

A near detector at a few km from the target

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Outline

- Motivation
- Requirements for the near detector
- Near/far ratio
- Physics
- Summary

Motivation

Physics goal in JHF-1 neutrino exp.

➡ Precise determination of neutrino oscillation parameters.

Accuracy: $\sin^2 2\theta_{23}$ - 1%

Δm^2 - a few %

$\sin^2 2\theta_{13}$ - > 0.01

Good neutrino beam monitor

Physics goal in JHF-2 neutrino exp.

➡ CP violation measurement.

Criteria for a “Good neutrino beam monitor”

- Event rate of the far detector (neglecting the volume):
 $\text{Event-rate}(\text{near}) \times \{ (L_{\text{near}}/L_{\text{far}})^2 + \epsilon \}$

ϵ should be as small as possible



Near detector should be as similar as possible to the Far detector (Super-Kamiokande)



Water Cherenkov detector

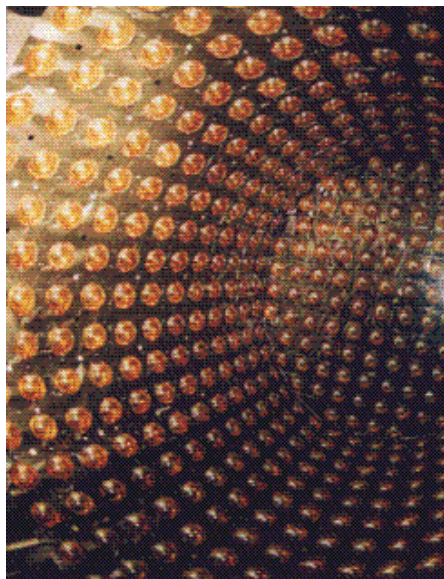
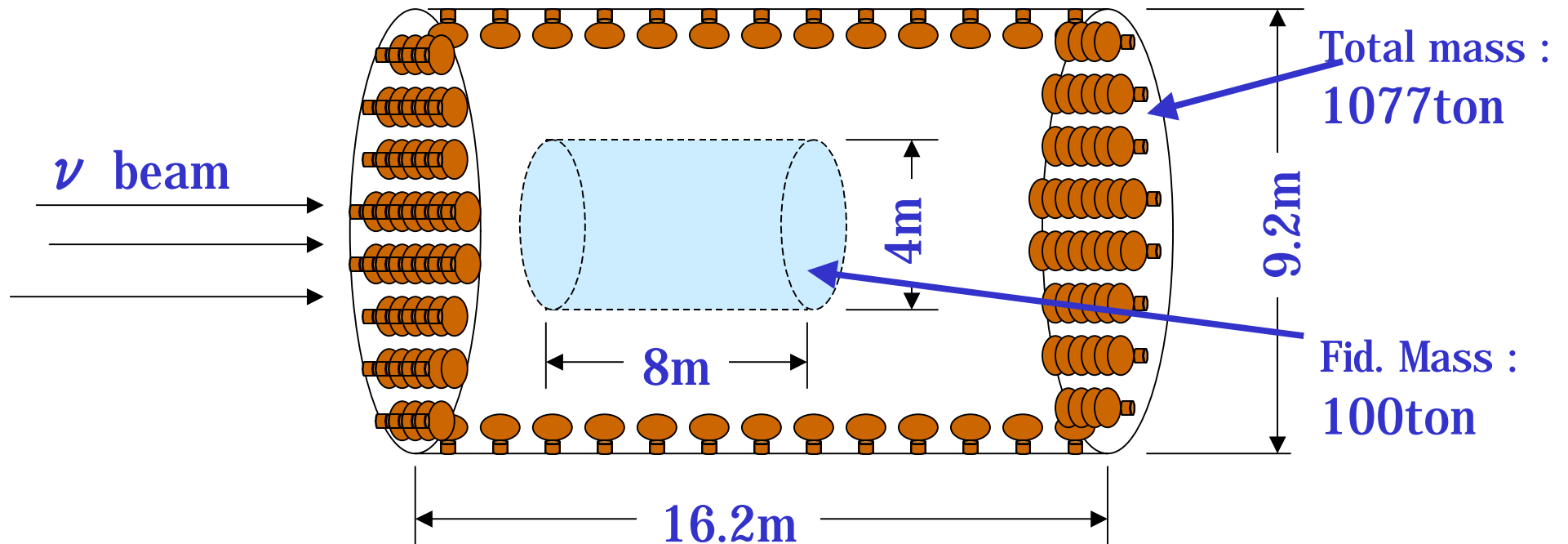


Near detector position should not be too near to the neutrino production region.



$L_{\text{near}} > 1\text{ km}$

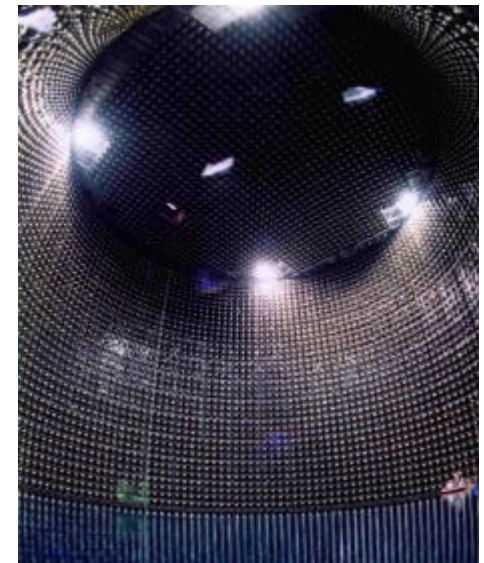
Water Cherenkov detector as a near detector



