NBI02@CERN
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JHF-nu Overview

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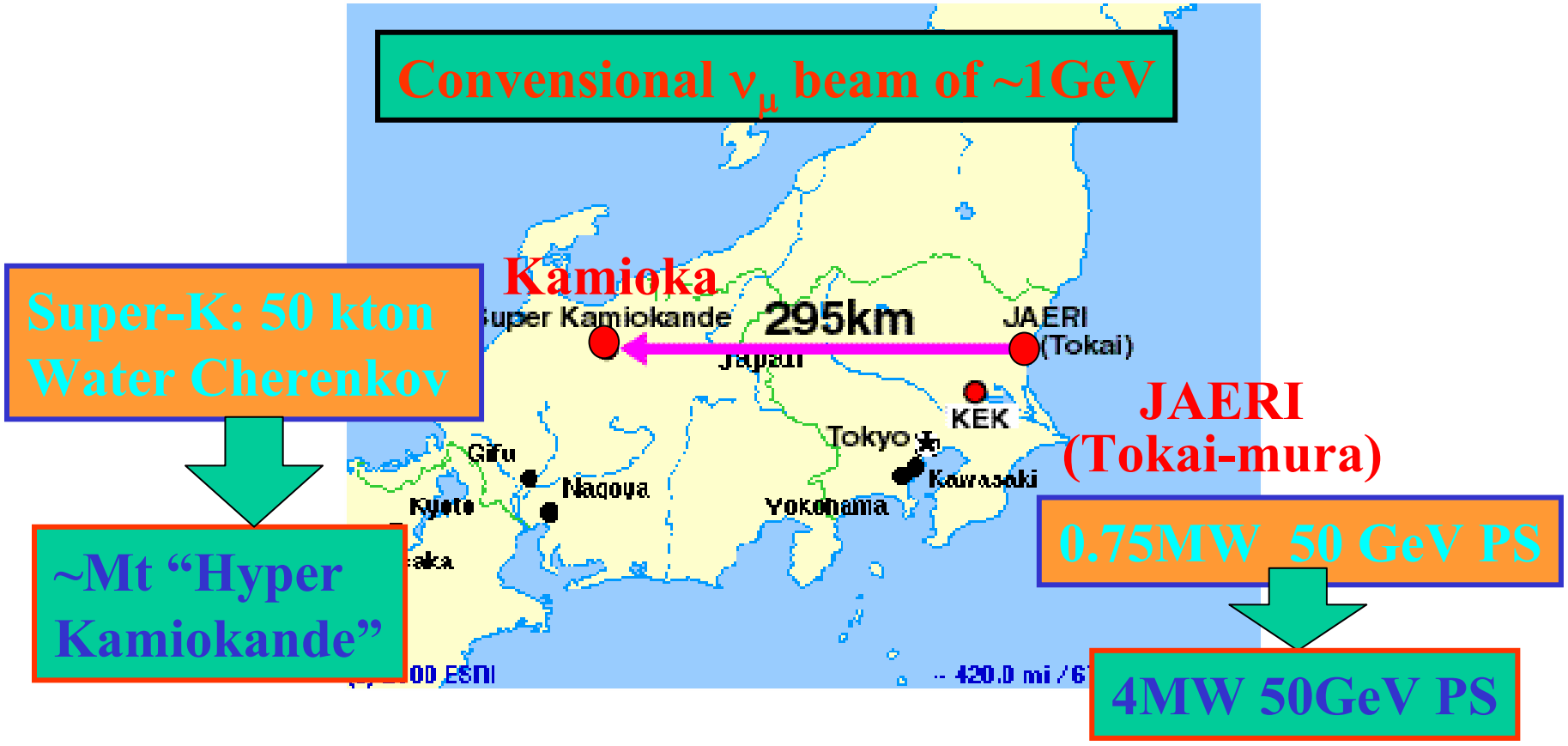
Contents

Overview of experiment



1st Phase

- $\nu\mu \rightarrow \nu x$ disappearance
- $\nu_\mu \rightarrow \nu e$ appearance
- NC measurement

2nd Phase

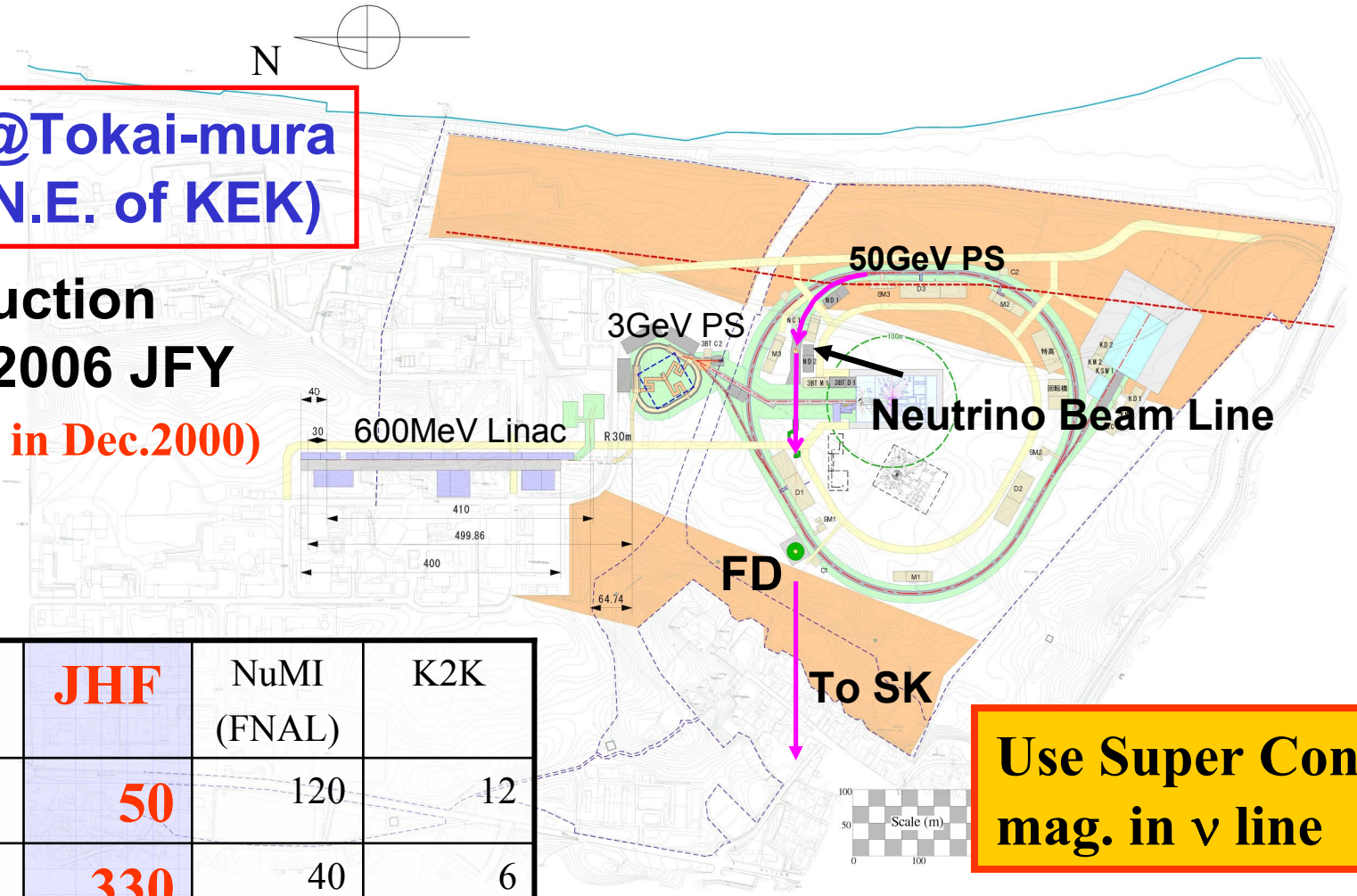
- CPV
- proton decay

JHF project and neutrino beam line

JAERI@Tokai-mura
(60km N.E. of KEK)

Construction
2001～2006 JFY

(Approved in Dec.2000)



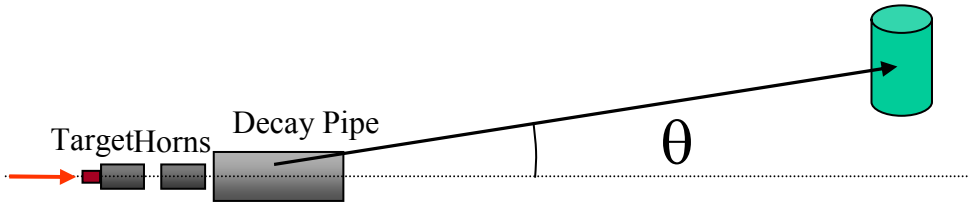
	JHF	NuMI (FNAL)	K2K
E(GeV)	50	120	12
Int.(10^{12}ppp)	330	40	6
Rate(Hz)	0.275	0.53	0.45
Power(MW)	0.75	0.41	0.0052

Use Super Con. mag. in ν line

10^{21}POT(130day)≡ “1 year”

Off Axis Beam

(ref.: BNL-E889 Proposal)



