
IEC Operation with the Cathode Designed for Extracting Ion from Ion Source

Y. Ishikura, N. Yamashita, K. Fukuta, A. Maeda, H. Osawa and M. Onishi
Kansai University, department of electrical engineering and computer science
Yamate-cho, Suita-shi, Osaka, 565-8680, Japan

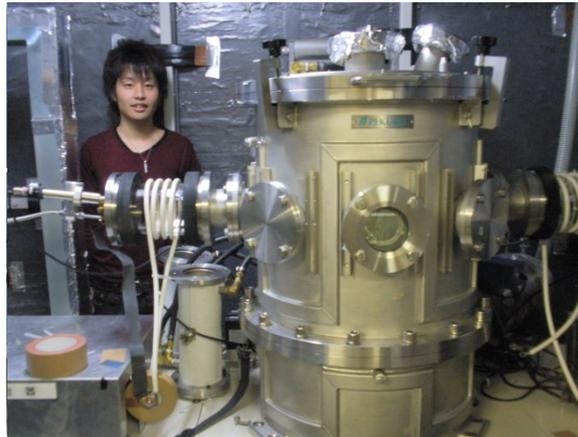
Outline

- Purpose of the study
 - Experimental setup at Kansai U.
 - Experiment 1 (Different size of diamond shape cathode)
 - Discharge characteristics of the diamond cathode
 - Neutron production rate with diamond cathode
 - Experiment 2 (Different size of cylindrical shape cathode)
 - Discharge characteristics of the cylindrical cathode
 - Neutron production rate with cylindrical cathode
 - Energy level of the E-M noise signal
 - Conclusions
-

Purpose of the study

- To achieve the high current operation with a pulse power supply in order to increase the neutron production rate (NPR).
 - To examine the characteristics of pulse operation for the cathode of the different size.
 - To clarify the discharge current and the applied voltage vs. the gas pressure.
 - To obtain the NPR vs. the gas pressure.
-

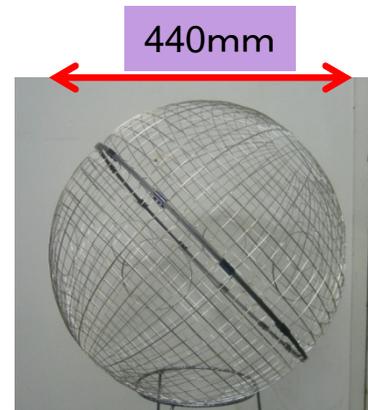
Experimental setup at Kansai University



Appearance

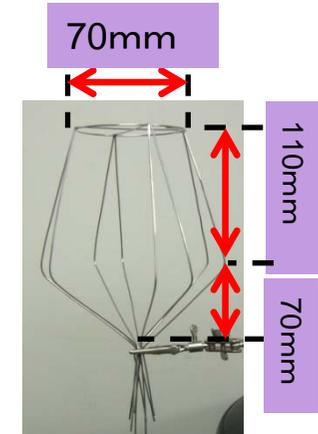


Inside of the device



440mm

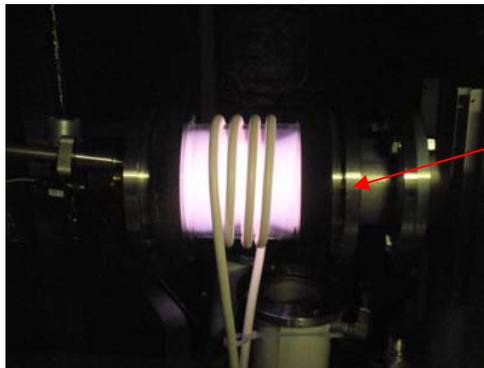
Anode



70mm

110mm
70mm

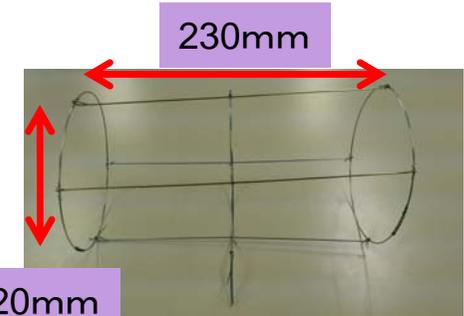
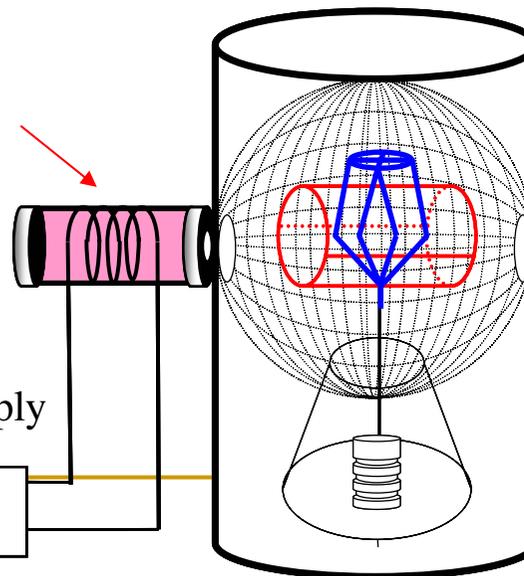
Diamond shape cathode



