JPARC-ν Decay Volume

M.Sakuda (KEK)

11 November 2003

In collaboration with
A.Ichikawa, E.Kusano, Y.Yamada, T.Kobayashi, H.Noumi,
M.Takasaki, T.Ishida, Y.Hayato, Y.Oyama, T.Suzuki, T.Miura

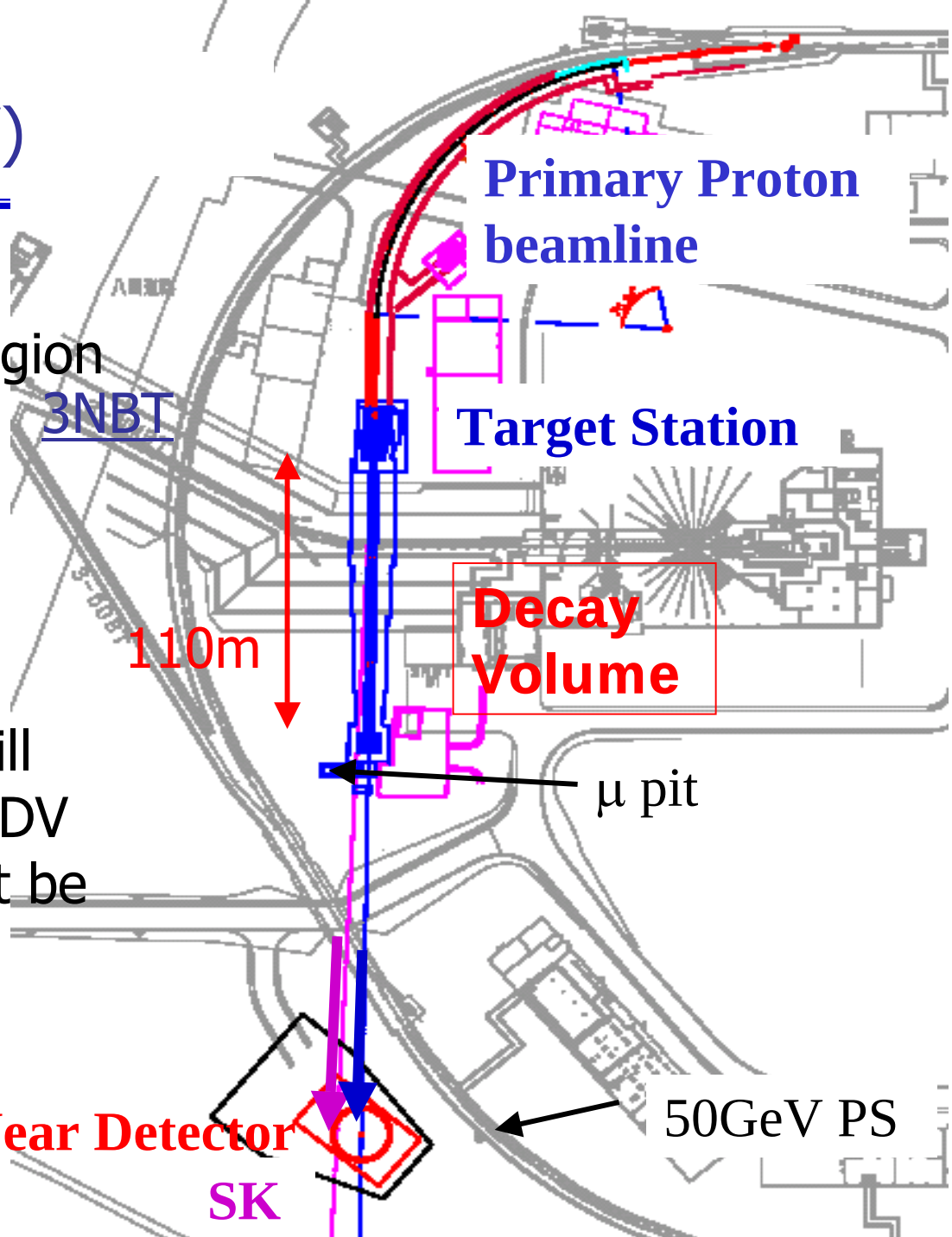
1. Decay Volume
   - Requirements
   - Design
2. Construction Status
3. Summary and schedule

1. Decay Volume (DV)

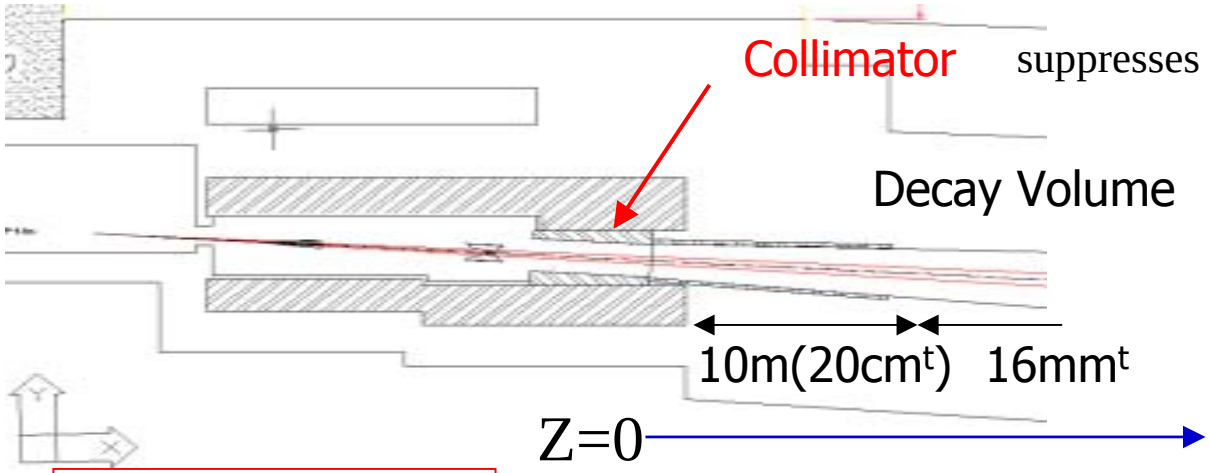
Requirements

- 0.8MW of energy loss in DV region @4MW operation.
  - Radiation safety regulation
  - Cooling
  - Mechanical stability
- Tight schedule

  Construction of 3NBT tunnel will begin from JFY2004. A part of DV beneath 3NBT, 30m long, must be completed in May, 2005.



