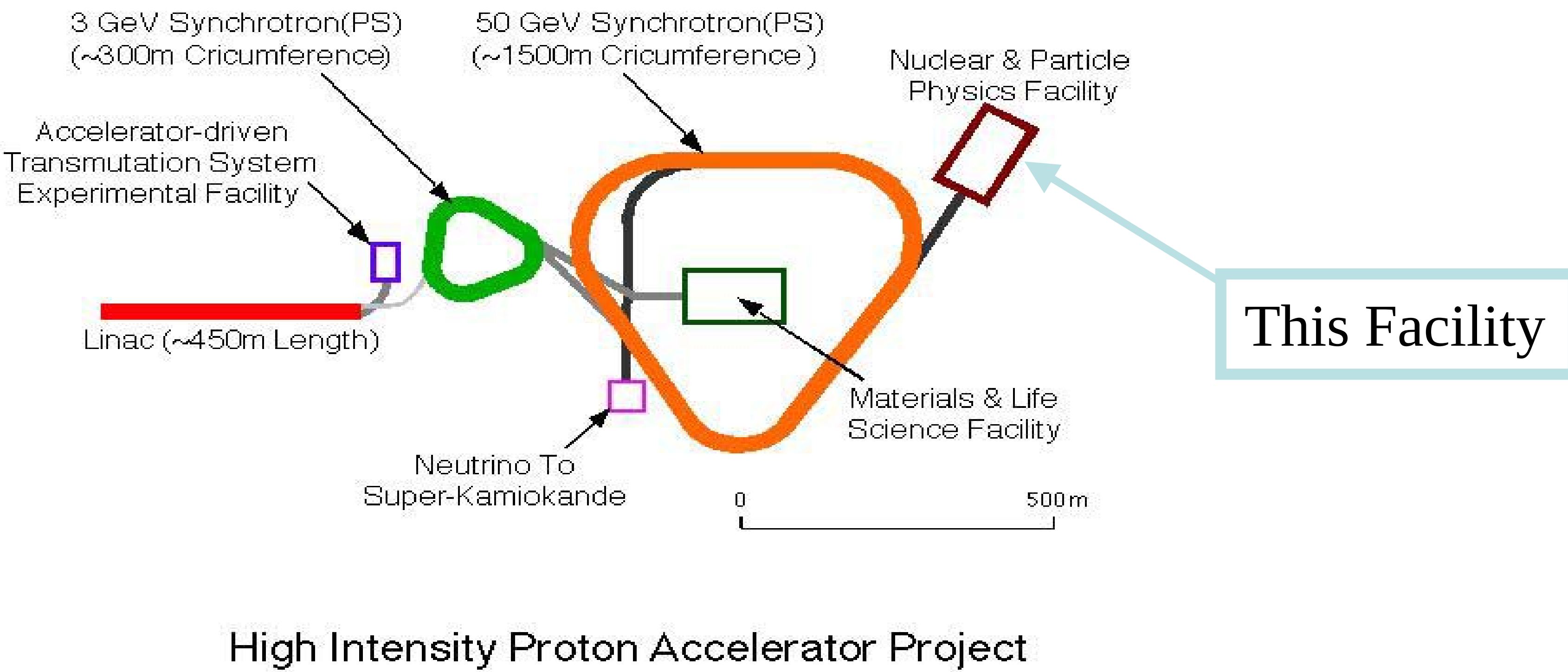
OUTLINE of the K-HALL

K.H. Tanaka for Hadron Beam Subgroup



Experimental Hall for 50GeV-15μA Slow Beam

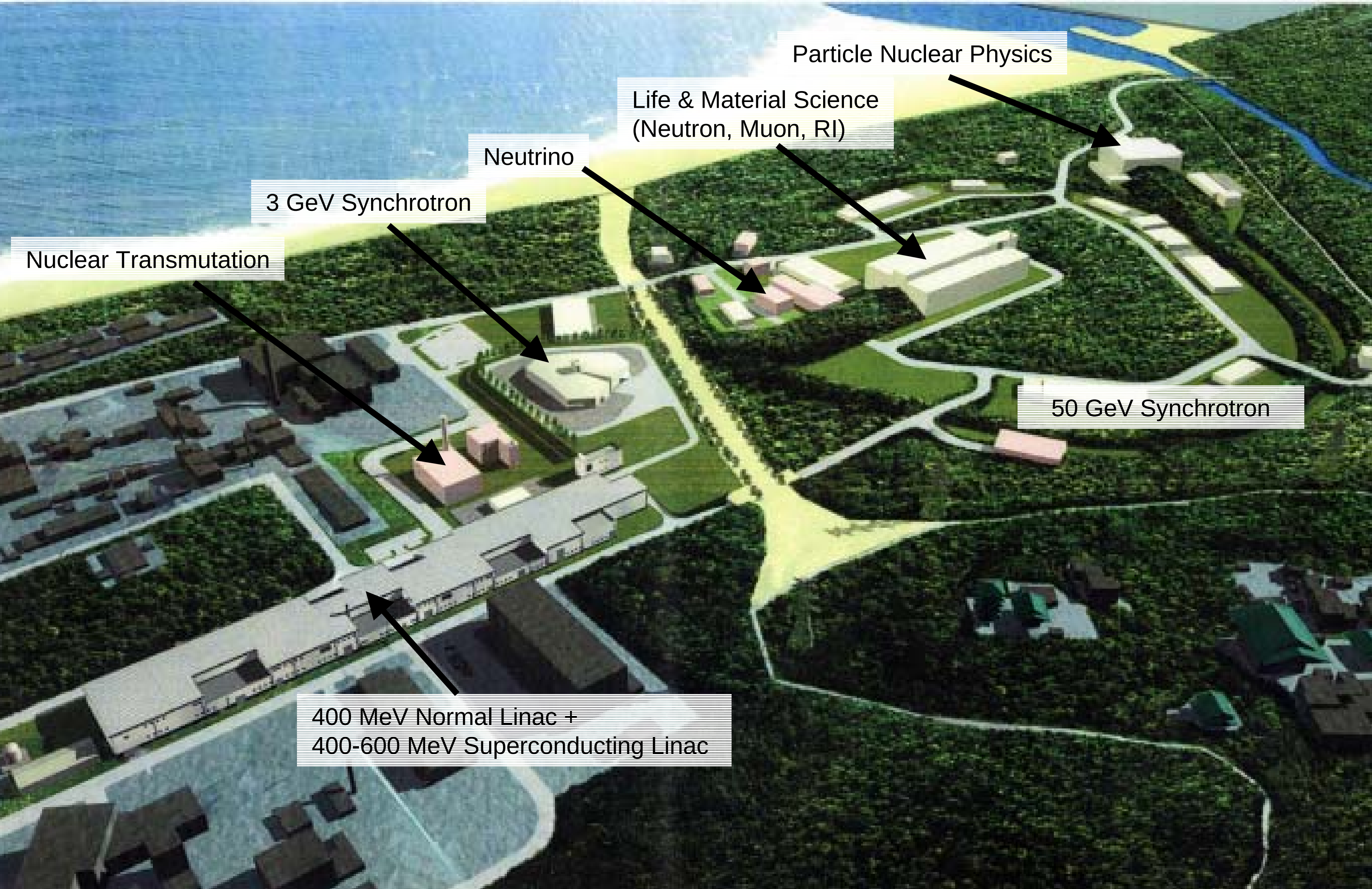
The First (Only One?) KAON FACTORY in the World

OUTLINE of the K-HALL

- General Layout
- Technical Issues
- Schedule
- Budget

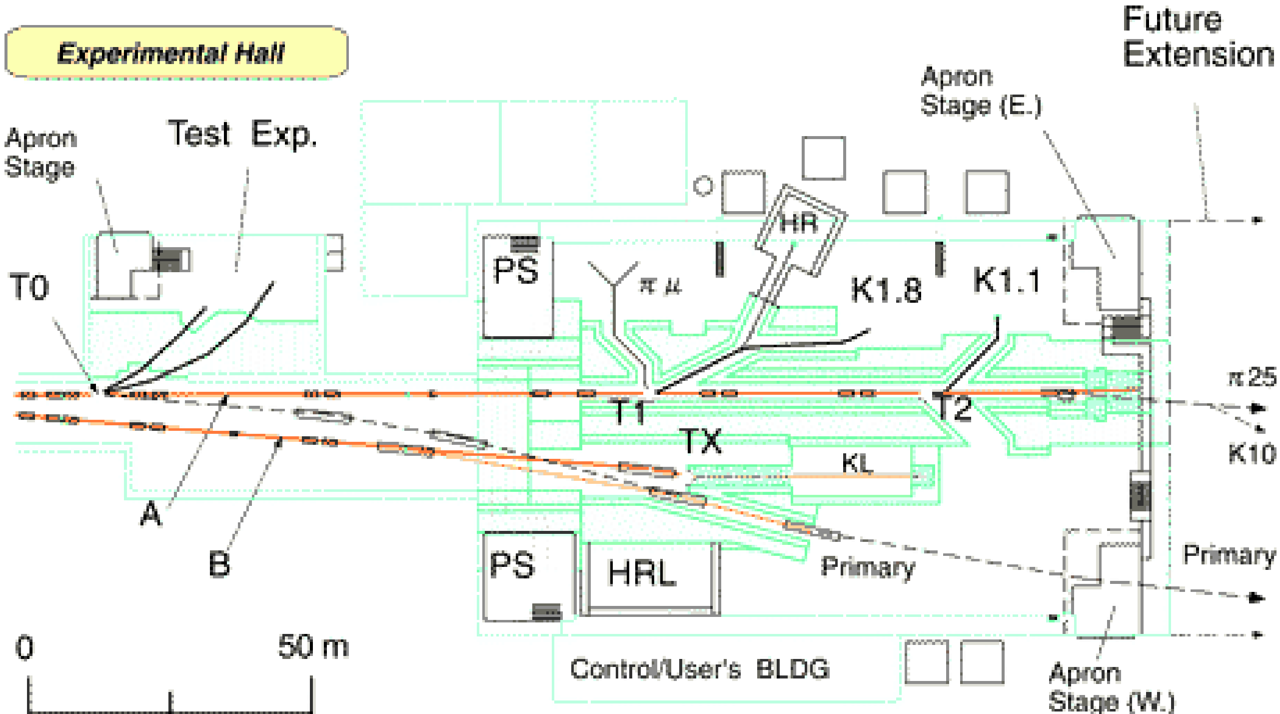
- Secondary Beam Lines & Physics
  – Prof. Noumi
- Target & Beam Dump
  – Dr. Sato

Site View of the Project



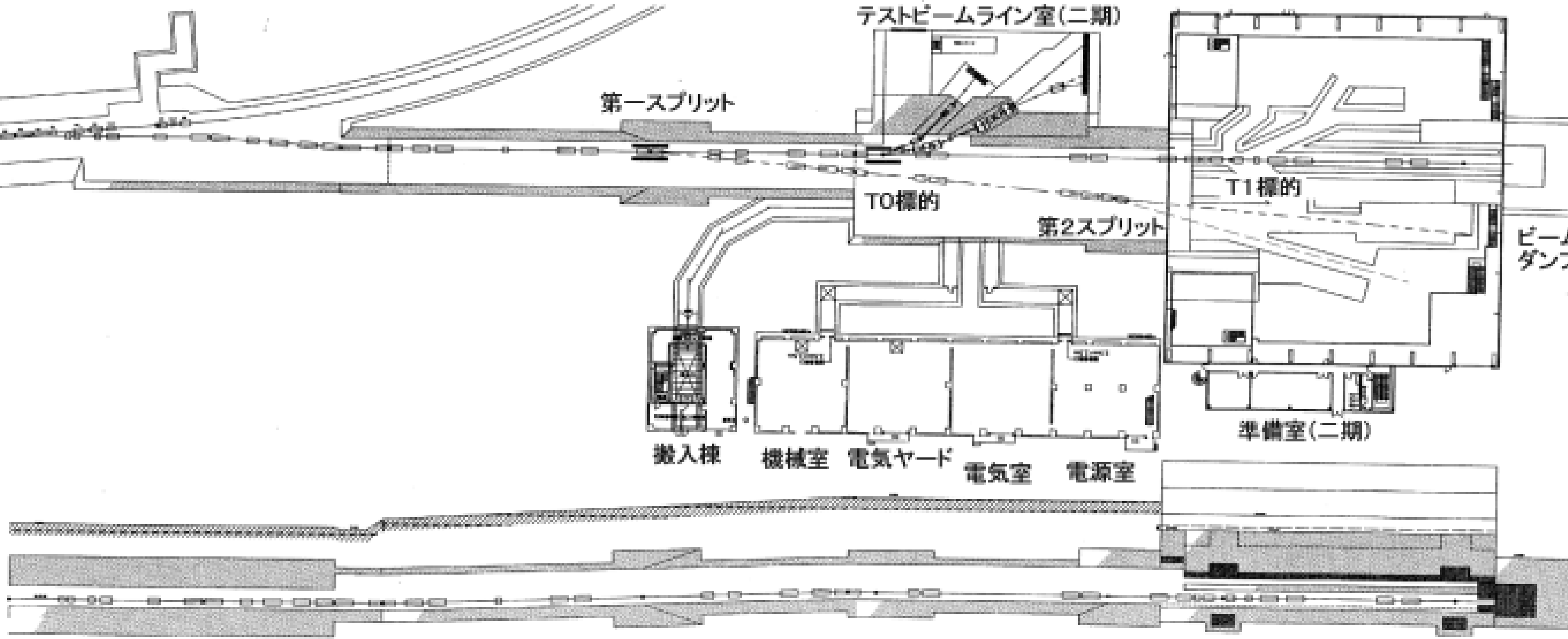
Tokai Campus of JAERI

K-HALL is the Facility for:



- High Intensity 50GeV･15μA Beam
- Many & Various Experiments
  - 3 Primary Proton Beam Line (A,B,C).
  - 3 Target Stations (T0,T1,T2) in the Line A.
    - T0: Test Beam Lines, Thin (0.5%) Target.
    - T1 & T2: Main Secondary Beam Lines, Thick (30%) Targets.
  - B-Line: For Neutral Kaons and/or Other Special Secondary Line.
    - TX: Target Station for the Immediate Beam Dumping
  - C-Line: For Primary Protons and/or High Momentum meams.
- Future Extension for the Beam Direction

