An Alternative method for Neutrino Mass Hierarchy determination in JUNO

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$$P^{NO}(\bar{\nu}_e \to \bar{\nu}_e) = 1 - \frac{1}{2}\sin^2 2\theta_{23}\left(1 - \cos\frac{\Delta m^2_{atm} L}{2E_\nu}\right)$$
$$-\frac{1}{2}\cos^4\theta_{13}\sin^2 2\theta_{12}\left(1 - \cos\frac{\Delta m^2_{\odot} L}{2E_\nu}\right)$$
$$+\frac{1}{2}\sin^2 2\theta_{13}\sin^2\theta_{12}\left(\cos\left(\frac{\Delta m^2_{atm} L}{2E_\nu} - \frac{\Delta m^2_{\odot} L}{2E_\nu}\right) - \cos\frac{\Delta m^2_{atm} L}{2E_\nu}\right)$$

$$P^{NO}(\bar{\nu}_e \to \bar{\nu}_e) \to \cos^2\theta_{12}$$

S.M. Bilenky, F. Capozzi, and S. T. Petcov: arXiv:1701.06328v1

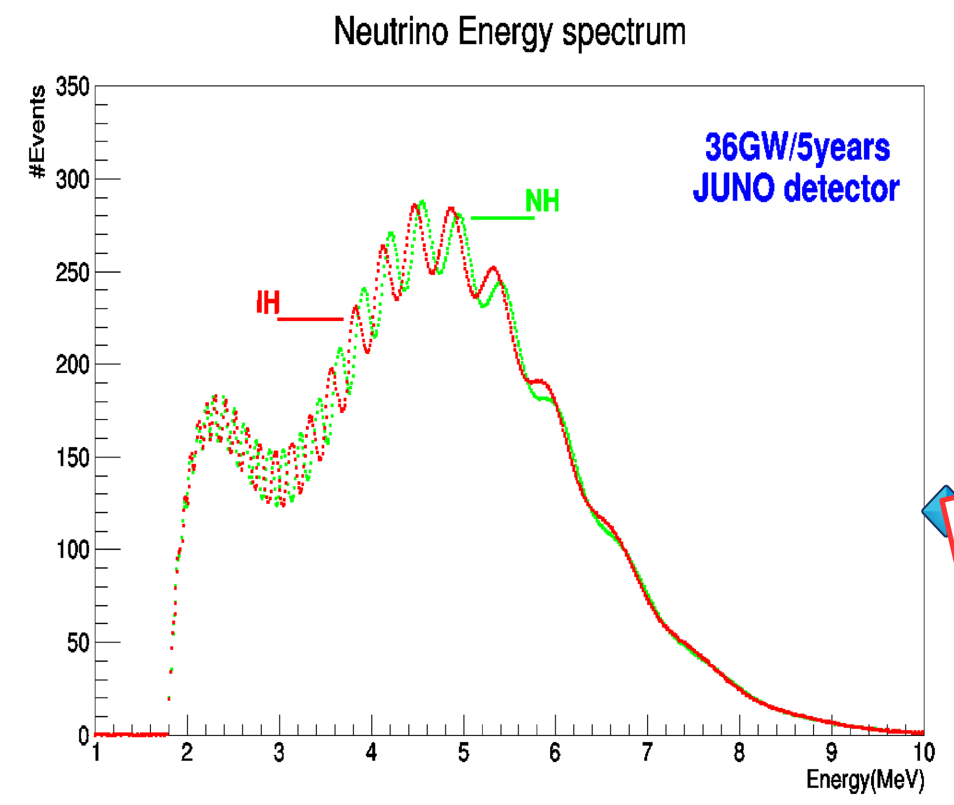
$$(\Delta m^2_{21})_{BF} = 7.37 \times 10^{-5} eV^2, \quad \Delta m^2_{21} = (6.93 - 7.97) \times 10^{-5} eV^2$$
$$(\sin^2\theta_{12})_{BF} = 0.297, \quad 0.250 < sin^2\theta_{12} < 0.354$$
$$|(\Delta m^2_{31})_{BF}| = 2.56\ (2.54) \times 10^{-3} eV^2,$$
$$|(\Delta m^2_{31})| = 2.45\ (2.43) - 2.69\ (2.66) \times 10^{-3} eV^2$$
$$(\sin^2\theta_{13})_{BF} = 0.0215\ (0.0215),$$
$$0.019\ (0.019) \le \sin^2\theta_{13} \le 0.0240\ (0.0242)$$

