

Monte Carlo Simulation of Pregnant Female Phantoms and Dose Assessment of Fetus and Pregnant Female from Diagnostic X-ray at Abdomen Examination

0, 3, 6, 9

X
ORNL

MCNP4B

AP PA

0.4 0.8MeV

AP X

9

6

ABSTRACT

Mathematical phantoms of representing the adult female at 0, 3, 6 and 9 months of gestation were constructed, and organ doses and effective doses were calculated in standard irradiation environment and abdomen X-ray examination. Phantoms were based on the data set of ORNL and MCNP4B, a general-purposed Monte Carlo code was used for dose calculation. Firstly, organ doses and effective doses of pregnant female and fetus for 0.4 and 0.8MeV broad parallel beam incident from AP and PA direction were calculated. Then, the same calculations were performed in abdomen AP X-ray examination. As gestation period went by, effective doses of pregnant woman decreased because major organs were shielded by expanded uterus. Fetus of 9 month is lower than that of 6 month because of shielding effect of placenta for AP irradiation.

1.

15%[1]

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X

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가

X

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가

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2.

Cristy Eckerman

ORNL 15

[2]

M. G. Stabin

3

[3]

. ORNL 15

0

3, 6, 9

MCNP4B[4]

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, 6, 9

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x=0

y=0

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6 9

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6 9

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Table 1. Elemental composition of the tissues for pregnant phantom sets

Element	Percent by weight			
	Soft tissue	Lung	Skeleton	Fetal skeleton
H	10.454	10.134	7.337	7.995
C	22.663	10.238	25.475	9.708
N	2.490	2.866	3.057	2.712
O	63.525	75.752	47.893	66.812
F	-	-	0.025	-
Na	0.112	0.184	0.326	0.314
Mg	0.013	0.007	0.112	0.143
Si	0.030	0.006	0.002	-
P	0.134	0.080	5.095	3.712
S	0.204	0.225	0.173	0.314
Cl	0.133	0.266	0.143	0.140
K	0.208	0.194	0.153	0.148
Ca	0.024	0.009	10.190	7.995
Fe	0.005	0.037	0.008	0.008
Zn	0.003	0.001	0.005	-
Rb	0.001	0.001	0.002	-
Sr	-	-	0.003	-
Zr	0.001	-	-	-
Pb	-	-	0.001	-
Density [g/cm ³]	1.04	0.296	1.4	1.22