- **Quasi Monochromatic Beam**
- **x2~3 intense than NBB**

Tuned at oscillation maximum

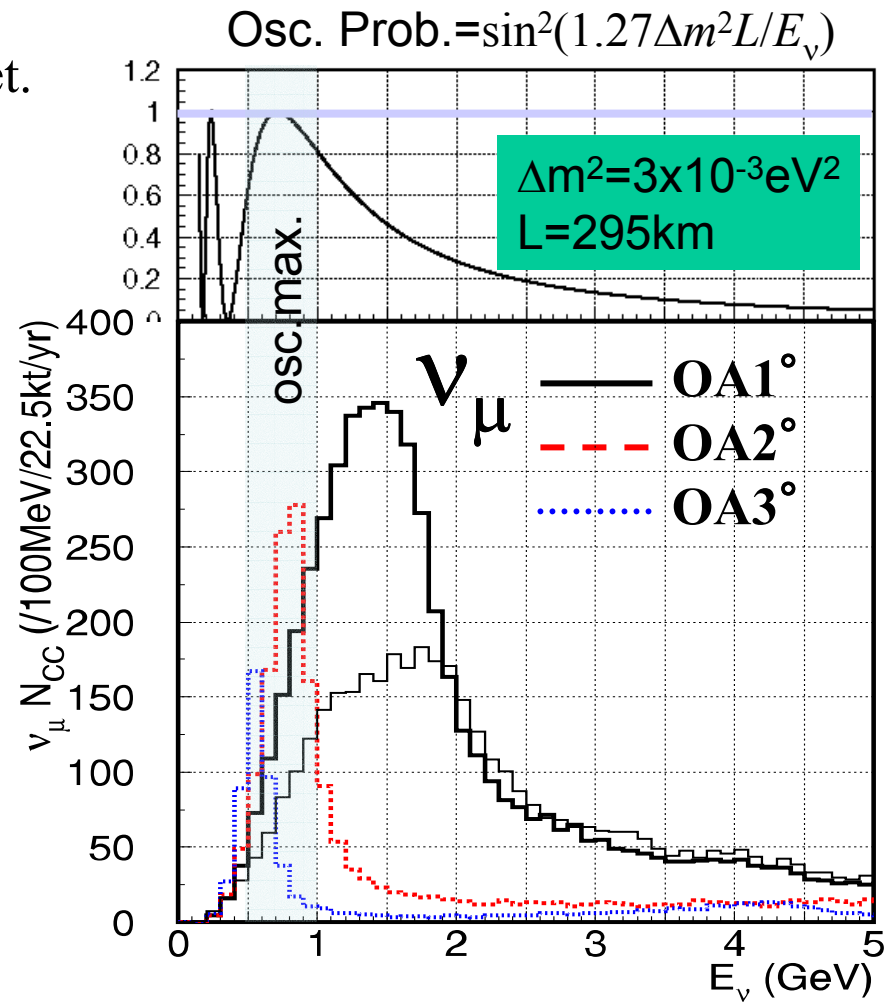
Exp'ed # of evts(1yr,22.5kt)

~4500 ν_μ tot

~3000 ν_μ CC (OAB 2degree)

ν_e contamination ~0.2% at ν_μ peak

~10^2 x (K2K)

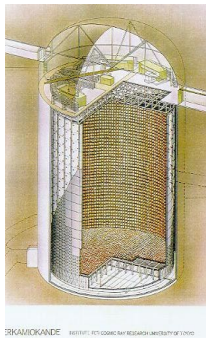


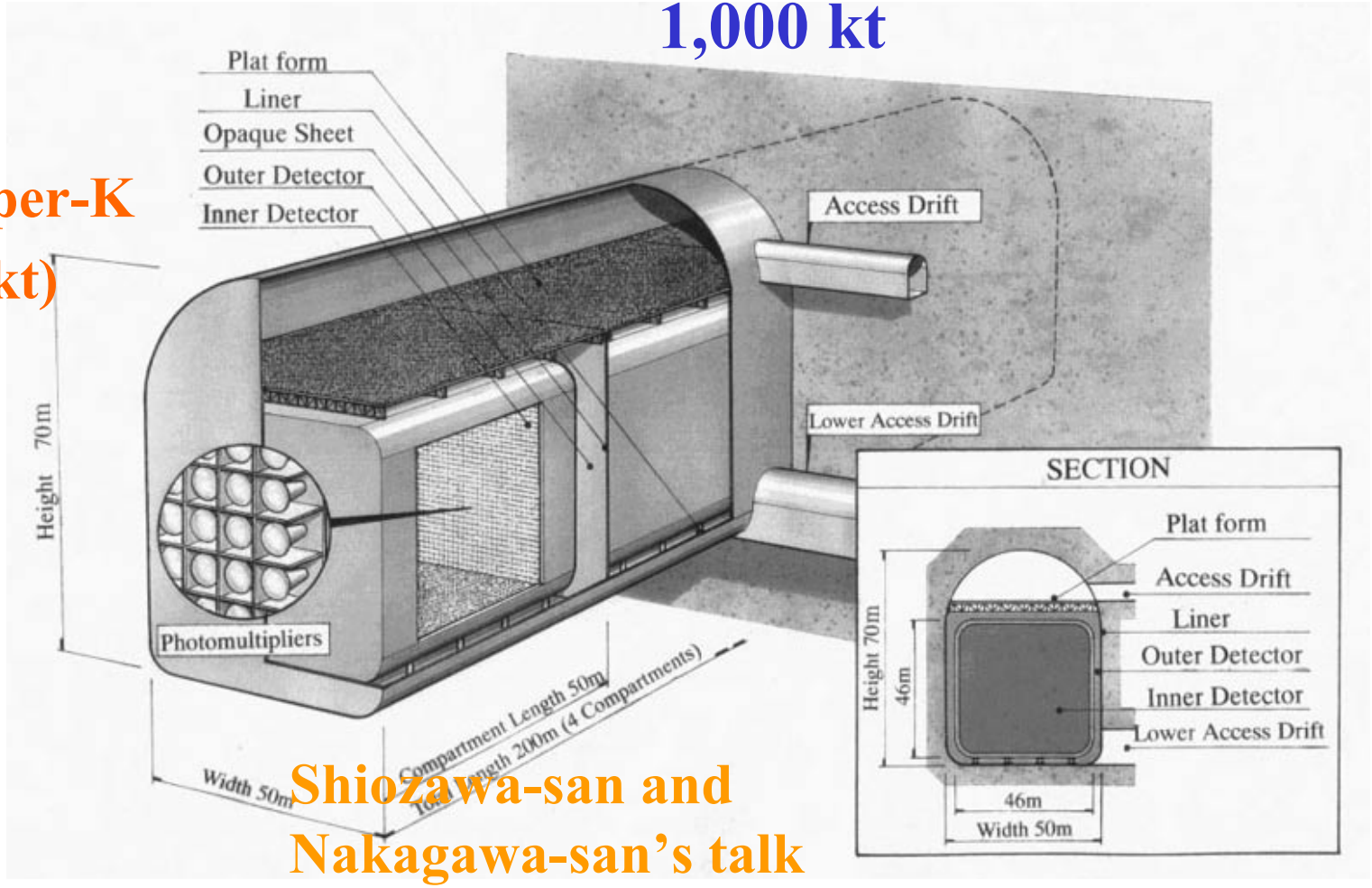
Expected spectrum (OAB2°)

Far ν detector

Phase-II: Hyper-K
1,000 kt

Phase-I: Super-K
22.5kt (50kt)

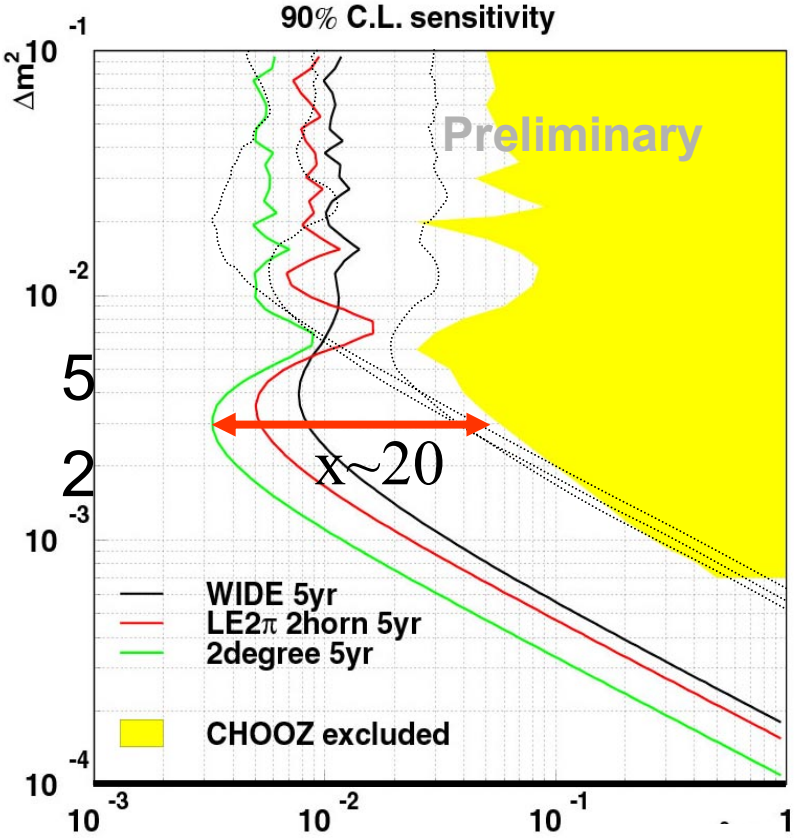




Shiozawa-san and Nakagawa-san's talk

Sensitivities in first phase(5yrs)

