Status and Prospect of NvDEx, a Se TPC detector for 0νββ decay

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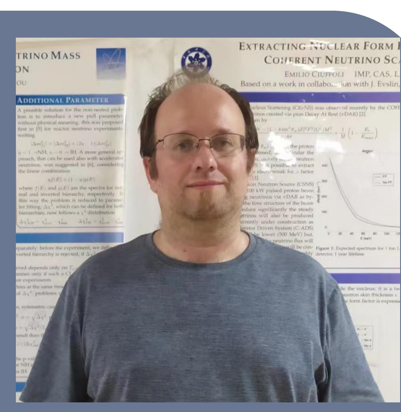
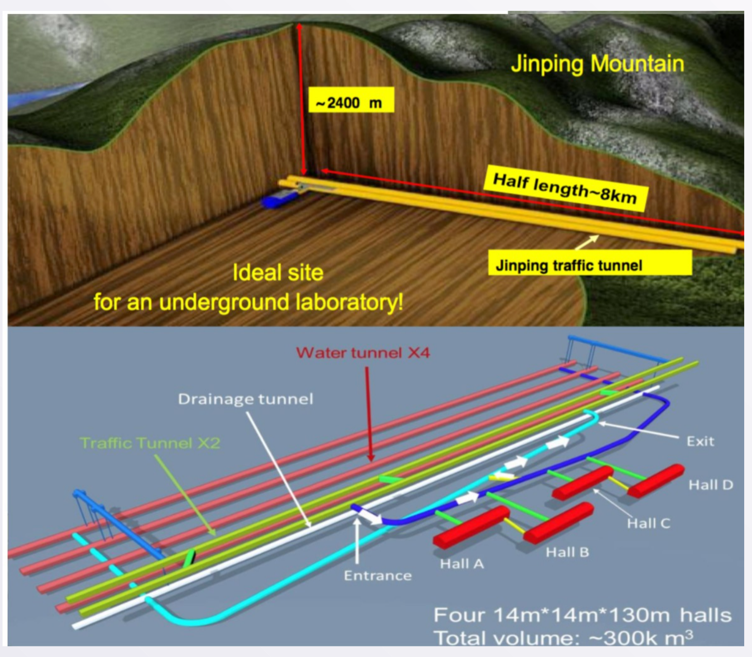


NvDEx

(No Neutrino Double beta decay Experiment)

HP SeF_6 TPC [1] looking for neutrinoless double beta decays



Advantages

- ^{82}Se high Q-value, 2.996 MeV
- CJPL → 2.4 km rock overburden
- TPC → topology used to veto bg estimated veto efficiency: 98.4%

} Very low bg, index estimated <4x10^{-6} evts/(kg yr keV) for NvDEX-100 → excellent prospects for scalability!

