Tue-Af-Po2.23
-05[92]

Development of Prototype MgB_2 Superconducting Solenoid Magnet for High-efficiency Klystron Applications

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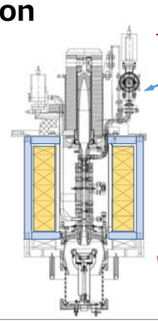
1. Introduction

＊Compact Linear Collider

■ **Motivation**

5000 klystrons for CLIC* by CERN



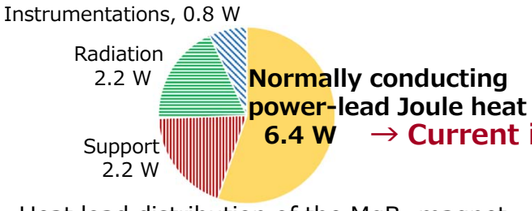
Cu magnet
・0.58 T
・20 kW
→ **100 MW**

MgB_2 magnet
・0.8 T
・<3 kW
→ **<15 MW**

2. Design and experimental approach

2.1 Energy-saving design concept and conductor parameters

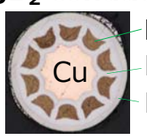
■ **Consumption energy**
≒ Refrigerator Power consumption
→ Low current design for power lead is effective!



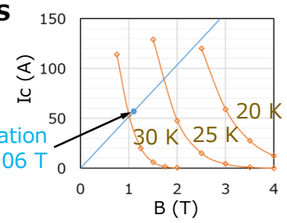
→ **Current is set at 57 A**

Heat load distribution of the MgB_2 magnet

■ **MgB_2 conductor parameters**



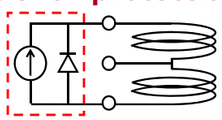
- O.D. = 0.67 mm
- 10 filaments

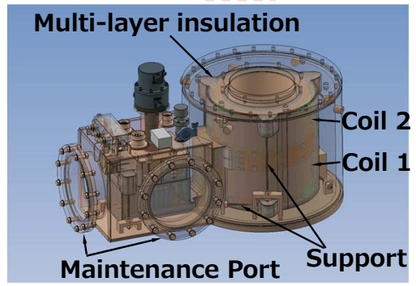


2.2 Coil structure and magnet design

For passive quench protection

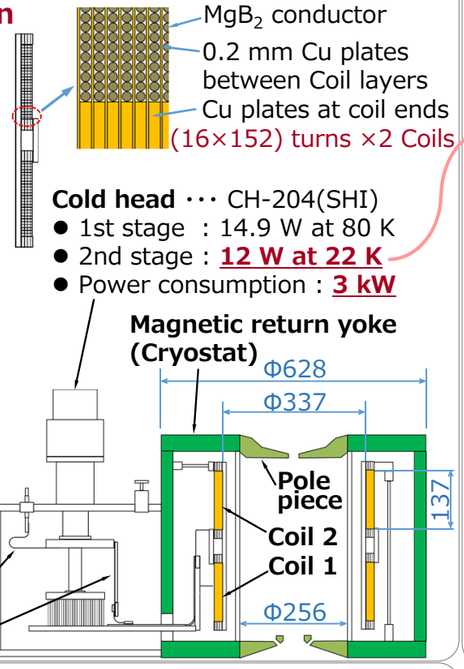
Power supply
Turn off over 5 V





- Wind & React
- Central field : 0.8 T
- Max. field in the winding : 1.06 T
- Stored energy : 11.8 kJ
- Coil weight : 19.5 kg (inc. Cu plates)
- Conductor length : 5600 m

Normally conducting power lead
BSCCO power lead



2.3 Series of various tests

(1) Small Coil Test
Quench propagation velocity

(2) Prototype Coils Test
Temperature rise after quench

(3) Magnet Test
Quench tests & Field measurements

3. Results and discussion

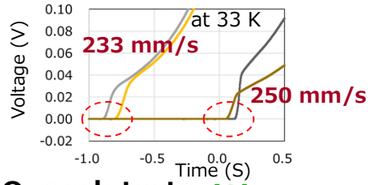
3.1 Energy consumption

Measured values
- 1st stage : 13.2 W at 71.3 K
- 2nd stage : **5.3 W at 14.7 K**

In the case of two magnets in series,
Power consumption : **1.5 kW/magnet**

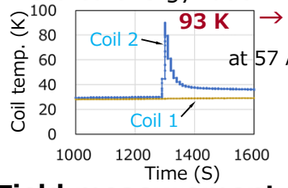
3.2 Quench propagation velocity (1)

- Forced quench test at 57 A
- Voltage taps on the coil surface



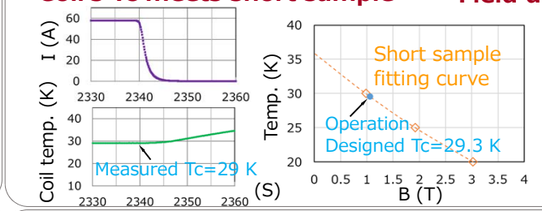
3.3 Temperature Rise (2)

- Coil max. temperature
- Stored energy ratio : 1.5 times



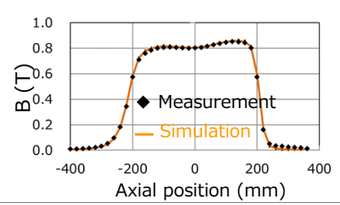
3.4 Quench tests (3)

Coil's Tc meets short sample



3.5 Field measurement (3)

Field distribution meets simulation



4. Conclusion

- The performance test of the prototype MgB_2 magnet has been completed.
- Energy consumption per magnet is less than 3 kW.
- The coil has been passively protected through 13 times quench tests.

5. Future Plan

- Wind & react was adopted in this coil, but react & wind is supposed to be adopted in the future.
- MgB_2 superconducting magnets have huge potential for further development and in various areas including MRI applications.

Klystron system and the MgB_2 conductor are presented in Wed-Af-Po3.15-08 and Wed-Af-Po3.25-04.