TRANSPORTATION OF THE DTL/SDTL FOR THE J-PARC

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Abstract

Three DTL tanks and 32 SDTL tanks for the Japan Proton Accelerator Research Complex (J-PARC) were assembled at KEK site. After the assembling, the high-power conditioning of the DTL1 and 12 SDTL tanks and the beam acceleration test for the DTL1 ware carried out [1, 2]. And then all the DTL and SDTL tanks have to be transported form KEK to JAEA.

In order to confirm the effect of the transportation to the drift tube alignment, we measured the displacement of the drift tube positions before and after the transportation by using a prototype cavity. As a result of the test, the measured displacement of the drift tubes by the transportation was less than 0.02mm which is consestent in the measurement accuracy. Based on this result, all the DTL and SDTL tanks were transported form KEK to JAEA. In this paper, the transportation results of the prototype cavity and the DTL/SDTL tanks are described.

INTRODUCTION

Japan Atomic Energy Agancy (JAEA) and High Energy Accelerator Research Organization (KEK) are jointly constructing the high intensity proton accelerator in Tokai site of JAEA.

A Drift Tube Linac (DTL) is used to accelerate an H- ion beam from 3MeV to 50MeV. The DTL consists of three tanks which length is about 9m and the each tank consists of three unit tanks which length is about 3m. The inner diameter of the tank is 560mm. The resonant frequency of the tank is 324MHz. All DTs in the tank have a built-in focusing quadrupole magnets

After the DTL section, a Separated type DTL (SDTL) accelerates H^- ion beam from 50MeV to 190MeV. It consists of 32 cavities which length is varied from 1.5m to 2.5m. The tank diameter is 520mm. A focusing magnet (Q-doublet) is set between the SDTL cavities.

All the DTL and SDTL cavities were assembled at KEK. The high-power conditioning was carried out for the DTL1 and 12 SDTL cavities and the beam acceleration test by using the DTL1 was done at KEK. All the DTL and SDTL cavities have to be transported form KEK to JAEA to install at J-PARC building.

ROUTE AND TRAILER

The transportation route is shown in figure 1. The distance form KEK to JAEA is about 95km. The maximum trailer speed is 30km/h on the ordinary road and 60km/h on the JOBAN expressway. The transportaion time is about three hours.

Figure 2 is the photograph of the trailer. It is the low body-type and the wide all-wheel air suspension trailer. The length is 18m, the width is 2.99m and the maximum load is 20t.

For the transportation of both the prototype cavity and the DTL/SDTL, the same route and the same trailer was used.

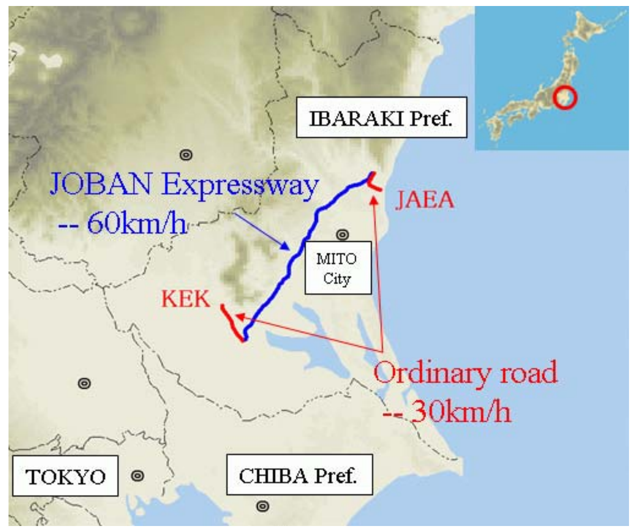

Figure 1: Transportation route.

Figure 2: Photograph of the trailer.

TRANSPORTATION TEST BY USING PROTPTYPE CAVITY

Before the transportation of the cavities for the actual use, we measured the displacement of the drift tube positions before and after the transportation by using a prototype cavity for the confirmation of the effect to the drift tube alignment[3].

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Figure 3 shows the prototype cavity on the trailer. The most suitable weight for transportation is about 12 ton. Then the vivration of the trailer is minimum. Therefore the dummy weights are mounted on the trailer as the total load is about 12t. (Then the vibration of the trailer is minimum.)

