POSSIBILITY OF THE STERILE NEUTRINO SEARCH WITH NINJA

Author

Doris Barčot

Ruđer Bošković Institute, Croatia

dbarcot@irb.hr

NINJA

INTRODUCTION

- Anomalies reported in various short-baseline neutrino experiments that cannot be explained by the standard three-flavor neutrino oscillation model

New model proposition

- 3+1 scenario:
  - PMNS matrix update:

$$U^{4\nu}_{PMNS} = R(\theta_{34},\delta_{34})R(\theta_{24},\delta_{24})R(\theta_{14},0)U^{3\nu}_{PMNS}$$

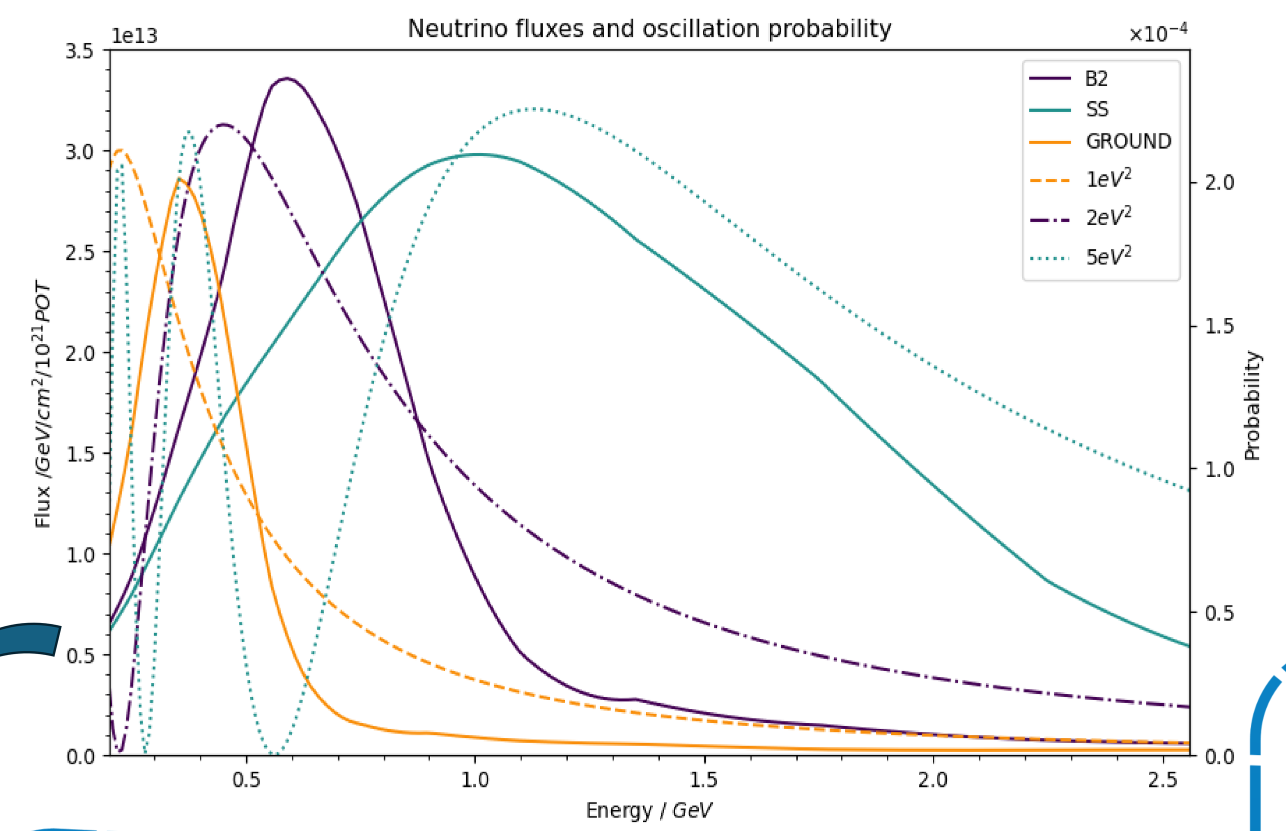
  - Oscillation probability:

$$P_{\mu e} = s^2_{24} sin^2\theta_{24} sin^2\frac{\Delta m^2_{41}L}{4E}$$

NINJA EXPERIMENT

- Measures CC interactions on a water target using the T2K neutrino beam
- Aiming to achieve multi-differential cross-section measurements with low momentum thresholds, down to 200 MeV/c for protons
- Using an alternating structure of emulsion films and thin target layers, we can achieve clear detection of short-range tracks from interaction vertices
- More on NINJA on Friday, poster #535 by Ayaka Kasumi

