(2700, 3000)
r (mm)	(0, 200)
E_{single} (keV)	(0, 2800)
Δy (mm)	(0, 60)
Δz (mm)	(0, 95)
P_{int}	$(1 \times 10^{-4}, 1.0)$
P_{ext}	(0.0, 0.01)
l_1 (mm)	(0, 3000)
l_2 (mm)	(0, 3000)

0nubb comparison ND vs 1D + high vs low radon

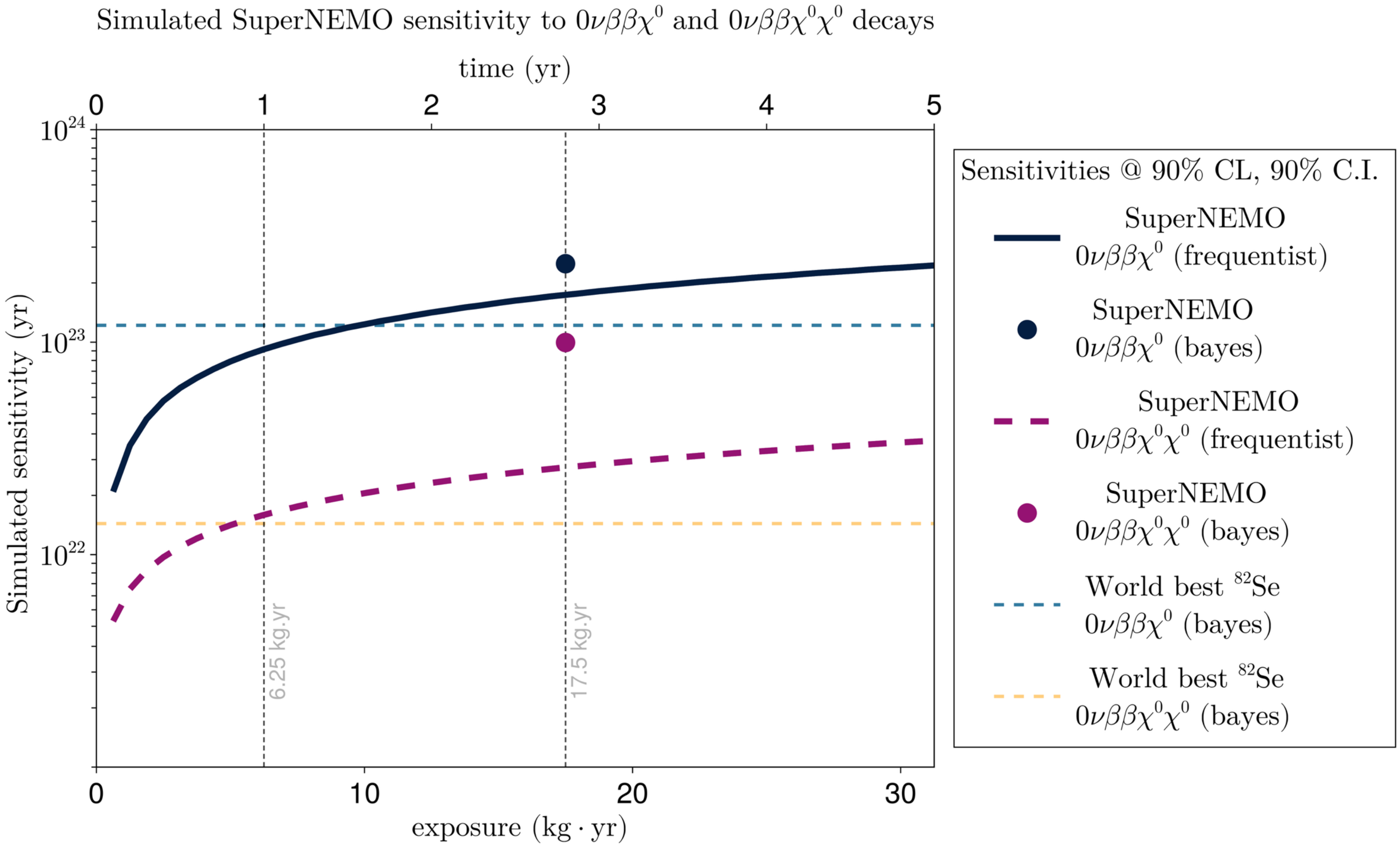
Table 6.6: Summary of the $0\nu\beta\beta$ sensitivity results for the one-dimensional (1D) and multidimensional (ND) ROI approaches under different radon background conditions. Sensitivities are quoted for one year and 2.86 years of data taking.