Discharge of ion source with hydrogen

Ion source

RF power supply



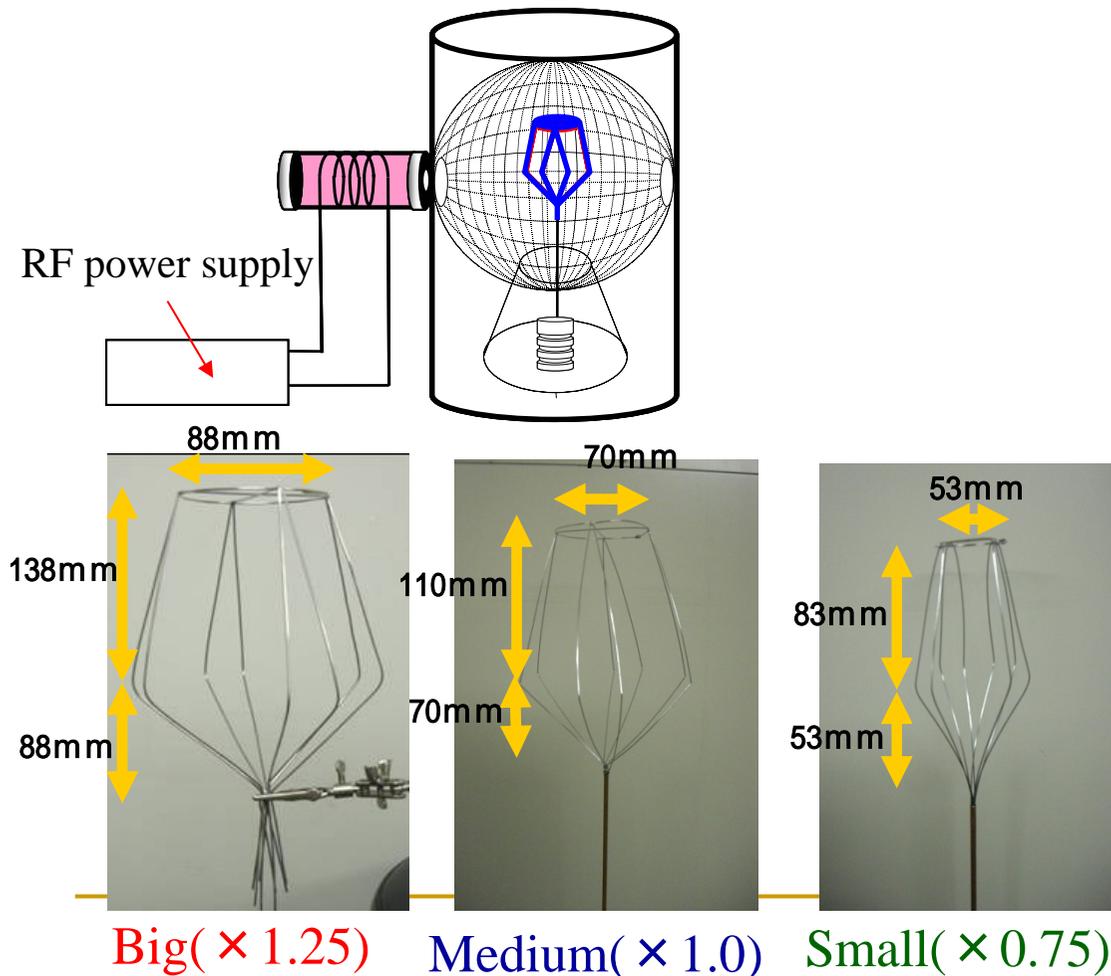
230mm

120mm

The cylindrical shape cathode

Experiment 1, Diamond cathode (Different size of the diamond cathode)

An experiment is operated for study on discharge characteristic and neutron production rate with the different size cathode.