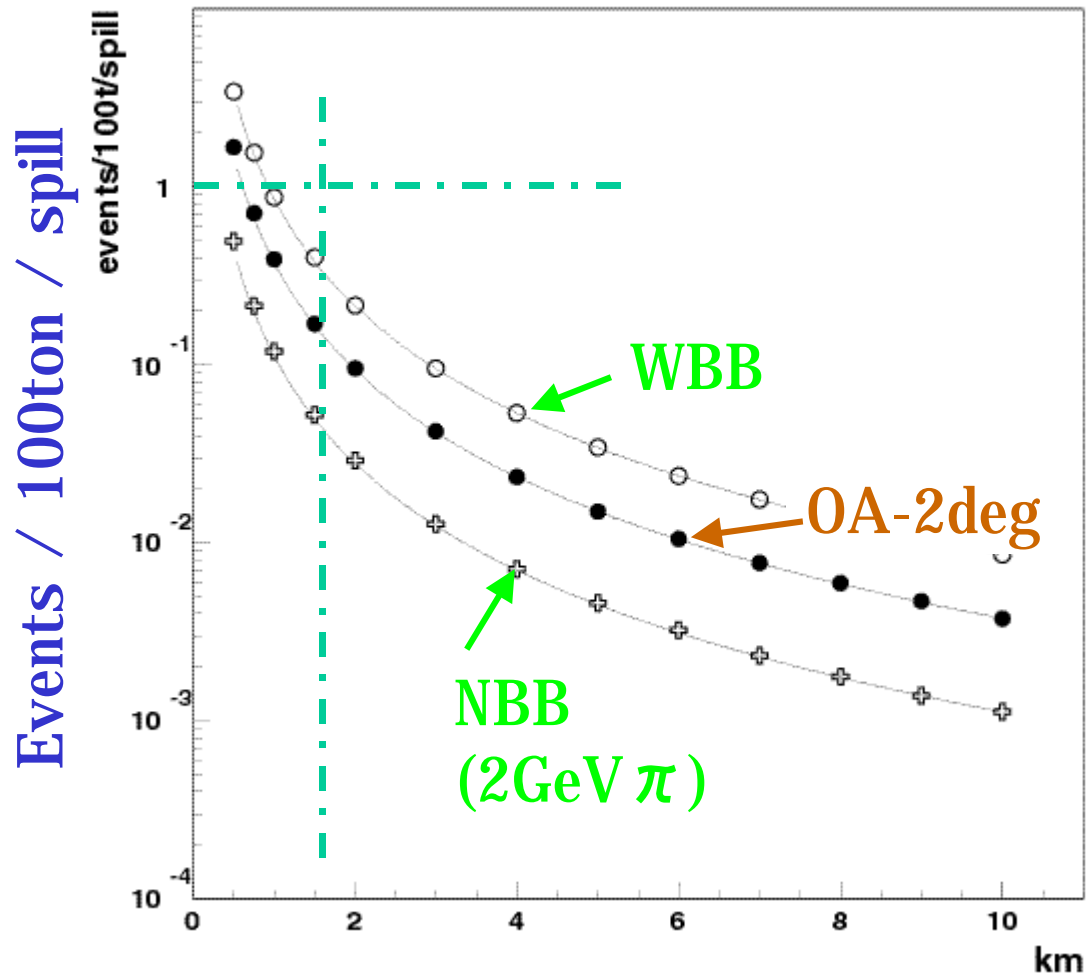
Near detector should look like



Far detector looks like



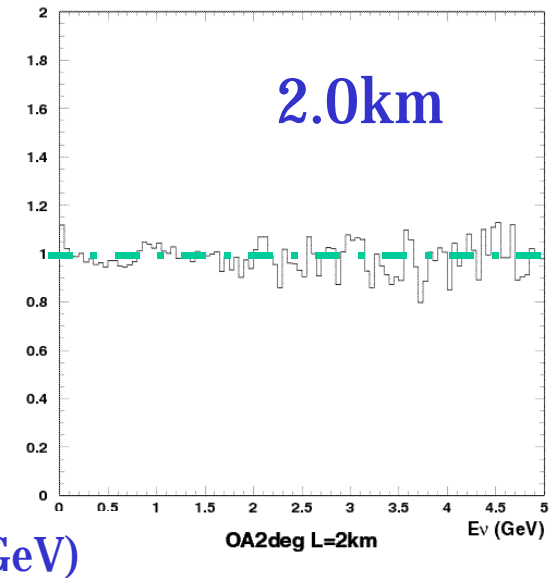
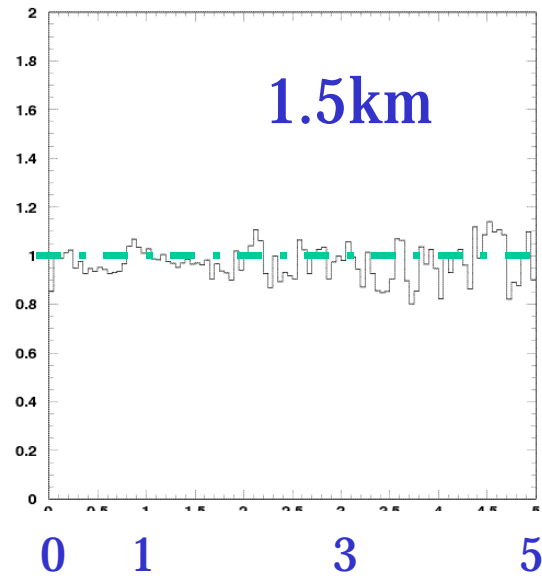
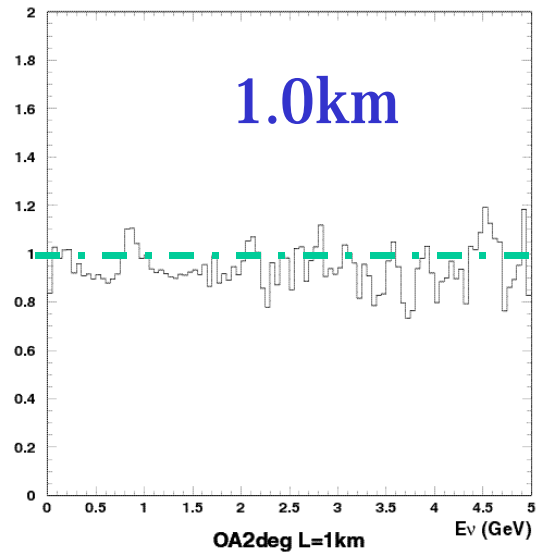
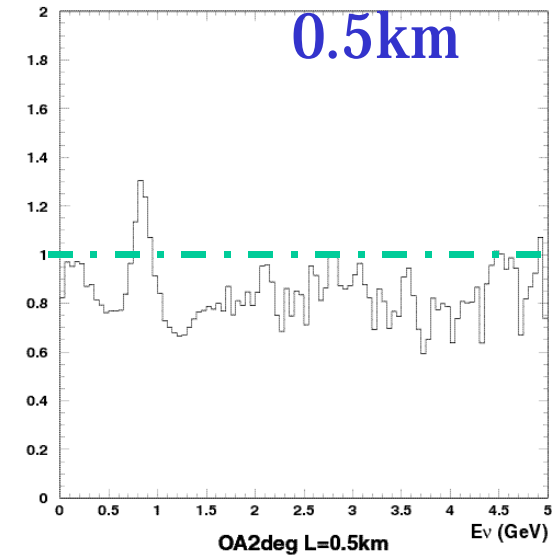
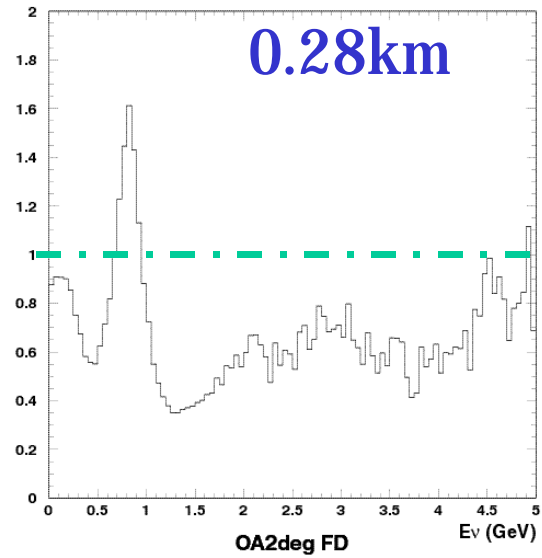
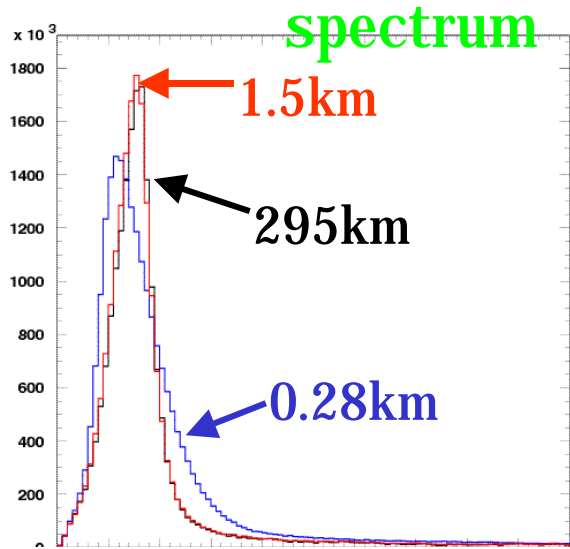
Event rate