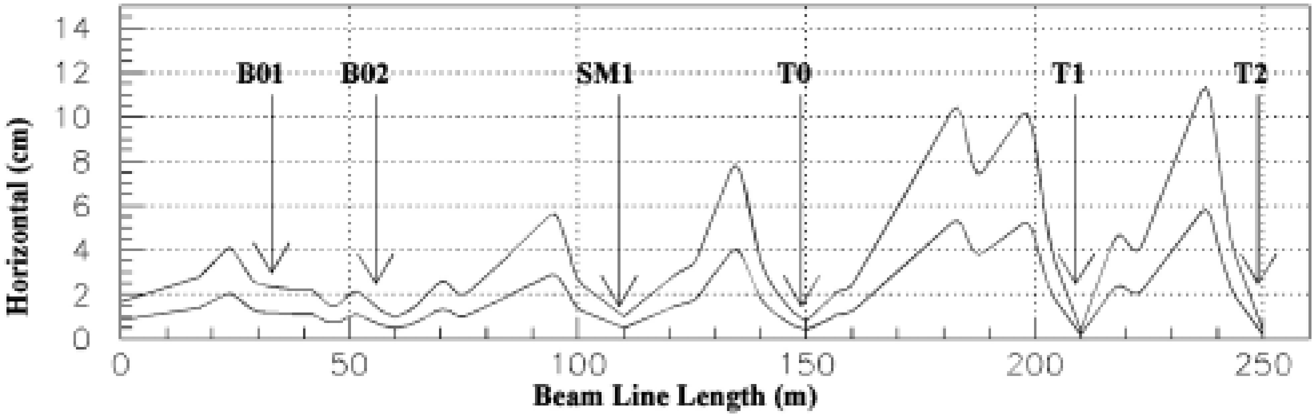
Switchyard and K-Hall (1st Stage)

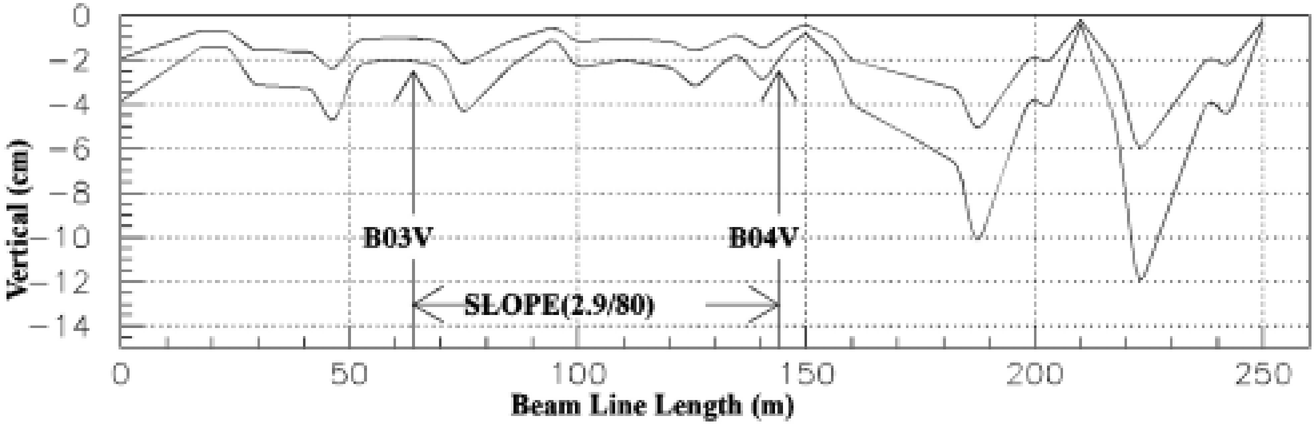


- One Target station, One Secondary Line.
- 30GeV Operation.
- No Research/Preparation Building.
- Easy Extension to the Beam Direction.

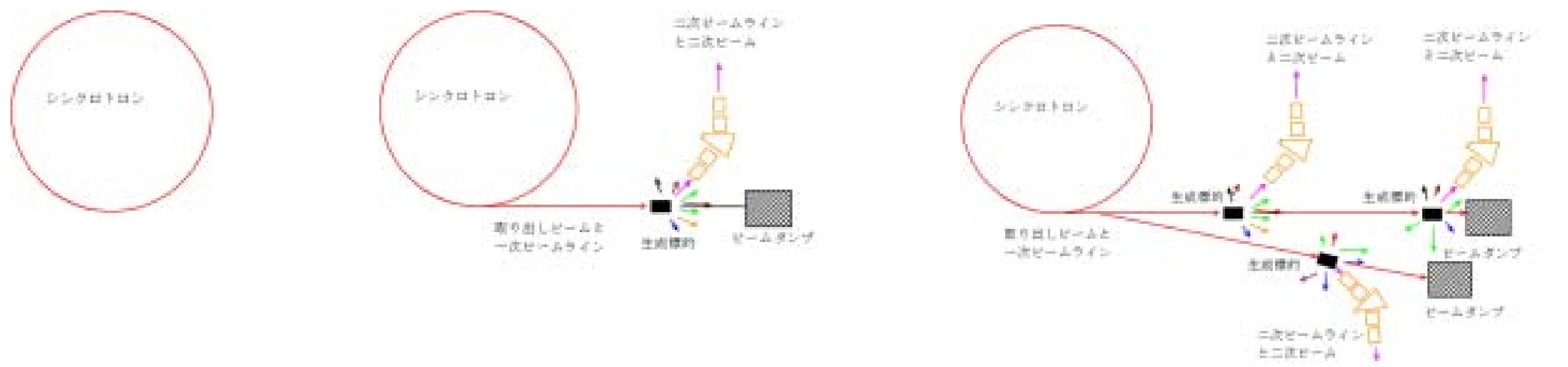
Beam Optics (Slow Extraction)

Outer Line： $\varepsilon = 24\pi$ mm・mr
Inner Line： $\varepsilon = 6\pi$ mm・mr





K-HALL（1st Stage)



- Future Extension
  - Second, Third Targets can be placed
- Multi Purpose
  - Neutrals, Primary Beams, High Momentum Beams,
- Stable operation
  - Tight Radiation Shield.
  - Radiation Resistant Beam Line Elements.
  - Facility Design Oriented for the Maintenance.

Beam Profile of JHF-PS(&KEK-PS)

• Beam Energy：	50GeV (12GeV)
• Beam Repetition:	3.4s (2.2～4s)
• External Beam Width：	0.7s (0.2 ～2s)
• Beam Intensity:	3.3×10^{14}ppp
	(6×10^{12}ppp: Fast)
	(3×10^{12}ppp: Slow)
• Beam Power:	750kW(6kW,3kW)

Beam Profile of JHF-PS(1st Stage)

- Beam Energy： 30GeV
- Beam Repetition: 3.4s
- External Beam Width： 0.7s
- Beam Intensity: $>2x10^{14}$ppp
- Beam Power: >270kW

Technical Issue

Problem is:

- JHF (50GeV) PS: More than 100 times Higher Beam Power than KEK (12GeV) PS.
  - More than 100 times Higher Radiation Dose.
  - More than 100 times Larger Heat Deposit.

How to Handle MW-Class Beam.

For the Stable Operation

- Tight/Enormous Radiation Shield.
- Radiation/Heat Resistant Beam Line Elements.
- Facility Design Oriented for the Maintenance.

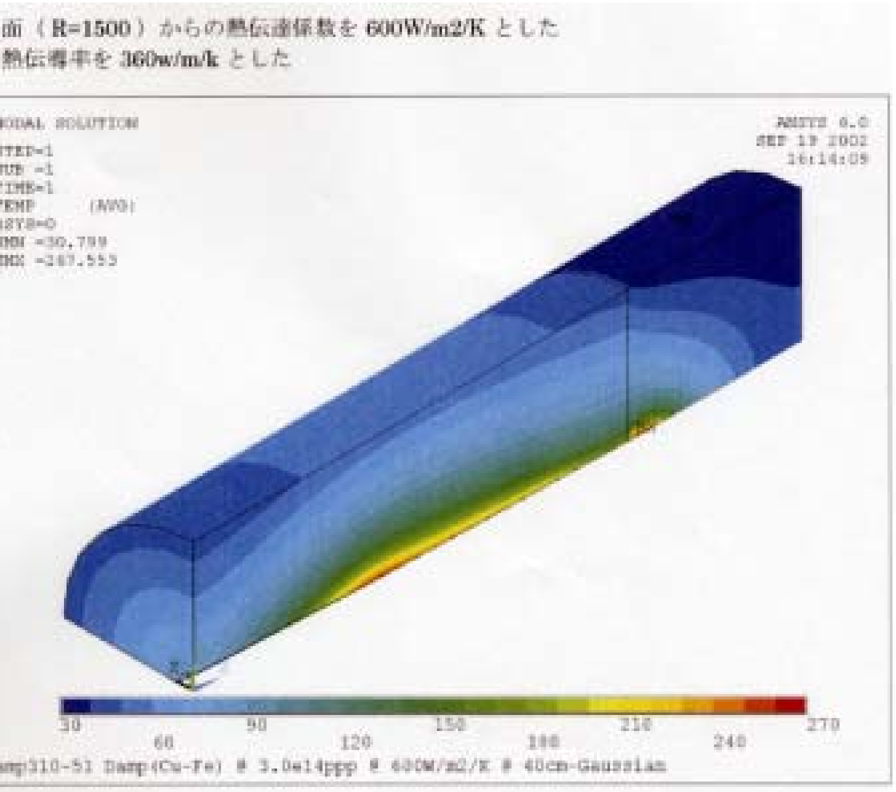
Radiation/Heat Resistant Beam line Elements

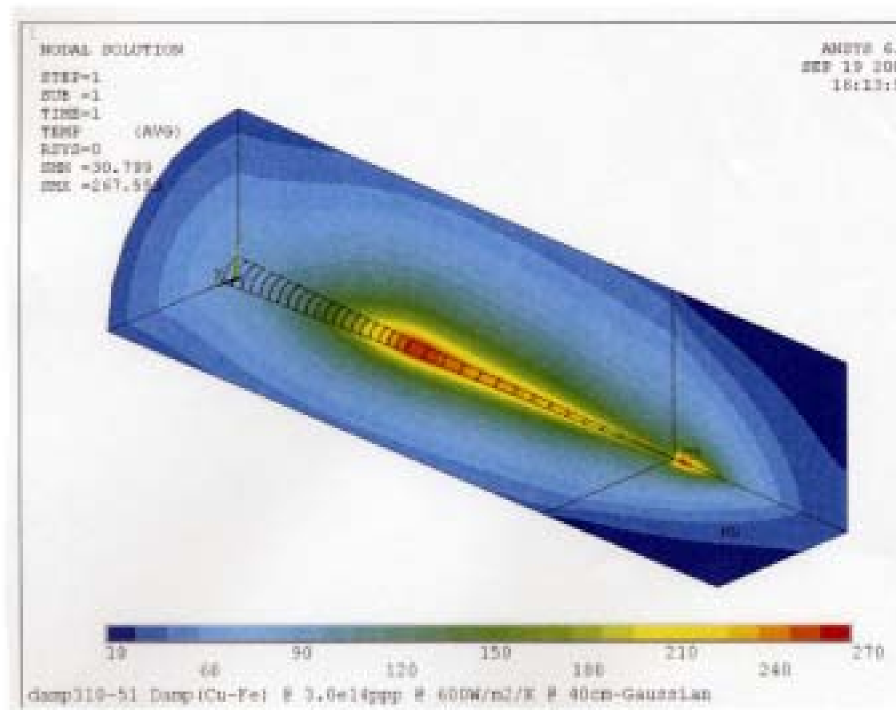
- High Radiation Resistance
- High Heat Resistance

Natural Solution: Remove Organic Materials from the Beam Line.

Rubber, Plastic, Oil, Paint, and Semiconductors, etc. etc.

