Fermilab

# SDC SOLENOID DESIGN NOTE #190

TITLE: Prototype Test Plan

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DATE: Dec. 9, 1992

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This design note is one of a series which represents the proceedings of the SDC solenoid subgroup meeting held in Japan on December 8-11, 1992. The plan and purpose of the meeting was to:

- Look at the prototype coil winding and honeycomb vessel R&D in Japan
- Reports of technical progress from each group
- **Plan and schedule for the prototype magnet assembly and test**
- Discussions on design of the SDC solenoid power supply
- Discussions on cryogenic design for the SDC solenoid
- Discussions on responsibilities for the cryogenics fabrication
- Response to the report of the DOE review sub-committee
- Publications and presentations of the technical progress

SDC Solenoid Subgroup Meeting in Japan

# Prototype Test Plan

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Dec. 9, 1992

SDC superconducting magnet subgroup meeting in JAPAN
Dec.8 - 11, 1992

# Prototype magnet assembly and test plan

Y. Makida (KEK)
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Contents

1. Basic Performance Test at Toshiba
2. Stability and Quench Safety Test at KEK

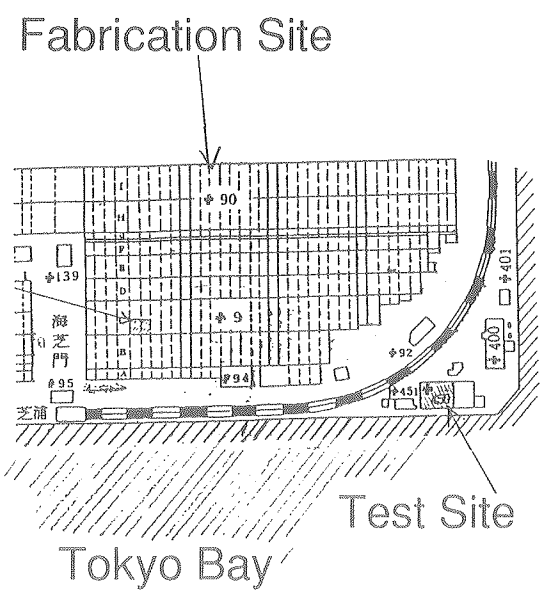
## Prototype Superconducting Coil R&D Status

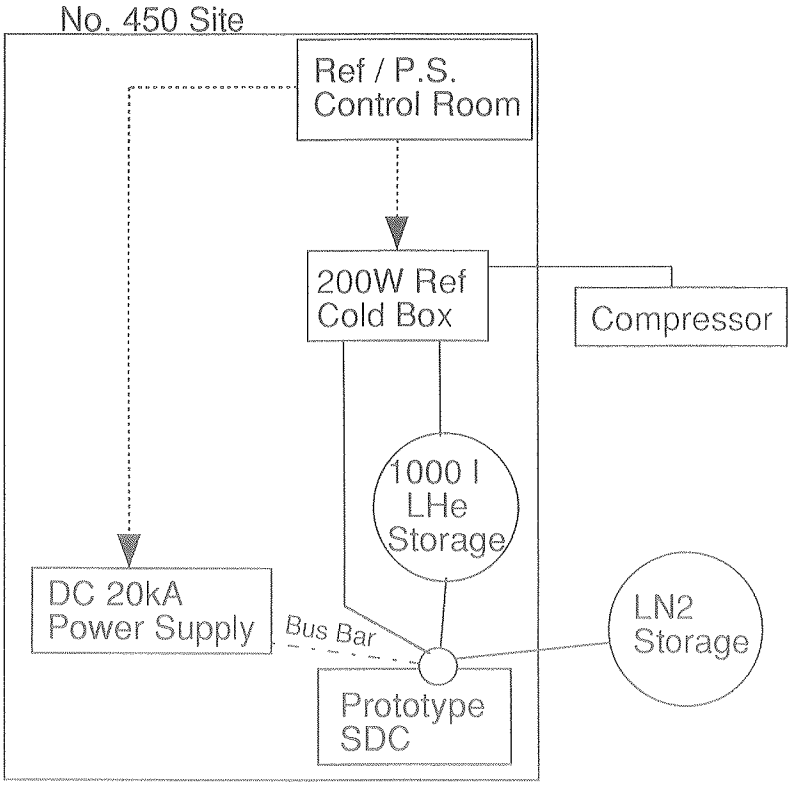
- Prototype Coil with Full Diameter and 1/4 length

  to Validate :
  - Performance of High Strength Aluminum Stablized Conductor
  - Coil Winding Technique in Large Scale Inner Coil Winding
  - Quench Safety
  - Mechanical Reliability Based on the Present Design Guide Line