Challenges

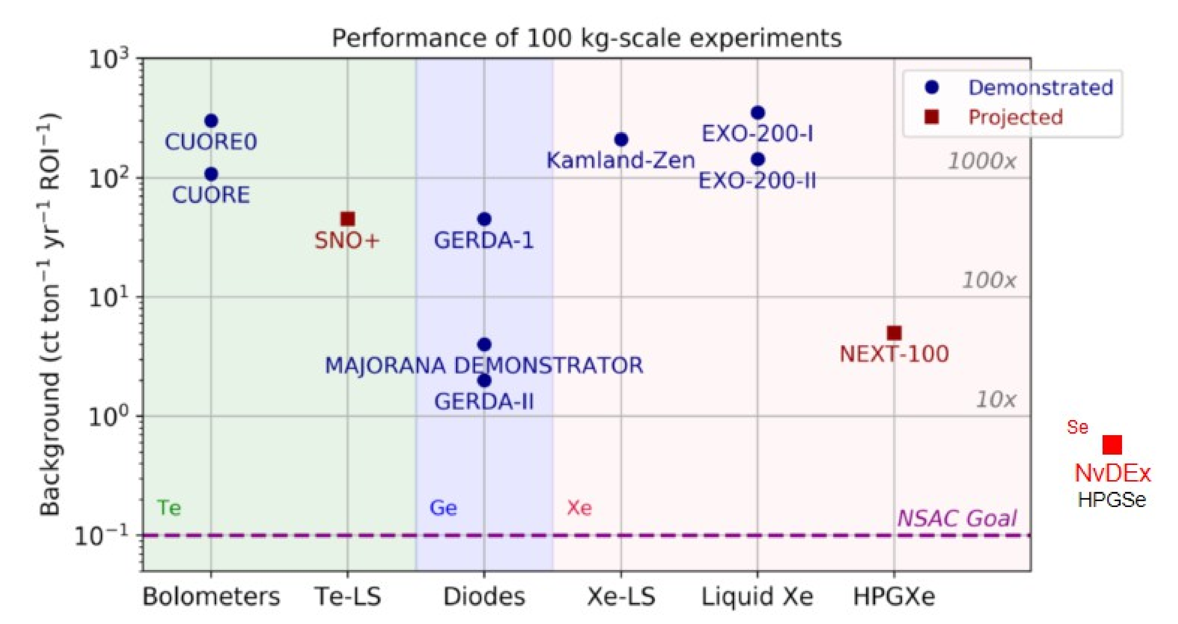
- SeF_6 is toxic → security measures must be implemented
- SeF_6 high electron affinity → negative ions are drifting → new sensor developed to detect negative ions and achieve good energy resolution without electron avalanche multiplication

Background (evts/yr)[2,3]		
Source	No veto	Veto
Nat. Rad.	0.42	7*10^{-3}
Fast n	0.03	4*10^{-4}
Rn (est.)	0.38	6*10^{-3}
Total	0.83	0.013

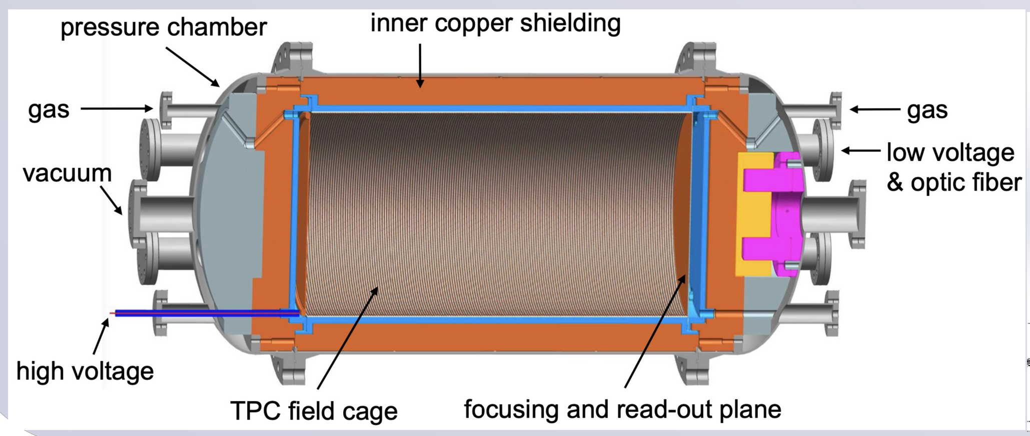
NvDEx-100

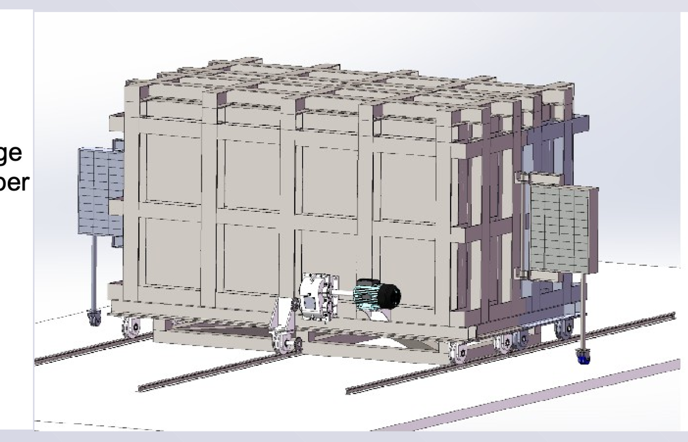
- First phase: NvDEx-100, 100 kg of SeF_6 [2]
- Expected FWHM: 1% at ROI
- Expected sensitivity: 3x10^{25}(3x10^{26}) yrs with nat. (enr.) Se