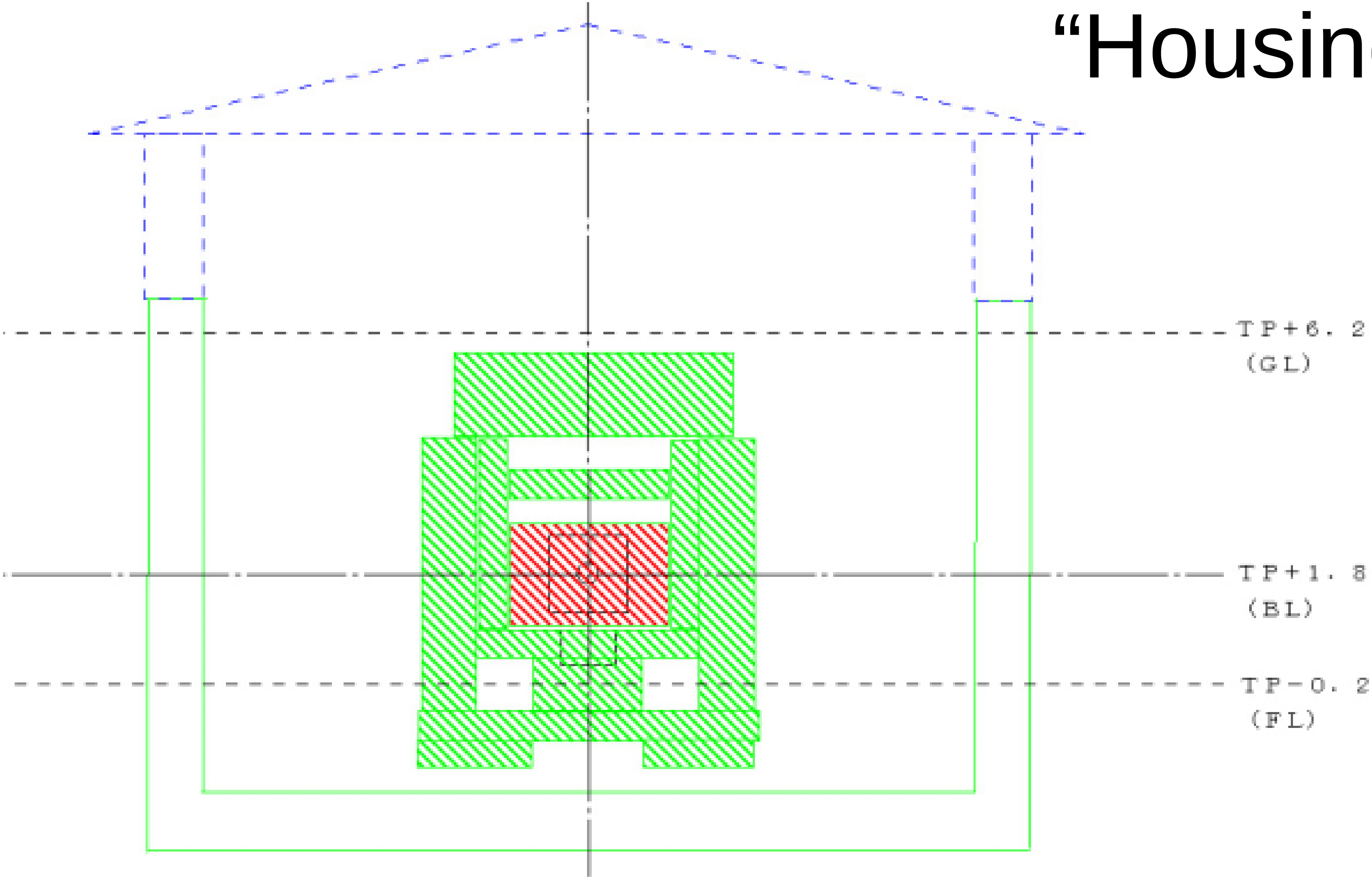
Heat Up of Beam Dump by 750kW Beam





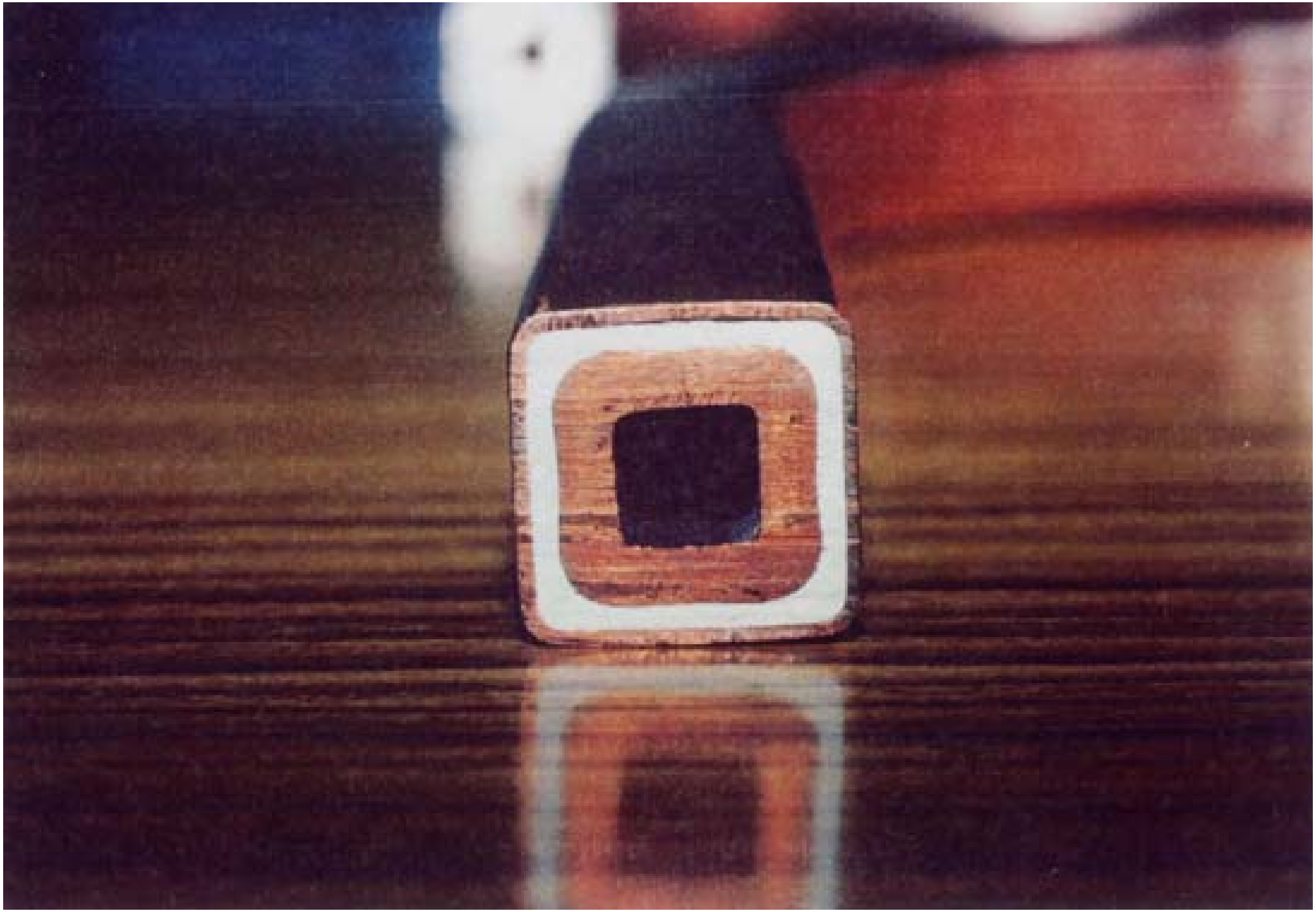
- Without Water Cooling: Copper melts
- With Water Cooling: Copper Temp. go down to 300 ℃

Beam Dump "Housing"



We have to prepare such a tremendous beam dump with water cooling!

2500A Class Mineral Insulation Cable



MI Cable: Completely Inorganic High Power Cable!

Magnet coil winding by 60m-2500A HC-MIC

High-Pot. leak test

Coil winding!

The first coil of 60m-2500A HC-MIC

Magnet with 60m 2500A HC-MIC Coils

Nominal: 3000A/34V

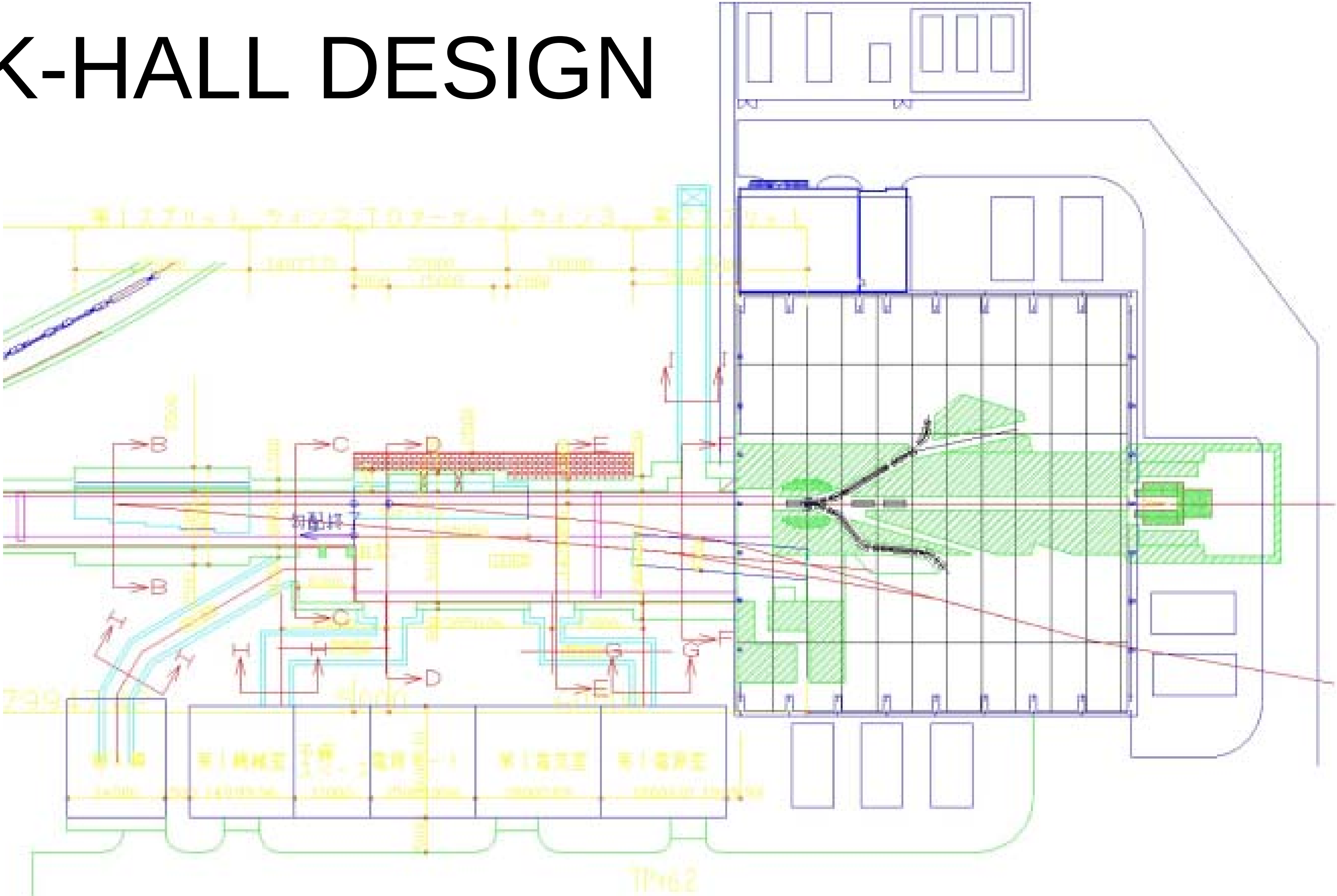
Δ Twater=37**°C**(35Lit./m)

Δ Twater=60**°C**(35Lit./m) Tcoil=74**°C**(Tair=18**°C**)
@3600A/41V(Max)

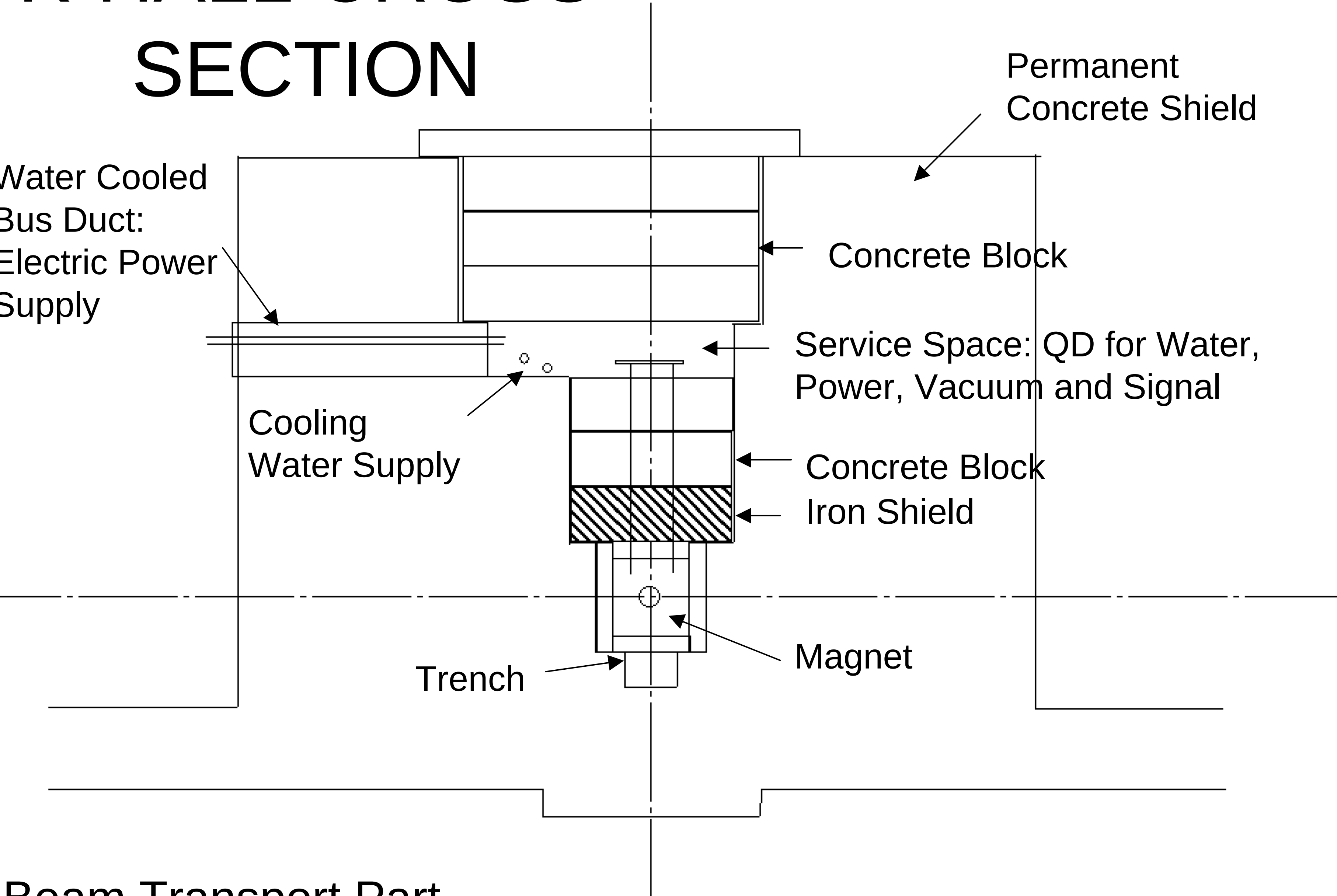
Facility Design Oriented for the Maintenance (Maintenance Scenario)

- Remote Maintenance
  - Service Space for Water & Electric power
- Easy Replacement
  - Quick Disconnect from the Service Space