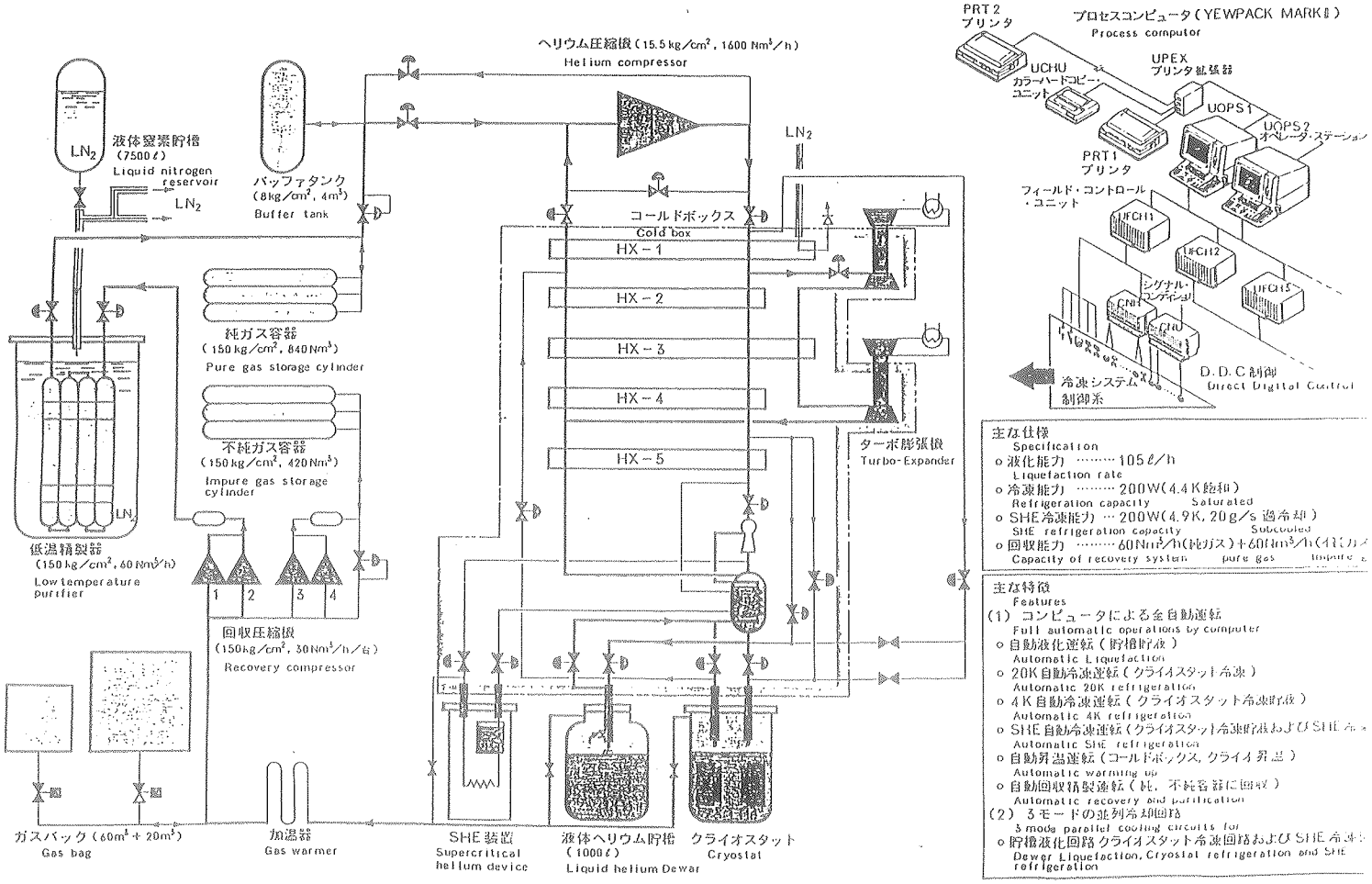
- Concept of Test
  1. Basic Performance Test at Toshiba
     - Excitation up to a Nominal Current ( 11250 A)
     - Switch Test (Break Off) at a Current
  2. Stability and Quench Safety Test at KEK
     - Dependence of AC loss on Ramping Rate
     - Heater Quench Test

# Test Site and Test Facilities for the Prototype Magnet in Toshiba



# 全自動ヘリウム冷凍液化システム
## Fully Automated Helium Refrigeration System




主な仕様
Specification

- 液化能力 ……105ℓ/h
  Liquefaction rate
- 冷凍能力 ……200W(4.4K飽和)
  Refrigeration capacity Saturated
- SHE冷凍能力 …200W(4.9K, 20g/s 過冷却)
  SHE refrigeration capacity Subcooled
- 回収能力 ……60Nm³/h(純ガス)＋60Nm³/h(不純ガス)
  Capacity of recovery system pure gas impure gas

主な特徴
Features

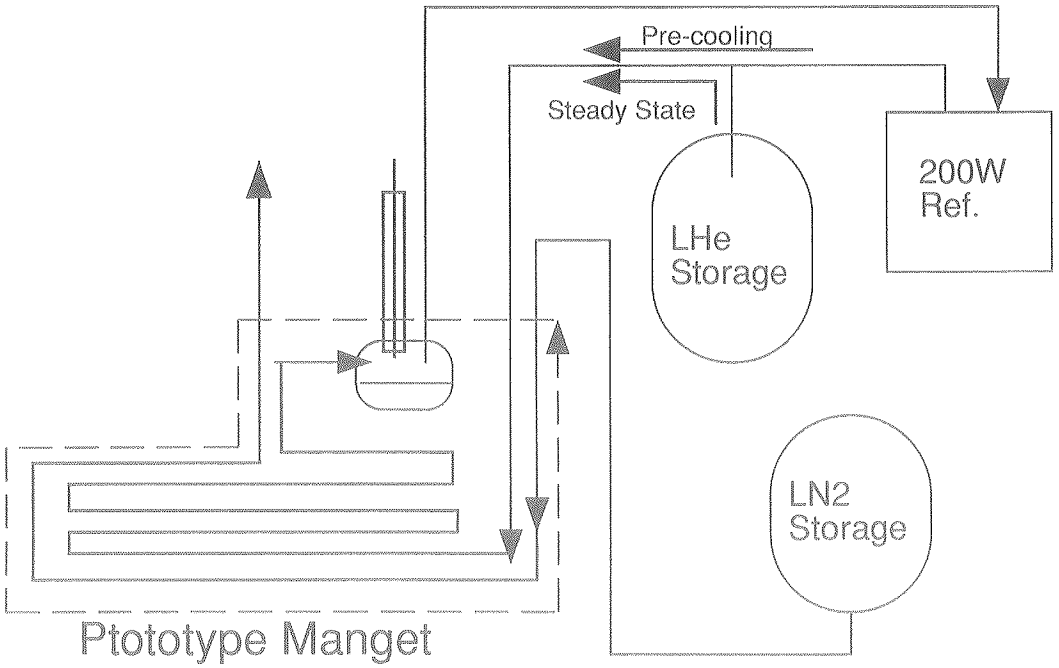
(1) コンピュータによる全自動運転
Full automatic operations by computer

- 自動液化運転（貯槽貯液）
  Automatic Liquefaction
- 20K自動冷凍運転（クライオスタット冷凍）
  Automatic 20K refrigeration
- 4K自動冷凍運転（クライオスタット冷凍貯液）
  Automatic 4K refrigeration
- SHE自動冷凍運転（クライオスタット冷凍貯液およびSHE冷凍）
  Automatic SHE refrigeration
- 自動昇温運転（コールドボックス, クライオ昇温）
  Automatic warming up
- 自動回収精製運転（純, 不純容器に回収）
  Automatic recovery and purification

