TUPP070

STATUS AND RECENT MODIFICATIONS TO 324-MHz RF SOURCE IN J-PARC LINAC

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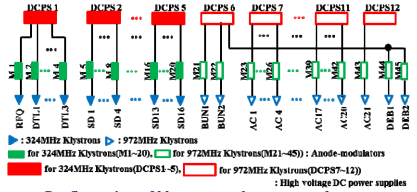
PRESENT STATUS



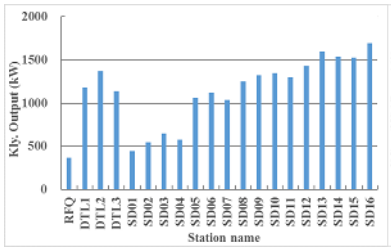
Configuration of klystrons and power supply system for klystrons in J-PARC 400MeV linac.

324-MHz Klystron (Toshiba E3740A)

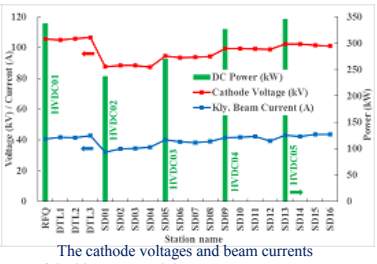
Frequency	324 MHz
Output Power	3 MW
Efficiency	50 %
Gain	55 dB
RF Pulse Length	620 μs
Beam Pulse Length	700 μs
Repetition Rate	50 Hz
Beam Voltage	110 kV
Anode Voltage	94 kV
Beam Perveance	1.37×10^{-6}
No. of cavities	5
Window	Coaxial
Output Flange	WR-2300
Tube Length	4.55 m

High voltage DC power supplies (HVDC01 ~ 05)

No. of klystrons	4
Cathode voltage	110 kV
Average of current	6.3 A
Power	693 kW
Pulse current	180 A
Pulse width	700 μs
Repetition rate	50 pps
Duty factor	5 %
Capacitor bank	25.5 μF



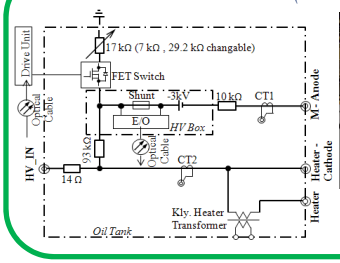
The klystron output powers.



The cathode voltages and beam currents of the klystrons, and the HVDC output powers.

The measured values of the 324-MHz RF source (when the linac accelerate 15mA, 500μs H- beams) .

Anode modulators (M1 ~ 20)



(From left to right) DISCON switch, anode-modulator, 324 MHz klystron. The control cabinets are at the right end.

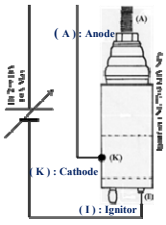
- The linac is upgraded to 400MeV and began to operate on January 17th 2014.
- Since 2006, the majority of the 324-MHz RF source components have total operating times of over 35,000 hours.

RECENT MODIFICATIONS

(1) Recovery from Earthquake Disaster

A large earthquake with a magnitude of 9.0 struck north-eastern Japan on March 11, 2011 (*the Great East Japan Earthquake Disaster*).
The earthquake's intensity at J-PARC measured a "6-lower", which equates to the third highest intensity on the ten-ranked Japanese seismic scale.

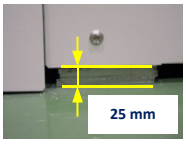
Concerning the components of the 324-MHz RF source, the most significant damage was the subsequent decrease in the external resistance of the ignitrons.
Ignitrons (National Electronics, NL7703EHVNP) are *used as crowbar switches* , and comprise 29 components of the 6 HVDCs (HVDC1-6).
The external resistances between the ignitors and the cathodes, which are *infinite at normal level*, decreased by under 10 Ω in 24 components (82.8% overall).



The cause of this decrease was taken to be the shaking sustained in the ignitrons during the earthquake, which resulted in the spillage of the mercury in the ignitrons onto the ignitors.
To repair the 24 faulty ignitrons, *the method of impressing DC voltages (2 – 10 V) between the ignitors (-) and the cathodes (+) was used.*
As a result of this treatment, 20 pieces were recovered (a recovery rate of 83.3%).
The 4 remaining faulty ignitrons were replaced.

A broken anode-modulator anchor bolt.

A deformed flexible waveguide near a klystron output window.



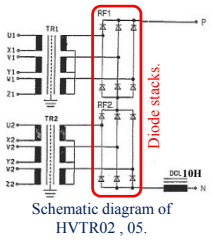
Metal plates are inserted under a rack because of deforming the floor.

(2) 324-MHz Klystrons — Results of 324-MHz Klystron Replacement

(i) ~ (iv) The problems of klystrons themselves (breakdown , discharge , etc.)
(v) , (vi) The other reasons (HVTR exchange , cathode-voltage-changing)

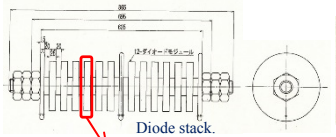
(3) High-voltage Transformers (HVTRs)

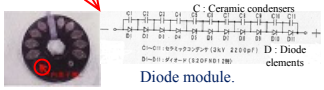
A total of 3 HVTRs failed:
_ HVTR01 in Mar. 2012 (the total operating hours was 28,400h (hours)).
It was replaced with HVTR11.
_ HVTR02 in Dec. 2013 (30,200h), replaced with HVTR14.
_ HVTR05 in Jun. 2014 (36,000h).
It will be replaced with repaired HVTR02.



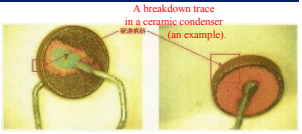
Schematic diagram of HVTR02 , 05.

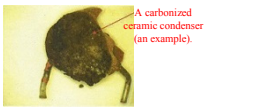
Inside the HVTR02 oil tank.



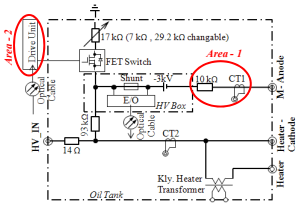


Diode module.

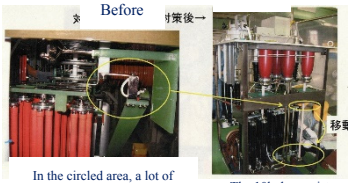




(4) Anode-Modulators



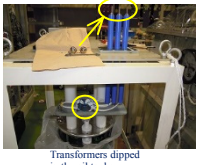
Area - 1



In the circled area, a lot of discharge occurred.

The 10kohm resister connected lower area .

Area - 2



Transformers dipped in the oil tanks.

The cranes in the linac building could not function, so the anode-modulators were moved overground. (Aug. 2012).

Anode-modulators were re-arranged using cranes.(Jul. 2013).