Jiangmen Underground Neutrino Observatory (JUNO)is designed to determine the neutrino mass hierarchy via measurement of reactor neutrino energy spectrum with 3% /√E relative energy resolution. Jiangmen site (China) where the JUNO detector is ~ 53 km from Nuclear Power Plants giving a total power of about 36 (26) GW. It will start data taking from 2020 and the detector will be located about 700 meters underground.

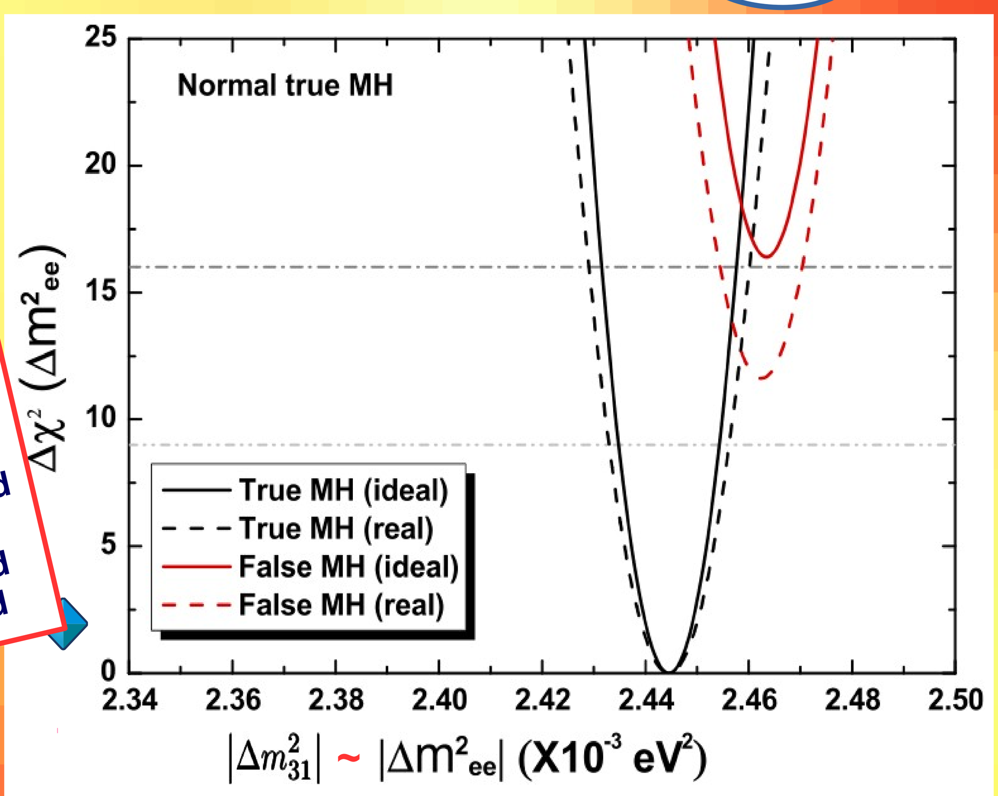
Table 2. Summary of the thermal power and baseline to the JUNO detector for the Yangjiang (YJ) and Taishan (TS) reactor cores, as well as the remote reactors of Daya Bay (DYB) and Huizhou (HZ).

