

X 가

# 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.

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15%[1]

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X

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X

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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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x=0

y=0

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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 <sup>3</sup> ]	1.04	0.296	1.4	1.22

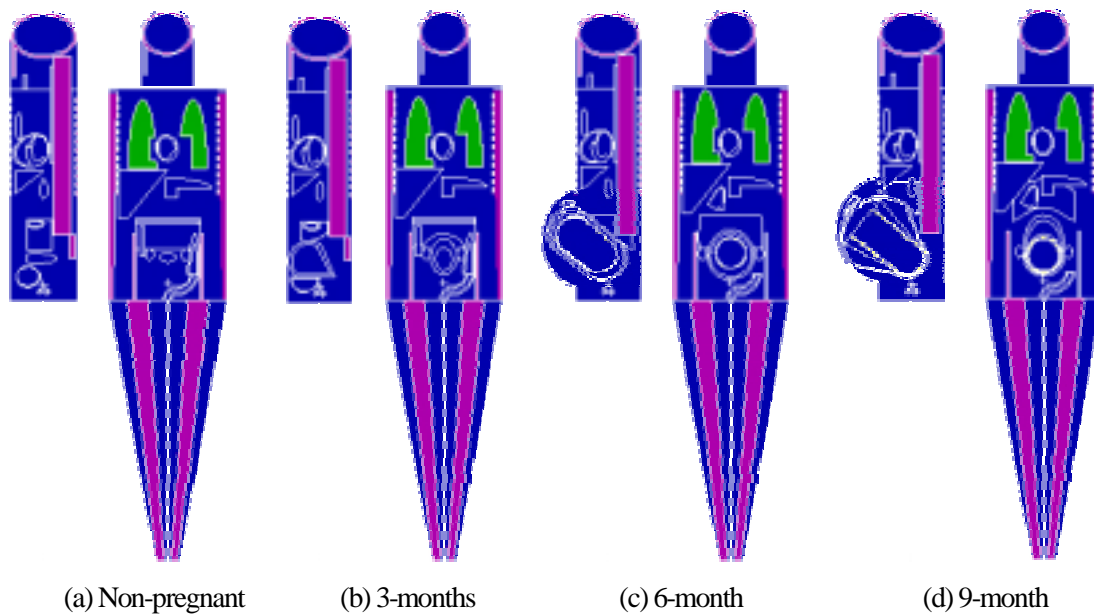


Figure 1. The phantom set in view of  $x=0$  and  $y=0$

Table 2. Volumes of the models of the uterus, uterine contents, fetus and placenta

Volume [cm <sup>3</sup> ]	Non-pregnant	3-month	6-month	9-month
Uterine wall	76	359	802	1053
Uterine contents	-	440	2710	5730
Fetal soft tissue	-	-	1470	2510
Fetal skeleton	-	-	94.6	287
Placenta	-	-	298	448

X

IPEM(Institute of Physics and Engineering in Medicine)

"Catalogue of Diagnostic X-Ray Spectra and other Data(Report 78)"

SPEC78[5]                      30 150kVp                      6 22° 가                      25  
 32kVp                      9 23° 가                      0.5keV  
 75cm                      mAs                      ,  
 32

MCNP4B

MCNP  
 4B                      ,                      ENDF[6]  
 X  
 가                      . MCNP  
                     5 × 10<sup>7</sup>  
 \*F6  
 X  
 X                      가                      AP  
                     . AP  
 Philips Optimus                      ,                      ,                      ,                      ,  
 [7]                      ,                      NRPB-R262[8]                      .                      3  
                     ,                      2 X                      ,                      ,

Table 3. Condition of abdomen AP examination

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)