● 100 ton fiducial volume is enough for a near detector at 1.5km.

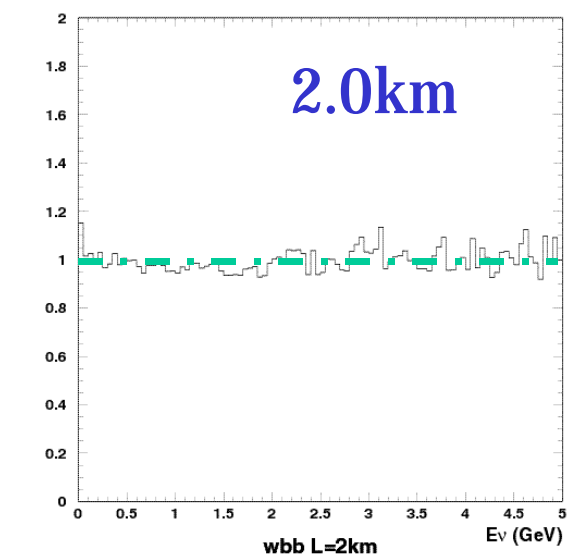
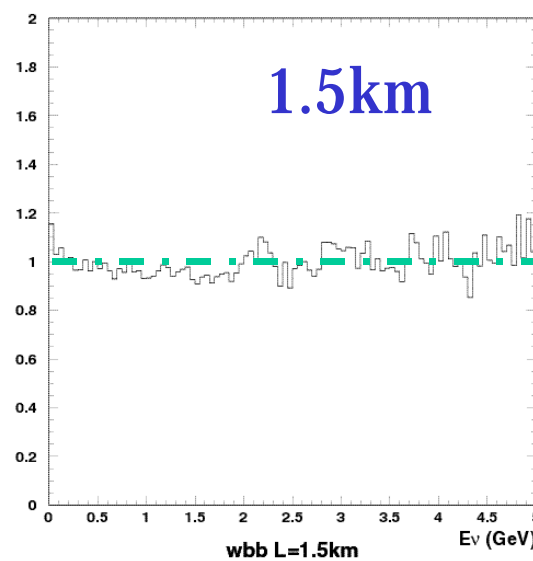
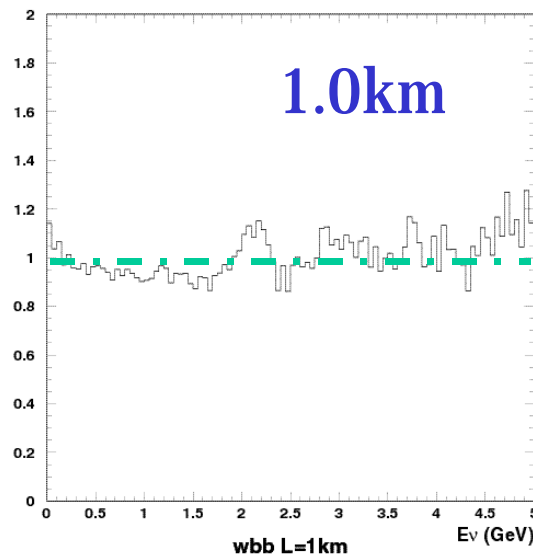
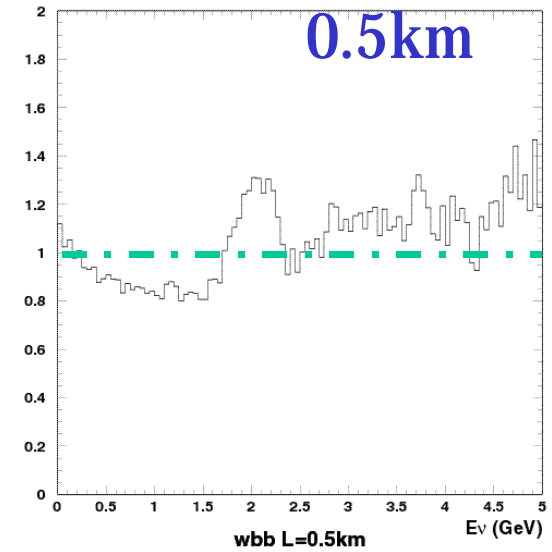
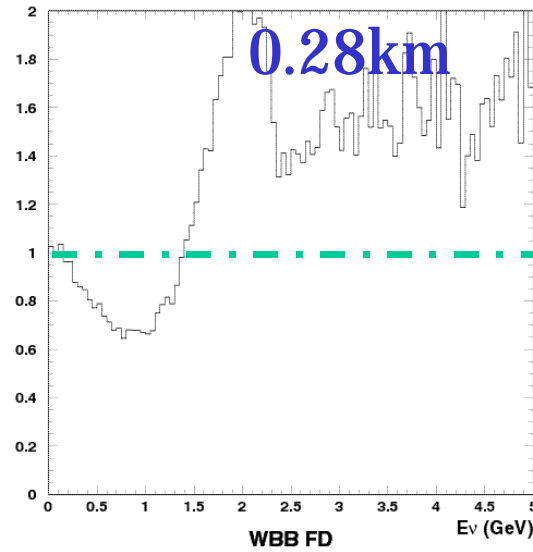
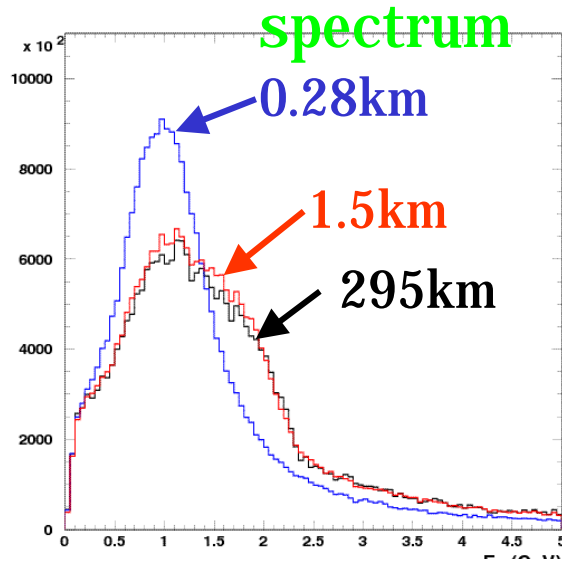
Distance from the target (km)