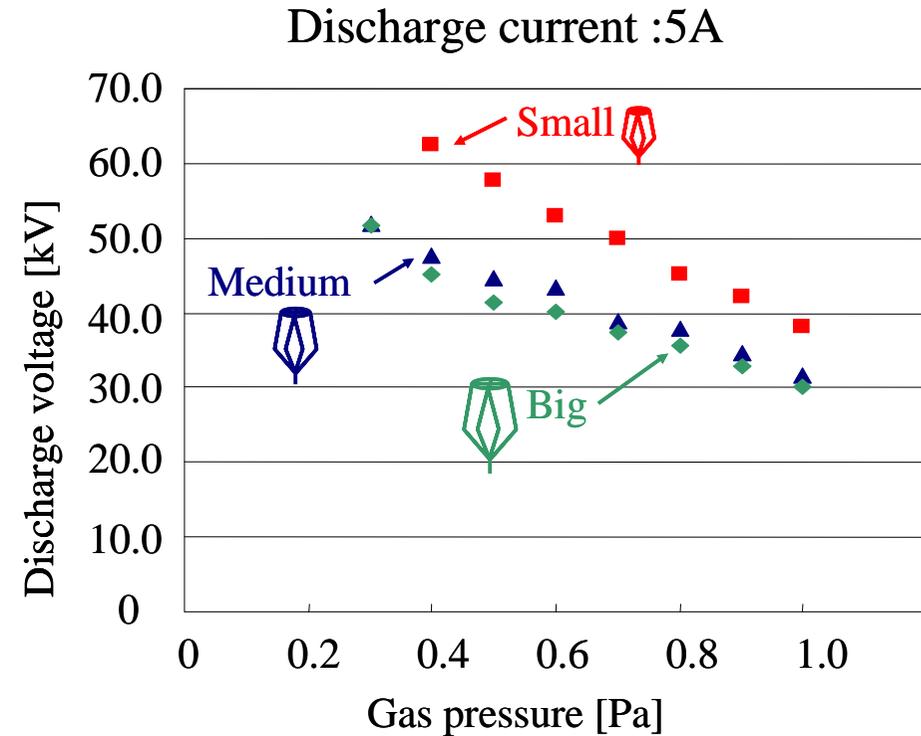
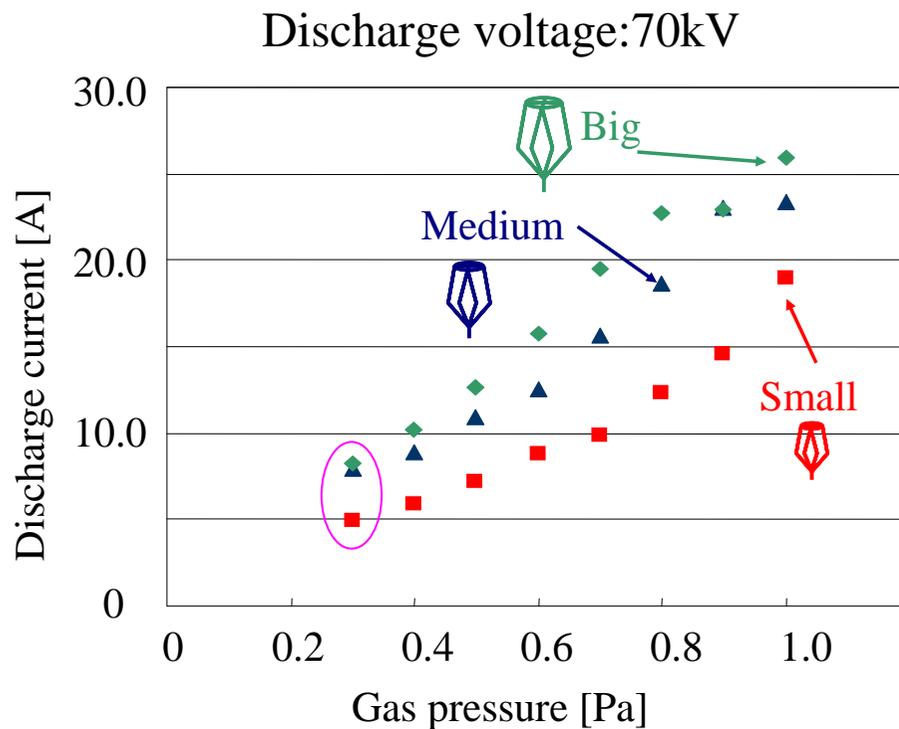


Experiment parameter table

Anode	ϕ 440mm
Cathode	diamond shaped
Gas	Deuterium
RF power supply	400W
Gas inflow	10 sccm
pulse	20pps, 6usec
Ion source	left
Measurement time for Neutron	150sec/shot

(70kV or 5A)

Discharge characteristic with the diamond cathode (Experiment 1, Diamond cathode)



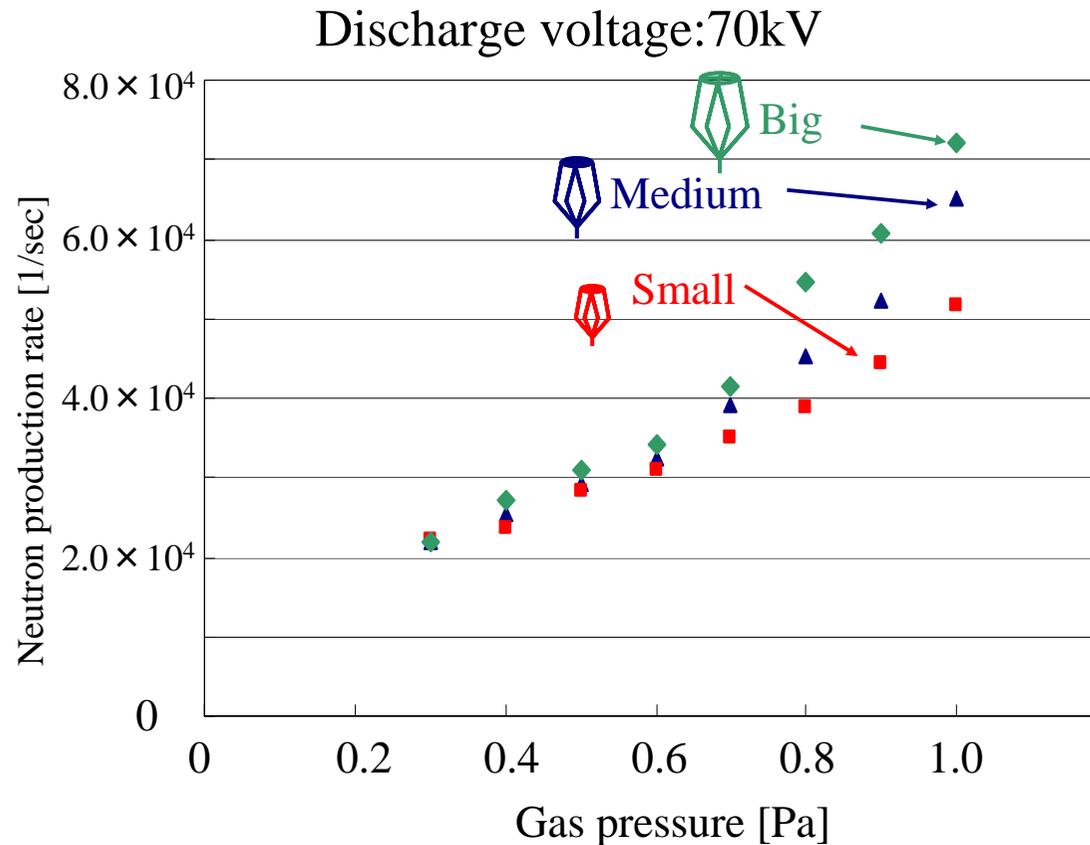
When the gas pressure becomes low, the discharge current is low and the voltage becomes high.