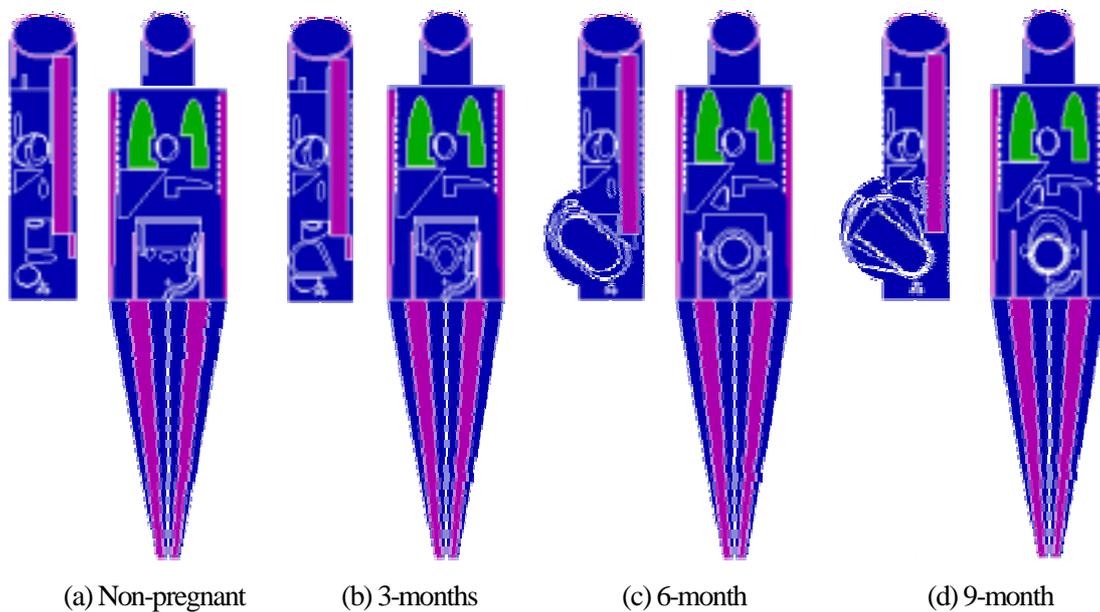


Figure 1. The phantom set in view of $x=0$ and $y=0$

Target material	W
Voltage [kVp]	75
Current*Exposure time [mAs]	16
Anode angle [°]	13
Material of filtration	Al
Thickness of filtration [mm]	2.5
Focus to Surface Distance [cm]	75
Beam size at the midplane [cm × cm]	28.2×37.6
Beam Center	(0, -84.8, 18.03)

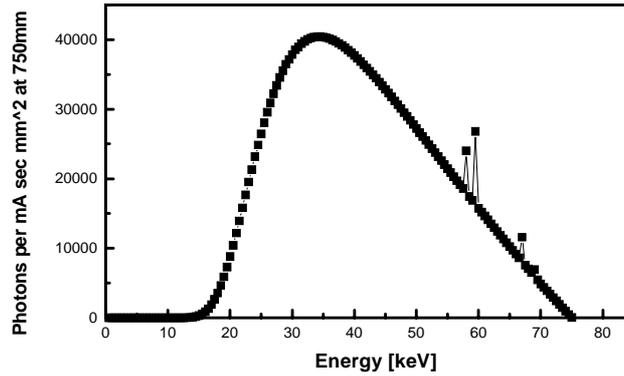


Figure 2. X-ray spectrum of W target, 75kVp, 13°, 2.5mm Al total filtration

3.

AP(Antero-Posterior)

PA(Postero-Anterior)

