OPERATION EXPERIENCES OF THE DTL/SDTL FOR THE J-PARC

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Abstract

An operation of a DTL and a Separated type DTL (SDTL) of J-PARC started in November 2006. The DTL and SDTL are currently running stable and accelerating the beam. To maintain the stable operation of the DTL and SDTL, we have done the maintenance of various equipment for the tank and solved many troubles. In this paper, we will present the operation experiences of the DTL and the SDTL.

INTRODUCTION

A Drift Tube Linac (DTL) and a Separated type DTL (SDTL) for the Japan Proton Accelerator Research Complex (J-PARC) are typical Alvalez structure linacs. The DTL consist of three tanks and accelerates an H^- ion from 3MeV to 50MeV. The SDTL consist of 30 tanks (without 2 debuncher tanks) and accelerate the beam from 50MeV to 181MeV. The operating rf power of the DTL and the SDTL is fed from klystrons and the operating frequency is 324MHz. The DTL and the SDTL have acceleration electrodes named Drift Tubes (DT), tuners to adjust the resonant frequency, rf couplers to feed rf power. Only the DTL have post couplers to stabilize the electric field. Each DT of the DTL contains a focusing electric quadrupole magnet. A focusing magnet of the SDTL is set between the SDTL tanks. The main parameter of the DTL and the SDTL is shown in Table 1.

Table 1: Main parameters of the DTL and SDTL

		DTL1	DTL2	DTL3	SDTL
Beam Energy [MeV]	In	3.0	19.7	36.7	50.1
	Out	19.7	36.7	50.1	181
Ave. electric field [MV] (upper:S1A, lower:S15B)		2.5	2.7	2.9	2.53 3.74
Tank length [mm] (upper:S1A, lower:S15B)		9920	9440	7323	1471 2508
Tank Diameter [mm]		560	560	560	520
DT diameter [mm]		140	140	140	92
Bore diameter [mm]		13, 18	22	26	36
No. of Tanks		-	-	-	30
No. of Cells		75	42	26	5
No. of Post couplers		36	42	26	-
No. of RF couplers		2	2	2	1
No. of Movable Tuners		2	2	2	1
No. of Fixed Tuners		10	10	8	2
Operating Freq. [MHz]		324	324	324	324

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During three months from April to June 2010, the availability in this period is above 90% for MLF and a neutrino experiment [1]. This high availability is a result of the prompt action to the troubles and the improvement of various equipment that is done by members of each facility of J-PRAC. The photograph of the DTL installed in the accelerator tunnel is shown in Figure 1.

Figure 1: Photograph of the DTL. The right side is the upstream and the left side is downstream.

In this paper, we will present the operation experiences of the DTL and the SDTL.

REPLACEMENT OF THE CERAMIC WINDOW OF RF COUPLER

The rf coupler is used to feed the rf power to the tank. The rf coupler have the ceramic window and it is used to through the rf power to the tank and keep the vacuum in the tank. Deteriorating a ceramic window, trip rate increase. Thus a ceramic window is replaced periodically before severe trouble such as vacuum leak, temperature rise, and so on occurs.

DTL

The operation of the DTL started in November 2006. Since then, the DTL is operated over three years without the replacement of the ceramic window. Fortunately, we did not experience the trouble of ceramic window during this period.

We replaced the ceramic window in 2009 (DTL1 and DTL2) and 2010 (DTL3) summer maintenance period as a preventive measure. Figure 2 is the photograph of ceramic window before and after. The surface of the tank side of used ceramic window was dark color and changed like mirror. In spite of this condition, there was no trouble that the beam acceleration became impossible.

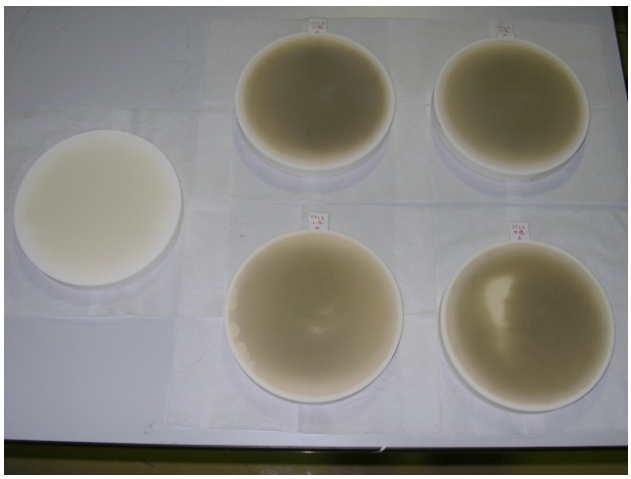

Figure 2: Photograph of the ceramic window. The left one is an unused window and four other windows are used.

Table 2 shows the trip rate (ex. electric discharge) of the DTL1 and DTL2 before and after the replacement. Just after the replacement of the ceramic window, the trip rate was improved somewhat. It was improved as conditioning by RUN34. Currently, DTL1 and DTL2 is very stable.

Table 2: Trip rate of the DTL1 and DTL2

RUN No. (period)		Trip Rate (times/day)	
		DTL1	DTL2
RUN 25 (2009/06)	before	1.71	5.93
RUN 26 (2009/10)	after	1.29	4.43
RUN 34 (2010/06)	after	0.65	0.73

SDTL

The ceramic window is brazed to coaxial tube of the SDTL rf coupler. Consequently, it is impossible to remove only the ceramic window from rf coupler. However, as the electric field and an X ray from the cavity is not strong around the ceramic window, the ceramic window is not so deteriorated and it is not necessary to replace the ceramic window periodically. If the rf coupler have troubles, we exchange used rf coupler for new one.