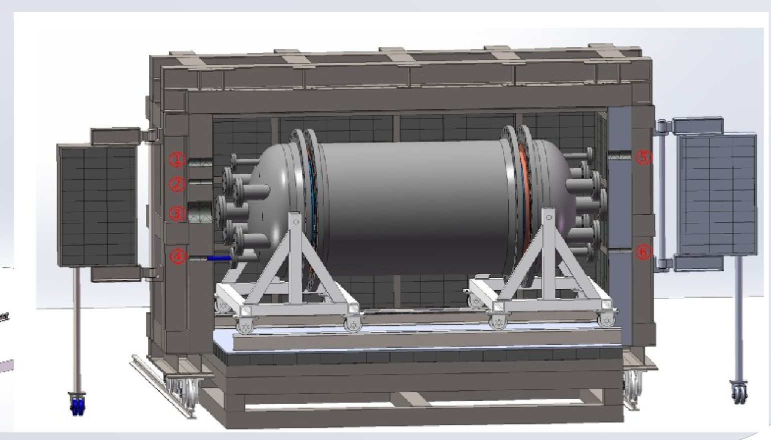
"100kg-class" experiments: Plot taken from [1]



Future Plans	
2026	Finish surface testing
2027	Install in CJPL, SF_6 run
2030	SeF_6 run