0.4MeV 0.8MeV

3~4 가

ORNL

15

가

PA

가

,AP

가

가

가

가

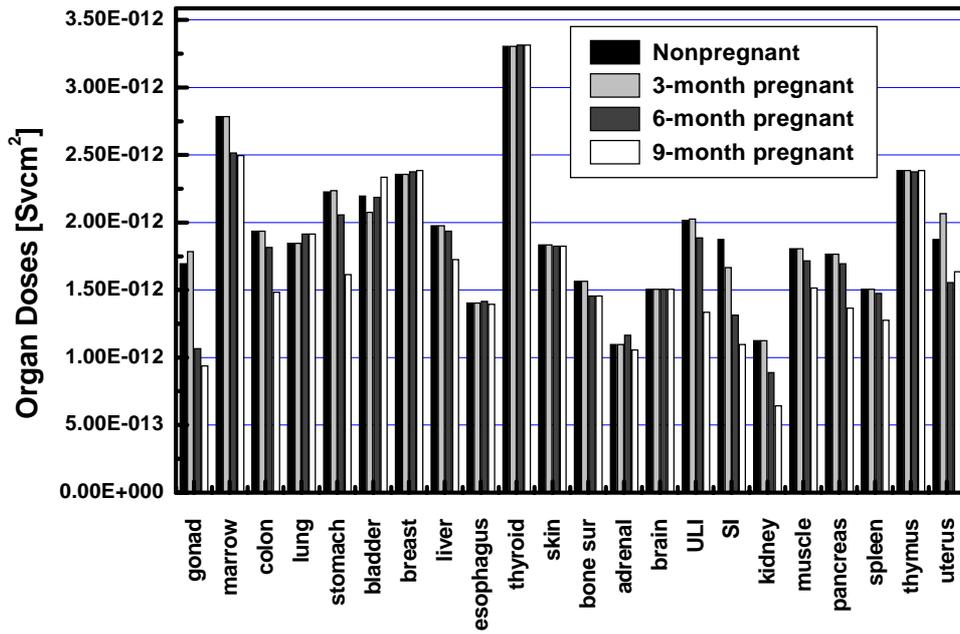


Figure 3. Organ doses of 4 phantoms for 0.4MeV parallel beam in AP direction

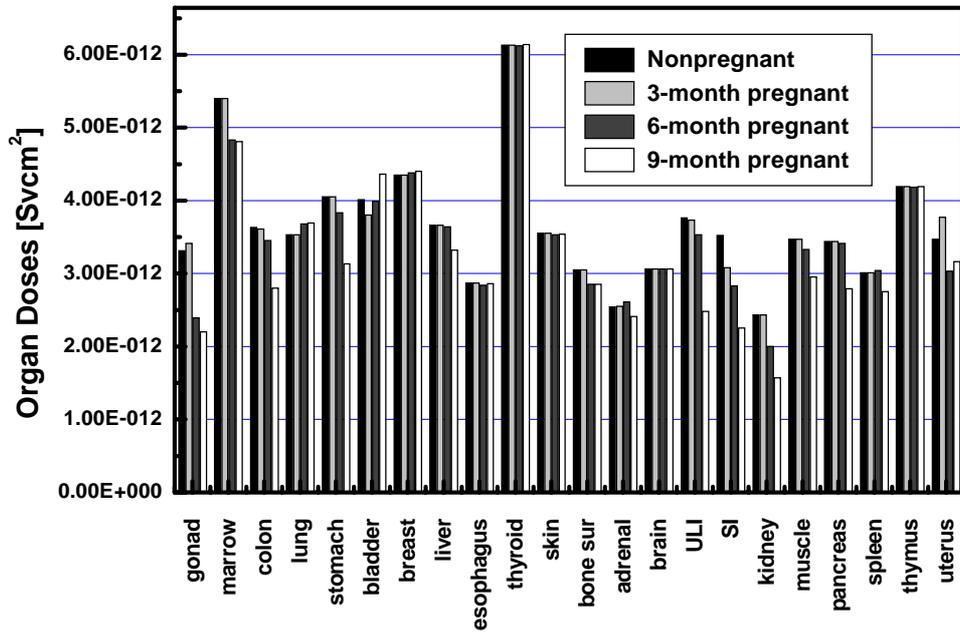


Figure 4. Organ doses of 4 phantoms for 0.8MeV parallel beam in AP direction

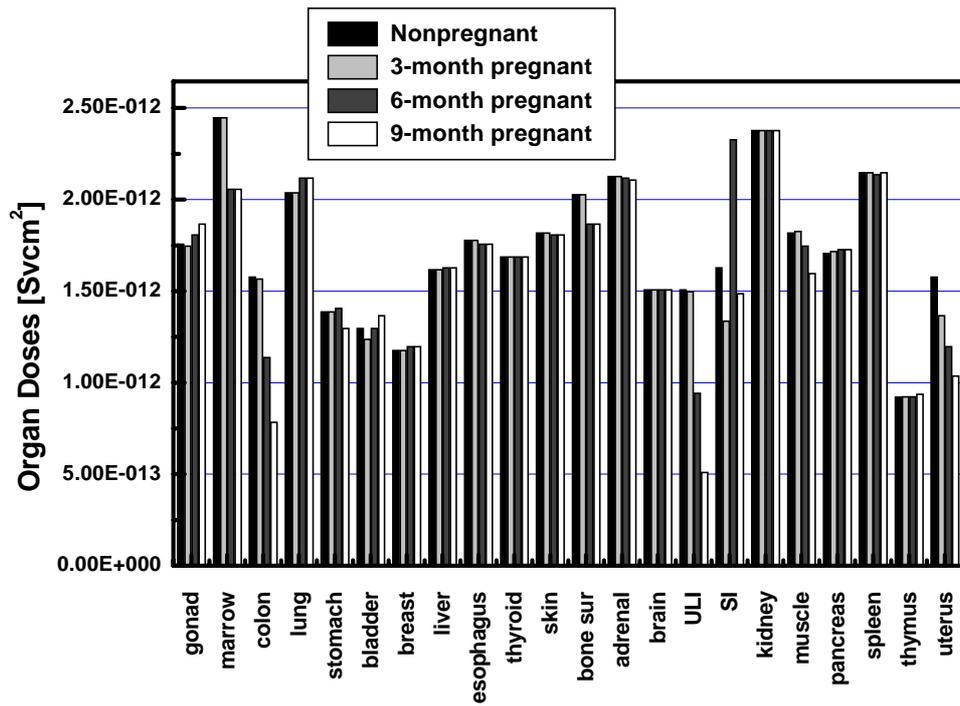


Figure 5. Organ doses of 4 phantoms for 0.4MeV parallel beam in PA direction