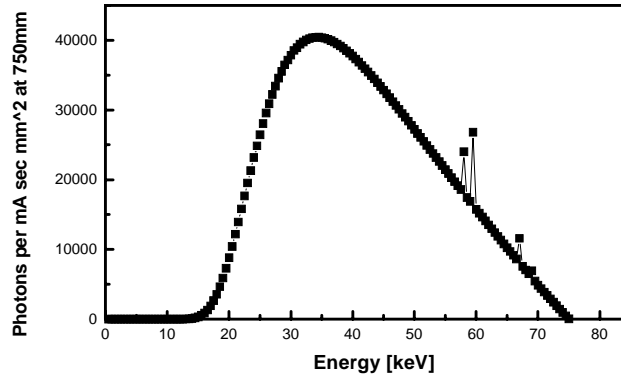


Figure 2. X-ray spectrum of W target, 75kVp, 13°, 2.5mm Al total filtration

3.

AP(Antero-Posterior)

PA(Postero-Anterior)

0.4MeV 0.8MeV

3~4 가

ORNL

15

가

PA

가

, AP

가

가

가

가

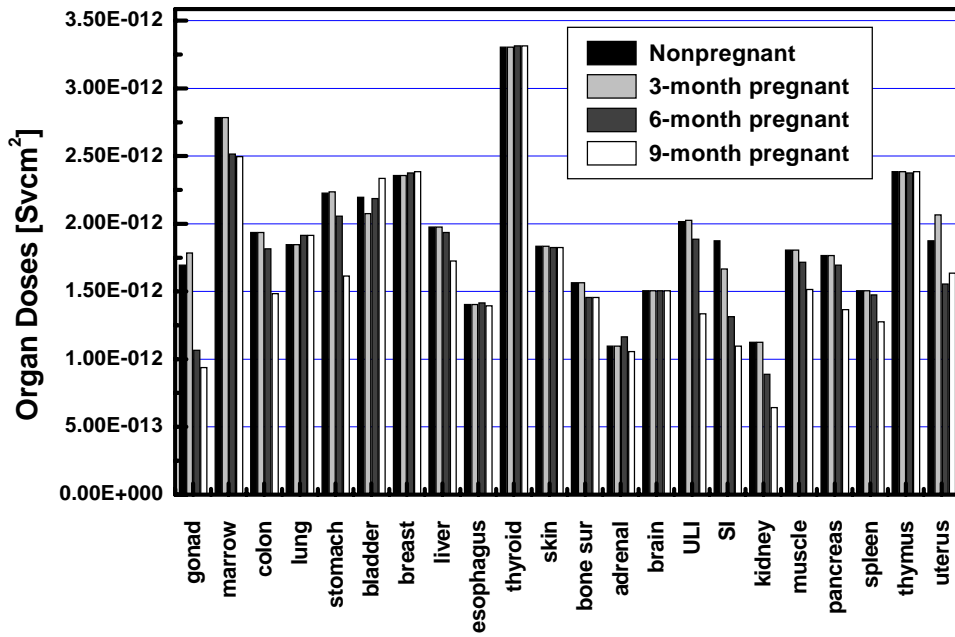