(2) 3モードの並列冷却回路
3 mode parallel cooling circuits for

- 貯槽液化回路クライオスタット冷凍回路およびSHE冷凍
  Dewar Liquefaction, Cryostat refrigeration and SHE refrigeration

# Cooling of the Prototype Magnet at Toshiba

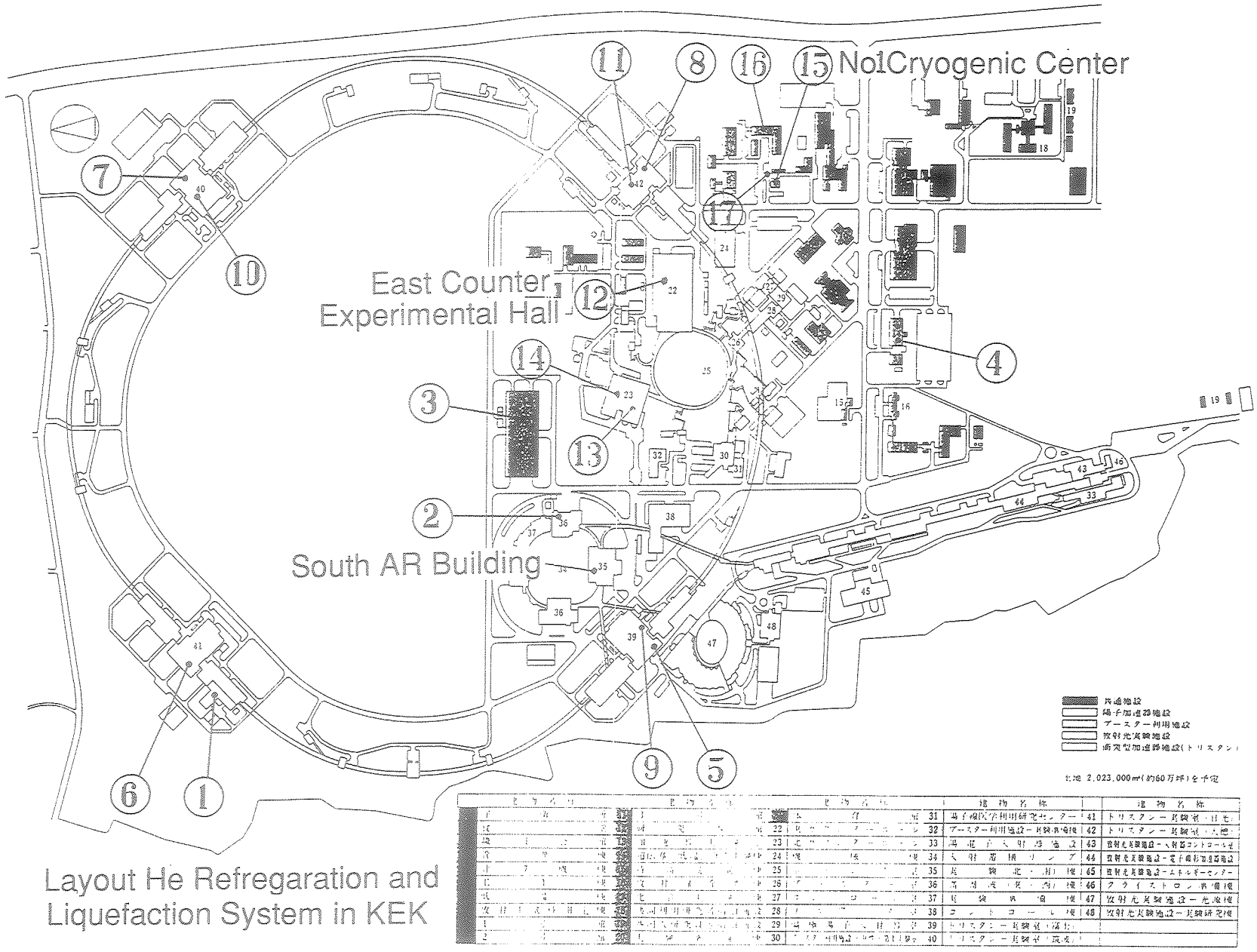


## Area for the Prototype Magnet Test in KEK (Candidates)

1. Area in the East Counter Hall will be requested.
   - 200 l / h (700 W) He liquefier is acceptable.
   - Magnet & P/S will be indoors.
   - Approval by other colleague .