When the bigger cathode is used, the higher current flows and the discharge voltage becomes lower.

Using the bigger cathode, the distance between ion source and the cathode becomes shorter, and the electric field becomes strong.

The discharge is very stable and the low gas pressure of 0.3 Pa is achieved.

Neutron production rate with diamond cathode (Experiment 1, Diamond cathode)

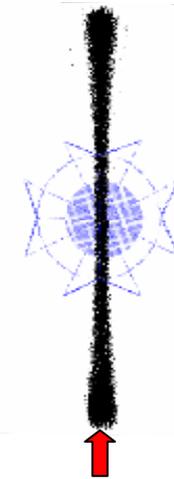
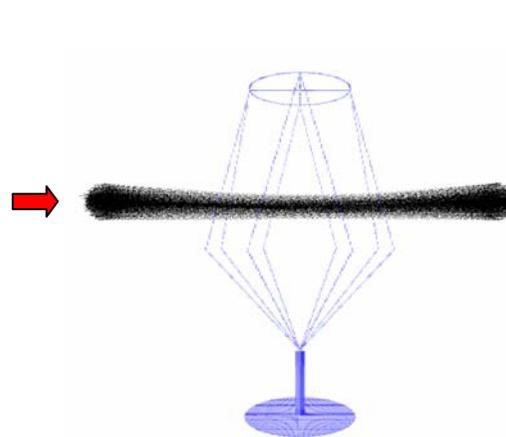
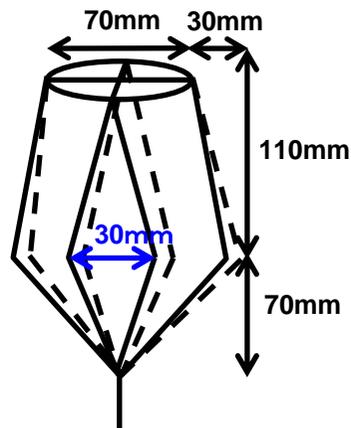


This graph shows that bigger cathode has a good performance of neutron production rate . When the big cathode is used, more ion beam is extracted from the ion source, and the Neutron production rate is increased.

New cathode designed for extraction ion

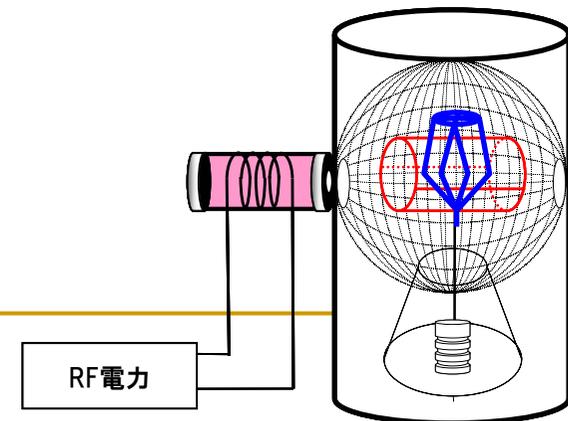
Diamond shaped cathode is designed for the good transparency of ion beam from the ion source by orbital calculation.

And The ion trajectory is very stable, discharge of 0.3Pa is achieved.

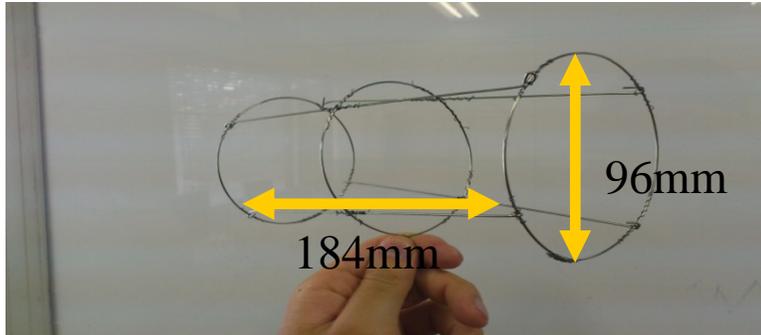


If the cathode is set closer to the ion source, the neutron production rate might be raised.