Far/near ratio (0A 2deg)

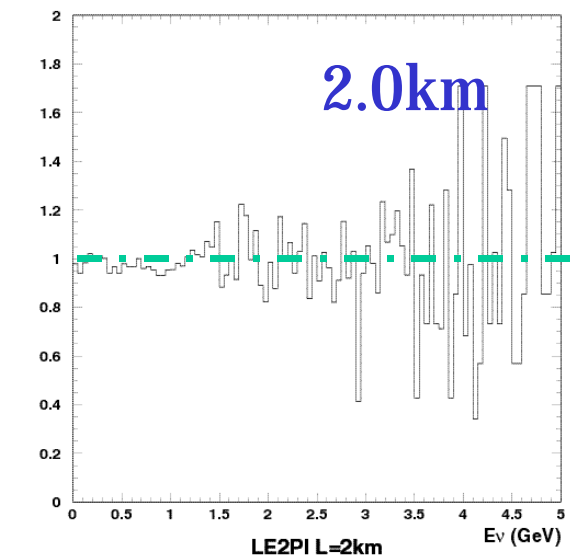
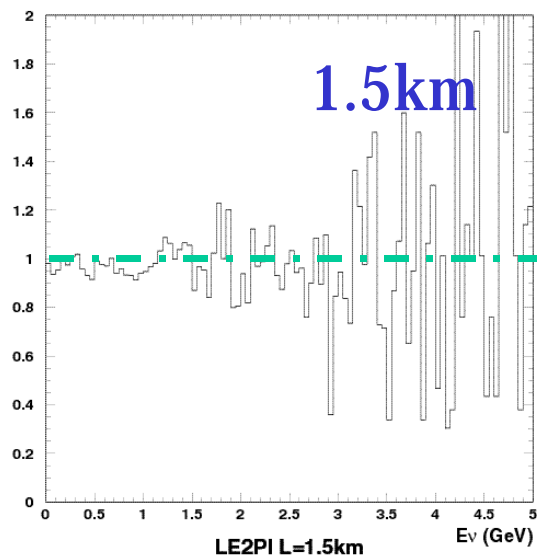
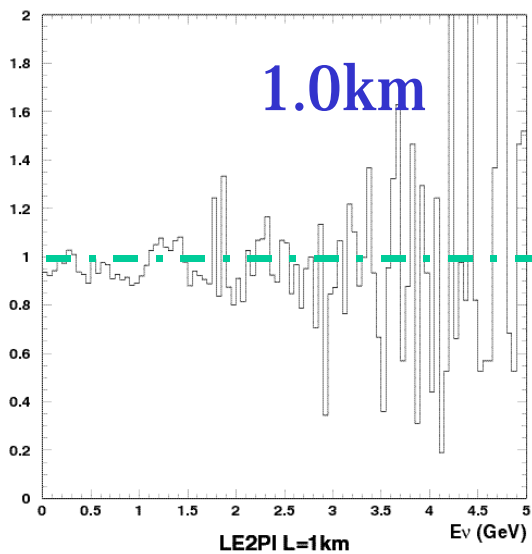
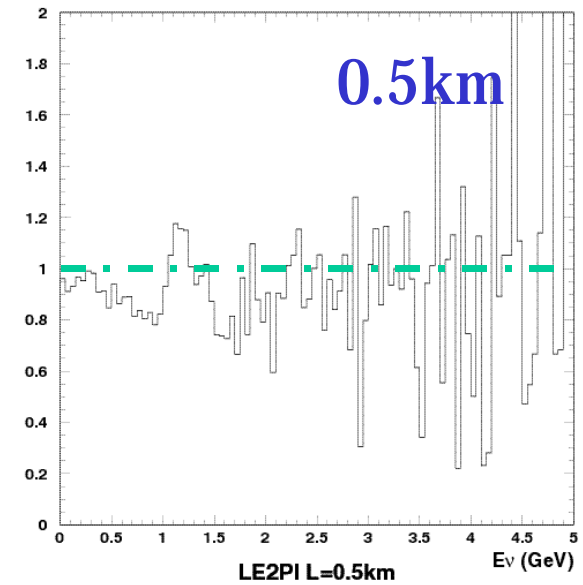
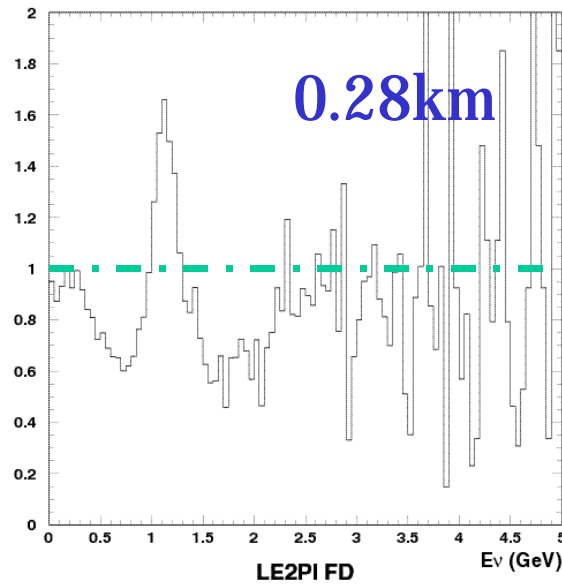
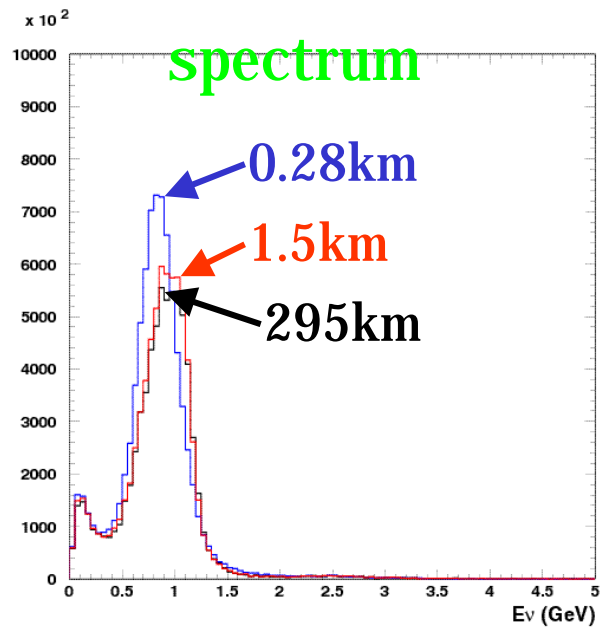