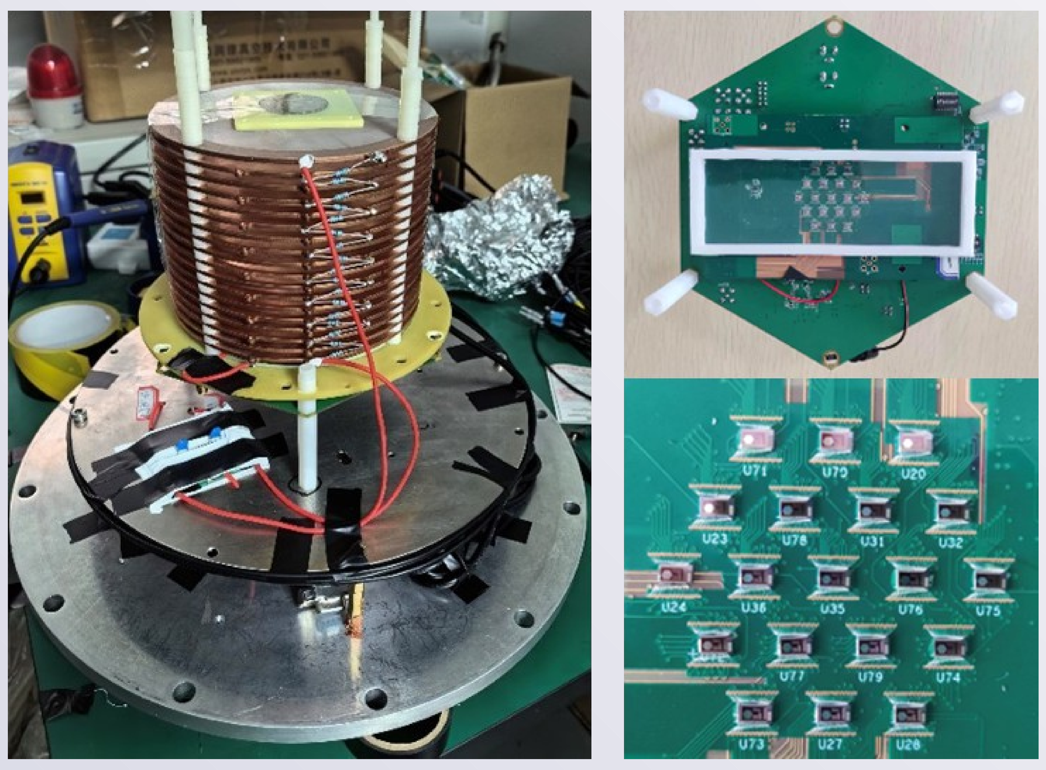


TPC Surface Test

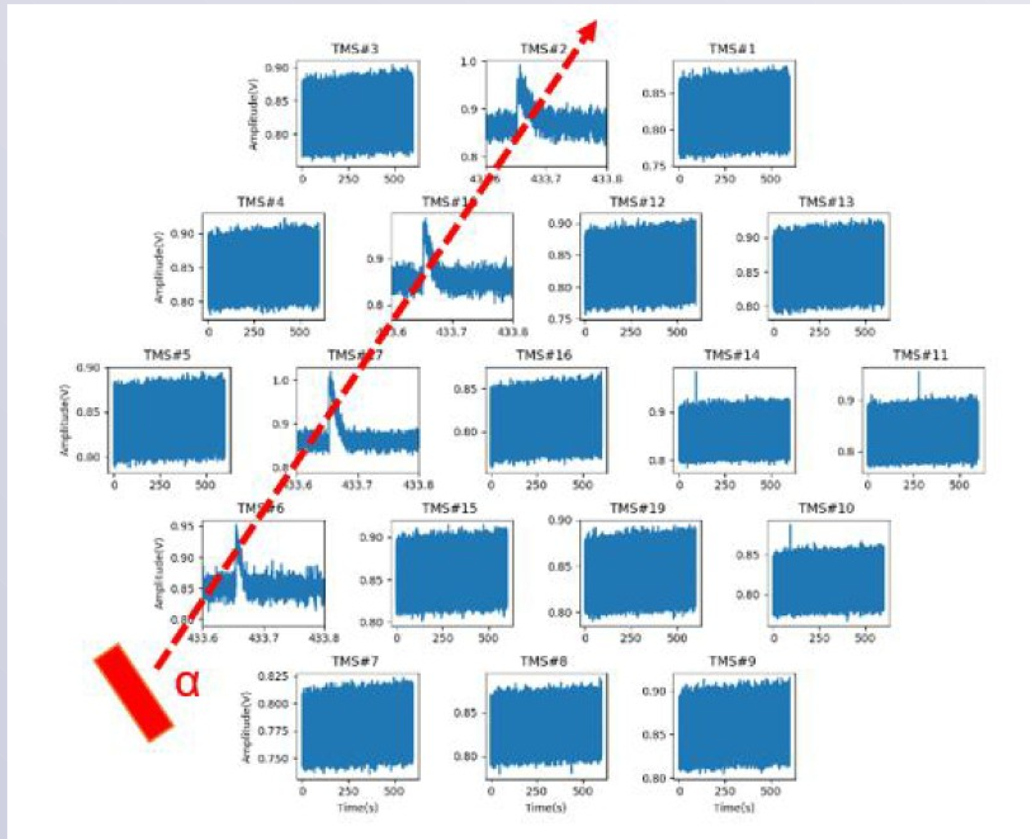
A prototype of the TPC is being currently tested at IMP, in Lanzhou