Heat Generated at Decay Region (4MW)

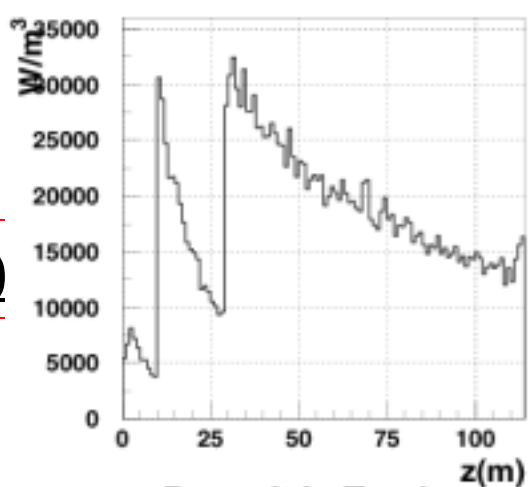


Target Station

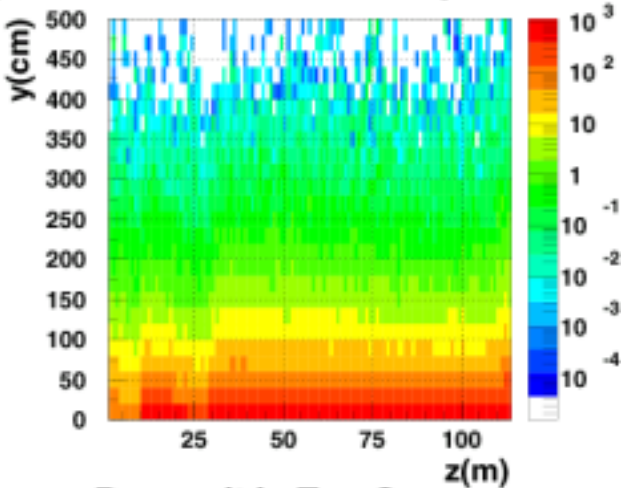
Concrete

Steel plate (Pipe)

Energy Deposit in Decay Volume at 4MW beam power



Deposit in Top Iron



Denposit in Top Concrete

Design of Decay Region

1) Mechanical shape
   - (square) box is cheaper than O (cylinder) by 20-30%.
   - 16mm-thick steel is strong enough to endure the weight of 2m concrete during the construction and the thermal stress (later).
   - One plate is 4mx2m wide, welded with ribs embedded in concrete. In addition, anchors every 4.5m pitch.
2) 5.0-5.9m thick concrete and 6m of soil surrounding the iron box is needed for radiation safety regulation <5mSv/h. (Oyama's report)
3) Filled with Helium
   - About 7% more flux than air.
   - Less Tritium rate by a factor 1/3 than air. (<30Bq/cc)
4) Cooling under 4MW for Iron <60deg, Concrete <120deg
   - 20 Plate-Coils (S=6.7cm^2) with 1.2m/sec water flow