The operation of the SDTL started at the same time as the DTL operation and we exchanged the only one rf coupler of the SDTL on March 2009 (SDTL-8A). The reason of the exchange of the rf coupler is the frequently trip caused by the electric discharge around the ceramic window. After the exchange, the trip by the electric discharge of the coupler does not occur.

DAMAGE OF THE COAXIAL TUBE

In the accelerator tunnel, the rf power for the DTL and the SDTL is fed through a coaxial tube. The damage event of the coaxial tube was occurred at the connection between the tubes. Figure 3 is the photograph of the damaged coaxial tube. As the contactors of the inner conductor was not jointed each other correctly, the electric connection was loose. As a result, the contactor was heated abnormally, the surface of the contactor was crumbly texture and the polyethylene inner tube support was heavily charred. The cause of this problem is faulty wokmanship of installation of the coaxial tube.

This trouble has ever occurred twice. The first was on February 2009, we happened to find this problem at SDTL-7A. The operation of the SDTL-7A was very stable and the trip rarely happened at SDTL-7. When we entered the accelerator tunnel in order to do the maintenance work after the beam acceleration, we felt the burned smell slightly and could identify the location of the problem point. The outer conductor was too hot to touch for a long time. When measuring the coaxial tube, The temperature was about 40 degrees at the outer conductor surface and 54 degrees at the contactor surface about 2 hours after the beam was stopped.

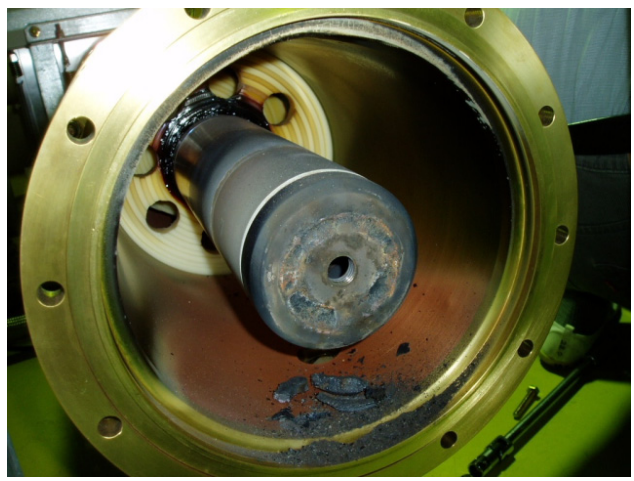

Figure 3: Photograph of damaged coaxial tube.

To check that the same thing occur to other connections of the coaxial tube, we put thermo labels on almost all connections of outer conductor.

The second incident was on June 2010. the trip rate of SDTL-15A increased and the operation of the tank was impossible finally. Unfortunately, the thermo label was not put on this connection and the color of the neighbor label was not changed. At this time, it took 7 hours to restart the beam acceleration.

In an effort to improve the situation, we will put the labels on no-label connections of outer conductor in this summer maintenance period.

VACUUM LEAK AT THE E-SEAL

A metal seal covered with indium plating, named E-seal, is used for a vacuum seal at an end plate of the SDTL. The vacuum leak was occurred at this E-seal. Fortunately the beam acceleration have never been stopped about this problem because the worsening of the vacuum was very slow and it is possible to stop the vacuum leak by using an outer seal as the end plate has double seal structure. Figure 4 is the photograph of the end plate removed from the SDTL. The silver ring is the E-seal and outer black ring is an elastomer O ring. If the vacuum leak is occurred at the E-seal, it is possible to stop the leak by the O ring.

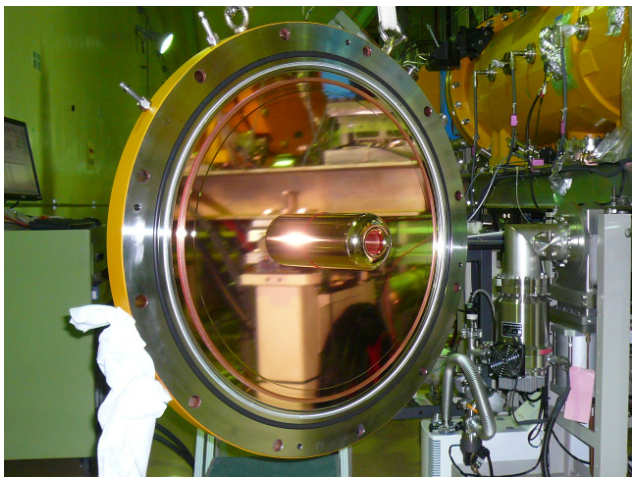

Figure 4: The end plate detached from the SDTL. The inner seal (silver) is an E-seal and the outer seal (black) is an elastomer O ring.

The vacuum leak was occurred at the downstream end plate of SDTL-15B, upstream and downstream (twice) of SDTL10A and upstream and downstream of SDTL-2A. Amount of time required to replacement of the E-seal is about one week per one end plate. Therefore we have replaced E-seals during the summer maintenance period of 2008, 2009 and 2010.

So far, it is not known exactly why the vacuum leak is occurred. We suspect that the deterioration of the indium plating by oxidation and the nonuniform tightening torque of the end plate may have caused the vacuum leak

SUMMARY

After the first operation of the DTL and SDTL, we have made an effort to improve the availability of beam acceleration because the trouble caused the reduction of experimental time of J-PARC user. In the past, we have solved the rf , vacuum and many minor troubles and done the maintenance of equipment of the tank. Currently, the operation of the DTL and the SDTL become stable by these continued effort.

ACKNOWLEDGMENT

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REFERENCES

[1] S. Nagamiya et.al, J-PARC Project Newsletter No. 41, http://j-parc.jp/hypermail/news-l.2010/0004.html