Search for ν_e appearance

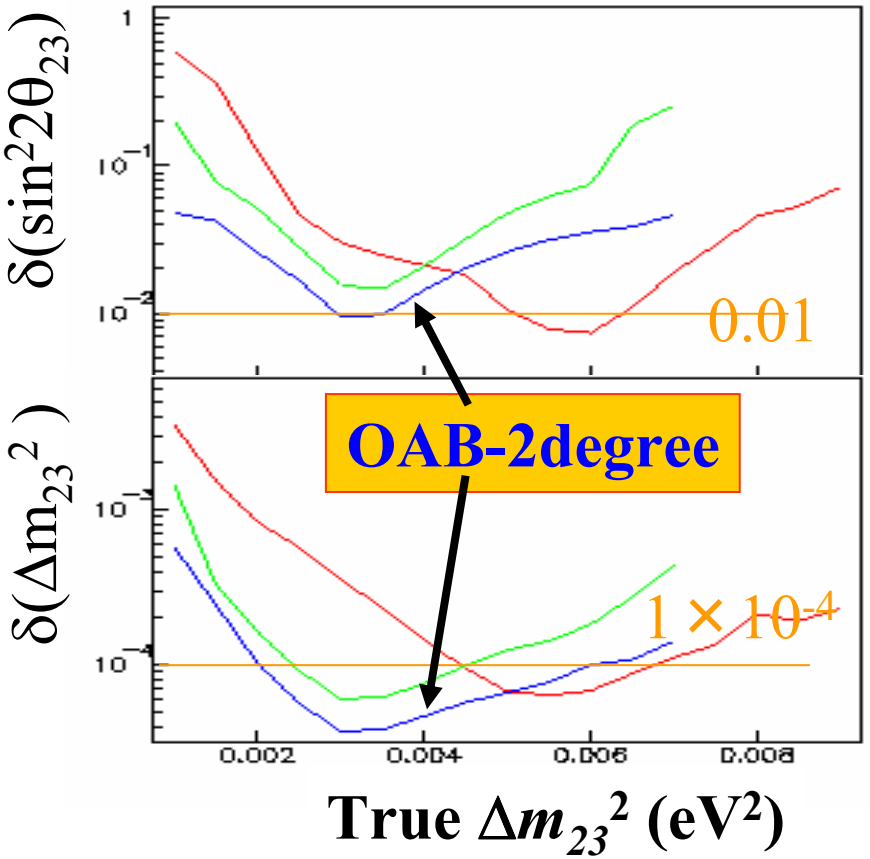


$$\sin^2 2\theta_{\mu e} \equiv \sin^2 \theta_{23} \cdot \sin^2 2\theta_{13}$$

~0.5

Sensitive $\sin^2 2\theta_{13} > 0.006$ (90%)
$\sin^2 2\theta_{13} > 0.018$ (3σ)

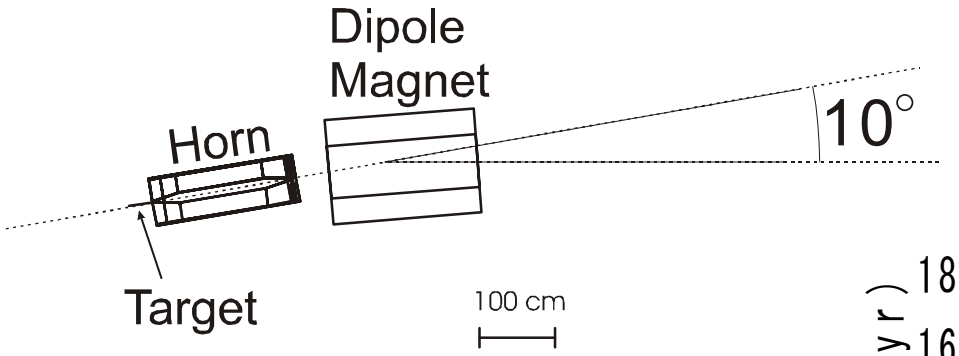
ν_μ disappearance



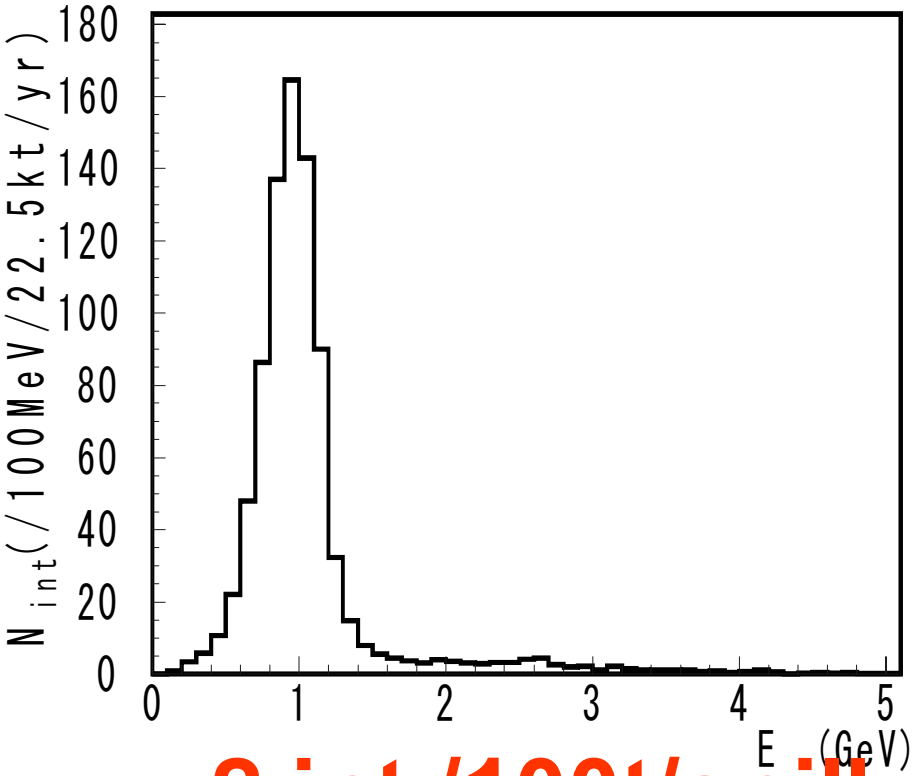
δ(sin²2θ)~0.01 in 5 years
δ(Δm²) ~<1 × 10⁻⁴ in 5 years

w/ beam MC sim, & full SK det. sim.

Narrow Band Beam for ν int study @ near



- **Easy to tune E_ν**
- Less HE tail (than OAB)



～2 int./100t/spill

Neutrino beam facility

Construction group

- Officially formed in KEK on April, 2001
- The 3rd physics division, IPNS(~10persons)
- Cryogenic facility group, IPNS(~10persons)
- Cryogenic Science Center, KEK(8persons)
- w/ strong support from existing beam channel group

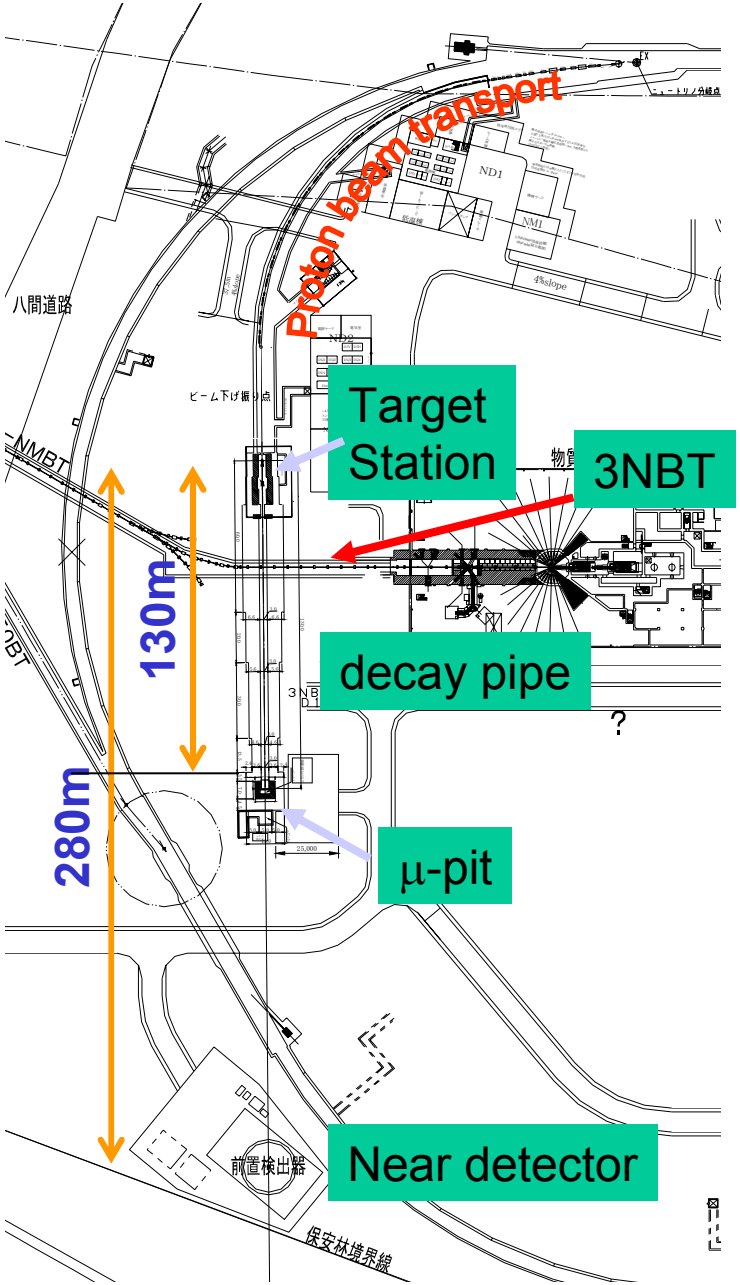
Neutrino beam facility Overview

Components

- Proton beam transport
  - matching section
  - **Arc section (Supercond.)**
  - Final focusing
- Target/Horn system
- Decay pipe (130m) **cross w/ 3NBT**
- Beam dump
- muon monitors
- 2 front detectors (280m/~2km)