Design of Decay Region

ディケイ・ボリューム

Top View

Side View

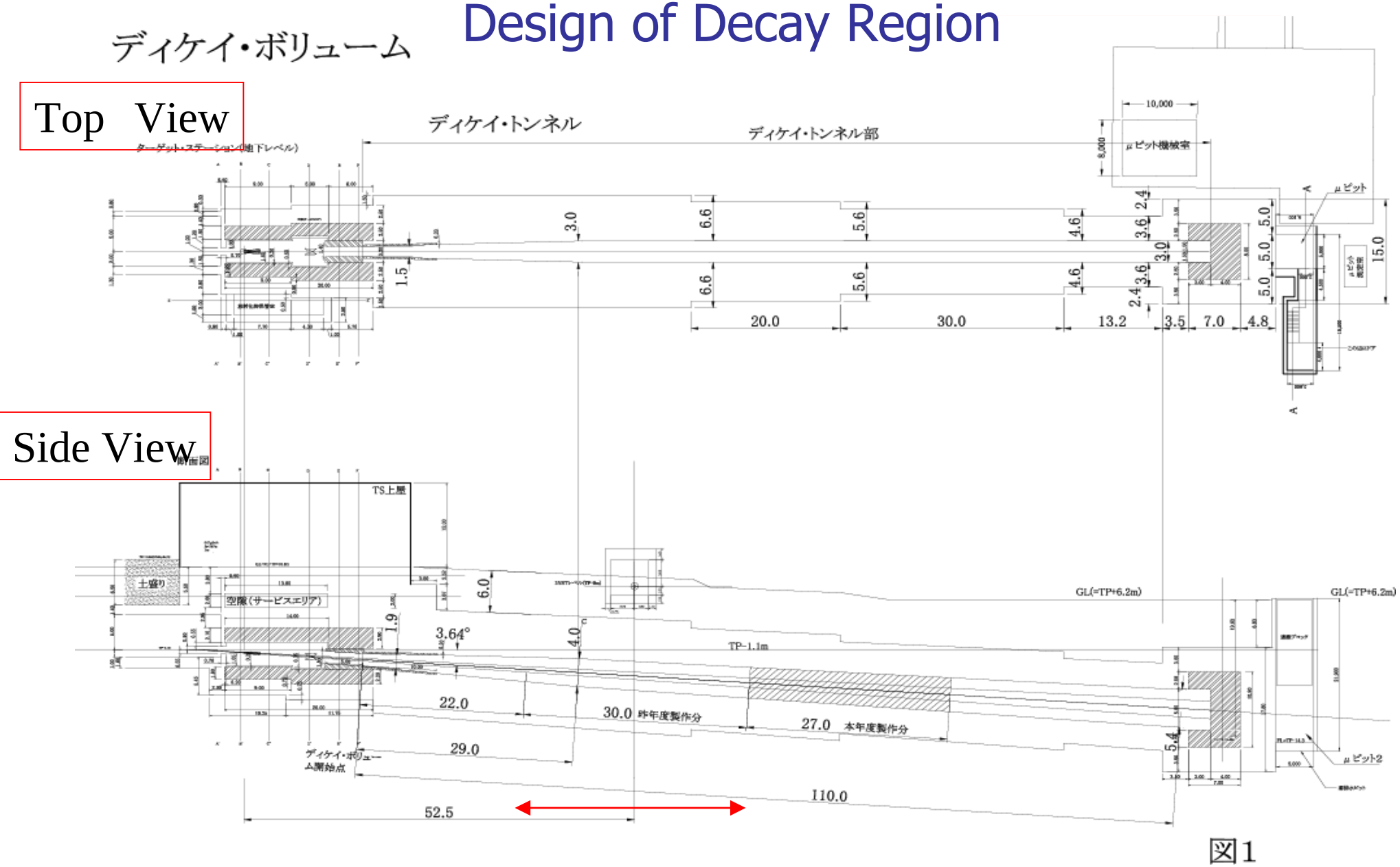
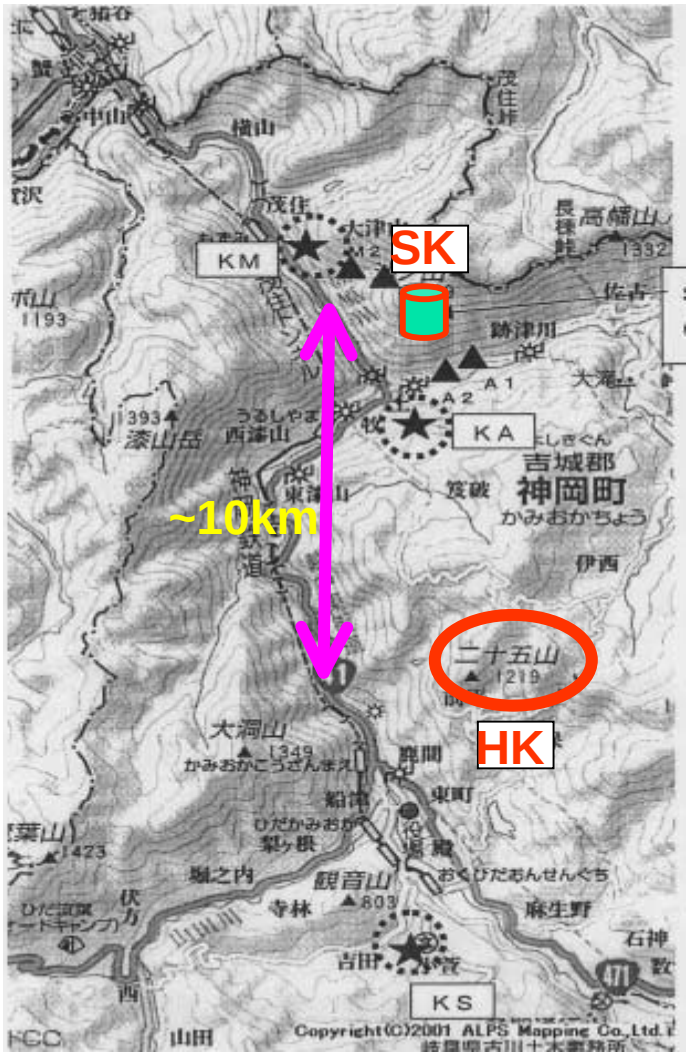