0 1 3 5 (GeV)

Far/near ratio (WBB)



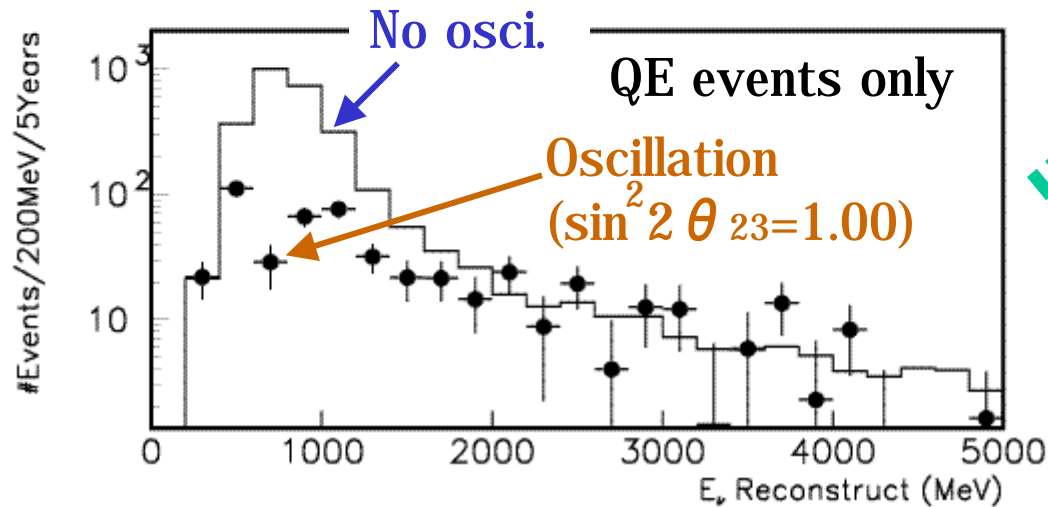
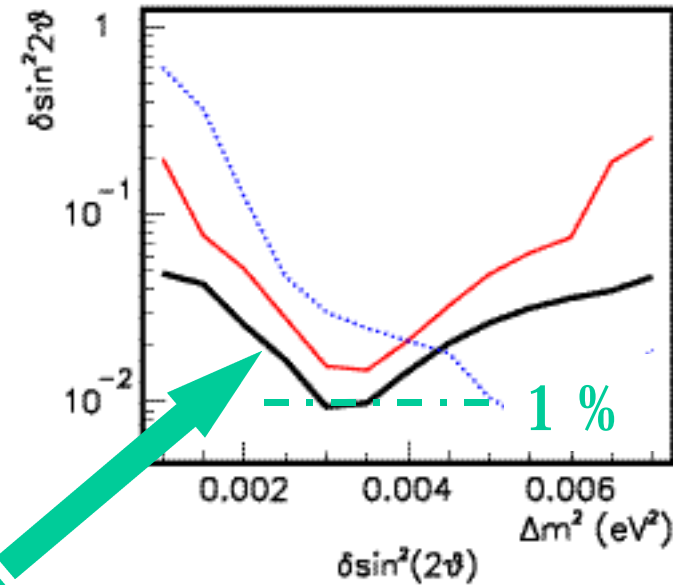
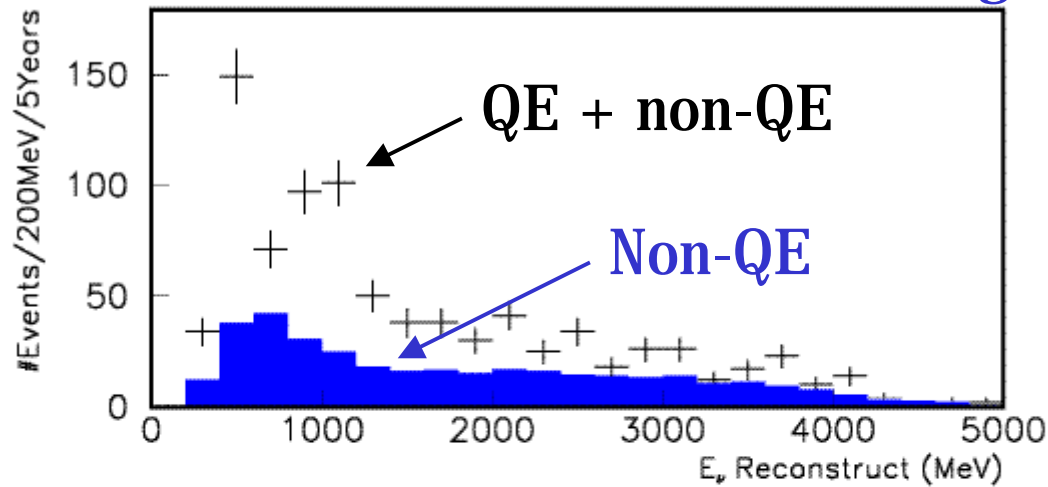
Far/near ratio (NB2GeV π)