K-HALL DESIGN

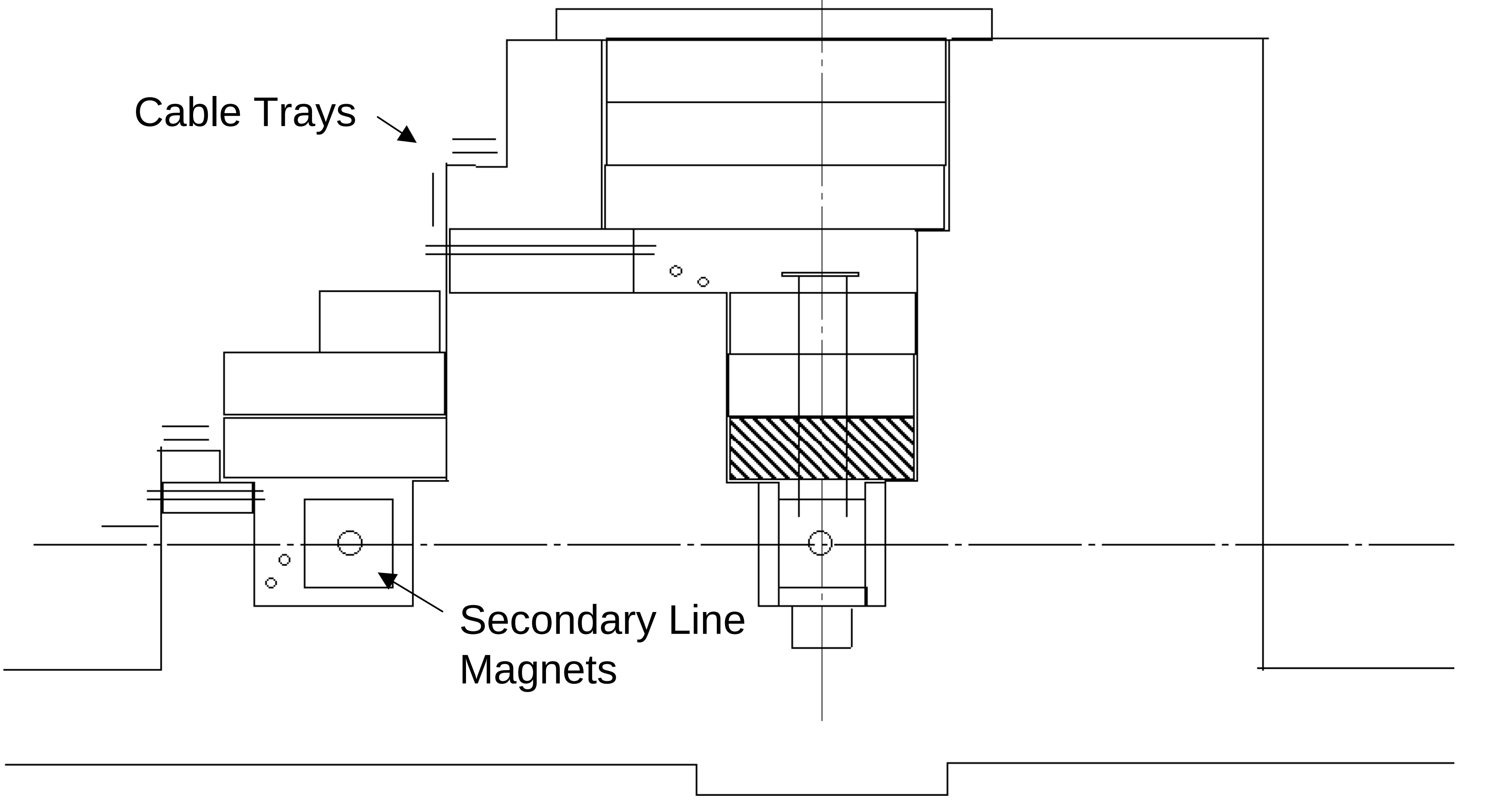


K-HALL CROSS SECTION



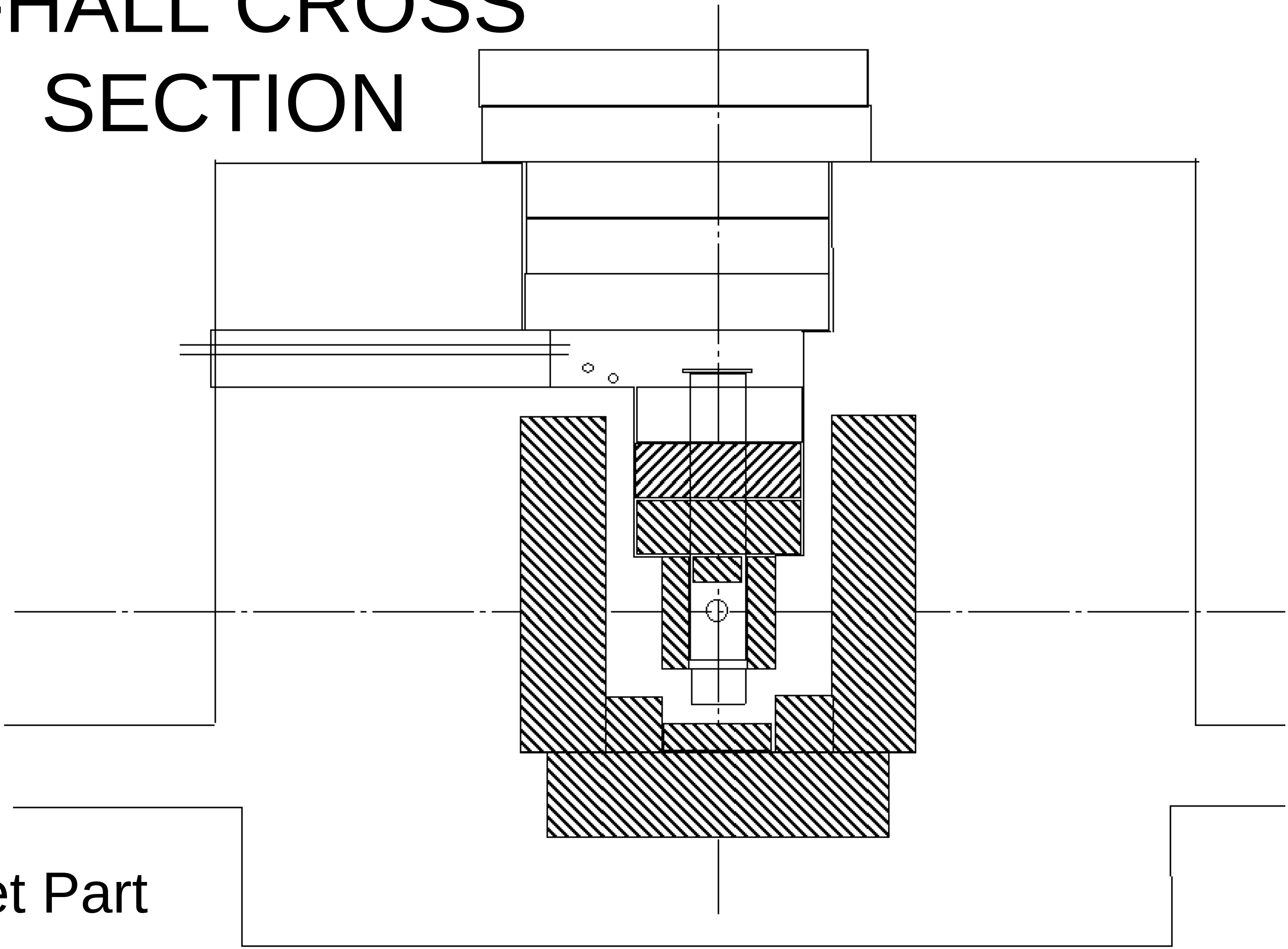
Beam Transport Part

K-HALL CROSS SECTION



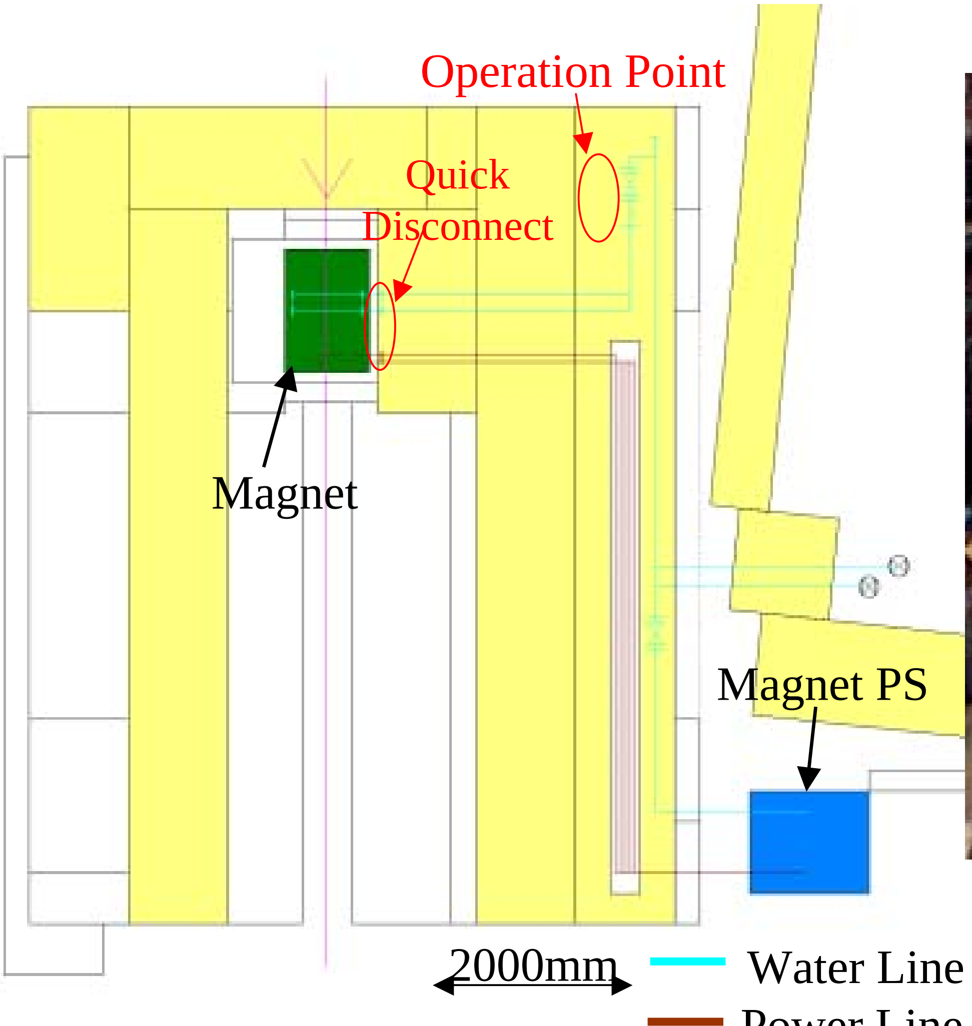
Actual Design: Beam Target Part with Secondary Line.