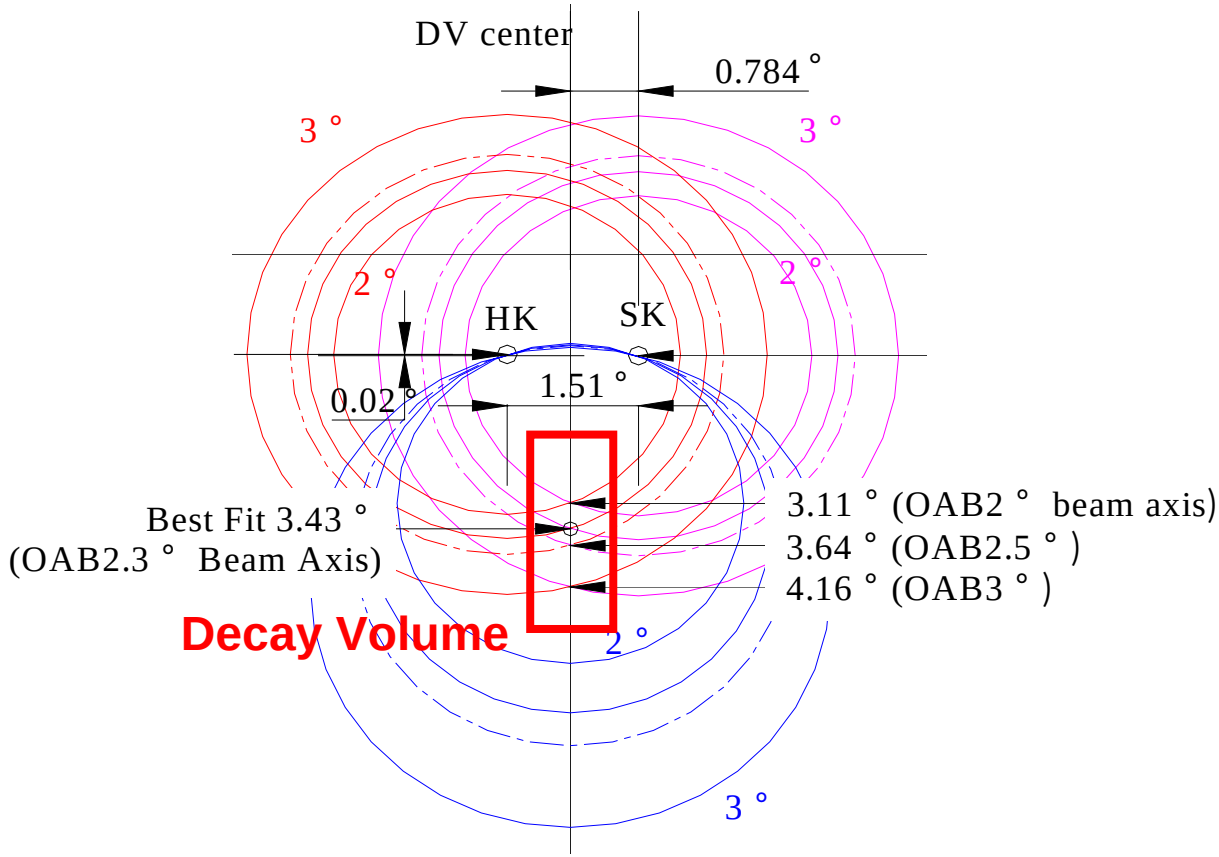
図1

Decay Volume common with SK/HK

ハイパーカミオカンデの候補地



Beam View



2. Construction of Decay Volume
- Iron Plates (16mm^{t}) with PlateCoils -

- Production in 2002-2003
- 71.4m(/110m) plates purchased.

Platecoils welded on iron plate

Platecoils (1cm^{t}x6.5cm^{w})

(continued)