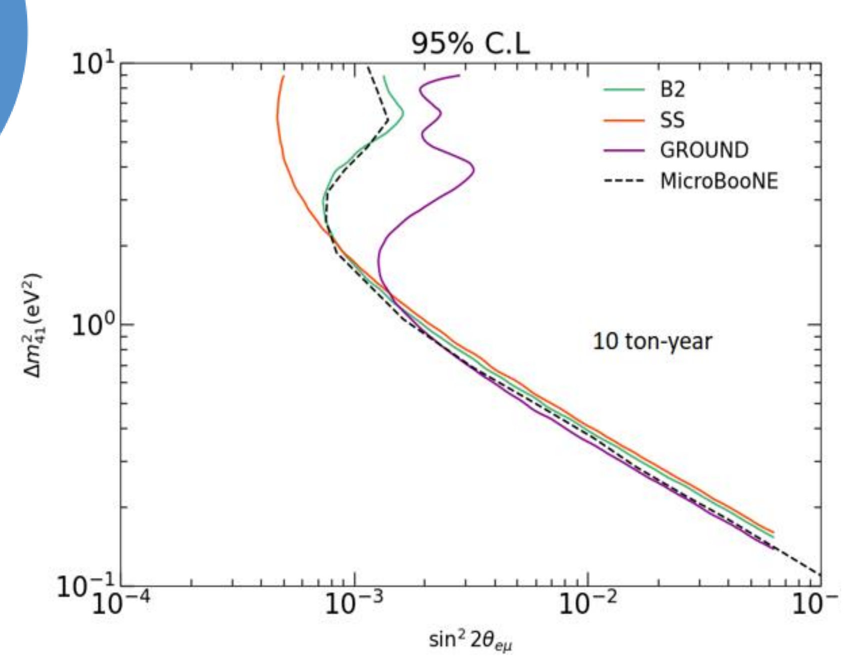
PROBABILITY

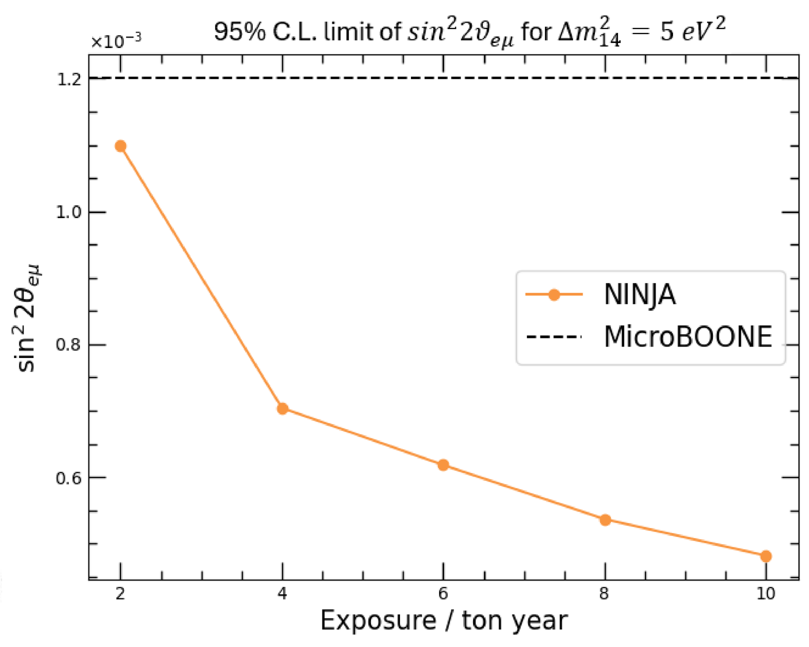


Sensitivity of flux to Δm^2_{41}

- SS floor to $5\ eV^2$
- B2 floor to $2\ eV^2$
- GROUND floor to $1\ eV^2$

SENSITIVITY





Sensitivity of NINJA

- SS floor flux can give better sensitivity than current bound (above $1\ eV^2$)
- Even with a small detector volume we can produce significant results

Events at the detector

- Too much background to see a signal
- Possibility of altering baseline and target volume to get better results (at GROUND floor)

EVENT RATES

		APPERANCE CH. (0.95@ $\nu_\mu \to \nu_e$)				DISAPPERANCE CH. (0.95@ $\nu_\mu \to \nu_\mu$)			
		DETECTOR EFFICIENCY (%)	EVENTS (1 t)			DETECTOR EFFICIENCY (%)	EVENTS (1 t)		
			B2	SS	GR		B2	SS	GR
BACKGROUNDS: INTRINSIC BEAM	$\nu_e \to \nu_e$	100	14412.4	27872.9	5759.58	/	/	/	/
MISS ID (ν_μ as ν_e)	$\nu_\mu \to \nu_\mu$	1	8782.45	35257.2	2087.55	/	/	/	/
	$\nu_e \to \nu_\mu$	1	0.003	0.004	0.002	/	/	/	/
MISS ID (ν_e as ν_μ)	$\nu_\mu \to \nu_e$	/	/	/	/	1	0.37	0.605	0.165
	$\nu_e \to \nu_e$	/	/	/	/	1	144.12	278.729	57.6
NC active ν	$\nu_\mu \to \nu_e$	0.5	0.074	0.112	0.038	0.5	0.074	0.112	0.038
	$\nu_\mu \to \nu_\mu$	0.5	1713.43	6355.16	466.6	0.5	1713.43	6355.16	466.603
	$\nu_\mu \to \nu_\tau$	0.5	0.002	0.003	0.002	0.5	0.002	0.003	0.002
WRONG SIGN	$\bar{\nu}_\mu \to \bar{\nu}_e$	100	0.61	0.826	0.337	/	/	/	/
	$\bar{\nu}_e \to \bar{\nu}_e$	100	1415.18	1656.38	642.29	/	/	/	/
	$\bar{\nu}_\mu \to \bar{\nu}_\mu$	/	/	/	/	100	28563.8	62833.1	7954.79
	$\bar{\nu}_e \to \bar{\nu}_\mu$	/	/	/	/	100	0.01	0.012	0.008
SIGNAL			35.214	57.459	15.719		834333	3.349e+06	198317

SUMMARY

- NINJA has ability to constrain sterile neutrino parameters, depending on the flux
- We have to figure out how to experimentaly take care of the backgrounds
- The possibility of changing the baseline on the ground floor is under consideration in order to get larger signal and smaller background

REFERENCES

- A. Hiramoto et al. [NINJA], First measurement of $\bar{\nu}_\mu$ and ν_μ charged-current inclusive interactions on water using a nuclear emulsion detector, Phys. Rev. D 102 (2020) no.7, 072006
- M.A. Acero et al., White Paper on Light Sterile Neutrino Searches and Related Phenomenology, *Snowmass 2021*