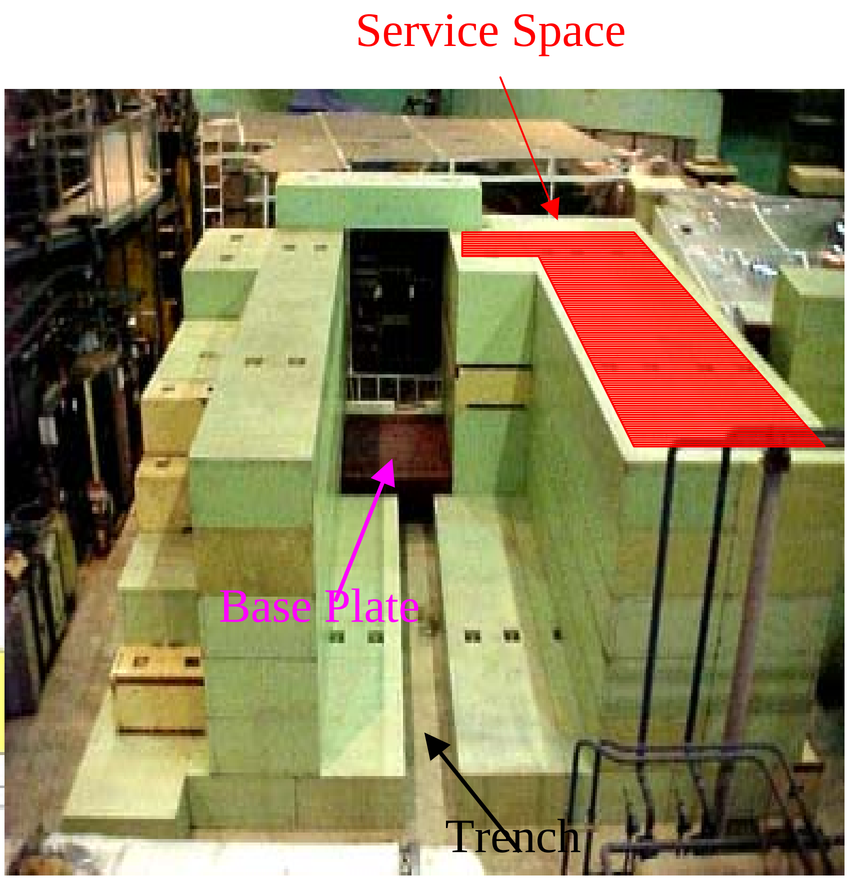
K-HALL CROSS SECTION



Target Part

Mockup for K-HALL

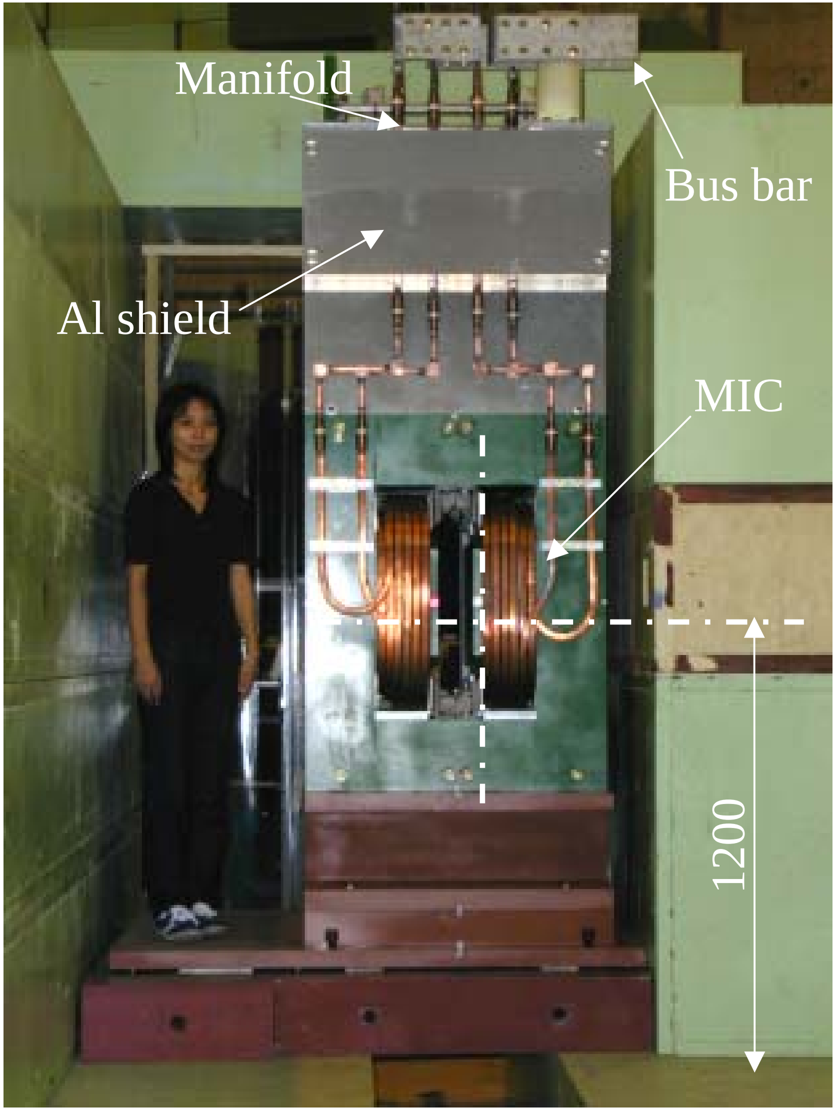




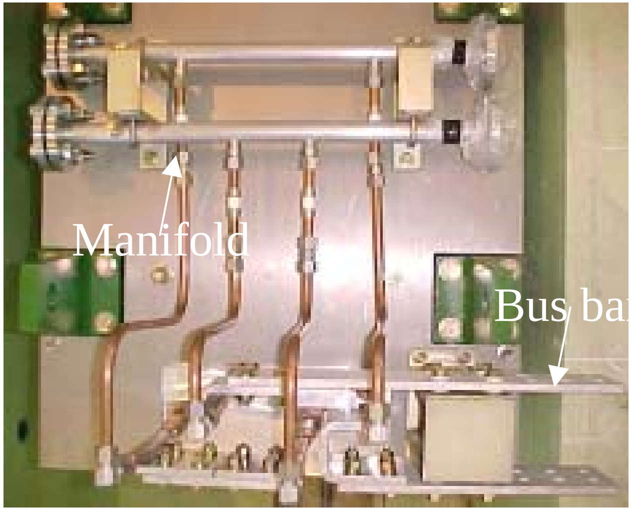
Mock up of the K-HALL 1

Status of September 26th, 2002

Mock up of the K-HALL 2



Front View



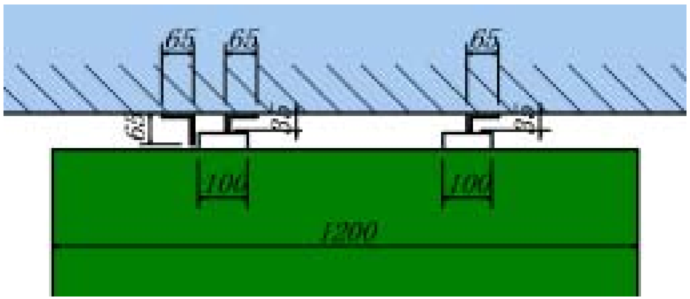
Top View

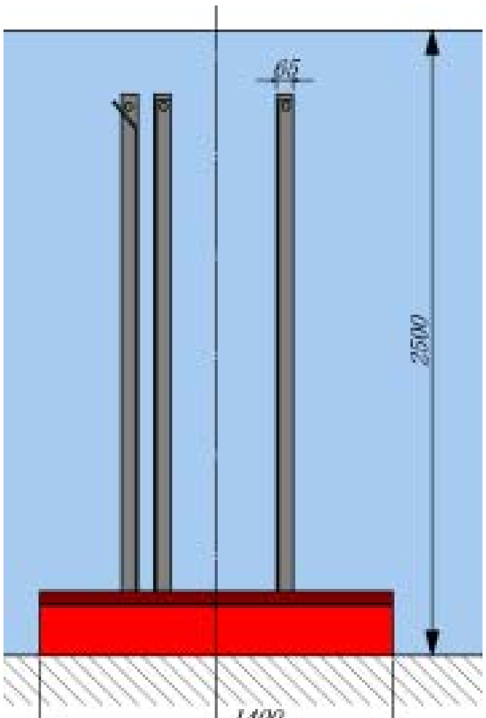
- Magnet: 8D216MIC
- Outer Size: 1060×850×800 mm^3
- Magnet Gap：400×100×800mm^3
- Nominal Current Voltage:

  3000 A, 33.1 V
- Weight: ～10 ton
- Beam Height: 1200 mm

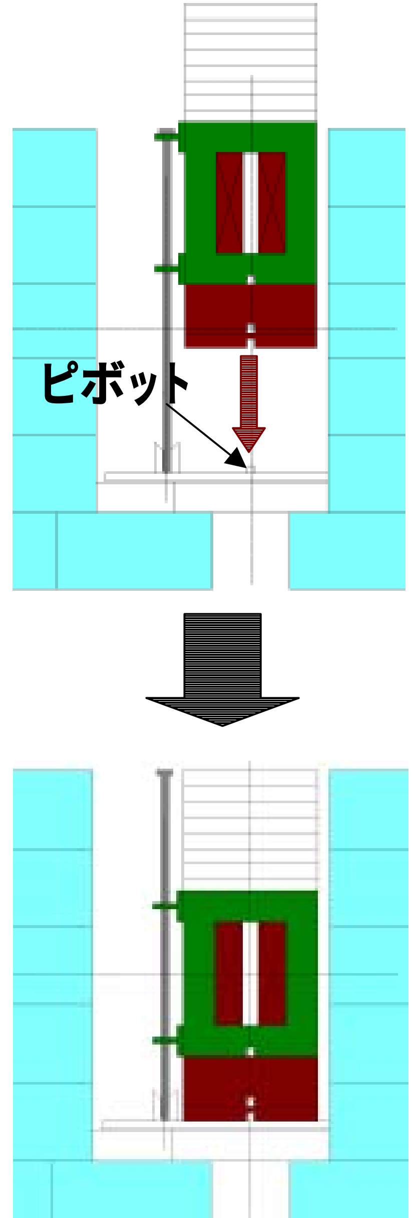
Alignment

Limiting Plate Type

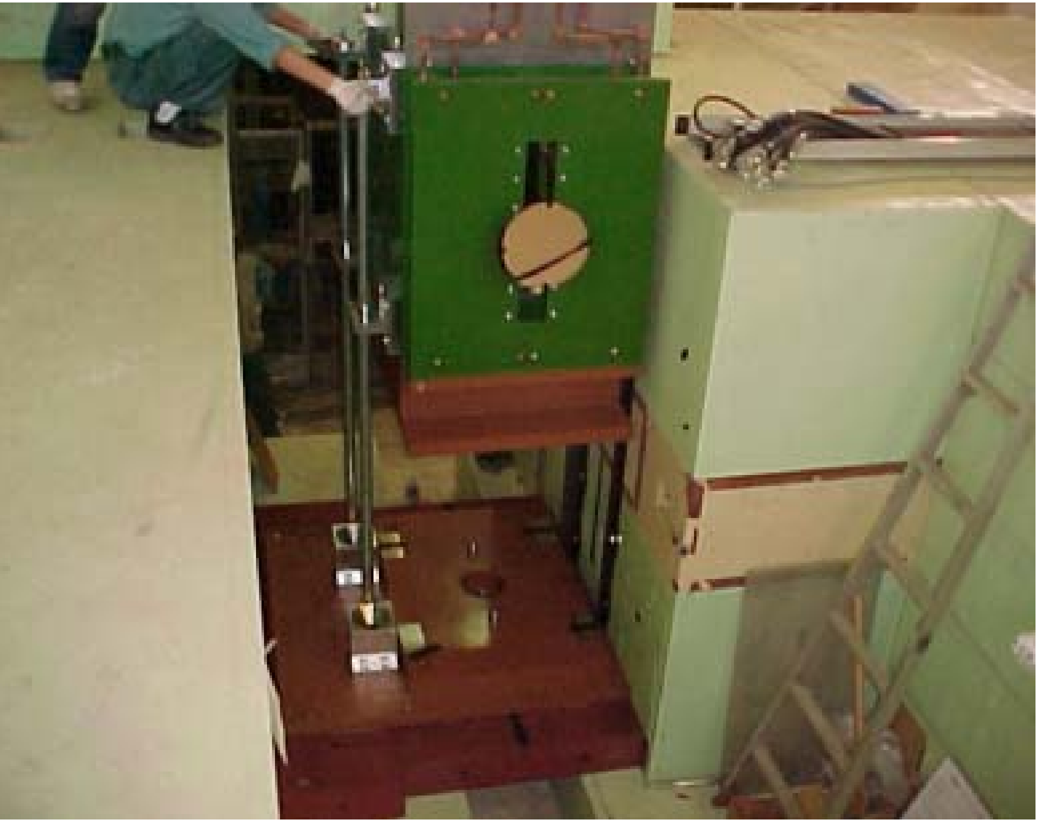




Pole Guide Type



Pole Guide Trial!



- K-Hall: PG + LP
- SY: LP

Limiting Plate Trial!

Limiting Plates

Pole Guide

Test results

- LP & PG: Within 10 min.
- PG:
  - We have to see the bottom of the beam line.
  - Pole can be bent by the magnet weight.
- LP:
  - Wall must be necessary

➢ Next Step

- Remote TV System.
- Automated Lifting Tool for Magnet.

Quick Disconnect Devices

Power, signal: Ready

Vacuum: Radial Seal and/or Pillow Seal

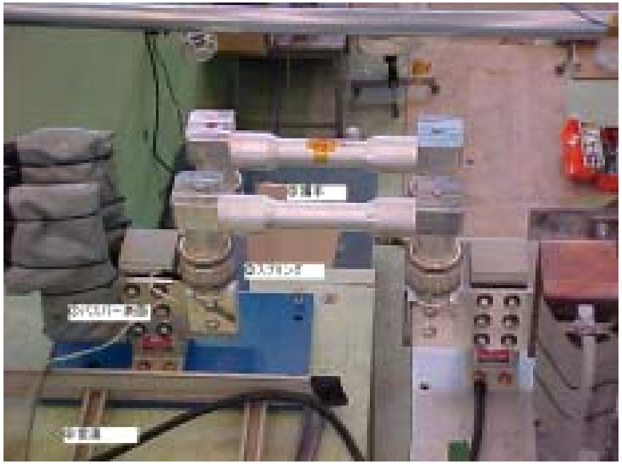
Water: Coupler Type or Swage-Lock Type or Holding-Arm Type

Alignment: Pole Type and/or Limiting Plate Type

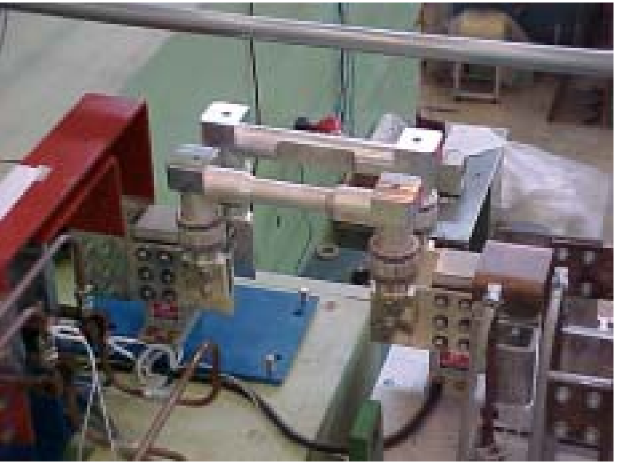
Electric Power

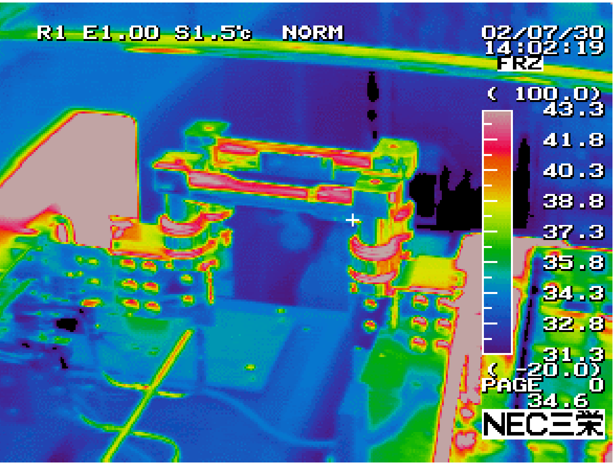
- Max Cur. 3000A
- Max Volt. 200V
- Limited Space
- 30sec for Disconnection
- Good Results
  - Knife Type
  - Plate Type
  - Plug Type