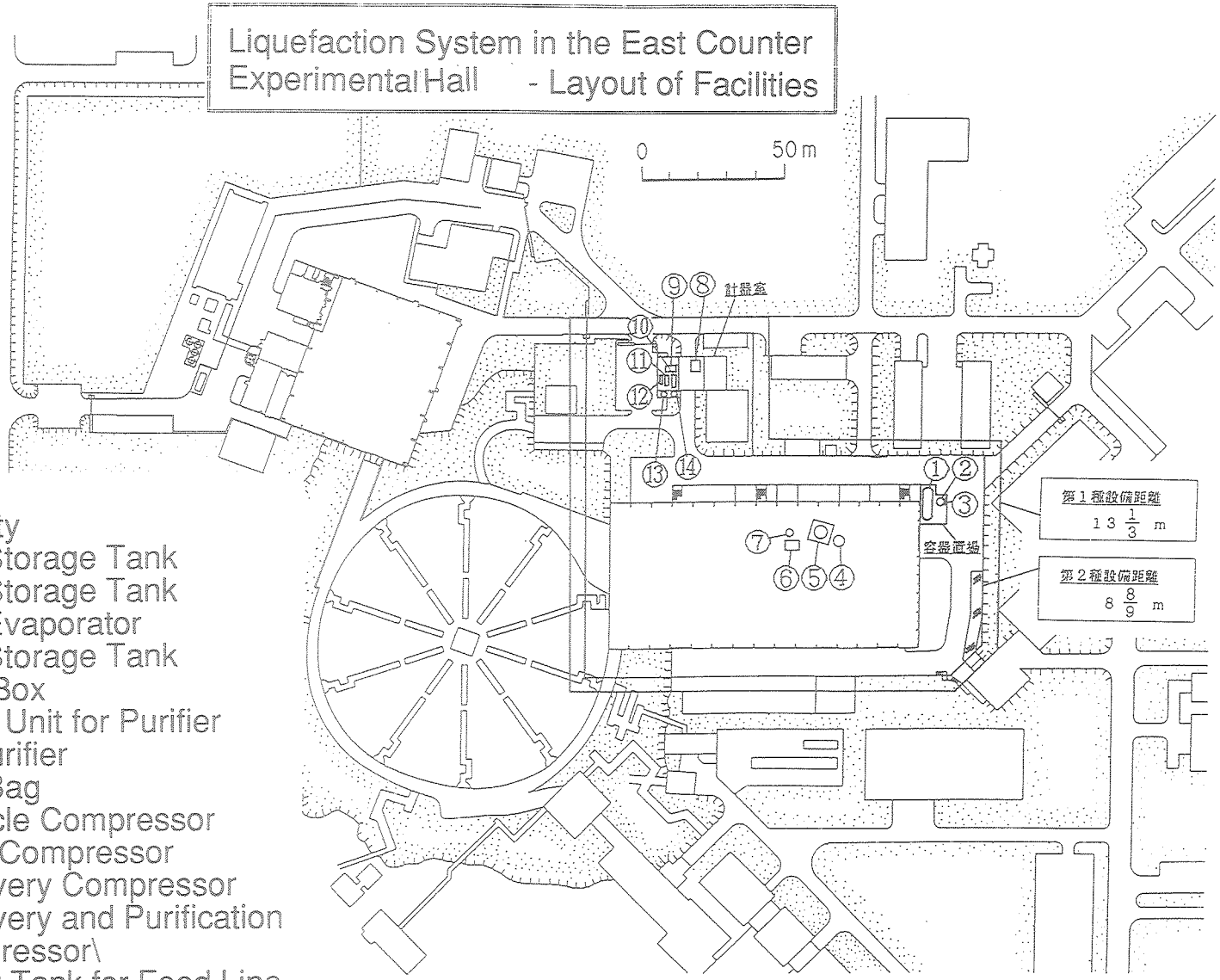
2. No. 1 Cryogenic Center
   - 100 l / h He liquefier is acceptable.
   - Remodeling cold box is necessary.
   - Magnet & P/S will be out of doors.

