ALIGNMENT OF THE ATF BEAM TRANSPORT LINE
(Alignment with Laser Tracker (SMART) for ATF Damping Ring)

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l. Introduction

An Accelerator Test Facility(ATF) is under construction at KEK[1]. The ATF has been designed to test the feasibility of the accelerator sub-systems and to confirm the specification of the total accelerator system for JLC(Japan Linear Collider). The JLC is a future project and an electron-positron collider for the energy frontier physics in TeV region[2,3,4]. The ATF consists of a 1.54 GeV S-band Linac, a Beam Transport, a Damping Ring, a Beam Test Area, a Test Station for Positron Production and a Computer Control System. Fig. 1 shows the layout of the ATF. The 1.54 GeV damping ring is the main accelerator system of the ATF. The goal of the system is to achieve the vertical normalized emittance less than 3.0x10-8 rad m with high intensity multi-bunch beam[5]. In order to get this performance, we need an active alignment system[6] and a precise alignment technique which is described in this report.

The beam transport line from the linac to the damping-ring was constructed in this autumn, and we tested the precise alignment technique there using Laser Tracker System (SMART) as R&D of the damping ring alignment. The alignment tolerances of magnets for the damping ring were obtained by beam tracking simulation (SAD) as follows:

1) Horizontal σ = 60 μm.
2) Vertical σ = 50 μm
3) Rotational σ = 0.2 mrad

Then, the target accuracy of the alignment was set to σ = 30 μm. We tried to align 8 quads in a straight section using SMART. We chose the straight section because we can use Micro-Alignment Telescope to check the results.

2. Alignment Method

2.1 SMART

The SMART from Leica is the first product of 3D mobile tracking system. The accuracy of the SMART 310 system is mainly determined by the accuracy of the angle encoders. The distance resolution is 1.26 μm, and the angular resolution is 0.7”.

