

Alignment of the SPring-8 Linac

Akihiko MIZUNO¹⁾, Yoshihiro HASUYAMA²⁾ and SPring-8 Linac Group

¹⁾SPring-8, Kamigori, Ako-gun, Hyogo 678-12, Japan

²⁾MITSUBISHI Electric Corporation, 8-1-1, Tsukaguchi-Honmachi, Amagasaki, Hyogo 661, Japan

1. Introduction

In the SPring-8 Linac, each magnet was installed by the end of September 1995, and alignment had been started. Because of long Linac length of 140 m and small alignment tolerance of less than 0.1 mm, we adopted a laser system for deciding the baseline of alignment. This report shows how the Linac was aligned, and the results of alignment.

2. Method of Alignment

Two reference points, at LSBT (Linac Synchrotron Beam Transport line) side and at the gun side, were defined. Between two points, imaginary beam line (pre-baseline) were drawn on the floor by tensile wire. And height level (1205 mm from floor) was marked on the wall of accelerator room using the laser in consideration of the curvature of the Earth.

Then at first, quadrupole magnets (triplets) are installed roughly along the pre-baseline, because the triplets are the most severe for accuracy of alignment. The tolerances, that were alignment accuracy of center of magnet's bore to the pre-baseline, were decided to catch the laser light by laser detectors, sensitive area of which is 4 mm square. And we obtained the alignment error of about 1 mm in the horizontal direction, and less than 1 mm in the vertical direction at this time.

Next, precision alignment of triplets was carried out using the laser system. Outline of the laser system is shown in Fig. 1. The laser head, Zygo MODEL7701, is mounted on the reference point of the gun side. The pointing stability of the laser is less than 1 arc sec, and beam diameter is 6mm ϕ . The laser beam was expanded to 12mm ϕ parallel beam just after the laser head, transported in 100mm ϕ paper pipe to avoid scattering with air, and was focused to 2.4mm ϕ beam just behind a laser detector. Two kind of detectors are used. One is a quarter divided position sensitive detector (PSD), set on the reference point of the LSBT side. The other is MELLES GRIOT, Super Beam Alyzer, set in the center of each triplet's pole. The later detector is movable for measuring the alignment error of each triplet. The position sensitivity of the Super Beam Alyzer is less than $\pm 15 \mu\text{m}$, so it is enough for the alignment tolerance.

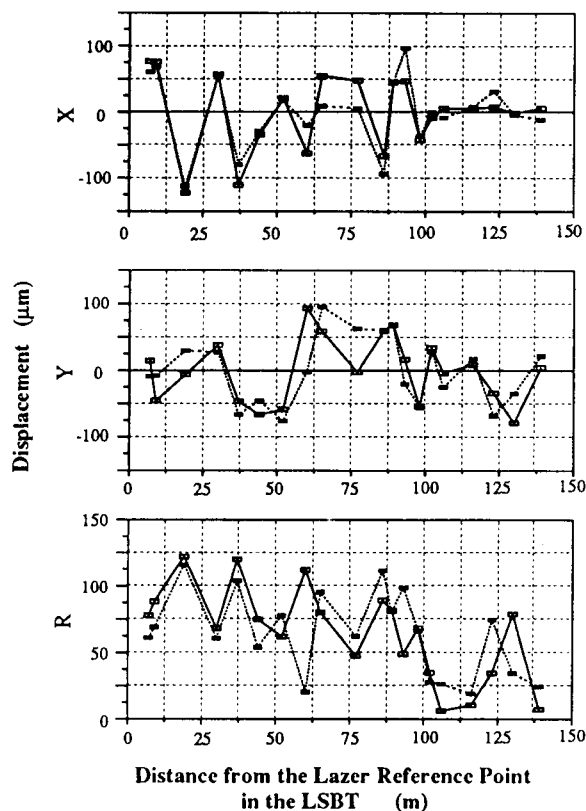


Fig. 2: Alignment data of 20 triplets along the baseline. These three data were measured in series. X is horizontal, Y is vertical, and R is radial direction.