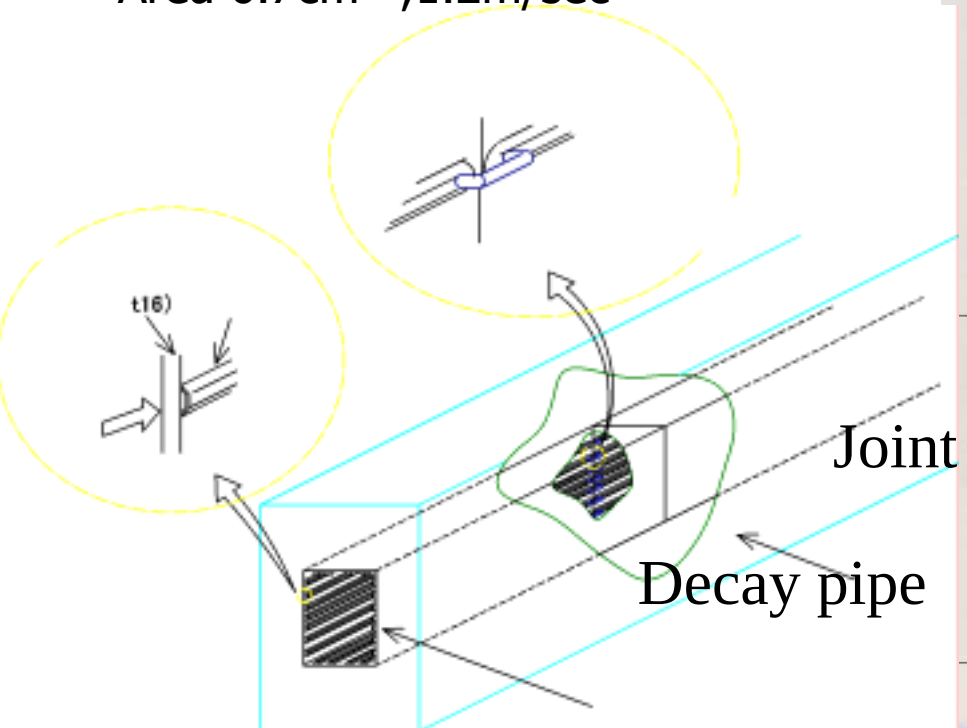
Complete

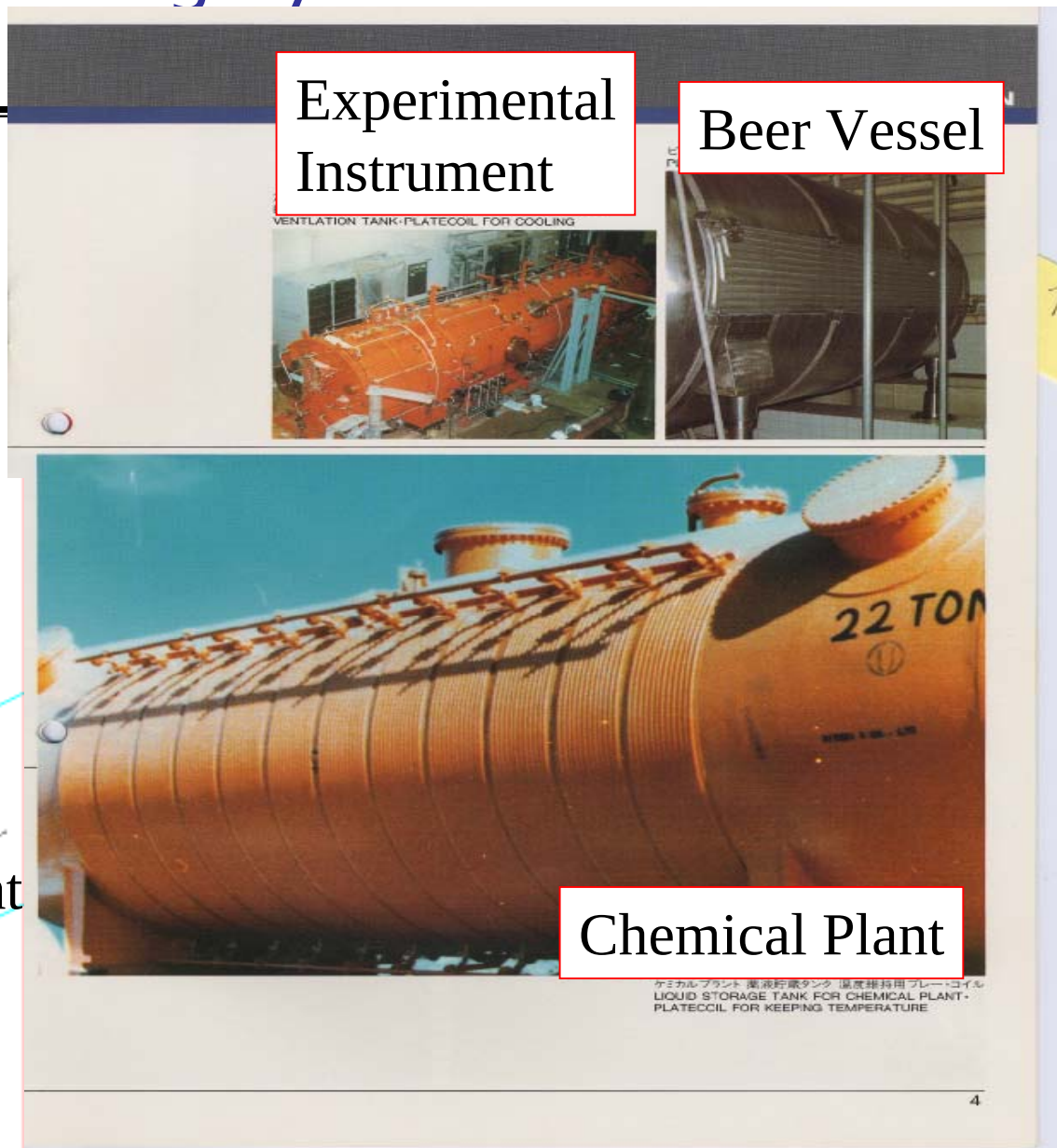
Pressure test

2003年3月

Platecoil for Water Cooling System

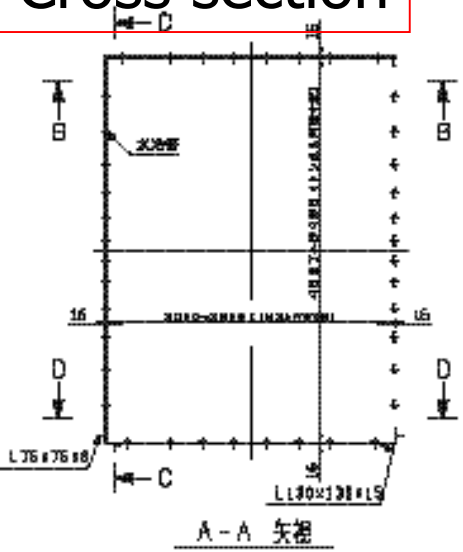
- Many industrial applications
  -Cheap and reliable
- Welded on the inside wall of decay pipe
- Area 6.7cm^2 ,1.2m/sec





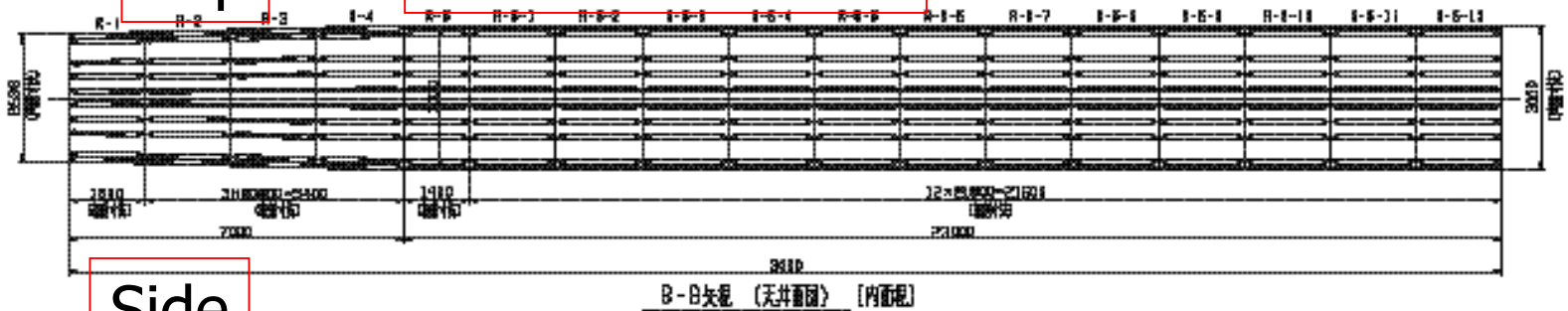
Arrangement of Watercooling Pipes (platecoils) inside DV iron plates