Figure 3. Organ doses of 4 phantoms for 0.4MeV parallel beam in AP direction

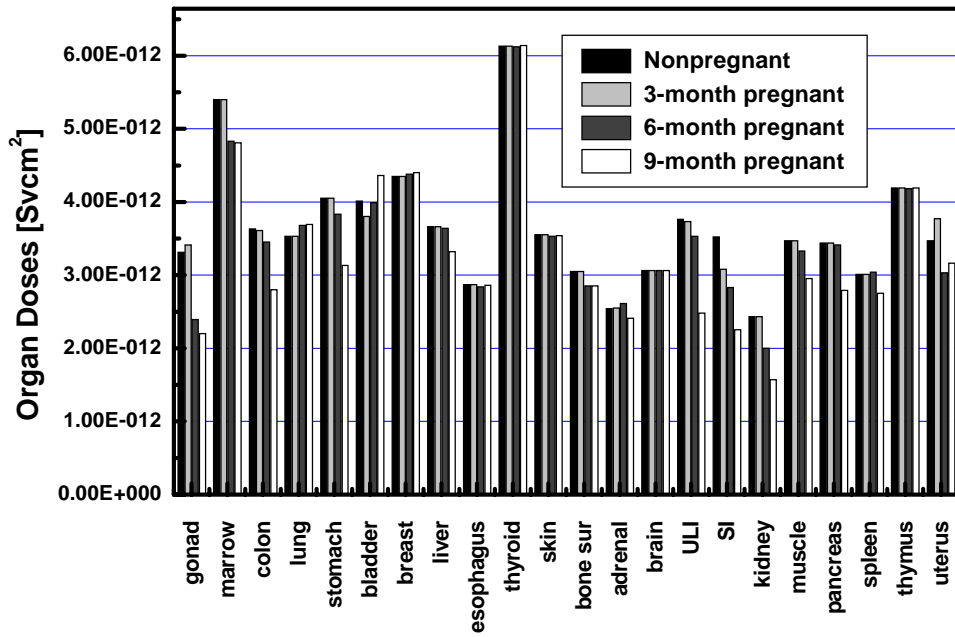


Figure 4. Organ doses of 4 phantoms for 0.8MeV parallel beam in AP direction

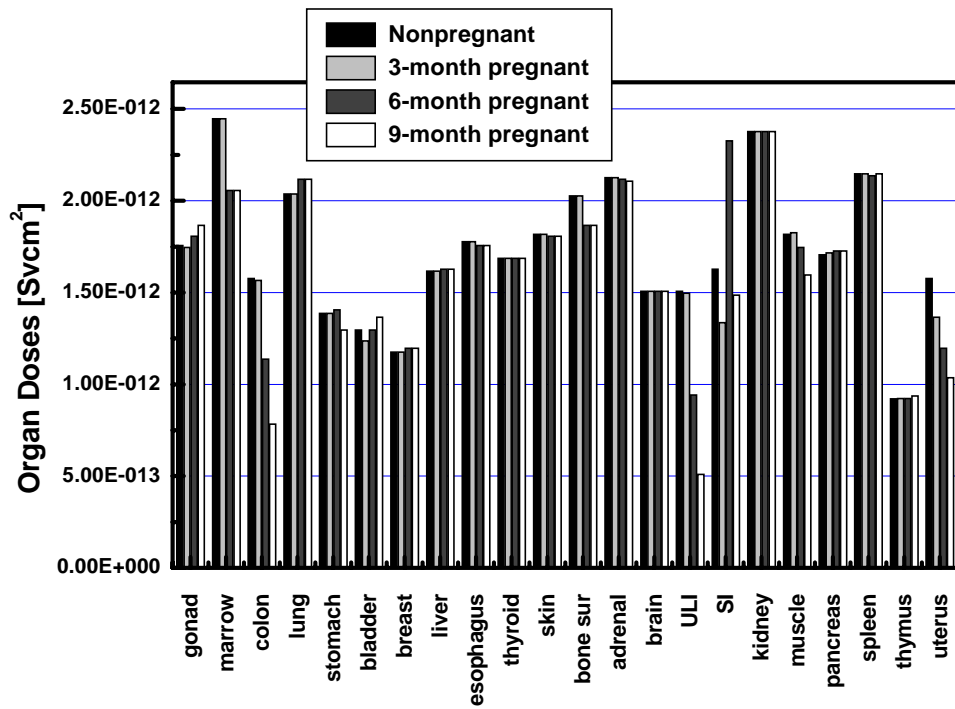


Figure 5. Organ doses of 4 phantoms for 0.4MeV parallel beam in PA direction

