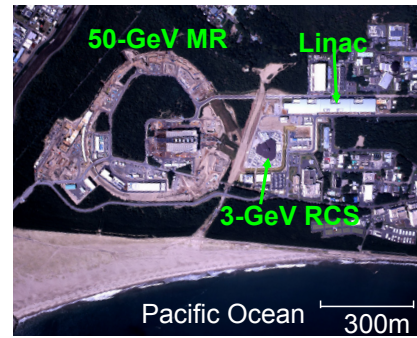


Alignment of Cavities and Magnets at J-PARC linac

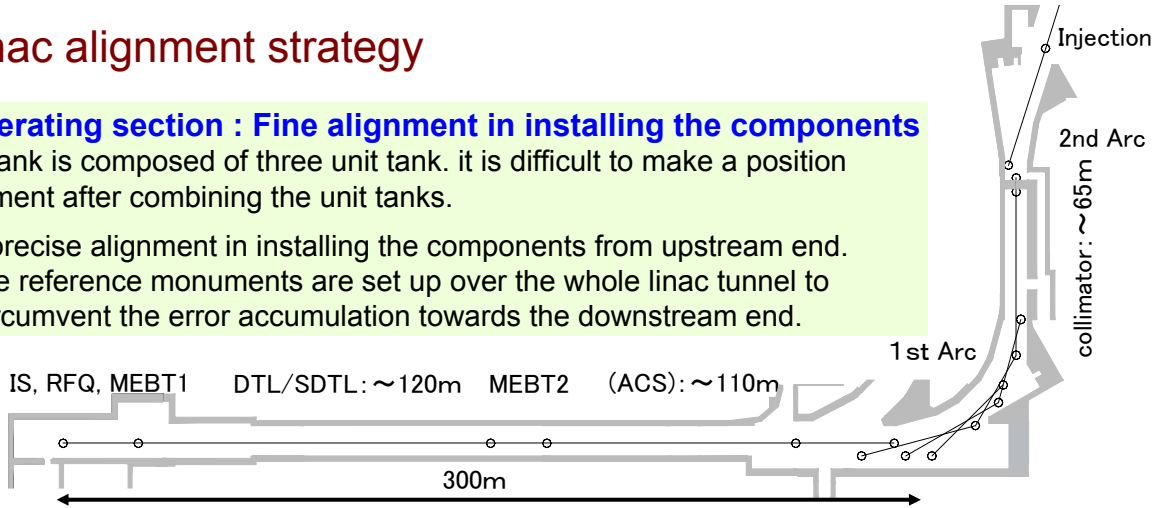
T. Morishita, H. Ao, H. Asano, T. Ito, A. Ueno, T. Ohkawa, and K. Hasegawa, JAEA
M. Ikegami, F. Naito, H. Tanaka, and K. Yoshino, KEK



I, Linac alignment strategy

Accelerating section : Fine alignment in installing the components

- DTL tank is composed of three unit tank. it is difficult to make a position adjustment after combining the unit tanks.
- A precise alignment in installing the components from upstream end.
- The reference monuments are set up over the whole linac tunnel to circumvent the error accumulation towards the downstream end.



Beam transport : Rough installation and precise alignment after the installation.

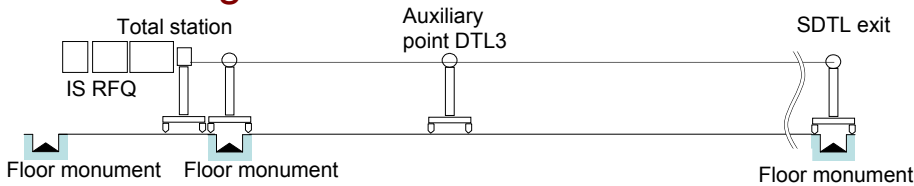
- A certain inconsistency between linac and RCS should be absorbed.
- The inconsistency is absorbed by adjusting the drift spaces and modifying the bending angle.
- A vertical difference is corrected by a slight vertical deflection at the exit of the first arc.

Fine alignment : Detailed survey after the completion of the installation.