- Single turn fast extraction
- 8 bunches/~5μs
- 3.3×10^{14} proton/pulse
- 3.94 (3.64) sec cycle
- 1yr≡10^{21} proton on target(POT)

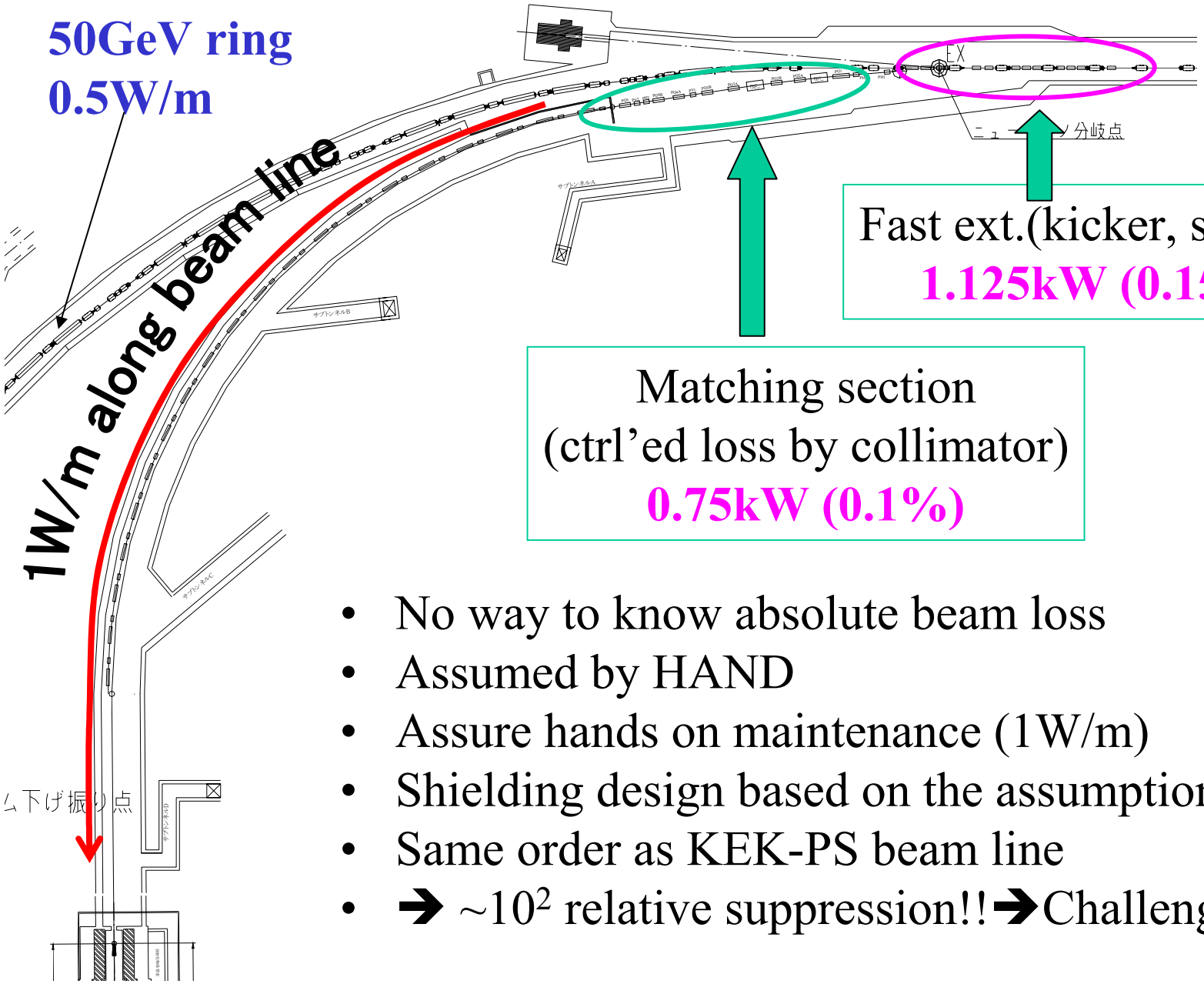
(3300hr~140days)



Key Issues

- Extremely severe radiation environment
  - Human exposure when maintenance
  - Damage to instruments
- Large heat load in a short time
  - cooling scheme, shock wave, quenching
- Key items
  - Beam abort in 50GeV ring (being developed.)
  - Beam scraping at matching sect.(→just started)
  - Radiation resistant magnets (→ Kusano)
  - Heat-load resistant SC magnets
  - Target/Horn (cooling, shock wave) (→Hayato)
  - Target station (cooling!, maintenance)
  - Decay volume (cooling) (→Hayato)
  - Beam dump (cooling) (→Hayato)
  - Radiation shielding (DV, Dump→Oyama)
- + K2K issues (timing, direction, …)

Beam loss

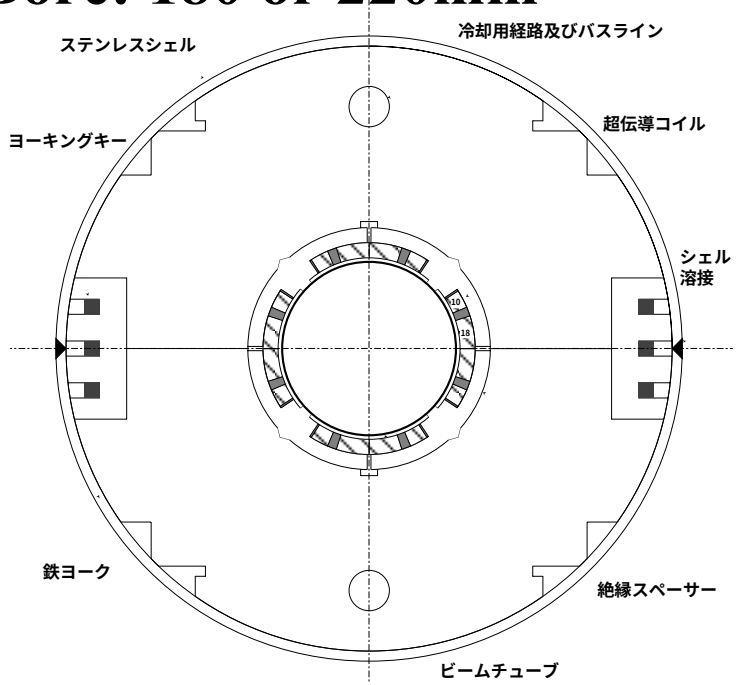


- No way to know absolute beam loss
- Assumed by HAND
- Assure hands on maintenance (1W/m)
- Shielding design based on the assumption
- Same order as KEK-PS beam line
- ➔ ~10^2 relative suppression!!➔Challenging

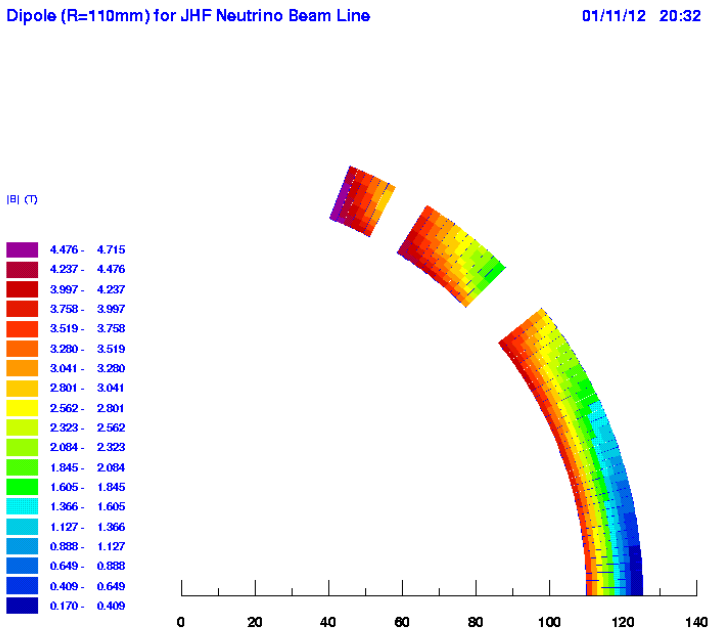
Design of Super con. mag started

Type	Magnetic Length	Operation Field	Number
Dipole	3 m	3.95 T	20
Quadrupole	1 m	32.4 T/m	20