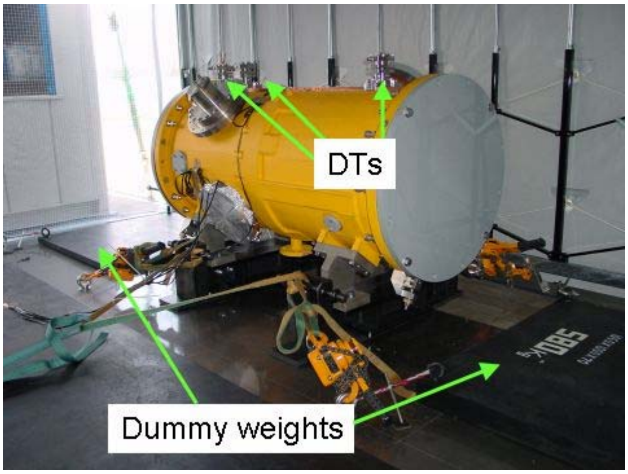

Figure 3: Prototype cavity on the trailer.

Three drift tubes (DT) which are different weights are aligned in the cavity. The acceleration meters are attached on the DTs, the cavity and the trailer (i.e. five meters are attached).

Figure 4 and 5 show the typical acceleration data for Y direction on the ordinay road and the JOBAN expressway (where X is holizontal, Y is vertical and Z is beam axis directions, respectively).

The horizontal axis is the time (sec.) and the vertical axis is the acceleration (G). The data shows that the acceleration is usually less than 0.5G. The maximum data we observed was less than 1G through the transportation.

Table 1 shows the displacement of DT positions before and after the transportation.

The X and the Y position is the distance from an optical alignment telescope axis to the target center attached on the DT bore. The Z position is the distance from the end-face of the cavity to the face of DT and it is measured by a laser scale.

The Displacement of the DT position before and after transportation is approximately 0.02mm. The values are consistent in the accuracy of the measurement system. Therefore we decided to transport the DTL/SDTL cavities using the same method. The requirement for the trailer's acceleration during the DTL/SDTL transportation is less than 1G.

TRANSPORTATION OF THE DTL/SDTL

For the DTL/SDTL cavities, it is mounted on the trailer up to four cavities per transportation. Only the acceleration meter attached on the trailer is used for the DTL/SDTL transportation.

Figure 6 is the acceleration data of the acceleration meter from KEK to JAEA. The horizontal axis is the clock time and the vertical axis is the acceleration. The data is measured every 2ms and the maximum value is recorded for every 5sec.

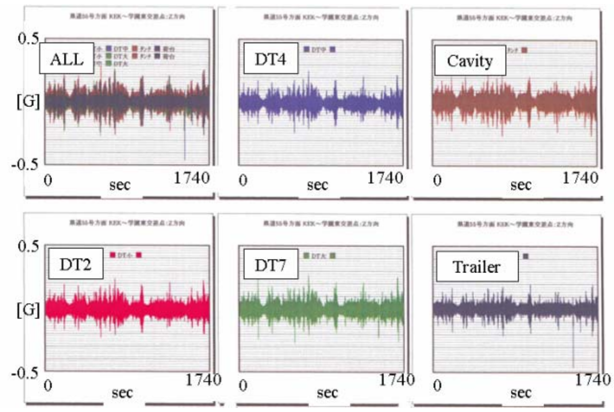

Figure 4: Acceleration data on the ordinary road.

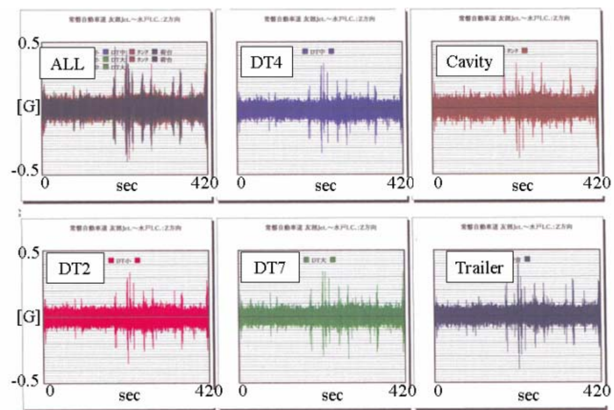

Figure 5: Acceleration data on the expressway.

Table 1: DT position before and after transportation

DT No.		X (mm)	Y (mm)	Z (mm)
No. 2	Before	0.03	0.06	112.986
	After	0.03	0.06	112.968
	Displacement	**0.000**	**0.000**	**-0.018**
No. 4	Before	-0.025	-0.02	264.925
	After	-0.01	-0.01	264.925
	Displacement	**0.015**	**0.010**	**0.000**
No. 7	Before	-0.05	-0.03	1071.618
	After	-0.04	-0.02	1071.601
	Displacement	**0.010**	**0.010**	**-0.017**

The driving time is about four hours and a half including an hour and a half break time.

The measured maximum acceleration is less than 1G. The values are usually less than 0.5G in all directions. This sisutation is equal to that of the prototype cavity transportation.