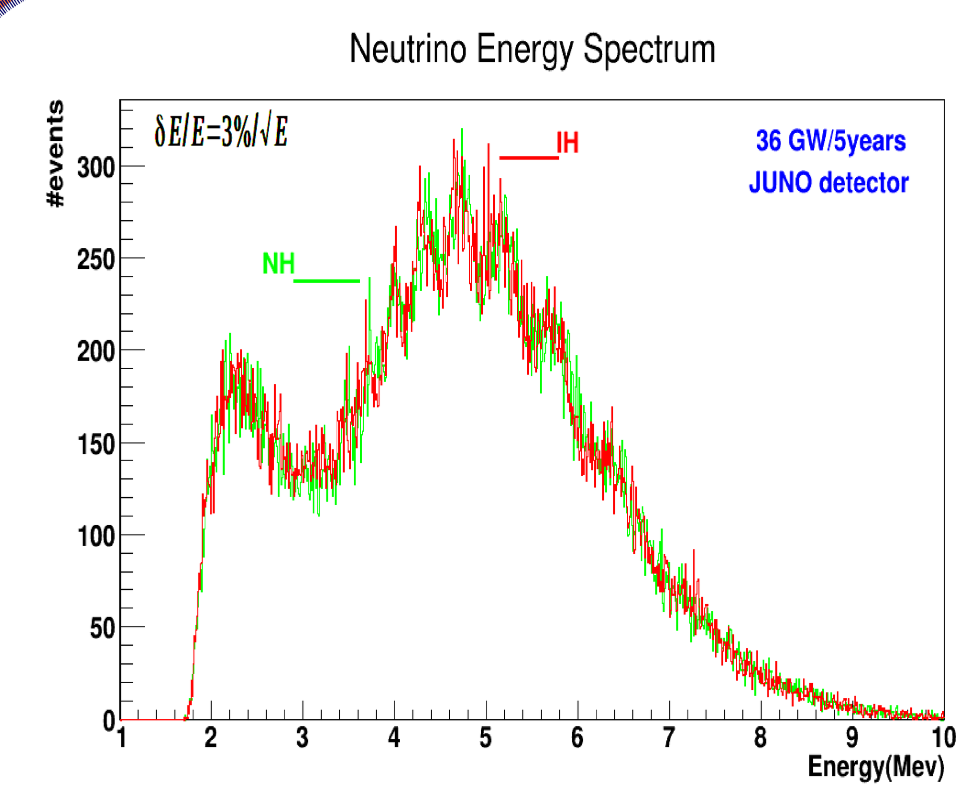
Cores	YJ-C1	YJ-C2	YJ-C3	YJ-C4	YJ-C5	YJ-C6
Power (GW)	2.9	2.9	2.9	2.9	2.9	2.9
Baseline(km)	52.75	52.84	52.42	52.51	52.12	52.21
Cores	**TS-C1**	**TS-C2**	**TS-C3**	**TS-C4**	**DYB**	**HZ**
Power (GW)	4.6	4.6	4.6	4.6	17.4	17.4
Baseline(km)	52.76	52.63	52.32	52.20	215	265

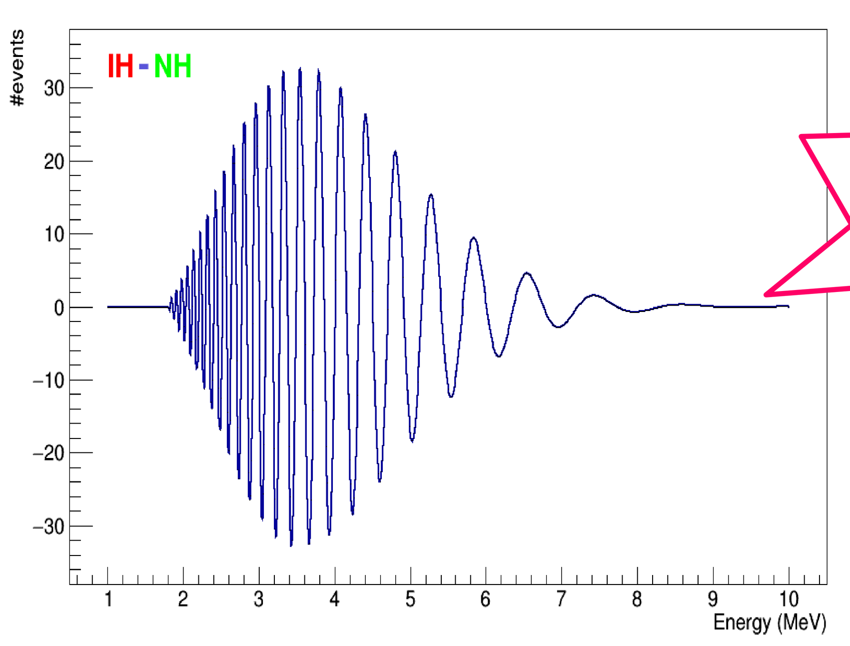
F. An et al (JUNO collaboration) J. Phys. G: Nucl. Part. Phys. 43 (2016) 030401