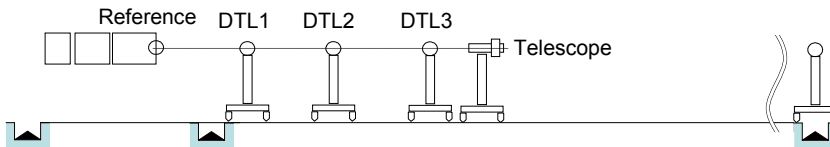
- The floor elevation change and the deformation of the new building should be addressed.
- A minimum position adjustment is conducted to realizing a smooth alignment rather than attaining an idealized straight alignment.

II, Cavity installation and alignment

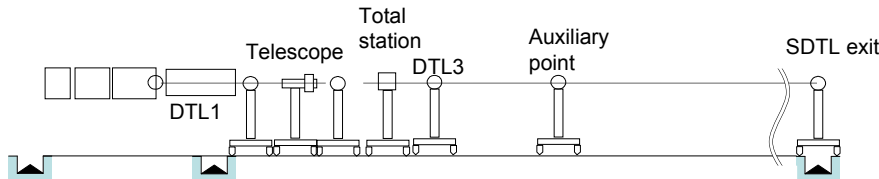
- Setting an auxiliary reference along floor monument with a total station.



- Setting an auxiliary reference for DTL with a telescope



- DTL alignment with a telescope
- Setting an auxiliary reference for SDTL



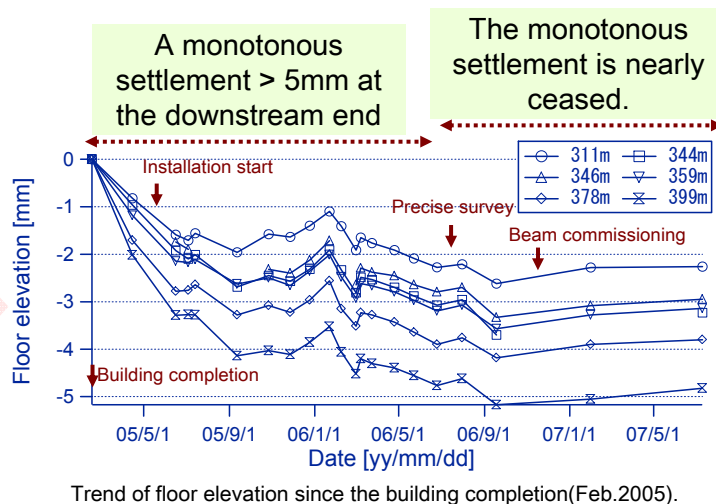
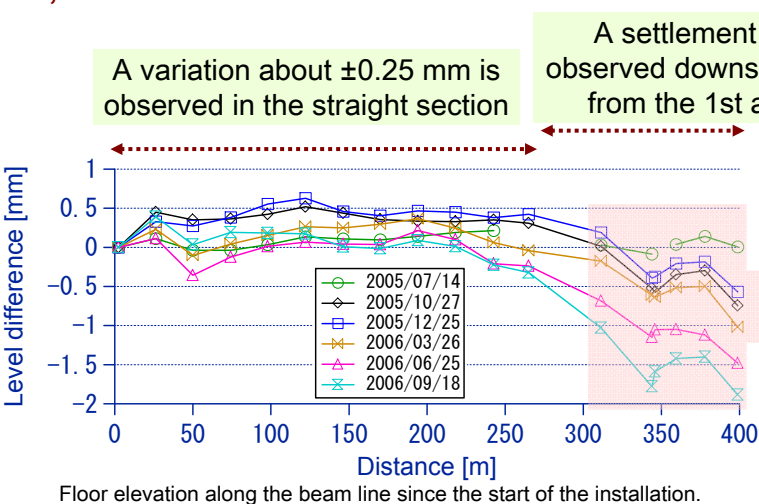
III, Instruments

- Accelerating section is installed by telescope.
- Reference base is measured by laser tracker at the final alignment.

