# Steering Magnets for the SPring-8 Storage Ring

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## 1. Introduction

The SPring-8 storage ring has 285 horizontal steering magnets and 283 vertical steering magnets for COD collection. 6 horizontal and 6 vertical magnets are installed in the unit cell. A type of horizontal steering magnet and two types of vertical steering magnets are constructed and measured its magnetic performances. All steering magnets are aligned in the storage ring.

## 2. Design

Parameters of the steering magnets are listed in Table 1. Maximum kick angle of I mrad for the horizontal and 0.5 mrad for vertical correction are required.

To reduce the magnetic hystersis effect, the materials which has small coercive force were chosen for the magnet core. The core for the horizontal steering magnets (H1) and the core for a type of vertical steering magnets (V1) are made of the oriented silicon steel plates of O.3-mm thickness. The core for another type of vertical steering magnets (V2) are made of FERROPERM [1] (NKK Corp. ). The typical coercive force (HC 15) of the oriented silicon steel plate was 4 - 5 A/m at the direction of rolling, and it was 35 - 40 A/m at the vertical direction of rolling. The coercive force of FERROPERM was about 13 - 20 A/m. These values are small compare with cases of oriented silicon steel plates or pure iron.

Estimated maximum kick angle due to the remanent field after the magnet was excited to the maximum field were 1μrad, 0.7μrad, 0.5μrad for H1, V1,and V2 magnet, respectively.

## 3. Measurements

Horizontal /vertical distribution of integrated magnetic fields along beam direction on the median plane are shown in fig.1. The magnetic fields were mapped with a hole probe and integrated.

Effective length of the magnetic field decrease owing to the effect of adjacent magnets aligned in the storage ring. We measured the length with a long flip coil.

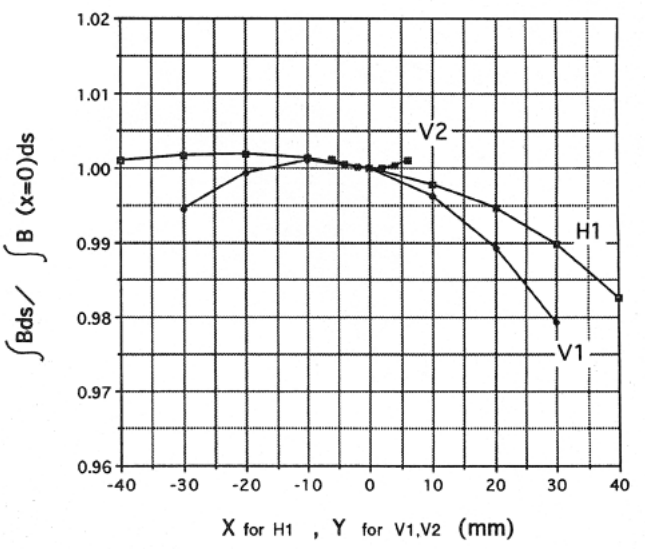


Fig.1 Horizontal / vertical distribution of integrated magnetic fields along beam direction on the median plane.

Table 1. Parameters of the steering magnets

| Type (unit) | H1 | V1 | V2 |
|---|---|---|---|
| Number | 285 | 196 | 87 |
| Kick Angle (mrad) | 1 | 0.5 | 0.5 |
| Core Length (mm) | 128 | 98 | 190 |
| Gap (mm) | 62 | 166 | 130 |
| Turn Number of coil (turn/pole) | 714 | 868 | 1216 |
| I max. (A) | ±5 | ±5 | ±5 |
| Field Strength max. (gauss) | 1436 | 562 | 510 |

The remanent field was measured as a function of the peak excite current of magnet as shown in Fig. 2. Kick angle due to the remanent field after the magnet was excited to the maximum field were calculated at 0.8μrad, 0.6μrad and 0.7μrad for H1, V1, and V2 magnet, respectively. There values are in good agreement with the theoretical ones.

The value of the remanent field was depend on the peak magnetic field. As the average strength of kick angle of all magnets are estimated 10-20% of the designed maximum kick angle, the remanent field are smaller than the case that the magnet was excited to the maximum.

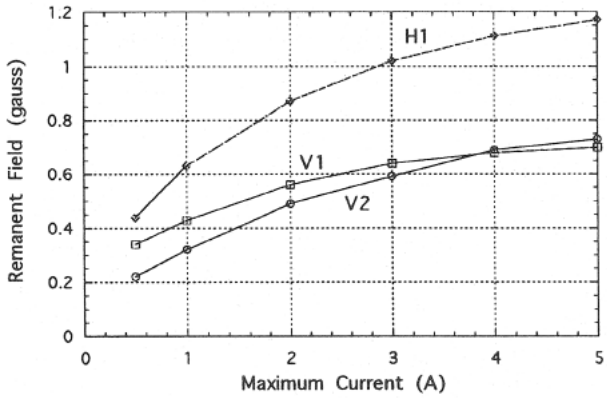


Fig. 2 The remanent field after the magnet was excited, and return to zero.

Table 2. Positioning tolerances for steering magnets

| max. displacement error | | | max. rotation error | | |
|---|---|---|---|---|---|
| Δx | Δy | Δz | Θx | Θy | Θz |
| (mm) | | | (mm/m) | | |
| 1 | 1 | 3 | 5 | 5 | 1 |

Δx, Δy, and Δz denote the horizontal, vertical, and longitudinal displacement errors, respectively. Θx, Θy, and Θz denote the rotation errors around the horizontal, vertical, and longitudinal axes, respectively.

## 4. PositiOning

All steering magnets are positioned on the girder in the storage ring. Positioning tolerances are listed in Table 2. All magnets are aligned under the tolerances.

## 5. Conclusion

568 steering magnets were started to construct in autumn of 1995, finished in summer of 1996. Magnets are installed in the storage ring from spring to autumn of 1996. These magnets are connected to 60V-5A bipolar power supply individually.

## References

[1] T. Omori, H. Suzuki, and T. Sampei: J. Appl. Phys., 69(8), 15, P.5927-5929, April 1991