Bore: 180 or 220mm



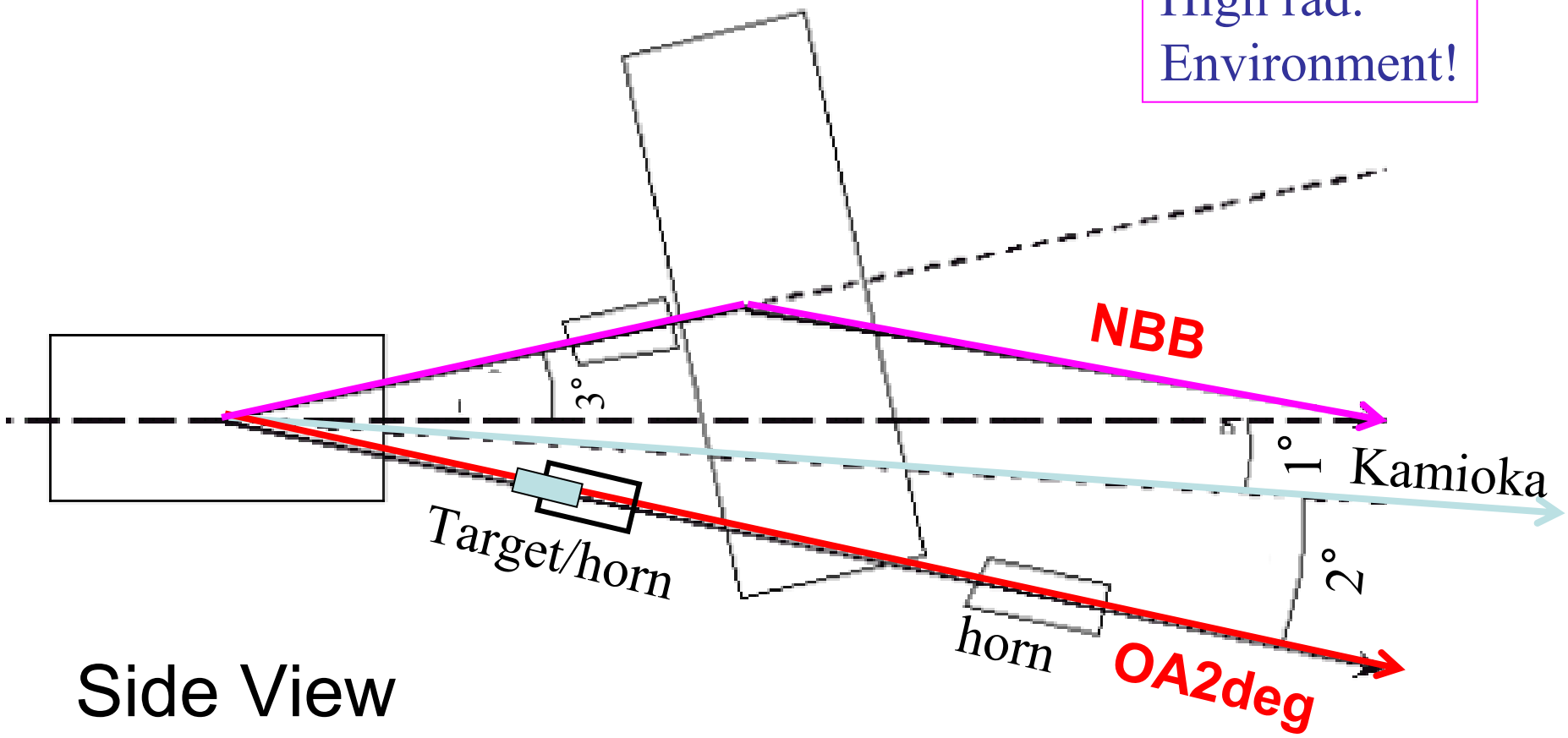
B field simulation



Cryo. Science Center of KEK

Concept of target station

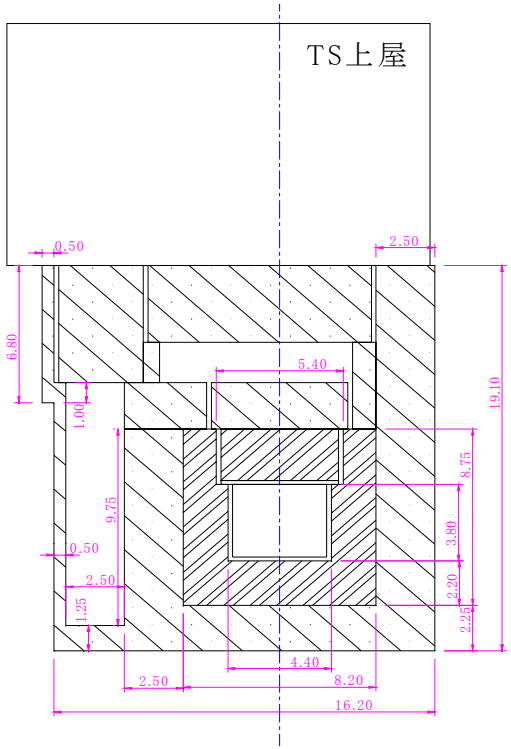
Extremely
High rad.
Environment!