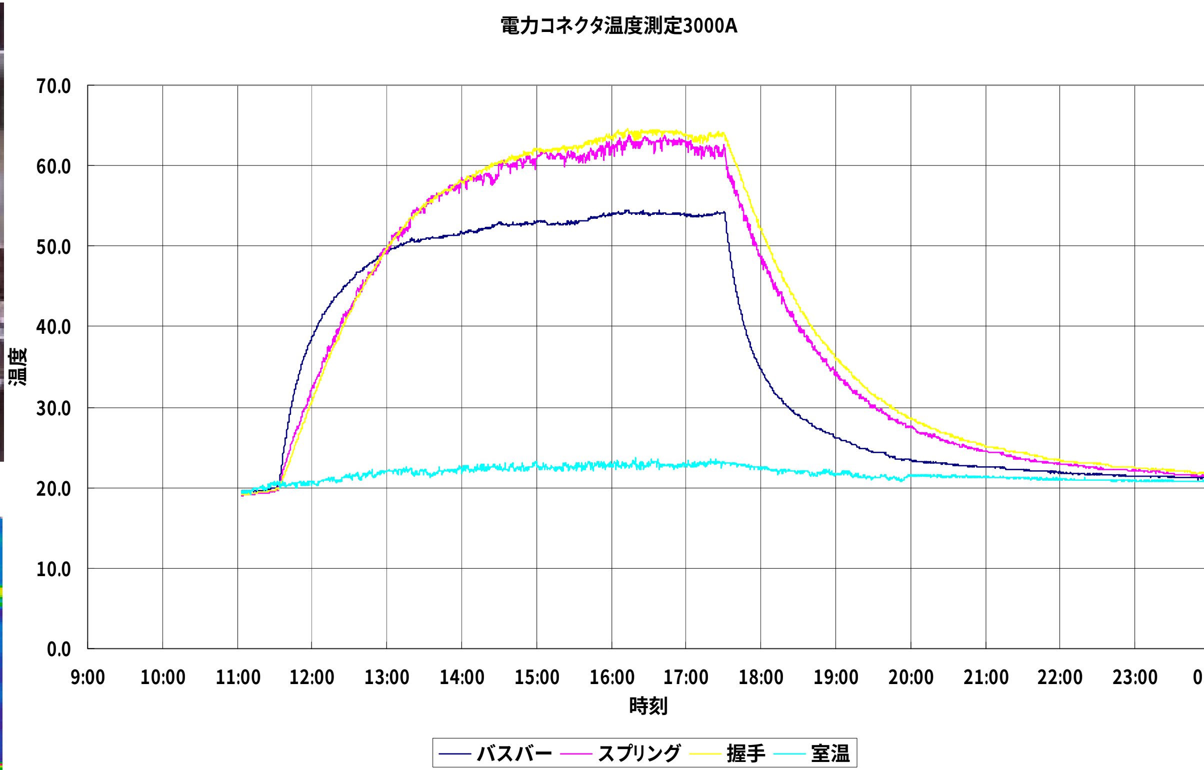
Plug-Type Bridge Connector



Full Power Test







➢Next Step

1600A-class connector for small magnet

Cooling Water Connector

- Regular Pressure: 20 atm.
- Regular Temp. 15-80 ℃
- Pure Water
- Size: 2-inches Inner Dia.
- Mineral Seal
- 30s-1min. Disconnect on Hand
- Water Leak: 100ml or less.
- Good Result
  - Holding-Arm Type
- Under Development
  - Coupler Type
  - Swage-Lock Type

Coupler-Type Connector

+ Full Metal Ball Valve for Steam.
KITS, Hisaka, etc.

Vacuum Connector

Inner Dia. 20-30cm

Mineral Seal

Vacuum better than 10^{-6} Torr.

Remote Operation Time: 10-30min.

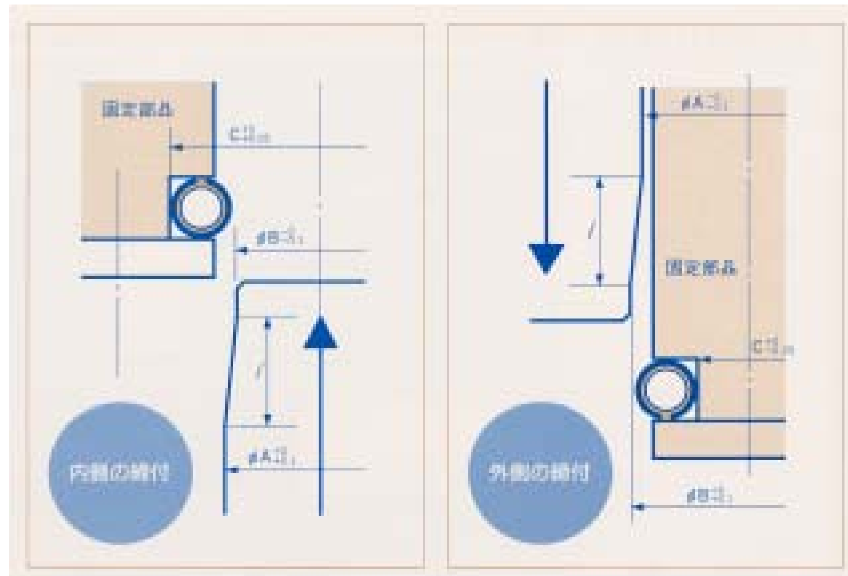
Good Results (EP1-K6)

- Pillow Seal
- Mechanical Holding Type

Under Development

- Radial Seal

Radial Seal Conceptual View



Interlock Signals

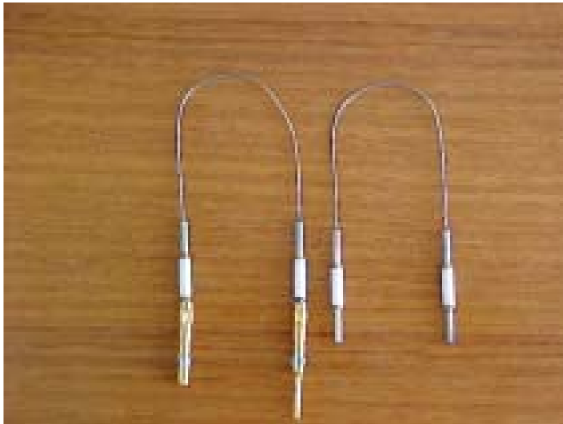
- Full Mineral Thermal Switch
- Water Pressure Switch
- Signal Cables
  - Ceramic Beads Cable
  - Thin MI Cable
- Signal Connectors
  - Full Ceramic FCI Connector
  - Spring Pin Contact Connector

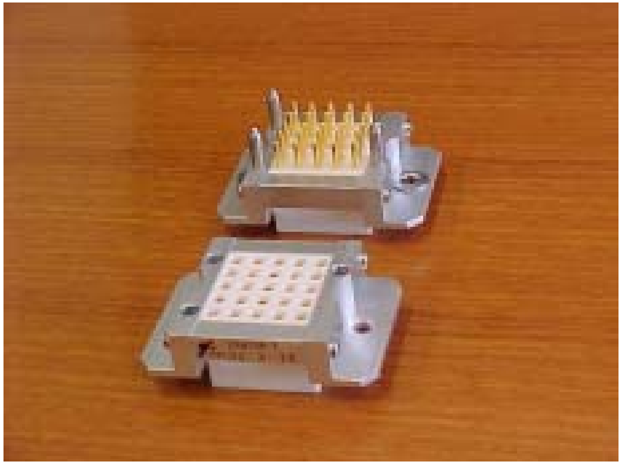
Thermal Switch

Cables

Ceramic Beads

Thin MIC





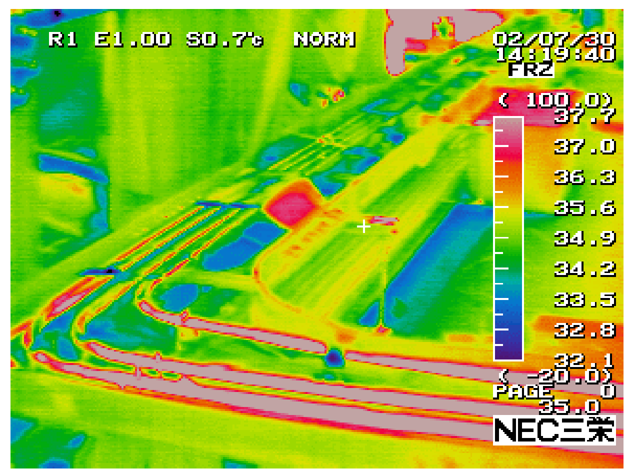
Full Ceramic FCI Connector

How to Introduce Electric Power into the Shield without Ohmic Loss?

- Problem
  - Radiation damage of the Cable insulation
  - Tight Radiation Shielding
  - Ohmic Loss of the Electric Power