Cross section

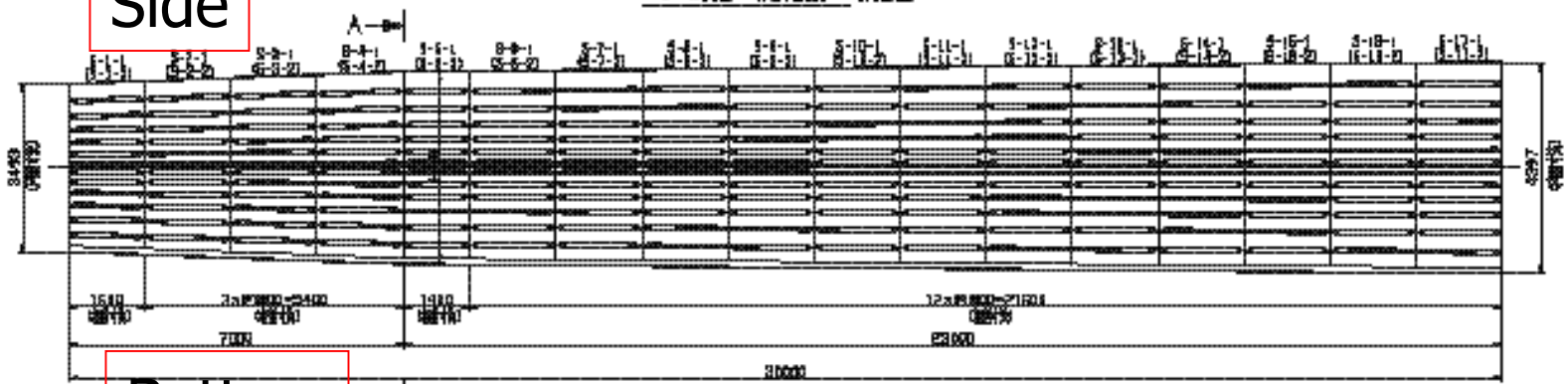


Top

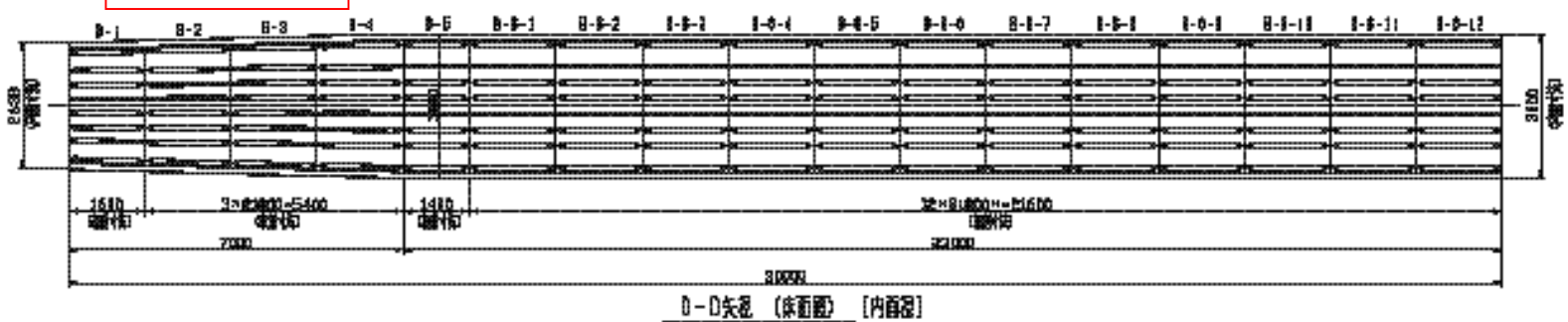
→Beam direction



Side



Bottom



Thermal analysis for 4MW beams

- FEM analysis for 4MW beam with 40 water-cooling platecoils
- Realistic condition

(1/2 year 100%, 1/2year 0%)x30year.