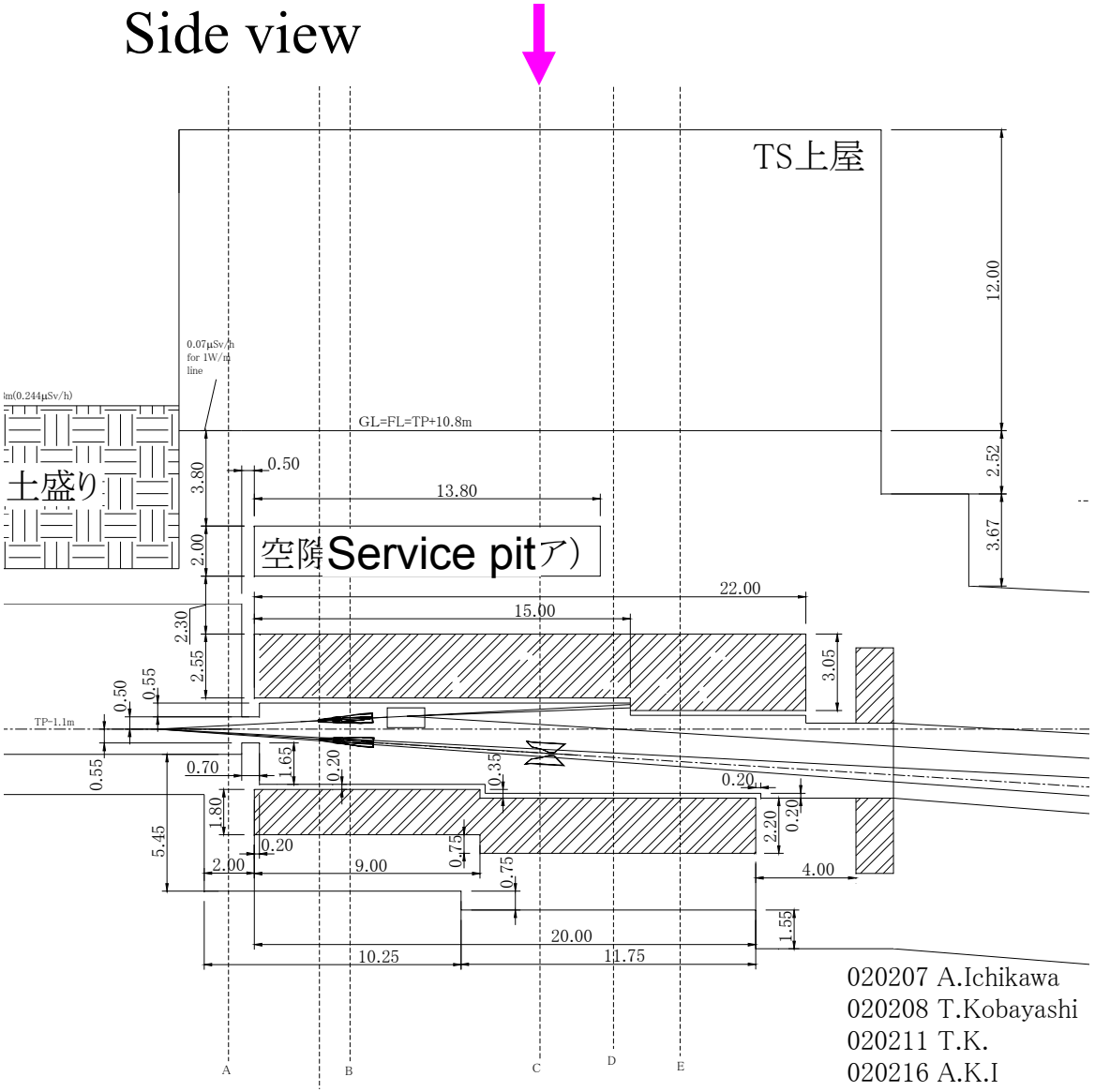
Side View

Design of target station

Front view



Side view

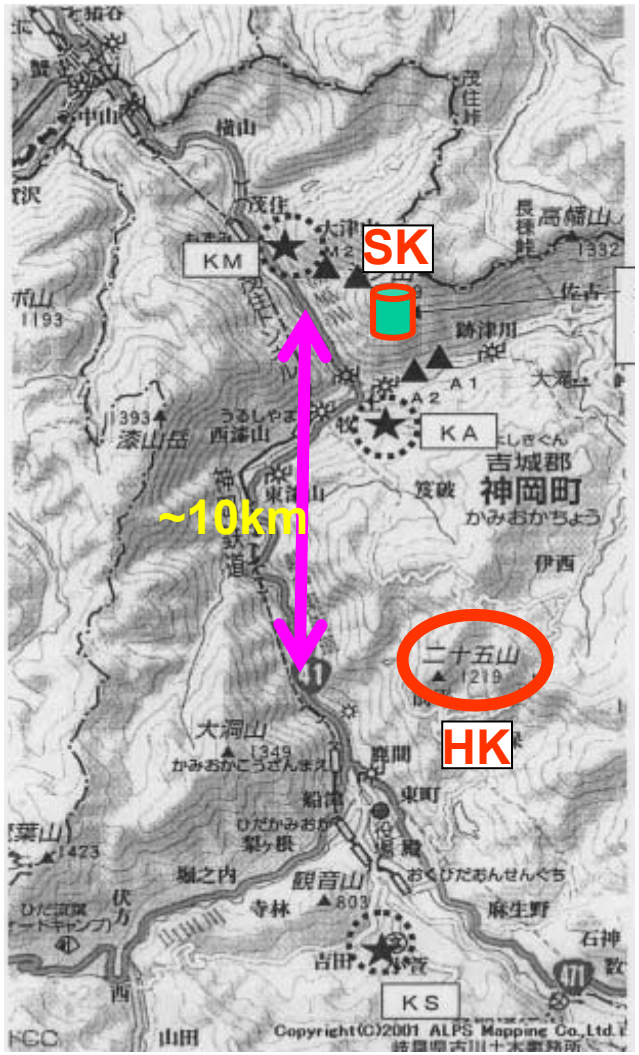


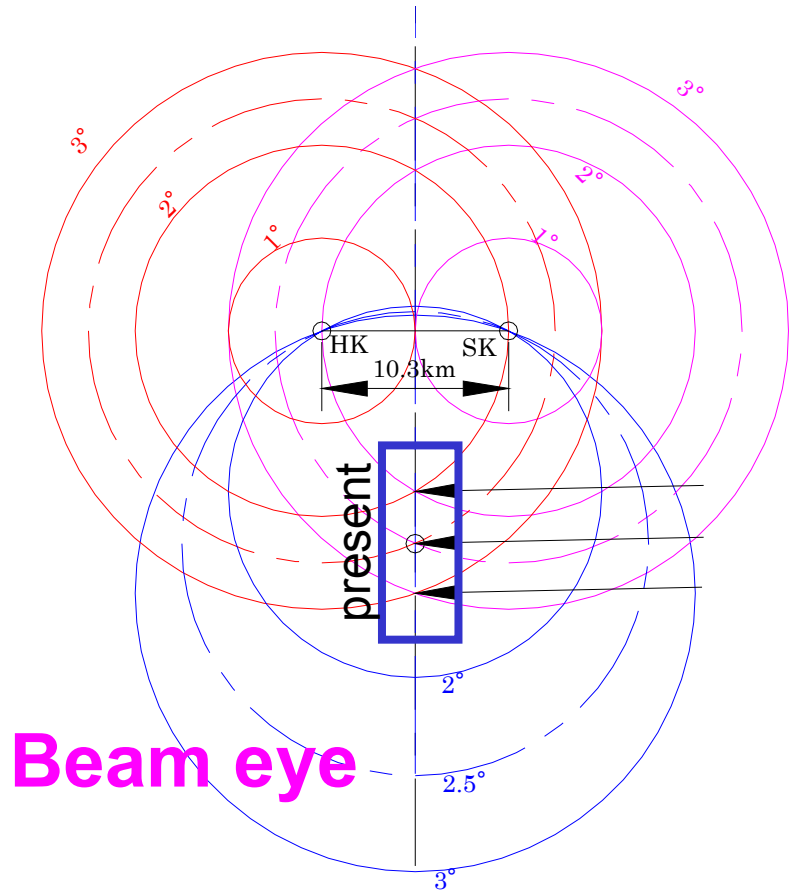
020207 A.Ichikawa
020208 T.Kobayashi
020211 T.K.
020216 A.K.I