Main goals

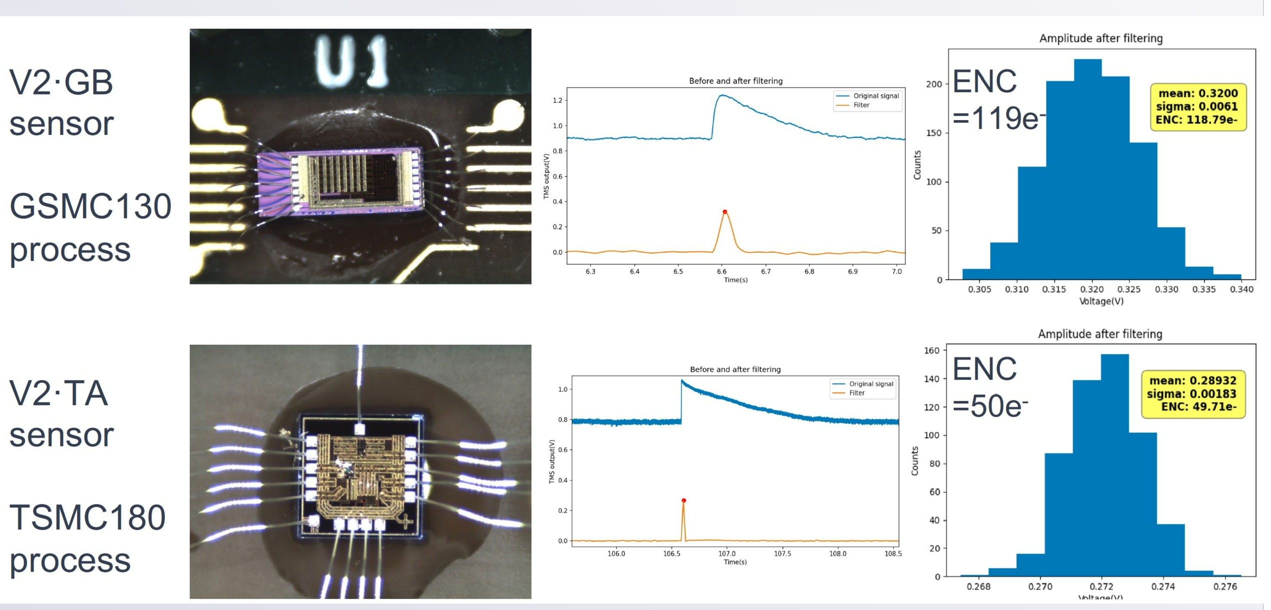
- Test Sensor
- Energy reconstruction
- Track detection



Currently α sources are being used, γ sources will be considered as well

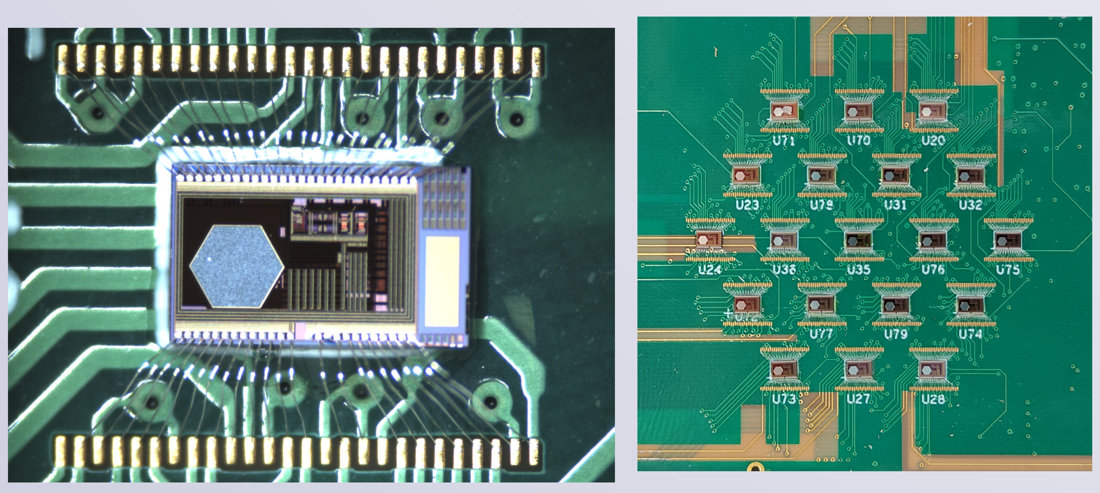


Sensor [4,5]