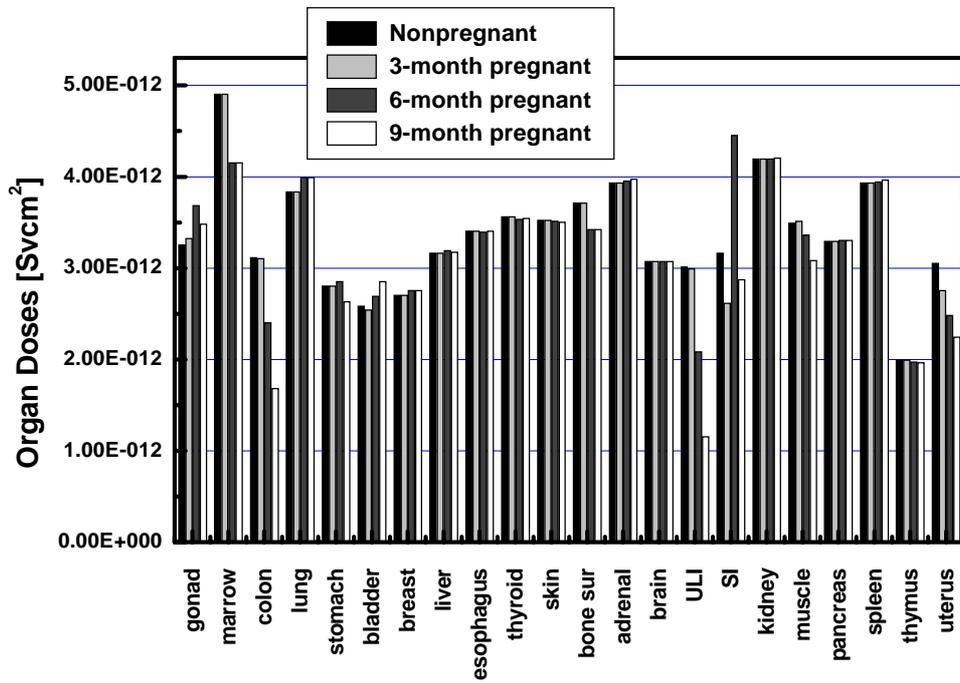


Figure 6. Organ doses of 4 phantoms for 0.8MeV parallel beam in PA direction

X

X 가 가 [9]

AP , 가 7 . 가 가

가 0.2[10] 가 . 8 가 가

(z=13.52) . 9 가 0 가 0,

.3 ,6 9 가 .

3 10cm 가 가 .

6,9 가 가 .3 6,9

, 10 .3

6 9 . 11 9

(z=23.5) 6,9 . 가 ,

AP 가 가 ,

AP 가 가 . z 가 23.5 6

6 9 y=-14 가 . 6 3cm 6

-19 9 -22 가 9 가 6 가

가 . 9 가 .