Measurement of $\sin^2 2\theta_{23}$

For $\sin^2 2\theta_{23}=1.00$ (OA 2deg)

T.Nakaya

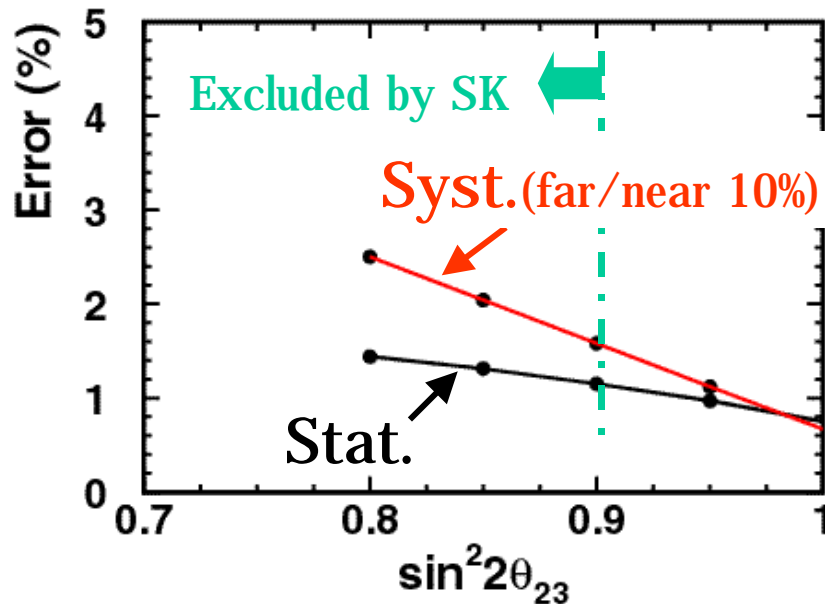
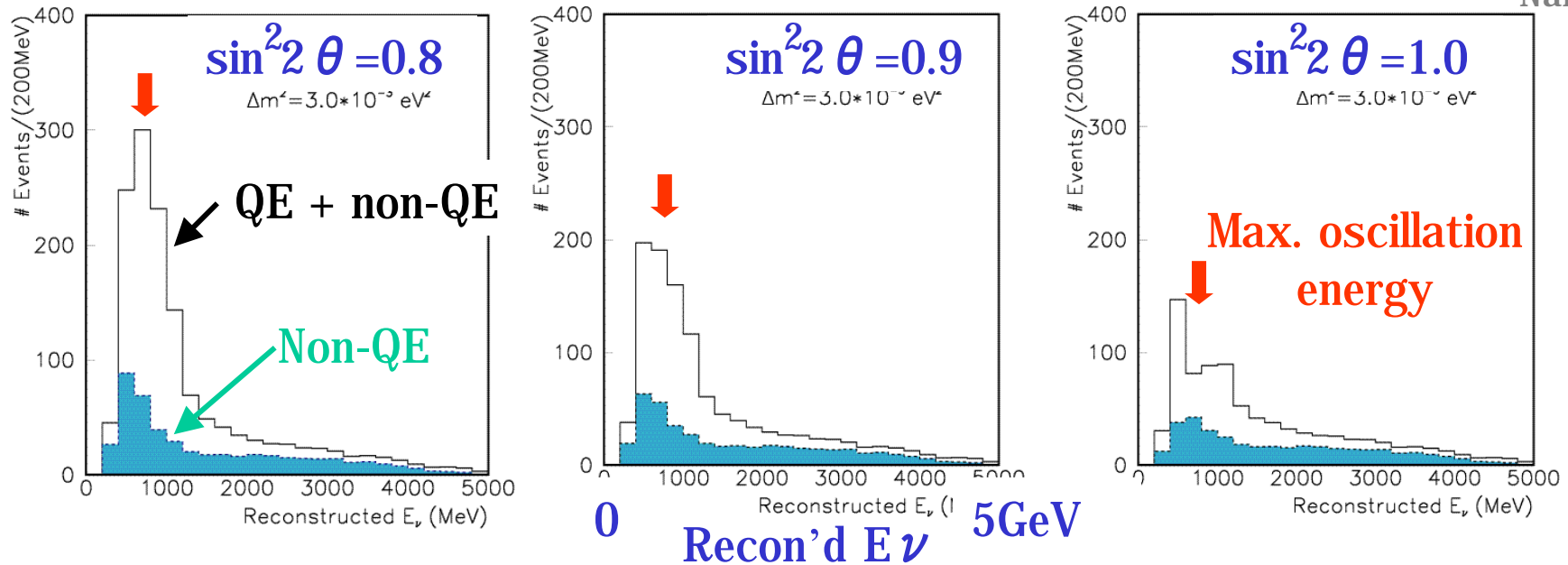


If $\sin^2 2\theta_{23} < 1.0$?

※ Absolute normalization is not very important because osc./no-osc. = 0.03.