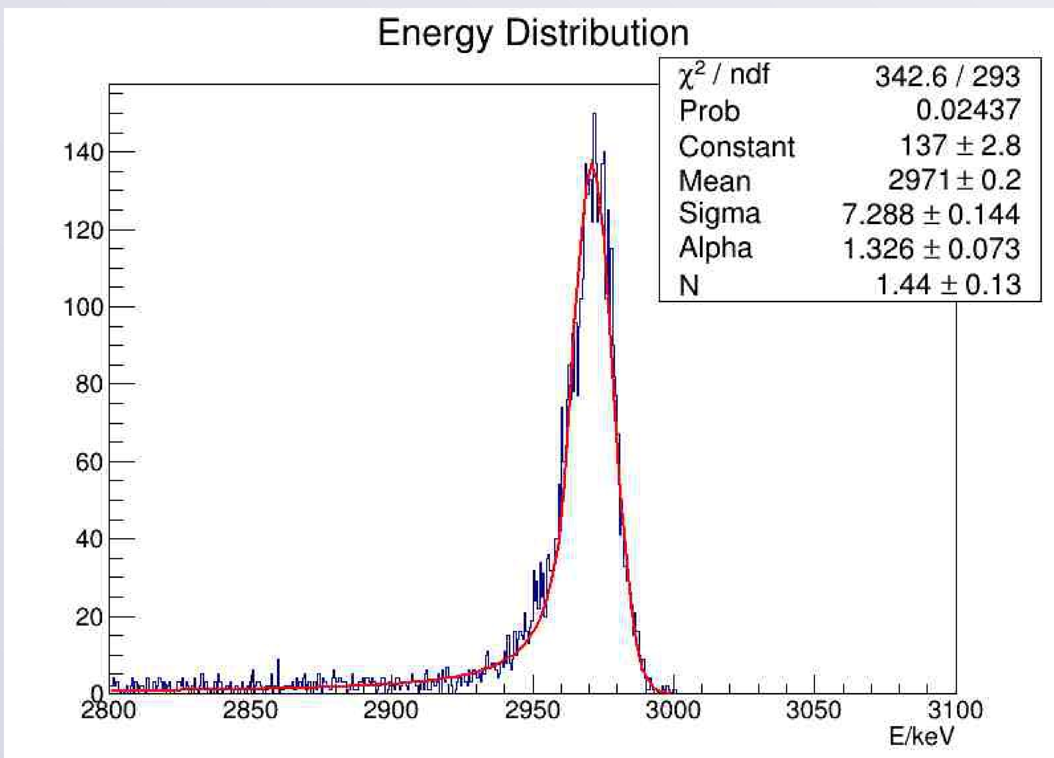


Designed to detect negative ions

- Three tape-outs already conducted (V0, V1 and V2)
- Noise: ~110 e^- for V1, V2 down to 50e^-
- NvDEx goal: <45 e^-
- Pixel dimension: ~ 8 mm
- Readout plane: ~10,000 sensors