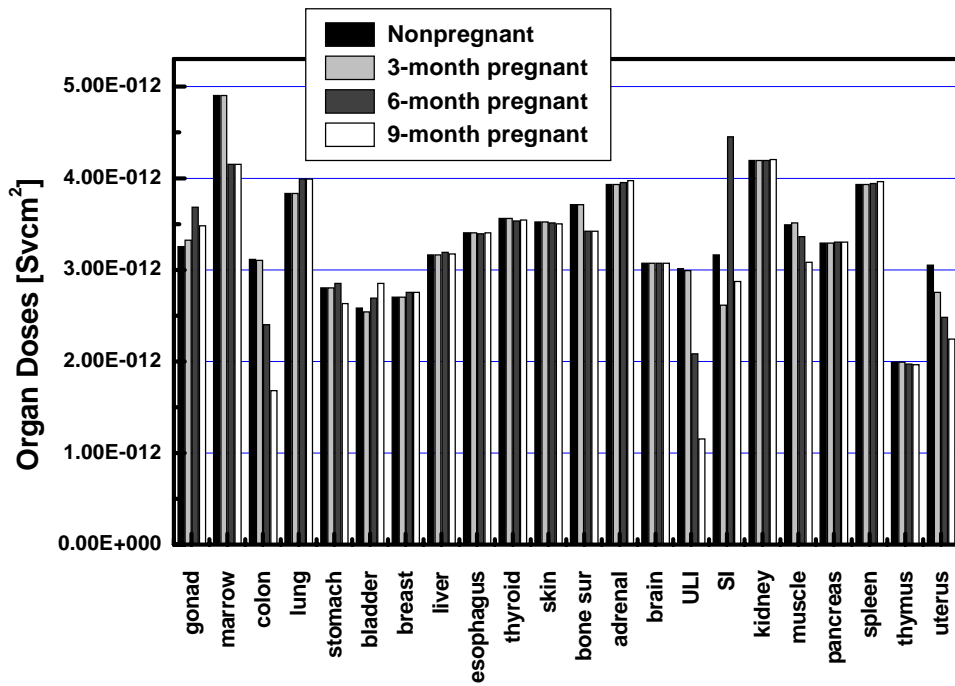


Figure 6. Organ doses of 4 phantoms for 0.8MeV parallel beam in PA direction

X

X 가 가 [9]

AP , 가 7 . 가

가 0.2[10] 가 . 8 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 . z 가 23.5 6

6 9 y=-14 가 .

-19 9 -22 가 6 3cm 가

가 . 9 가 6 가

가 .