➢ MIC Power Line

➢ Water Cooled Shield Penetrating Bus Duct



Voltage Drop @ 2000A

- 4 MICs
  - – 0.486V, about 7m
- 10 MFLC Cables
  - – 0.298V, about 10m

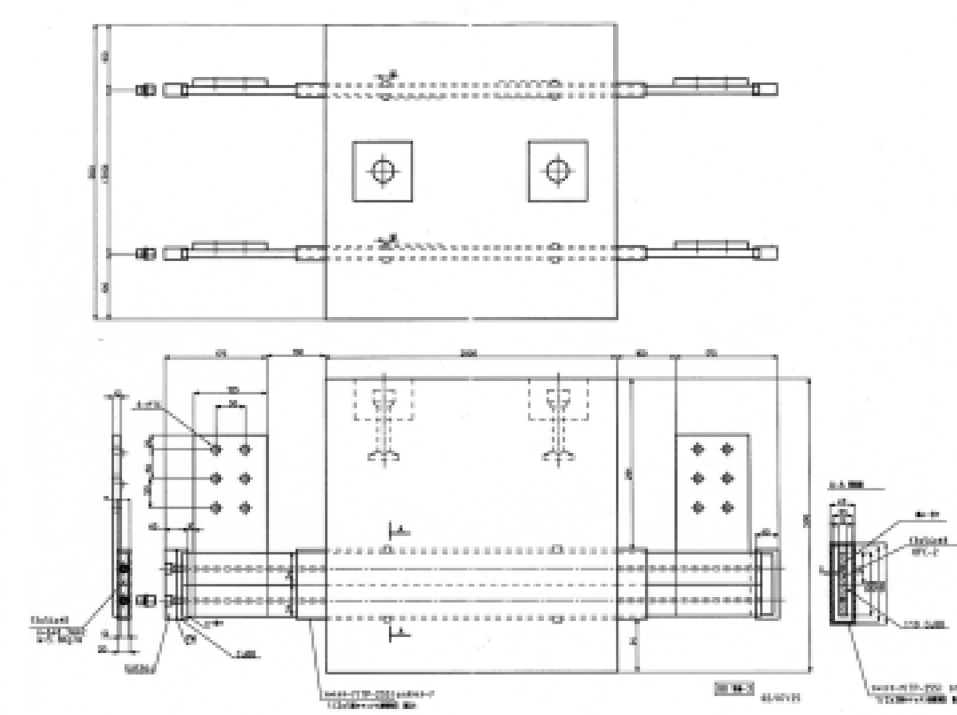
Twice Larger Voltage Drop

- Almost No Temp. Rise
- Hard Wiring Work

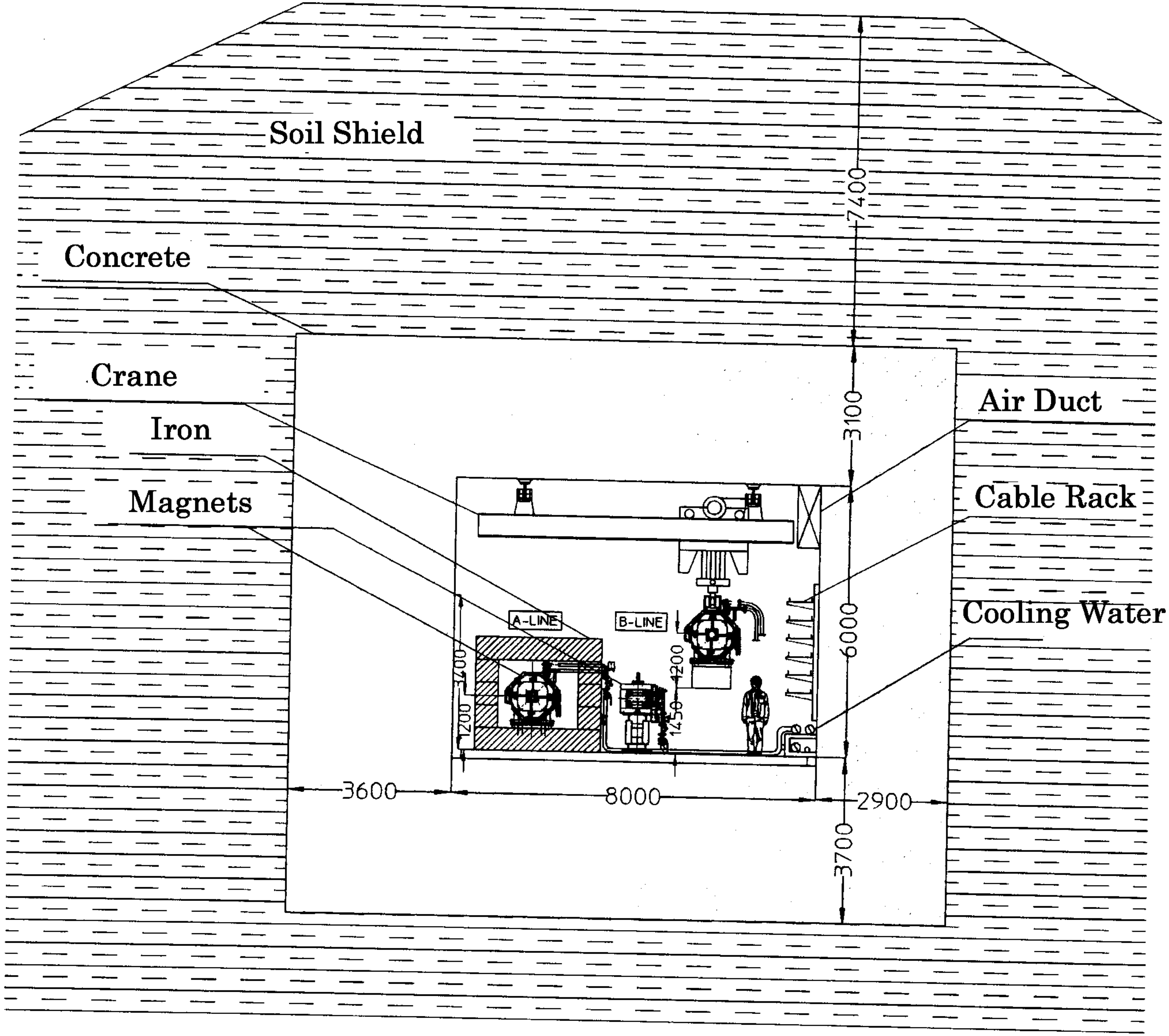
➢ Next Step

- Water Cooled Shield Penetrating Bus Duct

Water Cooled Shield Penetrating Bus Duct



Switch Yard

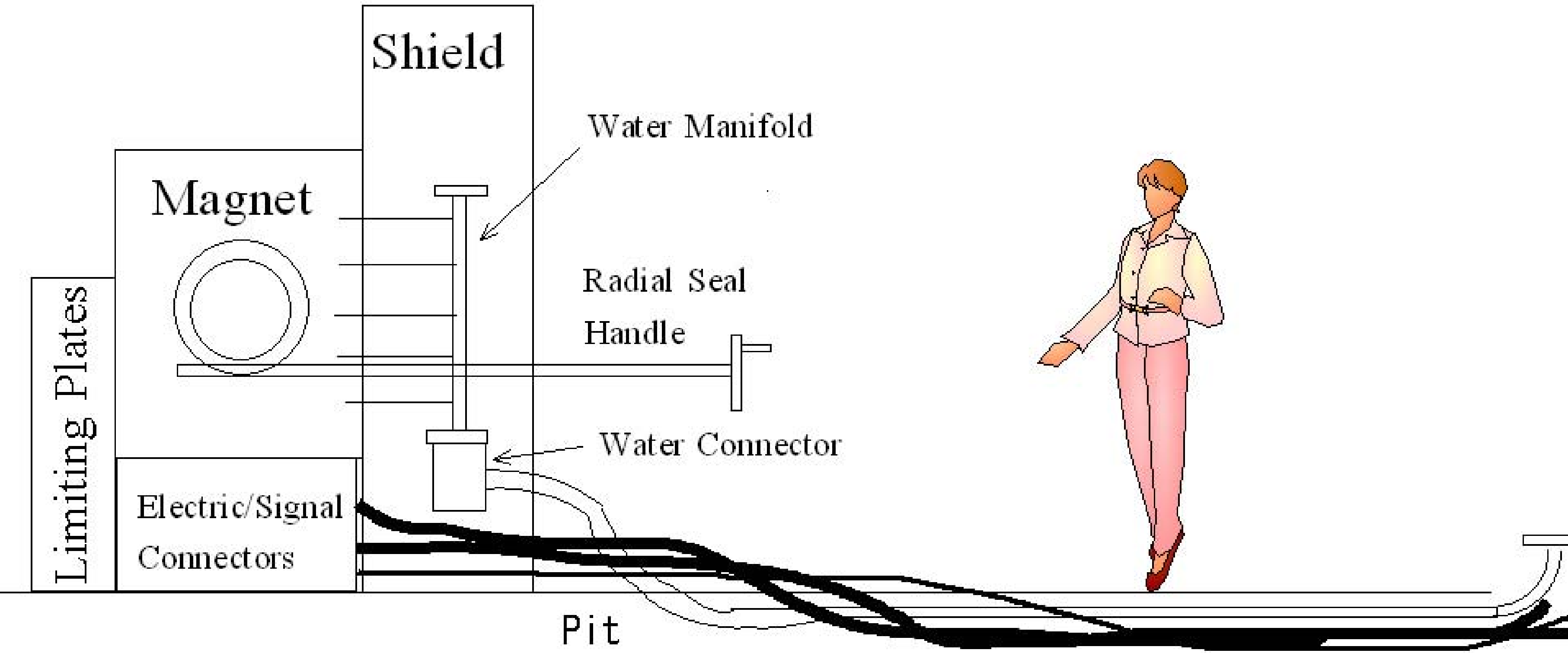


- Difficulty: The Roof is not Open.

Image of the SY

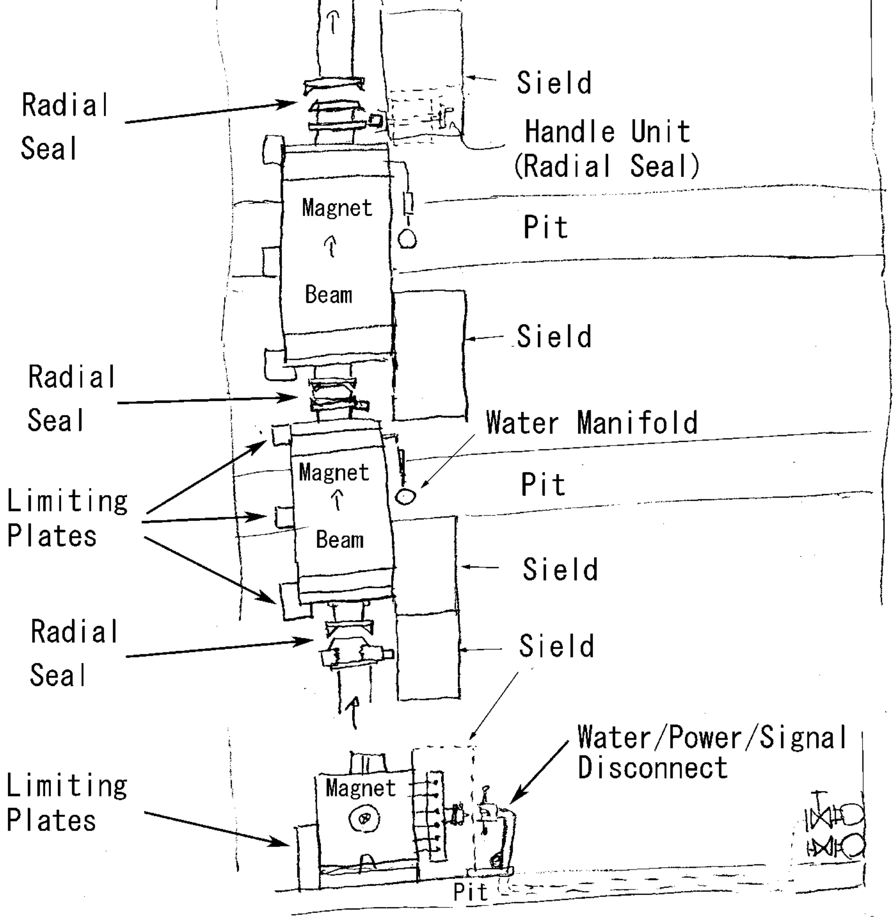
Slope Part of the Neutrino Beam line

Maintenance Scenario at SY



- Long Tools/Handles through the Shield Block.
- Quick Disconnect for Water, Vacuum and Electric Power
- Automatic Alignment by Limiting Plates

Switch Yard Top View



From Upstream;

Right: Manifold + Water Connector

Power & Signal Connector

Left: Limiting Plates

Upper: Crane Lifting Tool

Lower: Pivot Fixture

- Water, Electric Power: Quick Disconnect from the Back of the Shield.
- Vacuum: Radial Seal.
- Magnet Stand: Pivot Fixture
- Alignment: Limiting Plates.
- Automatic Crane Lifting Tool at the Top of the Magnet.

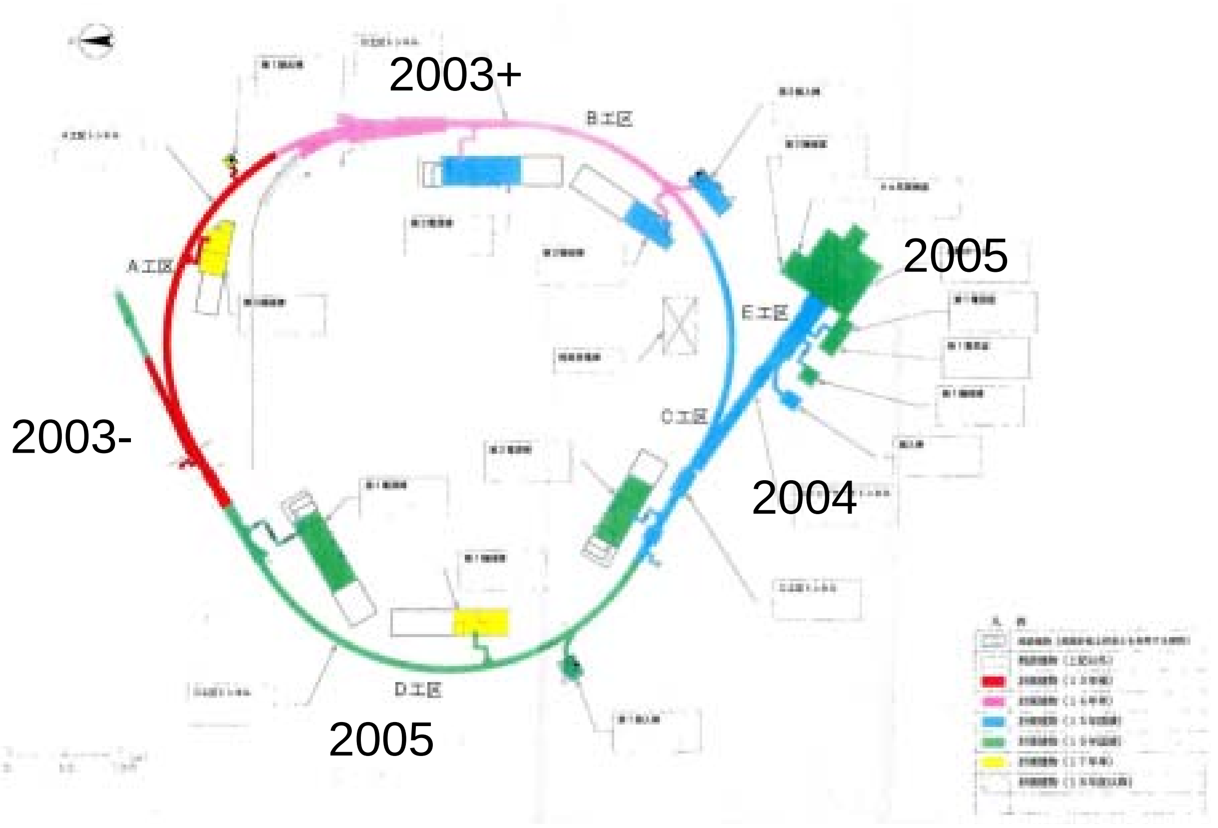
Slope Part of the Neutrino Beam line (Existing)

Image Model
of the SY

Status

- Radiation Resistant Parts/System.
  - Almost Ready.
- Heat Resistant Parts/System.
  - Final Stage.
- Remote Handling System/Maintenance Scenario.
  - Ready/Final Stage

Construction Schedule at Tokai



Magnet Installation in SY is Scheduled in 2004+

Magnet Installation in KH is scheduled in 2006-

Construction Budget

Civil Eng. + Building

- H14：(1億¥: Design) 2002
- H15：11億¥ 2003
- H16：13億¥ 2004
- H17：27億¥ 2005
- H18： 2006

Total：51億¥

Problem：

3億¥ for Neutrino Pre-Construction

Facility (Including Water)

- H14：
- H15：
- H16： 6億¥
- H17： 7億¥
- H18：10億¥

Total：23億¥

Problems：Water Pump 11億¥

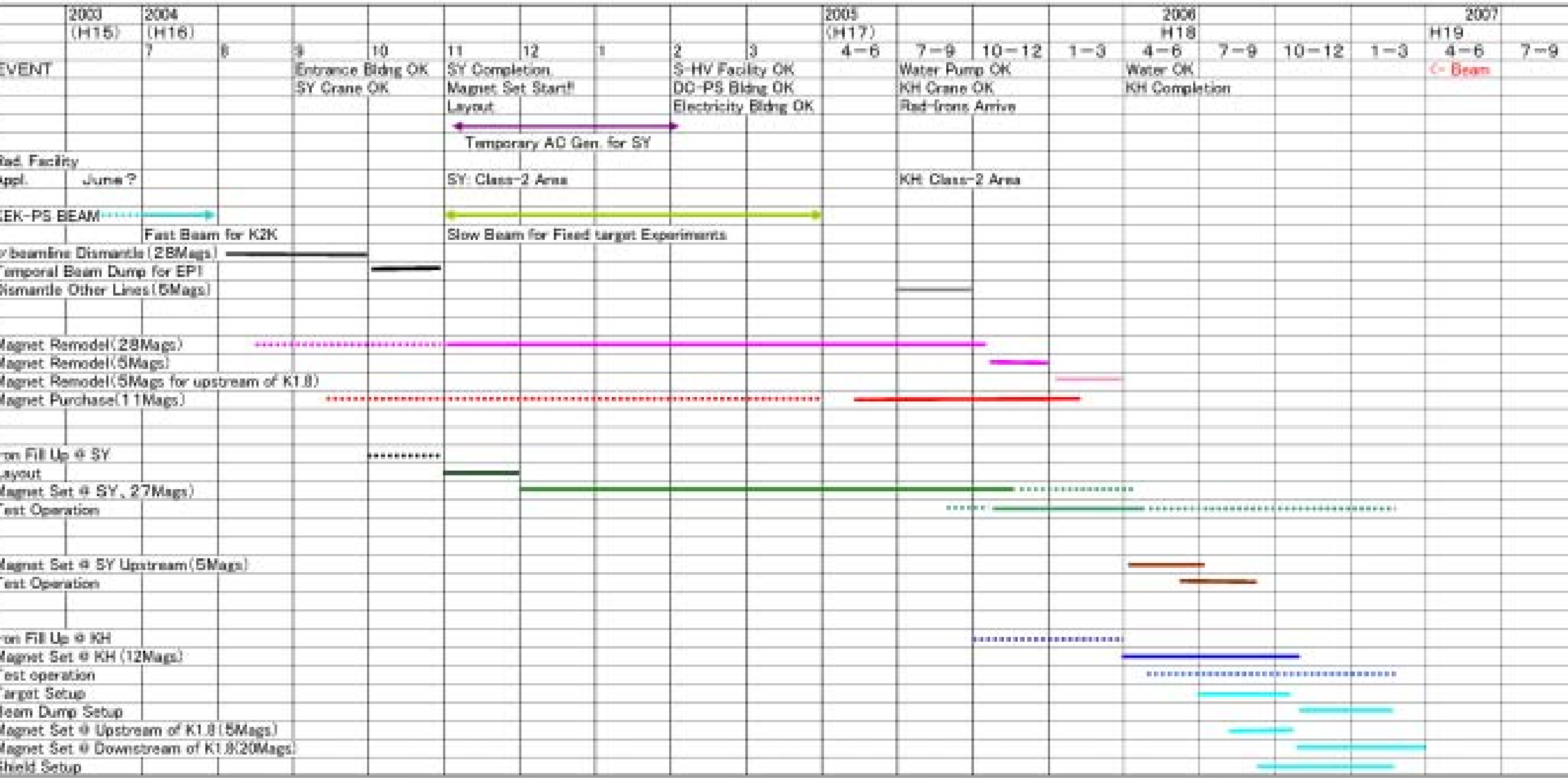
Radiation Shield 10億¥

1億¥ = 100M¥ = 1MEuro = 1M$

Very Much Limited Construction Budget

- Almost NO New Parts for Primary Beams
  - Recycle from the KEK-PS Resources
  - Second Handed Ones
  - Donation
- Zero (or very small) for Experimental Facility
  - BYO
  - HbY
  - Some Delay?