The sensitivity using Δχ2 test is considered as the standard method



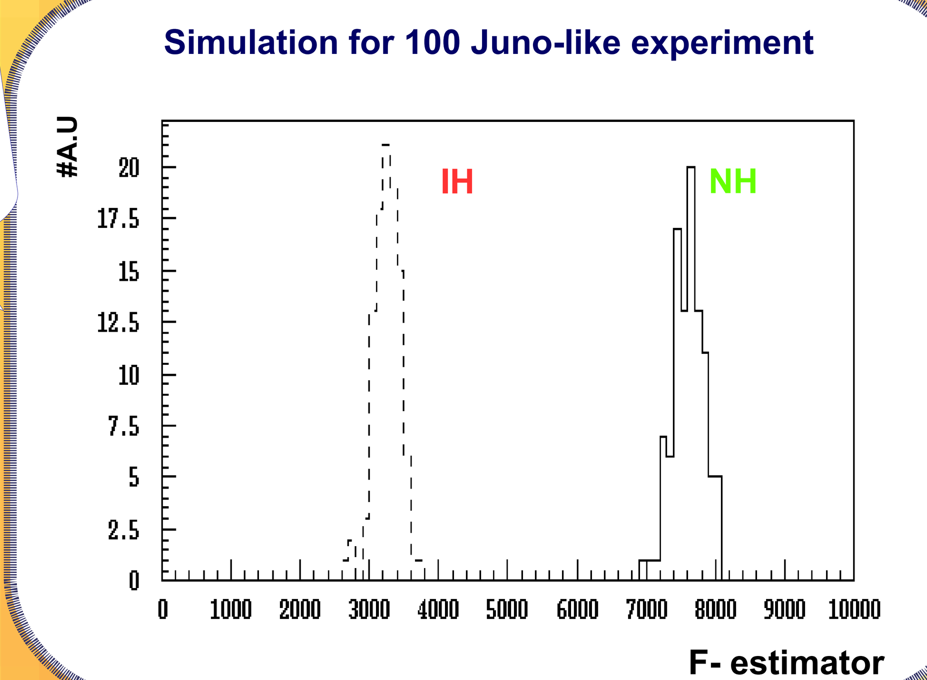




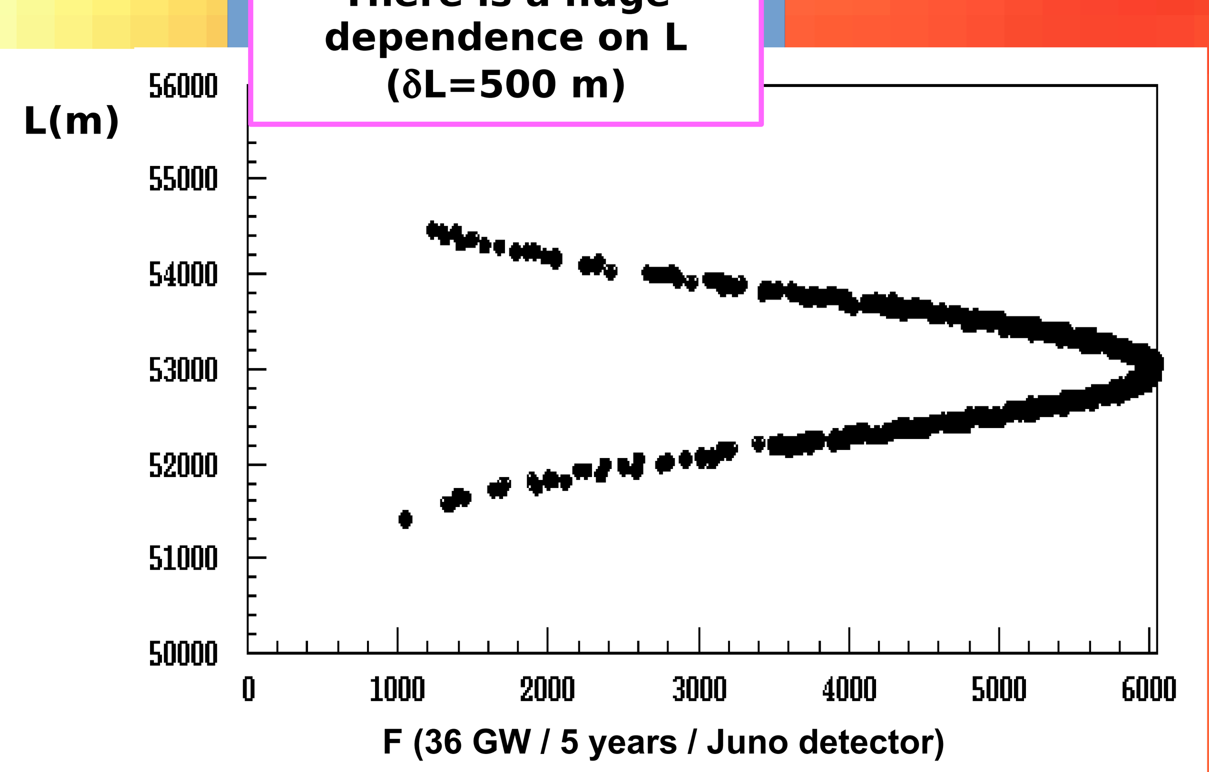
New complementary Method "F- estimator"