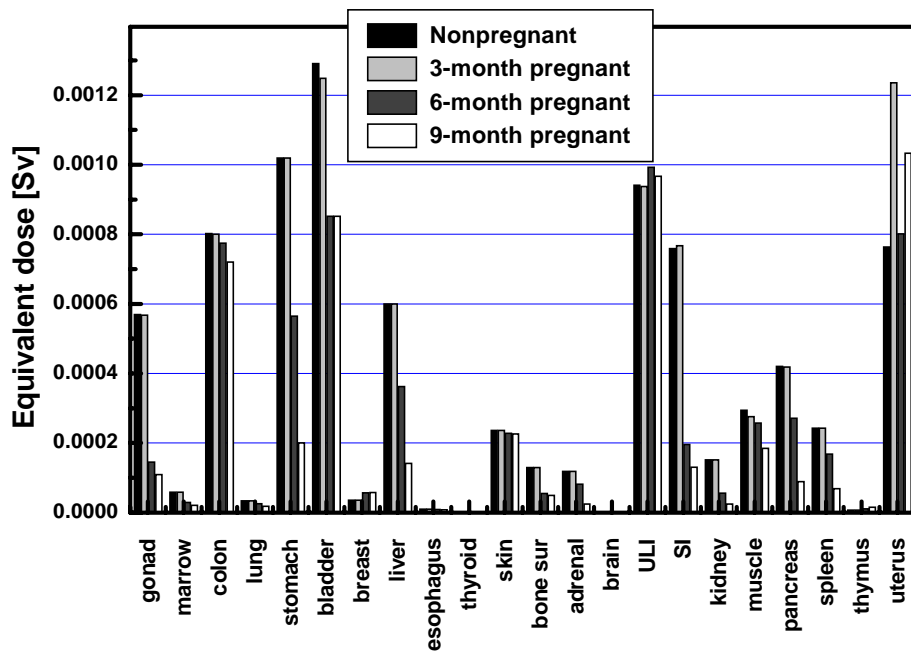


Figure 7. Equivalent doses of 4 pregnant phantoms in abdomen AP examination

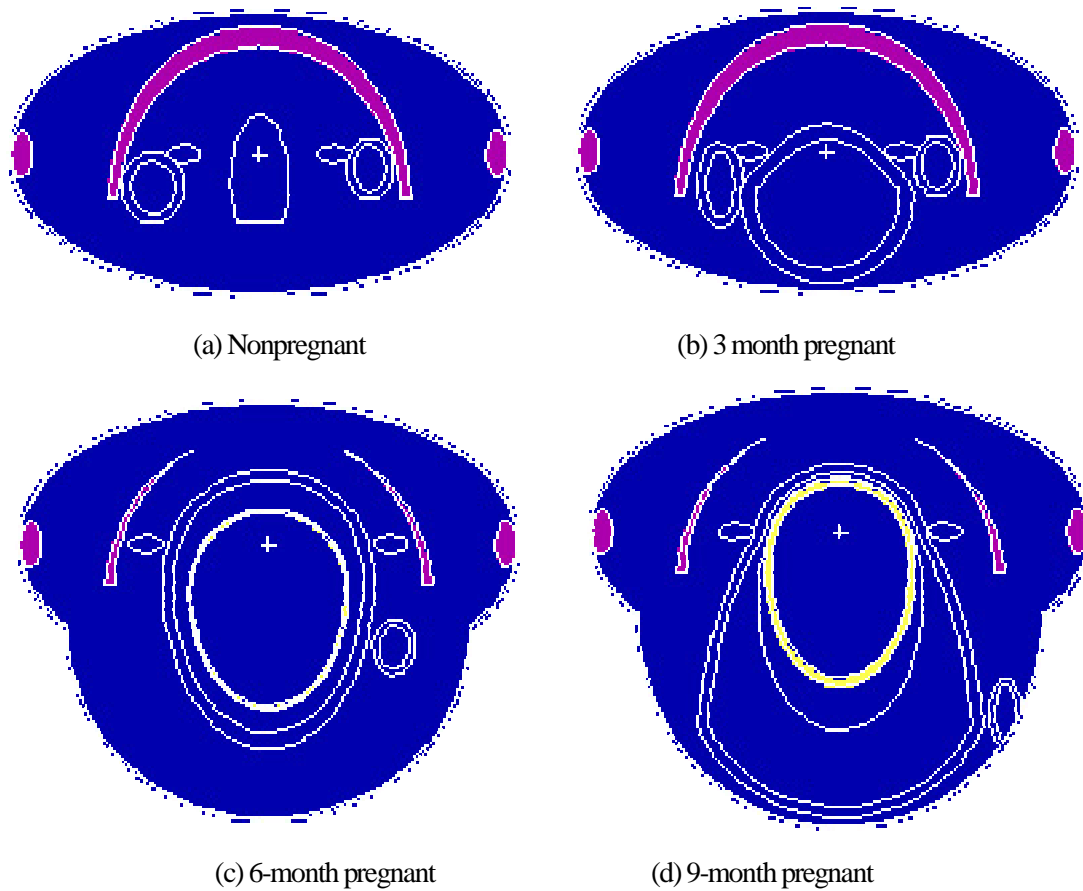


Figure 8. Cross sectional views of pregnant phantoms at  $z=13.52$

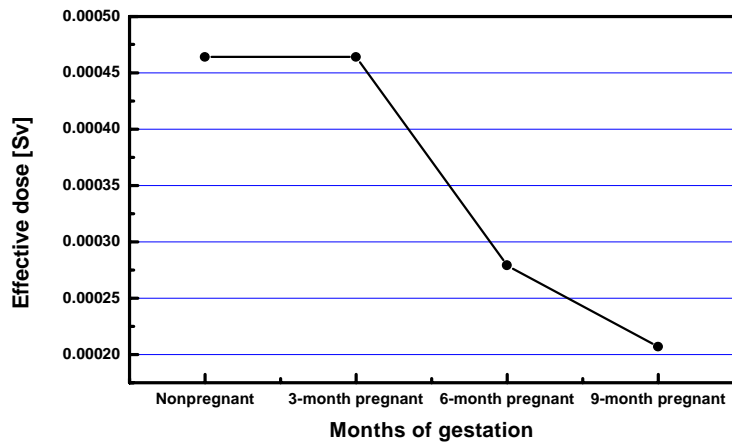


Figure 9. Effective doses of 4 pregnant phantoms in abdomen AP examination