Magnet Transfer Schedule

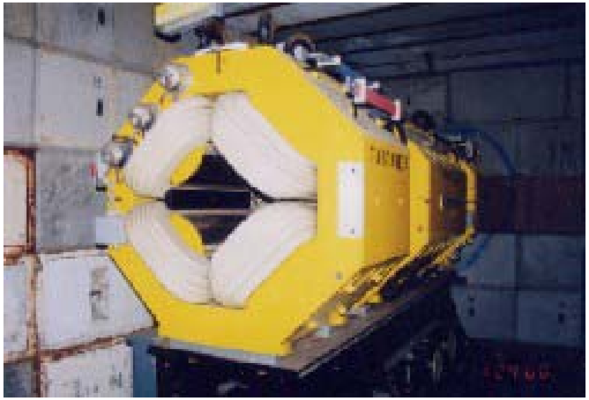


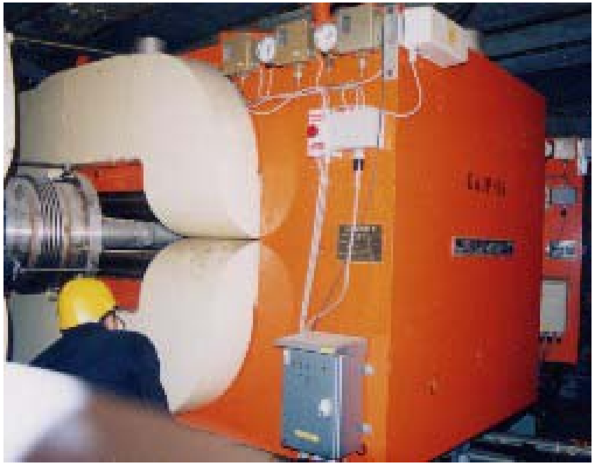
Problem：Can K2K be Finished in the summer 2004?

Magnet Collection Project

- The budget situation of the JHF is NOT very good.
- Let us construct the JHF as an international Facility/collaboration!
- Let us Collect USED magnets from all through the world!!!!
  - Magnets for secondary lines
    - Dipoles
      - Gap: 15-20cm
      - Width: 30-40 cm
      - Length: ～1 m
      - B: ～1 m
    - Quadrupoles
      - Bore: 20 – 30 cm
      - Length: ～1 m
      - B: ～1 Tesla at pole
    - Spectrometers
- Contribution from SLAC, CERN, CEA(Saturne), Tsukuba U, and LANL, BNL………

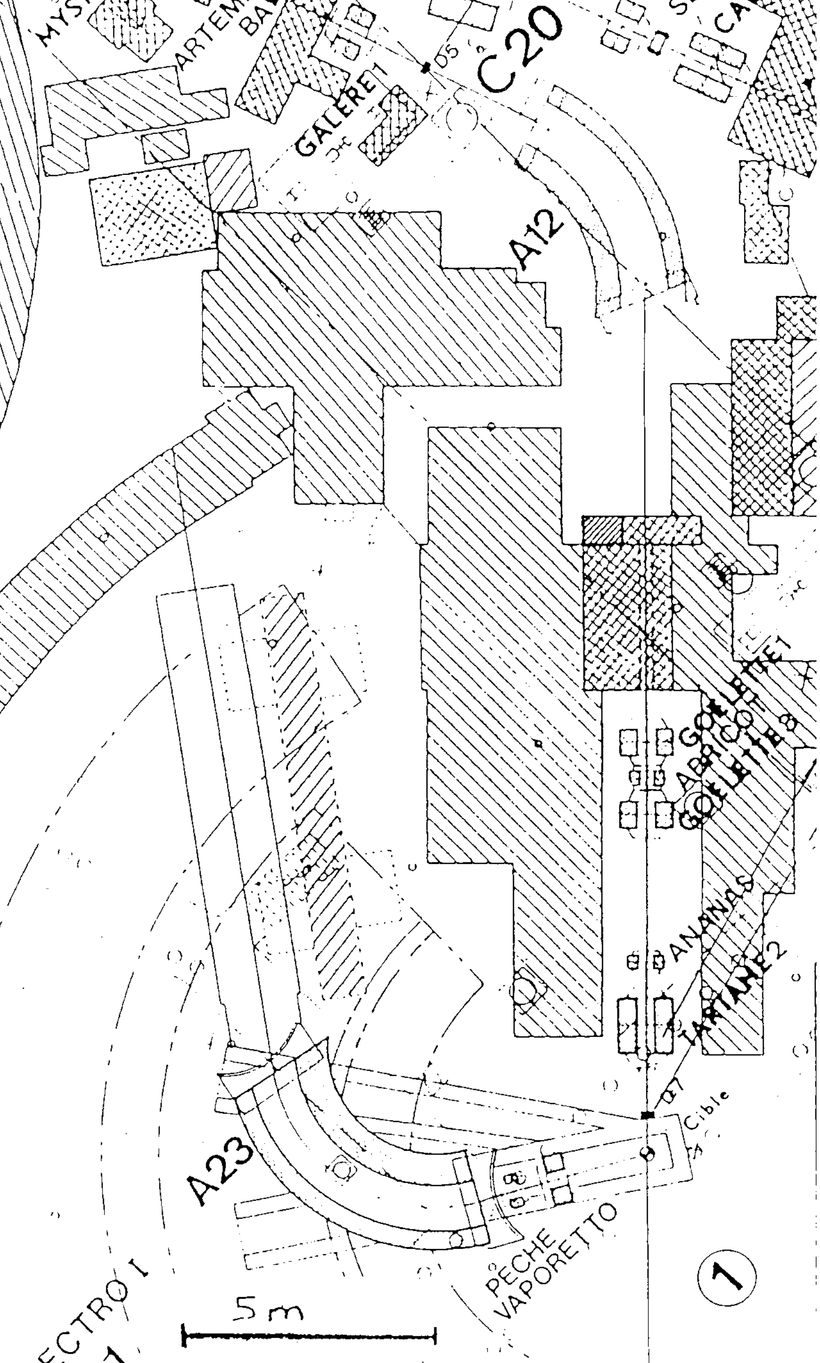
Magnet Collection Project from Saturne near Paris

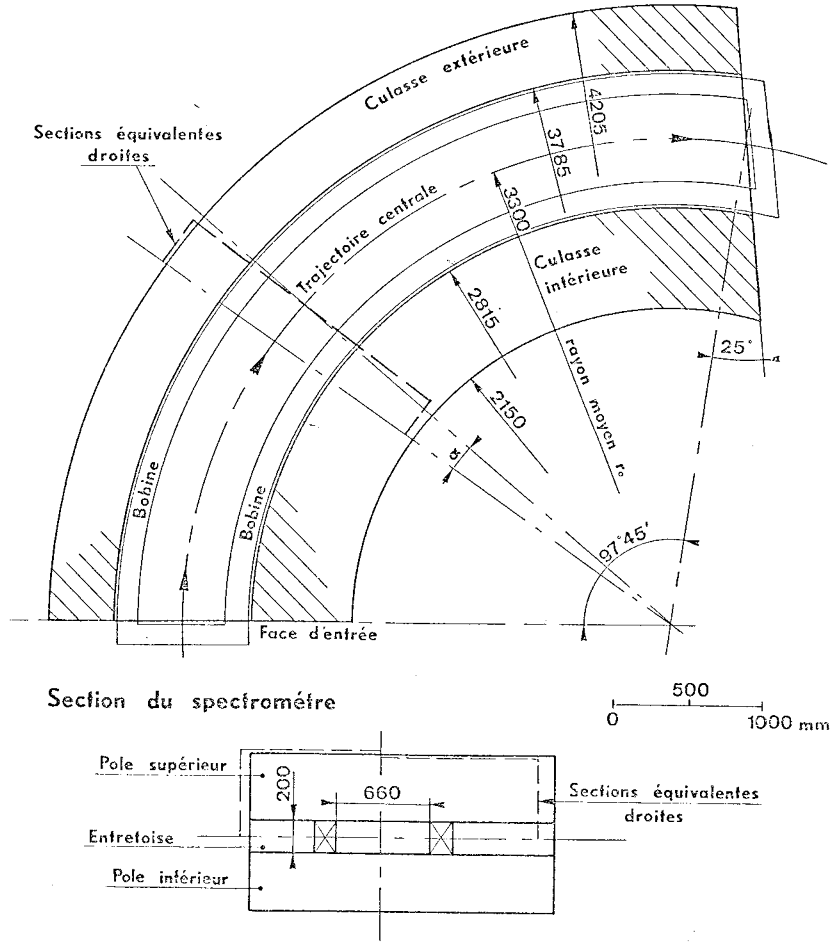




- 2 Spectrometer Systems (SPES-I,II)
- 40 Q-Mags, 30cmΦ0.8-1.6mL, 1T@pole
- 12 D-Mags, 15-20cm Gap, 1-2mL, 2T

SPES-I is coming to KEK





SPES-I(A23) Magnets

Magnet Collection project from CERN, SLAC, Tsukuba

Antiproton Accumulator Ring from CERN

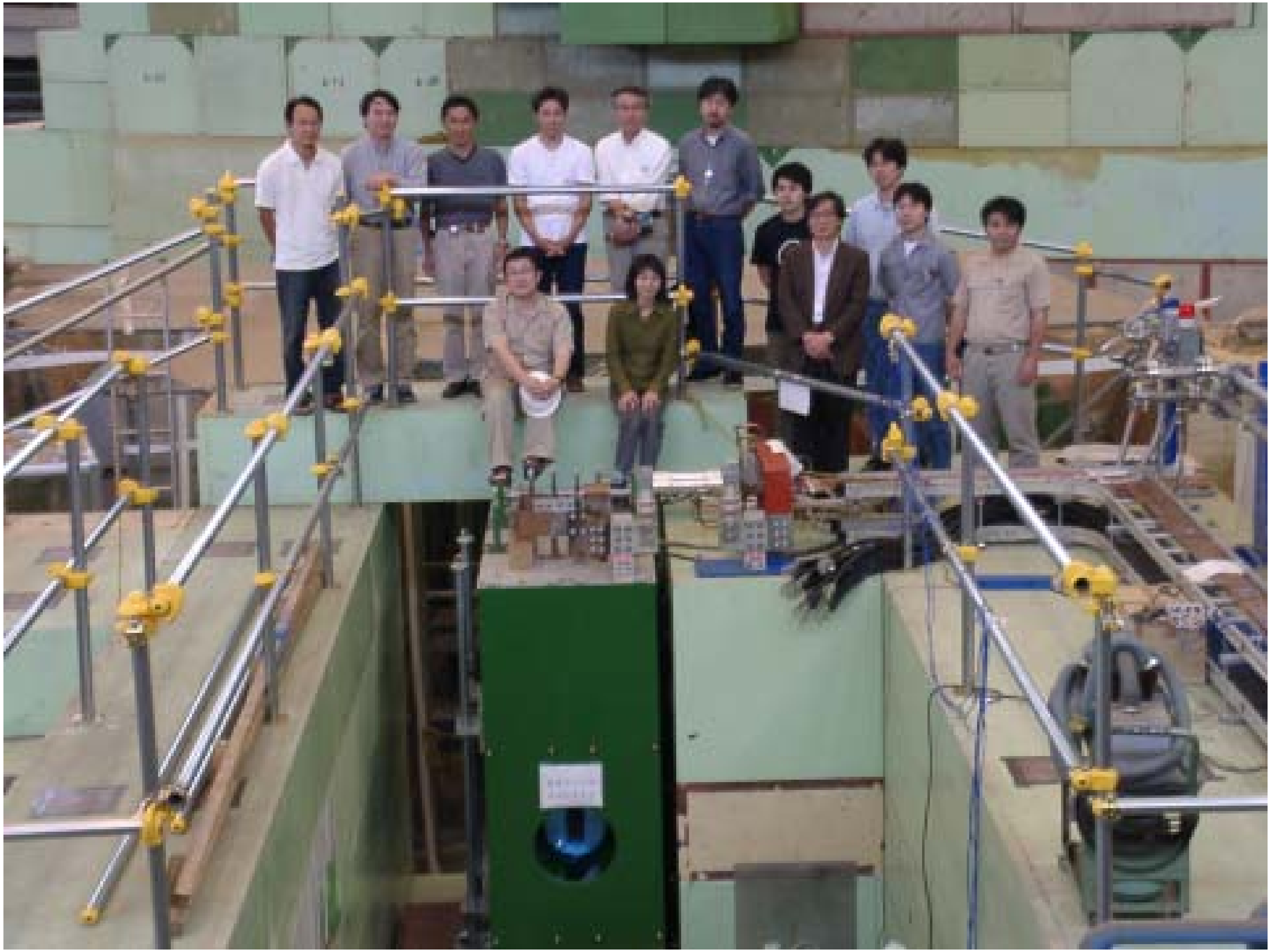
Fixed Target Facility Magnets from SLAC

Medical Facility Magnets from Tsukuba U.

Radioactive Iron from DURATEC

- 1$/10t
- 100$/1t including transport fee.
- 1/10 of Normal Iron
- Max. 2mR at Surface.
- Less than 2nCi/gr (74Bq/gr)
- Nuclear Wastes?
- Scheduling?
- Possible in Japan?

Design Construction of JHF K-Hall



Hadron Beam-Line Subgroup is Responsible