In order to avoid fluctuation of temperature, air motion and not to disturb other usual works in the daytime, measurement of each triplet position was carried out at night. For stabilizing the air motion, the measurement were started after two hours since last person exited from an accelerator room. The triplets' positions were observed one by one from the LSBT side to the gun side using the Super Beam Alyzer, and it took about two hours for one series measurement of 20 triplets. During the measurements, the PSD always monitored the laser beam at the reference point of LSBT side to make sure of the laser beam pointing stability. Data of triplets' positions were obtained from average data of 3 series. In the daytime, the triplets were adjusted to the baseline using an alignment telescope, based on the measured data at night.

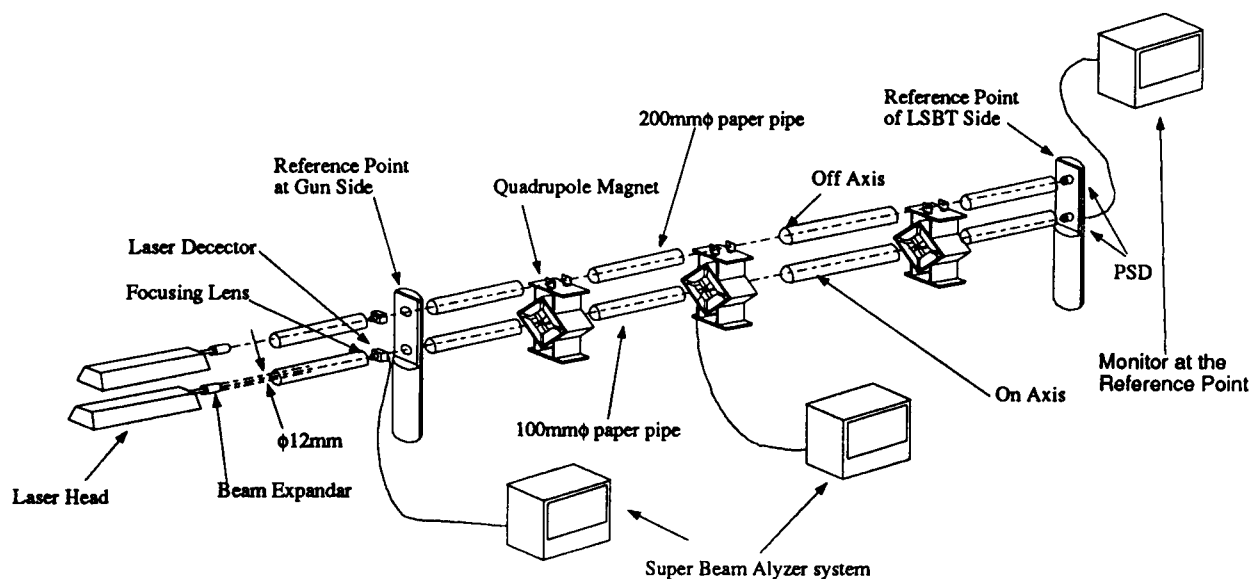


Fig. 1 Outline of the laser system

After the alignment of triplets, off-axis measurement were done using the laser system to obtain differences between on-axis and off-axis measurement. (see in Fig.1) After all devices are installed, the on-axis measurement will not be available, but it will be checked from off-axis measurement by considering with these differences data.

It took one and a half months for triplets' alignment and was finished in the beginning of October 1995.

3. Alignment Results

Alignment data is obtained in Fig. 2. In these data, the alignment error of less than 0.1 mm are observed at all positions of the triplets. But, after two or three weeks later since the alignment had been finished, it is observed that the triplets' positions were changed and the error grew up to about 0.6 ~ 1.0 mm from the off-axis measurement data. We can not realize what courses this error growth now. But another alignment step is planned just before the beam commissioning.

4. Other Installation Status

After the triplets' alignment, supports of accelerator tubes or other devices were installed and adjusted to the target of both side of the triplets' bore center, using the alignment telescope. The main bodies of accelerator tubes were just set on the supports after they were aligned.

Installation of chamber of the beamline, wave guide systems for the accelerator tube, modulator systems or other devices were installed by the end of November.