Measurement error of $\sin^2 2\theta_{23}$

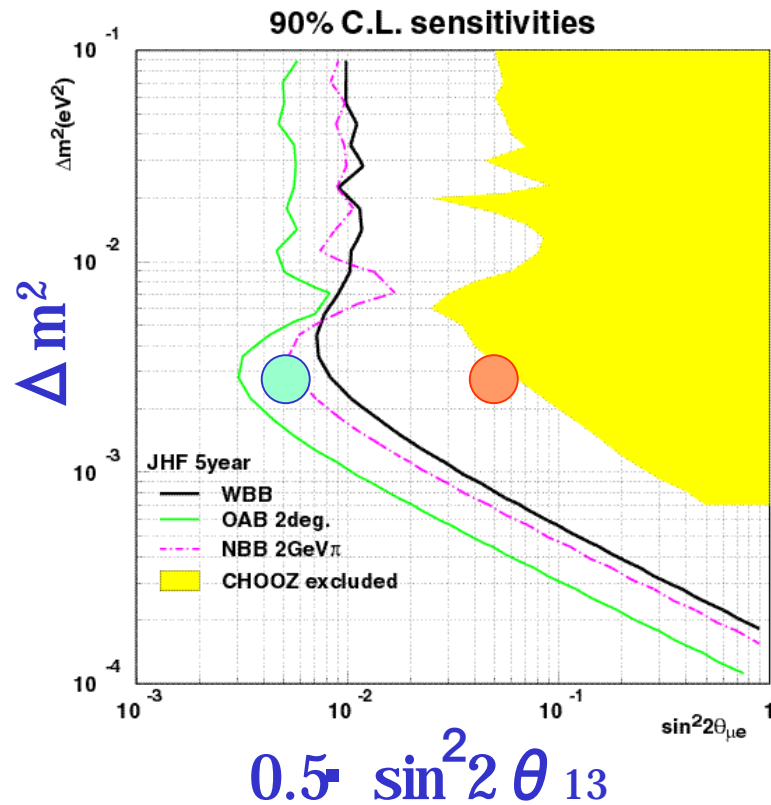
Nakaya



Limited by far/near-syst
for $\sin^2 2\theta_{23} < 1.0$

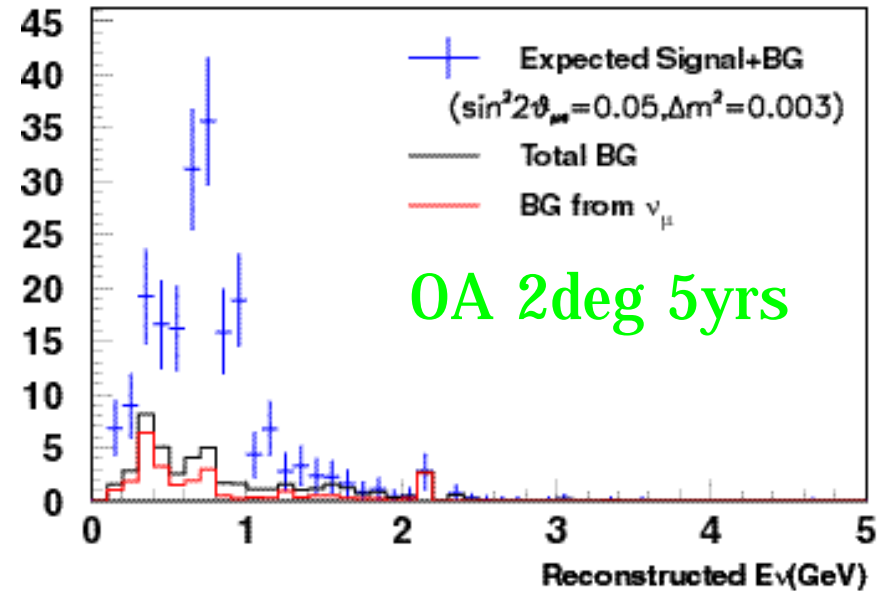
Need water Ch. @ $> 1\text{km}$

Measurement of $\sin^2 2\theta_{13}$



Expected signal for

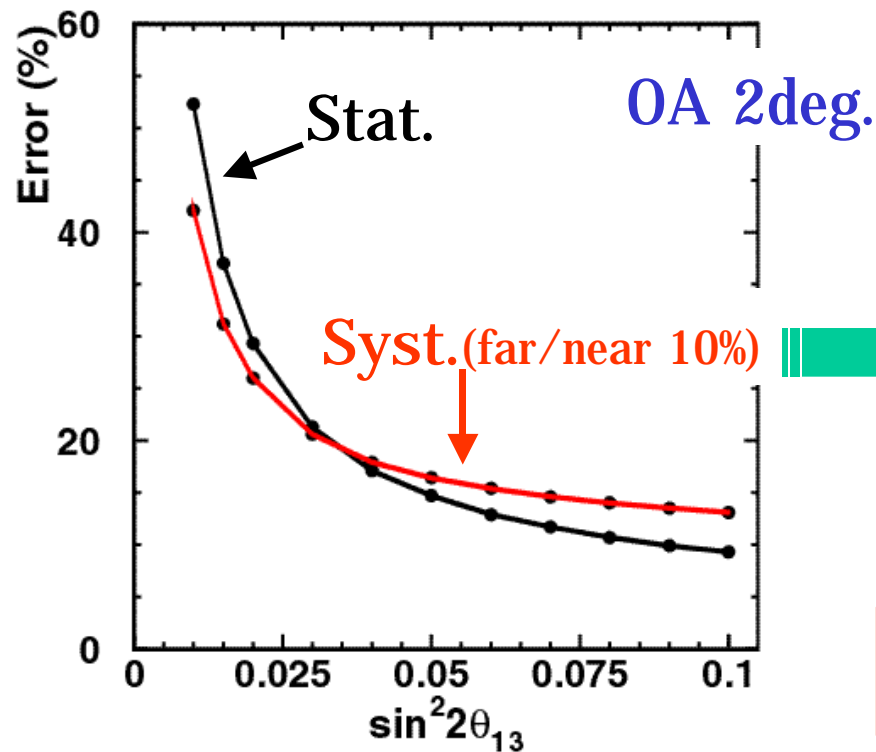
Y.Obayashi



$\sin^2 2\theta_{13}$	ν_{μ} (CC+NC)	Beam ν_e	Osc'd ν_e	Signal+BG
0.1	26.5	21.9	152.2	200.6
0.01	26.5	21.9	15.2	63.6

Measurement error of $\sin^2 2\theta_{13}$?

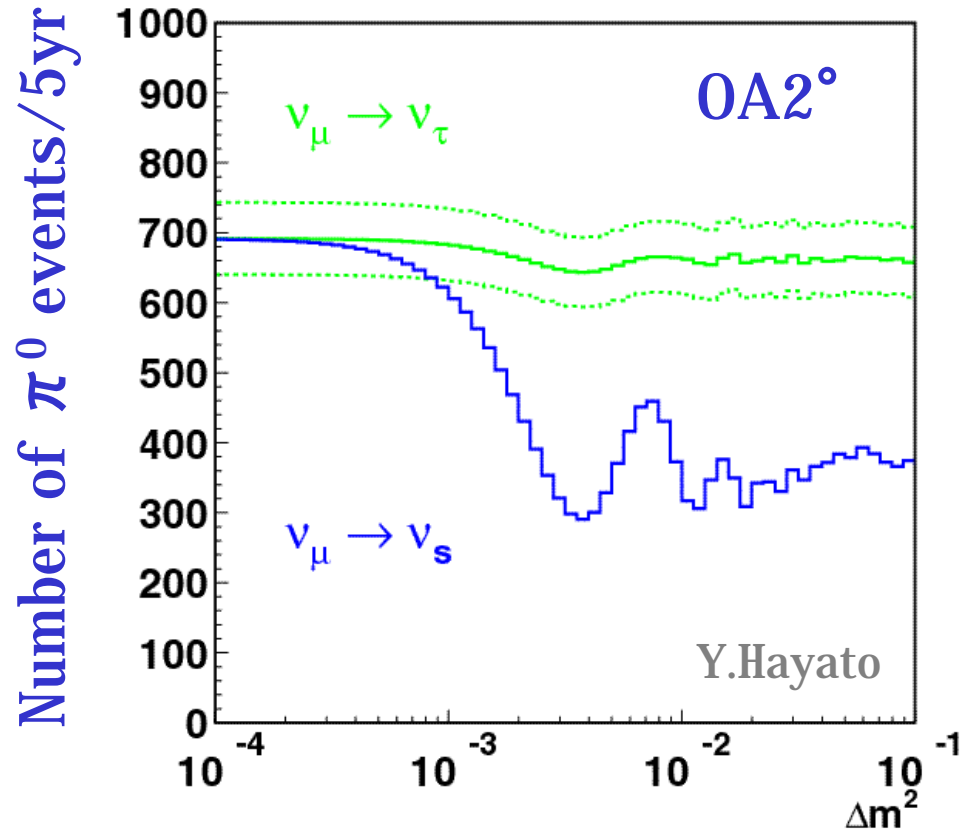
$\sin^2 2\theta_{13}$	ν_{μ} (CC+NC)	Beam ν_e	Osc'd ν_e	Signal+BG
0.1	26.5	21.9	152.2	200.6
0.01	26.5	21.9	15.2	63.6