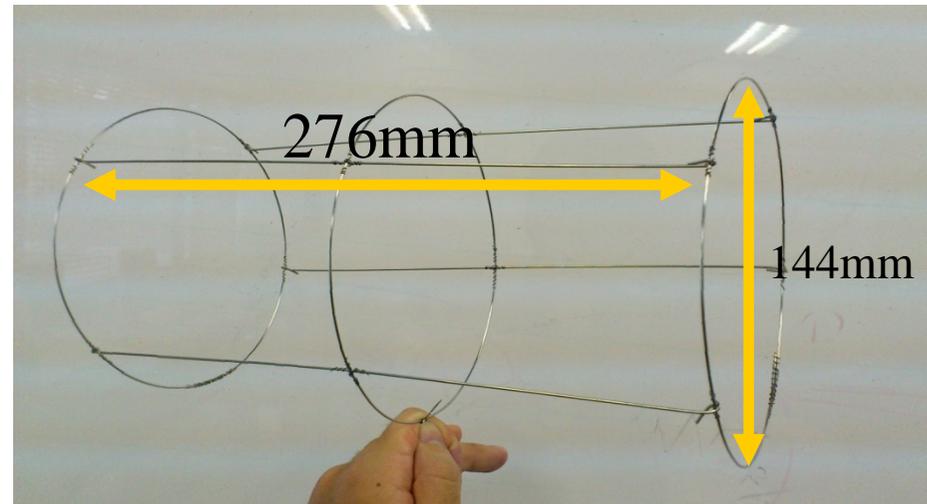
Therefore, the new designed cathode to set closer to the ion source for extraction ion beam is tested



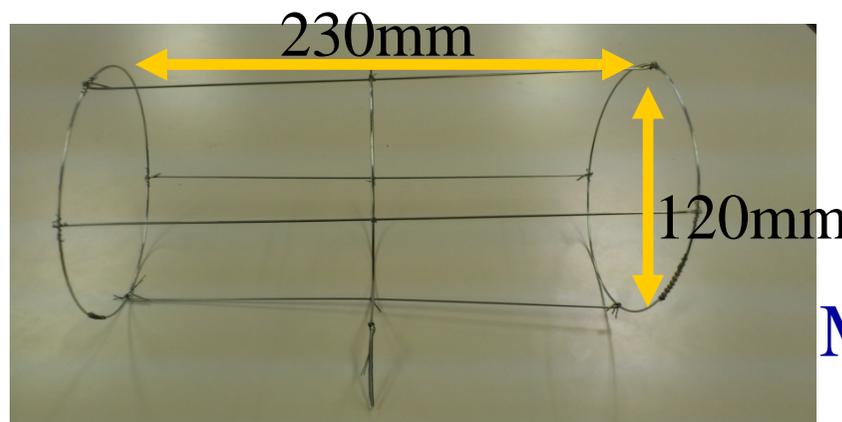
The different size of the cylindrical cathode



Small(× 0.8)



Big(× 1.2)



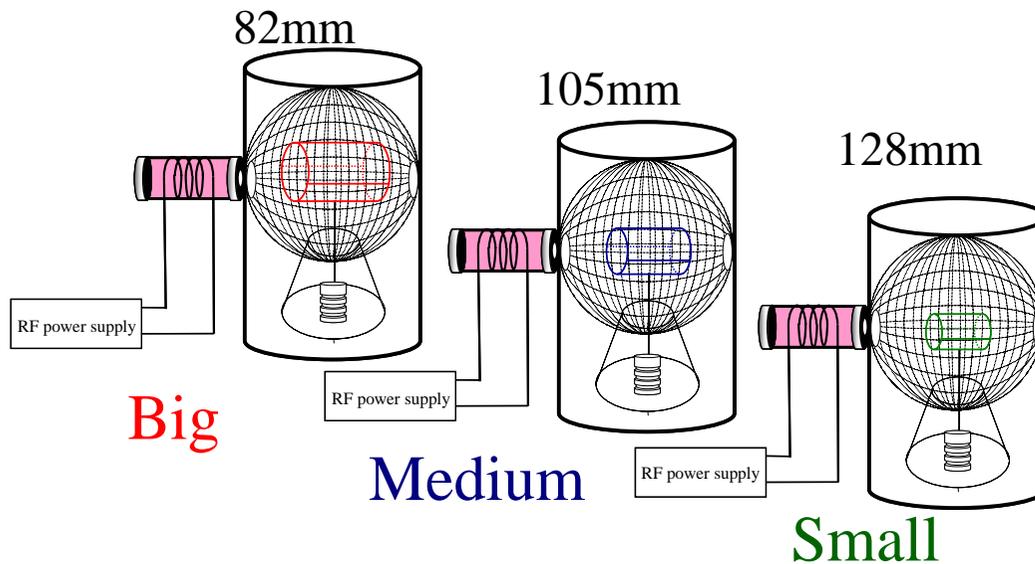
Medium(× 1.0)

From the results of diamond shaped cathode, the cathode near the ion source will be served as a extraction electrode.

So, the cylindrical cathode is designed.

Experiment 2, Cylindrical cathode (Different size of the cylindrical cathode)

An experiment is operated for study on discharge characteristic and neutron production rate with the different size cathode.



The discharge with cylindrical cathode is not so stable.

→ The applied voltage to study for discharge characteristics is changed from 70kV to 50kV.