3. South AR Building
   - Cooling w/o Refrigerator.
   - Magnet will be out of doors.



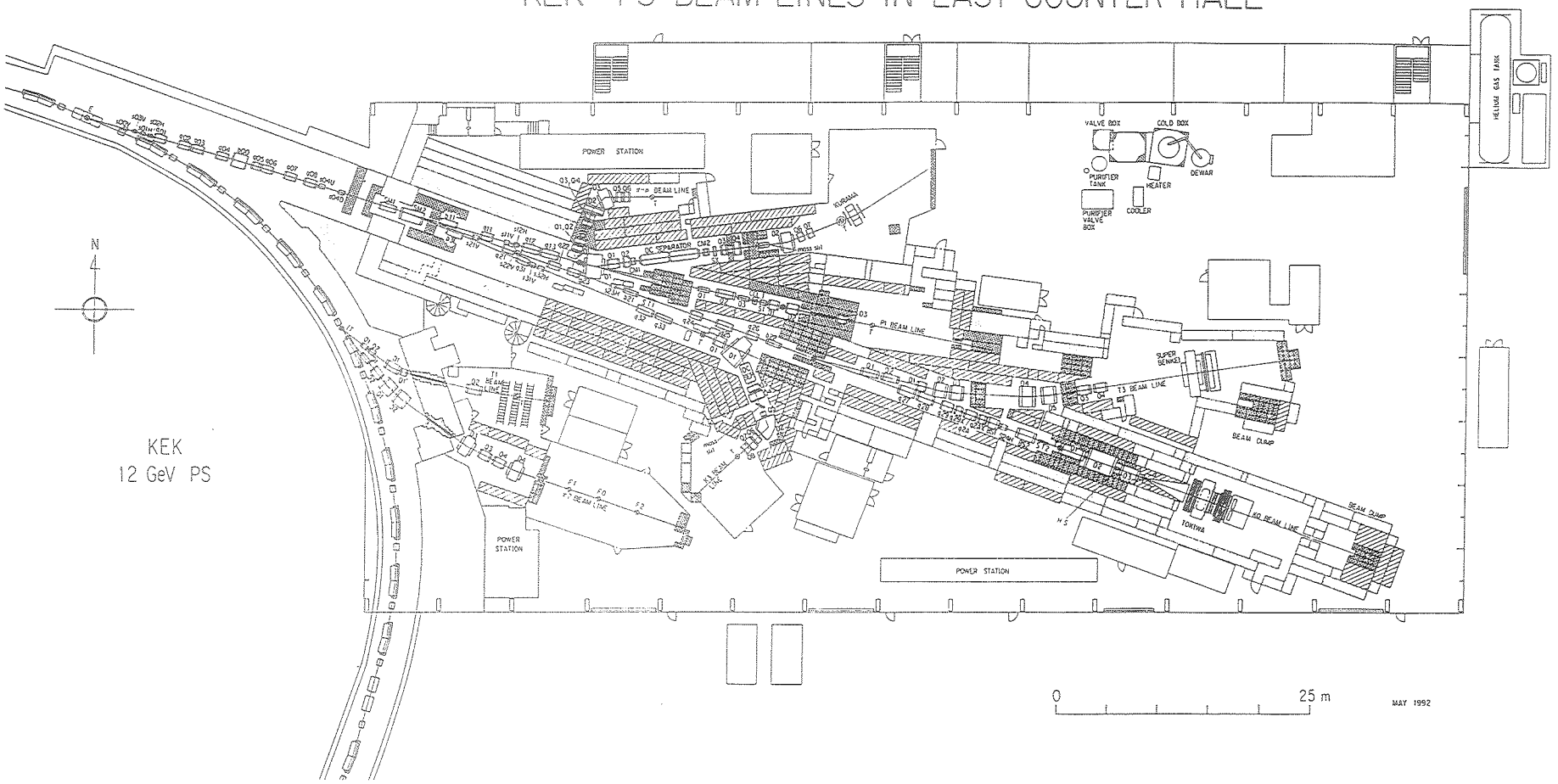

# Layout He Refregaration and Liquefaction System in KEK

# Liquefaction System in the East Counter Experimental Hall - Layout of Facilities




| No | Facility |
|---|---|
| 1 | Gas Storage Tank |
| 2 | LN2 Storage Tank |
| 3 | LN2 Evaporator |
| 4 | LHe Storage Tank |
| 5 | Cold Box |
| 6 | Valve Unit for Purifier |
| 7 | He Purifier |
| 8 | Gas Bag |
| 9 | Recycle Compressor |
| 10 | Feed Compressor |
| 11 | Recovery Compressor |
| 12 | Recovery and Purification Compressor\ |
| 13 | Buffer Tank for Feed Line |
| 14 | Buffer Tank for Recovery Line |