Limited by far/near-syst. for relatively large θ_{13} .

Need water Ch. @ >1km

ν_τ VS. ν_s



5% systematic error is assumed.

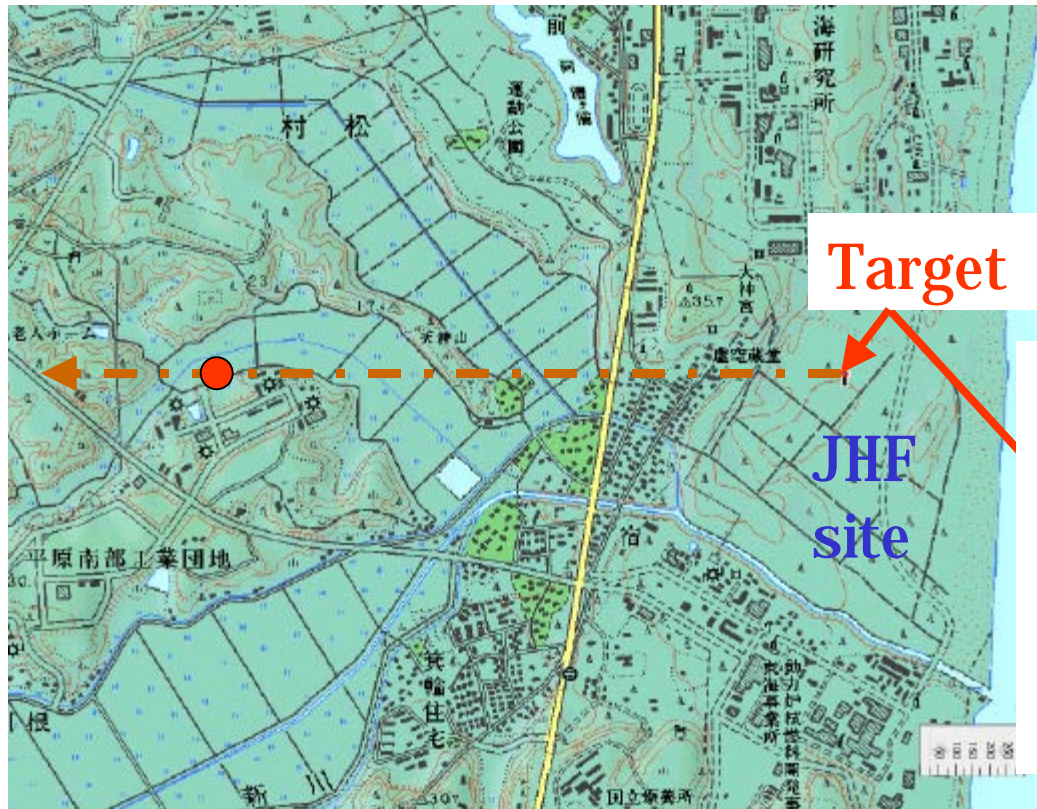


- Far/near systematic $\ll 5\%$
- Water Cherenkov needed

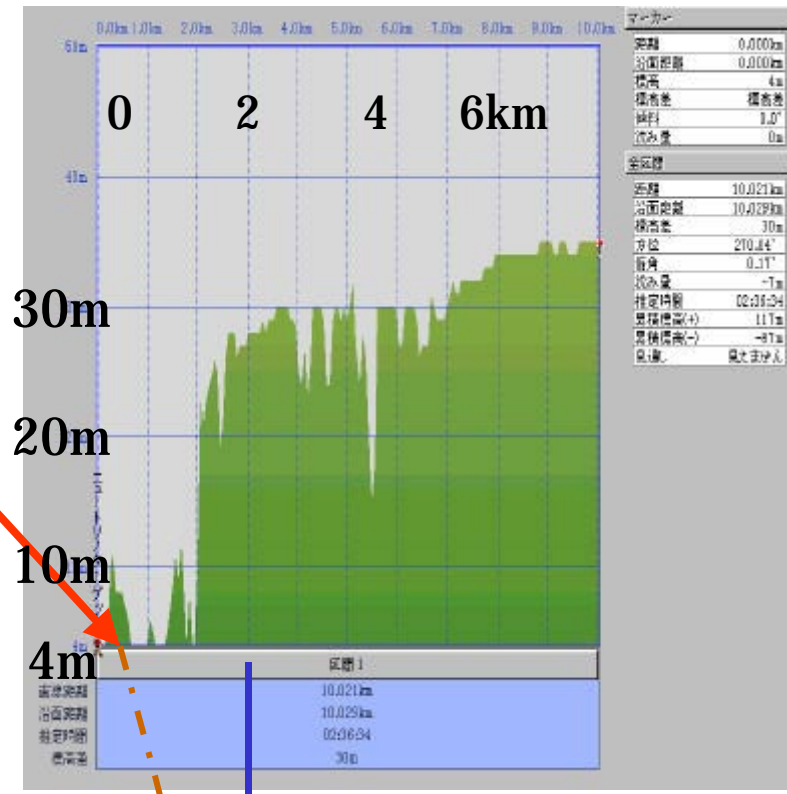


Need water Ch. @ >1km

Candidate place ?



Pacific ocean



v

40m @ 2km

Candidate place (2) ?



Summary

- Water Cherenkov detector at $>1.0\text{km}$ may not be a “must”.
- However, to get the “most” from JHF- ν project, a water Cherenkov Detector at $>1.0\text{km}$ is really needed.