Preliminary

Decay pipe common for SK/HK

Possible site for Hyper-K





2.98°（OAB2°）

3.54°（OAB2.5°）

4.08°（OAB3°）

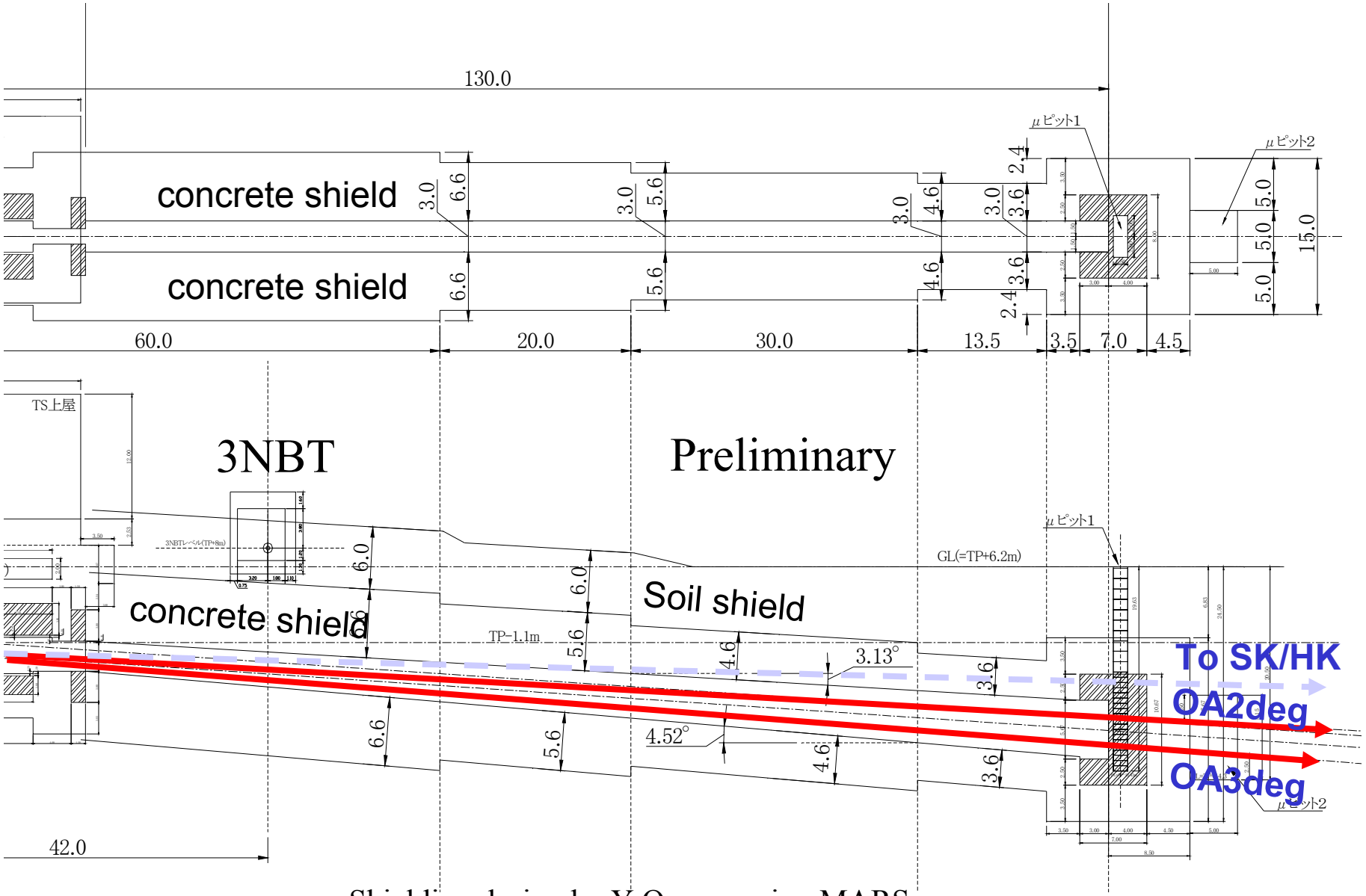
Beam eye

Ichikawa

p/π beam axis

-(3~4)deg

Design of decay volume and beam dump



Shielding design by Y.Oyama using MARS

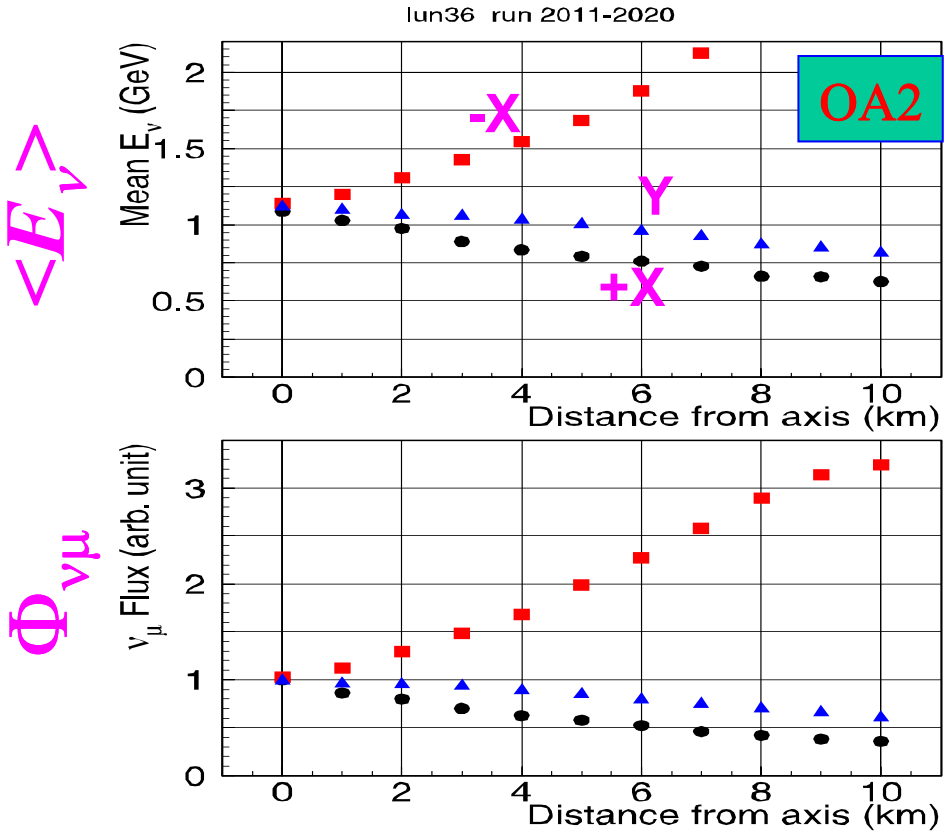
GPS survey

Nov.19~22: long baseline GPS survery @ Kamioka/Tokai simultaneously

Noumi/Ishii/Shiino

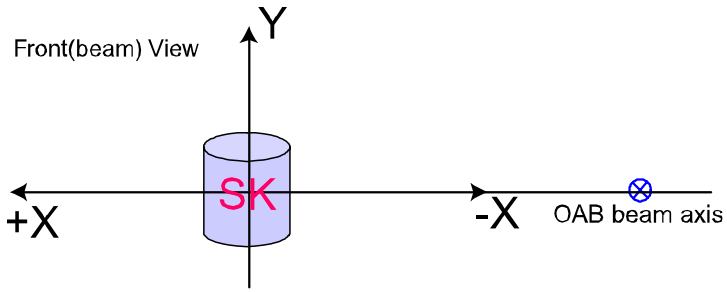
Beam monitoring and control

Beam profile @ SK



$\langle E_\nu \rangle$

$\Phi_{\nu\mu}$



OAB: $\langle E_\nu \rangle$ ~25MeV/mrad→$\delta(\Delta m^2)$**~1x10^{-4}eV^2**

$\Phi_{\nu\mu}$ ~4%/mrad

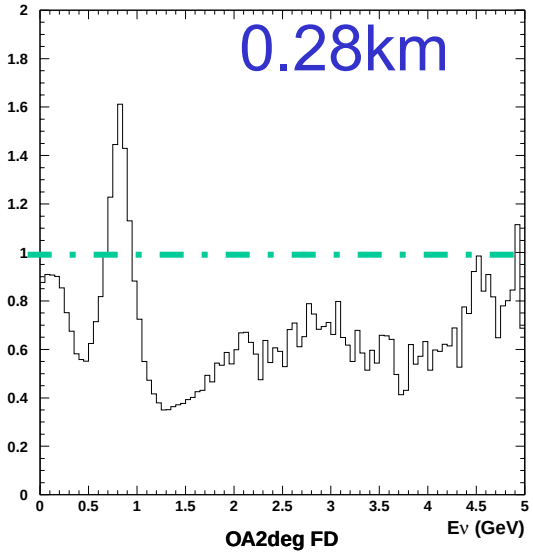
~<1mrad precision necessary as K2K

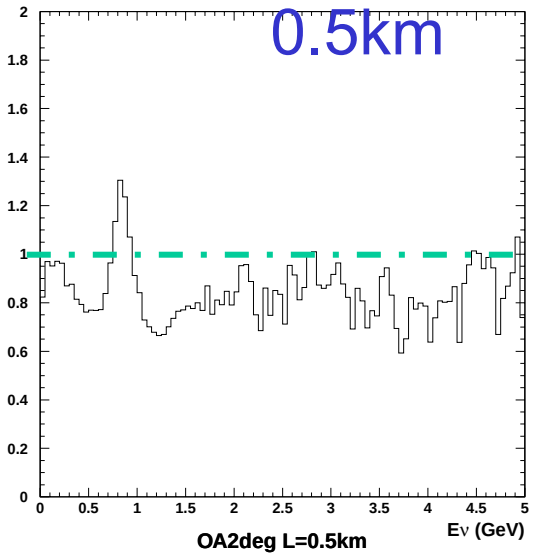
Far/near spectrum ratio

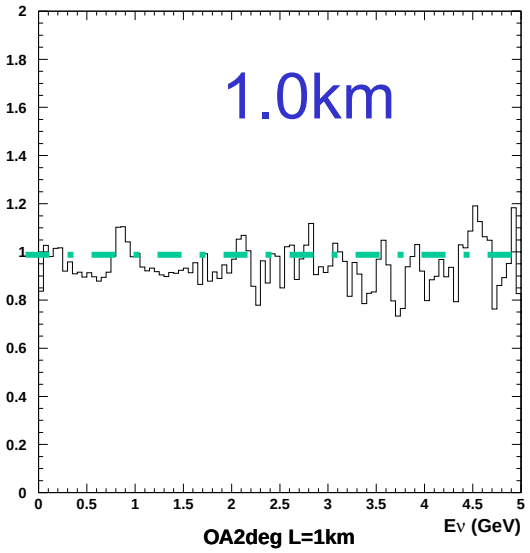
$$\frac{\Phi_{far}(E_\nu)\cdot L^2_{far}}{\Phi_{near}(E_\nu)\cdot L^2_{near}}$$

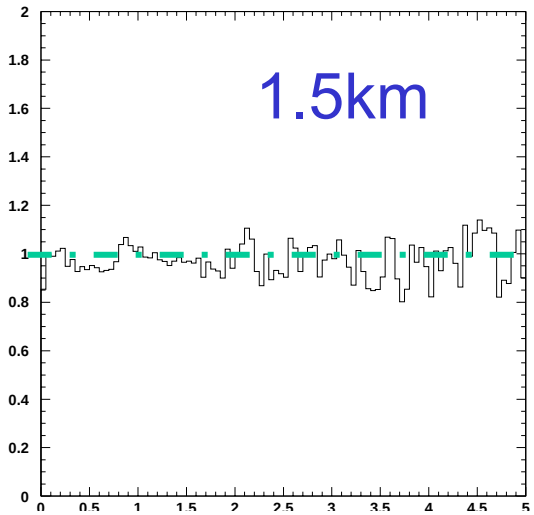
Flat >~1.5km

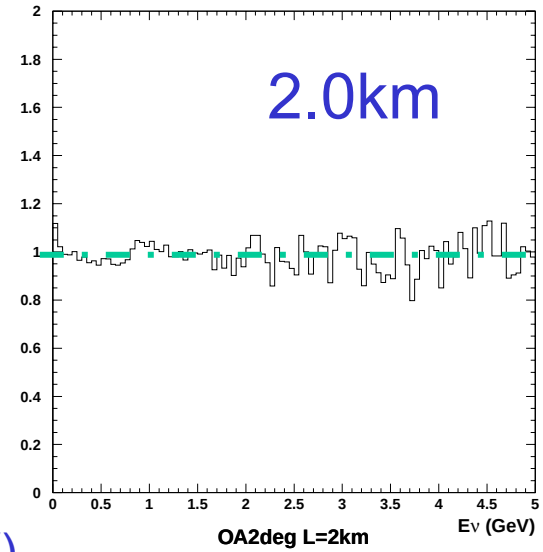
Place detector ~2km.





