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核物質非破壊検知システムのための高出力パルスDD-IEC中性子源の開発
Development of high-power pulsed DD-IEC neutron source for non-destructive nuclear materials detector

猪上和希[1], 増田開[2], 長崎百伸[2], 梶原泰樹[1], 中松良太[1], 羽田和慶[1]
K. Inoue[1], K. Masuda[2], K. Nagasaki[2], T. Kajiwara[1], R. Nakamatsu[1] and K. Hada[1]

[1]京大エネ科, [2]京大エネ理工研
[1]GSES, Kyoto Univ., [2]IAE, Kyoto Univ.

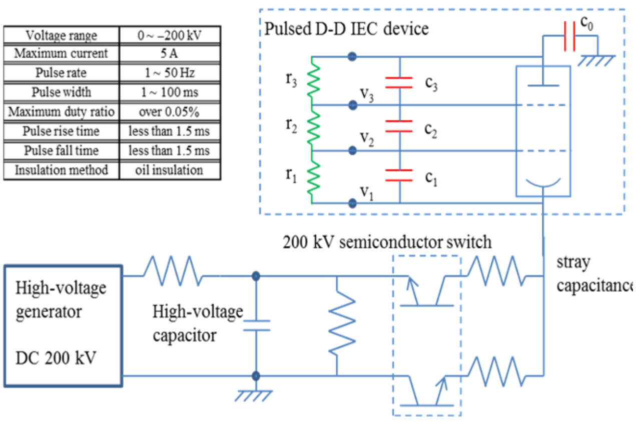
Inertial Electrostatic Confinement Fusion (IECF) has been studied as a compact neutron source, which accelerates ions produced by glow discharge toward the hollow cathode with the static electric field. Non-destructive detection of nuclear materials is one of its potential applications, which is expected to prevent nuclear terrorism. The neutron based method is beneficial since neutrons have high penetrating length. The IEC fusion research group at Institute of Advanced Energy, Kyoto University has been developing a pulsed D-D IEC device for this purpose.

The device was designed and is being tested in high voltage operation in order to achieve an averaged neutron production rate of 1.0×10^8 n / s. The anode and cathode consist of a spherical mesh, and a spherical grid respectively. In order to determine the cathode and anode size we conducted DC experiments by use of a prototype IEC. As the results, we adopted anode diameter of 560 mm and cathode diameter of 200 mm. Specifications of the pulsed power supply are summarized in the table in Fig. 1. The electromagnetic noise is expected to be minimized by an oil tank at grounded potential within which all the HV circuit components are placed unlike existing pulsed IEC devices.

The newly developed IEC device is featured by a 3-stage HV feedthrough with two intermediately biased electrodes (v_2 and v_3 in Fig. 1) with equal intervals to prevent arcing.

We have evaluated unknown capacitances from experiments as follows with moderate pulsed voltages around 20 kV. Capacitances between electrodes of the 3-stage HV feedthrough in the IEC device (c_1, c_2, c_3) were evaluated from measured voltages (v_1, v_2, v_3) (see Fig. 2) without the parallel resistances (r_1, r_2, r_3) and discharge current in the IEC device, i.e. the experiment was done without D_2 gas supply. Also, we evaluated the stray capacitance c_0 of the HV line in the oil tank from experimental pulse fall-time by use of a dummy load of known impedance instead of the IEC device. From those experiments, we thus evaluated all the unknown capacitances c_0 – c_3. We will then determine the dividing resistance (r_1, r_2, r_3) and move to experiments with a D_2 gas and high voltages up to 200 kV.

In the conference we report detail of the pulsed D-D IEC device design and experimental results from the prototype DC and the pulsed D-D IEC devices.



Voltage range	0～-200 kV
Maximum current	5 A
Pulse rate	1～50 Hz
Pulse width	1～100 ms
Maximum duty ratio	over 0.05%
Pulse rise time	less than 1.5 ms
Pulse fall time	less than 1.5 ms
Insulation method	oil insulation

Fig.1. circuit of pulsed D-D IEC device and po supply

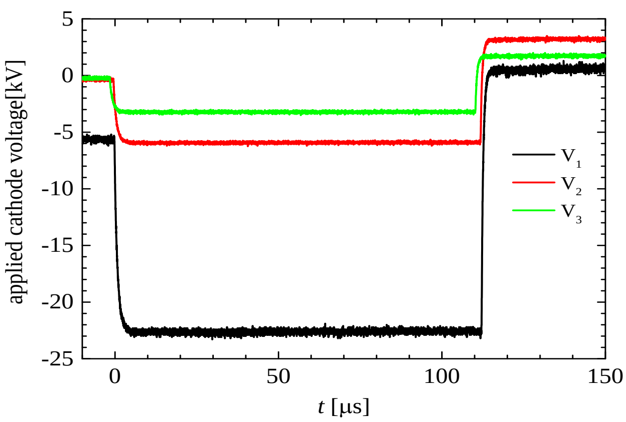


Fig.2. Voltages at each stages v_1, v_2 and v_3 without dividing resistors r_1, r_2 and r_3 under vacuum condition