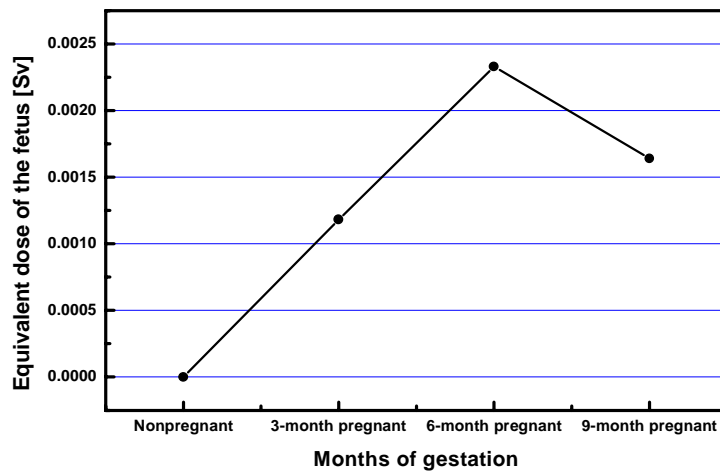


Figure 10. Fetus doses of 4 gestation periods in abdomen AP examination.

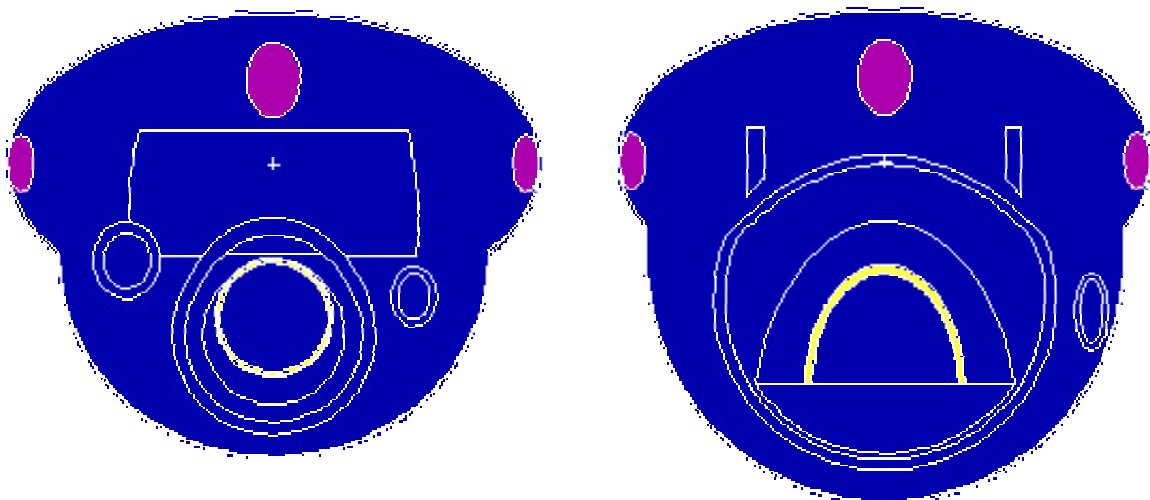


Figure 11. Comparison of cross sectional views at  $z=23.5$  plane between 6-month(left) and 9-month(right).

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

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