JUNO's Sensitivity to Neutrino Mass Ordering

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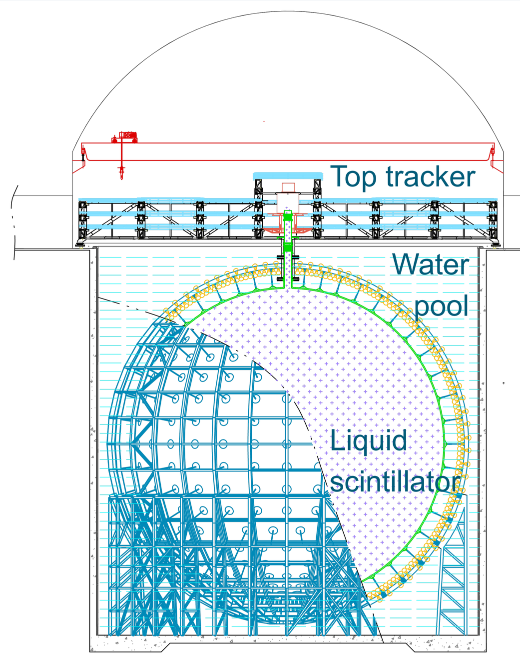
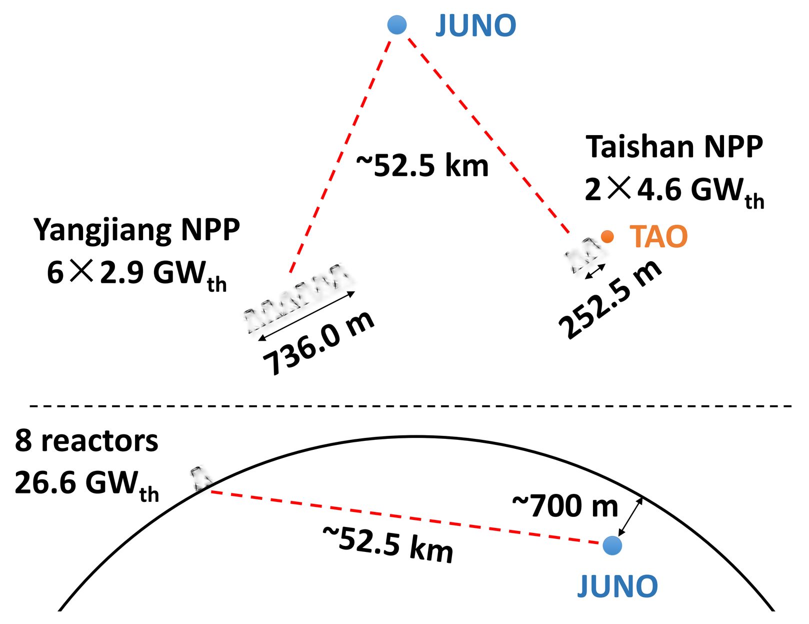
on behalf of the JUNO collaboration

Jiangmen Underground Neutrino Observatory (JUNO)