# KEK-PS BEAM LINES IN EAST COUNTER HALL



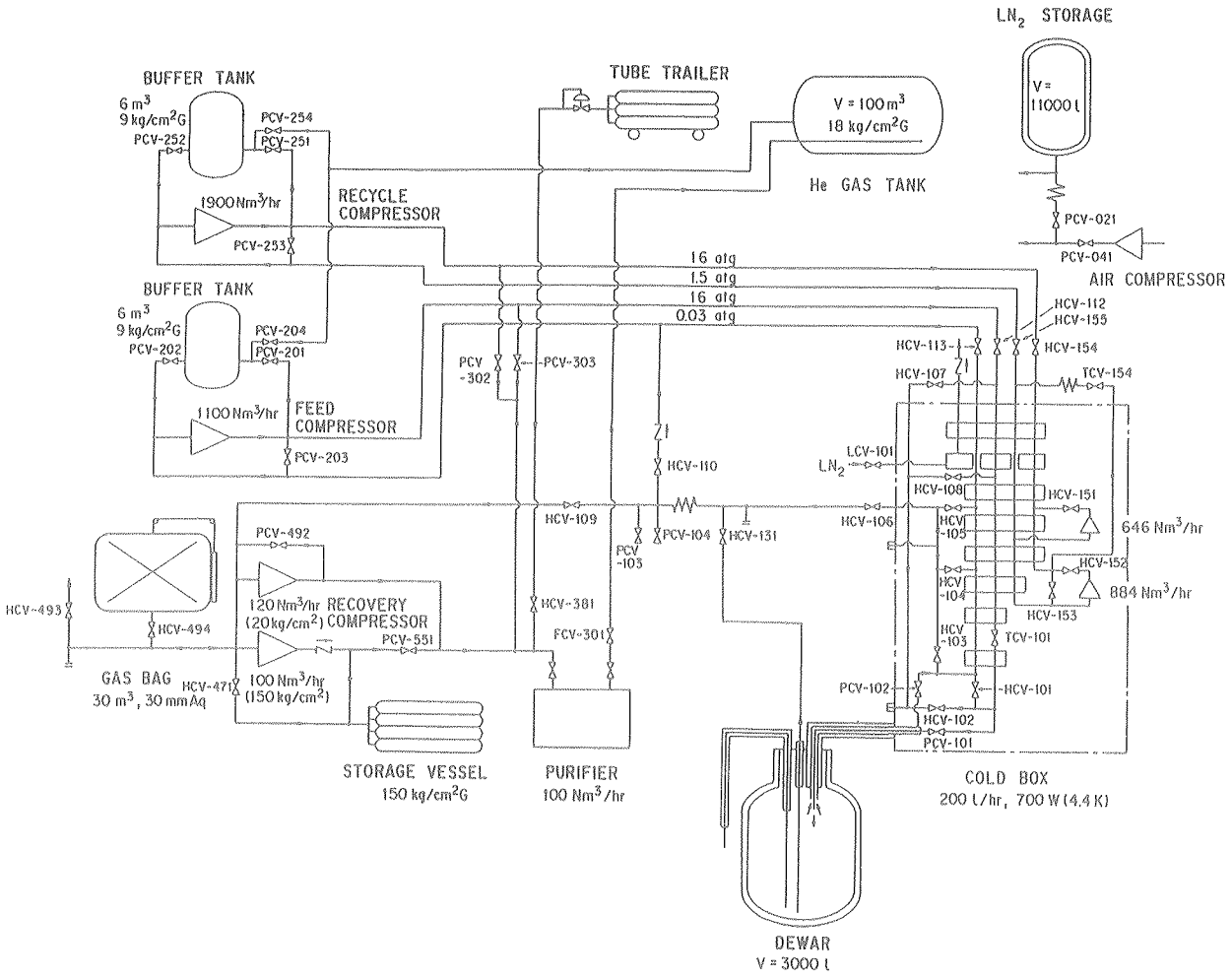
## Preparation of Support System

1. Cryogenic System for Prototype Magnet

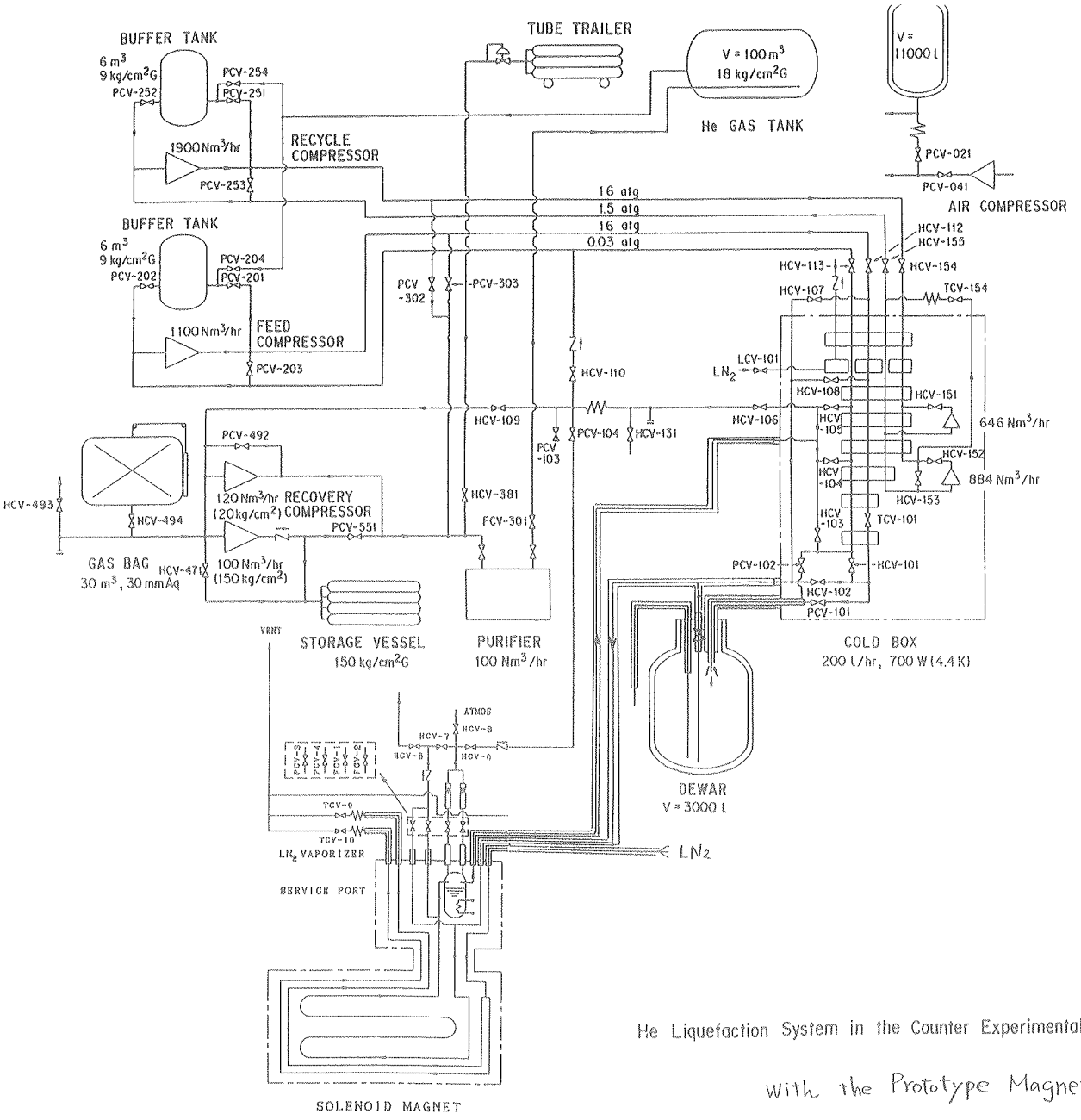
   - Assembling Magnet into $\pi$ 1 LHe Liquefier (200 l / h, 700 W)
     - Piping ( Tube, Valve, Sensor, etc)
     - Electric line ( Trnsmitter, Cable, etc)
   - Modification of Software in the Control System (CENTUM)
     - Addition of Subroutine for Magnet Cooling

2. Power Source for Prototype Magnet
   - DC P/S 150000A / 29V
   - Bus-bar or Power Cable
   - AC input 6.6kV / 700kVA for P/S
   - Cooling water 150 l/min with Chiller Unit

3. Monitor System




He Liquefaction System in the Counter Experimental Hall




He Liquefaction System in the Counter Experimental Hall

With the Prototype Magnet

Experimental Items (1)　( Progress of Test )

1. Arrival, Setting
   - Outlook Check, Dimension Check
   - Electric Isolation Check
2. Vacuum Evacuation
   - Mechanical Stability of the Vacuum Vessel
   - Leak Check
3. Pre-cooling
   - Cooling Performance
     dTcoil / dt , Pressure Drop
     Temperature Distribution
   - RRR of the Conductor

4. Thermal Performance of Cryostat
   - Temperature Distribution at Steady State Operation
   - Temperature Rise at Cooling Stop

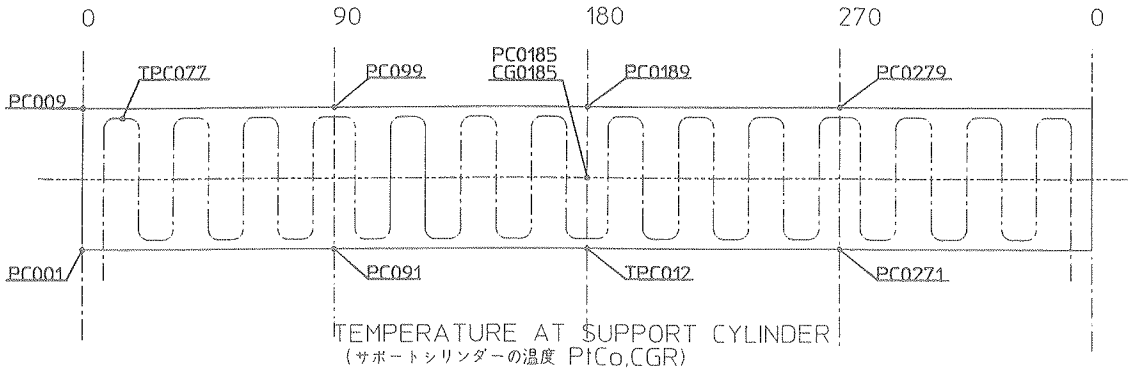
Experimental Items (2)