$$F = \sum_j \Delta^+_j + \sum_j \Delta^-_j$$
$$\Delta^+ = n_{obs} - n^{IH}_i \text{ when } n_{obs} > n^{IH}_i \text{ in } I^+ \text{ intervals}$$
$$\Delta^- = n^{IH}_i - n_{obs} \text{ when } n_{obs} < n^{IH}_i \text{ in } I^- \text{ intervals}$$
$$I^+ \text{ when } n^{IH}_i < n^{NH}_i$$
$$I^- \text{ when } n^{IH}_i > n^{NH}_i$$

Once Poisson statistical fluctuations taking in



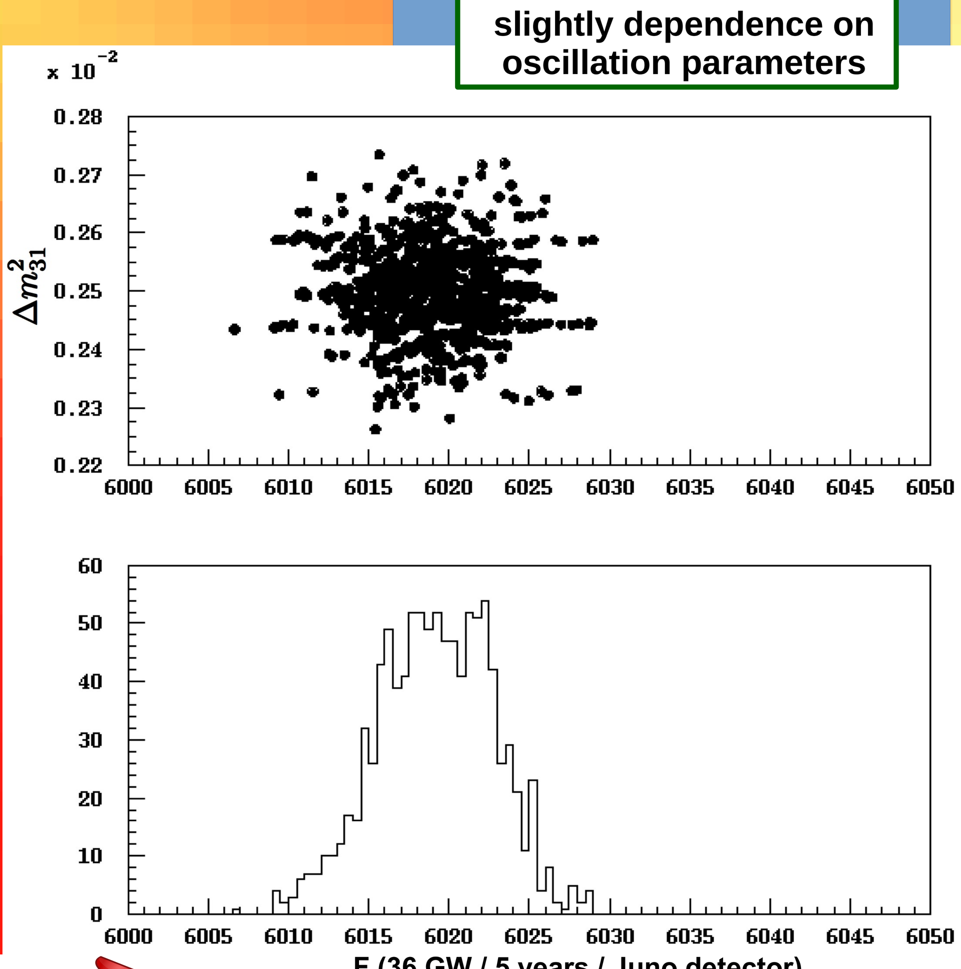
There is a huge dependence on L (δL=500 m)