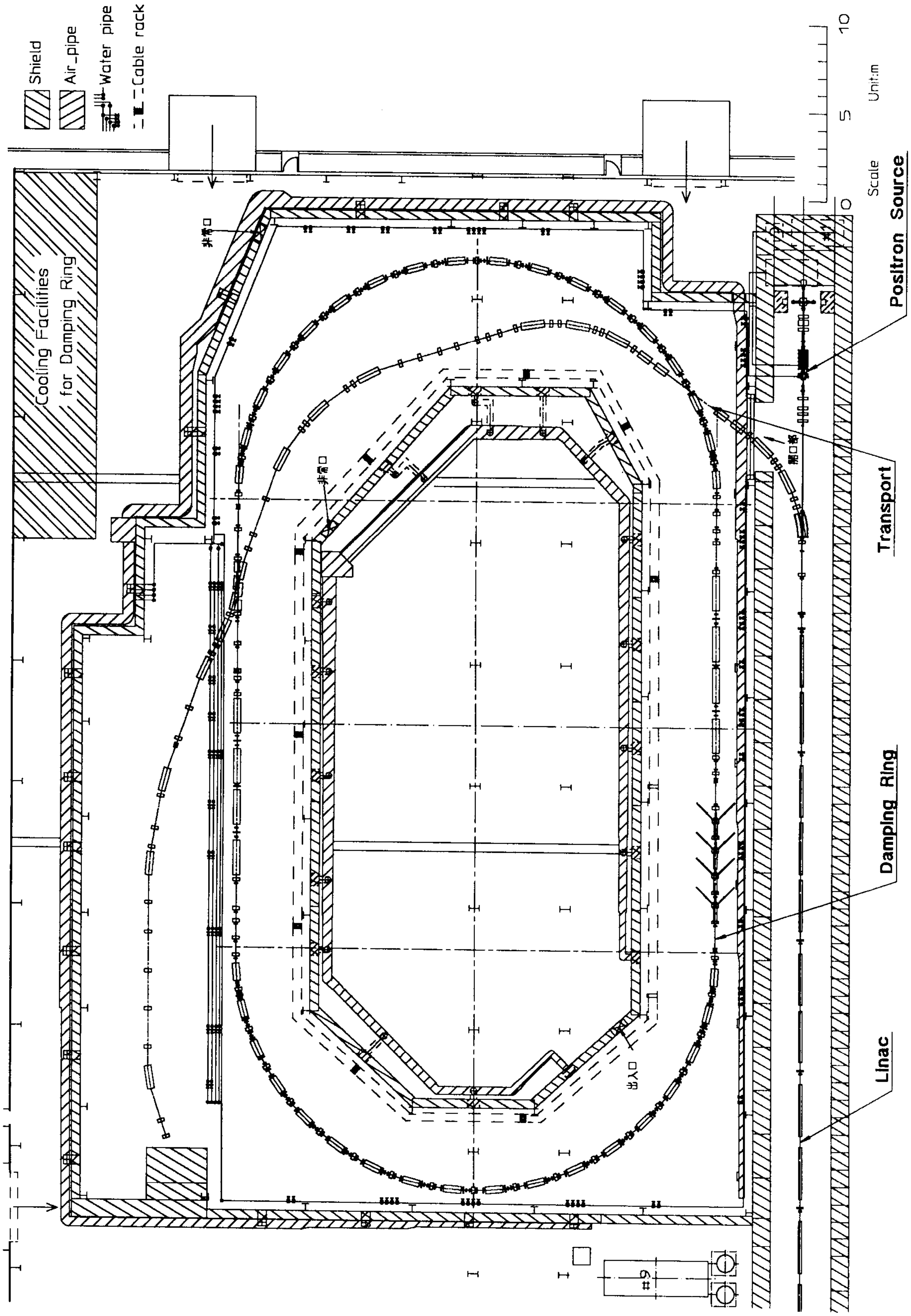

Fig.1: Layout of ATF

2.2 Adjustment for magnet position

The quads are fixed on the support table with adjusting mechanism. It consists of three screws for tilt and height, and six micrometer heads for positioning in a horizontal plane. (see Fig. 2)

2.3 Alignment

Fig. 3 shows layout of the beam transport line. The length of the straight section that we used for the precise alignment is about 7 m. SMART was set at position A. We put Cat's-eye on the quads and they are aligned with SMART. First, we measured the position of three magnets c, d and e. Then we defined the straight line with two points of d and e. Other 6 magnets were aligned along this reference line. We again measured their positions by SMART.