5. Excitation

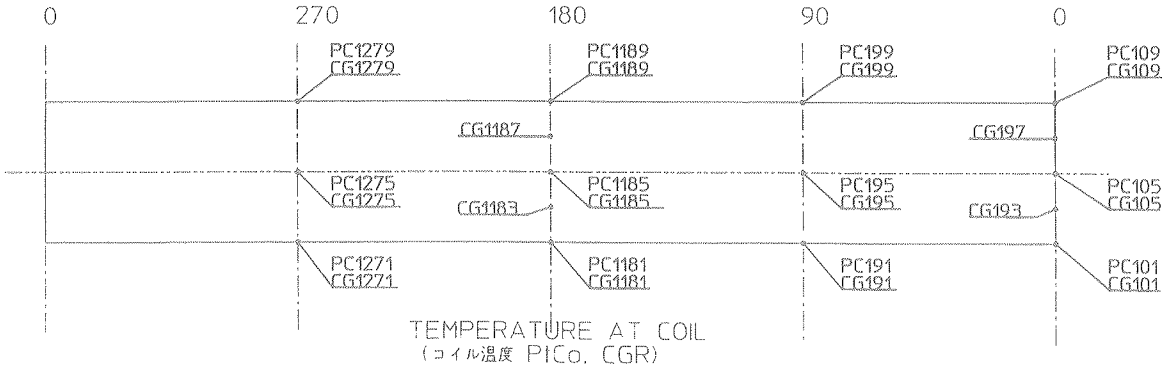
5-1 Excitation up to Nominal Current ( 11250 A )
Mechanical Stability of the Coil
Superconductive Performance / Training

5-2 Fast Discharge Test ( Not Break Down )
AC Loss
Fast Discharge w/o Quench due to AC Loss

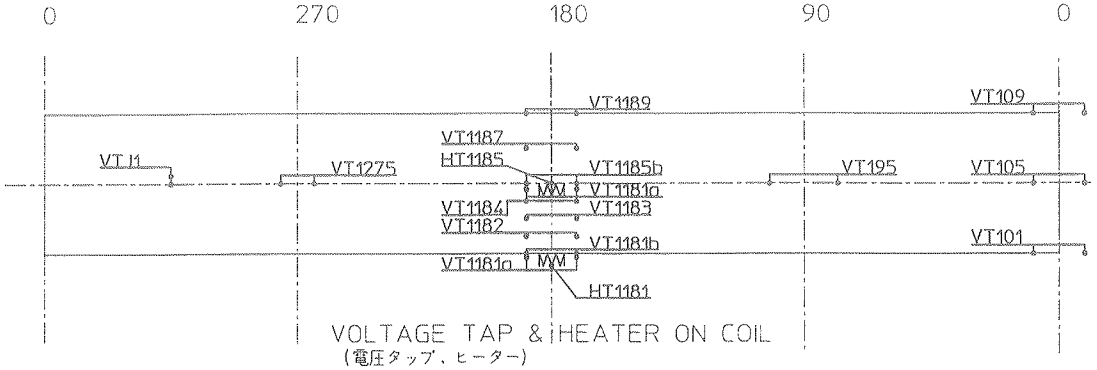
5-3 Heater Quench Test
Sueprconductive Stability
Minimum Quench Energy
Safety of the Coil at Quench
Homogenized Energy Dump
Temperature Distribution
Propagation Velocity



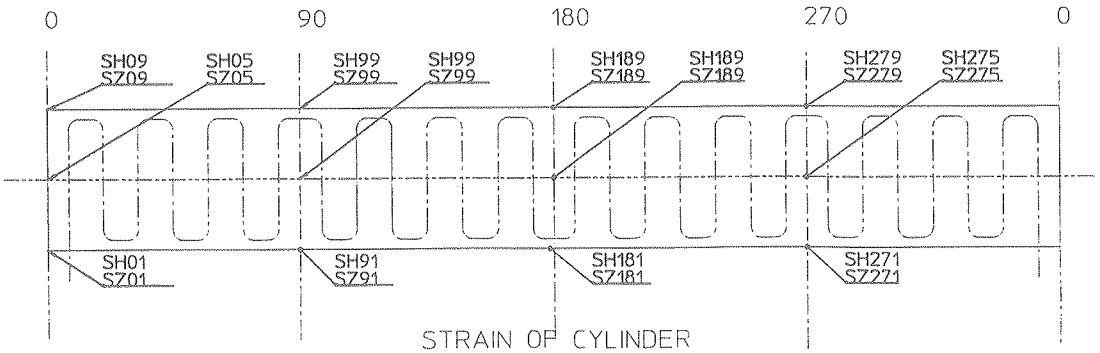

TEMPERATURE AT SUPPORT CYLINDER
(サポートシリンダーの温度 PtCo,CGR)



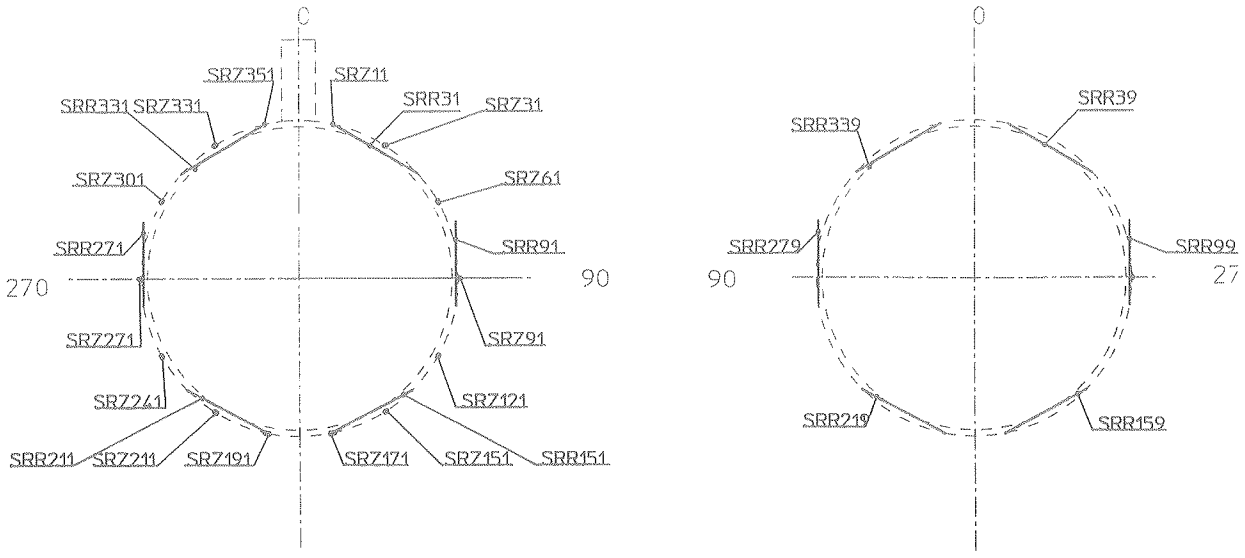

TEMPERATURE AT COIL
(コイル温度 PtCo, CGR)