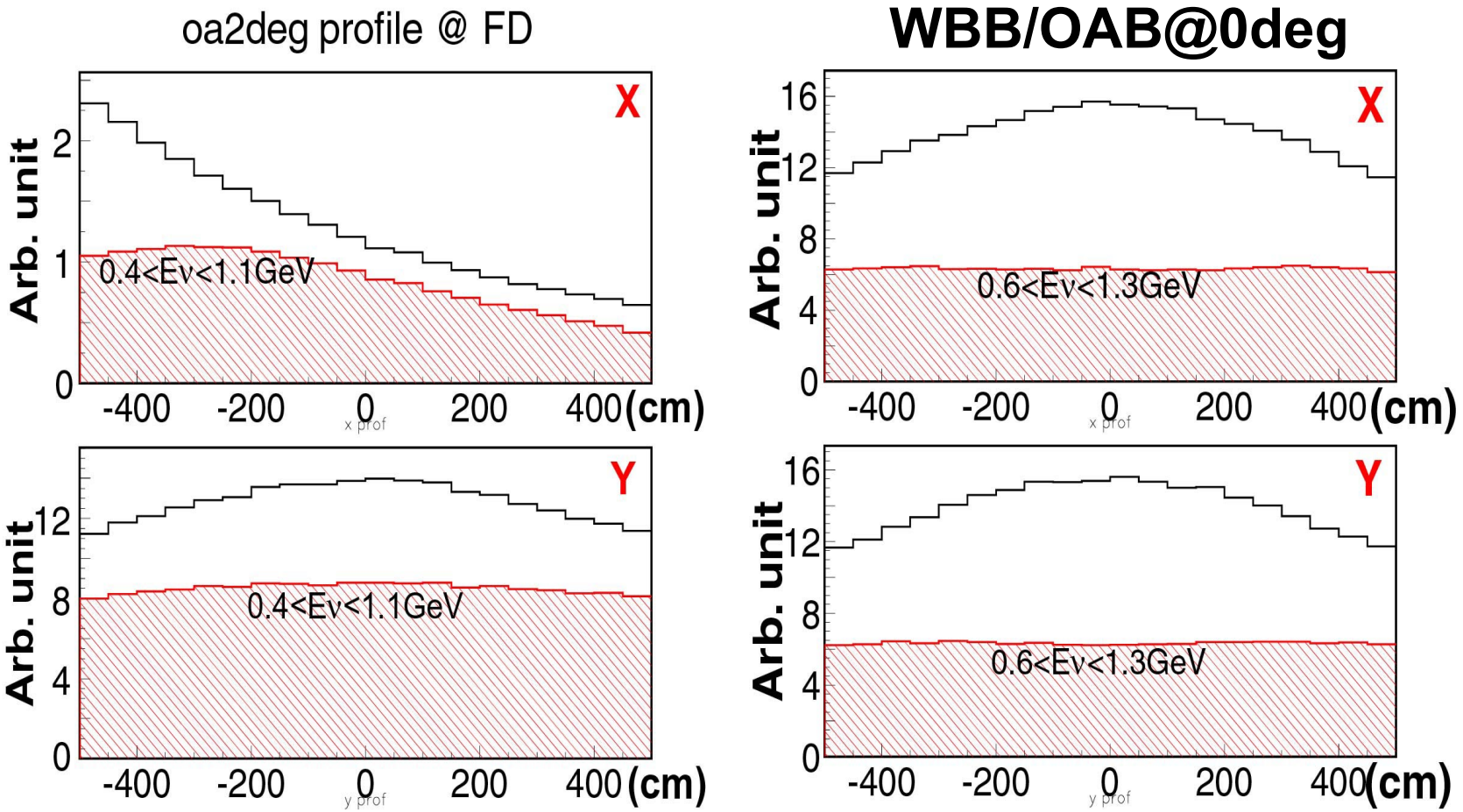






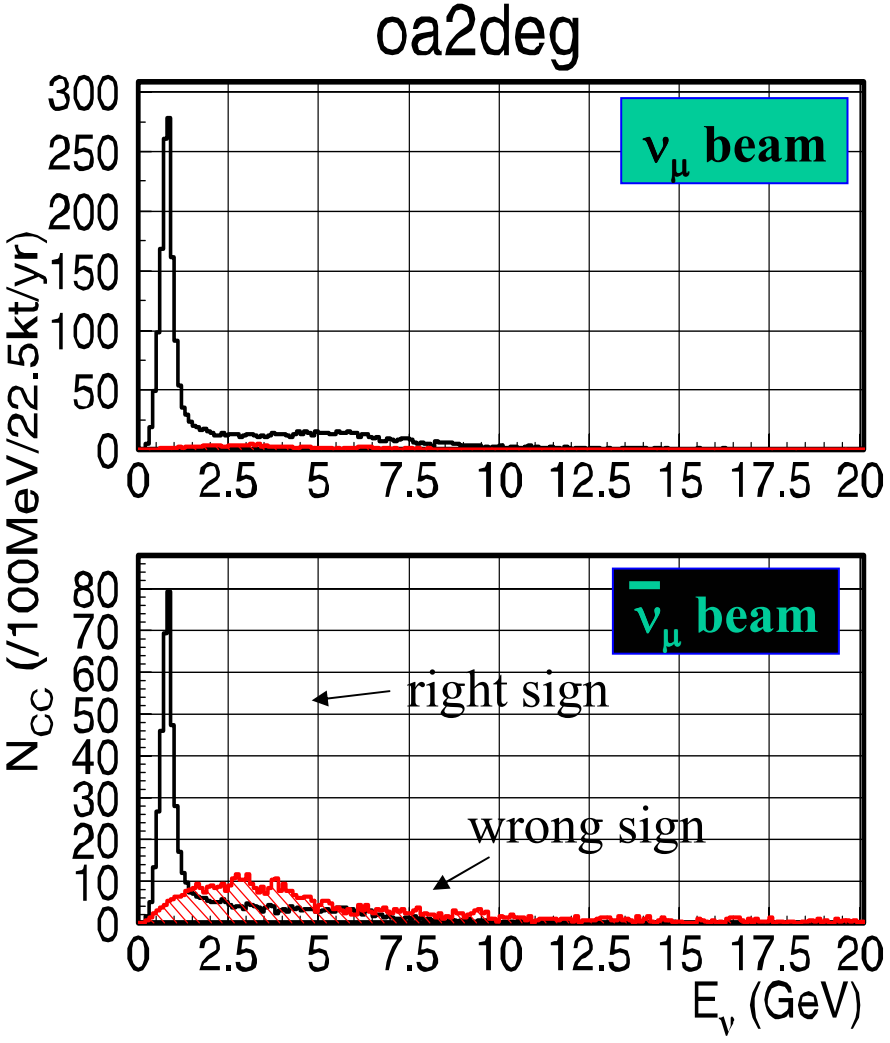
0 1 3 5 (GeV)

Neutrino profile @ FD



OAB direction can be monitored w/ beam profile on beam axis.
Low energy component has very wide spread.→ may need another method

$\nu_\mu / \bar{\nu}_\mu$ # of CC int.

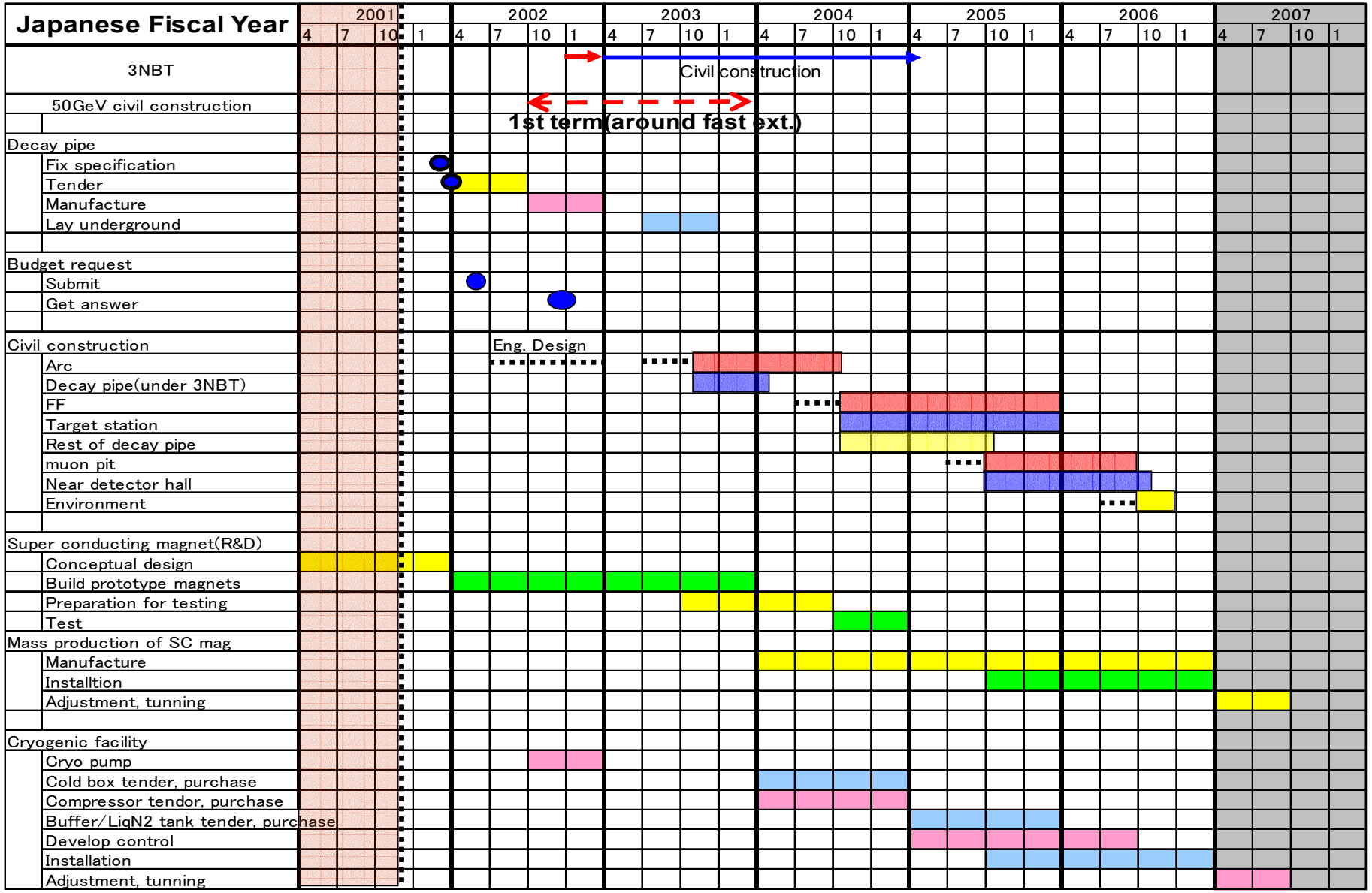


10^{21}pot/yr (1st phase)

80m pipe

- # of int. for $\bar{\nu}_\mu$ is factor ~3 smaller than ν_μ due to cross section.
- Wrong sign contamination is much higher for anti-ν.

Mile stones/Schedule



Not all items listed. We aim to complete construction by the end of JFY2006

Summary

1. JHF-Kamioka neutrino experiment
   - **ν_e app.: $\sin^2 2\theta_{13} > 0.006$**
   - **ν_μ disapp: $\delta(\sin^2 2\theta_{23}) \sim 0.01$, $\delta(\Delta m_{23}^2) \sim 1 \times 10^{-4} eV^2$**
2. Special features of JHFν beam facility
   1. Superconducting proton transport
   2. Low energy tunable OAB (w/NBB)
   3. Common facility for SK/HK
   4. 2 near detector (280m/2km for far/near ratio)
3. Facility design & development work started
   1. Intensity frontier→high radiation, heat load
      Not so each job.
   2. Optics, NC/SC mags, target/horns, shielding, etc.…
4. Plan to start experiment Apr. 2007

   ➔ need to be approved in 2002.