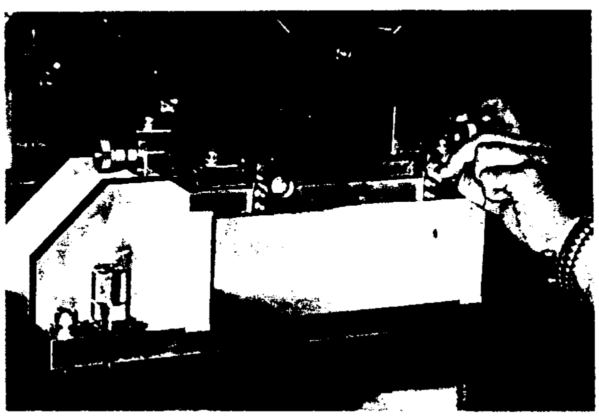

Fig.2: Support table for Quad

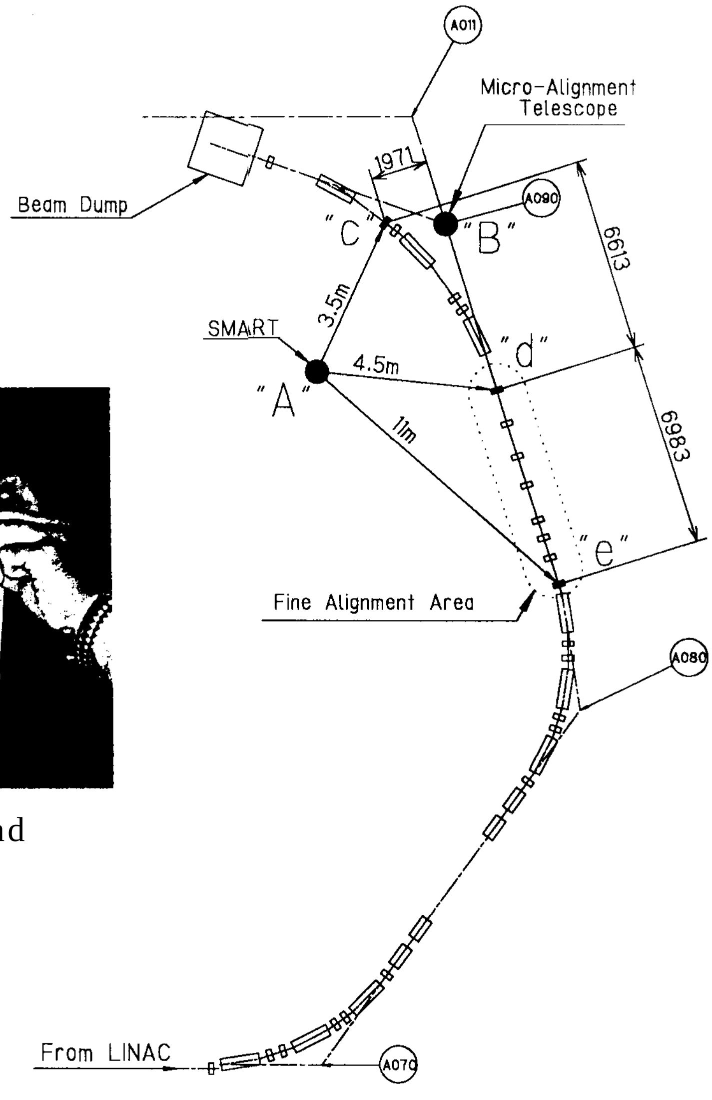

Fig.3: Layout of the beam transport line

3. Measurement

3.1 Measurement results

Fig. 4 shows the position of eight quads measured by SMART. Horizontal axis shows magnets position along the straight line. Vertical axis shows the deviation from the reference line in the horizontal and vertical direction. Measurement values are shown by cross points. Circles show average of 5 measurements. Bar are statistical errors.

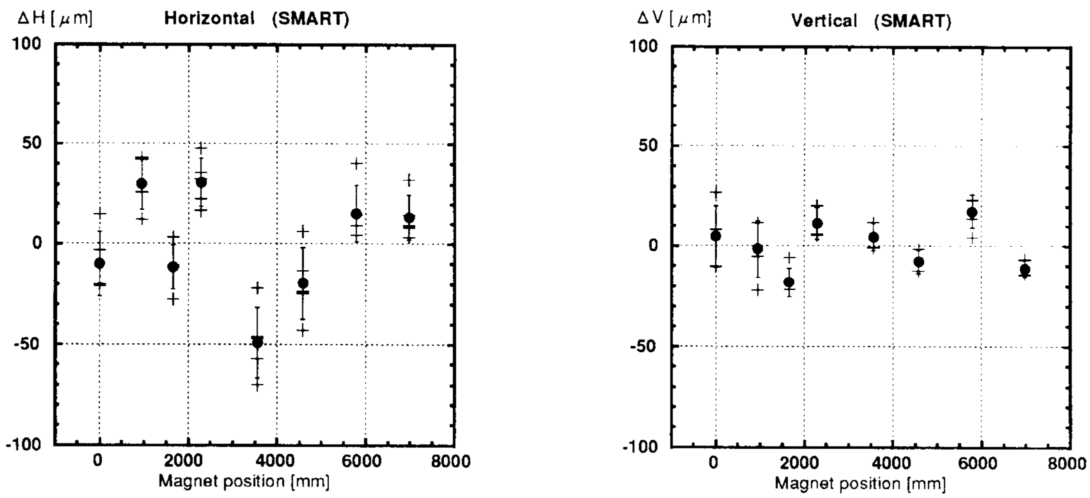

Fig. 4: The positions of 8 quadrupole magnets. The positions were measured 5 times by SMART.

3.2 Dependence on setting position of SMART

We changed the setting position of SMART and measured 8 quads positions 5 times. Fig. 5 shows the results. These position measurements were consistent within systematic error.