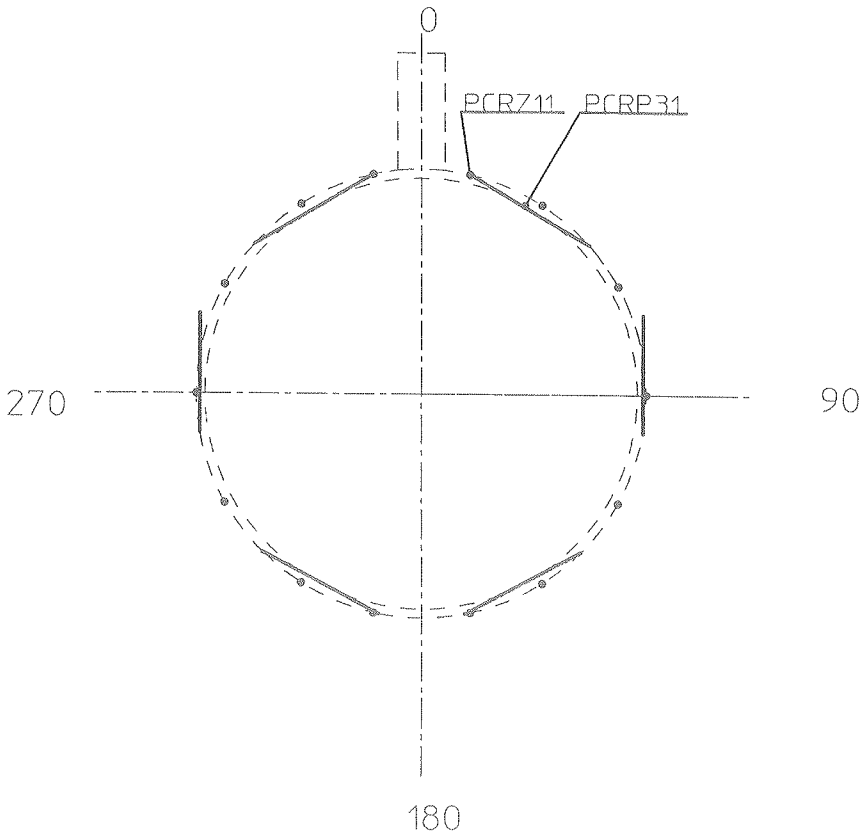

VOLTAGE TAP & HEATER ON COIL
(電圧タップ、ヒーター)



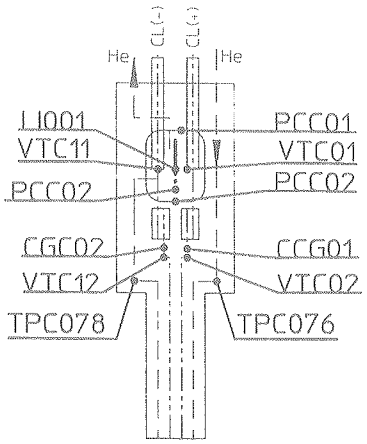

STRAIN OF CYLINDER
(サポートシリンダー歪みゲージ)



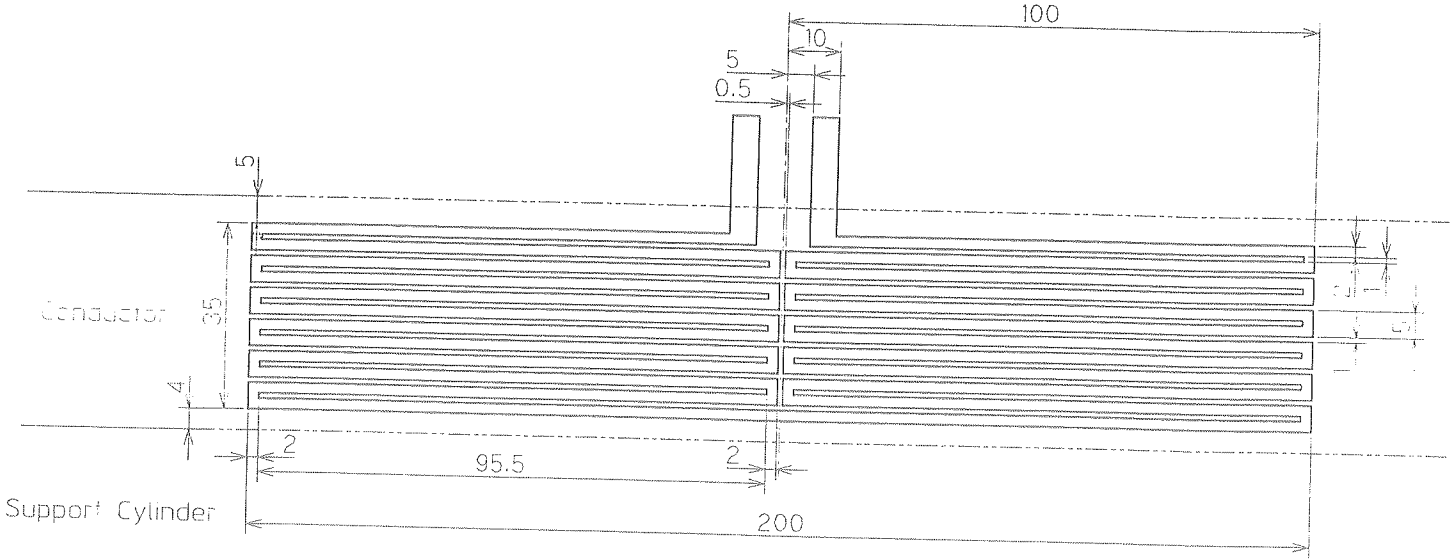

STRAIN OF SUPPORT ROD
(サポートロッド歪みゲージ)




TEMPERATURE AT SUPPORT ROD
（サポートロッド温度）




SENSOR IN CHIMNEY
（チムニー部温度、液面、電圧タップ）




SUS304 Film t0.01mm

Quench Heater ( 60 Ω )