After the transportation, we measured the DT position of all cavities.

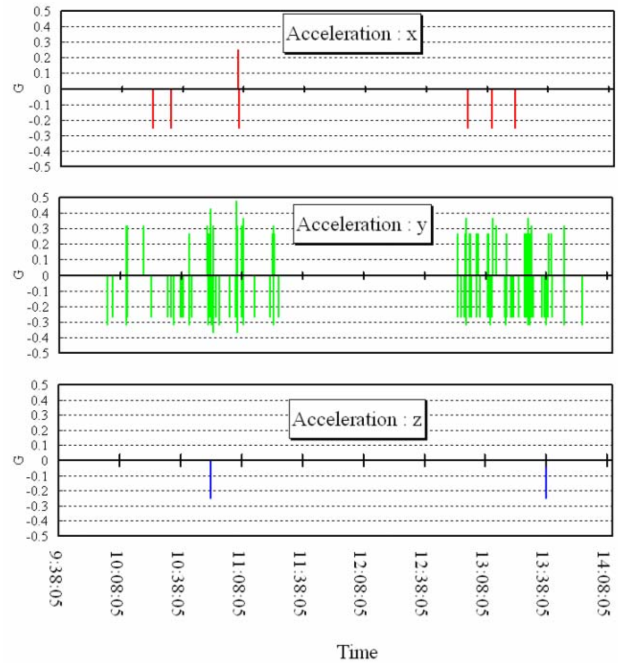

Figure 6: Acceleration data during the transportation.

Confirmation of the DT position of DTL2

For the DTL2, high accuracy measurement of the DT position by using optical target was done. The accuracy of measurement is about ±0.05mm.

Figure 7 is the all DT positions of the DTL2 after the transportation. The origin of coordinate is the beam axis determined by the templates attached on each flanges of the cavity.

The result shows the DT position after the transportation is about within the 0.05mm from the beam axis. The distribution of the DT position are as same as that measured when the assembled in the tank at KEK before.

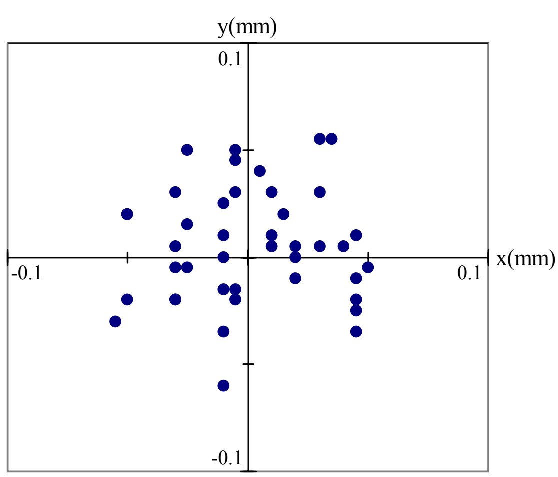

Figure 7: DT position of the DTL2 after the transportation.

Confirmation of the DT position of all cavities with an acrylic cylinder

We measured the DT position of all cavities with the metallic cylinders with an acrylic cap. The diameter of the cylinder is 0.5mm smaller than that of the DT bore and the length is about two twice of the DT gap length. Figure 8 is the schematic view of the measurement and an example data of the DT position of the SDTL cavity.

The accuracy of the measurement is about 0.1~0.2mm because of the error which is caused by the friction between the DT bore (inner face) and other factors. However the clear displacement of the DT position was not observed.

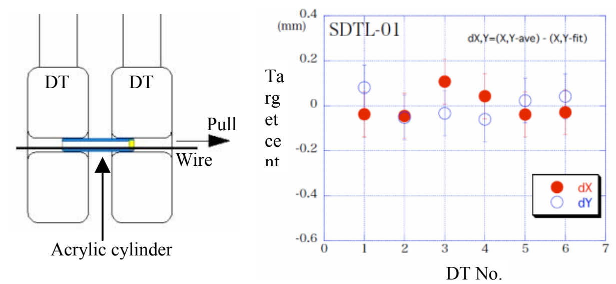

Figure 8: Schematic view of the measurement and the DT position of the SDTL1 after the transportation.

CONCLUSION

- All the DTL and SDTL cavities have to be transported form KEK to JAEA for the installation in the J-PARC building.
- We decided to transport the DTL/SDTL under the same condition confirmed by the prototype cavity transportation. It is required that the trailer's acceleration during the DTL/SDTL transportation should be less than 1G.
- As a result of the measurement of DT position after the transportation, the displacement of the DT position was not observed.

ACKNOWLEDGEMNETS

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