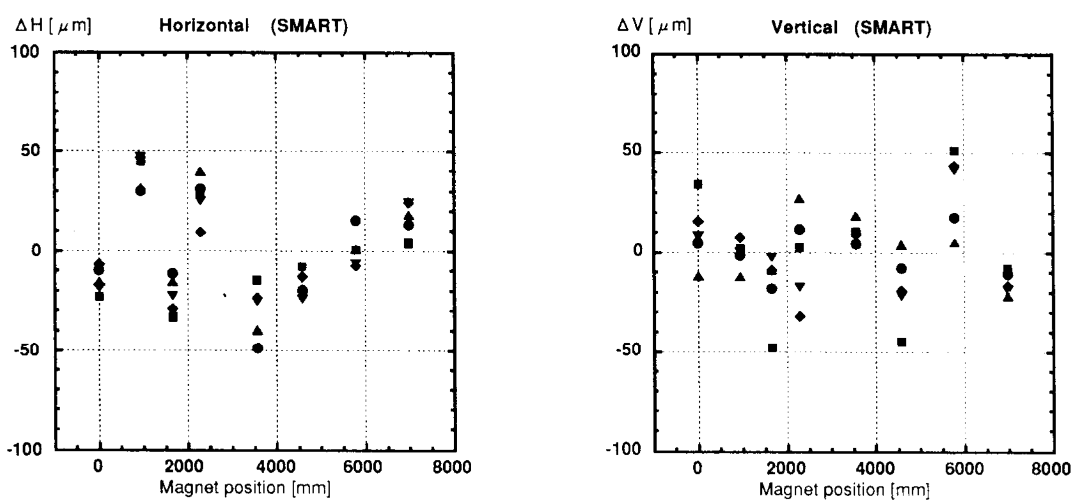

Fig. 5: Data show average of 5 measurements by SMART which was set at 5 different places.

3.3 Comparison with other measurement

To confirm the measurement accuracy of SMART, we also measured the positions of 8 quads using Micro-Alignment Telescope (MAT) which was set at B (see Fig. 3). Fig. 6 is the result of MAT measurement. You can find good agreement with the results of SMART.

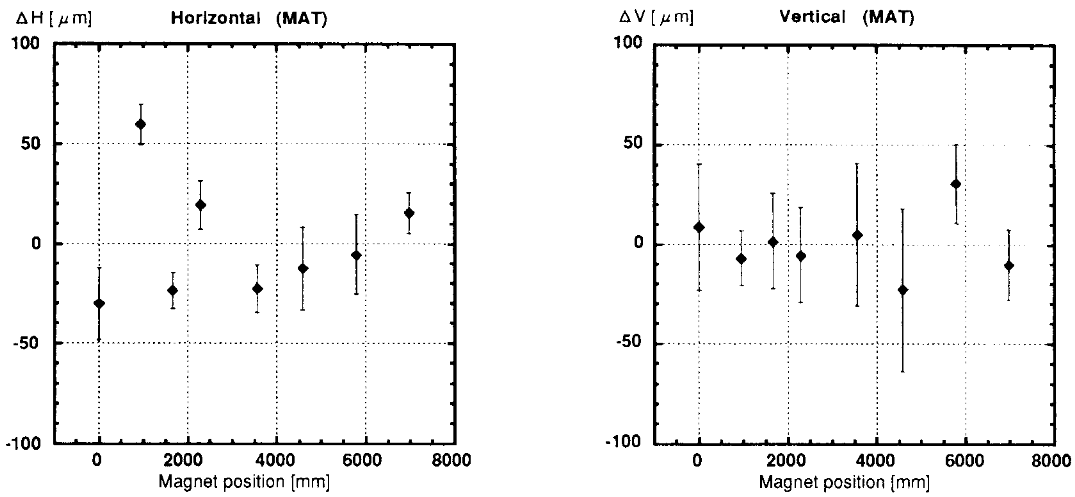

Fig. 6: Micro-Alignment Telescope (MAT) measurements

4. Realignment

In order to improve the alignment accuracy of 8 quads, we realigned 3 quads based on results of Fig. 5 and measured again. Fig. 7 shows the measurement of SMART after realignment. All magnets were aligned within 35 μm. Fig. 8 shows results of MAT measurements. Both measurements agree very well.