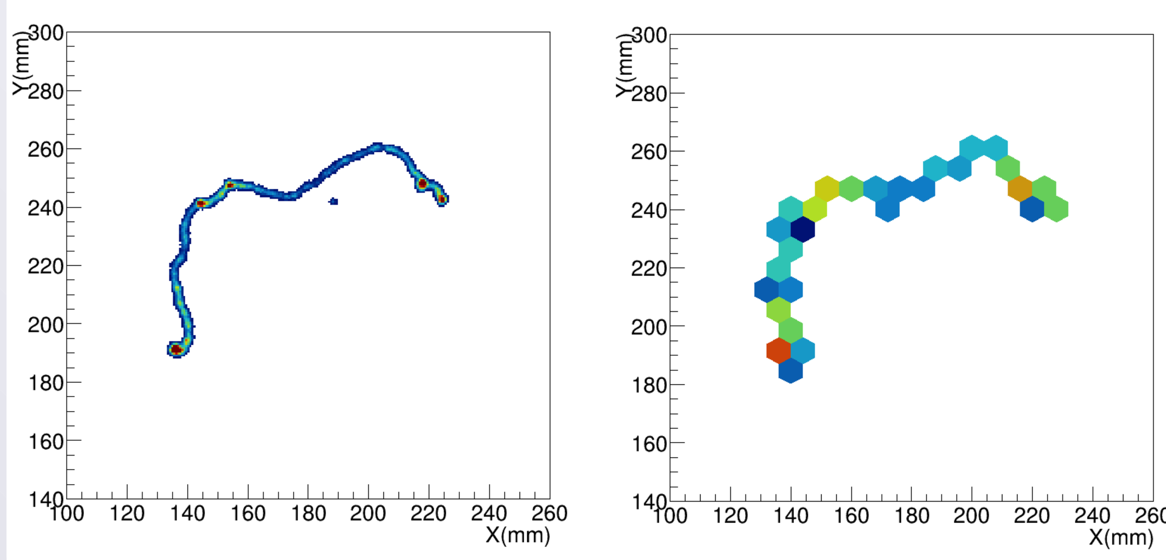


Simulations

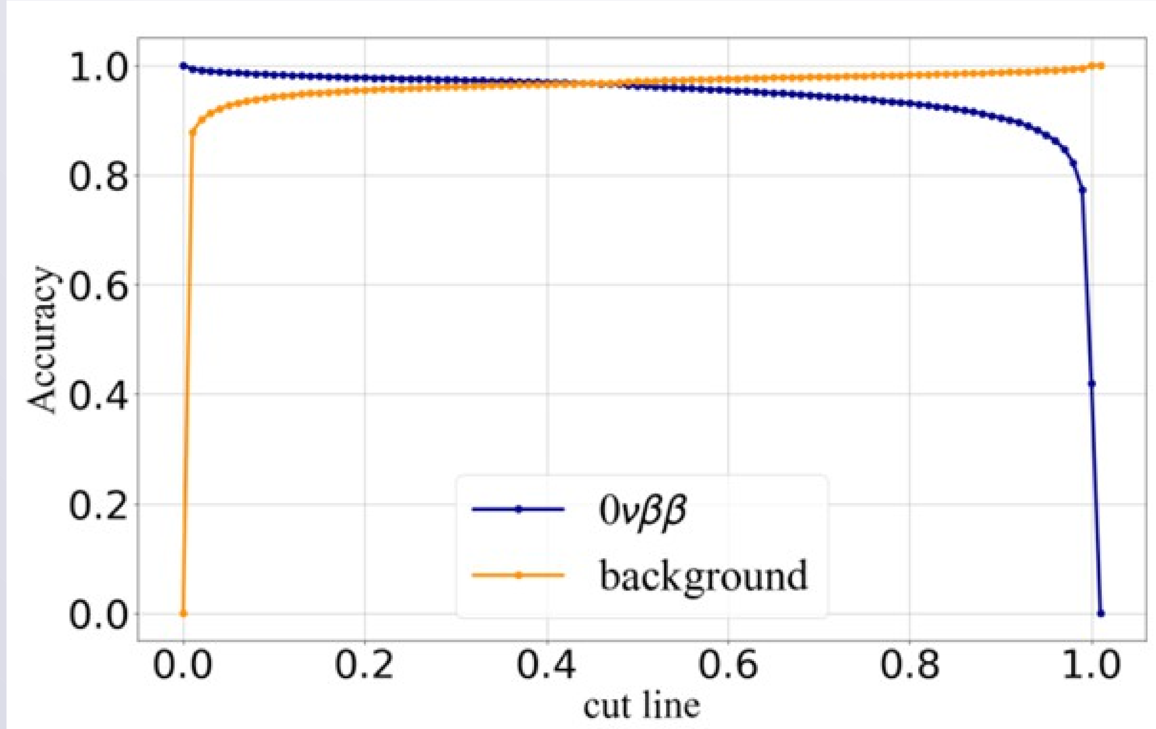


Reconstructed 0νββ energy from full simulation

- Full simulation and reconstruction software completed
- Chip noise 45e^- ⇒ Energy resolution 0.7% → Better than the requirement of 1%
- Background veto efficiency around 98.4% with 90% signal efficiency using neural networks → Much better than the estimate of 90% used in CDR



Simulated vs reconstructed 0νββ signal



Signal vs Background discrimination using neural networks

References

[1] JINST 13 (2018) 03, P03015 [2] Nucl.Sci.Tech. 35 (2024) 1, 3 [3] Astropart.Phys. 164 (2025) 103039 [4] JINST 19 (2024) 03, C03031 [5] JINST 19 (2024) 04, C04004