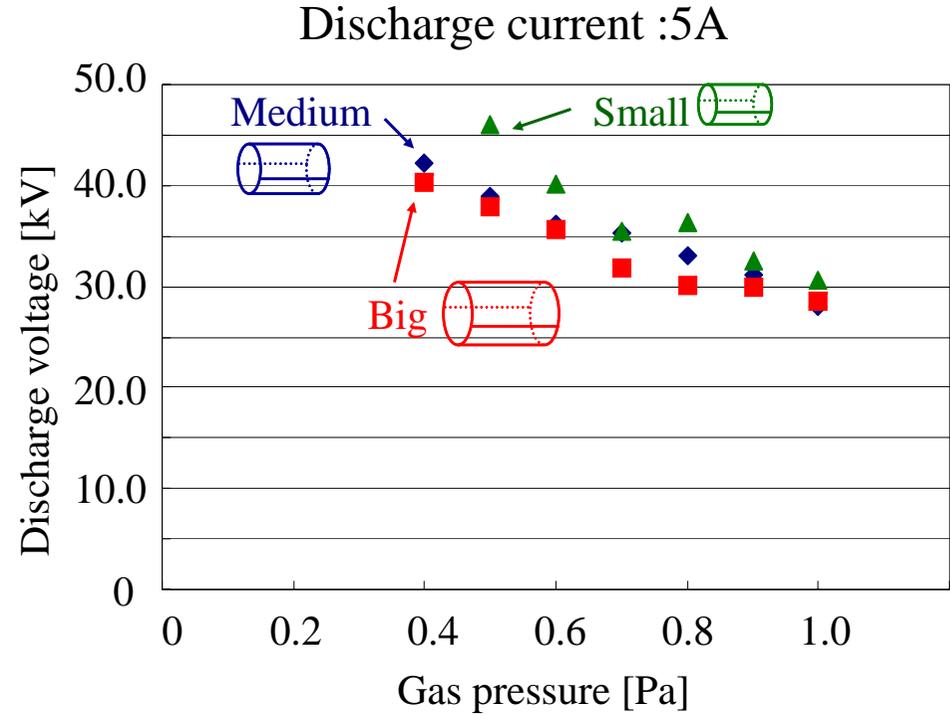
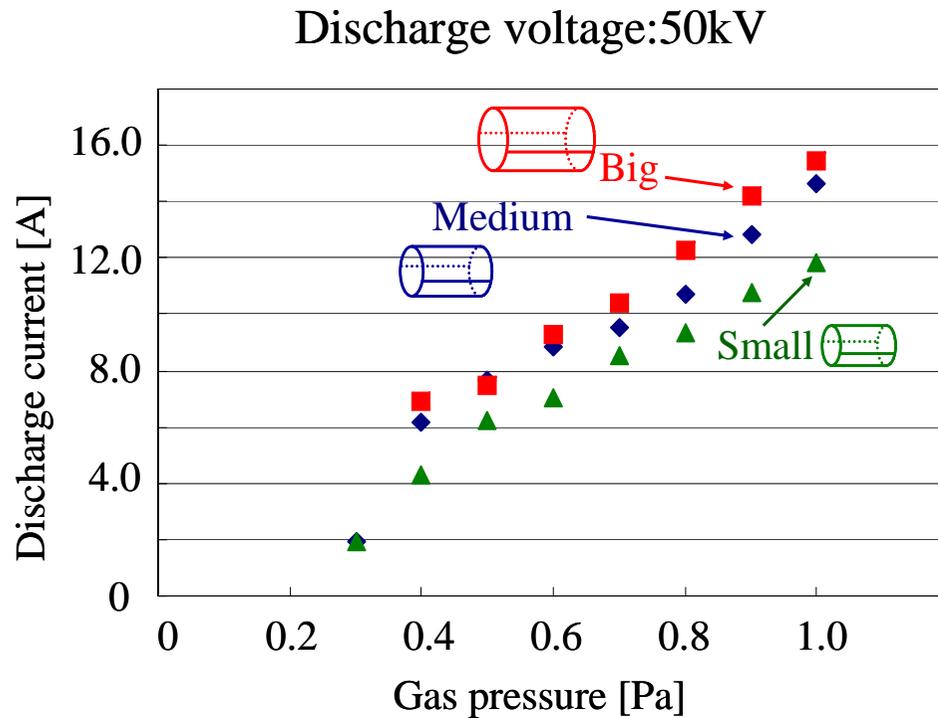
When the neutron measurement, the voltage of 40 kV is applied because of unstable discharge.

Experiment parameter table

Anode	ϕ 440mm
Cathode	The column shape
Gas	Deuterium
RF power supply	400W
Gas inflow	10sccm
pulse	20pps, 6usec
Ion source	left
Measurement time	150sec

(50kV , 5A for discharge, 40kV for NPR)

Discharge characteristic with the cylindrical cathode (Experiment 2, Cylindrical cathode)