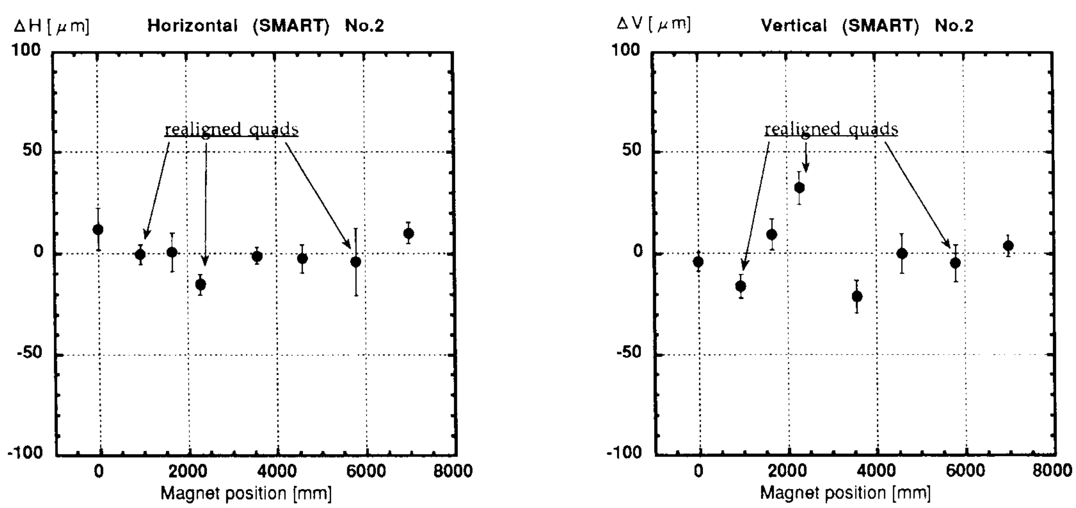

Fig. 7: After realignment (SMART)

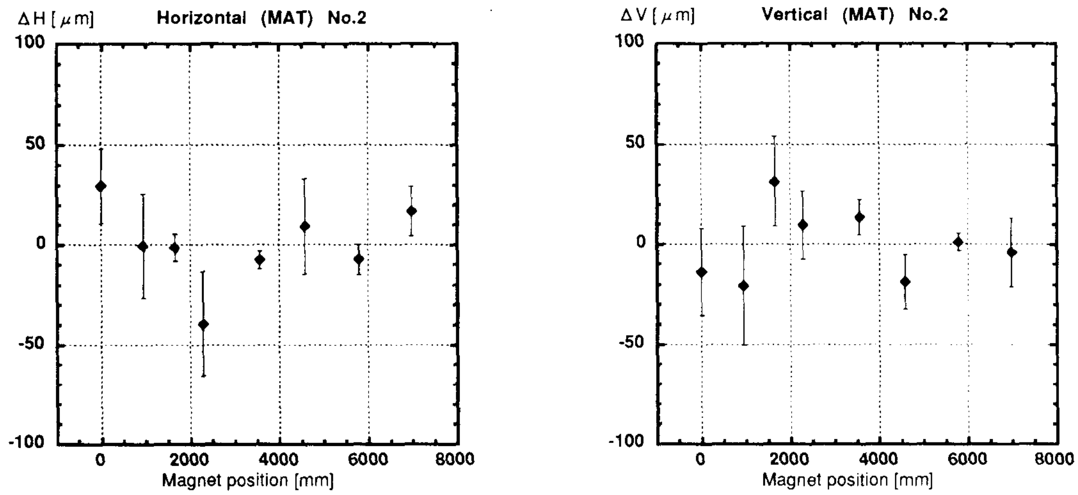

Fig. 8: After realignment (MAT)

5. Summary

Eight quadrupole magnets were aligned within +/- 35 μm (Full Width) accuracy which satisfies the requirement of the alignment for the ATF Damping Ring. We showed that measurement of SMART was consistent with that of MAT. Since SMART can be applied in arc section in the alignment of the ATF Damping Ring and SMART is much easier to use than MAT, we will align all magnets in the arc sections using SMART until mid. of 1996.

Acknowledgement

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