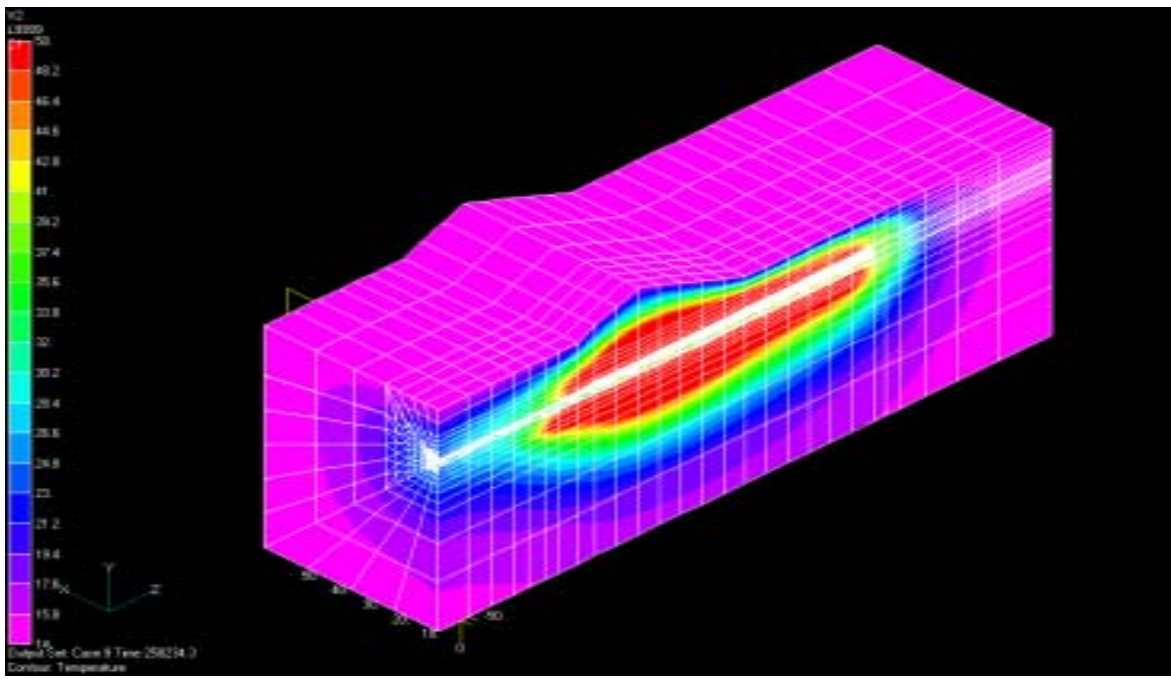
Input water =30degC

Max temperature

- Plate <60degC
- Concrete <120degC

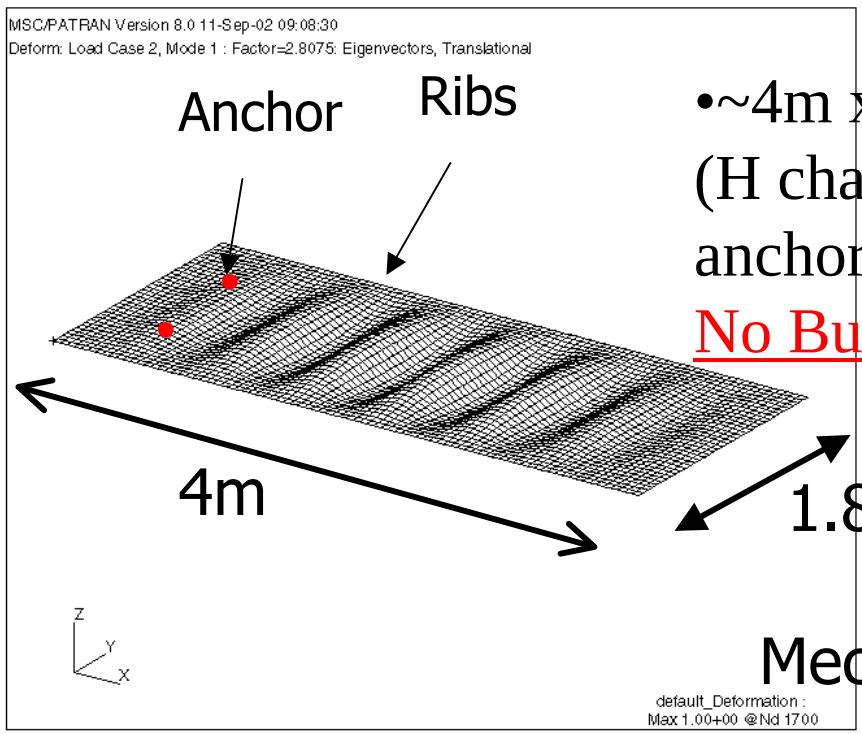
→OK.

	Thermal Conductivity (kcal/m·hr·℃)	Density (kg/m³)	Specific heat (kcal/kg·℃)
Steel Concrete Soil	44.2 1.4 0.46	7860. 2300. 1890.	0.113 0.21 0.21



Mechanical Analysis

Young modulus 19600kgf/mm^2,
Poisson ratio 0.3,
Linear expansion coefficient 0.00001153 ^{1}/°C



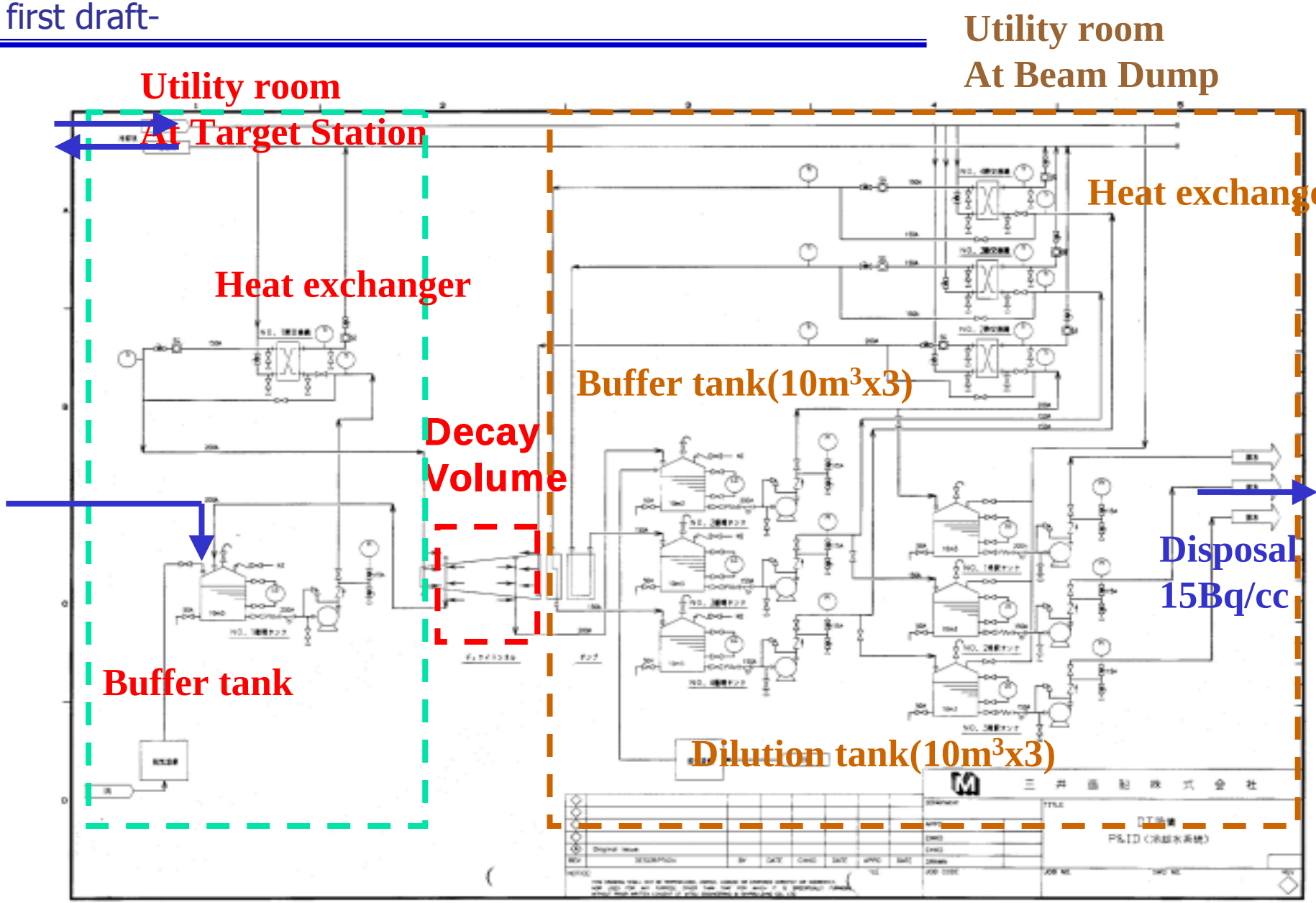
•~4m x 1.8m steel welded with steel ribs (H channels) at every corner. In addition, anchors are welded every 0.45m.