Configuration		Performance at 17.5 kg yr		Sensitivity	
a_{Rn} (mBq/m^3)	Method	ε	$\bar{b}$ (17.5 kg yr)	$T^{0\nu}_{1/2}$ (2.86 yr)	$T^{0\nu}_{1/2}$ (1 yr)
0.15	1D	0.163	1.46	4.03×10^{24}	1.77×10^{24}
2.0	1D	0.163	4.56	2.88×10^{24}	1.38×10^{24}
0.15	ND	0.178	1.24	4.59×10^{24}	1.98×10^{24}
2.0	ND	0.171	2.80	3.51×10^{24}	1.52×10^{24}

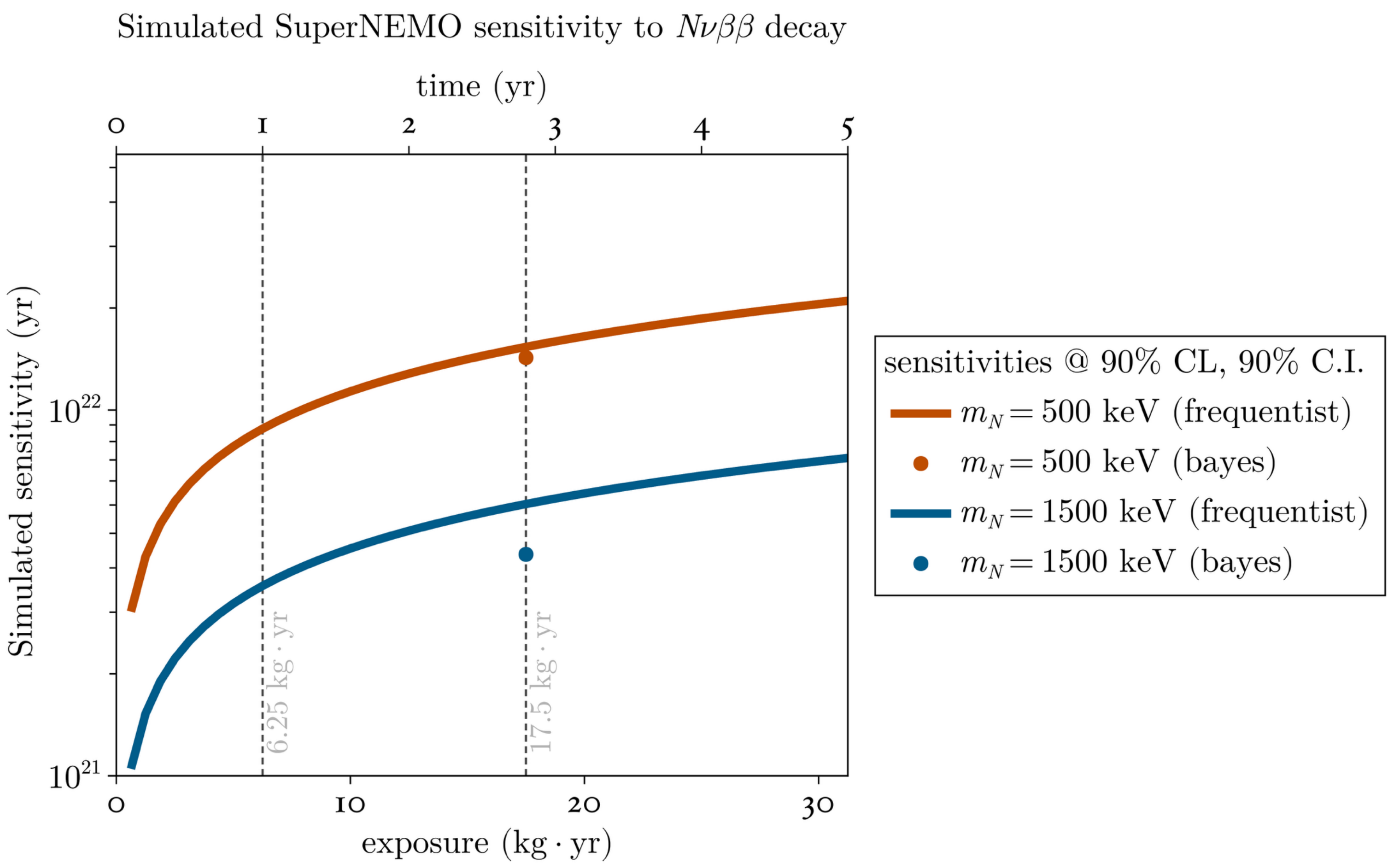
0nubb with Bayes limits



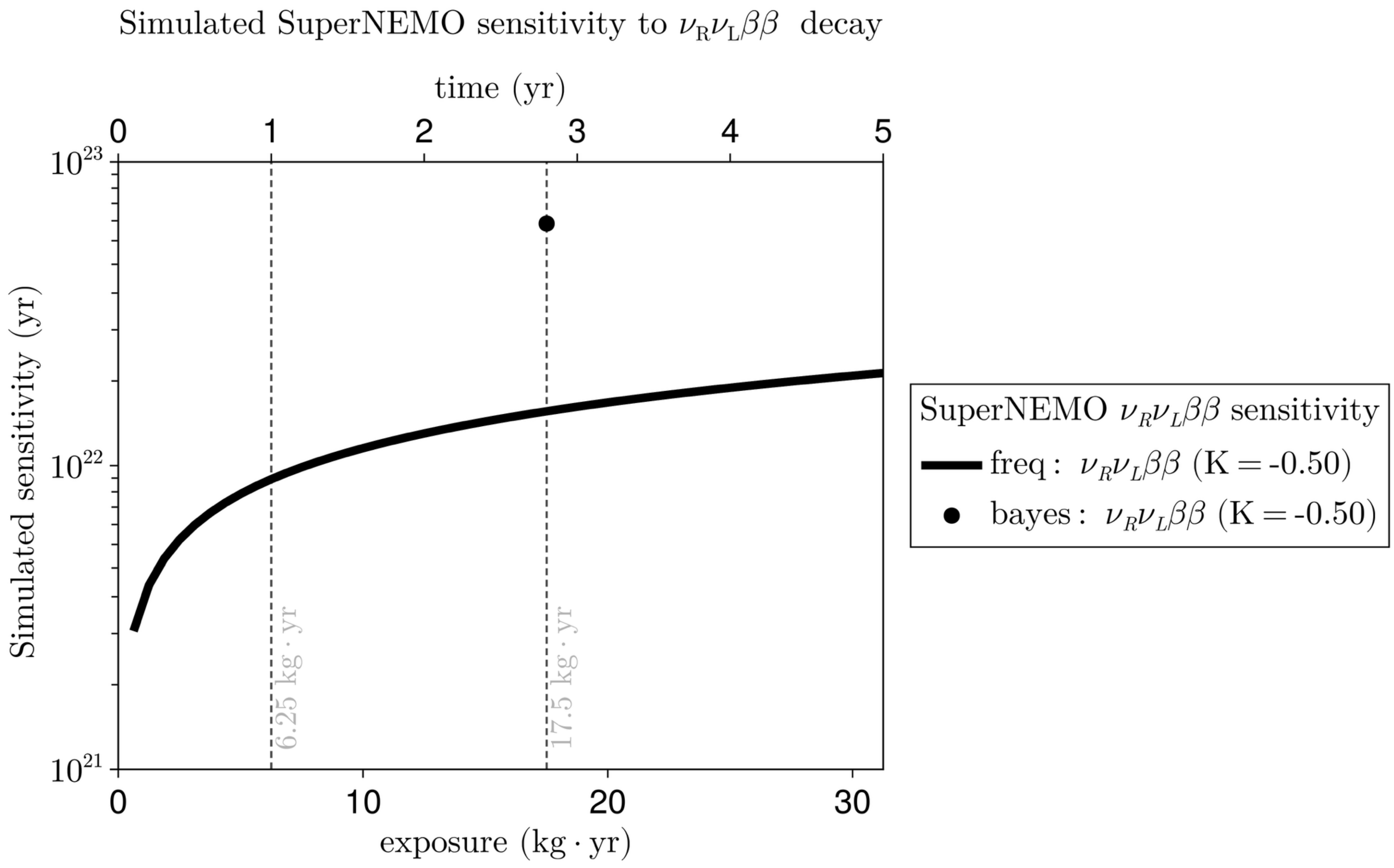
Majoron modes



Sterile neutrino with masses 500keV, 1500keV



2nubb with right handed neutrino



BSM sensitivities

Table 6.9: Expected sensitivities for an exposure of 17.5 kg·yr. Frequentist sensitivities are quoted at 90% CL, Bayesian sensitivities correspond to the median sensitivity obtained in an ensemble of pseudo-experiments with 90% credible interval for each.

Process	$\mathcal{S}^{90\%}_{\text{freq}}$ (yr)	$\mathcal{S}^{90\%}_{\text{Bayes}}$ (yr)
$\nu_R\nu_L\beta\beta\,(K = 0.5)$	1.52×10^{22}	6.27×10^{22}