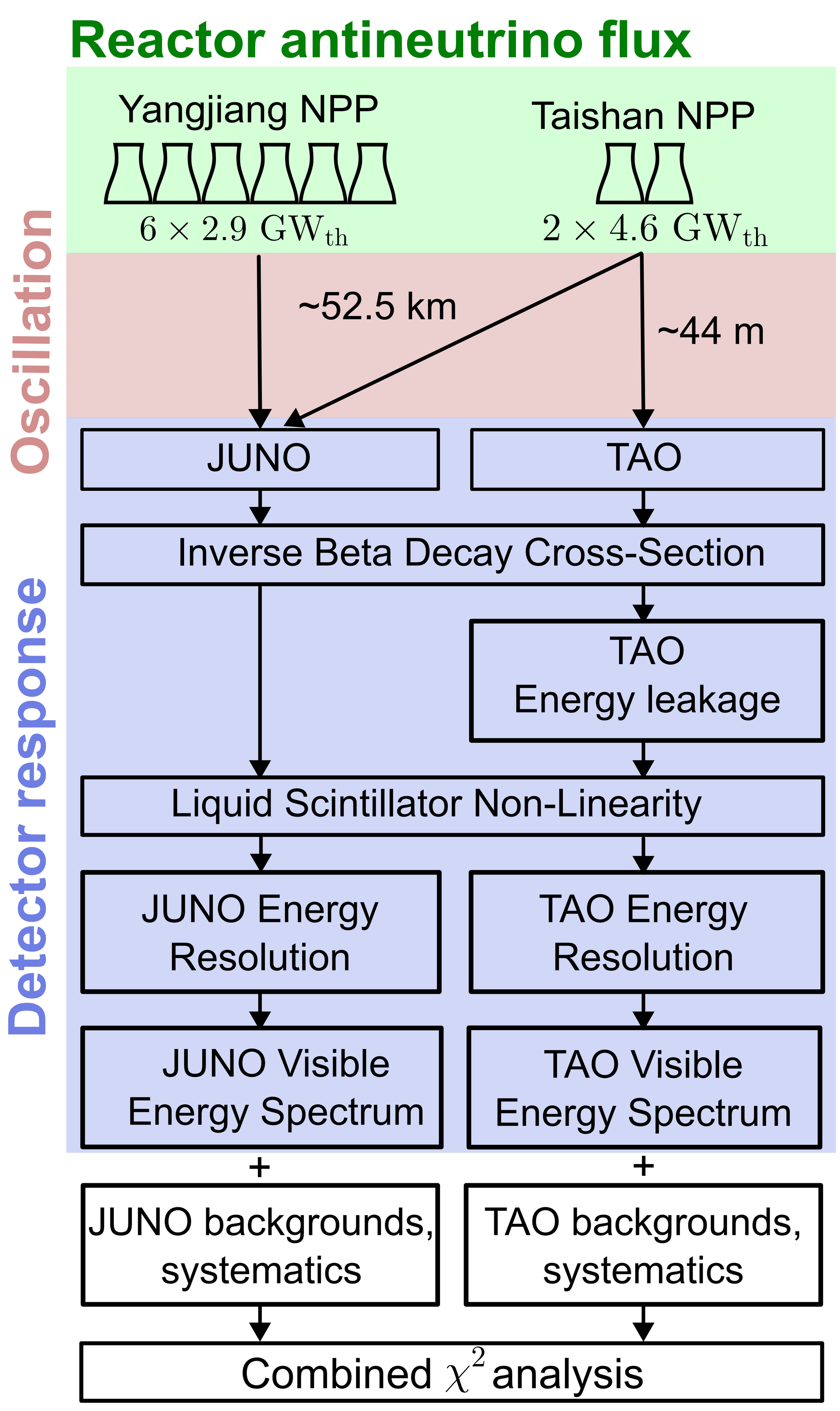


JUNO is multi-purpose liquid scintillator detector under construction in China [1]

- 20 kt of liquid scintillator
- Diameter of the target container 35 m
- Energy resolution σ is ~3% at 1 MeV
- Baseline is optimized for Neutrino Mass Ordering (NMO) determination
- Taishan Antineutrino Observatory (TAO) spectrum is used in combined analysis acting like a natural constraint for the antineutrino spectrum shape



Analysis Scheme

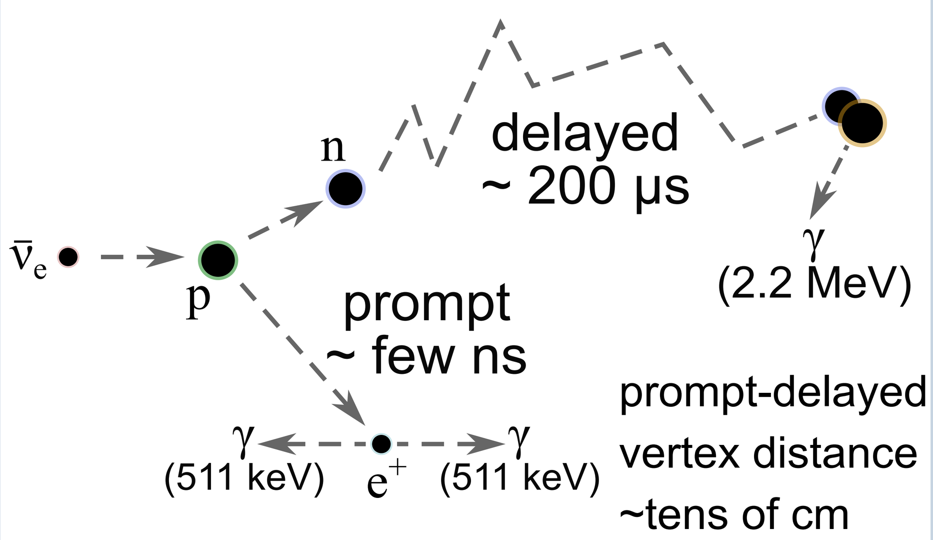


Inverse Beta Decay (IBD)

