PRACTICAL USE NEUTRON RADIOGRAPHY
WITH BABY CYCLOTRON

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Abstract

A fundamental test for Neutron Radiography Testing (NRT) were performed by Baby Cyclotron and a newly manufactured moderator and a collimetor.[1,2] In the case of collimation ratio L/D=67.3, $2.5X10^5 n/cm^2 \cdot sec.$ thermal neutron flux were obtained at the exit of the collimator by proton beam of 16 MeV,50 uA. It shows that the Baby Cyclotron has the possibility of practical use as a neutron generator for NRT.

Experiment and Results

The specifications of Baby Cyclotron and the experimental layout are shown in Table 1 and Fig.1, respectively.

a) Measurement of γ dose rate

γ-ray spectrum at the exit of the collimator was measured by the NaI(Tl) scintillation probe. The result showed that energy distribution extended to wide range and γ-rays were mainly induced in the vicinity of the target. Bismuth disc was placed in front of the collimator in order to reduce γ-ray and γ dose rate at the exit of the collimator were measured by TLD in various cases. The results are shown in Table 2.

b) Measurement of thermal neutron flux

Thermal neutron flux at the exit of the collimator was measured by Au foil activation method in various cases. The results are also shown in Table 2.

n/γ ratio,which is the figure of merit of the image quality, was obtained from Table 2. The results are shown in Table 3. (In general, $n/\gamma > 1.0X10^5$ is desirable.)

c) Imaging test

Imaging tests were performed in various cases. In the case of L/D=67.3 and 16MeV proton beam,the best result of R value=10 of the ASTM indicator was obtained.

The following results became clear from the experiments.

i) The neutron flux generated by 16 MeV proton is approximately five times larger than that of 8 MeV deuteron.

ii) Thermal neutron flux at the exit of the collimator (L/D=67.3) was 2 x 10^5 n/cm^2·sec. in the case of 16 MeV 50 μA proton.

iii) n/γ ratio was between 3.0 x 10^5 and 2.0 x 10^6.

iv) R value=10 of the ASTM indicator was obtained.

Above results show that Baby Cyclotron has enough ability for practical use for NRT.

References

1)N.D.Tyufyakov and A.S.Shtan,Principle of Neutron Radiography,Atomzdat Publisher,Moscow,(1975)

2)E.Hiraoka et al.,J.Non-Destructive Inspection,27(1978)

Table 1 Specifications of Baby Cyclotron

	BC 107A		BC 168	
Particle	p	d	p	d
Energy(MeV)	11	7.5	16	8
Current(μA)	50	50	50	50

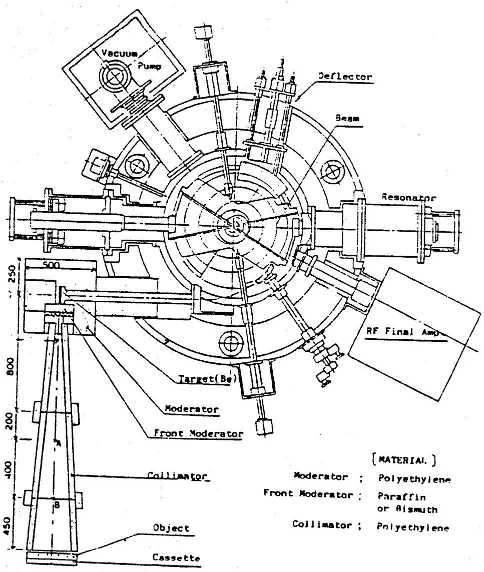

Fig. 1 Experimental Layout

Table 2 Thermal Neutron Flux and γ dose rate

	Particle	Proton	Proton	Deuteron
	Energy(MeV)	16	11	7.5
	Beam Current(μA)	50	50	50
Filter	Paraffin(mm)	25	25	25
	Bismuth(mm)	23	23	23
Thermal neutron flux (n/cm^2.sec)	No.1	—	—	4.3 x 10^8
	No.2 (L=220, L/D=7.3)	3.0 x 10^7	1.6 x 10^7	8.3 x 10^6
	No.3 (L=820, L/D=27.3)	1.5 x 10^6	7.8 x 10^5	2.8 x 10^5
	No.4 (L=1870, L/D=62.3)	2.1 x 10^5	—	—
	No.5 (L=2020, L/D=67.3)	2.0 x 10^5	—	—
γ dose rate (R/hr)	No.3	2.5	—	3.4
	No.4	2.1	—	—
	No.5	2.4	—	—

Table 3 n/γ ratio

Particle	Energy(MeV)	L(mm)	L/D	n/γ ratio
Proton	16	820	27.3	2.2 x 10^6
Proton	16	1870	62.3	3.6 x 10^5
Proton	16	2020	67.3	3.0 x 10^5