$0\nu\beta\beta\chi^0$	1.70×10^{23}	2.34×10^{23}
$0\nu\beta\beta\chi^0\chi^0$	2.71×10^{22}	9.96×10^{22}
$N\nu\beta\beta\,(m_N = 500\,\text{keV})$	1.50×10^{22}	1.39×10^{22}
$N\nu\beta\beta\,(m_N = 1500\,\text{keV})$	5.60×10^{21}	4.03×10^{21}

BSM ROIs

Table 6.8: Optimized multidimensional regions of interest (ROI) for individual processes. Quoted ranges correspond to the final ND optimization.

Variable	$0\nu\beta\beta\chi^0$	$0\nu\beta\beta\chi^0\chi^0$	$\nu_R\nu_L\beta\beta$ (K=-0.50)	$N\nu\beta\beta$ (m_N = 500 keV)	$N\nu\beta\beta$ (m_N = 1500 keV)
φ (°)	$(20, 180)$	$(15, 175)$	$(0, 180)$	$(15, 180)$	$(15, 180)$
E_{sum} (keV)	$(2500, 3000)$	$(1400, 3000)$	$(400, 2700)$	$(300, 2300)$	$(400, 1400)$
Δy (mm)	< 120	< 100	< 200	< 130	< 150
Δz (mm)	< 120	< 130	< 200	< 150	< 150
P_{int}	$(10^{-4}, 1)$	$(10^{-4}, 1)$	$(10^{-3}, 1)$	$(10^{-3}, 1)$	$(10^{-3}, 1)$
P_{ext}	$(0, 0.01)$	$(0, 0.01)$	$(0, 0.01)$	$(0, 0.1)$	$(0, 0.01)$