Signal source: $\bar{\nu}_e$ from products of fission of ^{235}U, ^{238}U, ^{239}Pu, and ^{241}Pu

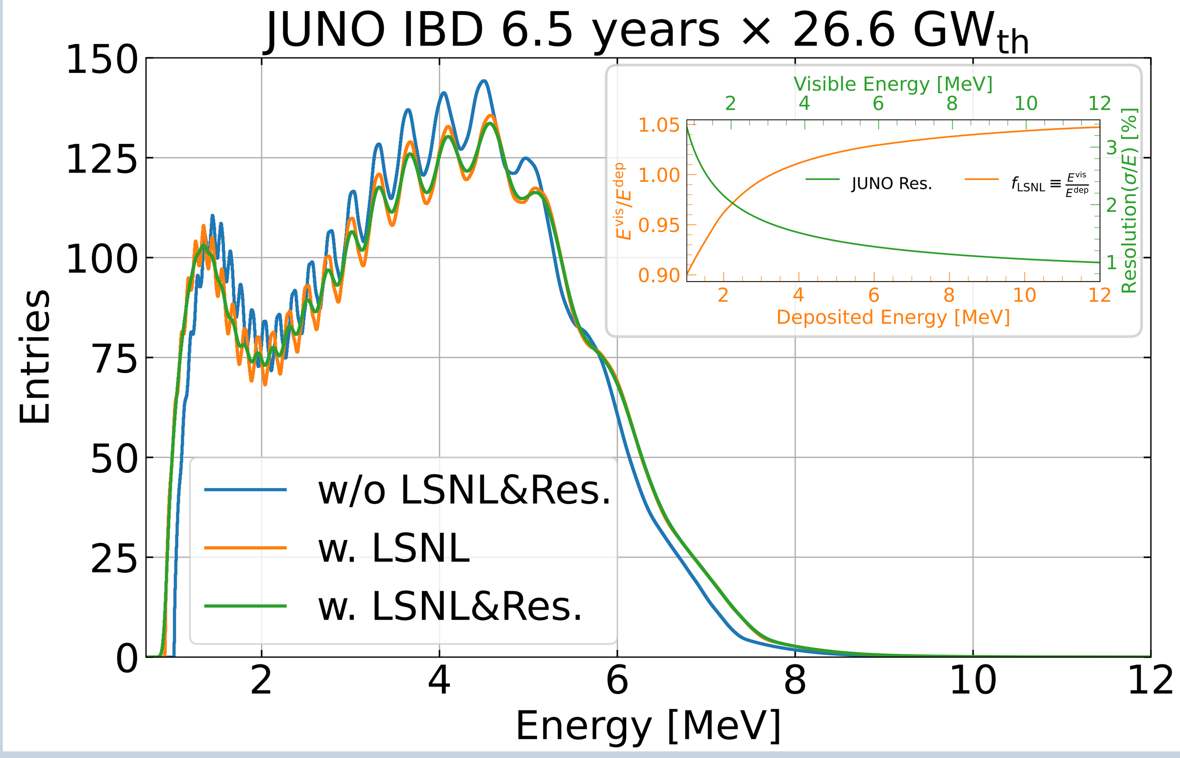
$\bar{\nu}_e$ detected via IBD reaction:

$$\bar{\nu}_e + p \rightarrow e^+ + n$$

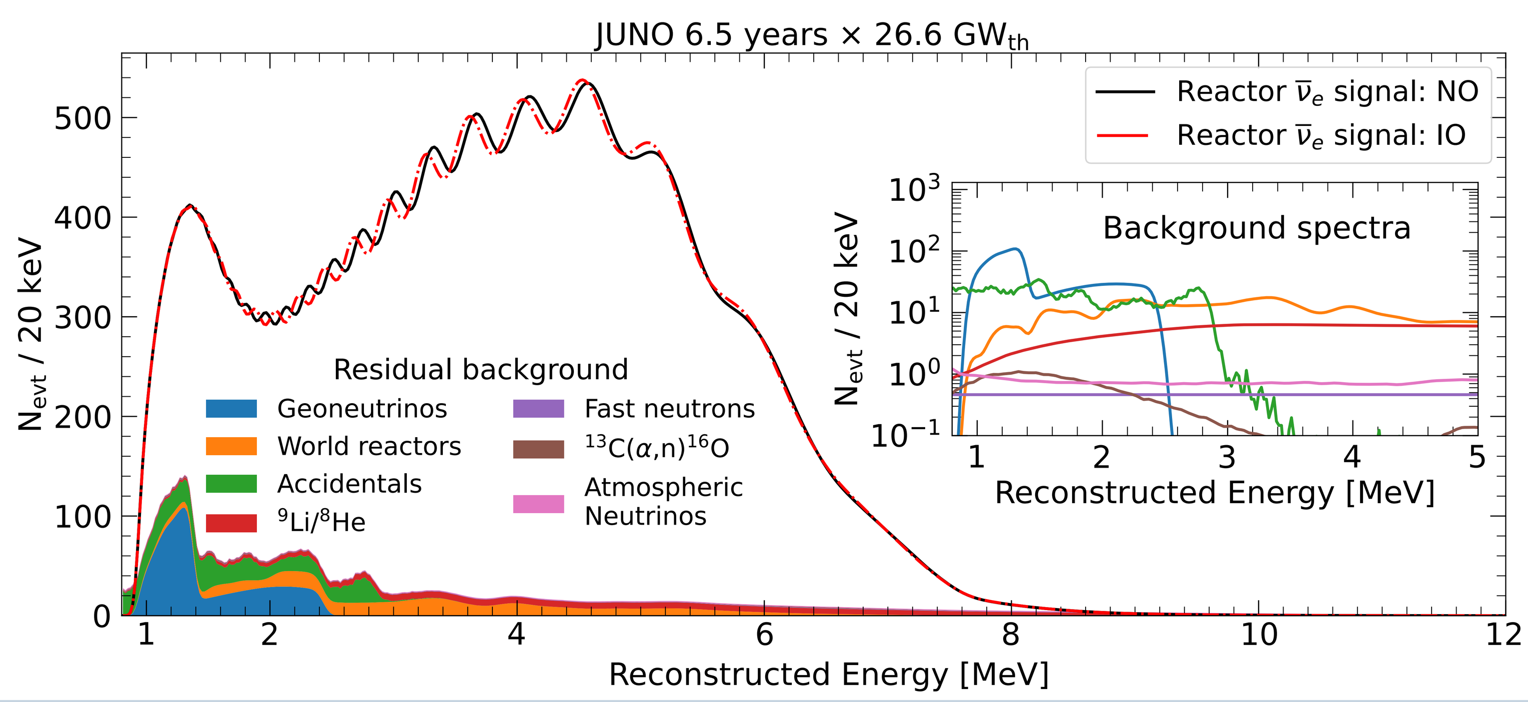


Detector response

Liquid Scintillator Non-Linearity (LSNL) [2] and energy resolution (Res.) [3] impact on JUNO spectrum