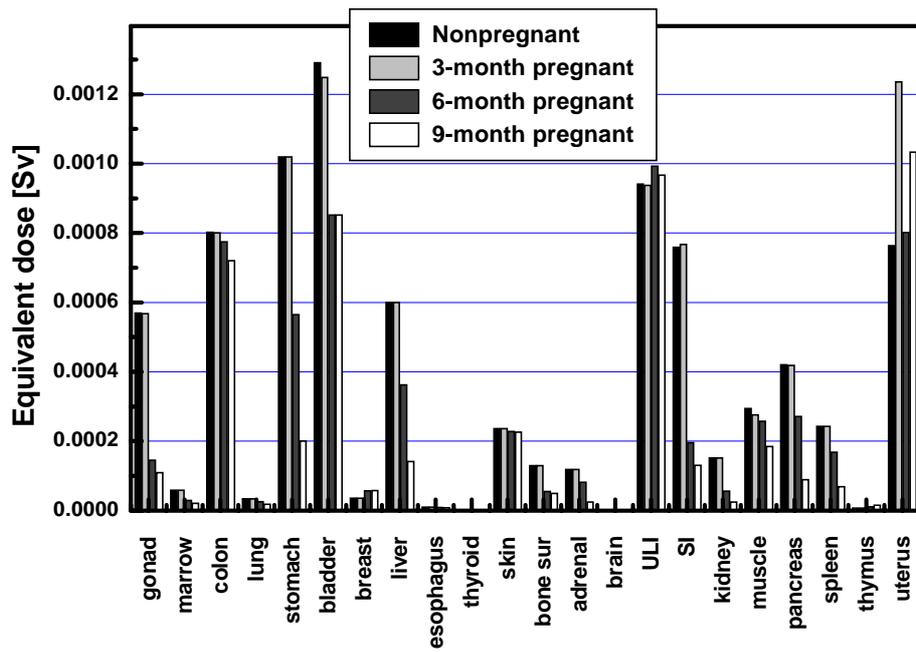


Figure 7. Equivalent doses of 4 pregnant phantoms in abdomen AP examination

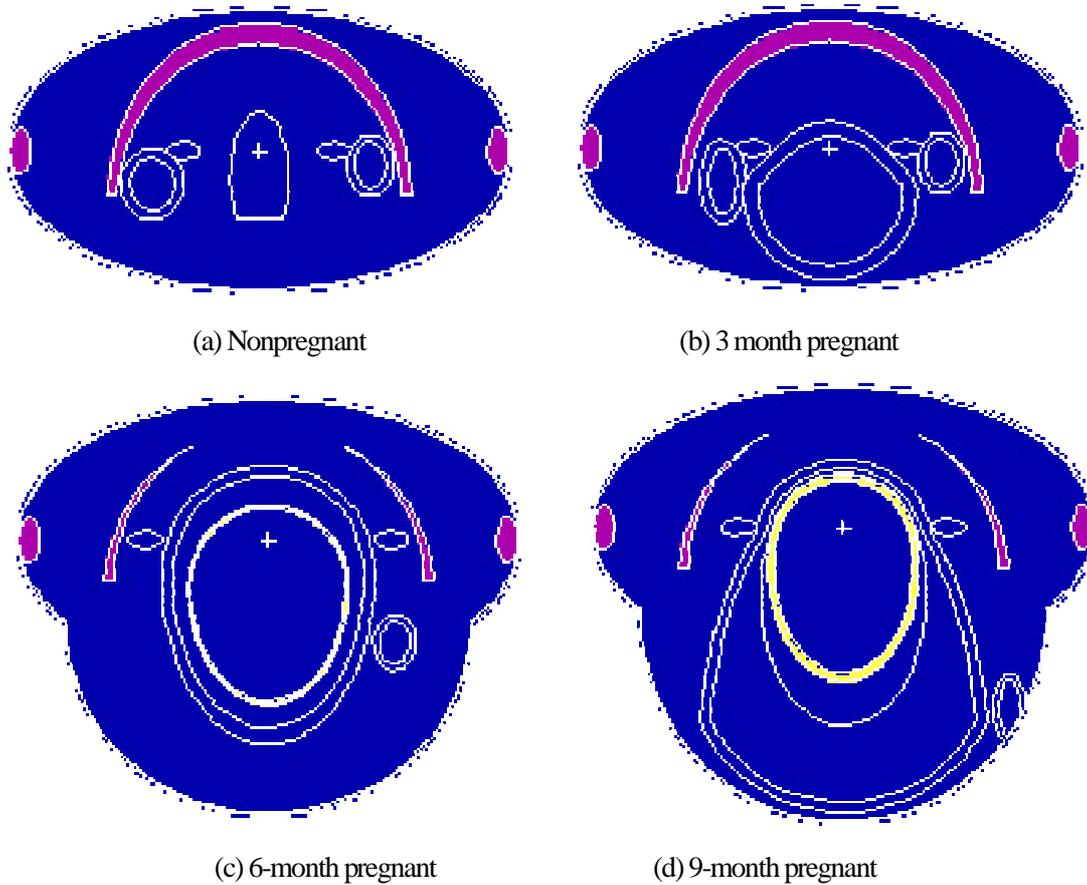


Figure 8. Cross sectional views of pregnant phantoms at $z=13.52$

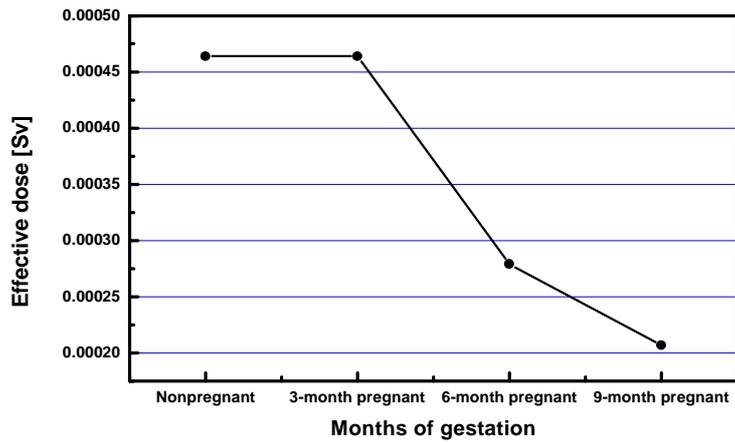


Figure 9. Effective doses of 4 pregnant phantoms in abdomen AP examination

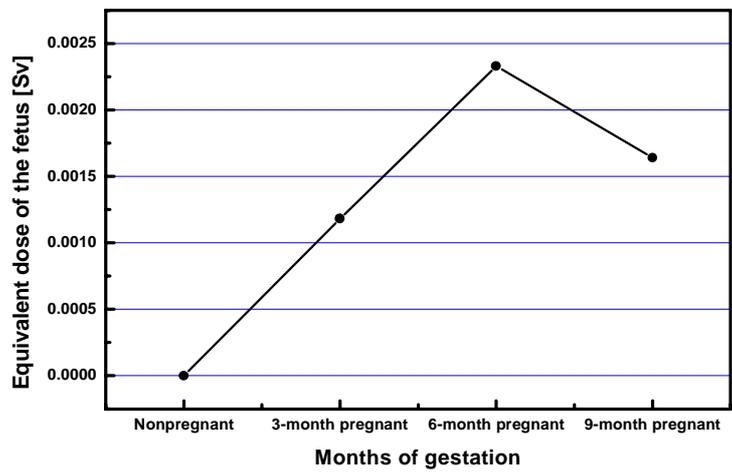


Figure 10. Fetus doses of 4 gestation periods in abdomen AP examination.

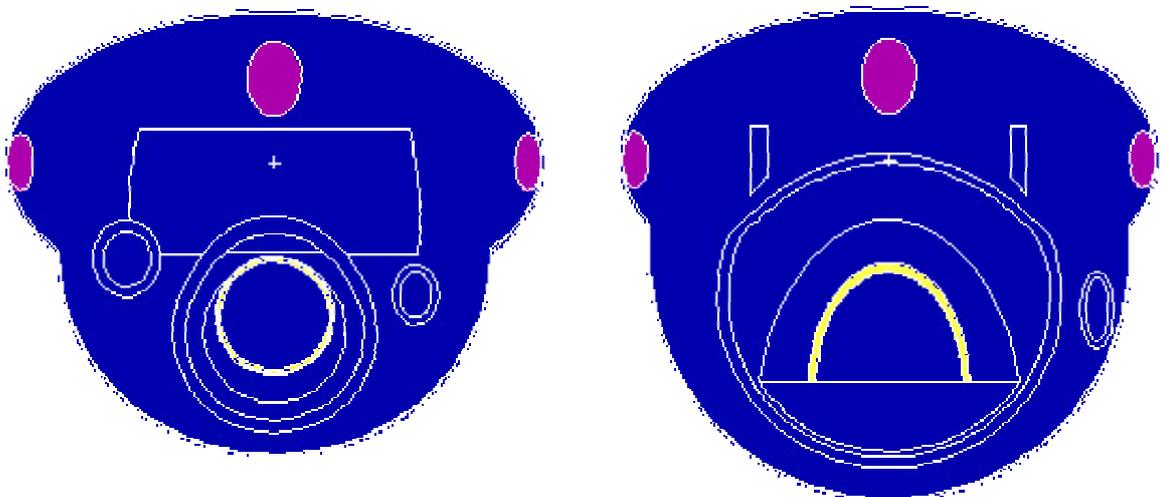


Figure 11. Comparison of cross sectional views at $z=23.5$ plane between 6-month(left) and 9-month(right).

4. 0, 3, 6, 9 X
 ORNL
 MCNP4B
 9
 6 X
 , 1, 2, 4, 5, 7, 8 가
 X
 가

[1] National Council on Radiation Protection and Measurement, *Ionizing Radiation Exposures of the Population of the United States*, NCRP Publication 93(1987).

[2] M. Cristy, and K. F. Eckerman, Specific Absorbed Fractions of Energy at Various Ages from Internal Photon Sources, Oak Ridge National Laboratory Report ORNL/TM-8381(1987).

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[10] International Commission on Radiological Protection, *1990 Recommendations of the International Commission on Radiological Protection*, ICRP Publication 60, Pergamon Press(1991).