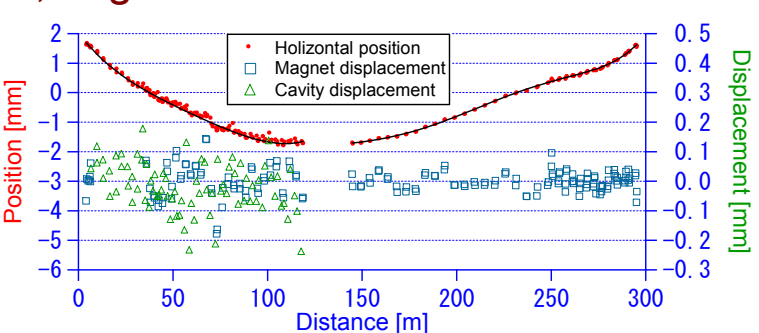
Instruments	Vender	Model #	Spec
Total station	Leica	TDA5005	Angular accuracy 2.4mrad(1s) Dist. accuracy ±0.2mm(<100m)
Telescope	Farrand	95360	
	Taylor Hobson	Micro Alignment Telescope	0.05mm / 30 m
Digital level	Leica	DNA03	Std. deviation per 1km double-run (invar staff) 0.3mm
Laser tracker	Leica	LT600	Dist. resolution 1.26 μm Dist. reproducibility ±5 μm / m Angular resolution 0.67 mrad Angular Repeatability ±5 μm/m

Objectives	Horizontal	Vertical
Acc. Installation	Telescope	
Acc. Realignment	LT600	DNA03
BT section	LT600	DNA03
Auxiliary reference	TDA5005	DNA03

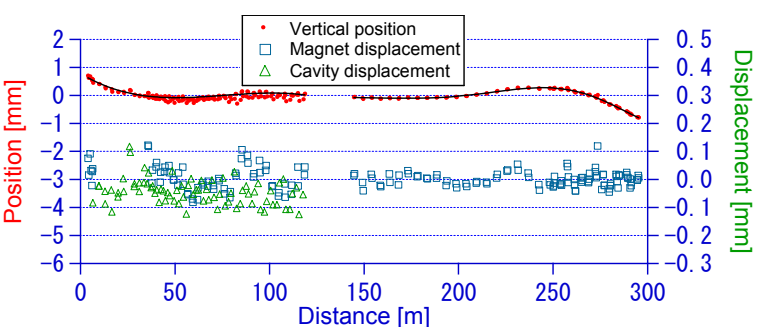
IV, Floor elevation



V, Alignment results



• Horizontal positions, Δ \square Displacement from the curve



• Vertical positions, Δ \square Displacement from the curve

Horizontal position is mostly on a smooth curve

- Total bent reaches 3 mm at both ends of the linac
- Error ellipsoid of this survey ~ 1 mm
- Accuracy of floor monuments ~ 1.7 mm.

A certain portion of this curvature is attributable to a building deformation and the survey error.

Vertical positions from 30m to 250m are on a straight line. The bent in the downstream portion can be attributed to the floor settlement during the installation.

Fine adjustment has performed to align along the curve.

- The realigned components are
 - half of quadruple doublets in the SDTL section,
 - three SDTL cavities,
 - one quadruple doublet in the beam transport section.

As a result, the accuracy of the readjustment is typically less than 0.1 mm for quadrupole magnets.

Inconsistency between the linac and the RCS is absorbed by introducing slight adjustments.

- The lengths of the collimator section and the injection section are adjustment 4.5mm and 4.0mm, respectively.
- The deflection angle of a bending magnet in the 2nd arc is slightly modified by 0.026mrad.
- The settlement is corrected by a slight deflection (0.056mrad) at the exit of the 1st arc.

VI, Summary

- The alignment of J-PARC linac has been conducted from Jun. 2005 to Sept. 2006.
- The emphasis is put on achieving sufficient smoothness.
- Sufficiently smooth alignment has been achieved with an excellent accuracy.
- Beam commissioning in linac has been started since November 2006.
- Nearly complete beam transmission was easily established without using a steering magnet.
- This successful beam transport proves the validity of the strategy and the accurateness of the alignment.