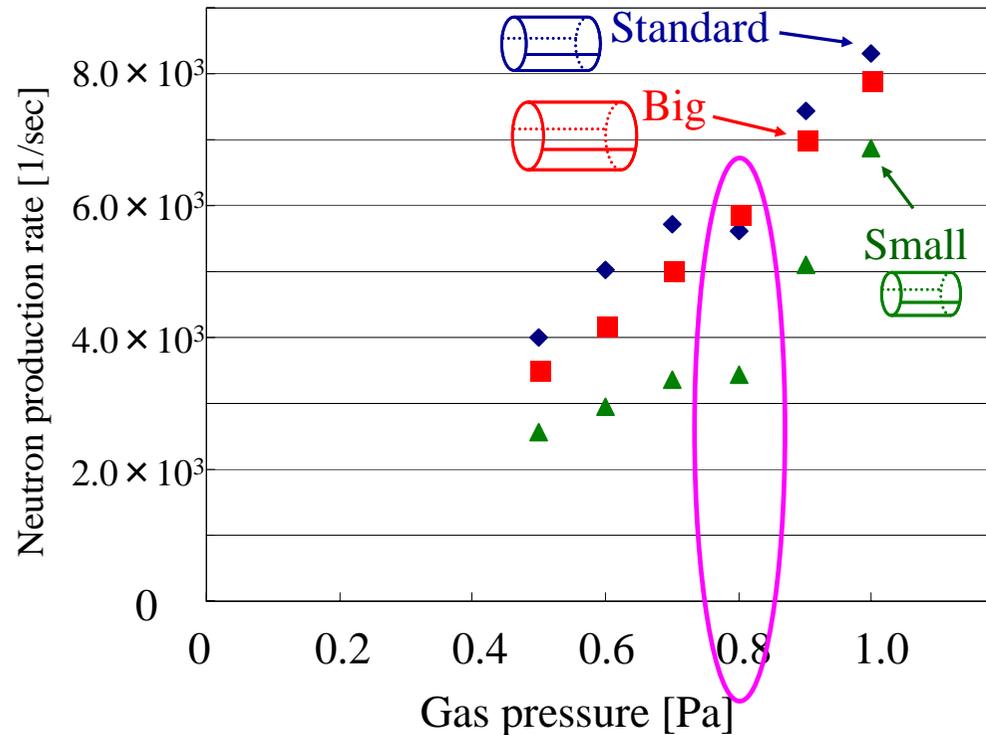
When the bigger cathode is used, the higher current flows and the discharge voltage becomes lower.

At 1.0Pa of the Pressure-Current curve, discharge current of big cathode is 1.3 times of small cathode.

Big and medium don't make much difference.

Neutron production rate with cylindrical cathode (Experiment 2 Cylindrical cathode)

Discharge voltage:40kV

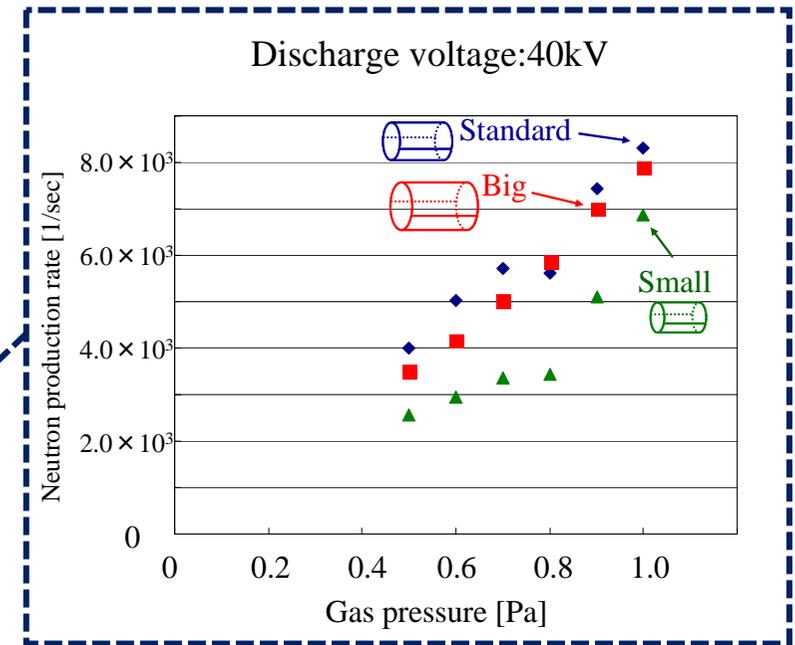
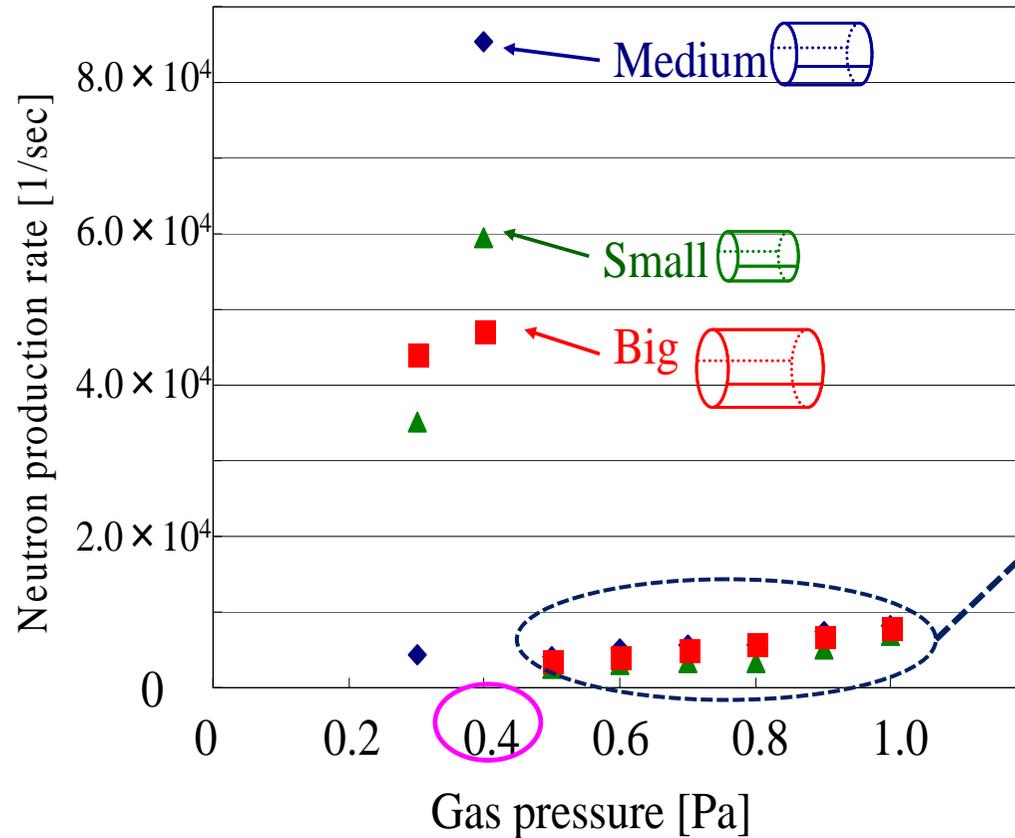