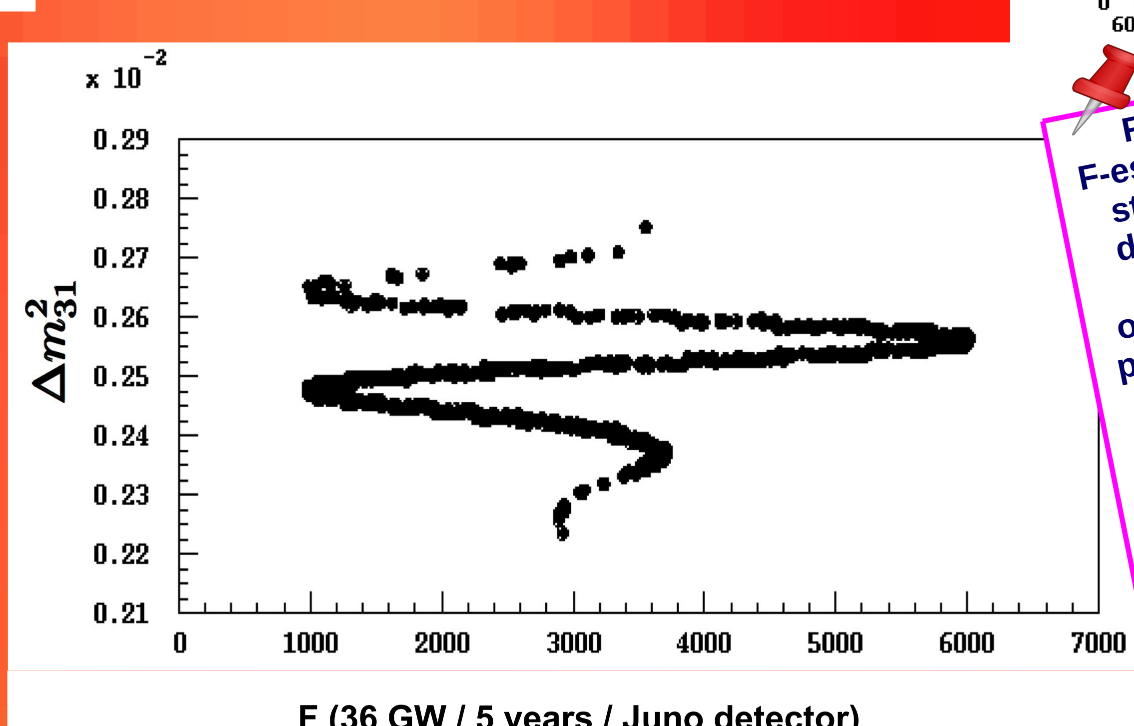
Good, but ....

* Oscillation Parameters
* Baseline dependence

True F-estimator has slightly dependence on oscillation parameters



Real F-estimator strongly depends on oscillation parameters through the definition of intervals (I- and I+)



Conclusions

*Alternative method to extract MH

*Define new estimator "F"

*Study F- estimator dependences

Perspectives

*Check convolutions

*Get MH sensitive

XVII Workshop on Neutrino Telescopes; 13-17 March 2017, Venice; Poster Session

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