No Buckling happens below 70 °C.

Mechanical Specifications are decided.

Design for Water Circulation System

-A first draft-

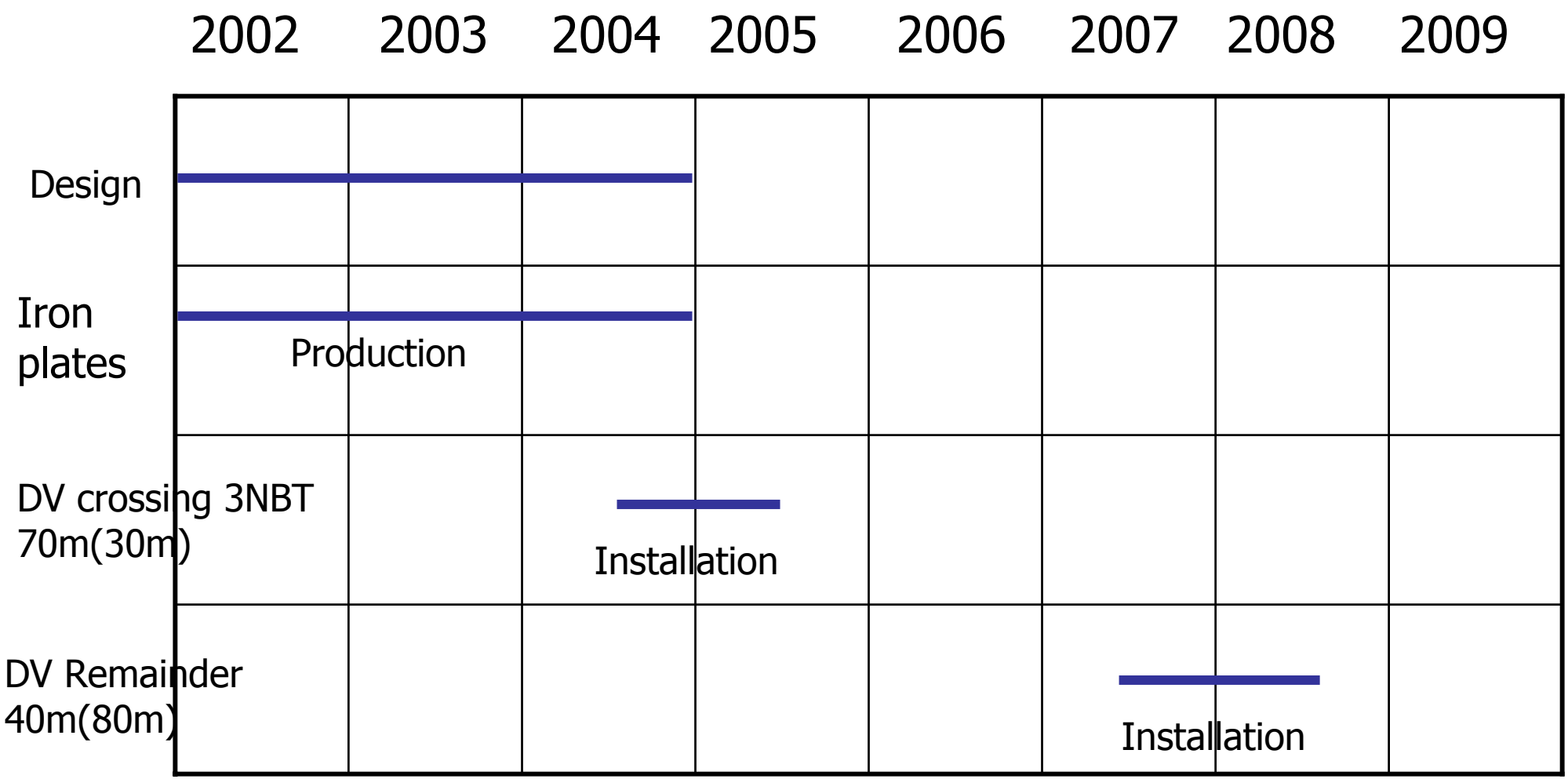


Summary

- FY2003: Design of the decay volume (Z=10-110m) with 4MW beam condition complete.
- FY2002-2003: Iron plates with platecoils (for 71m long) purchased.
- FY2003:
  - Civil engineering design of Decay Region is being done.
  - Details of the installation (Spec Document for installation of DV) must be decided within FY2003. Schedule and budget is very tight.
  - Construction of 3NBT line will begin in FY2004. DV beneath 3NBT tunnel, 30m (70m) long, must be completed in May, 2005.

- Tasks
  - Spec document for the DV installation (FY2004)
  - Design of Collimators+Iron plates(10m-long 20cm-thick)
  - Design Vacuum system+Window and Endplate
  - Design of water circulation system
  - How to protect iron plates from rusting with seawater permeating nearby

Decay Volume Schedule



Disposal Scenario of Radioactive Water

Y.Oyama

- After 20days operation, all radioactive water is transferred to a DP tank in the disposal system. The cooling system for decay volume considers this scheme.
- They are mixed with fresh water in the dilution tank.
- After measurement of radioactivity in the dilution tank, the water can be disposed. It takes 1 or 2 days for the measurement.

Arrangement of Iron Plates on DV