At 0.8Pa, bigger cathode has a good performance of neutron production rate and Neutron production rate of big cathode is 1.8 times of the small.

However, in the other gas pressure, neutron production rate of medium becomes highest. Big and medium don't make much difference.

Neutron production rate with the cylindrical shape cathode in 0.4Pa and 0.3Pa

Discharge voltage:40kV

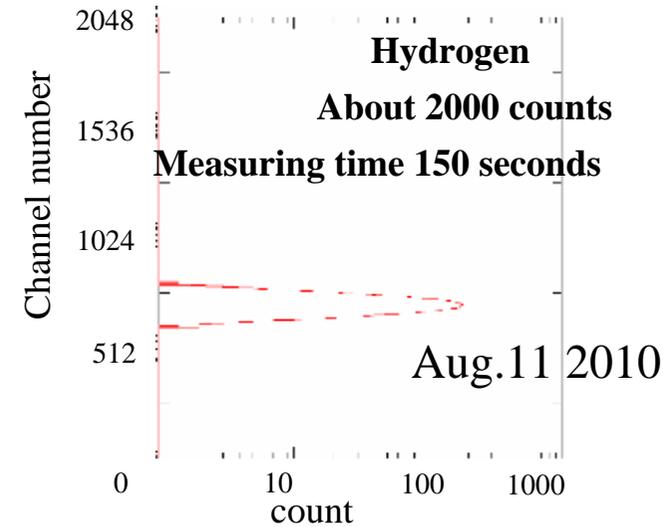
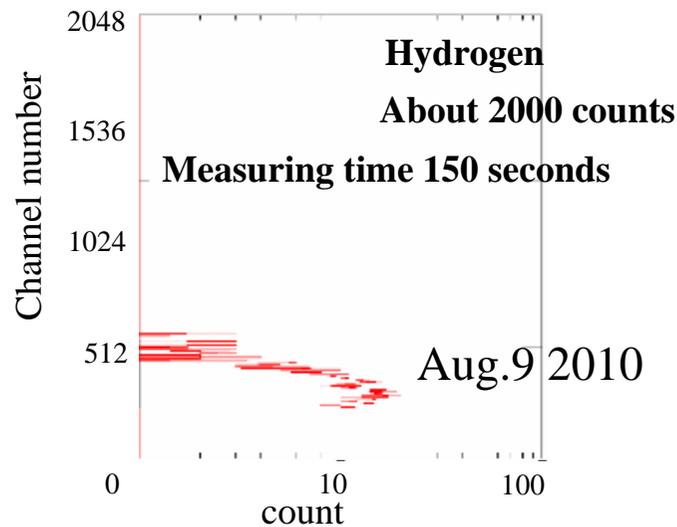


At 0.4Pa and 0.3, NPR is enormous value.

It is necessary to examine it whether this is an E-M noise or a neutron, in the near future

Energy level of the E-M noise signal

The energy level of the noise signal is not constant.



These figures are the noise signals that measured in another day.

The energy level of the noise signal differs by the slight change of experiment condition.

Therefore, that a noise occurs in 0.4Pa every time; cannot be concluded.

Of course, this E-M noise is eliminated by doing everything possible.

Conclusions

Experiment 1 Diamond shape cathode

When the bigger cathode is used, the higher current flows and the discharge voltage becomes lower.

The discharge is very stable and the low gas pressure of 0.3 Pa is achieved.

Bigger cathode has a good performance of neutron production rate .

When the big cathode is used, more ion beam is extracted from the ion source, and the Neutron production rate is increased.

Experiment 2 Cylindrical shape cathode

At 1.0Pa of the Pressure-Current curve, , discharge current of big cathode is 1.3 times of small cathode.

Neutron production rate ,at 0.8Pa, of big cathode is 1.8 times of the small.

Big and medium don't make much difference.

At 0.4Pa and 0.3, NPR is enormous value.

Thank you !