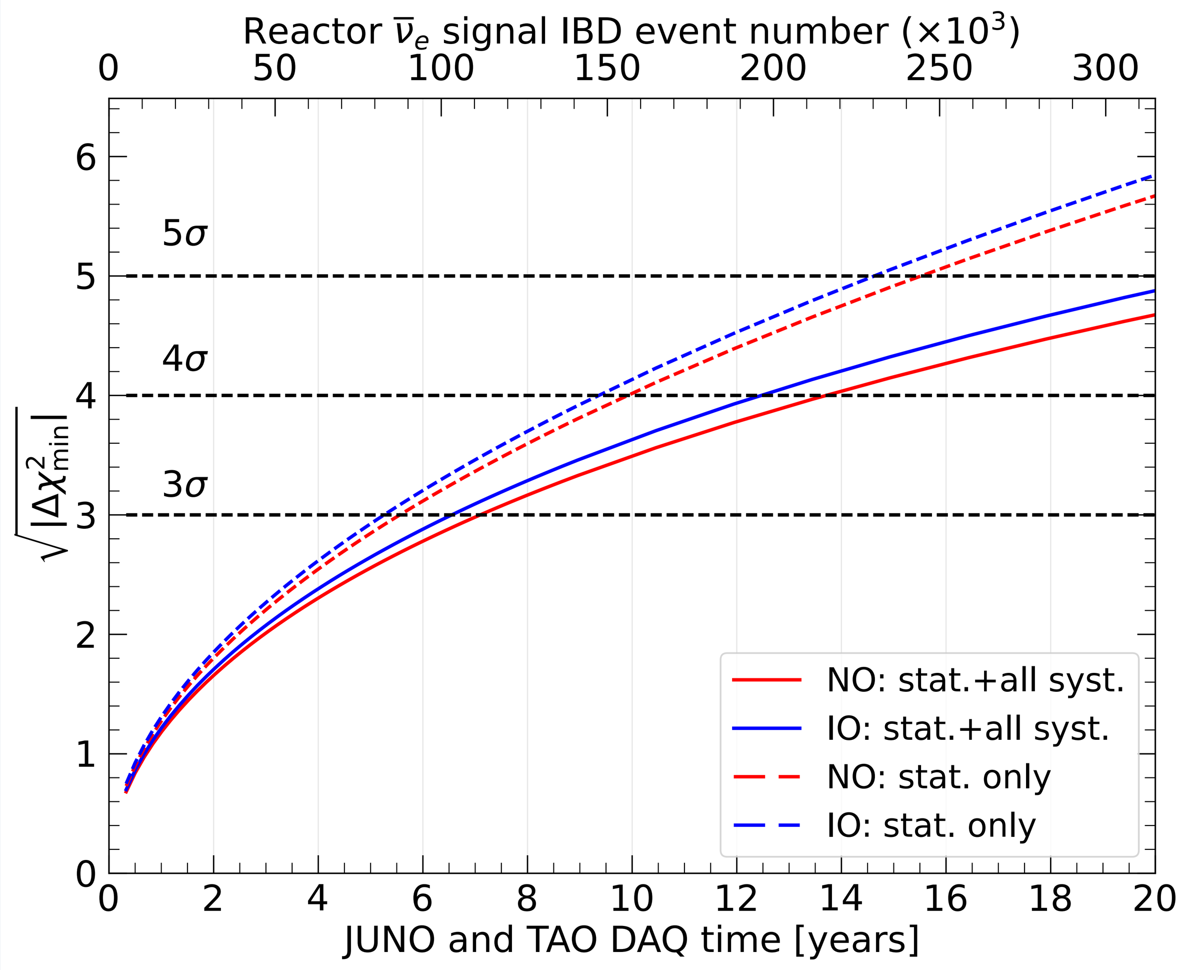
Signal and backgrounds



	day^{-1}
Signal:	
Reactor $\bar{\nu}_e$	47.1
Backgrounds:	4.11
Geoneutrinos	1.2
World reactors	1.0
Accidentals	0.8
^{9}Li/^{8}He	0.8
Atmospheric νs	0.16
Fast neutrons	0.1
^{13}C(α, n)^{16}O	0.05

Results: median sensitivty to NMO with Asimov data

Median sensitivity to NMO is based on Asimov data : $\Delta\chi^2_{\rm min} = \min \chi^2_{\rm false\ MO} - \min \chi^2_{\rm true\ MO}$



Relative impact of uncertainty sources on the NMO sensitivity:

Uncertainties	$\lvert\Delta\chi^2_{\rm min}\rvert$	$\lvert\Delta\chi^2_{\rm min}\rvert$ change
Statistics of JUNO and TAO	11.5	
+ Common uncertainty	10.8	−0.7
+ TAO uncertainty	10.2	−0.6
+ JUNO geoneutrinos	9.7	−0.5
+ JUNO world reactors	9.4	−0.3
+ JUNO accidental	9.2	−0.2
+ JUNO ^{9}Li/^{8}He	9.1	−0.1
+ JUNO other backgrounds	9.0	−0.05
Total	9.0	

Conclusion:

For 7.1 years of data taking, JUNO reactor antineutrino analysis gives [4]:

- Normal Ordering: 3σ median sensitivity to reject wrong MO
- Inverted Ordering: 3.1σ median sensitivity to reject wrong MO
- Asimov results are consistent with the ones from Monte-Carlo study

References

[1] "JUNO physics and detector", Prog.Part.Nucl.Phys. 123 (2022)

[2] "A high precision calibration of the nonlinear energy response at Daya Bay", Nucl.Instrum.Meth.A 940 (2019) 230-242

[3] "Prediction of Energy Resolution in the JUNO Experiment", arXiv:2405.17860

[4] "Potential to Identify the Neutrino Mass Ordering with Reactor Antineutrinos in JUNO", arXiv:2405.18008

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